SERVICE MANUAL

MODEL

KM2P-1

KM35A

KM35A2

KM35P

KM4A

KM5A

REFERENCE

YANMAR by KANZAKI

Code : M2-77070-9550

CONTENS

1.To Perform Service Safely

1.1 Warning Symbols

- Most accidents are caused by negligence of basic safety rules and precautions.
  For accident prevention,it is important to avoid such causes before development to accidents.
  Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures.
  Attempting a repair or maintenance job without sufficient knowledge may cause an unexpected accident.

- It is impossible to cover every possible danger in repair or maintenance in the manual.Sufficient consideration for safety is required in addition to the matters marke ⚠ CAUTION.
  Especially for safety precautions in a repair or maintenance job not described in this manual,receive instructions from a knowledgeable leader.

- Warning Symbols used in this manual and their meanings are as follows:

⚠ DANGER	DANGER-Indicates an imminently hazardous situation which,if not avoided,WILL result in death or serious injury.
⚠ WARNING	WARNING-Indicates a potentially hazardous situation which,if not avoided,COULD result in death or serious injury.
⚠ CAUTION	CAUTION-Indicates a potentially hazardous situation which,if not avoided,may result in minor or moderate injury.

- Any matter marked [NOTICE] in this manual is especially important in serving.If not observed, the product performance and quality may not be guaranteed.

1.2 Precautions for Safe Servicing

(1) Service Shop (Place)

⚠ CAUTION

● **Sufficiently wide and flat place**

The floor space of the service shop for inspection and maintenance shall be sufficiently wide and flat without any hole.

[Otherwise]

An accident such as a violent fall may be caused.

⚠ CAUTION

● **Clean,orderly arranged place**

No dust,mud,oil or parts shall be left on the floor surface.

[Otherwise]

An unexpected accident may be caused.

⚠ CAUTION

● **Bright,safety illuminated place**

The working place should be illuminated sufficiently and safely.

For a job in a dark position involving difficulty in observation,use a portable safety lamp. The bulb shall be covered with a wire cage.

[Otherwise]

The bulb may be broken accidentally to cause ignition of leaking oil.

⚠ CAUTION

● **Place equipped with a fire extinguisher**

Keep a first aid kit and fire extinguisher close at hand in preparation for an emergency of fire.

(2) Working Wear

⚠ CAUTION

● **Wears for safe operation**

Wear a helmet,working clothes,safety shoes and other safety protectors matching each job.Especially,wear well-fitting working clothes.

[Otherwise]

A serious accident such as trapping by a machine may arise.

(3) Tools to Be Used

⚠ WARNING ● Appropriate holding and lifting

Never operate when the marine gear is supported with blocks or wooden pieces or only with a jack. To lift and hold and the marine gear, always use a crane with a suffcient allowance in limit load or a rigid jack.

[Otherwise]

A serious accident may arise.

⚠ WARNING ● Use of appropriate tools

Use tools matching the jobs to be done. Use a correctly sized tool for loosening or tightening a machine part.

[Otherwise]

A serious injury or marine gear damage may arise.

(4) Use of Genuine parts, Oil and Grease

⚠ CAUTION ● Always use genuine product

[Otherwise]

Shortening of marine gear life or an unexpected accident may arise.

(5)Bolt and Nut Tightening Torques

⚠ WARNING ● Always tighten to the specified torque if designated in the manual

[Otherwise]

Loosening or falling may cause parts damage or an injury.

(6) Handing Of Product

⚠ WARNING

● Pay attention to hot portions

Do not touch the engine or marine gear during running or immediately after it is stopped

[Otherwise]

Scalding may be caused by a high temperature.

(4)Waste Disposal

⚠ CAUTION

Observe the following instructions with regard to waste disposal.
Negligence of each instruction will cause environmental pollution.

- Waste fluids such as engine and marine gear oil and cooling water shall be discharged into a container without spillage onto the ground.
- Do not let waste fluids be discharged into the sewerage,a river or the sea.
- Harmful wastes such as oil, fuel, coolants, solvents, filter elements and battery shall be disposed according to the relevant laws and regulations. Ask a qualified disposal company for example.

2.General
2.1 Specificatione

2.1.3 KM2P-1

Input torque capacity (MAX.RPM)		129 N-m (3800rpm)
Cluch type		Mechanical parallel servo cone
Reduction ratio	Forward	2.26 2.62 3.22
	Reverse	3.06
Direction of rotation (view from stern)	Input shaft	Conuter - clockwise
	Output shaft	clockwise
Position of shift lever		Left side, viewed from stern
Lubricating oil		SAE#20/30 (without multi - grade oil)
Lubricating oil capacity		0.3 ltr
Dry weight		9.8 kg

2.1.1 KM35A

Input torque capacity (MAX.RPM)		103 N-m (3800rpm)	
Cluch type		Mechanical angle servo cone	
Reduction ratio	Forward	2.33	2.64
	Reverse	3.04	
Direction of rotation (view from stern)	Input shaft	Conuter - clockwise	
	Output shaft	clockwise	
Position of shift lever		Right side, viewed from stern	
Lubricating oil		SAE#20/30 (without multi - grade oil)	
Lubricating oil capacity		0.65 ltr	
Dry weight		12.8 kg	

2.1.2 KM35A2

Input torque capacity (MAX.RPM)		129 N-m (3800rpm)	
Cluch type		Mechanical angle servo cone	
Reduction ratio	Forward	2.33	2.64
	Reverse	3.06	
Direction of rotation (view from stern)	Input shaft	Conuter - clockwise	
	Output shaft	clockwise	
Position of shift lever		Right side, viewed from stern	
Lubricating oil		SAE#20/30 (without multi - grade oil)	
Lubricating oil capacity		0.65 ltr	
Dry weight		12.8 kg	

2.1.3 KM35P

Input torque capacity (MAX.RPM)		129 N-m (3800rpm)	
Cluch type		Mechanical parallel servo cone	
Reduction ratio	Forward	2.36	2.61
	Reverse	3.16	
Direction of rotation (view from stern)	Input shaft	Conuter - clockwise	
	Output shaft	clockwise	
Position of shift lever		Left side, viewed from stern	
Lubricating oil		SAE#20/30 (without multi - grade oil)	
Lubricating oil capacity		0.5 ltr	
Dry weight		12.0 kg	

2.1.3 KM4A

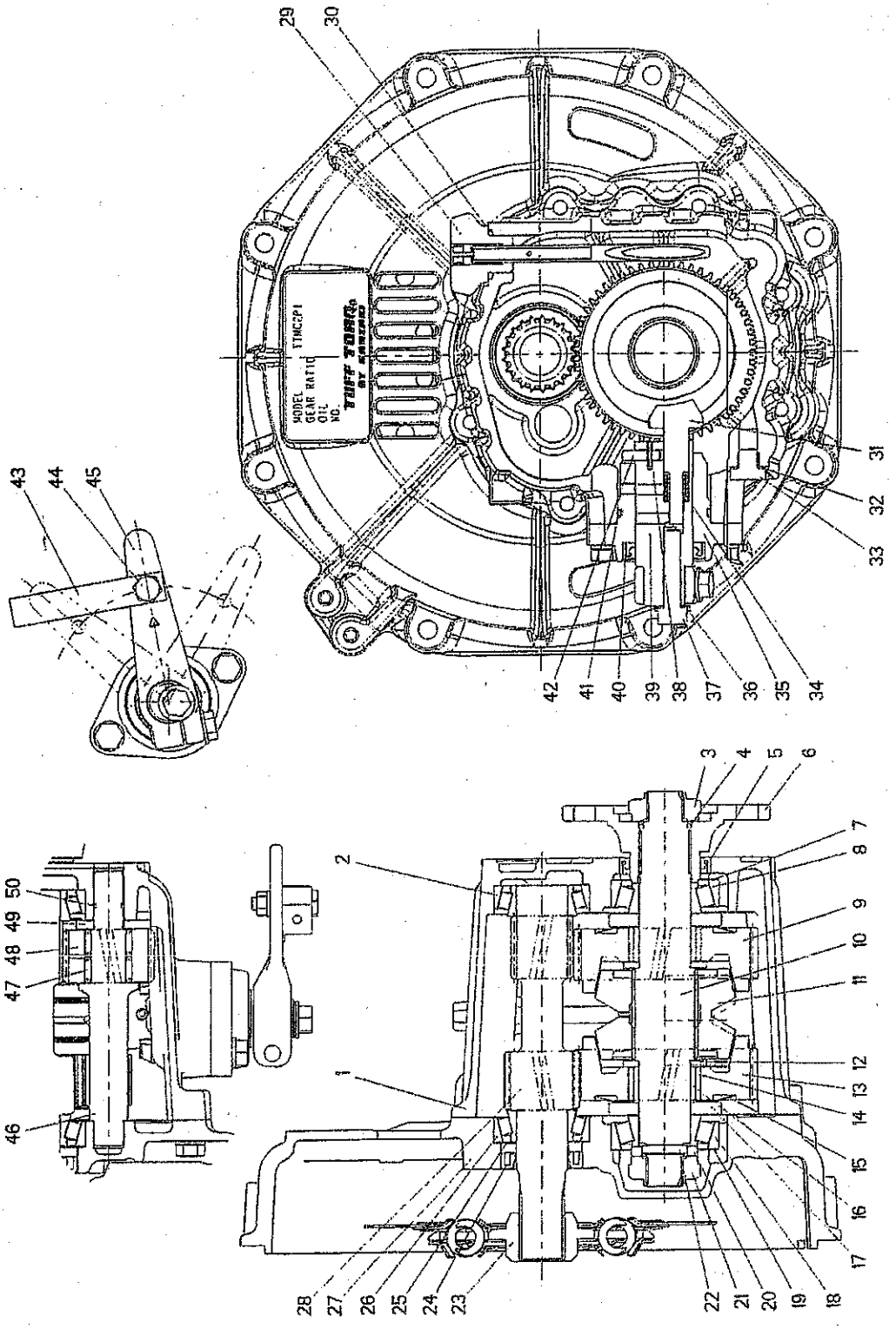
Input torque capacity (MAX.RPM)		185 N-m (3800rpm)			
Cluch type		Mechanical parallel servo cone			
Reduction ratio	Forward	1.47	2.14	2.63	3.30
	Reverse	1.47	2.14	2.63	3.30
Direction of rotation (view from stern)	Input shaft	Conuter - clockwise			
	Output shaft	Bi-rotation			
Position of shift lever		Right side, viewed from stern			
Lubricating oil		SAE#20/30 (without multi - grade oil)			
Lubricating oil capacity		2.3 ltr			
Dry weight		30.0 kg			

2.1.4 KM5A

Input torque capacity (MAX.RPM)		360 N-m (3300rpm)		
Cluch type		Mechanical angle servo cone		
Reduction ratio	Forward	1.46	2.07	2.57
	Reverse	1.46	2.07	2.57
Direction of rotation (view from stern)	Input shaft	Conuter - clockwise		
	Output shaft	Both		
Position of shift lever		Right side, viewed from stern		
Lubricating oil		SAE#20/30 (without multi - grade oil)		
Lubricating oil capacity		2.6 ltr		
Dry weight		45.5 kg		

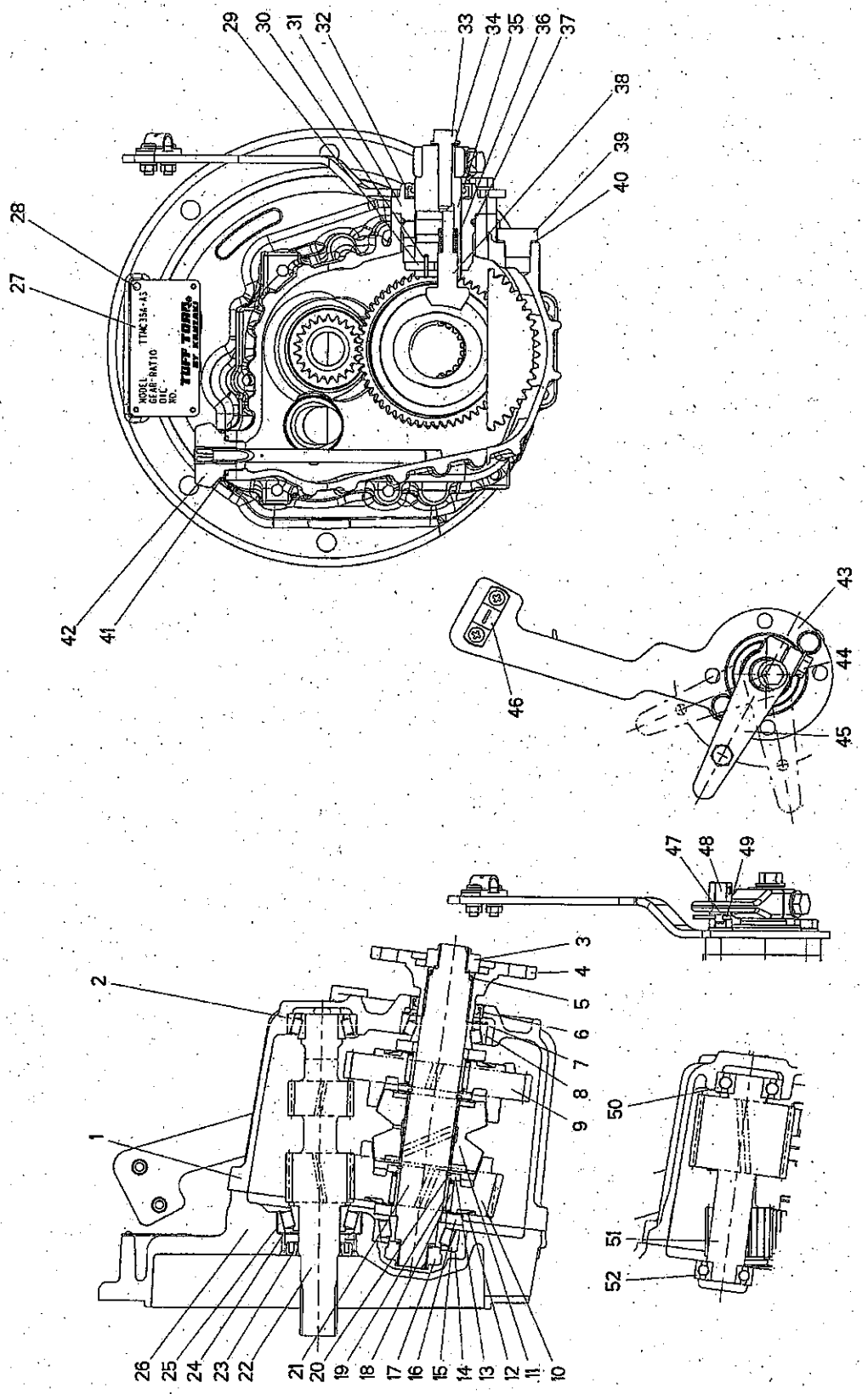
2.2 Sectional View

2.2.1 KM2P-1



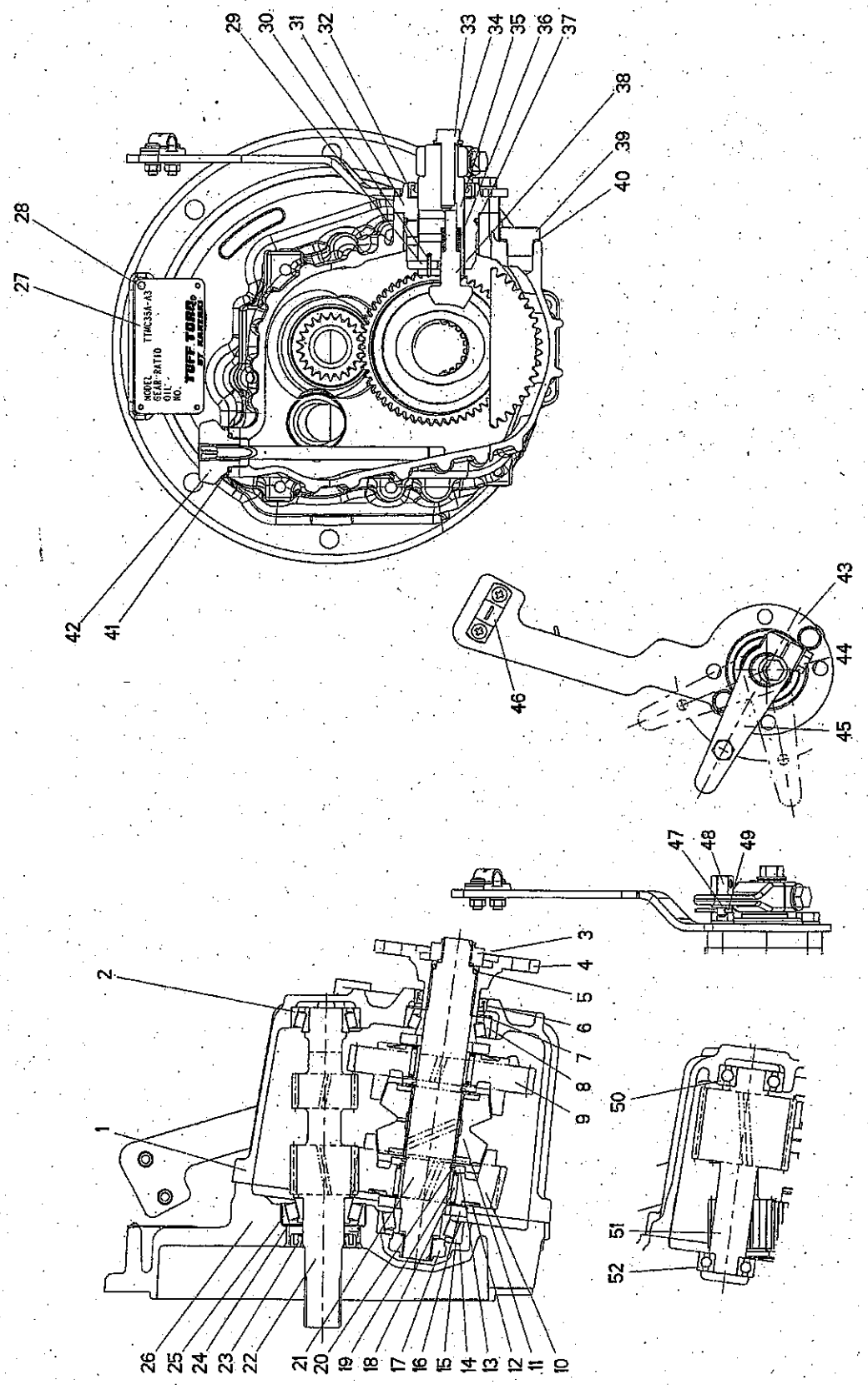
1 Case
2 Bearing
3 Locl nut
4 O-ring
5 Oil seal
6 Output flange
7 Shim set
8 Bearing
9 Reverse large gear
10 Output shaft
11 Drive cone
12 Collar
13 Forward large gear
14 Needle bearing
15 Cup spring
16 Bearing inner race
17 Collar
18 Bearing
19 Shim set
20 Collar
21 Lock nut
22 Pin
23 Damper disc
24 Oil seal
25 Shim set
26 Bearing
27 Mounting flange
28 Input shaft
29 Dipstick
30 O-ring
31 Shifter
32 Packing
33 Drain plug
34 Spring
35 Side cover
36 Shim
37 Bolt
38 Spring pin
39 Shift lever shaft
40 Oil seal
41 O-ring
42 Location pin
43 Joint
44 Bolt
45 Shift lever
46 Intermediate shaft
47 Needle bearing
48 Gear
49 Washer
50 O-ring

2.2.2 KM35A



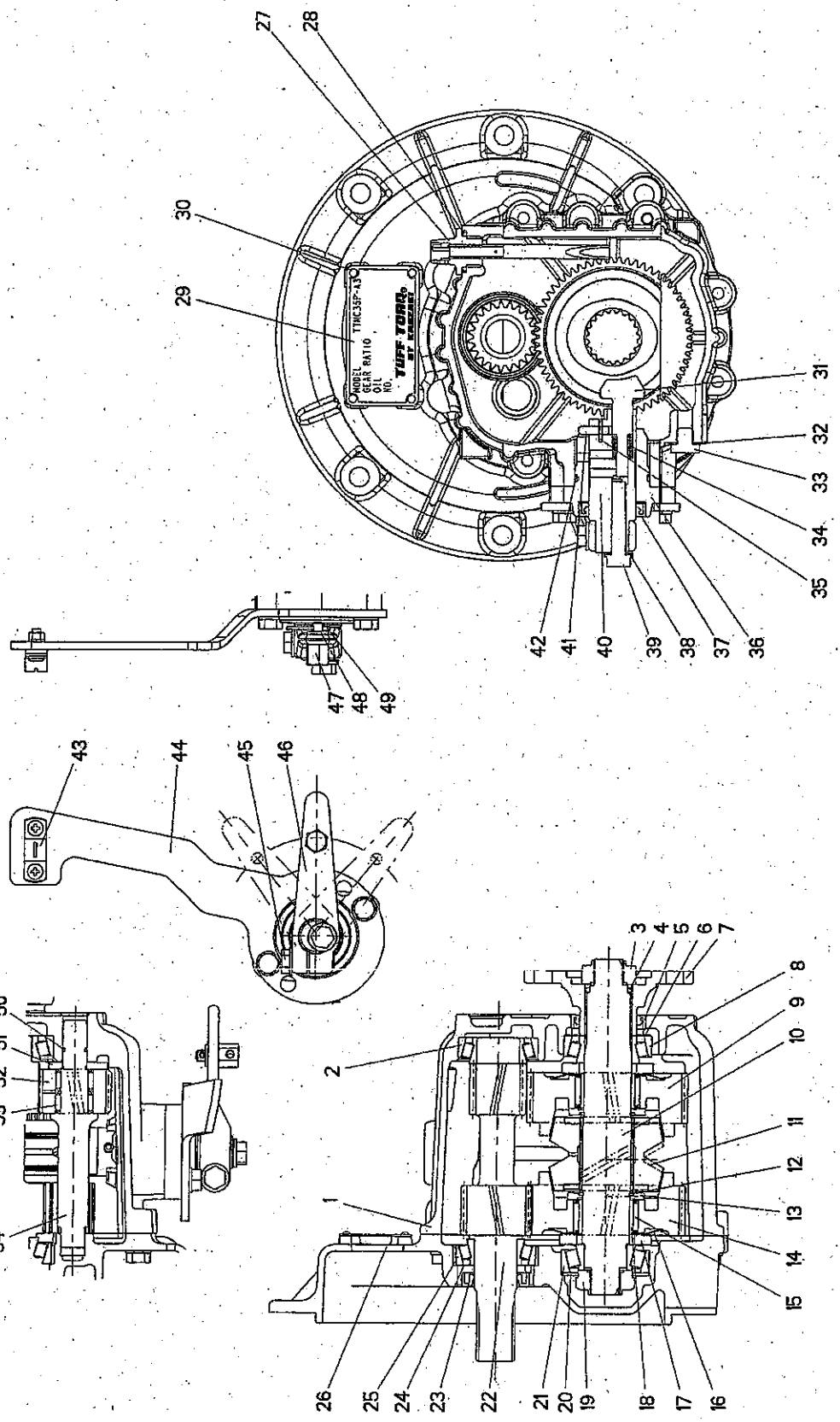
1 Case
2 Bearing
3 Lock nut
4 Output flange
5 O-ring
6 Oil seal
7 Shim set
8 Bearing
9 Reverse large gear
10 Forward large gear
11 Drive cone
12 Cup spring
13 Collar
14 Shim set
15 Bearing
16 Collar
17 Lock nut
18 Needle bearing
19 Bearing inner race
20 Snap ring
21 Output shaft
22 Input shaft
23 Oil seal
24 Shim set
25 Bearing
26 Mounting flange
27 Name plate
28 Rivet
29 Location pin
30 Spring pin
31 Side cover
32 Oil seal
33 Bolt
34 Shim
35 Shift lever shaft
36 Spring
37 O-ring
38 Shifter
39 Drain plug
40 Packing
41 O-ring
42 Dipstick
43 Cable Bracket
44 Bolt
45 Shift lever
46 Clamp
47 Washer
48 Pivot
49 Pin
50 Ball bearing
51 Intermediate shaft
52 Ball bearing

2.2.3 KM35A2



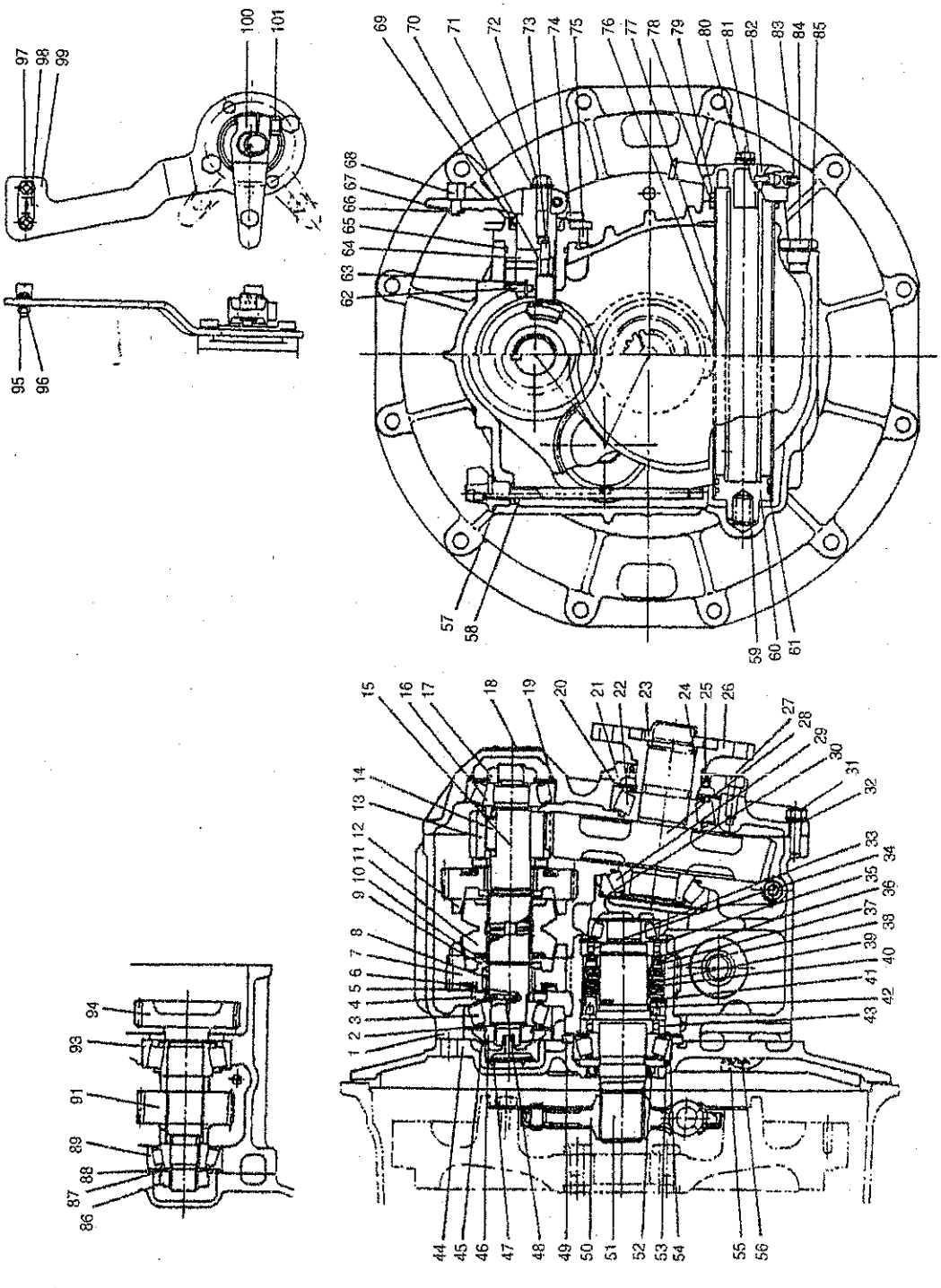
1 Case
2 Bearing
3 Lock nut
4 Output flange
5 O-ring
6 Oil seal
7 Shim set
8 Bearing
9 Reverse large gear
10 Forward large gear
11 Drive cone
12 Cup spring
13 Collar
14 Shim set
15 Bearing
16 Collar
17 Lock nut
18 Needle bearing
19 Bearing inner race
20 Snap ring
21 Output shaft
22 Input shaft
23 Oil seal
24 Shim set
25 Bearing
26 Mounting flange
27 Name plate
28 Rivet
29 Location pin
30 Spring pin
31 Side cover
32 Oil seal
33 Bolt
34 Shim
35 Shift lever shaft
36 Spring
37 O-ring
38 Shifter
39 Drain plug
40 Packing
41 O-ring
42 Dipstick
43 Cable Bracket
44 Bolt
45 Shift lever
46 Clamp
47 Washer
48 Pivot
49 Pin
50 Ball bearing
51 Intermediate shaft
52 Ball bearing

2.2.4 KM35P



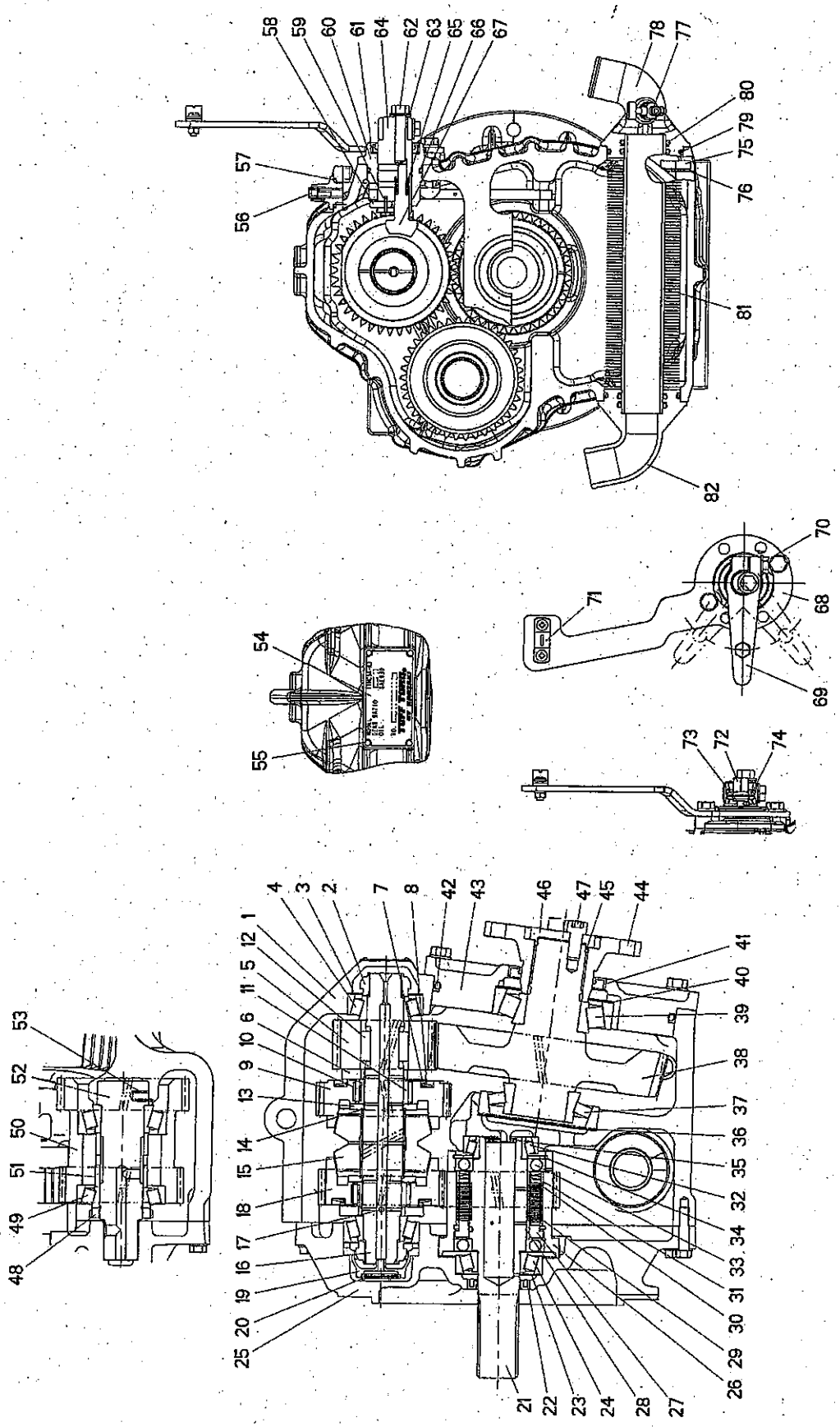
1 Case
2 Bearing
3 Lock nut
4 O-ring
5 Oil seal
6 Shim set
7 Output flange
8 Bearing
9 Reverse large gear
10 Output shaft
11 Drive cone
12 Snap ring
13 Collar
14 Forward large gear
15 Needle bearing
16 Cup spring
17 Collar
18 Bearing inner race
19 Lock nut
20 Shim set
21 Bearing
22 Input shaft
23 Oil seal
24 Shim set
25 Bearing
26 Mounting flange
27 Dipstick
28 O-ring
29 Name plate
30 Rivet
31 Shifter
32 Packing
33 Drain plug
34 Spring
35 Spring pin
36 Side cover
37 Oil seal
38 Shim
39 Bolt
40 Shift lever shaft
41 Location pin
42 O-ring
43 Clamp
44 Cable bracket
45 Bolt
46 Shift lever
47 Pivot
48 Washer
49 Pin
50 O-ring
51 Washer
52 Gear
53 Needle Bearing
54 Intermediate shaft

2.2.5 KM4A



1 Clutch case
2 Shim
3 Bearing
4 Thrust colar(A)
5 Spring retainer
6 Cup spring
7 Clutch gear(A)
8 Needle bearing
9 Thrust colar(B)
10 Snap ring
11 Drive cone
12 Clutch gear(B)
13 Drive gear
14 Key
15 Clutch shaft
16 Bearing
17 End nut
18 Name Plage
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 × 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 × 25)

2.2.6 KM5A



1 Case
2 Lock nut
3 Shim set
4 Roller bearing
5 Gear
6 Collar
7 Spring retainer
8 Cup spring
9 Reverse large gear
10 Needle bearing
11 Bearing inner race
12 Feather key
13 Collar
14 Snap ring
15 Drive cone
16 Output shaft
17 Spring pin
18 Forward large gear
19 Strainer case
20 Filter
21 Input shaft
22 Seal
23 Shim set
24 Roller bearing
25 Flange
26 Gear
27 Lock nut
28 Packing
29 Limiter plate
30 Keep plate
31 Spring limiter
32 Bearing
33 Bearing
34 Ring
35 Oil seal
36 Shim set
37 Roller bearing
38 Output shaft
39 Bearing
40 Shim set
41 Seal
42 Packing
43 Output rear cover
44 Output flange
45 O-ring
46 Coupling plate
47 Bolt
48 Nut
49 Bearing
50 Gear
51 Bearing
52 intermediate shaft
53 Spring pin
54 Name plate
55 Rivet
56 Dipstick
57 O-ring
58 Location pin
59 Spring pin
60 Side cover
61 seal
62 Bolt
63 Shim
64 Shift lever shaft
65 Spring
66 O-ring
67 Shifter
68 Bracket
69 Shift lever
70 Bolt
71 Clamp
72 Pivot
73 Washer
74 Pin
75 Drain plug
76 Packing
77 Cock
78 Cooler cover
79 Packing
80 Packing
81 Tube fin
82 Cooler cover

3.Overhaul
3.1 Precautions

(1)For Safe Operation
Read the safety precautions as the beginning of this manual carefully and operate safely.

(2)Past Inspections for the Marine Gear
For precise, high-quality operation, preparation is necessary. Check the customer management file for the past performance of the engine and marine gear.

(2.1) When was the last maintenance work done?
(2.2) How much has the marine gear been used (length of time/hrs.of use)since the last maintenance work?
(2.3) What problems were found at the last inspection,and what maintenance work was performed?
(2.4) Are the parts needed for replacement during maintenance on hand?
(2.5) Is there a check sheet for the maintenance work?

(3)Preparation for Disassembly
(3.1) Have ready all-purpose tools,special tools,gauges,grease,disposable parts,and replacement parts.
(3.2) When disassembling complicated sections, make alignment marking which will not damage the parts but will make reassembly easier.

(4)Precautions for Disassembly
(4.1) As each part is removed,check its condition and look for changes in shape, damage, and scratches.
(4.2) Disassemble the parts in an orderly manner separating parts which can be reused from those which need to be replaced.
(4.3) Clean or wash the parts to be reused thoroughly.

(5)Inspection and Measurement
(5.1) Make the necessary inspections and measurements for parts to be reused and determine whether they are good or bad.

(6)Reassembly
(6.1) Use the correct parts and assemble them in the correct manner to specified standards (tightening torque, adjustment values, etc.). Also, grease the important bolts and nuts as specified.
(6.2) Be sure to use genuine parts for replacements.
(6.3) Be sure to replace oil seals, O-rings, and packings with new ones.
(6.4) Depending upon the placement of the packing, grease the seal packing, oil or grease moving parts, and insert grease in the lip of the oil sheals.

(7)Adjustment and Inspectior
(7.1) Use gauges and testers to adjust to the specified standard.

3.2 Preparing for Overhaul

Prepare for the disassembly and maintenance of the marine gear as follows.

(1) Secure the marine gear on a level base.

⚠ CAUTION

Be sure the marine gear is secured.
If the marine gear falls over during operation, injury or damage to parts may occur.

(2)Drain the marine gear lube oil.

(3)Clean off any dirt, oil, or dust on the marine gear with detergent, air, steam, etc.

[NOTICE]

Be careful not to get any dust inside the marine gear during operation.

⚠ CAUTION

Wear goggles and protective gear when using air or steam.
Flying particles may injre the eyes.

[NOTICE]

- Be sure to replace the parts which upon inspection and measurement are faulty, whose measurements are outside the presribed limits, or have exceeded the prescribed period of use.
- Parts which still meet the standard measurements and prescribed period of use, but which are expected to fall below the standard before the next inspection should be replaced early.

3.6 KM35P

3.6.1 Construction

3.6.1.1 Construction

This clutch is a cone-type, mechanically operated clutch. When the drive cone (which is connected to the output shaft by the lead spline) is moved forward or backward, its taper contacts with the large gear and transfers power to the output shaft.
The construction is simple when compared with other types of clutch and it serves to reduce the number of components, making for a lighter, more compact unit which can be operated smoothly. Although it is small, the power transmission effciency is high even under a heavy load. Its durability is high and it is also 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 coupling devices.

- The drive cone is made from special aluminum bronze which has both high wear-resistance and durability. The drive cone is connected with the output shaft through the thread spline. The taper angle, diameter of the drive cone, twist angle, and diameter of the thread 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. It is also anticorrosive against seawater.
- There is 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 large gear is maintained by the shifter and V-groove of the drive cone. Even when the drive cones tapered surfaces and V-groove are worn, clutch engagement is maintained by the shift lever device. So that no adjustment of the remote control cable is required.
- The cup spring on the rear of the larger gear absorbs rotational fluctuations and stabilizes the engagement of the drive cone and the larger gear. Thus, the durability of the cone against wear is enhanced.

3.6.1.2 Specifications

Model			KM35P	
Clutch			Mechanical parallel serve cone	
Reduction of rotation	Forward		2.36	2.61
	Reverse		3.16	
Direction of rotation	Input shaft		Counter – clockwise	
	Output shaft	Forward	Clockwise	
		Reverse	Counter–clockwise	
Output shaft coupling	Outer diameter mm		ϕ100	
	Pitch circle diameter mm		PCϕ78	
	Connecting bolt holes I mm		4–ϕ10.5	
Position of shift lever			Left side, viewed from stern	
Lubricating oil			SAE#20/30(without multi – grade oil)	
Lubricating oil capscity ℓ			0.5	
Dry mass kg			11.5	

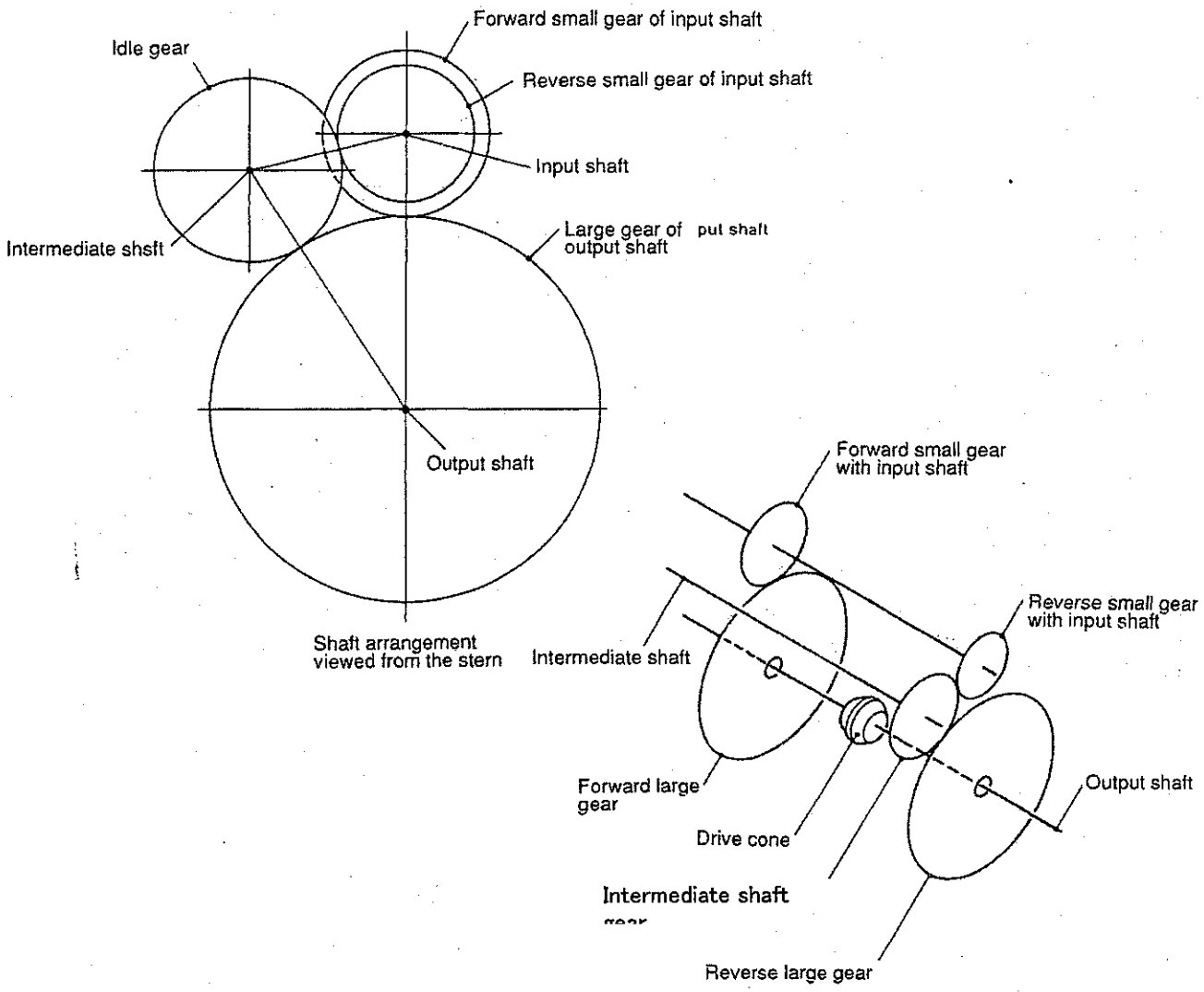
Note

In the case of clutch model KM35P, permissible diameter of propeller or moment of inerta of the propeller is as following table.

Reduction ratio	No.of blade	Diameter of the propeller (mm)	Moment of inertia GD^2kg-m^2(N-m^2)	Material
2.36	3	490	≦0.33 (3.3)	Bronze
	4	460		
2.61	3	510	≦0.41 (4.1)	
	4	490		

3.6.1.3 Power transmission system

1) Arrangement of shafts and gears



2) Reduction ratio

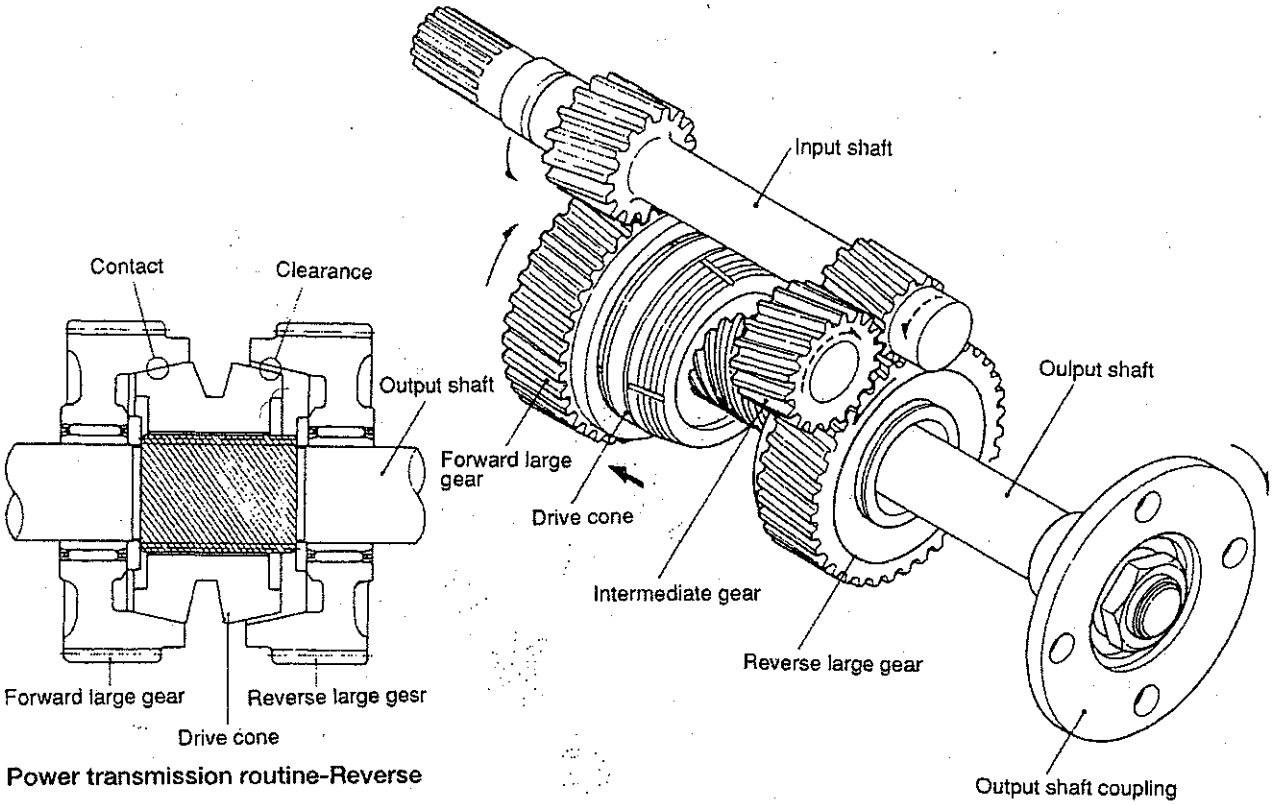
Forward

Model	No. of teeth of forward small gear Zif	No.of teeth of forward large gear Zof	Reduction retio Zof/Zif
KM35P	23	60	60/23 = 2.61
	25	59	59/25 = 2.36

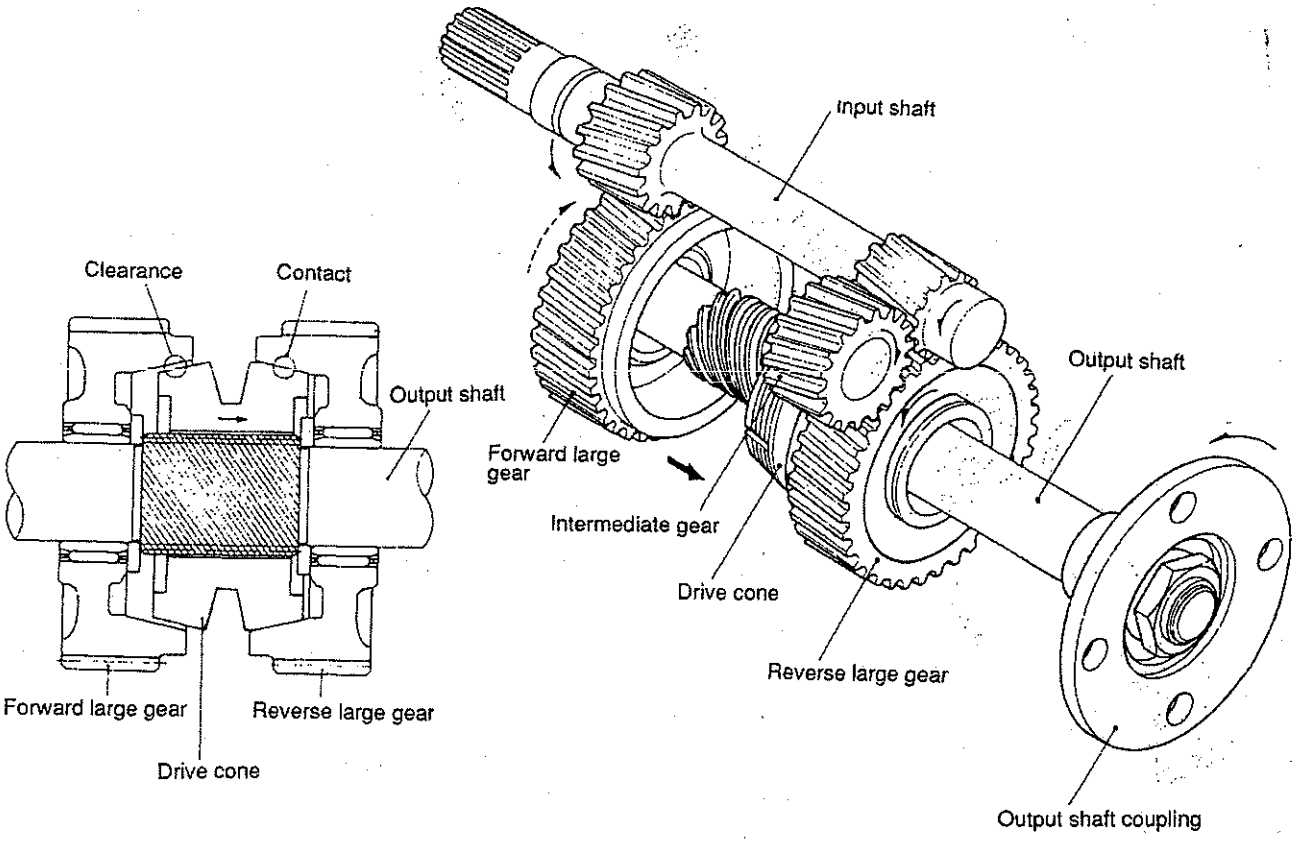
Reverse

Model	No. of teeth of reverse small gear Zif	No. of teeth of intemediate shaft gear Zi	No. of teeth of reverse large gear Zdr	Reduction ratio Zi/Zir•Zdr/Zi
KM35P	19	26	60	26/19•60/26 = 3.16

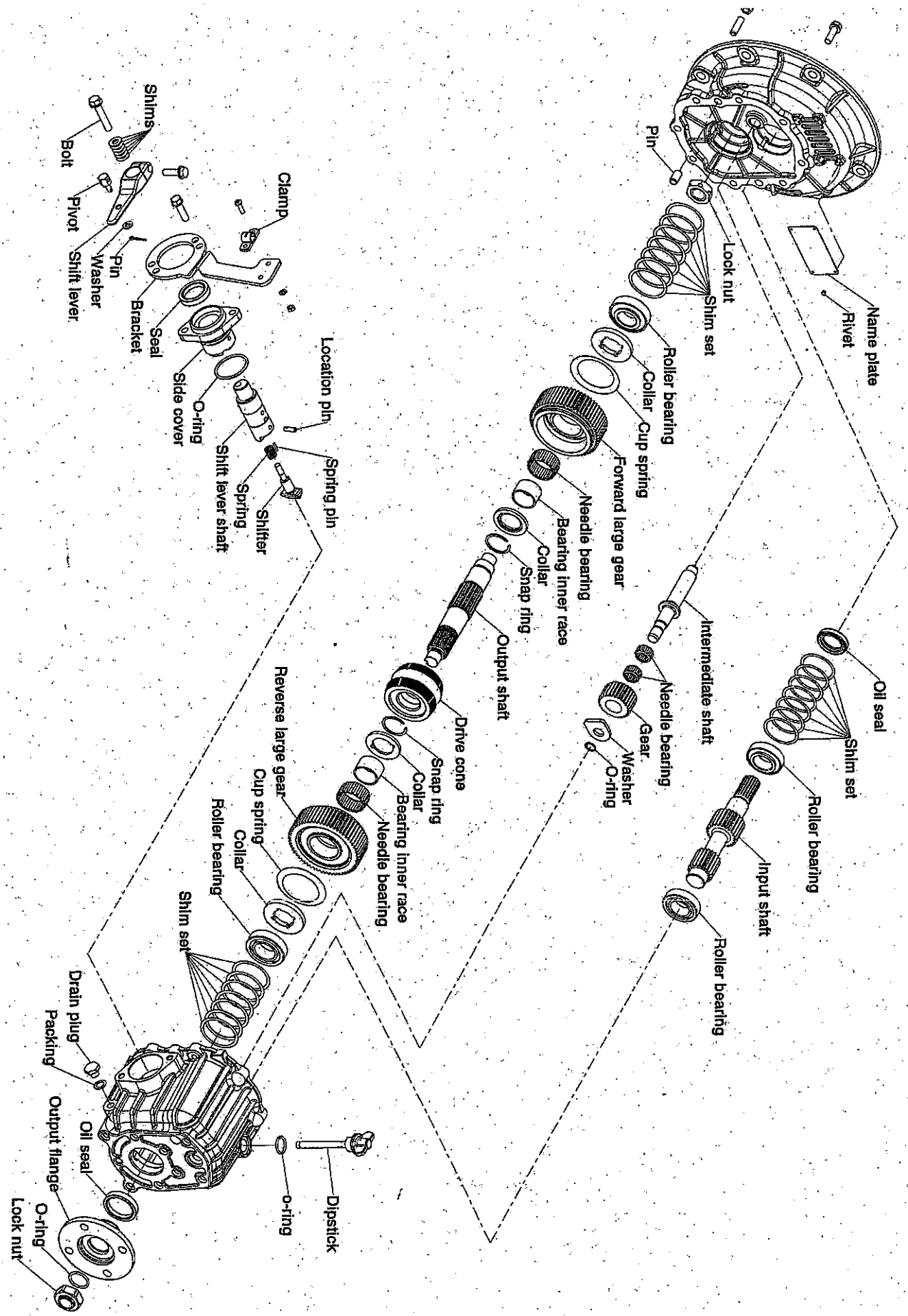
3) Power transmission routine-Forward



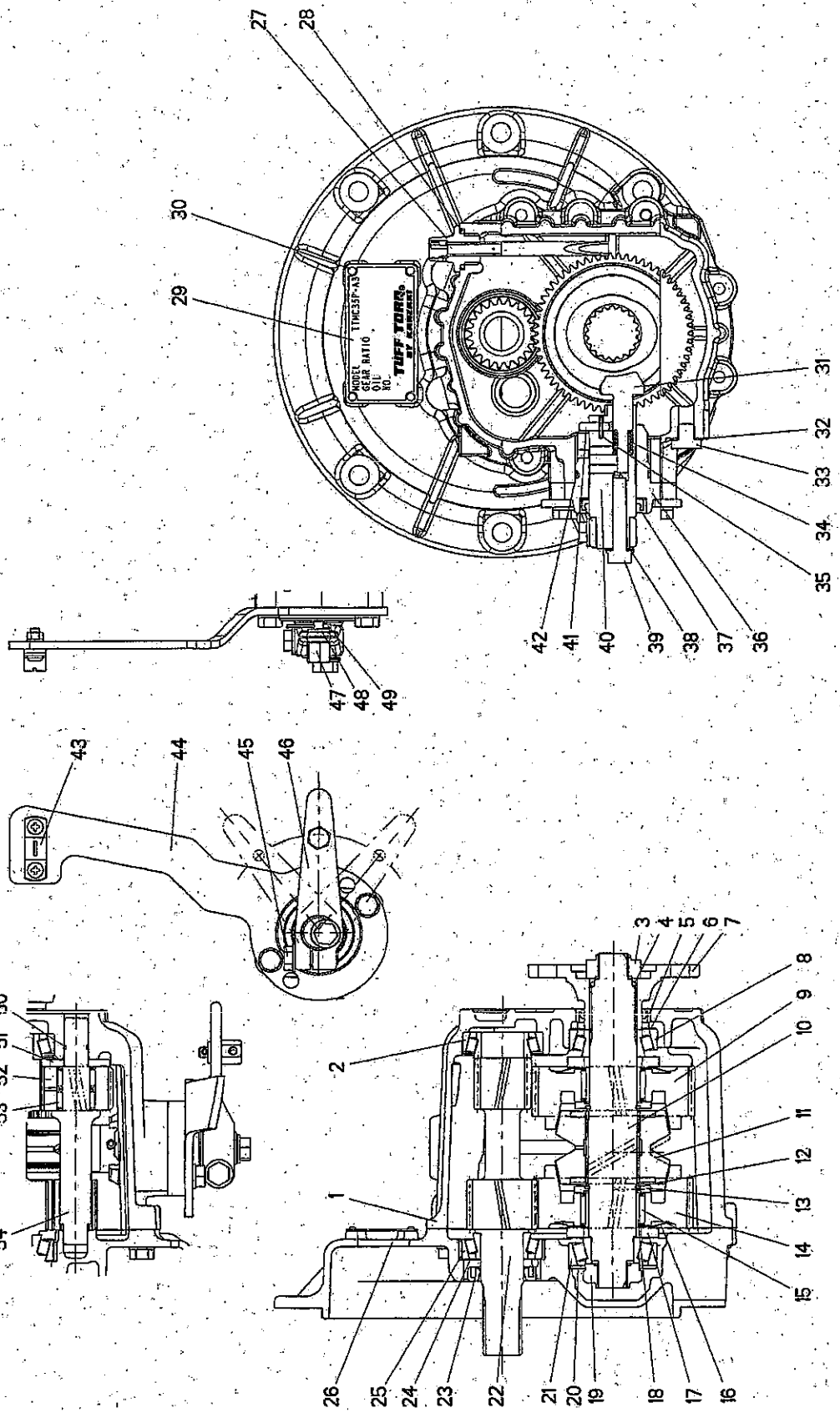
4) Power transmission routine-Reverse



3.6.1.4 Drawing



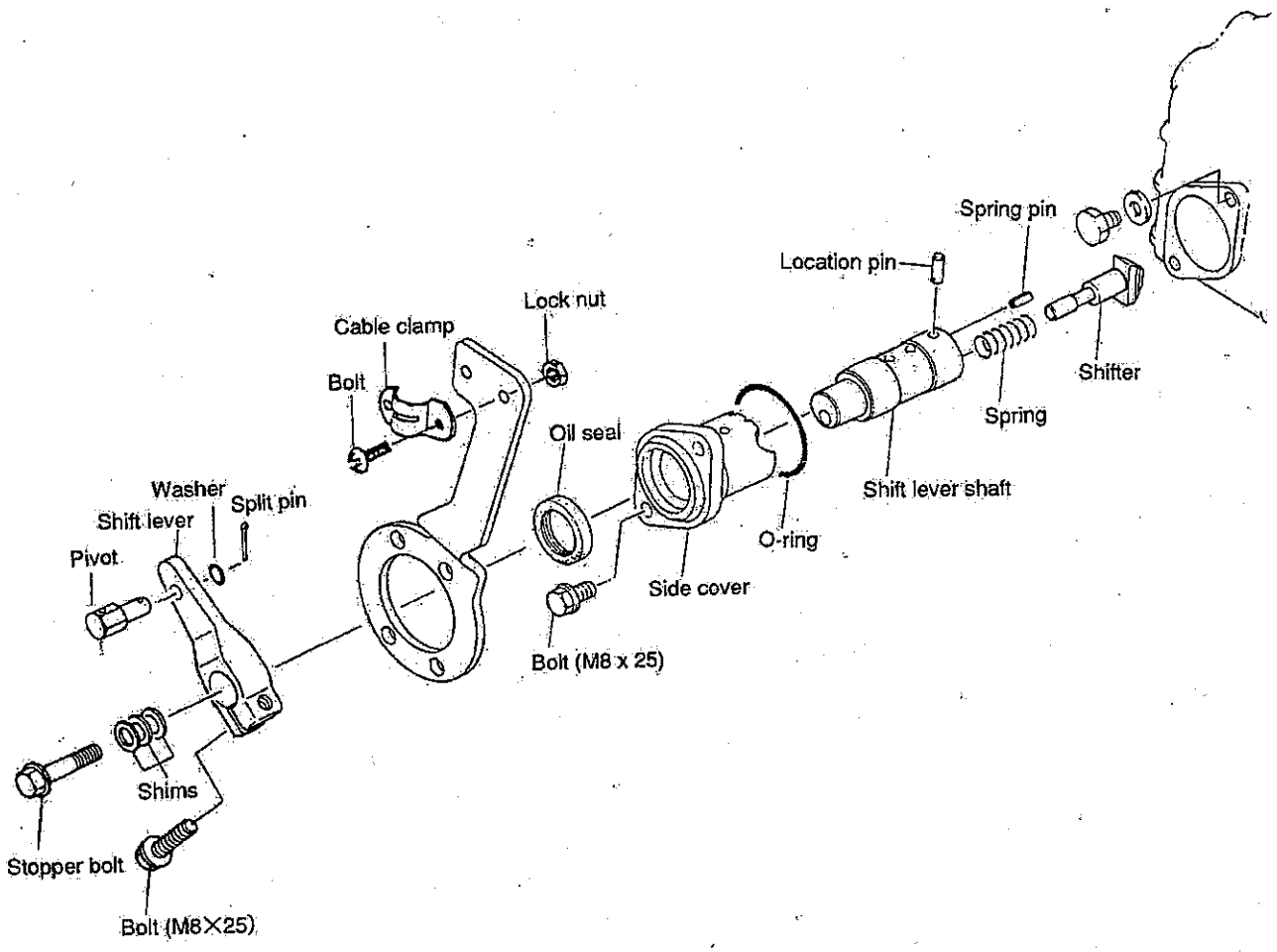
3.6.1.5 Sectional view



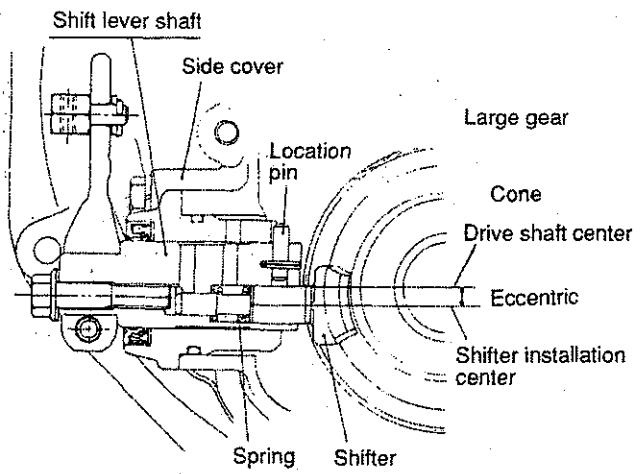
1 Case
2 Bearing
3 Lock nut
4 O-ring
5 Oil seal
6 Shim set
7 Output flange
8 Bearing
9 Reverse large gear
10 Output shaft
11 Drive cone
12 Snap ring
13 Collar
14 Forward large gear
15 Needle bearing
16 Cup spring
17 Collar
18 Bearing inner race
19 Lock nut
20 Shim set
21 Bearing
22 Input shaft
23 Oil seal
24 Shim set
25 Bearing
26 Mounting flange
27 Dipstick
28 O-ring
29 Name plate
30 Rivet
31 Shifter
32 Packing
33 Drain plug
34 Spring
35 Spring pin
36 Side cover
37 Oil seal
38 Shim
39 Bolt
40 Shift lever shaft
41 Location pin
42 O-ring
43 Clamp
44 Cable bracket
45 Bolt
46 Shift lever
47 Pivot
48 Washer
49 Pin
50 O-ring
51 Washer
52 Gear
53 Needle Bearing
54 Intermediate shaft

3.6.2 Shifting Device

3.6.2.1 Construction of shifting mechanism



The shift lever shaft is installed on the side cover with neutral, forward and reverse positions provided on this cover. The neutral, forward and reverse 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 forward or reverse positions, and then back to the neutral positions. (The shift lever shaft moves slightly to the shift lever or drive cone side when the shift lever is placed in the forward or reverse positions.)

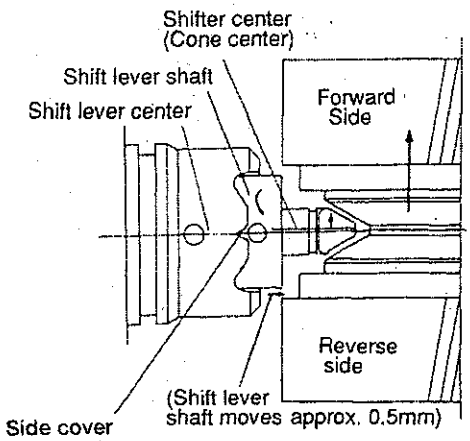


3.6.2.2 Forward and reverse clutch operation

(Neutral ⇒ Forward; Neutral ⇒ Reverse)

When the shift lever is moved to the forward 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 forward large gear.

When the location pin of the shift lever shaft falls in the forward position groove of the side cover, (the shift lever shaft moves to the shift lever side approx. 3mm), and the shifter starts to press the drive cone V-groove to the forward large gear side through the spring force.

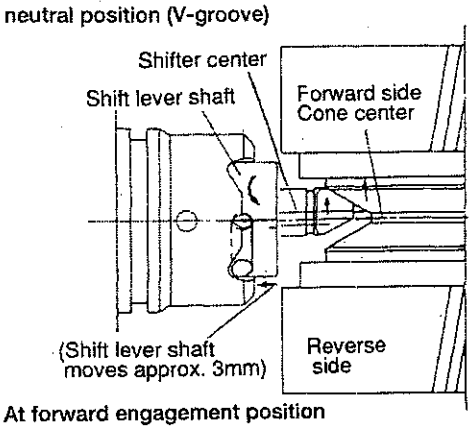


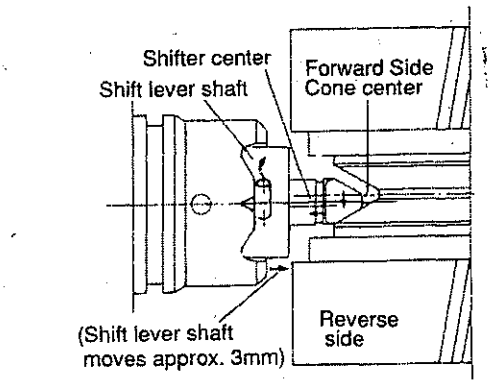
3.6.2.3 Engagement and disengagement of clutch

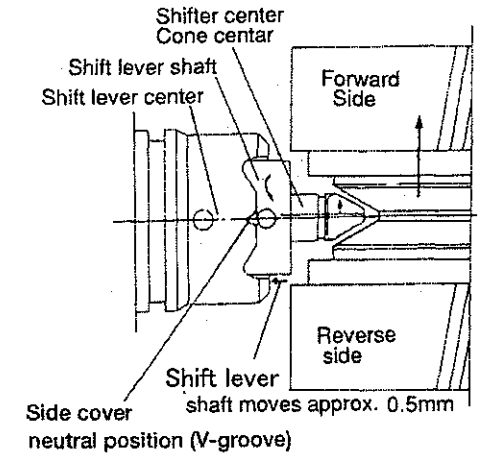
(Forward ⇒ Neutral; Reverse ⇒ Neutral)

When the shift lever is moved to the forward position from the neutral position, the shift lever shaft starts to revolve, and the location pin disengages from 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 moevd to the neutral side (reverse large gear side). The drive cone, however, is engaged with the forward large gear through 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 reverse large gear 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 reverse large gear side. Thus, the drive cone is disengaged from the forward large gear. 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 the spring force.

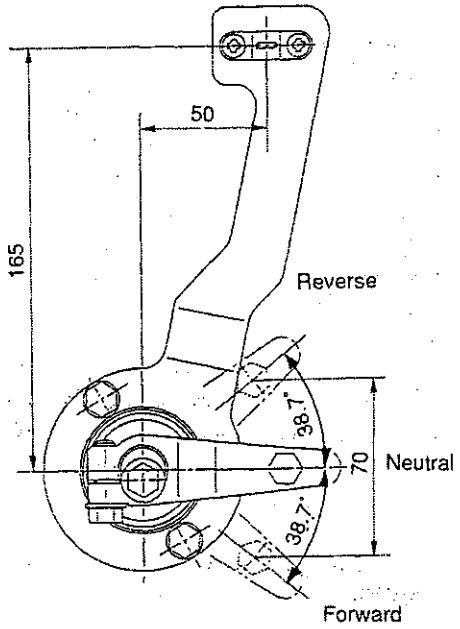






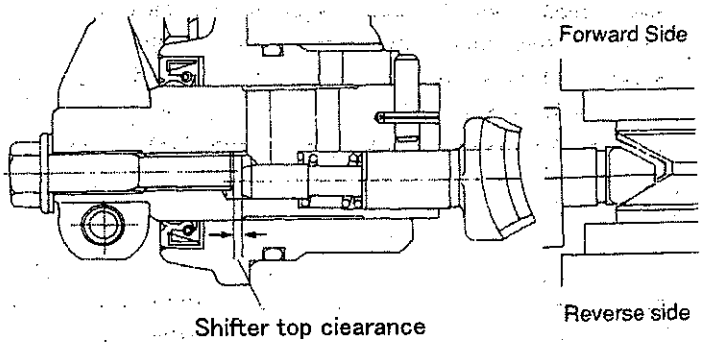
3.6.2.4 Clutch shifting force

Shifting position / Shifting direction	Shift lever position at 56mm	Remote control handle position at 170mm (Cable length, 4m)
Engaging force at 1000rpm	3 ~ 4kgf (29.4 ~ 39.2N)	4 ~ 5kgf (39.2 ~49N)
Disengaging force at 1000rpm	3.5 ~ 5kgf (34.3 ~ 49N)	4 ~ 6kgf (39.2 ~58.8N)



3.6.2.5 Adjustment of shifting device

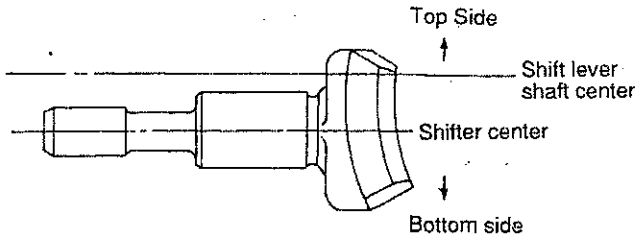
Whenever the side cover, shift lever shaft, shifter, stopper bolt or drive cone is replaced, be sure to adjust the clearance between the shifter end and the stopper bolt by using shims. When the adjustment of this clearance is not proper the drive cone may be properly fitted when the shift lever is moved to the neutral position from either the forward or reverse position.

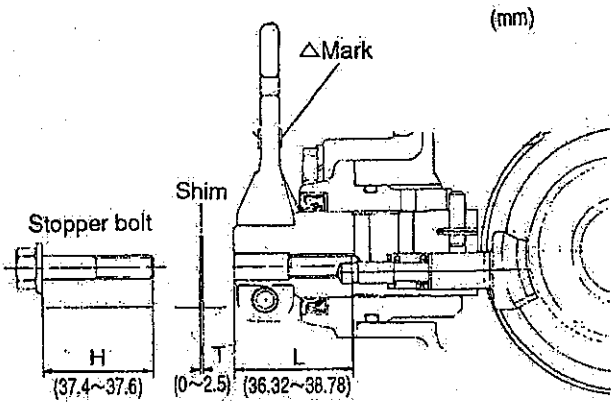


1)Measurement and adjustment of clearance

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

【 NOTICE 】
Ensure the correct direction of the shifter before assembly.





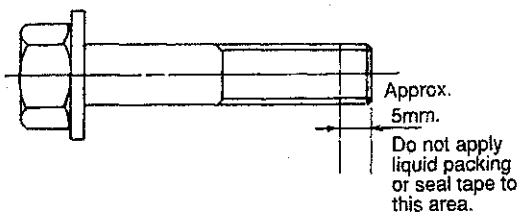
(b) Turn the shift lever 10～15 degree either to the forward or reverse position from the neutral position.
(c) Measure the L-distance between the shift lever shaft end surface and the shifter's end.
(d) Measure the H-distance (the distance from the neck of the stopper bolt to its end).
(e) Obtain the shim thickness T"by the following formula.

$$T = (H - L + 1.25) \pm 0.1mm$$

【 NOTICE 】
Shim set includes one piece each of 1mm, 0.4mm, 0.3mm, 0.25mm shims.
(Part No. 177088-06380)

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

【 NOTICE 】
When tightening the stopper bolt, apply either a non-drying type liquid packing (TREE BOND No.1215), or a seal tape around the bolt threads.



2) Inspect for the following points

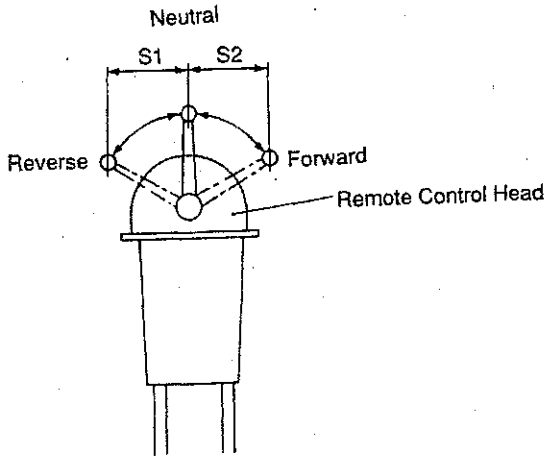
(to be inspected every 2-3 months)

(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.

3.6.2.6 Adjustment of the remote control head

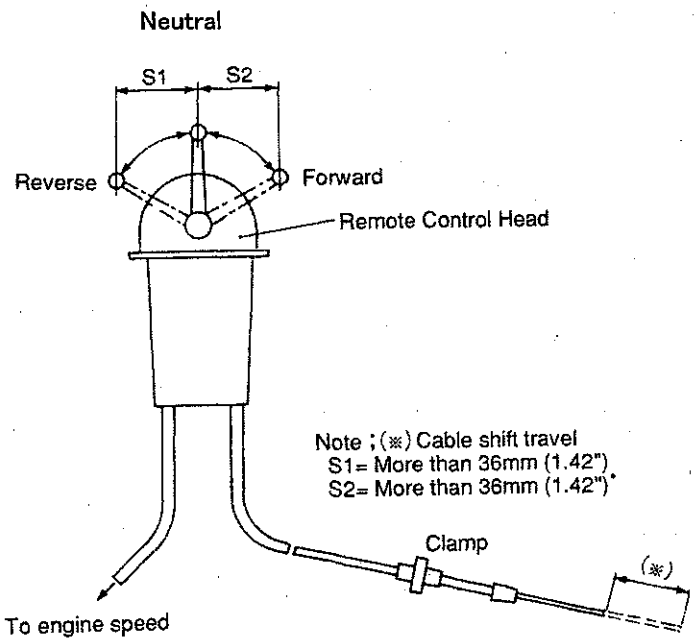
Marine gear box control side

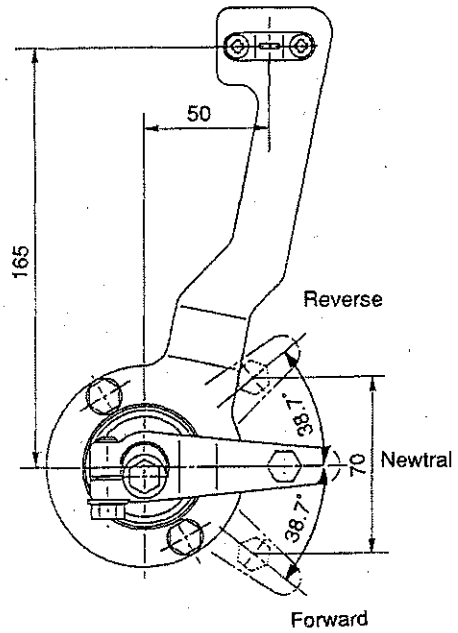
(1) Equal distribution of the control lever stroke.



The stroke between the neutral position → forward position (S2), and the neutral poition → reverse 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 that the cable shift travel of the S_1 and S_2 control lever strokes becomes identical.





3.4.2.7 Cautions

(1) attaching,adjusting and inspecting.
(2) When conducting inspection immediately after stopping the engine, do not touch the clutch. Oil temperature often rises 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 below 1000 rpm.

【 NOTICE 】

The dual (Two) lever remote control device cannot be usded.

3.6.3 Inspection and Servicing

3.6.3.1 Clutch case

(1) Check the clutch case for cracks 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.

3.6.3.2 Bearing

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

3.6.3.3 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 if it is worn beyond the wear limit.

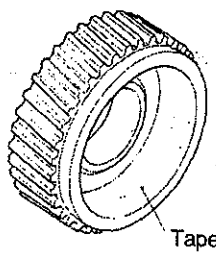
mm

	Maintenance standard	Wear limit
Input shaft forward gear and output shaft forward gear	0.06~0.12	0.2
Input shaft reverse gear and intermediate gear	0.06~0.12	0.2
Intermediate gear and output shaft reverse gear	0.06~0.12	0.2

(The same dimensions apply to both TTMC2P-1 and TTMC35P)

3.6.3.4 Forward and reverse large gears

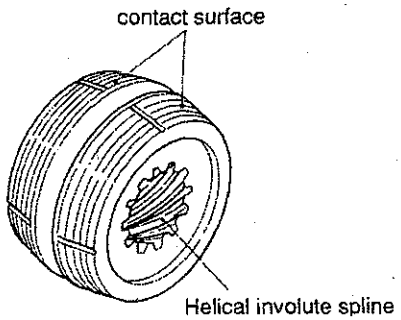
(1) Contact surface with drive cone.
Visually inspect the tapered surface of the forward and reverse large gears where they make contact with the drive cone to check if any abnormal condition or sign of overheating exists.
If any defect is found, replace the gear.



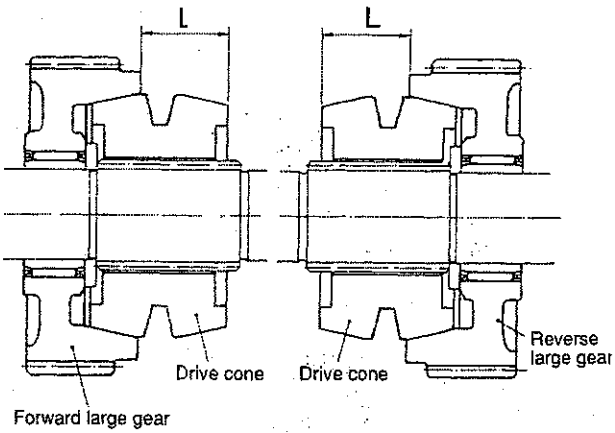
(2) Forward/reverse gear needle bearing.
When an abnormal sound is produced at the needle bearing, visually inspect the roller; replace the bearing if the rollers are faulty.

3.6.3.5 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.
(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

		Standard dimensions	Limited dimensions
Dimensions L	TTMC35P	32.7~33.3	32.4

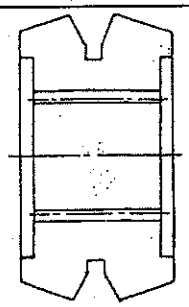
[NOTICE]

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.

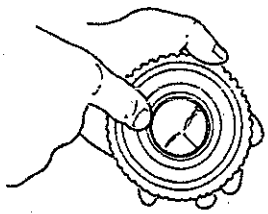
[NOTICE]

When replacing the dive cone, the dnve cone and forward large gear and reverse large gear must be lapped prior to assembly.
the lapping procedure is described below.

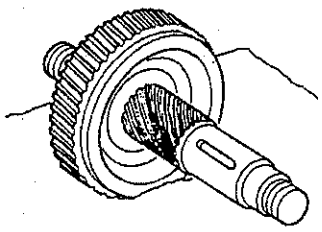


1) Lapping Procedure for Drive Cone

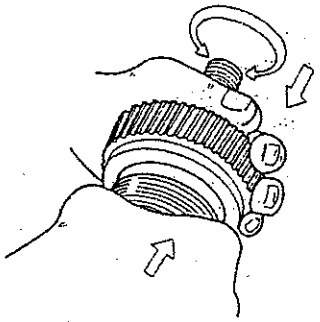
(1) Coat the lapping powder onto the cave of the clutch gear (Lapping powder : 67 micron silicon carbide #280)



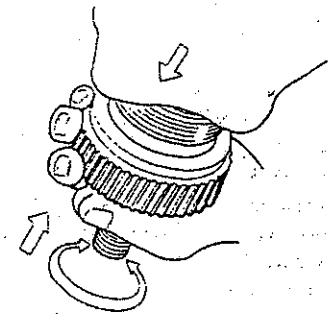
(2) Set the large gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft.



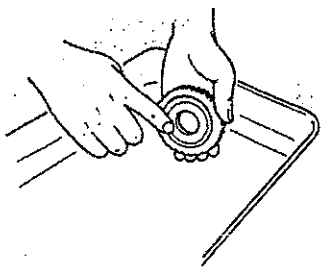
(3) Lap the large gear's cave and drive cone, pushing them together by hand.

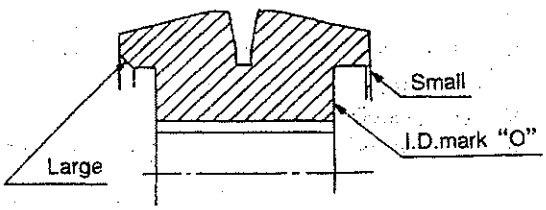


(4) Push and turn the clutch gear about 5 times both clockwise and counter-clockwise.



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

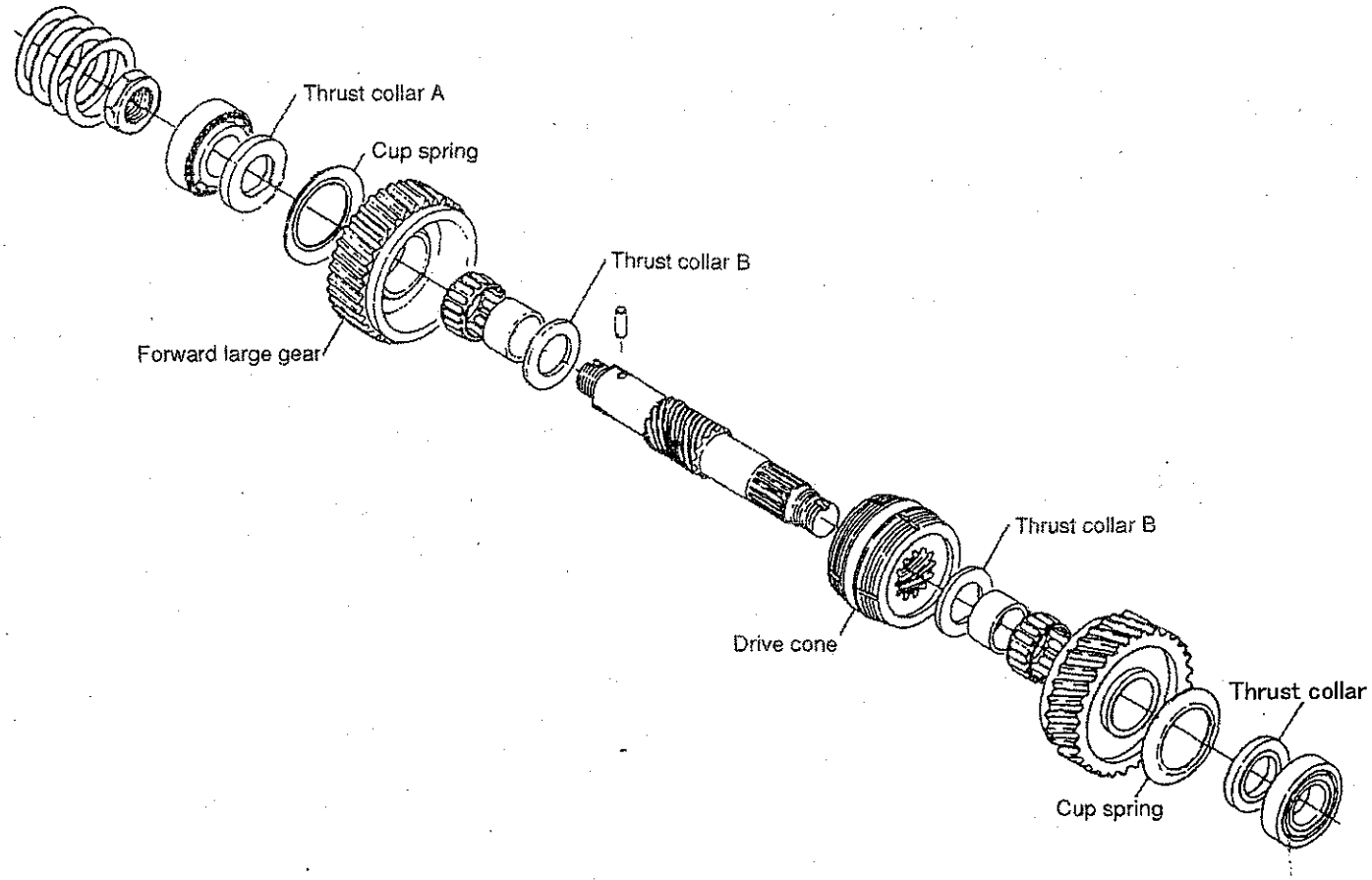




[NOTICE]

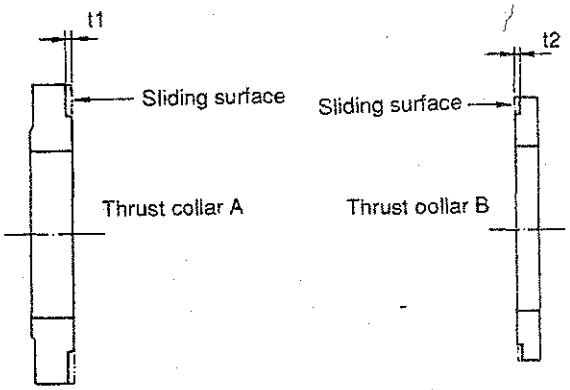
Do not mix the combination of the lapped parts. The washing oil should be changed frequently in order to prevent residual powder from being left on the parts. When assembling the drive cone, be sure to check its alignment. The larger chamfering face should be on the forward large gear side.

3.6.3.6 Thrust collar



(1) Visually inspect the sliding surfaces of thrust collar A and 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 collars A and B, and replace part when the dimension exceeds the specified limit.



mm

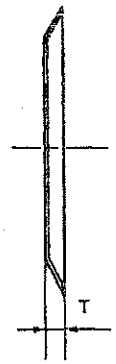
Stepped wear	Limit for use
Thrust collar A, t1	0.05
Thrust collar B, t2	0.20

3.6.3.7 Cup spring

(1) Check for cracks and damage to the cup spring.
Replace the part if defective.

(2) Measure the free length of the cup spring .
If the length or the thickness daviates from the standard size, replace the part.

Cap spring



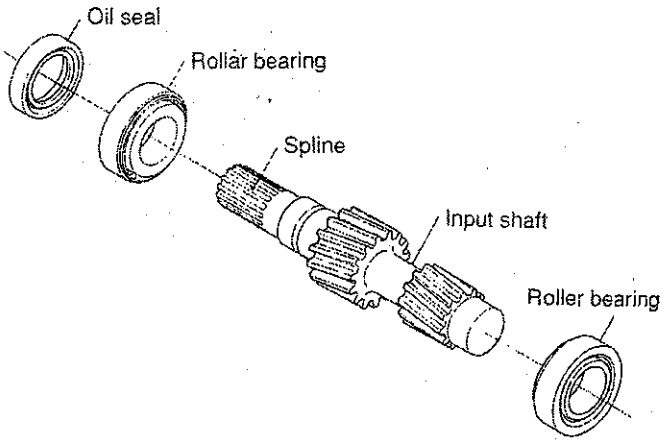
mm

	Standard	Limit
Cup spring, T	2.8 ~ 3.1	2.6

3.6.3.8 Oil seal of output shaft

Visually inspect the oil seal of the output shaft to check if there is any damage or oil leakage. Replace the seal when any abnormal condition is found.

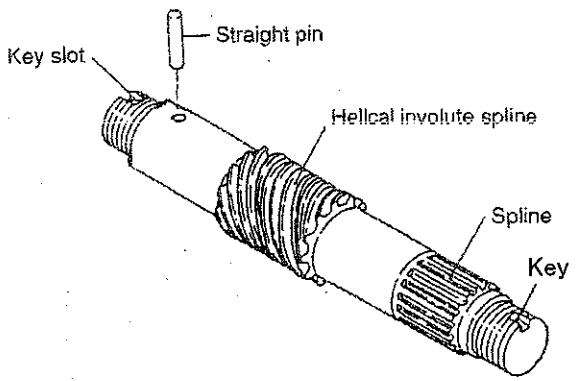
3.6.3.9 Input shaft



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

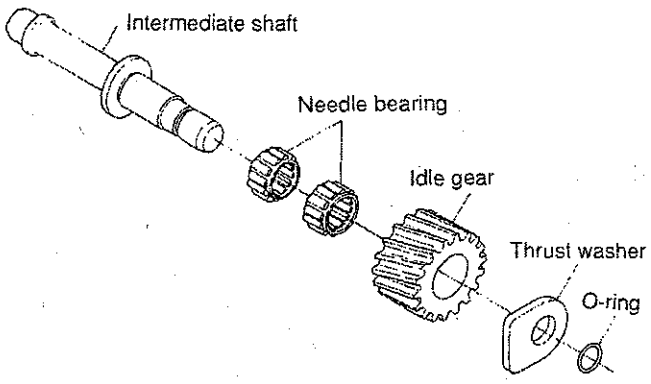
(2) Surface of oil seal.
If the sealing surface of the oil seal is worn or scratched, replace.

3.6.3.10 Output shaft

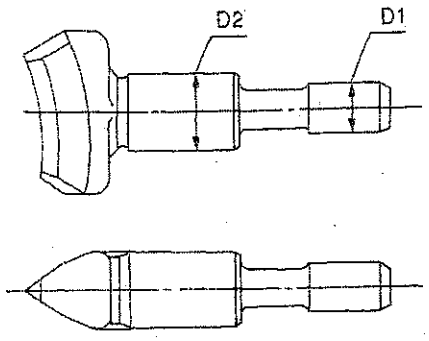


(1) Visually inspect the spline and the helical involute spline, and repair or replace a part when any abnormal condition is found on its surface.

3.6.3.11 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.

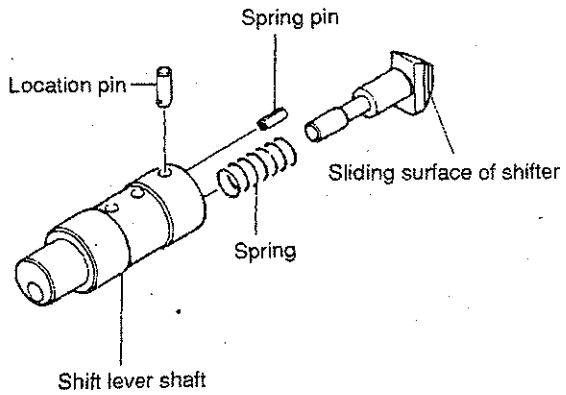


mm

	Standard	Limit
D1	6.69 ~ 6.70	6.50
D2	11.966~11.984	11.95
Shift lever shaft, Shifter insert hole	12.0 ~ 12.018	12.05

3.6.3.12 Shifting device

1) Shifter



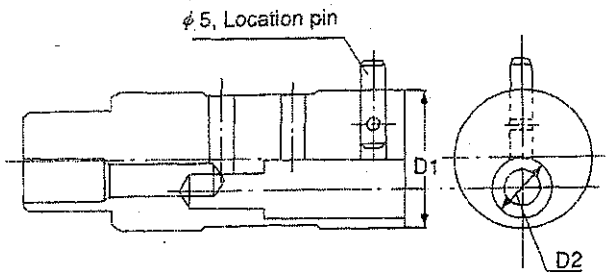
(1) Visually inspect the surface in contact with the drive cone, and replace the shifter when signs of overheating, damage or wear are found.

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

2) Shift lever shaft and location pin

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

(2) and the size deviates from the standard value.



mm

	Standard	Limit
D1	27.959~27.98	27.90
D2	12.0 ~ 12.018	12.05
Side cover, Shift isert hole	28.0 ~ 28.021	28.08

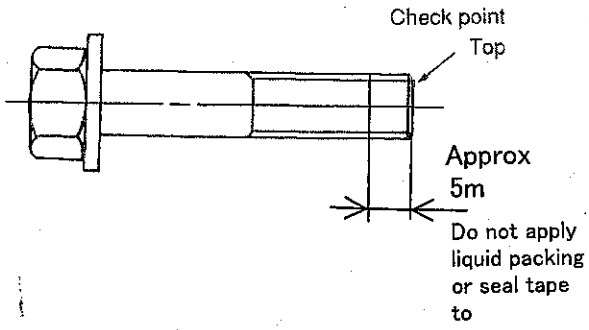
3) Shifter spring

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

Shifter spring	Standard	Limit
Free length	22.6mm	19.8mm
Spring constant	0.854kg/(8.37N)/mm	—
Length when attached	14.35mm	—
Load when attached	7.046kg	6.08kg

4) Stopper bolt

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

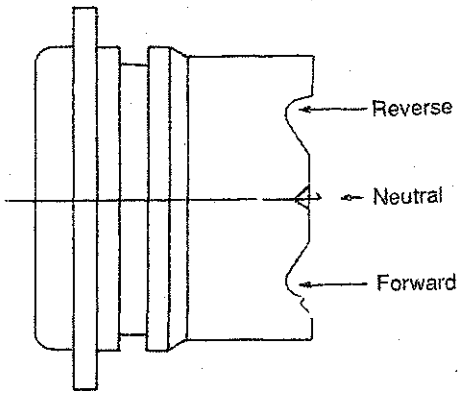


5) Side cover and oil seal

(1) Check the neutral, forward and reverse position grooves. Replace if the grooves are worn.

(2) Measure the insertion hold 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.



3.6.3.13 Shim adjustment for output and input shafts

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

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

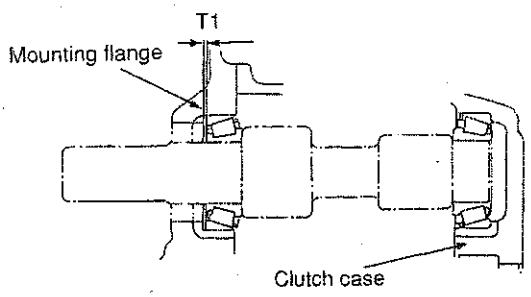
(1) Shim thickness (T_1) measurement of input shaft

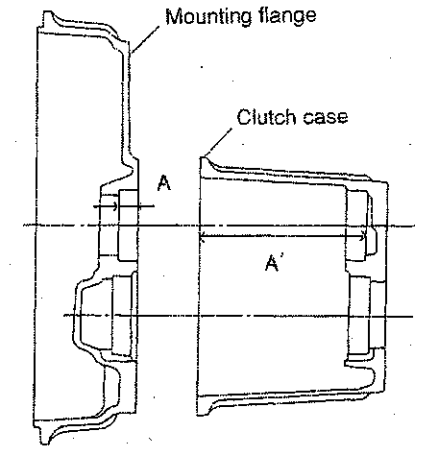
(a) Measure the bearing insertion hole depth (A) of the mounting flange, and the bearing insertion hole depth (A') of the clutch case.

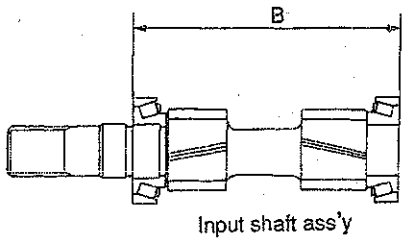
(b) Measure the length (B) between the bearing outer races of the input shaft assembly.

(c) Obtain the (T_1) thickness by the follwing formula :

$T_1 = A + A' - B$ (T_1 : Clearance $\pm$ 0.05mm)







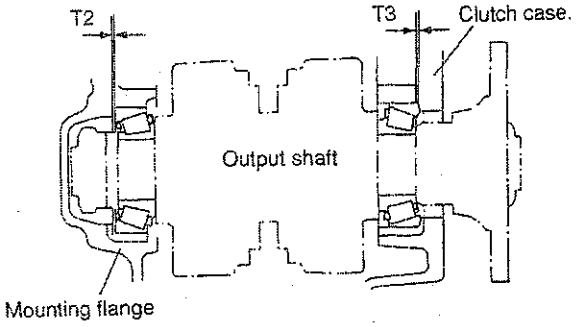
(2) Shim thickness (T2, T3) measurement of output shaft

(a) Measure the bearing insertion hole depth (C) of the mounting flange, and the bearing insertion hole depth (C') of the clutch case.

(b) Measure the length (D) between the bearing outer races.

[NOTICE]

Tighten the mounting flange nut on the output shaft assembly with the specified torque. Press-fit the inner race of the clutch case roller bearing to the large gear side.



(c) Measure the (F) and (E) length from the outer race end of the clutch case bearing included in the output shaft assembly.

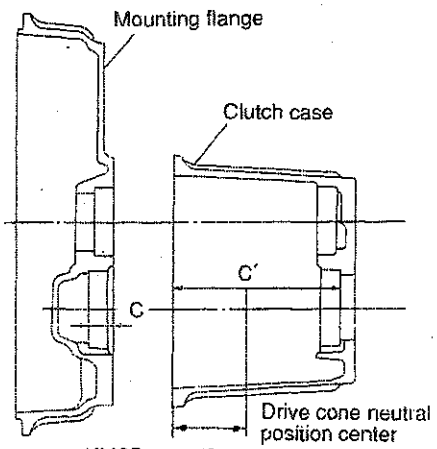
[NOTICE]

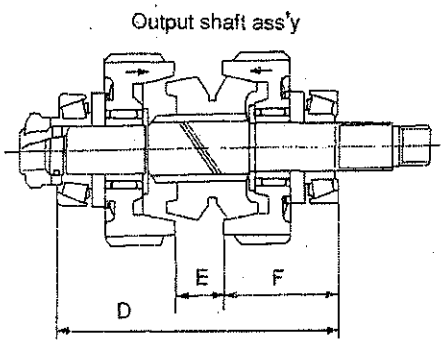
Before measuring the (F) and (E) length, press the forward large gear and the reverse large gear to the drive cone until there is no clearance among them.

(d) Obtain the (T_2) and (T_3) thicknesses by the following formulas :

$T_2 = C + C' - D - T_3$ (Clearance $-0.1 \sim 0$ mm)

T3 (KM35P) = C' - 47.3 - E/2 - F (Clearance $\pm$0.05mm)





(3) Standard size of parts

	A + A'	B	C + C'	D	E	F	Drive cone neutral center position
KM35P	132.40~132.75	131.20~132.10	141.20~141.55	139.56~141.00	23.50~24.10	57.83~58.65	47.3

[NOTICE]

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

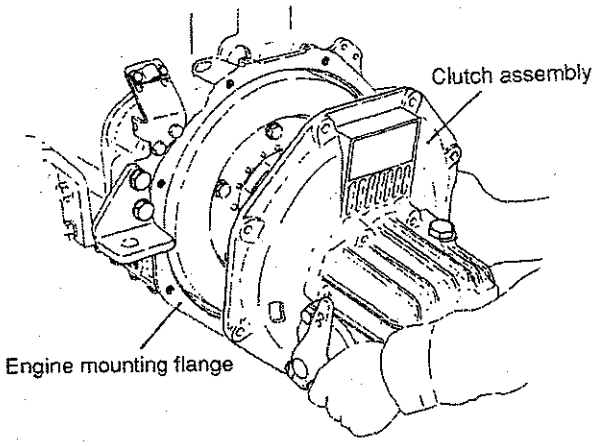
(4) Adjusting shim set

	Tickness.mm(in)	No.of shims
input shaft	0.5	1
	0.4	1
	0.3	2
Output shaft	1.0	1
	0.5	1
	0.3	2
	0.1	3

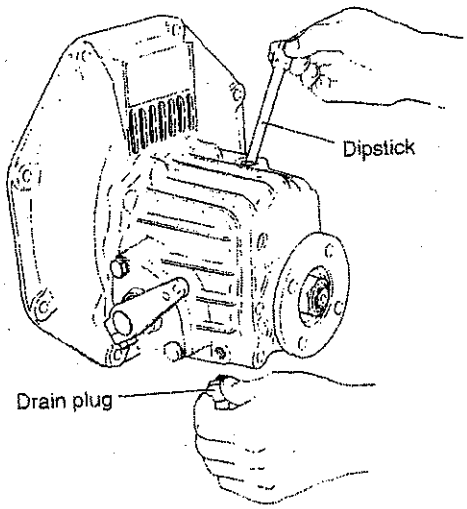
3.6.4 Disassembly

3.6.4.1 Dismantling the clutch

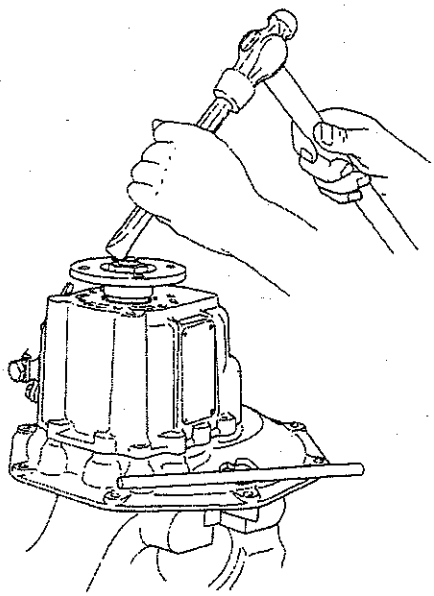
(1) Remove the remote control of cable.
(2) Remove the clutch assembly from the engine mounting flange.

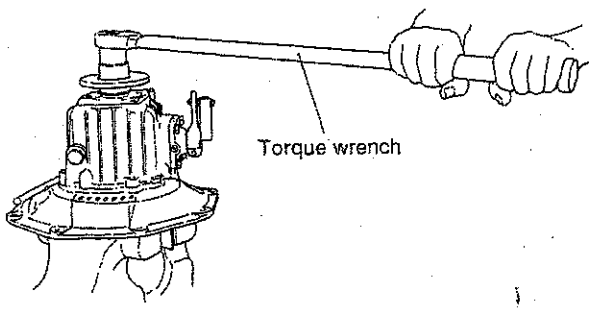


(3) Drain the lubricating oil.
Drain the lubricating oil by removing the plug at the bottom of the clutch case.



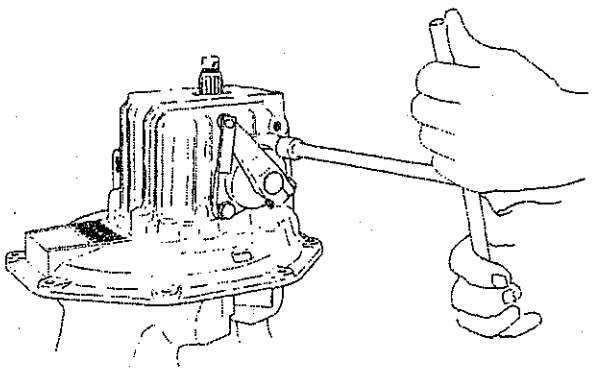
(4) Remove the end nut and output shaft coupling.



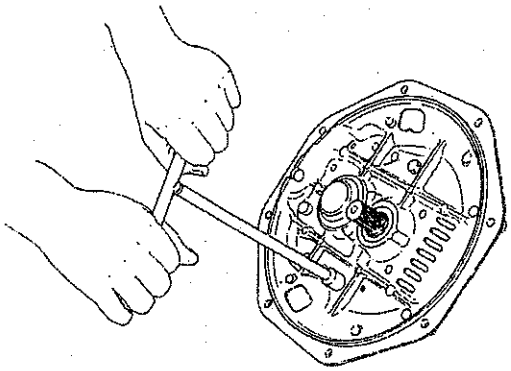


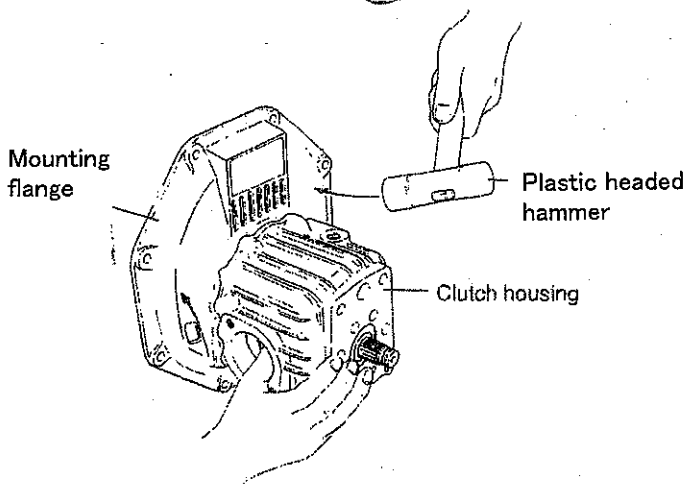
[NOTICE
Be aware that thread is left handed.

(5) Remove the oil dip stick and O-ring.
(6) Remove the 2 fixing bolts on the side cover, and remove the shift lever shaft, shift lever and shifter.

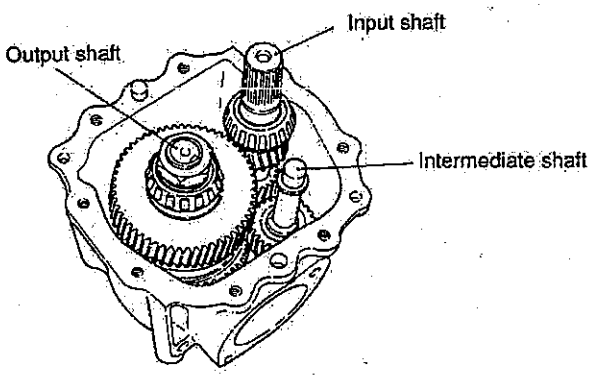


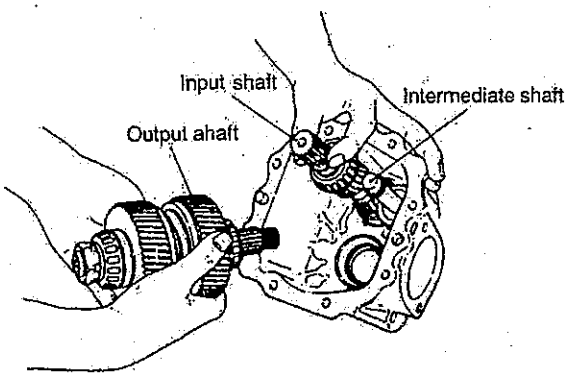
(7) Remove the 8 bolts which secure the mounting flange to the case body, give light taps to the left and right with a plastic headed hammer while supporting the clutch case with your hand, then remove the mounting flange.



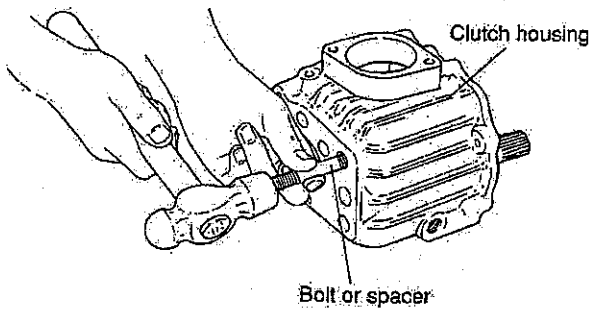


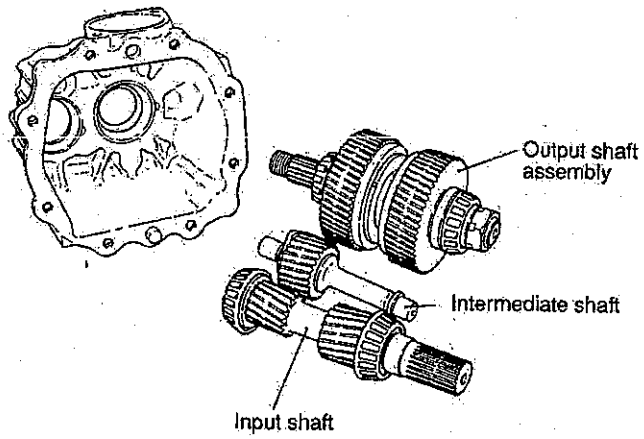
(8) Remove the output shaft assembly.



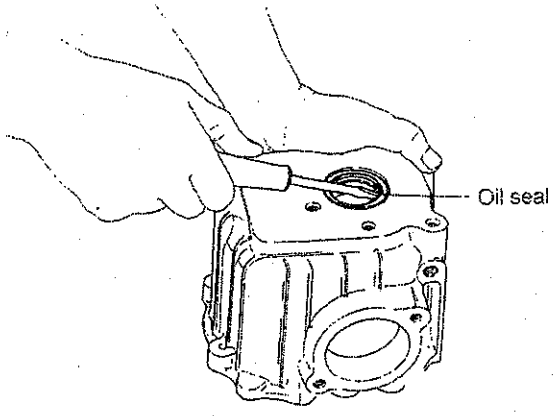


(9) Take out the intermediate shaft and input shaft
When taking out the intermediate shaft, place a bolt or spacer on the shaft hole of the case, and drive the shaft out by tapping it lightly.

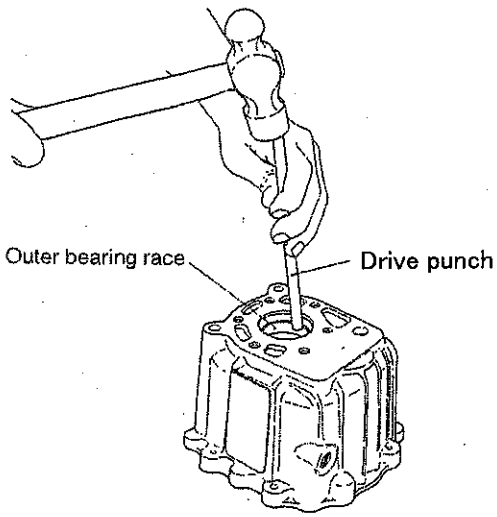


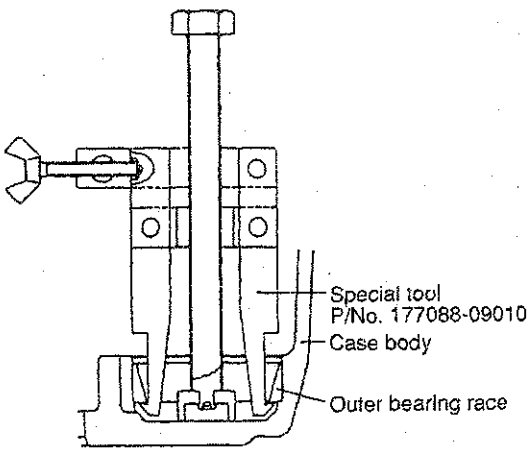


(10) Remove the output shaft oil seal from the case body.



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





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

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

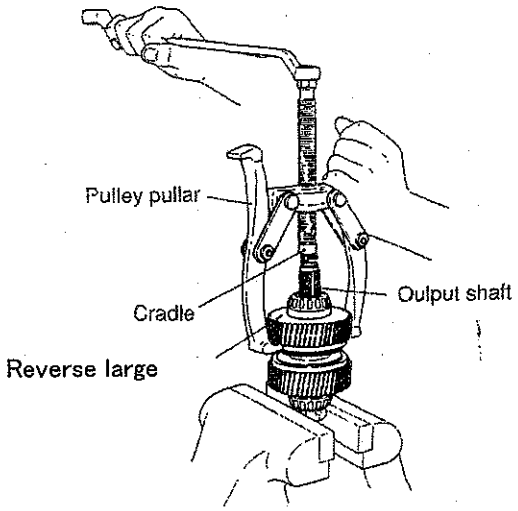
(14) Remove each adjusting plate from the input our output shaft.

[NOTICE]

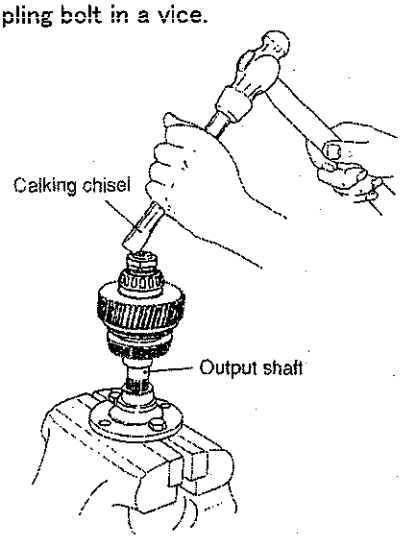
The same adjusting plates can be reused when the following parts are not replaced.
When any part is replaced however, readjustment is necessary.

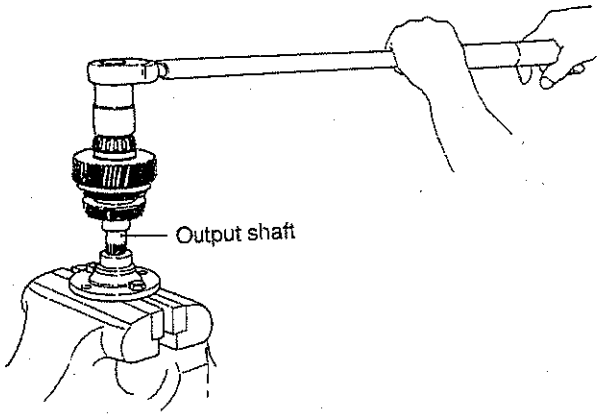
3.6.4.2 Removal of the output shaft

(1) Take out the reverse large gear, thrust collar A, cup spring and inner bearing race.
The reverse large gear must be remove using a pulley extracter, by grasping the nut at the forward end in a vice.

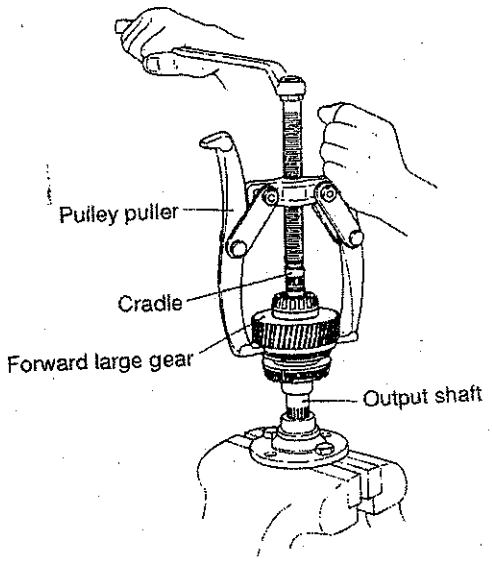


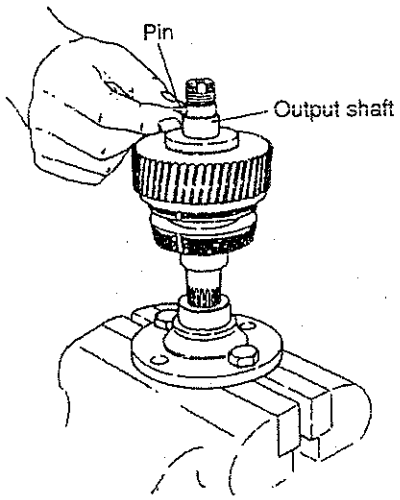
(2) Loosen the calking of the forward nut and remove the nut.
Remove the nut by using a torque wrench after setting the output shaft coupling and securing the coupling bolt in a vice.





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

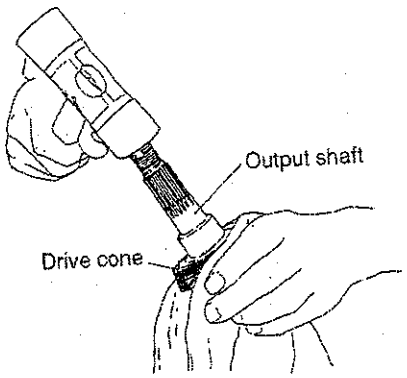


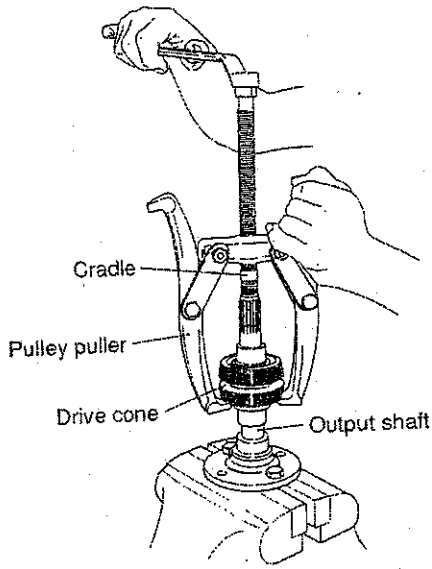


[NOTICE]

Be aware that nut has left-handed thread.

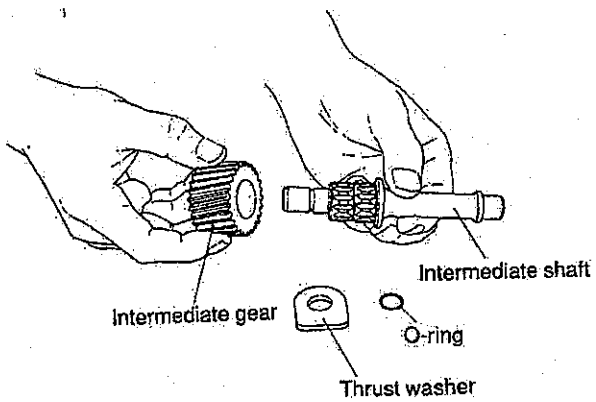
(4) While gripping the drive cone, tap the end of the shaft with a plastic headed hammer to remove the thrust collar B and inner needle bearing race.
A pulley extractor may by used.





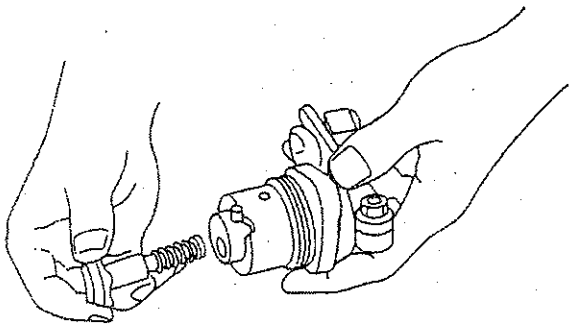
3.6.4.3 Removal of the intermediate shaft.

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

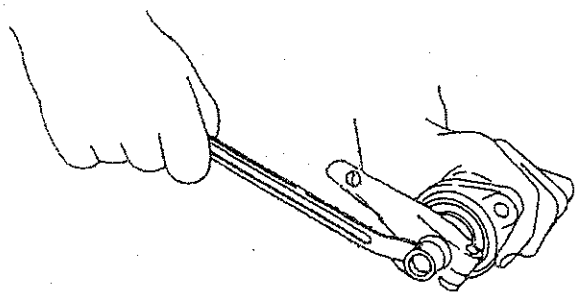


3.6.4.4 Dismantling the shifting device

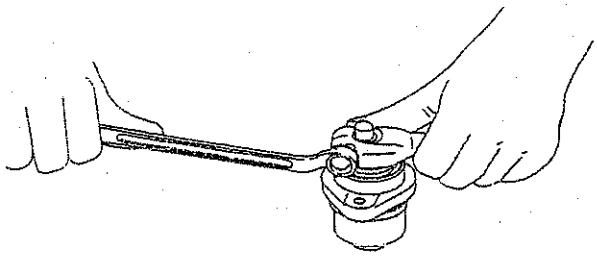
(1) Take out the shifter and shifter spring.



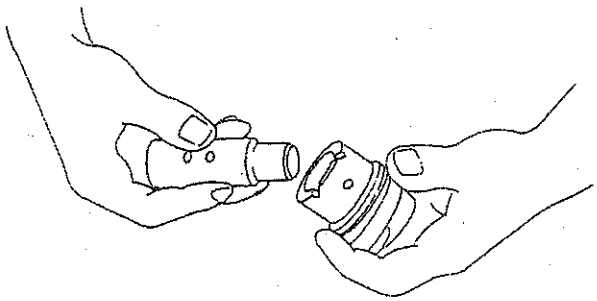
(2) Remove the stopper bolt and shims from the shifter.



(3) Loosen the bolt of the shift lever and remove the shift lever from the shift lever shaft.



(4) Remove the shift lever from the side cover.



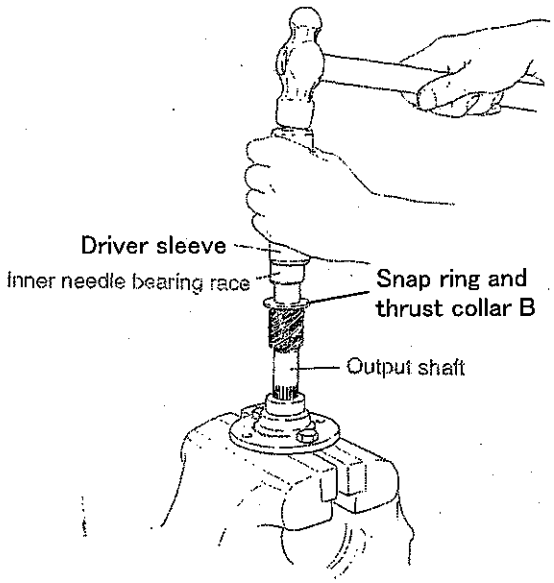
(5) Remove the oil-seal and O-ring.

3.6.5 Reassembly

3.6.5.1 Reassembly of output shaft

(1) Install the forward side snap ring and thrust collar B onto the shaft

(2) Install the forward end inner needle bearing race using a driver sleeve and hammer.

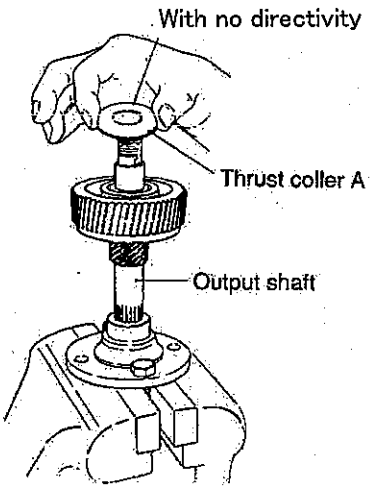


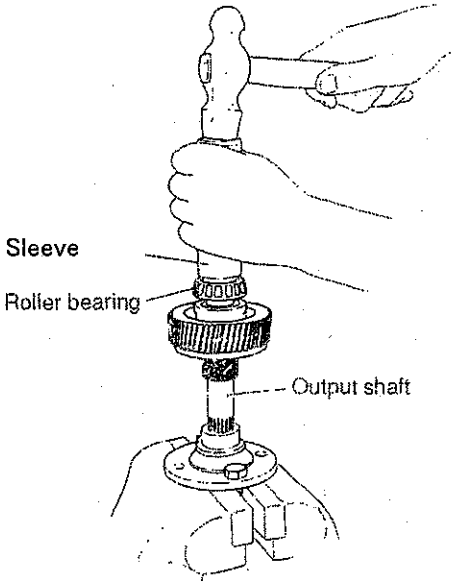
(3) Assemble the needle bearing and forward large gear.

[NOTICE]

Check that the forward large gear rotates smoothly.

(4) Install the cup spring, and thrust collar A, and drive inner bearing race onto shaft using a sleeve and hammer.

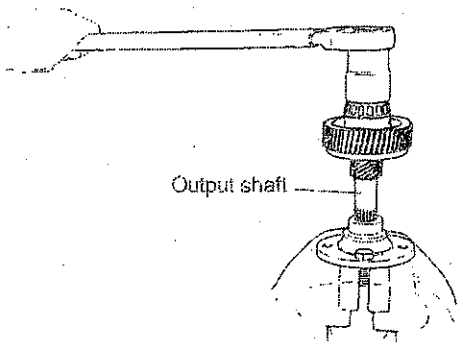




[NOTICE]

- Drive in with a plastic headed hammer. Do not hit it hard.
- Check that the forward large gear rotates smoothly.

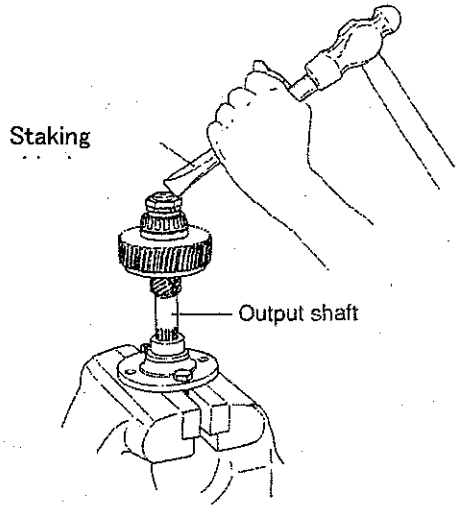
(5) Set and tighten the forward end nut. Insert the keeping the spline part upward.
Insert the shaft into the spline of the coupling, fit the spacer, and tighten the nut with a torgue wrench.



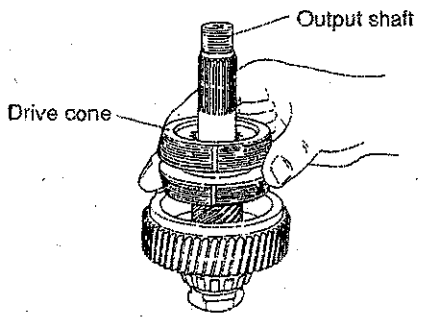
Tightening torque	10±1.5kgf-m(98±14.7N·m)

[NOTICE]

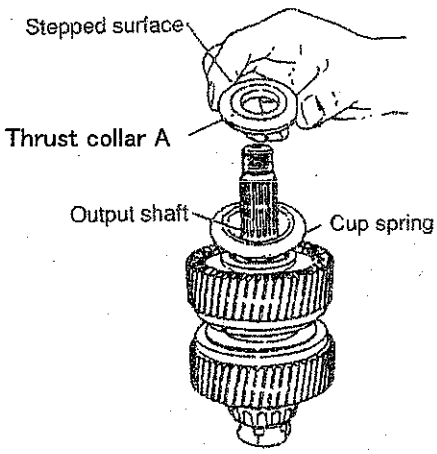
- Be aware that the thread is left handed.



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



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

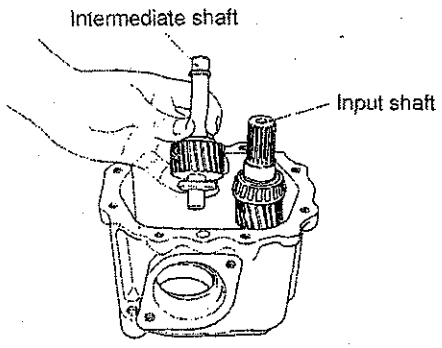


[NOTICE]

- Install thrust collar A so that the stepped surface faces the roller bearing side.
- Check and insure the reverse large gear rotates smoothly.

3.6.5.2 Reassembly of the clutch

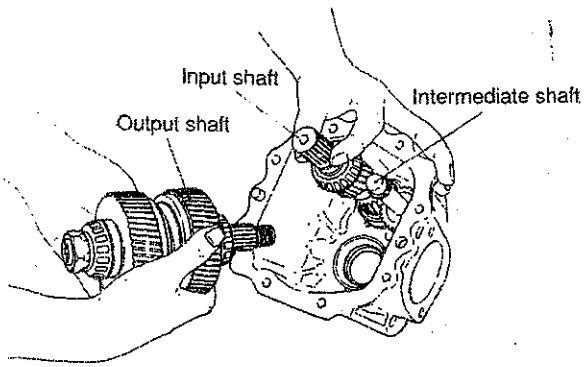
(1) Install the oil seal, bearing outer races and shim (output shaft side) in the clutch case.
(2) Insert the input shaft into the clutch case.
(3) Drive the intermediate shaft into the clutch case.



[NOTICE]

- If the output shaft is not fitted into the clutch case before driving-in the intermediate shaft, it cannot be assembled.
- Note the assembly direction of the thrust washer.

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



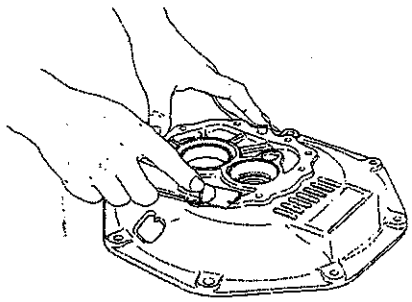
(5) Place the shims to the mounting flange, and drive outer bearing race into position.

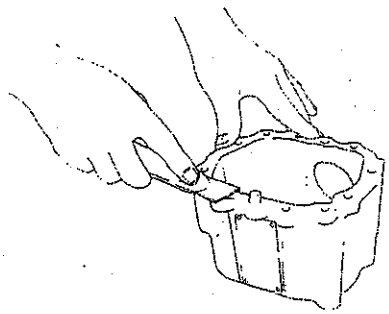
[NOTICE]

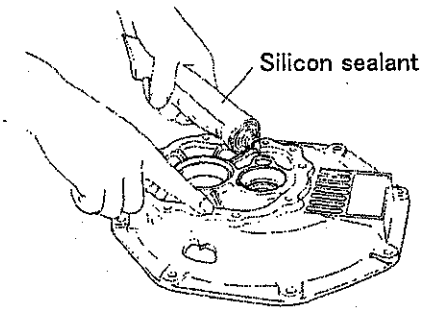
The outer bearing race can be easily driven in by heating the mounting flange to about 100℃, or by cooling the outer race with liquid hydrogen.

(6) Apply a silicon sealant around the outer surface of the oil seal, and insert the oil seal into the mounting flange while keeping the spring part of the oil seal facing the inside of the case.

(7) Apply a silicon sealant to the mating surfaces of the mounting flange end the case body.

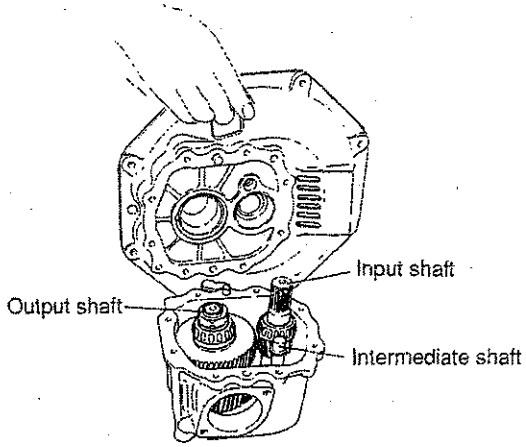






LIQUID PACKING PART NUMBER : Three Bond #1215
#1216
#1216B

(8) Insert the input shaft and output shaft into the shaft holes of the mounting flange. Fit the mounting flange to the case body by installing and tightening the bolt. [2.1 ± 0.2 kg·m (20.6 ± 2.0 N·m)]

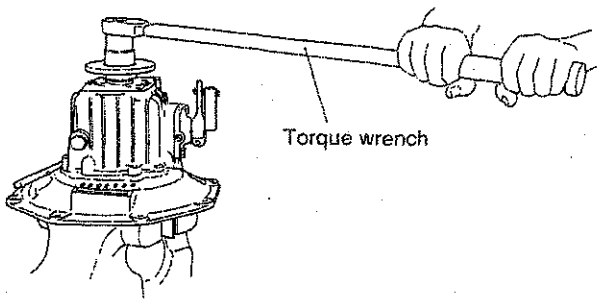


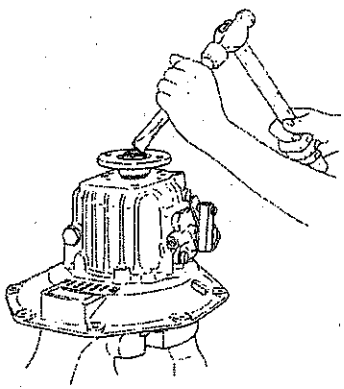
[NOTICE]

Apply silicon sealant to either the mounting flange or the case body.

(9) Assemble the output shaft coupling on the output shaft, and install O-ring.

(10) Tighten the end nut by using a torque wrench, then stake the nut.





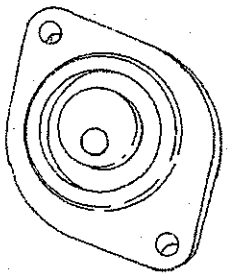
[NOTICE]

Be aware that the thread is left-handed.

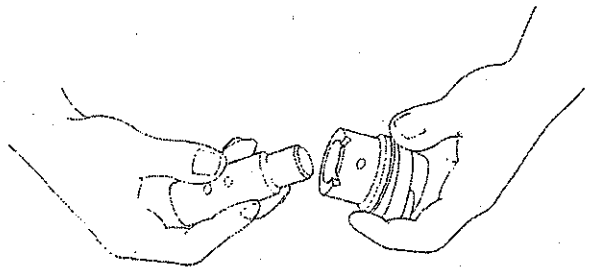
Tightening torque	20±1.5kgf-m(196±14.7N·m)

3.6.5.3 Reassembly of the shifting device

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



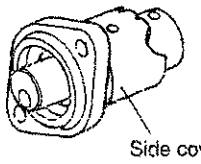
(2) Insert the shift lever shaft into the side cover.

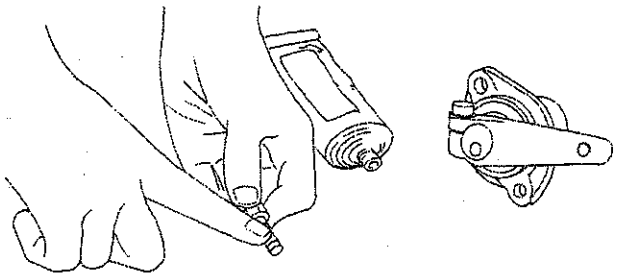


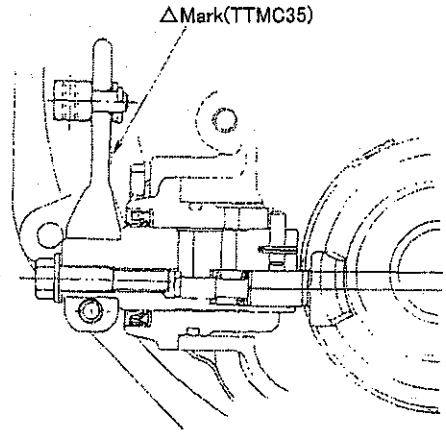
(3) Attach the shift lever to the shift lever shaft.

[NOTICE]

Check the direction of the shift lever △ mark.







(4) Insert the shiater spring and shifter into the shift lever shaft.

(5) Fit the side cover assembly to the clutch case.

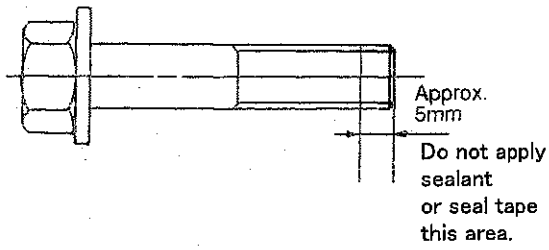
[NOTICE]

- Check the direction of the shifter (Top and bottom side).
- The shift lever may not turn smoothly until the clutch case is filled with oil.

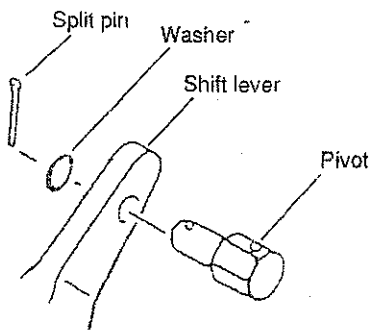
(6) Install the shims and stopper bolt to the shift lever shaft.

[NOTICE]

Apply silicon sealant or seal tape to the thread of the stopper bolt.



(7) Attach the cable connector to the shift lever.



3.7 KM4A

3.7.1 Construction

3.7.1.1 Construction

The clutch is a cone-type, mechanically openated 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 compared with other types of clutch and serves to reduce the number of components, making for a lighter, more compact unit which can be operated smoothly. Although it is small, the power transmisson effciency is high even under a heavy load. It is also durable and relianle because high grade materials are used for the shaft and gear, and a taper roller bearing is incorporated. Power transmisson is smooth because connection with the engine is made through the coupling devices.

- 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 inter mediate 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.

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

- When the load on the propeller is removed, the engage ment 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 on adjustment of the remote control cable is required.

- The cup spring on the rear of the clutch gear absorbs rotational fluctuatiions 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 per vent 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.

[NOTICE]

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

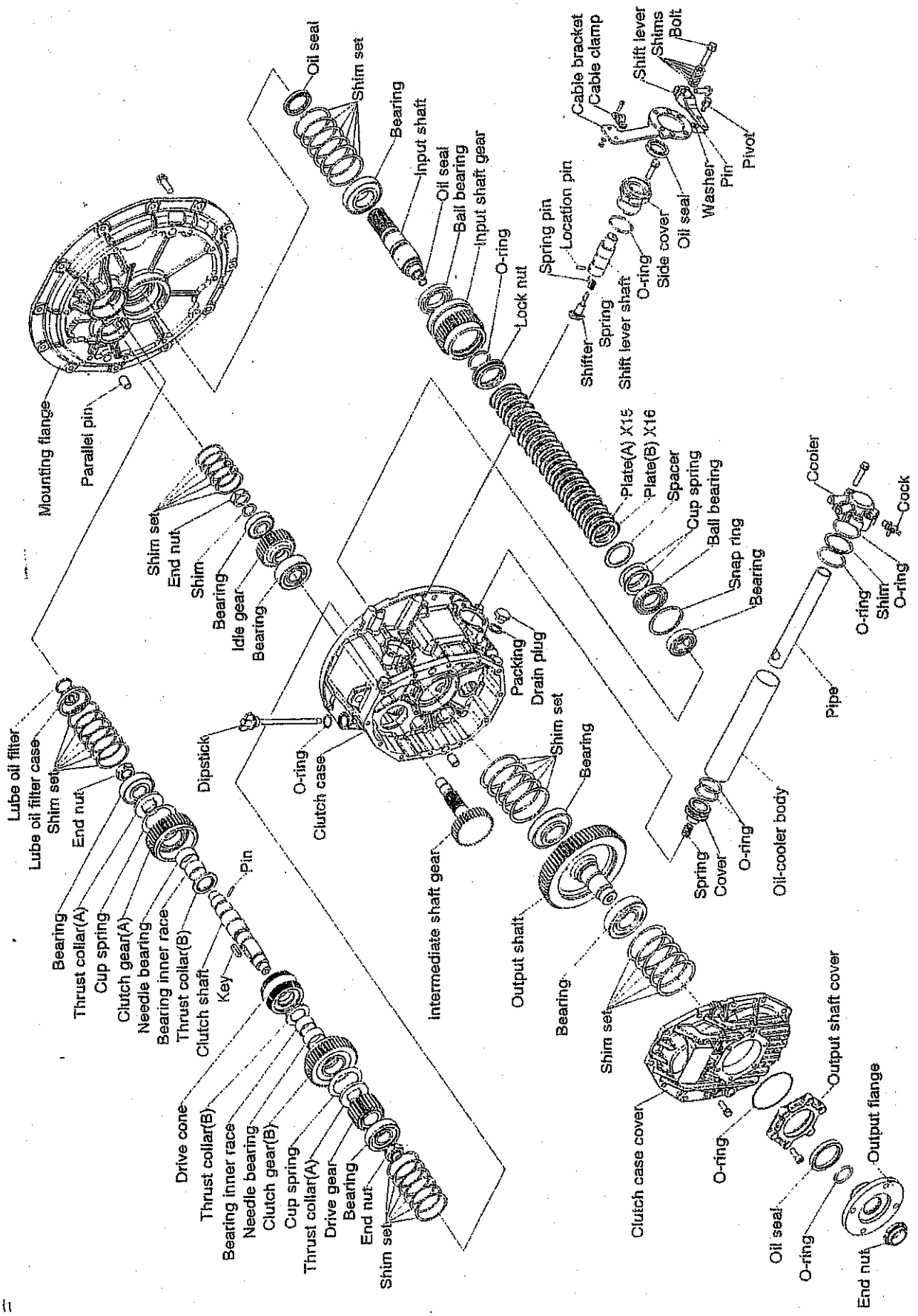
3.7.1.2 Specifications of Angle Drive Marine Gear

Model		KM4A				
Clutch		Mechanical angle servo cone				
Down angle		7°				
Reduction ratio	Forward	1.47	2.14	2.63	3.30	
	Reverse	1.47	2.14	2.63	3.30	
Direction of rotation	Input shaft	Counter-clockwise				
	Output shaft	Both				
Output shaft coupring	Outer diameter mm	ϕ 120				
	Pitch circle diameter mm	PC ϕ 100				
	Connecting bolt holes mm	4-ϕ 10.5mm				
Position of shift lever		Rihgt side, viewed from stern				
Lubricating oil		SAE#20/30(without multi - grade oil)				
Lubricating oil capacity ℓ		2.3				
Dry mass kg		30.0				
Lube oil cooler		Sea-water cooling				

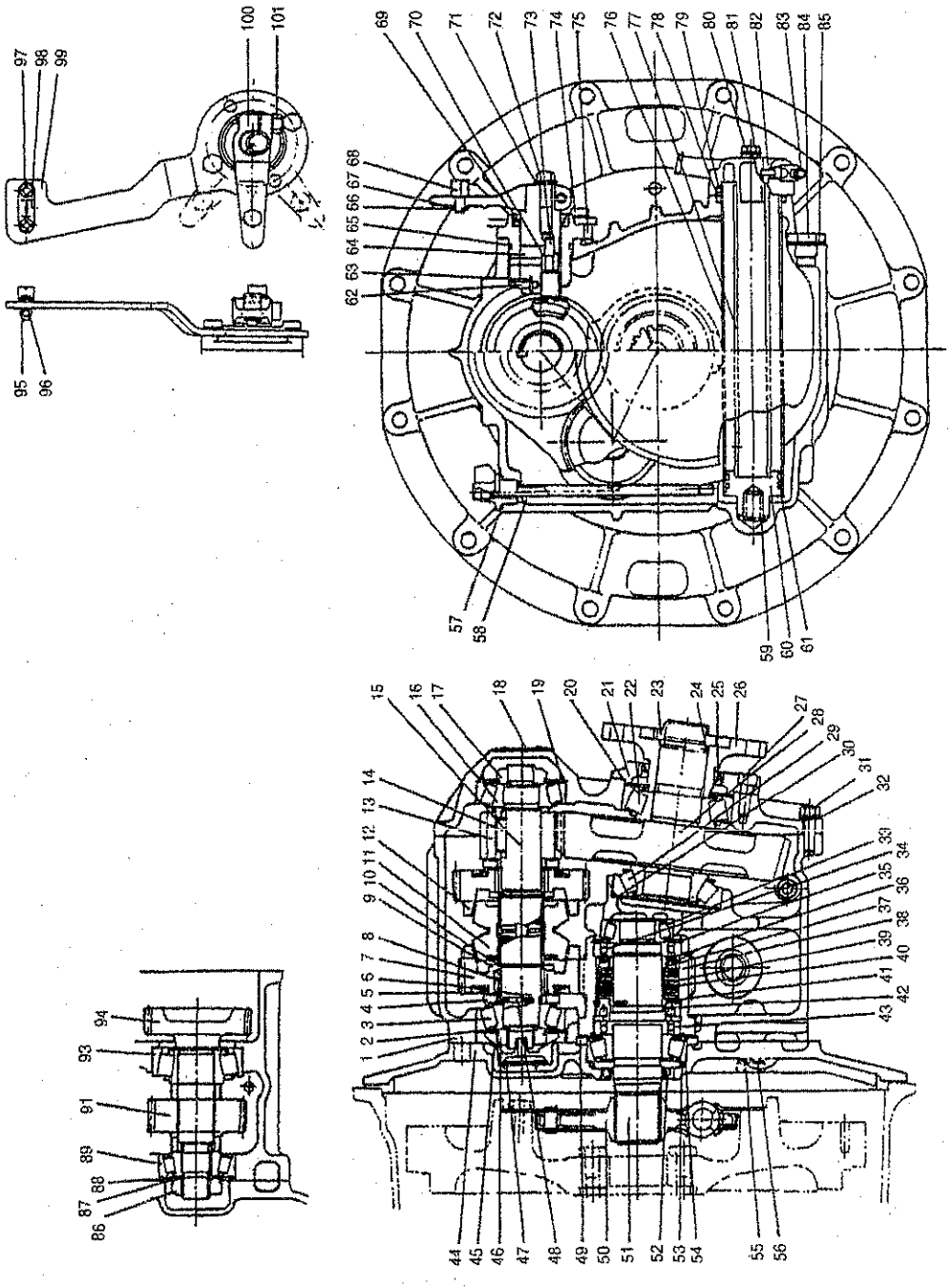
Note
In the case of clutch model KM4A, when are larger propeller or moment of inerta of the propeller than those listed in the table bellow is used, install the limiter (Option).

Reduction ratio	No.of blade	Diameter of the propeller (mm)	Moment of inertia GD^2kg-m^2(N-m^2)	Material
1.47	3	370	≦0.2 (2.0)	Bronze
	4	340		
2.14	3	460	≦0.42 (4.1)	
	4	430		
2.63	3	520	≦0.64 (6.3)	
	4	490		
3.30	3	600	≦1.02 (10.0)	
	4	570		

3.6.1.6 Drawing



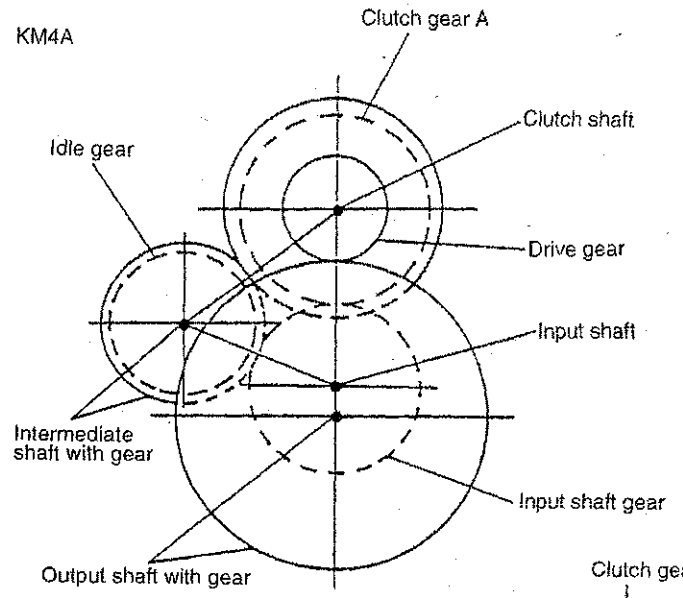
3.7.1.3 KM4A Sectional View

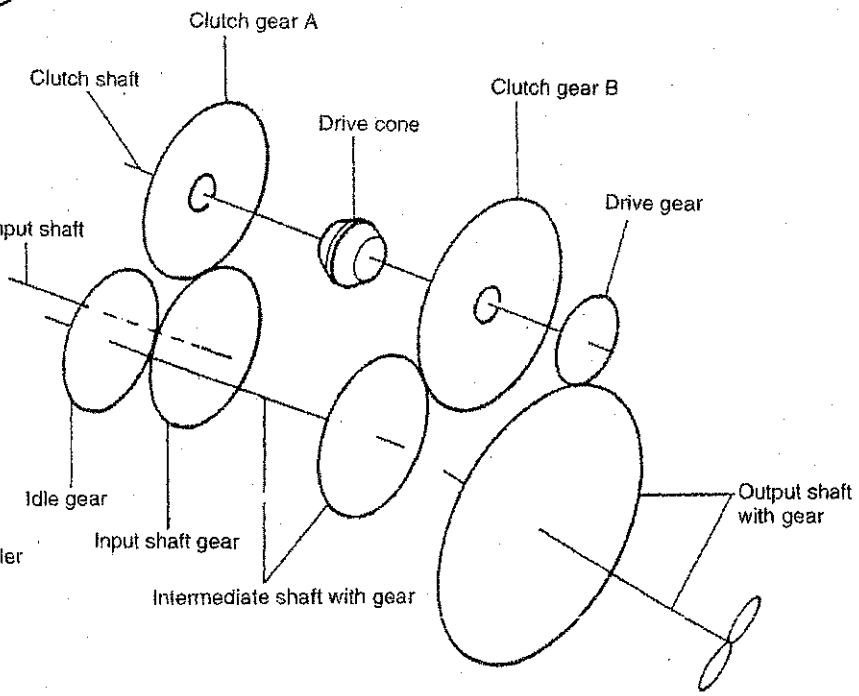


1 Clutch case
2 Shim
3 Bearing
4 Thrust colar(A)
5 Spring retainer
6 Cup spring
7 Clutch gear(A)
8 Needle bearing
9 Thrust colar(B)
10 Snap ring
11 Drive cone
12 Clutch gear(B)
13 Drive gear
14 Key
15 Clutch shaft
16 Bearing
17 End nut
18 Name Plage
19 Shim
20 Shim
21 Output shaft cover
22 Bearing
23 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(M8×30)
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(M8×25)

3.7.1.3 Powre transmission system

1) Arrangement of shafts and gears





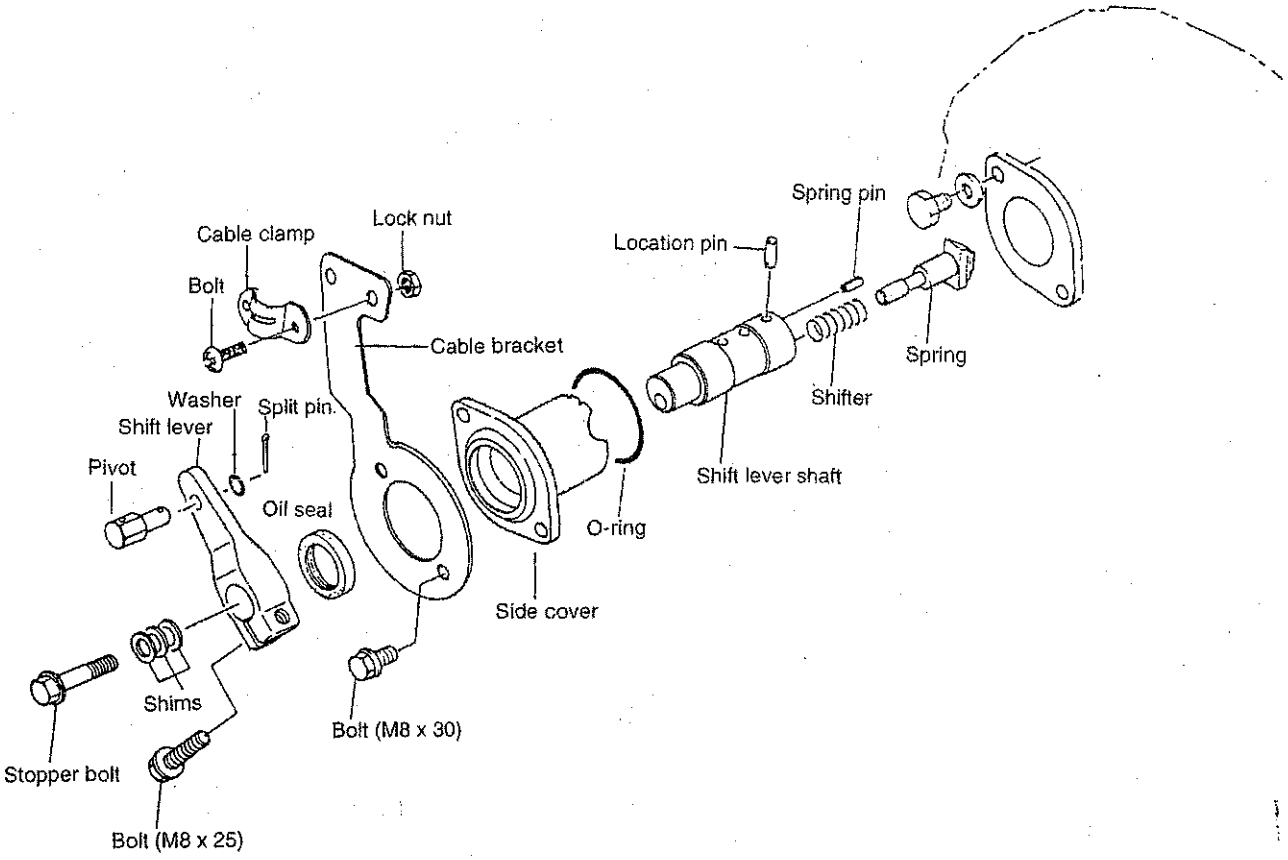
Shaft arrangement viewed from the propeller

2) Reduction ratio

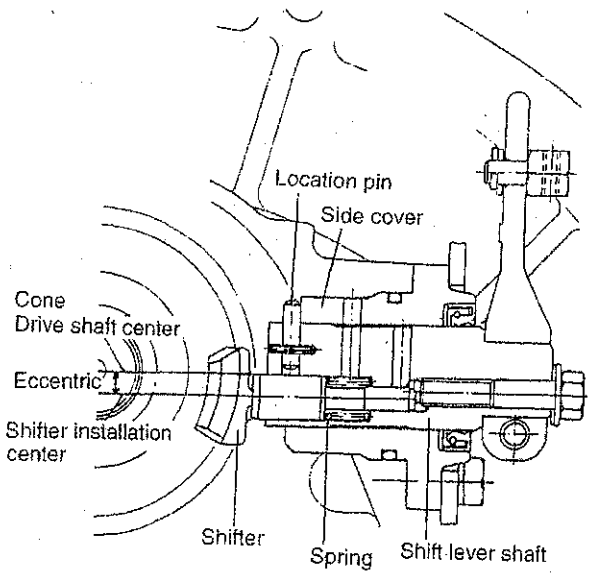
Input shaft gear	Clutch gear		Intermediate shaft		Drive gear	Output shaft with gear	Reduction ratio
	A	B	Idle gear	shaft gear			
39	41	45	31	34	38	53	1.47
					30	61	2.14
					26	65	2.63
					22	69	3.30

3.7.2 Shifting Device

3.7.2.1 Construction of shifting mechanism



The shift lever shaft is installed on the side cover with neutral, clutch gear (A) and clutch gear (B) position provided on the cover. The neutral, clutch gear (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.)



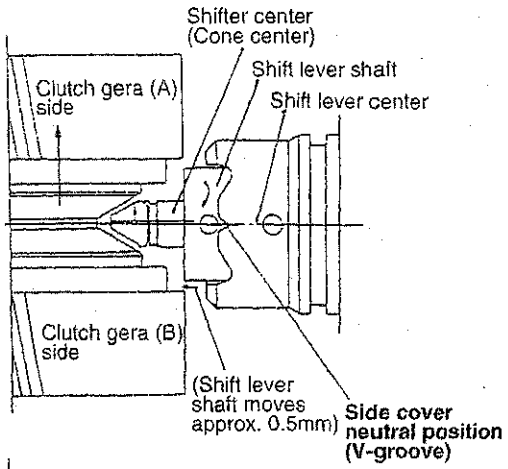
[NOTICE]

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

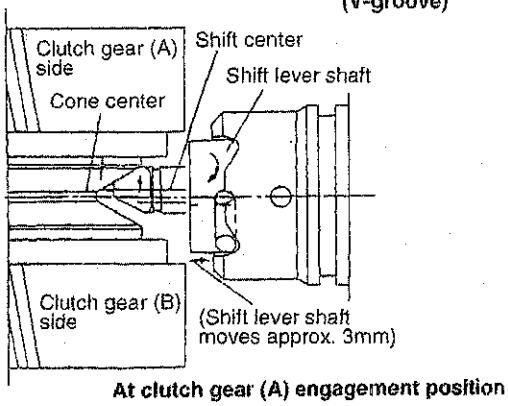
2 Clutch gear (B) position: Counterclockwise propeller rotation viewed from propeller side(C.W.)

3.7.2.2 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. (The 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).



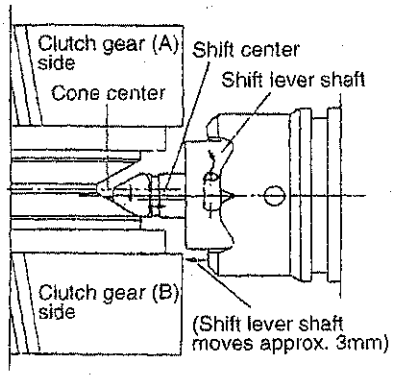
When the location pin of the shift lever shaft falls into the clutch gear(A) position groove on the side cover, the shift lever shaft moves approx. 3mm to the shift lever side, and the shifter starts to press the drive cone V-groove to the clutch gear(A) side by spring force.



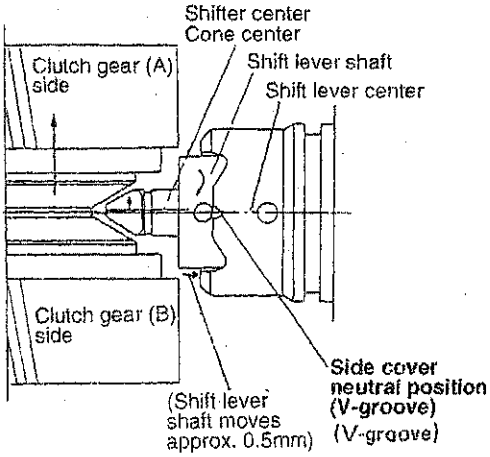
At clutch gear (A) engagement position

3.7.2.3 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 lever shaft moves appros. 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.

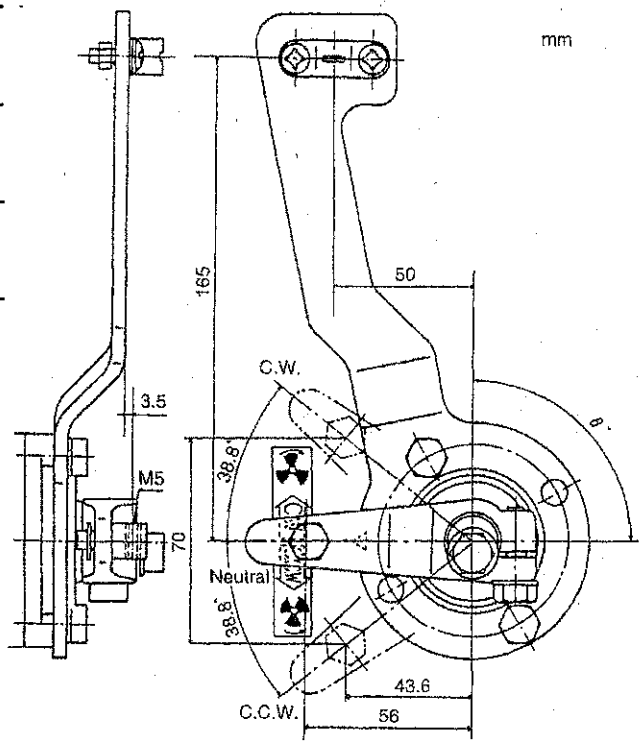


Further, when the shift lever shaft starts to revolve, and the positioning pin falls into the neutral V-groove position of the side cover (the shift lever shaft travels approx. 0.5mm to the shift lever side), the shifter moves to the shift lever side (to the spring side) while moving the V-groove of 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 toeque of the drive cone is decreased to zero and the shift lever is returned to the neutral position by spring force.



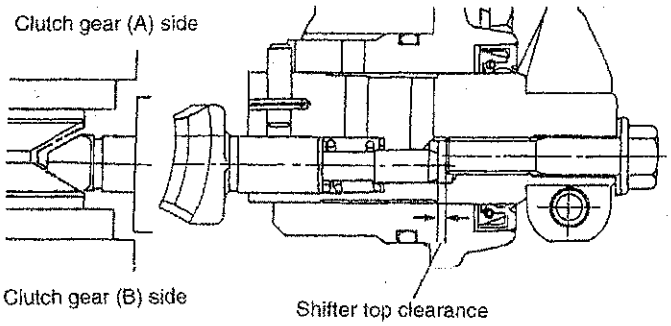
3.7.2.4 Clutch shifting force

Shifting position / Shifting direction	Shift lever position at 56mm	Remote control handle position at 170mm (Cable length, 4m)
Engaging force at 1000rpm	3 ~ 4kgf (29.4 ~ 39.2N)	4 ~ 5kgf (39.2 ~49N)
Disengaging force at 1000rpm	3.5 ~ 5kgf (34.3 ~ 49N)	4 ~ 6kgf (39.2 ~58.8N)



3.7.2.5 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.

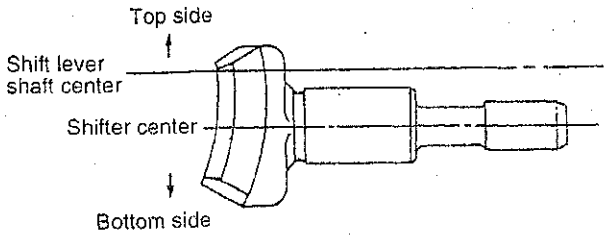


1)Measurement and adjustment of clearance

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

【 NOTICE 】

Ensure the correct direction 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 and surface and the shifter's 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.

$$T = (H - L + 1.25) \pm 0.1mm$$

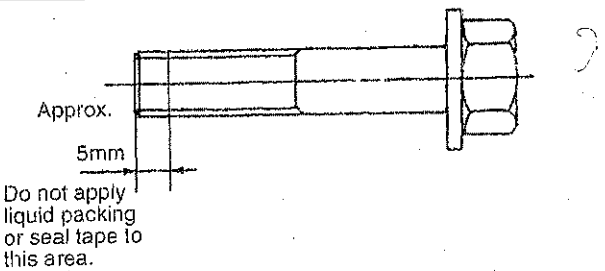
【 NOTICE 】

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

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

【 NOTICE 】

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

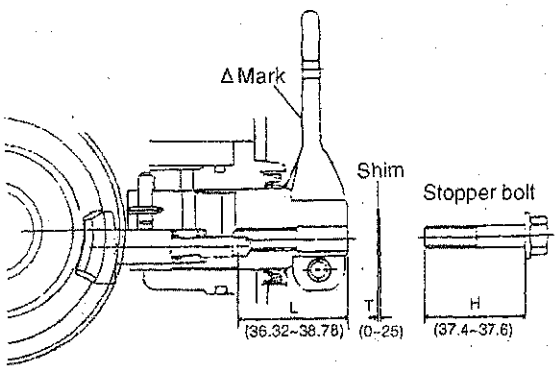


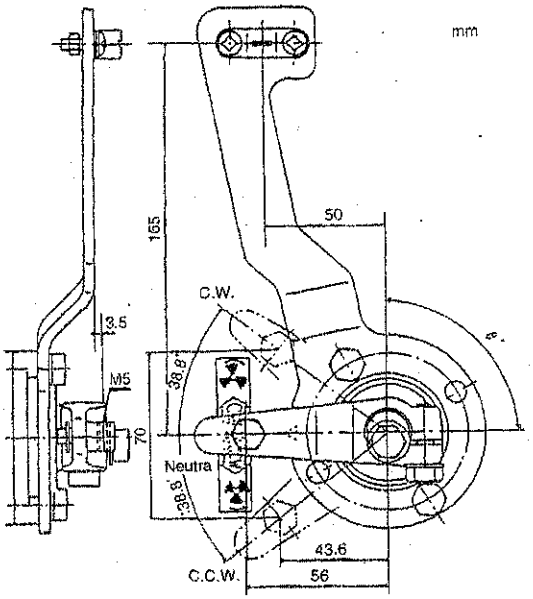
2) Inspect for the following points

(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)





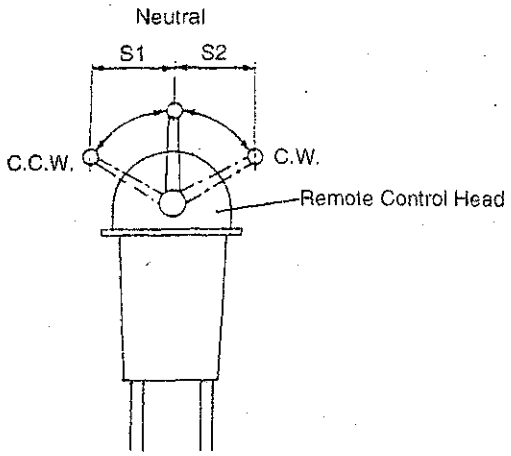
【 NOTICE 】

Shift lever must be installed in the direction of the △ mark ensuring the soecified installation angle(θ).

θ = 90°

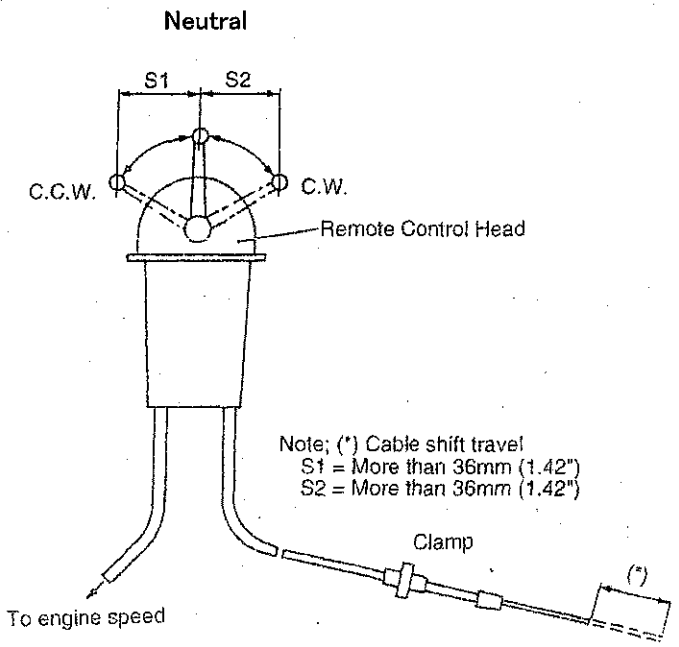
3.7.2.6 Adjustment of the remote control head
Marine gear box control side

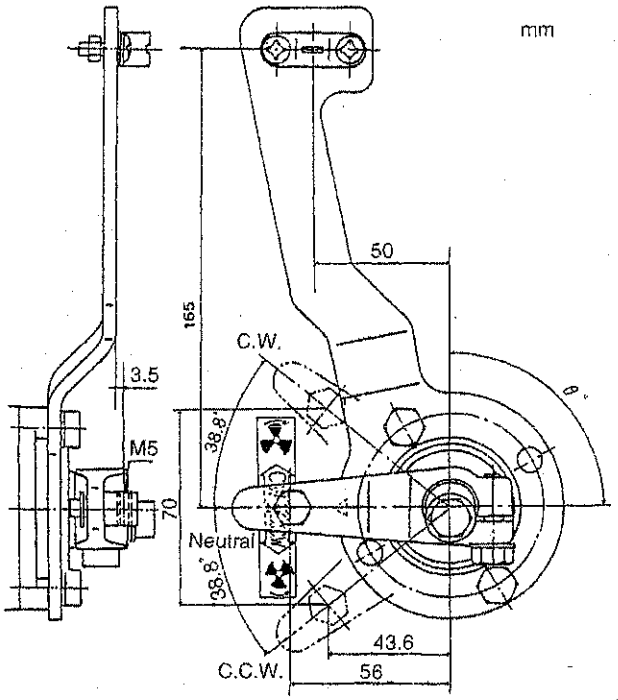
(1) Equal distribution of the control lever stroke.



The stroke between the neutral position → C.W. position (S2), and the neutral poition → 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.





3.7.2.7 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.
Oil temperature often raises 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.

【 NOTICE 】

The dual (Two) lever remote control device cannot be usded.

3.7.3 Inspection and Servicing

3.7.3.1 Clutch case and cover

(1) 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.

3.7.3.2 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.

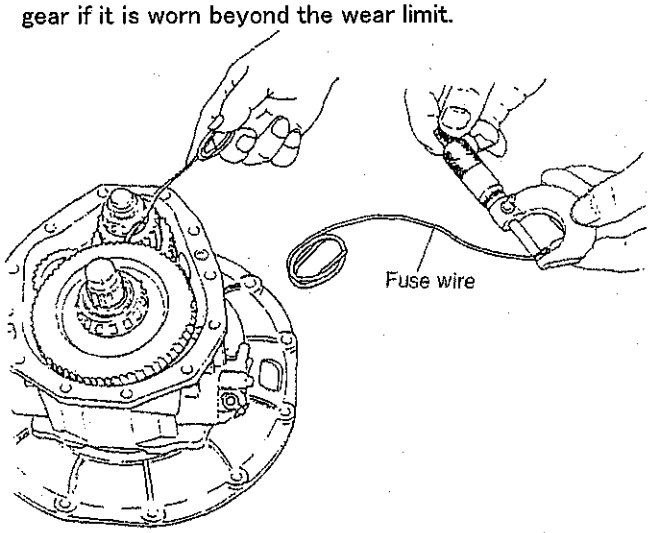
3.7.3.3 Gear

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 widht.

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

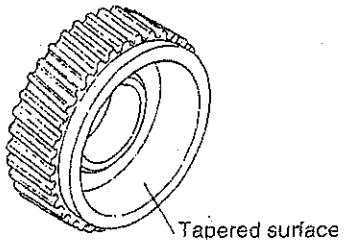


mm

	Maintenance Standard	Wear limit
All gears	0.08 ~ 016	0.3

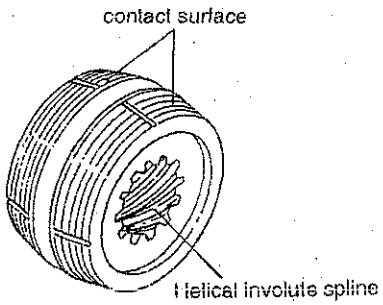
3.7.3.4 Clutch gear(A) and (B)

(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 condtion or sign of overheating.
If any defect is found, replace the gear.



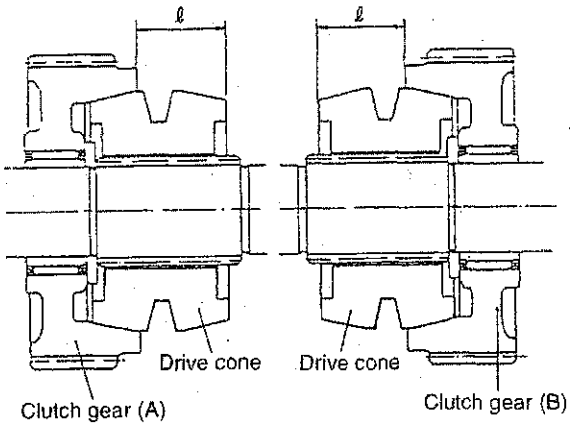
3.7.3.5 Drive cone

(1) Visually inspect that part of the surface that comes into contact with the circumferential triangular slot to check for sings 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.

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

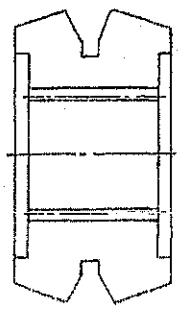


	Standard dimensions	Limited dimensions
Dimensions ℓ	29.2 ~ 29.8	28.1

【 NOTICE 】

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.

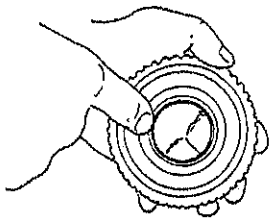


【 NOTICE 】

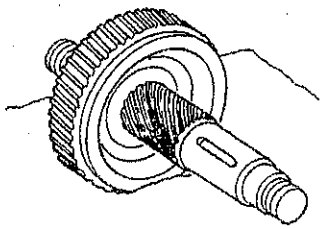
When replacing the drive cone, the drive cone and clutch gears (A) and (B) must be lapped prior to assembly.
The lapping procedure is described below.

1) Lapping Procedure for Drive Cone

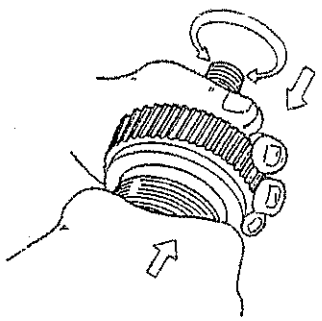
(1) Coat the lapping powder onto the cave of the clutch gear (Lapping powder: 67micron silicon carbide #280)



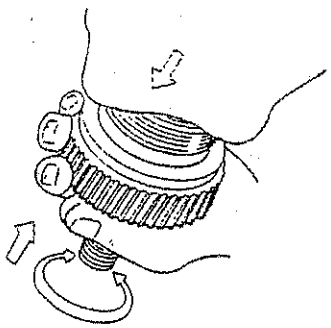
(2) Set the clutch gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft.



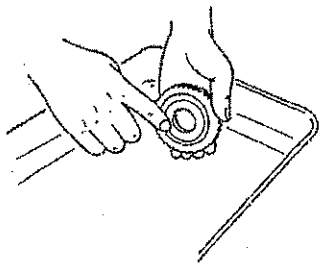
(3) Lap the clutch gear's cave and drive cone, pushing them together by hand.

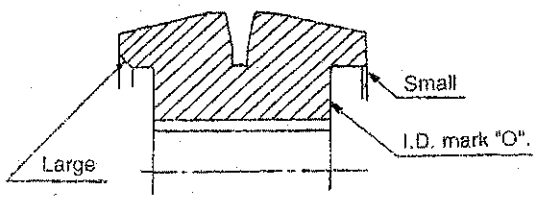


(4) Push and turn the clutch gear about 5 times both clockwise and counter-clockwise.



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

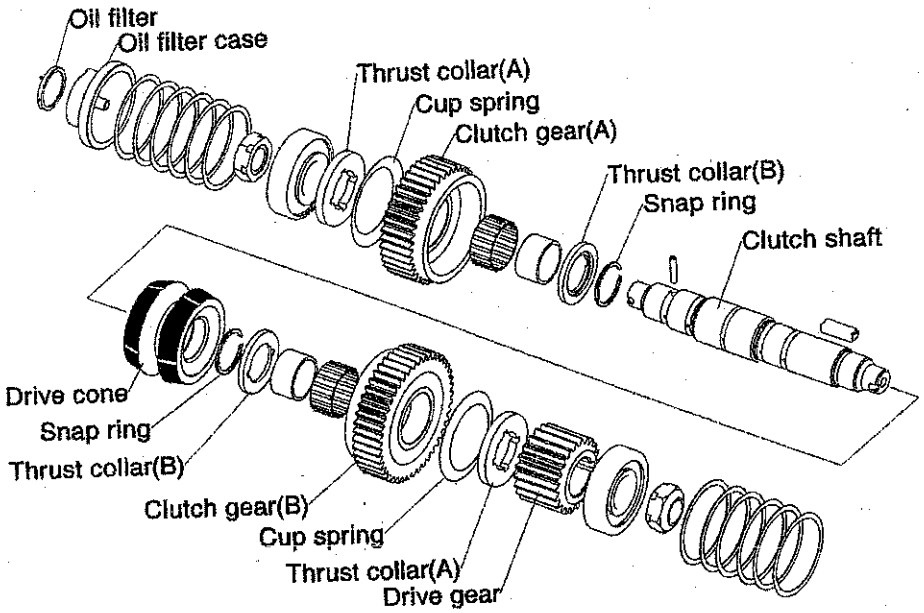




【 NOTICE 】

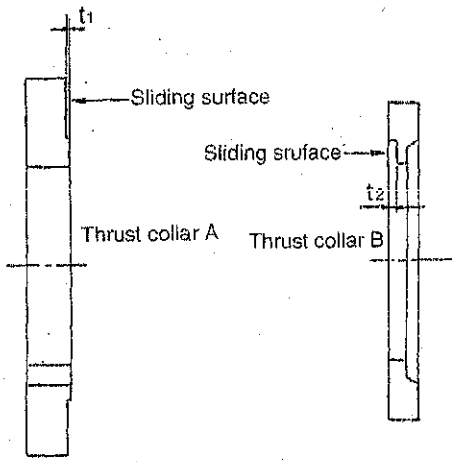
Do not mix the combination of the lapped parts.
The washing oil should be changed frequently in order to prevent residual powder from being left on the parts.
When assembling the drive cone, be sure to check its alignment.
The large chamfering face should be on the clutch gear (A) side.

3.7.3.6 Thrust collar A and B for clutch shaft



(1) and
B to check for signs of overheating, scoring , or cracks. Replace the collar if any abnormal condtion is found.

(2) Measure the thickness of thrust collars A and B, and replace part when the dimension exceeds the specified limit.



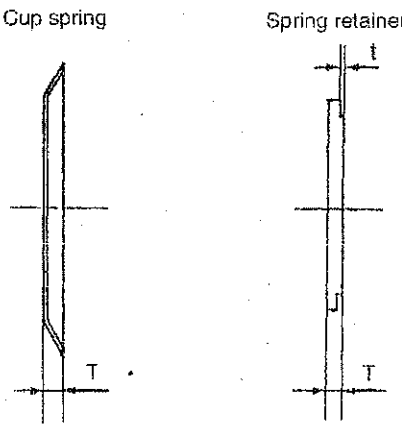
mm

Stepped wear	Standard	Limit
Thrust collar A, t_1	t1 0.1	0.05
Thrust collar B, t_2	t2 1.0	0.020

3.7.3.7 Cup spring and spring retainer

(1) Check for cracks and damage to the spring and spring retainer. Replaced the part if defective.

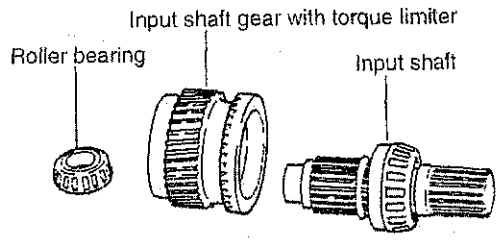
(2) Measure the free length of cup spring and the thickness of the spring retainer. If the length or the thickness deviates from the standard size, replace the part.



mm

	Standard	Limit
Cup spring, T	2.8~3.1	2.6
Spring retainer,T	2.92~3.08	2.8
Spring retainer,t	——	0.1

3.7.3.8 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 worm 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.

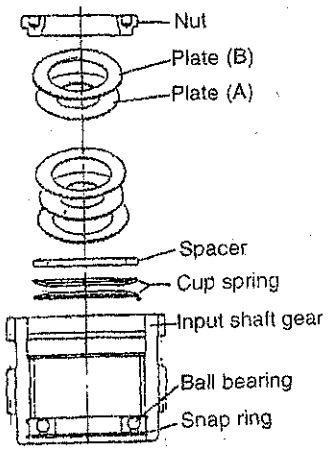


Plate (A) and (B) mm

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

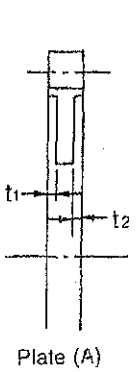


Plate (A)

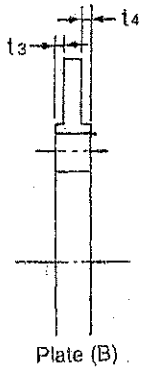
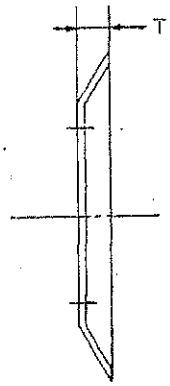


Plate (B)

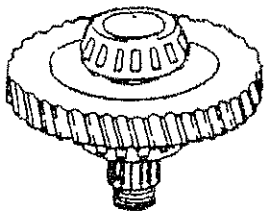
mm

	Standard	Limit
Cup spring, T	2.75~3.05	2.6



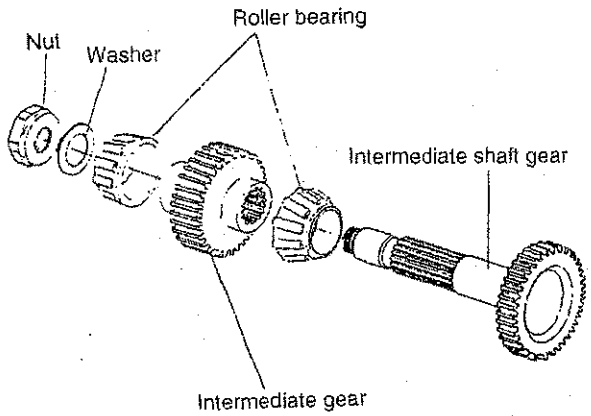
Cup spring

3.7.3.9 Output shaft

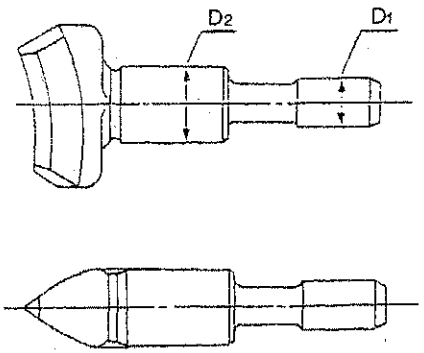


(1) Visually inspect the spline, oil seal and O-ring, and repair or replace a part when any abnormal condition is found on its surface.

3.7.3.10 Intermediate shaft



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



mm

	Standard	Limit
D1	6.69~6.70	6.50
D1	11.966~11.984	11.95
Shift lever shaft, Shifter insertion hole	12.0~12.018	12.05

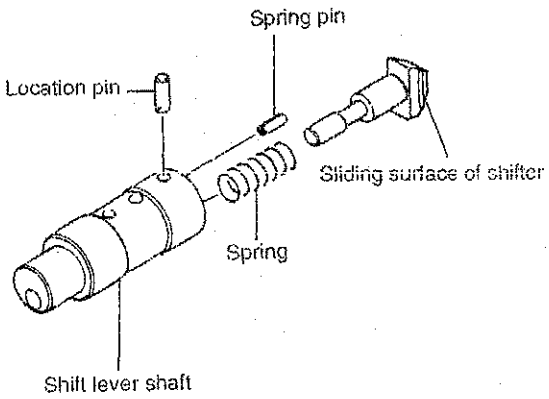
2) Shift lever shaft and location pin

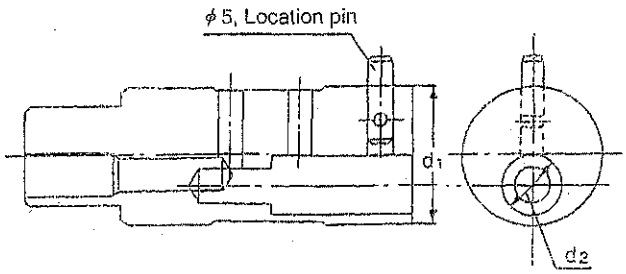
(1) Check the shift lever shaft and location pin for damage or distrotion, and replace defective parts. If the location pin must be replaced, replace it together with the shift lever shaft.

(2) Measure the diameter of the shift lever shaft (D1) and the shifter insertion hole(D2). Replace the part if the size deviates from the standerd value.

3.7.3.11 Shifting device

1) Shifter





mm

	Standard	Limit
d1	27.959~27.98	27.90
d2	12.0~12.018	12.05
Side cover, Shift insertion hole	28.0~28.021	28.08

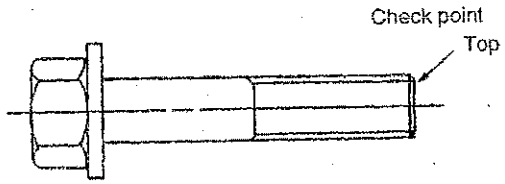
(1) Visually inspect the surface which contacts with the drive cone, and replace the shifter when signs of over heating, damage or wear are found.

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

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	22.6mm	19.8mm
Spring constant	0.854kg/mm(8.37N/mm)	——
Length when attached	14.35mm	——
Load when attached	7.046kg	6.08kg

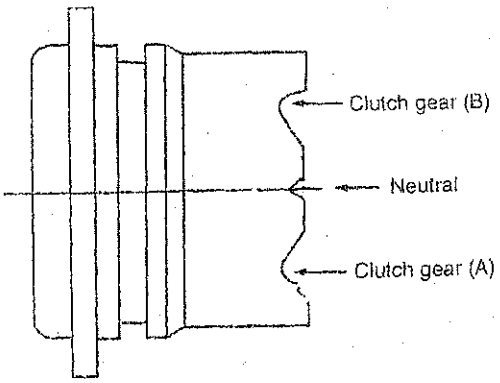
4) Stopper bolt
Check the stopper bolt. If it is worn or stepped, replace.



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 derective.



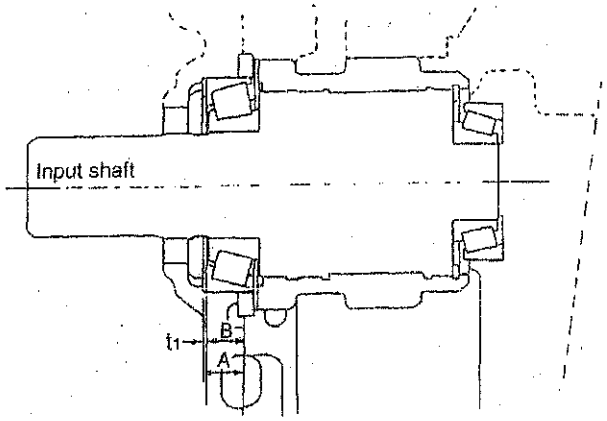
3.7.3.12 Shim adjustment for output and input shafts

Check the thickness of the shims for the intermediate, clutch, input and output shafts. When the component parts are not replace after dismantlinig, the same shims can be reused. When the clutch case, mounting flange and clutch case cover or any one of the following parts it 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

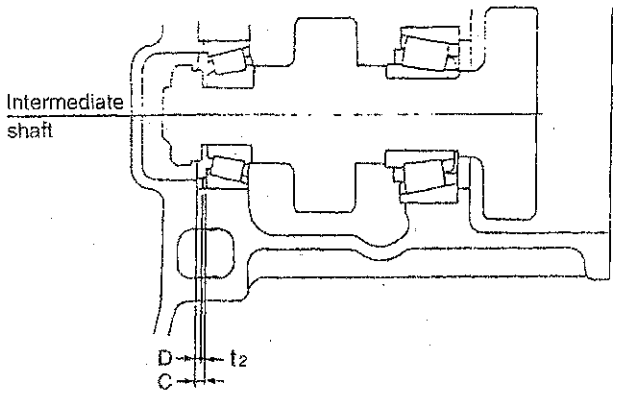
Measure the distance A and B.
Thicknees of Shim t_1



(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.

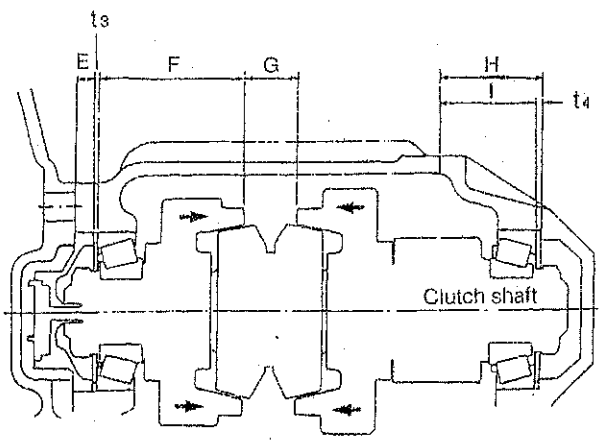
$$t_3 = \left(78 - E - F - G/2 \right)^{\pm 0.05}$$

【 NOTICE 】

When measuring the distance F and G, the clutch gears must be pushued in the direction of the drive cone.

Then measure distances H and I.

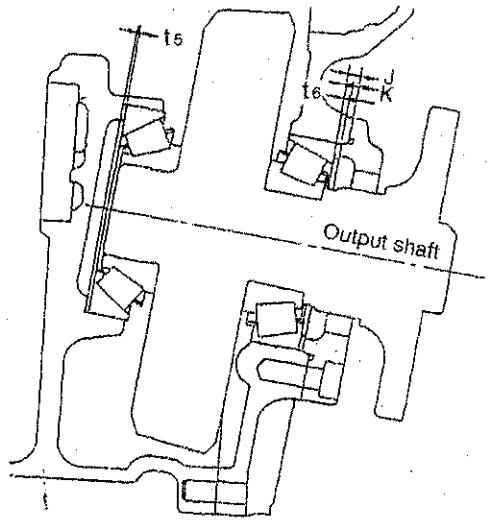
$$t_4 = (H - I)^{\pm 0.05}$$



(4) Output Shaft

Adjust the thickness of Shim t5 to make the backlash of gear at 0.08～0.16mm(0.0032～0.0063in).
Then measure the distance J and K.

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



(5) Standerd size of parts

mm

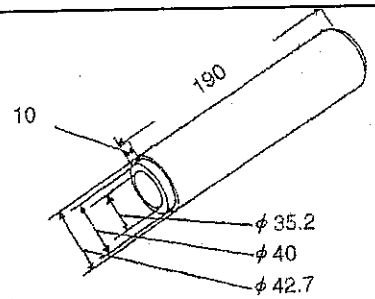
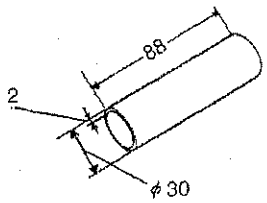
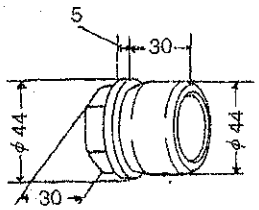
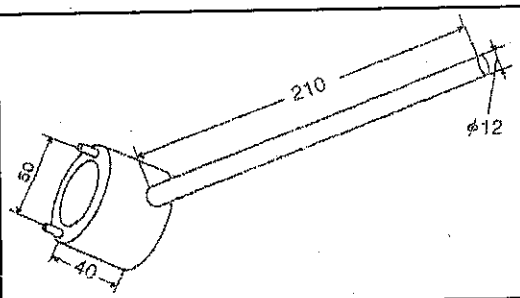
A	B	C	D	E	F	G	H	I	J	K	Drive cone neutral center position
14.0～14.2	11.4～12.9	2.3～3.7	1.9～2.1	7.4～7.5	57.8～58.7	20.3～21.2	39.9～40.3	37.7～39.5	3.6～4.7	2.4～2.6	78

【 NOTICE 】

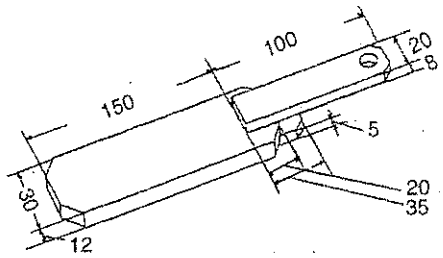
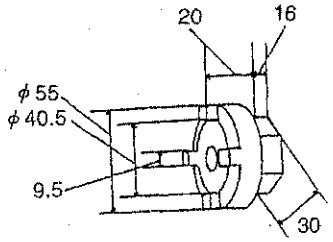
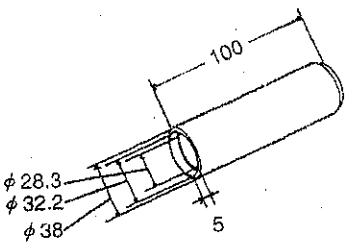
Compare your measurements with the above standard size. If your measurements differ greatly from the standard size, the measurements may not be correct. Check and measure again.

Adjusting point	Part No.	Thickness. mm	No. of Shims
t1	177095-02150	0.1 0.3 0.5 1.0	2 1 2 1
t2	177090-02250	0.1 0.3 0.5 1.0	2 1 1 1
t3 & t4	177075-02150	0.3 0.4 0.5	4 4 4
t5 & t6	177090-02310	0.1 0.3 0.5 1.0	4 2 2 2

3.7.4 Special Tools

Name of tool	Shape and size mm	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 torqure limiter

Special tools

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

3.7.5 Disassembly

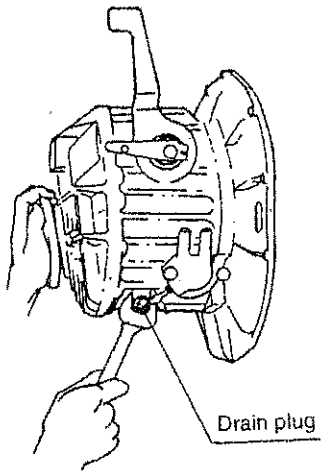
3.7.5.1 Disassembling the clutch and accessories.

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

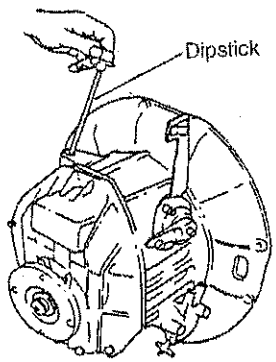
(2) Dismount the clutch main body from the mounting flange.

(3) Drain the lubricating oil
Drain the lubricating oil by removing the plug at the bottom of the clutch case. Also remove the dipstick from the clutch case at the same time.

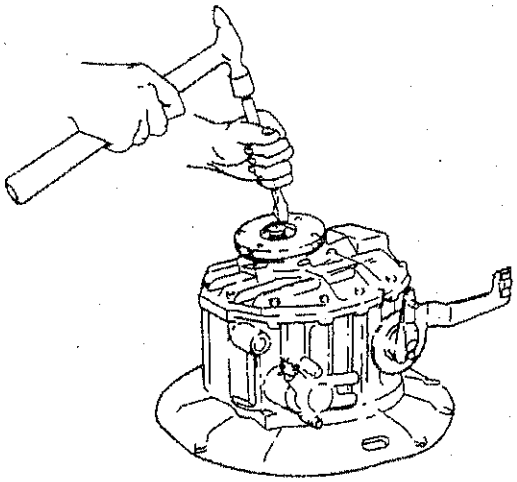
(4) Remove the drain plug and pull out the L.O.



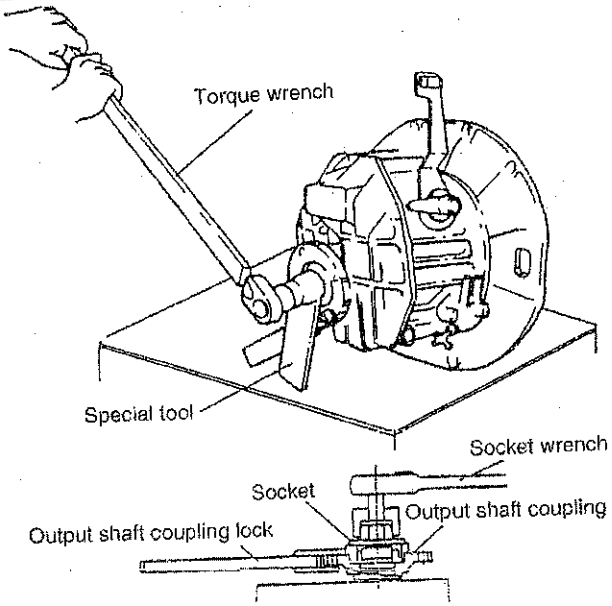
(5) Remove the dipstick.



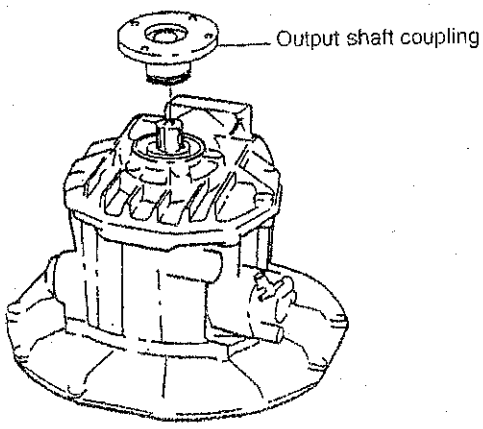
(6) Remove the end nut and output shaft coupling
1) loosen the calking of the endnut.



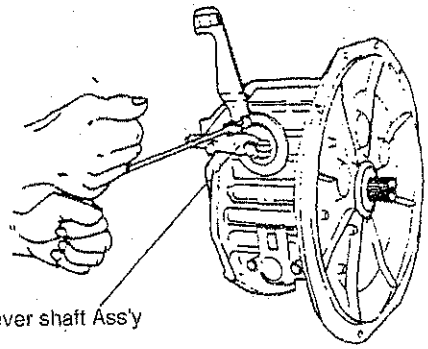
【 NOTICE 】
Loosen the endnut with the special tool and a torque wrench.



2) Remove the output shaft coupling

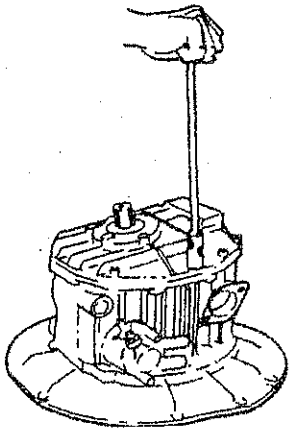


(7) Remove the 2 fixing bolts on the side cover or clutch case, and also remove the shift lever shaft assembly.

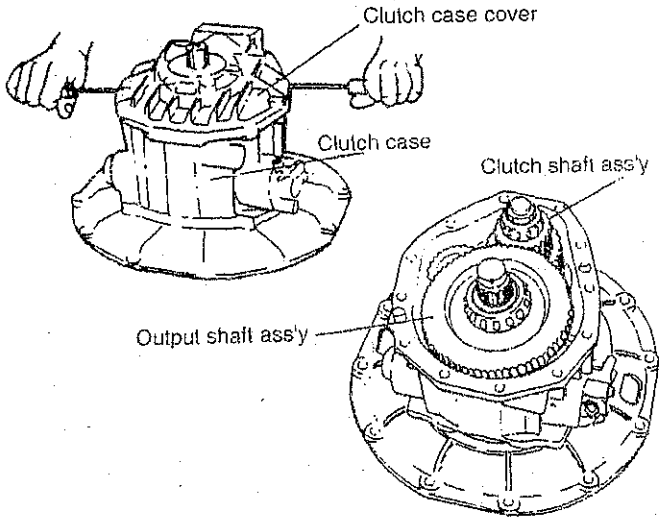


(8) Remove the bolt of the clutch case cover

① Remove the bolt of the clutch case cover

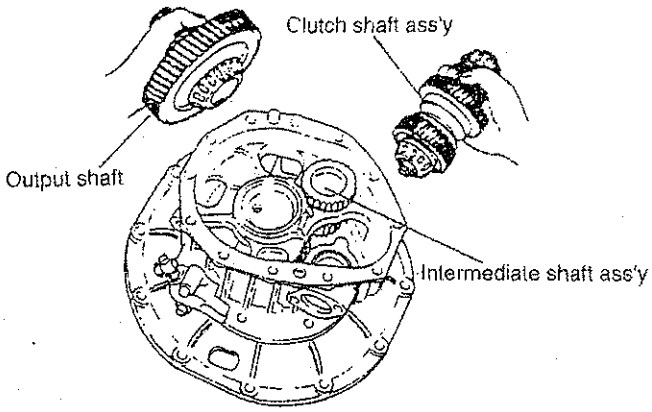


② Remove the clutch case cover from the clutch case.



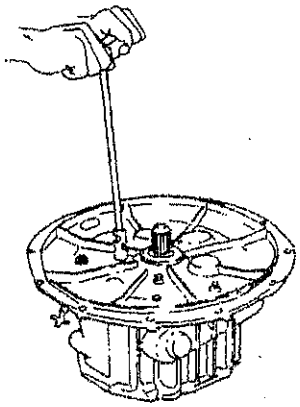
NOTE : To remove the case cover and the case, insert two drivers into the twe depressed points at the joint between the case cover and the case. This makes removal easy.

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



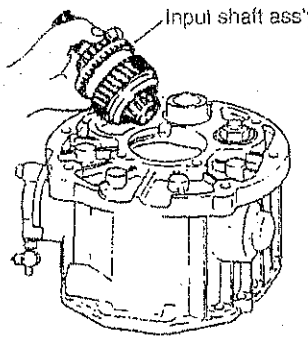
(10) Removing the mounting flange

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



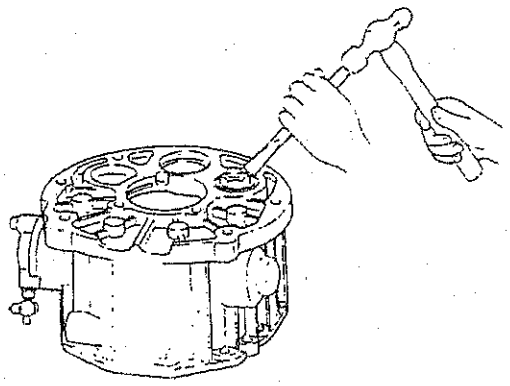
(11) Remove the input shaft assembly.

Draw out from the mounting flange side of the case.

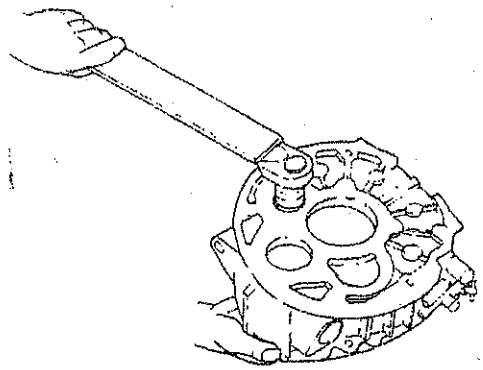


(12) Removing the intermediate shaft.

① Loosen the calking of locknut of the intermediate shaft.



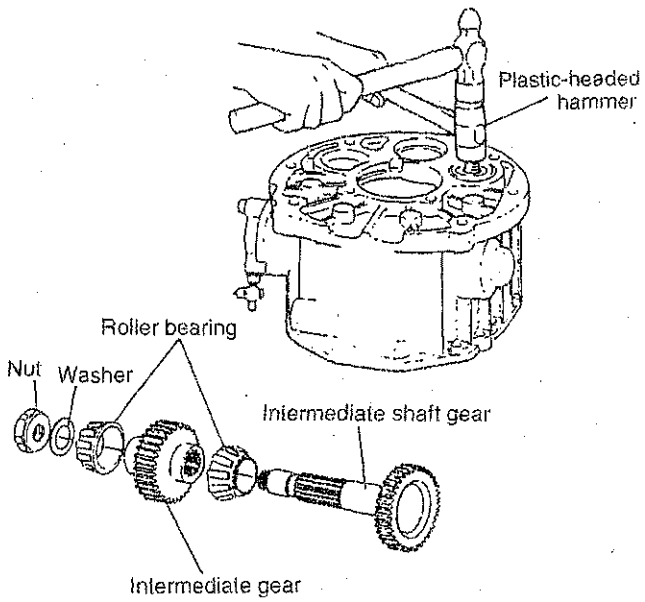
② Remove the locknut.



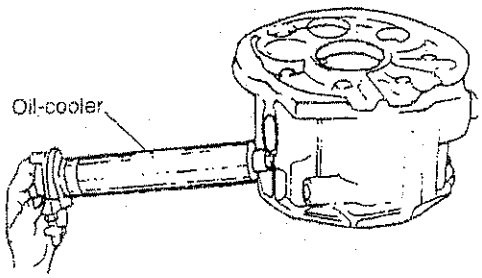
【 NOTICE 】

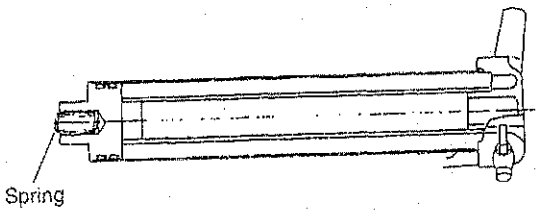
Be aware that nut has left-handed thread.

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

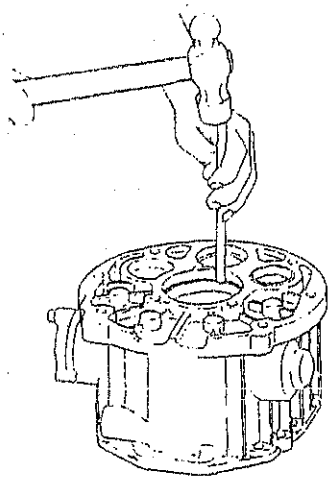


(13) Removing the oil-cooler.





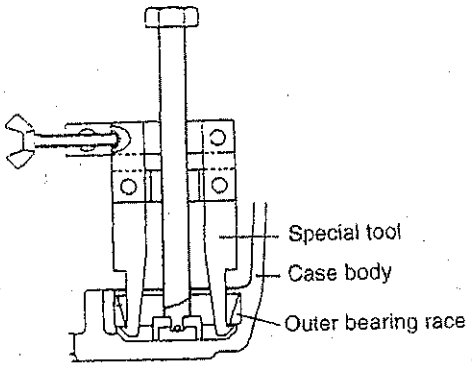
(14) Draw out the outer bearing reces.



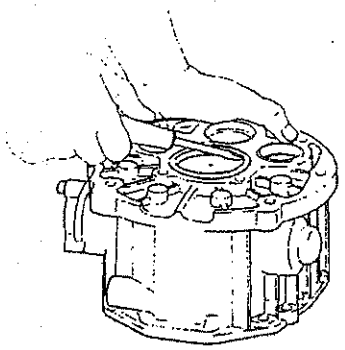
① Remove the outer bearing reace of the mounting flange, the case cover and the case.

【 NOTICE 】

Remove the outer bearing races with a special tool.



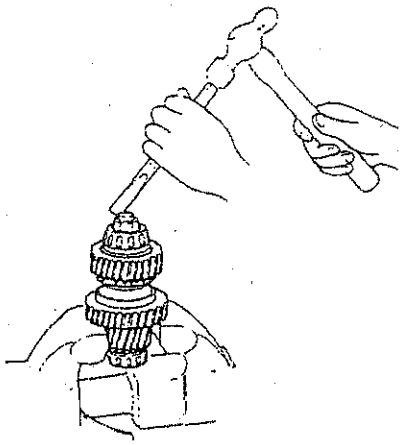
(15) Remove the oil seals of the mounting flange and the case cover.

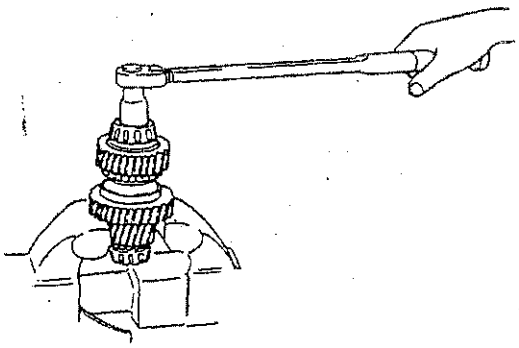


3.7.5.2 Disassembling the clutch shaft.

1) clutch gear (A) side

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

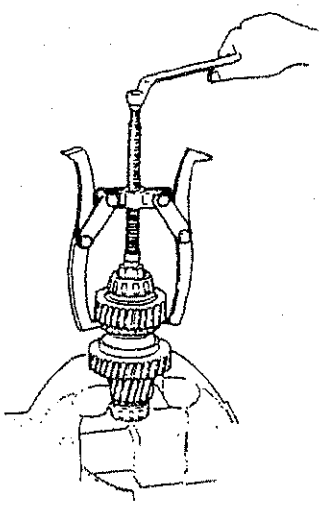




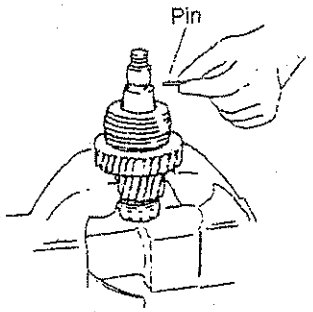
【 NOTICE 】

Be aware that nut has left-handed thread.

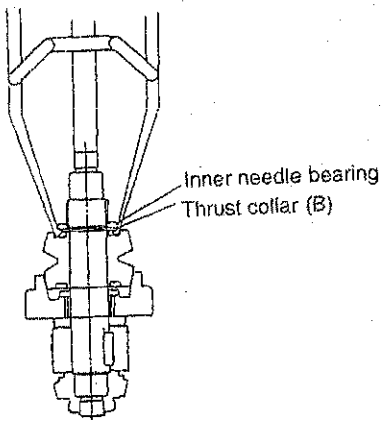
(2) Take out the clutch gear (A) , thrust collar (A) , cup spring, spring retainer and inner bearing trace. The clutch gear (A) must be withdrawn using a pulley extracter, with the clutch shaft fixed in a vice.



(3) Remove the pin

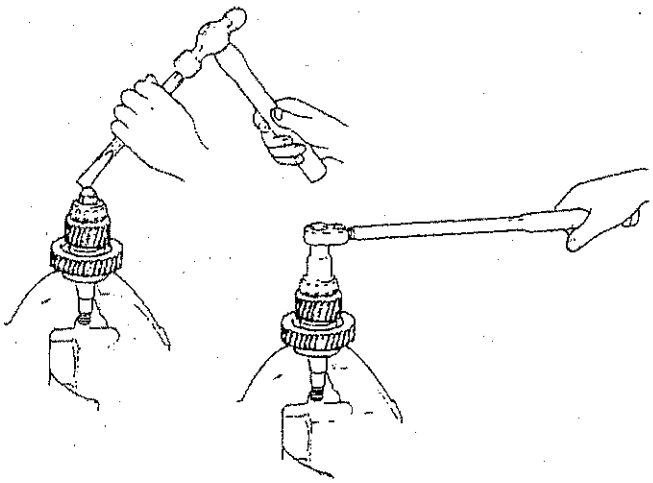


(4) Withdraw the trust coollar(B), inner needle bearing by pulley extractor.



2) Clutch gear(B) side

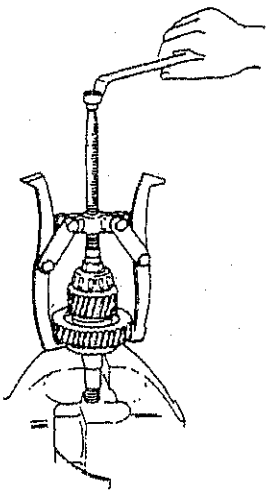
(1) Loosen the calking of the end nut and remover the nut. Remove the nut by a torque wrench, with the clutch shaft fixed in a vice.



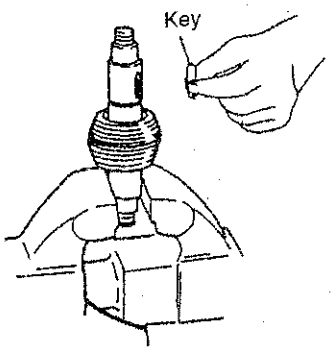
【 NOTICE 】

Be aware that nut has left-handed thread.

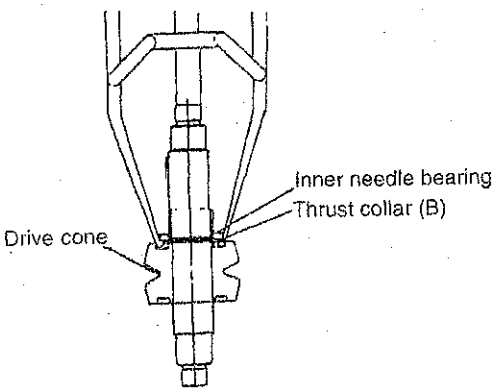
(2) Withdraw the large gear(B), thrust collar(A), cupspring, spring retainer, drive gear and inner bearing race. Use a pulley extracter, with the clutch shaft fixed in a vice.



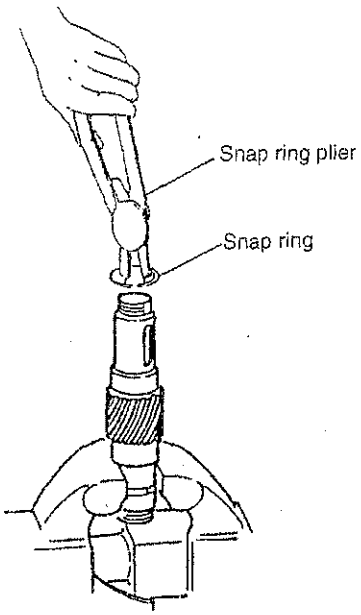
(3) Remove the key



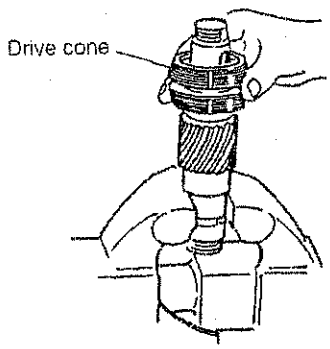
(4) Withdraw the thrust collar (B) and inner needle bearing race with the pulley extractor.



(5) Remove the snap ring.

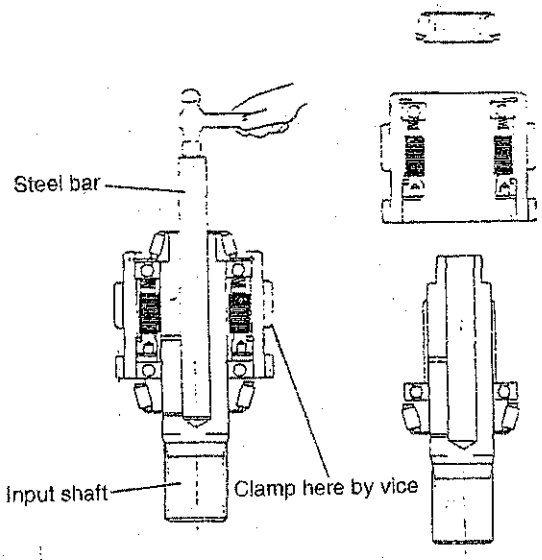


(6) Draw out the drive cone.

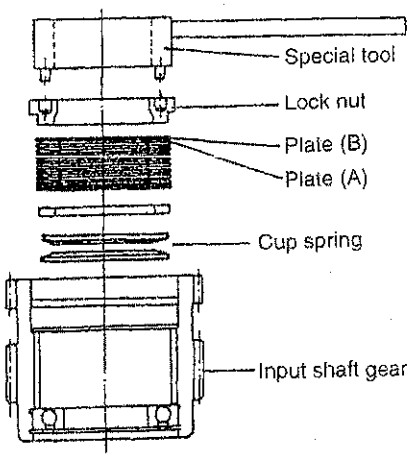


3.7.5.3 Disassembling the input shaft

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

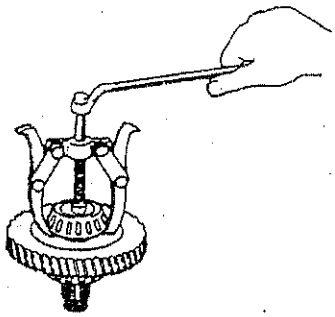


(2) Fix the input shaft gear in a vice, and remove the lock nut with a special tool.



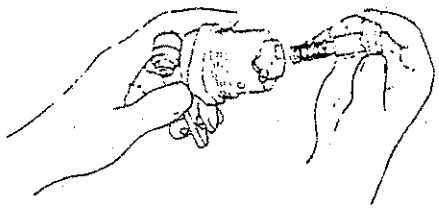
3.7.5.4 Disassembling the output shaft

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

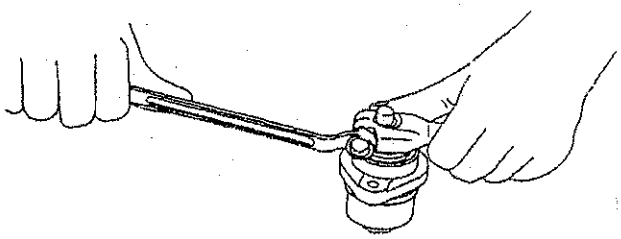


3.7.5.5 Disassembling the shifting device

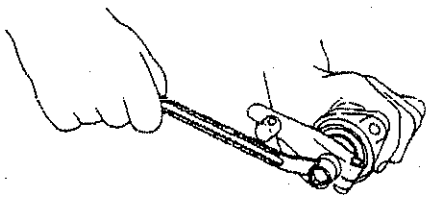
(1) Take out the shifter and shifter spring.



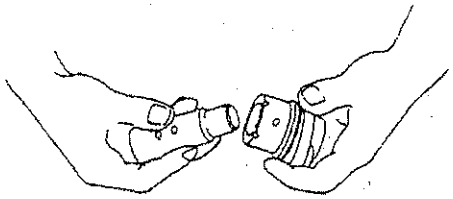
(2) Remove the stopper bolt and shims from the shifter.



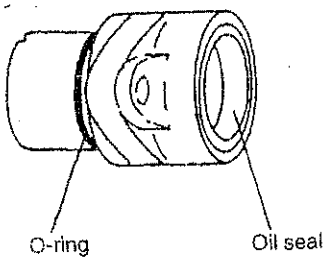
(3) Loosen the bolt of the shift lever and remove the shift lever and cable bracket.



(4) Remove the shift lever from the side cover.



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

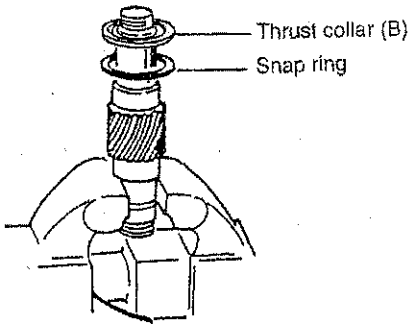


3.7.6 Reassembly

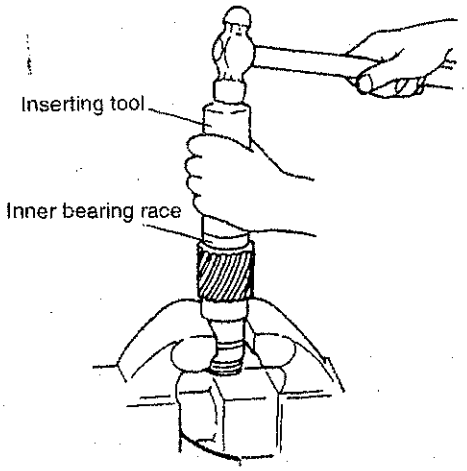
3.7.6.1 Reassembly of clutch shaft

1) Clutch gear (B) side

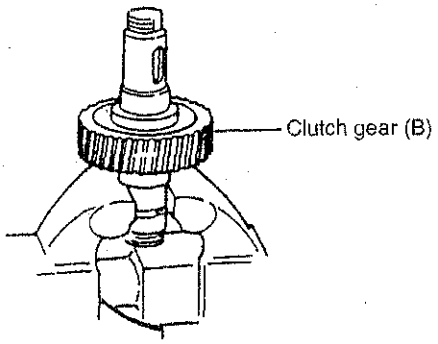
(1) Install the clutch gear (B) side snap ring and thrust collar (B) onto the shaft.



(2) Install the inner needle bearing race using the inseerting tool and hammer.



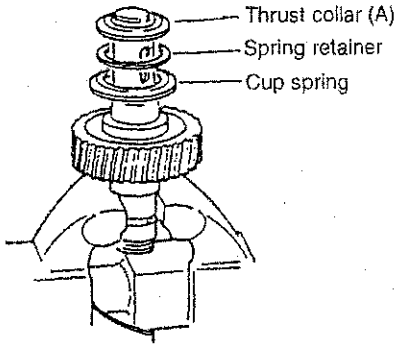
(3) Assemble the needle bearing and clutch gear(B).



【 NOTICE 】

Check that the clutch gear (B) rotates smoothly.

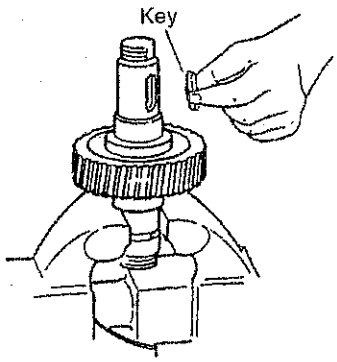
(4) Install the cup spring , spring retainer, thrust collar(A).



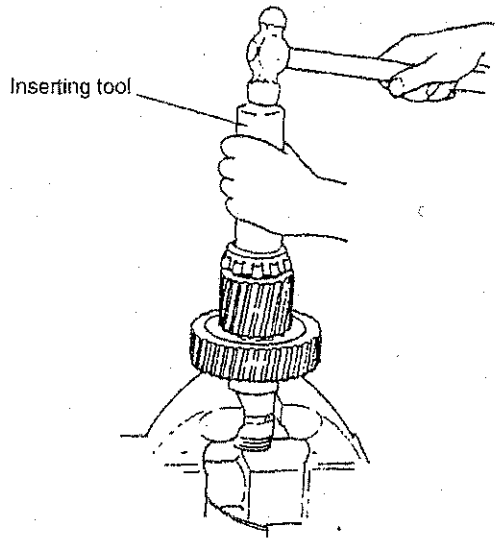
【 NOTICE 】

- Drive in with a plastic headed hammer. Do not hit hard.
- When fitting the thrust collar(A), note the fitting direction. Install it keeping the stepped surface toward the drive gear side.
- Check that the clutch gear(B) rotates smoothly.

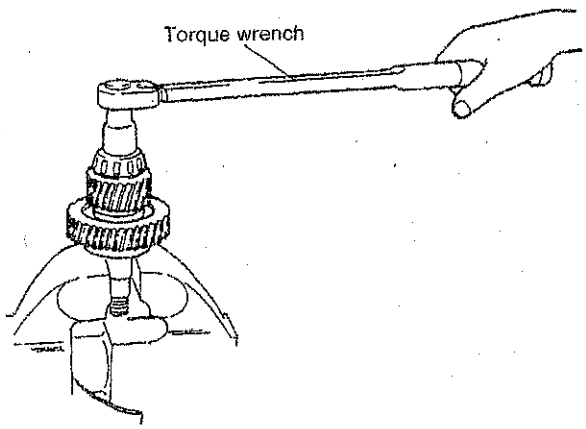
(5) Fit the key



(6) Install the driving gear and inner bearing race using the inserting tool and hammer.



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

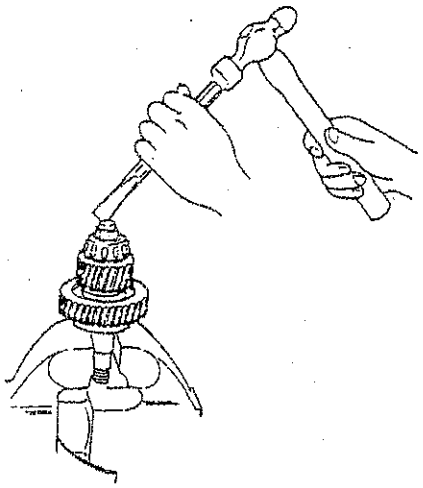


Tightening torque	8.5–11.5kgf–m (83.3–112.7N·m)

【 NOTICE 】

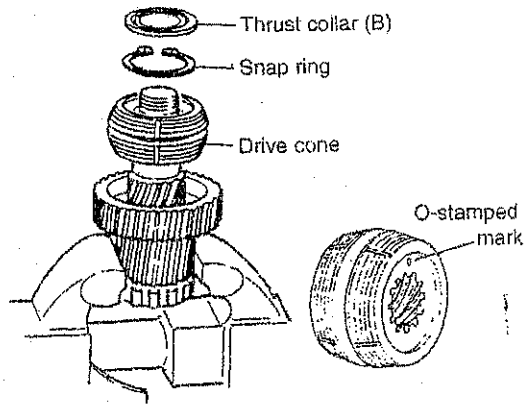
- Be aware that the thread is left-handed.
- Use the clutch gear (A) side nut which was used before dismantling for the clutch gear (B) end nut. This is to provide effective staking to the nut.

(8) Staking the end nut and clutch shaft.



2) Clutch gear (A) side

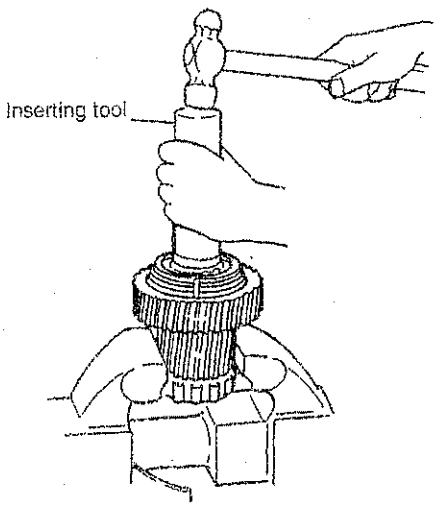
(1) Insert the drive cone, snap ring and thrust collar(B).



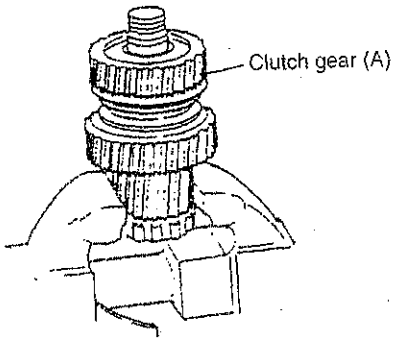
【 NOTICE 】

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

(2) Install the inner needle bearing race, using an inserting tool and hammer.



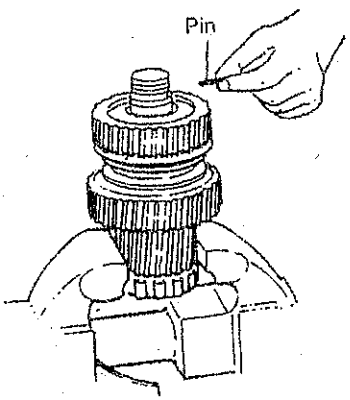
(3) Assemble the needle bearing and clutch gear(A)



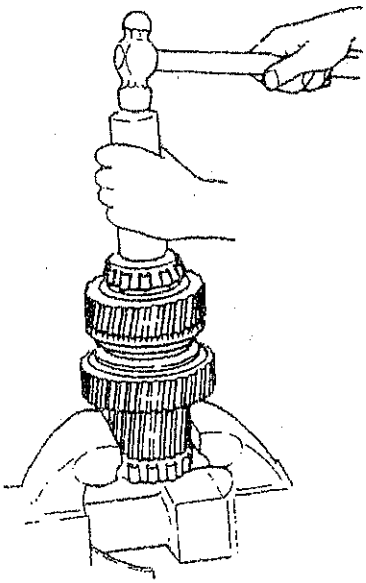
【 NOTICE 】

Check that the clutch gear(A) rotates smoothly.

(4) Insert the pin.



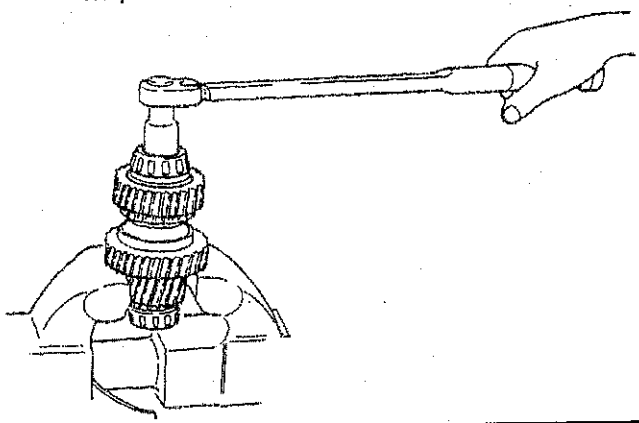
(5) Install the cup spring , spring retainer and thrust collar(A) and drive in the inner bearing race using the inserting tool.



【 NOTICE 】

- When fitting the thrust collar(A), note the fitting direction. Install it keeping the stepped surface toward the roller bearing side.
- The pin cannot be fitted after the inner bearing race has been driven in.
- Check that the large gear (B) rotates smoothly.

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

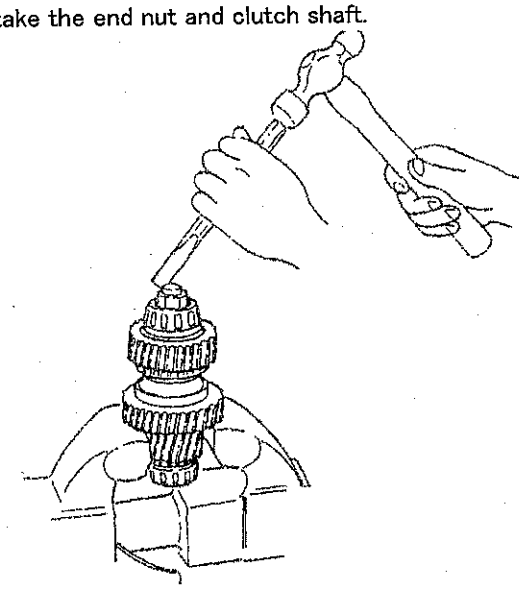


Tightening torque	8.5–11.5kgf-m (83.3–112.7N·m)

【 NOTICE 】

Be aware that the thread is left-handed.

(7) Stake the end nut and clutch shaft.



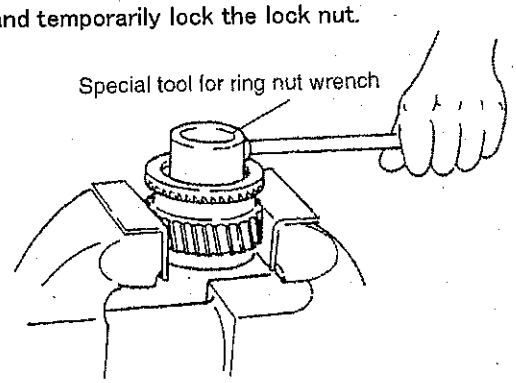
【 NOTICE 】

Use the clutch gear (A) side nut which was used before dismounting for the clutch gear (B) end nut. This to provide effective staking to the nut.

3.7.6.2 Reassembly of input shaft

(1) Install the boll bearing and fit the snap ring into the input shaft gear.

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



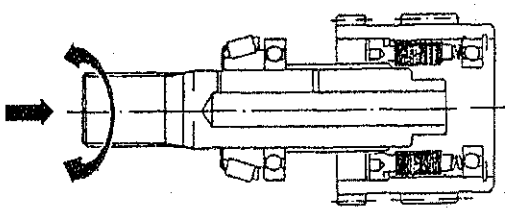
【 NOTICE 】

Apply lube oil to each insert part.

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

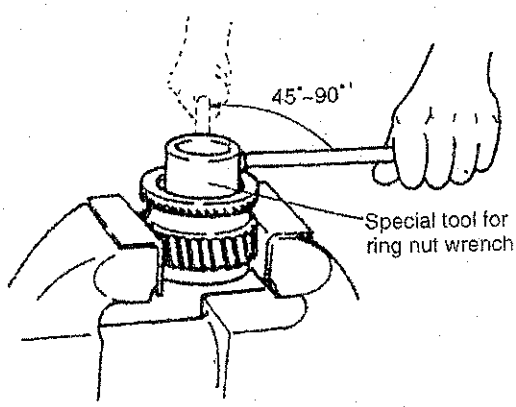
(4) Drive the ball bearing and the inner bearing race using an inserting tool.

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

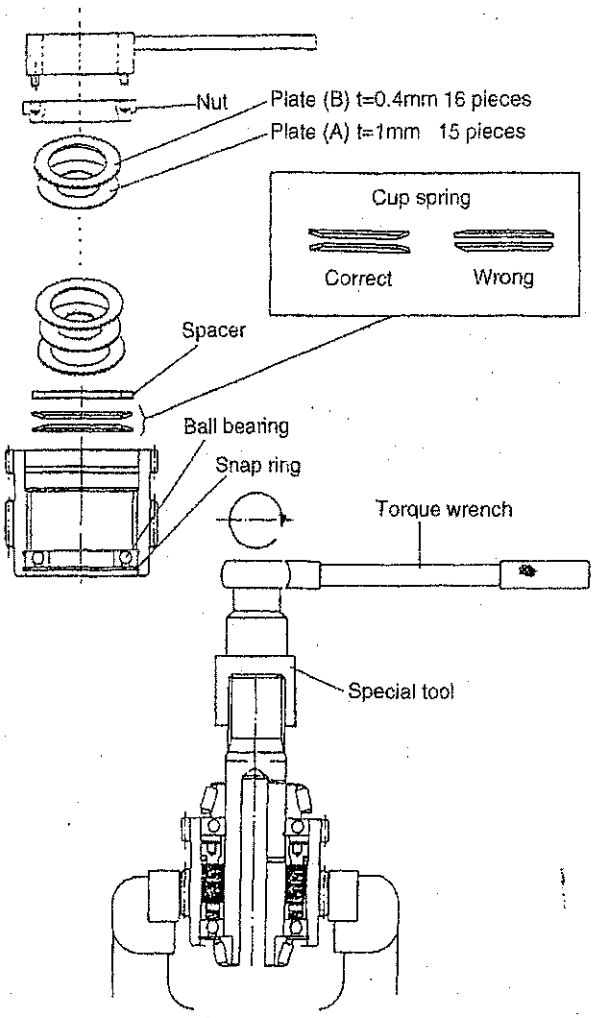


(6) Take the input shaft out again.

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



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

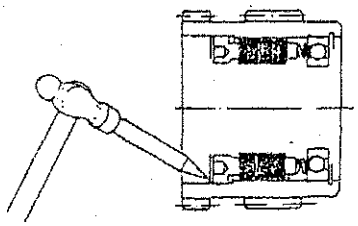


Torque:	55-60 kgf-m (539-588N·m)

【 NOTICE 】

Match up the teeth of plate(A).

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



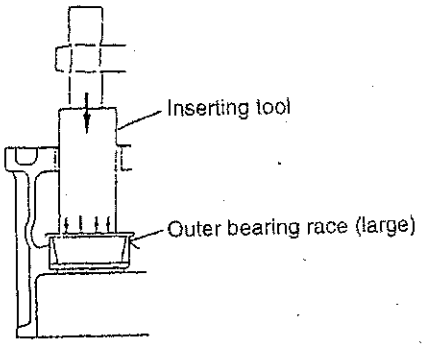
(10) Insert the input shaft into the input gear assembly.

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

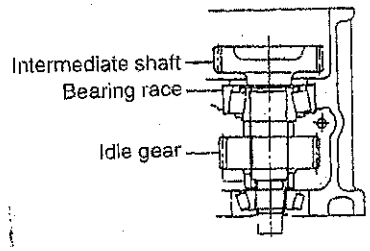
3.7.6.3 Reassembly of the clutch case

1) Reassemnly of the intermediate shaft

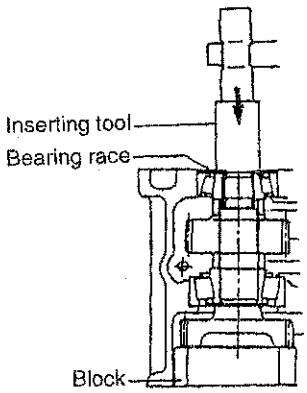
(1) Install the outer bearing race (large) into the clutch case.



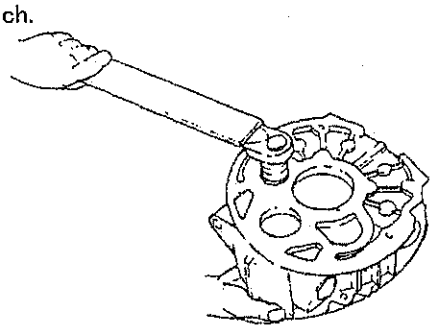
(2) Insert the inner bearing reces and idle gear and drive in the intermediate shaft.



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



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

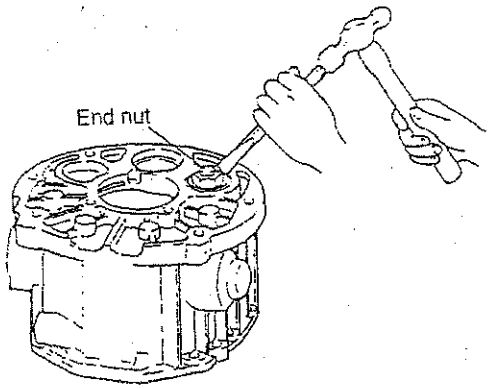


Tightening torque	8.5–11.5kgf-m (83.3–112.7N·m)

【 NOTICE 】

Remember it is a left-handed thread

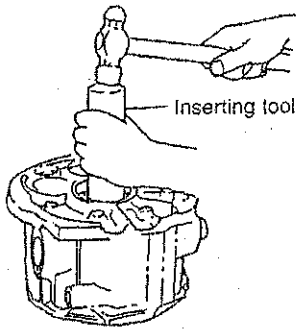
(5) Stake the end nut



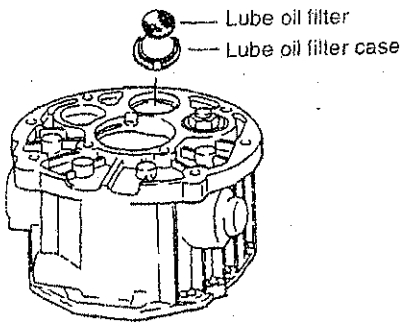
(6) Insert the shims into the clutch case.

2) Reassembly of the bearing outer races and shims in the clutch case

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

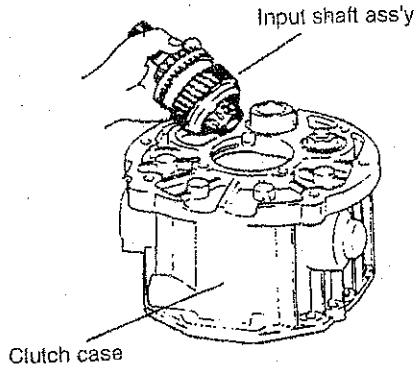


(2) Insert the clutch shaft shims, lube oil filter case and filter into the clutch case.

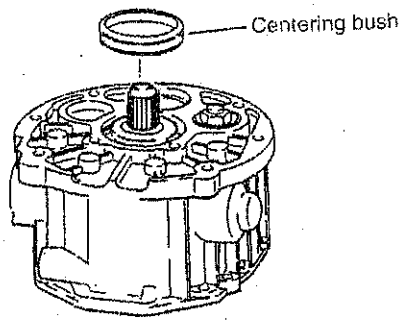


3) Reassmbly of the input shaft

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



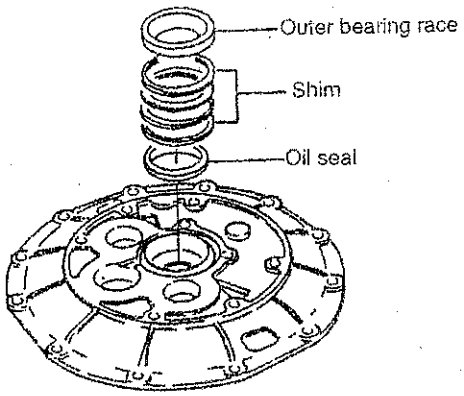
(2) Drive the centering bush into the clutch case.



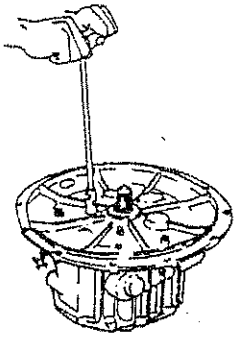
4) Reassembly of the mounting flange

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

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



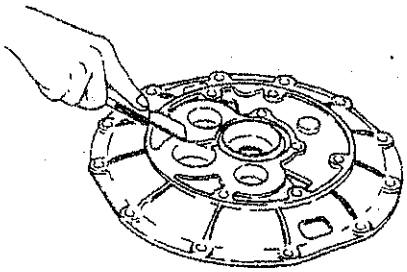
(3) Fit the mounting flange onto the clutch case, and tighten the bolt.

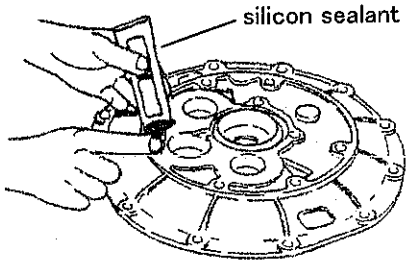


Tightening torque	5-6 kgf-m (49-58.8N·m)

【 NOTICE 】

Apply silicon sealant to the mating surface of the mounting flange and the clutch case.





LUQID PACKING PART NUMBER

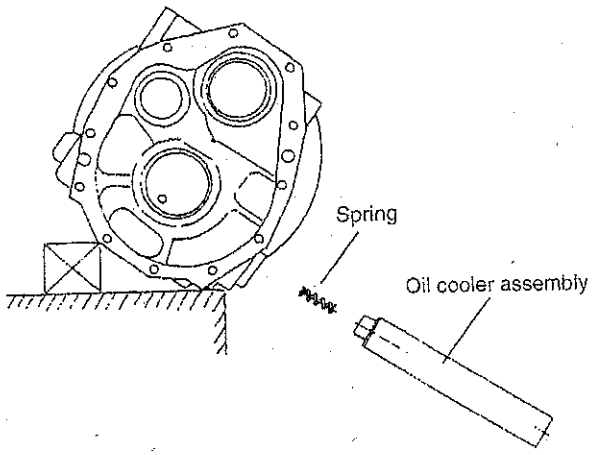
Three Bond #1215

#1216

#1216B

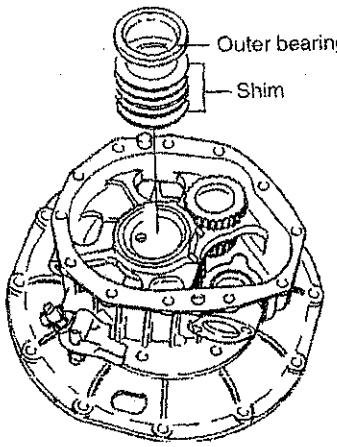
5) Reassembly of the oil cooler

【 NOTICE 】
Fasten taking care not to allow the spring at the tip of the oil cooler to drop out.

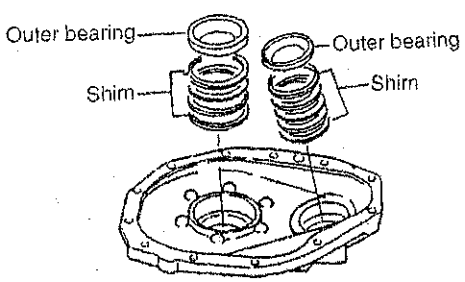


6) Reassembly of the clutch case cover.

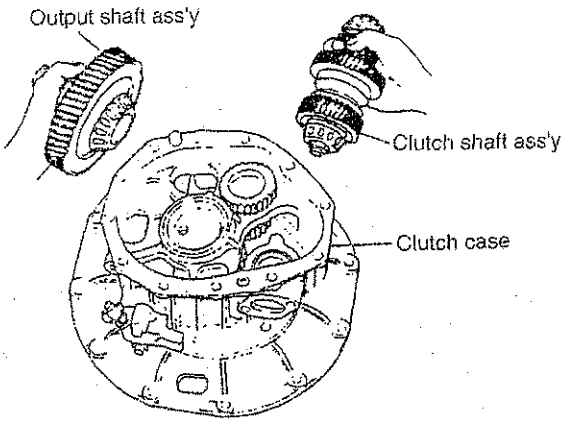
(1) Install the output shaft shim and outer bearing race into the clutch case.

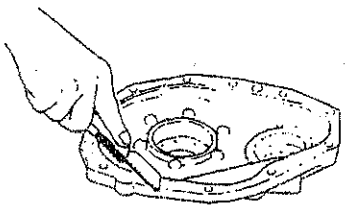


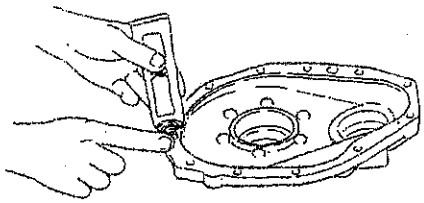
(2) Install the shims and the outer bearing races into the clutch case cover.



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

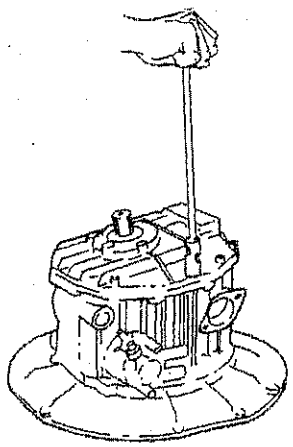






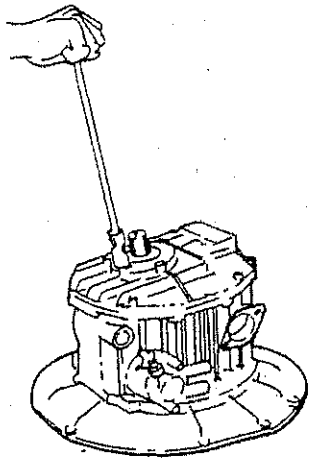
【 NOTICE 】
Apply silicon sealant to the maching surface of the clutch case cover and the clutch case.

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



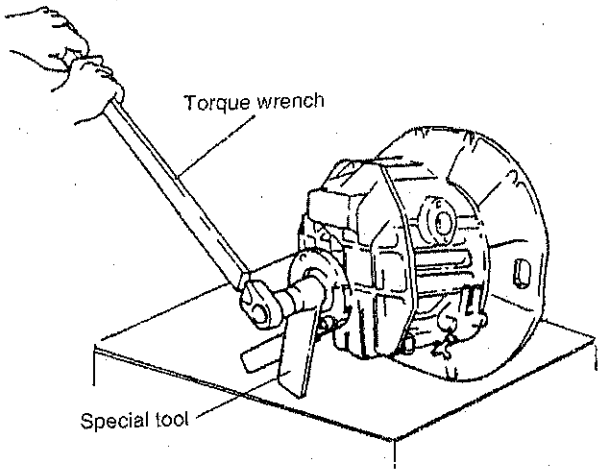
Tightening torque	2.3–2.8kgf-m (22.5–27.4N·m)

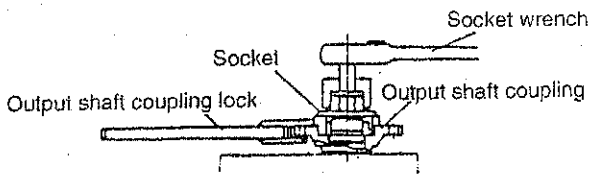
(5) Insert the outer bearing race, shim and the output shaft cover, and tighten the bolt.



(6) Insert the oil seal, output shaft coupring, 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.

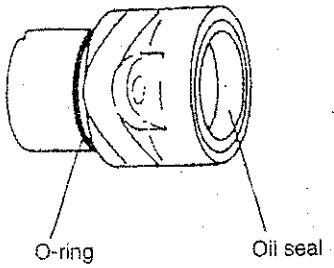




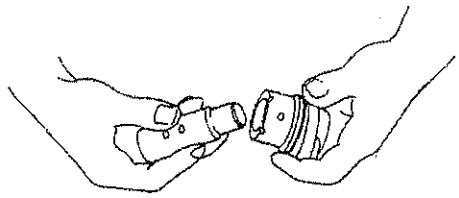
Tightening torque	54-56kgf-m (529.2-548.8N·m)

7) Reassembly of the shifting device

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



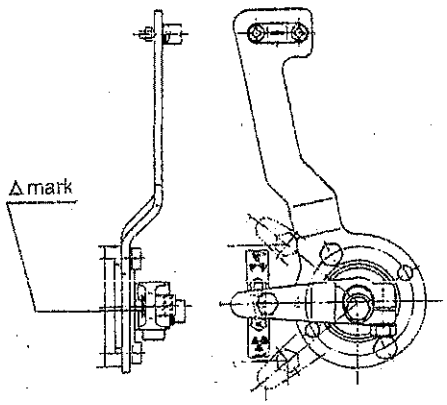
(2) Insert the shift lever shaft to the side cover.



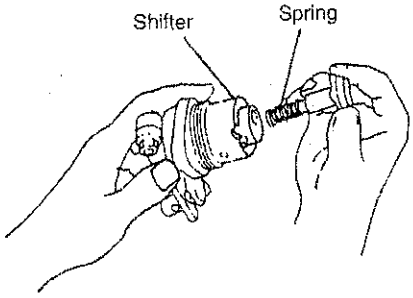
(3) Fit the shift lever to the shift lever shaft.

【 NOTICE 】

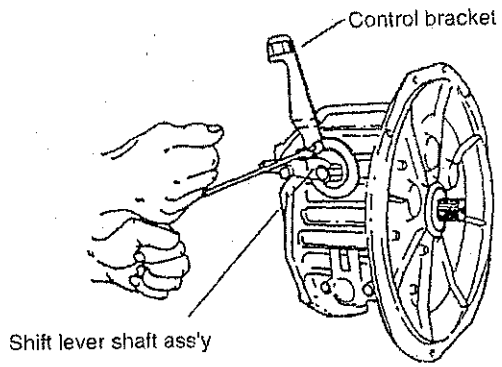
Check the direction of the shift lever △mark.



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



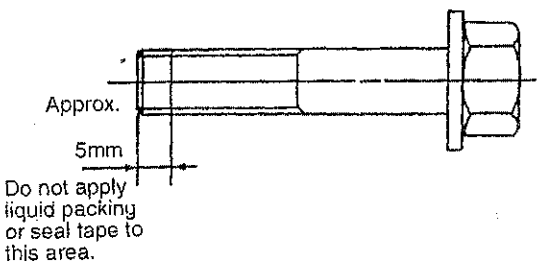
(5) Fit the side cover assembly and the remote control bracket to the clutch case.



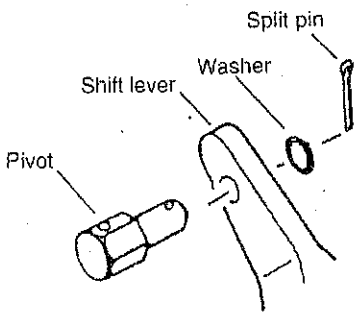
【 NOTICE 】
- Check the direction of the shifter(Top and bottom side)
- The shift lever may not turn smoothly if the clutch case is not filled with lubricating oil.

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

【 NOTICE 】
Apply silicon sealant or seal tape to the thread of the stopper bolt.



(7) Attach the pivot to the shift lever.



8) Reassembly of the lube oil drain plug and dipstick