

## SECTION 6. REPAIR OF EXTERNAL SUBASSEMBLIES

### 6.1 SAFETY NOTICE

#### CAUTION

Avoid contact with rotating output coupling and always shut down engine when doing even minor inspection or repair. Avoid contact with metal surfaces as operating temperature may exceed 200°

### 6.2 OIL PUMP

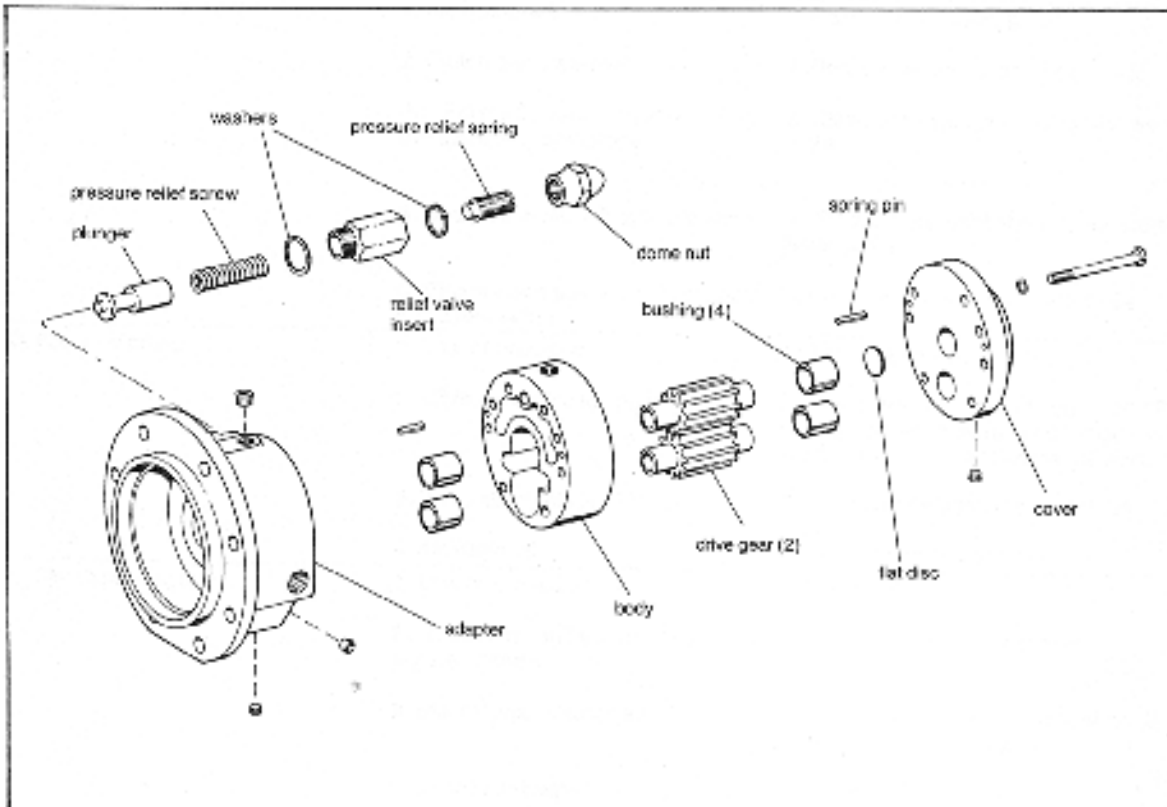


Fig. 19. Oil Pump Assembly

## **6.2 OIL PUMP**

### **A. RELIEF PLUNGER**

1. With oil pump in place on marine gear remove dome nut, relief valve insert with screw, spring and accompanying washers. NOTE: UNSCREW INSERT CAREFULLY BECAUSE PRESSURE RELIEF SPRING IS UNDER TENSION.

2. Check relief plunger to see if it is free moving. If not, inspect plunger burrs, heat scores, or distortions. Burrs may be removed with fine crocus cloth, otherwise plunger should be replaced.

3. Clean all parts with a good grade cleaning solvent or diesel fuel. Blow dry with compressed air.

4. Generously lubricate relief plunger with oil or Vaseline. Insert plunger, cup end last. Check plunger for free movement.

5. Insert pressure relief spring into cup of plunger

6. Screw pressure relief screw into relief valve insert just enough to start threads.

7. Apply washer and install relief valve insert with pressure relief screw. Tighten insert, do not tighten relief screw.

8. Cap and lock pressure relief screw with dome nut and washer

### **B. OIL PUMP DISASSEMBLY**

1. Remove oil pump assembly and filter from main housing cover by removing cap screws and hoses.

2. Remove cap screws and lock washers securing pump cover, pump body and pump adapter.

3. Using a soft hammer, separate cover, body and adapter from spring pins. NOTE: FOR REASSEMBLY, PUNCH MARK ALONG SIDE OF COVER, BODY AND ADAPTER.

4. Remove pump gears resting in adapter

5. Remove dome nut and relief valve insert  
NOTE: PRESSURE RELIEF SPRING IS UNDER TENSION.

6. Unscrew and separate pressure relief screw from relief valve insert. Remove pressure relief spring and plunger.

### **C. CLEANING AND INSPECTION**

1. Remove all permatex and clean all parts with good grade cleaning solvent or diesel fuel. Blow dry with compressed air.

2. Inspect gears and oil pump for damage or excess wear. See replacement wear limits chart.

3. Inspect cover and adapter for wear caused by gears. Note: if grooving does not exceed .030, both surfaces can be repaired by grinding smooth (.030" max cut).

4. Inspect bushings (2) in cover for wear, out of round condition or burrs. If bushings are damaged or if expansion plugs (2) are worn or loose, replace as necessary or order cover with flat discs and finish reamed bushings installed. (REFER TO WEAR LIMITS)

5. Inspect bushings (2) in adapter for wear, out of round condition or burrs. If bushings are damaged, replace as necessary, and ream to size. (REFER TO WEAR LIMITS).

6. Check relief plunger for free movement in adapter bore. Replace if necessary.

7. Inspect all mating surfaces for smoothness

8. Check to see that each oil passage is free from obstruction.

### **D. ASSEMBLY**

1. Generously lubricate pump gears with lubricate, Vaseline, or engine weight oil and position them in adapter. NOTE: BE SURE

SPLINED ENDS (INSIDE DIAMETER OF PUMP GEARS) ARE TOWARD COVER.

2. To both mating surfaces of body, sparingly apply a very thin coat of 'SUPER 300' permatex or equivalent. Too much sealer can prevent pump from functioning.

3. Place body on adapter and cover on body following punch marks. Note: If new body is used make sure sharp inside corners are filed smooth.

4. Secure cover and body to adapter with cap screws and lock washers, finger tight.

5. Drive spring pins (2) down through cover into body and adapter until they bottom in adapter. Drive 2 more spring pins into body until flush with top of cover.

6. Insert pump shaft through adapter into pump gear and revolve shaft to check ease of operation

7. Tighten all six cap screws to 16 foot-pounds torque.

8. Remove any excess permatex from seams with solvent.

last in bore of adapter. Check to make sure plunger slides free.

11. Insert pressure relief spring into cup of plunger

12. Screw pressure relief screw into relief valve insert just enough to start threads.

13. Install washer and relief valve insert with pressure screw in place.

14. Tighten relief valve insert. Do not tighten relief screw.

15. Cap and lock pressure relief screw with dome nut and washer

16. Recheck for ease of operation

17. Apply a thin coat of lubriplate, Vaseline or grease to hold new gasket in place on pump adapter.

18. Install oil pump (with new gasket) and oil filter. Secure in position with lock washers and cap screws. Tighten to 42 foot-pounds torque.

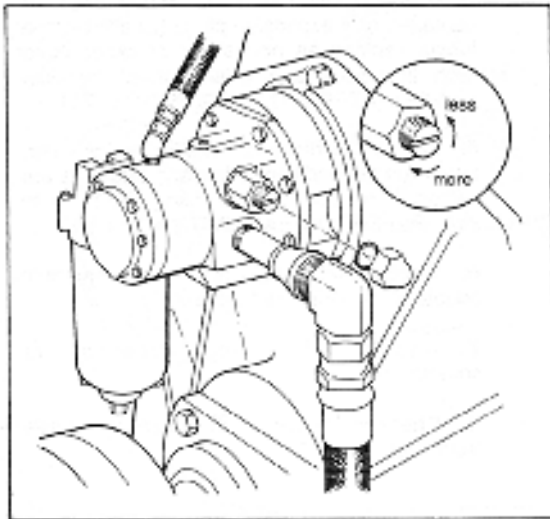


Fig. 20. Adjustment of Oil Pressure

9. Recheck for ease of operation

10. Generously lubricate relief plunger with Vaseline or lubriplate and position cup end

Correct operating  
oil pressure:  
200-210 PSI

## 6.3 SELECTOR VALVE

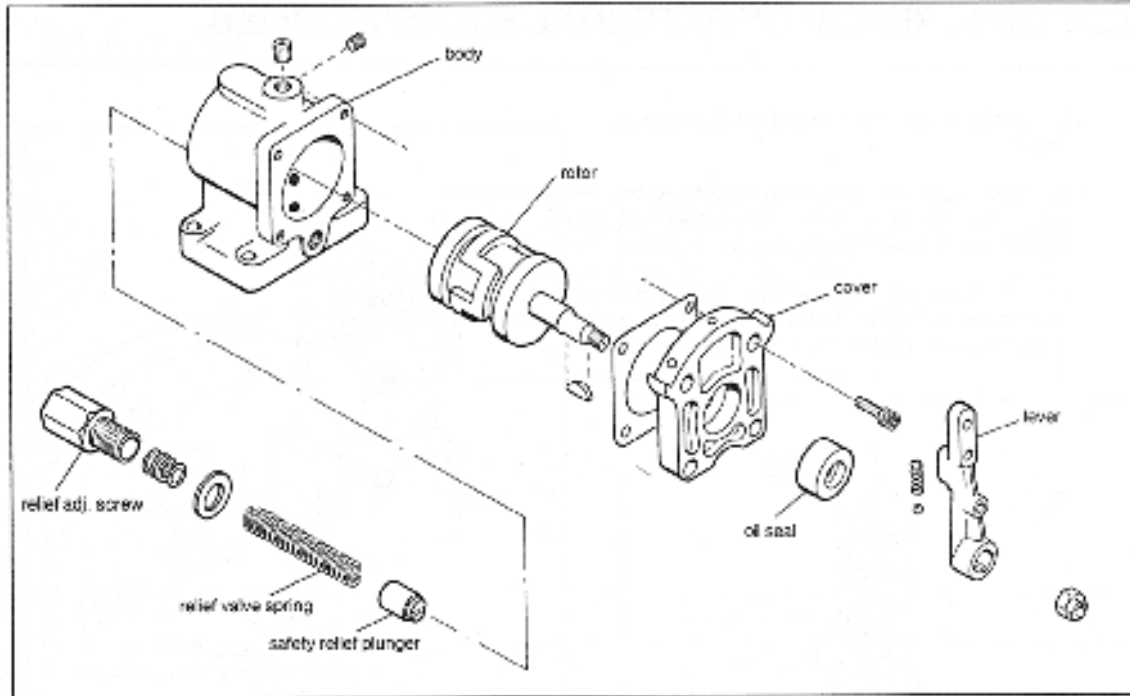


Fig. 21. Selector Valve Assembly

### A. REMOVAL

1. Disconnect hoses and control linkage from lever on selector valve
2. Remove cap screws and lock washers and lift off selector valve and base plate being very careful to keep gaskets in proper configuration for replacement. (They may be fixed in position with wire etc.)

### B. DISASSEMBLY

1. Remove lock nut from rotor and note position of keyways on level to rotor. (Matchmark if desired). Remove lever from rotor being careful not to lose indexing ball and spring.
2. Remove key from rotor shaft.
3. (Note position of cover). Remove cover, cover gasket, and rotor from block. (Note relative position of keyway to rotor and lever. Matchmark if desired).

### C. CLEANING AND INSPECTION

1. Clean all parts thoroughly with oil and clean all oil ports. Blow dry with compressed air.

2. Inspect rotor and valve block for scoring. Excessive scoring indicates replacement as valves are not repairable.

3. Inspect oil seals in cover. If it is worn or shows evidence of leaking replace it.

### D. ASSEMBLY

#### **NOTE:**

On all fittings use Permatex 'Super 300' sealant, graphite paste, or equivalent.

**CAUTION:** Do not use No.1 Permatex or Teflon tape

1. If necessary install new seal in cover. Press seal in until it bottoms in bore (rubber face out). Apply lubricant to seal.
2. Insert rotor shaft through oil seal in cover
3. Set key in rotor shaft and install lever with indexing ball and spring. Make sure that keyway in rotor shaft remains toward bottom of cover.

4. Tap control lever into position with a soft hammer and secure with lock nut.
5. Position new cover gasket on pilot face of cover.
6. Install rotor with cover into selector valve body. Secure cover with four cap screws. Tighten to 4 foot-pounds torque.
7. Check for correct assembly by moving lever back and forth. Selector valve is now ready to be installed on main housing.

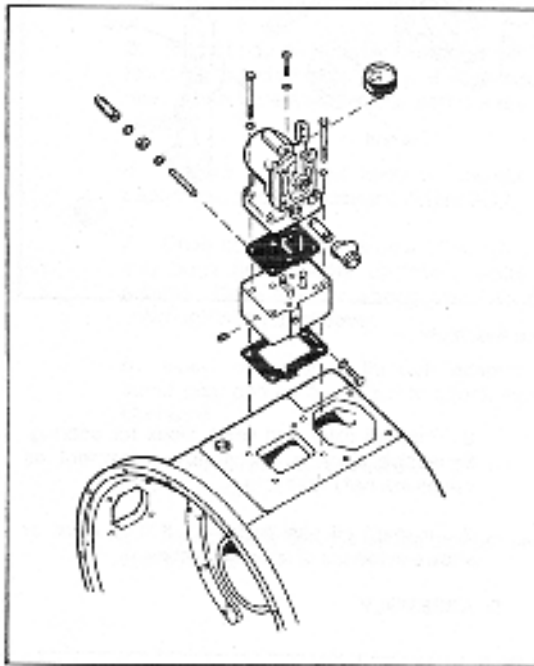


Fig. 22. Installation of Selector Valve

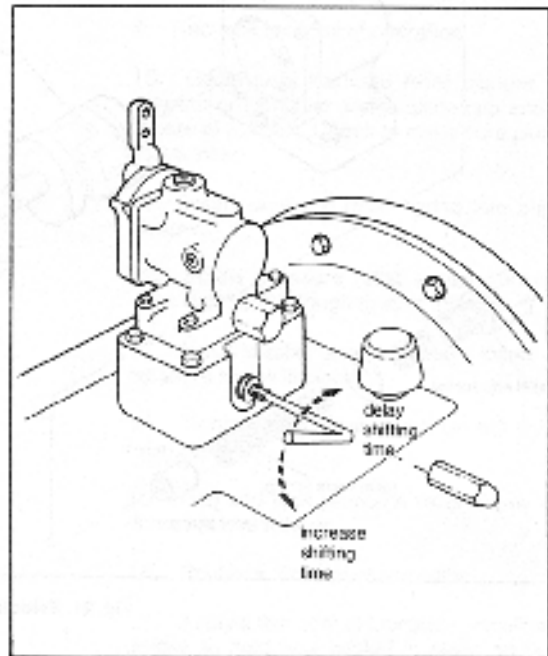


Fig. 23. Clutch Cylinder Timing Adjustment

## SECTION 7. REPAIR OF INTERNAL SUBASSEMBLIES

### 7.1 SAFETY NOTICE

#### CAUTION

Avoid contact with rotating output coupling and always shut down engine when doing even minor inspection or repair. Avoid contact with metal surfaces as operating temperature may exceed 200°.

### 7.2 REMOVAL OF MARINE GEAR

1. Remove drain plug at bottom rear of main housing and drain oil from sump.
2. Disconnect all oil lines from the oil pump and control valve, and remove water lines to cooler.
3. Disconnect control linkage from lever on selector valve.
4. Remove all inspection covers
5. Scribe alignment mark across outside diameter of flanges on output coupling and propeller shaft coupling for exact refit. Disconnect propeller shaft coupling from output coupling.
6. Remove or push propeller shaft back to obtain maximum clearance and remove pilot ring resting between propeller coupling and output drive coupling. NOTE: Protect mating faces of couplings and pilot rings to insure proper refit and alignment.
7. Remove oil pump with filter, and oil pump drive shaft at this time. If shaft cannot be completely removed, pull it out as far as possible to prevent bending forward end of shaft during removal.

8. Screw two 3/4"-10 eye bolts into lifting holes on top of main housing and connect hoist so it supports housing. Use hoist guide (special tool no. 1-90019-0000).

9. Remove cap screws and lock washers holding main housing of marine unit to oil dam.

10. Insert screwdriver or similar object through inspection cover opening to hold clutch assembly inside forward drum. Slowly move main housing aft and away from oil dam leaving clutch assembly inside forward drum and on stub shaft.

#### CAUTION:

Clutch must be maintained in forward drum to prevent falling

11. Remove clutch from forward driving drum

12. Remove forward clutch driving drum

#### NOTE:

In most cases removal of oil dam and stub shaft is not necessary unless further inspection of stub shaft and labyrinth seal indicate damage.

### **7.3 TABLE: REPLACEMENT WEAR LIMITS**

### **7.4 CLUTCH AND GEAR REPAIR**

#### **A) DISASSEMBLY**

1. Remove socket head cap screws, lock washers, and allen nuts securing both clutch flanges to bevel gear carrier.

2. Lift off clutch flanges and clutch discs

3. Press and remove bearing and driving gear from both forward and reverse clutch flanges.

4. Remove locknuts, clutch identification tag and cap screws from outer perimeter of cylinders.

5. Separate and remove cylinders

6. Remove and discard seal rings from bevel gear carrier. (always replace with new seal rings to avoid internal leaks).

7. Remove cap screws and locknuts securing pinion shafts in bevel gear carrier and remove bevel pinions with puller (see fig 24.)

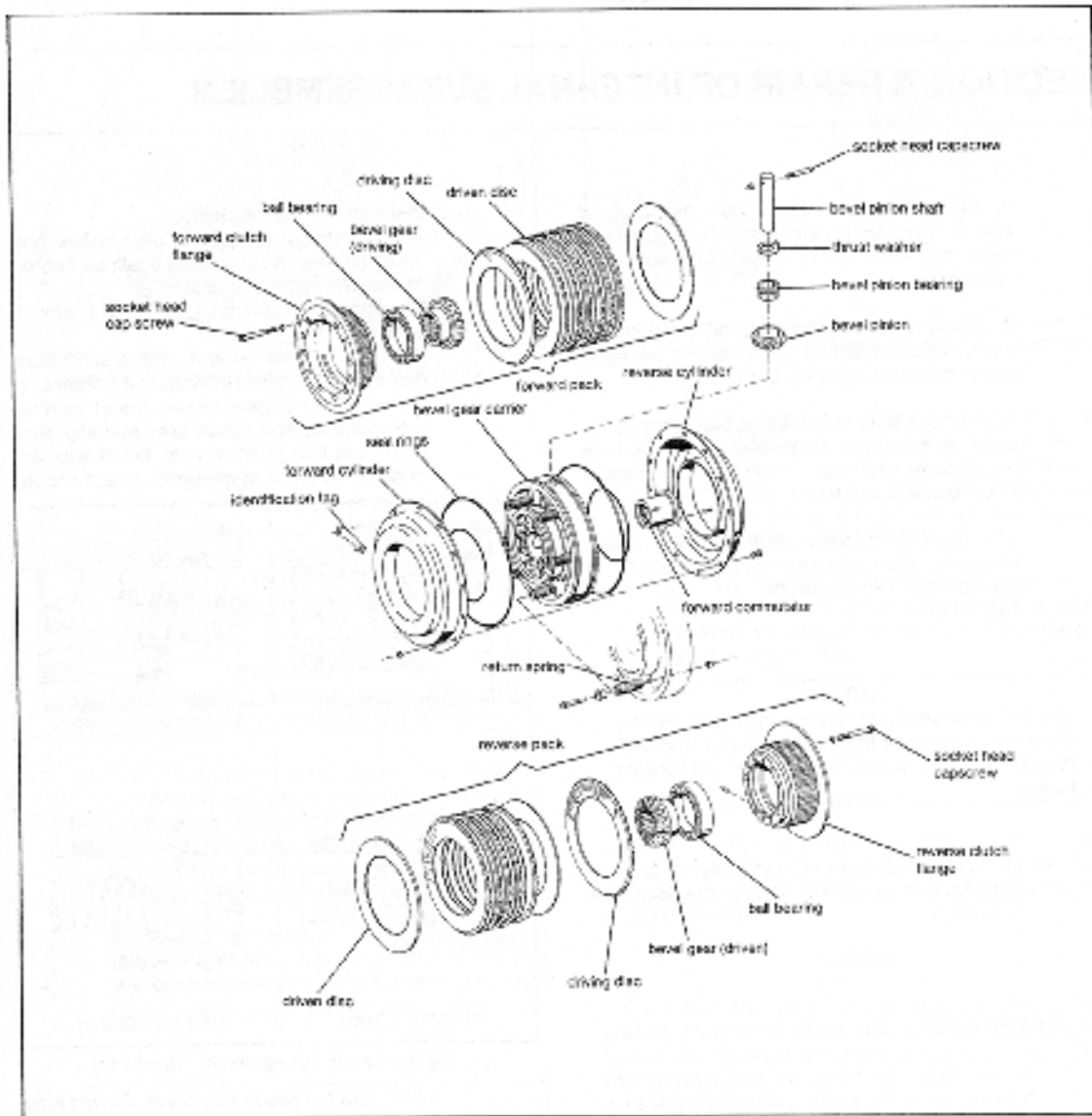


Fig. 24. Clutch and Gear Carrier Assembly ('HY' clutch shown)

## B) CLEANING AND INSPECTION

1. Inspect bevel pinions for wear, chips breaks or out of round condition. If there is any damage, we recommend replacing all of them as a set.
2. Check all pinion bearings and washers for distortion or rough operation. If one bearing needs replacement we recommend replacing all of them as a set.
3. Clean all parts with a good grade cleaning solvent or diesel fuel. Blow dry with compressed air.
4. Inspect all oil passages in bevel gear carrier to see that they are free from obstruction
5. Inspect bevel gear carrier for cracks, chips or worn mounting surfaces. Pay special attention to seal ring grooves. Discard carrier if damaged.
6. Inspect forward commutator bushings for chips, heat scores, scratches, distortion or wear (see wear limits). Repair or replace as necessary.
7. Inspect all hardware and springs for wear or distortion (see wear limits). Repair or replace as necessary.



8. Remove clutch discs from flanges and inspect discs for broken teeth, heat scores or wear (see wear limits). Replace as necessary.

9. Inspect driving gear and driven gear for wear, chips or cracks. If either one is damaged we recommend replacing both as a set.

10. Check both clutch flange ball bearings for wear, distortion or rough operation. Again we recommend replacement of both bearings if either one shows wear.

11. Inspect forward and reverse clutch flanges for wear, cracks or distortion and make certain all oil passages are free from obstruction.

**NOTE:**

The 'HY' reverse clutch flange can be identified by the spring pins in the three oil passages. The 'HP' reverse flange is interchangeable with the forward flange.

12. Inspect both clutch cylinders for cracks, distortions or scratches. Repair or replace as necessary.

**C) ASSEMBLY**

1. In order to install a new commutator bushing either the bushing should be frozen or the bevel gear carrier heated. This will allow ease and fit and will help prevent scoring of the gear carrier bore. An anti-sieze compound should be used on the bushing also.

**NOTE:**

Bushing may be frozen with a solution of alcohol and water or dry ice. Gear carrier may be heated in hot oil or water (275°F, 135°C maximum).

2. Line up holes in flanged end of bushing with roll pins in bevel gear carrier. Press in new bushing on side of carrier stamped 'REV'. until it seats in bore. The roll pins will lock the bushing in place and insure line-up of oil holes in the bushings and bevel gear carrier.

3. Installation of pinion shafts:

A. To prevent damage to gear carrier and bearings, the carrier should again be heated to expand the bore diameter.

B. Apply lubricant on shafts and bores to ease fit.

C. Stand carrier on end, with a shaft bore down, position thrust washer, if present, in round recess of gear carrier. Insert tapered roller bearing into pinion gear and slip gear (teeth up) into position over thrust washer. Holding these parts securely rotate carrier 180 deg. And tap pinion into place. Gloves may be required since gear carrier is hot.

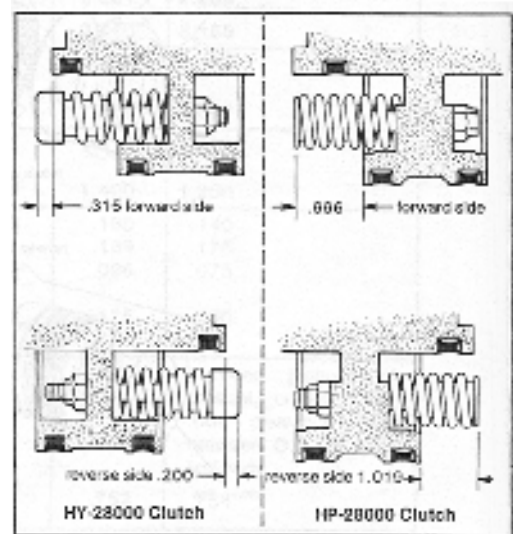


Fig. 25. Return Spring Height Adjustment

D. Repeat steps B and C for each of the remaining pinion shafts.

E. Secure shafts with cap screws and locknuts.

4. Replacement of return springs and retainers:  
A. Insert return spring retainers into return springs and secure in gear carrier using cap screws alternating from forward to reverse side of bevel gear carrier. Tighten cap screws until top of spring retainer protrudes the specified distance from face of bevel gear carrier hub. (see fig.25)

B. Hold capscrew in place with 3/16" allen wrench, install locknuts and tighten.

5. Apply lube in seal ring grooves in bevel gear carrier and slip on four new seal rings avoiding twists in the rings.

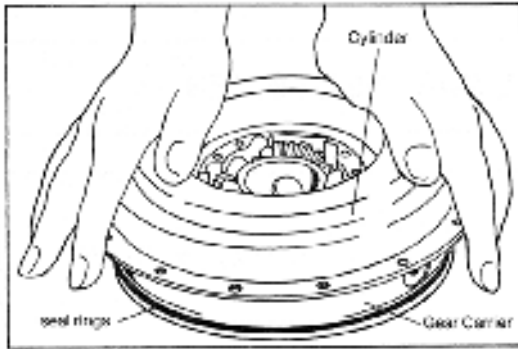


Fig. 26. Pressing Cylinder on Bevel Gear Carrier

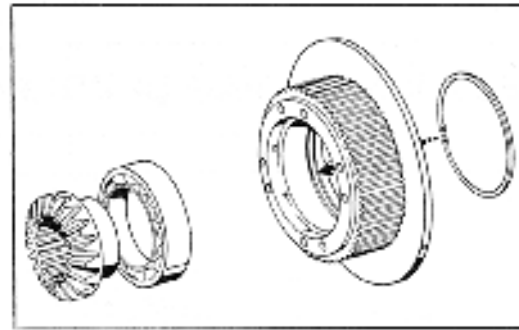


Fig. 28. Reverse Clutch Flange, Roller Bearing and Bevel Gear.

6. To install cylinders:

A. Apply a light coat of lubricant on inner walls of each clutch cylinder as well as seal rings.

B. With forward side of gear carrier up, press cylinder on by hand. (See fig, 26).

**CAUTION:**  
To prevent twisting or damaging of seal rings, take care to slip cylinders on evenly and straight down.

C. Turn bevel gear carrier over (reverse side up) and press remaining cylinder on checking to see that cap screw holes in both cylinders are aligned properly.

D. Insert cap screws and locknuts and tighten to 15-foot pounds torque.

7. Press ball bearing into forward clutch flange. Press bevel gear into ball bearing. See fig.27. In 'HP' units be sure to replace snap ring in innermost groove of forward flange.

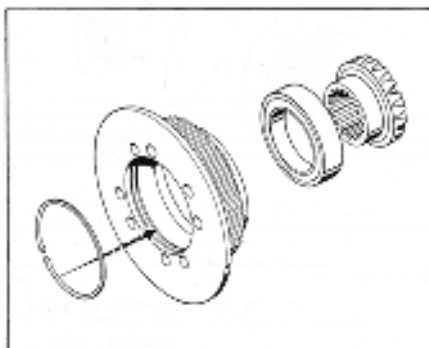


Fig. 27. Forward Clutch Flange, Roller Bearing and Bevel Gear.

8. Likewise press the other ball bearing into reverse clutch flange. On HP clutch be sure to install snap ring in outermost groove of reverse flange (see fig.28). Then press bevel gear into ball bearing. Check that ball bearings on both flanges are well sealed.

9. Arrange the driving friction discs (external tooth) with the steel driven discs (internal tooth) against the forward and reverse clutch flanges as described below:

'HP' 28000 Clutch

**Forward**

1. Position the graphitic impregnated driving disc against the face of the forward clutch flange. Followed alternately by six (6) thin steel driven discs and six (6) graphitic driving discs.

**Reverse**

2. Position the graphitic impregnated driving disc against the reverse clutch flange, followed alternately by five (5) thin steel driven discs and four (4) graphitic driving discs.

'HY' 28000 Clutch

**Forward**

1. Position the graphitic impregnated driving disc against the face of the forward clutch flange. Followed alternately by seven (7) thin steel driven discs and six (6) graphitic driving disc.

**Reverse**

2. Position the graphitic impregnated driving disc against the face of the reverse clutch flange followed alternately by five (5) thin steel driven discs and five (5) graphitic driving discs, followed by one (1) thick steel driven disc.

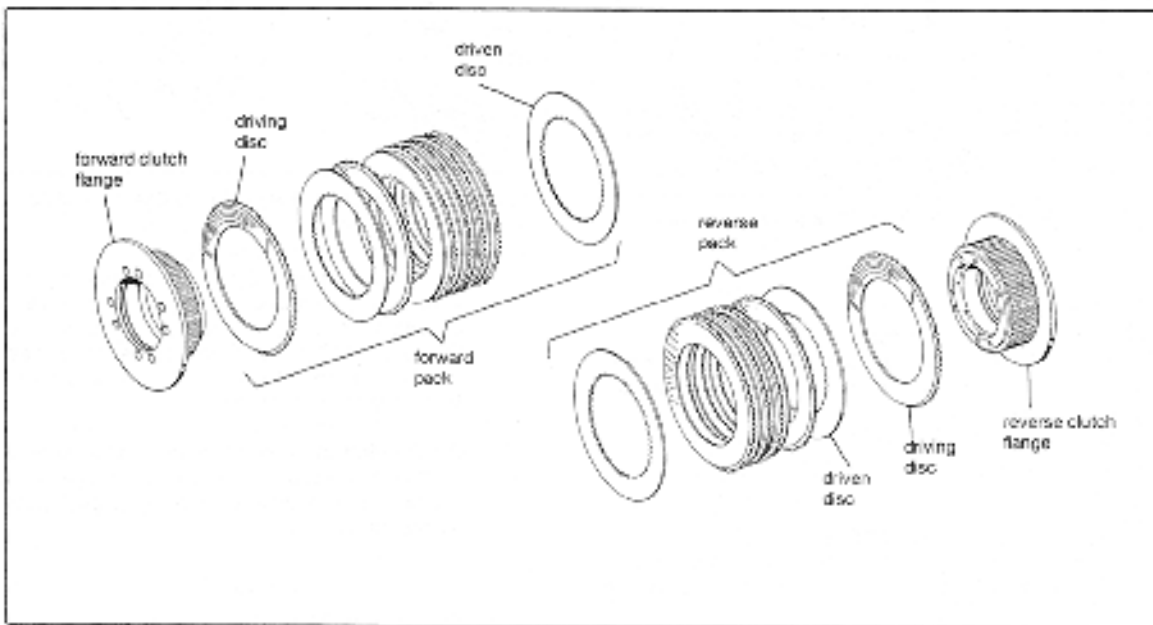


Fig. 29. 'HP' Clutch Disc Configuration

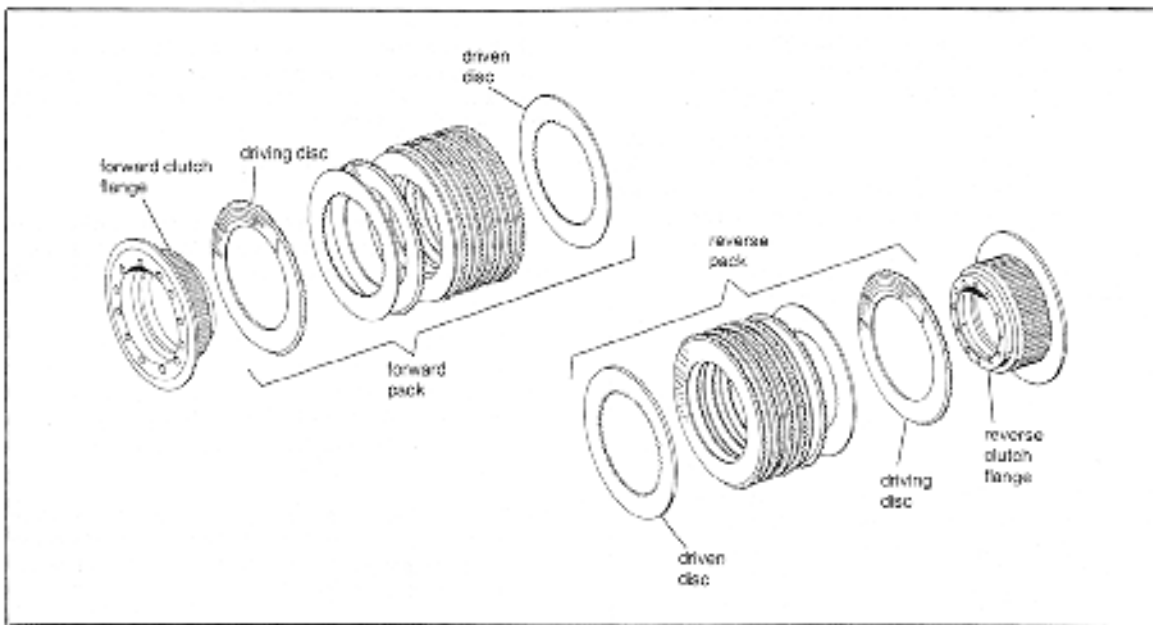


Fig. 30. 'HY' Clutch Disc Configuration

10. Position reverse clutch flange and reverse clutch discs on reverse side of gear carrier (flange on bushing is on reverse side). Position forward clutch flange with forward clutch discs and fasten both flanges to gear carrier. Tighten cap screws to 28 foot pounds torque.

11. Check for free movement of gears in clutch assembly.

Clutch is now ready for installation

## 7.5 REDUCTION GEARBOX

### A. Output Coupling

1. Remove 4 hex head cap screws from retainer plate and remove retainer plate.
2. Inspect o-ring and replace if necessary
3. With suitable puller, pull drive coupling from output shaft. See fig 31.

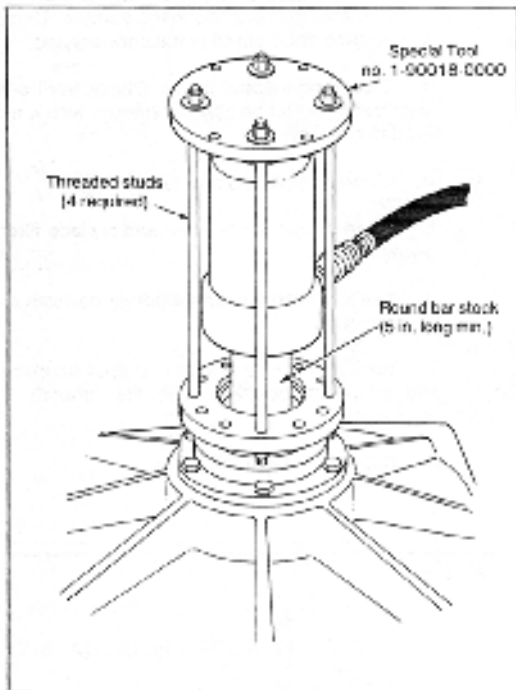


Fig. 31. Pulling Coupling from Output Shaft.

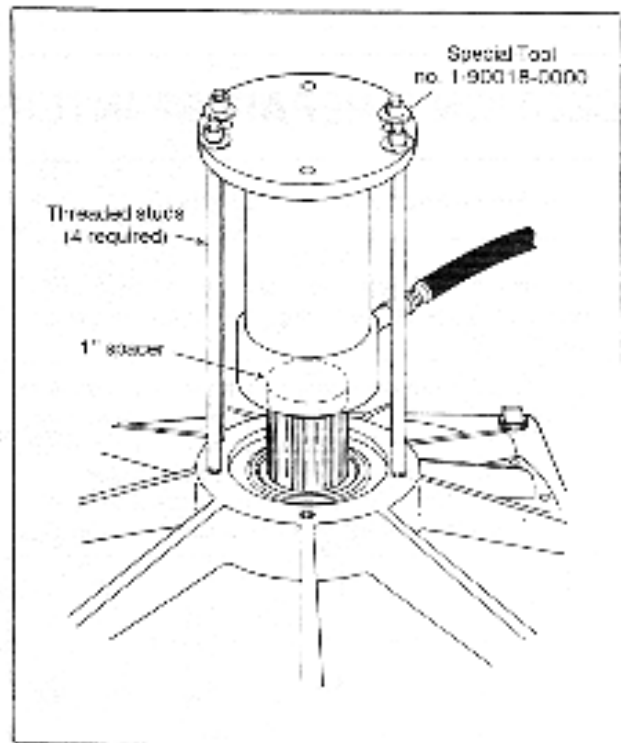


Fig. 32. Pulling Cover from Housing.

4. Inspect oil seal and replace if necessary
5. Tip unit to rest on bell end and remove bearing retainer
6. Remove cap screws and pull main housing cover from housing. (see fig 32)
7. Remove idler from housing (idler units only).
8. Remove output shaft from main housing. Inspect bearings and replace if necessary and inspect gear teeth for excessive wear (refer to wear limits chart).

## B. Pinion shaft and related parts

### NOTE:

The pinion shaft assembly can be removed and replaced without removing the main housing cover.

- 1.a. Release bearing locknut on pinion shaft by bending or punching tang of lockwasher.
- b. Unscrew bearing locknut with spanner wrench and remove keyed flat washer.
- c. With a suitable press, extract the pinion shaft out of the bearing retainer. See fig 33.

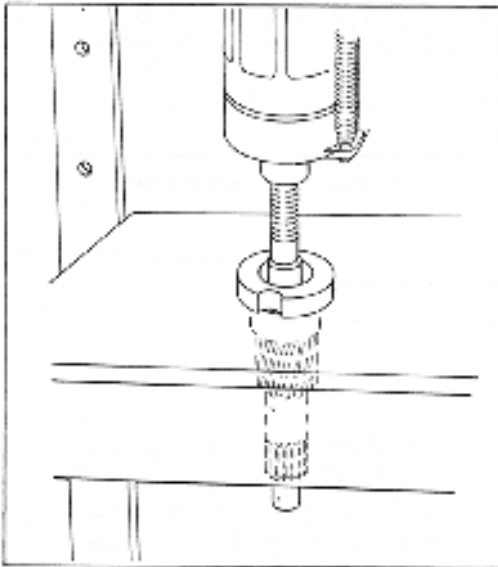


Fig. 33. Extracting Pinion Shaft

2. If rear pinion bearings are believed to be damaged or worn remove bearings and replace as necessary. See fig 34.

CAUTION: Because of close tolerance between pinion and inner cone of bearing, Puller must be applied to bearing cage which will destroy the bearing.

### NOTE:

The bearing spacer, two tapered cones and the two tapered cups constitutes a matched set: if any one part is damaged the entire set must be replaced

3. Inspect pinion teeth and front and rear commutator surfaces for excessive wear (see wear limits chart).

IF CHANGING RATIOS: Order new output gear, plus the following: Pinion shaft, rear pinion bearing set, bearing container (snap-ring installed), bearing locknut and bearing lockwasher.

## C. Housing parts

1. Clean oil breather
2. Flush clean and inspect main housing
  - a. Clean sump
  - b. Check front bell end for nicks and burrs
  - c. Inspect aft end mounting surfaces. Use a flat file to deburr in all of the above cases.
3. Clean and inspect cover. Check front and rear mating surfaces and file smooth with a flat file if necessary.
4. Clean rear commutator tubes
5. Clean oil suction screen, and replace filter element
6. Inspect reverse clutch drum for grooves or excess wear.
7. Inspect mating surfaces of output coupling and propeller coupling and file smooth if necessary.
8. Inspect and clean pilot ring.

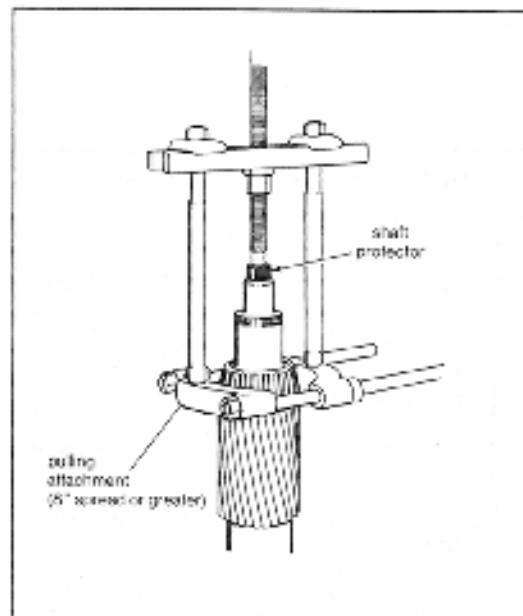


Fig. 34. Pulling Rear Pinion Shaft Bearing.

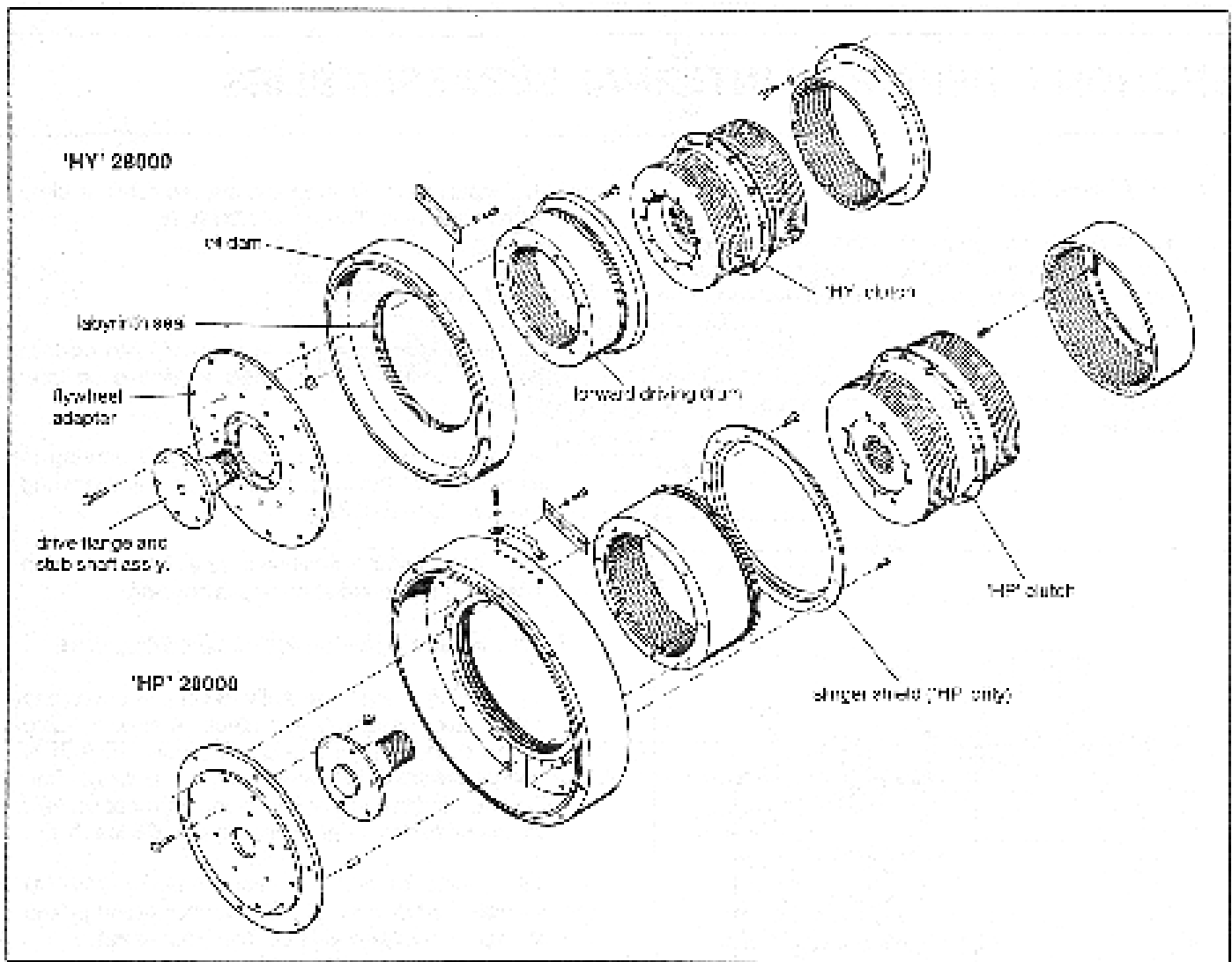


Fig. 35. Adapter Group and Clutch

### 7.6 ADAPTER GROUP

1. Clean and inspect stub shaft (mounted on engine flywheel) and forward clutch driving drum. Inspect spline on stub shaft for chips or wear. Replace as necessary.

2. Remove oil dam and inspect labyrinth oil seal on inside diameter. Repair or replace as necessary (wear or damage to seal indicates misalignment-check further!) (see fig 35).

3. Will oil dam is removed, inspect flywheel adaptor and drive flange for distortion or rough mounting surfaces. Repair or replace as necessary.

## 7.7 RE ASSEMBLY

1. With output gear on shaft, install bearing spacer, forward output bearing, bearing lockwasher and bearing locknut on threaded end of shaft.

2. Install first bearing cup (A) into output bore of housing cover, making sure cup seats in bore. See fig 36.

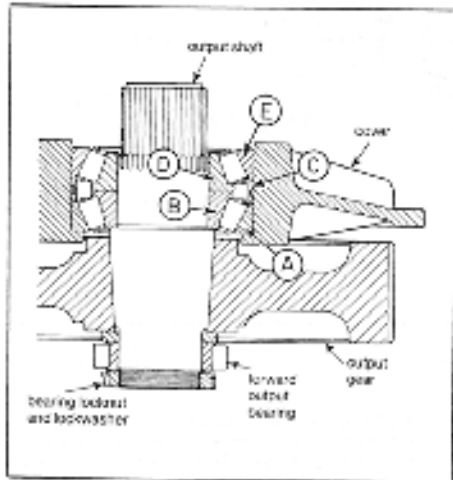


Fig. 36. Sub-assembly including output gear and shaft, cover and bearings.

3. With threaded end of output shaft resting on table, install cover on output shaft. Note: Bearings are a matched set. Do not mix parts.

4. Install heated bearing cone (B) onto the shaft and into cup. Install bearing spacer (C) and install second bearing cone (D) onto output shaft. Install second bearing cup (E) into cover. See fig 36.

5. Press output shaft seal into bearing retainer. Install retainer gasket and bearing retainer onto cover and secure with capscrew.

6. Install output flange on shaft (heat flange if necessary).

7. Install new 'O' rings and secure retainer plate with cap screws. Torque to 130lb ft.

Rest housing on bell end:

8. Slide idler assembly (if present) into bore in housing. Install new 'O' ring in groove on idler shaft.

9. Install outer race of output shaft bearing in lower bore of housing. Install oil pan and bearing retainer (see fig 38).

10. At this time, install snap ring. Forward pinion bearing and second snap ring in housing.

11. Secure cover gasket in place with grease.

12. Using a hoist, carefully lower the cover and output gear assembly into place. A slow twisting of the output flange can aid in proper location of bearing rollers into bearing race (in housing). See fig. 38 secure cover into place with cap screws and lock washers (tighten torque 65 lbs. Ft).

13. Install the first rear pinion bearing cone (A) on pinion shaft. See fig 37. Note: Bearings and spacers are a matched set. Don't mix parts!

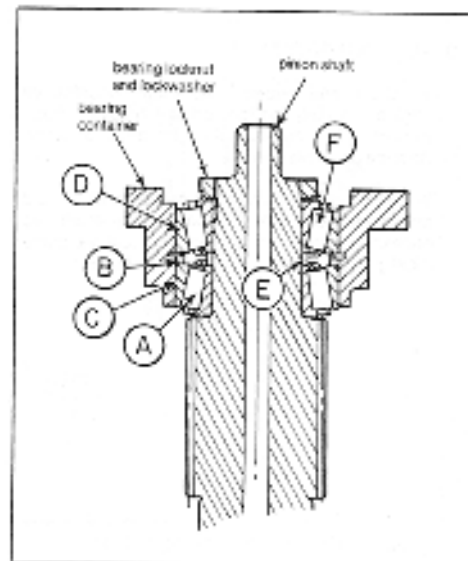


Fig. 37. Pinion shaft and bearing sub-assembly.

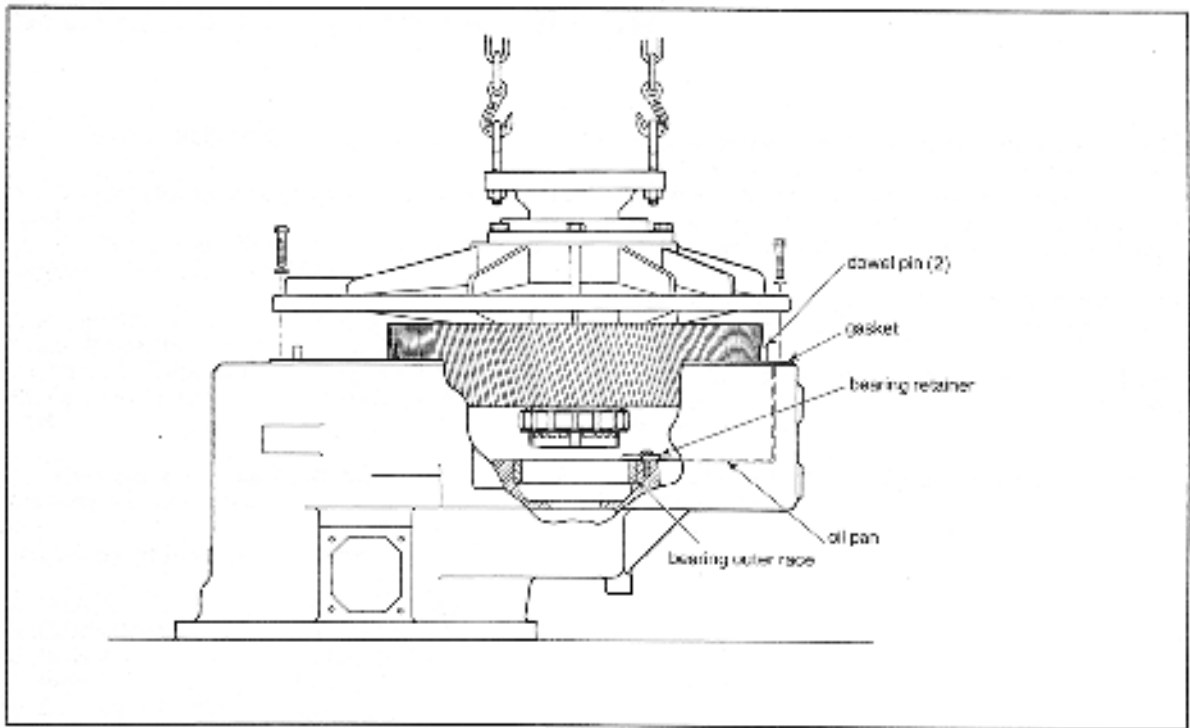


Fig. 38. Installing cover and output gear assembly into housing.

14. Install bearing spacer (B) into bearing container, and install both bearing cups (C) and (D) into container. See fig 37.

15. Install bearing container onto pinion shaft.

16. Install spacer (E) on pinion shaft and press rear bearing cone (F) on pinion shaft. Install bearing lock washer and bearing locknut on pinion shaft.

Stand housing upright:

17. Install new 'O' rings in commutator. Hold commutator in place, (anti-rotation sub on starboard side) and slide pinion shaft and bearing container assembly into housing and through commutator, seating bearing container in cover bore. Check pinion shaft for free rotation.

18. Install commutator tubes and new "O" rings in selector valve base plate. Install base plate gasket and base plate. Install selector valve gasket and selector valve (see fig 22).

19. Place gasket on bearing container and install oil pump and oil filter. Install oil pump shaft from bell end of housing.

20. Install reverse clutch drum in front half of housing.

21. On units with idler gear: connect hose from oil pump to idler shaft

22. Install oil breather and suction screen.



