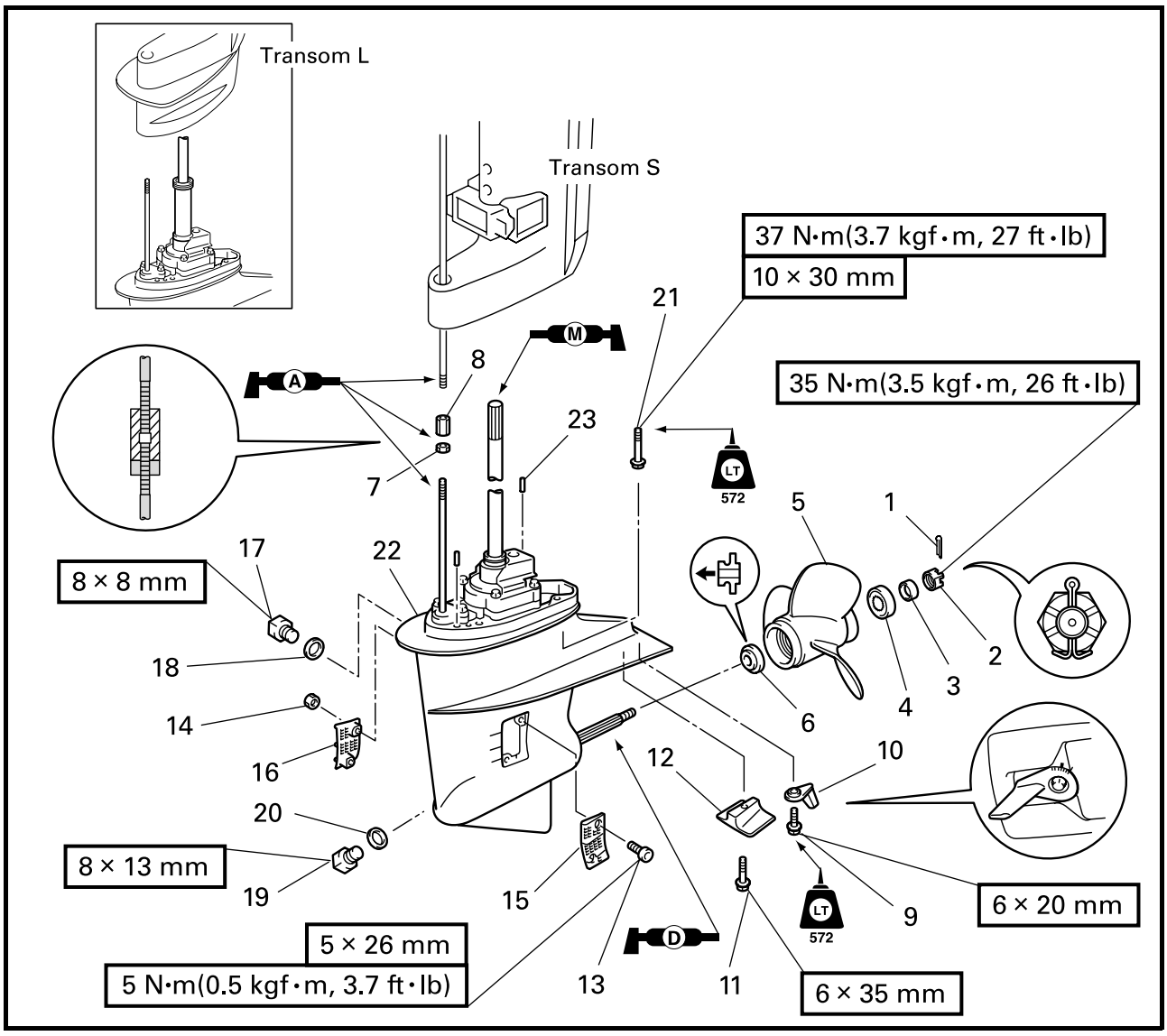
CHAPTER 6
LOWER UNIT

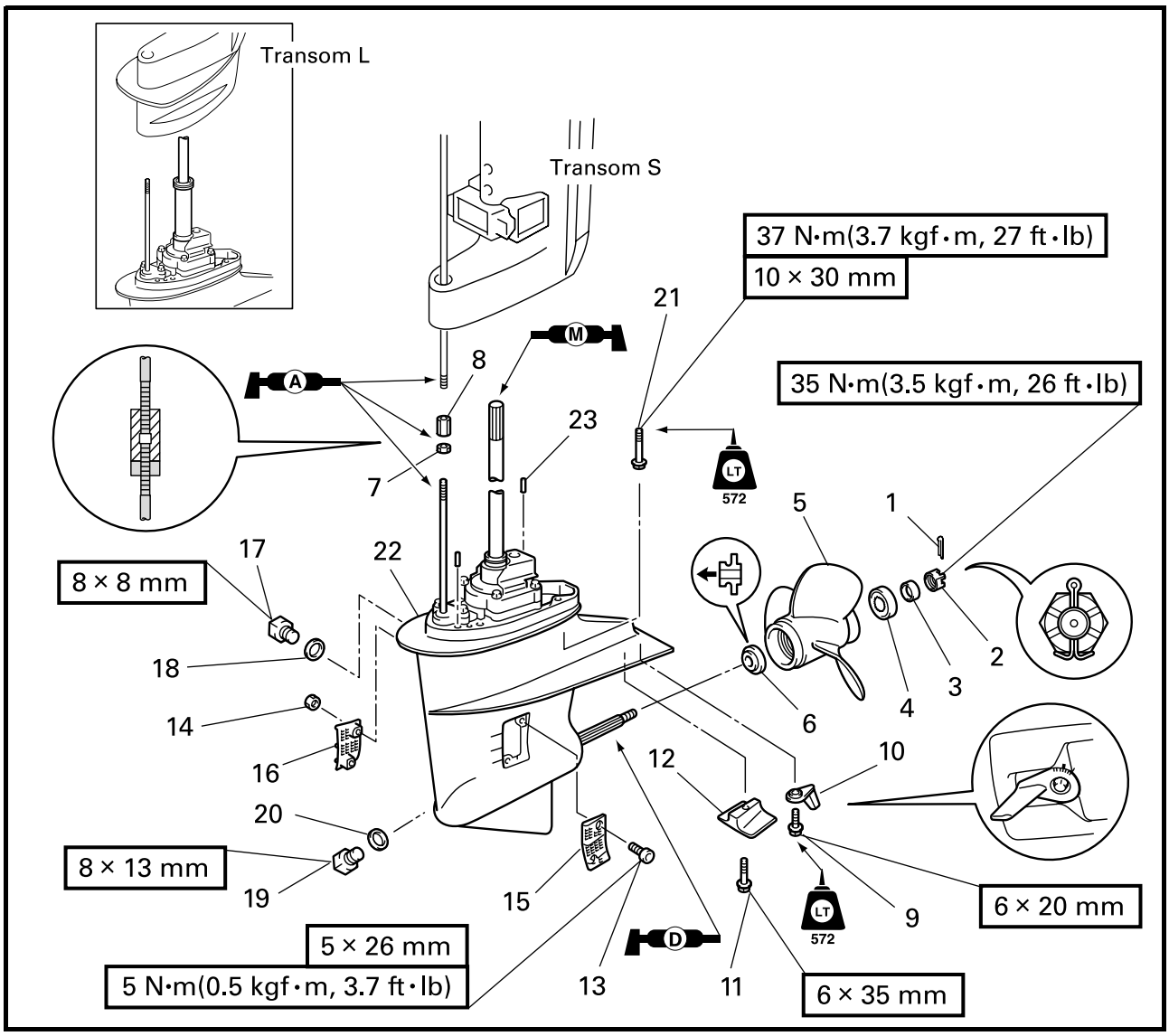
LOWER UNIT

REMOVING THE LOWER UNIT

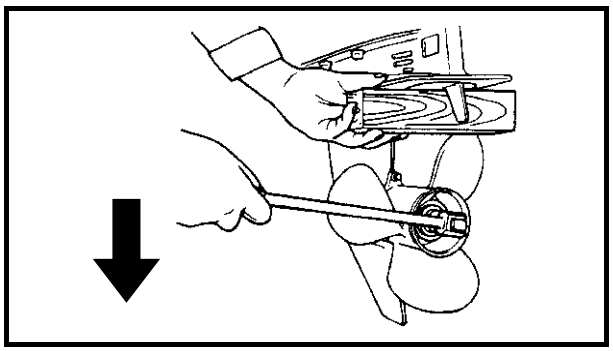


Step	Job/Part	Q'ty	Remarks
1	Cotter pin	1	**Not reusable**
2	Castle nut	1	
3	Washer	1	
4	Spacer	1	
5	Propeller	1	
6	Spacer	1	
7	Nut	1	
8	Shift connector	1	
9	Bolt (with washer)	1	
10	Trim tab	1	
11	Bolt	1	
12	Anode	1	
13	Screw	2	

Continued on next page.



Step	Job/Part	Q'ty	Remarks
14	Nut	2	
15	Water inlet cover 1	1	
16	Water inlet cover 2	1	
17	Gear oil level check screw	1	
18	Gasket	1	
19	Gear oil drain screw	1	
20	Gasket	1	
21	Bolt	4	
22	Lower unit	1	
23	Pin	2	



REMOVING THE PROPELLER

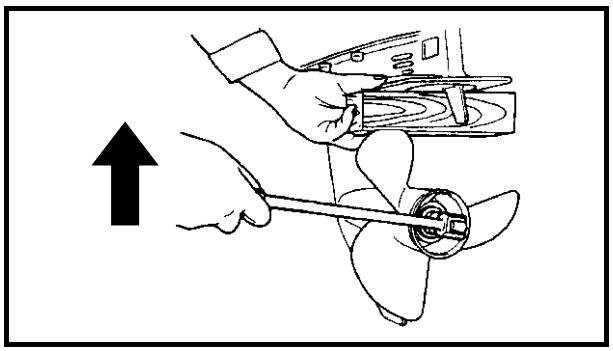
Remove:
- Propeller

⚠ WARNING

Do not hold the propeller with your hands when removing or installing it. Be sure to remove the battery leads from the batteries and the lanyard engine stop switch. Put a block of wood between the cavitation plate and propeller to keep the propeller from turning.

CHECKING THE PROPELLER

Check:
- Blades
- Splines
  Bent/cracks/damage/wear → Replace.
- Bushing
  Slippage → Replace.



INSTALLING THE PROPELLER

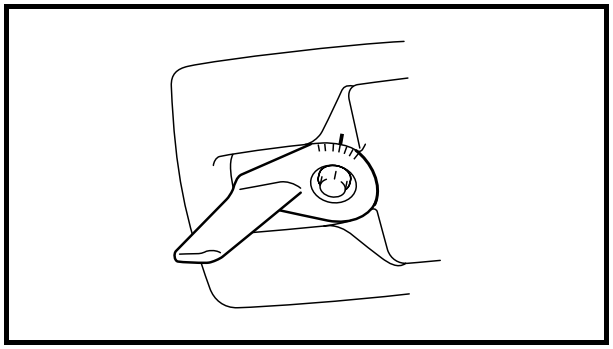
Install:
- Propeller

⚠ WARNING

Do not hold the propeller with your hands when removing or installing it. Be sure to remove the battery leads from the batteries and the lanyard engine stop switch. Put a block of wood between the cavitation plate and propeller to keep the propeller from turning.

NOTE:

If the groove in the propeller nut is not aligned with the cotter pin hole, tighten the nut further until they are aligned.



INSTALLING THE TRIM TAB

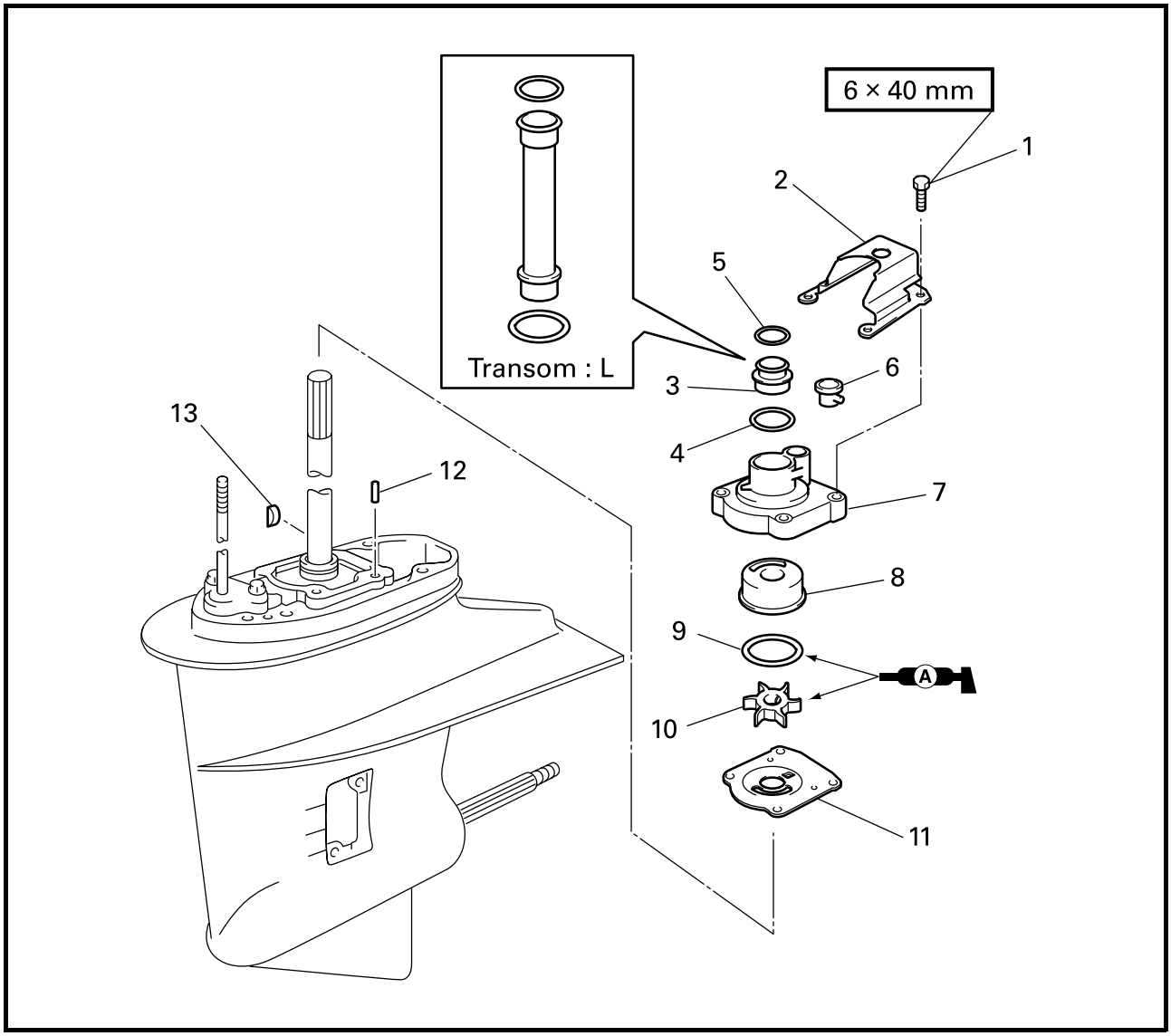
Install:
- Trim tab

NOTE:

- To ease installation, mark the original position of the trim tab.
- Steering load varies depending on the trim tab position as installed.

WATER PUMP

REMOVING THE WATER PUMP



Step	Job/Part	Q'ty	Remarks
1	Bolt	4	
2	Plate	1	
3	Water tube	1	
4	O-ring	1	**Not reusable**
5	O-ring	1	**Not reusable**
6	Water seal rubber	1	
7	Water pump housing	1	
8	Insert cartridge	1	
9	O-ring	1	**Not reusable**
10	Impeller	1	
11	Impeller plate	1	
12	Dowel pin	1	
13	Woodruff key	1	

CHECKING THE WATER PUMP HOUSING

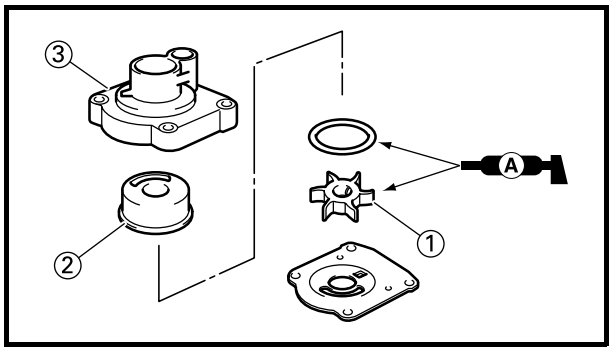
Check:
- Water pump housing
  Cracks/damage → Replace.

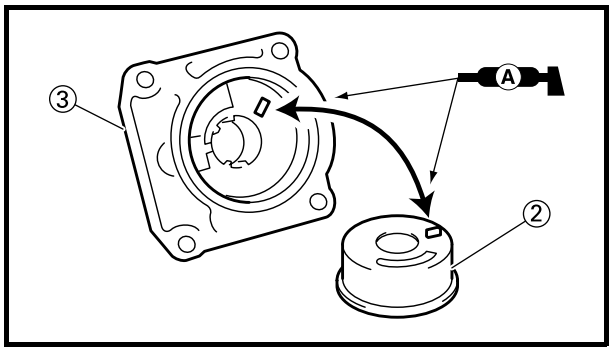
CHECKING THE IMPELLER AND INSERT CARTRIDGE

Check:
- Impeller
- Insert cartridge
  Cracks/damage/wear → Replace.

CHECKING THE WOODRUFF KEY

Check:
- Woodruff key
  Damage/wear → Replace.





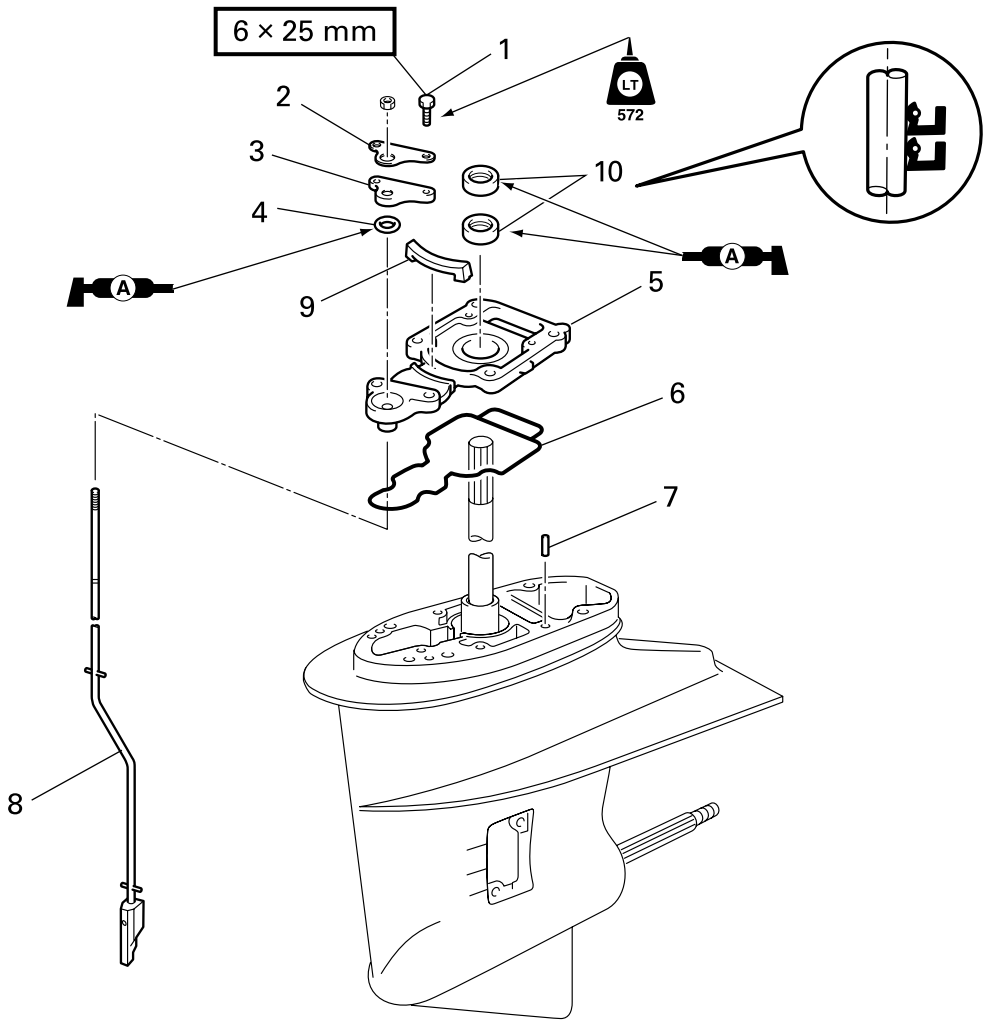
INSTALLING THE IMPELLER AND WATER PUMP HOUSING

Install:
- Impeller ①
- Insert cartridge ②
- Water pump housing ③

NOTE:
- When installing the insert cartridge ②, align its projection with the hole in the water pump housing ③.
- When installing the water pump housing, turn the drive shaft clockwise.
- Apply Yamaha grease A (water resistant grease) on the impeller ①, the insert cartridge ②, and the water pump housing ③.

SHIFT ROD

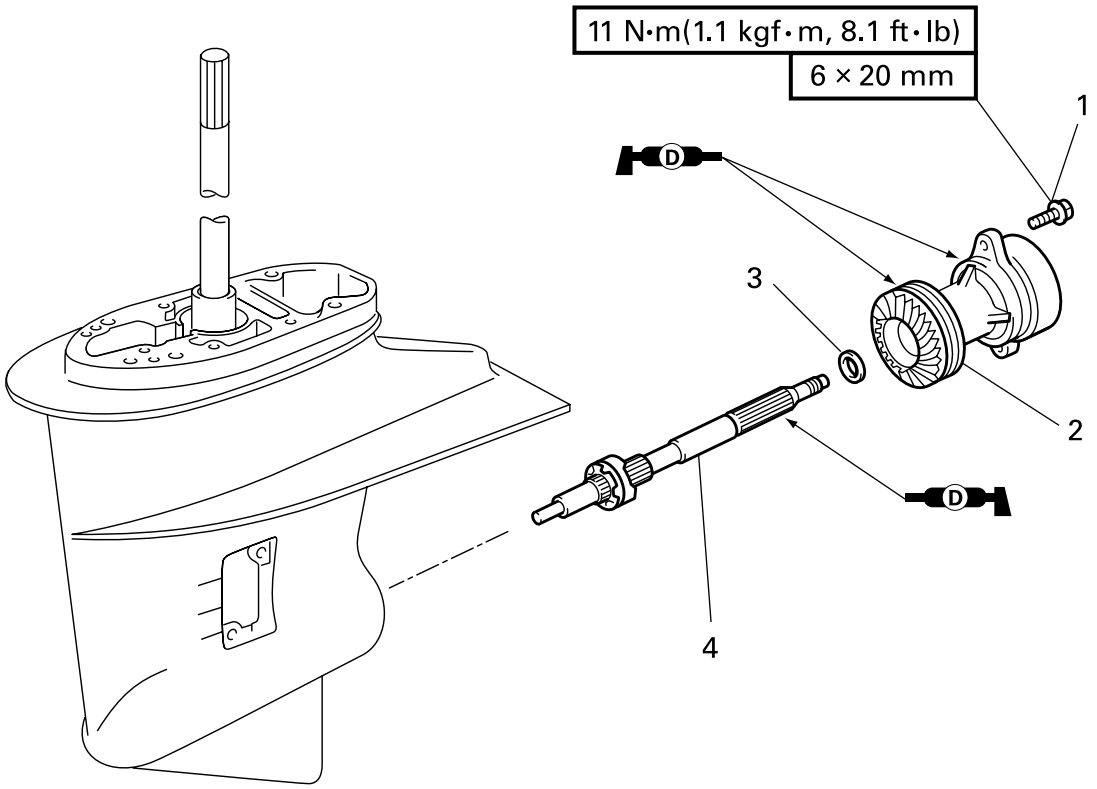
REMOVING THE SHIFT ROD



Step	Job/Part	Q'ty	Remarks
	Impeller plate		Refer to "WATER PUMP" on page 6-4.
1	Bolt	2	
2	Bracket	1	
3	Plate	1	
4	O-ring	1	**Not reusable**
5	Oil seal housing	1	
6	Lower casing packing	1	**Not reusable**
7	Dowel pin	1	
8	Shift rod	1	
9	Rubber seal	1	
10	Oil seal	2	

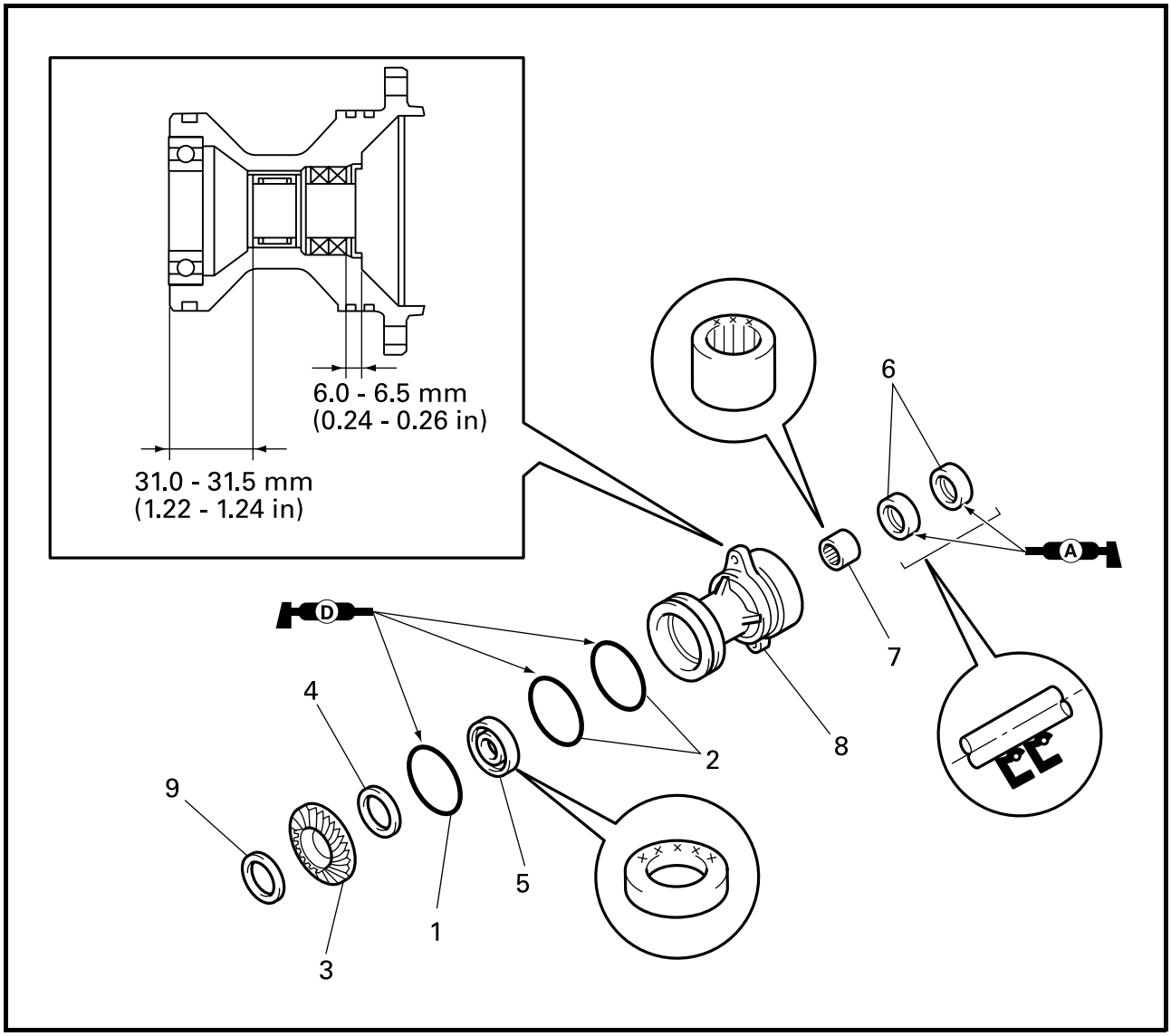
PROPELLER SHAFT HOUSING

REMOVING THE PROPELLER SHAFT HOUSING



Step	Job/Part	Q'ty	Remarks
	Gear oil		Refer to "CHANGING AND CHECKING THE GEAR OIL" on page 3-20.
	Shift rod assembly		Refer to "SHIFT ROD" on page 6-6.
1	Bolt	2	
2	Propeller shaft housing	1	
3	Washer	1	
4	Propeller shaft	1	

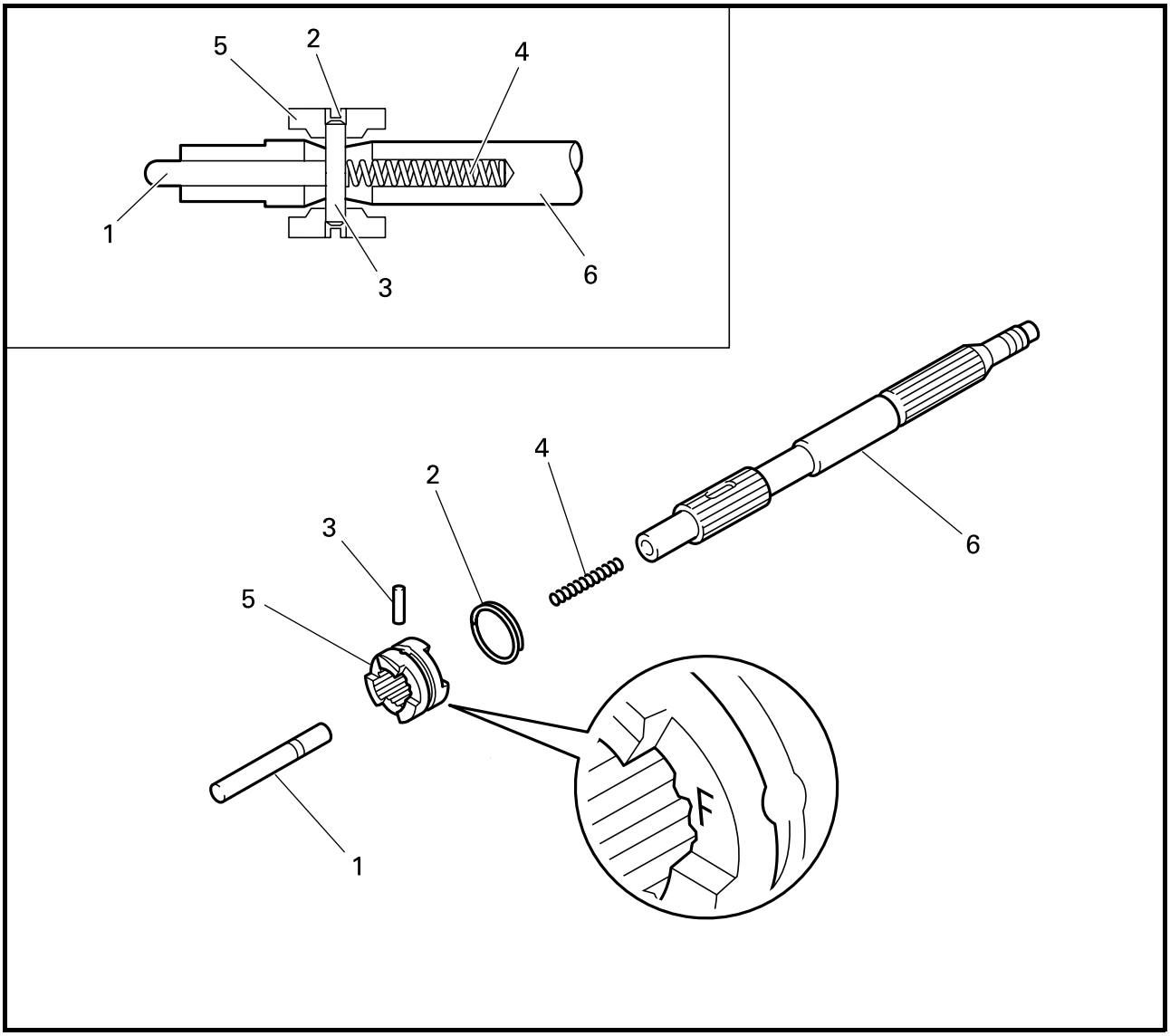
DISASSEMBLING THE PROPELLER SHAFT HOUSING



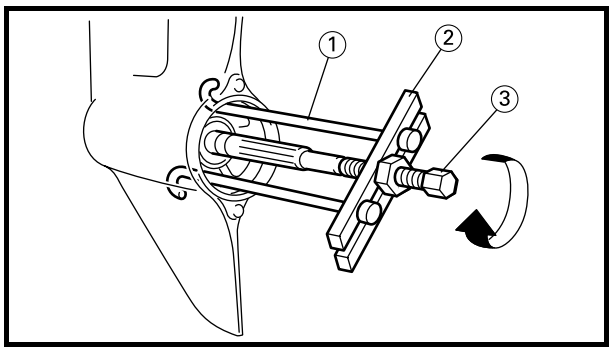
Step	Job/Part	Q'ty	Remarks
1	O-ring	1	**Not reusable**
2	O-ring	2	**Not reusable**
3	Reverse gear	1	
4	Reverse gear shim	*	
5	Ball bearing	1	
6	Oil seal	2	
7	Needle bearing	1	
8	Propeller shaft housing	1	
9	Washer	1	

* As required

DISASSEMBLING THE PROPELLER SHAFT



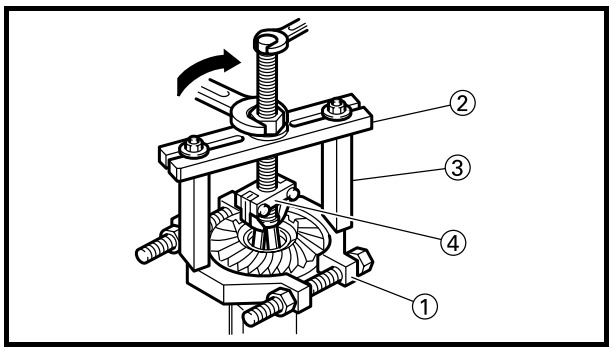
Step	Job/Part	Q'ty	Remarks
1	Shift plunger	1	
2	Cross pin ring	1	
3	Cross pin	1	
4	Spring	1	
5	Dog clutch	1	
6	Propeller shaft	1	

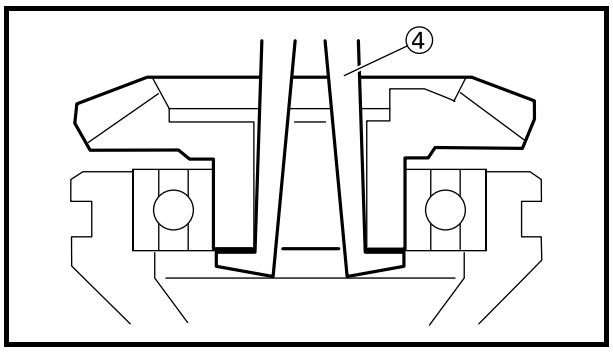


REMOVING THE PROPELLER SHAFT HOUSING

Remove:
- Propeller shaft housing

Bearing housing puller claw ..... ①
90890-06564
Stopper guide plate ..... ②
90890-06501
Center bolt ..... ③
90890-06504

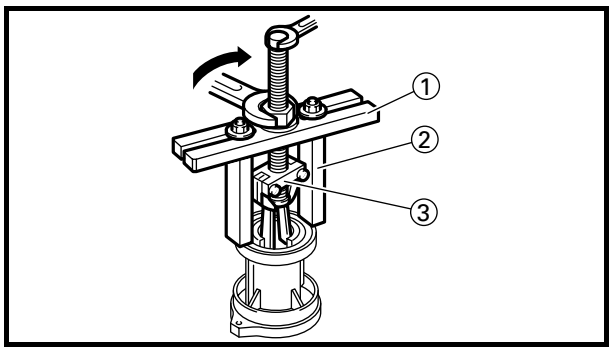




DISASSEMBLING THE PROPELLER SHAFT HOUSING

1. Remove:
   - Reverse gear

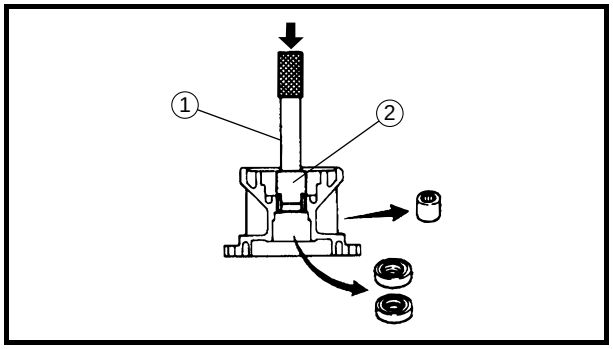
Bearing separator ..... ①
90890-06534
Stopper guide plate ..... ②
90890-06501
Stopper guide stand ..... ③
90890-06538
Bearing puller ass'y ..... ④
90890-06535



2. Remove:
   - Ball bearing

Stopper guide plate ..... ①
90890-06501
Stopper guide stand ..... ②
90890-06538
Bearing puller ass'y ..... ③
90890-06535

NOTE:
Do not reuse the bearing. Always replace it with a new one.



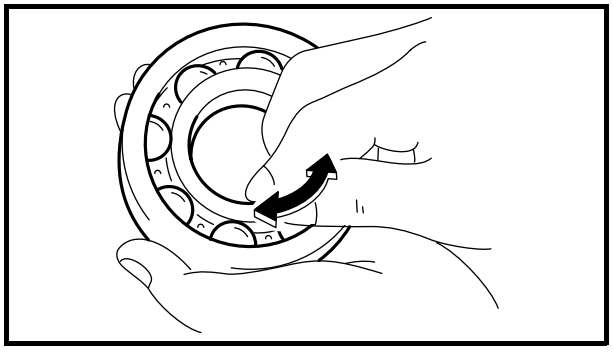
3. Remove:
   - Oil seal
   - Needle bearing

Driver rod L3 ..... ①
90890-06652
Needle bearing attachment ..... ②
90890-06615

CHECKING THE REVERSE GEAR

Check:
- Teeth
- Dogs

  Damage/wear → Replace.



CHECKING THE BEARING

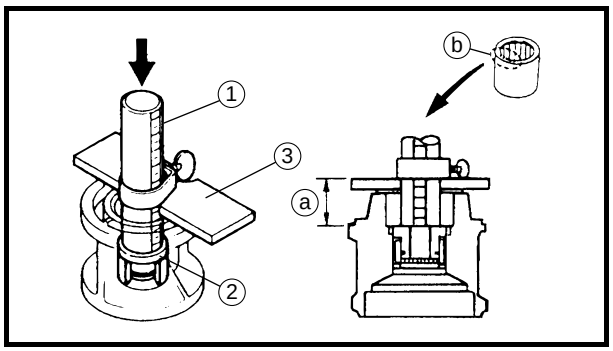
Check:
- Bearing

  Pitting/rumbling → Replace.

CHECKING THE PROPELLER SHAFT HOUSING

Check:
- Propeller shaft housing

  Cracks/damage → Replace.



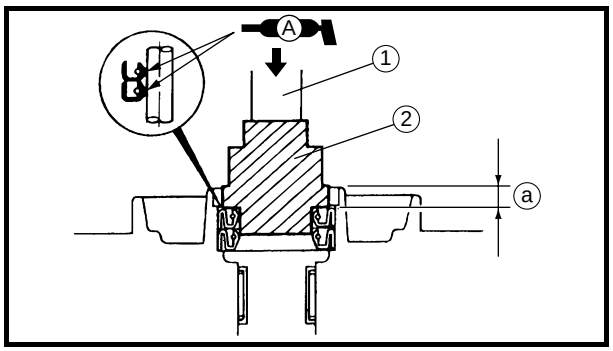
ASSEMBLING THE PROPELLER SHAFT HOUSING

1. Install:
   - Needle bearing

Needle bearing position ..... ⓐ
31.0 - 31.5 mm (1.22 - 1.24 in)

Driver rod-SS ..... ①
90890-06604
Needle bearing attachment ..... ②
90890-06615
Bearing depth plate ..... ③
90890-06603

NOTE:
Install the needle bearing with its manufacturer's marks ⓑ facing up. Apply Yamaha motor oil.

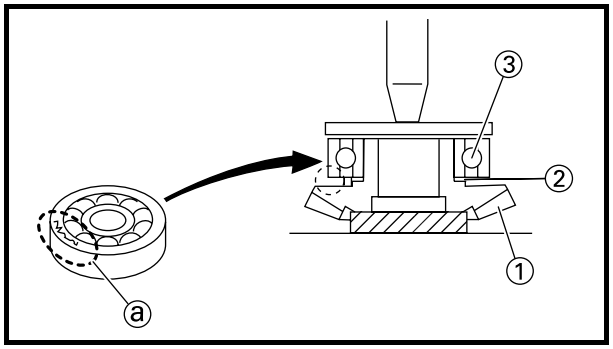


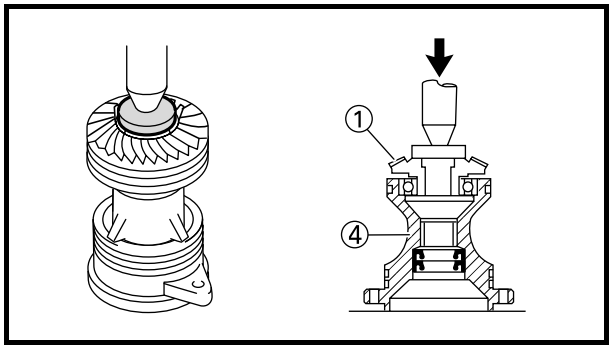
2. Install:
   - Oil seals

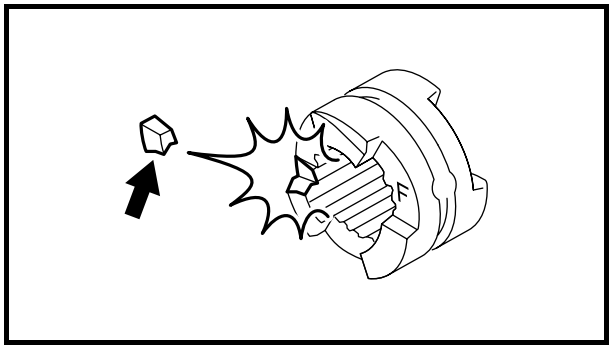
Oil seal position ..... ⓐ
6.0 - 6.5 mm (0.24 - 0.26 in)

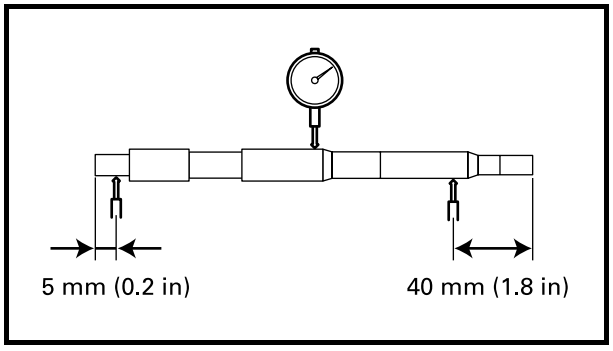
Driver rod L3 ..... ①
90890-06652
Needle bearing attachment ..... ②
90890-06611

CAUTION:
It is essential that the oil seals are installed correctly (as shown in the illustration). If they are installed the wrong way round, oil or water will leak out.









3. Install:
   - Reverse gear ①
   - Reverse gear shim(s) ②
   - Ball bearing ③
   - Propeller shaft housing ④

NOTE:
- Before press-fitting the ball bearing, install the reverse gear shim(s).
- Install the ball bearing with its manufacturer's marks ⓐ facing the reverse gear.

CAUTION:
Place a suitable base under the gear to protect it from damages.

CHECKING THE DOG CLUTCH

Check:
- Dog clutch
  Damage/wear → Replace.

CHECKING THE PROPELLER SHAFT

Check:
- Propeller shaft
  Damage/wear → Replace.

Maximum runout
0.1 mm (0.004 in)

CHECKING THE SHIFT PLUNGER

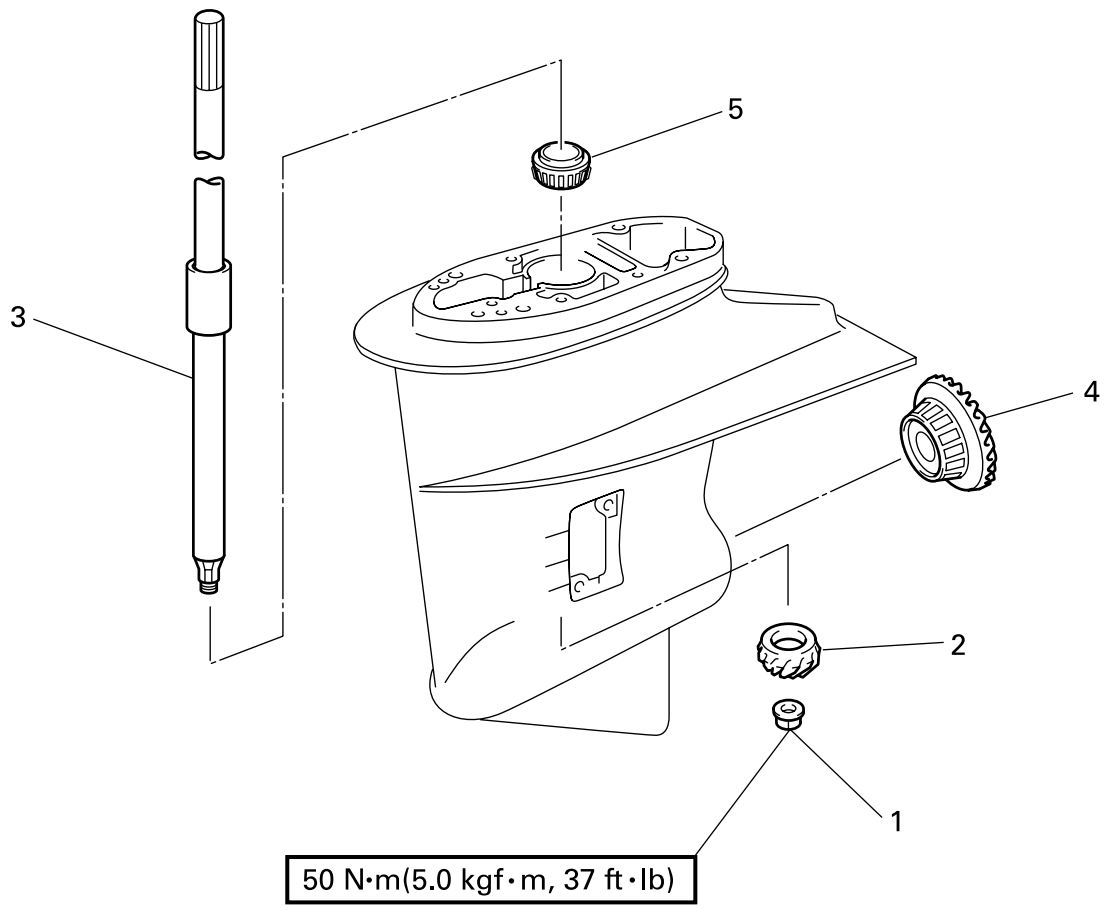
Check:
- Shift plunger
  Wear → Replace.

CHECKING THE SPRING

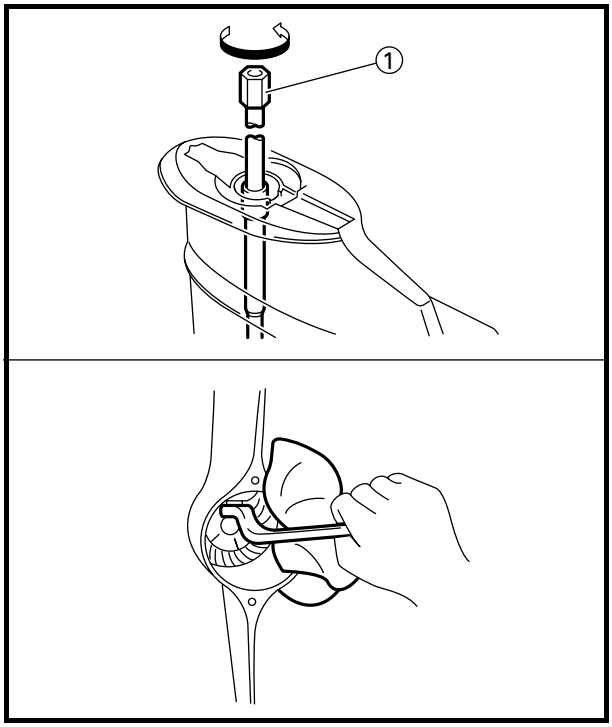
Check:
- Spring
  Weak → Replace.

DRIVE SHAFT

REMOVING THE DRIVE SHAFT



Step	Job/Part	Q'ty	Remarks
	Propeller shaft housing		Refer to "PROPELLER SHAFT HOUSING" on page 6-7.
1	Pinion gear nut	1	
2	Pinion gear	1	
3	Drive shaft	1	
4	Forward gear	1	
5	Drive shaft bearing	1	



REMOVING THE DRIVE SHAFT

Remove:
- Pinion gear nut
- Drive shaft

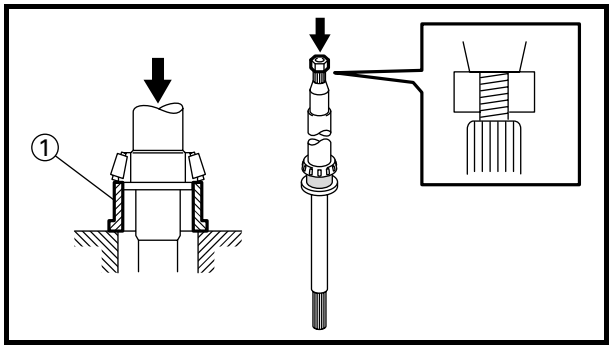
	Drive shaft holder 3 .....① **90890-06517**

Removing Steps

(1) Apply 12mm wrench on the pinion gear nut.

(2) Support the lower case with rags to hold the wrench in position.

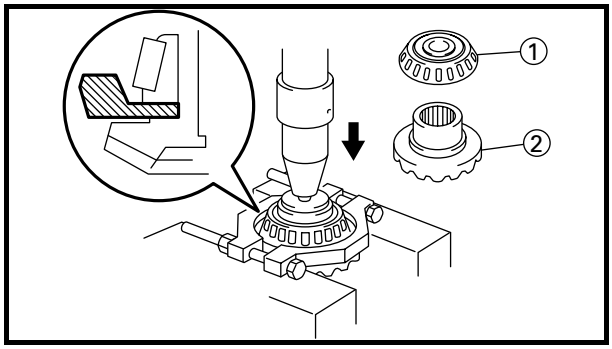
(3) Turn the drive shaft holder ①.



REMOVING THE DRIVE SHAFT BEARING

Remove:
- Taper roller bearing

	Bearing inner race attachment ....① **90890-06643**



DISASSEMBLING THE FORWARD GEAR

Remove:
- Taper roller bearing ①
- Forward gear ②

	Bearing separator **90890-06534**

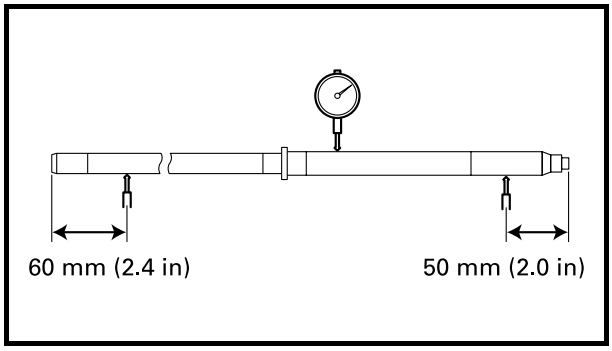
CAUTION:

Place a suitable base on the gear axle to prevent damage to the top of the axle.

CHECKING THE PINION AND FORWARD GEAR

Check:
- Teeth
- Dogs

Damage/wear → Replace.

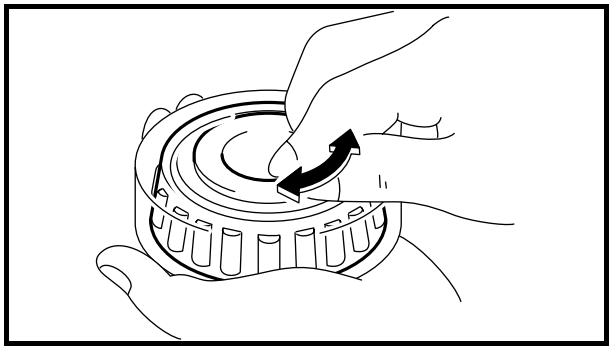


CHECKING THE DRIVE SHAFT

Check:
- Drive shaft

Damage/wear → Replace.

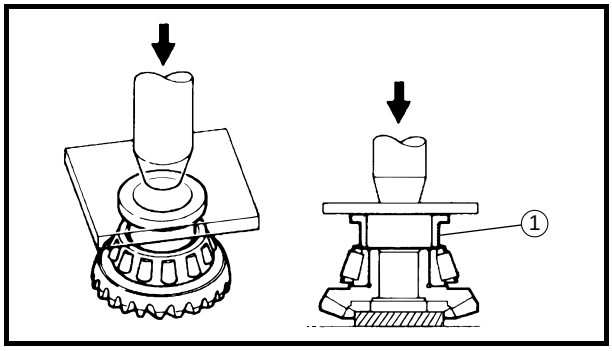
Maximum runout
0.5 mm (0.020 in)



CHECKING THE BEARINGS

Check:
- Bearings

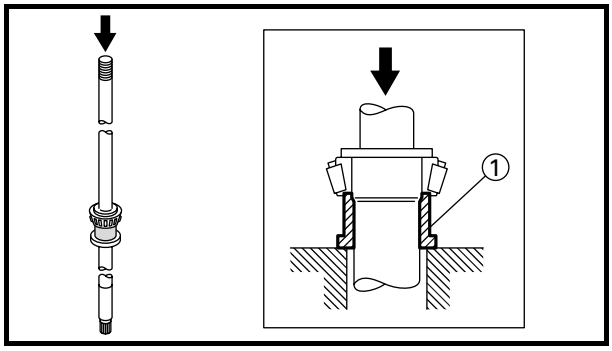
Pitting/rumbling → Replace.



ASSEMBLING THE FORWARD GEAR

Install:
- Forward gear
- Taper roller bearing

Bearing inner race attachment ....① 90890-06644



INSTALLING THE DRIVE SHAFT BEARING

Install:
- Drive shaft bearing

Bearing inner race attachment ....① 90890-06645

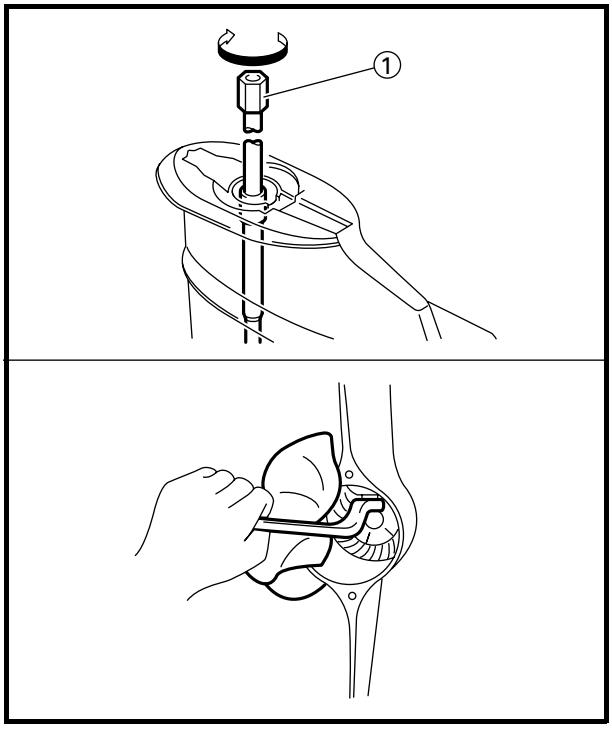
INSTALLING THE DRIVE SHAFT

1. Install:
   - Forward gear
     (with the tapered roller bearing)
   - Drive shaft
     (with the tapered roller bearing)
   - Pinion gear

	**Drive shaft holder 3 .....①** **90890-06517**

2. Tighten:
   - Pinion gear nut

	**Pinion gear nut** **50 N•m (5.0 kgf•m, 37 ft•lb)**



Tightening steps

(1) Apply 12mm wrench on the pinion gear nut.

(2) Support the lower case with rags to hold the wrench in position.

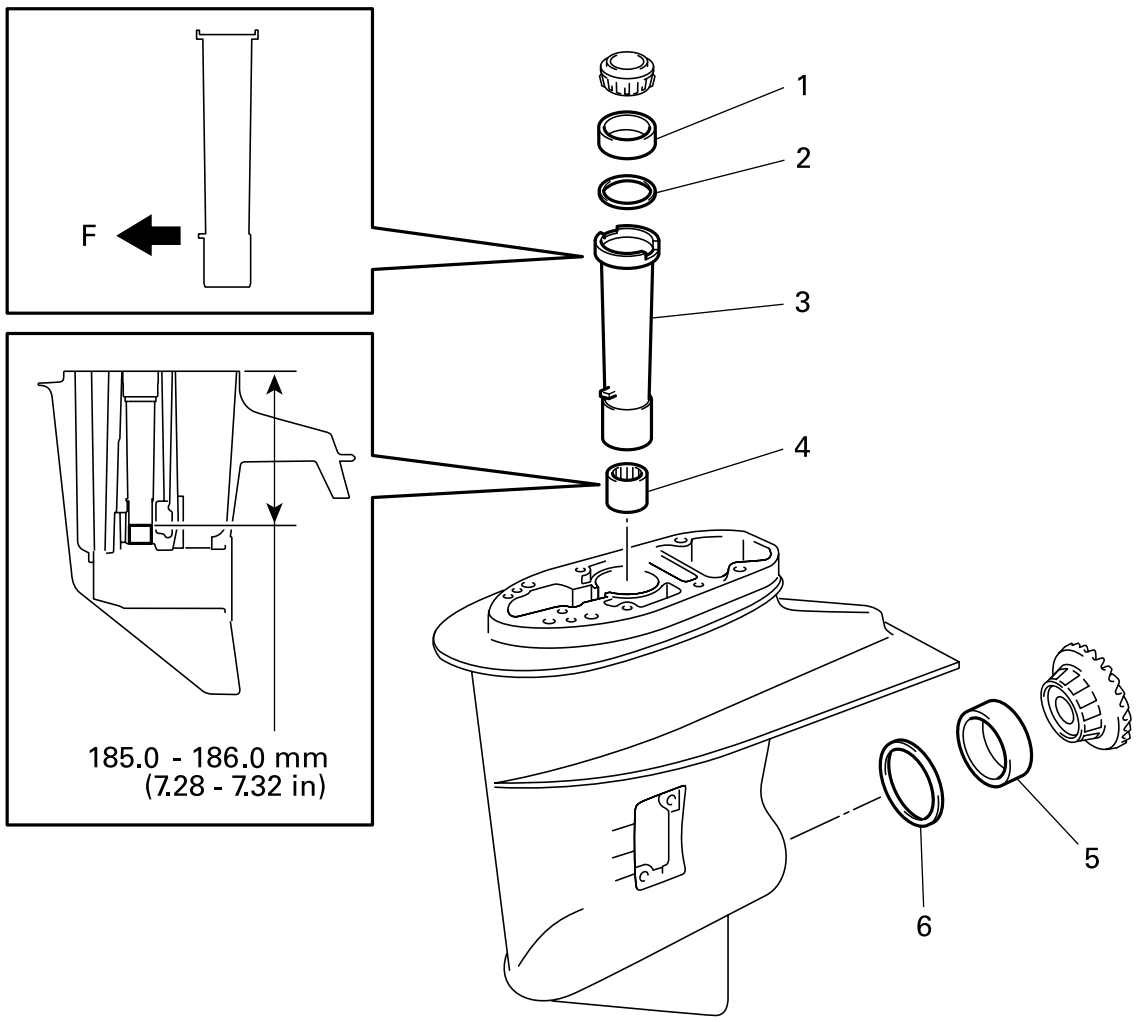
(3) Turn the drive shaft holder ①.

NOTE:

Tighten the pinion gear nut with the same tools that were used for removal.

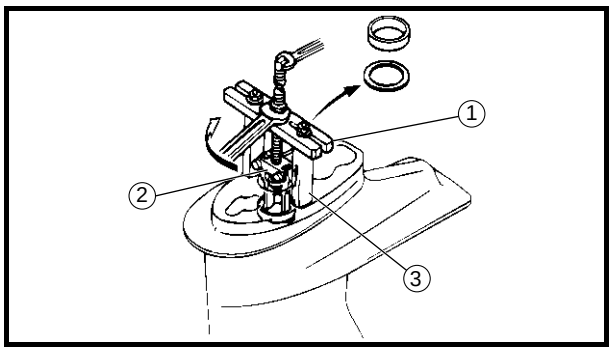
LOWER CASE

DISASSEMBLING THE LOWER CASE



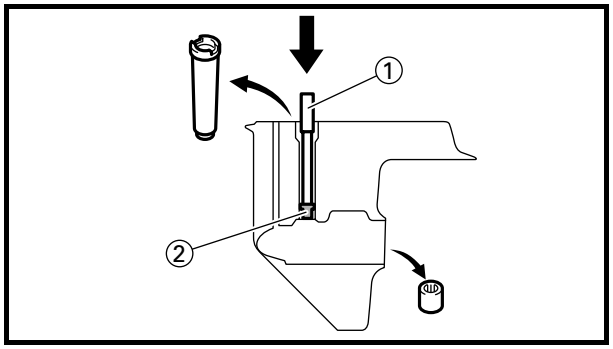
Step	Job/Part	Q'ty	Remarks
1	Drive shaft bearing outer race	1	
2	Pinion gear shim	*	
3	Drive shaft sleeve	1	
4	Needle bearing	1	
5	Tapered roller bearing outer race	1	
6	Forward gear shim	*	

* As required



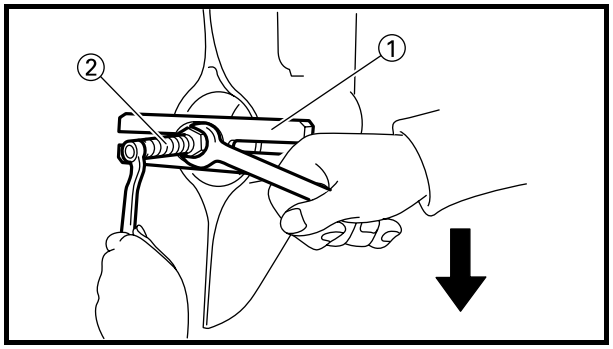
1. Remove:
   - Drive shaft bearing outer race
   - Pinion gear shim(s)

Stopper guide plate ..... ①
90890-06501
Bearing puller ass'y ..... ②
90890-06535
Stopper guide stand ..... ③
90890-06538



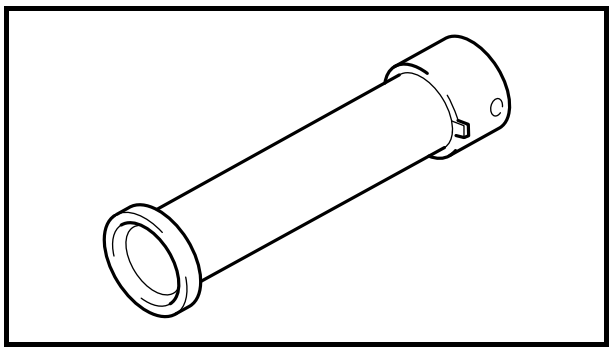
2. Remove:
   - Drive shaft needle bearing and sleeve

Driver rod L3 ..... ①
90890-06652
Needle bearing attachment ..... ②
90890-06615



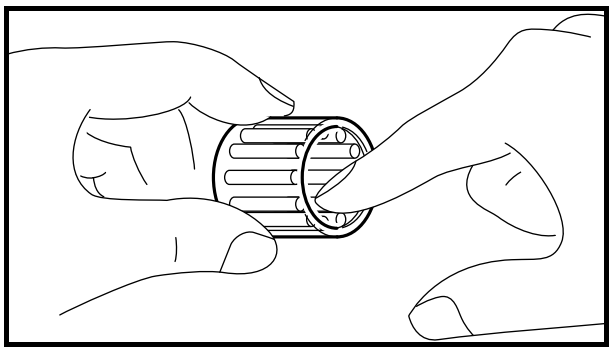
3. Remove:
   - Forward gear bearing outer race and shim(s)

Stopper guide plate ..... ①
90890-06501
Bearing puller ass'y ..... ②
90890-06535



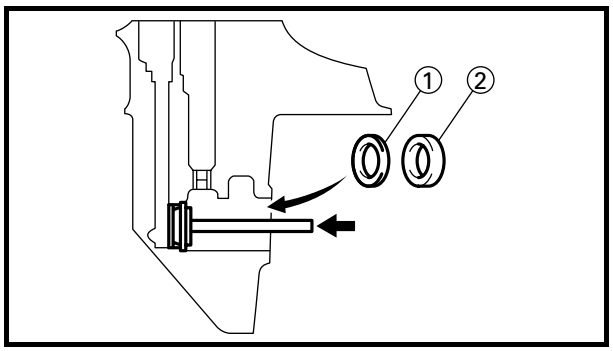
CHECKING THE DRIVE SHAFT SLEEVE

Check:
- Drive shaft sleeve
  Damage/wear → Replace.



CHECKING THE NEEDLE BEARING

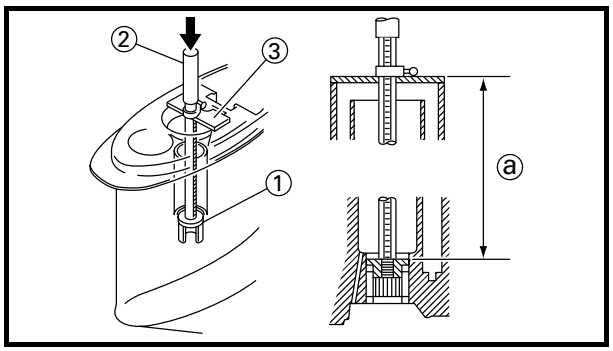
Check:
- Needle bearing
  Pitting/rumbling → Replace.



ASSEMBLING THE LOWER CASE

1. Install:
   - Forward gear shim(s) ①
   - Tapered roller bearing outer race ②

Bearing outer race attachment
90890-06622
Driver rod LL
90890-06605

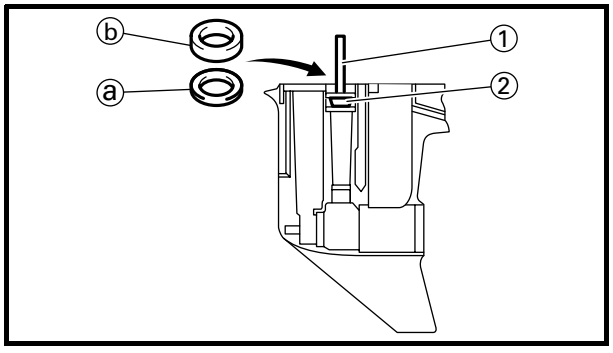


2. Install:
   - Drive shaft needle bearing

Depth ⓐ
185.0 - 186.0 mm (7.28 - 7.32 in)

Needle bearing attachment ..... ①
90890-06615
Driver rod SL ..... ②
90890-06602
Bearing depth plate ..... ③
90890-06603

NOTE:
Install the drive shaft needle bearing with the manufactuer's marks facing up.



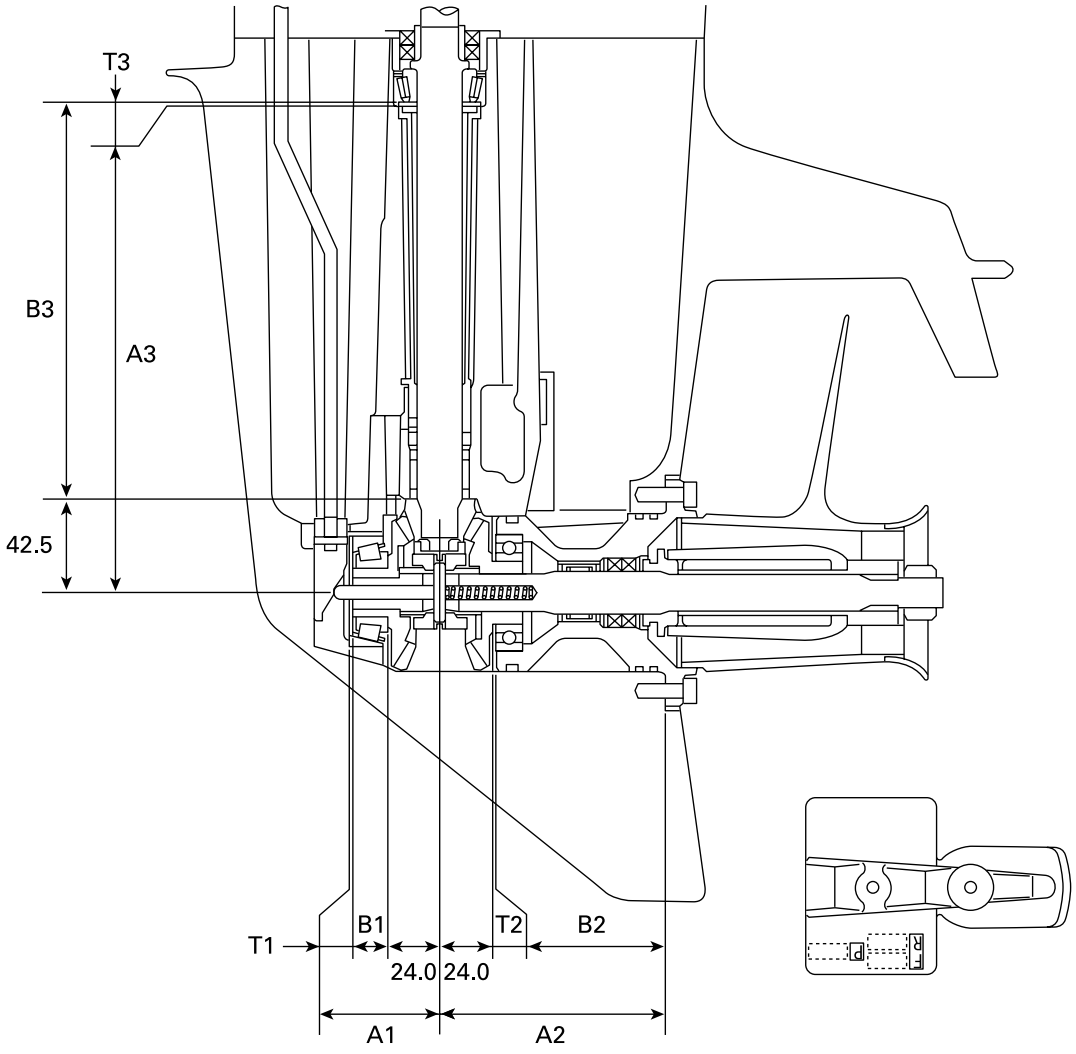
3. Install:
   - Pinion gear shim(s) ⓐ
   - Drive shaft bearing outer race ⓑ

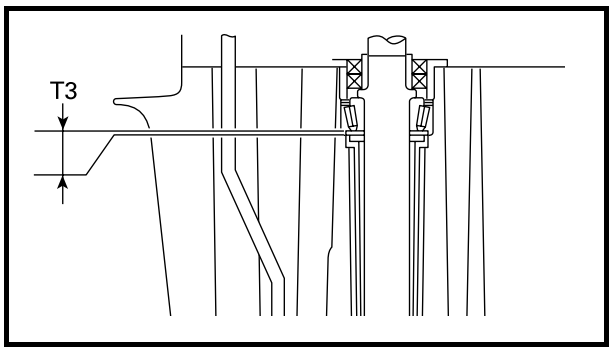
Driver rod LS ..... ①
90890-06606
Bearing outer race attachment .... ②
90890-06628

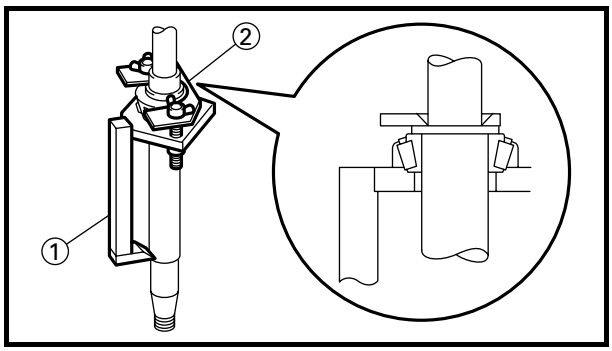
SHIMMING

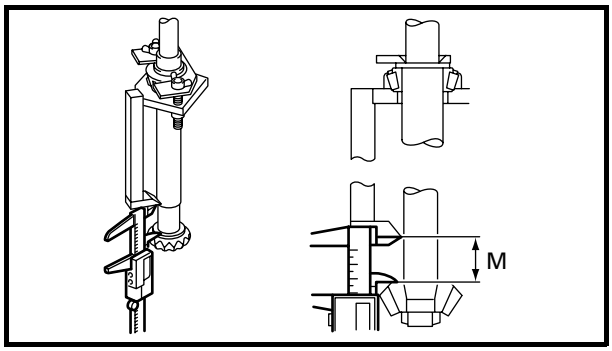
NOTE:

- There is no need to select shims when reassembling with the original case and inner part(s).
- Shim calculations are required when reassembling with the original inner parts and a new case (the difference between the original inner parts and the new case).
- Measurements and adjustments are required when replacing the inner part(s).









SELECTING THE PINION SHIMS

NOTE:
Select the shim thickness (T3) by using the specified measurement(s) and the calculation formula.

Select:
- Shim thickness (T3)

Selecting steps

(1) Install the pinion height gauge, drive shaft and bearing (with bearing race).

	Pinion height gauge .....① **90890-06702** **Drive shaft holder 3 .....②** **90890-06517**

NOTE:
- Attach the pinion height gauge to the drive shaft so that the shaft is at the center of the hole.
- After the wing nuts contact the fixing plate, tighten them another 1/4 of a turn.

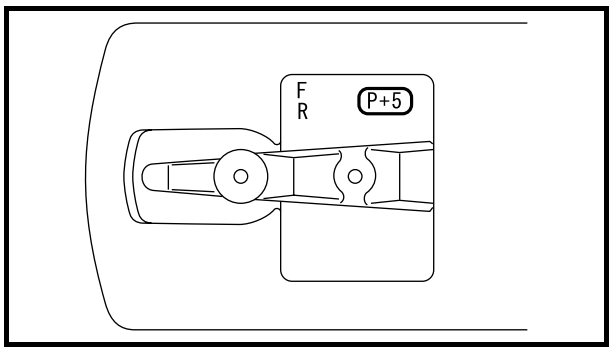
(2) Install the pinion gear and pinion gear nut.

	Pinion gear nut **50 N•m (5.0 kgf•m, 37 ft•lb)**

(3) Measure (M).

	Digital caliper **90890-06704**

NOTE:
- Measure the clearance between the pinion height gauge and the pinion, as shown.
- Perform the same measurement at three points on the pinion.
- Find the average of the measurements (M).
- When using the digital caliper, be sure to place it at right angles to the pinion. Otherwise, measurement will be incorrect.



(4) Calculate the pinion gear shim thickness (T3).

Pinion gear shim thickness (T3) = M - 27 mm - P/100 mm

NOTE:

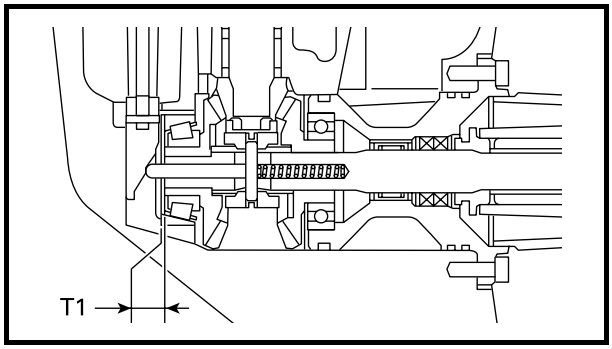
- "P" is the deviation of the lower case dimension from standard. It is stamped on the trim tab mounting surface of the lower case in 0.01 mm units. If the "P" mark is missing or unreadable, assume a "P" value of "0", and check the backlash when the unit is assembled.
- If the "P" mark is negative (-), then add the "P" value to the measurement.

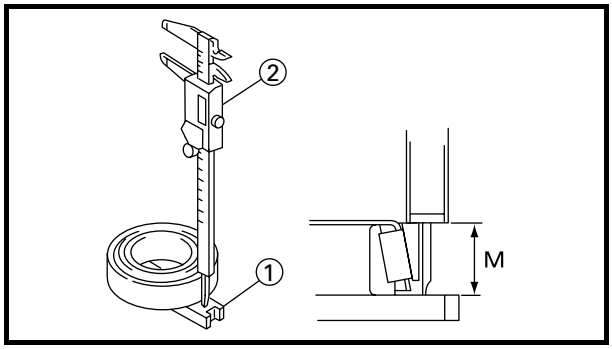
Example:
If M is "28.30 mm" and "P" is "+5", then:
T3 = 28.30 mm - 27 mm - (+5)/100 mm
= 1.3 mm - 0.05 mm
= 1.25 mm (0.049 in)
If M is "28.24 mm" and "P" is "-3", then:
T3 = 28.24 mm - 27 mm - (-3)/100 mm
= 1.24 mm + 0.03 mm
= 1.27 mm (0.05 in)

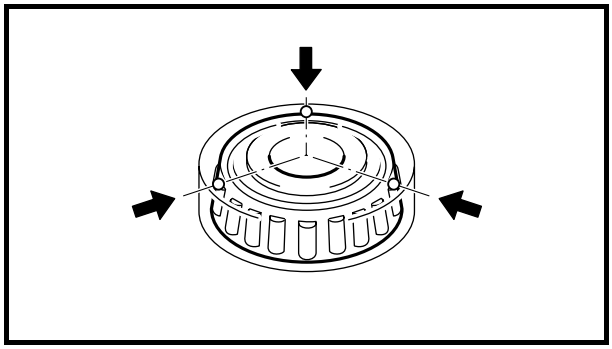
(5) Select the pinion gear shim(s) (T3).

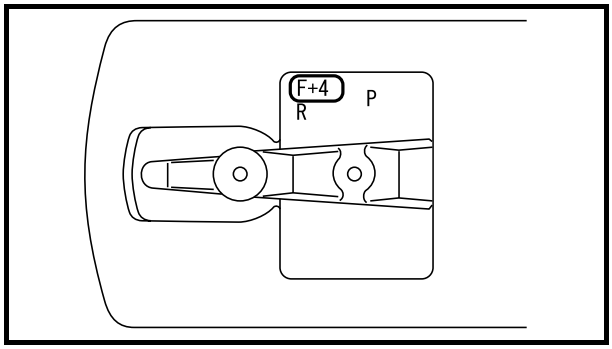
Calculated numeral at 1/100th place		Using shim
more than	or less	
1.10	1.20	1.2
1.20	1.30	1.3
1.30	1.40	1.4
1.40	1.50	1.5
1.50	1.60	1.6
1.60	1.70	0.7, 1.0
1.70	1.83	0.7, 1.1

Available shim thickness
0.7, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6 mm









SELECTING THE FORWARD GEAR SHIMS

NOTE:

Select the shim thickness (T1) by using the specified measurement(s) and the calculation formula.

Select:
- Shim thickness (T1)

Selecting steps

(1) Measure (M).

	Shimming plate ..... ① **90890-06701**
	Digital caliper ..... ② **90890-06704**

NOTE:

- Turn the tapered roller bearing outer race two or three times so that the rollers seat.
  Then, measure the height of the bearing, as shown.
- Perform the same measurement at three points on the tapered roller bearing outer race.
- Find the average of the measurements (M).
- When using the digital caliper, be sure to place it at right angles to the shimming plate.
  Otherwise, measurement will be incorrect.

(2) Calculate the forward gear shim thickness (T1).

	Forward gear shim thickness (T1) = 17.5 mm + F/100 mm - M

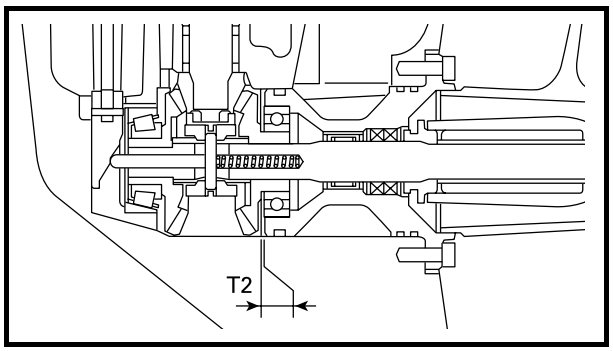
NOTE:

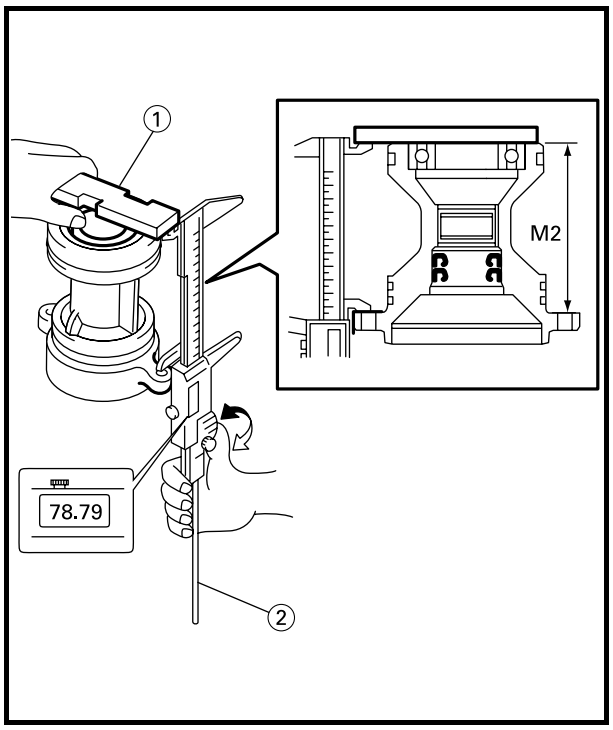
- "F" is the deviation of the lower case dimension from standard. It is stamped on the trim tab mounting surface of the lower case in 0.01 mm units. If the "F" mark is missing or unreadable, assume an "F" value of "0", and check the backlash when the unit is assembled.
- If the "F" mark is negative (-), then subtract the "F" value from the measurement.

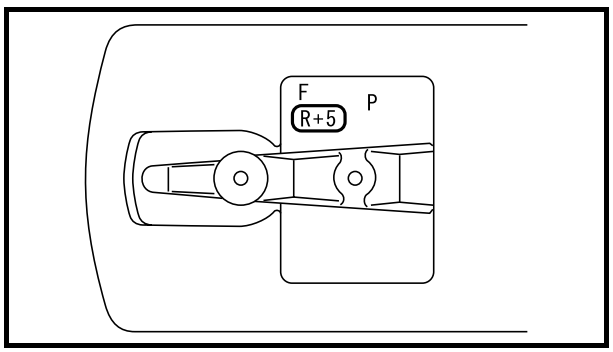
Example:
If M is "16.25 mm" and "F" is "+4", then:
T1 = 17.5 mm + (+4)/100 mm - 16.25 mm
= 17.5 mm + 0.04 mm - 16.25 mm
= 1.29 mm (0.051 in)
If M is "16.26 mm" and "F" is "-3", then:
T1 = 17.5 mm + (-3)/100 mm - 16.26 mm
= 17.5 mm - 0.03 mm - 16.26 mm
= 1.21 mm (0.048 in)

(3) Select the forward gear shim(s) (T1).

Calculated numeral at 1/100th place		Using shim
more than	or less	
1.00	1.10	1.0
1.10	1.20	1.1
1.20	1.30	1.2
1.30	1.40	1.3
1.40	1.50	1.4
	Available shim thickness 1.0, 1.1, 1.2, 1.3 and 1.4 mm	







SELECTING THE REVERSE GEAR SHIMS

NOTE:

Select the shim thickness (T2) the specified measurement(s) and the calculation formula.

Select:
- Shim thickness (T2)

Selecting steps

(1) Measure (M2).

Shimming plate ..... ①
90890-06701
Digital caliper ..... ②
90890-06704

NOTE:

- Measure the height of the gear as shown.
- Perform the same measurement at three points on the gear.
- Find the average of the measurements (M2).
- When using the digital caliper, be sure to place it at right angles to the shimming plate.
  Otherwise, measurement will be incorrect.

(2) Calculate the reverse gear shim thickness (T2).

Reverse gear shim thickness (T2) = 80 mm + R/100 - M2

NOTE:

- "R" is the deviation of the lower case dimension from standard. It is stamped on the anode mounting surface of the lower case in 0.01 mm units. If the "R" mark is missing or unreadable, assume a "R" value of "0", and check the backlash when the unit is assembled.
- If the "R" mark is negative (-), then subtract the "R" value from the measurement.

Example:
If M2 is "78.79 mm" and "R" is "+5", then:
T2 = 80 mm + (+5)/100 mm - 78.79 mm
= 80 mm + 0.05 mm - 78.79 mm
= 1.26 mm (0.050 in)
If M2 is "78.75 mm" and "R" is "-3", then:
T2 = 80 mm + (-3)/100 mm - 78.75 mm
= 80 mm - 0.03 mm - 78.75 mm
= 1.22 mm (0.048 in)

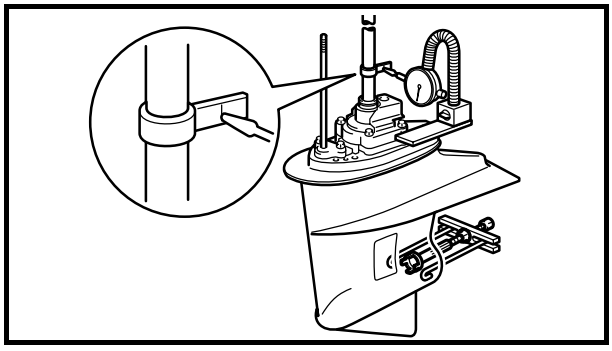
(3) Select the reverse gear shim(s) (T2).

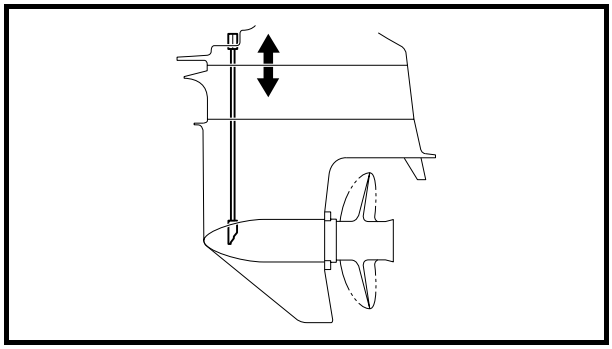
Calculated numeral at 1/100th place		Using shim
more than	or less	
1.00	1.10	1.0
1.10	1.20	1.1
1.20	1.30	1.2
1.30	1.32	1.3

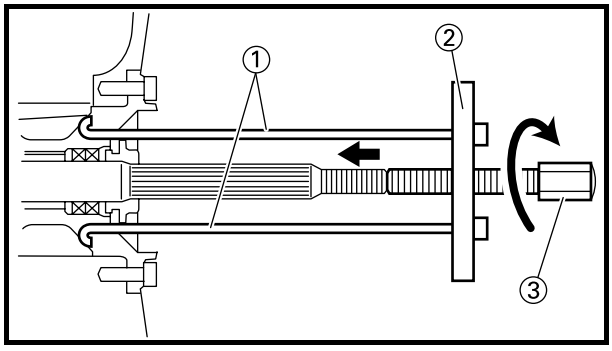
Available shim thickness
1.0, 1.1, 1.2 and 1.3 mm

BACKLASH

NOTE:
- Do not install the water pump components when measuring the backlash.
- Measure both the forward and reverse gear backlashes.
- If both the forward and reverse gear backlashes are larger than specification, the pinion gear may be too high.
- If both the forward and reverse gear backlashes are smaller than specification, the pinion gear may be too low.







MEASURING THE FORWARD GEAR BACKLASH

1. Measure:
   - Forward gear backlash
     Out of specification → Adjust.

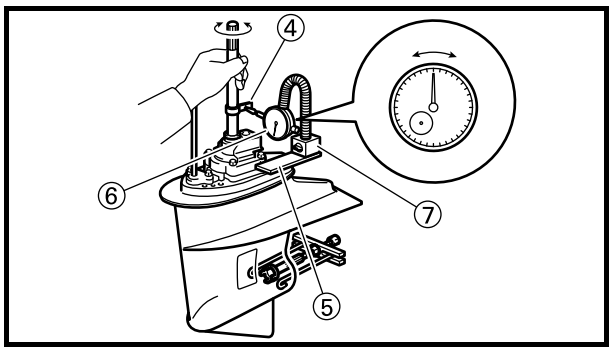
	Forward gear backlash **0.31 - 0.72 mm (0.012 - 0.028 in)**

Measuring steps

(1) Set the shift rod into the neutral position.

(2) Install the propeller shaft housing puller so it pushes against the propeller shaft.

	Bearing housing puller claw .....① **90890-06564** **Stopper guide plate .....②** **90890-06501** **Center bolt.....③** **90890-06504**
	Center bolt **5 N•m (0.5 kgf•m, 3.7 ft•lb)**



(3) Install the backlash indicator onto the drive shaft (16mm (0.63 in) diameter).

	Backlash indicator .....④ **90890-06706**

(4) Install the dial gauge onto the lower unit and have the dial gauge plunger contact the mark on the backlash indicator.

	Magnet base plate .....⑤ **90890-07003** **Dial gauge set .....⑥** **90890-01252** **Magnet base .....⑦** **90890-06705**

(5) Slowly turn the drive shaft clockwise and counterclockwise. When the drive shaft stops in each direction, measure the backlash.

2. Adjust:
   - Forward gear backlash

     Remove or add shim(s).

Forward gear backlash	**Shim thickness**
Less than 0.31 mm (0.012 in)	**To be decreased by (0.52 - M) × 0.49**
More than 0.72 mm (0.028 in)	**To be increased by (M - 0.52) × 0.49**
Available shim thickness: 1.0, 1.1, 1.2, 1.3 and 1.4 mm	

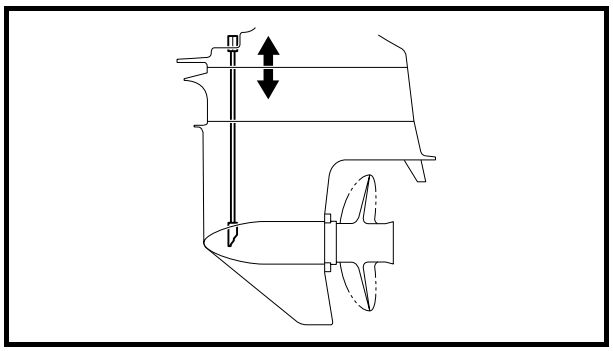
M : Measurement

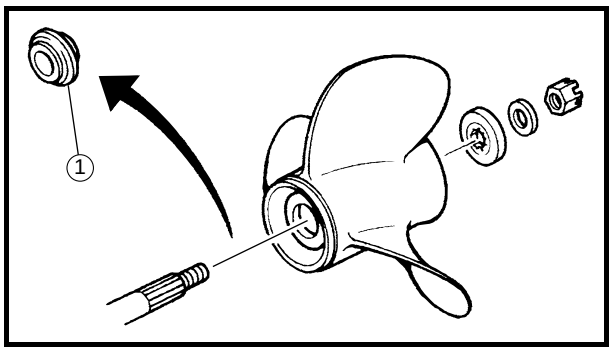
MEASURING THE REVERSE GEAR BACKLASH

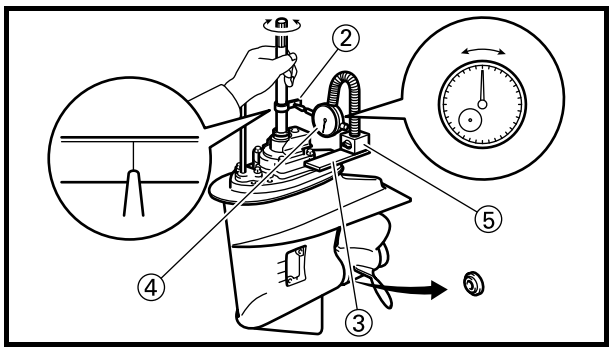
1. Measure:
   - Reverse gear backlash

     Out of specification → Adjust.

	Reverse gear backlash **0.93 - 1.65 mm (0.037 - 0.065 in)**







Measuring steps

(1) Set the shift rod into the neutral position.

(2) Load the reverse gear by installing the propeller without the collar ①, and then tighten the propeller nut.

	Propeller nut **5 N•m (0.5 kgf•m, 3.7 ft•lb)**

(3) Install the backlash indicator onto the drive shaft (16 mm (0.63 in) diameter).

	Backlash indicator .....② **90890-06706**

(4) Install the dial gauge onto the lower unit and have the dial gauge plunger contact the mark on the backlash indicator.

	Magnet base plate .....③ **90890-07003** **Dial gauge set .....④** **90890-01252** **Magnet base .....⑤** **90890-06705**

(5) Slowly turn the drive shaft clockwise and counterclockwise. When the drive shaft stops in each direction, measure the backlash.

2. Adjust:
   - Reverse gear backlash

     Remove or add shim(s).

	Reverse gear backlash	**Shim thickness**
	Less than 0.93 mm (0.037 in)	**To be decreased by (1.29 - M) × 0.49**
	More than 1.65 mm (0.065 in)	**To be increased by (M - 1.29) × 0.49**
	Available shim thickness 1.0, 1.1, 1.2 and 1.3 mm	

M : Measurement