CHAPTER 10

REDUCTION AND REVERSING GEAR

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[A] For engine models 1GM10, 2GM20(F) and 3GM30(F)

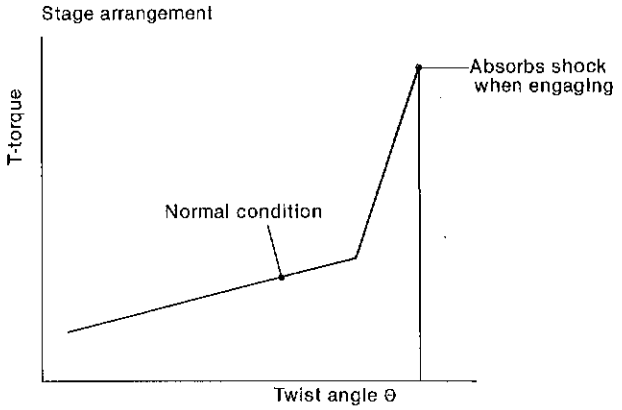
1. Construction

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 construciton is simple when compared with other types of clutch and it serves to reduce the number of components, making for a lighter, more compact unit which can be operated smoothly. Although it is small, the power transmission efficiency is high even under a heavy load. Its durability is high and it is reliable as high grade materials are used for the shaft and gear, and a taper roller bearing is incorporated. Power transmission is smooth as 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, mounting flange and side cover 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 output shaft, power can be transmitted smoothly. For the damper disc, springs of different strengths are used 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.



- The oil level dipstick hole doubles as a breather in addition to being the oil supply port. There is a small clearance between the dipstick and the inside of the dipstick tube which functions as a breather.
- The engagement between the cone and the large gear can be maintained even when the load on the propeller is zero. This is done by the action of the notch and spring joint on the operation lever in the operation device.
  The operation device can still be used without adjusting the remote operation device when the cone is internally worn, because it is compensated for by the spring joint.
- In order to reduce friction on the operation lever shaft, a needle bearing is used to allow smooth operation.

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1-2 Specifications

Model			KM2-C			KM3-A		
For engine models			1GM10, 2GM20(F)			3GM30(F)		
Clutch			Constant mesh gear with servo cone clutch (wet type)					
Reduction ratio	Forward		2.21	2.62	3.22	2.36	2.61	3.20
	Reverse		3.06	3.06	3.06	3.16	3.16	3.16
Propeller shaft rpm (Forward) rpm			1540	1298	1055	1441	1303	1063
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					
	Clamp		YANMAR made, standard accessory					
	Spring joint		YANMAR made, standard accessory					
Output shaft coupling	Outer diameter		ø100mm (3.93")					
	Pitch circle diameter		ø78mm (3.07")					
	Connecting bolt holes		4—ø10.5mm (4—ø0.41")					
Position of shift lever			Left side, viewed from stern					
Lubricating oil			SAE #10W-30, CC class					
Lubricating oil capacity			0.25ℓ			0.3ℓ		
Dry weight			9.5kg (20.9 lbs)			11.0kg (24.3 lbs)		

Models KM2C and KM3A reduction and reverse gear boxes, shafts and gears are the same except for the following items:

- No. of gear teeth (derives different gear ratios).
- Distance between bearings for input and output shafts.
- Clutch case, mounting flange.

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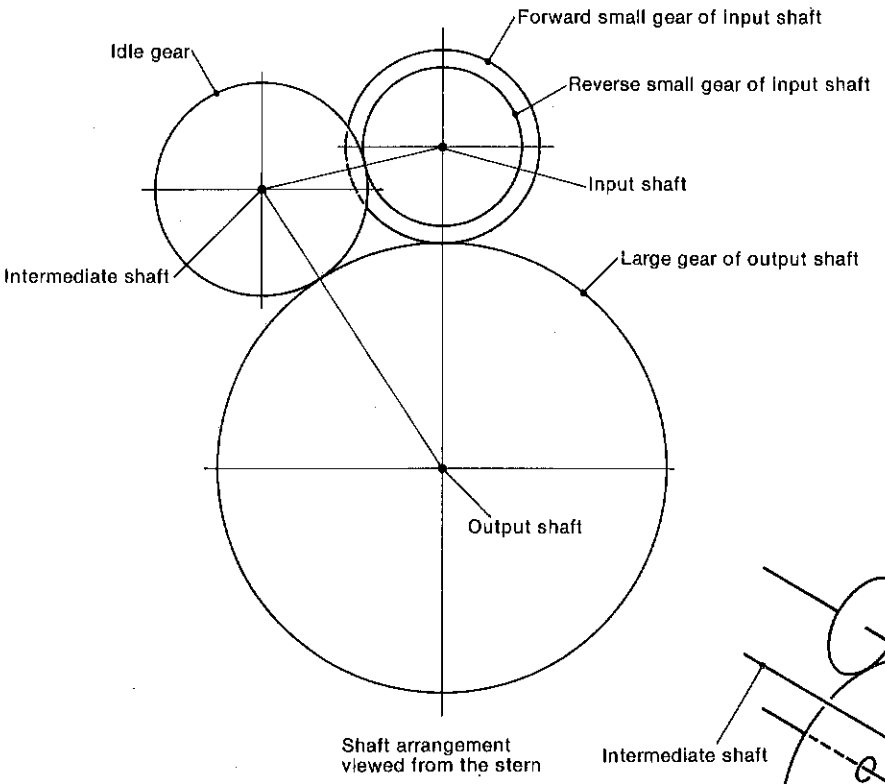
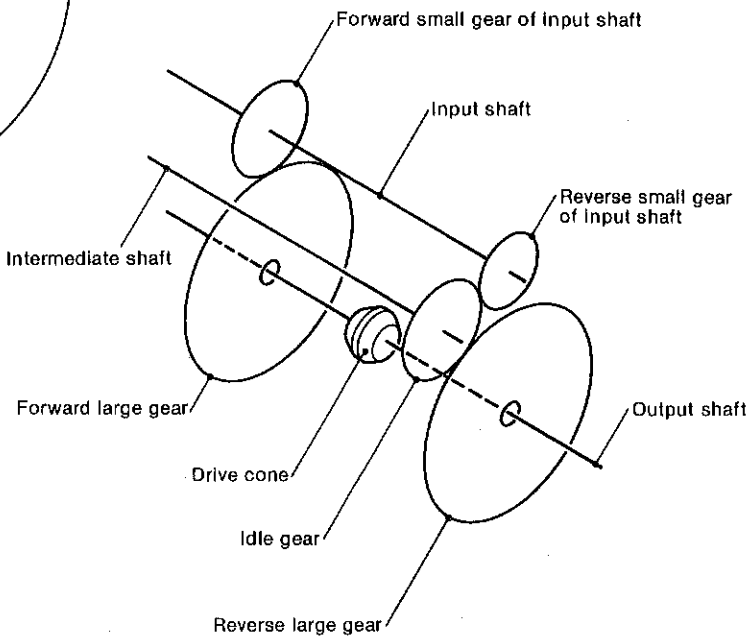
1-3 Power transmission system

1-3.1 Arrangement of shafts and gears





1-3.2 Reduction ratio

Forward

Model	No. of teeth of forward small gear Zif	No. of teeth of forward large gear Zof	Reduction ratio Zof/Zif
KM2-C	24	53	53/24 = 2.21
	21	55	55/21 = 2.62
	18	58	58/18 = 3.22
KM3-A	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 gear Zir	No. of teeth of intermediate shaft gear Zi	No. of teeth of reverse large gear Zdr	Reduction ratio Zi/Zir•Zdr/Zi
KM2-C	18	26	55	55/18 = 3.06
KM3-A	19	26	60	60/19 = 3.16

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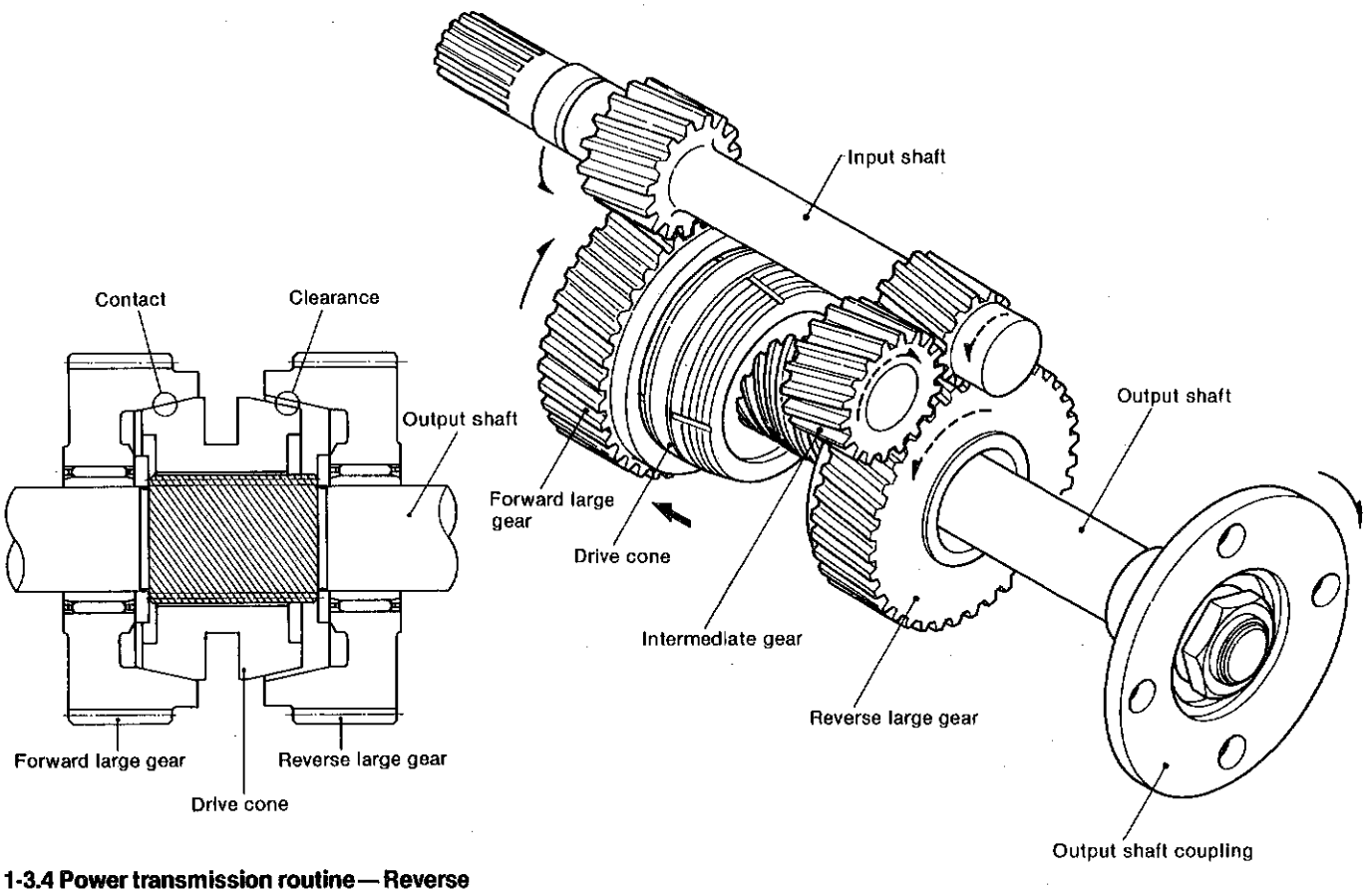
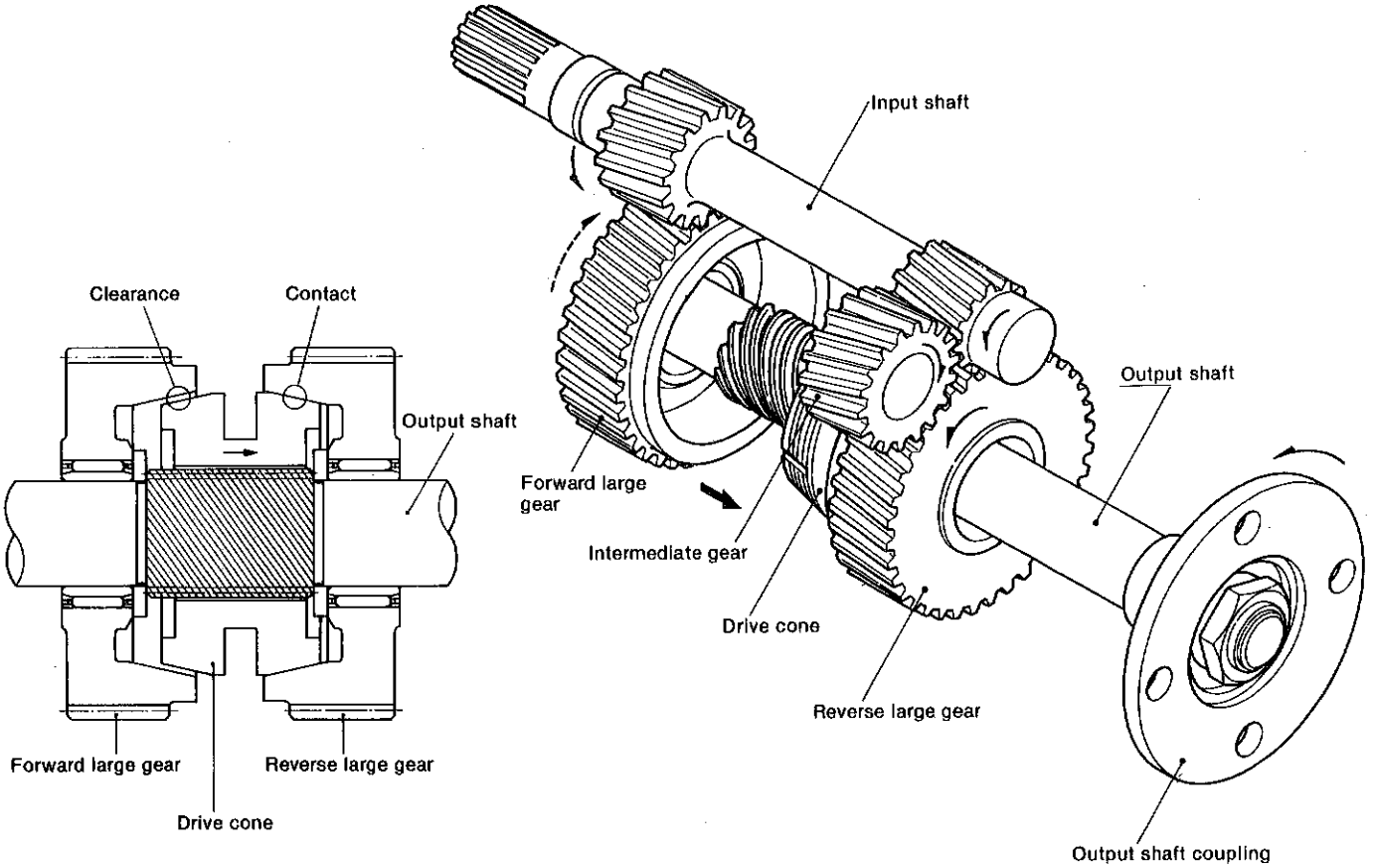
1-3.3 Power transmission routine—Forward



1-3.4 Power transmission routine—Reverse



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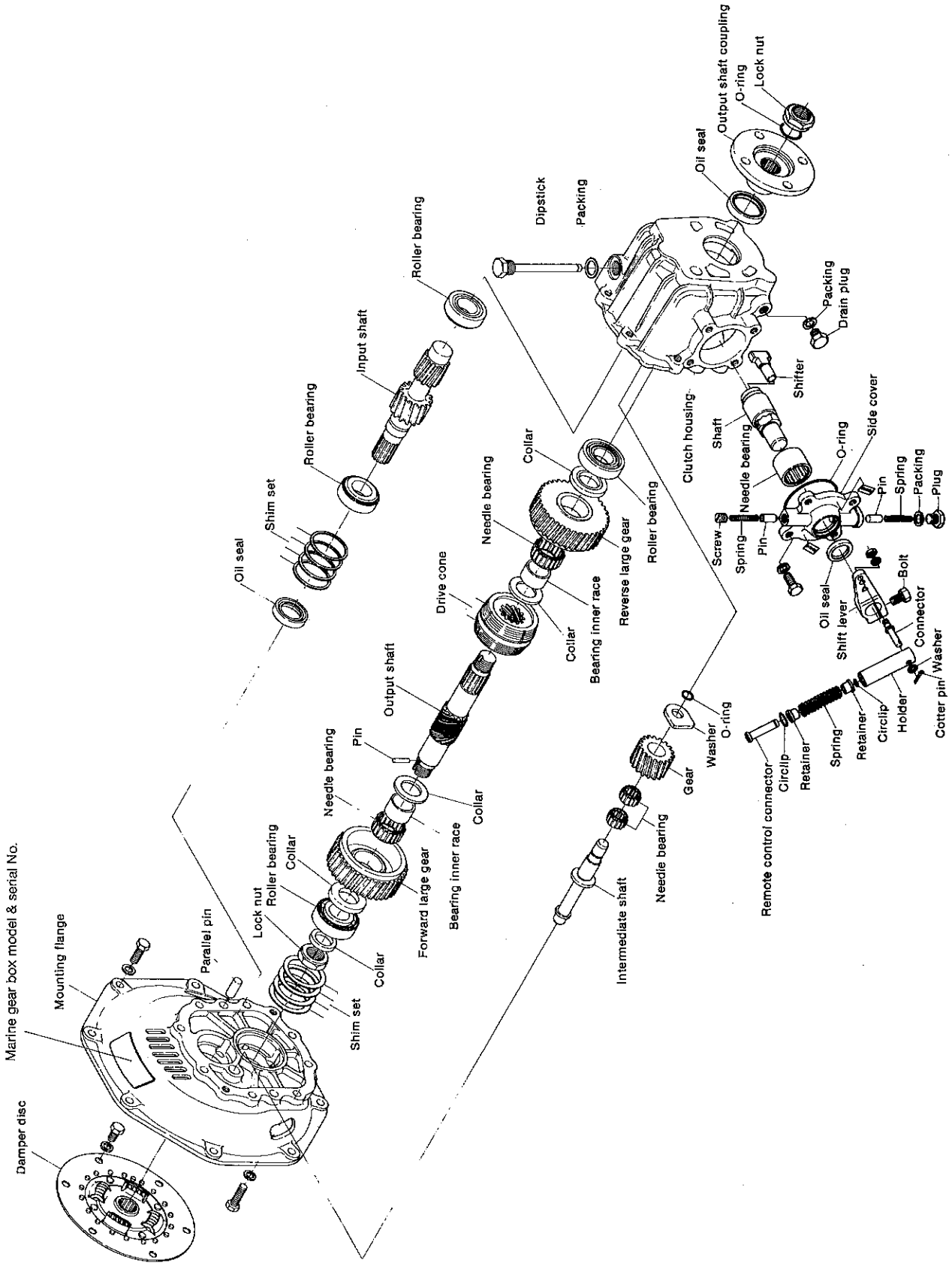
1-4 Drawing



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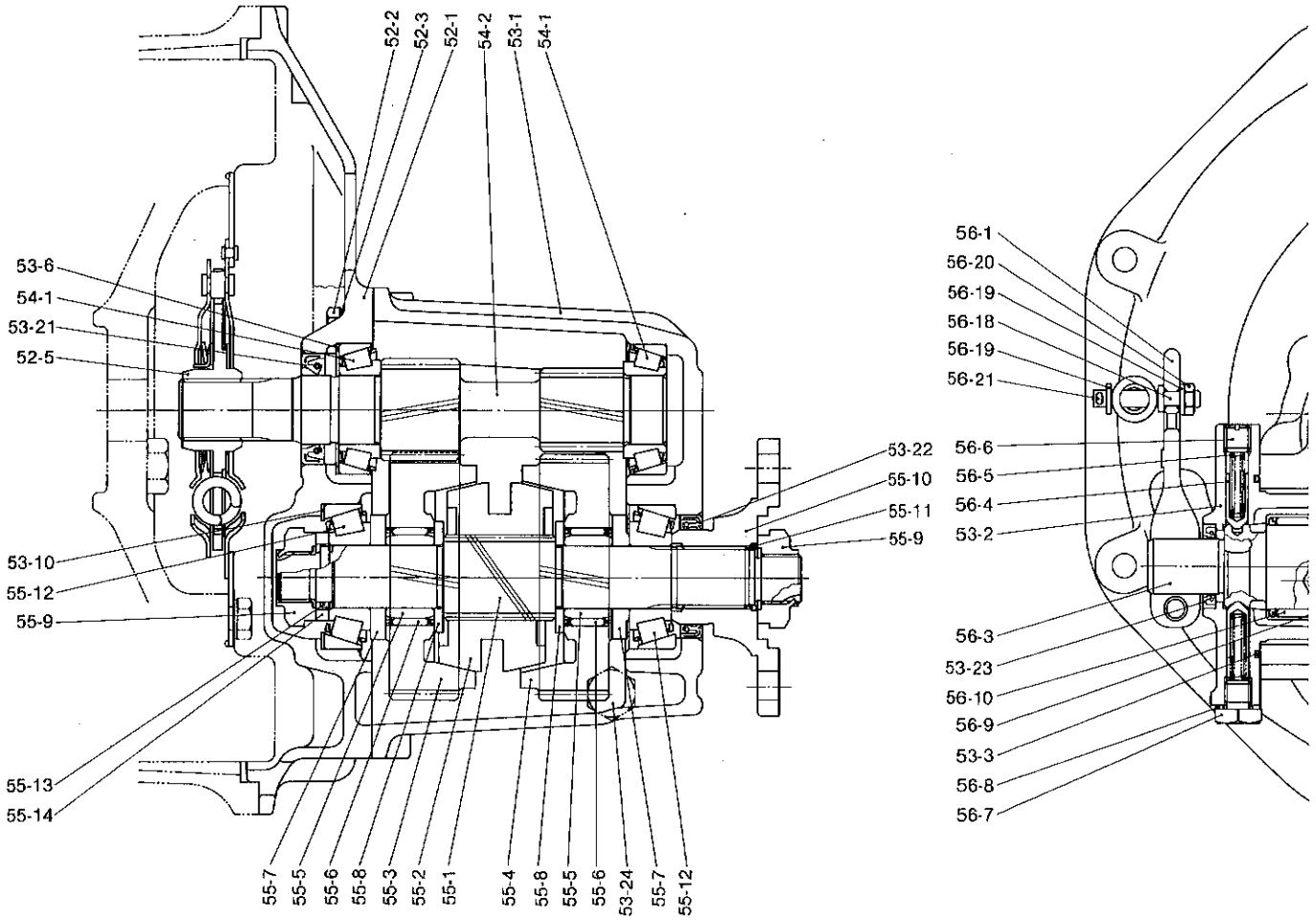

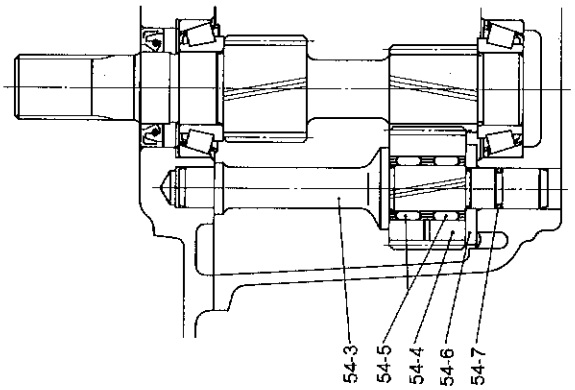

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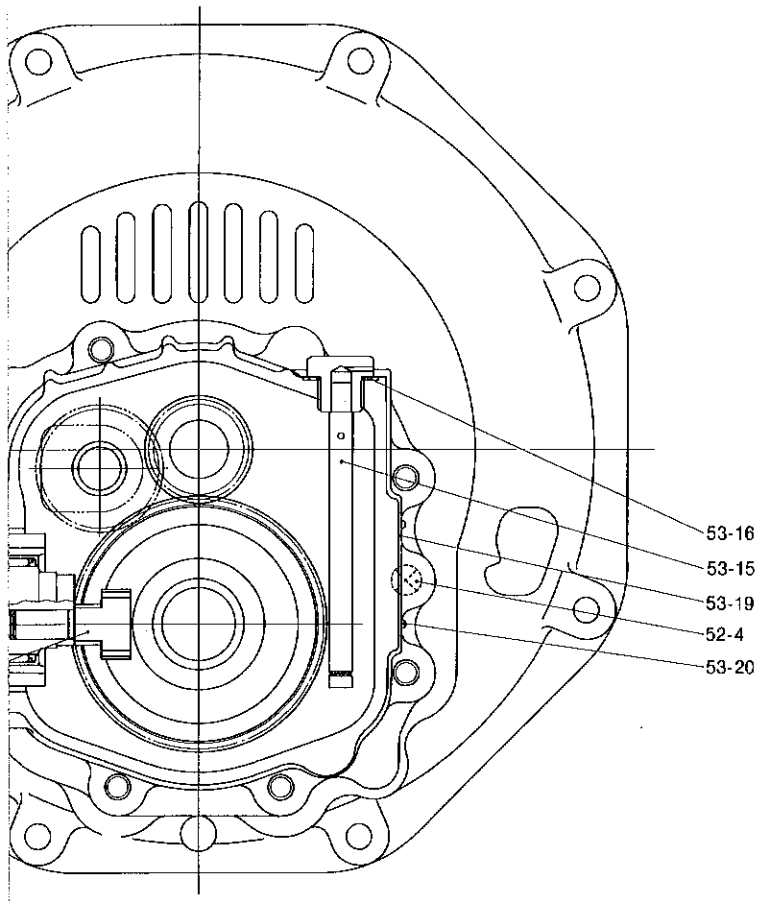
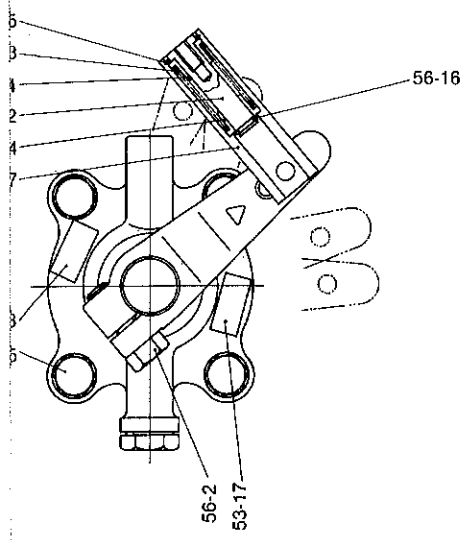


52-1 MOUNTING FLANGE
52-2 BOLT M8 × 25
52-3 WASHER 8
52-4 PARALLEL PIN 10 × 16
52-5 DAMPER DISK

53-1 CLUTCH HOUSING
53-2 SIDE COVER
53-3 O-RING 60-S
53-4 BOLT M8 × 20
53-5 WASHER 8
53-6 SHIM SET
53-10 SHIM SET
53-15 DIPSTICK
53-16 PACKING 16
53-17 LABEL, forward
53-18 LABEL, reverse
53-19 LABEL, clutch model
53-20 RIVET
53-21 OIL SEAL SC25408
53-22 OIL SEAL MHSA34448
53-23 OIL SEAL SC20305
53-24 PLUG M10

54-1 ROLLER BEARING #32005
54-2 INPUT SHAFT
54-3 INTERMEDIATE SHAFT
54-4 GEAR
54-5 NEEDLE BEARING #K162213
54-6 WASHER
54-7 O-RING 12-S

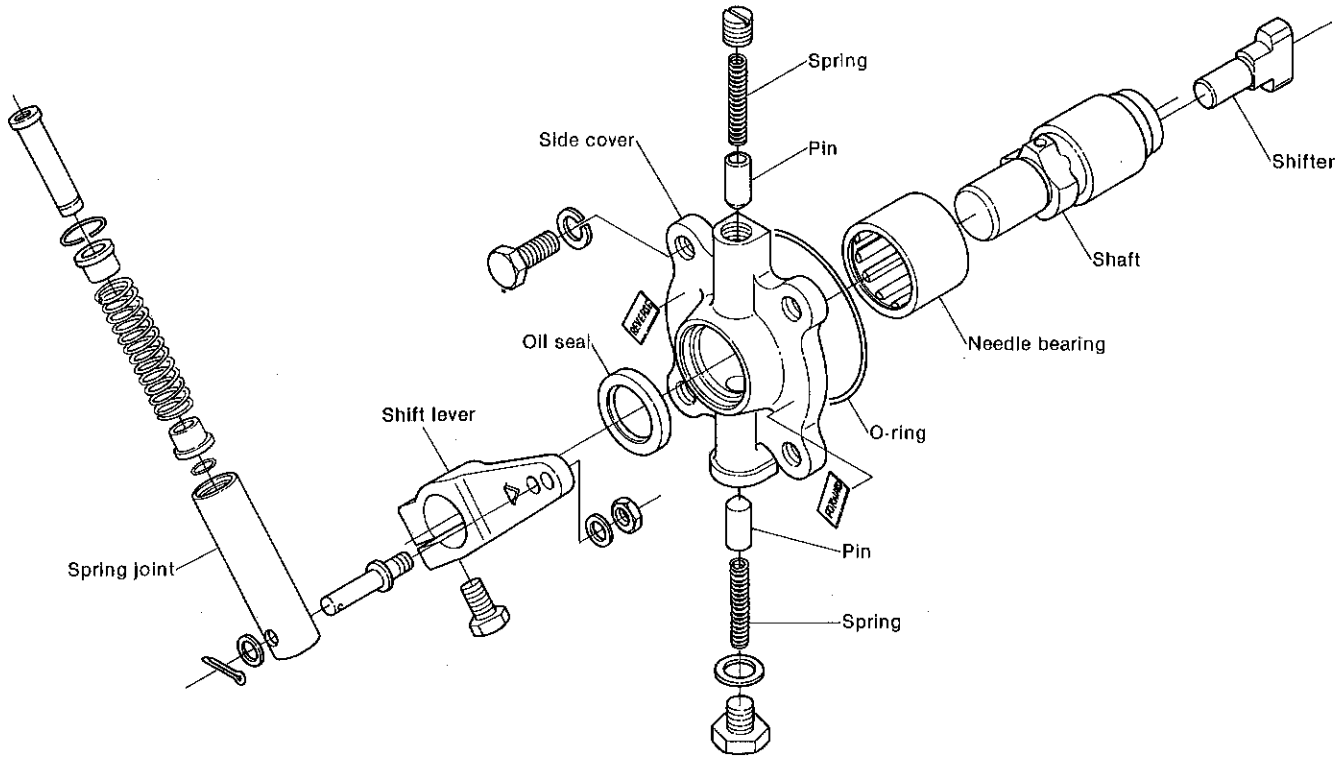
55-1 OUTPUT SHAFT
55-2 DRIVE CONE
55-3 FORWARD LARGE GEAR
55-4 REVERSE LARGE GEAR
55-5 BEARING INNER RACE
55-6 NEEDLE BEARING #K303517
55-7 COLLAR
55-8 COLLAR
55-9 LOCK NUT
55-10 OUTPUT SHAFT COUPLING
55-11 O-RING 18-P
55-12 ROLLER BEARING #07087/07204
55-13 PIN
55-14 COLLAR

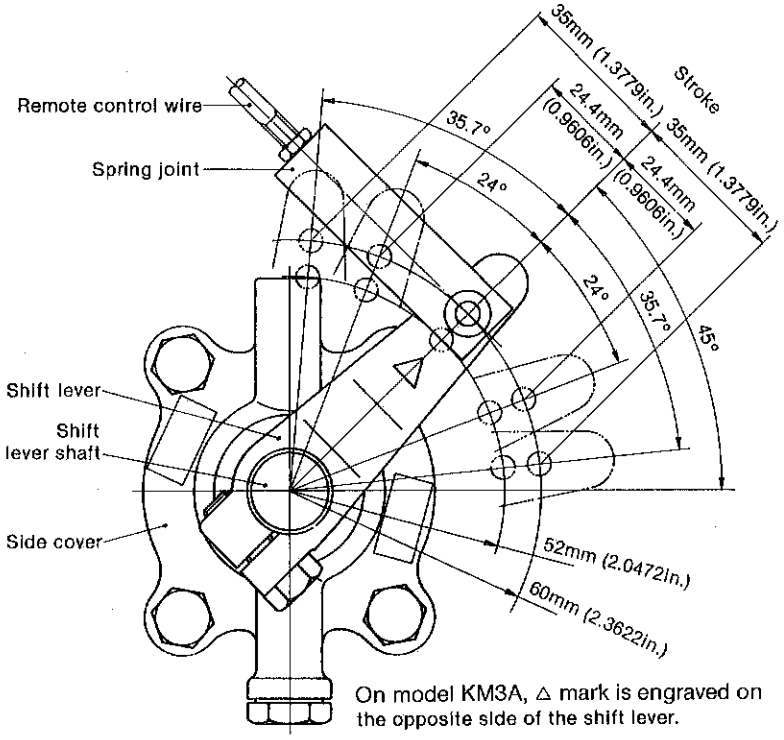


56-1 SHIFT LEVER
56-2 BOLT M8 × 25
56-3 SHAFT
56-4 PIN
56-5 SPRING
56-6 SCREW M10 × 10
56-7 PLUG M10
56-8 PACKING 10
56-9 SHIFTER
56-10 NEEDLE BEARING #HK3026
56-12 REMOTE CONTROL CONNECTOR
56-13 SPRING
56-14 RETAINER
56-15 CIRCLIP
56-16 CIRCLIP
56-17 HOLDER
56-18 CONNECTOR
56-19 WASHER 6
56-20 LOCK NUT M6
56-21 COTTER PIN 2.5 × 15

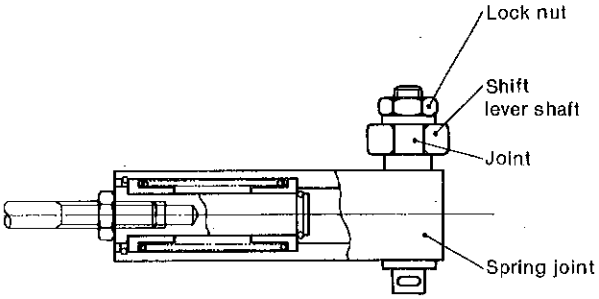
2. Shifting Device

2-1 Construction of shifting device





On model KM3A, △ mark is engraved on the opposite side of the shift lever.



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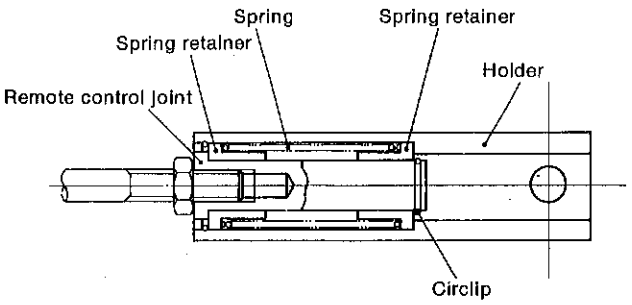
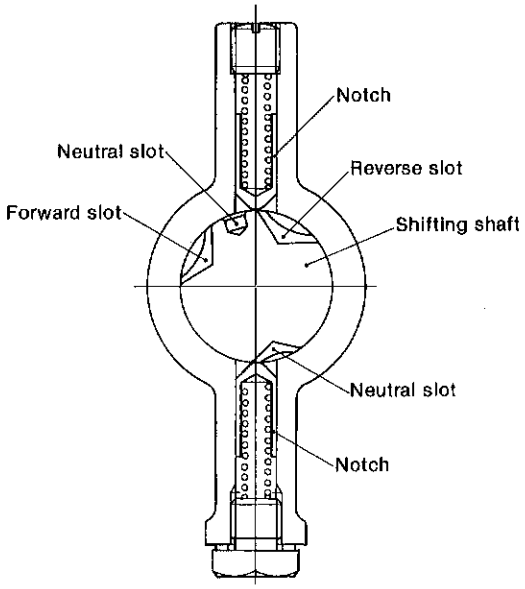


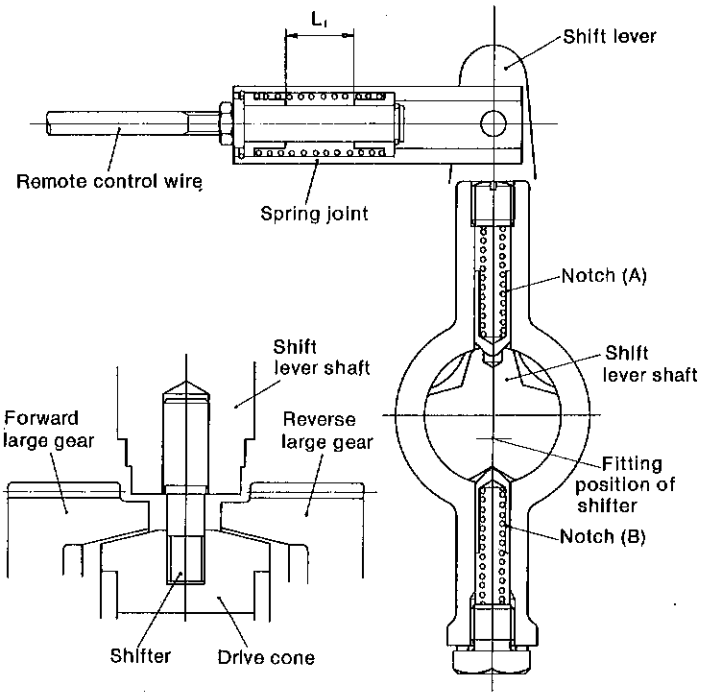


The shift lever shaft is supported by the side cover in which it rotates. Around the shift lever shaft, there are slots which engage the notch in order to control transmission of rotary power either forward or reverse, or to keep it in neutral. The notch engages each slot by the force of the notch spring.
The shifter is set at the end of the shift lever shaft eccentric to the shaft center line and the angular movement of the shift shaft (i.e. rotation). The shifter is moved forward or backward along the line of the output shaft and this in turn moves the drive cone forward or backward.
The spring joint contains a spring and 2 spring retainers in the holder, and the remote control joint is connected to the spring retainers so that it can slide a fixed distance. By pushing or pulling the remote control joint with the holder fixed, the remote control joint moves to a position where the two spring retainers touch.

2-2 Action of the shifting device

2-2.1 Changing from neutral to forward

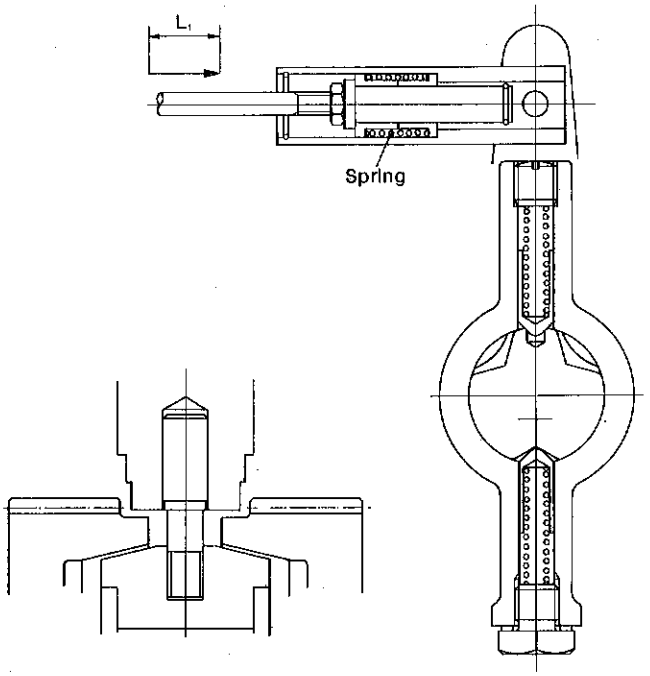
The relationship between the spring joint and the notch is as shown in the following figure, and the two spring retainers are the maximum distance apart.



Neutral position

The shift lever is kept securely in the neutral position by notches (A) and (B).

Changing the power transmitting direction to forward is explained below.
When pushed forward, the remote control joint moves the spring retainers. The spring is compressed until the two spring retainers touch.



L_1 position of remote operation stroke

The spring in the spring joint is compressed, but the shift lever does not move.

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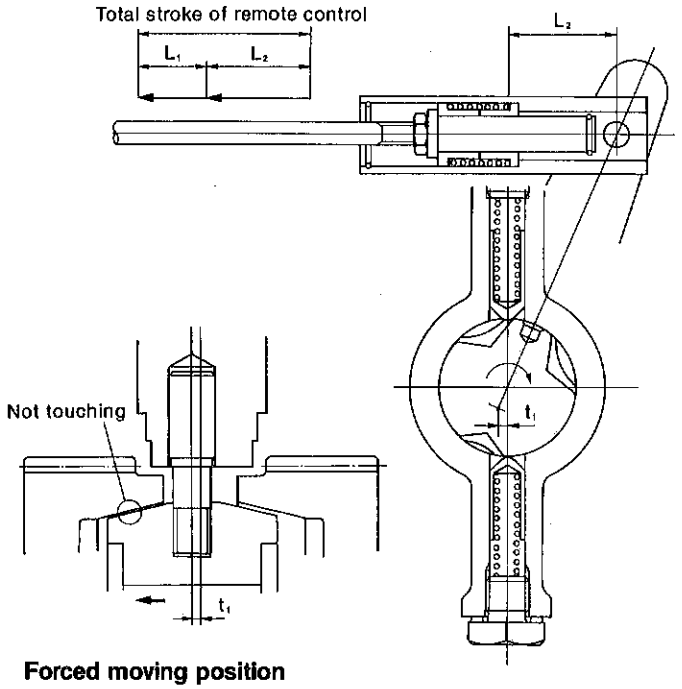
By pushing the remote control joint the holder moves, and the shift lever and the shift lever shaft also move to disengage the notch from the neutral position.



Forced moving position

When the shift lever is forcibly moved through distance L_2 the shifter moves distance t_1. In this position, the drive cone has not yet made contact. However, notches (A) and (B) are disengaged from the neutral notch slot, and notch (A) is positioned on the tapered surface.

The shift lever shaft is turned by the movement of the remote control joint. When the notch touches the tapered part of the forward setting slot, it is pushed by the notch spring force and turns the shift lever forward. At the same time, as the remote control joint is fixed by the two retainers of the spring joint being in contact with each other, the holder is moved by the spring reaction so that the shift lever is pushed forward.

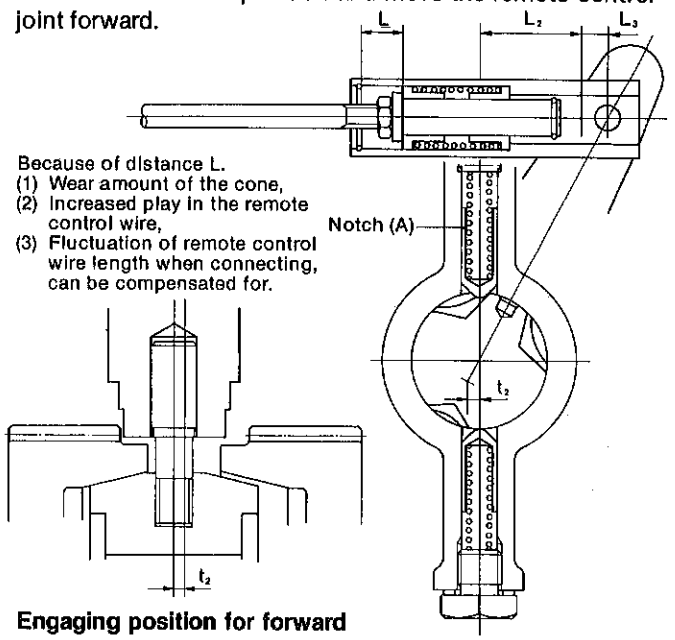
By the actions of the notch spring and spring joint, the shifter maintains pressure on the drive cone.

Engaging position for forward

By means of the shift lever shaft turning force which is caused by the spring in the joint and the notch (A), the shifter is moved distance L_3 and engagement is complete. Pressure is maintained on the drive cone after engagement.

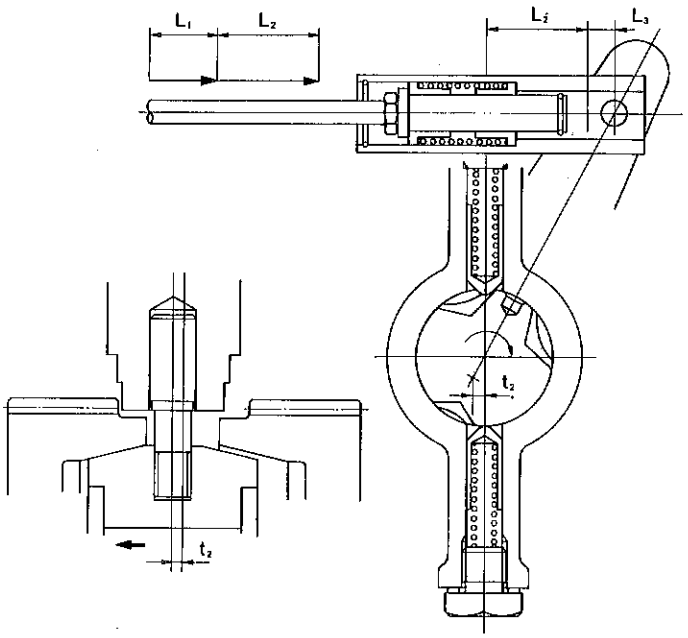
2-2.2 Engagement from forward to neutral

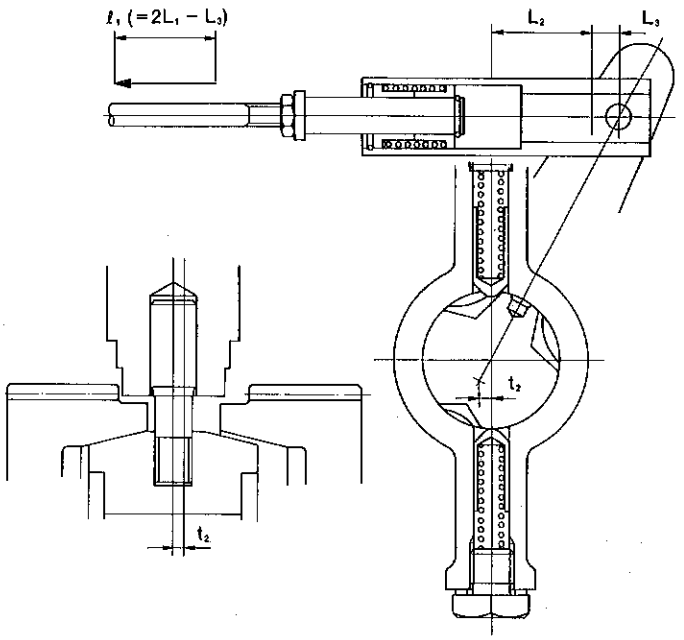
Engagement for reverse is the same as for forward, that is, return to the neutral position and move the remote control joint forward.



Engaging position for forward

The drive cone, which is moved by the spring in the joint and notch (A), is kept under force until distance L becomes zero even when the cone is worn.





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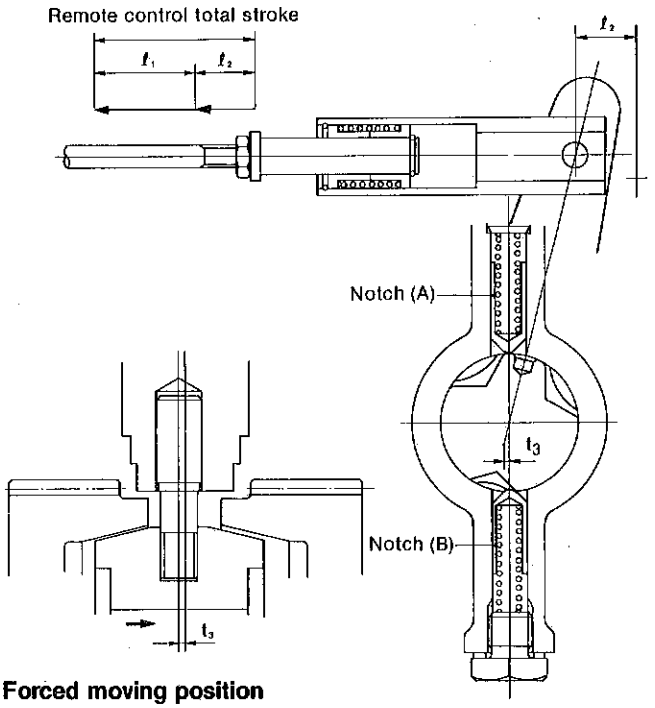
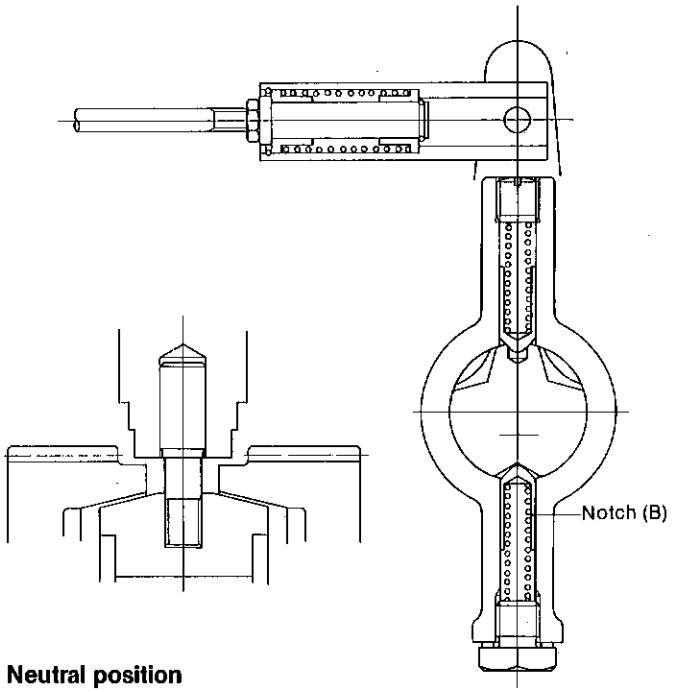
Position of remote control stroke ℓ_1

The shift lever does not move although the spring in the joint is compressed. The cone is kept in contact due to the transmission of torque when idling.



Forced moving position

The shift lever is forcibly moved through distance ℓ_2, overcoming light friction due to the transmitting torque and the drive cone separates. Notch (A) disengages and notch (B) engages.



Neutral position

The shift lever is returned to neutral by the turning force generated on the shift lever shaft by the spring in the joint and notch (B).

2-3 Clutch shifting force

(reference value) [Engine at 1000rpm]

Shifting Position / Shifting Direction	Shift lever position at 60mm	Remote control handle position at 170mm (cable length, 5m)
Engaging stroke	Approx. 3kg (6.6 lbs)	3 ~ 4kg (6.6 ~ 8.8 lbs)
Disengaging stroke	—	6 ~ 8kg (13.2 ~ 17.6 lbs)

Disengaging stroke:

(1) At the initial stage of usage, the stroke may be heavier than the above value, but the stroke gets light when adopted.

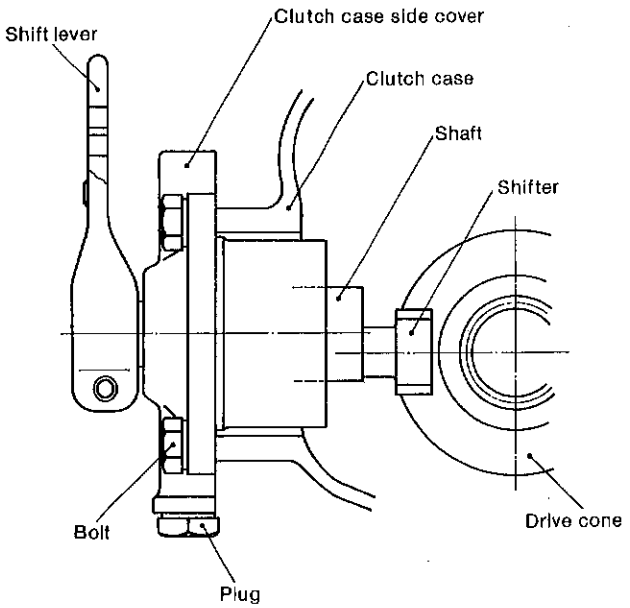
(2) It varies according to the idling speed of the engine. The lower the rotation becomes, the lighter the stroke becomes.

(3) The longer the remote control cable, the more bent it becomes, and the smaller the bending radius, the heavier the disengaging stroke.
[33-C minimum bending radius 203.2mm(8")]

(4) When the spring joint is attached to the shift lever at 52mm distance from the center of the lever shaft, the disengaging stroke will be 15% heavier then when attached at a distance of 60mm.

2-4 Adjustment

When the clutch side cover is removed, make the following adjustments at the time of reassembly.



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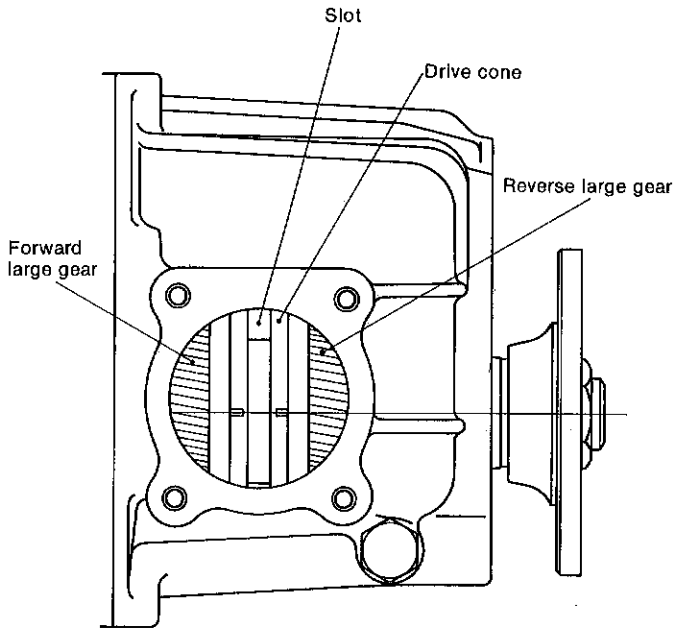
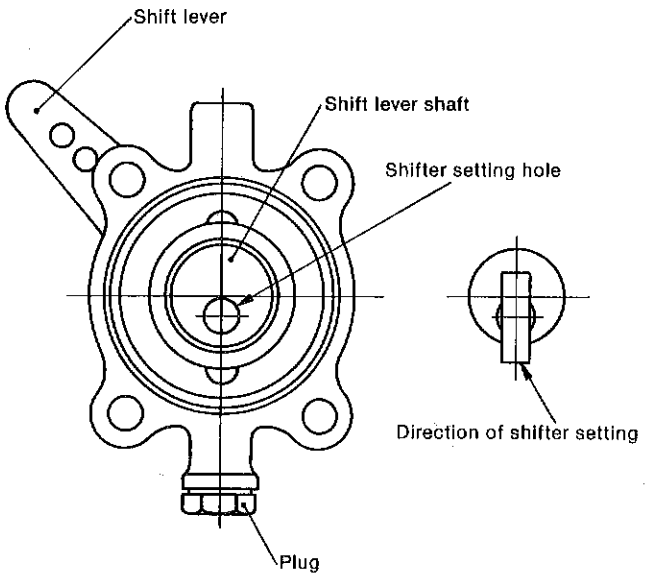
(1) Shift the slot into the drive cone so that it extends as far as the center of the two large gears.

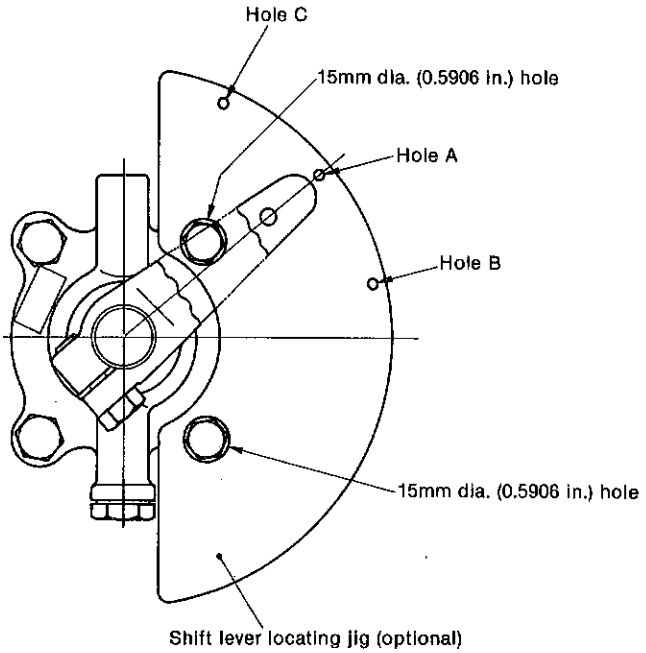


(2) Set the shift lever at neutral position. (Note that the shift lever can be rotated 360° when it is removed from case.) The neutral position is the position where the shifter comes downwards when the plug is below. When the plug is at the bottom, in the neutral position the shifter points downwards.

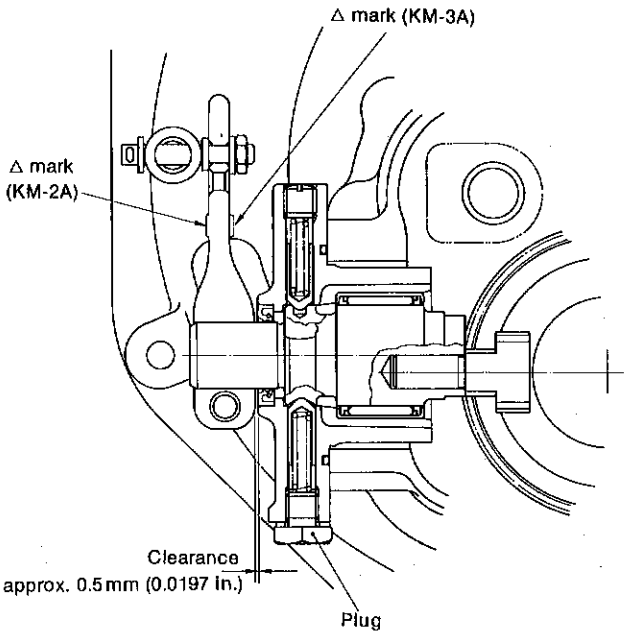


(3) Put the shifter of the side cover at bottom, and set the shifter to the ditch in the drive cone at the center of the forward and reverse gears. Do not move the drive cone from the center of the two gears at the time of the reassembly. (Note that 2mm diameter clearance is provided in the holes of the side cover, and the gear case.) This is for adjusting the difference between the engaging, and disengaging strokes.)

(4) Fit the shift lever locating jig into the holes of the side cover through the 15mm dia. holes as shown.



(5) Put the shift lever in neutral and check that the tip of the lever is aligned with hole A of the jig. It is not, loosen the fixing bolt on the shift lever, align it, then tighten the bolt. Take care to leave approximately 0.5mm (0.0197in.) clearance between the shift lever and the side cover.



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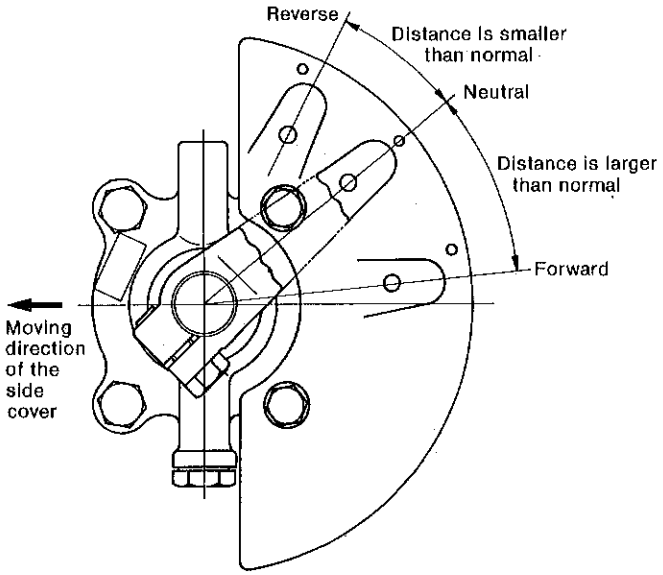
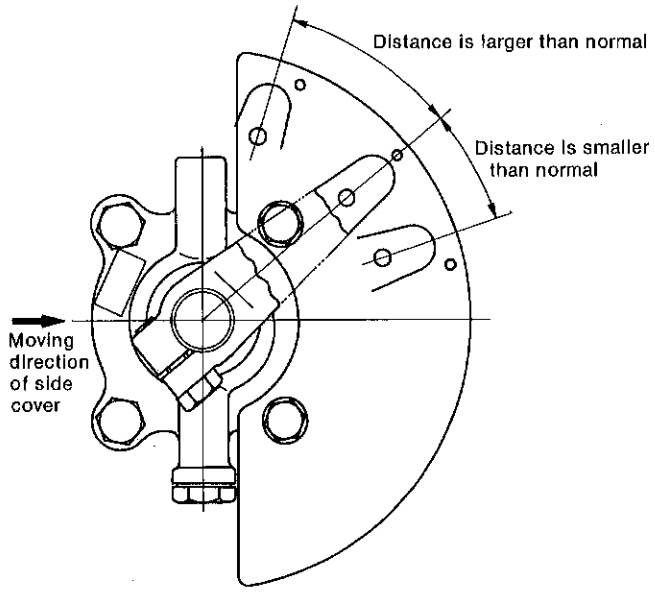
(6) Move the shift lever forward or back, and visually check the respective distances between the tip of the shift lever and holes B and C. Also check the difference between these distances.

(7) When these two distances are not equal, slightly loosen the four setting bolts of the side cover so that it can be moved a little in the shaft direction.

(8) When the distance is larger than normal in the forward setting, move the side cover slightly to the engine side.

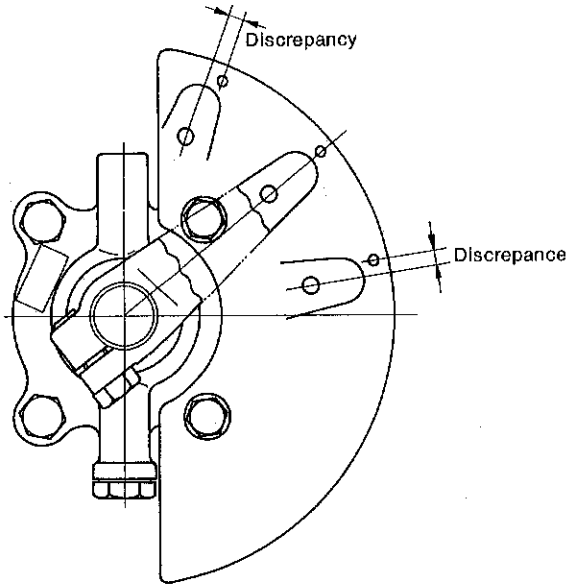


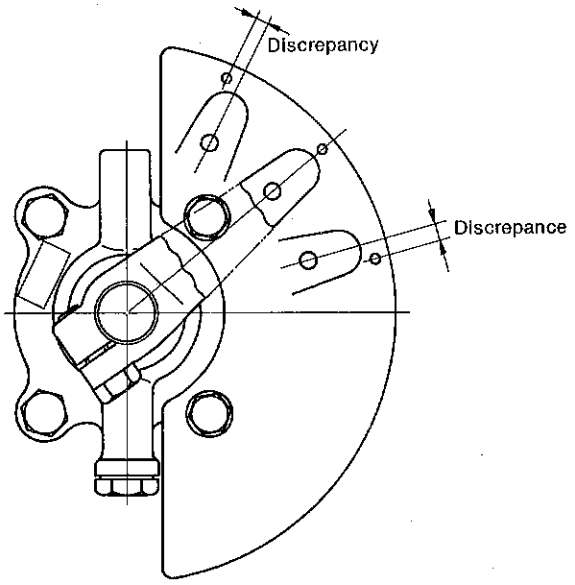
(9) When the distance is larger than normal in the reverse setting, move the side cover slightly to the propeller side.



(10) When the distances are equal between neutral and forward and neutral and reverse tighten the setting bolts of the side cover.

(11) Although these distances may be equal both for forward and reverse, there might be some discrepancy between holes B and C due to difference in machining. However, if the discrepancy Is the same for forward and reverse there is no problem.





(12) Install the spring joint on the shift lever.
(Only when it is dismantled in the boat).

NOTE: When the shift device is removed in the boat, the engine must always be stopped.

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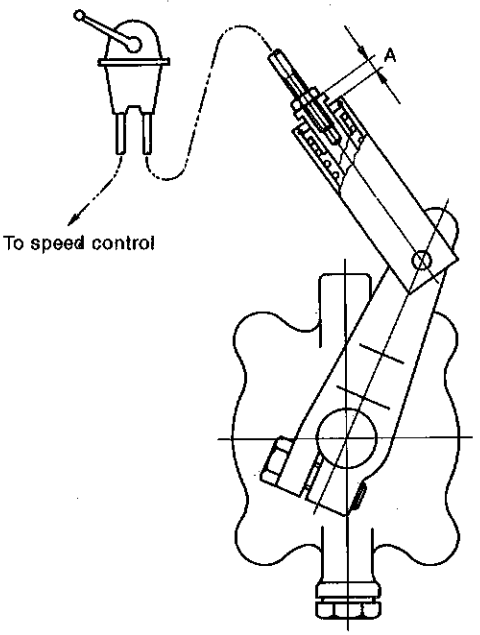
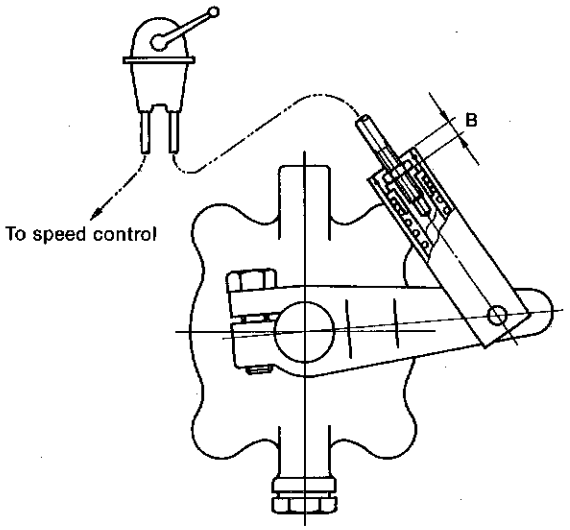
2-5 Inspect for the following points (to be inspected every 2-3 months)

(1) Looseness at the connection of the spring joint and the remote control cable.
(2) Looseness of the attaching nut of the spring joint and the shift lever.
(3) To make sure that the value of A, and B is not "Zero" at the engaging position of the remote control lever. If the value is "Zero", untighten the bolt of the side cover, and adjust according to the steps described in 2-4.
When the cone for the forward side gets worn, the value of B is decreased, and for reverse side, the value of A is decreased. When the play in the remote control system is increased, both values of A and B are decreased.





2-6 Cautions

(1) Always stop the engine when attaching, adjusting, and inspecting.
(2) When conducting inspection immediately after stopping the engine, do not touch the clutch. The oil temperature is often raised to around 90°C (194°F).
(3) Half-clutch operation is not possible with this design and construction. Do not use with the shift lever halfway to the engaged position.
(4) Set the idling engine speed at between 750 and 800 rpm.
NOTE: The dual (Two) lever remote control device cannot be used.

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3. Inspection and Servicing

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.

3-2 Bearing

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

3-3 Gear

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

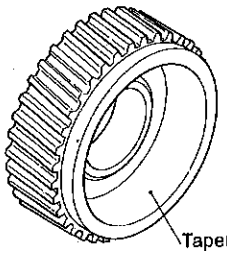
mm (in.)

	Maintenance standard	Wear limit
Input shaft forward gear and output shaft forward gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)
Input shaft reverse gear and intermediate gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)
Intermediate gear and output shaft reverse gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)

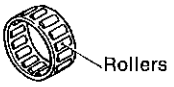
(The same dimensions apply to both KM2-C and KM3-A)

3-4 Forward and reverse large gears

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

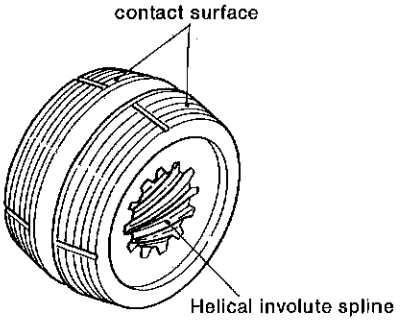


(2) Forward/reverse gear needle bearing.
When an abnormal sound is produced at the needle bearing, visually inspect the rollers; replace the bearing if the rollers are faulty.

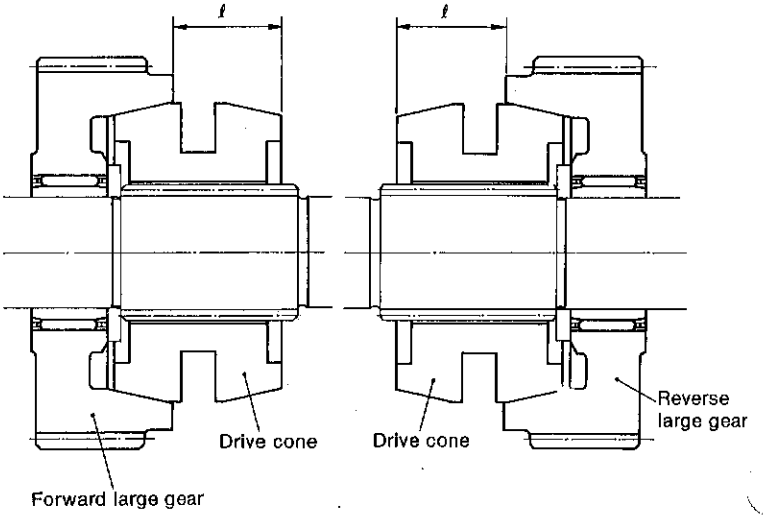


3-5 Drive cone

(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 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.



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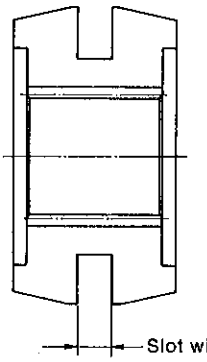
mm (in.)

		Standard dimensions	Limited dimensions
Dimensions *l*	KM2-C	24.4 ~ 24.7 (0.9606 ~ 0.9724)	24.1 (0.9488)
	KM3-A	29.9 ~ 30.2 (1.1772 ~ 1.1890)	29.6 (1.1654)

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

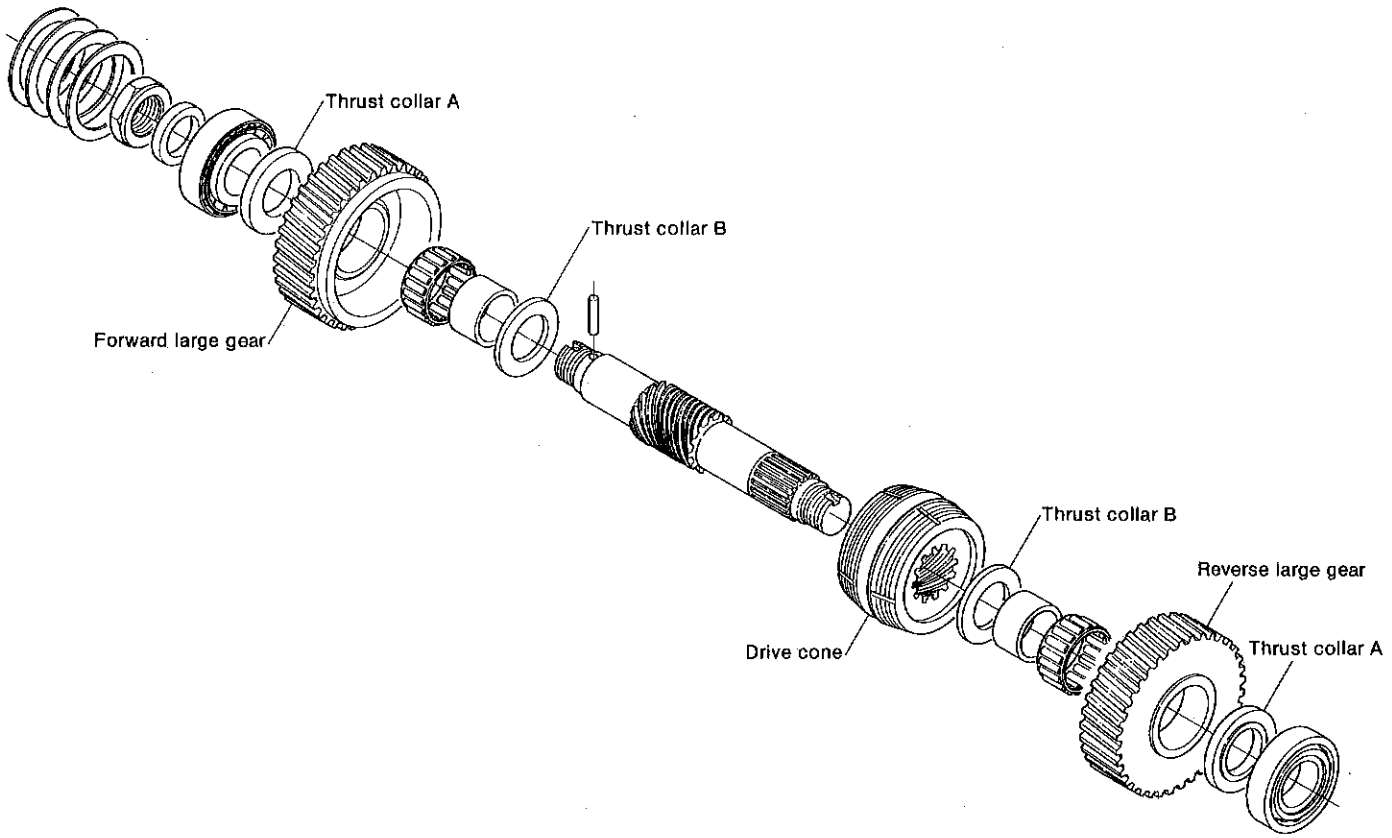
(4) Measure the dimension of the slot width of the drive cone, and replace the cone when the dimension is over the specified limit.



mm (in.)

	Standard dimensions	Standard clearance	Allowable clearance	Limited clearance
Slot width of drive cone	$8^{+0.1}_{0}$ (0.3150 ~ 0.3189)	0.15 ~ 0.3 (0.0059 ~ 0.0118)	0.6 (0.0236)	8.3 (0.3268)
Shifter width	$8^{-0.15}_{-0.20}$ (0.3071 ~ 0.3090)			7.7 (0.3031)

3-6 Thrust collar



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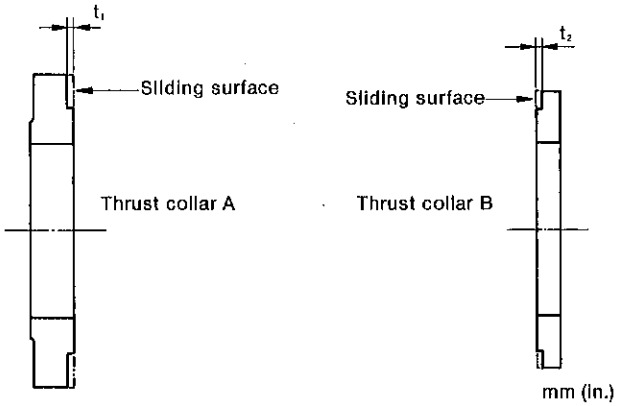
(1) Visually inspect the sliding surface of thrust collar A or B to check for signs of overheating, scoring, or cracks. Replace the collar if any abnormal condition is found.
(2) Measure the thickness of thrust collar A or B, and replace it when the dimension exceeds the specified limit.



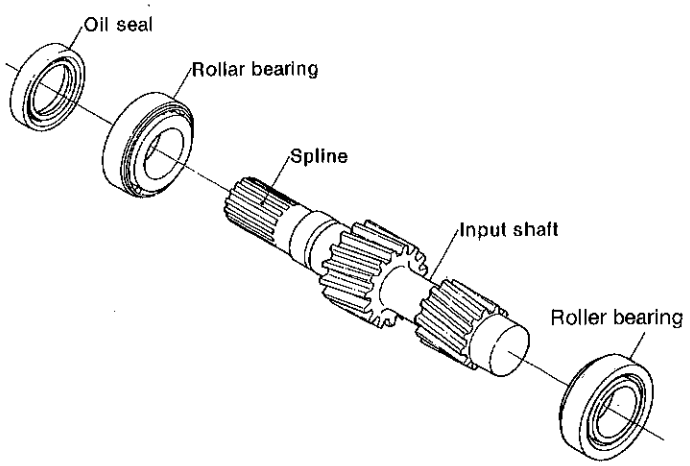
mm (in.)

Stepped wear	Limit for use
Thrust collar A, t_1	0.05 (0.0020)
Thrust collar B, t_2	0.20 (0.0079)

3-7 Oil seal of output shaft

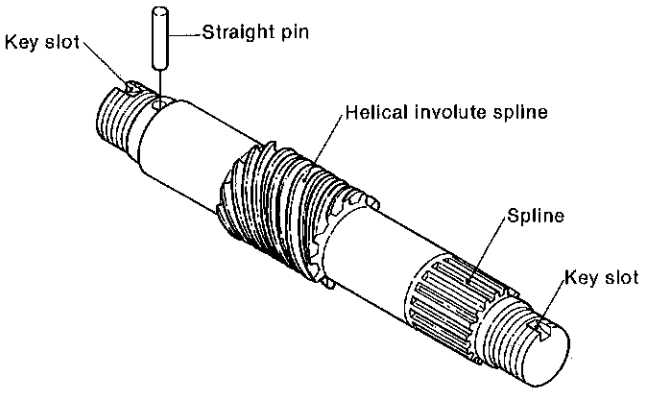
Visually inspect the oil seal of the output shaft to check if there is any damage or oil leakage; replace the seal when any abnormal condition is found.

3-8 Input shaft



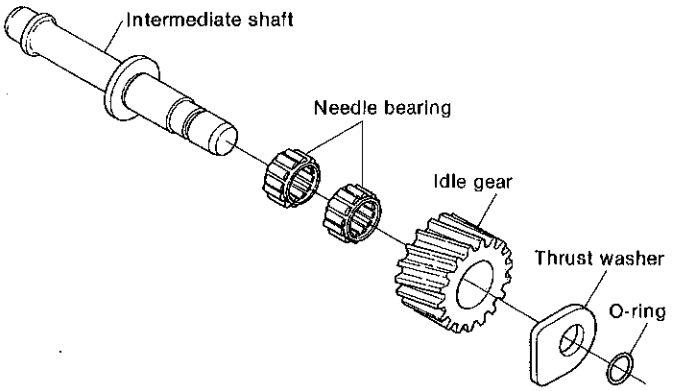
(1) Spline part.
Whenever uneven wear and/or scratches are found, replace with a new part.
(2) Surface of oil seal.
If the sealing surface of the oil seal is worn or scratched, replace.

3-9 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.

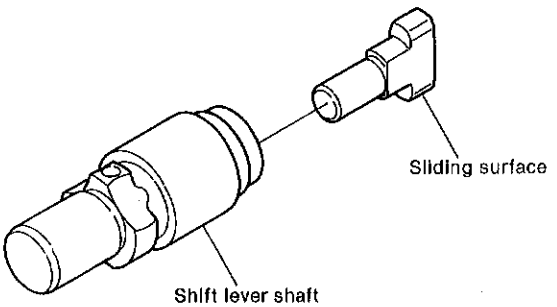
3-10 Intermediate shaft



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

3-11 Shifting device

3-11.1 Shifter



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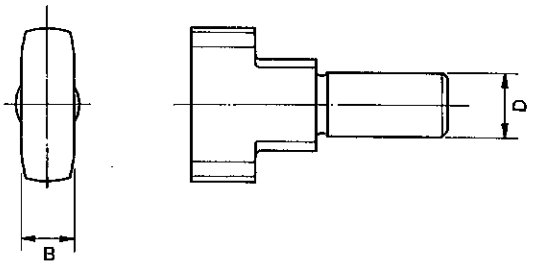
(1) Visually inspect the surface in contact with the drive cone, and replace the shifter when signs of overheating, damage or wear are found.
(2) Measure the width of the shifter, and replace it when the wear exceeds the specified limit. Also measure the diameter of the shifter shaft, and replace it when the wear exceeds the specified limit.

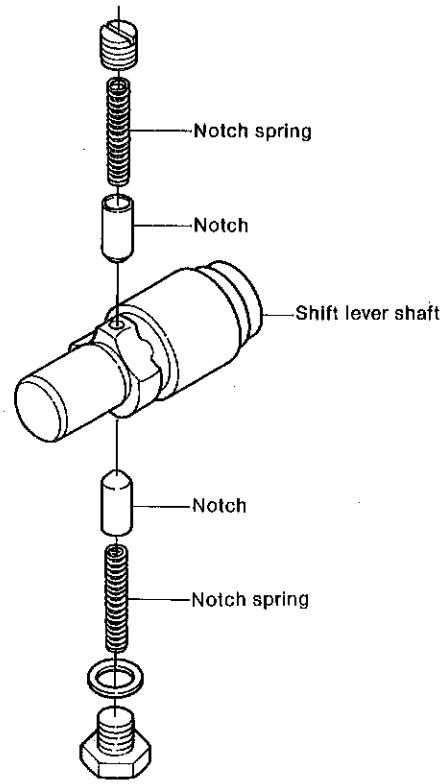


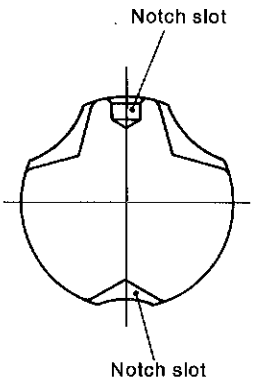
mm (in.)

	Standard dimensions	Clearance	Allowable clearance	Specified limit
Slot width of drive cone	$8^{+0.1}_{0}$ (0.3150 ~ 0.3189)	0.15 ~ 0.3 (0.0059 ~ 0.0118)	0.6 (0.0236)	8.3 (0.3268)
Shifter width	$8^{-0.15}_{-0.20}$ (0.3070 ~ 0.3091)			7.7 (0.3031)
Shifter shaft diameter	$10^{-0.005}_{-0.014}$ (0.3931 ~ 0.3935)	0.005 ~ 0.029 (0.0002 ~ 0.0011)	0.05 (0.0020)	9.95 (0.3917)
Shift lever shaft diameter	$10^{+0.015}_{0}$ (0.3937 ~ 0.3943)			10.05 (0.3957)

3-11.2 Notch slot of shift lever shaft

Visually inspect the notch slot of the shift lever shaft to check for any abnormal wear or cracking, replace any defective part if found.





3-11.3 Notch

Visually inspect the tip of the notch to check for wear, damage or deformation. Replace the notch if it is found to be defective in any way.

3-11.4 Notch spring

Visually inspect the notch spring to check for any damage, corrosion or permanent set; replace the spring when it is found to be defective.

Free length	34mm (1.3386in.)
Spring coefficient	0.459kg (0.992 lb)
Set length	25.5mm (1.0039in.)
Set load	3.90kg (8.598 lb)

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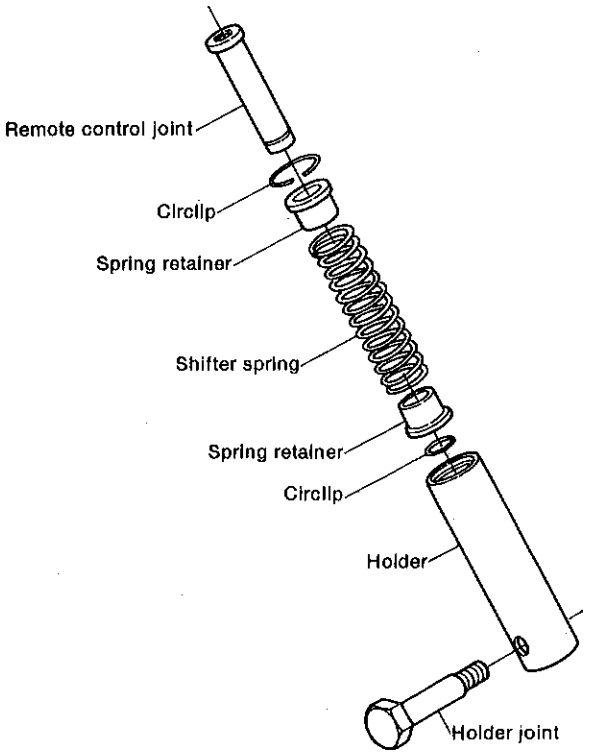
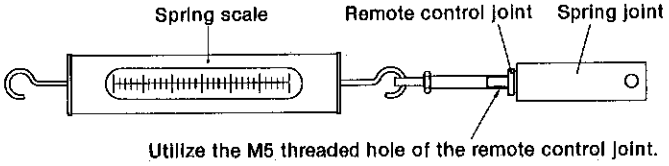
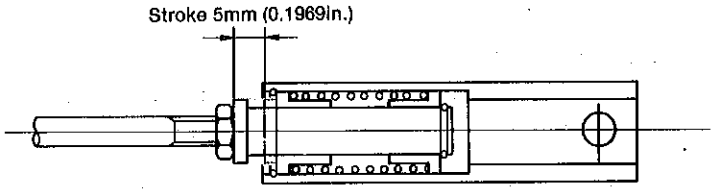
3-12 Spring joint



(1) Check each part for abnormal play, and replace if play is excessive.
(2) When the movement of each part is not smooth, measure the tension and replace as a complete unit when it exceeds the specified limit.

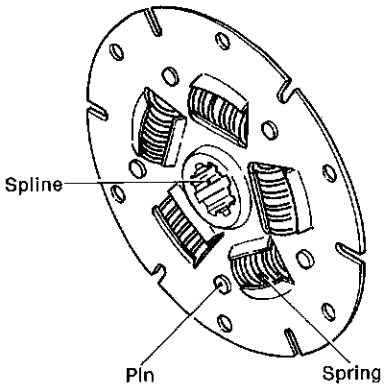




kg (lb)

	Standard value	Limit value
Tension (at the position of 5mm stroke)	2.8 (6.17)	2.5 (5.51)

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.

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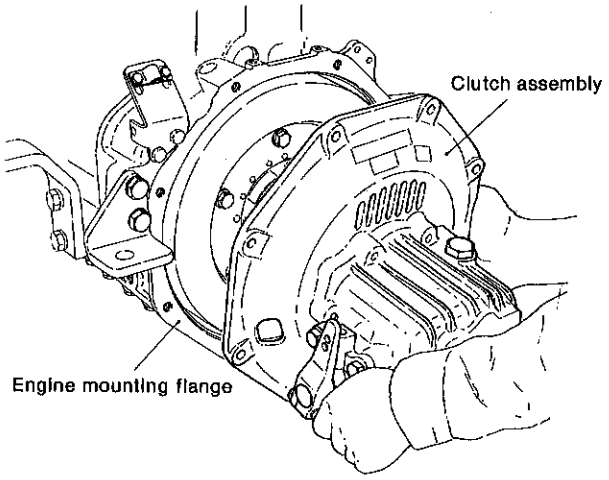
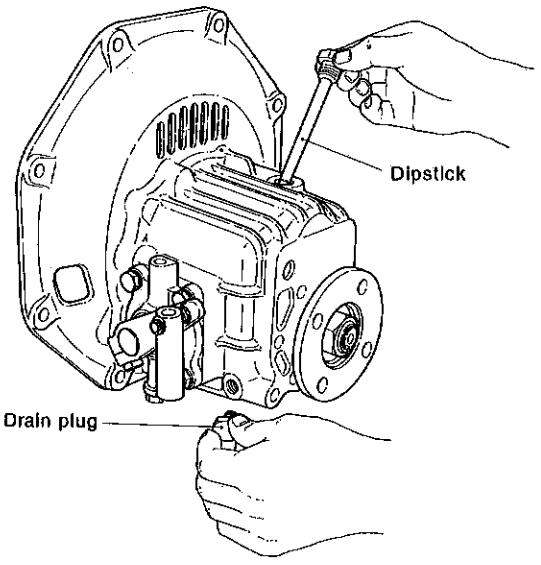
4. Disassembly

4-1 Dismantling the clutch

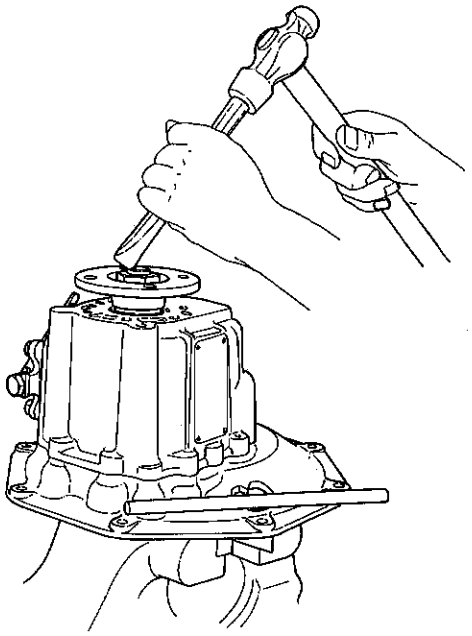
(1) Remove the remote control cable.
(2) Remove the clutch assembly from the engine mounting flange.

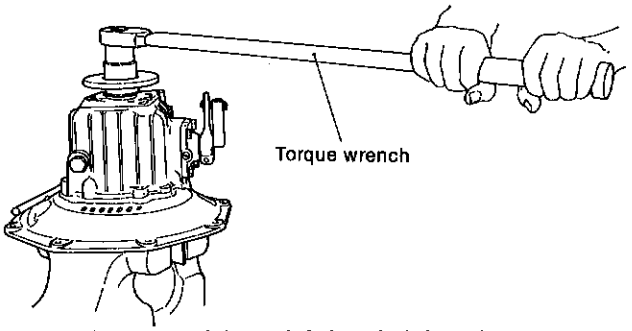


(3) Drain the lubricating oil.
Drain the lubricating oil by loosening the plug at the bottom of the clutch case.



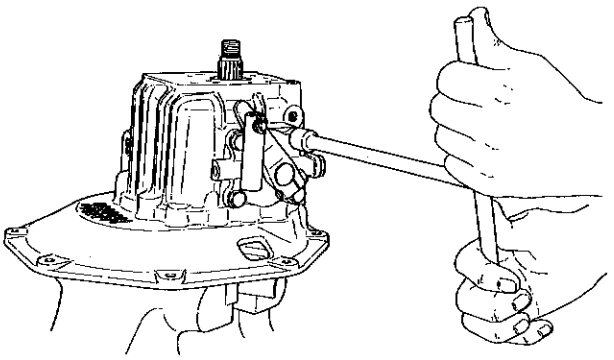
(4) Remove the end nut and output shaft coupling.





NOTE: Take care as it has a left-handed thread.

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



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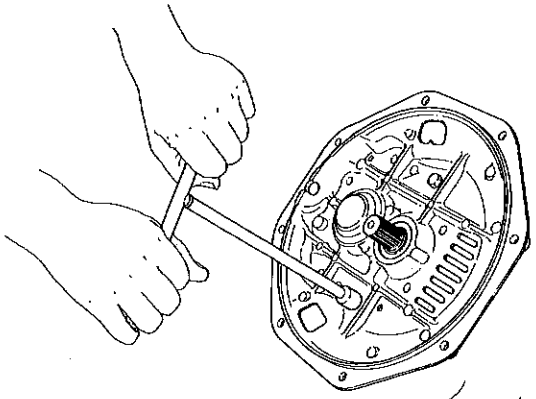
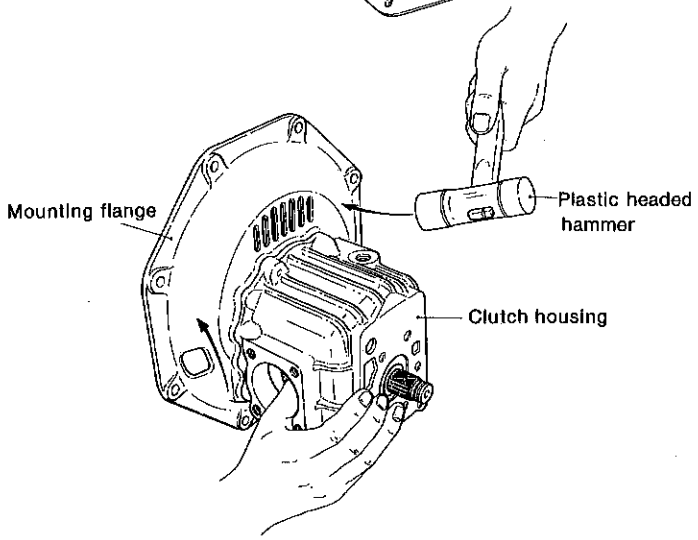
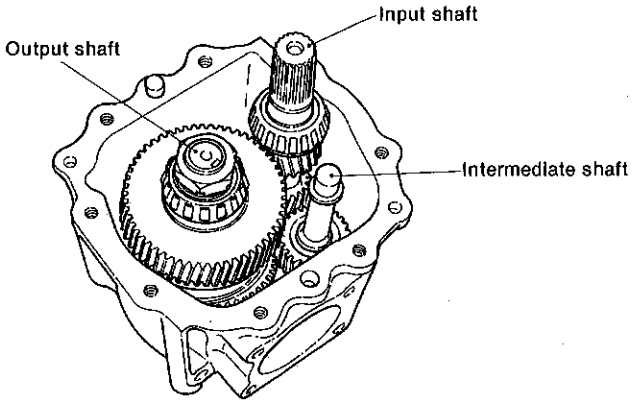
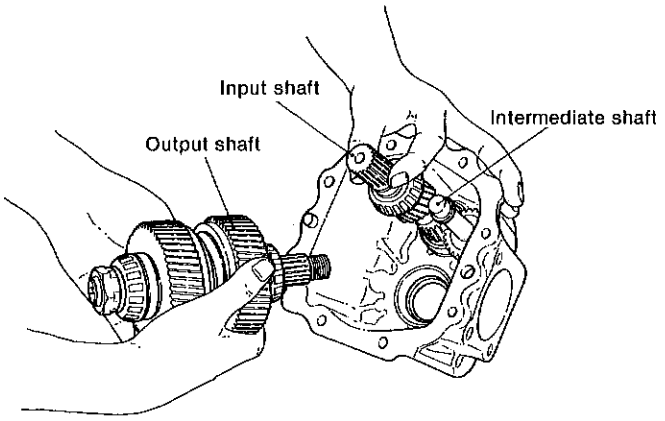
(7) Remove the bolts which secure the mounting flange to the case body, give light taps to the left and right with a plastic headed hammer while supporting the clutch case with your hand, then remove the mounting flange.



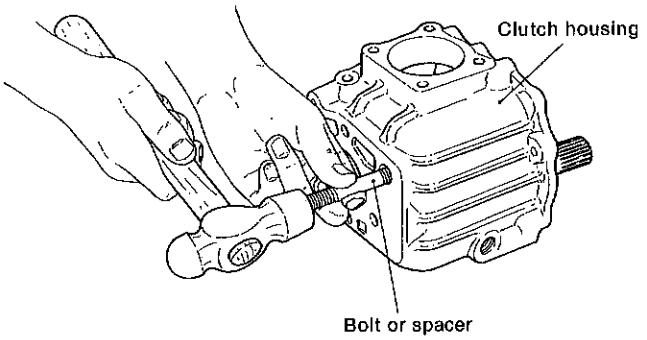


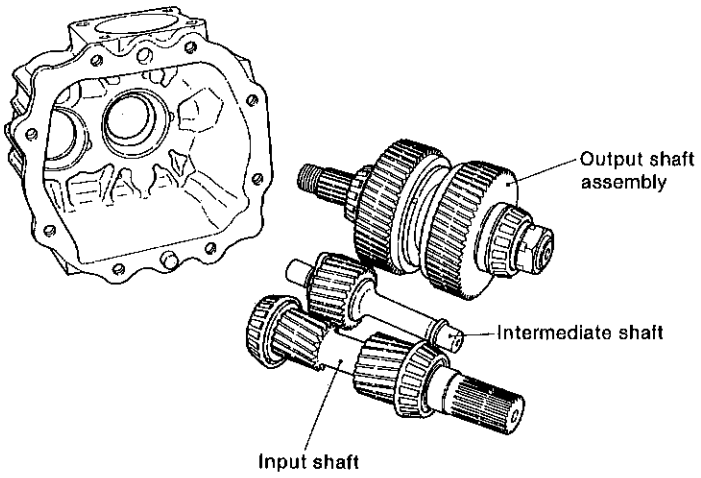
(8) Withdraw the output shaft assembly.





(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.





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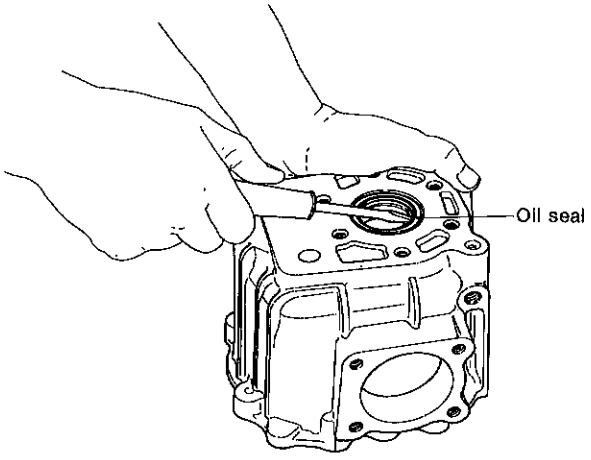
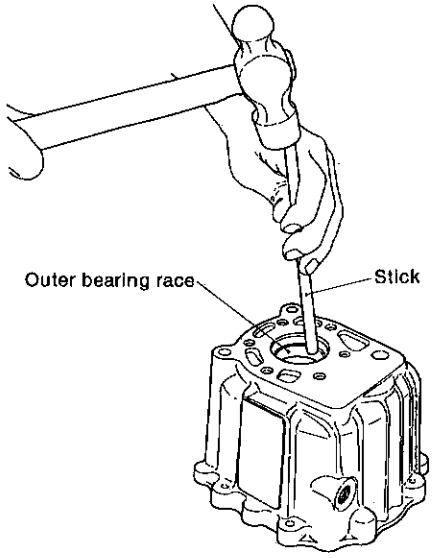
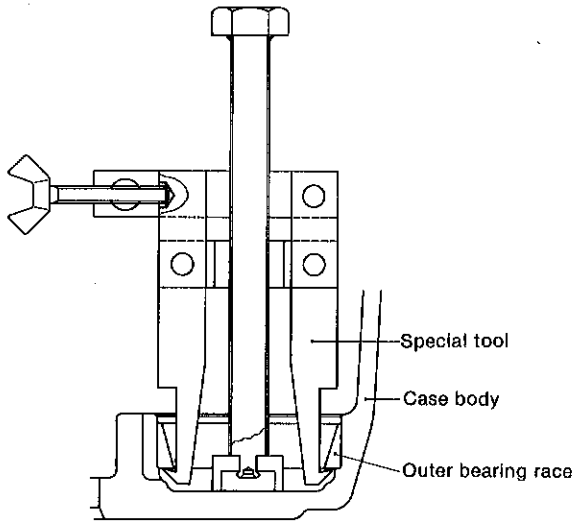
(10) Remove the oil seal of the output shaft from the case body.



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



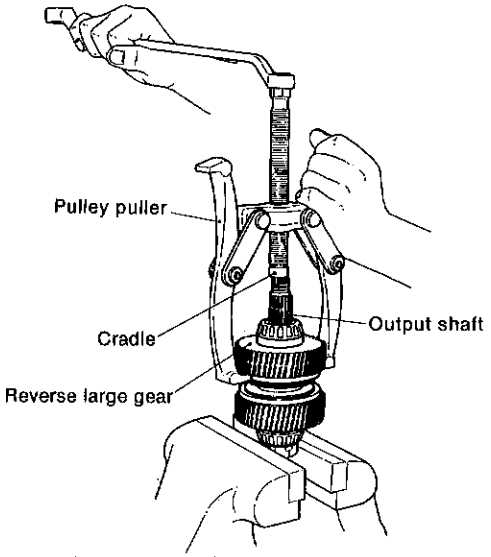


(12) Remove the oil seal of the input shaft from the mounting flange.
(13) Remove the outer bearing race from the mounting flange in the same way as with the case body.
(14) Remove each adjusting plate from the input or output shaft.

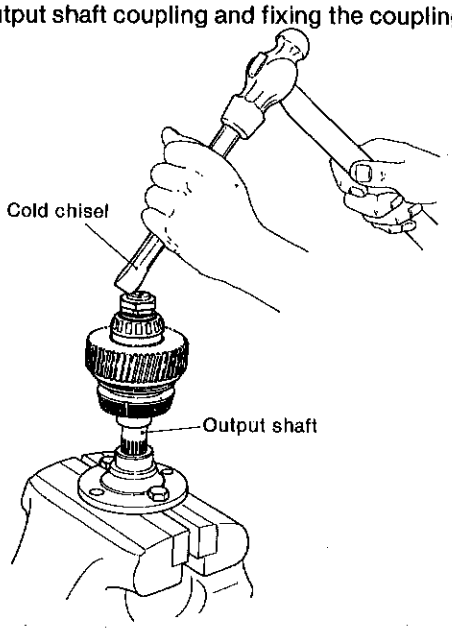
NOTE: The same adjusting plates can be reused when the following parts are not replaced. When any part is replaced however, re-adjustment is necessary.

4-2 Removal of the output shaft

(1) Take out the reverse large gear, thrust collar A 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.



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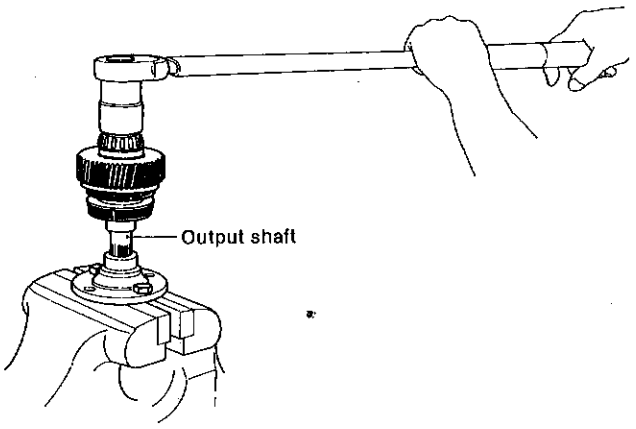
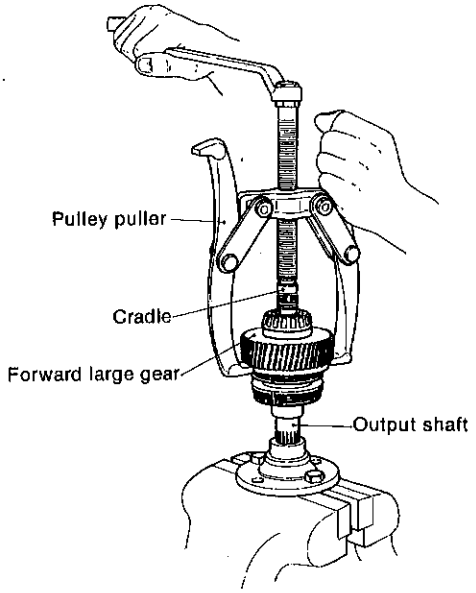
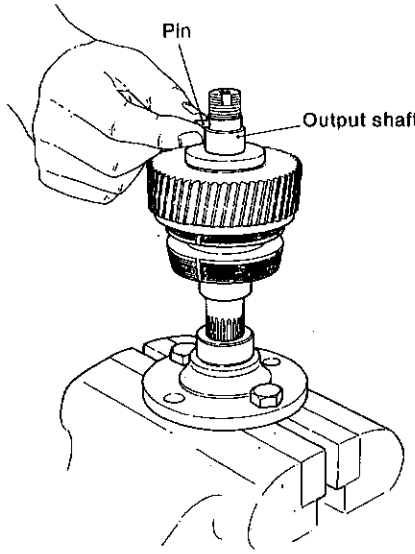


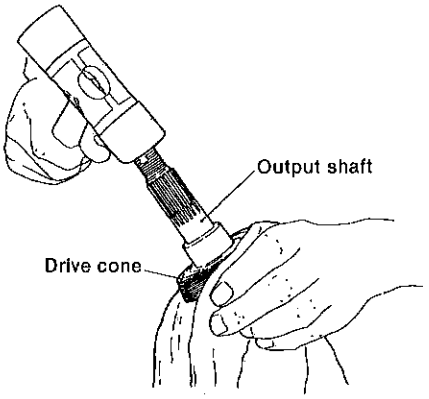
(3) Place the pulley extractor against the end surface of the forward large gear, and withdraw the forward large gear, thrust collar A and inner bearing race.

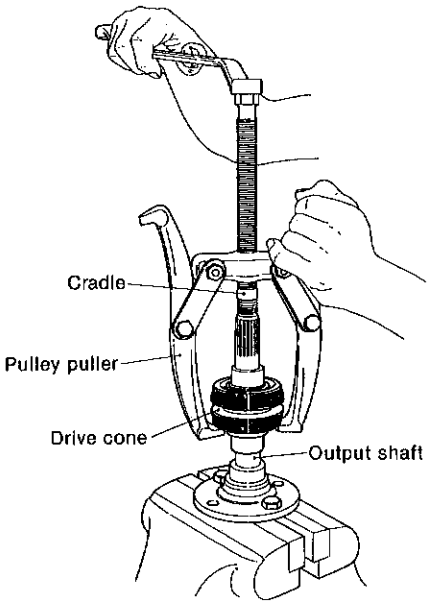




NOTE: Take care as the nut has left-handed thread.

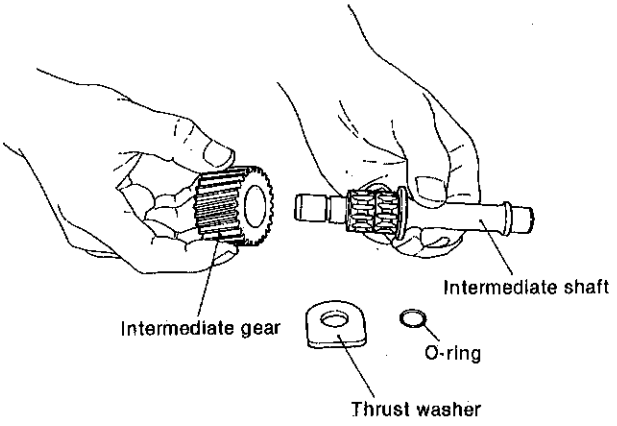
(4) While gripping the drive cone, tap the end of the shaft with a plastic beaded hammer, and withdraw the thrust collar B and inner needle bearing race. A pulley extractor may be used.





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.



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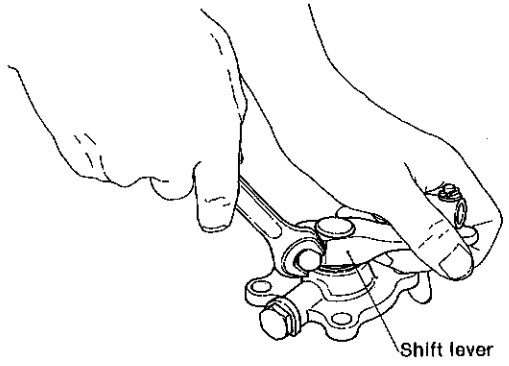
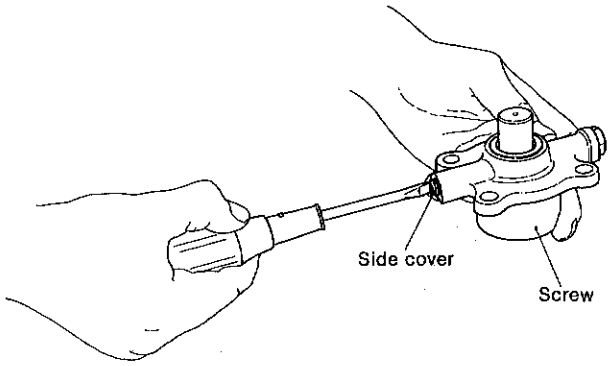
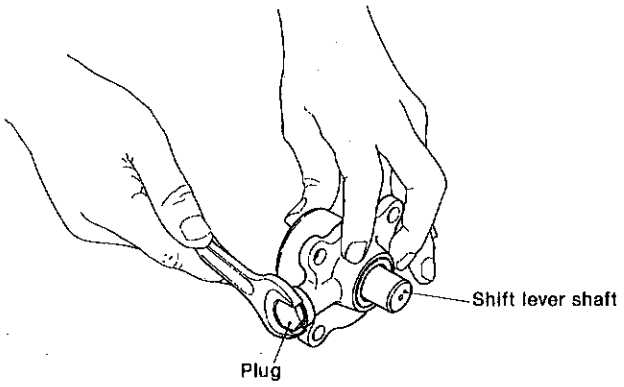
4-4 Dismantling the side cover assembly (Shifting device)

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

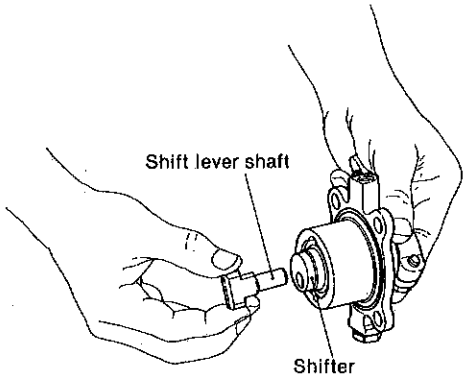


(2) Remove the stop screw for the notch and plug, and take out the notch and spring.

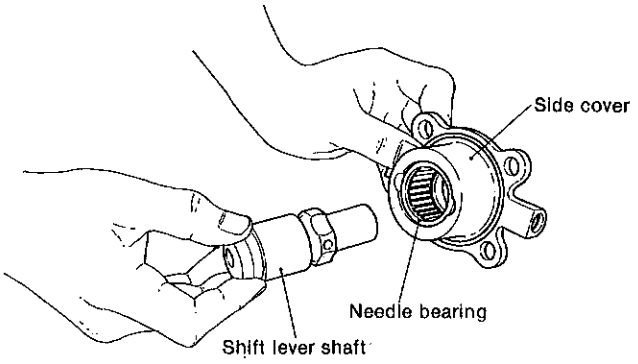




(3) Take out the shifter.

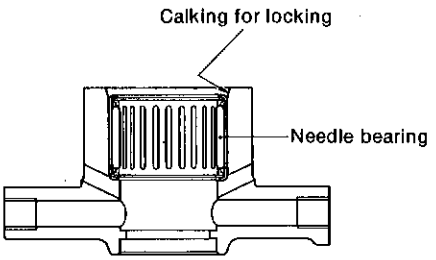


(4) Withdraw the shift lever shaft.



(5) Remove the oil seal.

(6) After removing the calking for locking, heat the needle bearing portion up to about 100°C, and extract the needle bearing from the side cover.



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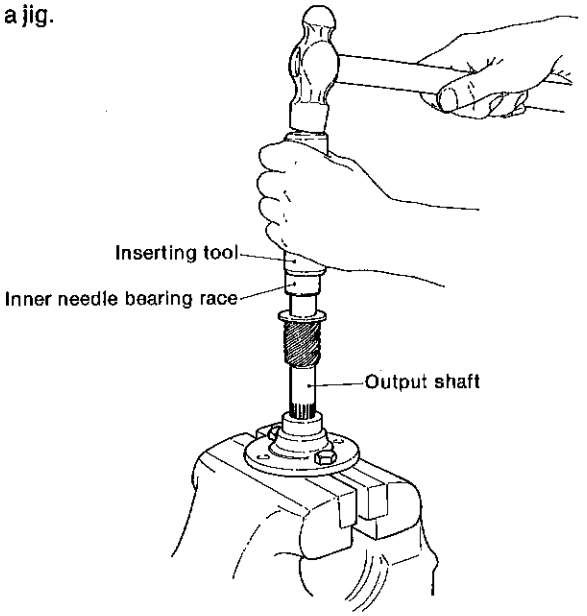
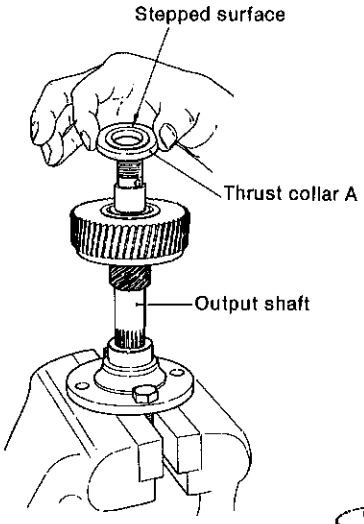
5. Reassembly

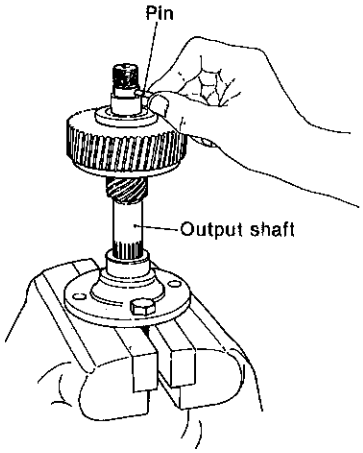
5-1 Reassembly of output shaft

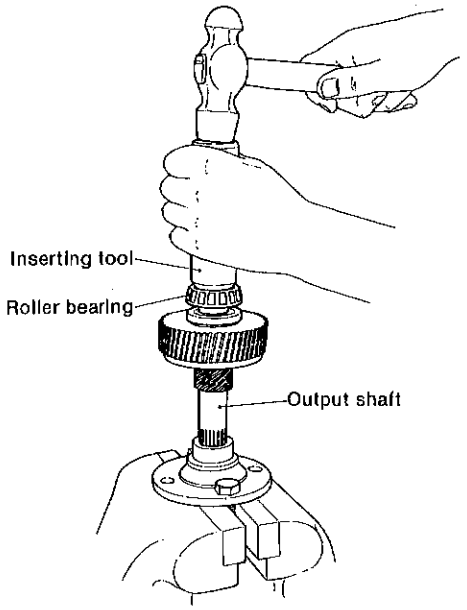
(1) Fit the forward side thrust collar B onto the shaft.
(2) Drive in the forward end inner needle bearing race using a jig.



(3) Assemble the needle bearing and forward large gear.
NOTE: Check that the forward large gear rotates smoothly.
(4) Fit the thrust collar A and pin, and drive in the inner bearing race using a jig.

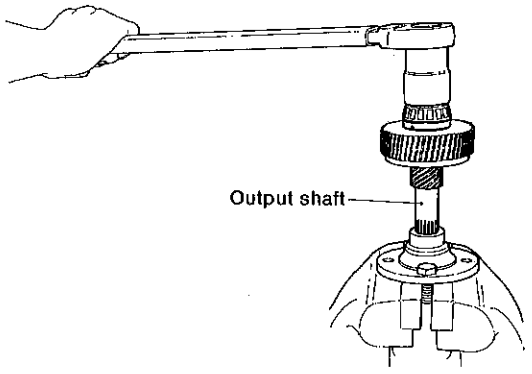






NOTES: 1) Drive in with a plastic headed hammer. Do not hit it hard.
2) When fitting the thrust collar A, note the fitting direction. Fit it keeping the stepped surface toward the bearing side.
3) Note that the pin cannot be fitted after the inner bearing race has been driven in.

(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 ±1.5 kg-m (61.5 ~ 83.2 ft-lb)

(The same torque applies to both models KM2-C and KM3-A).

NOTES: 1) Take care as it is a left-handed thread.
2) 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.

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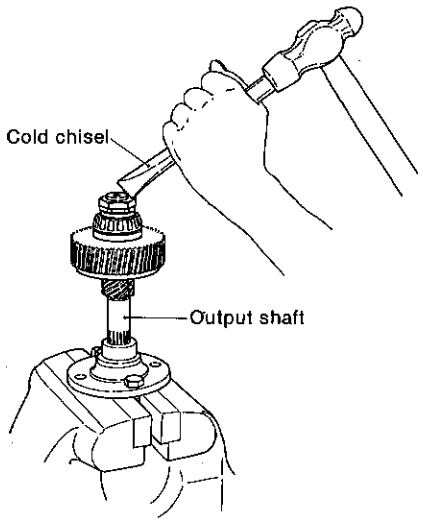
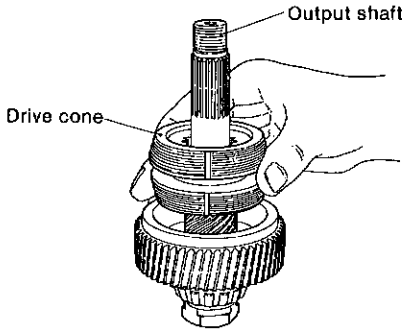
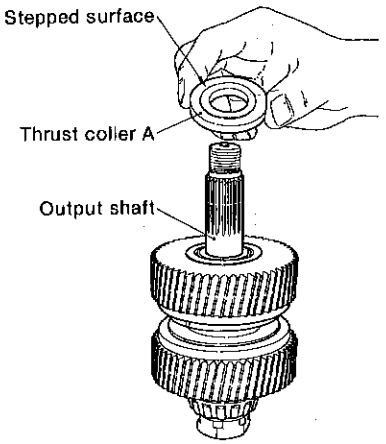


(7) Insert the drive cone while keeping the output shaft set for reverse.



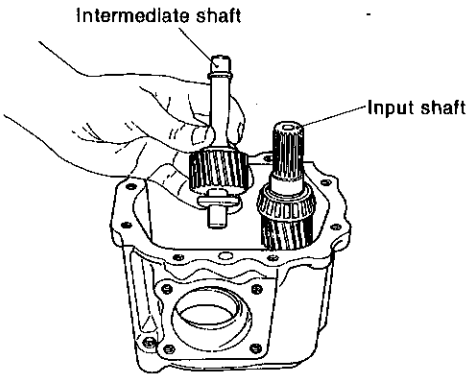
(8) Apply procedures 1 through 4 to the forward end.



NOTE: Fit thrust collar A so that the stepped surface faces the bearing side.

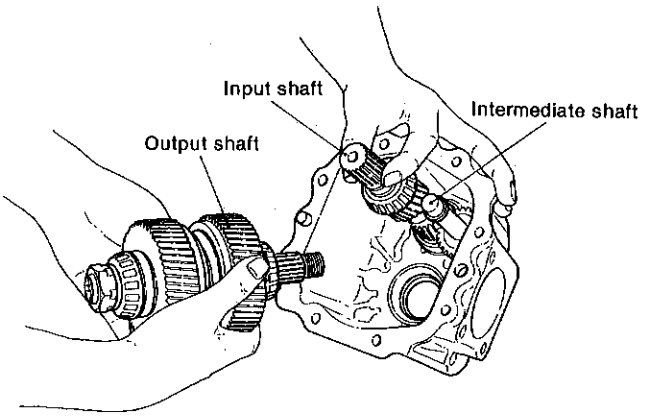
5-2 Reassembly of the clutch

(1) Fit the oil seal and bearing outer race in the clutch case.
(2) Insert the input shaft into the clutch case.
(3) Drive the intermediate shaft into the clutch case.



NOTES: 1) If the output shaft is not fitted into the clutch case before driving-in the intermediate shaft, it cannot be assembled.
2) Note the assembly direction of the thrust washer.

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



(5) 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 flange or any one of the following parts is replaced, the thickness of shim must be determined in the following manner.

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

1) Measure the distance between the clutch case body and the mounting flange, A or D for each shaft.
2) Fit the outer bearing race to each shaft, and measure the distance (B or C) between bearings.

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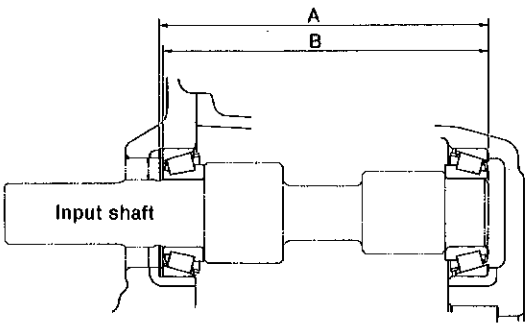
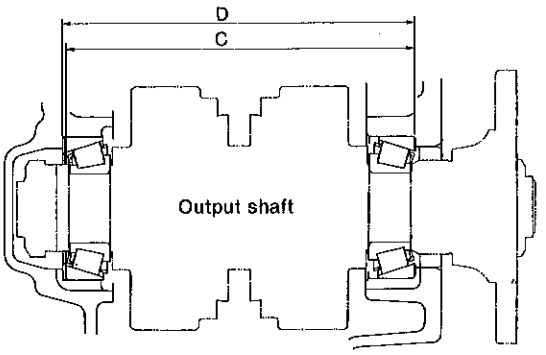




mm (in.)

	A	B	C	D
KM2-C	116.40 ~ 116.75 (4.5827 ~ 4.5964)	115.2 ~ 116.1 (4.5354 ~ 4.5709)	121.48 ~ 122.53 (4.7827 ~ 4.8240)	122.60 ~ 122.95 (4.8268 ~ 4.8406)
KM3-A	127.4 ~ 127.75 (5.0157 ~ 5.0295)	126.2 ~ 127.1 (4.9685 ~ 5.0039)	134.56 ~ 136.0 (5.2976 ~ 5.3543)	136.0 ~ 136.35 (5.3543 ~ 5.3681)

3) Determine the thickness of shim so that the values of clearance and interference after fitting comply with the values in the following table.

Clearance (or interference) for each shaft mm (in.)

Input shaft	±0.05 (±0.0020)
Output shaft	0 ~ −0.1 (0 ~ −0.0039)

NOTE: Negative value shows interference.

Adjusting plate

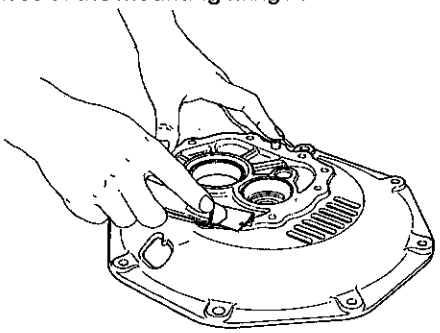
	Part No.	Thickness mm (in.)	No. of shims
Input shaft	177088-02350	0.5 (0.0197)	1
		0.4 (0.0157)	1
		0.3 (0.0118)	2
Output shaft	177090-02250	1.0 (0.0394)	1
		0.5 (0.0197)	1
		0.3 (0.0118)	1
		0.1 (0.0039)	2

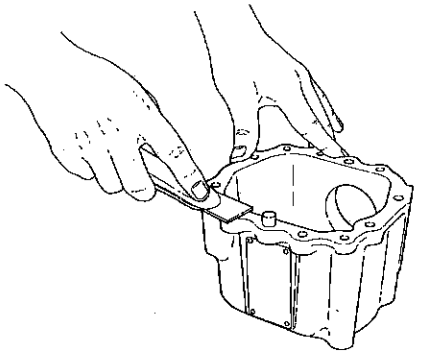
(6) Fit the adjusting plate to the mounting flange, and drive in the outer bearing race.

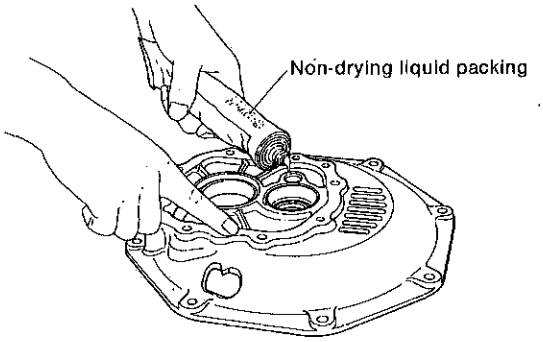
NOTE: The outer bearing race can be easily driven in by heating the mounting flange to about 100°C, or by cooling the outer race with liquid hydrogen.

(7) 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.

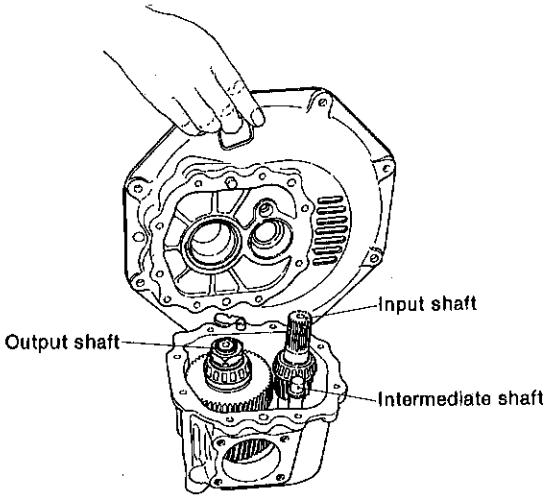
(8) Apply non-drying liquid packing to the matching surfaces of the mounting flange and the case body.







(9) 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.



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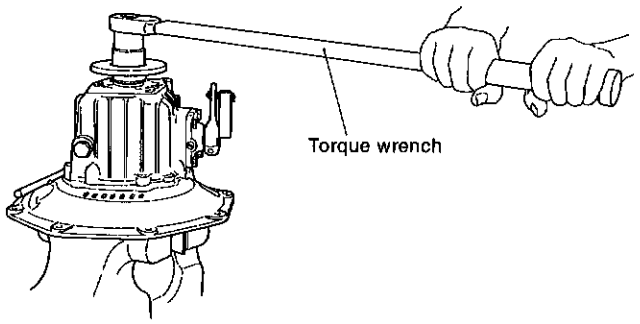
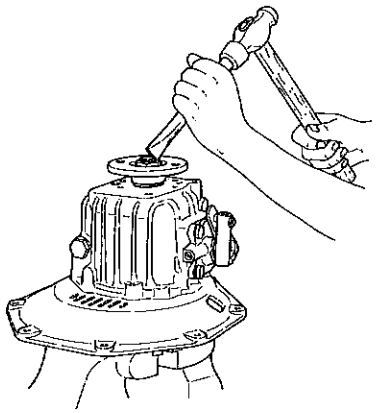
NOTE: Apply non-drying liquid packing to either the mounting flange or the case body.

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

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





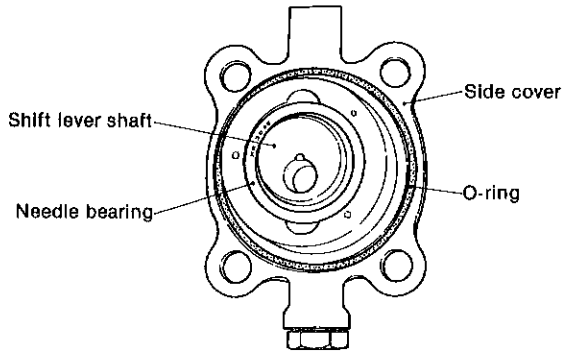
NOTE: Take care as it is a left-handed thread.

Tightening torque	10 ±1.5 kg-m (61.5 ~ 83.2 ft-lb)

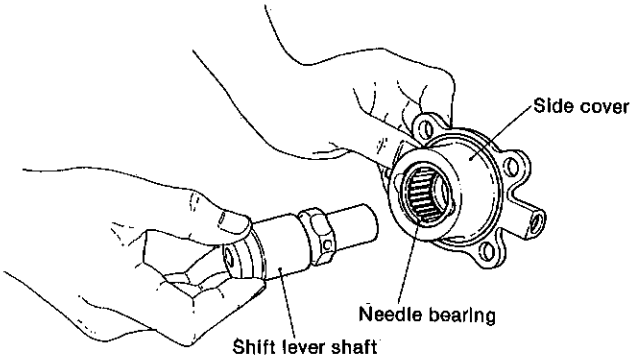
(The same torque applies to both models KM2-C and KM3-A).

5-3 Reassembly of the shifting device

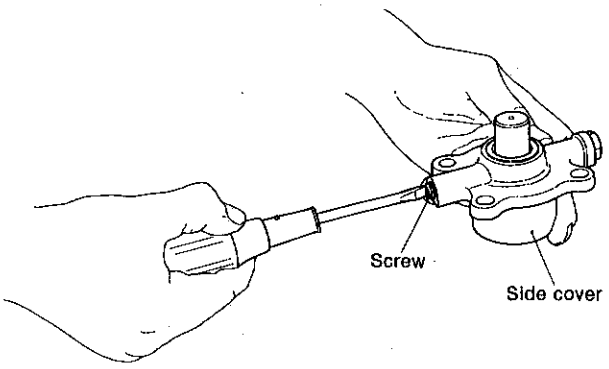
(1) Fit the oil seal and needle bearing to the side cover.

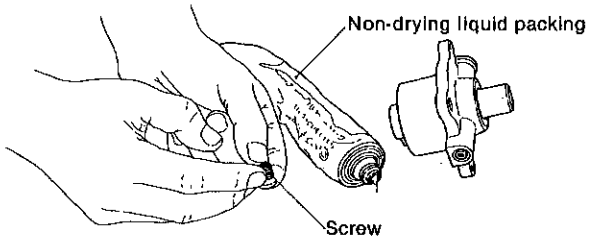


(2) Fit the shift lever.

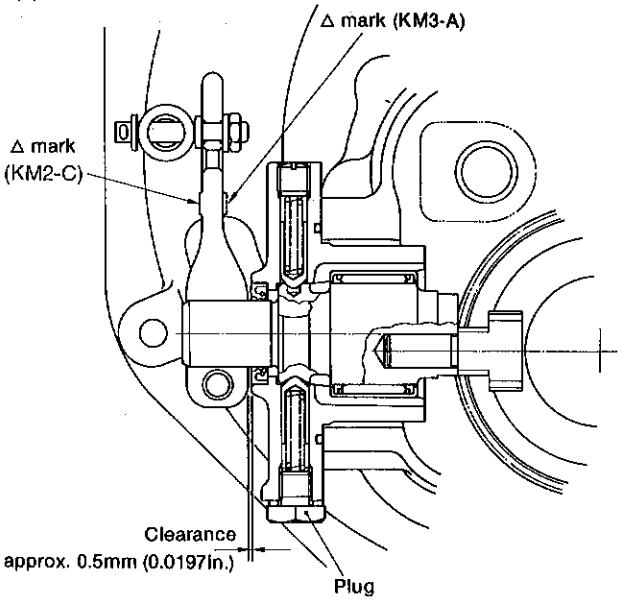


(3) Fit the notch and spring, and screw in the plug and stop screw.





(4) Fit the shift lever and set the bolt.



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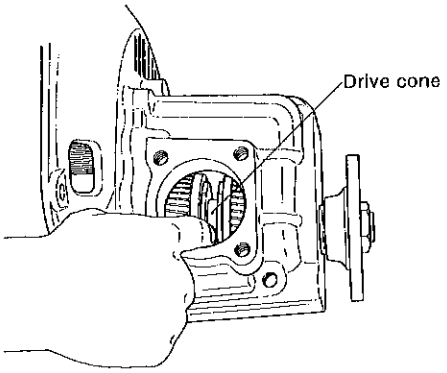
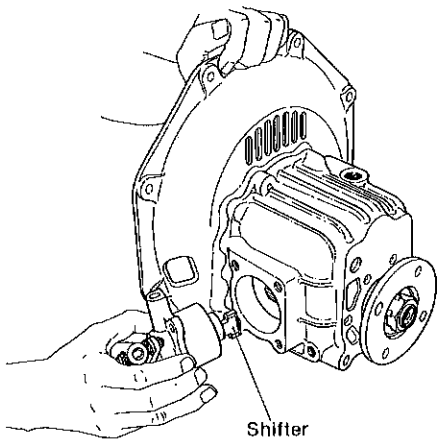
NOTE: The clearance between the surface of the side cover and the operation lever is to be 0 ~ 0.5mm (0 ~ 0.0197in.)

(5) Fit the shifter to the shift lever shaft.

(6) Fit the side cover to the clutch case. Ensure that the shifter engages the groove of the drive cone.





(7) Check that the lever turns smoothly.

NOTE: The lever may not turn smoothly if the housing is not filled with lubricating oil.

(8) Fit the spring joint, and set the remote control cable after adjusting.
For fitting and adjustment refer to the detailed explanation in the appropriate section.

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For model 3GM35(F)

1. Construction

1-1 Construction

The Kanzaki-Carl Hurth KBW10 reduction reversing gear was 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 KBW10 consists of a multi-disc clutch and reduction gear housed in a single case. It is small, light, simply constructed and extremely reliable.
*The force required to shift between forward and reverse can be controlled by a cable type remote control system much smaller and simpler than other types of reduction reversing gears.
*The friction discs are durable sinter plates, and the surface of the steel plates are corrugated in a sine curve shape to ensure positive engagement and disengagement and minimum loss of transmission force.
*Because of the special construction of this gear, the optimum pressure is automatically applied to the clutch plate in direct proportion to the input shaft torque.

1-2 Specifications

Engine model			3HM35(F)	
Nomenclature			KBW10E	
Reduction system			One-stage reduction, helical gear	
Reversing system			Constant mesh gear	
Clutch			Wet type multi-disc, mechanically operated	
Reduction ratio	Forward		2.14	2.83
	Reverse		2.50	
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			0.7ℓ	

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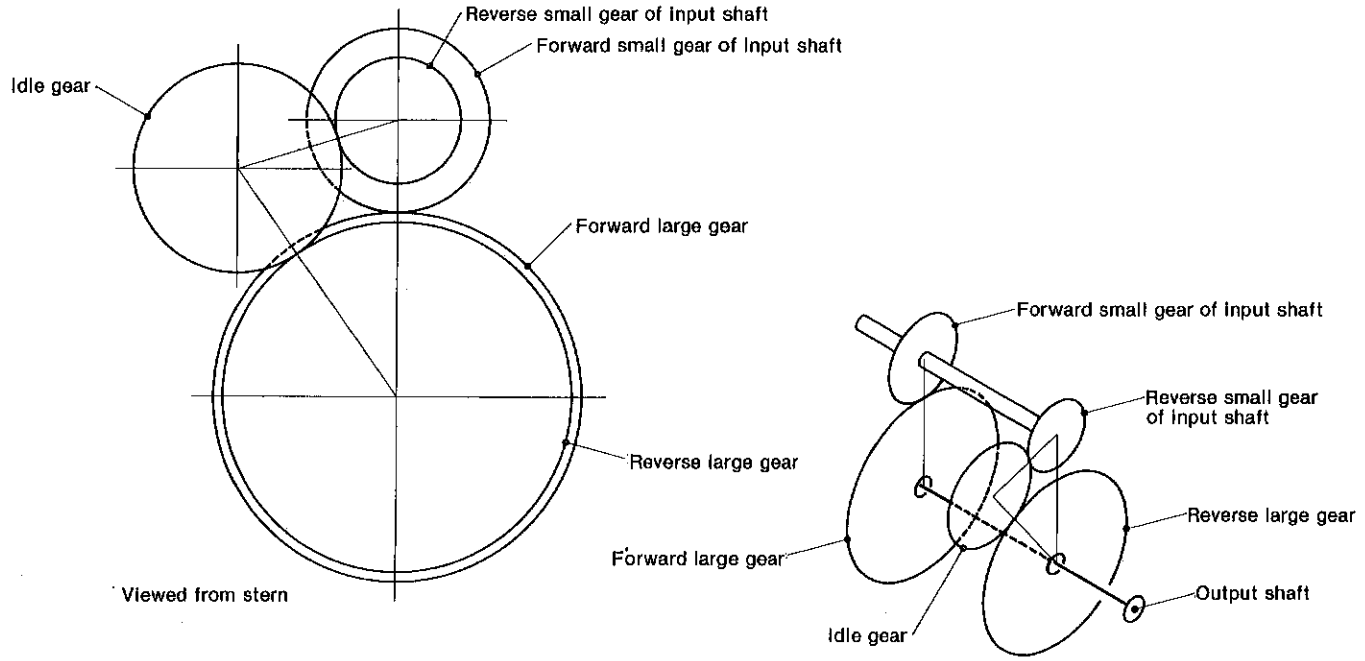
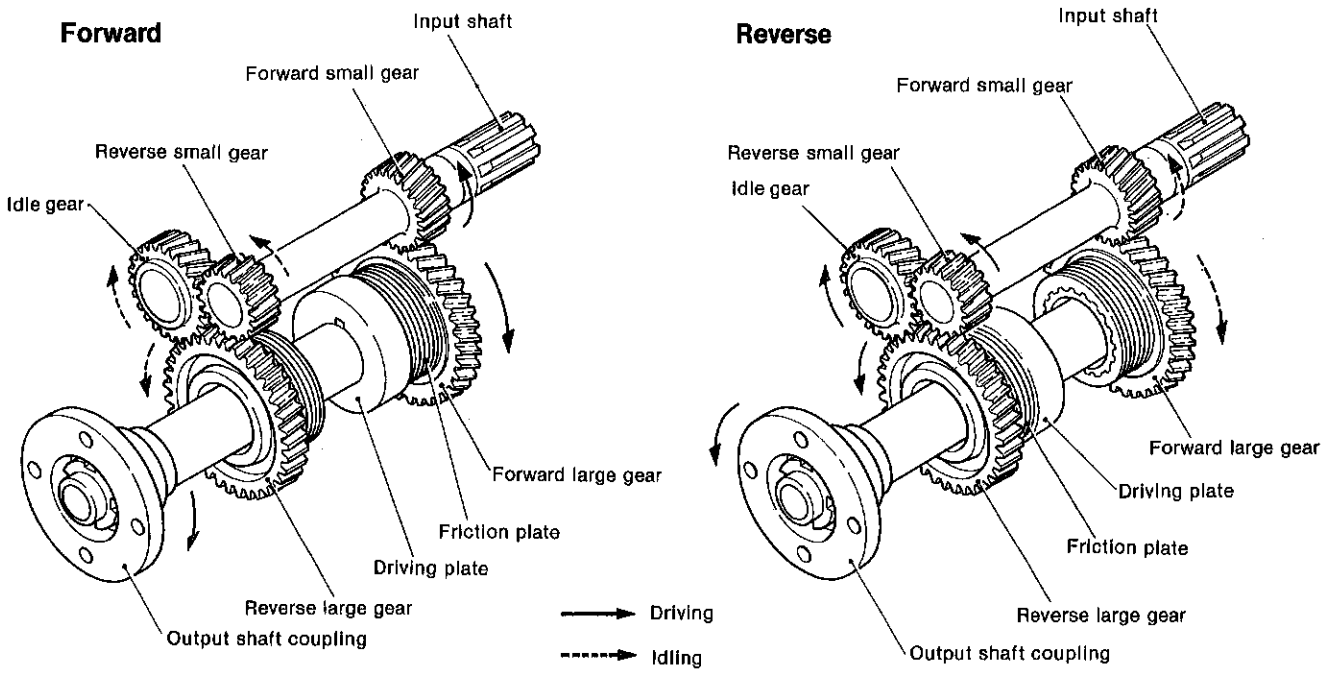
1-3 Power transmission system



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	
22	47	47/22 = 2.14	18	25	45	45/18 = 2.50
18	51	51/18 = 2.83				



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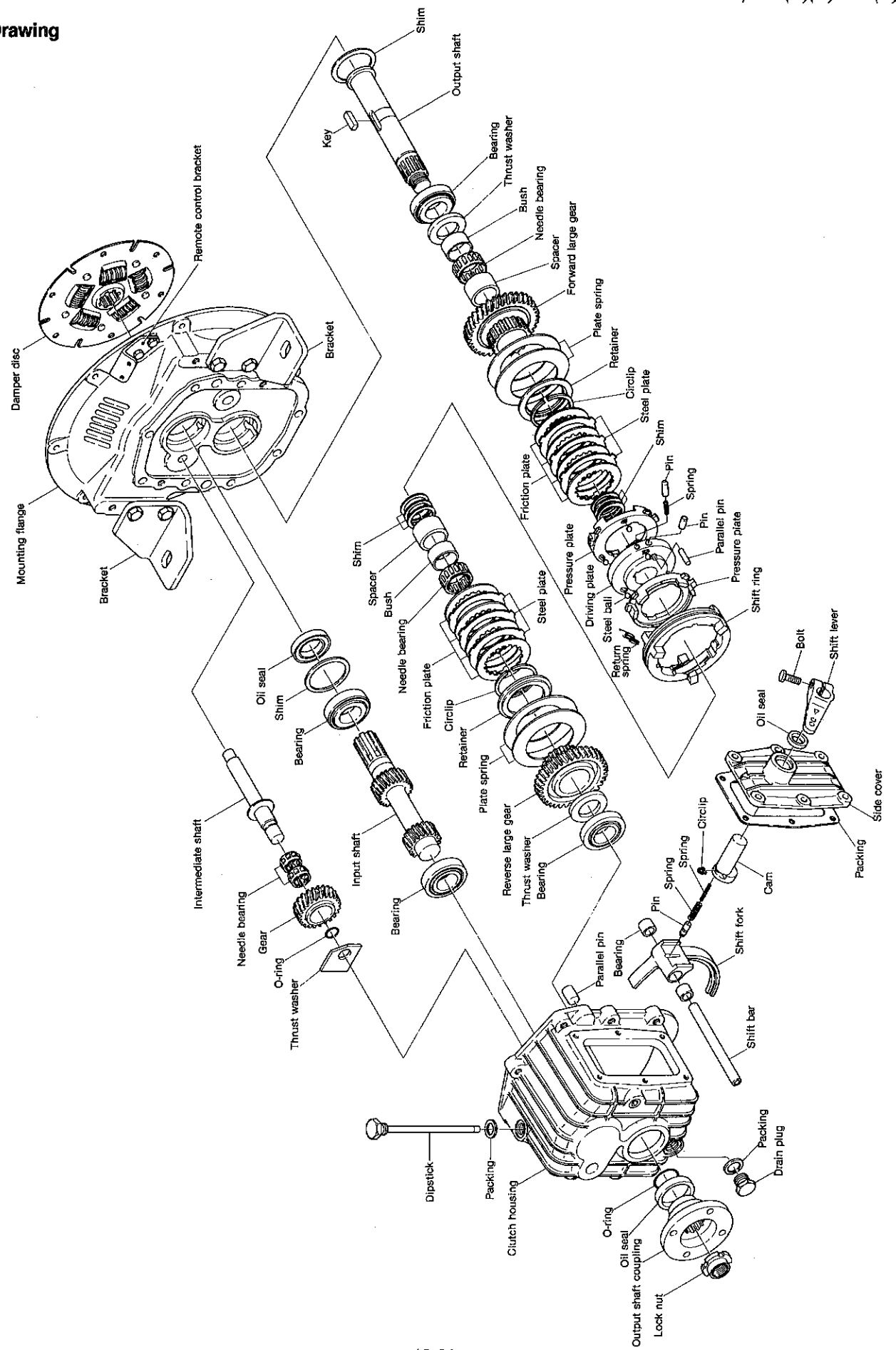
1-4 Drawing



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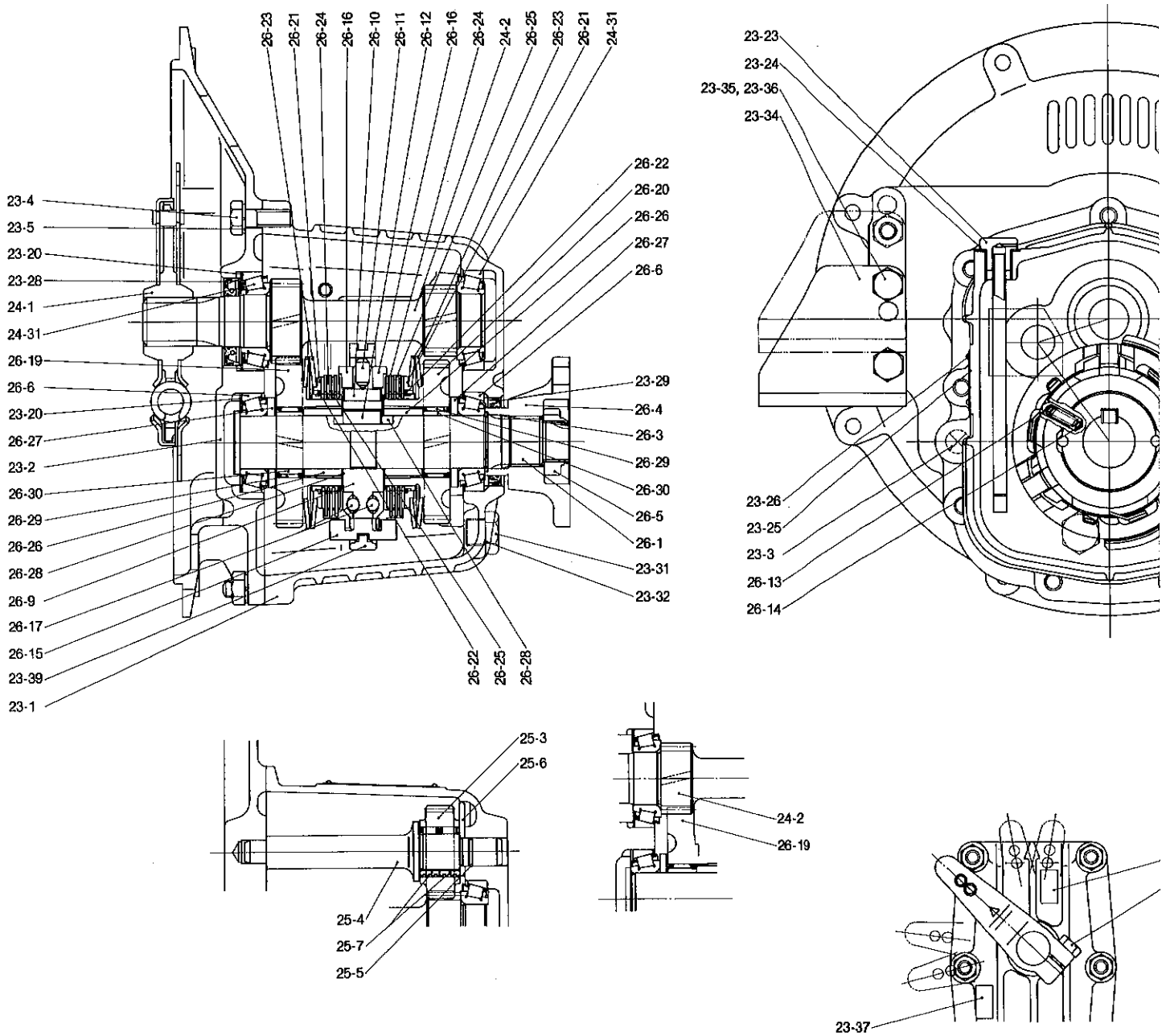
KBW10-E



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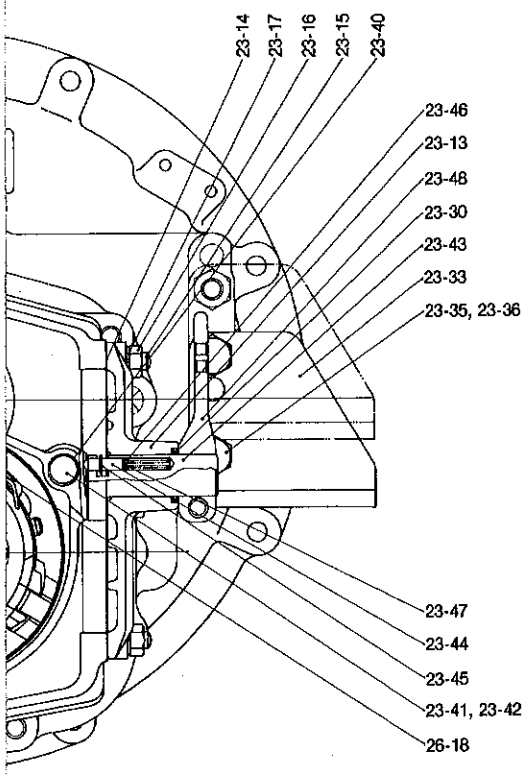


23-1 HOUSING, clutch
23-2 FLANGE, mounting
23-3 PARALLEL PIN
23-4 BOLT M10 × 30
23-5 LOCK WASHER 10
23-13 COVER (side)
23-14 PACKING, cover
23-15 STUD M8 × 22
23-16 NUT M8
23-17 LOCK WASHER 8
23-20 SHIM SET, output & Input shaft
23-23 DIPSTICK w/BREATHER, lube oil
23-24 PACKING 16
23-25 LABEL
23-26 RIVET
23-28 OIL SEAL (TC30528), Input shaft
23-29 OIL SEAL (TC40528), output shaft
23-30 OIL SEAL (SD 20264), cover
23-31 PLUG M16
23-32 PACKING 16
23-33 BRACKET (A)
23-34 BRACKET (B)
23-35 BOLT M10 × 30
23-36 LOCK WASHER 10
23-37 LABEL, FORWARD
23-38 LABEL, REVERSE
23-39 FORK Assembly, shift (Inc. 23-40)
23-40 DRY BEARING
23-41 SHAFT, shift
23-42 PLUG
23-43 CAM, shift
23-44 PIN
23-45 CIRCLIP
23-46 SPRING (A)
23-47 SPRING (B)
23-48 LEVER, shift
23-49 BOLT M8 × 25

24-1 DISC, damper
24-2 INPUT SHAFT
24-31 ROLLER BEARING LM67048/LM67010
25-3 IDLE GEAR
25-4 SHAFT, idle gear
25-5 O-RING S—15
25-6 WASHER, thrust
25-7 NEEDLE BEARING
26-1 OUTPUT SHAFT
26-3 O-RING S—30
26-4 COUPLING, output
26-5 LOCK NUT
26-6 ROLLER BEARING LM67048/LM67010
26-8 PLATE, assembly driving (Inc. 26-9 ~ 11)
26-9 PLATE, driving
26-10 PARALLEL PIN
26-11 PARALLEL PIN
26-12 KEY
26-13 PIN
26-14 SPRING
26-15 RING, shifting
26-16 PLATE, pressure
26-17 STEEL BALL (8mm)
26-18 SPRING, return
26-19 GEAR
26-20 GEAR
26-21 RETAINER
26-22 CIRCLIP
26-23 SPRING
26-24 DISC, friction
26-25 PLATE, steel
26-26 SPACER
26-27 WASHER, thrust
26-28 SHIM SET, output, shaft
26-29 NEEDLE BEARING
26-30 RACE, inner

2. Installation

2-1 Installation angle

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

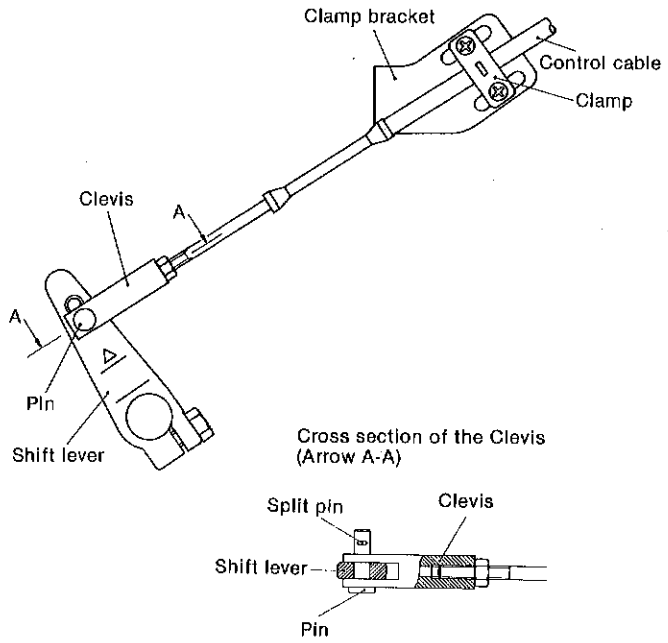
2-2 Remote control unit

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

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

The shift play, measured at the pivot point of the shift lever, must be at least 35mm on each side (reverse and forward) of the neutral position. Greater shift play has no adverse effect on the marine gearbox. After connecting the linkage, confirm that the remote control and the shift lever on the marine gearbox work properly.

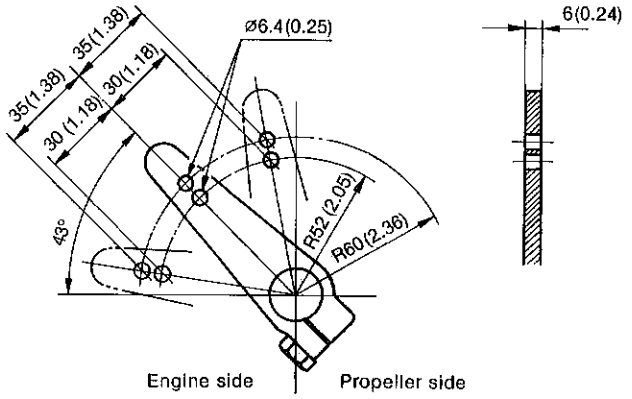
A typical linkage arrangement is illustrated in the figure below.



NOTE: Since the cable stroke may be insufficient, two holes are drilled in the shift lever.
When the cable is attached to the hole 60mm (2.3622in.) from the center of the rotation of the shift lever, the strokes from the center to the forward and reverse sides must both be 35mm (1.3780in.).

When the cable is attached to the hole 52mm (2.0472in.) from the center of the rotation of the shift lever, these strokes must be 30mm (1.1811in.)

mm(in.)



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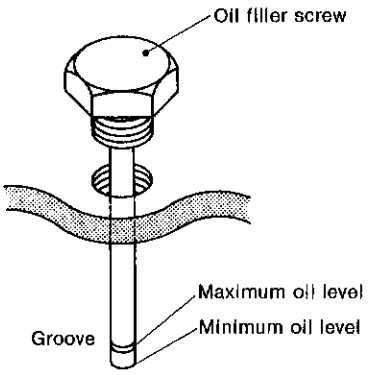
3. Operation and Maintenance

3-1 Lube oil

(1) Oil level

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



(2) Oil change

Change the oil after the first 100 hours of operation, and every 300 hours of operation thereafter. When adding oil between oil changes, always use the same type of oil that is in the marine gearbox.

(3) Recommended brands of lube oil

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

3-2 Precautions

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

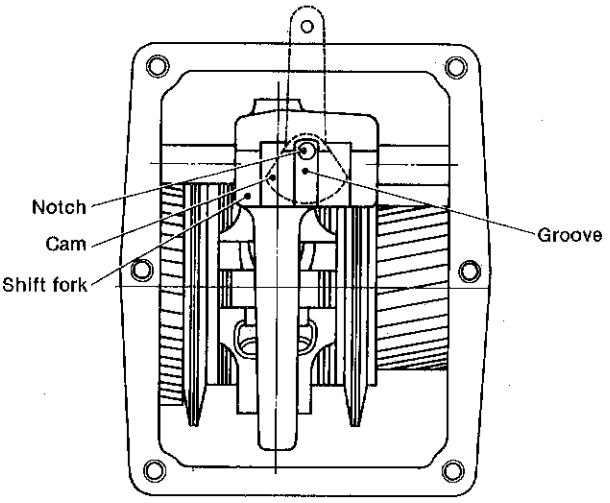
3-3 Side cover

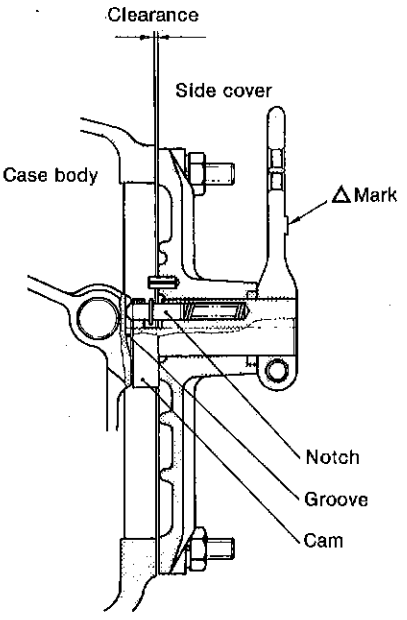
The internal shifting mechanism has been carefully aligned at the factory. Improper removal of the side cover can cause misalignment. If the side cover must be removed, proceed as follows:

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

—When installing the side cover, put the shift lever in neutral so that the cam lobe on the shift lever engages the groove on the internal shift mechanism. When the cam lobe and groove are engaged properly there will be no clearance between the body and the side cover. Do not use packing or gaskets 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.





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4. Inspection and Servicing

4-1 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.

4-2 Bearing

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

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

4-3 Gear

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

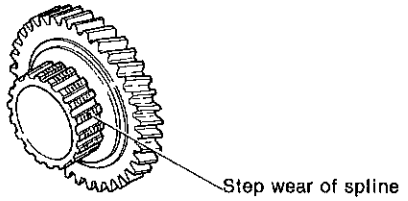
(2) Tooth surface contact
Check the tooth surface contact. The amount of tooth surface contact between the tooth crest and tooth flank must be at least 70% of the tooth width.

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

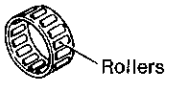
mm (in.)

	Maintenance standard	Wear limit
Input shaft forward gear and output shaft forward gear	0.1 ~ 0.2 (0.0040 ~ 0.0079)	0.3 (0.0118)
Input shaft reverse gear and intermediate gear	0.1 ~ 0.2 (0.0040 ~ 0.0079)	0.3 (0.0118)
Intermediate gear and output shaft reverse gear	0.1 ~ 0.2 (0.0040 ~ 0.0079)	0.3 (0.0118)

(4) Forward/reverse gear spline
1) Check the spline for damage and cracking.
2) Step wear of spline
Step wear depth limit: 0.1mm (0.0040in.)



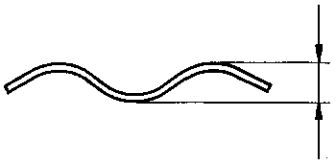
(5) Forward/reverse gear needle bearing
When an abnormal sound is produced at the needle bearing, visually inspect the rollers; replace the bearing if the rollers are faulty.



4-4 Steel plate

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

(2) Warping measurement

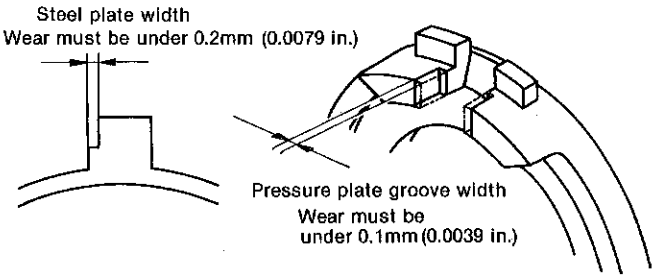


mm (in.)

	Maintenance standard	Wear limit
Warping	$1.6\ ^{+0.10}_{-0.11}$ (0.05870 ~ 0.067)	1.4 (0.0551)

(3) Steel plate pawl width measurement

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



mm (in.)

	Maintenance standard	Wear limit
Steel plate width	$12\ ^{0}_{-0.2}$ (0.4646 ~ 0.4724)	Worn 0.2 (0.0079)
Pressure plate groove	$12\ ^{+0.1}_{0}$ (0.4724 ~ 0.4764)	Worn 0.1 (0.0039)
Clearance	0 ~ 0.3 (0 ~ 0.0118)	0.3 ~ 0.6 (0.0118 ~ 0.0236)

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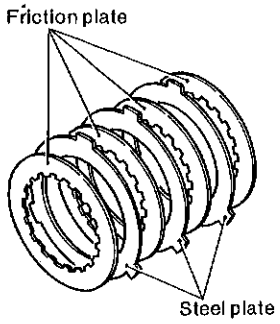
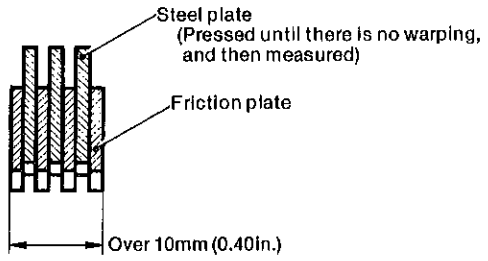
4-5 Friction plate

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

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





mm (in.)

	Maintenance standard	Wear limit
Friction plate thickness	$1.7\ ^{0}_{-0.05}$ (0.0650 ~ 0.0670)	1.5 (0.0591)

The assembled friction plate and steel plate dimensions must be over 10mm (0.0040in.).

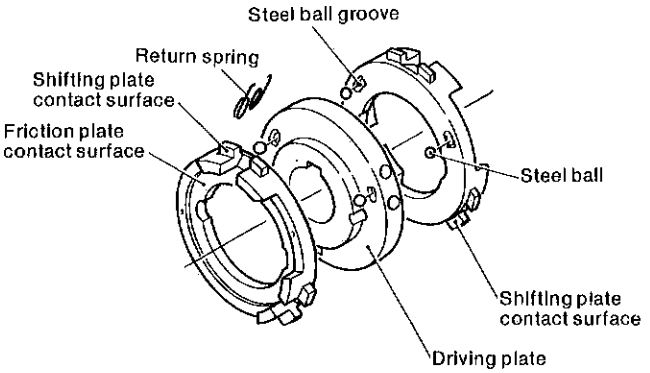
Both sides of the friction plate have a 0.35mm copper sintered layer. Replace the friction plate when this layer is worn more than 0.2mm on one side (standard thickness $1.7\ ^{0}_{-0.05}$ mm). However, the sum of the wear of the four friction plates must not exceed 0.8mm. When this value is exceeded, replace all friction plates. In unavoidable circumstances, it is permissible to replace only the friction plate with the greatest amount of wear.

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

mm (in.)

	Maintenance standard	Wear limit
Standard backlash	0.20 ~ 0.61 (0.0079 ~ 0.0240)	0.9 (0.0354)

4-6 Pressure plate

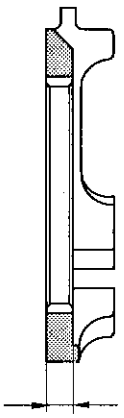


(1) Steel ball groove
Check the steel ball groove for stains and wear.
Replace the pressure plate if the groove is noticeably worn.

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

(3) Shifting plate contact surface

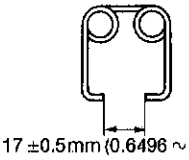
(4) Worn parts measurement



mm (in.)

	Maintenance standard	Wear limit
Thickness: t	$6.6\ ^{0}_{-0.2}$ (0.2520 ~ 0.2598)	6.3 (0.2480)

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



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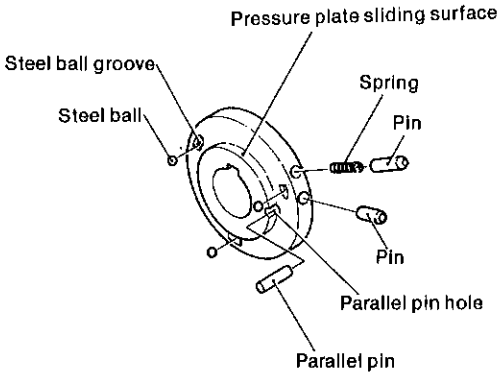
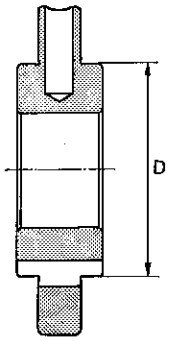
4-7 Driving plate



(1) Check the key groove for scoring and cracking, and the output shaft fitting section for burning. Repair if the damage is light and replace the driving plate if the damage is heavy.
(2) Outside diameter of pressure plate sliding part; others



mm (in.)

	Maintenance standard	Wear limit
Outside diameter: D	ø59 $^{-0.060}_{-0.134}$ (2.3176 ~ 2.3205)	ø58.8 (2.3150)

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

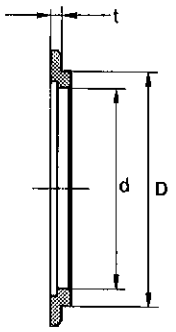
mm (in.)

	Maintenance standard	Wear limit
Spring free length	32.85 (1.2933)	32 (1.2598)

(6) Pin end wear.

4-8 Retainer

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

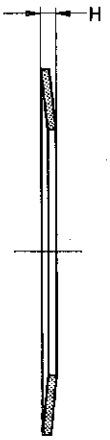


mm (in.)

	Maintenance standard	Wear limit
d	ø57.5 $^{+0.106}_{+0.060}$ (2.2661 ~ 2.2680)	ø57.8 (2.2756)
D	ø66 $^{0}_{-0.1}$ (2.5945 ~ 2.5984)	ø65.7 (2.5866)
t	2.8 $^{0}_{-0.08}$ (0.1071 ~ 0.1102)	2.6 (0.1024)

4-9 Plate spring

(1) Permanent strain



mm (in.)

	Maintenance standard	Wear limit
H: when plate spring is free	6.25 $^{\pm 0.1}$ (0.2421 ~ 0.2500)	6.0 (0.2362)

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 4.75mm (standard thickness: 5 $^{0}_{-0.1}$ mm).

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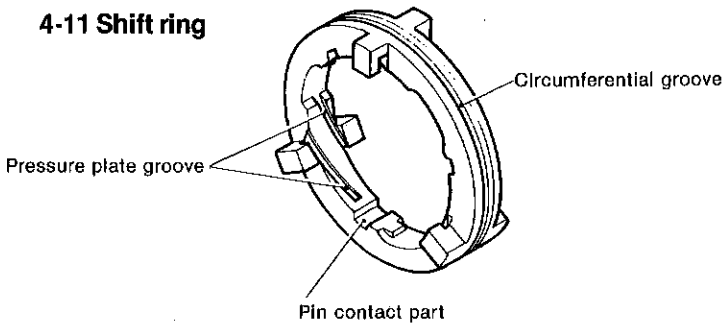
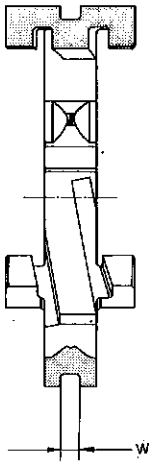
4-11 Shift ring



(1) Circumferential groove wear.



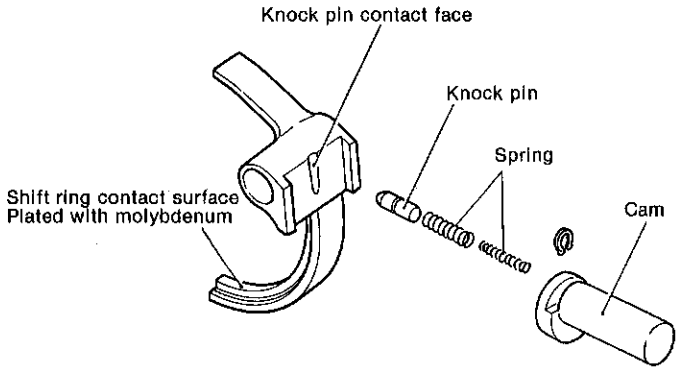
mm (in.)

	Maintenance standard	Wear limit
Shifting groove: w	$6\ ^{+0.1}_{0}$ (0.2362 ~ 0.2402)	6.3 (0.2480)

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

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

4-12 Shift fork and shift lever



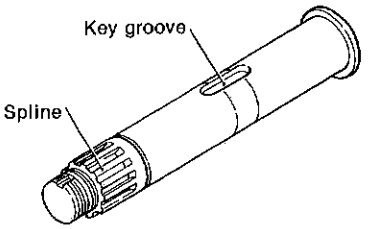
(1) End wear.
The shift ring contact surface of the shift fork is plated with molybdenum (thickness: 0.04—0.05mm). If this plating is peeled or worn to such an extent that the base metal of the shift fork is exposed, replace the shift fork.

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

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

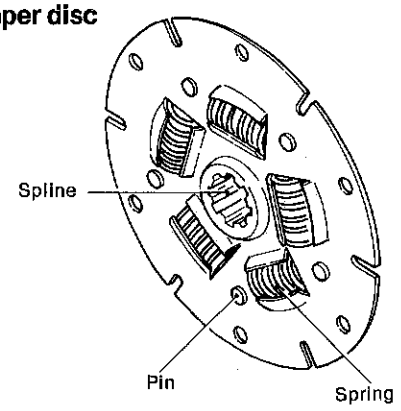
(4) Notch end wear.
Whenever uneven wear and/or scratches are found, replace with a new part.

4-13 Output shaft



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

4-14 Damper disc



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

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

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

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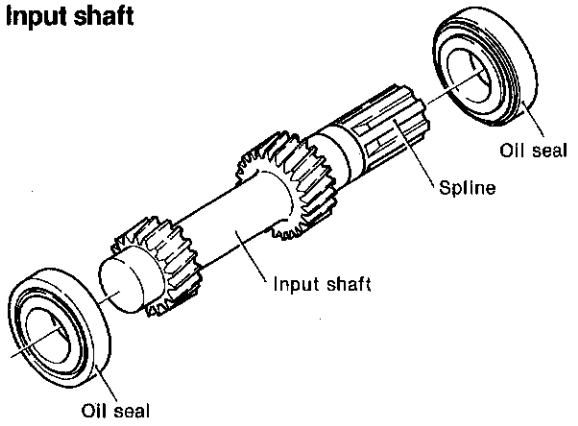
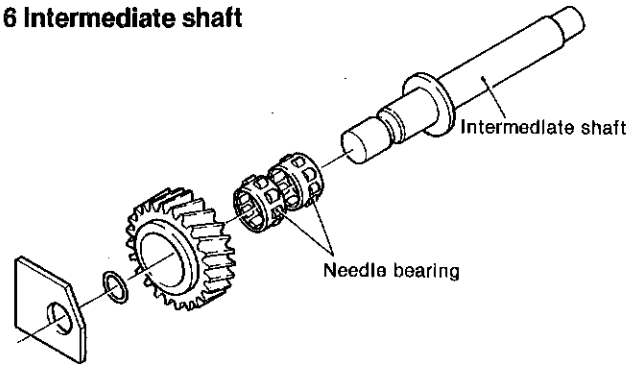
4-15 Input shaft



(1) Spline part
Whenever uneven wear and/or scratches are found, replace with a new part.
(2) Surface of oil seal.
If the sealing surface of the oil seal is worn or scratched, replace.

4-16 Intermediate shaft



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

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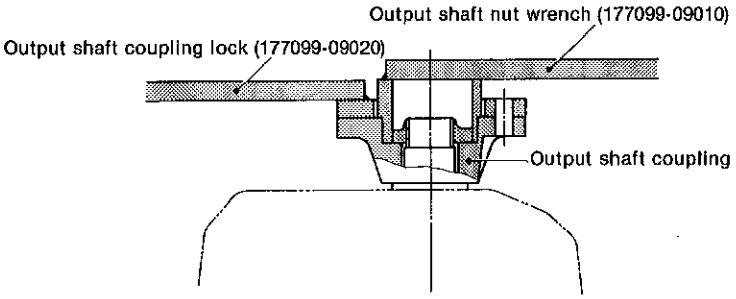
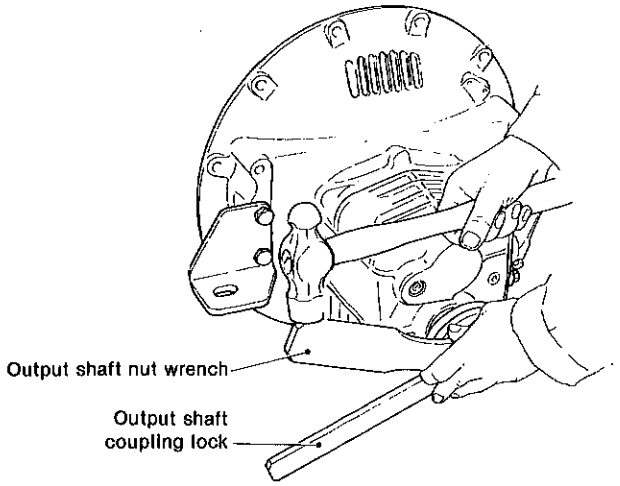
5. Disassembly

5-1 Disassembling the clutch and accessories

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

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



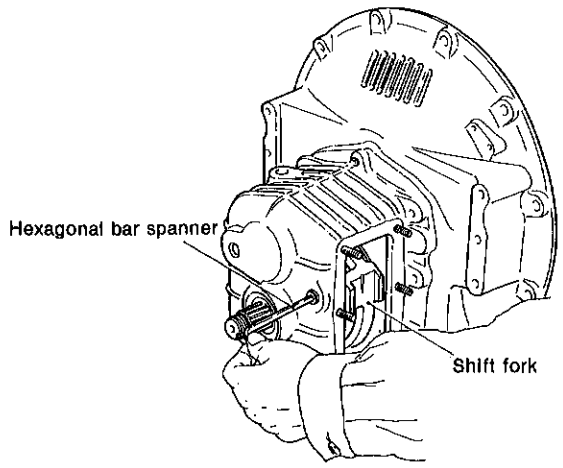


(3) Remove the output coupling.

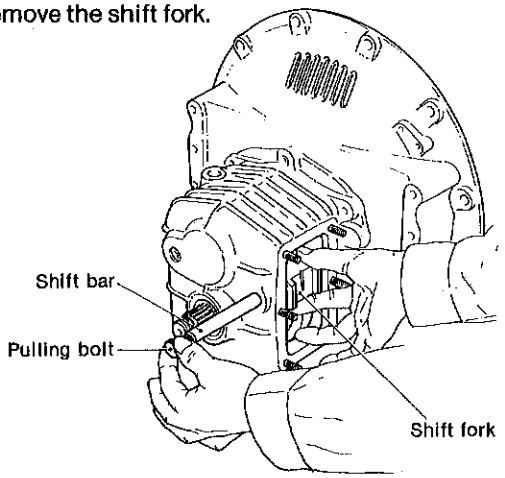
(4) Remove the dipstick and packing.

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

(6) Remove the shift bar plug with a hexagonal bar spanner (width across flats: 8mm (0.0394in.), and pull the shift bar from the case, using the M10 pulling bolt at the end of the shift bar.

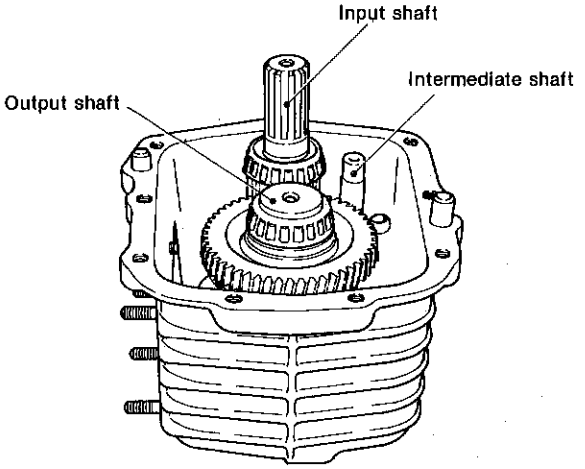


(7) Remove the shift fork.

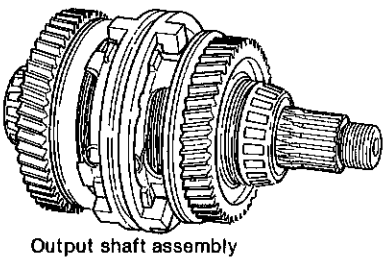


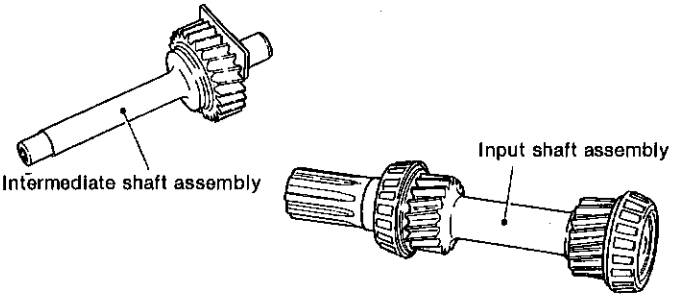
(8) Remove the M10 bolt and super lock washer on the mounting flange.

(9) 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.



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





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

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

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

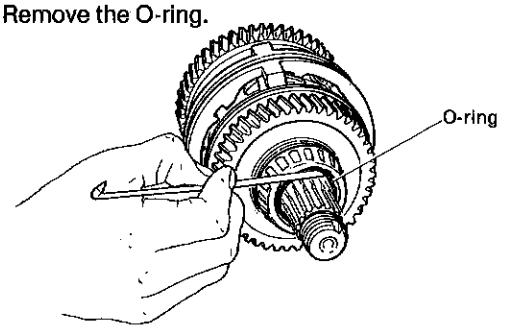
5-2 Disassembling the input shaft

Pull the bearing from the input shaft.

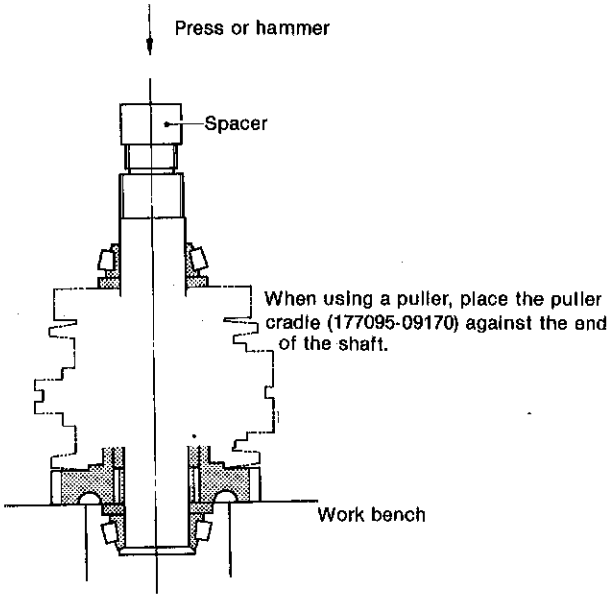
NOTE: Do not disassemble unless the input shaft parts are damaged.

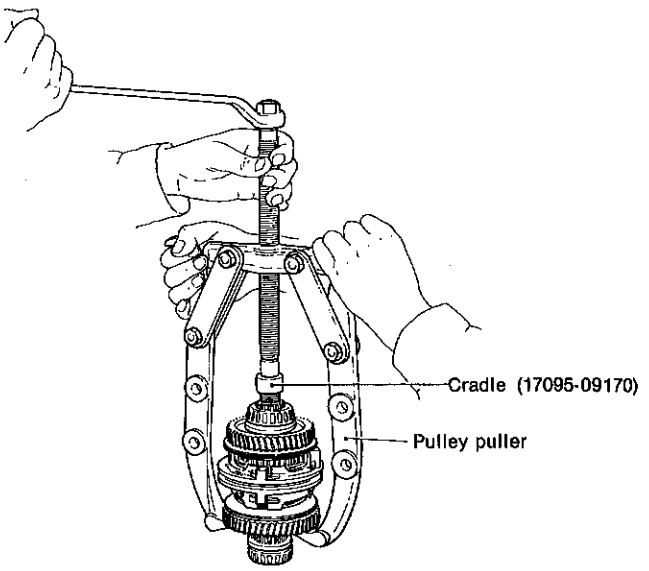
5-3 Disassembling the output shaft

(1) Remove the O-ring.



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





NOTE 1: When removing the shaft, place spacers between the shaft and the press to prevent damage.

NOTE 2: Make sure that the forward large gear parts and reverse large gear parts are not mixed together once they are removed.

(3) Remove the adjusting plate.

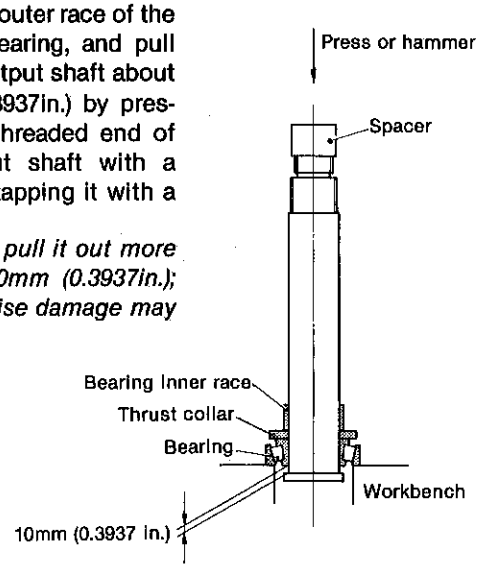
NOTE: Record the thickness of the adjusting plate to facilitate reassembly.
If the parts are not replaced, the adjusting plate may be reused without readjustment. However, if even one part is replaced, readjustment is required.

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

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

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

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



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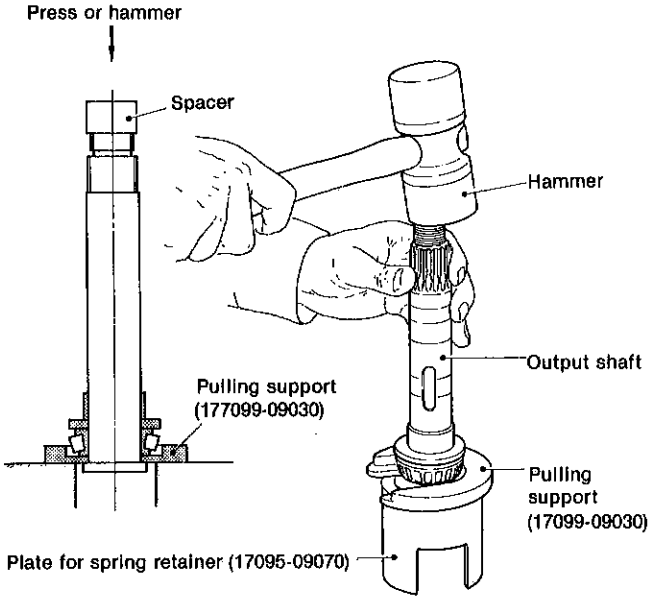
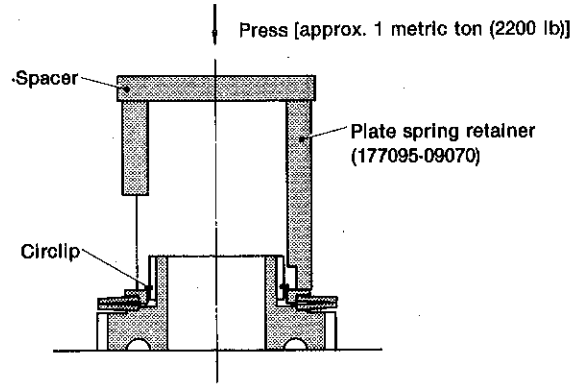
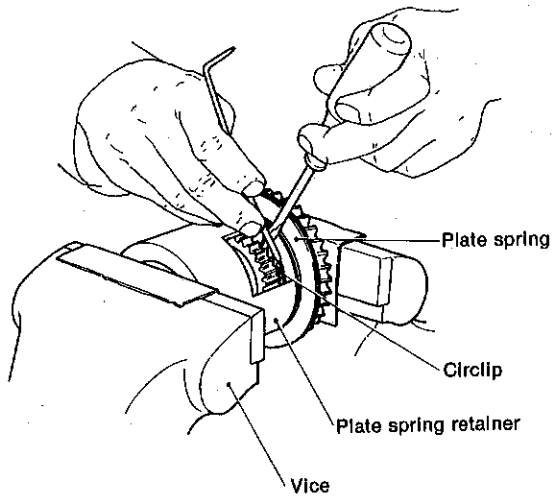
(8) Insert the disassembly tool between the collar of the output shaft and the bearing; next remove the bearing inner race, thrust collar, and bearing from the output shaft with a press or hammer.



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

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

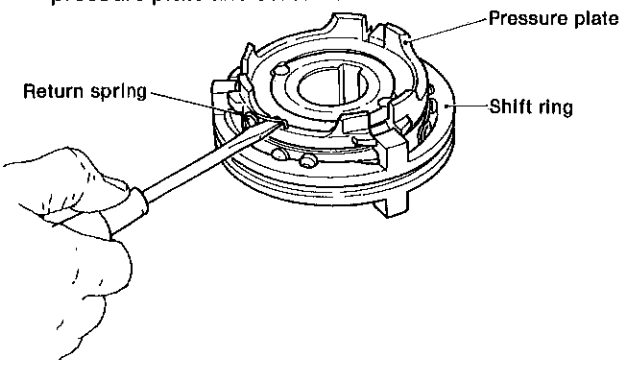




(11) Remove the retainer and plate spring.

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

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

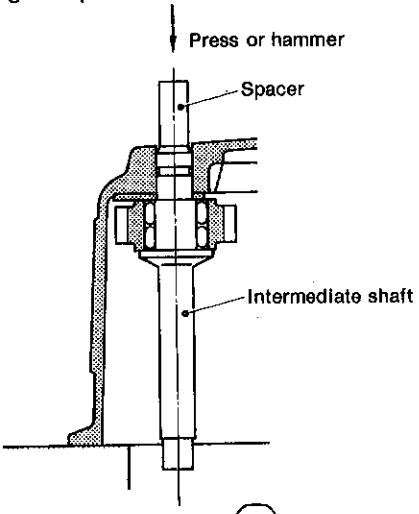


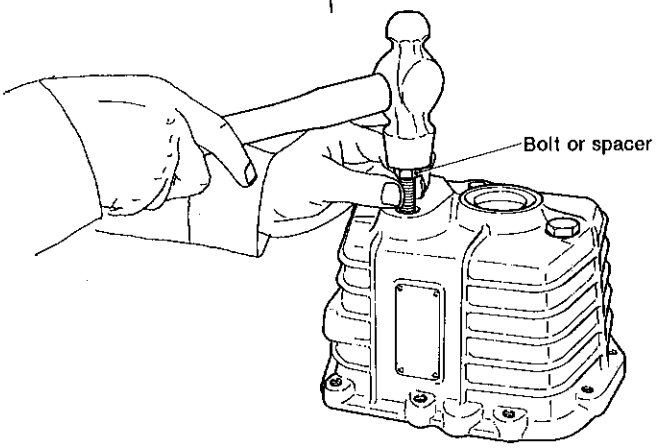
(14) Remove the shift ring.
To disassemble, remove the three knock pins. When disassembling the shift ring, cover it with a cloth to prevent it being lost.

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

5-4 Disassembling the intermediate shaft

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





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(2) Remove the O-ring.
(3) Remove the idle gear, needle bearing, and thrust washer.

5-5 Disassembling the operating system

(1) Loosen the M8 bolt of the shift lever; remove the shift lever.
(2) Pull the shift cam.
(3) Push in the knock pin and remove the circlip.
(4) Remove the knock pin and spring.
(5) Pull the oil seal from the case side cover.

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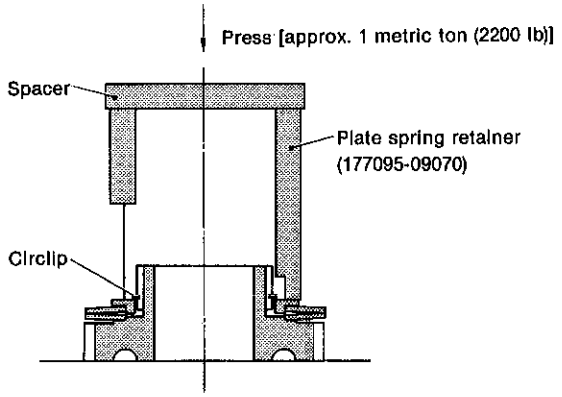
6. Reassembly

6-1 Reassembly precautions

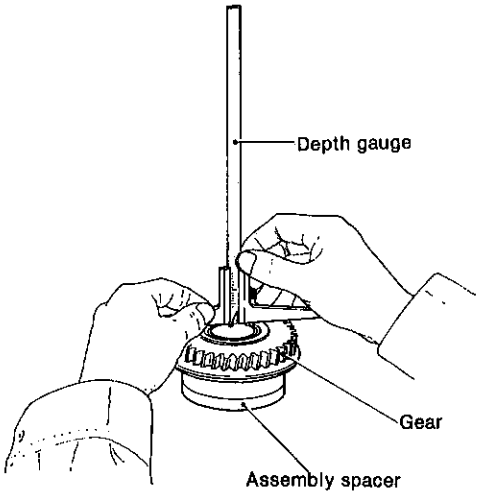
(1) Before reassembling, clean all parts in washing oil, and replace any damaged or worn parts.
Remove non-dry packing agent from the mating surface with a blunt knife.
(2) Pack the oil seal and O-ring parts with grease.
(3) Coat the mating surfaces of the case with wet packing.

6-2 Reassembling the output shaft

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

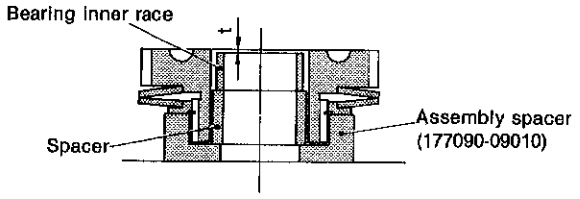


(2) Reassemble the reverse large gear and plate spring, retainer, and circlip as described in step (1) above.
(3) Determining the forward adjusting plate thickness



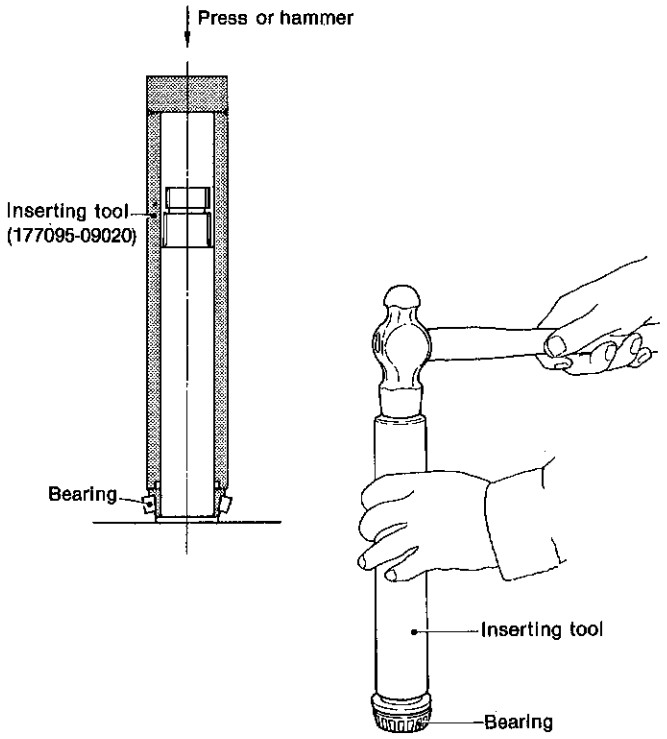
NOTE: As mentioned in section 5-3. (5), if no parts need to be replaced, the adjusting plate can be reused without adjustment.

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



2) Adjust the thickness of the adjusting plate until it conforms to the dimension shown in the figure.
3) Two adjustment plates of 0.5mm (0.0197in.) and 0.3mm (0.0118in.) are available.
Combine these plates to obtain the "t" dimension.
(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 (four friction plates and three 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 (four friction plates and three steel plates).
(7) Press the inner race of the bearing onto the output shaft up to the collar, using an assembly tool.

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



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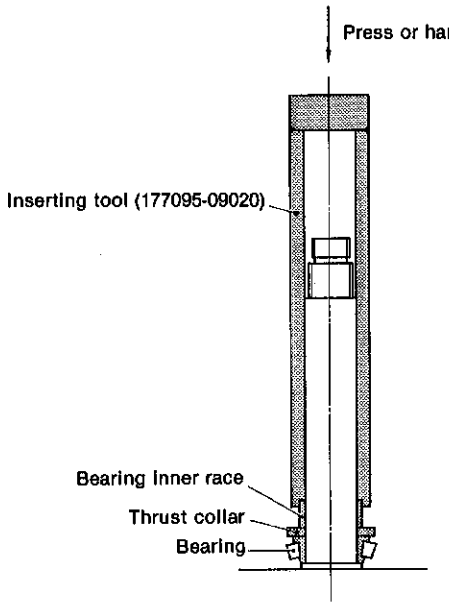
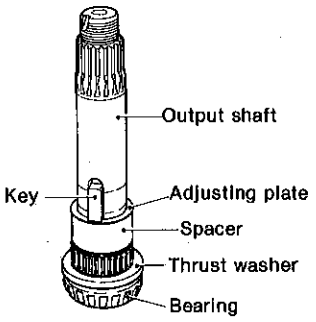
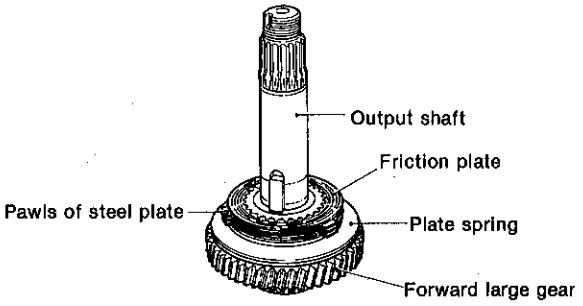
(8) Insert the thrust collar, with the sintered surface (brown surface) facing the gear side.
(9) Press the bearing inner race onto the output shaft, using an assembly tool.



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



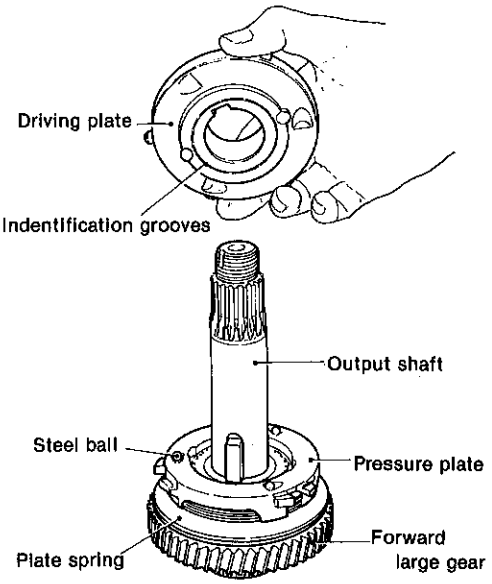
(13) Insert the forward large gear, together with the friction plates and steel plates. At this time, align the three pawls on the outside of the steel plates.

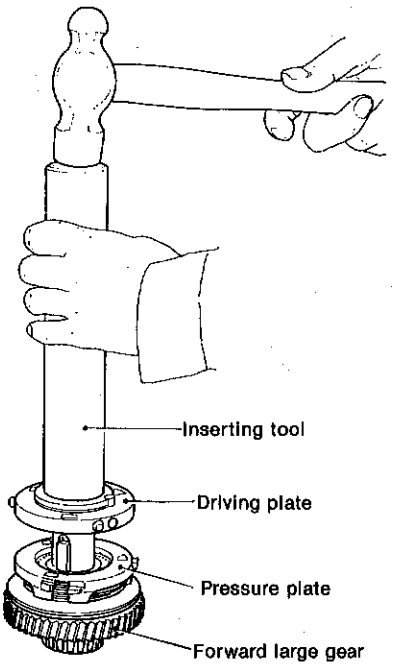


(14) Cover the friction plates and steel plates with the pressure plate so that the pawls of the steel plate fit into the three notches on the pressure plate.
(15) Insert the three steel balls into the three grooves in the pressure plate.

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

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





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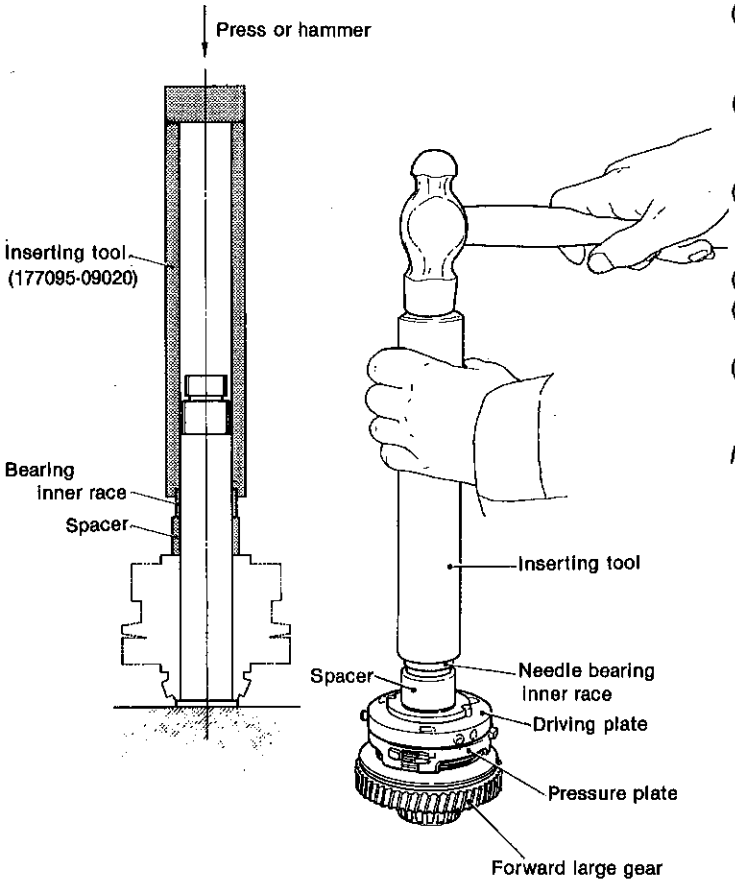
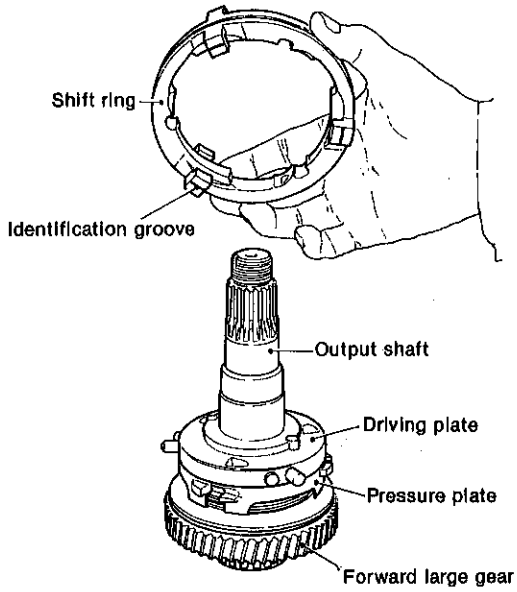
(17) Insert the adjusting plate and spacer.
(18) Press the bearing inner race, using an assembly tool.

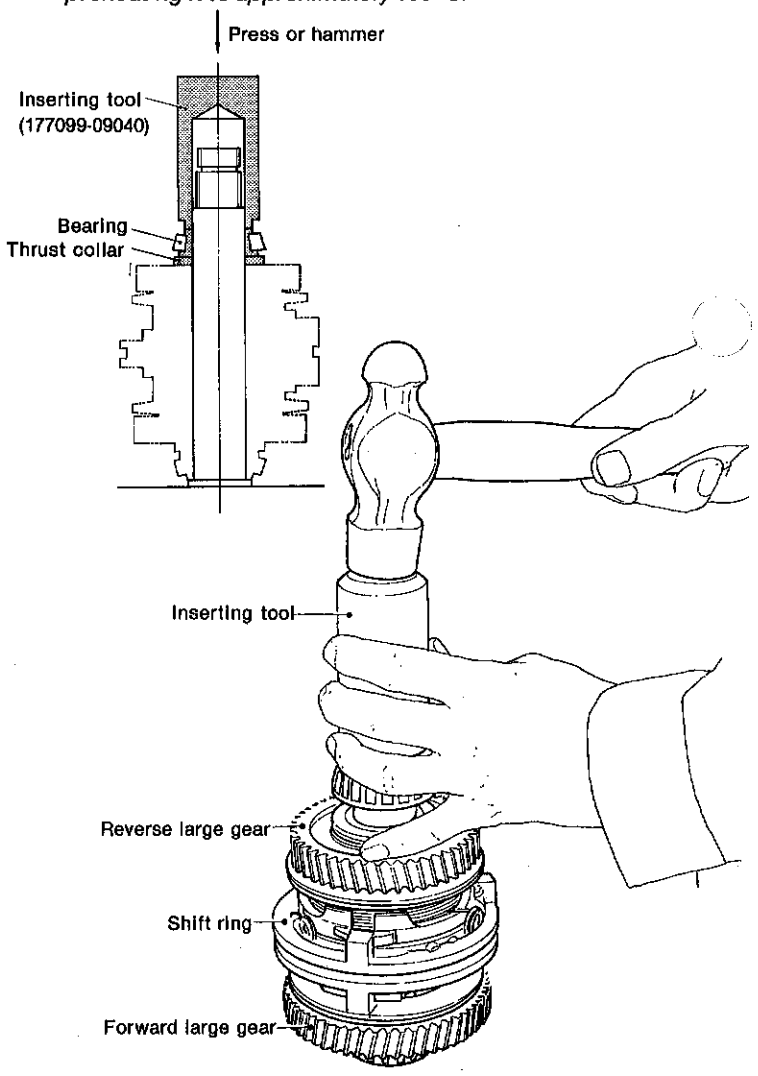


(19) Insert the knock pins and springs into the three holes around the circumference of the driving plate.
(20) Cover the driving plate with the shift ring so that the side with the identification groove faces the forward large gear side; install the ring so that the knock pins are pushed in.



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

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



(28) Insert the O-ring.
(29) 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.

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6-3 Reassembling the input shaft

Press the inner race of the bearing onto the input shaft. Make sure that the direction of the bearing is correct.

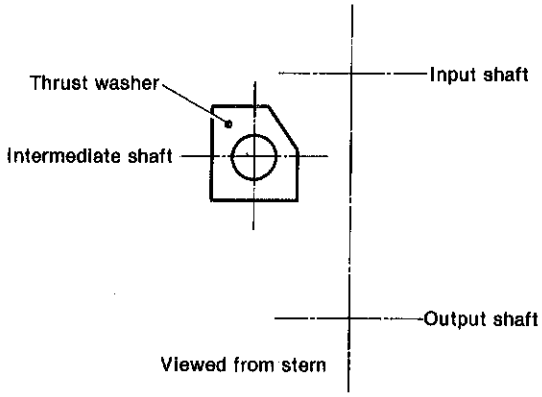
NOTE: The bearing inner race can be easily installed by preheating it to approximately 100°C.

6-4 Reassembling the intermediate shaft

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

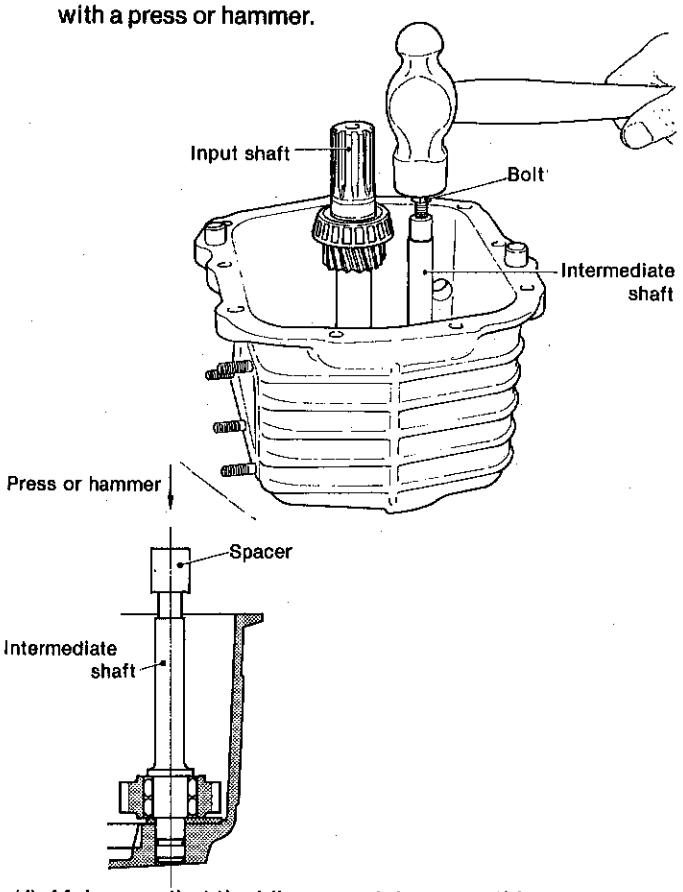
(1) Insert the needle bearing and idle gear on the intermediate shaft. Then insert the thrust washer.

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



(2) Insert the O-ring.

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



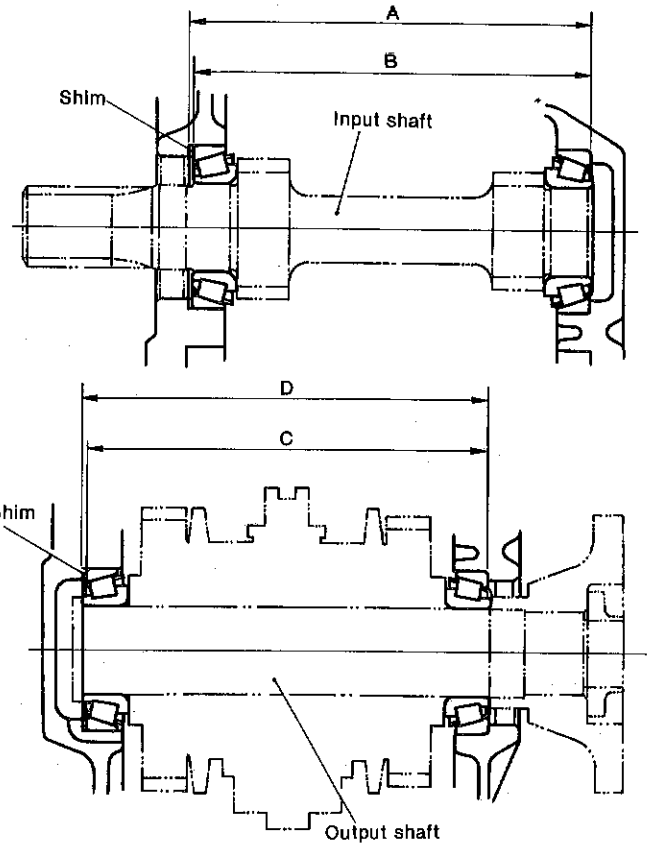
(4) Make sure that the idle gear rotates smoothly.

6-5 Installing the input shaft and output shaft

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

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

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



3) Adjust the input shaft adjusting plate thickness so that the clearance or tightening allowance is less than 0.05mm (0.0020in.).
4) Adjust the output shaft adjusting plate thickness so that the tightening allowance is within 0 ~ 0.1mm (0~0.0040in.).
5) Four adjusting plates of 1mm (0.0394in.), 0.5mm (0.0197in.), 0.3mm (0.0118in.) and 0.1mm (0.0040in.)are available.
Combine these plates to obtain the desired adjusting plate measurement.

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

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

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

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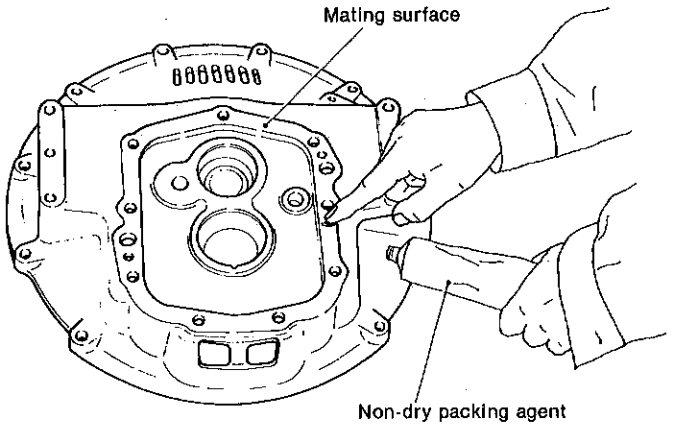
(4) Coat the mating surfaces of the mounting flange and case with a non-dry packing agent.
Wipe off oil and dirt on the mating surface of the case and coat with a thin film of non-dry packing agent.

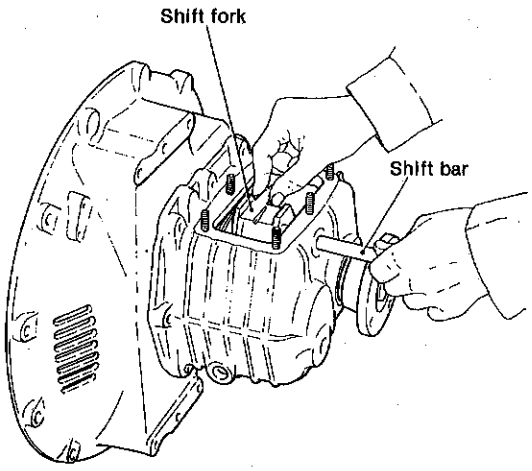


(5) Insert the input shaft into the case, assemble the intermediate shaft as described in section 6-4 and then insert the output shaft into the case.
(6) Align the mounting flange with the case, and insert the parallel pin by tapping the mounting flange with a plastic hammer.
(7) Insert the super lock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

6-6 Reassembling and installing the operating system

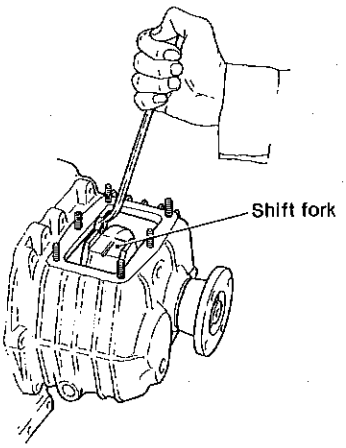
(1) Insert the shift fork into the case from the side, insert the shift bar.

NOTE: Insert the shift bar with the threaded end towards the outside (output shaft coupling side).



(2) Coat the threaded part of the shift bar plug with a non-dry packing agent and secure it to the case with a hexagonal bar spanner (width across flats: 8mm (0.3150in.).

NOTE: Put the shift fork into neutral before installing.



(3) Coat the circumference of the oil seal with a non-dry packing agent and press the seal to the case cover.
(4) Insert the spring into the shift cam.
(5) Insert the knock pin into the shift cam from the front end, and lock with the circlip.
(6) Insert the assembled shift cam into the case cover.
(7) Fit the shift lever to the shift cam, and tighten the M8 bolt.

NOTE: The shift cam must rotate smoothly.

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

NOTE: Put the shift fork into neutral before installing.

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

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

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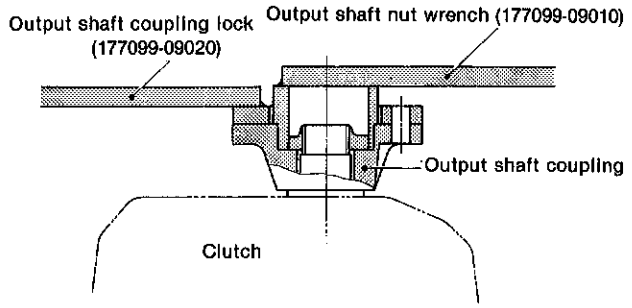
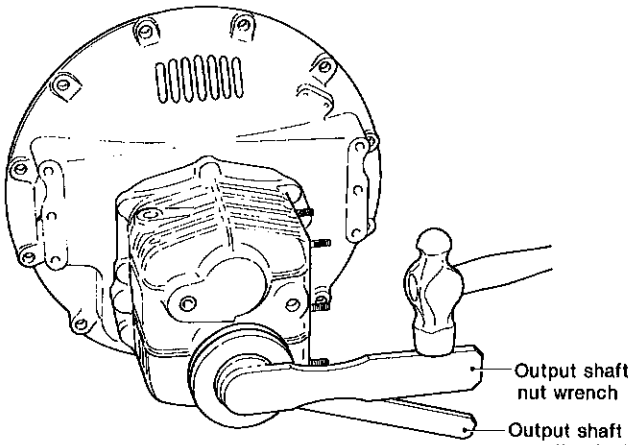
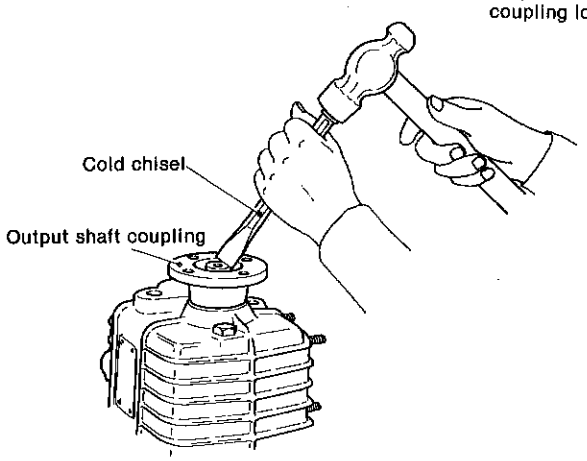
6-7 Installing the output shaft coupling

(1) Install the output shaft coupling on the output shaft.
(2) Tighten and caulk the output shaft lock nut, using the assembly tool.
Tightening torque....., 9.5kg-m (68.7ft-lb)







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

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[C] Marine Gear Models KM2P, KM3P and KM3V

for Engine Models 1GM10, 2GM20(F) and 3GM30(F)

Applicable Engine Models & Serial Nos.

		(Effective from:)
KM2P 1GM10	E/# 03413 and after	Aug. 1985
KM2P 2GM20(F)	E/# 03567 and after	Aug. 1985
KM3P 3GM30(F)	E/# 01888 and after	Aug. 1985

1. Construction

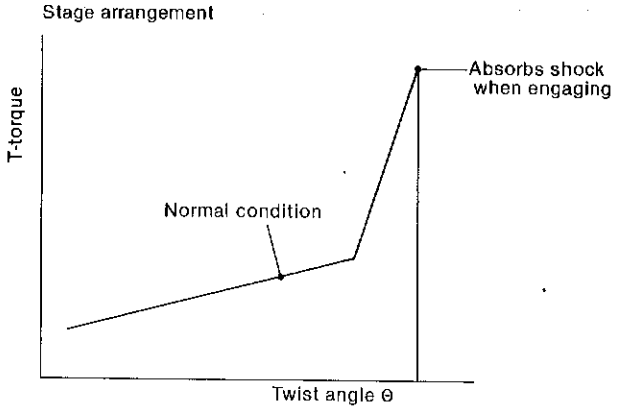
1-1 Construction

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 construc ton is simple when compared with other types of clutch and it serves to reduce the number of components, making for a lighter, more compact unit which can be operated smoothly. Although it is small, the power transmission efficiency is high even under a heavy load. Its durability is high and it is reliable as high grade materials are used for the shaft and gear, and a taper roller bearing is incorporated. Power transmission is smooth as 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 output shaft, power can be transmitted smoothly. For the damper disc, springs of different strengths are used so that two stages of torque and twist angle are applied. That is, in the first stage, only the weak spring is used, and the strong spring comes into action for a torque higher than a predetermined value.

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



- There is a small clearance between the dipstick and the inside of the dipstick tube. A small hole in the dipstick works as a breather.
- When the load on the propeller is removed, the engagement of the drive cone and the 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.

1-2 Specifications

Model			KM2P			KM3P		
For engine models			1GM10, 2GM20(F)			3GM30(F)		
Clutch			Constant mesh gear with servo cone clutch (wet type)					
Reduction ratio	Forward		2.21	2.62	3.22	2.36	2.61	3.20
	Reverse		3.06	3.06	3.06	3.16	3.16	3.16
Propeller shaft rpm (Forward)			1540	1298	1055	1441	1303	1063
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		ø100mm (3.93")					
	Pitch circle diameter		ø78mm (3.07")					
	Connecting bolt holes		4—ø10.5mm (4—ø0.41")					
Position of shift lever			Left side, viewed from stern					
Lubricating oil			SAE #10W-30, CC class					
Lubricating oil capacity			0.3ℓ			0.35ℓ		
Dry weight			10.3 kg (22.7 lbs)			11.5 kg (25.4 lbs)		

Models KM2P and KM3P reduction and reverse gear boxes, shafts and gears are the same except for the following items:

- No. of gear teeth
- Distance between bearings for input and output shafts.
- Clutch case, mounting flange.

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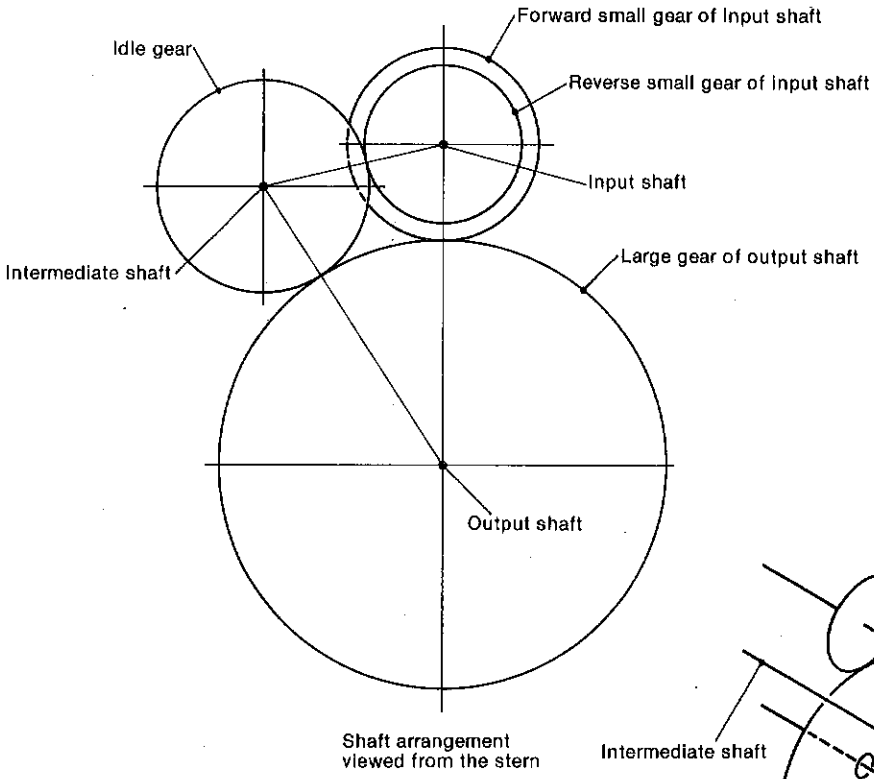
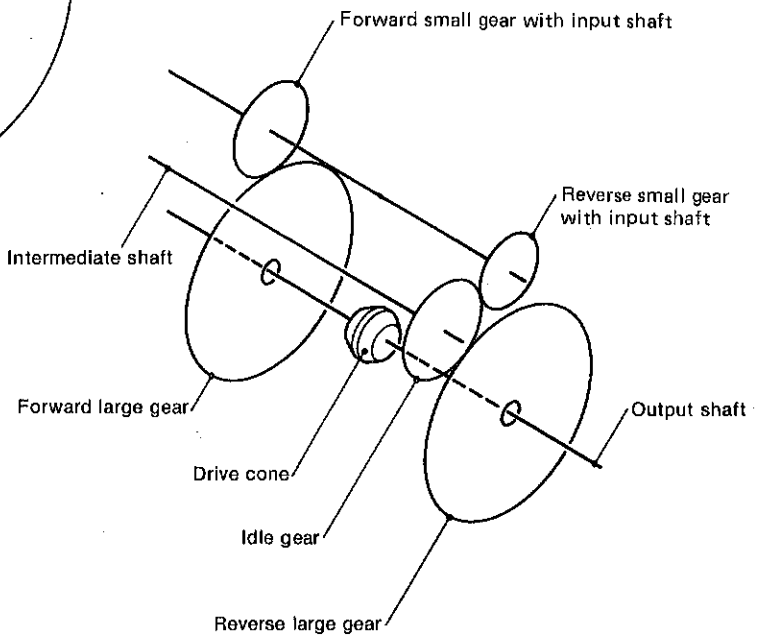
1-3 Power transmission system

1-3.1 Arrangement of shafts and gears





1-3.2 Reduction ratio

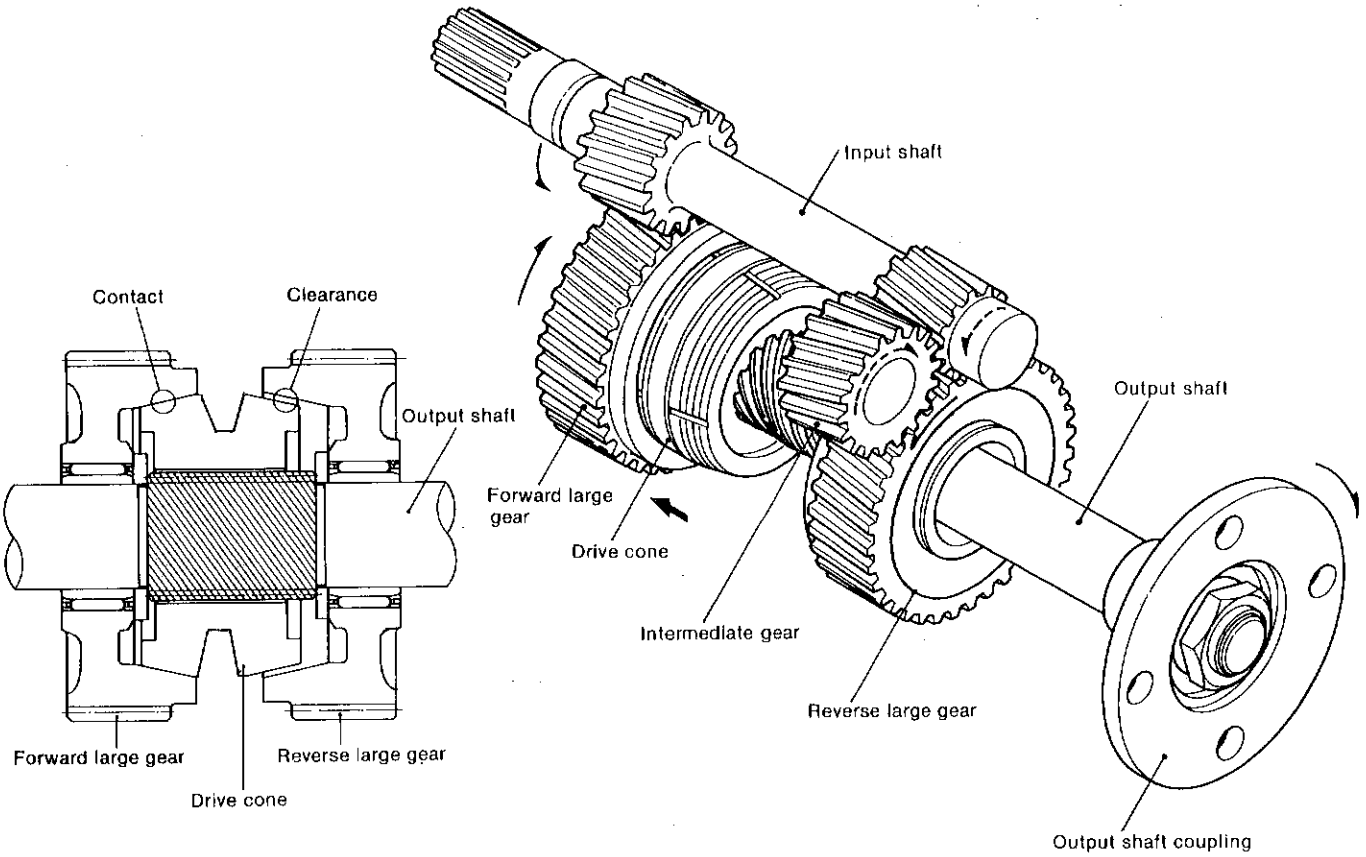
Forward

Model	No. of teeth of forward small gear Zif	No. of teeth of forward large gear Zof	Reduction ratio Zof/Zif
KM2P	24	53	53/24 = 2.21
	21	55	55/21 = 2.62
	18	58	58/18 = 3.22
KM3P	25	59	59/25 = 2.36
	23	60	60/23 = 2.61
	20	64	64/20 = 3.20

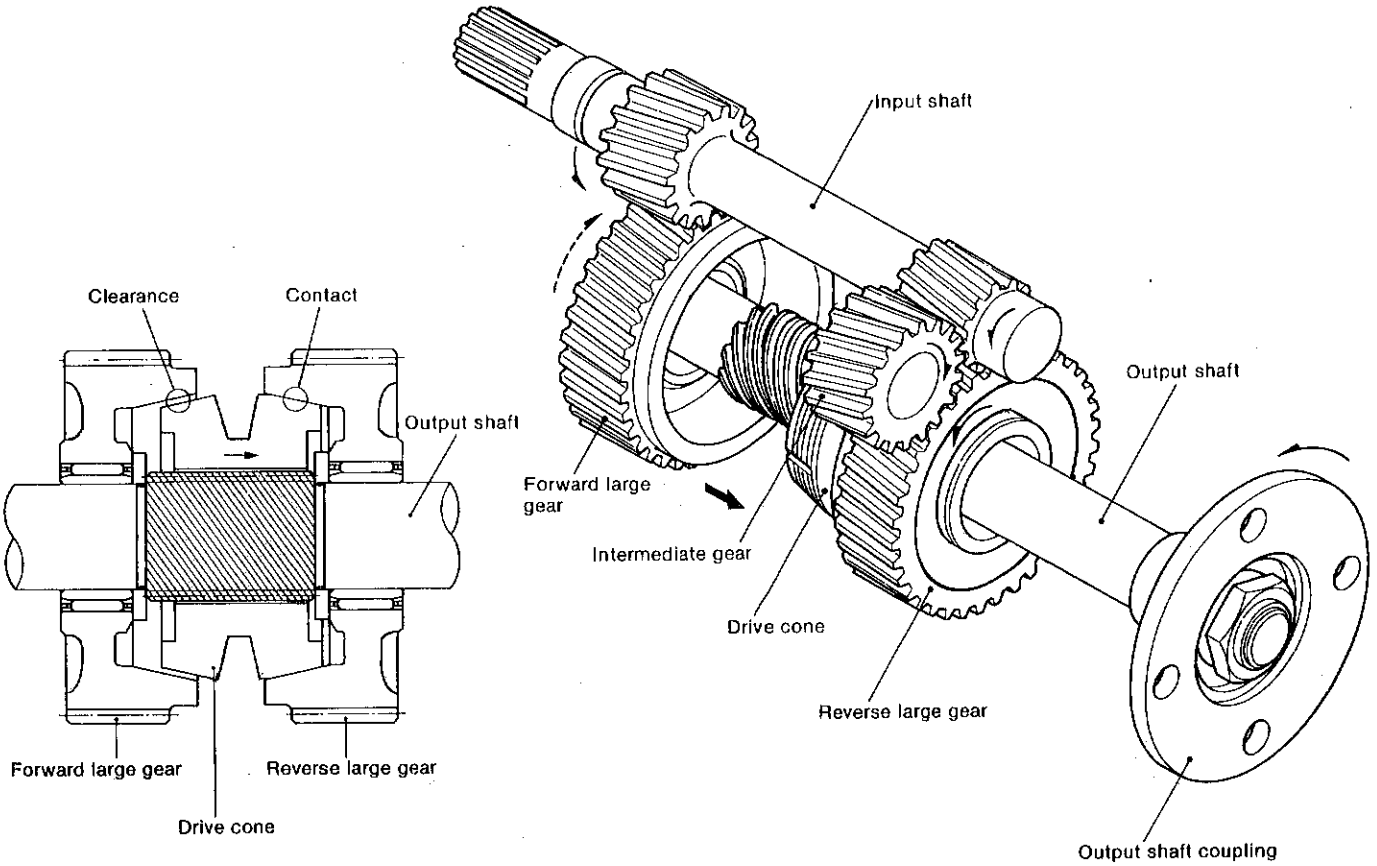
Reverse

Model	No. of teeth of reverse small gear Zir	No. of teeth of intermediate shaft gear Zi	No. of teeth of reverse large gear Zdr	Reduction ratio Zi/Zir·Zdr/Zi
KM2P	18	26	55	55/18 = 3.06
KM3P	19	26	60	60/19 = 3.16

1-3.3 Power transmission routine — Forward



1-3.4 Power transmission routine — Reverse



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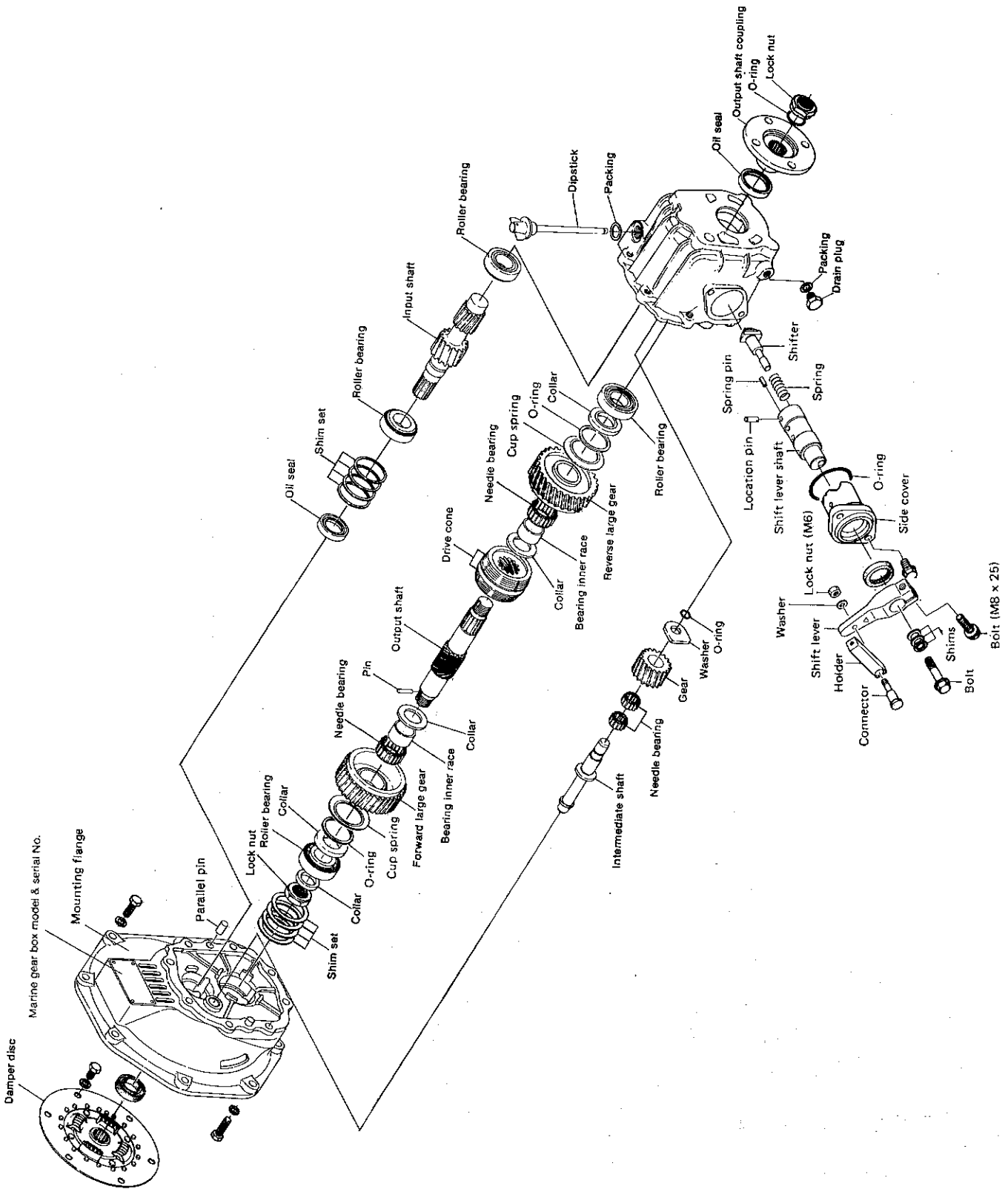
1-4 Drawing



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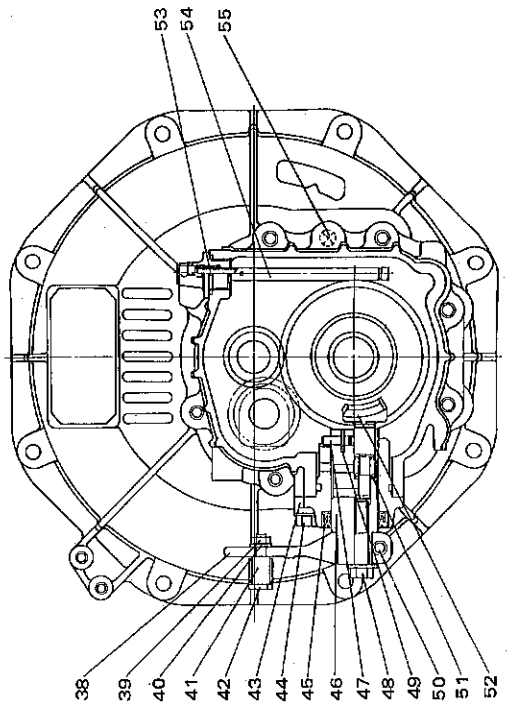
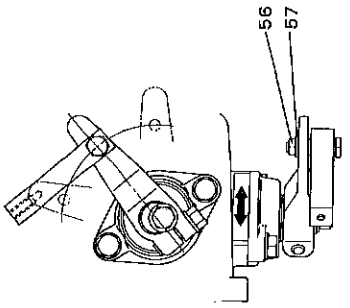
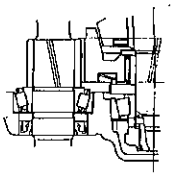
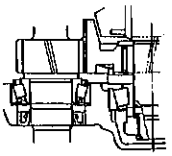
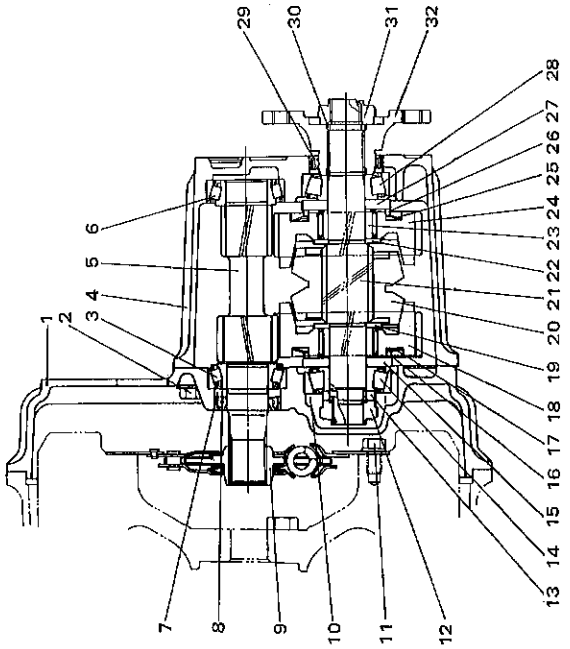
1-5 Sectional view

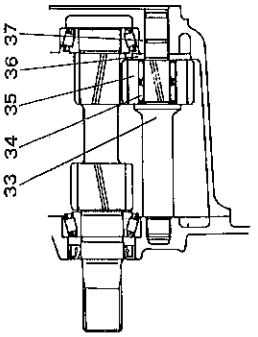












1	Mounting flange	
2	Bolt	M8 x 25
3	Bearing	
4	Clutch case	
5	Input shaft	
6	Bearing	
7	Oil seal	
8	Shim	
9	Dumper disk	
10	Shim	
11	Bolt	M8 x 14
12	Lock nut	
13	Collar	
14	Bearing	
15	Thrust collar A	
16	Spring retainer	
17	Cup spring	
18	Forward gear	
19	Thrust collar B	
20	Drive cone	
21	Output shaft	
22	Thrust collar B	
23	Inner rase	
24	Reverse gear	
25	Cup spring	
26	Spring retainer	
27	Thrust collar A	
28	Bearing	
29	Oil seal	
30	O-ring	
31	Lock nut	
32	Coupling	
33	Idle gear shaft	
34	Bearing	
35	Idle gear	
36	Thrust washer	
37	O-ring	
38	Shift lever	
39	Lock nut	
40	Washer	
41	Holder	
42	Connector	
43	Side cover	
44	Bolt	M8 x 25
45	Oil seal	
46	Shift lever shaft	
47	Location pin	
48	Stopper bolt	
49	Spring pin	
50	Bolt	M8 x 25
51	Spring	
52	Shifter	
53	Washer	
54	Dipstick	
55	Parallel pin	
56	Lock nut	
57	Washer	

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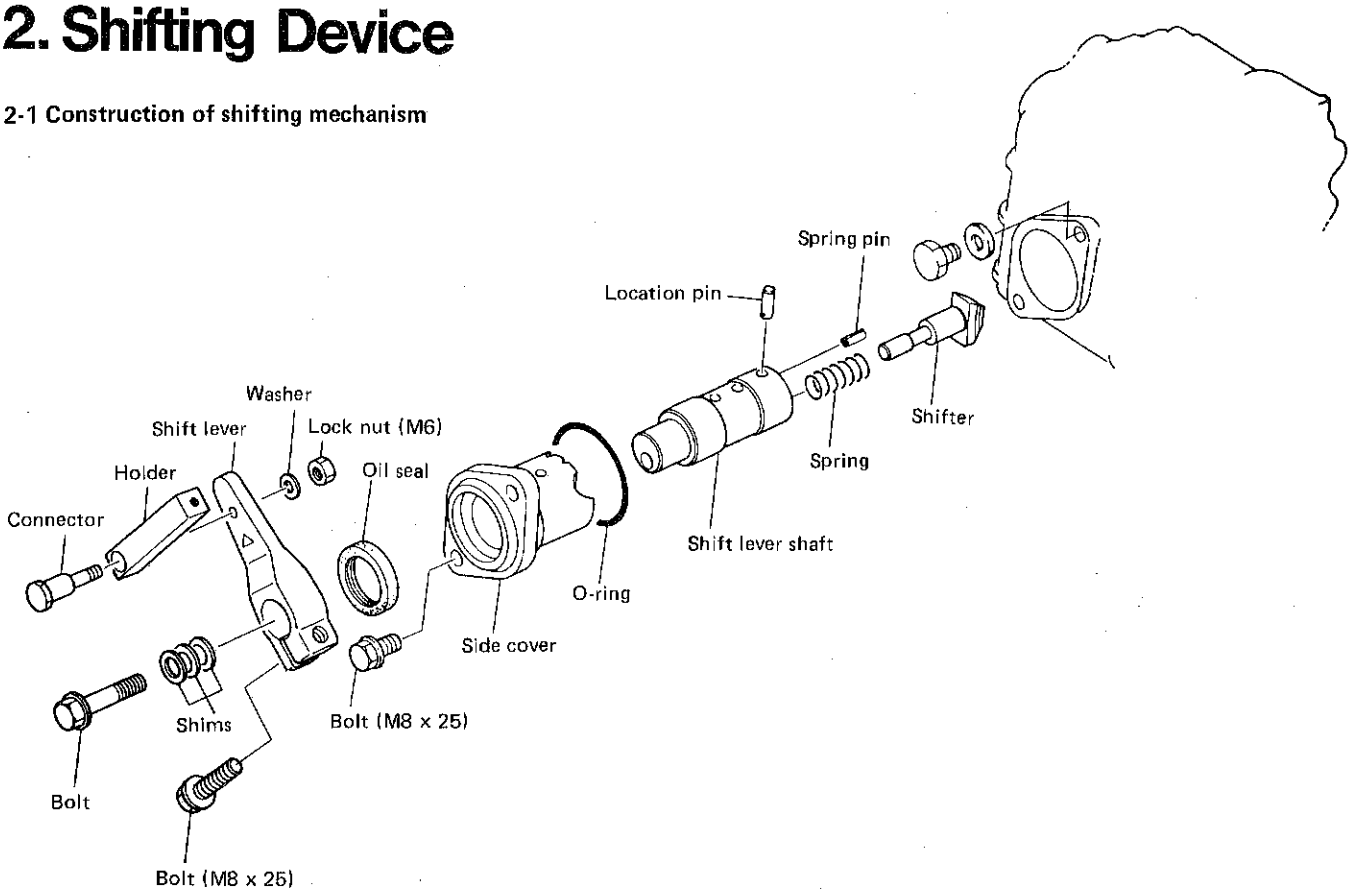
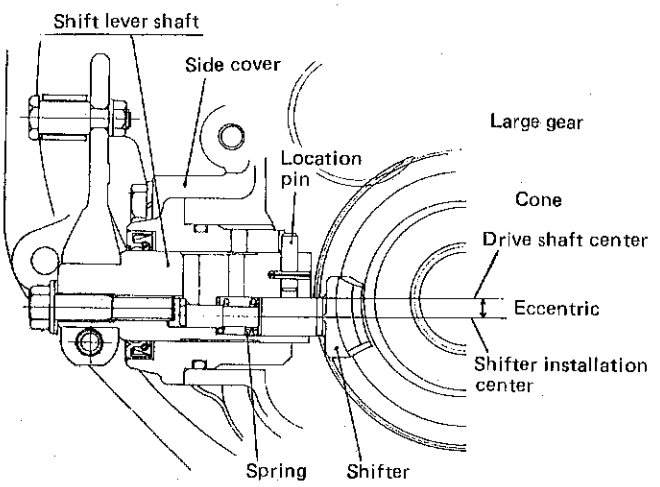
2. Shifting Device

2-1 Construction of shifting mechanism

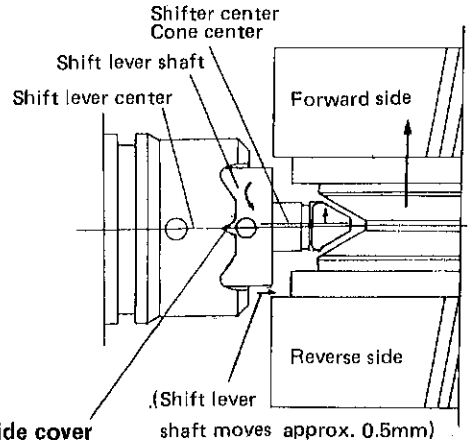


The shift lever shaft is installed on the side cover with neutral, forward and reverse positions provided on this cover. The neutral, forward and reverse location pins of the shift lever shaft are constantly inserted into their respective grooves on the shift lever by the tension of the shifter spring. 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 or reverse positions.)

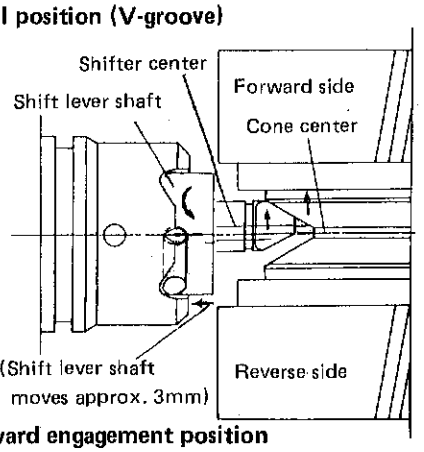


2-2 Forward and reverse clutch operation (Neutral ⇒ Forward; Neutral ⇒ Reverse)

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

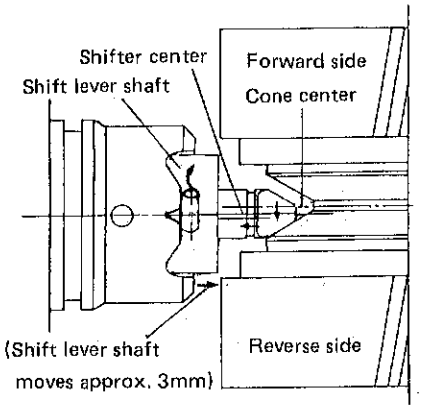


When the location pin of the shift lever shaft falls in the forward position groove of the side cover, (the shift lever shaft moves to the shift lever side approx. 3mm), and the shifter starts to press the drive cone V-groove to the forward large gear side through the spring force.

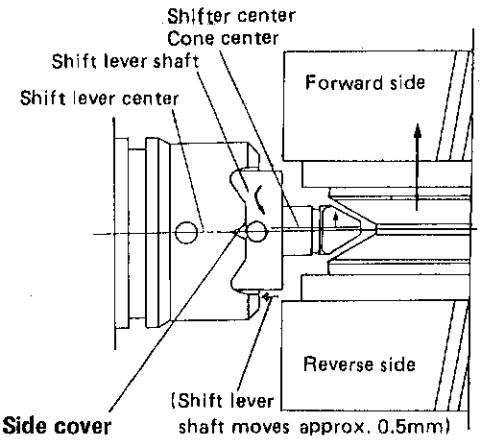


2-3 Engagement and disengagement of clutch (Forward ⇒ Neutral; Reverse ⇒ Neutral)

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.



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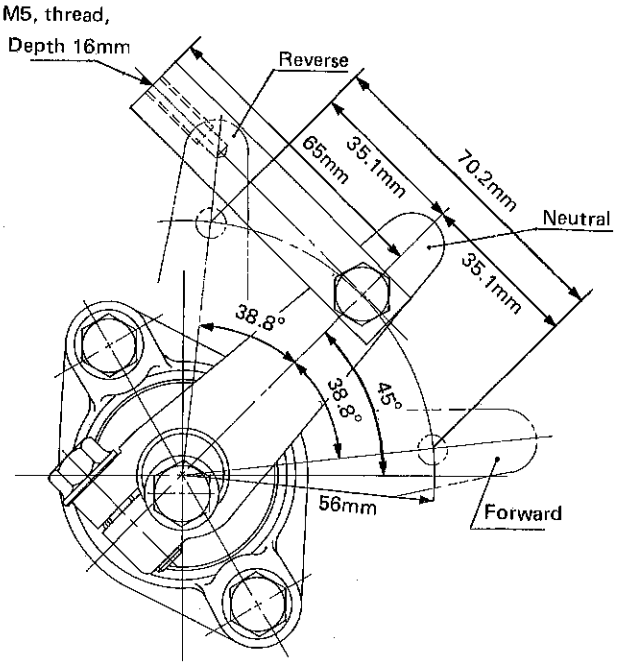
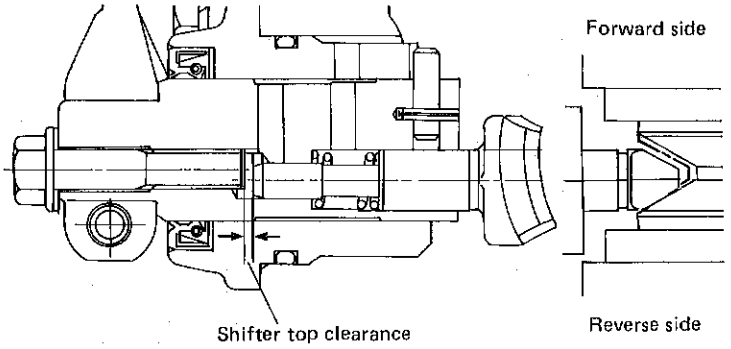
2-4 Clutch shifting force

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



2-5 Adjustment of shifting device

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



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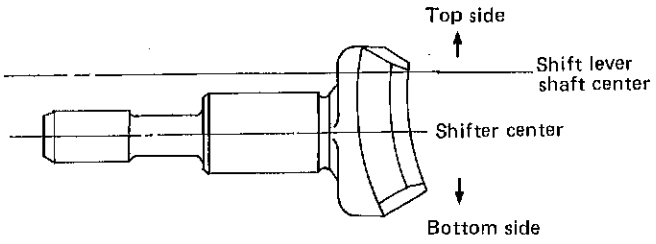
2-5.1 Measurement and adjustment of clearance

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

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



(b)Turn the shift lever 10 ~ 15 degrees 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).

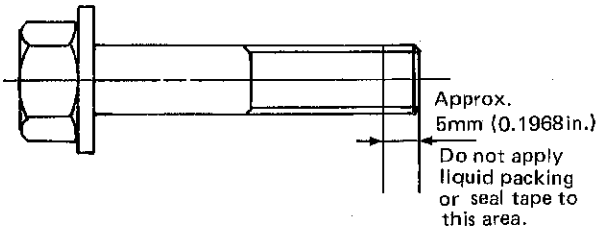
(e)Obtain the shim thickness "T" by the following formula.

$$T = (H - L + 1.25) \pm 0.1\text{mm} \ (0.004\text{in.})$$

NOTE: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 it to the shift lever shaft.

NOTE: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.

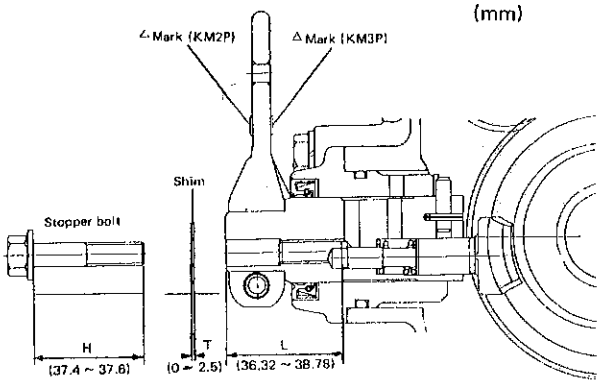


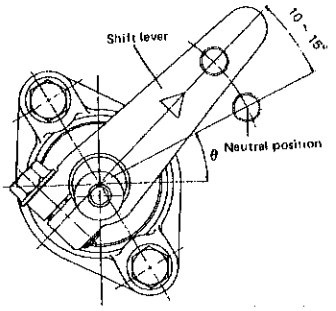
2-5.2 Inspect for the following points
(to be inspected every 2-3 months)

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

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

(mm)





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

θ=	KM2P	KM3P
	40°	45°

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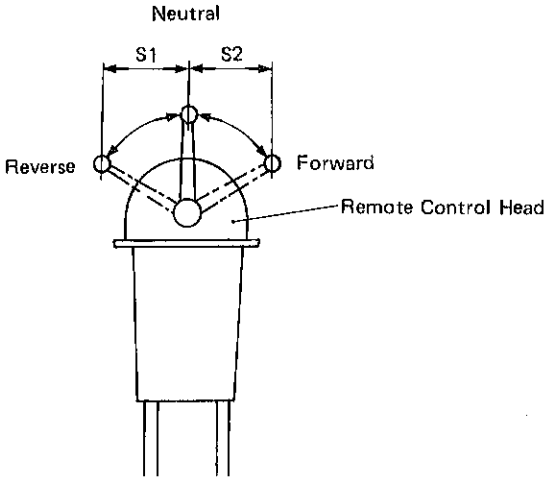
2-6 Adjustment of the remote control head

Marine gearbox control side

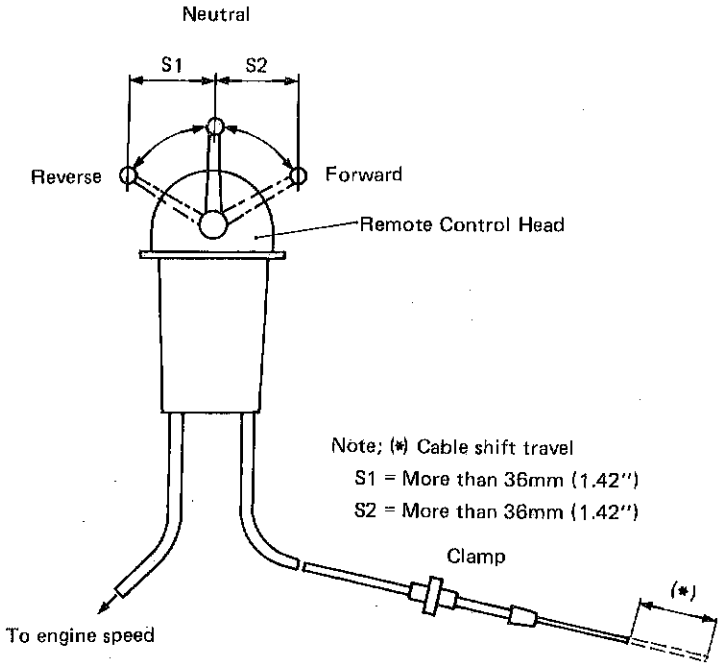
(1)Equal distribution of the control lever stroke.

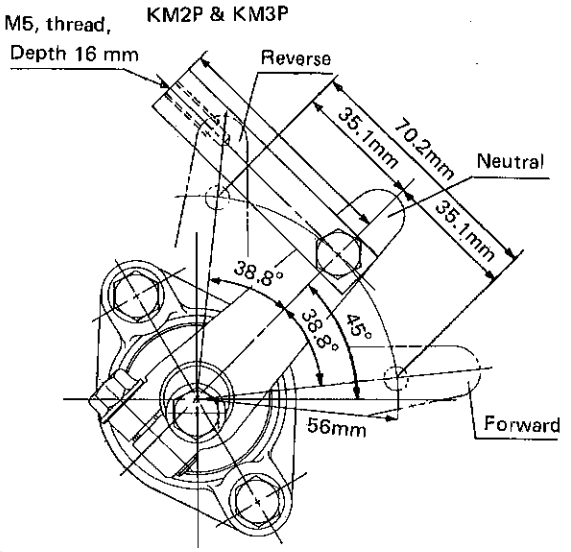


The stroke between the neutral position → forward position (S2), and the neutral position → reverse positon (S1) must be equalized.
When either stroke is too short, clutch engagement becomes faulty.

(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.





2-7 Cautions

(1)Always stop the engine when attaching, adjusting, and inspecting.
(2)When conducting inspection immediately after stopping the engine, do not touch the clutch. The oil temperature is often raised to around 90°C (194°F).
(3)Half-clutch operation is not possible with this design and construction. Do not use with the shift lever halfway to the engaged position.
(4)Set the idling engine speed at between 750 and 800 rpm.

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

3. Inspection and Servicing

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.

3-2 Bearing

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

3-3 Gear

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

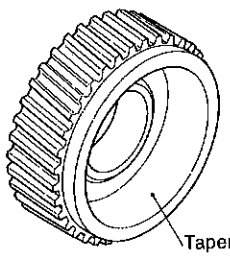
mm (in.)

	Maintenance standard	Wear limit
Input shaft forward gear and output shaft forward gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)
Input shaft reverse gear and intermediate gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)
Intermediate gear and output shaft reverse gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)

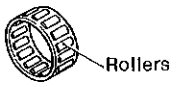
(The same dimensions apply to both KM2P and KM3P)

3-4 Forward and reverse large gears

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

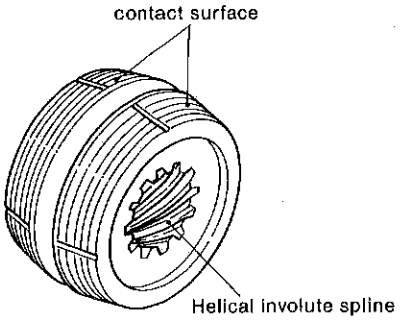


(2) Forward/reverse gear needle bearing.
When an abnormal sound is produced at the needle bearing, visually inspect the rollers; replace the bearing if the rollers are faulty.

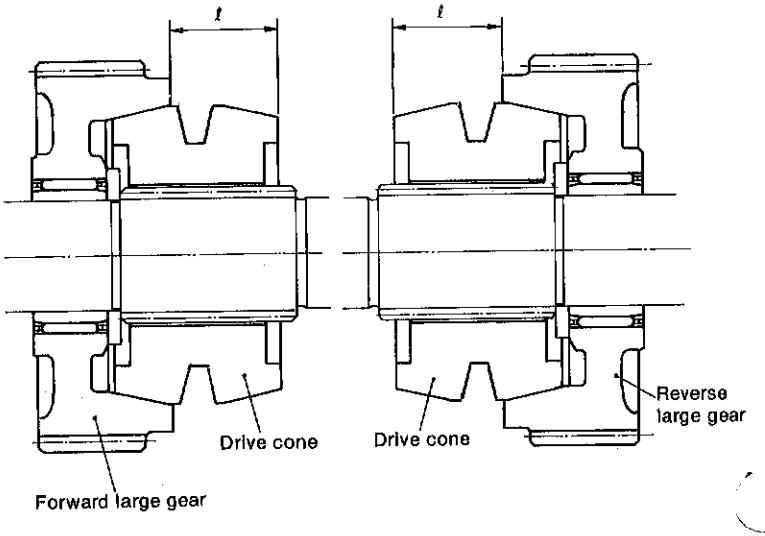


3-5 Drive cone

(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.



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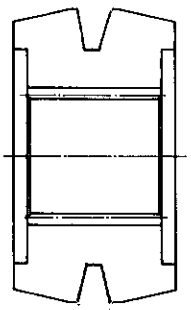
mm (In.)

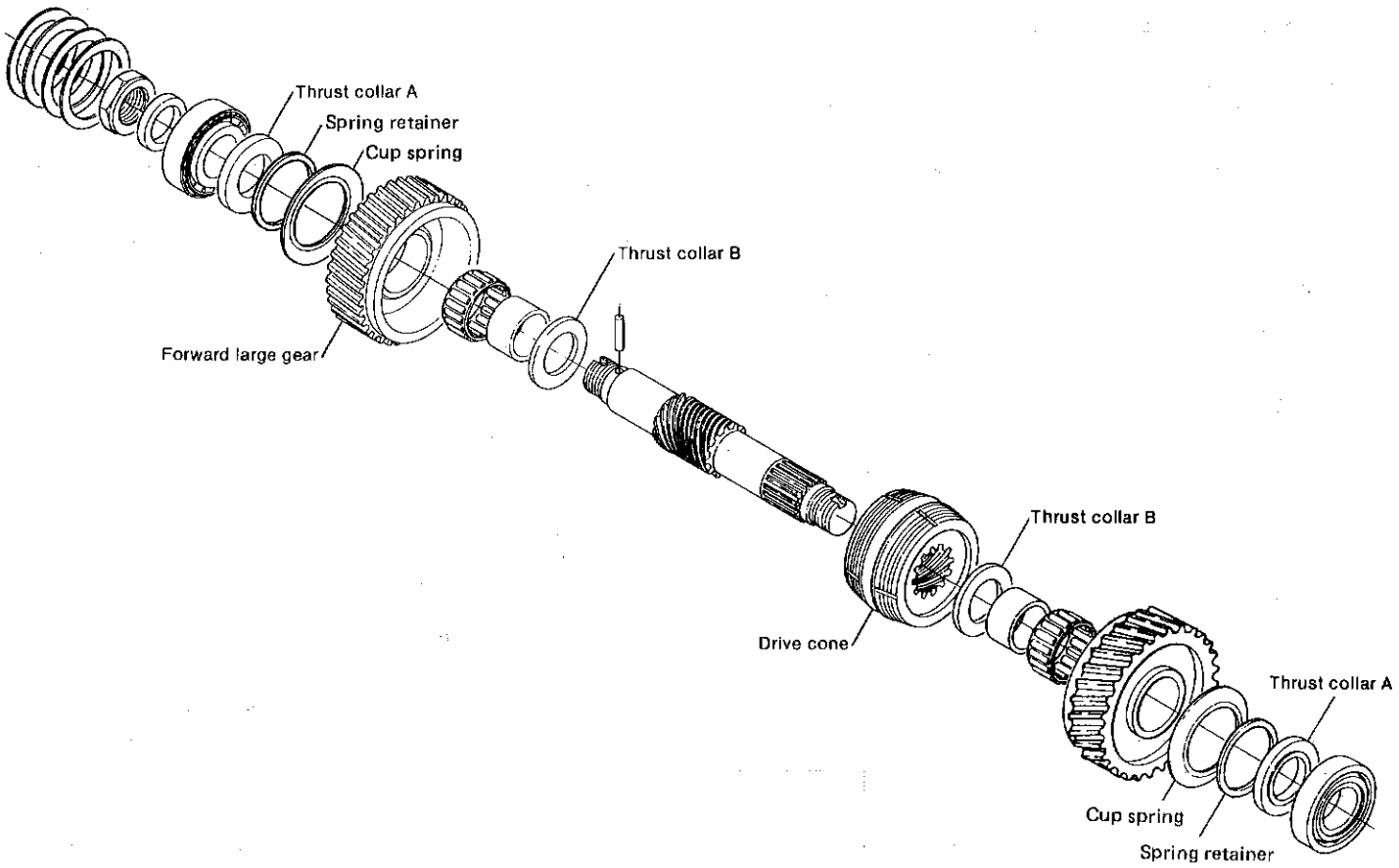
		Standard dimensions	Limited dimensions
Dimensions *ℓ*	KM2P	29.2 ~ 29.8 (1.1496 ~ 1.1732)	28.1 (1.1063)
	KM3P	32.7 ~ 33.3 (1.2874 ~ 1.3110)	32.4 (1.2756)

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

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



3-6 Thrust collar



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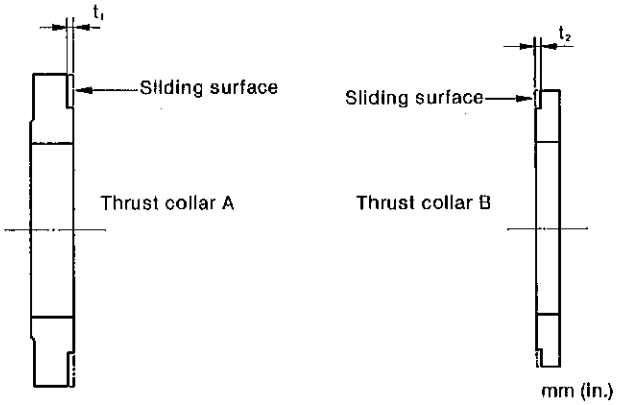
(1) Visually inspect the sliding surface of thrust collar A or B to check for signs of overheating, scoring, or cracks. Replace the collar if any abnormal condition is found.
(2) Measure the thickness of thrust collar A or B, and replace it when the dimension exceeds the specified limit.

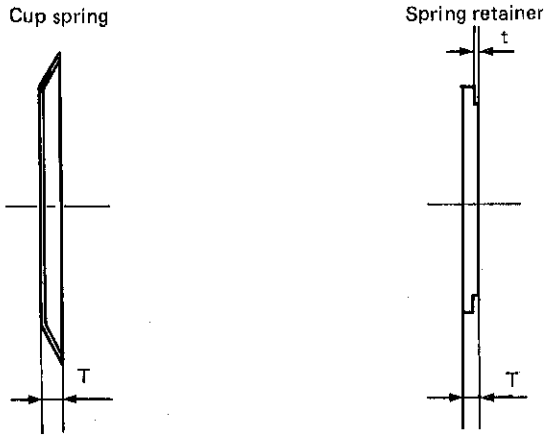


mm (in.)

Stepped wear	Limit for use
Thrust collar A, t_1	0.05 (0.0020)
Thrust collar B, t_2	0.20 (0.0079)

3-7 Cup spring and spring retainer

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



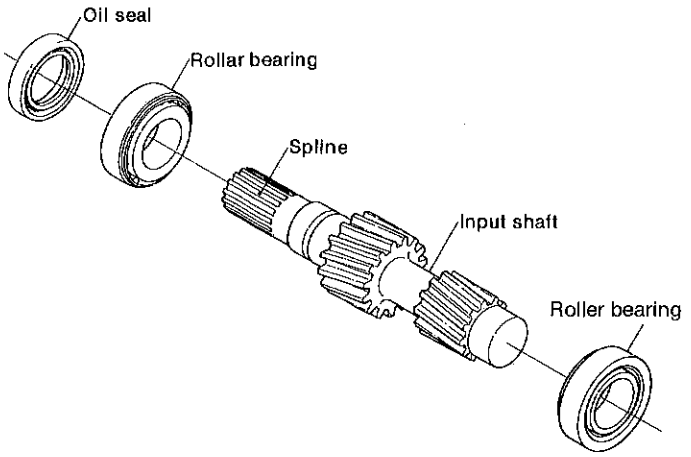
mm (in.)

	Standard	Limit
Cup spring, T	2.8 ~ 3.1 (0.1102 ~ 0.1220)	2.6 (0.1024)
Spring retainer, T	2.92 ~ 3.08 (0.1150 ~ 0.1213)	2.8 (0.1102)
Spring retainer, t	—	0.1 (0.0040)

3-8 Oil seal of output shaft

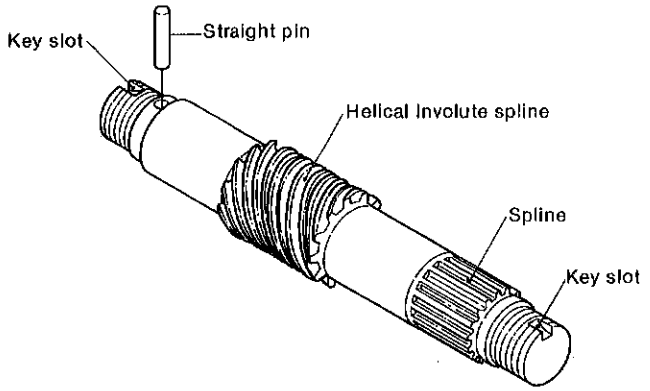
Visually inspect the oil seal of the output shaft to check if there is any damage or oil leakage; replace the seal when any abnormal condition is found.

3-9 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.

3-10 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.

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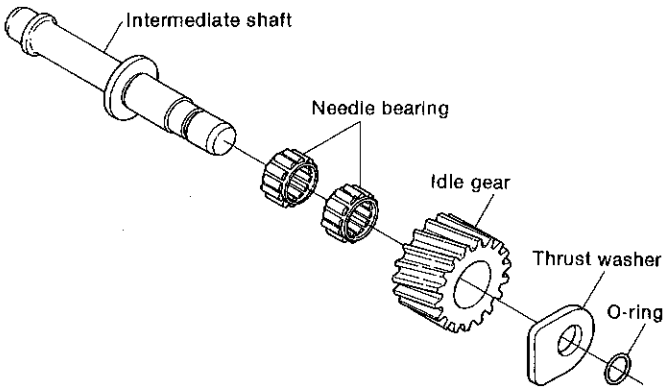
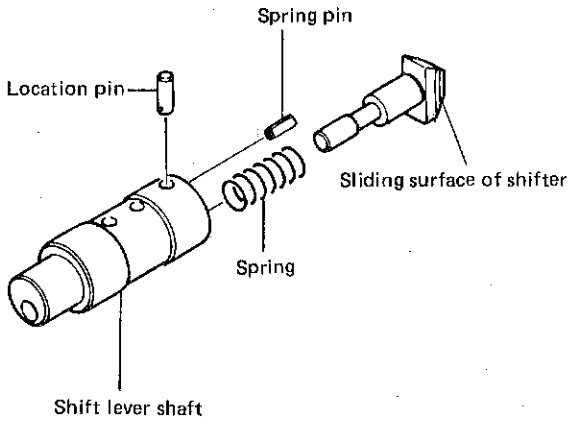
3-11 Intermediate shaft



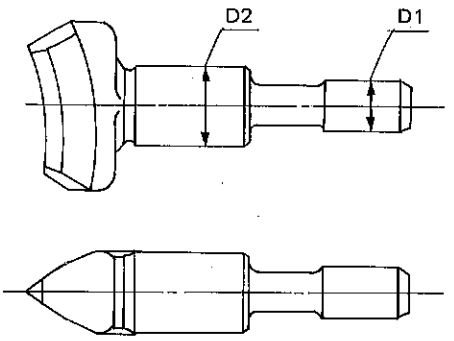
(1) Needle bearing dimensions, staining.
Check the surface of the roller to see whether the needle bearing sticks or is damaged. Replace if necessary.

3-12 Shifting device

3-12.1 Shifter



(1)Visually inspect the surface in contact with the drive cone, and replace the shifter when signs of overheating, damage or wear are found.
(2)Measure the shaft diameter of the shifter. Replace the shaft if the size deviates from the standard.

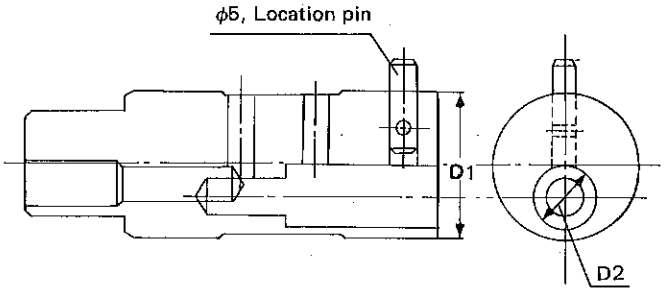


mm (in.)

	Standard	Limit
D1	66.9 ~ 67.0 (2.6338 ~ 2.6378)	65 (2.5591)
D2	11.966 ~ 11.984 (0.4711 ~ 0.4718)	11.95 (0.4705)
Shift lever shaft, Shifter insert hole	12.0 ~ 12.018 (0.4724 ~ 0.4731)	12.05 (0.4744)

3-12.2 Shift lever shaft and location pin

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



mm (in.)

	Standard	Limit
D1	27.959 ~ 27.98 (1.1001 ~ 1.1016)	27.90 (1.0984)
D2	12.0 ~ 12.018 (0.4724 ~ 0.4731)	12.05 (0.4744)
Side cover, Shift insert hole	28.0 ~ 28.021 (1.1024 ~ 1.1032)	28.08 (1.1055)

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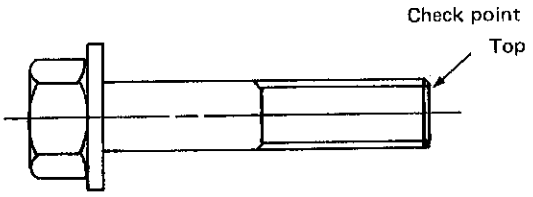
3-12.3 Shifter spring

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

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

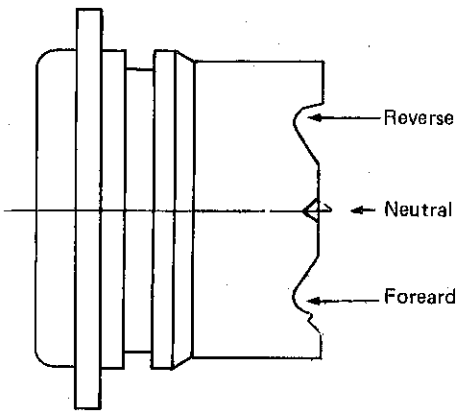
3-12.4 Stopper bolt

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

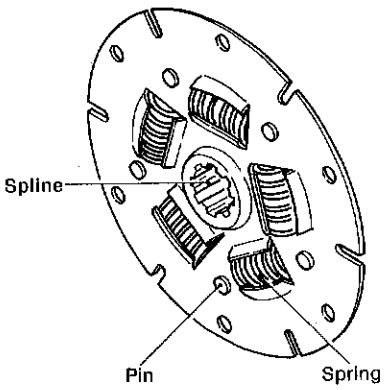


3-12.5 Side cover and oil seal

(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.



3-13 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.

3-14 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 parts: input shaft, bearing.
For output shaft parts: output shaft, thrust collar A, thrust collar B, gear, bearing.

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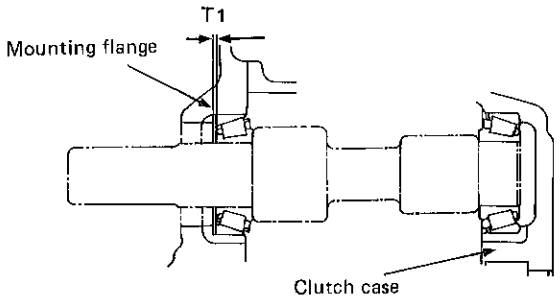
(1)Shim thickness (T1) measurement of input shaft

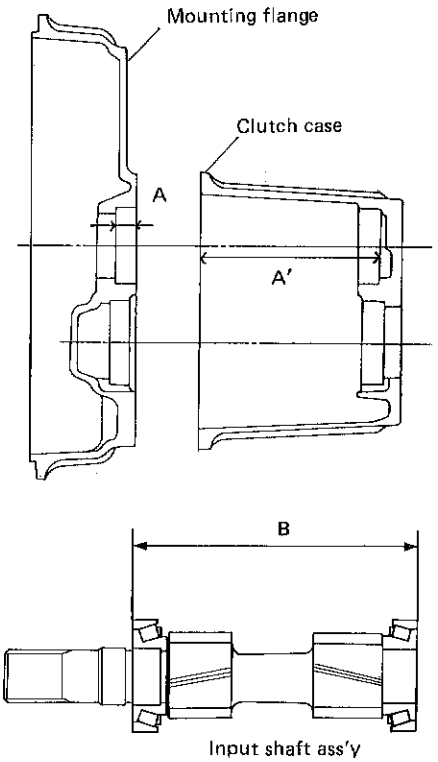
(a)Measure the bearing insertion hole depth (A) of the mounting flange, and the bearing insertion hole depth (A') of the clutch case.

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

(c)Obtain the (T1) thickness by the following formula:

$T_1 = A + A' - B$ (T1: Clearance ± 0.05mm)



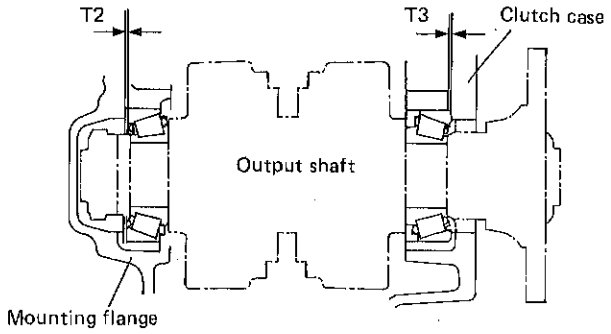


(2)Shim thickness (T2, T3) measurement of output shaft

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

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

NOTE: 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.

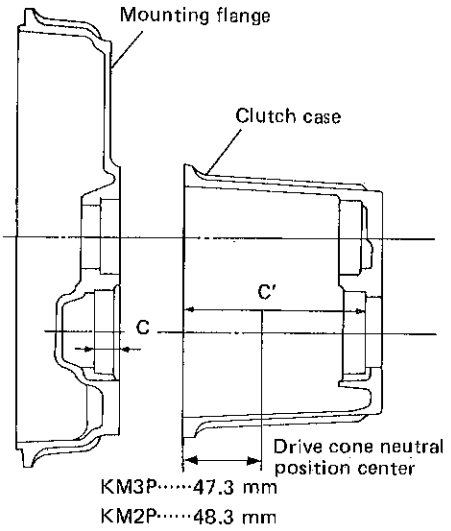
NOTE. Before measuring the (F) and (E) length, press the forward large gear and the reverse large gear to the drive cone until there is no clearance among them.

(d)Obtain the (T2) and (T3) thickness by the following formulas:

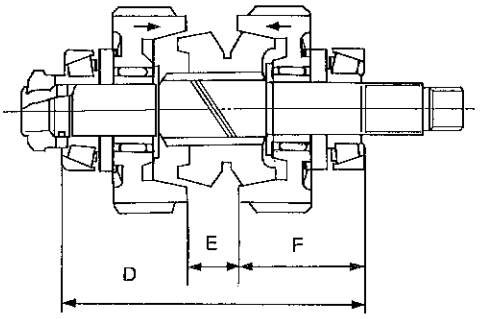
$T_2 = C + C' - D - T_3$ (Clearance $\pm^{0.1mm}_{0}$)

T_3 (KM2P) $= C' - 48.3 - \frac{E}{2} - F$ (Clearance ±0.05mm)

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



Output shaft ass'y



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(3)Standard size of parts

mm (in.)

	A + A'	B	C + C'	D	E	F	Drive corn neutral center position
KM2P	123.40 ~ 123.75 (4.8583 ~ 4.8720)	122.20 ~ 123.10 (4.8110 ~ 4.8465)	129.80 ~ 130.15 (5.1102 ~ 5.1240)	128.07 ~ 129.53 (5.0421 ~ 5.0996)	20.50 ~ 21.10 (0.8071 ~ 0.8307)	53.59 ~ 54.41 (2.1098 ~ 2.1421)	48.3 (1.9016)
KM3P	132.40 ~ 132.75 (5.2126 ~ 5.2264)	131.20 ~ 132.10 (5.1654 ~ 5.2008)	141.20 ~ 141.55 (5.5591 ~ 5.5728)	139.56 ~ 141.00 (5.4945 ~ 5.5512)	23.50 ~ 24.10 (0.9252 ~ 0.9488)	57.83 ~ 58.65 (2.2768 ~ 2.3091)	47.3 (1.8622)

NOTE: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

	Part No.	Thickness.mm(in.)	No. of shims
Input shaft	177088-02350	0.5 (0.0197)	1
		0.4 (0.0157)	1
		0.3 (0.0118)	2
Output shaft	177088-02300	1.0 (0.0394)	1
		0.5 (0.0197)	1
		0.3 (0.0118)	2
		0.1 (0.0039)	3

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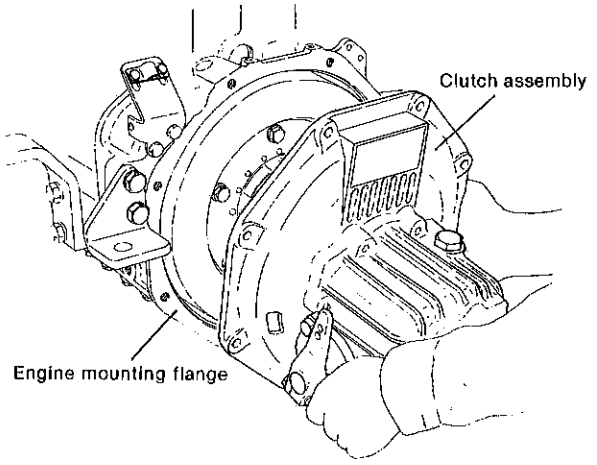
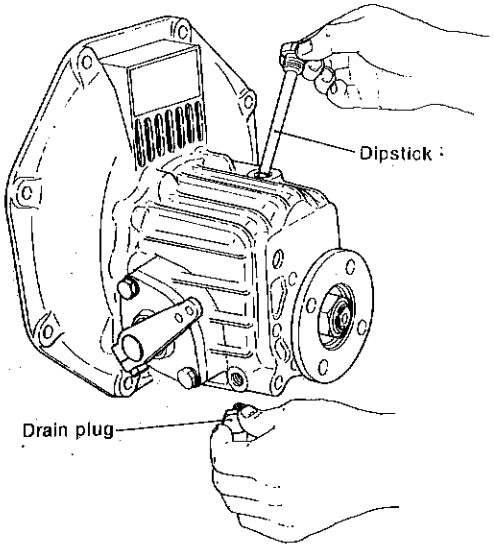
4. Disassembly

4-1 Dismantling the clutch

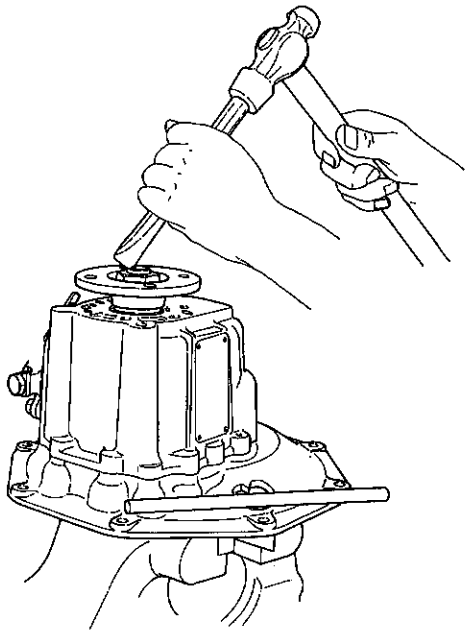
(1) Remove the remote control cable.
(2) Remove the clutch assembly from the engine mounting flange.

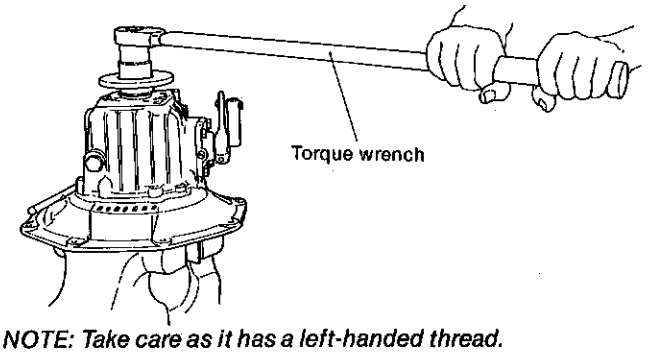


(3) Drain the lubricating oil.
Drain the lubricating oil by loosening the plug at the bottom of the clutch case.



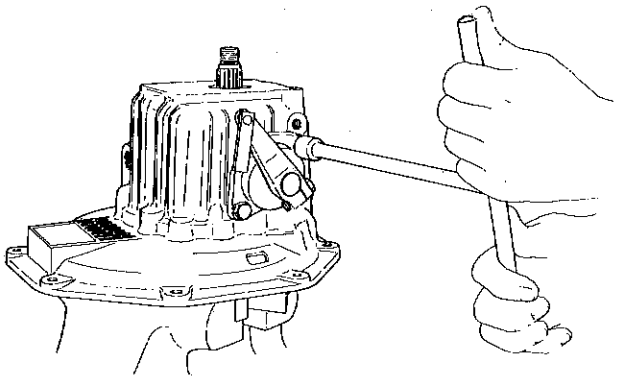
(4) Remove the end nut and output shaft coupling.





NOTE: 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.



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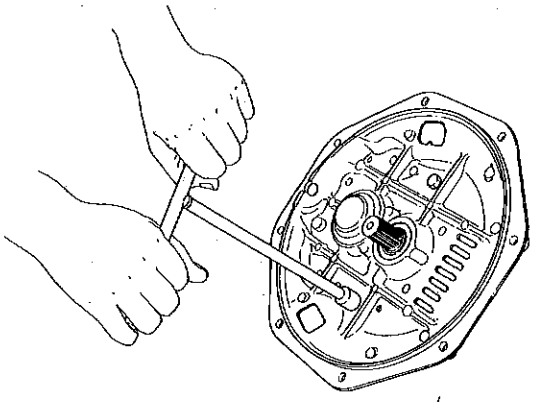
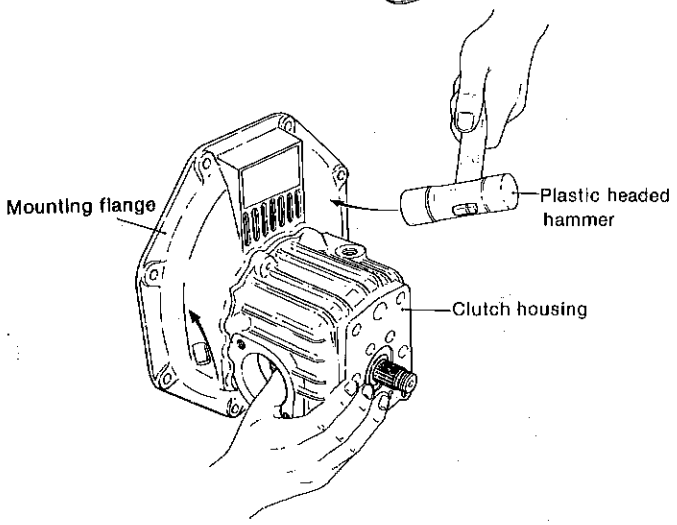
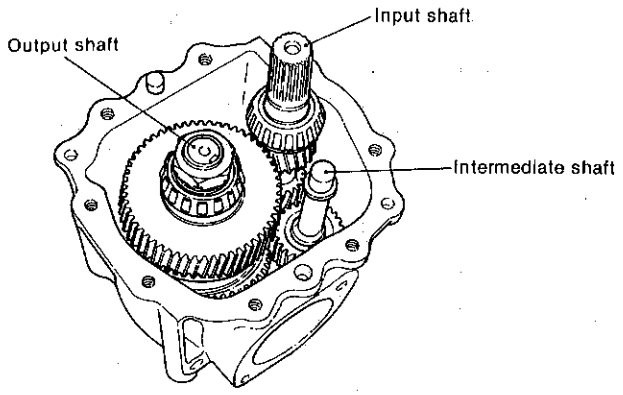
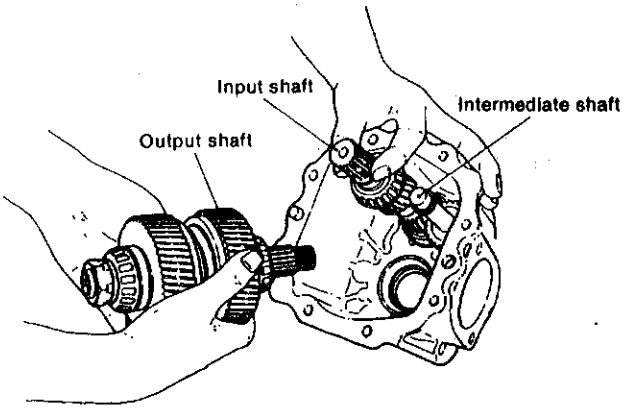
(7) Remove the bolts which secure the mounting flange to the case body, give light taps to the left and right with a plastic headed hammer while supporting the clutch case with your hand, then remove the mounting flange.



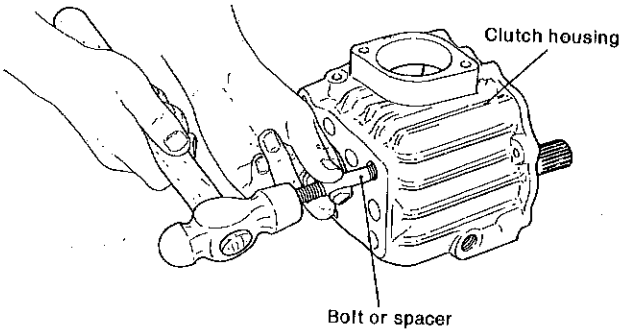


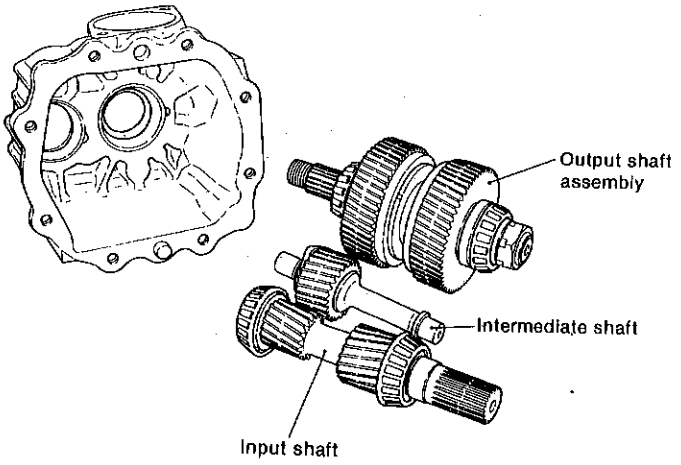
(8) Withdraw the output shaft assembly.





(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.





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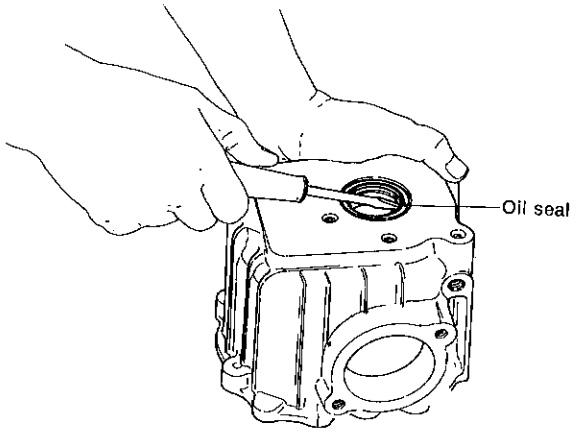
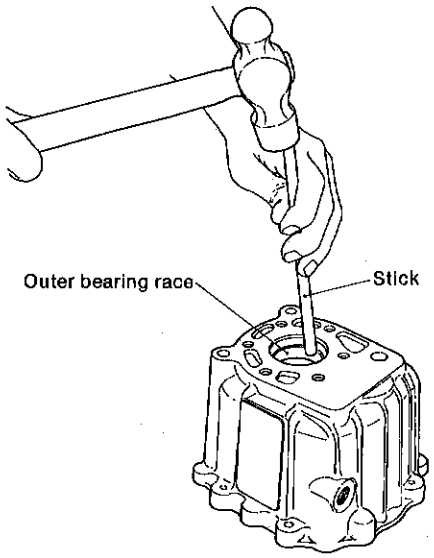
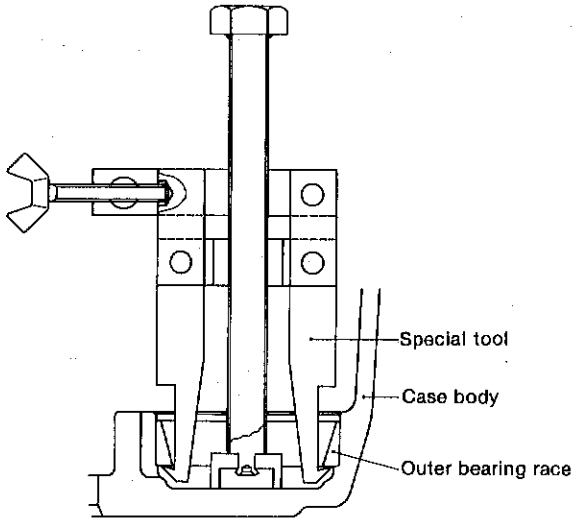
(10) Remove the oil seal of the output shaft from the case body.



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



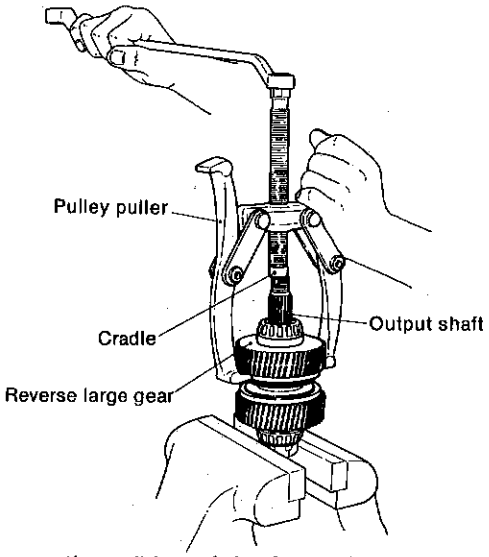


(12) Remove the oil seal of the input shaft from the mounting flange.
(13) Remove the outer bearing race from the mounting flange in the same way as with the case body.
(14) Remove each adjusting plate from the input or output shaft.

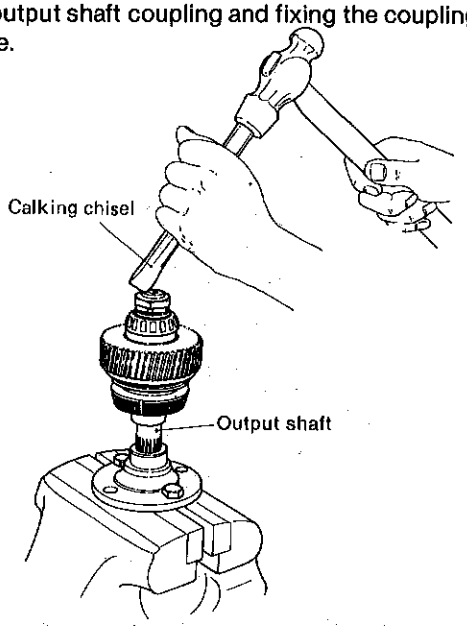
NOTE: The same adjusting plates can be reused when the following parts are not replaced. When any part is replaced however, re-adjustment is necessary.

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.



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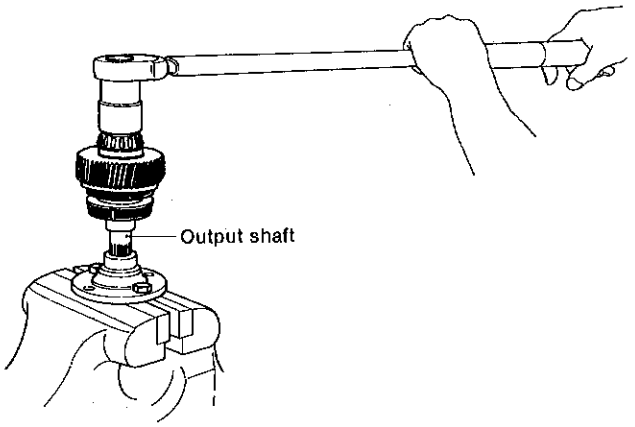
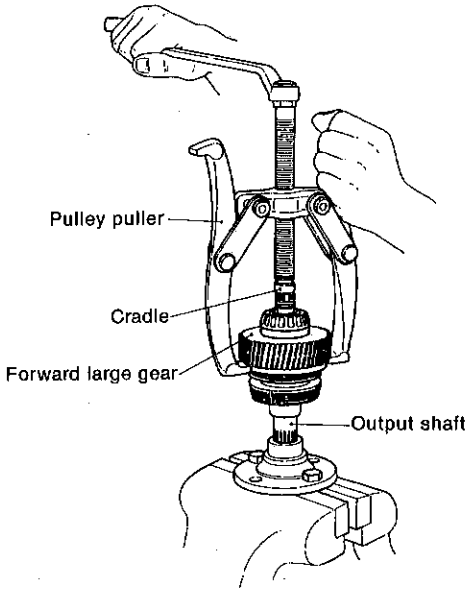
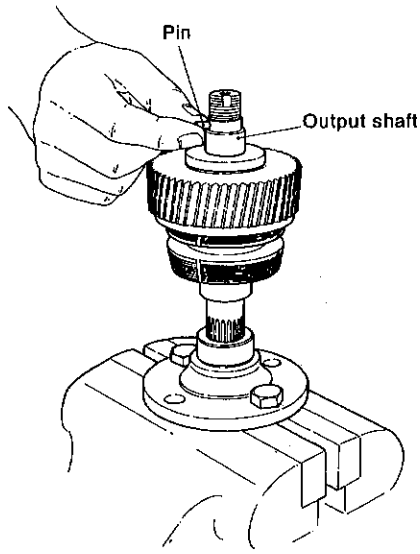


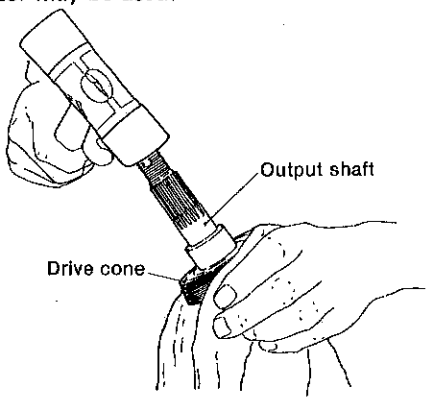
(3)Place the pulley extractor against the end surface of the forward large gear, and withdraw the forward large gear, thrust collar A, cup spring, spring retainer and inner bearing race.

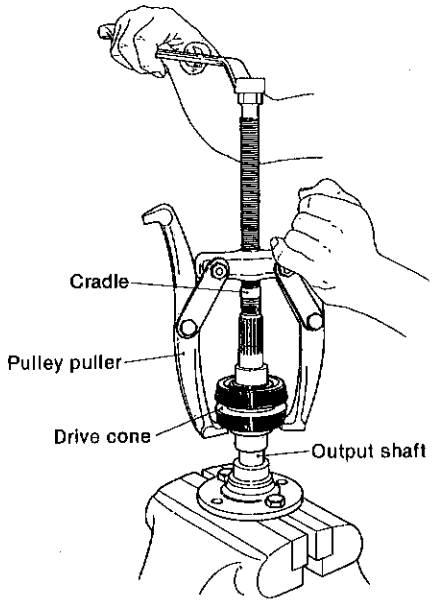




NOTE: Take care as the nut has left-handed thread.

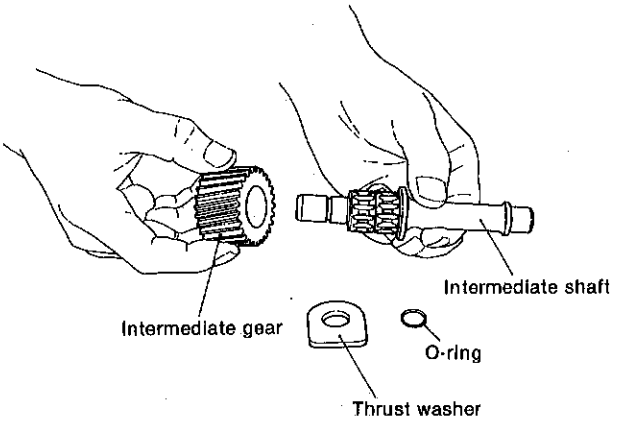
(4)While gripping the drive cone, tap the end of the shaft with a plastic headed hammer, and withdraw the thrust collar B and inner needle bearing race. A pulley extractor may be used.





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.



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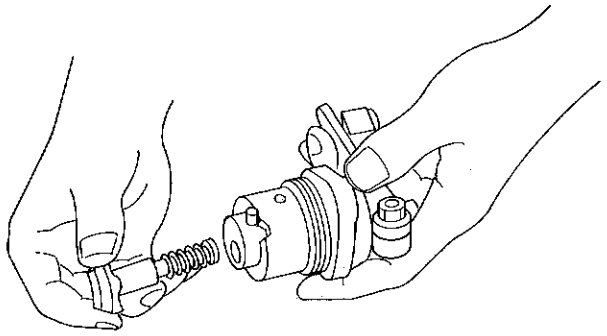
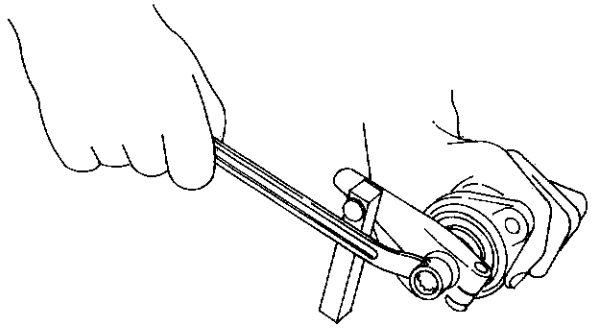
4-4 Dismantling the shifting device

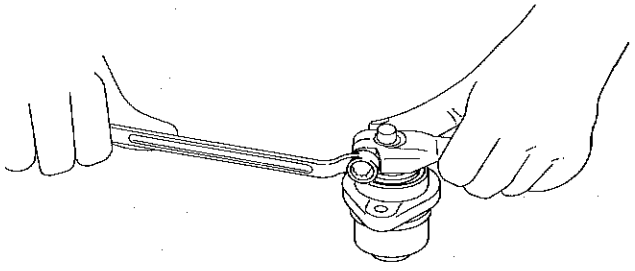
(1) Take out the shifter and shifter spring.



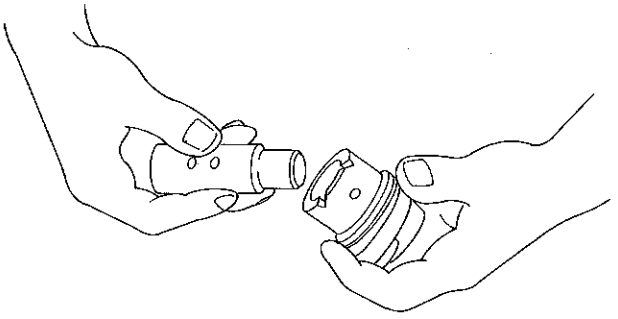
(2) Remove the stopper bolt of the shifter and shim.



(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.

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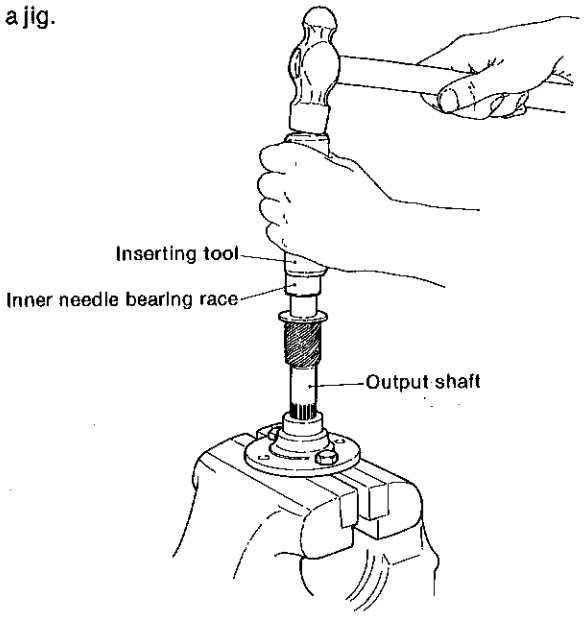
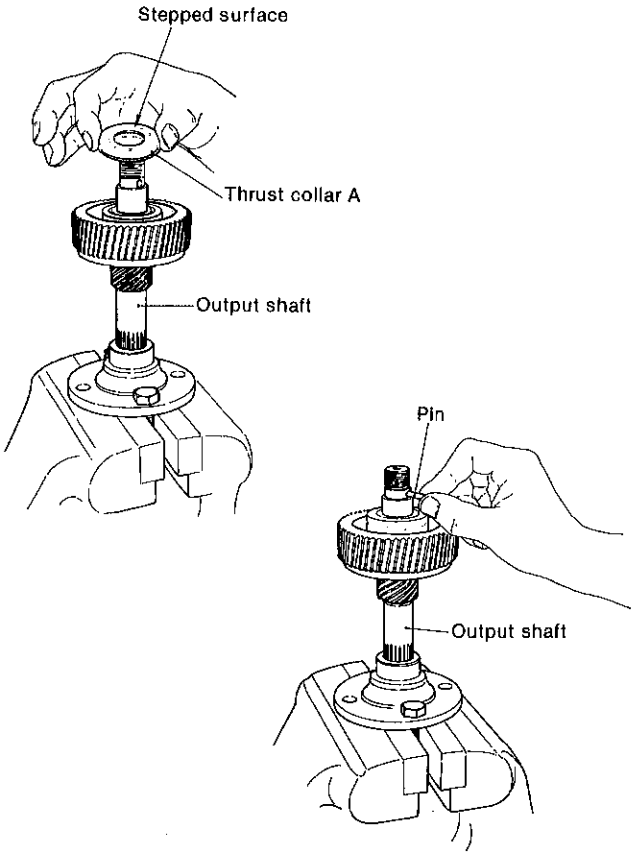
5. Reassembly

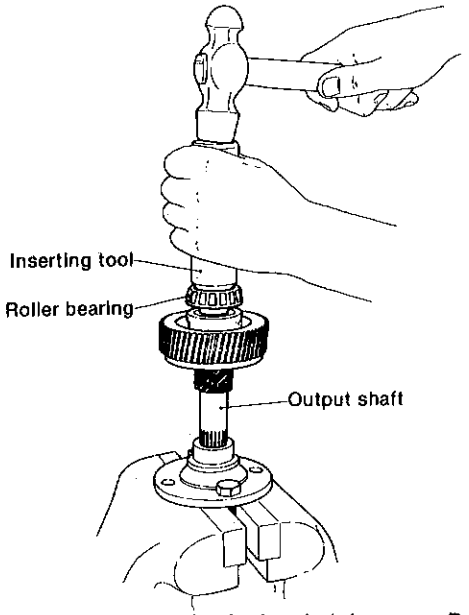
5-1 Reassembly of output shaft

(1) Fit the forward side thrust collar B onto the shaft.
(2) Drive in the forward end inner needle bearing race using a jig.



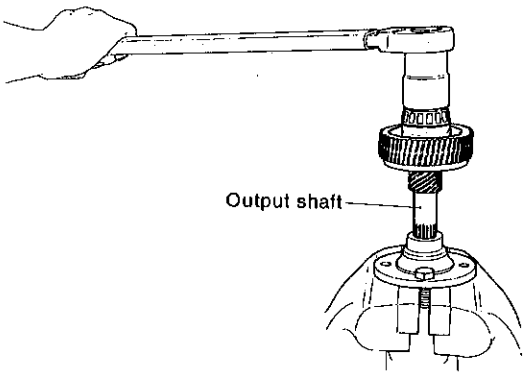
(3) Assemble the needle bearing and forward large gear.
NOTE: Check that the forward large gear rotates smoothly.
(4) Fit the cup spring, spring retainer, thrust collar A and pin, and drive in the inner bearing race using a jig.





NOTE: 1) Drive in with a plastic headed hammer. Do not hit it hard.
2) When fitting the thrust collar A, note the fitting direction. Fit it keeping the stepped surface toward the roller bearing side.
3) Note that the pin cannot be fitted after the inner bearing race has been driven in.
4) 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 ±1.5 kg-m (61.5 ~ 83.2 ft-lb)

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

NOTES: 1) Take care as it is a left-handed thread.
2) 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.

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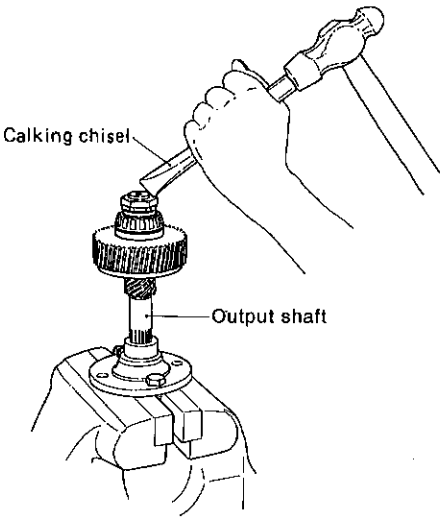
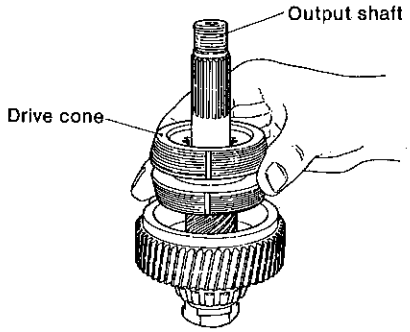
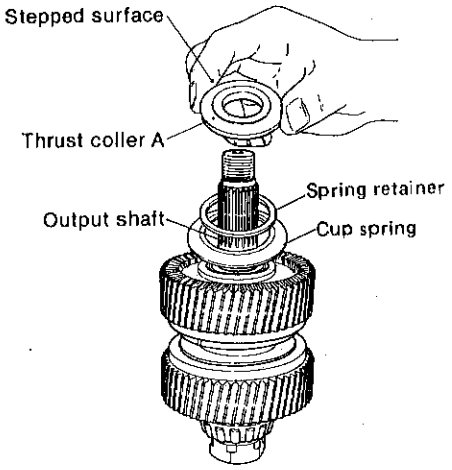


(7) Insert the drive cone while keeping the output shaft set for reverse.



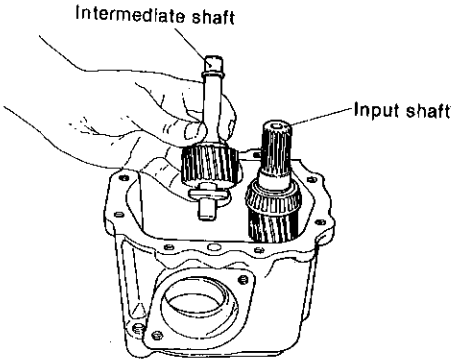
(8) Apply procedures 1 through 4 to the forward end.



NOTE: 1) Fit thrust collar A so that the stepped surface faces the roller bearing side.
2) Check that the reverse large gear rotates smoothly.

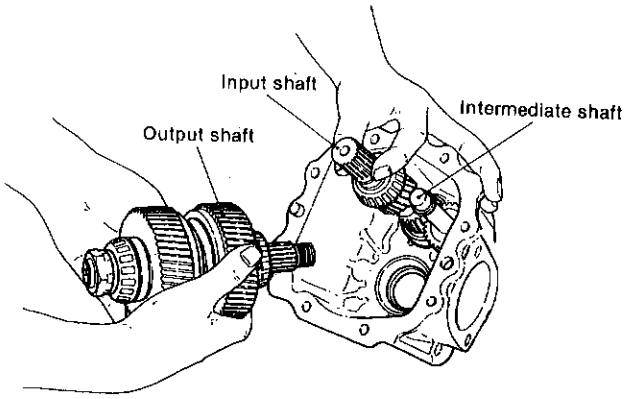
5-2 Reassembly of the clutch

(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.



NOTES: 1) If the output shaft is not fitted into the clutch case before driving-in the intermediate shaft, it cannot be assembled.
2) Note the assembly direction of the thrust washer.

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



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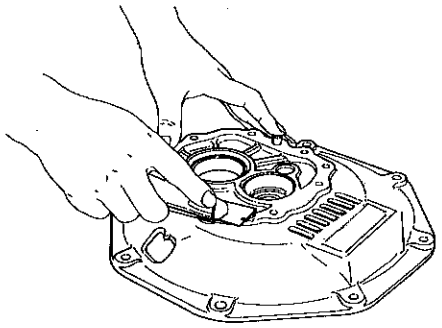
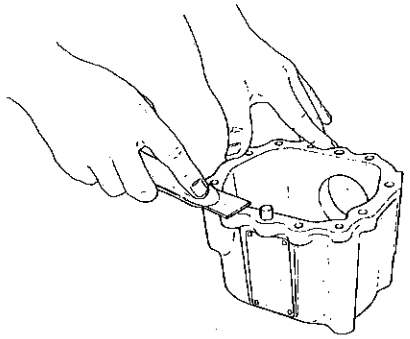
(5) Fit the adjusting plate to the mounting flange, and drive in the outer bearing race.

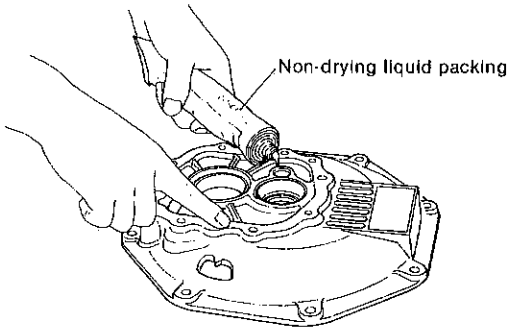
NOTE: The outer bearing race can be easily driven in by heating the mounting flange to about 100°C, or by cooling the outer race with liquid hydrogen.

(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.

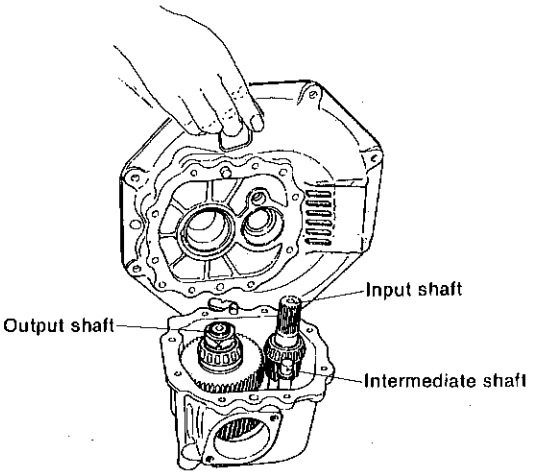
(7) Apply non-drying liquid packing to the matching surfaces of the mounting flange and the case body.







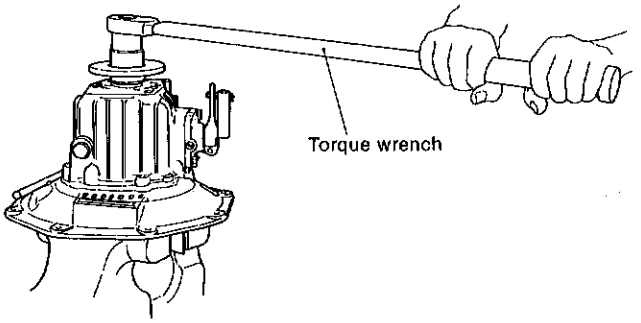
(8) Insert the input shaft and output shaft into the shaft holes of the mounting flange, assemble the mounting flange on the case body, and tighten the bolt.

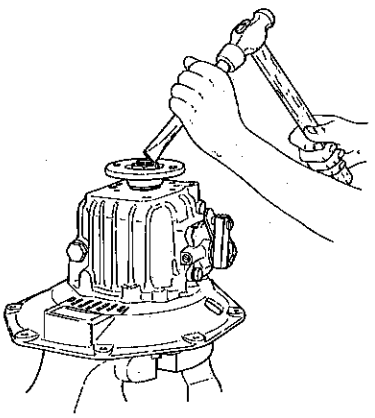


NOTE: Apply non-drying liquid packing to either the mounting flange or the case body.

(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.





NOTE: Take care as it is a left-handed thread.

Tightening torque	10 ±1.5 kg-m (61.5 ~ 83.2 ft-lb)

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

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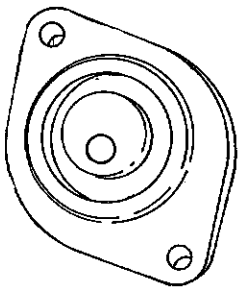
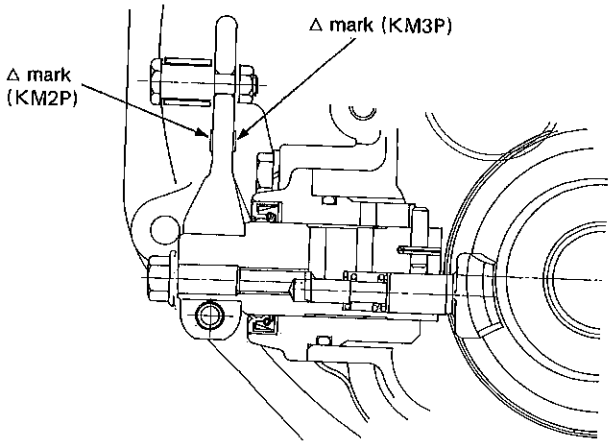
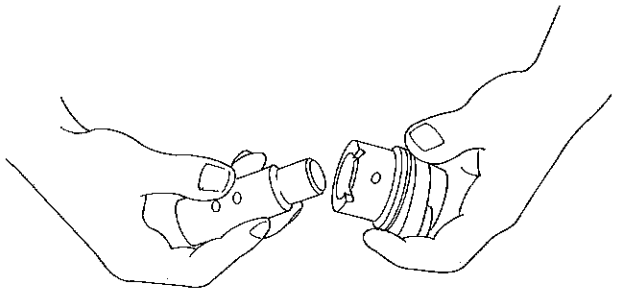
5-3 Reassembly of the shifting device

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



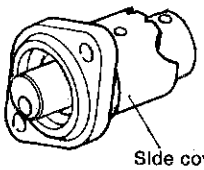


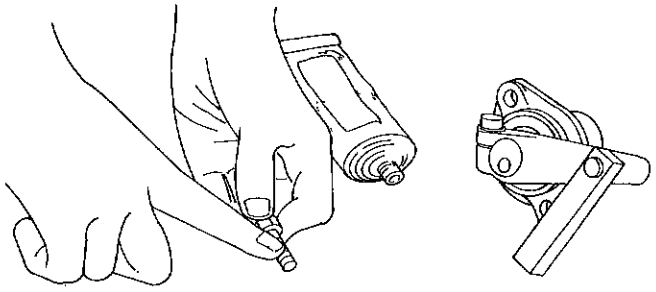
(2) Insert the shift lever shaft to the side cover.



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

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





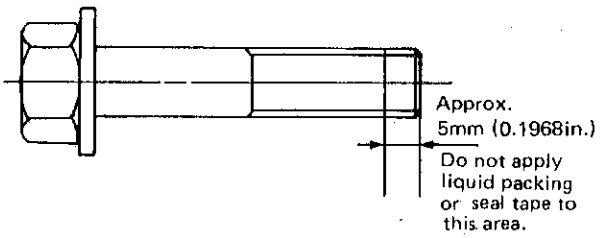
(4) Insert the shifter spring and shifter to the shift lever shaft.

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

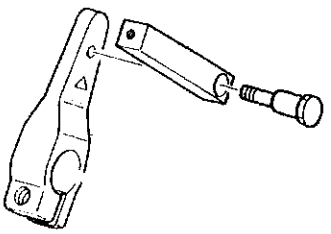
NOTE: 1) Check the direction of the shifter (Top and bottom side).
2) The shift lever may not turn smoothly if the clutch case is not filled with lubricating oil.

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

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



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



[D] V-drive Gear, Model KM3V

Applicable Engine Models: 1GM10V,2GM20(F)V,3GM30(F)V

1.Construction

1-1 Construction

Basically, the construction of the KM3V V-drive Gear is the combination of the KM3P mechanical cone type clutch, and the V-drive case. (However, there is no interchangeability between the KM3P clutch case and the KM3P.) The output shaft coupling of the KM3P is changed to the drive gear, and the power transmission is made through the drive gear connected with the conical gear inside the V-drive case. The conical gear is of mono-block construction with the V-drive output shaft.

The KM3V is equipped with the lube oil cooler which controls the lube oil temperature to a proper level in order to increase the durability of bearings, oil-seals, gears, and other relative parts.
The lube oil cooler is cooled by the cooling water coming from the engine's sea water pump. Cooling water flows as follows: Sea-water pump ⇒ Lube oil cooler ⇒ Engine side 3-way joint (for 1GM 10V), L-type joint (for 2GM20V, 3GM30V), or Heat exchanger (for 2GM20FV, 3GM30FV). In order to prevent cracking by freezing, the oil cooler is equipped with a drain cock which facilitates easy water draining.

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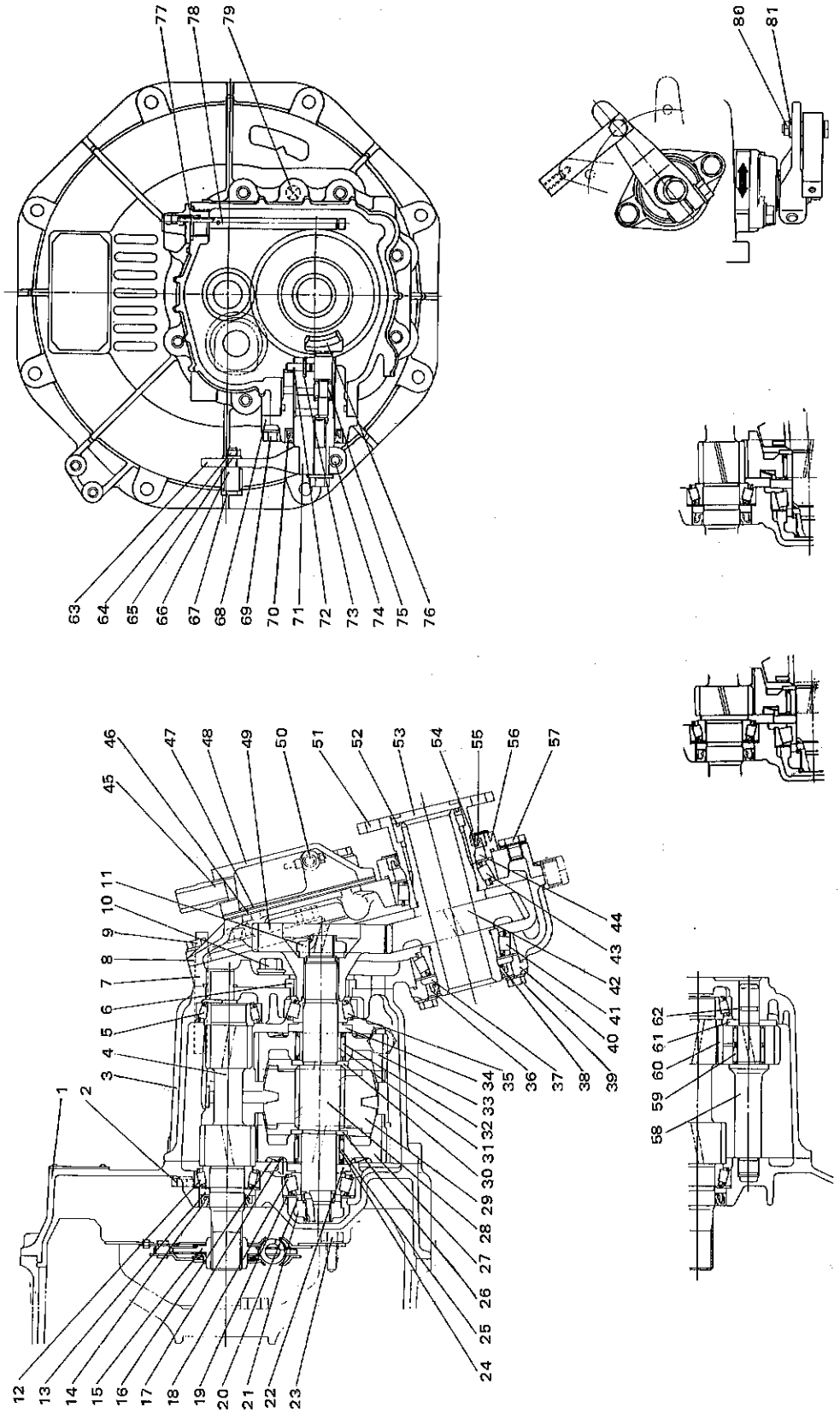
1-1.1 KM3V Sectional View



1 Mounting flange
2 Bolt M8 x 25
3 Clutch case
4 Input shaft
5 Bearing
6 Bush
7 V-drive case A
8 V-drive case B
9 Bolt M8 x 25
10 Bolt M10 x 25
11 Lock nut
12 Bearing
13 Shim
14 Oil seal
15 Dumper disk
16 Cup spring
17 Spring retainer
18 Bearing
19 Shim
20 Collar
21 Lock nut
22 Thrust collar A
23 Bolt M8 x 14
24 Inner rase
25 Bearing
26 Thrust collar B
27 Forward gear
28 Output shaft
29 Drive cone
30 Thrust collar B
31 Inner rase
32 Bearing
33 Reverse gear
34 Thrust collar A
35 Bearing
36 Oil seal
37 Shim
38 O-ring
39 Bolt M8 x 25
40 Cover A
41 Bearing
42 V-drive gear shaft
43 Bearing
44 Shim
45 Joint
46 Cooler plate
47 Gasket
48 Cooler body
49 Drive gear
50 Drain cock
51 Coupling
52 O-ring
53 Lock nut
54 O-ring
55 Oil seal
56 Cover B
57 Drain plug
58 Idle gear shaft
59 Bearing
60 Gear
61 Thrust washer
62 O-ring
63 Shift lever
64 Lock nut
65 Washer
66 Holder
67 Connector
68 Side cover
69 Bolt M8 x 25
70 Oil seal
71 Shift lever shaft
72 Location pin
73 Spring pin
74 Bolt M8 x 25
75 Spring
76 Shifter
77 Gasket 16
78 Dipstick
79 Parallel pin 10 x 6
80 Lock nut
81 Washer

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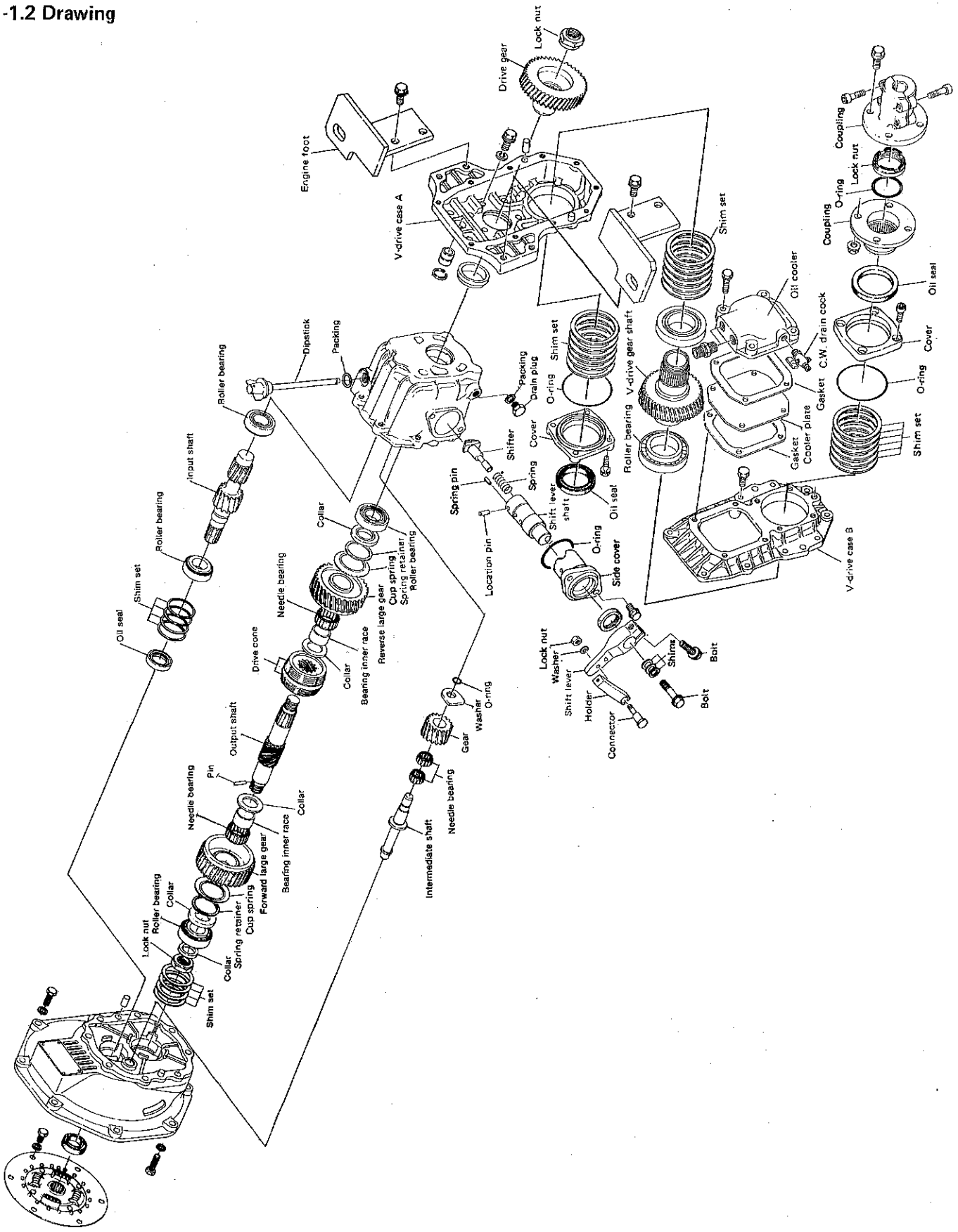
1-1.2 Drawing



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2. Specifications

Model			KM 3V		
For engine models			1GM10V, 2GM20(F)V, 3GM30(F)V		
Clutch			Constant mesh gear with servo cone clutch (wet type)		
Reduction ratio	Forward		2.36	2.61	3.20
	Reverse		3.16	3.16	3.16
Propeller shaft rpm (Forward)	rpm		1441	1303	1063
Direction of rotation	Input shaft		Clockwise, viewed from stern		
	V-drive 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 3 in)		
	Clamp		YANMAR made, standard accessory		
	Cable connector		YANMAR made, standard accessory		
Output shaft coupling	Outer diameter		ø100mm (3.93")		
	Pitch circle diameter		ø78mm (3.07")		
	Connecting bolt holes		4—ø10.5mm (4—ø0.41")		
Position of shift lever			Right side, viewed from stern		
Lubricating oil			SAE #10W-30, CC class		
Lubricating oil capacity			0.8ℓ		
Dry weight			19.5 kg (43 lbs)		

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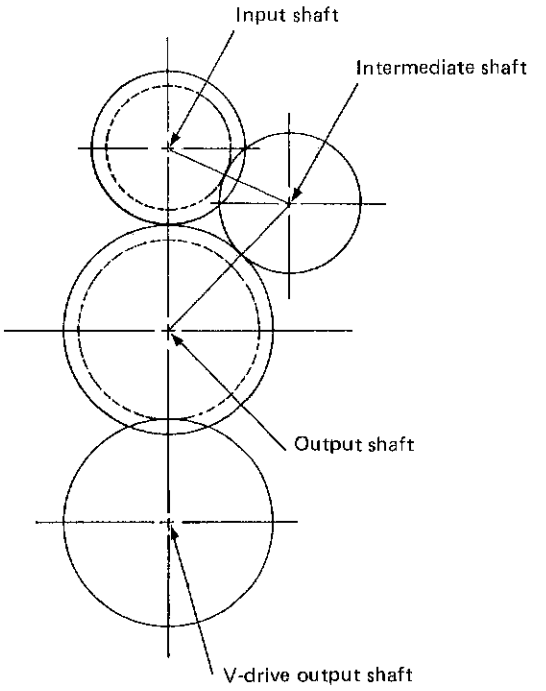
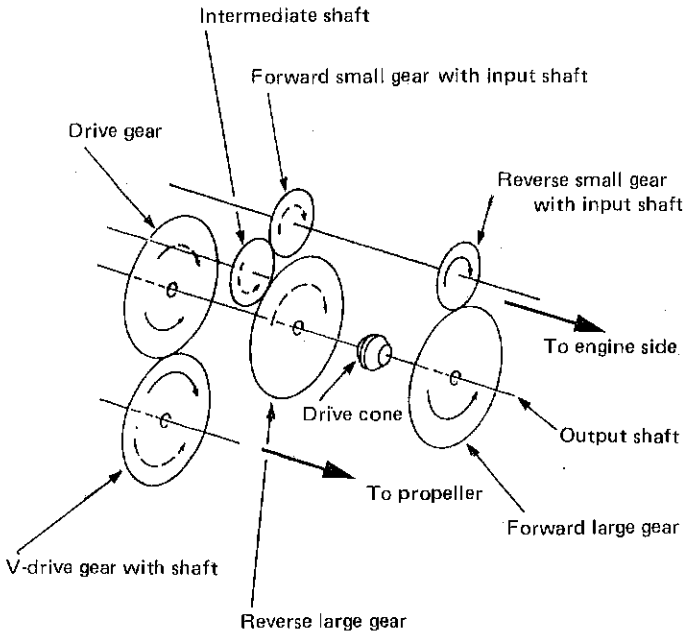
3. Power transmission system

3-1 Arrangement of shaft and gears



[Shaft arrangement viewed from the stern]



3-2 Reduction ratio

	Small gear		Large gear	Drive gear	V-drive gear	Reduction ratio
Forward	25		59	46	46	59/25 = 2.36
	23		60	46	46	60/23 = 2.61
	20		64	46	46	64/20 = 3.20
Reverse	19	26 Intermediate gear	60	46	46	60/19 = 3.16

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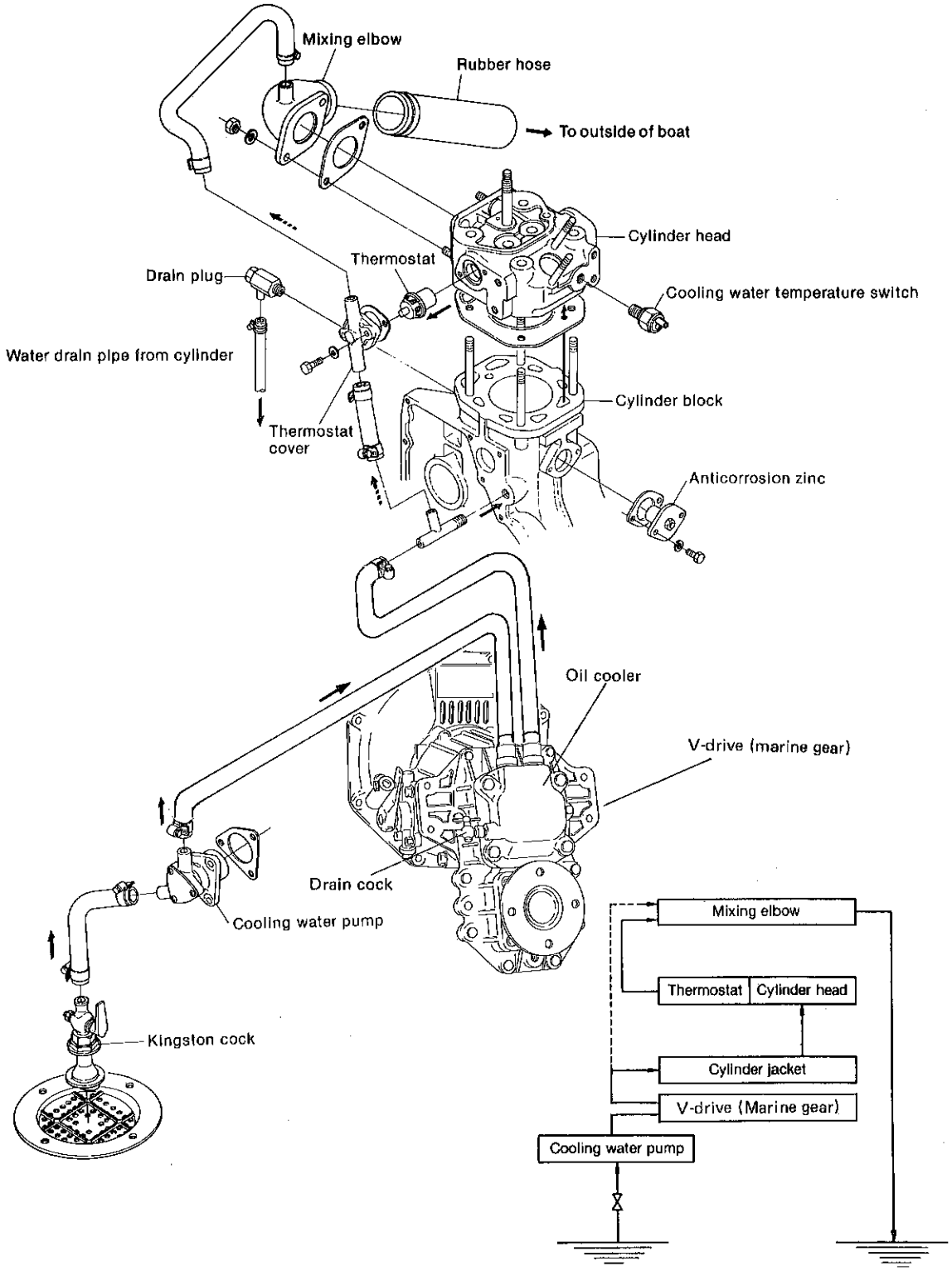
4.Cooling system(Sea-water Cooling Engine)

4-1 Cooling water passage of engine model 1GM10V



⟵ When the cooling water is at the correct temperature
⟵ ··· When the cooling water temperature is lower than the correct temperature

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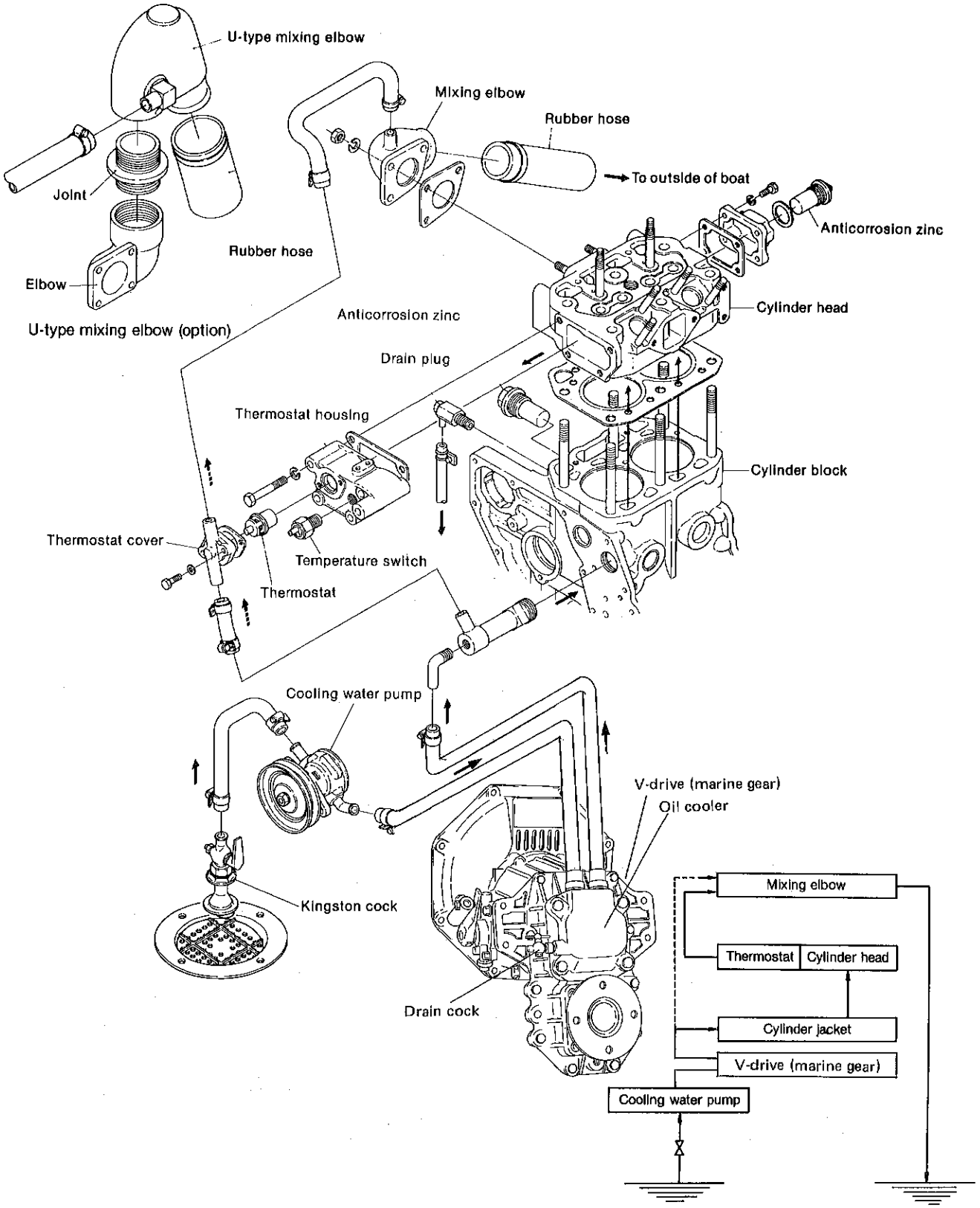
4-2 Cooling water passage of engine model 2GM20V and 3GM30V



← When the cooling water is at the correct temperature
←··· When the cooling water temperature is lower than the correct temperature

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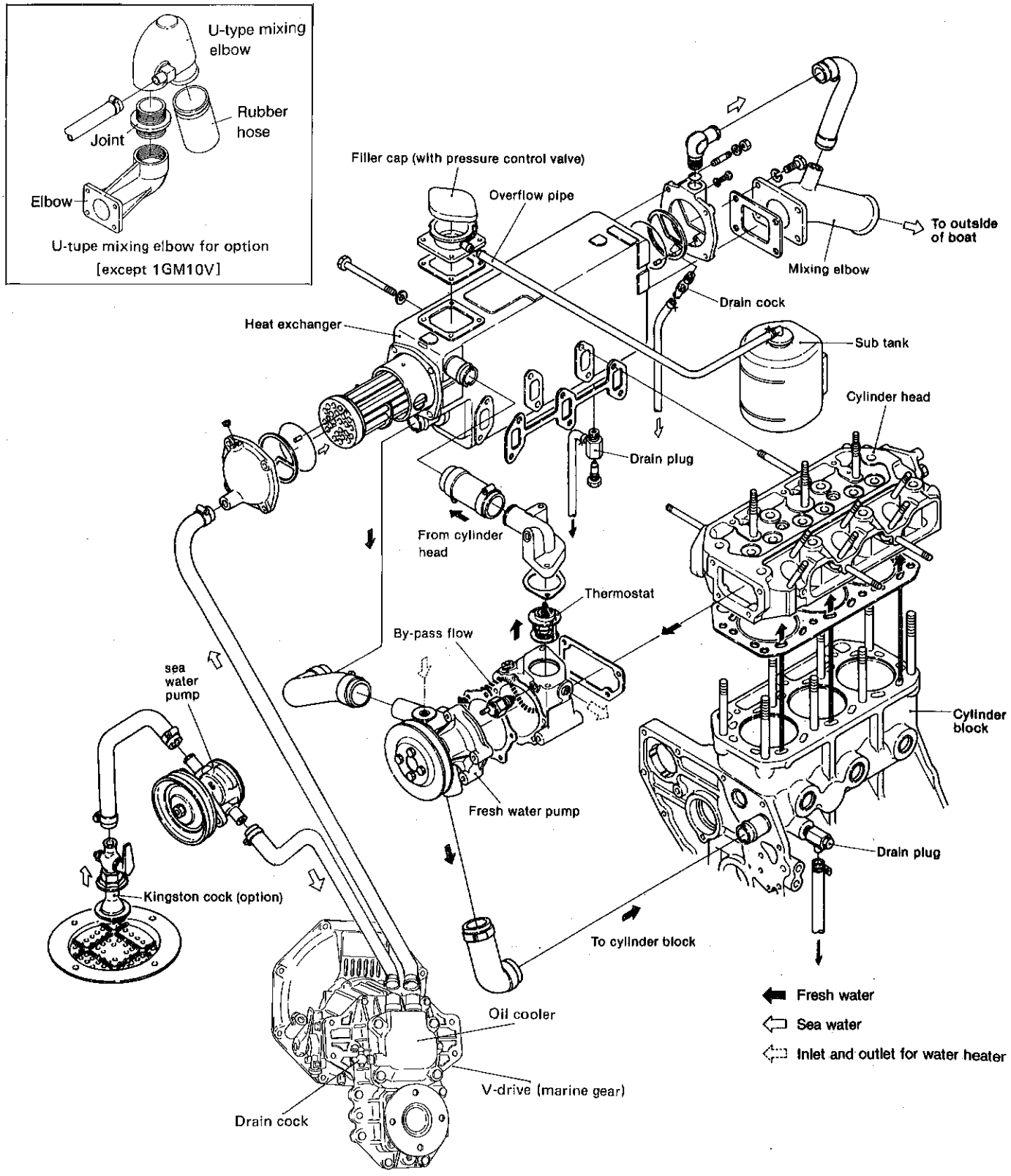
4-3 Cooling system (Fresh water cooling engine)

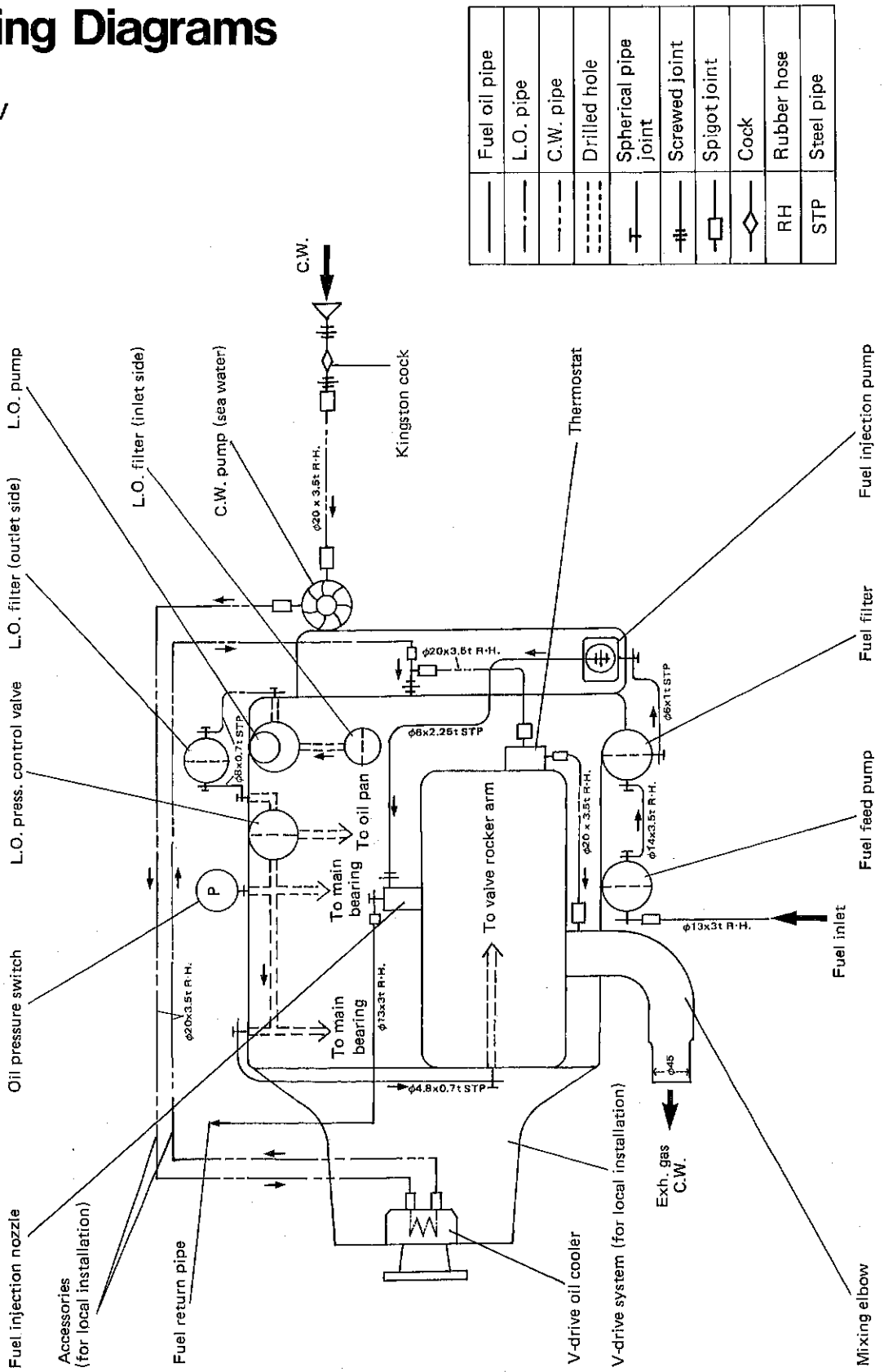
System Diagrams

Models 2GM20FV and 3GM30FV are constructed from different parts but use the same water flow.



5. Piping Diagrams

5-1 1GM10V



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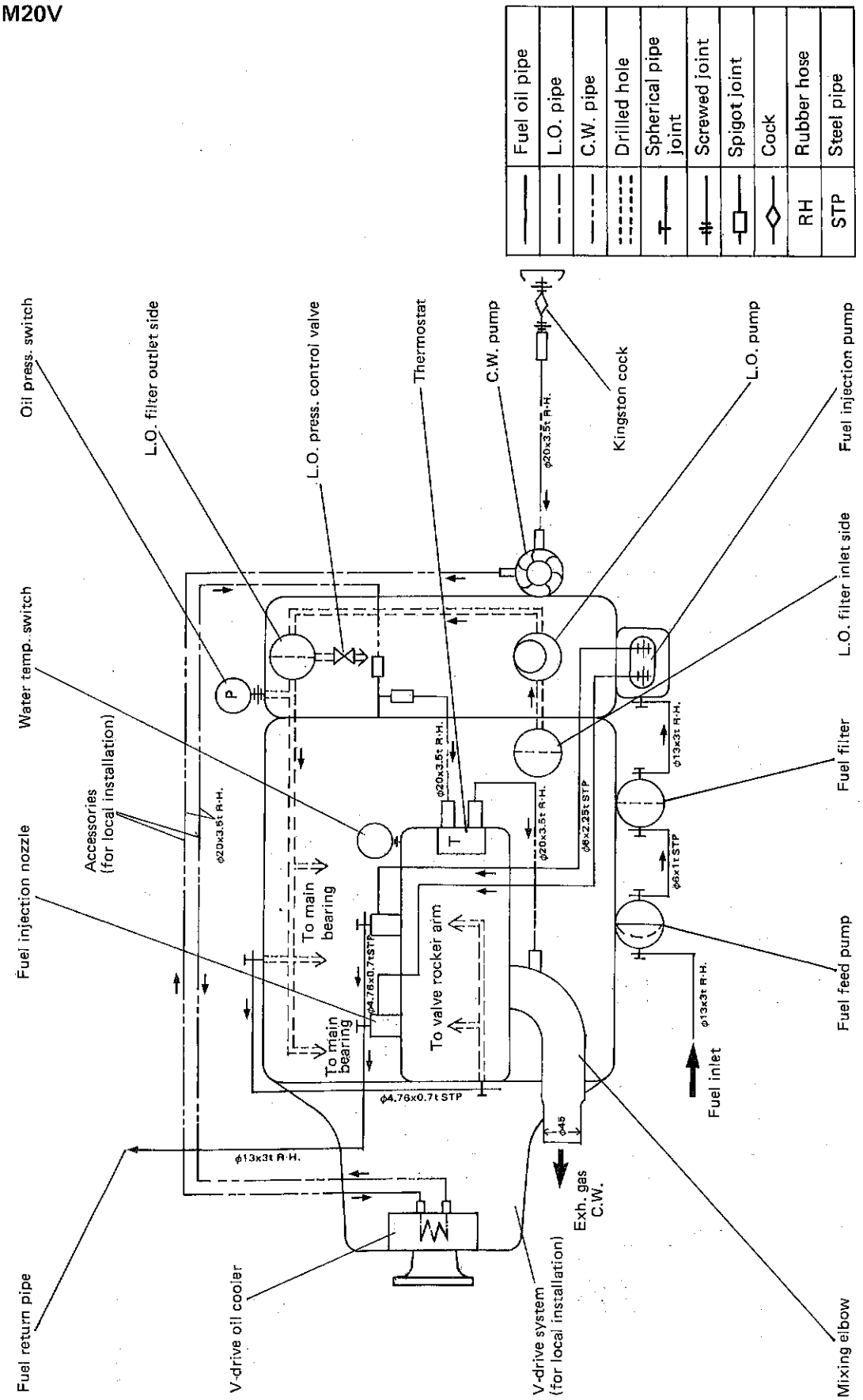
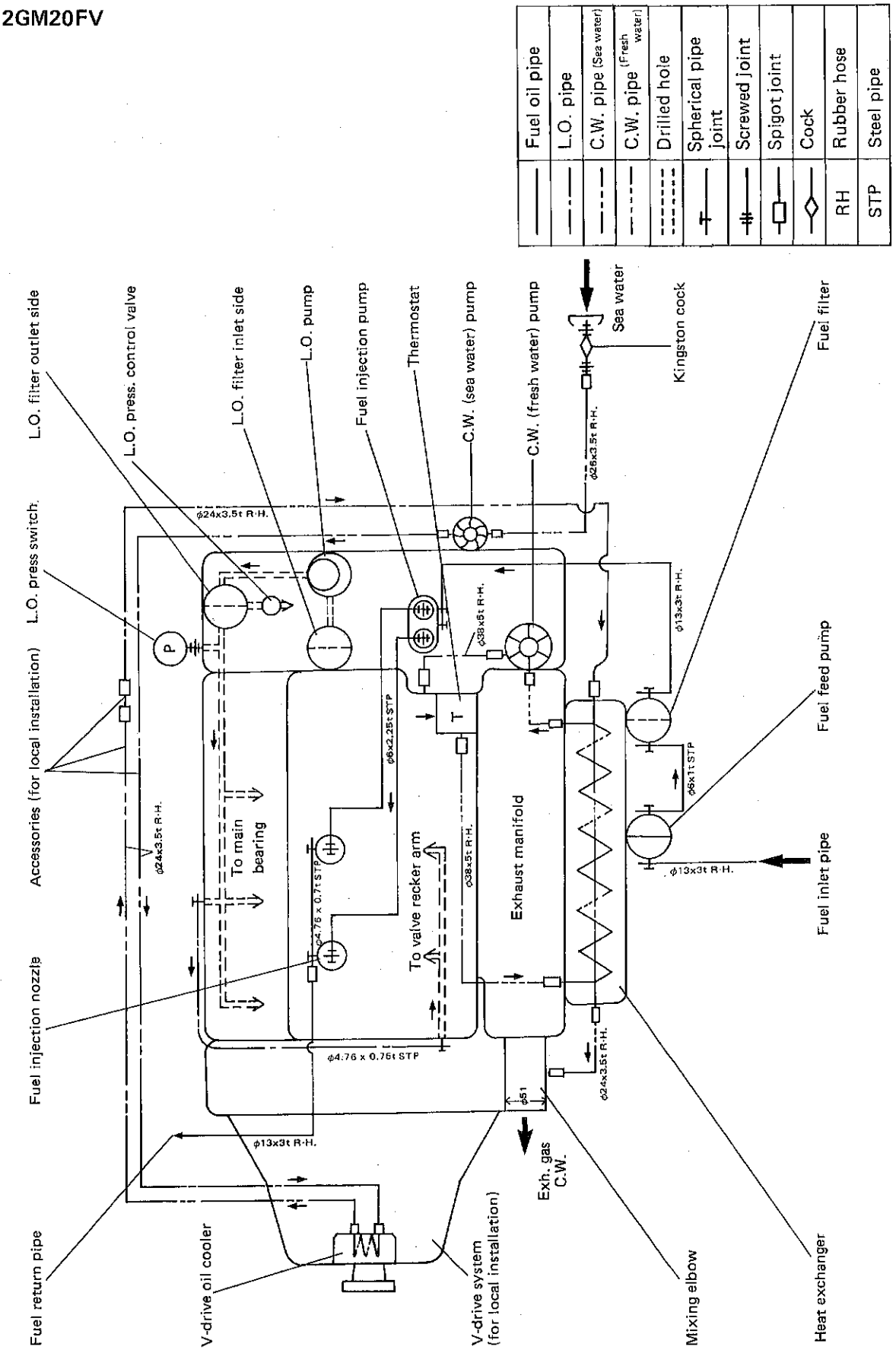
5-2 2GM20V


Fuel oil pipe
L.O. pipe
C.W. pipe
Drilled hole
Spherical pipe joint
Screwed joint
Spigot joint
Cock
RH
Rubber hose
STP
Steel pipe
Oil press. switch
L.O. filter outlet side
L.O. press. control valve
Thermostat
C.W. pump
Kingston cock
L.O. pump
Fuel injection pump
Water temp. switch
L.O. filter inlet side
Accessories (for local installation)
Fuel filter
Fuel injection nozzle
Fuel feed pump
Fuel inlet
Fuel return pipe
V-drive oil cooler
V-drive system (for local installation)
Exh. gas C.W.
Mixing elbow
To main bearing
To valve rocker arm
φ20x3.5t R-H.
φ13x3t R-H.
φ6x2.25t STP
φ6x1t STP
φ4.76x0.7t STP
φ45

5-3 2GM20FV



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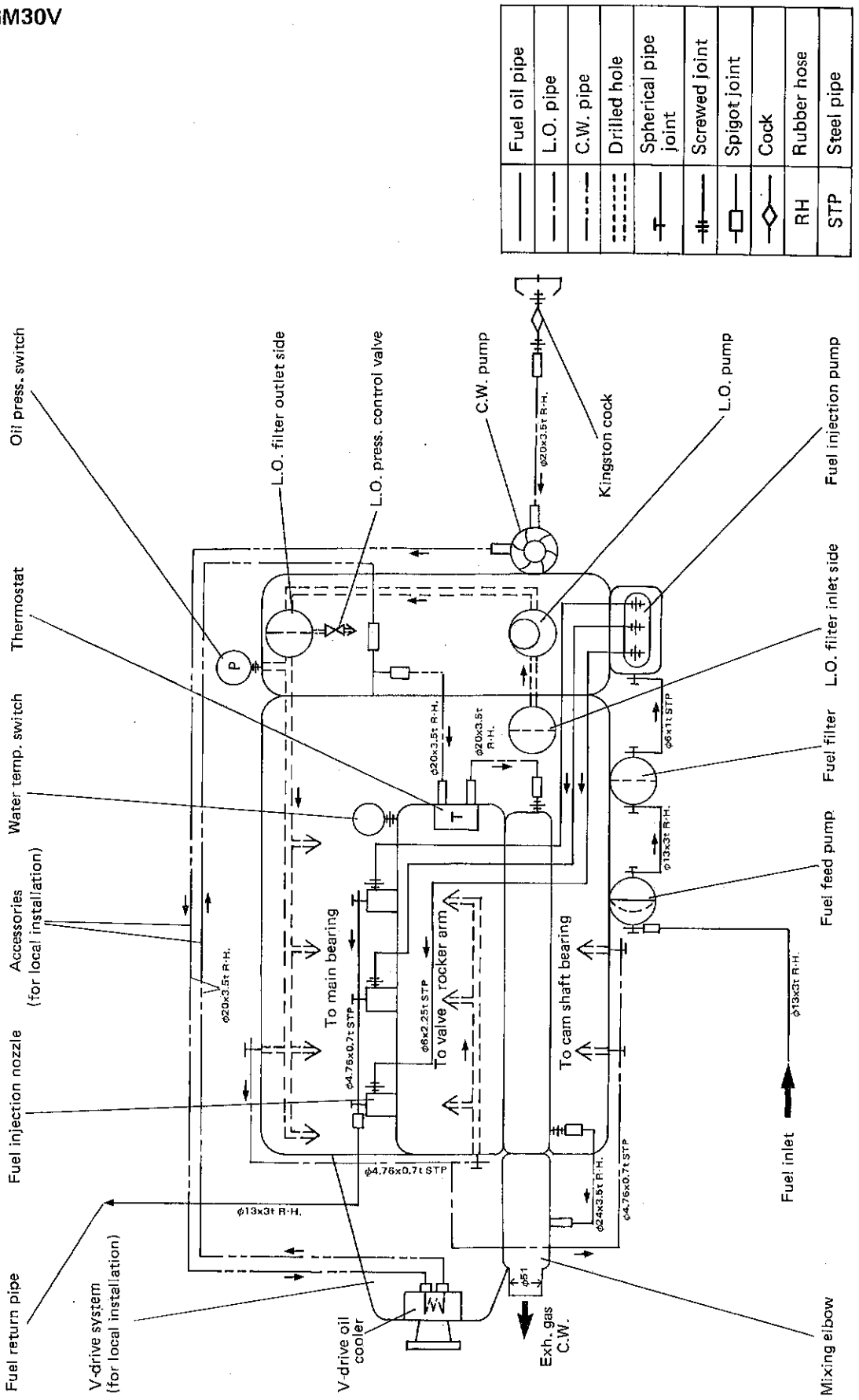
5-4 3GM30V



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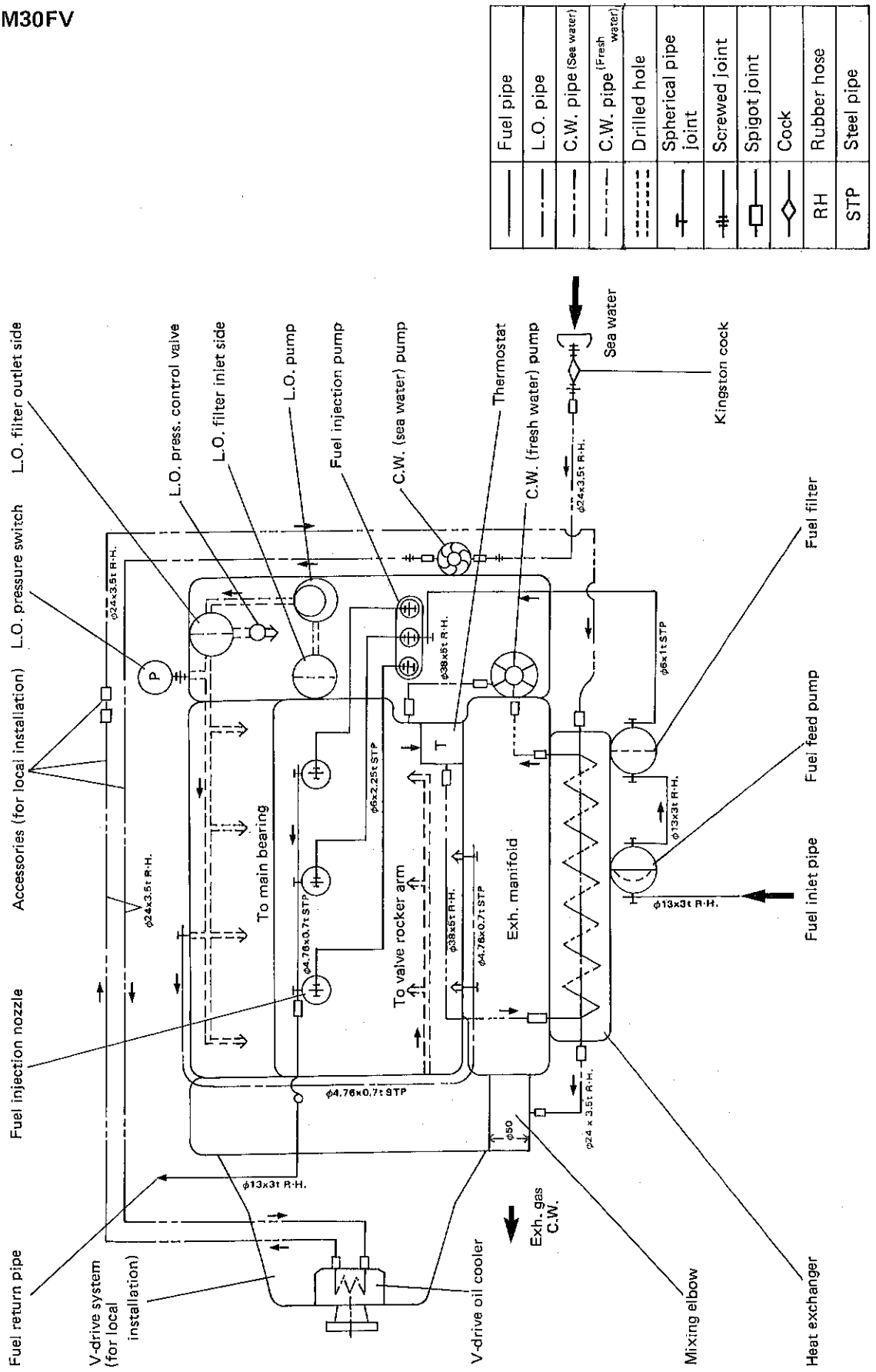
5-4 3GM30FV



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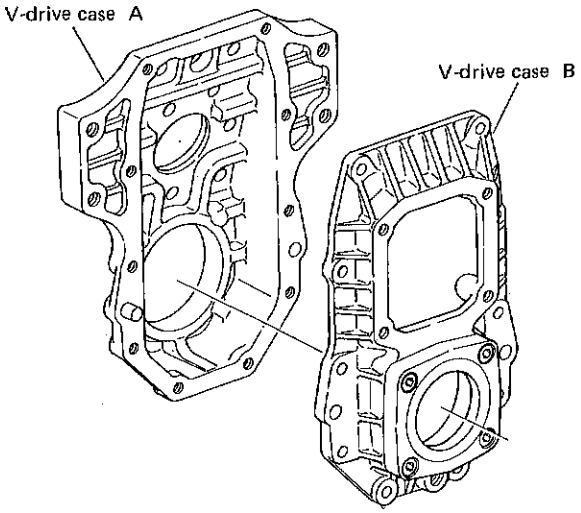
6. Inspection and Servicing

The KM3V V-Drive Gear is the combination of the V-drive system with the KM3P parallel drive gear. Accordingly, the explanation of this section is limited only to the V-drive system. Explanations for other parts excluding the V-drive system are identical to those described under the sections for model KM3P.

6-1 V-drive case

(1)Check the V-drive 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.

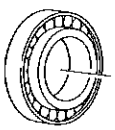


6-2 Bearing

(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.

Bearing of V-drive gear shaft



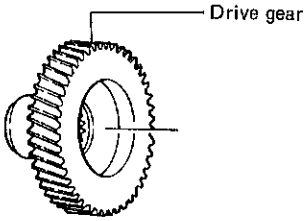
6-3 Gear

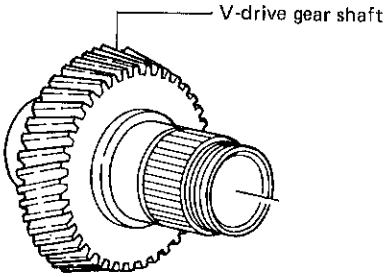
Check the surface, tooth face conditions and backlash of each gear. Replace any defective part.

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

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

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



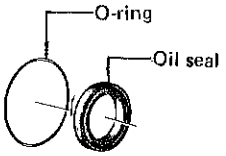


mm (in.)

Backlash	Maintenance standard	Wear limit
Drive gear and V-drive gear	0.08 ~ 0.16 (0.0031 ~ 0.0063)	0.3 (0.0118)

6-4 Oil seal and O-ring

Check the sealing surface of the oil seals and O-ring. If worn and/or scratched, replace.



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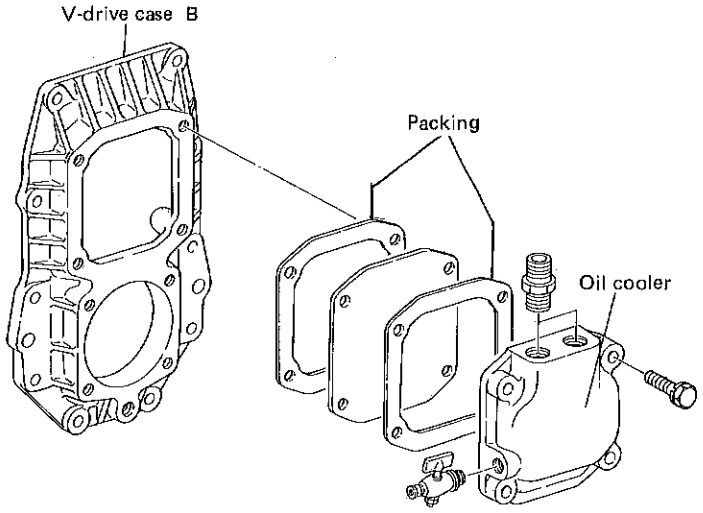
6-5 Packing

Check the oil cooler packings. If there are cracks, and/or scratches, repair.



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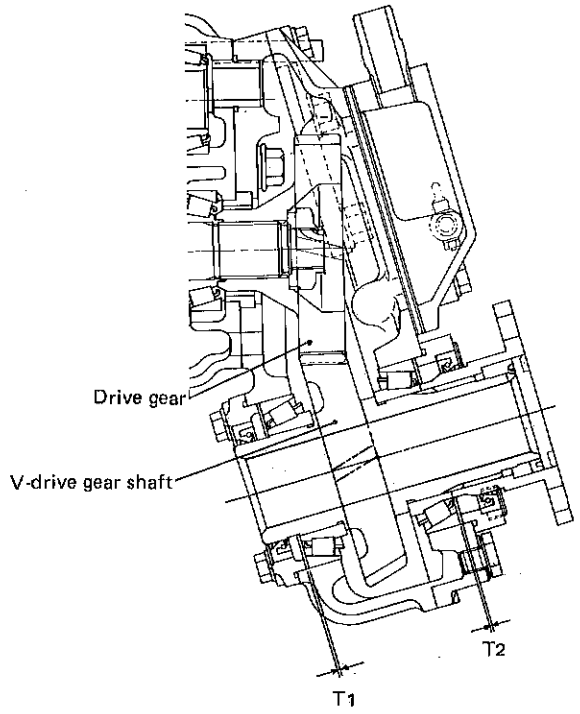
7. Shim adjustment for V-drive gear shaft, and backlash adjustment for V-drive gear shaft and drive gear

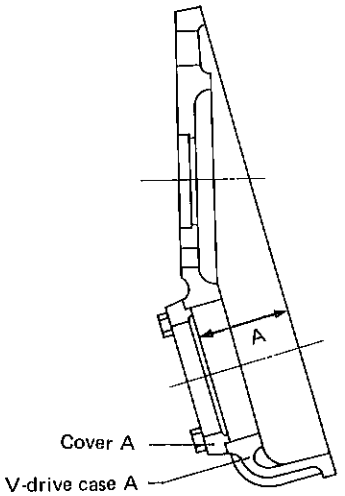
Check the thickness of shims for V-drive gear shaft. When the components are not replaced after dismantling, the same shims can be reused. When the clutch case, flange, V-drive case A and B or any of the following parts is replaced, the thickness of shim must be determined in the following manner.

For input shaft parts: input shaft, bearing
For output shaft parts: output shaft, thrust collar A, thrust collar B, gear, bearing
For V-drive gear shaft parts : V-drive gear shaft, cover A, cover B, bearing

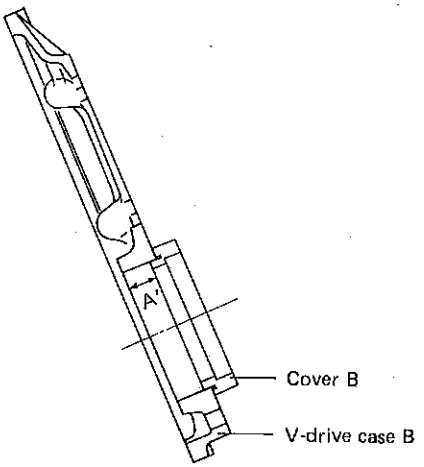
7-1 Measuring method of shim thickness(T_1, T_2) of V-drive gear shaft



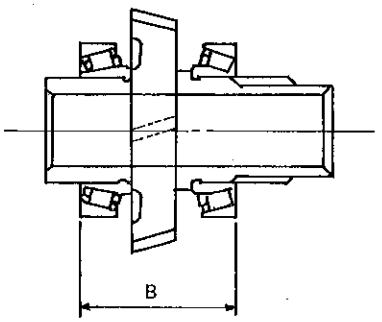
(1) Install the cover A to the V-drive case A, and measure the bearing insertion hole depth A.



(2) Install the cover B to the V-drive case B, and measure the bearing insertion hole depth A'.



(3) Insert bearings into the V-drive gear shaft, and measure the B-length between the bearing outer races.



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(4) Obtain the thickness T1, and T2 by the following formulas:

$T = A + A' - B$ Where: $T = T_1 + T_2$ Tolerance of T-dimension $\pm^{0.1}_{0}$

$T_2 = T - T_1$ (0.8 mm) T_1 standard dimension 0.8 mm

(5) Standard dimensions

	A	A'	B	T	T1
KM3V	49.8 ~ 50.2 (1.937 ~ 1.976)	20.8 ~ 21.2 (0.819 ~ 0.835)	68.7 ~ 69.3 (2.705 ~ 2.728)	1.3 ~ 2.7 (0.051 ~ 0.106)	0.8 (0.0315)

NOTE. If the measured values differ largely from the above values, your measurements may be incorrect. Measure again correctly.

(6) Adjusting shim set

Part No.	Thickness. mm(in.)	No. of shim
177070-02860	1.0 (0.0039)	1
	0.3 (0.0118)	3
	0.2 (0.0079)	2

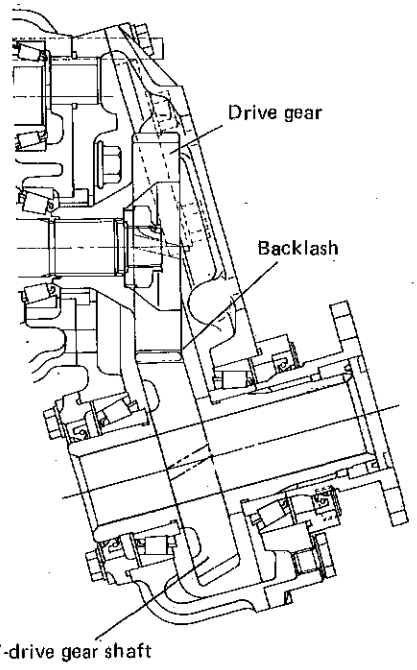
7-2 Backlash adjustment for V-drive gear shaft and drive gear

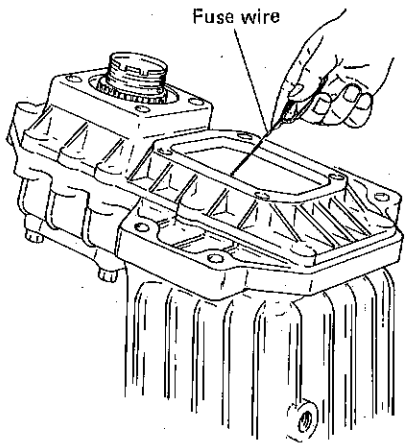
(1) Insert the fuse wire into the interval between the Drive gear and the V-drive gear from the cooler installation window. Turn the gear, and pull out the fuse wire. Measure the pressed thickness of the fuse wire with a micrometer.

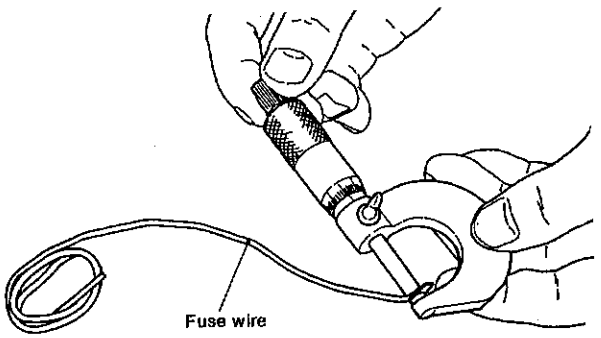
Backlash standard: 0.08 ~ 0.16 mm
(0.0032 ~ 0.0063 in.)

(2) When the backlash is larger than the standard value, move the T2 shim to the T1 side.
When the backlash is smaller than the standard value, move the T1 shim to the T2 side.

NOTE: By moving the T1, or T2 shim by 0.1mm, the backlash is varied by about 0.016 mm (0.0006 in.).







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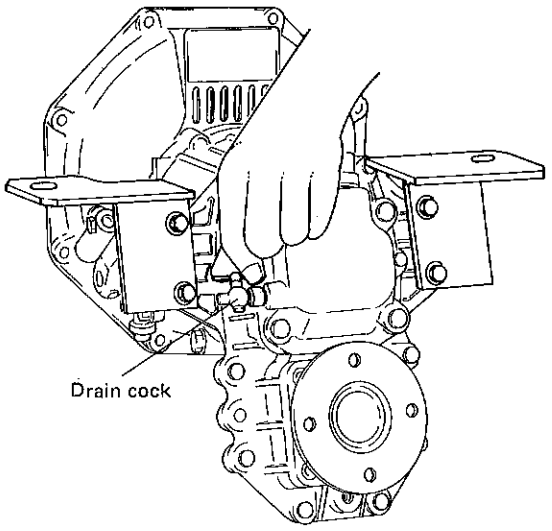
8. Disassembly

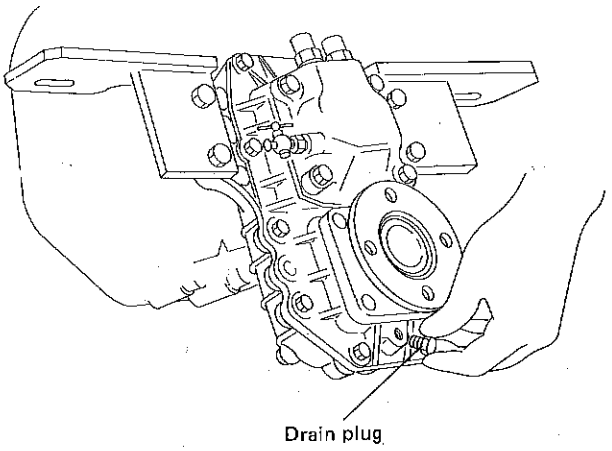
8-1 Dismantling the V-drive assembly

(1) Remove the remote control cable.
(2) Remove the cooling water hose of lube oil cooler.
(3) Remove the V-drive assembly from the engine mounting flange.

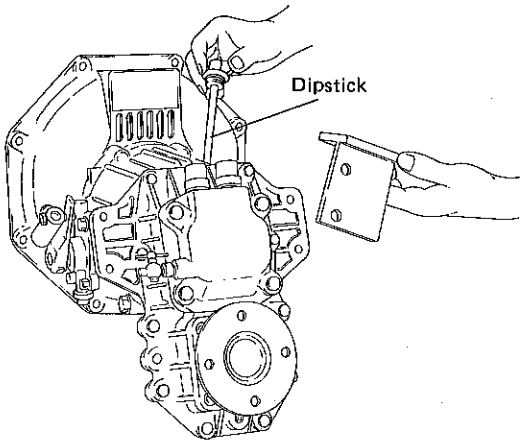
8-2 Drain the cooling water from the lube oil cooler.



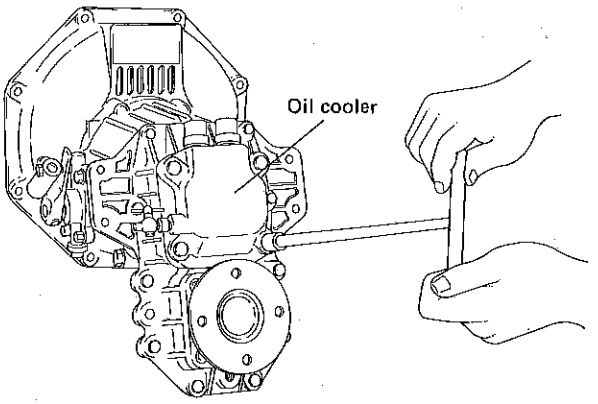
8-3 Loosen the plug at the bottom of the V-drive case, and drain the lube oil.



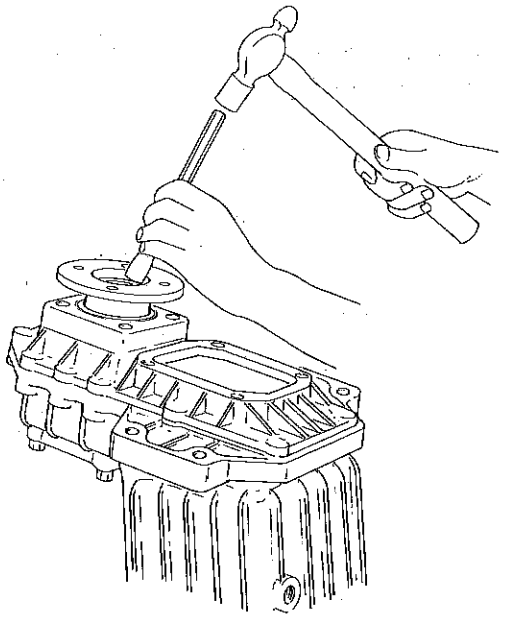
8-4 Remove the engine feet, lube oil dipstick, and O-ring.



8-5 Remove the lube oil cooler fixing bolts, and then remove the lube oil cooler body, packings, and plate.



8-6 Loosen the V-drive shaft end nut.



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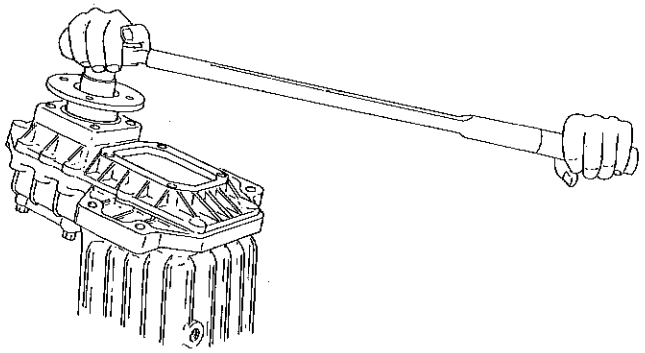
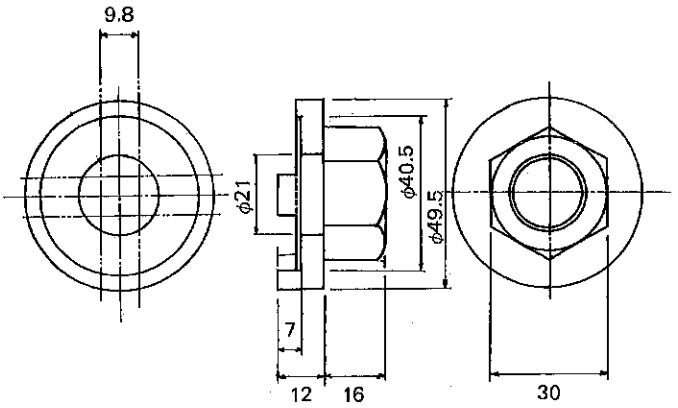
8-7 Remove the end nut, output shaft coupling, and O-ring.

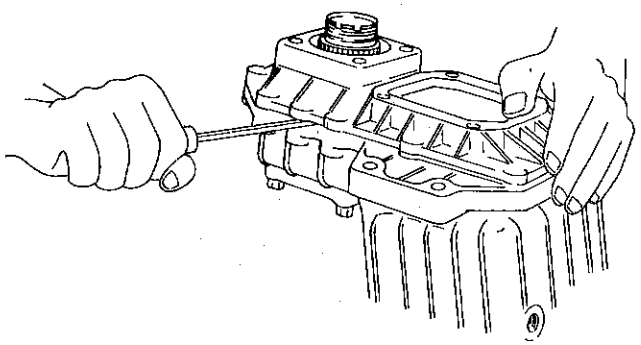


NOTE: 1) Use the special tool to remove the end nut from the V-drive shaft.
2) Special tool (option part) Part No. 177070-09010

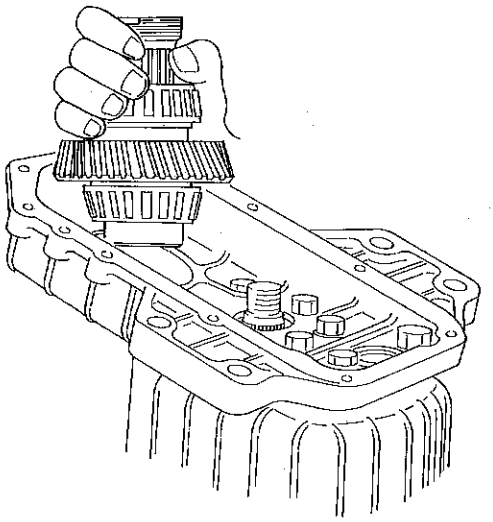
Dimension: mm
Material: Carbon steel
Hardness: HB 203 ~ 258
HS 31 ~ 38
(Hardening)



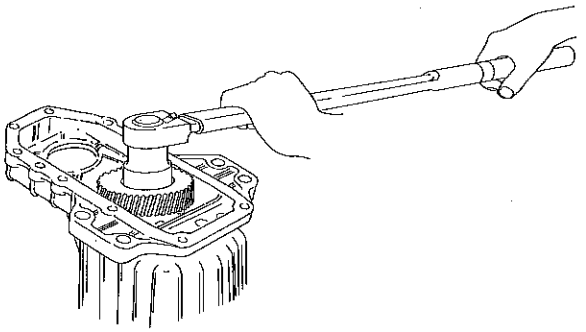
8-8 Remove the fixing bolts on the V-drive case B, and also remove the V-drive case B.



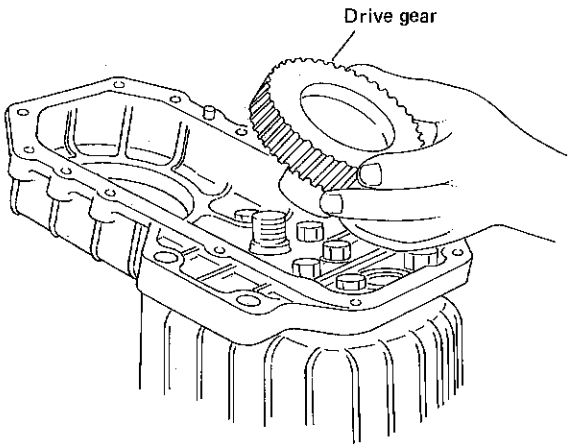
8-9 Remove the V-drive shaft.



8-10 Remove the end nut, and drive gear from the output shaft.



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



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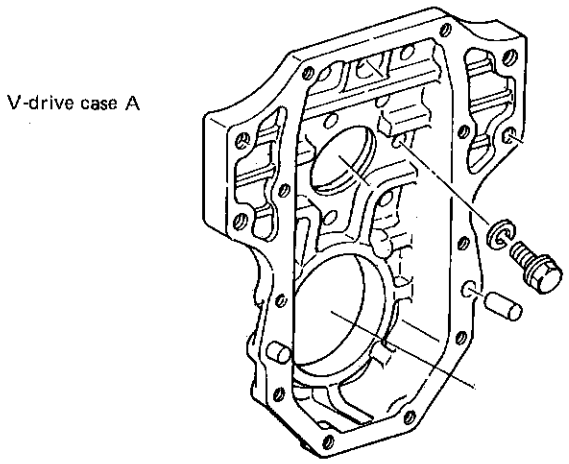
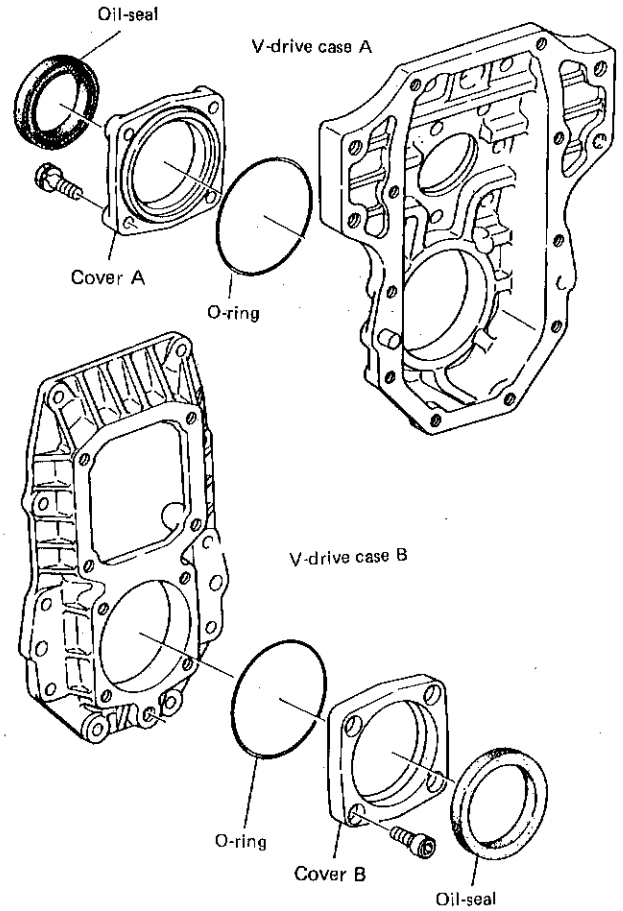
8-11 Remove the V-drive case A fixing bolts, and remove the V-drive case A.

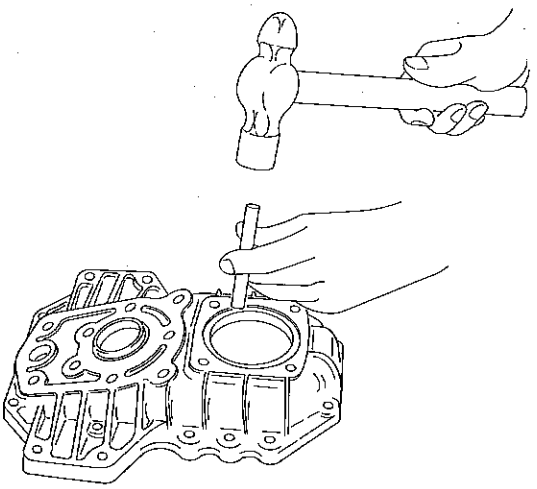


8-12 Disassembly of clutch assembly.
Follow to the same procedures described for model KM3P. (Refer to the sections under KM3P)

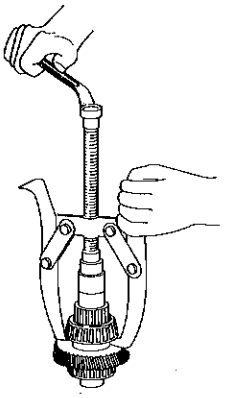
8-13 Remove the covers, O-rings, and oil-seals from the V-drive cases A and B.



8-14 Remove the bearing outer races from the V-drive cases A and B.



8-15 Remove the bearing inner races from the V-drive gear shaft.



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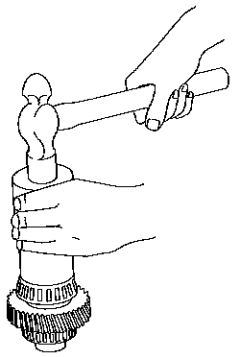
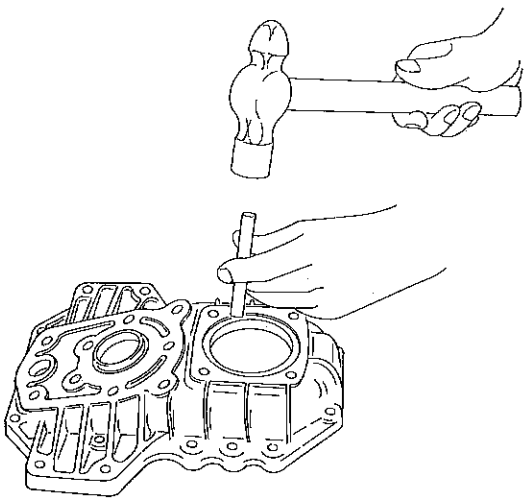
9. Reassembly

9-1 Reassembly of the clutch unit
Follow to the same procedures described for model KM3P. (Refer to sections under KM3P)

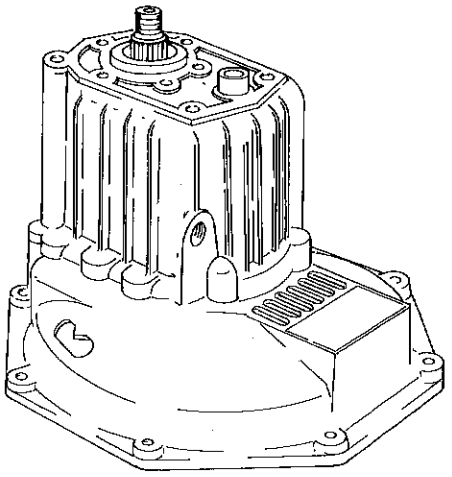
9-2 Fit the bearing inner races in the V-drive gear shaft.



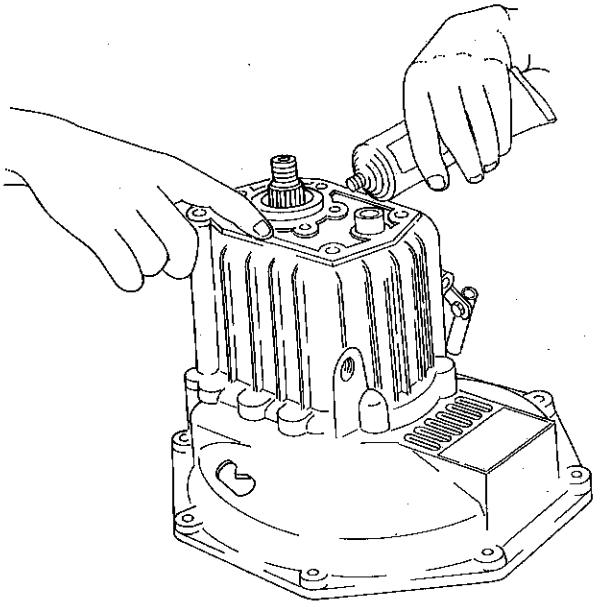
9-3 Fit the bearing outer races in the V-drive cases A and B.



9-4 Insert the center bush and location pin to the clutch case end holes.



9-5 Fit the V-drive case A to the clutch case.



NOTE: Apply a non-drying type liquid packing to the matching surfaces of the case A and the clutch case.

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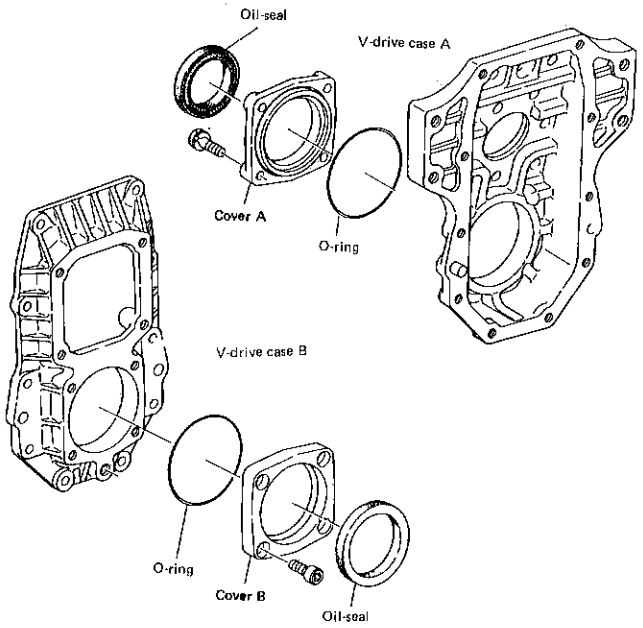
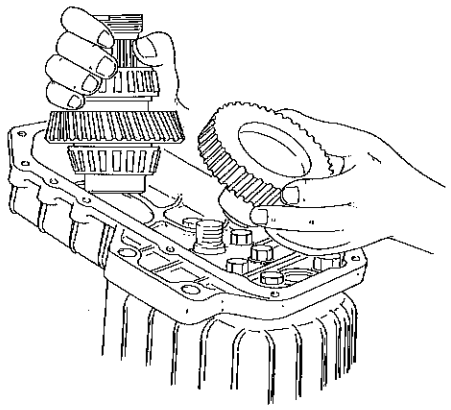
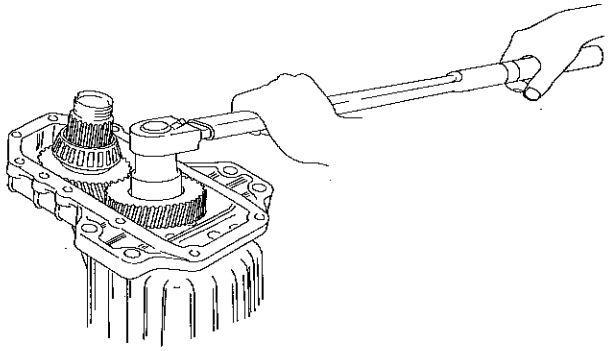
9-6 Fit the covers, O-rings, oil seals and shims into the V-drive cases A and B.



9-7 Insert the V-drive shaft into the V-drive case A, and insert the V-drive gear into the output shaft.



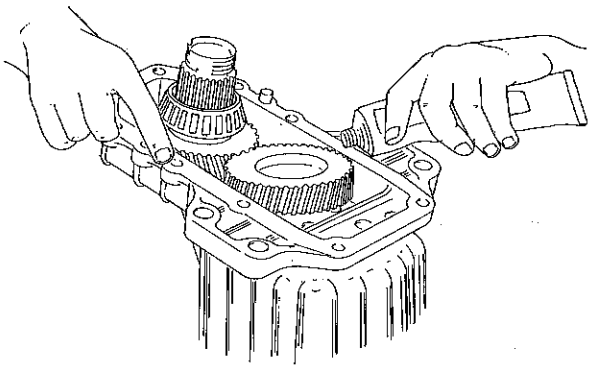
9-8 Tighten the end nut with a torque wrench



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

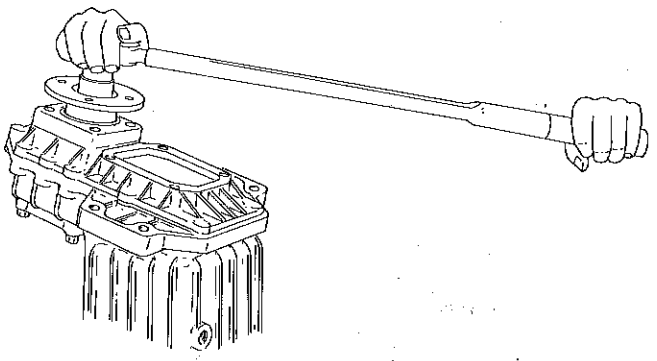
NOTE: Note that the end nut has a left-handed thread.

9-9 Fit the V-drive case B to the V-drive case A.



NOTES: 1) Apply a non-drying type liquid packing to the matching surfaces of the V-drive cases A and B.
2) Measure the backlash of the drive gear and V-drive gear. (Refer to the procedures under the foregoing 6-2.)

9-10 Insert the O-ring and output shaft coupling.
Tighten the lock nut. Use the special tool and the torque wrench.



Tightning torque	18 ~ 22 kg - m (130.2 ~ 159.1 ft-lb.)

NOTE: Check that the output shaft coupling turns smoothly at the neutral position of the shift lever.

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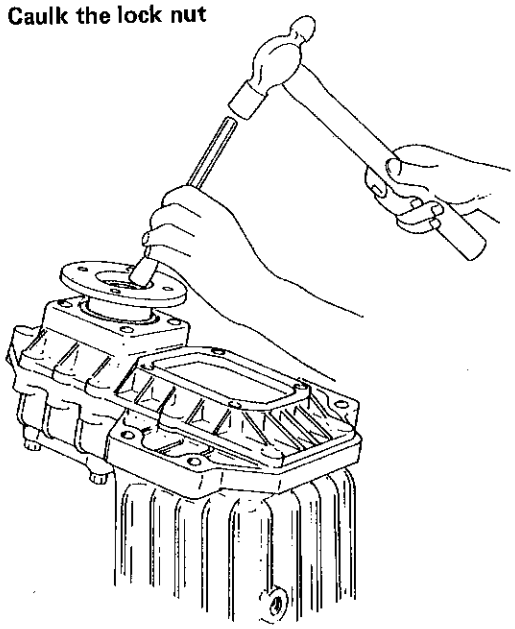
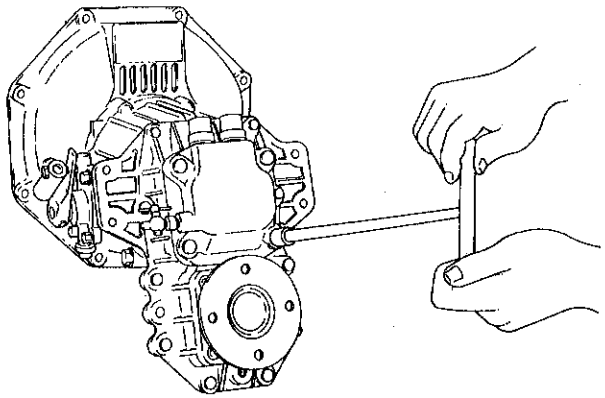
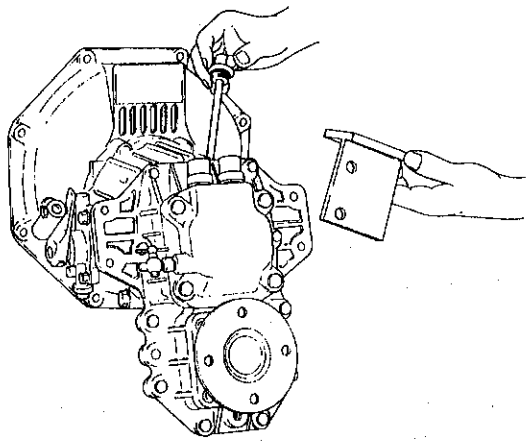
9-11 Caulk the lock nut



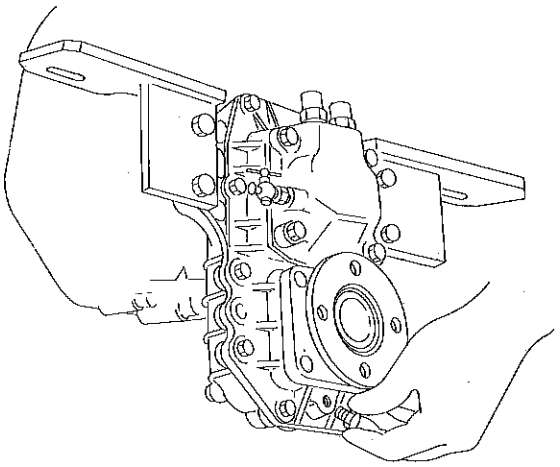
9-12 Fit the oil cooler



9-13 Fit the engine feet, lube oil dipstick and O-ring.



9-14 Fit the lube oil drain plug



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