YANMAR

HINSHI-H10-011

# SERVICE MANUAL

## MARINE GEAR

## KM3P/KM3A/KM4A
## KBW20/KBW21/KMH4A

1998.11

HINSHI-H10-011

# YANMAR

# SERVICE MANUAL

## YANMAR MARINE GEAR

**MODEL** **KM3P/KM3A/KM4A**
**KBW20/KBW21/KMH4A**

YANMAR DIESEL ENGINE CO.,LTD.

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| Manual Name | YANMAR SERVICE MANUAL FOR YANMAR MARINE GEAR |
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| Number of correction | Date of correction | Reason for correction | Outline of correction | correction item No.(page) | Corrected by |
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| • This manual has been updated to include model KMH4A in addition to the previous models KM3P, KM3A, KM4A, KBW20, KBW21. | | | | | |
| 1 st | Mar. 2001 | Tightening torque for bolts & nuts | • Added tightening torque of bolts and nuts for general use.<br>• Added the tightening torque of the nut for the remote control cable connection of clutch shifting lever (for KBW20/21) | 3–2<br>3–102 | Quality Assurance Dept. |
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# Introduction

This manual describes the handling and maintenance for KM3P, KM3A, KM4A, KBW20, KBW21 and KMH4A Marine Gears. Please use the manual to help you make necessary adjustments to the marine gear accurately, quickly, and safely. This manual explains the use with a standard engine.

In order to improve the quality of your marine gear, you will be notified of any modifications which have been made.



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# 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 the marine gear, always use a crane with a sufficient 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 correotly 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) Handling 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.**

## (7) 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 reguiations. Ask a qualified disposal company for example.

# 2. General

## 2.1 Specifications

### • KM3P

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Engine output (max.) (Flywheel) kw(hp)/rpm | | | 41.2(56)/3800 | | | | |
| Clutch | | | Constant mesh gear with serve cone clutch (wet type) | | | | |
| Reduction ratio | Forward | | 2.36 | 2.61 | 3.20 | 2.36 | 2.61 |
| | Reverse | | 3.16 | 3.16 | 3.16 | 3.16 | 3.16 |
| Direction of rotation | Input shaft | | Counter-clockwise, viewed from stern | | | | |
| | Output shaft | Forward | Clockwise, viewed from stern | | | | |
| | | Reverse | Counter-clockwise, viewed from stern | | | | |
| Position of shift lever | | | Right side, viewed from stern | | | | |
| Lubrication oil | | | SAE 20/30 | | | | |
| Lubrication oil capacity ℓ | | | 0.35 | | | | |
| Applicable engin (Standard name) | | | 3JH3E, 4JH3E | | | | |
| Dry mass kg(N) | | | 13(127) | | | | |

### • KM3A

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Engine output (max.) (Flywheel) kw(hp)/rpm | | | 41.2(56)/3800 | | | | |
| Output shaft | | | excentric down angle | | | | |
| Clutch | | | Constant mesh gear with serve cone clutch (wet type) | | | | |
| Reduction ratio | Forward | | 2.33 | 2.64 | 3.21 | 2.33 | 2.64 |
| | Reverse | | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 |
| Direction of rotation | Input shaft | | Counter-clockwise, viewed from stern | | | | |
| | Output shaft | Forward | Clockwise, viewed from stern | | | | |
| | | Reverse | Counter-clockwise, viewed from stern | | | | |
| Position of shift lever | | | Right side, viewed from stern | | | | |
| Lubrication oil | | | SAE 20/30 | | | | |
| Lubrication oil capacity ℓ | | | 0.45 | | | | |
| Applicable engin (Standard name) | | | 3JH3E, 4JH3E | | | | |
| Dry mass kg(N) | | | 13(127) | | | | |

### • KM4A

| | | | | | |
|---|---|---|---|---|---|
| Engine output (max.) (Flywheel) kw(hp)/rpm | | 73.6(100)/3800 | | | |
| Output shaft | | excentric 7° down angle | | | |
| Clutch | | Constant mesh gear with serve cone clutch (wet type) | | | |
| Direction of rotation | Input shaft | Counter-clockwise, viewed from stern | | | |
| | Output shaft | Bi-rotation | | | |
| Reduction ratio (Both forward and reverse) | | 3.30 | 2.63 | 2.14 | |
| Position of shift lever | | Right side, viewed from stern | | | |
| Lubrication oil | | Same as Engine lube oil | | | |
| Lubrication oil capacity ℓ | | 1.3 | | | |
| Lube oil cooler | | Sea-water cooling | | | |
| Applicable engin (Standard name) | | 4JH3E, 4JH3-TE, 4JH3-HTE | | | |
| Dry mass kg(N) | | 28(274) | | | |



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## • KBW20

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Engine output (max.) (Flywheel) kw(hp)/rpm | | | 41.2(56)/3800 | | | | | |
| Reduction system | | | One·stage recuction, helical gear | | | | | |
| Reversing system | | | Constant mesh gear | | | | | |
| Clutch | | | Wet type multi-disc, mechanically operated | | | | | |
| Reduction ratio | Forward | | 2.17 | 2.62 | 3.28 | 2.17 | 2.62 | 3.28 |
| | Reverse | | 3.06 | | | 3.06 | | |
| Direction of rotation | Input shaft | | Counterclockwise as viewed from stern | | | | | |
| | Output shaft | Forward | Clockwise as viewed from stern | | | | | |
| | | Reverse | Counterclockwise as viewed from stern | | | | | |
| Lubrication oil | | | DEXRON.ATF | | | | | |
| Lubrication oil capacity ℓ | | | 1.2 | | | | | |
| Applicable engin (Standard name) | | | 4JH3E | | | | | |
| Dry mass kg(N) | | | 26(255) | | | | | |

## • KBW21

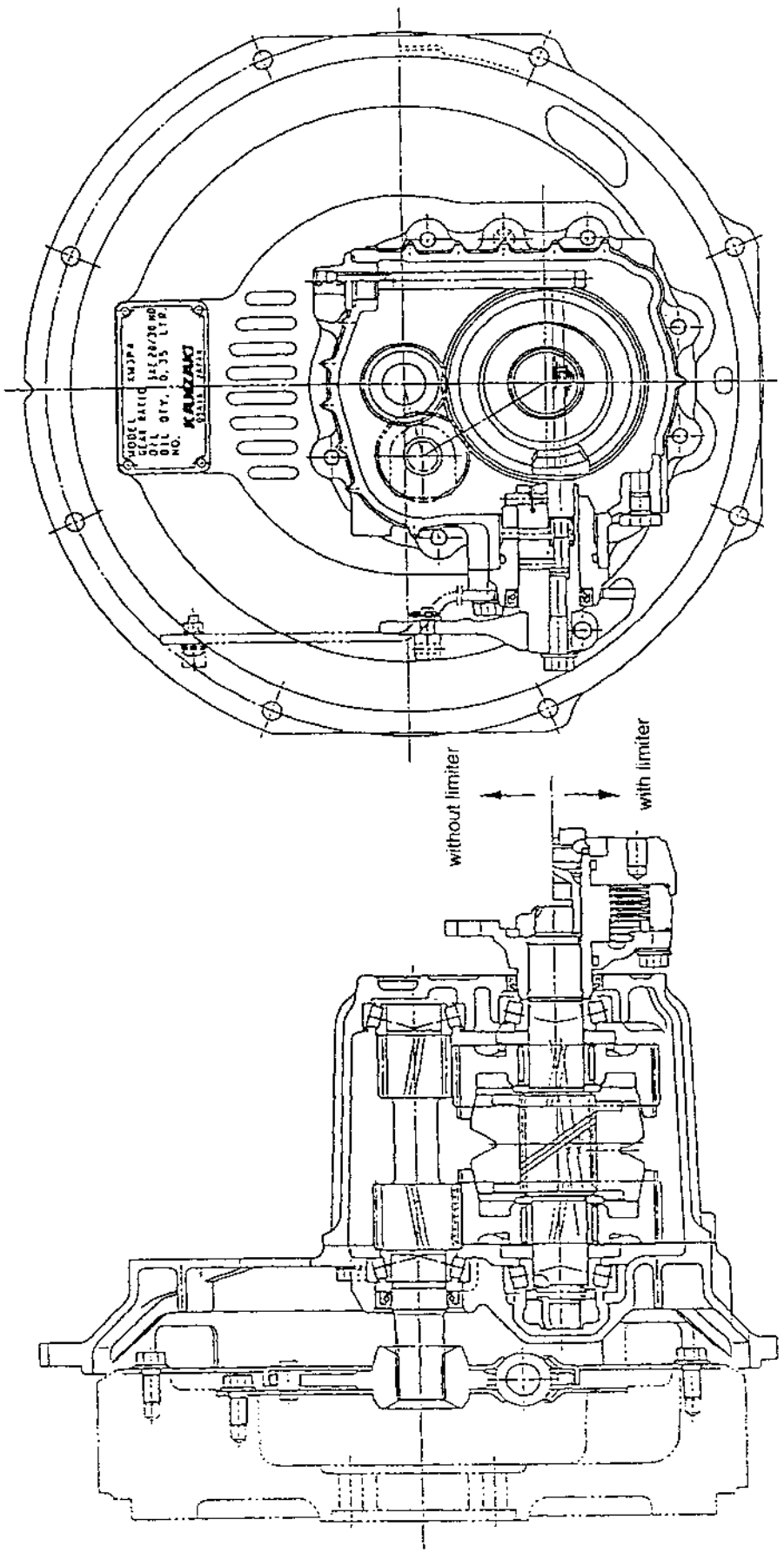
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Engine output (max.) (Flywheel) kw(hp)/rpm | | | 73.6(100)/3800 | | | | |
| Reduction system | | | One·stage recuction, helical gear | | | | |
| Reversing system | | | Constant mesh gear | | | | |
| Clutch system | | | Wet type multi-disc, mechanically operated | | | | |
| Reduction ratio | Forward | | 2.17 | 2.62 | —— | 2.17 | 2.62 |
| | Reverse | | 3.06 | | | 3.06 | |
| Direction of rotation | Input shaft | | Counterclockwise as viewed from stern | | | | |
| | Output shaft | Forward | Clockwise as viewed from stern | | | | |
| | | Reverse | Counterclockwise as viewed from stern | | | | |
| Lubrication oil | | | DEXRON.ATF | | | | |
| Lubrication oil capacity ℓ | | | 1.2 | | | | |
| lube oil cooler | | | Sea-water cooling | | | | |
| Applicable engin (Standard name) | | | 4JH3-TE, 4JH3-HTE | | | | |
| Dry mass kg(N) | | | 30(294) | | | | |

## • KMH4A

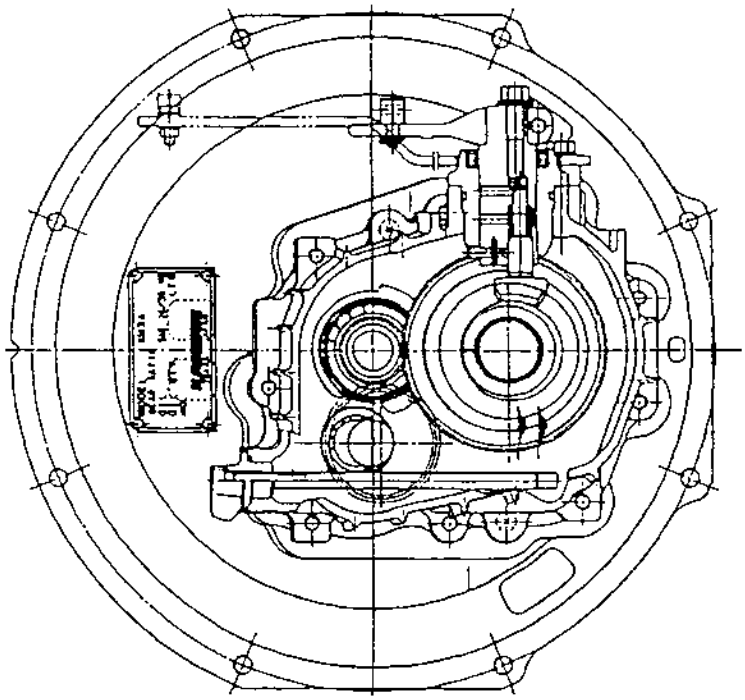
| | | | | |
|---|---|---|---|---|
| Engine output (max.) (Flywheel) kw(hp)/rpm | | | 91.9(125)/3800 | |
| Output shaft | | | excentric 8° down angle | |
| Reduction system | | | One-stage recuction, helical gear | |
| Reversing system | | | Constant mesh gear | |
| Clutch | | | Wet type multi-disc, hydraulic operation | |
| Reduction ratio (Both forward and reverse) | | | 2.04 | 2.45 |
| Direction of rotation | Input shaft | | Counter-clockwise, viewed from stern | |
| | Output shaft | Forward | Clockwise, viewed from stern | |
| | | Reverse | Counter-clockwise, viewed from stern | |
| Lubrication oil | | | SAE30 | |
| Lubrication oil capacity ℓ | | | 2.0 | |
| Lubrication oil cooler | | | Sea-water cooling | |
| Applicable engin (Standard name) | | | 4JH3-TE, 4JH3-HTE, 4JH3-DTE | |
| Dry mass kg(N) | | | 31(304) | |

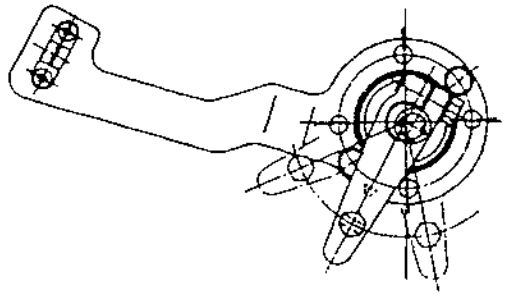
## 2.2 Sectional

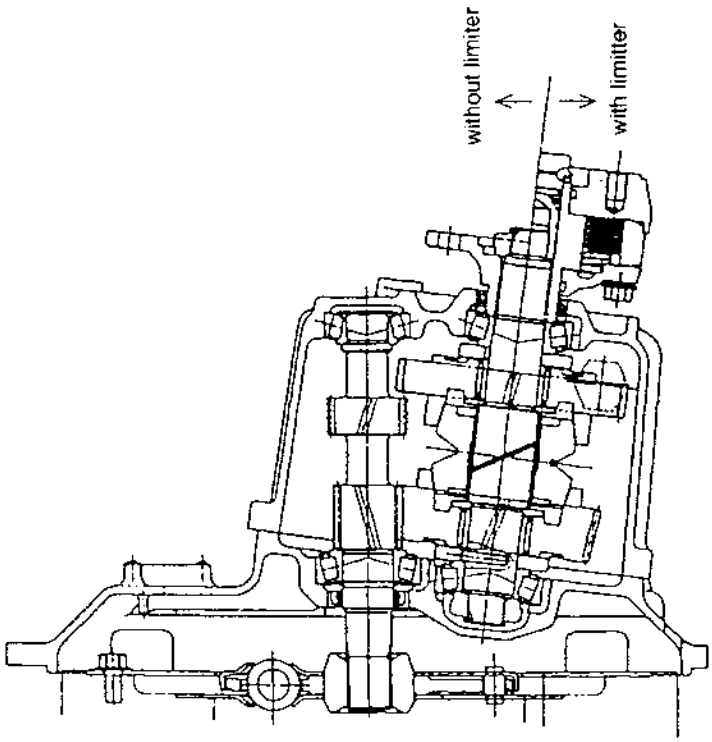
● **KM3P**

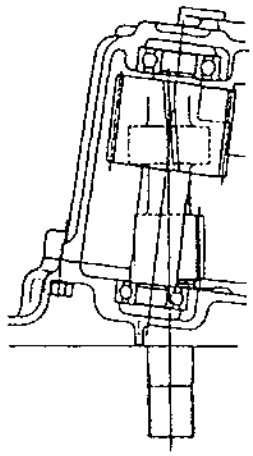


● KM3A







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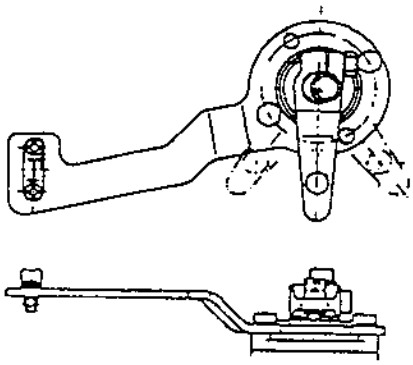
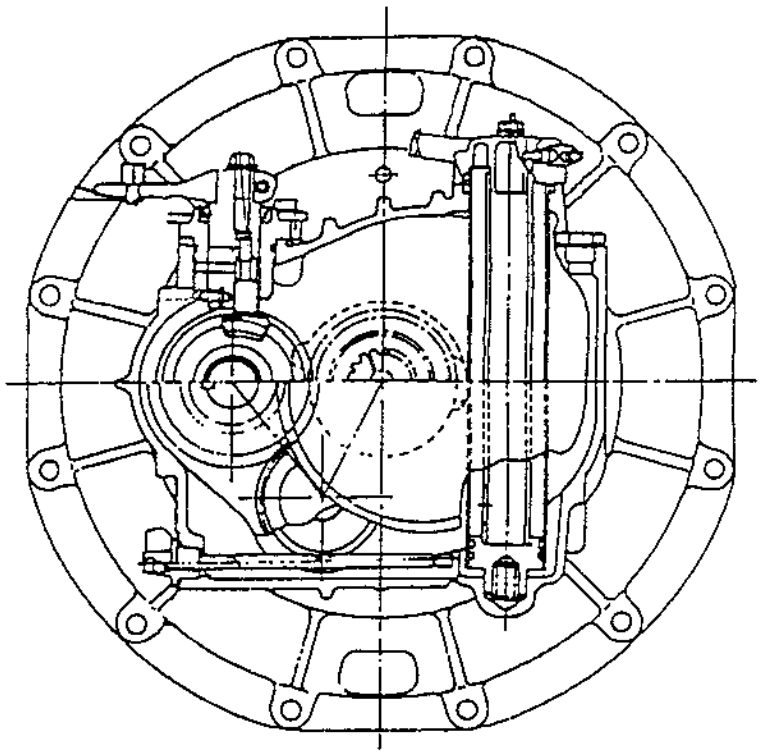
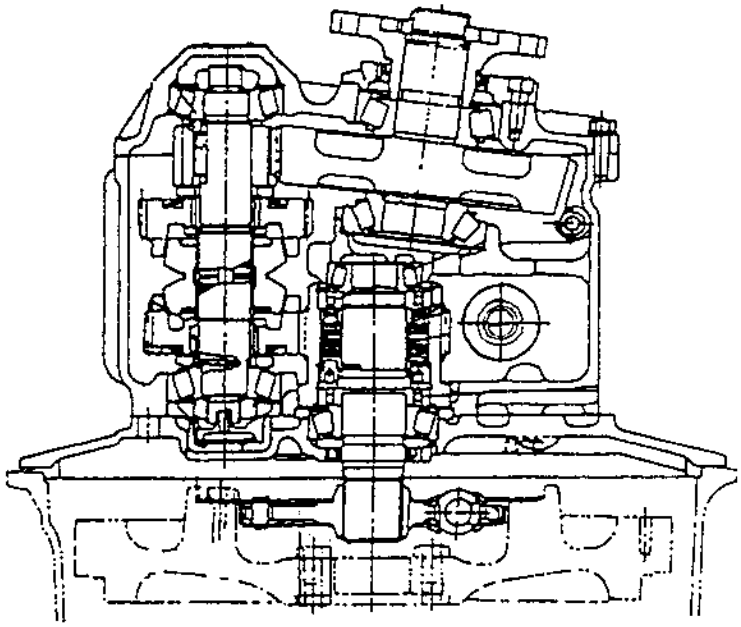
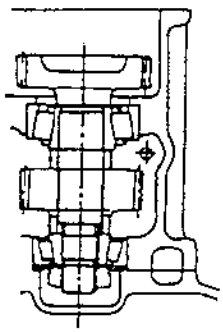
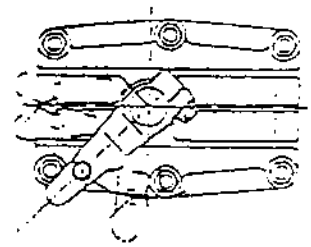


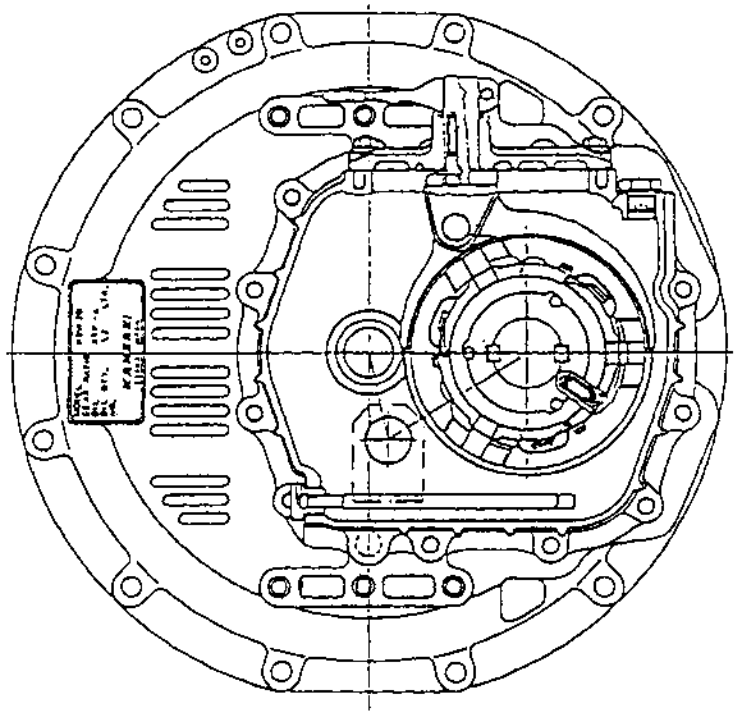


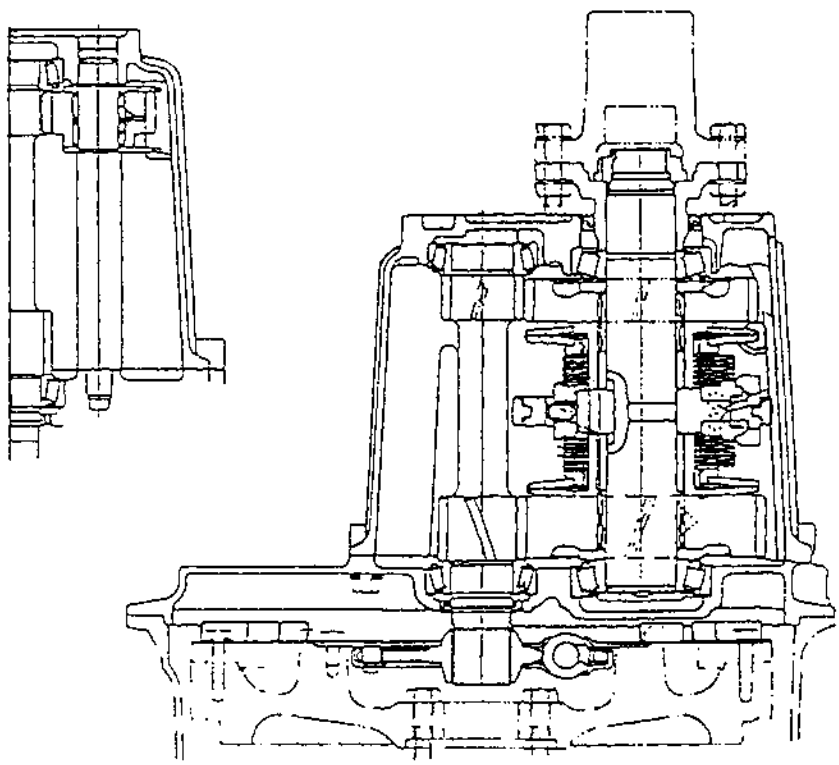




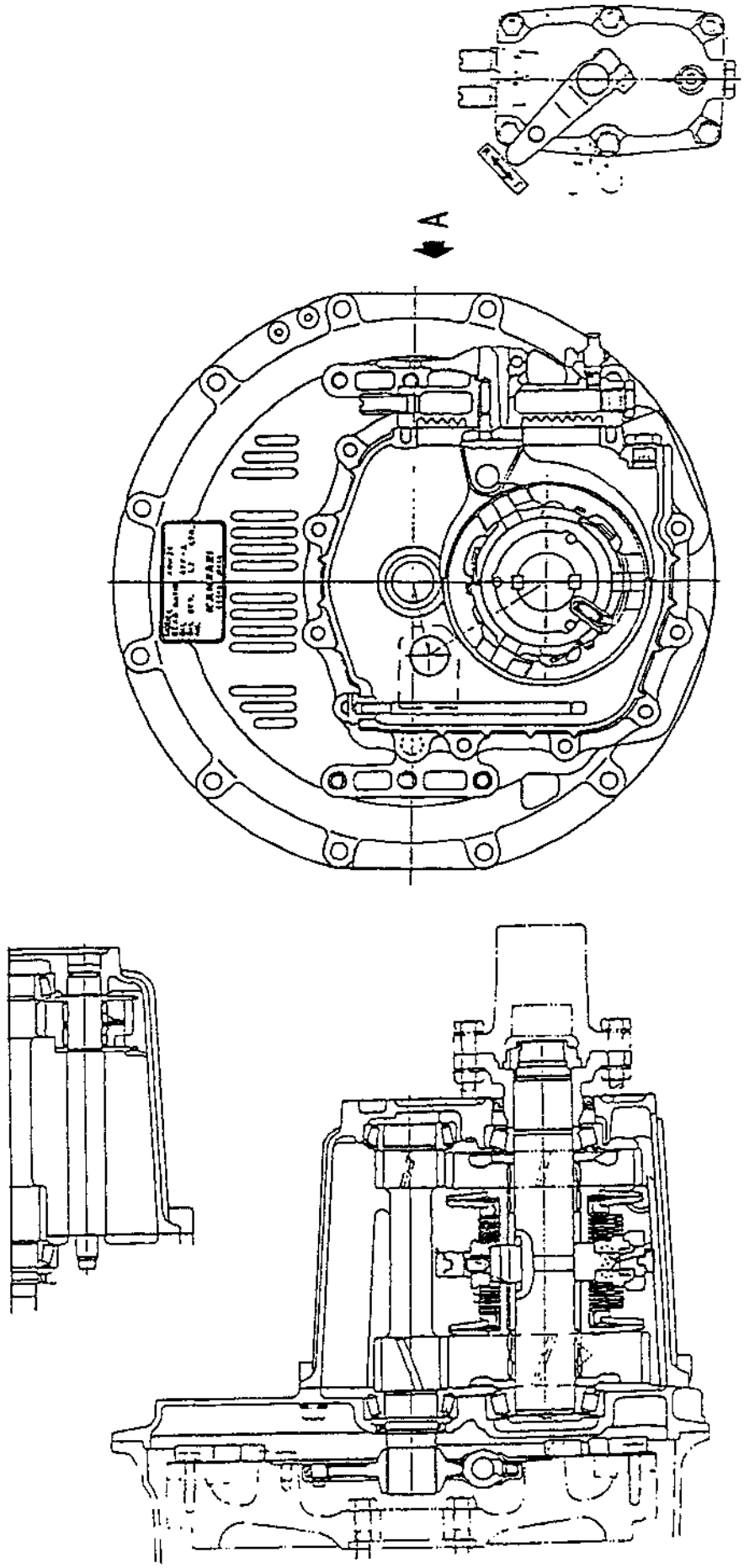
● KWB20



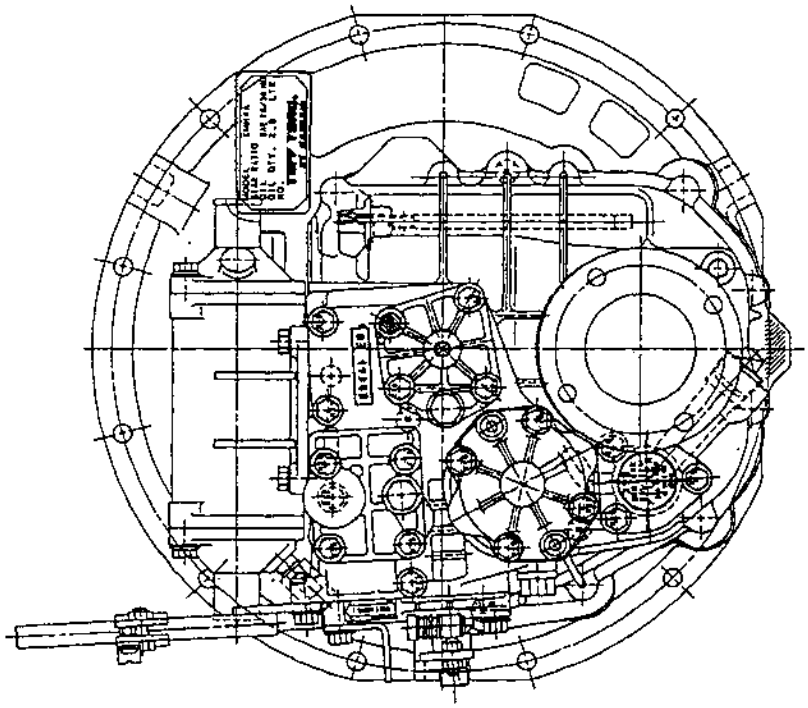


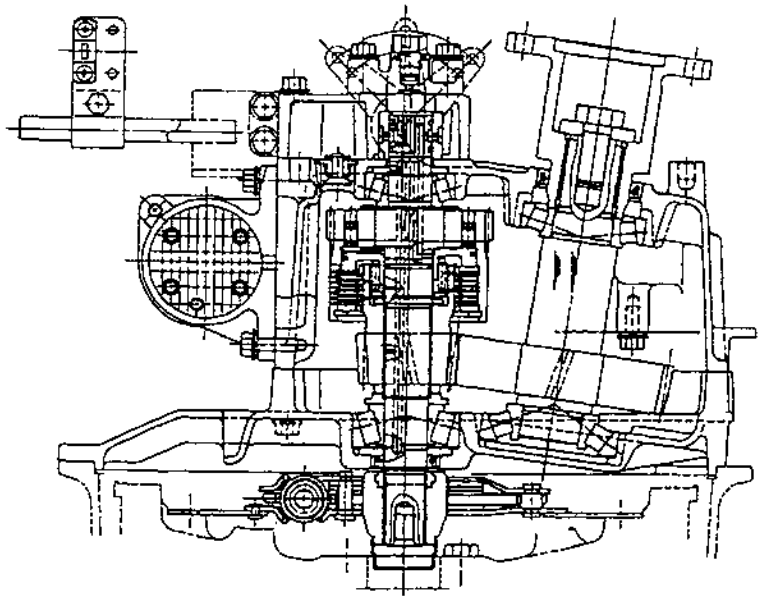


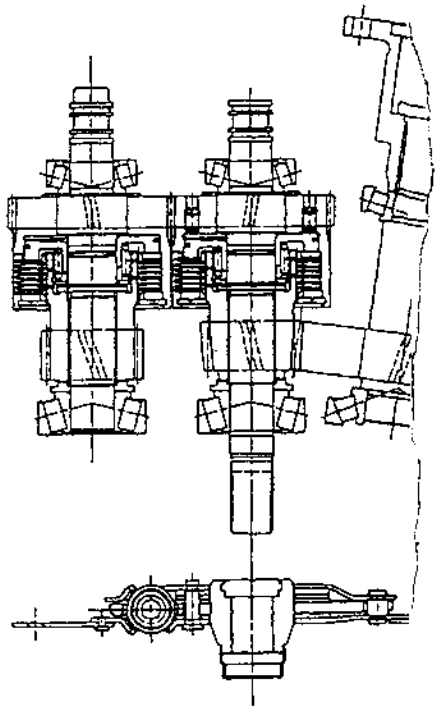
• KWB21



● KMH4A







# 3. Overhaul

## 3.1 Precautions

### (1) For Safe Operation

Read the safety precautions at the beginning of this manual carefully and operate safely.

### (2) Past Inspections for the Engine and 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 markings 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 sheet.

### (7) Adjustment and Inspection

(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 injure the eyes.*

**[NOTICE]**

- Be sure to replace the parts which upon inspection and measurement are faulty, whose measurements are outside the prescribed 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.

**Tighten torque of the standard bolts & nuts for general use.**

**[NOTICE]**

● Apply the following tightening torque to bolts having "7" on the head. (JIS strength classification : 7T)


○ Tighten bolts with no "7" mark to 60% tightening torque.
○ If the parts to be tightened are made from aluminum alloy, tighten the bolts to 80% tightening torque.

| Bolt dia. x pitch | mm | M6×1.0 | M8×1.25 | M10×1.5 | M12×1.75 | M14×1.5 | M16×1.5 |
|---|---|---|---|---|---|---|---|
| Tightening torque | N·m (Kgf-m) | 10.8±1.0 (1.1±0.1) | 25.5±2.9 (2.6±0.3) | 49.0±4.9 (5.0±0.5) | 88.3±9.8 (9.0±1.0) | 137±9.8 (14.0±1.0) | 226±9.8 (23.0±1.0) |

| Name | Thread diameter | Tightening torque N•m (kgf-m) |
|---|---|---|
| PT plug | 1/8 | 9.80 (1.0) |
| | 1/4 | 19.61 (2.0) |
| | 3/8 | 29.42 (3.0) |
| | 1/2 | 58.83 (6.0) |
| Ball joint bolt | M8 | 14.70 (1.5) |
| | M12 | 29.42 (3.0) |
| | M14 | 44.12 (4.5) |
| | M16 | 53.93 (5.5) |

# 3.3 KM3P

## 3.3.1 Construction

### 3.3.1.1 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 if 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 efficiency 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 damper disc.

- The drive cone is made from special aluminum bronze which has both higher 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.
- As the damper disc is fitted to the input shaft, power can be transmitted smoothly.
- 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 cone s tapered area and V-groove are worn, this engagement is maintained by the shift lever device and accordingly 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.

### 3.3.1.2 Specifications

| Model | | | KM3P | | | | |
|---|---|---|---|---|---|---|---|
| For engine models (standard) | | | 3JH3E | | | 4JH3E | |
| Clutch | | | Constant mesh gear with servo cone clutch (wet type) | | | | |
| Reduction ratio | Forward | | 2.36 | 2.61 | 3.20 | 2.36 | 2.61 |
| | Reverse | | 3.16 | 3.16 | 3.16 | 3.16 | 3.16 |
| Direction of rotation | Input shaft | | Counter-clockwise, viewed from stern | | | | |
| | Output shaft | Forward | Clockwise, viewed from stern | | | | |
| | | Reverse | Counter-clockwise, viewed from stern | | | | |
| Remote control | Control head | | Single lever control | | | | |
| | Cable | | Morse. 33-C (cable travel 76.2mm or | | | | |
| | Clamp | | YANMAR made. standard accessory | | | | |
| | Cable connector | | YANMAR made, standard accessory | | | | |
| Output shaft coupling | Outer diameter | | ϕ100 mm (3.93") | | | | |
| | Pitch circle diameter | | 4-ϕ78 mm (3.07") | | | | |
| | Connecting bolt holes i | | 4-ϕ10.5 mm (4-ϕ0.41") | | | | |
| Position of shift lever | | | Right side, viewed from stern | | | | |
| Lubricating oil | | | SAE 20/30 | | | | |
| Lubricating oil capscity | | ℓ | 0.35 | | | | |
| Dry mass | | kg(N) | 13 (127) | | | | |

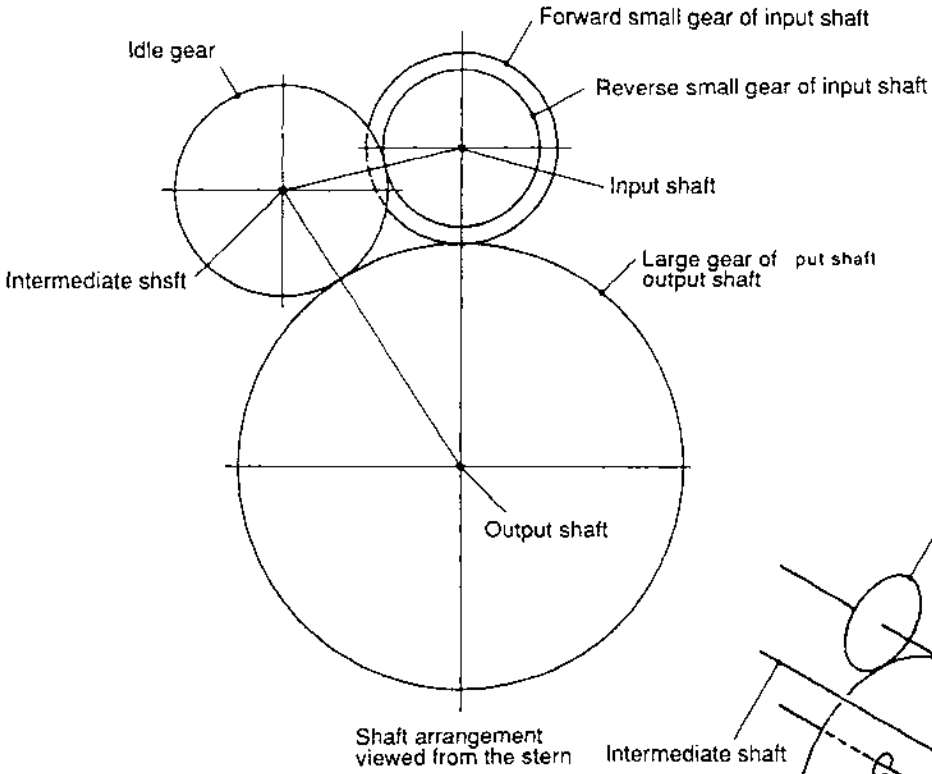
*Note*

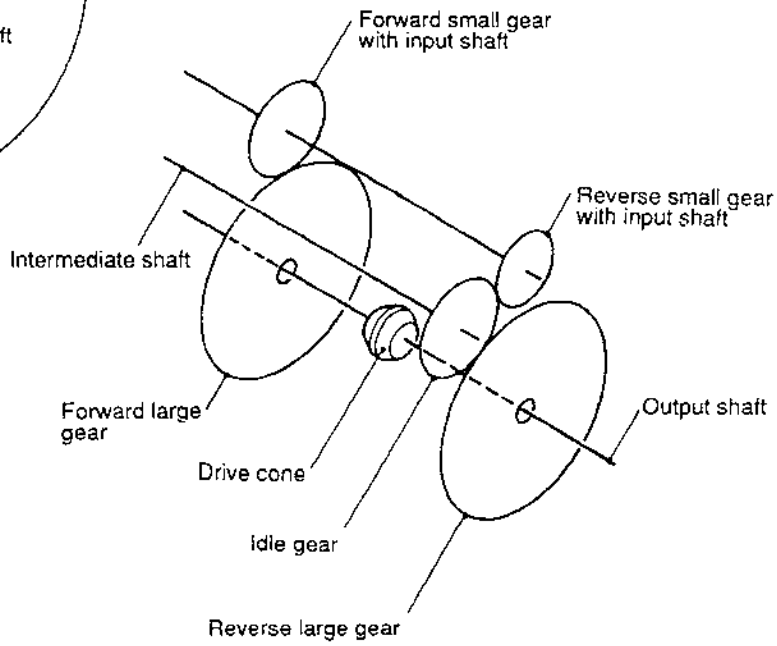
*In the case of clutch model KM3A, when are larger propeller or moment of inerta of the propeller than those listed in the table bellow is used, install the limiter (Option).*

| Reduction ratio | No. of blade | Diameter of the propeller | Moment of inertia GD²kg-m² (N-m²) | Material |
|---|---|---|---|---|
| 2.36 | 3 | 450 (17.5) | ≦0.15 (1.47) | Bronze |
| | 4 | 425 (16.5) | | |
| 2.61 | 3 | 470 (18.5) | ≦0.19 (1.86) | |
| | 4 | 440 (17.5) | | |
| 3.20 | 3 | 490 (19) | ≦0.23 (2.25) | |
| | 4 | 460 (18) | | |

### 3.3.1.3 Power transmission system

#### 1) Arrangement of shafts and gears




#### 2) Reduction ration

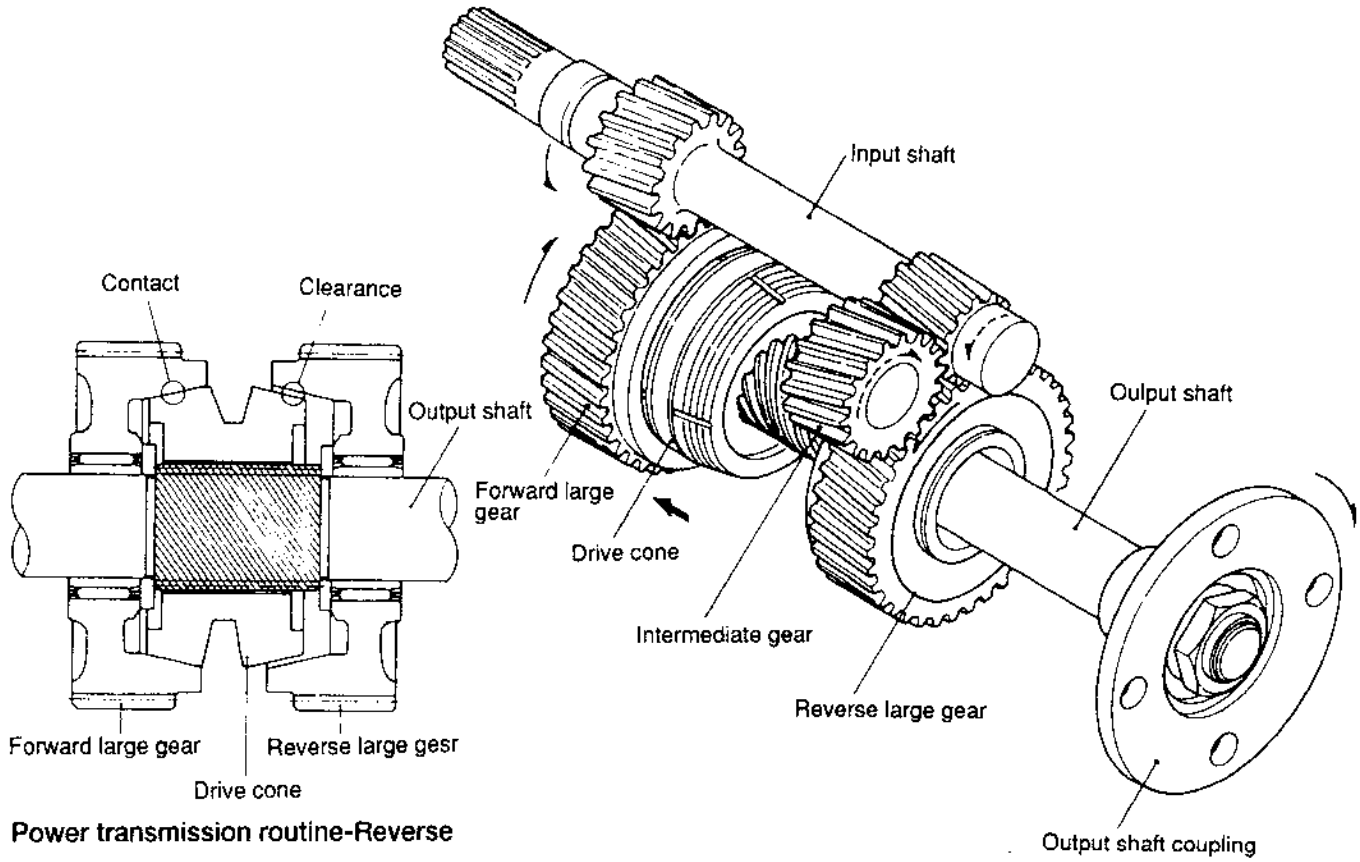
**Forward**

| Model | No. of teeth of forward small gesr Zif | No. of teeth of forward 18rge gear Zof | Reduction retio Zof/Zif |
|---|---|---|---|
| KM3P4 | 25 | 59 | 59/25 = 2.36 |
| | 23 | 60 | 60/23 = 2.61 |
| | 20 | 64 | 64/20 = 3.20 |

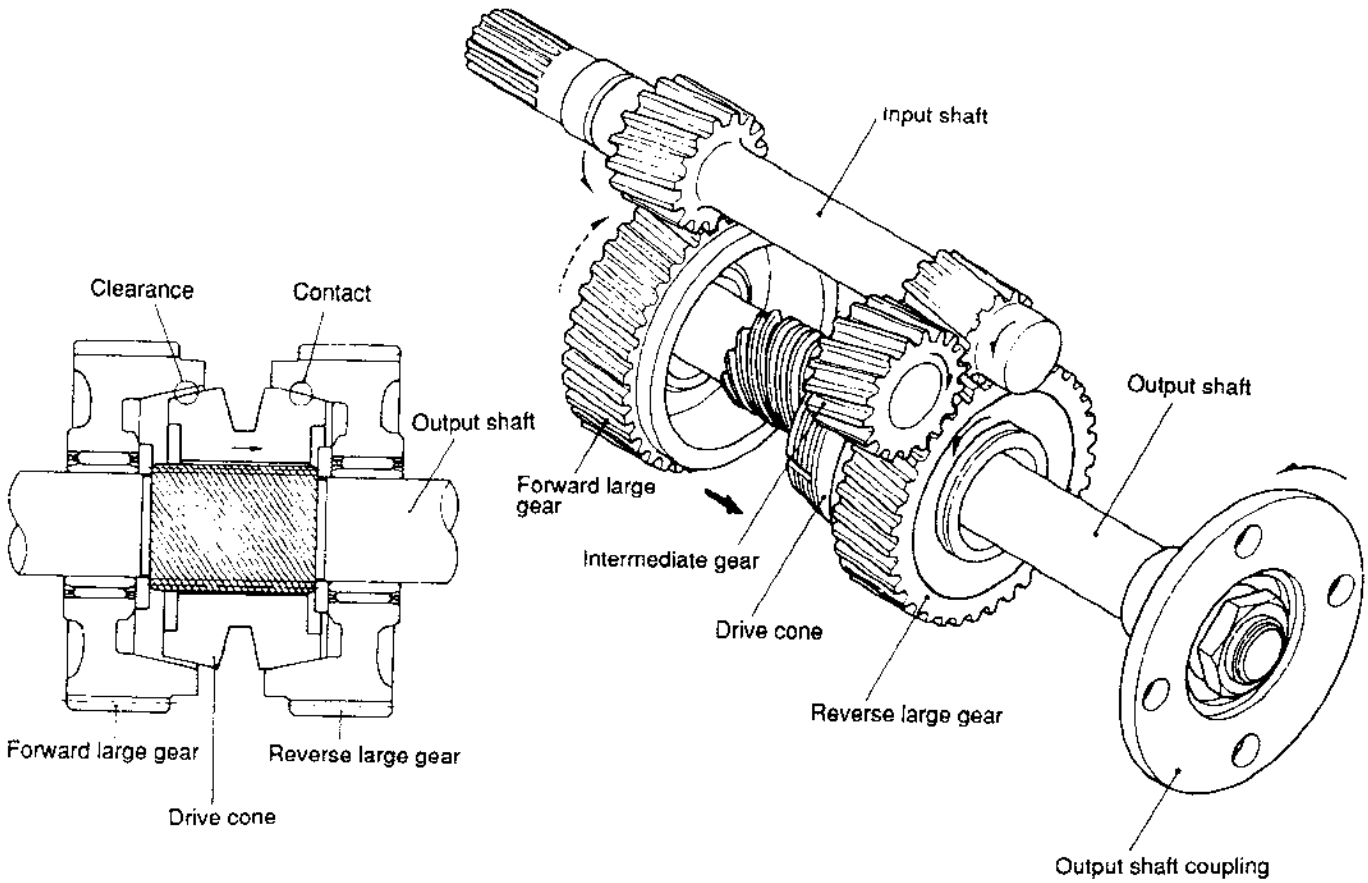
**Reverse**

| Model | No. of teeth of reverse small gesr Zif | No. of teeth of intemediate shaft gear Zi | No. of teeth of reverse large gear Zdr | Reduction ratio Zi/Zir · Zdr/Zi |
|---|---|---|---|---|
| KM3P4 | 19 | 26 | 60 | 60/19 = 3.16 |

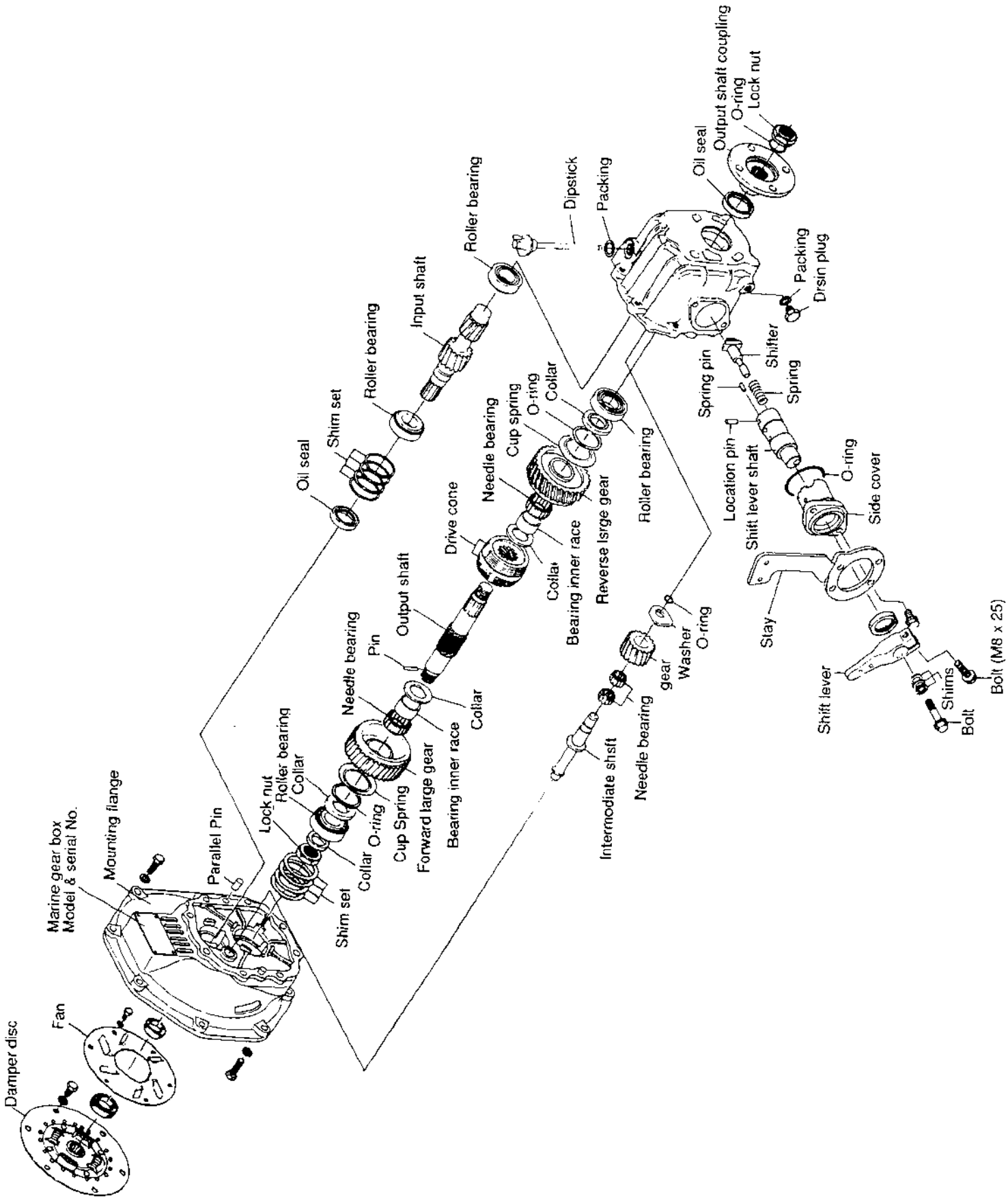
3) Power transmission routine-Forward



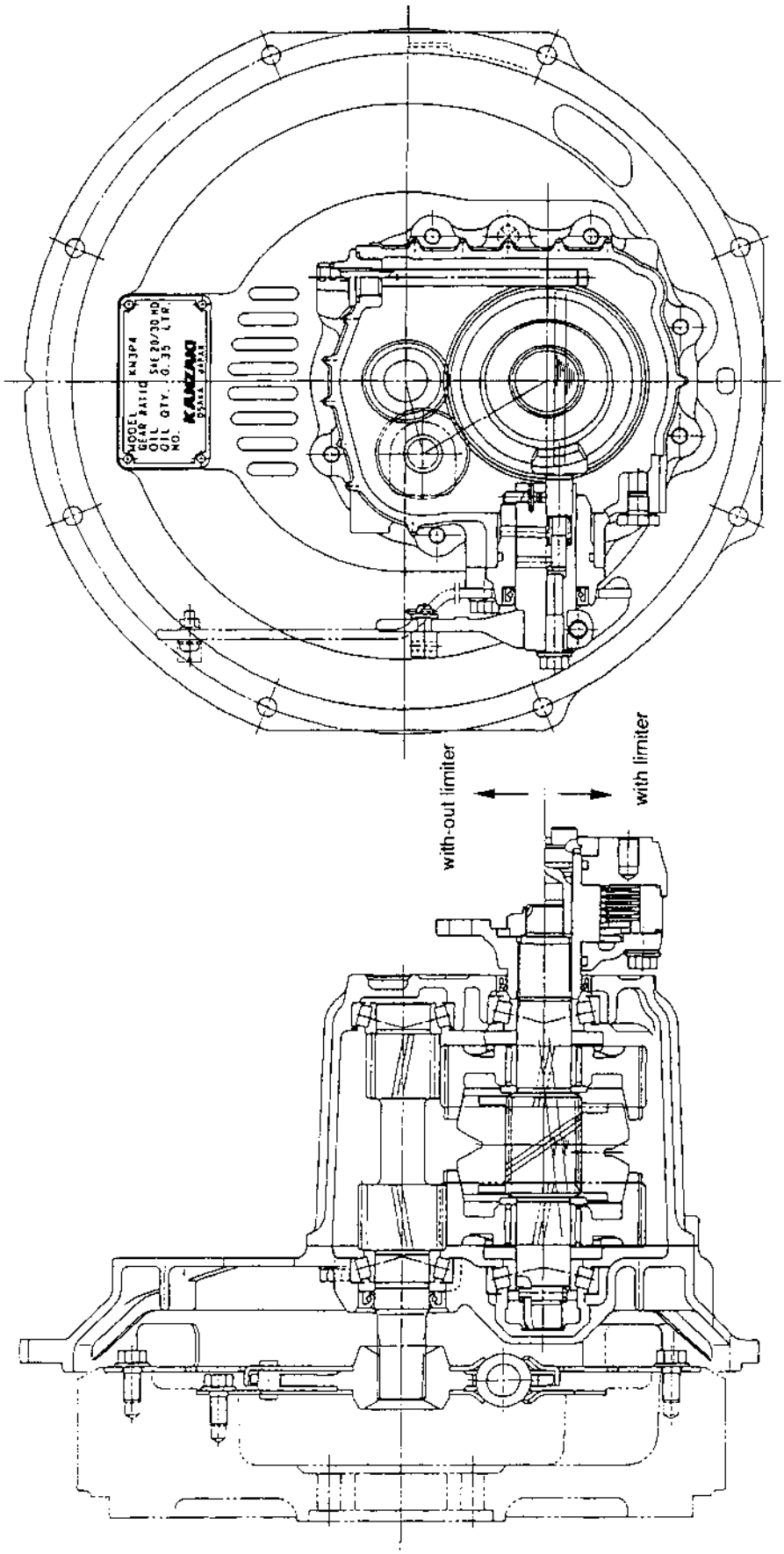

4) Power transmission routine-Reverse



### 3.3.1.4 Drawing

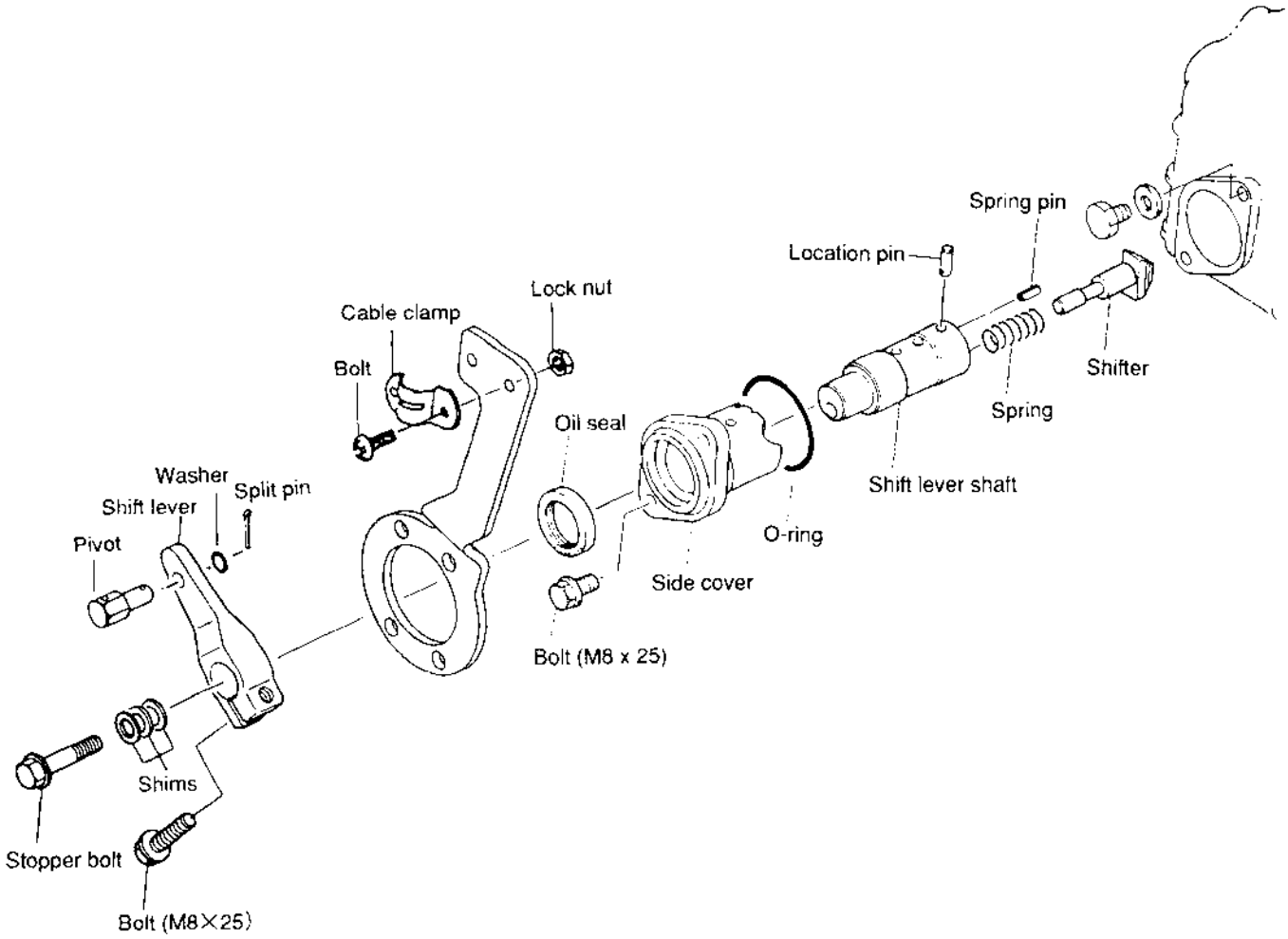


### 3.3.1.5 Sectional view

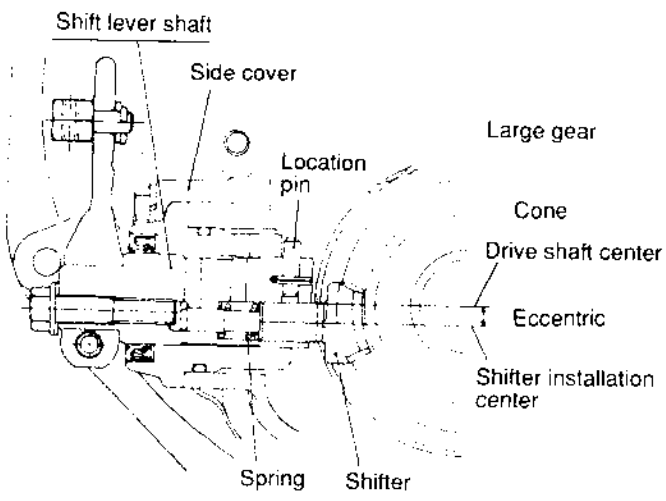


## 3.3.2 Shifting Device

### 3.3.2.1 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 on reverse positions.)

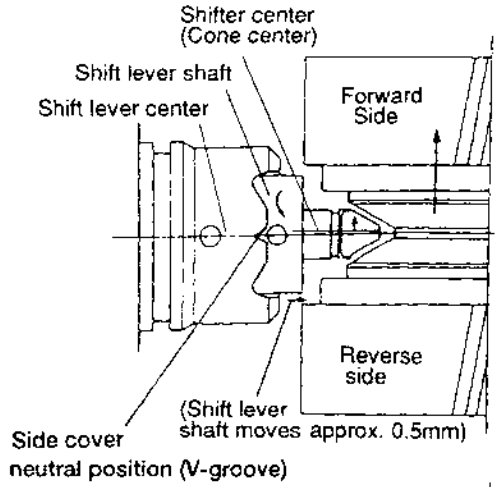


### 3.3.2.2 Forward and reverse clutch operation

(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 stars to press the drive cone V-groove to the forward large gear side through the spring force.

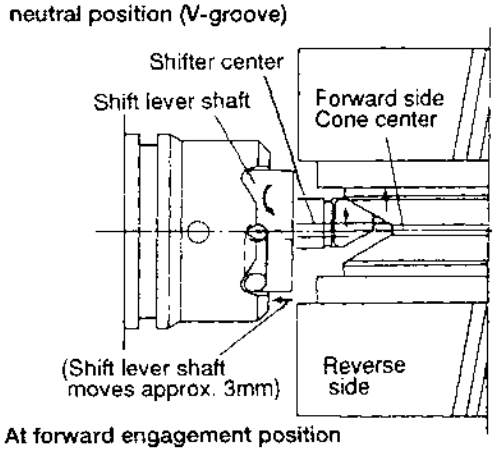


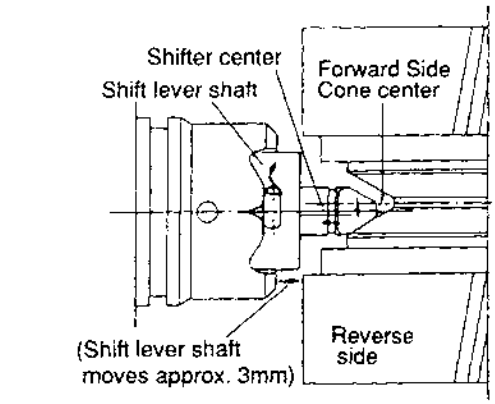

### 3.3.2.3 Engagement and disengagement of clutch

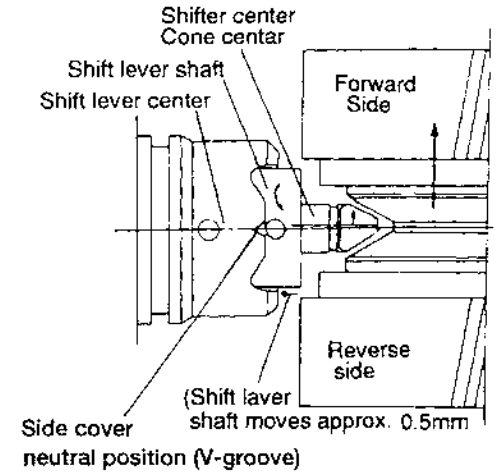
(Forward ⇒ Neutral; Reverse ⇒ Neutral)

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 forward position groove of the side cover. (The shift lever shaft moves approx. 3mm to the drive cone side.) At this time, the shifter which is set on the eccentric hole of the shift lever shaft is moved to the neutral side (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 in to 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.

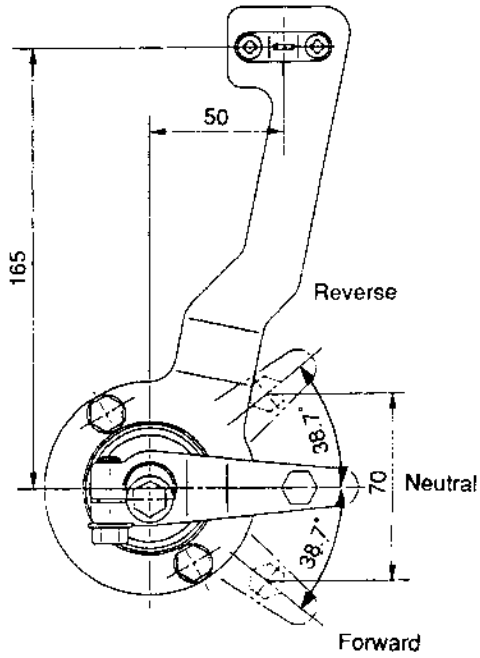


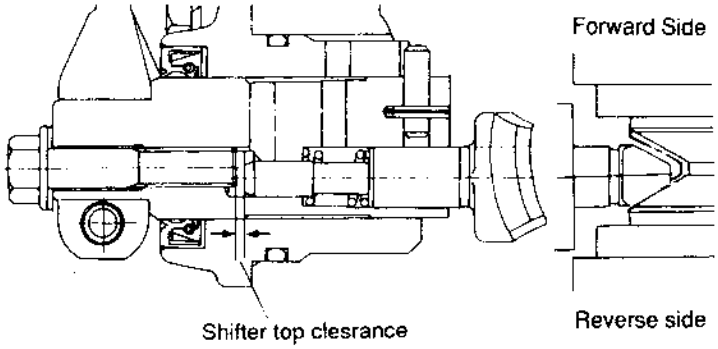
### 3.3.2.4 Clutch shifting force

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




### 3.3.2.5 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 either from the forward or reverse position.

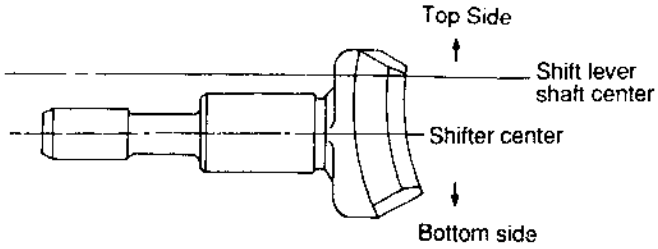


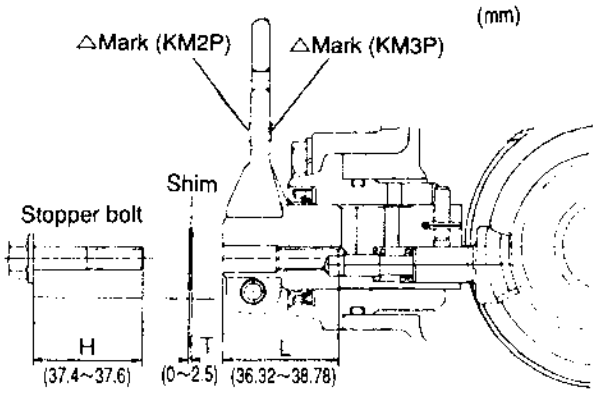
### 1) Measurement and adjustment of clearance

(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.

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

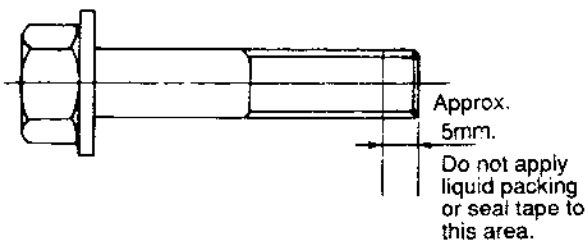
**[NOTICE]**

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

(f) Insert shim (s) of proper thickness to the stopper bolt side 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)

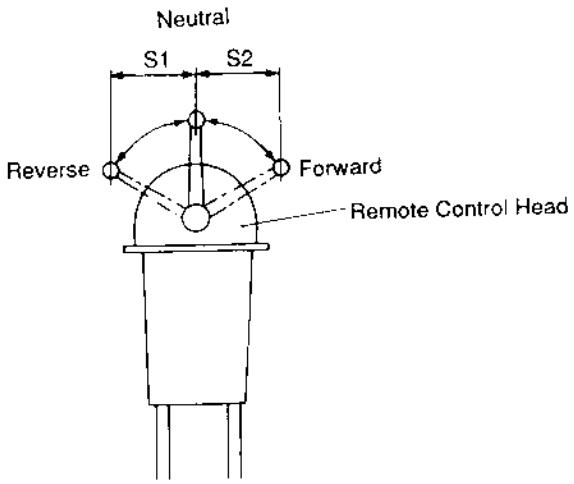
(1) Looseness at the connection of the cable connector and the remote control cable.

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

### 3.3.2.6 Adjustment of the remote control head

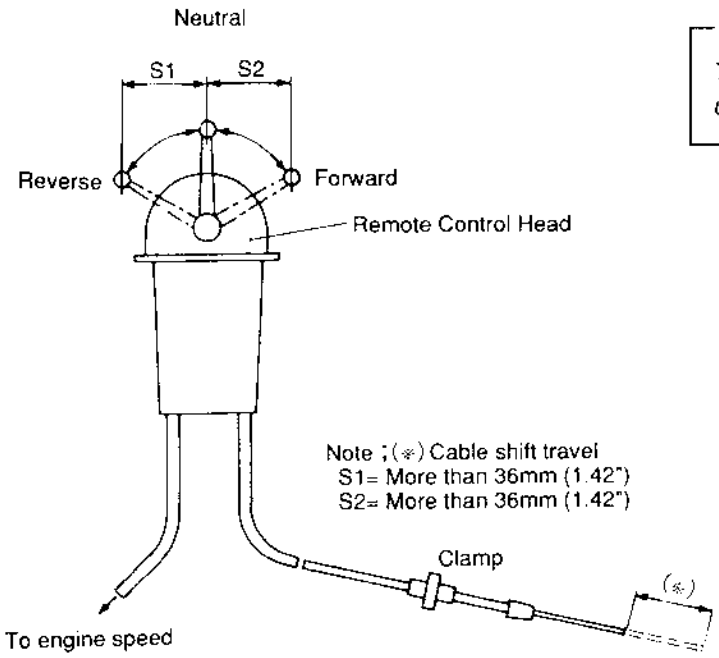
**Marine gear box control side**

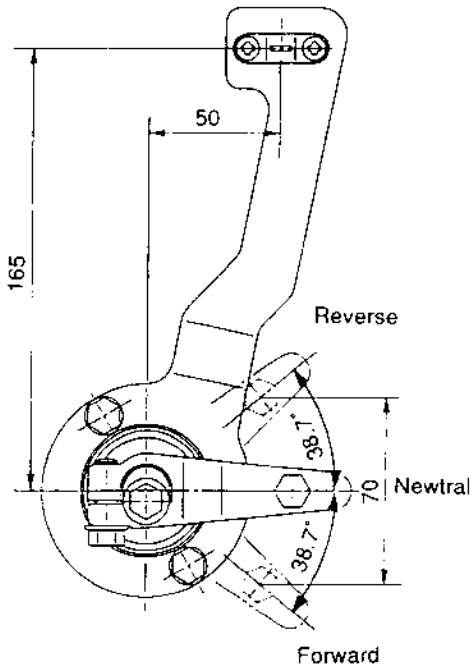
(1) Equal distribution of the control lever stroke.




The stroke between the neutral position → forward position (S2), and the neutral position → 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.




### 3.3.2.7 Cautions

(1) Always stop the engine when attaching, adjusting, and inspecting.
(2) When conducting inspection immediately after stopping the engine, do not touch the clutch.
The oil temperature is often raised to around 90℃ (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.

**[NOTICE]**

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

## 3.3.3 Inspection and Servicing

### 3.3.3.1 Clutch case

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

### 3.3.3.2 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 baring.

### 3.3.3.3 Gear

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

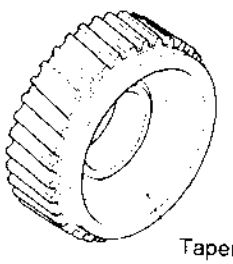
mm

| | 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 KM2P and KM3P)

### 3.3.3.4 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.



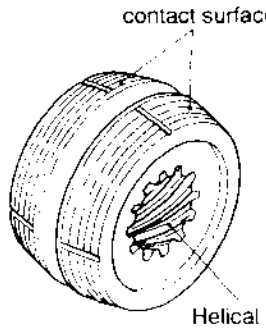
Tapered surface

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

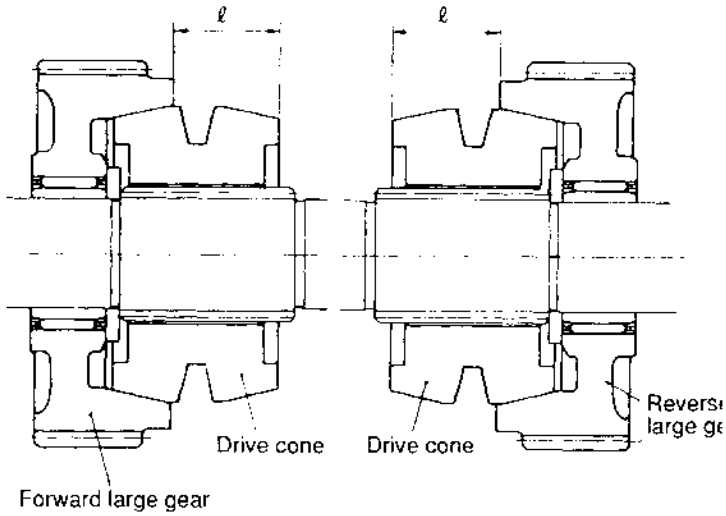
Rollers

### 3.3.3.5 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 R | KM3P4 | 32.7~33.3 | 32.4 |

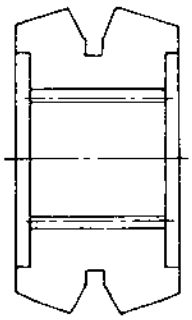
**[NOTICE]**

*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.

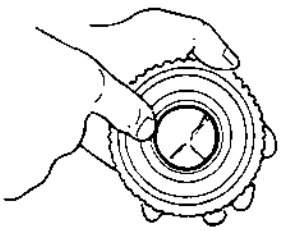
**[NOTICE]**

*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.*

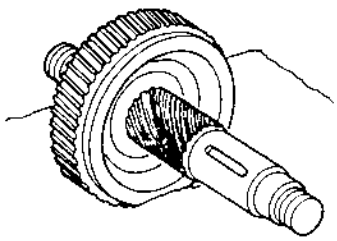


### 1) Lapping Procedure for Drive Cone

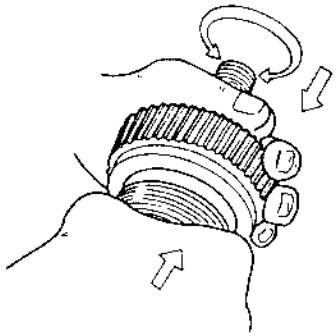
(1) Coat the lapping powder onto the cave of the clutch gear (Lapping powder : 67 micron silicon carbide #280)



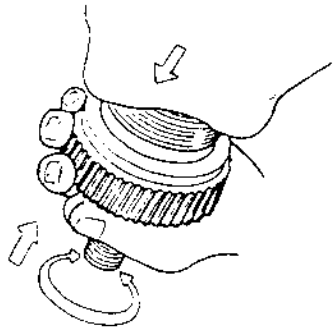
(2) Set the large gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft.



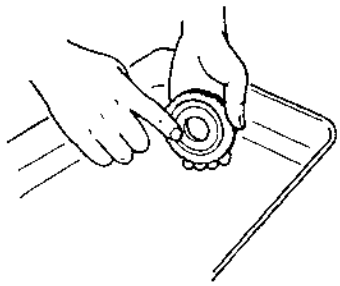
(3) Lap the large gear's cave and drive cone, pushing them together by hand.

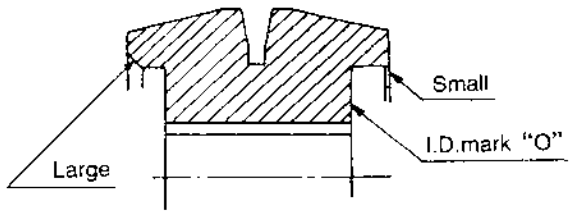


(4) Push and turn the clutch gear about 5 times both clockwise and counter-clockwise.



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

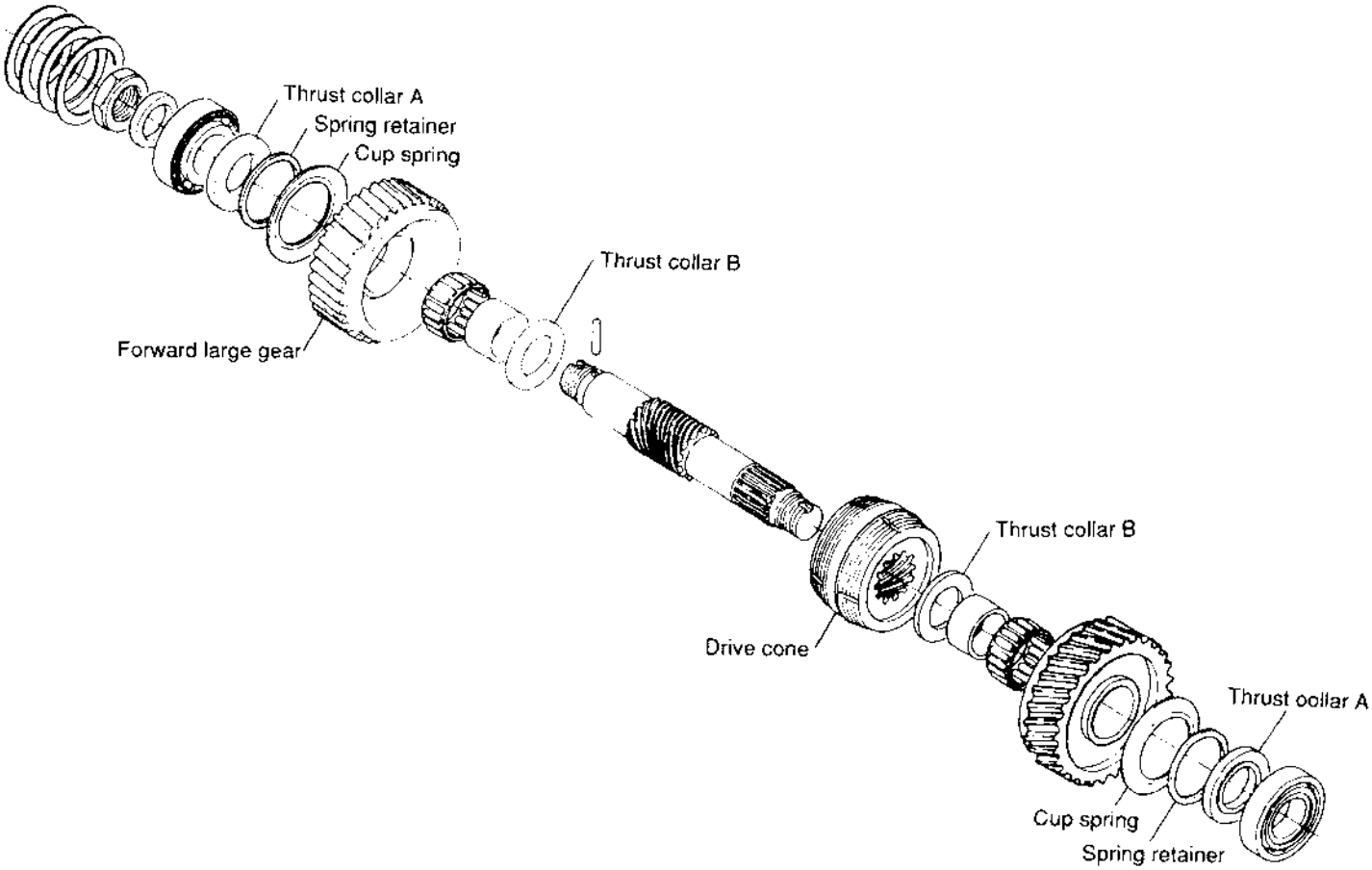





**[NOTICE]**

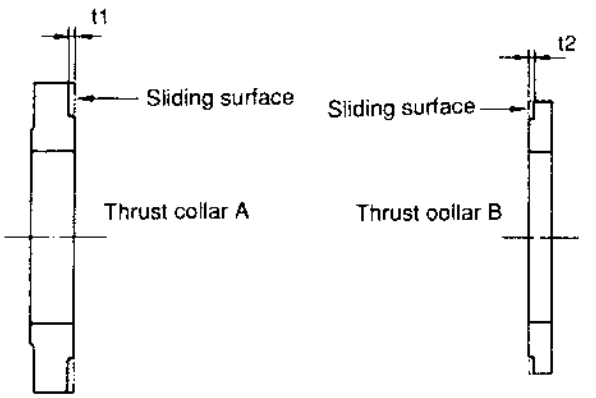
*Do not mix the combination of the lapped parts. The washing oil should be changed frequently in order to prevent residual powder being left on the parts.*
*When assembling the drive cone, be sure to check its alignment. The larger chamferrng face should be on the forward large gear side.*

### 3.3.6 Thrust collar



(1) Visually inspect the sliding surface of thrust collar A or B to check for signs of overheating, scoring, or cracks.
Replace the collar if any abnormal condition is found.

(2) Measure the thickness of thrust collar A or B, and replace it when the dimension exceeds the specified limit.



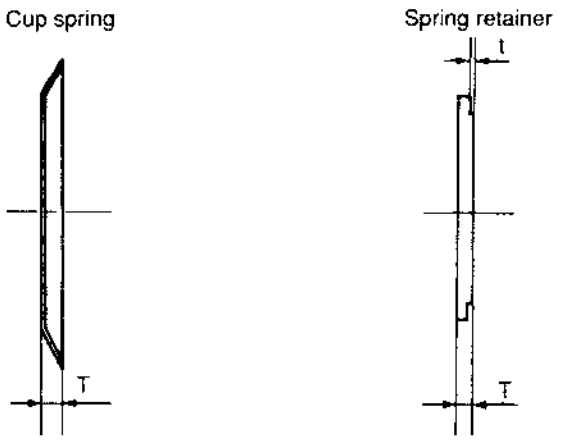

mm

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

### 3.3.3.7 Cup spring and spring retainer

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

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



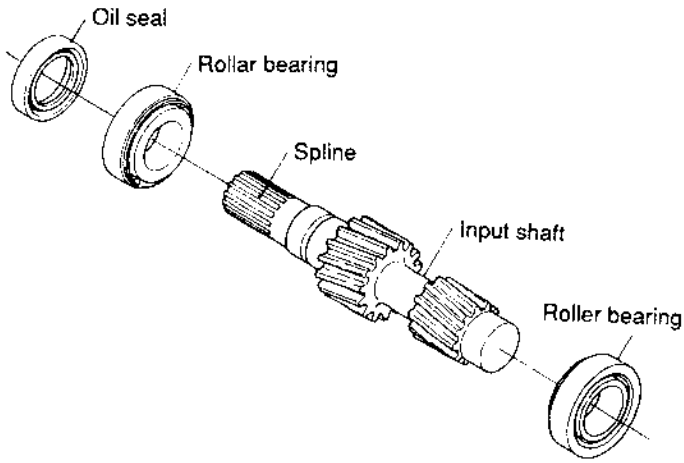

mm

| | 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 |

### 3.3.3.8 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.

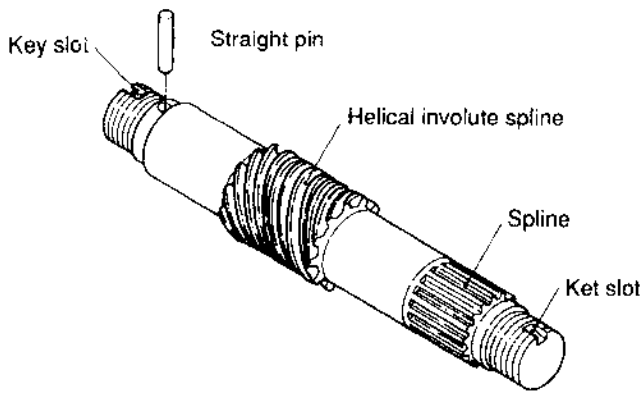
### 3.3.3.9 Input shaft




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

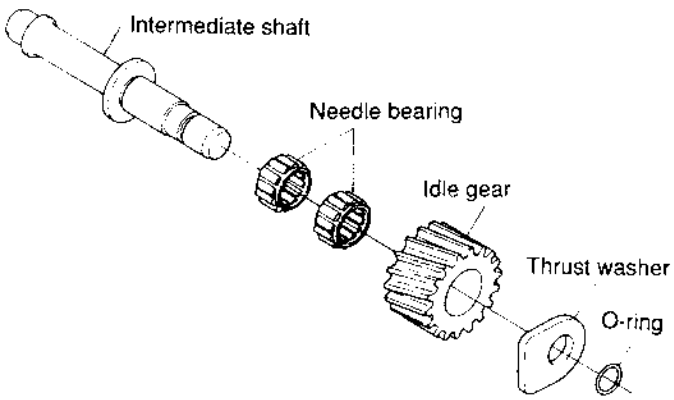
(2) Surface of oil seal.
If the sealing surface of the oil seal is worn or scratched, replace.

### 3.3.3.10 Output shaft

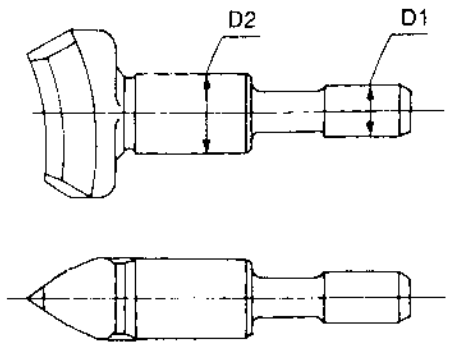



(1) Visually inspect the spline and the helical involute spline, and repair or replace a part when any abnormal condition is found on its surface.

### 3.3.3.11 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.

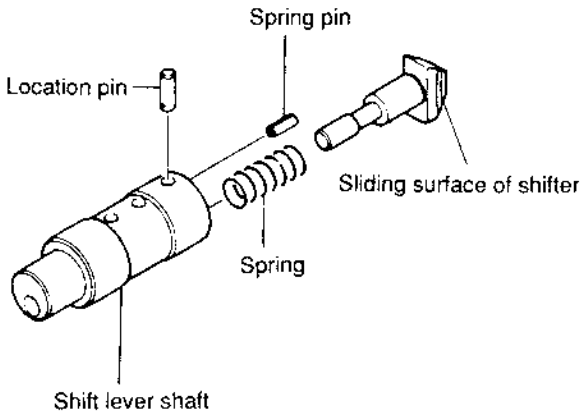



mm

| | Standard | Limit |
|---|---|---|
| D1 | 66.9~67.0 | 65 |
| D2 | 11.966~11.984 | 11.95 |
| Shift lever shaft, Shifter insert hole | 12.0~12.018 | 12.05 |

### 3.3.3.12 Shifting device

#### 1) Shifter



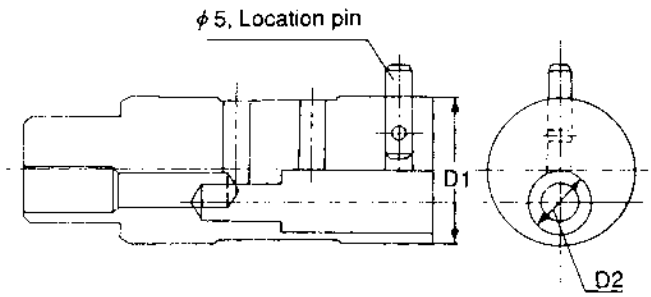

(1) Visually inspect the surface in contact with the drive cone, and replace the shifter when signs of overheating, damage or wear are found.

(2) Measure the shaft diameter of the shifter.
Replace the shaft f 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 parts. If the location pin must be replaced, replace it together with the shift lever shaft.

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




mm

| | Standard | Limit |
|---|---|---|
| D1 | 27.959~27.98 | 27. 90 |
| D2 | 12.0~12.018 | 12.05 |
| Side cover, Shift insert hole | 28.0~28.021 | 28.08 |

### 3) Shifter spring

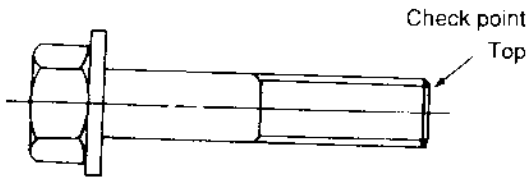
(1) Check the spring for scratches or corrosion.

(2) Measure the free length of the spring.

| Shifter spring | Standard | Limt |
|---|---|---|
| Free length | 22.6mm | 19.8mm |
| Spring constant | 0.854kgf(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.

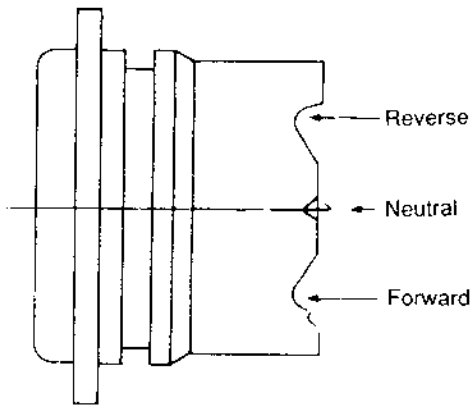



### 5) Side cover and oil seal

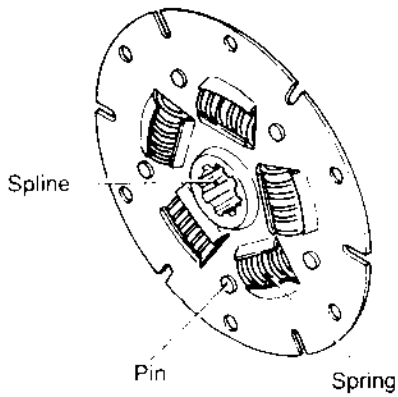
(1) Check the neutral, forward and reverse position grooves.
Replace if the grooves are worn.

(2) Measure the insertion hole of the shift lever s haft.
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.




## 3.3.3.13 Damper disc




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

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

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

(4) Whenever a crack or damage to the spring slot is found replace the defective part with a new one.

## 3.3.3.14 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.

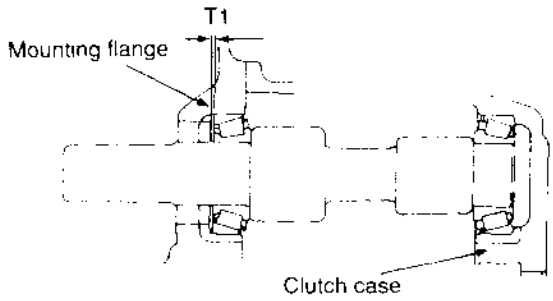
(1) Shim thickness ($T_1$) measurement of output shaft

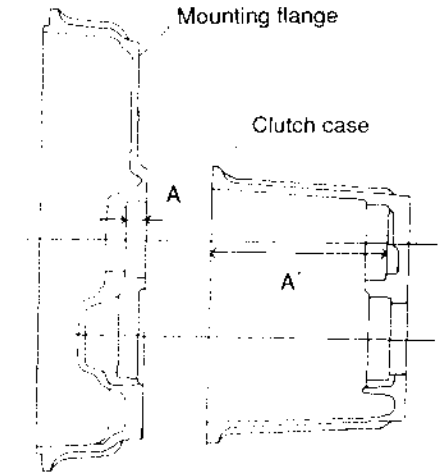
(a) Measure the bearing insertion hole depth (A) of the mounting flange, and the bearing insertion hole depth (A′) of the clutch case.

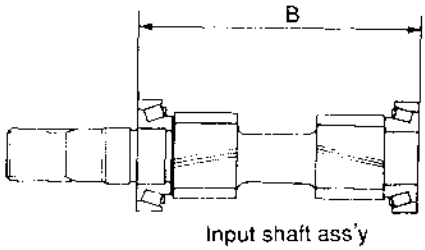
(b) Measure the length (B) between the bearing outer race of the input shaft assembly.

(c) Obtain the ($T_1$) thickness by the following formula :

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



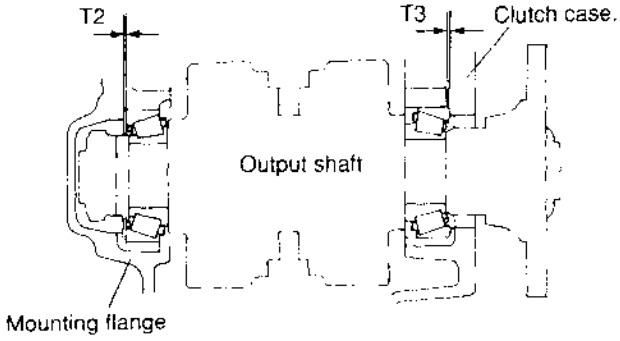

(2) Shim thickness (T2, T3) measurement of output shaft

(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 of 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

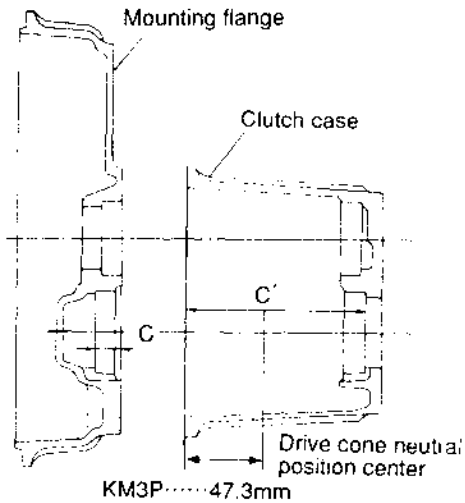
**[NOTICE]**

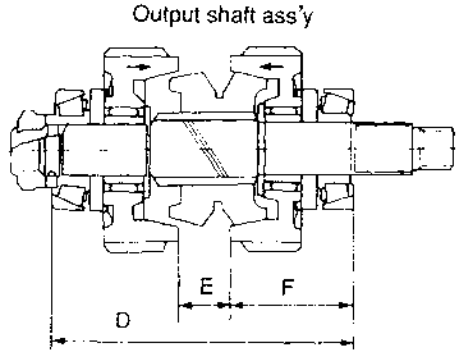
*Before measuring the (F) and (E) length, press the forward large gear and the reverse large gear to the drive cone until there is no clearance among them.*

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

$T_2 = C + C' - D - T_3$ (Clearance $^{\pm 0.1\text{mm}}_{0}$)

$T_3(\text{KM3P}) = C' - 47.3 - \frac{E}{2} - F$ (Clearance $\pm 0.05$mm)



(3) Standard size of parts

mm

| | A+A | B | C+C' | D | E | F | Drive cone neutral center position |
|---|---|---|---|---|---|---|---|
| KM3P | 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 |

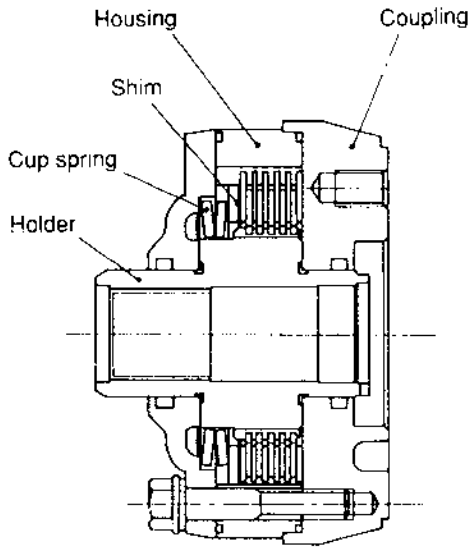
**[NOTICE]**

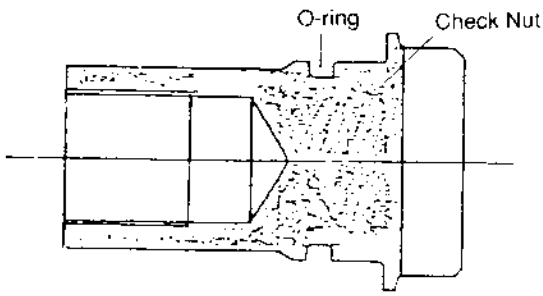
*Compare your measurements with the above standard size. If your measurements largely differ from the standard sizes, measurements may not be correct. Check and measure again.*

(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 |

### 3.3.3.15 Torque limiter



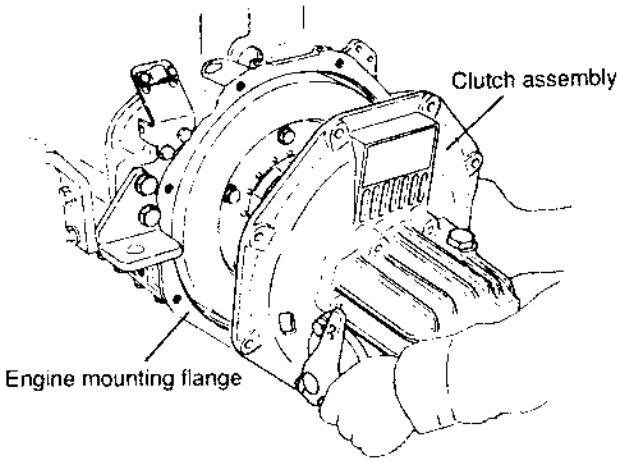

The torque limiter assembly includes these parts.
The conversion to the torque limiter specification is easy by exchanging the standard shaft coupling. (Use the check nut, not the end nut, to install the torque limiter.)

Check nut tightening torque : 10±1.5kgf·m(98±14.7N·m)

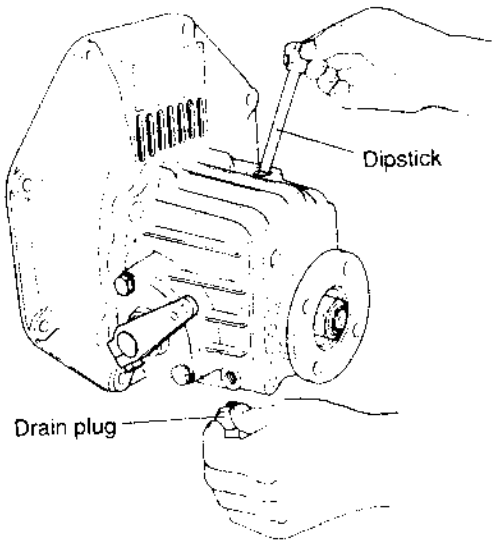
## 3.3.4 Disassembly

### 3.3.4.1 Dismantling the clutch

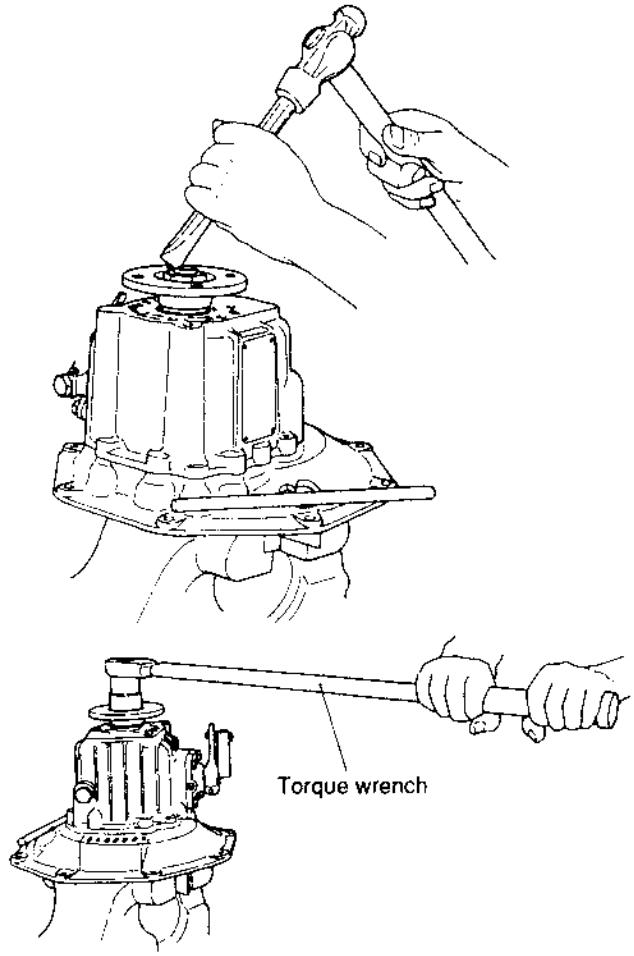
(1) Remove the remote control of cable.
(2) Remove the clutch assembly from the engine mounting flange.




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



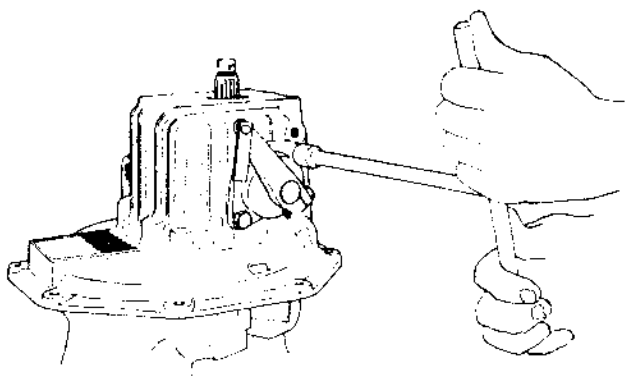

(4) Remove the end nut and output shaft coupling.



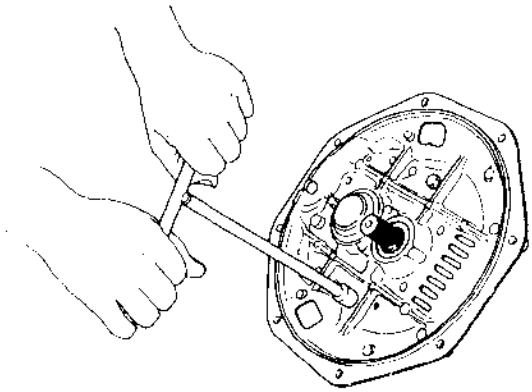

**[NOTICE]**

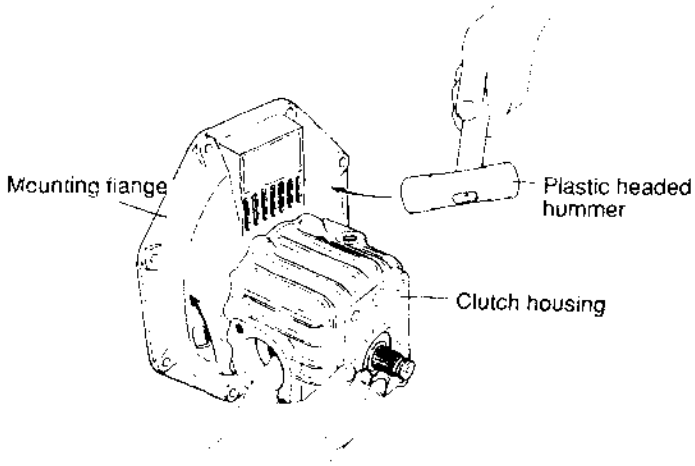
*Take care as it has a left-handed thread.*

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

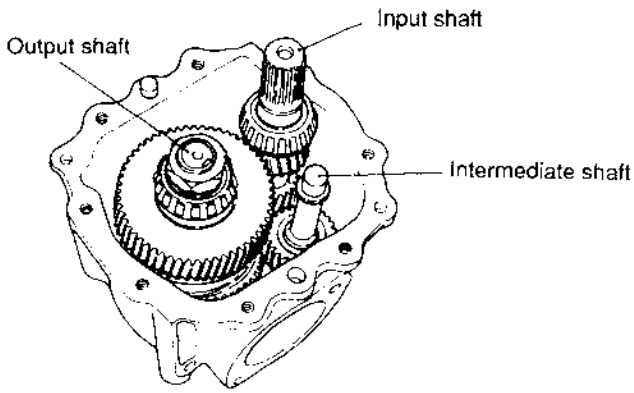


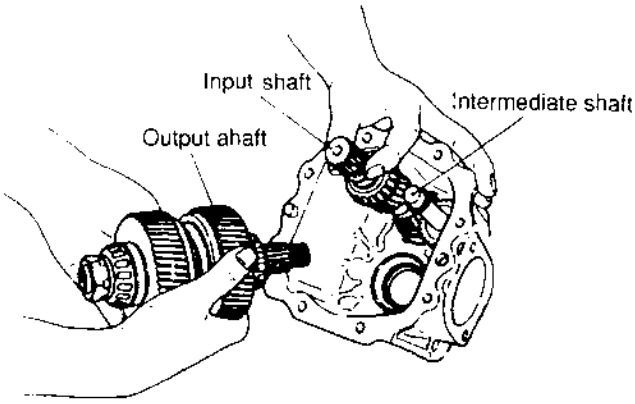
(7) Remove the bolts which secure the mounting flange to the case body, give light taps to the left and right with a plastic headed hammer while supporting the clutch case with your hand, then remove the mounting flange.



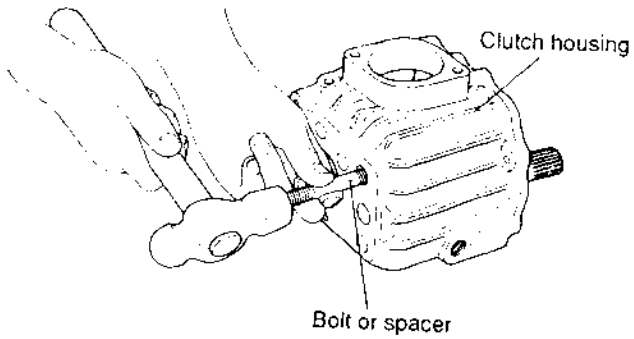


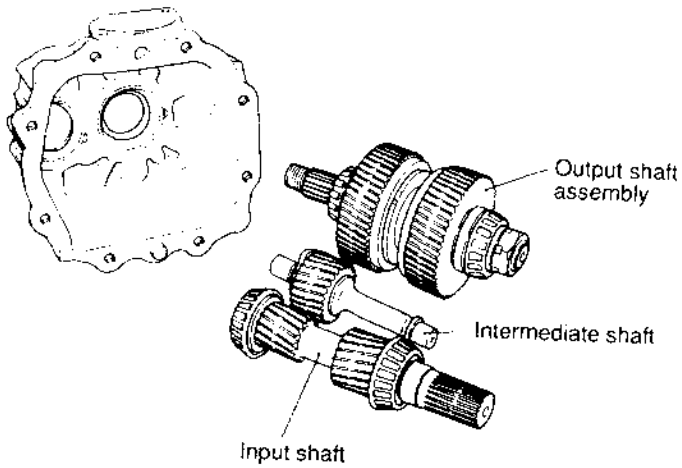

(8) Withdraw the output shaft assembly.



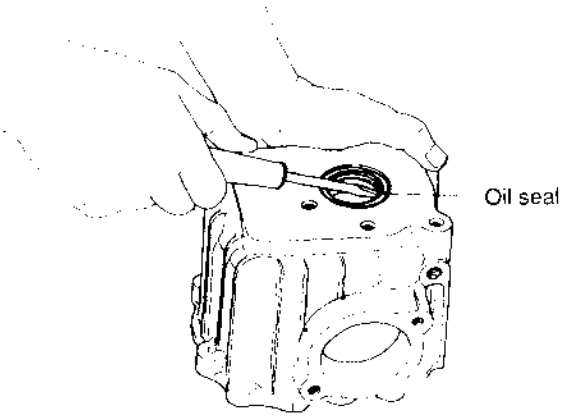




(9) Take out the intermediate shaft and input shaft. When taking out the intermediate shaft, place a bolt or spacer on the shaft hole of the case, and drive the shaft out by tapping it lightly.

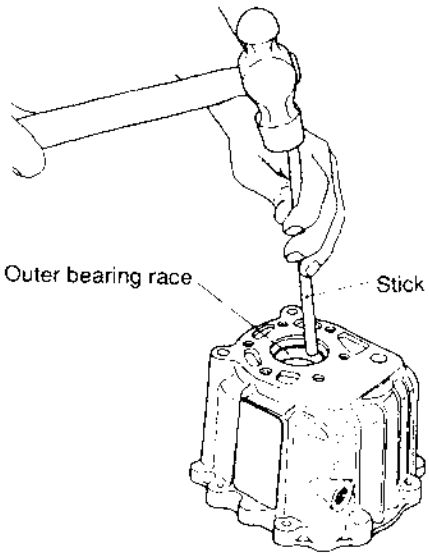


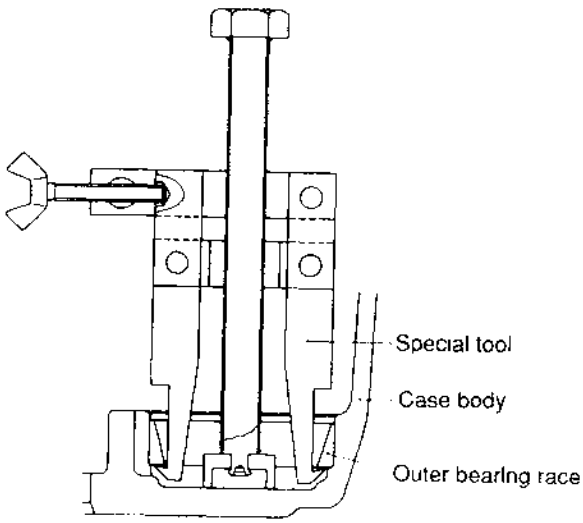



(10) Remove the oil seal of the output shaft from the case body.




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




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

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

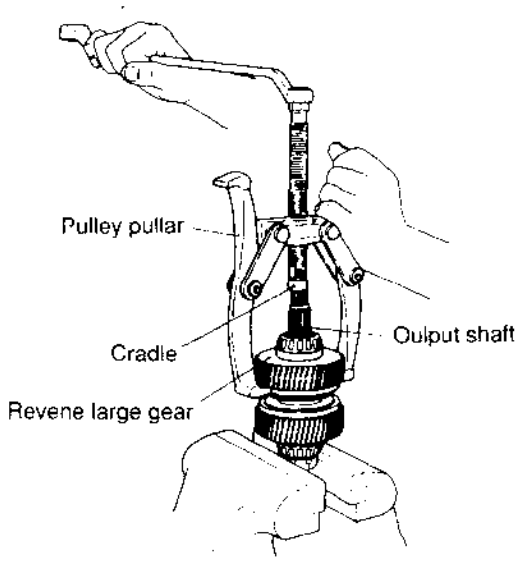
(14) Remove each adjusting plate from the input our output shaft.

**[NOTICE]**

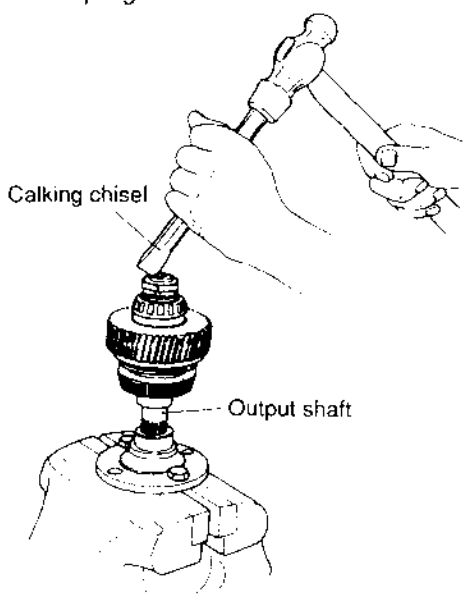
*The same adjusting plates can be revsed when the following parts are not replaced.*
*When any part is replaced however, readjustment is necessary.*

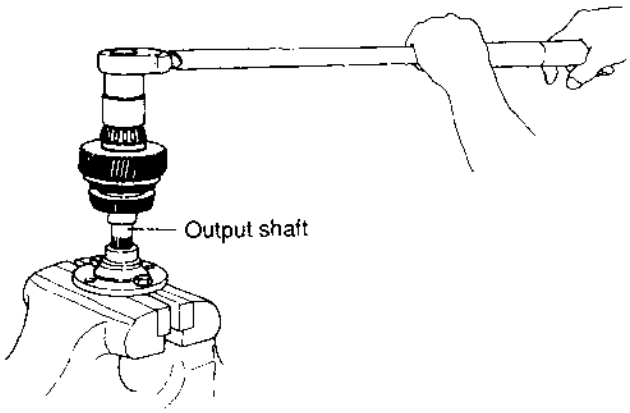
### 3.3.4.2 Removal of the output shaft

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

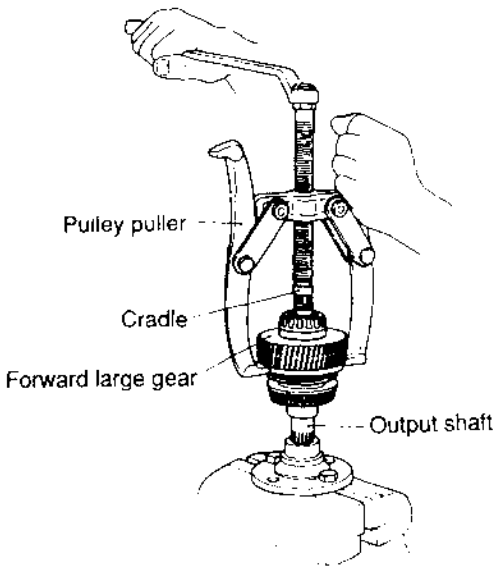


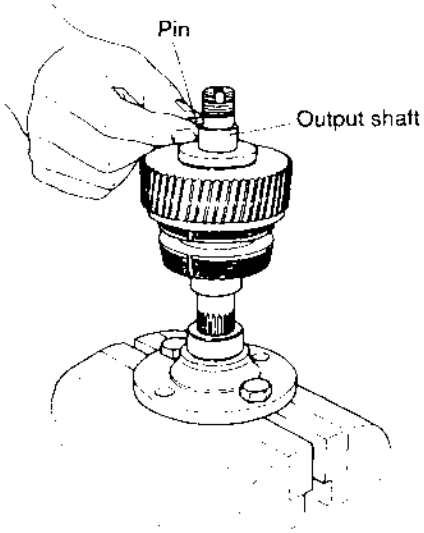

(2) Loosen the calking of the forward nut and remove the nut and spacer. Remove the nut by using a torque wrench after setting the output shaft coupling and fixing the coupling bolt in a vice.



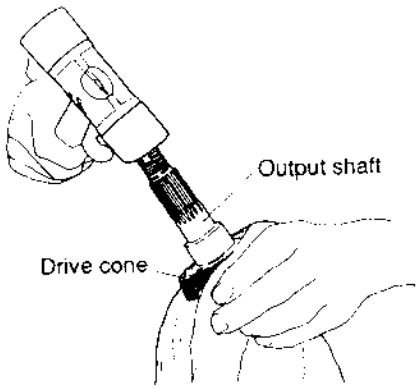


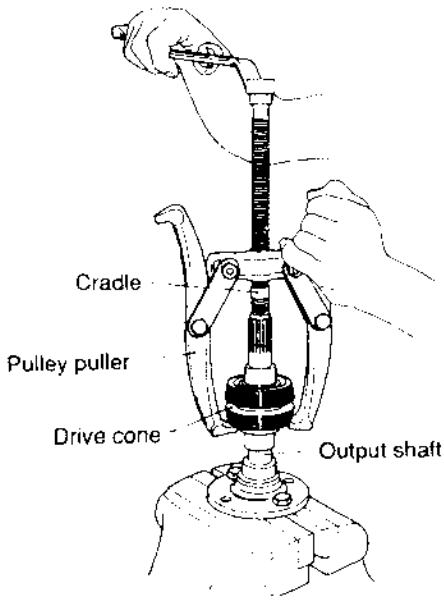

(3) Place the pulley extractor against the end surface of the forward large gear, and withdraw the forward large gear, thrust collar A, cup spring, spring retainer and inner bearing race.



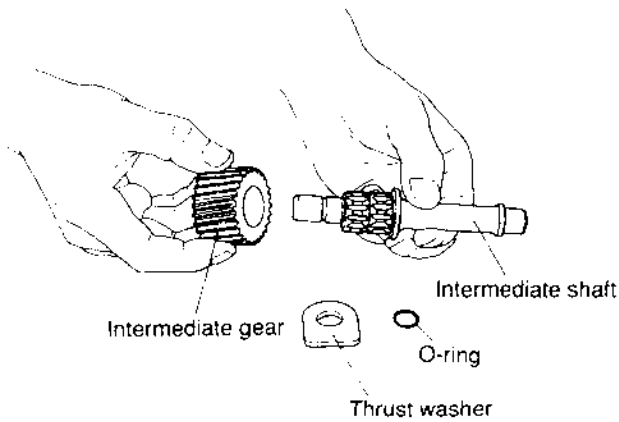

(4) While gripping the drive cone, tap the end of the shaft with a plastic headed hammer,and withdraw the thrust collar B and inner needle bearing race. A pulley extractor may be used.



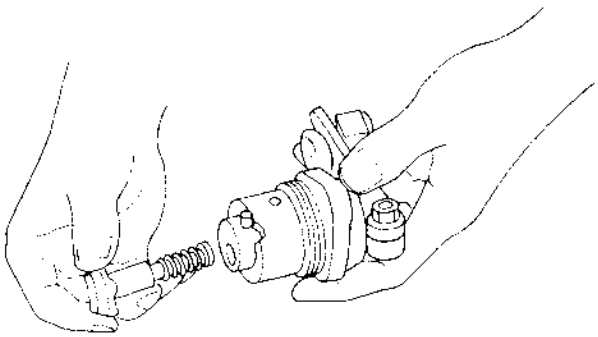

### 3.3.4.3 Removal of the intermediate shaft.

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

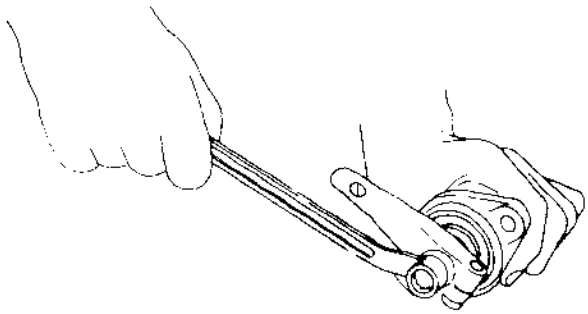


### 3.3.4.4 Dismantling the shifting device

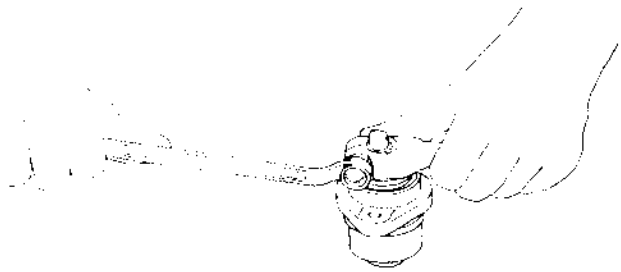
(1) Take out the shifter and shifter spring.



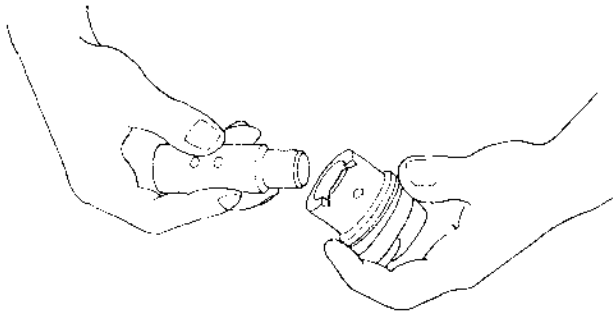
(2) Remove the stopper bolt of the shifter and shim.



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



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



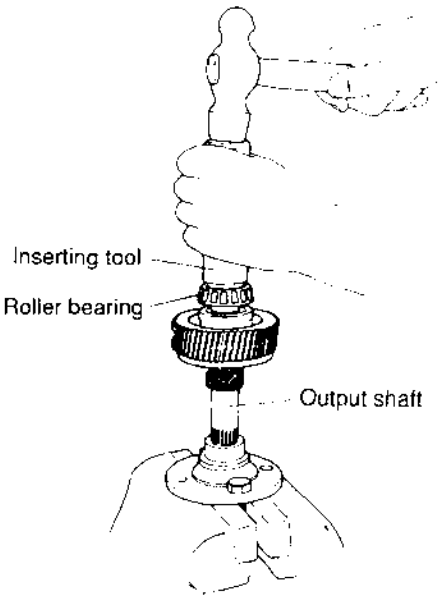
(5) Remove the oil-seal and O-ring.

## 3.3.5 Reassembly

### 3.3.5.1 Reassembly of output shaft

(1) Fit the forward side thrust collar B onto the shaft.

(2) Drive in the forward end inner needle bearing race using a jig.

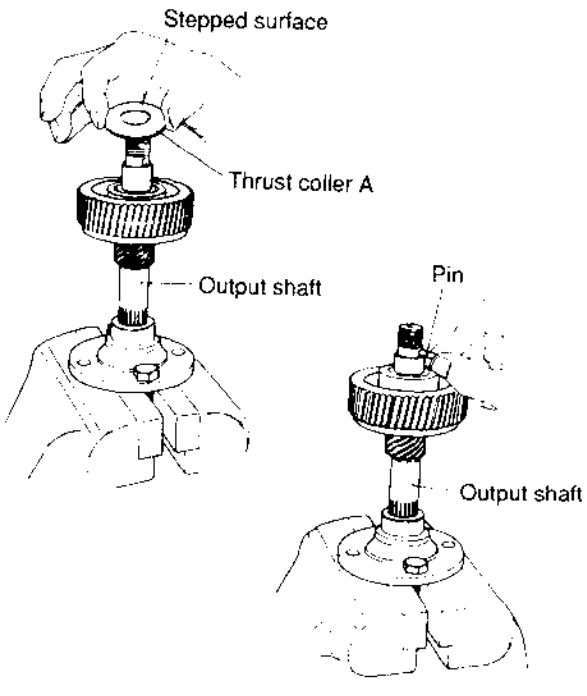


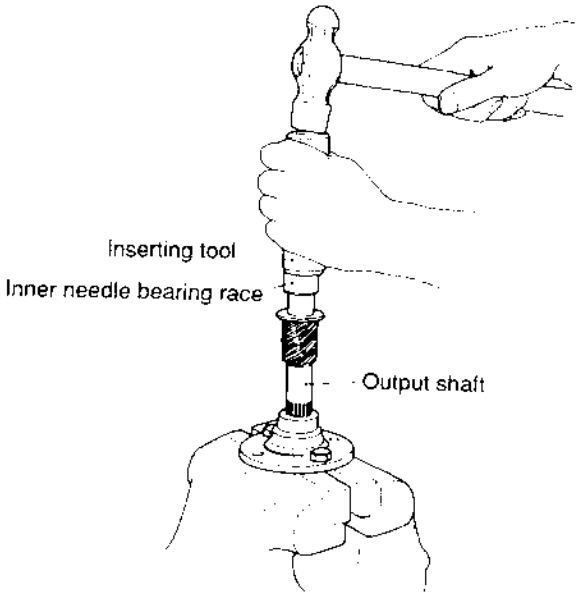

(3) Assemble the needle bearing and forward large gear.

**[NOTICE]**

*Check that the forward large gear rotates smoothly.*

(4) Fit the cup spring, spring retainer, thrust collar A and Pin, and driven in the inner bearing race using a jig.



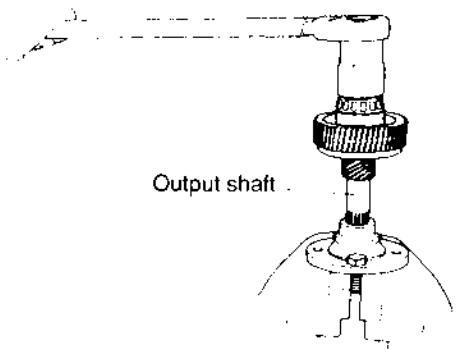




**[NOTICE]**

- *Drive in with a plastic headed hammer. Do not hit it hard.*
- *When fitting the thrust collar A, note the fitting direction. Fit it keeping the stepped surface toward the roller bearing side.*
- *Note that the pin cannot be fitted after the inner bearing race has been driven in.*
- *Check that the forward large gear rotates smoothly.*

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

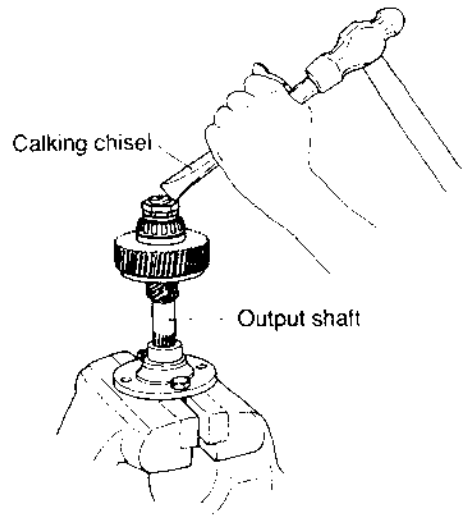
(6) Set and tighten the forward end nut. Insert the bolt into the coupling, and fix it in a vice, keeping the spline part upward.
Insert the shaft into the spline of the coupling, fit the spacer, and tighten the nut with a torque wrench.



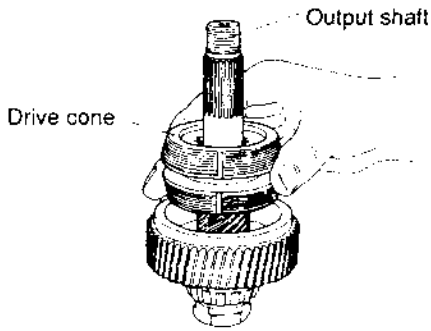

| | |
|---|---|
| Tightening torque | 10±1.5kgf-m(98+14.7N·m) |

**[NOTICE]**

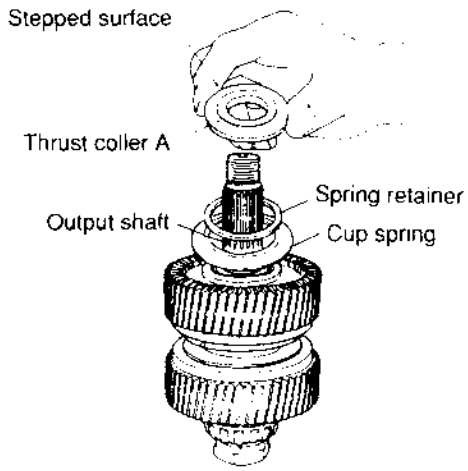
- *Take care as it is a left-handed thread.*
- *Use the reverse side nut used before dismantling as the forward end nut. This is so as not to match the calked portion to the same point.*




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




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




**[NOTICE]**

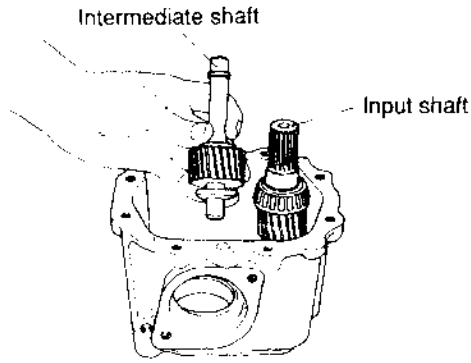
- *Fit thrust collar A so that the stepped surface faces the roller bearing side.*
- *Check that the reverse large gear rotates smoothly.*

### 3.3.5.2 Reassembly of the clutch

(1) Fit the oil seal, bearing outer races and shim (output shaft side) in the clutch case.

(2) Insert the input shaft into the clutch case.

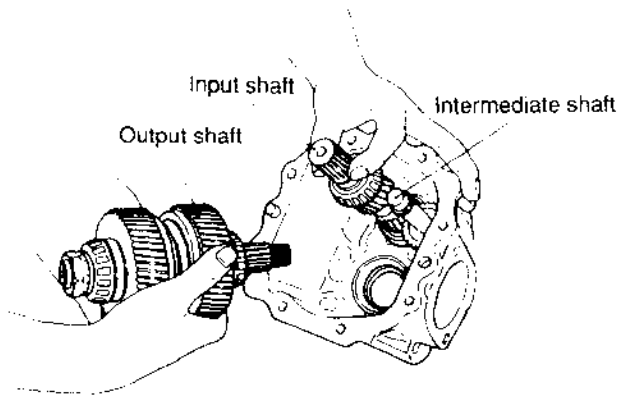
(3) Drive the intermediate shaft into the clutch case.




**[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.



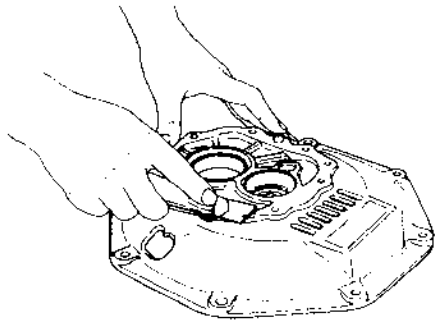
(5) Fit the adjusting plate to the mounting flange, and drive in the outer bearing race.

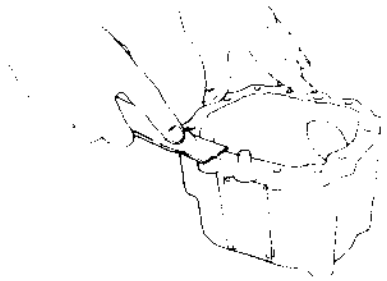
**[NOTICE]**

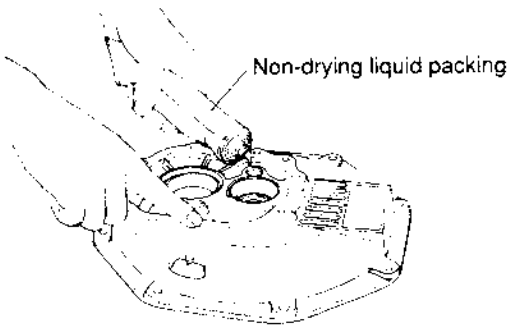
*The outer bearing race can be easily driven in by heating the mounting flange to about 100℃, or by cooling the outer race with liquid hydrogen.*

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

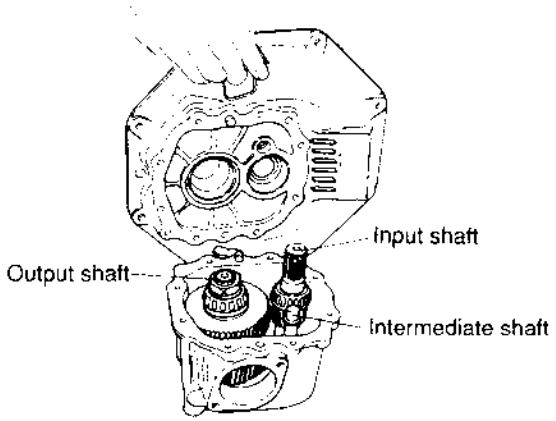
(7) Apply non-drying liquid packing to the matching surfaces of the mounting flange end the case body.








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

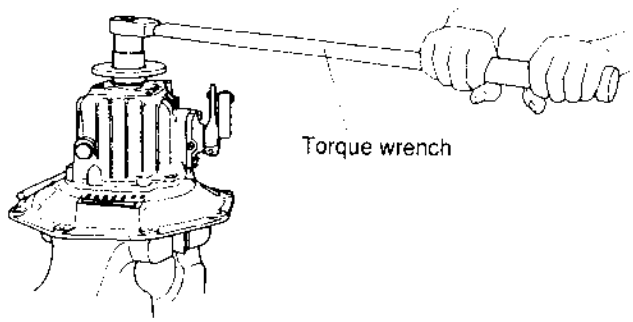


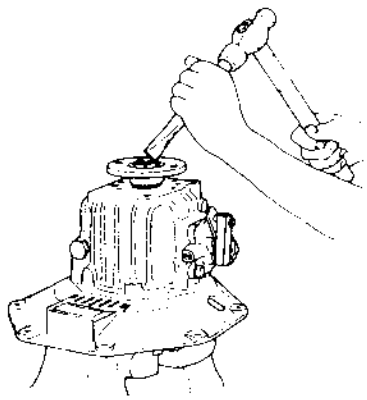

**[NOTICE]**

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

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

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



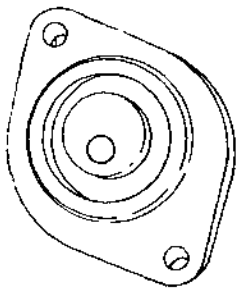
**[NOTICE]**

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

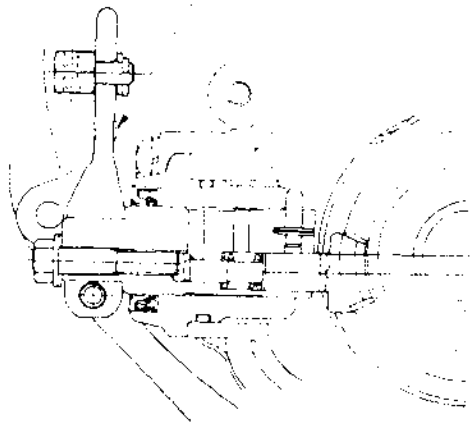
| | |
|---|---|
| Tightening torque | 10±1.5kgf-m (98±14.7Nm) |

### 3.3.5.3 Reassembly of the shiating device

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



△Mark(KM3P)

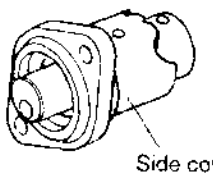


(2) Insert the shift lever shaft to the side cover.

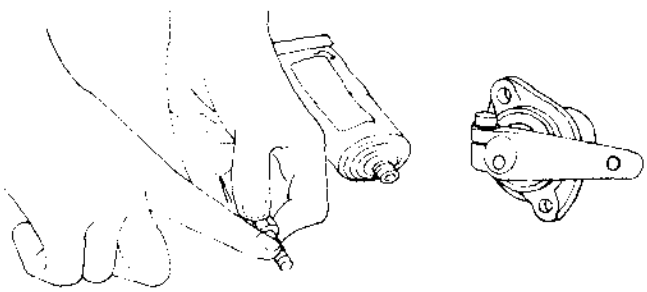
(3) Fit the shift lever to the shift lever shaft.

**[NOTICE]**

*Check the direction of the shift lever △ mark .*



Side cover



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

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

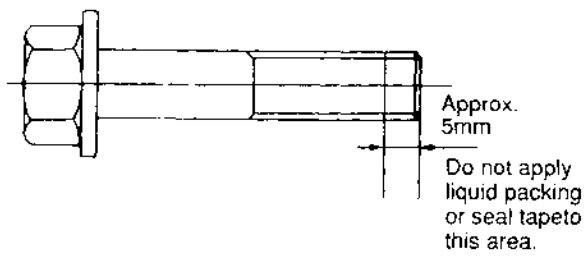
**[NOTICE]**

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

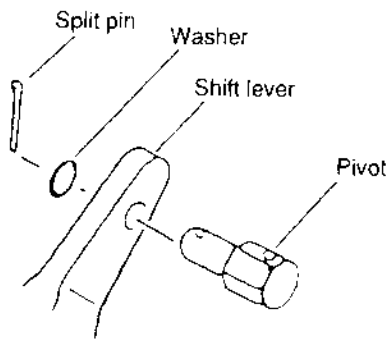
(6) Fit the shim and stopper bolt to the shift lever shaft.

**[NOTICE]**

*Apply non-drying liquid packing or sealtape to the thread of the stopper bolt .*




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



# 3.4 KM3A

## 3.4.1 Construction

### 3.4.1.1 Construction

This clutch is a cone-type, mechanically operated clutch. When the drive cone (which is connected to the output shaft bye 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 if 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 efficiency 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 damper disc.

- The drive cone is made from special aluminum broze which has both higher 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 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. It is also anticorrosive against seawater.
- As the damper disc is fitted to the input shaft, power can be transmitted smoothly.
- 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 engage ment of the drive cone and the large 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 and accordingly no adjustment of the remote control cable is required.
- The cup spring on the rear of the larger gear absorbs rotational fluctuations and stabilized the engagement of the drive cone and the larger gear. Thus, the durability of the cone againstwear is enhanced.

### 3.4.1.2 Specifications

| Model | | | KM3A | | | |
|---|---|---|---|---|---|---|
| For engine models (standard) | | | 3JH3E | | 4JH3E | |
| Clutch | | | Constant mesh gear with servo cone clutch (wet type) | | | |
| Reduction ratio | Forward | | 2.33 | 2.64 | 2.33 | 2.64 |
| | Reverse | | 3.04 | 3.04 | 3.04 | 3.04 |
| Direction of rotation | Input shaft | | Counter-clockwise, viewed from stern | | | |
| | Output shaft | Forward | Clockwise, viewed from stern | | | |
| | | Reverse | Counter-clockwise, viewed from stern | | | |
| Remote control | Control head | | Single lever control | | | |
| | Cable | | Morse, 33-C (cable travel 76.2mm or | | | |
| | Clamp | | YANMAR made, standard accessory | | | |
| | Cable connector | | YANMAR made, standard accessory | | | |
| Output shaft coupling | Outer diameter | | $\phi$ 100mm | | | |
| | Pitch circle diameter | | $\phi$ 78mm | | | |
| | Connecting bolt holes | | 4-$\phi$ 10.5mm | | | |
| Position of shift lever | | | Right side, viewed from stern | | | |
| Lubricating oil | | | SAE 20/30 | | | |
| Lubricating oil capacity | | ℓ | 0.45 | | | |
| Dry mass | | kg(N) | 13(127) | | | |

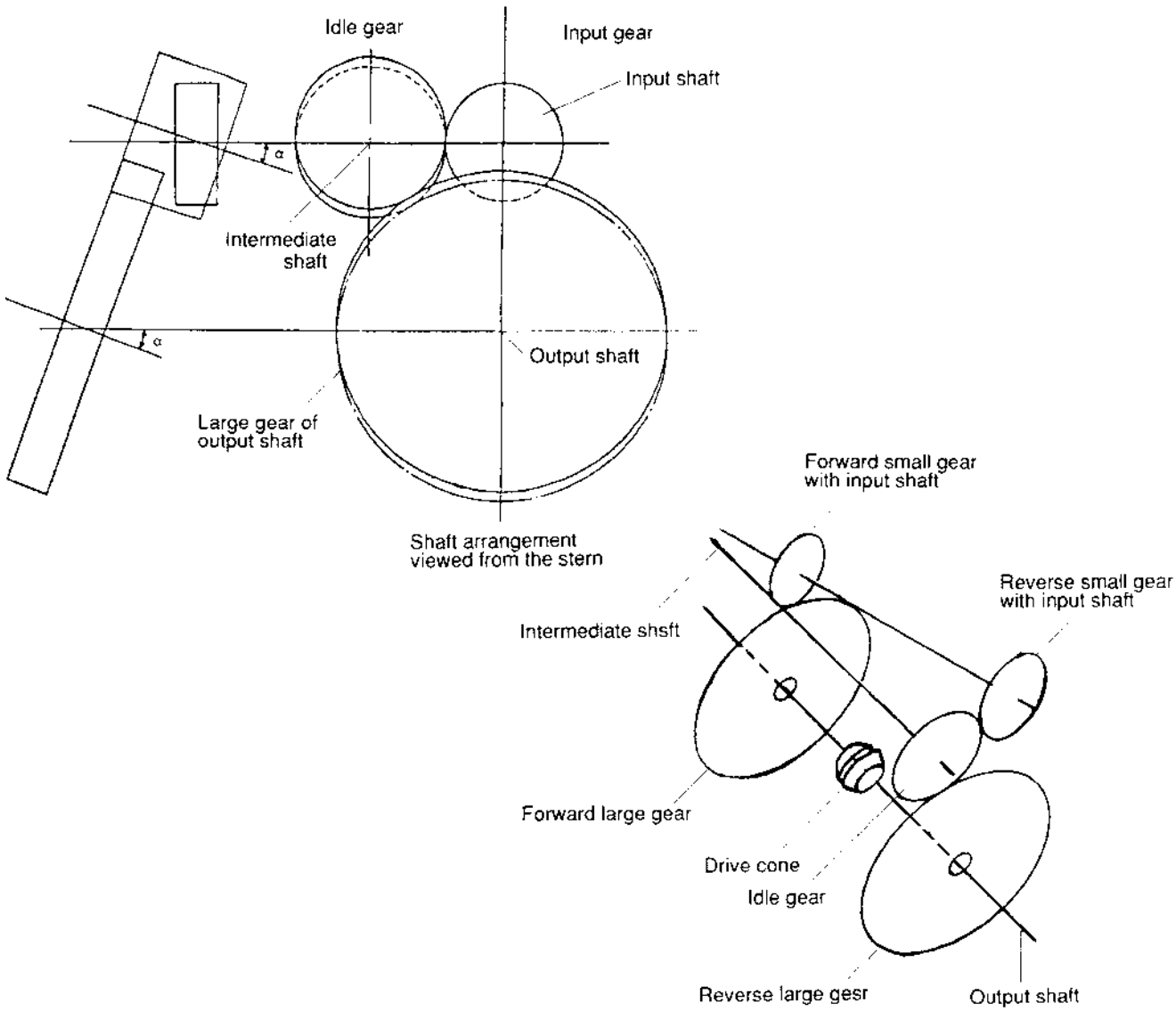
**[NOTICE]**

*In the case clutch model KM3A, when are large propeller or moment of inertia 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 | Moment of inertia $GD^2$(kg-m$^2$) (N-m$^2$) | Material |
|---|---|---|---|---|
| 2.33 | 3 | 450 | ≤0.15 (1.47) | Bronze |
| | 4 | 425 | | |
| 2.64 | 3 | 470 | ≤0.19 (1.86) | |
| | 4 | 440 | | |
| 3.21 | 3 | 490 | ≤0.23 (2.25) | |
| | 4 | 460 | | |

### 3.4.1.3 Power transmission system

#### 1) Arrangement of shafts and gears




#### 2) Reduction ration

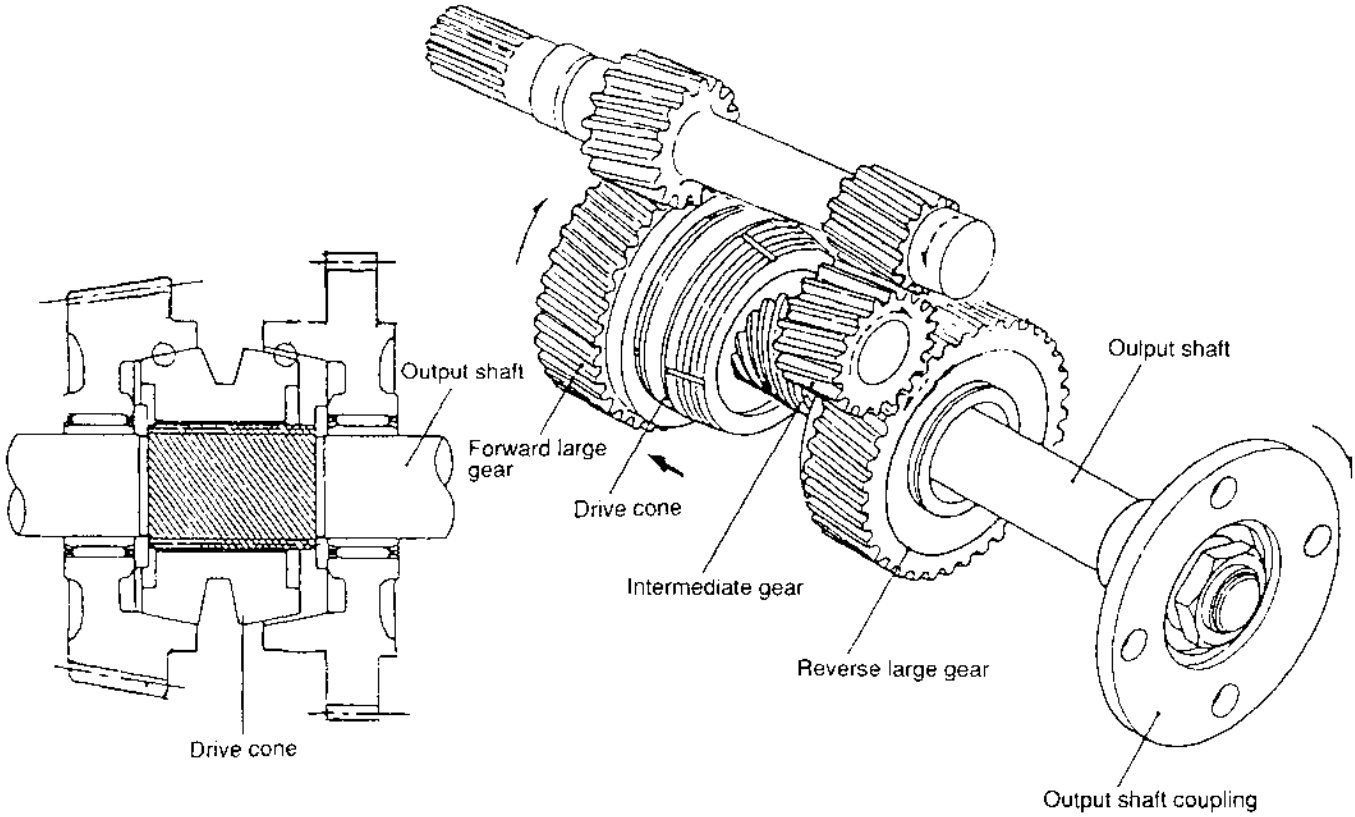
**Forward**

| Model | No. of teeth of forward small gear Zif | No. of teeth of forward large gear Zof | Reduction ratio Zof/Zif |
|---|---|---|---|
| KM3A | 24 | 56 | 56/24 = 2.33 |
| | 22 | 58 | 58/22 = 2.64 |
| | 19 | 61 | 61/19 = 3.21 |

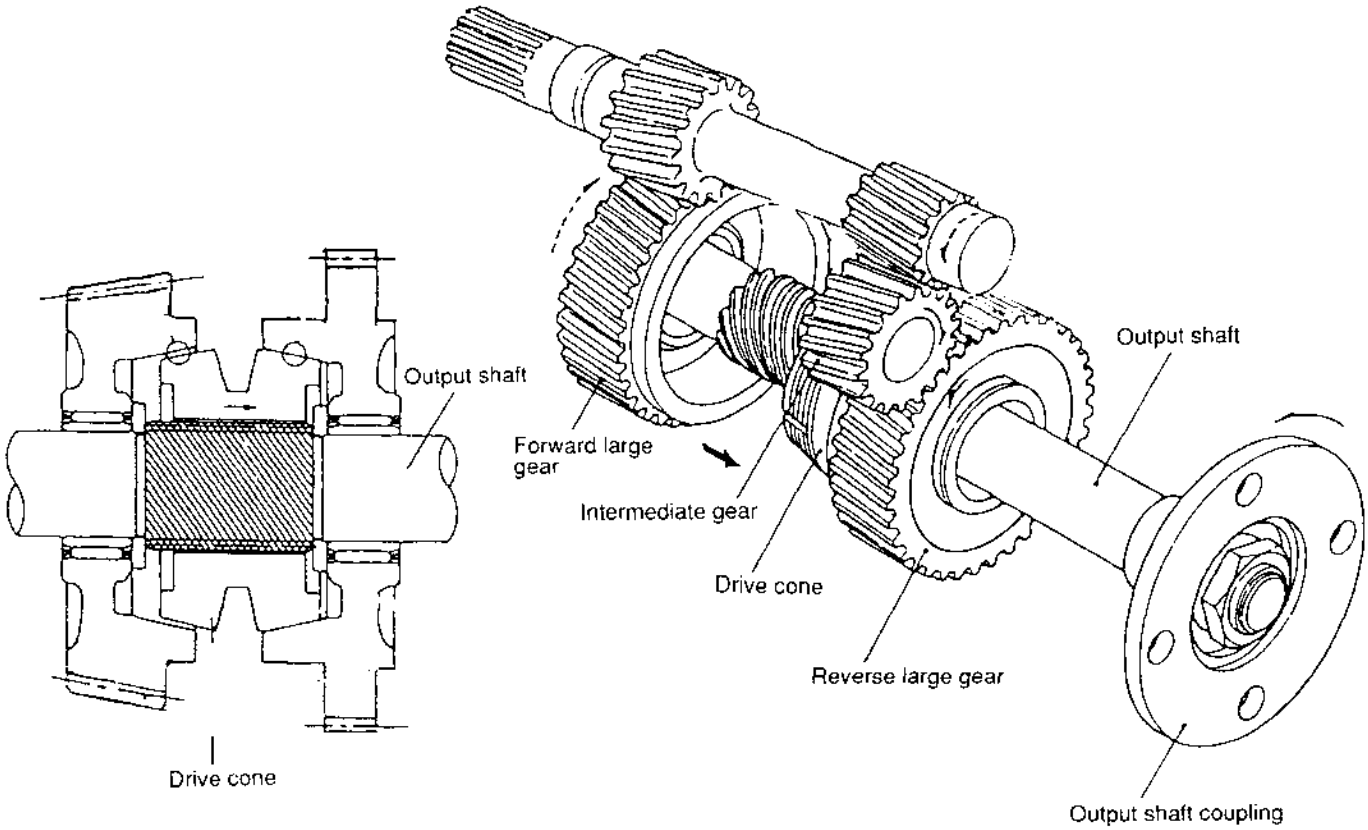
**Reverse**

| Model | No. of teeth of reverse small gear Zif | No. of teeth of inmediate shaft gear Zi | No. of teeth of reverse large gear Zdr | Reduction ratio Zi/Zir·Zdr/Zl |
|---|---|---|---|---|
| KM3A | 23 | 36 | 70 | 70/23 = 3.04 |

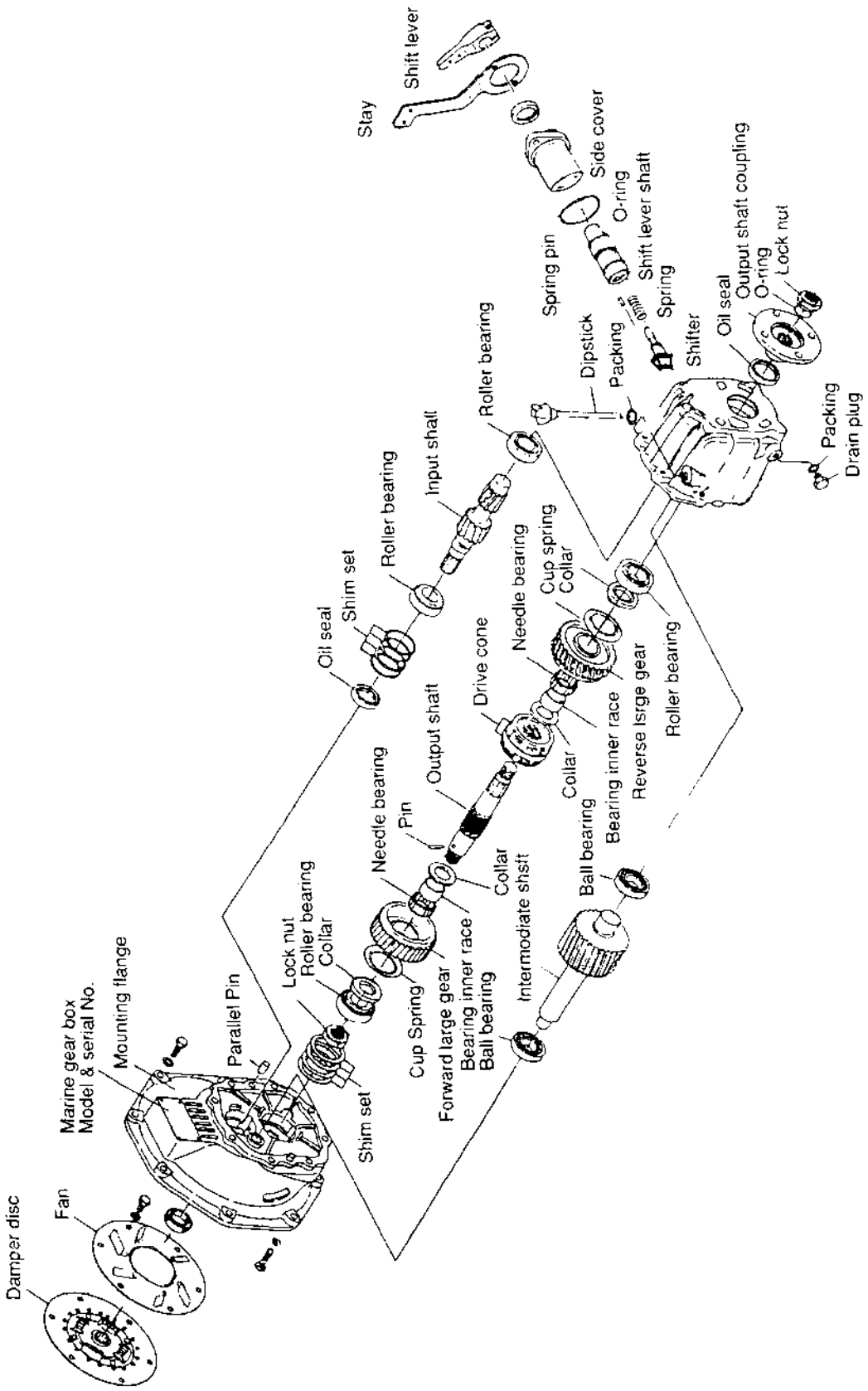
### 3) Power transmission routine-forward



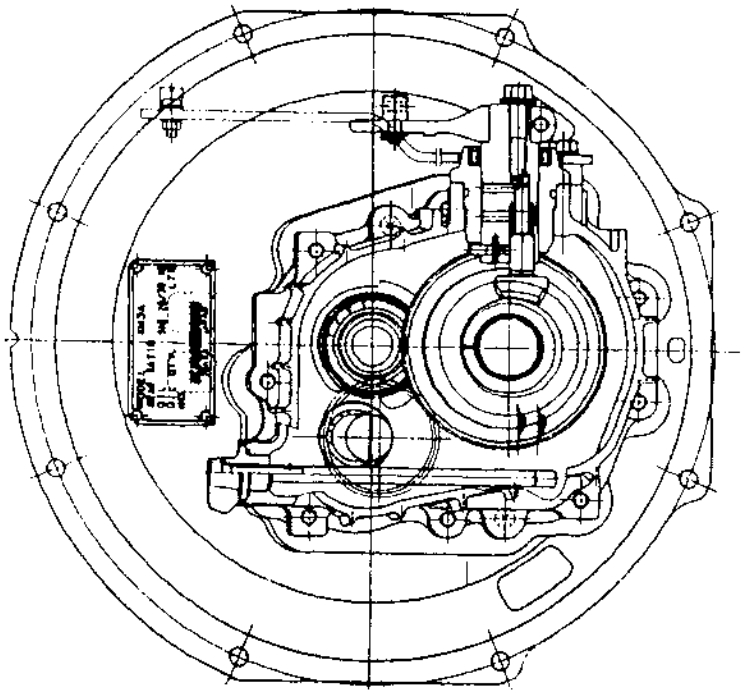

### 4) Power transmission routine-reverse

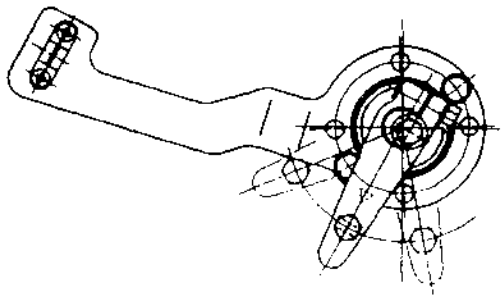


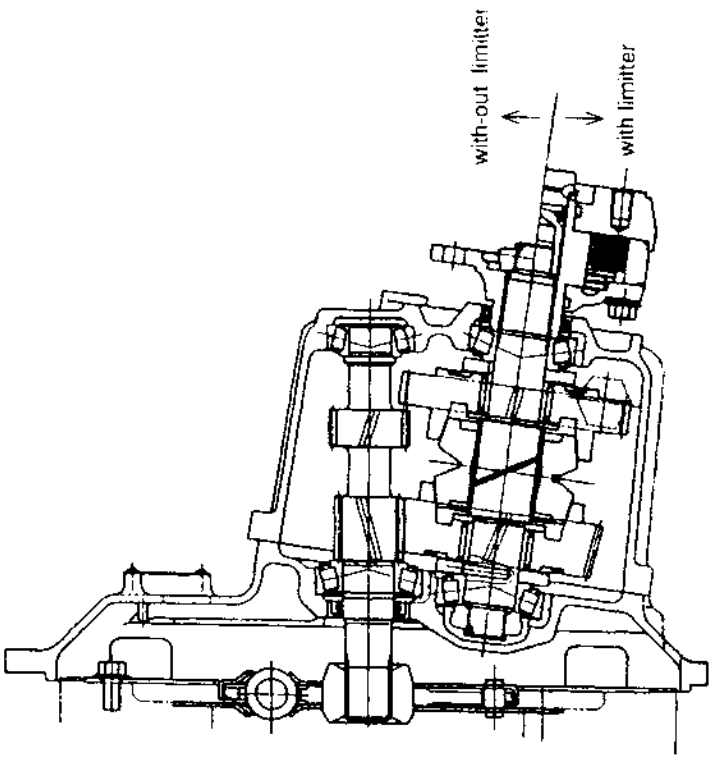
### 3.4.1.4 Drawing

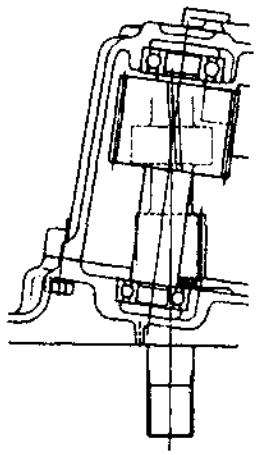


### 3.4.1.5 Sectional view



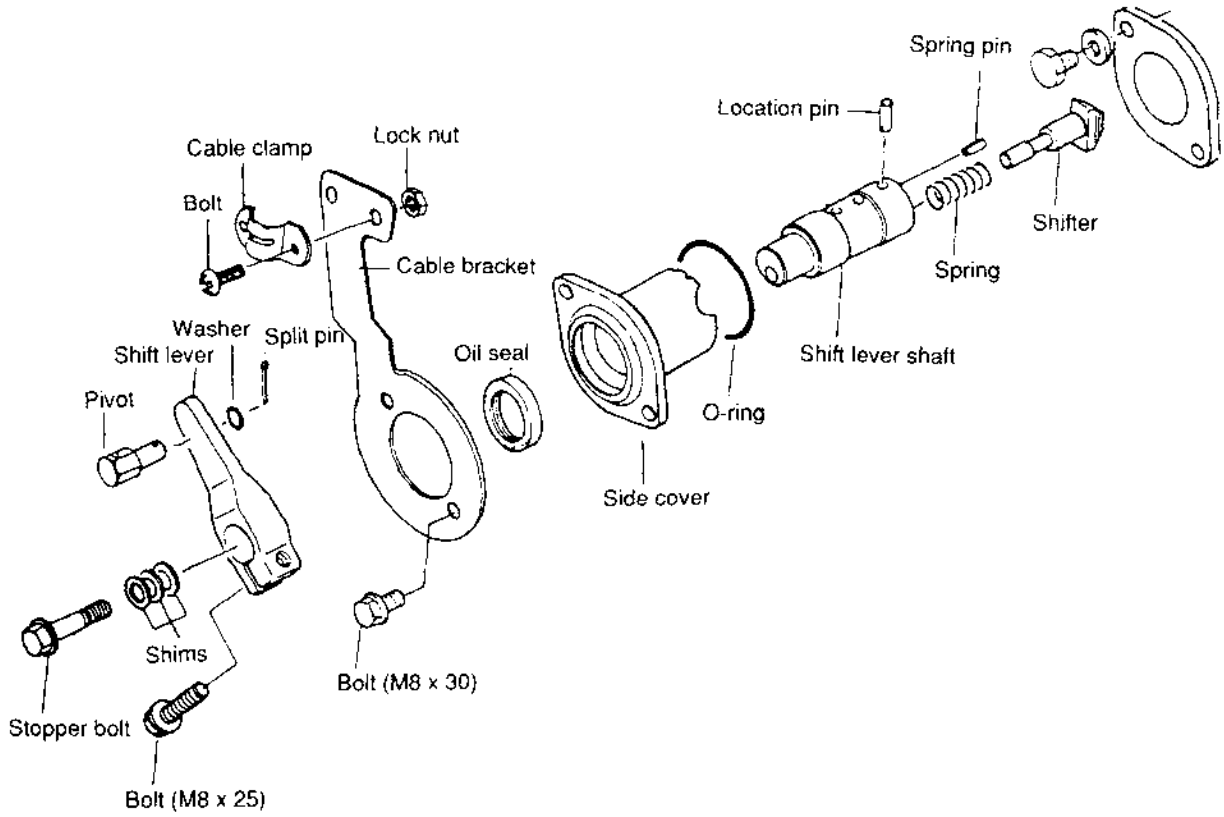




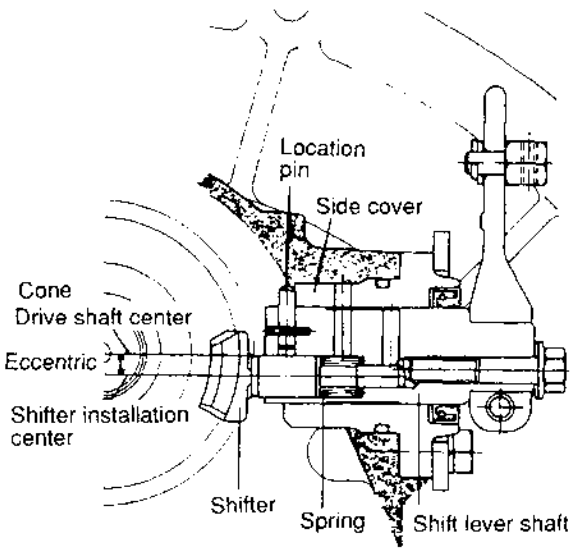



## 3.4.2 Shifting Device

### 3.4.2.1 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 position. (The shift lever shaft moves slightly to the shift lever or drive cone side when the shift lever is placed in the forward on reverse positions.)



### 3.4.2.2 Forward and reverse clutch operation

(Neutral ⇨ Forward; Neutral ⇨ Reverse)

When the shift lever is moved to 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, moves the drive cone's V-groove to the forward large gear.

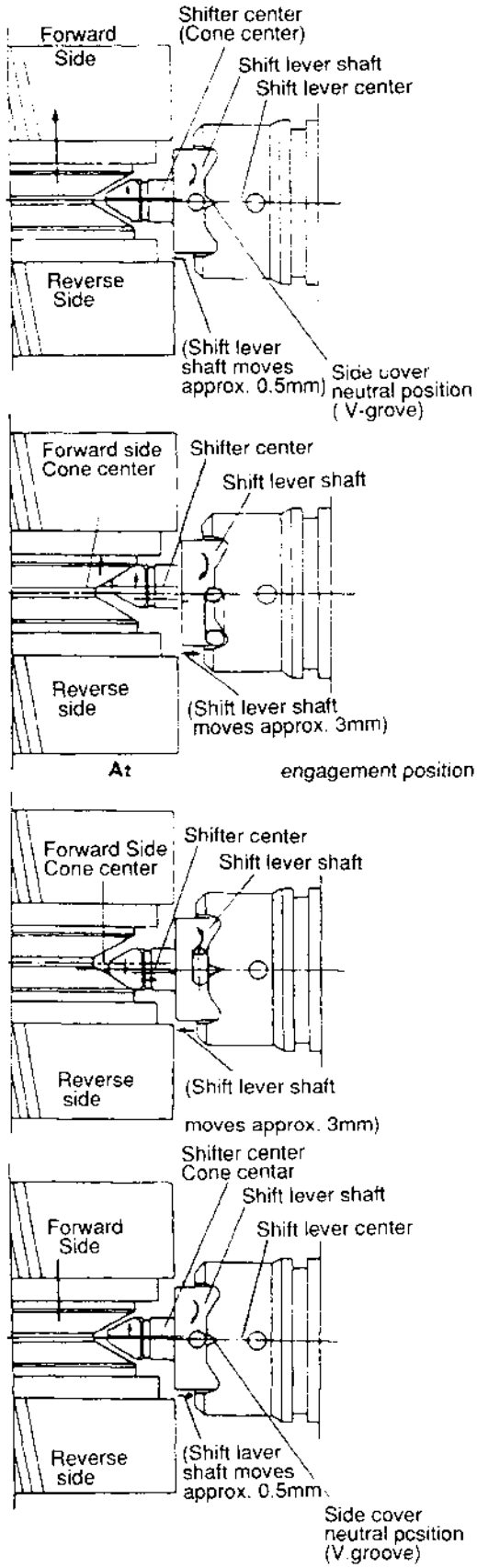
When the location pin of the shift lever shaft falls in the forward position groove of the side cover, the shift lever shaft moves approx. 3mm to the shift lever side, and the shifter stars to press the drive cone V-groove to the forward large gear side through the spring force.

### 3.4.2.3 Engagement and disengagement of clutch

(Forward ⇨ Neutral; Reverse ⇨ Neutral)

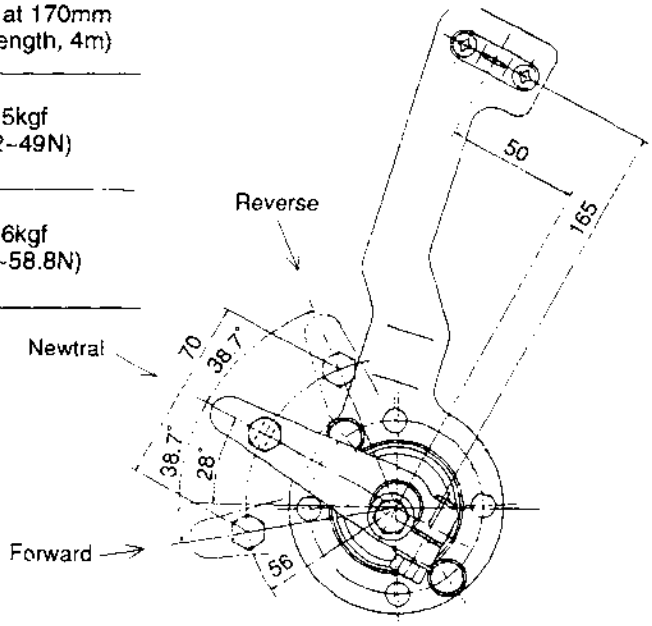
When the shift lever is moved to the forward position from the neutral position, the shift lever shaft starts to revolve, and the location pin disengages from the forward position groove of the side cover. (The shift lever shaft moves approx. 3mm to the drive cone side.) At this time, the shifter which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

Further, when the shift lever shaft starts to revolve, and the positioning pin falls in to 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 leverr 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.



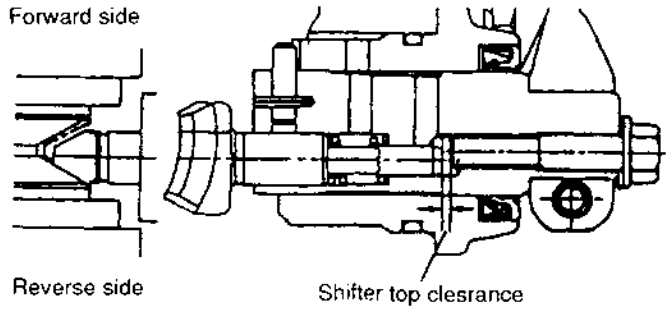
### 3.4.2.4 Clutch shifting force

| Shifting position / Shifting direction | Shifting 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) |




### 3.4.2.5 Adjustment of shifting device

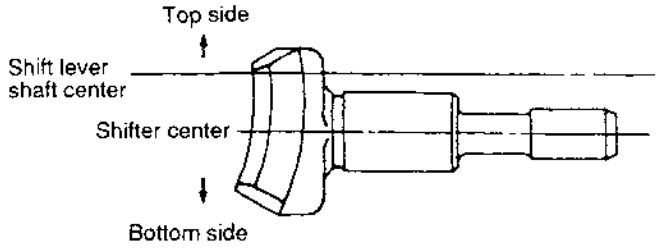
Whenever the side cover, shift lever shaft, shifter, stopper bolt or drive cone is replaced, be sure to adjust the clearance between the shifter end and the stopper bolt by using shims. When the adjustment of this clearance is not proper the drive cone may be improperly fitted when the shift lever is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



### 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 alignment of the shifter before assembly.*



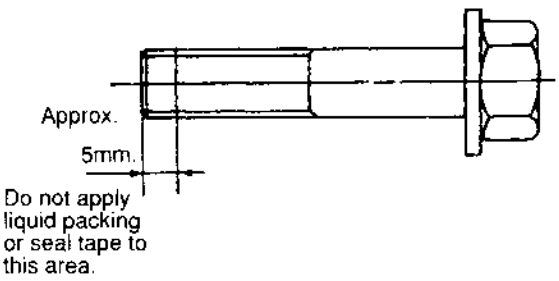

(2) Turn the shift lever 10~15 degree either to the forward or reverse position from the neutral position.
(3) Measure the L-distance between the shift lever shaft end surface and the shifter end and measure the minimum L (Lmin).
(4) Measure the H-distance (the distance from the neck of the stopper bolt to its end).
(5) Obtain the shim thickness "T" by the following formula.

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

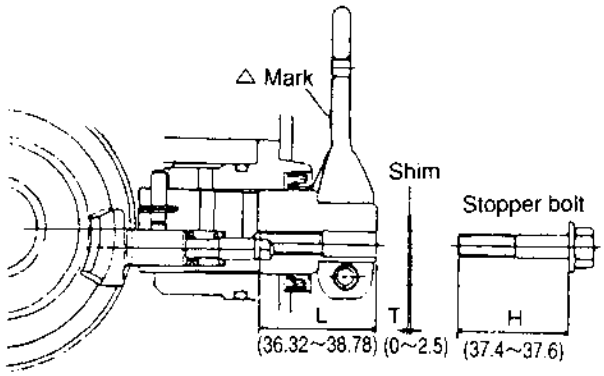
**[NOTICE]**
*Shim set includes one each of 1mm, 0.4mm, 0.3mm, 0.25mm shims.*
*(YANMAR Part No. 177088-06380)*

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

**[NOTICE]**
*When tightening the stopper bolt, apply eigher a non-drying type liquid packing (THREE BOND No.1215), or a seal tape around the bolt threads.*




(mm)



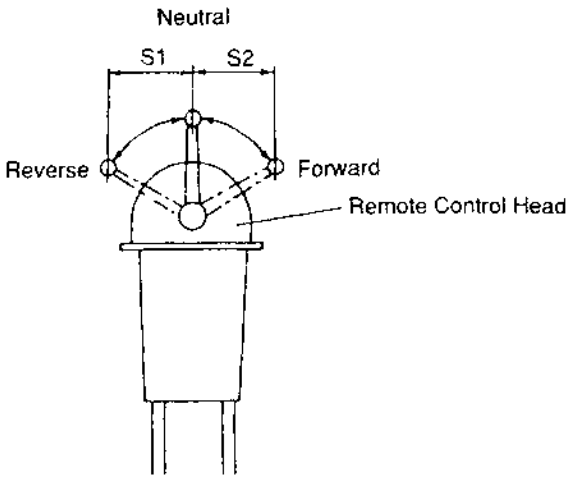

### 2) Inspect for the following points
**(to be inspected every 2-3 months)**

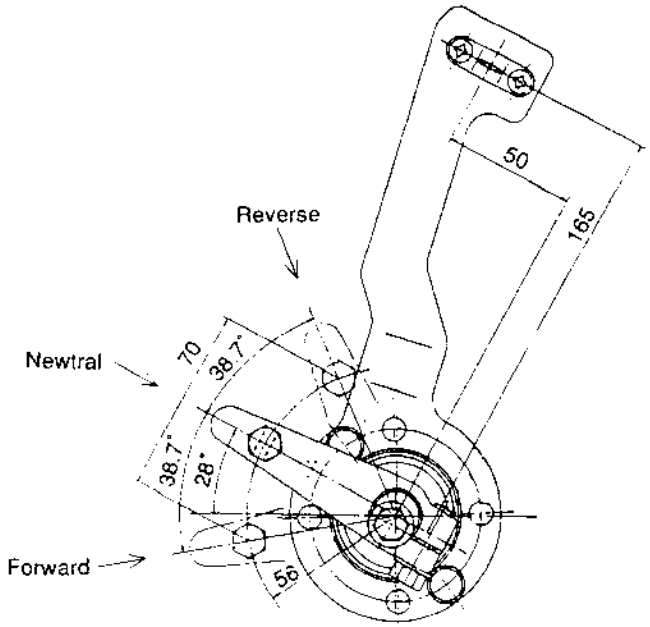
(1) Looseness at the connection of the cable connector and the remote control cable.

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

### 3.4.2.6 Adjustment of the remote control head Marine gear box control side

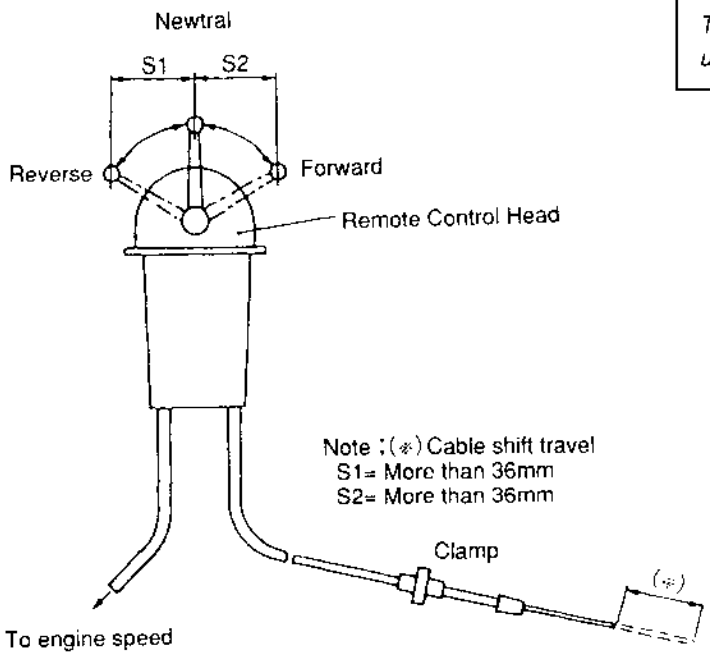
(1) Equal distribution of the control lever stroke.




The stroke between the neutral position → forward position (S2), and the neutral position → 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 so that the cable shift travel of the S1 and S2 control lever strokes becomes identical.




### 3.4.2.7 Cautions

(1) Always stop the engine when attaching, adjusting, and inspecting.
(2) When conducting inspection immediately after stopping the engine, do not touch the clutch. The oil temperature is often raised to around 90℃.
(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 650 and 800 rpm.

**[NOTICE]**

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

## 3.4.3 Inspection and Servicing

### 3.4.3.1 Clutch case

(1) Check the clutch case with a test hammer for cracking.
Perform a color check when required.
If the case is cracked, replace it.

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

### 3.4.3.2 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 baring.

### 3.4.3.3 Gear

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

(1) Tooth surface wear.
Check the tooth surface for pitting, abnormal wear, dents, and cracks. Repair the lightly damaged gears and replace heavily damaged gears.

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

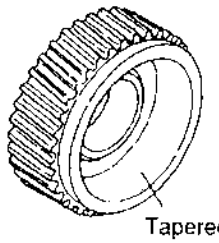
(3) Backlash.
Measure the backlash of each gear, and replace the gear when it is worn beyond the wear limit.

mm

| | Maintenance standard | Wear limit |
|---|---|---|
| Input shaft forward gear and output shaft forward gear | 0.05~0.14 | 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 |

### 3.4.3.3 Forward and reverse large gears

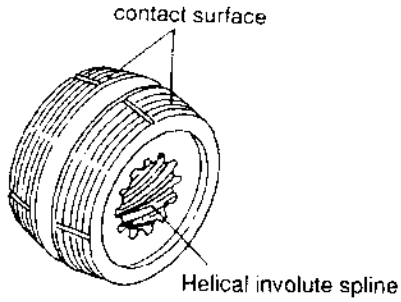
(1) Contact surface with drive cone.
Visually inspect the tapered surface of the forward and reverse large gears where they make contact with the drive cone to check if any abnormal condition or sign of overheating exists. If any defect is found, replace the gear.




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

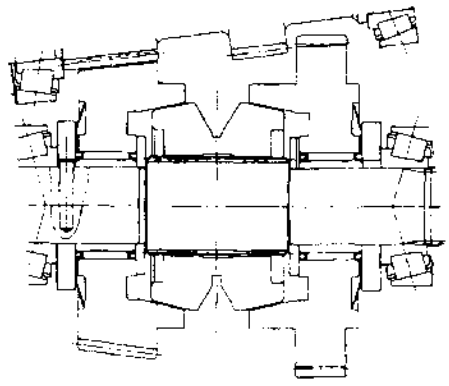

### 3.4.3.5 Drive cone

(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 |
|---|---|---|---|
| Dimesions ℓ | KM3A | 29.2~29.8 | 28.1 |

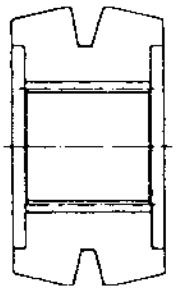
**[NOTICE]**

*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.

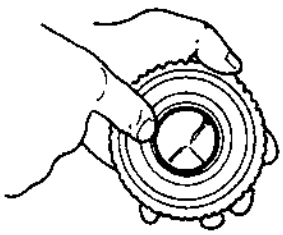
**[NOTICE]**

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

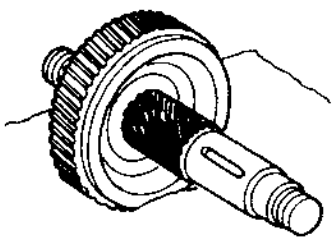


**1) Lapping Procedure for Drive Cone**

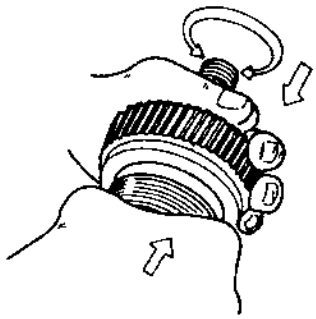
(1) Coat the lapping powder onto the cave of the clutch gear (Lapping powder : 67 micron silicon cable #280)



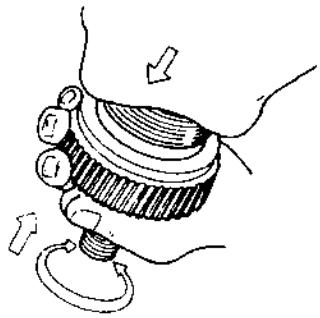
(2) Set the large gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft.



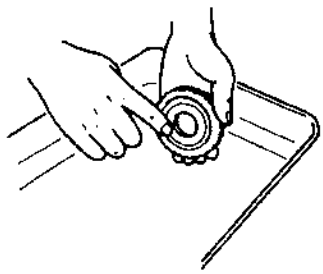
(3) Lap the large gear's cave and drive cone, pushing them together by hand.

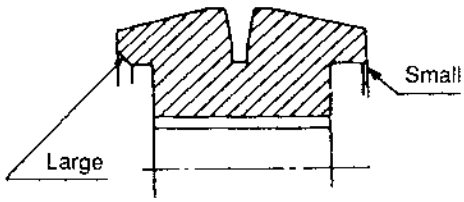


(4) Push and turn the clutch gear about 5 times both clockwise and counter-clockwise.



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

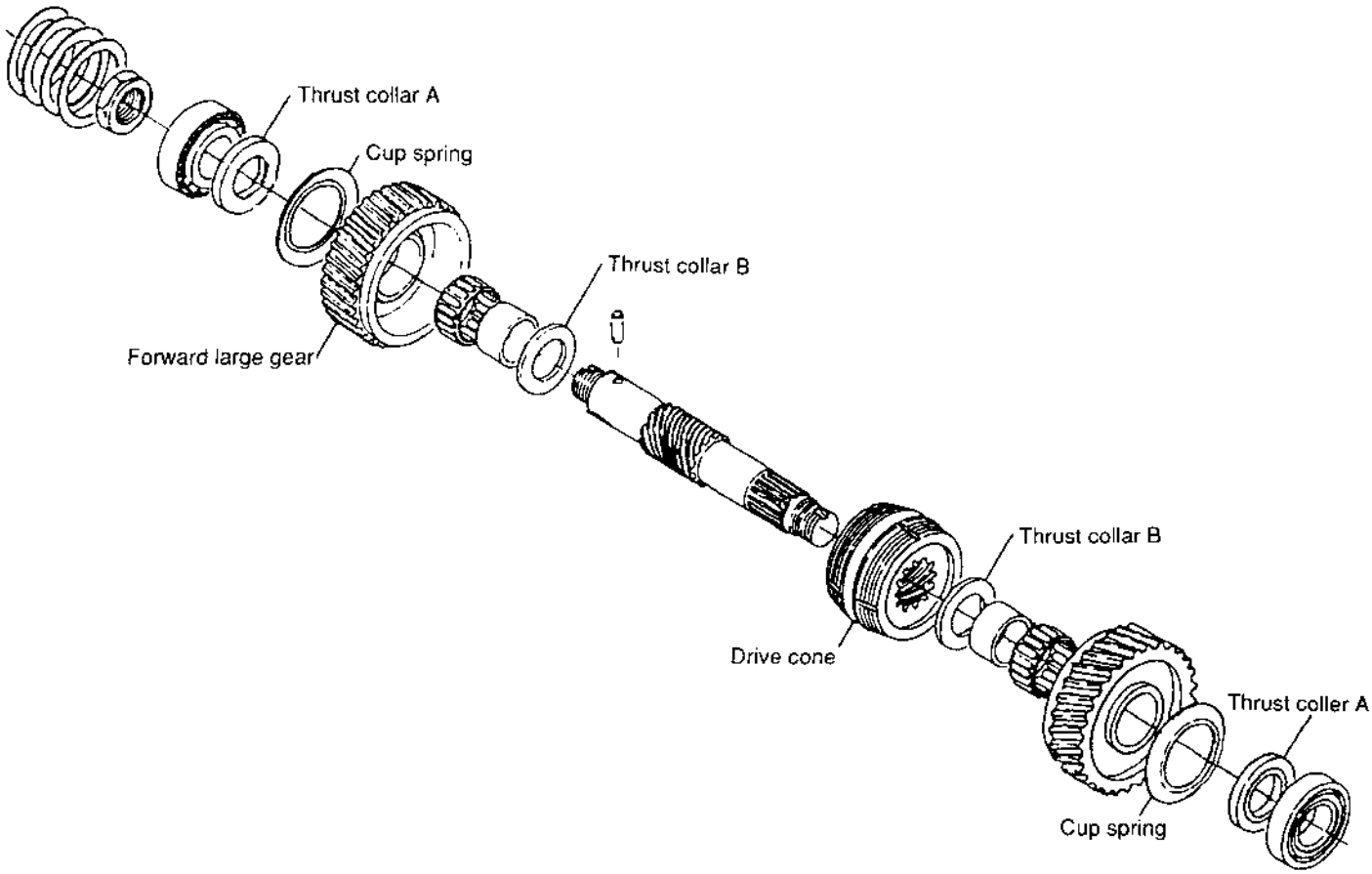





**[NOTICE]**

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

### 3.4.3.6 Thrust collar



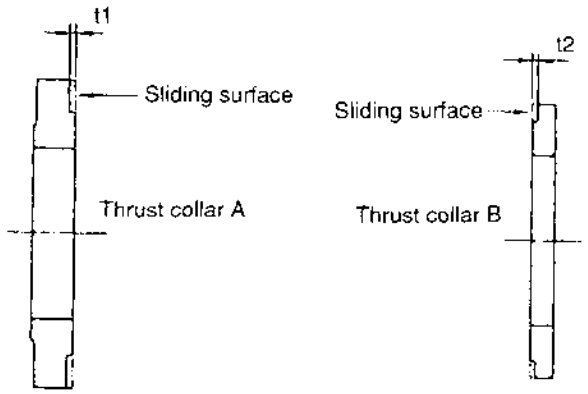





HINSHI-H10-011

(1) Visually inspect the sliding surface of thrust collar A or B to check for signs of overheating, scoring, or cracks. Replace the collar if any abnormal condition is found.

(2) Measure the thickness of thrust collar A or B, and replace it when the dimension exceeds the specified limit.



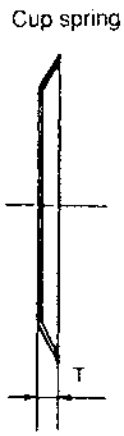

mm

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

### 3.4.3.7 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 deviates from the standard size, replace the part.



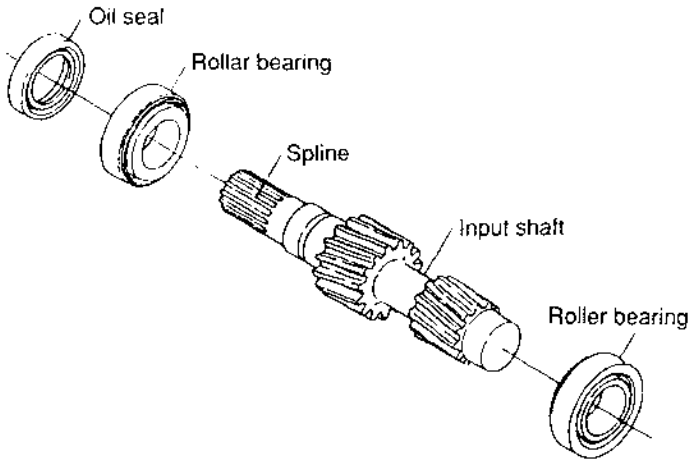

mm

| | Standard | Limit |
|---|---|---|
| Cup spring, T | 2.8~3.1 | 2.6 |

### 3.4.3.8 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.

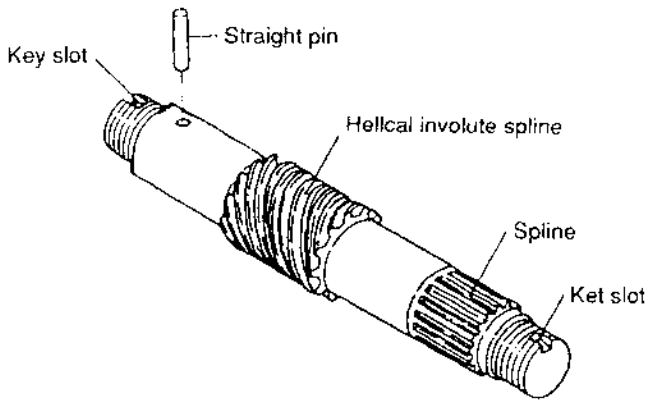
### 3.4.3.9 Input shaft




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

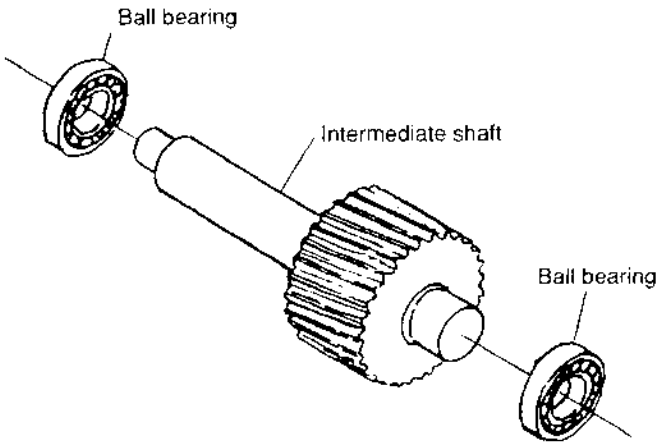
(2) Surface of oil seal.
If the sealing surface of the oil seal is worn or scratched, replace.

### 3.4.3.10 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.

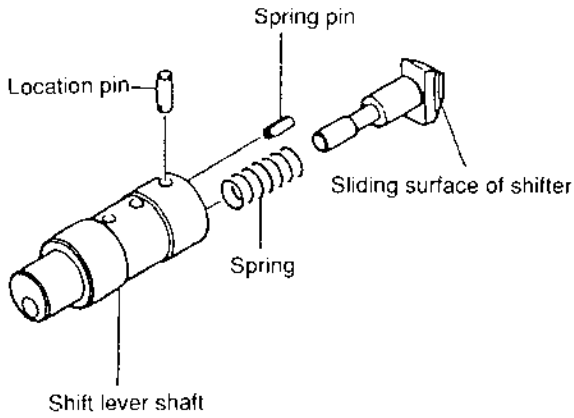
### 3.4.3.11 Intermediate shaft



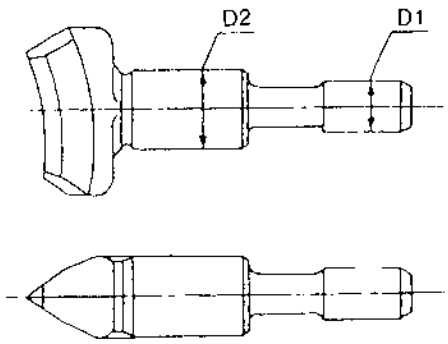

(1) Ball bearing
Check the turning condition with gently rotate, and when bearing is sticked or damaged. Replace if necessary.

### 3.4.3.12 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 shaftif the size deviates from the standard.

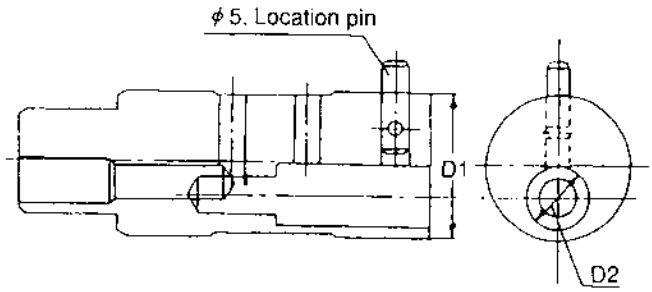



mm

| | 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 |

#### 2) Shift lever shaft and location pin

(1) Check the shift lever shaft and location pin for damage or disportion, and replace defective parts. If the location pin must be replaced, replace it together with the shift lever shaft.
(2) Measure the diameter of the shift lever shaft and the shifter insertion hole. Replace the part if the size deviates from the standard value.




mm

| | Standard | Limit |
|---|---|---|
| $D_1$ | 27.959~27.98 | 27.90 |
| $D_2$ | 12.0~12.018 | 12.05 |
| Side cover, Shift insert hole | 28.0~28.021 | 28.08 |

### 3) Shifter spring

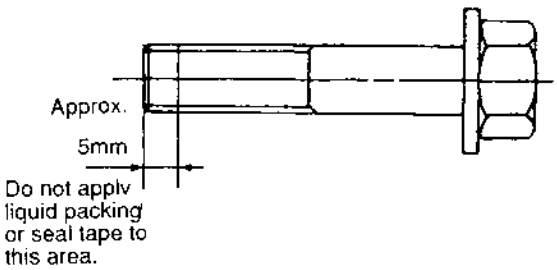
(1) Check the spring for scratches or corrosion.

(2) Measure the free length of the spring.

| Shifter spring | Standard | Limit |
|---|---|---|
| Free length | 22.6mm | 19.8mm |
| Spring constant | 0.854kg/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.

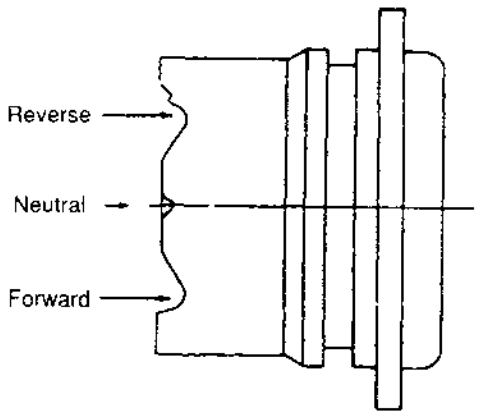



### 5) Side cover and oil seal

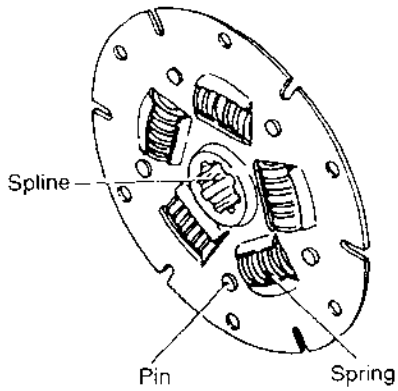
(1) Check the neutral, forward and reverse position grooves.
Replace if the grooves are worn.

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

(3) Check the oil seal and the O-ring for damage.
Replace if the part is defective.




## 3.4.3.13 Damper disc




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

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

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

(4) Whenever a crack or damage to the spring slot is found replace the defective part with a new one.

## 3.4.3.14 Shim adjustment for output and input shaft

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 the shim must be determined in the following manner.

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

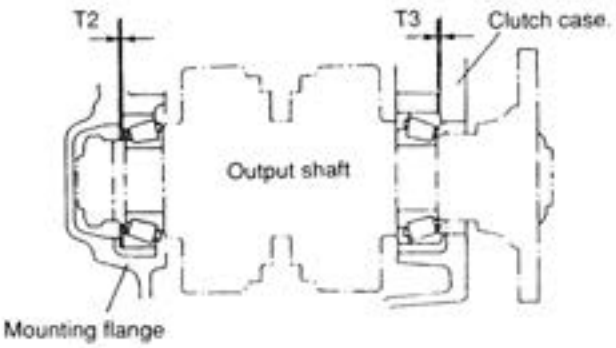
(1) Shim thickness (T2, T3) measurement of output shaft

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

(b) Measure the length (B) between the bearing outer race.

**[NOTICE]**

*Tighten the mounting flange nut of 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 lengths (D) and (C) from the outer race end of the clutch case bearing included in the output shaft assembly.

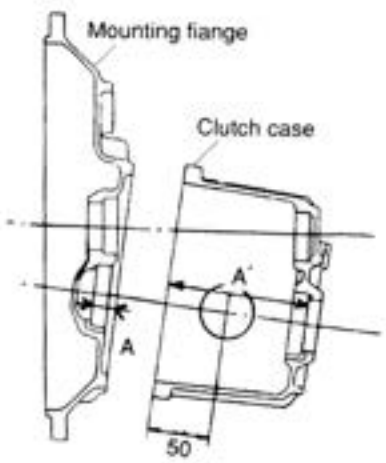
**[NOTICE]**

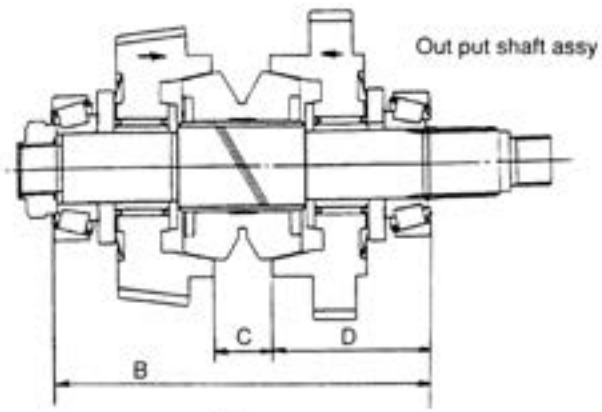
*Before measuring length (D) and (C), press the forward large gear and the reverse large gear to the drive cone until there is no clearance.*

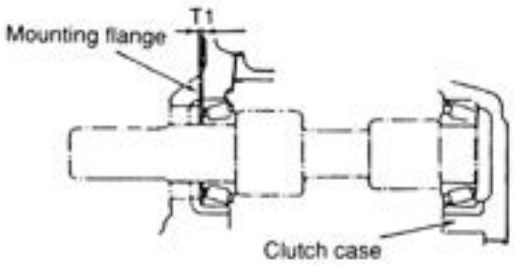
(d) Obtain thickness ($T_2$) and ($T_3$) by the following formulas:

$T_2 = A + A' - B - T_3$ ($T_2$: Clearance $^{+0.1}_{0}$ mm)

$T_3$ (KM3A) = A' - 50 - C/2 -D (Tolerance $\pm 0.5$mm)




T1 : Clearance $\pm 0.05$

① Assemble the outer bearing race without inserting shims into the clutch case body and flange, and then assemble only the input shaft.
(Caution): The outer bearing race should be inserted all the way to the bottom. Do not suspend it halfway.

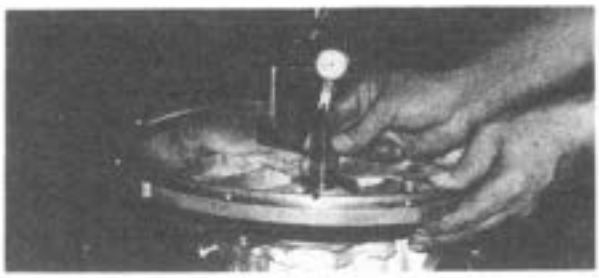
② Fasten the case body and the flange by tightening 2 bolts diagonally.

③ Fasten the dial guage to the flange and fit the needle to the end face of the input shaft.

④ Move the input shaft up and down manually and read the dial gauge figure to decide the shim thickness.

**[NOTICE]**

*The bearing installation hole does not make a right angle to the joint face of the case and flange. Accordingly, precise measurement at the service site is not possible.*



(3) Standard size of parts

mm

| | A+A' | B | C | D | Drive cone neutral center position |
|---|---|---|---|---|---|
| KM3P2 | 138.40~ 138.75 | 136.56~ 138.10 | 20.50~ 21.10 | 57.83~ 58.65 | 50 |

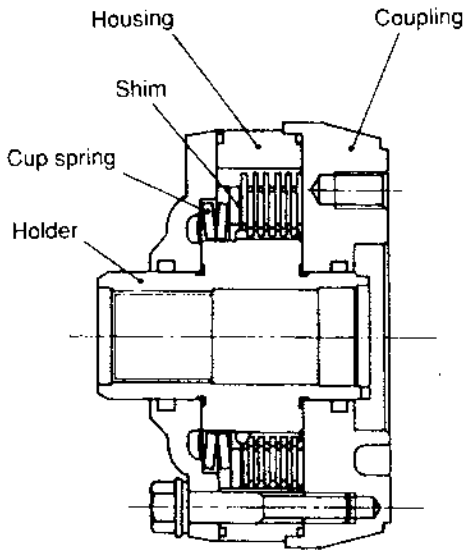
**[NOTICE]**

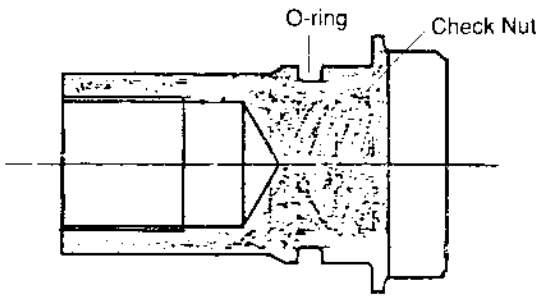
*Compare your measurements with the above standard size. If your measurements differ largely from the standard sizes, measurements may not be correct. Check and measure again.*

(4) Adjusting shim set

| | Part No. | Thickness mm (in.) | No. of shims |
|---|---|---|---|
| Input and Output shaft | 177088-02300 | 1.0(0.0394)<br>0.5(0.0197)<br>0.3(0.0118)<br>0.1(0.0039) | 1<br>1<br>2<br>3 |

## 3.4.3.15 Torque limiter




The torque limiter assembly includes these parts. The conversion to the torque limiter specification is easy by exchanging the standard shaft coupling. (Use the check nut, not the end nut, to install the torque limiter.)

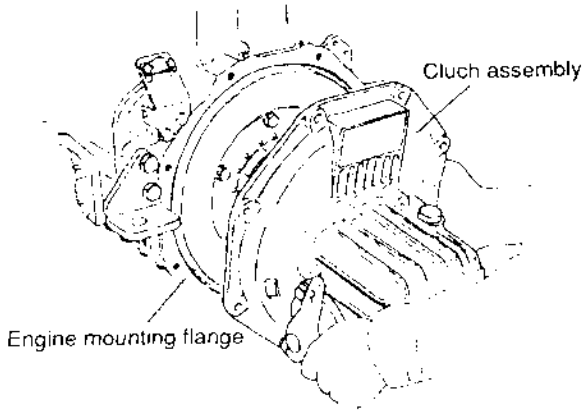
Check nut tightening torque:10±1.5 kgf·m(98±14.7N·m)

## 3.4.4 Disassembly

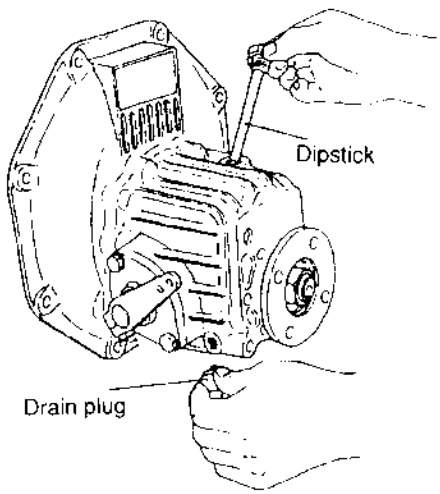
### 3.4.4.1 Disassembling the clutch

(1) Remove the remote control cable.

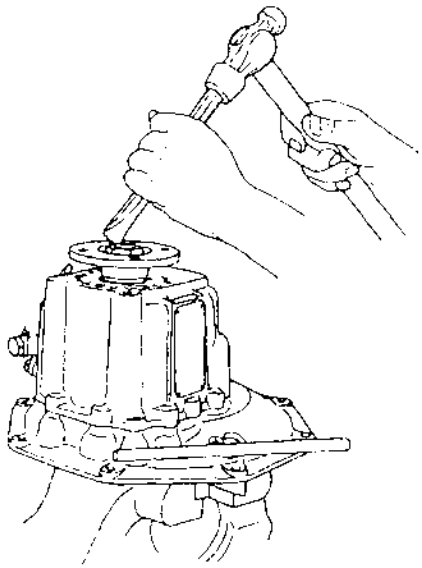
(2) Remove the clutch assembly from the engine mounting flange.

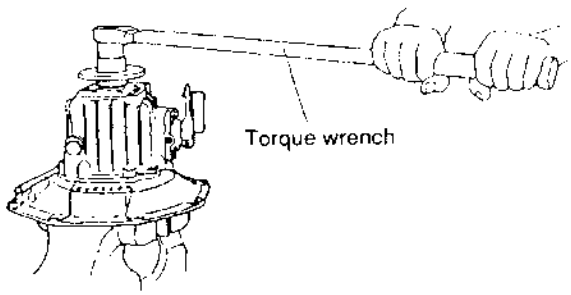



(3) Drain the lubricating oil.
Drain the lubricating oil by loosening the plug at the bottom of the clutch case.




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



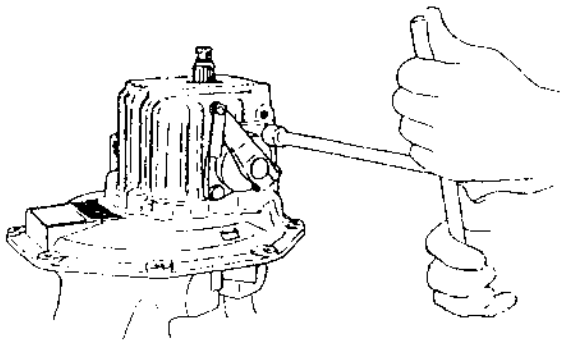



**[NOTICE]**

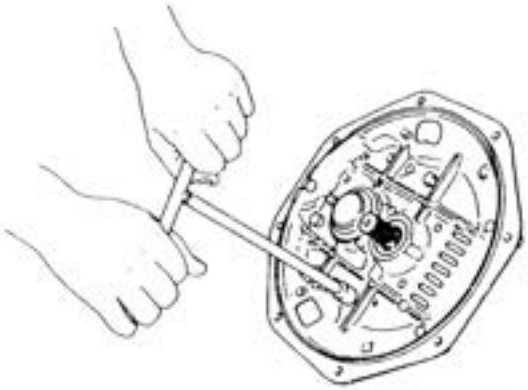
*Take care as it has a left-handed thread.*

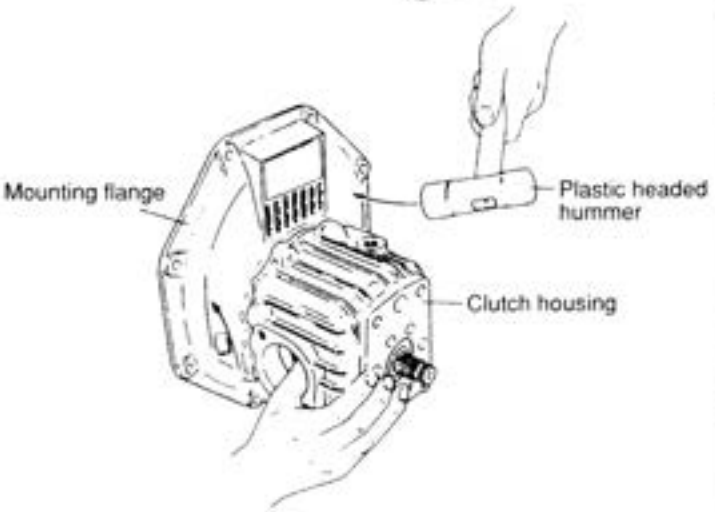
(5) Remove the oil dipstick and O-ring.

(6) Remove the fixing bolts on the side cover, and also remove the shift lever shaft, shift lever and shifter.



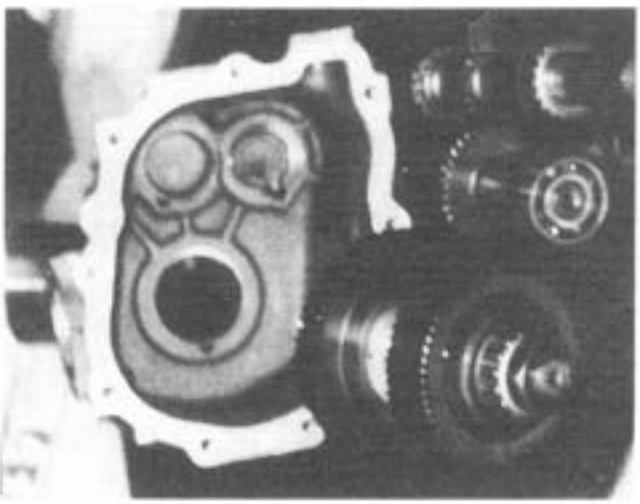
(7) Remove the bolts which secure the mounting flange to the case body, give light taps to the left and right with a plastic headed hammer while supporting the clutch case with your hand, then remove the mounting flange.



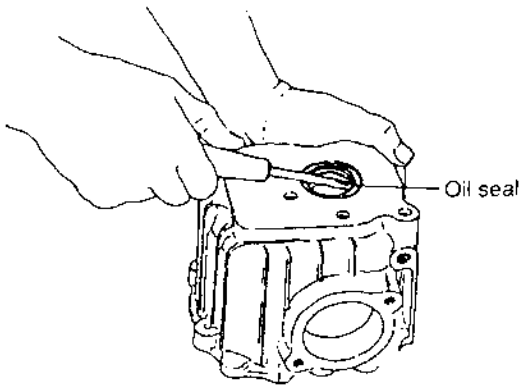



(8) Withdraw the output shaft assembly.

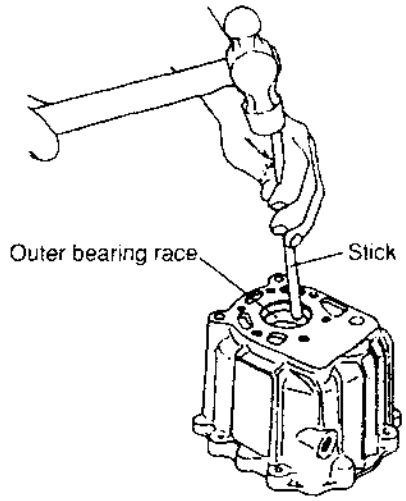
(9) Take out the intermediate shaft and input shaft and intermediate shaft.

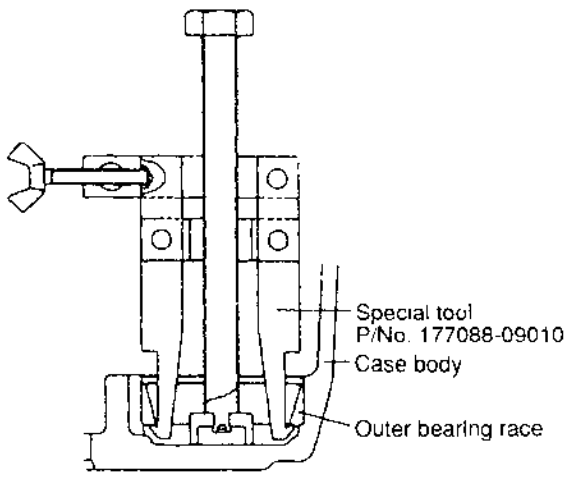


(10) Remove the oil seal of the output shaft from the case body.




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




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

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

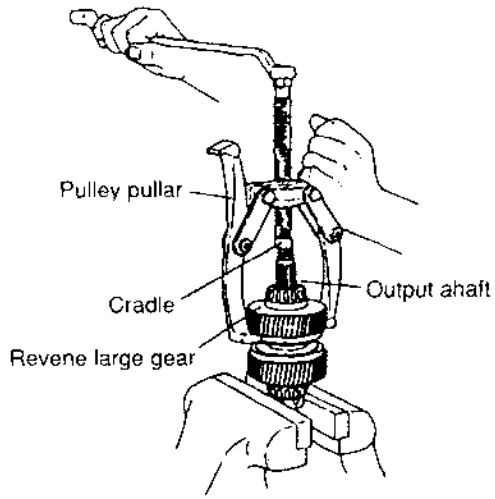
(14) Remove each adjusting plate from the input our output shaft.

**[NOTICE]**

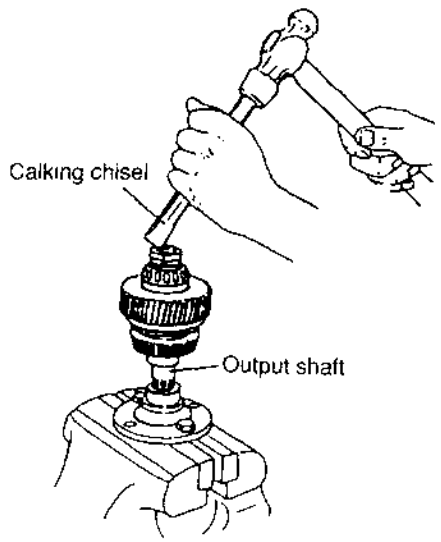
*The same adjusting plates can be reused when the following parts are not replaced. When any part is replaced however, readjustment is necessary.*

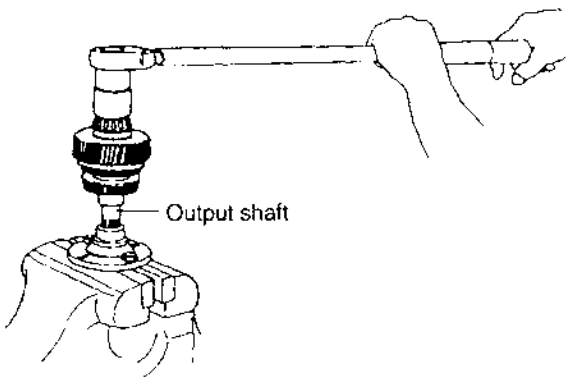
### 3.4.4.2 Removal of the output shaft

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

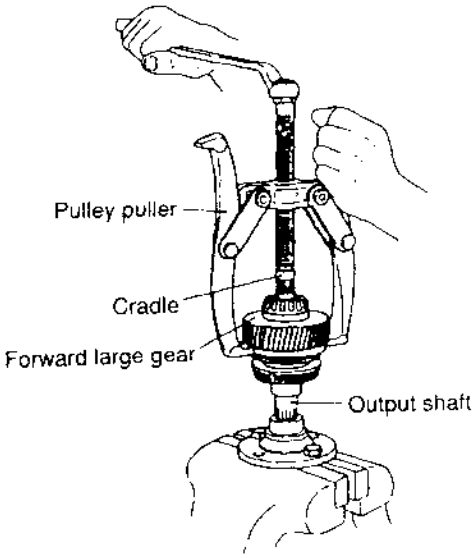


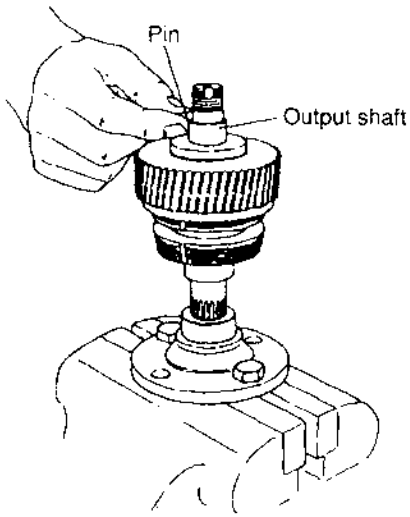

(2) Loosen the calking of the forward nut and remove the nut.
Remove the nut by using a torque wrench after setting the output shaft coupling and fixing the coupling bolt in a vice.






(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.

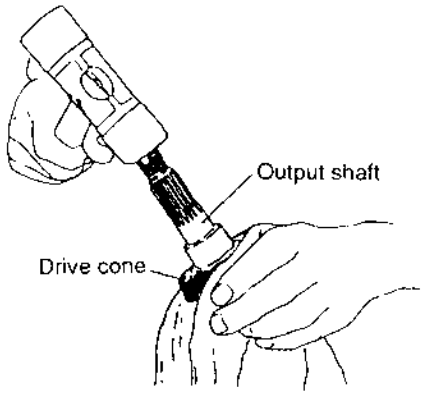


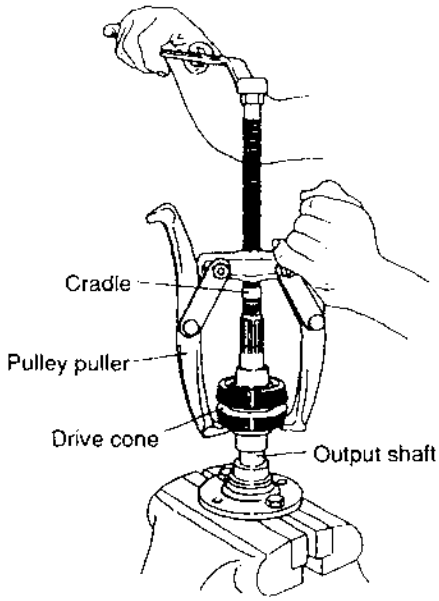




**[NOTICE]**

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

(4) While gripping the drive cone, tap the end of the shaft with a plastic headed hammer, and withdraw the thrust extractor may be used.

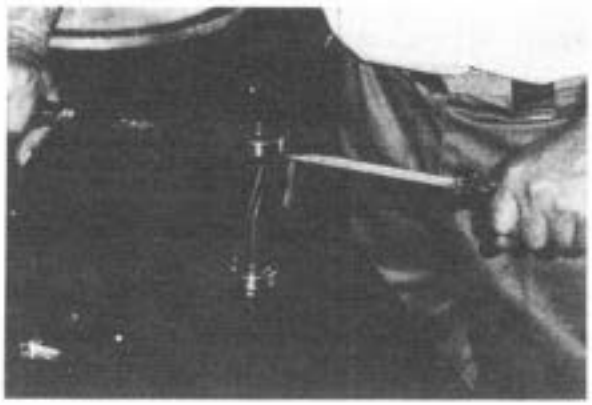


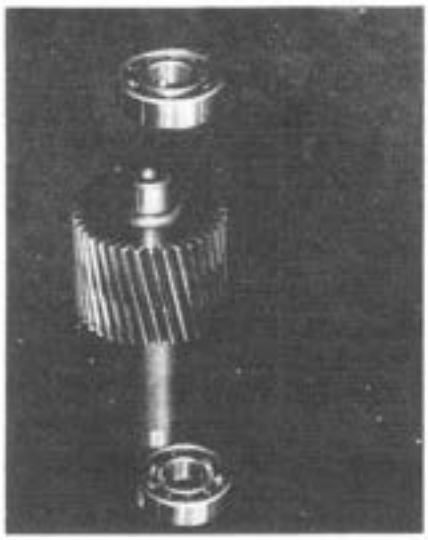



### 3.4.4.3 Removal of the intermediate shaft.

(1) Remove the ball bearing using a pully.

(2) Remove the ball bearing opposite narrow end using screw driver.

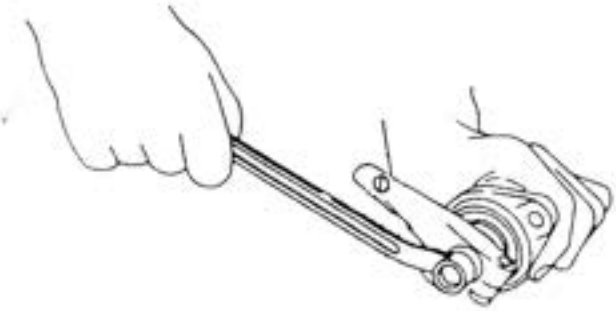




### 3.4.4.4 Dismantling the shifting device

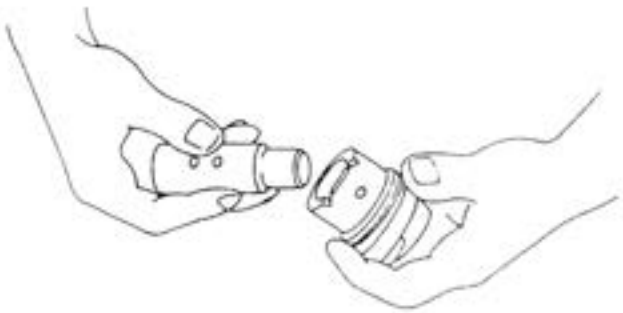
(1) Take out the shifter and shifter spring.

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



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

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



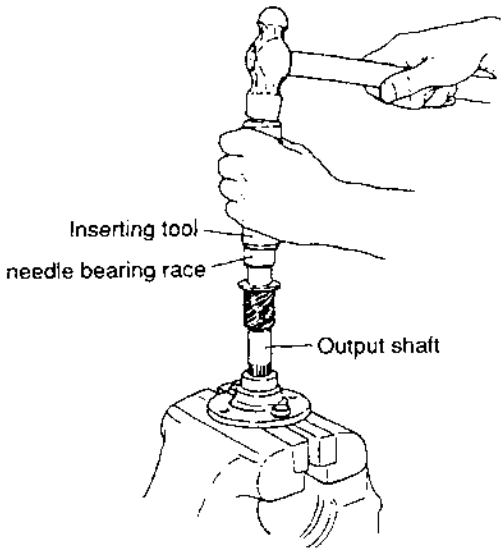
(5) Remove the oil-seal and O-ring.

## 3.4.5 Reassembly

### 3.4.5.1 Reassembly of output shaft

(1) Fit the forward side thrust collar B onto the shaft.

(2) Drive in the forward end inner needle bearing race using a jig.

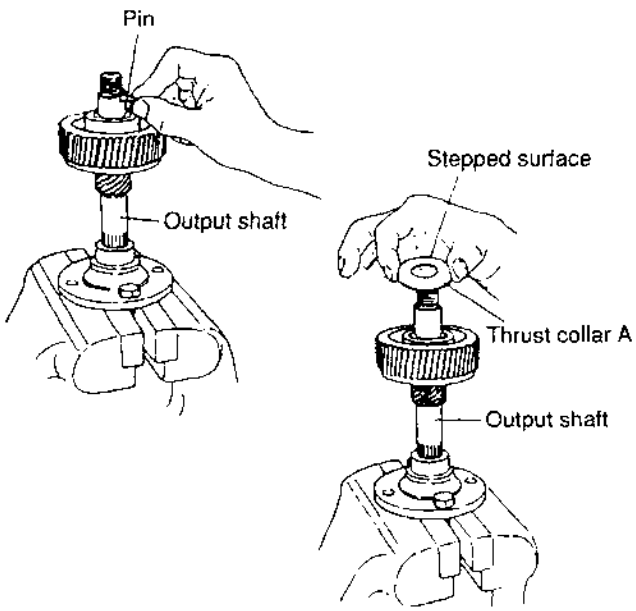


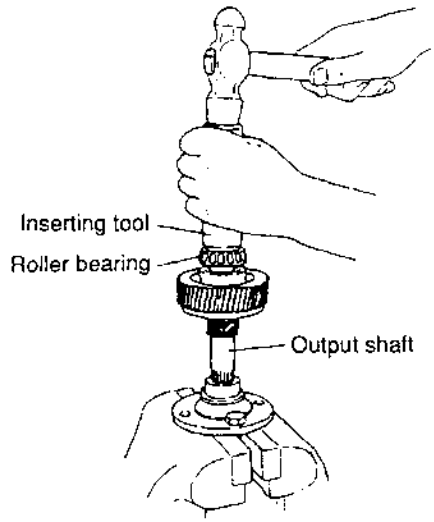

(3) Assemble the needle bearing and forward large gear.

**[NOTICE]**

*Check that the forward large gear rotates smoothly.*

(4) Fit the cup spring, Pin and thrust collar A, and dive in the inner bearing race using a jig.

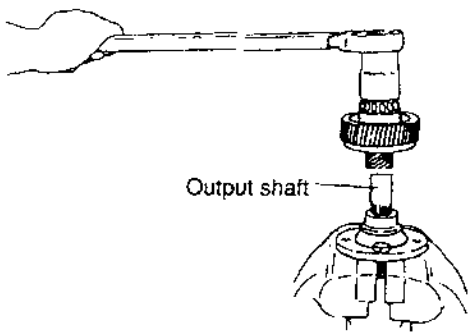



**[NOTICE]**

- *Drive in with a plastic headed hammer. Do not hit it hard.*
- *When fitting the thrust collar A, note the fitting direction. Fit it keeping the stepped surface toward the roller bearing side.*
- *Note that the pin cannot be fitted after the inner bearing race has been driven in.*
- *Check that the forward large gear rotates smoothly.*

(5) Set and tighten the forward end nut. Insert the bolt into the coupling, and fix it in a vice, keeping the spline part upward.
Insert the shaft into the spline of the coupling, fit the spacer, and tighten the nut with a torque wrench.

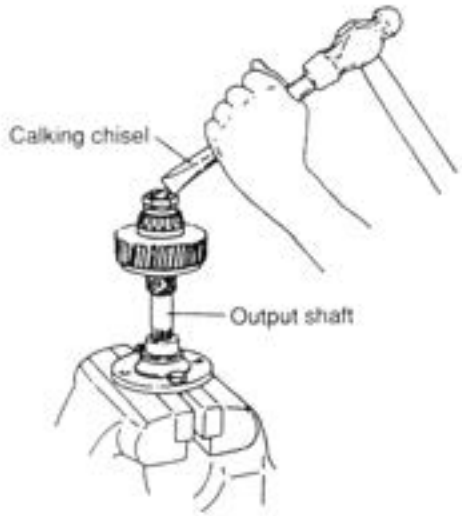



| | |
|---|---|
| Tightening torque | 10±1.5kg-m<br>(98±14.7 N·m) |

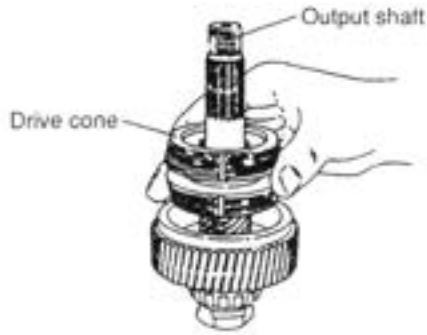
(The same torque applies to both models KM2P and KM3P)

**[NOTICE]**

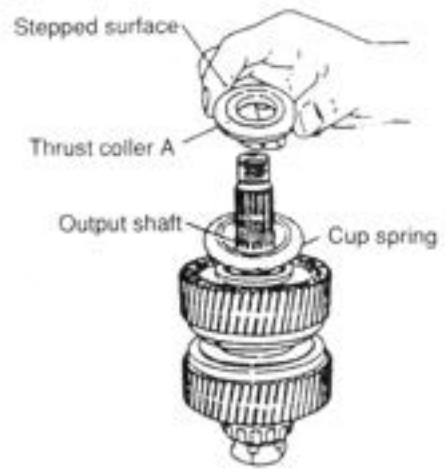
- *Take care as it is a left-handed thread.*
- *Use the reverse side nut used before dismantling at the forward end. This is to provide effective calking to the nut by changing the calking position.*




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




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




**[NOTICE]**

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

### 3.4.5.2 Reassembly of the clutch

(1) Fit 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.

(4) Insert the out put shaft into the clutch case.

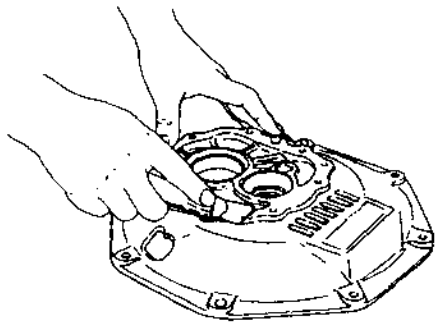
(5) Fit the adjusting plate to the mounting flange, and drive in the outer bearing race.

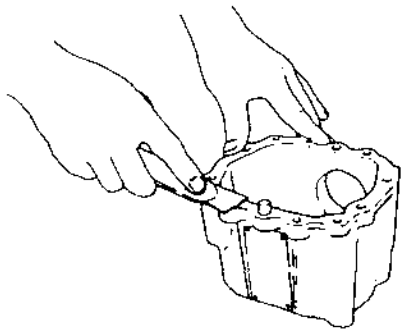
**[NOTICE]**

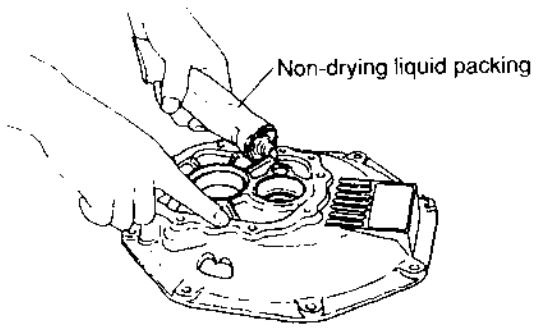
*The outer bearing race can be easily driven in by heating the mounting fainge to about 100℃, or by cooling the outer race with liquid hydrogen.*

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

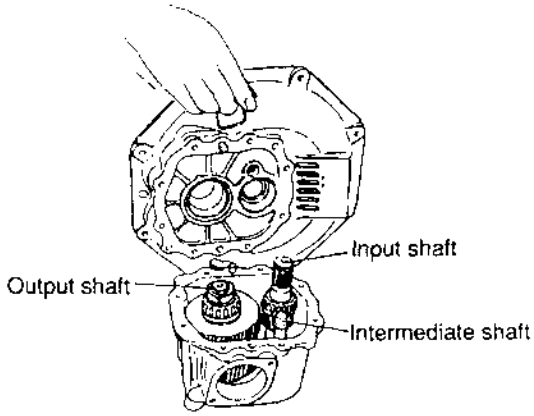
(7) Apply non-drying liquid packing to the matching surfaces of the mounting flange end the case body.








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

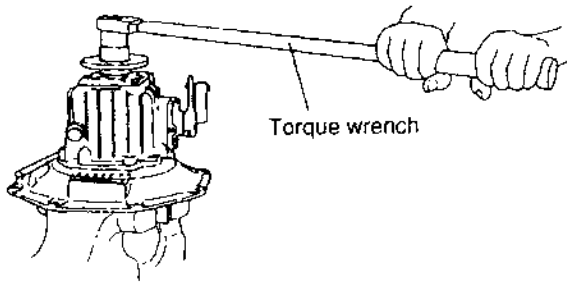


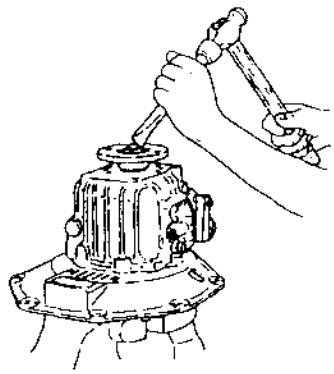

**[NOTICE]**

*Apply non-drying liquid packing to eigher the mounting flange or the case body.*

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

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



**[NOTICE]**

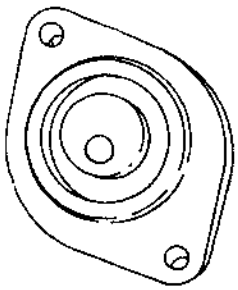
*Take care as it is a left-handed thread.*

| | |
|---|---|
| Tightening torque | 10±1.5kg-m<br>(98±14.7 N·m) |

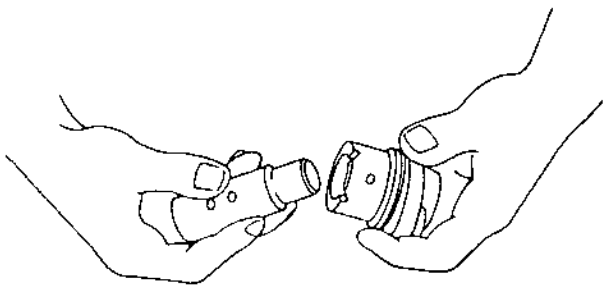
(The same torque applies to both models KM2P and KM3P)

### 3.4.5.3 Reassembly of the shifting device

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



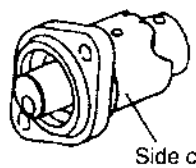
(2) Insert the shift lever shaft to the side cover.

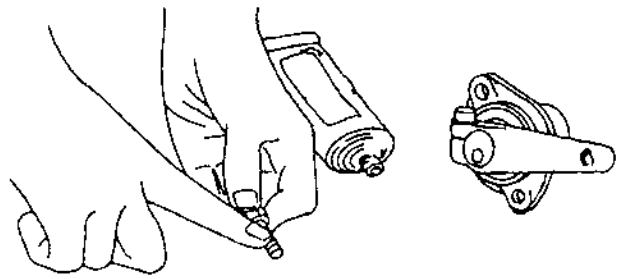


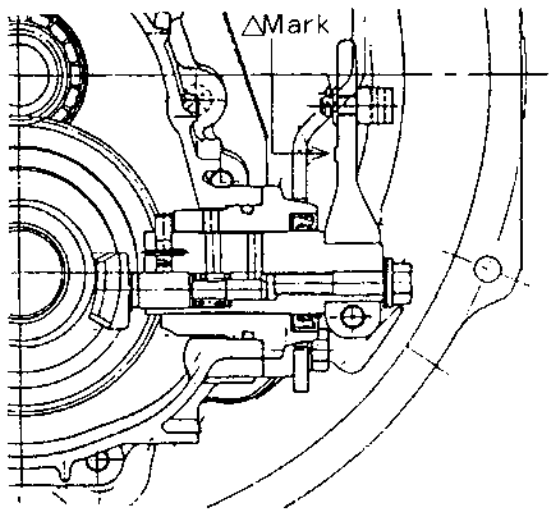
(3) Fit the shift lever to the shift lever shaft.

**[NOTICE]**

*Check the direction of the shift lever △ mark.*






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

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

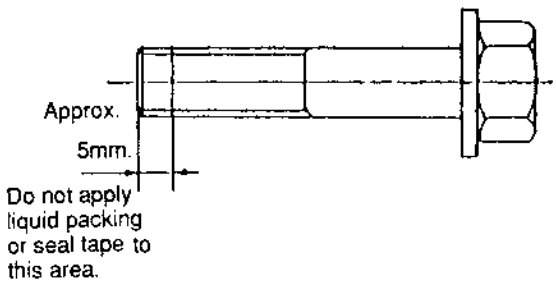
**[NOTICE]**

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

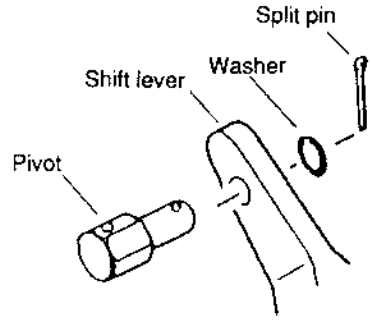
(6) Fit the shim and stopper bolt to the shift lever shaft.

**[NOTICE]**

*Apply non-drying liquid packing or sealtape to the thread of the stopper bolt.*




(7) Fit the pivot to the shift lever.



# 3.5 KM4A

## 3.5.1 Construction

### 3.5.1.1 Construction

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

The construction is simple 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 transmission efficiency is high even under a heavy load. It is also durable and reliable because high grade materials are used for the shaft and gear, and a taper roller bearing is incorporated. Power transmission is smooth because connection with the engine is made through the damper disc.

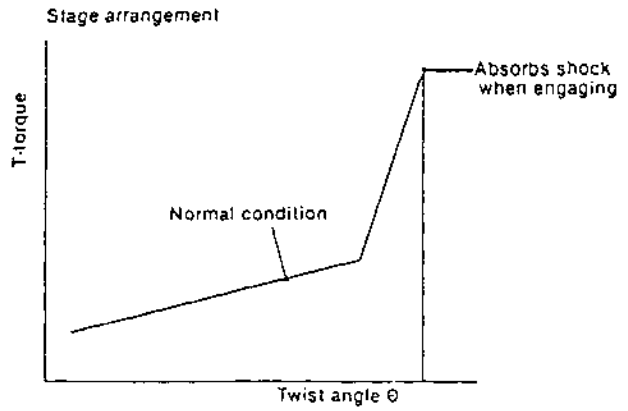
- The drive cone is made from special aluminum bronze which has high wear-resistance and durability. The drive cone is connected with the clutch shaft. The taper angle, diameter of the drive cone, twist angle, and diameter of the involute spline, are designed to give the greatest efficiency, thus ensuring that the drive cone can be readily engaged or disengaged.

- Helical gears are used for greater strength. The 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.

- The damper disc is fitted to the input shaft, so power can be transmitted smoothly. Springs of different strengths are used for the damper disc so that two stages of torque and twist angle are applied. That is, in the first stage, only the weak spring is used, and the strong spring comes into action for a torque higher than a predetermined value.

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




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

- When the load on the propeller is removed, the 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 no 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 pre 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.

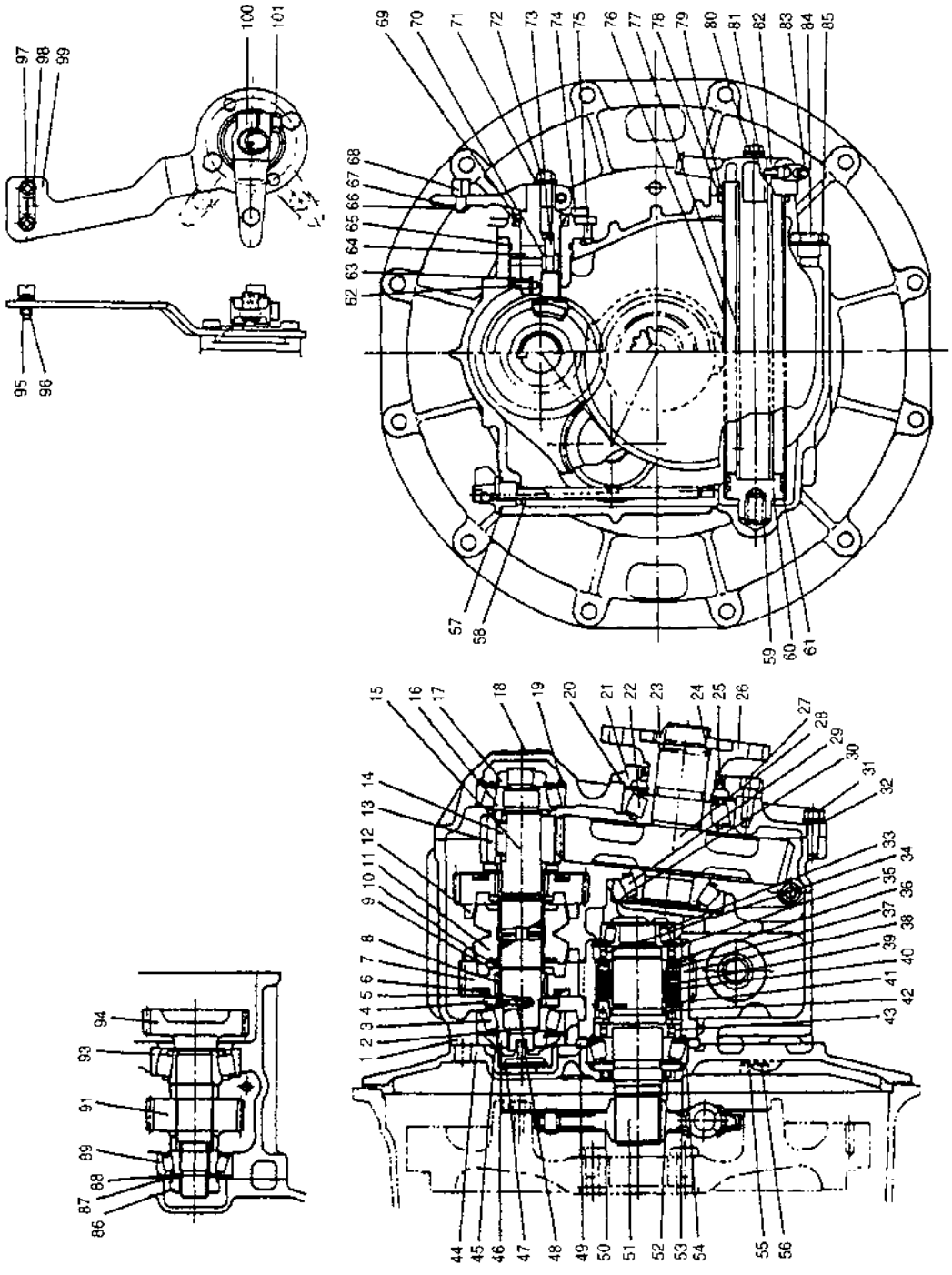
**[NOTICE]**

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

### 3.5.1.2 Specifications of Angle Drive Marine Gear

| Model | | KM4A | | |
|---|---|---|---|---|
| For engine models (standard) | | 4JH3E, 4JH3-TE, 4JH3-HTE | | |
| Down angle | | 7° | | |
| Clutch | | Constant mesh gear with servo cone clutch (wet type) | | |
| Direction of rotation | Input shaft | Counter-clockwise, viewed from stern. | | |
| | Output shaft | Bi-rotation | | |
| Reduction ratio | | 3.30 | 2.63 | 2.14 |
| Remote control | Control head | Single lever control | | |
| | Cable | Morse, 33-C (Cable travel 76.2mm) | | |
| | Clamp | YANMAR Made, standard accessory | | |
| | Cable connector | YANMAR Made, standard accessory | | |
| Output shaft coupling | Outer diameter | $\phi$ 120mm | | |
| | Pitch circle diameter | $\phi$ 100mm | | |
| | Connecting bolt holes | 4-$\phi$ 10.5mm | | |
| Position of shift lever | | Right side, viewed from stern | | |
| Lubricating oil | | Same as Engine lube oil | | |
| Lubricating oil capacity ℓ | | 1.3 | | |
| Lube oil cooler | | Sea-water cooling | | |

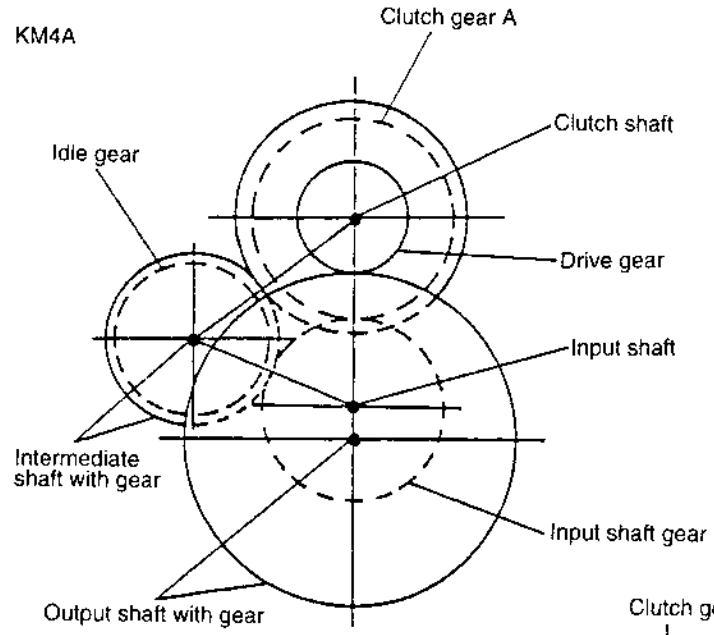
### 3.5.1.3 KM4A Sectional View

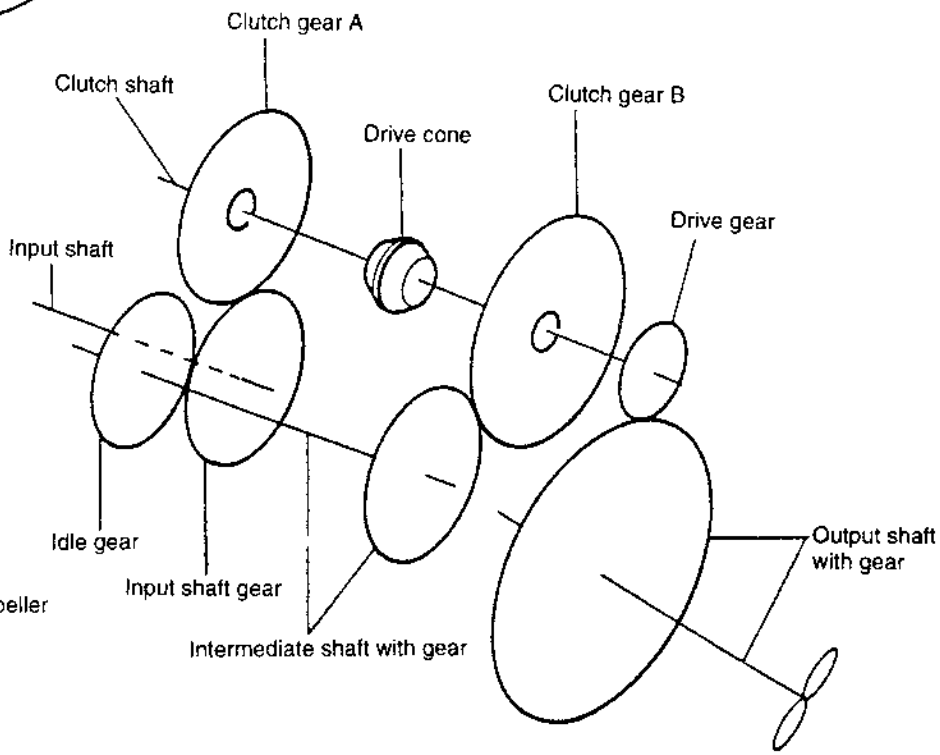


1 Clutch case
2 Shim
3 Bearing
4 Thrust colar(A)
5 Spring retainer
6 Cup spring
7 Clutch gear(A)
8 Needle bearing
9 Thrust collar(B)
10 Snap ring
11 Drive cone
12 Clutch gear B
13 Drive gear
14 Key
15 Clutch shaft
16 Bearing
17 End nut
18 Name Plage
19 Shim
20 Shim
21 Output shaft cover
22 Bearing
23 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 x 30)
75 Side cover
76 Oil-cooler body
77 Pipe
78 Shim
79 O-ring
80 Bolt
81 Washer
82 Cooler
83 Cock
84 Drain plug
85 Washer
86 End nut
87 Washer
88 Shim
89 Bearing
90
91 Idle gear
92
93 Bearing
94 Intermediate shaft gear
95 Washer
96 Lock nut
97 Bolt
98 Cable clamp
99 Cable blacket
100 Shift lever
101 Bolt (M8 x 25)

### 3.5.1.4 Power Transmission System

#### 1) Arrangement of shafts and gear



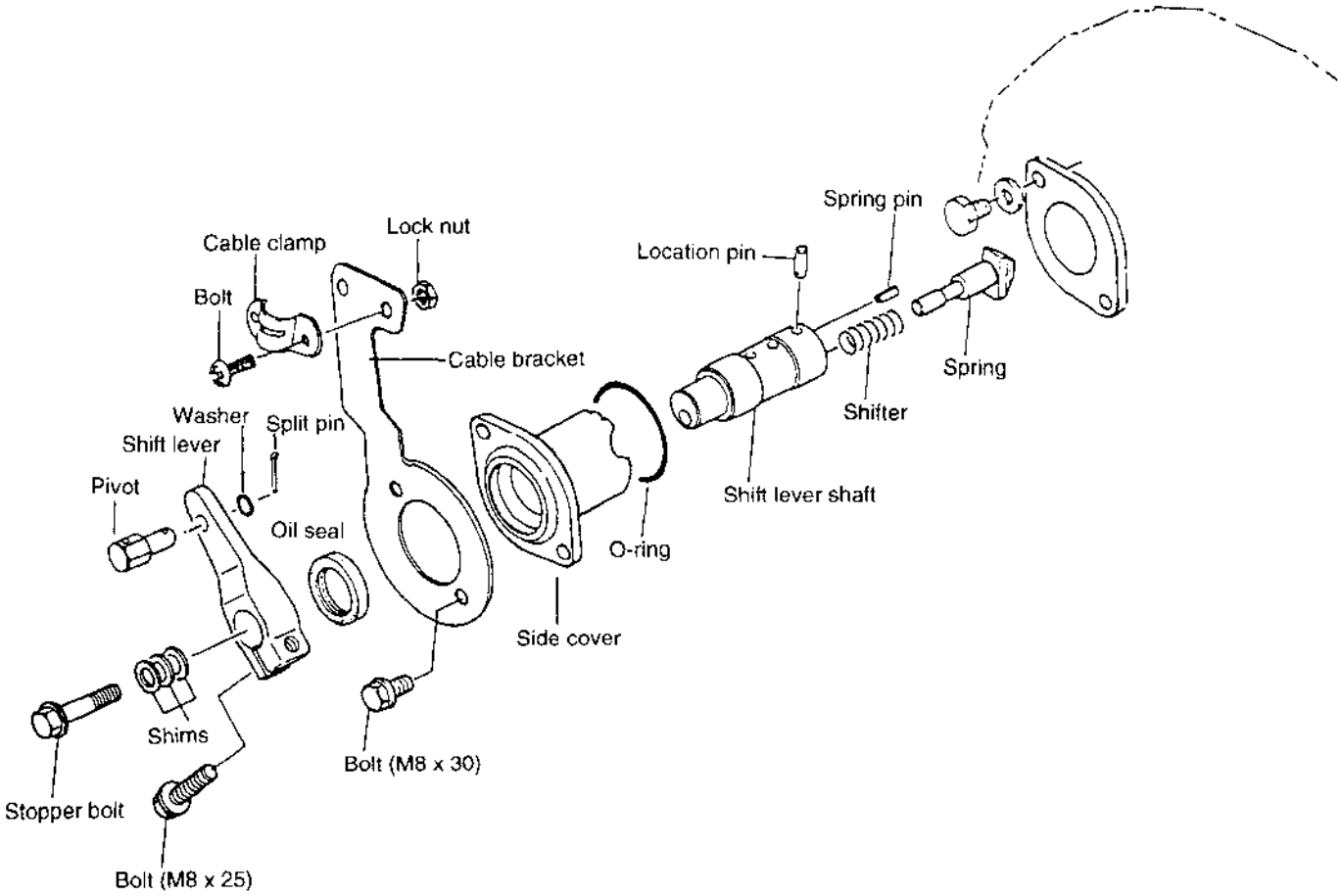

Shaft arrangement viewed from the propeller

#### 2) Reduction ratio

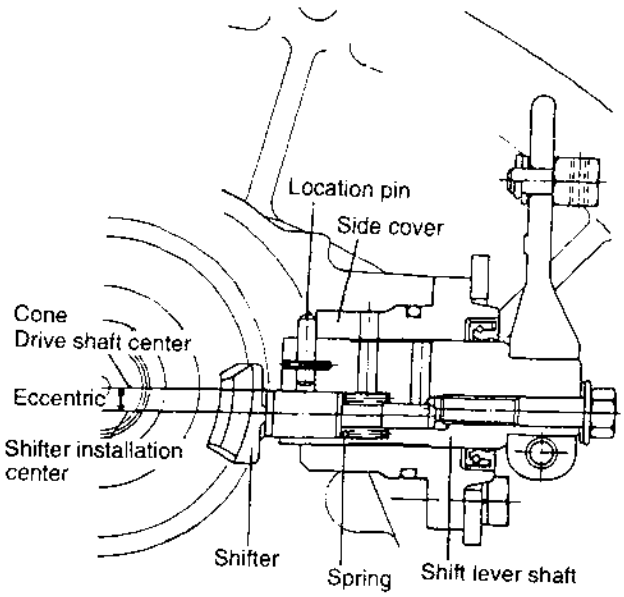
| Input shaft gear | Clutch gear | | Intermediate shaft | | Drive gear | Output shaft with gear | Reduction ratio |
|---|---|---|---|---|---|---|---|
| | A | B | Idle gear | Shaft gear | | | |
| 39 | 41 | 45 | 31 | 34 | 30 | 61 | 2.14 |
| | | | | | 26 | 65 | 2.63 |
| | | | | | 22 | 69 | 3.30 |

## 3.5.2 Shifting Device

### 3.5.2.1 Construction of shifting mechanism




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

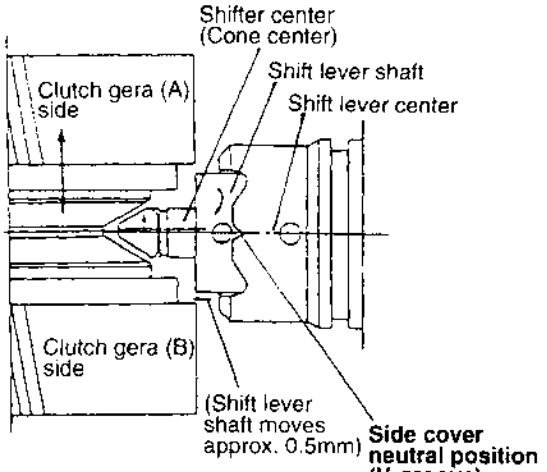



**[NOTICE]**

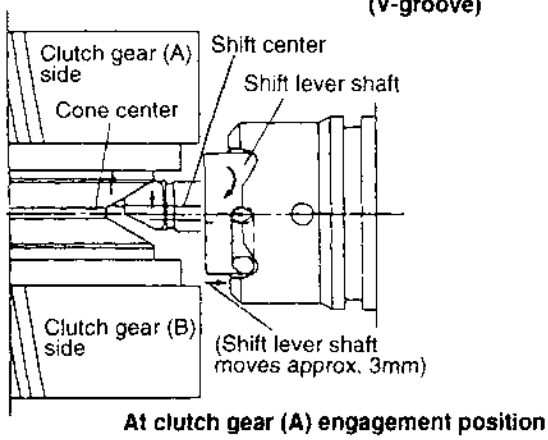
1. *Clutch gear (A) position: clockwise propeller rotation viewed from propeller side (C.C.W.)*
2. *Clutch gear (B) posision: Counterclockwise propeller rotation viewed from propeller side (C.W.)*

### 3.5.2.2 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).



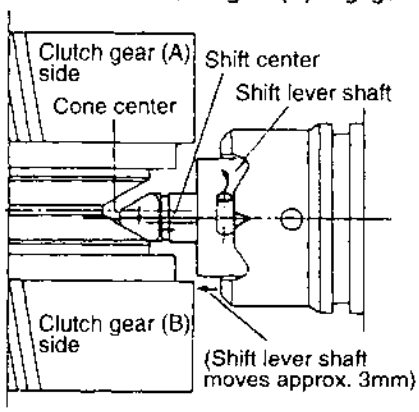

When the location pin of the shift lever shaft falls into the clutch gear (A) position groove on the side cover, the shift lever shaft moves approx. 3mm to the shift lever side, and the shifter starts to press the drive cone V-groove to the clutch gear (A) side by spring force.



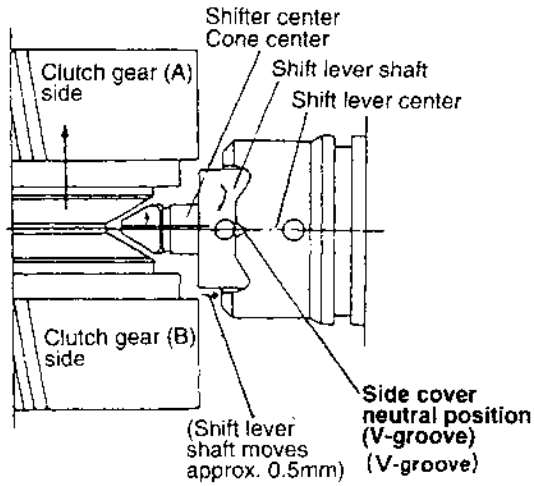

**At clutch gear (A) engagement position**

### 3.5.2.3 Engagement and disengagement of clutch (Clutch gear (A) ⇒ Neutral, Clutch gear (B) ⇒ Neutral)

When the shift lever is moved to the clutch gear (A) position from the neutral position, the shift lever shaft starts to revolve, and the location pin disengages from the clutch gear (A) position groove on the side cover. (The shift lever shaft moves 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.

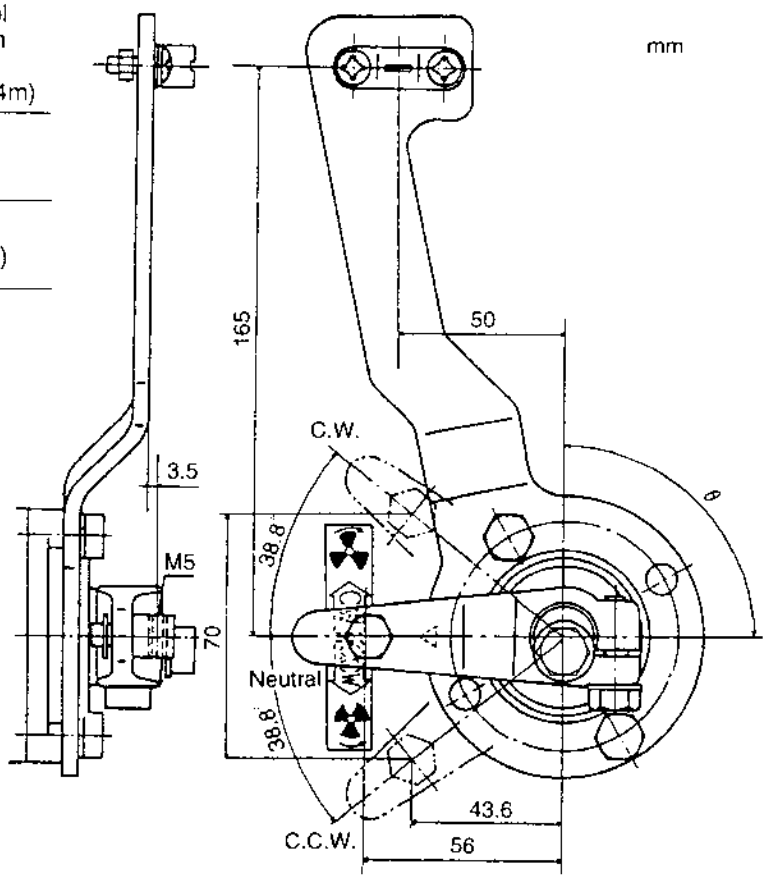



Further, when the shift lever shaft starts to revolve, and the positioning pin falls into the neutral V-groove position of the side cover (the shift lever shaft travels approx. 5mm to the shift lever side), the shifter moves to the shift lever side (to the spring side) while moving the V-groove of the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



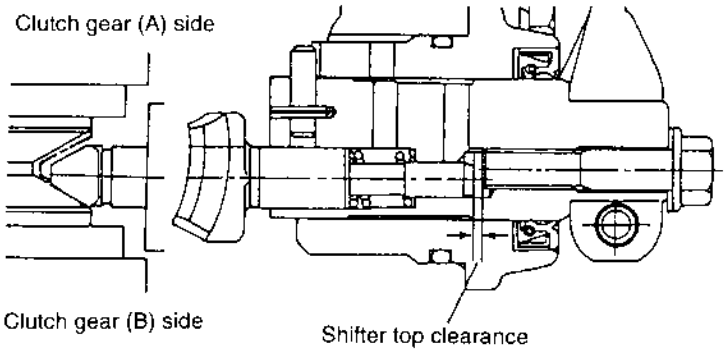
### 3.5.2.4 Clutch shifting force

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




### 3.5.2.5 Adjustment of shifting device

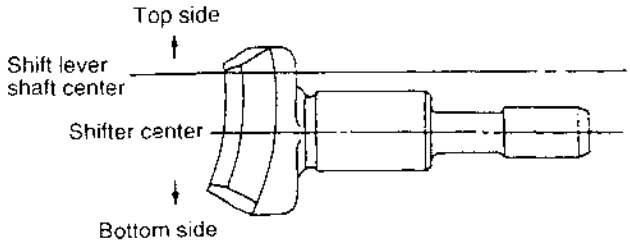
Whenever the side cover, shift lever shaft, shifter, stopper bolt or drive cone is replaced, be sure to adjust the clearance between the shifter end and the stopper bolt with shims. When the adjustment of this clearance is inadequate, the drive cone may not connect properly when the shift lever is moved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



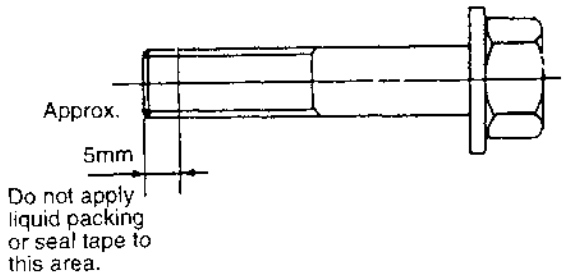

(2) Turn the shift lever 10 ~ 15 degrees eigher to the clutch gear (A) or clutch gear (B) position from the neutral position.
(3) Measure the L-distance between the shift lever shaft and surface and the shifter end.
(4) Measure the H-distance (the distance from the neck of the stopper bolt to its end) .
(5) Obtain the shim thickness "T" by the following formula.

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

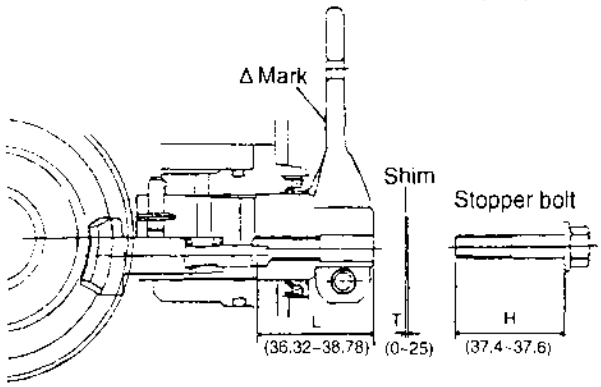
**[NOTICE]**
*Shim set includes one each of 1mm, 0.4mm, 0.3mm, 0.25mm shims. (YANMAR Part No.177088-06380)*

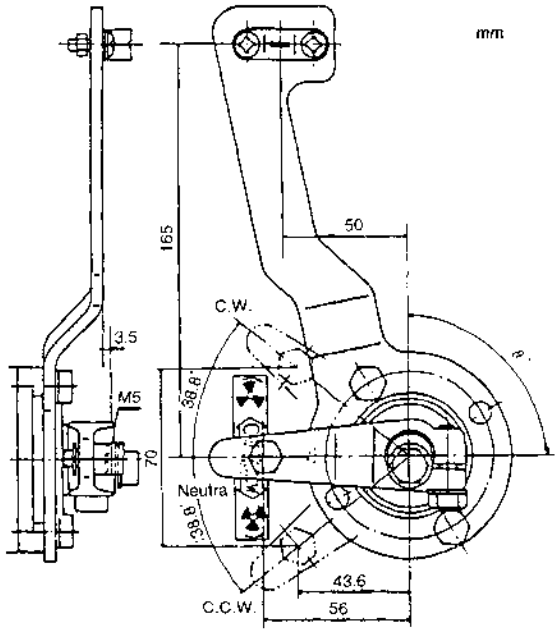
(6) Insert shim (s) of proper thickness to the stopper bolt side and tighten to the shift lever shaft.

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




(mm)




**[NOTICE]**
*Shift lever must be installed in the direction of the Δ - mark ensuring the specified installation angle ( # ) .*

*# = 90°*

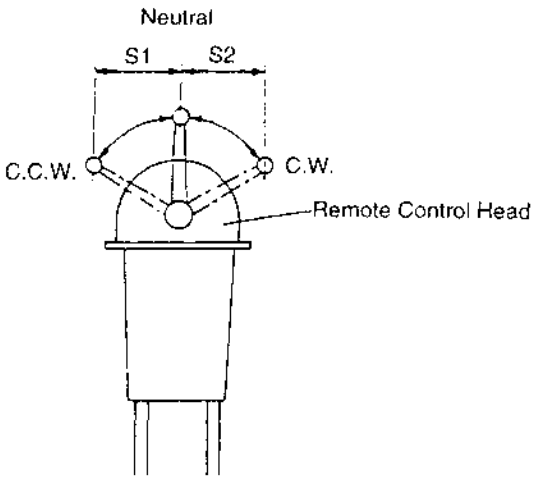
### 2) Inspect for the following points (to be inspected every 2-3 months)

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

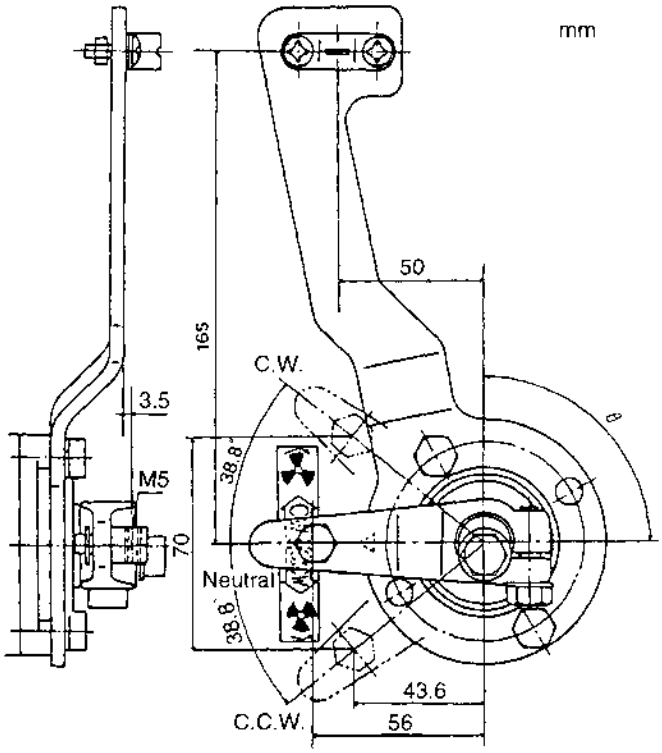
(2) Looseness of the attaching nut of the cable connector and the shift lever.

### 3.5.2.6 Adjustment of the remote control head Marine gearbox control side

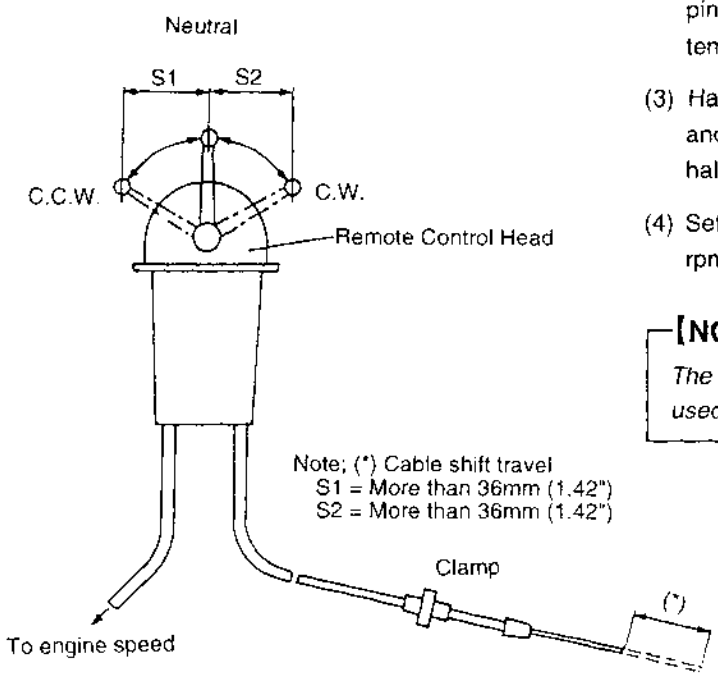
(1) Equal distribution of the control lever stroke.




The stroke between the neutral position → C.W. position (S2) , and the neutral position → C.C.W. position (S1) must be equalized.
When either stroke is too short, clutch engagement becomes faulty.




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




### 3.5.2.7 Cautions

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

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

(3) Harl-clutch operation is not possble with this design and construction. Do not use with the shift lever halfway to the engaged postion.

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

**[NOTICE]**

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

## 3.5.3 Inspection and Servicing

### 3.5.3.1 Clutch case and cover

(1) Check the clutch case and cover for carcking with a Ttest 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 teh wear limit.

### 3.5.3.2 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.

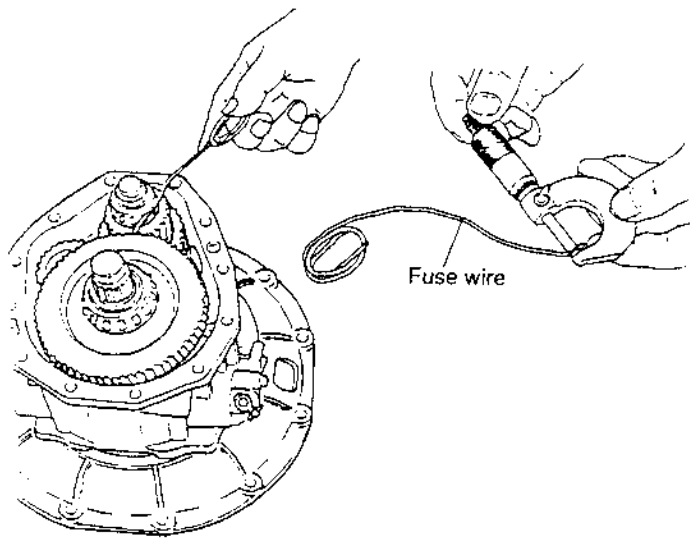
### 3.5.3.3 Gear

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 when it is worn beyond the wear limit.

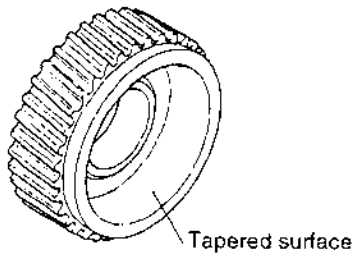



mm

| | Maintenance Standard | Wear limit |
|---|---|---|
| All gears | 0.08~0.16 | 0.3 |

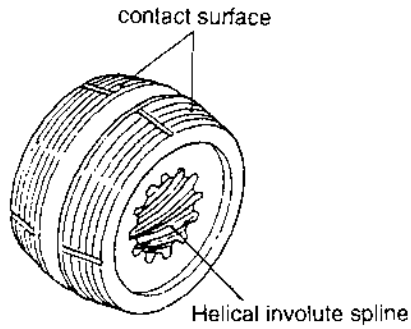
### 3.5.3.4 Clutch gear (A) and (B)

(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.



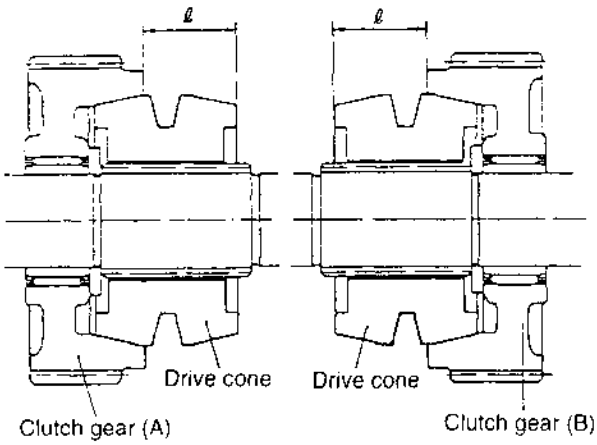

### 3.5.3.5 Drive cone

(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.



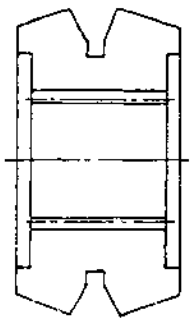

mm

| | 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.

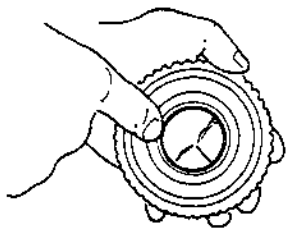


**[NOTICE]**

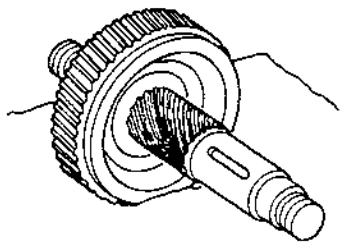
*When replacing the drive cone, the drive cone and clutch gears (A) and (B) must be lapped prior to assembly.*
*The lapping procedure is described below.*

### 1) Lapping Procedure for Drive Cone

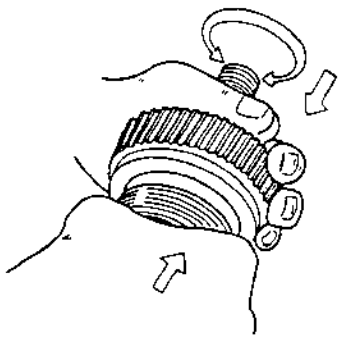
(1) Coat the lapping powder onto the cave of the clutch gear (Lapping powder: 67 micron silicon carbide = 280)



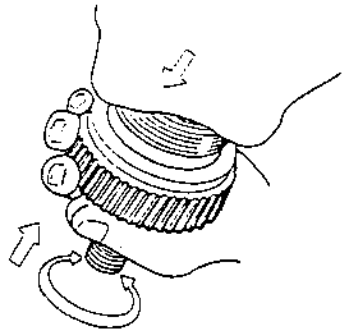
(2) Set hte clutch gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft



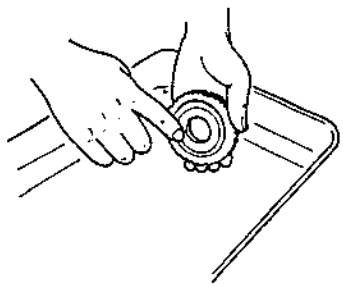
(3) Lap the clutch gear's cave and drive cone, pushing them together by hand

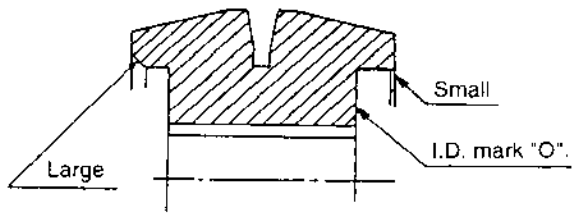


(4) Push and turn the clutch gear about 5 times both clockwise and counter-clockwise.



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

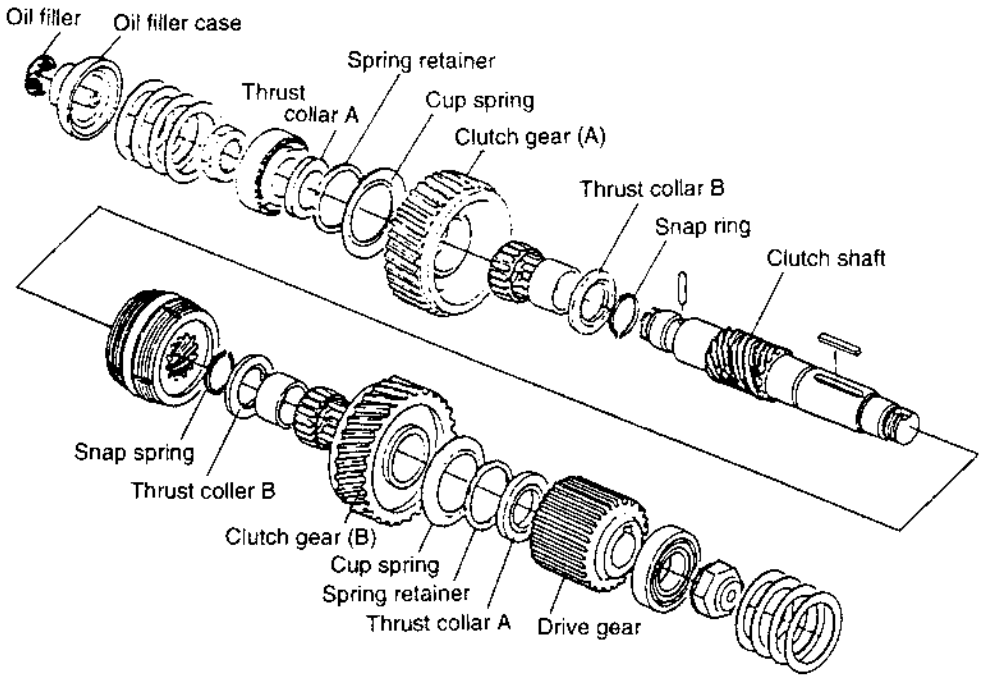





**[NOTICE]**

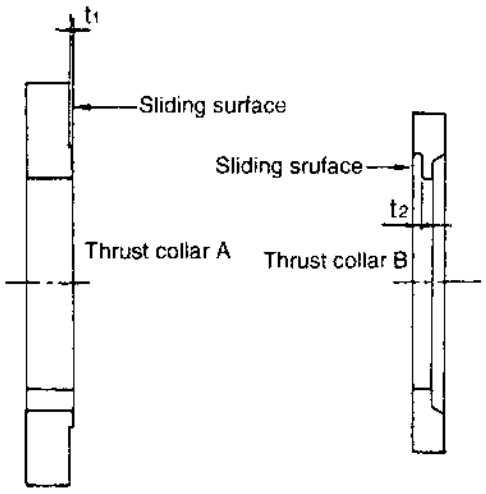
*Do not mix the combination of the lapped parts.*
*The washing oil should be changed frequently in order to prevent residual powder being left on the parts.*
*When assembling the drive cone, be sure to check its alignment.*
*The large chamferring face should be on the clutch gear (A) side.*

### 3.5.3.6 Thrust collar A and B for clutch shaft




(1) Visually inspect the sliding surface of thrust collar A or B to check for signs of overheating, scoring, or cracks. Replace the collar if any abnormal condition is found.

(2) Measure the thickness of thrust collar A or B, and replace it when the dimension exceeds the specified limit.



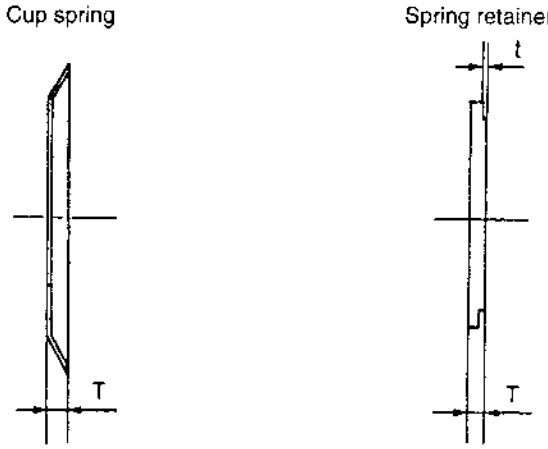

mm

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

### 3.5.3.7 Cup spring and spring retainer

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

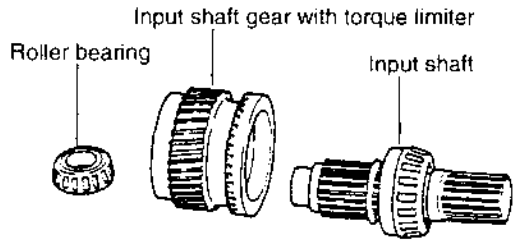
(2) Measure the free length of the cup spring and the thickness of the spring retainer. If the length or the thickness deviates from the standard size, replace the part.




mm

| | 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 |

### 3.5.3.8 Input shaft




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

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

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

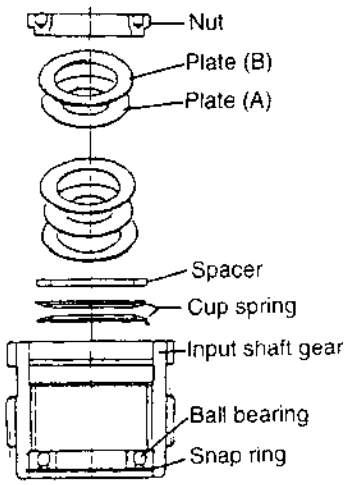



**Plate (A) and (B)** mm

| 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 |

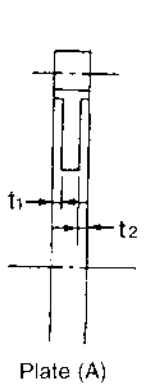


Plate (A)

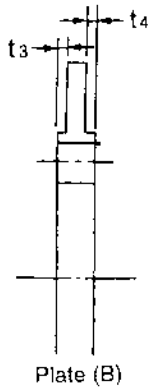
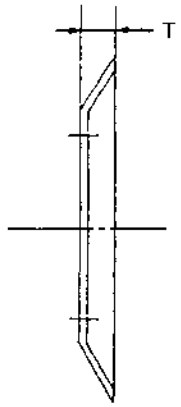


Plate (B)

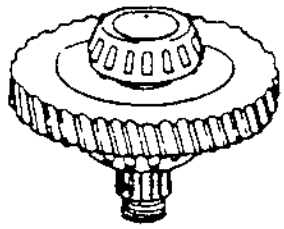
mm

| | Standard | Lmit |
|---|---|---|
| Cup spring, T | 2.75~3.05 | 2.6 |



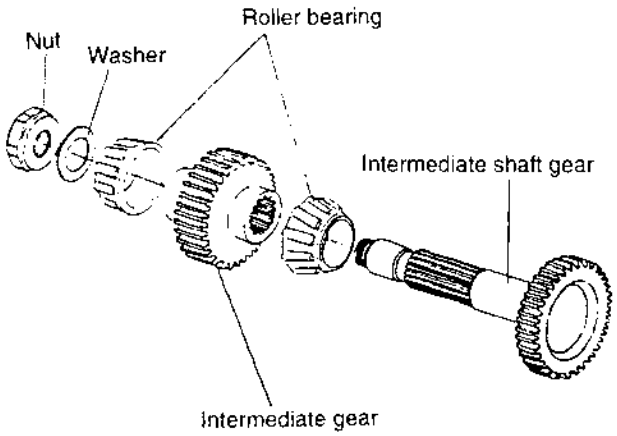
Cup spring

### 3.5.3.9 Output shaft

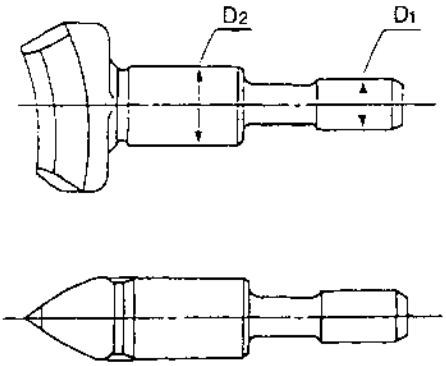


(1) Visually inspect the spline, oil seal and O-ring, and repair or replace a part when any abnormal condition is found on its surface.

### 3.5.3.10 Intermediate shaft




(1) Visually inspect the spline and repaire or replace a part when any abnormal condtion 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 |

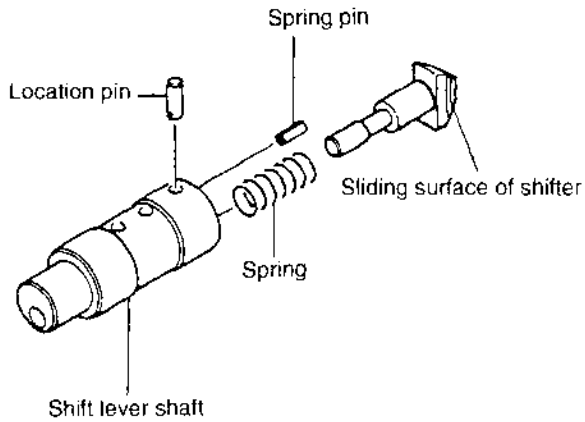
**2) Shift lever shaft and location pin**

(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 and the shifter insertion hole. Replace the part if the size deviates from the standard value.

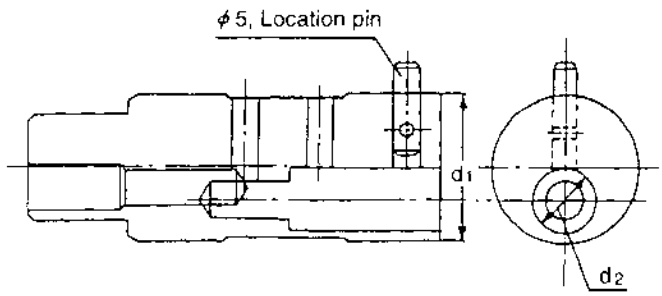
### 3.5.3.11 Shifting device

**1) Shifter**




(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.




mm

| | Standard | Limit |
|---|---|---|
| $d_1$ | 27.959~27.98 | 27.90 |
| $d_2$ | 12.0~12.018 | 12.05 |
| Side cover, Shift insertion hole | 28.0~28.021 | 28.08 |

### 3) Shifter spring

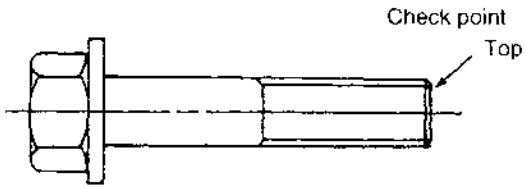
(1) Check the spring for scratches or corrosion.

(2) Measure the free length of the spring.

| Shifter spring | Standard | Limit |
|---|---|---|
| Free length | 22.6mm | 19.8mm |
| Spring constant | 0.854kg/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.

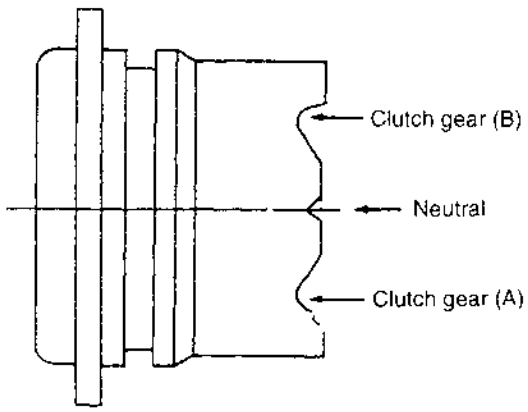



### 5) Side cover and oil seal

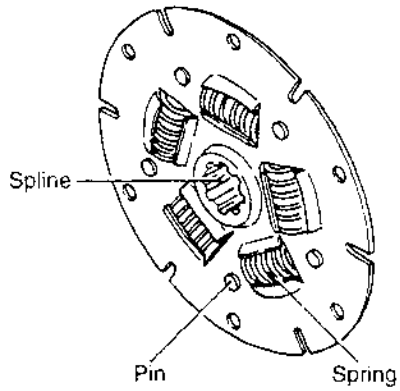
(1) Check the neutral, clutch gear (A) and clutch gear (B) position grooves. Replace if the grooves are worn.

(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.




## 3.5.3.12 Damper disc




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

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

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

(4) Whenever a crack or damage to the spring slot is found replace the defective part with a new one.

### 3.5.3.13 Shim adjustment for output and input shafts

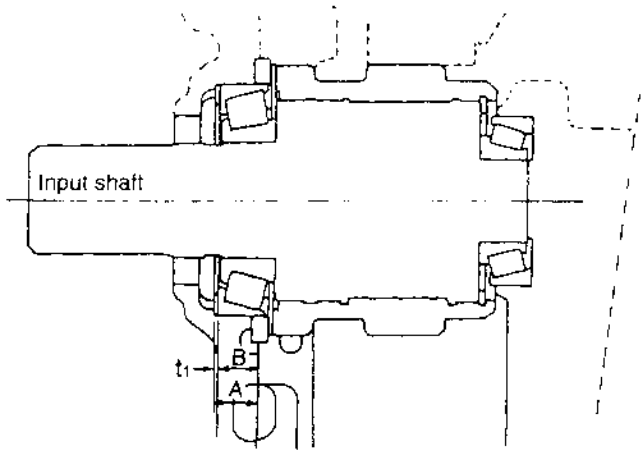
Check the thickness of the shims for the intermediate, clutch, input and output shafts. When the component parts are not replaced after dismantling, the same shims can be reused. When the clutch case, mounting flange and clutch case cover or any one of the following parts it replaced, the shim thickness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

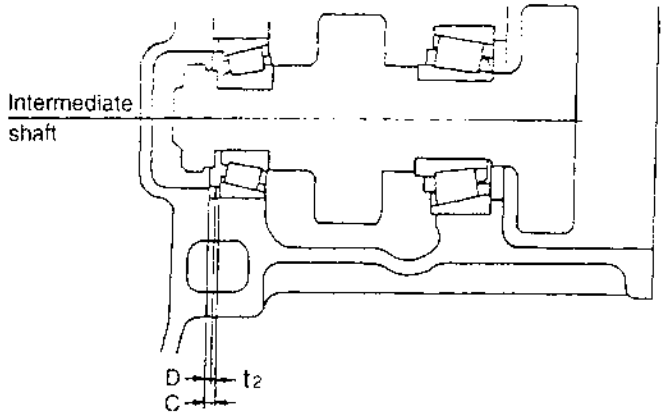
Thickness of Shim $t_1$




(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.

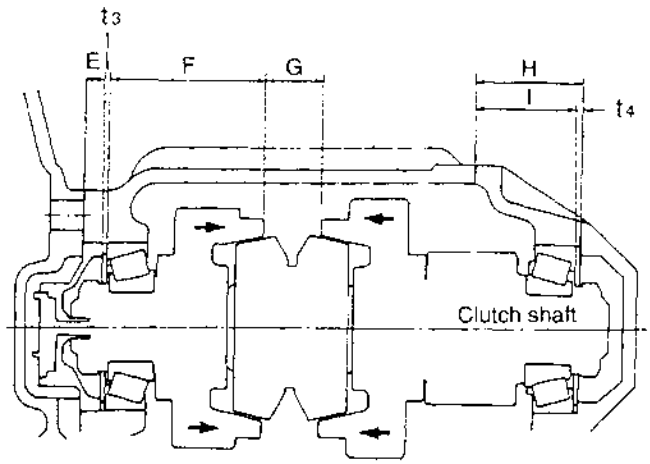
$$t_3 = \left(78 - E - F - \frac{G}{2}\right)^{\pm 0.05}$$

**[NOTICE]**

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

Then measure distances H and I.

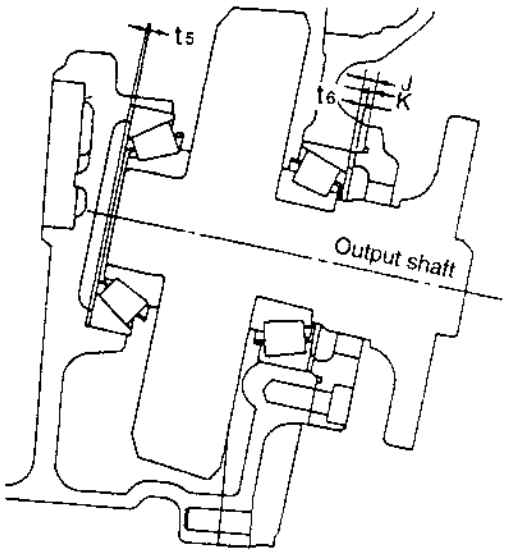
$$t_4 = (H - I)^{\pm 0.05}$$



(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 distances J and K.

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




(5) Standard size of parts

mm

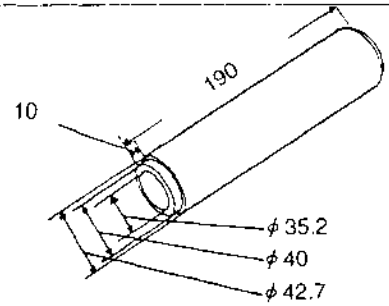
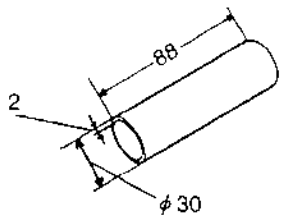
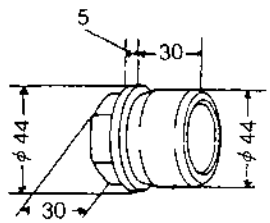
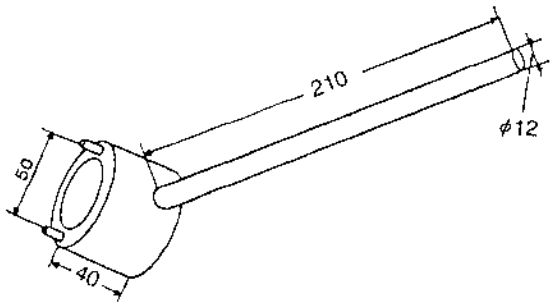
| A | B | C | D | E | F | G | H | I | J | K | Drive cone neutral center position |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14.0~ 14.2 | 11.4~ 12.9 | 2.3~ 3.7 | 1.9~ 2.1 | 7.4~ 7.5 | 57.8~ 58.7 | 20.3~ 21.2 | 39.9~ 40.3 | 37.7~ 39.5 | 3.6~ 4.7 | 2.4~ 2.6 | 78 |

**[NOTICE]**

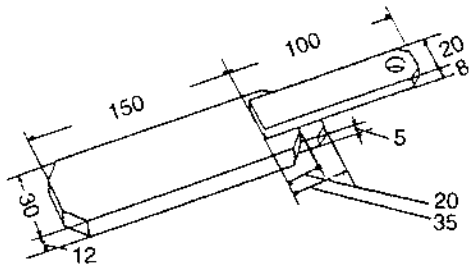
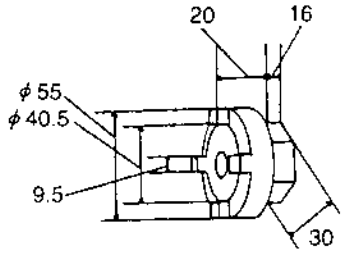
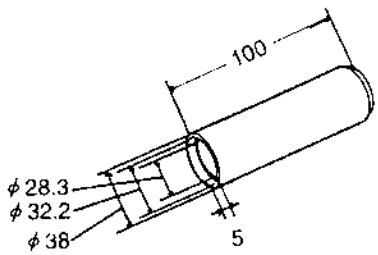
*Compare your measurements with the above standard size. If your measurements differ greatly from the standard sizes, the measurements may not be correct. Check and measure again.*

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

## 3.5.4 Special Tools

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

## Special tools

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

## 3.5.5 Disassembly

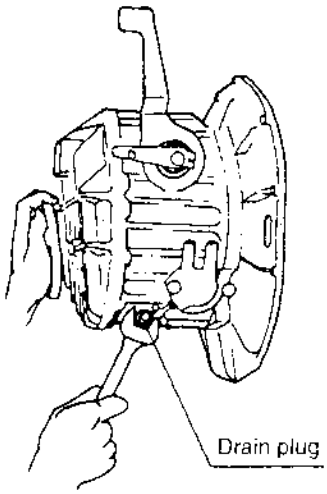
### 3.5.5.1 Disassembling the clutch and accessories.

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

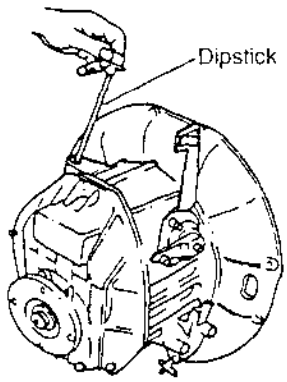
(2) Dismount the clutch main body from the mounting flange.

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

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

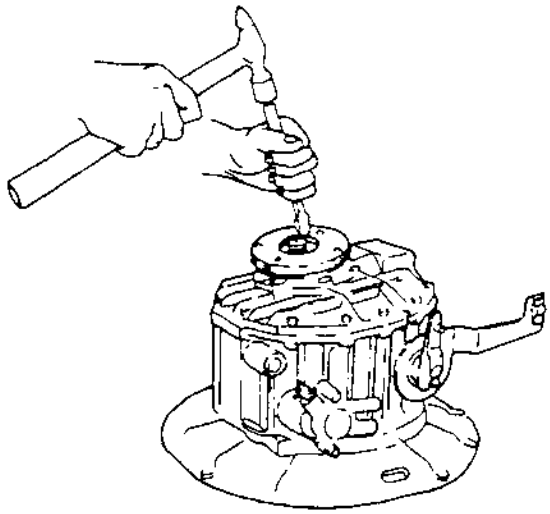



(5) Remove the dipstick.



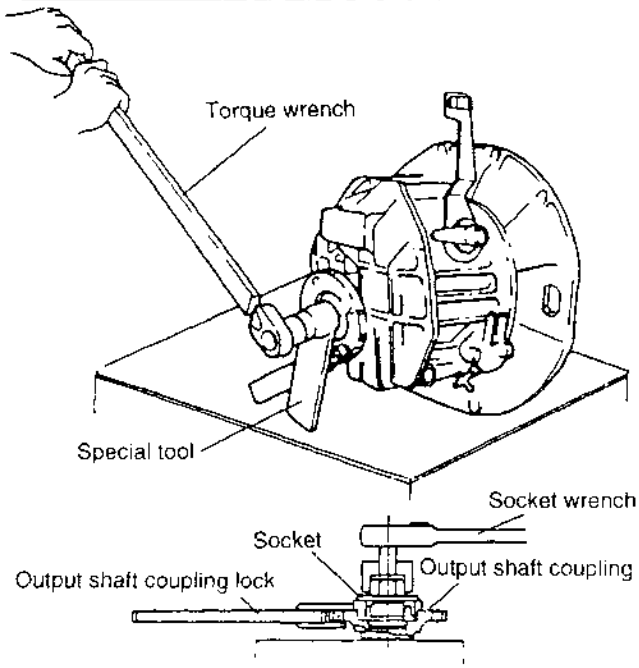

(6) Remove the end nut and output shaft coupling

1) loosen the calking of the endnut.

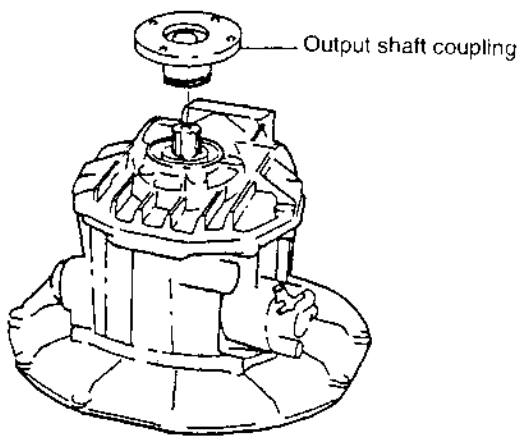


**[NOTICE]**

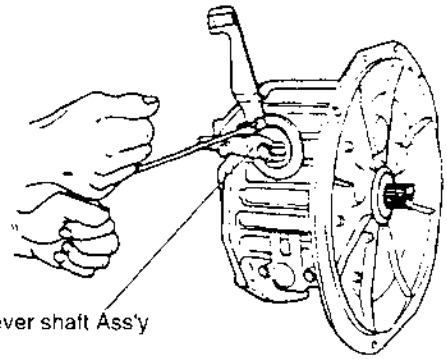
*Loosen the endnut with the special tool and a torque wrench.*




2) Remove the output shaft coupling

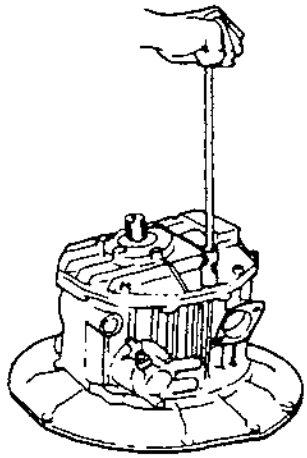


(7) Remove the fixing bolts on the side cover or clutch case, and also remove the shift lever shaft assembly.

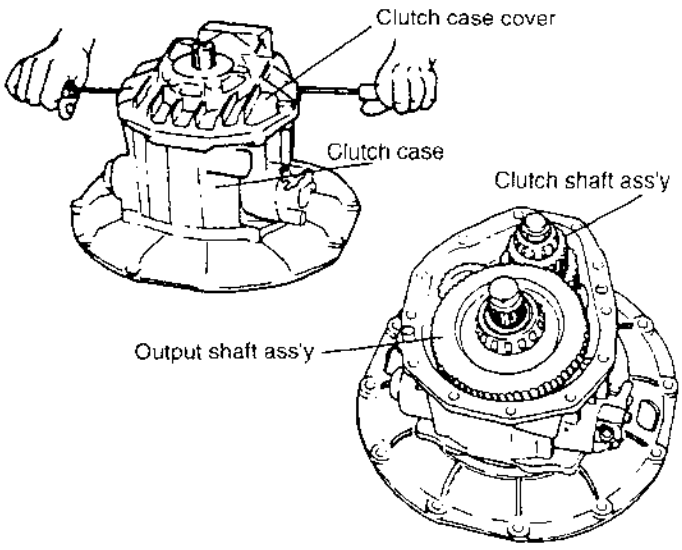



(8) Remove the bolt of the clutch case cover

1 Remove the bolt of the clutch case cover

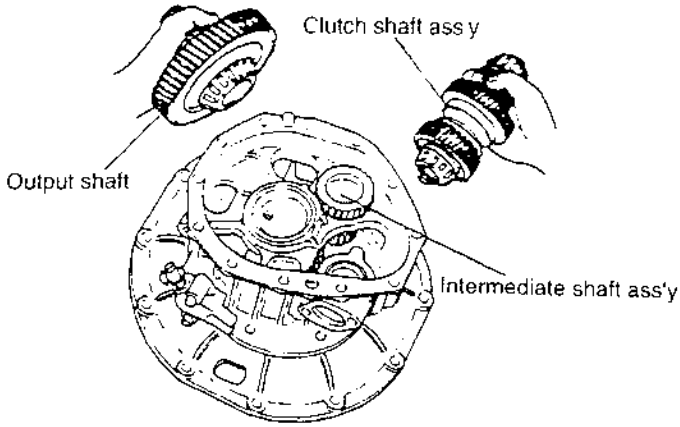


2 Remove the clutch case cover from the clutch case.



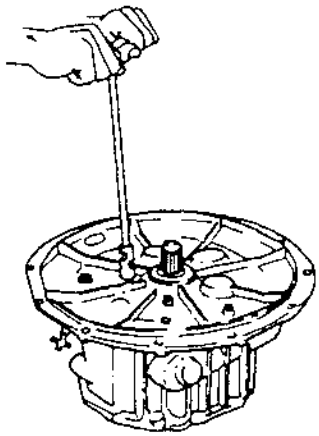

*NOTE : To remove the case cover and the case, insert two drivers into the two depressed points at the joint between the case cover and the case. This makes removal easy.*

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



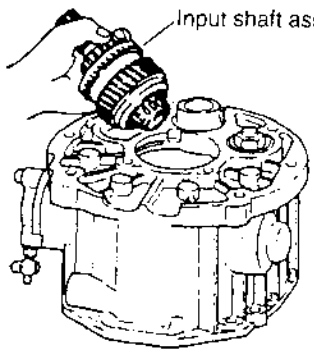

(10) Removing the mounting flange

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



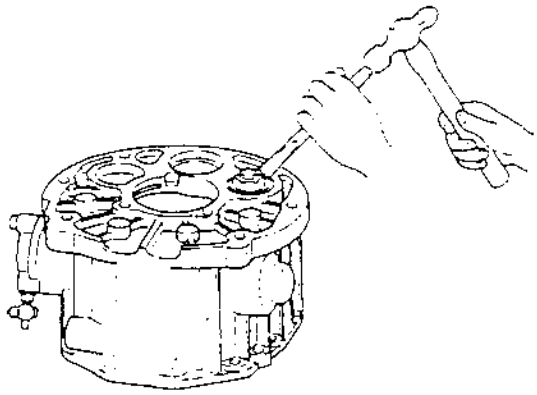
(11) Removing the input shaft assembly.

Draw out from the mounting flange side of the case.

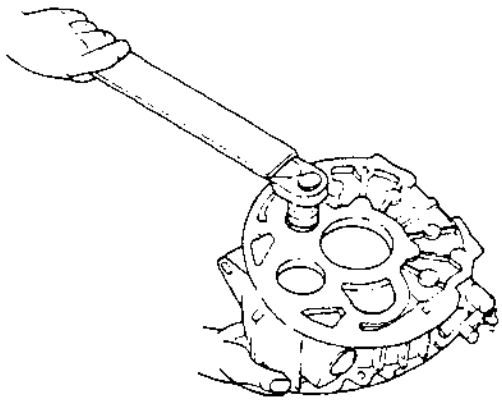


(12) Removing the intermediate shaft.

1 Loosen the calking of locknut of the intermdiate shaft.



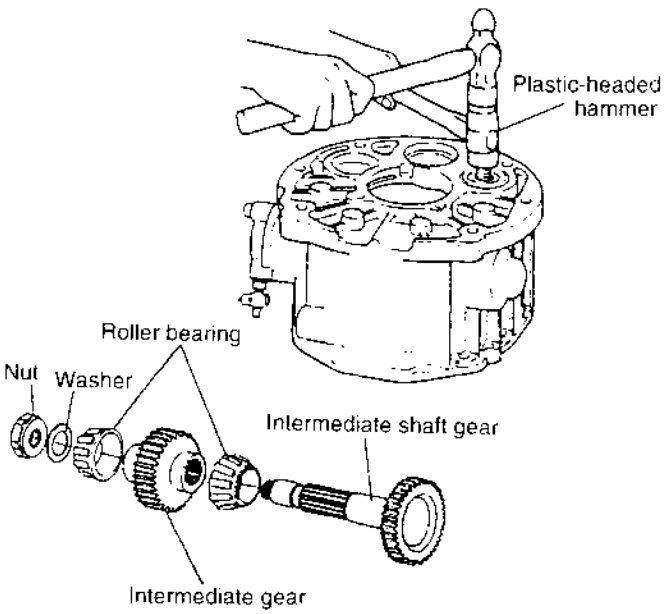
2 Remove the locknut.



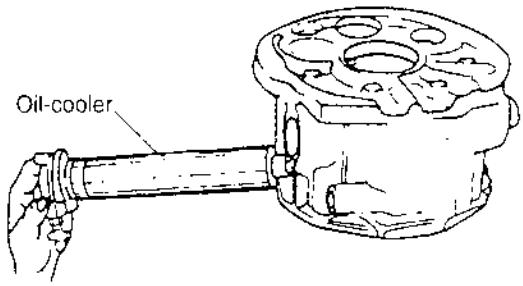
**[NOTICE]**

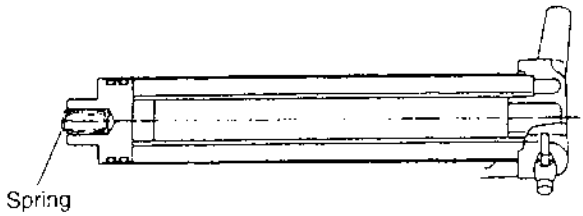
*Thread of the locknut is left-handed.*

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

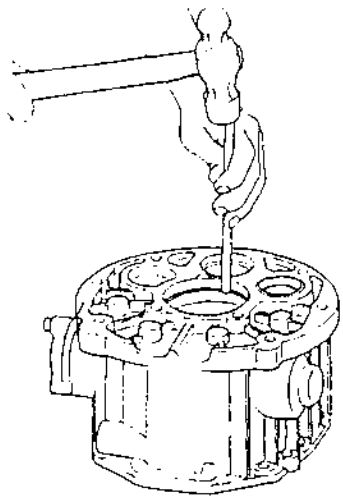



(13) Removing the oil-cooler.



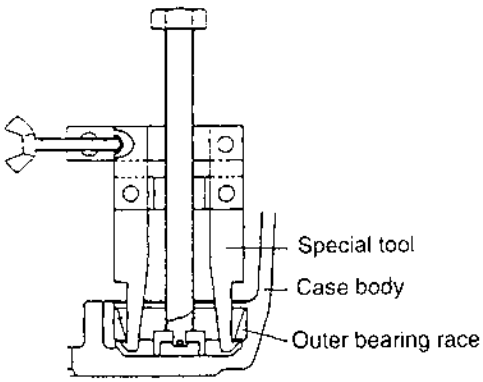

(14) Draw out the outer bearing races.



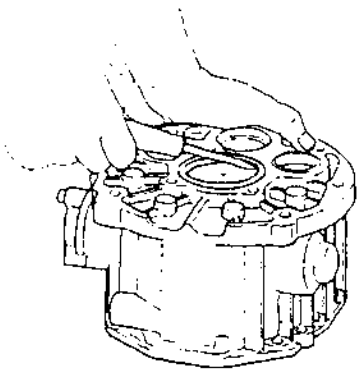
①Remove the outer bearing races of the mounting flange, the case cover and the case.

**[NOTICE]**

*Remove the outer bearing races with a special tool.*



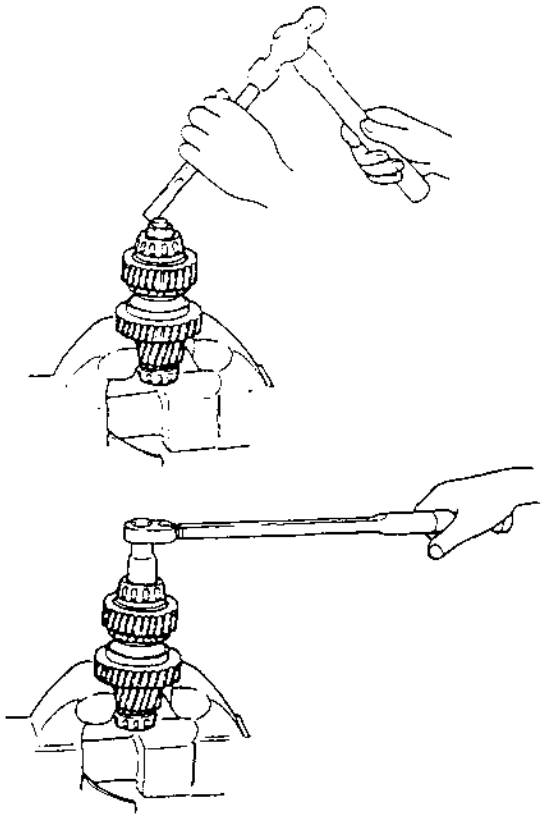

(15) Remove the oil seals of the mounting flange and the case cover.



### 3.5.5.2 Disassembling the clutch shaft.

**1) Clutch gear (A) side**

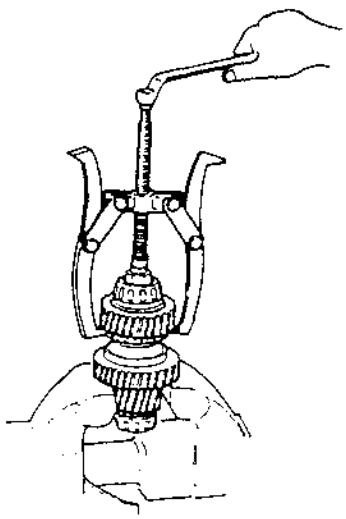
(1) Lossen the calking of the end nut and remove the nut. Remove the nut by a torque wrench, fixing the clutch shaft in a vice.



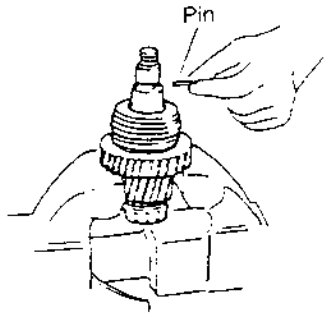
**[NOTICE]**

*Remember that he nut has a left-handed thread.*

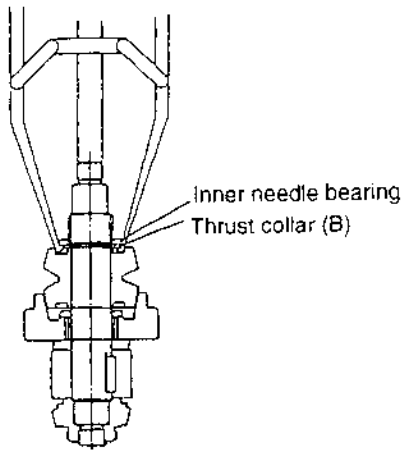
(2) Take out the clutch gear (A) , thrust collar (A) , cup spring, spring retainer and inner bearing trace. The clutch gear (A) must be withdrawn using a pulley extracter, with the clutch shaft fixed in a vice.



(3) Remove the pin

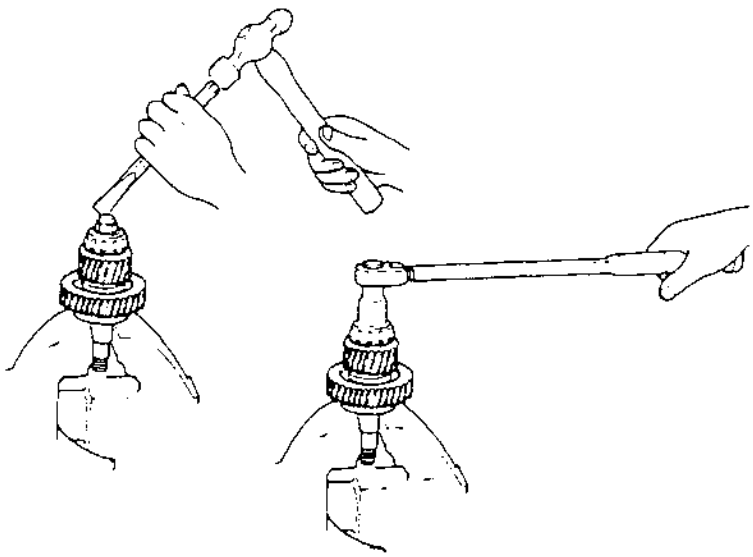



(4) Withdraw the trust collar (B) , inner needle bearing by pulley extractor.




**2) Clutch gear (B) side**

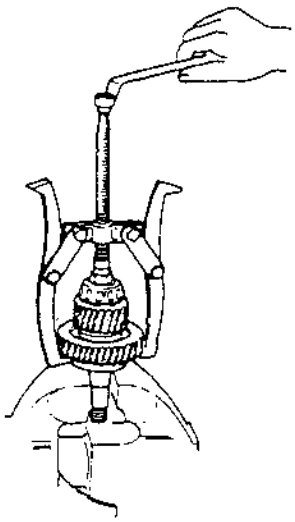
(1) Loosen the calking of the end nut and remove the nut. Remove the nut by a torque wrench, with the clutch shaft fixed in a vice.



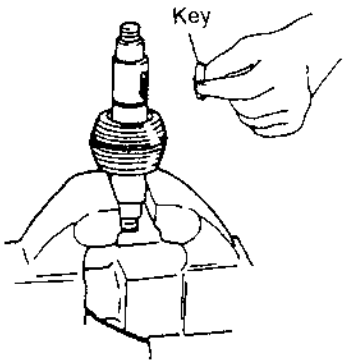
**[NOTICE]**

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

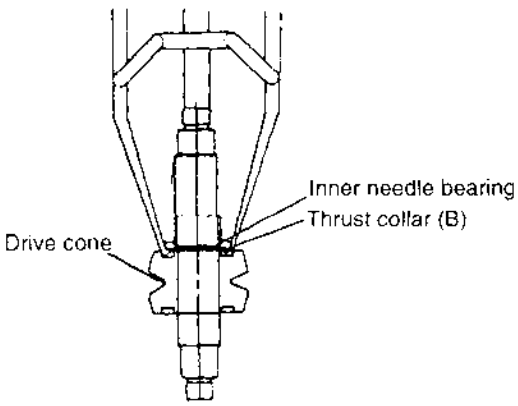
(2) Withdraw the large gear (B), thrust collar (A), cupspring, spring retainer, drive gear and inner bearing race.
Use a pulley extracter, with the clutch shaft fixed in a vice.



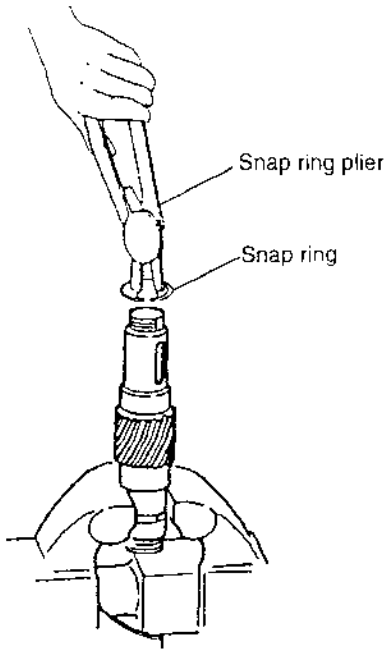
(3) Remove the key



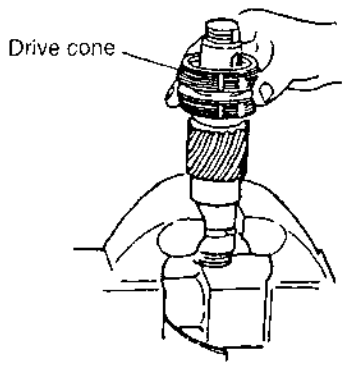

(4) Withdraw the thrust collar (B) and inner needle bearing race with the pulley extractor.




(5) Remove the snap rings

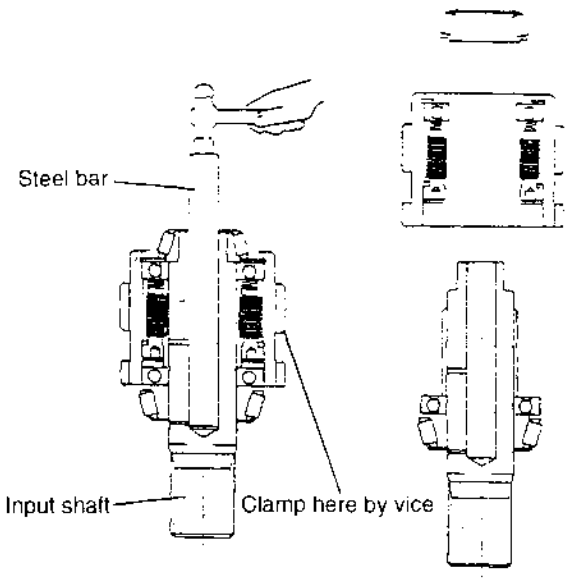



(6) Draw out the drive cone.

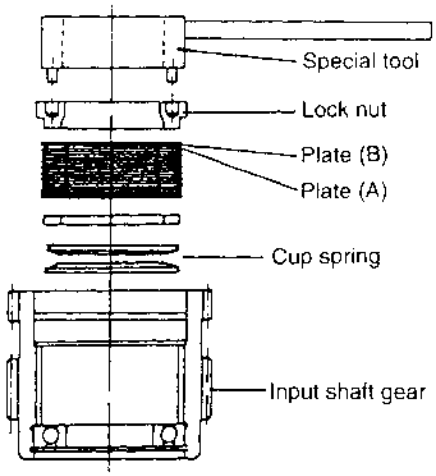


### 3.5.5.3 Disassembling the input shaft.

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

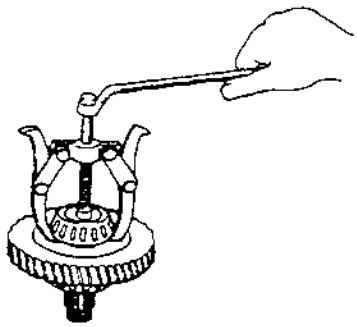



(2) Fix the input shaft gear in a vice, and remove the lock nut with a special tool.



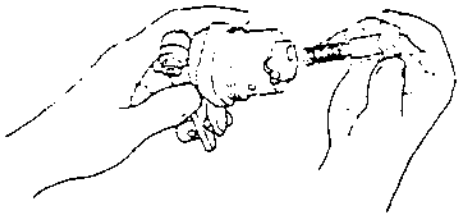

### 3.5.5.4 Disassembling the output shaft

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

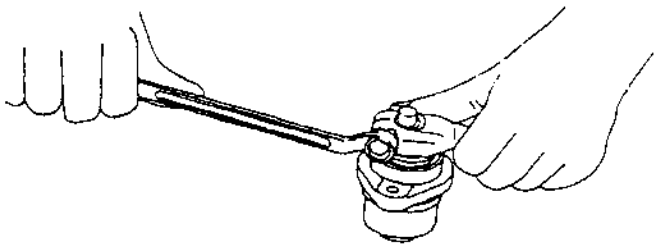


## 3.5.5.5 Disassembling the shifting device

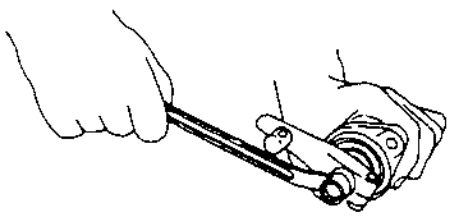
(1) Take out the shifter and shifter spring



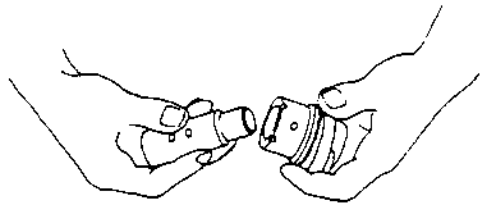
(2) Remove the stopper bolt of the shifter and shim.



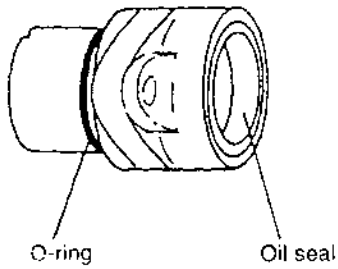
(3) Loosen the belt of the shift lever and remove the shift lever and cable bracket



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



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

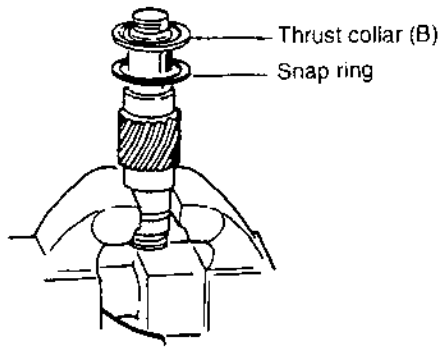


## 3.5.6 Reassembly

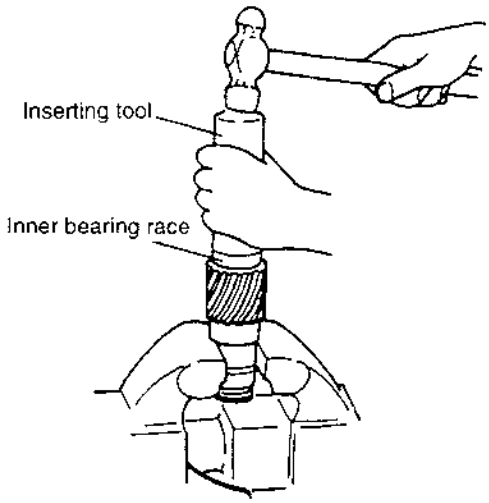
### 3.5.6.1 Reassembly of clutch shaft

#### 1) Clutch gear (B) side

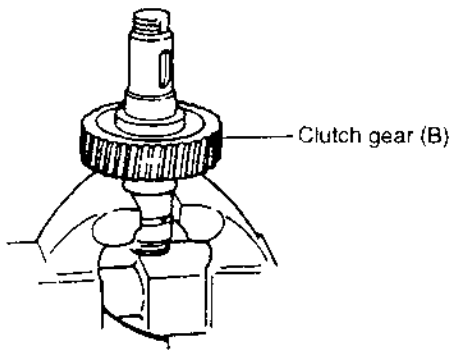
(1) Fit the clutch gear (B) side snap ring and thrust collar (B) onto the shart.




(2) Drive in the inner needle bearing race using the inseert-ing tool.



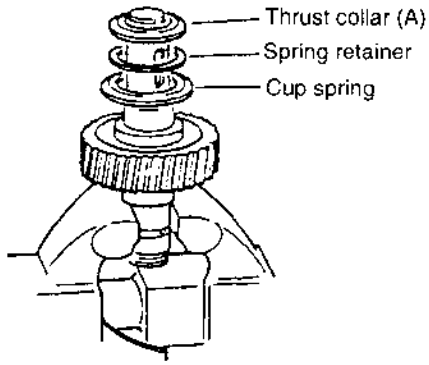

(3) Assemble the needle bearing and clutch gear (B)




**[NOTICE]**

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

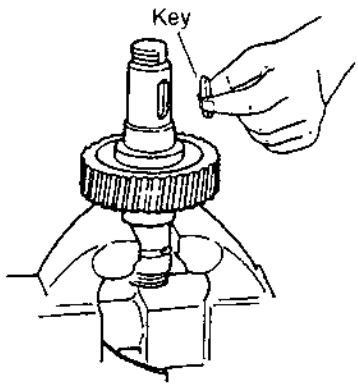
(4) Fit the cup spring, spring retainer, thrust collar (A).



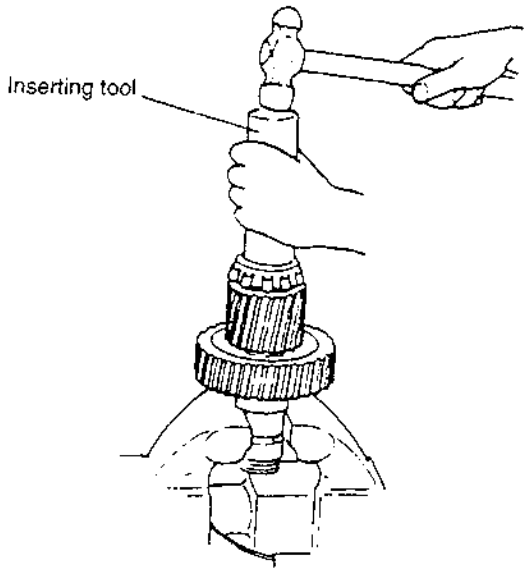

**[NOTICE]**

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

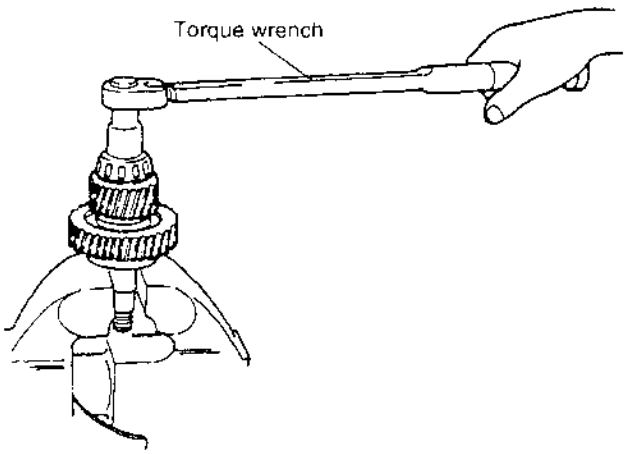
(5) Fit the key



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




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

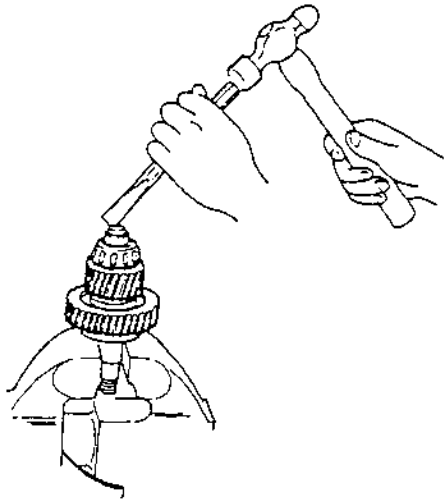



| | |
|---|---|
| Tightening torque | 8.5-11.5 kgf-m<br>(83.3-112.7 N·m) |

**[NOTICE]**

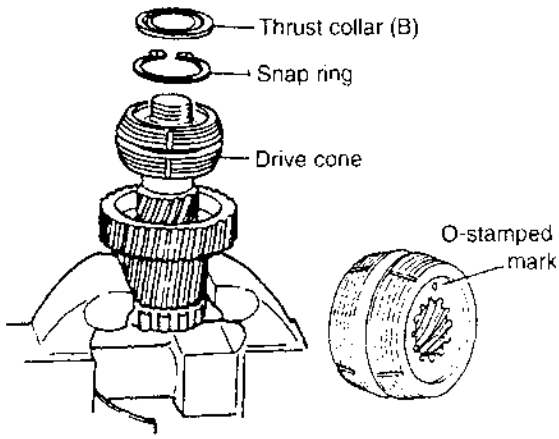
- *Remember it is a left-handed thread.*
- *Use the clutch gear (A) side nut which was used before dismantling for the clutch gear (B) end nut. This is to provide effective calking to the nut.*

(8) Calking the end nut and clutch shaft.



**2) Clutch gear (A) side**

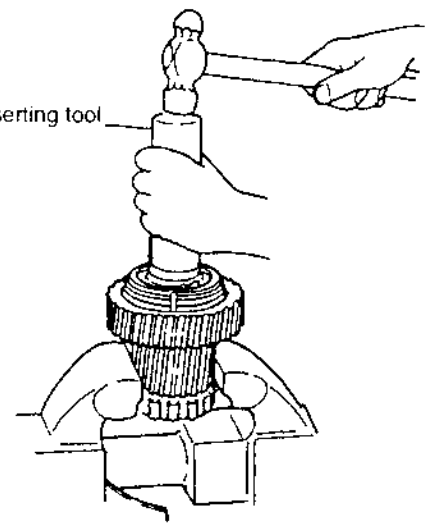
(1) Insert the drive cone, snap ring and thrust collar (B).



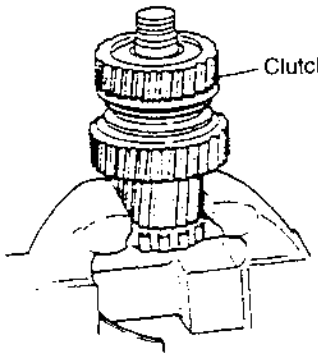

**[NOTICE]**

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

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



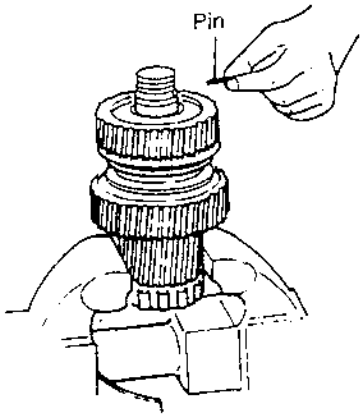
(3) Assemble the needle bearing and clutch gear (A)



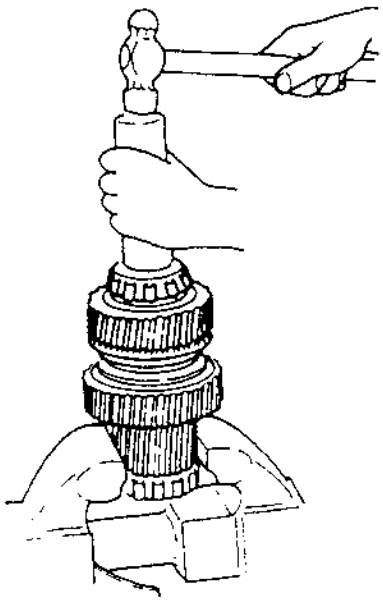

**[NOTICE]**

*Check that the clutch gear (A) rotates smoothly.*

(4) Insert the pin.



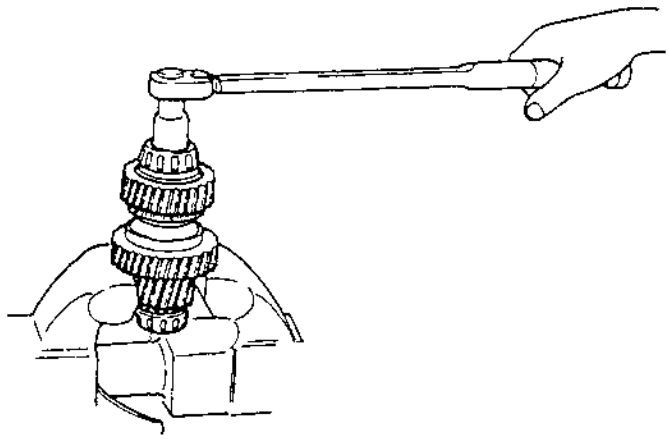

(5) Fit the cup spring, spring retainer and thrust collar (A) and drive in the inner bearing race using the inserting tool.



**[NOTICE]**

- *When fitting the thrust collar (A), note the fitting direction. Fit 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. Fix the clutch shaft in a vice and tighten the nut with a torque wrench.

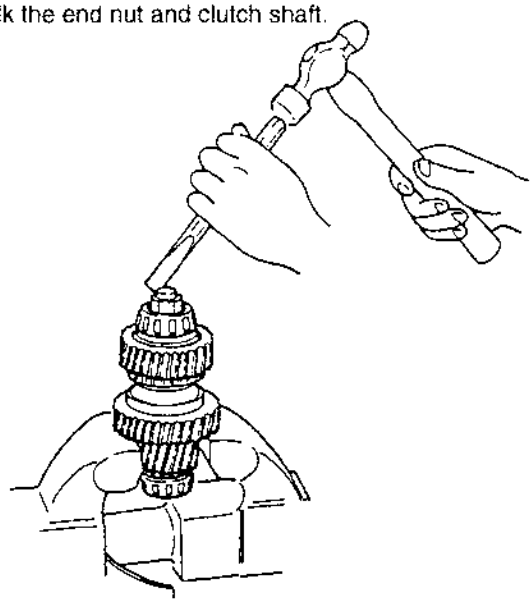


| | |
|---|---|
| Tightening torque | 8.5-11.5 kgf-m<br>(83.3-112.7 N·m) |

**[NOTICE]**

*Remember it is a left-handed thread.*

(7) Calk the end nut and clutch shaft.



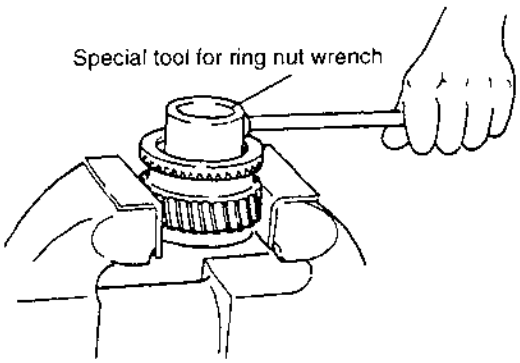
**[NOTICE]**

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

### 3.5.6.2 Reassembly of input shaft

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

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



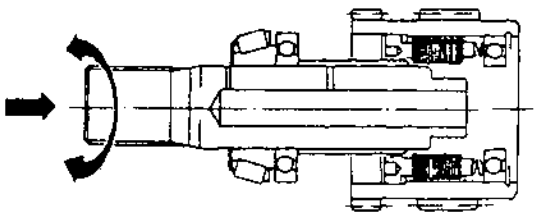

**[NOTICE]**

*Apply lube oil to each insert part.*

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

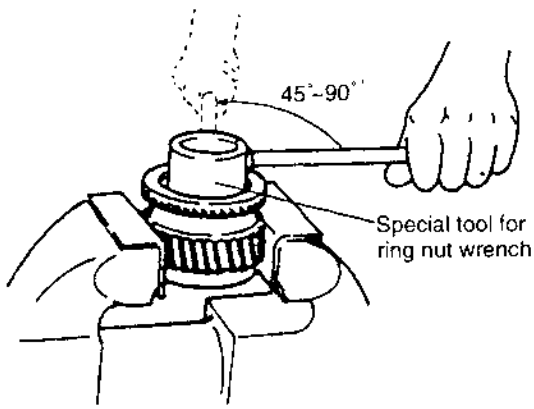
(4) Drive the ball bearing and the inner bearing race using an inserting tool.

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

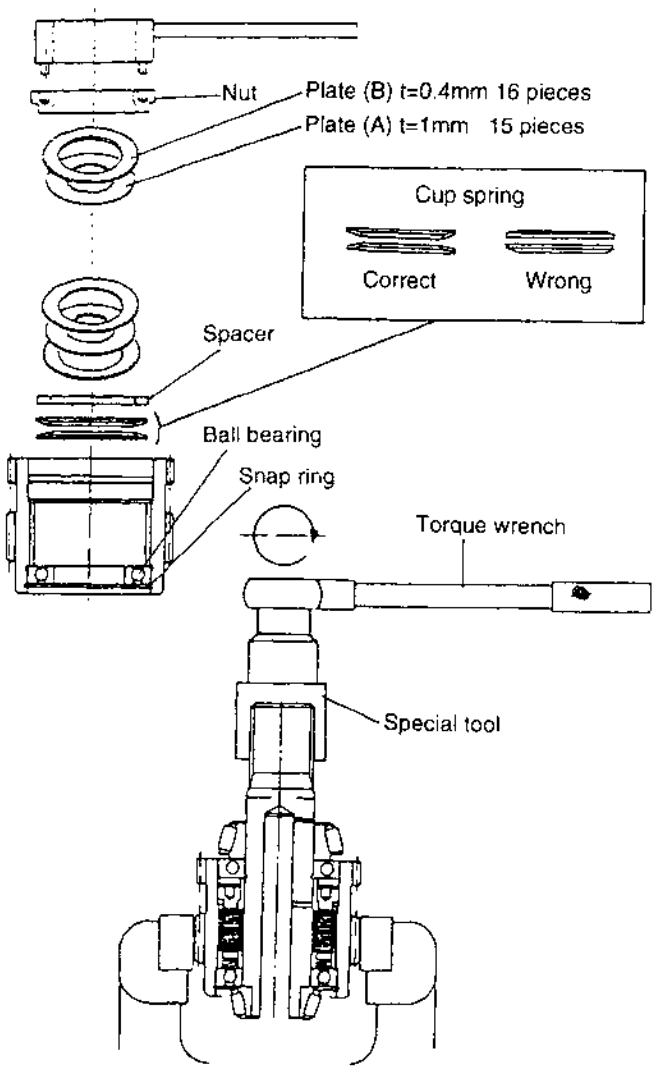


(6) Take the input shaft out again.

(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.

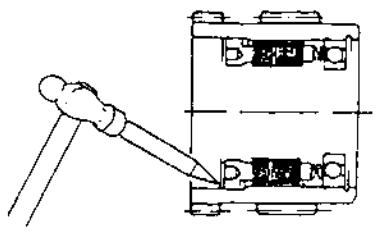



| | |
|---|---|
| Torque: | 55-60 kgf-m<br>(539-588 N·m) |

**[NOTICE]**

*Match up the teeth of plate (A).*

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



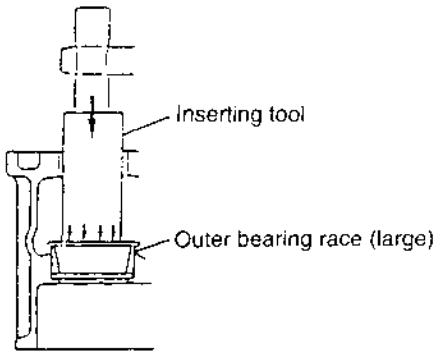
(10) Insert the input shaft into the input gear assembly.

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

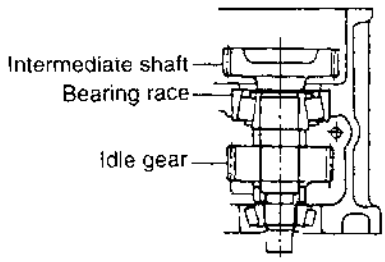
### 3.5.6.3 Reassembly of the clutch case

#### 1) Reassembly of the intermediate shaft

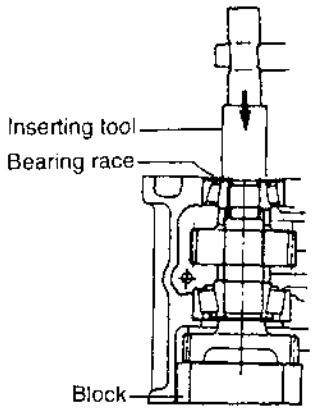
(1) Drive in the outer bearing race (large) into the clutch case.



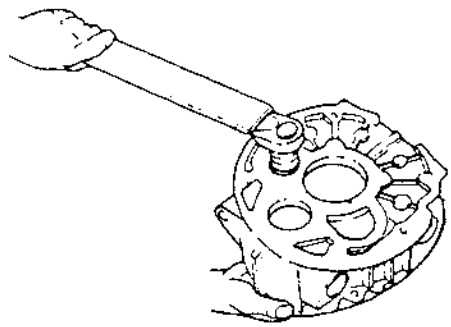

(2) Insert the inner bearing races and idle gear and drive in the intermediate shaft




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




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

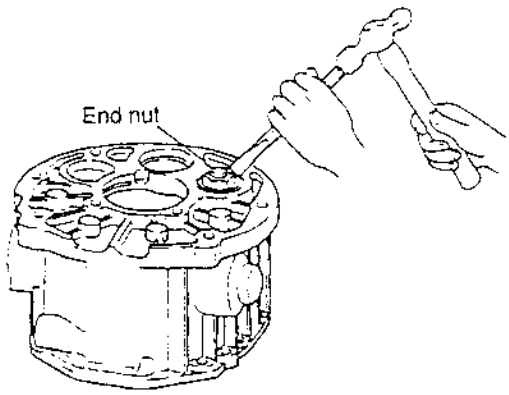


| | |
|---|---|
| Tightening torque | 8.5-11.5 kgf-m (83.3-112.7 N·m) |

**[NOTICE]**

*Remember it is a left-handed thread*

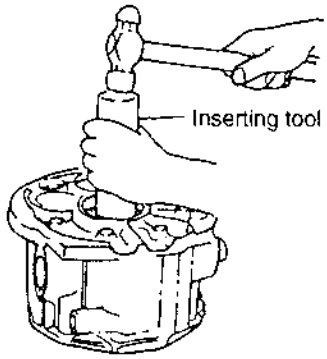
(5) Calk the end nut



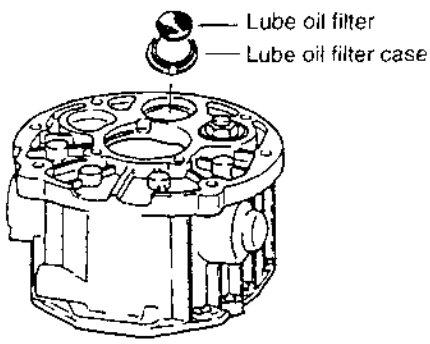

(6) Insert the shims into the clutch case.

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

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

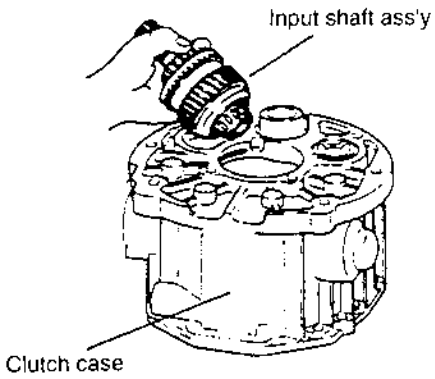



(2) Insert the clutch shaft shim, lube oil filter case and filter into the clutch case.

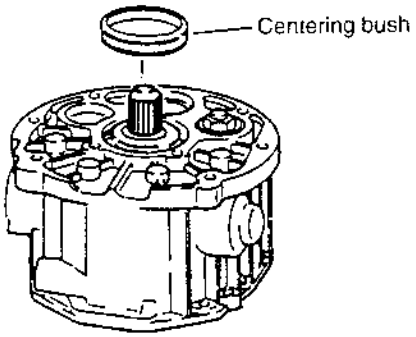


### 3) Reassembly of the input shaft

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



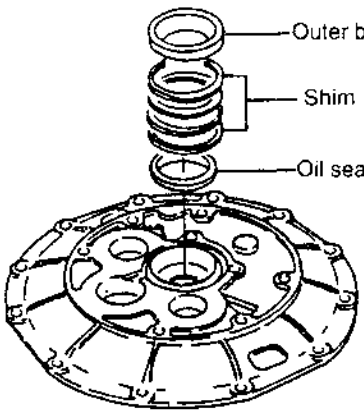

(2) Drive the centering bush into the clutch case.



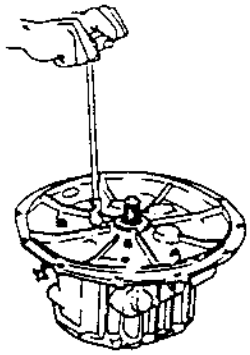

### 4) Reassembly of the mounting flange

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

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



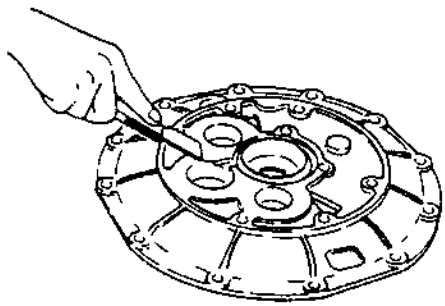

(3) Fit the mounting flange onto the clutch case, and tighten the bolt.

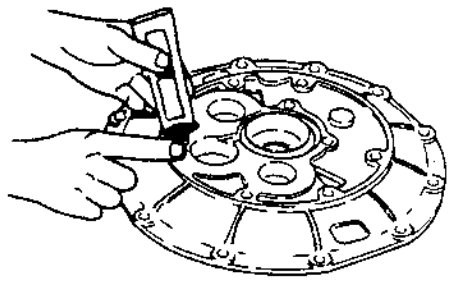


| | |
|---|---|
| Tightening torque | 5-6 kgf-m (49-58.8 N·m) |

**[NOTICE]**

*Apply non-drying liquid packing to the matching surface of the mounting flange and the clutch case.*

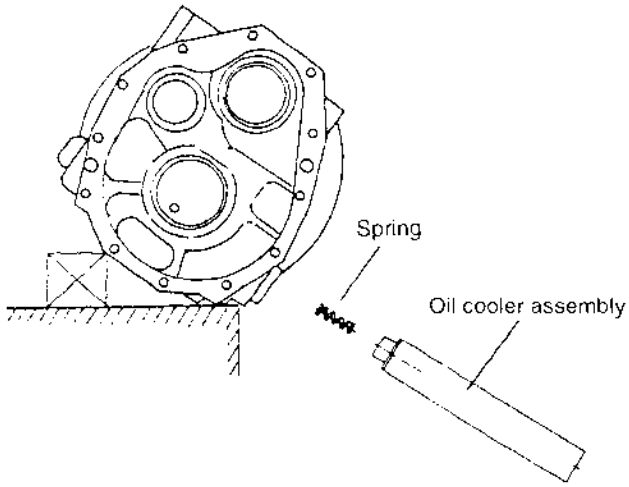




**5) Reassembly of the oil cooler**

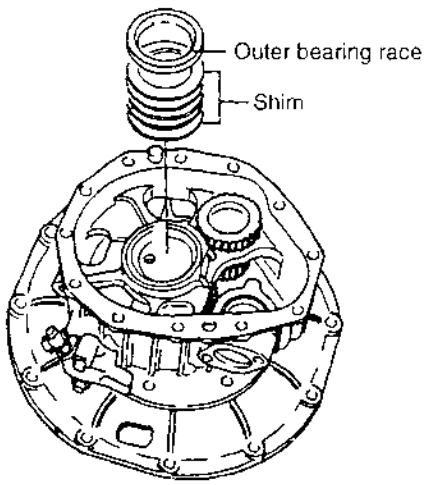
**[NOTICE]**

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

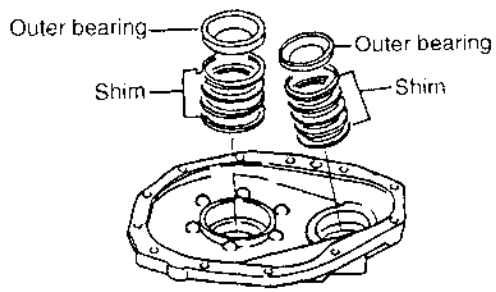



**6) Reassembly of the clutch case cover.**

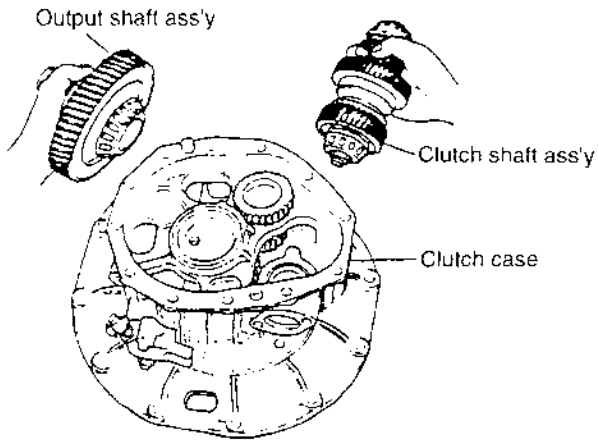
(1) Drive the output shaft shim and the outer bearing race into the clutch case.

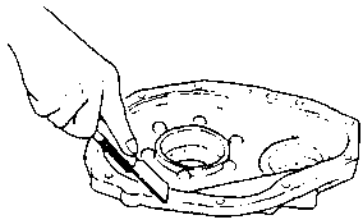


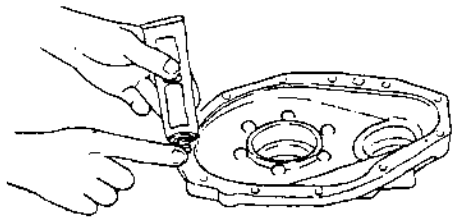

(2) Drive the shims and the outer bearing races into the clutch case cover




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



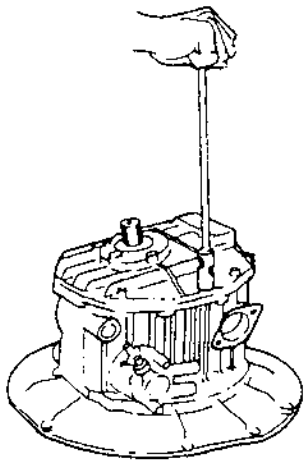





**[NOTICE]**

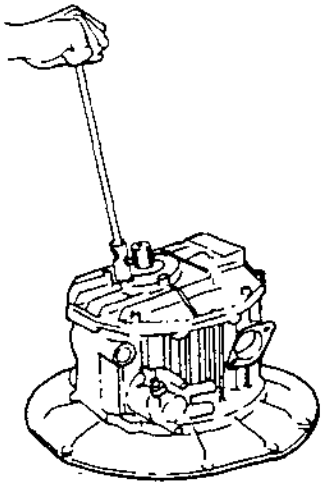
*Apply non-drying liquid packing to the maching surface of the clutch case cover and the clutch case.*

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



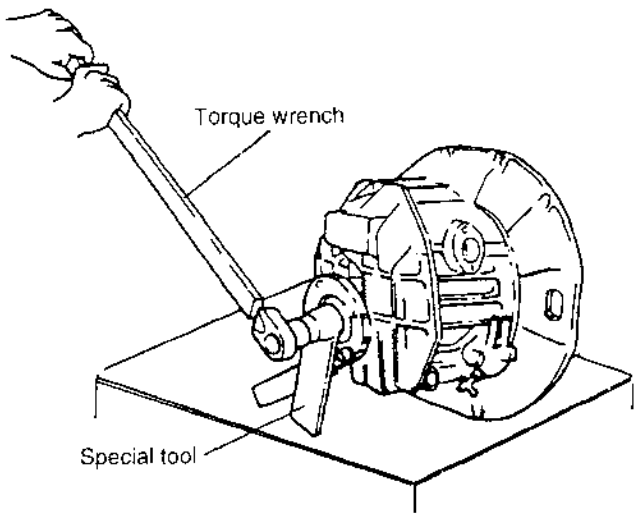
| | |
|---|---|
| Tightening torque | 2.3-2.8 kgf-m (22.5-27.4 N·m) |

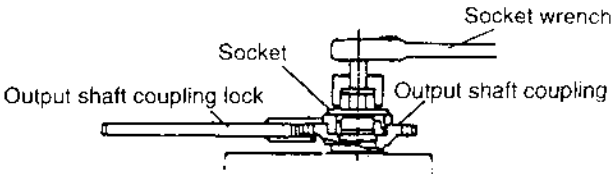
(5) Insert the outer bearing race, shim and the output shaft cover, and tighten the bolt.



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

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

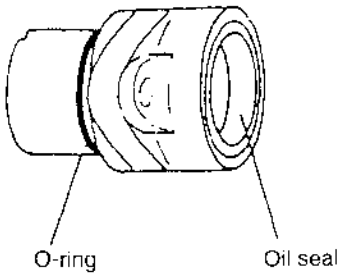


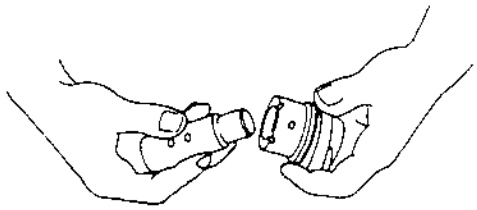

| | |
|---|---|
| Tightening torque | 54-56 kgf-m<br>(529.2 ~ 548.8 N·m) |

**7) Reassembly of the shifting device**

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



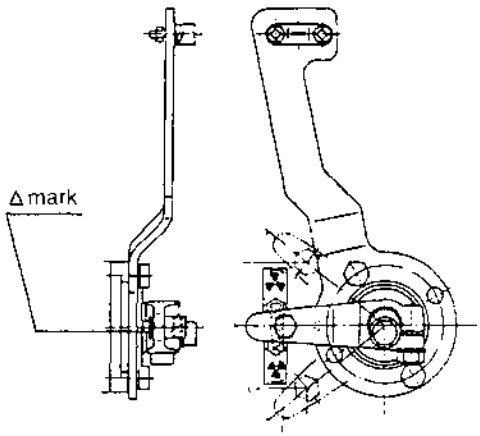

(2) Insert the shift lever shaft to the side cover



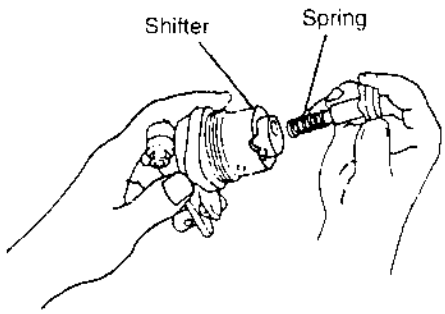
(3) Fit the shift lever to the shift lever shaft

**[NOTICE]**

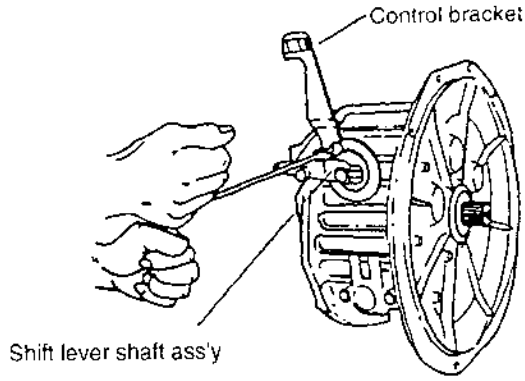
*Check the direction of the shift lever △ mark.*




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



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



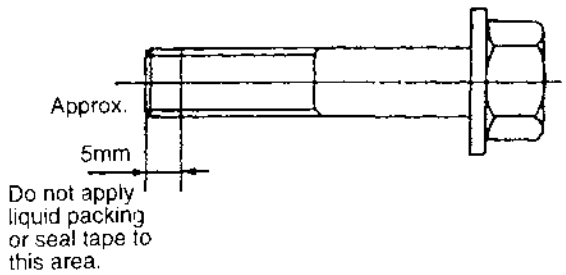

**[NOTICE]**

- *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.*

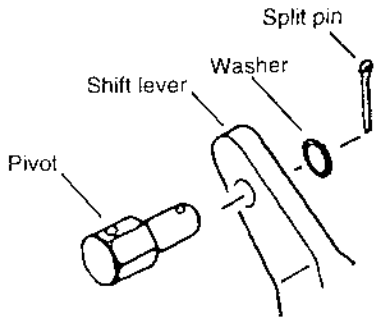
(6) Fit the shim and stopper bolt to the shift lever shaft.

**[NOTICE]**

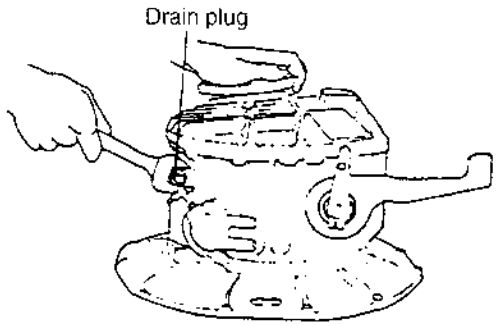
*Apply non-drying liquid packing or seal tape to the thread of the stopper bolt.*

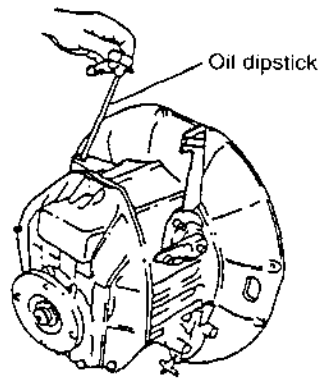



(7) Fit the pivot to the shift lever.




**8) Reassembly of the lube oil drain plug and dipstick**



# 3.6 KBW20/KBW21

## 3.6.1 Construction

### 3.6.1.1 Construction

The Kanzaki-Carl Hurth KBW20 and KBW21 reduction reversing gears were developed jointly by Kanzaki Precision Machine Co., Ltd., a subsidiary of Yanmar and one of Japan's leading gear manufacturers, and Carl Hurth Co.

The KBW20 and KBW21 consist of a multi-disc clutch and reduction gear housed in a single case. They are small, light, simply constructed adn extremely reliable.

* The force required to shift between forward and reverse can be controlled by a cable type remote control system much smaller and simpler than other types of reduction reversing gears.
* The friction discs are durable sinter plates, and the surface to the steel plates are corrugated in a sine curve shape to ensure positive engagement and disengagement and minimum loss of transmission force.
* Because of the special construction of this gear, the optimum pressure is automatically applied to the clutch plate in direct proportion to the input shaft torque.

### 3.6.1.2 Specifications

| | | | | | |
|---|---|---|---|---|---|
| Engine model (standard) | | | 4JH3E | | |
| Marine gear model | | | KBW20 | | |
| Reduction system | | | One-stage reduction, helical gear | | |
| Reversing system | | | Constant mesh gear | | |
| Clutch | | | Wet type multi-disc, mechanically operated | | |
| Reduction ratio | Forward | | 2.17 | 2.62 | 3.28 |
| | Reverse | | 3.06 | | |
| Direction of rotation | Input shaft | | Counterclockwise as viewed from stern | | |
| | Output shaft | Forward | Clockwise as viewed from stern | | |
| | | Reverse | Counterclockwise as viewed from stern | | |
| Lubricating oil | | | DEXRON, ATF | | |
| Lubricating oil capacity ℓ | | | 1.2 | | |

| | | | | |
|---|---|---|---|---|
| Engine model | | | 4JH3-TE, 4JH3-HTE | |
| Marine gear model | | | KBW21 | |
| Reduction system | | | One-stage reduction, helical gear | |
| Reversing system | | | Constant mesh gear | |
| Clutch | | | Wet type multi-disc, mechanically operated | |
| Reduction ratio | Forward | | 2.17 | 2.62 |
| | Reverse | | 3.06 | |
| Direction of rotation | Input shaft | | Counterclockwise as viewed from stern | |
| | Output shaft | Forward | Clockwise as viewed from stern | |
| | | Reverse | Counterclockwise as viewed from stern | |
| Lubricating oil | | | DEXRON, ATF | |
| Lubricating oil capacity | | ℓ | 1.2 | |
| Lube oil cooler | | | Sea-water cooling | |

***IMPORTANT :***

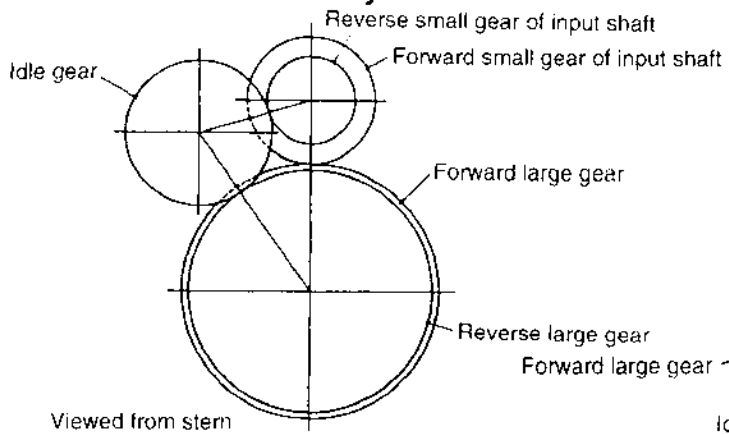
*Differences between Marine Gear Models KBW20 and KBW21*

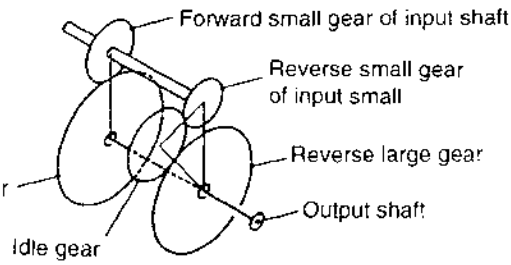
*KBW21 is provided with a lube oil cooler (of side cover monoblock construction).*

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

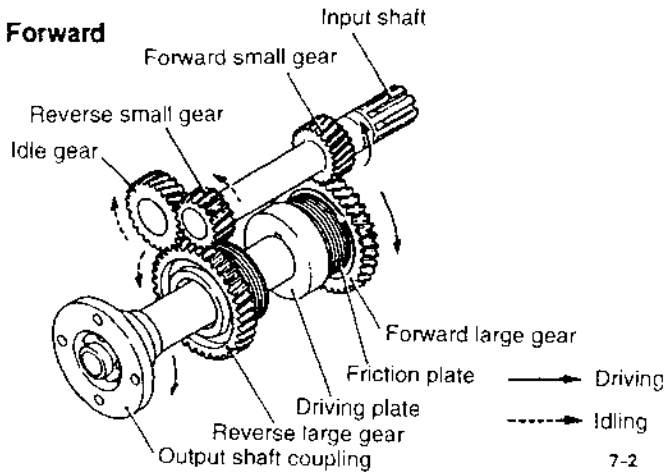
*Accordingly, KBW21 can be used both for models 4JH3E, however, KBW20 cannot be used for models 4JH3-HTE and 4JH3-DTE since KBW20 is not durable enough for these engine models.*

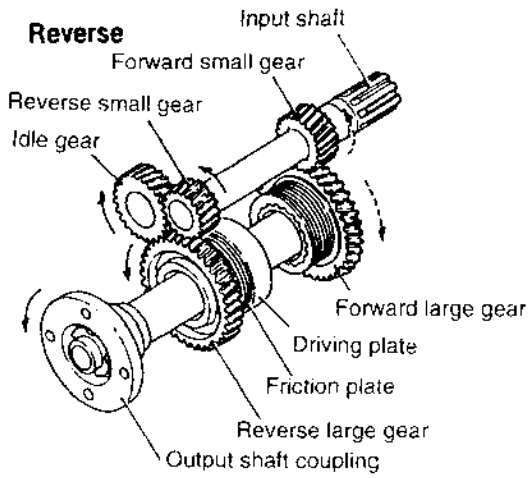
### 3.6.1.3 Power transmission system



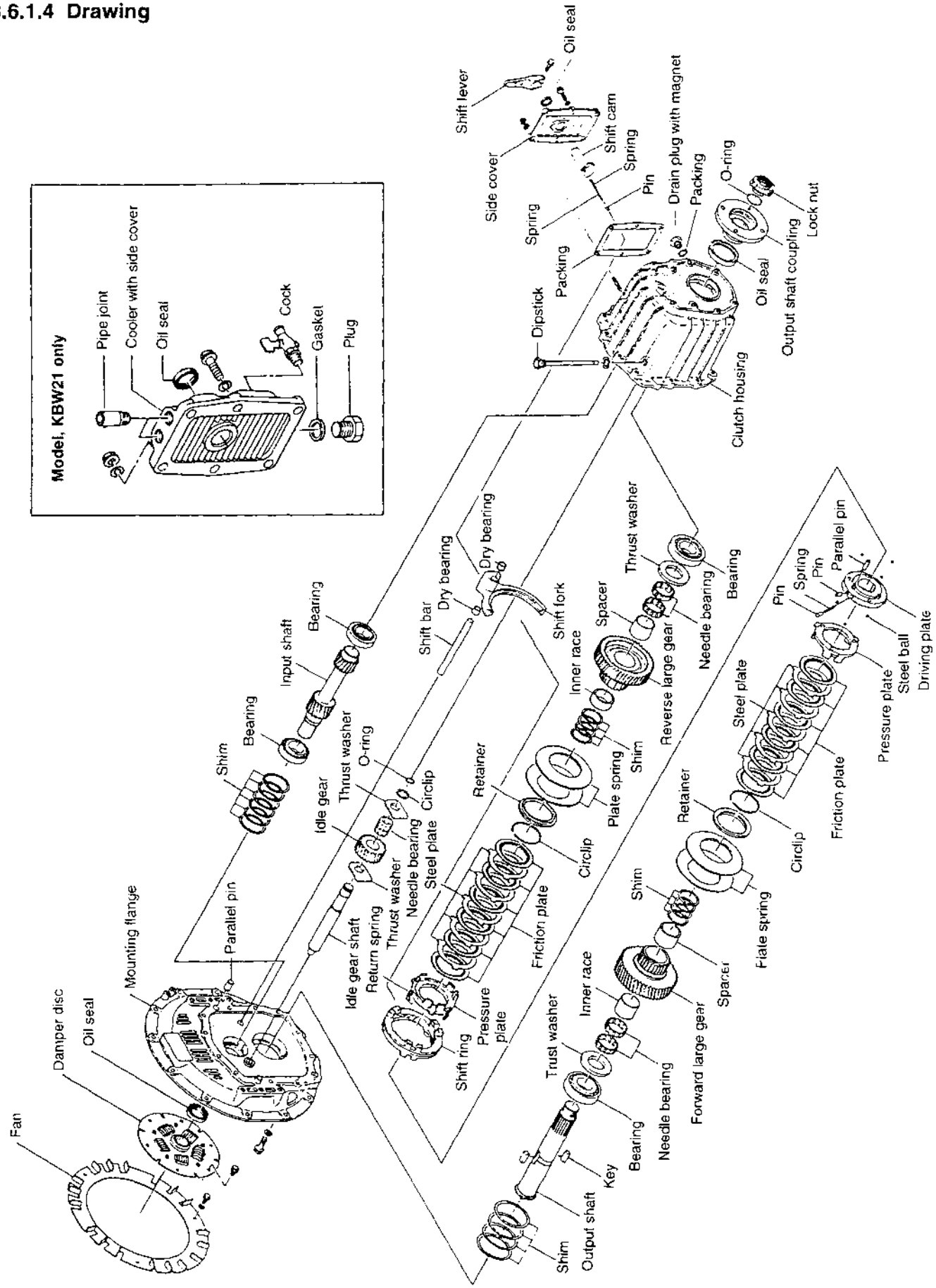




| Forward | | | Reverse | | | |
|---|---|---|---|---|---|---|
| Number of teeth | | Reduction ratio | Number of teeth | | | Reduction ratio |
| Forward small gear of input shaft | Forward large gear | | Reverse small gear of input shaft | Idle gear | Reverse large gear | |
| 24 | 52 | 52/24 = 2.17 |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



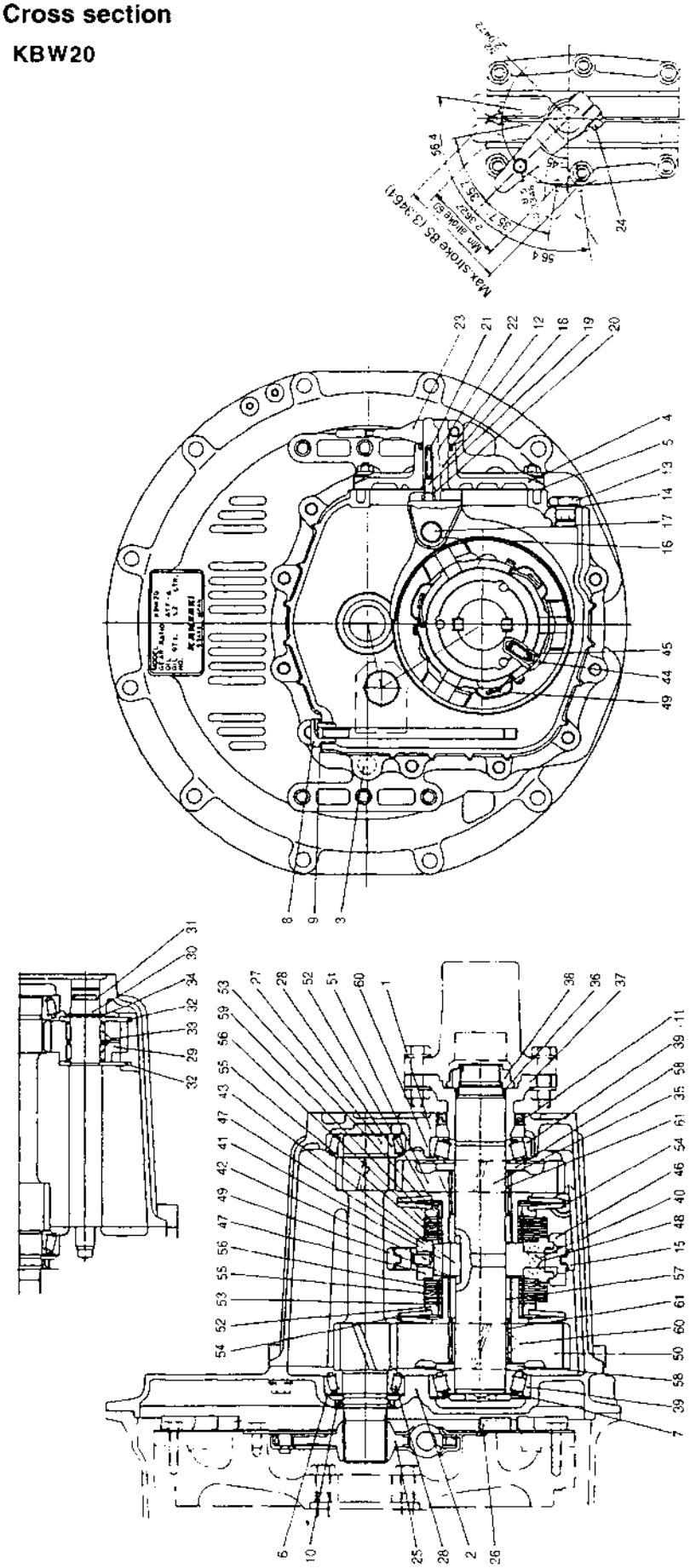



### 3.6.1.4 Drawing



### 3.6.1.5 Cross section

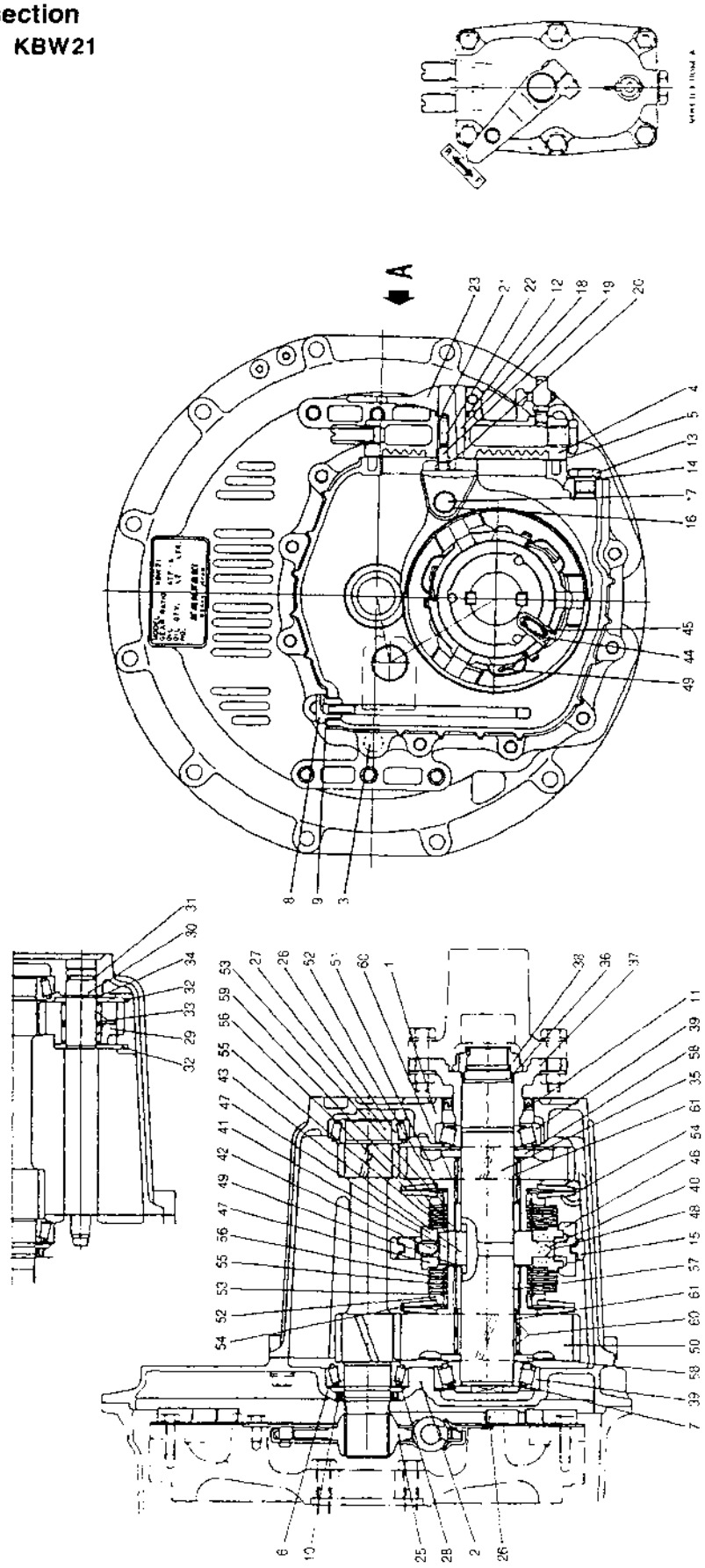
**Model: KBW20**



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

## Cross section

**Model: KBW21**




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

## 3.6.2 Installation

### 3.6.2.1 Installation angle

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

### 3.6.2.2 Remote control unit

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

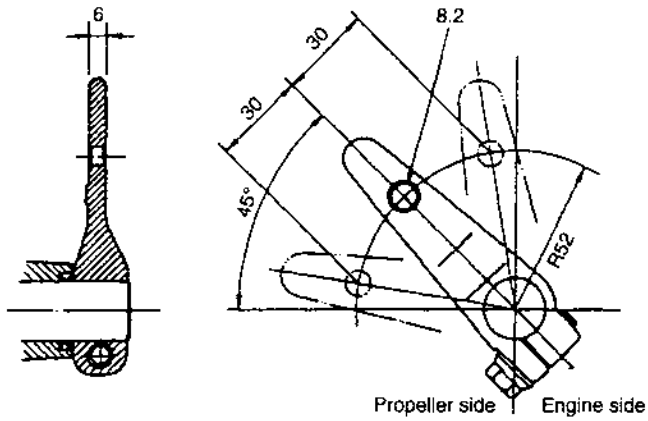
To connect the linkage, the operating cable must be positioned at right angles to te shift lever when the shift lever is in the neutral position.

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

A typical linkage arrangement it illustrated in the figure below.

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

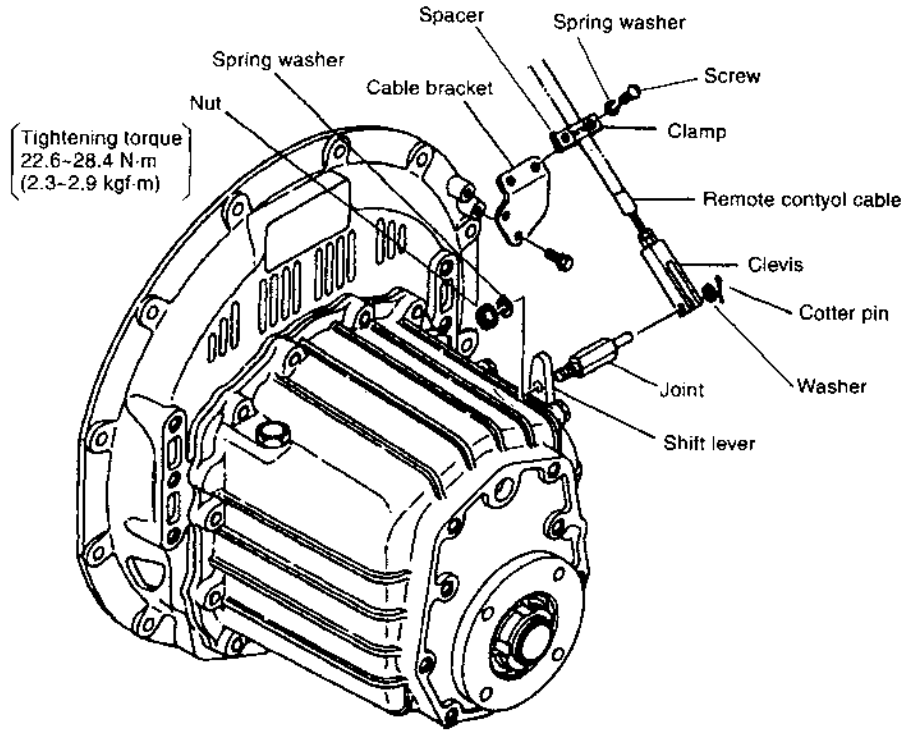
mm




Side view of clutch

### 3.6.2.3 Clutch operation force (reference value)

| Operation position / Operation direction | Operation lever position at 52mm | Remarks |
|---|---|---|
| Engaging stroke | Approx. 9.5kgf (93.1N) | Engine speed at 1000 rpm |
| Disengaging stroke | Approx. 11.5kgf (112.7N) | |

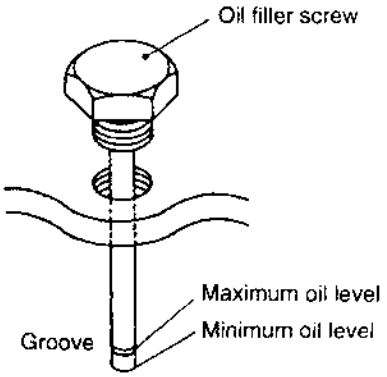


## 3.6.3 Operation and Mainttenance

### 3.6.3.1 Lube oil

(1) Oil level

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




(2) Oil change

Change the oil after the first 50 hours of operation, and every 150 hours of operation thereafter. When adding oil between oil changes, always use the same type of oil as is in the marine gearbox.

(3) Recommended brands of lube oil

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

### 3.6.3.2 Precautions

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

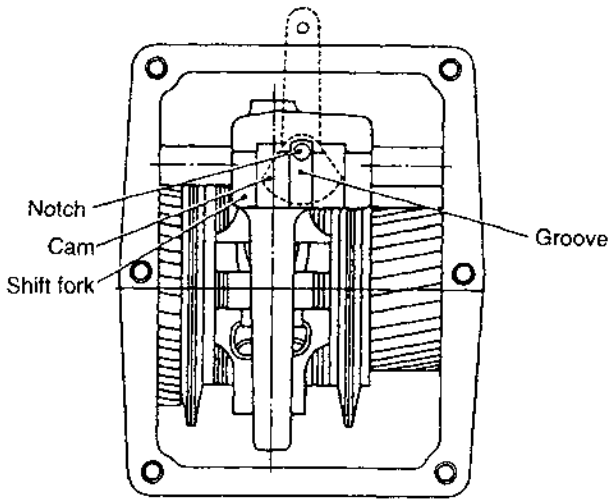
### 3.6.3.3 Side cover

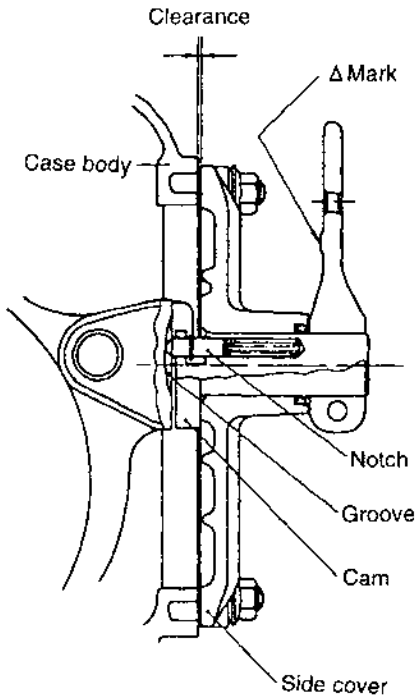
The internal shifting mechanism has been carefully aligned at the factory. Improper removal of the side cover can cause misalignment. If the side cover must be removed, proceds as follows:

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

—When installing the side cover, put the shift lever in neutral so that the cam lobe on the shift lever engages the groove on the internal shift mechanism. When the cam lobe and groove are engaged properly there will be no clearance between the body and the side cover. Use packing when installing the side cover.

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



## 3.6.4 Inspection and Servicing

### 3.6.4.1 Clutch case

(1) Check the clutch case for cracking with a test hammer. Perform a color check when required. If the case is cracked, replace it.

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

### 3.6.4.2 Bearing

(1) Rusting and damage
If the bearing is rusted or the taper roller retainer is damaged, replace the bearing.

(2 ) Make sure that the bearings rotate smmothly.
If rotation is not smooth, if ther is any binding, or if an abnormal sound is heard, replace the bearing.

### 3.6.4.3 Gear

(1) Tooth surface wear
Check the tooth surface for pitching, abnormal wear, dents, and cracks. Repair lightly damaged gears and replace heavily damaged gears.

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

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

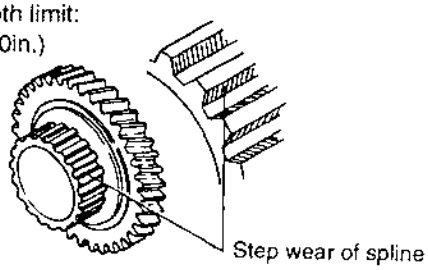
mm

| | Standard | Wear limit |
|---|---|---|
| Input shaft forward gear and output shaft forward gear | 0.1~0.2 | 0.3 |
| Input shaft reverse gear and intermediate gear | 0.1~0.2 | 0.3 |
| Intermediate gear and output shaft reverse gear | 0.1~0.2 | 0.3 |

(4) Forwarid/reverse gear spline

1) Check the spline for damage and cracking.

2) Step wear of spline
Step wear depth limit:
0.1mm (0.0040in.)




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


### 3.6.4.4 Steel plate

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

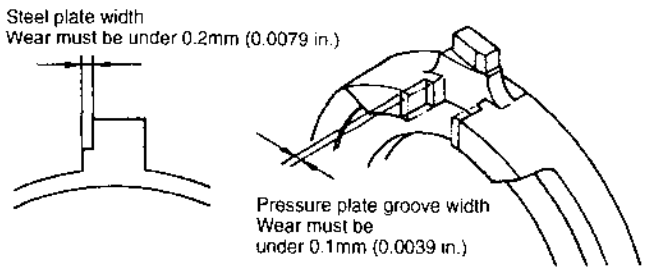
(2) Warping measurement

mm

| | Standard | Wear limit |
|---|---|---|
| Warping | 1.49~1.70 | 1.4 |

3) Steel plate pawl width measurement


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



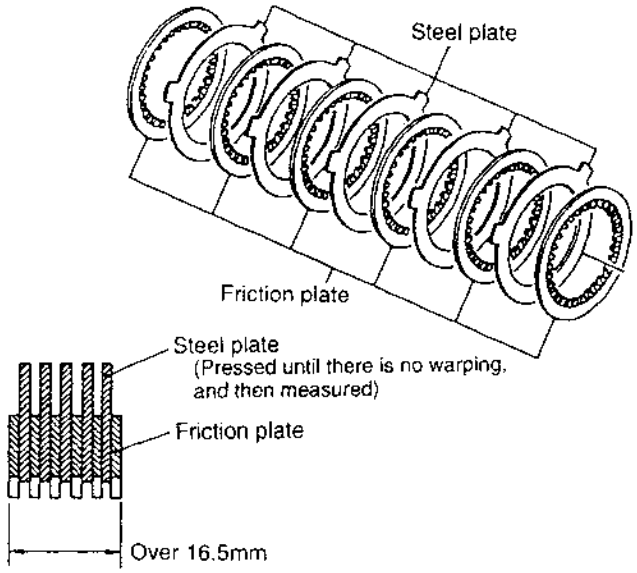

mm

| | Standard | Wear limit |
|---|---|---|
| Steel plate width | 11.8~12.0 | Worn 0.2 |
| Pressure plate groove | 12.0~12.1 | Worn 0.1 |
| Clearance | 0~0.3 | 0.3~0.6 |

### 3.6.4.5 Friction plate

(1) Check the friction plate for burning, scoring, or cracking. Repair the plate when the damage is light and replace the plate if the damage is heavy.

(2) Friction surface wear
Measure the thickness of the friction plate, and replace the plate when it is worn beyond the wear limit.




mm

| | Standard | Wear limit |
|---|---|---|
| Friction plate thickness | 1.65~1.70 | 1.5 |

The assembled friction plate and steel plate dimensions must be over 16.5mm.

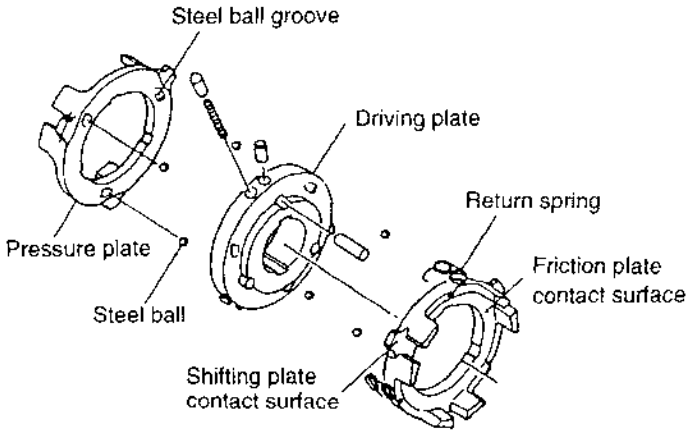
Both sides of the friction plate have a 0.35mm copper sintered layer. Replace the friction plate when this layer is worn more than 0.2mm on one side (standard thickness 1.65~1.70). However, the sum of the wear of the six friction plates must not exceed 1.2mm. When this value is exceeded, replace all friction plates. In unavoidable cricumstances, it is permissible to replace only the friction plate with the greatest amount of wear.

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

mm

| | Standard | Wear limit |
|---|---|---|
| Standard backlash | 0.20~0.61 | 0.9 |

### 3.6.4.6 Pressure plate

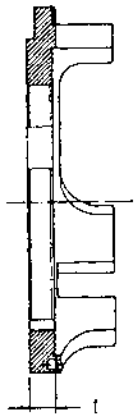



(1) Steel ball groove
Check the steel ball groove for stains and wear.
Replace the pressure plate if the groove is noticeably worn.

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

(3) Shifting plate contact surface

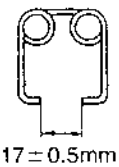
(4) Worn parts measurement



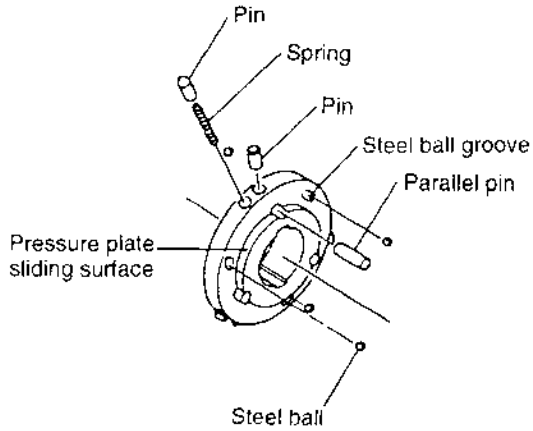

mm

| | Standard | Wear limit |
|---|---|---|
| Thickness: t | 8.0~8.1 | 7.9 |

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

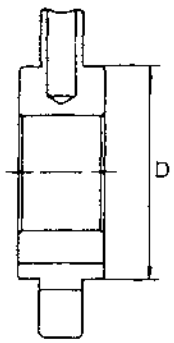


### 3.4.6.7 Driving Plate




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

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




mm

| | Standard | Wear limit |
|---|---|---|
| Outside diameter: D | ϕ68.366~68.440 | ϕ68.3 |

(3) Steel ball groove wear and stains.

(4) Determine the amount of wear and play of both teh axial and circumferential direction pins.

(5) Permanent spring strain.

mm

| | Standard | Wear limit |
|---|---|---|
| Spring free length | 32.85 | 32 |

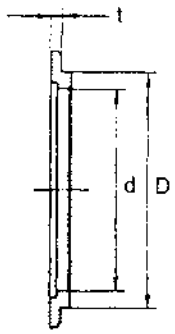
(6) Pin end wear.

### 3.4.6.8 Retainer

(1) Check for stains and damage on the friction plate contact surface.

(2) Check for wear and cracking on the plate spring contact surface.

(3) Measurement of dimensions

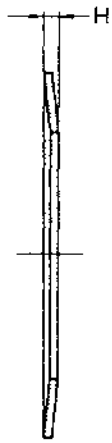



mm

| | Standard | Wear limit |
|---|---|---|
| d | ϕ67.060~67.106 | ϕ67.3 |
| D | ϕ75.9~76.0 | ϕ75.7 |
| t | 4.95~5.05 | 4.8 |

### 3.4.4.9 Plate spring

(1) Permanent strain



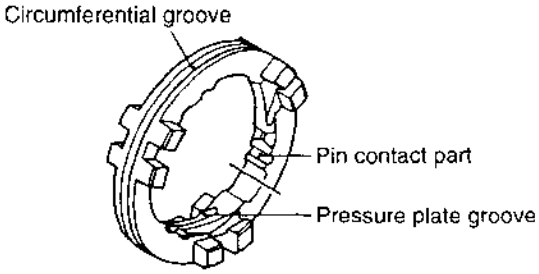

mm

| | Standard | Wear limit |
|---|---|---|
| H: when plate spring is free | 7.2~7.6 | 7.05 |

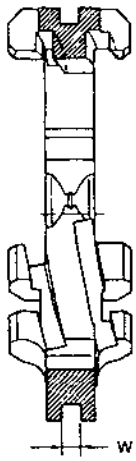
### 3.4.4.10 Thrust collar

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

### 3.6.4.11 Shift ring




(1) Circumferential groove wear.



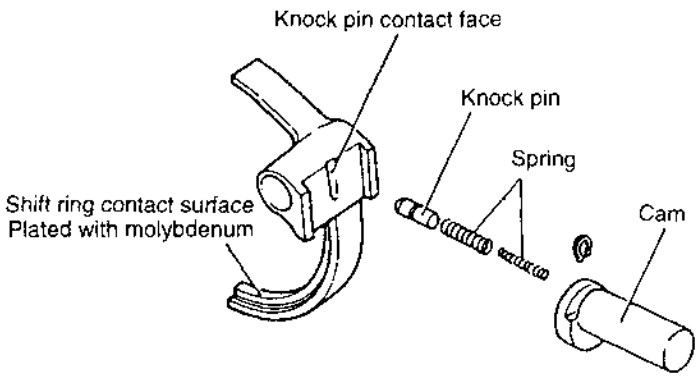

mm

| | Standard | Wear limit |
|---|---|---|
| Shifting groove: w | 6.0~6.1 | 6.3 |

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

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

### 3.4.6.12 Shift fork and shift lever



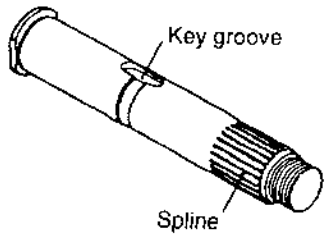

(1) End wear.
The shift ring contact surface of the shift fork is plated with molybdenum (thickness: 0.04~0.05mm). If this plating is peeled or worn to such an extent that the base metal of the shift fork is exposed, replace the shift fork.

(2) Cam surface wear and stains.
Whenever uneven wear and/or scratches are found, replace with a new part.

(3) Pin part play.
Whenever uneven wear and/or scratches are found, replace with a new part.

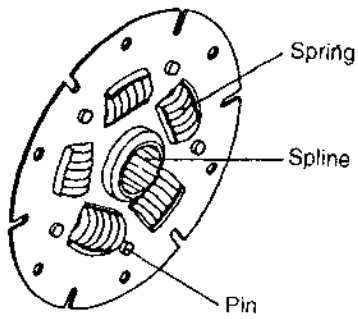
(4) Notch end wear.
Whenever uneven wear and/or scratches are found, replace with a new part.

### 3.6.4.13 Output shaft




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

### 3.6.4.14 Damper disc

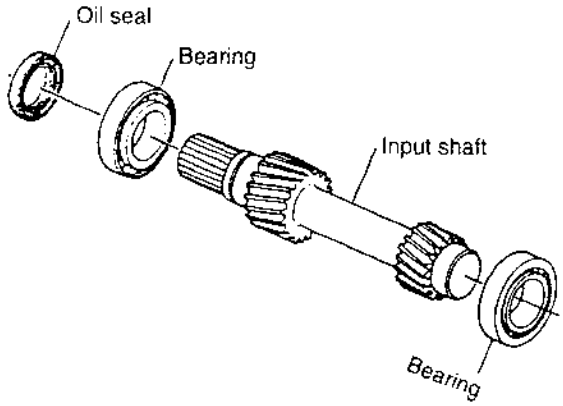



(1) Spline part
Whenever uneven wear and/or scratches are found, replace with a new part.

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

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

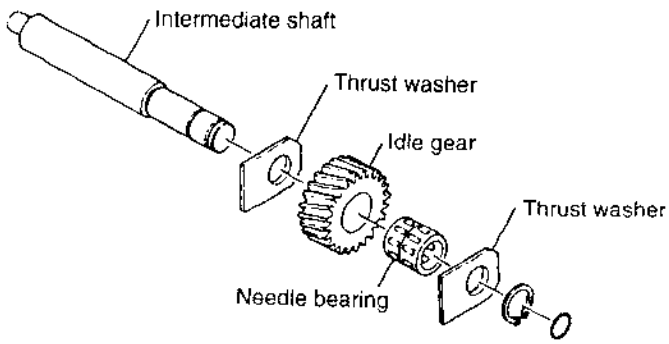
### 3.6.4.15 Input shaft




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

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

### 3.4.6.16 Intermediate shaft



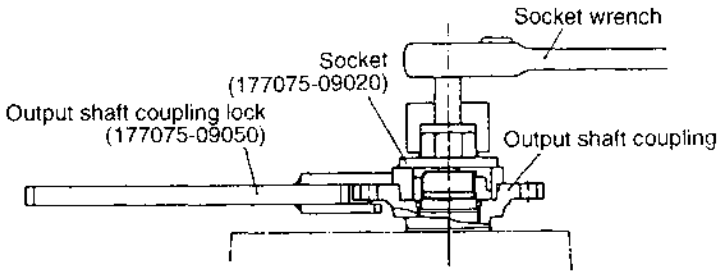

(1) Needle bearing dimensions, staining.
Check the surface of the roller to see whether the needle bearing sticks or is damaged. Replace if necessary.

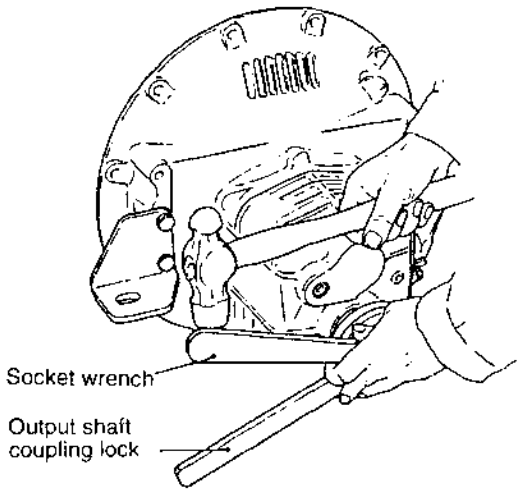
## 3.6.5 Disassembly

### 3.6.5.1 Disassembling the clutch and accessories

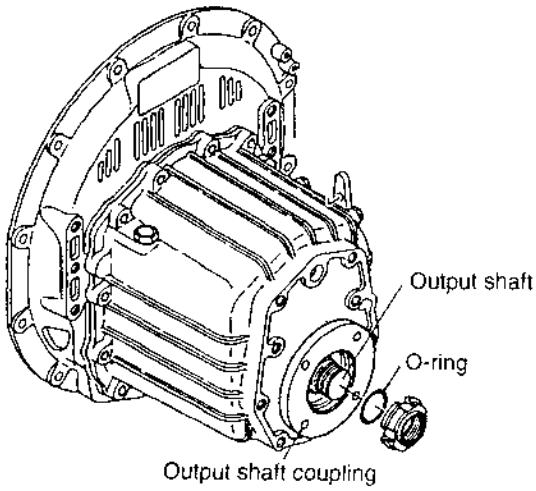
(1) Remove the drain plug and packing, and drain the oil from the clutch.

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



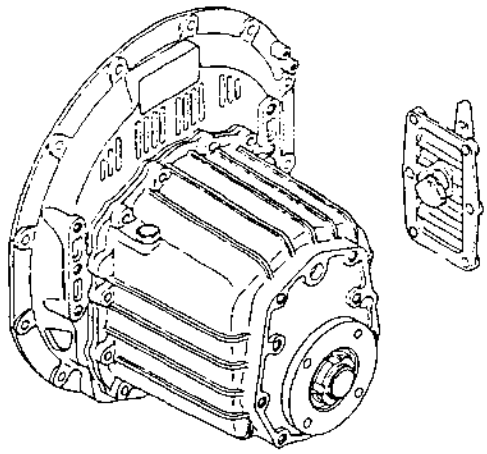




(3) Remove the output coupling with O-ring.



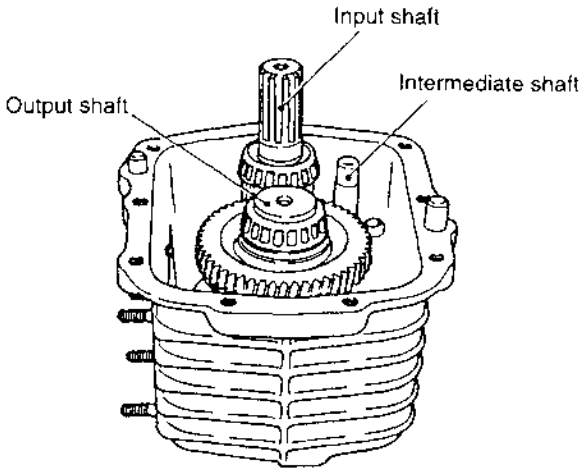

(4) Remove the dipstick and packing.

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



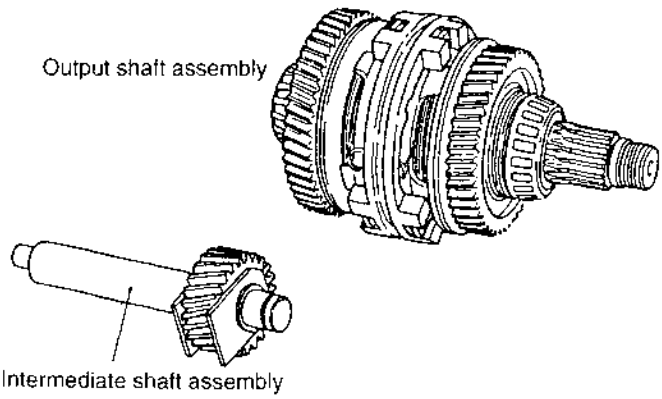
(6) Remove the M10 bolt and super lock washer on the mounting flange.

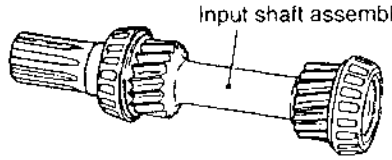
(7) Screw the M10 bolt into the M10 pulling bolt hole of the mounting flange, and remove the mounting flange. Do not remove the parallel pin.




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

(9) Remove the shift bar from the moving flange side.



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

**[NOTICE]**
*If the following parts are not replaced. the adjusting plates may be reused without readjustment.*
*However, if even one part is replaced, readjustment is necessary.*
*Input shaft part: 24-2, 24-31*
*Output shaft part: 26-6, 26-9, 26-26, 26-27, 26-28, 26-30*

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

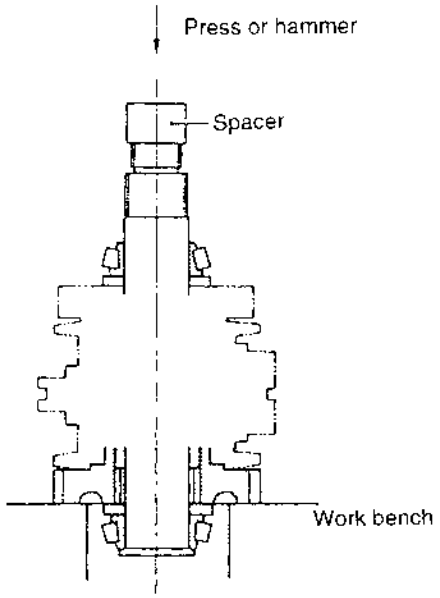
### 3.6.5.2 Disassembling the input shaft

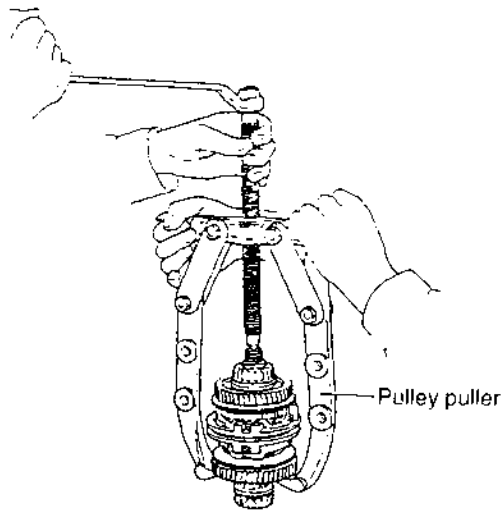
Pull the bearing from the input shaft.

**[NOTICE]**
*Do not disassemble unless the input shaft parts are damaged.*

### 3.6.5.3 Disassembling the output shaft

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




**[NOTICE]**
- *When removing the shaft, place spacers between the shaft and the press to prevent damage.*
- *Make sure that the forward large gear parts and reverse large gear parts and not mixed together once they are removed.*

(3) Remove the adjusting plate.

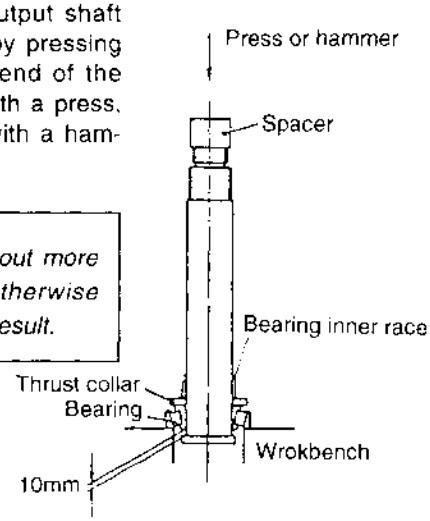
**[NOTICE]**
*Record the thickness of the adjusting plate to facilitate reassembly.*
*If the parts are not replaced, the adjusting plate may be reused without readjustment. However, if even one part is replaced, readjustment is required.*

(4) Remove the key.
To facilitate removal, clamp the key with a vise.
(5) Remove the adjusting plate.

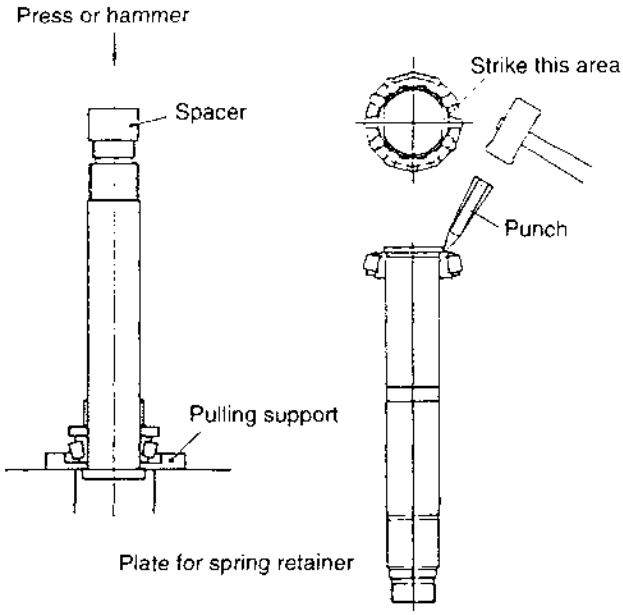
**[NOTICE]**
*Record the thickness of the adjusting plate to facilitate reassembly.*
*If the parts are not replaced, the adjusting plate may be reused without readjustment. However, if even one part is replaced, readjustment is required.*

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

**[NOTICE]**
*Do not pull it out more than 10mm otherwise damage may result.*

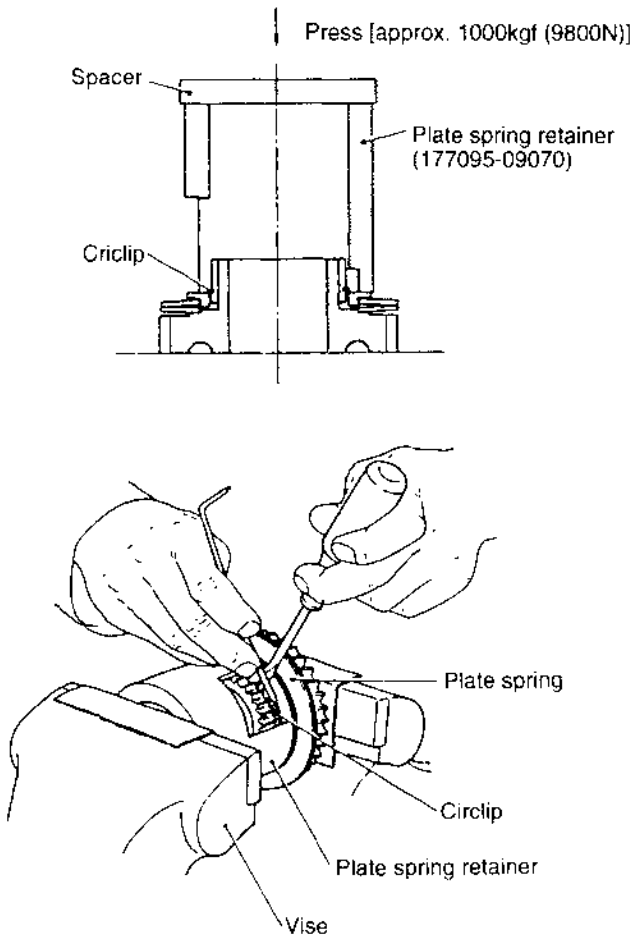


(8) Insert the disassembly tool between the collar of the output shaft and the bearing; next remove the vearing inner race, thrust collar, and bearing from the output shaft with a press or hammer.




(9) Remove the friction plates and steel plates from the forward large gear.

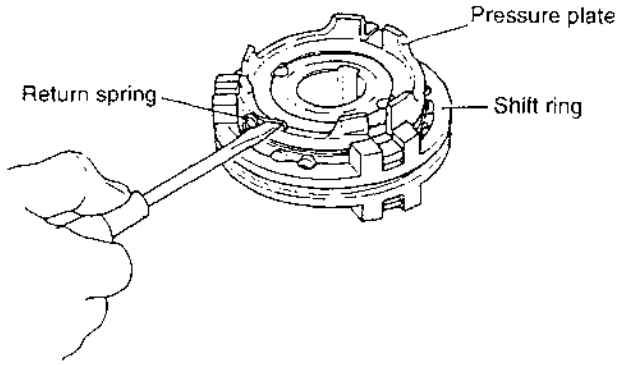
(10) Using a disassembly tool, compress the plate spring and remove the circlip from the forward large gear.




(11) Remove the retainer and plate spring.

(12) Remove the parts from the reverse large gear as described in steps (9)-(11) above.

(13) Remove the pressure plate return spring; remove the pressure plate and steel ball.

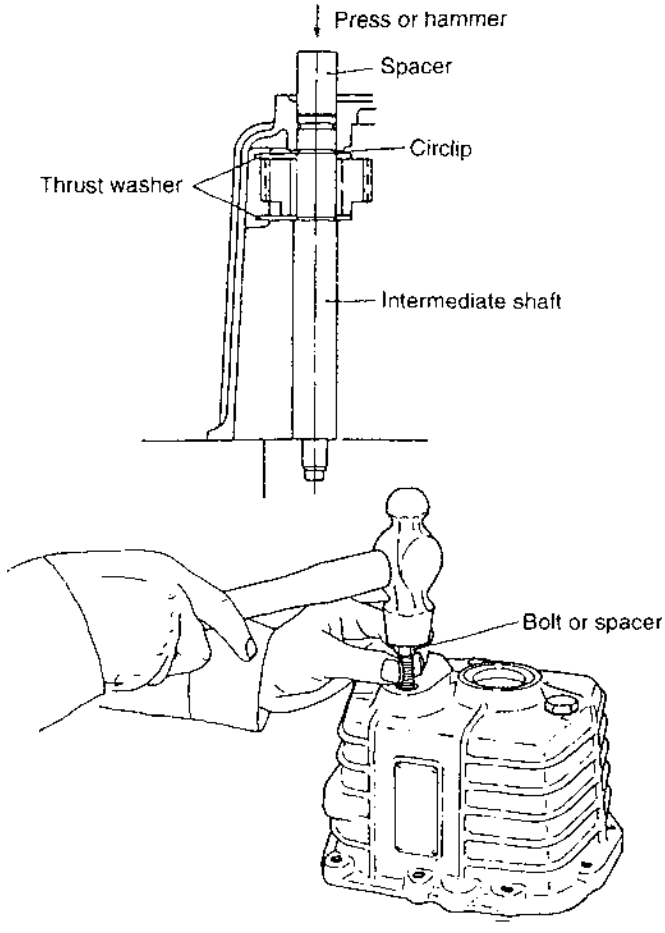



(14) Remove the shift ring.
To disassemble, remove the three knock pins. When disassembling the shift ring, cover it with a cloth to prevent it being lost.

(15) Remove the knock pin and spring from the driving plate.

### 3.6.5.4 Disassembling the intermediate shaft

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



(2) Remove the O-ring, and then remove the circlip.

(3) Remove the idle gear, needle bearing, and thrust washer.

### 3.6.5.5 Disassembling the operating system

(1) Loosen the M8 bolt of the shift lever; remove the shift lever.

(2) Pluu the shift cam.

(3) Push in the knock pin and remove the circlip.

(4) Remove the knock pin and spring.

(5) Pull the oil seal from the case side cover.

## 3.6.6 Reassembly

### 3.6.6.1 Reassembly precautions

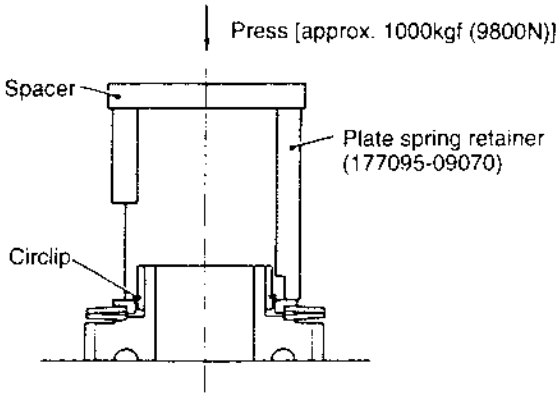
(1) Before reassembling, clean all parts in washing oil, and replace and damaged or worn parts.
Remove non-dry packing agent from the mating surface with a blunt knife.

(2) Pack the oil seal and O-ring parts with grease.

(3) Coat the mating surfaces of the case with wet packing.

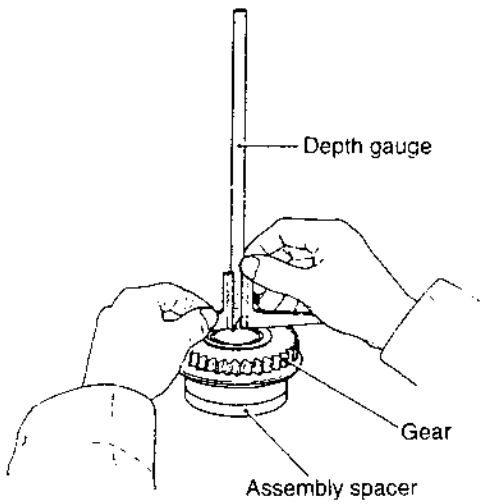
### 3.6.6.2 Reassembling the output shaft

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



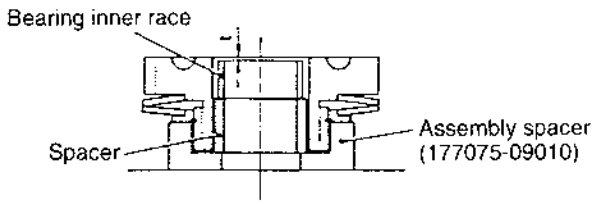

(2) Reassemble the reverse large gear and plate spring retainer, and the circlip as described in step (1) above.

(3) Determining the forward adjusting plate thickness




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

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




2 There adjustment plates of 0.5mm, 0.4mm and 0.3mm are available.
3 Measure the "t" dimension. Combine these plates to obtain a dimension from (t-0.5)mm to (t-0.5)mm.

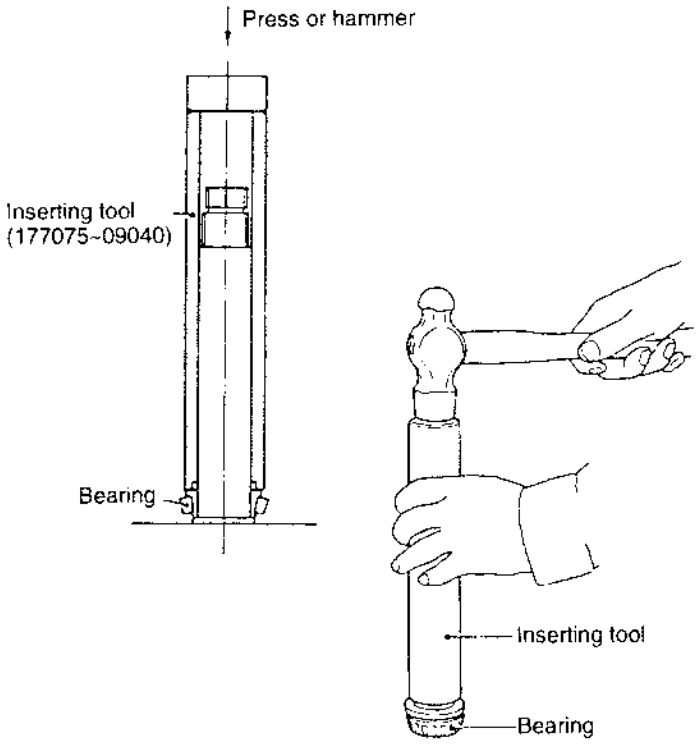
(4) Determine the thickness of the reverse adjusting plate by following the procedure described in step (3) above.

(5) First, insert a friction plate into the spline part of the forward large gear, next insert steel plates and friction plates alternately. Finally, insert a friction plate (six friction plates and five steel plates).

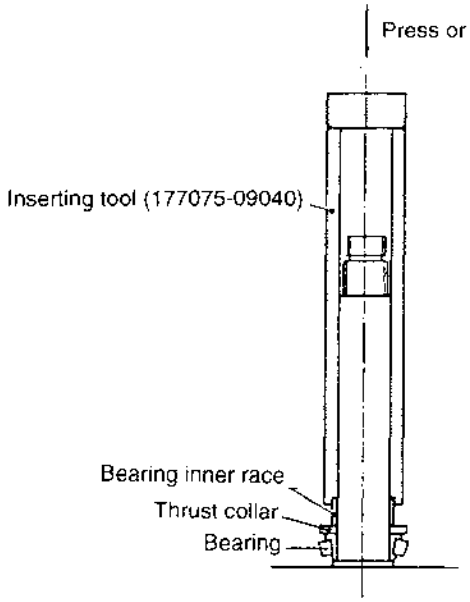
(6) Insert the friction plates and steel plates into the spline part of the reverse large gear in the same manner as described in step (5) above (six friction plates and five steel plates).

(7) Press the inner race of the bearing onto the output shaft up to the collar, using an assembly too.

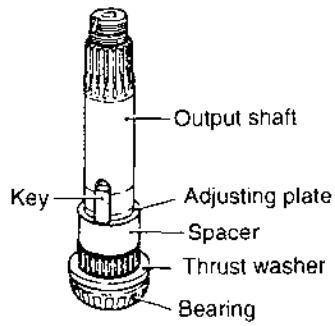
**[NOTICE]**
*The inner race can be installed easily by preheating it to approximately 100℃.*



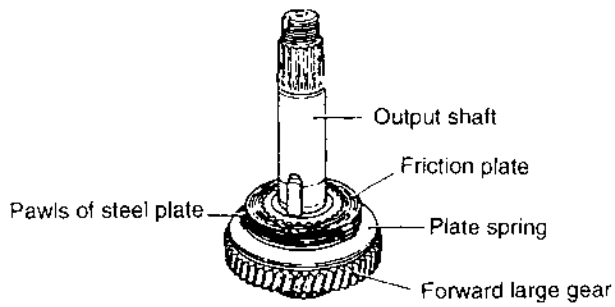
(8) Insert the thrust collar, with the sintered surface (brown surface) facing the gear side.
(9) Press the bearing inner race onto the output shaft, using an assembly tool.




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



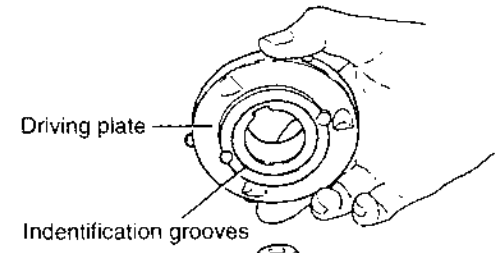

(13) Insert the forward large gear, together with the friction plates and steel plates. At this time, align the three pawls on the outside of the steel plates.

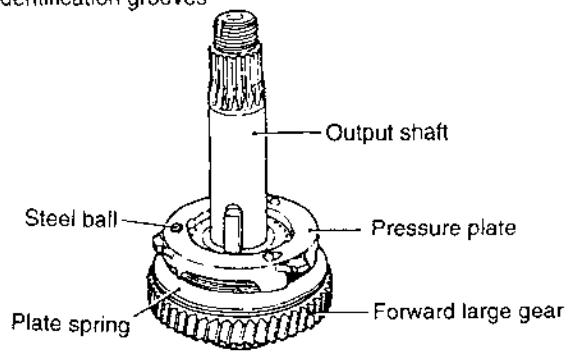


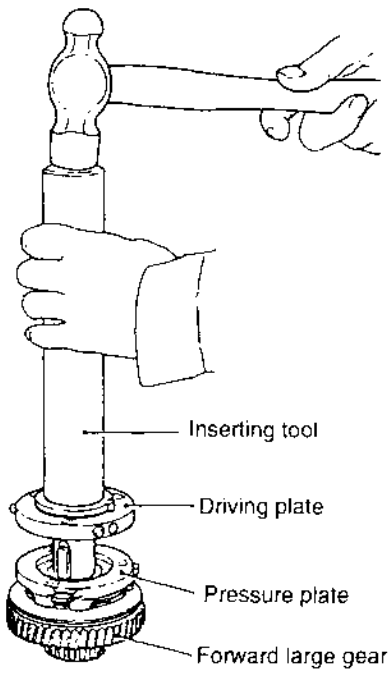

(14) Cover the friction plates and steel plates with the pressure plate so that the pawls of the steel plate fit into the three notches on the pressure plate.
(15) Insert the three steel balls into the three grooves in the pressure plate.
(16) Insert the drive plate into the output shaft so that the side with the identification groove faces the forward large gear side.

**[NOTICE]**

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

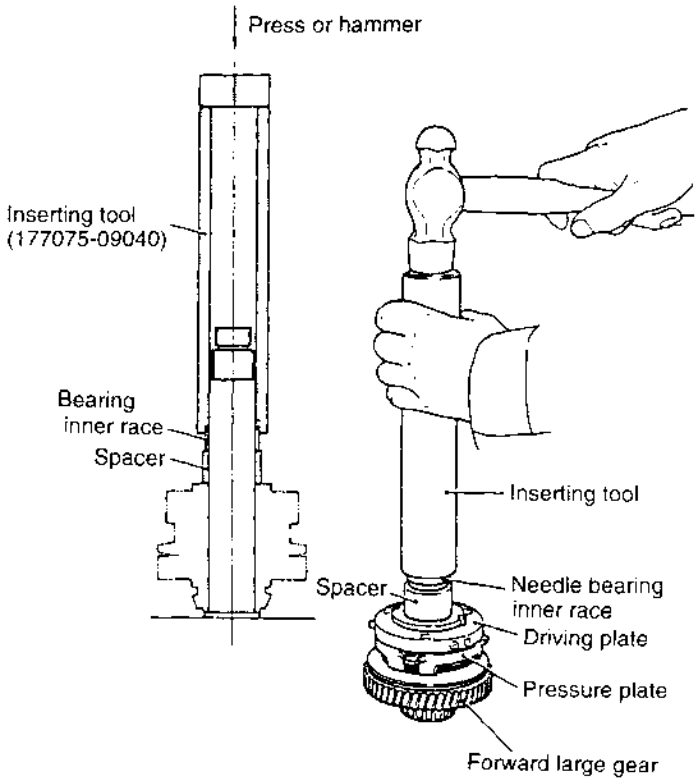


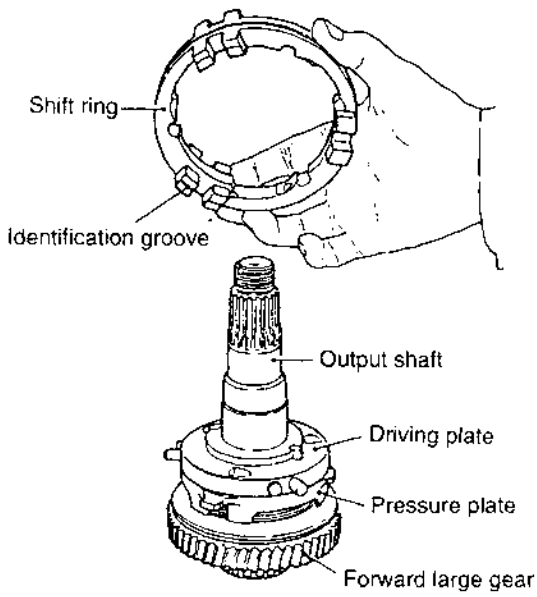
(17) Insert the adjusting plate and spacer.

(18) Press the bearing inner race, using an assembly tool.




(19) Insert the knock pins and springs into the three holes around the circumference of the driving plate.

(20) Cover the driving plate with the shift ring so that the side with the identification groove faces the forward large gear side; install the ring so that the knock pins are pushed in.




(21) Insert the three steel balls into the three grooves in the driving plate.

(22) Plage the pressure plate onto the driving plate so that the steel balls enter the three grooves of the pressure plate.

(23) Insert the three pressure plate return springs between the shift ring and the driving plate, and attach them to the small holes in the side of the pressure plate.

(24) Insert the reverse large gear [see step (6)] so that the three pawls of the steel plates enter the notches around the circumference of the pressure plate.

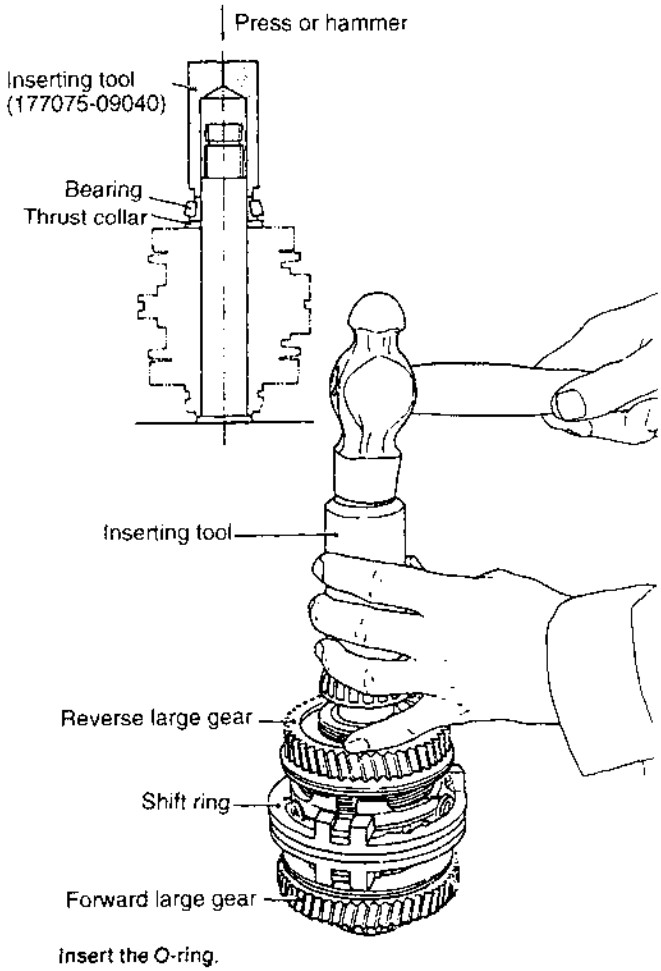
(25) Insert the needle bearing.

(26) Insert the thrust washer so that the sintered side (brown side) faces the gear side.

(27) Press the inner race of the bearing, using an assembly tool. At this time, make sure that the direction of the bearing is correct.

**[NOTICE]**

*The bearing inner race can be installed easily by preheating it to approximately 100℃.*




Insert the O-ring.

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

### 3.6.6.3 Reassembling the input shaft

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

**[NOTICE]**

*The bearing inner race can be easily installed by preheating it to approximately 100℃.*

### 3.6.6.4 Reassembling the intermediate shaft

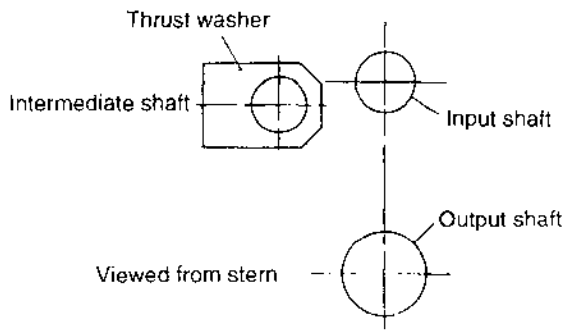
**[NOTICE]**

*Assemble the intermediate shaft as described in section 3.6.6.5(5).*

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

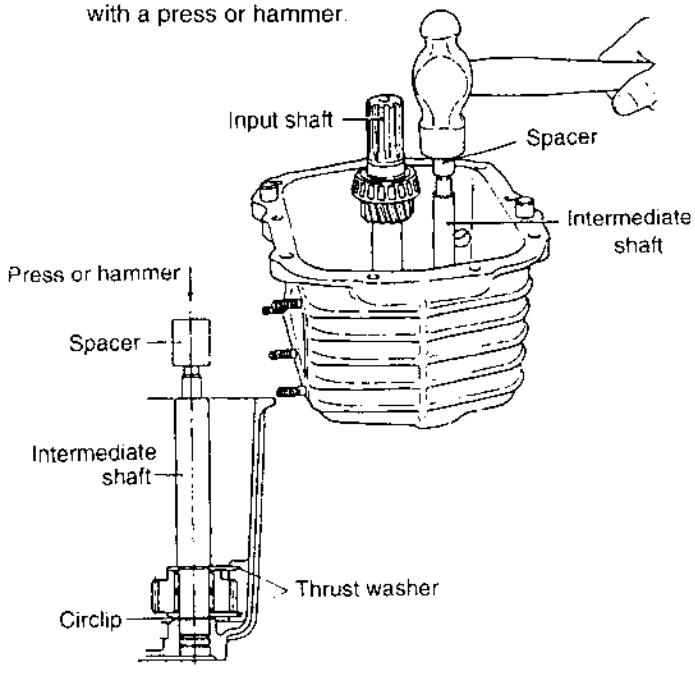
**[NOTICE]**

*Pay careful attention to the assembling direction of the thrust washer.*




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

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




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

### 3.6.6.5 Installing the input shaft and output shaft

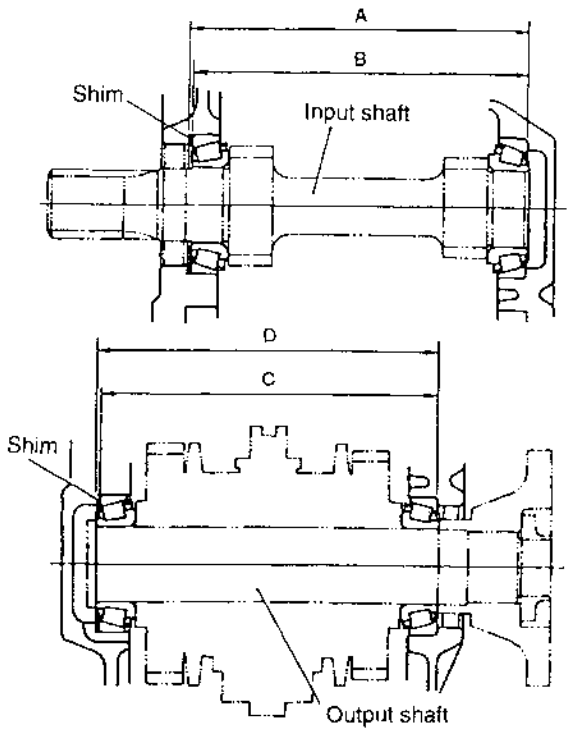
(1) Determining the thickness of the input shaft adjusting plate and output shaft adjusting plate

**[NOTICE]**

*As mentioned in section 3.6.5.1(13), when none of the parts are replaced the adjusting plate can be reused without readjustment.*

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

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




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

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

5 Three adjustment plates of 0.5mm, 0.4mm and 0.3mm are available.
Combine these plates to obtain the desired adjusting plate measurement.

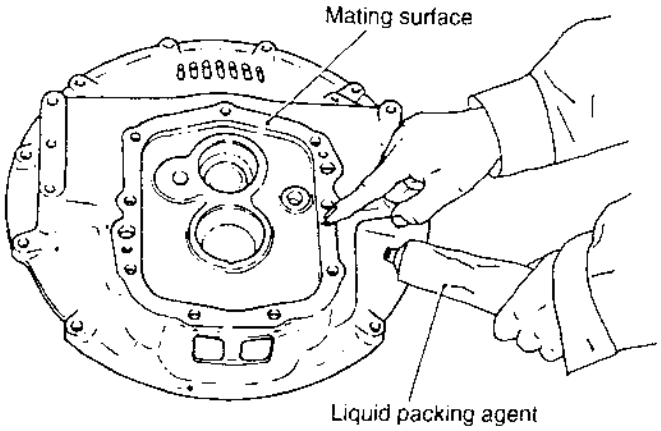
(2) Insert the adjusting plate into the mounting flange, and press the outer race of the bearing.
Also, press the outer race of the bearing into the case.

**[NOTICE]**

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

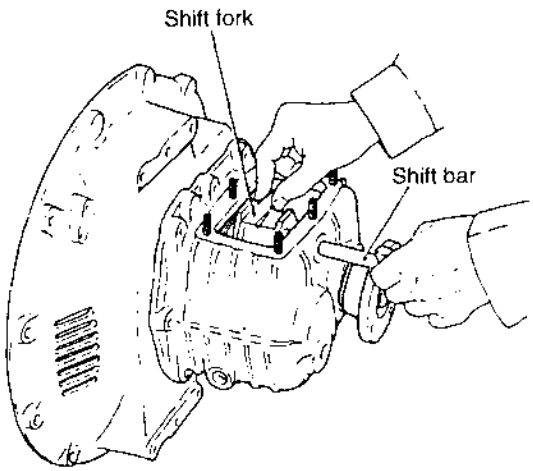
(3) Coat the circumference of the oil seal with a liquid packing agent, and press it onto the mounting flange and case so that the spring part of the oil seal is inside the case.

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

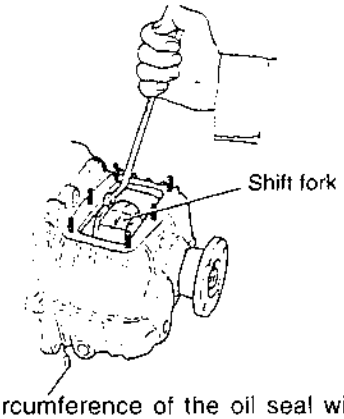



(5) Insert the input shaft into the case, assemble the intermediate shaft as described in section 6-4 and then insert the output shaft into the case, mounted with shift fork and shift ring.
(6) Align the mounting flange with the case, and insert the parallel pin by tapping the mounting flange with a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

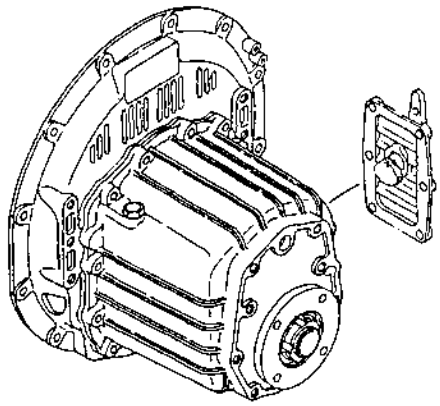
### 3.6.6.6 Reassembling and installing the operating system




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




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



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

**[NOTICE]**
*The shift cam must rotate smoothly.*

(7) Replace the packing if it is damaged.
(8) Attach the case side cover with operating system in the case body.
At this time, make sure that the shift cam is fitted to the shift fork, and that the shift lever is in neutral

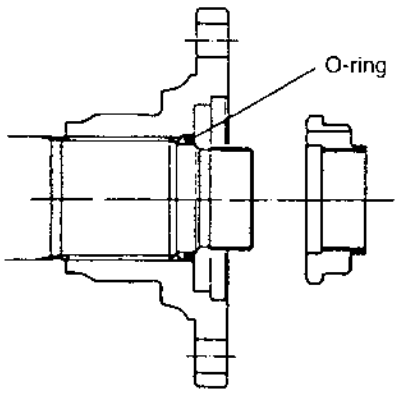
**[NOTICE]**
*Put the shift fork into neutral before installing.*

(9) Insert the super lock washer, and tighten the M8 nut.
(10) Shift the shift lever to forward and reverse to make sure that the lever operates normally.
If the lever does not operate normally, loosen the M8 nut, slide the case side cover forward, backward, and to the left and right, then re-tighten with the M8 nut in the position at which the lever operates normally.

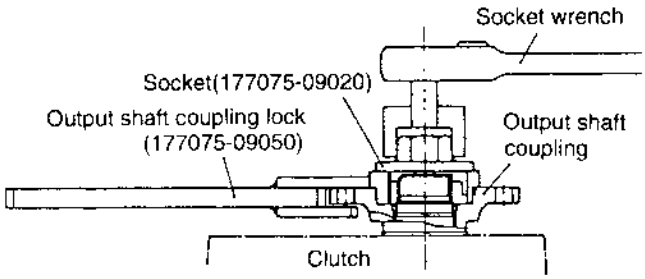
**[NOTICE]**
*IF the lever opeates normally a click will be heard when it is put into forward and reverse.*

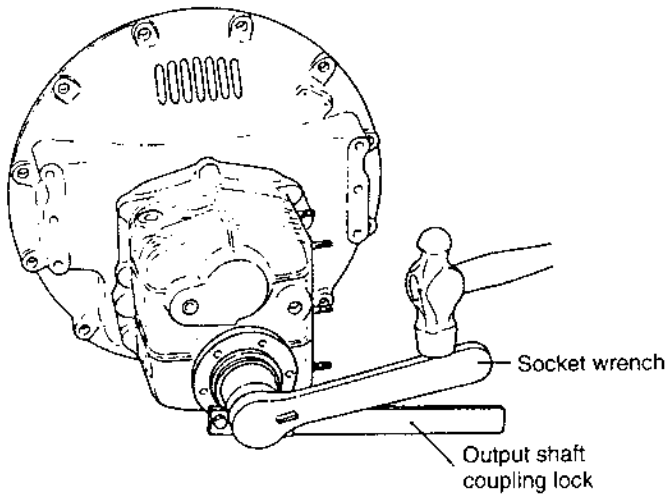
### 3.6.6.7 Installing the output shaft coupling

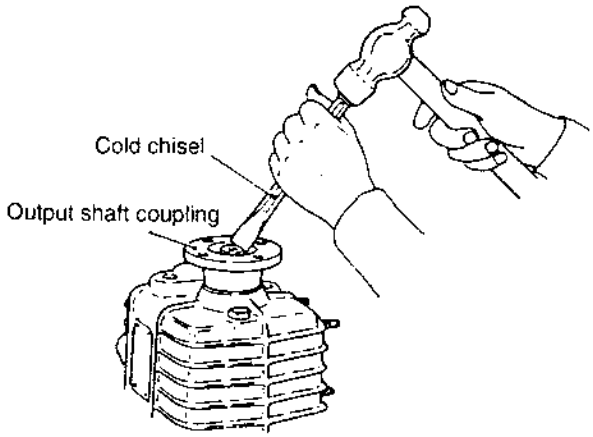
(1) Install the output shaft coupling on the output shaft and then insert the O-ring in the groove between the output shaft and the output shaft coupling.




(2) Tighten and caulk the output shaft lock nut, using the assembly tool.
Tightening torque.....15kgf-m (147N·m)

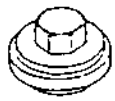
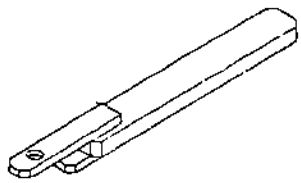
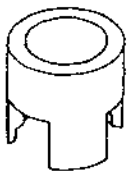
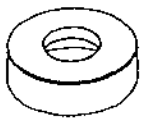
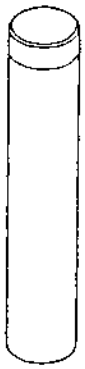



(3) Shift the shift lever to the neutral position and make sure the clutch engages when the shift lever is put into forward and reverse.
The input/output shafts will not rotate smoothly if the side gap of the bearing is too small in relation to the thickness of the adjusting plate.

## 3.6.7 Special Tools

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

# 3.7 KMH4A

## 3.7.1 Construction

### 3.7.1.1 Construction

This marine gear has a built-in wet type multi-disc clutch and is operated by the oil pressure of the hydraulic pump. It is composed of the damper disc, input shaft, reduction gear, clutch, hydraulic oil pump, and the clutch case. The lube oil for each of the parts is distributed by the oil pressure pump in a forced lubrication system.

When the forward/reverse changing valve lever is moved, oil pressure is applied to move the clutch to the forward or reverse position.

The forward clutch is fitted to the input shaft, and the reverse clutch is fitted to the support shaft.

The gear oil (lube oil) is cooled by a multi-pipe seawater cooler. The A2 trawling device is available as optional equipment.

### 3.7.1.2 Specifications

| | | | |
|---|---|---|---|
| Model | | KMH4A | |
| Applicable engine (Standard model) | | 4JH3-TE, 4JH3-HTE, 4JH3-DTE | |
| Flywheel coupling | | Damper disc | |
| Clutch | | Wet type multi-disc, hydraulic operation | |
| Output shaft | | Eccentric 8° down angle | |
| Reduction ratio (Both forward and reverse) | | 2.04 | 2.45 |
| Direction of rotation (viewed from stern) | Input shaft | Counterclockwise | |
| | Output shaft | Clockwise | |
| Reduction gear | Forward | One stage constant mesh helical gear | |
| | Reverse | | |
| Lubricating system | | Force lubricating (Gear oil pump) | |
| Lube oil cooling syste | | Sea water cool (Multi-pipe cooler) | |
| Lube oil | | SAE#30 | |
| Lube oil capacity (Max./effective) ℓ | | 2.0/0.2 | |
| Hydraulic oil press. kgf/cm² (MPa) | | 24~26.5 (2.35~2.59) | |
| Lube oil press. kgf/cm² (MPa) | | 1.5~2.5 (0.15~0.24) | |
| Trawling device | | A2 type (optional) | |
| Dry mass kg(N) | | 31 (304) | |

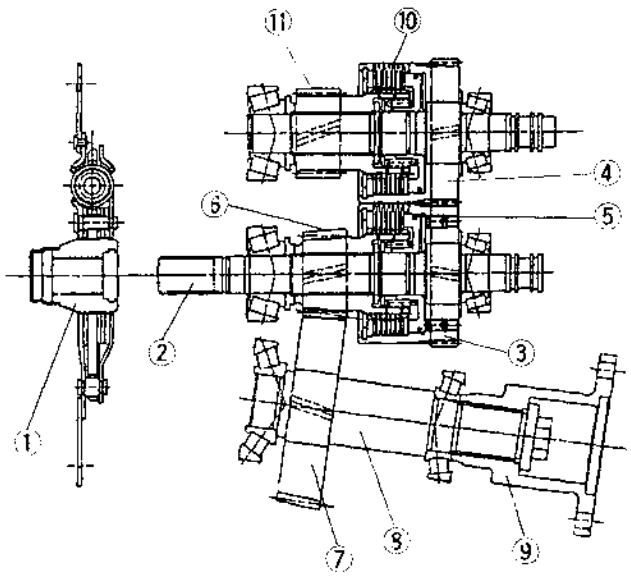
### 3.7.1.3 Power Transmission Process

- Forward power transmission process

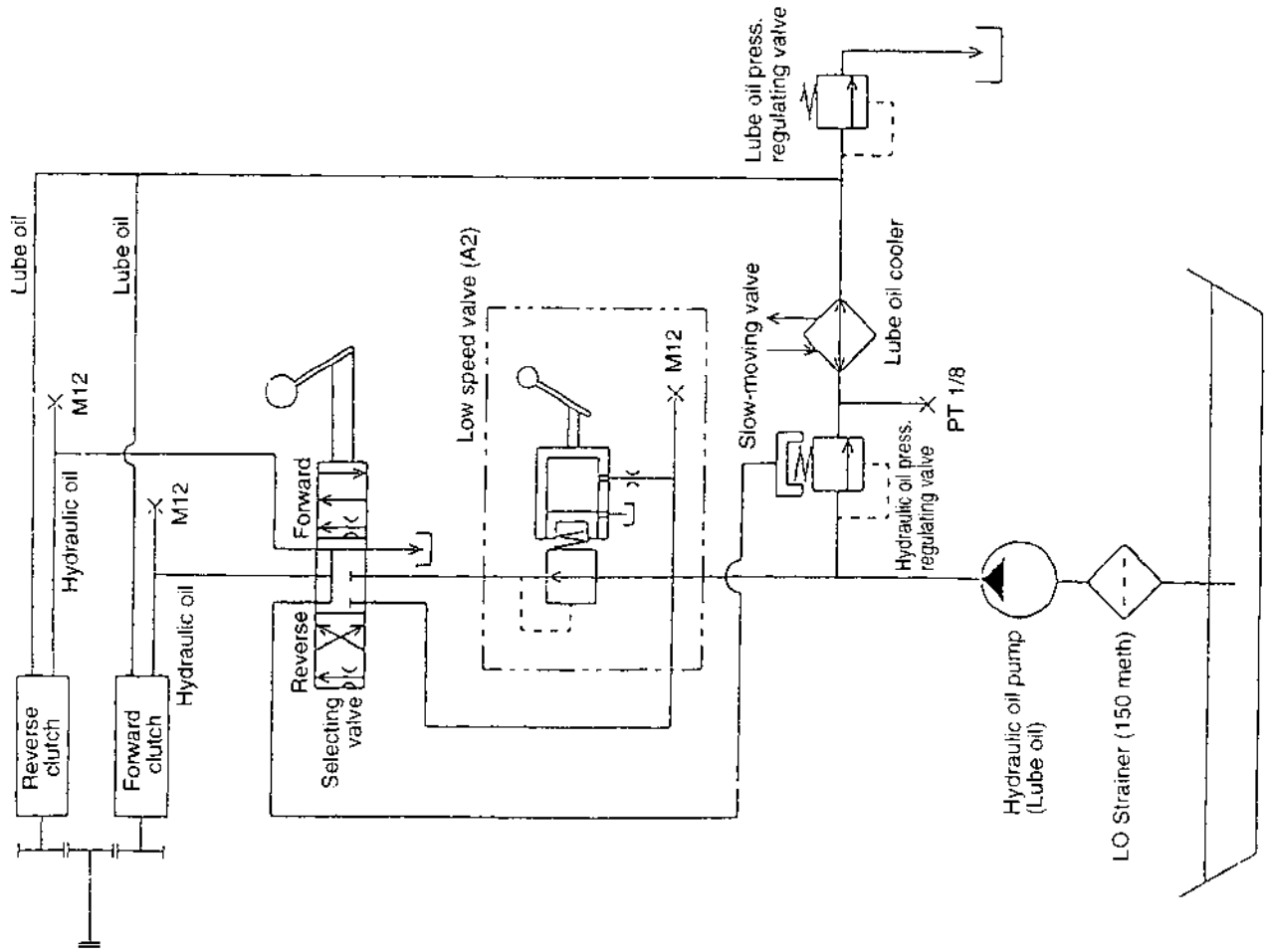
Damper disc ①→ Input shaft ②→ Gear (drive) ③→ Forward clutch ⑤→ Forward pinion ⑥→Gear ⑦→ Output shaft ⑧→ Coupling (output) ⑨

- Reverse power transmission process

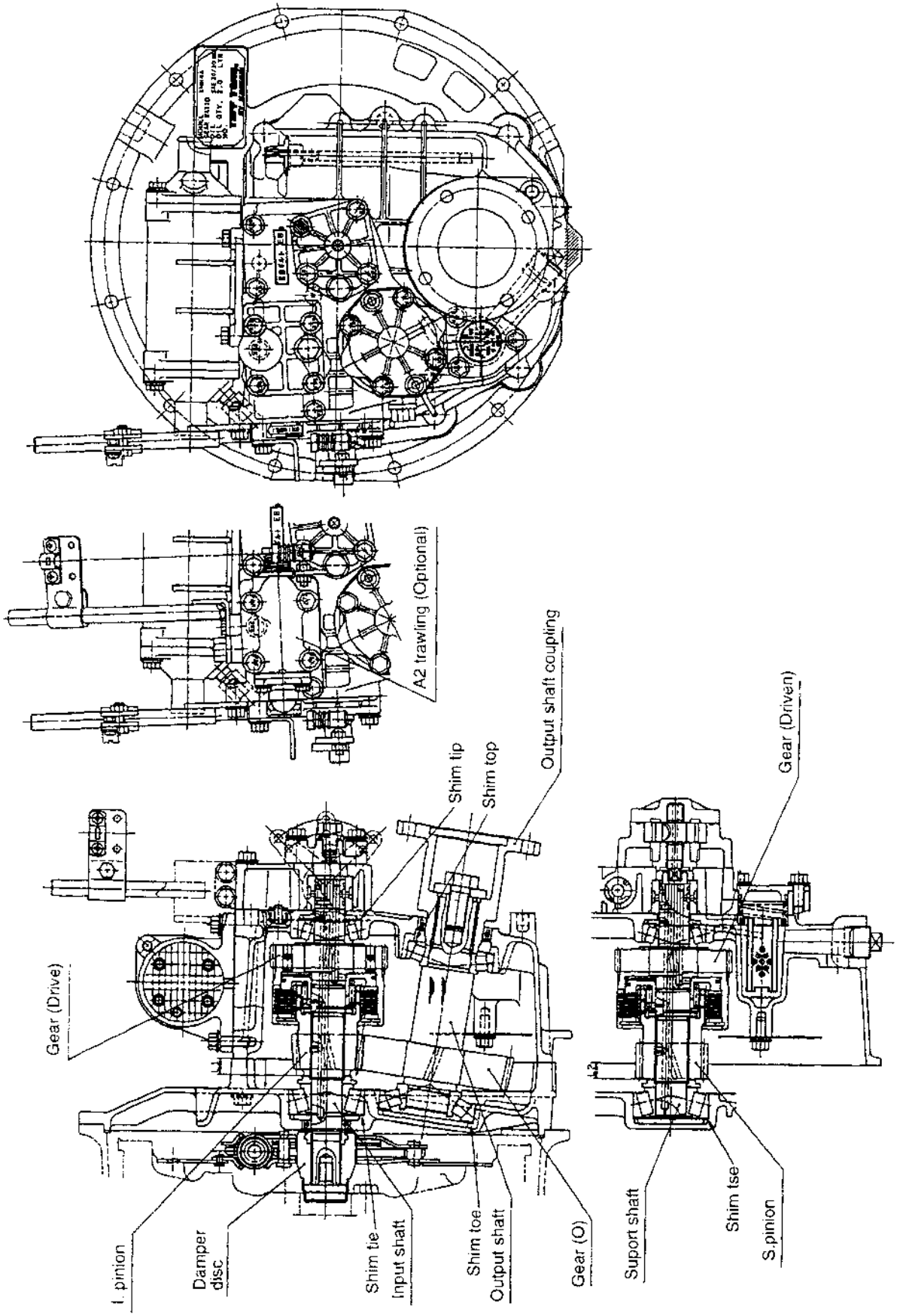
Damper disc ①→ Input shaft ②→ Gear (drive) ③→ Gear (driven) ④→ Reverse clutch ⑩→ Reverse pinion ⑪→ Gear ⑦→ Output shaft ⑧→Coupling (output) ⑨



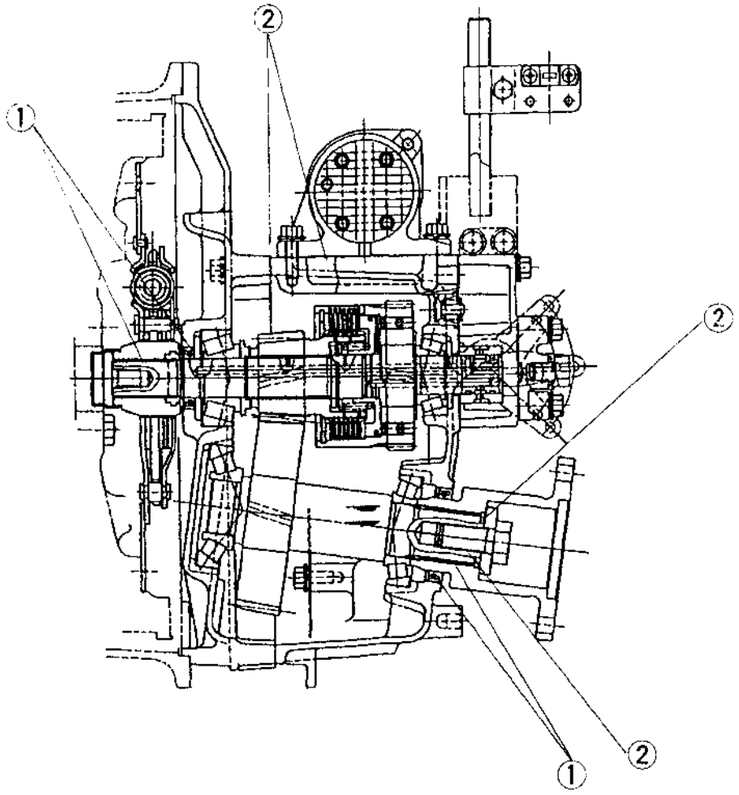

### 3.7.1.4 Hydraulic circuit

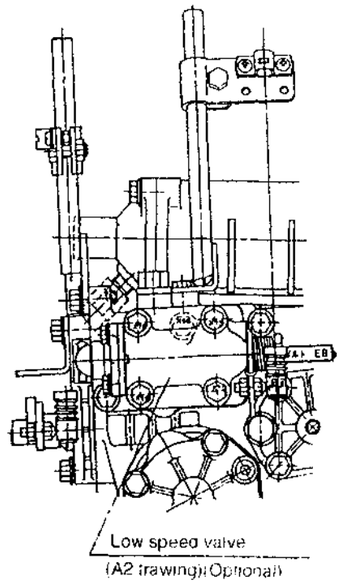


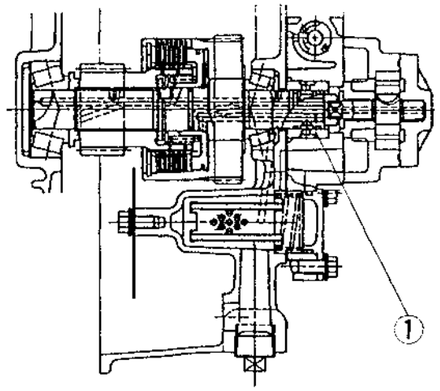
### 3.7.1.5 Sectional view

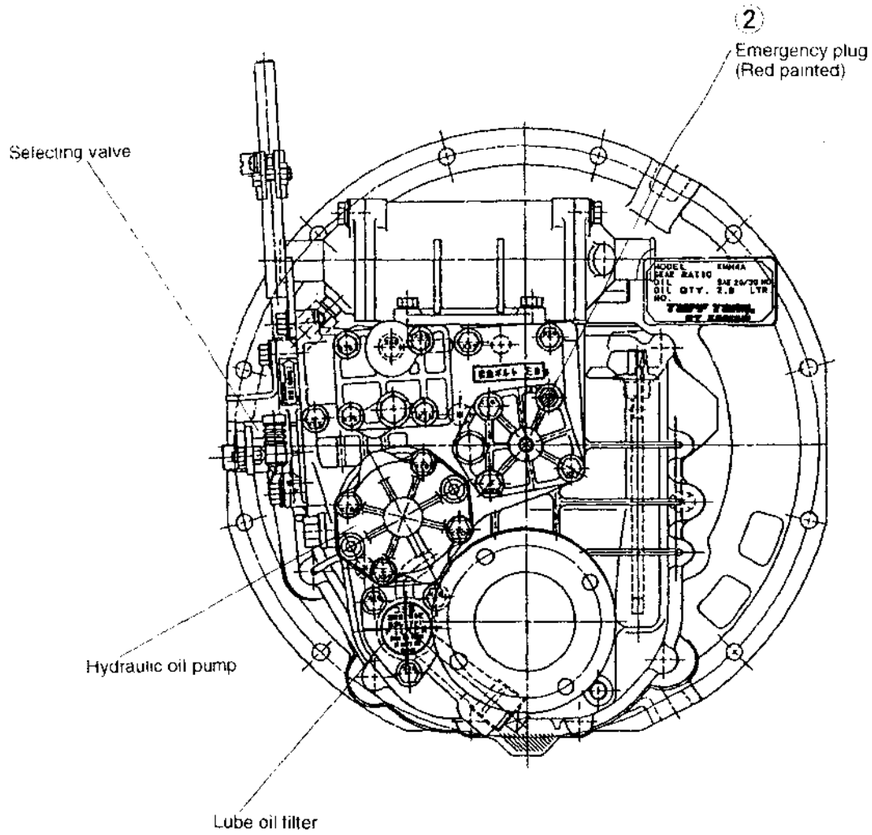


**2) Applying grease, liquid seal, adhesion and bolt, nut tightening torque**




1) Place to Grease
- Spline of the input/output shaft
- Oil seal
- Square ring and seal ring for each shaft
- 40% of the end space on the damper disc

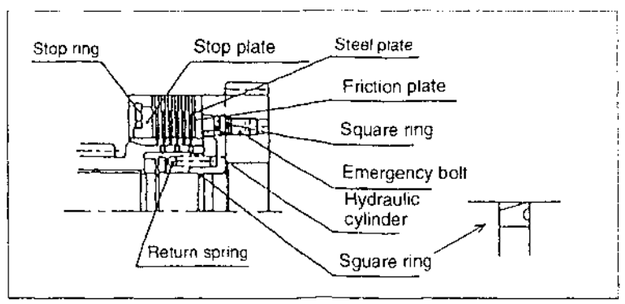
2) Place for Three Bond

A. Alignment faces to prevent oil leakage (#1215)
- Case, flange
- Case, lube oil cooler
- Emergency bolt screw

B. Prevent loosening (#1401)
- Input/output shaft screw

3) Hydraulic Oil Pump
- Remove 4 bolts only at time of disassembly.
- Direction of attachment is shown in the diagram.

4) Be careful of the direction of the square ring assembly on the clutch shaft side.




5) Tightening torque

kgf·m(N-m)

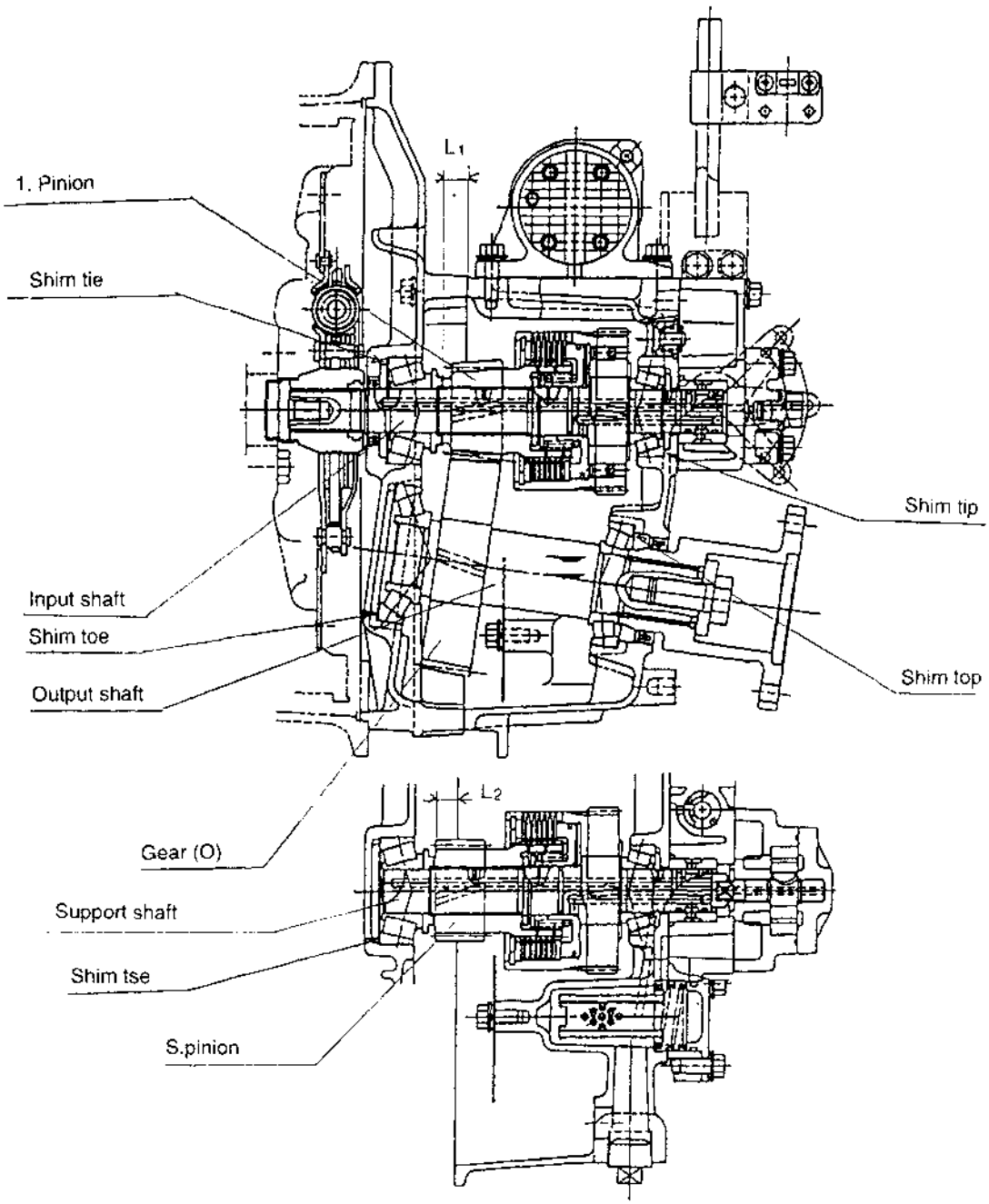
| Part Name | Screw | Tightening Torque |
|---|---|---|
| Selecting valve lever mounting bolt | M10×1.5 | 4 ± 0.2 (39.2 ± 1.96) |
| Low speed valve assembly mounting bolt | M8×1.25 | 2.1 ± 0.1 (20.5 ± 0.98) |
| Hydraulic oil pump mounting bolt | M8×1.25 | 2.1 ± 0.1 (20.5 ± 0.98) |
| Emergency bolt mounting bolt | M8×1.25 | 1.9 ± 0.1 (18.6 ± 0.98) |
| Output shaft coupling | M16×1.5 | 23 ± 1 (225.4 ± 9.8) |
| Input shaft flange | M12×1.75 | 9 ± 1 (88.2 ± 9.8) |
| Output coupling reamer | M10×1.5 | 5 ± 0.5 (49 ± 4.9) |

## 3.7.2 Disassembly and Reassembly

For disassembly and reassembly, see YX - Series Marine Gear Service Manual, A0A5019-JC09 YX-15-1(YX-10).

### 3.7.2.1 Important Items for Disassembly and Reassembly

1) Shim adjusting




- Measure L2
  Set the amount of shim tip so that L1=L2 ± 0.05
- Set the amount of shim top so that the backlash of the S.pinion and gear (O) is 0.12 ± 0.04.
- Confirm that the backlash of the I.pinion and gear (O) is 0.12 ± 0.04.
- Set the shim tie and shim tse so that the bearing gap for the input shaft and support shaft is 0 ± 0.05.
- Set the shim toe so that the bearing tightening for the output shaft is 0~0.1.

### 3.7.2.2 Component Adjustment

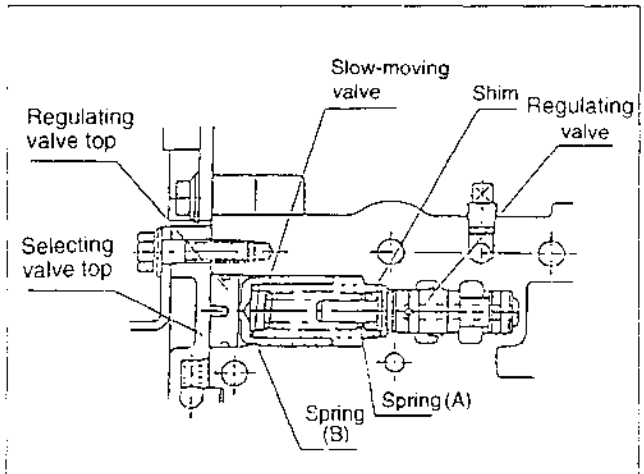
**1) Clutch hydraulic oil pressure regulaing valve**

This device has the regulating valve with slow-moving valve which raises the hydraulic oil pressure to engage the clutch slowly and smoothly.

a) For oil pressure adjustment, insert a shim between the regulating valve and the inner spring (spring A). First, attach the pressure gauge (35kgf/cm²) (3.43MPa) to the port for checking the hydraulic oil pressure, and remove the selecting valve top and the regulating valve top and push the slow-moving valve to the back. The valve will come off with the spring's force of repulsion.

b) Remove the spring and insert a shim between the regulating valve and the inner spring (spring A). For a shim of 1 mm the pressure change is approximately 2.9kgf/cm²(0.28MPa).

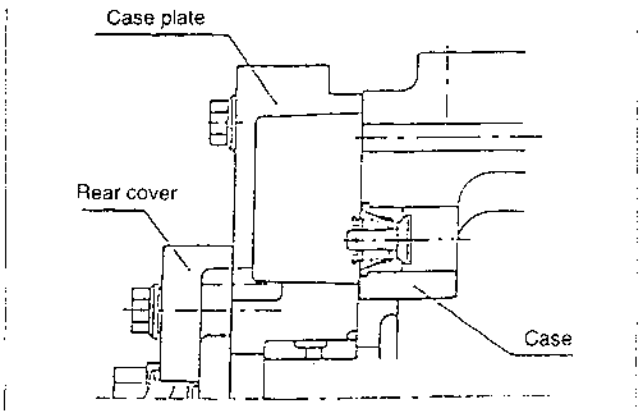
c) After reassembly, put the selecting valve in forward, set the input speed at the maximum practical limit, and measure the oil pressure. (When in neutral, the pressure is set at approximately 2.5kgf/cm²(0.25MPa) and does not rise to the standard pressure.)



(Clutch hydraulic oil pressure regulating valve)

**2) Lube oil pressure regulaing valve**

The oil pressure has been set in advance and further adjustment is not necessary.



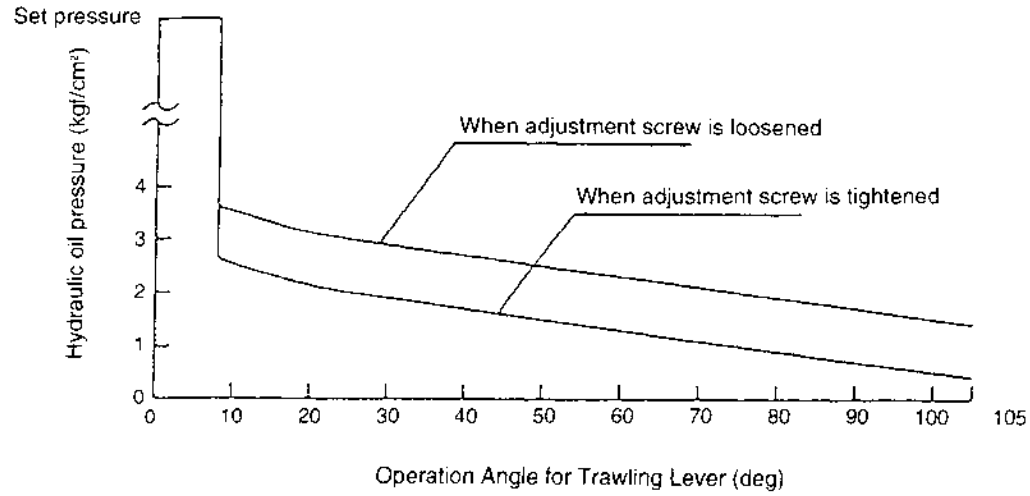
(Lube oil pressure regulating valve)

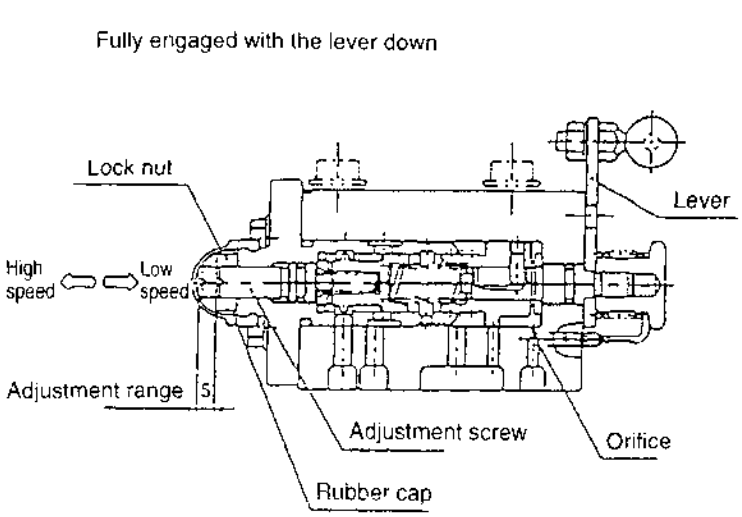
### 3) Trawling Device (Type A2) (Optional)

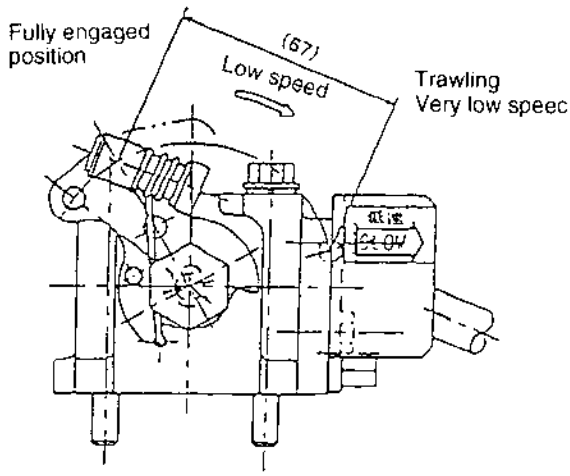
With this device the clutch hydraulic oil pressure is lowered to about 1~2kgf/cm²(0.1 ~ 0.2MPa), the clutch slips and the propeller rotates at a low speed allowing the boat to move very slowly. This trawling device is a simple one which does not give feedback on fluctuations in the propeller speed. From the standpoint of stability, feedback, setting limits on the trawling operation, this device is slightly inferior to the EB type of trawling device.

- **Oil pressure adjustment procedure**

When the rubber cap is removed, the lock nut loosened, and the adjustment screw turned to the right (tightened), the angle of a lever lowers the hydraulic oil pressure and reduces the speed of the boat.




- NOTICE

Be careful of the following when using the trawling device

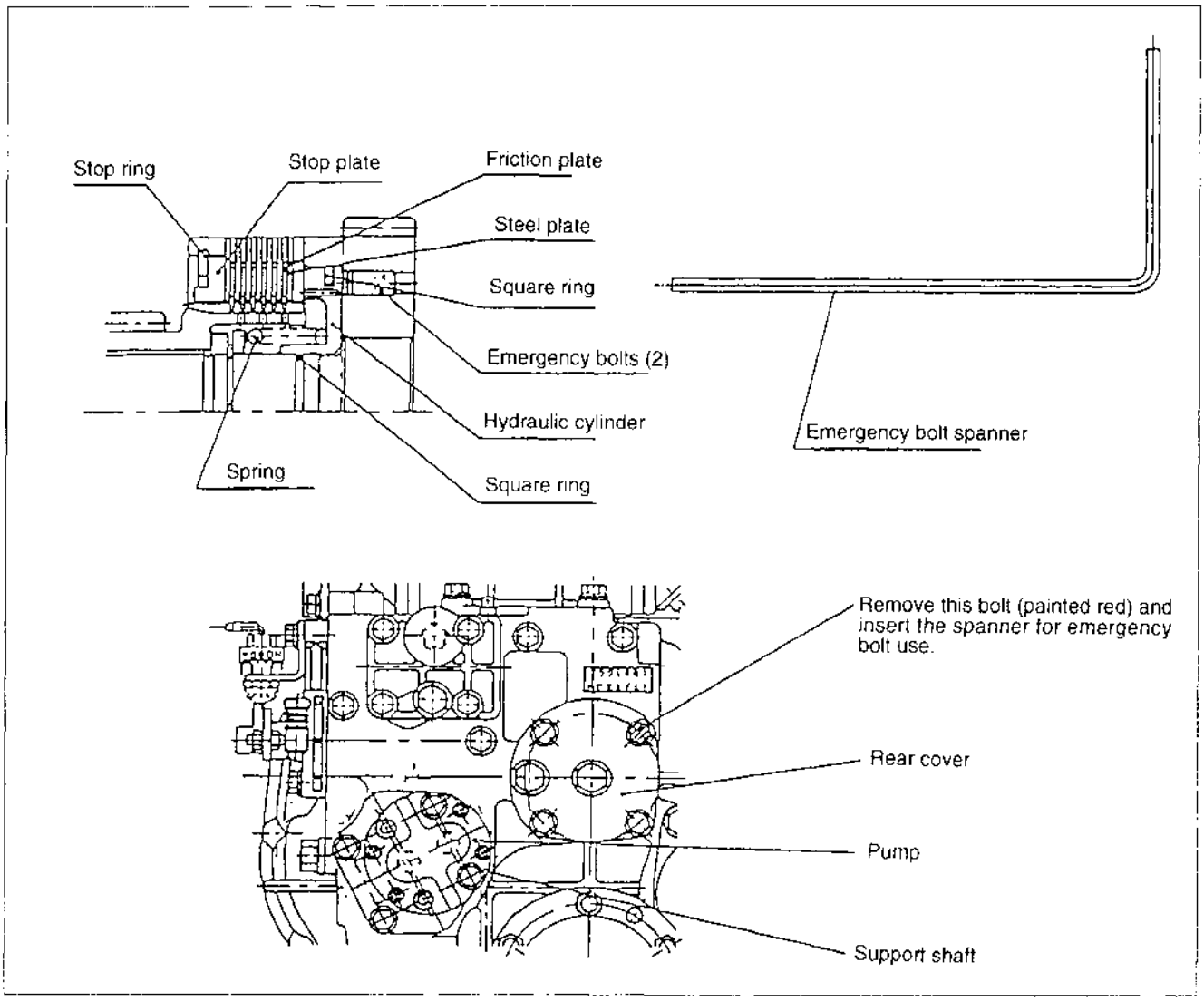
1 Wash the filter when the oil is changed.

2 Use the trawling device once daily. Failure to do so may cause the device to operate poorly due to clogging of the orifice of the low speed valve.

3 When the trawling device is not being used, secure it in place so that it does not move with the vibration of the boat.

#### 4) Method for Engaging the Clutch in Emergencies

If for some reason the clutch slips and will not work, it can be be engaged (with the exception of reverse clutch) by the tightening the emergency bolt.




#### Handling of the Emergency Bolt

a) After stopping the engine remove the attachment fort for the rear cover (painted red: 1 spot).
b) Turn the engine flywheel and stop it when the emergency bolt can be seen in the bolt hole.
c) Insert the attached emergency bolt spanner into the hole and tighten the emergency bolt.
There are 2 emergency bolts, and they should be tightened equally while turning. With this the clutch is engaged in the forward position.
d) Reattach the bolts which were removed in order to tighten the emergency bolt.
e)

> After the clutch has been engaged, the boat will move forward at the same time the engine is started. Care should be taken to make sure it is safe ahead before starting the engine.

(6) At times when the emergency bolt is being used, be sure the changing valve lever is in neutral or forward. Because it is not possible to run the ship in neutral or reverse, care should be taken in operating the boat.

- The engine should be run at 1/2 the standard speed and overloading should be avoided. After returning to port, disassemble completely and repair the faulty parts. When the emergency bolt is turned in the opposite direction (stop position), it can be reused.
- When using the emergency bolt, put lube oil in near the center of the support shaft and use.

### 3.7.2.3 Service Standards

**Service standards for Main Parts**

(mm)

| Part | Item | Limit |
|---|---|---|
| Steel plate and gear (drive, driven) | Backlash | 0.5 |
| Friction plate and pinion | Backlash | 0.5 |
| Pinion and bush | Shaft gap | 0.2 |
| Thrust Collar (stern) | Thickness | 3.1 |
| Thrust collar (stern) | Thickness | 6.1 |

### 3.7.2.4 Troubleshooting

● Faulty Operation of Trawling Device

| Problem | Countermeasure |
|---|---|
| 1. Is the remote control adjustment correct? (Is there a gutter in the link?) | Adjust. |
| 2. Is the low speed valve sticked? | Clean. |
| 3. Is there anything clogging the low speed valve? | Clean. |
| 4. Is there anything clogging the orifice? | Clean. |

● Clutch Slippage due to Abnormal Low Hydraulic Oil Pressure

| Problem | Countermeasure |
|---|---|
| 1. Is the remote contral phase out of position? | Adjust. |
| 2. Is the low speed valve handle in the correct position? | Adjust. |
| 3. Is the oil level too low? | Refill. |
| 4. Is there abnormal wear to the hydraulic oil pump? | Replace pump assembly. |
| 5. Is the lube oil filter clogged? | Clean. |
| 6. Is the assembly of the selecting valve, low speed valve, and hydraulic oil pressure regulating valve correct? | Repair. |
| 7. Is the spring (hydraulic oil pressure regulating valve) damaged or worn? | Repair. |
| 8. The slow-moving valve inside the hydraulic oil pressure regulating valve and the pressure regulating valve are sticked, or the selecting valve orifice is clogged. | Clean or replace. |
| 9. The seal ring is damaged or worn. | Replace. |
| 10. The O-ring and the square ring are damaged or worn. | Replace. |
| 11. The low speed valve piston is sticked. | Clean or replace. |
| 12. The low speed valve orifice is clogged. | Clean. |

● Overheating (When the temperature of the lube oil in the oil pan or cooler inlet is 90℃ or higher, check the following.)

| Problem | Countermeasure |
|---|---|
| 1. Is there clutch slippage? | See (2). |
| 2. Is the oil level too high? | Lower the oil level to specified limit. |
| 3. Is the bearing damaged ? (Is the temperature abnormally high due to a problem in part of the gear case?) | Disassemble and check. Replace if necessary. |
| 4. Is the low speed valve being used correctly? | Repair. |
| 5. Is there clogging in the piping or drilled hole? | Clean. |
| 6. Is there clogging in the oil cooler? | Clean |
| 7. Is the lube oil pressure insufficient? | See (4). |

● Faulty Lube Oil Pressure

| Problem | Countermeasure |
|---|---|
| 1. Is there oil leakage? | Retighten bolts or replace PK types. |
| 2. Is the lube oil pressure regulating valve piston sticked, the spring weak, or is there damage? | Clean or replace. |
| 3. Is the lube oil filter clogged? | Clean. |
| 4. The seal ring is damaged or worn. | Replace. |

● Dragging

| Problem | Countermeasure |
|---|---|
| 1. Is there clutch seizure? | Replace. |
| 2. Is the bush inside the pinion seized? | Replace. |
| 3. Are the thrust collars on the ends of the pinion seized? | Replace. |
| 4. Is the clutch piston return spring worn or damaged? | Replace. |

● Faulty Changing to Forward and Reverse

| Problem | Countermeasure |
|---|---|
| 1. Clutch seizure (This is due to clutch slippage. Check the problem.) | Replace clutch parts. |
| 2. Is the remote control adjustment correct? | Adjust. |
| 3. Is the clutch piston return spring worn or damaged? | Replace. |

YANMAR MARINE GEAR

MODEL **KM3P/KM3A/KM4A**
**KBW20/KBW21/KMH4A**

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