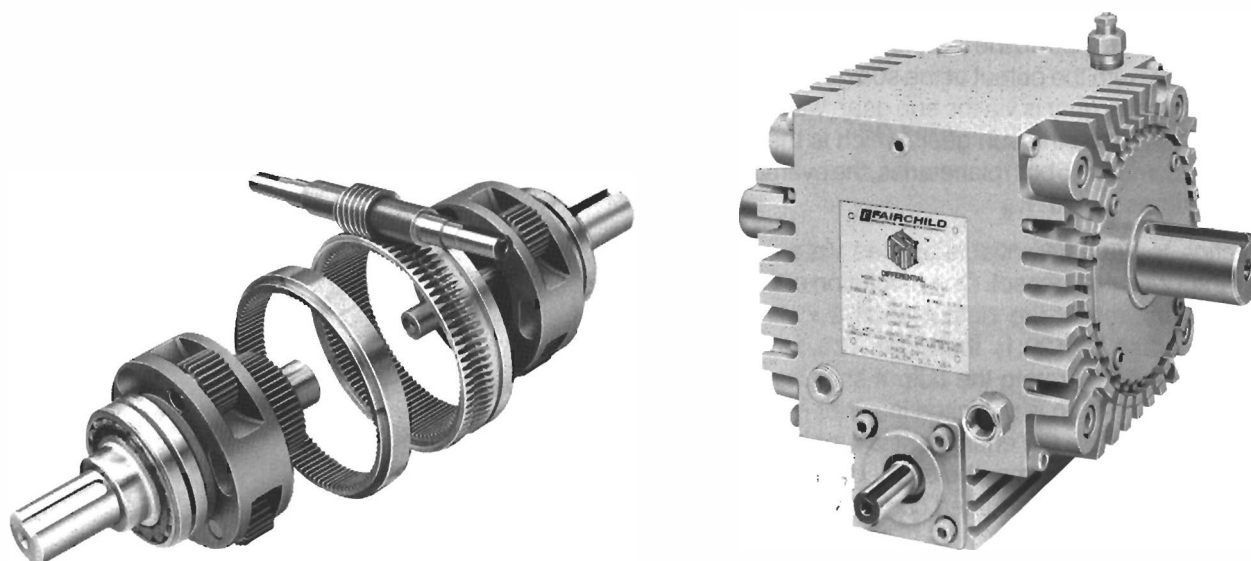


CUBIC® DIFFERENTIAL

Installation, Operating and Maintenance Instructions



The Specon CUBIC® Differential Transmission offers a reliable and precise means for adjusting the speed of, or altering the phase of shaft-driven equipment, with a continuous input.



Principles of Operation

Three basic transmissions comprise the CUBIC® Differential family of gear trains. They are the:

- FHT-Fairchild One to One Transmission
- FRA-Fairchild Right Angle Transmission
- FT-Fairchild Three to One Transmission

All three transmissions are positive gear trains with two degrees of freedom. With primary input to either the "X" or "Y" shaft, output can be altered at the corresponding "Y" or "X" shaft by a secondary input applied to the "Z" shaft.

FHT Series

Both shafts of the Cubic® Differential rotate in the same direction, and either shaft may be used as the input to obtain a ratio of 1:1. Rotation may be in either direction. The planetary configuration allows for the accommodation of high overhung loads. (See Table 1) The Cubic® Differential consists of two 1:3 ratio-simple planetaries coupled together. Input to the first planetary gear is via the planet carrier, with the output at the sun gear. Input to the second planetary gear is via the sun gear, with the output at the carrier. Since the sun gear, which is the coupling member is common to both planetaries, the overall coupled ratio is $\frac{1}{3}$ times $\frac{3}{1}$ or 1:1.

Correction to the differential is applied via a worm and integral spur-worm gear set. One revolution of the correction shaft will rotate the output shaft 2.791 degrees. Correction ratio is 129:1; therefore 129 turns of the correction shaft will rotate the output shaft through one revolution. 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 by means of an integrally mounted correction motor.

The high ratio of 129:1 between the correction shaft and the output shaft, permits fine adjustments to be made. At the same time, phase correction of considerable magnitude can be accomplished quickly since the low torque required at the correction shaft permits it to be turned rapidly with a low power correction motor.

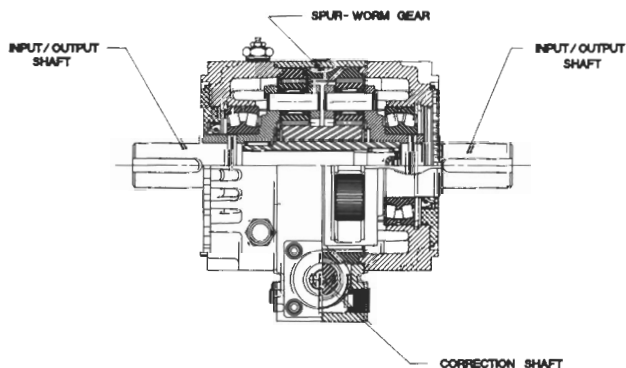


Figure 1

FRA Series

Both shafts of the FRA series differentials may or may not rotate in the same direction. The relative rotation of the shafts depends on the bevel gear configuration. The FRA series consists of a simple epicyclic planetary with bevel gearing accessed to the sun gear.

Input to the planetary gear is via the planet carrier with the output at the sun gear. Input to the bevel pinion is via the sun gear. Output is via the bevel gear with the output at right angles to the input.

The overall coupled ratio is 1:3Rb where:

$$Rb = Gt/Pt$$

Gt = Number of teeth in the bevel gear

Pt = Number of teeth in the bevel pinion.

Correction to the differential is applied via a worm and integral spur-worm gear set. Correction ratio will depend on the bevel gear ratio and whether the input is applied to the "X" or the "Y" 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 by means of an integrally mounted correction motor.

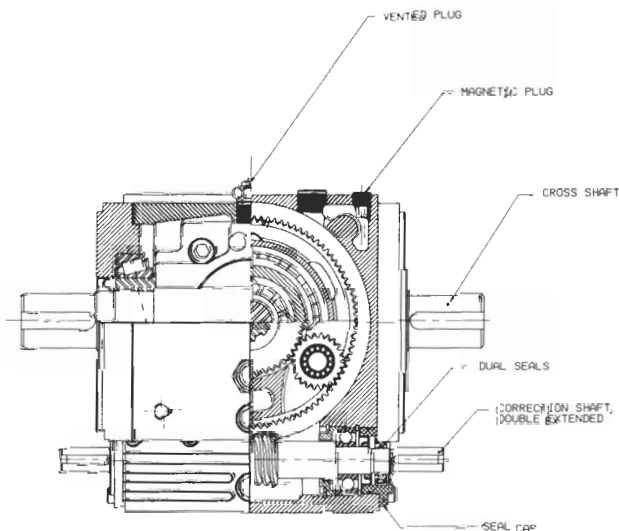


Figure 1A

Shifter Mechanism (Optional)

Any Right Angle Cubic® Differential can be equipped with a shifter mechanism that will allow the output shaft rotation to be reversed while the transmission is in operation. Figure 1D identifies an FRS-C1 unit with shifter mechanism assembly mounted on the side of the unit.

Both spiral gears (part of a spiral bevel set) in the right angle box are meshed with the pinion. (Figure 1B and 1C.) A shifter hub equipped with a spline at each end is able to slide on the cross shaft so that it engages either of the spiral gears.

The hub is actuated by a rest button mounted on the end of the shift lever which pivots around a pivot pin to which the shifter handle is attached.

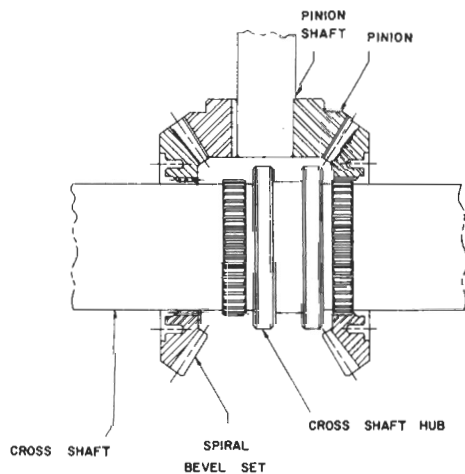
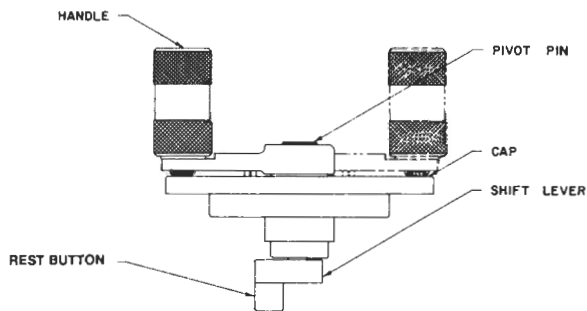


Figure 1B

**Top View Figure
Shifter Mechanism
Shifter Handle on top of Right Angle Box**

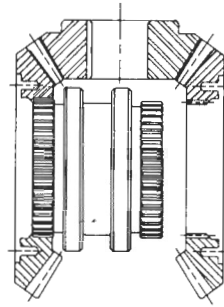
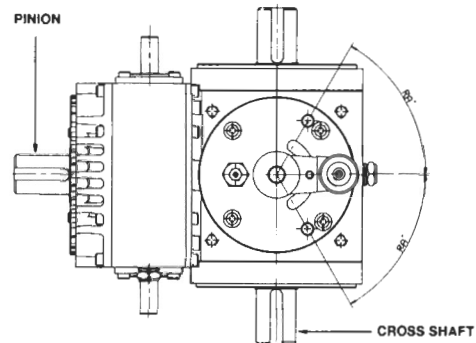
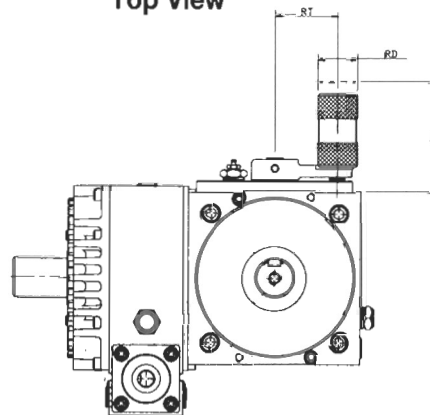


Figure 1C



Top View



Side View

Figure 1D

FT Series

Both shafts of the FT Series Differential rotate in the same direction and either shaft may be used as the input to obtain either a 3:1 or 1:3 ratio.

The FT series is the most basic of the three differential transmissions consisting of a simple epicyclic planetary gear configuration.

Input to the planetary gear is via the planet carrier with the output at the sun gear. The overall coupled ratio is 1:3. Correction to the differential is applied via worm and integral spur-worm gear set. One revolution of the correction shaft will rotate the low speed shaft 2.791 degrees or the high speed shaft 8.372 degrees.

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 by means of an integrally mounted correction motor.

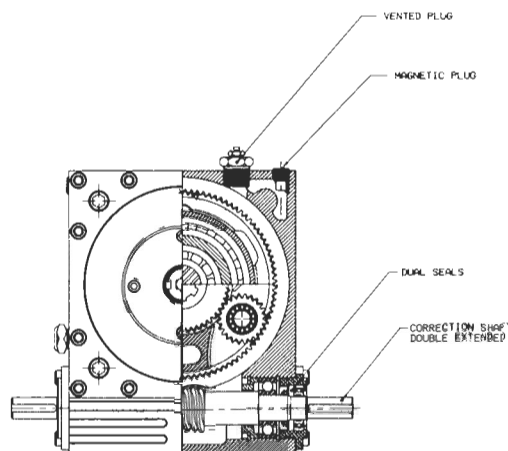


Figure 1E

Installation

The Cubic® Differential can be mounted on any of six sides specified by the user. However, for standard units the input/output shaft must be horizontal. The correction shaft can be positioned horizontally or vertically.

Accurately align the shafts. Use of flexible couplings is recommended for direct coupling. If the unit is to be connected by a timing belt or roller chain, select pulley diameters large enough so that overhung loads do not exceed the capacities indicated (Table 1).

Pulleys should be mounted on input and output shafts as close to the housing as possible. Use outboard bearings for overhung loads in excess of those indicated.

Lubrication

The unit is shipped with the proper amount of Mobil SHC 630 oil. Before running the transmission, remove the square head plug and install the attached vent plug.

After running the transmission for 1000-1500 hours, or 6 months, whichever comes sooner, change the oil and thereafter every 6 months. Replenish the oil with an equivalent viscosity high-grade synthetic oil such as Mobil SHC 630.

WARNING: DO NOT USE —

1. Ordinary motor oil
2. Automotive rear end oils
3. EP lubricants containing compounds of sulfur or phosphorus.

For outdoor applications, consult the factory for the proper grade of oil to use.

Table 1
FHT

MAXIMUM OVERHUNG LOAD* ON X AND/OR Y SHAFT	
FHT-01	350 POUNDS
FHT-A1	450 POUNDS
FHT-B1	650 POUNDS
FHT-C1	850 POUNDS
FHT-D1	1050 POUNDS

*Measured @ ½ length shaft extension

FRA

MAXIMUM OVERHUNG LOAD		
SIZE	"X" SHAFT	"Y" SHAFT
FRA-01	350 POUNDS	350 POUNDS
FRA-0A	450 POUNDS	350 POUNDS
FRA-A1	450 POUNDS	600 POUNDS
FRA-0B	650 POUNDS	600 POUNDS
FRA-B1	650 POUNDS	800 POUNDS
FRA-0C	850 POUNDS	800 POUNDS
FRA-C1	850 POUNDS	1100 POUNDS
FRA-0D	1050 POUNDS	1100 POUNDS
FRA-D1	1050 POUNDS	1600 POUNDS
FRA-0E	1400 POUNDS	1600 POUNDS

*Measured @ ½ length shaft extension

FT

MAXIMUM OVERHUNG LOAD		
SIZE	"X" SHAFT	"Y" SHAFT
FT-01	350 POUNDS	120 POUNDS
FT-A1	450 POUNDS	150 POUNDS
FT-B1	650 POUNDS	220 POUNDS
FT-C1	850 POUNDS	285 POUNDS
FT-D1	1050 POUNDS	350 POUNDS
FT-E1	1400 POUNDS	460 POUNDS

*Measured @ ½ length shaft extension

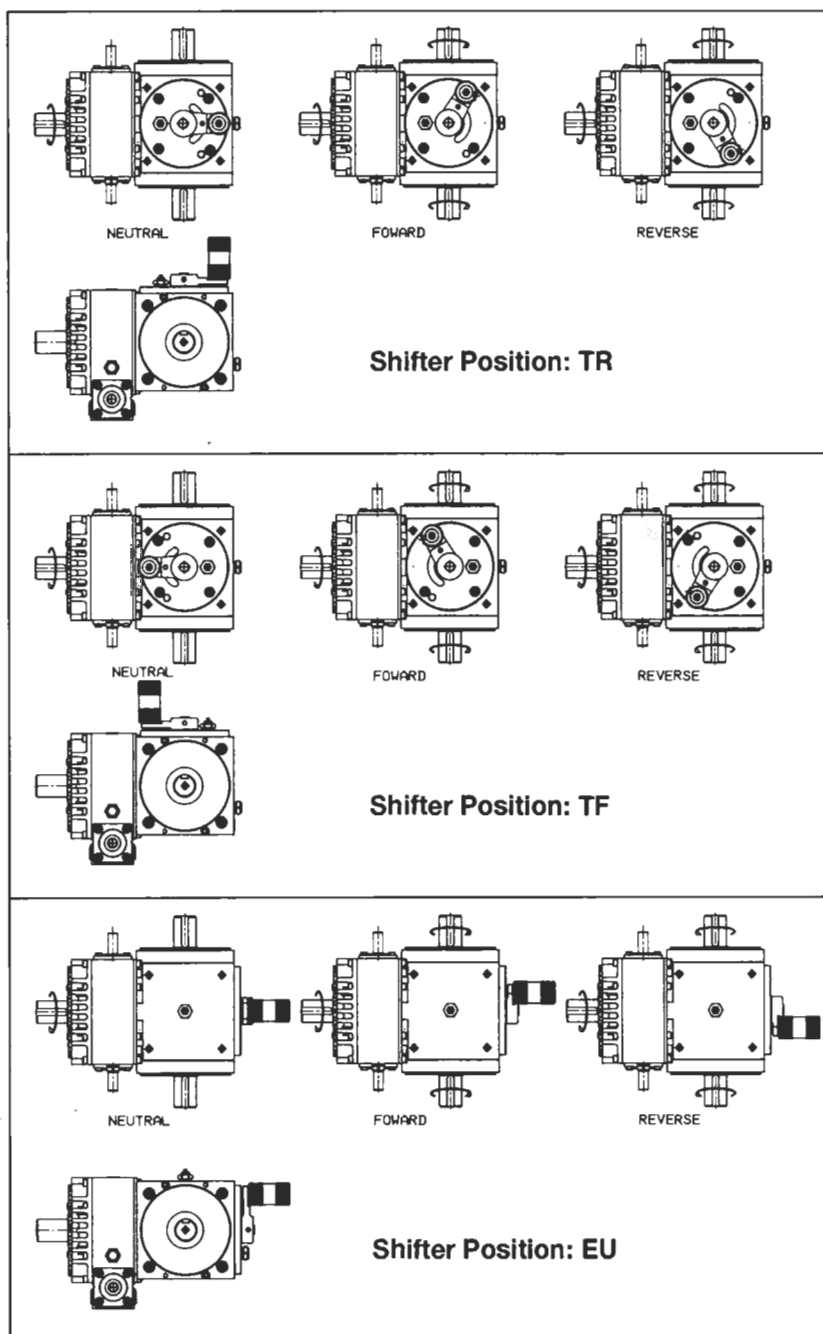
Adjustment

There are no field adjustments required.

Operation

There are no operating controls on the Cubic® Differential transmissions Types FHT and FT. For FRA types equipped with FRS (Forward, Neutral, Reverse) or FRN (Forward, Neutral or Reverse Neutral) shifter, the Figure shows the output shaft rotation and corresponding shifter arm position for shifters mounted in each of three positions (TR = top rear, TF = top forward, or EU = end up).

Figure 1F



Maintenance

FHT Series

The following procedures for disassembly of the FHT Cubic® Differential are general in nature and apply typically to units of any size.

Individual assembly drawings and bills of materials for the respective sizes and assemblies are available from the factory if required.

To reassemble the unit, reverse the procedure given.

NOTE: The bevel snap rings (39) are designed to axially pre-load the planetary assembly-A. When reassembling the unit it may be necessary to readjust the axial position of both bevel snap rings (39) in order that both snap rings (39) are properly seated and the planetary assembly-A is centered axially in the center housing (1).

2. Drain oil from the unit.
3. Remove screws (48, 49) that retain seal caps (4, 5).
4. Remove seal caps (4, 5).

NOTE: Unit can be disassembled further from either end, but it is best to start at the "X" shaft end. (The shaft should be marked on the extension end.)

5. Remove screws (50, 51, 52), retaining end bell (2) on the "X" shaft side.
6. Remove bevel snap ring (39). See Figure 3.
7. Remove end bell (2). Use a rubber or soft material hammer to free end bell. See Figure 3.
8. The ring gear (7) can be removed at this point if replacement is required. Press ring gear (7) off end bell (2).

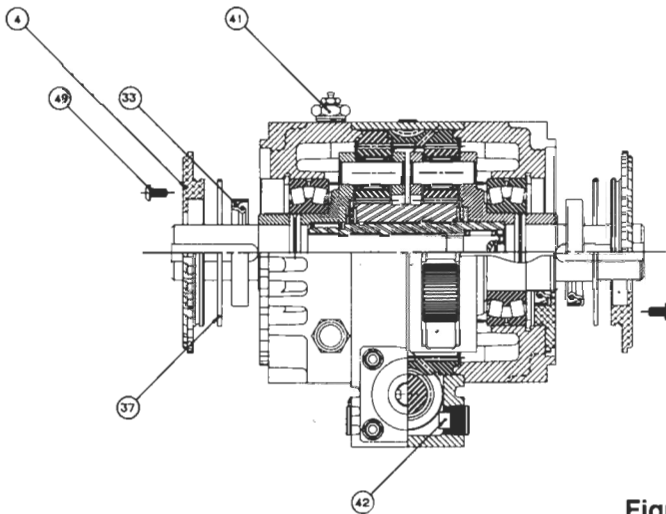
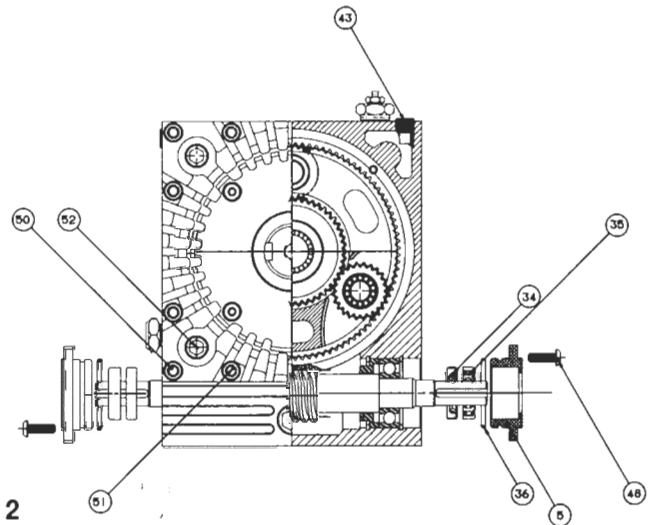


Figure 2



A. Replacement of Seals (Figure 2)

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.
2. Drain oil from the unit.
3. Remove screws (48, 49) that retain seal caps (4, 5).
4. Remove seal caps (4, 5) and replace seals (33, 34, 35).

NOTE: Item 35 is not required if the correction shaft (9) is above the oil level in the unit.

5. Examine "O" rings (36, 37) and replace if damaged.
6. Clean magnetic plugs (42, 43). Clean or replace the breather plug (41).

B. Replacement of Gears, Bearings and Transmission Components.

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.

NOTE: In some units the ring gear is retained by screws (45). In other units the ring gear is retained by roll pins (45). If the ring gear is retained by screws, the screws must be removed before the ring gear can be pressed free. See Figure 3.

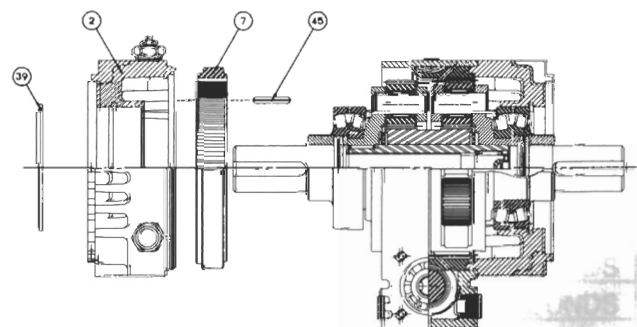


Figure 3

9. Press planetary assembly-A from center housing (1) and the other end bell (2). See Figure 4.

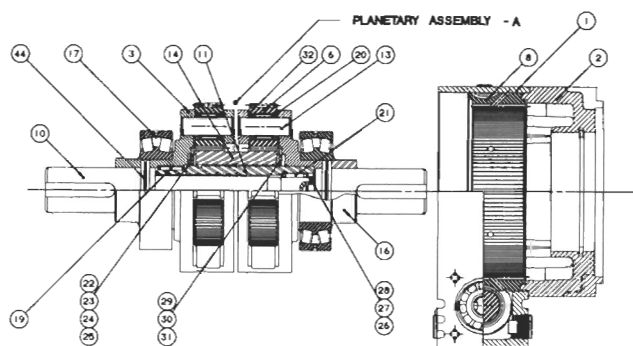
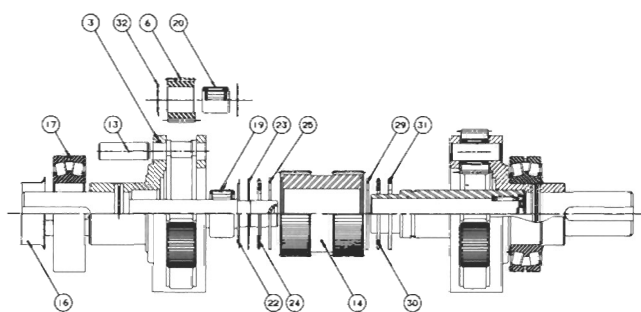


Figure 4

10. Separate planetary assembly-A. See Figure 5.
11. Remove bearings (17) and wear sleeves (16) from carrier (3). See Figure 5.



Planetary Assembly-A

Figure 5

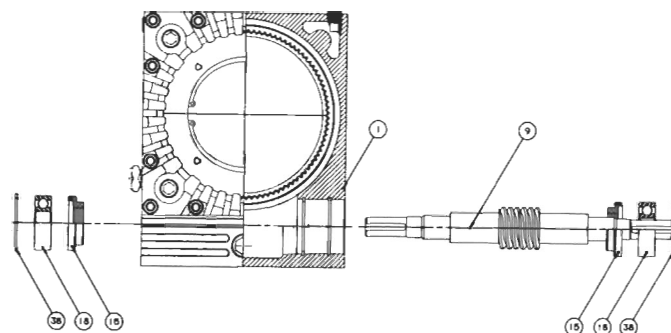


Figure 6

16. Remove spur worm gear (8) from the center housing (1) and end bell (2). See Figure 7.
17. Remove bevel snap ring (39) from the end bell (2). See Figure 7.
18. End Bell (2) can be separated from the center housing (1) if either needs replacing. Remove screws (50, 51, 52) and use a rubber or soft hammer to free end bell (2). See Figure 7.

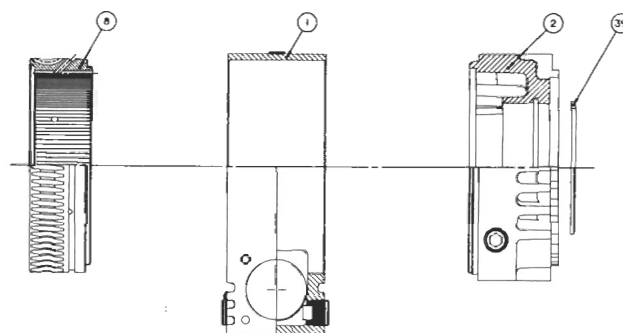


Figure 7

12. Press pinion pin (13) free and remove the pinion and thrust races (6, 32). When reassembling the unit, retain the pinion pins (13) in the carrier (3) by staking holes in the carrier (3) with a center punch (three places, both ends).
13. Press needle bearing (20) from the pinions (6). See Figure 5.
14. Remove the two outboard retaining rings (38) and carefully press worm shaft (9) from center housing (1). See Figure 6.
15. Remove bearing and grease retainer (15, 18) from worm shaft (9) and center housing (1).

NOTE: Item 15 is omitted on FHT-01. See Figure 6.

19. Use a bearing puller to remove the female shaft (11) from the carrier (3). A snap ring groove is provided so that a heavy-duty snap ring and a backup collar that is sufficiently thick and rigid can be used to free the female shaft (11) (customer-supplied snap ring and backup collar). See Figure 8.
20. Press needle bearing (21) from the female shaft (11). See Figure 8.

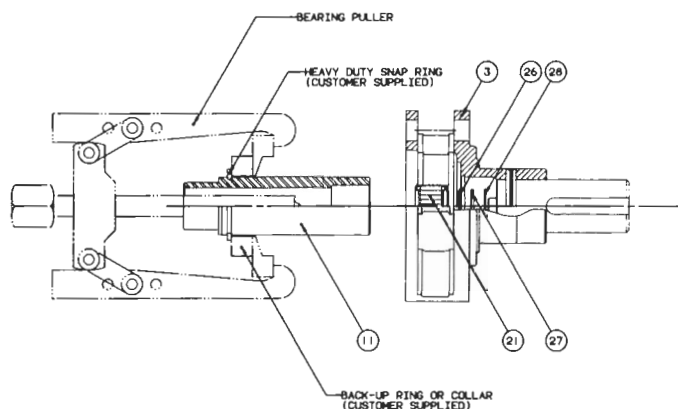


Figure 8

21. Press roll pins (44) free from carrier (3). See Figure 9.
22. Press male shaft and stub shaft (10, 12) from carrier (3). See Figure 9. When reassembling make sure that the male shaft (10) and the stub shaft (12) are pressed back into the original positions.
23. The holes must be aligned so that the roll pins (44) can be reinserted.
24. Clean all parts with Varsol. Bearings which have been moved from their original positions, should be coated with Loctite 242. In replacing housings (1, 2) use Permatex Gasket Forming Compound.

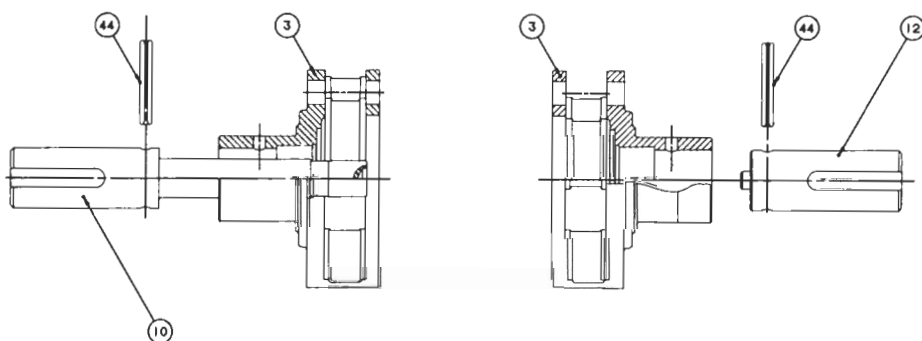


Figure 9

25. When replacing screws (50, 51, 52), replace Nylite Rolled Collars (55, 56, 57).
26. Clean magnetic plugs (42, 43). Clean or replace the breather plug (41). See Figure 2.

Backlash in the Cubic® Differential cannot be adjusted. Backlash is dependent on the stackup of tolerances. A small amount of backlash is necessary to insure proper lubrication and to allow for differential thermal expansion of the components.

Maximum backlash is shown in Table 2.

Table 2 Backlash All Series

Differential Size	Backlash Input/Output (Static or Dynamic)	Backlash Correction/Output (Dynamic)
FHT-01	less than 7 arcmin	less than 11 arcmin
FHT-A1	less than 7 arcmin	less than 11 arcmin
FHT-B1	less than 9 arcmin	less than 14 arcmin
FHT-C1	less than 9 arcmin	less than 14 arcmin
FHT-D1	less than 12 arcmin	less than 18 arcmin

One arcmin equals 1/60 degree equals 0.017°.

Typical

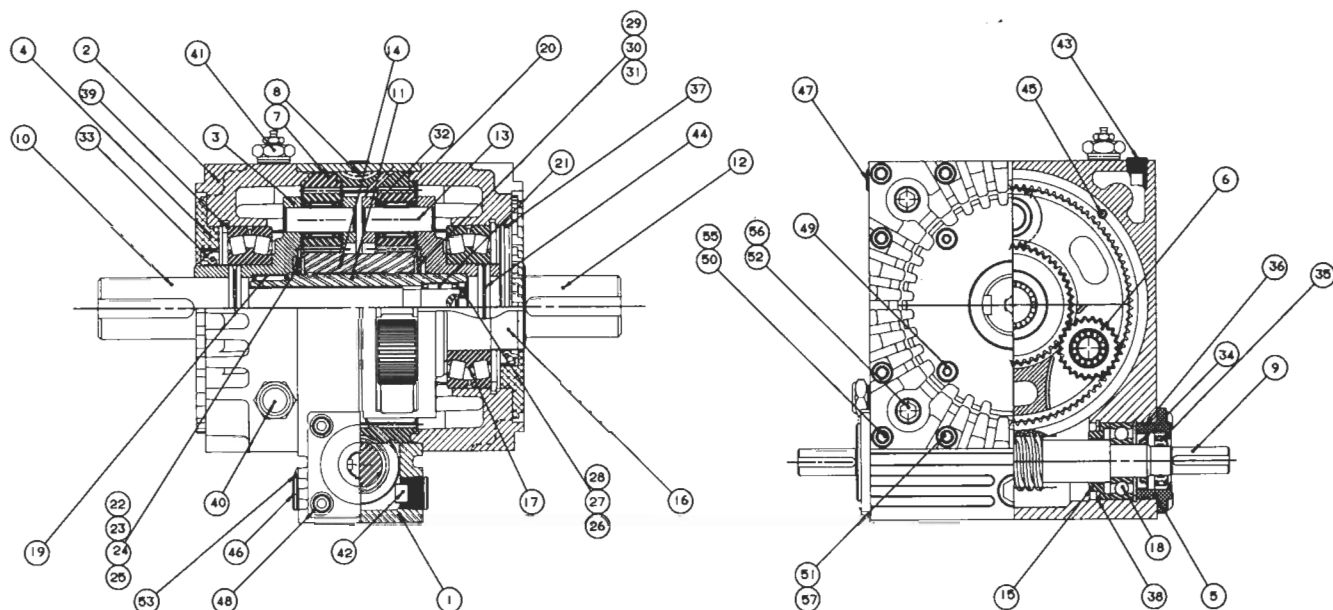


Figure 10
FHT

FHT Parts List

Loc No.	Description	Qty.	Loc No.	Description	Qty.	Loc No.	Description	Qty.
1	Center Housing	1	22	Spring Washer	1	43	Magnetic Plug	1-2
2	End Bell	2	23	Thrust Race	1	44	Roll Pin	2
3	Carrier	2	24	Needle Thrust Bearing ..	1	45	Roll Pin/Screw	4-8
4	Seal Cap	2	25	Thrust Race	1	46	Reces. Soc. HD Pipe Plug	3
5	Worm Seal Cap	2	26	Thrust Race	1	47	Reces. Soc. HD Pipe Plug	0-1
6	Pinion	6	27	Needle Thrust Bearing ..	1	48	Button HD Cap Screw ...	8
7	Ring Gear	1	28	Thrust Race	1	49	Button HD Cap Screw ...	8
8	Spur Worm Gear	1	29	Thrust Race	1	50	Socket HD Cap Screw ..	6-20
9	Worm Shaft	1	30	Needle Thrust Bearing ..	1	51	Socket HD Cap Screw ..	4
10	Male Shaft	1	31	Thrust Race	1	52	Socket HD Cap Screw ..	6
11	Female Shaft	1	32	Thrust Race	12	53	1/4-28 Grease Fit (Straight)	0-2
12	Stub Shaft	1	33	Seal	2		*1/4-28 x 3/8 Lg. Set Screw	
13	Pinion Pin	6	34	Seal	2	54	Nameplate	1
14	Sun Gear	1	35	Seal	0-2	55	Nyltite Rolled Collars	20
15	Grease Retainer	1	36	"O" Ring	2	56	Nyltite Rolled Collars	4-8
16	Wear Sleeve	2	37	"O" Ring	2	57	Nyltite Rolled Collars	4
17	Spher. Roll Bearing	2	38	Retaining Ring	2-4			
18	Spher. Ball Bearing	2	39	Retaining Ring	2			
19	Needle Bearing	1	40	Sight Gauge	1			
20	Needle Bearing	6	41	Breather	1			
21	Needle Bearing	1	42	Magnetic Plug	1			

*If worm is in sump use two to replace both grease fittings. If worm is vertical use one to replace one grease fittings.

Maintenance

FRA Series

The following procedures for disassembly of the FRA Cubic® Differential are general in nature and apply typically to units of any size.

Individual assembly drawings and bills of material for the respective sizes and assemblies are available from the factory if required.

To reassemble the unit, reverse the procedure given.

NOTE: The bevel snap ring (39) is designed to axially pre-load the planetary assembly. When reassembling the unit it may be necessary to readjust the axial position of the bevel snap ring (39) in order that the snap ring (39) is properly seated and the planetary assembly is centered axially in the center housing (1).

B. Replacement of Gears, Bearings and Transmission Components.

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.
2. Drain oil from the unit.
3. Remove screw (48) that retains seal cap (4).
4. Remove seal cap (4) and "O" Ring (37).
5. Remove screws (50, 51, 52), retaining end bell (2).
6. Remove bevel snap ring (39).
7. Remove end bell (2). Use a rubber or soft metal hammer to free end bell. Press out seal (33) from end bell (2). Remove worm gear (8).
8. The carrier (3) can be removed if necessary at this point. See Figure 11. This includes shaft (10), bearing (17), pinion pin (13), needle bearing (20), wear sleeves (16) and thrust race (32).

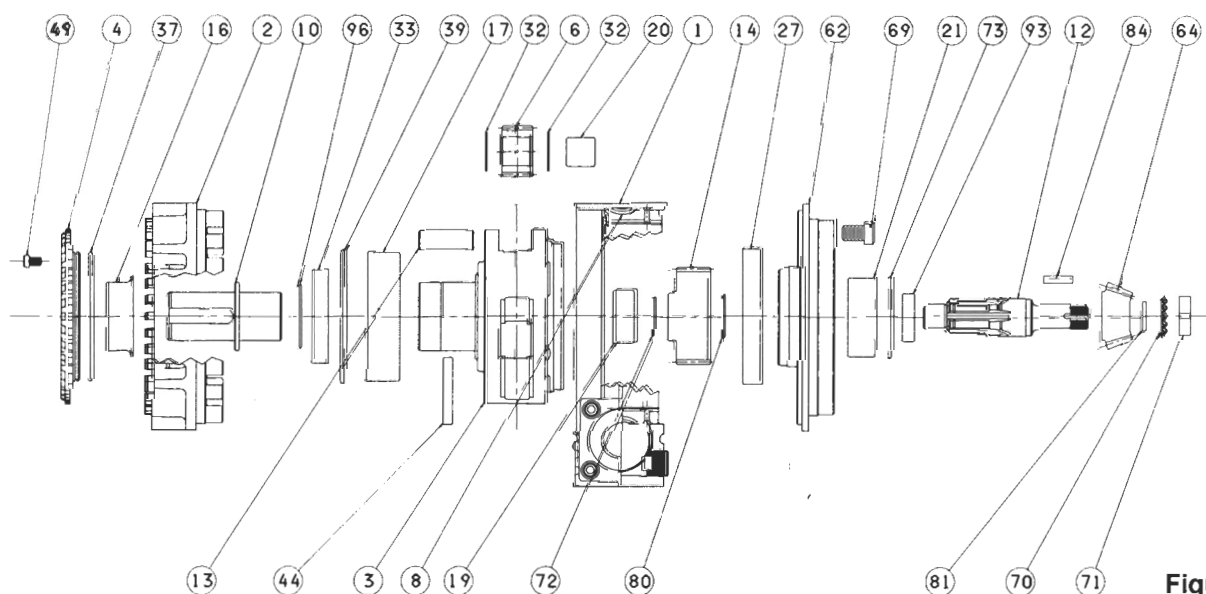


Figure 11

A. Replacement of Seals (Figure 11, 13)

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.
2. Drain oil from the unit.
3. Remove screws (48, 49) that retain seal caps (4, 5).
4. Remove seal caps (4, 5) and replace seals (33, 34, 35).

NOTE: Item 35 is not required if the correction shaft (9) is above the oil level in the unit.

5. Examine "O" rings (36, 37, 96) and replace if damaged.
6. Clean magnetic plugs (42, 43, 44). Clean or replace the breather plug (41).

NOTE: Roller bearing (21) and Ball bearing (27) will remain with end bell (62). The sun gear assembly (19, 14, 12, 93, 81, 70, 71) and spiral bevel pinion 64, will also remain with end bell (62).

9. Remove cap screws (76) securing end bells (60) to right angle box (61). See Figure 12. Remove shims (85). Slide out shaft (65), spiral bevel set (64), cross shaft hubs (82, 95) roller bearing (67) and seal (68).
10. Remove bevel snap ring (73). Press out sun gear shaft (12) and sun gear (14) assembly. See Figure 11.
11. Press out bearing (17) roll pin (44), shaft (10) wear sleeves (16) and "O" ring (96) from carrier (3).
12. Press pinion pin (13) free and remove the pinion and thrust races (6, 32).

NOTE: When reassembling the unit, retain the pinion pin (13) in the carrier (3) by staking holes in the carrier (3) with a center punch.

13. Press needle bearing (20) from the pinion (6).
14. Press out bearing (19), remove snap ring (72) and sun gear (14). See Figure 11.
15. Remove four cap screws (69) holding end bell (62) to right angle box (61). Press out bearings (21, 27) from end bell (62). Remove snap ring (80).
16. Slide spacer (93) from shaft, remove nut (71), lockwasher (70) and Spacer (81). Remove key (84) and spiral pinion (64) from shaft (12).
17. Remove the two outboard retaining rings (38) from the worm shaft (9). Remove screw (49) that retains seal cap (5). Remove seal cap (5). See Figure 13.

18. Remove seal (34, 35) and "O" ring (36). Carefully press worm shaft (9) from center housing (1).

19. Remove bearing and grease retainer (15, 18) from worm shaft (9) and center housing (1).

NOTE: Maintenance of other assemblies in the FRA series is essentially the same except that the location of cap nuts that secure the right angle box to the FRA housing may vary. Also, some assemblies may have double ended cross shafts and some may have an integral shifter mechanism.

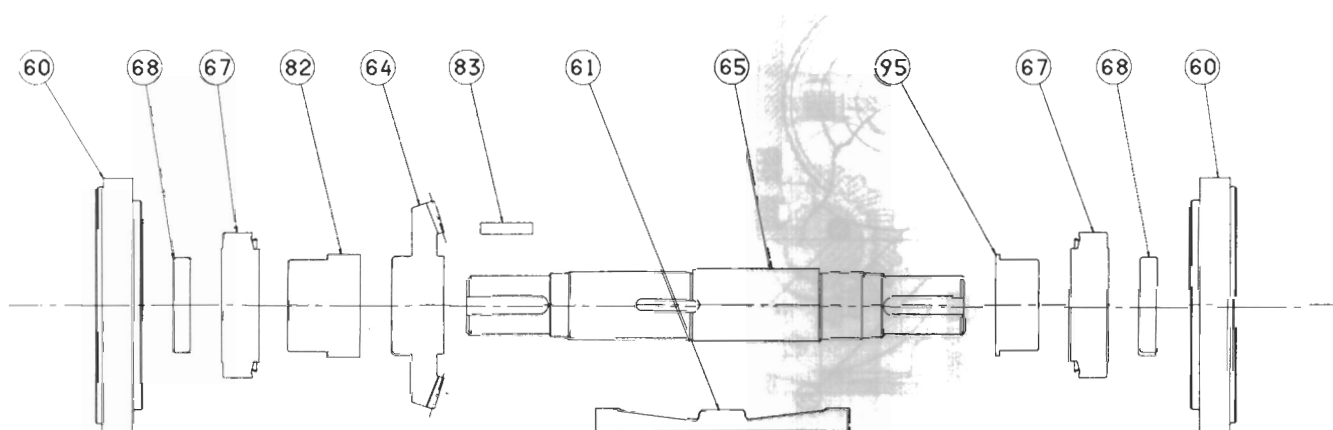


Figure 12

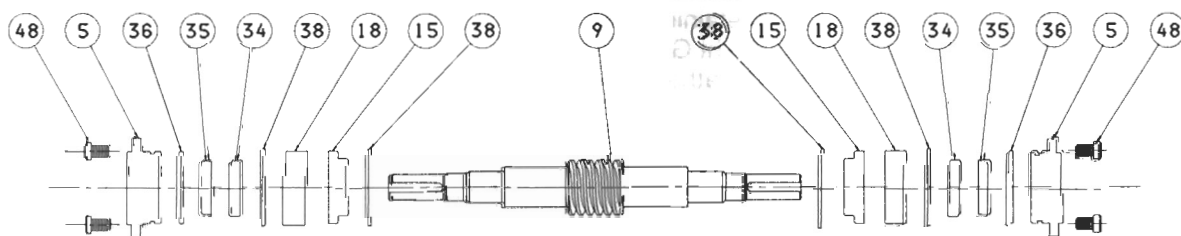


Figure 13

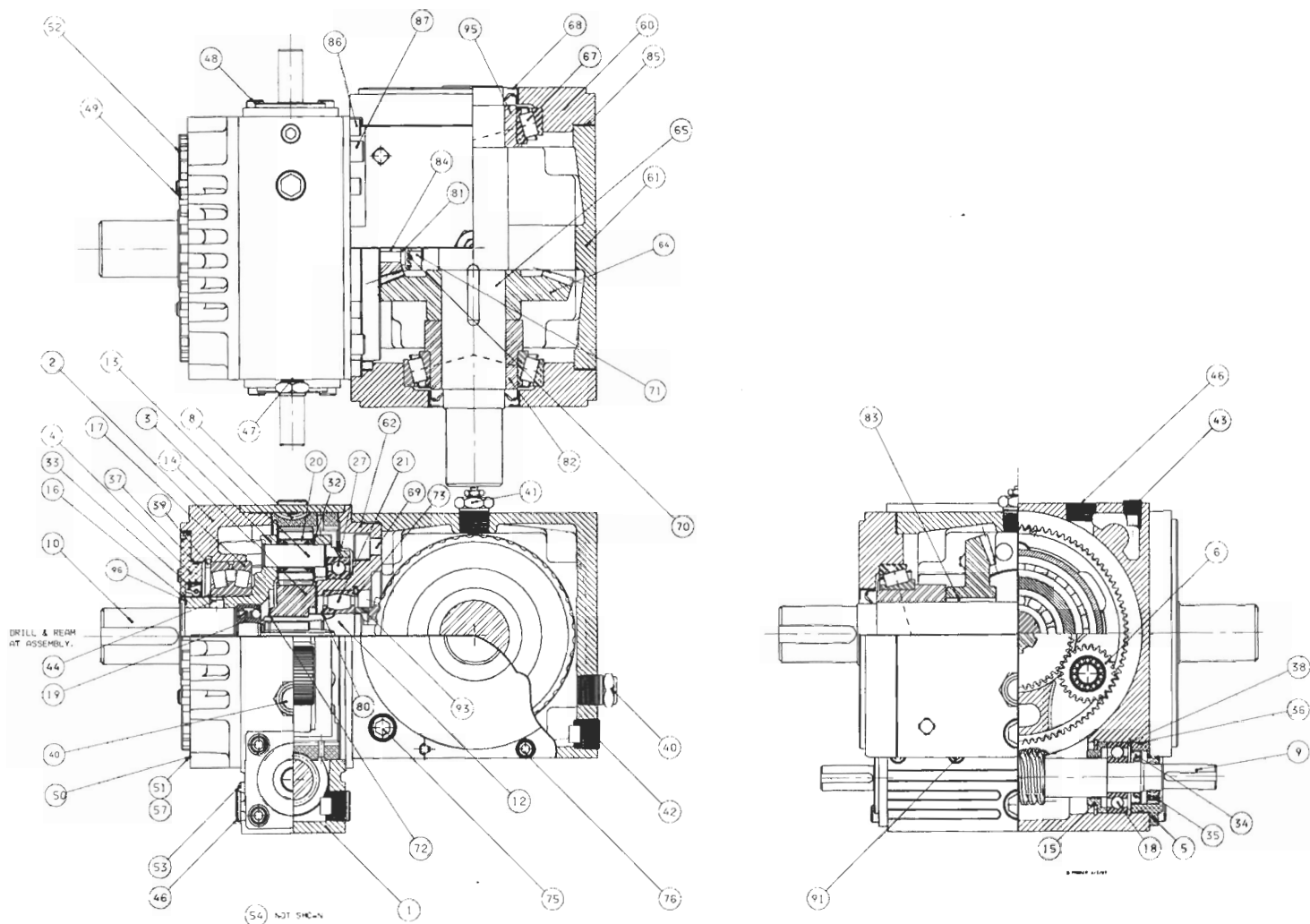


Figure 14
FRA-A1

FRA-A1 Parts List

Loc No.	Description	Qty.	Loc No.	Description	Qty.	Loc No.	Description	Qty.
1	Center Housing	1	35	Seal	2	65	Cross Shaft	1
2	FRA End Bell	1	36	"O" Ring	2	67	Tapered Roller Bearing	2
3	FRA Carrier	1	37	"O" Ring	1	68	Seal	2
4	Seal Cap	1	38	Retaining Ring	4	69	Soc. HD Cap Screw	4
5	Worm Seal Cap	2	39	Retaining Ring	1	70	Lock Washer	1
6	Pinion	3	40	Sight Gauge	2	71	Lock Nut	1
8	FRA Spur Worm Gear	1	41	Breather	1	72	Snap Ring	1
9	Worm Shaft	1	42	Magnetic Plug	2	73	Bevel Snap Ring	1
10	Carrier Shaft	1	43	Magnetic Plug	1	75	Soc. HD Cap Screw	8
12	Sun Gear Shaft	1	44	Dowel Pin	1	76	Soc. HD Cap Screw	4
13	Pinion Pin	3	46	Pipe Plug	2	80	Snap Ring	1
14	FRA Sun Gear	1	47	Pipe Plug	1	81	Spacer	1
15	Grease Retainer	2	48	Soc. HD Cap Screw	8	82	Cross Shaft Hub	1
16	Wear Sleeve	1	49	Soc. HD Cap Screw	4	83	Key	1
17	Spher. Roll Bearing	1	50	Soc. HD Cap Screw	10	84	Key	1
18	Ball Bearing Radial	2	51	Soc. HD Cap Screw	2	85	Shims	*
19	Self-aligning Ball Bearing	1	53	1/4-28 Grease Fitting (Straight)	2	86	Soc. HD Cap Screw	10
20	Needle Bearing	3		*1/4-28 x 3/8 Lg. Set Screw	*2	87	Soc. HD Cap Screw	4
21	Sphere-Roll Bearing	1	54	Nameplate	1	91	Soc. HD Cap Screw	2
27	Ball Bearing	1	60	Right Angle Box End Bell	2	93	Spacer	1
32	Thrust Race	6	61	Right Angle Box	1	95	Cross Shaft Hub	1
33	Seal	1	62	FRA-A1 End Bell	1	96	"O" Ring	1
34	Seal	2	64	Spiral Bevel Set	1			

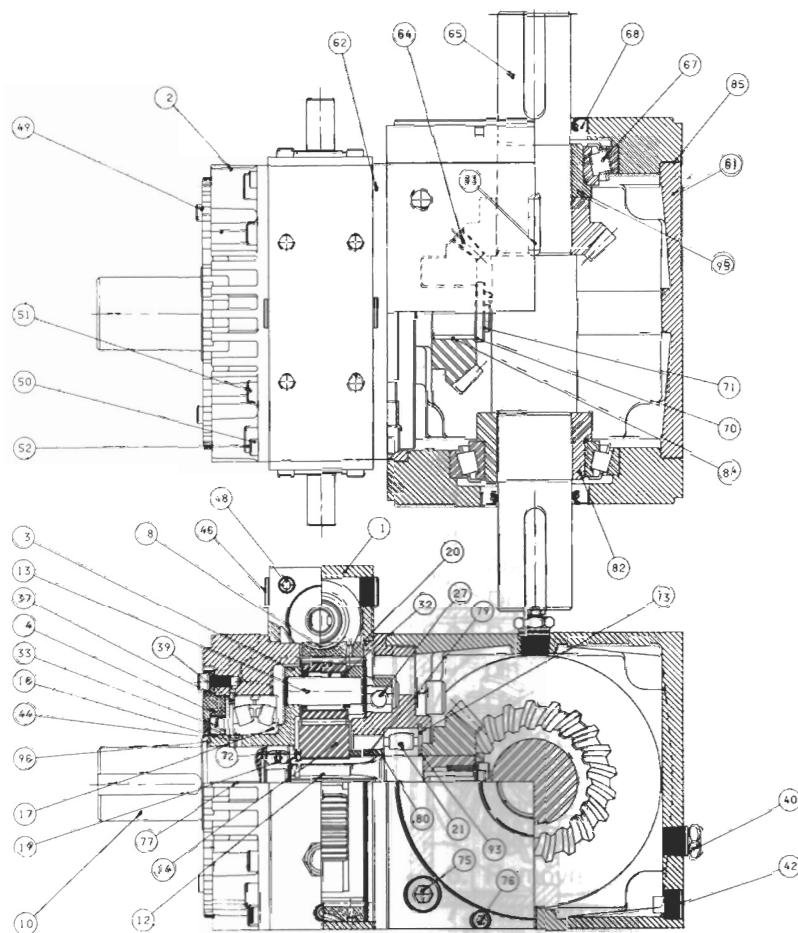
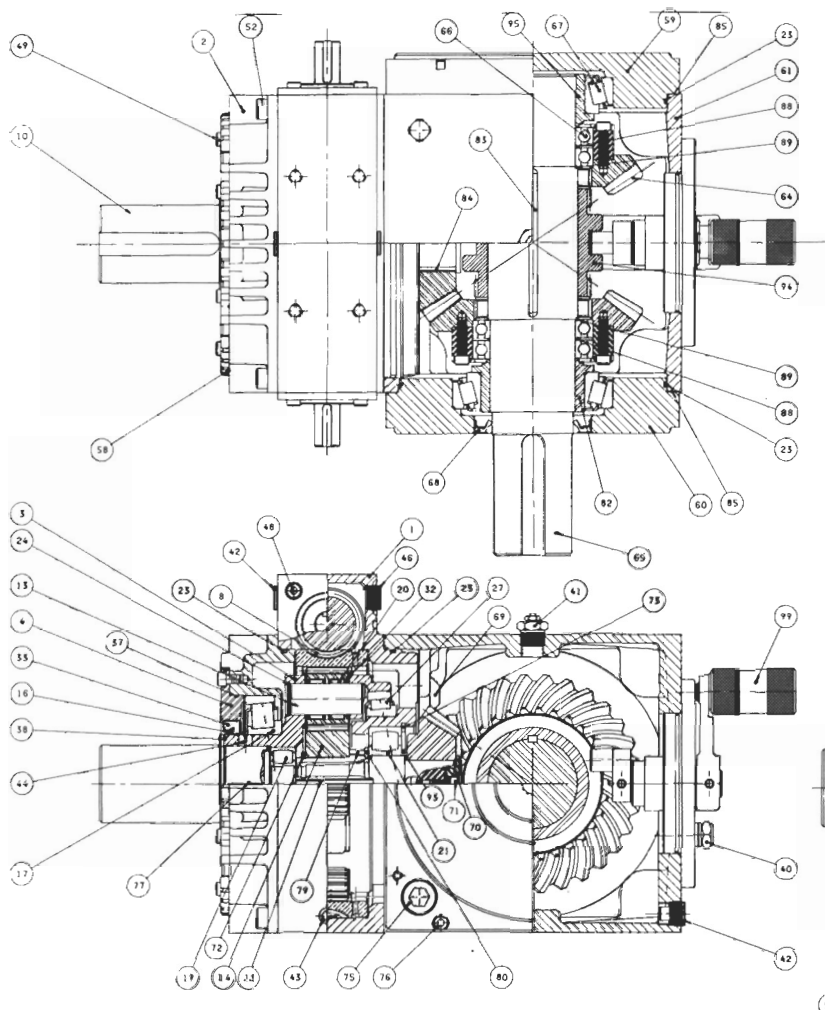


Figure 15
FRA-B1

FRA-B1 Parts List

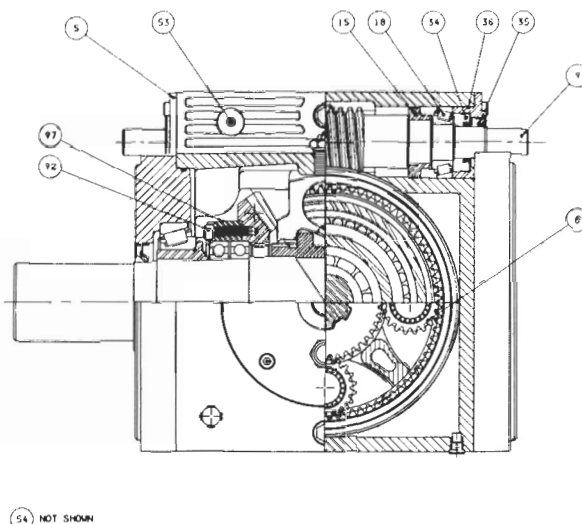
Loc No.	Description	Qty.	Loc No.	Description	Qty.	Loc No.	Description	Qty.
1	Center Housing	1	36	"O" Ring	2	67	Tapered Roller Bearing .	2
2	B1 End Bell	1	37	"O" Ring	1	68	Seal	2
3	B1 Carrier	1	38	Retaining Ring	4	69	Soc. HD Cap Screw	4
4	Seal Cap	1	39	Retaining Ring	1	70	Washer	1
5	Worm Seal Cap	2	40	Sight Gauge	2	71	Soc. HD Cap Screw	3
6	Pinion	3	41	Breather	1	73	Snap Ring	1
8	Spur Worm Gear	1	42	Magnetic Plug	2	75	Soc. HD Cap Screw	8
9	Worm Shaft (Metric)	1	43	Magnetic Plug	2	76	Soc. HD Cap Screw	4
10	Carrier Shaft (Metric)	1	44	Roll Pin	1	77	Key	1
12	Sun Gear Shaft	1	46	Recessed Soc. HD Pipe Plug	3	79	Spacer	1
13	Pinion Pin	3	48	Soc. HD Cap Screw	8	80	Snap Ring	1
14	FRA-B1 Sun Gear	1	49	Soc. HD Cap Screw	6	82	Cross Shaft Hub	1
15	Grease Retainer	2	50	Soc. HD Cap Screw	4	83	Key	1
16	Wear Sleeve	1	51	Soc. HD Cap Screw	4	84	Key	1
17	Spher. Roll Bearing	1	53	1/4-28 Grease Fitting (Straight)	2	85	Shims	*
18	Ball Bearing	2	54	Nameplate	1	86	Soc. HD Cap Screw	4
19	Self-aligning Ball Bearing	1	60	Right Angle Box End Bell	2	87	Soc. HD Cap Screw	8
20	Needle Bearing	3	61	Right Angle Box	1	91	Soc. HD Cap Screw	4
21	Sphere-Roll Bearing	1	62	FRA-B1 End Bell	1	93	Spacer	1
27	Ball Bearing	1	64	Spiral Bevel Set	1	95	Cross Shaft Hub	1
32	Thrust Race	6	65	Cross Shaft	1	96	"O" Ring	1
33	Seal	1						
34	Seal	2						



NOTES:

1. PRELOAD ON TAPERED ROLLER BEARINGS, ITEMS 17 & 27 SHOULD BE .002 - .004 CLEARANCE
2. PRELOAD ON TAPERED BEARINGS ITEM 67 SHOULD BE .000 - .002 CLEARANCE

FRS-C1



54 NOT SHOWN

Figure 16
FRS-C1

FRS-C1 Parts List

Loc No.	Description	Qty.	Loc No.	Description	Qty.	Loc No.	Description	Qty.
27	Tapered Roller Bearing	1	59	Right Angle Box End Bell	1	84	Key	1
32	Thrust Race	8	60	Right Angle Box End Bell	1	85	Right Angle Box Shims	*
33	Seal	1	61	Right Angle Box	1	88	Bearing Shim	*
34	Seal	2	64	Spiral Bevel Set	1	89	Bearing Shim	*
35	Seal	2	65	Cross Shaft	1	92	Soc. HD Cap Screw	12
36	"O" Ring	2	66	Ball Bearing	4	93	Spacer	1
37	"O" Ring	1	67	Tapered Roller Bearing	2	94	Splined Shifter Hub	1
38	"O" Ring	1	68	Seal	1	95	Cross Shaft Hub	1
40	Sight Gauge	1	69	Button Head Cap Screw	4	97	Spiral Bevel Hub	2
41	Breather	1	70	Washer	1			
42	Magnetic Plug	2	71	Soc. HD Cap Screw	1			
43	Magnetic Plug	2	72	Snap Ring	1			
44	Roll Pin	1	73	Snap Ring	1			
46	Recessed Soc. HD Pipe Plug	1	75	Soc. HD Cap Screw	8			
48	Soc. HD Cap Screw	8	76	Soc. HD Cap Screw	8			
49	Soc. HD Cap Screw	6	77	Key	1			
53	1/4-28 Grease Fitting (Straight)	2	79	Spacer	1			
	*1/4-28 x 3/8 Lg. Set Screw	*2	80	Snap Ring	1			
54	Nameplate	1	82	Cross Shaft Hub	1			
58	Soc. HD Cap Screw	4	83	Key	1			

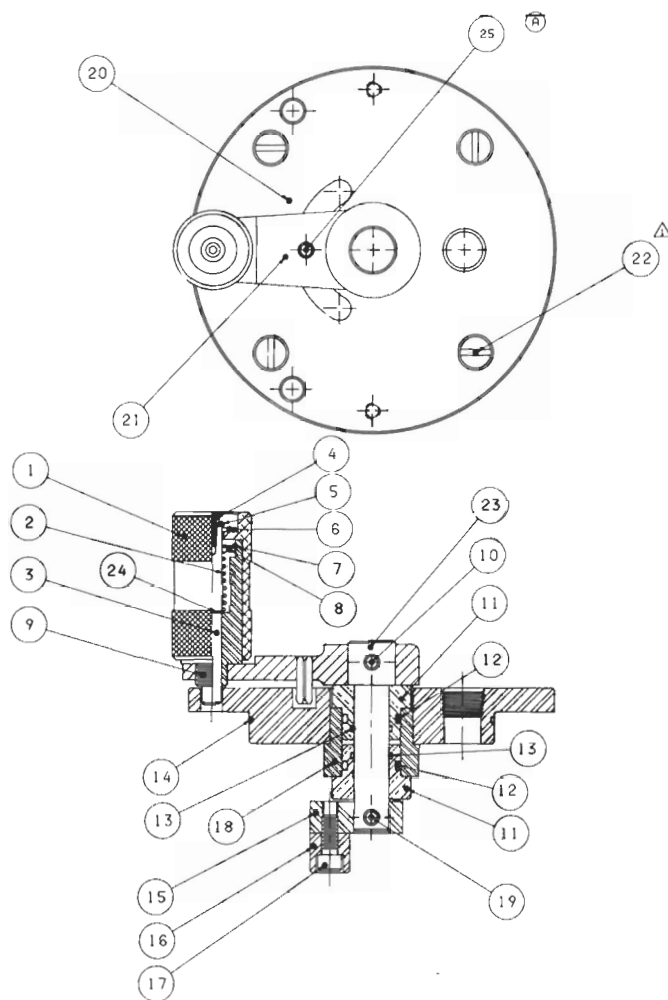


Figure 17
FRS Shifter

FRS Shifter

A. Replacement of "O" Rings

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.
2. Drain oil from the unit.
3. Remove roll pin (10) and pull handle (21) off the pivot pin (23).
4. Remove screws (48) holding end bells (60) on the right angle box.
5. Using a gear puller, pull out the gears in the right angle box.
6. Remove and replace "O" Rings (12, 13, 14).

B. Replacement of Shifter Components

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.
2. Drain oil from the unit.
3. Remove roll pin (10) and pull handle (21) off the pivot pin (23).
4. Using a gear puller, pull out the gears in the right angle box. Remove seal screws (22) holding shifter cap (20) to the right angle box.
5. Using a hammer made of soft material, punch out pivot pin (23) from the top plate.
6. Remove roll pin (19) from pivot pin (23).
7. Remove screw (17) securing rest button (16) to shift lever (15).
8. Pull out retainer bushing (11) and spacer bushing (18).
9. Remove screw (4) holding handle assembly.
10. Pull up handle (1) and remove spring (2).

FRS SHIFTER Parts List

Loc No.	Description	Qty.			
1	Handle	1	13	"O" Ring	2
2	Stock Compression Spring	1	14	"O" Ring	1
3	Plunger Pin	1	15	Shift Lever	1
4	Soc. HD Screw	1	16	Circular Rest Button	1
5	Washer (Flat)	1	17	Soc. HD Screw	1
6	Washer (Flat)	1	18	Spacer Bushing	1
7	Snap Ring	1	19	Roll Pin	1
8	Washer (Flat)	1	20	Shifter Cap	1
9	Handle Bushing	1	21	Malleable Mach. Handle	1
10	Roll Pin	1	22	Integral Seal Screw	4
11	Retainer Bushing	2	23	Pivot Pin	1
12	"O" Ring	2	25	Roll Pin	1

Maintenance

FT Series

The following procedures for disassembly of the FT Cubic® Differential are general in nature and apply typically to units of any size.

Individual assembly drawings and bills of material for the respective sizes and assemblies are available from the factory if required.

To reassemble the unit, reverse the procedure given.

A. Replacement of Seals (Figure 18, 19)

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.
2. Drain oil from the unit.
3. Remove screws (48, 49) that retrain seal caps (4, 5).
4. Remove seal caps (4, 5) and replace seals (33, 34, 35).

NOTE: Item 35 is not required if the correction shaft (9) is above the oil level in the unit.

5. Examine "O" rings (36, 37) and replace if damaged.
6. Clean magnetic plugs (42, 43). Clean or replace the breather plug (41).

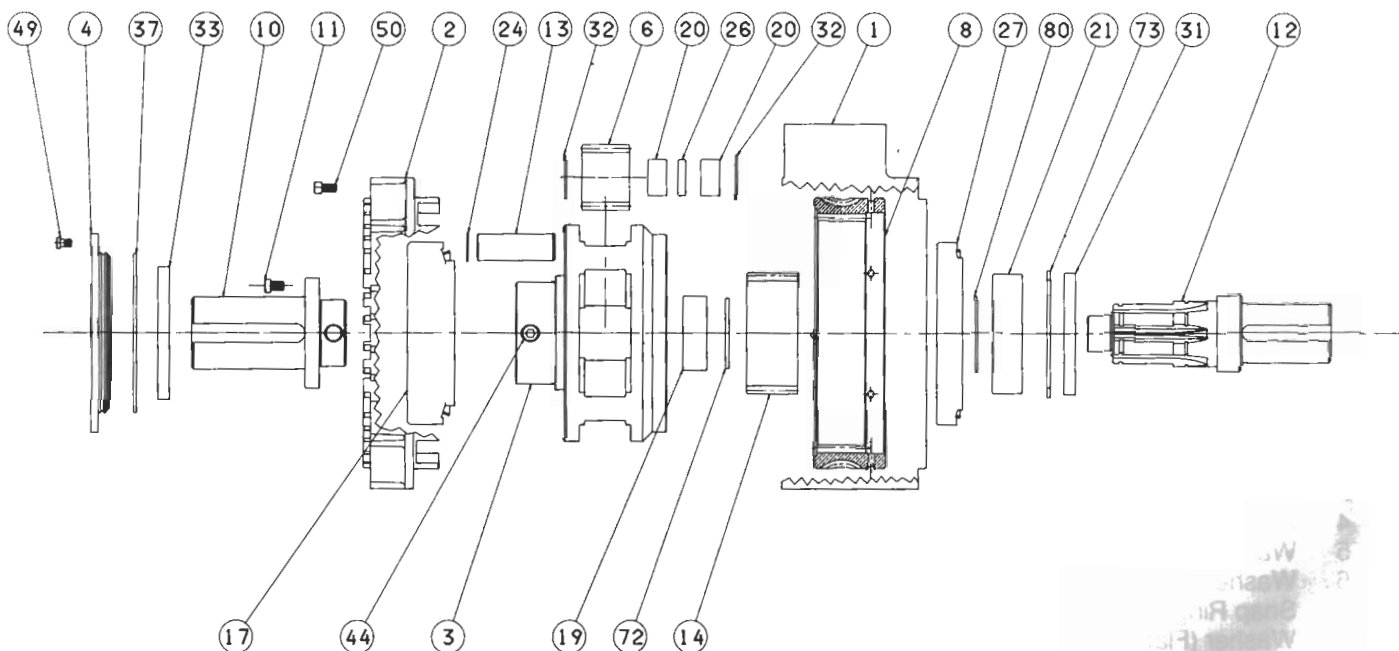


Figure 18

B. Replacement of Gears, Bearings and Transmission Components.

1. Disconnect the unit from the input and output equipment. Remove pulleys, gears and couplings from the shafts.
2. Drain oil from the unit.
3. Remove screw (49) that retains seal cap (4).
4. Remove seal cap (4), seal (33) and "O" Ring (37).
5. Remove screws (50, 51, 58), retaining end bell (2).
6. Remove assembly consisting of shaft (10), bearing (17), carrier (3) and pinions (16).
7. Remove roll pin (44) and screw (11), carrier (3) can be removed from shaft (10). Press needle bearing (20) from pinion (6). Press out bearing (17). Remove retaining ring (24) press out pinion pin (15) and remove pinion and thrust races (6, 32). See Figure 18.
8. Remove bearing (19), snap ring (72) and sun gear (14).
9. Remove bearing (21) and (27) from end bell (1). See Figure 18. Remove snap ring (73), seal (31) and shaft (12) from end bell (1).
10. Remove spur gear (8) from housing (1).
11. Remove screws (48) holding seal cap (5). See Figure 19. Remove seals (34, 35) and "O" Ring (36).
12. Remove worm shaft (9), bearing (18) and grease retainer (15).

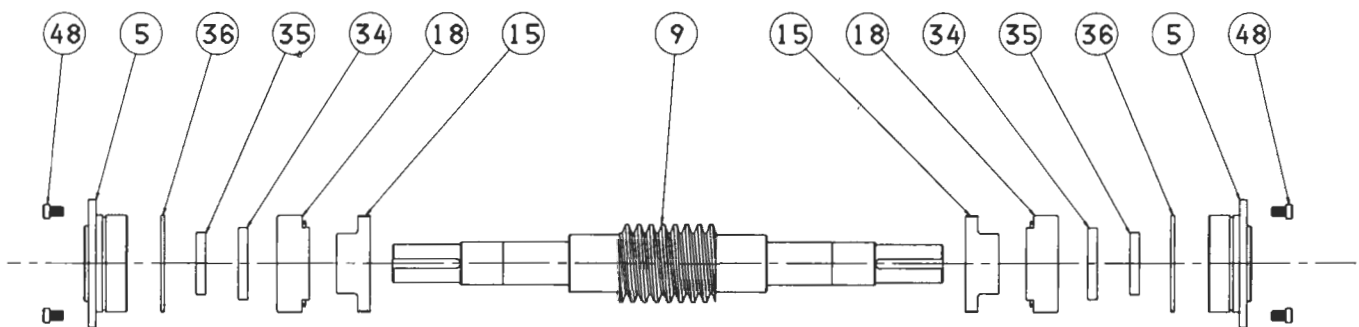


Figure 19

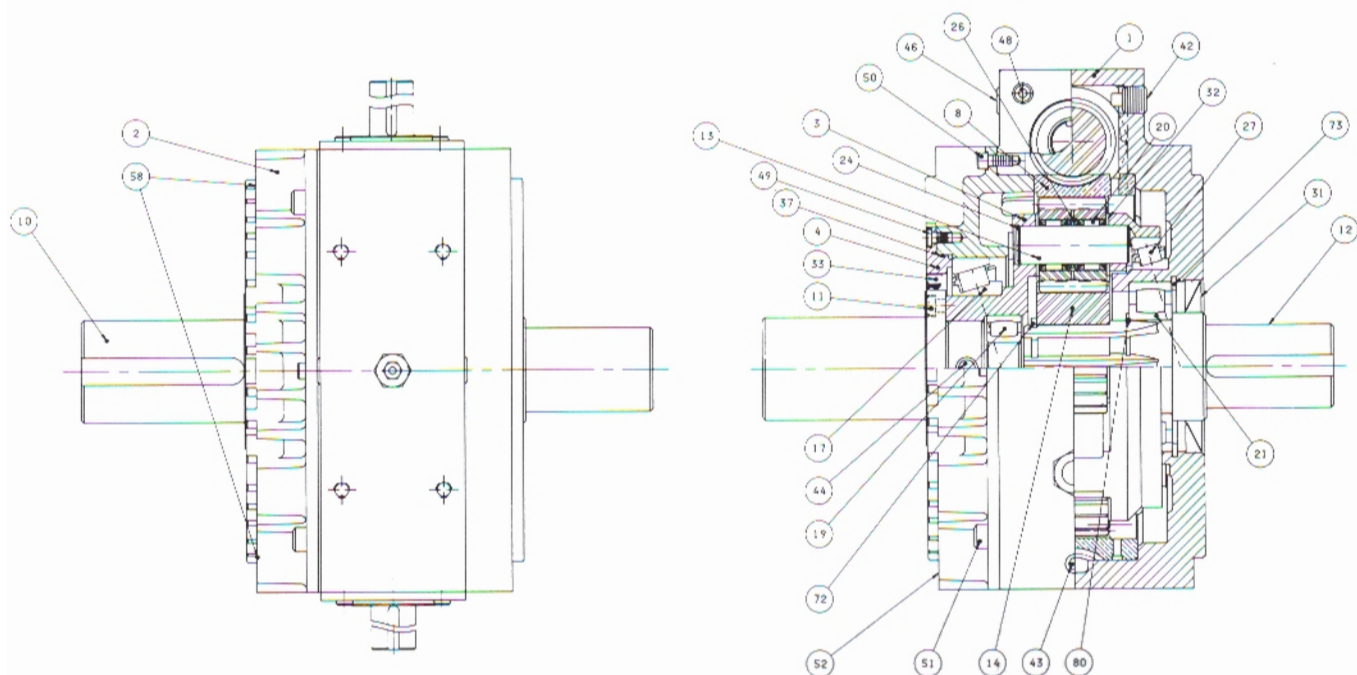


Figure 20
FT-D1

FT-D1 Parts List

Loc No.	Description	Qty.	Loc No.	Description	Qty.	Loc No.	Description	Qty.
1	D1 Center Housing	1	21	Spher. Roll Bearing	1	48	Low HD Soc. Cap Screw	8
2	D1 End Bell	1	24	Retaining Ring	4	49	Low HD Soc. Cap Screw	6
3	D1 Carrier	1	26	Spacer	4	50	Soc. HD Cap Screw	4
4	Seal Cap	1	27	Tapered Roll Bearing	1	51	Soc. HD Cap Screw	4
5	Worm Seal Cap	2	31	Seal	1	52	Soc. HD Cap Screw	8
6	Pinion	4	32	Thrust Race	8	53	1/4-28 Grease Fit (Straight)	2
8	Spur Worm Gear	1	33	Seal	1		*1/4-28 x 3/8 Lg. Set Screw	*2
9	Worm Shaft	1	34	Seal	2	54	Nameplate	1
10	Carrier Shaft	1	35	Seal	2	58	Soc. HD Cap Screw	2
11	Shoulder Screw	8	36	"O" Ring	2	72	Snap Ring	1
12	Sun Gear Shaft	1	37	"O" Ring	1	73	Snap Ring	1
13	Pinion Pin	4	40	Sight Gauge	1			
14	FT-D1 Sun Gear	1	41	Breather	1			
15	Grease Retainer	2	42	Magnetic Plug	2			
17	Tapered Roll Bearing	1	43	Magnetic Plug	2			
18	Tapered Roll Bearing	2	44	Roll Pin	1			
19	Spher. Roll Bearing	1	46	Recessed Soc. HD Pipe Plug	7			
20	Needle Bearing	8						