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Maintenance, troubles and remedies of pumping-sets

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by

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In the past few years, there has been significant achievement in the development of ground water resource involving increase in the number of irrigation pumping sets. In Uttar Pradesh, at the end of the year 1975-76 the total number of pumping sets was 8,49,988 which included 6,08,109 diesel-operated pumping units and 2,41,879 electrified units. The population of pumping sets in the state has now reached to about 9,50,000. The increase in pumping sets has likewise been effected throughout the country. However, comparable facilities for proper repair and maintenance have so far been lacking. It may not be possible for the users to take up major repairs by themselves but usual maintenance, proper handling and minor repairs can be performed by them knowing schedule of maintenance, possible troubles and their remedies. A properly maintained pumping set gives trouble free operation and low operating cost.

The pumping sets commonly used are centrifugal pumps driven by diesel engine or electric motor. The maintenance schedule, troubles and remedies pertaining to centrifugal pumps diesel engines and electric motors have been described here to familiarise the owners of the pumping sets.

CENTRIFUGAL PUMP

Supervision

1. Avoid idle running or operation against closed discharge valve for a longer period of time.
2. See the temperature rise of the bearings
3. Keep an eye over the stuffing box. See that they drip at the rate of 30 to 60 drops per minute.

Lubrication

1. Grease lubrication: Select a lime base, moisture resistant grease for bearing temperatures up to 66°C. For temperature in excess of 66°C, use a short fibre, soda base or mixed base grease.

First re-fill-up is done after 200 hours of service. Then onwards, the frequency of lubrication depends upon the operating conditions for normal duty of eight hours daily, relubricate after every 1000 hours of operation. Lubricate the bearings while the unit is running. Do not over-lubricate, for in many cases overlubrication is the cause of abnormal rise in temperature. Grease must not squirt out through shaft cover clearance space.

The temperature of bearings may rise to about 50°C above ambient temperature but it must not exceed 80°C.

Prior to first operation, the bearings must be filled with lubricant. For this purpose, flush bearings and bearing pedestal with gasoline or benzene to remove impurities. During flushing, turn the shaft slowly and then fill in the lubricant.

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2. Oil lubrication: Each pump is provided with some device which enables the operator to check at a glance the requisite quantity of oil. Keep an eye over the same.

Only a premium quality hydraulic oil containing antifoam, antioxidation and antirust additives should be used. For normal purpose, following are the recommendations.

Bearing temperature	Viscosity of oil at 37.8°C
0°C to 66°C	150 SSU
above 66°C	400 SSU

Initial lubrication method is the same as with the grease lubrication. First re-fill-up should be done after a month's service. Then onwards, normally with eight hours daily service, oil should be replaced after every six months.

Stuffing Box Packing

1. Spin the shaft by hand to see that there is no binding. Rub a thin film of oil on the shaft and in the stuffing box.
2. Insert the required no. of rings behind the lantern ring staggering the joints by 180° and pushing each ring as far as possible. The rings should slide-in easily.
3. Insert the lantern ring and see that it lines up with the drilled hole for the sealing water connection.
4. Insert the remaining packing rings, staggering the joints and take up on the gland studs tight and then loosen off so that while in service, water should leak at the rate of 30 to 60 drops per minute. This is to be achieved in combination with the control valve installed into the sealing liquid supply line.

Stuffing Box Cooling

Hot models are provided with cooling chambers for stuffing box. The cooling chamber is accordingly fitted with inlet and outlet water pipes. The cooling water flow will be regulated by a valve in supply line so that the temperature of cooling water is water under control. In normal operations, permissible temperature rise of cooling water is 10°C to 15°C.

Overhauling

The overhauling of the pump depends upon the type of liquid handled by the pump. If the liquid handled is rough and mixed with sand or gravel parts, a complete overhauling may be necessary every fortnight or earlier. In other cases it may be necessary only after 2 or 3 years. After overhaul and before inserting the packing, the pump shaft should rotate very easily. It must be remembered that when replacing old and worn out bearings, all the bearings should be removed and new bearings should not be fitted to work with old bearings. The correct method of mounting bearings is to heat them in oil bath to a temperature of about 100 to 110°C and then carefully mounting them on the shaft, tapping the inner race slightly, if necessary.

It is advised that following spares be maintained for quick replacement.

1. Pump shaft
2. Set of ball bearings
3. Set of shaft sleeves
4. Set of neckrings or renewable rings
5. Set of coupling bolts with rubber washer
6. About 1 Kg gland packings

Centrifugal pump troubles and their remedies

Cause	Remedy	KD 3720
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PUMP STOPS DELIVERING WATER WHILE WORKING

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| i. Air leaks through the gland | i. Tighten the gland |
| ii. Air leaks through the flange or some joint in the suction line. | ii. Locate the leak in the suction line and remove the cause of the leak. |
| iii. Impeller is choked up with foreign matter | iii. Remove the foreign matter |
| iv. Foot valve strainer choked up with rubbish. | iv. Clean the foot valve |
| v. Water level gone down below practical suction lift | v. Wait till the water rises or lower the pump within the practical suction lift. |
| vi. Belt is slipping | vi. Tighten the belt |
| vii. Engine is running slow | vii. Adjust the engine to its proper speed. |

PUMP TAKES TOO MUCH POWER

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|---|--|
| i. The total head too low for the rpm either by lowered discharge head or rise in water supply level. | i. Reduce the pump speed to proper rpm for the new total head. |
| ii. The bearings are running hot | ii.a. See that suction and delivery pipe weight does not twist the pump.
b. See that the lubrication is properly given
c. See that the belt is not over tight
d. See the foundation is sound. |
| iii. Speed too high | iii. Adjust the speed suitably. |
| iv. Wrong direction of rotation | iv. Check for the direction of the rotation in the direction of arrow mark on the casing. |
| v. Vibration in pump | v.a. Use correct foundation for rigidity.
b. Check for pump misalignment
c. Check for bent shaft. |

PUMP DOES NOT DELIVER WATER AT THE FIRST START

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| i. Lack of prime | i. Fill the pump and its suction pipe completely with water. Leave the vents open until clear bubble free liquid flows from them. Close the vents and start the pump. |
| ii. Speed of pump driver too low | ii. Adjust the drivers speed to its proper speed. |
| iii. Discharge head too high | iii. Check vertical head (particularly friction loss). |
| iv. Suction lift too high | iv.a. Total lift including friction loss in suction pipe should not exceed 7.5 meter nor in any case be more than 2/3 total head. Check with gauge.
b. Check the pump inlet for clogging by mud or some other obstruction.
c. Check the foot valve strainer choking. |

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| v. Wrong direction of rotation | v. See that the pump turns in the direction of the arrow on its casing. |
| vi. Air leaks in gland | vi. Tighten the gland |
| vii. Air leaks in suction pipe | vii. Tighten the suction pipe |
| viii. Water leaks through foot valve or suction or gland and pump does not keep up priming | viii. Check up the foot valve. |

BELT SLIPS AWAY FROM THE FAST PULLEY

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|---------------------------------------|--|
| i. Pump gets out of line or level | i. Adjust line and level and tighten foundation bolts firmly |
| ii. Pump shaft jammed in the bearing. | ii. Take out, clean and lubricate bearings well |
| iii. Belt too loose | iii. Tighten the belt |

NOT ENOUGH WATER DELIVERED

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|---|--|
| i. Speed too low | i. Adjust to its proper speed |
| ii. Impeller eye too small | ii. Install the pump having a suitable capacity for the job. |
| iii. Discharge head higher than anticipated. | iii. Check particularly friction loss. |
| iv. Impeller or suction pipe or opening partially plugged up. | iv. Remove the foreign matter causing plugging. |
| v. Wrong direction of rotation. | v. Correct the direction of rotation in the direction of arrow mark on its casing. |
| vi. Air pocket in suction line | vi. Remove air pocket by filling the pump and suction pipe completely by water. Leave the vents open until clear bubble free water flows from them, close the vents and start the pump. |
| vii. Air leaks | vii.a. Check the flanges and screwed joints with a flame or match only. The flame will be drawn towards any leaks, if it is held close to the pipe and flanges.
b. Check the pump stuffing boxes and adjust the gland to give the suitable flow from the box. |
| viii. Foot valve too small | viii. Replace with the suitable foot valve having area 1 to 2 times and net area of strainer should be 3 to 4 times that of suction pipe. |
| ix. Area provided in foot valve and strainer is less than suction pipe area. | ix. Replace with the suitable foot valve having area 1 to 2 times and net area of strainer should be 3 to 4 times, that of suction pipe. |
| x. Mechanical defects:
a. Wearing rings worn out
b. Impeller damaged.
c. casing packing defective. | x. Remove mechanical defects:
a. Replace all worn out parts during a pump overhaul
b. Repair or replace the damaged impeller
c. Make the casing packing properly effective. |

LOW PUMP DISCHARGE PRESSURE

- i. Speed too low
- ii. Mechanical defects:
 - a. Worn wearing rings, packing, gasket etc.
 - b. Damaged impeller
- iii. Wrong direction of rotation.
- iv. Incorrect place of pressure gauge.
- v. Pump water passages obstructed
- vi. Impeller diameter too small
- i. Adjust suitable speed
- ii. Remove mechanical defects:
 - a. Replace the worn out parts.
 - b. Repair or replace the damaged impeller.
- iii. Check the directional arrow on the casing.
- iv. Be sure that pressure gauge is in correct place, not on top of the casing.
- v. Remove any obstructions in the passages.
- vi. Check with the pump manufacturer

PUMP IS NOISY

- i. Hydraulic noise-cavitation or suction lift too high
- ii. Mechanical defects
 - a. Shaft bent
 - b. Rotating parts bind or loose or broken.
 - c. Bearing worn out.
 - d. Pump and driving units misaligned
- iii. Foundation is not rigid
- i. Check with the gauge.
- ii. Remove mechanical defects:
 - a. Replace the shaft if necessary
 - b. Check for loose and broken parts, replace the broken parts and tighten the loose one.
 - c. Replace the bearings.
 - d. Make the proper alignment of pump and driving unit.
- iii. Use correct foundation for rigidity.

PUMP DOES NOT START

- i. Impeller locked
- ii. Trash in casing.
- iii. Corrosion or growths in case of pumps out of service for long period.
- iv. Too much bearing friction
- v. Motor or wiring faulty.
- i. Remove the sand or any other cause of locking.
- ii. Remove the obstruction and fit the suction with strainer to keep trash out of the pump.
- iii. Remove corroded matter or growths from the pump by using acid or other recommended chemicals.
- iv. a. Use the right lubricating oil.
 - b. Check the shaft bent, replace if necessary.
 - c. Check the tube tension nut for tightness.
- v. Check the circuit breaker or fuses for an open line.

DIESEL ENGINE

- Keep high speed diesel oil tank, filter and piping clean. Use clean and the correct grade of lubricating oil. Keep oil level in sump topped up. Keep oil-washed air filters clean, supplied with oil and air intakes and exhaust silencers free of soot and any other restriction.
- iii. Make sure that the vent hole in fuel tank cap is clear.
- iv. Check cylinder head joints for leaks. Tighten nuts, if necessary.
- v. Knock out soot from the exhaust silencer.
- vi. Check and tighten all nuts, bolts and keys.

Maintenance of Diesel Engine

Daily

Every 250 hours

- i. Check the lubricating oil level on the dipstick and top up, if necessary.
- ii. The outlet temperature of the cooling water near the engine outlet port should be kept within the limit of 74°C to 94°C, the cooling water temperature must not be allowed to fall down or exceed the temperature stated above.
- i. Drain the sump, flush out with flushing oil and refill with new lubricating oil. Clean the oil strainer.
- ii. Test fuel system for leaks.
- iii. Remove injectors and test spray. If in order, replace without interference.
- iv. Check valve clearance. Adjust, if necessary.

Every 48 hours

Every 1000 hours

- i. Clean and top up the oil-washed air cleaner. (In dusty conditions this must be done more frequently).
- ii. Put one table spoonfull of lubricating oil in the oil cup on the governor.
- i. Remove cylinder head, decarbonize piston top and inside of inlet and exhaust ports.
- ii. Withdraw the pistons and carefully clean out oil return holes.

Every 190 hours

Every 2000 hours

- i. Thoroughly clean out the fuel tank.
- ii. Clean the fuel oil filter.
- i. Wash out lubricating oil pipes
- ii. Thoroughly clean out the fuel tank to remove sludge.
- iii. Examine large end bearings and replace if clearance is excessive.

Trouble Locating Chart for Diesel Engines

Reason	Causes	Remedy
ENGINE DOES NOT START ON TURNING THE HANDLE		
Fuel supply failure (check by operating the fuel pump priming lever and listen for the characteristic "squeak" in the injector)	No fuel in the tank. Fuel tap closed. Air in the pipeline. Broken fuel pipe or leaking connection Fuel filter choked. Faulty injector nozzle Fuel pump plunger sticking.	Fill the tank Open the tap. 'Bleed' the system. Repair or replace the pipe and tighten connection. Clean the fuel filter. Fit a new nozzle. Remove the pump and replace, free and clean the plunger.
Poor compression	Valve sticking Cylinder head loose. Cylinder head gasket blown. Piston rings stuck in the grooves. Worn cylinder liner and piston. Valves not seating properly.	Free the valves. Tighten all nuts. Fit a new gasket. Check the rings and clean the piston. Overhaul the engine Check the valve springs, grind, if necessary, check the tappet clearance.

ENGINE STARTS BUT FIRES INTERMITTENTLY OR SOON STOPS

Incorrect lubricating oil		Drain the sump and fill up with an approved brand of lubricating oil.
Faulty fuel supply	Air-in fuel lines Water-in the fuel	"Bleed" the system. Drain the tank and fill up with clean fuel.
	Faulty injector nozzle Fuel filter choked	Fit a new nozzle Clean the filter
Faulty compression	Broken valve spring. Sticking valve	Replace the valve spring Free the valve

ENGINE LACKS POWER WITH DIRTY EXHAUST

Faulty fuel supply	Broken fuel pump, spring Faulty injector nozzle Unsuitable fuel	Replace Fit a new nozzle Drain the tank and fill up with correct fuel.
Out of adjustment	Valve tappet clearance incorrect Fuel timing retarded	Adjust Adjust timing
Dirty engine	Blocked exhaust pipe or similar Dirty air filter Faulty piston ring Excessive carbon on piston and cylinder head Worn cylinder liner and piston	Clean out Clean out Replace Decarbonize Overhaul the engine

FAULTY RUNNING

Knocking	Carbon on piston crown Injector needle sticking. Fuel timing too far advanced Broken piston ring Slack piston Worn large end bearing	Decarbonize Fit a new nozzle Adjust the timing. Fit a new ring Replace Replace and check the lubrication
Overheating	Water supply failed Lubricating oil failure Cylinders giving unequal power Excessive valve tappet clearance	Renew the supply and check for leaks Fill the sump and check the system Check and adjust the fuel pump setting Adjust
Speed surges	Air in fuel pipes Centrifugal governor sticking	"Bleed" the system Free the governor

Sudden stop	Empty fuel tank.	Fill the tank.
	Choked injector.	Fit a new nozzle
	Fuel pipe broken	Replace or repair
	Siezed piston	Fit a new piston or in an emergency stone down.

ELECTRIC MOTOR

Care & Maintenance of the Electric Motor

1. Keep the motor bearings properly lubricated
2. Keep the motor clean and well ventilated.
3. Never overload the motor and thus avoid damage due to bearing of the windings.
4. Never connect the motor to too low or high supply voltage both conditions are harmful.
5. Keep the motor grounded .
6. Keep the motor away from moisture, dust and saw dust.

Cleaning of motor

For the longer life and efficiency, motor should be kept clean and lubricated. The following procedure should be observed to keep a motor clean.

- i. First disconnect the motor from the power and then disassemble it by removing the rotor, shaft and fan assembly. All possible care should be taken not to break any wire connection or centrifugal switch mounted on the rotor shaft or elsewhere.
- ii. Blowout the loose dirt from the motor windings and from inside the end plates by using pressurised air from a blower or from a cycle pump.
- iii. All dirt from the air passages in thr rotor should be removed. Metal parts may be washed with non-inflammable fluid.
- iv. All the accessories like the starting switch, the commutator and brushes should be checked and repaired before the parts are re-assembled.
- v. Lastly, the motor bearings are lubricated with the recommended type of lubricant before the connection is provided to check its operation.

Trouble locating chart for Electric Motors

Cause	Remedy
Ventilation blocked, end windings filled with fine dust or lint (dust may be cement, saw dust, rock dust grain dust, coal dust and the like).	i. Dismantle entire motor and clean all windings and parts. Clean motor will run 10°C to 30°C cooler.

- ii. Rotor winding clogged. ii. a. Clean and grind sliprings
b. Clean and treat windings with good insulating varnish.
- iii. Bearing and brackets coated inside iii. Dust and wash with cleaning solvent.

MOTOR WET

- i. Subject to dripping i.a. Wipe motor and dry by circulating hot air through motor.
b. Install drip or canopy type covers over motor for protection.
- ii. Drenched condition ii. Cover the motor to retain heat and shift the rotor position, frequently.
- iii. Submerged in flood water iii.a. Dismantle and clean the parts.
b. Bake windings in oven at 90°C for 24 hours or until resistance to ground is sufficient.

MOTOR STALLS

- i. Wrong application i. a. Change type or size
b. Consult manufacturer.
- ii. Overloaded motor. ii. Reduce load.
- iii. Low motor voltage. iii. See that name plate voltage is maintained.
- iv. Open circuit. iv. Replace fuses, check overload relay, starter and push button.
- v. Incorrect control resistance of wound rotor. v.a. Check control sequence.
b. Replace broken resistors.
c. Repair open circuits.
- vi. Mechanical leaking in bearing or at air gap vi.a. Examine sleeve bearings for seizer.
b. Dismantle and repair.
c. Clean air gap, if choked.

MOTOR CONNECTED BUT DOES NOT START

- i. No supply voltage i. Check voltage on each phase.
- ii. One phase open. ii. Check voltage on each phase.
- iii. Voltage too low. iii. Check voltage on each phase.
- iv. Motor may be overloaded. iv. Reduce load or try to start uncoupled from load.
- v. Control gear defective. v.a. Examine each step of the control gear for bad contacts or open circuit.
b. Make sure that brushes are making good contact with the rings.
- vi. Starting torque of load too high. vi.a. If torque squirrel-cage and with auto-transformer starting, change to a higher tap.
b. If torque slip-ring type, lower the starting resistance.
- vii. Rotor defective vii. Look for broken rings.
- viii. Poor starter coil connection. viii. Remove end belts, locate with test lamp.
- ix. Mechanical locking in bearing or at air gap ix.a. Examine sleeve bearings for seizer
b. Dismantle and repair
c. Clean air gap, if choked.

MOTOR RUNS AND THEN DIES DOWN

- i. Power failure
- ii. Overload.
- i. Check for loose connections to line, to fuses and to control gear.
- ii. a. Examine overload trips and see that they are set correctly to approximately 150% full load current.
- b. See that the dash-pots are filled with correct quantity and grade of oil.

MOTOR DOES NOT COME UP TO SPEED

- i. Not applied properly.
- ii. Voltage too low at motor terminals because of line drop.
- iii. If wound rotor, improper operation of secondary control resistance.
- iv. Starting load too high.
- v. Check that all brushes may not be riding on rings
- vi. Broken motor bars.
- vii. Open primary circuit
- i. Consult the supplier for proper type.
- ii. Use higher voltage on transformer terminals or reduce load.
- iii. Correct secondary control.
- iv. Check the load, motor is supposed to carry at start.
- v. a. Check secondary connection.
- b. Leave no leads poorly connected.
- vi. a. Look for cracks near the rings.
- b. New motor may be required as repairs are usually temporary.
- vii. Locate fault with testing device and repair.

MOTOR TAKES TOO LONG TO ACCELERATE

- i. Excess loading
- ii. Poor circuit
- iii. Defective squirrel cage rotor
- iv. Applied voltage too low.
- i. Reduce load. If motor is driving a heavy load or is starting up a long line of shafting, start motor slowly, allow ample time for acceleration.
- ii. Check for high resistance.
- iii. Replace with new rotor
- iv. Get power company to increase voltage tap.

WRONG ROTATION

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| Wrong sequence of phases. | Reverse connections of motor or at switch board. |
| i. Motor misaligned. | i. Re-align. |
| ii. Weak foundations. | ii. Strengthen base. |
| iii. Coupling out of balance. | iii. Balance coupling. |
| iv. Defective ball or roller bearings | iv. Replace bearings |
| v. Bearings not in line | v. Line up properly. |
| vi. Balancing weights shifted | vi. Rebalance rotor. |
| vii. Wound rotor coils replaced | vii. Rebalance rotor. |
| viii. Polyphase motor running single phase. | viii. Check for open circuit |
| ix. Excessive end play. | xi. Adjust bearings or add washer. |

UNBALANCED LINE CURRENT ON POLYPHASE MOTORS DURING NORMAL OPERATION

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|---|--|
| i. Unequal terminal voltage. | i. Check leads and connections. |
| ii. Single phase operation. | ii. Check for open contacts. |
| iii. Poor rotor contacts in control resistance wound rotor. | iii. Check control devices. |
| iv. Brushes not in proper position in wound rotor motor | iv. See that brushes are properly seated and shunts are in good condition. |

MOTOR SPARKING AT SLIP RINGS

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| i. Motor may be overloaded and unbalanced. | i. Reduce the load. |
| ii. Brushes may not be of correct quality and may be sticking in the holders. | ii. Use brushes of the grade recommended, adjust the brush pressure correctly. |
| iii. Slip-rings may be rough, dirty or oily. | iii. Clean the slip-rings and maintain them smooth, glossy and free from oil and dirt. |
| iv. Slip-rings may be rigid. | iv. Turn and grind the slip-rings in a lathe to a smooth finish. |

SCRAPING NOISE

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| i. Fan rubbing air shield. | i. Remove interference. |
| ii. Fan striking insulation. | ii. Clean fan. |
| iii. Loose on bed plate. | iii. Tighten holding bolts. |

OIL LEAKIAGE FROM OVERFLOW PLUGS

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| i. Stream of overflow, plug not tight. | i. Remove, re-cement threads, replace and tighten. |
| ii. Cracked or broken overflow plug. | ii. Replace the plug. |
| iii. Plug cover not tight | iii. Fit cork gasket, or if screw type, tighten. |

HOT BEARINGS, BALL OR ROLLER

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| i. Insufficient grease. | i. Maintain proper quantity of grease in bearings. |
| ii. Deterioration of grease, or lubricant contaminated. | ii. Remove old grease, wash bearing thoroughly in petrol to which a few drops of oil have been added and replace with new grease. |
| iii. Excess lubricant. | iii. Reduce quantity of grease (bearings should be not more than half filled) |
| iv. Heat from hot motor or external source. | iv. Protect bearings by reducing motor temperature. |
| v. Overloaded bearings. | v. Check alignment, side thrust and end thrust. |
| vi. Broken ball or rough races | vi. Replace bearings, first clean the housing thoroughly. |

HOT BEARINGS, GENERAL

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| i. Bent or sprung shaft, excessive belt pull. | i. Straighten or replace shaft, decrease belt tension. |
| ii. Pulleys too far away. | ii. Move pulley closer to bearing. |
| iii. Pulley diameter too small. | iii. Use larger pulley. |
| iv. Misalignment. | iv. Correct by re-alignment of drive. |

HOT BEARING SLEEVE

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| i. Oil grooving in bearing obstructed by dirt. | i. Remove bracket or pedestal with bearing and clean oil grooves and bearing housing, renew oil. |
| ii. Bent or damaged oil rings. | ii. Repair or replace oil rings. |
| iii. Oil too heavy. | iii. Use a recommended lighter oil. |
| iv. Oil too light. | iv. Use a recommended heavier oil. |
| v. Insufficient oil. | v. Fill reservoir to proper level in overflow plug with motor at rest. |
| iv. Too much end thrust | vi. Reduce thrust induced by driven machine or supply external means to carry thrust. |
| vii. Badly worn bearing. | vii. Replace bearing. |

Warning: The use of too light grade oil is likely to cause the bearings to seize up.

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