SERVICE MANUAL

Speedmaster® 10000 Series

HIGH-SPEED GEAR UNITS

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CONTENTS

INTRODUCTION

This manual contains information regarding installation, maintenance, and overhaul of the 10000 Series High-Speed Gear Units (fig. 1) manufactured by the Power Transmission Division of Western Gear Corporation. You are invited to consult with Western Gear engineers and technicians on all problems not covered in this manual.

All Western Gear power transmission equipment is designed and constructed in accordance with the latest AGMA approved engineering practices. It is rugged in construction and efficient in operation. With proper installation and maintenance it will give excellent service for many years.

Behind this unit is a background of continuous, specialized research and development. It was produced by a company with over 70 years experience in the manufacture of gears and power transmission equipment. Skilled and specially trained craftsmen fabricated the parts and assembled the unit.

STORAGE PREPARATION

SHORT TERM

For inside storage, where there is no great temperature change which would cause condensation to form inside the gearcase, the unit should have ample protection for a period of 3 to 6 months. Western Gear High-Speed Gear Units are tested with a preservative oil with high rust inhibiting qualities. A periodic inspection inside the unit through the inspection opening should be performed at some predetermined interval and any indication of condensation or rust must be remedied by flushing with a preservative oil. If rust is present or a much longer storage period is required, other protective measures must be taken as described under Long Term.

LONG TERM

For long term storage, unusual conditions, or for the utmost protection, all openings such as breather and shaft openings can be sealed and the unit filled with a preservative oil, or with oil which is to be eventually used as lube oil. To seal shaft openings, add a can-type cover which can be bolted to the open covers. This will also insure protection for the shaft extensions.

A second method of protection is to fill the gearcase sump with a corrosion preventive oil such as Shell VS1 32. For detailed information on this method, consult Western Gear Corporation.

A third and more costly method is to disassemble the unit and protect each item. Coat each part with preservative in accordance with MIL-C-16173 Grade 2 or Grade 4, or equivalent. The pinion, gear, and bearings should be boxed in addition to coating to prevent accidental damage. Split-line surfaces should be coated with cosmoline and housings assembled to prevent possible housing warpage.

INSTALLATION

This unit is shipped dry without special preservatives unless specified in the order. Standard test procedures involve the use of an oil which contains rust inhibitors. Under normal protected storage at reasonably constant temperature, this oil will prevent rust for a period of 3 to 6 months. Western Gear Corporation assumes no responsibility for weather damage or damage by action of corrosive elements in the atmosphere when unit is stored before being put into service. No solvents or special treatment is required to place the unit in service if special preservative protection has not been specified.

Upon receiving the unit, check to be sure it is in accordance with other requirements and is correct for the job.

The successful operation of this unit depends to a large extent on a proper installation. The unit must be securely bolted to a rigid foundation and carefully aligned with the machinery to which it connects. The flexible couplings used between this machinery and the gear box cannot be considered as universal joints. Therefore, the shaft alignment must be within the limitations set up by the coupling manufacturer. Flexible couplings provide protection against misalignment caused by normal deflection and small movements of shaft centers under varying operating loads. Adequate allowances should be made for thermal growth in drive line components and supporting structures.

The foundation must allow for a minimum of 1/16-inch vertical adjustment of gear unit relative to driver and driven components. The foundation must be level and flat, providing even bearing support all around. The foundation must be rigid and of sufficient mass to prevent deflections from weight or transmitted loads and to minimize vibrations from adjacent sources.

Western Gear Corporation does not assume responsibility for vibrations originating in, or excited by the power source, the driven machine, or any combination of these.

If structural steel bedplates are used, we recommend that the base be filled with concrete and grouted. Tapped holes and/or leveling screws are provided in the unit base to assist in leveling. U-shaped shims fitting around the main holddown bolts and under the gearbox base should be used to remove the weight from leveling screws before tightening holddown bolts and doweling the unit to the foundation. These shims are available as standard accessories.

NOTE: Use of soft type shims, e.g., aluminum or brass, is not recommended.

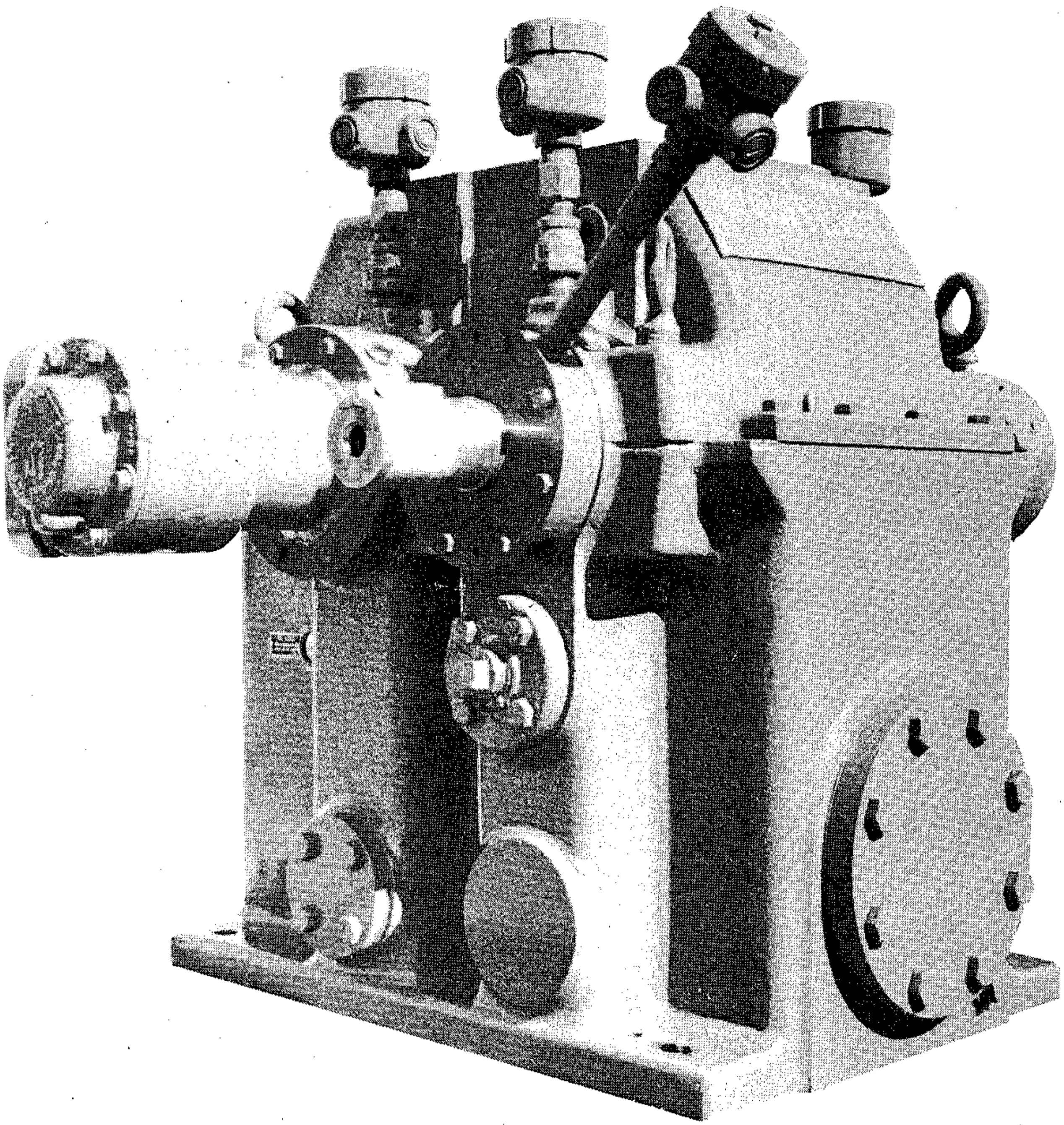


Fig. 1. 10000 Series High-Speed Gear Unit

HANDLING

The unit should always be moved by slinging from lifting eyes provided, or by rolling on bars or skates. AT NO TIME should the shaft extensions be used to support the unit, and care should always be used so as not to damage machined surfaces.

MOUNTING OF COUPLINGS, ETC.

We recommend that all couplings turning 10,000 rpm and over have hubs balanced in place on the pinion shaft. Prior to mounting of couplings, etc., a check should be made to ascertain that there are no handling burrs on shaft extensions and that coupling faces are true and free of nicks. Observing the following hints will insure proper installation of couplings, gears, etc.:

1. Inspect key and keyway for proper fit before attempting to install coupling on shaft. Make certain there is a small amount of clearance at the top of the key.

2. Measure the shaft and coupling bores to determine that interference is in accordance with specifications. Coat the shaft with an antiseizing compound if a keyed fit is used. If a shrink fit without key is used, install coupling on a dry and clean shaft.

3. Heat the coupling uniformly until it measures oversize enough to be installed with a light drive. The amount of heat required varies with the shaft diameter and the amount of interference. Therefore, it is necessary that the bore size be watched closely during heating.

> **CAUTION:** Do not heat over 500°F. Be careful not to overheat localized spots. Do not pound directly on coupling with steel hammers; use lead or rawhide mallets, bronze block or drift.

A temporary block should be used as a stop to prevent the coupling from sliding too far on to the shaft.

Units ordered with coupling guards are often shipped without guards installed. Depending on size, the guards will either bolt directly to the shaft bearing cover or to an adapter plate installed at the factory. Two-piece coupling guards have a bolt circle in the flange of the lower half only for bolting to the unit. The upper half is then bolted to the lower half and is easily removed for maintenance of the coupling.

Stem type thermometers are usually shipped separately to avoid breakage and must be installed at the job site.

> **NOTE:** When installing thermometers, seal pipe threads with Silastic, or equivalent, to prevent leakage.

FOUNDATION & ALIGNMENT

Rigid, secure mounting and accurate alignment of the High-Speed Gear Unit is necessary to minimize wear, abnormal bearing temperatures, vibration, and coupling problems. Although some form of flexible coupling must be used, it is essential that accurate alignment between the coupling hubs of connecting shafts be achieved. The maximum degree of alignment error should be no greater than 0.005 total indicator reading of the shaft true running position. Two mounting methods are commonly used:

Common Bedplate. When the unit is placed on a structural steel bedplate common with driving or driven machinery, the high speed unit may be shimmed under each holddown bolt. The size of the shim depends on the unit size, but should be large enough to give a generous area for substantial support of the weight of the gear unit.

The alignment of machinery should start from the driving or driven machine (whichever is most permanently settled in position). The gear unit will then be aligned to it followed by the aligning of the third machinery component to the gear unit. Jacking screw holes are provided to move vertically.

Concrete Foundation & Soleplates. A concrete foundation should allow for final grouting of the machinery. Vertical positioning of the unit and its soleplates can be done by using jacking screws. After accurate alignment of all machinery components to one another, each should be grouted to the concrete foundation. Use of soleplates will allow for removal of the gear housing at a later date and retain a permanent mounting pad.

> **NOTE:** We recommend that an allowance be made for a minimum of 1/16-inch shimming between the gear unit and bedplate or soleplates to provide latitude for final alignment.

METHOD OF CHECKING ALIGNMENT

One recommended method of checking alignment is by fixing a dial indicator to one of the shafts or coupling hubs. Span the indicator arm across to the mating shaft or coupling hub (fig. 2). Proceed in the following manner:

1. Rotate shaft B to check coupling hub (or shaft) concentricity. Set indicator at top and pointer at zero.

2. Rotate shaft A and take indicator readings at shaft B at top, bottom, and each side at 90 degrees (angle).

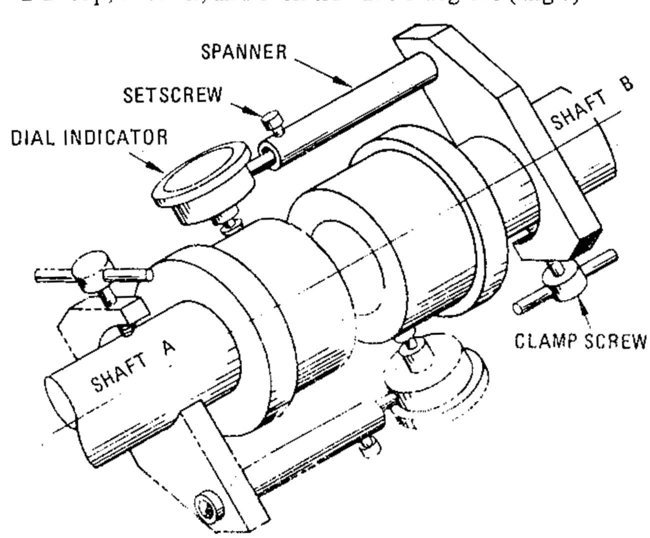


Fig. 2. Method of Checking Alignment.

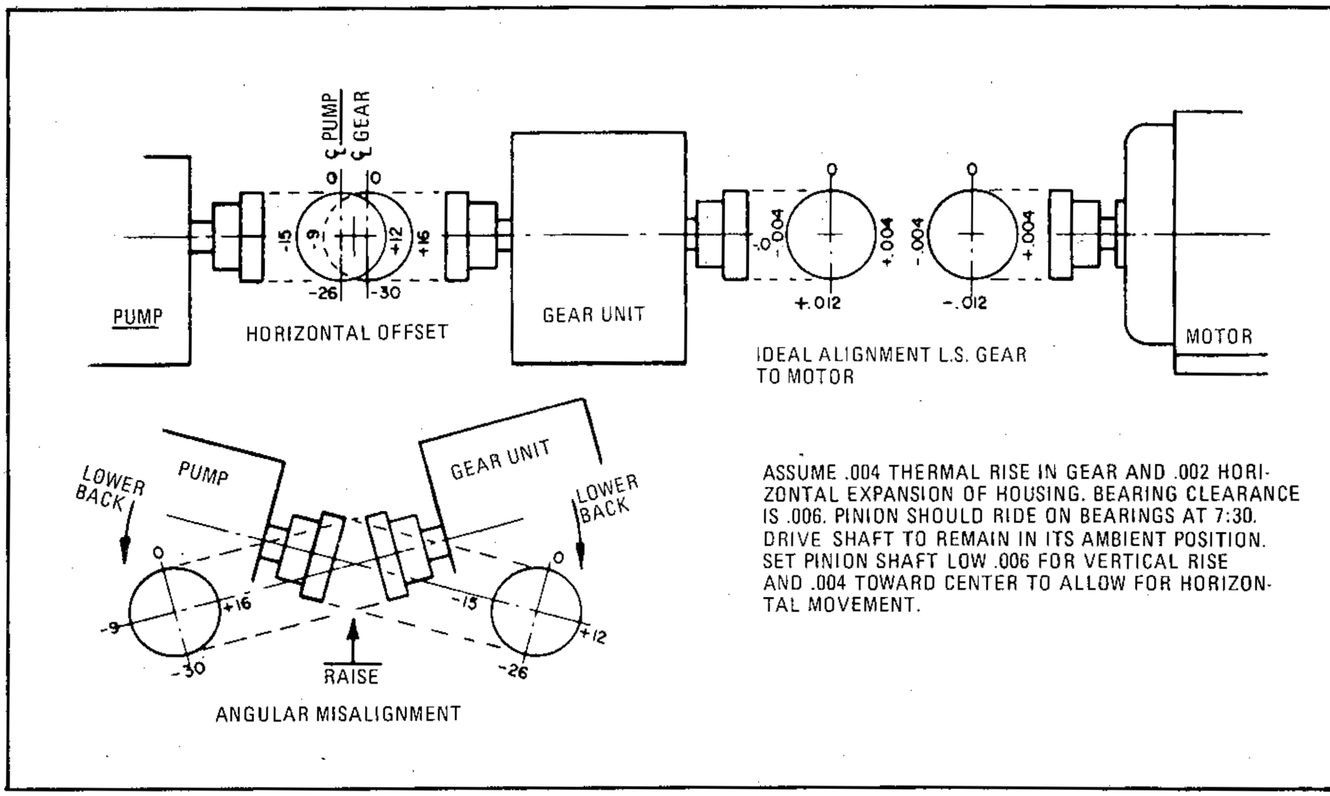


Fig. 3. Ideal Cold Alignment.

A typical example of readings and correction requirements are shown in fig. 3. The spanner device to which the indicator is fixed must be custom made for the application. It must be made rigid enough so as not to deflect due to the weight of the spanner and indicator.

A deflection check can be made by attaching the spanner and indicator to a tube or pipe. Set the indicator to zero at the top and rotate the pipe to the bottom. If deflection is noted, the spanner should be reinforced to eliminate it. The coupled shafts in the system may likely change position when operating under full load and normal operating temperatures. When final alignment is made, it is necessary to consider the operating shaft positions.

NOTE: It is not necessary to disconnect the coupling to check alignment by this method.

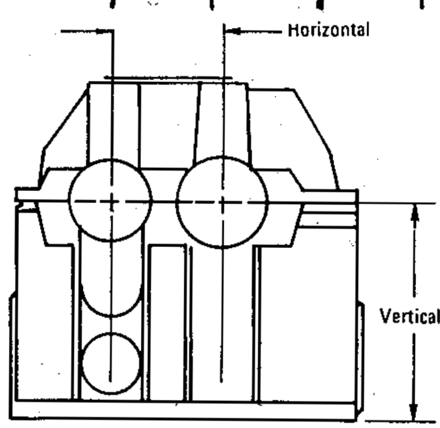
THERMAL EXPANSION WITH 100°F TEMPERATURE RISE

Table 1 shows the anticipated thermal expansion of Western Gear High-Speed Gear Units vertically and horizontally for 100°F of temperature rise. Normal temperature rise is usually 40 to 70°F and a percentage of the figures shown in the table can be used.

The position of the shafts in the bearings will also affect alignment under operating conditions. The position of the shafts depends on direction of rotation, loading, and bearing clearances. Fig. 4 illustrates the approximate operating position of the shafts under each condition.

Table 1. Thermal Expansion.

Model	Vertical		Horizontal	
	in.	mm	in.	mm
10600	0.0100	.688	0.0035	.234
10700	0.0100	.688	0.0044	.294
10900	0.0112	.749	0.0056	.374
11100	0.0112	.749	0.0068	.455
11400	0.0142	.949	0.0083	.555
11600	0.0159	1.063	0.0094	.628
11900	0.0159	1.063	0.0112	.749
12200	0.0177	1.183	0.0130	.869
12500	0.0177	1.183	0.0148	.989
13000	0.0221	1.477	0.0177	1.183



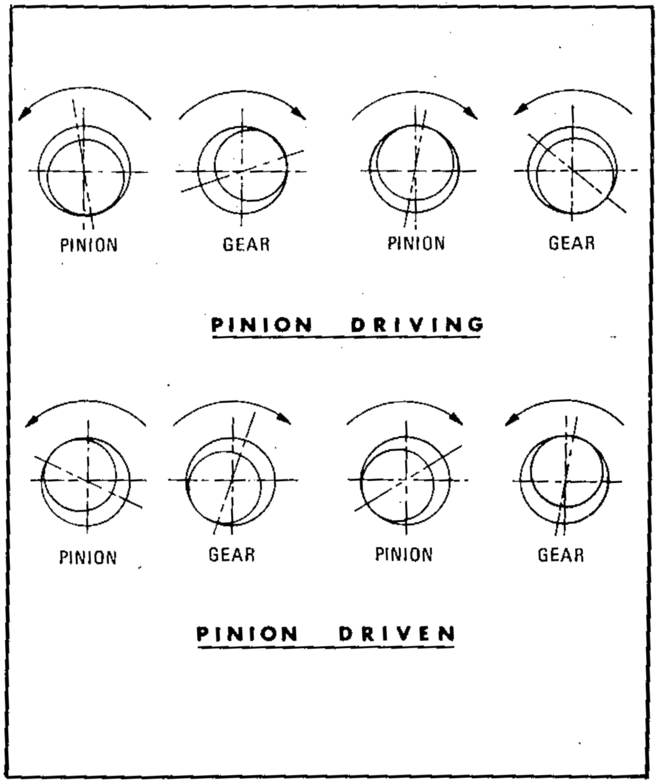


Fig. 4. Approximate Running Positions of Shaft in Bearing Under Operating Conditions.

HOT ALIGNMENT CHECK

After all components of the system have reached their normal operating temperatures, a hot alignment check must be made as quickly as possible. A spanner device for the high speed and/or low speed coupling should be made so that the coupling sleeves and/or spacer can be bridged and the alternate hub readings can be made without disconnecting the coupling (fig. 2). Readings and correction requirements should be noted as quickly as possible before temperature attains ambient conditions. Correction can then be made to suit hot alignment requirements.

AXIAL POSITIONING

The low speed shafts of standard units are located axially by babbitt faced thrust bearings. If diaphragm type couplings are used, it is frequently desirable to increase the clearance of the thrust bearings to allow the couplings to locate the shafts. Additional clearance can be provided at the factory for applications where the couplings are to locate the gear shafts of the unit. In applications anticipating high external thrust loads, self equalizing, tilt pad thrust bearings are used.

FINAL ANCHORING OF BASE

The base and soleplate should now be drilled and reamed together and fitted with tapered dowel pins. In most units, the bases are drilled for dowel pins in all four corners. Only two of these holes are to be drilled and reamed on the job site after thermal check is completed. Either the forward or aft two dowel holes may be used. Holes diagonally located should not be used. We recommend you dowel as close to pinion shaft as possible.

> **CAUTION:** Ensure jacking bolts (if used) are completely backed off during final tightening of holddown bolts.

TOOTH CONTACT PATTERN CHECK

After the High-Speed Unit has been aligned and grouted on to its foundation, a tooth pattern check should be made to be certain that the contact is the same as during testing at Western Gear prior to shipment. This can be done in two ways:

1. The oil should be carefully cleaned from both the gear and the pinion. The pinion teeth should then be coated with a light application of Prussian Blue. Apply a drag to the low speed shaft by wrapping several turns of rope around the shaft extension. Turn the pinion several turns in direction to load drive side of teeth to provide a contact marking on the gear teeth. Note the impressions of Prussian Blue on the bull gear teeth as well as contact marking shown in the blue pattern on the pinion teeth. Tooth contact should be evenly distributed across the face of both helixes with approximately a 70-75% contact noted.

2. Clean and dry the teeth on the high-speed pinion and apply a coat of Layout Blue to approximately eight to ten teeth in two or three positions on the gear. The tooth contact pattern can be checked after approximately 12 hours of operation by shutting the unit down and removing the inspection cover and observing the areas on the pinion and gear teeth where the Layout Blue has worn off.

> **CAUTION:** All articles must be removed from shirt or jacket pocket such as cigarettes, lighters, pencils, etc., prior to working around the open inspection port. Contact should be approximately 70-75% on each helix for light loads and 80-90% for full loads. Further information on tooth patterns is provided in Gear Tooth Inspection (page 12).

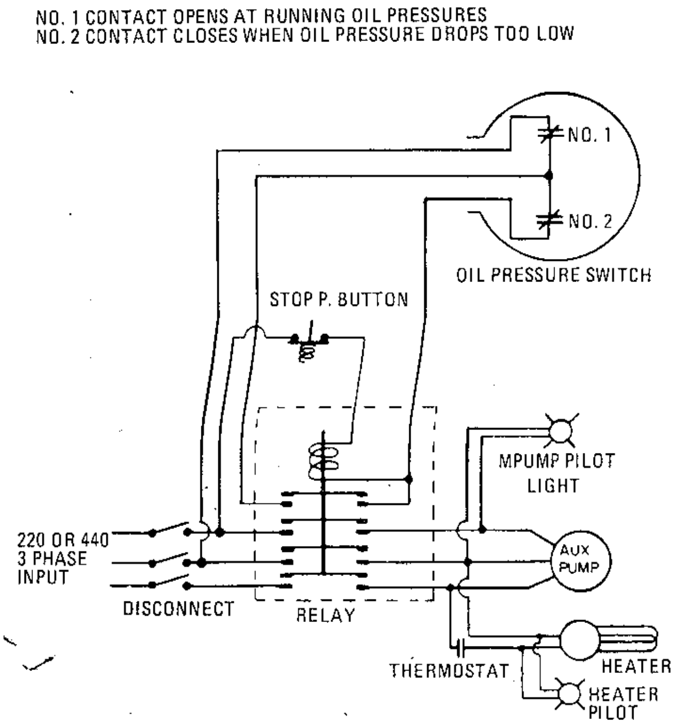


Fig. 5. Accessory Wiring.

WIRING OF ACCESSORIES

Oil immersion heaters may be necessary in cold climates. Preheating the oil before startup is usually necessary since recommended minimum starting temperature is 50°F. Any deviation from this should be cleared with Western Gear. The unit will maintain the proper temperature level during operation by an adjustment to the water flow through the heat exchanger. The heaters should be combined with an auxiliary pump to keep the oil circulating when a gear unit is not running. This arrangement inhibits local oxidation. Many smaller heating units have internal automatic thermostats.

For protection against low oil pressure, a switch should be installed which will sound an alarm and/or a light on the control panel when the oil pressure drops below a specified minimum.

An electric driven auxiliary oil pump is recommended for all installations where its use is practical as it allows the unit to start up with the lube oil circulating under normal operating pressure. This will minimize the possibility of wear occurring while the parts are dry. The auxiliary pump is specially important for any application where frequent starts and stops are foreseen. For many variable speed applications, an auxiliary pump is required.

To maintain required minimum oil pressure and to provide insurance against main lube pump failure, the auxiliary pump should be wired into the system so that the low pressure alarm starts the pump. We recommend that the auxiliary pump be manually stopped to avoid pump cycling that usually occurs when shutdown is controlled with a pressure switch. (Refer to fig. 5 for a typical wiring diagram.)

PREPARATION OF GEARCASE

Units are shipped dry from the factory. If a long term storage preservative has been added, this should be flushed out completely before filling with proper lubricant. Flush with flushing oil and drain thoroughly before filling with specified lubricating oil.

Console type lubrication oil systems should be flushed separately from the unit. A bypass should be connected immediately ahead of the gear unit with the unit isolated to prevent the possibility of accumulating dirt or foreign material in the gear unit.

Special preservation for long term storage or export shipping may dictate the need for a protective coating of all parts with a preservative. Special cleaning will be necessary and the unit will be so marked. It will be necessary to completely disassemble the unit to wash all preservative from unit and parts in this instance.

PIPING

Standard integral lubrication involves the use of a heat exchanger which must be connected to a source of cool water or other coolant. A shutoff and regulating valve should be installed in the coolant line on the inlet side to avoid excessive pressure to the heat exchanger. A thermostatic control valve is recommended to control the oil temperature to the gear unit. Gear units furnished without integral lubrication must be connected to oil lines supplying oil in the amount, temperature, and pressure specified on the certified drawings at the time of purchase. In such units, the oil return is gravity flow so the return piping should be provided with a slope of approximately 1 inch in 12 inches to drain properly.

> **NOTE:** In applications where a temperature monitor is installed in the drain line, ensure it is installed in an area that will not restrict the flow rate of the drain back.
>
> **CAUTION:** The use of teflon tape to seal pipe joints is not recommended.

NEW UNIT CHECKOUT

FACTORY TEST

Every Western Gear High-Speed Gear Unit is thoroughly inspected and tested in accordance with established quality control procedures. As a minimum, testing includes operation at rated speed and 10% overspeed. Sound, vibration, and temperature characteristics are carefully monitored, recorded, and evaluated. If supplied, the lubrication system is checked for proper flow, temperatures at various points in the system are monitored, and the results are recorded in the test report. Following the operational test, a final check is made of the tooth contact pattern. Unusual conditions are corrected prior to shipment.

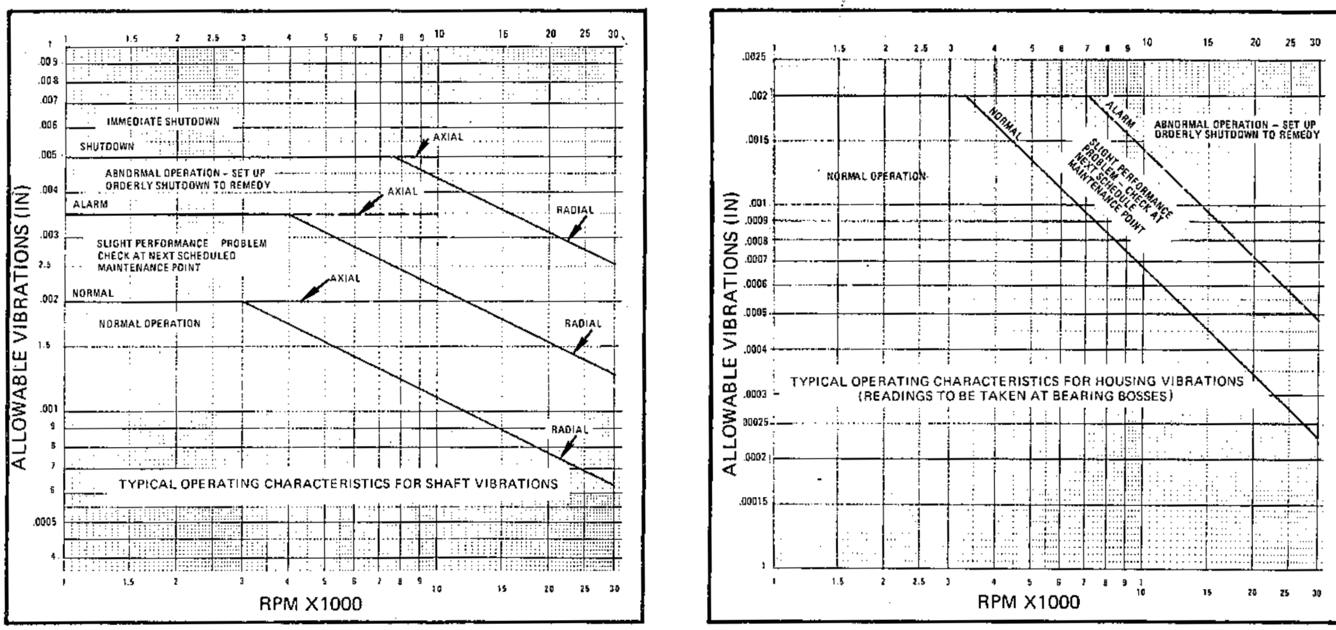


Fig. 6. Vibration Limits.

BEFORE STARTING

Upon receiving the unit and prior to operation, make the following inspection:

1. Check the atmosphere at the installation site. Excessive dust or dirt, moisture, chemical contaminants, high or low ambient temperatures, or adverse weather conditions may affect the operation of the unit.

2. Check for free turning of the shafts.

3. Check for proper alignment and foundation bolt tightness.

4. Check that all necessary piping and wiring of accessories is completed.

5. Check the oil pump or lubrication system for proper type and quantity of oil.

6. Check that the lubrication system is pre-filled to minimize buildup time of positive oil pressure. When oil pressure is available from an electric driven pump or other remote source, the operation of the spray jets should be checked. Spray jets cannot be practically checked when shaft driven pumps are used because of splash from the revolving gears.

7. Check that the breather is clean and free from obstruction.

AFTER STARTING

1. The outside of the gearcase and the air breather should be kept clean to maintain maximum heat radiation from the gearcase.

2. When possible, check initially at light load and/or low speed (¼ operating speed) for free-running and proper lubrication.

> **NOTE:** If lubrication is provided by shaft driven pump only, do not operate for prolonged periods or under load at speeds too low to supply proper oil pressure.

3. Check operation under load for vibration, unusual noise, oil leaks, and excessive heating. Normal vibration limits are shown in figure 6.

> **NOTE:** Special contract or operating conditions may require different values.

4. Check operation of the oil pressure relief valve.

5. Check operation of the low oil pressure alarm and auxiliary oil pump.

6. Check and correct alignment after 6 hours of normal running with load.

After the first week of operation, a thorough check should be made for vibration, unusual noise, oil leaks, and excessive heating. The oil filter element should be replaced at this time. A small amount of metallic particles are commonly found during this initial running period. These should be removed and a new filter element installed. All bolts should be tightened. Inspection for the most likely problems should be made in accordance with the instructions in the Troubleshooting section.

> **WARNING:** DO NOT OPERATE THE UNIT WITH THE INSPECTION COVER REMOVED. Serious accidents have been known to occur by accidental ignition of the oil vapor present in a gearcase. Keep flames, sparks, and lighted cigarettes away when the gearcase is open.

LUBRICATION

TYPE & GRADE

We recommend that High-Speed Gear Units be lubricated with high quality turbine oil which contains oxidation and corrosion inhibitors and a defoamant. This oil should have a viscosity index of not less than 95. In the event of low ambient temperatures, it may be necessary to heat the oil prior to startup. Normally, the minimum oil temperature at startup is 50°F.

If the addition of a pour point depressing compound appears to be necessary, it should be specifically approved by the lubricating oil manufacturer. Normal lubricating oil viscosity required for single-stage high speed units is 150-240 SSU at 100°F. For the specific requirements of any unit, refer to the unit nameplate.

A mild extreme pressure lubricant may be advisable where heavy tooth loads or shock loads are anticipated. The use of mild EP oil should be approved by Western Gear prior to using. Normal service life can be expected from mild EP lubricants providing the maximum recommended bulk oil temperature is not exceeded. The lubricant supplier should be consulted when bulk oil temperature exceeds 170°F at the pump.

OPERATION OF LUBRICATION SYSTEM

Standard integral lubrication provides a positive displacement pump driven from one of the shafts. When a cold unit is started, the oil pressure must be verified at the pressure gauge immediately. If oil pressure does not begin to build up in 3 to 5 seconds, stop the unit and prime the pump. Normal operating pressure may vary, depending on temperature and operating conditions. The relief valve is set in factory tests at 20-25 PSIG and does not normally require adjustment.

The amount of cooling water required at the heat exchanger will depend on water temperature. The flow required at 85°F is shown on the certified print. The ideal inlet oil temperature to the unit is 110-120°F. The normal oil sump temperature will be 140-160°F and should not exceed 180°F. The measured temperatures at bearings should not exceed those shown in table 2 unless approved by Western Gear.

> **NOTE:** These limits are based on standard lubrication systems with inlet oil temperature approximately 120°F. For higher inlet temperatures, the normal operating, warning, and shutdown levels may be increased somewhat, but care must be taken that babbitt and oil properties are considered.

Table 2. Maximum Bearing Temperatures

Type of Instrument	Normal Max. Operating	Warning Signal	Shutdown
Bearing Thermometers	180°F	190°F	200°F
Probe type RTD or thermocouple	180°F	190°F	200°F
Imbedded RTD or thermocouple	225°F	240°F	250°F

A shutoff and regulating valve should be installed in the cooling water line on the inlet side of the cooler to avoid excessive pressure on the cooler. Normal operating temperatures and pressures will soon be established in any installation and any large variation should be investigated immediately. The following precautions should be observed to obtain maximum performance from the heat exchanger:

1. Exchanger must be full of liquid in both shell and tube side (oil and water).

2. Provide periodic venting if air tends to accumulate in the system.

3. Maintain rated flow of both mediums.

4. Avoid excessive flow of cooling water. It is a frequent cause of tube failure through erosion, and may decrease cooling efficiency.

5. When a unit is commonly started several times a day and ambient temperatures are below 50°F, the use of an oil heater is recommended.

Some applications require that a unit be kept running continuously even during minor maintenance. These units have twin filter, cooler, and transfer valve arrangements. The handles of the transfer valves indicate which filter or cooler is in operation. At startup be sure that transfer valves indicate a minimum of one filter and one cooler in use. Transfer of oil flow to the idle units during operation must be done carefully. Open the transfer valves slowly allowing these units to prefill. Then, rotate the transfer valve handles the remaining 90°, thus completing the cycle.

MAINTENANCE

MAINTENANCE

A positive inspection and maintenance schedule will prolong the life of the unit and lead to the detection of trouble spots before producing serious damage. The schedule below is recommended for most operating conditions.

INSPECTION & MAINTENANCE SCHEDULE

Daily Check.

1. Check pressure and temperature gauge readings and compare with established normal operating pressures and temperatures.

2. Check for unusual noises in gears, bearings, couplings, and pumps.

3. Check for excessive vibration of couplings, shaft extensions, and housing.

4. Check for oil leaks in lube system and around shaft extensions.

5. Check oil level.

Monthly Check.

1. Clean outside of case to improve heat radiation to the atmosphere.

2. Clean breather.

3. Check condition of oil.

4. Check for pressure drop across oil filter.

5. Check operation of pressure switch, auxiliary oil pump, and/or alarm.

6. Check operation of temperature switch and oil immersion heater.

7. After first month of operation, check contact pattern of gear teeth.

Six Month Check.

1. Check pressure.

2. Check gear tooth wear.

3. Check zincs in heat exchanger.

Annual Check.

1. Check tooth pattern.

2. Check bearing clearances.

3. Check end play.

4. Change oil.

5. Check alignment.

6. Check foundation.

7. Clean oil heater element.

8. Check spray nozzles for tightness and contamination.

9. Check internal lube supply lines for tightness and contamination.

10. Replace oil filter element.

11. Check and recalibrate gauges.

MAINTENANCE OF LUBRICATING OIL

The principal contaminants of the oil are metal particles from the bearings and gear teeth, and water condensation inside the gearcase and/or foreign materials. These conditions are unavoidable in any gear unit and the most practical means of correction are continuous filtration and periodic oil changes.

Under severe operating conditions, it may be necessary to change the oil at frequent intervals. Such conditions are a rapid rise and fall in temperatures of the gear case, with accompanied condensation on inside walls or resulting formation of sludge, or operation in moist or dusty atmosphere or in the presence of chemical fumes. Improperly maintained lubricating oil will cause wear and premature failure. Every precaution should be taken to prevent water and foreign particles from entering the gear case. The only sure way to determine the condition of the oil is to have samples tested periodically by a laboratory. This service is furnished as a courtesy by many oil suppliers.

In adding oil, it is important to avoid mixing oils of different brands and grades because of the danger of increased sludge formation and chemical reactions.

The air breather should never be plugged, in an attempt to prevent oil contamination. This will result in pressure build-up inside the case and may result in leakage of the seals at the exposed shafts. Actually, very little dust can get inside the unit through the breather because of its size and design.

BEARING CLEARANCE

High-Speed Gear Units use sleeve type bearings which must operate with a specific clearance over the shaft. This clearance is calculated to allow the proper flow of oil through the bearing with consideration for the shaft speed and load. Fig. 7 shows the normal bearing clearances. In some cases, special bearing clearances may be used due to operating conditions. Measurement of bearing clearance is easily done by lifting the uncoupled shaft to the top of the bearing and measuring the distance of travel with an indicator. Measure as close to the bearing as possible.

> **NOTE:** Some units are supplied with special bearings where the clearance cannot be checked in this manner. If this unit is so equipped, a special nameplate is attached to the unit.

END PLAY

A certain amount of end play of the shafts is necessary to allow for thermal expansion. The limits of end play are not critical unless excessive axial movement affects the unit or other components in the system.

The axial end play measurement of the low speed shaft can be made by moving the shaft from one extreme to the other. This will give the thrust bearing clearance. The axial movement of the high speed pinion is a function of the backlash of the gear set and can be compared to the axial movement built into the gear train at the time of manu-

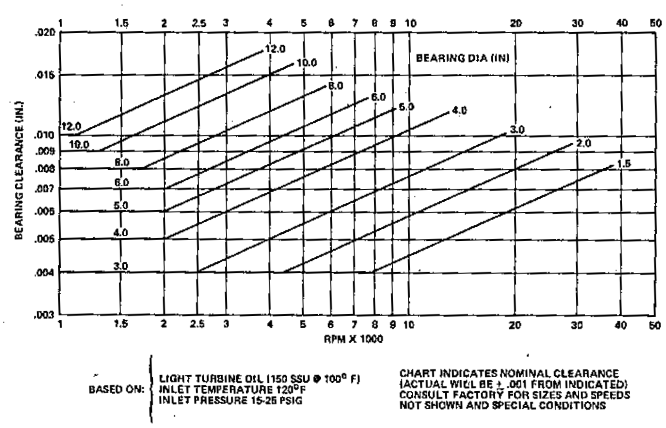


Fig. 7. Normal Bearing Clearance.

facture. Unless externally restricted, the HS pinion will operate in the center of its axial float range.

GEAR TOOTH INSPECTION

An inspection plate is provided on the upper case to permit examination of the gear and pinion.

> **CAUTION:** DO NOT OPERATE UNIT WITH THE INSPECTION COVER REMOVED. Serious accidents have been known to occur by accidental ignition of the oil vapor, which, under some conditions, may be present in the gear housing. Keep flames, sparks, and lighted cigarettes away when the gear case is open.

The normal service life of the gear set in high speed gear drives depends upon:

1. Adequate lubrication.
2. Correct tooth contact pattern.
3. Sufficient backlash to allow for thermal expansion.
4. Normal operation at no more than design load.
5. Cleanliness.
6. Axial growth allowance in the drive, driven shaft, and couplings.
7. The system being free of frequent shock or torsional load fluctuations.
8. Maintenance of good alignment and rigid mounting.

When Western Gear High-Speed Gear Units are manufactured, a careful check of backlash, bearing clearance, and tooth contact pattern is a part of the inspection and test procedure. Ideal tooth contact under full load conditions covers a minimum of 75% of each helix longitudinally and approximately 70% vertically starting from just above the root to an area slightly below the tip. Contact, ideally, will be closely centered on the helix and will not extend completely to either end of the tooth. Fig. 8 shows tooth nomenclature. Fig. 9 through 14 describe the most common defects. The procedure for making a tooth contact pattern check is described in Tooth Contact Pattern (page 7).

Destructive Pitting (Fig. 10). Overload and/or poor lubrication may cause pitting which can start similarly to corrective pitting, but where larger pits will occur. If the number of large pits seriously reduces contact area, the pitting will eventually destroy the tooth. If this condition begins, check for possible overload or inferior lubricating oil quality.

Scoring (Fig. 11). Scoring results from improper or insufficient lubrication for the loading conditions that occur. Scoring produces vertical scratches and grooves which run from the pitch line to tip of tooth. Check oil spray nozzles and make certain they are open and the flow of oil is unimpeded in the system. Also, check quality and condition of lubricating oil.

Galling & Plastic Flow (Fig. 12). This condition occurs when loading is too great for maintenance of the oil film. This can be a fault of the oil or existence of an overload. Galling is usually preceded by scoring and its continuation will lead to plastic flow. Plastic flow is a condition where tooth pressures actually cause a flow of metal from the pitch line toward the tip of the tooth. In these instances, a wire edge will appear at the tip. Again check the lubrication passages. It is essential to retard the problem and promote healing. Be sure to check for possibility of overload.

Abrasive Wear (Fig. 13). When abrasive particles larger than the thickness of the oil film contaminate the lubricating oil, they will cause wear and scoring. It is characterized by radial scratch marks or grooves and may have the appearance of a lapped surface. If abrasion appears, a thorough cleaning of the unit and lubricating oil system is necessary.

Corrective Pitting (Fig. 14). During initial operation of a new gear set, it is not unusual to have fine pitting occur on the loaded side of the tooth. Although machined surfaces are smooth to the eye, the machining operation actually leaves microscopic high and low spots. Thus, in early stages of operation, tooth load will be carried on high spots which will be overstressed. High spots will then fatigue and break out in fine pits, thereby reducing the high spots to give a broader contact area. The surface will gradually smooth and work harden without further pitting occurring.

If there is insufficient tooth contact initially, pitting may occur in the area of contact and will gradually disappear as the slight wear creates a fuller contact. The characteristics of the lubricant and the oil film strength do have a decided influence on the occurrence of pitting and degree of severity.

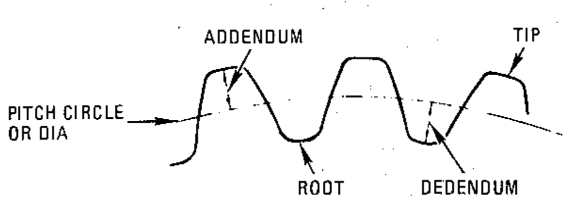


Fig. 8. Tooth Nomenclature.

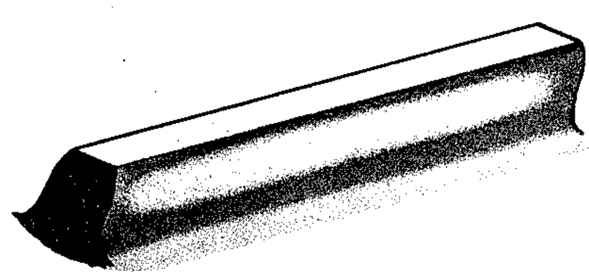


Fig. 9. Ideal Tooth Contact.

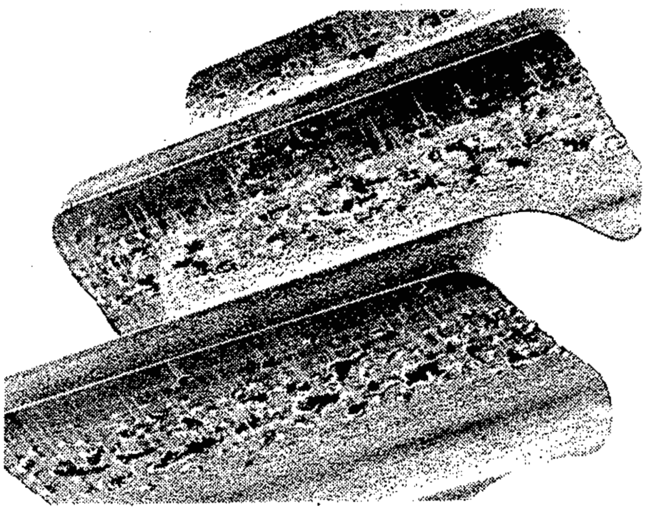


Fig. 10. Destructive Pitting.

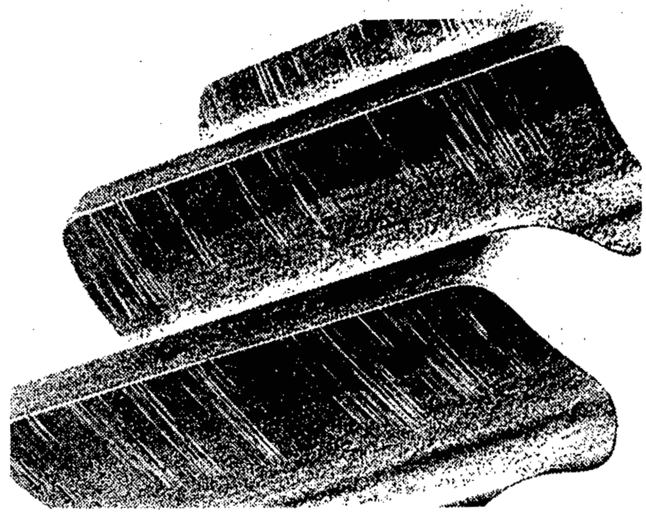


Fig. 11. Scoring

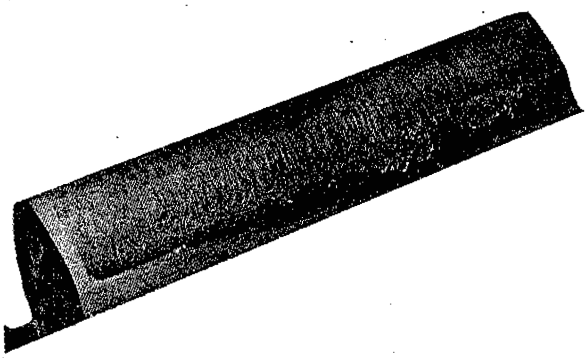


Fig. 12. Galling & Plastic Flow.

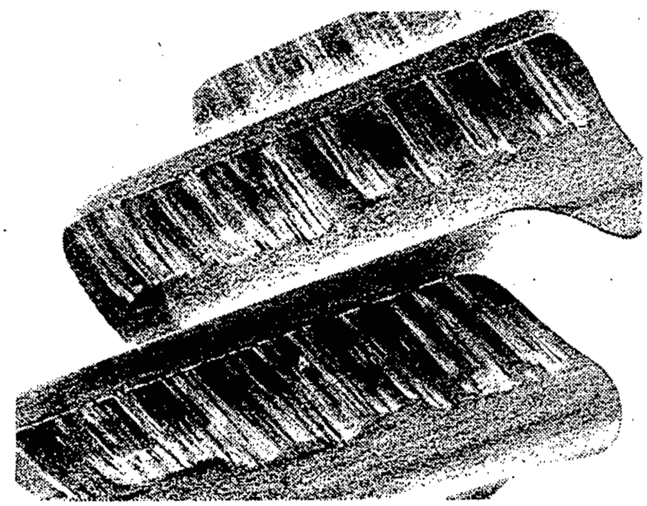


Fig. 13. Abrasive Wear.

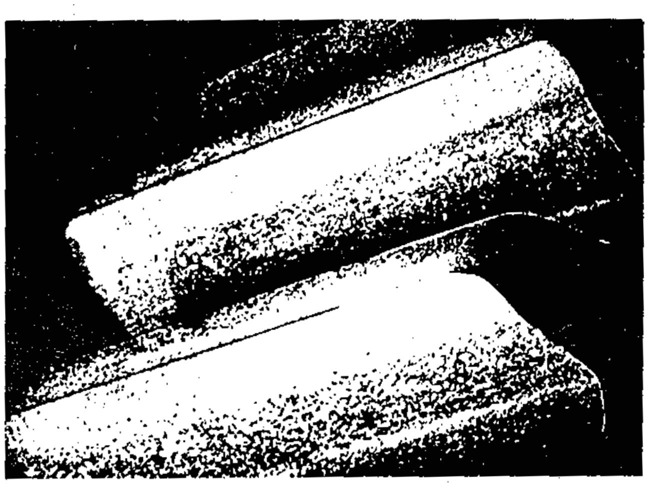


Fig. 14. Corrective Pitting.

LUBRICATION SYSTEMS

LUBRICATION SYSTEMS

Western Gear offers three types of standard lubrication systems to meet user's requirements. Each system is rated to the heat load requirement of the gear unit. The systems are standarized with quality components throughout for interchangeability, availability, and simplicity. The following lubrication systems are available for use with the 10000 Series:

PANEL MOUNTED STANDARD LUBRICATION SYSTEM

The parts that comprise this system are listed in table 4 and illustrated in fig. 15. Except for the gear driven pump, the components of the lubricating system are mounted on a panel at the side of the gear case.

Table 4. Panel Mounted Standard Lubrication System

Item	Nomenclature	Units Per Assembly
1	Main Pump	1
2	Filter	1
3	Heat Exchanger	1
4	Relief Valve	1
5	Pressure Gauge	1
6	Temperature Gauge	1

PANEL MOUNTED AUXILIARY LUBRICATION SYSTEM

The parts that comprise this system are listed in table 5 and illustrated in fig. 16. All components, with the exception of the gear driven pump, are mounted on a panel at the side of the gear case.

Table 5. Panel Mounted Auxiliary Lubrication System

Item	Nomenclature	Units Per Assembly
1	Main Pump	1
2	Filter	1
3	Heat Exchanger	1
4	Relief Valve	2
5	Pressure Gauge	1
6	Temperature Gauge	1
7	Check Valve	2
8	Auxiliary Pump	1
9	Auxiliary Motor	1
10	Low-Pressure-Auxiliary Start Switch	1

SKID MOUNTED DUAL LUBRICATION SYSTEM

The parts that comprise this system are listed in table 6 and illustrated in fig. 17. All components, except the gear driven pump, are mounted on a panel on a skid assembly and require connection to the gear case through suitable piping.

Table 6. Skid Mounted Auxiliary Lubrication System

Item	Nomenclature	Units Per Assembly
1	Main Pump	1
2	Filter	2
3	Heat Exchanger	2
4	Relief Valve	2
5	Pressure Gauge	1
6	Temperature Gauge	1
7	Check Valve	6
8	Auxiliary Pump	1
9	Auxiliary Motor	1
10	Auxiliary Start Switch	1
11	Transfer Valve	2

LUBRICATION SYSTEM MAINTENANCE

PUMP

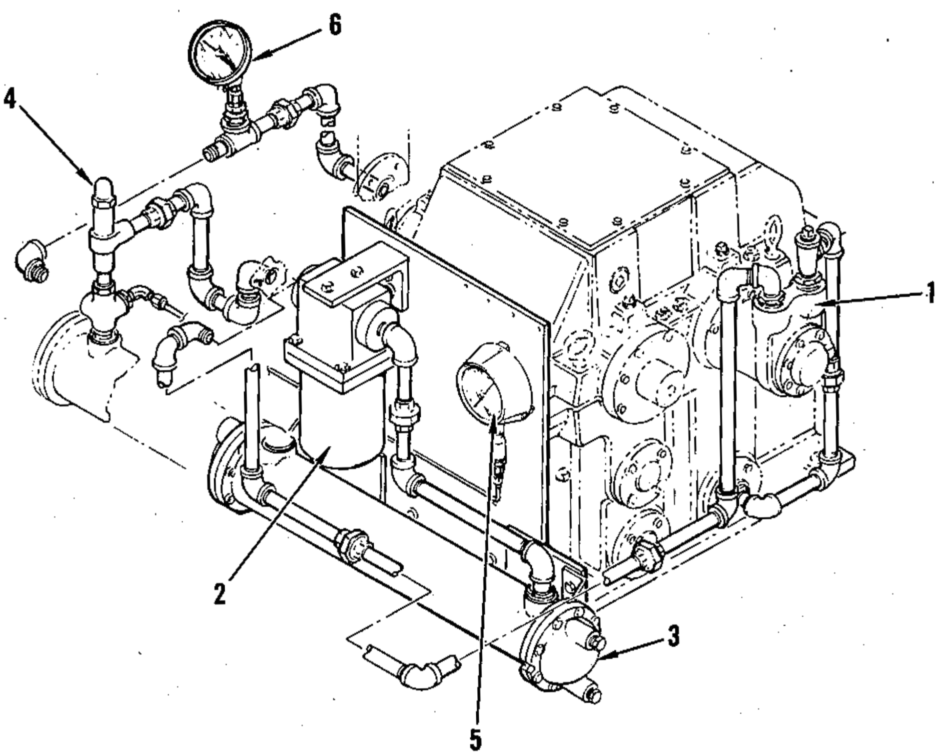
Standard integral lubrication is normally provided with a rotary gear type pump. One style of pump (fig. 18) is coupled directly to the low speed shaft. It is a positive displacement pump which is lubricated by the oil pumped. Under normal conditions there is no service or maintenance required during the life of the pump. Pumps equipped with compression or Chevron type packing require occasional adjustment. Do not tighten the gland excessively since a slight leakage is necessary for lubrication of the stuffing box. If problems are encountered with a pump, refer to the Oil Pump Troubleshooting section (page 20). It is usually impractical to overhaul a worn out pump. However, repair parts can be purchased direct from the pump manufacturer. New replacement pumps can be ordered through Western Gear sales offices or representatives listed on the back of this manual. If it becomes necessary to remove a pump to return it to the manufacturer, plugs should be inserted in the ports to prevent foreign material from entering the moving parts.

PRESSURE RELIEF VALVE (Fig. 19)

No maintenance is necessary. The recommended setting of 20-25 PSIG is set at the factory and does not normally require adjustment. The setting can be changed by removing the cap, releasing the locknut on the stem, and adjusting the regulating screw with a wrench.

FILTER

Standard filters furnished will remove all foreign material down to 40 microns. The filters are replaceable element type. Filters with finer filtration are available upon request.



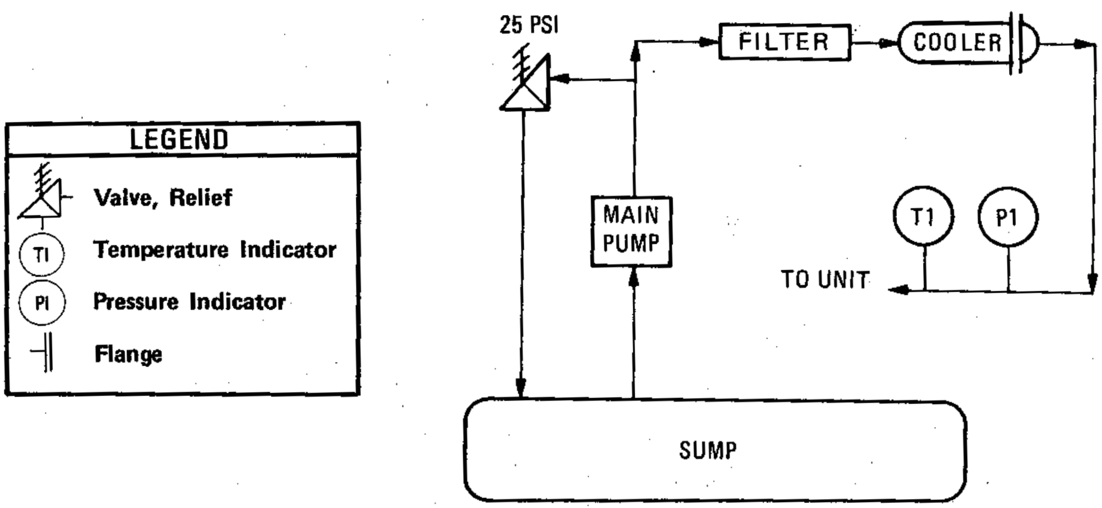


Fig. 15. Panel Mounted Standard Lubrication System

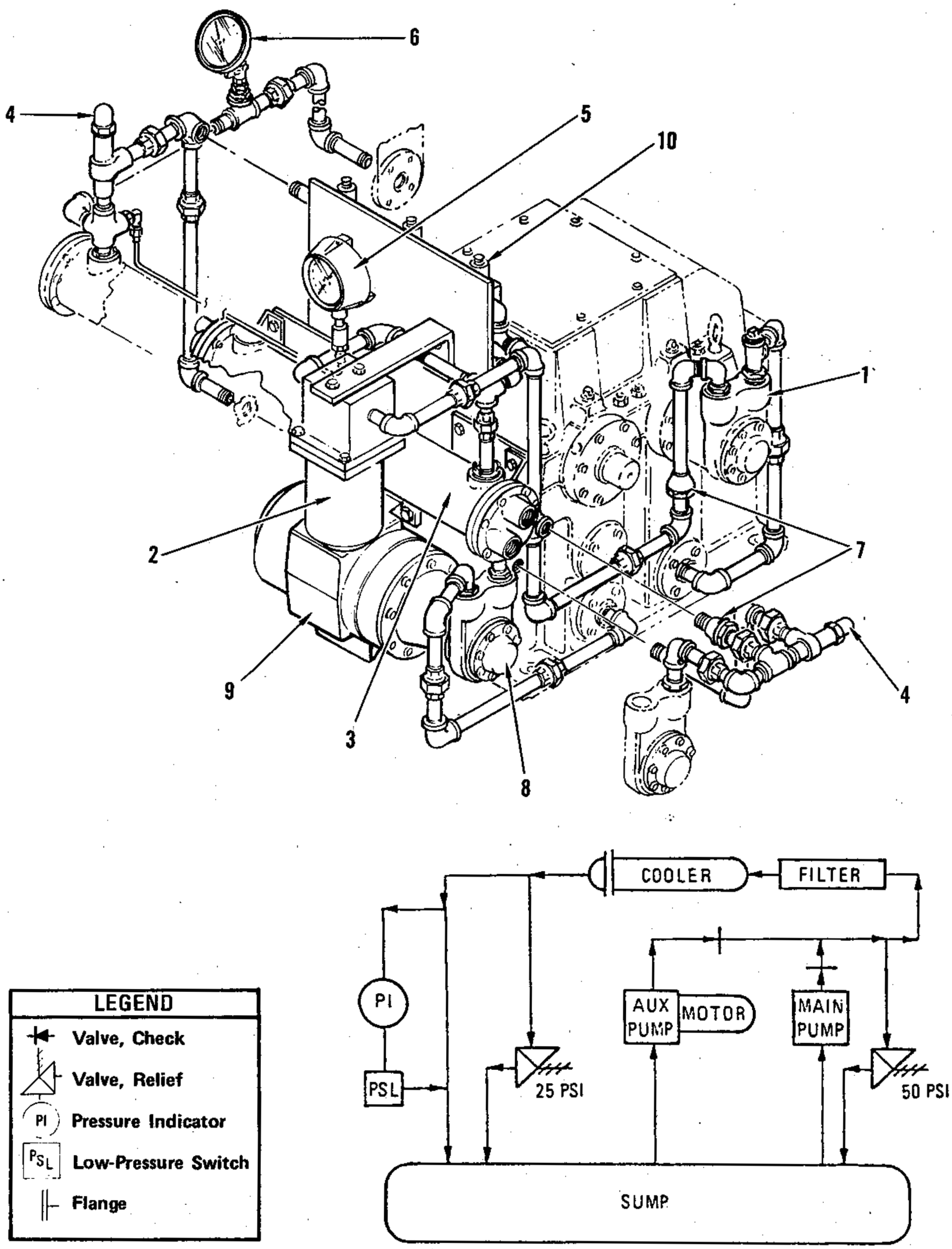
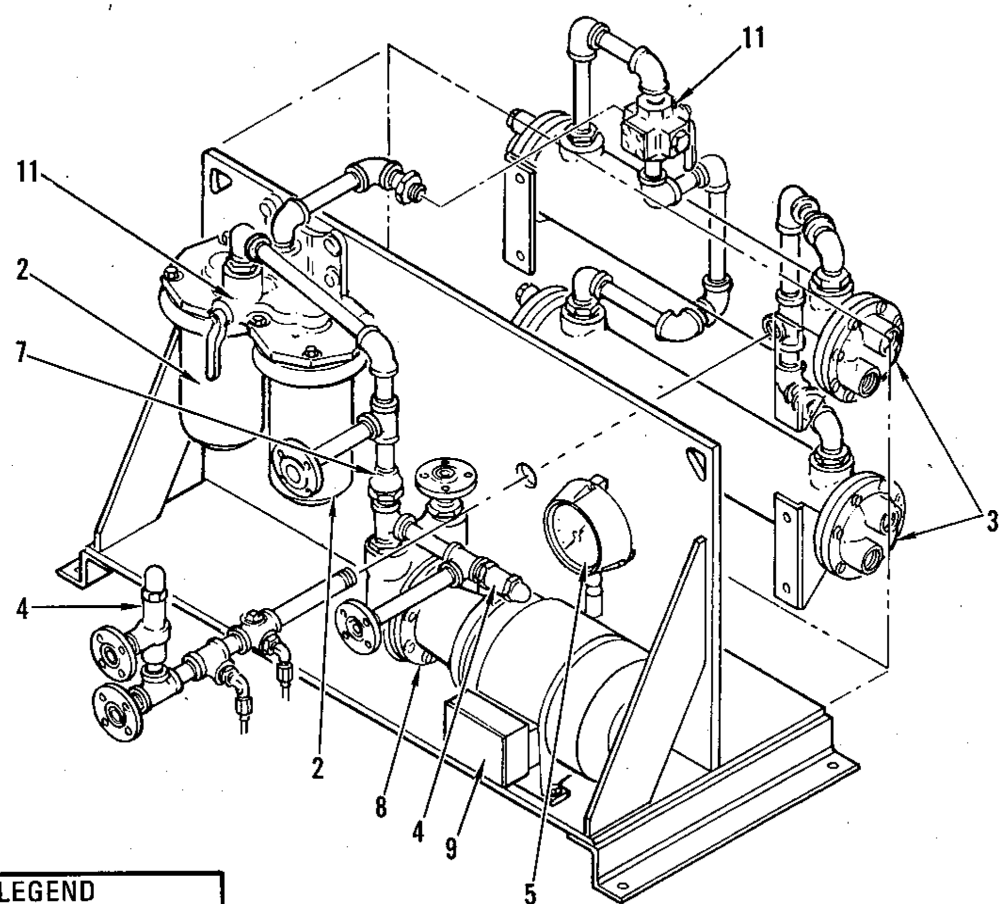


Fig. 16. Panel Mounted Auxiliary Lubrication System.



LEGEND

- Valve, Check
- Valve, Relief
- Temperature Indicator
- Pressure Indicator
- Low-Pressure Switch
- Flange
- Valve, 3 way-2 port

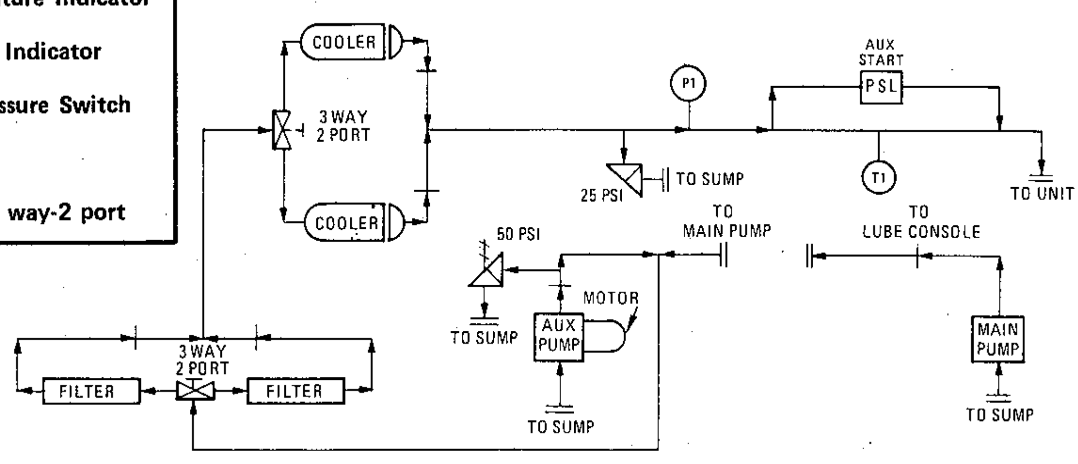


Fig. 17. Skid Mounted Dual Lubrication System

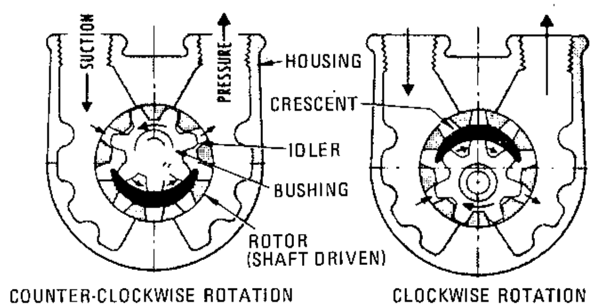


Fig. 18. Rotary Gear Pump.

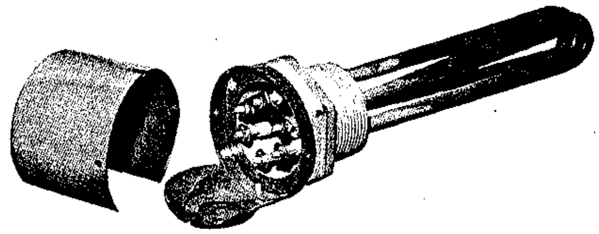


Fig. 20. Immersion Heater.

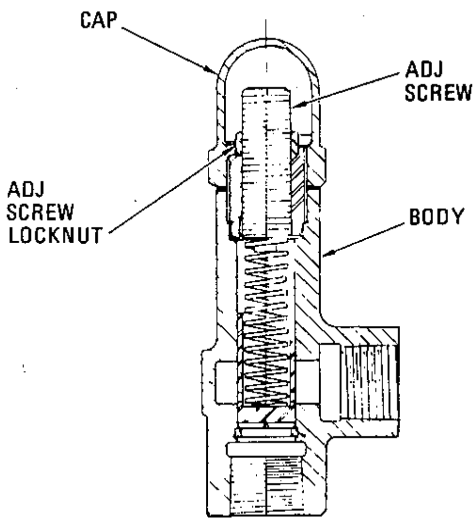


Fig. 19. Pressure Relief Valve.

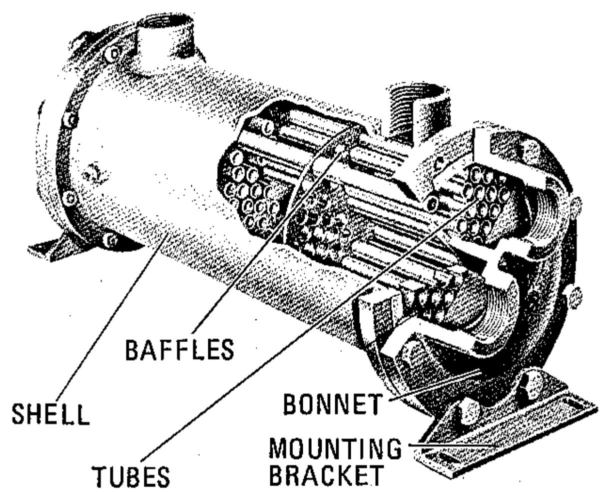


Figure 21. Heat Exchanger.

IMMERSION HEATER (Fig. 20)

It is important that the entire heating element be covered with at least 2 inches of oil during operation. Burnout from overheating is the likely result if any portion of the element is not covered. The only required maintenance is periodic cleaning of the heating element. It is advisable that the oil be circulating during heating to minimize carbonization of the heater element.

HEAT EXCHANGER (Fig. 21)

A heat exchanger needs little attention, but to insure continued satisfactory performance it should be inspected at regular intervals.

1. Remove the bonnets. Inspect all tubes carefully for possible erosion, corrosion, or foreign matter.

2. Inspect all zincs, if used, to be sure they are neither excessively corroded nor insulated with scale. Scrape to a bright surface or replace if excessively deteriorated.

When the interior of the shell and tubes become fouled with scale, we recommend that the cleaning be done by specialists e.g., a radiator repair shop.

TROUBLESHOOTING

The gear unit is connected between other rotating machinery in the system of rotating parts. It, therefore, readily reflects any abnormal or undesireable characteristics which may exist in driven or driving equipment, couplings, or in the connected system. It is designed to operate with clearances and relative freedom of motion in axial, torsional, and radial directions, e.g. with adequate end float, backlash, and radial bearing clearances. End float is present on the output shaft due to axial clearance between locating bearing surface and babbitted stationary pads, and on the high-speed pinion due to normal backlash requirements. All elements of the system and the combination must be checked for possible causes of abnormal operating characteristics.

VIBRATION

Special attention is given the subject of vibration because it is the most easily observed sign of trouble. If vibration is excessive in spite of corrective action described in the troubleshooting chart (table 7), measurements should be

Table 7. Troubleshooting Chart

Observation	Frequency of Inspection	Cause	Correction
Noisy operation	Weekly	1. Worn or damaged parts	Replace or repair.
		2. Misalignment	Realign - See coupling mfgr. instruction.
		3. Overloading	Investigate - eliminate.
		4. Faulty lubrication	Check oil pumps, oil pressure, filter.
		5. Worn or improperly installed or maintained couplings	Inspect couplings. Check correct type and quantity lubricant. Check for wear. Check for operational limitations as specified by manufacturer.
		6. Excessive vibration	See below - Excessive vibration.
		7. Resonant foundation or other installation characteristics	Investigate with suitable instruments to determine source and frequency.
Low oil pressure		1. Excessive oil temperature	Investigate cooling. See below - Abnormal Heating.
		2. Clogged filter	Investigate and clean.
		3. Worn bearings	Check clearances - replace bearings if clearance excessive.
		4. Excessive suction head on pump	Check suction piping and fittings. Clean suction strainer, if used.
		5. Incorrect relief valve setting	Investigate and correct.
Abnormal heating	Weekly	1. Inadequate or incorrect water supply	Check water lines for fouling or restrictions. Check water temperature and flow.
		2. Insufficient oil circulation	Check filter, check oil pressure - if low adjust relief valve. Check oil lines for restrictions or foreign material.
		3. Incorrect oil	Replace with recommended oil.
		4. Incorrect bearing clearance	Check for high spots in babbitted bearing surfaces - check clearances. Refer to page 11.
		5. Excessive vibration	Investigate and correct (see below - Excessive Vibration).
		6. Unusual ambient conditions	Sun or other radiant heat sources may cause capacity of cooler to be exceeded. Insulate or provide a radiant barrier.
		7. Improper oil level	Remove excess oil. Obtain proper level.
Excessive vibration	Monthly	1. Misalignment	Investigate and correct. Allowances must be made for thermal expansion in all drive train elements and supports. Check axial freedom of HS pinion.

Table 7. Troubleshooting Chart - Continued

Observation	Frequency of Inspection	Cause	Correction
		2. Unbalance	Investigate couplings, unnecessary extension of keys or hollow portion of keyways, other rotating elements in system.
		3. Resonant support	Check plane of vibration with instruments and stiffen support or provide suitable dampening.
		4. Torsional excitation	Check characteristics with suitable instruments and correct.
		5. Flexural excitation	Check characteristics, noting frequencies amplitudes - correct.

taken with a vibration analyzer at operating speed and load. Take vertical and horizontal housing vibration readings by holding the pick-up against the bearing caps at each shaft extension. Vibration amplitude should not exceed the values established for the application. When vibration exceeds the limits established, the unit should be shut down and the cause corrected.

Experience has shown that a gear unit can check out perfectly on the factory test stand and seem to perform badly when installed in the field. Such vibration problems are usually the result of system problems of the combined components.

System vibration problems are highly complex and are not within the capability of the average user to diagnose. Therefore, we recommend that the services of a VIBRATION TEST ANALYST be obtained. System analysis is not a courtesy service of Western Gear Corporation. However, representatives will investigate units suspected of being faulty.

When vibration is experienced, it may be one or a combination of types:

1. Torsional vibration.
2. Mechanical vibration.
3. Lateral vibration.

Torsional vibration is normally associated with systems where reciprocating equipment is used for the driver (internal combustion engines) or for the driven equipment (reciprocating pumps or compressors). Some types of electric motors, turbines, and centrifugal pumps also have torsional vibration characteristics. If gear hammering (tooth separation or torque reversals) occurs in the operating speed range, operation should not be permitted until an investigation is made to determine the cause and correction is completed.

Mechanical vibration can be caused by inadequate foundation, loose bolts, faulty alignment, system unbalance, eccentric shafting or vibrations from sources outside the unit.

All shafts in a system have their own natural resonant frequencies like a tuning fork which vibrate at a certain frequency when struck. When a shaft is rotated at a speed equal to its resonant frequency, lateral vibrations sometimes occur and the speed is called the "critical speed." Operation at or near critical speeds can quickly destroy a gear unit. Therefore, High-Speed Gear Units are normally designed to have critical speeds well above the normal operating speed range. The resonant frequency of a given shaft is a function of its diameter, length, distribution of weight or mass along its length, and the support locations.

OIL PUMP

If any pump does not perform properly in the installation, the following are some of the things to look for:

1. Pump fails to prime or deliver liquid:

   A. Suction lift too high for vapor pressure of liquid pumped.

   B. Leak in suction line.

   C. Viscosity of liquid is too high for size of suction pipe used.

   D. Pump drained completely during the idle period.

   E. Excessive wear of pump parts.

   F. Suction line obstructed.

   G. Pump shaft not rotating due to defective coupling.

   H. Suction line not immersed in liquid.

2. Capacity is too low:

   A. Suction lift too high.

   B. Air leaks in suction line.

C. Suction line too small or obstructed. Can be detected by installing a vacuum gauge directly at the pump suction. The maximum vacuum at the pump suction should never exceed 15 inches of mercury. It is necessary to keep below 15 inches not because of the inability of the pump to handle a higher vacuum, but primarily because of the vaporization that is liable to take place at a higher vacuum. Vaporization caused by higher vacuum will generally result in capacity dropoff.

D. Pump speed too slow.

E. Relief valve setting too low.

F. Suction line not immersed in the liquid.

G. Piping improperly installed permitting air pocket to form.

H. Increased clearances due to wear in the pump will sometimes cause a decrease in capacity of the pump.

I. Excessive oil temperature.

J. Worn bearings in gear box.

K. Clogged filter.

L. Spray jets too large.

3. Pump works spasmodically:

A. Leaky suction lines.

B. Suction lift too high.

C. Air or vapor in liquid.

D. Coupling slipping on pump shaft.

4. Pump wastes power:

A. Pressure too high.

B. Liquid more viscous than assumed.

C. Suction or discharge lines obstructed.

D. Mechanical defects: Drive shaft and pump shaft misaligned. Pump shaft bent. Misalignment within pump due to strains built up by improper piping or installation of pump into equipment.

5. Pump is noisy:

A. Machine or part of it is acting as sounding board.

B. Misalignment of coupling.

C. Excessive aeration of liquid in reservoir.

D. Leaky suction line.

E. Suction in lift so high that vapor forms within liquid.

F. Suction line not submerged in liquid.

G. Suction line obstructed.

OVERHAUL

DISASSEMBLY

During disassembly, refer to appropriate assembly drawings in the Parts List section. The first step is to remove the top half of the gearcase. Any pipelines, wiring, etc., that cross the splitline must be disconnected or removed. Remove all bearing covers, shaft driven pump, and pump adapter. Next, remove all bolts or nuts at the splitline and also the dowel pins located at opposite corners of the case. Attach slings to the eyebolts and free the cover. Care must be exercised so that damage does not occur to either the gearcase contact surfaces, the bearings, or gear teeth. If difficulty is encountered in breaking the joint, use the jacking screws located in opposite corners of the upper case. The upper bearing halves may stick in place, and should be carefully pried loose before removing the cover completely.

NOTE: If embedded temperature detectors have been supplied, be sure all wires have been disconnected.

The gearset may now be removed. Be sure adequate padding is used under slings to prevent damage to carefully finished surfaces. If possible, remove the pinion first, then the gear assembly. After removing, do not allow these parts to rest on their tooth surfaces except on wood planking. When the gearset is removed, the lower bearing halves may be removed by prying between the bearing and gearcase in the oil groove. If bearings are to be reused, identification marks should be made on the ends of bearings and the gearcase to insure replacement in their original position.

After all components are removed, the lower half of the gearcase should be thoroughly cleaned and make sure all drain holes and oil passages are flushed with solvent.

After cleaning, exposed oil passages should be plugged to prevent foreign material from entering while working about the unit. Gear tooth contact, backlash, end float, and bearing clearance must be checked each time a unit is disassembled. Unless a person specially trained in gear adjustments is available, we recommend that a Western Gear service representative be consulted.

PUMP DISASSEMBLY

To remove the pump only, first disconnect the two unions on the suction and discharge lines and swing them away. Remove the four long bolts from the back end of the pump housing and the entire assembly can then be withdrawn from the adapter flange. The pump drive coupling consists of three pieces, a hub attached to the gear shaft, a hub attached to the pump shaft, and a nylon sleeve connecting the two hubs. The sleeve floats; it can be easily taken out with the fingers. Small reducers require the removal of the adapter flange for removal of the sleeve as it is too large to remove through the pump pilot hole. When reassembling the pump to the unit, mount the coupling hubs flush with the ends of their respective shafts. Place the sleeve over the teeth of the gearshaft hub and push the pump into place, rocking it slightly, to engage the coupling gear teeth.

BEARING INSPECTION

The condition of journal bearings at inspection, during overhaul, or disassembly is an important consideration for future operation. Correct evaluation of the conditions can save costly and unnecessary replacement.

Worn Bearings (Fig. 22). New bearing radial clearances vary, depending on bearing size, journal velocity, and other factors. The amount of wear can be determined by measuring the movement of the uncoupled shafts when located in their assembled housing.

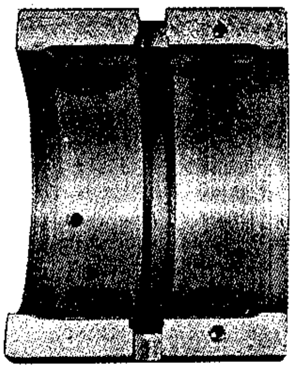


Fig. 22. Worn Bearing.

The appearance of bright spots shows evidence of high spots or hard bearing area on a localized surface of the bearing metal. These should be lightly scraped and polished and the bearing contact area checked by rolling the shaft journals in the installed bearing halves. Apply a light coat of Prussian Blue to the shaft journals to show contact pattern.

Optimum bearing contact should be approximately one-third the circumference of the shell with 90% contact length in that area. Scrape high spots with a bearing scraper and polish with fine steel wool.

> **CAUTION:** Some units may be equipped with special bearings that cannot be scraped . The unit will be identified by a special nameplate attached to the gear-case.

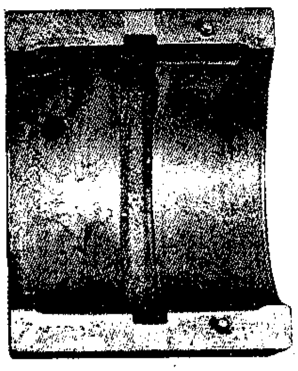


Fig. 23. Corrosive Pitting.

Corrosive Pitting (Fig. 23). Corrosive pitting is caused by chemical reaction of impurities in the lubricating oil. An extreme condition, which requires replacement, is shown in fig. 23. Less extreme conditions can be corrected if a 90% contact area can be established and if bonding of the greater portion of the babbitt surface is not impaired. However, the bearing surface must be polished and blued as described above.

Hammering & Vibration (Fig. 24). Hammering and vibration will cause the bearing material to fatigue and break loose from its bond, breaking into small particles along the bearing surface.

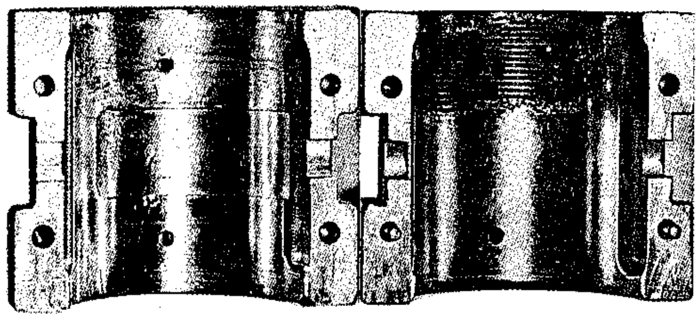


Fig. 24. Hammering and Vibration

Advanced cases will reduce the bearing area so as to make it unsuitable for satisfactory operation. Likewise, other areas will continue to break out as evidenced by visible cracks in the bearing material. The pieces that break out will also cause scoring and oil contamination. Hammering and vibration can be caused from misalignment, unbalance, improper installation, or a system problem. Bearings must be replaced, but a thorough investigation and correction of the cause must be made if satisfactory service of the new bearings is to be expected.

Scoring (Fig. 25). Scoring is usually a result of dirt or metal particles in the lubricating oil, but can also result from scratches or blemishes on the shaft journal. With even the most tidy housekeeping during the preparation and assembly of the unit, particles may remain which will cause light scoring. Scoring, as such, is not detrimental to the operation of the unit as long as the bearing area is not seriously reduced. However, bearings should be carefully cleaned to smooth rough edges left by scoring, and then polished with steel wool.

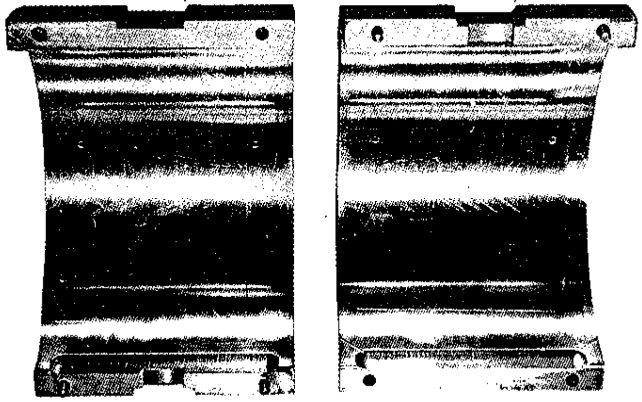


Fig. 25. Scoring.

The shaft journals must always be carefully inspected for blemishes and should be polished with crocus cloth or very fine emery cloth before placing the shaft in the bearings. A heavy coat of clean lubricating oil should also be spread across the bearing to provide initial lubrication.

Wiping (Fig. 26). A wiped bearing is the result of momentary bearing temperature which exceeds the pour point of the bearing metal. This may be localized in one spot in the bearing leaving a small blemish which can be cleaned satisfactorily. However, a wiped bearing starting in a particular area, may cause sufficient bearing metal flow to impair future operation of the bearing.

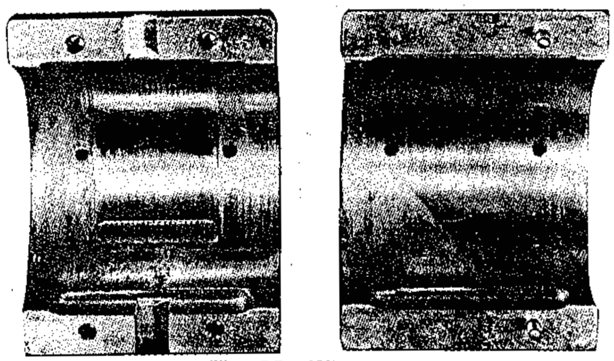


Fig. 26. Wiping.

Some of the causes of bearing wiping are:

1. Lack of lubricating oil/or lubricating oil pressure.
2. Insufficient bearing clearance.
3. Excessive lubricating oil temperature.
4. Insufficient bearing contact on the journal.
5. Severe misalignment or extreme radial load caused by failure or jamming of foreign material in the gear mesh.

Before a wiped bearing is replaced, the cause of wiping should be determined. First, check that the gear and pinion are not damaged. Check the internal oil supply piping for tightness. Carefully check the housing bores for rough edges or high spots which might cause distortion of the bearing halves. Likewise check the O.D. and I.D. of the bearings and the bearing split-line for projections or sharp edges, and remove as necessary. Install the bearing halves in their respective fits in the housing bores and check bearing contact area by coating the journals lightly with Prussian Blue.

Check that approximately 90% contact length is obtained on the center one-third of each bearing shell. After establishing bearing contact, assemble the unit. Check bearing clearances by attaching a dial indicator adjacent to the bearing and, with the stylus on the shaft, lift the shaft vertically.

REPLACEMENT PARTS

When ordering parts, list the unit model number and serial number on the order (refer to the unit nameplate). List the item number and the name of the part required (refer to the assembly drawing and parts list in the Parts List section).

Bearings. Journal bearings are precision type and normally do not require hand scraping to fit. Always order both lower and upper halves when replacing (or rebabbitting) bearings. Should scraping be required, journal should be blued and bearings scraped for approximately 90% contact.

Clearance. Bearing clearance should not be exceeded by more than 0.003 on 10600 through 10900 series units and by 0.005 for larger units.

Gears. Gears must be replaced in sets since they are manufactured in matched sets.

Shafts. Since Western Gear High-Speed Gear Units are manufactured to precise tolerances, the gear and shaft must be replaced as a unit. All hobbing and finish machining is performed on the low speed shaft and gear assembly after the shaft is pressed into the gear blank. If a shaft is damaged to the extent a new shaft or remachining is required, consult Western Gear.

ASSEMBLY

The installation and fitting of bearings in preparation for assembly of the unit is important for optimum bearing life. All new bearing shells should be examined for any burrs or blemishes on the back of the shell, split-line, and bearing metal. All edges of the back of the shell can be lightly chamfered with a mill file. The edges of the bearing metal must be smoothed with a bearing scraper.

The housing bores must also be free of burrs, raised edges, or nicks. The shells can then be placed in the housing. All shells are precision machined and any new half is interchangeable with another half except that one anti-whirl shell mates with a plain shell for some high speed applications. Anti-whirl bearings may be used under certain conditions. When installing these bearings the anti-whirl groove should be positioned on the unloaded side of the bearing. Units which were originally equipped without anti-whirl bearings should not have anti-whirl bearings installed without factory approval.

> **CAUTION:** In the event anti-whirl bearings are used, care should be taken to install them according to the direction of shaft rotation. The bearing oil dam is designed to build pressure when the shaft is rotating towards the dam. Therefore, the shaft should be rotating toward the oil dam.

Be sure that the oil groove, provided in the bearing shell, comes in line with the oil channel provided in the lower half of the gear case. Install the bearings with the split-line rotated approximately 10° from the split-line of the housing. The direction of rotation is determined by the shaft rotation and loading of the shaft as shown in fig. 27. The

Table 8. Torque Values

Suggested Tightening Torque Values to Produce Corresponding Bolt Clamping Loads For SAE Grade 5 Bolts

Size	Bolt Diam. D (in)	Tensile Stress Area A (sq in)	Proof Load (psi)	Clamp Load P (lb)	Tightening Dry K = 0.20	Torque Lub. K = 0.15
					(lb in)	(lb in)
1/4-20	0.250	0.0318	85,000	2020	96	75
1/4-28	0.2500	0.0364		2320	120	86
					(lb ft)	(lb ft)
5/16-18	0.3125	0.0524		3340	17	13
5/16-24	0.3125	0.0580		3700	19	14
3/8-16	0.3750	0.0775		4940	30	23
5/8-24	0.3750	0.0878		5600	35	25
7/16-14	0.4375	0.1063		6800	50	35
7/16-20	0.4375	0.1187		7550	55	40
1/2-13	0.5000	0.1419		9050	75	55
1/2-20	0.5000	0.1599		10700	90	65
9/16-12	0.5625	0.1820		11600	110	80
9/16-18	0.5625	0.2030		12950	120	90
5/8-11	0.6250	0.2260		14400	150	110
5/8-18	0.6250	0.2560		16300	170	130
3/4-10	0.7500	0.3340		21300	260	200
3/4-16	0.7500	0.3730		23800	300	220
7/8-9	0.8750	0.4620		29400	430	320
7/8-14	0.8750	0.5090		32400	470	350
1-8	1.0000	0.6060		38600	640	480
1-12	1.0000	0.6630		42200	700	530
1 1/8-7	1.1250	0.7630	74,000	42300	800	600
1 1/8-12	1.1250	0.8560		47500	880	660
1 1/4-7	1.2500	0.9690		53800	1120	840
1 1/4-12	1.2500	1.0730		59600	1240	920
1 3/8-6	1.3750	1.1550		64100	1460	1100
1 3/8-12	1.3750	1.3150		73000	1680	1260
1 1/2-6	1.5000	1.4050		78000	1940	1460
1 1/2-12	1.5000	1.5800		87700	2200	1640

bearing is doweled in the lower housing. After the bearing half is in place, check between the housing bore and shell with a 0.001 to 0.002 inch feeler gauge to be certain that the shell is seated.

Although new shells are precision machined, small high spots may prohibit a good bearing contact. A good check of contact can be made by carefully polishing the shaft journals with a crocus cloth or fine emery cloth and applying a light coat of Prussian Blue.

NOTE: Journals must be clean and dry before applying the blue.

With the bearings in place in the housing, install the shaft and roll it several times in the bearing shell. An acceptable contact will give a transfer to blue in the center 1/3 of the shell approximately 90% of the length. If the contact shows high spots, these can be lightly scraped down to provide a spread of the contact. After scraping, polish the shell with fine steel wool. Take care that all steel wool particles are cleaned out of the bearing.

CAUTION: Some units may be equipped with special bearings that cannot be scrapped. These units are identified with a special nameplate attached to the gearcase.

Bearings which have been in service and show a good wear pattern with full contact and limited amount of scoring can be polished and replaced without checking area with blue. Before placing the gears back in the housing, flood the babbitt surfaces of the bearings with clean lubricating oil. Use caution to prevent dirt from slings or hoist from falling on journal or bearings when lowering gear assembly or pinion in place. Position the gear assembly in its proper location before installing the pinion. Recoat split-line surfaces with non-hardening sealing compound.

CAUTION: When applying sealing compound to split-line, remain a minimum of ½ inch from the bearing's outside surface.

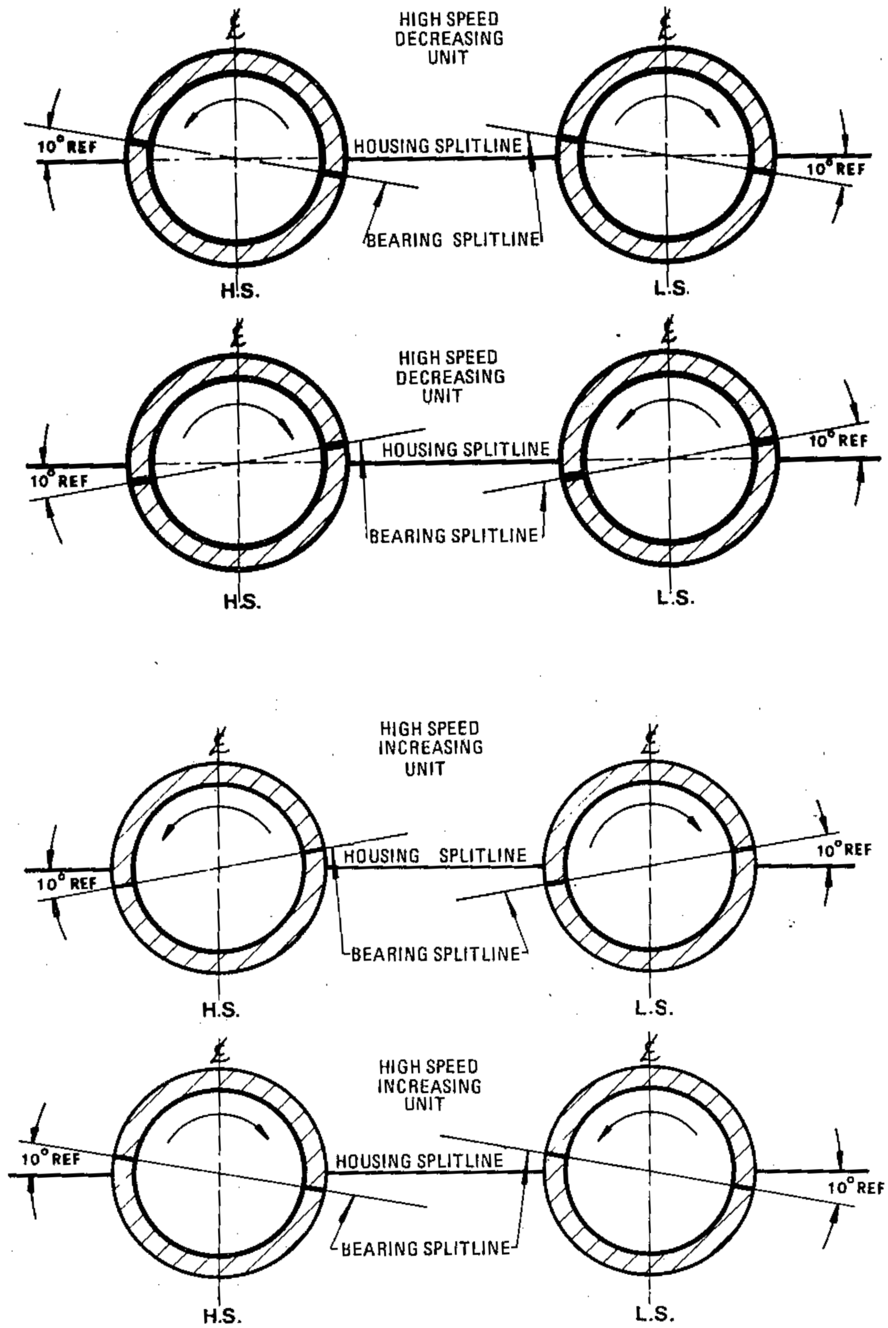


Fig. 27. Bearing Installation.

(Make sure sealing compound is compatible with type of oil being used.) The upper housing can now be swung into position and lowered onto the lower housing. Use caution to prevent the upper housing from bumping or touching gears while it is being lowered into position.

Locate the top of housing in relation to the lower half by inserting dowel pins. Use care when tightening the main-hold bolts to prevent the upper half of the housing from shifting. (Refer to table 8.)

When fully tightened there should not be a step in the bores or on the side of the housing. Complete the assembly by bolting up covers, oil lines, and accessories.

Replace the inspection cover gasket when replacing the inspection cover. Fill with lubricating oil to the level indicated and the unit is ready for operation.

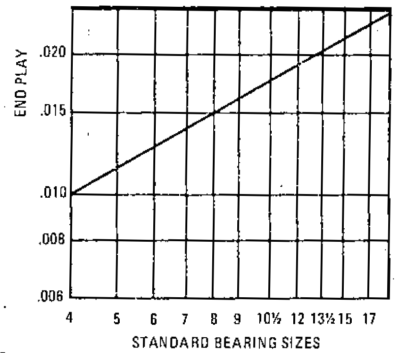
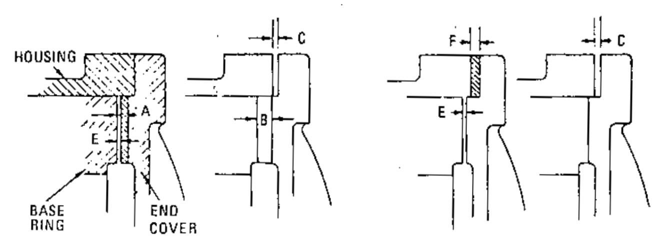


Fig. 28. Recommended Nominal Dimensions for End Play.



MEASURING END PLAY IN BEARING. A, REGULAR, FILLER PLATE. B, DUMMY FILLER. C, AIR GAP. E, END PLAY. F, REGULAR FILLER RING.
LEFT: A = B - C - E RIGHT: F = C - E

Fig. 29. Measuring End Play in Bearing.

TILTING PAD SELF-EQUALIZING HORIZONTAL THRUST BEARING END PLAY

Some end play or clearance is always necessary for tilting pad horizontal thrust bearings. This type of bearing is not easily damaged even by considerable end play; for most applications the amount of end play is not an exacting matter. Usually the nominal amount, plus or minus a few thousandths, is quite satisfactory.

CAUTION: Ensure bearing housing is filled with oil prior to unit startup.

In Western Gear units, end play is fixed by the insertion of filler pieces or shims. These may be located inside a housing bore or under the flange of an end cover. Usually the final thickness of filler pieces is obtained by grinding after all parts have been assembled and the axial location of the shaft is known. In order to ascertain the nominal end play allowance for a specific tilting pad horizontal thrust bearing application, refer to fig. 28. Note the tilting pad self-equalizing bearing size number and find that number on the horizontal scale at the bottom of the chart. The bearing size number corresponds to the nominal diameter of the bearing. Directly above the size number is a vertical line. Follow this line upward to the point where it cuts the diagonal line. Read the end play nominal setting on the vertical scale at the level directly and horizontally to the left of the intersection point. Establish the range of setting vibration by adding 0.002 inch to this nominal setting and subtracting 0.002 inch from it. For example, observe that the vertical line above 9, the size number of tilting pad No. 9, cuts the diagonal line at a point which corresponds to 0.016 inch, the nominal end play setting. Adding 0.002 inch to and subtracting 0.002 inch from this nominal dimension obtains the limits 0.018 - 0.014 inch, the axial clearance.

Measuring tilting pad horizontal thrust bearing end play is a relatively easy task if the low speed shaft assembly on which the bearing is mounted may be conveniently moved axially within the housing. Simply move the shaft assembly from one axial extreme to the other, measuring the amount of axial movement with an indicator. Filler pieces or shims with the proper thickness may be then prepared to provide the desired end play clearance. For installing and for later checking, another method of measuring end play to determine filler thickness is illustrated in fig. 29. If the filler piece is located under the flange of the end cover (right-hand view), the matter is simple. Remove the filler (if it is in place) and draw up the end cover bolts. The required thickness F will equal the air gap C plus the specified end play E.

If the filler is in the housing bore (left-hand view), remove it and replace with a somewhat thicker dummy filler B, making an outside air gap C. Then the required thickness A will be the dummy filler thickness B minus air gap C, minus the specified end play E.

PARTS LIST

major assemblies (Fig. 30-32) with an accompanying list of the parts on the illustration. Locate the part on the illustration, note the item number, and refer to the parts list for a description of the part.

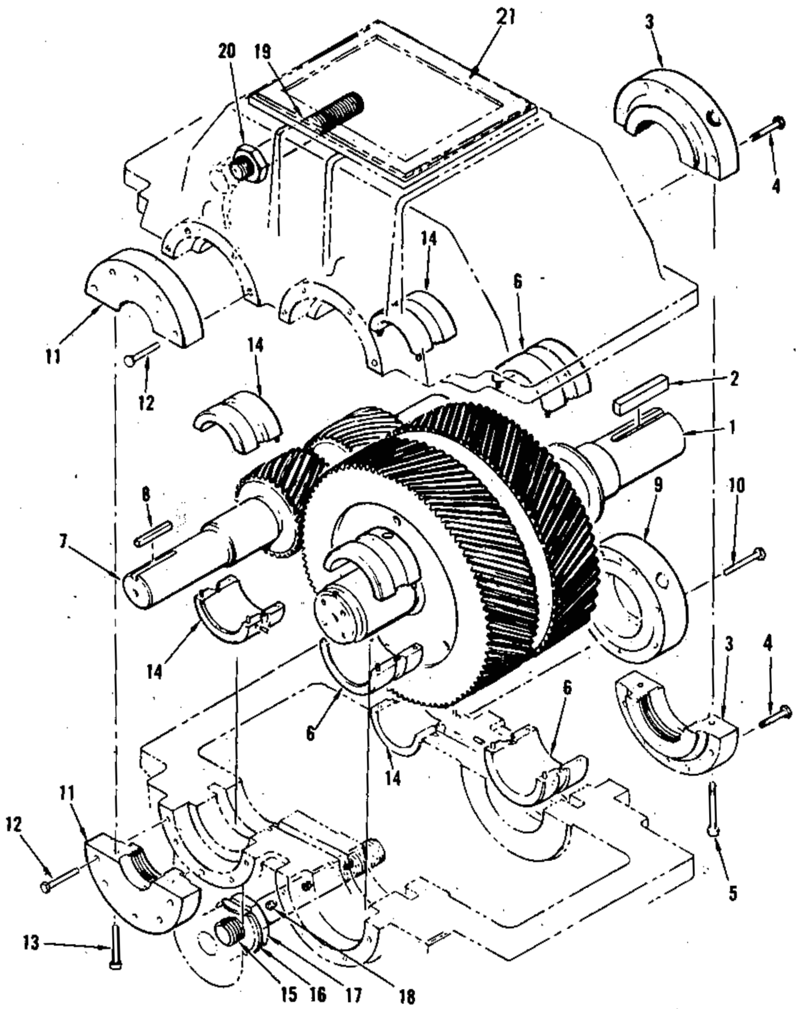


Fig. 30. Gear Unit, Exploded View.

Item	Nomenclature	Units Per Assy
1	. GEAR AND SHAFT ASSY	1
2	. KEY, Square	1
3	. SEAL, Labyrinth, Split	1
4	. SCREW, Cap, Hex Head	8
5	. SCREW, Cap, Socket Head	2
6	. BEARING HALF, Journal	4
7	. PINION, High Speed	1
8	. KEY, Square	1
9	. COVER, Bearing	1
10	. SCREW, Cap, Hex Head	8
11	. SEAL, Labyrinth, Split	1

Item	Nomenclature	Units Per Assy
12	. SCREW, Cap, Hex Head	8
13	. SCREW, Cap, Socket Head	2
14	. BEARING HALF, Journal	4
15	. TUBE, Spray (Upper or Lower)	1
16	. WASHER, Lock	1
17	. NUT	2
18	. NOZZLE, Oil Spray	3
19	. TUBE, Transfer, Oil (Upper or Lower)	1
20	. NUT	2
21	. GASKET, Inspection Cover	1

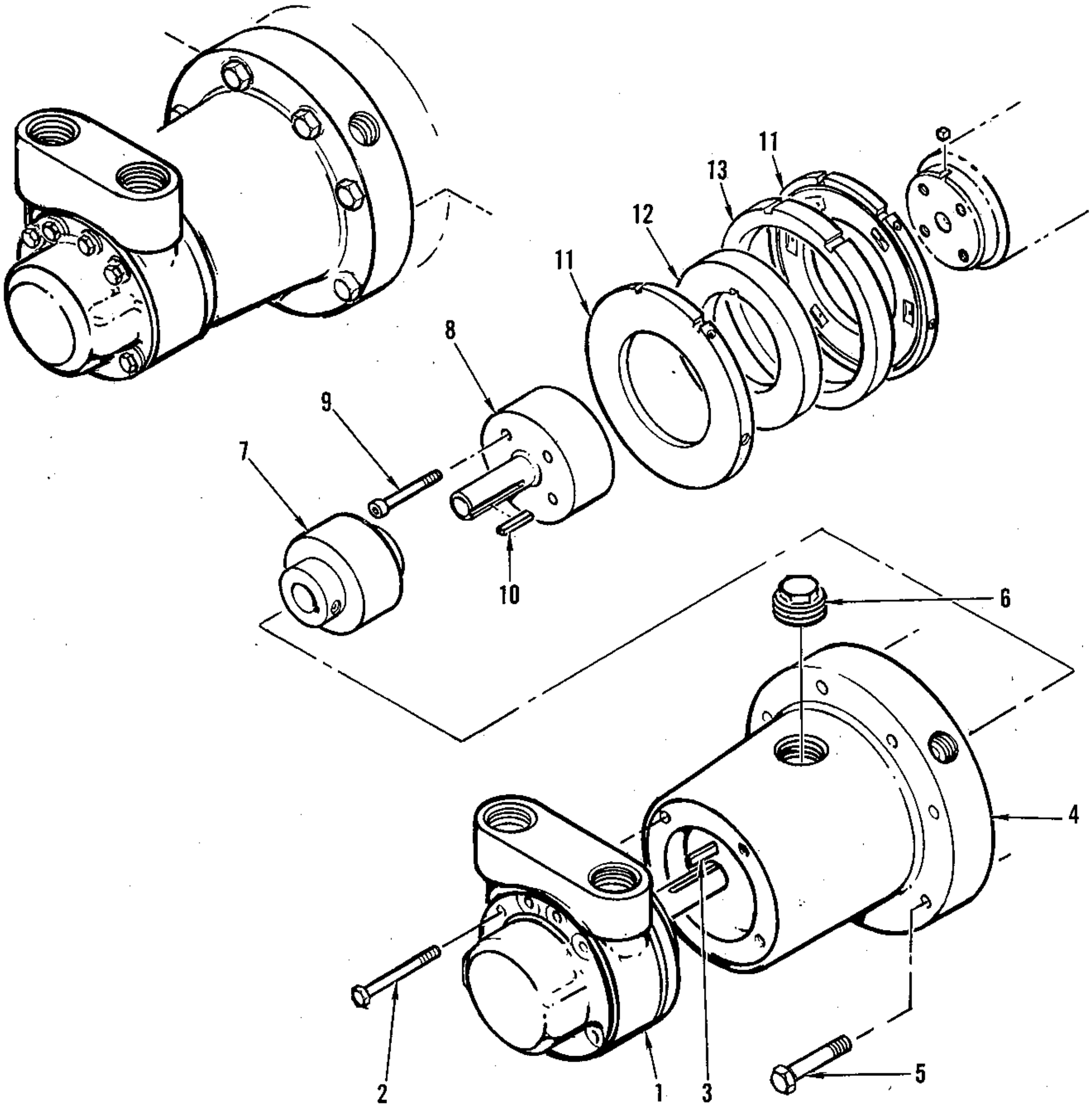


Fig. 31. Thrust Bearing and Pump Assembly, Exploded View.

Item	Nomenclature	Units Per Assy
1	. PUMP, Oil	1
2	. SCREW	AR
3	. KEY	1
4	. ADAPTER, Pump	1
5	. SCREW, Cap, Hex Head	8
6	. PLUG, Square Head	1
7	. COUPLING, Flexible	1

Item	Nomenclature	Units Per Assy
8	. SHAFT, Stub	1
9	. SCREW, Cap, Hex Head	AR
10	. KEY	1
11	. PLATE, Thrust-Thrust Bearing	2
12	. COLLAR, Thrust	1
13	. SPACER, Thrust Bearing	1

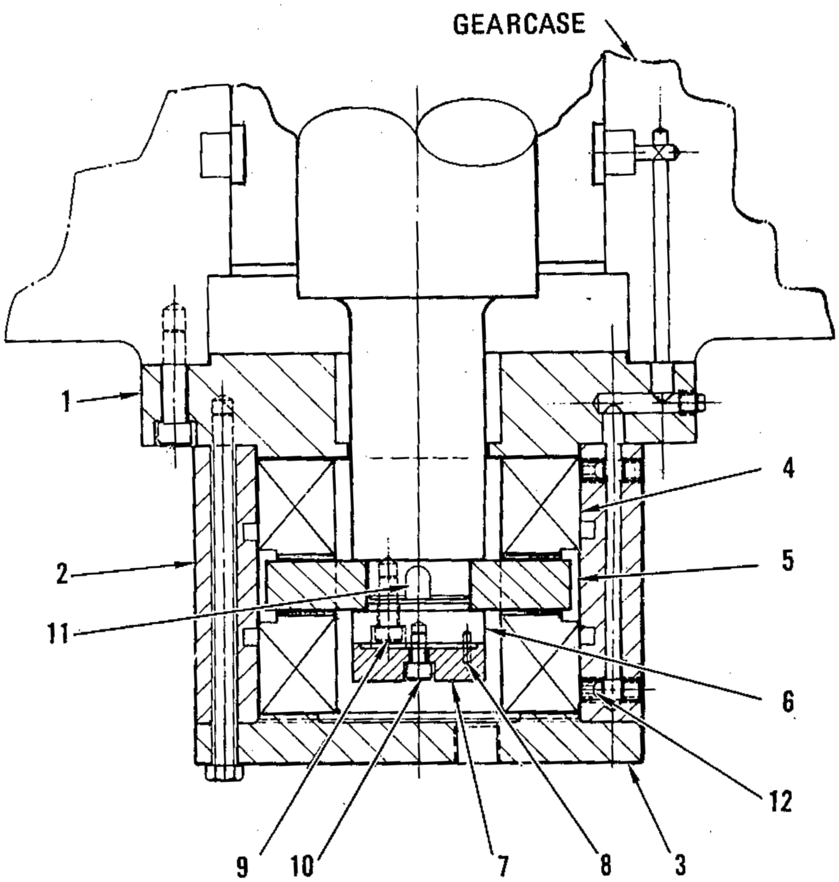


Fig. 32. Tilting Pad Self-Equalizing Thrust Bearing.

Item	Nomenclature	Units Per Assy
1	. ADAPTER THRUST BEARING	1
2	. HOUSING, Thrust Bearing	1
3	. COVER, Thrust Bearing	1
4	. BEARING, Tilting Pad Self-Equalizing	1
5	. RUNNER, Thrust Bearing	1

Item	Nomenclature	Units Per Assy
6	. PLATE, Clamping	1
7	. PLATE, Axial Probe Pick-Up	1
8	. PIN, Dowel	1
9	. SCREW, Cap, Hex Head	AR
10	. SCREW, Cap, Hex Head	1
11	. KEY	1
12	. ORIFICE, Oil Metering	2