CHAPTER 9

# REDUCTION AND REVERSING GEAR

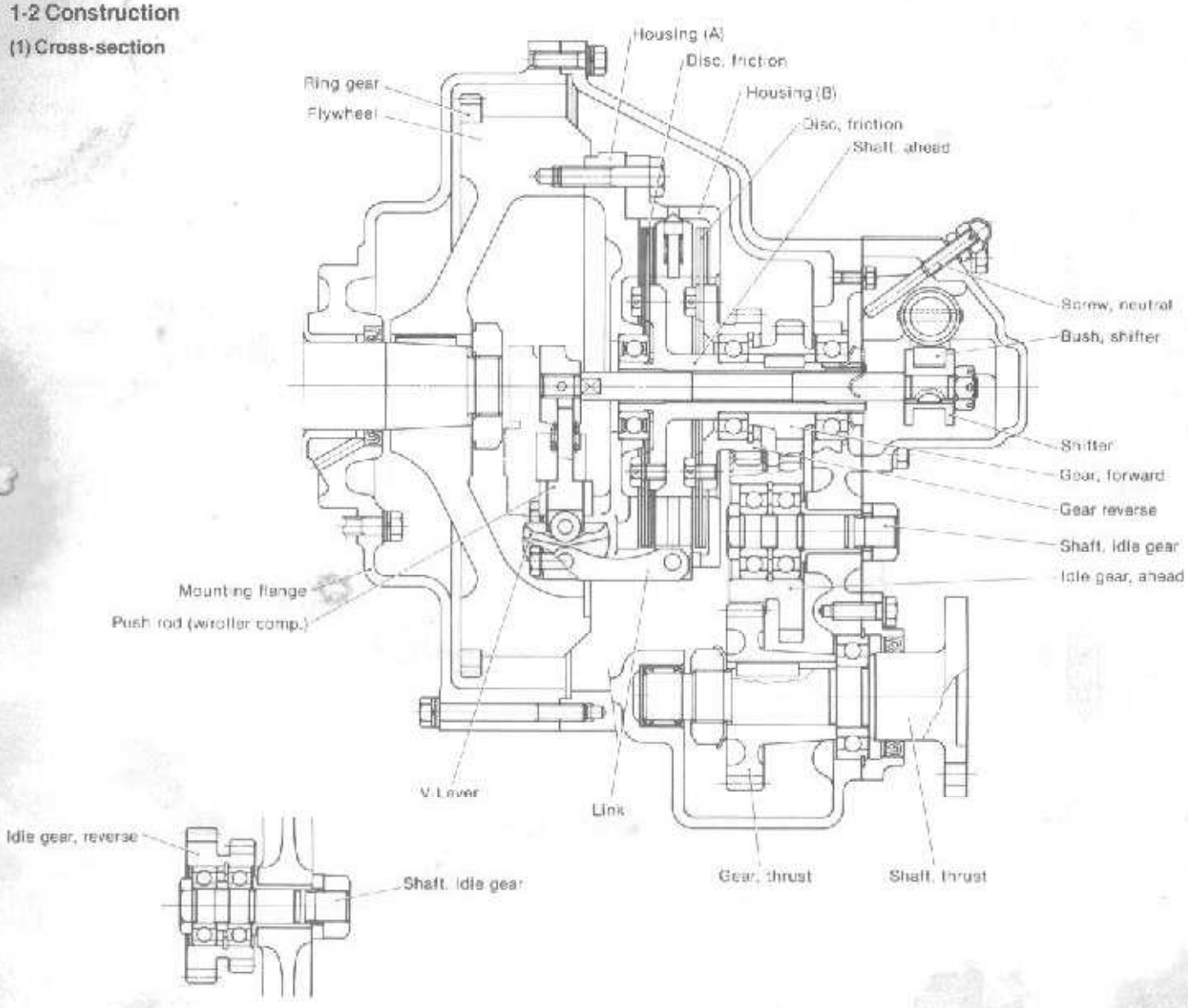
# 1. Construction

## 1-1 Specifications

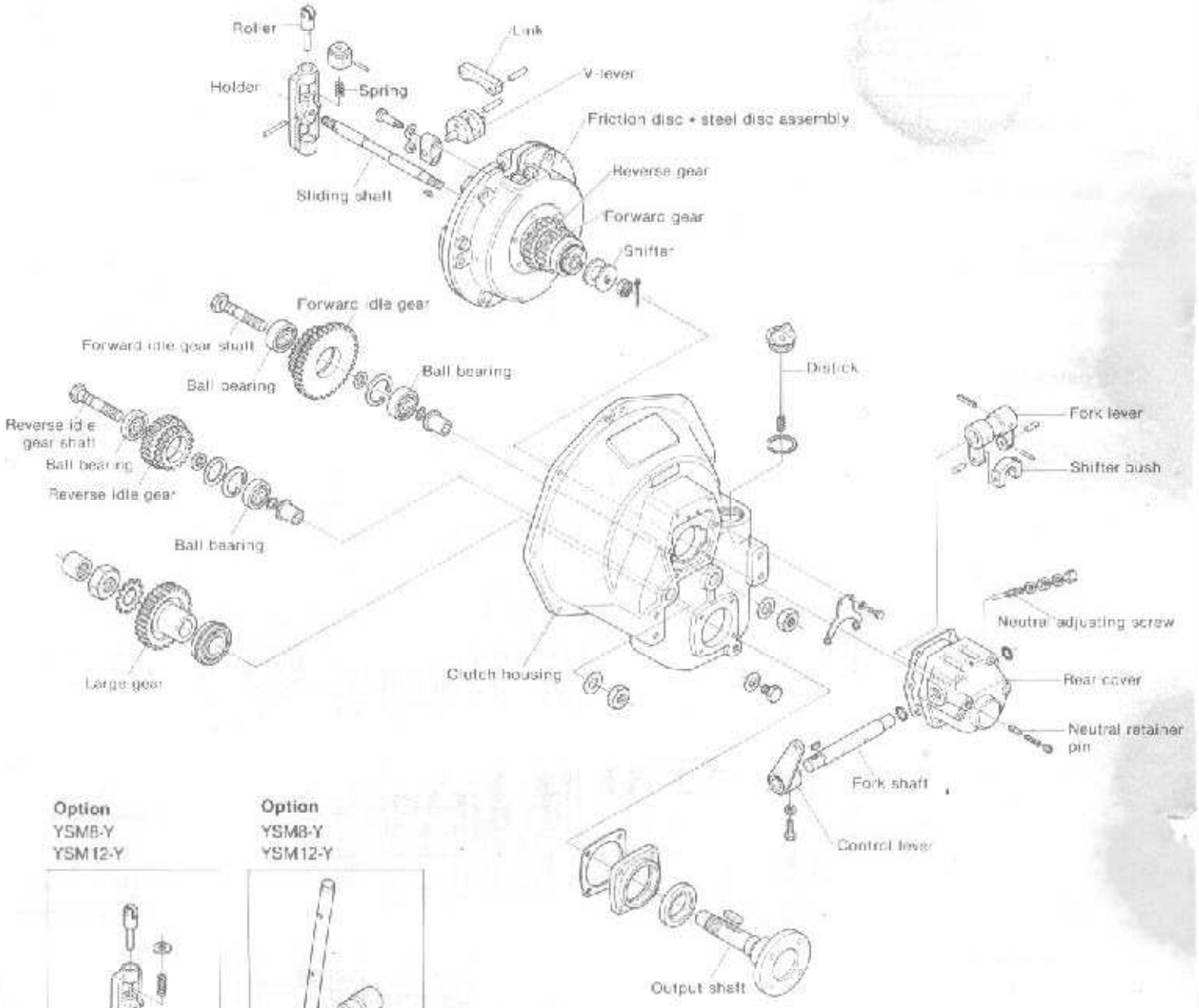
| | | | | |
|---|---|---|---|---|
| Engine model | | | YSM8 | YSM12 |
| Reduction system | | | Two-stage reduction, spur gear | |
| Reversing system | | | Constant mesh gear | |
| Clutch | | | Wet type single-disc, mechanically operated | |
| Reduction ratio | Forward | | 1.95, 2.93 | 1.98, 3.06 |
| | Reverse | | 1.95, 2.93 | 1.98, 3.06 |
| Direction of rotation | Input shaft | | Counter clockwise as viewed from stern | |
| | Output shaft | Forward | Counter clockwise as viewed from stern | |
| | | Reverse | Clockwise as viewed from stern | |
| Lubricating oil | | | SAE 20/30 | |
| Lubricating oil capacity | | | 0.7ℓ (0.185 U.S. Gal.) (total)/0.2ℓ (0.053 U.S. Gal.) (effective) | |
| Dry weight | | | 21.5kg (47.3 lbs.) | 23.5kg (51.7 lbs.) |

## 1-2 Construction

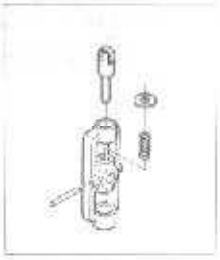
### (1) Cross-section



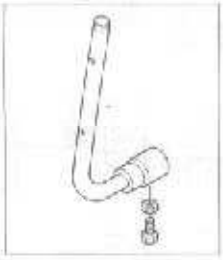
**(2) Drawing**



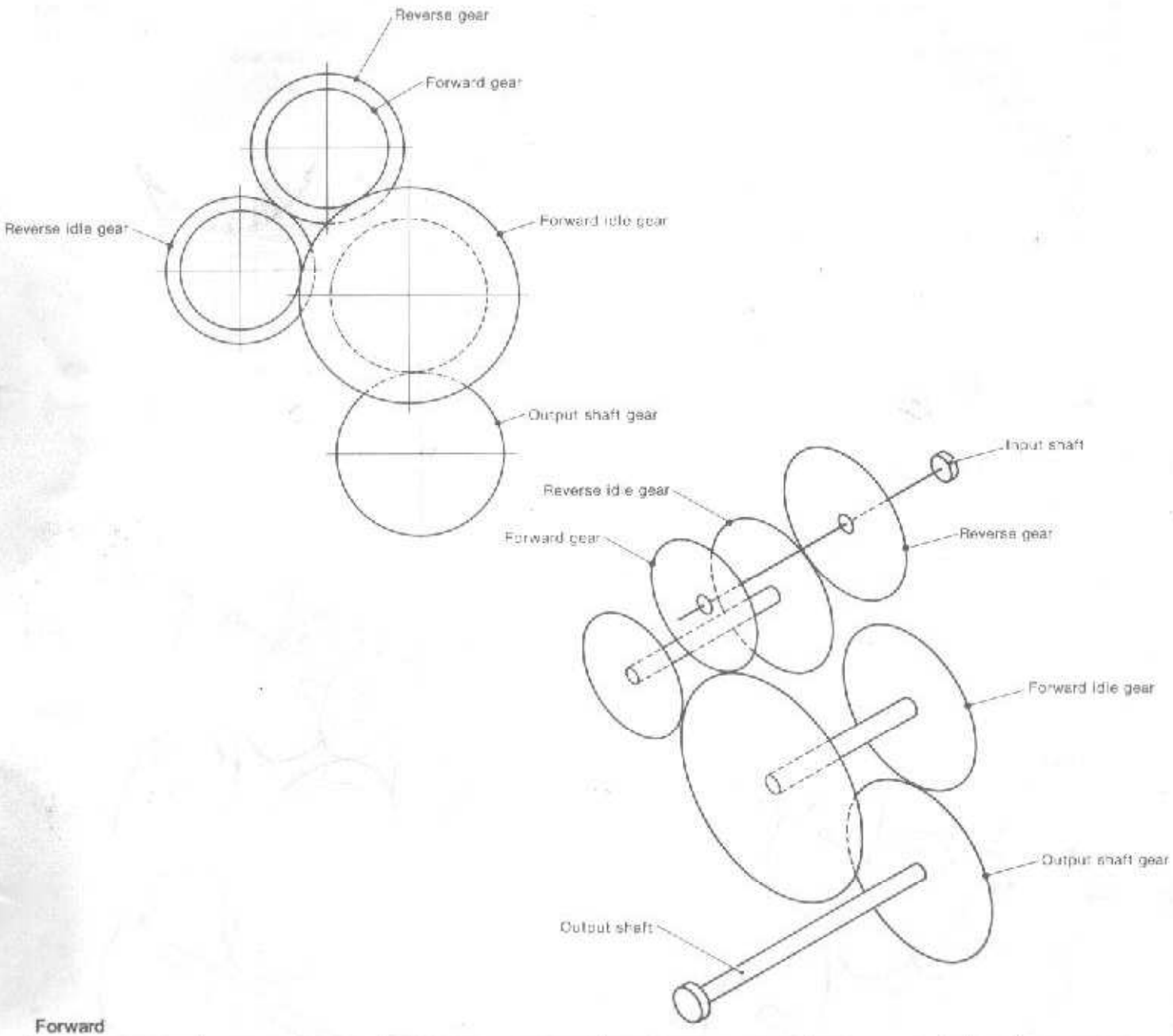

**Option**
YSM8-Y
YSM12-Y



**Option**
YSM8-Y
YSM12-Y



## 1-3 Power transmission system




**Forward**

| Model | Forward gear | Forward idle gear | Large gear | Reduction ratio |
|---|---|---|---|---|
| YSM8 | Z = 20 | Z = 35, 26 | Z = 29 | 35/20 × 29/26 = 1.952 |
| | Z = 19 | Z = 36, 22 | Z = 34 | 36/19 × 34/22 = 2.928 |
| YSM12 | Z = 24 | Z = 42, 31 | Z = 35 | 42/24 × 35/31 = 1.976 |
| | | Z = 42, 24 | Z = 42 | 42/24 × 42/24 = 3.063 |

**Reverse**

| Model | Reverse gear | Reverse idle gear | Forward idle gear | Large gear | Reduction ratio |
|---|---|---|---|---|---|
| YSM8 | Z = 24 | Z = 20—24 | Z = 35—26 | Z = 29 | 24/24 × 35/20 × 29/26 = 1.952 |
| | | Z = 19—24 | Z = 36—22 | Z = 34 | 24/24 × 36/19 × 34/22 = 2.928 |
| YSM12 | Z = 28 | Z = 24—28 | Z = 42—31 | Z = 35 | 28/28 × 42/24 × 35/31 = 1.976 |
| | | Z = 24—28 | Z = 42—24 | Z = 42 | 28/28 × 42/24 × 42/24 = 3.063 |

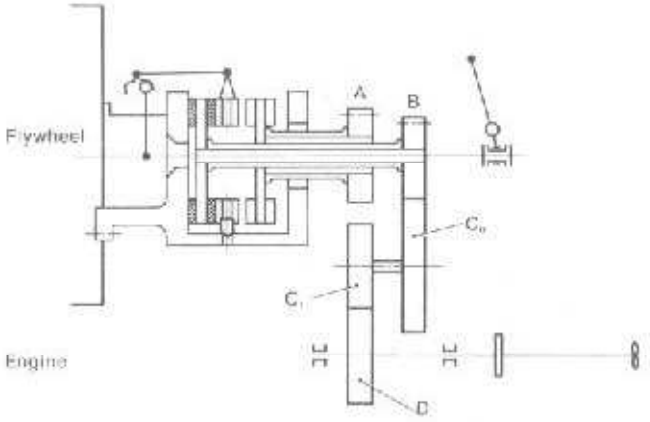
*Printed in Japan*
F023A9078

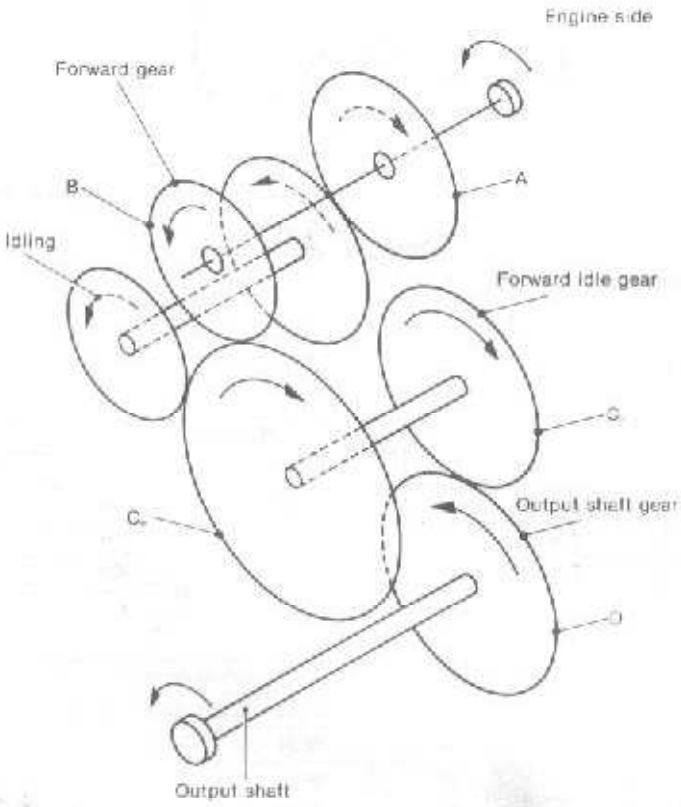
### 1-4 Clutch transmission mechanism

The reduction and reversing gears of this engine include a forward gear, reverse gear, output shaft gear and two idle gears (a forward idle gear and a reverse idle gear). In the idle gear, the gear wheel and pinion are constructed integrally with each other.

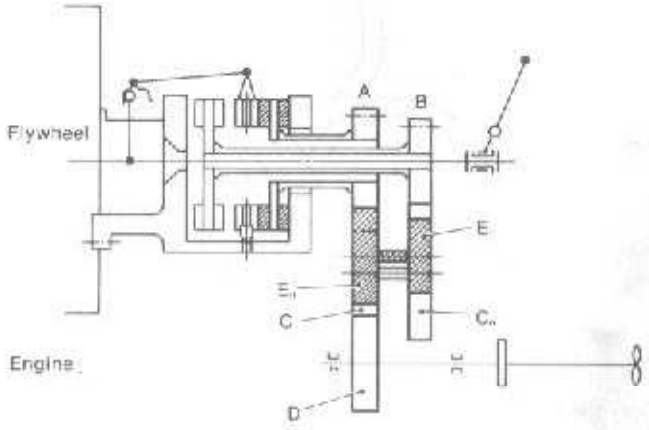
These gears are always in mesh and rotate both forward and backward.

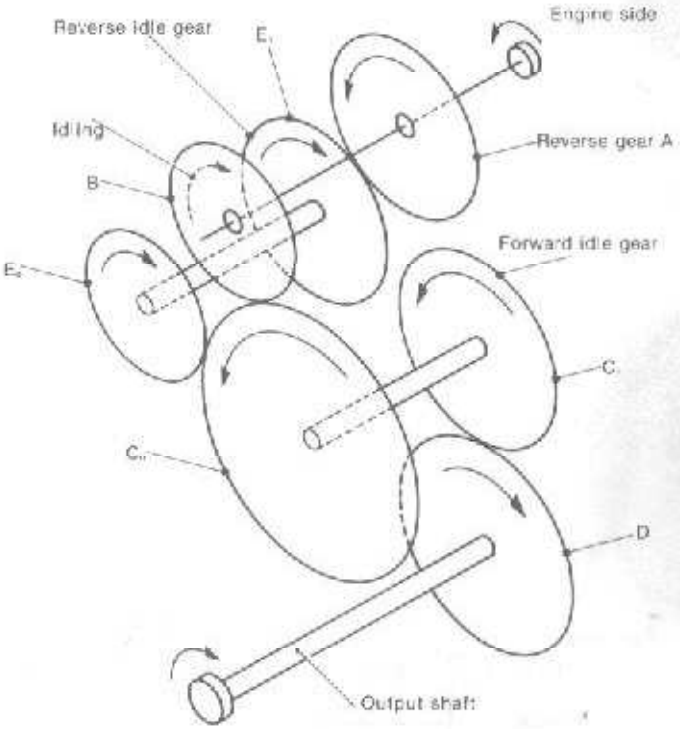
(1) When moving forward:
There are two friction discs. The power is transmitted to the left friction disc, then from gear B to gear C ($C_o$ & $C_i$) and gear D to drive the propeller shaft.




(2) When moving astern:
The power is transmitted to the right friction disc, and in turn to gear A, gear E ($E_o$ & $E_i$), gear C ($C_o$ & $C_i$), and gear D to drive the propeller shaft.

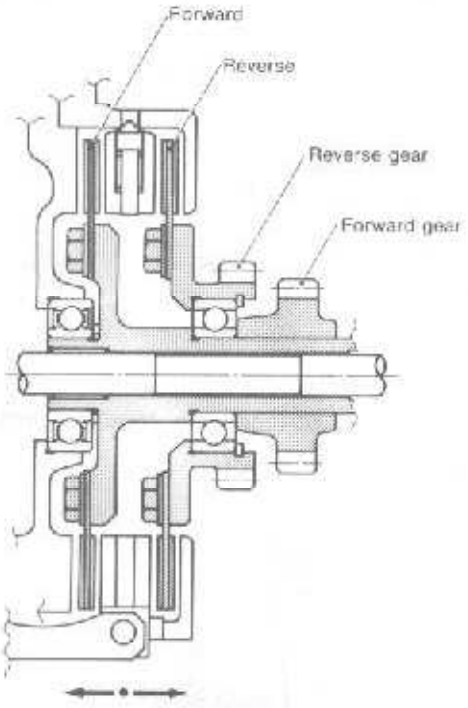



Thus, by operating a gear lever, the right and left friction discs are used as appropriate, depending upon the transmission mode of ahead or astern. All gears are constant meshed type, and the friction discs are normally turning in opposite directions except in their neutral position.

*Printed in Japan*
F023A9078

(3) When in neutral position:
The two friction discs are free from the friction plate, and gears A, B, C and D are all stationary even when the engine is running. A neutral positioning piece is furnished so as not to transmit power to between the friction plate and the friction discs. Therefore, "accompaniment" does not occur with the propeller shaft while the mechanism is in its neutral position.

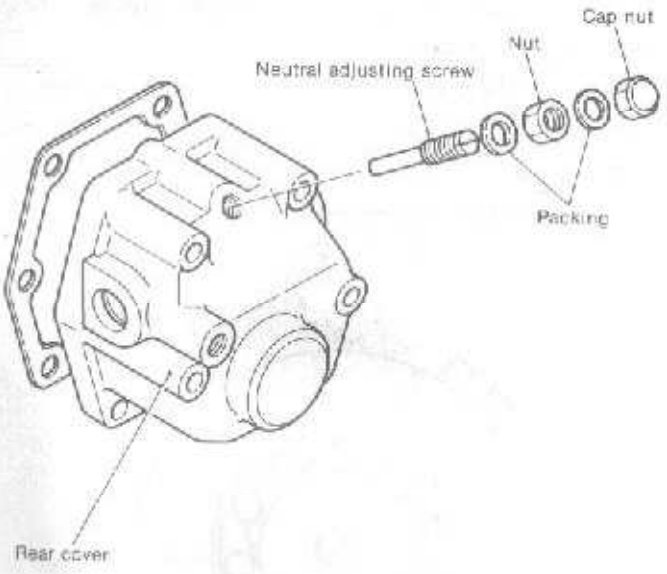


# 3. Handling the Reduction and Reversing Gears

## 3-1 Adjustments

### 3-1.1 Adjusting the adjusting screw for clutch neutral position

1. Remove the cap nut on the upper inclined surface of the clutch forward shaft gear box and loosen the clamp nut.
2. Operate the engine, and with the controlling lever in the neutral position, turn the neutral position adjusting screw clockwise or counterclockwise until the output shaft coupling stops rotating (about 1/2 or 1 full).
3. After making sure the output shaft coupling will not rotate forward or backward, tighten the clamp nut.
4. After tightening the clamp nut, securely tighten the cap nut.
5. Too much tightening may break the inside spring. Be very careful.




*Printed in Japan*
F023A9078

# 4. Inspection and Servicing

### 4-1 Condition of clutch housing

1. Check the clutch case for cracks using a test hammer and, if necessary, inspect by color-check. If cracks are noted, replace it with new one.
2. Check each bearing housing for burning damage. If any damage is detected, measure the inside diameter. If the inside diameter has reached the wear limit, replace the housing.

### 4-2 Condition of each bearing

1. Check each bearing for damage and rust. If a bearing is rusty or its balls, retainer, etc. are damaged, replace.
2. Smooth rotation
   If the rotation of a bearing is uneven or produces noise, replace it with a new one.

### 4-3 Condition of each gear

1. Damaged tooth surface
   Check the tooth surface of each gear for cracks, scratches and pitching. Replace when serious damage is found.
2. Bearing of tooth surface
   Check the tooth surface of each gear for bearing.
   If the bearing is less than 70% of the face width, find out why this has happened, and, if necessary, replace the gear. Neither the tooth top nor the tooth flank should have any bearing.
3. Check the fitted part of shafts or a key grooves for cracks and burning damage and replace, when needed.
4. Backlash of gear

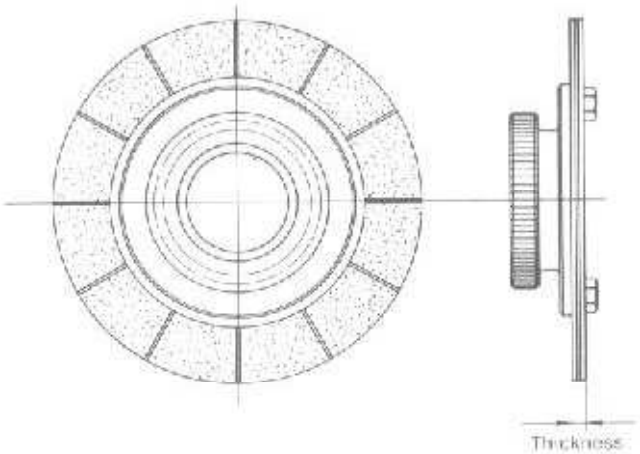
mm (in.)

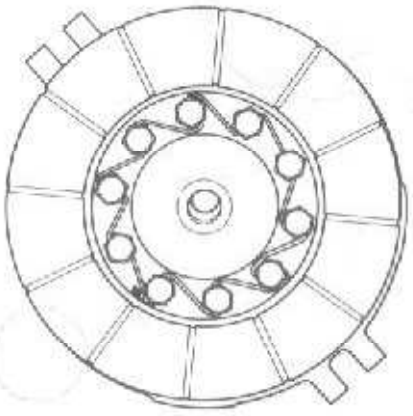
| | YSM8 | YSM12 |
|---|---|---|
| | Standard value | |
| Forward gear and idler gear | 0.12 ~ 0.2 (0.0047 ~ 0.0079) | |
| Reverse gear and idler gear | | |
| Idler gear and large gear | | |

Replace the gear when gear noise becomes too loud.

### 4-4 Friction disk

1. Check the friction disk for cracks, burning damage and fracture, and repair any damage. Replace all discolored or seriously damaged friction disks.
2. Check the friction disk for wear.
   If its thickness is less than the values listed below, replace.



Friction disk

mm (in.)

| | YSM8 | | YSM12 | |
|---|---|---|---|---|
| | Standard value | Wear limit value | Standard value | Wear limit value |
| Thickness of friction disk | $6^{+0.3}_{0}$ (0.2362 ~ 0.2480) | 4.5 (0.1772) | $6^{-0.3}_{0}$ (0.2362 ~ 0.2480) | 4.5 (0.1772) |

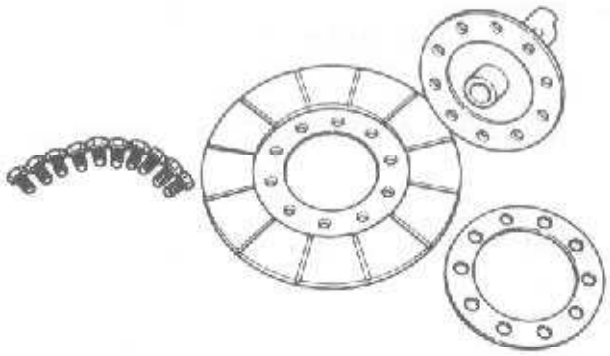
*Printed in Japan*
F023A9078

3. Replacing the friction disk
   1) Remove the clutch and take out the friction disk.
   2) After removing the binding wire, remove the bolt.
   3) After replacing the friction disk, tighten the bolt.

kg-m (ft-lb)

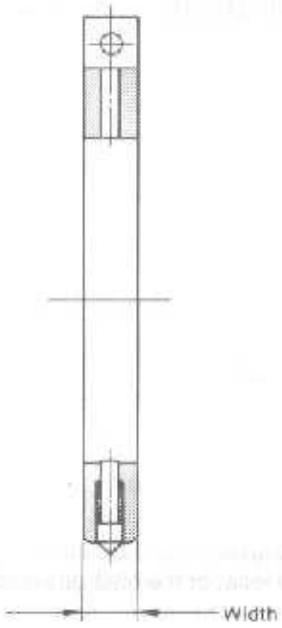
| | |
|---|---|
| Tightening torque | 2.0 to 2.5 (14.26 ~ 18.07) |

   4) By using a binding wire, bind the bolt in the direction in which the bolt is tightened.



## 4-5 Friction disk and neutral position holding pawl.

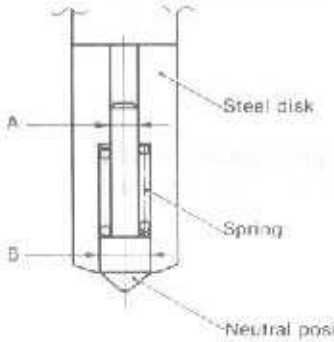
1. Check the friction disk and neutral position holding pawl for damage and burning damage. If they are seriously damaged, replace.
2. Friction disk wear.




mm (in.)

| | YSM8 | | YSM12 | |
|---|---|---|---|---|
| | Standard dimensions | Limit dimensions | Standard dimensions | Limit dimensions |
| Width of friction disk | 18 (0.7087) | 17.8 (0.7008) | 18 (0.7087) | 17.8 (0.7008) |

3. Neutral position holding pawl.




mm (in.)

| YSM8/YSM12 | Standard dimensions | Clearance at assembly | Wear limit of component part |
|---|---|---|---|
| Outside diameter of pawl A | $6\ ^{-0.05}_{-0.15}$ (0.2303 ~ 0.2343) | 0.05 ~ 0.25 (0.0020 ~ 0.0098) | 0.5 (0.0197) |
| Diameter of hole of disk | $6\ ^{+0.1}_{0}$ (0.2362 ~ 0.2402) | | |
| Outside diameter of pawl B | $9\ ^{-0.35}_{-0.15}$ (0.3484 ~ 0.3524) | | |
| Diameter of hole of disk | $9\ ^{+0.1}_{0}$ (0.3543 ~ 0.3583) | | |

Check the pawl tip for wear

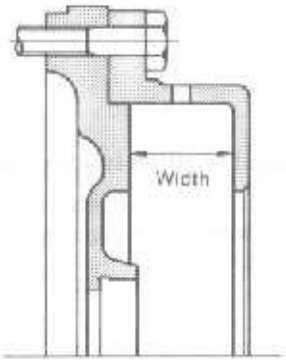
4. Spring for neutral position holding pawl (for both YSM8 and YSM12)
Check the spring for breaks, corrosion, and permanent deformation.

mm (in.)

| | Standard dimensions | Limit dimension |
|---|---|---|
| Free length of spring | 23 mm (0.9055) | 21 mm (0.8268) |

## 4-6 Clutch housing A and clutch housing B

1. Check the friction surface of the clutch housing for cracks, damage, seizure, etc. Repair any damage. If the housing is cracked or seriously damaged, replace.
2. Wear of friction surface
After bolting clutch housing A and clutch housing B together, as shown in the diagram below, measure the wear and width of the friction surface.

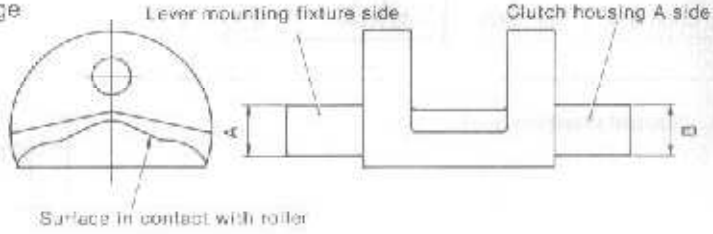



mm (in.)

| | YSM8 | | YSM12 | |
|---|---|---|---|---|
| | Standard dimension | Wear limit dimension | Standard dimension | Wear limit dimension |
| Friction surface and friction surface width | 33.4 mm (1.3150) | 35 (1.3780) | 33.4 mm (1.3150) | 35 (1.3780) |

## 4-7 V-lever and spectacle link

1. Wear of V-lever underside
Check the V-lever's surface, where it comes into contact with the roller of the hold down clamp, for damage and wear.




*Note:* R specifications differ from Y specifications in V-lever shape, but the two specifications are the same in shaft diameter.

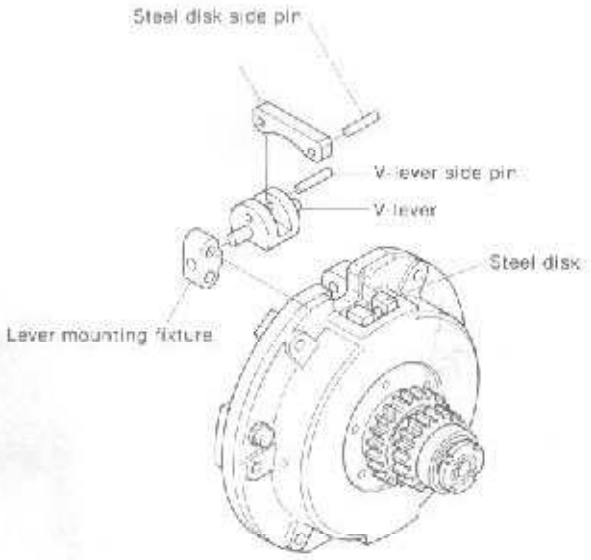
2. Shaft diameter and clearance of V-lever

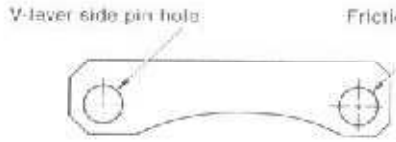
mm (in.)

| | Standard dimensions | Clearance at assembly | Maximum allowable clearance limit |
|---|---|---|---|
| Shaft diameter A | $12^{-0.07}_{-0.10}$ (0.4685 ~ 0.4697) | 0.07 ~ 0.118 (0.0028 ~ 0.0046) | 0.3 (0.0018) |
| Diameter of hole in lever mounting fixture | $12^{+0.018}_{0}$ (0.4724 ~ 0.4731) | | |
| Shaft diameter B | $12^{-0.07}_{-0.10}$ (0.4685 ~ 0.4697) | 0.07 ~ 0.118 (0.0028 ~ 0.0046) | 0.3 (0.0018) |
| Diameter of hole in clutch housing A | $12^{+0.018}_{0}$ (0.4724 ~ 0.4731) | | |

*Printed in Japan*
F023A9078

3. Spectacle link



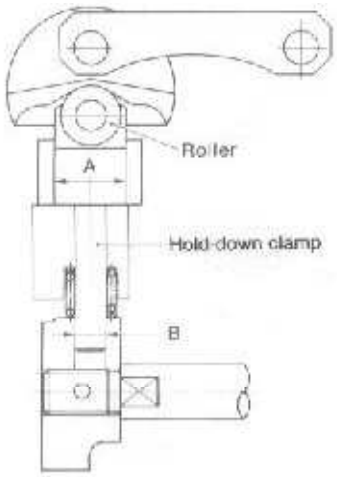



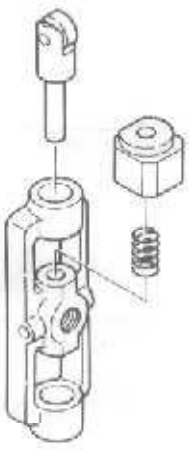

mm (in.)

| | Standard dimensions |
|---|---|
| Diameter of hole in V-lever | 8 $^{+0.020}_{+0.005}$ (0.3152 ~ 0.3157) |
| Diameter of pin hole in V-lever side (spectacle link) | 8 $^{+0.130}_{+0.115}$ (0.3195 ~ 0.3209) |
| Diameter of hole in friction disk side (spectacle link) | 8 $^{+0.015}_{0}$ (0.3150 ~ 0.3156) |
| Diameter of pin | 8 $^{-0.015}_{-0.009}$ (0.3152 ~ 0.3158) |

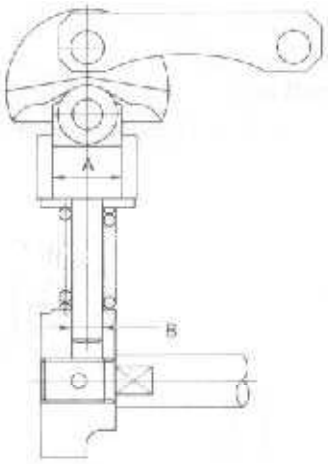
## 4-8 Hold-down clamp

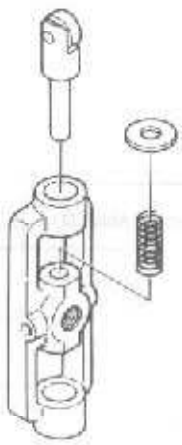
**YSM8-R, YSM12-R**



**YSM8-Y, YSM12-Y**



1. Hold-down clamp Roller
Check the roller surface for damage and wear. If it is seriously damaged or worn out, replace the roller. Make sure that the roller rotates smoothly.

mm (in.)

| | YSM8-R YSM12-R YSM8-Y YSM12-Y | |
|---|---|---|
| | Standard dimensions | Wear limit dimension |
| Outside diameter of roller | 15 (0.5906) | 14.5 (0.5709) |

2. Clearance between roller and hold-down clamp case.

mm (in.)

| | Standard dimensions | Clearance at assembly | Wear limit |
|---|---|---|---|
| Shaft diameter of hold-down clamp A | 18 (0.7087) | 0.016 ~ 0.052 (0.0006 ~ 0.0020) | 0.15 (0.0059) |
| Diameter of hole in hold-down clamp case A | 18 (0.7087) | | |
| Shaft diameter of hold-down clamp B | 8 (0.3150) | 0.013 ~ 0.043 (0.0005 ~ 0.0017) | 0.15 (0.0059) |
| Diameter of hole in hold-down clamp case B | 8 (0.3150) | | |

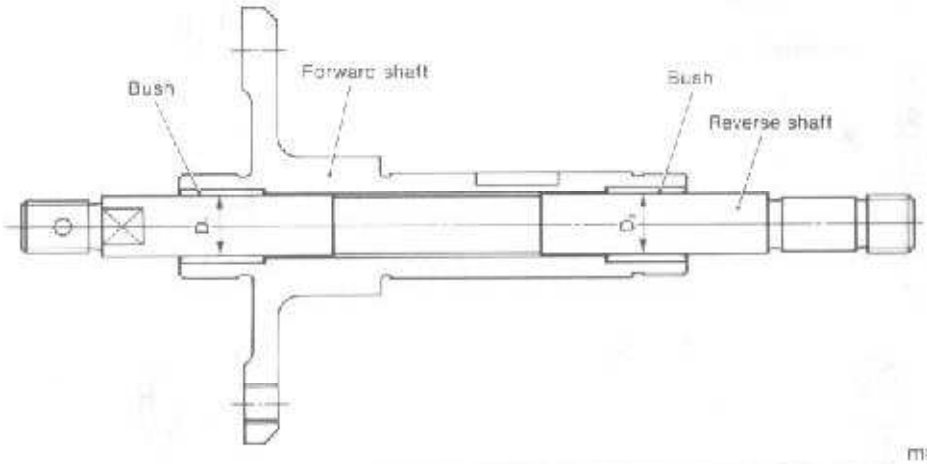
3. Spring for hold-down clamp
Check the spring for breaks, corrosion, permanent deformations, etc.

mm (in.)

| | YSM8-R YSM12-R | | YSM8-Y, YSM12-Y | |
|---|---|---|---|---|
| | Standard dimensions | Limit dimensions | Standard dimensions | Limit dimensions |
| Free length of spring for hold-down clamp | 19 (0.7480) | 17.5 (0.6890) | 31 (1.2205) | 29 (1.1417) |

## 4-9 Forward shaft and sliding shaft (for both YSM8 and YSM12)

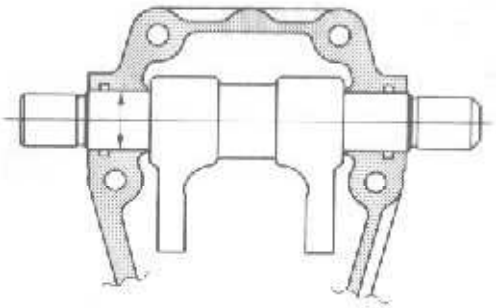
1. Clearance between forward shaft and sliding shaft




mm (in.)

| | Standard dimensions | Clearance at assembly | Maximum allowable clearance |
|---|---|---|---|
| Outside diameter of sliding shaft D1 | $15^{-0.10}_{-0.15}$ (0.5846 ~ 0.5866) | 0.10 ~ 0.17 (0.0039 ~ 0.0067) | 0.3 (0.0118) |
| Inside diameter of bush | $15^{+0.02}_{0}$ (0.5906 ~ 0.5913) | | |
| Outside diameter of sliding shaft D2 | $15^{-0.10}_{-0.15}$ (0.5846 ~ 0.5866) | 0.10 ~ 0.17 (0.0039 ~ 0.0067) | 0.3 (0.0118) |
| Inside diameter of bush | $15^{+0.02}_{0}$ (0.5906 ~ 0.5913) | | |

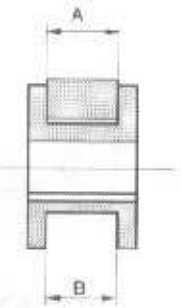
### 4-10 Lever fork

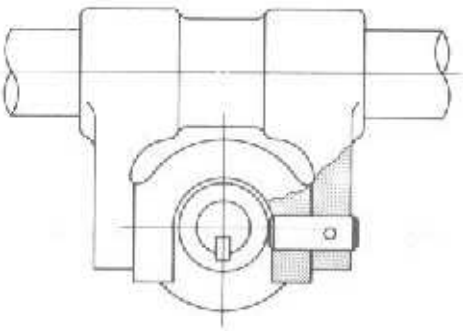


mm (in.)

| | Standard dimension | Clearance at assembly | Clearance at limit of use |
|---|---|---|---|
| Diameter of lever fork shaft | $20\ ^{0}_{-0.050}$ (0.7854 ~ 0.7874) | 0.020 ~ 0.091 (0.0009 ~ 0.0036) | 0.25 (0.0098) |
| Diameter of hole in rear lid | $20\ ^{+0.041}_{+0.020}$ (0.7882 ~ 0.7890) | | |

### 4-11 Shifter bush and shifter driving plate



mm (in.)

| | Standard dimension | Clearance at assembly | Clearance at limit of use |
|---|---|---|---|
| Width of shifter bush | $16\ ^{-0.032}_{-0.050}$ (0.6280 ~ 0.6287) | 0.032 ~ 0.068 (0.0013 ~ 0.0027) | 0.3 (0.0118) |
| Width of groove in shifter driving plate | $16\ ^{+0.018}_{0}$ (0.6299 ~ 0.6306) | | |

### 4-12 Idle gear shaft (forward side and reverse side)

1. Check bearings for burning damage. If the damage is serious, replace the idle gear shaft.
2. Check the O ring for damage. If it is seriously damaged, replace the idle gear shaft.

### 4-13 Output shaft.

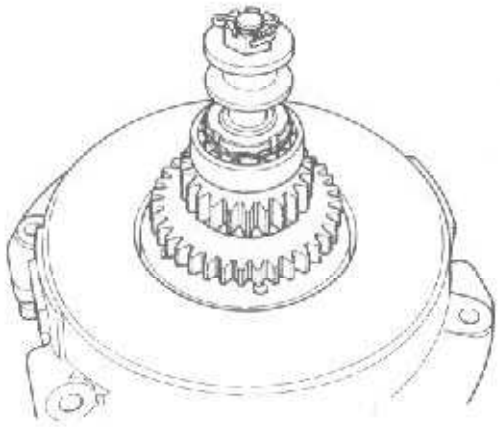
1. Check the key groove for cracking. If it is defective, replace the output shaft.
2. Check the bearing for burning damage and wear. If it is considerably damaged or worn, replace the bearing.
3. Check the oil seal section for wear. If it is considerably worn, replace the oil seal.
4. Check the oil seal. If it is defective, replace it.

*Printed in Japan*
F023A9078

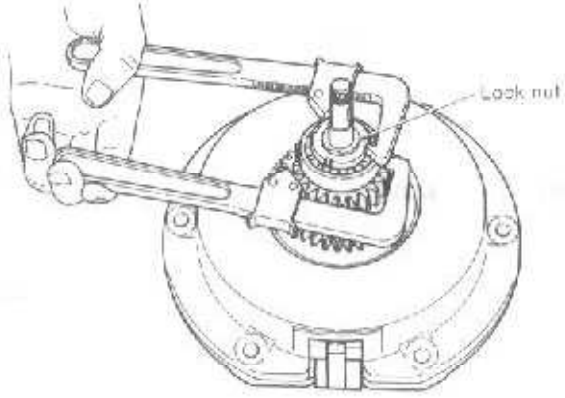
# 5. Disassembling the Reduction and Reversing Gears

### 5-1 Disassembling the clutch

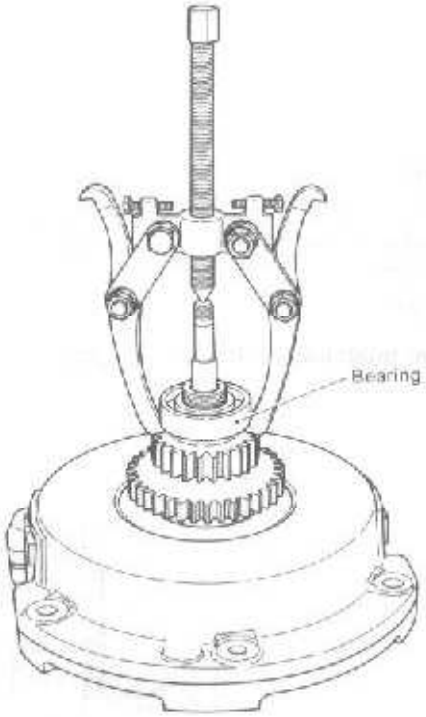
1. Remove split pin, slotted nut and shifter.



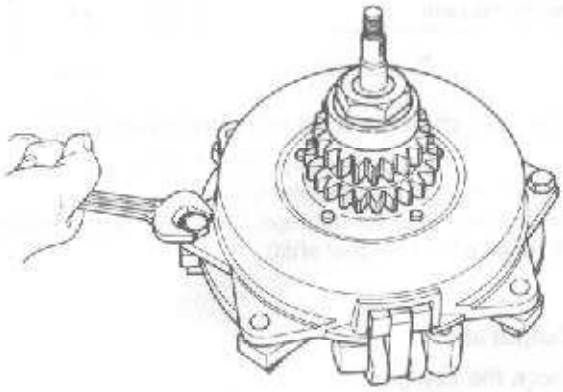
2. By straightening the bent washer remove the lock nut.



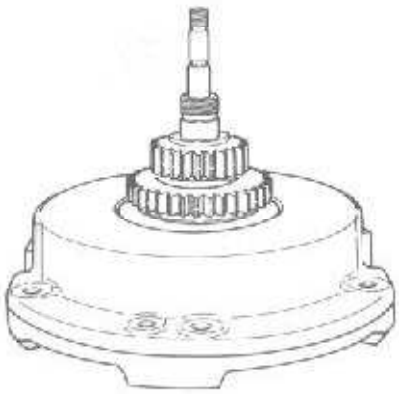

3. Extract the bearing



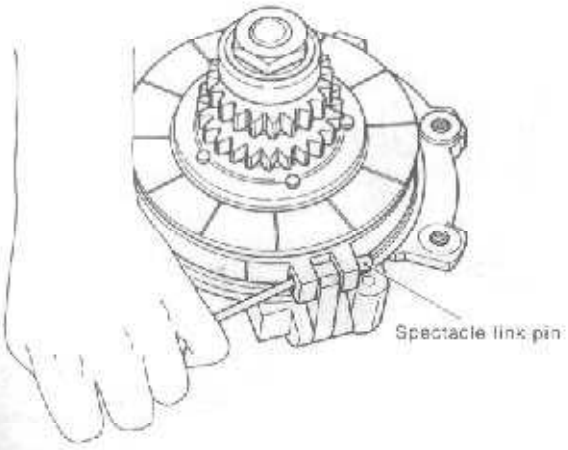

4. Remove the clamp bolts from clutch housings A and B.



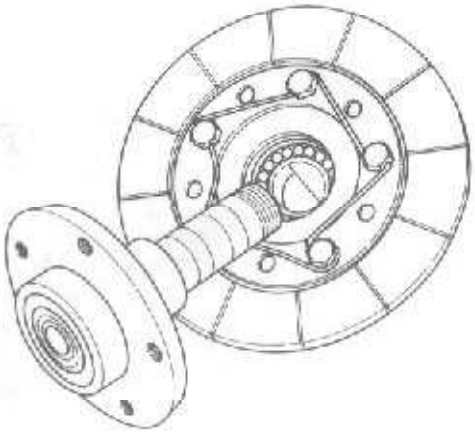
5. Remove clutch housing B.
   This can be removed easily by prying open the gap between A and B.
   The positioning pawl and spring can jump out. Be careful. Each 4 pieces.



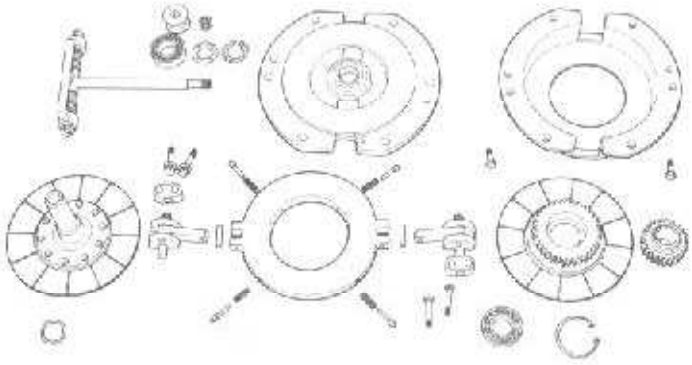
6. Remove the pin of the connecting spectacle link and the V-lever, pin, fixtures, housing A, and sliding shaft.




7. Remove the forward gear, its feather key and circlip.
8. Remove the forward shaft and holding friction plate. Pull out the ball bearing at the same time.

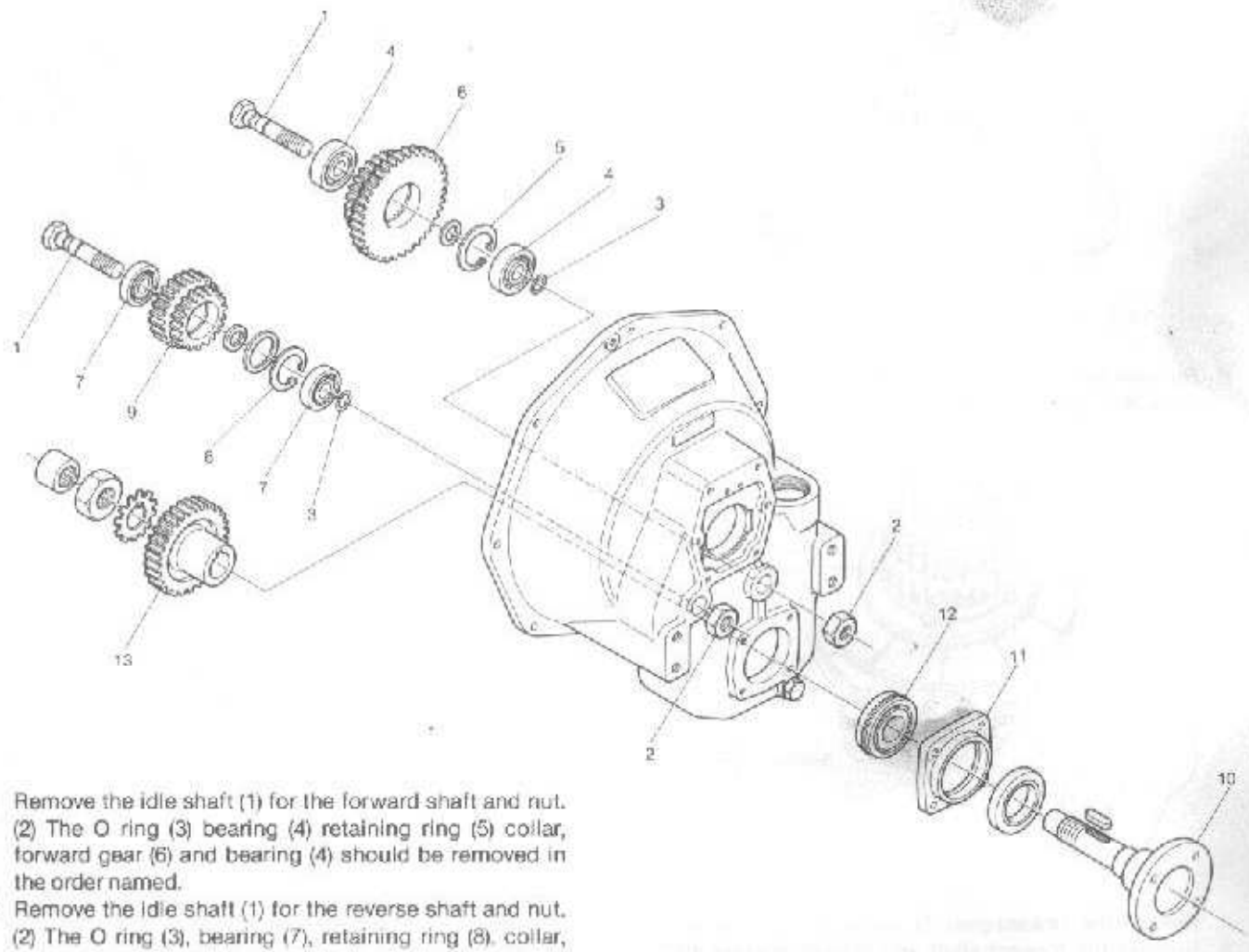


9. Component parts after disassembling



*Printed in Japan*
F023A9078

## 5-2 Disassembling the idle gear and output shaft



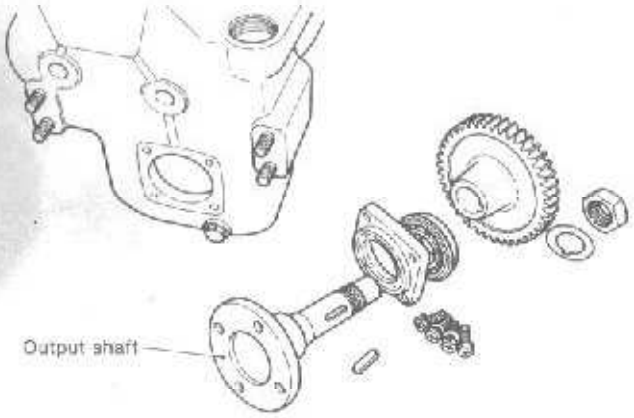

1 Remove the idle shaft (1) for the forward shaft and nut. (2) The O ring (3) bearing (4) retaining ring (5) collar, forward gear (6) and bearing (4) should be removed in the order named.
2 Remove the idle shaft (1) for the reverse shaft and nut. (2) The O ring (3), bearing (7), retaining ring (8), collar, reverse gear (9) and bearing (7) should be removed in the order named.
3 Extract the output shaft (10) by straightening its washer and loosening its clamp nut.
The rear lid (11), bearing (12) and output gear (13) should be removed in the order named.

# 6. Reassembling the Reduction and Reversing Gears

*Note:* Rinse the component parts and reassemble them in the correct sequence.

### 6-1 Reassembling the idle gear and output shaft

1. Attach the output shaft.
   Be careful not to damage the oil seal.

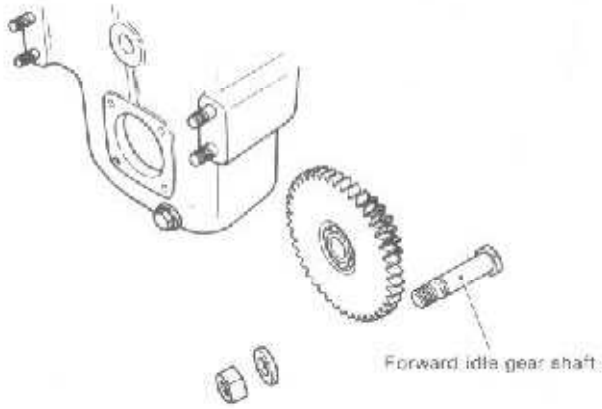



2. Attach the idle shaft for the reverse shaft along with its component parts.
   Reassemble the component parts by reversing the reassembly procedures.

kg-m (ft-lb)

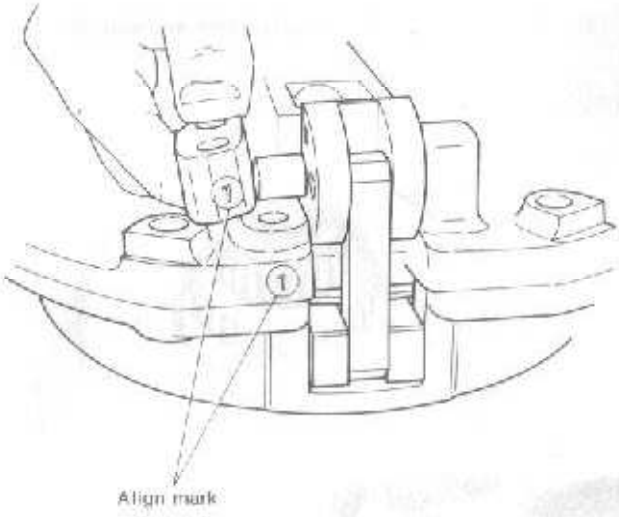
| Tightening torque | Bolt 10 (57.8 ~ 72.3) |
|---|---|


3. Attach the idle shaft for the forward shaft along with its component parts.
   Reassemble the component parts by reversing the disassembly procedures.




### 6-2 Reassembling the clutch

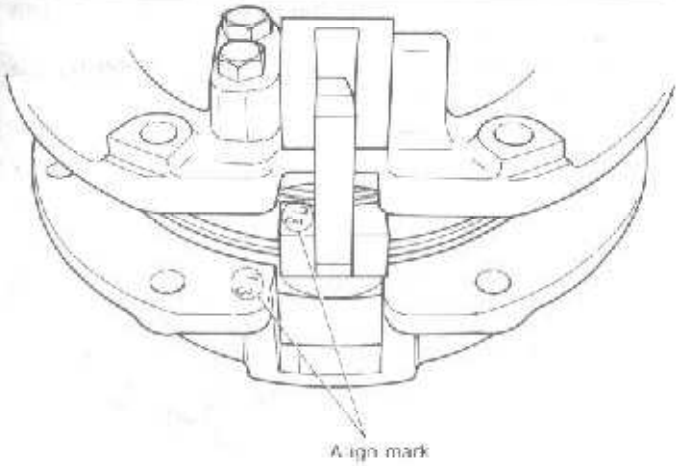
1. Reassemble the forward shaft and the friction plate (reverse) with the holding friction plate placed in-between.
2. Insert the ball bearing and fit the circlip.
   The bearing No. should be visible from outside.
3. Put the sliding shaft and housing A back together, and attach them to the forward shaft.
   Do not fail to attach the neutral position holding spring.
4. Attach the V-lever, pin, fixture and connecting spectacle link pin.
   Arrange them so that the V-lever No. coincides with the friction plate housing No.



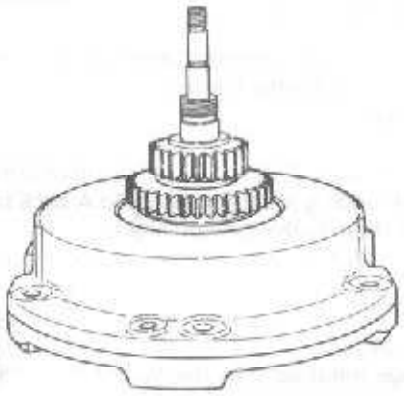
5. Fit the clutch housing B into place and tighten the clamp bolt.
   Align the mark on housing B with that on the V-lever.

kg-m (ft-lb)

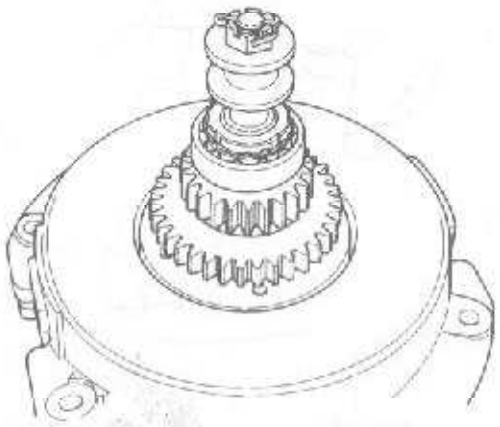
| Tightening torque | 2.3 to 2.7 (16.63 ~ 19.52) |
|---|---|




6. Assemble the feather key, forward gear, ball bearing and bent washer, and tighten the lock nut.
   Place them inside the forward gear face with the longer flange.



7. Mount the shifter, slotted groove and split pin.



*Printed in Japan*
F023A9078