CHAPTER 7b

REDUCTION AND REVERSING GEAR

Marine gear model KM4A (Angle drive)

Marine Gear Model

KM4A

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

1. Construction

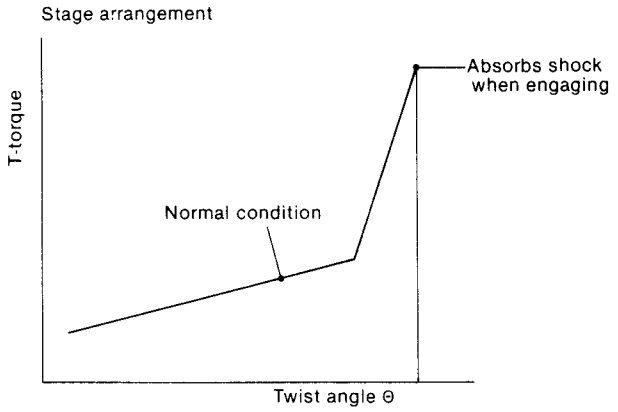
1-1 Construction

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		

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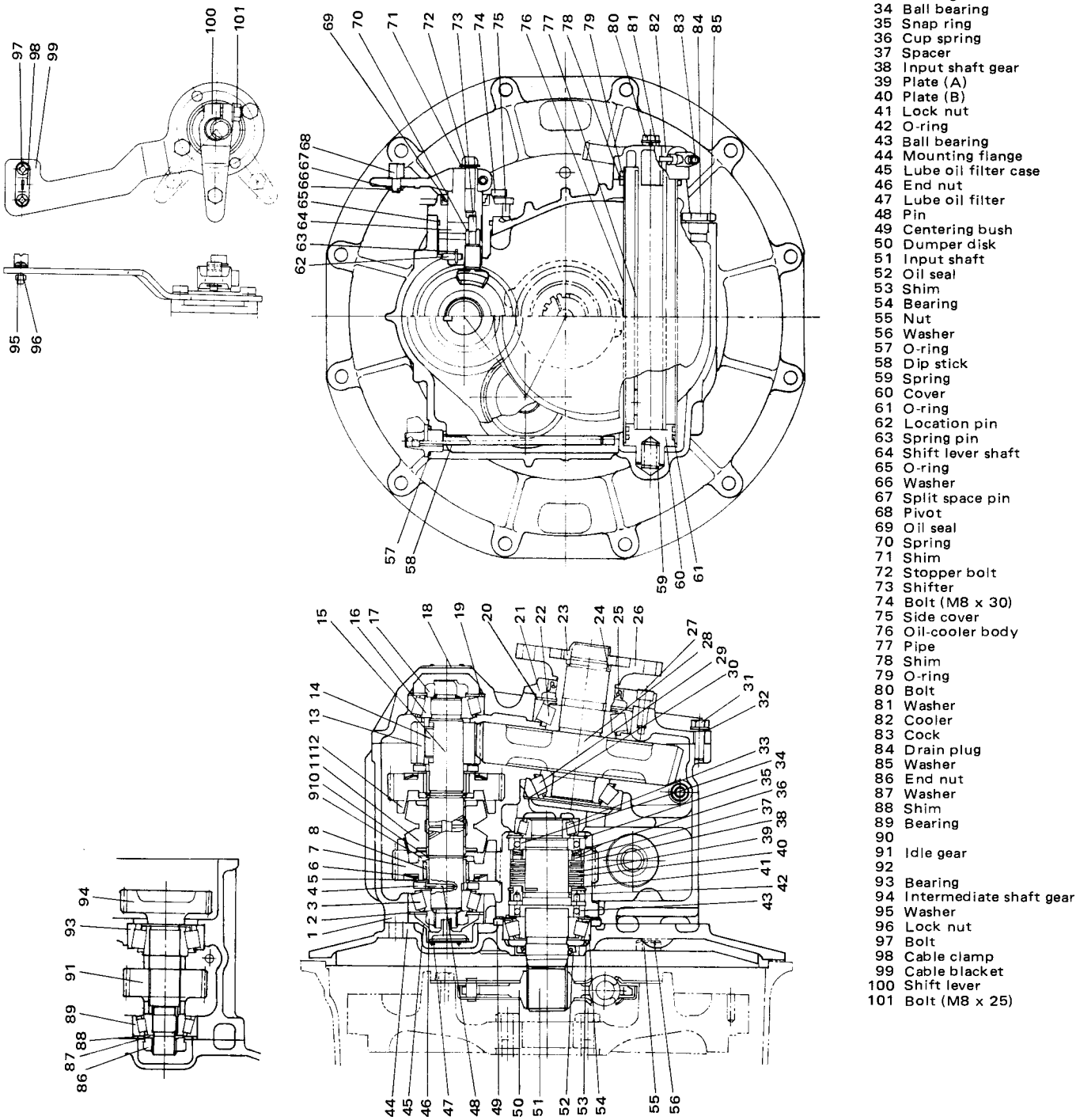
1-3 KM4A Sectional View

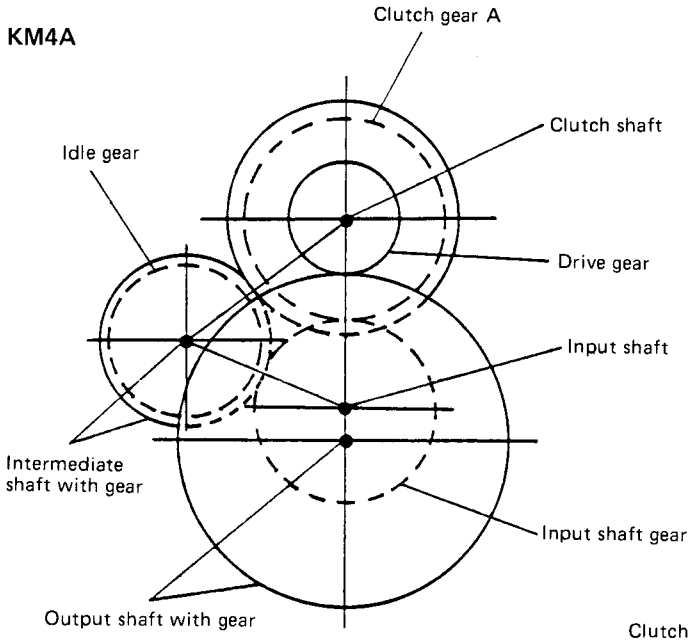


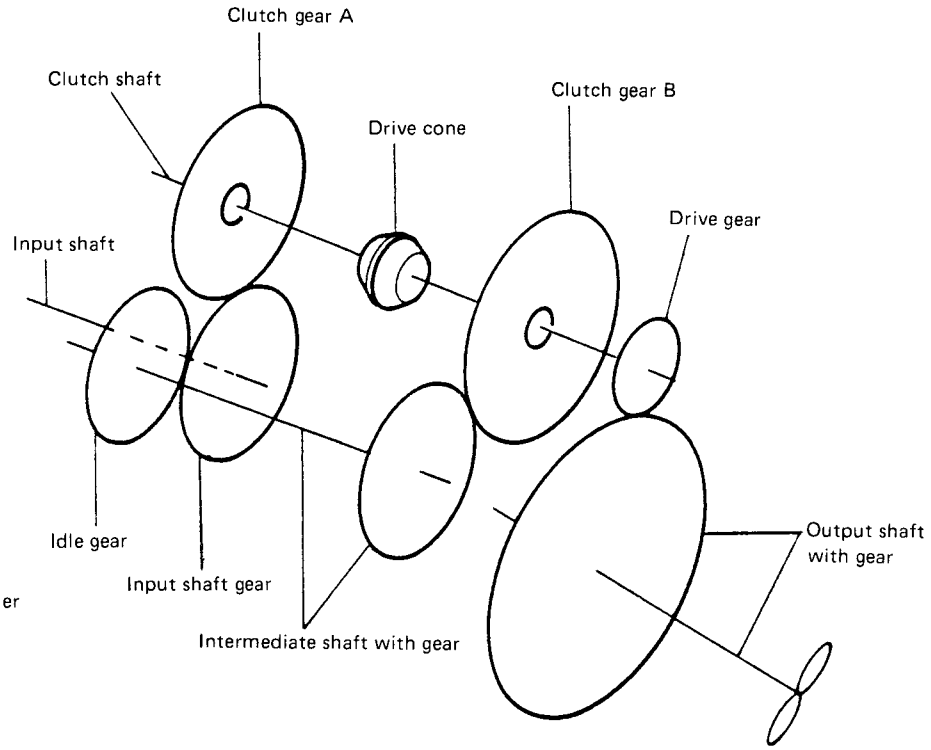
1 Clutch case
2 Shim
3 Bearing
4 Thrust collar (A)
5 Spring retainer
6 Cup spring
7 Clutch gear (A)
8 Needle bearing
9 Thrust collar (B)
10 Snap ring
11 Drive cone
12 Clutch gear B
13 Driving gear
14 Key
15 Clutch shaft
16 Bearing
17 End nut
18 Name plate
19 Shim
20 Shim
21 Output shaft cover
22 Bearing
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

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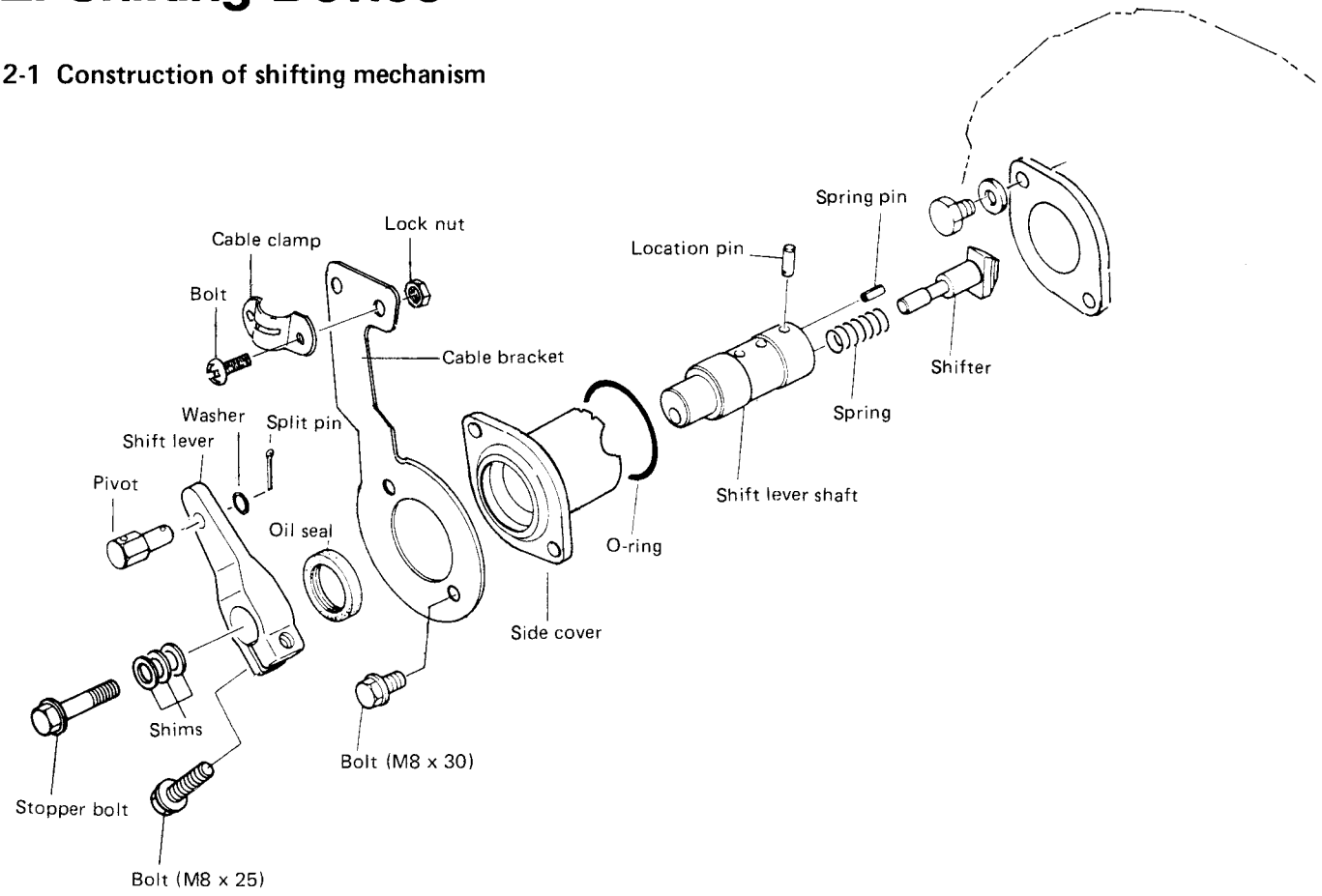
2. Shifting Device

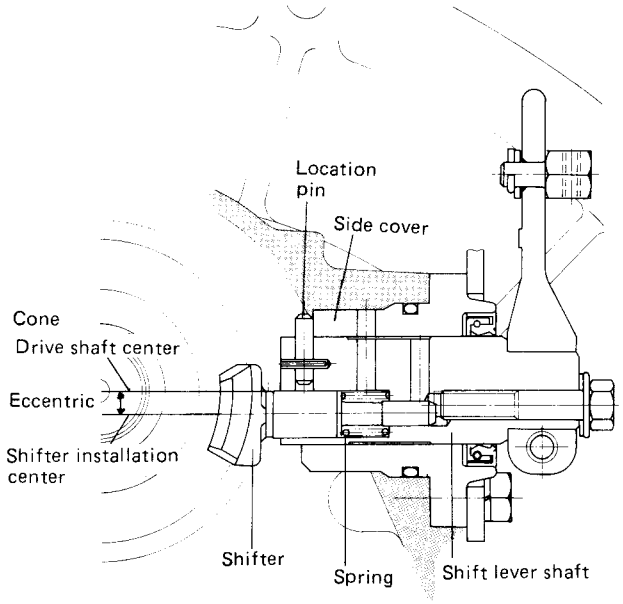
2-1 Construction of shifting mechanism



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.)

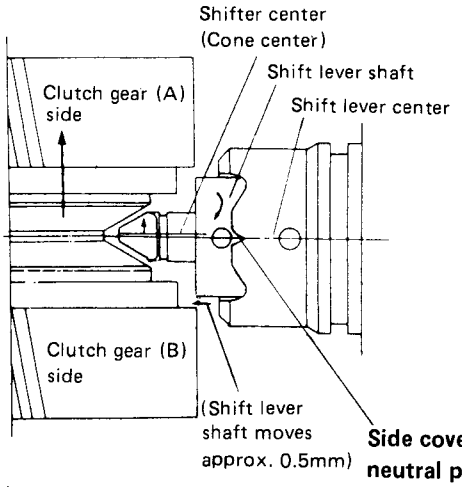
NOTE:1 Clutch gear (A) position: clockwise propeller rotation viewed from propeller side (C.C.W.)

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

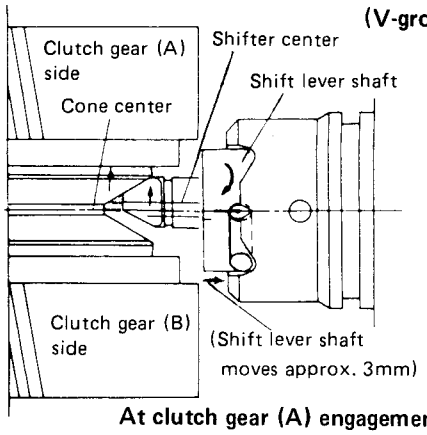


2-2 Clutch gear (A) and clutch gear (B) operation (Neutral ⇒ clutch gear (A), Neutral ⇒ clutch gear (B))

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).



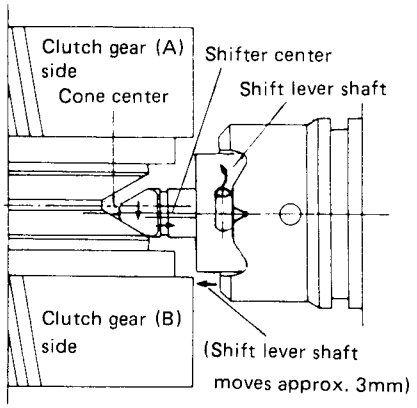
When the location pin of the shift lever shaft falls into the clutch gear (A) position groove on the side cover, the shift lever shaft moves approx. 3mm to the shift lever side, and the shifter starts to press the drive cone V-groove to the clutch gear (A) side by spring force.



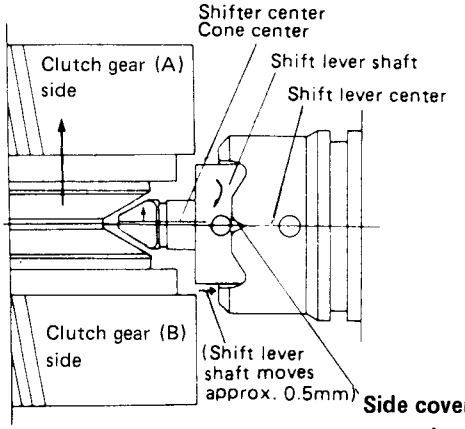
At clutch gear (A) engagement position

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.



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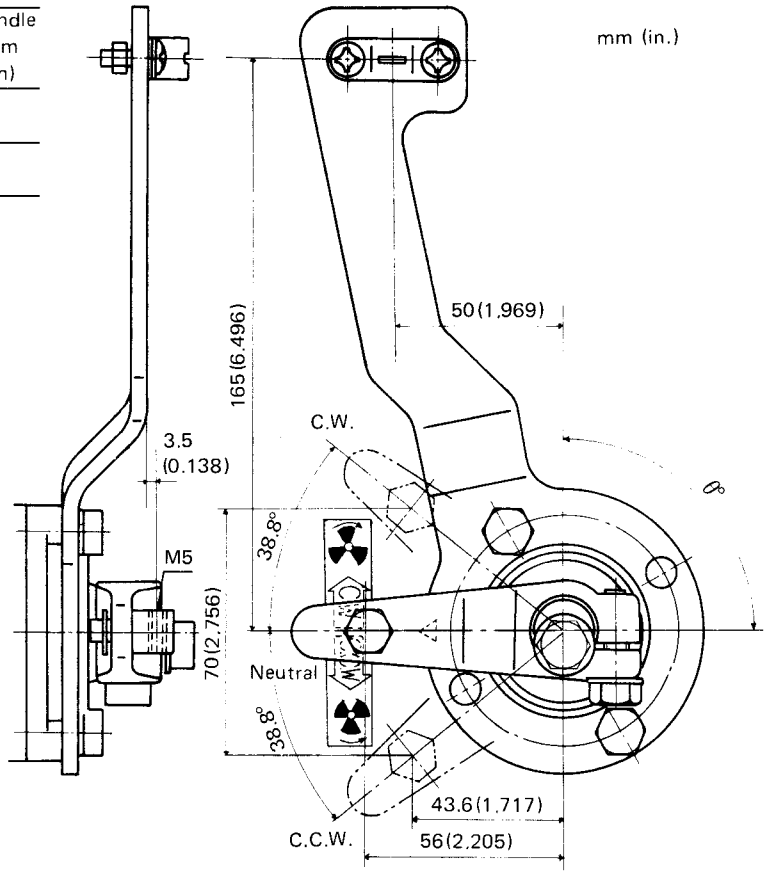
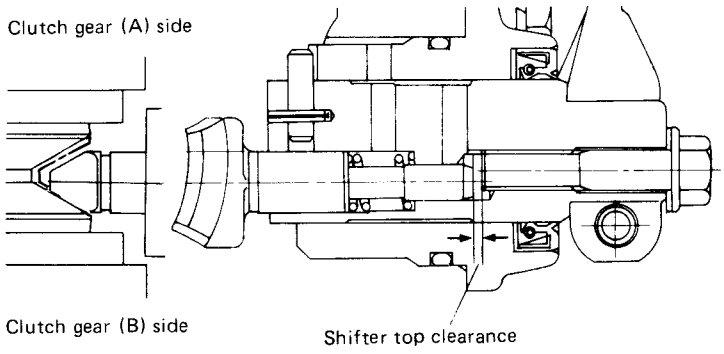
2-4 Clutch shifting force

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

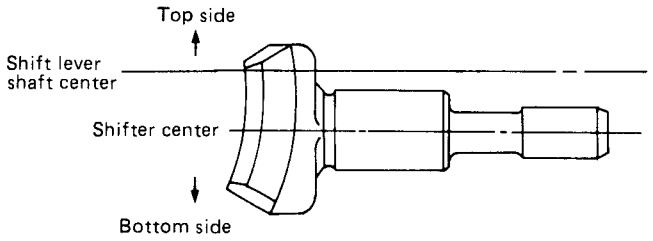
Whenever the side cover, shift lever shaft, shifter, stopper bolt or drive cone is replaced, be sure to adjust the clearance between the shifter end and the stopper bolt with shims. When the adjustment of this clearance is inadequate, the drive cone may not connect properly when the shift lever is moved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

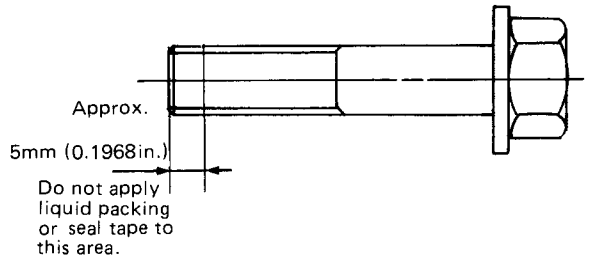
(5)Obtain the shim thickness "T" by the following formula.

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

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.

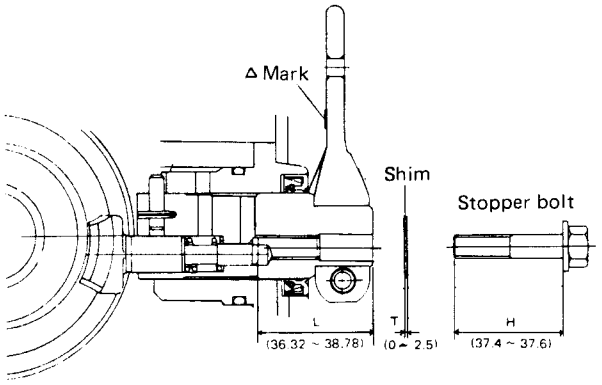


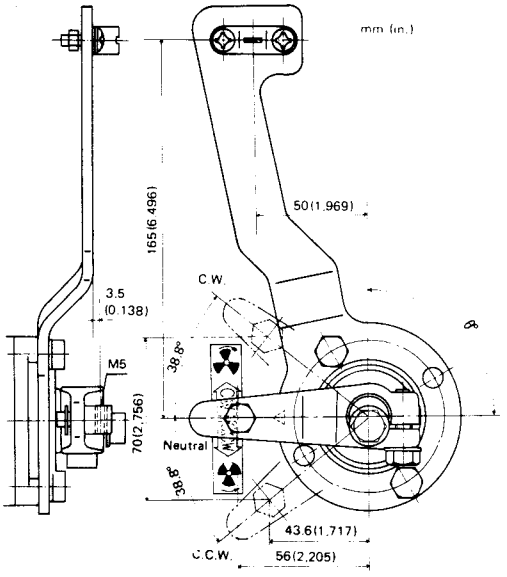
2-5-2 Inspect for the following points (to be inspected every 2-3 months)

(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).

$$\theta = 90°$$

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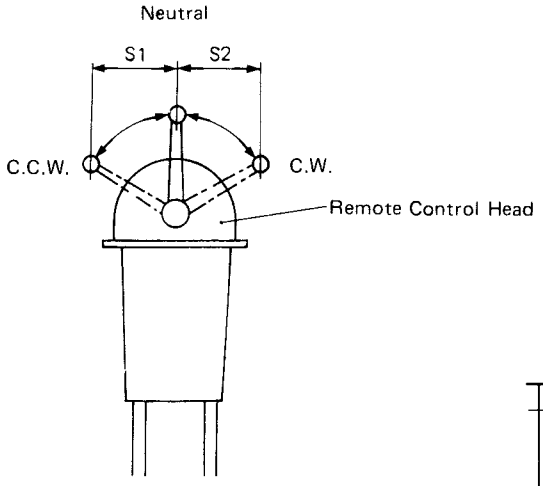
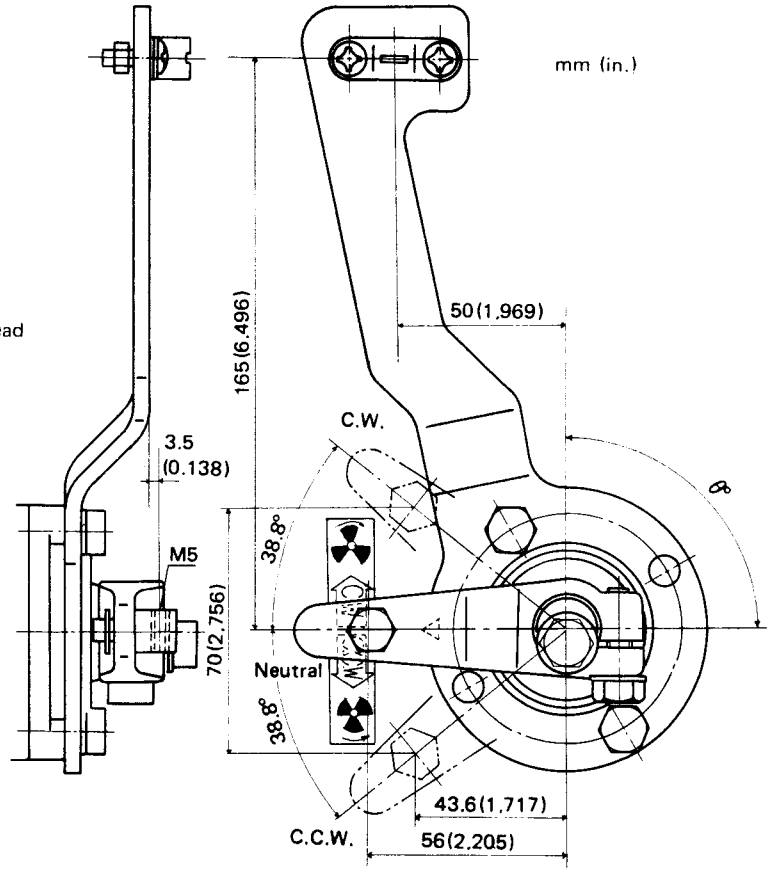
2-6 Adjustment of the remote control head Marine gearbox control side

(1)Equal distribution of the control lever stroke.



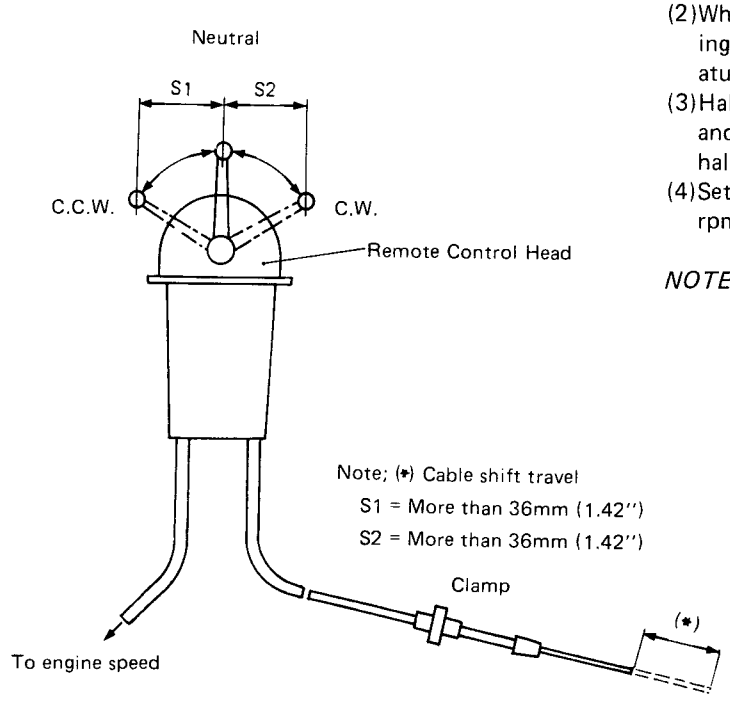
The stroke between the neutral position → C.W. position (S2), and the neutral position → C.C.W. position (S1) must be equalized.

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 S_1 and S_2 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.

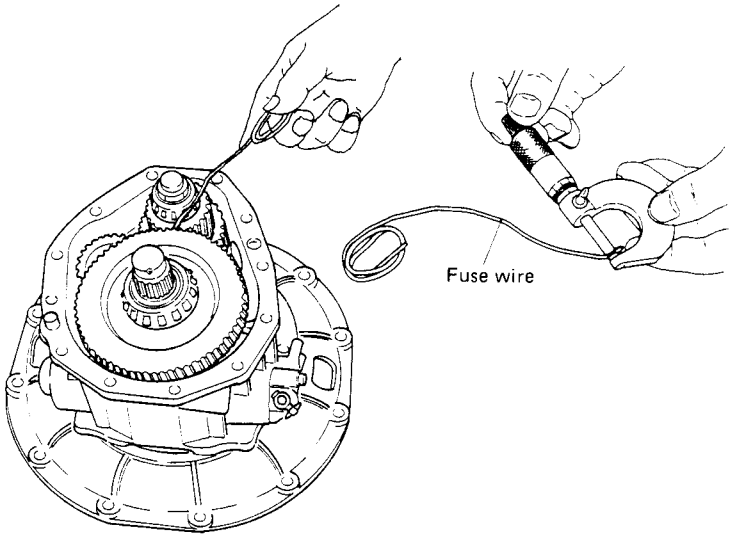
3-3 Gear

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.

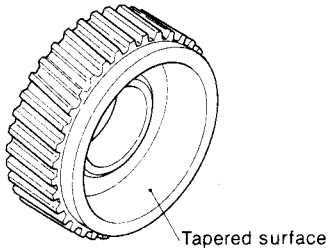


mm (in.)

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

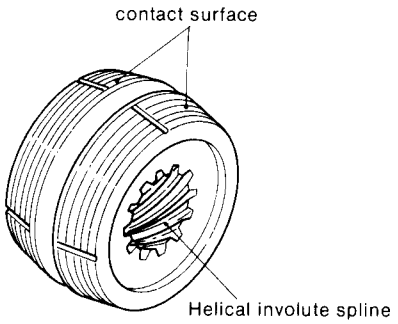
3-4 Clutch gear (A) and (B)

(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.

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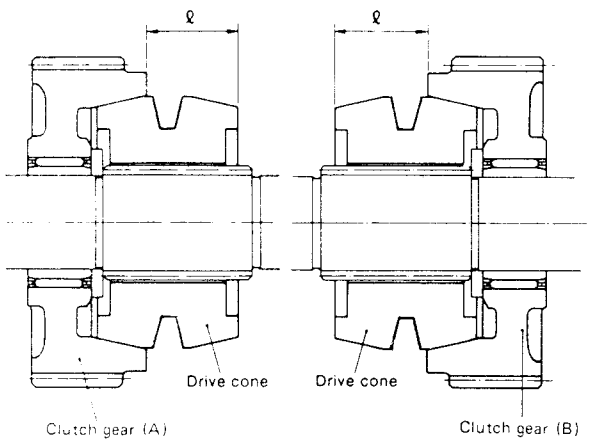
(3)Measure the amount of wear on the tapered contact surface of the drive cone, and replace the cone when the wear exceeds the specified limit.

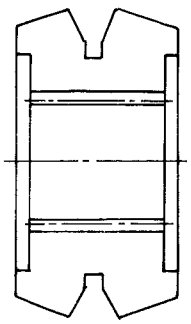


mm(in.)

	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.

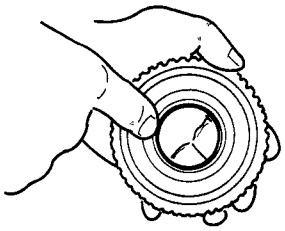
(4)If the wear of the V-groove of the drive cone is excessive, replace the part.



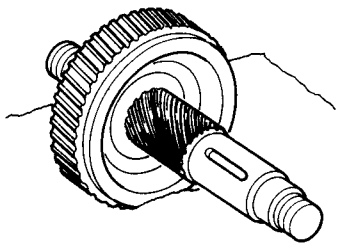
NOTE: When replacing the drive cone, the drive cone and clutch gears (A) and (B) must be lapped prior to assembly.
The lapping procedure is described below.

3-5-1 Lapping Procedure for Drive Cone

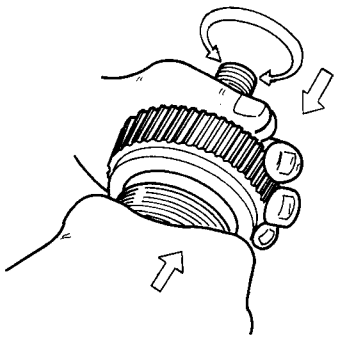
(1) Coat the lapping powder onto the cave of the clutch gear (Lapping powder: 67 micron silicon carbide #280)



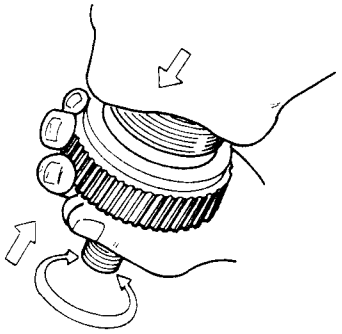
(2)Set the clutch gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft



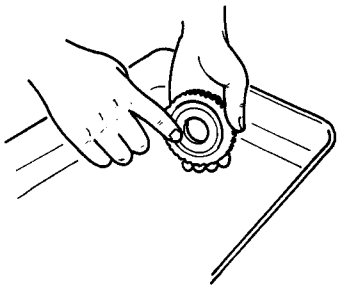
(3)Lap the clutch gear's cave and drive cone, pushing them together by hand

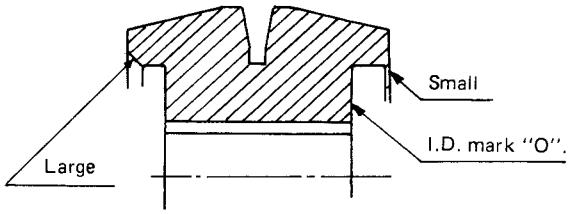


(4)Push and turn the clutch gear about 5 times both clockwise and counter-clockwise.



(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.

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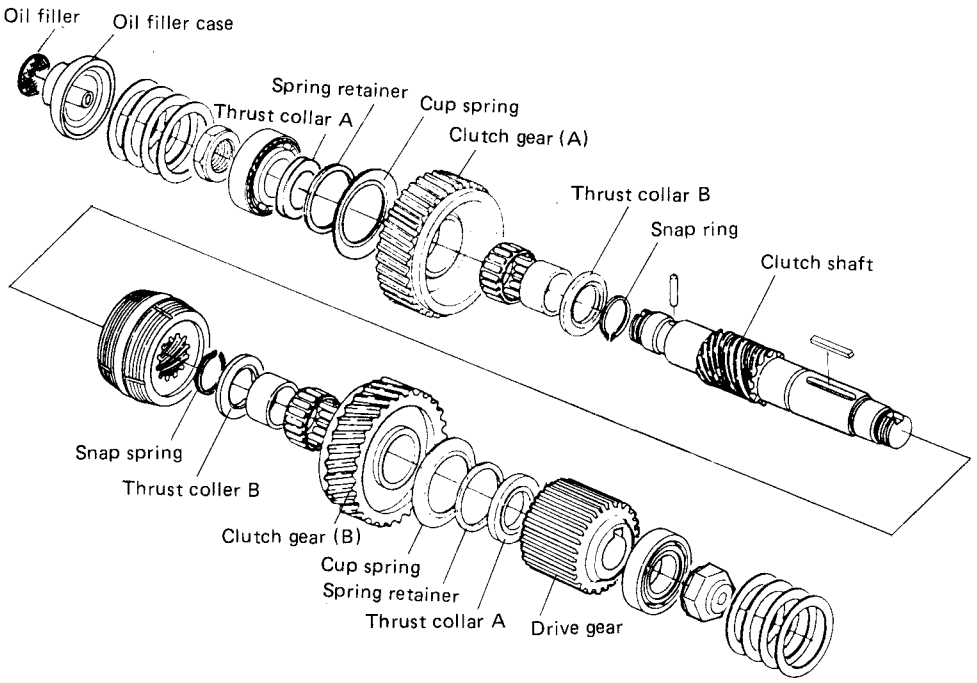
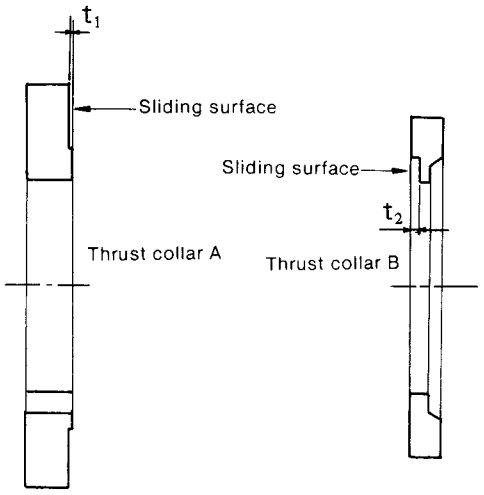
3-6 Thrust coller A and B for clutch shaft



(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.

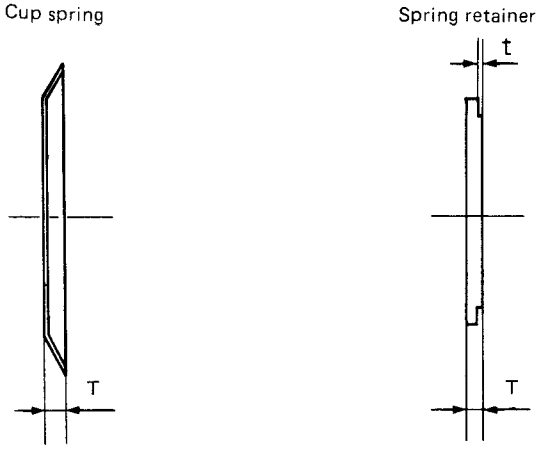


mm (in.)

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

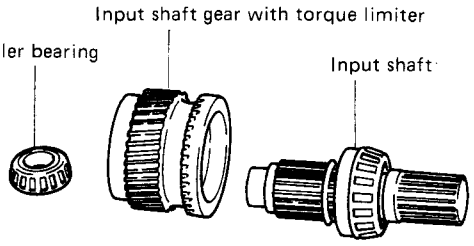
(1) Check for cracks and damage to the cup spring and spring retainer. Replace the part if defective.
(2) Measure the free length of the cup spring and the thickness of the spring retainer. If the length or the thickness deviates from the standard size, replace the part.



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.

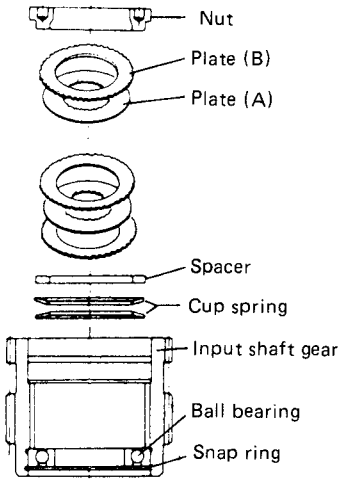
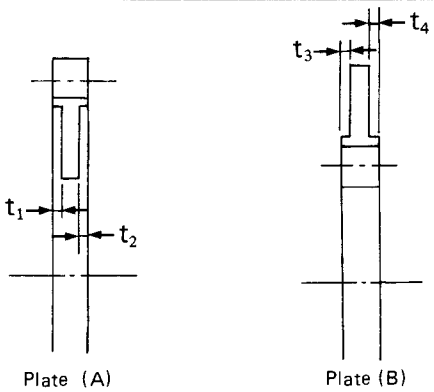


Plate (A) and (B)

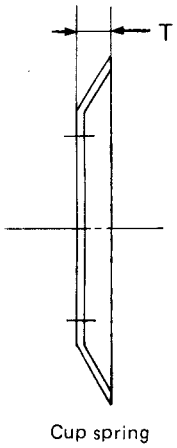
mm(in.)

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



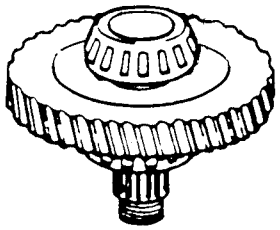
mm(in.)

	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.

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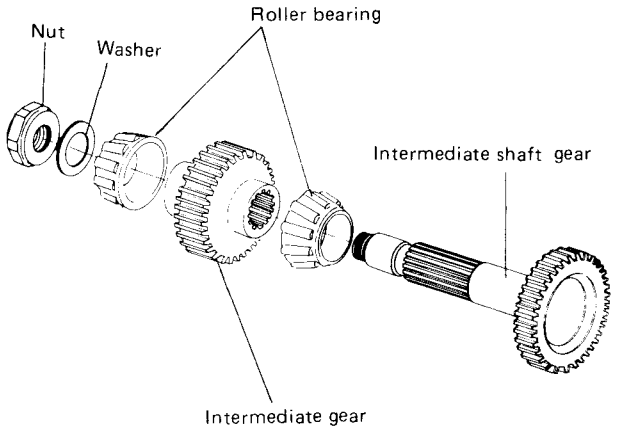
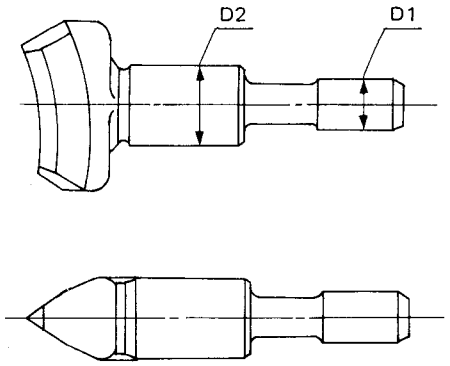
3-10 Intermediate shaft



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

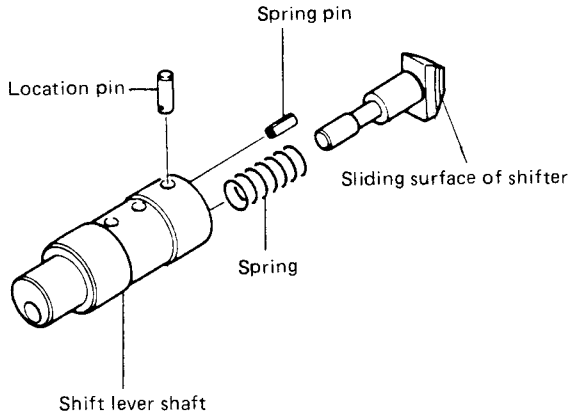


mm (in.)

	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 Shifting device

3-11-1 Shifter



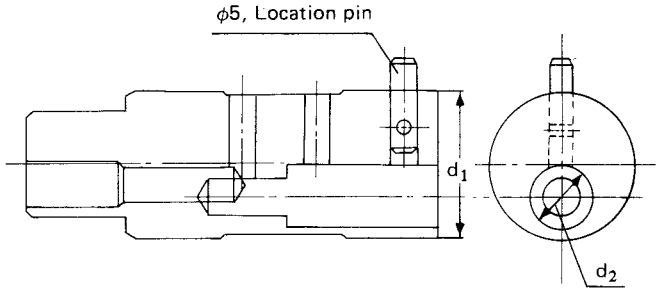
(1)Visually inspect the surface which contacts with the drive cone, and replace the shifter when signs of overheating, damage or wear are found.

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

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)

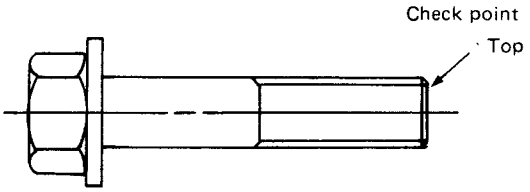
3-11-3 Shifter spring

(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)

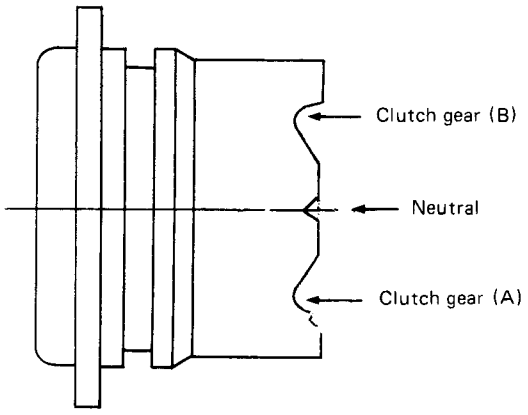
3-11-4 Stopper bolt

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

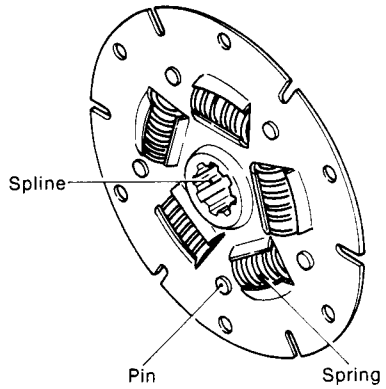


3-11-5 Side cover and oil seal

(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.

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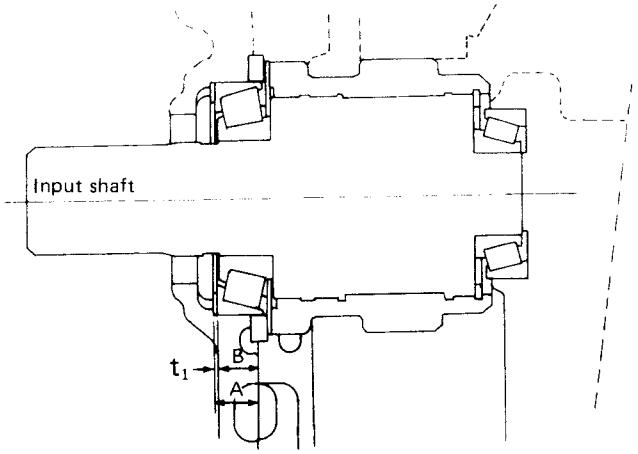
3-13 Shim adjustment for output and input shafts

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.

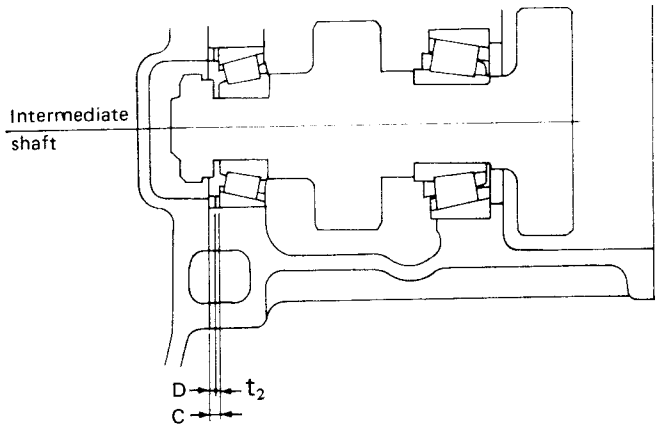
(1) Input Shaft
Measure the distance A and B.
Thickness of Shim t_1

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



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

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



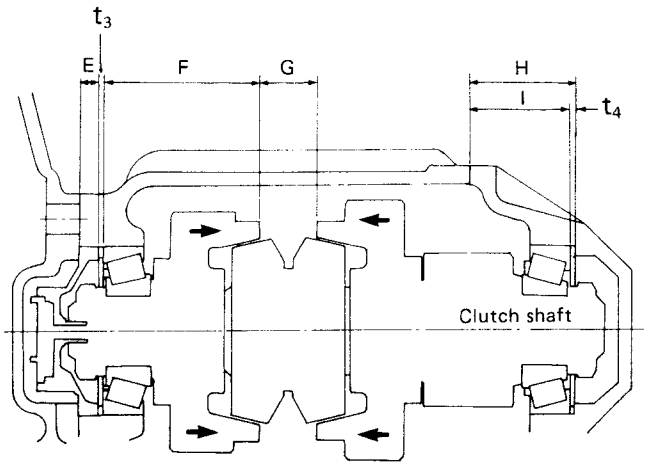
(3) Clutch Shaft
Measure the distance E, F and G.

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

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.

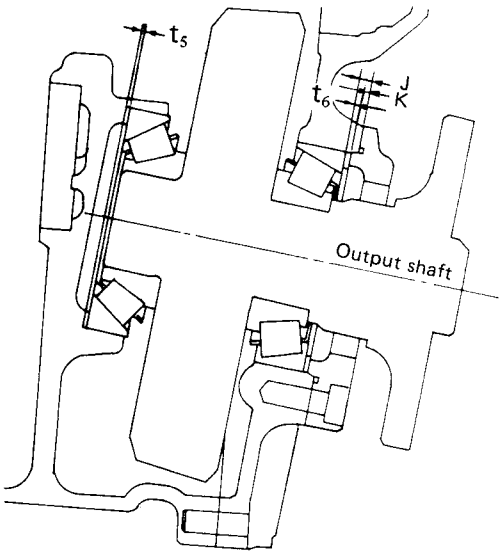
$$t_4 = (H - I)^{\pm 0.05}$$



(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.

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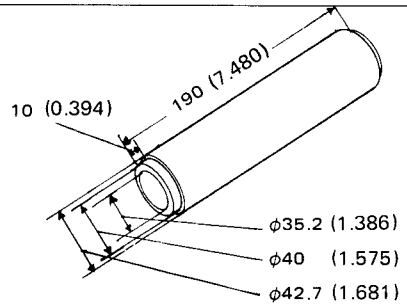
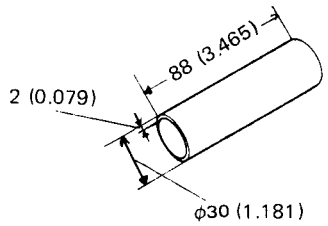
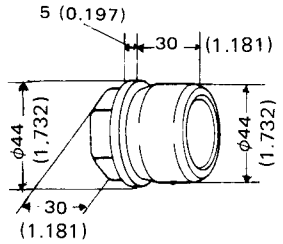
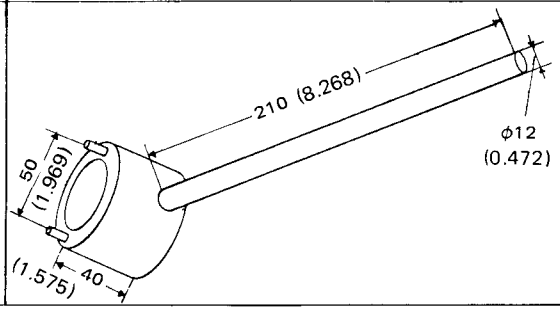
Adjusting point	Part No.	Thickness. mm (in.)	No. of shims
t1	177095-02150	0.1 (0.0039)	2
		0.3 (0.0118)	1
		0.5 (0.0197)	2
		1.0 (0.0394)	1
t2	177090-02250	0.1 (0.0039)	2
		0.3 (0.0118)	1
		0.5 (0.0197)	1
		1.0 (0.0394)	1
t3 & t4	177075-02150	0.3 (0.0118)	4
		0.4 (0.0157)	4
		0.5 (0.0197)	4
t5 & t6	177090-02310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

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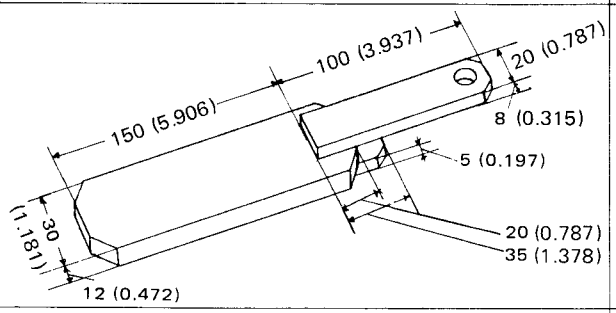
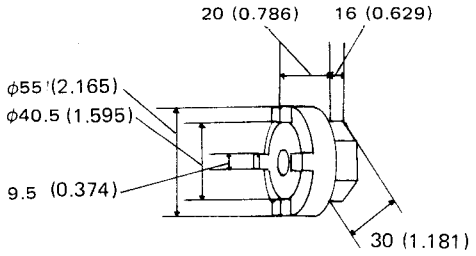
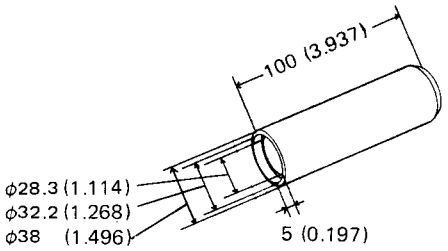
Special tools

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.

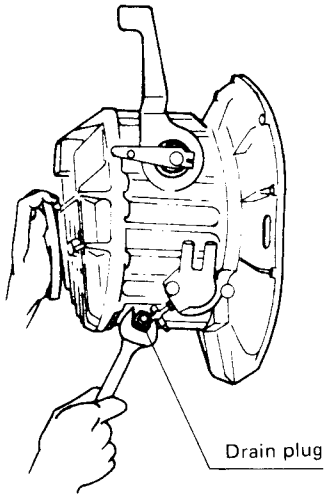
(1)Remove the remote-control cable and the C.W. hose of L.O. cooler.

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

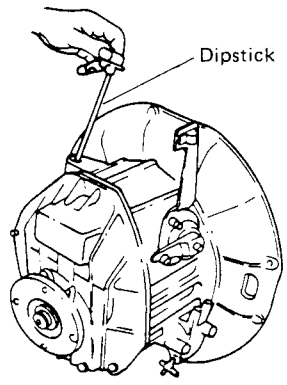
(3)Drain the lubricating oil

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.

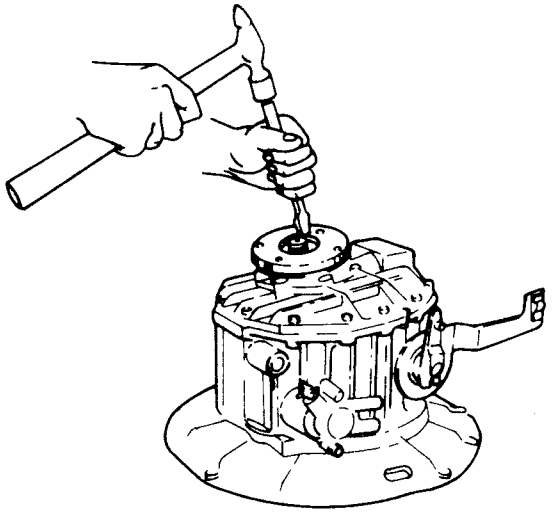


(5) Remove the dipstick.

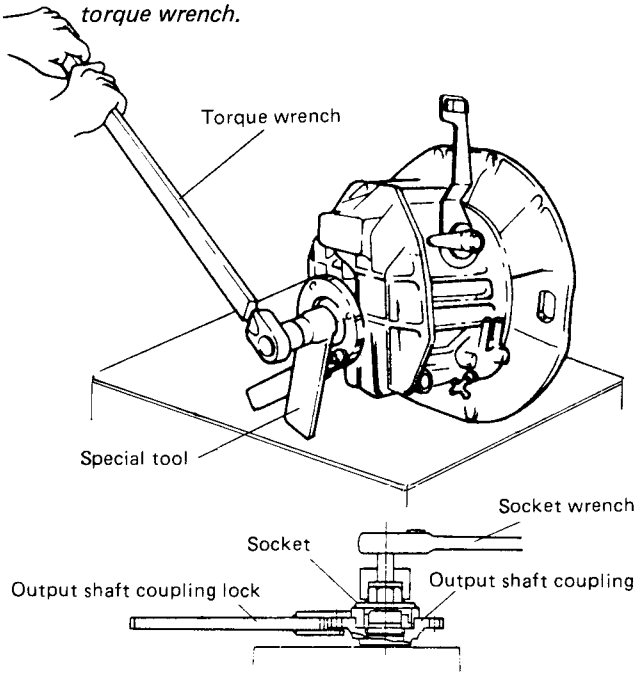


(6) Remove the end nut and output shaft coupling

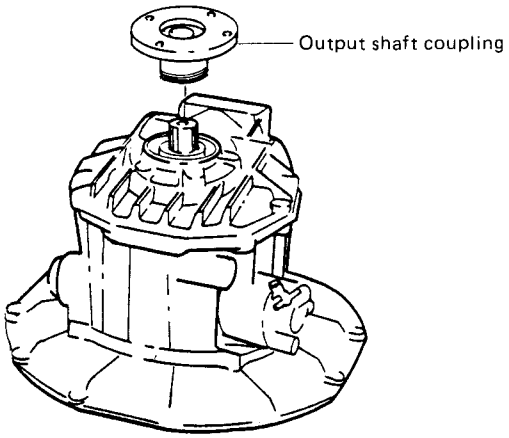
1) Loosen the calking of the endnut.



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



2)Remove the output shaft coupling



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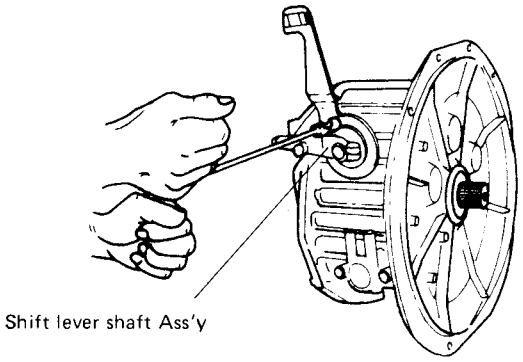
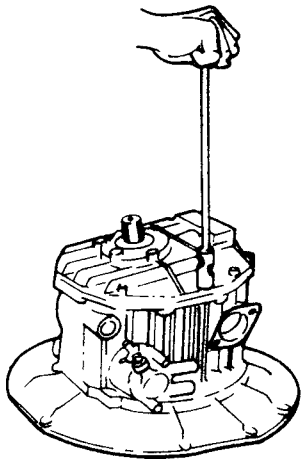
(7) Remove the fixing bolts on the side cover of clutch case, and also remove the shift lever shaft assembly.

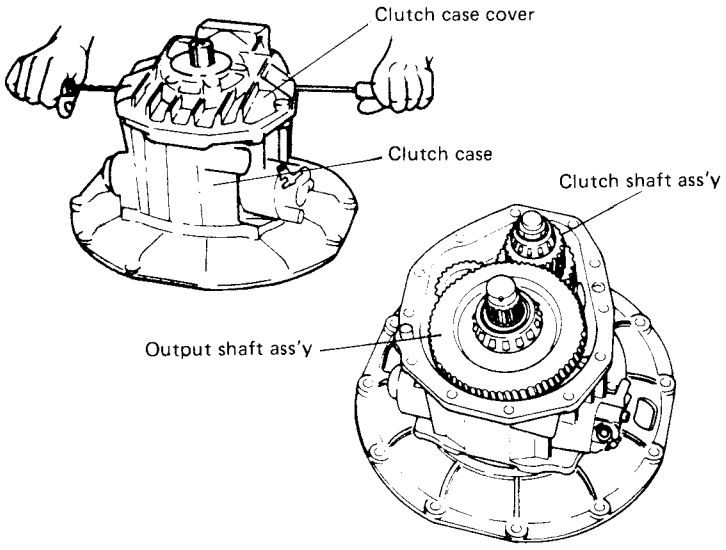


(8) Remove the clutch case cover.

1) Remove the bolt of the clutch case cover

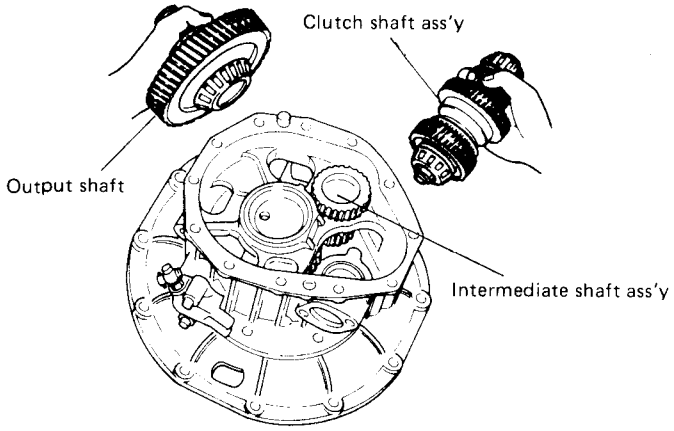


2) Remove the clutch case cover from the clutch case.



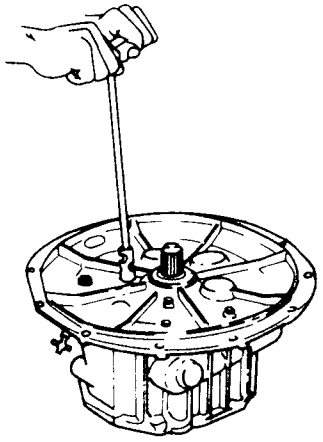
NOTE: To remove the case cover and the case, insert two drivers into the two depressed points at the joint between the case cover and the case. This makes removal easy.

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

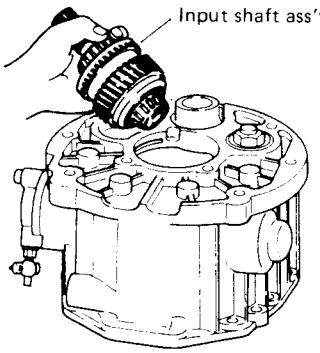


(10) Removing the mounting flange

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

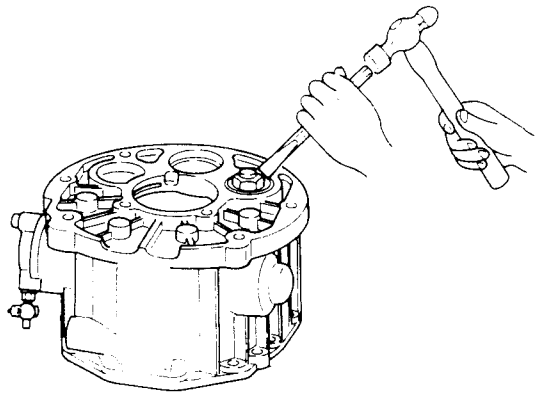


(11) Removing the input shaft assembly.
Draw out from the mounting flange side of the case.

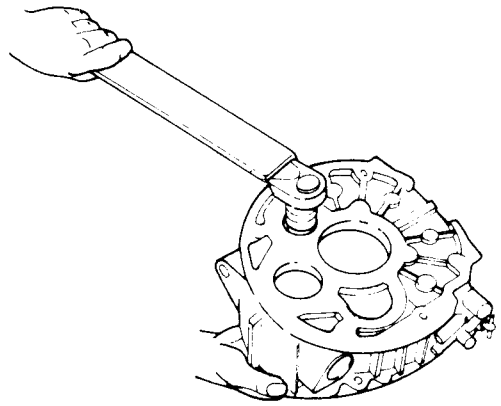


(12) Removing the intermediate shaft.

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

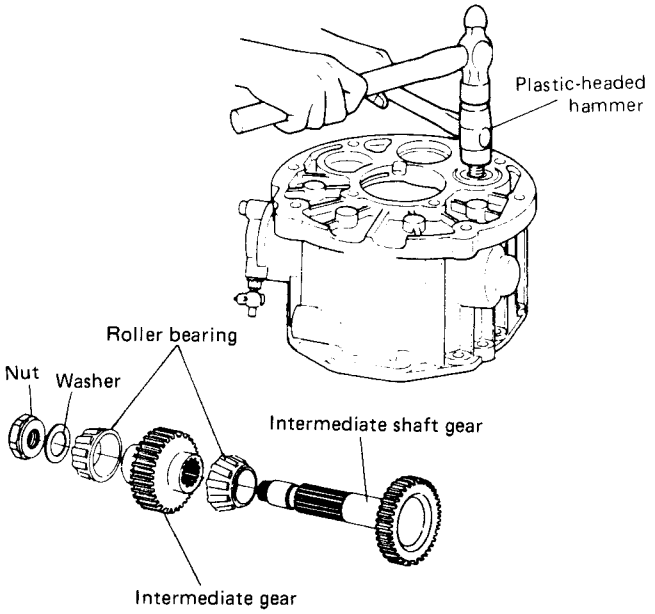


2) Remove the locknut.

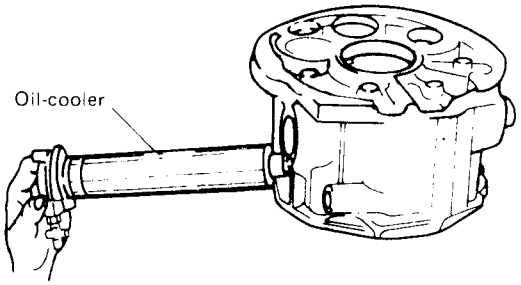


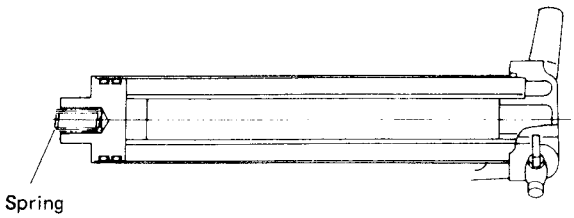
***NOTE:** Thread of the locknut is left-handed.*

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

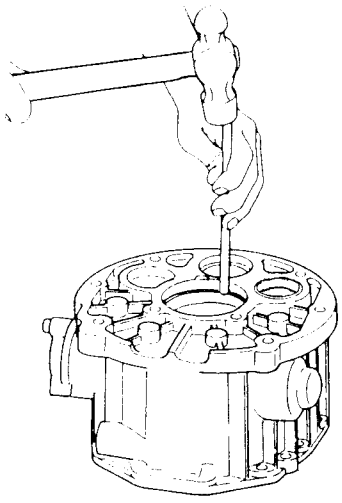


(11) Removing the oil-cooler.





(14) Draw out the outer bearing races.



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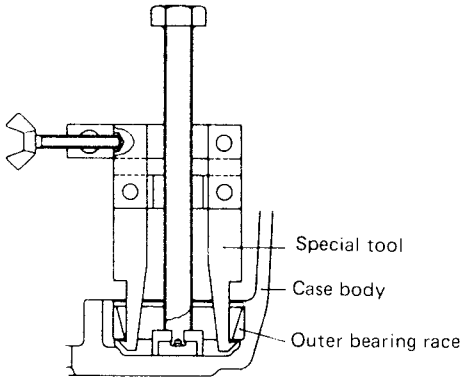
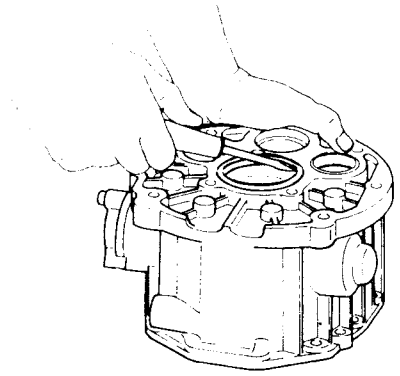
1) Remove the outer bearing races of the mounting flange, the case cover and the case.

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



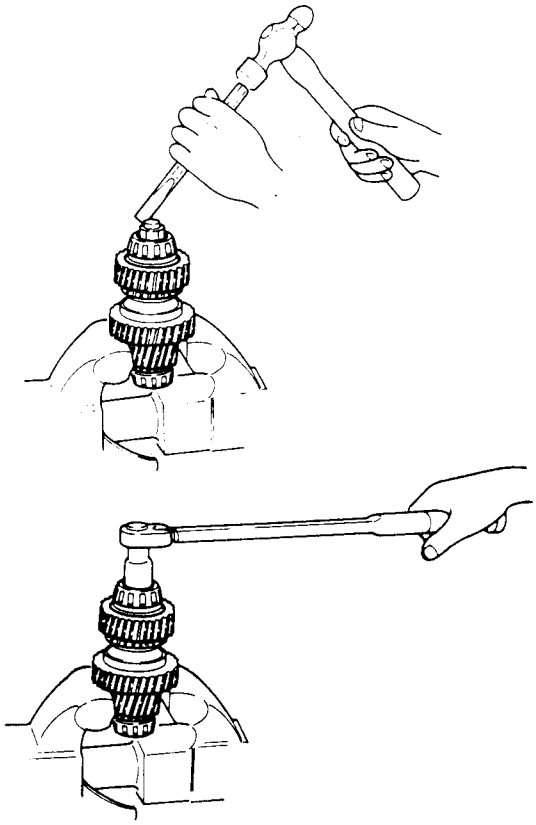
(15) Remove the oil seals of the mounting flange and the case cover.



5-2 Disassembling the clutch shaft.

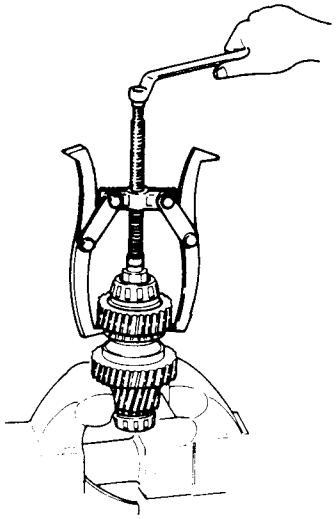
5-2-1 Clutch gear (A) side

(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.

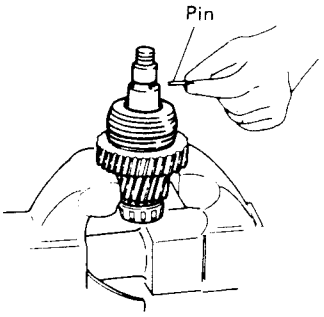


NOTE: Remember that the nut has a left-handed thread.

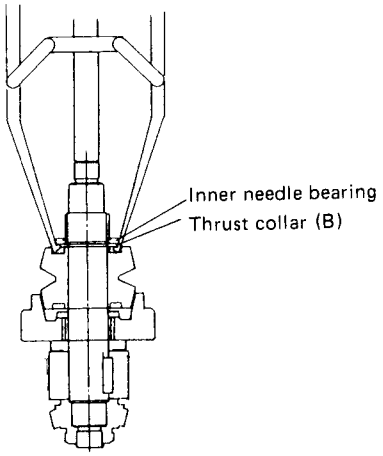
(2) Take out the clutch gear (A), Thrust collar (A), cup spring, spring retainer and inner bearing trace. The clutch gear (A) must be withdrawn using a pulley extracter, with the clutch shaft fixed in a vice.



(3) Remove the pin

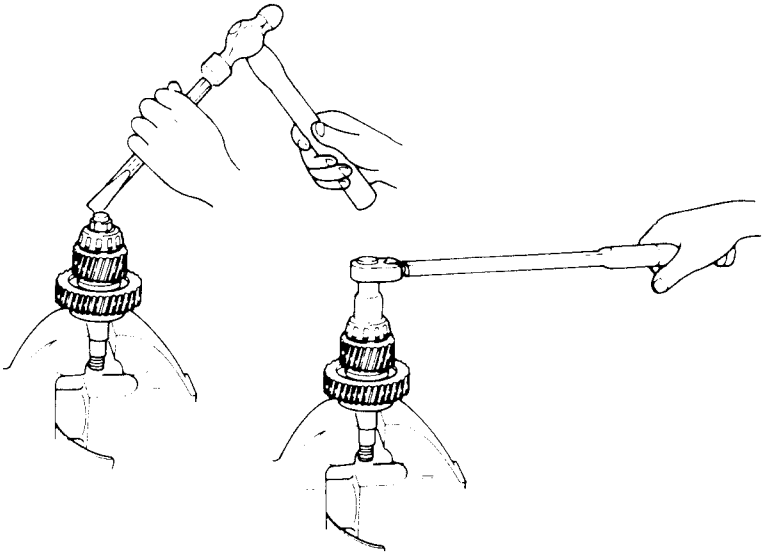


(4) Withdraw the thrust collar (B), inner needle bearing by pulley extractor.



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.

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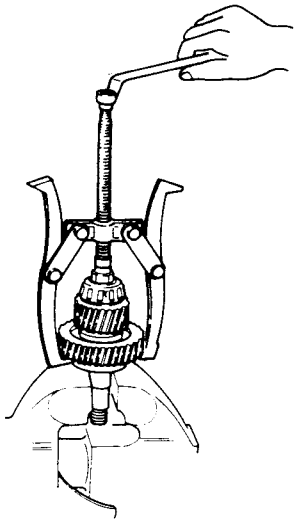
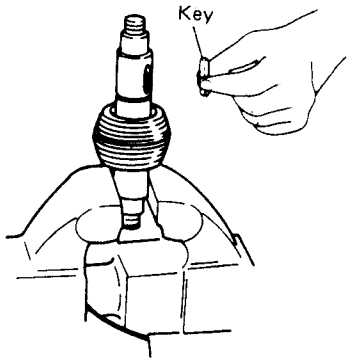
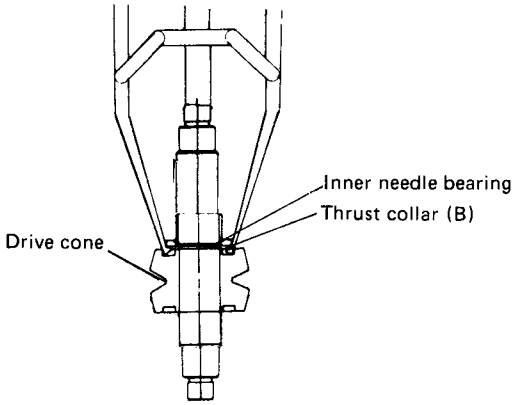
(2)Withdraw the large gear (B), thrust collar (A), cup-spring, spring retainer, drive gear and inner bearing race.
Use a pulley extracter, with the clutch shaft fixed in a vice.



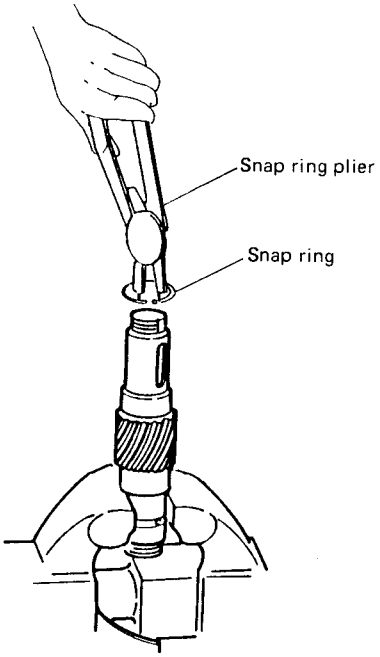
(3)Remove the key



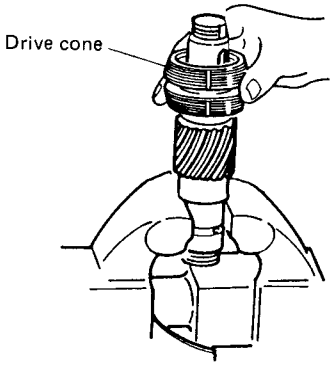
(4)Withdraw the thrust collar (B) and inner needle bearing race with the pulley extractor.



(5)Remove the snap rings

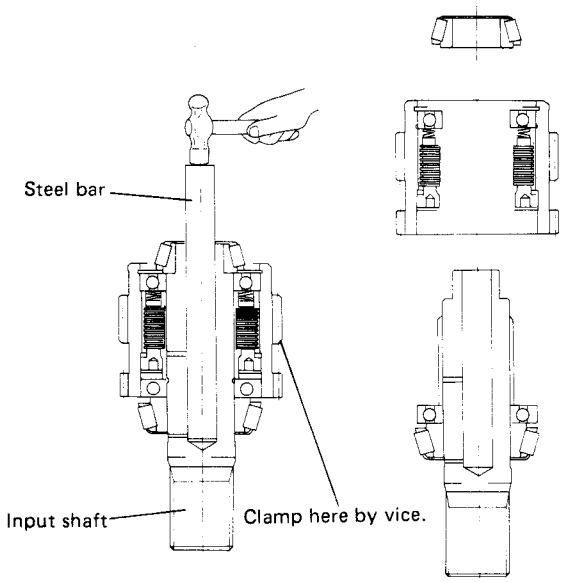


(6)Draw out the drive cone.

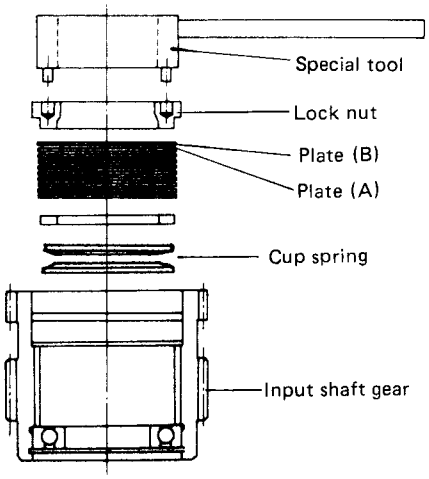


5-3 Disassembling the input shaft.

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

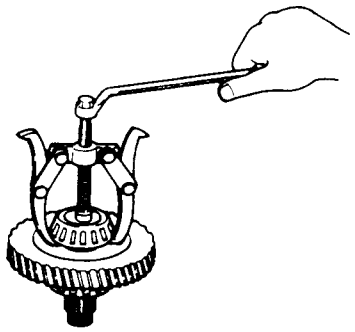


(2)Fix the input shaft gear in a vice, and remove the lock nut with a special tool.



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.



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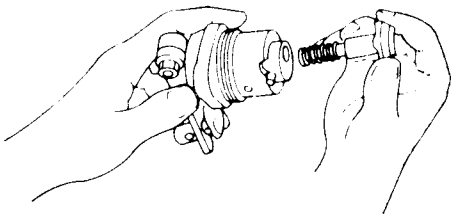
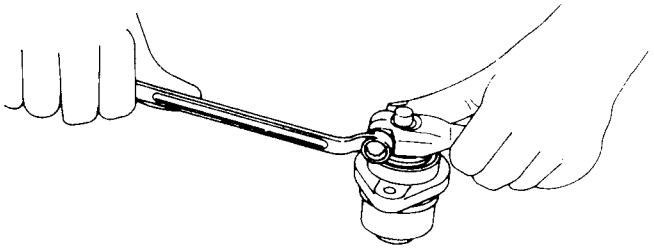
5-5 Disassembling the shifting device

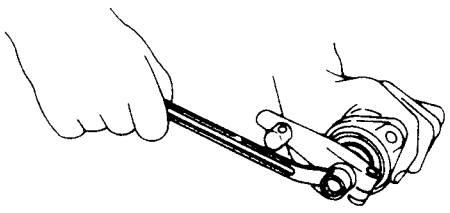
(1)Take out the shifter and shifter spring



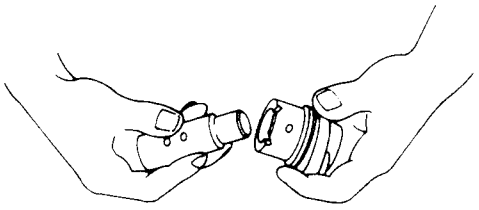
(2)Remove the stopper bolt of the shifter and shim.



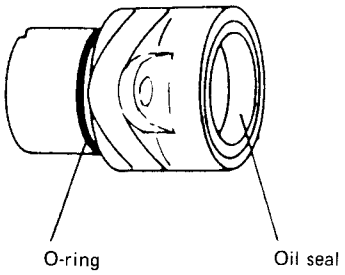
(3)Loosen the belt of the shift lever and remove the shift lever and cable bracket



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



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

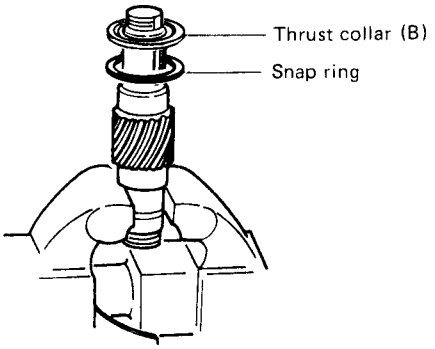


6.Reassembly

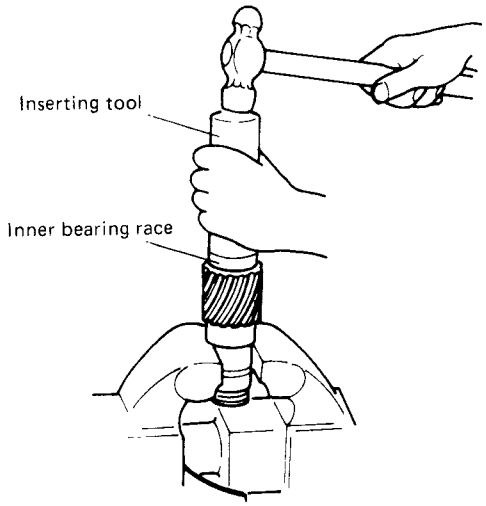
6-1 Reassembly of clutch shaft

6-1-1 Clutch gear (B) side

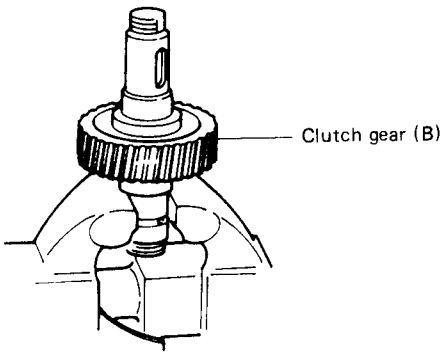
(1)Fit the clutch gear (B) side snap ring and thrust collar (B) onto the shaft.



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

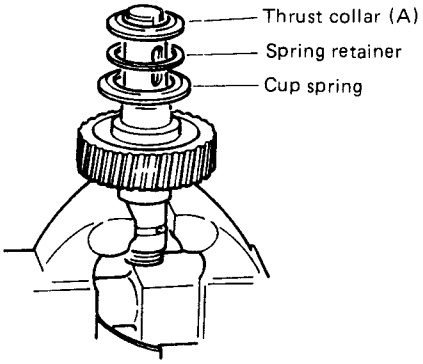


(3)Assemble the needle bearing and clutch gear (B)



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

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

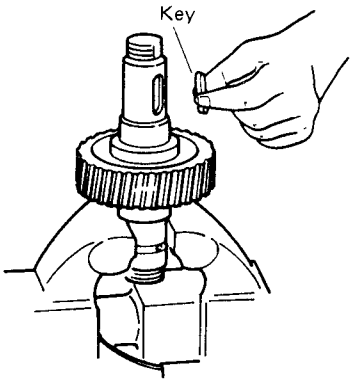


NOTE: 1) Drive in with a plastic headed hammer. Do not hit hard.

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



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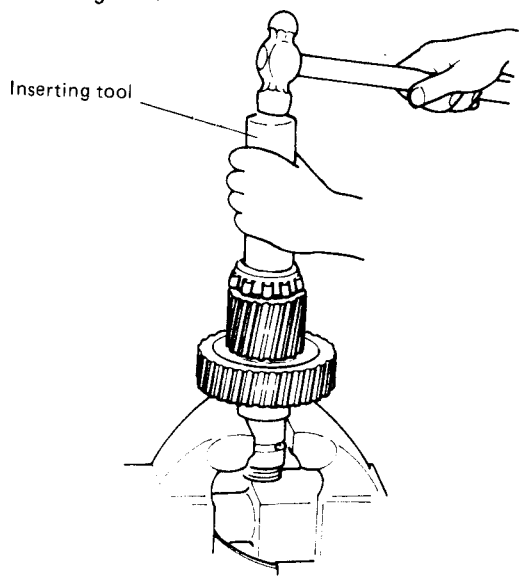
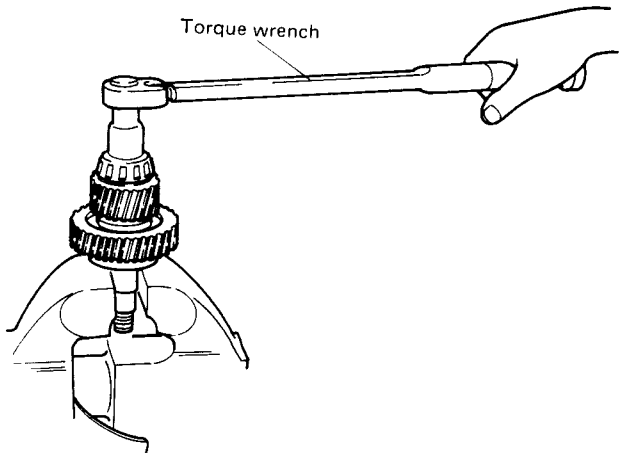
(6)Drive in the driving gear and inner bearing race using the inserting tool.



(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.

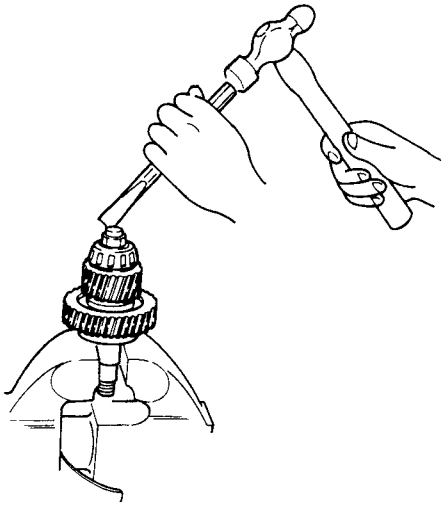


Tightening torque	8.5 – 11.5 kg-m (61.5 – 83.2 ft-lb)

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

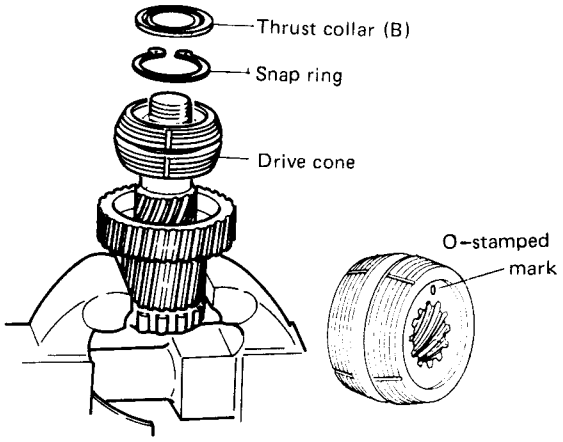
2) Use the clutch gear (A) side nut which is used before dismantling for the clutch gear (B) end nut. This is not to make the calked portion to the same point.

(8)Calking the end nut and clutch shaft.



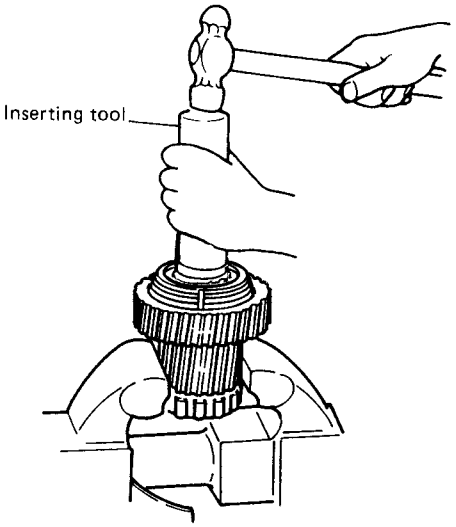
6-1-2 Clutch gear (A) side

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

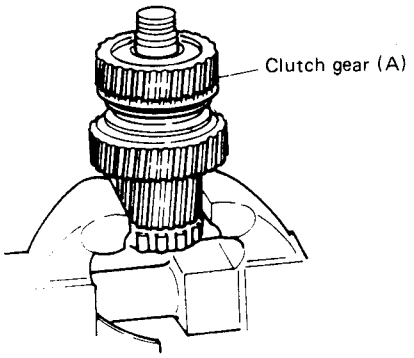


NOTE: Insert it keeping the O-stamped make surface toward the clutch gear (B) side.

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

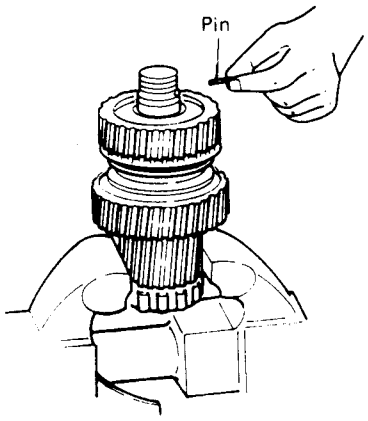


(3)Assemble the needle bearing and clutch gear (A)

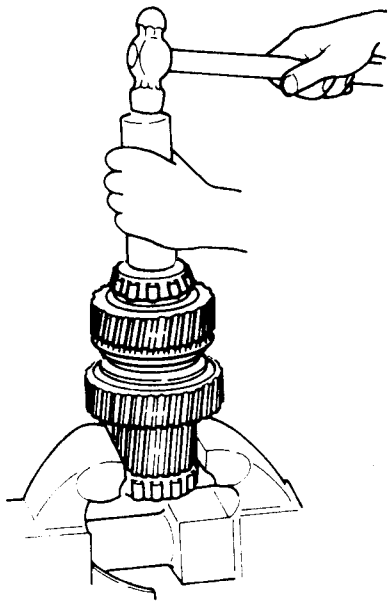


NOTE: Check that the clutch gear (A) rotates smoothly.

(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.

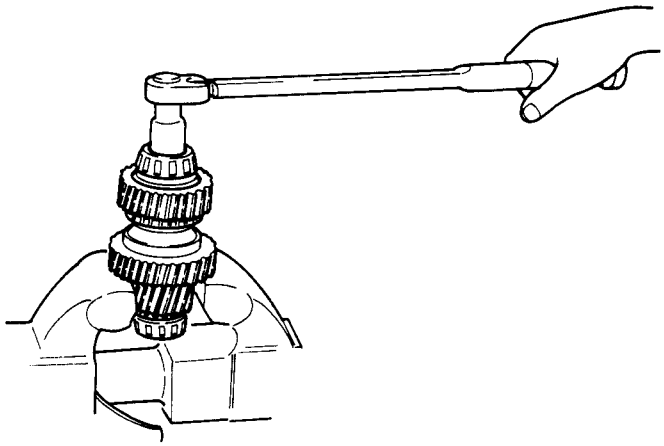


NOTE: 1) When fitting the thrust collar (A), note the fitting direction. Fit it keeping the stepped surface toward the roller bearing side.

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

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

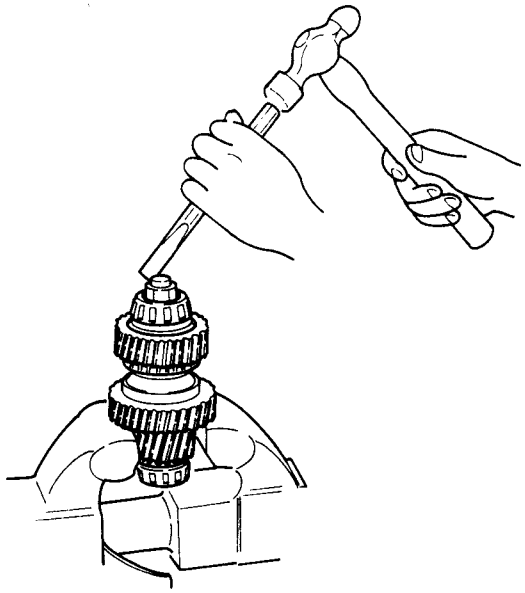
(6)Set and tighten the clutch gear (A) end nut. Fix the clutch shaft in a vice and tighten the nut with a torque wrench.



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.

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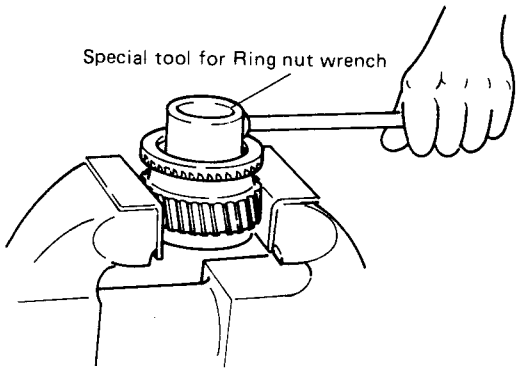
6-2 Reassembly of input shaft

(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.

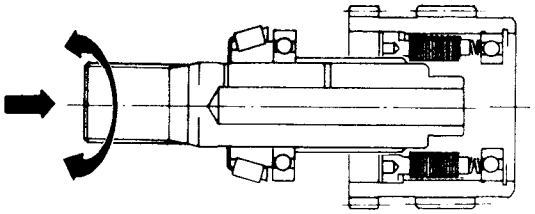


NOTE: Apply lube oil to each insert parts.

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

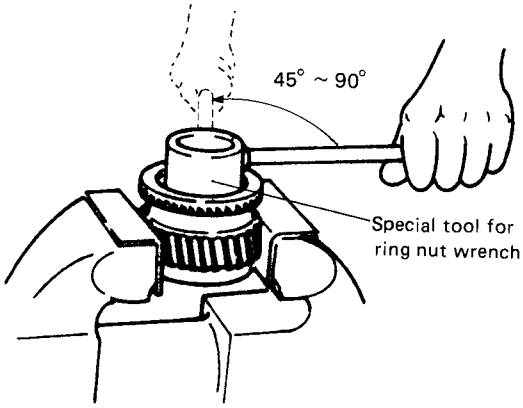
(4)Drive the ball bearing and the inner bearing race using a inserting tool.

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

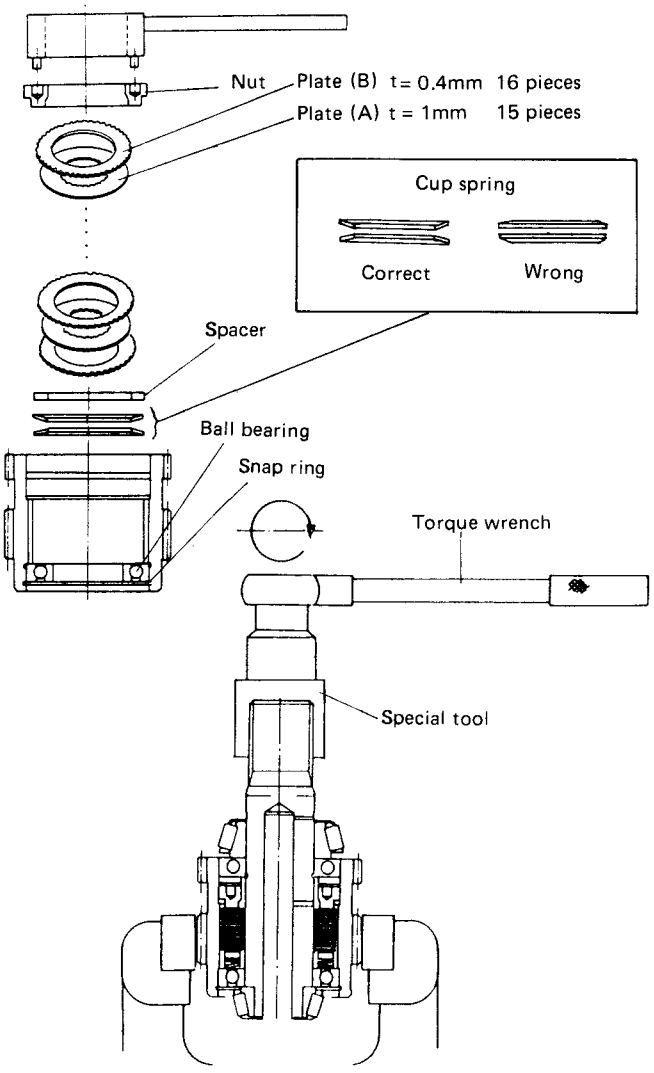


(6)Take out the input shaft again.

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



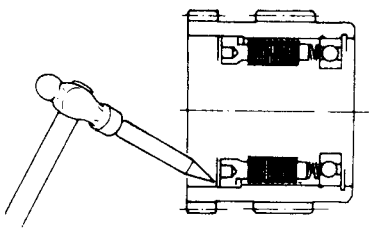
(8)Insert the input shaft, then measure the torque of the input shaft using a torque wrench.



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.



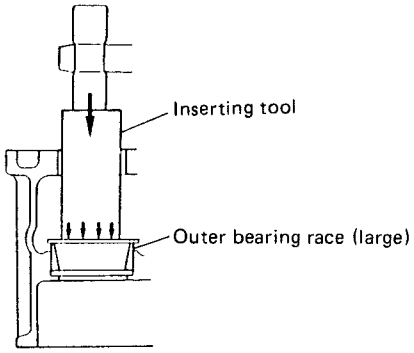
(10)Insert the input shaft into the input gear assembly.

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

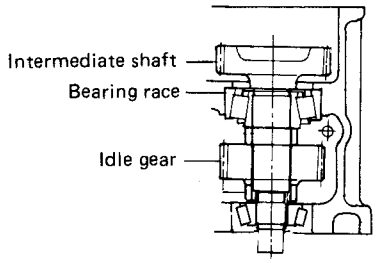
6-3 Reassembly of the clutch case

6-3-1 Reassembly of the intermediate shaft

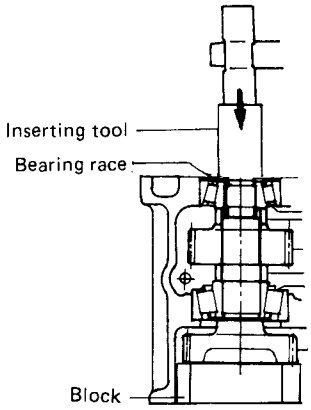
(1)Drive in the outer bearing race (large) into the clutch case.



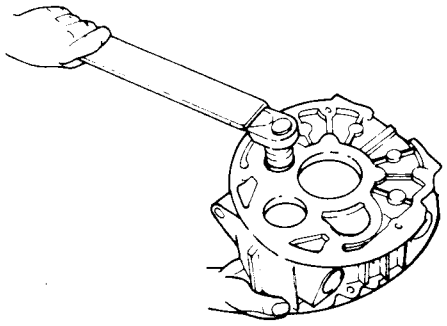
(2) Insert the inner bearing races and idle gear and drive in the intermediate shaft



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



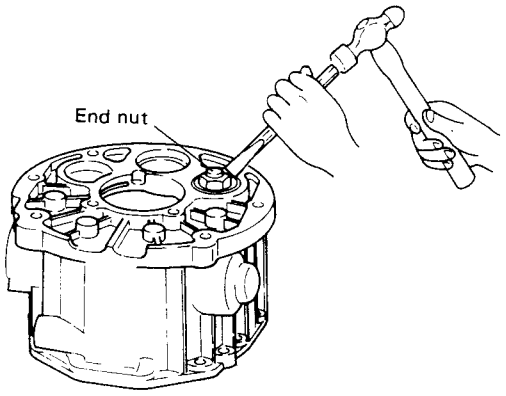
(4)Insert the washer and tighten the end nut using a torque wrench.



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

NOTE: Remember it is a left-handed thread

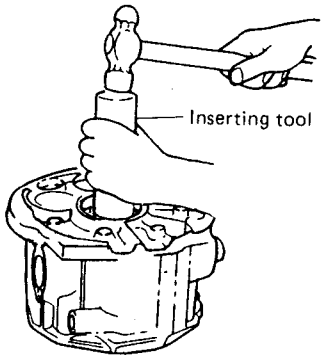
(5)Calk the end nut



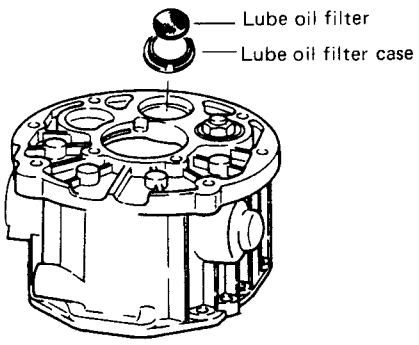
(6)Insert the shims into the clutch case.

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.



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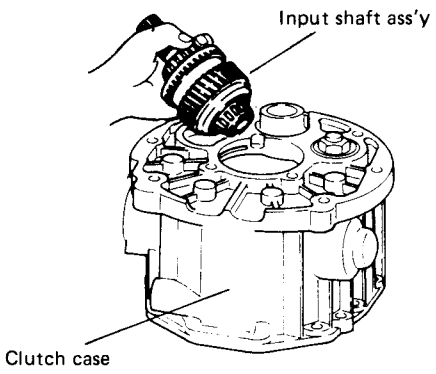
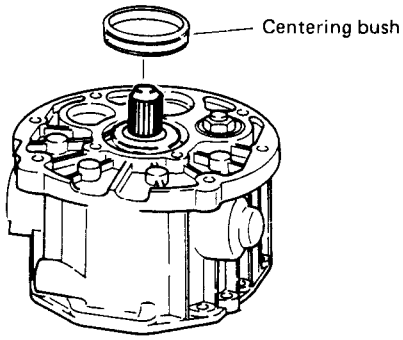
6-3-3 Reassembly of the input shaft

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



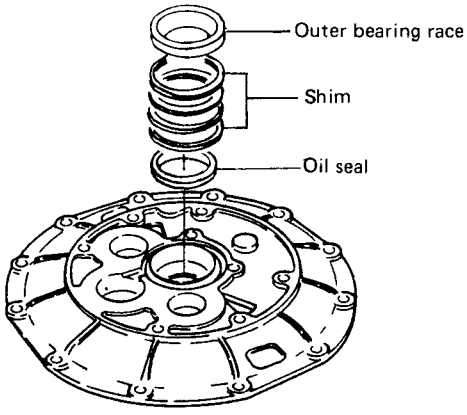
(2)Drive the centering bush into the clutch case.



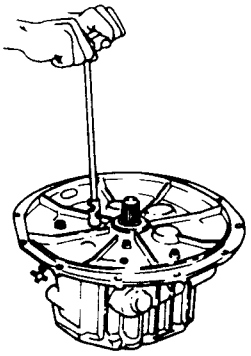
6-3-4 Reassembly of the mounting flange

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

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

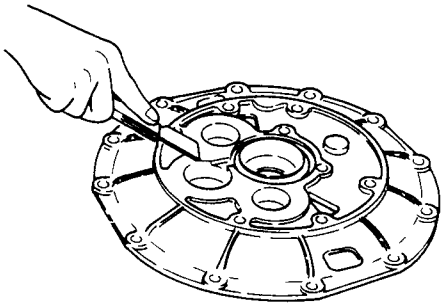


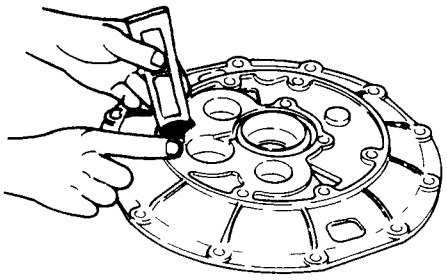
(3)Fit the mounting flange onto the clutch case, and tighten the bolt.



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

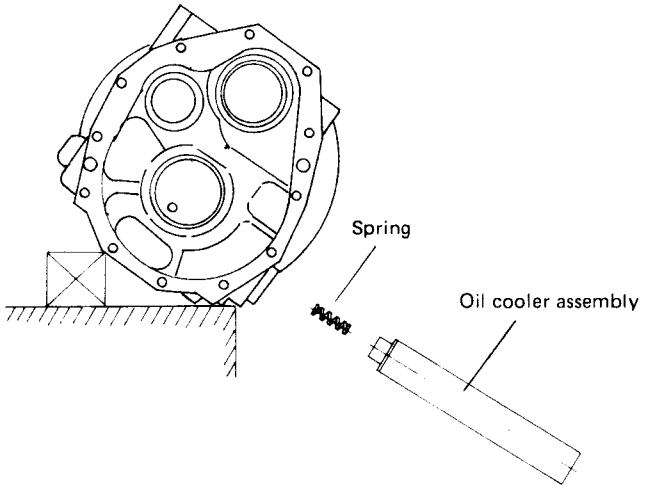
NOTE: Apply non-drying liquid packing to the maching surface of the mounting flange and the clutch case.





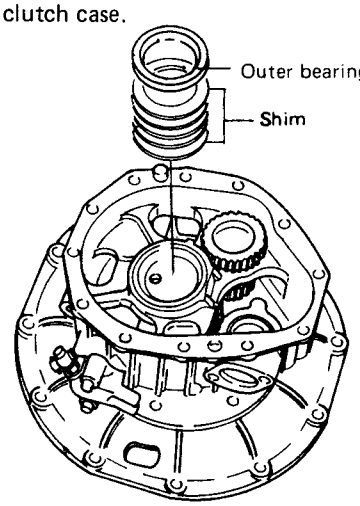
6-3-5 Reassembly of the oil cooler

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

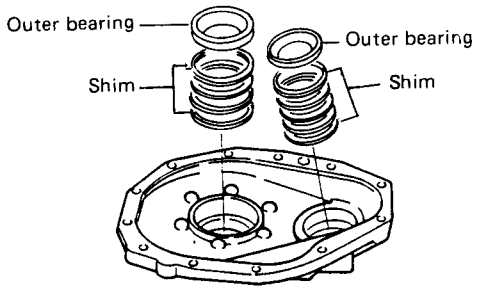


6-3-6 Reassembly of the clutch case cover.

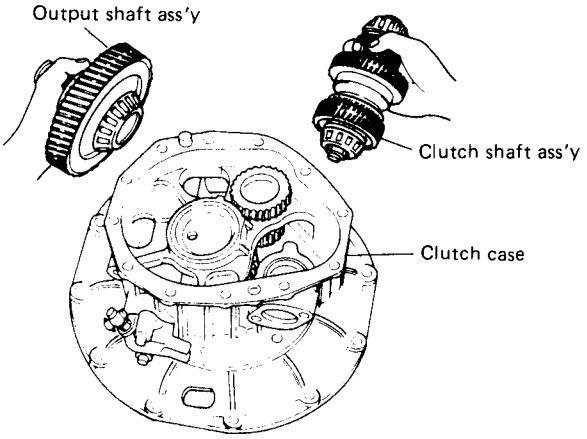
(1)Drive the output shaft shim and the outer bearing race into the clutch case.

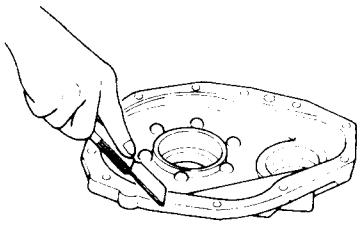


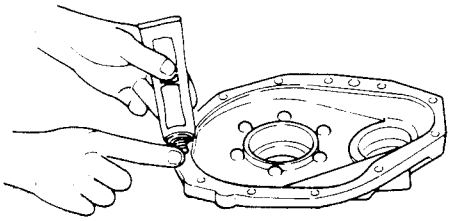
(2)Drive the shims and the outer bearing races into the clutch case cover



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

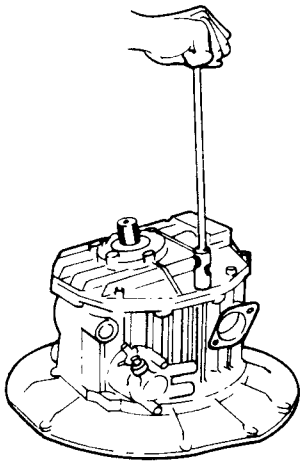






NOTE: Apply non-drying liquid packing to the maching surface of the clutch case cover and the clutch case.

(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)

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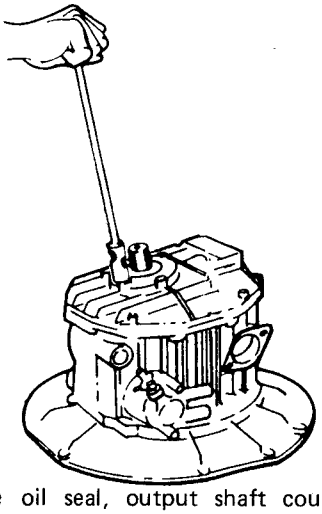
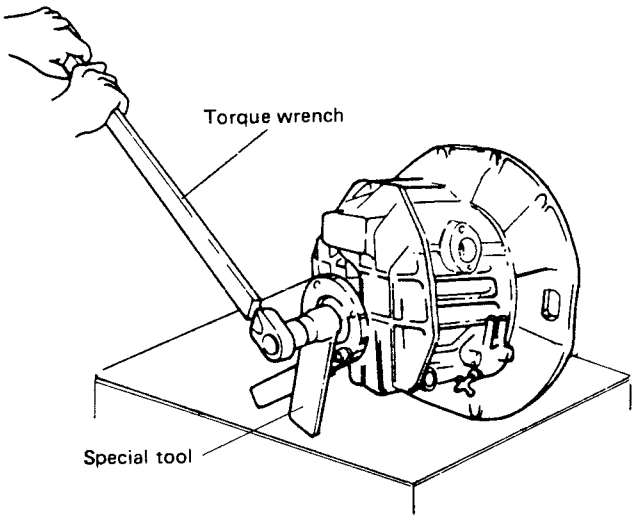
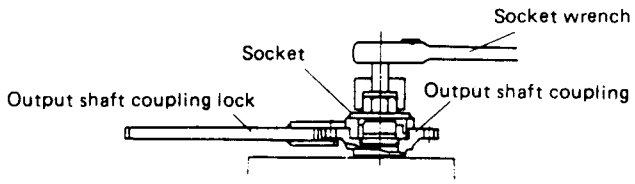
(5)Insert the outer bearing race, shim and the output shaft cover, and tighten the bolt.



(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.

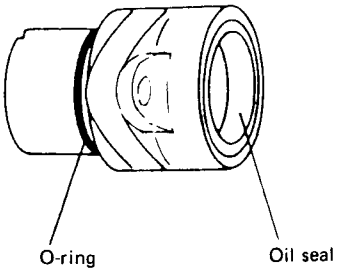




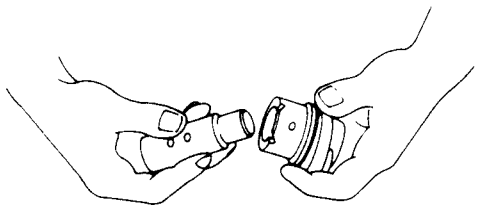
Tightening torque	54 – 56 kg-m (391 – 405 ft-lb)

6-3-7 Reassembly of the shifting device

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

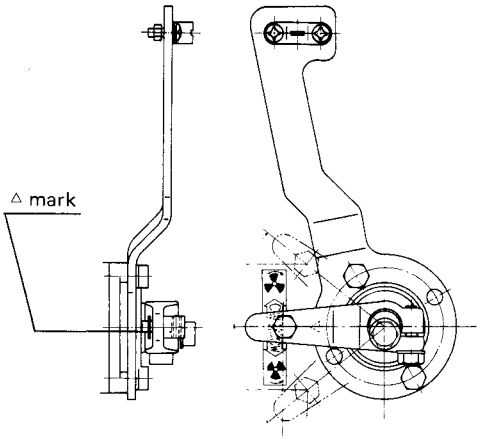


(2)Insert the shift lever shaft to the side cover

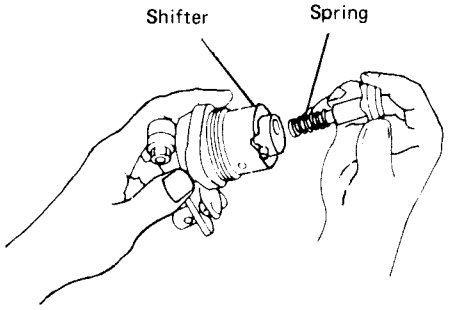


(3)Fit the shift lever to the shift lever shaft

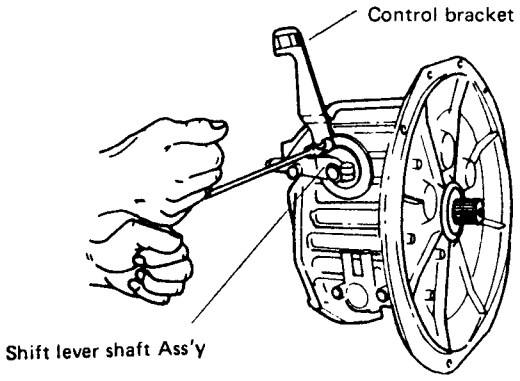
NOTE: Check the direction of the shift lever △ mark.



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



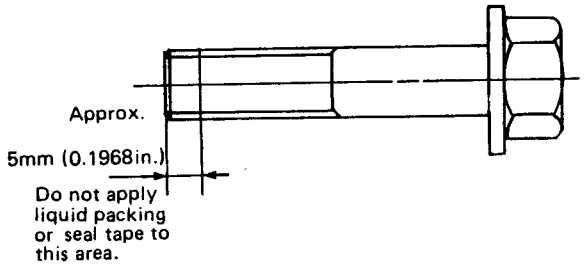
(5) Fit the side cover assembly and the remote control bracket to the clutch case.



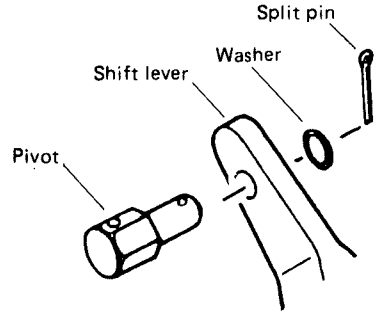
NOTE: 1) Check the direction of the shifter (Top and bottom side)
2) The shift lever may not turn smoothly if the clutch case is not filled with lubricating oil.

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

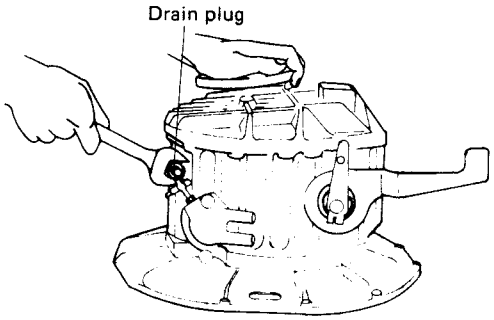
NOTE: Apply non-drying liquid packing or seal tape to the thread of the stopper bolt.

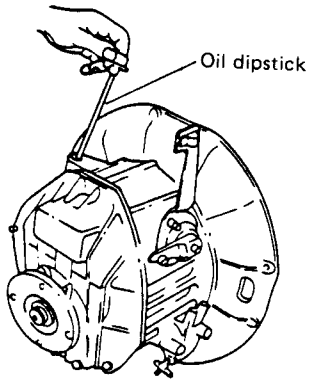


(7) Fit the pivot to the shift lever.



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





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