

# Geareducer® model 3600 and 4000

INSTALLATION - OPERATION - MAINTENANCE

Z0493915\_C ISSUED 11/2022

READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING THIS PRODUCT

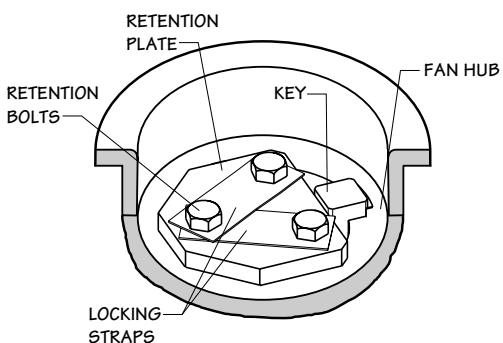


# fan hub installation

The following instructions detail the process for installing a fan on a Marley Geareducer with a straight fan shaft using a split taper bushing or a tapered fan shaft utilizing a bolted fan hub retention plate.

## Straight Fan Shaft with Split Taper Bushing

1. Remove the retention plate and hardware from the top of the Geareducer shaft. Thoroughly clean the fan shaft, fan shaft key, and the fan hub center bore to remove any debris and/or protective coatings. After cleaning, apply a coat of anti-seize compound to the top 7" (180mm) of the fan shaft.
2. Prior to hub installation, fully seat the key in the fan shaft keyway. The key is a tight fit across the width and must never be altered.
3. Raise the fan hub above the fan shaft for installation. Slowly lower the hub onto the shaft with the keyways properly aligned. Make certain the key does not slide down during installation. Stake the key in the keyway with a center punch if necessary.  
  
The fan shaft key should be approximately centered in the engaged portion of the hub when engaged on the shaft. Verify the center hub is fully seated by visual inspection.
4. Install the retention plate and hardware. Torque bolts to 70 ft·lb<sub>f</sub> (95 N·m).



**Figure 1** Retention Plate Assembly

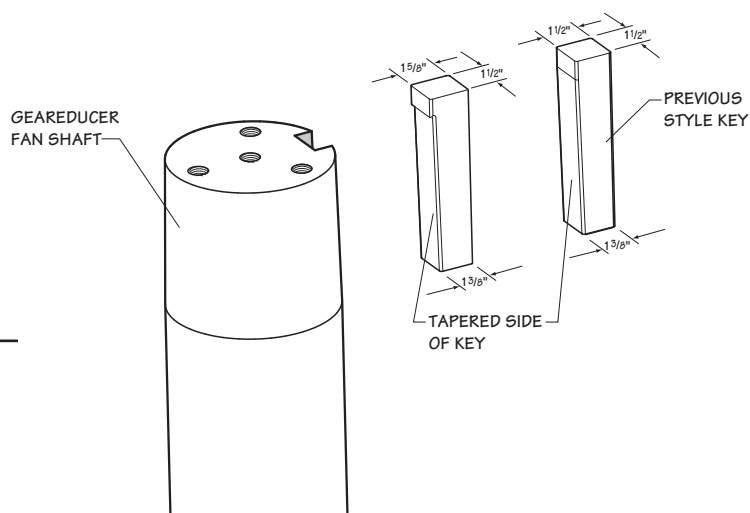
## Tapered Fan Shaft

**Warning** – Correct key installation is imperative for proper and safe operation

1. Remove the retention plate and hardware from the top of the Geareducer shaft. Thoroughly clean the fan shaft, fan shaft key, and the hub center bore to remove any debris and/or protective coatings. After cleaning, apply a coat of anti-seize compound to the top 7" (180mm) of the fan shaft.
2. Install the fan shaft key in the fan shaft keyway as shown in **Figure 2**. The key is a tight fit across the width and must never be altered.
3. Raise the hub assembly above the fan shaft for installation. Slowly lower the assembly onto the shaft with the keyways aligned. Make certain the key does not slide down during installation.

After the hub assembly is installed the bottom end of the key must extend through the bottom of the center hub, and the top end of the key must be at least 5/8" (16mm) above the top of the fan shaft. Do not force the key down once these criteria are met.

4. **Figure 1** illustrates proper retention plate and hardware installation. The retention plate is designed to allow clearance for the fan shaft key, and when properly installed will not extend over or interfere with the key in any way. Torque the retention bolts to 70 ft·lb<sub>f</sub> (95 N·m) then turn up the locking strap corners to prevent the bolts from loosening.



**Figure 2** Key Installation

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# operation and service

## Corrosion and Dry Start-Up Protection

Marley Geareducers utilize iron and steel materials, which if not maintained correctly, may degrade. While some external corrosion is acceptable, an internal lubrication film must be maintained at all times to protect the working components against corrosion and potential startup damage. The following information describes methods of operation and preventive measures to ensure suitability for long-term operation.

## Status Definitions

### Pre-Commission

Duration\* = Up to 4 months after receipt.

\*export shipment status duration is reduced by 1 month

This is the as-shipped condition, which contains a factory rust-proofing coating on the interior of the unit as well as a grease coating on the exposed shaft surfaces.

If the cooling tower is not ready for operation at the time of status expiration, steps must be taken to place the Geareducer into **Long-Term Storage or Downtime** status.

### Operational

This stage is initiated upon the first motor driven sequence. The Geareducer is now considered as being placed into regular service and operation.

### Idle

Duration = 2 to 4 weeks.

This stage is a suspension in operational status and lasts up to two weeks. The duration may be doubled by completing a **Run Cycle**.

It is not recommended to extend the idle status more than once in any given sequence.

A common application is during a temporary outage

### Seasonal Shutdown

Duration = Up to 4 months after operational is suspended.

This stage may be considered an extended idle condition.

Requires additional preventive maintenance.

### Long-Term Storage or Downtime

Duration = Indefinite.

Requires long-term preventive measures.

### Run Cycle

Defined as full speed operation for a minimum of 30 minutes. This recoats all internal components and surfaces with lubricant and also helps to expel some moisture that may have accumulated from daily ambient condition cycling.

As shipped, a Marley Geareducer is protected internally against corrosion with machine enamel on un-machined parts and with rust-proofing oil and grease on machined surfaces. These coatings normally protect the Geareducer against corrosion for the duration of the **Pre-Commission** phase. Adding normal lubricant to the unit will dissolve the rust-proofing oil in the Geareducer sump. Provided it is added via the filler-neck or pumped in through the drain connection, this lubricant will not reduce the overall level of protection however, if the unit is operated for any amount of time, the **Pre-Commission** period is depleted and the unit is now considered to be in **Operational** status.

Check the Geareducer exterior yearly. Touch up with paint as required. Exposed pipe threads are coated to prevent corrosion. Touch up coating as required.

## Initial Operation

### Priming

Due to lack of control over facility operational readiness, site ambient conditions or storage practices, etc., it is recommended to supplement lubricant prior to initial operation. The same fill lubricant should be poured or pumped into the port above the interstage shaft. Remove pipe plug in center of Interstage Bearing Cap to expose port. Refer to **Figure 3**. If additional oil is being used, an amount of 1 to 1 1/2 quarts should be used. If the lubricant is being pumped from the sump bulk volume, at least 1 quart **should** be transferred. In either case, this priming step should be performed within 5 days of initial operation. If a delay occurs and the 5 day duration is exceeded, repeat the process. In either case, this priming step should be performed *while rotating the gear train by hand* and within 5 days of initial operation.

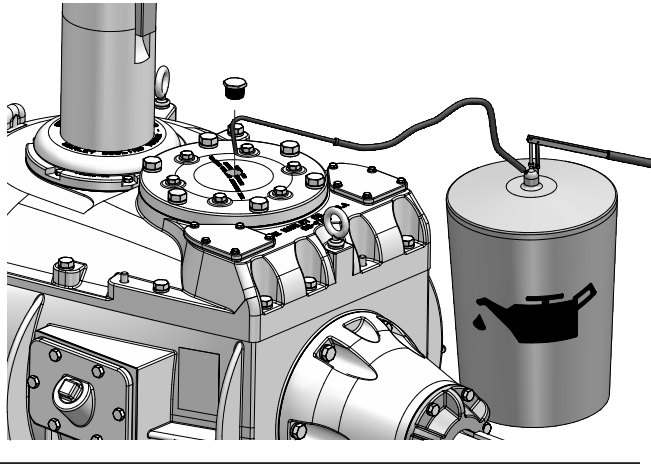
**Warning** – Operating the Geareducer at an oil level other than between the Add and Full levels may damage the unit and possibly mating equipment. This could also escalate to a safety concern for nearby personnel.

The Geareducer must be filled with oil to the Full oil level mark on the Geareducer case before it is placed in operation. If the unit is being taken out of **Long-Term Storage or Downtime**, the oil should be drained down to the Full operating level. If drain-down occurs within 5 days of the initial startup, the above priming sequence may be skipped. See **Changing Geareducer Oil** section for oil filling instructions.

Geareducers supplied with new cooling towers include oil for the initial filling and in some cases, will also ship with an additional amount required to place the unit into **Long-Term Storage or Downtime** status. Normally, oil is not furnished with Geareducers supplied as a spare or on replacement orders. Before operating the mechanical equipment, check to be sure the oil level is at the Full mark at the Geareducer and that the external gauge placard Full mark corresponds with the Full level in the Geareducer. Check oil lines to be sure there are no leaks.

## operation and service

The Geareducer vent or vent line must be checked for blockage to prevent failure of pinion shaft oil seal—clean when necessary.



**Figure 3** Priming Interstage Shaft

Check all gasketed joints for oil seepage. Tighten cap screws and flange bolting if necessary.

The Geareducer must be installed level and properly aligned with the driveshaft and motor shaft. Refer to the **Driveshaft User Manual**.

It is recommended to operate the Geareducer for no less than 30 minutes in any given run sequence. It is acceptable to ignore this when “bumping” the motor for confirmation of the correct direction of rotation.

### Seasonal Shutdown up to 4 months

At start of shutdown period, perform a **Run Cycle** and change the oil. See section on **Changing Geareducer Oil**.

Every 2 weeks check the oil level and perform a **Run Cycle**.

Once each month drain any water condensation from the lowest point of the Geareducer and its oil system. Check the oil level and add oil if necessary. Perform a **Run Cycle**.

To put back into operation, drain water condensation from the lowest point of the Geareducer and its oil system and check oil level. Add oil if necessary.

### Long-Term Storage or Downtime indefinite duration

If unit has been in an operational state, perform a **Run Cycle** and drain the oil including volume in the oil line, if equipped. If in storage, unit does not need to be operated.

Fabricate and install an overflow reservoir system and fill unit entirely full of oil.

**Maintenance Cycle** If unit is stored outdoors, drain condensate monthly and top off oil as necessary. If unit is stored indoors, but not climate controlled, maintenance cycle may be extended to 3 months. If stored in climate controlled space, cycle may be extended to once per year.

See *Marley User Manual Z0238848 “Cooling Tower Downtime Instructions”* and *Marley Drawing Z0544916 “Marley Geareducer Reservoir System”* for further information.

### Inspection Of Internal Parts

Remove the inspection cover plate from the side of the Geareducer case at each oil change. Check inside of Geareducer for cleanliness of case and internal parts. If any sludge is present, flush inside of Geareducer and connecting oil line.

### Changing Geareducer Oil

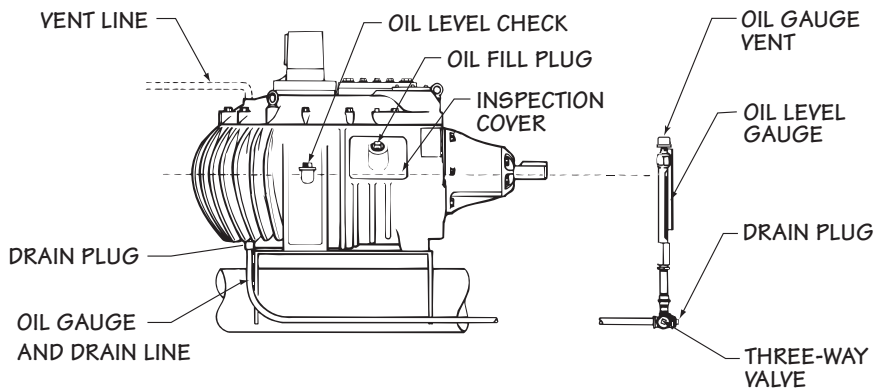
Drain the Geareducer oil by removing the drain plug. See **Figure 4** for location. If equipped with an external dipstick/oil level gauge, remove the drain plug at that location, and drain the entire system.

When using synthetic oil with extended service intervals remove a sample for lab analysis and look for evidence of foreign material, such as water, metal shavings or sludge. If you find unacceptable condensation or sludge, flush the Geareducer with mineral oil before refilling.

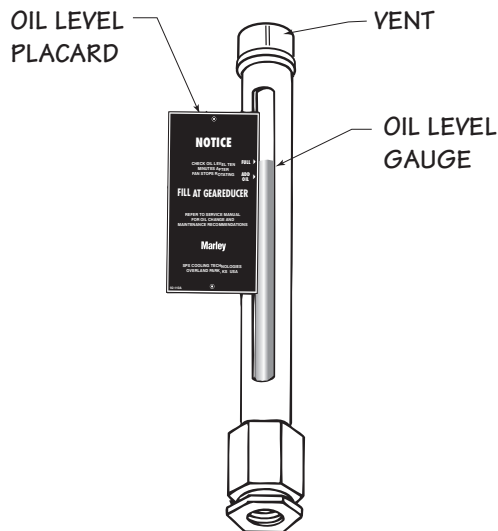
After inspection is complete, fill the Geareducer with **18.5 gallons (70 liters)** of oil. See **Figure 4** for location. If the Geareducer is equipped with an external dipstick/oil level gauge an additional 3 to 4 quarts of oil will be required. Be certain that the vent on the Geareducer (and external dipstick/oil level gauge, if present) is not plugged. Verify that the gauge/drain line is full and that there aren't any leaks at the connections.

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## operation and service



**Figure 4** Service Fittings



**Figure 5** Oil Level Gauge Assembly

Fill the Geareducer and oil line system with oil, using one of the following procedures:

Recommended procedure:

1. Install oil at the opening at the Geareducer inspection cover until it reaches the level of the Full mark on the Geareducer case and at the oil level gauge. See **Figures 4** and **5**. Install plug.
2. Start the fan drive and run for one minute.
3. Stop the fan drive. Allow ten minutes for oil level to stabilize and recheck oil level at the Geareducer.
4. If necessary, repeat steps 2 and 3 until stabilized oil level is at the proper level.
5. Check gauge placard location. Full mark on the placard must be at the same elevation as the Full mark at the Geareducer.

Alternate procedure:

The cooling tower has an external oil gauge and drain line equipped with a three-way valve below the oil level gauge. See **Figure 4**.

1. Remove pipe plug. Turn valve control stem clockwise to open drain.
2. With Geareducer drained, the three-way valve turned clockwise, and the pipe plug removed, connect fill source (usually a hose to a pump, to the three-way valve).

Pump oil through the hose. Check oil level occasionally by turning the valve control stem counterclockwise and allowing the oil level in the sight glass to stabilize.

Continue filling until full level mark is reached.

3. With the oil level at the full mark turn the valve control stem counterclockwise to close the drain and open the valve to the sight glass. Remove the oil filling line and reinstall pipe plug in the three-way valve.

## scheduled maintenance

**Warning**—Make certain that mechanical equipment is inoperable during periods of maintenance—or during any situation of possible endangerment to personnel. If your electrical system contains a disconnect switch, lock it out until the period of exposure to injury is over.

**Monthly**—Check Geareducer oil level. Shut down the unit and allow 5 minutes for the oil level to stabilize. Add oil if required, noting the addition in your maintenance log. If equipped with an external dipstick/oil level gauge, small quantities of oil can be added at that location.

**Semi-annually**—If using turbine-type mineral oil, change oil—see **Changing Geareducer Oil** for instructions. Check that all the assembly bolts and cap screws are tight, that oil plugs and pipe connections are in place and free from leaks, and that the vent on the Geareducer (and external dipstick/oil level gauge, if present) is clear—a clogged vent can lead to oil leaks. Intermittent operation and extended periods of downtime can cause condensation of water in the oil. If using synthetic Marley Gearlube, the oil condition must be inspected every six months—see **Changing Geareducer Oil** for maximizing service life.

**Annually**—Check mechanical equipment anchor bolts, drive shaft coupling bolts, and coupling set screws. Tighten as required. Check Geareducer exterior yearly and touch up with epoxy paint if required. Coat all exposed threads at pipe joints to prevent corrosion.

**Every 5 Years**—If using synthetic Marley Gearlube, change oil. To maintain five-year change intervals, use only synthetic Marley Gearlube. It is recommended to monitor the oil condition every six months throughout the five-year period per the instructions in **Changing Geareducer Oil**.

Maintenance Service	Monthly	Semi-annually	Seasonal Startup or Annually
<b>Geareducer Drive:</b>			
Inspect and tighten all fasteners including oil plug		<b>x</b>	<b>x</b>
Check for and repair oil leaks	<b>x</b>	<b>x</b>	<b>x</b>
Check oil level	<b>x</b>	<b>R</b>	<b>x</b>
Change oil		<b>R</b>	<b>R</b>
Make sure vent is open		<b>x</b>	<b>x</b>
Check driveshaft or coupling alignment			<b>x</b>
Inspect and tighten driveshaft or coupling fasteners			<b>x</b>
Check driveshaft or coupling bushing / flex elements for unusual wear			<b>x</b>
<b>Lube Lines</b> (if equipped)			
Check for oil leaks in hoses and fittings	<b>x</b>	<b>R</b>	<b>x</b>

**R** – Refer to instructions within this manual

Note: It is recommended at least weekly, that the general operation and condition be observed. Pay particular attention to any changes in sound or vibration that may signify a need for closer inspection.

# repair and lubricants

## Repair and Overhaul

If your Geareducer ever needs replacement or repair, SPX Cooling Tech recommends returning the unit to a Marley factory service center. Contact your Marley sales representative to discuss a course of action. The Marley Order Number on your cooling tower will be required if the Geareducer is shipped back to the factory for repair. Obtain a **“Customer Return Material”** tag from the Marley sales representative in your area. To find your Marley sales representative call **913 664 7400** or check the internet at **spxcooling.com**.

Major repairs require the use of a fully equipped machine shop. If you decide to repair or overhaul your Geareducer, refer to the **Field Repair** Section and Geareducer **Parts List**.

## Suggested Lubricants

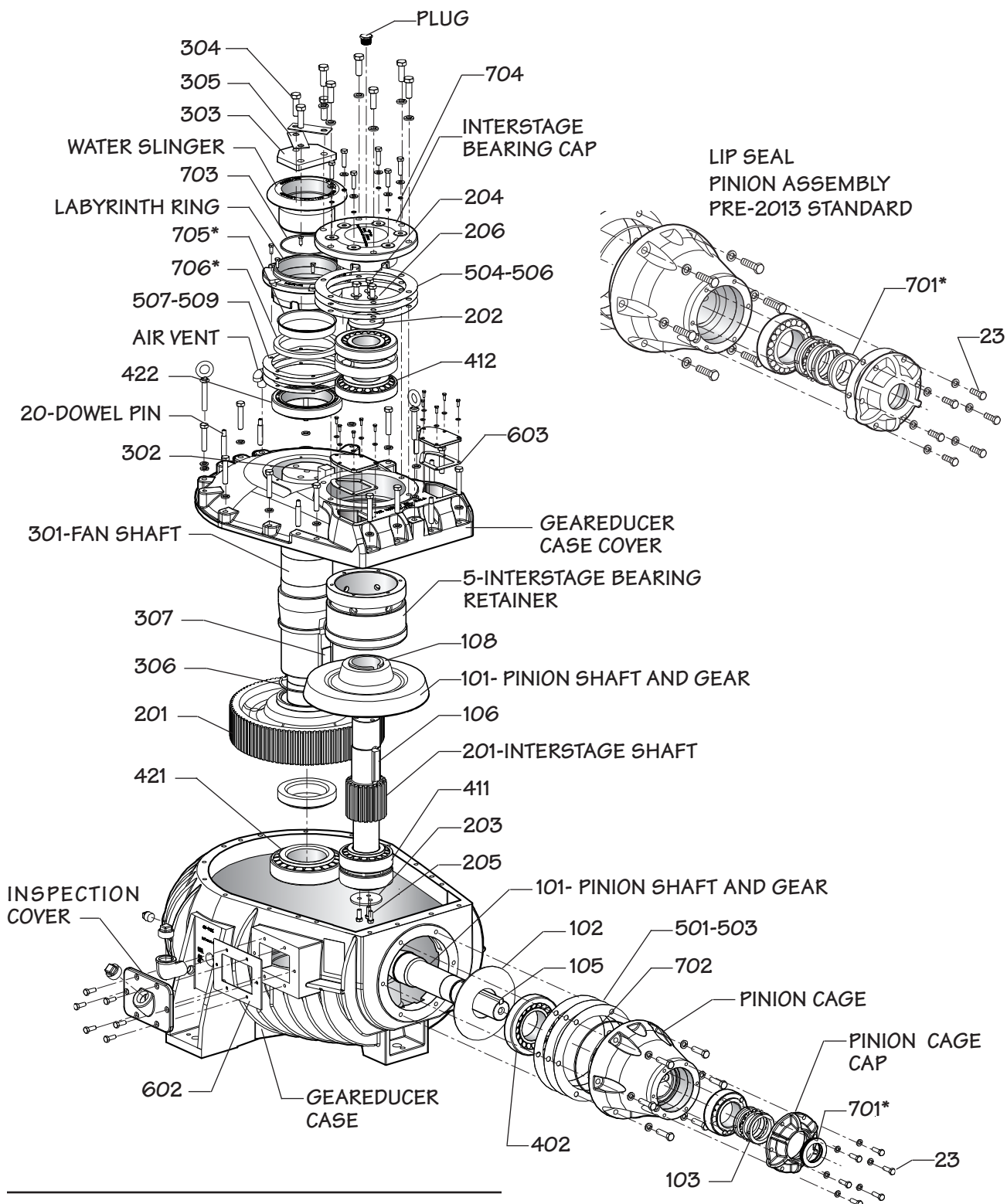
The following list of lubricants in **Table 1** is provided as reference only. These products have been recommended by their respective manufacturers as acceptable for use in a Marley spiral bevel and/or helical Geareducer for cooling tower applications. This list is not an attempt to include all the lubricants that may be satisfactory. If lubricants other than those listed are used they must not contain any additives—such as detergents or EP additives—which are adversely affected by moisture and could reduce the service life of the Geareducer. Suitability of lubricants used other than those listed rests with the customer/owner and lubricant supplier.

Manufacturer	Product
SPX Cooling Tech, LLC	Mineral Turbine ISO 220
Chevron	Regal R & O 220
Citgo Petroleum Corp.	Pacemaker 220
ConocoPhillips	Multipurpose R & O 220
ExxonMobil Corp.	DTE Oil BB
ExxonMobil Corp.	Teresstic 220
Lubrication Engineers Inc.	Monolec 6405
Shell	Morlina S3 GA 220
Synthetic Oil*	
SPX Cooling Tech, LLC	Gearlube ISO 220
Chevron	Clarity 220 Synthetic
Citgo Petroleum Corp.	Citgear Synthetic HT 220
ConocoPhillips	Syncon R & O 220
ExxonMobil Corp.	SHC 630
Shell	Morlina S4 B220
*Synthetic oil may be applicable for high temperature service or extended oil life	

**Table 1**



## parts list



**Figure 6** Exploded Assembly



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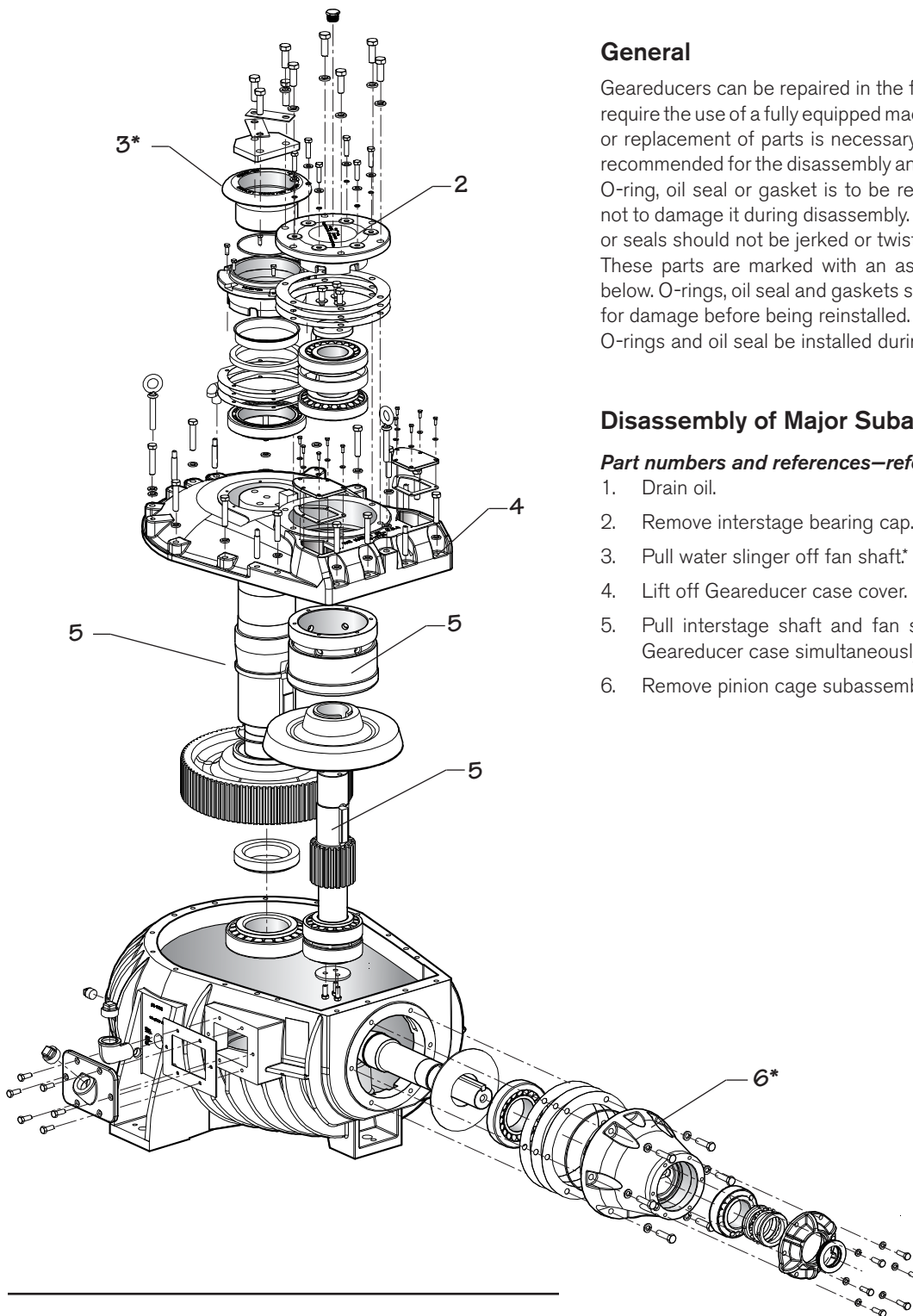
## parts list

- 1** Complete Geareducer Assembly
- 100** Spiral Bevel Gear Set
  - 101** Set of matched spiral bevel gears including integral pinion shaft with key
    - Gear ratios as follows:
    - 2.304 to 1      2.435 to 1      2.762 to 1
    - 3.158 to 1      3.167 to 1      3.944 to 1
  - 102** Oil slinger
  - 103** Locknuts
  - 104** Lockwasher
  - 105** Pinion shaft key
  - 106** Interstage shaft key
  - 108** Ring gear spacer (2.304 and 2.435 gear sets only)
- 200** Helical Gear Set
  - 201** Set of matched helical gears including interstage shaft and special key
    - Gear ratios as follows:
    - 4.18 to 1      4.70 to 1      5.00 to 1
  - 202** Top interstage bearing retainer disc
  - 203** Bottom interstage bearing retainer disc
  - 204** Place bolts and washers
  - 205** Place bolts and washers
  - 206** Place bolts and washers
- 300** Fan Shaft Assembly
  - 301** Fan shaft
  - 302** Key
  - 303** Fan hub retainer
  - 304** Cap screw
  - 305** Locking plates
  - 306** Retainer ring
  - 307** Key
- 400** Pinion Shaft Bearing Set
  - 401** Tail, tapered roller bearing
  - 402** Head, tapered roller bearing
- 410** Interstage Bearing Set
  - 411** Lower, double row, tapered roller bearing. Matched assembly with cone spacer
  - 412** Upper, double row, tapered roller bearing. Matched assembly with cup spacer
- 420** Fan Shaft Bearing Set
  - 421** Lower tapered roller bearing
  - 422** Upper tapered roller bearing
- 500** Shim set
  - 501-502-503** Pinion shaft shims
  - 504-505-506** Interstage shaft shims
  - 507-508-509** Fan shaft shims
- 600** Gasket Set
  - 602** Inspection cover gasket
  - 603** Oil trough gasket
- 700** O-Rings Set.
  - 702** Pinion cage O-ring, 9¾" ID x 10" OD x ⅛"
  - 703** Water slinger O-ring, 6½" ID x 6¾" OD x ⅛"
  - 704** Interstage cap bolt O-rings, ½" ID x ⅝" OD x ⅛"
- 701\*** Pinion shaft oil seal
- 705\*** Water slinger seal wear sleeve
- 706\*** Fan shaft seal

**\*Geareducers prior to 2013 utilize a lip type oil seal. Current geareducer models utilize an Inpro/Seal® bearing isolator.**

**\*Geareducers prior to 2013 do not utilize a water slinger wear sleeve and fan shaft seal items (705) and (706).**

## field repair



**Figure 7** Disassembly of Major Subassemblies

### General

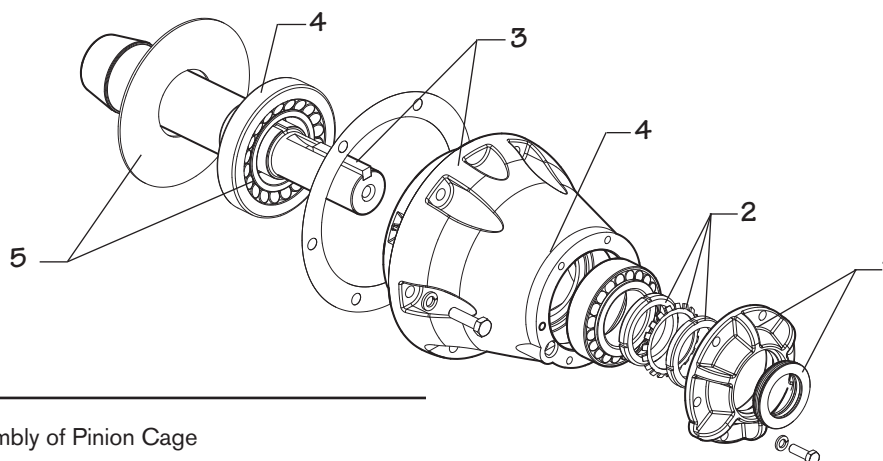
Geareducers can be repaired in the field—however, major repairs require the use of a fully equipped machine shop. When field repair or replacement of parts is necessary, the following procedure is recommended for the disassembly and assembly of the unit. If any O-ring, oil seal or gasket is to be reused, care should be taken not to damage it during disassembly. Parts which contain O-rings or seals should not be jerked or twisted past a shoulder or edge. These parts are marked with an asterisk (\*) in the description below. O-rings, oil seal and gaskets should be carefully inspected for damage before being reinstalled. SPX recommends that new O-rings and oil seal be installed during every major overhaul.

### Disassembly of Major Subassemblies

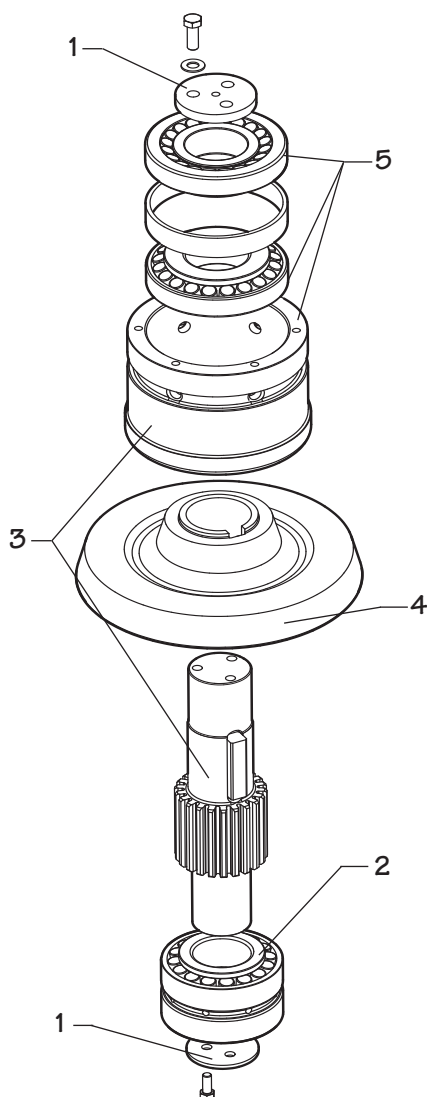
**Part numbers and references—refer to Figures 6 and 7.**

1. Drain oil.
2. Remove interstage bearing cap.
3. Pull water slinger off fan shaft.\*
4. Lift off Geareducer case cover.
5. Pull interstage shaft and fan shaft subassemblies out of Geareducer case simultaneously.
6. Remove pinion cage subassembly.\*

## field repair



**Figure 8** Disassembly of Pinion Cage



**Figure 9** Disassembly of Interstage

### Disassembly of Pinion Cage

**Part numbers and references—refer to Figures 6 and 8.**

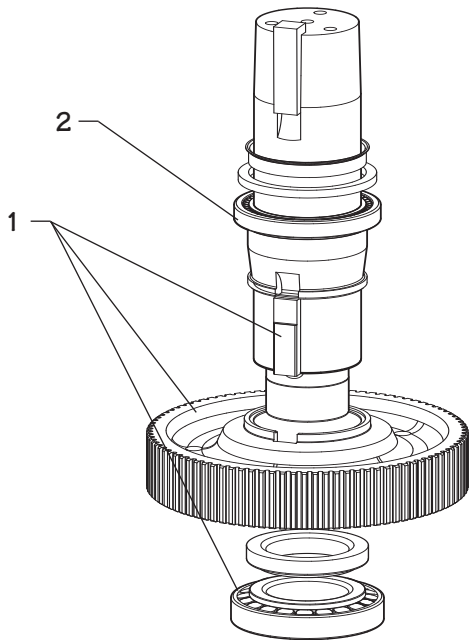
1. Remove pinion cage cap and oil seal (701).
2. Remove locknuts (103) and washer (104) from pinion shaft.
3. Press pinion shaft with head bearing cone (402) out of pinion cage. This will free cone of tail bearing (401).
4. Remove bearing cups from pinion cage.
5. If bearing cone on head of pinion shaft is to be replaced, it will be necessary to press off oil slinger (102) and bearing cone at the same time.

### Disassembly of Interstage

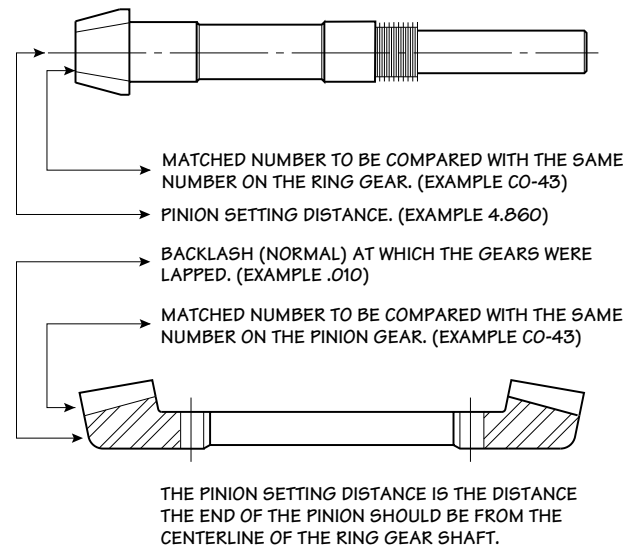
**Part numbers and references—refer to Figures 6 and 9.**

1. Remove top and bottom interstage bearing discs (202 and 203).
2. Pull bottom bearing (411), two cones with spacer and one cup from shaft.
3. Push shaft out of upper bearing (412) and retainer.
4. Remove spiral bevel ring gear from shaft.
5. Pull upper bearings from top interstage retainer (5).

## field repair



**Figure 10** Disassembly of Fan Shaft



**Figure 11** Gear Match Numbers and Setting Data

### Disassembly of Fan Shaft

**Part numbers and references—refer to Figures 6 and 10.**

1. Press helical ring gear (201), lower fan shaft spacer (40) and lower cone (421) from shaft. Remove key spacer ring.
2. Remove upper bearing cone (422).
3. Remove upper fan shaft bearing cup (422) from case cover (not illustrated).
4. Remove lower fan shaft bearing cup (421) from case (not illustrated).

### Assembly of Geareducer

#### Gear Match Numbers and Setting Data

Before assembling a new pinion gear in the pinion cage check match numbers on pinion gear and spiral bevel ring gear to be certain that they are a matched set. Gears are lapped in matched sets at the factory and should not be separated. Numbers are etched on both the pinion and ring gear as illustrated in **Figure 11**.

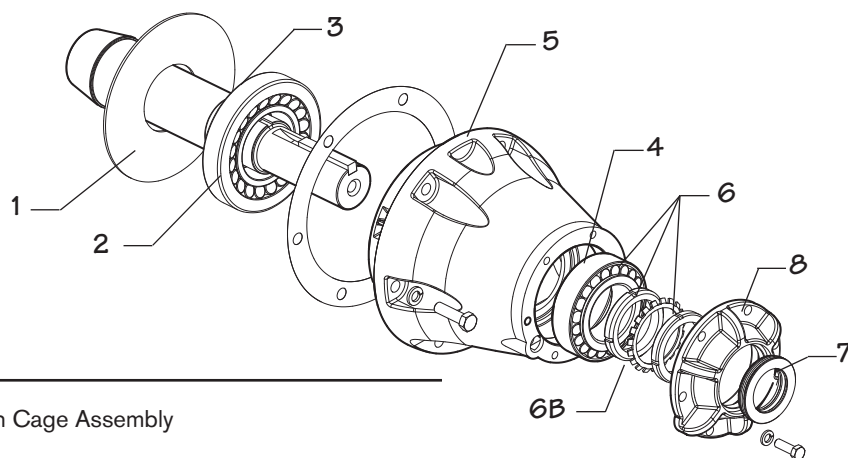
#### Pinion Cage Assembly

**Part numbers and references—refer to Figures 6 and 12 .**

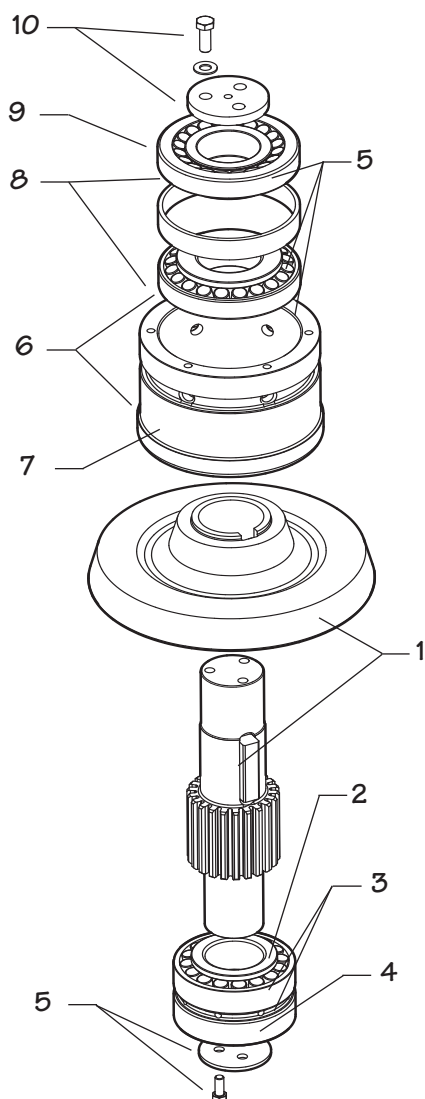
1. Press oil slinger (102) onto pinion shaft.
2. Install pinion head bearing cone (402) on pinion shaft.
3. Press pinion head bearing cup (402) into pinion cage.
4. Press pinion tail bearing cup (401) into pinion cage.
5. Lower pinion cage over pinion shaft until head bearing cone (402) mates with cup.
6. Press tail bearing cone (401) onto pinion shaft.
  - a. Lock with lock nuts (103) and lockwasher (104) to provide bearing preload of 10 to 18 in·lb<sub>f</sub> (1130-2034 mN·m) resistance to rotation of pinion shaft.
  - b. Crimp ears of lockwasher (104) to locknuts after obtaining proper preload.
7. For Inpro/Seals (701) press the stator into the pinion cage cap.

For conventional lip seals (701) install the lip seal in the pinion cage cap.
8. Apply a bead of RTV sealer on the face of the pinion cage interface with the pinion cage cap, encircling all the holes. Fasten the pinion cage cap to the pinion cage. Tighten bolts (23) to 55 in·lb<sub>f</sub> (75 N·m) torque. For Inpro/Seal complete the rotor installation per the instructions included with the seal.

## field repair



**Figure 12** Pinion Cage Assembly



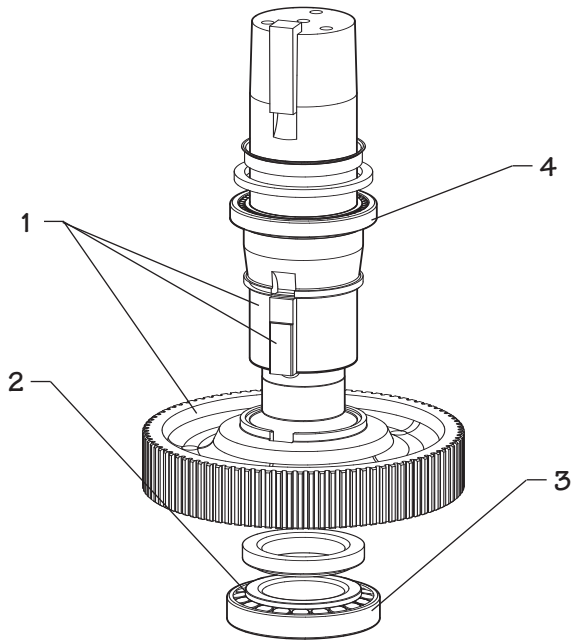
**Figure 13** Interstage Assembly

### Interstage Assembly

**Part numbers and references—refer to Figures 6 and 13.**

1. Install key (**106**) and spiral bevel ring gear on interstage shaft.
2. Press top cone of bottom interstage bearing (**411**) onto interstage shaft.
3. Install double cup and spacer of bottom interstage bearing (**411**).
4. Press bottom cone into place.
5. Install retainer (**203**) with bolts. Tighten to 55 ft·lb<sub>f</sub> (75 N·m) torque.
6. Press lower cup of upper interstage bearing into retainer (**5**).
7. Lower retainer (**5**) over interstage shaft.
8. Press upper bearing cones (**412**) onto shaft.
9. Press upper cup (**412**) and spacer into retainer (**5**).
10. Install disc (**202**) with place bolts. Tighten to 150 ft·lb<sub>f</sub> (204 N·m) torque.

## field repair



**Figure 14** Fan Shaft Assembly

### Fan Shaft Assembly

**Part numbers and references—refer to Figures 6 and 14.**

1. Install the key spacer ring. Install helical gear key and press helical gear (201) on fan shaft.
2. Press lower bearing spacer (40) on fan shaft.
3. Press bottom bearing cone (421) onto fan shaft.
4. Press upper bearing cone (422) on fan shaft.
5. Install lower fan shaft bearing cup (421) into Geareducer case (not illustrated).

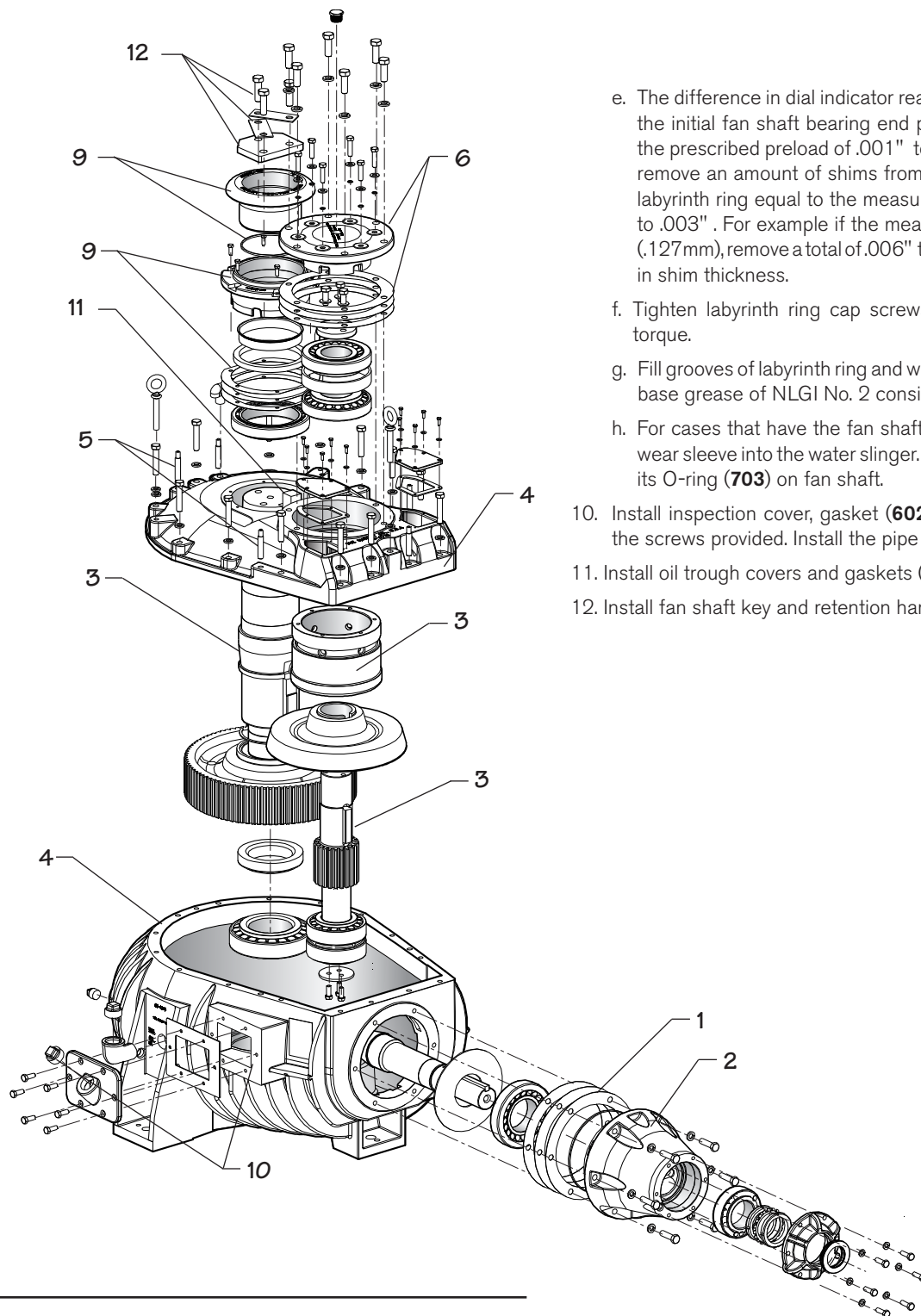
### Final Assembly

**Part numbers and references—refer to Figure 15.**

1. Install O-ring (702) onto pinion cage subassembly.
2. Bolt pinion cage subassembly to case using proper number of shims to give indicated pinion setting distance which is etched on front face of pinion gear. See **Figure 11**. Tighten to 75 ft·lb<sub>f</sub> (102 N·m) torque.

3. Lower fan shaft and interstage shaft subassemblies into case simultaneously. Engage marked spiral bevel ring gear teeth with marked spiral bevel pinion tooth. The gear and pinion are match-marked when lapped and must be assembled the same way. The ring gear has the end of two teeth marked "X" and the pinion has one tooth so marked— the gears should be engaged with the X-marked pinion tooth between those marked on the ring gear. Match mark location can be checked through the inspection opening.
4. Apply a coat of Permatex® Form-a-Gasket No. 2 to surface of Geareducer case which mates with case cover. Lower case cover subassembly onto case, piloting both shaft subassemblies into their respective bores.
5. Install dowel pins (20) to align bearing bores. Fasten case cover to case with cap screws and eye bolts tightening to 75 ft·lb<sub>f</sub> (102 N·m) torque.
6. Position top interstage cap shims and install interstage bearing cap with place bolts tightening to 85-90 ft·lb<sub>f</sub> (116-122 N·m) torque.
7. Install upper fan shaft bearing cup (422) into Geareducer case cover (not illustrated).
8. Adjust shims to give proper backlash—.007–.009" normal (.178–.228mm)—between spiral bevel gears. See **Gear Setting Procedure**, page 15.
9. Fan shaft bearing must be preloaded to .001–.003" (.025–.076mm) in the following manner:
  - a. For cases that have the fan shaft lip seal, press the new lip seal into the labyrinth ring. Install labyrinth ring in case-cover initially with a quantity of shims between cover and labyrinth ring to insure that axial bearing end play exists. Tighten labyrinth ring cap screws to 35 ft·lb<sub>f</sub> (48 N·m) torque.
  - b. Mount a dial indicator to measure axial movement of fan shaft. Support indicator stand on the cover or interstage cap adjacent to fan shaft and position indicator to read on machined top surface of fan shaft
  - c. Rotate the fan shaft slowly in one direction until all downward movement stops. Rotation is necessary to align the bearing rollers and seat roller ends on cone lip. Record the dial indicator reading or zero the indicator.
  - d. Move shaft in the opposite axial direction by attaching to the shaft with a swivel joint and hoist and lifting on shaft. Lifting force should be 800 lb (363 kg) to sufficiently overcome the weight of the fan shaft assembly. Rotate the shaft slowly in one direction until all axial movement stops. Record the dial indicator reading.

## field repair



- e. The difference in dial indicator readings (steps c and d) is the initial fan shaft bearing end play. In order to achieve the prescribed preload of .001" to .003" (.025–.076mm) remove an amount of shims from between the case and labyrinth ring equal to the measured end play plus .001" to .003" . For example if the measured end play is .005" (.127mm), remove a total of .006" to .008" (.152–.203mm) in shim thickness.
- f. Tighten labyrinth ring cap screws to 35 ft·lb<sub>f</sub> (48 N·m) torque.
- g. Fill grooves of labyrinth ring and water slinger with lithium-base grease of NLGI No. 2 consistency.
- h. For cases that have the fan shaft lip seal, press the new wear sleeve into the water slinger. Install water slinger and its O-ring (**703**) on fan shaft.
10. Install inspection cover, gasket (**602**) and then fasten with the screws provided. Install the pipe plugs.
11. Install oil trough covers and gaskets (**603**).
12. Install fan shaft key and retention hardware.

**Figure 15** Final Assembly



# field repair

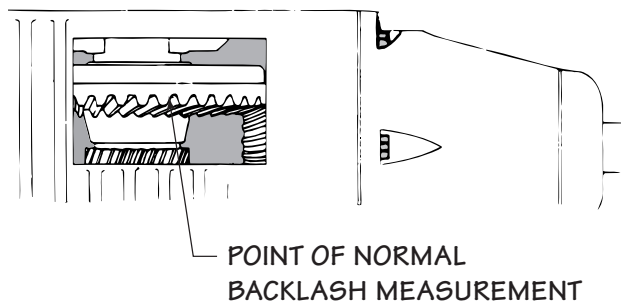
## Gear Setting Procedure

### Part numbers and references—refer to Figures 6 and 16.

The proper mounting of the gear set is essential to obtain long life and smooth operation of the gears. The pinion cage position adjustment is obtained by shims under the flange of the pinion cage. Shims are placed under the top interstage bearing cap to adjust ring gear position. The gear setting may require several attempts before obtaining the proper backlash and tooth contact pattern.

The gear and pinion are match-marked when lapped and must be assembled the same way. The ring gear has the end of two teeth marked "X" and the pinion has one tooth so marked—the gears should be engaged with the X-marked pinion tooth between those marked on the ring gear. Match marks can be checked through the inspection opening.

With the marked teeth of the gear engaged, check backlash with dial indicator—see **Figure 16**. The indicator can be installed through the inspection cover opening. Change shims under top interstage bearing cap until backlash is between .007–.009" (.178–.228mm) normal to ring gear tooth.



**Figure 16** Gear Backlash Measurement

With gears adjusted for proper backlash, blue (Prussian Blue in oil) the gear teeth. Drive the pinion by turning ring gear in both directions for several revolutions. Observe the contact pattern on both gears on both sides of the teeth. The contact pattern should be as shown in **Figure 17**.

If correct tooth contact pattern is not obtained on first attempt, refer to **Figure 17**—these illustrations show the two cases of "out-of-position contact" in the extreme. One of the remedies indicated will correct the out-of-position contact—compare the tooth contact pattern with the illustrations in **Figure 17** and choose the required remedy.

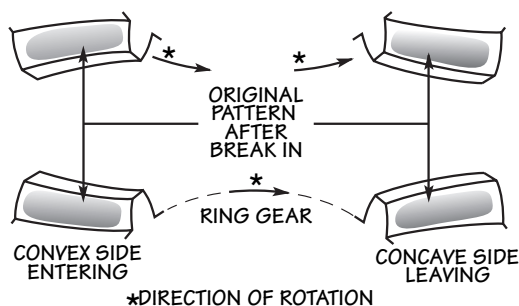
When proper tooth contact has been obtained, recheck the backlash at marked teeth. If it is within the desired range—.007–.009" (.178–.228mm), check backlash with dial indicator at two additional points 120° apart (with inspection cover removed), and as shown in **Figure 16**. All backlash readings must be within the specified range. If backlash is not within the limits, adjust ring gear height with shims until it is, checking again as described.

The tooth contact pattern should again be checked to determine if adjusting the backlash has produced any shift. If it has shifted, move the pinion in the opposite direction the gear was moved with respect to the cone center. If the gear mounting distance is reduced, increase pinion setting distance, and vice versa, (see **Figure 12**) an amount proportional to the number of teeth in the respective members. For example: on a 10 to 1 gear set, if the ring gear was moved .010" (.25mm), the pinion should be moved 0.001" (.025mm). This would be necessary only if the contact pattern had visually shifted due to movement of the ring gear while adjusting backlash.

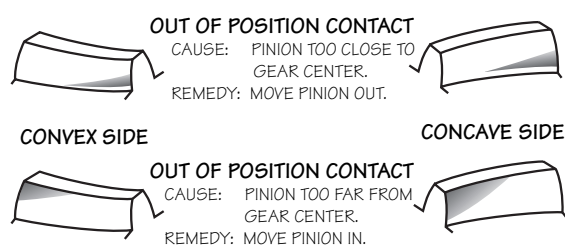
When setting a used set of gears, follow the method outlined above. However, depending upon the amount of wear, it may be necessary to set the gears up with slightly greater backlash in order to obtain proper contact. **Proper tooth contact pattern is the most important factor for correct installation.**

Should a condition be encountered where correct contact cannot be obtained as described in this manual, the Geareducer should be returned to Marley in exchange for a factory reconditioned unit.

### CORRECT PINION AND RING GEAR TOOTH CONTACT PATTERNS



### INCORRECT RING GEAR TOOTH CONTACT PATTERNS



**Figure 17** Spiral Bevel Gear Tooth Pattern







# Geareducer 3600 - 4000

USER MANUAL

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