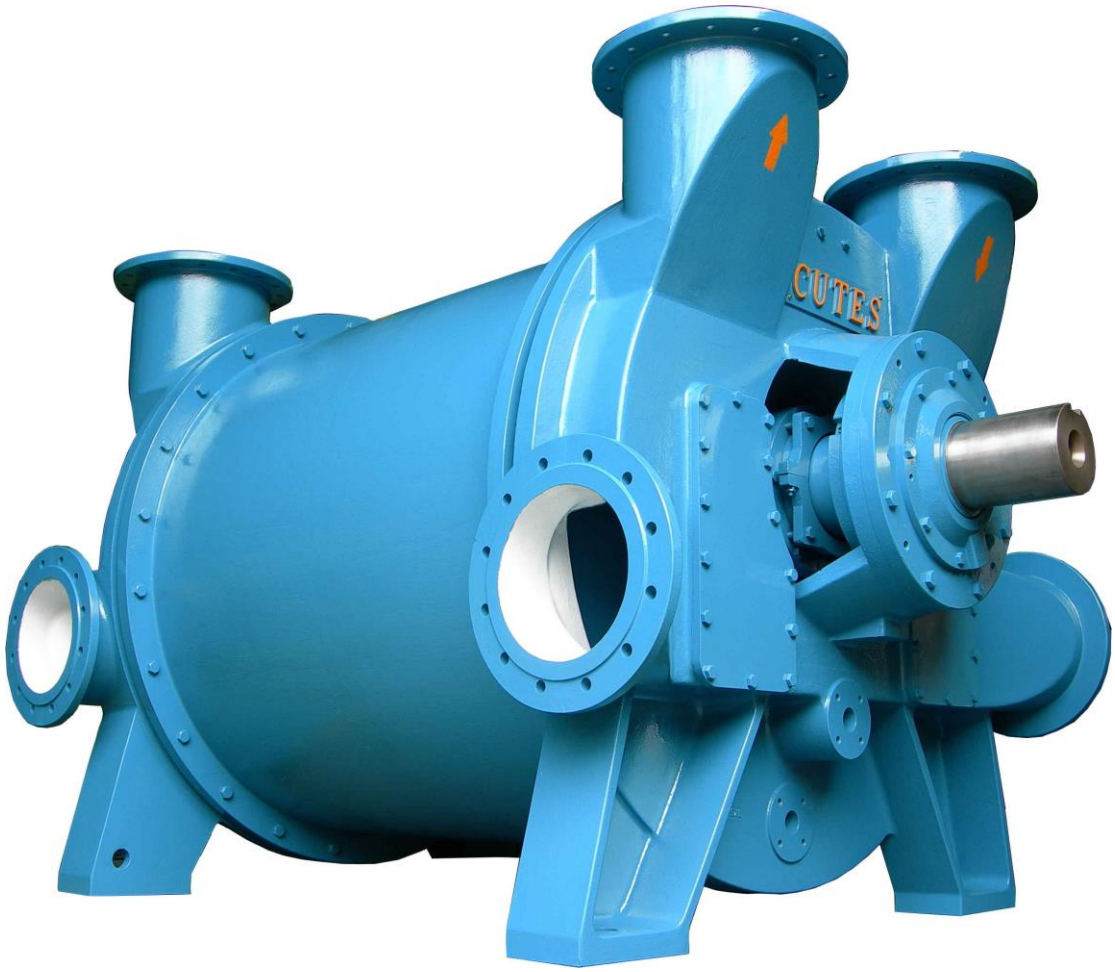
# *CE1 Series*

# Installation / Operation / Maintenance User Manual




# *Liquid Ring Vacuum Pumps & Compressors*

cutes

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## FOR CE1 MODEL WATER RING VACUUM PUMPS ONLY

## DESCRIPTION

### ABOUT THIS MANUAL

This manual is to be followed for **CUTES** liquid ring vacuum pumps (**CE1** 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 3-D 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 360º 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.

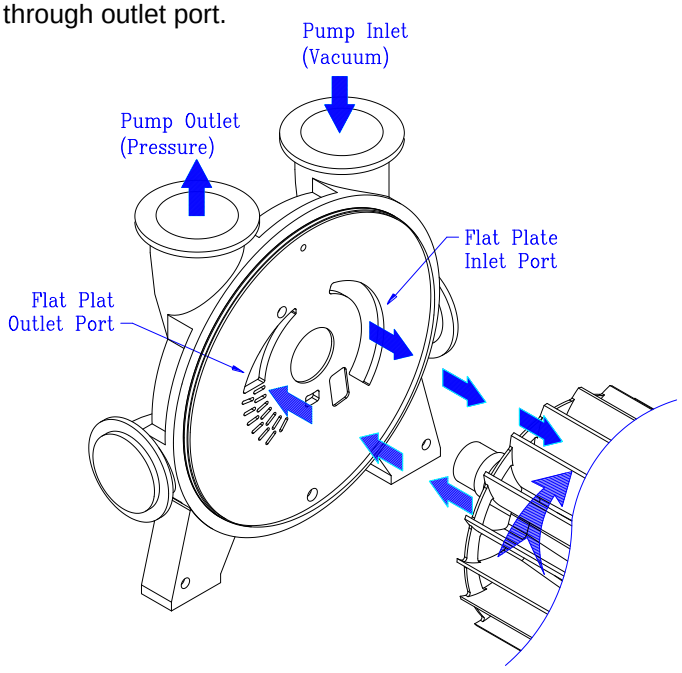



**Figure 1. How the pump work**

**Section 2**

## After receiving a CUTES Vacuum product

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.

**Figure 2. After receiving a CUTES Vacuum product**

### 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 lo 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 lime 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 (M101) 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 (M103) 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 bolls 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 o1 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**

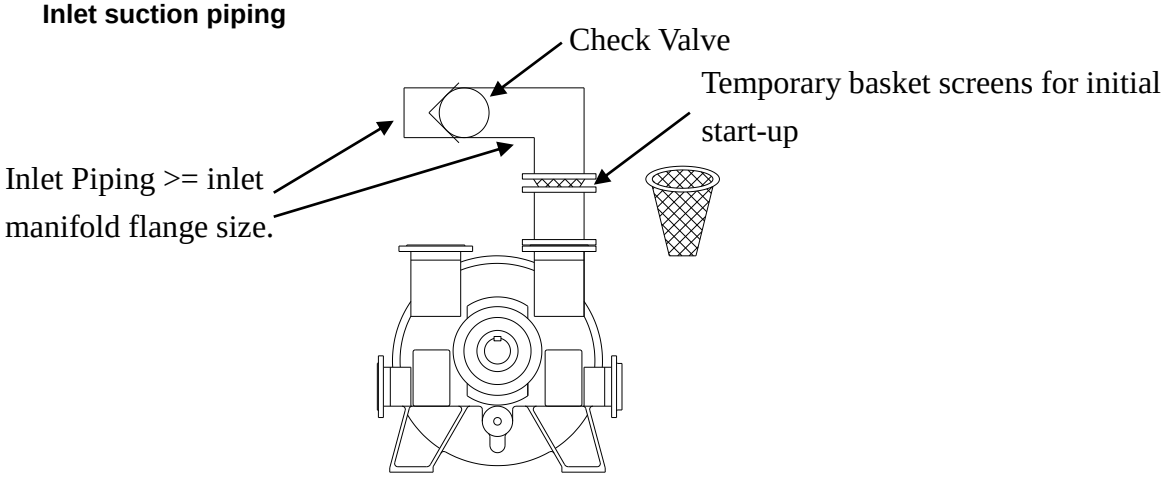



**Figure 3. Inlet suction piping**

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**

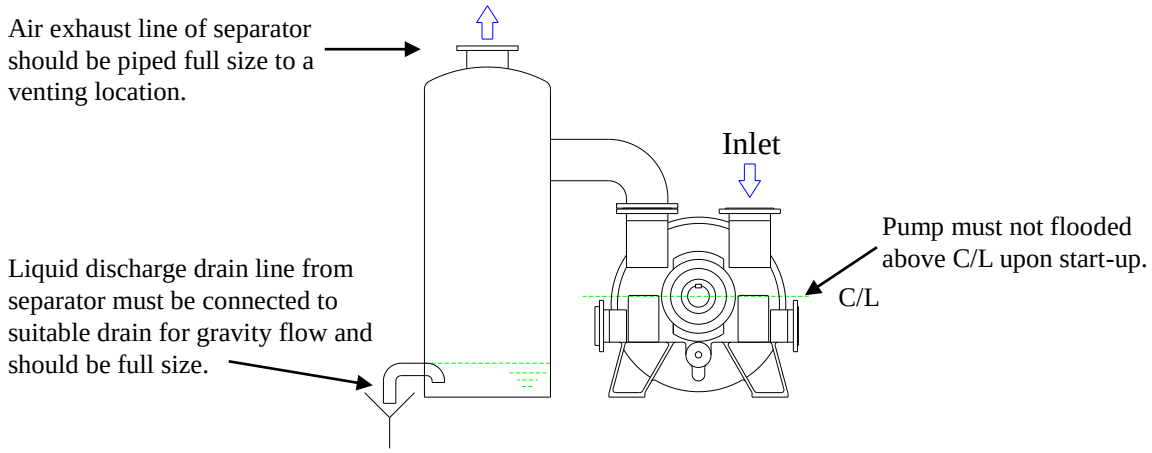



**Figure 4. Outlet discharge piping**

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 CE1 vacuum pump

### CE1 – 353 / 355 / 356

| mbar(A) / Flow Requirement $m^3/hr$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RPM** | *100* | *200* | *300* | *400* | *500* | *600* | *800* |
| **372** | 7.9 | 7.6 | 7.3 | 6.5 | 5.6 | 4.7 | 3 |
| **420** | 8.9 | 8.6 | 8.3 | 7.3 | 6.3 | 5.3 | 3.4 |
| **472** | 10 | 9.7 | 9.3 | 8.2 | 7.1 | 6 | 3.8 |
| **500** | 10.6 | 10.3 | 9.8 | 8.7 | 7.5 | 6.4 | 4.1 |
| **530** | 11.2 | 10.9 | 10.4 | 9.3 | 8 | 6.7 | 4.3 |
| **590** | 12.5 | 12.1 | 11.6 | 10.3 | 8.9 | 7.5 | 4.8 |
| **660** | 14 | 13.5 | 13 | 11.5 | 10 | 8.4 | 5.4 |

### CE1 – 403 / 405 / 406

| mbar(A) / Flow Requirement $m^3/hr$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RPM** | *100* | *200* | *300* | *400* | *500* | *600* | *800* |
| **330** | 12.6 | 11.6 | 11.1 | 9.9 | 8.5 | 7.2 | 4.7 |
| **372** | 14.2 | 13.1 | 12.6 | 11.2 | 9.6 | 8.1 | 5.3 |
| **420** | 16 | 14.7 | 14.2 | 12.6 | 10.9 | 9.2 | 5.9 |
| **472** | 18 | 16.6 | 15.9 | 14.2 | 12.2 | 10.3 | 6.7 |
| **530** | 20.2 | 18.6 | 17.9 | 15.9 | 13.7 | 11.6 | 7.5 |
| **565** | 21.5 | 19.8 | 19.1 | 16.9 | 14.6 | 12.4 | 8.0 |

### CE1 – 503 / 505 / 506

| mbar(A) / Flow Requirement $m^3/hr$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RPM** | *100* | *200* | *300* | *400* | *500* | *600* | *800* |
| **266** | 15.9 | 15 | 15 | 13 | 11 | 10 | 6 |
| **298** | 17.8 | 17 | 17 | 15 | 13 | 11 | 7 |
| **330** | 19.7 | 19 | 18 | 16 | 14 | 12 | 8 |
| **372** | 22.2 | 21 | 21 | 18 | 16 | 13 | 9 |
| **420** | 25.1 | 24 | 23 | 21 | 18 | 15 | 10 |
| **472** | 28.2 | 27 | 26 | 23 | 20 | 17 | 11 |

### CE1 – 603 / 605 / 606

| mbar(A) / Flow Requirement $m^3/hr$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RPM** | *100* | *200* | *300* | *400* | *500* | *600* | *800* |
| **236** | 23.3 | 22 | 21 | 19 | 16 | 14 | 9 |
| **266** | 26.2 | 25 | 24 | 21 | 18 | 16 | 10 |
| **298** | 29.4 | 28 | 27 | 24 | 21 | 18 | 11 |
| **330** | 32.5 | 31 | 30 | 26 | 23 | 19 | 12 |
| **372** | 36.7 | 35 | 34 | 30 | 26 | 22 | 14 |
| **398** | 39.3 | 38 | 36 | 32 | 28 | 23 | 15 |

### CE1 – 703 / 705 / 706

| mbar(A) / Flow Requirement $m^3/hr$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RPM** | *100* | *200* | *300* | *400* | *500* | *600* | *800* |
| **210** | 34.3 | 33 | 32 | 28 | 25 | 21 | 13 |
| **236** | 38.5 | 37 | 36 | 32 | 27 | 23 | 15 |
| **266** | 43.4 | 42 | 40 | 36 | 31 | 26 | 17 |
| **298** | 48.6 | 47 | 45 | 40 | 35 | 29 | 19 |
| **330** | 53.8 | 52 | 50 | 44 | 38 | 32 | 21 |

### CE1 – 723 / 725 / 726

| mbar(A) / Flow Requirement $m^3/hr$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RPM** | *100* | *200* | *300* | *400* | *500* | *600* | *800* |
| **200** | 44 | 42 | 40 | 36 | 31 | 26 | 17 |
| **225** | 50 | 48 | 46 | 41 | 36 | 30 | 20 |
| **257** | 56 | 54 | 52 | 46 | 40 | 34 | 23 |
| **300** | 62 | 60 | 58 | 52 | 46 | 40 | 30 |
| **340** | 68 | 66 | 64 | 58 | 52 | 46 | 36 |

**Table 1. CUTES CE1 model seal flow rate**

## Section 5

## Sealing liquid control system

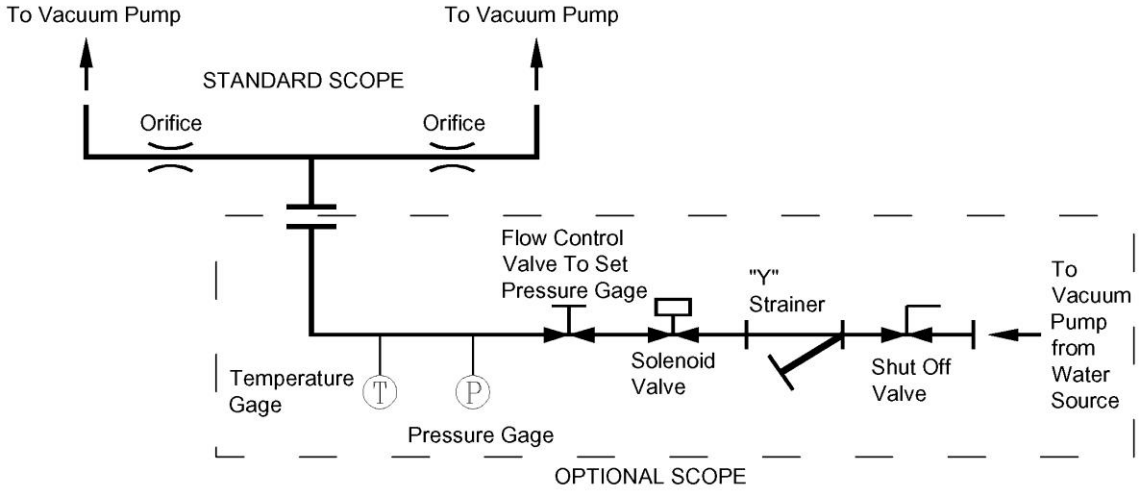



**Figure 5. Full flow sealing liquid control systems**

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 CE1 series**. 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. 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 sealing inlet pipe size for each **CUTES CE1** model:

| **Model** | **353/5/6** | **403/5/6** | **503/5/6** | **603/5/6** | **703/5/6** | **723/5/6** |
|---|---|---|---|---|---|---|
| **Pipe size** | 1 - 1/4” | 1 - 1/2” | 1 - 1/2” | 2” | 2 - 1/2” | 2 - 1/2” |

**Table 2. CUTES CE1 nominal pipe size**

| **Pump Model** | **Orifice Diameter (in.)** | **Orifice No.** | **Pressure Kg/cm$^2$ (G)** |
|---|---|---|---|
| **353** | **Based on rpm and vacuum level** | **2** | **0.7~1.5** |
| **355/ 6** | | **2** | |
| **453** | | **2** | |
| **455/ 6** | | **2** | |
| **503** | | **2** | |
| **505/ 6** | | **2** | |
| **603** | | **2** | |
| **605/ 6** | | **2** | |
| **703** | | **2** | |
| **705/ 6** | | **2** | |
| **723** | | **2** | |
| **725/ 6** | | **2** | |

**Table 3. CUTES CE1 model sealing orifice sizes and operating pressure**

## Section 6

## Packing for stuffing box

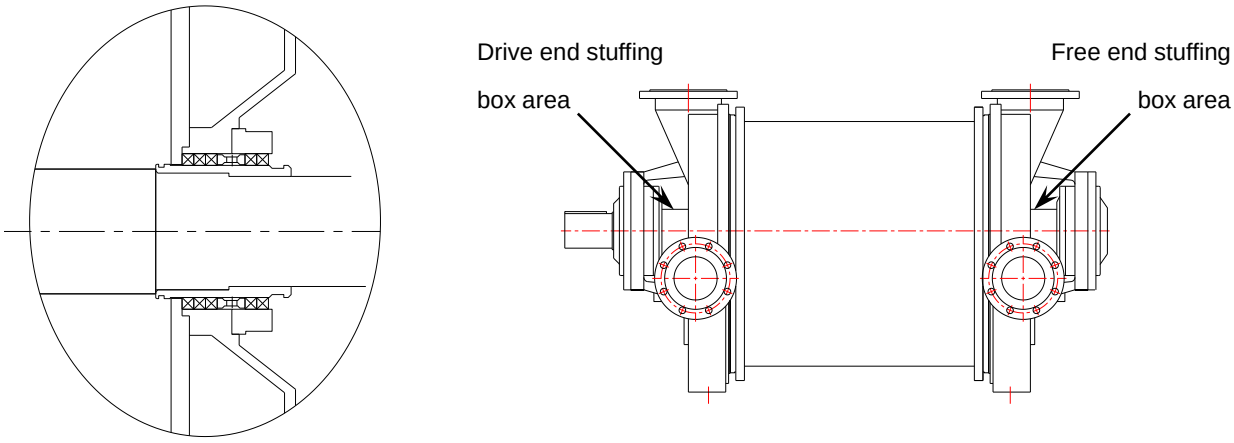



**Figure 6. Packing for stuffing**

Table 4 lists the number of packing rings (D108, F108) for stuffing boxes for each pump. Install each ring to ends butt squarely and joints are 90º apart. Instructions for tightening the packing glands (D110, F110) are located in the section 9. START-UP section of this manual.

| Model | Rotor Side | Lantern Ring | Gland Side | Cross section |
|---|---|---|---|---|
| 353/ 5/ 6 | 2 | 1 | 3 | 5/8” * 5/8”* |
| 403/ 5/ 6 | 3 | 1 | 3 | 3/4” * 3/4” |
| 503/ 5/ 6 | 3 | 1 | 3 | 3/4” * 3/4” |
| 603/ 5/ 6 | 3 | 1 | 3 | 3/4” * 3/4” |
| 703/ 5/ 6 | 3 | 1 | 3 | 3/4” * 3/4” |
| 723/ 5/ 6 | 3 | 1 | 3 | 3/4” * 3/4” |

**Table 4. Number of packing rings for CE1 model, each pump end**

**Section 7**

## Draining and flushing pump before Start-up

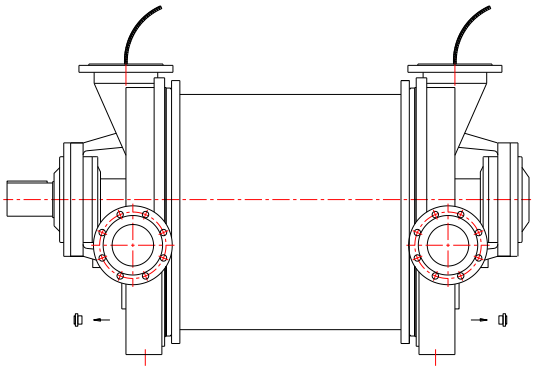


**Figure 7. Draining and flushing pump before start-up**

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)

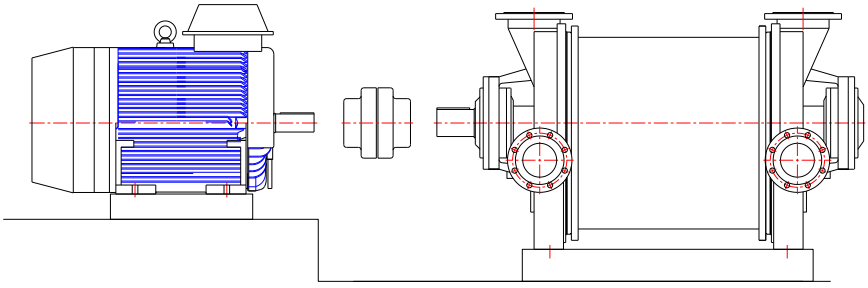


**Figure 8. Driver installation (Coupling and sheave alignment)**

## 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 lit, 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 CE1- P compressor piping and Start-Up

The following piping arrangement should be used for **CUTES CE1-P** compressors to insure the pump works properly and is not damaged.

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

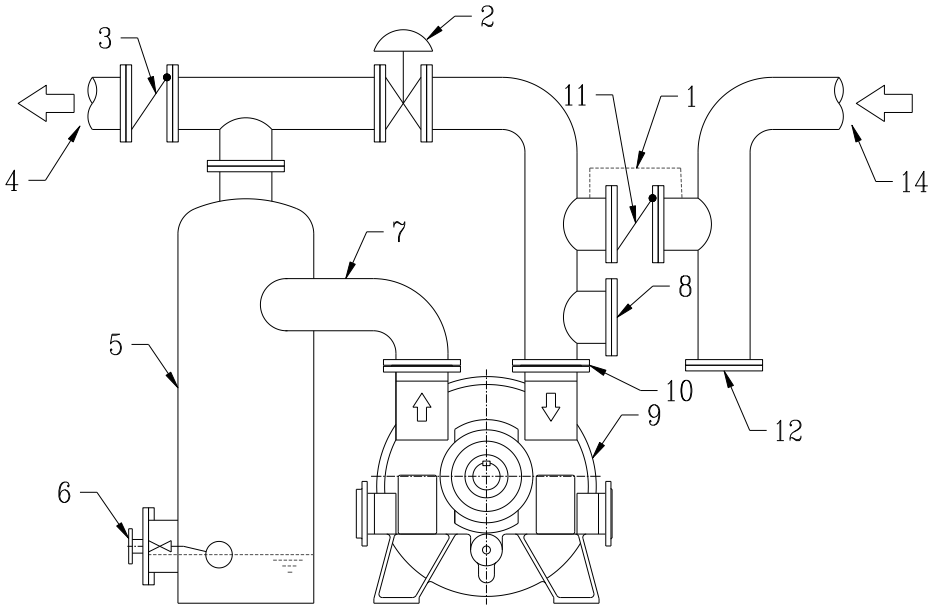



**Figure 9. Proper compressor piping arrangement**

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.) |
|---|---|---|
| **CE1 355** | 6 | 300 |
| **CE1 405** | 10 | 320 |
| **CE1 505** | 12 | 360 |
| **CE1 605** | 14 | 480 |
| **CE1 705** | 16 | 520 |
| **CE1 725** | 16 | 560 |

**Table 5. 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.

### A. Bearings with Standard Grease and Packing Ring: (Standard Bearing Package):

This bearing package, the standard package for **CUTES** pumps, consists of packing ring 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 B-D 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 lo lubricate the bearings every six (6) months. A log should always be kept to keep track of the bearing lubrication.

### B. 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.

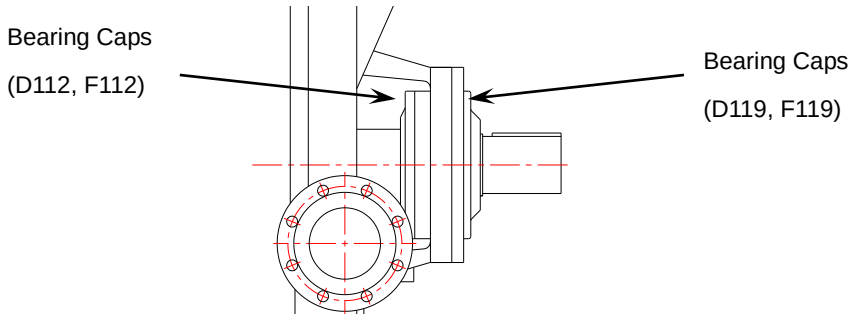



**Figure 10. Removal of bearing caps.**

### C. 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 lifting.
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 have two (2)

tapped holes in the inner bearing cap. 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.

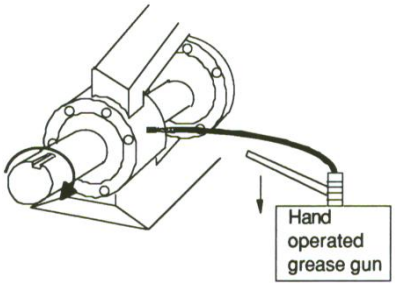



**Figure 11. Re-lubricating bearing**

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

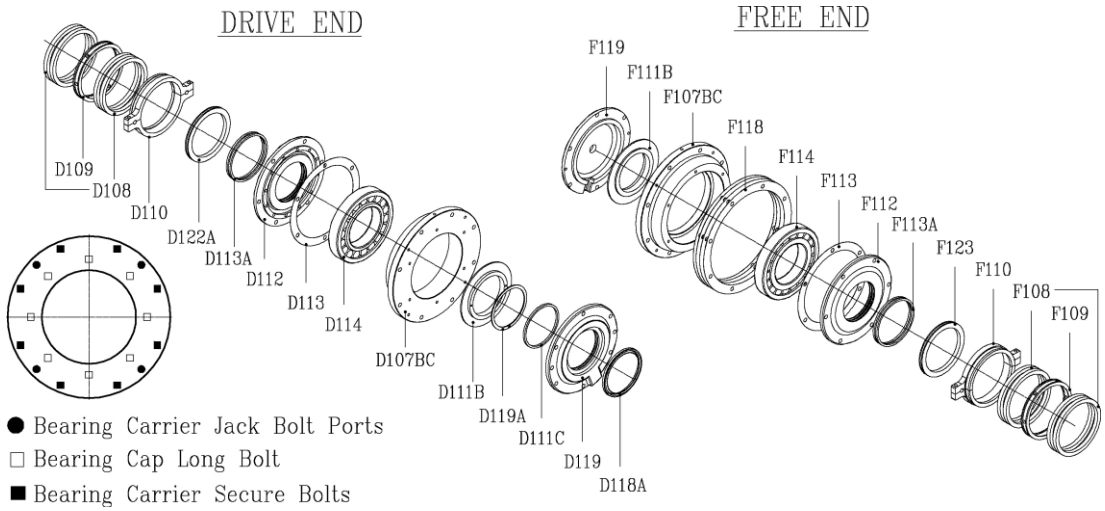



**Figure 12. Removal of bearing carrier**

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

**A. <u>Free end</u>**

**A.1.** Remove outer bearing cap (F119). Measure and record total thickness of 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 port plate. 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 grease retainer (F111B).

**A.3.** Remove the bolts that secure the bearing carrier (F107BC) to the head and loosely install the bolls in the threaded holes in the bearing carrier (bearing carrier jack bolt ports).

**A.4.** Due to the weight of the bearing carrier (D107BC) and the bearing of CE1 353 ~ 725, and the assembly must be supported by a sling before proceeding with disassembly to prevent injury and/or damage to the pump parts.

**A.5.** 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.

**B. Drive end**

**B.1.** Follow all steps for bearing removal of free end (A.1.-A.5) to remove drive end bearing.

**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 (200ºF to 240ºF), 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 knew 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 11: 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 bearing carrier exactly as removed.

**Section 13**

## Shut-down periods (more than 2 weeks)

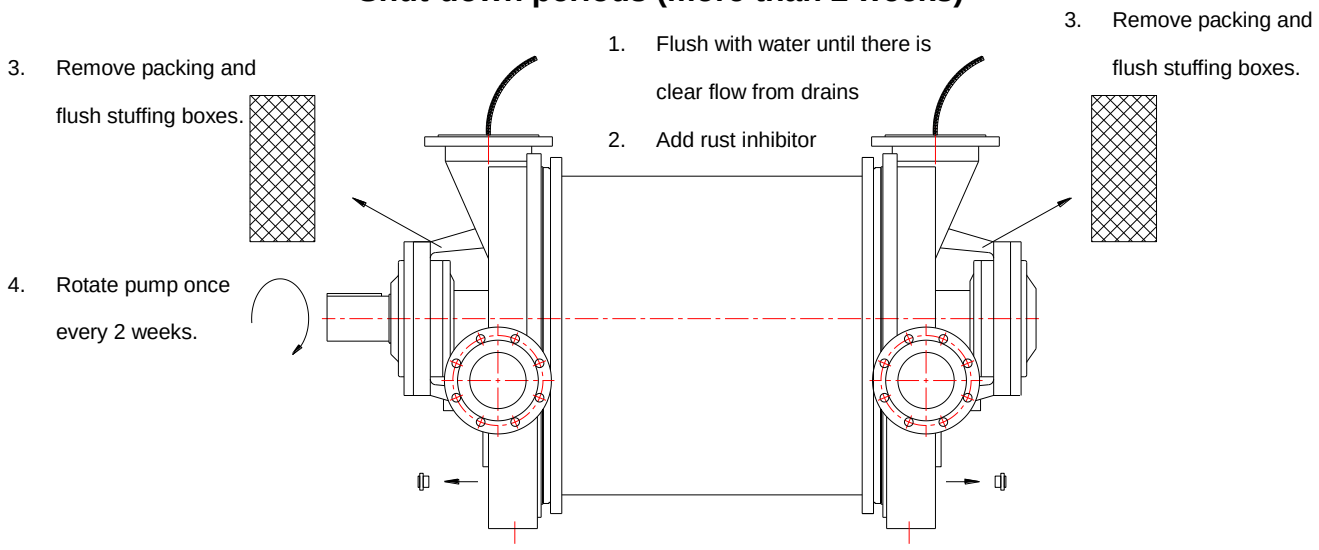



**Figure 13. Draining and flushing**

**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 form 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, turning on water and starting motor.
5. If the pump is to be placed in "long term storage", refer to 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 6 for approximate weights of parts)**

*** Mark all parts**

*** Check new parts against originals**

***Disassemble and reassemble pump on level base**

***Adjust clearance to original specification**

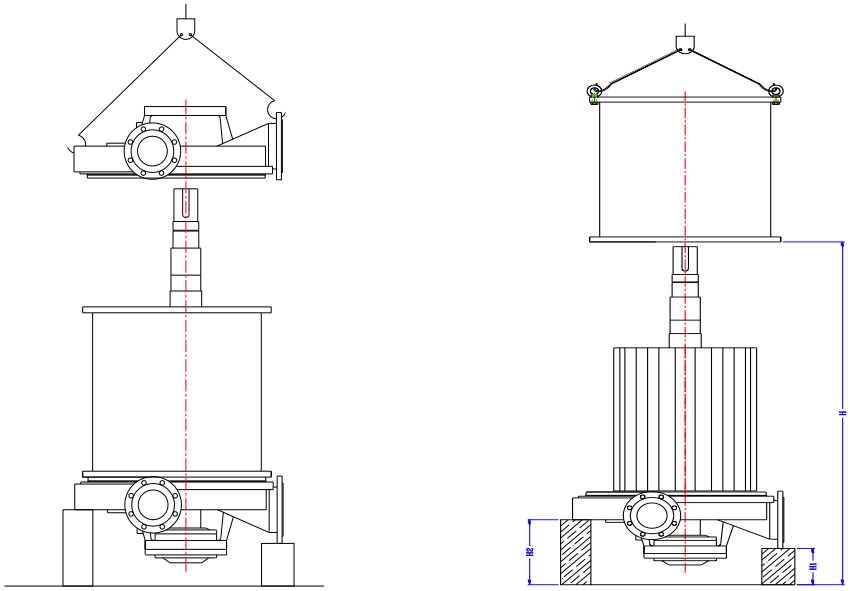


**Figure 14. Pump disassembly**

**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 port plate, 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 | CE1 Model No. | | | | | | | Memo |
|---|---|---|---|---|---|---|---|---|---|
| | | 355/6 | 405/6 | 505/6 | 605/6 | 625 | 705/6 | 725/6 | |
| M100A | Housing, CI | 360 | 600 | 1050 | 1450 | 1600 | 2395 | 2870 | |
| M101 | Rotor/Shaft Ass. | 850 | 1450 | 2250 | 2950 | 3200 | 4100 | 6000 | |
| M103 | Shaft | 170 | 435 | 675 | 835 | 955 | 1230 | 1800 | |
| D105 | Port plate, Drive End | 150 | 250 | 270 | 450 | 450 | 630 | 630 | |
| F105 | Port plate, Free End | 150 | 250 | 270 | 450 | 450 | 630 | 630 | |
| D107 | Head, Drive End, CI | 290 | 430 | 700 | 1000 | 1000 | 1585 | 1585 | |
| F107 | Head, Free End, CI | 290 | 430 | 700 | 1000 | 1000 | 1585 | 1585 | |
| Bare pump weight (without manifold) | | 2350 | 3800 | 5800 | 8000 | 8600 | 12000 | 15000 | |

**Table 6. Approximate weights of parts**

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

**Bearing Kit:**

| | | | |
|---|---|---|---|
| D111A, | Packing Ring. Inner Drive End. | F111A, | Packing Ring. Inner Free End |
| D114, | Bearing, Drive End | F114, | Bearing, Free End |
| D118A, | Lip seal, Outer Drive End | F118, | Shim gasket, 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. Port plates (D105, F105)

Finally, it is very helpful lo 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

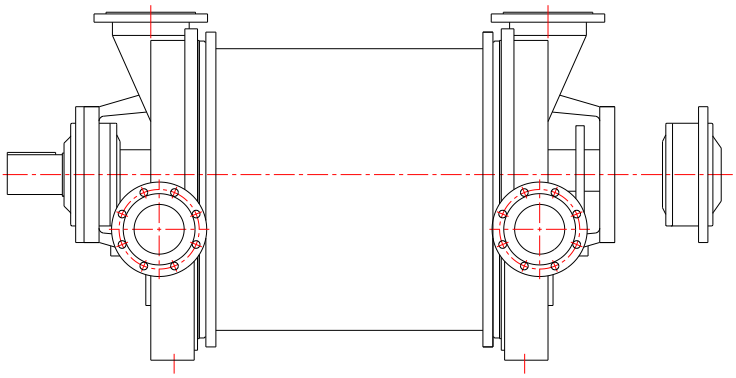


**Figure 15. Disassembly of free end**

1. Remove free end bearing carrier (F107BC) with bearing (F114) from shaft (M103) (see Section 12 and Figure 12: 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. Remove the stuffung-box gland one the free end and free end (if both ends of the pump are to be dismantle)
4. Mark off the casing's mounting position.
5. Remove the flange connection between the Drive end Head (D107) and the casing (M100A)
6. Lift off the Drive end Head (D107) together with the port plate (D105)
5. Remove the flange connection between the casing (M100A) and the free end head (F107).
7. Lift off the casing (M100A) (see Figure 15).
8. Withdraw the rotor (M101). To suspend it, use a ring bolt similar to DIN 580 but with a longer thread, 0.8 x D at least, screw into the shaft's center hole.
9. Remove the Drive end Port plate (D105) from Drive end Head (D107) (see section 17)
10. Remove the Free end Port plate (F105) from the Free end Head (F107) (see section 17)

* The rotor (M101) is shrunk on the shaft and only can be force off with appropriate tools.

## Section 16

## Internal inspection of the pump

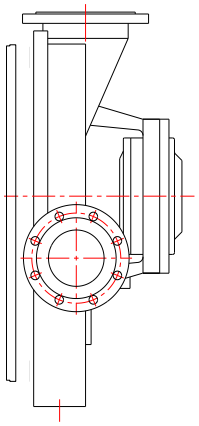


**Figure 16. Port plate and Head**

With the pump disassembled, inspect the parts for wear from corrosion and erosion. Normally, the flat surfaces of the Port plate (D105, F105) will be smooth, requiring only cleaning and light filing. The rotor (M101) surface 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 rotor surface. If the score marks are not too deep, high spots can be removed by light filing or grinding. If the scoring is deep, Port plates should be removed from the heads (D107, F107) and re-machined. Usually, a light skin cut will remove most score marks. The max. dimension can be re-machining see table 7.

Surface of the rotor (M101) should be inspected on the same bases as the Port plate. If the rotor requires light machining; the max. dimension cab be re-machining see Table 7 below.

The rotor and casing length different “Z” show in below which must be adhered to as well as the necessary plane parallelism.

In the case of two-part casing with a partition wall, dimension “Z” applies to the fully assembled casing halves with the partition wall inserted as a complete unit.

| Model | Rotor one side surface max. dim. For re-machining (mm) | Port plate surface max. dim. For re-machining (mm) | Z (mm) |
|---|---|---|---|
| CE1 353/ 5/ 6 | 1.2 | 2.3 | 0.75 +/- 0.1 |
| CE1 403/ 5/ 6 | 1.2 | 2.5 | 0.85 +/- 0.1 |
| CE1 503/ 5/ 6 | 1.4 | 2.8 | 1.0 +/- 0.1 |
| CE1 603/ 5/ 6 | 1.9 | 3.8 | 1.1 +/- 0.1 |
| CE1 703/ 5/ 6 | 2.3 | 4.5 | 1.2 +/- 0.1 |
| CE1 723/ 5/ 6 | 2.3 | 4.5 | 1.3 +/- 0.1 |

**Table 7. Maximum surface re-machining dimension**

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

The impeller two surfaces should be under cut in the blade-tip and area in accordance with below table:

| Model | D (mm) | S (mm) |
|---|---|---|
| CE1 353/ 5/ 6 | 570 | 0.2 |
| CE1 403/ 5/ 6 | 680 | |
| CE1 503/ 5/ 6 | 800 | |
| CE1 603/ 5/ 6 | 950 | |
| CE1 703/ 5/ 6 | 1130 | |
| CE1 723/ 5/ 6 | 1130 | |

**Table 7A Rotor undercut dimension**

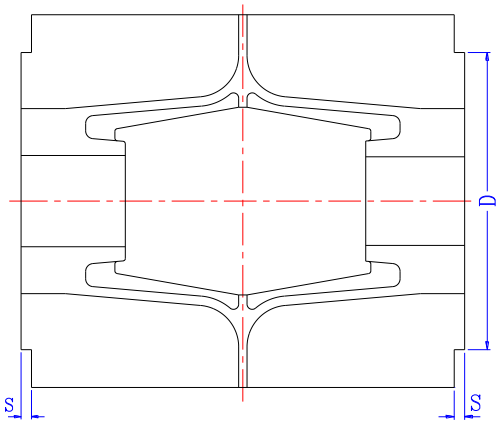



**Fig 16A Rotor undercut drawing**

## Section 17

## Replacing Port plate and heads

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

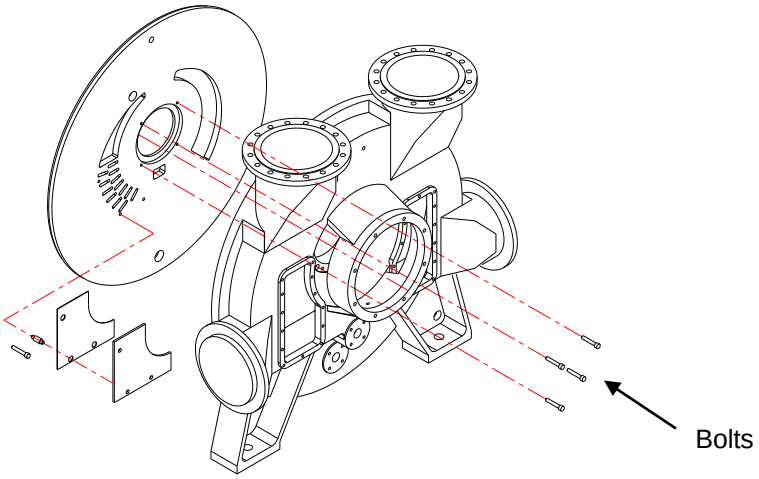



**Figure 16A. Remove port plate and head**

1. Remove the bolts from head side, which fixed port plate and head together.
2. Separate port plate (D105, F105) from Head (D107, F107).
3. Separate flex valve (D131. F131) from port plate (D105, F105).
4. Replace new port plate or 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, use a ring bolt similar to DIN 580 but with a longer thread, 0.8 x D at least, screw into the shaft's center hole and lift with a crane or hoist.

2. Place the assembly in a press (see Table 8 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 lit over the shaft shoulder and shaft key (see Table 8 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.

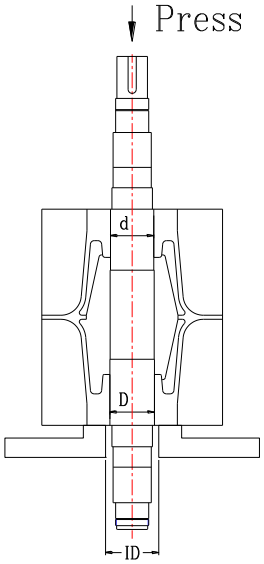



**Figure 17. Pressing shaft from rotor**

| Model | Press (Tons) | Press Cap. (Tons) | Bushing bore ID (mm) |
|---|---|---|---|
| **CE1 353/ 5/ 6** | **20** | **50** | **190** |
| **CE1 403/ 5/ 6** | **20** | **50** | **220** |
| **CE1 503/ 5/ 6** | **35** | **100** | **240** |
| **CE1 603/ 5/ 6** | **40** | **100** | **280** |
| **CE1 703/ 5/ 6** | **50** | **100** | **310** |
| **CE1 723/ 5/ 6** | **60** | **100** | **310** |

**Table 8. Press loading force by model size**

## Section 19

## Reassembly of rotor and shaft

1. Check the ground surface of the rotor seat diameter and bearing journal on the shaft for dents or galling.

2. Polish the shaft smooth with a grinding stone and emery cloth.

3. Coat the rotor hub bore and rotor seat of the shaft with anti seize compound (such as FEL-PRO C5-A) to prevent galling or seizing when the shaft is pressed into the rotor.

4. Put the rotor into the oven until rotor have 80 deg. C increase, then put on the press base ready for insert shaft.

5. 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.

6. Sling the rotor by a line around the outside diameter at the point of balance, and place the rotor in the press.

7. Place the shaft in the rotor, with the shoulder side towards the ram.

8. Usually, shaft can be insert till right position under right temperature rise. If not press the shaft into the rotor until the shoulder of the shaft makes firm, flush contact with the rotor hub.

9. Install Drive end and Free end shaft sleeve.

## 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. Assemble the housing body (M100) and drive end head/port plate assembly using the same sting 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.

1. Place the Free end head/ port plate under horizontal level.
2. Install a suitable ring bolt into the center of shaft end, lift the rotor.
3. Insert the rotor into Free end head/port plate
4. Lift the casing and assembly with Free end in the same mark position.
5. Tight all the flange bolts

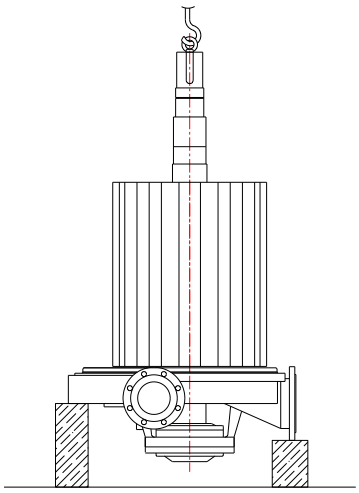


**Figure 18. Insert the rotor into the Free end head/port plate by a ring bolt**

**Section 22**

**Assembling Drive end head/port plate to housing**

1. Lift the Drive end/port plate to housing in the same mark position.
2. Tight all the flange bolts.
3. Lift whole pump to horizontal position then put on the level base, checking the feet level, if feet not alignment, loosen one side of casing and head flange bolts, after alignment then tighten all the casing and head bolts.

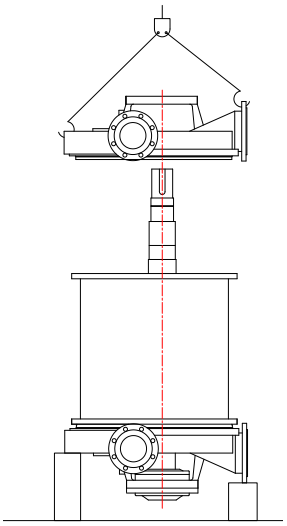


**Figure 19. Assembling Drive end/port plate to housing**

**Section 23**

**Bearing assembly (both drive end and free end)**

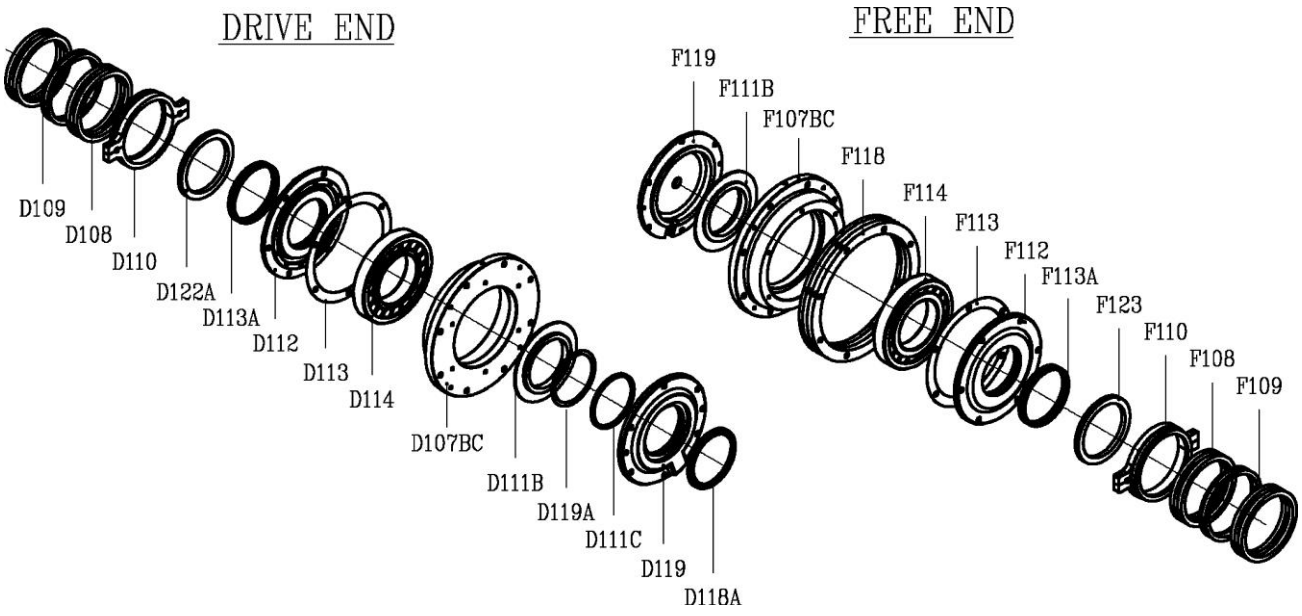



**Figure 20. Bearing assembly**

**Caution:** Be sure that the inner end bearing caps (D112, F112), bearing cap packing ring (D111A, F111A), Inner bearing cap gaskets (D113, F113) and slinger (D123, F123) 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.

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 100℃(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 bearing (D114, F114) on the shaft (M103), placing it flush against the shaft shoulder.

## 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).

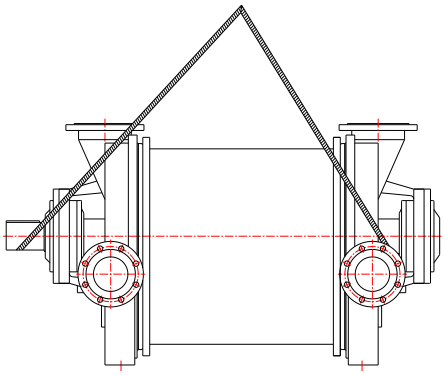
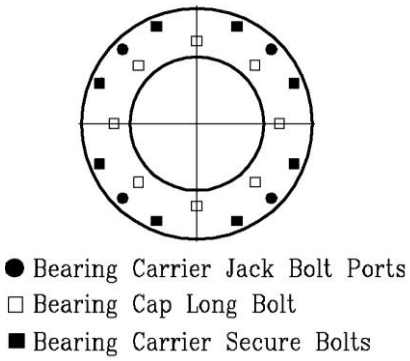


**Figure 21. Sling arrangement**

2. Slide the bearing carrier (D107BC, F107BC) over the bearing (D114, F114) to where all bearing carrier and head (D107, F107) surfaces are parallel with each other.
3. 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.



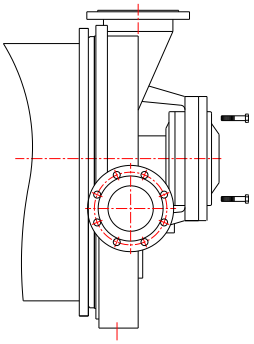



**Figure 22. Bearing carrier assembly**

3. Install the drive end bearing grease retainer (D111B) ,and bearing retaining (D11C).
4. Install the drive end outer bearing cap (D119).
5. Install the free end bearing grease retainer (F111B) after tightens then set screw bolt.
6. Install the free end outer bearing cap (F119) without the shim gaskets (F118).
7. Lubricate the bearings using a hand-operated gun after they have cooled. Pump grease completely covering both sides of the bearing.

**Section 25**

**Checking and setting rotor end travel**

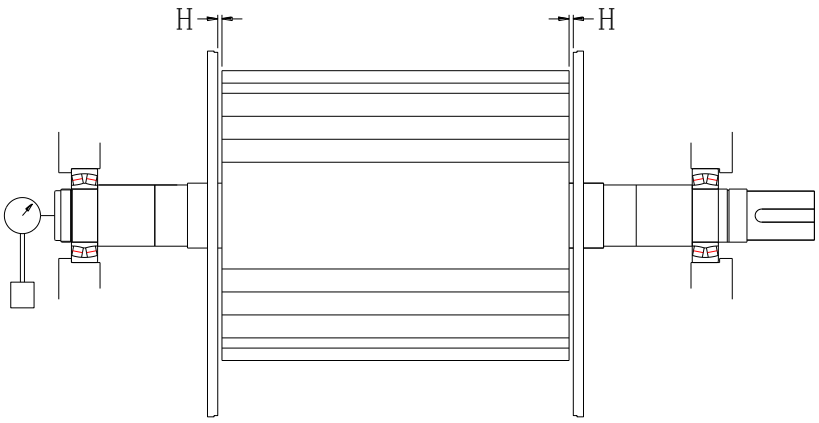



**Figure 24. Checking rotor travel schematic**

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

**Hard-to-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 +/- 0.1 mm. 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 bolts (connecting the free end inner and outer bearing caps).
2. Tighten four jack screws against the head (F107) until the rotor is locked "hard" onto the free end port plate. Do not force past this point.
3. Remove the jackscrews.
4. Place a dial indicator on the drive end shaft end surface and zero the gauge.
5. Tighten four take-up screws that thread into the head, until the rotor is locked "hard" onto the drive end port plate.
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 port plates.

| Model | Hard-to-Hard (+/- 0.1 mm) | |
|---|---|---|
| | C. I. Port plate / Rotor | SS Port plate /Rotor |
| CE1 353/ 5/ 6 | 0.75 | 1.25 |
| CE1 403/ 5/ 6 | 0.85 | 1.40 |
| CE1 503/ 5/ 6 | 1.00 | 1.65 |
| CE1 603/ 5/ 6 | 1.10 | 1.85 |
| CE1 703/ 5/ 6 | 1.20 | 2.00 |
| CE1 723/ 5/ 6 | 1.30 | 2.20 |

**Table 9. Rotor end travel**

**Caution:** Hard-to-hard dimension are setting by " Z " value from table 7, if over the tolerance, re-machining the housing.

**Section 26**

**Final assembly**

Once the end travels have been set and the rotor/shaft assembly (M101) is centered between the port plate (D105, F105), the shim gaskets (F116) must be installed between the free end outer bearing carrier (F107BC) and the head (F107). With a feeler gauge, measure the open distance between the bearing carrier and head. Remove the free end bearing carrier and install the correct thickness of shim gaskets to equal the distance measured. Remove the bearing carrier take-up screw bolt. Tighten all of the bearing carrier screws.

**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 |

## Liquid Ring Vacuum Pump Trouble Shooting (cont.)

| SYMPTOM | POSSIBLE CAUSES | SOLUTION |
|---|---|---|
| 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 drop leg or extraction pump |
| | Sealant piping wrong side | Change to another side |
| | Inlet separator flooding | Check separator sizing, barometric drop leg design, or condition of extraction 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 |
| 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 10”HgV from one side of pump to other |

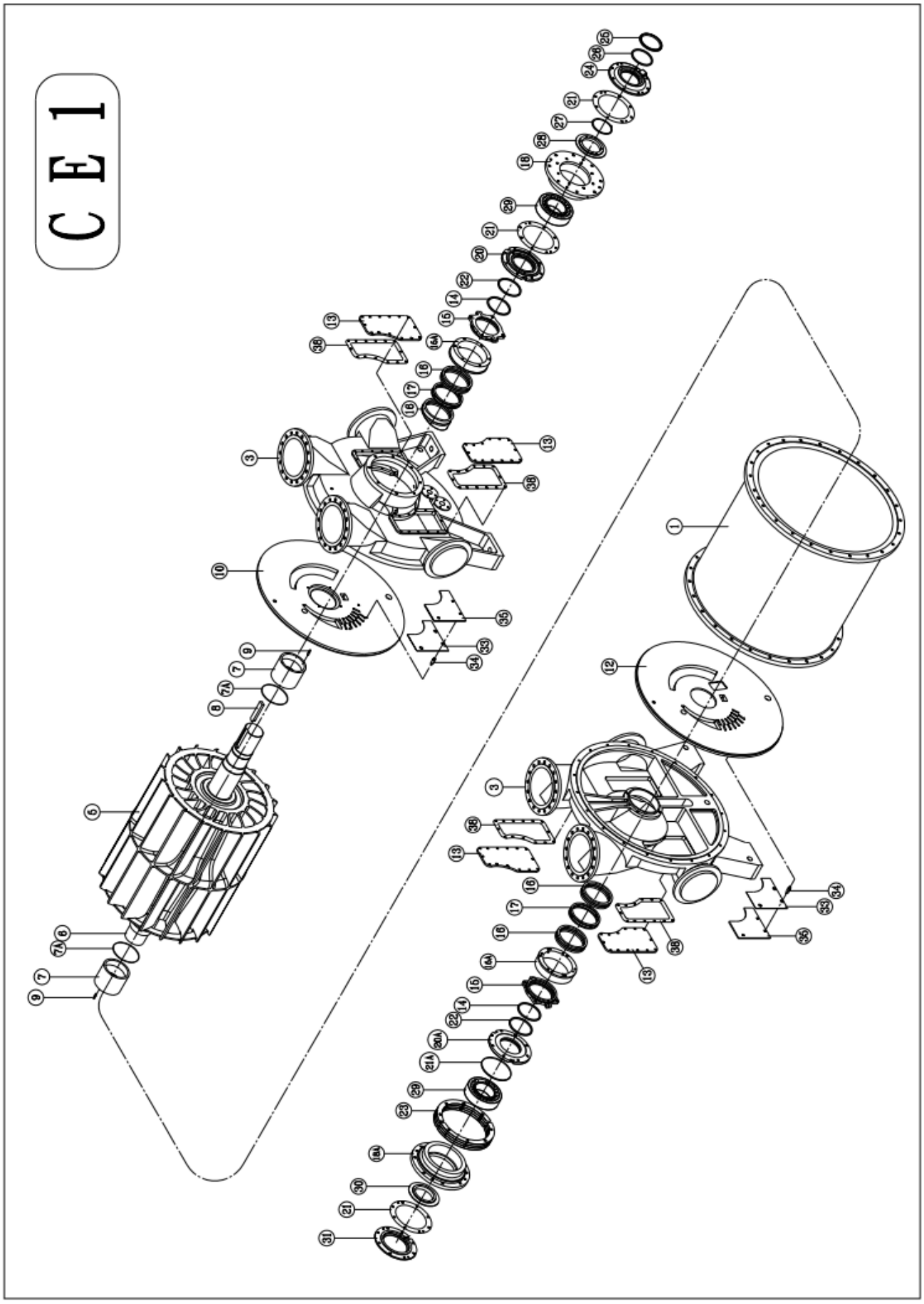
| Model | Bearing Model |
|---|---|
| CE1 353/ 5/ 6 | 22226 |
| CE1 403/ 5/ 6 | 22230 |
| CE1 503/ 5/ 6 | 22234 |
| CE1 603/ 5/ 6 | 22238 |
| CE1 703/ 5/ 6 | 22244 |
| CE1 723/ 5/ 6 | 22244 |

- Bearing standard brand: **NSK, Koyo** or **NTN**
- Grease Standard Brand: **Mobil**

  Type: Green, **UNIREX N2 ( Lithium Complex Grease ).**

**Parts Order Key No.**

| DRIVE END | | | FREE END | | |
|---|---|---|---|---|---|
| **Item No.** | **Key No.** | **Parts Description** | **Item No.** | **Key No.** | **Parts Description** |
| **1** | **M100** | Housing. | | | |
| **5** | **M101** | Rotor/Shaft Assembly (concentrically and dynamically balanced). | | | |
| **6** | **M103** | Shaft | | | |
| **10** | **D105** | Port plate. Drive End. | **12** | **F105** | Port plate. Free End. |
| **3** | **D107** | Head. Drive End. | **3** | **F107** | Head. Free End. |
| **18** | **D107 BC** | Bearing Bracket. Drive End. | **18A** | **F107 BC** | Bearing Bracket. Free End. |
| **16** | **D108** | Packing Rings. Drive End. | **16** | **F108** | Packing Rings. Free End. |
| **17** | **D109** | Lantern Ring. Drive End. | **17** | **F109** | Lantern Ring. Free End. |
| **15** | **D110** | Packing Gland. Drive End. | **15** | **F110** | Packing Gland. Free End. |
| **15A** | **D110A** | Stuffing Box Housing. Drive End. | **15A** | **F110A** | Stuffing Box Housing. Free End. |
| **22** | **D111 A** | Inner Bearing Cap Oil seal. Drive End. | **22** | **F111 A** | Inner Bearing Cap Oil seal. Free End |
| **28** | **D111 B** | Grease Retainer. Drive End. | **30** | **F111 B** | Grease Retainer. Free End. |
| **26** | **D111 C** | Outer Bearing Cap Packing Ring -Drive End | | | |
| **20** | **D112** | Inner Bearing Cap. Drive End. | **20A** | **F112** | Inner Bearing Cap. Free End. |
| **21** | **D113** | Bearing Cap Gasket. Drive End. | **21A** | **F113** | Bearing Cap O-Ring. Free End. |
| **29** | **D114** | Bearing. Drive End (Floating Bearing). | **29** | **F114** | Bearing. Free End (Fixed Bearing) |
| **25** | **D118 A** | Outer Bearing Cap Z-Seal-Drive End | | | |
| | | | **23** | **F118** | Bearing Bracket Gasket. |
| **24** | **D119** | Outer Bearing Cap. Drive End. | **31** | **F119** | Outer Bearing Cap. Free End |
| **27** | **D119 A** | Retaining Ring. Drive End. | | | |
| **8** | **D120** | Shaft Key | | | |
| **7** | **D122** | Shaft Sleeve. 304SS. Drive End. | **7** | **F122** | Shaft Sleeve. 304SS. Free End. |
| **9** | **D122 A** | Shaft Sleeve Key. Drive End | **9** | **F122 A** | Shaft Sleeve Key. Free End |
| **7A** | **D122B** | Shaft Sleeve O-Ring. Drive End | **7A** | **F122B** | Shaft Sleeve O-Ring. Free End |
| **14** | **D123** | Slinger. Drive End. | **14** | **F123** | Slinger. Free End |
| **13** | **D124** | Head plate. Drive End. | **13** | **F124** | Head plate. Free End |
| **33** | **D131** | Unloading Valve | **33** | **F131** | Unloading Valve |
| **34** | **D132** | Guiding Pins | **34** | **F132** | Guiding Pins |
| **35** | **D133** | Unloading Valve Plate | **35** | **F133** | Unloading Valve Plate |
| **38** | **D136** | Head Plate Gasket | **38** | **F136** | Head Plate Gasket |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