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VACUUM SYSTEMS SINCE 1993

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Building A,

Fairfield, NJ 07004

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**Operation &
Maintenance**

Manual

for N904 Series

Vacuum Pumps

and

Compressors

WARNING

Do not operate PUMP before primed and connected to the constant supply of clean compressant liquid. **IF RUN DRY, PUMP WILL BE DAMAGED**; always use a strainer to prevent sand and scale from entering the pump with liquid sealant.

Specific operating conditions combined with water hardness may result in excessive lime deposits inside the pump, causing it to bind. Should this condition be evident, flush the pump with a solvent at regular intervals.

This pump has been drained and flushed with water-soluble preservative oil before shipment. After the pump has been in service, do not store without draining as specified in this manual. The freezing of the preservative oil can damage the pump.

USE CAUTION when removing inlet screens. Any foreign material on the screen may fall into the pump and cause extensive damage at start-up.

The base must be mounted to a leveled foundation, and final coupling alignment is done during installation. (Refer to manual No.XXX, Installation Instructions, N.E.S. Company Vacuum Pumps and Compressors.)

NOTICE

SERVICE AND PARTS

SERVICE AND PARTS FOR NES VACUUM PUMPS ARE ASSURED THROUGH A WORLDWIDE NETWORK OF SALES AND SERVICE OFFICES LISTED ON THE BACK COVER OF THIS MANUAL. ANY REQUEST FOR INFORMATION, SERVICE, AND PARTS SHOULD BE DIRECTED TO THE NEAREST NES SITE / FIELD OFFICE. WHEN ORDERING REPLACEMENT AND SPARE PARTS, SERIAL NUMBERS AND PUMP SIZES MUST BE PROVIDED.

Serial number and pump size are located on nameplates riveted/fastened to the pump's casing/body. Parts must be identified by index number and name. Refer to pump exploded view and legend found in this manual.

If the location of the nearest office is unknown, information may be secured directly from N.E.S. Company Inc. New Jersey Headquarters: 333 RT 46 W, BLDG: A, FAIRFIELD NJ 07004. Telephone number is 1-800-297-3550, Fax No. 973-933-6322

WARRANTY

NES Company warrants that (1) the goods will be of the kind described on its acceptance of Buyer's order as modified by any subsequent mutual agreement of the parties, (2) it will convey to Buyer good title to such goods, (3) such goods will be delivered free of any lawful security interest or lien or encumbrances unknown to Buyer, and (4) such goods will be of merchantable quality and free from defects in material or workmanship defects under normal use and prescribed maintenance for a period of two (2) years from the date of shipment. The warranties specified shall also extend to goods manufactured by others and supplied by N.E.S., unless such goods have been separately stated and quoted by N.E.S., in which case only the warranties in clauses (1), (2) and (3) shall apply. NES MAKES NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE MERCHANTABILITY OF GOODS MANUFACTURED BY ITS SUPPLIERS AND SEPARATELY STATED AND QUOTED HEREIN. N.E.S. 's warranty in clause (4) above shall not apply to goods of standard construction when handling corrosive gasses or using corrosive liquid compressant nor will clause (4) apply to goods which have been damaged, altered, or negligently maintained after delivery. Buyer's exclusive remedy for N.E.S.'s breach of the warranties outlined in clauses (1), (2) and (3) above shall be the replacement by N.E.S. of non-conforming goods with conforming goods, without extra cost to Buyer, F.O.B. point of manufacture, with transportation prepaid to U.S. destination or domestic port, and Buyer's exclusive remedy for N.E.S. 's breach of the

warranty contained in clause (4) above shall be the repair by N.E.S. without charge, or the furnishing by N.E.S. F.O.B. point of manufacture, with transportation prepaid to U.S. destination or domestic port of a part or item of equipment to replace any part or item of equipment which is proved to have been defective; provided that (1) Buyer shall have notified N.E.S. of any such breach not later than ten days after the expiration of two (2) years from the date of shipment of the goods, and that (2) N.E.S. shall have the option of requiring the return of any defective material transportation prepaid to establish a claim. N.E.S. shall in no event be liable for Buyer's manufacturing costs, lost profits, goodwill, expenses, or any other consequential or incidental damages resulting from a breach by N.E.S. of any warranty. THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH EXTENDED BEYOND THE WARRANTIES SET FORTH HEREIN.

SAFETY PRECAUTIONS

1. Wear appropriate personal protective equipment, including safety glasses, lab coats, long pants, closed-toe shoes, and gloves, when working with vacuum pumps.
2. Store vacuum pumps on spill trays to prevent oil spills and ensure proper containment.
3. Insulate running areas of the vacuum pump for noise reduction, if necessary.
4. Dispose of used vacuum pump oils according to prevailing EH&S (Environmental Health and Safety) procedures.

Safety During Operation:

During continuous operation of the pump, observe the following safety precautions:

1. Ensure electrical cables/cords and power switches are in good condition and free from defects or loose connections.
2. Keep belt guards in place to prevent hands or loose clothing from getting caught in the belt pulley.
3. Avoid operating pumps near containers of flammable chemicals, flammable chemical wastes, or combustible materials such as paper or cardboard.
4. Use appropriate vacuum tubing with thick walls, avoiding thin Tygon-type hoses.
5. Avoid placing pumps in enclosed, unventilated cabinets to prevent heat buildup and exhaust accumulation.
6. Replace old tubing that is crumbling to maintain optimal performance.
7. Use the shortest length of tubing necessary to reach the desired location.
8. Avoid using solvents that may damage the pump.
9. Always close the valve between the vacuum vessel and the pump before shutting off the pump to prevent vacuum oil from being drawn into the system.
10. Place a pan under pumps to catch and collect oil drips.
11. Regularly check oil levels and change the oil as needed. Properly dispose of vacuum pump oil contaminated with condensate following EH&S procedures.
12. For oil-filled pumps with total recirculation service, be aware that many vapors can condense in the pump oil. Use cold traps or other appropriate methods to trap evaporated materials and ensure proper venting of the pump exhaust.

Safety During Service:

Before performing maintenance or service on a vacuum pump or compressor, adhere to the following safety precautions:

1. Stop the pump and ensure all power switches and circuit breakers are turned off. Use proper tagging to indicate "Do Not Switch On."

2. Equalize the pump pressure with atmospheric pressure by passing air into or out of the piping.
3. Empty or clear the service liquid from the pump before opening it.
4. If the pump has operated with harmful liquids or media, wash it thoroughly with an appropriate liquid as specified in the Material Safety Data Sheet (MSDS) of the operating fluid.
5. Maintain a record for each pump, documenting oil change dates, bearing greasing dates, shaft rotation dates, and maintenance schedule.

Please NOTE that these rephrased instructions are provided for clarity and understanding. It is important to follow the specific safety guidelines and procedures recommended by your organization and the equipment manufacturer.



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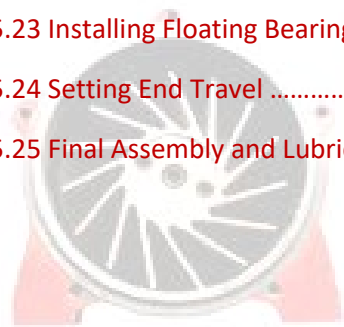
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1. Description

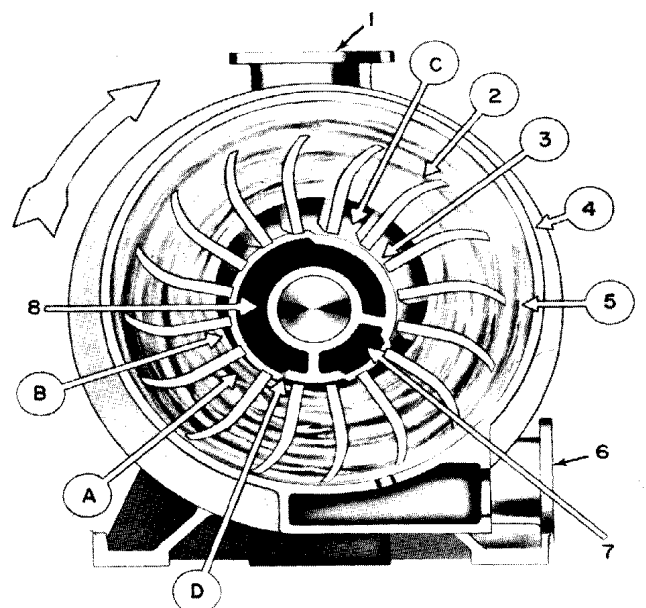
This manual provides essential information for individuals responsible for the NES N904® Vacuum Pumps and Compressors (Models L, M, P, R, S, T, and U), detailing operational and maintenance guidelines.

1.1 Working Principle

Section 1-2 delves into the operational mechanics illustrated in Figure 1-1. The pump's functionality is depicted wherein a rotor (2) operates within a circular casing (4) containing a liquid compressant, typically water (5). The rotor, composed of blades encased in a hollow cylindrical hub, rotates without metallic contact. These blades, shrouded on the sides, create chambers with a curvature aligning with the rotation arrow.

Commencing at point A, the rotor chambers are filled with water, rotating in tandem with the rotor but conforming to the casing's contour. As the rotor progresses, the water (5) initially filling the rotor chamber at point A recedes into the casing, leaving the chamber empty at point C. The converging casing directs the water back into the rotor chamber, reaching fullness again at point D. This cycle repeats with each rotor revolution.

During water recession at point B, air is drawn through an inlet port (8) in the stationary conical casing (3), connected to the pump inlet (1). As the rotor completes a 360-degree rotation, water forced back into the rotor chamber displaces air through discharge ports. The liquid compressant, water, serves the dual purpose of compressing air and sealing clearances between the rotor and cone, referred to as seal water.



- | | |
|------------------------------|----------------------------|
| 1. Pump Inlet | 5. Liquid Compressant |
| 2. Rotor | 6. Pump Discharge |
| 3. Stationary Conical Casing | 7. Internal Discharge Port |
| 4. Circular Casing | 8. Internal Inlet Port |

Fig. 1.1 Vacuum Pump and Compressor Operation

2. Operation

2.1 Preparation for Initial Startup

Please contact NES company for assistance with startup.

2.2 Liquid Compressant (Seal Water)

To ensure the pump operates effectively, it is crucial to supply the liquid compressant (seal water) at the appropriate pressure and flow rate. The recommended flow rates are detailed in Table 2-1. For compressors, the flow rate is approximately 1/4 US gallon per minute per brake horsepower, considering the minimum supply pressure outlined in Table 2-2.

Fluctuations in the seal water quantities reaching the pump impact its performance. It is essential to regulate the supplied quantity to optimize results based on specific operating conditions. This regulation can be achieved using a combination of an orifice union, adjusting valve, and pressure gauge, as illustrated in Figure 2.1. Additionally, a strainer should be integrated into the upstream piping.

Orifice unions play a pivotal role in regulating flow rates, relying on pressure differentials. Regardless of whether one or two orifice unions are employed, flow regulation is tied to maintaining an upstream pressure of 10 psig. The orifice unions specified in Figure 2.1 are recommended for the designated flow rates.

For real-time monitoring of seal water flow, the installation of a water meter (or flow indicator) is advisable, providing a visual representation of the actual flow rate to the unit.

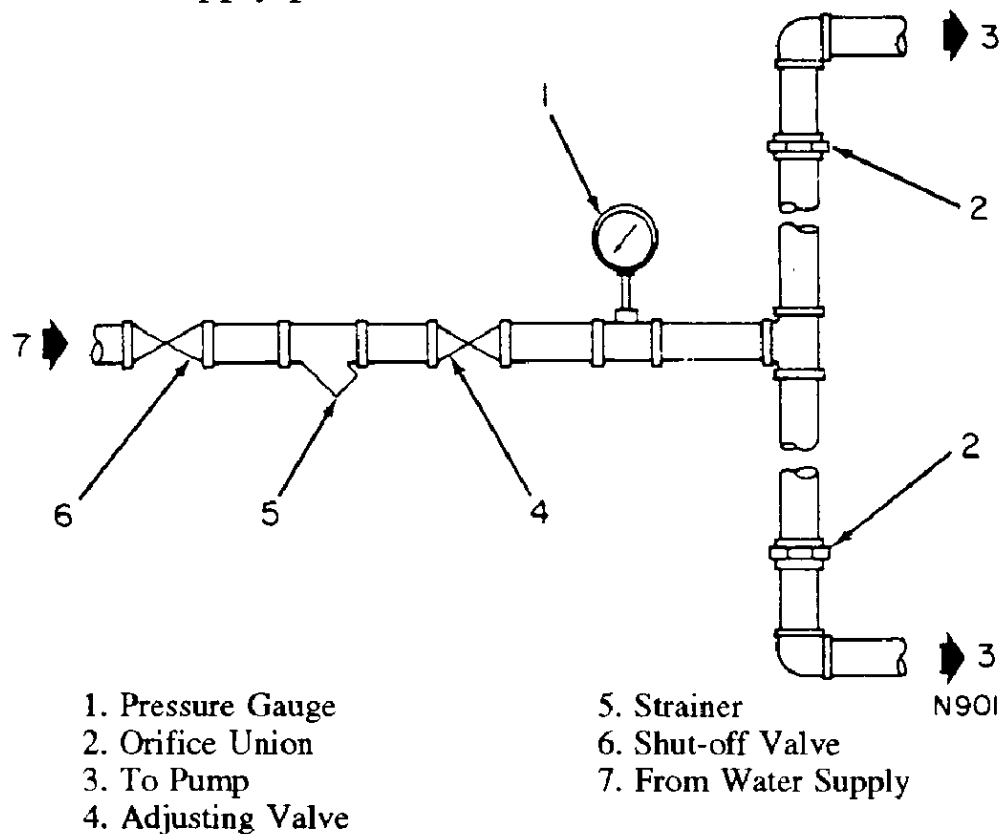


Fig. 2.1 Typical Seal Water Flow Rate Control

Pump Model	Orifice Diameter (In*)	Orifice Union (ips)
L1	15/32	1 - 1/2
L2	9/16	1 - 1/2
M1	1/2	1 - 1/2
M2	11/16	1 - 1/2
P1	17/32	1 - 1/2
P2	3/4	1 - 1/2
P3	25/32	1 - 1/2
R1	19/32	1 - 1/2
R2	25/32	1 - 1/2
R3	27/32	1 - 1/2
S1	21/32	2
S2	7/8	2
S3	15/16	2
T1	11/16	2
T2	31/32	2
T3	1	2
U1	7/8	3
U2	1 - 5/16	3

*For recommended seal water flow rates.

Arrangement for Cone Seal Flow Only

Pump Model	Flow Rate - GPM for Vacuum Range	
	0 to 15 in. Hg	15 to 20 in. Hg
L1	24	32
L2	32	48
M1	28	38
M2	40	72
P1	35	42
P2	53	70
P3	48	112
R1	45	53
R2	60	80
R3	50	130
S1	55	65
S2	75	100
S3	56	150
T1	60	72
T2	85	115
T3	60	170
U1	84	100
U2	120	180

Table 2.1. Recommended Seal water Flow Rates, Vacuum Pumps Only

Compressor Model	Seal Supply Pressure PSIG
L1	30
M1	30
P1	35
R1	35
S1	35
T1	35

Table 2.2. Recommended Seal Supply for Compressors

Compressor Size	†Valve and Line Size*	Start-up Bypass Interval (Minutes)
904 L1	6	3
904 M1	6	3
904 P1	8	3
904 R1	8	3
904 S1	10	3
904 T1	10	3

*Dimensions are in inches with millimeters shown in parentheses.

†Valve sizes below 2 inches (51 mm) are ball valves.

2 inches (51 mm) and above are butterfly valves.

Table 2.3. Startup Bypass Intervals, Compressors Only

CAUTION!

DO NOT ACTIVATE THE PUMP'S DRIVER UNTIL THE SEAL WATER SUPPLY IS TURNED ON. ENSURE THAT SEAL WATER IS SUPPLIED TO THE UNIT BEFORE STARTING IT, EVEN IF THE PUMP IS ONLY BEING OPERATED TO VERIFY THE DIRECTION OF THE DRIVER SHAFT ROTATION OR FOR ANY OTHER TESTING PURPOSES.

2.3 Lantern Gland Liquid

Lantern glands are provided in a pump upon customer request as an optional feature. To minimize the leakage of compressant liquid from the pump shaft packing, it is advisable to connect the lantern gland to the pump inlet. In instances where lantern glands are installed to manage air leakage into the pump through the shaft packing, they should be connected to a clean liquid source, typically water. When setting up the piping for the liquid source to the lantern gland, it is essential to include a strainer, an

adjusting valve, and a pressure gauge calibrated from 0 to 15 psig. These components are necessary for effectively controlling the pressure supplied to the lantern gland. While the pump is in operation, the pressure to the lantern gland should be adjusted to a range of 2.5 to 3.5 psig. It is crucial to avoid applying excessive pressure to lantern glands, as this can lead to increased wear on the packing and result in external leakage. Proper control within the specified pressure range is key to maintaining optimal lantern gland performance.

2.4 Draining and Flushing

Before initiating the pump following the completion of alignment, undertake the following steps: remove the drain plugs indicated in Figure 2-2 or Figure 2-2A from both the floating and fixed bearing end heads, and from the body. Ensure that the shut-off valve for the liquid compressant supply is open. Despite the pump being flushed with an inhibiting, water-soluble oil before shipment, a slight rust film may develop before installation is finalized. This film will dissipate after the pump has been operational for a few minutes. Once this occurs, close the shut-off valve for the liquid compressant supply. Subsequently, reinstall the drain plugs using a pipe thread compound. In situations where the pump will not be in continuous service for three weeks or more, and after draining and flushing refer to section 4.6 for preservation.

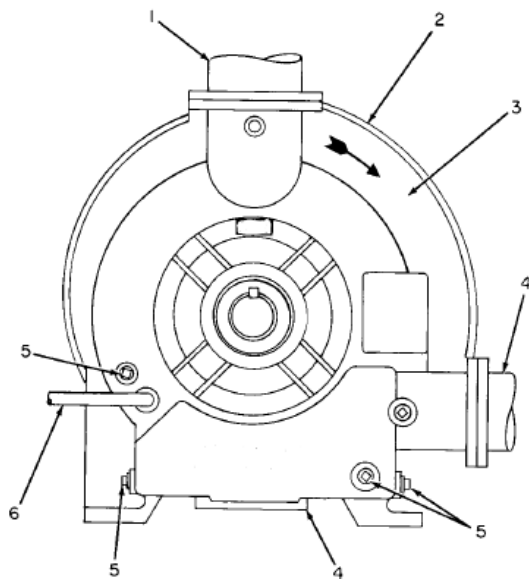


Fig. 2.2 Typical Piped Vacuum Pump L, M, P, R, S, T & U

2.5 Preliminary Inspection

Conduct the following preliminary inspections before initiating the pump:

WARNING!

PERFORM ALL OF THE FOLLOWING STEPS IN ORDER TO ENSURE PERSONNEL SAFETY AND EQUIPMENT PROTECTION.

- a. Ensure all power sources to the driver unit are isolated to prevent accidental starting.
- b. Inspect the pump and, if applicable, the recirculation pump, to ensure proper installation of all drain plugs.
- c. Then prime the pump with a liquid compressant.
- d. Inspect the separator, receiver, and heat exchanger (if used) to confirm the removal of all shipping plug protectors. Ensure that all open connections are either plugged or piped.
- e. Inspect all piping to confirm proper connections to the pump and its basic system in accordance with the NES installation drawing(s) provided with the pump. Verify that all piping is the correct size, securely connected, and adequately supported.

f. Inspect all other significant operational component connections (recirculation pump, dryer, turbine, etc.) associated with the pump, ensuring compliance with the recommendations provided by their respective equipment manufacturers.

g. Inspect all pump control components (control valves, flow metering devices, check valves, strainers, gauges, etc.) to confirm their allocation in accordance with the NES installation drawing(s). Verify that these components are correctly oriented in the piping scheme to achieve the proper direction of flow and ensure functional operation.

h. Inspect the pump inlet to ensure that the inlet screen and clean-out connections have been properly made and are free of tools, equipment, and debris (refer to Installation Instructions, NES Vacuum Pumps and Compressors).

i. Remove the coupling or V-belt guard(s) and manually rotate the pump shaft in the specified direction of rotation, as indicated by an arrow cast on the pump and illustrated on the installation drawing. It is crucial that the pump shaft rotates freely. If the pump shaft is bound and manual rotation is not achievable, contact your NES Representative for assistance.

j. With the main supply valves open and the pump properly primed, as outlined in step c, briefly engage the drive for the pump to verify the correct direction of shaft rotation and ensure the appropriate functioning of the recirculating pump (if used).

CAUTION!

DO NOT TRY TO RELEASE A BOUND PUMP SHAFT BY APPLYING POWER TO THE DRIVER. SERIOUS DAMAGE MAY OCCUR.

NEVER OPERATE THE PUMP WITHOUT SUFFICIENT PRIMING AND LIQUID SEAL FLOW. ELEVATED LIQUID SEAL SUPPLY PRESSURES DO NOT GUARANTEE ADEQUATE FLOW. VERIFY FLOW FROM THE VACUUM PUMP DISCHARGE (OR WATER TRAP SILENCER).

2.6 STARTUP AND OPERATING CHECKS for VACUUM PUMPS

Once the preliminary inspection and preoperational check procedures are finished, initiate the pump and assess its operation using the following steps:

WARNING!

IF THE PUMP IS TO BE TESTED IN A SYSTEM, ALERT THE RELEVANT PLANT PERSONNEL BEFORE PUTTING THE PUMP ONLINE, ESPECIALLY WHEN INITIATING THE PUMP FOR THE FIRST TIME. STARTING UP A SYSTEM ABRUPTLY MAY RESULT IN PERSONNEL INJURY.

NOTE

REFER TO THE TROUBLESHOOTING SECTION (SECTION 3) IF ANY OPERATIONAL CHALLENGES ARISE DURING THE EXECUTION OF THE FOLLOWING STEPS.

IF PUMP OPERATION BECOMES UNSTABLE, THERE WILL BE AN INCREASE IN PUMP VIBRATION LEVELS AND A DECREASE IN PUMPING VOLUME. IF THE PUMP FAILS TO STABILIZE, SHUT DOWN THE SYSTEM IMMEDIATELY AND IDENTIFY THE ROOT CAUSE.

a. Confirm proper priming of the pump and the system, then activate all main water supply sources to the pump or heat exchanger.

b. With the water supply sources activated and all personnel and equipment clear of the pump system, energize the driver.

c. While stabilizing the pump at the required inlet vacuum, examine the flow of liquid seal (water) to the pump. In once-through systems, validate that the liquid seal is flowing out of the water trap silencer drain. In recirculated systems, ensure the recirculation pump (if used) is operational.

d. Continuously monitor the temperature of the pump casing during the startup process. If the temperature rises rapidly or exceeds 25°F (14°C) above the liquid compressant temperature, immediately shut down the unit and investigate the cause.

e. After initiating the pump, closely observe the temperature of the bearing housing until it stabilizes and begins to decrease. This process may take several hours and should level out at approximately 30°F (17°C) higher than the casing or ambient temperature. Excessive bearing temperatures may be due to factors such as excessive v-belt drive pull, coupling misalignment, excessive piping loads, or improper greasing of bearings. Over-greasing is a common cause; inspect the outer bearing housing cap. If it contains more than 1/3 grease, remove the excess and reassemble. If minimal or no grease is present, add grease through the fitting until it extrudes from the bearing face. Ensure the cap is filled to 1/3 and reassemble.

f. Inspect the pump for abnormal vibration and noise. If excessive vibration and noise are detected, promptly shut down the pump and investigate the cause.

g. Verify the speed (RPM) of the pump shaft rotation. For pumps with a single extended shaft, remove the access plug from the fixed bearing outer cap and insert a tachometer with a shaft extension if needed. Compare the measured speed with the rated speed for the pump, which can be obtained from purchase specifications or NES Representative consultation.

h. After the pump has operated for ten minutes with steady leakage from the stuffing box, evenly tighten the gland nuts through 30 degrees. Repeat at ten-minute intervals until there is a drip leakage from the gland without overheating. Subsequent tightening of the gland nuts through 30 degrees should be done with the pump operating at normal working temperature and vacuum.

CAUTION!

DURING START-UP, IF THE BEARING HOUSING TEMPERATURE EXCEEDS 180°F (82°C), OR IF ABNORMAL BEARING NOISE, VIBRATION, ODOR, OR SMOKING OCCURS, SHUT DOWN THE PUMP IMMEDIATELY AND INVESTIGATE THE CAUSE.

2.7 STARTUP AND OPERATING CHECKS for COMPRESSORS

Once the preliminary inspection and pre-operational check procedures are completed, initiate the compressor and inspect its operation using the following steps:

WARNING!

IF THE COMPRESSOR IS TO BE TESTED IN A SYSTEM, ALERT THE RELEVANT PLANT PERSONNEL BEFORE PUTTING THE COMPRESSOR ONLINE, ESPECIALLY WHEN INITIATING THE COMPRESSOR FOR THE FIRST TIME. STARTING UP A SYSTEM ABRUPTLY MAY RESULT IN PERSONNEL INJURY.

NOTE

REFER TO TROUBLESHOOTING, SECTION 3, IF ANY OPERATIONAL CHALLENGES ARISE DURING THE EXECUTION OF THE FOLLOWING STEPS.

- a. Inspect the compressor and the system to ensure adequate priming, then activate all main water supply sources to the compressor and the heat exchanger.
- b. Open the separator bypass valve to its maximum position.
- c. With the water supply sources activated and all personnel and equipment clear of the compressor system, energize the driver. Gradually close the separator bypass valve until the separator pressure gauge indicates a maximum of 3 psig.

CAUTION!

THE PRESSURE READ AT THE SEPARATOR PRESSURE GAUGE MUST NOT EXCEED 3 PSIG FOR THE TIME SPECIFIED IN TABLE 2-3 TO AVOID UNSTABLE OPERATION AND POSSIBLE COMPRESSOR DAMAGE.

IN ONCE-THROUGH SYSTEMS, IF THE SEPARATOR WATER LEVEL RISES ABOVE THE GAUGE GLASS, IMMEDIATELY SHUT DOWN THE COMPRESSOR AND INSPECT FOR RESTRICTION IN THE WATER DISCHARGE FROM THE SEPARATOR. IF THE SEPARATOR PRESSURE IS BELOW 3 PSIG, ADJUST A DISCHARGE VALVE AND RECHECK. DURING NORMAL OPERATION, SYSTEM BACK PRESSURE SHOULD BE SUFFICIENT TO PRESSURIZE THE SEPARATOR. IF SYSTEM BACK PRESSURE IS INSUFFICIENT, A DISCHARGE ORIFICE MAY BE REQUIRED. SEEK ADVICE FROM YOUR NES REPRESENTATIVE FOR RECOMMENDATIONS.

NOTE

IF THE COMPRESSOR IS TURBINE-DRIVEN, THE SEPARATOR BYPASS VALVE MAY NEED READJUSTMENT (OPENING) TO MAINTAIN THE 3 PSIG VALUE WHILE THE TURBINE IS COMING UP TO SPEED. IF COMPRESSOR OPERATION BECOMES UNSTABLE, RESULTING IN INCREASED VIBRATION LEVELS AND DECREASED PUMPING VOLUME, GRADUALLY OPEN THE SEPARATOR BYPASS VALVE TO ATTEMPT TO RESTABILIZE THE COMPRESSOR. IF STABILIZATION OCCURS, PARTIALLY CLOSE (THROTTLE) THE SEPARATOR BYPASS VALVE. IF THE COMPRESSOR FAILS TO STABILIZE, IMMEDIATELY SHUT DOWN THE SYSTEM AND DETERMINE THE CAUSE. IF THE COMPRESSOR IS BEING CHECKED IN THE SYSTEM, THE DISCHARGE ISOLATION VALVE MAY NEED TO BE PARTIALLY CLOSED TO ACHIEVE THE REQUIRED 3 PSIG SEPARATOR BACK PRESSURE.

- d. While stabilizing the compressor at the discharge pressure setting, inspect the flow of liquid seal (water) to the compressor. In once-through systems, confirm that the liquid seal is flowing out of the ball float. In recirculated systems, ensure that the recirculation pump (if used) is operational.

e. Maintain continuous monitoring of the temperature of the compressor casing during the start-up procedure. If the temperature rises rapidly or exceeds 25°F or more above the liquid compressant temperature, promptly shut down the unit and investigate the cause.

f. After initiating the compressor, closely monitor the temperature of the bearing housing until it stabilizes and starts to decrease. This process may take several hours and should level out at approximately 30°F (17°C) higher than the casing or ambient temperature.

CAUTION!

DURING START-UP, IF THE BEARING HOUSING TEMPERATURE EXCEEDS 180°F (82°C), OR IF ABNORMAL BEARING NOISE, VIBRATION, ODOR, OR SMOKING OCCURS, SHUT DOWN THE COMPRESSOR IMMEDIATELY AND INVESTIGATE THE CAUSE.

h. Inspect the compressor for excessive vibration and noise. Abnormal levels of vibration and noise indicate a malfunction in a NES compressor. Shut down the compressor immediately and investigate the root cause.

i. Check the speed (RPM) of the compressor shaft rotation by removing the access plug from the fixed bearing outer cap and inserting a tachometer with a shaft extension if necessary. Compare the measured speed with the rated speed for the compressor, which can be determined from purchase specifications or by consulting with your NES Representative.

j. Once the compressor has completed the stabilization interval specified in Table 2-3 for operation at 3 psig, gradually close (throttle) the separator bypass valve until the normal discharge operating pressure is achieved. Observe for any abnormal noise or vibration as the separator bypass valve is throttled. If abnormal noise or vibration is observed, gradually open the separator bypass valve until the abnormal condition disappears. Afterward, close the separator bypass valve again to attain the normal discharge operating pressure. If noise

or vibration reoccurs, shut down the compressor and identify the cause.

k. After the compressor has been running for ten minutes with steady leakage from the stuffing box, evenly tighten the gland nuts one flat at a time. Repeat at ten-minute intervals until there is a leakage of approximately 45 to 60 drops per minute from the gland with no overheating. Subsequent tightening of the gland nuts one flat at a time should be performed with the compressor operating at normal working temperature and pressure.

3 Troubleshooting

3.1 Detecting Troubles

NES N904 pumps typically require minimal attention, with periodic checks of V-belt tension (if applicable) and the pump's ability to achieve full volume or maintain a constant vacuum. In the event of operational issues, conduct the following checks:

a. Verify the proper liquid compressant flow rate by referring to the established flow rate for the unit (see section 2.2).

b. Confirm the correct direction of shaft rotation as indicated on the pump body.

c. Ensure that the pump is operating at the correct RPM, noting that it may not necessarily be the test RPM stamped on the pump nameplate (refer to instructions in section 2.6, step g).

d. Check for obstructions in the discharge piping, as back pressure at the discharge port can reduce capacity, vacuum level (for vacuum pumps), or discharge pressure (for compressors), and increase the required driving horsepower.

e. Examine the gas inlet line for restrictions by reading the vacuum or pressure gauge in the inlet piping at the pump and at the process. Undersize piping and line obstructions can result in a higher vacuum at the pump than the

readings obtained at the work or process. Avoid using inlet throttling in compressor systems.

f. If the pump is shut down due to changes in temperature, abnormal noise, or vibration from normal operating conditions, inspect the bearings' lubrication, bearing condition, and coupling or V-belt drive alignment.

NOTE

IF THE ISSUE PERSISTS AFTER THESE CHECKS, CONTACT YOUR NES REPRESENTATIVE BEFORE DISMANTLING THE PUMP. THEY WILL ASSIST IN LOCATING AND CORRECTING THE PROBLEM.

4. Preventive Maintenance

4.1 Periodic Maintenance

NOTE

THE FOLLOWING SCHEDULES SHOULD BE ADJUSTED AS NEEDED TO ACCOMMODATE YOUR SPECIFIC OPERATING CONDITIONS.

4.2 Six-Month Intervals

- a. If the drive coupling requires lubrication, fill it with oil or grease following the instructions provided by the coupling manufacturer.
- b. Lubricate the pump bearings as outlined in Section 4.4.
- c. Follow the motor manufacturer's instructions to relubricate the drive motor bearings.

4.3 Twelve-Month Intervals

- a. Replace the stuffing box packing following the guidelines outlined in Section 4.5.

4.4 Bearing Lubrication

The pumps described in this Bulletin are equipped with grease-lubricated bearings. Bearings are pre-lubricated before shipment and

generally do not require additional lubrication for approximately six months.

NOTE

LUBRICATE THE BEARINGS EVERY SIX MONTHS, UNLESS THE PUMP IS OPERATING IN A CORROSIVE ATMOSPHERE OR WITH A LIQUID COMPRESSANT OTHER THAN WATER, IN WHICH CASE THE INTERVAL SHOULD BE SHORTENED. LUBRICATION SHOULD BE CARRIED OUT WHILE THE PUMP IS IN OPERATION.

CAUTION!

WHEN LUBRICATING THE BEARINGS, A TEMPERATURE RISE OF 40°F (22°C) OR MORE MAY OCCUR. DO NOT BE ALARMED; THE BEARING TEMPERATURE WILL GRADUALLY RETURN TO ITS ORIGINAL LEVEL.

Lubricate the bearings as follows:

- a. Check the slots at the bottom of the floating and fixed bearing inner and outer caps (115, 116, 117, and 118, Figure 5.21, 5.22, or 5.23) to ensure that they are not clogged with old dried-out grease.
- b. Apply grease as specified in Table 4.1 to the grease fittings (23) in the floating and fixed bearing brackets (108 and 109) until grease flows from the slots in the inner and outer caps.
- c. Examine the condition of the grease after the initial flow from the slots for contamination or the presence of water.
- d. If the grease is contaminated, remove the inner and outer caps, thoroughly clean the caps, bearing housing, and bearing of contaminated grease. Inspect the bearing. If the bearing is undamaged, reinstall the caps and add fresh grease as specified in Section 5.25, steps a and b. If the bearing is damaged, replace it with a new bearing specified in Table 5.1 following the procedures in Section 5.
- e. Continuously monitor the operation and temperature of the bearings during regular pump operation.

GENERAL REQUIREMENTS:

- A. Premium quality industrial bearing grease.
- B. Consistency grade: NLGI #2
- C. Oil viscosity (minimum):
 - @100° (38° C)- 500 SSU (108 cSt)
 - @ 210° (99° C)- 58 SSU (10c St)
- D. Thickener (Base): Lithium or Lithium Complex for optimum WATER RESISTANCE.
- E. Performance characteristics at operating temperature:
 - 1. Operating temperature range; at least 0° to 250° (18° to 121° C)
 - 2. "Long-Life" performance
 - 3. Good mechanical and chemical stability.
- F. Additives – Mandatory:
 - 1. Oxidation inhibitors
 - 2. Rust inhibitors
- G. Additives – Optional:
 - 1. Anti-wear agents
 - 2. Corrosion Inhibitors
 - 3. Metal deactivators
 - 4. Extreme Pressure (E.P.) agents
- H. Additives – Objectionable:
 - 1. Molybdenum disulfide
 - 2. Tackiness agents

NES STANDARD GREASE RECOMMENDATIONS:

The following is a list, by manufacturer, of some grease that exhibits the desired characteristics required by N.E.S.

Grease Manufacturer	Product
AMOCO	Super Permalube or Amolith 2EP
B.P. Oil	Energrease LS-EP2
Castrol Oil	Spheerol SW 2 E.P.
Chevron Oil	Ulti-Plex Synthetic EP2
Exxon	Unirex N2 or Unirex EP2
Mobil Oil	Mobilith SHC 100 or Mobilith AW2
Shell Oil	Alvania 2 or Alvania EP2
Texaco Oil	Starplex 2 or Marfak MP2
Thames	Lithium EP2

CAUTION!

THE TOTAL THICKNESS OF SHIMS (4) AND SHIM GASKETS (4-1), EQUAL TO THE THICKNESS REMOVED FROM THE FIXED BEARING END OF THE PUMP, MUST BE REINSTALLED TO MAINTAIN THE REQUIRED END TRAVEL.

4.5 Stuffing Box Packing

Create a regular maintenance timetable for the tightening and renewal of packing within the pump's stuffing boxes. For pumps employed in ongoing process systems, it is recommended to replace the packing in the stuffing boxes during the annual shutdown. In instances of demanding process applications where the liquid compressant in the pump is exposed to foreign substances or is incompatible with the current packing material, more frequent replacements might be necessary. The packing comprises six rings with dimensions provided in Table 5.1. In situations where a distinct packing material is needed due to the type of liquid compressant utilized, adjustments may be necessary.

When replacing packing in a stuffing box, follow these steps to remove the old packing:

NOTE

IF LANTERN GLANDS ARE IN USE, DOCUMENT THE POSITION AND NUMBER OF PACKING RINGS ON EACH SIDE OF THE LANTERN GLAND. THIS INFORMATION ENSURES PROPER ALIGNMENT DURING REASSEMBLY.

- a. Slide the slinger spring (3-1, Figure 5-21, 5-22, or 5-23) and slinger (3) away from the stuffing box on the shaft.
- b. Loosen and remove gland nuts (102-1 or 103-1, Figure. 4-1) from the studs.
- c. Move the packing gland assembly (112) as far away from the stuffing box as possible or loosen two packing gland nuts holding the halves of the packing gland assembly (112) together and remove the two halves.

d. Screw the tips of packing pullers (2, Figure 4-2) into the packing (1).

e. Pull the packing (1) out of the stuffing box.

f. If a lantern gland (10, Figure 4-1) is utilized, create two lantern gland pullers from 1/8-inch diameter steel wire following the illustration in Figure 4-3.

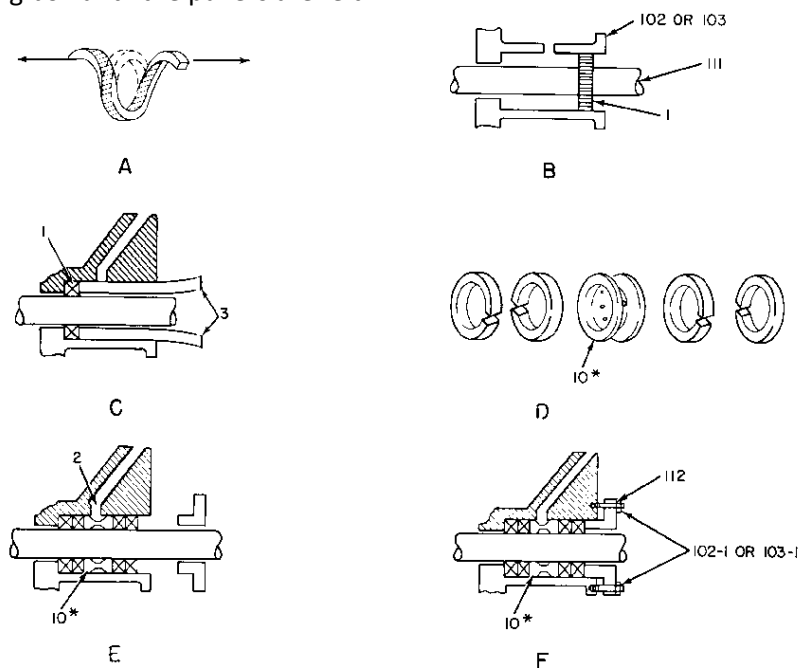
g. Maneuver the bent tip of each lantern gland puller around the outer diameter of the lantern gland in the stuffing box until the pullers are felt

catching in the slots in the lantern gland on opposite sides.

h. Extract the lantern gland from the stuffing box.

i. Screw the tips of packing pullers (2, Figure 4-2) into the remaining packing in the stuffing box and pull the packing out, as shown in Figure 4-2.

j. Thoroughly clean the stuffing box before installing new packing.



Note: View F rotated 90 degrees to show gland studs and nuts

N717A

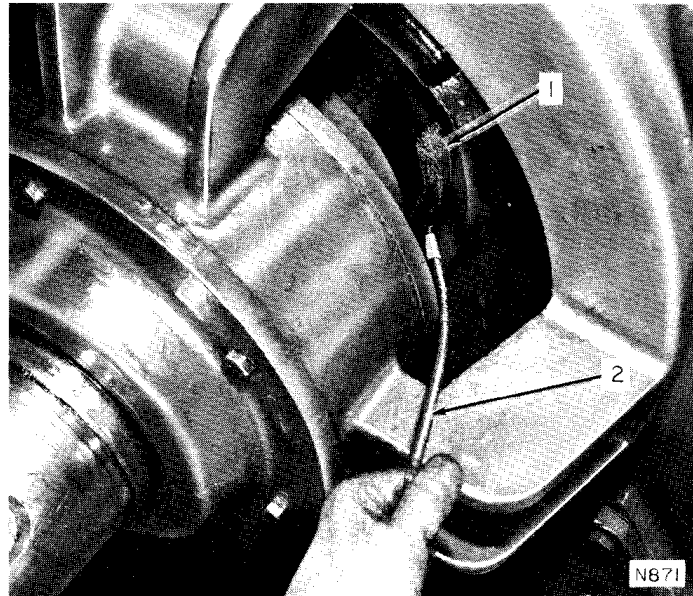
1. Packing Ring
2. Lantern Gland Supply Connection*
3. Packing Ring Pusher

*When used

10. Lantern Gland*
102. Floating Bearing End Head
- 102-1. Gland Nut
103. Fixed Bearing End Head

- 103-1. Gland Nut
111. Shaft
112. Packing Gland Assembly

Fig. 4.1 Packing Stiffing Boxes



1. Packing Ring

2. Packing Pullers

Fig. 4.2 Removing Stuffing Box Packing

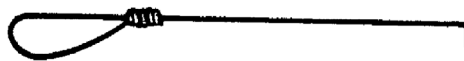


Fig. 4.3 Stuffing Box Lantern Gland Puller

To install the new packing in the stuffing boxes, follow these steps:

a. Craft two hard rubber strips to fit between the outer diameter of the shaft (111) and the inner diameter of the stuffing box, as illustrated in Figure 4-1, Part C, for use as packing ring pushers.

b. Lubricate the inside diameter of packing rings with Molykote G-n paste or an equivalent lubricant.

c. Open each packing ring into a spiral by pulling the ends axially apart, as demonstrated in Figure 4-1, Part A.

d. Turn the shaft (111) to ensure that it turns freely.

e. Work each packing ring into the shaft and into the stuffing box area, following the guidance in Figure 4-1, Part B.

f. Using the pushers (3) created in step a, firmly push the first packing ring into the stuffing box,

ensuring that the packing ring is seated against the end of the stuffing box, as depicted in Figure 4-1, Part C. As each additional packing ring is installed, stagger the location of the butted ends of the ring so that each successive ring is offset (by 180 degrees when two packing rings are used or 120 degrees when three packing rings are used) (See Figure 4.1, Part d.) Ensure that each packing ring is securely seated.

NOTE

WHEN A LANTERN GLAND (10) IS UTILIZED, INSTALL THE CORRECT NUMBER OF PACKING RINGS AS RECORDED DURING DISASSEMBLY TO ENSURE THAT THE LANTERN GLAND IS CORRECTLY POSITIONED AXIALLY BELOW THE SUPPLY CONNECTION FOR THE STUFFING BOX.

g. If used, install the lantern gland. (See Figure 4.1, Part E.)

h. Install the remaining packing rings as specified in step f.

i. Slide the packing gland (112) onto the shaft so that it is flush against the last packing ring installed. Install and evenly tighten the gland nuts (102-1 or 103-1) finger tight (See Figure 4.1, Part F).

j. Start up the pump and adjust the stuffing box leakage as specified in Section 2-6.

4.6 Shutdown Periods

If the pump remains inactive for a period of 2 to 3 weeks, manually rotate the vacuum pump and recirculating pump (if applicable) at least once every week. This practice is essential to prevent the buildup of rust between cast iron parts, which could lead to seizing. If the pump needs to be taken out of service for more than 3 weeks up to one year, follow the steps below to prevent seizing during storage due to rust formation:

NOTE

THESE PRESERVATION PROCEDURES ARE APPLICABLE TO STANDARD CAST IRON OR ALL-CAST IRON PUMPS AND SHOULD BE IMPLEMENTED IN COVERED STORAGE.

a. Remove the drain plugs from the pump following the instructions in Section 2-4 and completely drain all liquid compressant. Replace the drain plugs securely.

b. Seal off the pump discharge flanges.

c. Pour a quarter of the pump's capacity with water-soluble preserving oil, such as J. L. Quimby NRPIOO or an equivalent, through the inlet flanges.

d. Start the pump and rotate it for 5 to 15 seconds, then shut it down. Repeat the process by starting the pump again, rotating for another 5 to 15 seconds, and shutting it down.

e. Drain all the preserving oil from the pump for reuse by removing the drain plugs as specified Section 2.4. Replace the drain plugs using pipe compound.

f. Remove all packing according to the instructions in Section 4.5 and flush out the stuffing boxes with a rust inhibitor.

g. Address any areas where paint has chipped and apply Houghton's Rust Veto #344 coating compound or an equivalent to external surfaces as needed.

h. Seal off the pump inlets.

NOTE

FOR LONG-TERM PRESERVATION PROCEDURES DURING STORAGE PERIODS EXCEEDING 1 YEAR, PLEASE CONSULT YOUR NES REPRESENTATIVE.

i. When preparing to put the pump back into service, repack the stuffing boxes with new packing as specified in Section 4.5. Drain and flush the pump as directed in Section 2.4. Check the condition of the bearing grease as specified in Section 4.4 and initiate the startup procedure outlined in Sections 2.5 and 2.6.

j. Once the preserving oil has been flushed from the pump, periodically rotate the vacuum pump and recirculating pump (if used) at weekly intervals until the pump is back in continuous use.

5. Disassembly, Inspection & Reassembly

5.1 Dismantling Pump

Pump Disassembly Procedure:

Before initiating the disassembly of the pump, adhere to the following steps:

Isolation and Disconnection:

a. Isolate the electrical input and disconnect seal liquid connections.

b. Disconnect the coupling to the drive motor or V-belt drive.

c. Disconnect the inlet and outlet connections.

Moving the Pump:

- a. Remove foundation bolt nuts and washers.
- b. Use lifting equipment with sufficient capacity for handling the pump (Refer to Table 5.2 for approximate weights of pumps).
- c. For Model U pumps, avoid using lugs at the top of the body for lifting.
- d. Lower the pump onto 6-inch pads on a level surface, ensuring the pump feet are aligned in the same plane for disassembly and reassembly.
- e. Mark all accessible parts during disassembly to ensure correct positioning during reassembly.

WARNING!

CONFIRM THAT THE LIFTING EQUIPMENT HAS THE CAPACITY TO HANDLE THE PUMP SAFELY.

Special Tools and Preparation:

- a. Collect all required parts, materials, and standard tools for disassembly.
- b. Fabricate the special tools mentioned in the following Sections, essential for disassembly and reassembly.

By carefully adhering to these guidelines, the pump can be efficiently disassembled, ensuring safe and accurate reassembly.

Parts and Materials:

One set of stuffing box packing (1)
One set of adjusting shims (4 and 4-1)
One set of gaskets
Floating and fixed bearings (119 and 120)
Molykote G-n paste or equivalent
Grease as specified in Table 4-1
Solvent such as kerosene
Three high tensile steel threaded rods with washers and nuts
Two 7/8-9 (Model L, M, P and R pumps) or 1-8 (Model S, T and U pumps) eyebolts
Wood blocks to support body (101) and end of rotor (110)
Two 3/4-10 (Model L and M pumps) or 1-8 (Model P, R, S, T and U pumps) by 4-inch-long studs or threaded rods

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Two 1/2-13 (Model L, M, P and R pumps), 5/8-11 (Model S and T pumps) or 3/4-10 (Model U pumps) jackscrews

One 1/2-13 (Model L, M, P and R pumps), 5/8-11 (Model S and T pumps) or 3/4-10 (Model U pumps) by 30 inches long threaded rod with nuts
Machinist's hammer and brass drift

Hydraulic jack, 20-ton capacity

Press: approximately 150-ton capacity for Model L, M, P and R pumps; approximately 200-ton capacity for Model S, T and U pumps

Spirit level

Grab hooks

Leaf (feeler) gauge

Metal straightedge

Rawhide hammer

Soft-faced (brass) ram

Machinist's dial indicator with suitable clamps and mounts

Needle-nosed pliers

Induction heater and 250°F (121°C) temp stick

Asbestos gloves

Floor jack

Hoists and slings

Standard Tools:

- a. Socket wrench set with shaft extension.
- b. Hexagonal (Allen) wrenches
- c. Spanner wrench for bearing lockouts (Machinist's hammer and brass drift can be substituted)
- d. Soft-faced (brass) ram
- e. Machinist's dial indicator with suitable clamps and mounts
- f. Needle-nosed pliers
- g. Induction heater and 250°F (121°C) temp stick

Fabricated Tools:

- a. Jack backup plate (Figure 5-3)
- b. Split ring (Figure 5-3)
- c. Six spacers (Figure 5-3)
- d. Shaft sleeve tool (Figure 5-6 or 5-6A)

NOTE: Do not disassemble the pump beyond the point required to remedy the observed trouble. Before disassembling the pump, drain all liquid from the pump by removing the drain plugs from the floating and fixed bearing end heads and the body.

5.2 Removing Fixed Bearing

To disassemble the fixed bearing and its associated components, follow these steps:

a. Remove the key (111-2, Figure 5.21, 5.22, or 5.23) from the shaft.

b. Loosen three outer cap screws (117-1), three outer cap screws (117-2), and lockwashers (117-4) securing the fixed bearing outer cap (117).

c. Take off the fixed bearing outer cap, shim gaskets (4-1), and shims (4). Measure and record the total thickness of shim gaskets.

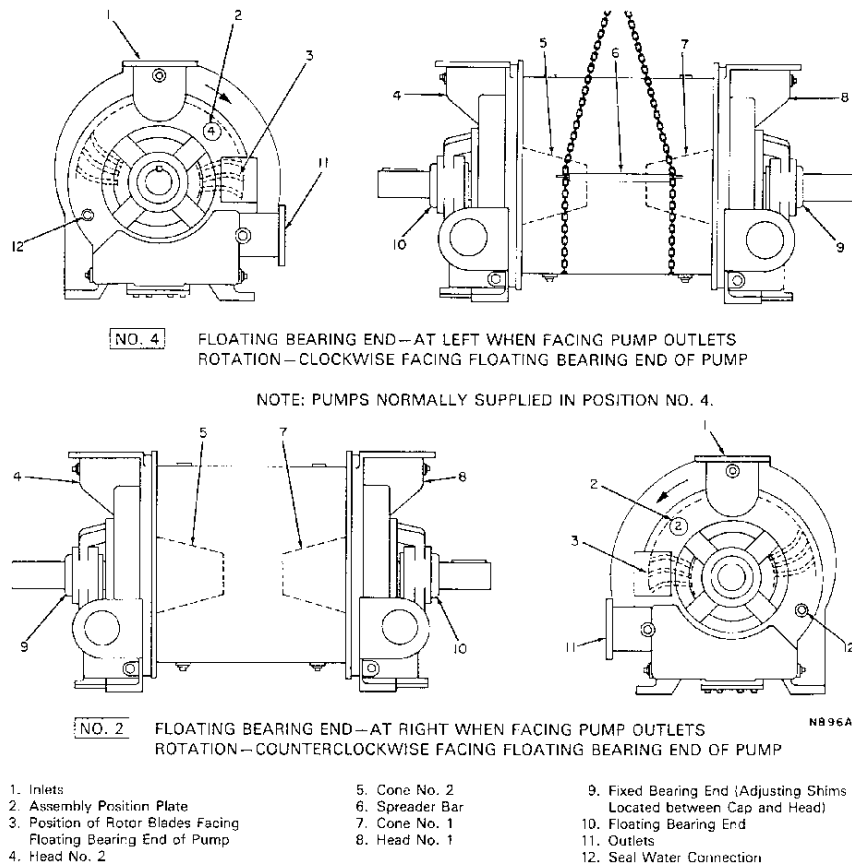


Fig. 5.1 Assembly Positions and Hoisting Arrangements of N904 L, M, P, R, S, T & U

NOTE

IF THE DISASSEMBLY IS SPECIFICALLY FOR FIXED BEARING REPLACEMENT, RETAIN SHIM GASKETS (4-1) AND SHIMS (4) FOR REASSEMBLY TO MAINTAIN THE CORRECT END TRAVEL. DISCARD

ANY TORN SHIM GASKETS AND REPLACE THEM TO MAINTAIN THE RECORDED TOTAL THICKNESS. IF FURTHER DISASSEMBLY IS REQUIRED TO REMOVE HEADS AND ADJUST END TRAVEL, DISCARD ALL SHIM GASKETS AND SHIMS.

Part Name (See Figure 5-21, 5-22 or 5-23)	L, M	P, R	S, T	U
Packing (1) - Dimensions	3/4 square x 7ID x 8 - 1/2 OD	3/4 square x 8 - 3/4 ID x 10 - 1/4 OD	3/4 square x 9 - 3/4 ID x 11 - 1/4 OD	3/4 square x 11 - 1/4 ID x 12 - 3/4 OD
No. of Rings per Stuffing Box*	6	6	6	6
Lip Seal (5), Floating and Fixed Bearing Inner Caps	Contact NES	Contact NES	Contact NES	Contact NES
Lip Seal (5-1), Floating and Fixed** Bearing Outer caps	Contact NES	Contact NES	Contact NES	Contact NES
Body Gasket (101-3), 0.010 thick† Qty. Floating Bearing End	4	5	5	7
Qty. Fixed Bearing End	6	7	7	10
Cone Gaskets (104-3 and 105-3), 0.010 thick, Qty.	1 each	1 each	1 each	1 each
Floating Bearing (119) and Fixed Bearing (120)	Contact NES	Contact NES	Contact NES	Contact NES
<p>*If lantern glands (10) are used, one less packing ring is required.</p> <p>**For double extended shaft only.</p> <p>†Quantities listed are for trial assembly with extra gaskets at the fixed bearing end to allow removal of gaskets to obtain the final correct rotor (end) travel.</p>				

Note: All dimensions are in Inches

Table 5.1 Pump Data

Figure 5-21, 5-22 or 5-23								
Index No.	Parts Name	L	M	P	R	S	T	U
101	Body	1512	1742	2400	2650	3800	4140	7540
	Floating and Fixed Bearing							
102, 103	End Head	1373	1373	2000	2000	3300	3300	3540
	Floating and Fixed Bearing							
104, 105	End Cone	180	180	440	440	450	450	750
	Floating and Fixed Bearing							
108, 109	Bracket	183	183	425	425	525	525	760
110	Rotor	1800	2240	3500	4900	5800	6800	9180
111	Shaft	882	1118	1730	1870	2675	3070	5000
	Floating and Fixed Bearing							
119, 120	(each)	25	25	40	40	85	85	73
Total Pump		8055	9025	14248	16213	22965	24705	33000

Table 5-2. Approximate Weights of Parts (lb.)

d. Remove the lip seal (5-l) from the outer cap and discard it.

e. Unscrew the four fixed bearing bracket screws (109-1).

f. Place chains with a spreader bar and chain hoist around the two top ribs of the fixed bearing bracket as shown in Figure 5.2. Support the bearing bracket without lifting it.

g. Install two bearing bracket screws (109-1) into tapped holes in the flange of the fixed bearing bracket (109) to serve as jackscrews. (See Figure 5.2.)

h. Gradually tighten both jackscrews installed in step g until the bearing bracket flange is released from the head. Use a chain hoist to cautiously slide the bearing bracket off the fixed bearing (120) and shaft, and then remove the two jackscrews.

i. For Model L, M, P, R, S, and T pumps, bend the tab of the fixed bearing lockwasher (120-2, Figure 5.21) out of the notch in the fixed bearing locknut (120-1). Using a spanner wrench or punch and hammer, loosen and remove the locknut and washer.

j. For Model U pumps, eliminate the lockwire, two screws (120-3, Figure 5.22), and locknut lockplate (120-2) from the fixed bearing locknut

(120-1). Using a spanner wrench or punch and hammer, loosen and remove the locknut.

k. Construct a jack backup plate, three spacers, and a split ring as illustrated in Figure 5.3.

l. Screw one inner nut (5, Figure 5.4) onto each of the three high-tensile steel rods, positioning them approximately 3 1/2 inches from the end of the rod, and place flat washers (3) against the nuts.

m. Glide the fixed bearing inner cap (118) back to the gland studs (103-2) sufficiently to insert the split ring (7) between the fixed bearing (120) and the inner cap.

n. Align the three holes in the split ring with the tapped holes in the fixed bearing inner cap. Insert three spacers between the split ring and the inner cap. Thread the threaded rods (end with nuts installed) through the split ring and spacers, continuing to thread them through the tapped holes in the inner cap until flat washers press against the split ring. Secure the threaded rods with flat washers (3) and outer nuts (1), tightening them against the inner cap flange. Finally, tighten the inner nuts (5).

o. Mount the jack backup plate (9), crafted in step j, onto the threaded rods and fasten it with flat washers (3), lockwashers (2), and nuts (1) on

the ends of the rods. Provide support to the backup plate until the hydraulic jack exerts sufficient pressure in step o to maintain the plate in position.

CAUTION!

ENSURE THAT THE HYDRAULIC JACK, BACKUP PLATE, SPLIT RINGS, AND CAP ARE SQUARE, AND THAT FORCE IS APPLIED EVENLY TO AVOID DAMAGE TO THE INNER CAP.

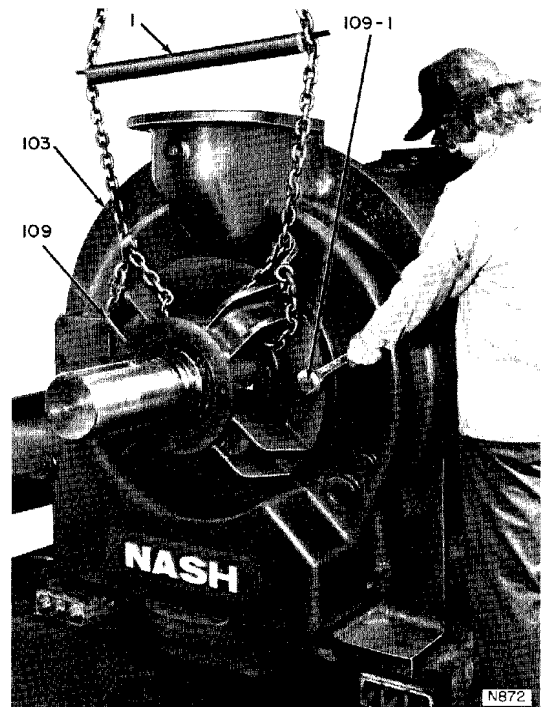
p. Position the hydraulic jack between the jack backup plate and the end of the shaft. Apply pressure to extract the bearing. Dispose of the bearing and gaskets (117-3 and 118-3, Figure 5.21, 5.22, or 5.23).

q. Eliminate the jack backup plate, threaded rods, spacers, and split ring.

r. Take off the fixed bearing inner cap.

s. Extract the lip seal (5) from the inner cap and discard the lip seal.

t. Remove the slinger spring (3-1) and the slinger (3) from the shaft.



1. Spreader Bar
103. Fixed Bearing End Head
109. Fixed Bearing Bracket
109-1. Bearing Bracket Screw (Jackscrew)

Fig. 5.2 Removing Fixed Bearing Bracket

5.3 Removing Floating Bearing

To disassemble the floating bearing and its associated components, follow these steps:

- Extract the key (111-1, Figure 5.21, 5.22, or 5.23) from the shaft (111).
- Remove three floating bearing outer cap screws (115-1), three outer cap screws (115-2), and lockwashers (115-4) from the floating bearing outer cap (115-1).
- Remove the floating bearing outer cap and gasket (115-3). Discard the gasket.
- Extract the lip seal (5-1) from the outer cap and dispose of the lip seal.
- Remove the floating bearing bracket (108) following the same procedure as specified for the fixed bearing bracket (109) in Section 5-2, steps e through h. Remove and discard the floating bearing inner cap gasket (116-3).

g. On Model U pumps, remove the floating bearing locknut lockplate (119-2, Figure 5.22), locknut (119-1), and floating bearing (119) using the same method as specified in Section 5.2, steps j and 1 through q.



Pump Model	A	B	C	D (Ref)	E	F (Ref)	G	H (Ref)	J (Ref)	K	Notes
L, M	9/16	7-9/32	10.6	1/2	12 15.	1	0.75	0.622	0.84	0.24	2, 3, 4
P, R	5/8	8-25/32	13.4	1/2	6	1	0.94	0.622	0.84	0.38	2, 3, 4
S, T	3/4	9-25/32	15.5	1	18	1	1.13	0.824	1.05	0.38	2, 3, 5
U	7/8	11-1/2	17	1	20	1	1.08	0.824	1.05	0.27	2, 3, 5

NOTES:

1. Dimensions are in inches unless otherwise indicated.
2. Dimensions B, C and K tolerances: ± 0.010 inch.
3. Material: boiler plate for split ring and jack backup plate.
4. Make Fixed and floating bearing end spacers from 1/2-inch steel pipe, 3 each.
5. Make Fixed and floating bearing end spacers from 3/4-inch steel pipe, 3 each.

Fig. 5.3 Bearing Pulling Tools

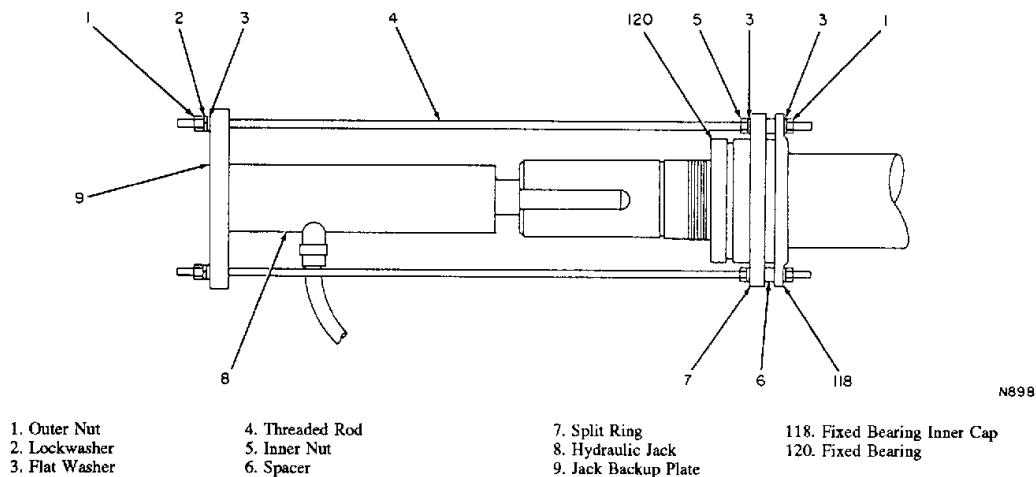


Fig. 5.4 Pulling Fixed Bearing

h. Remove the floating bearing inner cap (116).

i. Extract the lip seal (5) from the inner cap and discard the lip seal.

j. Remove the slinger spring (3-1) and slinger (3) from the shaft.

5.4 Removing Fixed Bearing End Head and Cone Assembly

To remove the fixed bearing end head and cone assembly and disassemble the associated parts, follow these steps:

a. Install two 7/8-9 (Model L, M, P, and R pumps) or 1-8 (Model S, T, and U pumps) eyebolts into two opposite tapped holes in the inlet flange of the fixed bearing end head (103, Figure 5.21, 5.22, or 5.23) as shown in Figure 5.5. Support the head with a chain hoist without lifting it. Use wood blocks to support the fixed bearing end of the body (101) as illustrated in Figure 5.5.

b. For Models L, M, P, R, S, and T pumps, proceed as follows:

Remove 12 fixed bearing end head screws (103-4, Figure 5.21).

Install two head screws (103-4) into tapped holes in the flange of the body (101) to act as jackscrews. (See Figure 5-22.)

c. For Model U pumps, proceed as follows:

Remove three fixed bearing end head screws (103-4, Figure 5.22).

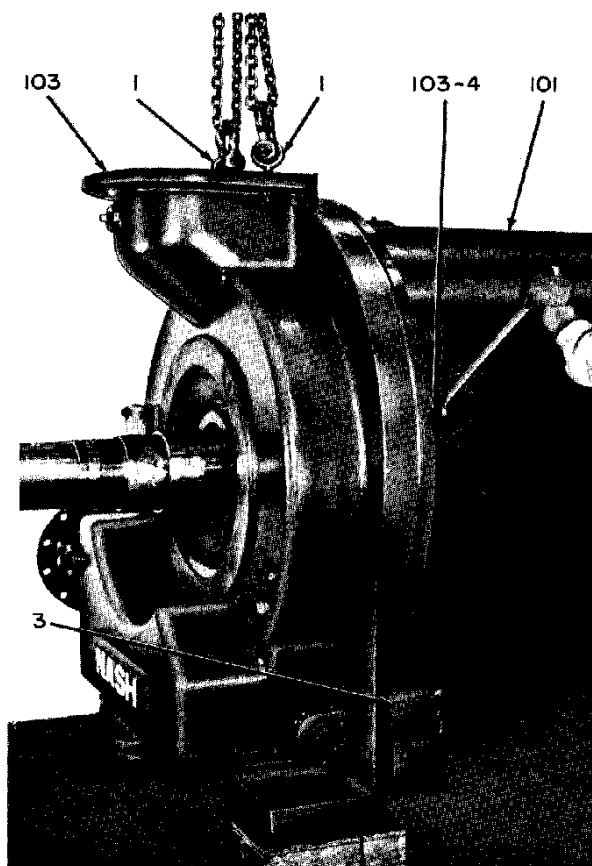
Remove 10 fixed bearing end head screws (103-5).

Install two head screws (103-5) into tapped holes in the flange of the fixed bearing end head (103) to serve as jackscrews.

d. Evenly tighten the two jackscrews until the head is free from the body.

e. Using a chain hoist, carefully slide the head and cone assembly off the shaft. Lower the head until the feet contact two 6-inch blocks on a level surface. Remove two gland nuts (103-1) and the gland assembly (112). Take out the packing rings from the stuffing box and discard them.

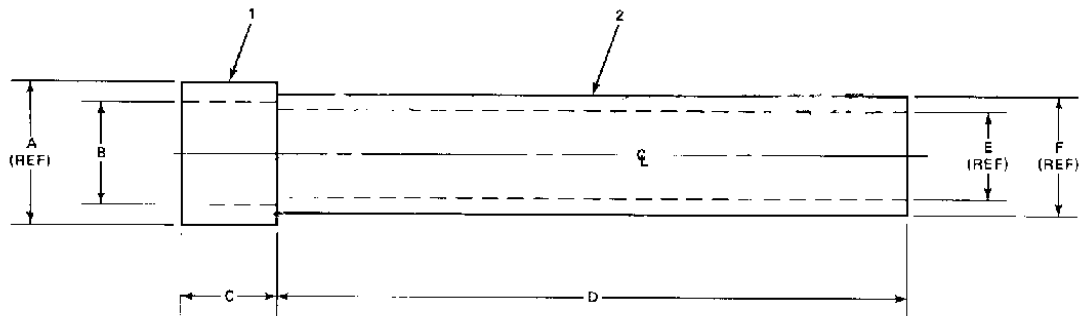
f. Lower the head to the floor with the cone facing up, remove the chain hoist, and inspect the fixed bearing end cone (105) as specified in Section 5.10.



- 1. Eyebolt
- 3. Wood Blocks
- 101. Body

- 103. Fixed Bearing End
- 103-4. Fixed Bearing End
- Screw (Jackscree

Fig. 5.5 Removing Fixed Bearing End Head and Cone Assembly



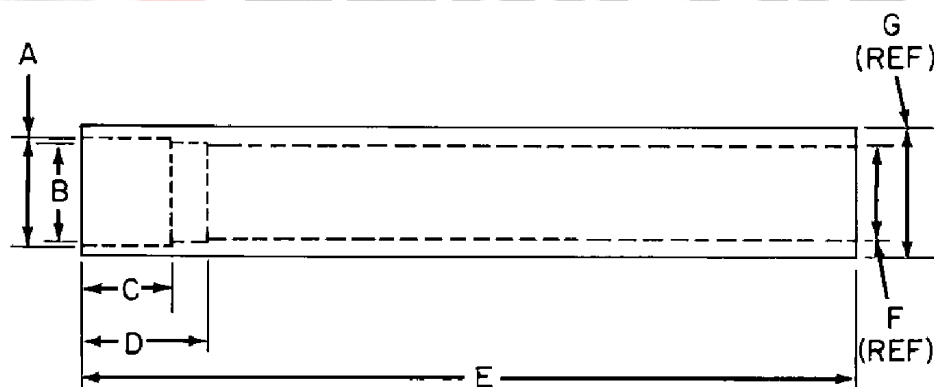
Dimensions in Inches					
A (Ref)	B	C	D	E (Ref)	F (Ref)
6.625	6.263	5.125	55	5.047	5.563

NOTES:

1. Fabricate piece No. 1 from 6-inch Schedule 40 steel pipe. Machine ID to dimension B specified above.
2. Fabricate piece No. 2 from 5-inch Schedule 40 steel pipe.
3. Weld piece No. 1 and 2 concentrically on centerline. Approximate weight of finished tool is 80 lbs.
4. Dimension B tolerance: $-0.000 +0.010$ inch.
5. Dimension C tolerance: ± 0.010 inch.



Fig. 5.6 Shaft Sleeve Tool, model L and M pumps



Pump Model	Dimensions in Inches							Notes
	A	B	C	D	E	F (Ref)	G (Ref)	
P, R	8.063	7.313	6.25	8.5	66	7.25	8.75	1, 3, 4
S, T	8.313	8	5.875	8	72	7.75	9.25	2, 3, 4

NOTES:

1. For Model P and R pumps, make from 8-3/4-inch OD steel mechanical tubing with 3/4-inch wall thickness. Approximate weight of finished tool 335 lbs.
2. For Model S and T pumps, make from 9-1/4-inch OD steel mechanical tubing with 3/4-inch wall thickness. Approximate weight of finished tool 390 lbs.
3. Dimension A and B tolerance: -0.000 + 0.010 inch.
4. Dimension C and D tolerance: ± 0.010 inch

Fig. 5.6 A Shaft Sleeve Tool, model P, R, S, & T Pumps

5.5 Removing Rotor and Shaft Assembly

To disassemble the rotor and shaft assembly from the body and the floating bearing end head, follow these steps:

- a. Remove the two gland nuts (102-1, Figure 5.21, 5.22, or 5.23) and the gland assembly (112) from the floating bearing end head (102). Discard the packing rings (1).
- b. Construct a shaft sleeve tool according to the specifications in Figure 5-6 or 5-6A. For Model U pumps, cut a piece of 10-inch Schedule 40 steel pipe, 60 inches long, for use as a shaft sleeve tool.

NOTE

THE SHAFT SLEEVE TOOL IS ESSENTIAL TO GUIDE THE SHAFT THROUGH THE CONE AND HEAD, PROTECTING THE SHAFT BEARING JOURNAL AND LOCKNUT THREADS FROM DAMAGE.

- c. Carefully position the machined end of the shaft sleeve tool over the floating bearing end of the shaft (111, Figure 5.21, 5.22, or 5.23) until

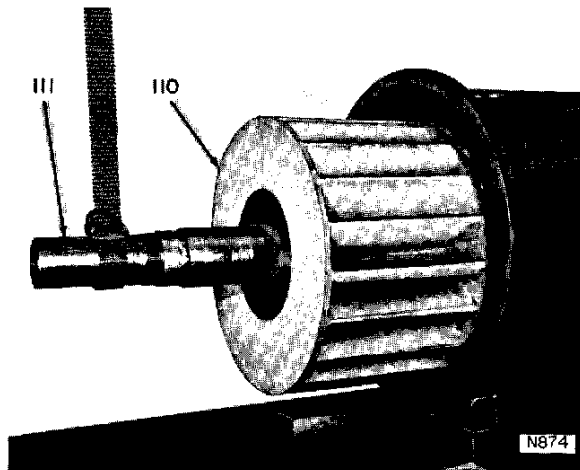
the sleeve tool seats against the bearing journal shoulder.

- d. Utilize a chain hoist and strap at the fixed bearing end of the shaft (as illustrated in Figure 5.7), and another chain hoist and strap or a floor jack on the shaft sleeve tool at the floating bearing end of the shaft. Keep the shaft level and advance the rotor and shaft assembly toward the fixed bearing end until the center shroud of the rotor approaches the end of the body (101).

- e. Support the fixed bearing end of the rotor with wood blocks and remove the strap from the shaft. Install two chains, one on either side of the rotor center shroud, with hooks engaging the bottom edges of the rotor blades as shown in Figures 5.8.

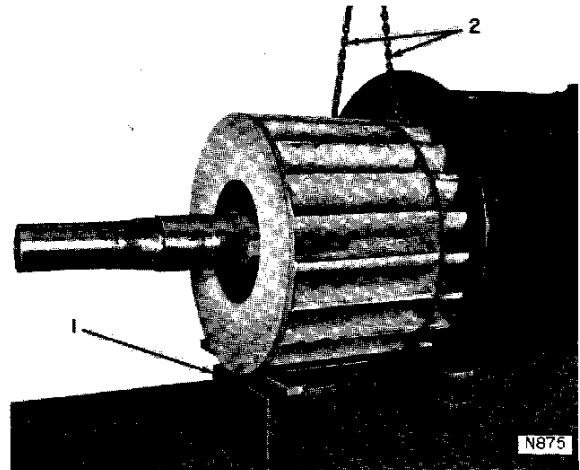
- f. Eliminate the wood blocks, maintain the shaft level, and continue to slide the rotor and shaft assembly out of the body. Remove the sling or floor jack and shaft sleeve tool when the floating bearing end of the rotor becomes visible.

- g. Examine the rotor and shaft assembly following the guidelines specified in Sections 5.11 and 5.12.



110. Rotor 111. Shaft

Fig. 5.7 Removing Rotor and Shaft Assembly
Hoist



1. Wood Blocks 2. Chains

Fig. 5.8 Supporting rotor to Move Chain

5.6 Removing Body and Final Disassembly

To detach the body from the floating bearing end head and cone assembly and complete the disassembly, follow these steps:

a. Using a chain hoist, chains, and spreader bars, support the body (101, Figure 5.21, 5.22, or 5.23) without lifting it. (See Figure 5.9.) Remove wood blocks from under the body.

b. On Model L, M, P, R, S, and T pumps, proceed as follows:

a. Remove 12 screws (102-4, Figure 5.21) securing the floating bearing end head.

b. Install two screws (102-4) into tapped holes in the body's flange to serve as jackscrews. (Refer to Figure 5-9.)

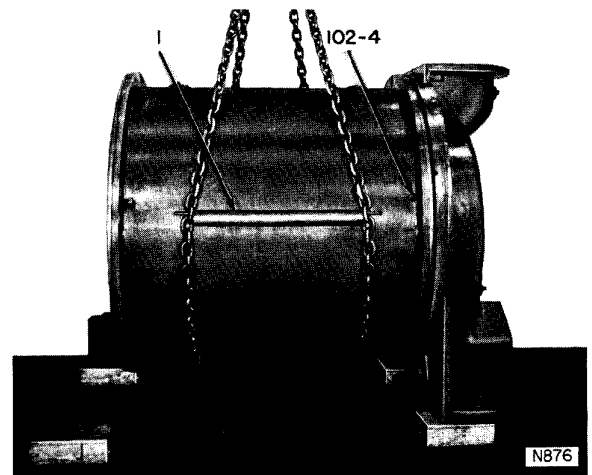
c. For Model U pumps:

a. Remove three screws (102-4, Figure 5.22) from the floating bearing end head.

b. Remove 10 screws (102-5) from the floating bearing end head.

c. Install two screws (102-5) into tapped holes in the floating bearing end head's flange to serve as jackscrews.

d. Evenly tighten the two jackscrews until the body is free from the head.



1. Spreader Bar
102-4. Floating Bearing End Head Screw (Jackscrew)

Fig. 5.9 Removing Body

e. Remove the two gland nuts (102-1, Figure 5.21, 5.22, or 5.23) and the gland assembly (112) from the floating bearing end head (102). Dispose of the packing rings (1) from the stuffing box of the floating bearing end head.

f. Install two 7/8-9 (Model L, M, P, and R pumps) or 1-8 (Model S, T, and U pumps) eyebolts into two opposite tapped holes in the inlet flange of

the head. Use a chain hoist to carefully lower the head to the floor with the cone facing upward.

g. Examine the floating bearing end cone (104) according to the specifications outlined in Section 5-10.

5.7 Disassembling Rotor and Shaft

If the inspection of the rotor (Section 5.11) or shaft (Section 5.12) indicates the need for replacement or repair requiring disassembly, follow these steps:

a. Lift the rotor and shaft assembly by placing a sling around the center shroud of the rotor or using chains, as shown in Figure 5.8.

CAUTION!

FOR MODEL U PUMPS, THE PIPE SECTION USED IN STEP b MUST BE 16-INCH STEEL PIPE, SCHEDULE 30 MINIMUM, SCHEDULE 100 MAXIMUM.

b. Place a bushing or pipe section over the fixed bearing end of the shaft, ensuring that the face of the bushing contacts only the rotor hub face.

c. Position the rotor and shaft assembly in a press that can accommodate the rotor diameter, aligning the floating bearing end of the shaft against the press ram and placing the end of the bushing, installed in step c, against the press backup plate.

d. Provide support for the fixed bearing end of the shaft as it is pushed away from the rotor. Use blocks or a sling passed through the rotor blades and around each shroud to support the rotor.

e. Ensure that the shaft remains level and apply ram force to facilitate the removal of the shaft from the rotor.

f. If the rotor taper bore needs to be machined oversize, seek guidance from your local NES Representative for the appropriate dimensions.

g. Install the floating and fixed bearing locknuts (119-1 and 120-1, Figure 5.21, 5.22, or 5.23) to protect the threads of the shaft.

5.8 Disassembling Head and Cone Assembly

If an inspection of the cone (Section 5-10) reveals that the cone needs replacement or reworking, proceed with the following steps:

a. Insert an Allen wrench into the socket of each cone screw (104-1 or 105-1, Figure 5.21, 5.22, or 5.23) individually. Tap the Allen wrench with a mallet, as demonstrated in Figure 5.10, to loosen and remove 8 cone screws (for Model L and M pumps), 12 cone screws (for Model P, R, S, and T pumps), or 15 cone screws (for Model U pumps).

b. Use a soft-headed mallet to tap the side of the floating or fixed cone (104 or 105), freeing the cone from the head (102 or 103).

c. With a hoist and grab hooks (hooks inward) inserted into cone ports, pull the cone away from the head.

d. Remove gaskets (104-3 or 105-3). Record the number of gaskets removed and discard them.

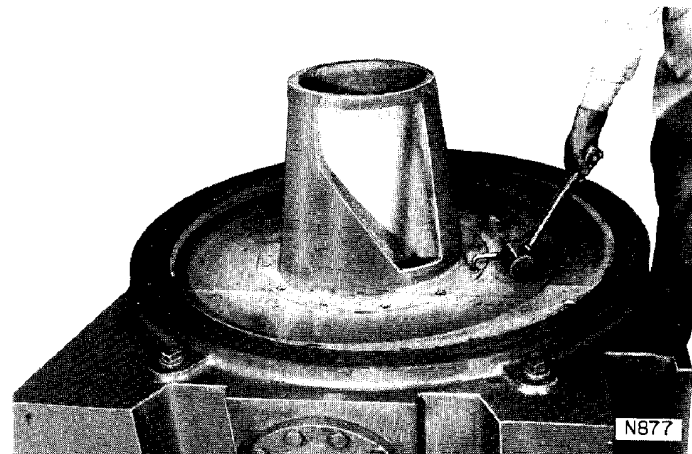


Fig. 5.10 Loosening Cone Screws

5.9 Inspection of Disassembled Parts

With the pump disassembled, carefully examine the components as detailed in the subsequent Sections.

NOTE: If there is any uncertainty regarding the reusability or repair of worn major pump parts,

it is advisable to get in touch with your local NES Representative.

5.10 Cones

Typically, worn tapered surfaces of the cones will exhibit smoothness, necessitating only cleaning and light filing around the ports and tips. In instances where foreign material has entered the pump suction inlet during operation, circular score marks may be observed around the outside of the cone tapers. Evaluate the cones for damage and wear by following these steps:

- Check for uneven wear and scoring between the ports and at the edges of the ports using a straightedge, as illustrated in Figure 5.11.
- Localized wear or scoring not exceeding 0.030 inches in depth is acceptable unless the pump is required to operate at or near maximum capacity.
- If the localized wear or scoring surpasses 0.030 inches in depth, it is recommended to contact your NES Representative for guidance on determining the reusability of the rotor.
- Minor pitting is considered acceptable during the inspection process.

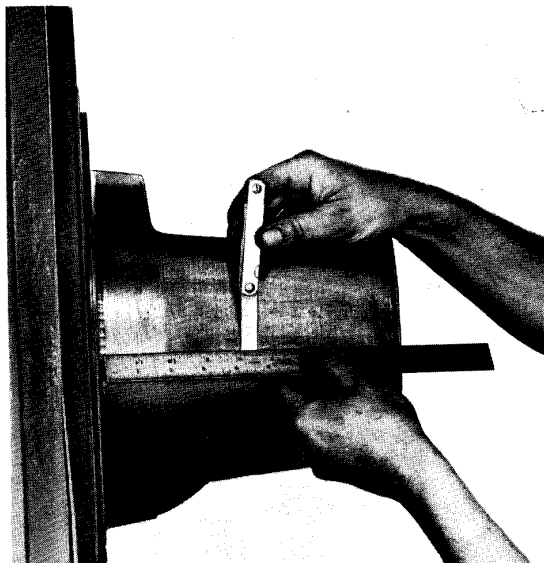


Fig. 5.11 Checking Cone for Water

5.11 Rotor

Examine the taper cone bores of the rotor using the same criteria as applied to the tapered surfaces of the cones:

- Check for uneven wear, undercutting, or scalloping on the cone bore tapered surface, utilizing a straightedge in a manner akin to the illustration in Figure 5.11.
- Localized wear, undercutting, or scalloping up to a depth of 0.030 inches is deemed acceptable.
- If the localized wear, undercutting, or scalloping exceeds a depth of 0.030 inches, it is recommended to contact your NES Representative for guidance in determining the reusability of the rotor.
- Minor pitting is considered acceptable.

This inspection process ensures a thorough assessment of the rotor's taper cone bores, allowing for appropriate decisions regarding reusability or necessary repairs.

5.12 Shaft

Examine the shaft diameters, specifically where the packing seats, for any signs of excessive wear. If the shaft exhibits scoring or has worn through the metalized surface, it is advisable to contact your NES Representative for guidance in determining the reusability of the shaft.

Additionally:

- Inspect the shaft journals for indications of pick-up.
- Scrutinize all surfaces for evidence of wear and/or damage.

Performing a thorough check on these aspects will contribute to a comprehensive evaluation of the shaft's condition.

5.13 Heads

Ensure that all ports and passages within the fixed and floating bearing end heads are clear and devoid of any obstructions. Thoroughly inspect internal passages by removing all pipe

plugs. Cleanse the passages of any foreign material and then replace the pipe plugs securely.

Proceed with the following steps:

- Remove the cover plate (12-1, Figure 5.21, 5.22, or 5.23).
- Verify the freedom of the check ball (18).
- For Model L, M, P, R, S, and T pumps, confirm the presence of three roll pins (12-4, Figure 5.21).
- Reinstall the cover plate with a new gasket (12-3, Figure 5.21, 5.22, or 5.23) if needed.

These measures guarantee the cleanliness and proper functioning of the internal components, ensuring optimal performance of the pump.

5.14 Reassembling Pump

CAUTION!

BEFORE REASSEMBLY, ENSURE METICULOUS CLEANING OF ALL PARTS. REMOVE ALL REMNANTS OF OLD GASKET MATERIAL FROM MOUNTING FLANGES. ADDITIONALLY, ELIMINATE ANY BURRS PRESENT ON MATING SURFACES AND MOUNTING FACES. THIS PRECAUTION IS CRUCIAL FOR A SMOOTH AND EFFECTIVE REASSEMBLY PROCESS.

5.15 Reassembling Rotor and Shaft

To reassemble the rotor on the shaft, follow these steps:

CAUTION!

THIS PROCEDURE IS APPLICABLE ONLY FOR THE ASSEMBLY OF AN IRON ROTOR ON A STEEL SHAFT. THE ROTOR AND SHAFT MUST BE AT THE SAME TEMPERATURE DURING ASSEMBLY.

a. File the tapered bores of the rotor (110, Figure 5.21, 5.22, or 5.23) to eliminate burrs and high spots.

b. Inspect the shaft for dents or rough spots on the rotor seat and bearing journals.

c. Stone or polish the shaft smooth.

d. Apply Molykote G-n paste or an equivalent substance to coat the rotor hub bore and the rotor seat of the shaft. This prevents damage from friction or pick-up when the shaft is pressed into the rotor.

NOTE

ENSURE THAT THE BEARING LOCKNUTS (119-1 AND 120-1) HAVE BEEN REMOVED FROM THE SHAFT.

CAUTION!

CHECK THE HEAD (102 OR 103) AND NOTE THE NUMBER SHOWN ON THE ASSEMBLY POSITION PLATE. REFER TO FIGURE 5.1 OR 5.1A AND DETERMINE THE LOCATION OF THE FIXED AND FLOATING BEARING ENDS FOR THIS ASSEMBLY POSITION NUMBER.

e. Align the rotor on the shaft with the blades curving in the proper direction according to the assembly position number. Refer to Figure 5-1 or 5-1a for guidance.

f. Place the same bushing or pipe section used in disassembly onto the floating bearing end of the shaft. Consult Figure 5.12 for reference.

g. Suspend the rotor and shaft using a sling around the outside diameter at the point of balance. Position the rotor and shaft in a press, aligning the fixed bearing end of the shaft with the ram end of the press. Ensure that the face of the bushing or pipe section contacts the rotor hub face only, and that the bushing or pipe section is supported by the press backup plate. Level the shaft within the press.

h. Apply pressure to the press to push the shaft into the rotor until dimension A, as indicated in Figure 5-12, from the recess of the outer shroud surface to the floating bearing journal shoulder, meets the specified requirements.

Model "A" Dimension

L, M	13.563 +/- 0.010
P, R	13.438 +/- 0.010
S, T	16.062 +/- 0.010
U	16.500 +/- 0.010

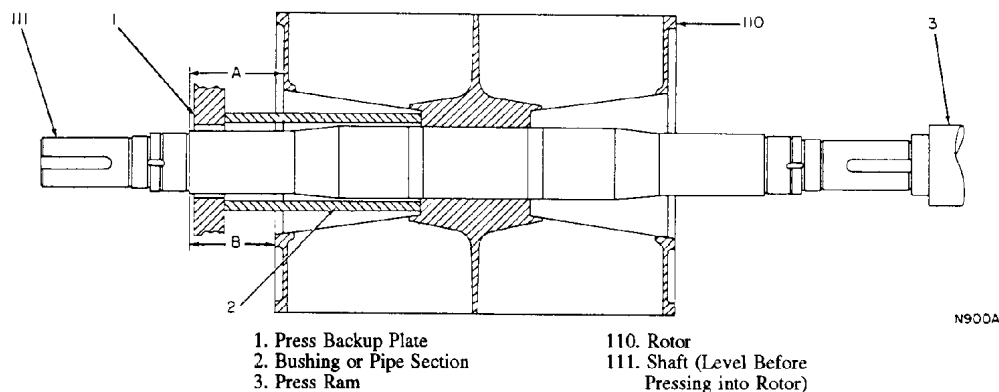


Fig. 5.12 Pressing Rotor onto Shaft

Record the force applied. Minimum allowable force is as follows:

Pump Model	Minimum Allowable Force-tons
L	19
M	20
P	30
R	50
S	55
T	60
U	69

CAUTION!

IF THE RECORDED ASSEMBLY FORCE IS LESS THAN THE MINIMUM SPECIFIED ABOVE, REFRAIN FROM INSTALLING THE ASSEMBLED ROTOR AND SHAFT INTO THE VACUUM PUMP. CONTACT YOUR LOCAL NES REPRESENTATIVE TO ASSESS WHETHER THE ROTOR AND/OR SHAFT MUST BE REPLACED.

WARNING!

BEFORE REMOVING THE ROTOR AND SHAFT ASSEMBLY FROM THE PRESS, RELOCATE THE SLING TO A NEW POINT OF BALANCE TO PREVENT INJURY OR DAMAGE.

5.16 Installing Cone in Head

If one or both the head and cone assemblies have been disassembled, follow these steps to reassemble them:

- Position the head in a horizontal position with the cone side facing upward.
- If a new cone is being installed, carefully inspect it against the old cone to ensure the correct number and orientation of ports. Remove any rust preventative from the surfaces using a solvent such as kerosene.
- File the taper surfaces on the cone, paying special attention to the edges of cone ports, to achieve a smooth finish.
- Apply a light coat of grease to both sides of the replacement cone gasket (104-3 or 105-3, Figure

5.21, 5.22, or 5.23), and position the gasket on the head (102 or 103).

CAUTION!

ON MODEL P, R, S, AND T PUMPS, THE CONE MOUNTING HOLE PATTERN IS SYMMETRICAL ABOUT BOTH CENTERLINES. TO AVOID INSTALLING THE CONE IN THE WRONG POSITION, MAKE CERTAIN TO ALIGN PORTS IN THE CONE WITH PORTS IN THE HEAD. (SEE FIGURE 5.13.)

e. Place grab hooks in ports at the small end of the cone, lift the cone with a chain hoist, lower it into place on the associated head, and then remove the grab hooks.

Model	Qty	Index	Screw
L, M	8	104-1	5/8 - 11
P, R, S, T	12	104-1	5/8 - 11
U	15	105-1	3/4 - 10

f. Thread in the following:

Using a leaf (feeler) gauge inserted between the cone and the head, ensure proper alignment.

Continue with the assembly process, following the specific instructions provided for threading or securing components in the subsequent steps.



Fig. 5.13 Aligning Cone Ports with Ports on Head, Model P, R, S & T Pumps

5.17 Installing Body on Floating Bearing End

To install the body (101, Figure 5.21, 5.22, or 5.23) on the floating bearing end head and cone assembly, follow these steps:

a. Insert two 7/8-9 eyebolts (for Model L, M, P, and R pumps) or 1-8 eyebolts (for Model S, T, and U pumps) into the tapped holes located opposite each other in the inlet flange of the floating bearing end head (102). Utilize a chain hoist to elevate the floating bearing end head and cone assembly to an upright position. Lower it onto the level pads previously used during the pump disassembly and secure the feet to the work surface using mounting bolts.

b. Apply a light coating of grease to the body mounting flange on the floating bearing end head.

c. Place two studs or threaded rods into two horizontally opposite tapped holes in the flange of the floating bearing end head. This is done to facilitate the alignment of gaskets and the body during the assembly process.

CAUTION!

ON MODEL L, M, P, R, S, AND T PUMPS, WHEN INSTALLING BODY GASKETS (101-3), MAKE SURE TO ALIGN THE 9/16-INCH DIAMETER HOLE IN EACH GASKET WITH THE CORRESPONDING HOLE IN THE HEAD FLANGE.

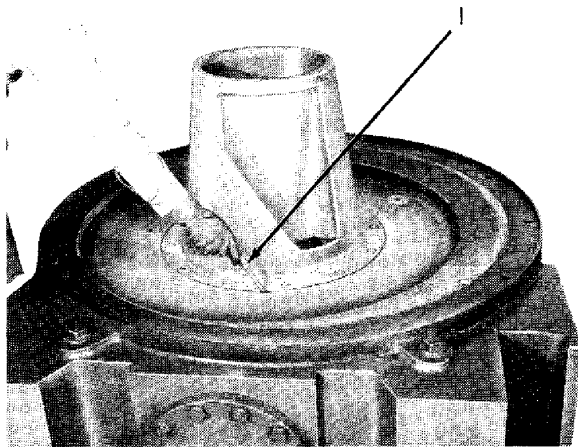
d. Apply a light coat of grease to four (Model L and M pumps), five (Model P, R, S, and T pumps), or seven (Model U pumps) body gaskets (101-3). Install each gasket separately over the studs installed in step d and against the floating bearing end head flange.

Model	Stud/Rod
L, M	3/4 - 10 x 4.0
P, R, S, T, U	1.0 - 8 x 4.0

Model	Qty	Screw	Index
L, M	2	3/4 - 10	102 - 4
P, R, S, T	2	1.0 - 8	102 - 4

CAUTION!

ON MODEL L, M, P, R, S, AND T PUMPS, MAKE SURE THAT BOTH BODY PINS (101-2, Figure 5-21) PROTRUDE A MINIMUM OF 5/8 INCH FROM THE BODY FLANGE.



1. Leaf (Feeler) Gauge

Fig. 5.14 Checking Cone Concentricity

e. Use chains and a spreader bar, as depicted in Figure 5-9, to raise the body (101). Align the body with the rotation arrow matching the direction indicated on the floating bearing end head.

f. Insert the body into the rabbet of the floating bearing end head until it is properly seated. For Model L, M, P, R, S, and T pumps, ensure that the body pin (101-2, Figure 5-21) enters the 9/16-inch diameter hole in the head, while the body flange mounting holes engage the studs installed in step d.

g. Fasten the body to the floating bearing end head by tightening the head screws or body nuts until finger-tight.

Model	Qty	Screw/Nut	Index	Ref. Fig
L, M	10	3/4 - 10	102 - 4	5 - 21
P, R, S, T	10	1.0 - 8	102 - 4	5 - 21

Removal of studs followed by remaining head screw replacement:

h. For Model U pumps, use eight 1-8 x 3-inch head screws (102-5, Figure 5-22) and three 1-8 x 4-inch head screws (102-4) to secure the body to the floating bearing end head. Tighten them finger-tight, remove two studs, replace them, and then tighten the remaining two head screws (102-5).

i. Support the fixed bearing end of the body with wood blocks, and subsequently, remove the chains.

5.18 Installing Rotor and Shaft Assembly

To install the rotor and shaft assembly in the body and the floating bearing end head and cone assembly, follow these steps:

NOTE: Make sure that the floating bearing locknut (119-1) has been removed from the shaft (111).

a. Insert the machined end of the shaft sleeve tool, as fabricated in Section 5-5, step b, through the floating bearing end head (102) and the shaft bore of the cone (104).

b. Utilize a chain hoist and sling around the rotor center shroud or chains, as depicted in Figure 5-8, to raise the rotor and shaft assembly. Introduce the floating bearing end of the shaft into the body until the shaft engages with the shaft sleeve tool.

c. Maintain the shaft sleeve tool level and continue moving the rotor and shaft assembly into the body until the bearing journal shoulder on the shaft seats against the end of the shaft sleeve tool.

d. Continue moving the rotor and shaft assembly with the shaft guided through the cone and head by the shaft sleeve tool until the strap or chains reach the body flange. Provide support for the

fixed bearing end of the rotor using wood blocks, as illustrated in Fig. 5.8.

e. Detach the sling or chains from the rotor. Place a strap around the fixed bearing end of the shaft and attach a second sling and chain hoist or floor jack to the shaft sleeve tool at the floating bearing end.

f. Level the rotor and shaft assembly, eliminate the wood blocks, and proceed to advance the rotor and shaft assembly into the body, ensuring that the rotor is centered in the body shroud ID, until the rotor taper bore engages with the floating bearing end cone.

g. Remove the straps, hoists, floor jack, and shaft sleeve tool.

5.19 Installing Fixed Bearing End Head and Cone Assembly

To install the fixed bearing end head and cone assembly, follow these steps:

a. Insert two eyebolts into the inlet flange of the fixed bearing end head (103, Figure 5.21, 5.22, or 5.23) using the same procedure outlined in Section 5.17, step a. Employ a chain hoist to elevate the fixed bearing end head and cone assembly to a vertical position.

b. Execute steps c and d as specified in Section 5.17 for the fixed bearing end head.

CAUTION!

WHEN INSTALLING BODY GASKETS (101-3) ON MODEL L, M, P, R, S, AND T PUMPS, ENSURE PROPER ALIGNMENT BY MATCHING THE 9/16-INCH DIAMETER HOLE IN EACH GASKET WITH THE CORRESPONDING HOLE IN THE HEAD FLANGE.

c. Apply a light coat of grease to six (for Model L and M pumps), seven (for Model P, R, S, and T pumps), or 10 (for Model U pumps) body gaskets (101-3). Install each gasket individually over the studs installed in step b, pressing them against the fixed bearing end head.

d. Remove the fixed bearing locknut (120-1) from the shaft (111).

e. Align the shaft bore of the cone (105) with the fixed bearing end of the shaft (111) and position the fixed bearing end head and cone assembly accordingly.

f. Insert the machined end of the shaft sleeve tool, created in Section 5.5, step b, through the fixed bearing end head and the shaft bore of the cone until the shaft sleeve tool securely engages the shaft.

g. While supporting the end of the shaft sleeve tool by hand, move the fixed bearing end head and cone assembly along with the shaft sleeve tool towards the body (101) until the shaft sleeve tool is seated against the bearing journal shoulder on the shaft, and the head and cone assembly begins to move over the shaft.

h. Continue carefully moving the fixed bearing end head and cone assembly towards the body until the head rabbet seats on the body flange. For Model L, M, P, R, S, and T pumps, ensure that the body pin (101-2, Figure 5.21) enters the 9/16-inch diameter hole in the head as studs, installed in step b, engage the body flange mounting holes.

NOTE

IT MIGHT BE NECESSARY TO LIFT THE END OF THE SHAFT SLEEVE TOOL WITH A STRAP AND CHAIN HOIST OR A FLOOR JACK TO ENABLE THE ROTOR END SHROUD TO ENGAGE THE SHROUD RECESS IN THE HEAD.

i. Remove the shaft sleeve tool.

j. Secure the fixed bearing end head to the body using the following steps:

Model	Qty	Screw/Nut	Index	Ref. Fig
L, M	10	3/4 - 10	103 -	5 - 21
			4	
P, R, S, T	10	1.0 - 8	103 -	5 - 21
			4	

k. For Model U pumps, secure the fixed bearing end head to the body with eight 1-8 x 3.00 inch head screws (103-5, Figure 5.22) and three 1-8 x 4.00 inch head screws (103-4) finger-tight.

l. Lift the fixed bearing end head end of the pump and remove the wood blocks supporting the body.

m. Lower the pump so that all four mounting feet are on level pads.

n. Remove studs and replace them with the remaining two 3/4-10 (Model L and M pumps) or 1-8 (Model P, R, S, and T pumps) head screws (103-4, Figure 5.21) or two 1-8 (Model U pumps) head screws (103-5, Figure 5.22).

o. Loosen floating bearing end head screws (102-4, Figure 5.21 or 5.22) and, on Model U pumps, floating bearing head screws (102-5, Figure 5-22).

p. Ensure that the pump mounting feet are level on the mounting pads. Securely tighten the fixed and floating bearing end head screws or nuts as required.

Model	Qty	Screw/Nut	Index	Ref. Fig
L, M	24	3/4 - 10	103 - 4	5 - 21
P, R, S, T	24	1.0 - 8	103 - 4	5 - 21
			102 - 4	
			103 - 5	5 - 22
U	20	1.0 - 8	102 - 5	
			103 - 4	5 - 22
	6	1.0 - 8	102 - 4	

5-20 Installing Fixed Bearing Bracket

Install the fixed bearing bracket (109, Figure 5.21, 5.22, or 5.23) and its associated parts on the fixed bearing end head (103) using the following steps:

a. If gland studs (103-2) were removed, insert replacement gland studs into the head.

b. Mount the gland assembly on the fixed bearing end gland studs (103-2). Attach two 1/2-13 (Model L and M pumps) or 5/8-11 (Model P, R, S, T, and U pumps) gland nuts (103-1). Do not tighten the gland nuts.

c. Place the slinger (3) and slinger spring (3-1) on the fixed bearing end of the shaft (111).

d. Apply a light coat of grease to the inner diameter (ID) and outer diameter (OD) of the new lip seal (5). Install the lip seal in the fixed bearing inner cap (118) with the sealing edge (and spring) facing the head side of the inner cap.

e. Install the fixed bearing inner cap on the fixed bearing end of the shaft, taking care not to damage the sealing edge of the lip seal.

f. Lightly grease the fixed bearing inner cap gasket (118-3) and position it on the fixed bearing inner cap lip.

g. Place chains with a spreader bar around the top two ribs of the fixed bearing bracket (109) as illustrated in Figure 5-2. Lift the fixed bearing bracket into position on the fixed bearing end head (103) and tap the bracket flange into the head rabbet using a rawhide mallet. Secure the bearing bracket to the head with four 7/8-9 (Model L and M pumps), 1-8 (Model P and R pumps), or 1-1/4-7 (Model S, T, and U pumps) bearing bracket screws. Ensure that the bearing bracket is fully seated against the head.

5.21 Installing Fixed Bearing

a. Shift the shaft towards the fixed bearing end of the pump to ensure proper centering in the bearing housing, allowing the rotor taper bore to ascend on the fixed bearing end cone (105). Utilize a soft-faced hammer or ram to gently impact the floating bearing end of the shaft.

b. Press the fixed bearing inner cap (118) against the gland studs (103-2).

c. Warm two tapered cone bearings of the fixed bearing set in a hot air oven to a temperature range of 240°F to 250°F (116°C to 121°C), using a temperature stick for accuracy.

CAUTION!

DO NOT HEAT THE BEARING CUP OR SPACER.
WARNING: USE ASBESTOS GLOVES WHEN HANDLING HEATED TAPERED CONE BEARINGS TO AVOID SERIOUS BURNS.

NOTE

CONFIRM THE REMOVAL OF THE FIXED BEARING LOCKNUT (120-1) FROM THE SHAFT (111).

CAUTION!

EXERCISE CAUTION TO PREVENT MISPLACEMENT OF THE BEARING CUP AND SPACER PROVIDED WITH TAPERED CONE BEARINGS DURING THE HEATING PROCESS. THE CUP, SPACER, AND TAPERED CONE BEARINGS FORM A MATCHED SET, AND COMPONENTS FROM ONE SET SHOULD NOT BE INTERCHANGED WITH THOSE FROM ANOTHER SET TO AVOID POTENTIAL CLEARANCE ISSUES.

d. Remove one tapered cone bearing from the heater or oven. Position the large end of the taper towards the shaft and align the ID of the bearing with the OD of the shaft.

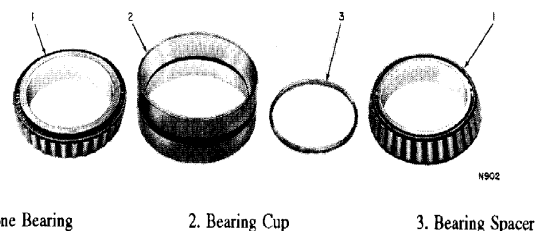
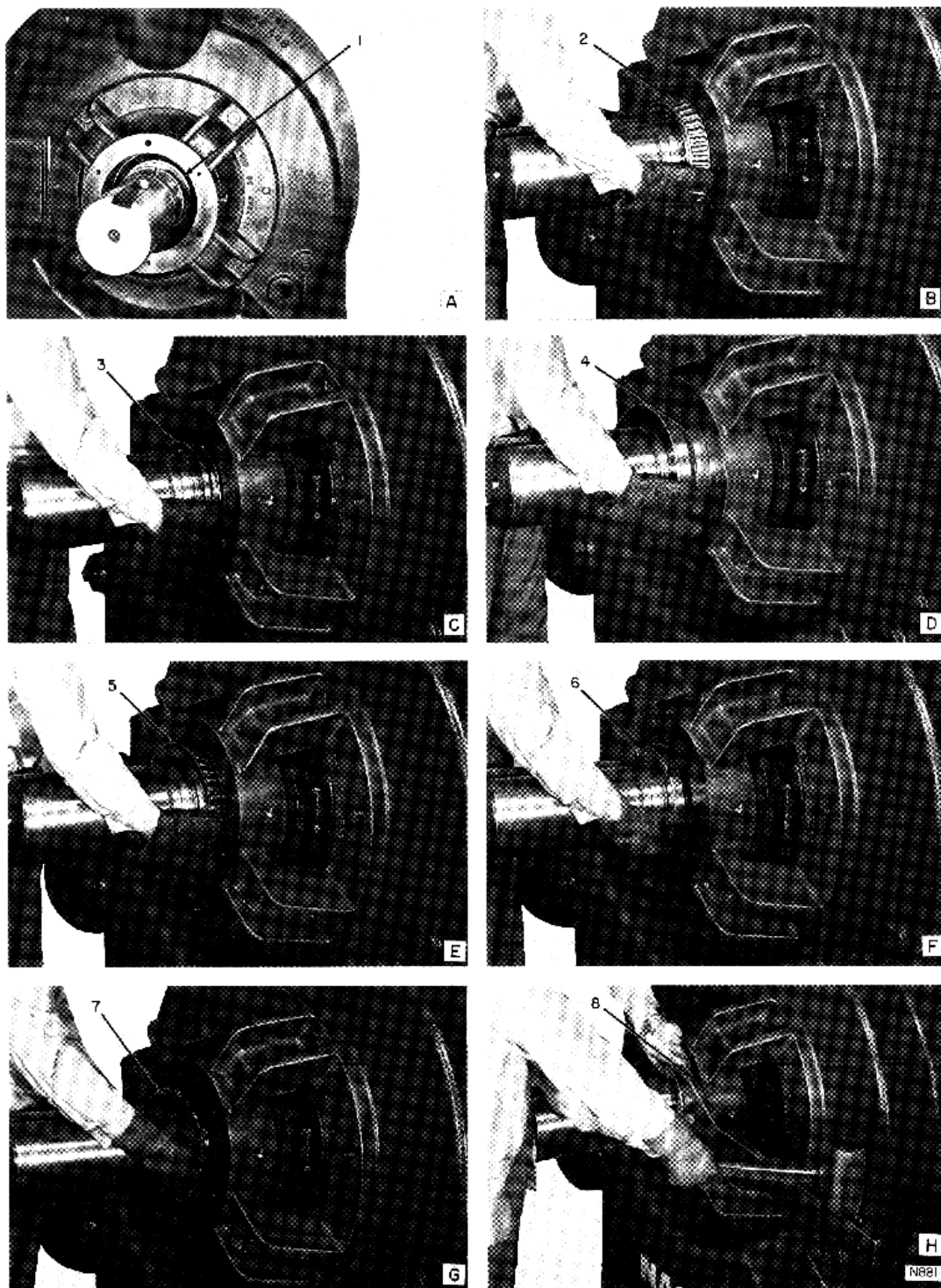


Figure 15.15 Tapered Roller Bearing Assembly



1. Bearing Journal
2. Inner Tapered Cone Bearing

4. Bearing Cup
5. Outer Tapered Cone Bearing

6. Fixed Bearing Locknut
7. Fixed Bearing Lockwasher
8. Spanner Wrench

Fig. 5.16 Installing Fixed Bearing

NOTE

THIS STEP MUST BE EXECUTED SWIFTLY, AS THE HEATED TAPERED BEARING ENCOUNTERS THE SHAFT. IT WILL RAPIDLY COOL AND CONTRACT, AND THIS CONTRACTION MAY BE SUFFICIENT TO CAUSE THE BEARING TO SEIZE AT THE WRONG LOCATION ON THE SHAFT, NECESSITATING THE REMOVAL, REHEATING, AND REINSTALLATION OF THE BEARING.

e. With one fluid, rapid motion, center the bearing on the shaft and push it onto the bearing journal until it contacts the bearing journal shoulder (refer to Figure 5.16, Parts A and B). Ensure that the tapered cone bearing is firmly seated against the bearing journal shoulder.

f. Slide the bearing spacer onto the shaft and into the bearing bracket until it contacts the tapered cone bearing (see Figure 5.16, Part C).

g. Proceed to install the bearing cup over the tapered cone bearing that was placed in position during step e. Be cautious not to force the bearing cup into the bearing bracket, ensuring a proper seat on the tapered cone bearing (refer to Figure 5.16, Part D).

h. While using asbestos gloves, carefully extract the second tapered cone bearing from the heater or oven. Orient the small end of the taper towards the shaft and align the inner diameter (ID) of the bearing with the outer diameter (OD) of the shaft.

i. Observing the precaution mentioned in the NOTE prior to step e, and employing a smooth and swift motion, center the bearing on the shaft and push it onto the bearing journal until the spacer installed in step f is securely wedged between the two tapered cone bearings (see Figure 5.16, Part D).

j. Promptly install the fixed bearing locknut (120-1) onto the shaft, ensuring careful engagement of the threads, and tighten it using a spanner wrench or a punch and hammer (refer to Figure 5.16, Parts F and H).

k. After the fixed bearing has cooled on Model L, M, P, R, S, and T pumps:

- Remove the fixed bearing locknut from the shaft.
- Place the fixed bearing lockwasher (120-2, Figure 5.21) into position as shown in Figure 5-6, Part G, ensuring that the inner tab securely fits into the slot in the shaft.
- Reattach the fixed bearing locknut and tighten it using a spanner wrench and mallet or punch and hammer until the slot in the locknut aligns with the tab on the lockwasher.
- Bend the lockwasher tab into the locknut slot.

For Model U pumps, following the cooling of the fixed bearing:

- Tighten the fixed bearing locknut with a spanner wrench and mallet or punch and hammer until the locknut lockplate (102-2, Figure 5.22) can be correctly placed on the locknut, with the tab fitting into the keyway in the shaft (111).
- Secure the locknut lockplate to the locknut using two screws (120-4). Ensure that the screws are securely lockwired in place.

5.22 Preliminary End Travel Check

Perform the following procedure to check end travel and determine the required number of body gaskets (101-3, Figure 5.21, 5.22, or 5.23):

NOTE

ENSURE THAT THE ROTOR TAPER BORE IS STILL ENGAGED WITH THE FIXED BEARING END CONE (105), AND THE SHAFT CANNOT BE ROTATED.

a. Attach a dial indicator to the floating bearing end of the shaft using a strap or a magnetic mount, positioning the dial indicator spindle against the machined bearing bracket mounting face on the floating bearing head (102). Set the dial indicator to zero.

b. Install the fixed bearing outer cap (117) onto the fixed bearing bracket (109) and secure it to the fixed bearing inner cap (118) with fasteners.

Model	Qty	Screw	Index
L, M, P, R	3	1/2 - 13	117 - 2
S, T	3	5/8 - 11	117 - 2
U	3	3/4 - 10	117 - 2

c. Thread the specified screws through the fixed bearing outer cap and into the bearing bracket to serve as take-up screws (refer to Figure 5.17).

Model	Qty	Screw	Index
L, M, P, R	3	1/2 - 13	117 - 1
S, T	3	5/8 - 11	117 - 1
U	3	3/4 - 10	117 - 1

d. Alternately tighten the three take-up screws (117-1) until the rotor and shaft assembly cannot be moved any farther, and the shaft cannot be rotated. Do not attempt to tighten the screws beyond this point. At this stage, the rotor taper bore is now mating against the floating bearing end cone (104). Record the dial indicator reading and then remove the dial indicator.

e. If the value recorded in step d is less than the recommended end travel specified in Table 5.3, subtract the recorded value from the recommended end travel. If the difference is 0.010 inches or more, proceed to step f; if the difference is less than 0.010 inches, proceed to Section 5-23. If the value recorded in step d is more than the recommended end travel specified in Table 5-3, proceed to Section 5-23.

f. Choose the thickness of body gaskets (101-3) equal to the difference calculated in step e and install them at the floating bearing end as follows:

NOTE

THE PROCEDURE IN STEPS F.1 THROUGH F.18 BELOW IS FOR ADDING BODY GASKETS WHEN END TRAVEL IS LESS THAN THE RECOMMENDED END TRAVEL. EACH BODY GASKET IS 0.010 INCHES THICK.

1. Install eyebolts into the inlet flange of the floating bearing end head (102) as outlined in Section 5-6, step f.

Pump Model	End Travel - Inches (Iron)	End Travel - Inches (St. Steel)
L	0.160	0.290
M	0.170	0.305
P	0.190	0.345
R	0.195	0.350
S	0.220	0.395
T	0.230	0.410
U	0.250	0.445

Table 5.3 Recommended End Travel

- Remove the mounting bolts from the feet of the floating bearing end head.
- Utilize a chain hoist connected to the eyebolts installed in step 1 to lift the pump, raising the mounting feet of the floating bearing end head off the level pads.
- Support the floating bearing end of the body (101) using wood blocks. Lower the pump so that it is supported by wood blocks while maintaining tension on the chain hoist.
- Remove 12 screws (Model L, M, P, R, S, and T pumps) or three screws (Model U pumps) from the floating bearing end head (102-4), along with 10 screws (Model U pumps, 102-5, Figure 5.22).
- Install two 3/4-10 studs (Model L and M pumps) or 1-8 threaded rods (Model P, R, S, T, and U pumps) each measuring 4 inches long, as specified in Section 5.17, step d.
- Install two 3/4-10 screws (Model L and M pumps) or 1-8 screws (Model P, R, S, T, and U pumps) into tapped holes in the flange of the body to serve as jackscrews.
- Tighten the two jackscrews evenly until the floating bearing end head rabbet is free of the body flange. Remove the floating bearing end head and cone assembly.

CAUTION!

FOR MODEL L, M, P, R, S, AND T PUMPS, EXERCISE CAUTION WHEN INSTALLING BODY GASKETS. ENSURE TO ALIGN THE 9/16-INCH DIAMETER HOLE IN EACH GASKET WITH THE CORRESPONDING HOLE IN THE HEAD FLANGE.

9. Apply a light coat of grease to each additional body gasket and install them individually over the studs installed in step f.5, positioning them against the previously installed body gaskets.
10. Align the floating bearing end head and cone assembly with the shaft bore of the cone (104) in line with the floating bearing end of the shaft (111).
11. Slide the machined end of the shaft sleeve tool, fabricated in Section 5.5, step b, through the floating bearing end head and the shaft bore of the cone until the shaft sleeve tool engages the shaft.
12. Supporting the end of the shaft sleeve tool by hand, move the floating bearing end head and cone assembly along with the shaft sleeve tool toward the body (101) until the shaft sleeve is seated against the bearing journal shoulder on the shaft, and the head and cone assembly begins to move over the shaft.
13. Carefully continue moving the floating bearing end head and cone assembly toward the body until the head rabbet seats on the body flange. For Model L, M, P, R, S, and T pumps, ensure that the body pin (101-2, Figure 5.21) enters the 9/16-inch diameter hole in the head as studs installed in step f.5 engage the body flange mounting holes.

NOTE

IT MIGHT BE NECESSARY TO LIFT THE END OF THE SHAFT SLEEVE TOOL WITH A STRAP AND CHAIN HOIST OR FLOOR JACK TO ENABLE THE ROTOR END SHROUD TO ENGAGE THE SHROUD RECESS IN THE HEAD.

14. Remove the shaft sleeve tool.
15. Secure the floating bearing end head with the specified screws or nuts (on studs), tightening them finger-tight.

Model	Qty	Screw	Index	Ref. Fig
L, M	10	3/4 - 10	102 - 4	5 - 21
P, R, S, T	10	1.0 - 8	102 - 4	5 - 21
		1.0 - 8 x		
	3	4.0	102 - 4	
U		1.0 - 8 x		
	8	3.0	102 - 5	5 - 22

16. Slightly raise the pump and remove the wood blocks supporting the body.
17. Lower the pump so that the mounting feet are on level pads. Remove the chain hoist and eyebolts.
18. Remove the studs and replace them with the remaining screws.

Mode	Qty	Screw	Index	Ref. Fig
L, M	2	3/4 - 10	102 - 4	5 - 21
P, R, S, T	2	1.0 - 8	102 - 4	5 - 21
		1.0 - 8 x		
U	2	4.0	102 - 5	5 - 22

19. Ensure that all pump parts are level and tighten:

Mode	Qty	Screw	Index	Ref. Fig
L, M	12	3/4 - 10	102 - 4	5 - 21
P, R, S, T	12	1.0 - 8	102 - 4	5 - 21
		1.0 - 8 x		
	3	4.0	102 - 4	
U		1.0 - 8 x		
	10	3.0	102 - 5	5 - 22

5.23 Installing Floating Bearing Bracket and Floating Bearing

To assemble the floating bearing bracket (108, Figure 5.21 or 5.22), the floating bearing (119), and related components onto the floating bearing end head (102), follow these steps:

- Install the floating bearing bracket (108) and its corresponding components for the floating bearing end as detailed in Section 5.20, steps a through g. Ensure that the rotor and shaft assembly properly engages with the floating bearing end cone (104).
- Install the floating bearing following the procedure outlined in Section 5.21, steps b through j.
- Insert screws into the tapped holes in the fixed bearing outer cap (117) to act as jackscrews (see Figure 5.17).

Model	Qty	Screw
L, M, P, R	2	1/2 - 13
S, T	2	5/8 - 11
U	2	3/4 - 10

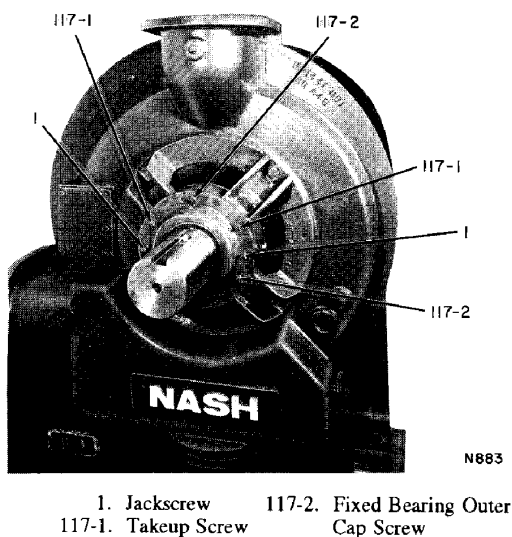
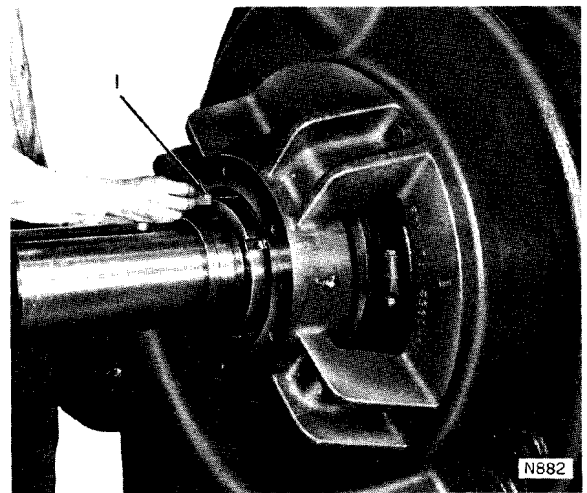


Fig. 5.17 End Travel Check Setup at Fixed Bearing End

d. Loosen the three take-up screws (117-1) on the fixed bearing outer cap. Tighten the two jackscrews installed in step c, pulling the rotor and shaft assembly away from the floating bearing end cone (102) until the shaft becomes rotatable.

e. Rotate the shaft using a spanner wrench for a minimum of three complete revolutions.

f. Place a leaf (feeler) gauge between a high point of any tapered cone bearing roller and the inner race of the bearing cup, following the illustration in Figure 5-18, to measure the bearing roller-cup clearance. Ensure that the maximum allowable clearance at any point does not exceed 0.002 inches. If the clearance surpasses 0.002 inches, it indicates a potential incorrect bearing installation or the presence of unmatched bearing parts. To address this, disassemble the pump as needed to remove the bearing, inspect the bearing parts, reassemble the pump, and reinstall the bearing.



1. Leaf (Feeler) Gauge

Fig. 5.18 Measuring Bearing Roller-Cup Clearance. Models L, M, R, S & T

g. Remove the fixed bearing outer cap (117) and repeat step f for the fixed bearing (120). Subsequently, reinstall the fixed bearing outer cap.

h. For Model L, M, P, R, S, and T pumps, follow these steps:

- Remove the floating bearing locknut (119-1, Figure 5-21) from the shaft (111).
- Install the floating bearing lockwasher (119-2) as illustrated in Figure 5-16, Part G, ensuring the inner tab fits into the slot in the shaft.
- Reinstall the floating bearing locknut and tighten it using a spanner wrench and mallet, or punch and hammer, until the slot in the locknut aligns with the tab on the lockwasher.
- Bend the lockwasher tab into the locknut slot.

i. For Model U pumps, proceed with the following:

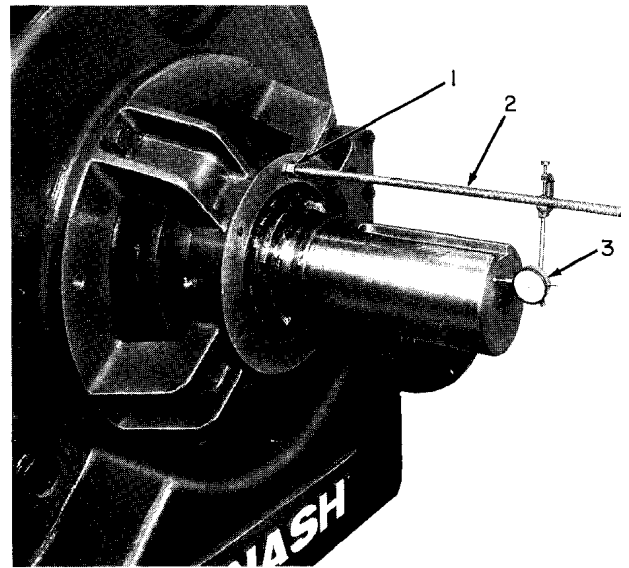
- Retighten the floating bearing locknut using a spanner wrench and mallet, or punch and hammer, until the locknut lockplate (119-2, Figure 5-22) can be placed on the locknut with the tab fitting into the keyway in the shaft (111).
- Secure the locknut lockplate to the locknut using two screws (119-4). Ensure that the screws are lockwired in place.

5.24 Setting End Travel

Set the end travel as outlined below:

- Ensure that three fixed bearing outer cap screws (117-2) are tightened and confirm that three take-up screws (117-1) are loosened at least 1/4 inch (Model L, M, P, R, S, and T pumps) or 3/8 inch (Model U pumps). (Refer to Figure 5-17.)
- Install the threaded rod in the top floating bearing outer cap mounting hole in the floating bearing bracket (108) and secure it with one nut on each side of the bearing housing (see Figure 5.19).

Model	Thread	Length (In)
L, M, P, R	1/2 - 13	30
S, T	5/8 - 11	30
U	3/4 - 10	30



1. Nut
2. Threaded Rod

3. Dial Indicator

Fig. 5.19 Measuring End Travel at Floating

c. Affix the dial indicator to the threaded rod, ensuring the dial indicator spindle is pressed against the end of the shaft, as depicted in Figure 5-19.

d. Evenly tighten two jackscrews in the fixed bearing outer cap (117, Figure 5-21 or 5-22) until the rotor and shaft assembly can no longer be moved, and the shaft is immobile. (Refer to Figure 5-17.) DO NOT EXCEED THIS TIGHTENING POINT. The rotor taper bore is now in contact with the fixed bearing end cone (105). Set the dial indicator to zero.

e. Remove the jackscrews from the fixed bearing outer cap.

f. Alternately tighten the take-up screws (117-1) until the rotor and shaft assembly cannot be moved any farther, and the shaft cannot be rotated. (Refer to Figure 5-17.) DO NOT EXCEED THIS TIGHTENING POINT. The rotor taper bore is now aligning with the floating bearing end cone (104). Record the dial indicator reading.

g. Compare the value recorded in step f with the recommended end travel specified in Table 5-3. If the recorded end travel value is greater than

the value specified in Table 5-3, proceed to step h; if the value recorded is less than the value specified in Table 5-3, proceed to step j.

h. Subtract the value specified in Table 5-3 from the value recorded in step f. If the difference is 0.010 inches or more, remove body gaskets (101-3) as specified in step i; if the difference is less than 0.010 inches, the end travel is within limits, proceed to step l.

i. Execute the removal of body gaskets (101-3) from the fixed bearing end as follows:

1. Install eyebolts into the inlet flange of the fixed bearing end head (103) following the instructions in Section 5-4, step a.
2. Utilize a chain hoist connected to the eyebolts to raise the pump, lifting the mounting feet of the fixed bearing end head off the level pads.
3. Support the fixed bearing end of the body (101) with wood blocks. Lower the pump so that it is supported by the wood blocks while maintaining tension on the chain hoist.
4. Remove three fixed bearing outer cap screws (117-2) to release the fixed bearing inner cap (118).
5. Take out 12 (Model L, M, P, R, S, and T pumps) or three (Model U pumps) fixed bearing end head screws (103-4) and 10 (Model U pumps) fixed bearing end head screws (103-5, Figure 5-22). Install two 3/4-10 (Model L and M pumps) or 1-8 (Model P, R, S, T, and U pumps) by 4-inch-long studs or threaded rods as specified in Section 5-17, step d.
6. Insert the following screws into the tapped holes of the listed flanges to serve as jackscrews.

Model	Qty	Screw	Flange
L, M, P, R	2	3/4 - 10	Body
S, T	2	1.0 - 8	Body
U	2	1.0 - 8	Head

7. Evenly tighten two jackscrews until the fixed bearing end head rabbet is free of the body flange.

CAUTION!

ENSURE THAT THE COMPLETE GASKET IS REMOVED WHEN PERFORMING STEP i.8.

8. Move the fixed bearing end head back just enough to insert the jaws of needle-nosed pliers into the space. Tear off the thickness of body gaskets equal to the value calculated in step h. Each gasket is 0.010-inch thick.

NOTE

IF THE NUMBER OF GASKETS TO BE REMOVED IS MORE THAN THE QUANTITY INSTALLED OR WILL RESULT IN ONLY ONE GASKET REMAINING, GASKETS MAY HAVE TO BE REMOVED FROM THE FLOATING BEARING END, OR ADDITIONAL CONE GASKETS (104-3 AND 105-3) MAY BE ADDED. CONTACT YOUR NES REPRESENTATIVE FOR ASSISTANCE IN ESTABLISHING ACCEPTABLE END TRAVEL.

9. Reassemble the fixed bearing end head and cone assembly to the body in the same manner as specified in Section 5-22, steps f.12 and f.14 through f.18.
10. Repeat steps d through g.

j. If the recorded end travel value in step f is less than the value specified in Table 5-3, subtract the recorded end travel value from the specified value in Table 5-3. If the difference is greater than 0.010 inches, add body gaskets as outlined in step k; if the difference is less than 0.010 inches, the end travel is within limits, proceed to step l.

k. Choose body gaskets (101-3) with a thickness equal to the difference calculated in step j. Disassemble the pump, and install additional body gaskets at the floating bearing end following these steps:

1. Remove the dial indicator and threaded rod from the floating bearing end.
2. Remove the floating bearing bracket (108), floating bearing (119), and associated parts as specified in Section 5-3.

3. Remove the floating bearing end head and cone assembly in the same manner as specified in Section 5.4.

CAUTION!

ON MODELS L, M, P, R, S, AND T PUMPS, WHEN INSTALLING BODY GASKETS, ENSURE THAT THE 9/16-INCH DIAMETER HOLE IN EACH GASKET IS ALIGNED WITH THE HOLE IN THE HEAD FLANGE.

4. Apply a light coat of grease to each additional body gasket and install each separately over the studs in the head and against the body gaskets previously installed.
5. Reinstall the floating bearing end head and cone assembly following the procedure specified in Section 5-22, steps f.10 through f.18.
6. Reinstall the floating bearing bracket, floating bearing, and associated parts as specified in Section 5-23.
7. Repeat steps a through g to ensure that the end travel is as specified in Table 5.3.
- l. When the end travel is acceptable, remove three take-up screws and reinstall two jackscrews in the fixed bearing outer cap (117). Evenly tighten two jackscrews until the dial indicator reading is equal to one-half of the final end travel value recorded to center the rotor. Ensure that the shaft turns freely. Record the dial indicator reading.

m. Utilizing a leaf (feeler) gauge, measure the gap between the fixed bearing outer cap and fixed bearing bracket (109) at four locations 90 degrees apart. Sum the four measurements and divide the total by four to calculate the average gap.

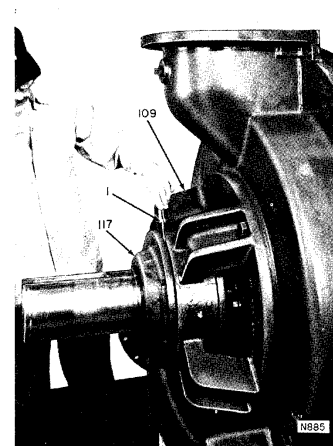
n. Choose a combination of new shims (4) and new shim gaskets (4-1) equal to the average gap calculated in step m.

NOTE

SELECT A COMBINATION OF METAL SHIMS AND PAPER SHIM GASKETS TO INCLUDE A SHIM GASKET AGAINST THE FIXED BEARING BRACKET, AT LEAST ONE SHIM GASKET BETWEEN EACH PAIR OF SHIMS, AND A SHIM GASKET AGAINST THE FIXED BEARING OUTER CAP.

- o. Remove two jackscrews, three screws (117-2), and lock washers (117-4), and remove the fixed bearing outer cap.
- p. For pumps with a double extended shaft, apply a light coat of grease to the inner diameter (ID) and outer diameter (OD) of the new lip seal (95-1). Install the lip seal in the fixed bearing outer cap so that the sealing edge (and spring) faces the end of the shaft.
- q. Lightly grease the fixed bearing outer cap gasket (117-3) and position it on the outer cap lip.
- r. Position the shims and shim gaskets selected in step n on the fixed bearing outer cap.
- s. Install the fixed bearing outer cap on the bearing bracket (109) and secure it with:

Model	Qty	Screw	Index
L, M, P, R	3	1/2 - 13	117 - 1
S, T	3	5/8 - 11	117 - 1
U	3	3/4 - 10	117 - 1



1. Leaf (Feeler) Gauge 117. Fixed Bearing Outer Cap
109. Fixed Bearing Bracket

Fig. 5.20 Measuring Shim Cap

t. Ensure that the fixed bearing inner cap (118) with gasket (117-3) is seated against the bearing in the bearing bracket and secure it with:

u. Confirm that the dial indicator reading is the same as the value recorded in step l. Then remove the dial indicator and threaded rod from the floating bearing bracket (108).

v. Install the new lip seal (5-1) in the floating bearing outer cap in the same manner as specified in step p.

w. Lightly grease the floating bearing outer cap gasket (115-3) and position it in the floating bearing outer cap.

x. Install the floating bearing outer cap on the bearing bracket and secure it with three screws (115-1) of appropriate size (1/2-13 for Model L, M, P, and R pumps, 5/8-11 for Model S and T pumps, or 3/4-10 for Model U pumps).

y. Slide the floating bearing inner cap (116) with gasket (116-3) properly positioned onto the bearing bracket and secure it with the following fasteners:

Model	Qty	Screw	Index	Lock washer	Index
L, M, P, R	3	1/2 - 13	115 - 2	1/2	115 - 4
S, T	3	5/8 - 11	115 - 2	5/8	115 - 4
U	3	3/4 - 10	-	3/4	

5.25 Final Assembly and Lubricating Bearings

Complete the pump assembly and lubricate both the floating and fixed bearings with the following steps:

a. If removed, insert the reducing bushing (23-1, Figure 5-21 or 5-22) and grease fitting (23) into the floating and fixed bearing brackets (108 and 109). Ensure that plugs (22-4) are securely installed.

b. Using fresh grease as specified in Table 4.1 and an automatic grease gun, inject grease into the grease fittings on both ends of the pump until grease starts to extrude from the end of the rollers. Continue pumping grease while slowly rotating the shaft 360 degrees. Pump grease into the outer bearing caps until they are approximately 1/3 full. Assemble the caps.

c. Place new packing (1) into the floating and fixed end heads (102 and 103) as specified in Section 4.5.

d. Attach slingers and springs to both the fixed and floating ends of the shaft.

NOTE

LEAVE THE 1.0-INCH SEAL WATER LINE OPEN.

e. Insert one 2.5-inch Teflon vent passage gasket in each head.

f. Attach one vent passage gasket and cover to each head, using four 1/2-13 screws.

NOTE

BEFORE RETURNING THE PUMP TO SERVICE, ALIGN THE COUPLING OR V-BELT DRIVE ACCORDING TO THE INSTRUCTIONS PROVIDED IN INSTALLATION INSTRUCTIONS FOR NES VACUUM PUMPS AND COMPRESSORS.

LEGEND FOR FIGURE 5-21

Index No.	Qty	Part Name	Index No.	Qty	Part Name	Index No.	Qty	Part Name
*1	12 rings	Packing	102-1	2	Gland Nut	115-1	3	Outer Cap Screw
*3	2	Slinger	102-2	2	Gland Stud	115-2	3	Outer Cap Screw
*3-1	2	Slinger Spring	102-4	12	Floating Bearing End Head Screw	*115-3	1	Outer Cap Gasket
*4	AR	Shim	103	1	Fixed Bearing End Head	115-4	3	Outer Cap Lockwasher
*4-1	AR	Shim Gasket	103-1	2	Gland Nut	116	1	Floating Bearing Inner Cap
*5	2	Lip Seal	103-2	2	Gland Stud	*116-3	1	Inner Cap Gasket
*5-1	2(1†)	Lip Seal	103-4	12	Fixed Bearing End Head Screw	117	1	Fixed Bearing Outer Cap
**10	2	Lantern Gland	104	1	Floating Bearing End Cone	117-1	3	Outer Cap Screw
12	2	Cover Plate	104-1	12(18†)	Cone Screw	117-2	3	Outer Cap Screw
12-1	12(18†)	Cover Plate Screw	*104-3	1	Cone Gasket	*117-3	1	Outer Cap Gasket
*12-3	2	Cover Plate Gasket	105	1	Fixed Bearing End Cone	117-4	3	Outer Cap Lockwasher
12-4	6	Rollpin	105-1	12(18†)	Cone Screw	117-5	1	Access Plug
18	2	Check Ball	*105-3	1	Cone Gasket	118	1	Fixed Bearing Inner Cap
22	14	Pipe Plug	108	1	Floating Bearing Bracket	*118-3	1	Inner Cap Gasket
22-1	8	Pipe Plug	108-1	4	Bearing Bracket Screw	*119	1	Floating Bearing
22-2	2	Pipe Plug	109	1	Fixed Bearing Bracket	*119-1	1	Floating Bearing Locknut
22-4	2	Pipe Plug	109-1	4	Bearing Bracket Screw	*119-2	1	Floating Bearing Lockwasher
23	2	Grease Fitting	110	1	Rotor	*120	1	Fixed Bearing
23-1	2	Reducing Bushing	111	1	Shaft	*120-1	1	Fixed Bearing Locknut
101	1	Body	111-1	1	Floating Bearing End Shaft Key	*120-2	2	Fixed Bearing Lockwasher
101-2	2	Body Pin	111-2	1	Fixed Bearing End Shaft Key	#143	2	Blank Flange
*101-3	12(10†)	Body Gasket	112	2	Gland Assembly	#143-1	24	Flange Screw
102	1	Floating Bearing End Head	115	1	Floating Bearing Outer Cap	*143-3	2	Flange Gasket

AR — As required.

*Minimum recommended spares.

**When used.

†Single extended shaft only.

‡Model L and M pumps only.

#Model P, R, S and T pumps only.

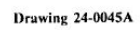


Fig. 5.21 Exploded view of

NES N904 vacuum Pumps, Model U

LEGEND FOR FIGURE 5-22

Index No.	Qty	Part Name	Index No.	Qty	Part Name	Index No.	Qty	Part Name
*1	12 rings	Packing	102-5	10	Floating Bearing End Head Screw	*115-3	1	Outer Cap Gasket
*3	2	Slinger	103	1	Fixed Bearing End Head	115-4	3	Outer Cap Lockwasher
*3-1	2	Slinger Spring	103-1	2	Gland Nut	116	1	Floating Bearing Inner Cap
*4	AR	Shim	103-2	2	Gland Stud	*116-3	1	Inner Cap Gasket
*4-1	AR	Shim Gasket	103-4	3	Fixed Bearing End Head Screw	117	1	Fixed Bearing Outer Cap
*5	2	Lip Seal	103-5	10	Fixed Bearing End Head Screw	117-1	3	Outer Cap Screw
*5-1	2	Lip Seal	104	1	Floating Bearing End Cone	117-2	3	Outer Cap Screw
**10	2	Lantern Gland	104-1	15	Cone Screw	*117-3	1	Outer Cap Gasket
12	2	Cover Plate	*104-3	1	Cone Gasket	117-4	3	Outer Cap Lockwasher
12-1	12	Cover Plate Screw	105	1	Fixed Bearing End Cone	117-5	1	Access Plug
*12-3	2	Cover Plate Gasket	105-1	15	Cone Screw	118	1	Fixed Bearing Inner Cap
18	2	Check Ball	*105-3	1	Cone Gasket	*118-3	1	Inner Cap Gasket
22	4	Pipe Plug	108	1	Floating Bearing Bracket	*119	1	Floating Bearing
22-1	10	Pipe Plug	108-1	4	Bearing Bracket Screw	*119-1	1	Floating Bearing Locknut
22-2	2	Pipe Plug	109	1	Fixed Bearing Bracket	*119-2	1	Floating Bearing Locknut Lockplate
22-4	2	Pipe Plug	109-1	4	Bearing Bracket Screw	119-4	2	Lockplate Screw
23	2	Grease Fitting	110	1	Rotor	*120	1	Fixed Bearing
23-1	2	Reducing Bushing	111	1	Shaft	*120-1	1	Fixed Bearing Locknut
101	1	Body	111-1	1	Floating Bearing End Shaft Key	*120-2	1	Fixed Bearing Locknut Lockplate
*101-3	17	Body Gasket	111-2	1	Fixed Bearing End Shaft Key	120-4	2	Lockplate Screw
102	1	Floating Bearing End Head	112	2	Gland Assembly	143	2	Blank Flange
102-1	2	Gland Nut	115	1	Floating Bearing Outer Cap	143-1	24	Flange Screw
102-2	2	Gland Stud	115-1	3	Outer Cap Screw	*143-3	2	Flange Gasket
102-4	3	Floating Bearing End Head Screw	115-2	3	Outer Cap Screw			

AR — As required.

*Minimum recommended spares.

**When used.