



PHASE SHIFTING DIFFERENTIAL

Installation, Operating and Maintenance Instructions



The Phase Shifting Differential Transmission
is used to precisely correct register or adjust phase.



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For total control when the power's on.

FM NO. 25571

Principles of Operation

Both shafts of the PSD units rotate in the same direction, and either may be used as the input to obtain a 2:1 speed increase or decrease. Rotation may be in either direction. Wide-span shaft mounting accommodates high overhung loads.

Use of the spider shaft as the input gives an inherent 2:1 speed step up between input and output. Conversely, using the side gear shaft as the input results in an inherent 2:1 speed reduction. When the spider shaft is the input, each full turn of the correction shaft changes phase relationship by 3.6 degrees. When the side gear shaft is the input, each turn of the correction shaft results in a 1.8° change in phase relationship.

Correction is unlimited in either direction and can be applied while the equipment is running or while it is stopped. Correcting torque is low; therefore the correction shaft may be operated manually or by motor. Once made, the correction is "locked in." Correction is made by a worm gear fastened rigidly to one of the differential assembly side gears. A worm on the correction shaft drives the combined worm gear and side gear element to introduce a relative speed change between the input and output shafts of the transmission and thereby change their phase relationship.

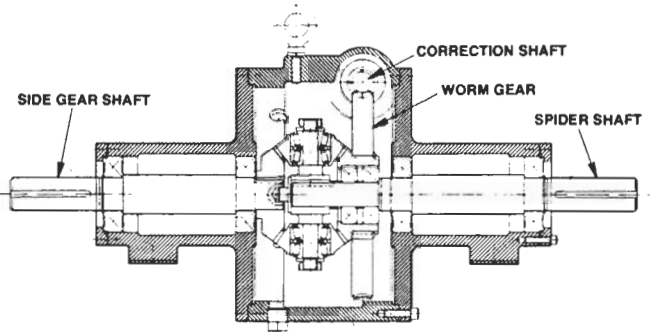


Figure 1 PSD Unit

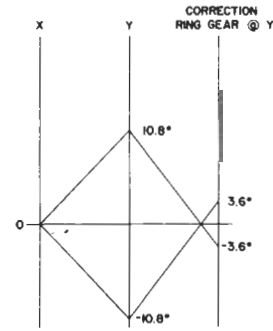
The high ratio of 100:1 between the correction shaft and the worm gear, permits extremely fine adjustments to be made with ease. At the same time, phase corrections of considerable magnitude can be accomplished speedily since the low torque needed by the correction shaft permits it to be turned rapidly with a low power correction motor.

Both shafts of the LPSD unit rotate in the same direction and either shaft may be used as the input shaft to obtain a 1:1 ratio. Rotation may be in either direction.

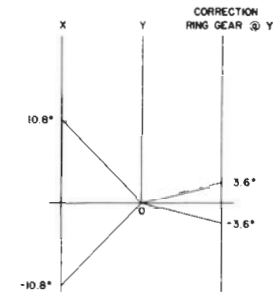
Since the input/output relationship is 1:1 with zero correction applied, an existing line shaft may be cut and the transmission added with standard couplings at both the input and output shafts.

One revolution of the correction shaft will rotate the output shaft 10.8°. Correction ratio is 33.3:1 so thirty three and one third turns of the correction shaft will rotate the output shaft through one revolution. If the X shaft is at 0°, the Y shaft will be at (-3) times the correction worm gear, since with a 100:1 worm gear ratio, one turn of the correction shaft equals 3.6°. If the Y shaft is at 0°, the X shaft will be at (3) times the correction shaft.

Correction is unlimited in either direction and can be applied while the equipment is running or while it is stopped. Correction may be applied manually or electrically through an integrally mounted correction motor.



If x equals 0, y equals -3 times Correction



If y equals 0, x equals 3 times Correction

Correction is made by a worm gear fastened rigidly to a movable internal gear, within which rotate three needle bearing mounted planet gears.

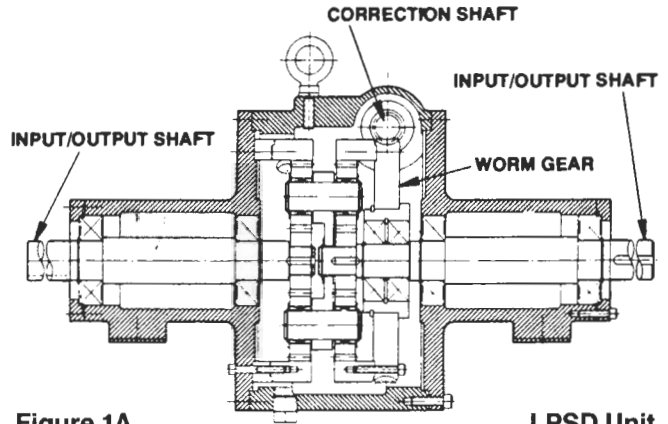


Figure 1A

LPSD Unit

In the Fairchild LPSD, Figure 1A, two planetary drives with a common carrier are mounted back to back. The fixed internal (ring) gear and the movable internal (ring) gear are stationary. Planet gear motion from either shaft used as input is transmitted through the carrier to the other set of planet gears, and subsequently to the central pinion (sun) of the other shaft.

The phase shifting differential can be equipped with a right angle drive, Figure 1B, for applications where shaft configurations require 90 degree mounting of a transmission unit.

Assemblies include single shaft horizontal, double shaft horizontal, single shaft vertical and double shaft vertical outputs.

Output shafts may be configured to the right or left, up or down, at either the spider or side gear ends or at both ends of the phase shifting differential.

A 1:1 ratio, either opposite or of the same rotational relation can be accomplished using either the PSD or LPSD. If a 33.3:1 correction ratio is required, the LPSD must be used. For the LPSD, the configurations described above can be accomplished at either the X or the Y shaft.

Installation – PSD, LPSD & FPSD

Mount unit securely on a flat, rigid foundation without any flexing. Mounting pads of transmission must rest firmly on the foundation before bolting down. Shims should be used for leveling.

Accurately align shafts. Use of flexible couplings is recommended for direct coupling. If unit is to be connected by belting or roller chain, pulley diameters should be at least three times shaft diameter. Pulleys should be mounted on input and output shaft as close to housing as possible.

Lubrication

UNIT IS SHIPPED WITHOUT OIL. BEFORE RUNNING, remove top oil plug and fill transmission with quantity of oil as specified on each unit. Use a high grade gear oil such as MOBILGEAR 634 AGMA #7 EP or equivalent.

After running 50 hours, change oil and thereafter every 6 months.

In an outdoor application the proper grade oil must be used in order to achieve proper lubrication at different seasonal temperatures.

Installation – Right Angle Drive

If ordered as an integral part of the PSD, the right angle drive will be installed at the factory.

Flexible couplings to the pinion shaft are recommended because they minimize bearing and gear wear caused by slight misalignments. Follow the coupling manufacturers installation directions.

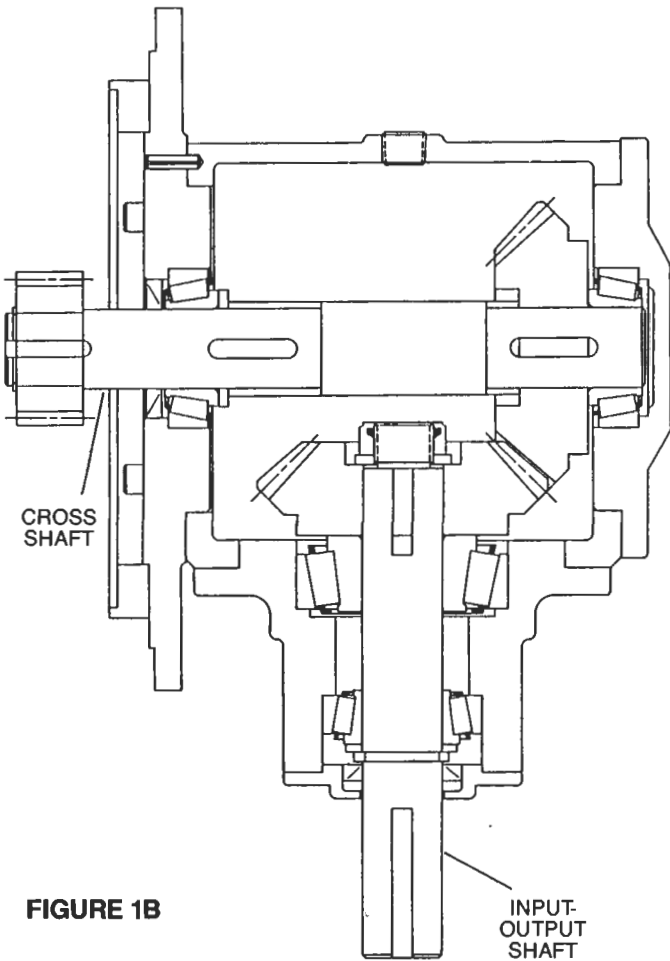
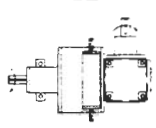
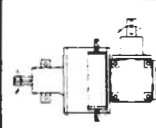
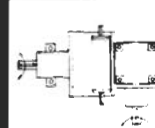
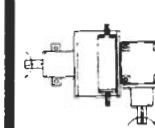
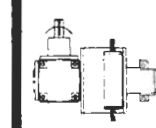
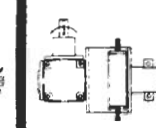
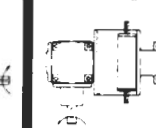
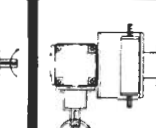
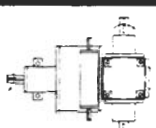
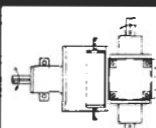
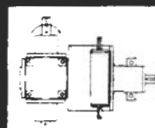
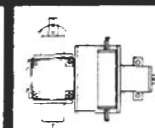
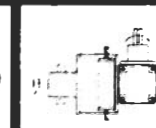
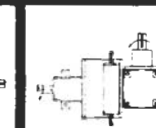
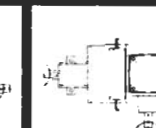
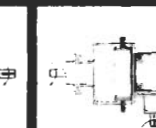
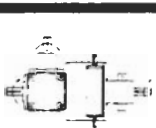
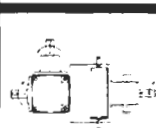
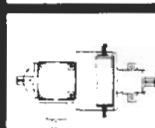
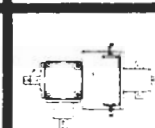
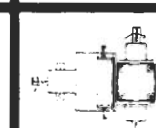
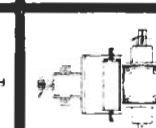
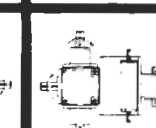
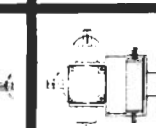
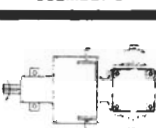
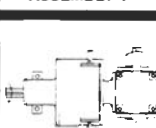
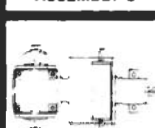
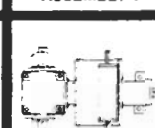


FIGURE 1B

ASSEMBLIES

 ASSEMBLY A	 ASSEMBLY B	 ASSEMBLY C	 ASSEMBLY D	 ASSEMBLY E	 ASSEMBLY F	 ASSEMBLY G	 ASSEMBLY H
 ASSEMBLY J	 ASSEMBLY K	 ASSEMBLY L	 ASSEMBLY M	 ASSEMBLY N	 ASSEMBLY P	 ASSEMBLY Q	 ASSEMBLY R
 ASSEMBLY S	 ASSEMBLY T	 ASSEMBLY U	 ASSEMBLY V	 ASSEMBLY W	 ASSEMBLY X	 ASSEMBLY Y	 ASSEMBLY Z
 ASSEMBLY AA	 ASSEMBLY BB	 ASSEMBLY CC	 ASSEMBLY DD	STANDARD RIGHT ANGLE RATIOS 1:1, 1.5:1, 2:1, 1:1.5, 1:2			

Lubrication

Unit is shipped without oil. Before operating, remove Breather and/or fill Plug (1) and Oil Level Plug, Figure 1C. Fill right angle drive gear box with an approved lubricant (Hub City GL-90, AGMA number 5EP<ISO-ASTM viscosity grade 220, or equivalent) until the lubricant starts coming out of the oil level plug hole. Clean threads on removed plug and plug hole, with a degreaser. Install plug securely in gear case.

Note

Breather and/or fill plug (1) must always be installed in the top of the gear case opposite the drain plug (3). After running 100 hours, drain out the initial oil, flush out the gear case with an approved nontoxic, nonflammable solvent and refill. Thereafter, oil should be changed at least every 2500 operating hours or every six months, whichever occurs first.

If unit is operating in extremely dirty or high/low temperature environments, change oil more often.

GL-90 lubricant is a heavy duty industrial gear lubricant containing sulfur, phosphorous antiwear additives. Lubricants selected must be compatible with nitrile rubber seals. For ambient temperatures above 125 degrees F, consult the factory.

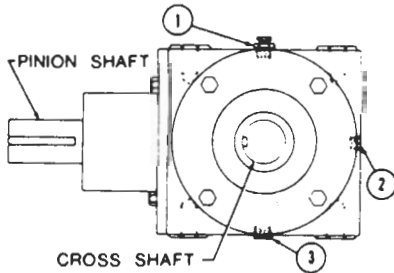


FIGURE 1-C

Adjustment

There are no field adjustments required.

Operation

There are no operating controls on the Phase Shifting Differential Transmission.

Maintenance—2:1 PSD (See Figure 2)

The procedures for disassembly of the 2:1 spider, side gear shaft bearing and correction motor worm are typical and apply to units of any size. To reassemble the units reverse the procedures given.

A. Replacement of spider

1. Drain oil from the unit.
2. Remove twelve screws (37) from the side gear housing (14). The entire assembly including differential side gear (17) will pull away from the center housing (2).
3. Remove twelve screws (37) from the spider shaft end. The entire assembly including spider (3) and bronze worm gear (27) will pull away from the center housing.
4. Remove screw (15) and washer (16) from spider shaft (33).
5. Remove four (33) screws (34) from spider shaft bearing cap (1C opposite end).
6. Place assembly in arbor press and push out the shaft until spider key (36) is free from assembly.
7. Clean parts with Varsol. Bearings which have been moved from their original positions should be coated with Loctite®. In replacing the housings (14) use Permatex gasket forming compound.

B. Replacement of side gear shaft bearing (Typical)

1. Disassemble unit as for replacement of spider Steps 1 and 2.
2. Remove four screws (33) from side gear shaft bearing cap (10).
3. Place assembly in arbor press and push out shaft until side gear key (8) is free from assembly. Continue pressure until side gear shaft bearing and side gear shaft (12) are freed from housing.
4. Remove snap ring (11).

C. Replacement of Correction motor worm

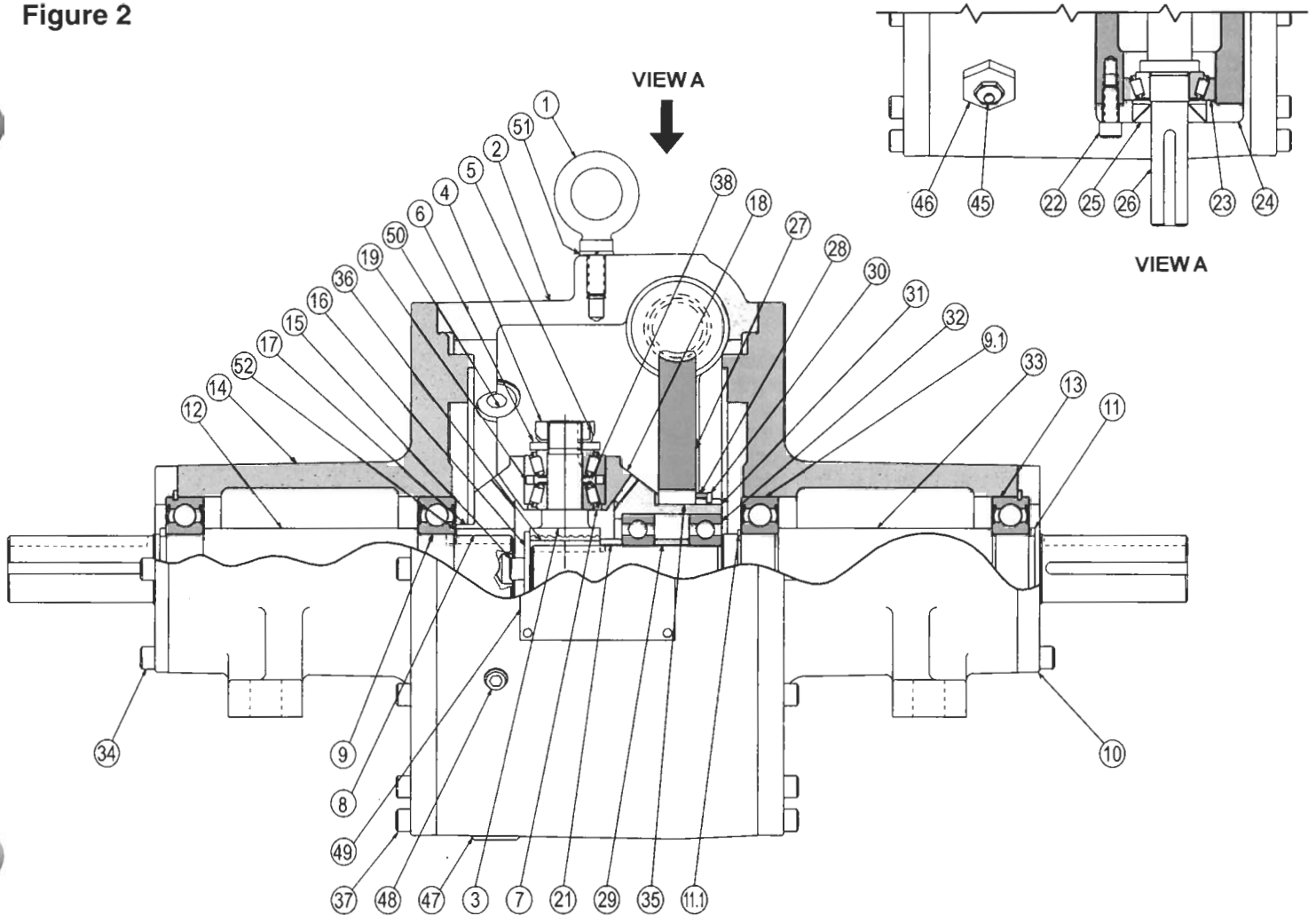
1. Remove the side gear and the spider assembly from housing (2).
2. Remove eight button head screws from both bearing caps (24).
3. Worm shaft (26) can be removed from either end. Oil seals (25) should be replaced.

NOTE: The spacer, Item 21, controls the backlash in the unit. The table below gives the backlash in inches for the assembled unit related to diametral pitch of the gear in the unit.

Table I

Differential Size	Backlash/Mesh (Assembled)	
00	.002	.004
0	.002	.004
1	.002	.004
3	.003	.006
5	.003	.006
7	.004	.009

Figure 2



Parts List 2:1 PSD*

Loc. No.	Description	Quan.	Loc. No.	Description	Quan.
1	Eye Bolt (Not required on Size 00 & 0)	1	23	Bearing	2
2	Center Housing	1	24	Bearing Cap	2
3	Spider	1	25	Oil Seal (Not used on Size 00)	2
4	Locknut	2	26	Worm Shaft (Specify ratio – 100:1, 50:1, or 25:1)	1
5	Lockwasher (Not required on Size 00)	2	27	Worm Gear (Specify ratio – 100:1, 50:1, or 25:1)	1
6	Washer	2	28	Spacer (Size 5 only)	1
7	Spider Pinion Bearing (Size 00, 0, 1, 3 & 4) ..	4	29	Spacer	1
7	Spider Pinion Bearing (Size 5 only)	2	30	Snap Ring	1
8	Key	1	31**	Differential Side Gear	1
9	Bearing (Size 00-4)	2	32	Bearing	2
9.1	Bearing (Size 5 only)	1	33	Spider Shaft	1
10	Bearing Cap	2	34	Screw	8
11	Snap Ring (Size 00, 3 & 5)	3	35	Key	1
11	Snap Ring (Size 0 & 1)	2	36	Key	1
11.1	Snap Ring (Size 0 only)	1	37	Screw	24
11.1	Spacer (Size 4 only)	1	38	Spacer (Size 00 Only)	2
12	Side Gear Shaft	1	45	Breather	1
13	Bearing	2	46	Reducer Bushing	1
14	Housing	2	47	Drain	1
15	Screw	1	48	Oil Level Pipe Plug	2
16	Washer	1	49	Nameplate	1
17	Differential Bevel Gear Set	1	50	Pipe Plug	1
18**	Differential Pinion Gear	2	51	Lock Washer (Not used on 00 & 0)	1
19	Spacer (Size 0, 1, 3, 4)	2	52	Shim	as required
21	Spacer	1			
22	Screw	8			

* For Size 7 Parts List, Consult Factory.

** Differential Pinion Gear (18) & Differential Side Gear (31) are included in the Differential Bevel Gear Set (17) and are not sold separately.

Maintenance – 2:1 PSD with right angle drive.

The procedures for disassembly of the right angle drive from the PSD are typical and apply to units of any size. To reassemble the unit, reverse the procedure.

A. Right Angle Drive Removal

1. Drain oil from the PSD housing and from the Right angle Drive gearbox. Do not mix the oil.
2. Remove twelve screws location (37) to remove the gearbox from the PSD. Do not lose roll pin location (20).
3. Remove Side Gear location (17) and Key location (8).

Keep oil seal (41) and Bearing (42) with right angle adapter.

4. Four screws (39) can be removed to dismount adapter (40).

B. Preventative Maintenance

Keep shafts and vent plug clean to prevent foreign particles from entering seals or gear case. Inspect periodically for oil leaks. Check coupling, set screws and bevel gear drive mounting bolts for tightness. Check end play in shafts. Movement indicates need for service or parts replacement.

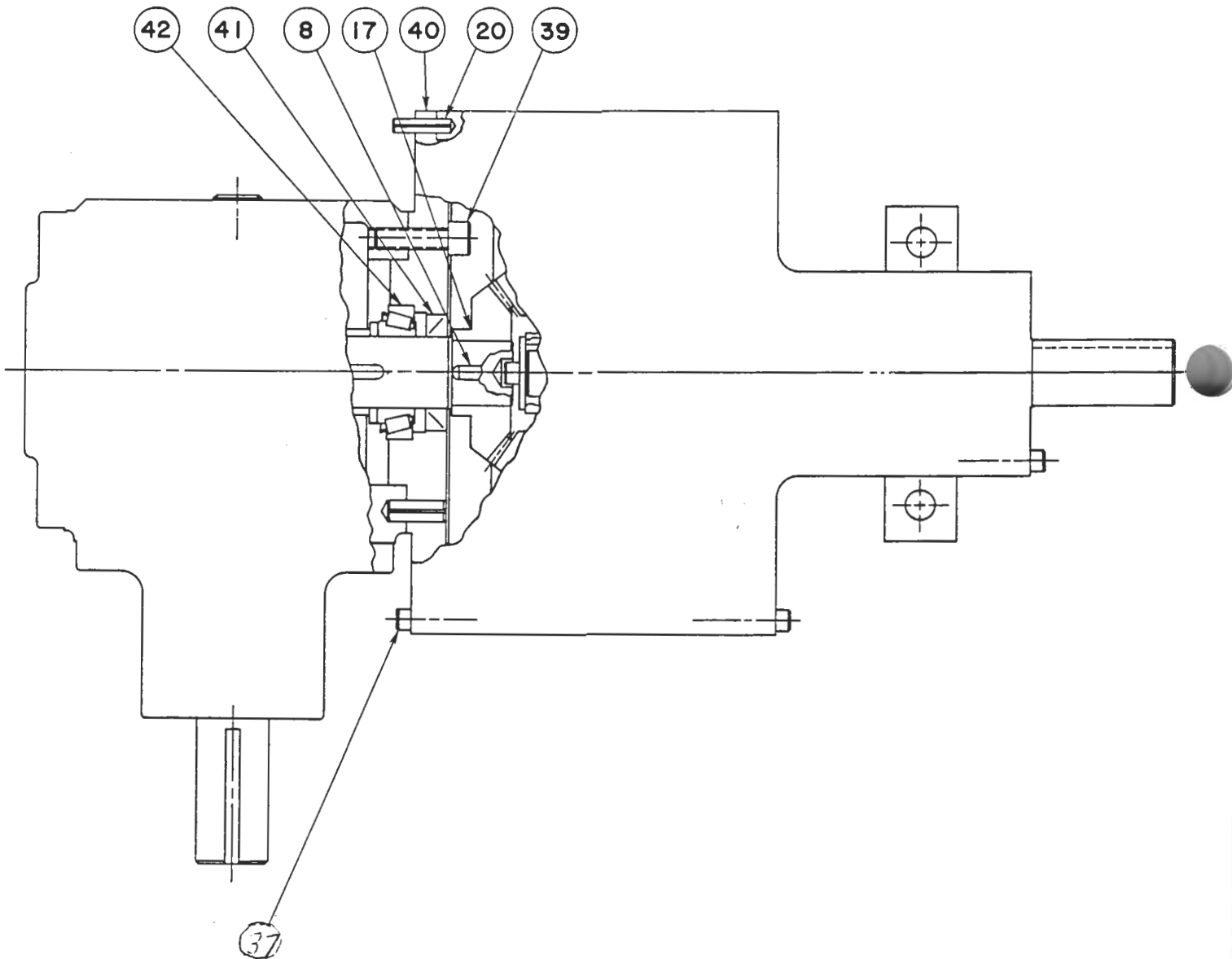


FIGURE 3

It is advisable to periodically inspect your Bevel Gear Drive for any signs of impending service. Spare or replacement parts can be ordered and obtained before disassembly is necessary, minimizing machine down-time. The following symptoms can be inspected visually without disassembly and in some cases, indicate extensive maintenance procedures.

Oil leaking from pinion housing, caps, cap screws or pipe plugs – might be corrected by retightening or removal and recoating with Loctite® before tightening. If this does not correct the leaking condition, disassembly is necessary to replace gaskets.

High internal operating temperature (above 200°F.) – could indicate that unit was being overloaded and should be replaced entirely with a larger capacity unit. Damaged bearings or inadequate oil level can also cause heat build-up.

Oil leaking from seals – indicates that shaft and/or seals are worn and need replacing. Keep dirt and foreign particles off shafts in the area of the seals to minimize wear.

Note: On initial run of new unit or after a new replacement of seals, some lubricant leakage is normal for the first few hours of running time until seals seat against the shafts. If condition persists, seal replacement is necessary.

Excessive end play of shafts – if there is a noticeable (.005" or more measurable) shaft movement when couplings are removed and shaft moves back and forth, it is an indication of bearing wear. Removing gaskets between caps and gear case can usually correct the condition and avoid bearing replacement.

Excessive backlash – might indicate worn gears which often may be readjusted, instead of replacing.

IMPORTANT

In the initial factory assembly, Loctite® was used on the threads of all cap screws. If any screws are removed, a new application of Loctite® is necessary or lock washers must be installed.

Note – Screw threads and threaded hole must be degreased before the application of Loctite®

Disassembly Procedure

1. Disconnect Bevel Gear Drive from drive motor, couplings or driven shafts to guard against personal injury. Remove all sprockets, or sheaves from Bevel Gear Drive shafts with a puller tool to prevent accidental damage to shafts. Remove all keys from keyways.
2. Remove Pipe Plug (1) from bottom of Gear Case (2) and drain all lubricant from unit, preferably while unit is warm.
3. If old seals are to be salvaged, cover keyways with cellophane tape, plastic shim stock or paper. Remove cap screws from Pinion Housing (3). CAREFULLY remove Pinion Shaft Assembly (4). Be careful – keep bearings clean and do not damage Gear (5) teeth.
4. Remove cap screws from Open Cap (6) which is opposite the gear side of Cross Shaft Assembly (7, Figure 4) and remove bearings to prevent damage to gear teeth. Slip open cap with seal off cross shaft.
5. Remove cap screws from Open Cap (9) on the gear side of Gear Case (2) and remove cap and gaskets. This completes disassembly of sub-assemblies.

Pinion Shaft Disassembly

Secure Pinion Shaft (10, Figure 4) with a vise, and remove Lock Nut (12) and washer from shaft. Place pinion assembly in a press with threaded end of shaft up and back side of Bevel Gear (5) supported. Remove gear by pressing out.

Support outer flange surface of Pinion Housing (3) on press anvil and push threaded end of pinion shaft through housing, thereby removing inner Bearing Cone (14), Outer Bearing Cone (13), Spacer Washer (15), Seal (16) and shaft from pinion housing.

Note – disassembly of the pinion shaft from the housing will cause damage to the seal and seal must be replaced.

Cross Shaft Disassembly

Cross Shaft Assembly (7, Figure 4) is disassembled by removing Snap Rings (17) and placing Shaft (18) in a press with sleeve between anvil and gear.

Figure 5 shows the use of a sleeve to support gear at hub. On certain types of bevel gears it is recommended that this tool be used to protect gear teeth. This tool may be obtained from Hub City or machined for the purpose in your shop.

Push shaft through Bearing Cone (19) and Bevel Gear (20). Invert shaft and rest Bearing Cone (21) on sleeve and anvil or, on some models, on Spacer (22) and push shaft through bearing cone. If bearings are to be replaced,

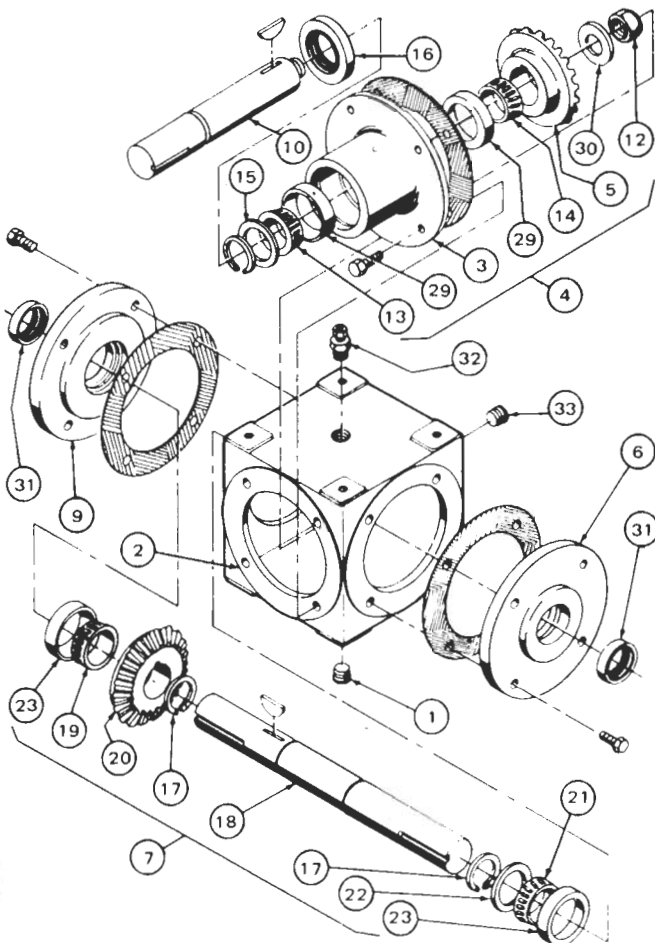


FIGURE 4

remove Bearing Cups (23) from Open Caps (6 and 9) with a puller tool or, if one is not available, gently tap opposite back sides of the bearing cups with a flat punch so that they are moved evenly and no damage occurs to caps.

Variations in Group 1 Drives – On Models 800, 810, 1000, 1010 and 1200 Drives, shouldered cross shafts are used and no snap rings or spacers are used. Cross shaft bearings on these units must be removed by moving them away from shoulder of shaft.

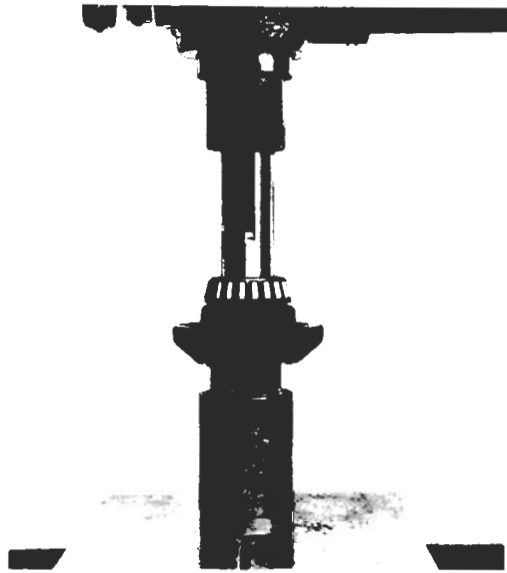


FIGURE 5 – Pressing Shaft out of Bearing and Gear

Inspection

Examine all seals for wear or damage and press out of open caps, pinion housings and seal carrier if replacement is necessary. Inspect all other parts for damage or wear before proceeding to reassembly.

Assembly Procedure

1. All parts including the gear case, should be cleaned thoroughly with an approved, nonflammable, nontoxic solvent. Any accumulation of sludge deposits or corruptions should be removed. Whenever pinion housing and caps are removed, it is recommended that seals and gaskets be replaced. These and other miscellaneous items are included in each Drive Repair Kit. (See Parts Lists.)

Before reassembly, examine pinion and cross shafts or output sleeve for grooving in the shaft seal areas. If the shafts are to be reused, polish out any imperfections with a fine grade of Emery Cloth. The polishing motion should be circumferential, not axial or spiral in direction.

2. Replace Bearing Cups (23 and 29. Figure 4) in pinion housing and open caps being careful to remove any foreign particles in the counterbore. Bearing cup must seat squarely in counterbore. If cup must be tapped into place, use a rubber hammer or piece of wood to protect cup surfaces. Do not insert seals at this time.
3. When reassembling Pinion Shaft Assembly (4, Figure 4), Cross Shaft Assembly (7, Figure 4) refer to Figure 4 so that all parts are included in their proper position. Be sure that parts are pressed tightly against one another and that no foreign material is included between them.

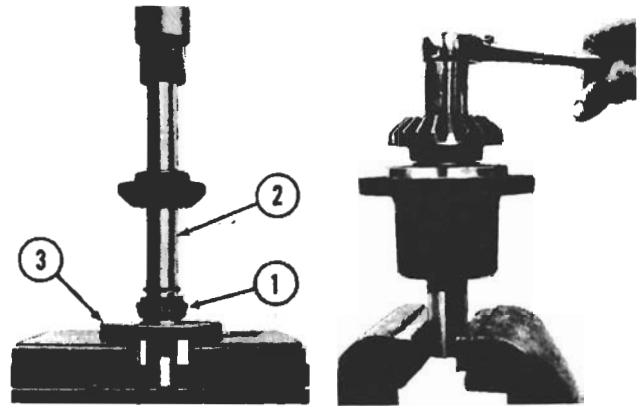


FIGURE 7 – Reassembly of Gear and Bearing Cone

FIGURE 8 – Pinion Assembly Adjustment

Figure 7 shows the recommended method of pressing the Bearing Cone (1) onto Shaft (2). An Inserting Tool (3) is shown pressing evenly on the bearing inner race. This tool may be obtained from Hub City or machined for the purpose in your shop. A substitute inserting tool may also be made from tubing which would have an I.D. sufficient to accept the shaft and an O.D. no larger than the inner bearing race.

CAUTION

Contact on the cage of the bearing or using the bearing cup to press the bearing on will damage bearing. If it is impossible to install the bearings as recommended above, the alternate method would be to heat the bearing (to increase the I.D. temporarily) and gently tap opposite sides of the bearing inner race with a flat punch without damaging bearing.

Assembly of Cross Shaft Assembly (7, Figure 4) is essentially the reverse of the disassembly procedures except that when installing Bevel Gear (20) on shaft, first insert Snap Rings (17) and woodruff key. Gear is then heated in hot oil and then installed on shaft where it will cool and shrink fit.

The Pinion-Shaft Assembly (4, Figure 4) is assembled as follows: Insert snap ring and Spacer (15) on Pinion Shaft (10). Press Outer Bearing Cone (13) on shaft using inserting tool. Place threaded end of shaft into Pinion Housing (3) and press Inner Bearing (14) over shaft and into pinion housing with inserting tool. Install woodruff key and press Pinion Gear (5) on shaft. Assemble Pinion Washer (30) and Lock Nut (12) on shaft. Secure assembly in a vise as shown in Figure 8 and tighten lock nut enough to draw down gear and washer until the bearings bind. Nut is then



FIGURE 9 – Pinion Assembly Adjustment

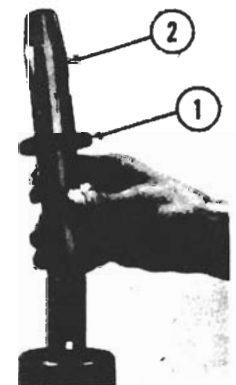


FIGURE 10 – Oil Seal Installation

backed off slightly (approx. ¼ turn). Release pinion shaft from the vise and rap nut and shaft end sharply with a rubber mallet while supporting pinion housing on vise (see Figure 9). This will free up the bearings so that they will rotate freely with no noticeable end play. Do not install seals at this time. See FINAL ASSEMBLY AND BACKLASH ADJUSTMENT section to complete assembly.

Final Assembly & Backlash Adjustment

Install Open Cap (9, Figure 4) on the gear side of Case (2, Figure 4) with 3 shims. Fasten caps and gaskets to gear case by torquing down cap screws securely. Insert Cross Shaft Assembly (7, Figure 4) carefully through opening in case and into open caps. Install 2 shims and Open Cap (6, Figure 4) on the case side which is opposite the gear with cap screws and torque down all screws evenly.

Bearings are then adjusted by removing or adding gaskets until the bearings bind and then add one gasket at a time until shaft or sleeve rotates freely, with no end play.

Note – Position of gear will be closer to center if the number of gaskets on each end cap does not vary by more than one.

Insert Pinion Shaft Assembly (4, Figure 4) carefully into Case (2) using 3 shims and cap screws. Gear backlash is adjusted by moving shims from the cross shaft or output sleeve open cap on the gear side to the side opposite the gear until gears rotate freely, with no noticeable backlash. At this point, move 2 shims back to the gear side end cap and the gears will then be properly adjusted.

Note – If there are not enough shims left in open cap opposite gears to move 2 shims back – further gear adjustment must be made by removing 2 shims from between the pinion housing and case and repeat the entire procedure listed in this and two preceding paragraphs.

When bearings and gear backlash have been properly adjusted, remove cap screws a final time, clean threads on screws and in holes with degreaser. Coat threads with Loctite®. If Loctite® or equivalent is not available, use lock washers (not supplied) behind screw heads. Torque down all screws evenly.

Oil Seal Installation

Oil seals (30 and 31, Figure 4) and (16, Figure 4) can now be installed in open caps and pinion housings. Slip Seal (1, Figure 10) over tapered end of Pilot Sleeve (2, Figure 10), making sure that the spring loaded lip of the seal is facing toward the Bevel Gear Drive. Slip pilot sleeve over shaft and down until end of sleeve is against bearing. Install Seal Driver (1, Figure 11) over pilot sleeve and tap seal down sleeve until it is seated in housing or cap. Remove seal driver and pilot sleeve. These installation tools are available from Hub City.

If a pilot sleeve and seal driver (or their equivalent) are not readily available, seal must be installed with a rubber hammer or block of wood to prevent seal damage.



FIGURE 11 – Oil Seal Installation

CAUTION

Damage to seals can be avoided by covering the shaft keyways with cellophane tape, plastic shim stock or paper before sliding seals onto shaft.

Refilling Gear Case With Lubricant

Clean and recoat Drain Plug (1, Figure 4) with Loctite® and replace in bottom of gear case. Remove Fill and Breather Plug (32, Figure 4) and Oil Level Plug (33, Figure 4). Fill gear case with recommended lubricant and follow all recommended procedures as detailed in Lubrication and Installation Instructions which are included with each Drive.

Maintenance FPSD

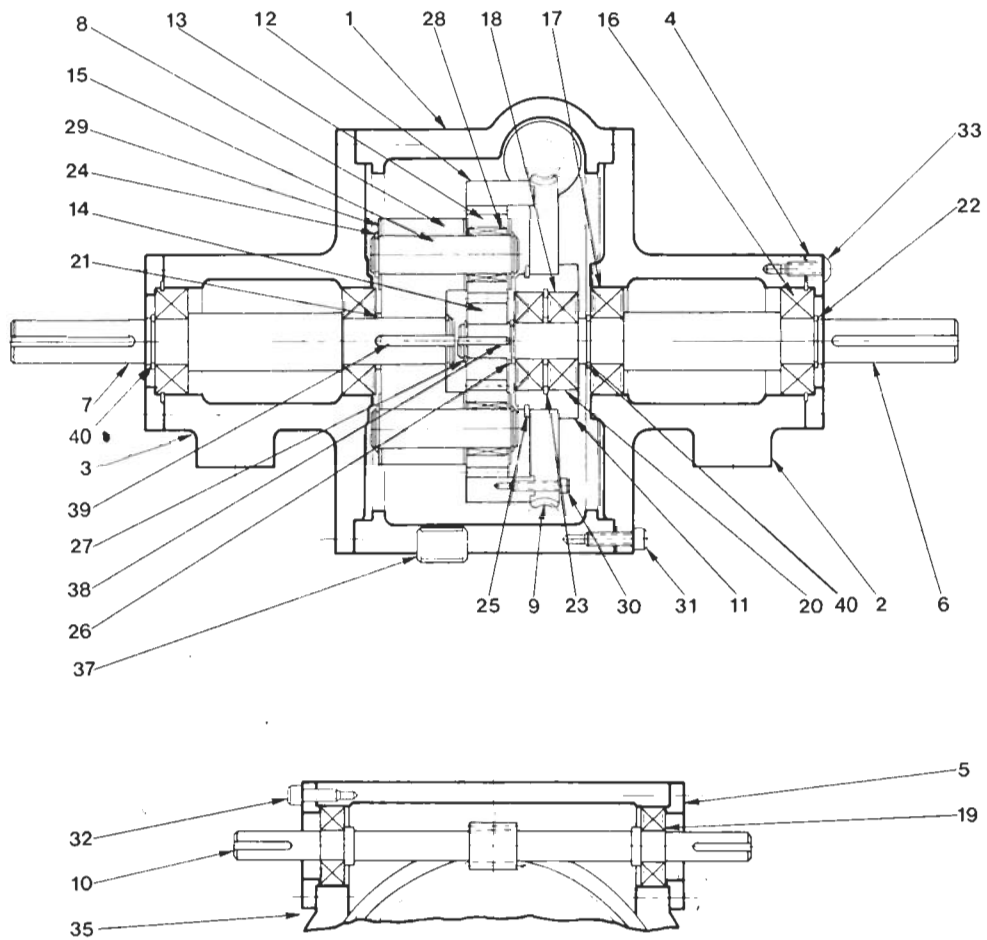
(Typical Assembly) See Figure 12

The procedures for disassembly of the 4:1 PSD are typical and apply to units of any size. To reassemble the units, reverse the procedure.

1. Press worm gear (9) on spur gear (12) and fasten together with six socket Head screws (30).
2. Press bearings (17) and (16) on both ends of shafts (6) and (7).
3. Install snap rings (22).
4. Install key (39) and snap ring (40) on shaft (7).
5. Press assembly from step 4 into shaft housing (3) and assemble bearing cap (4) onto housing with four screws (33).
6. Press shaft (6) into shaft housing (2).
7. Insert bearings (18) and spacer (20) onto hub (11).
8. Press assembly from step 7 into assembly from step 1 and add snap ring (25).
9. Press fit the assembly in step 8 against the assembly in step 6 and add snap ring (26).
10. Bolt spur gear (12) to assembly in step (4) with six screws (31).
11. Press bearings (19) onto worm shaft (10), insert into center housing (1) and place bearing caps (5) over the ends using screws (32).
12. Temporarily place the assembly in step 9 into the center housing (1) and engage worm shaft making sure that no interference occurs. Remove assembly.
13. Place key into shaft (6) at worm gear end, add sun gear (14) and thrust race (29).
14. Press fit the planet shafts (15) into carrier (8).
15. Press fit needle bearings (28) into planet gear (13).
16. Place thrust races (29) planet gears (13) and thrust race and lock ring on each of the three planet shafts (15) – both sides, and assure that gears turn smoothly.
17. Insert assembly in step 16 onto shaft (6) worm gear side, and add thrust race and snap ring.
18. Insert assembly in step 16 into center housing and mesh with worm gear. Assemble to center housing with screws (31).
19. Insert assembly in step 10 into center housing, mesh gears and secure with screws (31).

Figure 12 FPSD

NOTE: Assembly for the 4:1 FPSD will be similar to LPSD.
Sun gears and spur gears on the lefthand (X Shaft) side of the LPSD (Figure 14) are not present in the FPSD.



Parts List FPSD

Loc. No.	Description	Quan.	Loc. No.	Description	Quan.	Loc. No.	Description	Quan.
1	Differential Housing	1	14	Sun Gear	1	28	Needle Bearings	3
2	Shaft Housing	1	15	Planet Shaft	3	29	Thrust Race	9
3	Shaft Housing	1	16	Ball Bearing	2	30	Socket Head Cap Screw	6
4	Bearing Cap	2	17	Ball Bearing	2	31	Socket Head Cap Screw	24
5	Bearing Cap	2	18	Ball Bearing	2	32	Socket Head Cap Screw	8
6	Input Shaft	1	19	Ball Bearing	2	33	Socket Button Head Cap Screw	8
7	Output Shaft	1	20	Spacer .495	1	34*	Pipe Plug	2
8	Carner	1	21	Spacer	1	35*	Pipe Plug (Vented)	1
9	Worm Wheel	1	22	Snap Ring (Outboard)	4	36*	Pipe Plug	1
10	Worm	1	23	Snap Ring	1	37	Pipe Plug (Magnetic)	1
11	Worm Wheel Hub	1	24	Snap Ring	6	38	Key	1
12	Internal Ring Gear	1	25	Snap Ring	1	39	Key	1
13	Planet Gear	3	26	Snap Ring	1	40	Snap Ring (Size 1) (Inboard)	0
			27	Snap Ring	1			

Note: For 00 FPSD 22 = 2, 40 = 2
 0 FPSD 22 = 2, 40 = 2
 1 FPSD 22 = 1 (one omitted on item 7), 40 = 2
 3 FPSD 22 = 2, 40 = 2

*Parts Not Shown:

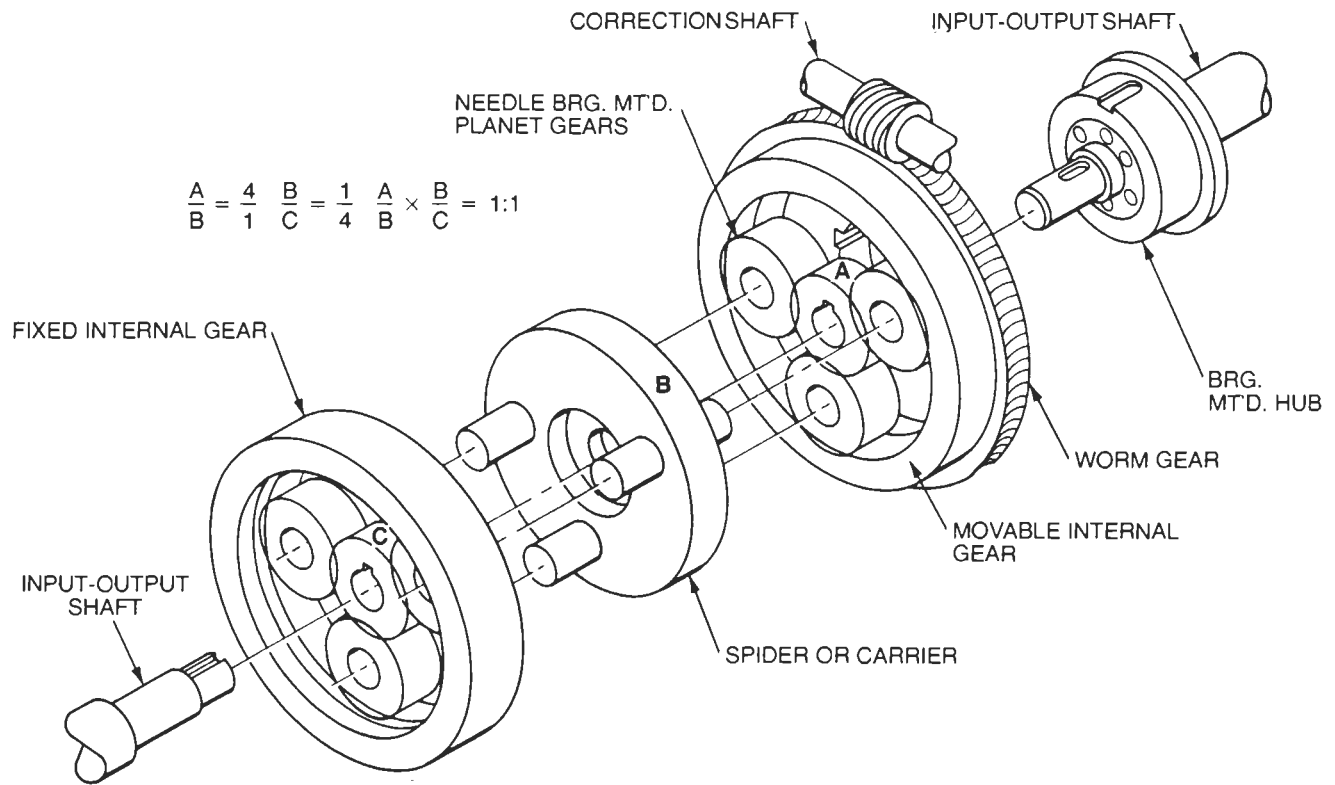
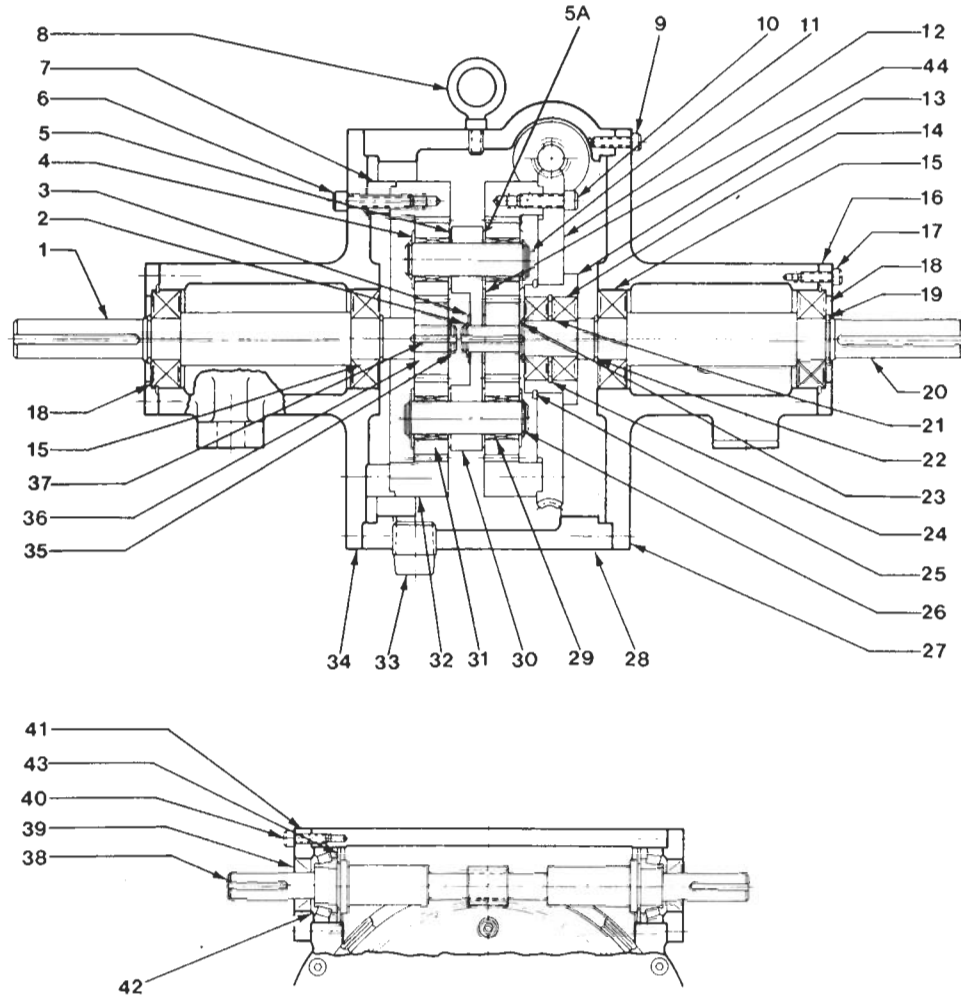


Figure 13 Exploded internal view of the LPSD transmission.

Maintenance – LPSD Typical Assembly (See Figure 14)

1. Press worm gear (12) on spur gear (32) and fasten together with six socket lead screws (10).
2. Press bearings (15) and (18) on both ends of shafts (20) and (1).
3. Install snap rings (19).
4. Install sun gear (36), key (37) and snap ring (35) on shaft (1).
5. Press assembly from Step 4 into shaft housing (34) and assemble bearing cap (16) onto housing with four screws (17).
6. Press shaft (20) into shaft housing (27).
7. Insert bearings (14) and spacer (21) onto hub (13).
8. Press assembly from step 7 into assembly from step 1 and add snap ring (25).
9. Press fit assembly in step 8 against the assembly in step 6 and add snap ring (23).
10. Bolt spur gear (32) to assembly in Step 4 with six screws (6).
11. Press bearings (42) onto worm shaft (38), insert into center housing (28), install grease seals (43), (39) and place bearing caps (41) over both ends using screws (40).
12. Temporarily place the assembly in Step 9 in the center housing (28) and engage worm shaft making sure no interference occurs. Remove assembly.
13. Place key into shaft (20) at worm gear end, add sun gear (36) and thrust race (3).
14. Press fit the planet shafts (11) into carrier (30).
15. Press fit needle bearings (29) into 6 planet gears (31.)
16. Place thrust race (5) planet gears (31) and thrust race and lock ring (26) on each of three planet shafts (11) (both sides) and assure that gears turn smoothly.
17. Insert assembly in Step 16 onto shaft (20) (worm gear side) and add thrust race and snap ring (2) (3).
18. Insert assembly in Step 16 into center housing and mesh with worm gear. Assemble to center housing with screws (9).
19. Insert assembly in Step 10 into center housing, mesh gears and secure with screws (9).

Figure 14. LPSD



Parts List FPSD

Loc. No.	Description	Quan.	Loc. No.	Description	Quan.	Loc. No.	Description	Quan.
1	Shaft, Input-Output	1	14-1	Bearing, Double Row (Inboard Size 5, 7)	1	31	Planet Gear	6
2	Snap Ring (Size 00, 0, 1, 3, 4)	1	15	Bearing	2	32	Internal Spur Gear	2
2	Snap Ring (Size 5, 7)	2	16	Bearing Cap	2	33	Magnetic Drain Plug	1
3	Thrust Race	1	17	Screw	8	34	Shaft Housing	1
3	Thrust Race (Size 4)	2	18	Bearing	2	35	Snap Ring	1
4	Thrust Race	6	19	Snap Ring	2	36	Sun Gear	2
5	Thrust Race	3	20	Shaft, Input/Output	1	37	Key	2
5A	Thrust Race	3	21	Spacer	1	38	Worm Shaft (Specify 33.3:1, 16.67:1 or 8.3:1) ..	1
6	Screw (Size 00, 0, 7)	6	22	Snap Ring	1	39**	Seal	2
6	Screw (Size 3, 4)	8	22	Snap Ring on Shaft (All Sizes) ..	1	39**	Seal (Size 7)	4
6	Screw (Size 5)	12	22-1	Spacer (Sizes 5, 7)	1	40	Screw	8
7	Spacer (Size 0, 1, 3, 4)	1	23	Snap Ring	1	40	Screw (Size 7)	12
8	Eye Bolt (Not required on Size 00, 0, 1)	1	23-1	Spacer (Size 5, 7)	3	41	Bearing Cap (Sizes 0-7 have grease fittings)	2
9	Screw	24	24	Snap Ring (Size 00, 0, 1, 3,) ..	1	42	Bearing	2
10	Screw (Size 00, 0, 7)	6	24	Snap Ring (Size 4)	2	43	Grease Seal (Size 0, 1, 4, 5, 7) (Size 00 & 3 use Sealed Bearings)	2
10	Screw (Size 3, 4)	8	25	Snap Ring	1	44	Thrust Race	1
10	Screw (Size 1, 5)	12	26	Snap Ring	6	45*	Pipe Plug, Vented Square Head	1
11	Planet Shaft	3	27	Shaft Housing	1	46*	Pipe Plug, Hex Socket	2
12	Worm Gear (Specify 33.3:1, 16.67:1 or 8.3:1) ..	1	28	Center Housing	1	47*	Pipe Plug, Hex Socket (Oil Level)	2
13	Hub	1	29	Bearing (Size 00, 0, 1, 3, 4)	6			
14	Bearing, Single Row (Size 00, 0, 1, 3, 4)	2	29-1	Bearing Long (Size 5)	6			
14	Bearing, Single Row (Outboard Size 5, 7)	1	29	Bearing Short (Size 5)	6			
			29	Bearing (Size 7)	12			
			30	Carrier	1			

* Parts Not Shown
 ** Not Used in Size 00

FIGURE 15 PSD with Right Angle Adapter on Spider (Lo-Speed) Shaft (Typical)

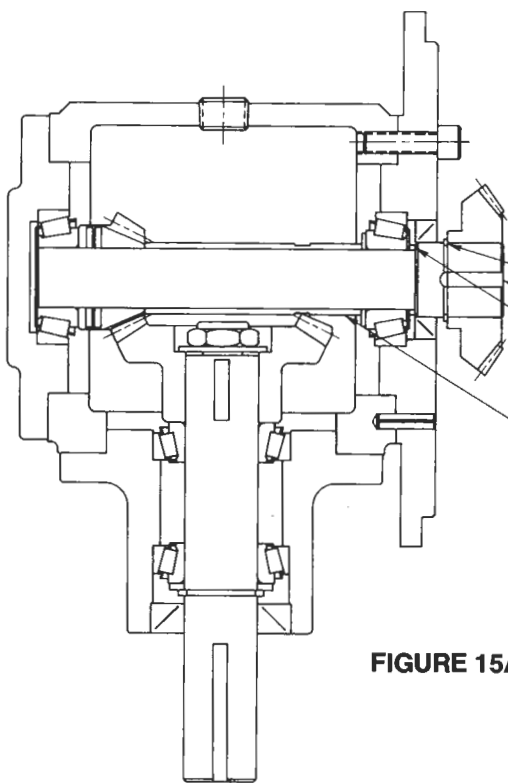
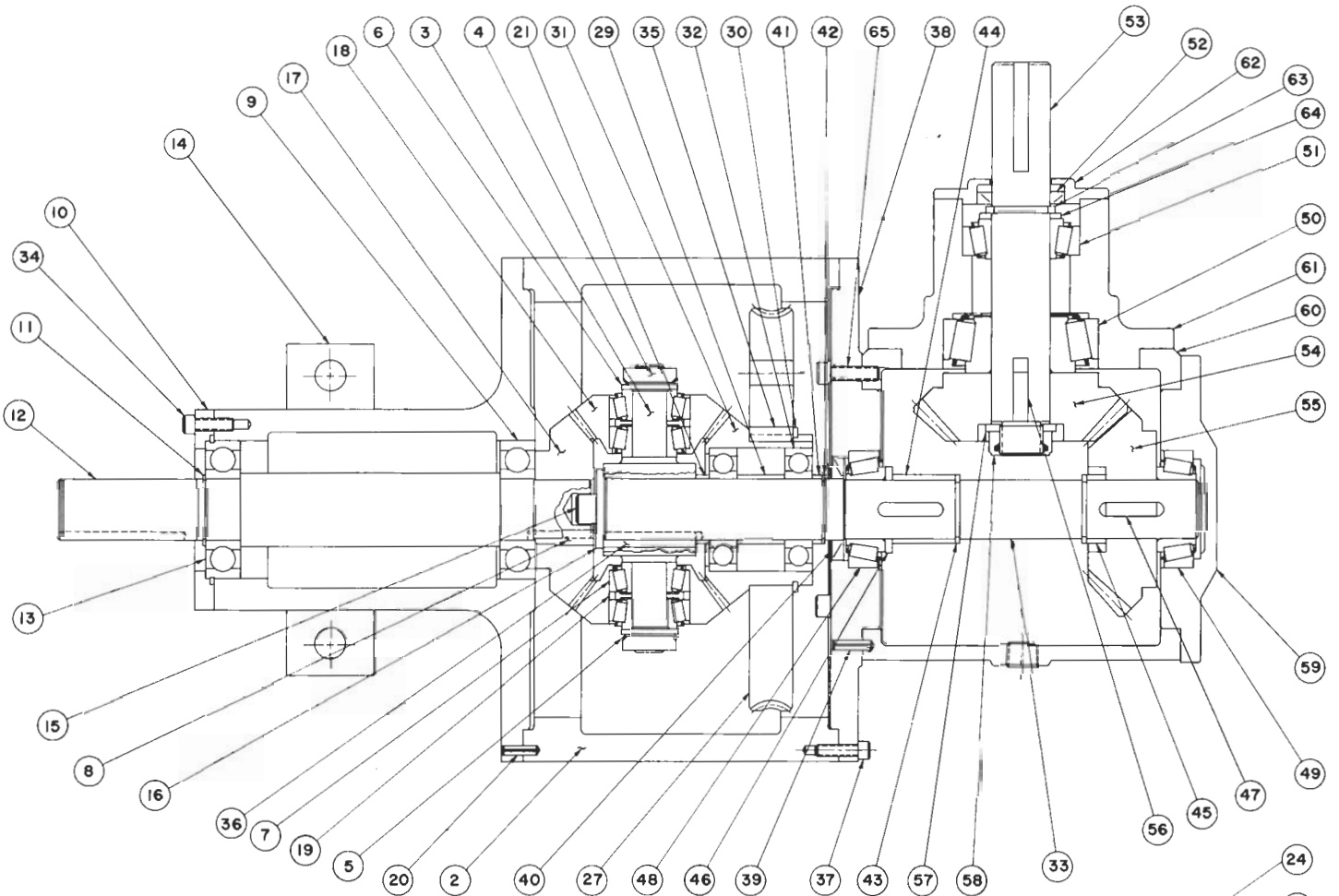


FIGURE 15A

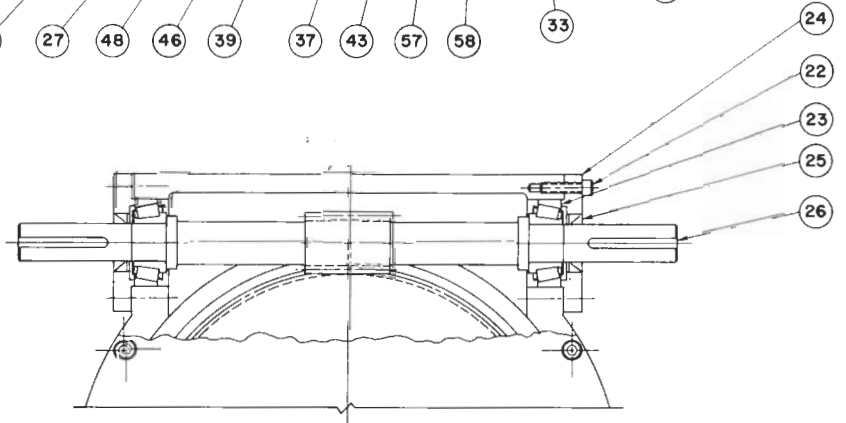


FIGURE 15B

- 66
- 67
- 68
- 69

Figure 15A shows the right angle adapter as it would appear mounted on the Side Gear Shaft of the PSD, 180° removed from its position in Figure 15. All parts except those which are called out as locator numbers 66 through 69 are the same as for the right side mounting. For this mounting, refer to Figure 2 to identify parts in the right hand shaft housing.

Parts List RAPSD

Loc. No.	Description	Quan.
1 *	Eye Bolt (Not required on Size 00, 0, 1)	1
2	Center Housing	1
3	Spider	1
4	Locknut	2
5	Lockwasher (Not required on Size 00)	2
6	Washer	2
7	Spider Pinion Bearing (Size 00, 0, 1, 3, 4)	4
7	Spider Pinion Bearing (Size 5, 7)	2
8	Key	1
9	Bearing	1
10	Bearing Cap	1
11	Snap Ring	1
12	Side Gear Shaft	1
13	Bearing	1
14	Housing	1
15	Screw	1
16	Washer	1
17	Differential Side Gear	1
18	Differential Pinion Gear	2
19	Spacer (Size 0, 1, 3, 4)	2
19	Spacer, Outer Race (Size 0, 1, 3, 4)	2
19-1	Spacer, Inner Race (Size 0)	2
20	Dowel Pin	2
21	Spacer	1
22	Screw	8
23	Bearing	2
24	Bearing Cap	2
25 **	Oil Seal	2
26	Worm Shaft (Specify ratio - 100:1, 50:1, or 25:1)	1
27	Worm Gear (Specify ratio - 100:1, 50:1, or 25:1)	1
29	Spacer	1
30	Snap Ring	1
31	Differential Side Gear	1
32	Bearing	2
33	Shaft, Cross	1

* Part Not Shown
 ** Not Used in Size 00

Loc. No.	Description	Quan.
34	Screw	4
35	Key	1
36	Key	1
37	Screw	24
38	Adapter	1
39	Roll Pin	2
40	Seal	1
41	Spacer	1
42	Snap Ring (Size 4, 5 or certain ratios of other sizes)	1
43	Snap Ring (Size 4, 5)	2
44	Spacer	1
45	Spacer (Certain ratios)	1
46	Spacer	1
47	Key	1
47	Roll Pin (Certain ratios)	1
48	Bearing	1
49	Bearing	1
50	Bearing	1
51	Bearing	1
52	Seal	1
53	Shaft, Output/Input	1
54	Bevel Gear	1
55	Bevel Gear	1
56	Key	1
57	Washer	1
58	Locknut	1
59	Bearing Cap	1
60	Housing	1
61	Shaft Housing	1
62	Bearing Cap (Size 4, 5, 7)	1
63	Snap Ring	1
64	Spacer (Size 1, 3, 4, 5)	1
65	Screw (Size 00, 0, 1)	4
65	Screw (Size 3, 4, 5)	6
65	Screw (Size 7)	8
66	Snap Ring (Size 1, 1:1, in-out, 4, 5)	1
67	Shaft, Cross	1
68	Spacer (Size 1, 1:1, in-out, 4, 5)	1
69	Spacer	1

FIGURE 16 LPSD with RIGHT ANGLE ADAPTER on Y Shaft Side (Typical)

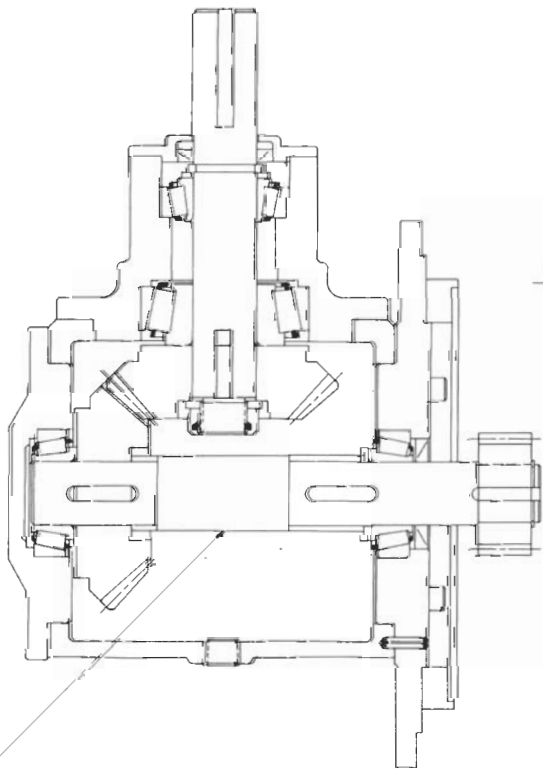
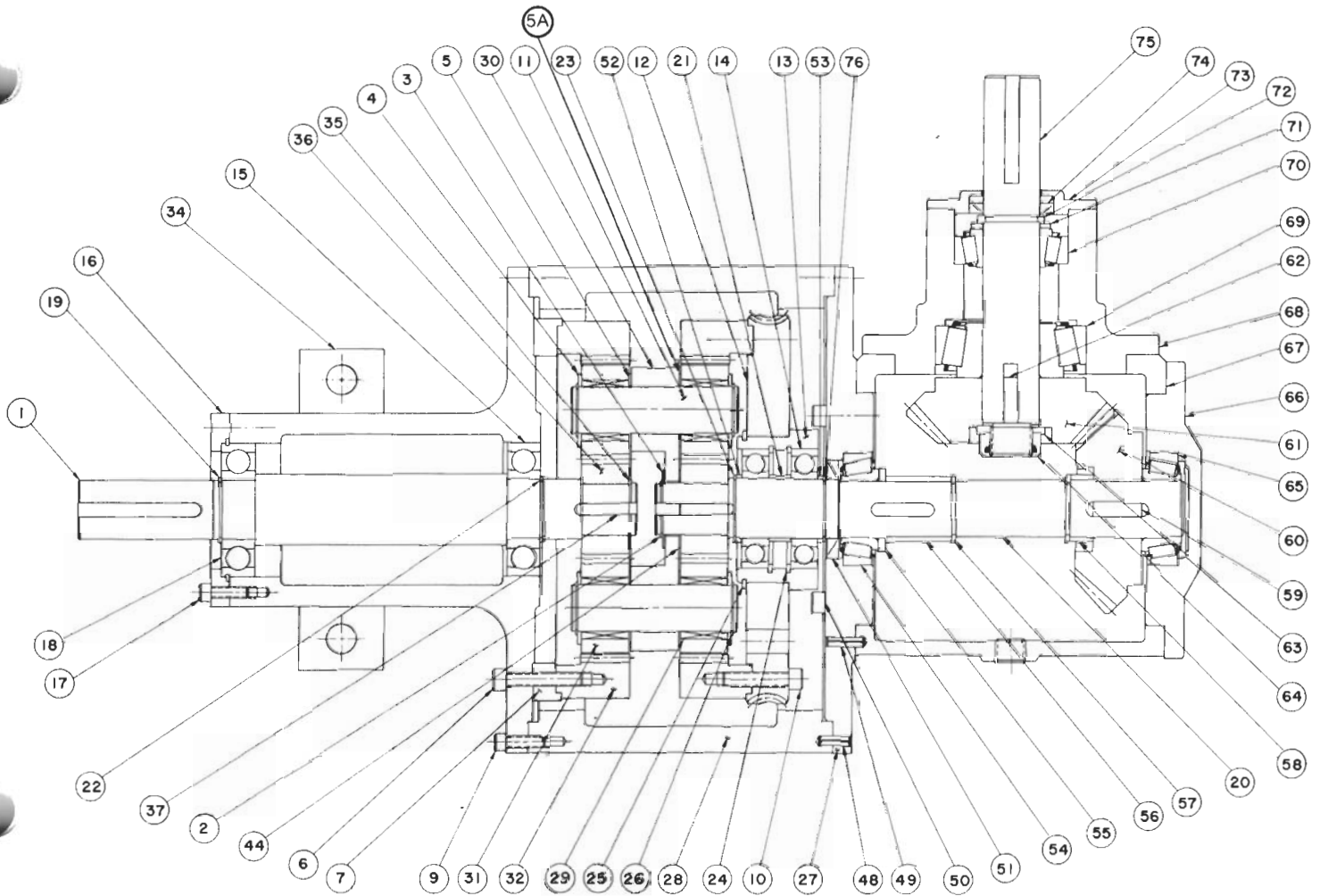


FIGURE 16A

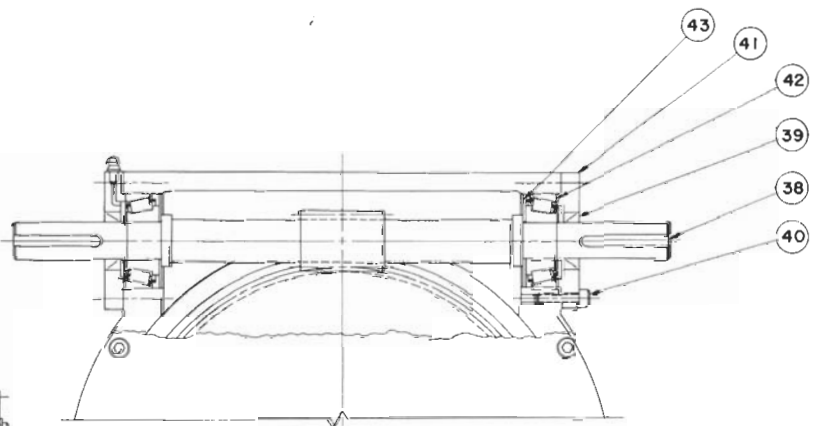


FIGURE 16B

Figure 16A shows the right angle adapter as it would appear mounted on the X shaft side of the PSD in the same position shown in Figure 16. All parts except locator number 77 are the same as for the right side mounting. For this mounting refer to Figure 14 to identify parts in the right hand shaft housing.

Parts List RALPSD

Loc. No.	Description	Quan.	Loc. No.	Description	Quan.
1	Shaft, Input-Output	1	36	Sun Gear	2
2	Snap Ring (Size 00, 0, 1, 3, 4)	1	37	Key	2
2	Snap Ring (Size 5, 7)	2	38	Worm Shaft (Specify 33.1:1, 16.67:1 or 8.3:1) ..	1
3	Thrust Race	1	39**	Seal	2
3	Thrust Race (Size 4)	2	39**	Seal (Size 7)	4
4	Thrust Race	6	40	Screw	8
5	Thrust Race	3	40	Screw (Size 7)	12
5A	Thrust Race	3	41	Bearing Cap (Sizes 0-7 have grease fittings) ...	2
6	Screw (Size 00, 0, 1, 7)	6	42	Bearing	2
6	Screw (Size 3, 4)	8	43	Grease Seal (Size 0, 1, 4, 5, 7) (Size 00 & 3 use Sealed Bearings)	2
6	Screw (Size 5)	12	44	Thrust Race	1
7	Spacer (Size 0, 3)	1	45*	Pipe Plug, Vented Square Head	1
8*	Eye Bolt (Not required on Size 00, 0, 1)	1	46*	Pipe Plug, Hex Socket	2
9	Screw	24	47*	Pipe Plug, Hex Socket (Oil Level)	2
10	Screw (Size 00, 0, 7)	6	48	Roll Pin	2
10	Screw (Size 3, 4)	8	49	Roll Pin	1
10	Screw (Size 1, 5)	12	50	Screw (Size 00, 0, 1)	4
11	Planet Shaft	3	50	Screw (Size 3, 4, 5)	6
12	Worm Gear (Specify 33.1:1, 16.67:1 or 8.3:1)	1	50	Screw (Size 7)	8
13	Hub	1	51	Seal	1
14	Bearing, Single Row (Size 00, 0, 1, 3, 4)	2	52	Spacer	1
14	Bearing, Single Row (Outboard 5, 7)	1	53	Spacer	1
14-1	Bearing, Double Row (Inboard 5, 7)	1	54	Bearing	1
15	Bearing	1	55	Spacer	1
16	Bearing Cap	1	56	Spacer	1
17	Screw	4	57	Snap Ring (Size 4, 5)	2
18	Bearing	1	58	Spacer (Certain ratios)	1
19	Snap Ring	1	59	Key	1
20	Shaft, Cross	1	59	Roll Pin (Certain ratios)	1
21	Spacer	1	60	Bevel Gear	1
22	Snap Ring	1	61	Bevel Gear	1
23	Snap Ring (Size 3, 4)	1	62	Key	1
24	Snap Ring (Size 00, 0, 1, 3)	1	63	Washer	1
24	Snap Ring (Size 4)	2	64	Locknut	1
25	Snap Ring	1	65	Bearing	1
26	Snap Ring	6	66	Bearing Cap	1
27	Adapter	1	67	Housing	1
28	Center Housing	1	68	Shaft Housing	1
29	Bearing (Size 00, 0, 1, 3, 4)	6	69	Bearing	1
29	Bearing Long (Size 5)	6	70	Bearing	1
29-1	Bearing Short (Size 5)	6	71	Spacer (Size 1, 3, 4, 5)	1
29	Bearing (Size 7)	12	72	Snap Ring	1
30	Carrier	1	72	Locknut (Size 7)	2
31	Planet Gear	6	73	Bearing Cap (Size 4, 5, 7)	1
32	Internal Spur Gear	2	74	Seal	1
33*	Drain Plug	1	75	Shaft, Output-Input	1
34	Shaft Housing	1	76	Snap Ring (Size 4, 5 or certain ratios of other sizes)	1
35	Snap Ring	1	77	Shaft, Cross	1

* Parts Not Shown

** Not Used on Size 00

Preventative maintenance procedures and assembly/disassembly procedures for the right angle adapter, including exploded views and photographs are from Hub City Engineering Manual number 3 (Safeguard Power Tech Systems) and are used by permission.

We are grateful to Hub City for allowing us to include this material in Bulletin 205-IOM.



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