

# ***YANMAR***

# ***SERVICE MANUAL***

## ***MARINE DIESEL ENGINE***

### **MODELS**

**1GM (10L)**

**2GM (F)(L)**

**3GM (D)(F)(L)**

**3HM (F)(L)**

## Chapter 8 Reduction and Reversing Gear

[A] For engine models 1GM, 2GM and 3GMD

### 4. Disassembly

- (7) Remove the bolts which secure the mounting flange to the case body, give light taps to the left and right with a plastic headed hammer while supporting the clutch case with your hand, then remove the mounting flange.

Input shaft

- (9) Take out the intermediate shaft and input shaft. When taking out the intermediate shaft, place a bolt or spacer on the shaft hole of the case, and drive the shaft out by tapping it lightly.

Mounting

Clutch housing

Bolt or spacer

- (8) Withdraw the output shaft assembly.

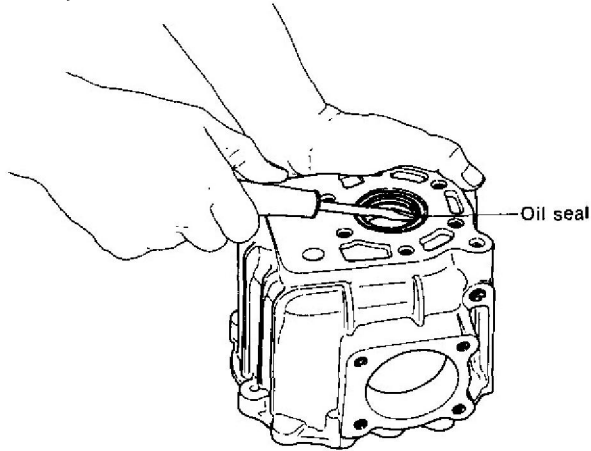
Output shaft

Input shaft

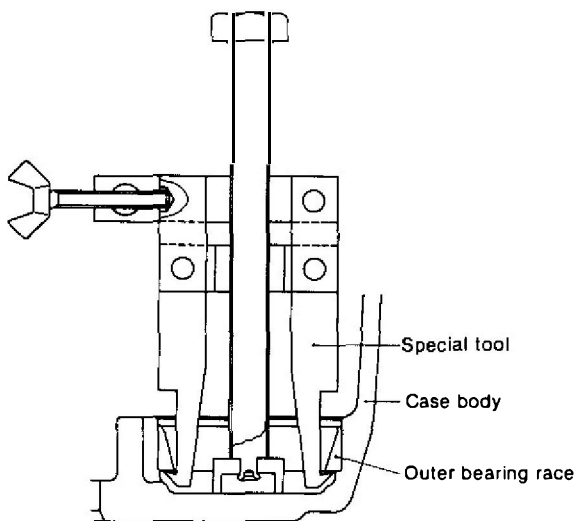
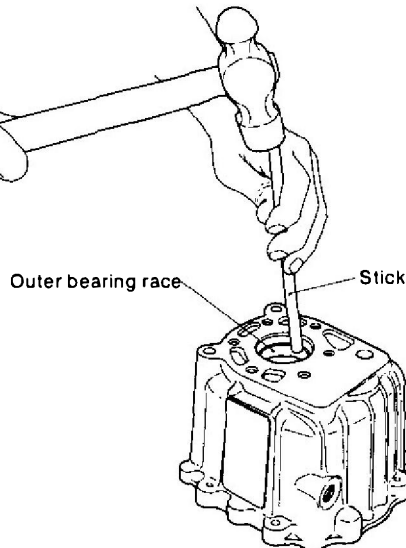
Output shaft  
assembly

Input shaft

- (10) Remove the oil seal of the output shaft from the case body.



- (11) Remove the outer bearing race from the case body by using the special tool.



- (12) Remove the oil seal of the input shaft from the mounting flange.

- (13) Remove the outer bearing race from the mounting flange in the same way as with the case body.

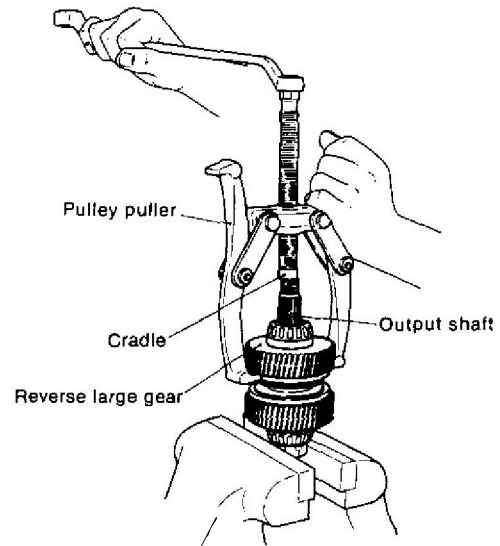
- (14) Remove each adjusting plate from the input or output shaft.

**NOTE:** The same adjusting plates can be reused when the following parts are not replaced, however, when any part is replaced, re-adjustment is necessary.

#### 4-2 Removal of the output shaft

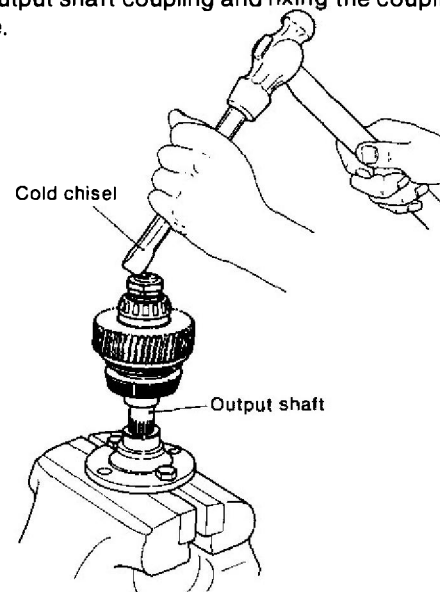
- (1) Take out the reverse large gear, thrust collar A and inner bearing race.

The reverse large gear must be withdrawn using a pulley extractor, by fixing the nut at the forward end in a vice.



- (2) Loosen the locking of the forward nut and remove the nut and spacer.

Remove the nut by using a torque wrench after setting the output shaft coupling and fixing the coupling bolt in a vice.



## Chapter 8 Reduction and Reversing Gear

- (4) While gripping the drive cone, tap the end of the shaft with a plastic beaded hammer, and withdraw the thrust collar B and inner needle bearing race. A pulley extractor may be used.

Output shaft

- (3) Place the pulley extractor against the end surface of the forward large gear, and withdraw the forward large gear, thrust collar A and inner bearing race.

### 4-3 Removal of the intermediate shaft

- (1) Remove the "O" ring.
- (2) Remove the thrust washer.
- (3) Remove the intermediate gear and needle bearing.

Intermediate gear

Intermediate shaft

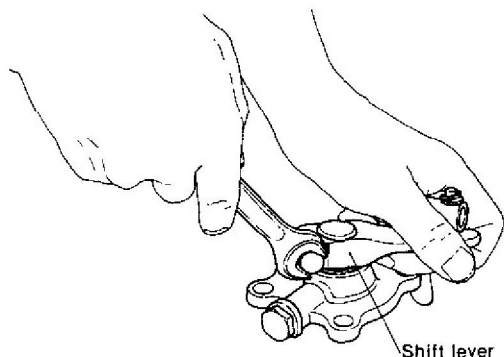
O-ring

Thrust washer

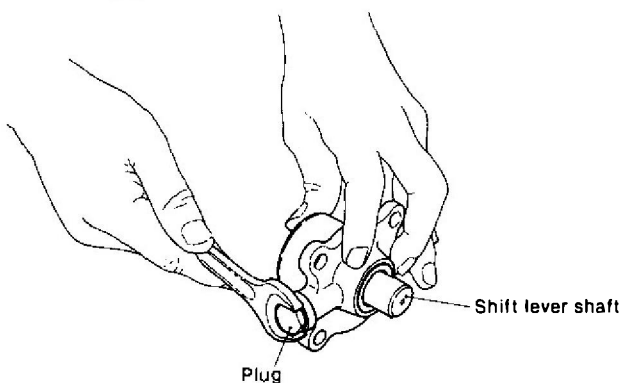
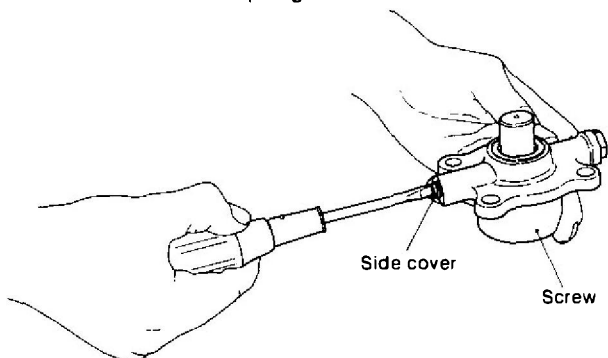
**NOTE:** Take care as the nut has left-handed thread.

#### 4-4 Dismantling the side cover assembly (Shifting device)

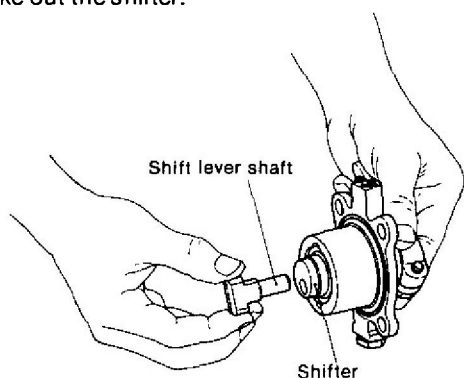
- (1) Loosen the bolt of the shift lever, and remove the shift lever from the shaft.



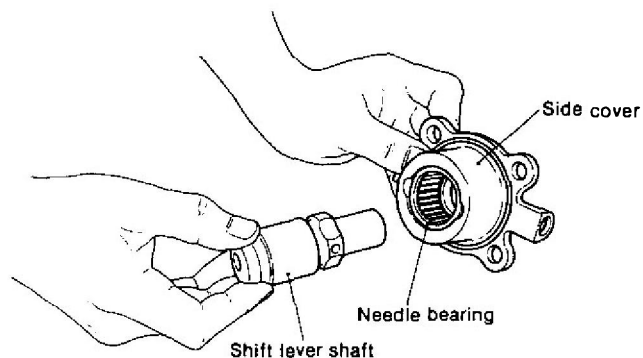
- (2) Remove the stop screw for the notch and plug, and take out the notch and spring.



- (3) Take out the shifter.

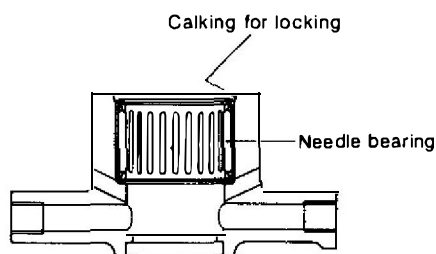


- (4) Withdraw the shift lever shaft.



- (5) Remove the oil seal.

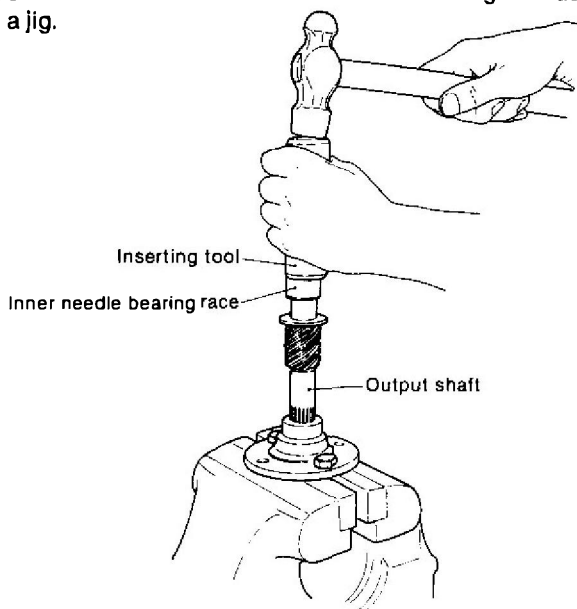
- (6) After removing the calking for locking, heat the needle bearing portion up to about 100°C, and extract the needle bearing from the side cover.



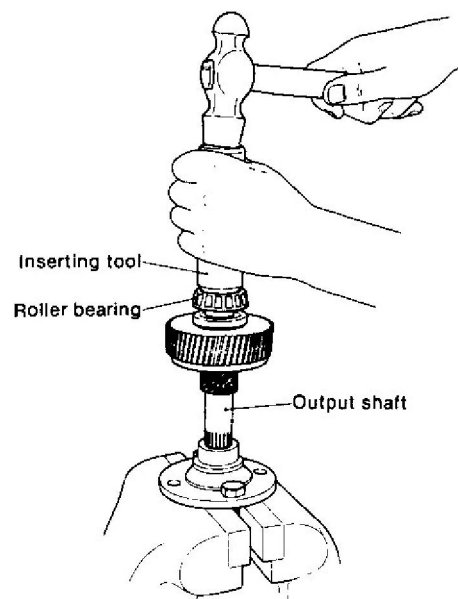
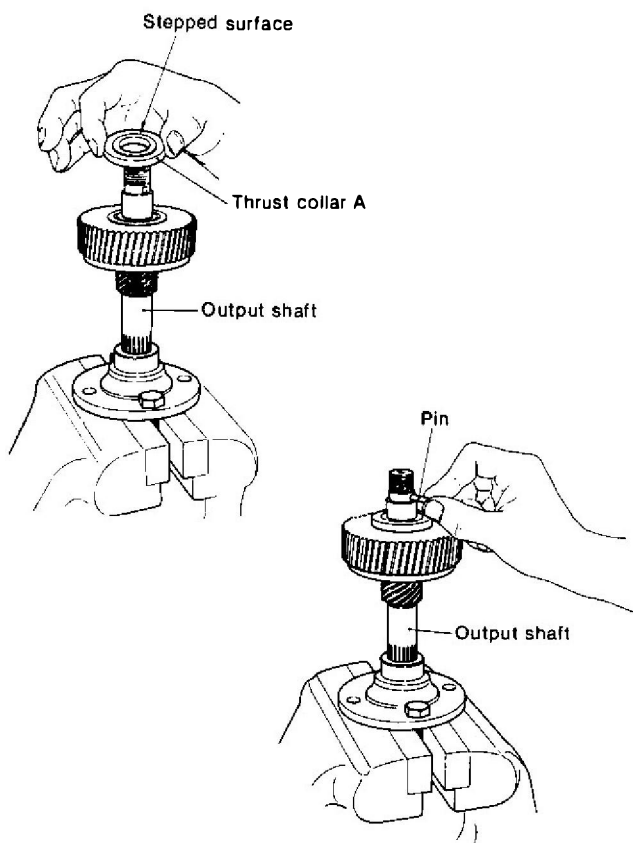
## 5. Reassembly

### 5-1 Reassembly of output shaft

- (1) Fit the forward side thrust collar B onto the shaft.
- (2) Drive in the forward end inner needle bearing race using a jig.



- (3) Assemble the needle bearing and forward large gear.  
**NOTE:** Check that the forward large gear rotates smoothly.
- (4) Fit the thrust collar A and pin, and drive in the inner bearing race using a jig.



**NOTES:** 1) Drive in with a plastic headed hammer. Do not hit it hard.

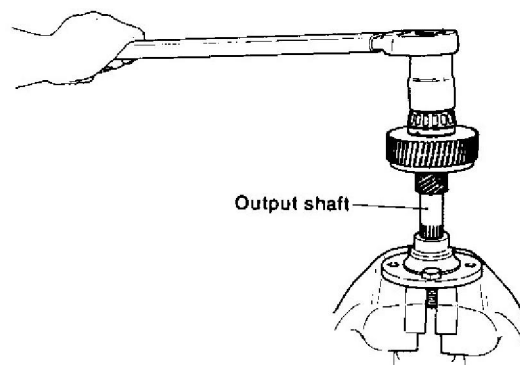
2) When fitting the thrust collar A, note the fitting direction. Fit it keeping the stepped surface toward the bearing side.

3) Note that the pin cannot be fitted after the inner bearing race has been driven in.

(5) Assemble the collar and pin so that the pin is in the groove of the collar.

(6) Set and tighten the forward end nut. Insert the bolt into the coupling, and fix it in a vice, keeping the spline part upward.

Insert the shaft into the spline of the coupling, fit the spacer, and tighten the nut with a torque wrench.

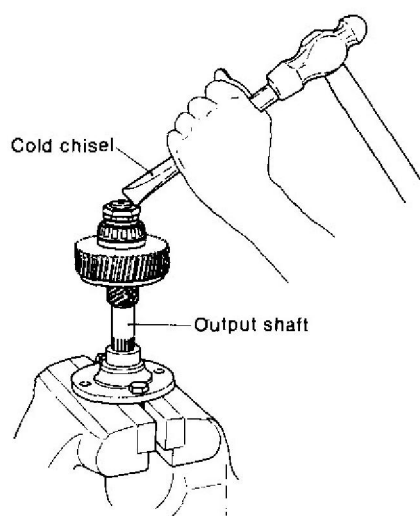


Tightening torque	10 ± 1.5 kg-m (81.5 ~ 83.2 ft-lb)
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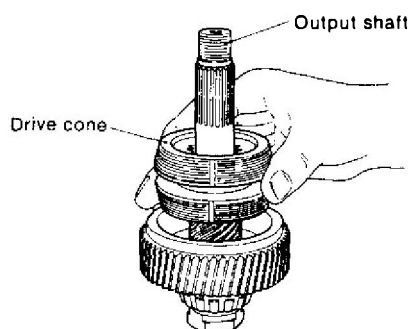
(The same torque applies to both models KM2-A and KM3-A).

**NOTES:** 1) Take care as it is a left-handed thread.

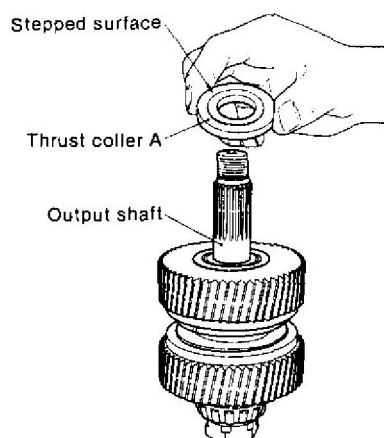
2) Use the reverse side nut used before dismantling as the forward end nut. This is so as not to match the calked portion to the same point.



- (7) Insert the drive cone while keeping the output shaft set for reverse.



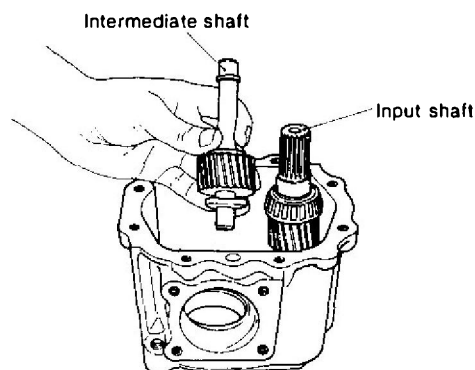
- (8) Apply procedures 1 through 4 to the forward end.



**NOTE:** Fit thrust collar A so that the stepped surface faces the bearing side.

## 5-2 Reassembly of the clutch

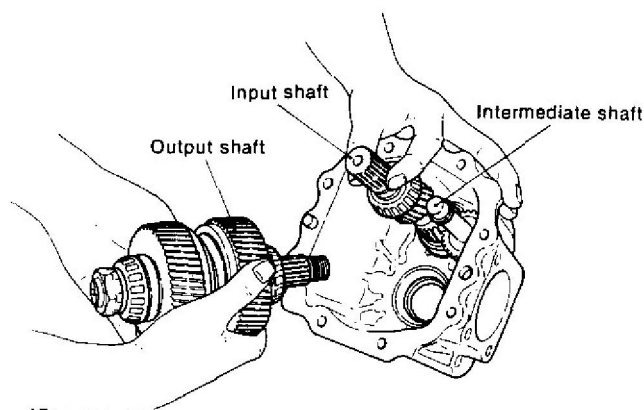
- (1) Fit the oil seal and bearing outer race in the clutch case.
- (2) Insert the input shaft into the clutch case.
- (3) Drive the intermediate shaft into the clutch case.



**NOTES:** 1) If the output shaft is not fitted into the clutch case before driving-in the intermediate shaft, it cannot be assembled.

2) Note the assembly direction of the thrust washer.

- (4) Insert the output shaft into the clutch case.

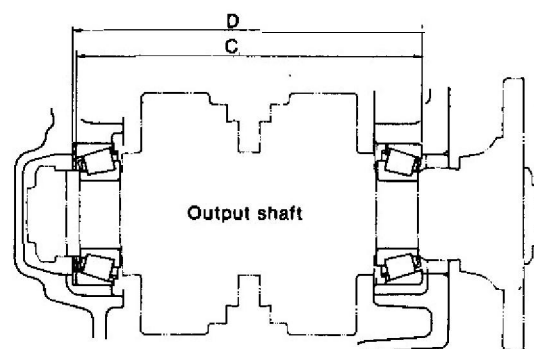
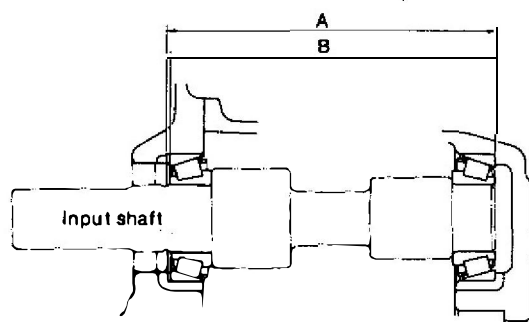


- (5) Check the thickness of shims for both input and output shafts. When the component parts are not replaced after dismantling, the same shims can be reused. When the clutch case flange or any one of the following parts is replaced, the thickness of shim must be determined in the following manner.

For input shaft parts: input shaft, bearing.

For output shaft parts: output shaft, thrust collar A, thrust collar B, gear, bearing.

- 1) Measure the distance between the clutch case body and the mounting flange, A or D for each shaft.
- 2) Fit the outer bearing race to each shaft, and measure the distance (B or C) between bearings.



mm (in.)

	A	B	C	D
KM2-A	116.40 ~ 116.75 (4.5627 ~ 4.5964)	115.2 ~ 116.1 (4.5354 ~ 4.5709)	121.48 ~ 122.53 (4.7827 ~ 4.8240)	122.60 ~ 122.95 (4.8268 ~ 4.8406)
KM3-A	127.4 ~ 127.75 (5.0157 ~ 5.0295)	126.2 ~ 127.1 (4.9685 ~ 5.0039)	134.56 ~ 136.0 (5.2976 ~ 5.3543)	136.0 ~ 136.35 (5.3543 ~ 5.3681)

- 3) Determine the thickness of shim so that the values of clearance and interference after fitting comply with the values in the following table.

Clearance (or interference) for each shaft		mm (in.)
Input shaft	$\pm 0.05$ ( $\pm 0.0020$ )	
Output shaft	0 ~ -0.1 (0 ~ -0.0039)	

NOTE: Negative value shows interference.

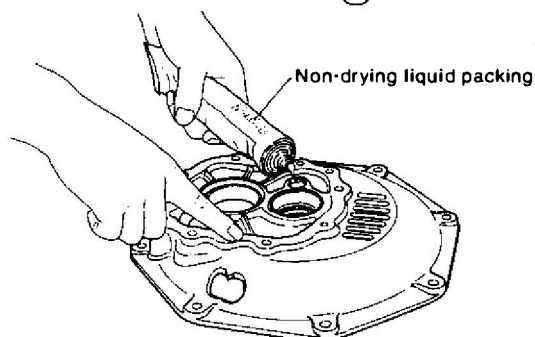
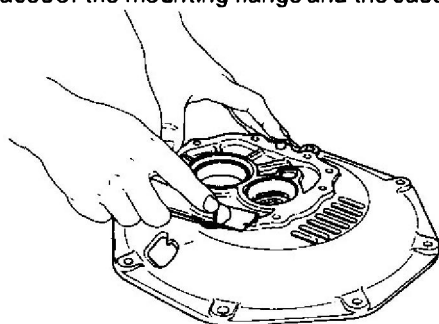
#### Adjusting plate

	Part No.	Thickness mm (in.)	No. of shims
Input shaft	177088-02350	0.5 (0.0197)	1
		0.4 (0.0157)	1
		0.3 (0.0118)	2
Output shaft	177090-02250	1.0 (0.0394)	1
		0.5 (0.0197)	1
		0.3 (0.0118)	1
		0.1 (0.0039)	2

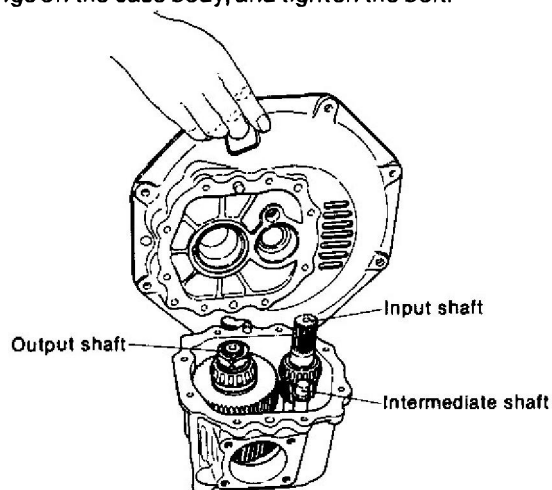
- (6) Fit the adjusting plate to the mounting flange, and drive in the outer bearing race.

NOTE: The outer bearing race can be easily driven in by heating the mounting flange to about 100°C, or by cooling the outrace with liquid hydrogen.

- (7) Apply non-drying liquid packing around the outer surface of the oil seal, and insert the oil seal into the mounting flange while keeping the spring part of the oil seal facing the inside of the case.
- (8) Apply non-drying liquid packing to the matching surfaces of the mounting flange and the case body.



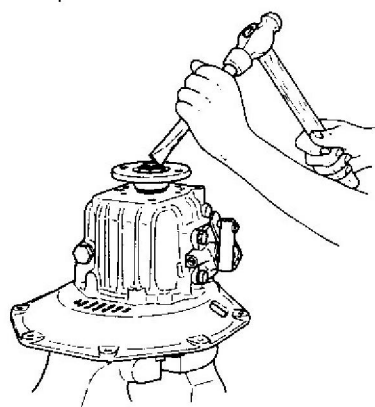
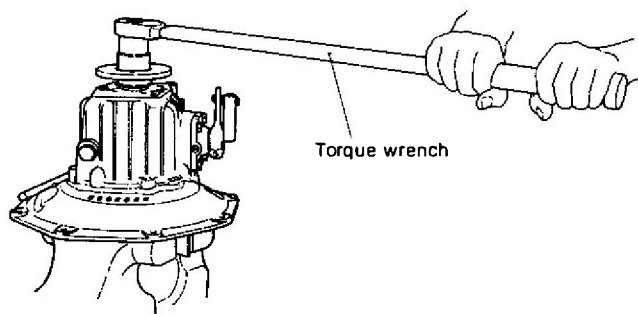
- (9) Insert the input shaft and output shaft into the shaft holes of the mounting flange, assemble the mounting flange on the case body, and tighten the bolt.



**NOTE:** Apply non-drying liquid packing to either the mounting flange or the case body.

(10) Assemble the output shaft coupling on the output shaft, and fit the O-ring.

(11) Tighten the end nut by using a torque wrench, then calk it.



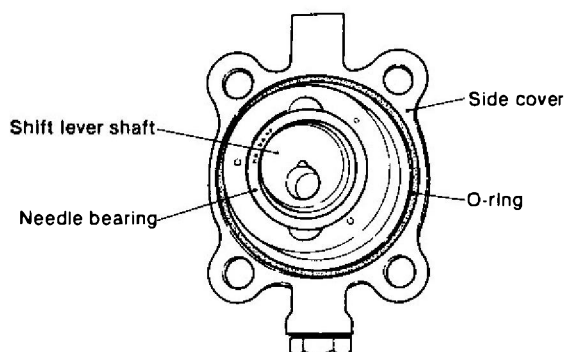
**NOTE:** Take care as it is a left-handed thread.

Tightening torque	$10 \pm 1.5 \text{ kg-m}$ (61.5 ~ 83.2 ft-lb)
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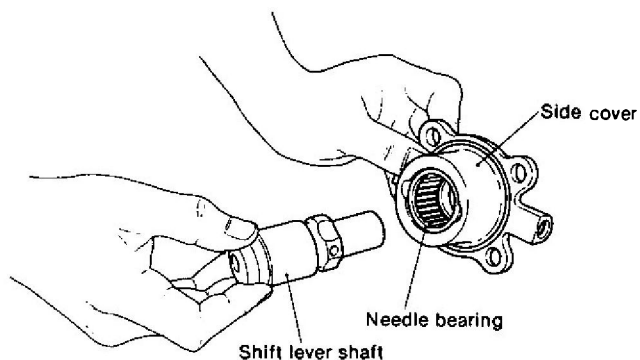
(The same torque applies to both models KM2-A and KM3-A.)

### 5-3 Reassembly of the shifting device

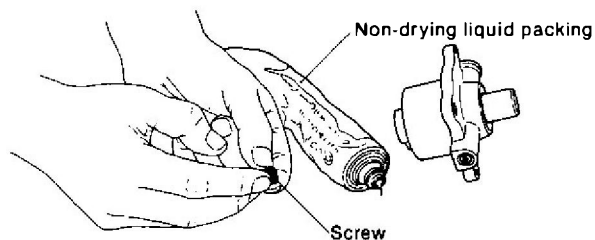
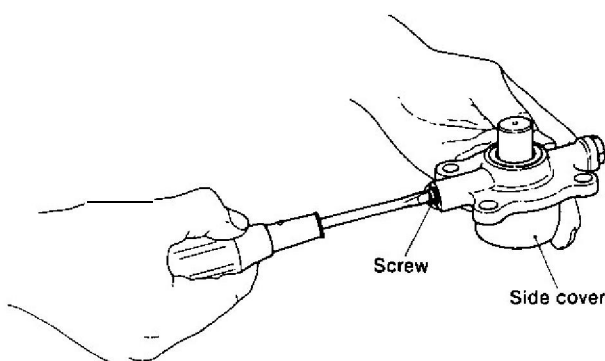
(1) Fit the oil seal and needle bearing to the side cover.



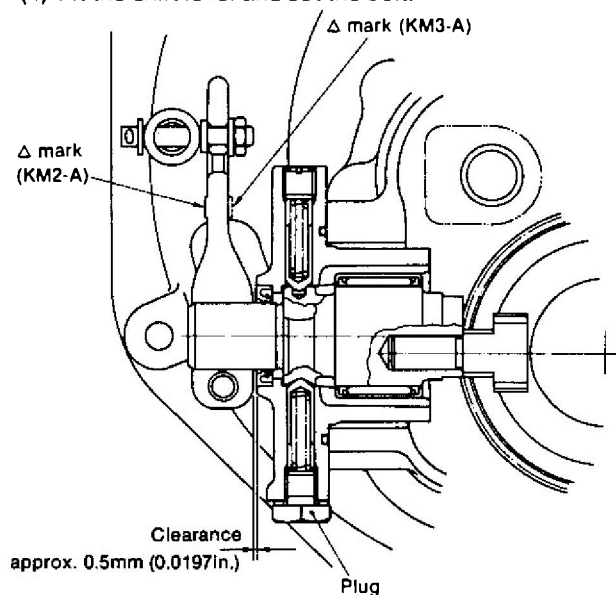
(2) Fit the shift lever.



(3) Fit the notch and spring, and screw in the plug and stop screw.



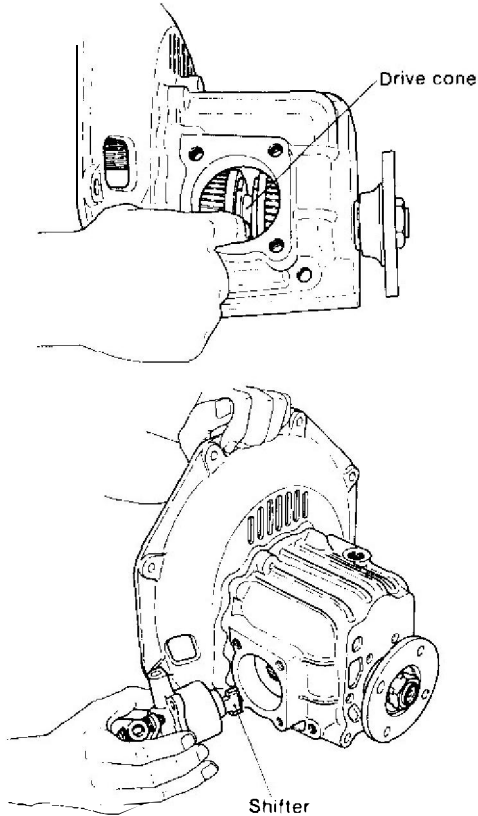
(4) Fit the shift lever and set the bolt.



**NOTE:** The clearance between the surface of the side cover and the operation lever is to be 0 ~ 0.5mm (0 ~ 0.0197in.)

(5) Fit the shifter to the shift lever shaft.

(6) Fit the side cover to the clutch case. Ensure that the shifter engages the groove of the drive cone.



(7) Check that the lever turns smoothly.

**NOTE:** The lever may not turn smoothly if the housing is not filled with lubricating oil.

(8) Fit the spring joint, and set the remote control cable after adjusting.

For fitting and adjustment refer to the detailed explanation in the appropriate section.

# [B] For models 3GM and 3HM

## 1. Construction

### 1-1 Construction

The Kanzaki-Carl Hurth KBW10 reduction reversing gear was developed jointly by Kanzaki Precision Machine Co., Ltd., a subsidiary of Yanmar and one of Japan's leading gear manufacturers, and Carl Hurth Co.

The KBW10 consists of a multi-disc clutch and reduction gear housed in a single case. It is small, light, simply constructed and extremely reliable.

\*The force required to shift between forward and reverse can be controlled by a cable type remote control system

much smaller and simpler than other types of reduction reversing gears.

\*The friction discs are durable sinter plates, and the surface of the steel plates are corrugated in a sine curve shape to ensure positive engagement and disengagement and minimum loss of transmission force.

\*Because of the special construction of this gear, the optimum pressure is automatically applied to the clutch plate in direct proportion to the input shaft torque.

### 1-2 Specifications

Engine model			3GM			3HM		
Nomenclature			KBW10D			KBW10E		
Reduction system			One-stage reduction, helical gear					
Reversing system			Constant mesh gear					
Clutch			Wet type multi-disc, mechanically operated					
Reduction ratio	Forward		2.14	2.63	2.83	2.14	2.83	
	Reverse		2.50			2.50		
Direction of rotation	Input shaft		Counterclockwise as viewed from stern					
	Output shaft	Forward	Clockwise as viewed from stern					
		Reverse	Counterclockwise as viewed from stern					
Lubricating oil			DEXRON-ATF					
Lubricating oil capacity			0.7ℓ					

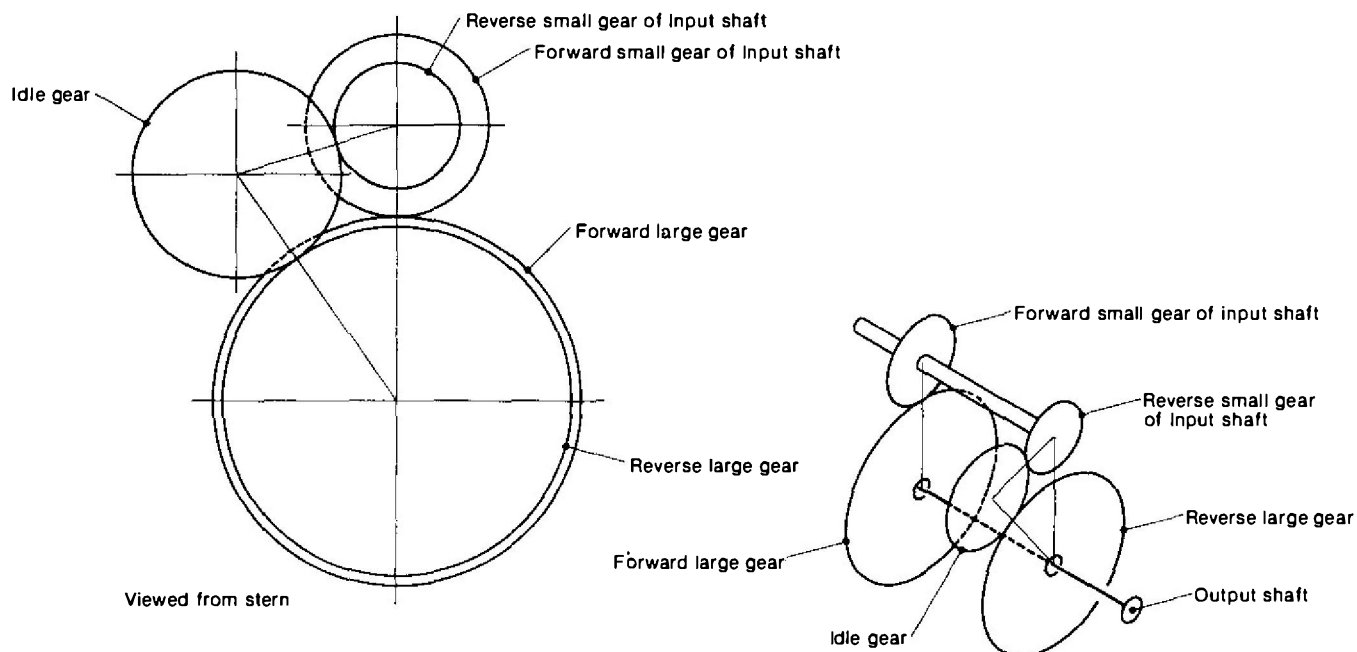
The construction of models KBW10D and KBW10E is the same except for the following:

- Mounting flange at the engine side

For KBW10D: SAE No.6

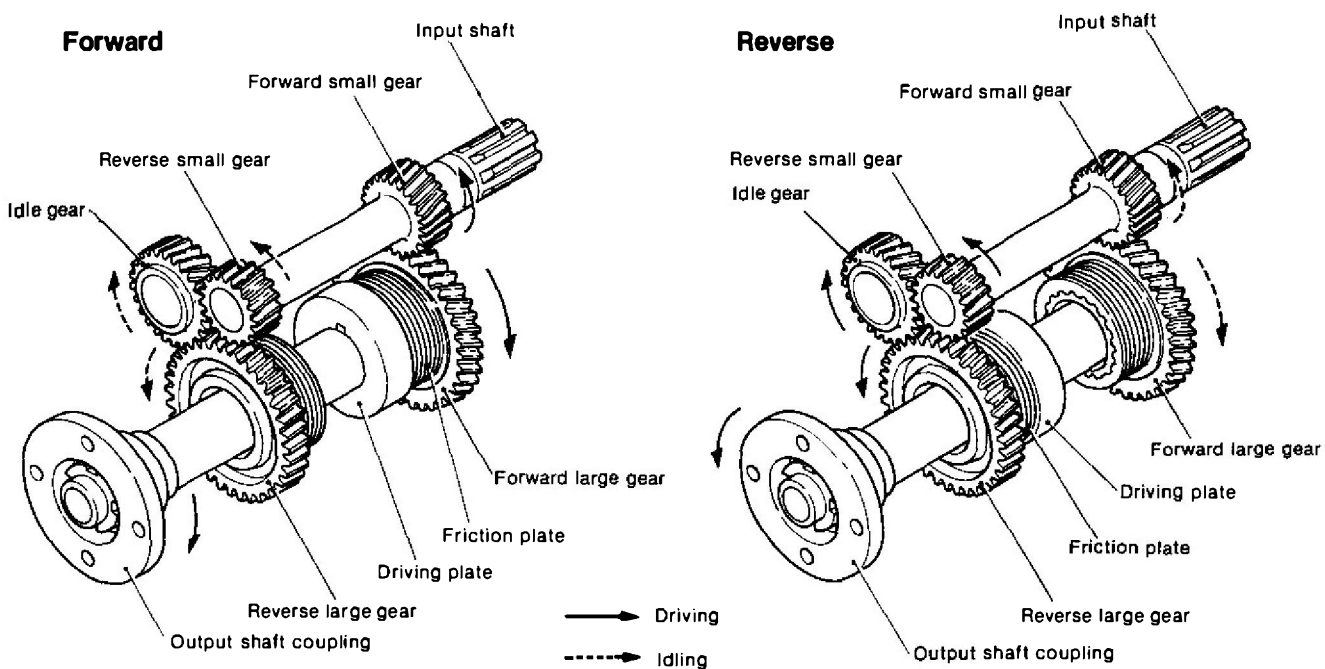
For KBW10E: SAE No.5

### 1-3 Power transmission system

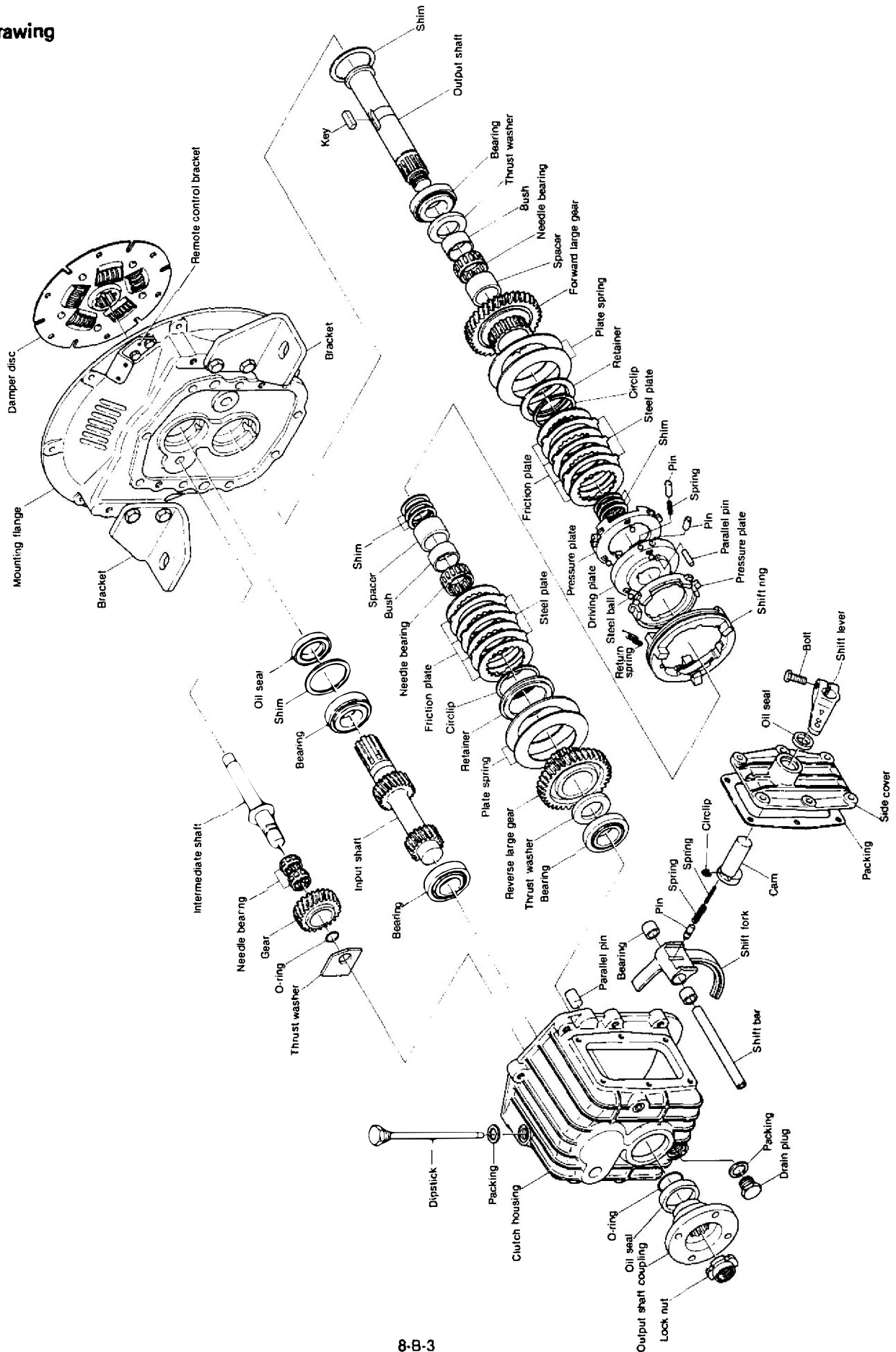


Forward			Reverse			
Number of teeth		Reduction ratio	Number of teeth			Reduction ratio
Forward small gear of input shaft	Forward large gear		Reverse small gear of input shaft	Idle gear	Reverse large gear	
22	47	$47/22 = 2.14$	18	25	45	$45/18 = 2.50$
18	51	$51/18 = 2.83$				
* 19	50	$50/19 = 2.63$				

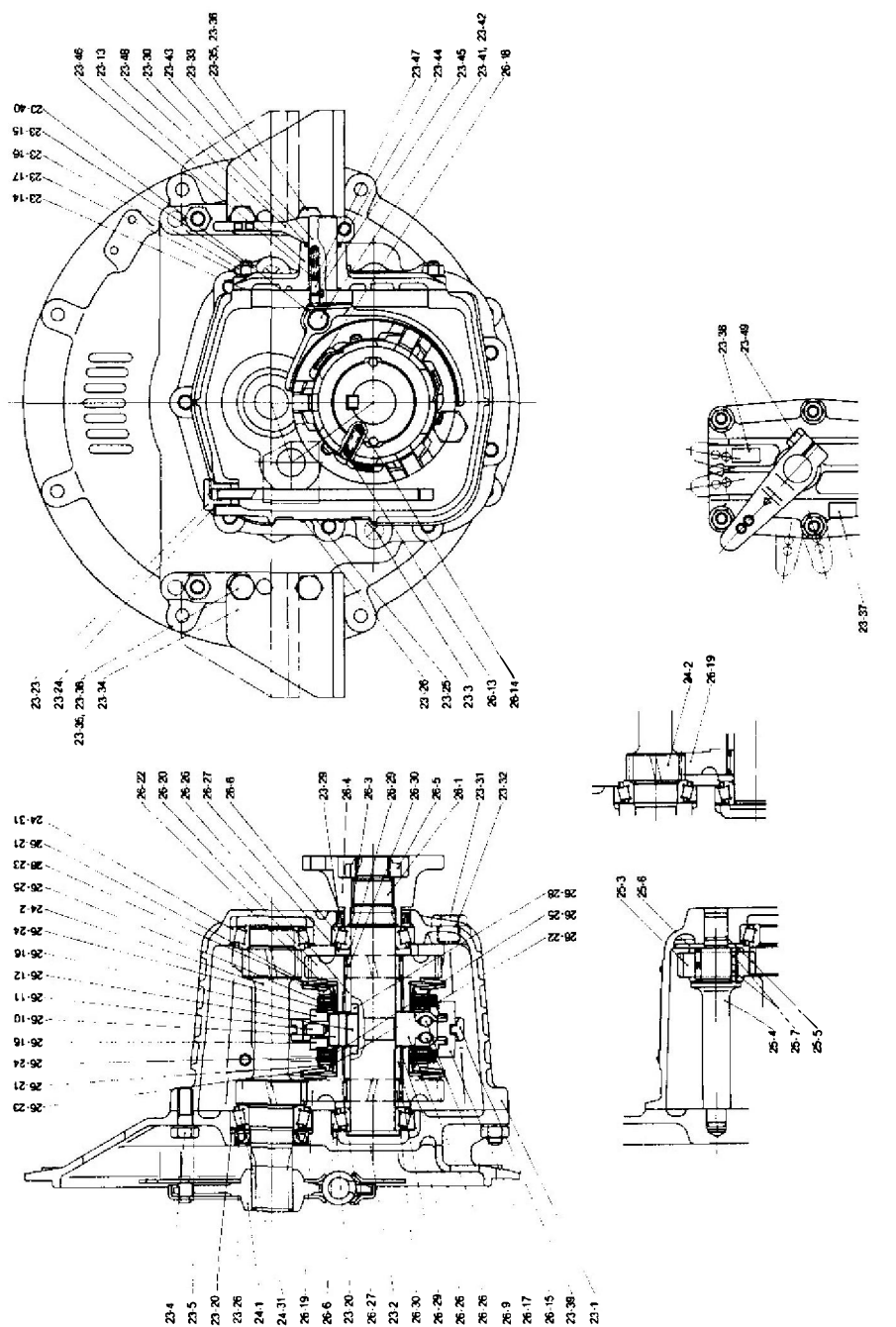
Parts marked\* are used for model KBW10D only.



1-4 Drawing



KBW10-A



- |                           |                               |
|---------------------------|-------------------------------|
| 23.1 HOUSING, clutch      | 24.1 DISC, damper             |
| 23.2 FULCRUM, shifting    | 24.2 INPUT SHAFT              |
| 23.3 PARALLEL PIN         | 24.31 ROLLER BEARING          |
| 23.4 BOLT M10 × 30        | 24.32 LM6708RLM67010          |
| 23.5 LOCK WASHER 10       | 25.1 SHAFT, idle gear         |
| 23.6 PACKING, cover       | 25.2 O-RING S-15              |
| 23.7 STUD M8 × 22         | 25.3 NEEDLE BEARING           |
| 23.8 NUT M8               | 25.4 OUTPUT SHAFT             |
| 23.9 LOCK WASHER 8        | 25.5 O-RING S-30              |
| 23.10 SHIM SET, output    | 25.6 COUPLING, output         |
| 23.11 DIPSTICK            | 25.7 LOCK NUT                 |
| 23.12 BREAKER             | 25.8 ROLLER BEARING           |
| 23.13 PACKING 16          | 25.9 LM6708RLM67010           |
| 23.14 LABEL               | 25.10 PLATE, assembly         |
| 23.15 RIVET               | 25.11 PLATE, friction         |
| 23.16 OIL SEAL (TC0528)   | 25.12 PARALLEL PIN            |
| 23.17 OIL SEAL (TC0528)   | 25.13 KEY                     |
| 23.18 OIL SEAL (SD 20284) | 25.14 PIN                     |
| 23.19 OIL SEAL (SD 20284) | 25.15 SPRING                  |
| 23.20 OIL SEAL (SD 20284) | 25.16 RING, shifting          |
| 23.21 LOCK M16            | 25.17 PLATE, pressure         |
| 23.22 PACKING 16          | 25.18 STEEL BALL (8mm)        |
| 23.23 BRACKET (A)         | 25.19 SPRING, return          |
| 23.24 BRACKET (B)         | 25.20 GEAR                    |
| 23.25 BOLT M10 × 30       | 25.21 BEARING                 |
| 23.26 LOCK WASHER 10      | 25.22 CIRCLIP                 |
| 23.27 LABEL, FORWARD      | 25.23 SPRING                  |
| 23.28 LABEL, REVERSE      | 25.24 DISC, friction          |
| 23.29 FORK Assembly       | 25.25 PLATE, steel            |
| 23.30 SHIM (inc. 23.40)   | 25.26 SPACER                  |
| 23.31 DRY BEARING         | 25.27 WASHER, thrust          |
| 23.32 SHAFT, shift        | 25.28 SHIM SET, output, shaft |
| 23.33 PLUG                | 25.29 NEEDLE BEARING          |
| 23.34 PIN, shift          | 25.30 RACE, inner             |
| 23.35 CIRCLIP             |                               |
| 23.36 SPRING (A)          |                               |
| 23.37 SPRING (B)          |                               |
| 23.38 LEVER, shift        |                               |
| 23.39 BOLT M8 × 25        |                               |

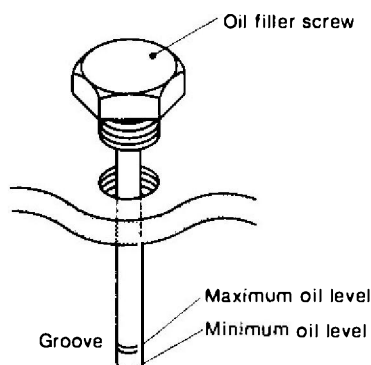


## 3. Operation and Maintenance

### 3-1 Lube oil

#### (1) Oil level

The oil level should be checked each month and must be maintained between the groove and the end of the dipstick. The groove indicates the maximum oil level and the end of the dipstick is the minimum oil level. When checking the oil level with the dipstick, do not screw in the oil filler screw; it should rest on top of the oil filler hole.



#### (2) Oil change

Change the oil after the first 100 hours of operation, and every 300 hours of operation thereafter. When adding oil between oil changes, always use the same type of oil that is in the marine gearbox.

#### (3) Recommended brands of lube oil

Supplier	Brand name
SHELL	SHELL DEXRON
CALTEX	TEXAMATIC FLUID (DEXRON)
ESSO	ESSO ATF
MOBIL	MOBIL ATF220
B.P. (British Petroleum)	B.P. AUTRAN DX

### 3-2 Precautions

Do not stop the shift lever halfway between the neutral and forward or reverse positions. The lever must be set to the neutral position or shifted into forward or reverse in a single motion.

### 3-3 Side cover

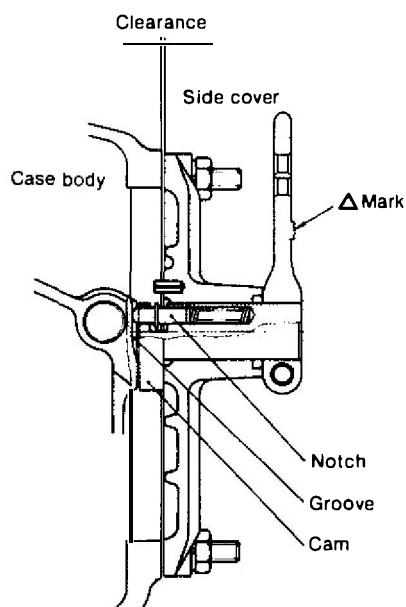
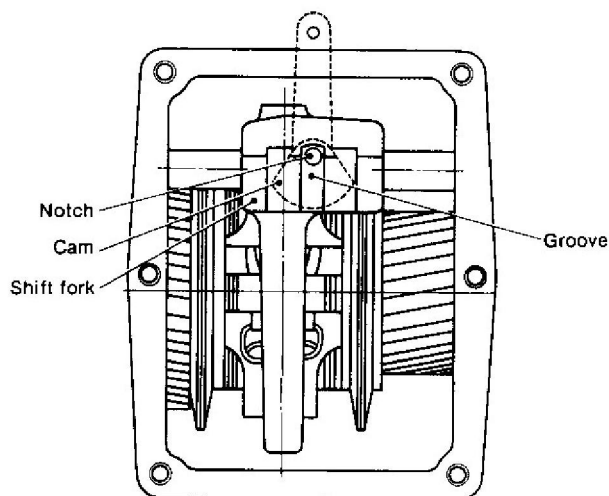
The internal shifting mechanism has been carefully aligned at the factory. Improper removal of the side cover can cause misalignment. If the side cover must be removed, proceed as follows:

—Before removing the cover, put alignment marks on the side cover and the case to facilitate accurate installation.

—When installing the side cover, put the shift lever in neutral so that the cam lobe on the shift lever engages the groove on the internal shift mechanism. When the cam

lobe and groove are engaged properly there will be no clearance between the body and the side cover. Do not use packing or gaskets when installing the side cover.

—After making sure that the cam lobe and notches are aligned properly, securely tighten all the bolts. After tightening the bolts, move the lever back and forth. Positive contact should be felt and a click should be clearly audible as the gears shift; otherwise, the cam and notch are not properly engaged, and the cover must be loosened and readjusted until proper engagement is achieved.



## 4. Inspection and Servicing

### 4-1 Clutch case

- (1) Check the clutch case with a test hammer for cracking. Perform a color check when required. If the case is cracked, replace it.
- (2) Check for staining on the inside surface of the bearing section. Also, measure the inside diameter of the case. Replace the case if it is worn beyond the wear limit.

### 4-2 Bearing

- (1) Rusting and damage  
If the bearing is rusted or the taper roller retainer is damaged, replace the bearing.
- (2) Make sure that the bearings rotate smoothly. If rotation is not smooth, if there is any binding, or if an abnormal sound is heard, replace the bearing.

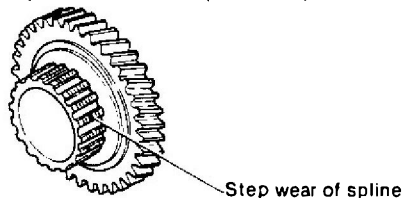
### 4-3 Gear

- (1) Tooth surface wear  
Check the tooth surface for pitching, abnormal wear, dents, and cracks. Repair lightly damaged gears and replace heavily damaged gears.
- (2) Tooth surface contact  
Check the tooth surface contact. The amount of tooth surface contact between the tooth crest and tooth flank must be at least 70% of the tooth width.
- (3) Backlash  
Measure the backlash of each gear, and replace the gear when it is worn beyond the wear limit.

	mm (in.)	
	Maintenance standard	Wear limit
Input shaft forward gear and output shaft forward gear	0.1 ~ 0.2 (0.0040 ~ 0.0079)	0.3 (0.0118)
Input shaft reverse gear and intermediate gear	0.1 ~ 0.2 (0.0040 ~ 0.0079)	0.3 (0.0118)
Intermediate gear and output shaft reverse gear	0.1 ~ 0.2 (0.0040 ~ 0.0079)	0.3 (0.0118)

#### (4) Forward/reverse gear spline

- 1) Check the spline for damage and cracking.
- 2) Step wear of spline  
Step wear depth limit: 0.1mm (0.0040in.)



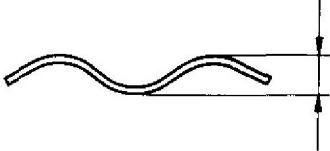
#### (5) Forward/reverse gear needle bearing

When an abnormal sound is produced at the needle bearing, visually inspect the rollers; replace the bearing if the rollers are faulty.



### 4-4 Steel plate

- (1) Burning, scratching, cracking  
Replace any steel plates that are discolored or cracked.
- (2) Warping measurement

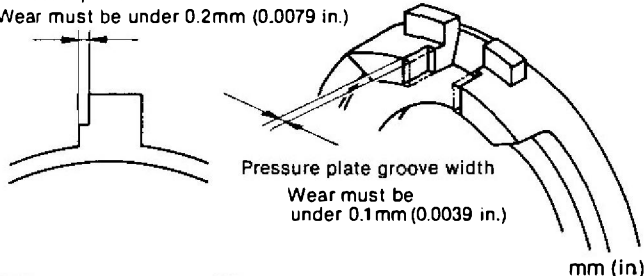


	mm (in.)	
	Maintenance standard	Wear limit
Warping	1.6 $\begin{smallmatrix} +0.10 \\ -0.11 \end{smallmatrix}$ (0.05870 ~ 0.067)	1.4 (0.0551)

#### (3) Steel plate pawl width measurement



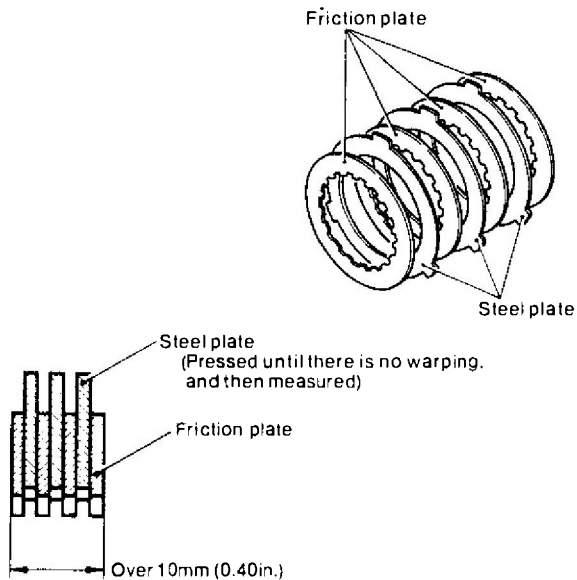
Measure the width of the steel plate pawl and the width of the pressure plate; replace the plate when the clearance exceeds the wear limit.



	mm (in.)	
	Maintenance standard	Wear limit
Steel plate width	12 $\begin{smallmatrix} 0 \\ -0.2 \end{smallmatrix}$ (0.4646 ~ 0.4724)	Worn 0.2 (0.0079)
Pressure plate groove	12 $\begin{smallmatrix} +0.1 \\ 0 \end{smallmatrix}$ (0.4724 ~ 0.4764)	Worn 0.1 (0.0039)
Clearance	0 ~ 0.3 (0 ~ 0.0118)	0.3 ~ 0.6 (0.0118 ~ 0.0236)

#### 4-5 Friction plate

- (1) Check the friction plate for burning, scoring, or cracking. Repair the plate when the damage is light and replace the plate if the damage is heavy.
- (2) Friction surface wear  
Measure the thickness of the friction plate, and replace the plate when it is worn beyond the wear limit.



	mm (in.)	
	Maintenance standard	Wear limit
Friction plate thickness	$1.7 \begin{smallmatrix} 0 \\ -0.05 \end{smallmatrix}$ (0.0650 ~ 0.0670)	1.5 (0.0591)

The assembled friction plate and steel plate dimensions must be over 10mm (0.0040in.).

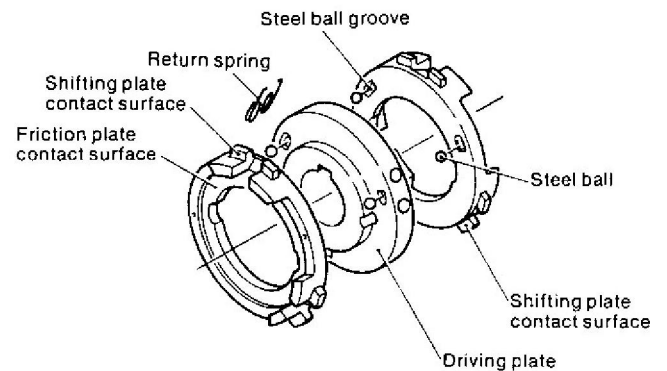
Both sides of the friction plate have a 0.35mm copper sintered layer. Replace the friction plate when this layer is worn more than 0.2mm on one side (standard thickness  $1.7 \begin{smallmatrix} 0 \\ -0.05 \end{smallmatrix}$  mm). However, the sum of the wear of the four friction plates must not exceed 0.8mm. When this value is exceeded, replace all friction plates. In unavoidable circumstances, it is permissible to replace only the friction plate with the greatest amount of wear.

- (3) Friction plate and gear spline back clearance

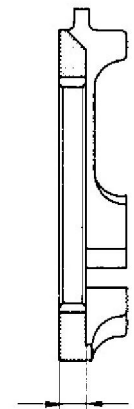
Measure the clearance between the friction plate spline collar and the output shaft gear spline, and replace the plate or spline when they are worn beyond the wear limit.

	mm (in.)	
	Maintenance standard	Wear limit
Standard backlash	0.20 ~ 0.61 (0.0079 ~ 0.0240)	0.9 (0.0354)

#### 4-6 Pressure plate



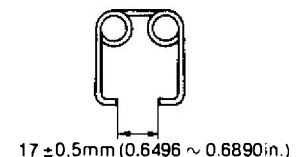
- (1) Steel ball groove  
Check the steel ball groove for stains and wear. Replace the pressure plate if the groove is noticeably worn.
- (2) Friction plate contact surface  
Check the contact face for stains and damage.
- (3) Shifting plate contact surface
- (4) Worn parts measurement



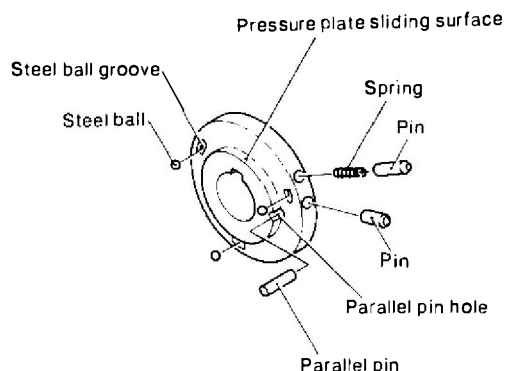
	mm (in.)	
	Maintenance standard	Wear limit
Thickness: t	$6.6 \begin{smallmatrix} 0 \\ -0.2 \end{smallmatrix}$ (0.2520 ~ 0.2598)	6.3 (0.2480)

- (5) Return spring permanent strain.

Make sure the length (free length) is within the values specified in the figure.

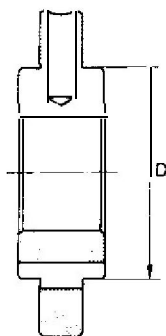


## 4-7 Driving plate



- (1) Check the key groove for scoring and cracking, and the output shaft fitting section for burning. Repair if the damage is light and replace the driving plate if the damage is heavy.

- (2) Outside diameter of pressure plate sliding part; others



	mm (in.)	
	Maintenance standard	Wear limit
Outside diameter: D	$\phi 59 \begin{smallmatrix} -0.060 \\ -0.134 \end{smallmatrix}$ (2.3176 ~ 2.3205)	$\phi 58.8$ (2.3150)

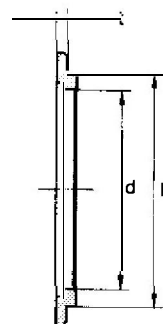
- (3) Steel ball groove wear and stains.
- (4) Determine the amount of wear and play of both the axial and circumferential direction pins.
- (5) Permanent spring strain.

	mm (in.)	
	Maintenance standard	Wear limit
Spring free length	32.85 (1.2933)	32 (1.2598)

- (6) Pin end wear.

## 4-8 Retainer

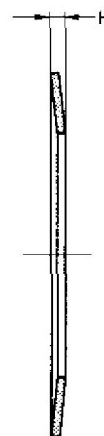
- (1) Check for stains and damage on the friction plate contact surface.
- (2) Check for wear and cracking on the plate spring contact surface.
- (3) Measurement of dimensions



	mm (in.)	
	Maintenance standard	Wear limit
d	$\phi 57.5 \begin{smallmatrix} +0.106 \\ +0.060 \end{smallmatrix}$ (2.2661 ~ 2.2680)	$\phi 57.8$ (2.2756)
D	$\phi 66 \begin{smallmatrix} 0 \\ -0.1 \end{smallmatrix}$ (2.5945 ~ 2.5984)	$\phi 65.7$ (2.5866)
t	$2.8 \begin{smallmatrix} 0 \\ -0.08 \end{smallmatrix}$ (0.1071 ~ 0.1102)	2.6 (0.1024)

## 4-9 Plate spring

- (1) Permanent strain

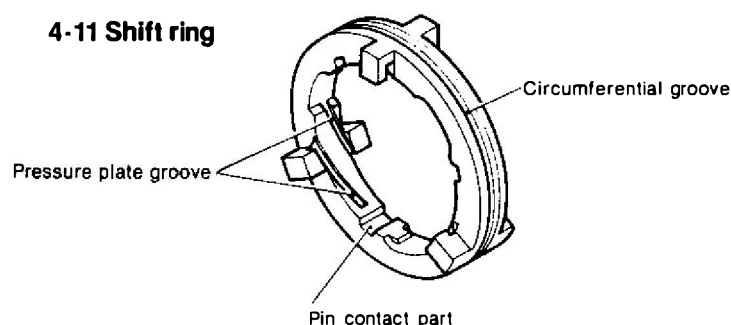


	mm (in.)	
	Maintenance standard	Wear limit
H: when plate spring if free	$6.25 \pm 0.1$ (0.2421 ~ 0.2500)	6.0 (0.2362)

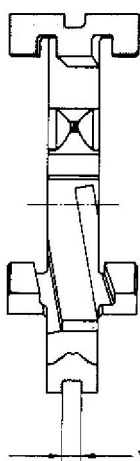
## 4-10 Thrust collar

The gear side of the thrust washer has a 0.3mm copper sintered layer. Replace the thrust collar when the thickness is less than 4.75mm (standard thickness:  $5 \begin{smallmatrix} 0 \\ -0.1 \end{smallmatrix}$  mm).

## 4-11 Shift ring



## (1) Circumferential groove wear.



	Maintenance standard	Wear limit
Shifting groove:w	6 <sup>+0.1</sup> <sub>0</sub> (0.2362 ~ 0.2402)	6.3 (0.2480)

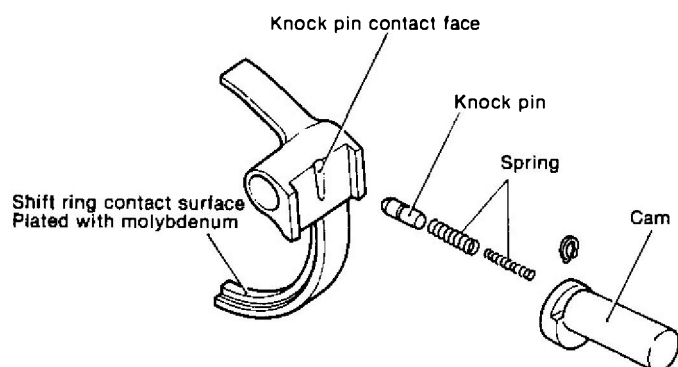
## (2) Pressure plate groove wear.

Whenever uneven wear and/or scratches are found, replace with a new part.

## (3) Parallel pin contact part wear.

Whenever uneven wear and/or scratches are found, replace with a new part.

## 4-12 Shift fork and shift lever



## (1) End wear.

The shift ring contact surface of the shift fork is plated with molybdenum (thickness: 0.04—0.05mm). If this plating is peeled or worn to such an extent that the base metal of the shift fork is exposed, replace the shift fork.

## (2) Cam surface wear and stains.

Whenever uneven wear and/or scratches are found, replace with a new part.

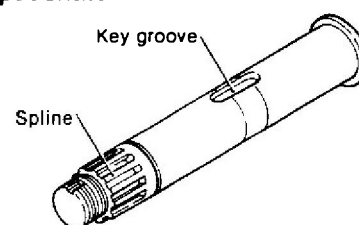
## (3) Pin part play.

Whenever uneven wear and/or scratches are found, replace with a new part.

## (4) Notch end wear.

Whenever uneven wear and/or scratches are found, replace with a new part.

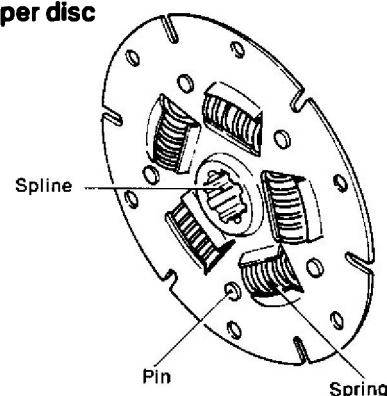
## 4-13 Output shaft



## (1) Key groove.

Whenever uneven cracks and/or stains are found, replace with a new part.

## 4-14 Damper disc



## (1) Spline part

Whenever uneven wear and/or scratches are found, replace with a new part.

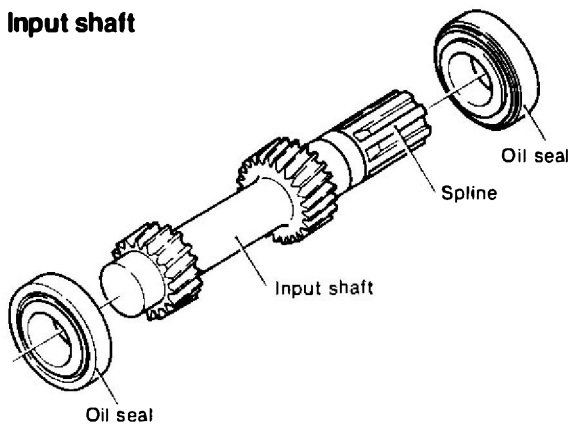
## (2) Spring.

Whenever uneven wear and/or scratches are found, replace with a new part.

## (3) Pin wear.

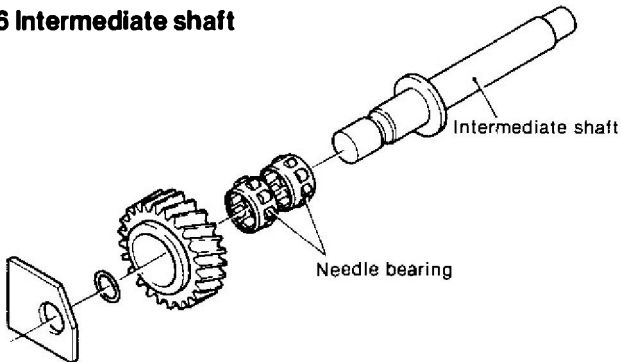
Whenever uneven wear and/or scratches are found, replace with a new part.

#### 4-15 Input shaft



- (1) Spline part  
Whenever uneven wear and/or scratches are found, replace with a new part.
- (2) Surface of oil seal.  
If the sealing surface of the oil seal is worn or scratched, replace.

#### 4-16 Intermediate shaft

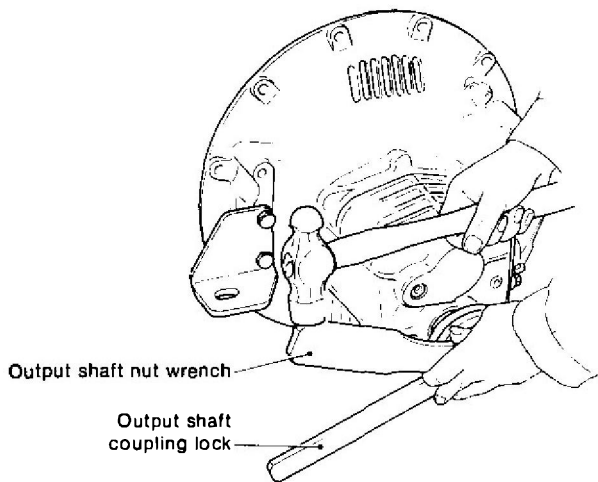
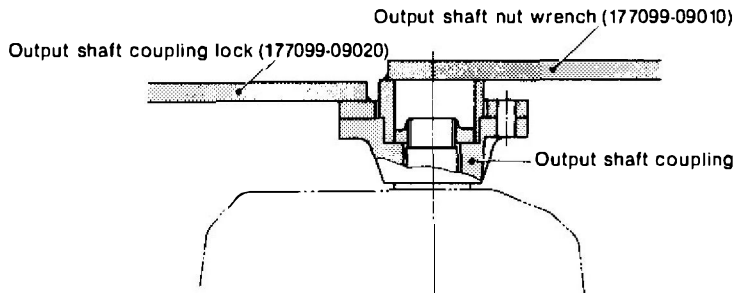


- (1) Needle bearing dimensions, staining.  
Check the surface of the roller to see whether the needle bearing sticks or is damaged. Replace if necessary.

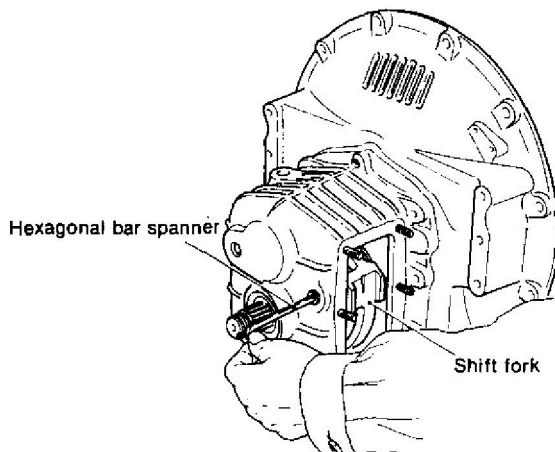
## 5. Disassembly

### 5-1 Disassembling the clutch and accessories

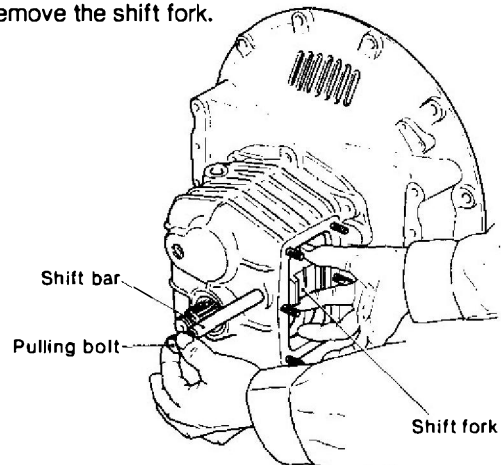
- (1) Remove the drain plug and packing, and drain the oil from the clutch.
- (2) Uncaulk the output shaft nut, and remove the nut using a disassembly tool.



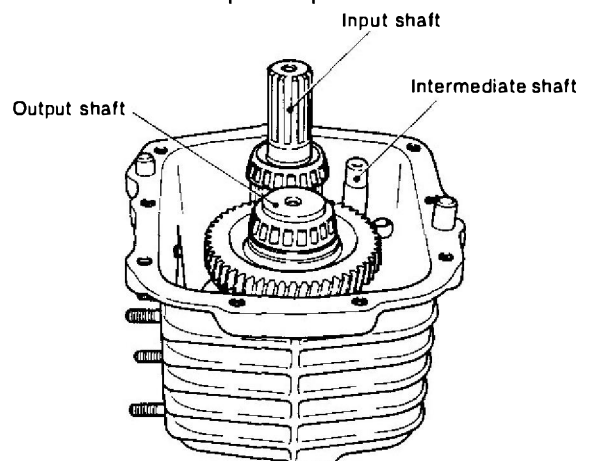
- (3) Remove the output coupling.
- (4) Remove the dipstick and packing.
- (5) Remove the case cover M8 nut super lock washer; remove the case cover, with the operating lever, shift cam, etc. in position.
- (6) Remove the shift bar plug with a hexagonal bar spanner (width across flats: 8mm (0.0394in.)), and pull the shift bar from the case, using the M10 pulling bolt at the end of the shift bar.



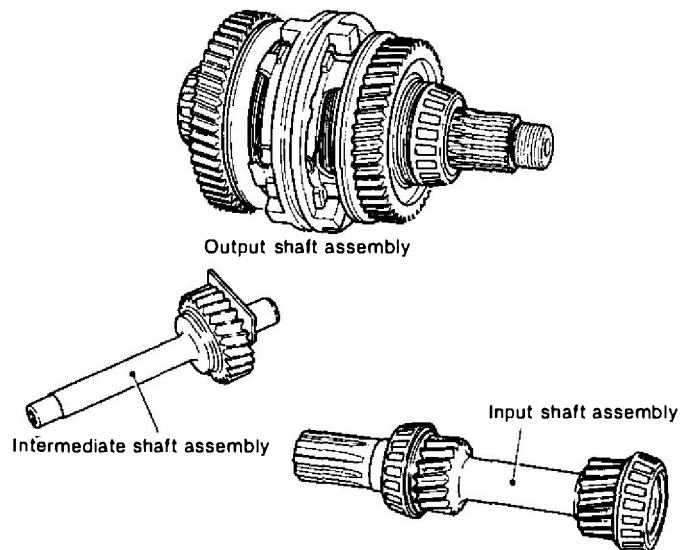
- (7) Remove the shift fork.



- (8) Remove the M10 bolt and super lock washer on the mounting flange.
- (9) Screw the M10 bolt into the M10 pulling bolt hole of the mounting flange, and remove the mounting flange. Do not remove the parallel pin.



- (10) Remove the output shaft, intermediate shaft, and input shaft from the case, in that order.



- (11) Heat the case body to about 100°C and remove the outer race of the input shaft and output shaft bearings. If the outer races are difficult to remove, tap them out with a plastic hammer from the rear of the case, or pull them by using the pulling groove in the case at the rear of the races.
- (12) Remove the outer race of the bearing from the mounting flange as described in step (11) above.
- (13) Remove the input shaft and output shaft adjusting plates.

**NOTE:** If the following parts are not replaced, the adjusting plates may be reused without readjustment. However, if even one part is replaced, readjustment is necessary.

Input shaft part: 24-2, 24-31

Output shaft part: 26-6, 26-9, 26-26, 26-27, 26-28, 26-30

- (14) Pull the oil seal from the case.
- (15) Pull the oil seal from the mounting flange.

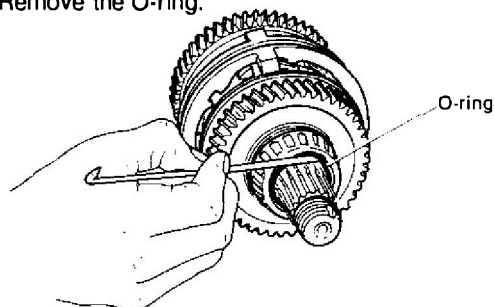
### 5-2 Disassembling the input shaft

Pull the bearing from the input shaft.

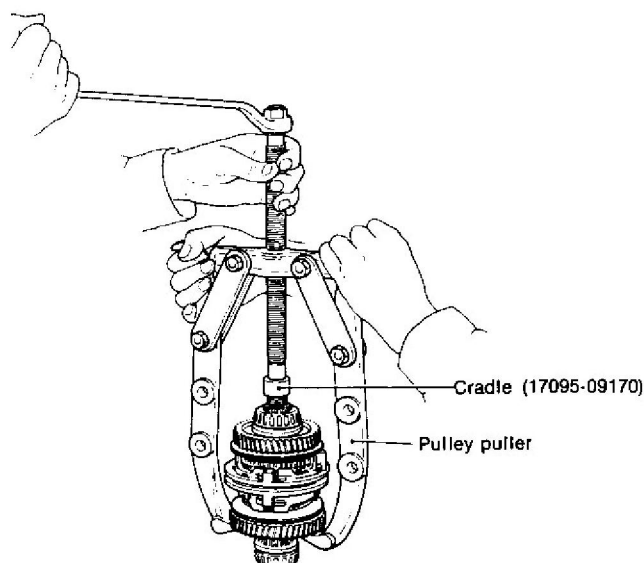
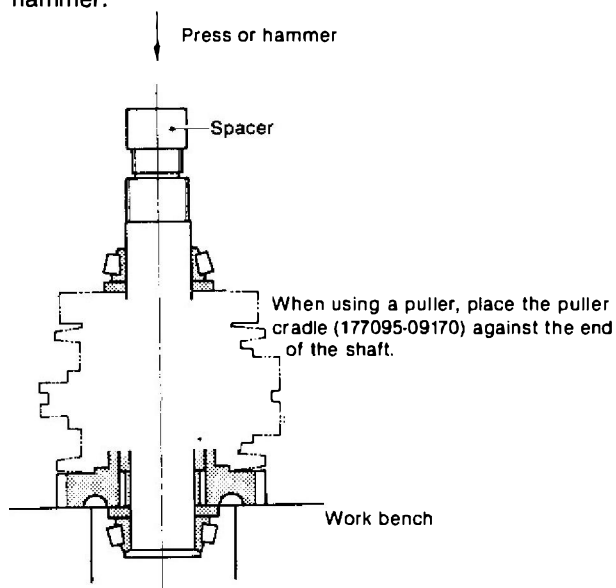
**NOTE:** Do not disassemble unless the input shaft parts are damaged.

### 5-3 Disassembling the output shaft

- (1) Remove the O-ring.



- (2) Remove the output shaft by pressing the threaded end of the output shaft with a press, or tapping it with a hammer.



**NOTE 1:** When removing the shaft, place spacers between the shaft and the press to prevent damage.

**NOTE 2:** Make sure that the forward large gear parts and reverse large gear parts are not mixed together once they are removed.

- (3) Remove the adjusting plate.

**NOTE:** Record the thickness of the adjusting plate to facilitate reassembly.

If the parts are not replaced, the adjusting plate may be reused without readjustment. However, if even one part is replaced, readjustment is required.

- (4) Remove the key.

To facilitate removal, clamp the key with a vice.

- (5) Remove the adjusting plate.

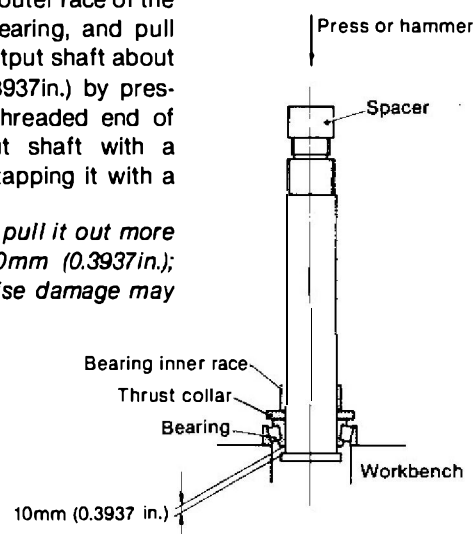
**NOTE:** Record the thickness of the adjusting plate to facilitate reassembly.

If the parts are not replaced, the adjusting plate may be reused without adjustment. However, if even one part is replaced, readjustment is required.

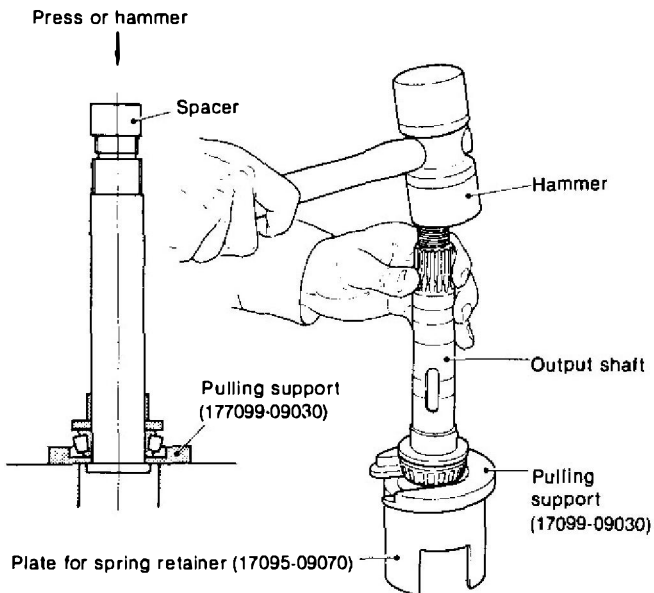
- (6) Remove the spacer and needle bearing.

- (7) Cover the outer race of the forward bearing, and pull out the output shaft about 10mm (0.3937in.) by pressing the threaded end of the output shaft with a press, or tapping it with a hammer.

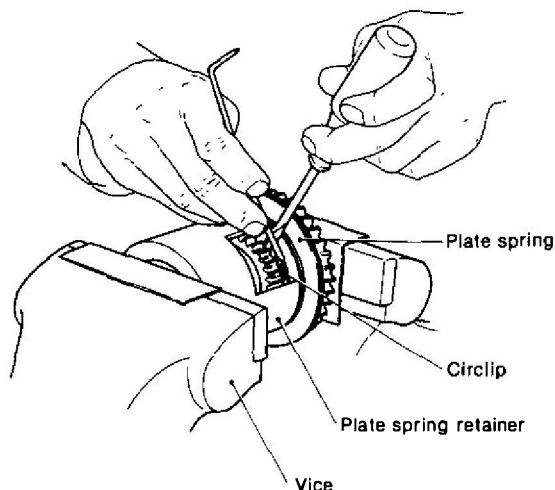
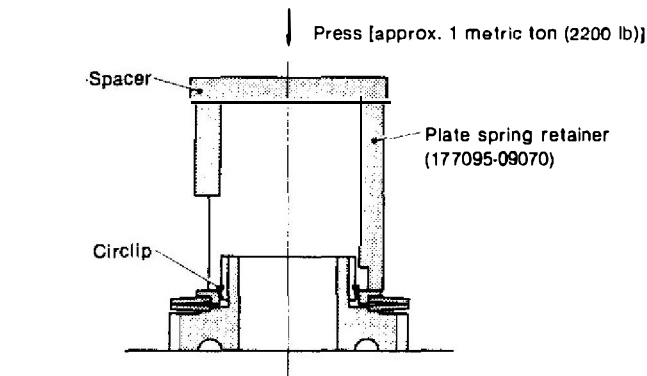
**NOTE:** Do not pull it out more than 10mm (0.3937in.); otherwise damage may result.



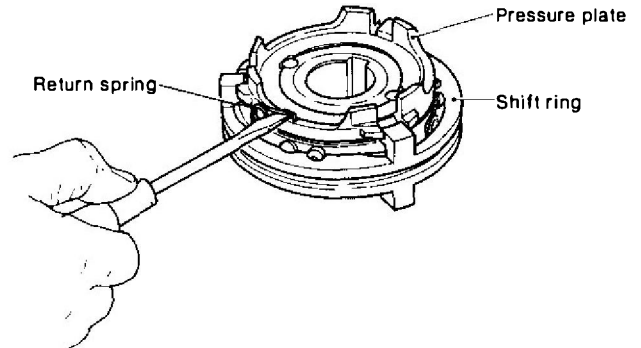
- (8) Insert the disassembly tool between the collar of the output shaft and the bearing; next remove the bearing inner race, thrust collar, and bearing from the output shaft with a press or hammer.



- (9) Remove the friction plates and steel plates from the forward large gear.
- (10) Using a disassembly tool, compress the plate spring and remove the circlip from the forward large gear.



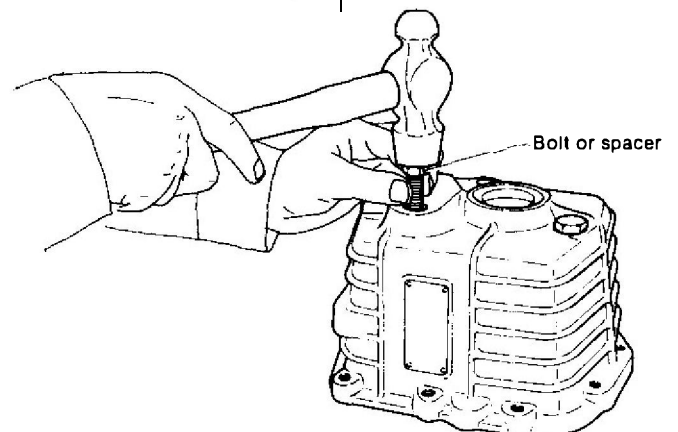
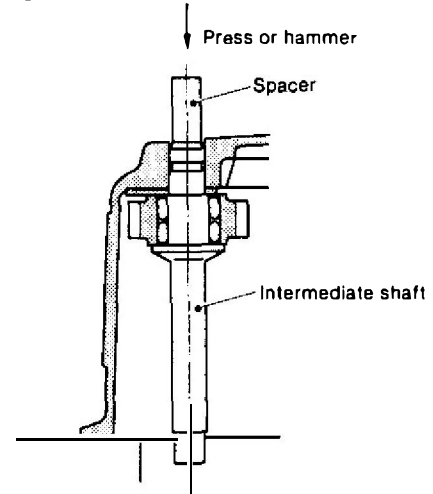
- (11) Remove the retainer and plate spring.
- (12) Remove the parts from the reverse large gear as described in steps (9)–(11) above.
- (13) Remove the pressure plate return spring; remove the pressure plate and steel ball.



- (14) Remove the shift ring.  
To disassemble, remove the three knock pins. When disassembling the shift ring, cover it with a cloth to prevent it being lost.
- (15) Remove the knock pin and spring from the driving plate.

#### 5-4 Disassembling the intermediate shaft

- (1) Place a spacer against the case side end of the intermediate shaft and remove the shaft from the case by tapping the spacer with a hammer.



- (2) Remove the O-ring.
- (3) Remove the idle gear, needle bearing, and thrust washer.

#### **5-5 Disassembling the operating system**

- (1) Loosen the M8 bolt of the shift lever; remove the shift lever.
- (2) Pull the shift cam.
- (3) Push in the knock pin and remove the circlip.
- (4) Remove the knock pin and spring.
- (5) Pull the oil seal from the case side cover.

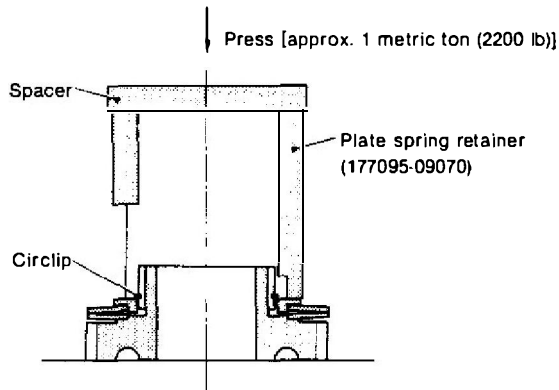
## 6. Reassembly

### 6-1 Reassembly precautions

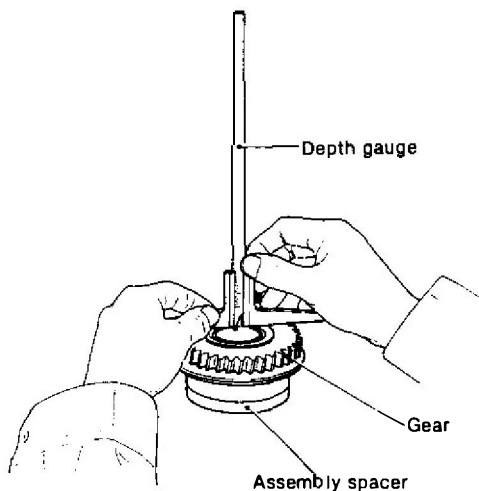
- (1) Before reassembling, clean all parts in washing oil, and replace any damaged or worn parts.  
Remove non-dry packing agent from the mating surface with a blunt knife.
- (2) Pack the oil seal and O-ring parts with grease.
- (3) Coat the mating surfaces of the case with wet packing.

### 6-2 Reassembling the output shaft

- (1) Reassembling forward large gear and plate spring
  - 1) Insert the two plate springs of the forward large gear so that their large diameter sides are opposite each other.
  - 2) Insert the retainer and install the circlip.
  - 3) Compress the plate spring, using the disassembly tool, and snap the circlip into the groove on the outside of the spline of the forward large gear.

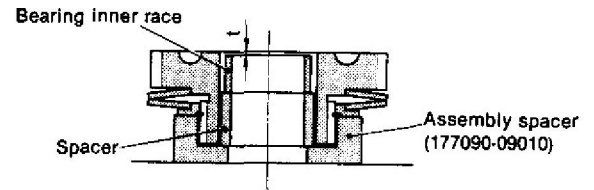


- (2) Reassemble the reverse large gear and plate spring, retainer, and circlip as described in step (1) above.
- (3) Determining the forward adjusting plate thickness



**NOTE:** As mentioned in section 5-3. (5), if no parts need to be replaced, the adjusting plate can be reused without adjustment.

- 1) Position the assembled large gear on the assembly tool so that the spline part is on the bottom; insert the spacer and bearing inner race into the gear.



- 2) Adjust the thickness of the adjusting plate until it conforms to the dimension shown in the figure.
- 3) Two adjustment plates of 0.5mm (0.0197in.) and 0.3mm (0.0118in.) are available.  
Combine these plates to obtain the "t" dimension.
- (4) Determine the thickness of the reverse adjusting plate by following the procedure described in step(3)above.
- (5) First, insert a friction plate into the spline part of the forward large gear; next insert steel plates and friction plates alternately. Finally, insert a friction plate (four friction plates and three steel plates).
- (6) Insert the friction plates and steel plates into the spline part of the reverse large gear in the same manner as described in step (5) above (four friction plates and three steel plates).
- (7) Press the inner race of the bearing onto the output shaft up to the collar, using an assembly tool.

**NOTE:** The inner race can be installed easily by preheating it to approximately 100°C.

