

REDUCTION AND REVERSING GEAR

Marine gear model KBW 20 and 21

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1. Construction

1-1 Construction

The Kanzaki-Carl Hurth KBW20 and KBW21 reduction reversing gears were 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 KBW20 and KBW21 consist 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		4JHE			4JH-TE		
Marine gear model		KBW20					
Reduction system		One-stage reduction, helical gear					
Reversing system		Constant mesh gear					
Clutch		Wet type multi-disc, mechanically operated					
Reduction ratio	Forward	2.17	2.62	3.28	2.17	2.62	3.28
	Reverse	3.06			3.06		
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		1.2ℓ					

Engine model		4JH-HTE			4JH-DTE		
Marine gear model		KBW21					
Reduction system		One-stage reduction, helical gear					
Reversing system		Constant mesh gear					
Clutch system		Wet type multi-disc, mechanically operated					
Reduction ratio	Forward	2.17	2.62	3.28	2.17	2.62	
	Reverse	3.06			3.06		
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		1.2ℓ					
Lube oil cooler		Sea-water cooling					

IMPORTANT:

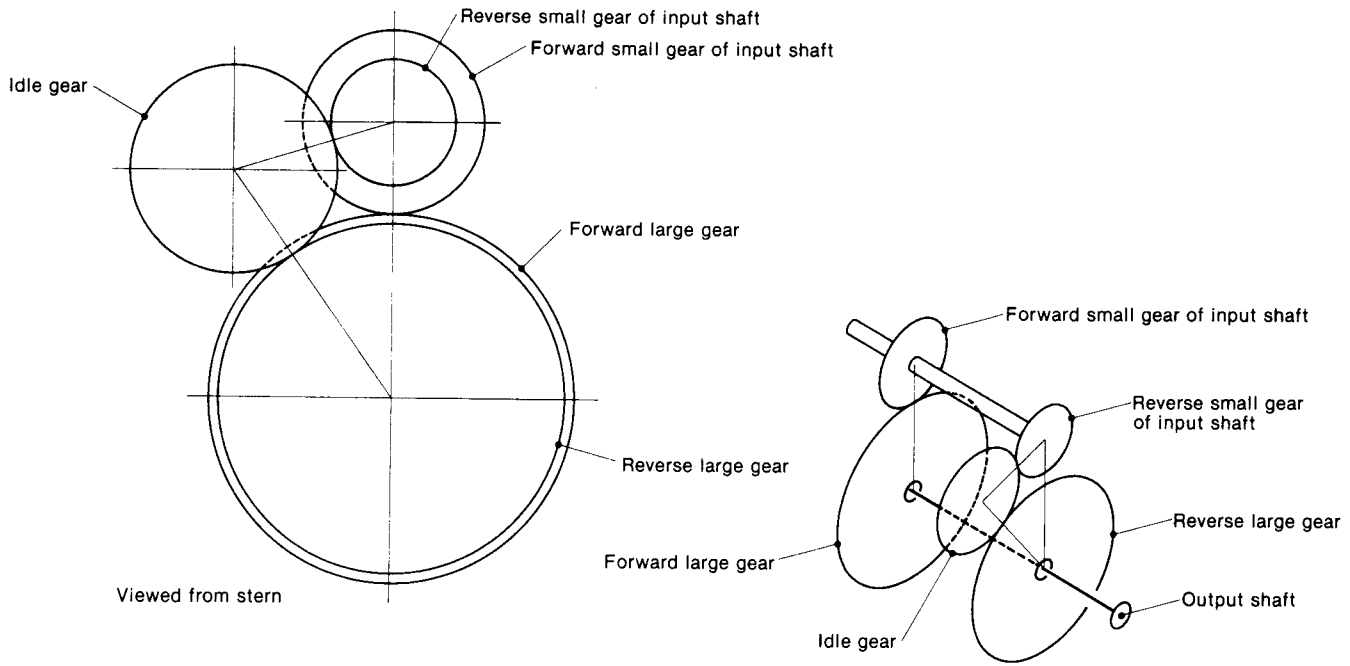
Differences between Marine Gear Models KBW20 and KBW21

KBW 21 is provided with a lube oil cooler (of side cover monoblock construction).

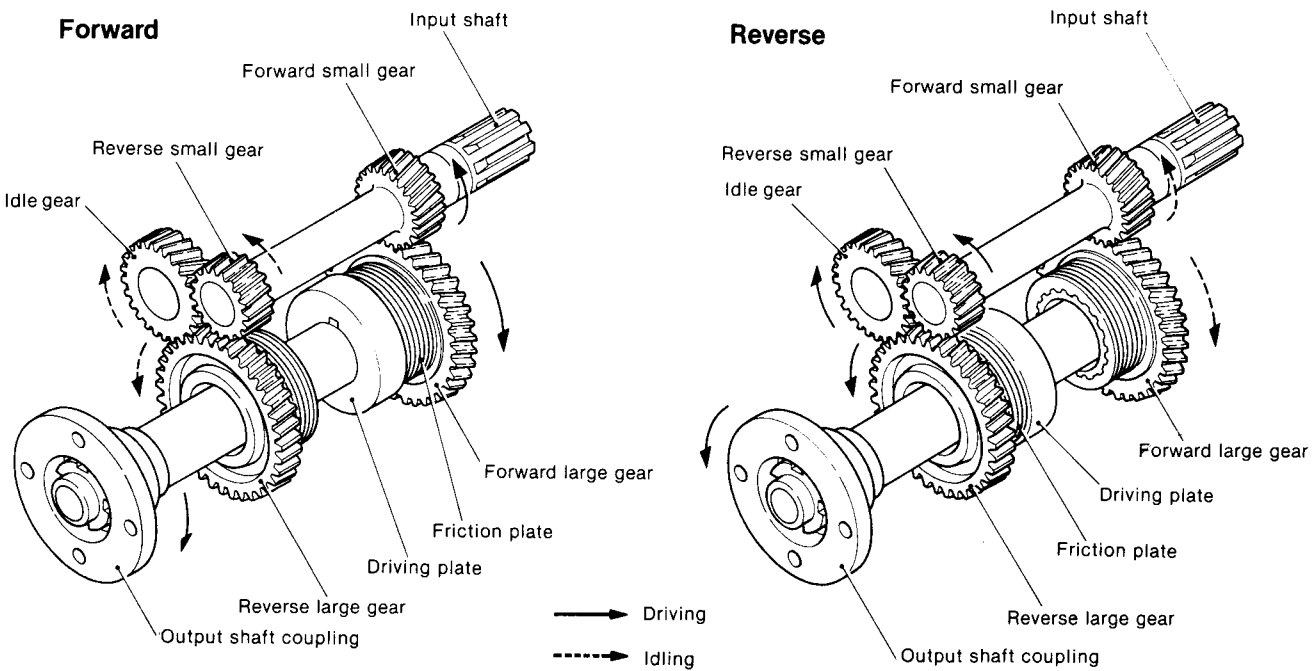
The dimensions of all KBW21 internal marine gear box components are identical to those of KBW20. However, all KBW21 gears are provided with higher strength through a gear teeth hardening process.

Accordingly, KBW21 can be used both for models 4JHE and 4JH-TE, however, KBW20 cannot be used for models 4JH-HTE and 4JH-DTE since KBW20 is not durable enough for these engine models.

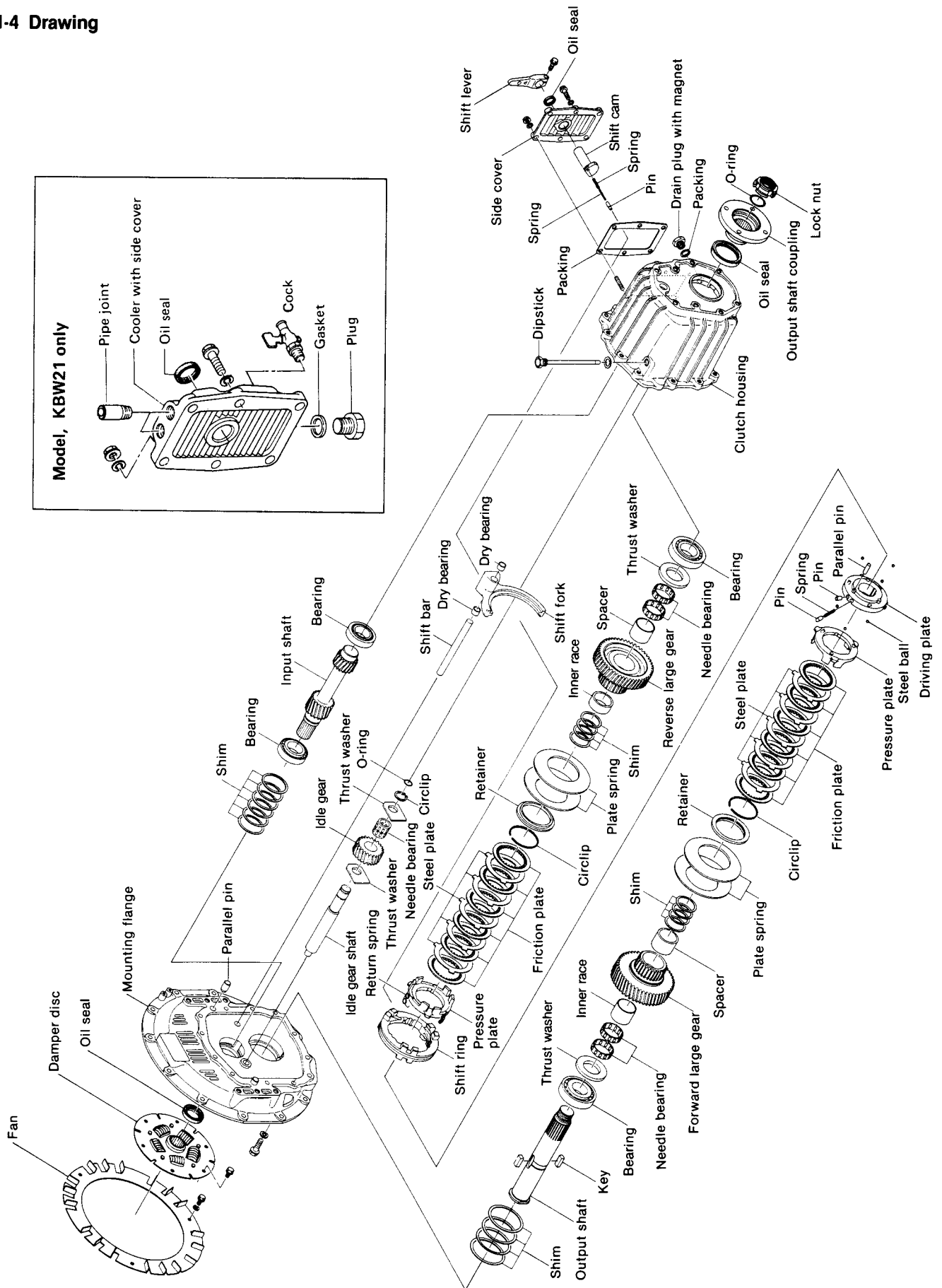
1-3 Power transmission system



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	
24	52	$52/24 = 2.17$	18	25	55	$55/18 = 3.06$
21	55	$55/21 = 2.62$				
18	59	$59/18 = 3.28$				

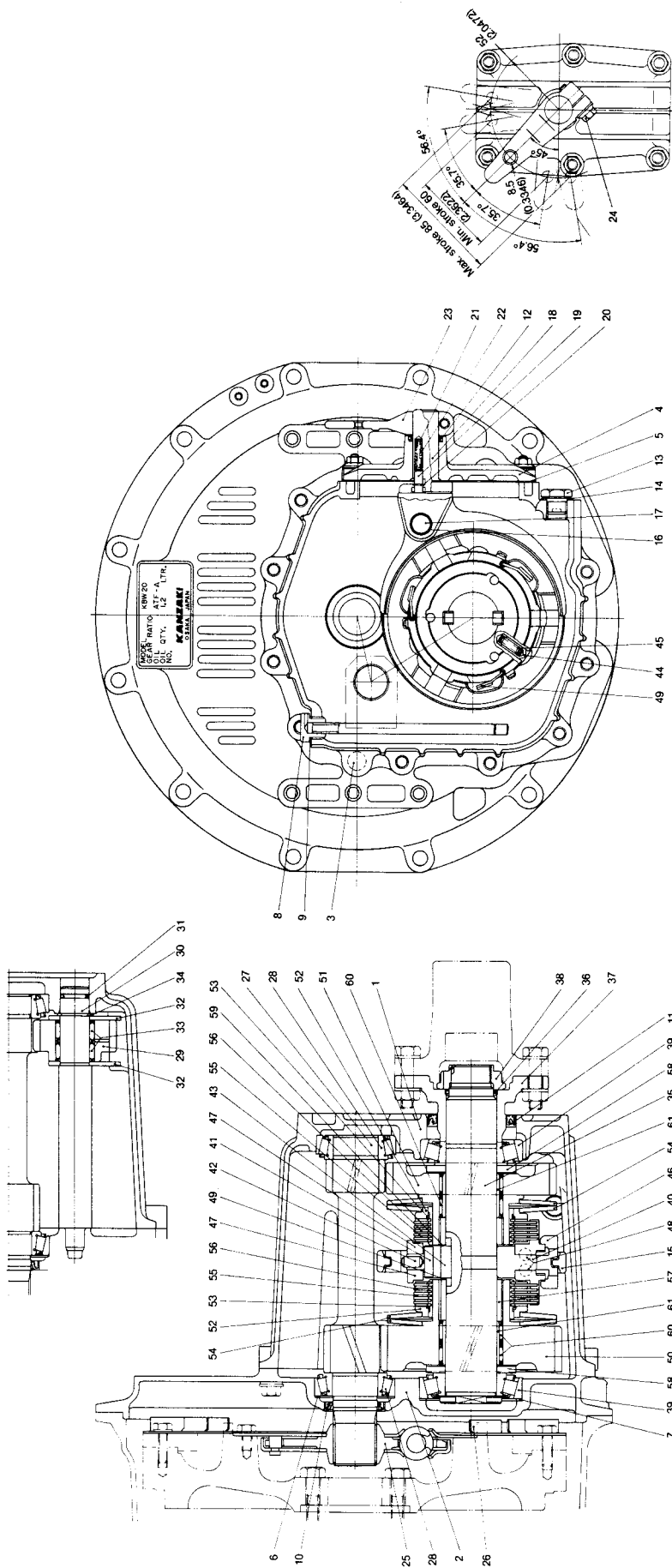


1-4 Drawing



1-5 Cross section

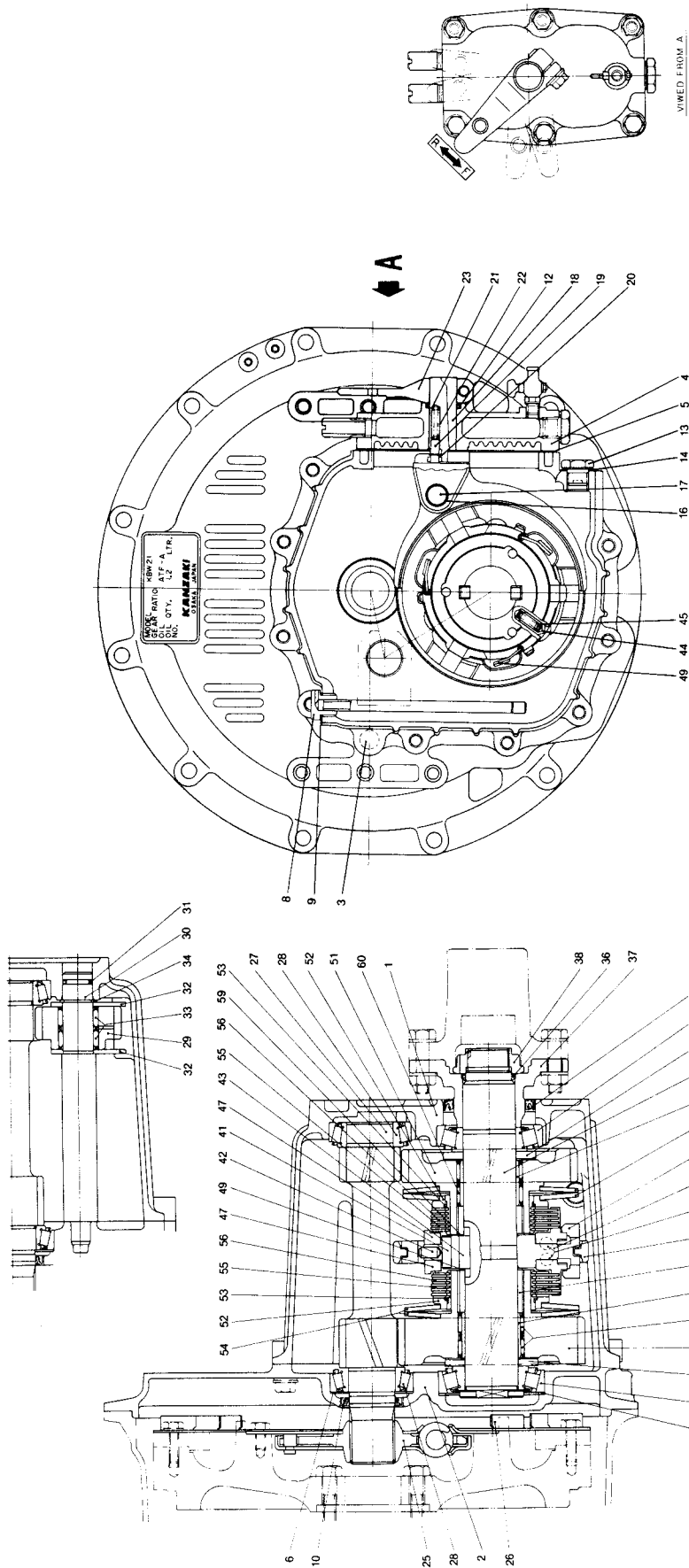
Model: KBW20



- 1 Clutch housing
- 2 Mounting flange
- 3 Parallel pin
- 4 Side cover
- 5 Packing
- 6 Shim (input shaft)
- 7 Shim (output shaft)
- 8 Packing
- 9 Packing
- 10 Oil seal (input shaft)
- 11 Oil seal (output shaft)
- 12 Oil seal (shift cam)
- 13 Plug
- 14 Packing
- 15 Shift fork
- 16 Drv bearing
- 17 Shift bar
- 18 Shift cam
- 19 Pin
- 20 Circlip
- 21 Spring
- 22 Spring
- 23 Shift lever
- 24 Bolt
- 25 Damper disc
- 26 Fan
- 27 Input shaft
- 28 Roller bearing
- 29 Idle gear shaft
- 30 Idle gear shaft
- 31 O-ring
- 32 Thrust washer
- 33 Needle bearing
- 34 Circlip
- 35 Output shaft
- 36 O-ring
- 37 Circlip
- 38 Roller bearing
- 39 Output shaft coupling
- 40 Driving plate
- 41 Parallel pin
- 42 Parallel pin
- 43 Key
- 44 Pin
- 45 Spring
- 46 Shift ring plate
- 47 Pressure ball
- 48 Return spring
- 49 Forward gear
- 50 Reverse gear
- 51 Retainer
- 52 Circlip
- 53 Circlip
- 54 Friction ring
- 55 Friction disc
- 56 Steel plate
- 57 Spacer
- 58 Thrust washer
- 59 Shim (output shaft)
- 60 Needle bearing
- 61 Inner race

Cross section

Model: KBW21



- | | | | |
|-----------------------------|---------------------------|-------------------------|----------------|
| 1. Clutch housing | 31. O-ring | 46. Shift ring | 61. Inner race |
| 2. Mounting flange | 32. Thrust washer | 47. Pressure plate | |
| 3. Shim (input shaft) | 33. Needle bearing | 48. Steel ball | |
| 4. Side cover | 34. Circlip | 49. Return spring | |
| 5. Packing | 35. Output shaft | 50. Forward gear | |
| 6. Shim (input shaft) | 36. O-ring | 51. Reverse gear | |
| 7. Shim (output shaft) | 37. Output shaft coupling | 52. Retainer | |
| 8. Dimple | 38. Roller bearing | 53. Plate spring | |
| 9. Packing (input shaft) | 39. Output shaft | 54. Friction disc | |
| 10. Oil seal (output shaft) | 40. Damping plate | 55. Steel plate | |
| 11. Oil seal (input shaft) | 41. Parallel pin | 56. Thrust washer | |
| 12. Oil seal (shift cam) | 42. Parallel pin | 57. Shim (output shaft) | |
| 13. Plug | 43. Key | 58. Needle bearing | |
| 14. Packing | 44. Pin | | |
| 15. Shift fork | 45. Spring | | |

2. Installation

2-1 Installation angle

During operation the angular inclination of the gearbox in the longitudinal direction must be less than 20° relative to the water line.

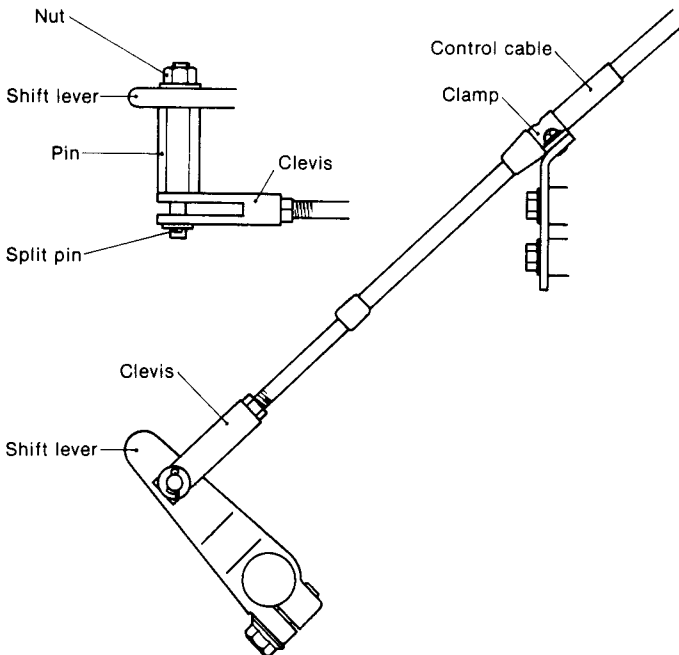
2-2 Remote control unit

This marine gearbox is designed for single lever control to permit reversing at full engine speed (e.g. to avoid danger, etc.). Normally, Morse or Teleflex single lever control is employed. During installation, make sure that the remote control lever and shift lever on the marine gearbox are coordinated. Shifting the lever toward the propeller side produces forward movement, while moving the lever toward the engine side causes the vessel to move in the reverse direction.

To connect the linkage, the operating cable must be positioned at right angles to the shift lever when the shift lever is in the neutral position.

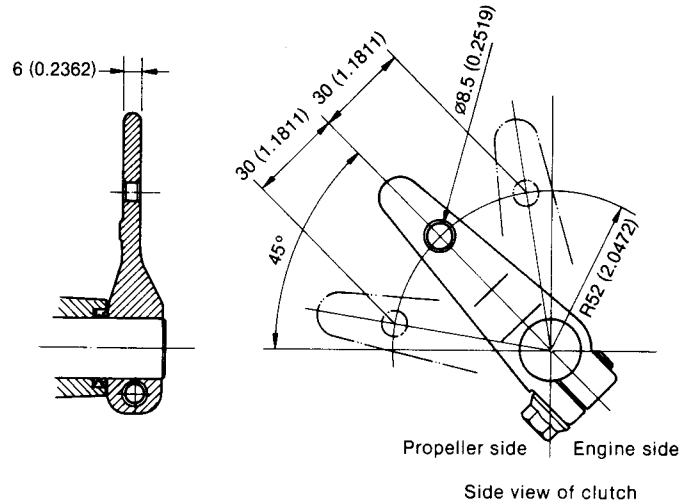
The shift play, measured at the pivot point of the shift lever, must be at least 30mm (1.181in.) on each side (reverse and forward) of the neutral position. Greater shift play has no adverse effect on the marine gearbox. After connecting the linkage, confirm that the remote control and the shift lever on the marine gearbox work properly.

A typical linkage arrangement is illustrated in the figure below.



When the cable is attached to the hole 52mm (2.0472in.) from the center of the rotation of the shift lever, these strokes must be 30mm (1.181in.)

mm(in.)



2-3 Clutch operation force (reference value)

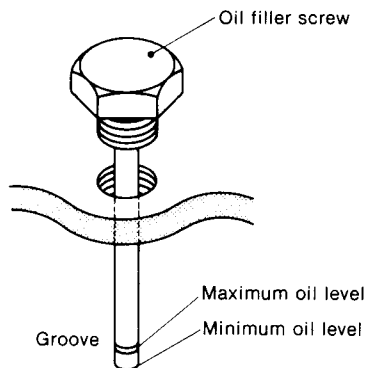
Operation position	Operation lever position at 52mm (2.0472in.)	Remarks
Engaging stroke	Approx. 9.5kg (20.94 lb)	Engine speed at 1000 rpm
Disengaging stroke	Approx. 11.5kg (25.35 lb)	

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 50 hours of operation, and every 150 hours of operation thereafter. When adding oil between oil changes, always use the same type of oil as 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. ATRAN 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.

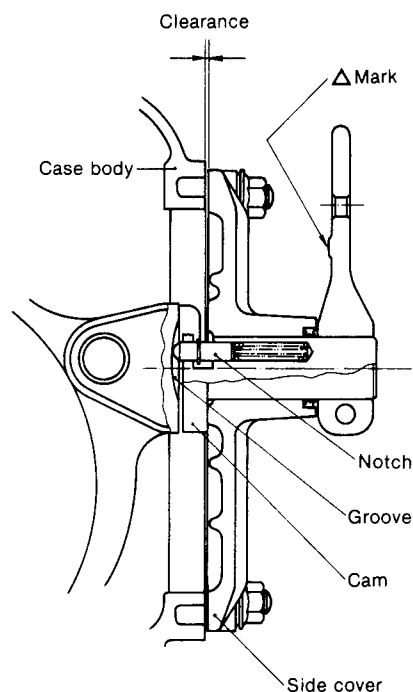
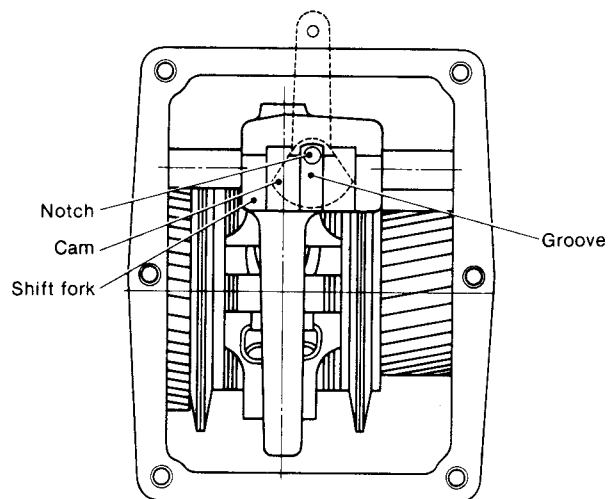
3-3 Side cover

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. Use packing 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 for cracking with a test hammer. 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.

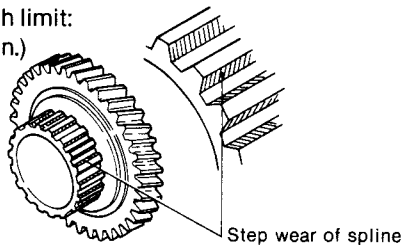
4-3 Gear

- (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.)	
	Standard	Wear limit
Input shaft forward gear and output shaft forward gear	0.1 ~ 0.2 (0.0039 ~ 0.0078)	0.3 (0.0118)
Input shaft reverse gear and intermediate gear	0.1 ~ 0.2 (0.0039 ~ 0.0078)	0.3 (0.0118)
Intermediate gear and output shaft reverse gear	0.1 ~ 0.2 (0.0039 ~ 0.0078)	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.)



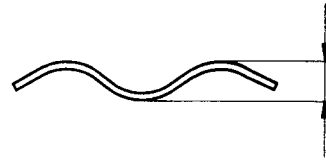
(5) Forward/reverse gear needle bearing

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



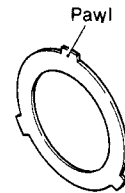
4-4 Steel plate

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

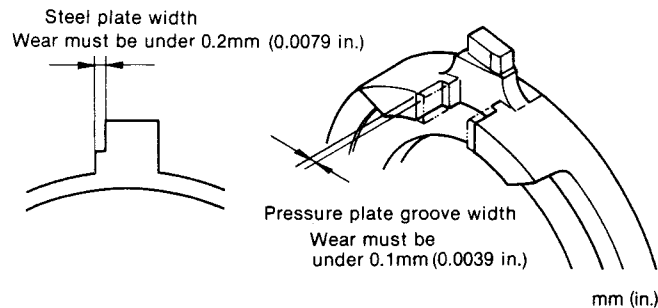


	mm (in.)	
	Standard	Wear limit
Warping	1.49 ~ 1.70 (0.0586 ~ 0.0669)	1.4 (0.0551)

(3) Steel plate pawl width measurement



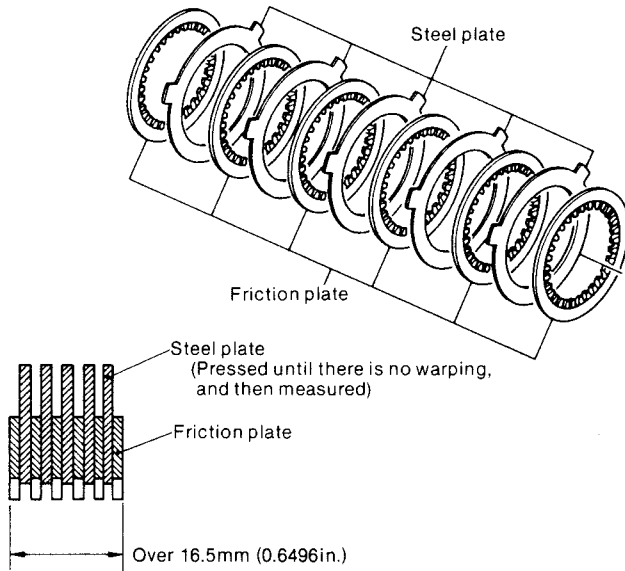
Measure the width of the steel plate pawl and the width of the pressure plate; replace the plate when the clearance exceeds the wear limit.



	mm (in.)	
	Standard	Wear limit
Steel plate width	11.8 ~ 12.0 (0.4645 ~ 0.4724)	Worn 0.2 (0.0078)
Pressure plate groove	12.0 ~ 12.1 (0.4724 ~ 0.4763)	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.)	
	Standard	Wear limit
Friction plate thickness	1.65 ~ 1.70 (0.0649 ~ 0.0669)	1.5 (0.0590)

The assembled friction plate and steel plate dimensions must be over 16.5mm (0.6496in.).

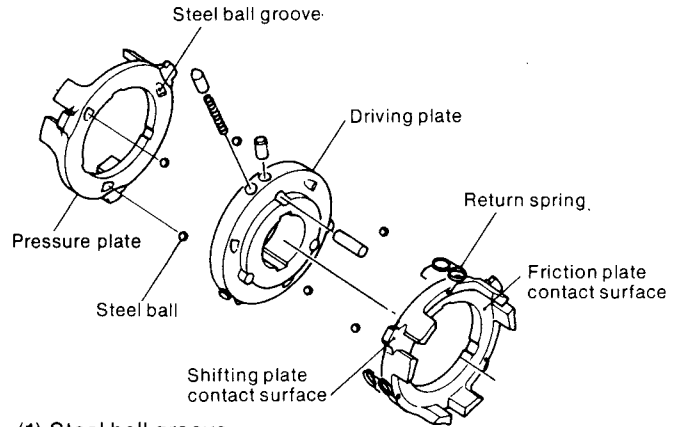
Both sides of the friction plate have a 0.35mm (0.0138in.) copper sintered layer. Replace the friction plate when this layer is worn more than 0.2mm (0.0079in.) on one side (standard thickness 1.65 ~ 1.70 (0.0650 ~ 0.0670in.)). However, the sum of the wear of the six friction plates must not exceed 1.2mm (0.0472in.). 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

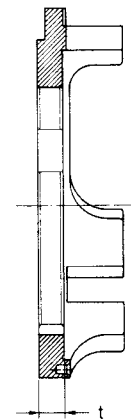
Measure the clearance between the friction plate spline collar and the output shaft gear spline, and replace the plate or spline when they are worn beyond the wear limit.

	mm (in.)	
	Standard	Wear limit
Standard backlash	0.20 ~ 0.61 (0.0078 ~ 0.0240)	0.9 (0.0354)

4-6 Pressure plate



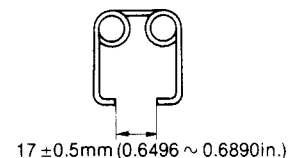
- (1) Steel ball groove
Check the steel ball groove for stains and wear. Replace the pressure plate if the groove is noticeably worn.
- (2) Friction plate contact surface
Check the contact face for stains and damage.
- (3) Shifting plate contact surface
- (4) Worn parts measurement



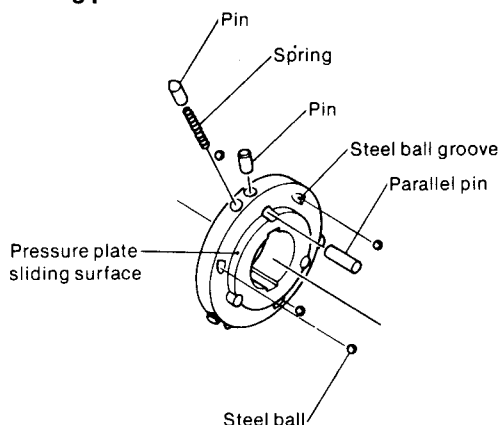
	mm (in.)	
	Standard	Wear limit
Thickness: t	8.0 ~ 8.1 (0.3149 ~ 0.3188)	7.9 (0.3110)

(5) Return spring permanent strain.

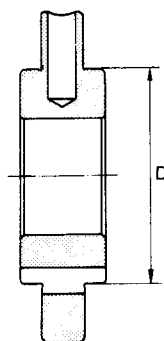
Make sure the length (free length) is within the values specified in the figure.



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.)	
	Standard	Wear limit
Outside diameter: D	ø68.366 ~ 68.440 (2.6915 ~ 2.6944)	ø68.3 (2.6889)

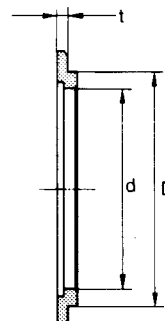
- (3) Steel ball groove wear and stains.
- (4) Determine the amount of wear and play of both the axial and circumferential direction pins.
- (5) Permanent spring strain.

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

- (6) Pin end wear.

4-8 Retainer

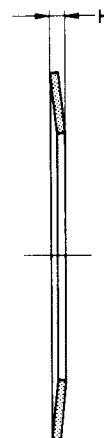
- (1) Check for stains and damage on the friction plate contact surface.
- (2) Check for wear and cracking on the plate spring contact surface.
- (3) Measurement of dimensions



	mm (in.)	
	Standard	Wear limit
d	ø67.060 ~ 67.106 (2.6401 ~ 2.6419)	ø67.3 (2.6496)
D	ø75.9 ~ 76.0 (2.9881 ~ 2.9921)	ø75.7 (2.9803)
t	4.95 ~ 5.05 (0.1948 ~ 0.1988)	4.8 (0.1889)

4-9 Plate spring

- (1) Permanent strain

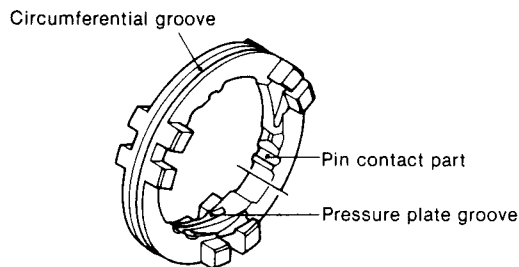


	mm (in.)	
	Standard	Wear limit
H: when plate spring is free	7.2 ~ 7.6 (0.2834 ~ 0.2992)	7.05 (0.2775)

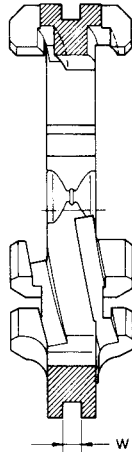
4-10 Thrust collar

The gear side of the thrust washer has a 0.3mm (0.0118in.) copper sintered layer. Replace the thrust collar when the thickness is less than 5.75mm (0.2263in.) (Standard thickness: 5.9 ~ 6.0mm (0.2322 ~ 0.2362).

4-11 Shift ring



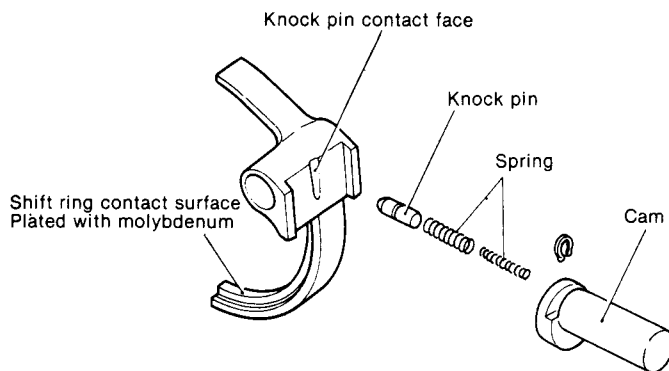
- (1) Circumferential groove wear.



	mm (in.)	
	Standard	Wear limit
Shifting groove: w	6.0 ~ 6.1 (0.2362 ~ 0.2401)	6.3 (0.2480)

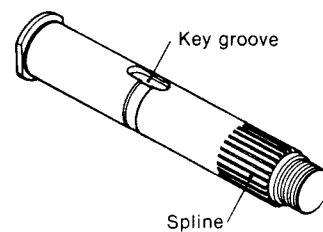
- (2) Pressure plate groove wear.
Whenever uneven wear and/or scratches are found, replace with a new part.
- (3) Parallel pin contact part wear.
Whenever uneven wear and/or scratches are found, replace with a new part.

4-12 Shift fork and shift lever



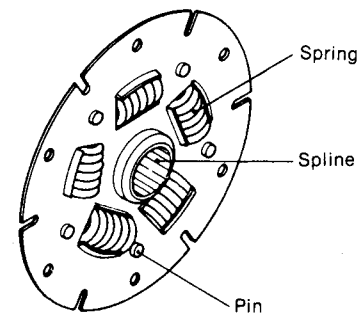
- (1) End wear.
The shift ring contact surface of the shift fork is plated with molybdenum (thickness: 0.04 ~ 0.05mm (0.0016 ~ 0.0020in.)). If this plating is peeled or worn to such an extent that the base metal of the shift fork is exposed, replace the shift fork.
- (2) Cam surface wear and stains.
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



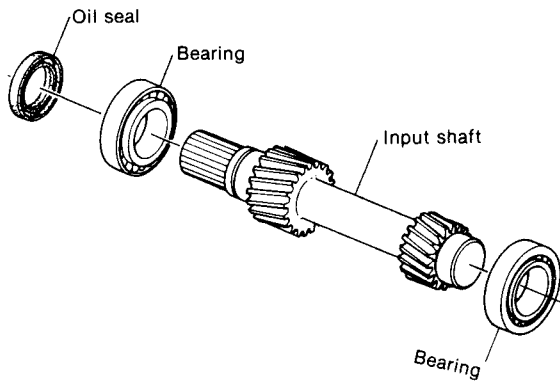
- (1) Key groove.
Whenever uneven cracks and/or stains are found, replace with a new part.

4-14 Damper disc



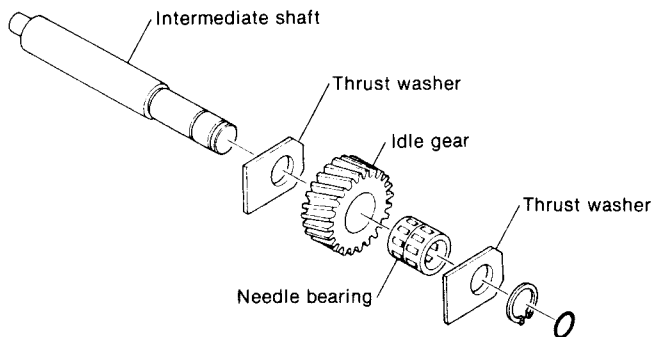
- (1) Spline part
Whenever uneven wear and/or scratches are found, replace with a new part.
- (2) Spring.
Whenever uneven wear and/or scratches are found, replace with a new part.
- (3) Pin wear.
Whenever uneven wear and/or scratches are found, replace with a new part.

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

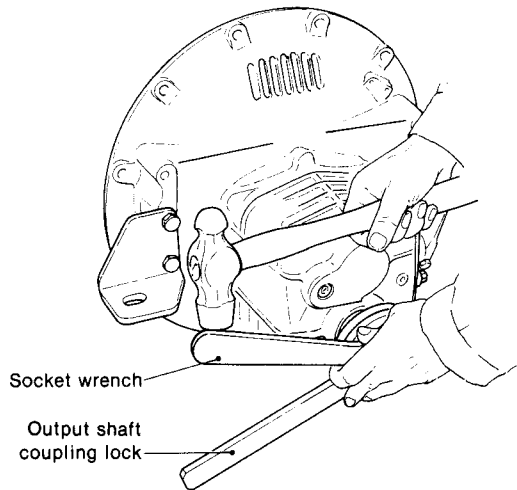
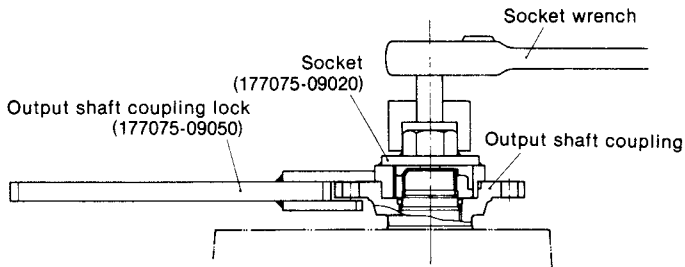


- (1) Needle bearing dimensions, staining.
Check the surface of the roller to see whether the needle bearing sticks or is damaged. Replace if necessary.

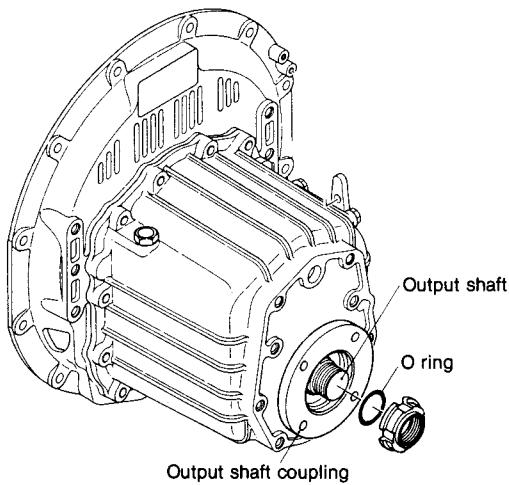
5. Disassembly

5-1 Disassembling the clutch and accessories

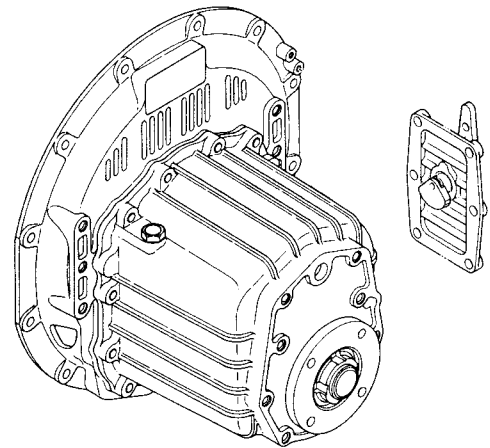
- (1) Remove the drain plug and packing, and drain the oil from the clutch.
- (2) Uncaulk the output shaft lock nut, and remove the nut using a disassembly tool.



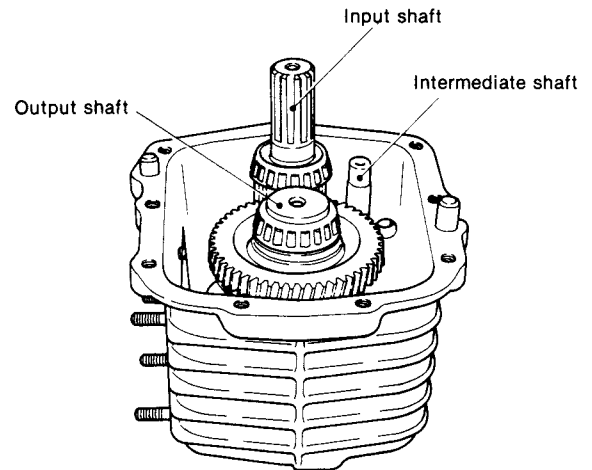
- (3) Remove the output coupling with O-ring.



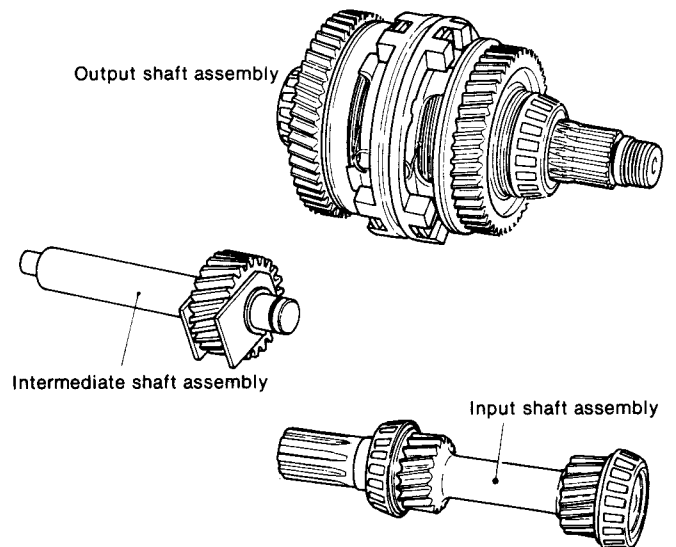
- (4) Remove the dipstick and packing.
- (5) Remove the case cover M8 nut and M8 bolt; remove the case cover, with the operating lever, shift cam, etc. in position.



- (6) Remove the M10 bolt and super lock washer on the mounting flange.
- (7) 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.



- (8) Remove the output shaft, intermediate shaft, and input shaft from the case, in that order.
- (9) Remove the shift bar from the moving flange side.



- (10) 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.
- (11) Remove the outer race of the bearing from the mounting flange as described in step (11) above.
- (12) 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

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

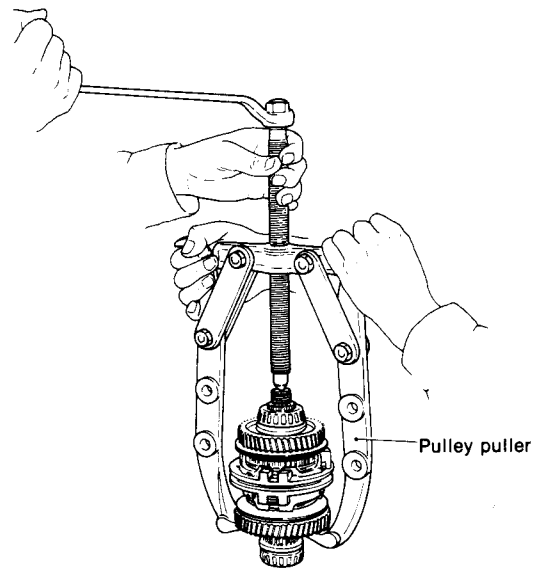
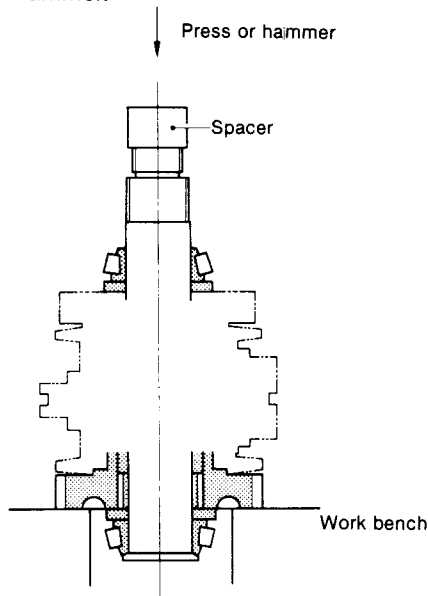
5-2 Disassembling the input shaft

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 vise.

- (5) Remove the adjusting plate.

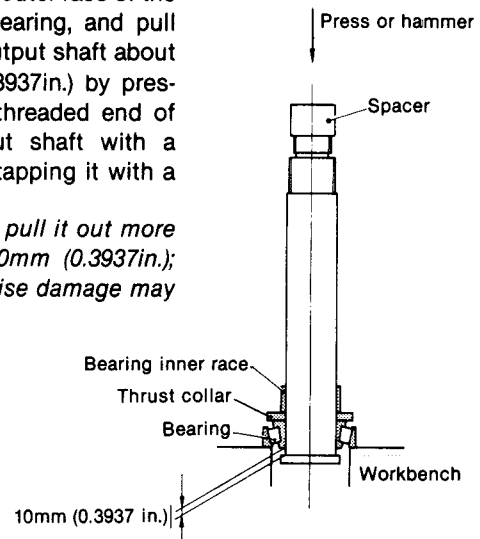
NOTE: Record the thickness of the adjusting plate to facilitate reassembly.

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

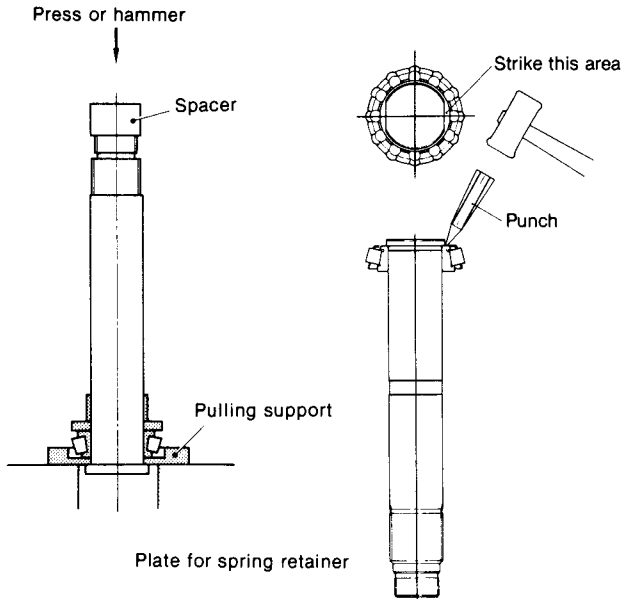
- (6) Remove the spacer and needle bearing.

- (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.

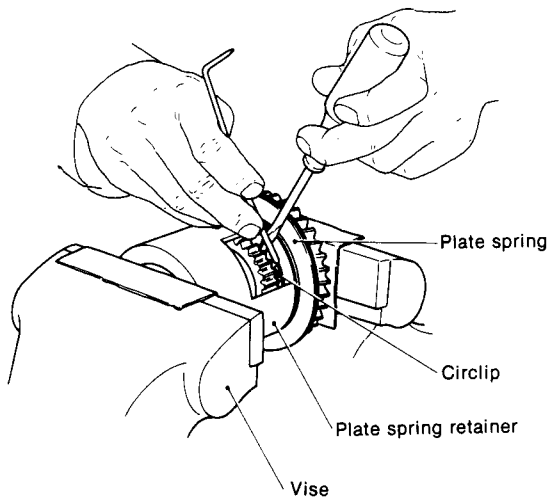
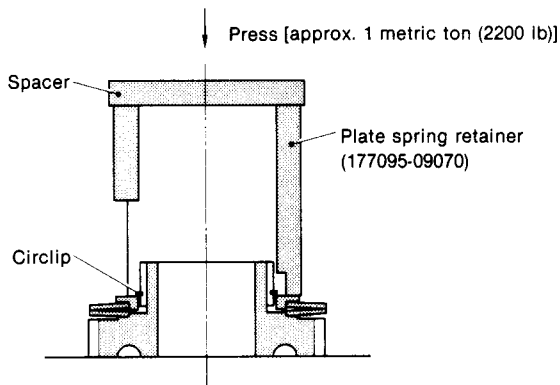
NOTE: Do not pull it out more than 10mm (0.3937in.); otherwise damage may result.



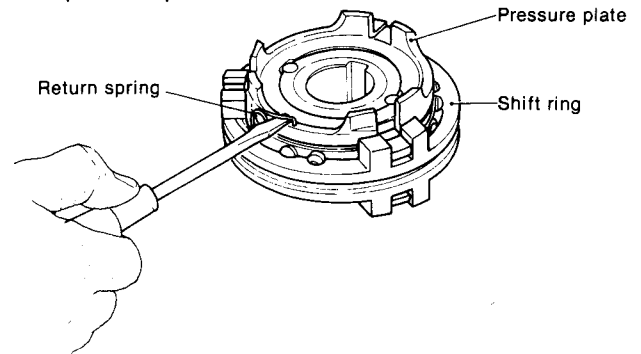
- (8) Insert the disassembly tool between the collar of the output shaft and the bearing; next remove the bearing inner race, thrust collar, and bearing from the output shaft with a press or hammer.



- (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.



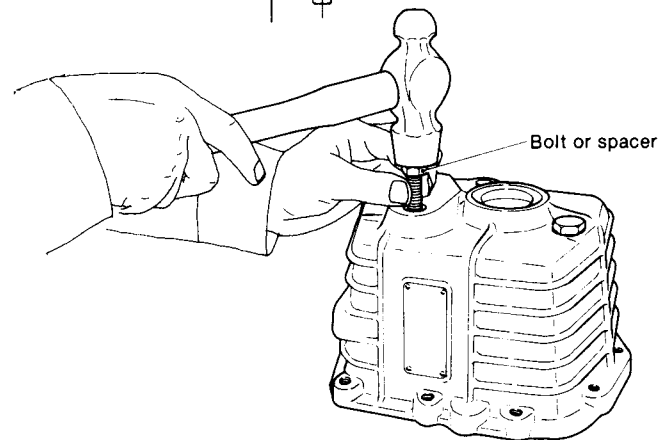
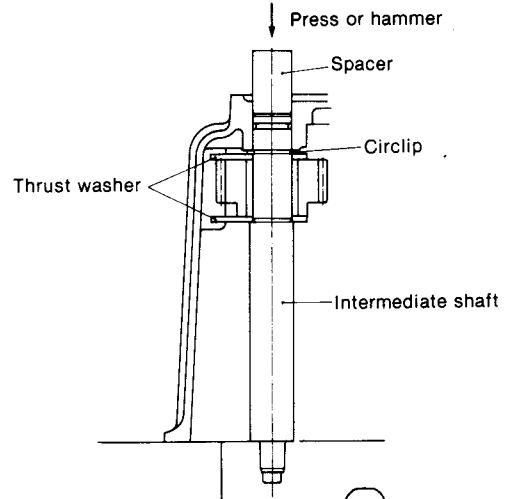
- (11) Remove the retainer and plate spring.
(12) Remove the parts from the reverse large gear as described in steps (9)—(11) above.
(13) Remove the pressure plate return spring; remove the pressure plate and steel ball.



- (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, and then remove the circlip.
- (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.

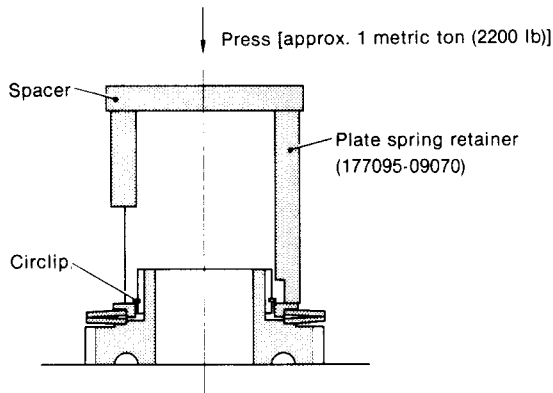
6. Reassembly

6-1 Reassembly precautions

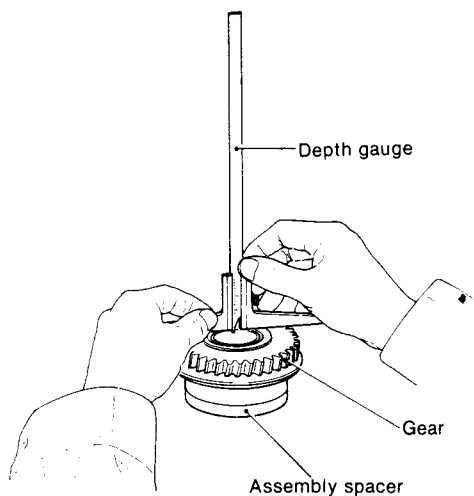
- (1) Before reassembling, clean all parts in washing oil, and replace any damaged or worn parts.
Remove non-dry packing agent from the mating surface with a blunt knife.
- (2) Pack the oil seal and O-ring parts with grease.
- (3) Coat the mating surfaces of the case with wet packing.

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.

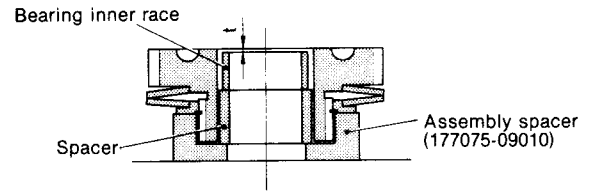


- (2) Reassemble the reverse large gear and plate spring retainer, and circlip as described in step (1) above.
- (3) Determining the forward adjusting plate thickness



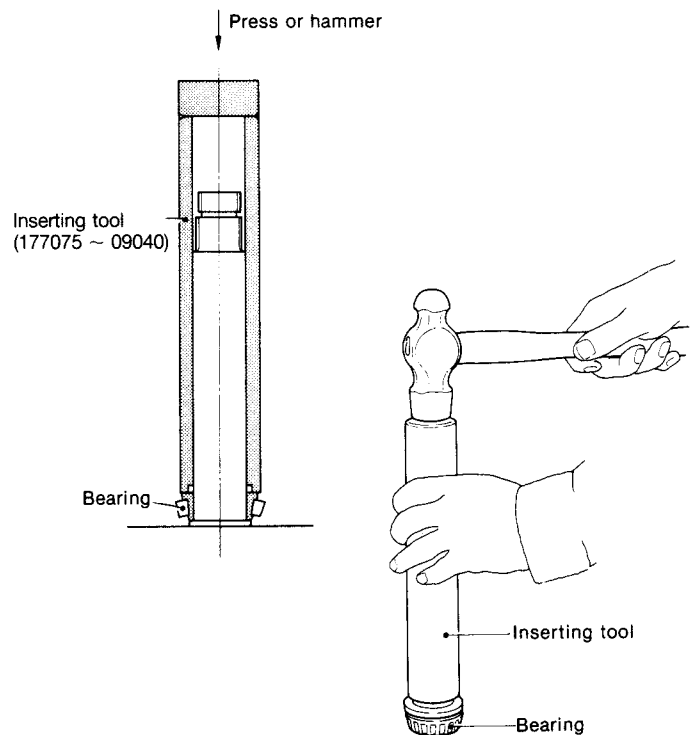
NOTE: As mentioned in section 5-3. (5), if no parts need to be replaced, the adjusting plate can be reused without adjustment.

- 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.

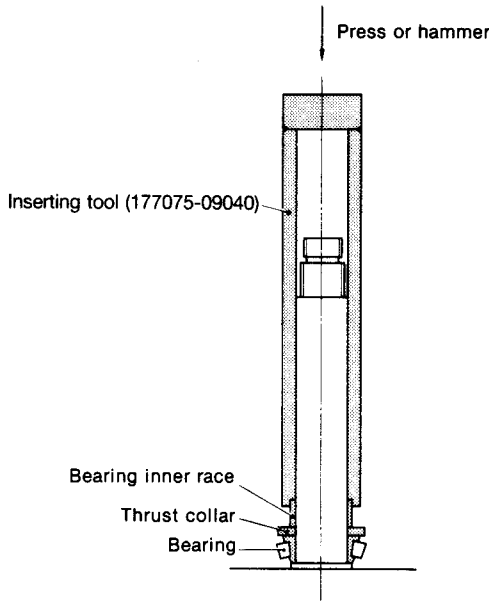


- 2) Three adjustment plates of 0.5mm (0.0196in.), 0.4mm (0.0157in.) and 0.3mm (0.0118in.) are available.
- 3) Measure the "t" dimension. Combine these plates to obtain a dimension from (t-0.5)mm to (t+0.5)mm.
- (4) Determine the thickness of the reverse adjusting plate by following the procedure described 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 (six friction plates and five 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 (six friction plates and five 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.



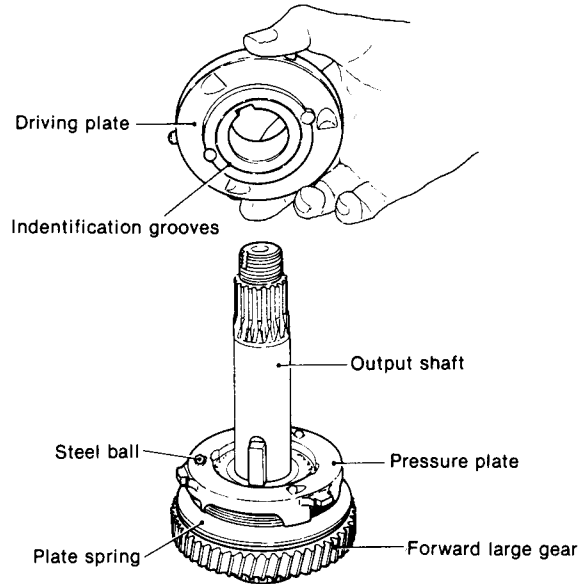
- (8) Insert the thrust collar, with the sintered surface (brown surface) facing the gear side.
- (9) Press the bearing inner race onto the output shaft, using an assembly tool.



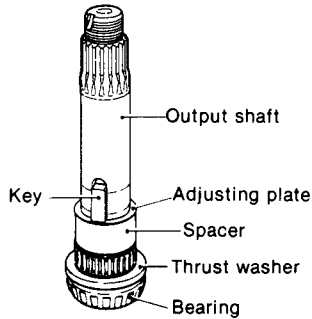
- (16) Insert the drive plate into the output shaft so that the side with the identification groove faces the forward large gear side.

NOTE: Make sure that the three steel balls are in the three grooves of the driving plate.

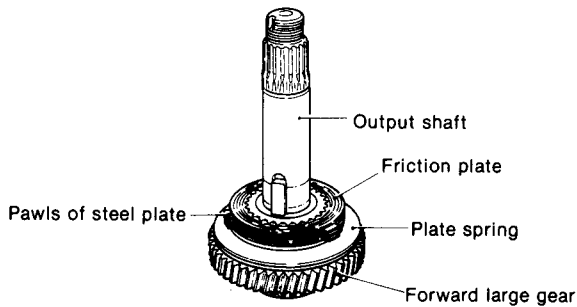
At the same time, make sure that the pin for the driving plate fits into the groove of the torque limiter for the pressure plate.



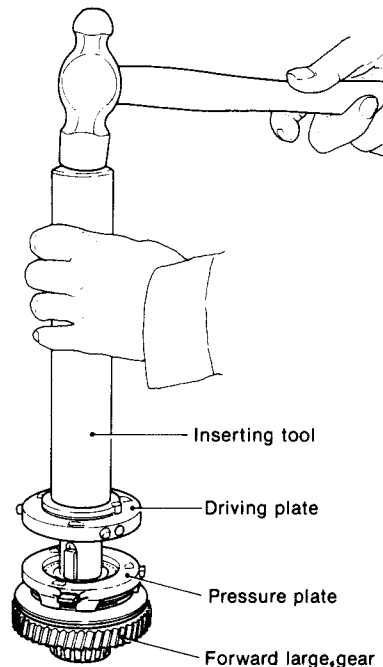
- (10) Insert the needle bearing.
- (11) Insert the spacer and adjusting plate.
- (12) Fit the key so that the fillet side is facing the threaded part of the output shaft.



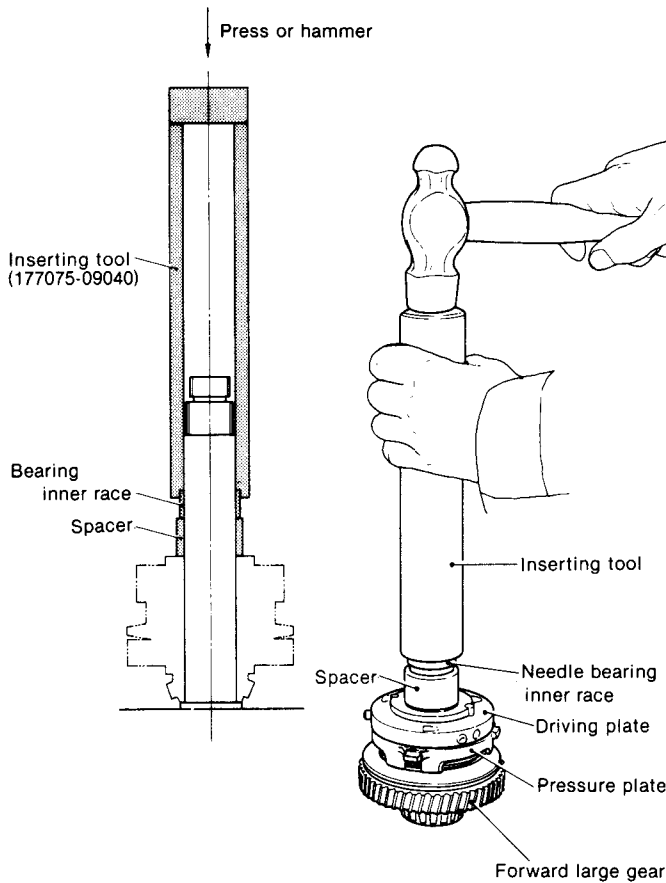
- (13) Insert the forward large gear, together with the friction plates and steel plates. At this time, align the three pawls on the outside of the steel plates.



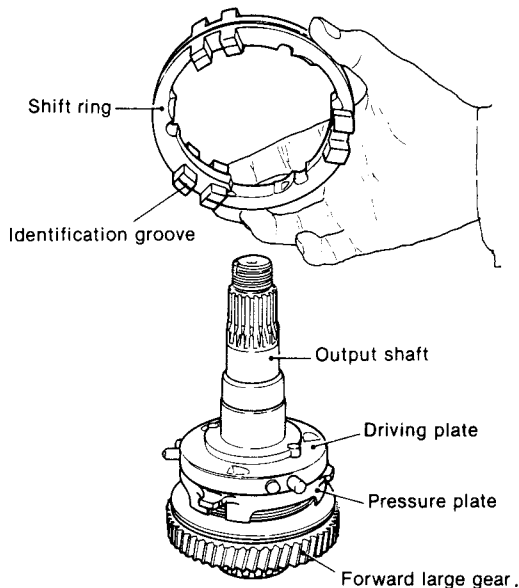
- (14) Cover the friction plates and steel plates with the pressure plate so that the pawls of the steel plate fit into the three notches on the pressure plate.
- (15) Insert the three steel balls into the three grooves in the pressure plate.



- (17) Insert the adjusting plate and spacer.
- (18) Press the bearing inner race, using an assembly tool.

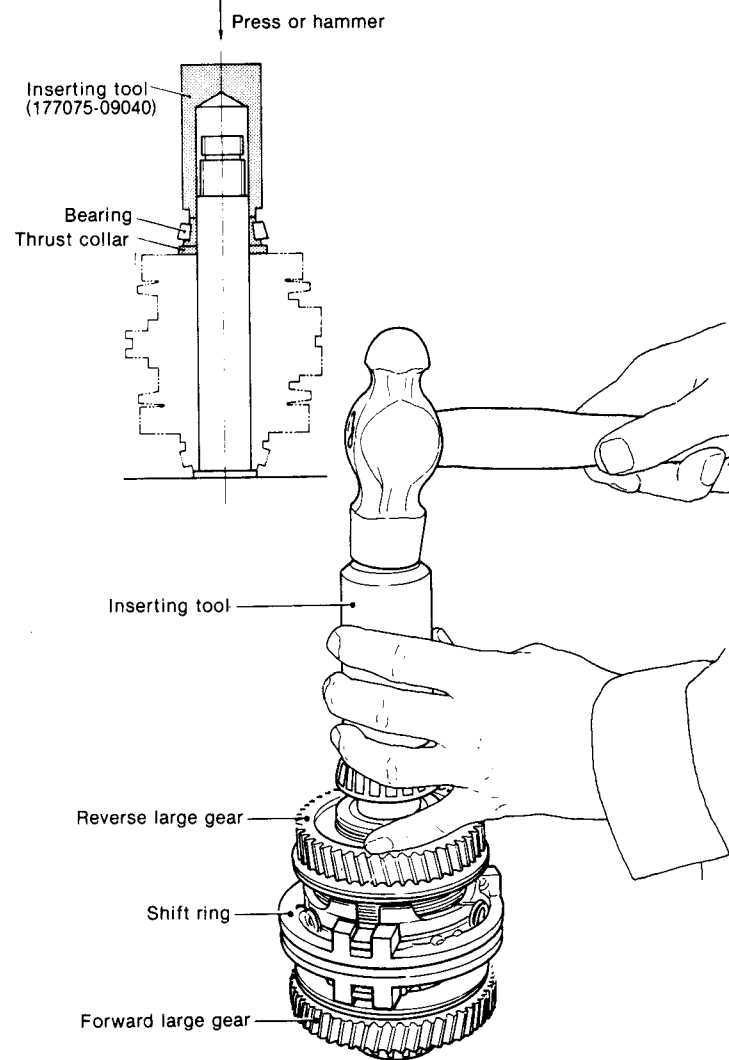


- (19) Insert the knock pins and springs into the three holes around the circumference of the driving plate.
- (20) Cover the driving plate with the shift ring so that the side with the identification groove faces the forward large gear side; install the ring so that the knock pins are pushed in.



- (21) Insert the three steel balls into the three grooves in the driving plate.
- (22) Place the pressure plate onto the driving plate so that the steel balls enter the three grooves of the pressure plate.
- (23) Insert the three pressure plate return springs between the shift ring and the driving plate, and attach them to the small holes in the side of the pressure plate.
- (24) Insert the reverse large gear [see step (6)] so that the three pawls of the steel plates enter the notches around the circumference of the pressure plate.
- (25) Insert the needle bearing.
- (26) Insert the thrust washer so that the sintered side (brown side) faces the gear side.
- (27) Press the inner race of the bearing, using an assembly tool. At this time, make sure that the direction of the bearing is correct.

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



- Insert the O-ring.
- (28) With the shift ring in the reverse position, check the forward large gear to make sure it rotates smoothly. Next, with the shift ring in the forward position, check the reverse large gear to make sure it rotates smoothly.

6-3 Reassembling the input shaft

Press the inner race of the bearing onto the input shaft. At this time, make sure that the direction of the bearing is correct.

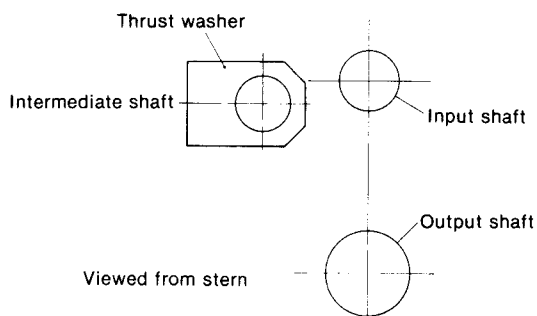
NOTE: The bearing inner race can be easily installed by preheating it to approximately 100°C.

6-4 Reassembling the intermediate shaft

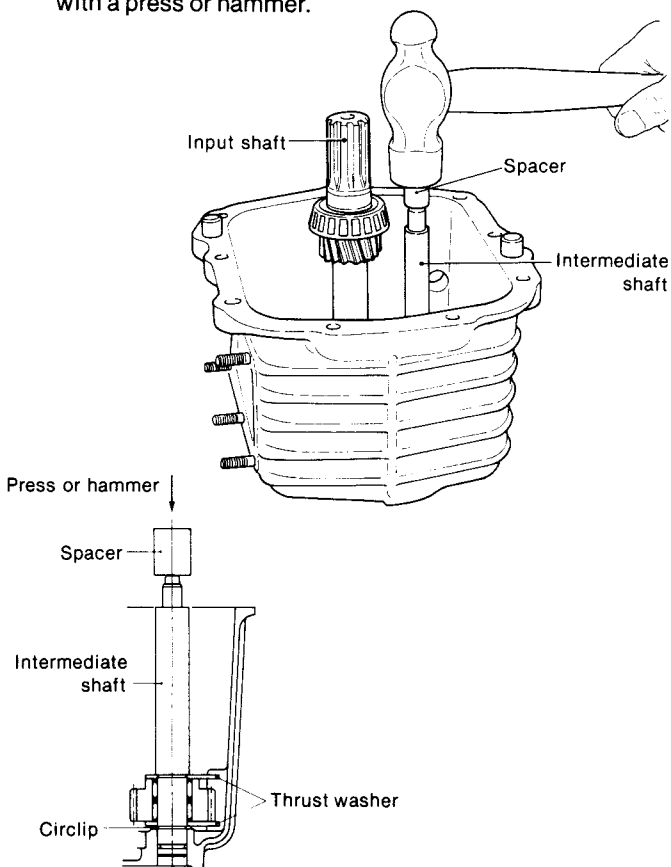
NOTE: Assemble the intermediate shaft as described in section 6-5. (5).

- Insert the thrust washer the needle bearing and idle gear on the intermediate shaft. Then insert the thrust washer.

NOTE: Pay careful attention to the assembling direction of the thrust washer.



- Insert the circlip on the intermediate shaft, and then insert the O-ring.
- Press the assembled intermediate shaft into the case with a press or hammer.



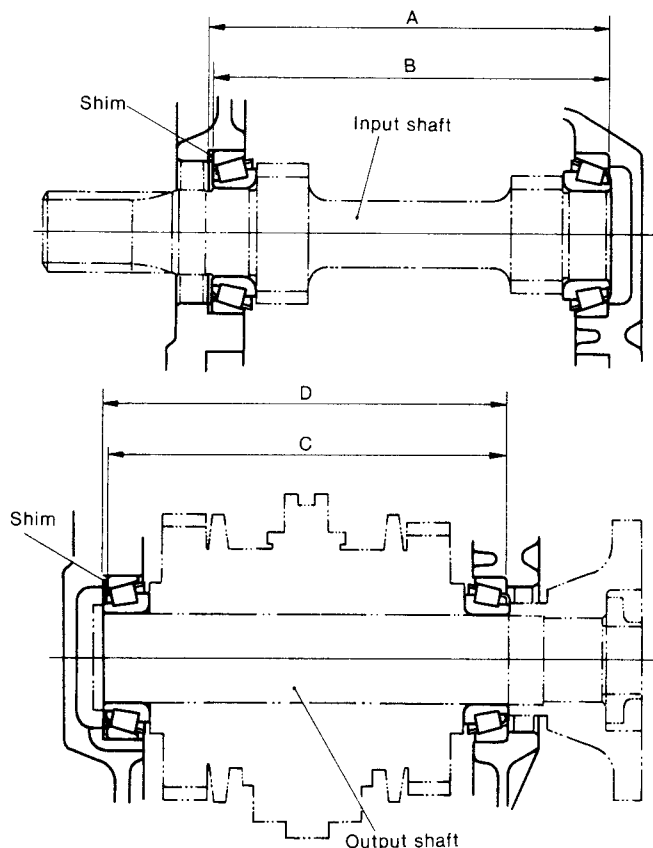
- Make sure that the idle gear rotates smoothly.

6-5 Installing the input shaft and output shaft

- Determining the thickness of the input shaft adjusting plate and output shaft adjusting plate

NOTE: As mentioned in section 5-1. (13), when none of the parts are replaced the adjusting plate can be reused without readjustment.

- Measure length "A" "D" between the cases of each shaft of the case body and mounting flange.
- Cover each bearing with the bearing outer race, and measure length "B" "C" between the bearings.



- Adjust the input shaft adjusting plate thickness so that the clearance or tightening allowance is less than 0.05mm (0.0020in.).
- Adjust the output shaft adjusting plate thickness so that the tightening allowance is within 0 ~ 0.1mm (0~0.0040in.).
- Three adjustment plates of 0.5mm (0.0196in.), 0.4mm (0.0157in.) and 0.3mm (0.0118in.) are available.

Combine these plates to obtain the desired adjusting plate measurement.

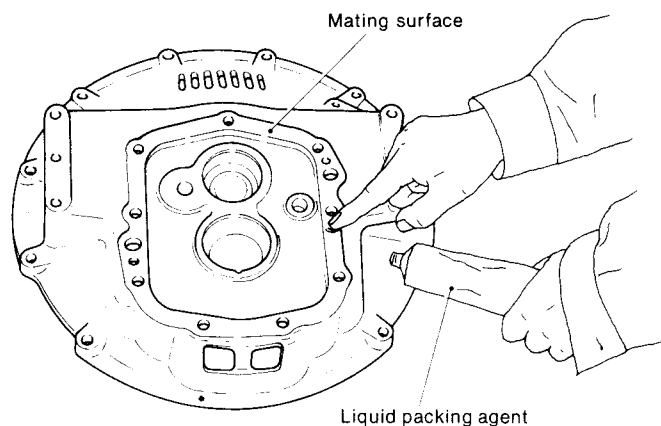
- Insert the adjusting plate into the mounting flange, and press the outer race of the bearing.

Also, press the outer race of the bearing into the case.

NOTE: The outer race can be installed easily by heating the mounting flange and case to approximately 100°C, or by cooling the bearing outer race with liquid nitrogen, etc.

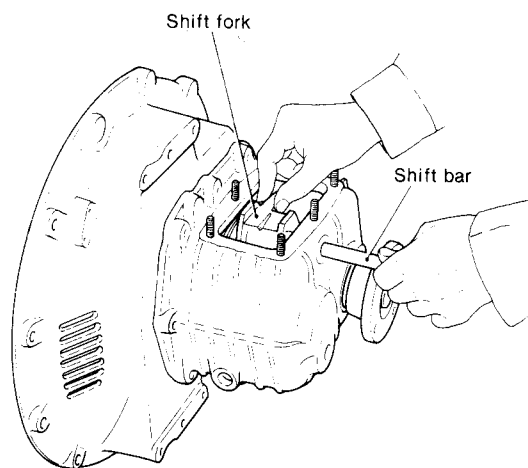
- Coat the circumference of the oil seal with a liquid packing agent, and press it onto the mounting flange and case so that the spring part of the oil seal is inside the case.

- (4) Coat the mating surfaces of the mounting flange and case with a liquid packing agent.
Wipe off oil and dirt on the mating surface of the case and coat with a thin film of liquid packing agent.

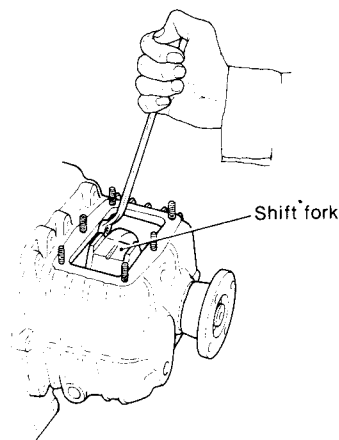


- (5) Insert the input shaft into the case, assemble the intermediate shaft as described in section 6-4 and then insert the output shaft into the case, mounted with shift fork and shift ring.
(6) Align the mounting flange with the case, and insert the parallel pin by tapping the mounting flange with a plastic hammer.
(7) Insert the super lock washer and tighten the M10 bolt.
(8) Install the dipstick and packing.
(9) Install the drain plug and packing.

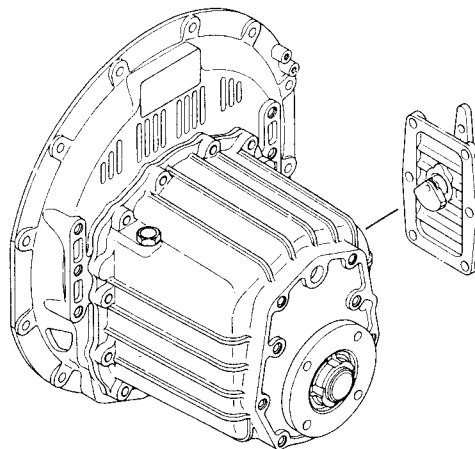
6-6 Reassembling and installing the operating system



- (1) Put the shift fork into neutral before installing.



- (3) Coat the circumference of the oil seal with a liquid packing agent and press the seal against the case cover.
(4) Insert the spring into the shift cam.
(5) Insert the knock pin into the shift cam from the front end, and lock with the circlip.
(6) Insert the assembled shift cam into the case cover.



- (7) Fit the shift lever to the shift cam, and tighten the M8 bolt.

NOTE: The shift cam must rotate smoothly.

- (8) Replace the packing if it is damaged.
(9) Attach the case side cover with operating system in the case body.

At this time, make sure that the shift cam is fitted to the shift fork, and that the shift lever is in neutral.

NOTE: Put the shift fork into neutral before installing.

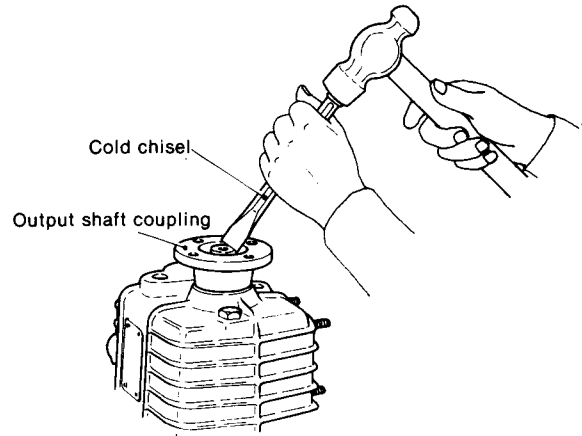
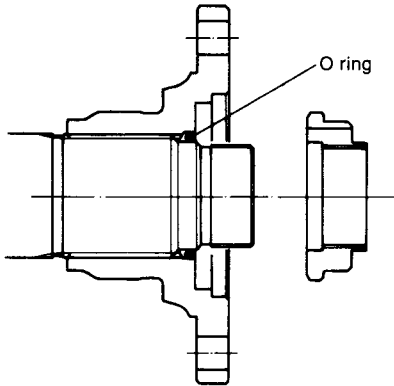
- (10) Insert the super lock washer, and tighten the M8 nut.
(11) Shift the shift lever to forward and reverse to make sure that the lever operates normally.

If the lever does not operate normally, loosen the M8 nut, slide the case side cover forward, backward, and to the left and right, then re-tighten with the M8 nut in the position at which the lever operates normally.

NOTE: If the lever operates normally a click will be heard when it is put into forward and reverse.

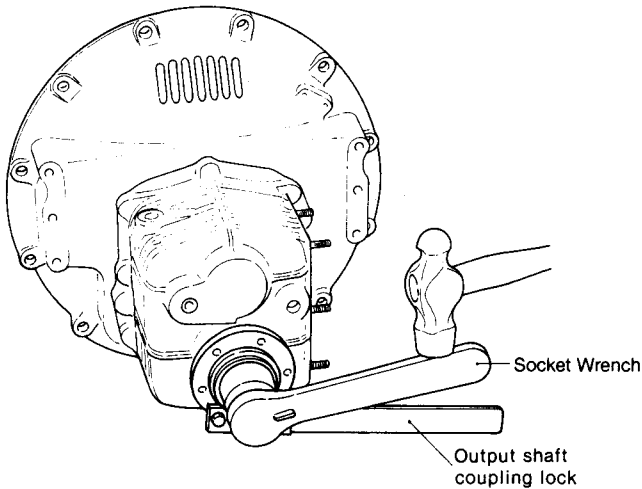
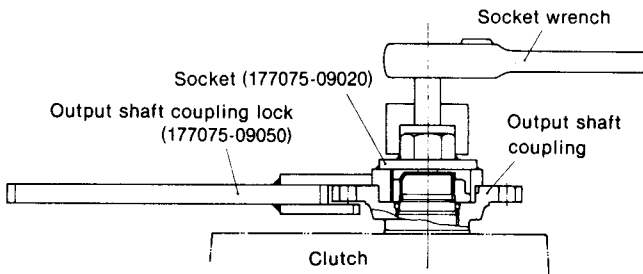
6-7 Installing the output shaft coupling

- (1) Install the output shaft coupling on the output shaft and then insert the O-ring in the groove between the output shaft and the output shaft coupling.

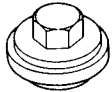
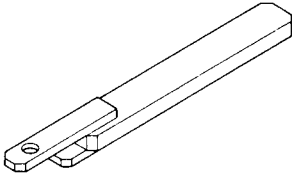
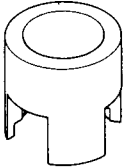
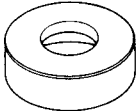




- (2) Tighten and caulk the output shaft lock nut, using the assembly tool.
Tightening torque.....15kg-m (108.5ft-lb)

- (3) Shift the shift lever to the neutral position and make sure the clutch engages when the shift lever is put into forward and reverse.
The input/output shafts will not rotate smoothly if the side gap of the bearing is too small in relation to the thickness of the adjusting plate.



7. Special Tools

Name of tool	Part number	Illustration	Application
Socket	177075-09020		For removing and tightening the output shaft nuts.
Output shaft coupling lock	177075-09050		For removing and tightening the output shaft nut.
Plate for spring retainer	177095-09070		For removing and installing the plate spring, retainer and circlip of the large gear (forward and reverse).
Assembly spacer	177075-09010		For determining the thickness of adjusting plate.
Inserting tool	177075-09040		For installing the spacer and needle bearing inner race of the output shaft (reverse small gear side).
Inserting tool	177075-09030		For installing the thrust bearing of the input shaft.