Installation / Operation / Maintenance

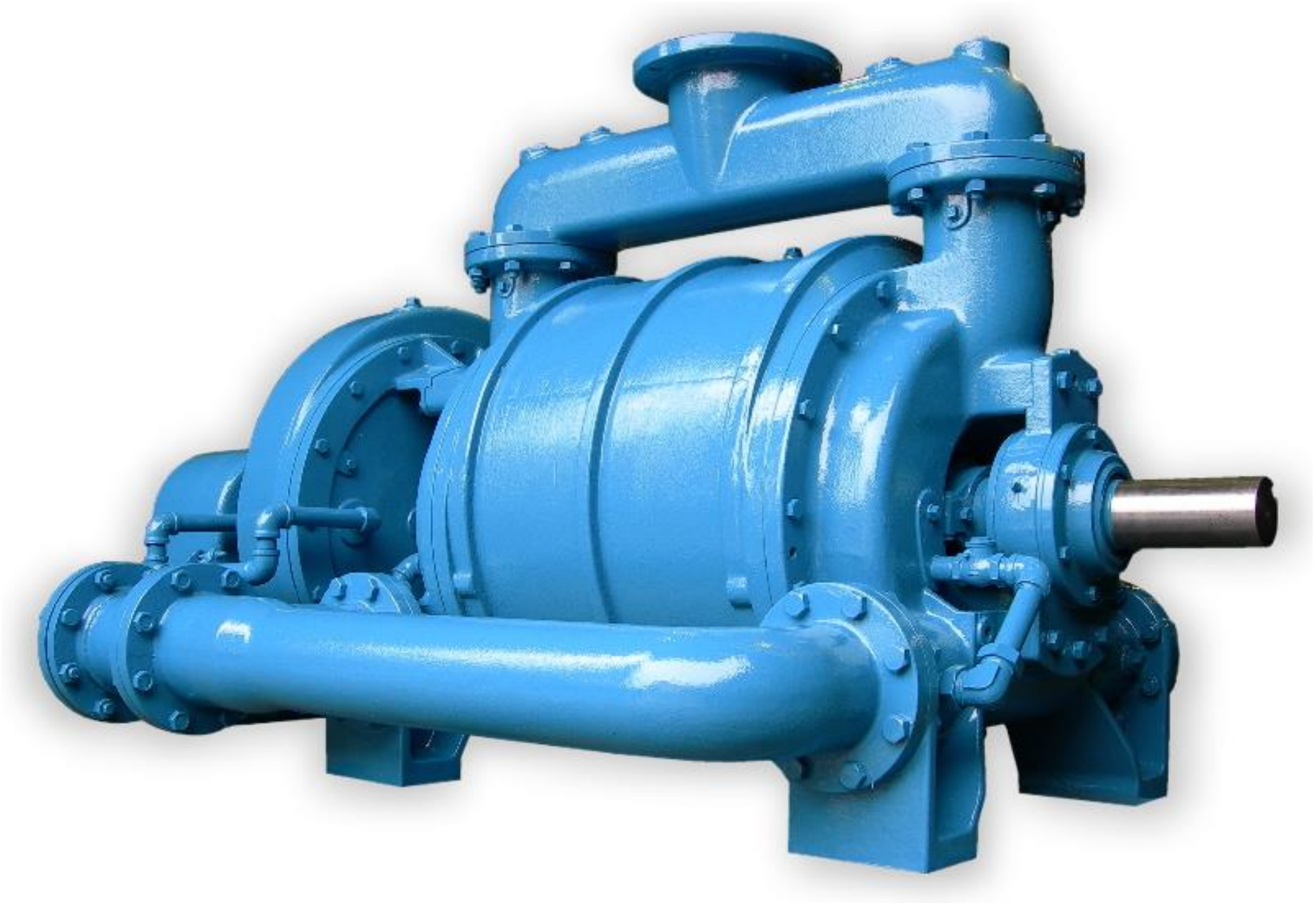
User Manual

For

CAT – 706, 1006, 2006 Model

Double Stages Liquid Ring Vacuum Pump

– *Cones Type Design*



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1. About this manual.

This manual contains information for Cutes Vacuum pumps – CAT models. This information includes a description of how to install, operate and maintenance the CAT Vacuum pumps.

2. How the CAT vacuum pump works.

CAT pump outlook are show in **Fig. 1** contains two rotors on the one shaft and rotating at the same speed.

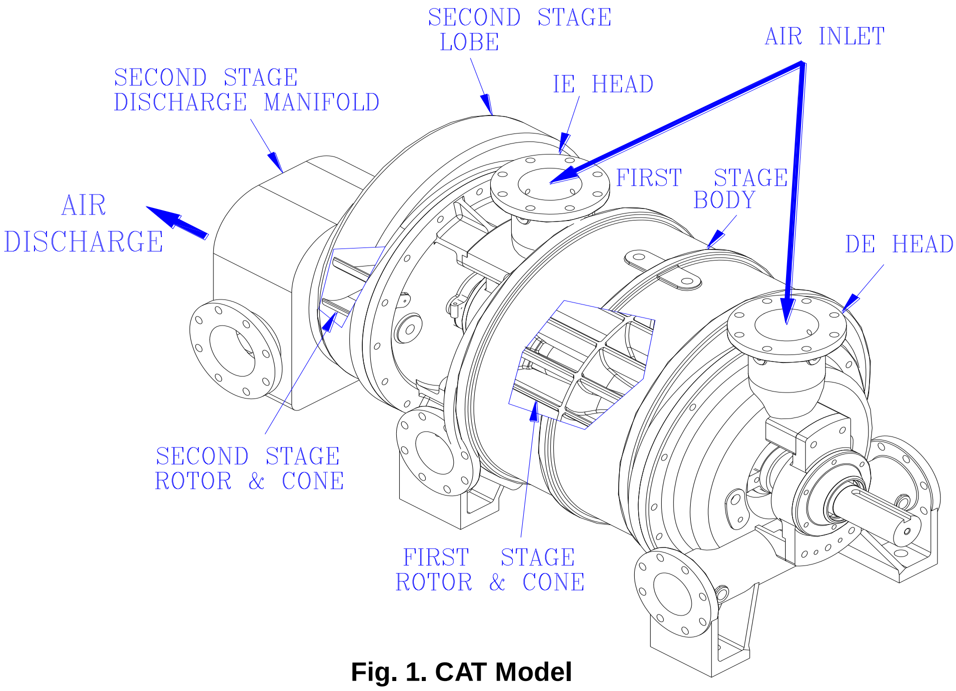


Fig. 1. CAT Model

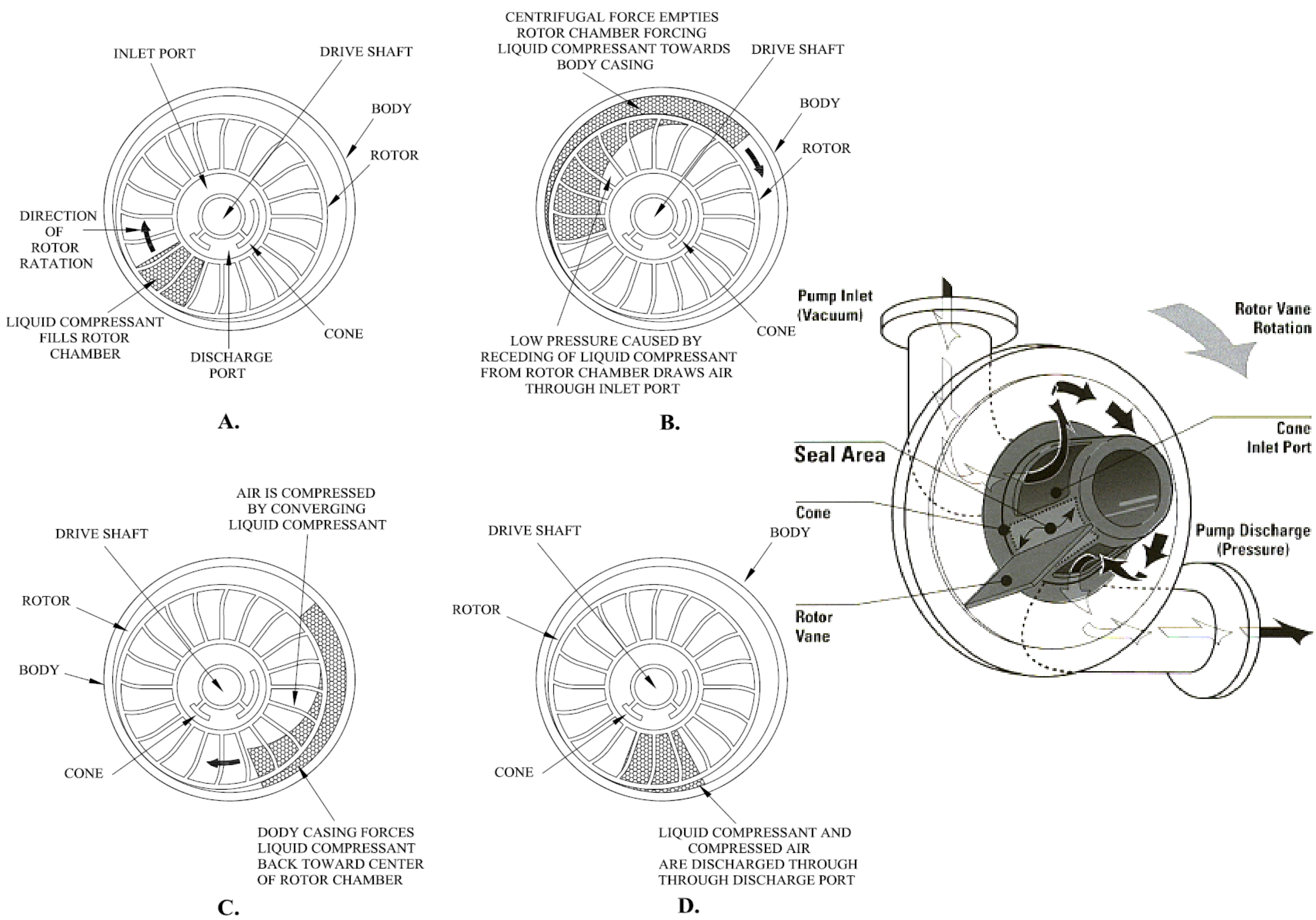


Fig. 2. CAT vacuum pump working principle

Gas suction from DE head and IE head Inlet through the Inlet head chamber to cones suction port then enter into rotor, along the rotor rotate and liquid ring compressant, gas will discharge through the cones outlet port into the head discharge chamber => first stage outlet manifold => inter stage piping (90 degree flange elbow) => second stage discharge manifold.

In this stage will have 2 ways, when low (hogging) or high (holding) vacuum level.

Inside the second stage manifold have a check valve design, open and close automatically and control by the inlet vacuum level as show on Fig. 3.

During the low vacuum (high pressure) the valve will open and most of the gas will be discharged directly, when high vacuum (low pressure), valve will close and all the gas will enter to the second stage of pump, to get higher capacity and stable vacuum.

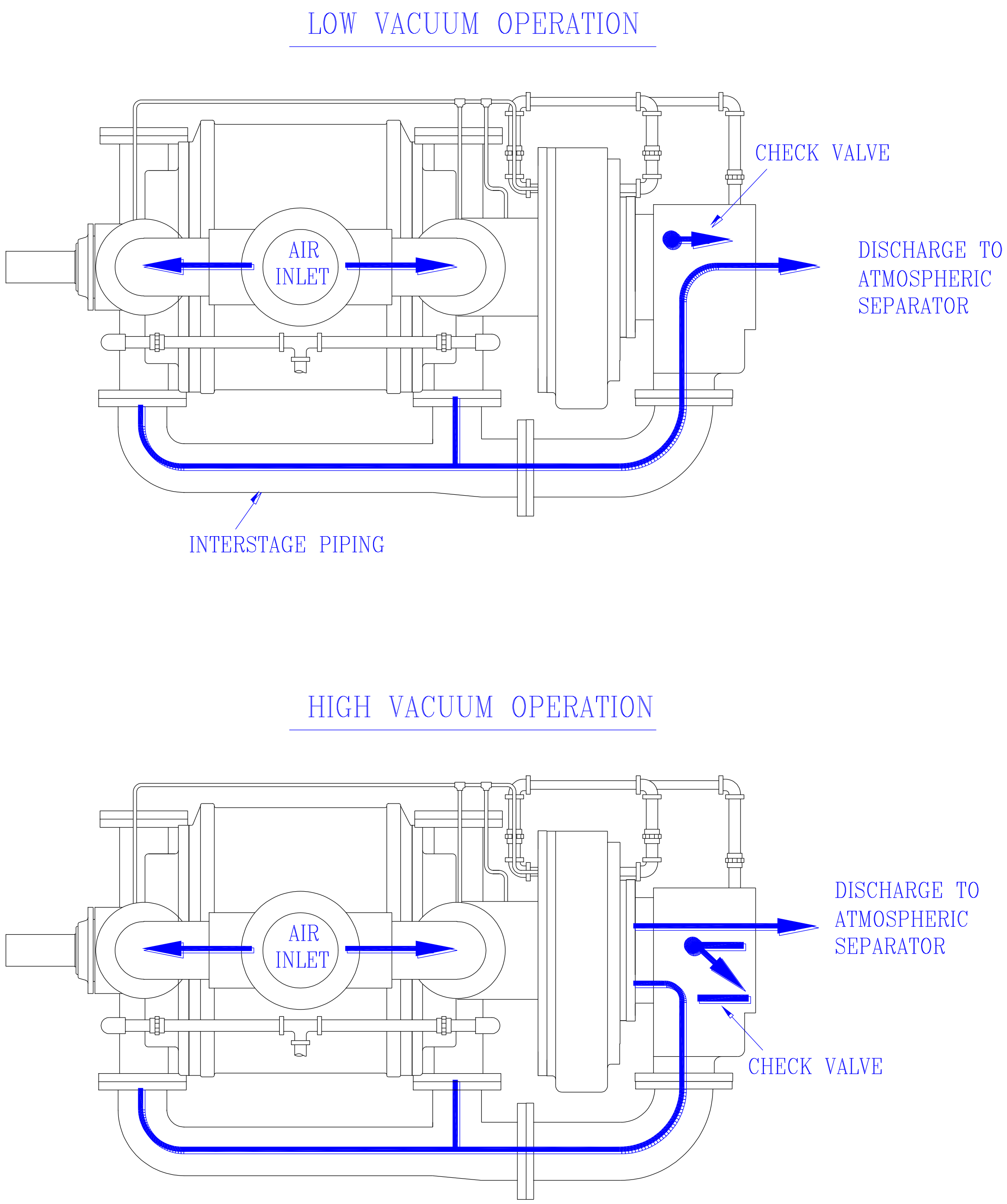
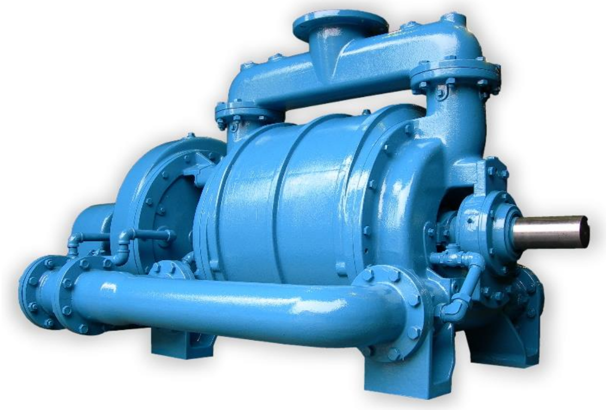


Fig. 3. Low / High - Vacuum Operation

3. After receive Cutes pump



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.

Fig. 4. After receiving CUTES pump products

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 (111) 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 body (101) and heads (102, 103), 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 (112, 613) away from the stuffing box and remove the packing rings (1-1) from pump. Coat the packing area of the shaft (111) 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 (115, 116, 117, 118) and completely fill cavities (both inside and outside, both pump ends) with suitable grease. **<u>Do not remove or add any shims, which will affect rotor center.</u>** 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 (111) 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.

4. Installation

4.1. Piping:

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.

1. Inlet suction piping :

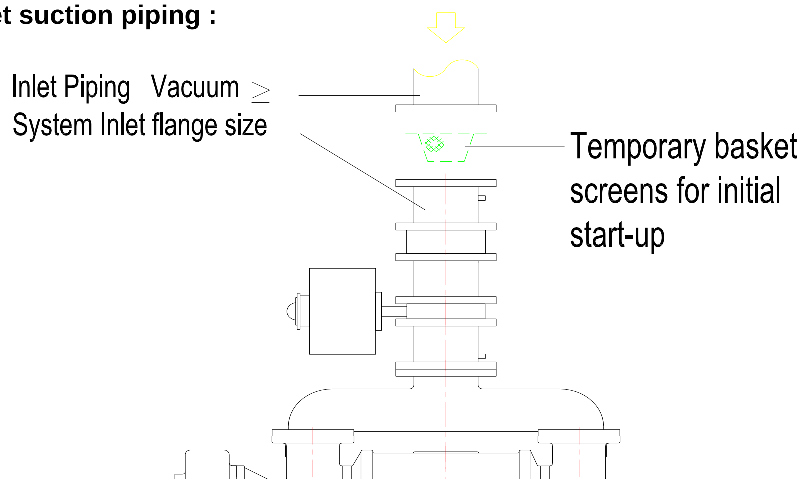


Fig. 5. Inlet suction piping

1-1. 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.

1-2. Inlet suction piping should be equal to or greater than inlet manifold flange size.

3-3 Outlet discharge piping :

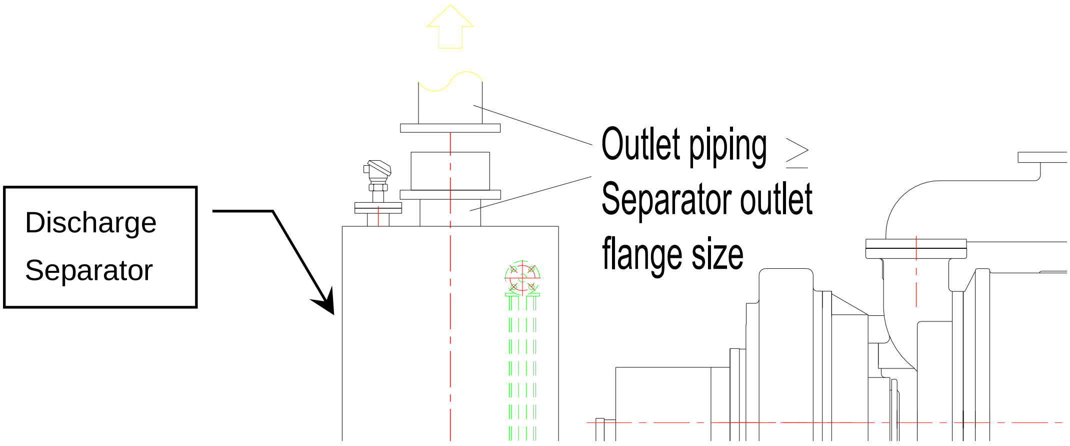


Fig. 6. Outlet discharge piping

4.2. Foundation

The foundation must form a rigid support in order to maintain proper alignment of the drive motor and vacuum pump shafts. Pour concrete to a height that is within 1/2 to 1 1/2 inches of the finished foundation. Locate foundation bolts according to the prints supplied with the system and set them as shown in **Fig 7**. Use pipe sleeves that are two or three diameters larger than the foundation bolt, permitting the bolts to be moved to conform to the soleplate slot locations after the concrete is poured.

Place the pump soleplate on the foundation and then carefully level it by shimming at the foundation bolts. Tighten the foundation bolts securely.

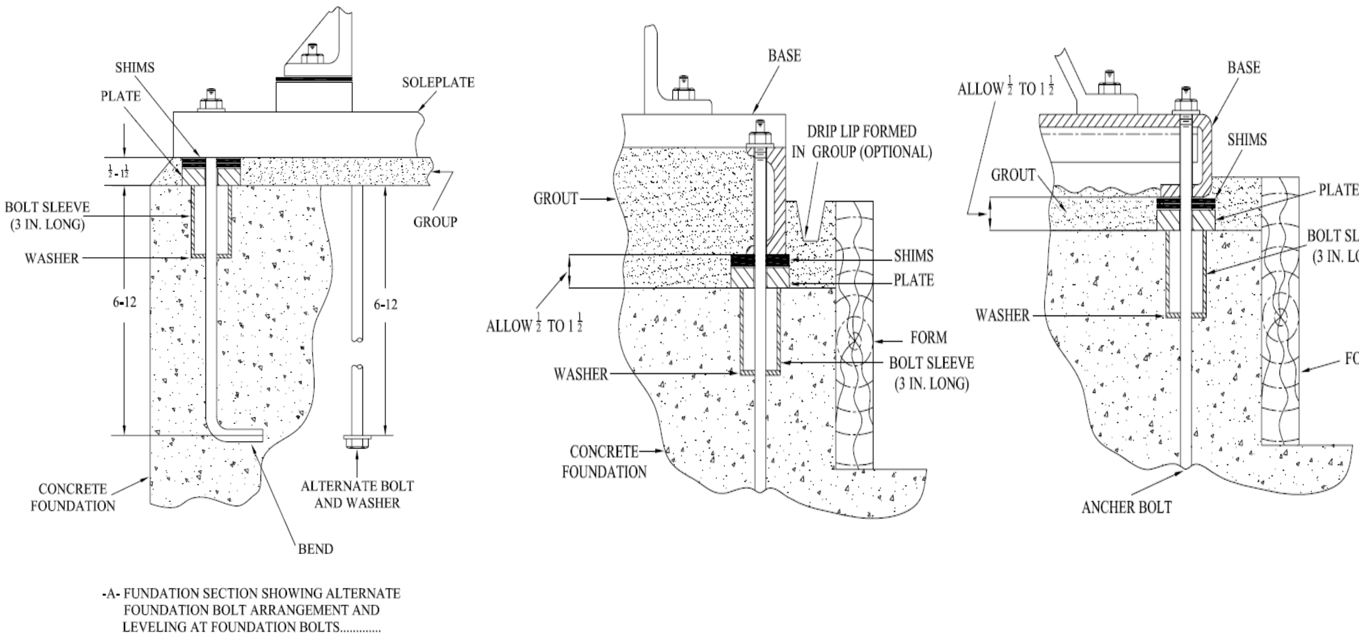


Fig. 7. Foundation drawing for different base

4.3. Coupling alignment

Coupling halves and V-belt pulleys should not be forced on the vacuum pump or electric drive motor shaft. If there is not a slip fit, expand the part to size by heating it with a propane torch. DO NOT FORCE THE PART! Forcing may damage bearings or the vacuum pump interior.

Coupling Alignment. In most cases, units are shipped with the vacuum pump and electric drive motor mounted on the soleplate and couplings shipped separately. (Refer to Section 3.) *The vacuum pump and electric drive motor have been checked on level pads at the factory to ensure that field alignment can be made, provided that the base is field mounted on a level foundation.* However, as indicated in Section 4, they must be realigned at your installation. Shims are packed separately and shipped with systems.

A flexible coupling will accept some degree of misalignment such as that caused by temperature change or other variations for a short period of time. However, *a coupling must be in alignment for continuous operation in all cases.*

Even though a coupling may be lubricated, excess misalignment causes wear, vibration, and bearing loads that result in premature bearing failure, mechanical seal wear, or ultimate seizing of the vacuum pump. Misalignment can be angular, parallel, or a combination of these: in addition, misalignment can be in the horizontal plane, vertical plane, or both. (See Figure 8.) If proper alignment cannot be achieved, recheck the tightness of foundation bolts and the leveling provided by the shimming of the foundation bolts.

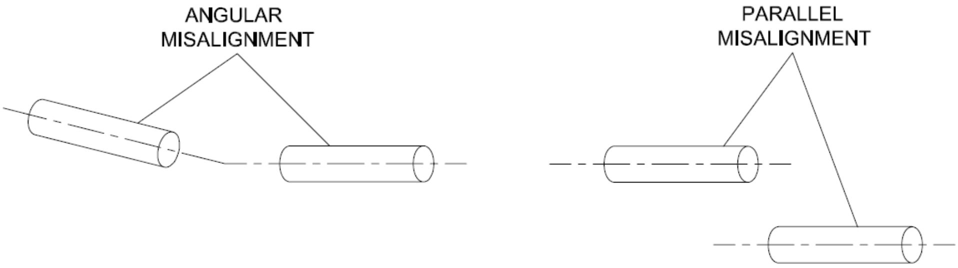
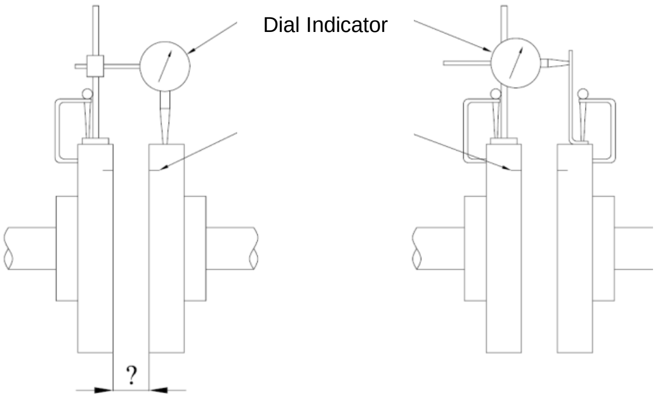


Fig. 8. Misalignment conditions

The VACUUM PUMP MUST BE FIELD ALIGNED IN ACCORDANCE WITH THE FOLLOWING INSTRUCTIONS:

a. Adjusting the center level and parallel by shim thickness.



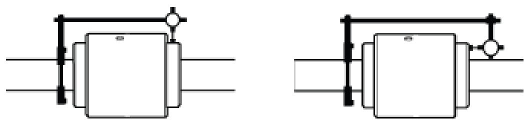


Fig. 10. Checking after assembly

For Parallel **For Angular**

Fig. 9. Checking Coupling Alignment With a Dial

b. Adjust the coupling halves to the gap dimension shown on the Engineering Certification Data Sheet. *Avoid a coupling fit that is too loose (fit greater than 0.1mm); excessive strain may be caused to a shaft-coupling key by a loose fit.*

c. Mark both halves of the coupling with a reference or benchmark.

d. Mount a dial indicator as shown in Figure 9.

e. Slowly rotate both shafts together and make all measurements between the reference marks. Make certain that the foundation bolts are securely tightened when taking these readings.

f. Adjust the position of the motor until the coupling hubs are aligned within a total dial indicator reading of less than 0.1 mm (that is, 0.05 mm, maximum, on each side) for both parallel and angular alignment.

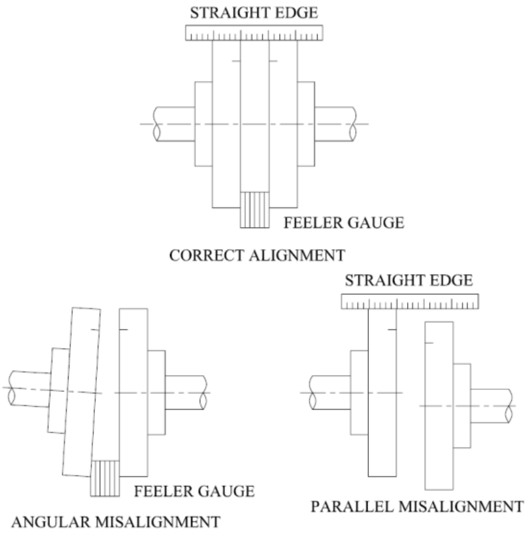
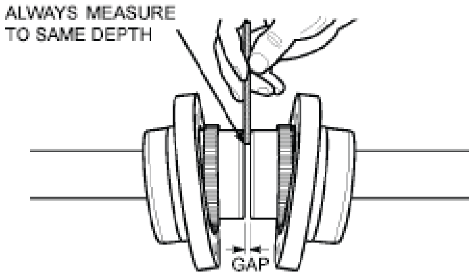


Figure 11. Checking Alignment with Straight Edge and Feeler Gauge.



(An alternate, less reliable procedure can be performed using a straight edge and feeler gauge as shown in Figure 11. Take readings at the same reference mark on both coupling hubs at four positions, 90 degrees apart. Keep the straight edge in line with the axis of both shafts. Parallel alignment is achieved when the straight edge is level between the coupling hubs. Angular alignment is accomplished when a feeler gauge of one thickness just enters between the coupling hubs at the reference marks in all positions.)

5. Starting

5.1 Flushing:

After foundation, piping and alignment coupling, flushing pump and close system accessories before operation to avoid damage.

Infuse water from inlet plug, open the plug from bottom of pump housing and separator drain valve, rotate rotor when flushing until discharge water are clean. Close the plug and valves after water drained completely.

> ⚠ **CAUTION**
>
> **Please contact local Cutes distributor if pump cannot run, another force treatments for the pump are not allowed.**

5.2 Inspection before start up:

WARNING

Confirm all of the following steps to ensure personal safety and equipment protection.

CAUTION

When repair work is required during stoppage, install a bulletin board stating "Do Not Turn On Power", in order that no other people may accidentally turn on the power source.

1. Ensure all of the plugs on pump and tight.
2. Ensure all of the piping have connected and sized with equipments.
3. Open inlet and discharge isolation valves.
4. Open sealant shut off valves.
5. Close separator drain valves.
6. Control panel switch to LOCAL.
7. Control power on (below steps may not required for your system).
8. Check compresses air providing (pressure 6barG above), using for driving pneumatic valves.
9. Check water make up on/off valves.
   A. Check make up valves can stop automatically at set up point.
   B. Open drain valves, close at under setting level, check make up valve water can supply or not.
10. Run Re-circulation pump, check motor drive direction, adjust water flow rate to set up value (>6m3/h), open By-Pass Valve if water pressure higher than 1 barG.
11. Run motor and inspect any unusual happen:
    A. Drive direction.
    B. RPM.
    C. Noise.
    D. Vibration.
    E. Housing temperature higher than inlet water under 15 Degree C.
    F. Bearing housing temperature higher than housing under 35 Degree C.
    G. Record Motor current to ensure lower then rated value.

CAUTION

Please immediately stop operation and inspecting when any unusual

12. Adjusting packing gland to proper location, recommend 45-60 water drops within 1 minute at least, too tight will cause overheat and wear on sleeve or shaft. Tight with similar force for both side.

13. After pump run, check Inlet System Valve open or not, it will follow below when pump

Run => Open

Stop=> Close

Stand-by pump Inlet System Valve condition:

Hogging:

Open => when system starting

Close => vacuum up to set point

Holding:

Open => When Condenser pressure drop.

Close => After vacuum back to enough level.

5.3 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.

6. Disassembling

Following below steps for CAT pump disassembly.

6.1 Packing ring

a. Packing ring can be moved together with head.

6.2. Second stage disassembly

a. Second stage construction as Fig.12
b. Dismantle the inter stage piping and liquid line piping.
c. Loosen and remove nuts from second stage manifold (134), second stage body (601).
d. Remove second stage manifold (134) from pump.
e. Remove second stage cone (605) and shims (4-2) from pump.
f. Loosen and remove bolts from second stage body (601) from pump.
g. Loosen and remove the second stage locknuts and washers (610-1. 610-2, 610-3).
h. Using proper cable to hold the second stage rotor (610). Slide and remove the second stage rotor (601) from shaft (111).

Note:

Second stage rotors (610) are slide tolerance with shaft (111), if rusty between may need a puller to dismantle the rotor.

i. Slide the bracket (608) packing gland (613) from stuffing box. Loosen and remove the bolts between bracket (608).

j. Remove the bracket (608) packing gland (613) from shaft (111). Second stage dismantles completed.

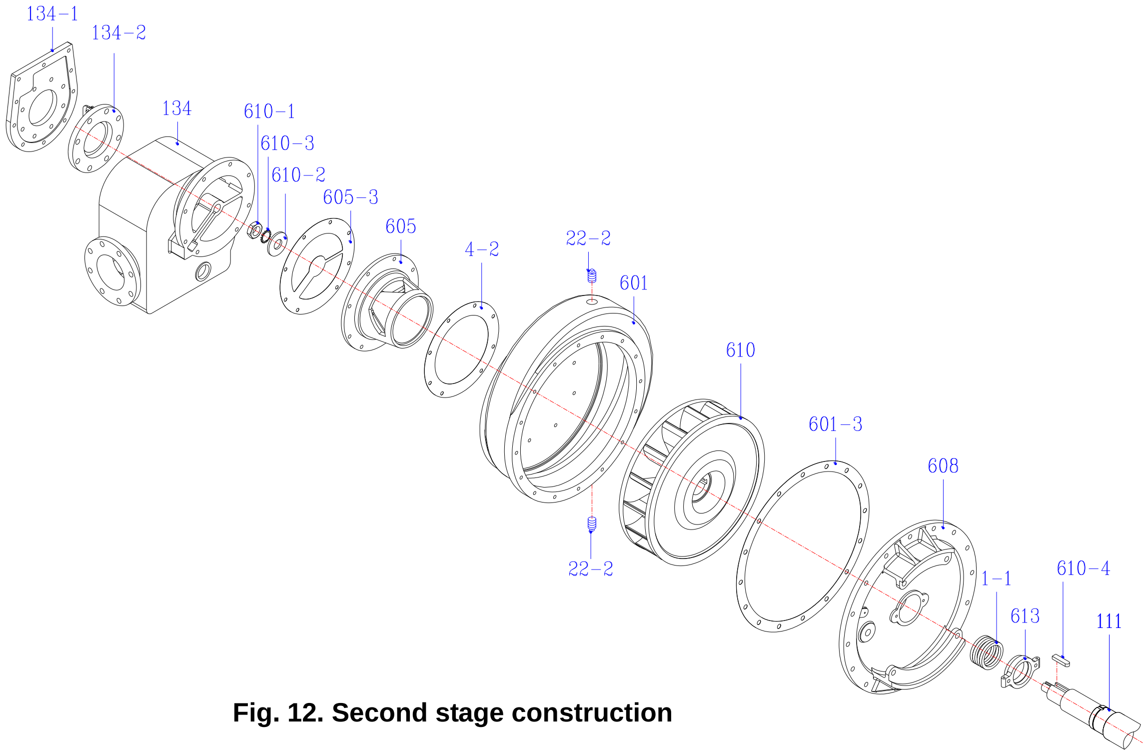


Fig. 12. Second stage construction

6.3. IE head disassembly

Below description the IE head dismantle procedure, IE head and relative parts drawing as Fig.13.

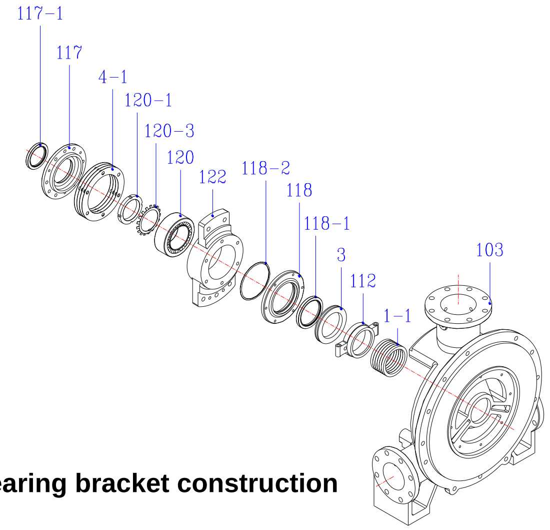


Fig. 13. IE Head & bearing bracket construction

Before remove head, put support block under body (101) below, make sure pump foots are not contact grounds.

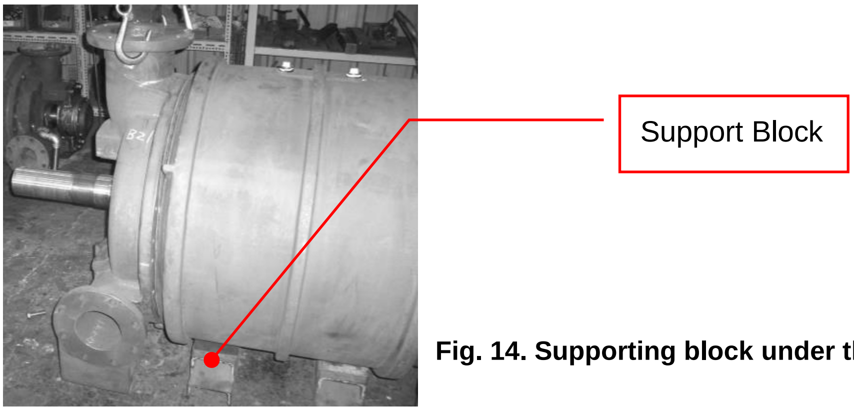


Fig. 14. Supporting block under the body

a. Remove the bolts and nuts from outer IE bearing cap (117).

b. Loosen the bolts between IE bearing bracket (122) – IE head (103).

c. Screw the bolts into IE bearing bracket (122) thread, bolts size and dimension as below table.

d. Tight these bolts balance, to remove the IE bearing bracket (608).

e. Loosen and remove the IE bearing nut and washer (120-1, 120-3).

f. Preparing below equipment for bearing dismantle.

1. Hydraulic jack-20Tons
2. STUDS MB x Length
3. Back up plate- 15mm thickness.

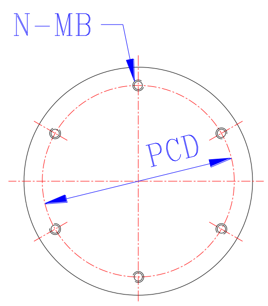


Fig.15A. Back up plate drawing

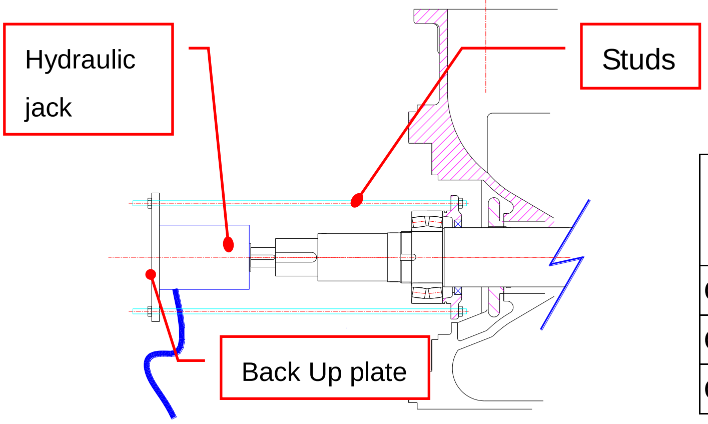


Fig. 15. Jig assembly for bearing remove

Model	Stud info.	Back up Plate		
		N	B	PCD
CAT-706	M10x 500L	4	10	146
CAT-1006	M10x 550L	4	10	210
CAT-2006	M12x 650L	6	12	214

Table 2. Bearing disassembly jig info.

g. After bearing move out then remove the slinger (3) and packing gland (1-1).

h. Body (101) bottom support with block to hold the pump and head without touch ground.

i. Lift and holding the IE head (103) and loosen the bolts between IE head (103) – Body (101).

j. Remove the IE head (103) from body (101).

6.4. DE head disassembly

Below description the DE head (102) dismantle procedure. DE head and relative parts drawing as Fig.17.

a. DE head (102) remove are similar as IE head (103) remove procedure. Please follow section 6.3

b. DE bearing (119) remove jig and assembly same as IE head (103).

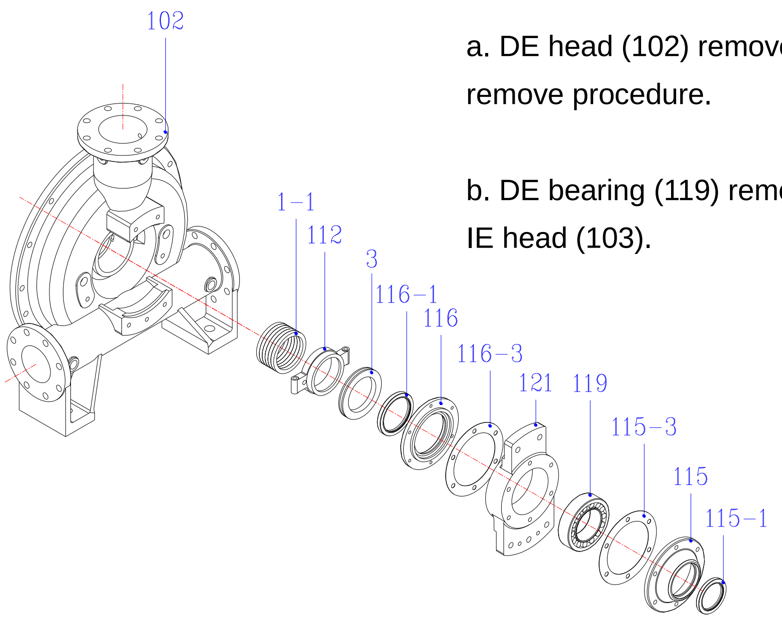


Fig. 17. DE Head & bearing bracket construction

6.5. Remove rotor from body

Slide the rotor shaft assemble from housing to prevent damage to the inner bore of the housing.

6.6. Cone disassembly

a. Remove all the cap screw from cone as Fig.18.

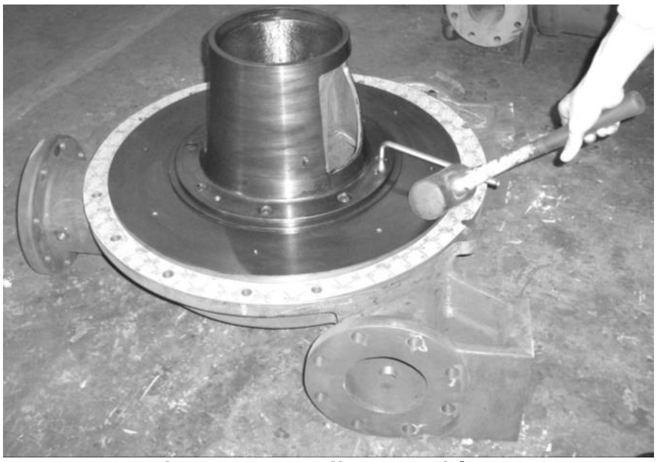


Fig. 18. Cone disassembly

b. Screw the cap screw into the cone thread to push cone leave from head.

c. Life the cones from head assembly.

Note: Before dismantle the cones, mark on cones and heads to avoid wrong side and angle installation.

6.7. Rotor-shaft- disassembly

Before removing the rotor (110) from the shaft (111), 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 3 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 cause shaft have shoulder design.

3. Secure a bushing with a bore, sized to slip lit over the shaft shoulder and shaft key (see Table 5 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.

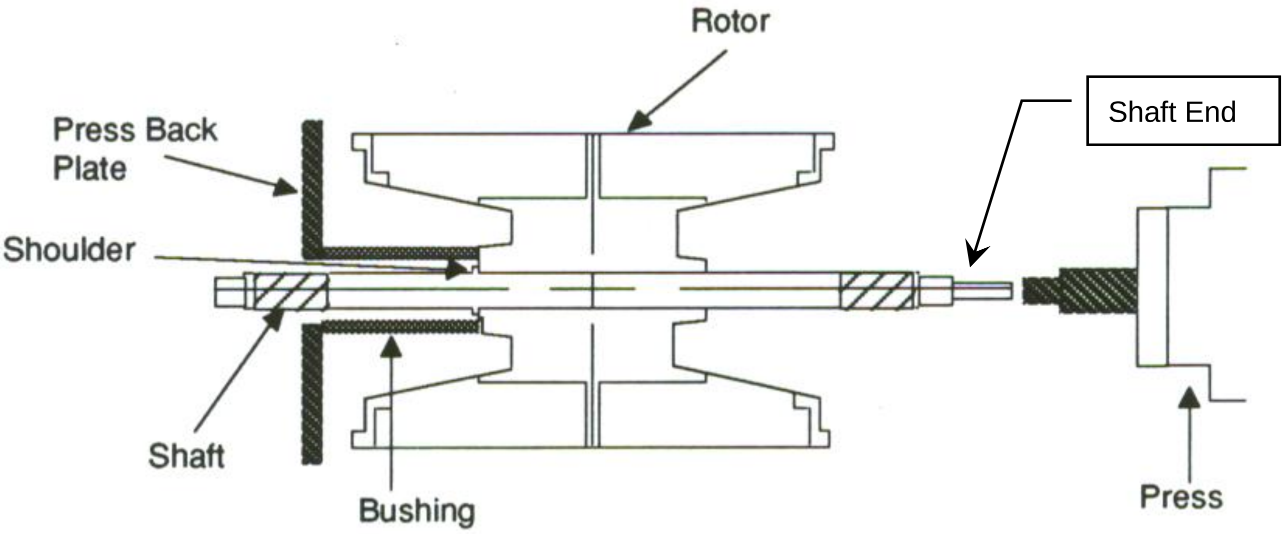


Fig. 19. Pressing shaft from rotor

CAT Model	Press (Tons)	Press Cap. (Tons)	Bushing bore ID (in)
706	4.8 – 6.0	20	3 1/4
1006	7.7 – 8.6	50	4
2006	9.6 – 11.5	50	5 3/8

Table 3. Press loading force by model size

7. Inspection

Before description after pump dismantled, inspect parts for wear from corrosion.

7.1. Cones

a. Checking cones for wear as Fig.20. After cones surface clean up.

b. If the corrosion deeper than 0.4 mm, replace the cone.

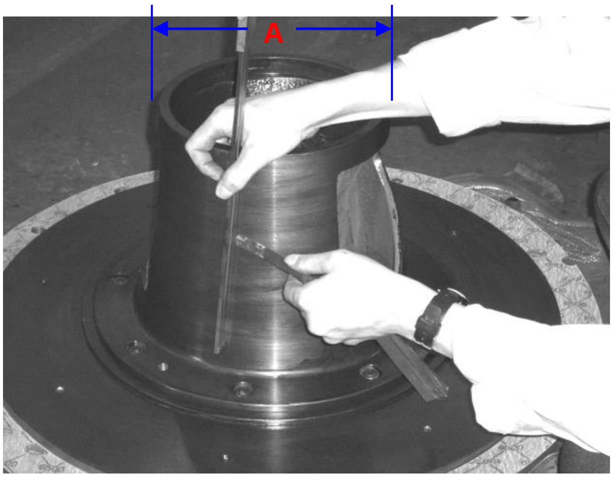
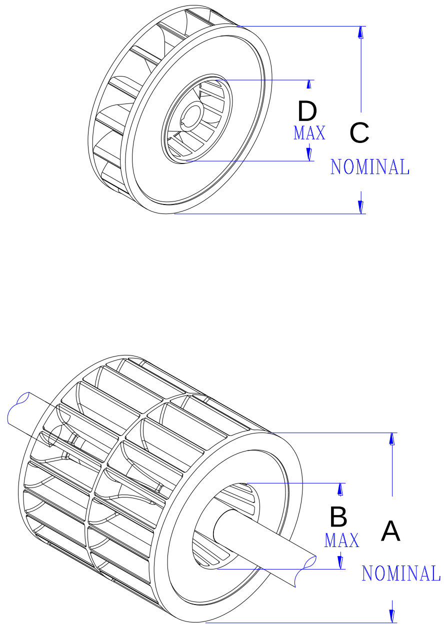


Figure 20. Checking Cone for Wear

Parts	DIMENSION "A" (INCHES)		
	CAT-706	CAT-1006	CAT-2006
FIRST STAGE CONE	5.096	6.564	9.150
SECOND STAGE CONE	5.102	6.566	9.150

Table 4. Cone wears tolerance

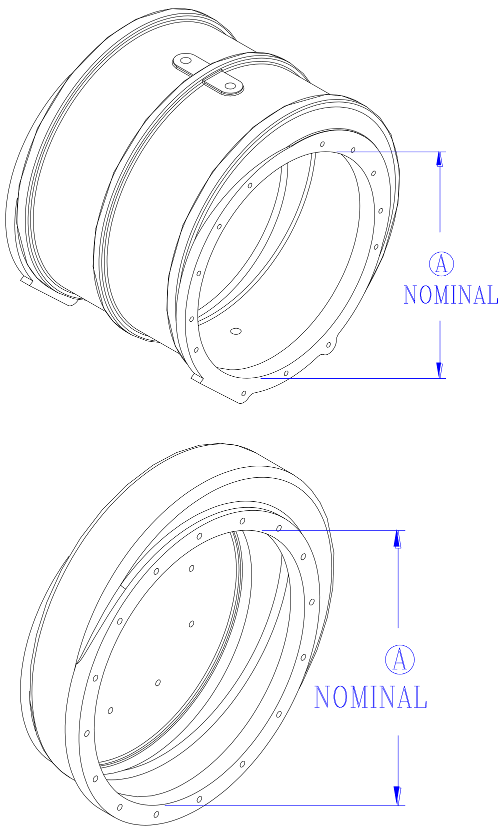
7.2. First and second stage of rotor and housing dimensions check



PUMP	DIMENSION (INCHES)			
MODEL	A	B	C	D
CAT-706	14.250	6.183	14.250	6.696
CAT-1006	18.000	7.821	18.000	8.424
CAT-2006	25.000	10.688	25.000	11.659

Table 5. Rotor wears tolerance

Figure 21. Rotor Wear Tolerances



	DIMENSION A (INCHES)		
Model	CAT-706	CAT-1006	CAT-2006
A	14.270	18.020	25.023

Table 5. First stage body Wear Tolerances

Model	CAT-706	CAT-1006	CAT-2006
A	14.270	18.020	25.020

Table 5A Second stage body Wear Tolerances

Figure 22. Body Wear Tolerances

7.3. Shaft

Shaft surface cannot have any damage or corrosion on the IE/DE bearing, 1 & 2 rotor hub position. Replace shaft if damage or corrosion once occur.

8. Reassembling the CAT vacuum pump

Following below steps for CAT pump assembly

8.1. Rotor and shaft assembly

a. Clean the surface of the shaft and bore of the rotor.

b. Apply Molykote to the section of the shaft on which rotor will be set.

c. Apply Molykote to the inner bore of the rotor.

d. Move rotor into the oven and heat for 3~4 hours until temperature reach 120 degree C.

e. Slide the DE of the shaft into the IE of the rotor hub until shaft shoulder touches the rotor hub, press shaft IE end if not touch.

Note: SS rotor will have rotor key design. Put the key on the shaft before shaft install into the rotor.

f. Wait the rotor cooling down till ambient temperature for next assembly step.

8.2. Body and rotor assembly

a. Support the first stage housing by supporting blocks.

b. Slide the rotor into housing, do not damage the housing inner bore.

Note: Standard direction – C.W view from DE shaft end. The housing eccentrics are up-right side.

8.3. DE head assembly

a. Clean DE head (102) surface for cones install position, then place a new cones gasket (104-3). On the DE head (102) can be applying with grease seal for avoid leakage.

b. Clean DE cones (104) surface for install position.

c. Install the DE cones (104) on the DE head (102), must same as original angle.

d. Use soft hammer hit the DE cone (104) flange to make sure surface are complete contact.

e. Screw all the bolts for cones and head by hand.

8.4. IE head assembly

Same as section 8.3.

8.5. DE and IE head assembly

a. Lift DE head (102) and body gasket (101-3) then install into the body (101).

b. Screw the bolts from DE Head (102) to body (101).

c. Lift IE head (103) with body gasket (101-3) and install into body (101).

d. Screw the bolts from IE Head (103) to body (101).

e. Lift the pump then put on a flat table for foot level adjusting, release all the bolts between head (102, 103) and body (101).
Check all the foot are complete contact with table, if not, hit the foot by soft hammer.

f. After foot level adjusting complete then tighten all the bolts.

8.6. DE bearing & bearing bracket assembly

a. Before bearing assembly that - packing ring (1-1), packing gland (112), slinger (3) and IB cap (116) and IB Cap's gasket (116-3) must be assembly first.

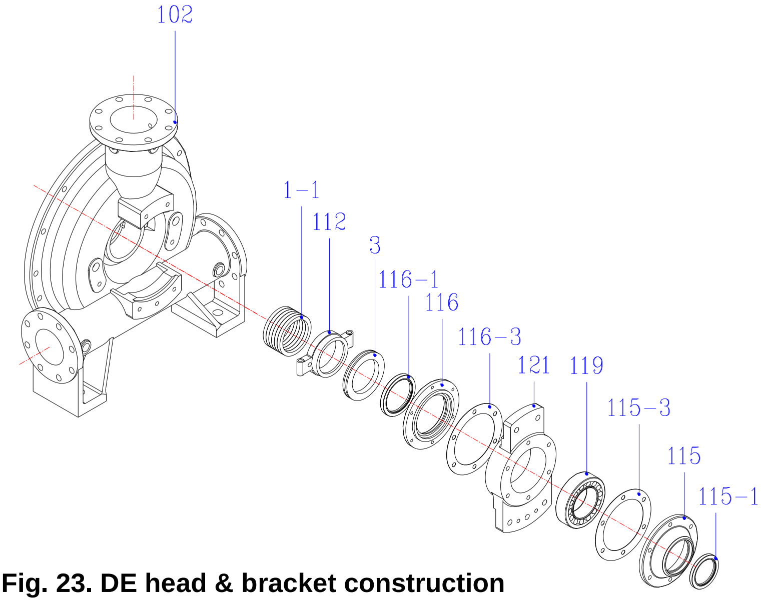


Fig. 23. DE head & bracket construction

b. Shaft bearing area applying with Molykote before bearing assembly, this can protect shaft when disassembly.

c. Heat the bearing (119) by electric resistance heater or hot oil bath until temperature reach setting from 95 ~ 120 deg C (△T = 80~90 deg C).

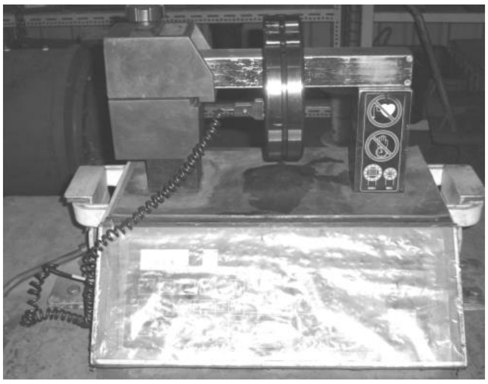


Fig. 24. Heater setting from 95 ~ 120 ^{o}C

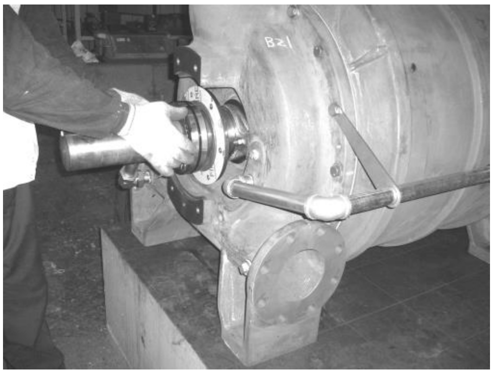


Fig. 25. Bearing install must contact the shoulder

d. After bearing reach setting temp. then install the bearing on the shaft immediately and confirm the bearing contact the shaft shoulder.

e. After bearing down to 40 deg C below then can be next step for bearing bracket assembly.

f. Assembly the bearing brackets with head, screw the bearing bracket and head by longer stud.

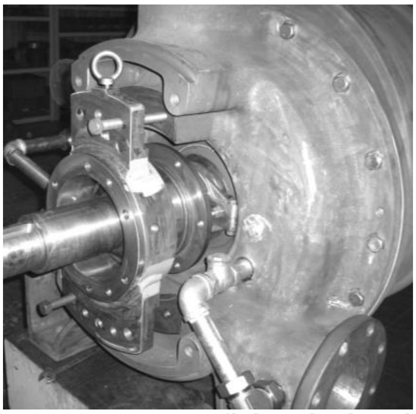


Fig. 26. Temporary fixing the bracket by longer studs

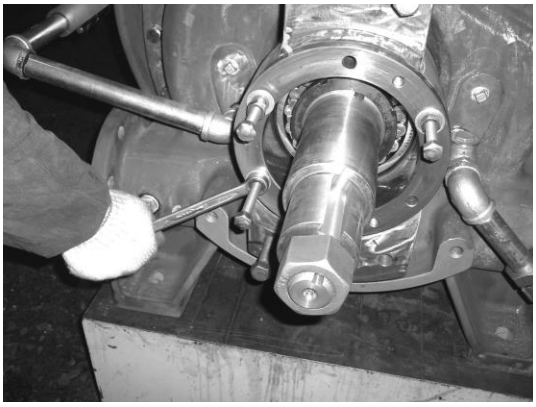


Fig. 27. Assembly the bracket by screw the nuts

g. Screw the bolts from bearing bracket (121) to Inner DE bearing cap (116), this will force slowly move the bearing bracket (121) until contact with the DE head (102).

h. Take out the longer stud and change the original bolts then screw and tighten together the bearing bracket (121) and DE head (102).
DE outer bearing cap (115) wills assembly later till rotor end travel setting completely.

8.7. IE bearing & bearing bracket assembly

a. Follow section 8.6.

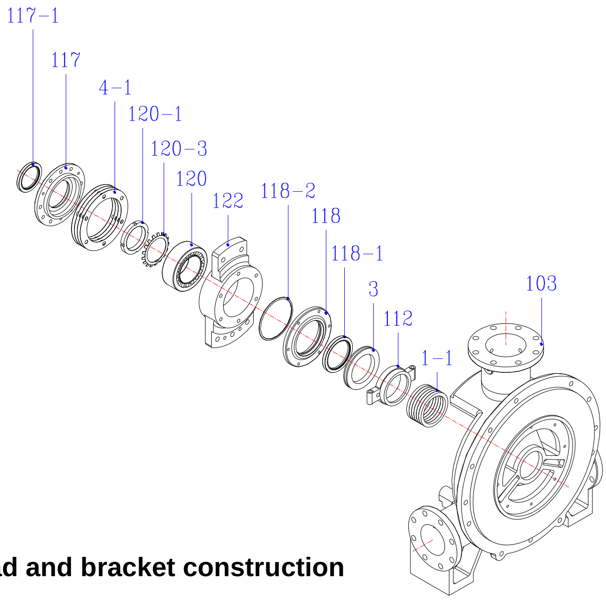


Fig. 28. IE head and bracket construction

b. Assembly the bearing washer and lock nut after bearing assembly and cooling down.

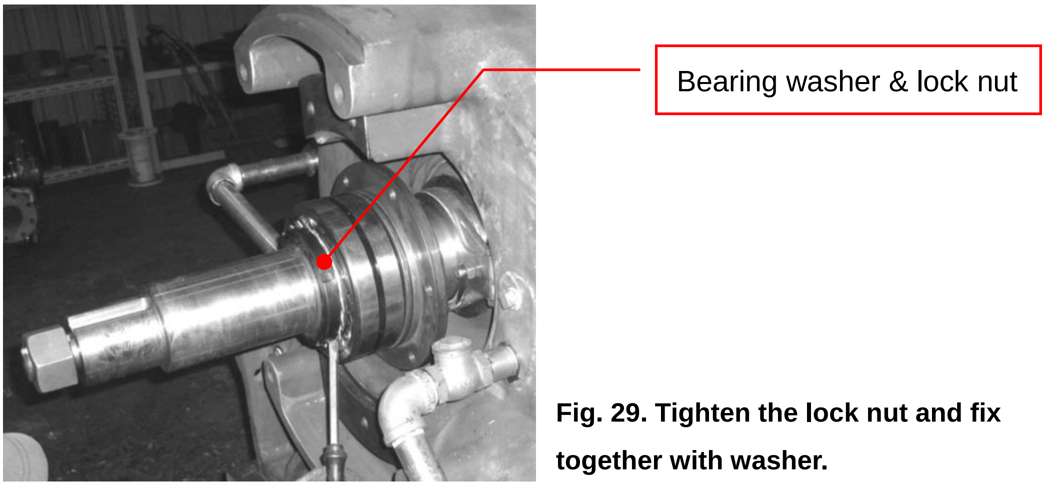


Fig. 29. Tighten the lock nut and fix together with washer.

c. Same procedure for DE bearing bracket (121) assembly.

d. Assembly IE outer bearing cap (117).

8.8. Checking and setting rotor end travel

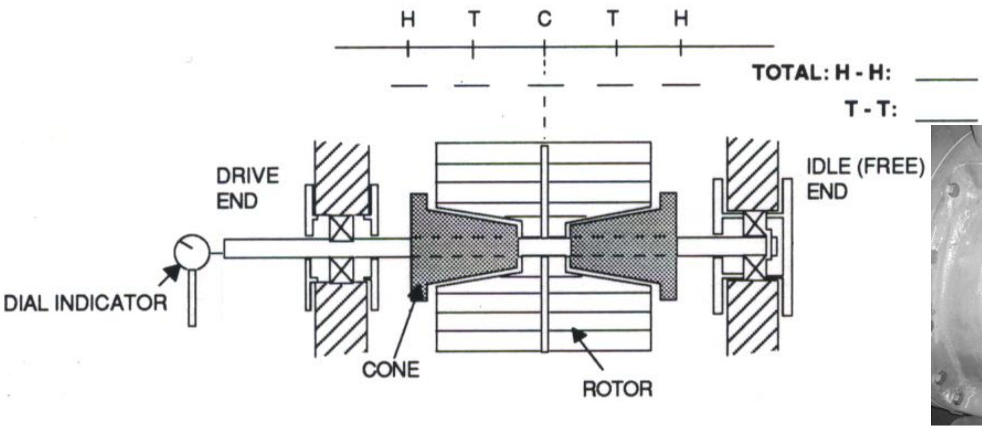


Fig. 30. Checking rotor travel schematic

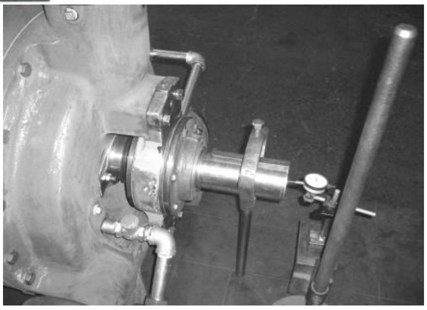


Fig. 30A. Rotor end travel measurement

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 tree 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.

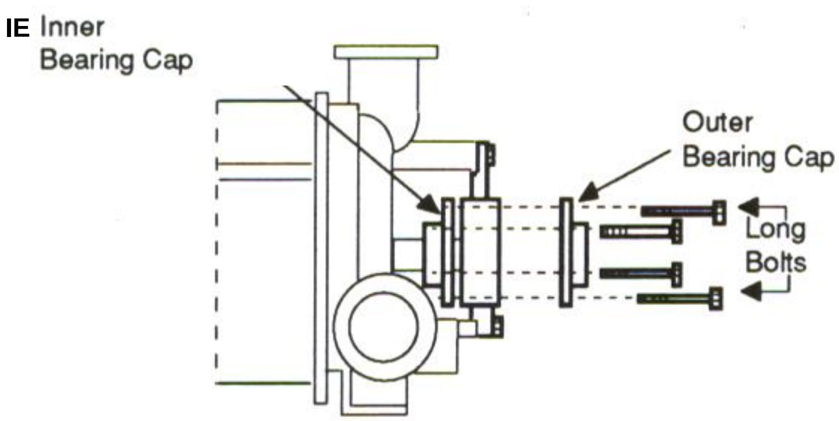


Fig. 31. Move rotor by tighten IE outer bearing cap different bolts

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 lake-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 lo 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%)**
700	2.9	2.0
1000	3.2	2.1
2000	4.7	3.1

Table 7. Rotor end travel value

Correcting for hard-to-hard values

If the hard-to-hard measurement is greater than the value in Table 7 (+10%), use the following procedure to correct:

1. Subtract the value in Table 7 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 7 (-10%), use the following procedure to correct:

1. Subtract the touch-to-touch measurement from the value in Table 7. 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.

8.9. IE bracket assembly

a. Loosen the IE bracket packing gland nuts and let the packing ring can be slide over the shaft.
b. Lift the IE bracket (608) and assembly to IE head (103), screw together.
c. Measure the distance "D" as below drawing position distance.

Fig. 32. Measure the distance "D"

PUMP MODEL	Dimension "D"(± 0.15mm)
CAT-706	6.35mm
CAT-1006	4.75mm
CAT-2006	7.9mm

Table 8. Distance D value

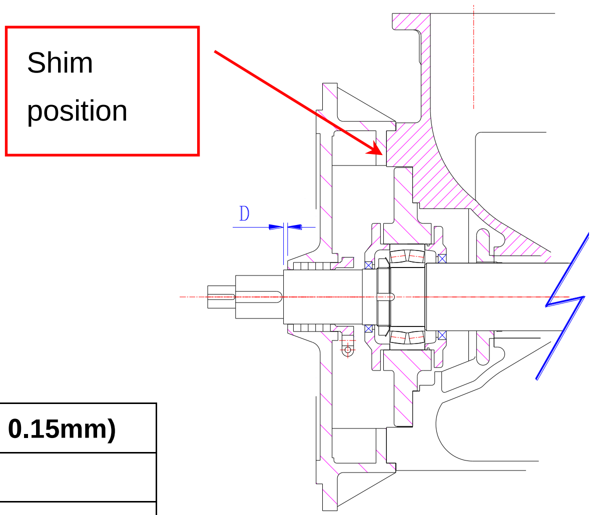


Fig. 33. Bracket setting and adjusting

d. If "D" are larger then table 8 list, then put 4 piece of shim between IE bracket (608) and IE head (103) as above drawing position.

e. Verticals and centering between IE bracket (608) and shaft (111), measure by dial indicator between shaft and bracket (608) outside machine area as below picture.

f. Adjusting the vertical by shim between IE bracket (608) and IE head (103).

g. Adjusting the IE bracket centering by soft hammer to To hit the outside edge of IE bracket (608).

h. After confirm vertical and centering then tight the bolts between IE bracket (608) and IE head (103).

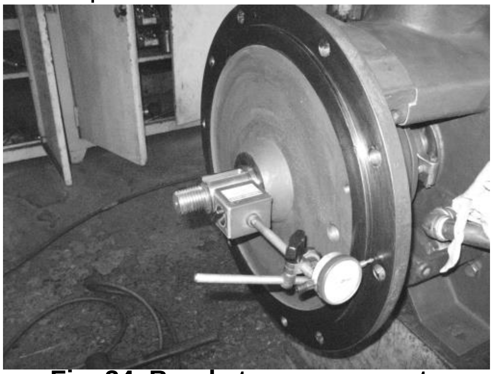


Fig. 34. Bracket measurement

8.10. Second stage rotor assembly

a. Put the second stage shaft key (610-4) and lift the rotor (610) for assembly.

b. Slide rotor (610)on the shaft (111) until contact the shaft shoulder.

c. Tight the second stage rotor (610) with nut and washer (610-1, 610-2, 610-3).

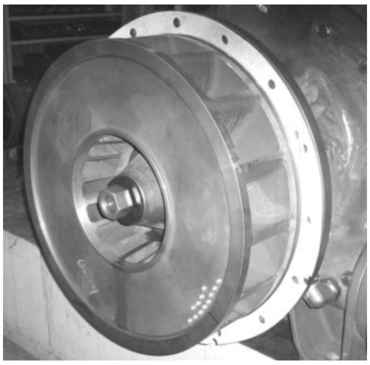


Fig. 35. Second stage rotor installation

8.11. Second stage body assembly

a. Put the second stage body gasket (601-3) on the IE bracket (608).

b. Lift the body (601) and assembly with IE bracket (608), notice the direction must be correct and follow original.

c. Screw second stage body (601) and IE bracket (608) together.

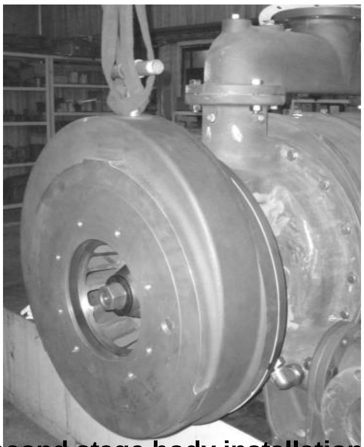


Fig. 36. Second stage body installation

8.12. Second stage cones and manifold assembly

a. Lift the second stage cone (605) and put into the body (601), screw by 2~3 bolts average until cones (605) and rotor (610) contact completely.

b. Measure the gap distance by feeler gauge (4 point, 90 deg distance) between second stage cone (605) and body (601).

c. Total shim thickness = measure distance + Gap A (as below table)

PUMP MODEL	Dimension “A”(± 0.12mm)
CAT-706	0.95 mm
CAT-1006	1.0 mm
CAT-2006	1.5mm

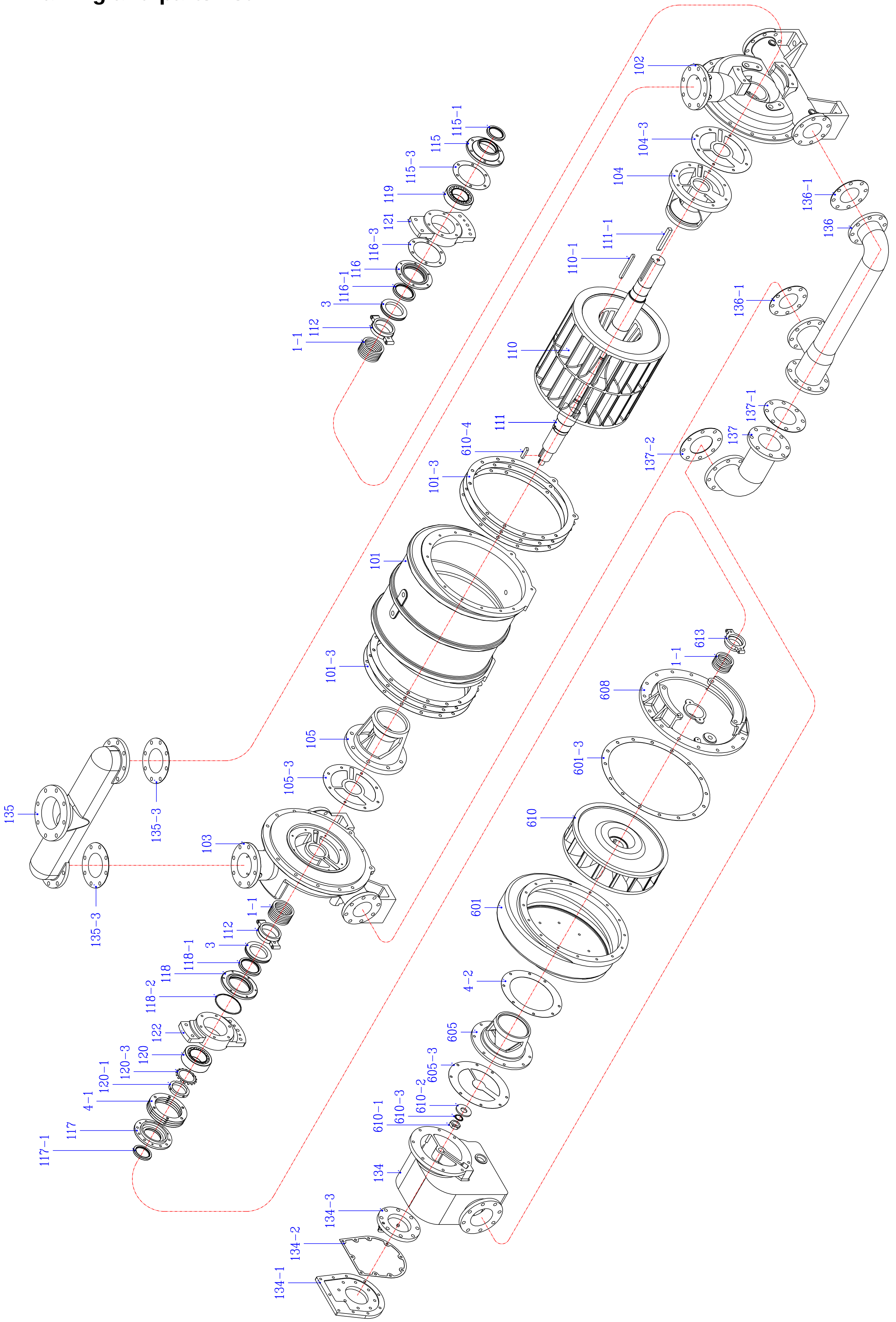
Table 9. Gap setting value for Second stage cone.

Fig. 37. Measure the gap by feeler gauge

d. Put the correct shim (4-2) thickness between second stage cone (605) and body (601), screw all the studs on the body (601). All the studs must apply grease sealing first for avoid leakage.

e. Put the second stage cone gasket (605-3) behind the cone (605) and make sure on the correct angle.
f. Lift the second stage manifold (134) and assembly together with cone (605) and body (601).
g. Secure all the nuts for complete the second stage manifold (134) and cones (605) assembly.
h. Rotating extent shaft (111) and make sure no any metal contact happen.
i. Complete assembly for DE outer bearing cap (115).
j. Complete all the sealing piping and pump assembly work done.

9. Drawing and parts list



	(Numbers in parentheses indicate weight in pounds)				
1-1	Packing ring	116	Inner DE Bearing Cap	136	First Stage Outlet Manifolds
3	Slinger	116-1	Inner DE Bearing Cap Oil Seal	136-1	Gasket
4-1	Shim	116-3	Inner DE Bearing Cap Gasket	137	Weld Neck Flange
4-2	Shim	117	Outer NDE Bearing Cap	137-1	Gasket
101	First Stage Body (690)	117-1	Outer NDE Bearing Cap Oil Seal	137-2	Gasket
101-3	First Stage Body Gasket	118	Inner NDE Bearing Cap	601	Second Stage Housing (283)
102	DE Head (516)	118-1	Inner NDE Bearing Cap Oil Seal	601-3	Second Stage Housing Gasket
103	IE Head	118-2	Inner NDE Bearing Cap O-ring	605	Second Stage Cone (58)
104	DE Cone (64)	119	DE Bearing (24)	605-3	Second Stage Cone Gasket
104-3	DE Cone Gasket	120	NDE Bearing (24)	608	Bracket (143)
105	NDE Cone (64)	120-1	NDE Bearing Nut	610	Second Stage Rotor (240)
105-3	NDE Cone Gasket	120-3	NDE Bearing Washer	610-1	Second Stage Rotor Locknut
110	First Stage Rotor (630)	134.	Second Stage Head (75)	610-2	Second Stage Rotor Flat Washer
111	Shaft (300)	134-1	Second Stage Cover	610-3	Second Stage Rotor Locknut Washer
111-1	Shaft Key (SS rotor only)	134-2	Gasket	610-4	Shaft Rotor Key
112	Packing Gland	134-3	Check Valve	613	Packing Gland
115	Outer DE Bearing Cap	135	Inlet Manifold (150)		
115-1	Outer DE Cap Oil Seal	135-1	Inlet Manifold Nut		
115-3	Outer DE Beating Cap Gasket	135-2	Inlet Manifold Bolt		
		135-3	Inlet Manifold Gasket		
		135-5	Inlet Manifold Gasket		

Appendix A - Trouble Shooting Guide

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
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

Appendix B - Bearing model and location

Location / Model	Drive End x 1 set	Inner End x 1 set
CAT- 700	21311 EAE4	21311 EAE4
CAT- 1000	22315 EAE4	22317 EAE4
CAT- 2000	22220 EAE4	23220 EAE4