MM6105-B
DECEMBER 1996
INSTALLATION
LUBRICATION
OPERATION
MAINTENANCE INSTRUCTIONS
PRICE $2.00

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

SPIRAL BEVEL 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.

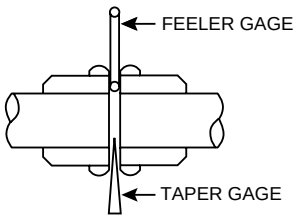
CARE should be taken in installation to insure that all components are properly shimmed or grouted in place. Failure to shim properly may result in deflection and misalignment when base mounting bolts are tightened.

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.

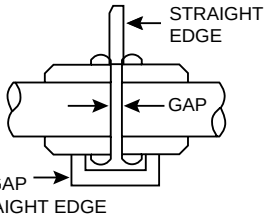
Base mounting bolts should be rechecked for alignment and coupling gap after installation, leveling, and permanent mounting of the bedplate. Then proceed as above.

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



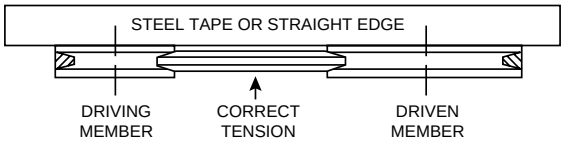
Parallel Alignment

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.

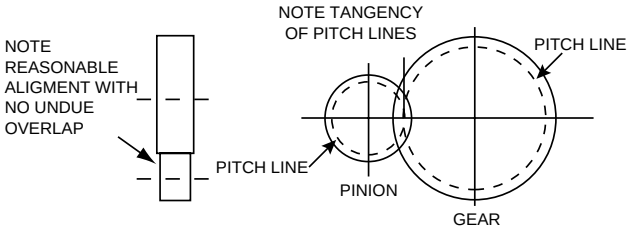
SPROCKETS, SHEAVES AND EXTERNAL GEARING

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 the 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 nameplate 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-in 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.

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, lay a strip of scotch tape along the exposed edge.

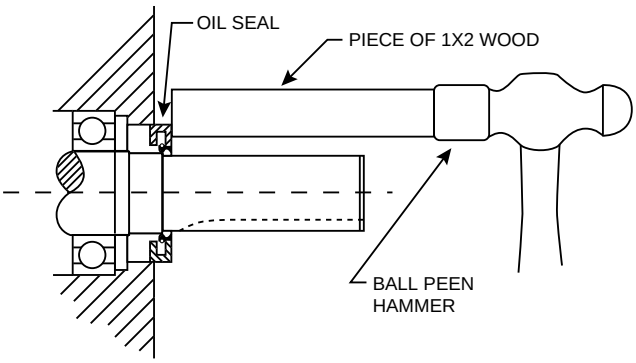


Fig. 7

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 base grease NLGI consistency No. 2.

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)

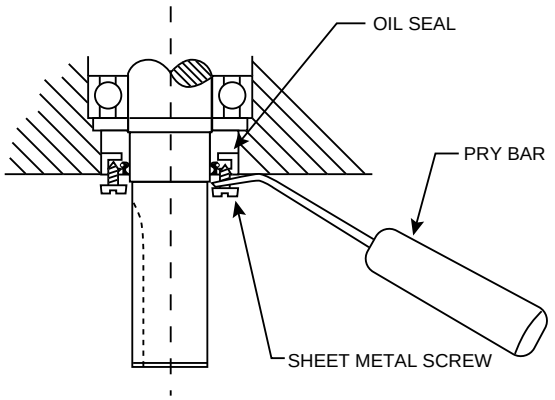


Fig. 8

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.

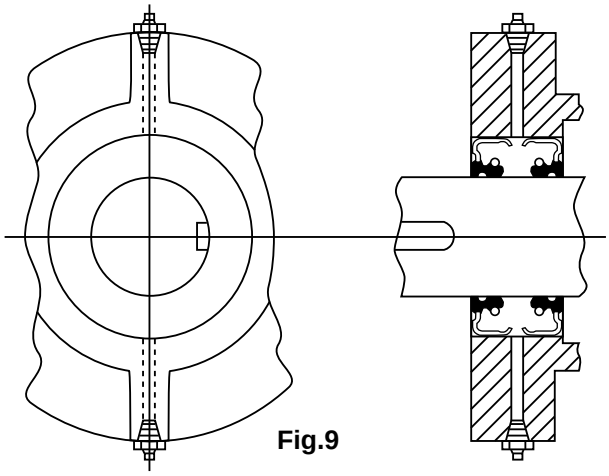


Fig.9

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

RECOMMENDED LUBRICANTS

MANUFACTURE	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 Turbine 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 parenthesis are pour points of the lubricant in degrees fahrenheit.

LUBRICATION

Lubricant Numbers for Spiral Bevel Helical 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				
0702, 0802, 0703, 0803 BHC, VBHC, BHE, VBHE	3	3EP	4	4EP
0902, 1002, 0903, 1003 BHC, VBHC, BHE, VBHE	3	3EP	5	5EP
*1102 through 4002 BHC, VBHC, BHE, VBHE 1103 through 2003 BHC, VBHC, BHE, VBHE	3	3EP	5	5EP
*2103 through 4003 BHC, VBHC, BHE, VBHE	4	4EP	6	6EP
*EP oils cannot be used in units containing internal backstops - Sizes 2102 to 3202, 2103 to 3203 BHC, VBHC, BHE, VBHE				

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.

OIL CAPACITIES

Appropriate Oil Capacities			
BHC, BHE		**VBHC, VBHE**	
SIZE	**CAPACITY, Gals. (Liters)**	**SIZE**	**CAPACITY, Gals. (Liters)**
7SBH	1-1/2 (6)		
9SHB	2 1/2 (10)		
10SBH	4-1/2 (17)		
12SBH	7-1/2 (29)		
16SBH	15 (57)		
20SBH	26 (98)		
22SBH	45 (170)		
24SBH	45 (170)		
27SBH	70 (264)		
30SBH	70 (264)		
0702	3 (12)		
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 (128)	1602	50 (189)
1702, 1802	50 (189)	1802	60 (226)
1902, 2002	60 (226)	2002	75 (283)
0703	3 (12)		
0803	5 (19)		
0903	7 (27)		
1003	9 (34)		
1103, 1203	13 (49)	1203	20 (75)
1303, 1403	20 (75)	1403	30 (113)
1503, 1603	30 (113)	1603	45 (170)
1703, 1803	35 (132)	1803	53 (200)
1903, 2003	55 (207	2003	83 (313)

The above capacities are for 1750 RPM. For lower input speeds refer to the factory.

DISASSEMBLY

NOTE: Do not disassemble reducers without first disconnecting driving and driven equipment.

A) HORIZONTAL (BHC & BHE) UNITS:

1. Drain oil from reducer and remove breather and inspection cover taking care not to damage the gasket under the cover.

2. Remove bolts holding upper and lower housing together and the two dowel pins located at each end of the housing.

3. Remove bearing cover bolts holding the covers to the upper housing. Back the bearing cover bolts in the lower housing out 3/16" (4.76 mm) and move covers away from the housing taking care not to damage shims. Shims may stick to housing. If so, loosen with sharp flat tool such as a knife or putty knife. Tie each shim pack to its respective cover to prevent damage.

4. Lift off upper housing.

(Upper Housing Removed)

NOTE:
Input shaft bearings on all double and triple reduction units are mounted in bearing retainers. (See Fig. 1) With the exception of Style IV Reducers, output shaft bearing cups on Size 1402 through 2002 and 1403 through 2003 units are mounted in the bearing covers. Style IV units have their output shafts mounted directly in the housing bores.

All sizes 2102 through 3202, and 2103 through 3203, have their output shaft bearings mounted in bearing retainers.

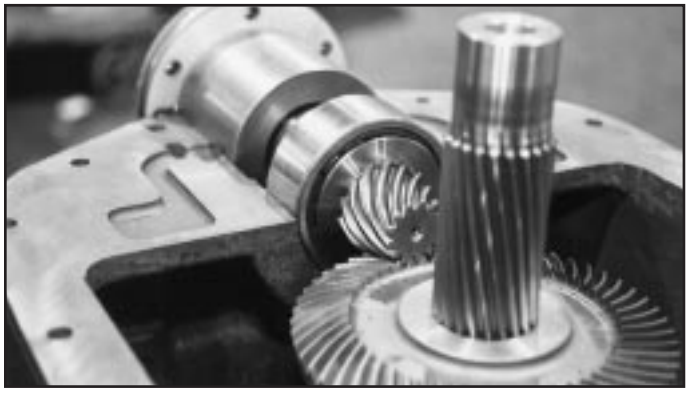


Fig. 11

5. Remove remaining bearing cover bolts and lift out all bearing cups. The weight of each shaft must be supported with a sling to prevent damage to bearing cone assemblies. (Should shaft weight be allowed to push aside bearing cups, cone assemblies will drop into housing bores.) Lift out each shaft assembly starting with the input shaft and set aside making sure that bearing cone assemblies are not resting on the ground or carrying the weight of their shafts. Take care to keep each shim pack intact and with its respective bearing cover.

6. For all bearings, cone assemblies are press fit on shafts and cups are push fit in housings, bearing covers, or bearing retainers. Should it become necessary to remove a bearing cone assembly, a conventional bearing or gear puller can be used. Grip cone shoulder with puller fingers making certain that puller arms clear the bearing assembly. A small press may also be used to remove bearings by supporting the shaft assembly on the cone shoulder. Keep bearings off of floors and away from dirt.

NOTE:
The input shaft assembly on sizes 0702 through 2003 consists of one straight roller bearing and two tapered roller bearings mounted in a bearing retainer and secured by means of a locknut and lockwasher. On sizes 2102-2103 through 3202-3203 the input shaft assembly consists of two double row tapered roller bearings.

7. Should it become necessary to examine the tapered roller bearings, remove locknut and lockwasher and press input shaft from bearing retainer. Do not support the bearing retainer on its flange while pressing the input shaft. Support across the surface nearest the straight roller bearing. Once the shaft has been removed the bearings can be drawn from the retainer. In an effort to prevent damage to bearings never support any weight on cage or rollers. (i.e. cone assembly)

8. All gears are press fit on their respective shafts. A press is desirable for their removal.

9. All oil seals are press fit into their respective bearing covers. Oil seals should be driven from bearing covers using a piece of wood so as to avoid damaging the seal bore surface in the cover.

B) VERTICAL (VBHC & VBHE) UNITS:

1. Drain oil from reducer and remove breather and inspection cover taking care not to damage the gasket under the cover.

2. Remove pump adaptor bearing cover from upper housing and lift out pump and pump spring.

NOTE:
Pump cap need not be removed from bearing cover.

3. Remove bolts holding upper and lower housing together and the two dowel pins located at each end of the housing.

4. Remove the bolts holding the input shaft bearing cover to the upper housing. Back the remaining input bearing cover bolts out 3/16" (4.76 mm) and move cover and retainer away from housing taking care not to damage shims.

5. Lift off upper housing.

NOTE:
Input shaft bearings on all double and triple reduction units are mounted in bearing retainers. With the exception of style IV reducers, output shaft bearing cups on size 1402 through 2002 and 1403 through 2003 units are mounted in the bearing covers. (All 2102-2103 through 3202-3203 and all units designated style IV have their output shaft bearings mounted directly in the housing bores.)

6. On units where the output shaft extends downward a dry well and umbrella are employed. The dry well is fastened to the inside of the lower housing at the output shaft bore while the umbrella is assembled on the output shaft.

7. After removing the input shaft bearing cover, lift out each shaft assembly starting with the input shaft on double reduction units and the first intermediate shaft on triple reduction units. Set each shaft assembly aside making sure that bearing cone assemblies are not resting on the ground or supporting the weight of the shaft.

8. Remove bearing covers from upper and lower housing taking care to keep shim packs intact. Should shims stick to housing, loosen with sharp instrument. Tie each shim pack to its respective cover to prevent damage.

9. Follow steps 6 through 9 in horizontal (BHC & BHE) disassembly.

CLEANING:
All parts, including housing, should be thoroughly washed with kerosene or a mineral solvent. All accumulations of sludge and corrosion deposits should be removed. Do not use a wire brush on bearing or gear tooth surfaces. Avoid scratching these areas. All old sealant should be scraped from mating flange surfaces of housing and bearing covers.

REASSEMBLY
HORIZONTAL (BHC & BHE) AND VERTICAL (VBHC & VBHE) UNITS:
1. Reassembly is basically the reverse of the disassembly procedure.

2. Install new oil seals in the open end input shaft and output shaft bearing covers. (See special instructions under oil seals.)

3. Bearing cones may be heated to facilitate assembly onto shafts. Heating can be done with an infra-red lamp, a heated oil bath, or an oven. If an oil bath or oven is used take care to support the bearing away from the bottom and sides of the container so as to avoid direct contact between bearing and areas of localized heat (heating element or flame).

CAUTION: Heating beyond 250°F (121.1°C) may tend to draw back the bearing hardness. Do not exceed this temperature. If heating facilities are not available it will be necessary to use a press. Before pressing check shaft shoulders for burrs or dirt. Remove them is present; otherwise, bearing and gears will not seat squarely. In pushing bearing cone onto shaft make sure that
no force is exerted on cage or rollers. Apply anti-seize compound to bearing seat prior to pressing. Press only on cone shoulder making certain that cone seats flush with shaft shoulder. In supporting shaft make sure that point of support is on the shaft and not on bearing cone assembly.
4. To reassemble the input shaft assembly first seat the inside bearing cup in the bearing retainer then pass the input shaft through the retainer. Press both bearing cone assemblies onto the input shaft and insert the outside bearing cup in the retainer. Put spacer in place and secure with locknut and lockwasher.

5. Shafts with bearings and gears installed along with bearing covers and shim packs should be placed back in the housing in the reverse order of disassembly. Coat bearings with film of oil prior to assembly into housing. A sealant such as General Electric RTV-102 or Permatex No. 2 should be applied to the housing split and to the bearing cover flange surfaces of the housing and the bearing cover flanges.

6. All bearing covers should be mounted with their original shim packs in position. In mounting the open covers with oil seals care must be taken not to damage the seals. Wrap .005” (.127 mm) plastic shim stock around shaft extensions over keyseats and/or shoulders to protect the seal lip. Slide seal along shaft extension gently to prevent dislocation of the spring behind the seal lip. Align housing halves with dowels and tighten housing bolts evenly to prevent warping of the housing. Bearing cover bolts should be tightened last.

NOTE:
Apply a silicone sealant such as Dow Corning RTV 732 or an equivalent to the bearing cover gaskets on VBHC & VBHE units. Failure to do so will result in oil leakage.

RECOMMENDED BOLT TIGHTENING TORQUES* (lb-ft)

BOLT SIZE	GRADE II	GRADES III & V	GRADE VIII, STUDS, & SOC. HD. SCREWS
1/4	6	9	13
5/16	11	18	28
3/8	19	31	46
7/16	30	50	75
1/2	45	75	115
9/16	66	110	165
5/8	93	150	225
3/4	150	250	370
7/8	200	380	590
1	300	585	895
1-1/8	475	780	1410
1-1/4	660	1100	1960
1-3/8	885	1460	2630
1-1/2	1060	1750	3150
1-5/8	1450	2390	4310
1-3/4	1880	3110	5610
1-7/8	2340	4190	7550
2	2720	4500	8100
2-1/4	3420	6500	11,700
2-1/2	4380	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

PATTERNING OF SPIRAL BEVEL GEAR SET:

To insure the proper functioning of spiral bevel gear sets correct tooth contact must be maintained. The desired tooth contact is shown in Fig. 12. To achieve this contact, the following procedure is recommended.

1. Adjust gear and pinion so that the surface designated “P” and “G” in Fig. 12 lie in the same plane.

2. Coat bevel pinion teeth with prussian blue or red lead.

3. Rotate pinion while applying a slight drag to bevel gear. This will cause coating in areas of contact to rub onto mating gear leaving a clearly defined contact pattern.

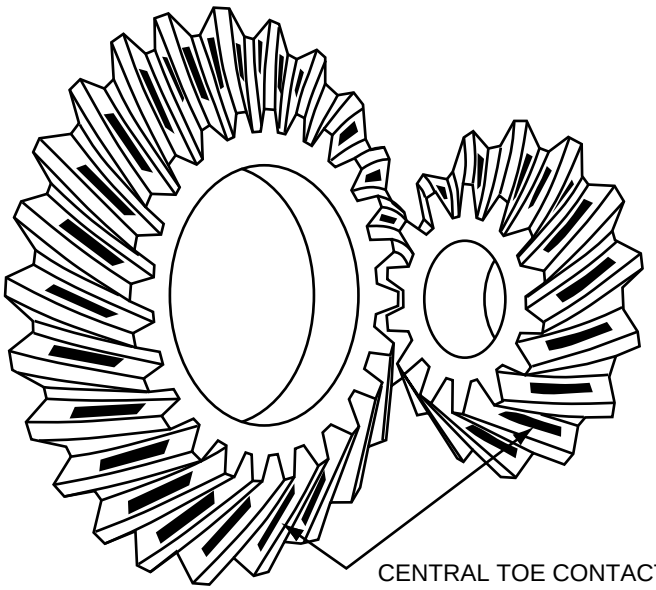
The optimum pattern is called a “central toe pattern.” In defining terminology toe is the thin while heel is the thick portion of the tooth. It is desirable to have the initial pattern begin slightly to the toe side of the midpoint of the tooth and extend over 50% to 60% of the face width (under moderate load).

Typical conditions that might be encountered in spiral bevel assemblies are shown in Figs. 12-14. The corrective action to be taken when these conditions are encountered is also indicated. In or out adjustment of the bevel pinion requires the addition or removal of shims between the input shaft bearing retainer and housing. When it is desired move the bevel gear in or out, shims from between the bearing cover and housing must be removed from one side of the reducer and added to the opposite side.

IMPORTANT: In addition to achieving the proper contact pattern on gear tooth surfaces, the correct backlash must be established. The backlash for each spiral bevel set is marked on both pinion and gear. To check backlash place pointer of dial indicator against tooth of bevel pinion. While holding bevel gear firmly in place, rotate pinion back and forth. Total deviation in indicator readings is the backlash (See Fig. 15). To increase backlash move bevel gear towards pinion, recheck pattern after setting backlash. Do not attempt to establish backlash by adjusting the bevel pinion as this will adversely affect the contact pattern. Inadequate backlash will result in abnormal wear of gear and pinion, thereby diminishing the life of the reducer.

Fig.15

TOOTH CONTACT PATTERN SPIRAL BEVEL GEARS – LH PINION PREFERRED CONTACT RESULTING FROM CORRECT MOUNTING POSITION



CENTRAL TOE CONTACT

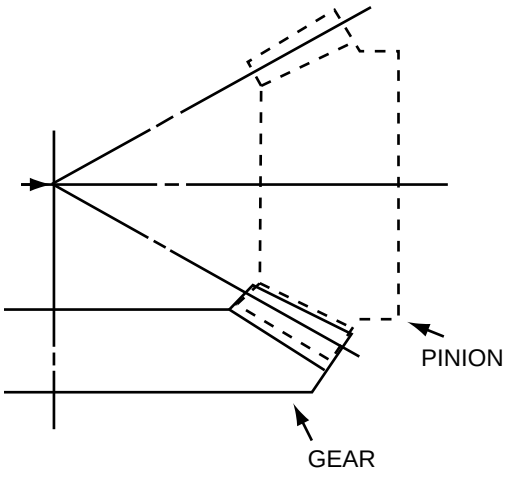


Fig. 12

TOOTH CONTACT PATTERN SPIRAL BEVEL GEARS – LH PINION HIGH OR LOW CONTACT RESULTING FROM PINION AXIAL POSITION ERROR

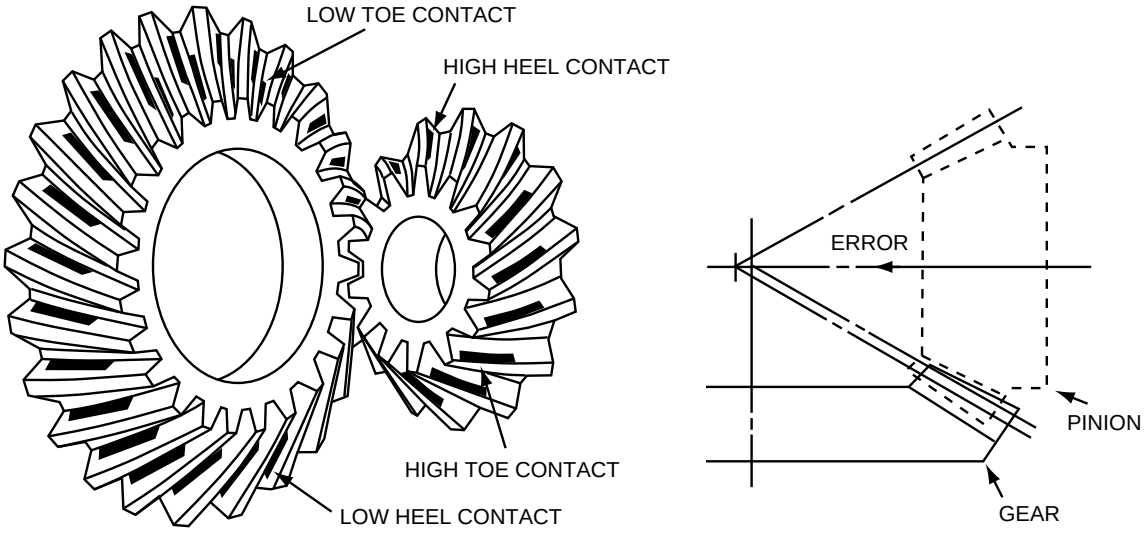


Fig. 13

If the contact pattern is high on the profile of the pinion and low on the profile of the gear, the pinion should be moved axially out of mesh.

Unlike straight bevel gears, the movement of the contact up and down the profile is accompanied by a movement along the length of the tooth caused by the lengthwise tooth curvature. Generally, the contact will be near the toe on the convex side of the gear tooth and near heel on its concave side. When viewing the pinion, the opposite contact patterns will exist. (See Figure 13).

It may be necessary to move the gear axially into mesh until the required backlash and tooth-contact patterns are obtained.

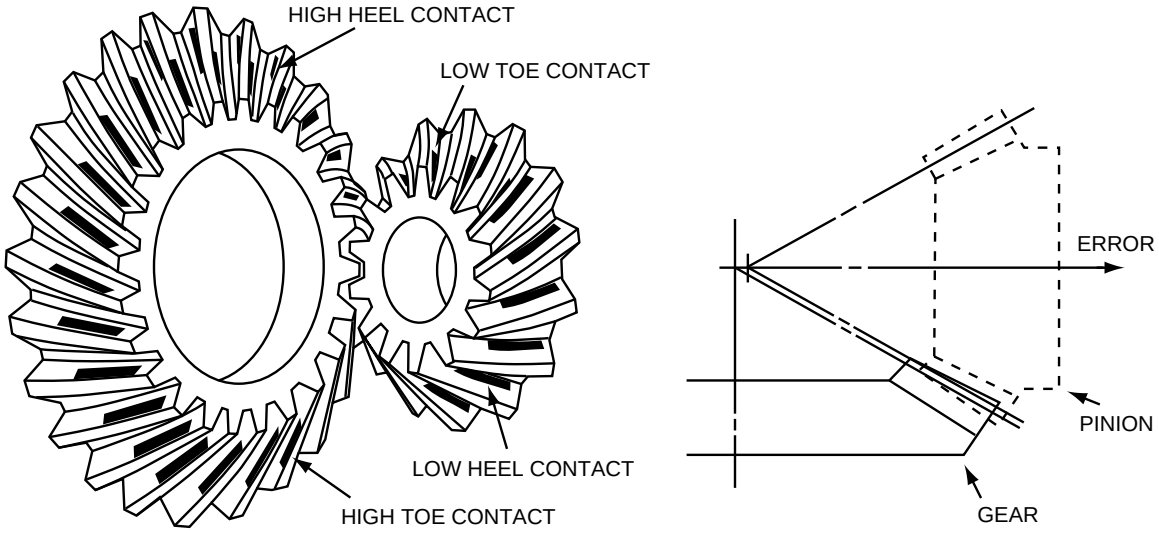


Fig. 14

If the contact pattern is low on the profile of the pinion and high on the profile of the gear, the pinion should be moved axially into mesh.

Unlike straight bevel gears, the movement of the contact up and down the profile is accomplished by a movement along the length of the tooth caused by the lengthwise tooth curvature. Generally, the contact will be near the heel on the convex side of the gear tooth and near the toe on its concave side. When viewing the pinion the opposite contact patterns will exist. (See Figure 14).

It may be necessary to move the gear axially out of mesh until the required backlash and tooth-contact patterns are obtained.

BEARING ADJUSTMENT

H.S. SHAFT

0702-0703 through 2002-2003 BHC/BHE & VBHC/VBHE.

The H.S. Shaft consists of two tapered roller bearings & one straight roller bearing. Refer to the chart below to determine the proper axial endplay for the tapered roller bearings.

2102-2103 through 3202-3203? BHC/BHE & VBHC/VBHE.

The high speed bearings adjacent to the shaft extension on BHC and VBHC reducers have a specific endplay for each reducer. These bearings must be purchased from the factory. If bearings must be purchased from a supplier, specific ordering instructions must be obtained from the factory to insure correct assembly. Failure to do so will result in premature failure of gearing and/or bearings. The high speed double row tapered roller bearing adjacent to the pinion is preset at the factory and requires no endplay adjustment.

SINGLE ROW TAPERED ROLLER BEARINGS

All single row tapered roller type bearings require a specific axial endplay for each size.

Tabulated below is the allowable axial endplay for each shaft assembly. Before checking endplay rotate the input shaft until the output shaft has made two complete rotations. This is done to seat the bearing rollers. To check endplay, place a dial indicator pointer against shaft end or face of gear mounted on shaft and wedge shaft to its extreme opposite positions. The total dial variation is the shaft endplay. If the measured endplay does not fall within the limits specified above, it will be necessary to alter the shim packs accordingly. (Add shims to increase endplay, remove shims to decrease endplay). Rotate shafts each time shim packs are altered and recheck endplay. Access to shim packs is gained by removing bearing covers. When removing those covers that contain bearing cups, it will be necessary to support the shaft with a rope or sling.

SINGLE-ROW TAPERED ROLLER BEARING ENDPLAY

REDUCER SIZE	H.S. SHAFT	INT. SHAFT	2nd INT. SHAFT	L.S. SHAFT
0702	.003-.006	.002-.004	–	.002-.004
0703	.003-.006	.002.004	.002-.004	.002-.004
0802	.003-.006	.003-.005	–	.002-.004
0803	.003-.006	.003-.005	.002-.004	.002-.004
0902	.003-.006	.003-.005	–	.002-.004
0903	.003-.006	.003-.005	.002-.004	.002-.004
1002	.003-.006	.003-.005	–	.002-.004
1003	.003-.006	.003-.005	.002-.004	.002-.004
1102/1202	.004-.007	.004-.006	–	.002-.004
1103/1203	.004-.007	.004-.006	.002-.004	.002-.004
1302/1402	.004-.007	.005-.007	–	.002-.004
1303/1403	.004-.007	.005-.007	.003-.005	.002-.004
1502/1602	.004-.007	.005-.007	–	.002-.004
1503/1603	.004-.007	.005-.007	.003-.005	.002-.004
1702/1802	.005-.008	.006-.008	–	.003-.005
1703/1803	.005-.008	.006-.008	.004-.006	.003-.005
1902/2002	.005-.008	.007-.009	–	.003-.005
1903/2003	.005-.008	.007-.009	.004-.006	.003-.005

METRIC EQUIVALENTS

INCHES	MILLIMETERS	INCHES	MILLIMETERS
.002	.051	.006	.152
.003	.076	.007	.178
.004	.102	.008	.203
.005	.127	.009	.229

At all positions where double row tapered roller or spherical roller bearings are employed, no specific axial endplay is required. However, in reassembly, one bearing on each shaft must be allowed to float in the housing to allow for axial expansion of the shaft, the other bearing is to be fixed.

NOTE:

Plastic/Aluminum shims are used in original assembly. Use no substitutes. After setting the axial endplay, recheck the tooth contact on the spiral bevel pinion and gear.

BACKSTOPS

Only horizontal units may be equipped with a backstop. For 0702 through 2003 BHC's & BHE's the backstop is mounted on the low speed pinion and shaft extension on double reduction and on the first intermediate shaft extension on double reduction and on the first intermediate shaft extension on triple reduction. On 2102-2103 through 3202-3203 BHC's & BHE's the backstop is mounted internally on the high speed pinion shaft.

WARNING. 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.

0702 through 2003 BHC & BHE

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

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

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

5. 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 oil becomes contaminated or oxidized (dark colored), it should be flushed and oil changed.

2102-2103 through 3202-3203 BHC & BHE

1. Follow steps 1 - 4 on BHC & BHE disassembly, (0702 through 2003).

2. Remove remaining bearing cover bolts from the high speed bearing cover, and the four bolts holding the bearing support to the lower housing.

3. Lift high speed shaft assembly from lower housing. Remove locknut and lockwasher and press input shaft from bearing retainer.

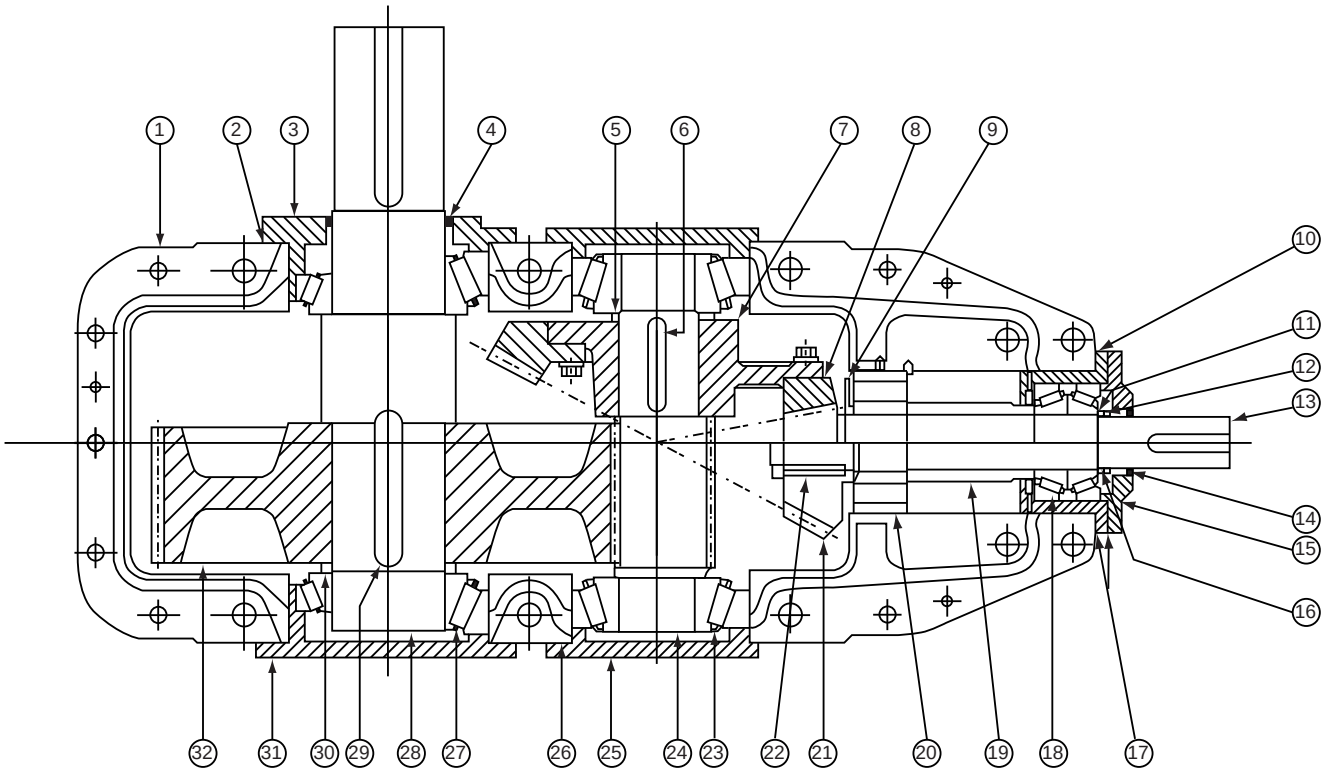
4. Remove the backstop and torque arm from the input shaft.

5. Reassembly is reverse of disassembly. Check torque arm for free movement. It must not bind in bottom of its stop.

6. WARNING. Do not use lubricants of the EP type, (extreme pressure characteristics, or those containing slippery additives).

ASSEMBLY AND PARTS LIST DRAWING

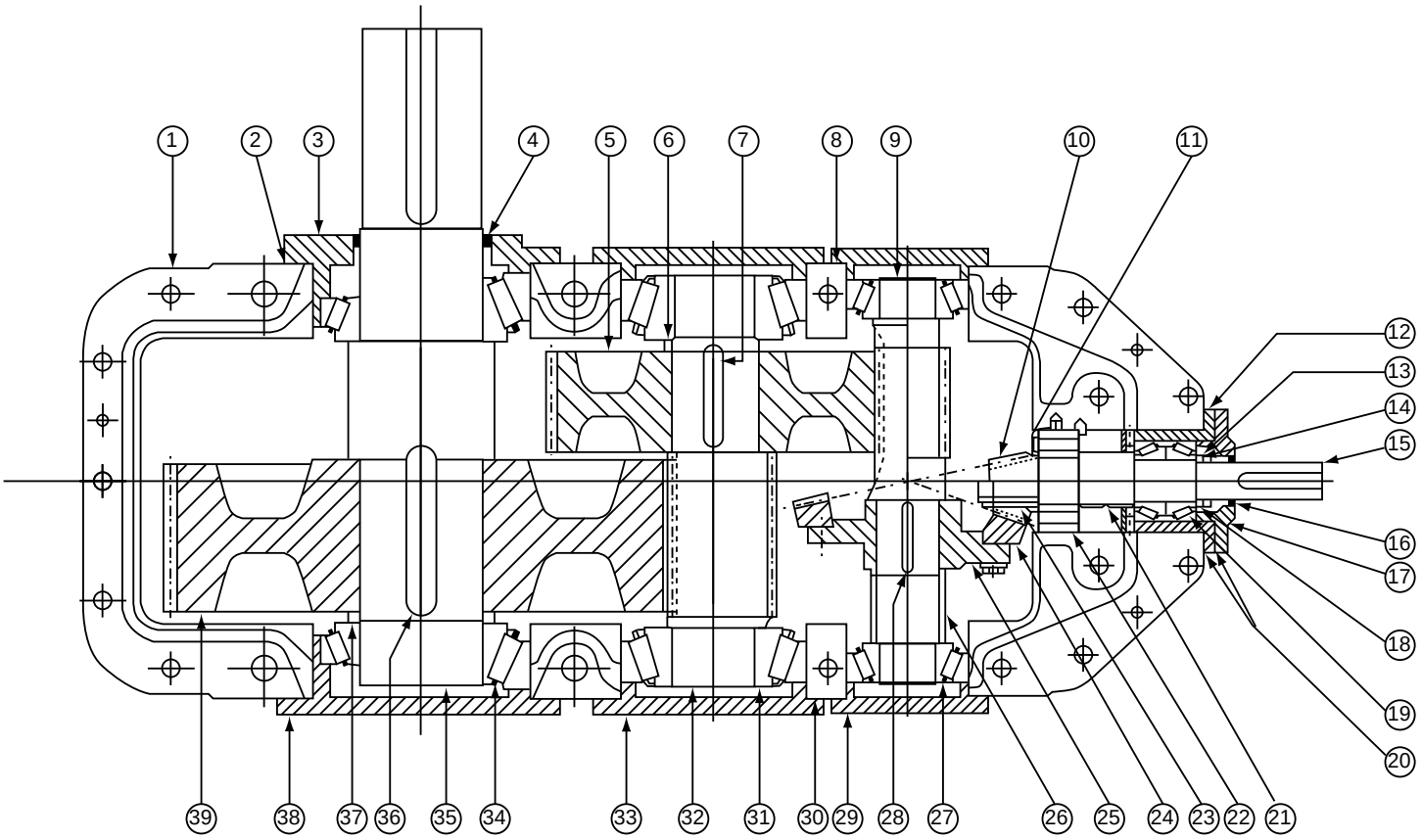
SPIRAL BEVEL GEAR REDUCERS
TYPE BHC, BHE
DOUBLE REDUCTION



1. HOUSING, LOWER (UPPER NOT SHOWN)
2. LOW SPEED BEARING COVER SHIM
3. LOW SPEED BEARING COVER (OPEN)
4. LOW SPEED SHAFT OIL SEAL
5. LOW SPEED PINION AND SHAFT SPACER
6. LOW SPEED PINION AND SHAFT KEY
7. SPIRAL BEVEL GEAR SPIDER
8. SPIRAL BEVEL GEAR RING
9. HIGH SPEED OIL SLINGER
10. HIGH SPEED BEARING RETAINER
11. HIGH SPEED LOCKNUT SPACER
12. HIGH SPEED BEARING LOCKWASHER
13. HIGH SPEED SHAFT
14. HIGH SPEED SHAFT OIL SEAL
15. HIGH SPEED BEARING COVER (OPEN)
16. HIGH SPEED BEARING LOCKNUT
17. HIGH SPEED BEARING COVER SHIMS
18. HIGH SPEED TAPERED ROLLER BEARING
19. HIGH SPEED BEARING SPACER
20. HIGH SPEED STRAIGHT ROLLER BEARING
21. SPIRAL BEVEL PINION
22. HIGH SPEED PINION KEY
23. INTERMEDIATE BEARINGS
24. LOW SPEED PINION AND SHAFT
25. LOW SPEED PINION AND SHAFT BEARING COVER
26. INTERMEDIATE BEARING COVER SHIMS
27. LOW SPEED BEARINGS
28. LOW SPEED SHAFT
29. LOW SPEED SHAFT KEY
30. LOW SPEED SPACER
31. LOW SPEED BEARING COVER (CLOSED)
32. LOW SPEED GEAR

TYPICAL ON ALL PARTS LISTS.
NOTE: HIGH SPEED BEARINGS ON SIZE 2102 THROUGH 3202 ARE TAPERED ROLLER DESIGN. INTERMEDIATE BEARINGS MAY BE MOUNTED IN BEARING RETAINERS. REFER TO FACTORY WITH REDUCER SERIAL NUMBER FOR INFORMATION ON BEARINGS AND BEARING RETAINERS.

SPIRAL BEVEL GEAR REDUCERS
TYPE BHC, BHE
TRIPLE REDUCTION

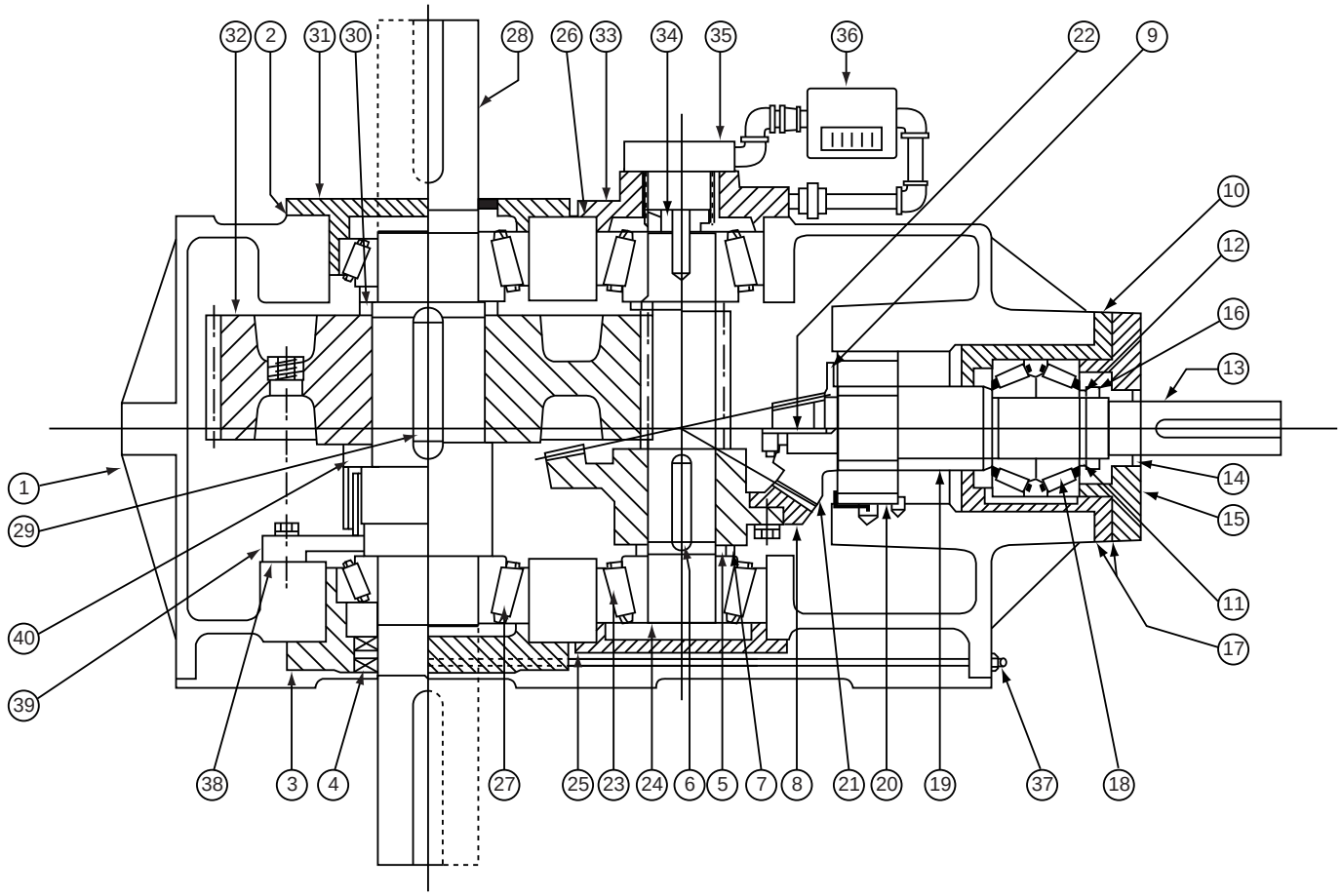


1. LOWER HOUSING (UPPER NOT SHOWN)
2. LOW SPEED BEARING COVER SHIMS
3. LOW SPEED BEARING COVER (OPEN)
4. LOW SPEED OIL SEAL
5. INTERMEDIATE GEAR
6. LOW SPEED PINION AND SHAFT SPACER
7. LOW SPEED PINION AND SHAFT KEY
8. FIRST INTERMEDIATE BEARING COVER SHIMS
9. INTERMEDIATE PINION AND SHAFT
10. SPIRAL BEVEL PINION
11. HIGH SPEED OIL SLINGER
12. HIGH SPEED BEARING RETAINER
13. HIGH SPEED BEARING LOCKWASHER
14. HIGH SPEED BEARING LOCKNUT
15. HIGH SPEED SHAFT
16. HIGH SPEED OIL SEAL
17. HIGH SPEED BEARING COVER (OPEN)
18. HIGH SPEED LOCKNUT SPACER
19. HIGH SPEED TAPERED ROLLER BEARING
20. HIGH SPEED BEARING COVER SHIMS
21. HIGH SPEED BEARING SPACER
22. HIGH SPEED STRAIGHT ROLLER BEARING
23. HIGH SPEED PINION SHAFT KEY
24. SPIRAL BEVEL GEAR RING
25. SPIRAL BEVEL GEAR SPIDER
26. FIRST INTERMEDIATE SPACER
27. FIST INTERMEDIATE BEARINGS
28. FIRST INTERMEDIATE KEY
29. FIRST INTERMEDIATE BEARING COVER
30. INTERMEDIATE BEARING COVER SHIMS
31. INTERMEDIATE BEARINGS
32. LOW SPEED PINION AND SHAFT
33. LOW SPEED PINION AND SHAFT BEARING COVER
34. LOW SPEED BEARINGS
35. LOW SPEED SHAFT
36. LOW SPEED SHAFT KEY
37. LOW SPEED BEARING SPACER
38. LOW SPEED BEARING COVER
39. LOW SPEED GEAR

TYPICAL ON ALL PARTS LISTS.

NOTE: HIGH SPEED BEARINGS ON SIZE 2103 THROUGH 3203 ARE TAPERED ROLLER DESIGN. INTERMEDIATE AND 1ST INTERMEDIATE BEARINGS MAY BE MOUNTED IN BEARING RETAINERS. REFER TO FACTORY WITH REDUCER SERIAL NUMBER FOR INFORMATION ON BEARINGS AND BEARING RETAINERS.

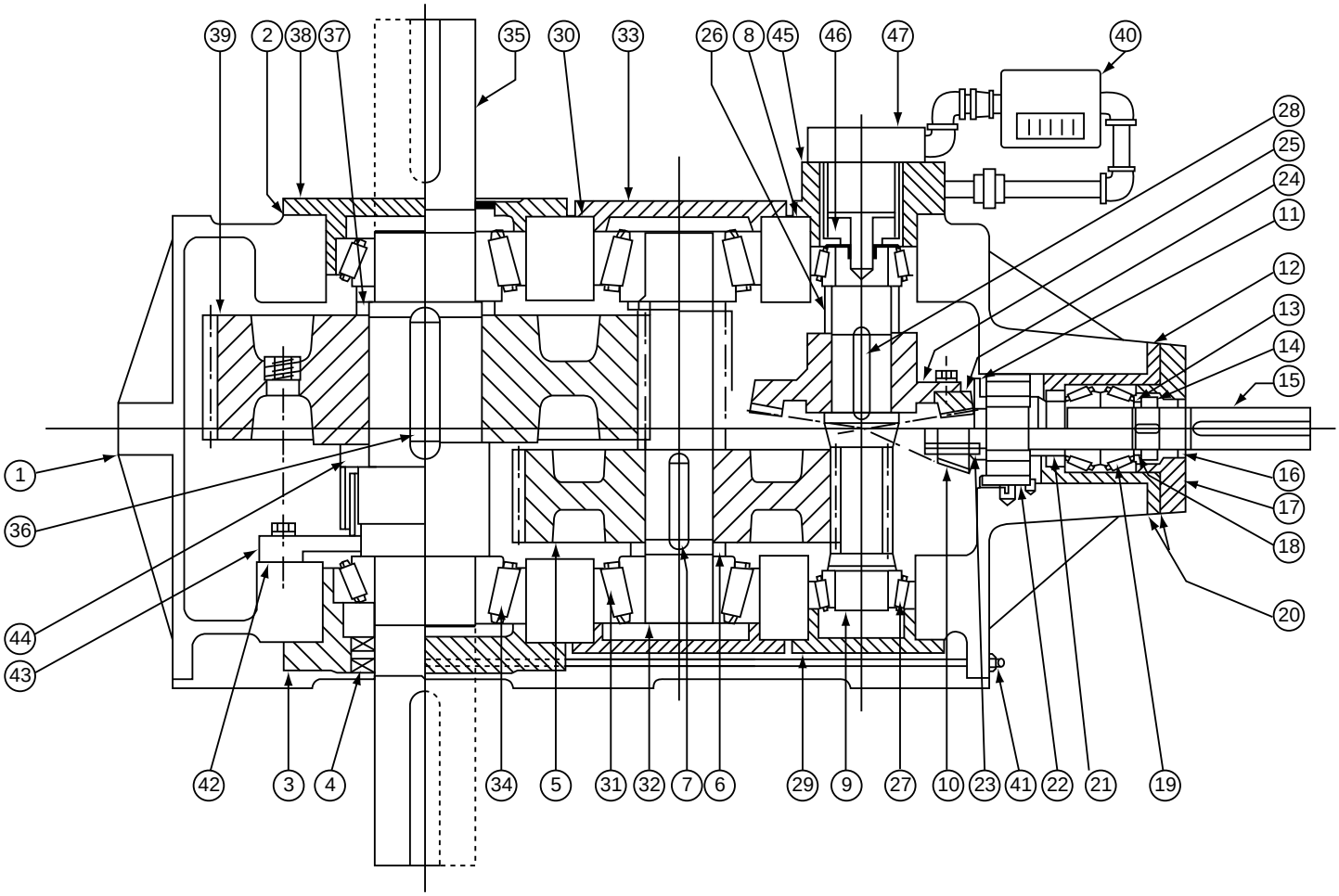
SPIRAL BEVEL GEAR REDUCER
TYPE VBHC, VBHE
DOUBLE REDUCTION



1a. LOWER HOUSING
1b. UPPER HOUSING
2. LOW SPEED BEARING COVER SHIMS
3. LOW SPEED BEARING COVER (OPEN)
4. LOW SPEED OIL SEAL
5. INTERMEDIATE SPACER
6. LOW SPEED PINION AND SHAFT KEY
7. SPIRAL BEVEL GEAR SPIDER
8. SPIRAL BEVEL GEAR RING
9. HIGH SPEED OIL SLINGER
10. HIGH SPEED BEARING RETAINER
11. HIGH SPEED LOCKNUT SPACER
12. HIGH SPEED LOCKWASHER
13. HIGH SPEED SHAFT
14. HIGH SPEED OIL SEAL
15. HIGH SPEED BEARING COVER (OPEN)
16. HIGH SPEED LOCKNUT
17. HIGH SPEED BEARING SHIMS
18. HIGH SPEED TAPERED ROLLER BEARINGS
19. HIGH SPEED BEARING SPACER
20. HIGH SPEED STRAIGHT ROLLER BEARING
21. SPIRAL BEVEL PINION
22. HIGH SPEED SHAFT KEY
23. INTERMEDIATE BEARINGS
24. LOW SPEED PINION AND SHAFT
25. LOW SPEED PINION AND SHAFT BEARING COVER (CLOSED)
26. INTERMEDIATE BEARING COVER SHIMS
27. LOW SPEED BEARINGS
28. OUTPUT SHAFT
29. LOW SPEED SHAFT KEY
30. LOW SPEED SPACER
31. LOW SPEED BEARING COVER CLOSED
32. LOW SPEED GEAR
33. INTERMEDIATE BEARING COVER AND PUMP ADAPTER
34. PUMP COUPLING
35. PUMP
36. FLOW INDICATOR
37. ALEMITE FITTING
38. DRY WELL GASKET
39. DRY WELL
40. UMBRELLA

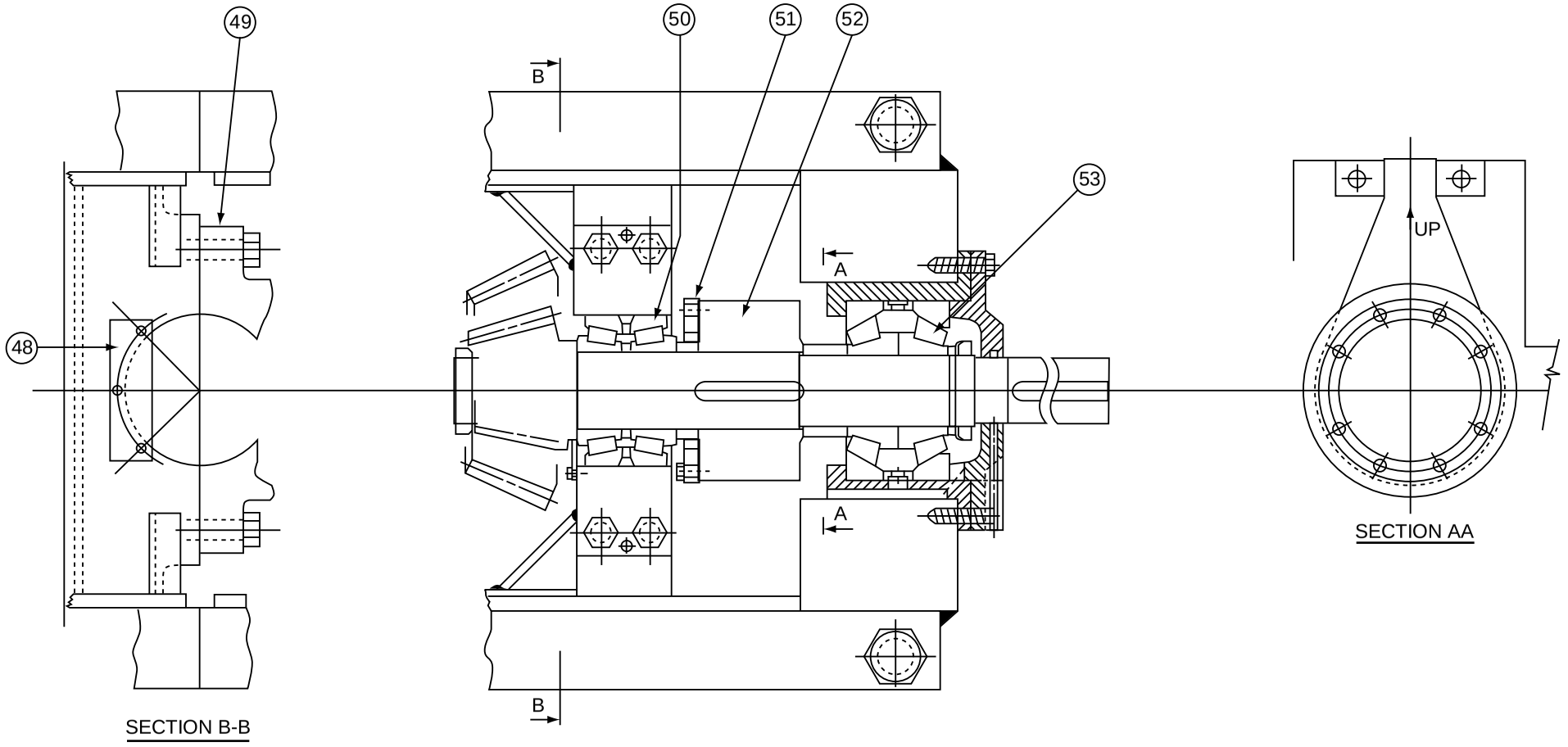
TYPICAL ON ALL PARTS LISTS.
NOTE: HIGH SPEED BEARINGS ON SIZE 2102 THROUGH 3202 ARE TAPERED ROLLER DESIGN. INTERMEDIATE BEARINGS MAY BE MOUNTED IN BEARING RETAINERS. REFER TO FACTORY WITH REDUCER SERIAL NUMBER FOR INFORMATION ON BEARINGS AND BEARING RETAINERS.

SPIRAL BEVEL GEAR REDUCER
TYPE VBHC, VBHE
TRIPLE REDUCTION



1a. LOWER HOUSING
1b. UPPER HOUSING
2. LOW SPEED BEARING COVER SHIMS
3. LOW SPEED BEARING COVER (OPEN)
4. LOW SPEED OIL SEAL
5. INTERMEDIATE GEAR
6. LOW SPEED PINION AND SHAFT SPACER
7. LOW SPEED PINION AND SHAFT KEY
8. FIRST INTERMEDIATE BEARING COVER SHIMS
9. FIRST INTERMEDIATE PINION AND SHAFT
10. SPIRAL BEVEL PINION
11. HIGH SPEED OIL SLINGER
12. HIGH SPEED BEARING RETAINER
13. HIGH SPEED LOCKWASHER
14. HIGH SPEED LOCKNUT
15. HIGH SPEED SHAFT
16. HIGH SPEED OIL SEAL
17. HIGH SPEED BEARING COVER (OPEN)
18. HIGH SPEED LOCKNUT SPACER
19. HIGH SPEED TAPERED ROLLER BEARING
20. HIGH SPEED BEARING COVER SHIMS
21. HIGH SPEED BEARING SPACER
22. HIGH SPEED STRAIGHT ROLLER BEARING
23. HIGH SPEED PINION KEY
24. SPIRAL BEVEL GEAR RING
25. SPIRAL BEVEL GEAR SPIDER
26. FIRST INTERMEDIATE SPACER
27. FIRST INTERMEDIATE BEARINGS
28. FIRST INTERMEDIATE PINION AND SHAFT KEY
29. FIRST INTERMEDIATE BEARING COVER
30. INTERMEDIATE BEARING COVER SHIMS
31. INTERMEDIATE BEARINGS
32. LOW SPEED PINION AND SHAFT
33. LOW SPEED PINION AND SHAFT BEARING COVER
34. LOW SPEED BEARINGS
35. OUTPUT SHAFT
36. LOW SPEED SHAFT KEY
37. LOW SPEED SPACER
38. LOW SPEED BEARING COVER (CLOSED)
39. LOW SPEED GEAR
40. FLOW INDICATOR
41. ALEMITE FITTING
42. DRY WELL GASKET
43. DRY WELL
44. UMBRELLA
45. FIRST INTERMEDIATE BEARING COVER AND PUMP ADAPTER
46. PUMP COUPLING

SPIRAL BEVEL GEAR REDUCERS
TYPE BHC & VBHC, BHE & VBHE
DOUBLE & TRIPLE REDUCTION
BACKSTOP ARRANGEMENT FOR SIZES - 2102-3202 THROUGH 2103-3203



NOTE: THIS VIEW ROTATED 90°

48. OIL RETAINER
49. BEARING SUPPORT
50. HIGH SPEED TAPERED ROLLER BEARING
51. TORQUE ARM
52. BACKSTOP
53. HIGH SPEED TAPERED ROLLER BEARING

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