

# **amarillo**

## **AMARILLO PUMP DRIVES**

### **MODEL 1000A, 1200, 1500, 1800**

#### **INSTRUCTIONS FOR REPAIRING**

#### **MARCH 1, 1993**

## **AMARILLO GEAR COMPANY**

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**INSTRUCTIONS FOR REPAIRING**  
**AMARILLO RIGHT ANGLE GEAR DRIVES**  
**MODELS 1000A, 1200, 1500, AND 1800**  
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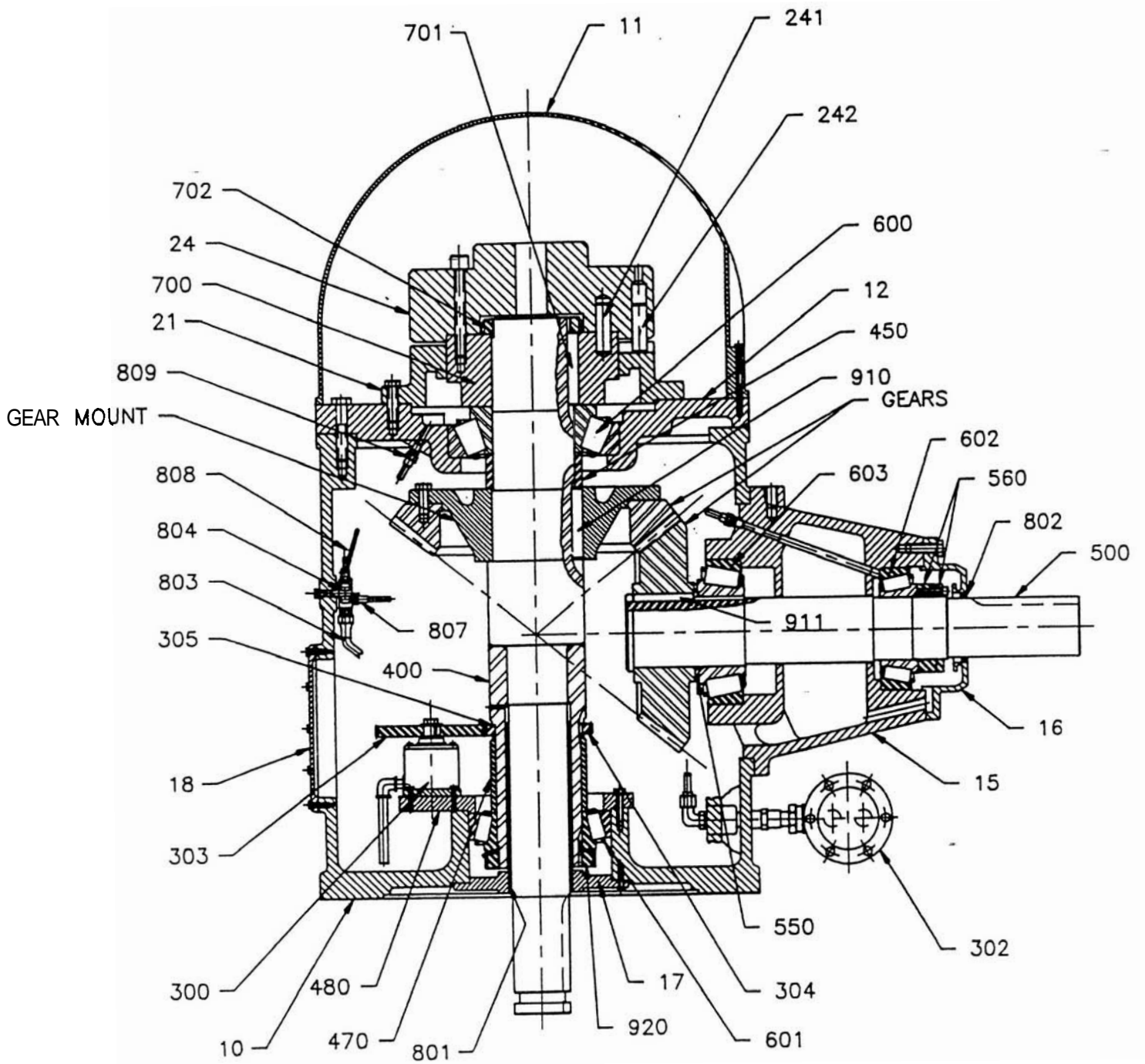
Amarillo Right Angle Pump Drives, if properly installed and maintained, should provide years of service with a minimum amount of maintenance. Repairs, when required, usually involve bearing or gear replacement. While the job is not difficult, it should only be performed in an adequately equipped shop by capable personnel. It should be noted that any repairs made outside the factory without the consent of the manufacturer will void the warranty.

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## 1.0 General Disassembly Instructions.

- 1.1 Refer to the appropriate cross sectional drawing during disassembly. See Figures 1, 2 and 3.
- 1.2 Drain and dispose of the oil.
- 1.3 Remove the rear inspection plate (18) and side inspection plate (not shown).
- 1.4 Reach through the side inspection opening and disconnect the oil line(s) going to the outer horizontal bearing (602). **Note:** On some models this oil line is plumbed from the heat exchanger and is external to the gear case.
- 1.5 Loosen the two pipe fittings on the heat exchanger (302) and remove the heat exchanger and mounting brackets.
- 1.6 Match mark the horizontal shaft carrier (14 or 15R) and the gear case (10).
- 1.7 Remove the horizontal carrier (14 or 15R) from the gear case (10) using the following procedure.
  - 1.7.1 Install guide pins in two bolt holes on opposite sides of the horizontal carrier.
  - 1.7.2 A quick jerk up and down on the end of the horizontal shaft (500) will usually pull the horizontal carrier out of the gear case. If the carrier remains in place, deliver a sharp blow using a soft mallet to the side of the shaft. This should loosen the horizontal carrier so that it can be pried out of the gear case. Take care not to damage the gasket.
  - 1.7.3 On models having a single piece horizontal carrier (see Figure 1 or 3), guide the horizontal carrier (14) assembly out of the gear case (10) using a hoist. Proceed to step 1.8.
  - 1.7.4 On models having a two piece horizontal carrier (see Figure 2), pull the horizontal carrier (15R) out far enough to allow it to clear the gear case register.
  - 1.7.5 After placing hoist hooks in two upper bolt holes of the horizontal carrier, remove the guide pins.
  - 1.7.6 Lower the horizontal carrier assembly and guide it out of the gear case (10) using care to avoid contact between the inner bearing carrier and the vertical gear.



**Figure 1**  
**SSL Model**  
**Single Piece Horizontal Carrier**  
**With Non-Reverse**

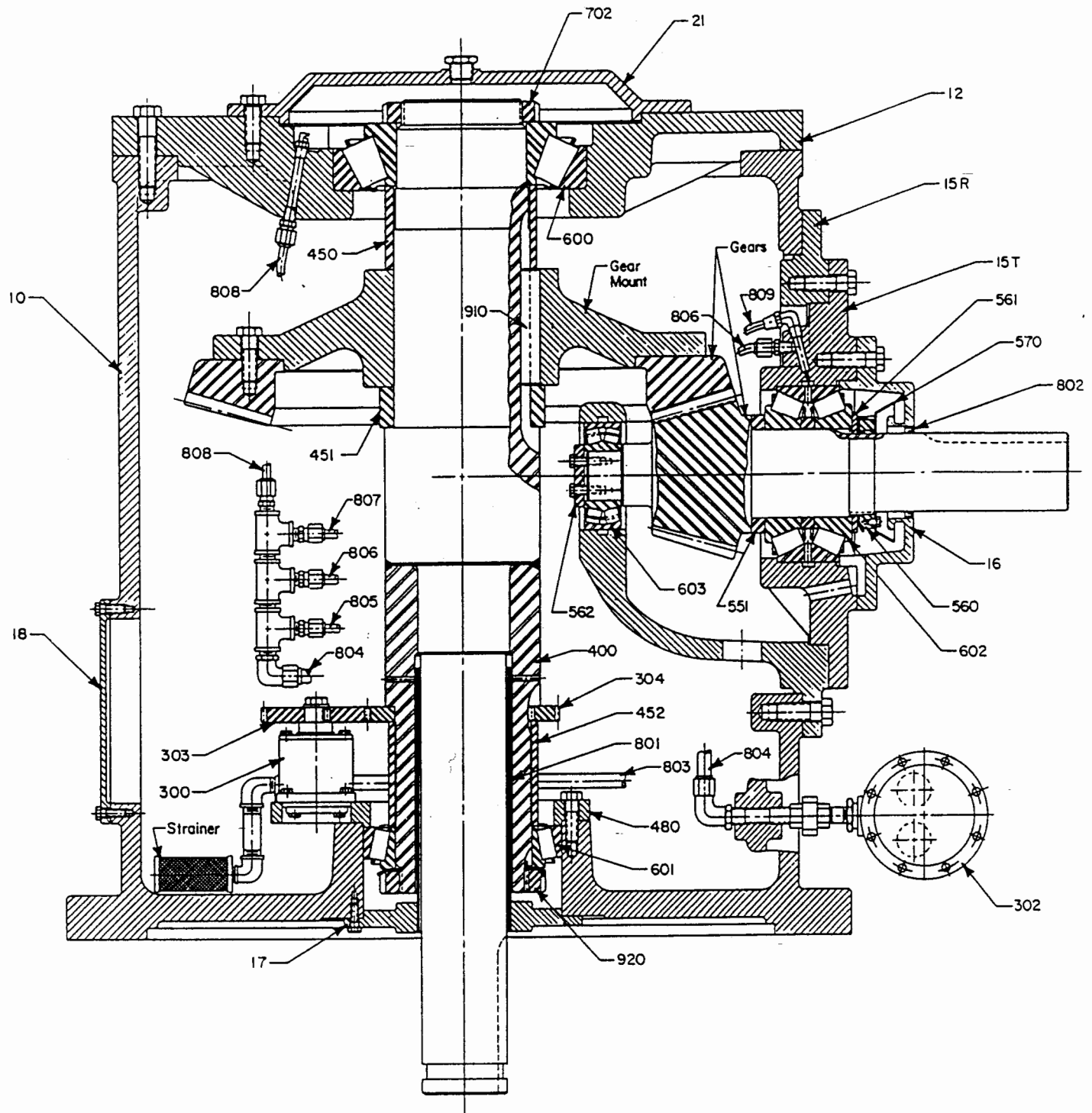
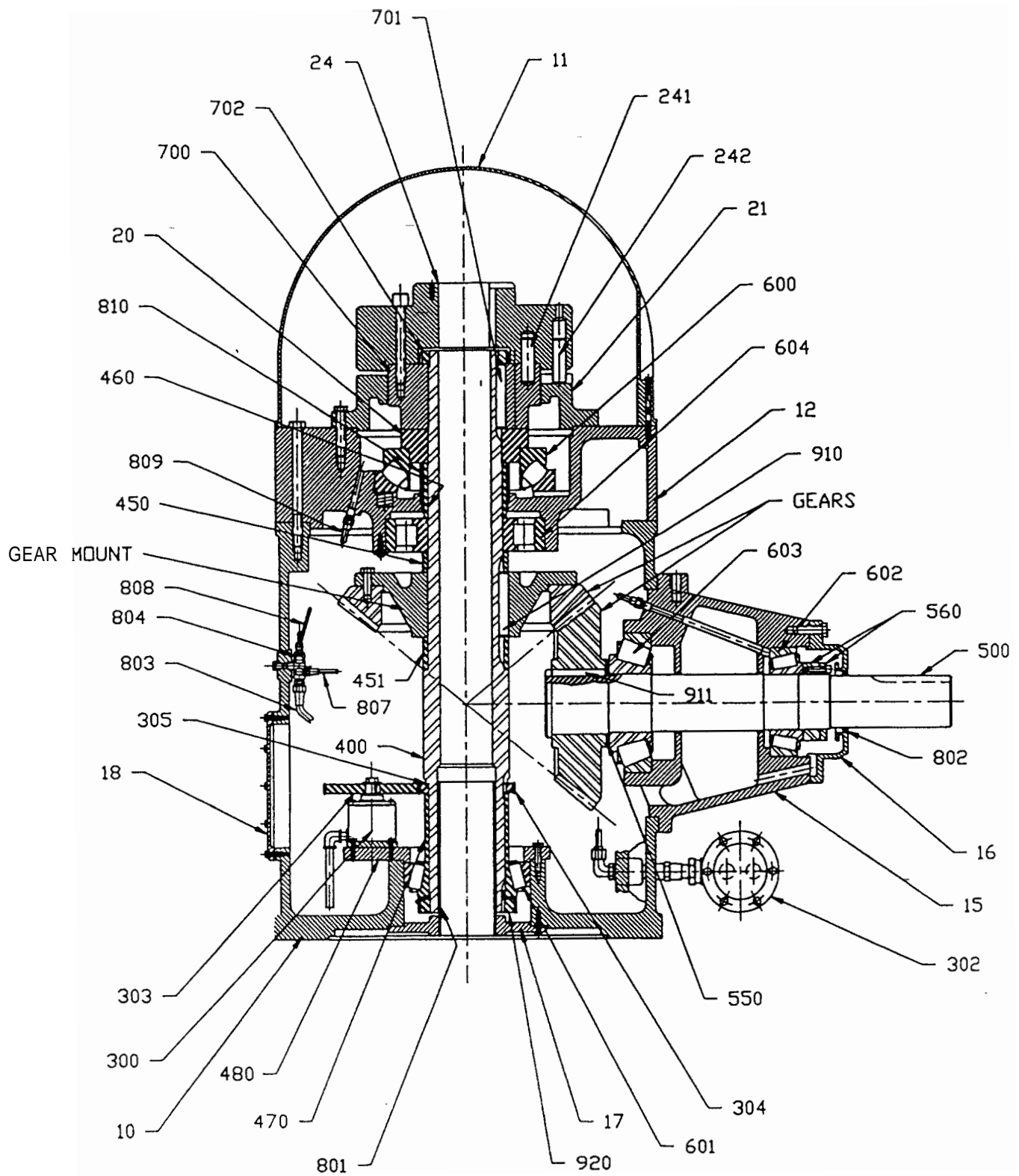


Figure 2  
 SSL Model  
 Two Piece Horizontal Carrier  
 Without Non-Reverse



**Figure 3**  
**S Model**  
**Single Piece Horizontal Carrier**  
**With Non-Reverse**

- 1.8 Reach through the horizontal opening left by the carrier and remove the oil line to the thrust bearing carrier (12) and remove the oil line between the pump discharge and the gear case.
- 1.9 Reach through the rear inspection port and remove the spur gear (303) from the oil pump (300).
- 1.10 On models with non-reverse (see Figure 1 or 3), remove the top cover (11) and non-reverse clutch (24).
- 1.11 Match mark the thrust bearing cover (21) and the thrust bearing carrier (12), then remove the thrust bearing-cover.
- 1.12 Install allthread, 180° apart, into two holes used to secure the thrust bearing cover (21). Place a draw bar, washers, and nuts over the allthread and tighten the draw bar until no movement in the vertical assembly is detectable.
- 1.13 Reach through the horizontal opening in the gear case and remove the cap screws in the oil pump mounting plate (480).
- 1.14 Lift the mounting plate (480) and remove the shims. **Note:** The shims are in two halves and should be kept separate.
- 1.15 Rotate the oil pump mounting plate (480) around until the oil pump (300) is next to the horizontal opening in the gear case.
- 1.16 Remove the oil pump (300) by removing the four cap screws.
- 1.17 Match mark the thrust bearing carrier (12) and the gear case (10). Remove the cap screws and eye bolts in the thrust bearing carrier (12). Note the position of the two eyebolts.
- 1.18 Attach a hoist to the draw bar and slowly raise the vertical shaft assembly, taking care not to damage the oil tube (801) or remaining oil lines.
- 1.19 Carefully set the assembly on a clean work surface, taking care not to damage the lower bearing (601). Remove the draw bar.
- 1.20 If replacing the oil tube (801), remove the bottom plug (17) from the gear case (10) and replace with a new bottom plug/oil tube assembly.



## 2.0 Disassembly of the Vertical Shaft Assembly.

**Note:** Each gear drive contains several spacers. These spacers are not interchangeable. Note the location of each spacer during disassembly to assure proper reassembly.

2.1 Remove the drive sleeve locknut (702) using a drift punch or spanner wrench.

**Note:** On Models without a non-reverse mechanism (see Fig. 2), proceed to Step 2.3.

2.2 The following steps will use a port-a-power between a spreader bar and vertical shaft (400) and allthread to pull components off of the vertical shaft.

2.2.1 Thread the allthread into the drive sleeve (700), pull the drive sleeve off of the shaft. Some heat may be required to make the drive sleeve easier to remove. Be careful not to overheat the drive sleeve. Remove the drive sleeve key. **Note:** On some models the thrust bearing (600) is pressed on the drive sleeve. If a tapered roller thrust bearing is pressed on the drive sleeve, the thrust bearing carrier (12) can now be lifted off of the vertical shaft and Step 2.2.2 may be skipped.

2.2.2 Thread the allthread into the threaded holes used to secure the thrust bearing cover (11). Pull the thrust bearing carrier off of the shaft (400).

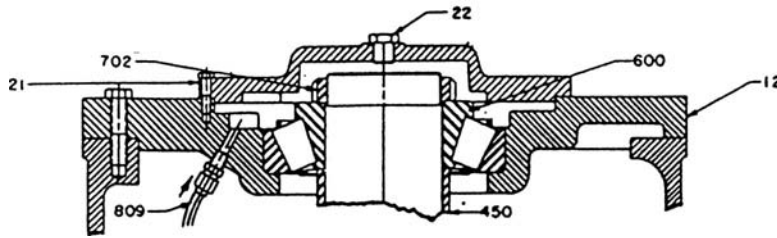
2.3 Remove the vertical spacer (450) and orient the assembly with the top of the vertical shaft (400) up and place in a press.

2.4a For SL or SSL models using a tapered roller thrust bearing (see Figure 4), use the following procedure.

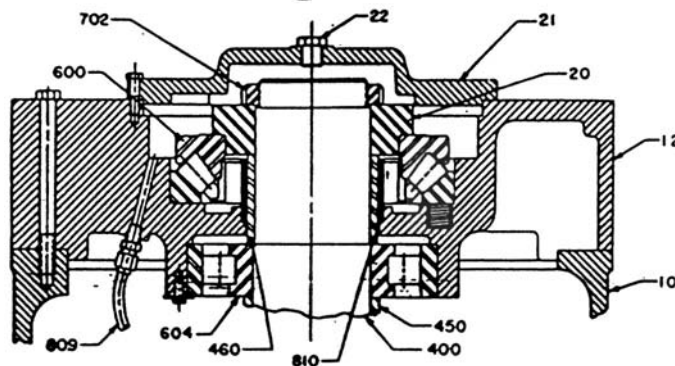
2.4a.1 If the gear mount is being replaced, press off the gear mount/gear assembly by blocking under the gear mount and pressing on the end of the shaft (400). Remove the vertical shaft gear key (910) and under gear spacer (451), if present.

2.4a.2 Remove the thrust bearing cup (600) from the thrust bearing carrier (12) with a brass punch or a bearing puller.

- 2.4b For S, SS, SH, or SSH models using a spherical roller thrust bearing (see Figure 5), use the following procedure.
- 2.4b.1 Press off the gear mount/gear assembly and inner race of the upper radial bearing (604) by blocking under the gear mount and pressing on the end of the shaft (400). Remove the vertical shaft gear key (910) and under gear spacer (451), if present.
  - 2.4b.2 Remove the thrust bearing (600) and springs from the thrust bearing carrier (12).
  - 2.4b.3 Remove the two screws and washers retaining the upper radial bearing (604).
  - 2.4b.4 Pipe plugs are located on the top side of the thrust bearing carrier (12) in two of the raised surfaces between the springs. Remove the pipe plugs to expose the knock-out holes, then remove outer race of the radial bearing (604) using a drift punch.
  - 2.4b.5 Remove the thrust bearing cone (600) from the bearing bushing (20). **Note:** On some models the thrust bearing cone will be pressed on the drive sleeve (700).



**Figure 4**  
**SL & SSL Models Using Tapered Roller Bearings**



**Figure 5**  
**S, SH, SS, & SSH Models Using Spherical Roller Bearings**

- 2.5 Bend the tab of the keyed washer out of the groove in the lower bearing locknut (920) and remove the locknut using a spanner wrench or drift punch.
- 2.6 Insert allthread in two holes, 180° apart, in the oil pump mounting plate (480). Place a spreader bar, washers, and nuts on the allthread. Be sure to leave enough room to place a porta-power ram between the spreader bar and the end of the shaft (400).
- 2.7 Ensure that the oil pump mounting plate (480) is centered with the outer race of the lower bearing (601). Slowly apply pressure to the porta-power and pull the lower bearing off of the shaft (400).
- 2.8 Slide the lower bearing spacer (470) off of the vertical shaft (400).
- 2.9 If replacing the oil pump spur gears, remove the vertical shaft spur gear (304) and key. A soft mallet may be used to tap the spur gear to start it moving on the journal.
- 2.10 If the gear is being replaced, remove the bolts holding the gear to the gear mount. If the gear mount is still pressed on the shaft (400), slide the gear off the end of the shaft.

- 3.0 Disassembly of the Horizontal Shaft Assembly for Models with Single Piece Horizontal Carrier (See Figure 1 or 3).**
- 3.1 Match mark the oil seal plate (16) and the horizontal carrier (14).
  - 3.2 Remove the oil seal plate (16).
  - 3.3 Loosen the horizontal locknut set (560) from the end of the horizontal shaft (500) by removing the socket head cap screws. Note the orientation of the oil slinger (570), if present, and remove it from the horizontal shaft.
  - 3.4 Remove the locknut set with a spanner wrench or drift punch. Remove the thinner portion first. (Right Hand Threads)
  - 3.5 Place the horizontal assembly in a press with the pinion down. Remove the horizontal carrier (14) and outer bearing (602) by blocking under the horizontal carrier and pressing on the end of the shaft (500).
  - 3.6 For models with a locknut retaining the gear proceed as follows:
    - 3.6.1 Bend the tab of the keyed washer out of the locknut groove. Remove the locknut using a drift punch or spanner wrench. (Right Hand Threads)
    - 3.6.2 Orient the horizontal shaft (500) vertically with the gear up. Remove the pinion (and gear mount if present) by blocking under the pinion (or gear mount) and pressing on the end of the shaft.
    - 3.6.3 Turn the horizontal shaft (500) over and remove the inner bearing cone (603) by blocking under the inner race and pressing on the end of the shaft.
  - 3.7 For models without a gear retainer, use the following procedure.
    - 3.7.1 Orient the horizontal shaft (500) vertically with the pinion down.
    - 3.7.2 Remove the pinion (and gear mount if present) and inner bearing cone (603) by blocking under the pinion and pressing on the end of the shaft (500).
  - 3.8 Remove the horizontal shaft gear key (911).
  - 3.9 Remove the inner and outer bearing cups (602 & 603) from the horizontal carrier (14) using a brass punch or bearing puller.

- 4.0 Disassembly of the Horizontal Shaft Assembly for Models with Two Piece Horizontal Carrier (See Figure 2).**
- 4.1 Match mark the inner horizontal bearing carrier (15R) and outer horizontal bearing carrier (15T).
  - 4.2 Separate the inner horizontal bearing carrier (15R) from the outer horizontal bearing carrier (15T).
  - 4.3 Match mark the oil seal plate (16-) and the outer horizontal carrier (15T). Remove the oil seal plate.
  - 4.4 Note the orientation of the oil slinger (570), if present, and remove it from the horizontal locknut set (560).
  - 4.5 Bend the tab of the keyed washer out of the locknut groove (560) and remove the locknut using a spanner wrench or drift punch. (Right Hand Threads)
  - 4.6 Two types of inner bearing retainers (562) are used on these models. One type is a locknut, the other type is a plate bolted to the end of the shaft.
    - 4.6.1 Remove the plate type retainer (562) by removing the two cap screws.
    - 4.6.2 For the locknut type, bend the tab of the keyed washer out of the locknut groove (562). Remove the locknut using a drift punch or spanner wrench. (Right Hand Threads).
  - 4.7 Using a bearing puller, remove the inner bearing (603). Remove the inner spacer, if present.
  - 4.8 Place the horizontal assembly in a press with the pinion down. Remove the outer horizontal bearing set (602) by blocking under the horizontal bearing carrier (15T) and pressing on the end of the shaft (500).
  - 4.9 Remove the outer bearing cup (602) from the outer horizontal bearing carrier (15T) using a brass punch or bearing puller.
- Note:** If the pinion is an integral part of the horizontal shaft, proceed to step 4.11.
- 4.10 Turn the shaft (500) over so that the pinion is up and remove the pinion by blocking under the pinion with a pressing ring and pressing on the end of the shaft (500). Turn the shaft over so that the pinion is down.
  - 4.11 Remove the inner cone of the horizontal outer bearing (602) by blocking under the bearing and pressing on the end of the shaft (500).

## 5.0 General Assembly Instructions.

- 5.1 Wash all disassembled parts and housings thoroughly with clean solvent. Clean out all oil lines.
- 5.2 Check the new gear set (if required) to make sure it is a matched set. Our gears are lapped in matched sets at the factory and must not be separated. Each set of gears is assigned a serial number which is etched on each member of a set. Along with the serial number, the mounting distance, part number, and minimum amount of backlash is etched on each member.
- 5.3 Do not remove bearings from their cartons until they are needed for use. Wash all bearings in clean solvent. DO NOT spin dry the bearings with pressurized air. Lubricate each bearing and roll the cone in its cup to check for any roughness. To protect against contamination, cover any bearing that is not going to be used immediately.
- 5.4 Inspect new replacement parts to ensure that there are no burrs on shoulders that could cause assembly problems. Check for burrs on keys and keyways. Ensure that keys fit properly in keyways and have a chamfer or radius on their edges.
- 5.5 When pressing ANY component on a shaft or into a housing, **ALWAYS** use an antigalling compound.
- 5.6 The correct gear positions are obtained through the use of spacers (450 & 550 or 551). The required spacer lengths will vary with changes in the mounting distances (M.D.) of the gears. Spacer lengths should be changed if the M.D. of the new gear differs more than 0.003 inch from the M.D. of the old gear. Usually spacer changes are not required when replacing bearings. If the gear case (10) or horizontal carrier (14, 15R, or 15T) is replaced, the assembled castings will have to be remeasured and the spacers changed accordingly. Note: On some models the horizontal spacer is integral with the horizontal shaft (500).

## 6.0 Assembly of Parts on the Vertical Shaft.

**Note:** If the gear mount was not removed from the vertical shaft, proceed to Step 6.4.

6.1 Slide the under gear spacer (451) onto the vertical shaft.

6.2 Insert the vertical gear key (910) into the vertical shaft keyway.

6.3 Press the gear mount onto the shaft (400). Make sure that the gear mount is pressed tightly against the under gear-spacer.

**Note:** If a new gear mount was installed in Step 6.3, proceed to Step 13.

6.4 Bolt the gear to the gear mount.

6.5 Invert the vertical shaft (400) so that the gear is down, and insert the spur gear key.

6.6 Slide the spur gear (304) and spur gear spacer (452) onto the shaft (400). If necessary use the spacer to tap the spur against the shoulder.

6.7 Slide the oil pump mounting plate (480) and lower radial bearing cup (601) onto the vertical shaft (400) and press on the bearing cone. Take care not to damage the bearing roller cage.

6.8 Slide the keyed washer onto the end of the shaft (400) and thread on the locknut (920).

6.9 Tighten the locknut securely using a spanner wrench and bend a tab of the keyed washer into a groove on the locknut.

6.10a For SL or SSL Models using a tapered roller thrust bearing use the following procedure (see Figures 1 & 4).

6.10a.1 Press the bearing cup (600) into the thrust bearing carrier (12).

6.10a.2 Turn the shaft (400) over, slide the vertical spacer (450) onto the shaft, and set the thrust bearing carrier on the gear mount.

6.10a.3 Press the bearing cone (600) on the shaft (400). Take care not to damage the bearing roller cage.

6.10b For S, SS, SH, and SSH Models using a spherical roller thrust bearing use the following procedure. (see Figures 3 and 5)

6.10b.1 Slide the outer race of the upper radial bearing (604) into the thrust bearing carrier (12). Secure with two cap screws and washers.

6.10b.2 Install the pipe plugs removed in Step 2.7b.3. Pour some oil around the interface between the oil tube (810) and thrust bearing carrier (12). Ensure that fit is tight enough to prevent oil leakage through the thrust bearing carrier.

6.10b.3 Turn the shaft over and slide on the vertical spacer (450) and press on the upper radial bearing (604).

6.10b.4 Place the pre-load springs in the recessed areas of the thrust bearing carrier (12). Check the pre-load springs to ensure they still have the proper temper. The top of the spring should protrude approximately 3/8" above the outer race seating surface on the thrust bearing carrier.

6.10b.5 Set the outer race of the thrust bearing (600) on top of the pre-load springs.

6.10b.6 Press the inner race of the thrust bearing (600) onto the bearing bushing (20). Note: On some models the thrust bearing (600) is pressed on the drive sleeve (700).

6.10b.7 Set the thrust bearing carrier down over the radial bearing. Slide on the bearing spacer (460) and press the bearing bushing/inner race assembly (20/600) onto the shaft (400).

**Note:** On Models without a non-reverse mechanism, proceed to Step 6.13.

6.11 Insert the drive sleeve key (701) into the vertical shaft keyway.

6.12 Press the drive sleeve (700) on the vertical shaft (400).

**Note:** **Make sure** that all components are pressed together tightly, shoulder to shoulder. Spacers should not spin freely on the shaft. If the assembly is not tightly pressed together, it will **not** be possible to obtain correct bearing and gear settings.

6.13 Thread the drive sleeve locknut (702) on the shaft (400) and tighten securely using a spanner wrench or drift punch.



- 6.14 Install allthread, 180' apart, into two holes used to secure the thrust bearing cover (21). Place a draw bar, washers, and nuts over the allthread and tighten the draw bar until the thrust bearing (600) has compressed the springs and seated in the thrust bearing carrier (12). This will require a force of approximately 7,100 lb.
- 6.15 Coat the top of the gear case (10) with plastic lead seal (or equivalent).
- 6.16 Using a hoist attached to the draw bar, slowly lower the vertical assembly into the gear case (10). Take care not to damage the oil tube (801) or oil lines. Make sure the match marks on the thrust bearing carrier (12) and gear case are aligned.
- 6.17 Install the cap screws and two eyebolts in the thrust bearing carrier (12) and tighten securely. Make sure the eyebolts are placed in the same location noted in Step 1.16.
- 6.18 Install the oil pump (300) onto the oil pump mounting plate (480).
- 6.19 Rotate the oil pump mounting plate (480) until the pump is at the back of the gear case (10).
- 6.20 Place the shims under the oil pump mounting plate (480). Make sure that the thickness of the shim set is the same on both sides.
- 6.21 Tighten the oil pump mounting plate (480) to the hub in the gear case (10). Make sure that the register on the mounting plate fits inside the hub and is on top of the lower bearing cup (601).
- 6.22 Use the following procedure for SL or SSL models using tapered roller thrust bearings. (See Figure 1 or 2)
  - 6.22.1 Remove the draw bar.
  - 6.22.2 Install two eyebolts in the drive sleeve (700) or one eyebolt in the end of the vertical shaft (400) and rotate the shaft several revolutions in both directions to seat the bearing.

- 6.22.3 Attach a dial indicator on top of the thrust bearing carrier (12), so that the indicator reads off of the drive sleeve (700) or vertical shaft (400). While watching the indicator, pull up on the drive sleeve with a hoist. The indicator should read 0.001 to 0.003 inch T.I.R. If the reading is outside the limits, add or subtract shims as required. A 0.001 inch change in shim pack thickness will change the axial movement of the shaft by 0.001 inch. If shims are changed, rotate the shaft several revolutions to seat the bearing and recheck the axial movement.
- 6.23 Use the following procedure for S, SS, SH, or SSH models using spherical roller thrust bearings. (See Figure 3)
- 6.23.1 Attach a dial indicator on top of the thrust bearing carrier (12), so that the indicator reads off of the drive sleeve (700) or vertical shaft (400). While watching the indicator, loosen the nuts on the draw bar. The indicator should read 0.001 to 0.004 inch T.I.R.
- Note:** **DO NOT** attempt to remove or install the oil pump mounting plate (480) without compressing the thrust bearing pre-load springs.
- 6.23.2 If the reading is outside the limits, tighten the nuts on the draw bar to compress the pre-load springs and add or subtract shims as required. A 0.001 inch change in shim pack thickness will change the axial movement of the shaft by 0.001 inch. If shims are changed, loosen the draw bar nuts and rotate the shaft several revolutions to seat the bearing. Tighten the draw bar nuts and repeat Step 6.23.1.
- 6.24 Install the spur gear (303) on the oil pump (300).
- 6.25 Connect the oil line from the pump discharge to the front cooling coil boss. Note: If the gear drive is equipped with an external filter system, this oil line will be connected to the upper side cooling coil boss.
- 6.26 Connect the oil line to the thrust bearing carrier (12).
- 6.27 Rotate the vertical shaft (400) until the two gear teeth marked with "X" are located at the horizontal opening of the gear case (10).

**7.0 Assembly of the Horizontal Shaft Assembly for Models with Single Piece Horizontal Carrier (See Figure 1 or 3).**

- 7.1 Press the bearing cups (602 & 603) into the horizontal carrier (14).
- 7.2 Insert the horizontal shaft gear key (911) into the shaft keyway.
- 7.3 Use the following procedure if a gear retainer is used:
  - 7.3.1 Press the pinion on the horizontal shaft (500).
  - 7.3.2 Plate the keyed washer on the end on the shaft and thread on the locknut.
  - 7.3.3 Tighten the locknut with a spanner wrench or drift punch. Bend one of the washer tabs into the locknut slot.
  - 7.3.4 Turn the shaft (500) over so that the pinion is down. Press the inner bearing cone (603) on the shaft. Take care not to damage the bearing roller cage.
- 7.4 Use the following procedure if the model does not use a gear retainer.
  - 7.4.1 Press the pinion on the horizontal shaft (500).
  - 7.4.2 Slide the horizontal inner spacer (550) on the shaft and press on the inner bearing cone (603). Take care not to damage the bearing roller cage. Ensure that the bearing seats tightly against the spacer (550).
- 7.5 Set the horizontal carrier (14) over the shaft and press the horizontal outer bearing cone (602) onto the shaft. **DO NOT** press the bearing on too tight. Leave a minimum of 0.015" axial play. Final axial bearing adjustment will be made using the locknut (560).
- 7.6 Thread the thicker portion of the locknut (560) on the horizontal shaft (500). **Note:** The ground surface on the thicker locknut should be installed against the outer bearing cup. Do not tighten.
- 7.7 Insert the horizontal assembly into gear case (10). A gasket approximately 0.015 inch thick should be placed between the horizontal carrier (14) and gear case. **Note:** Make sure that the timing mark ("X") on the pinion is aligned with the timing marks on the gear. Also make sure the match marks on the horizontal carrier and gear case are aligned. Install and tighten the cap screws.

- 7.8 Mount a dial indicator between the horizontal carrier (14) and end of the horizontal shaft (500) so that axial movement of the shaft can be measured.
- 7.9 Tighten the locknut (560) with a spanner wrench or drift punch until the in and out movement bearing clearance) is from 0.005 to 0.006 inch T.I.R. **Note:** The horizontal shaft should be rotated before each reading so the bearings will remain seated.
- 7.10 Remove the dial indicator and thread the thinner part of the locknut (560) to within 1/32 to 1/16 inch of the thicker locknut. DO **NOT** butt the two nuts together.
- 7.11 Align the holes in the locknut set (560), position the oil slinger (570), if equipped, and insert the cap screws. Tighten the cap screws until the outer nut deflects and almost touches the inner nut.

## 8.0 Assembly of the Horizontal Shaft Assembly for Models with Two Piece Horizontal Carrier (See Figure 2).

8.1 Press the outer horizontal bearing cup into the outer horizontal carrier (15T).

**Note:** If the pinion is an integral part of the horizontal shaft, proceed to Step 8.3.

8.2 Press the pinion on the horizontal shaft (500). Slide the horizontal inner spacer onto the shaft.

8.3 Press the inner horizontal bearing (603) on the end of the horizontal shaft (500).

8.4 Install the inner horizontal bearing retainer (562).

8.4.1 If the pinion is an integral part of the horizontal shaft, a plate will be used to retain the bearing. Secure the plate by tightening the two cap screws.

8.4.2 If the pinion is separate from the horizontal shaft, a locknut will be used for the bearing retainer. Install the keyed washer and thread the locknut on the end of the shaft. Tighten the locknut securely using a drift punch or spanner wrench. Bend one of the washer tabs into the locknut groove.

8.5 Slide the horizontal outer spacer (551) onto the shaft and press on one outer horizontal bearing cone (602).

8.6 Set the outer horizontal carrier (15T) on the previously installed bearing cone and slide the between bearing spacer onto the shaft (500). Press the second outer bearing cone firmly against the spacer.

8.7 Install the keyed washer (561) and thread the horizontal locknut (570) on the shaft (500). Tighten the locknut using a drift punch or spanner wrench.

8.8 Place a gasket between the inner horizontal carrier (15R) and outer horizontal carrier (15T). The gasket thickness should be approximately 0.015 inch.

8.9 Slide the inner horizontal bearing (603) into the inner horizontal carrier (15R) and assemble the inner and outer horizontal carriers. Be sure to align the match marks.

8.10 Place a gasket between the inner horizontal carrier (15R) and the gear case (10). The gasket thickness should be approximately 0.015 inch.

- 8.11 Make sure the timing mark ("X") on the pinion is aligned with the timing marks on the gear. Once the inner carrier (15R) has cleared the vertical gear, raise the horizontal assembly and insert it into the gear case register. Make sure the match marks on the inner horizontal carrier (15R) and gear case (10) are aligned. Install and tighten the cap screws.
- 8.12 Mount a dial indicator between the horizontal carrier (15T) and end of the horizontal shaft (500) so that axial movement of the shaft can be measured.
- 8.13 Rotate the horizontal shaft (500) to seat the bearings. Pull on the horizontal shaft and measure the axial movement (bearing clearance). For horizontal shaft speeds below 1800 rpm, the axial movement should be 0.004 to 0.006 inches. For horizontal shaft speeds greater than 2100 rpm, contact the factory for the proper bearing setting. If the movement is within specifications, proceed to Step 8.16.
- 8.14 If the end play is greater than specified, disassemble the horizontal assembly and reduce the between bearing spacer thickness by an amount equal to the actual movement minus the specified movement. **Note:** Removal of stock from the spacer must be done on a surface grinder or a lathe with the spacer mounted on an expanding mandrel. This method will ensure that the ends are parallel to each other and perpendicular to the bore.
- 8.15 If the axial movement is less than specified, fabricate a new spacer. The new spacer thickness will equal the old spacer thickness plus the specified movement minus the actual movement. **Note:** Machining of the new spacer must be done on a lathe with the spacer mounted on an expanding mandrel to ensure that the ends are parallel to each other and perpendicular to the bore.
- 8.16 Remove the dial indicator and bend one of the keyed washer tabs into the locknut slot.
- 8.17 Install the oil slinger (570), if equipped.

## 9.0 Backlash Check.

Backlash is the amount of clearance between the mating teeth of a gear set and is obtained by measuring the amount of movement of one member at the pitch diameter, when the other member is held stationary. Backlash is very difficult to measure directly in an assembled gear drive. Following is an indirect method of measuring backlash.

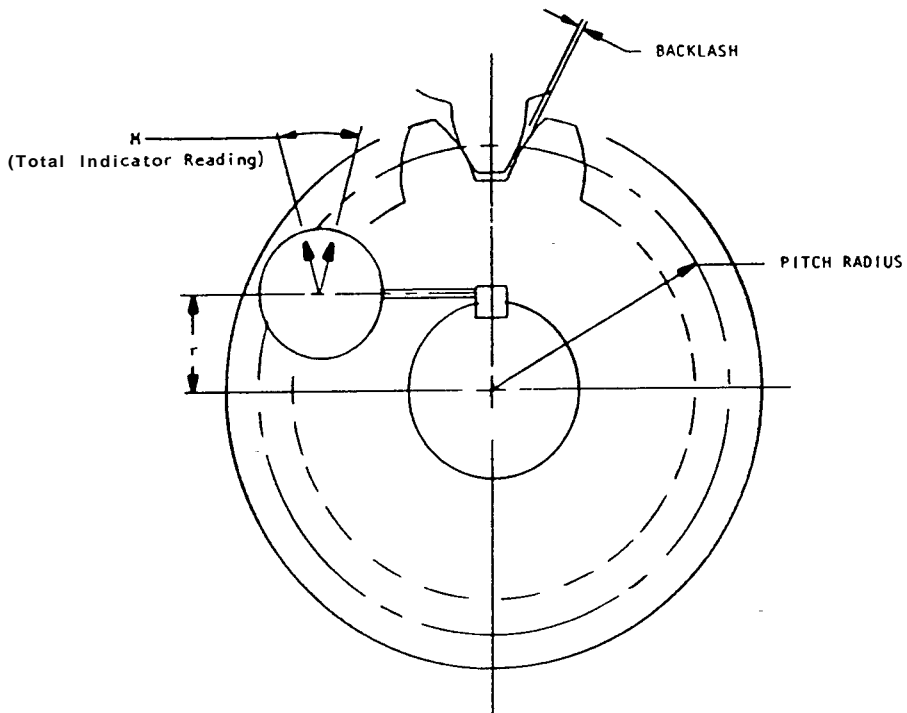
- 9.1 Place a spreader bar on top of the drive sleeve locknut (702) and thread two cap screws into the thrust bearing cover (21) bolt hole circle.
- 9.2 While rotating the horizontal shaft (500), alternately tighten the cap screws until the shaft becomes too difficult to rotate by hand.
- 9.3 Place a key in the horizontal shaft (500) keyway and retain with a C-clamp to eliminate any movement between the key and shaft.
- 9.4 Place a dial indicator against the key and set to zero.
- 9.5 Measure the distance from the center of the shaft (500) to the contact point between the indicator and key (see Figure 6). This is the "r" value in the equation in Step 9.7.
- 9.6 Rotate the horizontal shaft (500) back and forth and record the total indicator reading (T.I.R.). This is the "M" value in the equation in Step 9.7. **Note:** Make sure no movement occurs in the vertical shaft.
- 9.7 Calculate the backlash using the following equation. The "C" value is found in Table.1.

$$\text{Backlash} = \frac{(C \times M)}{r}$$

- 9.8 The amount of backlash must not be less than the amount etched on the gear set; however, the backlash may be as high as twice the etched value. If the backlash is not within the limits stated above, it must be corrected. Refer to Step 11 after performing the tooth contact pattern check. **NEVER** run the gears without backlash.

**Table 1**  
**Values of "C" Used in Backlash Calculations**

<u>Ratio</u>	<u>Model</u> <u>1000A</u>	<u>Model</u> <u>1200</u>	<u>Model</u> <u>1500</u>	<u>Model</u> <u>1800</u>
1.00	N/A	8.70	8.70	10.75
1.20	N/A	8.33	8.33	10.00
1.25	N/A	8.00	8.00	9.60
1.33	N/A	7.52	7.52	9.02
1.50	N/A	6.67	6.67	8.00
1.75	5.71	6.86	6.86	8.00
2.00	5.00	6.00	6.00	7.00
2.25	4.44	5.33	5.33	6.22
2.50	4.00	4.80	4.80	5.60
3.00	3.33	4.00	4.00	4.67
3.50	2.86	3.43	3.43	4.00
4.00	2.50	3.00	3.00	3.50
4.50	2.22	2.67	2.67	3.11
5.00	2.00	2.40	2.40	2.80
5.50	1.82	2.18	2.18	2.55
6.00	1.67	2.00	2.00	2.33



**Figure 6**  
**Backlash Check**



## 10.0 Tooth Contact Pattern Check

- 10.1 Remove the spreader bar from the top of the gear drive.
- 10.2 Apply a suitable marking compound to the teeth of the gears and rotate the horizontal shaft.
- 10.3 The correct tooth contact for a gear set is shown in Figure 7. If the tooth contact is correct, and the backlash is within limits, proceed to Step 12.0. If the tooth contact is correct, and the backlash needs to be corrected, proceed to Step 11.0.
- 10.4 Figure 8 shows the two most common forms of incorrect tooth contact. When a tooth contact occurs as shown in Figure 8A, check the following items.
  - 10.4.1 Make sure the horizontal shaft carrier (15) is pulled up tightly to the gear case (10).
  - 10.4.2 Make sure that only one gasket was used between the horizontal carrier (14 or 15R) and the gear case (10).
  - 10.4.3 Make sure that the gasket used between the horizontal carrier (14 or 15R) and the gear case is 0.015" thick.
  - 10.4.4 If the above steps do not correct the tooth contact, then the pinion will have to be moved toward the gear by increasing the thickness of the horizontal inner spacer (550 or 551).
- 10.5 When tooth contact occurs as shown in Figure 8B, check the following items.
  - 10.5.1 Make sure that a gasket was installed between the horizontal shaft carrier (14 or 15R) and the gear case (10).
  - 10.5.2 Make sure that the gasket used between the horizontal carrier (14 or 15R) and the gear case is 0.015" thick.
  - 10.5.3 If the above steps do not correct the tooth contact, then the pinion will have to be moved away from the gear by decreasing the thickness of the horizontal inner spacer (550 or 551). **Note:** Removal of stock from the spacer must be done on a surface grinder or in a lathe with the spacer mounted on an expanding mandrel.

10.6 When a tooth contact occurs as shown in Figure 9 or 10, refer to the following instructions.

10.6.1 The most probable cause of cross contact or shaft angle error is that the horizontal carrier is cocked in the register of the gear case.

10.6.2 To correct, remove the horizontal assembly and check for burrs, chips, a folded gasket, or any condition that will prevent the horizontal carrier (14 or 15R) from seating flat and square on the gear case (10). Contact the factory if the problem cannot be corrected.

## 11.0 Backlash Adjustment

After correct tooth contact is obtained, the backlash must be rechecked according to the procedure outlined in Step 9.0.

11.1 If the backlash is less than the amount etched on the gear set, the vertical gear will have to be moved away from the pinion. This is accomplished by removing stock from the vertical spacer (450). **Note:** Removal of stock from the spacer must be done on a surface grinder or in a lathe with the spacer mounted on an expanding mandrel. This ensures that the ends of the spacer remain parallel to each other and perpendicular to the bore.

11.2 If the backlash is more than twice the amount etched on the gear set, the vertical gear will have to be moved toward the pinion. This is accomplished by increasing the length of the vertical spacer (450). **Note:** When making a new spacer, make sure that the ends of the spacer are parallel to each other and perpendicular to the bore.

11.3 Use the following table to determine how much to change the vertical spacer length. The values given will change the backlash 0.001".

<u>Ratio</u>	<u>Change in Vertical Spacer Length (in.)</u>
1.00	0.0020
1.20	0.0018
1.25	0.0018
1.33	0.0017
1.50	0.0017
1.75	0.0016
2.00	0.0015
2.25	0.0015
2.50	0.0014
3.00	0.0014
3.50	0.0013
4.00	0.0013
4.50	0.0013
5.00	0.0013
5.50	0.0013
6.00	0.0013

11.4 When the backlash is within limits, proceed to Step 12.

**SPIRAL BEVEL GEARS—Typical Preferred Tooth Contact**  
 (Pinion Member Left Hand in All Cases Shown)

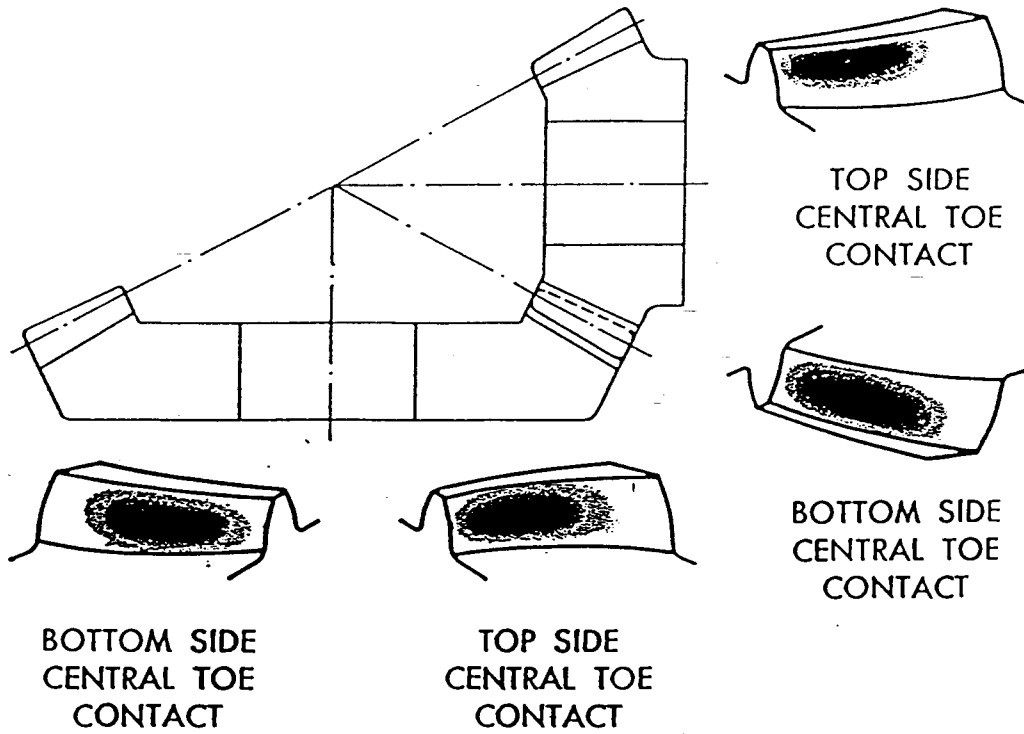
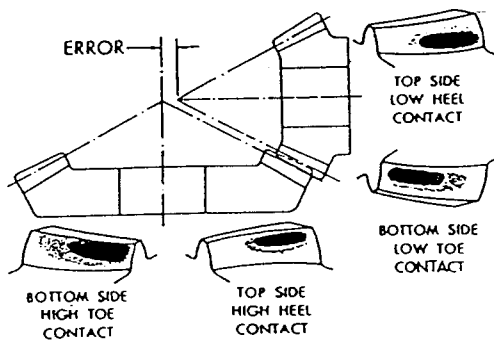


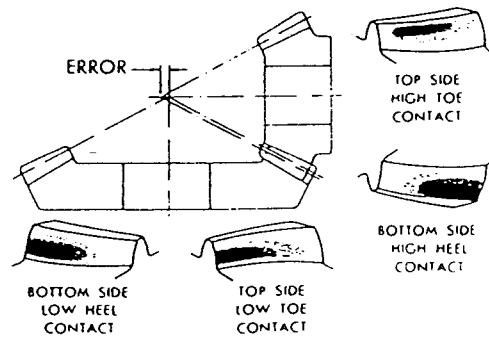
Figure 7

PROFILE ERROR—To Correct: move in on pinion cone.



(A)

PROFILE ERROR: To Correct: move out on pinion cone.



(B)

Figure 8

Proper profile contact and backlash must be obtained first before an attempt is made to correct for any of the following conditions if they should exist.

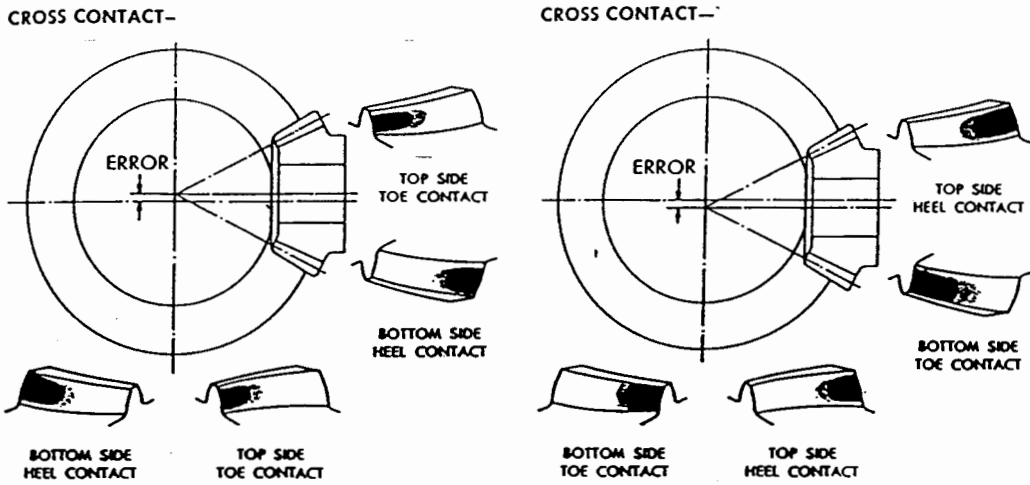


Figure 9

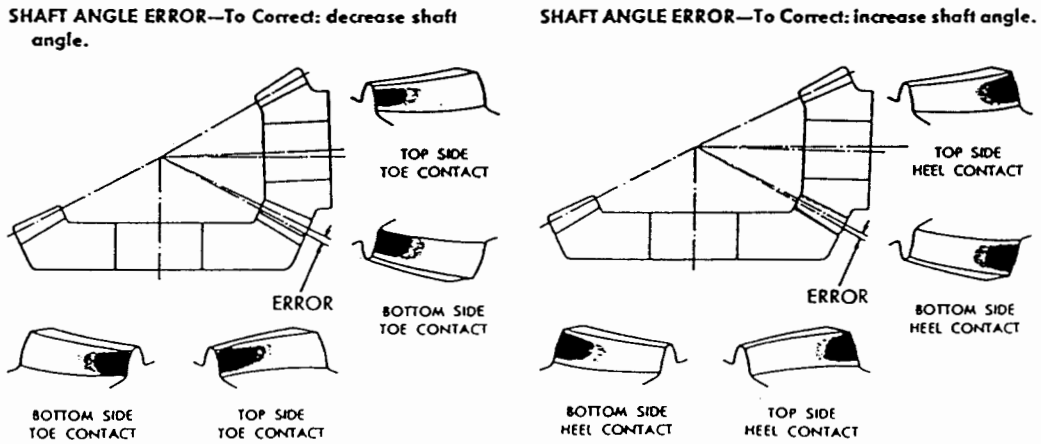


Figure 10

## 12.0 Final Assembly

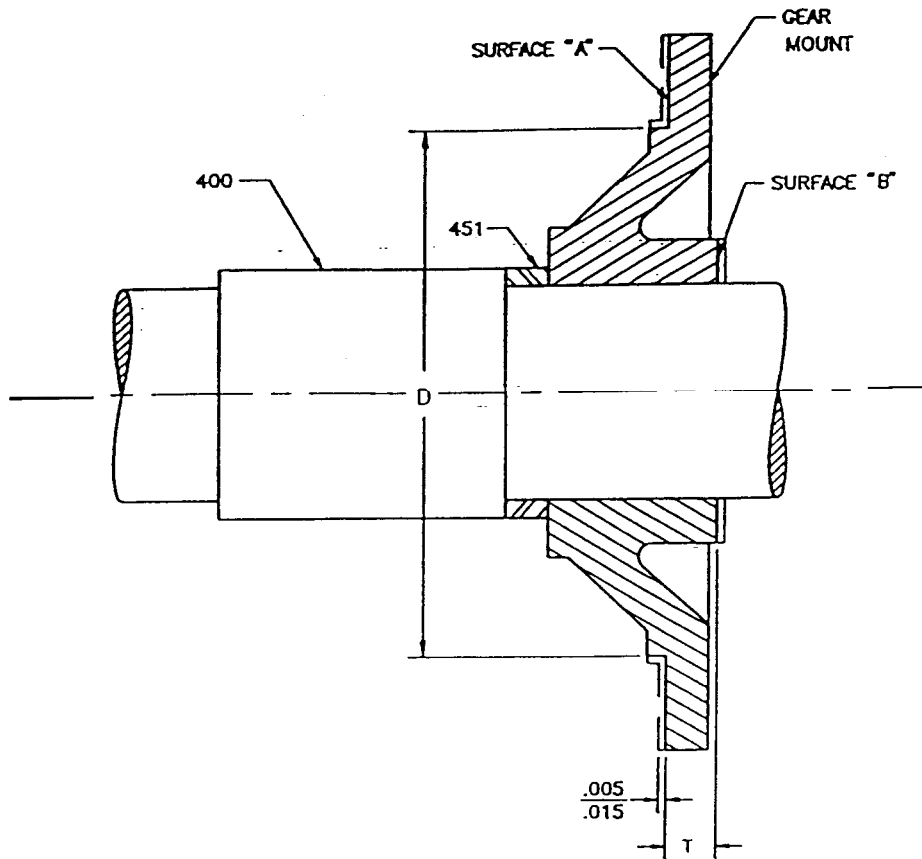
- 12.1 If equipped with a horizontal oil seal (802), cover the horizontal shaft keyway with tape to prevent the seal from being cut as it slides over the keyway.
  - 12.2 Align the match marks and install the oil seal plate (16).
  - 12.3 Reach through the side inspection port and connect the oil line that supplies the inner horizontal bearing (602).  
**Note:** On some models this oil line is plumbed from the heat exchanger and is external to the gear-case.
  - 12.4 On models using spherical roller thrust bearings (600) as in Figure 3 or 5, prefill the thrust bearing reservoir with oil. The oil level should be just below the top of the oil tube (810). See the Operating and Maintenance Instructions for the proper type of oil.
  - 12.5 Align the match marks on the thrust bearing cover (21) and the thrust bearing carrier (12). Tighten all eight of the cap screws in the thrust bearing cover.
- Note:** On models without a non-reverse clutch, proceed to Step 12.8.
- 12.6 Using a 0.001 inch feeler, ensure that clearance exists between the thrust bearing cover (21) and drive sleeve (700).
  - 12.7 Install the non-reverse clutch (24) on the drive sleeve (700). The drive pins (241) in the clutch must line up with the holes in the drive sleeve.
  - 12.8 Align the match marks and install the cover (11) on the thrust bearing carrier (12).
  - 12.9 Make sure that the oil line to the gears is located from 1/3 to 1/2 of the face width back from the pinion toe. The oil line should be as close to the gear mesh-as possible without interfering with the gears. **Note:** On models 1800 and larger the oil line will be orificed and should be positioned so that the spray pattern covers the width of the pinion face.
  - 12.10 Install both inspection plates on the gear case.
  - 12.11 Mount the heat exchanger (302), with its brackets, on the gear drive and tighten the pipe unions.
  - 12.12 Fill the gear drive with the proper oil. See the Operating and Maintenance Instructions for the proper type and amount of oil.

- 12.13 If possible, test the drive before installation or observe the initial operation after overhaul. Rotate the drive slowly until the heat exchanger and other lubrication system components are filled with oil. Ensure that the lubrication system is operating correctly. Most gear drives will have an internal or external pressure relief valve. In most cases, this valve is factory set at 30 psi. Upon cold start up the oil pressure will be high and will decrease as the oil temperature increases. Contact the factory for exact lubrication system characteristics.
- 12.14 Return the gear drive to service.

**13.0 Machining of New Gear Mount (Refer to Figure 11)**

Gear mounts as supplied by the factory are not finish machined on the gear mounting surfaces. These features are machined after the gear mount is assembled on the vertical shaft to assure that the ring gear will be perfectly centered. This operation will require a lathe with the ability to drive the shaft between centers.

- 13.1 Place the vertical shaft (400) between the centers on the lathe.
- 13.2 Machine surface "A", taking a 0.005" to 0.015" cut.
- 13.3 Machine diameter "D" to the same diameter as on the original gear mount or for a tight flit with the gear.
- 13.4 Machine surface "B", holding dimension "T" to the same thickness as the original gear mount.
- 13.5 Clean the cast iron dust from the shaft and gear mount.
- 13.6 Proceed to Step 6.4.



**Figure 11  
Gear Mount Machining**