MM6104-C
DECEMBER 1996
INSTALLATION
LUBRICATION
OPERATION
MAINTENANCE INSTRUCTIONS
PRICE $2.00

FOOTE-JONES
A REGAL-BELOIT Company
2914 Industrial Ave. • Aberdeen, SD 57402-1089

PARALLEL SHAFT HELICAL REDUCER

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SAFETY

Rotary equipment is dangerous unless adequately guarded. The user is responsible for complying with all applicable safety regulations. Adequate safety instructions must be given by the user to personnel directly responsible for the installation, maintenance, and operation of the equipment. The gear unit must not be operated above its service rating.

DAMAGE IN SHIPMENT

The equipment should be inspected immediately upon receipt of shipment for indications of rough handling or damage. Report to the carrier any apparent or suspected damage.

STORAGE

NORMAL PREPARATION

Prior to shipment, all gear units are tested with a rust inhibiting oil that covers all interior surfaces. Shaft extensions and external machined surfaces are coated with a drying-film rust-preventive material. These measures constitute the normal preparation for shipment and for temporary delays during installation, and will provide some protection, for some period of time, depending on the ambient conditions. **Outdoor, unprotected storage is not recommended.** The table below shows **approximate** storage periods.

APPROXIMATE STORAGE PERIODS		
Type of Preparation	Outdoor*	Indoor**
Normal	2 Months	6 Months
Long Term	12 Months	24 Months

* Unit stored on blocks and covered with a tarpaulin in a protected area.
** Dry building with reasonably constant temperature.

PREPARATION FOR LONG-TERM STORAGE

If the storage period provided by normal preparation is not adequate, the gear unit must be prepared for long term storage.

Protection of gear units against corrosion of internal surfaces during long-term storage is best accomplished by submerging the internals in oil and limiting the entry of air into any remaining space over the oil. The major problem in the preparation of the unit is to prevent leakage of the oil, which would (1) lower the oil level and leave surfaces exposed and (2) contaminate the storage area. Despite careful preparation by the manufacturer, some oil seepage can be expected. The gear unit should be located in the storage area so as to avoid damage to other equipment and the surroundings.

It is preferable that long-term preparation be done at the factory but, if this is not possible, the following procedure is recommended:

1. Place the gear unit on wooden blocks.

2. Tighten all bolts on the housing and all pipe connections such as plugs, standpipes, dipstick caps, and heaters. Replace the breather with a pressure-relief valve having a 1 PSI setting.

3. Clean the outside diameter surfaces of the bearing covers and the adjacent surfaces of the bearing blocks with solvent. Apply a fillet of adhesive sealant such as General Electric RTV-102 around the junction of these surfaces.

4. All exposed unpainted parts such as shafts should be coated thoroughly with a corrosion preventative compound, solvent cut back type, leaving a firm film. Use Nox Rust No. 369 (Daubert Chemical Co.) or equivalent.

5. Completely fill the gear unit with the type of lubricant specified for operation, and tighten the fill-hole plug.

6. Protect other Buyer's or Seller's vendor-furnished items in accordance with the manufacturer's recommended storage procedures.

7. Cover the gear unit with tarpaulins.

8. It is recommended that the input shaft of every reducer be rotated once a month enough turns to produce one complete turn on the output shaft to prevent Water Etching or False Brinelling of the bearings and seizure of the Elastomeric Seal Lip Material on the shaft.

9. The gear unit should be inspected every three months. If oil has leaked out, it should be replaced. Breaks in the paint or in the protective film should be repaired. If the unit is outdoors, its shelter should be renovated as required.

INSTALLATION

FOUNDATION
The equipment should be mounted on a rigid foundation. This is to prevent flexing, vibration and/or misalignment of shafting under all conditions of normal loading. All components of the drive including the motor, the reducer and the driven load should be securely bolted in place after proper alignment and leveling of all elements.

If the above procedure is not followed, noise and unsatisfactory operation may result.

ERECTION
CAUTION should be used in handling the equipment to prevent damage from striking another object. This could result in internal damage to gears or bearings, broken housings and bent shafting.

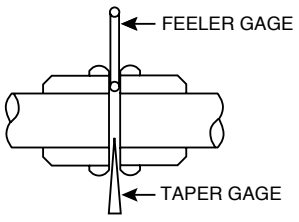
Lift only at eye bolts or lifting lugs provided on unit. Do not place sling around shafts.

CARE should be taken in installation to insure that all components are properly shimmed or grouted in place. Failure to shim properly may result in deflection and misalignment when base mounting bolts are tightened.

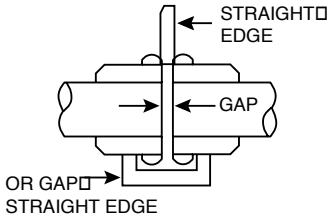
If fitted base mounting bolts (bolts tight fitting in mounting holes) are not used, it is recommended that the components be doweled in place or shear blocks added at sides and ends of mounting flange. A dowel in each of two diagonally opposed corners provides adequate holding and an easy means of accurate realignment in the event of removal for repairs.

Base mounting bolts should be rechecked for alignment and coupling gap after installation, leveling, and permanent mounting of the bedplate. Then proceed as above.

CONNECTIONS
COUPLINGS - A gear-type flexible coupling is recommended. The correct coupling gap should be provided by shifting the most convenient drive element. This is most important in allowing the shafts of all components to float free, to center themselves without restriction and to prevent abnormal thrust loading. The gap (shown in coupling manufacturers catalog) should be set with the reducer input shaft in its neutral or loaded running position and the motor shaft and rotor at its magnetic center or running position.



Angular Alignment

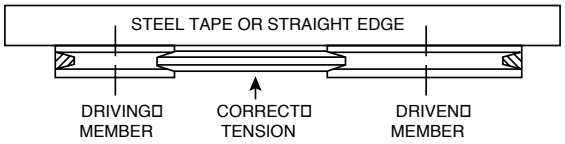


Parallel Alignment

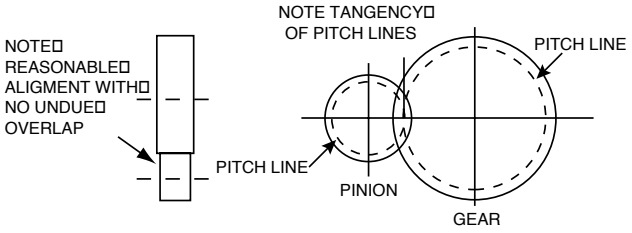
Proper alignment of coupling halves is required to prevent side-loading of the shafts and excessive wear in the coupling. Misalignment, both angular and parallel, must not exceed .005" (.127mm). The sketches (top right) show methods of checking alignment with a feeler gage and a straight-edge; measurements are taken at four positions 90 degrees apart.

SPROCKETS, SHEAVES AND EXTERNAL GEARING
In mounting these items the center of the load should be located no farther out than the center of the shaft extension key seat. Otherwise, excessive overhung loading could exist resulting in early failures to bearings, gears or shafts. Refer to the product catalog for applicable overhung load rating capacity.

These elements should also be properly aligned. In the case of sprockets and sheaves, a steel straight edge or tape layed across the ends will aid in squaring up. See below.



The straight edge should lay evenly across both members with no gapping. CAUTION: Belts or chains should not be too tight as this can place undue loading on the connected elements.



NOTE TANGENCY OF PITCH LINES

External gearing should be set to the correct center distance and alignment. In some cases gear tooth pitch lines are scribed in one or both end faces of the gear and pinion. It is intended that they be matched to a point of tangency. This can also be done by checking backlash with a feeler gage. Bluing in the teeth with prussian blue will check for squareness in alignment. Contact should be as close as possible to 100% across the tooth face. This should be done both a no load and under load to determine if proper alignment has been attained.

GENERAL
When couplings, sheaves, sprockets and external gearing are furnished with reducers, they are generally mounted at the factory.

If it is necessary to mount these items in the field, it is important that extreme care be used. It is quite easy to damage internal members by heavy blows used in trying to drive on one of these parts. It is recommended that a bore be selected to give a tapping or light driving fit. If necessary, the bore should be enlarged to provide this class of fit. If it is a requirement to have a press fit it is suggested that the external element be heated to insure an easy assembly. Heating beyond 250° F (121.1° C) is not recommended, as heat conducted along the shaft may damage the shaft seal.

CAUTION - For safety, purchaser or user should provide protective guards over shaft extensions and any couplings, sheaves and belts, sprockets and chains, open gearing, etc., mounted thereon.

LEVELLING

To achieve alignment in the horizontal plane, it is necessary to place the shims between the gear unit and the base. Care must be taken to make the shim-stack firm to prevent distortion of either the housing or the foundation when the foundation bolts are tightened later on. The gear unit may then be moved horizontally to achieve alignment in this other plane.

After correct alignment has been achieved, the foundation bolts should be torqued to the value shown in this table.

RECOMMENDED BOLT TIGHTENING TORQUES* (lb-ft)		
BOLT SIZE	**GRADES III & V** 	**GRADE VIII, STUDS, & SOC. HD. SCREWS** 
1/4	9	13
5/16	18	28
3/8	31	46
7/16	50	75
1/2	75	115
9/16	110	165
5/8	150	225
3/4	250	370
7/8	380	590
1	585	895
1-1/8	780	1410
1-1/4	1100	1960
1-3/8	1460	2630
1-1/2	1750	3150
1-5/8	2390	4310
1-3/4	3110	5610
1-7/8	4190	7550
2	4500	8100
2-1/4	6500	11,700
2-1/2	7140	16,200

*Maximum torque values are shown. Use 90% to 100% of these values.

It is important that bolts and studs be tightened to the above values. If mechanical means are not available to develop the high torques required for the larger sizes, thermal means may be used. By this method, bolts or studs are expanded by heating in accordance with the table below. They are then installed quickly and torqued snugly before significant cooling can occur. The shrinkage produces the desired tension in the bolt or stud without heavy torquing. Bolts and studs should be heated in a temperature-controlled oven.

TEMPERATURE DIFFERENTIAL FOR THERMAL TENSIONING			
Grade or Type	**II**	**III & V**	**VIII, STUDS SOC. HD. SCRS.**
Temperature above ambient	240° F (115° C)	400° F (200° C)	635° F (335° C)
Tensile stress in bolt or stud when cool (psi)	45,000	75,000	120,000

LUBRICATION

GEAR UNITS ARE SHIPPED WITHOUT OIL. Before startup, fill the unit to the indicated level with the grade and type of oil shown on the nameplate for the ambient temperature. Suitable oils are listed in a chart in this manual. If the unit will be operated at ambient temperatures outside the range shown on the nameplate, consult the factory for recommendations. Special lubricants, oil coolers, or sump heaters may be required.

Do not overfill; a high oil level will generate heat through churning. To ensure proper lubrication of all moving parts, do not underfill or let the oil level drop more than 1/4" (6 mm) below the indicated level.

The initial oil fill should be changed after two weeks of operation. Thereafter, the oil should be changed every six months or seasonally if viscosity changes are required.

OPERATION

START-UP

1. After the installation has been completed, but before the initial startup, the following checks should be made:

   A. Verify the rating of the reducer, (indicated on the name plate and certified print) to be sure the service rating, RPM or speed range, thermal rating, and any overhung or thrust loading are not exceeded in actual operation.

   B. Make sure reducer is filled with the correct lubricant to the proper level. Too much oil in the reducer causes churning and excessive heat generated by fluid friction. Likewise, an insufficient amount of oil will make the reducer operate at higher temperatures.

   Make sure all oil passages are clear and permit free flow of the lubricant. Refer to section of this bulletin on lubrication and/or the nameplate affixed to the reducer.

   C. On vertical units, prime pump and check for oil flow.

   D. Lubricate couplings with manufacturer's recommended lubricant.

   E. If backstop is used make sure it is filled to the oil level mark with the proper lubricant.

   F. Fan - On units equipped with a fan check the air supply for proper fan circulation. Avoid high surrounding ambient temperatures.

2. Check for free rotation of all elements. In many cases, the input shaft of the reducer can be turned by hand even with a connected load.

3. Check all bolts and capscrews to make sure they are tight.

4. Check belts and/or chains for proper tension.

5. After energizing motive power, if any undue noise occurs, shut off power immediately.

6. Observe temperature rise. This may take up to two hours to stabilize. In some instances depending on ratio, size and input speed the temperature in the oil sump may rise as much as 100° F (55.6° C) above the ambient. Actual operating temperature will vary with the reducer size, ratio, type and operating conditions. Under no circumstances should the oil bath temperature exceed 200°F (93.3° C), consult the factory. The housing and shaft adjacent to the high speed seal may show temperatures significantly above 200° F (93.3° C). This will diminish as the seal and shaft sealing area wear in. Application of oil at this area during the break-i n period will help in assisting this process. Many times the reducer temperature is judged by the touch of hand and may be considered to be quite hot. The only positive method is to use a surface temperature measuring instrument such as a

7. Bearings can produce localized heating from cramping either radial or axial. Check for insufficient end play.

8. CAUTION: Do not operate this unit beyond its service rating as any failure resulting could cause damage to property or life and limb.

9. CAUTION: The system of connected rotating parts must be free from critical speed, torsional or other type vibration, no matter how induced. The responsibility for this system analysis lies with the purchaser of the speed reducer.

MAINTENANCE CHECK POINTS

For optimum protection and preventative maintenance it is recommended that the reducer be inspected daily. Points to cover are:

1. OIL LEAKAGE at oil seal, housing split, bearing cap shims, pipe fittings. Tighten housing bolts, bearing cap bolts and pipe fittings and/or replace oil seal if leakage is sufficient to cause rapid drop in oil level. It may be necessary to add sealant between bearing cap shim packs and the housing.

2. OIL LEVEL - Any undue drop in oil level is an indication of oil leakage from some point on the reducer and should be corrected. If backstop is used, check oil level also.

3. TEMPERATURE - Check the actual temperature of the oil bath, gear case, and shafts at various points. This should be done after the unit has been in operation at least two hours. The average oil bath temperature is 140° F (60° C), however, the range can vary from 100° F to 200° F (37.8° to 93.3° C). Bearings can produce localized heating from cramping either radial or axial. Check for insufficient end play. Any undue rise in temperature above that normally encountered and not accountable for by a rise in the ambient should be investigated. Low oil level, abnormal loading, thickening of lubricant, bearing seizure are possible sources. If in a particular bearing, the heat would be localized in the housing area adjacent to the bearing.

4. SOUND LEVEL - A sudden change in the sound level is a possible indication of low oil level, undue thinning out of lubricant, abnormal loading, worn coupling or deterioration of internal parts.

   Noise is usually difficult to isolate because sound can travel throughout the entire drive system. A noise can be pin-pointed to a specific area by determining its approximate frequency and if it is at accurate regular intervals.

5. LUBRICANT CONDITION - A change of color in the oil or thickening or unexplainable corrosion of internal parts is an indication that it has deteriorated and should be changed.

6. LOADING - Periodic load checks are valuable in making sure that reducer rating is not exceeded.

7. OIL BREATHER - Must be kept clean.

8. VIBRATION - A change in the vibration normally associated with the system can indicate worn couplings or internal reducer parts.

9. DIRT ACCUMULATION - Any undue accumulation of dirt on the reducer or in fan components where fans are used will affect proper cooling of the unit.

10. BACKSTOPS - Check oil level and for any sudden increase in sound level. There should be no undue radial play and the torque arm should move freely within the limits of its stop.

11. GREASE PURGED OIL SEALS - Grease should be applied once a week to the Alemite fitting on the open bearing caps until it escapes from the Alemite relief fitting on the opposite side of the cap or from the outer seal lip. Use a good Lithium base grease (NLGI No. 2 consistency) should be used.

12. PUMP (VHLD & VHLE or VBHC & VBHE Only) - A decrease or increase in oil line pressure indicates that the pump is not functioning properly. The possible causes for pump failure are listed below.

    SYSTEM PROBLEM
    High Oil Pressure
    POSSIBLE CAUSES
    Closed or block in orifice, or crimp in tubing. Drive speed increased substantially, axial spring force too high.
    SYSTEM PROBLEM
    Low or No Oil Pressure
    POSSIBLE CAUSES
    Seal Leaks
    Break In Line
    Enlarged Orifice
    Pump Running In Relief

13. COUPLINGS - If noisy, check for lubrication.

14. REPAIR PARTS - Keep recommended spare parts, oil seals, and bearings on hand to reduce down time.

BACKSTOP MAINTENANCE

1. To take off the backstop, drain oil from the reservoir and remove it by unscrewing cap screws holding it to the backstop body. Bend back locking tab on lock washer and unscrew locknut. The backstop and torque arm can be pulled off by prying between the torque arm and the housing or by use of a gear puller. The manufacturer does not recommend repair in the field nor attempting to change direction of rotation in the field. In either case the backstop should be returned to the factory.

2. Clean off all sealant from the shaft surfaces as well as the key, keyways and backstop bore. Flush out backstop with Mobil Oil Solvosol or equivalent. Do not use Carbon Tetrachloride. Clean the breather also with the same solvent. (See Fig. 6)

3. IMPORTANT: Prior to replacing the backstop coat thoroughly the shaft surface under the backstop, the shaft keyway, the backstop bore and its keyway and the key with an adhesive sealant such as General Electric RTV-102 or Permatex No. 2 (Non-Hardening).

   This is to prevent oil leakage from the reservoir back along the shaft.

4. Balance of reassembly is reverse of disassembly. Check torque arm for free movement. It must not bind in bottom of its stop.

5. Fill backstop to indicated level with proper oil. (See section under lubrication).

6. Flushing is recommended every six months for up to 12 hours per day operation and every three months for 12 to 24 hours per day operation. Drain oil from reservoir fill with Mobil Oil Solvosol or equivalent and run for several minutes. Then drain after removing both the plug in the housing and the plug in the reservoir. Add fresh oil (see section under lubrication). For extremely dusty or dirty operating conditions, it may be necessary to change oil at more frequent intervals or often enough to keep oil clean. When the oil becomes contaminated or oxidized (dark colored), it should be flushed and changed.

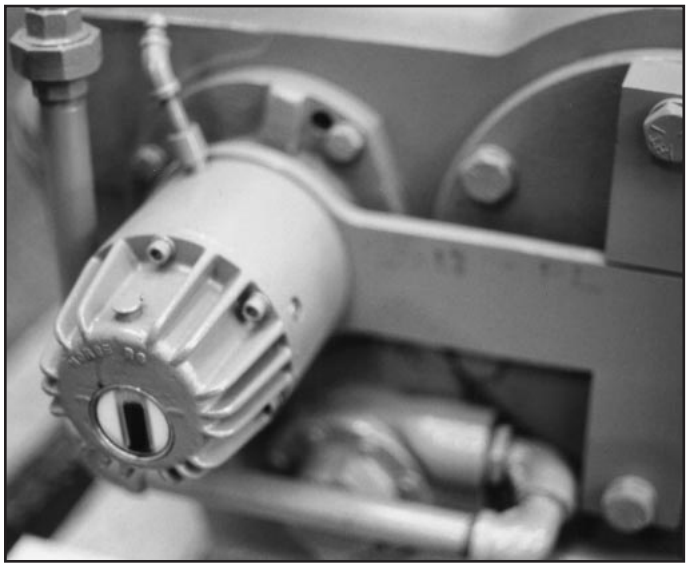


Fig. 6

BACKSTOP INSPECTION

The backstop must be periodically inspected by the manufacturer and reconditioned, if necessary, to insure satisfactory performance. These units should be returned to the Formsprag Company according to the following schedule.

Shaft Speed	Inspection Interval
900 to 1800 RPM	2 Years
below 900 RPM	3 Years

NOTE: Disassembly and repair of the backstop in the field is not recommended.

OIL SEALS

All oil seals used in these units have a synthetic elastomer dual lip seal. They are provided with a spring back of the inner lip which exerts constant pressure and keeps the lip in contact with the shaft.

1. In any disassembly of the reducer or removal of bearing caps it is recommended that all oil seals be replaced.

2. Examine the new oil seal for cuts or imperfections in the lip. The lip should have a smooth and uninterrupted edge with no flashes from moulding. The O.D. of the seal should be free of scratches and burrs. Test the seal for grip on the shaft upon which it is to run; it should not be loose but should offer some drag to axial movement. If the seal if not satisfactory, discard it and try another one.

3. Clean the bearing cap seal bore and remove any burrs; coat the cap bore and the seal O.D. with an adhesive sealant such as General Electric RTV-102 or Permatex No. 2.

4. The shaft in the seal area should be examined for score marks, scratching or grooving. First try polishing out the imperfections with a fine grade of Emery (No. 240). The polishing motion should not be axial or spiral in direction but circumferential. If the shaft surface can not be reconditioned sufficiently by polishing to remove all imperfections, it may be possible to shift the seal position sufficiently to escape this area. The inner lip with the spring in back of it is the important one to consider. The other alternative is to metallize the shaft and regrind to a surface finish of 10 to 20 RMS. If the surface imperfections are not too deep, a simple plunge grind to no more than .010" (.254 mm) undersize on the diameter may clean up the shaft. In fact, plunge grinding is preferable t o polishing to remove any possibility of spiral marks on the shaft which can cause oil leakage.

5. Wrap .005" (.127 mm) plastic shim stock around the shaft to cover up the keyway and any shoulders. Wipe oil or grease on the seal lip to facilitate assembly. Slip the seal on the shaft up to the bearing cap with the lip and spring facing in toward the reducer. Using the end of a piece of wood about 1 x 2", drive the seal in tapping first on one side then the other. (See Fig. 7) The seal should be flush with bearing cap outer face and square with the shaft. Remove the shim stock. If steel or brass shim stock is used, make sure all burrs on the edge are removed to avoid cutting the seal. For maximum protection,

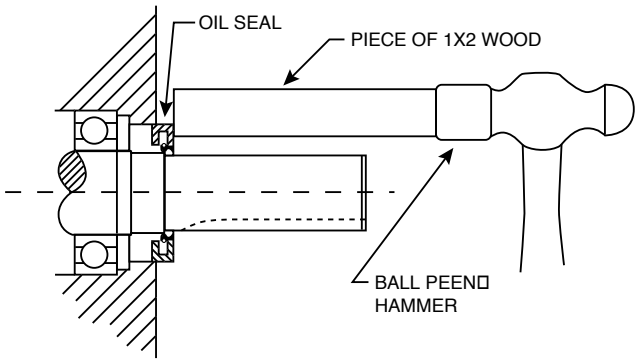


Fig. 7

lay a strip of scotch tape along the exposed edge.

6. On those units using two seals, the inner seal should be pressed in until the open depth remaining is the thickness of one seal. The outer seal is pressed down on top of it and should come flush with the bearing cap outer face. Pack grease between the two seals. Use a high quality Lithium

7. CHANGING SEALS ON THE UNIT

A. It will be necessary to shift the driving motor and remove coupling if coupling is used. If belt drive, only the sheave need be removed.

B. Drill two holes in the seal face 180° apart. Insert large sheet metal screws and leave about 3/16" (4.76 mm) length of screw under the head protruding. Use a pry bar with the notch at one end under the screw head to lift the seal out. (See Fig. 8)

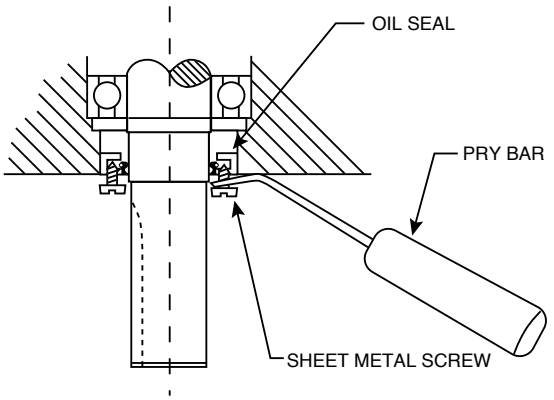


Fig. 8

C. Take care not to damage the seal bore in the bearing cap or the shaft surface.

D. Proceed as outlined previously in Paragraphs 2, 3, 4, 5, & 6.

8. GREASE BARRIER OIL SEALS

Some units on special order are furnished with grease purged high speed and low speed oil seals for use in areas subjected to a considerable accumulation of external foreign matter. This consists of two oil seals with a grease chamber in between. An Alemite pressure fitting and relief fitting are mounted on the bearing cap 180° apart. The seals are mounted as shown in Fig. 9. In reassembly, prepack with grease in between the two seals.

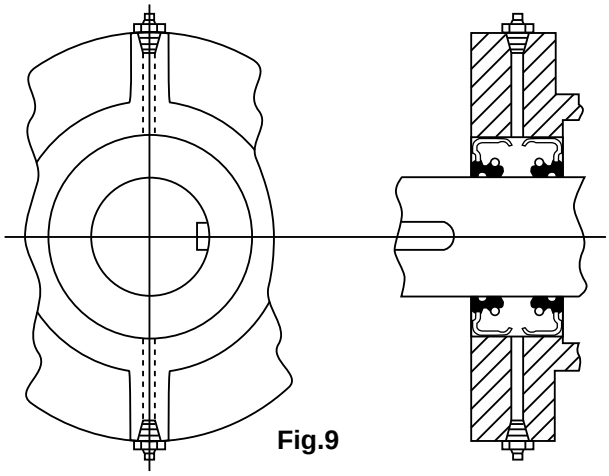


Fig.9

FANS

Some units may be equipped with a fan or fans for cooling. If the fan is on the end of the shaft opposite the drive end, a shaft guard is provided. The fan guard is split in two pieces as is the mounting plate which fastens to the housing through the bearing cap bolt holes. The fan hub is split in the center hub and clamps to the shaft with bolts through the hub split. In reassembly, make sure that the fan is in its original position and does not rub against either the fan guard, mounting plate, or bolt heads. If two fans are used, make certain that the mounting plate goes back on the same side as originally installed. The hole openings are different for the right and left sides. Openings in the fan guard and support plate should be kept free of dirt accumulation to permit proper air flow. See Fig. 10.

Fig. 10

HEAT EXCHANGER

Some units will incorporate a heat exchanger and a pump to circulate the lubricant. Before placing the exchanger in operation initially, or after a service inspection be sure that the unit is clean and full of fluid.

Oil Pump

Units furnished with heat exchangers are equipped with an oil pump mounted externally to the high speed shaft. When starting up the unit recheck the lubrication system to be sure it is functioning properly.

Heat Exchanger

To insure satisfactory performance the exchanger should be inspected periodically.

A. Remove the bonnets. Inspect all tubes carefully for possible erosion, corrosion, or foreign material.
B. Inspect all zincs to be sure they are neither excessively corroded. Scrape to a bright surface.
C. Inspect filters to prevent foreign matter from entering exchanger.
D. The interior of the tubes may be flushed by directing a stream of water through them. More stubborn deposits may require brushes, rods, or other cleaning tools.
E. The unit can be cleaned by circulating a mild alkaline cleaning solution, such as okite or an equal.

Oil Filter

Units furnished with heat exchangers are equipped with an oil filter. The filter should be cleaned after every change of lubricant. Remove filter elements and immerse in any non-caustic cleaning solvent for a short period of time.

A stiff brush may be used, if necessary, to remove impacted deposits between serrations. If compressed air is available, blow dry from inside out.

LUBRICATION

WARNING - This unit is shipped DRY! Oil must be added prior to operation. Any couplings attached are also DRY! and must be lubricated prior to operation. Manufacturer's recommendations should be followed.

The oil used should be a high quality product, having rust and oxidation inhibitors, anti-foaming agent, a high viscosity index (preferably above 90) and a low acid content. It should be neutral in reaction, free from girt or abrasives and non-corrosive to gears or bearings.

CAUTION - LOW TEMPERATURE OPERATION

1. The pour point of the oil should not exceed and preferably should be 5 to 10 degrees Fahrenheit (2.8° to 5.6° C) below the lowest ambient starting temperature.

2. When temperatures are below 15 degrees Fahrenheit, (-9.4° C) please refer to the factory for recommendations giving ambient temperature expected and operating cycle.

3. On vertical units or special horizontal units equipped with pumps, the viscosity can be critical at Low Temperatures in effecting proper operation of the pump. The oil viscosity in a pump driven lube system should not exceed 15,000 SUS. High viscosity lubricants may cause cavitation.

Prime pump with appropriate lubricant and check for oil flow.

For recommendations, refer to the factory giving full particulars of the lowest ambient temperatures affected and the operation cycle.

CHANGE CYCLE

We recommend changing oil every 2,500 hours or six months whichever occurs first. Make certain to be guided by seasonal temperature variations and change oil accordingly. Operating conditions can vary this guide line. Abnormal temperatures and contamination can seriously affect the lubricant causing early sludging, oxidation and acid formation. Under these conditions, a sample of the lubricant should be submitted to the petroleum supplier at periodic intervals. This will enable the establishment of a change cycle which would provide for renewal of the oil prior to its degradation. After the initial fill, the first oil change should be made after two weeks, or 100 hours of operation.

FOOD AND DRUG INDUSTRY

Some operations in the Food and Drug Industry require special lubrication considerations in view of possible toxicity from contamination by the oil or grease used in the equipment. Some EP products contain Lead Naphthenate, Phosphorus, or Chlorine which are toxic and could be harmful.

CAUTION: In the Food (including animal food) and Drug Industry, consult the petroleum supplier for recommendations of lubricants which are acceptable to the Food and Drug Administration and/or other authoritative bodies having jurisdiction.

COUPLINGS

Each coupling shipped with a reducer is tagged with a list of the proper lubricants and an outline of the correct lubrication practice to follow. They should be relubricated at regular intervals and not allowed to go dry.

BREATHER

Each unit is equipped with a breather. This should be cleaned at intervals to insure that it is working.

GREASE PURGED SEALS

Lubricate once a week with a high quality Lithium base grease NLGI No. 2 consistency.

GREASE LUBRICATION - VERTICAL REDUCER

Grease lubricate the lower output shaft bearings once a week at the Alemite grease fitting. A good grade of antifriction bearing grease or its equivalent should be used. It should have neutral and channeling characteristics with a consistency of NLGI #2. It should not be subject to excessive bleeding or deterioration.

NLGI #2 GREASE FOR REDUCERS

SUPPLIER	LUBRICANT
Amoco	Amolith EP2
BP Oil	Energrease LS EP2
Castrol	Molub-Alloy 860/150-2
Chevron Oil Co.	Chevron Ultra-Duty EP2
Citgo	Lithoplex #2
Conoco	EP Conalith
Exxon	Lidok EP2 or Unirex N2
Keystone	81EP2 or 84EP2
Lubriplate	No. 1200-2
Mobil Oil Co.	Mobilux EP-2
Pennzoil	Premium Lithium Complex 2
Phillips	Philube L+EP
Shell Oil Co.	Alvania #2 or EP-2
Sun Oil Co.	Ultra Prestige EP2
Texaco	Starplex 2
Unocal	Unoba EP2

DISASSEMBLY

It is recommended that prior to and during disassembly, reference be made to certified drawings, assembly layouts, and parts lists furnished with this manual.

CAUTION: Before starting to work on any part of the drive, be certain that the prime mover is turned off and locked to prevent accidental starting or rotation.

Disassembly and reassembly should be done in a clean, dry area where the likelihood of dirt or other contamination entering the open housing or adhering to the exposed components is nil. When components are removed from the gear unit, they should be carefully placed on clean wooden boards or pallets and covered with paper or plastic sheets.

NOTE: Any work done on the gear unit during the warranty period will void the warranty unless prior approval is obtained from the factory or a factory representative is present.

DISASSEMBLY PROCEDURE

1. Drain the oil from the gear unit.

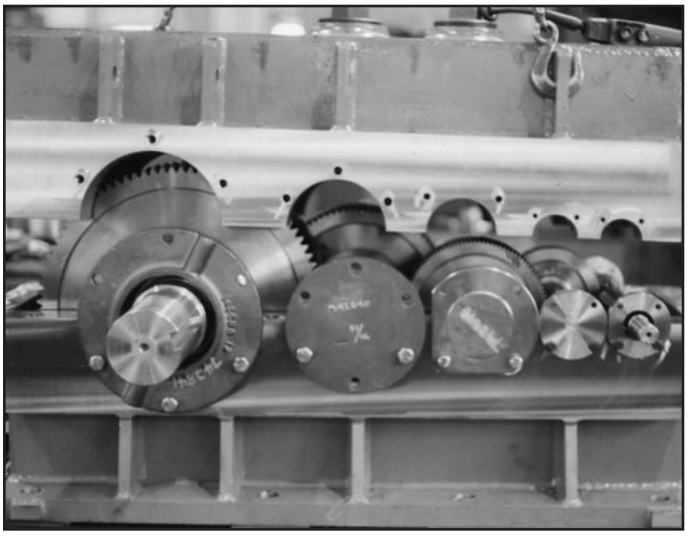
2. Remove the inspection cover taking care not to damage the gasket.

3. Remove the bolts holding the upper and lower housing pieces together. Remove the two dowel pins, one in each flange at opposite ends of the housing.

4. Remove the bearing-cover bolts above the housing split. Back out the bearing-cover bolts below the split about 3/16" (5 mm). Move the bearing-covers out (away from the housing). If shims stick to the housing, loosen them with a sharp knife. Tie the shims to the bearing cover at one of the upper bolt holes to keep them from being damaged.

5. On units equipped with pressure lube systems, separate the piping between the upper and the lower housing.

6. Lift off the upper housing using the eye bolts or attachment points furnished for this purpose. An eye bolt may be screwed into one of the inspection-cover bolt holes for lifting the upper housing, but the entire gear unit must not be lifted in this manner.

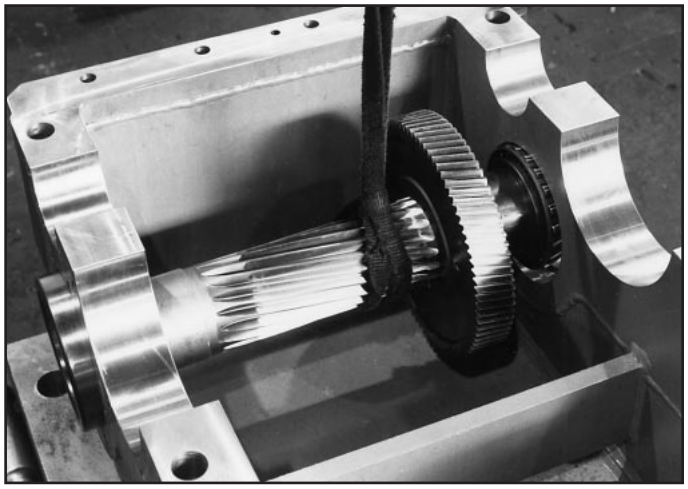


7. After picking up the weight of the high-speed shaft with a soft sling, remove the high-speed bearing covers. Lift out the high-speed shaft assembly taking care not to damage any of the gear teeth, bearings, or machined surfaces.

8. Repeat the procedures of step 7 for the low-speed pinion-shaft assembly and then for the low-speed shaft assembly.

9. On most triple-reduction units, the intermediate-shaft assembly is located below the housing split and cannot be lifted out directly. On such units, pick up the weight of the shaft assembly with a soft sling and remove the bearing covers and bearing cups. Then push the shaft partially through the bearing bore on one side until the bearing on the other side clears its bore. Carefully swivel the shaft on the sling while withdrawing the opposite bearing from its bore. When the bearing is clear, lift out the assembly.

CAUTION: Lay shaft assemblies on wooden supports as required to keep the weight off the bearings and the bearings off the floor.



10. If bearings are to be removed, a conventional bearing or gear puller should be used because the bearings are interference-fitted on their shafts. The puller fingers must grip the back side of the bearing. In some cases, it may be easier to use a small press, supporting the bearing on the inner-race shoulder.

11. Gears are interference-fitted on their shafts. A press is essential for their removal.

12. Remove the seals from the bearing covers.

All parts including the housing should be cleaned thoroughly with a mineral solvent. Remove sludge deposits and corrosion from all components. Scrape the sealant off all housing split, bearing cover, and seal bore surfaces. Take care in cleaning and handling not to scratch or nick the surfaces on gear teeth, bearings, and shaft journals and shoulders. Examine all parts for damage or indications of wear; replace if necessary. Instructions for examining the more critical parts are given in the next section.

COMPONENT INSPECTION AND EVALUATION

After the gear unit has been disassembled, certain components should be carefully inspected to determine their suitability for further service. Some types of progressive degeneration can be halted or reversed by certain procedures. Other types of degeneration disclosed by inspection will render the component unsatisfactory for further service and call for replacement.

BEARINGS

Bearings in standard units are single-row tapered roller bearings in the smaller sizes and double-row tapered roller bearings in the larger sizes. Special units may contain either or both of these types of bearing as well as single-row and double-row spherical roller bearings and cylindrical roller bearings. The parts drawings in this manual identify the bearings in standard units. Bearings in special units are identified by the special parts drawing included with this manual.

Bearings may be damaged by impact loads, excessive overhung loads, improper adjustment, inadequate lubrication, or from normal fatigue that results from repeated stress cycles. When a bearing fails, an attempt should be made to determine why the failure occurred because it may be possible to eliminate the cause.

After careful cleaning, both of the races and all of the rollers of all bearings should be examined for visible pitting or spalling and the cage should be examined for cracks and excessive wear. When a visible defect is discovered, the bearing should be replaced without delay.

GEARING

Certain operating conditions will accelerate the degeneration of the gearing. Some of these are contaminated lubricant, unsuitable lubricant, improper bearing adjustment, and overloading. Gearing should be inspected at six-month intervals. If degeneration is discovered, the probable cause should be determined and steps taken to rectify the condition.

Lubricant that is contaminated by fine particles will cause abrasive wear as the particles pass through the gear mesh. The particles may have been in the oil, may have been carried in from the surrounding environment, or may have detached from gear tooth surfaces or from bearings. If the oil is found to be contaminated, it should be drained out, the housing thoroughly flushed, and the unit refilled with the recommended lubricant to the proper level. The breather should be checked for deterioration and replaced if necessary.

Under normal operating conditions, minor imperfections in the working surfaces of the gearing will be smoothed out and polished during the first month of operation. Thereafter, the loss of metal from the working surfaces will occur at a very slow rate and gear life will be long. However, under heavy loads, the gear tooth surface may fatigue due to repeated compressive stress beyond the fatigue limit of the material and pits may form. Initial pitting is very common and consists of very small pits that form in a narrow band at or just below the pitch line. This type of pitting is not serious and usually disappears as normal wear spreads the contact area. Another type of pitting, though, is serious. It is known as destructive pitting and occurs when the spreading of the contact area does not reduce the compressive stress below the endurance level. It is characterized by progressive surface failure which may culminate in tooth failure. Possible causes of destructive pitting are poor tooth contact, overloading, and unsuitable lubricant.

Repeated bending stresses above the endurance limit of the gear-tooth material will eventually result in fatigue breakage. A crack usually originates in the fillet on the loaded side and propagates across and along the tooth until the section is weakened to the point where it fails. Possible causes of fatigue breakage are overload, poor tooth contact, defective material, or notches in the tooth surface.

Short of actual tooth breakage, it is often difficult to determine the optimal time to replace degenerating gearing. Surface defects can be monitored by taking periodic photographs or impressions and noting the rate of change. This is particularly important in differentiating between initial pitting which will stabilize and destructive pitting which is progressive and will probably result in the eventual failure of the gear.

Fatigue cracks are almost always fatal to a gear, the only unknown being how quickly failure will occur. Once a fatigue crack has been discovered, replacement of the gear should be made without delay.

SHAFTS

If the shafts have been subjected to loading far beyond the rating of the gear unit, they may have developed fatigue cracks. They should then be checked using either the Magnaflux or dye-penetrant method.

SEALS

When a seal which has been in operation in a gear unit is removed from its shaft, it is good practice not to reuse it but to replace it regardless of its apparent condition.

For an effective seal, the seal lip must make contact with a smooth, cylindrical surface. Examine the input and output shafts in the seal area for scratching or grooving of the surface. If the imperfections found are minor, they can be polished out with a fine grade of Emery (No. 240). Polishing must be circumferential in direction to avoid spiral marks that could cause leakage. If the imperfections cannot be polished out, consider using a seal sleeve (National Seal or Chicago Rawhide). The other alternative is to metalize the shaft and regrind to a surface finish of 10 to 20 RMS.

REASSEMBLY

SHAFT REASSEMBLY, GEARING

1. If gears are to be mounted or remounted, inspect shaft shoulders and gear hubs for nicks that would prevent proper seating of the gears; remove any nicks found.

2. Heat each gear to about 300° F (150° C) to enlarge the bore.

3. Place the gear on the shaft and quickly position it firmly against the shoulder before it can shrink.

   NOTE: Gears that were previously in service must be remounted with the same orientation of the contact side of the teeth as before.

4. After the assembly has cooled, check with a .0015" (.04 mm) feeler gage to determine that the gear has remained fully seated against the shoulder.

SHAFT REASSEMBLY BEARINGS

1. If bearings are to be mounted or remounted, inspect shaft shoulders or spacers for nicks that would prevent proper seating of the inner races; remove any nicks found.

2. Heat each bearing to about 250° F (120° C) to facilitate mounting. Heating can be done with a heat lamp or in an oil bath or oven. Heat uniformly; do not place the bearing in contact with an area of localized heat.

   CAUTION: Do not exceed 250° F to avoid drawing back the bearing hardness.

3. Place the bearing on the shaft and quickly position it firmly and squarely against the shoulder before it can shrink.

4. After the assembly has cooled, check with a .0015" (.04 mm) feeler gage to determine that the bearing has remained fully seated against the shoulder.

SHAFT INSTALLATION

1. Using a soft sling, gently lower each shaft assembly into the housing starting with the low-speed shaft and progressing toward the high-speed shaft. (In triple-reduction units having a drop-center intermediate shaft, the intermediate shaft must be installed first.) Care must be taken when lowering each shaft assembly to guide the gear teeth into mesh to avoid nicking the working surfaces.

2. A shaft carrying single-row tapered roller bearings should be lowered to a position 1/4" (6 mm) above its final position and held there while the cups are being installed on the bearing cones. If the bearing cup is contained in a retainer-type bearing cover, the cup and cover assembly should be installed on the cone as a unit.

3. Immediately after installing a shaft assembly which includes single-row tapered roller bearings, it is advisable to bolt its bearing covers (with shim packs in place) loosely on the lower housing to ensure that the bearing cups will not be forced out.

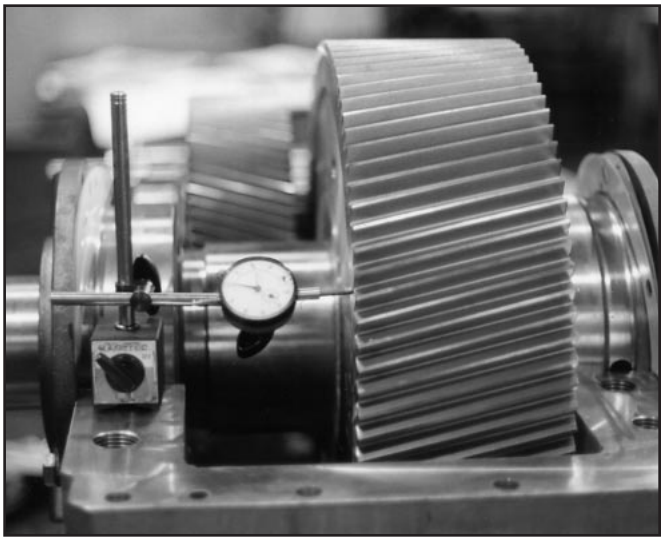
4. Coat bearings and gear-tooth surfaces with oil after installation of the shaft assemblies.

ADJUSTMENT OF SINGLE-ROW TAPERED ROLLER BEARINGS

It is necessary to adjust this type of bearing before the upper housing is installed. These bearings require a specific endplay that is affected by the size of the gear unit and the shaft position. Endplay is adjusted as follows:

1. Firmly tighten the bearing-cover bolts below the housing split.

2. Mount a dial indicator on the housing with the spindle in contact with the gear face or the end of the shaft.



3. Rotate the shaft through several revolutions to seat the rollers and then pry the shaft axially, first in one direction and then in the other. The force exerted should be sufficient to move the shaft easily to the limit of its travel - 100 pounds for a light component to 1000 pounds for a heavy one. The total indicator reading is the axial endplay.

4. Add or remove shims until the endplay corresponds to the appropriate value in the table below. After the shimming has been completed, the prying operation should be repeated several times; a constant endplay value should be obtained and it should be within the range given in the table.

ENDPLAY FOR SINGLE-ROW TAPERED ROLLER BEARINGS

(IN THOUSANDTHS OF AN INCH)

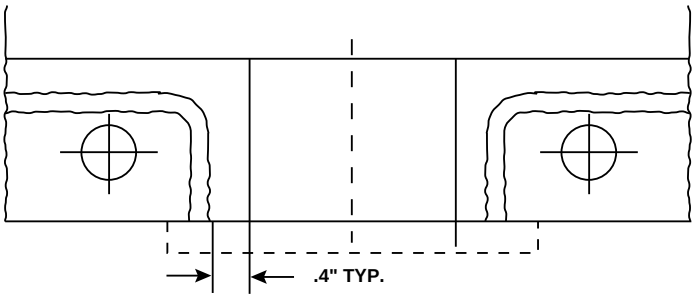
REDUCER SIZE	H.S. SHAFT	INT. SHAFT	L.S. PINION SHAFT	L.S. SHAFT
0701	.003-.005			.002-.004
0702	.003-.005	.002-.004		.002-.004
0703	.003-.005	.002.004	.002-.004	.002-.004
0801	.004-.006			.002-.004
0802	.004-.006	.003-.005		.002-.004
0803	.004-.006	.003-.005	.002-.004	.002-.004
0901	.004-.006			.003-.005
0902	.004-.006	.003-.050		.002-.004
0903	.004-.006	.003-.005	.002-.004	.002-.004
1001	.005-.007			.003-.005
1002	.005-.007	.003-.005		.002-.004
1003	.005-.007	.003-.005	.002-.004	.002-.004
1101/1201	.006-.008			.004-.006
1102/1202	.006-.008	.004-.006		.002-.004
1103/1203	.006-.008	.004-.006	.002-.004	.002-.004
1301/1401	.007-.009			.005-.007
1302/1402	.007-.009	.005-.007		.002-.004
1303/1403	.007-.009	.005-.007	.003-.005	.002-.004
1501/1601	.008-.010			.005-.007
1502/1602	.008-.010	.005-.007		.003-.005
1503/1603	.008-.010	.005-.007	.003-.005	.002-.004
1701/1801	.009.-.011			.006-.008
1702/1802	.009-.011	.006-.008		.003-.005
1703/1803	.009-.011	.006-.008	.004-.006	.002-.004
1901/2001	.010-.012			.007-.009
1902/2002	.010-.012	.007-.009		.003-.005
1903/2003	.010-.012	.007-.009	.004-.006	.002-.004
2102/2252	.011-.013	-	*	.004-.006
2103/2253	.011-.013	*	*	.003-.005
2402/2502	.012-.014	-	*	.004-.006
2403/2503	.012-.014	*	*	.003-.005

* Double-row tapered roller bearings are used in these positions.

After all of the single-row tapered roller bearings have been adjusted, the bearing cover bolts should be backed out and the bearing covers moved away from the housing to provide clearance for the upper housing when it is installed.

UPPER HOUSING AND BEARING COVER REPLACEMENT

1. Apply a 1/4" (6 mm) wide bead of General Electric RTV-102 to the split surface of the lower housing. The bead must go completely around the housing inside the bolt holes with lateral beads at each bearing cover. The illustration below shows a typical section of the housing with the bead in place.



2. Carefully lower the upper housing into place, guiding it to keep it from striking other components. Work quickly to complete this operation before the sealant begins to set.

3. Insert the two dowel pins into their holes to reestablish the proper relationship between the two housing members. Install the bolts and tighten them in a progressive pattern in several stages to avoid distorting the housing. Torque values are given in the table on page 2.

4. Apply a circular bead of sealant such as General Electric RTV-102 to the surfaces of the bearing cover flanges at the bolt circle. Circle each bolt hole with sealant. Mount the covers, torquing the bolts to the values in the table on page 3.

ADJUSTMENT OF BEARINGS OTHER THAN SINGLE-ROW TAPERED ROLLER BEARINGS

DOUBLE-ROW TAPERED ROLLER BEARINGS and DOUBLE-ROW SPHERICAL ROLLER BEARINGS require no endplay adjustment. They are frequently used when single-row tapered roller bearings are unsuitable for an application. The bearing at one end of the shaft must be fixed in the housing while the bearing at the other end must be allowed to float.

Shim packs at the fixed end must be adjusted to just fill the gap between the bearing-cover flange and the housing when the rabbet is lightly contacting the outer race of the bearing. Shim packs at the floating end must be adjusted to provide a gap of at least .015" (0.4 mm) between the rabbet and the outer race of the bearing.

ADJUSTMENT OF BEARINGS OTHER THAN SINGLE-ROW TAPERED ROLLER BEARINGS

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS or SINGLE-ROW SPHERICAL ROLLER BEARINGS are sometimes used at the floating end of shaft. They require no adjustment but their bearing covers must be shimmed to provide a gap of at least .015" (0.4 mm) between the rabbet and the outer race of the bearing.

OIL SEALS

After the bearing covers have been mounted on the gear unit, the oil seals may be installed. Follow the procedure on page 4.

RESTARTING THE GEAR UNIT

If it was removed from its base, the gear unit should now be reinstalled in accordance with the installation instructions on page 1. Before restarting the gear unit, it is advisable to perform the pre-startup checks on page 2. Initial startup should be done in accordance with the instructions on page 2.

RECOMMENDED LUBRICANTS

MANUFACTURER	3 (ISO 100)	3EP (ISO 100)	4 (ISO 150)	4EP (ISO 150)	5 (ISO 220)	5EP (ISO 220)	6 (ISO 320)	6EP (ISO 320)
Amoco Oil Co.	American Ind. Oil 100 (-15)	Permagear EP 100 (0)	American Ind. Oil 150 (-10)	Permagear EP150 (0)	American Ind. Oil 220 (-15)	Permagear EP220 (0)	American Ind. Oil 320 (-15)	Permagear EP 320 (+10)
Ashland Oil	Valvoline R&O 100 (-5)	Valvoline AGMA 3EP (-12)	Valvoline R&O 150 (-5)	Valvoline AGMA 4EP (-12)	Valvoline R&O 220 (0)	Valvoline AGMA 5EP (-9)	Valvoline R&O 320 (+5)	Valvoline AGMA 6EP (-9)
Bp Oil		Energear EP100 (+10)		Energear EP150 (+10)		Energear EP220 (+16)		Energear EP320 (+16)
Castrol Performance Lubes	Tribol 1100/100 (-8)	Tribol 1100/100 (-8)	Tribol 1100/150 (-8)	Tribol 1100/150 (-8)	Tribol 1100/220 (-8)	Tribol 1100/220 (0)	Tribol 1100/320 (0)	Tribol 1100/320 (0)
Chevron USA, Inc.	AW Machine Oil 100 (+5)		AW Machine Oil 150 (+10)	Ultra Gear 150 (-17)	AW Machine Oil 220 (+10)	Ultra Gear 220 (0)	AW Machine Oil 320 (+5)	Ultra Gear 320 (0)
Citgo Petroleum	Pacemaker 100 (+10)	Citgear EP100 (0)	Pacemaker 150 (+10)	Citgear EP150 (0)	Pacemaker 220 (+10)	Citgear EP220 (0)	Pacemaker 320 (+10)	Citgear EP320 (0)
Conoco Inc.	Dectol R&O 100	Gear 100	Dectol R&O 150	Gear 150	Dectol R&O 220	Gear 220	Dectol R&O 320	Gear 320
Exxon Co. USA	Teresstic 100 (0)	Spartan EP100 (0)	Teresstic 150 (0)	Spartan EP150 (0	Teresstic 220 (0)	Spartan EP220 (0)	Teresstic 320 (+16)	Spartan EP320 (+16)
Keystone Div. Penwalt Corp.	KLC-30 (+5)		KLC-40 (+5)	Keygear 90 (+5)	KLC-50 (+5)			Keygear 110 (+10)
Lubrication Engineers	Monolec Turbine 6404 (-10)	Almasol Gear 606 (-15)	Monolec Turbine 6405 (-10)	Almasol Turbine 604 (-10)	Monolec Turbine 6406 (-10)	Almasol Turbine 607 (-10)	Monolec Turbine 6407 (0)	Almasol Tutbine 605 (0)
Lubriplate	SPO-233 (-35)	APG-80W-90 (-35)	SPO-244 (-25)	APG-90 (-20)	SPO-255 (-10)		SPO-266 (+10)	APG-80W-140 (-25)
Lyondell Oil	Duro 100 (+10)		Duro 150 (+15)	Pennant NL 150 (-10)	Duro 220 (+15)	Pennant NL 220 (0)	Duro 320 (+15)	Pennant NL320 (+10)
Mobil Oil Corp.	DTE 18-M (-20)	Mobilgear 627 (-10)	DTE Oil Extra Heavy (+25)	Mobilgear 629 (-10)	DTE Oil BB (+25)	Mobilgear 630 (0)	DTE Oil AA (+25)	Mobilgear 632 (0)
Pennzoil Co.	Pennzbell R&O 100 (-10)	Super Maxol EP100 (-5)	Pennzbell R&O 150 (+10)	Super Maxol EP150 (+10)	Pennzbell R&O 220 (+15)	Super Maxol EP220 (+15)	Pennzbell R&O 320 (+15)	Super Maxol EP320 (+10)
Phillips Petroleum Co.	Magnus 100 (-15)		Magnus 150 (-15)	Philgear 150 (+5)	Magnus 220 (-12)	Philgear 220 (+10)	Magnus 320 (-15)	Philgear 320 (+10)
Shell Oil Co.	Morlina 100 (0)	Omala 100 (-10)	Morlina 150 (0)	Omala 150 (0)	Morlina 220 (+10)	Omala 220 (+10)	Morlina 320	Omala 320
Sun Oil Co.	Sunvis 9100 (+10)	Sunep 100	Sunvis 9150 (+10)	Sunep 150 (+10)	Sunvis 9220 (+10)	Sunep 220 (+10)	Sunvis 9320	Sunep 320
Texaco Lubricants	Regal R&O 100 (+15)	Meropa 100 (-25)	Regal R&O 150 (+15)	Meropa 150 (-25)	Regal R&O 220 (+15)	Meropa 220 (-10)	Regal R&O 320 (+20)	Meropa 320 (-15)
Unocal		Extra Duty NL 3EP (+5)		Extra Duty NL 4EP (0)		Extra Duty NL 5EP (+10)		Extra Duty NL 6EP (+5)

Numbers in parenthesis are pour point of the lubricant in degrees fahrenheit.

LUBRICATION

Lubricant Numbers for Parallel Shaft Reducers

SIZE AND TYPE OF UNIT	AGMA LUBRICANT NUMBER			
	AMBIENT TEMP. IN DEGREES FAHR			
	15° to 60° F (-9.4° to 15.6° C)		50° to 125° F (10° to 51.7° C)	
	Type of Service			
	Normal	Heavy Duty	Normal	Heavy Duty
Parallel Shaft Reducers				
0701, 0801, 0702, 0802, 0703, 0803, HLD/HLE	3	3EP	4	4EP
0901, 1001, 0902, 1002, 0903, 1003, HLD/HLE	3	3EP	5	5EP
1001 through 2001 HLD/HLE 1102 through 4002 HLD/HLE 1103 through 2003 HLD/HLE	3	3EP	5	5EP
2103 through 4003 HLD/HLE	4	4EP	6	6EP

EP lubricants are recommended for all but the lightest applications.

VISCOSITY RANGES FOR AGMA LUBRICANTS

Rust and oxidation inhibited gear oils	Viscosity range	Equivalent ISO grade	Extreme pressure gear lubricants	Synthetic gear oils
AGMA Lubricant No.	mm 2/s (cSt) at 40° C		AGMA Lubricant No.	AGMA Lubricant No.
3	90 to 110	100	3EP	3S
4	135 to 165	150	4EP	4S
5	198 to 242	220	5EP	5S
6	288 to 352	320	6EP	6S

BACKSTOP LUBRICATION

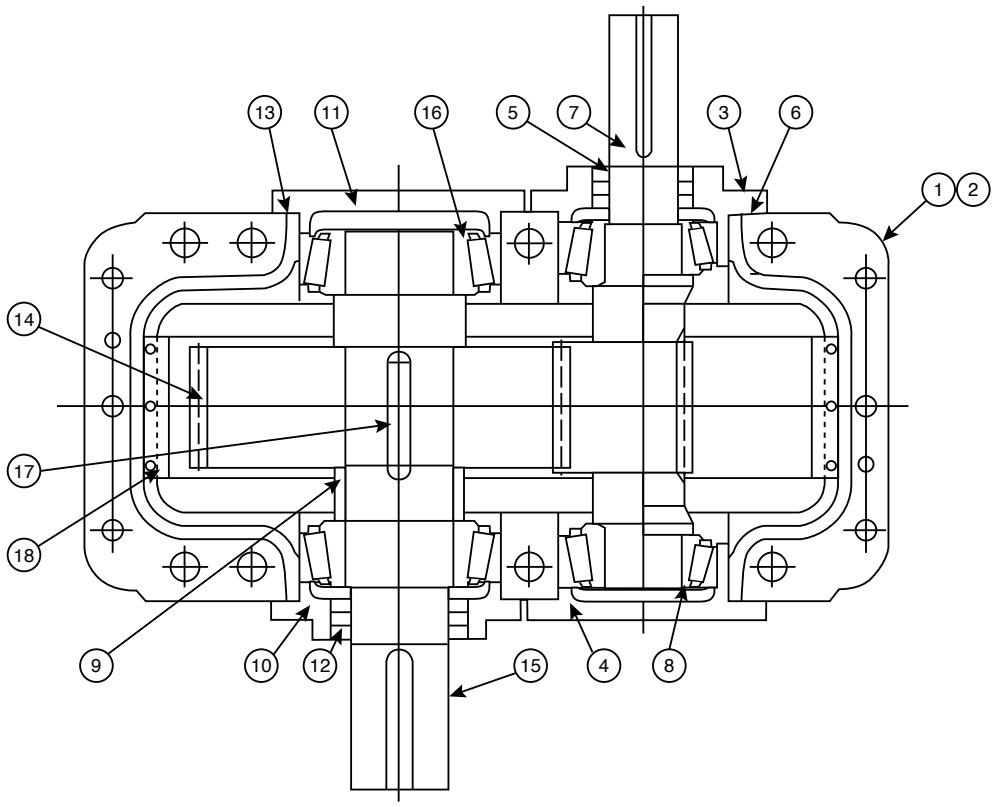
Temperature Range	+20° F to +150° F (Maximum permissible ambient temp.)	-10° F to +20° F	-40° F to +150° F
Recommended Lubricant	Mobil DTE Heavy Medium Any Automatic Transmission Fluid (high grade only) Texaco Regal R & O #68 Shell Turbo Oil #68 Gulf Harmony #68 Amoco Industrial Oil #68 Exxon Terresco Oil #68 Sunoco Sunvis 931	Mobile Gargoyle Arctic “C” Heavy Texaco Regal R & O #46 Any Automatic Transmission Fluid (high grade only) Sunoco Sunvis 921 Chevron GST Oil 931	Mobil Jet Oil #2 Shell Turbine Oil #500 Exxon Turbo Oil #2389 Standard Esso Turbo Oil #2389 Military Oils MIL-L-7808 or MIL-L-23699

CAUTION: Do not use lubricants of the E.P. type (extreme pressure characteristics), or those containing slippery additives in backstops.

HLD & HLE OIL CAPACITIES

Appropriate Oil Capacities			
HLD/HLE		VHLD/VHLE	
SIZE	CAPACITY, Gals. (Liters)	SIZE	CAPACITY, Gals. (Liters)
0701	2 (8)		
0801	2 1/2 (10)		
0901	3 1/4 (12)		
1001	3 3/4 (14)		
1101, 1201	6 (23)		
1301, 1401	8 1/2 (32)		
1501, 1601	12 1/2 (47)		
1701, 1801	20 (76)		
1901, 2001	29 (109)		
0702	3 (11)		
0802	5 (19)		
0902	7 (27)		
1002	9 (34)		
1102, 1202	15 (57)	1202	23 (87)
1302, 1402	23 (87)	1402	35 (132)
1502, 1602	34 (129)	1602	59 (189)
1702, 1802	50 (189)	1802	60 (227)
1902, 2002	60 (227)	2002	75 (284)
2252	95 (360)		
2502	130 (490)		
0703	3 (11)		
0803	5 (19)		
0903	7 (27)		
1003	9 (34)		
1103, 1203	13 (49)	1203	20 (76)
1303, 1403	20 (76)	1403	30 (114)
1503, 1603	30 (114)	1603	45 (170)
1703, 1803	35 (132)	1803	53 (200)
1903, 2003	55 (208)	2003	83 (314)
2253	110 (415)		
2503	170 (645)		

HLD - HLE SINGLE REDUCTION SERVICE PARTS LIST



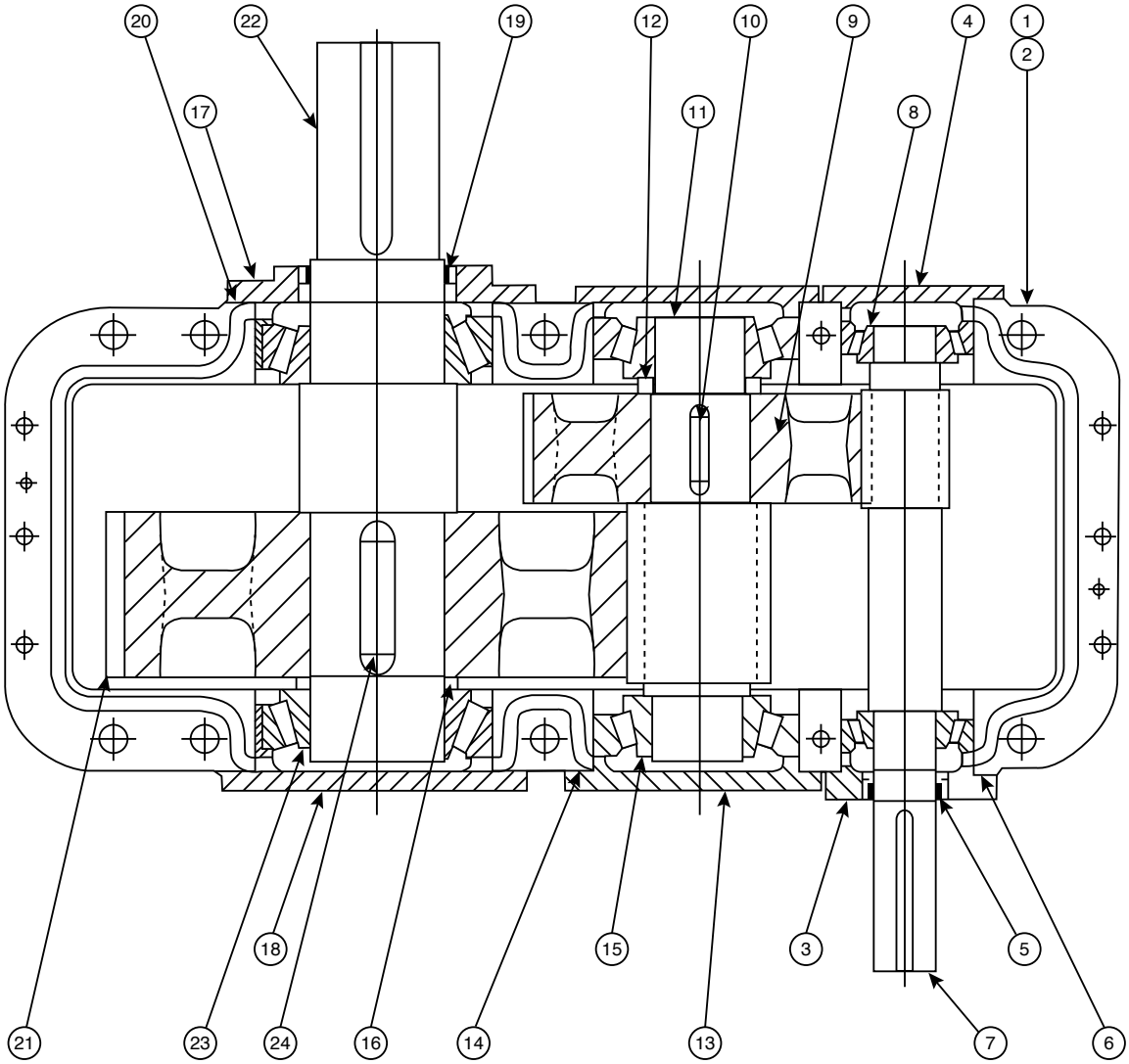
1. HOUSING, UPPER PORTION
2. HOUSING, LOWER PORTION
3. COVER, HIGH SPEED OPEN BEARING
4. COVER, HIGH SPEED CLOSED BEARING
5. OIL SEAL, HIGH SPEED*
6. SHIM, HIGH SPEED BEARING COVERS*
7. PINION AND SHAFT, HIGH SPEED**
8. BEARING, HIGH SPEED PINION AND SHAFT*
9. SPACER, OUTPUT SHAFT
10. COVER, LOW SPEED OPEN BEARING
11. COVER, LOW SPEED CLOSED BEARING
12. OIL SEAL, LOW SPEED*
13. SHIM, LOW SPEED BEARING COVERS*
14. GEAR, LOW SPEED**
15. SHAFT, OUTPUT
16. BEARING, OUTPUT SHAFT**
17. KEY OUTPUT SHAFT
18. OIL PAN

*MINIMUM PROTECTION **MAXIMUM PROTECTION

When ordering parts please provide the following information:

1. Reducer model
2. Ratio
3. Serial number

HLD - HLE DOUBLE REDUCTION SERVICE PARTS LIST



1. HOUSING, UPPER PORTION
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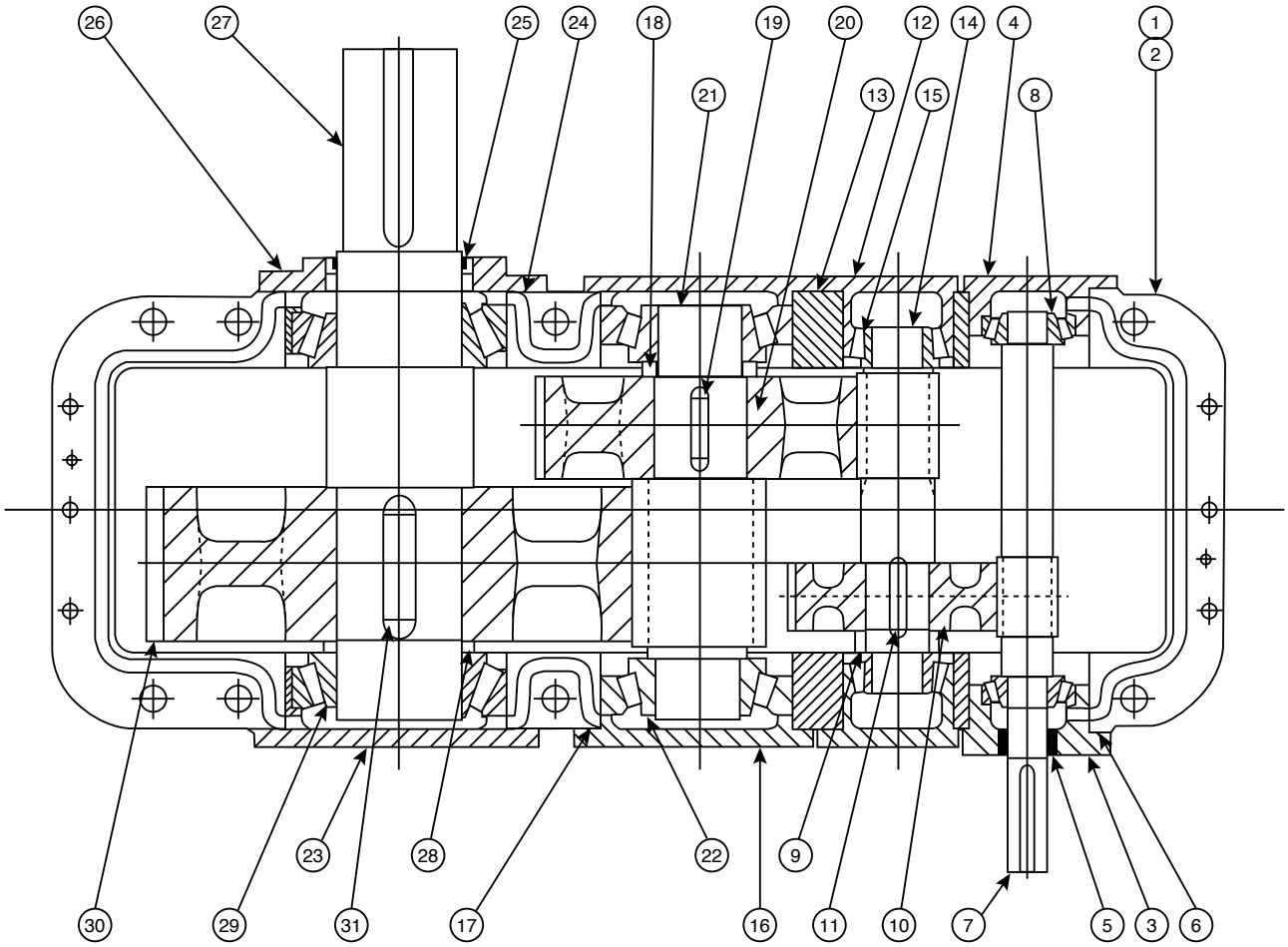
3. COVER, HIGH SPEED OPEN BEARING
4. COVER, HIGH SPEED CLOSED BEARING
5. OIL SEAL, HIGH SPEED*
6. SHIM, HIGH SPEED BEARING COVERS*
7. PINION AND SHAFT, HIGH SPEED**
8. BEARING, HIGH SPEED PINION AND SHAFT*
9. GEAR, HIGH SPEED*
10. KEY, LOW SPEED PINION AND SHAFT
11. PINION AND SHAFT, LOW SPEED**
12. SPACER, LOW SPEED PINION AND SHAFT
13. COVER, LOW SPEED PINION AND SHAFT BEARING
14. SHIM, LOW SPEED PINION BEARING COVERS*
15. BEARING, LOW SPEED PINION AND SHAFT*
16. SPACER, OUTPUT SHAFT
17. COVER, LOW SPEED OPEN BEARING
18. COVER, LOW SPEED CLOSED BEARING
19. OIL SEAL, LOW SPEED*
20. SHIM, LOW SPEED BEARING COVERS*
21. GEAR, LOW SPEED**
22. SHAFT, OUTPUT
23. BEARING, OUTPUT SHAFT**
24. KEY, OUTPUT SHAFT

*MINIMUM PROTECTION **MAXIMUM PROTECTION

TYPICAL ON ALL PARTS LISTS.

NOTE: HIGH SPEED BEARINGS ON SIZE 2102 THROUGH 4152 ARE TAPERED ROLLER DESIGN. LOW SPEED PINION BEARINGS MAY BE MOUNTED IN BEARING RETAINERS. REFER TO FACTORY WITH REDUCER SERIAL NUMBER FOR INFORMATION ON BEARINGS AND BEARING RETAINERS.

HLD - HLE TRIPLE REDUCTION SERVICE PARTS LIST



1. HOUSING, UPPER PORTION
2. HOUSING, LOWER PORTION
3. COVER, HIGH SPEED OPEN BEARING
4. COVER, HIGH SPEED CLOSED BEARING
5. OIL SEAL, HIGH SPEED*
6. SHIM, HIGH SPEED BEARING COVERS*
7. PINION AND SHAFT, HIGH SPEED*
8. BEARING, HIGH SPEED PINION AND SHAFT*
9. SPACER, FIRST INTERMEDIATE PINION AND SHAFT
10. GEAR, HIGH SPEED*
11. KEY, FIRST INTERMEDIATE PINION AND SHAFT BEARING
12. COVER, FIRST INTERMEDIATE PINION AND SHAFT BEARING
13. SHIM, FIRST INTERMEDIATE SHAFT BEARING COVERS*
14. PINION AND SHAFT, FIRST INTERMEDIATE**
15. BEARING, FIRST INTERMEDIATE PINION AND SHAFT*
16. COVER, LOW SPEED PINION AND SHAFT BEARING
18. SPACER, LOW SPEED PINION AND SHAFT
19. KEY, LOW SPEED PINION AND SHAFT
20. GEAR, INTERMEDIATE**
21. PINION AND SHAFT, LOW SPEED**
22. BEARING, LOW SPEED PINION AND SHAFT*
23. COVER, LOW SPEED CLOSED BEARING
24. SHIM, LOW SPEED BEARING COVERS*
25. OIL SEAL, LOW SPEED*
26. COVER, LOW SPEED OPEN BEARING
27. SHAFT, OUTPUT
28. SPACER, OUTPUT SHAFT
29. BEARING, OUTPUT SHAFT*
30. GEAR, LOW SPEED**
31. KEY, OUTPUT SHAFT

*MINIMUM PROTECTION **MAXIMUM PROTECTION

TYPICAL ON ALL PARTS LISTS.

NOTE: HIGH SPEED BEARINGS ON SIZE 2103 THROUGH 4153 ARE TAPERED ROLLER DESIGN. FIRST INTERMEDIATE AND LOW SPEED PINION BEARINGS MAY BE MOUNTED IN BEARING RETAINERS. REFER TO FACTORY WITH REDUCER SERIAL NUMBER FOR INFORMATION ON BEARINGS AND BEARING RETAINERS.

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