CONTENTS

INTRODUCTION .................................................. 2
INSTALLATION .................................................. 3
HANDLING ...................................................... 3
MOUNTING OF COUPLING ..................................... 3
FOUNDATION REQUIREMENTS .................................. 3
UNIT ALIGNMENT .............................................. 3
CHECKING ALIGNMENT ....................................... 3
LUBRICATION .................................................. 3
GENERAL ...................................................... 3
TYPE AND GRADE ............................................. 5
OIL CAPACITY .................................................. 5
OVERHAUL ..................................................... 6
DISASSEMBLY ................................................ 6
SPEED REDUCER DISASSEMBLY ............................... 6
INPUT PINION DISASSEMBLY ................................ 6
GENERAL INSPECTION ....................................... 6
ASSEMBLY ..................................................... 6
SPEED REDUCER ASSEMBLY ................................ 10
PUMP ASSEMBLY ............................................. 13
MAINTENANCE ................................................ 15
PERIODIC CHECKS ........................................... 15
VARIATIONS AND OPTIONAL EQUIPMENT .................. 16
OPTIONAL EQUIPMENT ...................................... 16
VARIATIONS .................................................. 16
TROUBLESHOOTING .......................................... 17
GUIDE ......................................................... 17
PARTS LIST ................................................... 18
PARTS ORDERING ........................................... 18
This manual comprises installation and maintenance instructions for Cooling Tower Speed Reducers.

Philadelphia Gear brand cooling tower drives can be found in power plants across the globe.

Cooling tower speed reducers are usually driven by an electric motor and, most commonly, drive a fan generally mounted directly on the unit output shaft. The unit consists of a housing that contains an arrangement of shafts, pinions, and gears with appropriate bearings and seals. The reducer is equipped with a shaft-driven, reversible, lubricating pump that continuously sprays the bevel gearing and upper bearings.
INSTALLATION

HANDLING
Always move the unit by slinging it from the lifting lugs, or
eyes provided, or by rolling, using suitable bars or skates
under the unit. AT NO TIME should the shaft extensions
be used to support the unit, and care should always be taken
so as not to damage machined surfaces.

MOUNTING OF COUPLING
Prior to the mounting of couplings, a check should be
made to ascertain that there are no handling burrs on
shaft extensions and that coupling faces are true and free
of burrs or nicks. The mounting, on shaft extensions, of
any equipment that requires an interference fit should be
accomplished by heating the component to a maximum
of 350 °F. Hammering on shaft ends may cause damage to
bearings or other internal parts of the unit. Sprockets or
gears, mounted on shaft extensions, should always be
mounted as close as possible to the face of the unit to mini-
imize overhung loads.

FOUNDATION REQUIREMENTS
The unit may be mounted on structural steel or concrete.
It is imperative that the foundation for the unit be flat,
allowing the unit to sit flush at the bolt locations; or is
shimmed to accomplish this. A check with a feeler gauge
should be made before tightening mounting bolts. Simi-
larly, the foundation must be sufficiently rigid to prevent
deflection, either from the weight of the unit or from trans-
mittted load, and to control vibration.

Any deflection caused by an inadequate foundation will re-
result in misalignment or uneven loading of the housing, with
consequential danger of seriously overloading some part of
the reducer.

For easy removal of the unit, it is recommended that it be
mounted on a grouted base (i.e., soleplates) rather than
grouting the unit directly to the foundation.

UNIT ALIGNMENT
Correct alignment of the unit is essential to ensure trouble-
free service. The unit covered by this manual is designed to
operate in a horizontal position, unless specially ordered for
operating in some other position.

Particular attention should be paid to correct coupling align-
ment. If either the high-speed or low-speed shaft is coupled
to a mating shaft with a non-flexible coupling, mating
shafts must be concentric and parallel; and, when a flexible
coupling is used, eccentricity, parallel, and angular misalign-
ment must be kept within 0.005 inch total indicator read-
ing.

If pinions, sprockets, or belt pulleys are mounted, overhung
load capacity must be verified to avoid overloads. Care
must be used in the alignment of pinions and sprockets to
avoid end loading or excessive bearing tension.

Various types of misalignment and methods of checking
each are shown in figure 2. A final check should be made
after installation to ensure no misalignment has taken place
during shipment or installation.

CHECKING ALIGNMENT
The most accurate method of checking coupling alignment
is by fixing a dial indicator to one of the shafts or coupling
hubs as shown in figure 3. Procedure is as follows:

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

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

The spanner device, to which the indicator is fixed (figure
3), must be custom made for the application and become
part of the tooling for the operation. It must be made rigid
enough so as not to deflect due to the weight of the span-
ner and indicator. A deflection check can be made by
attaching the spanner and indicator to a tube or pipe. Set
the indicator to zero at the top and rotate the pipe to the
bottom. If deflection is noted, the spanner should be rein-
forced to eliminate it.

The coupled shafts in the system may likely change posi-
tion when operating under full load and normal operating
temperatures. When final alignment is made; it is necessary
to consider the operating shaft positions.

LUBRICATION

GENERAL
Lubricating oil serves a two-fold purpose in a gear unit.
First it reduces friction at the bearings and mating gear
teeth and second it carries away generated heat.

Friction is reduced because an oil film actually separates
the moving parts. The oil’s resistance to flow, which is its
viscosity, prevents it from being squeezed out from be-
tween the mating surfaces. The higher the viscosity of the
oil the thicker the oil film will be. Conversely, the higher
the pressure on the surfaces, the thinner the oil film. When
almost all the oil is squeezed away, the condition is called
boundary lubrication. During boundary lubrication, micro-
scopic high spots on the gear teeth meet metal-to-metal and
weld together. The result is initial pitting.
Fig. 2. Misalignment Examples

Fig. 3. Alignment Check
CAUTION: Units are shipped dry from the factory. If a storage preservative has been added to the unit, drain unit completely before filling with proper oil.

Before placing the unit in service it must be filled with the proper lubricating oil. The quantity of oil required by the reducer varies both with frame size and ratio; therefore, each unit must be filled to the level indicated on the oil sight gauge or dipstick. Refer to tables 1, 2, and 3 for grade, viscosity ranges, and typical trade names.

CAUTION: Do not mix or dilute different brands of oil.

### Table 1. Temperature/AGMA Lubricant Grades

<table>
<thead>
<tr>
<th>Gear Case</th>
<th>AGMA Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature, F</td>
<td>Group A</td>
</tr>
<tr>
<td>-40° to 0°</td>
<td>1</td>
</tr>
<tr>
<td>0° to 40°</td>
<td>2</td>
</tr>
<tr>
<td>40° to 100°</td>
<td>3</td>
</tr>
<tr>
<td>100° to 130°</td>
<td>4</td>
</tr>
<tr>
<td>130° to 200°</td>
<td>5</td>
</tr>
</tbody>
</table>

The oil used should be a high grade mineral oil, and shall equal AGMA specifications and quality, and be within the viscosity range given in table 2.

Mild extreme pressure (EP) lubricants are recommended due to their ability to withstand heavy tooth loads, high peak loads, shock loads, etc., where ordinary classes of oils may be unsatisfactory.

Normal service life can be anticipated from mild EP lubricants, provided the maximum bulk oil temperature does not exceed 160 degrees or fall below zero degrees F. In either case, the lubricant supplier must be consulted as to recommendations.

### Table 2. Mild EP Lubricant Viscosities

<table>
<thead>
<tr>
<th>AGMA Grade</th>
<th>Viscosity SSU at 100°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>193-235</td>
</tr>
<tr>
<td>2</td>
<td>284-347</td>
</tr>
<tr>
<td>3</td>
<td>417-510</td>
</tr>
<tr>
<td>4</td>
<td>626-765</td>
</tr>
<tr>
<td>5</td>
<td>918-1122</td>
</tr>
<tr>
<td>6</td>
<td>1335-1632</td>
</tr>
</tbody>
</table>

### Table 3. Recommended Lubricants

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Grade 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Oil</td>
<td>Omala 68</td>
<td>Omala 100</td>
<td>Omala 150</td>
<td>Omala 220</td>
<td>Omala 320</td>
</tr>
<tr>
<td>Shell Oil Co. of Calif.</td>
<td>NL Gear Comp. 68</td>
<td>NL Gear Comp. 100</td>
<td>NL Gear Comp. 150</td>
<td>NL Gear Comp. 220</td>
<td>NL Gear Comp. 320</td>
</tr>
<tr>
<td>Std. Oil Co. of Calif.</td>
<td>Texaco</td>
<td>Union Oil Co.</td>
<td>Mobil Oil Co.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OVERHAUL

DISASSEMBLY
Philadelphia Gear Corporation recommends that gear reducers needing extensive repairs be returned to the local service center for inspection and overhaul.

If necessary, repairs, including installation of replacement gear sets, can be achieved in the field. Major repairs, such as correcting the alignment of housing bores, require the use of a fully equipped machine shop. When field repair or replacement of parts is necessary, the following procedure is recommended for assembly and disassembly of the unit:

1. Remove unit to a suitable work space.
2. Necessary equipment includes a hoist, hydraulic press, dial indicator holder, surface plate, feeler gauge, and a device to heat bearing cones.

SPEED REDUCER DISASSEMBLY
Disassembly procedure for the speed reducer unit is as follows:

1. Drain lubricating oil from unit.
2. Disconnect unit from associated equipment and remove to a working area where a hoist is available.
3. Provision must be made to have necessary tools available before disassembly. These will include a hydraulic or bench press, dial indicator with magnetic holder, surface tools and a sheet of shim stock for 0.002 inch, 0.007 inch, 0.010 inch, and 0.020 inch thicknesses; and, a means to heat bearings.
4. Remove low-speed shaft key and moisture shield bearing retainer. Tag shims that are removed for later identification. (If seals are to be reused, wrap a piece of plastic or thin shim stock around shaft keyway to protect them when removing retainer.)
5. Remove cover bolts and taper pins. Attach hoist sling to eyebolts and remove cover.
6. Thread eyebolt into tapped hole in end of low-speed shaft, attach hoist and lift out.
7. As an assembly, remove bevel gear and shaft assembly.
8. Remove all retainer bolts holding input pinion assembly to housing. Remove input assembly and place on workbench for later disassembly.
9. Bearings are removed by pressing them off in a bench or hydraulic press, or by heating them with a torch. Heating, however, must be done very carefully to avoid distortion and softening.
10. Remove bottom low-speed bearing cups.
11. Wash out housing and all reusable parts very thoroughly with solvent or kerosene. Make certain all oil passages are well cleaned.

INPUT PINION DISASSEMBLY
Disassembly of the input pinion is accomplished as follows:

1. Wrap input shaft with plastic, thin shim material, or paper to protect seal when removing retainer. Remove retainer.
2. Place carrier assembly on blocks, in a vertical position, with shaft extension down. This setup may be arranged in a hydraulic press or on the workbench. Pinion with bearings is now pressed (or driven) out of the carrier.
3. Remove bearing cup from small end of carrier.
4. Bearings are also removed in a press or may be heated with a torch, until expanded enough to easily slide off. If bearings will be reused, heating must proceed very carefully, to avoid distortion and softening.
5. If seals are to be replaced, they can be removed with a mallet and drift.

GENERAL INSPECTION
Following disassembly and cleaning of parts, carry out a visual inspection checking for obvious wear and damage. Defective parts must be replaced.

ASSEMBLY
As a general aid during assembly observe and use the following instructions:

1. Wash housing and all parts thoroughly with kerosene.
2. Check new bevel gear and pinion to be sure they are a matched set. Bevel gears and pinions are lapped in matched sets at the factory and should not be separated. Match numbers are etched on the pinion and ring gears, as shown in figure 4.
3. Adjust bevel pinion and ring gear backlash as shown in figure 5. The bevel pinion will be adjusted first, for correct mounting distance; then the ring gear is adjusted to correct backlash.
4. Do not remove new bearings from carton until ready to use. Wash all bearings (new or old) with kerosene. Do not spin dry bearings. Take each bearing set and roll the cup on the cone to note any roughness. If bearings cannot be installed immediately after washing, lubricate and cover them for protection against dust, moisture, etc. Avoid touching rolling surfaces.
5. Install oil seals in bearing retainer with seal lips facing out, when assembled to unit. Do not apply mallet blows or uneven pressure directly to seal. Use a short piece of pipe with an outside diameter a little less than that of the seal. A sleeve made of light shim stock should always be used when slipping seals over shafts to protect against snagging on burrs.
6. Bearing cones may require heating to ease installation. They can be heated in an oven, with infrared lamps.
Fig. 4. Pinion and Ring Gear Match Numbers

Fig. 5. Pinion and Ring Gear Adjustment
or with oil baths, not to exceed 300°F. If this temperature is exceeded, bearings will begin to draw and soften. If an oil bath is used, bearings should be supported an inch or so above the bottom of the pan to prevent local overheating.

7. For suggested bolt torque values during assembly, refer to table 5.

8. Preferred tooth contact patterns for bevel gears are shown in figure 6. Method for correcting tooth profile errors is shown in figure 7.

<table>
<thead>
<tr>
<th>Size</th>
<th>Bolt Diam. D (in)</th>
<th>Tensile Stress Area A (sq in)</th>
<th>Proof Load (psi)</th>
<th>Clamp Load P (lb)</th>
<th>Tightening Lub K = 0.20 (lb in)</th>
<th>Torque Lub K = 0.15 (lb ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-20</td>
<td>0.250</td>
<td>0.0318</td>
<td>85000</td>
<td>2020</td>
<td>96</td>
<td>75</td>
</tr>
<tr>
<td>1/4-28</td>
<td>0.2500</td>
<td>0.0364</td>
<td></td>
<td>2320</td>
<td>120</td>
<td>86</td>
</tr>
<tr>
<td>5/16-18</td>
<td>0.3125</td>
<td>0.0524</td>
<td></td>
<td>3340</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>5/16-24</td>
<td>0.3125</td>
<td>0.0580</td>
<td></td>
<td>3700</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>3/8-16</td>
<td>0.3750</td>
<td>0.0775</td>
<td></td>
<td>4940</td>
<td>30</td>
<td>23</td>
</tr>
<tr>
<td>5/8-24</td>
<td>0.3750</td>
<td>0.0878</td>
<td></td>
<td>5600</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td>7/16-14</td>
<td>0.4375</td>
<td>0.1063</td>
<td></td>
<td>6800</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>7/16-20</td>
<td>0.4375</td>
<td>0.1187</td>
<td></td>
<td>7550</td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td>1/2-13</td>
<td>0.5000</td>
<td>0.1419</td>
<td></td>
<td>9050</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>1/2-20</td>
<td>0.5000</td>
<td>0.1599</td>
<td></td>
<td>10700</td>
<td>90</td>
<td>65</td>
</tr>
<tr>
<td>9/16-12</td>
<td>0.5625</td>
<td>0.1820</td>
<td></td>
<td>11600</td>
<td>110</td>
<td>80</td>
</tr>
<tr>
<td>9/16-18</td>
<td>0.5625</td>
<td>0.2030</td>
<td></td>
<td>12950</td>
<td>120</td>
<td>90</td>
</tr>
<tr>
<td>5/8-11</td>
<td>0.6250</td>
<td>0.2260</td>
<td></td>
<td>14400</td>
<td>150</td>
<td>110</td>
</tr>
<tr>
<td>5/8-18</td>
<td>0.6250</td>
<td>0.2560</td>
<td></td>
<td>16300</td>
<td>170</td>
<td>130</td>
</tr>
<tr>
<td>3/4-10</td>
<td>0.7500</td>
<td>0.3340</td>
<td></td>
<td>21300</td>
<td>260</td>
<td>200</td>
</tr>
<tr>
<td>3/4-16</td>
<td>0.7500</td>
<td>0.3730</td>
<td></td>
<td>23800</td>
<td>300</td>
<td>220</td>
</tr>
<tr>
<td>7/8-9</td>
<td>0.8750</td>
<td>0.4620</td>
<td></td>
<td>29400</td>
<td>430</td>
<td>320</td>
</tr>
<tr>
<td>7/8-14</td>
<td>0.8750</td>
<td>0.5090</td>
<td></td>
<td>32400</td>
<td>470</td>
<td>350</td>
</tr>
<tr>
<td>1-8</td>
<td>1.0000</td>
<td>0.6060</td>
<td></td>
<td>38600</td>
<td>640</td>
<td>480</td>
</tr>
<tr>
<td>1-12</td>
<td>1.0000</td>
<td>0.6630</td>
<td></td>
<td>42200</td>
<td>700</td>
<td>530</td>
</tr>
<tr>
<td>11/8-7</td>
<td>1.1250</td>
<td>0.7630</td>
<td>74000</td>
<td>42300</td>
<td>800</td>
<td>600</td>
</tr>
<tr>
<td>11/8-12</td>
<td>1.1250</td>
<td>0.8560</td>
<td></td>
<td>47500</td>
<td>880</td>
<td>660</td>
</tr>
<tr>
<td>11/4-7</td>
<td>1.2500</td>
<td>0.9690</td>
<td></td>
<td>53800</td>
<td>1120</td>
<td>840</td>
</tr>
<tr>
<td>11/4-12</td>
<td>1.2500</td>
<td>1.0730</td>
<td></td>
<td>59600</td>
<td>1240</td>
<td>920</td>
</tr>
<tr>
<td>13/8-6</td>
<td>1.3750</td>
<td>1.1550</td>
<td></td>
<td>64100</td>
<td>1460</td>
<td>1100</td>
</tr>
<tr>
<td>13/8-12</td>
<td>1.3750</td>
<td>1.3150</td>
<td></td>
<td>73000</td>
<td>1680</td>
<td>1260</td>
</tr>
<tr>
<td>11/2-6</td>
<td>1.5000</td>
<td>1.4050</td>
<td></td>
<td>78000</td>
<td>1940</td>
<td>1460</td>
</tr>
<tr>
<td>11/2-12</td>
<td>1.5000</td>
<td>1.5800</td>
<td></td>
<td>87700</td>
<td>2200</td>
<td>1640</td>
</tr>
</tbody>
</table>
(PINION MEMBER LEFT HAND IN ALL CASES SHOWN)

NOTE: ILLUSTRATION SHOWS LEFT HAND OF PINION MEMBER IN ALL CASES.

Fig. 6. Preferred Tooth Contact Patterns

To correct these types of profile errors, move in on pinion core.

Fig. 7. Correcting Tooth Profile Errors
SPEED REDUCER ASSEMBLY

Install internal plumbing, positioning the spray jet to spray the bevel mesh.

Install pump adapter without shims to the lower housing.
Note timing hole for correct assembly to the housing.

Press bearing cups into lower housing.

Assemble the bearing cones and bevel gear to the helical pinion.

Place the helical pinion and bevel gear assembly into the lower housing.
Note bevel gear mounting distance. Dimension A, Figure 5.

Measure from the lower housing split line to the upper surface of the bevel gear, in three places.
Record the average which is Dimension B, Figure 5.

Measure from split line of lower housing to input bore center line.
Dimension C, Figure 5.

Calculate shim thickness between pump adapter and lower housing.
Shim thickness = C - (A+B)

Apply a thin film of Permatex on the lower housing face and the pump adapter face install shims and assemble.

Assemble low speed gear, shaft and bearing cones.

Place low speed assembly output shaft and bevel gear assembly in lower housing.

Coat the lower housing split line with Permatex sealant.

Mount upper gearcase on lower housing, install dowel pins and bolts.

Shim between upper bearing retainer and housing to give .001-.003 bearing clearance on bevel gear/helical pinion assembly, and zero to .002 clearance between bearings on the output shaft.
DO NOT PRELOAD BEARINGS.
Assemble seals to output shaft bearing retainer. Fill cavity between seals with grease. Assemble to unit.

Pack moisture shield with grease and press down on shaft shoulder just short of touching the retainer.

![Figure 8](image)

Assemble spiral bevel pinion as shown in Figure 8.

Press bearing cups into housing and inner bearing cone on spiral bevel pinion.

Place pinion and bearing assembly in the housing and assemble the outer bearing, flat washer, lockwasher and nut.

Tighten the nut until a drag torque increase of 3 to 5 inch pounds on the pinion is obtained.

Bend a tang on the lockwasher into a slot on the nut.

Press the seals into the seal retainer and fill area between the seals with multi-purpose grease.

Assemble the seal retainer to the pinion housing.

Coat 3-4 spiral bevel pinion and gear teeth with soft bluing for tooth check.

Using .090 shims between the pinion housing and lower gearcase check the backlash between the bevel pinion and gear.
Backlash should be between .007 and .015.

Bevel gear and bevel pinion shims can now be adjusted to obtain tooth contact shown in Figure 6.

Rotate pinion one and one-third revolutions and check the backlash. Allowable backlash variation at any position is -.002 to +.004 from the initial reading.
Before initial start of pump (after servicing), it is recommended that oil be introduced into the pump ports to insure wetting of the rotation elements. Also check alignment and rotation of the driver to see that pump will rotate in the designated proper direction of rotation.

**Pump Disassembly & Inspection**

Mark cover, housing and bracket for proper alignment when reassembling.

Remove cover cap screws (10), cover (3), idler (2), and rotor (5) from housing (4) and thoroughly clean all parts.

The individual parts should be inspected for damage. The keyway in the end of the rotor shaft must be in good condition. There must not be any grooves or deep scratches on the following surfaces:

- a. The I.D. surface in the housing.
- b. The O.D. of the rotor.
- c. The end face of the rotor.
- d. The O.D. of the idler.
- e. Both faces on the idler.
- f. The inside surfaces of the cover including the surfaces on the crescent.

The rotor should be positioned in bracket and checked for clearance in the bearing. The shaft must turn freely without any detectable side play. Excessive side play will require replacement of the housing, rotor, bracket or all three parts.

The idler must turn freely on the idler pin in the pump cover without any detectable side play.

**Reassembly**

1. Clean all parts thoroughly, using great care to eliminate all dirt.
2. Install rotor (5) in bracket (1).
3. Position a minimum of .006" total thickness of plastic material gaskets over mounting registers of each bracket and cover.

CAUTION: A minimum of .006" thick gaskets are required to prevent bracket and cover registers from bottoming in housing counterbores.

**NOTE:** Gaskets of various thickness are supplied so that proper internal end clearances are obtained. This clearance depends upon the size of the pump and viscosity of the lubricant handled. Select gasket thickness to obtain minimum end clearances as follows:

<table>
<thead>
<tr>
<th>No. 2 Size Pump</th>
<th>.001&quot; to .002&quot; clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 3 &amp; 4 Size Pumps</td>
<td>.002&quot; to .003&quot; clearance</td>
</tr>
<tr>
<td>No. 5 &amp; 6 Size Pumps</td>
<td>.003&quot; to .005&quot; clearance</td>
</tr>
</tbody>
</table>

4. Install housing over rotor head and position on bracket register.

5. Apply idler to cover and position in housing register. Align matching marks for proper location. In “R” series pumps, check position of boss on cover to be certain it is located on the suction side of the pump. Check position of vent plugs in bracket.

6. Install cover cap screws.

**NOTE:** Pull down gradually and evenly when tightening cap screws. The shaft should be revolved slowly as the cap screws are tightened gradually. Not one fastened down to the limit and another, and so on, but each screw, in its turn, tightened a little at a time until all finally become secure and the shaft turns freely without and detectable end play or binding.
PUMP TROUBLE SHOOTING

NO OIL IS DELIVERED
a. Suction lift too high for vapor pressures of liquid pumped.
b. Bad leaks in suction line or port passages can be detected by submerging line from discharge side of pump into a bucket of water where the air will be seen in the form of bubbles.
c. Wrong direction of shaft rotation. In “R” models, check position of cover base.
d. Pump shaft not rotating. Check coupling.
e. Relief valve setting too low, discharging oil through by-pass piping.

CAPACITY IS TOO LOW
a. Suction lift is too high.
b. Air leaks in suction line.
c. Pump speed too slow.
d. Strainer or filter obstructed.
e. Oil level too low.
f. Increased clearances or wear in the pump will sometimes cause the pump to deliver an insufficient supply of oil. This can generally be corrected by reducing the thickness of cover gaskets. Great care must be exercised in this operation. A folded gasket or a slight amount of dirt not only will frequently exaggerate the original trouble but will also be the cause of leakage.
Refer to assembly pump note for minimum and clearances.

PUMP WORKS ERRATICALLY
a. Leaky suction line.
b. Air or vapor in oil.
c. Check for damaged coupling.

PUMP IS NOISY
a. Unit, or associated equipment is acting as a sounding board.
b. Pump vibration because of bent shaft or worn parts.
c. Air leaks on suction side of pump.

PUMP LEAKS
a. Cover bolts require tightening, or cover gasket is defective. Check minimum gasket thickness as described under “Reassembly.”

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>PART NO.</th>
<th>PART NAME</th>
<th>NO./UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>Bracket Assembly</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>Idler Assembly</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>Cover Assembly</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
<td>Housing</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>24</td>
<td>Rotor</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>34</td>
<td>Gasket</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Cover Bolts</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Pump Mounting Bolts</td>
<td>4</td>
</tr>
</tbody>
</table>
MAINTENANCE

PERIODIC CHECKS

Carry out routine maintenance on the speed reducer as follows:

1. After initial three months of service, and at annual intervals thereafter, oil in the unit must be filtered and a sample submitted to the oil manufacturer's laboratory to determine if replacement is necessary. If a laboratory oil check is not carried out, it is recommended that the oil be replaced annually.

2. Every week check oil level in the unit and, if necessary, replenish oil to proper level.

3. On installations where a remote oil standpipe is connected to the unit, periodically check that the indicated oil level both at the unit and at the standpipe are in the same horizontal place. If necessary, adjust the full level indicator on the standpipe to the full level indicator on the unit. This will preclude false oil level indications at the remote standpipe.

4. Periodically ensure that there is no water or other contaminants in the lubricating oil. In winter, when a cooling cell may be inoperative for some period of time, it is possible for entrained water to freeze and cause damage to the lubricating pump. Water also prevents or diminishes the ability of oil to form the adequate films that prevent metal-to-metal contact on gear tooth surfaces.

5. Periodically check bearings and flow and adjust as necessary. Loose bearings lead to additional damage when shock loads occur.

6. Periodically inspect internal components of the unit. Heavily pitted gears will be susceptible to failure since their strength will be weakened. On units where a bevel gear-center is bolted to a pinion, ensure that attaching bolts are tight and lockwired in place.

7. Periodically inspect the upper gear case assembly. There should be no evidence of wear or damage at the low-speed pinion bearing area.

8. Periodically lubricate (with grease gun) the seals in bearing retainer, serving high-speed input pinion and low-speed gear shaft.
VARIATIONS AND OPTIONAL EQUIPMENT

OPTIONAL EQUIPMENT

The most commonly supplied optional equipment, with the speed reducer, is an oil sump heater, oil pressure switch, and oil filter. This equipment is furnished in various configurations and by numerous suppliers. For performance and maintenance data of optional equipment supplied, refer to applicable manufacturer's technical data.

VARIATIONS - BEVEL PINION ASSEMBLY

Assemble roller bearing and inner taper bearing cup into carrier.
Lock roller bearing in the carrier with a bolt and washer.

Slide bevel pinion into carrier and assemble the two bearing cones, spacer and cup. Clamp with bearing lockwasher nut and spacer, tighten nut to 150-200 foot pounds, bend tab on lockwash into a slot on the nut.

Assemble seals to seal retainer, and pack grease between seal lips to fill the cavity.

 Shim between the seal retainer and carrier to give .001 press to .001 clearance on the bearing cups.
<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>LOOK FOR</th>
<th>REMEDY</th>
</tr>
</thead>
</table>
| A. Noisy gears.        | 1. Poor tooth contact.  
3. Worn bearings.  
4. Warped ring gear.  
5. Worn gear set.  
7. Contaminated oil.  
8. Dust and moisture shield rubbing gear case. | Check high speed bearing wear. There should be no movement in pinion other than normal backlash. All bearings are preloaded at factory and have no side or end play. Take off inspection cover. Inspect gear tooth contact with flashlight. There should be no larger metal particles or wear on the teeth of the ring gear or pinion. Check oil for proper level and for contamination. Have bearings, oil seals, or gear sets replaced if worn. Recheck tooth contact. A noisy gear unit is not necessarily a bad unit. Replace all bearings and oil seals. Check tooth contact. All oil to proper level. Replace contaminated oil. |
| B. Noisy bearings.     | 1. Gravelly sound.  
2. Low oil.  
3. Contaminated oil.  
4. Bearing fatigue. | Replace all bearings and oil seals. Check tooth contact. Add oil to proper level. Replace contaminated oil. |
| C. Movement in pinion shaft. | 1. Worn high speed bearings (no movement of pinion in, out, up or down is allowed). Apply pressure on pinion.  
Look carefully at oil seals for movement. | Replace all bearings and oil seals. Check tooth contact after replacing gears. |
| D. Movement in low speed shaft. | 1. Worn low speed bearings (no sidewise movement in low speed shaft is allowed. Lift up and down on tip of fan blade.)  
| E. Water in oil.      | 1. Broken or plugged vent line.  
2. Loose inspection plug, loose gear inspection plate, loose or missing cap screws.  
3. Oil seals worn due to worn bearings.  
4. Gear units out of service for period longer than one week.  
5. Water in oil storage container. | Have all bearings and oil seals replaced. Check tooth contact of gears after replacing bearings. |
| F. Throwing oil at oil seals. | 1. Worn oil seals.  
2. Worn bearings.  
3. Plugged oil vent.  
4. High oil level or foaming of oil. | Inspect gear vent line and gear inspection holes. Replace loose or missing cap screws. Replace all bearings and seals if any are noisy or throwing oil. Run gear units for a ten (10) minute period once a week if there is a lengthy shutdown period. Keep oil in an airtight container stored in a dry place. Never store spare oil in weather. Check for leaking heat exchanger. |
| G. Oil leak from a fitting, cap screws, gear case, inspection plug or drain plug. | 1. Loose or misaligned bearing retainers.  
2. Dirty or distorted adjustment shims.  
3. Loose or cracked elbow, plug or plate.  
4. Sand hole in casting. | Inspect for worn bearings. Replace oil seals if bearings are quite and light. Replace all bearings and oil seals if bearings are worn. Oil should rise in oil fill line. Do not fill oil above oil level line. Do not fill gear unit while unit is running. Use only recommended oils. |
| H. Low oil.            | 1. Be sure monthly oil level check is maintained.  
2. Oil leak. | Tighten all cap screws, clean adjustment shims and use sealing compound on metal-to-metal seals if necessary. Renew inspection plate gasket, tighten cap screws. Replace any cracked or distorted fittings.  
Add oil, locate oil leak and correct. |
PHILADELPHIA GEAR
CONTACT INFORMATION

US Locations

Corporate Office & Technical Center
King of Prussia, PA
Toll free: 800.766.5120
Outside US: +1.610.265.3000

Northeast Service Center
New Castle, DE
Toll free: 800.388.1824
Outside US: +1.302.633.4600

Southeast Service Center
Birmingham, AL
Toll free: 888.742.2476
Outside US: +1.205.424.0442

Gulf Coast Service Center
Houston, TX
Toll free: 800.874.0270
Outside US: +1.713.224.4900

Midwest Service Center
Chicago, IL
Toll free: 800.833.4429
Outside US: +1.708.720.9400

Western Service Center
Los Angeles, CA
Toll free: 800.605.1002
Outside US: +1.310.605.2600

International Locations

Latin America Sales Office
Queretaro, Mexico
Phone: +52 442 2239774

Europe Sales Office
The Netherlands
Phone: +31 (0) 68 190 4558

Middle East Sales Office
Dubai, United Arab Emirates
Phone: +971 (0) 4 881 5427

Asia Sales Office
Chengdu, Sichuan, China
Phone: +86 28 86507200