CHAPTER 7

REDUCTION AND REVERSING GEAR

Marine gear model KBW 20 and 21

1. Construction. 7-1
2. Installation. 7-6
3. Operation and Maintenance 7-7
4. Inspection and Servicing 7-8
5. Disassembly 7-13
6. Reassembly 7-17
7. Special Tools 7-23

Marine gear model KM4A, (Angle drive)

1. Construction. 7-24
2. Shifting Device 7-28
3. Inspection and Servicing 7-33
4. Special Tools 7-43
5. Disassembly 7-45
6. Reassembly 7-53

Printed in Japan
0000A0A1647

1. Construction

1-1 Construction

The Kanzaki-Carl Hurth KBW20 and KBW21 reduction reversing gears. were developed jointry 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

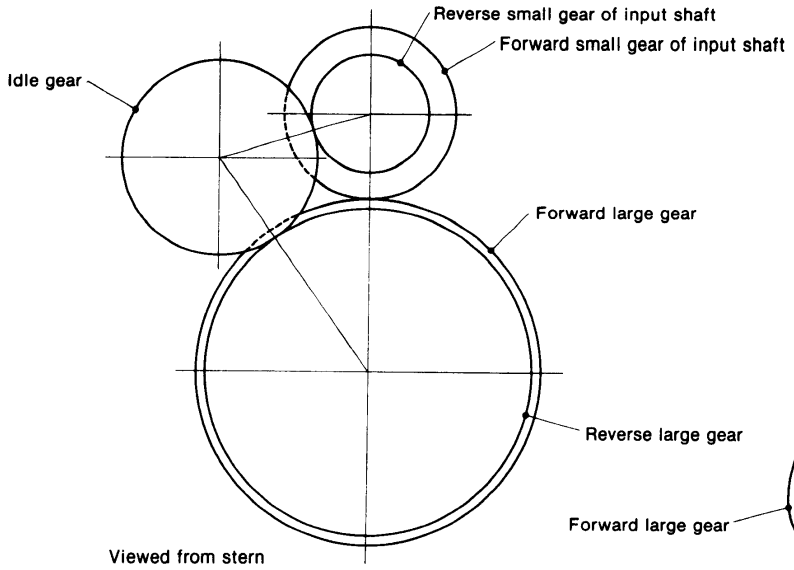
Engine model			4JHE			4JH-TE			
Marine gear model			KBW20						
Reduction system			One-stage reduction, helical gear						
Reversing system			Constant mesh gear						
Clutch			Wet type multi-disc, mechanically operated						
Reduction ratio	Forward		2.17	2.62	3.28	2.17	2.62	3.28	
	Reverse		3.06			3.06			
Diection 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						

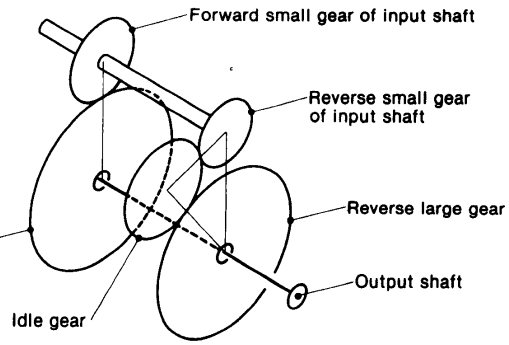
Engine model			4JH-HTE			4JH-DTE		
Marine gear model			KBW21					
Reduction system			One-stage reduction, helical gear					
Reversing system			Constant mesh gear					
Clutch system			Wet type multi-disc, mechanically operated					
Reduction ratio	Forward		2.17	2.62	3.28	2.17	2.62	
	Reverse		3.06			3.06		
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.

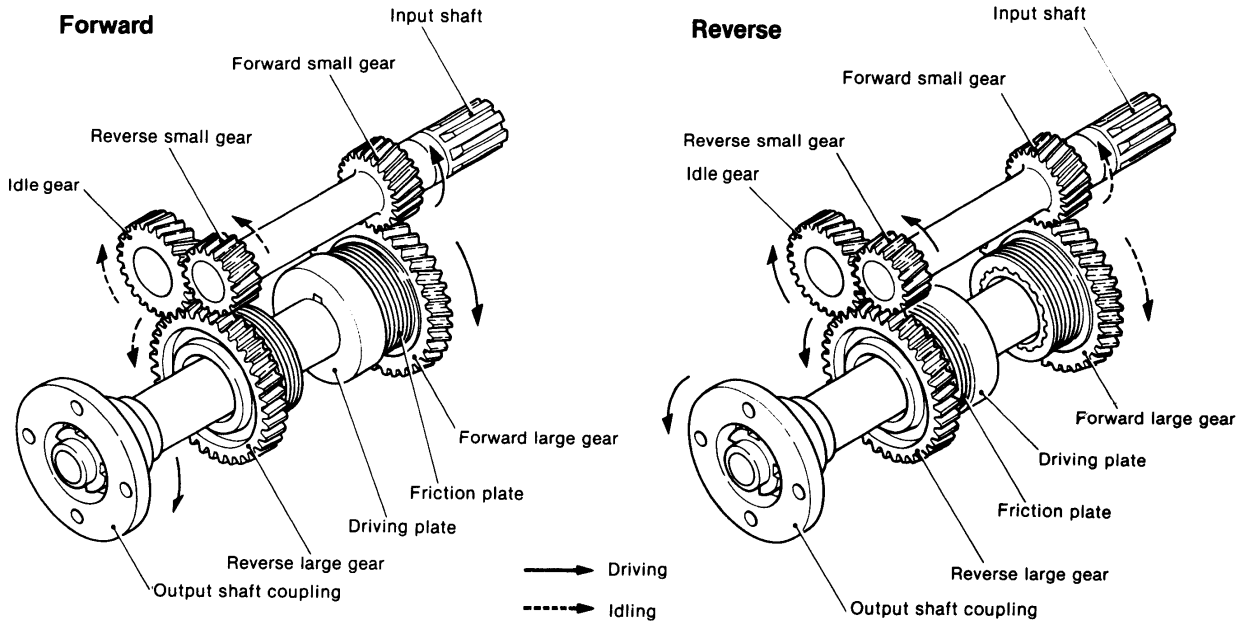
Accordingly, KBW21 can be used both for models 4JHE and 4JH-TE, however, KBW20 cannot be used for models 4JH-HTE and 4JH-DTE since KBW20 is not durable enough for these engine models.

1-3 Power transmission system



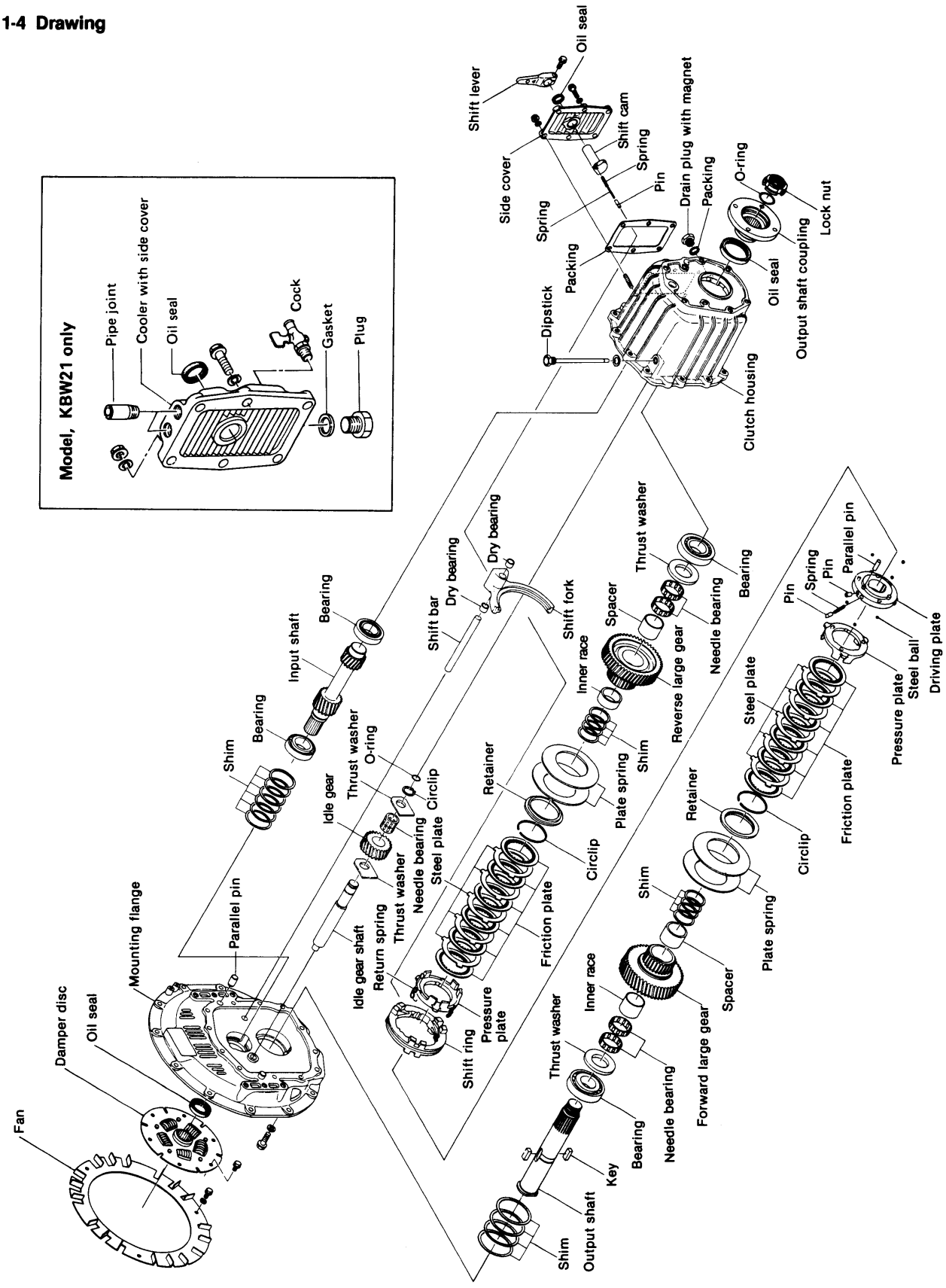


Forward			Reverse			
Number of teeth		Reduction ratio	Number of teeth			Reduction ratio
Forward small gear of input shaft	Forward large gear		Reverse small gear of input shaft	Idle gear	Reverse large gear	
24	52	52/24 = 2.17	18	25	55	55/18 = 3.06
21	55	55/21 = 2.62				
18	59	59/18 = 3.28				



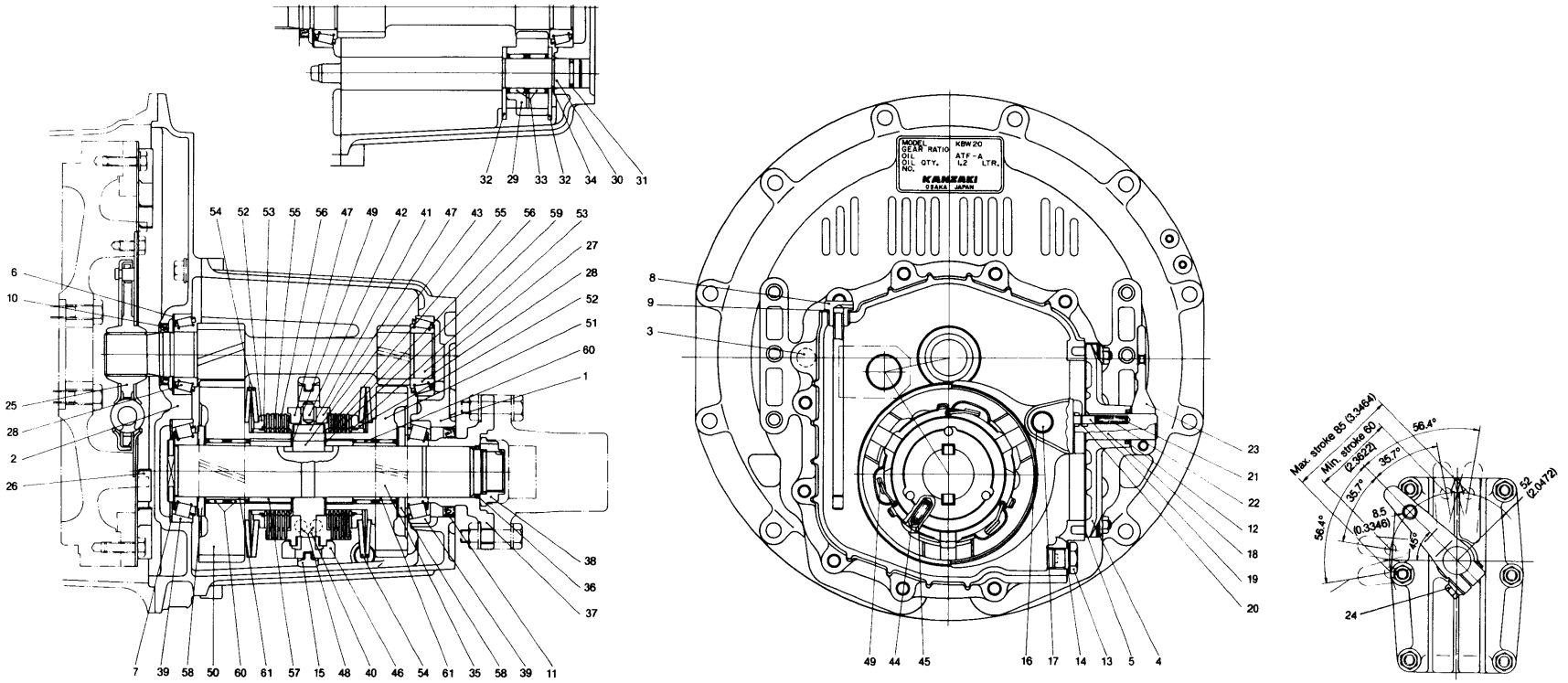
Printed in Japan
0000A0A1647

1-4 Drawing



1-5 Cross section

Model: KBW20



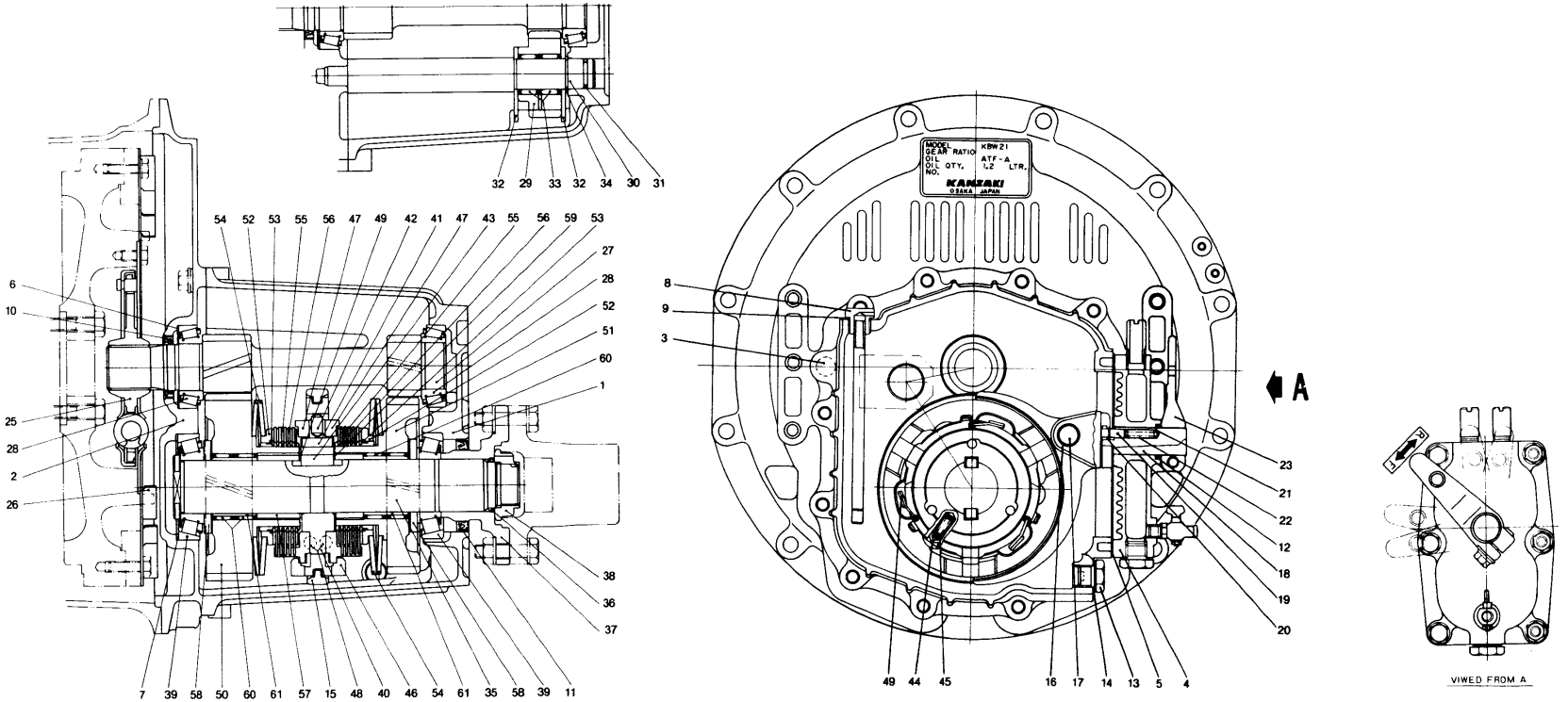
1. Clutch housing
2. Mounting flange
3. Parallel pin
4. Side cover
5. Packing
6. Shim (input shaft)
7. Shim (output shaft)
8. Dipstic
9. Packing
10. Oil seal (input shaft)
11. Oil seal (output shaft)
12. Oil seal (shift cam)
13. Plug
14. Packing
15. Shift fork
16. Dry bearing
17. Shift bar
18. Shift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

Printed in Japan
00000A0A1647

Printed in Japan
0000A0A1647

Cross section

Model: KBW21



1. Clutch housing
2. Mounting flange
3. Parallel pin
4. Side cover
5. Packing
6. Shim (input shaft)
7. Shim (output shaft)
8. Dipstic
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. Dry 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. Imput shaft
28. Roller bearing
29. Idle gear
30. Idle gear shaft
31. O-ring
32. Thrust washer
33. Needle bearing
34. Circlip
35. Output shaft
36. O-ring
37. Output shaft coupling
38. Lock nut
39. Roller bearing
40. Driving plate
41. Parallel pin
42. Parallel pin
43. Key
44. Pin
45. Spring
46. Shift ring
47. Pressure plate
48. Steel ball
49. Return spring
50. Forward gear
51. Reverse gear
52. Retainer
53. Circlip
54. Plate spring
55. Friction disc
56. Steel plate
57. Spacer
58. Thrust washer
59. Shim (output shaft)
60. Needle bearing
61. Inner race

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.

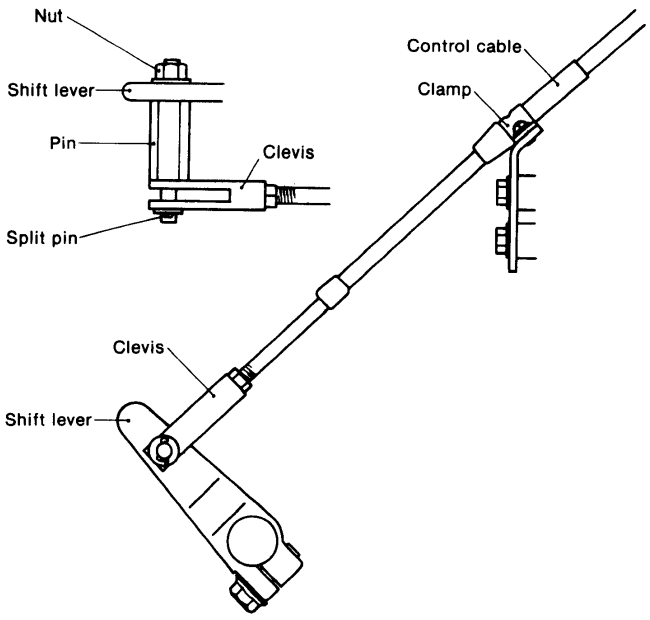
2-2 Remote control unit

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.

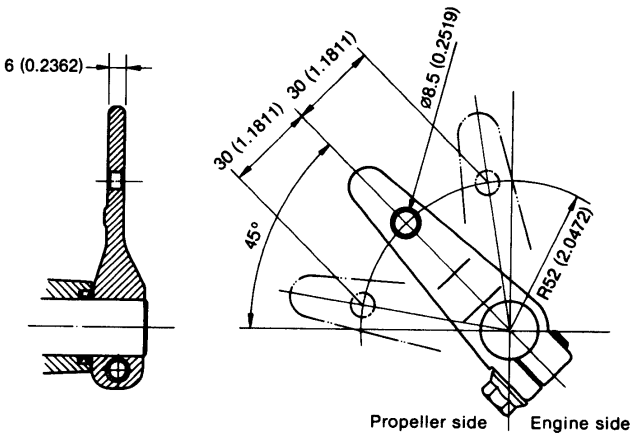
The shift play, measured at the pivot point of the shift lever, must be at least 30mm (1.1811in.) on each side (reverse and forward) of the neutral position. Greater shift play has no adverse effect on the marine gearbox. After connecting the linkage, confirm that the remote control and the shift lever 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 (1.1811in.)

mm(in.)



Side view of clutch

2-3 Clutch operation force (reference value)

Operation position / Operation direction	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)	

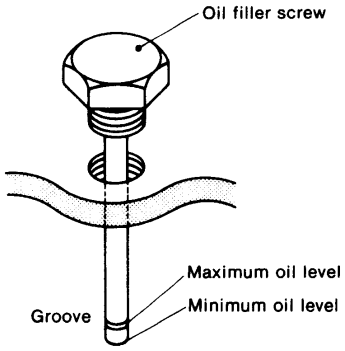
Printed in Japan
0000A0A1647

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. 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.

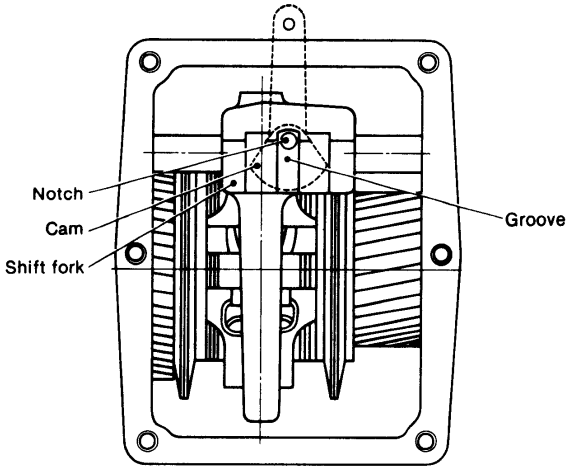
3-3 Side cover

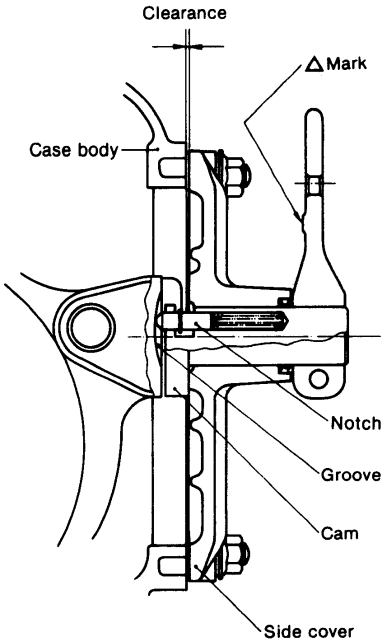
The internal shifting mechanism has been carefully aligned at the factory. Improper removal of the side cover can cause misalignment. If the side cover must be removed, proceed as follows:

—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. 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.





Printed in Japan
0000A0A1647

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.

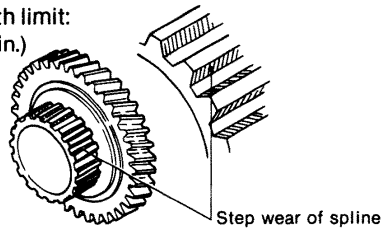
(2) Tooth surface contact
Check the tooth surface contact. The amount of tooth surface contact between the tooth crest and tooth flank must be at least 70% of the tooth width.

(3) Backlash
Measure the backlash of each gear, and replace the gear when it is worn beyond the wear limit.

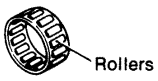
mm (in.)

	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.)



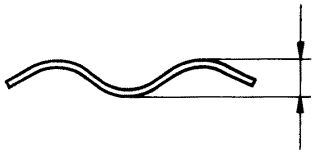
(5) Forward/reverse gear needle bearing
When an abnormal sound is produced at the needle bearing, visually inspect the rollers; replace the bearing if the rollers are faulty.



4-4 Steel plate

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

(2) Warping measurement

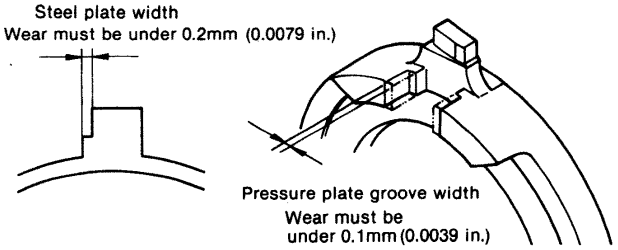


mm (in.)

	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.)

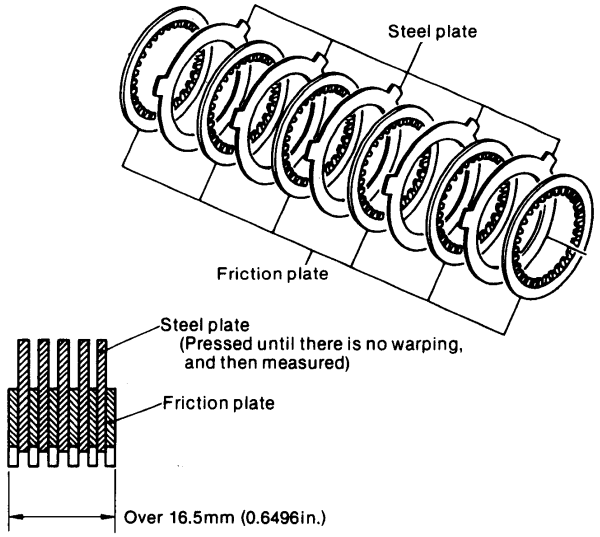
	Standard	Wear limit
Steel plate width	11.8 ~ 12.0 (0.4645 ~ 0.4724)	Worn 0.2 (0.0078)
Pressure plate groove	12.0 ~ 12.1 (0.4724 ~ 0.4763)	Worn 0.1 (0.0039)
Clearance	0 ~ 0.3 (0 ~ 0.0118)	0.3 ~ 0.6 (0.0118 ~ 0.0236)

Printed in Japan
0000A0A1647

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.).

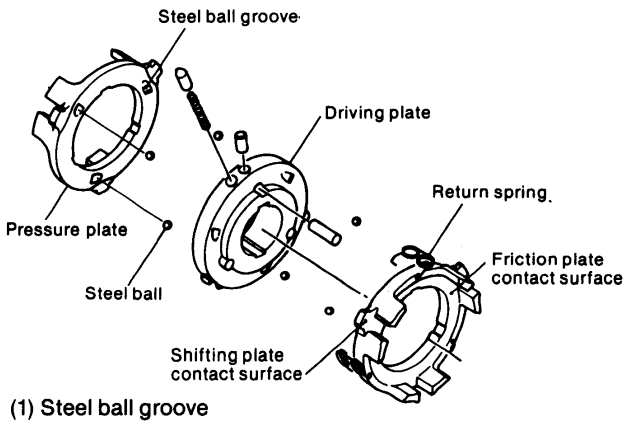
Both sides of the friction plate have a 0.35mm (0.0138in.) copper sintered layer. Replace the friction plate when this layer is worn more than 0.2mm (0.0079in.) on one side (standard thickness 1.65 ~ 1.70 (0.0650 ~ 0.0670in.)). However, the sum of the wear of the six friction plates must not exceed 1.2mm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

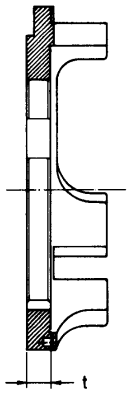


(1) Steel ball groove
Check the steel ball groove for stains and wear.
Replace the pressure plate if the groove is noticeably worn.

(2) Friction plate contact surface
Check the contact face for stains and damage.

(3) Shifting plate contact surface

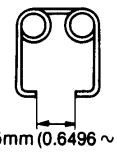
(4) Worn parts measurement



mm (in.)

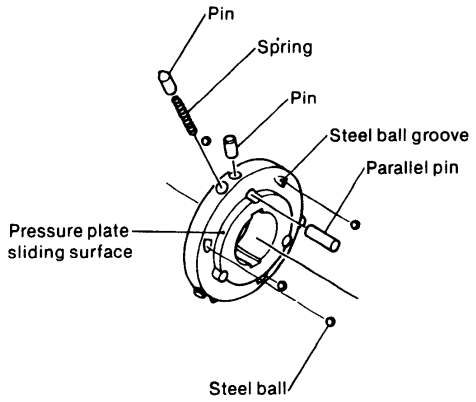
	Standard	Wear limit
Thickness: t	8.0 ~ 8.1 (0.3149 ~ 0.3188)	7.9 (0.3110)

(5) Return spring permanent strain.
Make sure the length (free length) is within the values specified in the figure.

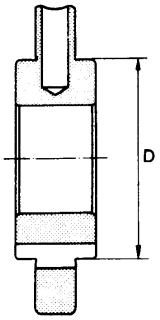


Printed in Japan
0000A0A1647

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.

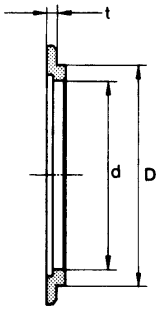
mm (in.)

	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

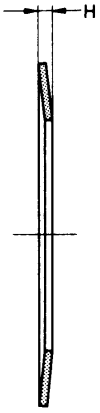


mm (in.)

	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.)

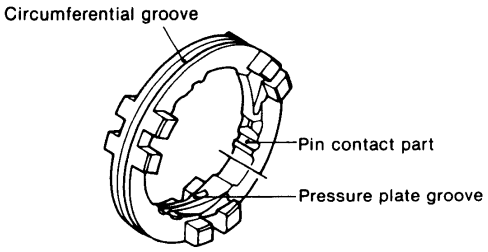
	Standard	Wear limit
H: when plate spring is free	7.2 ~ 7.6 (0.2834 ~ 0.2992)	7.05 (0.2775)

4-10 Thrust collar

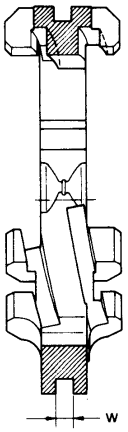
The gear side of the thrust washer has a 0.3mm (0.0118in.) copper sintered layer. Replace the thrust collar when the thickness is less than 5.75mm (0.2263in.) (Standard thickness: 5.9 ~ 6.0mm (0.2322 ~ 0.2362).

Printed in Japan
0000A0A1647

4-11 Shift ring



(1) Circumferential groove wear.



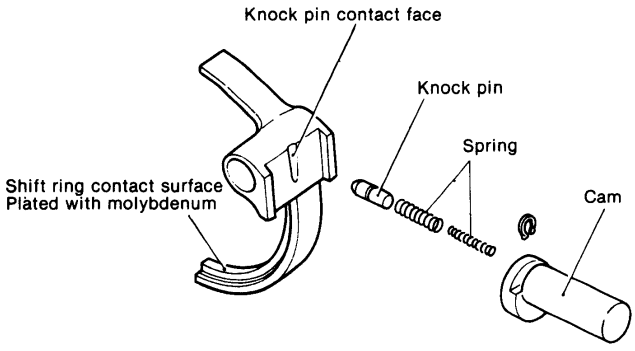
mm (in.)

	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



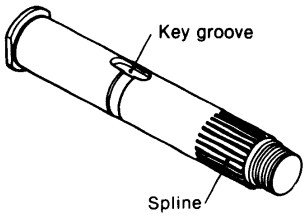
(1) End wear.
The shift ring contact surface of the shift fork is plated with molybdenum (thickness: 0.04 ~ 0.05mm (0.0016 ~ 0.0020in.)). If this plating is peeled or worn to such an extent that the base metal of the shift fork is exposed, replace the shift fork.

(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.

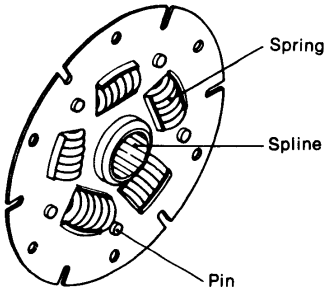
(4) Notch end wear.
Whenever uneven wear and/or scratches are found, replace with a new part.

4-13 Output shaft



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

4-14 Damper disc



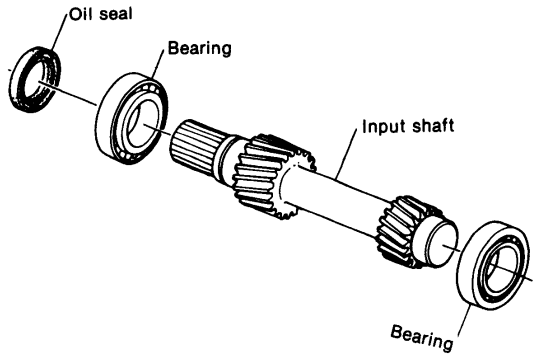
(1) Spline part
Whenever uneven wear and/or scratches are found, replace with a new part.

(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.

Printed in Japan
0000A0A1647

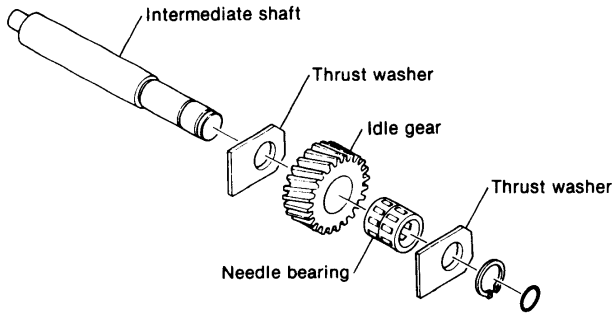
4-15 Input shaft



(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.

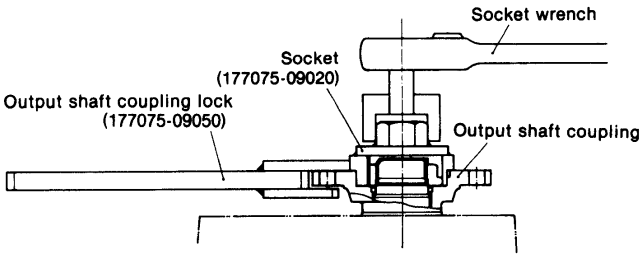
Printed in Japan
0000A0A1647

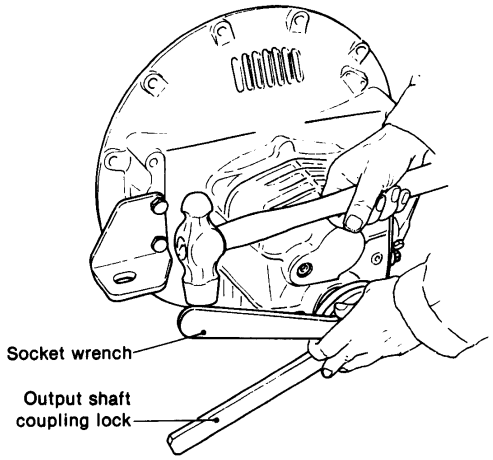
5. Disassembly

5-1 Disassembling the clutch and accessories

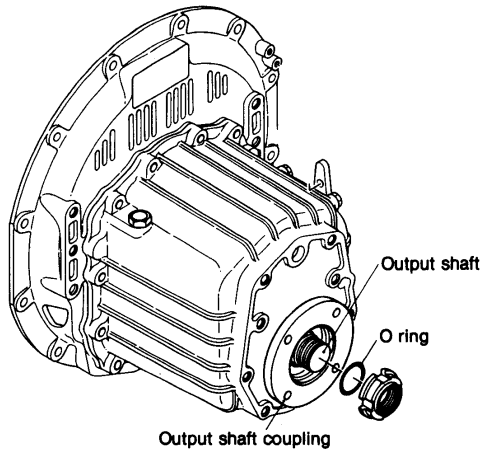
(1) Remove the drain plug and packing, and drain the oil from the clutch.

(2) Uncaulk the output shaft lock nut, and remove the nut using a disassembly tool.



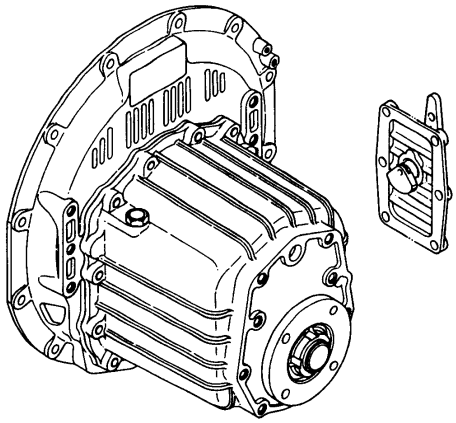


(3) Remove the output coupling with O-ring.



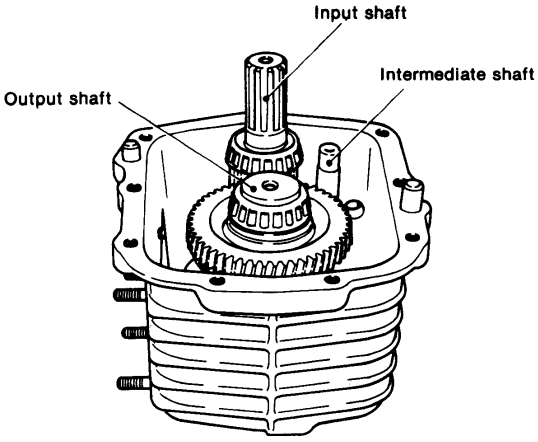
(4) Remove the dipstick and packing.

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



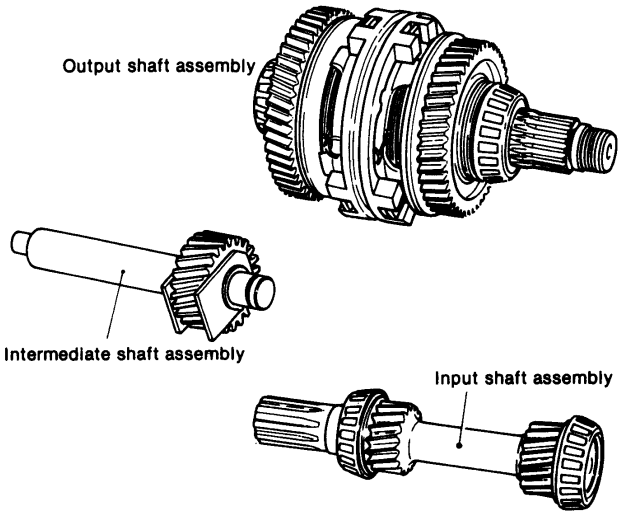
(6) Remove the M10 bolt and super lock washer on the mounting flange.

(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.



Printed in Japan
0000A0A1647

(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.

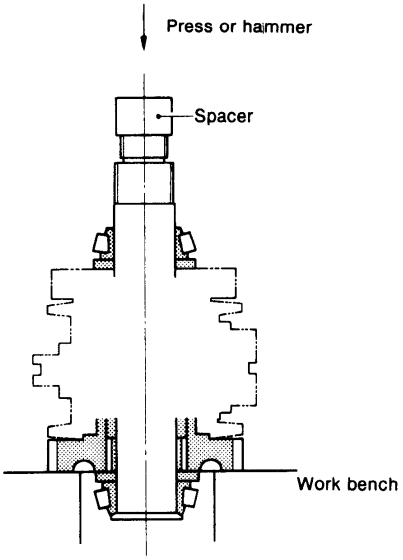
5-2 Disassembling the input shaft

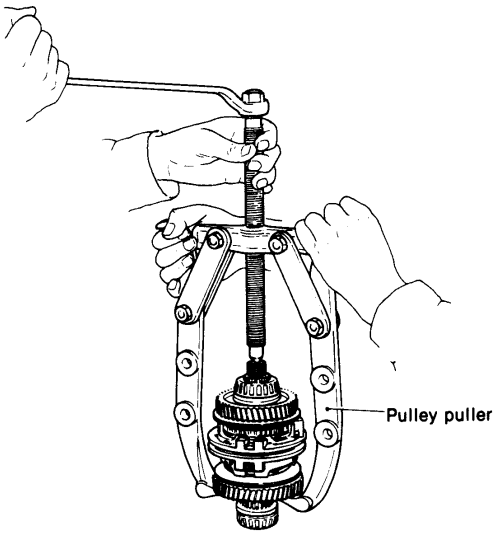
Pull the bearing from the input shaft.

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.

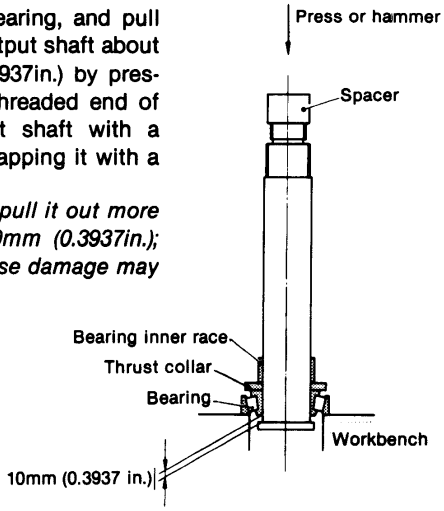
NOTE: Record the thickness of the adjusting plate to facilitate reassembly.
If the parts are not replaced, the adjusting plate may be reused without readjustment. However, if even one part is replaced, readjustment is required.

(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.

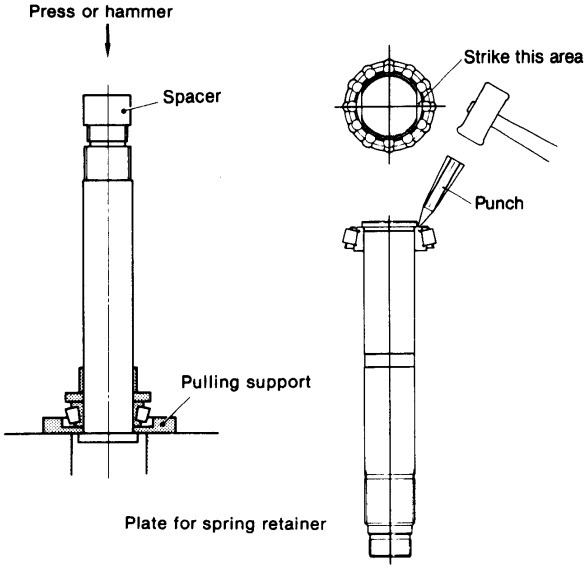
(6) Remove the spacer and needle bearing.
(7) Cover the outer race of the forward bearing, and pull out the output shaft about 10mm (0.3937in.) by pressing the threaded end of the output shaft with a press, or tapping it with a hammer.

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



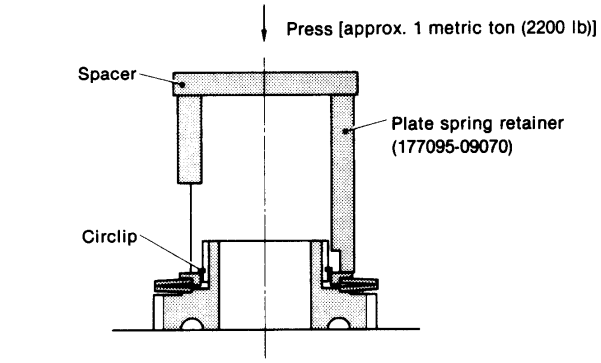
Printed in Japan
0000A0A1647

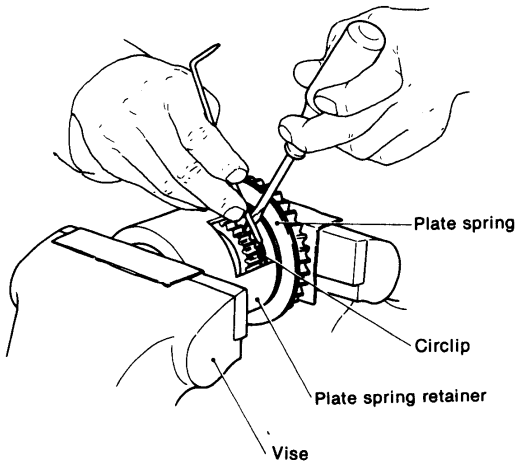
(8) Insert the disassembly tool between the collar of the output shaft and the bearing; next remove the bearing inner race, thrust collar, and bearing from the output shaft with a press or hammer.



(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.

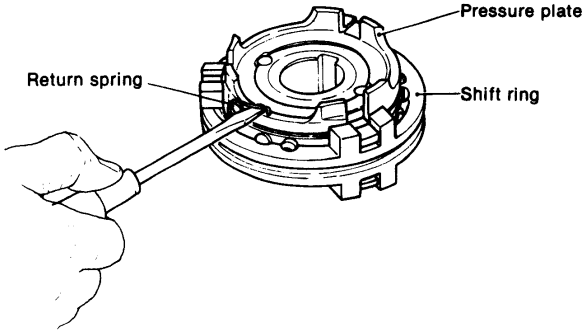




(11) Remove the retainer and plate spring.

(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.

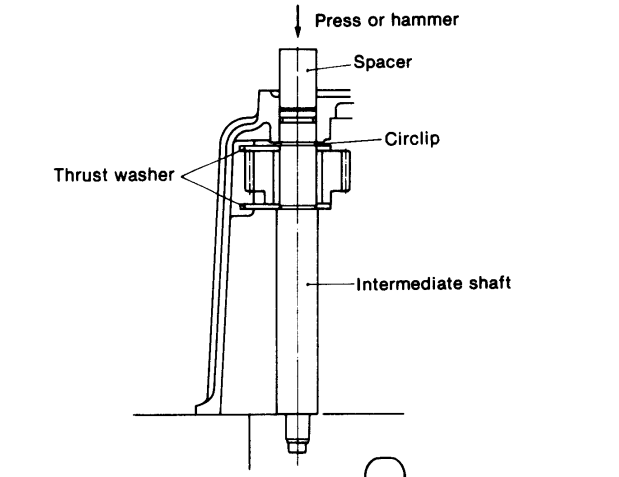


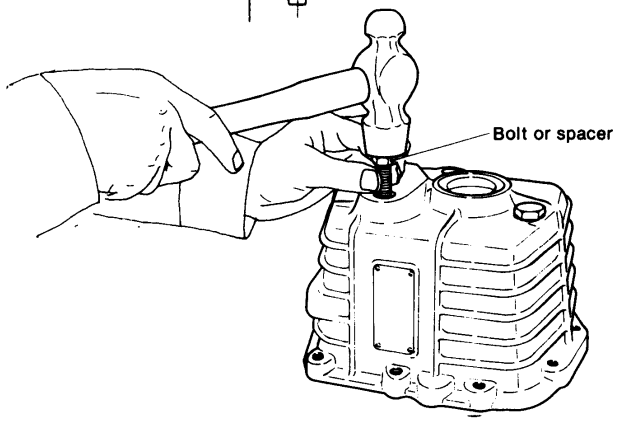
(14) Remove the shift ring.
To disassemble, remove the three knock pins. When disassembling the shift ring, cover it with a cloth to prevent it being lost.

(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.





Printed in Japan
0000A0A1647

(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.

Printed in Japan
0000A0A1647

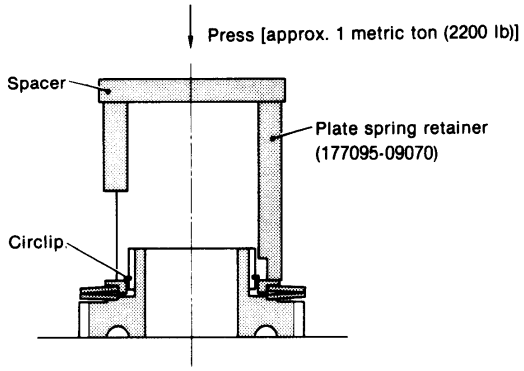
6. Reassembly

6-1 Reassembly precautions

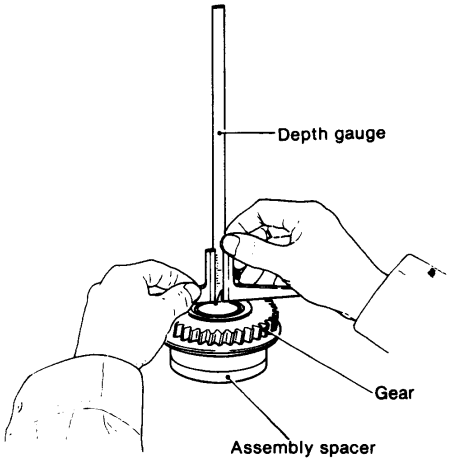
(1) Before reassembling, clean all parts in washing oil, and replace any damaged or worn parts.
Remove non-dry packing agent from the mating surface with a blunt knife.
(2) Pack the oil seal and O-ring parts with grease.
(3) Coat the mating surfaces of the case with wet packing.

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.

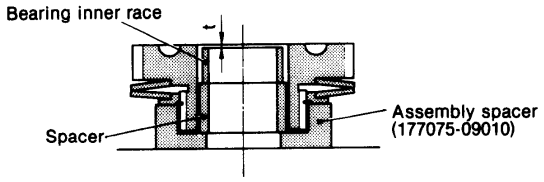


(2) Reassemble the reverse large gear and plate spring retainer, and circlip as described in step (1) above.
(3) Determining the forward adjusting plate thickness



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

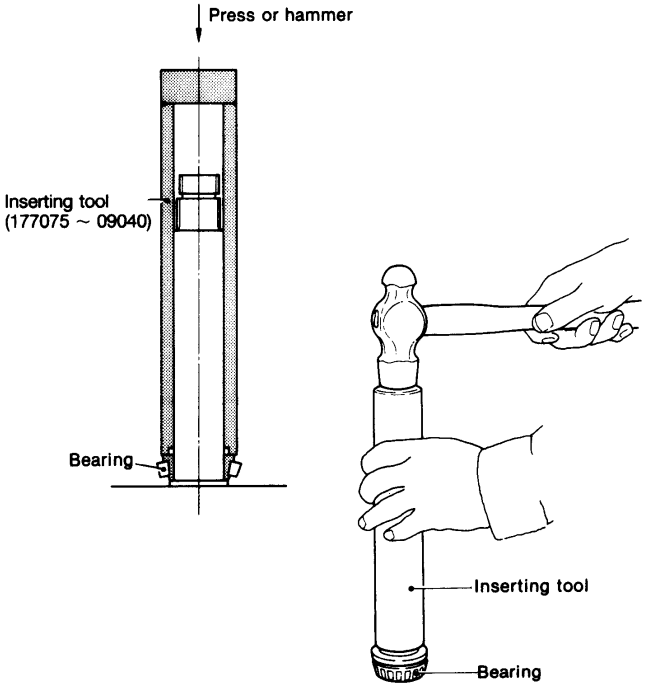
1) Position the assembled large gear on the assembly tool so that the spline part is on the bottom; insert the spacer and bearing inner race into the gear.



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.

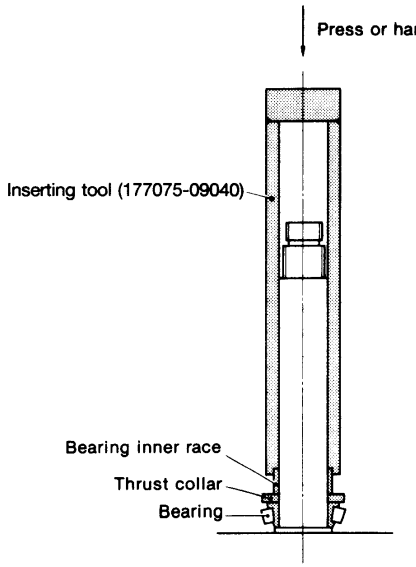
(4) Determine the thickness of the reverse adjusting plate by following the procedure described in step(3)above.
(5) First, insert a friction plate into the spline part of the forward large gear; next insert steel plates and friction plates alternately. Finally, insert a friction plate (six friction 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.

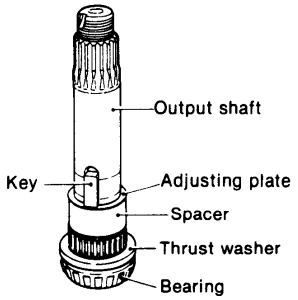


Printed in Japan
0000A0A1647

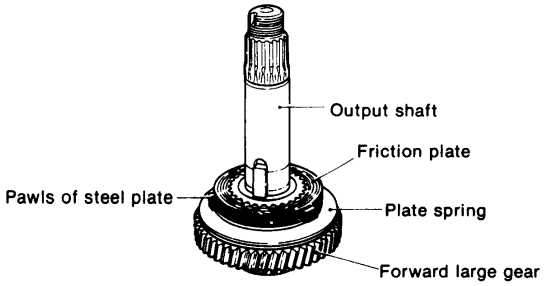
(8) Insert the thrust collar, with the sintered surface (brown surface) facing the gear side.
(9) Press the bearing inner race onto the output shaft, using an assembly tool.



(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.



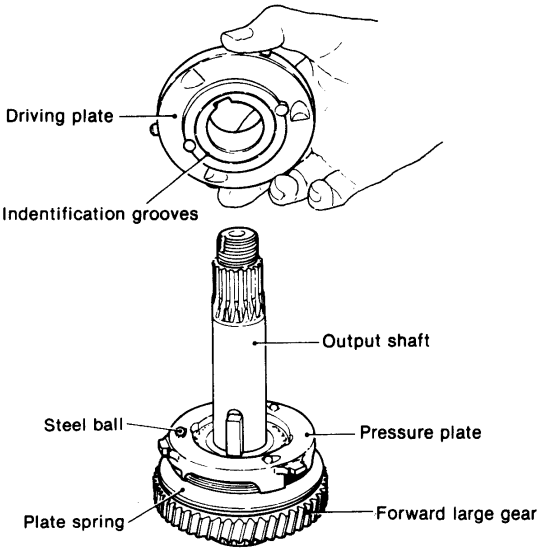
(13) Insert the forward large gear, together with the friction plates and steel plates. At this time, align the three pawls on the outside of the steel plates.

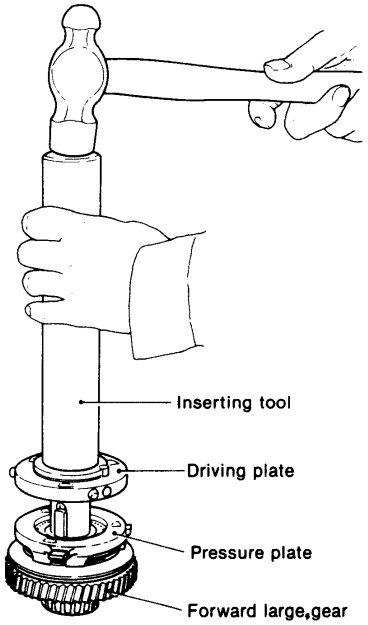


(14) Cover the friction plates and steel plates with the pressure plate so that the pawls of the steel plate fit into the three notches on the pressure plate.
(15) Insert the three steel balls into the three grooves in the pressure plate.

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

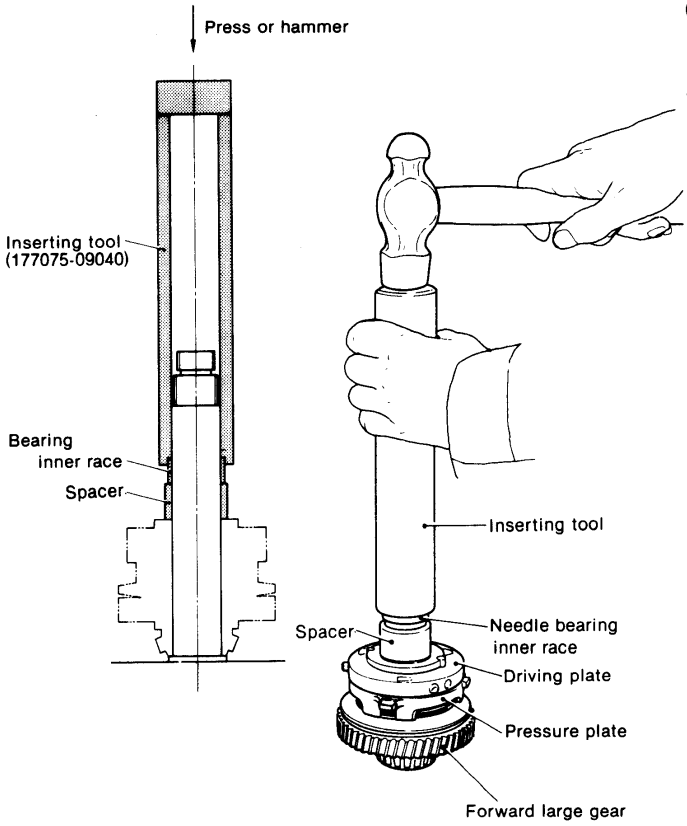
NOTE: Make sure that the three steel balls are in the three grooves of the driving plate.
At the same time, make sure that the pin for the driving plate fits into the groove of the torque limitter for the pressure plate.



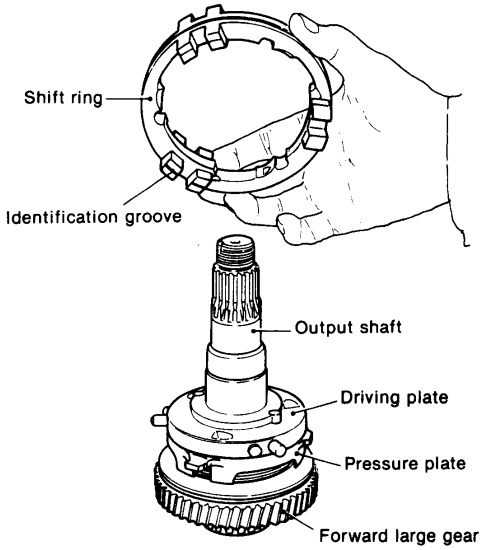


Printed in Japan
0000A0A1647

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

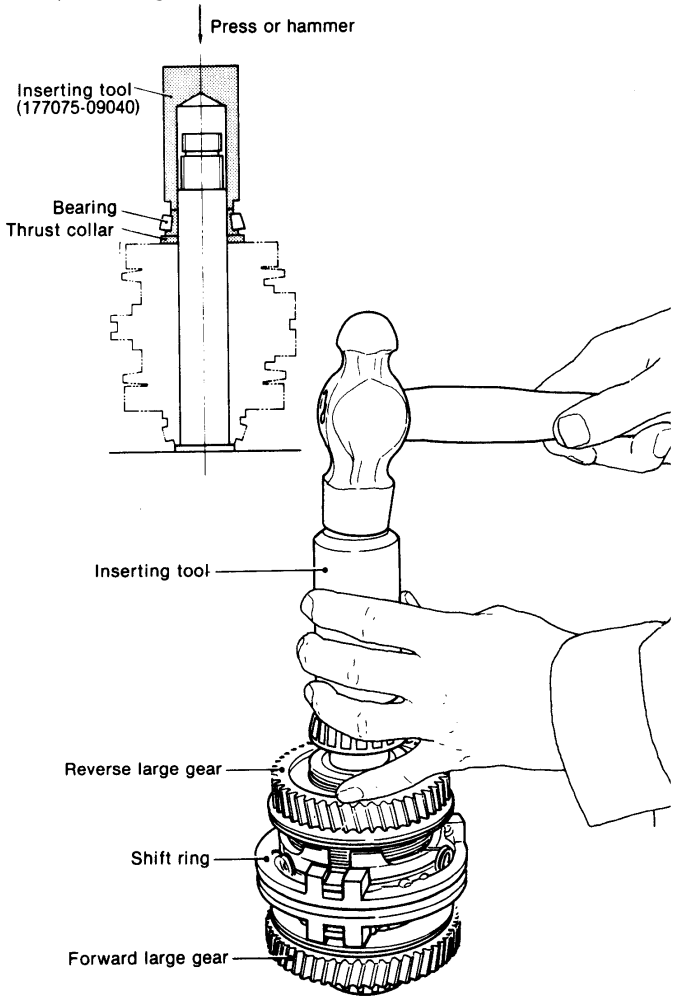


(19) Insert the knock pins and springs into the three holes around the circumference of the driving plate.
(20) Cover the driving plate with the shift ring so that the side with the identification groove faces the forward large gear side; install the ring so that the knock pins are pushed in.



(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.

Printed in Japan
0000A0A1647

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.

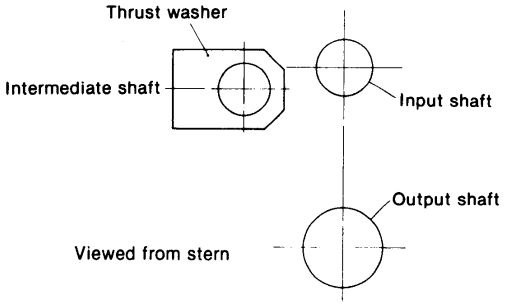
NOTE: The bearing inner race can be easily installed by preheating it to approximately 100°C.

6-4 Reassembling the intermediate shaft

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

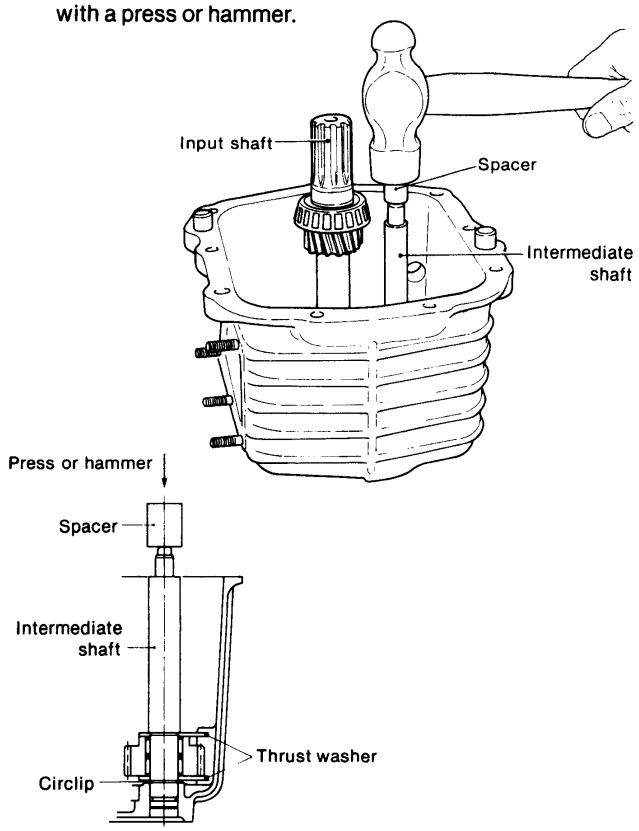
(1) Insert the thrust washer the needle bearing and idle gear on the intermediate shaft. Then insert the thrust washer.

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



(2) Insert the circlip on the intermediate shaft, and then insert the O-ring.

(3) Press the assembled intermediate shaft into the case with a press or hammer.



(4) Make sure that the idle gear rotates smoothly.

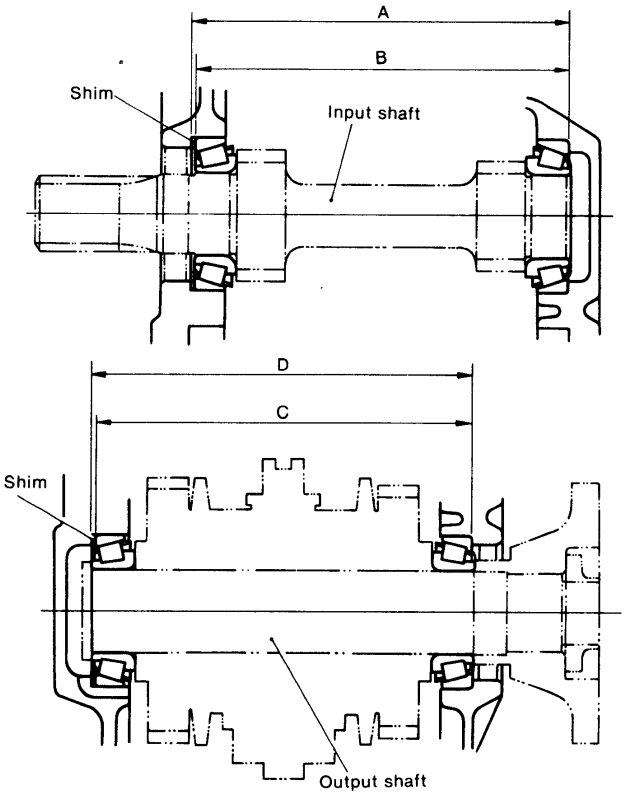
6-5 Installing the input shaft and output shaft

(1) 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.

1) Measure length "A" "D" between the cases of each shaft of the case body and mounting flange.

2) Cover each bearing with the bearing outer race, and measure length "B" "C" between the bearings.



3) Adjust the input shaft adjusting plate thickness so that the clearance or tightening allowance is less than 0.05mm (0.0020in.).

4) Adjust the output shaft adjusting plate thickness so that the tightening allowance is within 0 ~ 0.1mm (0~0.0040in.).

5) 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.

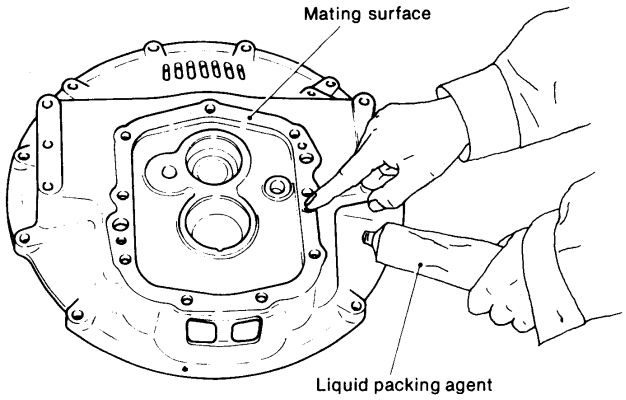
(2) Insert the adjusting plate into the mounting flange, and press the outer race of the bearing.
Also, press the outer race of the bearing into the case.

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.

(3) 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.

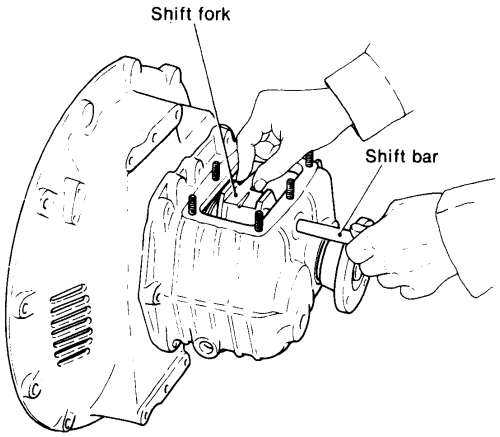
Printed in Japan
0000A0A1647

(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.

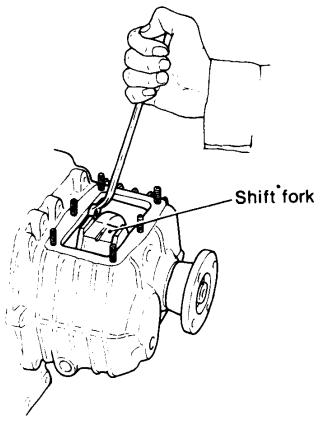


(5) Insert the input shaft into the case, assemble the intermediate shaft as described in section 6-4 and then insert the output shaft into the case, mounted with shift fork and shift ring.
(6) Align the mounting flange with the case, and insert the parallel pin by tapping the mounting flange with a 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.

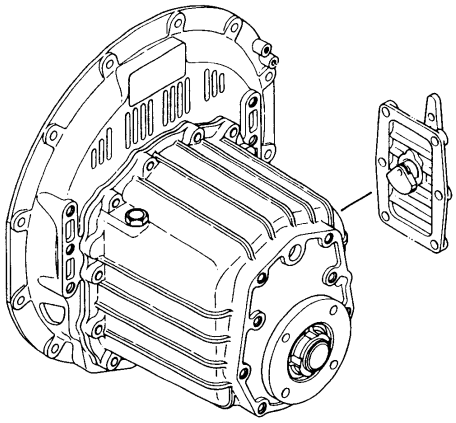
6-6 Reassembling and installing the operating system



(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.

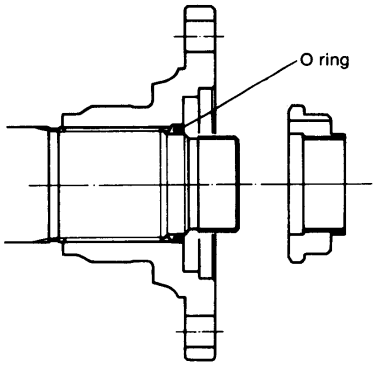


(7) Fit the shift lever to the shift cam, and tighten the M8 bolt.
NOTE: The shift cam must rotate smoothly.
(8) Replace the packing if it is damaged.
(9) Attach the case side cover with operating system in the case body.
At this time, make sure that the shift cam is fitted to the shift fork, and that 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.

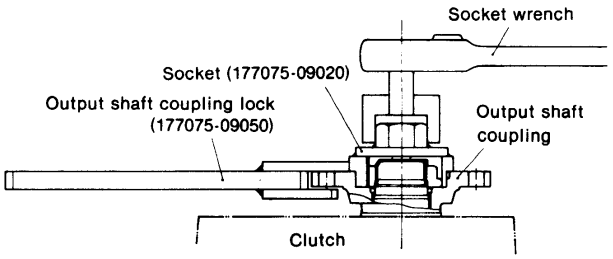
Printed in Japan
0000A0A1647

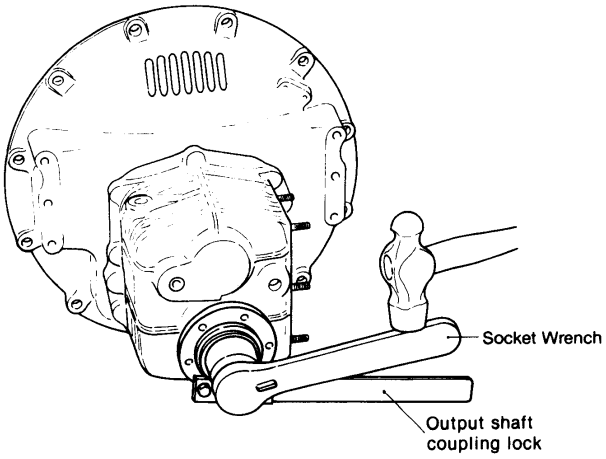
6-7 Installing the output shaft coupling

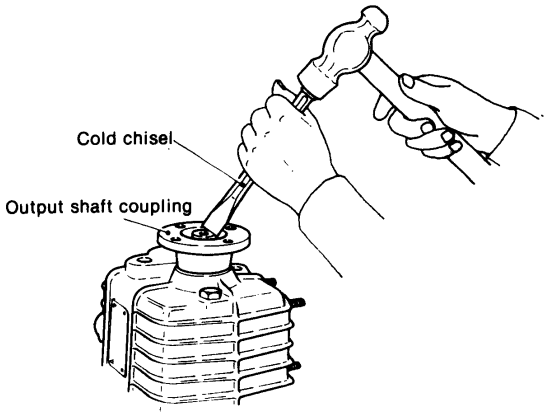
(1) Install the output shaft coupling on the output shaft and then insert the O-ring in the groove between the output shaft and the output shaft coupling.



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



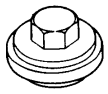
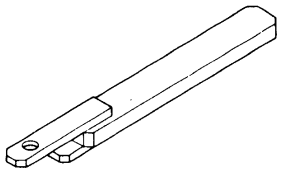
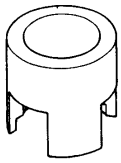
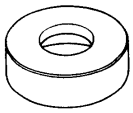
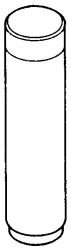




(3) Shift the shift lever to the neutral position and make sure the clutch engages when the shift lever is put into forward and reverse.
The input/output shafts will not rotate smoothly if the side gap of the bearing is too small in relation to the thickness of the adjusting plate.

Printed in Japan
0000A0A1647

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.

Printed in Japan
0000A0A1647

Marine Gear Model

KM4A

for Engine Models 4JH-BE, 4JH-TBE, 4JH-HTBE and 4JH-DTBE

1. Construction

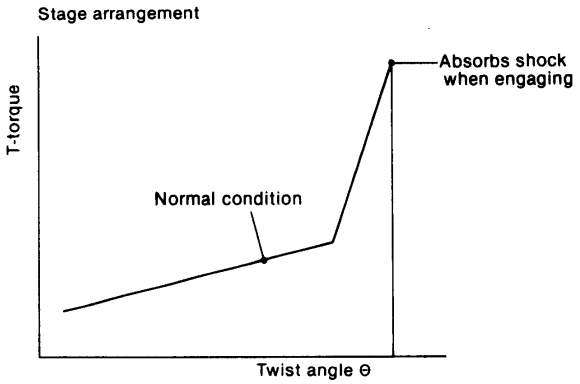
1-1 Construction

The clutch is a cone-type, mechanically operated clutch. When the drive cone (which is connected to the clutch shaft by the lead spline) is moved forward or backward, its taper contacts with the clutch gear and transfers power to the output shaft.

The construction is simple when compared with other types of clutch and it serves to reduces the number of components, making for a lighter, more compact unit which can be operated smoothly. Although it is small, the power transmission efficiency is high even under a heavy load. It is also durable and reliable because high grade materials are used for the shaft and gear, and a taper roller bearing is incorporated. Power transmission is smooth because connection with the engine is made through the damper disc.

- The drive cone is made from special aluminum bronze which has high wear-resistance and durability. The drive cone is connected with the clutch shaft. The taper angle, diameter of the drive cone, twist angle, and diameter of the involute spline, are designed to give the greatest efficiency, thus ensuring that the drive cone can be readily engaged or disengaged.
- Helical gears are used for greater strength. The intermediate shaft is supported at 2 points to reduce deflection and gear noise.
- The clutch case and mounting flange are made from an aluminum alloy of special composition to reduce weight. This is non-corrosive in seawater.
- The damper disc is fitted to the input shaft, so power can be transmitted smoothly. Springs of different strengths are used for the damper disc so that two stages of torque and twist angle are applied. That is, in the first stage, only the weak spring is used, and the strong spring comes into action for a torque higher than a predetermined value.

This prevents gear noise due to torsional vibration, as well as absorbing shock when engaging.



There is a small clearance between the dipstick and the inside of the dipstick tube. A small hole in the dipstick works as a breather.

- When the load on the propeller is removed, the engagement of the drive cone and the clutch gear is maintained by the shifter and V-groove of the drive cone. Even when the drive cone's tapered area and V-groove are worn, this engagement is maintained by the shift lever device. Accordingly no adjustment of the remote control cable is required.
- The cup spring on the rear of the clutch gear absorbs rotational fluctuations and stabilizes the engagement of the drive cone and the clutch gear. Thus, the durability of the cone against wear is enhanced.

- A torque limiter is built into the input shaft gear to prevent damage caused by excessive torque.
- The lube oil temperature can be controlled because in addition to the input shaft gear which functions as a centrifugal pump, an oil cooler is also equipped.
- The oil cooler is equipped with a cooling water drain cock to prevent cracks caused by freezing in cold weather. It is therefore easy to drain the water.
- The propeller shaft can rotate in both counter clockwise (C.C.W.) and clockwise (C.W.) directions.

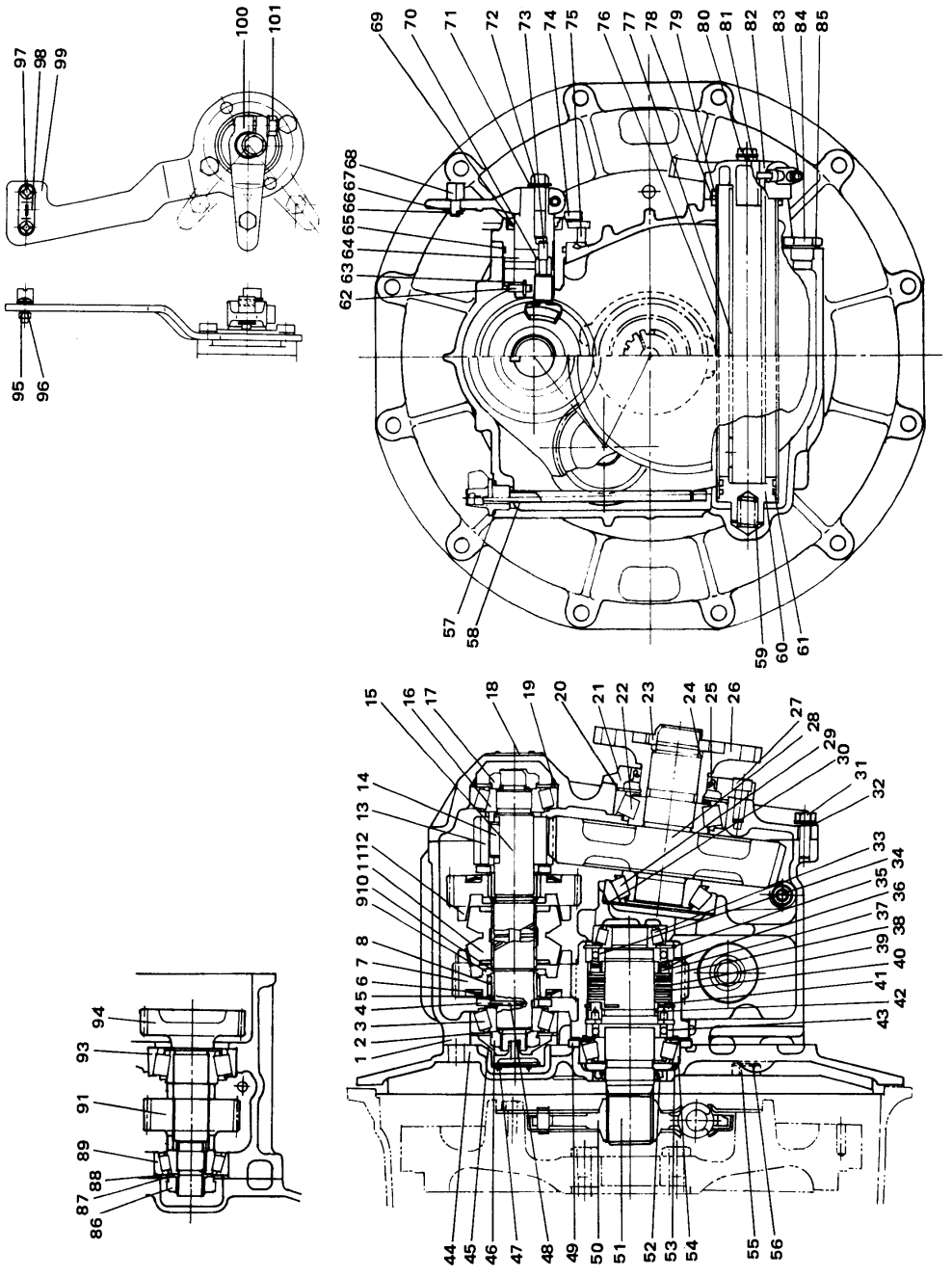
NOTE: Since the difference in reduction gear ratio between C.C.W. and C.W. rotations is within 0.07%, no problem occurs in operation.

1-2 Specifications of Angle Drive Marine Gear

Model		KM4A		
For engine models		4JH-BE, 4JH-TBE, 4JH-HTBE, 4JH-DTBE		
Down angle		7 degree		
Clutch		Constant mesh gear with servo cone clutch (wet type)		
Direction of rotation	Input shaft	Counter-clockwise, viewed from stern.		
	Output shaft	Bi-rotation		
Reduction ratio		3.30	2.63	2.14
Propeller shaft rpm at cont. rating		1062	1332	1637
Remote control	Control head	Single lever control		
	Cable	Morse, 33-C (Cable travel 76.2mm or 3 in.)		
	Clamp	YANMAR Made, standard accessory		
	Cable connector	YANMAR Made, standard accessory		
Output shaft coupling	Outer diameter	ϕ120mm (4.72")		
	Pitch circle diameter	ϕ100mm (3.93")		
	Connecting bolt holes	4–ϕ10.5mm (4–ϕ0.41")		
Position of shift lever		Right side, viewed from stern		
Lubricating oil		Same as Engine lube oil		
Lubricating oil capacity		1.3ℓ		
Lube oil cooler		Sea-water cooling		

Printed in Japan
0000A0A1647

1-3 KM4A Sectional View

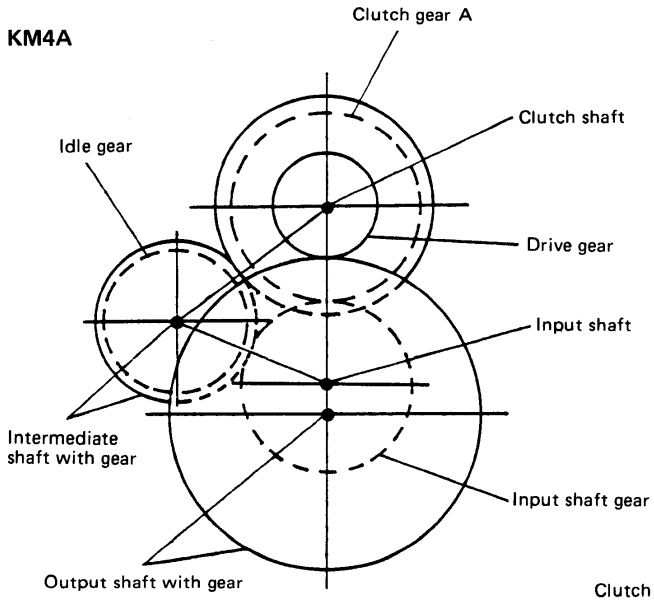


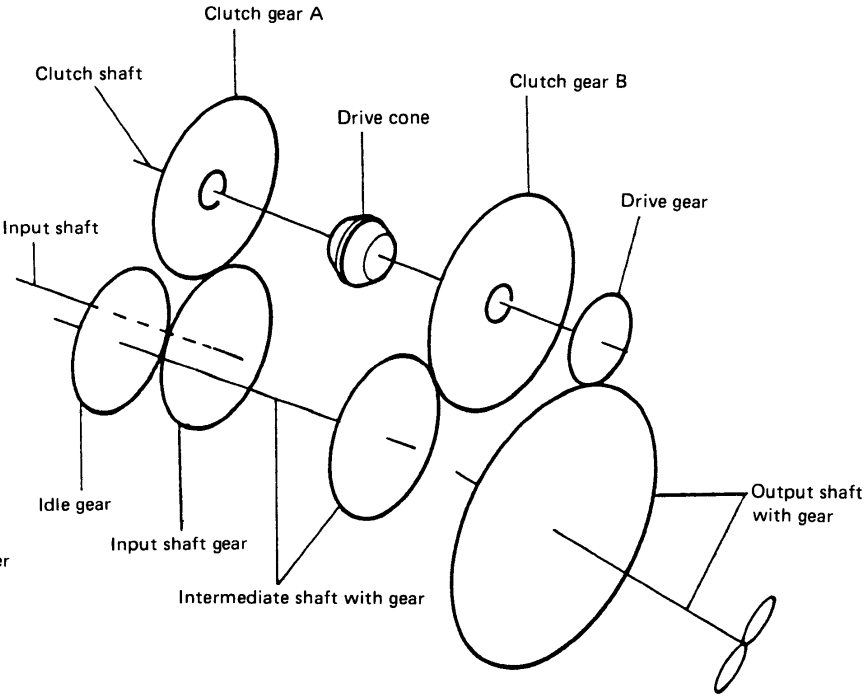
1 Clutch case
2 Shim
3 Bearing
4 Thrust collar (A)
5 Spring retainer
6 Cup spring
7 Clutch gear (A)
8 Needle bearing
9 Thrust collar (B)
10 Snap ring
11 Drive cone
12 Clutch gear B
13 Driving gear
14 Key
15 Clutch shaft
16 Bearing
17 End nut
18 Name plate
19 Shim
20 Shim
21 Output shaft cover
22 Bearing
23 End nut
24 O-ring
25 Oil seal
26 Output shaft coupling
27 Bolt
28 Output shaft
29 Bearing
30 Shim
31 Bolt
32 Washer
33 Bearing
34 Ball bearing
35 Snap ring
36 Cup spring
37 Spacer
38 Input shaft gear
39 Plate (A)
40 Plate (B)
41 Lock nut
42 O-ring
43 Ball bearing
44 Mounting flange
45 Lube oil filter case
46 End nut
47 Lube oil filter
48 Pin
49 Centering bush
50 Dumper disk
51 Input shaft
52 Oil seal
53 Shim
54 Bearing
55 Nut
56 Washer
57 O-ring
58 Dip stick
59 Spring
60 Cover
61 O-ring
62 Location pin
63 Spring pin
64 Shift lever shaft
65 O-ring
66 Washer
67 Split space pin
68 Pivot
69 Oil seal
70 Spring
71 Shim
72 Stopper bolt
73 Shifter
74 Bolt (M8 x 30)
75 Side cover
76 Oil-cooler body
77 Pipe
78 Shim
79 O-ring
80 Bolt
81 Washer
82 Cooler
83 Cock
84 Drain plug
85 Washer
86 End nut
87 Washer
88 Shim
89 Bearing
90
91 Idle gear
92
93 Bearing
94 Intermediate shaft gear
95 Washer
96 Lock nut
97 Bolt
98 Cable clamp
99 Cable blacket
100 Shift lever
101 Bolt (M8 x 25)

1-4 Power Transmission System

1-4-1 Arrangement of shafts and gear

KM4A





Shaft arrangement viewed from the propeller

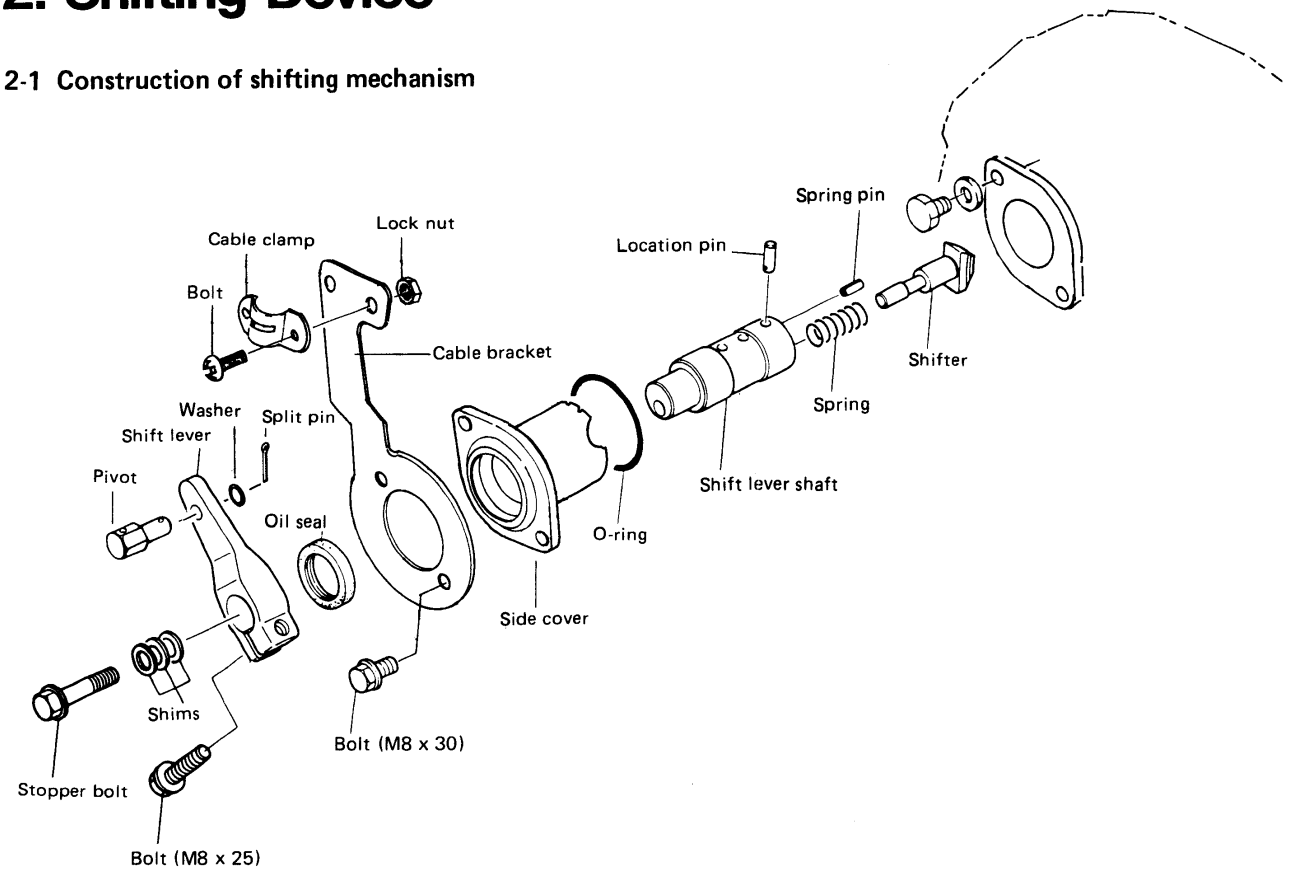
1-4-2 Reduction ratio

Input shaft gear	Clutch gear		Intermediate shaft		Drive gear	Output shaft with gear	Reduction ratio
	A	B	Idle gear	Shaft gear			
39	41	45	31	34	30	61	2.14
					26	65	2.63
					22	69	3.30

Printed in Japan
0000A0A1647

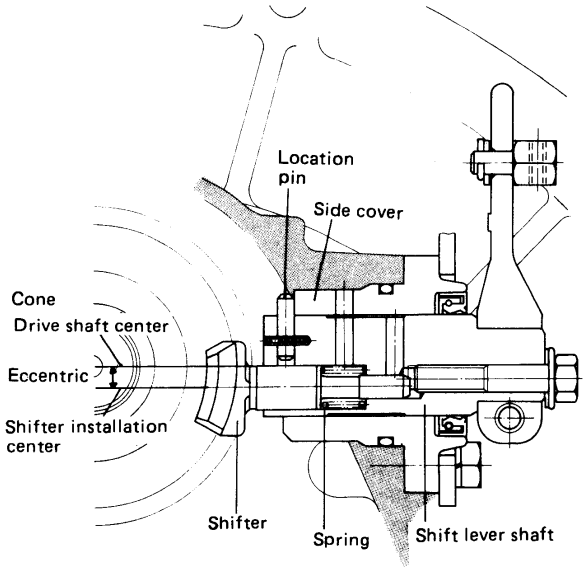
2. Shifting Device

2-1 Construction of shifting mechanism



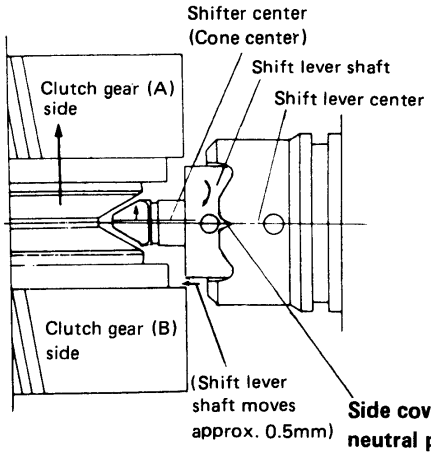
The shift lever shaft is installed on the side cover with neutral, clutch gear (A) and clutch gear (B) positions provided on the cover. The neutral, clutchgear (A) and clutch gear (B) location pins of the shift lever shaft are constantly inserted into their respective grooves on the shift lever by the tension of the shifter spring. The shifter is set on the eccentric hole of the shift lever shaft and moves the drive cone in the neutral position either to the clutch gear (A) or clutch gear (B) positions, and then back to the neutral position. (The shift lever shaft moves slightly to the shift lever (or drive cone) side when the shift lever is placed in the clutch gear (A) or clutch gear (B) positions.)

NOTE:1 Clutch gear (A) position: clockwise propeller rotation viewed from propeller side (C.C.W.)
NOTE:2 Clutch gear (B) position: Counterclockwise propeller rotation viewed from propeller side (C.W.)

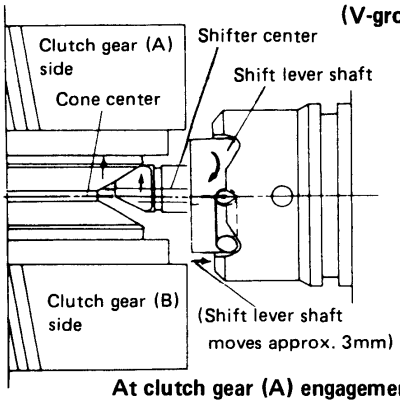


2-2 Clutch gear (A) and clutch gear (B) operation (Neutral ⇒ clutch gear (A), Neutral ⇒ clutch gear (B))

When the shift lever is moved to the clutch gear (A) position from the neutral position, the shift lever shaft starts to revolve, and the location pin disengages from the neutral V-groove position of the side cover. (Shift lever moves approx. 0.5mm to the drive cone side.) At this time the shifter, which is set on the eccentric hole of the shift lever shaft, moves the drive cone's V-groove to the clutch gear (A).



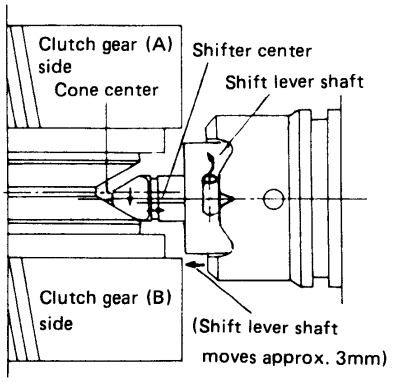
When the location pin of the shift lever shaft falls into the clutch gear (A) position groove on the side cover, the shift lever shaft moves approx. 3mm to the shift lever side, and the shifter starts to press the drive cone V-groove to the clutch gear (A) side by spring force.



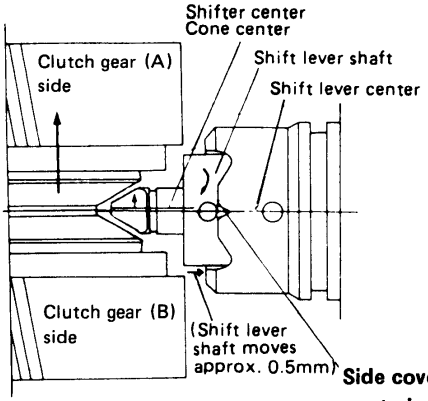
At clutch gear (A) engagement position

2-3 Engagement and disengagement of clutch (Clutch gear (A) ⇒ Neutral, Clutch gear (B) ⇒ Neutral)

When the shift lever is moved to the clutch gear (A) position from the neutral position, the shift lever shaft starts to revolve, and the location pin disengages from the clutch gear (A) position groove on the side cover. (The shift lever shaft moves approx. 3mm to the drive cone side.) At this time, the shifter which is set on the eccentric hole of the shift lever shaft, is moved to the neutral side (clutch gear (B) side). The drive cone, however, is engaged with the clutch gear (A) as the torque force produced by the revolving centrifugal force.



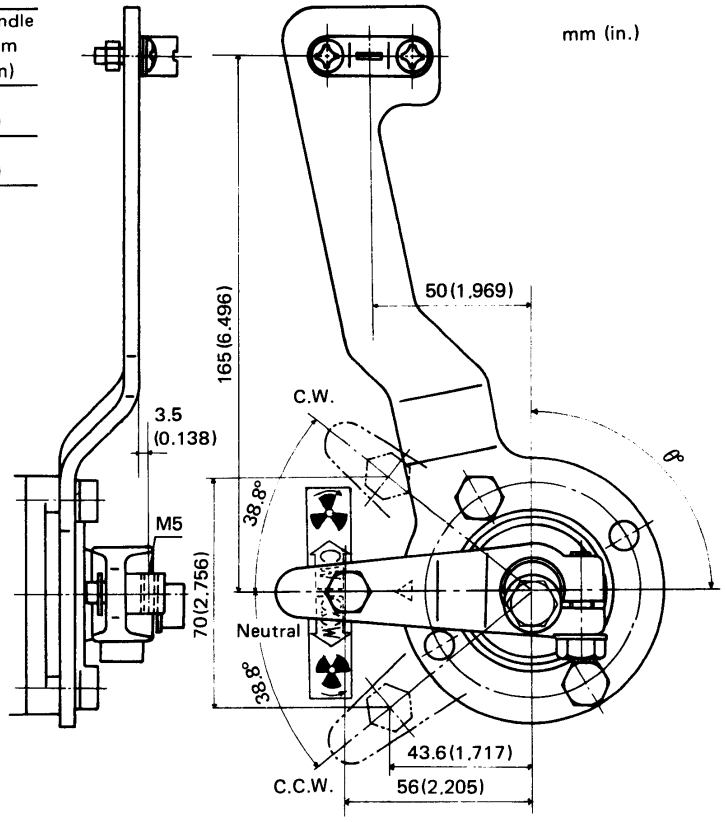
Further, when the shift lever shaft starts to revolve, and the positioning pin falls into the neutral V-groove position of the side cover (the shift lever shaft travels approx. 5mm to the shift lever side), the shifter moves to the shift lever side (to the spring side) while moving the V-groove of the drive cone to the clutch gear (B) side. The movement of the shifter to the shift lever side, however, is stopped when the shifter end contacts the stopper bolt. The shifter only works to press the V-groove of the drive cone to the clutch gear (B) side. Thus, the drive cone is disengaged from the clutch gear (A). After this disengagement, the transmission torque of the drive cone is decreased to zero and the shift lever is returned to the neutral position by spring force.



Printed in Japan
0000A0A1647

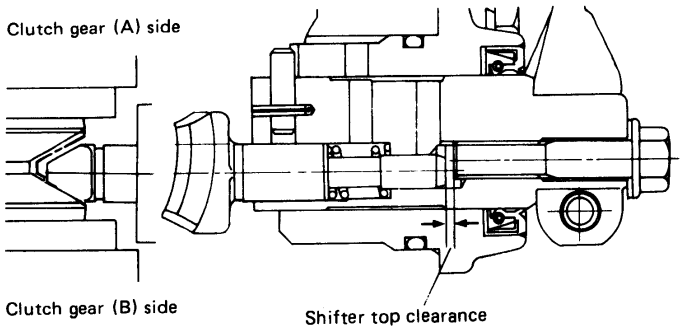
2-4 Clutch shifting force

Shifting position / Shifting direction	Shift lever position at 56mm	Remote control handle position at 170mm (Cable length, 4m)
Engaging force at 1000 rpm	3 ~ 4 kg (6.6 ~ 8.8 lbs)	4 ~ 5 kg (8.8 ~ 11.0 lbs)
Disengaging force at 1000 rpm	3.5 ~ 5 kg (7.7 ~ 11.0 lbs)	4 ~ 6 kg (8.8 ~ 13.2 lbs)



2-5 Adjustment of shifting device

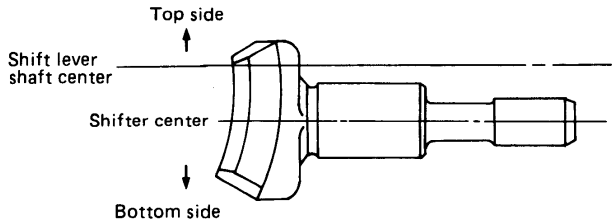
Whenever the side cover, shift lever shaft, shifter, stopper bolt or drive cone is replaced, be sure to adjust the clearance between the shifter end and the stopper bolt with shims. When the adjustment of this clearance is inadequate, the drive cone may not connect properly when the shift lever is moved to the neutral position, either from the clutch gear (A) or clutch gear (B) position.



2-5-1 Measurement and adjustment of clearance

(1)Assemble the shifting mechanism (without installing the stopper bolt of the shifter) to the marine gear case.

NOTE: Ensure the correct alignment of the shifter before assembly.



(2)Turn the shift lever 10 ~ 15 degrees either to the clutch gear (A) or clutch gear (B) position from the neutral position.

(3)Measure the L-distance between the shift lever shaft end surface and the shifter end.

(4)Measure the H-distance (the distance from the neck of the stopper bolt to its end).

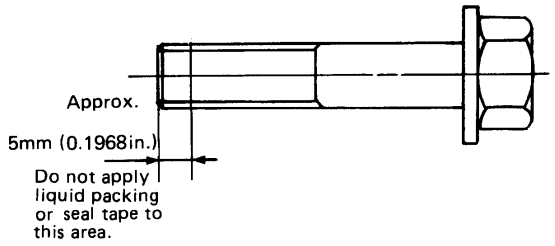
(5)Obtain the shim thickness "T" by the following formula.

$$T = (H - L + 1.25) \pm 0.1\text{mm } (0.0039\text{in.})$$

NOTE: Shim set includes one each of 1mm, 0.4mm, 0.3mm, 0.25mm shims.
(YANMAR Part No. 177088-06380)

(6)Insert shim (s) of proper thickness to the stopper bolt side and tighten to the shift lever shaft.

NOTE: When tightening the stopper bolt, apply either a non-drying type liquid packing (THREE BOND No.1215), or a seal tape around the bolt threads.

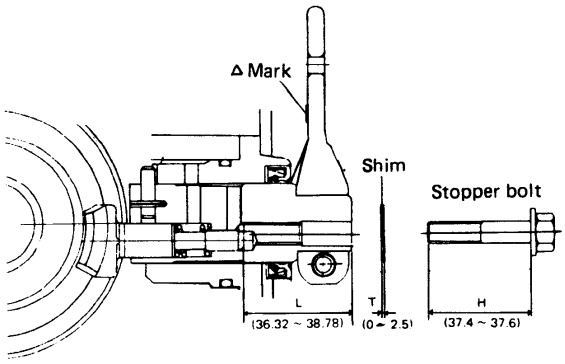


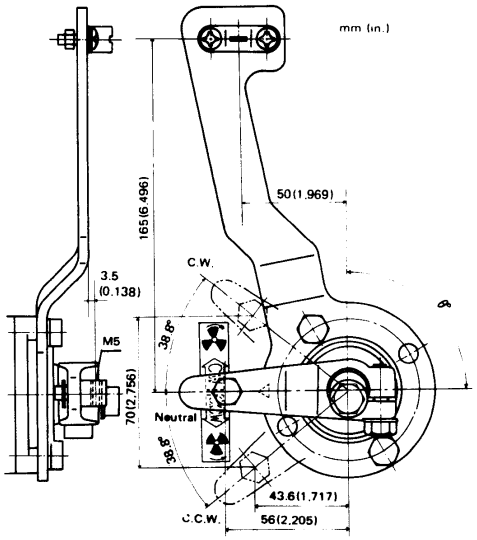
2-5-2 Inspect for the following points (to be inspected every 2-3 months)

(1)Looseness at the connection of the cable connector and the remote control cable.

(2)Looseness of the attaching nut of the cable connector and the shift lever.

(mm)





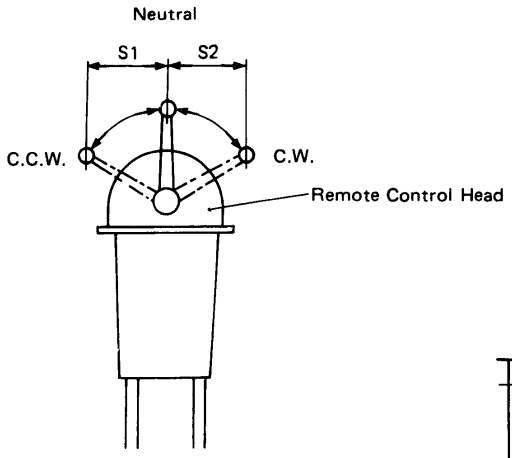
NOTE. Shift lever must be installed in the direction of the Δ-mark ensuring the specified installation angle (θ).

$\theta = 90°$

Printed in Japan
0000A0A1647

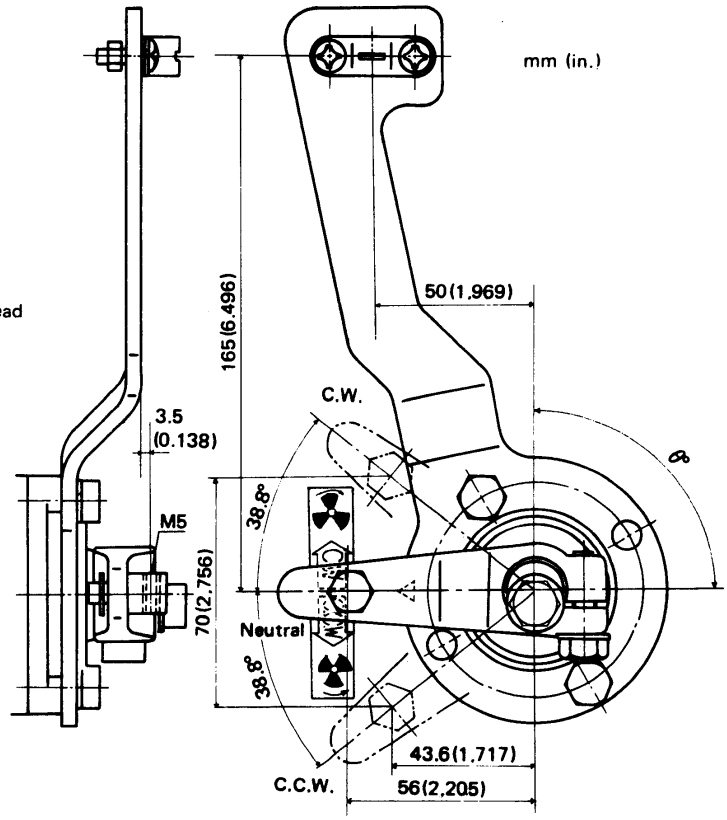
2-6 Adjustment of the remote control head Marine gearbox control side

(1)Equal distribution of the control lever stroke.



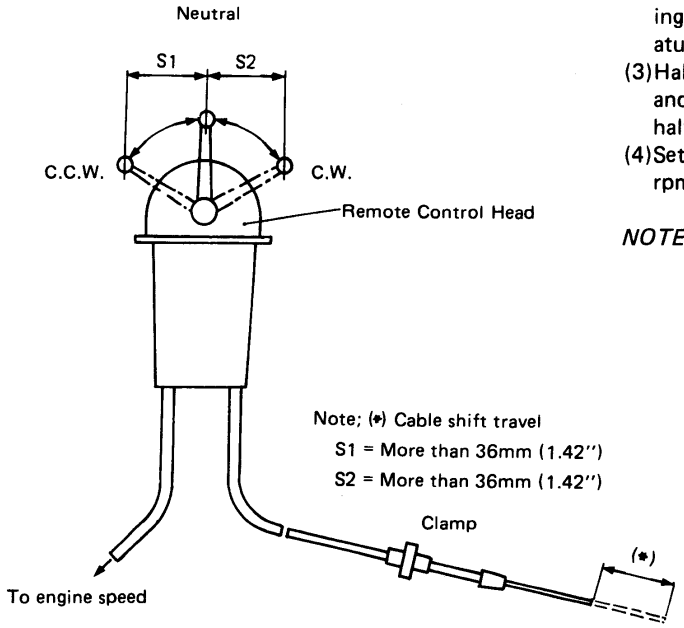
The stroke between the neutral position → C.W. position (S2), and the neutral position → C.C.W. position (S1) must be equalized.

When either stroke is too short, clutch engagement becomes faulty.



(2)Equalizing the travel distance of the control cable.

After ensuring the equal distribution of the stroke described in (1), connect the cable to the control head. Adjust so that the cable shift travel of the S1 and S2 control lever strokes becomes identical.



2-7 Cautions

(1)Always stop the engine when attaching, adjusting, and inspecting.

(2)When conducting inspection immediately after stopping the engine, do not touch the clutch. The oil temperature is often raised to around 90°C (194°F).

(3)Half-clutch operation is not possible with this design and construction. Do not use with the shift lever halfway to the engaged position.

(4)Set the idling engine speed at between 800 and 850 rpm.

NOTE: The dual(Two) lever remote control device cannot be used.

3. Inspection and Servicing

3-1 Clutch case and cover

(1)Check the clutch case and cover for cracking with a test hammer.
Perform a color check when required.
If the case and cover are cracked, replace those together.

(2)Check for staining on the inside surface of the bearing section.
Also, measure the inside diameter of the case and cover. Replace the case and cover if these are worn beyond the wear limit.

3-2 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 any abnormal sound is evident, replace the bearing.

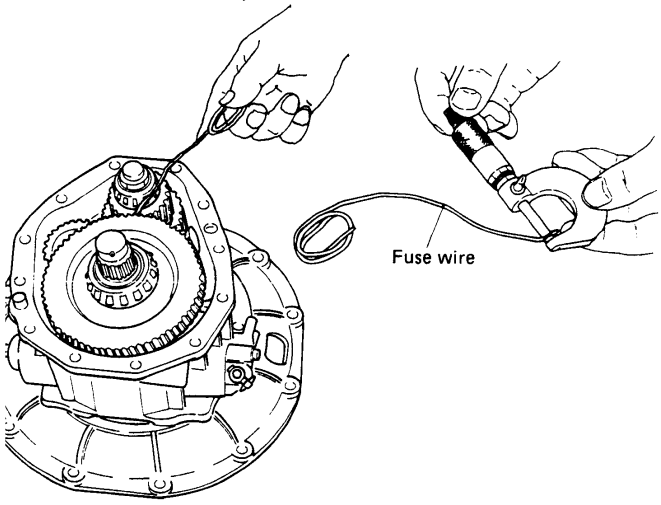
3-3 Gear

Check the surface, tooth face conditions and backlash of each gear. Replace any defective part.

(1)Tooth surface wear.
Check the tooth surface for pitting, abnormal wear, dents, and cracks. Repair the 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.

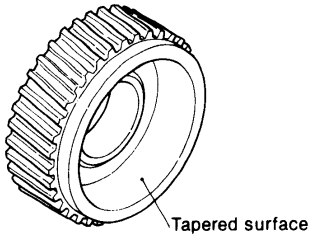


mm (in.)

	Maintenance Standard	Wear limit
All gears	0.08 ~ 0.16 (0.0031 ~ 0.0063)	0.3 (0.0118)

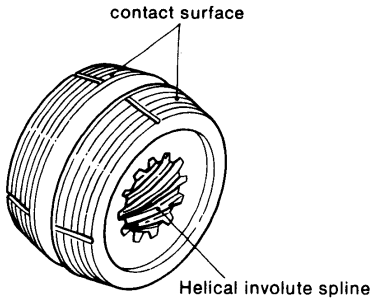
3-4 Clutch gear (A) and (B)

(1)Contact surface with drive cone.
Visually inspect the tapered surface of the clutch gears (A) and (B) where they make contact with the drive cone to check if there is any abnormal condition or sign of overheating.
If any defect is found,
replace the gear.



3-5 Drive cone

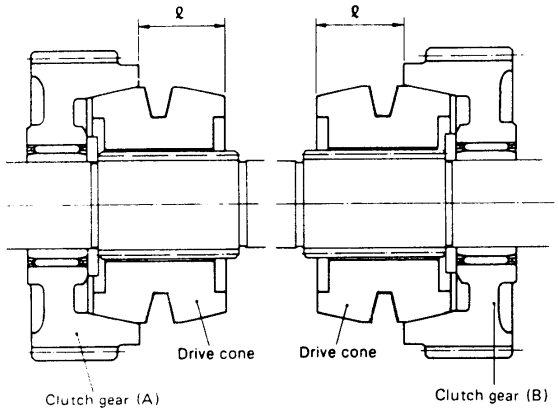
(1)Visually inspect that part of the surface that comes into contact with the circumferential triangular slot to check for signs of scoring, overheating or wear. If deep scoring or signs of overheating are found, replace the cone.



(2)Check the helical involute spline for any abnormal condition on the tooth surface, and repair or replace the part should any defect be found.

Printed in Japan
0000A0A1647

(3)Measure the amount of wear on the tapered contact surface of the drive cone, and replace the cone when the wear exceeds the specified limit.

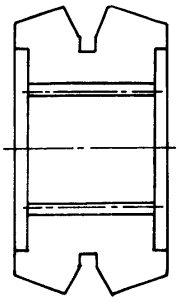


mm(in.)

	Standard dimensions	Limited dimensions
Dimensions ℓ	29.2 ~ 29.8 (1.1496 ~ 1.1732)	28.1 (1.1063)

NOTE: When dismantled, the forward or reverse direction of the drive cone must be clearly identified.

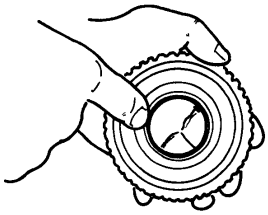
(4)If the wear of the V-groove of the drive cone is excessive, replace the part.



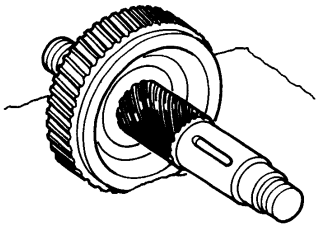
NOTE: When replacing the drive cone, the drive cone and clutch gears (A) and (B) must be lapped prior to assembly.
The lapping procedure is described below.

3-5-1 Lapping Procedure for Drive Cone

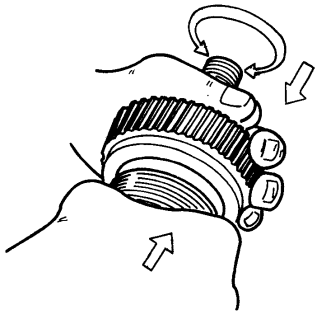
(1) Coat the lapping powder onto the cave of the clutch gear (Lapping powder: 67 micron silicon carbide #280)



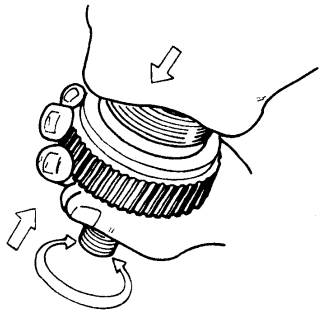
(2)Set the clutch gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft



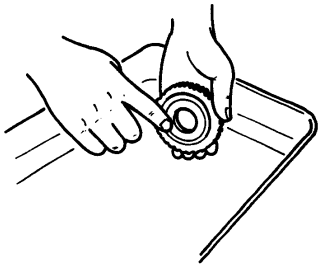
(3)Lap the clutch gear's cave and drive cone, pushing them together by hand

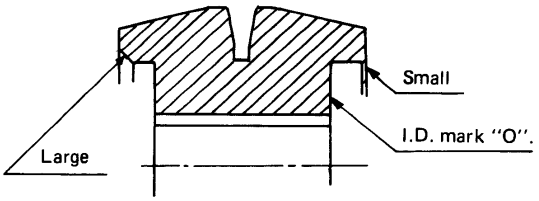


(4)Push and turn the clutch gear about 5 times both clockwise and counter-clockwise.



(5)After lapping them, wash them with washing oil. The lapped parts should be cleaned completely.

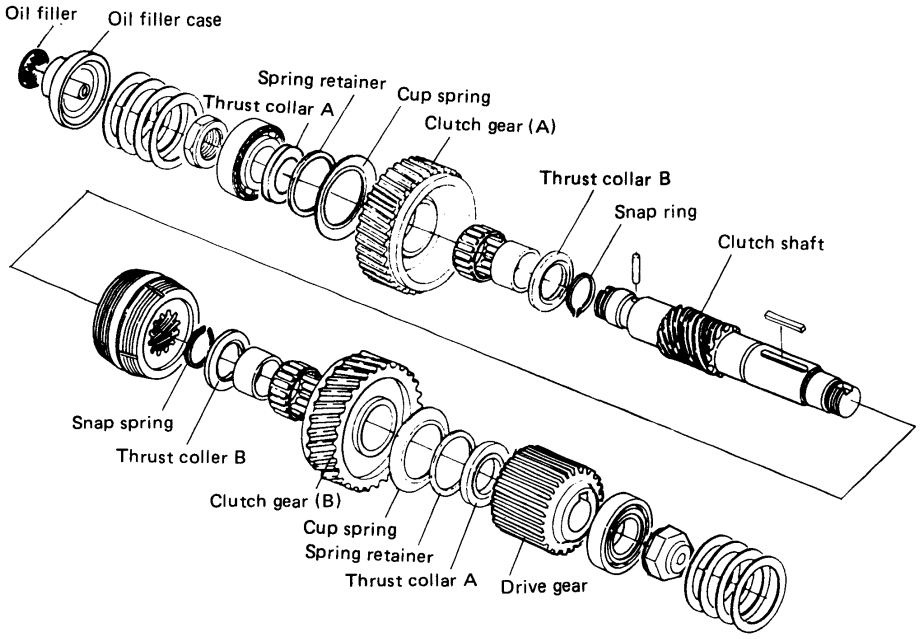




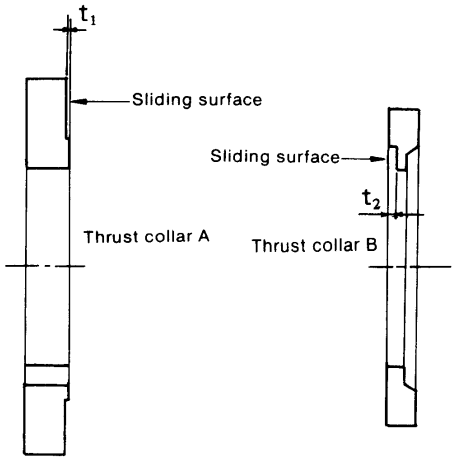
NOTE: Do not mix the combination of the lapped parts. The washing oil should be changed frequently in order to prevent residual powder being left on the parts.
When assembling the drive cone, be sure to check its alignment.
The larger chamferring face should be on the clutch gear (A) side.

Printed in Japan
0000A0A1647

3-6 Thrust coller A and B for clutch shaft



(1) Visually inspect the sliding surface of thrust collar A or B to check for signs of overheating, scoring, or cracks. Replace the collar if any abnormal condition is found.
(2) Measure the thickness of thrust collar A or B, and replace it when the dimension exceeds the specified limit.

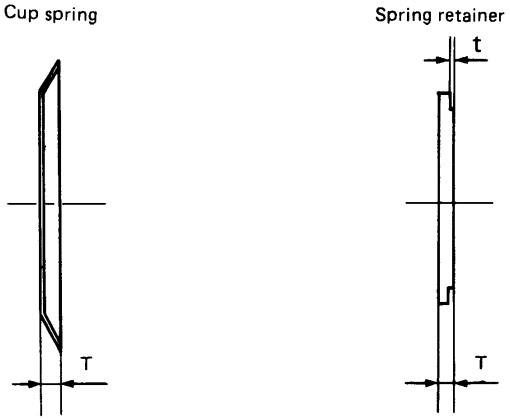


mm (in.)

Stepped wear	Standard	Limit
Thrust collar A, t_1	t_1 0.1 (0.0039)	0.05 (0.0020)
Thrust collar B, t_2	t_2 1.0 (0.0394)	0.20 (0.0079)

3-7 Cup spring and spring retainer

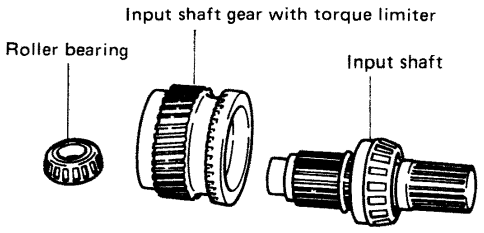
(1) Check for cracks and damage to the cup spring and spring retainer. Replace the part if defective.
(2) Measure the free length of the cup spring and the thickness of the spring retainer. If the length or the thickness deviates from the standard size, replace the part.



mm (in.)

	Standard	Limit
Cup spring, T	2.8 ~ 3.1 (0.1102 ~ 0.1220)	2.6 (0.1024)
Spring retainer, T	2.92 ~ 3.08 (0.1150 ~ 0.1213)	2.8 (0.1102)
Spring retainer, t	—	0.1 (0.0039)

3-8 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.

(3)Torque limiter parts.
If the torque limiter has slipped due to excessive torque, measure the size of the inner parts listed top right. If the parts are excessively damaged replace.

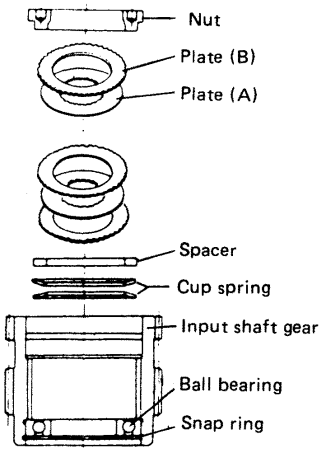
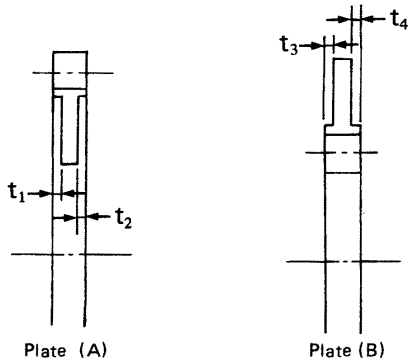


Plate (A) and (B)

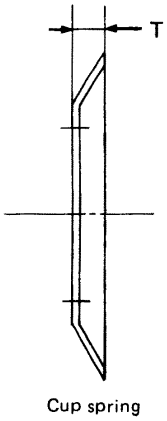
mm(in.)

Stepped wear	Standard	Limit	Q'ty/unit
Plate (A) ($t_1 + t_2$)	0.95 ~ 1.05 (0.0374 ~ 0.0413)	0.92 (0.0362)	15
Plate (B) ($t_3 + t_4$)	0.35 ~ 0.45 (0.0138 ~ 0.0177)	0.32 (0.0126)	16



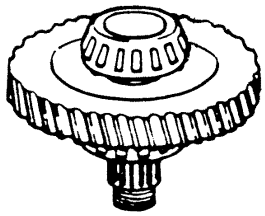
mm(in.)

	Standard	Limit
Cup spring, T	2.75 ~ 3.05 (0.1083 ~ 0.120)	2.6 (0.1024)



Cup spring

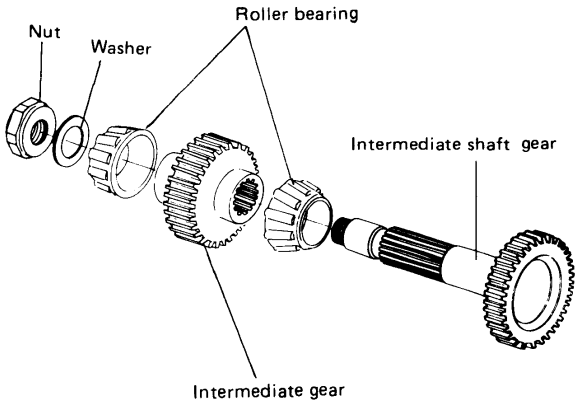
3-9 Output shaft



(1)Visually inspect the spline, oil seal and O-ring, and repair or replace a part when any abnormal condition is found on its surface.

Printed in Japan
0000A0A1647

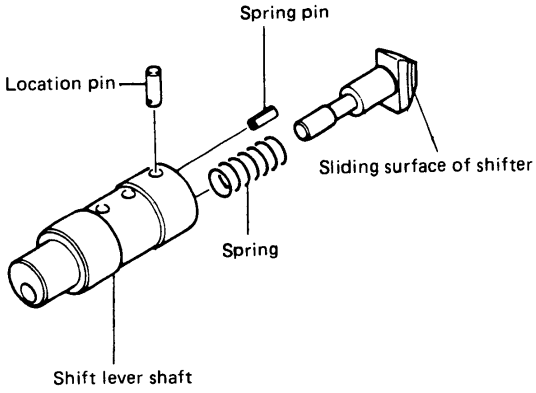
3-10 Intermediate shaft



(1)Visually inspect the spline and repair or replace a part when any abnormal condition is found on its surface.

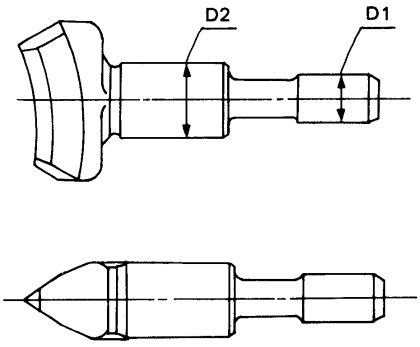
3-11 Shifting device

3-11-1 Shifter



(1)Visually inspect the surface which contacts with the drive cone, and replace the shifter when signs of overheating, damage or wear are found.

(2)Measure the shaft diameter of the shifter. Replace the shaft if the size deviates from the standard.



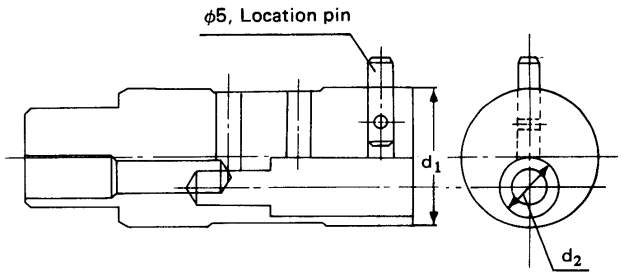
mm (in.)

	Standard	Limit
D1	6.69 ~ 6.70 (0.2634 ~ 0.2638)	6.50 (0.2559)
D2	11.966 ~ 11.984 (0.4711 ~ 0.4718)	11.95 (0.4705)
Shift lever shaft, Shifter insertion hole	12.0 ~ 12.018 (0.4724 ~ 0.4731)	12.05 (0.4744)

3-11-2 Shift lever shaft and location pin

(1)Check the shift lever shaft and location pin for damage or distortion, and replace defective parts. If the location pin must be replaced, replace it together with the shift lever shaft.

(2)Measure the diameter of the shift lever shaft and the shifter insertion hole. Replace the part if the size deviates from the standard value.



mm (in.)

	Standard	Limit
d_1	27.959 ~ 27.98 (1.1001 ~ 1.1016)	27.90 (1.0984)
d_2	12.0 ~ 12.018 (0.4724 ~ 0.4731)	12.05 (0.4744)
Side cover, Shift insertion hole	28.0 ~ 28.021 (1.1024 ~ 1.1032)	28.08 (1.1055)

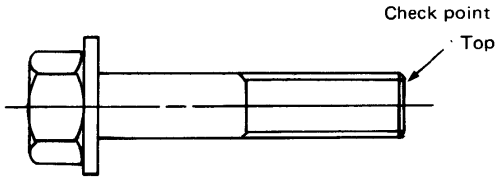
3-11-3 Shifter spring

(1)Check the spring for scratches or corrosion.
(2)Measure the free length of the spring.

Shifter spring	Standard	Limit
Free length	22.6 mm (0.890in.)	19.8 mm (0.780in.)
Spring constant	0.854 kg/mm (1.88 lbs/0.04in.)	–
Length when attached	14.35 mm (0.5650 in.)	–
Load when attached	7.046 kg (15.54 lbs)	6.08 kg (13.41 lbs)

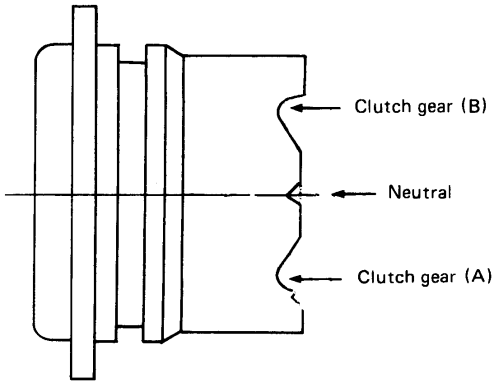
3-11-4 Stopper bolt

Check the stopper bolt. If it is worn or stepped, replace.

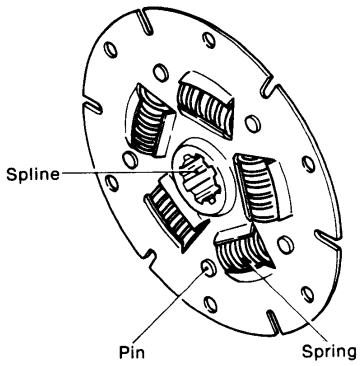


3-11-5 Side cover and oil seal

(1)Check the neutral, clutch gear (A) and clutch gear (B) position grooves. Replace if the grooves are worn.
(2)Measure the insertion hole of the shift lever shaft. Replace if the size deviates from the standard value.
(3)Check the oil seal and the O-ring for damage. Replace if the part is defective.



3-12 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) Whenever a crack or damage to the spring slot is found replace the defective part with a new one.

Printed in Japan
0000A0A1647

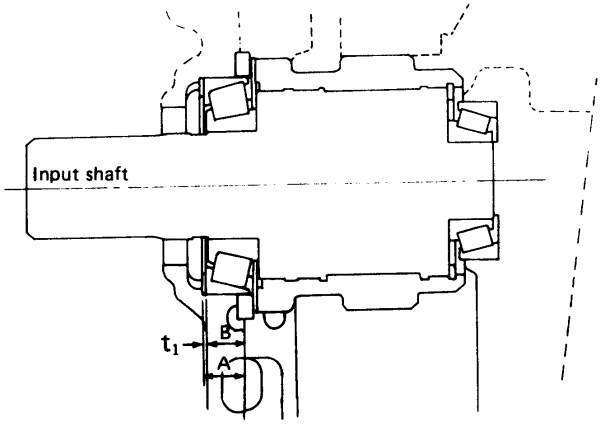
3-13 Shim adjustment for output and input shafts

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

For input shaft parts : input shaft, bearing.
For output shaft parts: output shaft, bearing.
For intermediate shaft parts : intermediate shaft, spacer, gear bearing.
For clutch shaft parts : clutch shaft, thrust collar (A), (B), gear, bearing.

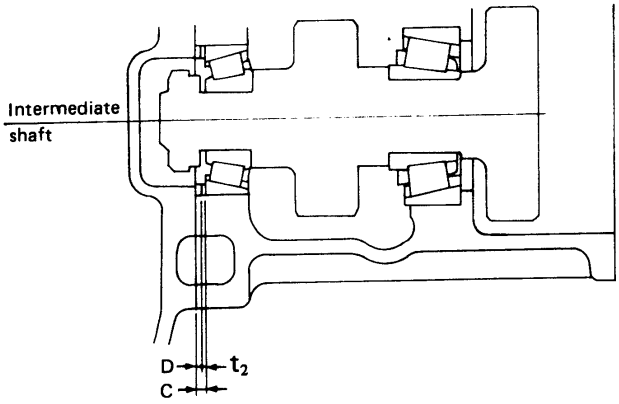
(1) Input Shaft
Measure the distance A and B.
Thickness of Shim t_1

$$t_1 = (A - B)^{\pm 0.05}$$



(2) Intermediate Shaft
Measure the distance C and thickness D

$$t_2 = (C - D)^{\pm 0.05}$$



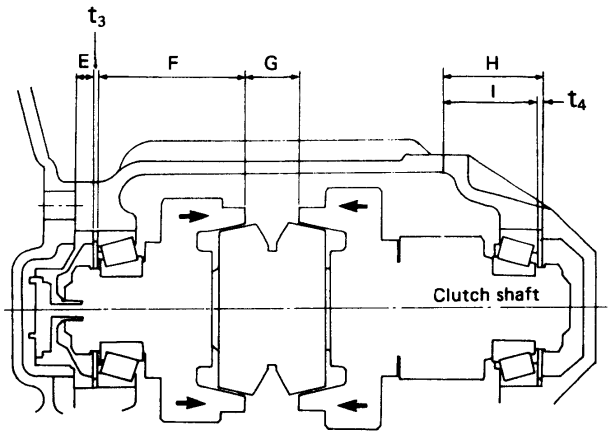
(3) Clutch Shaft
Measure the distance E, F and G.

$$t_3 = \left(78 - E - F - \frac{G}{2}\right)^{\pm 0.05}$$

NOTE: When measuring the distances F and G, the clutch gears must be pushed in the direction of the drive cone.

Then measure distances H and I.

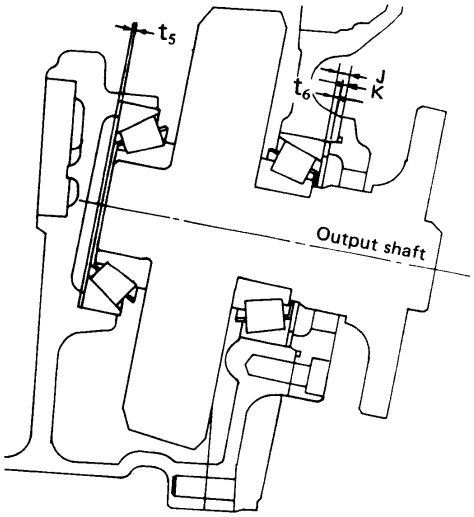
$$t_4 = (H - I)^{\pm 0.05}$$



(4)Output Shaft

Adjust the thickness of Shim t_5 to make the backlash of gear at 0.08~0.16mm (0.0032~0.0063in).
Then measure the distances J and K.

$$t_6 = (J - K)^{+0}_{-0.1}$$



(5)Standard size of parts

mm (in.)

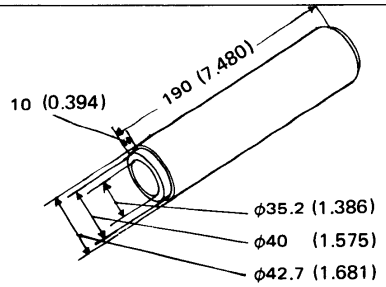
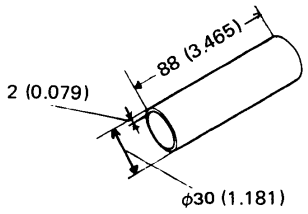
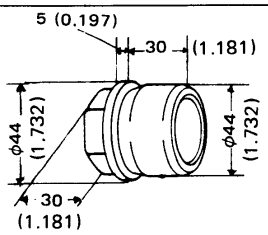
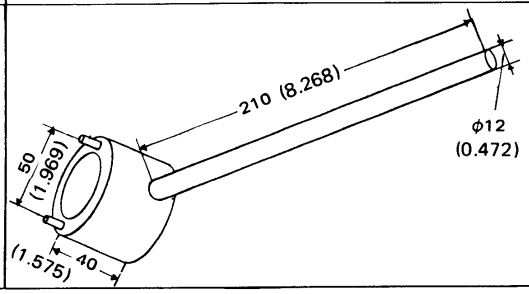
A	B	C	D	E	F	G	H	I	J	K	Drive cone neutral center position
14.0 ~ 14.2 (0.551 ~ 0.559)	11.4 ~ 12.9 (0.449 ~ 0.508)	2.3 ~ 3.7 (0.091 ~ 0.146)	1.9 ~ 2.1 (0.075 ~ 0.083)	7.4 ~ 7.5 (0.291 ~ 0.295)	57.8 ~ 58.7 (2.276 ~ 2.311)	20.3 ~ 21.2 (0.799 ~ 0.835)	39.9 ~ 40.3 (1.571 ~ 1.587)	37.7 ~ 39.5 (1.484 ~ 1.555)	3.6 ~ 4.7 (0.142 ~ 0.185)	2.4 ~ 2.6 (0.094 ~ 0.102)	78 (3.071)

NOTE: Compare your measurements with the above standard size. If your measurements differ greatly from the standard sizes, the measurements may not be correct. Check and measure again.

Printed in Japan
0000A0A1647

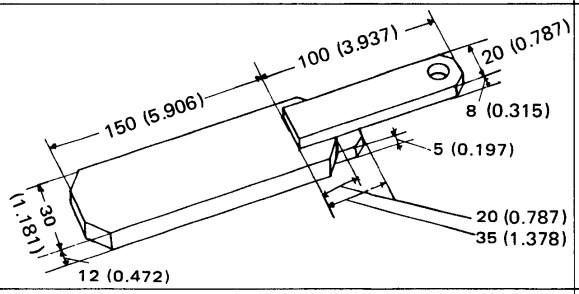
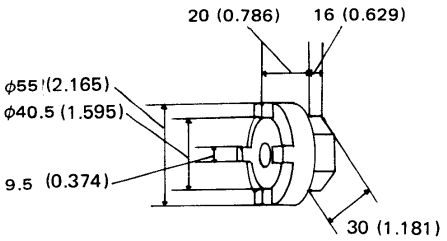
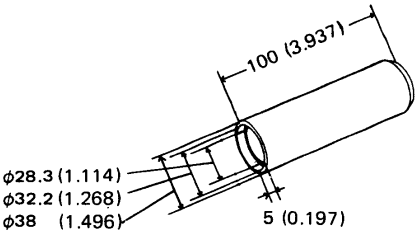
Adjusting point	Part No.	Thickness. mm (in.)	No. of shims
t1	177095-02150	0.1 (0.0039) 0.3 (0.0118) 0.5 (0.0197) 1.0 (0.0394)	2 1 2 1
t2	177090-02250	0.1 (0.0039) 0.3 (0.0118) 0.5 (0.0197) 1.0 (0.0394)	2 1 1 1
t3 & t4	177075-02150	0.3 (0.0118) 0.4 (0.0157) 0.5 (0.0197)	4 4 4
t5 & t6	177090-02310	0.1 (0.0039) 0.3 (0.0118) 0.5 (0.0197) 1.0 (0.0394)	4 2 2 2

4.Special Tools

Name of tool	Shape and size mm(in.)	Application
Inserting tool Part No. 177075-09030		For installing input and output shaft bearings.
Inserting tool Part No. 177088-09150		For installing intermediate shaft and clutch shaft bearings.
Spline socket Part No. 177073-09020		For checking limiter torque of the torque limiter
Ring nut wrench Part No. 177073-09010		For removing and tightening the torque limiter

Printed in Japan
0000A0A1647

Special tools

Name of tool	Shape and size mm (in.)	Application
Output shaft coupling lock Part No. 177075-09050		For removing and tightening the output shaft nut.
Socket Part No. 177073-00050		For removing and tightening output shelf nut.
Inserting tool Part No. 177073-09030		For installing the clutch shaft bearing

5.Disassembly

5-1 Disassembling the clutch and accessories.

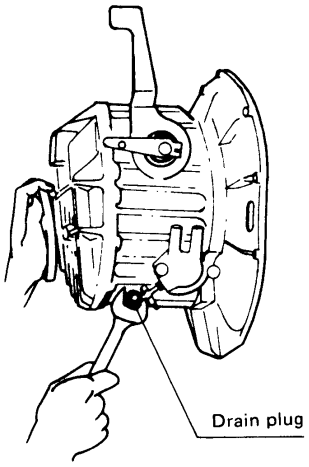
(1) Remove the remote-control cable and the C.W. hose of L.O. cooler.

(2) Dismount the clutch main body from the mounting flange.

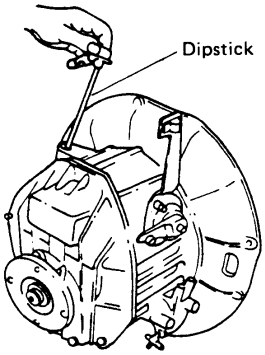
(3) Drain the lubricating oil

Drain the lubricating oil by loosening the plug at the bottom of the clutch case. Also remove the dipstick from the clutch case at the same time.

(4) Remove the drain plug and pull out the L.O.

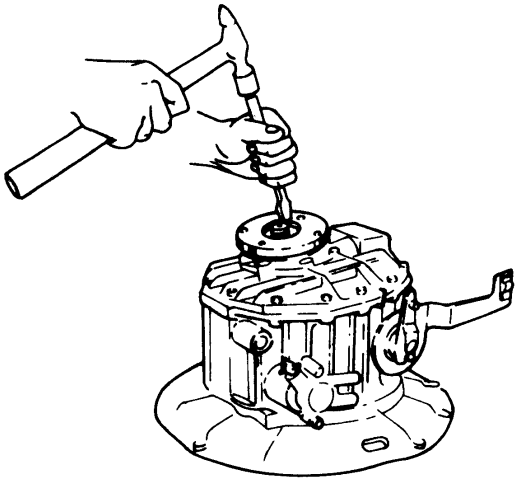


(5) Remove the dipstick.

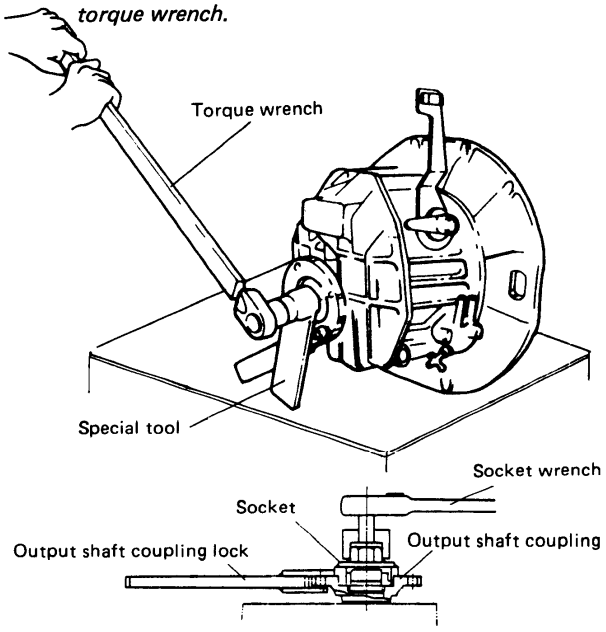


(6) Remove the end nut and output shaft coupling

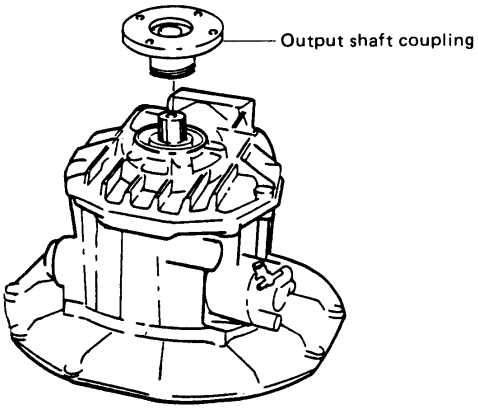
1) Loosen the calking of the endnut.



NOTE: Loosen the endnut with the special tool and a torque wrench.

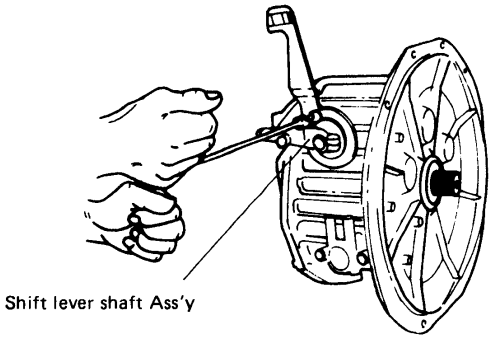


2) Remove the output shaft coupling



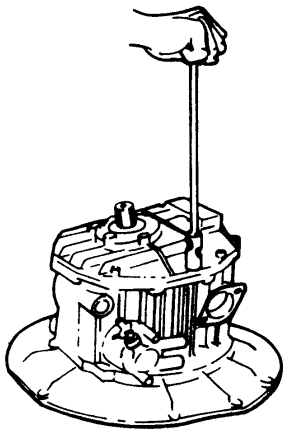
Printed in Japan
0000A0A1647

(7) Remove the fixing bolts on the side cover of clutch case, and also remove the shift lever shaft assembly.

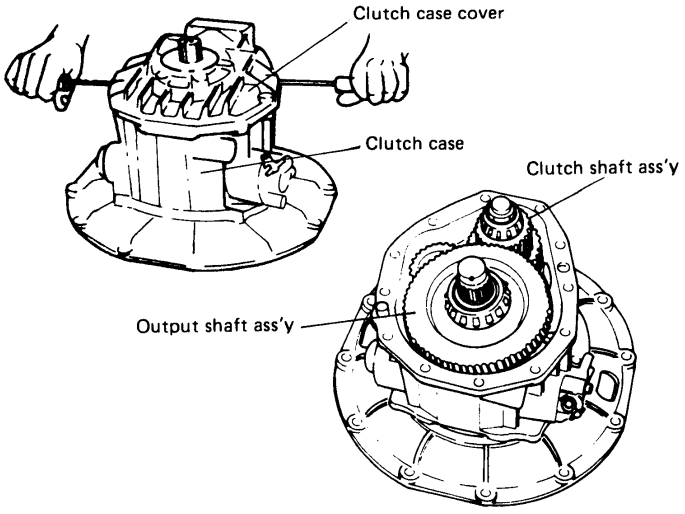


(8) Remove the clutch case cover.

1) Remove the bolt of the clutch case cover

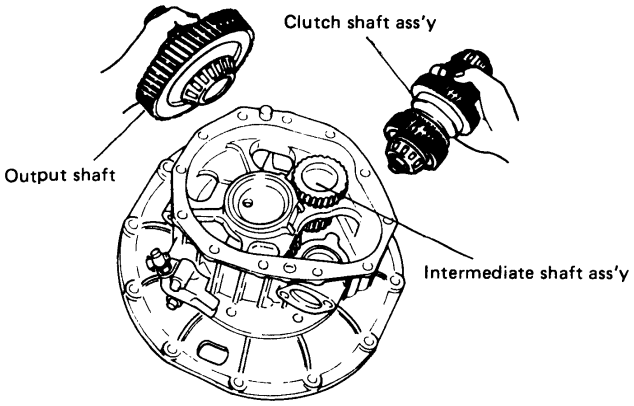


2) Remove the clutch case cover from the clutch case.



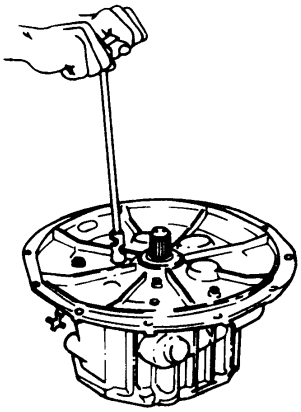
NOTE: To remove the case cover and the case, insert two drivers into the two depressed points at the joint between the case cover and the case. This makes removal easy.

(9) Removing the output shaft assembly and clutch shaft assembly.

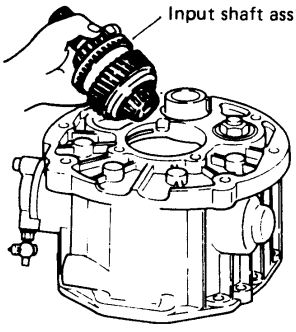


(10) Removing the mounting flange

Remove the fastening bolt of the mounting flange and then remove the mounting flange.

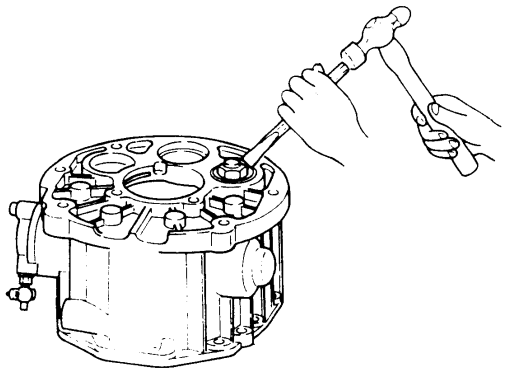


(11) Removing the input shaft assembly.
Draw out from the mounting flange side of the case.

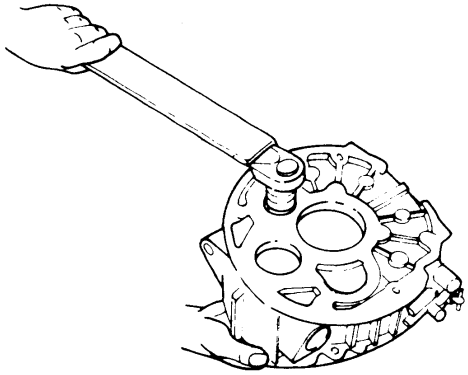


(12) Removing the intermediate shaft.

1) Loosen the calking of locknut of the intermediate shaft.

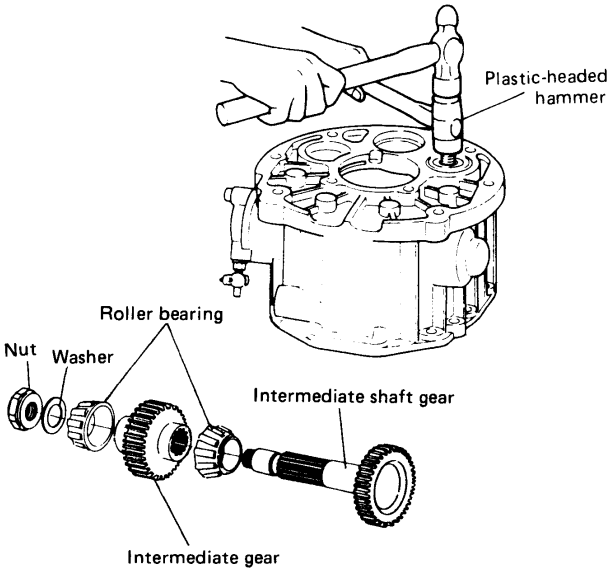


2) Remove the locknut.

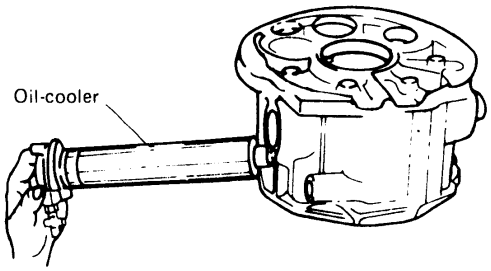


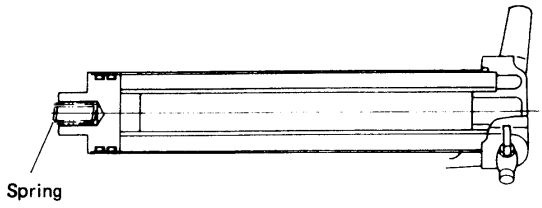
***NOTE:** Thread of the locknut is left-handed.*

3) Draw out the intermediate shaft tapping to the case cover side with a plastic-headed hammer.

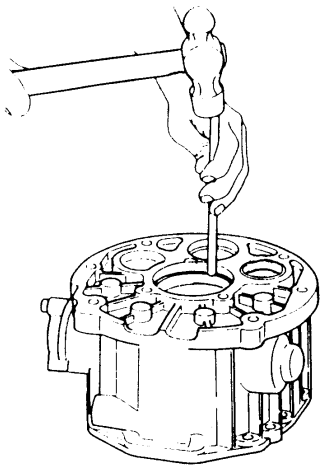


(11) Removing the oil-cooler.





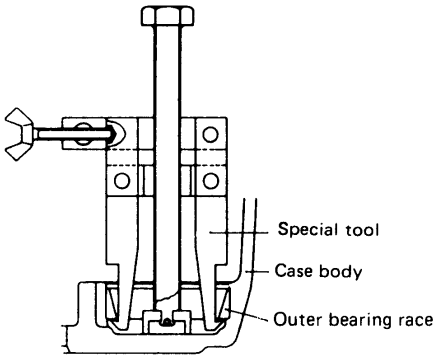
(14) Draw out the outer bearing races.



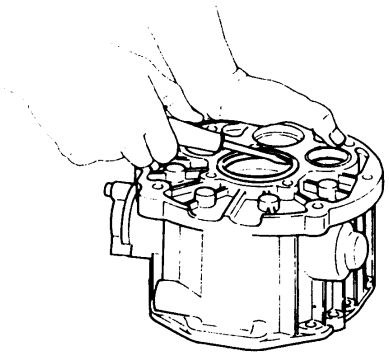
Printed in Japan
0000A0A1647

1) Remove the outer bearing races of the mounting flange, the case cover and the case.

NOTE: Remove the outer bearing races with a special tool.



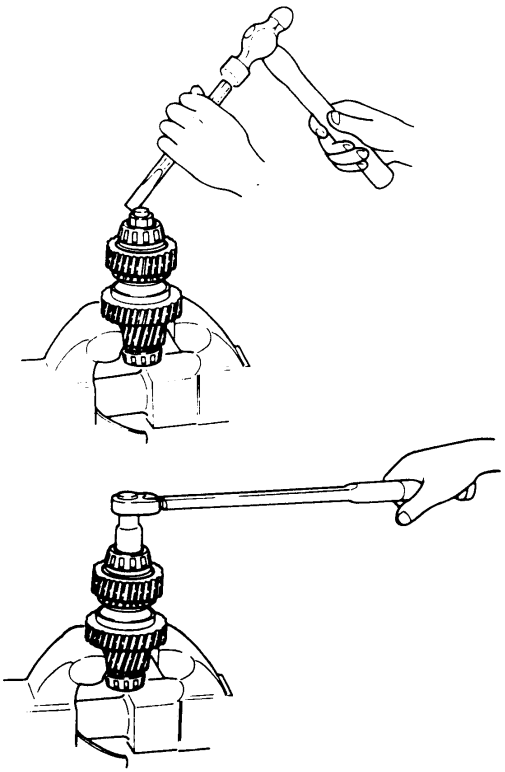
(15) Remove the oil seals of the mounting flange and the case cover.



5-2 Disassembling the clutch shaft.

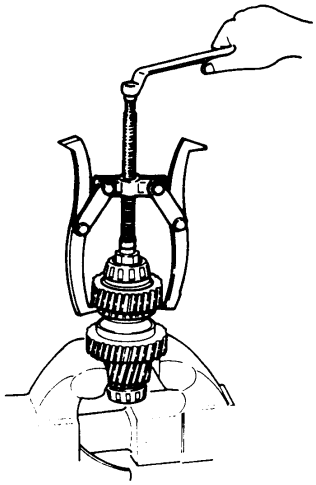
5-2-1 Clutch gear (A) side

(1) Loosen the calking of the end nut and remove the nut. Remove the nut by a torque wrench, fixing the clutch shaft in a vice.

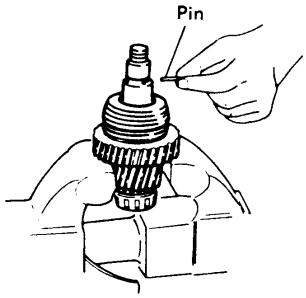


NOTE: Remember that the nut has a left-handed thread.

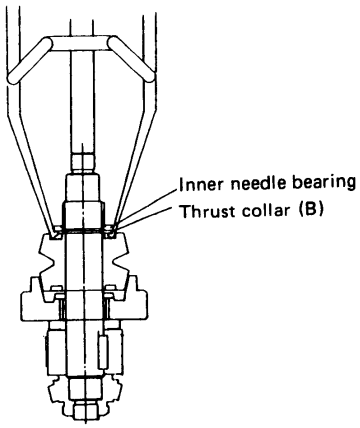
(2) Take out the clutch gear (A), Thrust collar (A), cup spring, spring retainer and inner bearing trace. The clutch gear (A) must be withdrawn using a pulley extracter, with the clutch shaft fixed in a vice.



(3) Remove the pin

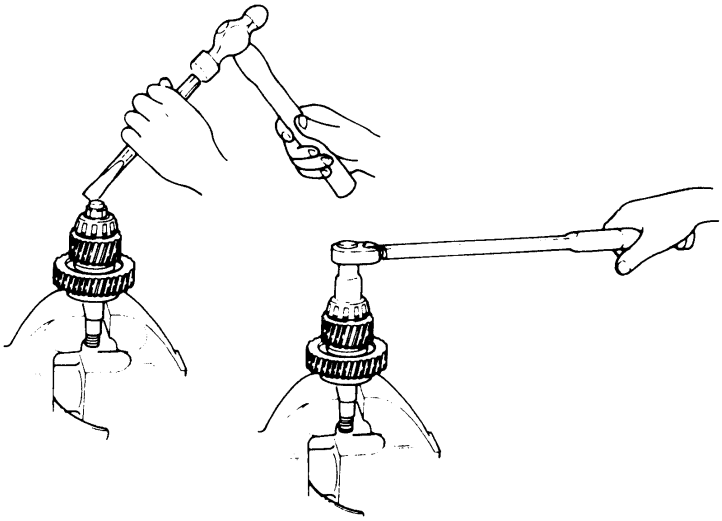


(4) Withdraw the thrust collar (B), inner needle bearing by pulley extractor.



5-2-2 Clutch gear (B) side

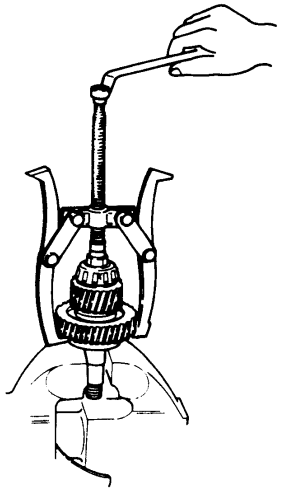
(1) Loosen the calking of the end nut and remove the nut. Remove the nut by a torque wrench, with the clutch shaft fixed in a vice.



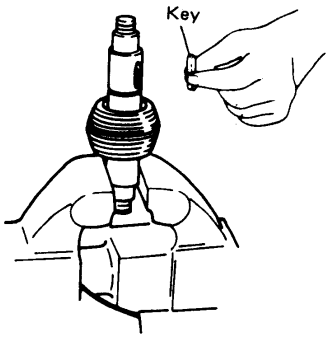
NOTE: Remember that as the nut has a left-handed thread.

Printed in Japan
0000A0A1647

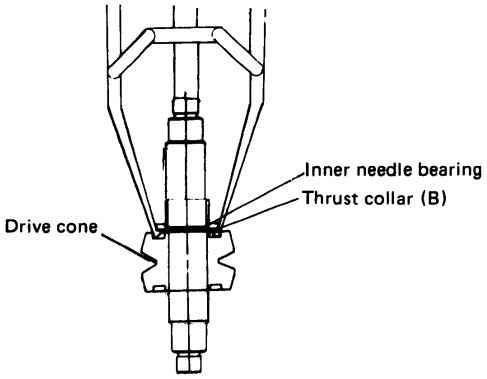
(2)Withdraw the large gear (B), thrust collar (A), cup-spring, spring retainer, drive gear and inner bearing race.
Use a pulley extracter, with the clutch shaft fixed in a vice.



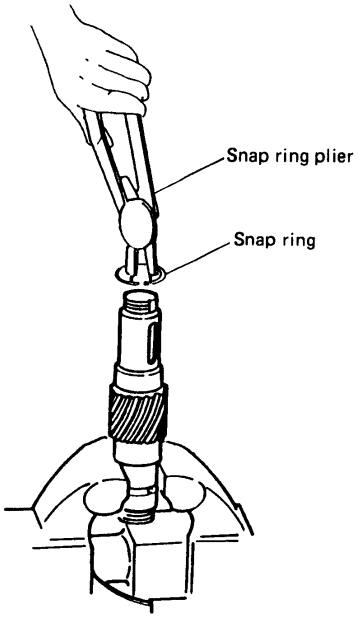
(3)Remove the key



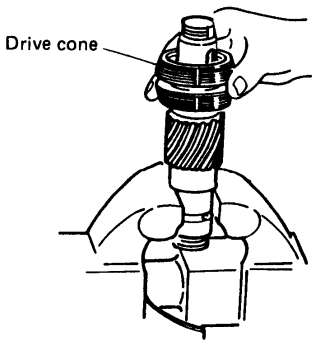
(4)Withdraw the thrust collar (B) and inner needle bearing race with the pulley extractor.



(5)Remove the snap rings

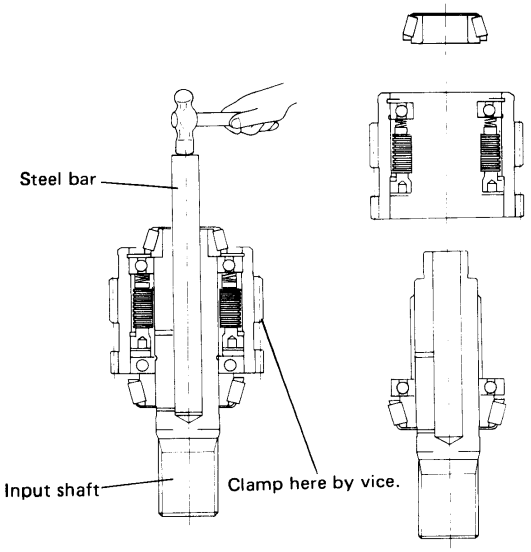


(6)Draw out the drive cone.

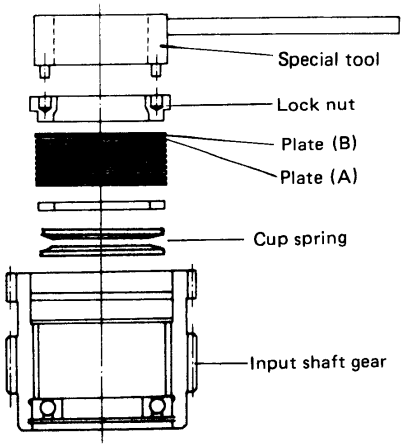


5-3 Disassembling the input shaft.

(1) Draw out the input shaft tapping to the small roller bearing side with a steel bar.

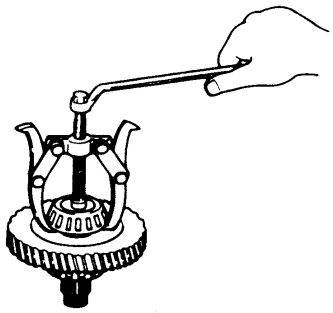


(2) Fix the input shaft gear in a vice, and remove the lock nut with a special tool.



5-4 Disassembling the output shaft

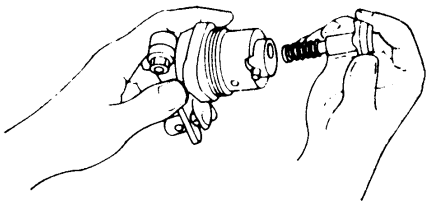
(1) Remove the bearing inner race from the output shaft. Use a pulley extracter, fixing the output shaft in a vice.



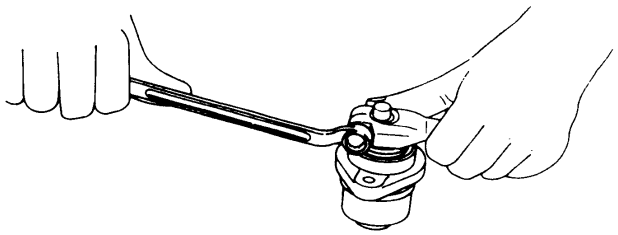
Printed in Japan
0000A0A1647

5-5 Disassembling the shifting device

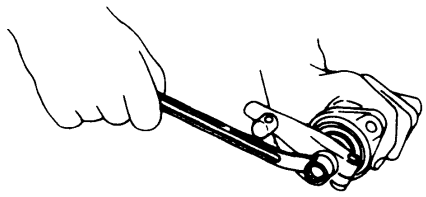
(1) Take out the shifter and shifter spring



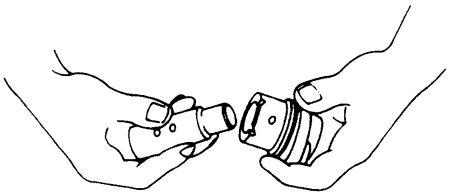
(2) Remove the stopper bolt of the shifter and shim.



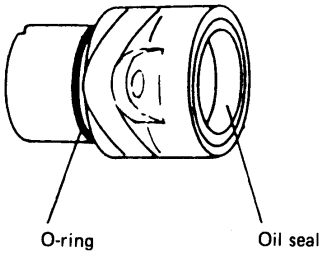
(3) Loosen the belt of the shift lever and remove the shift lever and cable bracket



(4) Remove the shift lever to the anti-shift lever side.



(5) Remove the oil-seal and O-ring.

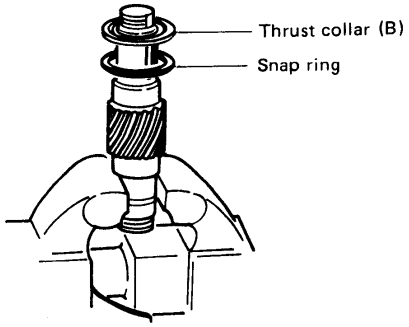


6.Reassembly

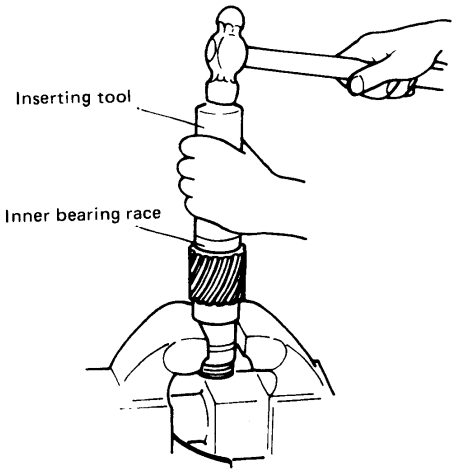
6-1 Reassembly of clutch shaft

6-1-1 Clutch gear (B) side

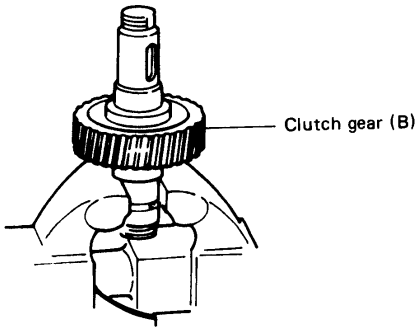
(1)Fit the clutch gear (B) side snap ring and thrust collar (B) onto the shaft.



(2)Drive in the inner needle bearing race using the inserting tool.

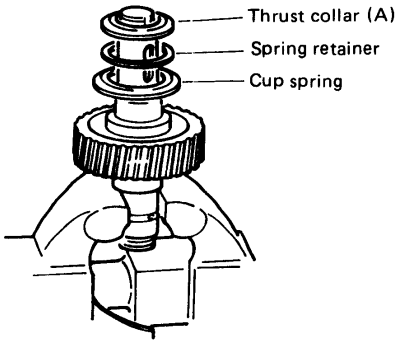


(3)Assemble the needle bearing and clutch gear (B)



NOTE: Check that the clutch gear (B) rotates smoothly.

(4)Fit the cup spring, spring retainer, thrust collar (A).

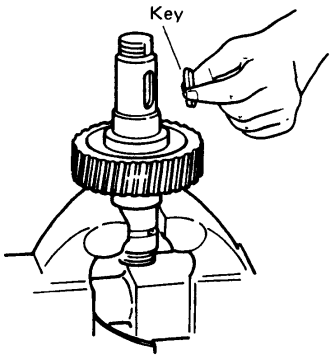


NOTE: 1) Drive in with a plastic headed hammer. Do not hit hard.

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

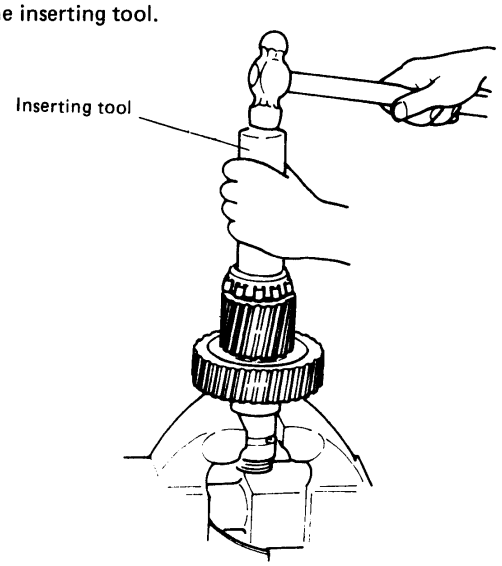
3) Check that the clutch gear (B) rotates smoothly.

(5)Fit the key

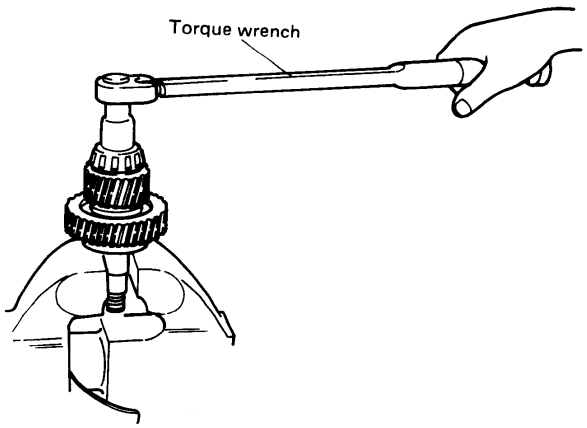


Printed in Japan
0000A0A1647

(6)Drive in the driving gear and inner bearing race using the inserting tool.



(7)Set and tighten the clutch gear (B) end nut
Fit the clutch shaft in a vice, and tighten the nut with a torque wrench.

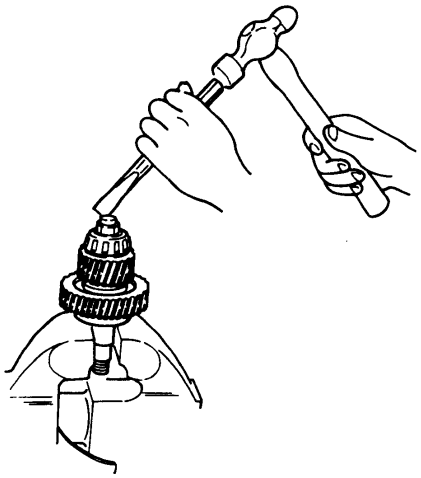


Tightening torque	8.5 – 11.5 kg-m (61.5 – 83.2 ft-lb)

NOTE: 1) Remember it is a left-handed thread.

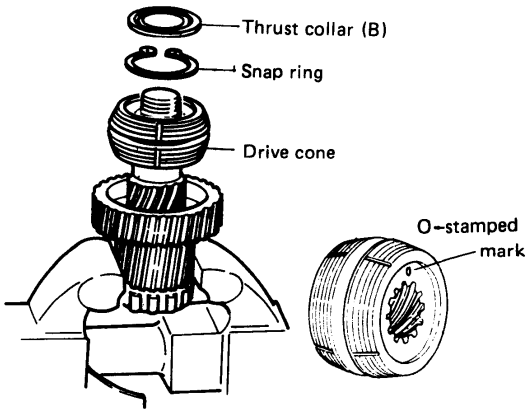
2) Use the clutch gear (A) side nut which is used before dismantling for the clutch gear (B) end nut. This is not to make the calked portion to the same point.

(8)Calking the end nut and clutch shaft.



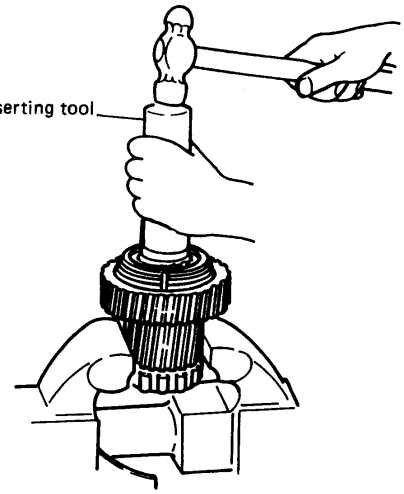
6-1-2 Clutch gear (A) side

(1)Insert the drive cone, snap ring and thrust collar (B).

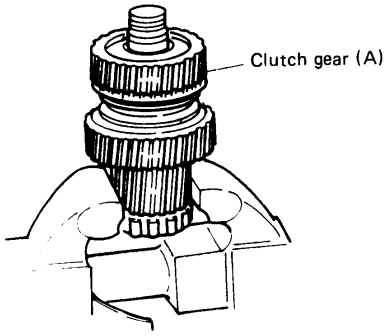


NOTE: Insert it keeping the O-stamped make surface toward the clutch gear (B) side.

(2)Drive in the inner needle bearing race, using an inserting tool.

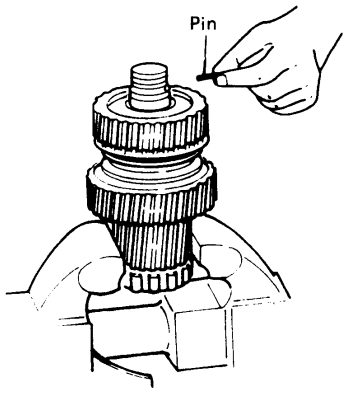


(3)Assemble the needle bearing and clutch gear (A)

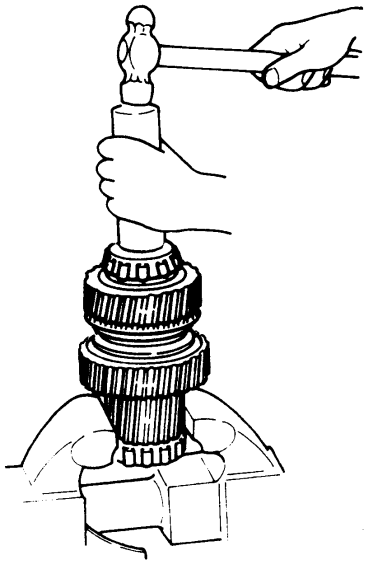


NOTE: Check that the clutch gear (A) rotates smoothly.

(4)Insert the pin.



(5)Fit the cup spring, spring retainer and thrust collar (A) and drive in the inner bearing race using the inserting tool.

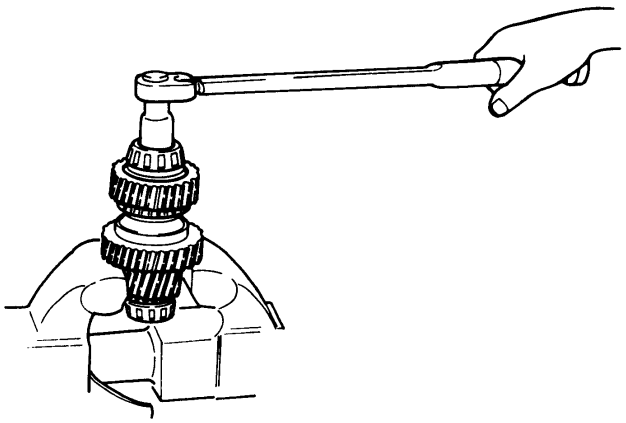


NOTE: 1) When fitting the thrust collar (A), note the fitting direction. Fit it keeping the stepped surface toward the roller bearing side.

2) The pin cannot be fitted after the inner bearing race has been driven in.

3) Check that the large gear (B) rotates smoothly.

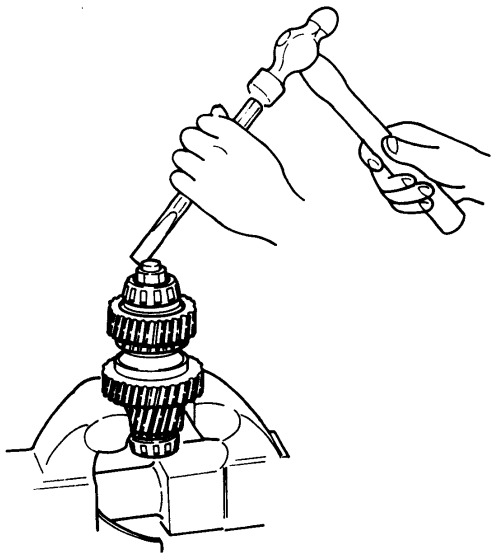
(6)Set and tighten the clutch gear (A) end nut. Fix the clutch shaft in a vice and tighten the nut with a torque wrench.



Tightening torque	8.5 – 11.5 kg-m (61.5 – 83.2 ft-lb)

NOTE: 1) Remember it is a left-handed thread.

(7)Calk the end nut and clutch shaft.



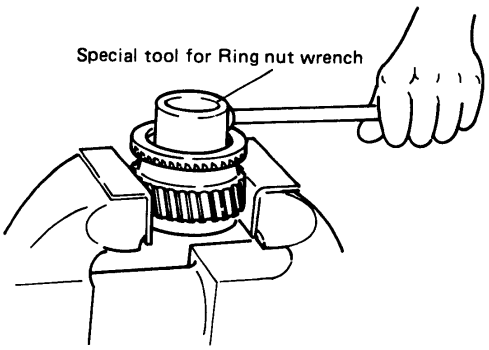
NOTE: Use the clutch gear (A) side nut which is used before dismounting for the clutch gear (B) end nut. This not to make the calked portion to the same point.

Printed in Japan
0000A0A1647

6-2 Reassembly of input shaft

(1)Drive in the ball bearing and fit the snap ring into the input shaft gear.

(2)Insert the cup springs, spacer, plates (A) and plates (B) and temporarily lock the lock nut.

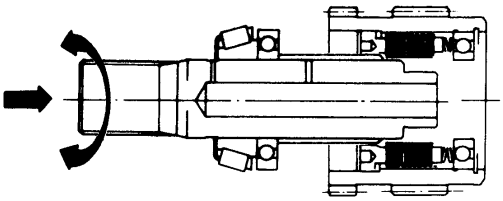


NOTE: Apply lube oil to each insert parts.

(3)Fit the O-ring onto the input shaft.

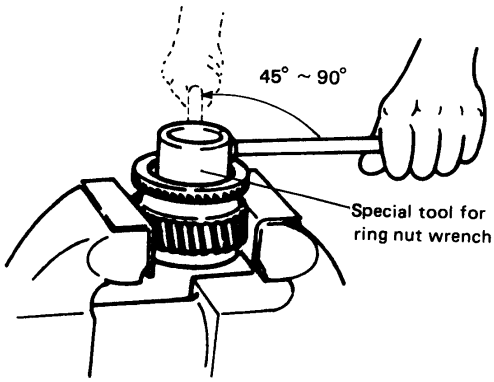
(4)Drive the ball bearing and the inner bearing race using a inserting tool.

(5)Insert the input shaft into the plate (A).

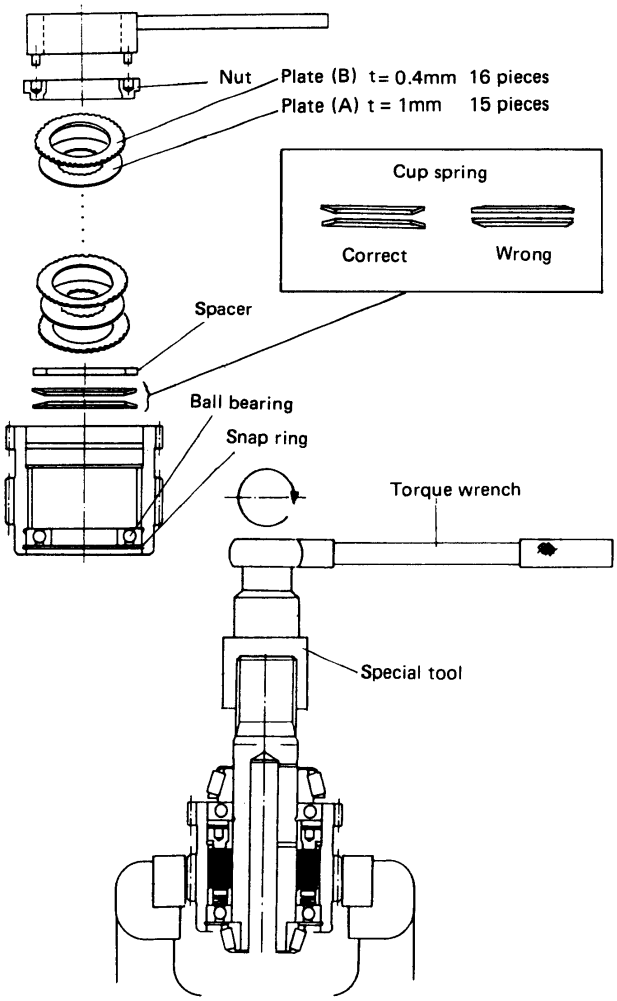


(6)Take out the input shaft again.

(7)Tighten the nut firmly by using a special tool, then return the nut to 45 – 90 degrees.



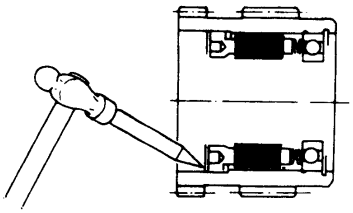
(8)Insert the input shaft, then measure the torque of the input shaft using a torque wrench.



Torque:	55 – 60 kg-m (398 – 434 ft-lb.)

NOTE: Match up the teeth of plate (A).

(9)Take out the input shaft and calking the lock nut end of the thread.



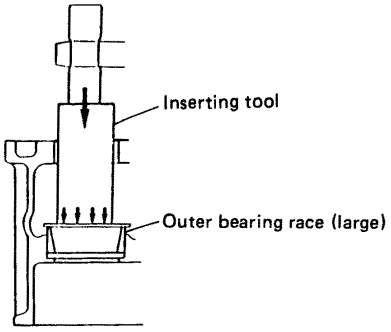
(10)Insert the input shaft into the input gear assembly.

(11)Drive in the inner bearing race onto the input shaft end.

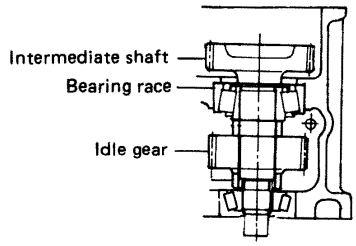
6-3 Reassembly of the clutch case

6-3-1 Reassembly of the intermediate shaft

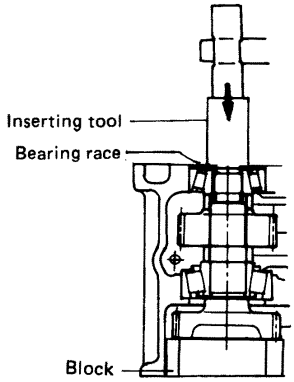
(1)Drive in the outer bearing race (large) into the clutch case.



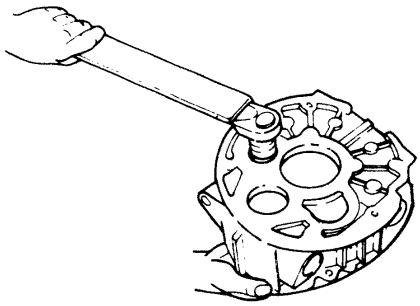
(2) Insert the inner bearing races and idle gear and drive in the intermediate shaft



(3)Drive the outer bearing race into the clutch case.



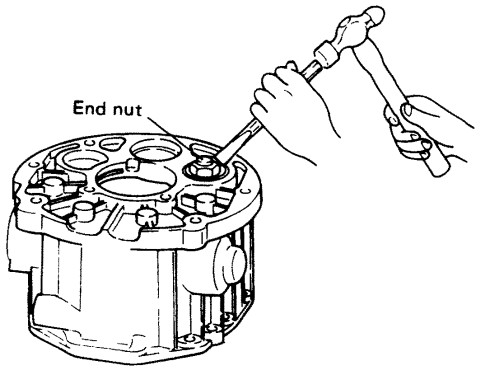
(4)Insert the washer and tighten the end nut using a torque wrench.



Tightening torque	8.5 ~ 11.5 kg-m (61.5 ~ 83.2 ft-lb)

NOTE: Remember it is a left-handed thread

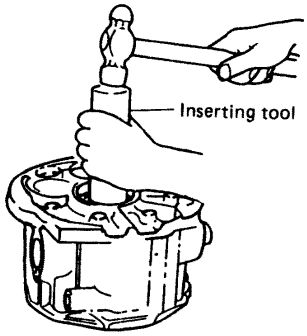
(5)Calk the end nut



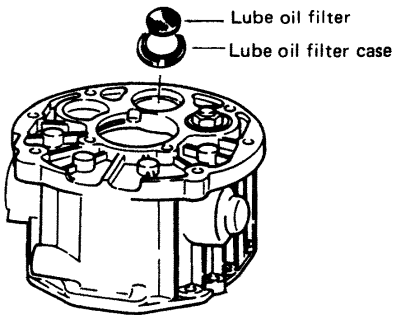
(6)Insert the shims into the clutch case.

6-3-2 Reassembly of the bearing outer races and shims in the clutch case

(1)Drive the input shaft outer bearing race and clutch shaft outer bearing race into the clutch case.



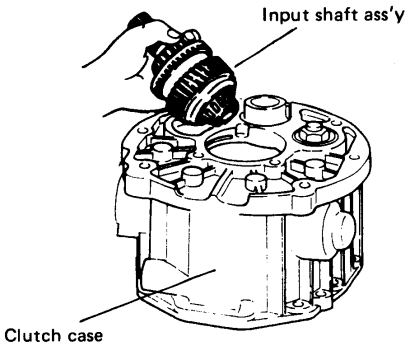
(2)Insert the clutch shaft shim, Lube oil filter case and filter into the clutch case.



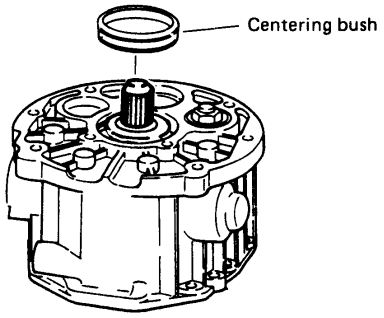
Printed in Japan
0000A0A1647

6-3-3 Reassembly of the input shaft

(1)Insert the input shaft assembly into the clutch case.



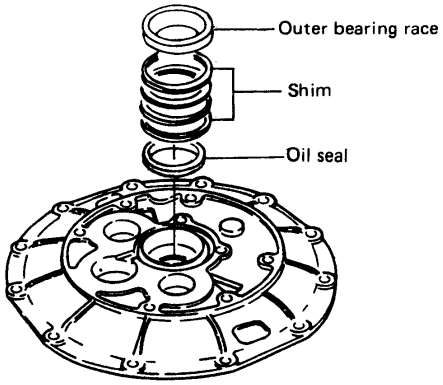
(2)Drive the centering bush into the clutch case.



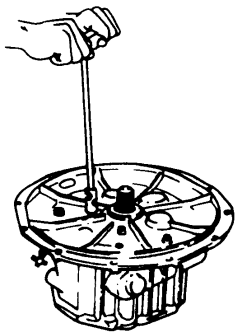
6-3-4 Reassembly of the mounting flange

(1)Insert the oil seal and the shim into the mounting flange.

(2)Drive the outer bearing race into the mounting flange.

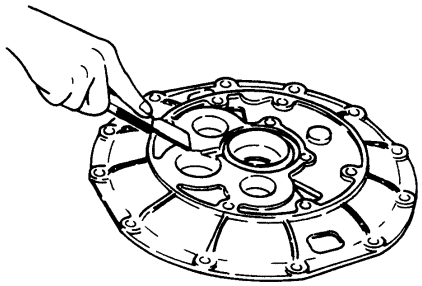


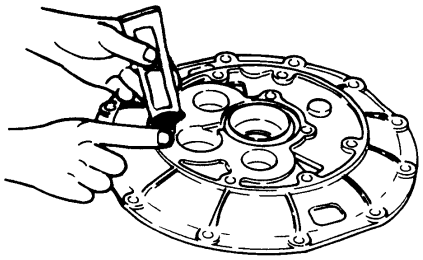
(3)Fit the mounting flange onto the clutch case, and tighten the bolt.



Tightening torque	5 – 6 kg-m (36.2 – 43.4 ft-lb)

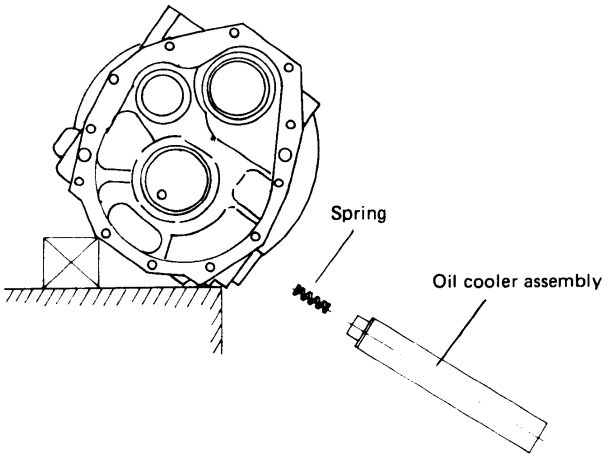
NOTE: Apply non-drying liquid packing to the maching surface of the mounting flange and the clutch case.





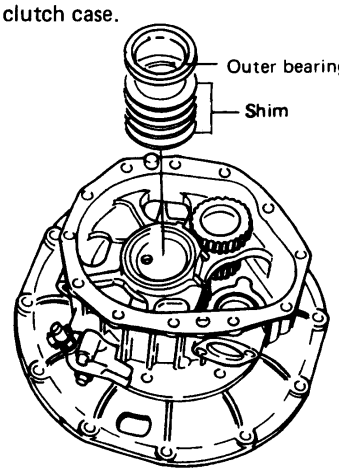
6-3-5 Reassembly of the oil cooler

NOTE: Fasten taking care not to allow the spring at the tip of oil cooler to drop out.

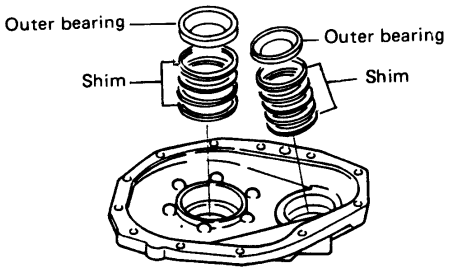


6-3-6 Reassembly of the clutch case cover.

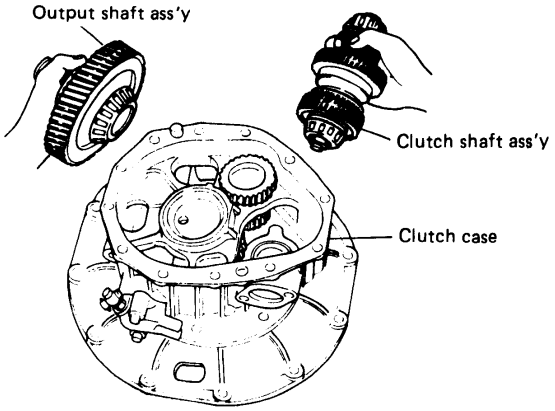
(1) Drive the output shaft shim and the outer bearing race into the clutch case.

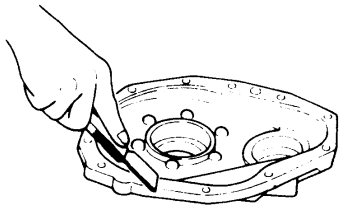


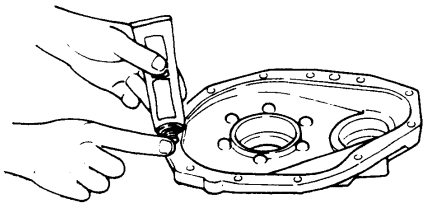
(2) Drive the shims and the outer bearing races into the clutch case cover



(3) Insert the clutch shaft assembly and the output shaft into the clutch case.

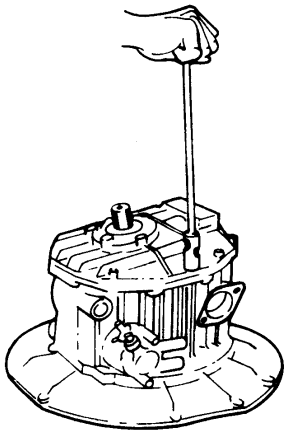






NOTE: Apply non-drying liquid packing to the maching surface of the clutch case cover and the clutch case.

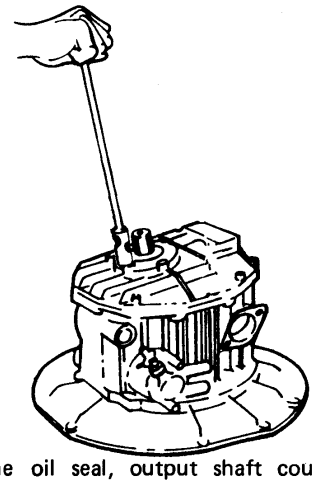
(4) Fit the clutch case cover on the clutch case, and tighten the bolt.



Tightening torque	2.3 – 2.8 kg-m (16.6 – 20.3 ft-lb)

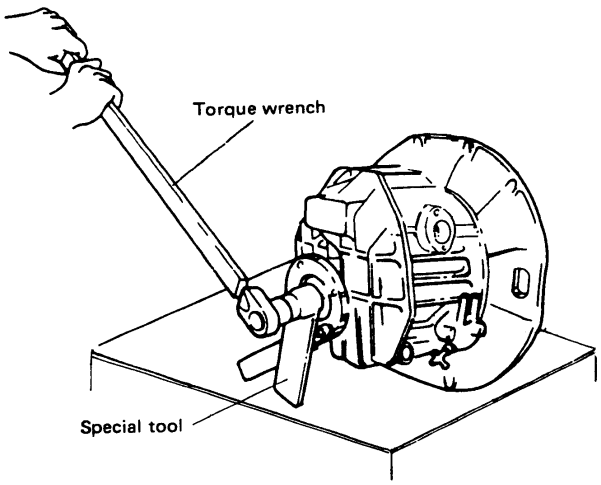
Printed in Japan
0000A0A1647

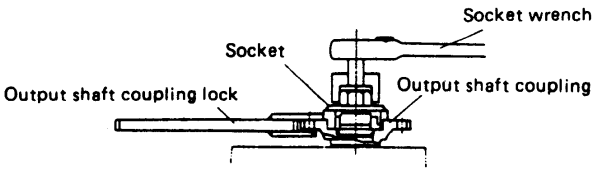
(5)Insert the outer bearing race, shim and the output shaft cover, and tighten the bolt.



(6)Insert the oil seal, output shaft coupling, O-ring and the end nut into the output shaft.

(7)Tighten the end nut with the special tool and a torque wrench, then calk it.

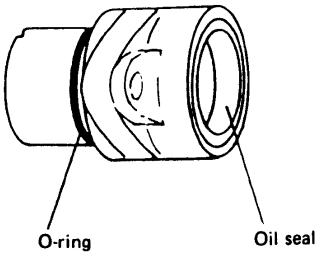




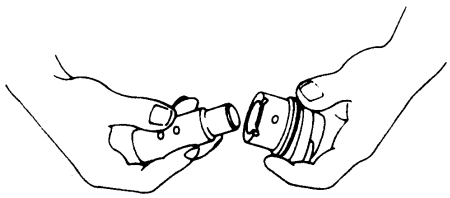
Tightening torque	54 – 56 kg-m (391 – 405 ft-lb)

6-3-7 Reassembly of the shifting device

(1)Fit the oil seal and O-ring to the side cover

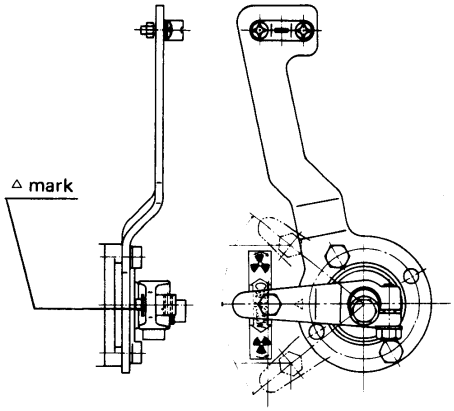


(2)Insert the shift lever shaft to the side cover

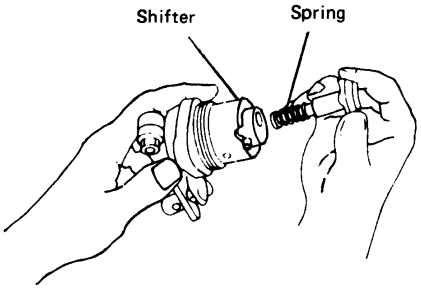


(3)Fit the shift lever to the shift lever shaft

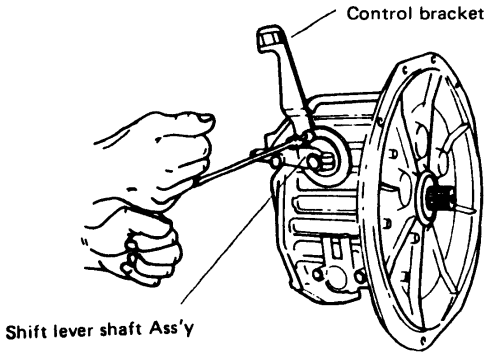
NOTE: Check the direction of the shift lever △ mark.



(4)Insert the shifter spring and shifter to the shift lever shaft



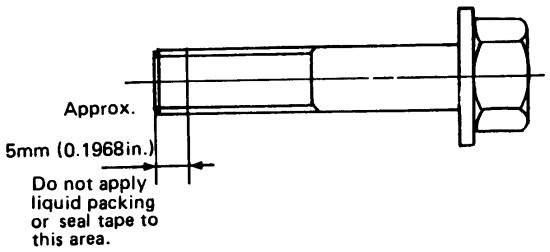
(5) Fit the side cover assembly and the remote control bracket to the clutch case.



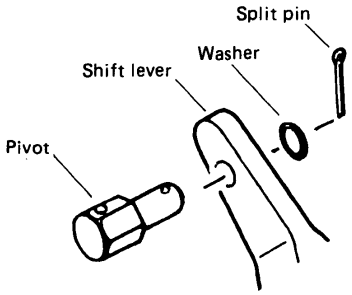
NOTE: 1) Check the direction of the shifter (Top and bottom side)
2) The shift lever may not turn smoothly if the clutch case is not filled with lubricating oil.

(6) Fit the shim and stopper bolt to the shift lever shaft.

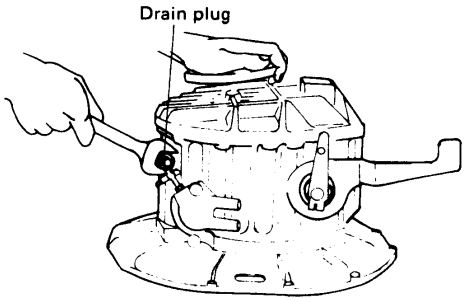
NOTE: Apply non-drying liquid packing or seal tape to the thread of the stopper bolt.

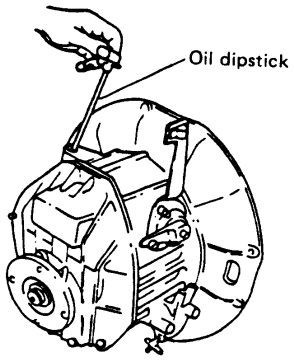


(7) Fit the pivot to the shift lever.



6-3-8 Reassembly of the lube oil drain plug and the dipstick





Printed in Japan
0000A0A1647

CHAPTER 8

REMOTE CONTROL (OPTIONAL)

1. Remote Control System 8-1
2. Remote Control Installation. 8-2
3. Remote Control Inspection 8-5
4. Remote Control Adjustment 8-6

Printed in Japan
0000A0A1647

1. Remote Control System

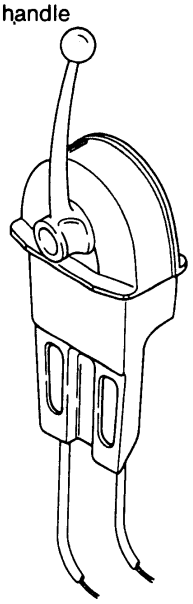
1-1 Construction of remote control system

The remote control permits one handed control of the engine speed, changing from forward to reverse, and stopping.
Fittings which allow for easy connection of the remote control cables with the fuel injection pump and transmission are provided with the remote control set.
The use of Morse remote control cables, clamps and a remote control head, are also provided for. The device to stop the engine is electric and will be explained under the section on electrical equipment.

1-2 Remote control device components

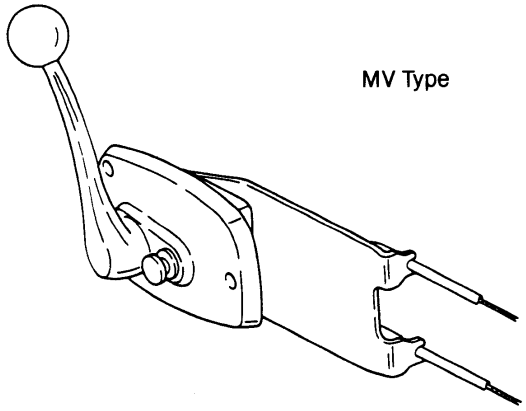
	Morse description	Yanmar Part No.
Remote control head	Morse MT2 top mounting single lever	41730-000680
	Morse MV side mounting single lever	128170-86500
Remote control cable	Morse 33C x 4m (13.12ft.)	41710-000360
	Morse 33C x 7m (23.00ft.)	129470-86500
Engine stop cable	Yanmar 4m (13.12ft)	129470-67550
	Yanmar 7m (22.96ft)	129470-67560

(1) Remote control handle



MT-2 Type

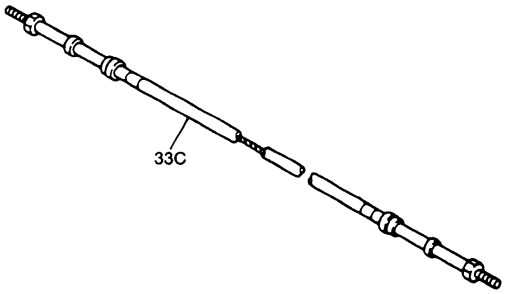
The model MT-2 remote control has been designed so that operation of the clutch (shift) and governor (throttle) can be effected with one lever.
Two cables are required for the MT-2 single, one for the clutch and the other for the governor.
When warming up the engine, to freely control the governor separately from the clutch put the lever in-neutral, the central position, and pull the knob in the center of the control lever. When the lever is returned to the neutral position, the knob automatically returns to its original position, and the clutch is free. The governor can then be freely operated.



MV Type

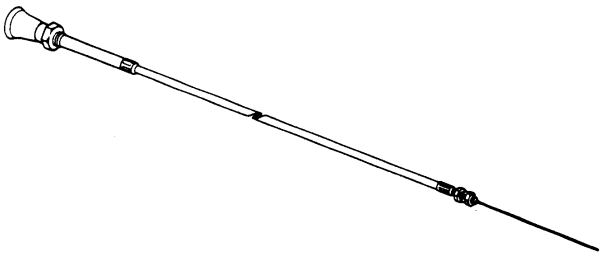
The MV type controller has been designed so that operation of the clutch and throttle can be effected with one lever. When the button next to the control lever is pulled out with the lever in the central position, it holds the clutch in the neutral position so that the throttle can be opened all the way and warm up the engine.
When the engine is warmed up, return the handle to the central position and push the button back in. Control of the clutch and throttle is thus effected with one handle.

(2) Remote control cable



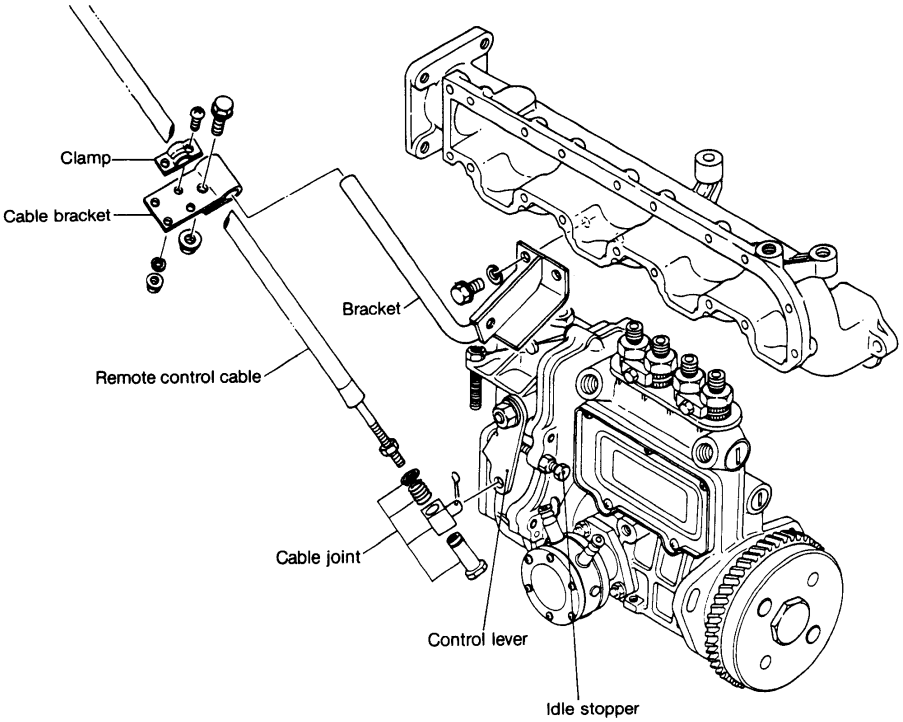
Use only Super-Responsive Morse Control Cables.
These are designed specifically for use with Morse control heads. This engineered system of Morse cables, control head and engine connection kits ensures dependable, smooth operation with an absolute minimum of backlash.

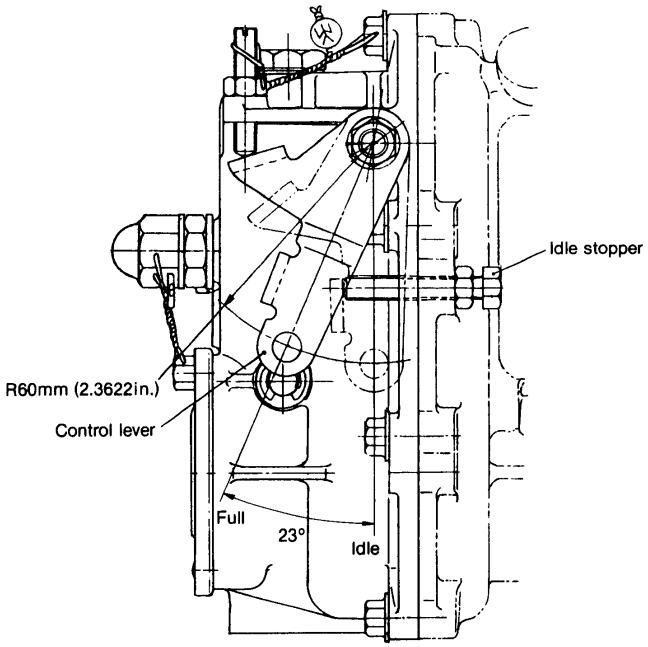
(3) Engine stop cable



2. Remote Control Installation

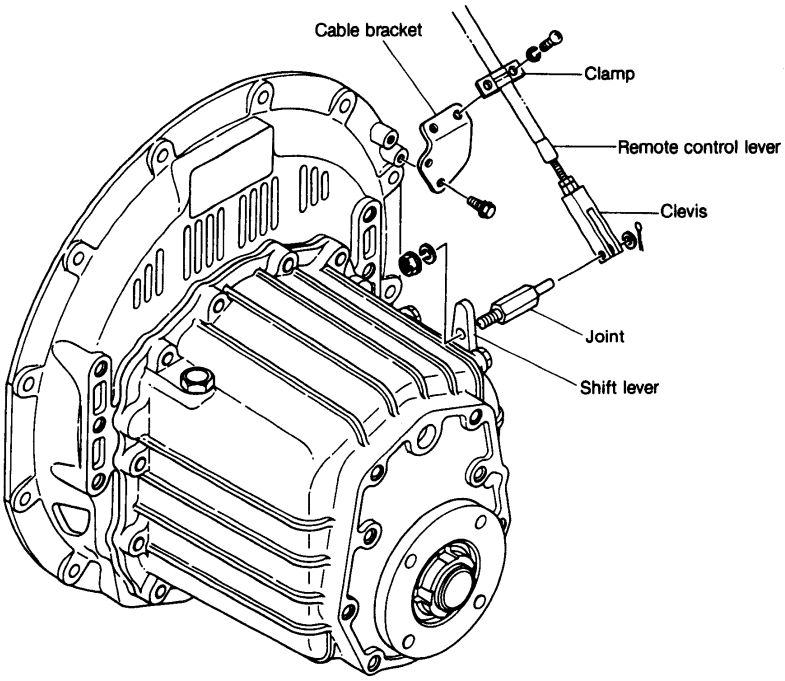
2-1 Speed control

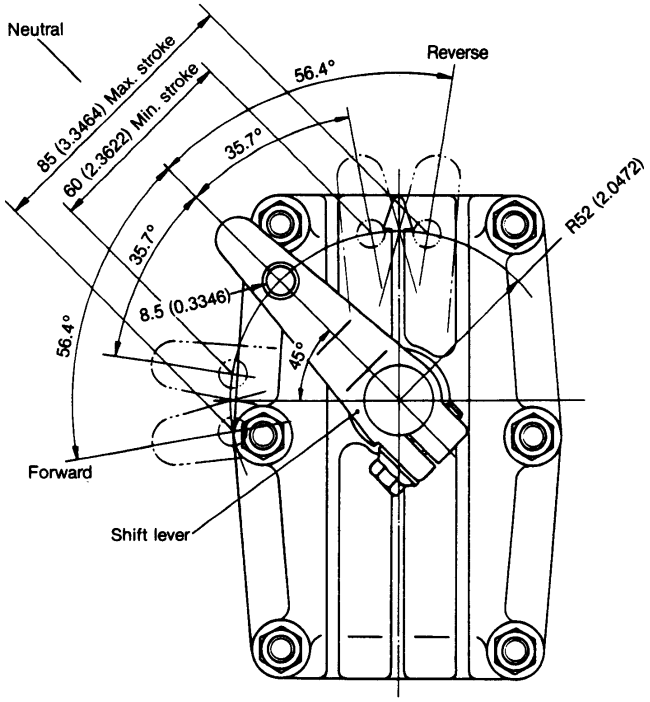




Printed in Japan
0000A0A1647

2-2 Clutch control

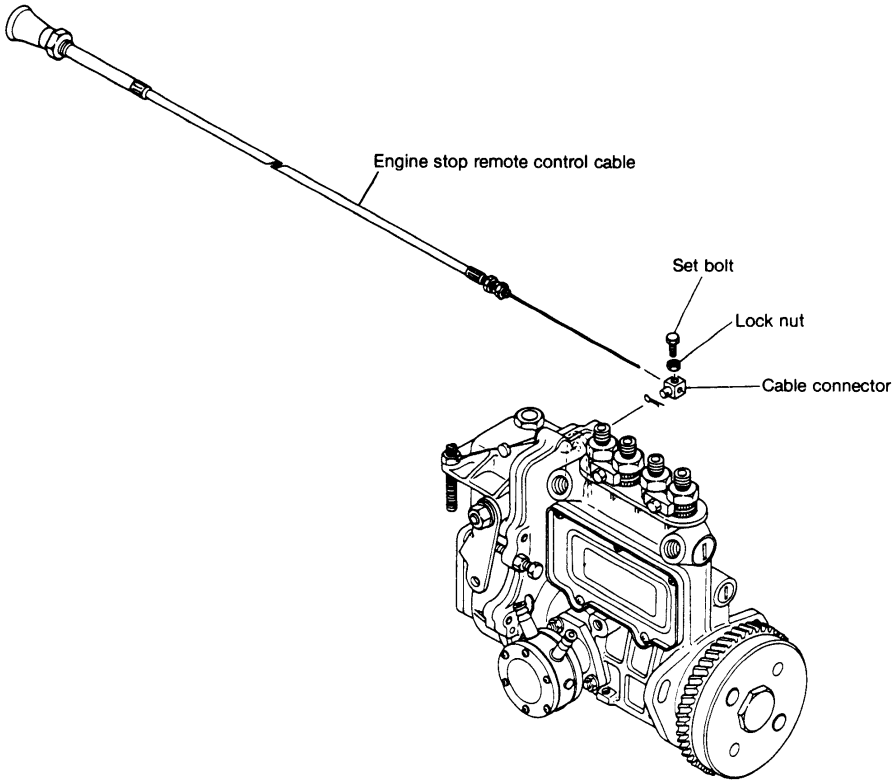


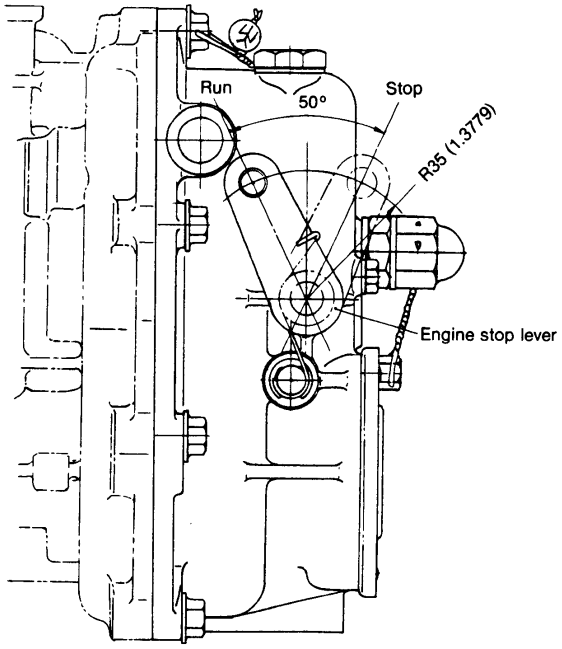


mm (in.)

Printed in Japan
0000A0A1647

2-3 Engine stop



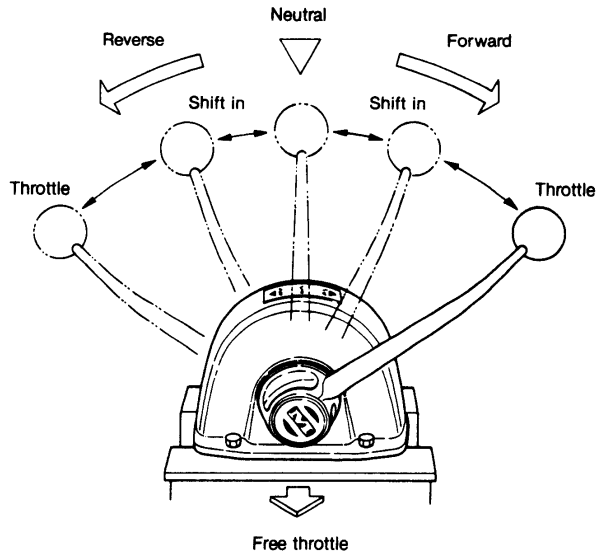


mm (in.)

Printed in Japan
0000A0A1647

3. Remote Control Inspection

(1) When the control lever movement does not coincide with operation of the engine, check the cable end stop nut to see whether or not it is loose, and readjust/ retighten when necessary.



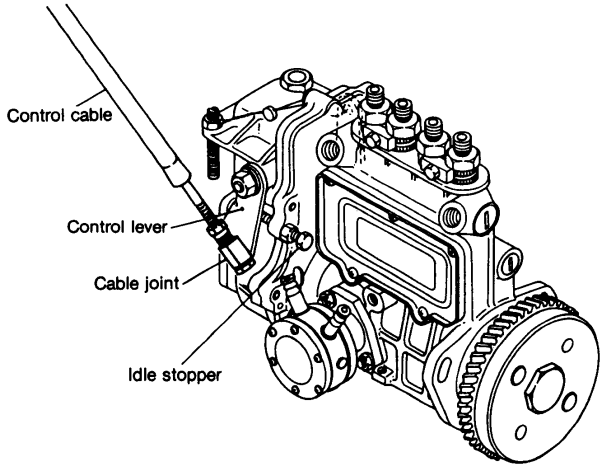
(2) To many bends (turns) in the cable or bends at too extreme an angle will make it difficult to turn the handle. Reroute the cable to reduce the number of bends or enlarge the bending radius as much as possible (to 200mm or more).
(3) Check for loose cable bracket/clamp bolts or nuts and retighten as necessary.
(4) Check cable connection screwheads, cable sleeves and other metal parts for rust or corrosion. Clean off minor rust and wax or grease the parts. Replace if the parts are heavily rusted or corroded.

Printed in Japan
0000A0A1647

4. Remote Control Adjustment

(1) Shift lever adjustment
Move the lever several times—the movement of the clutch lever on the engine from forward, neutral and reverse must coincide with the forward, neutral and reverse on the control lever. If they do not coincide, adjust the fittings as necessary (first engine side, then controller side).

(2) Throttle lever adjustment
Move the control lever all the way to full throttle several times, and then return. The throttle lever on the engine must lightly push against the idle switch when it is returned. If it is properly adjusted, the knob can be easily pulled out when the lever is in the neutral position, and will automatically return when the control lever is brought back to the neutral position. If the control lever presses too hard against the knob, it may not return automatically, in which case the cable end must be adjusted as explained for the clutch. The knob cannot be pulled out when the lever is not in the neutral (central) position.



Printed in Japan
0000A0A1647