YAMAHA

F150B
FL150B

SERVICE MANUAL

6BM-28197-5L-11

Preface

This manual has been prepared by Yamaha primarily for use by Yamaha dealers and their trained mechanics when performing maintenance procedures and repairs to Yamaha equipment. It has been written to suit the needs of persons who have the Bronze Technical Certificate of YTA (Yamaha Technical Academy) marine or the equivalent basic understanding of the mechanical and electrical concepts and procedures inherent in the work, for without such knowledge attempted repairs or service to the equipment could render it unsafe or unfit for use.

Because Yamaha has a policy of continuously improving its products, models may differ in detail from the descriptions and illustrations given in this publication. Use only the latest edition of this manual. Authorized Yamaha dealers are notified periodically of modifications and significant changes in specifications and procedures, and these are incorporated in successive editions of this manual. Also, up-to-date parts information is available on YPEC-web. Additional information and up-to-date information on Yamaha product and services are available on Service Portal.

Important information

Particularly important information is distinguished in this manual by the following notations:

⚠ The Safety Alert Symbol means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!

⚠ WARNING

A WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

NOTICE

A NOTICE indicates special precautions that must be taken to avoid damages to the outboard motor or other property.

TIP:

A TIP provides key information to make procedures easier or clearer.

F150B, FL150B
SERVICE MANUAL

1st Edition, June 2008

Printed in China

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General information

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⚠Safety while working

To prevent an accident or injury and to ensure quality service, follow the safety procedures provided below.

Rotating part

- Hands, feet, hair, jewelry, clothing, Personal flotation device straps, and so on can become entangled with internal rotating parts of the engine, resulting in serious injury or death.
- Keep the top cowling in place whenever possible. Do not remove or replace the cowling with the engine running.
- Only operate the engine with the cowling removed according to the specific instructions in the manual. Keep hands, feet, hair, jewelry, clothing, Personal flotation device straps, and so on away from any exposed moving parts.

Hot part

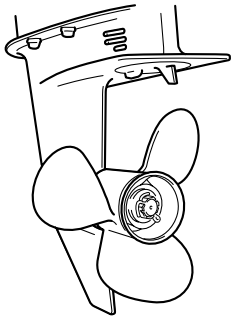
During and after operation, engine parts are hot enough to cause burns. Avoid touching any parts under the top cowling until the engine has cooled.

Electric shock

Do not touch any electrical parts while starting or operating the engine. They can cause shock or electrocution.

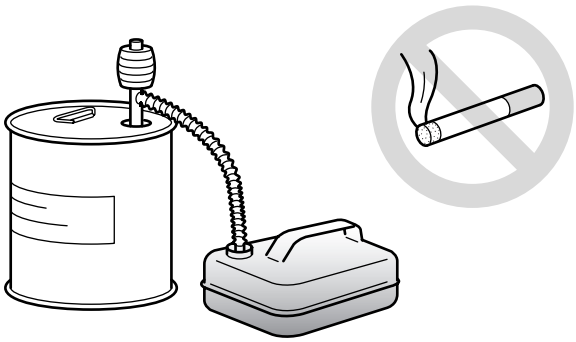
Propeller

Do not hold the propeller with your hands when loosening or tightening it.



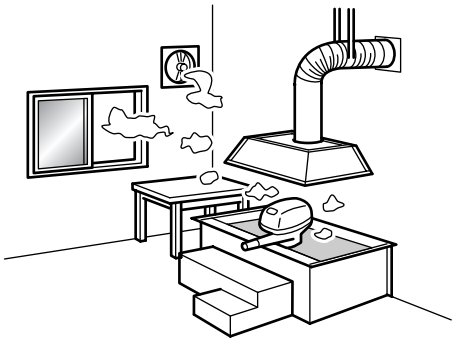
Handling of gasoline

- Gasoline is highly flammable. Keep gasoline and all flammable products away from heat, sparks, and open flames.
- Gasoline is poisonous and can cause injury or death. Handle gasoline with care. Never siphon gasoline by mouth. If you should swallow some gasoline or inhale a lot of gasoline vapor, or get some gasoline in your eyes, see your doctor immediately. If gasoline spills on your skin, wash with soap and water. If gasoline spills on your clothing, change your clothes.



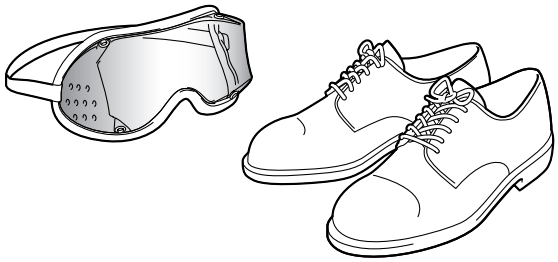
Ventilation

- Gasoline vapor and exhaust gas are heavier than air and extremely poisonous. If inhaled in large quantities they may cause loss of consciousness and death within a short time.
- When test running an engine indoors (example: in a water tank), be sure to do so where adequate ventilation can be maintained.



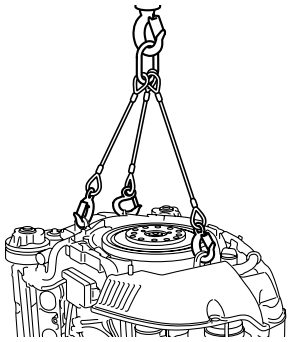
Self-protection

- Protect your eyes by wearing safety glasses or safety goggles during all operations involving drilling and grinding, or when using an air compressor.
- Protect your hands and feet by wearing protective gloves and safety shoes when necessary.



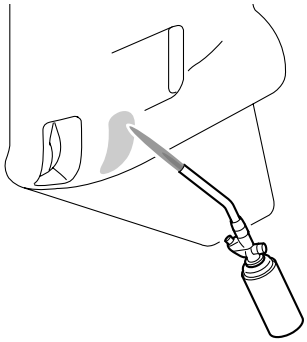
Working with crane

- Outboard motors weighing 18.0 kg (39.7 lb) and over must be carried by a crane.
- Use a wire rope of adequate strength, and lift up the outboard motor with the three point suspension.
- If the outboard motor does not have three or more points to be suspended, support it with additional ropes or the like so that the outboard motor can be lifted and carried in a stable manner.



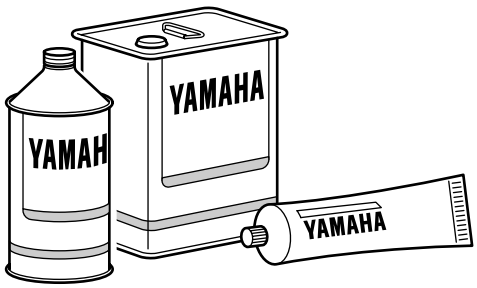
Handling of burner

- Incorrect handling of burner may result in burns. Refer to the operation manual issued by the manufacturer to assure the correct handling.
- When using a burner, keep it away from the gasoline and oil, to prevent a fire.
- Components become very hot enough to cause burns. Do not touch directly.



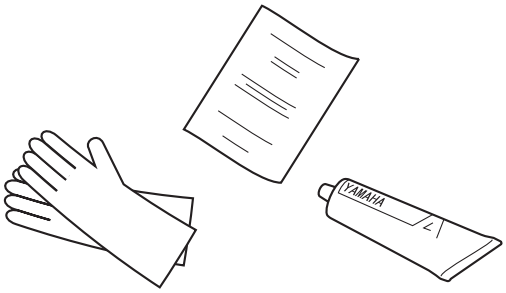
Part, lubricant, and sealant

Use only genuine Yamaha parts, lubricants, and sealants or those recommended by Yamaha, when servicing or repairing the outboard motor.



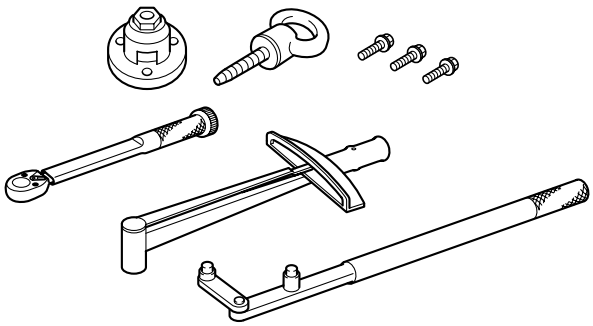
Handling of sealant

- Wear protective gloves to protect your skin, when using the sealants.
- Refer to the material data sheet issued by the manufacturer. Some of the sealants may be harmful for human health.



Special service tool

Use the recommended special service tools to work safety, and to protect parts from damage.

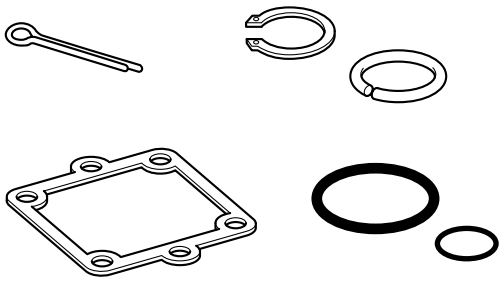


Tightening torque

Follow the tightening torque specifications provided throughout the manual. When tightening nuts, bolts, and screws, tighten the large sizes first, and tighten fasteners starting in the center and moving outward.

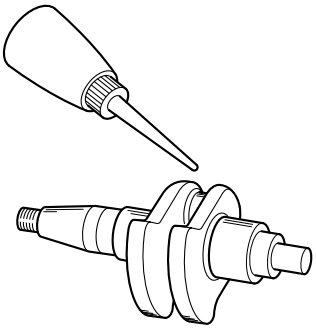
Non-reusable part

Always use new gaskets, seals, O-rings, cotter pins, circlips, and so on, when installing or assembling parts.



Disassembly and assembly

- Use compressed air to remove dust and dirt during disassembly.
- Apply engine oil to the contact surfaces of moving parts before assembly.



- Install bearings with the manufacture identification mark in the direction indicated in the installation procedure. In addition, be sure to lubricate the bearings liberally.
- Apply a thin coat of water-resistant grease to the lip and periphery of an oil seal before installation.
- Check that moving parts operate normally after assembly.

How to use this manual

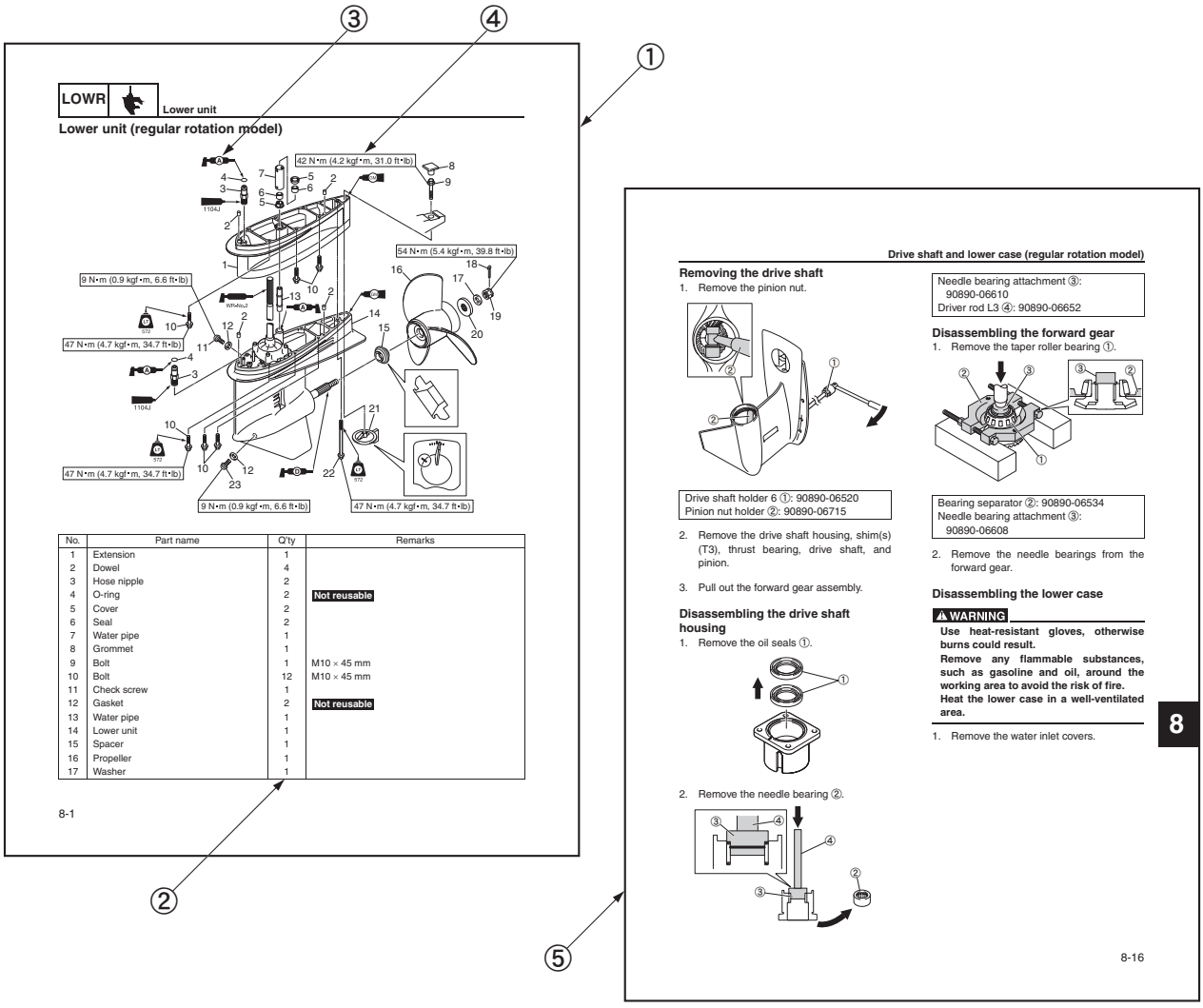
Manual format

The format of this manual has been designed to make service procedures clear and easy to understand. Use the information below as a guide for effective and quality service.

- Parts are shown and detailed in an exploded diagram and are listed in the component list (see ① in the figure below for an example page).
- The component list consists of part names and quantities, as well as bolt and screw dimensions (see ② in the figure below).
- Symbols are used to indicate important aspects of a procedure, such as the grade of lubricant and lubrication point (see ③ in the figure below).
- Tightening torque specifications are provided in the exploded diagrams (see ④ in the figure below for an example), and in the related detailed instructions. Some torque specifications are listed in stages as torque figures or angles in degrees.
- Separate procedures and illustrations are used to explain the details of removal, checking, and installation where necessary (see ⑤ in the figure below for an example page).

TIP:

For troubleshooting procedures, see Chapter 4, “Troubleshooting.”



No.	Part name	Q'ty	Remarks
1	Extension	1	
2	Dowel	4	
3	Hose nipple	2	
4	O-ring	2	Not reusable
5	Cover	2	
6	Seal	2	
7	Water pipe	1	
8	Grommet	1	
9	Bolt	1	M10 × 45 mm
10	Bolt	12	M10 × 45 mm
11	Check screw	1	
12	Gasket	2	Not reusable
13	Water pipe	1	
14	Lower unit	1	
15	Spacer	1	
16	Propeller	1	
17	Washer	1	

Abbreviation

The following abbreviations are used in this service manual.

Abbreviation	Description
ABYC	American Boat and Yacht Council
AFT	Aft end
API	American Petroleum Institute
AWG	American Wire Gauge
BL	Backlash
BOW	Bow end
BTDC	Before Top Dead Center
CA	Crank Angle
CCA	Cold Cranking Ampere
C/E	Check Engine
C/L	Centerline
D.E.S.	Dual Engine System
DN	Down side
ECM	Electronic Control Module
EN	European Norm (European standard)
EX	Exhaust
F	Forward
IEC	International Electro-technical Commission
IN	Intake
ISC	Idle Speed Control
M	Measurement
N	Neutral
PCV	Pressure Control Valve
PORT	Port side
PTT	Power Trim and Tilt
R	Reverse
RON	Research Octane Number
SAE	Society of Automotive Engineers
STBD	Starboard side
SW	Switch
TDC	Top Dead Center
TPS	Throttle Position Sensor
UP	Upside
W/F	Water in Fuel
YDIS	Yamaha Diagnostic System

Sealant and locking agent

Symbol

Symbols in an exploded diagram or illustration indicate the grade of lubricant and the lubrication point.

Symbol	Name	Application
	Yamaha 4-stroke motor oil	Lubricant
	Gear oil	Lubricant
	Water resistant grease (Yamaha grease A)	Lubricant
	Molybdenum disulfide grease	Lubricant
	Corrosion resistant grease (Yamaha grease D)	Lubricant
	Low temperature resistant grease (Yamaha grease C)	Lubricant
	WR-No.2 grease	Lubricant

Symbols in an exploded diagram or illustration indicate the grade of sealant and the seal point.

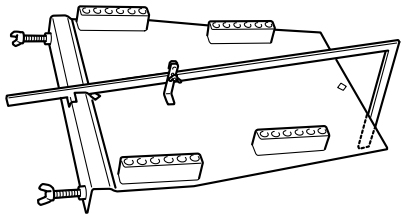
Symbol	Name	Application
	Gasket Maker	Sealant
	ThreeBond 1104J	Sealant
	ThreeBond 1280B	Sealant
	ThreeBond 1322	Sealant
	ThreeBond 1386B	Sealant
	LOCTITE 271 (red)	Sealant

Symbol	Name	Application
 242	LOCTITE 242 (blue)	Sealant
 572	LOCTITE 572 (white)	Sealant

Special service tool

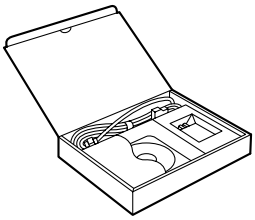
For all markets except for U.S.A. and Canada
Special tools with Yamaha parts number (90890-*****) are distributed by Parts Division.

Drilling plate
90890-06783

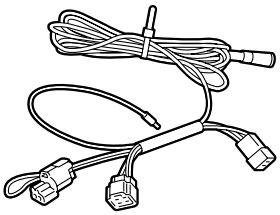


YDIS (CD-ROM, Ver. 1.30)
60V-WS853-04

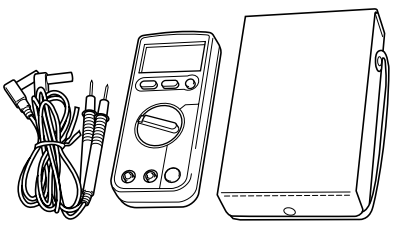
YDIS (KIT)
60V-85300-04



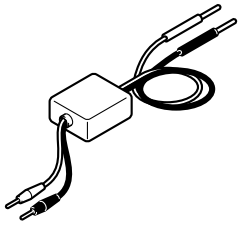
Diagnostic flash indicator B
90890-06865



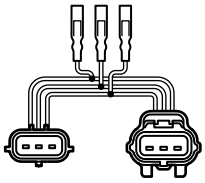
Digital circuit tester
90890-03174



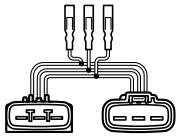
Peak voltage adapter B
90890-03172



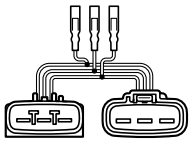
Test harness (3 pins)
90890-06869



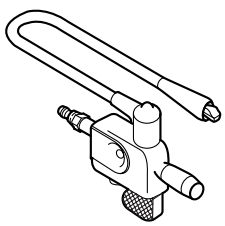
Test harness (3 pins)
90890-06847



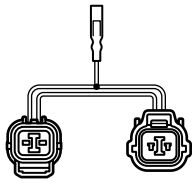
Test harness (3 pins)
90890-06846



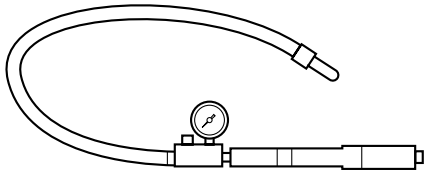
Ignition tester
90890-06754



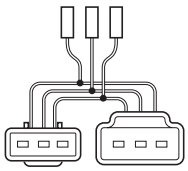
Test harness (2 pins)
90890-06792



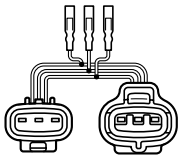
Leakage tester
90890-06840



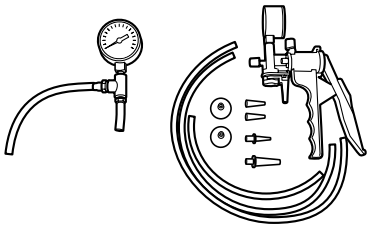
Test harness (3 pins)
90890-06791



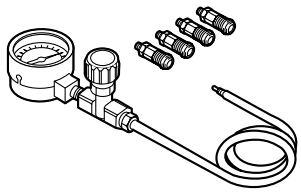
Test harness (3-pins)
90890-06793



Vacuum/pressure pump gauge set
90890-06756



Vacuum gauge
90890-03159



Test harness (2 pins)
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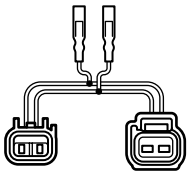
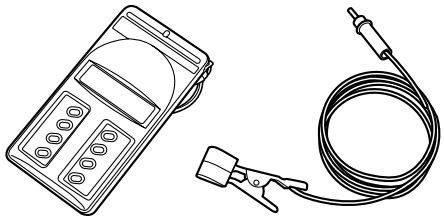


Digital tachometer
90890-06760



Fuel pressure gauge
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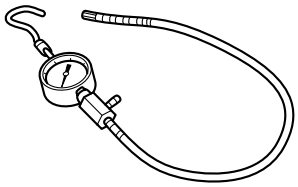
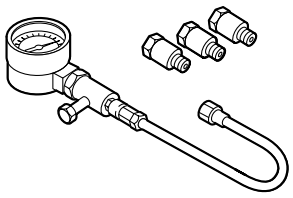


Compression gauge
90890-03160



Compression gauge extension
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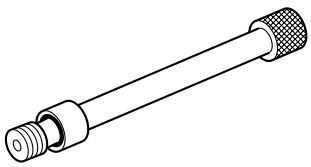
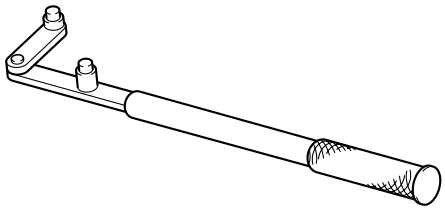


Flywheel holder
90890-06522



Flywheel puller
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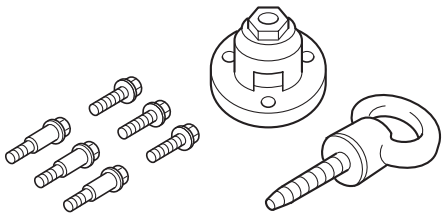
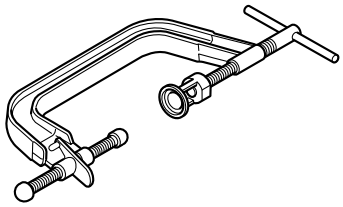


Valve spring compressor
90890-04019



Valve spring compressor attachment
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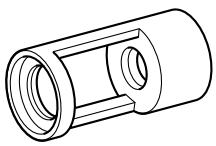
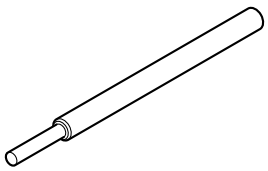
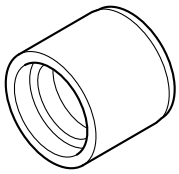


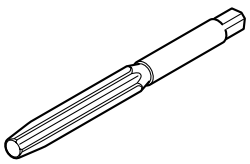
Valve guide remover/installer
90890-06801



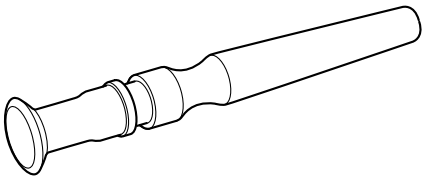
Valve guide installer
90890-06810



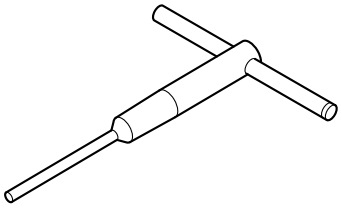
Valve guide reamer
90890-06804



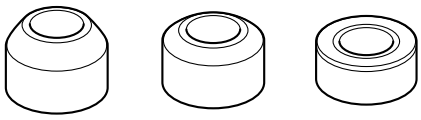
Valve lapper
90890-04101



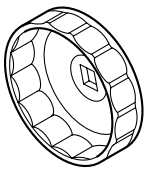
Valve seat cutter holder
90890-06316



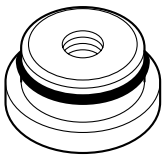
Valve seat cutter
90890-06817, 90890-06326, 90890-06816, 90890-06325, 90890-06324



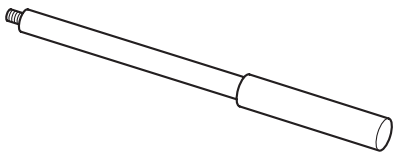
Oil filter wrench
90890-06830



Needle bearing attachment
90890-06654, 90890-06611, 90890-06653, 90890-06610, 90890-06612



Driver rod L3
90890-06652



Bearing separator
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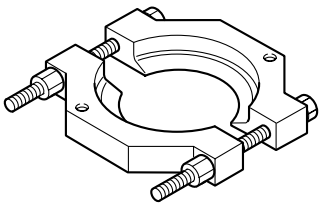

Gear puller
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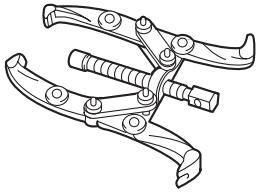

Piston ring compressor
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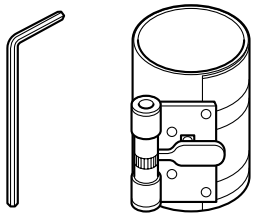

Shift rod push arm
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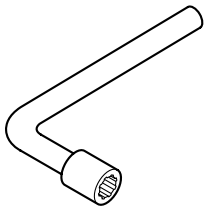
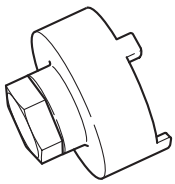


Ring nut wrench 4
90890-06512



Ring nut wrench extension
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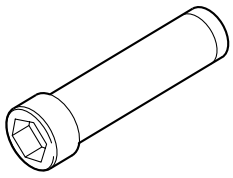

Bearing housing puller claw L
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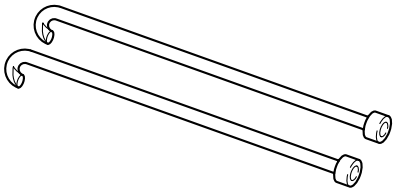

Driver rod SS
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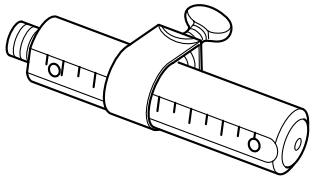
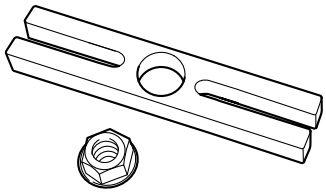


Stopper guide plate
90890-06501



Bearing depth plate
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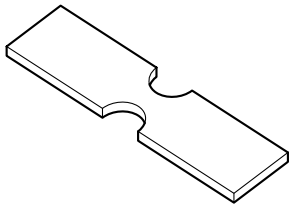

Center bolt
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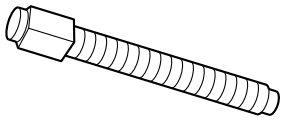

Bearing inner race attachment
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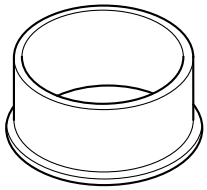

Stopper guide stand
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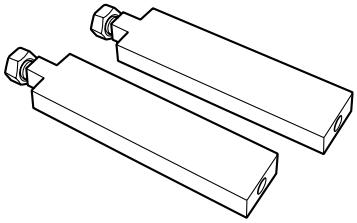
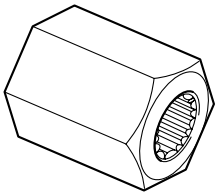


Drive shaft holder 6
90890-06520



Bearing puller assembly
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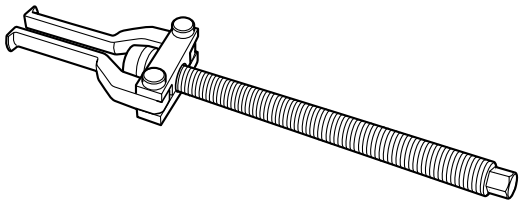
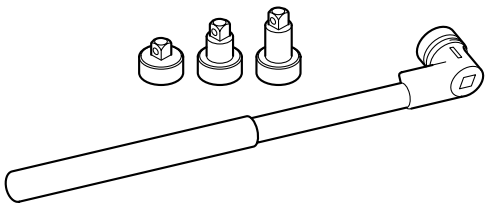
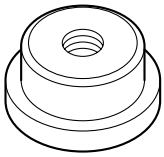


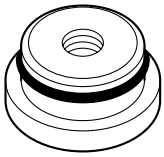
Pinion nut holder
90890-06715



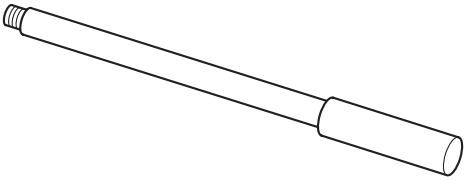
Needle bearing attachment
90890-06608, 90890-06607



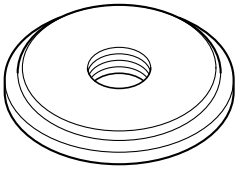
Ball bearing attachment
90890-06636, 90890-06633



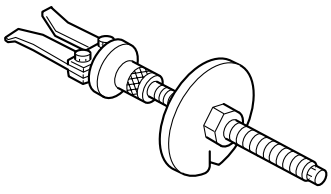
Driver rod LL
90890-06605



Bearing outer race attachment
90890-06619



Bearing outer race puller assembly
90890-06523



Driver rod LS
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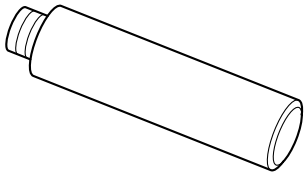
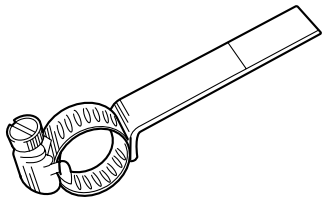
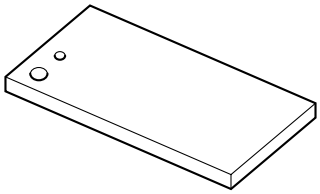


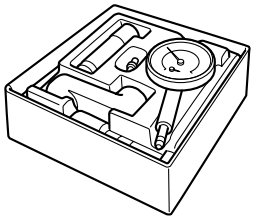
Backlash indicator
90890-06706



Magnet base plate
90890-07003



Dial gauge set
90890-01252



Magnet base B
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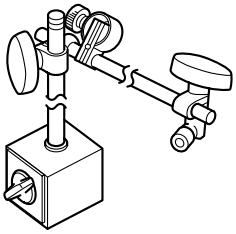
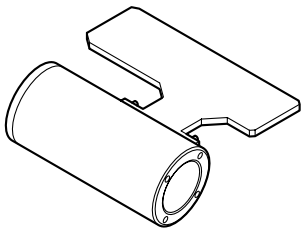
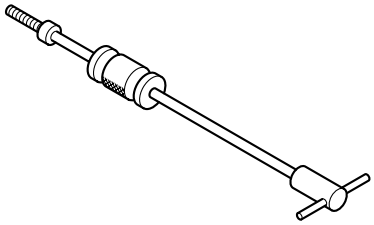


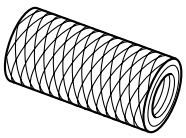
Pinion height gauge
90890-06671



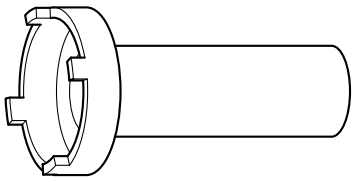
Slide hammer handle
90890-06531



Puller head
90890-06514

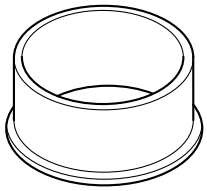


Ring nut wrench
90890-06578

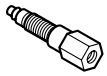


Ball bearing attachment
90890-06629

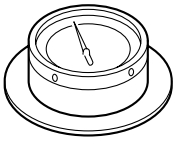
Bearing inner race attachment
90890-06660



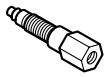
Up relief fitting
90890-06773/06838



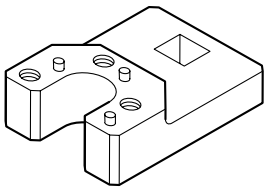
Hydraulic pressure gauge
90890-06776/06800



Down relief fitting
90890-06774



Trim & tilt wrench
90890-06587



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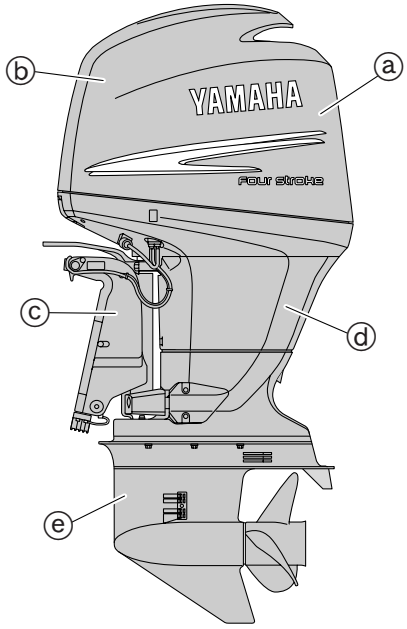
Model features

General feature

F150B and FL150B Overall Features;

- Light weight and compact, 4-stroke, L4, DOHC, 16-valve, 2670 cm^3 (162.9 cu. in) engine
- Easy startability and drivability
- Low noise, low emission, low fuel consumption

ⓐ **Power unit**
- Offset cylinder
- Forged piston and chrome plated piston rings
- 4 throttle valves and multipoint fuel injection
- Large intake silencer
- Plastic intake manifold
- Long intake manifold



ⓑ **Electrical**
- Electronic fuel injection system
- Self-diagnosis system with flush indicator and YDIS (New YDIS 1.30 version or later)
- Water-cooled Rectifier Regulator
- Engine running time recorded hour-meter

ⓒ **Bracket unit**
- Same bracket as same F150A model
- F150A type PTT unit

ⓓ **Upper case**
- Water-wall cooling system around muffler
- Labyrinth idle exhaust system
- Dual idle silencer

ⓔ **Lower unit**
- Chrome plated water pump
- Same lower casing as same F150A model

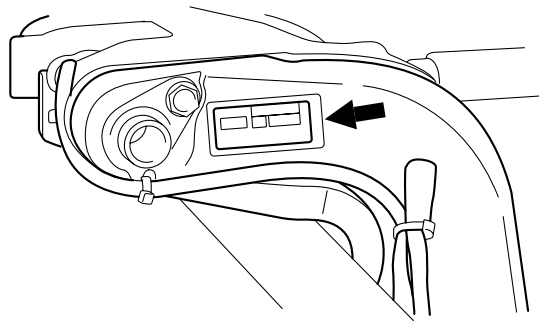
Model designation

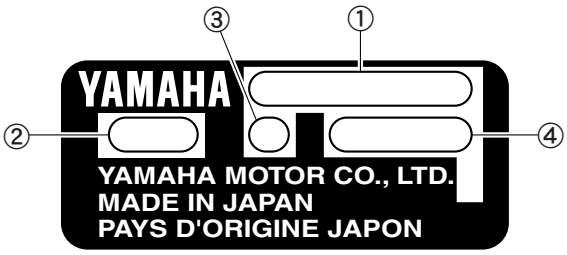
F 150 B E T X
① ② ③ ④ ⑤ ⑥

①	Model Description	F : 4-stroke regular rotation FL: 4-stroke counter rotation
②	Model name	150: 150
③	Product Generation	B: A and up
④	Functions	E: Electric starter
⑤		T: Power trim and tilt
⑥	Transom Height	X: UL (25 in)

Serial number

The outboard motor serial number is stamped on a label attached to the port clamp bracket.





① Model name
② Approved model code
③ Transom height
④ Serial number

Model name	Approved model code	Starting serial No.
F150BET	6BM	1000001–
FL150BET	6BN	1000001–

Model data

Dimension and Weight

Item	Unit	Model	
		F150B	FL150B
Overall length	mm (in)	862 (33.9)	
Overall width	mm (in)	512 (20.2)	
Overall height	mm (in)	1842 (72.5)	
Boat transom height	mm (in)	635 (25.0)	
Weight (with aluminum propeller)	kg (lb)	227.0 (500.4)	

Performance

Item	Unit	Model	
		F150B	FL150B
Maximum output	kW (HP)	105.3 (143.2) at 5000 r/min	
Full throttle operating range	r/min	4500–5500	
Maximum fuel consumption	L (US gal, Imp gal)/hr	49.5 (13.1, 10.9) at 5000 r/min	
Engine idle speed	r/min	650–750	

Power unit

Item	Unit	Model	
		F150B	FL150B
Type		4-stroke, DOHC	
Cylinder quantity		L4	
Total displacement	cm^3 (cu. in)	2670 (162.9)	
Bore × stroke	mm (in)	94.0 × 96.2 (3.70 × 3.79)	
Compression ratio		9.0 : 1	
Control system		Remote control	
Starting system		Electric	
Fuel system		Fuel injection	
Ignition control system		TCI	
Advance type		Micro computer	
Maximum generator output	V, A	12.0, 35.0	
Spark plug		LFR5A-11 (NGK)	
Firing order		1–3–4–2	
Cooling system		Water	
Exhaust system		Through propeller boss	
Lubrication system		Wet sump	

Lower unit

Item	Unit	Model	
		F150B	FL150B
Gear shift positions		F–N–R	
Gear ratio		2.00 (28/14)	
Reduction gear type		Spiral bevel gear	
Clutch type		Dog clutch	
Propeller shaft type		Spline	
Propeller direction (rear view)		Clockwise	Counter clockwise
Propeller mark		M	ML

Bracket unit

Item	Unit	Model	
		F150B	FL150B
Trim angle (at 12° boat transom)	Degree	–4 to 16	
Tilt-up angle	Degree	70	
Steering angle	Degree	35 + 35	

Fuel and oil requirement

Item	Unit	Model	
		F150B	FL150B
Fuel type		Regular unleaded gasoline	
Fuel minimum rating	RON	84	
Engine oil		4-stroke motor oil	
Engine oil grade (*1)	API	SE, SF, SG, SH, SJ, or SL	
	SAE	5W-30, 10W-30, or 10W-40	
Total engine oil quantity (oil pan capacity) (*2)			
Without oil filter replacement	L (US qt, Imp qt)	5.2 (5.49, 4.57)	
With oil filter replacement	L (US qt, Imp qt)	5.4 (5.70, 4.75)	
Gear oil type		Hypoid gear oil	
Gear oil grade (*3)	API	GL-4	
	SAE	90	
Gear oil quantity	L (US qt. Imp qt)	0.980 (1.036, 0.862)	0.870 (0.919, 0.765)

(*1) If the recommended engine oil grades are not available, use engine oil with an API classification of SH, SJ, or SL and an SAE classification of 15W-40, 20W-40, or 20W-50.
(*2) For actual engine oil amount required at periodical oil check, see “Power unit technical data” (1-12).
(*3) Meeting both API and SAE requirements.

Battery requirement

Item	Unit	Model	
		F150B	FL150B
Minimum cold cranking amps CCA/EN	A	711	
Minimum rated capacity 20HR/IEC	Ah	100	

PTT requirement

Item	Unit	Model	
		F150B	FL150B
Fluid type		ATF Dexron II	
Fluid type quantity	L (US qt, Imp qt)	0.7 (0.7, 0.6)	

Electrical technical data

Ignition timing control system

Item	Unit	Model	
		F150B	FL150B
Spark plug			
Gap	mm (in)	1.0–1.1 (0.039–0.043)	
Spark plug wire			
Resistance at 20 °C (68 °F)			
#1	kΩ	4.6–10.9	
#2	kΩ	3.3–8.0	
#3	kΩ	3.8–9.3	
#4	kΩ	4.2–10.0	
Ignition coil			
Input voltage	V	12.0	
Output peak voltage			
at cranking (unloaded)	V	210.0	
at 1500 r/min (loaded)	V	260.0	
at 3500 r/min (loaded)	V	270.0	
Primary coil resistance			
at 20 °C (68 °F)	Ω	1.6–2.0	
Secondary coil resistance (spark plug wire–spark plug wire)			
at 20 °C (68 °F)	kΩ	12.50–16.91	
Pulser coil			
Resistance (*1)			
at 20 °C (68 °F)	Ω	459.0–561.0	
Output peak voltage			
at cranking (unloaded)	V	3.5	
at cranking (loaded)	V	3.0	
at 1500 r/min (loaded)	V	21.0	
at 3500 r/min (loaded)	V	39.0	
Air temperature sensor			
Resistance (*1)			
at 20 °C (68 °F)	kΩ	2.21–2.69	
at 80 °C (176 °F)	kΩ	0.32	
Input voltage	V	4.75–5.25	

(*1) The figures are for reference only.

Item	Unit	Model	
		F150B	FL150B
Air pressure sensor			
Input voltage	V	4.75–5.25	
Output voltage			
at –20.0 kPa (–0.20 kgf/cm², –2.9 psi)	V	3.21	
at –46.7 kPa (–0.467 kgf/cm², –6.8 psi)	V	2.16	
Engine temperature sensor			
Resistance (*1)			
at 20 °C (68 °F)	kΩ	54.2–69.0	
at 98 °C (208 °F)	kΩ	3.12–3.48	
Input voltage	V	4.75–5.25	
Thermoswitch			
Input voltage	V	11.1	
Temperature			
Switch ON	°C (°F)	84–90 (183–194)	
Switch OFF	°C (°F)	68–82 (154–180)	

(*1) The figures are for reference only.

Fuel injection control system

Item	Unit	Model	
		F150B	FL150B
Fuel injector			
Resistance (*1)			
at 20 °C (68 °F)	Ω	14.0–15.0	
Input voltage (*1)	V	12.0	
High-pressure fuel pump			
Resistance (*1)	Ω	0.5–10.0	
Input voltage (*1)	V	12.0	
ISC			
Input voltage	V	12.0	
Water detection switch			
Input voltage	V	4.75–5.25	
Float height	mm (in)	40.0 (1.57)	

(*1) The figures are for reference only.

Engine speed control system

Item	Unit	Model	
		F150B	FL150B
Oil pressure sensor			
Input voltage	V	4.75–5.25	
Output voltage (*1)			
at 450.0 kPa (4.50 kgf/cm², 65.3 psi) and 60 °C (140 °F) with SL 10W-30 engine oil and at 700 r/min	V	2.8	
TPS			
Output voltage (*1)			
with throttle valve fully closed TPS1	V	0.703	
with throttle valve fully open TPS1	V	4.255	
Throttle valve opening angle (*1)			
with throttle valve fully closed	Degree	0.1	
with throttle valve fully open	Degree	88.6	
Input voltage	V	4.75–5.25	
Shift-cut switch			
Input voltage	V	4.75–5.25	
Resistance (*1)			
at 20 °C (68 °F)	kΩ	4.465–4.935	

(*1) The figures are for reference only.

PTT system

Item	Unit	Model	
		F150B	FL150B
Trim sensor			
Free position resistance (*1)	Ω	238.8–378.8	
Setting resistance (*1)	Ω	9.0–11.0	

(*1) The figures are for reference only.

Charging system

Item	Unit	Model	
		F150B	FL150B
Lighting coil			
Output peak voltage			
at cranking (unloaded)	V	11.0	
at 1500 r/min (unloaded)	V	50.0	
at 3500 r/min (unloaded)	V	110.0	
Resistance (*1)			
at 20 °C (68 °F)	Ω	0.2–0.3	
Fuse	A	50	
Rectifier Regulator			
Output peak voltage			
at 1500 r/min (loaded)	V	13.0	
at 3500 r/min (loaded)	V	13.0	

(*1) The figures are for reference only.

Starting system

Item	Unit	Model	
		F150B	FL150B
Starter motor			
Type		Sliding gear	
Output	kW	1.4	
Cranking time limit	Second	30	
Brushes			
Standard length	mm (in)	15.5 (0.61)	
Wear limit	mm (in)	9.5 (0.37)	
Commutator			
Standard diameter	mm (in)	29.0 (1.14)	
Wear limit	mm (in)	28.0 (1.10)	
Neutral switch			
Input voltage	V	4.75–5.25	

Gauge / sensor

Item	Unit	Model	
		F150B	FL150B
Hour meter Input voltage	V	11.2	
Water pressure sensor Input voltage	V	4.75–5.25	
Output voltage at 392.0 kPa (3.92 kgf/cm^2, 56.8 psi)	V	2.5	
at 784.0 kPa (7.84 kgf/cm^2, 113.7 psi)	V	4.5	
Speed sensor Input voltage	V	4.75–5.25	
Output voltage at 392.0 kPa (3.92 kgf/cm^2, 56.8 psi)	V	2.5	
at 784.0 kPa (7.84 kgf/cm^2, 113.7 psi)	V	4.5	

Fuel system technical data

Fuel system

Item	Unit	Model	
		F150B	FL150B
Fuel filter assembly Holding pressure			
Positive pressure	kPa (kgf/cm^2, psi)	200.0 (2.00, 29.0)	
Negative pressure	kPa (kgf/cm^2, psi)	80.0 (0.80, 11.6)	
Fuel pump Holding pressure			
Inlet positive pressure	kPa (kgf/cm^2, psi)	50.0 (0.50, 7.3)	
Inlet negative pressure	kPa (kgf/cm^2, psi)	30.0 (0.30, 4.4)	
Outlet positive pressure	kPa (kgf/cm^2, psi)	50.0 (0.50, 7.3)	
Fuel pressure at engine start switch to “ON” with in 3 seconds (*1)	kPa (kgf/cm^2, psi)	300.0 (3.00, 43.5)	
at engine idle speed (*1)	kPa (kgf/cm^2, psi)	260.0 (2.60, 37.7)	
Primer pump Holding pressure			
Positive pressure	kPa (kgf/cm^2, psi)	170.0 (1.70, 24.7)	
Throttle link Roller clearance	mm (in)	0.50 (0.02)	
Vapor separator Float height	mm (in)	55.0–61.0 (2.2–2.4)	
Canister Holding pressure	kPa (kgf/cm^2, psi)	19.6 (0.196, 2.8)	

(*1) The figures are for reference only.

Power unit technical data

Power unit

Item	Unit	Model	
		F150B	FL150B
Cylinder Minimum compression pressure (*1)	kPa (kgf/cm^2, psi)	880.0 (8.80, 127.6)	
Engine oil Oil pressure (*2) at 60 °C (140 °F) with SL 10W-30 engine oil and at 700 r/min	kPa (kgf/cm^2, psi)	450.0 (4.50, 65.3)	
Replacement engine oil quantity (at periodic maintenance) Without oil filter replacement	L (US qt, Imp qt)	4.30 (4.54, 3.78)	
With oil filter replacement	L (US qt, Imp qt)	4.50 (4.76, 3.96)	

(*1) Measuring conditions: Ambient temperature 20 °C (68 °F), wide open throttle, with spark plugs removed from all cylinders. The figures are for reference only.
(*2) For details of the checking method, see “Checking the oil pressure” (7-2). The figures are for reference only.

Cylinder head assembly

Item	Unit	Model	
		F150B	FL150B
Cylinder head Warpage limit	mm (in)	0.1 (0.0039)	
Valve stem Diameter Intake	mm (in)	5.477–5.492 (0.2156–0.2162)	
Exhaust	mm (in)	5.464–5.479 (0.2151–0.2157)	
Runout limit Intake	mm (in)	0.01 (0.0004)	
Exhaust	mm (in)	0.01 (0.0004)	
Valve stem guide Inside diameter Intake	mm (in)	5.504–5.522 (0.2167–0.2174)	
Exhaust	mm (in)	5.504–5.522 (0.2167–0.2174)	
Stem-to-guide clearance Intake	mm (in)	0.025–0.058 (0.0010–0.0023)	
Exhaust	mm (in)	0.025–0.058 (0.0010–0.0023)	
Valve spring Free length	mm (in)	44.2 (1.74)	
Tilt limit	mm (in)	1.2 (0.05)	

Item	Unit	Model	
		F150B	FL150B
Valve lifter			
Outside diameter	mm (in)	32.982–32.997 (1.2985–1.2991)	
Camshaft			
Cam lobe height			
Intake	mm (in)	45.300–45.400 (1.7835–1.7874)	
Exhaust	mm (in)	44.350–44.450 (1.7461–1.7500)	
Cam lobe width			
Intake	mm (in)	35.950–36.050 (1.4154–1.4193)	
Exhaust	mm (in)	35.950–36.050 (1.4154–1.4193)	
Journal diameter	mm (in)	24.960–24.980 (0.9827–0.9835)	
Runout limit	mm (in)	0.03 (0.0012)	
Cap inside diameter	mm (in)	25.000–25.021 (0.9843–0.9851)	
Valve			
Clearance			
Intake	mm (in)	0.20±0.03 (0.008±0.001)	
Exhaust	mm (in)	0.34±0.03 (0.013±0.001)	
Seat contact width			
Intake	mm (in)	1.10–1.40 (0.043–0.055)	
Exhaust	mm (in)	1.40–1.70 (0.055–0.067)	
Margin thickness			
Intake	mm (in)	0.70 (0.0276)	
Exhaust	mm (in)	1.00 (0.0394)	

Crankcase assembly

Item	Unit	Model	
		F150B	FL150B
Cylinder			
Bore	mm (in)	94.000–94.017 (3.7008–3.7014)	
Piston			
Diameter	mm (in)	93.921–93.941 (3.6977–3.6985)	
Measuring point	mm (in)	14.0 (0.55)	
Piston clearance (*1)	mm (in)	0.075–0.080 (0.0030–0.0031)	
Ring groove (Top)	mm (in)	1.23–1.25 (0.0484–0.0492)	
Ring groove (2nd)	mm (in)	1.22–1.24 (0.0480–0.0488)	
Ring groove (Oil)	mm (in)	2.51–2.53 (0.0988–0.0996)	
Piston ring			
End gap measuring point	mm (in)	20.0 (0.8)	
Top ring			
Type		Barrel	
Dimension height (B)	mm (in)	1.17–1.19 (0.0461–0.0469)	
Dimension width (T)	mm (in)	2.80–3.00 (0.1102–0.1181)	
End gap	mm (in)	0.15–0.30 (0.0059–0.0118)	
Side clearance	mm (in)	0.04–0.08 (0.0016–0.0031)	
2nd ring			
Type		Taper	
Dimension height (B)	mm (in)	1.17–1.19 (0.0461–0.0469)	
Dimension width (T)	mm (in)	3.70–3.90 (0.1457–0.1535)	
End gap	mm (in)	0.30–0.45 (0.0118–0.0177)	
Side clearance	mm (in)	0.03–0.07 (0.0012–0.0028)	
Oil ring			
Dimension height (B)	mm (in)	2.40–2.47 (0.0945–0.0972)	
Dimension width (T)	mm (in)	2.30–2.70 (0.0906–0.1063)	
End gap	mm (in)	0.15–0.60 (0.0059–0.0236)	
Side clearance	mm (in)	0.04–0.13 (0.0016–0.0051)	
Connecting rod			
Big end side clearance (*1)	mm (in)	0.14–0.31 (0.006–0.012)	
Crankpin oil clearance (*1)	mm (in)	0.027–0.052 (0.0011–0.0020)	
Crankshaft			
Journal diameter	mm (in)	51.980–52.000 (2.0465–2.0472)	
Crankpin diameter	mm (in)	49.980–50.000 (1.9677–1.9685)	
Runout limit	mm (in)	0.03 (0.0012)	
Crankpin width	mm (in)	22.0–22.10 (0.8661–0.8701)	

(*1) The figures are for reference only.

Item	Unit	Model	
		F150B	FL150B
Crankcase			
Crankshaft journal oil clearance	mm (in)	0.021–0.050 (0.0008–0.0020)	
Thermostat			
Valve opening temperature			
at 0.05 mm (0.0020 in)	°C (°F)	58.0–62.0 (136.4–143.6)	
Fully open temperature	°C (°F)	70.0 (158.0)	
Fully open stroke			
at 70.0 °C (158.0 °F)	mm (in)	4.3 (0.17)	

Lower unit technical data

Lower unit assembly (regular rotation model)

Item	Unit	Model
		F150B
Lower unit Holding pressure	kPa (kgf/cm^2, psi)	68.6 (0.686, 9.9)
Pinion-to-forward gear Backlash (*1)	mm (in)	0.15–0.68 (0.0059–0.0268)
Pinion-to-reverse gear Backlash (*1)	mm (in)	0.33–0.74 (0.0130–0.0291)
Pinion shim (T3)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50
Forward gear shim (T1)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50
Reverse gear shim (T2)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50
Propeller shaft Runout limit	mm (in)	0.02 (0.0008)
Drive shaft Runout limit	mm (in)	0.2 (0.008)

(*1) Figures obtained using the special service tools.

Lower unit assembly (counter rotation model)

Item	Unit	Model
		FL150B
Lower unit Holding pressure	kPa (kgf/cm^2, psi)	68.6 (0.686, 9.9)
Pinion-to-forward gear Backlash (*1)	mm (in)	0.15–0.49 (0.0059–0.0193)
Pinion-to-reverse gear Backlash (*1)	mm (in)	0.24–0.65 (0.0094–0.0256)
Pinion shim (T3)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50
Forward gear shim (T2)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50
Reverse gear shim (T1)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50
Propeller shaft shim (T4)	mm	0.10, 0.12, 0.15, 0.18, 0.30, 0.40, 0.50
Propeller shaft Free play	mm (in)	0.25–0.35 (0.010–0.014)
Runout limit	mm (in)	0.02 (0.0008)
Drive shaft Runout limit	mm (in)	0.2 (0.008)

(*1) Figures obtained using the special service tools.

Bracket unit technical data

PTT system

Item	Unit	Model	
		F150B	FL150B
PTT			
Hydraulic pressure			
Down (*1)	MPa (kgf/cm^2, psi)	5.9–8.8 (59.0–88.0, 855.5–1276.0)	
Up (*1)	MPa (kgf/cm^2, psi)	9.8–11.8 (98.0–118.0, 1421.0–1711.0)	
Motor brush			
Standard length	mm (in)	9.8 (0.39)	
Wear limit	mm (in)	4.8 (0.19)	
Motor commutator			
Standard diameter	mm (in)	22.0 (0.87)	
Wear limit	mm (in)	21.0 (0.83)	

(*1) The figures are for reference only.

Special tightening torque

Fuel system

Part to be tightened	Thread size	Tightening torques		
		N·m	kgf·m	ft·lb
Canister bracket bolt	M6	10	1.0	7.4
Fuel pump cover screw	M6	4	0.4	3.0
Fuel pump assembly bolt	M6	10	1.0	7.4
Filter cup	—	5	0.5	3.7
Intake silencer bolt	M6	6	0.6	4.4
Throttle body bolt	M8	13	1.3	9.6
Fuel rail bolt	M8	13	1.3	9.6
Fuel cooler bolt	M6	5	0.5	3.7
Air pressure sensor screw	M5	5	0.5	3.7
Vapor separator bolt	M6	5	0.5	3.7
Pressure regulator screw	M6	5	0.5	3.7
Float chamber cover screw	M4	2	0.2	1.5
Float chamber cover inner plate screw	M4	2	0.2	1.5
Needle valve assembly screw	M4	2	0.2	1.5
Vapor separator drain screw	—	2	0.2	1.5

Power unit

Part to be tightened		Thread size	Tightening torques		
			N·m	kgf·m	ft·lb
Spark plug		—	25	2.5	18.4
Power unit mounting bolt		M8	20	2.0	14.8
		M10	42	4.2	31.0
Upper case cover bolt		M6	4	0.4	3.0
PTT motor lead bolt		M6	4	0.4	3.0
Flywheel magnet nut		—	270	27.0	199.1
Ignition coil bolt		M6	7	0.7	5.2
Starter relay lead bolt		M6	4	0.4	3.0
Starter motor bolt		M8	29	2.9	21.4
Starter motor terminal nut		—	9	0.9	6.6
Timing belt tensioner bolt		—	39	3.9	28.8
Cylinder head cover plate screw		M4	2	0.2	1.5
Drive sprocket bolt		M5	7	0.7	5.2
Driven sprocket bolt		M10	60	6.0	44.3
Camshaft cap bolt	1st	M7	8	0.8	5.9
	2nd		17	1.7	12.5
Cylinder head bolt	1st	M8	14	1.4	1.3
	2nd		28	2.8	20.7
	1st	M10	19	1.9	14.0
	2nd		37	3.7	27.3
	3rd		90°		

Part to be tightened		Thread size	Tightening torques		
			N·m	kgf·m	ft·lb
Thermoswitch	1st	—	6	0.6	4.4
	2nd		12	1.2	8.9
Exhaust cover plug		M14	23	2.3	17.0
		M18	55	5.5	40.6
Exhaust cover bolt	1st	M6	6	0.6	4.4
	2nd		12	1.2	8.9
Engine temperature sensor		—	15	1.5	11.1
Cylinder block plug		M14	23	2.3	17.0
Engine hanger bolt		M6	12	1.2	8.9
Oil pressure sensor		—	18	1.8	13.3
Oil filter		—	18	1.8	13.3
Oil filter union bolt		—	34	3.4	25.1
Crankcase plug		—	54	5.4	39.8
Crankcase cover bolt	1st	M6	7	0.7	5.2
	2nd		13	1.3	9.6
	1st	M8	18	1.8	13.3
	2nd		31	3.1	22.9
Oil pump screw		—	4	0.4	3.0
Crankcase bolt	1st	M10	30	3.0	22.1
	2nd		90°		
	1st	M8	14	1.4	10.3
	2nd		26	2.6	19.2
Main bearing cap bolt	1st	M10	30	3.0	22.1
	2nd		90°		
Connecting rod cap	1st	—	23	2.3	17.0
	2nd		43	4.3	31.7
	3rd		90°		

Lower unit (regular rotation model)

Part to be tightened	Thread size	Tightening torques		
		N·m	kgf·m	ft·lb
Gear oil check screw	—	9	0.9	6.6
Gear oil drain screw	—	9	0.9	6.6
Lower case mounting bolt	M10	47	4.7	34.7
Trim tab bolt	M10	42	4.2	31.0
Propeller nut	—	54	5.4	39.8
Cooling water inlet cover screw	M5	5	0.5	3.7
Ring nut	—	143	14.3	105.5
Pinion nut	—	94	9.4	69.3

Lower unit (counter rotation model)

Part to be tightened	Thread size	Tightening torques		
		N·m	kgf·m	ft·lb
Gear oil check screw	—	9	0.9	6.6
Gear oil drain screw	—	9	0.9	6.6
Lower case mounting bolt	M10	47	4.7	34.7
Trim tab bolt	M10	42	4.2	31.0
Propeller nut	—	54	5.4	39.8
Cooling water inlet cover screw	M5	5	0.5	3.7
Ring nut	—	143	14.3	105.5
Pinion nut	—	94	9.4	69.3

Bracket unit

Part to be tightened	Thread size	Tightening torques		
		N·m	kgf·m	ft·lb
Neutral switch screw	M4	2.5	0.25	1.84
Shift cut switch screw	M4	2.5	0.25	1.84
Shift bracket bolt	—	19	1.9	14.0
Shift rod detent bolt	—	18	1.8	13.3
Grease nipple	—	1	0.1	0.7
Hose joint adapter screw	ø6	3	0.3	2.2
Upper mounting nut	—	72	7.2	53.1
Lower mounting nut	—	72	7.2	53.1
Upper mount bracket bolt	M10	54	5.4	39.8
Baffle plate screw	M6	4	0.4	3.0
Oil pan assembly bolt	M8	20	2.0	14.8
	M10	42	4.2	31.0
Engine oil drain bolt	—	27	2.7	19.9
Oil strainer bolt	M6	11	1.1	8.1
Oil pan bolt	M8	20	2.0	14.8
Exhaust manifold bolt	M8	20	2.0	14.8
Muffler bolt	M8	20	2.0	14.8
Self-locking nut	—	15	1.5	11.1
Grease nipple	—	3	0.3	2.2
Trim stopper nut	—	48	4.8	35.4

PTT unit

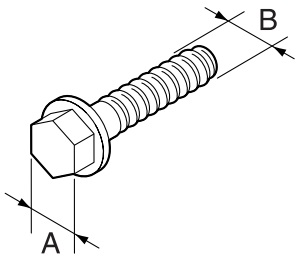
Part to be tightened	Thread size	Tightening torques		
		N·m	kgf·m	ft·lb
Lower mounting shaft bolt	M10	39	3.9	28.8
Reservoir mounting bolt	M6	5	0.5	3.7
Reservoir cap	—	0.7	0.07	0.5
PTT motor mounting bolt	M6	5	0.5	3.7
Gear pump cover bolt	M5	6	0.6	4.4
Gear pump housing mounting bolt	M8	8	0.8	5.9

Part to be tightened	Thread size	Tightening torques		
		N·m	kgf·m	ft·lb
Manual valve	—	3.5	0.35	2.58
Tilt cylinder end screw	—	128	12.8	94.4
Tilt piston nut	—	96	9.6	70.8
Trim cylinder end screw	—	140	14.0	103.3
Filter plug	—	6	0.6	4.4

General tightening torque

This chart specifies tightening torques for standard fasteners with a standard ISO thread pitch. Tightening torque specifications for special components or assemblies are provided in applicable sections of this manual. To avoid warpage, tighten multi-fastener assemblies in a crisscross fashion and progressive stages until the specified torque is reached. Unless otherwise specified, torque specifications require clean, dry threads. Components should be at room temperature.

Width across flat (A)	Screw size (B)	General torque specifications		
		N·m	kgf·m	ft·lb
8 mm	M5	5	0.5	3.7
10 mm	M6	8	0.8	5.9
12 mm	M8	18	1.8	13.3
14 mm	M10	36	3.6	26.6
17 mm	M12	43	4.3	31.7



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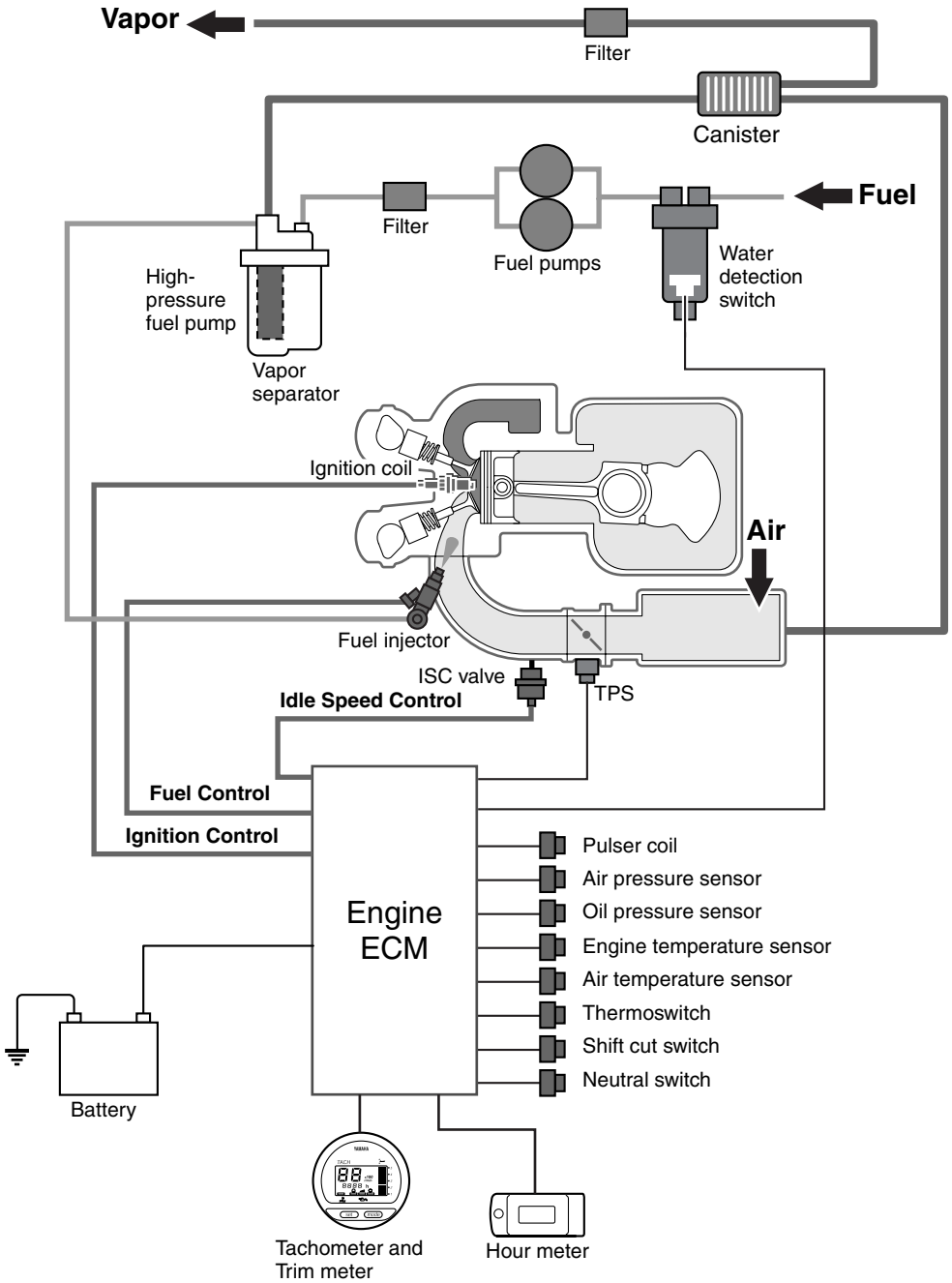
Electronic control system

F150B uses engine ECM to control the fuel injection amount and the ignition timing, and to reduce the engine speed in case of over heating and low oil pressure. Dependable startability, stable trolling speed, sharp acceleration, high output power, improved fuel economy, and low exhaust emissions are assured by controlling the air-fuel ratio and ignition timing appropriately depending on various engine operating conditions.

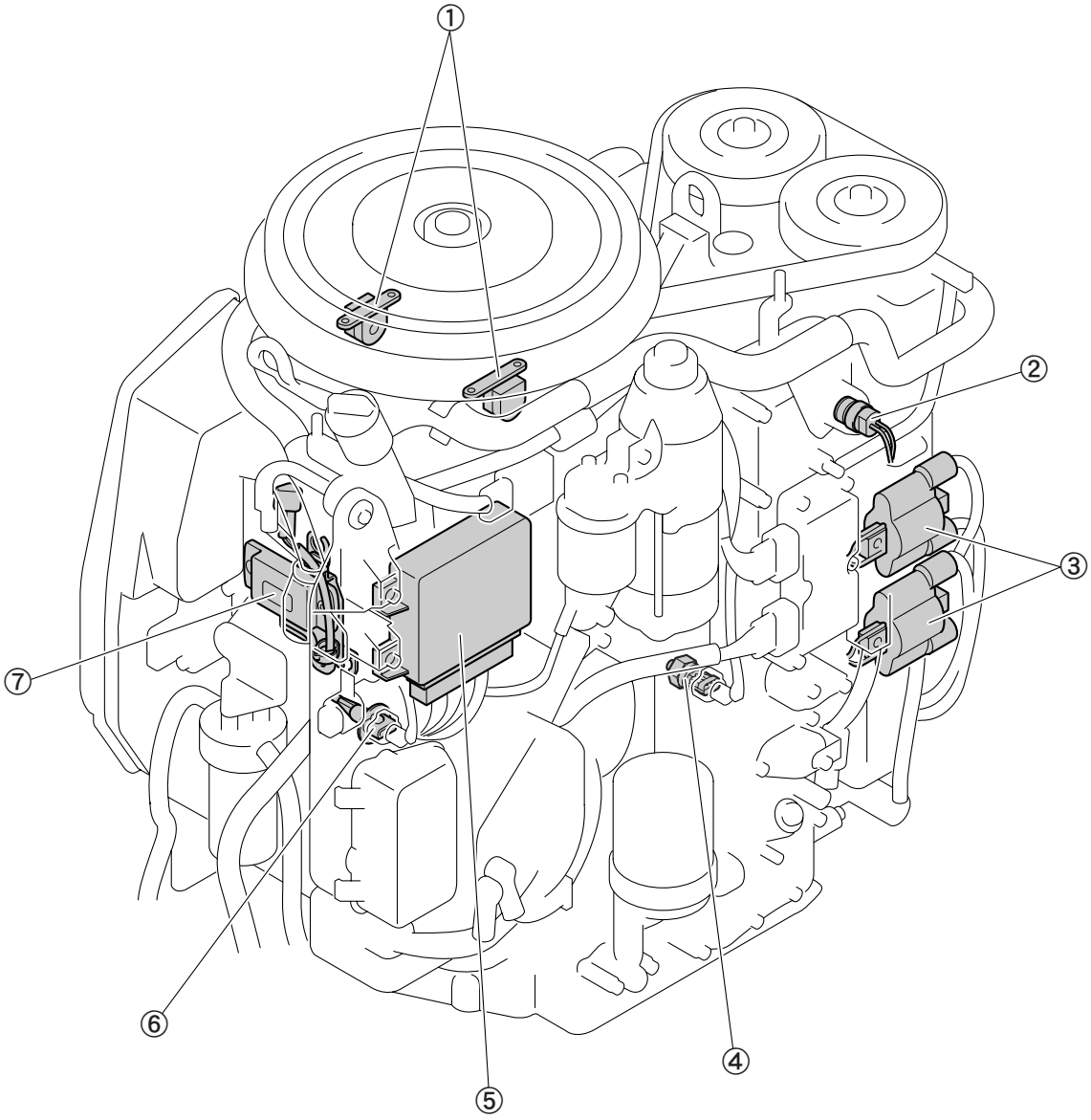
Self-diagnosis function is incorporated in F150B. Malfunctions can be detected quickly by running the optional diagnostic software to be installed in a personal computer.

F150B has fail-safe functions. In the event of a failure related to each sensor and actuator, the fail-safe function works to continue the control using the reference values set by engine ECM, or stop the engine. It also gives warning to the boat operator of the occurrence of failure by lighting the alert indicator, or activating the alert buzzer.

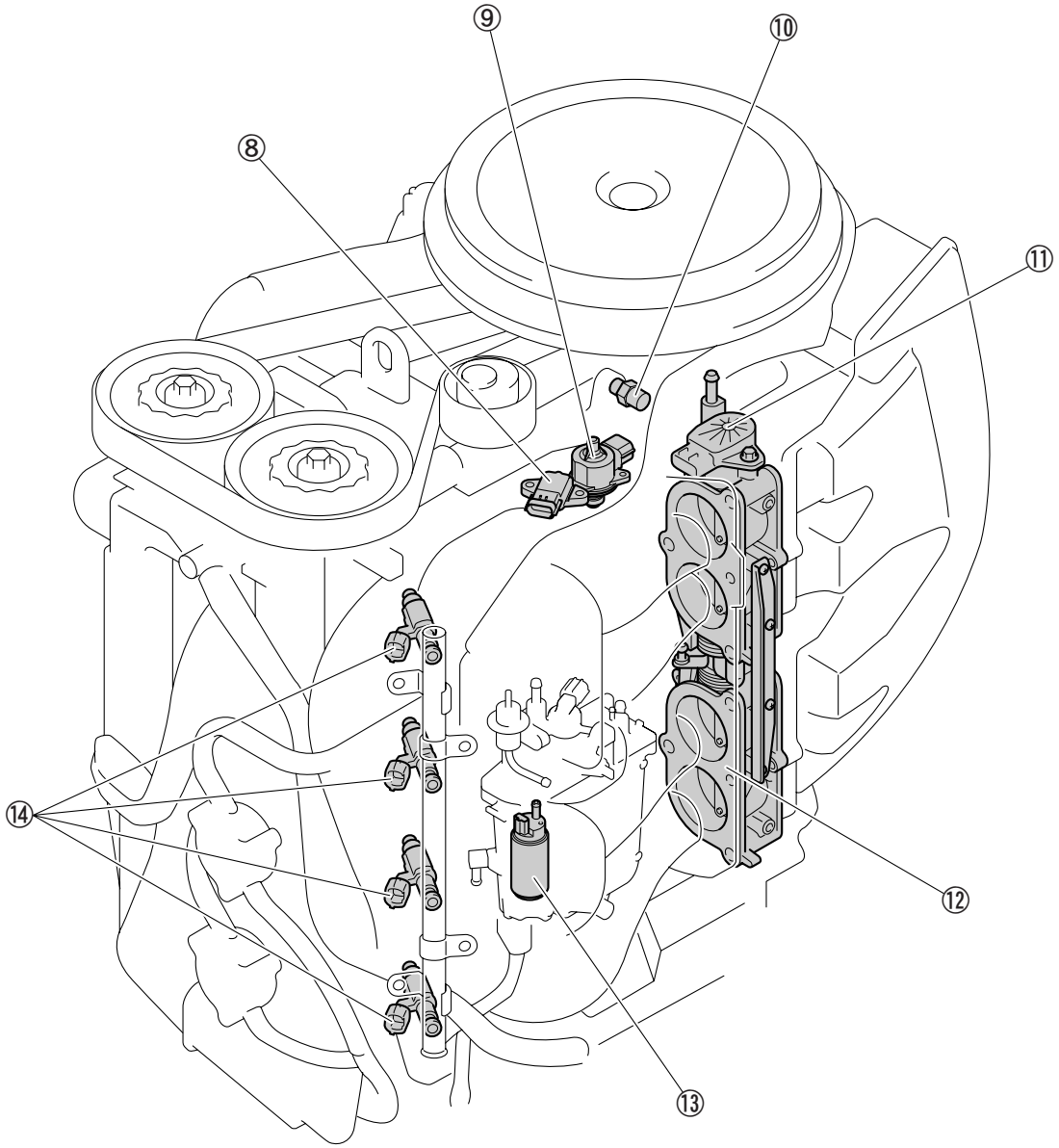
Electronic control module system diagram



Engine ECM component



① Pulser coil
② Thermoswitch
③ Ignition coil
④ Oil pressure sensor
⑤ Engine ECM
⑥ Air temperature sensor
⑦ Hour meter



⑧ Air pressure sensor
⑨ ISC valve
⑩ Engine temperature sensor
⑪ TPS
⑫ Throttle body
⑬ High-pressure fuel pump
⑭ Fuel injector

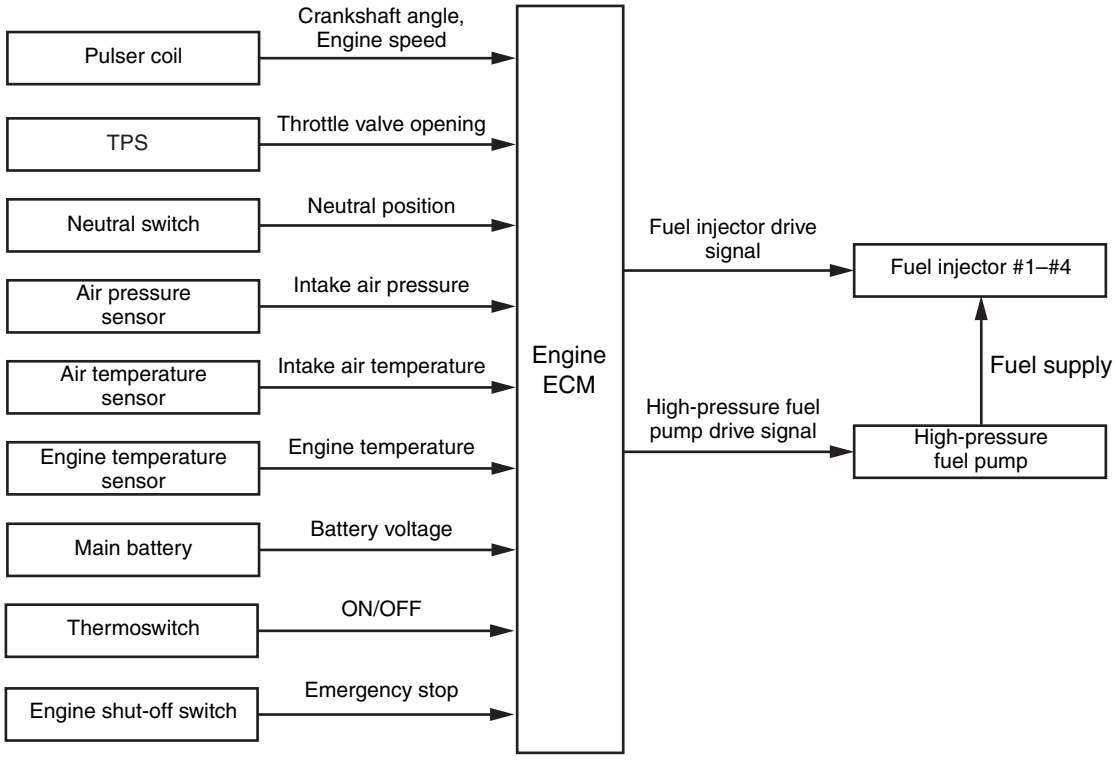
Sensor, switch and actuator

Engine ECM	Calculates the command values, and controls the fuel injection, ignition timing, and the engine speed based on the signals sent by each sensors.
Pulser coil	For detecting the engine speed.
	For detecting the crankshaft angle and the position of the pistons.
	For identifying each group of cylinders (#1 and #4, #2 and #3).
	For utilizing the detected signals to controlling the fuel injection, ignition timing, and the engine speed.
TPS	To detect the throttle valve opening.
Air pressure sensor	To detect the intake air pressure for controlling the ignition timing and the fuel injection amount.
Air temperature sensor	To detect the intake temperature for compensating the ignition timing.
Engine temperature sensor	Compensate the ignition timing and the fuel injection amount.
Oil pressure sensor	To detect the oil pressure and apply it to the alert of low oil pressure and the engine speed control.
Thermoswitch	In case of overheat, the thermoswitch is turned on. Once it is turned on, the engine ECM activates the engine speed control and the alert buzzer goes off.
Neutral switch	Detects the neutral position.
Engine shut-off switch	Activates the engine stop function compulsorily.
Fuel injector	Gives optimal amount of fuel at the optimal timing according to the engine ECM command signals.
Ignition coil	Activates the ignition at the optimal timing based on the signals from engine ECM.
High-pressure fuel pump	Pressurizes the fuel in the vapor separator, and delivers the fuel to the fuel rails.
Shift cut switch	To identify shift-in or shift-out condition for the forward gearshift.
ISC valve	To adjust the amount of intake air into the engine at idle.
YDIS	Allows quick, precise and detailed diagnosis by reading out the diagnosis codes and/or by performing the active test, after connecting the personal computer installed with the valid software.

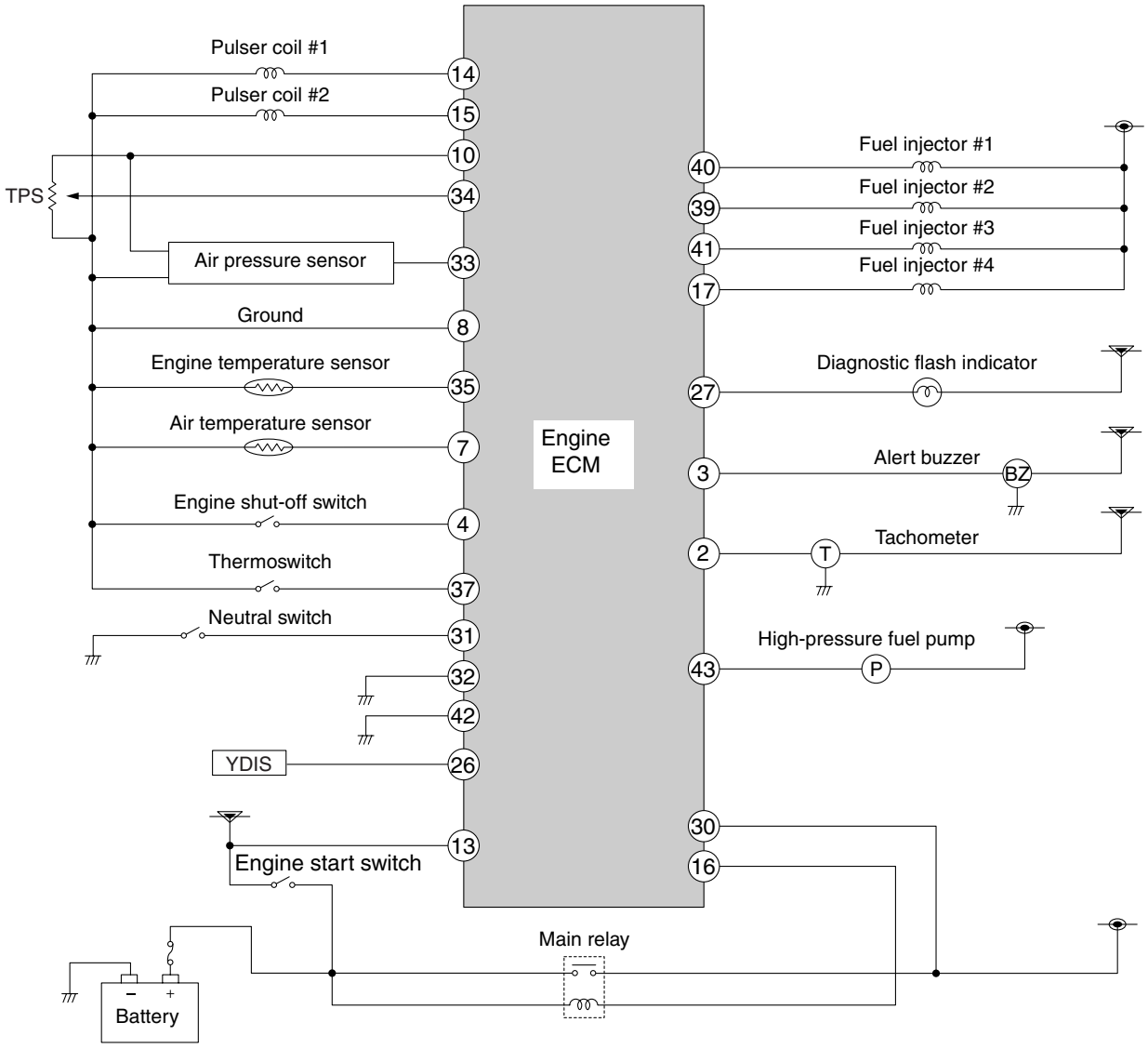
Electronic fuel injection control system

F150B uses electronic fuel injection control system to control the fuel injection timing and the amount of injected fuel. The fuel injection amount (example: duration of fuel injector energization) is controlled to assure the appropriate air/fuel ratio based on the intake air flow rate calculated from intake pressure and engine speed, responding to every engine operating condition represented by the signals from each sensor. High output power, improved fuel economy, and low exhaust emissions are attained by this system. Two types of fuel injection are carried out. One is synchronous injection in which the fuel injection always occurs at certain crankshaft angle, after the required compensation is made in accordance with the signals from each sensor. The other is asynchronous injection in which the fuel is injected regardless of crankshaft angle, once the demand for the fuel injection is detected in the signals from each sensor.

Block diagram



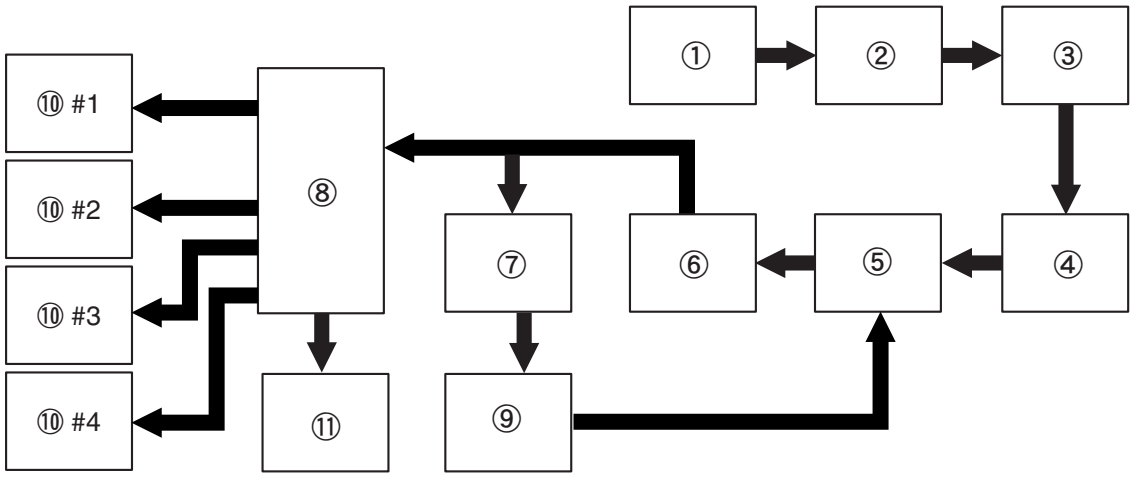
Circuit diagram

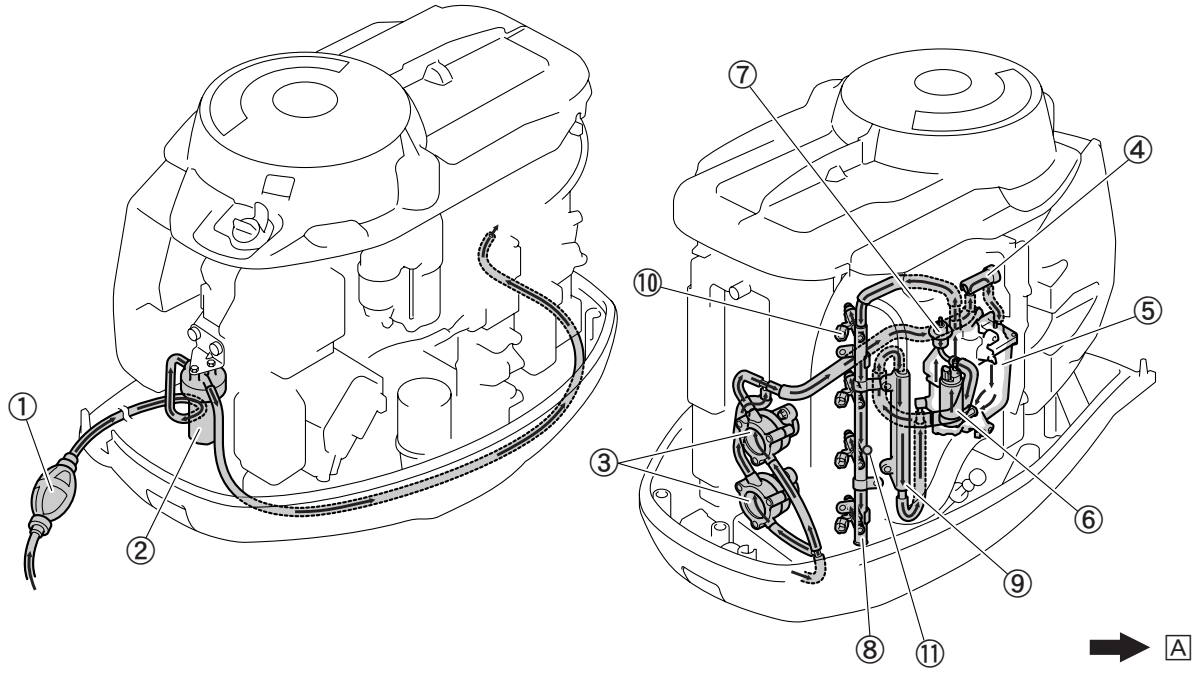


Same marks are connected by each other.

System chart

After running through the fuel filter, the fuel is sent to the vapor separator by the fuel pump attached to the cylinder head cover and driven by the camshaft.
Then, the fuel is pressurized by the electric fuel pump within the vapor separator, runs through the pressure regulator to the fuel rail, and injected into the combustion chamber through the fuel injector.
The pressure regulator is installed at the outlet of the electric fuel pump to make the design compact and to allow simple delivery of the fuel.
The fuel discharged from the pressure regulator is cooled down by the fuel cooler, and sent back to the vapor separator.
The pressure check valve is installed on the fuel rail for improved serviceability of the fuel system.





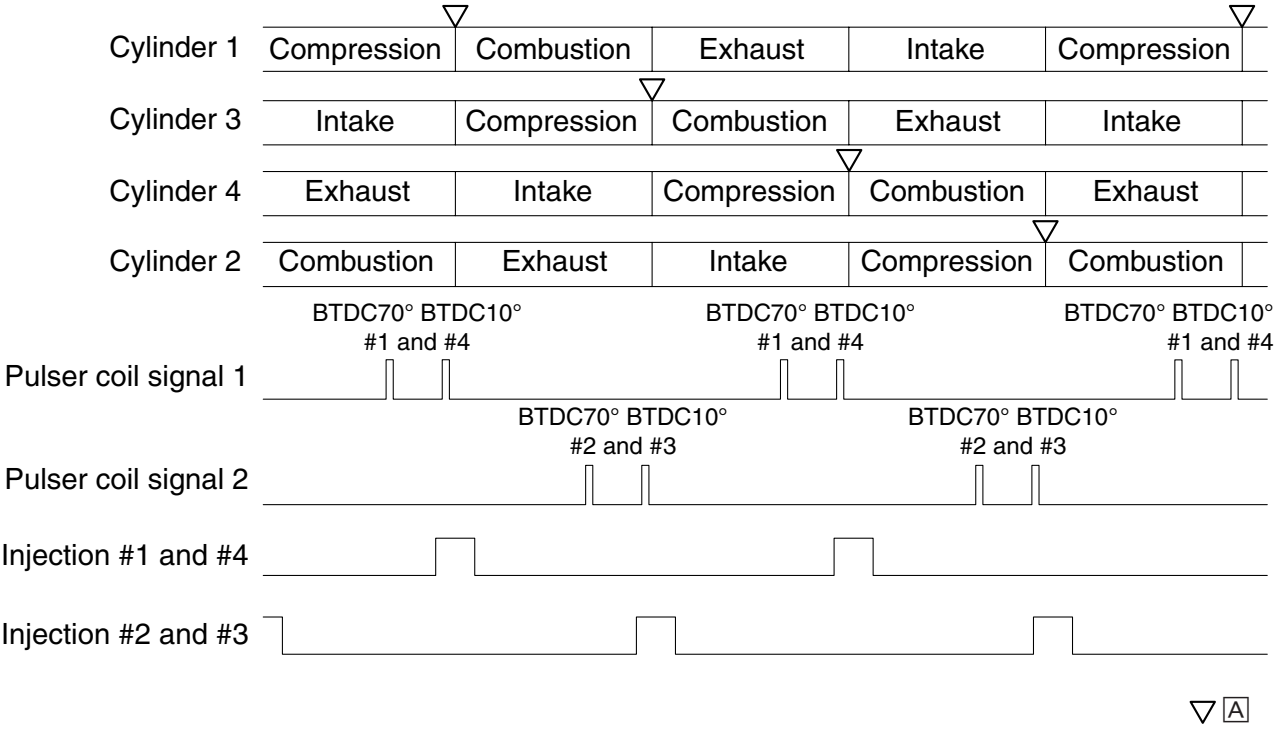
A Fuel flow

① Primer pump
② Fuel filter
③ Fuel pump
④ Fuel filter
⑤ Vapor separator
⑥ High-pressure fuel pump
⑦ Pressure regulator
⑧ Fuel rail
⑨ Fuel cooler
⑩ Fuel injector
⑪ Pressure check valve

Fuel injection control

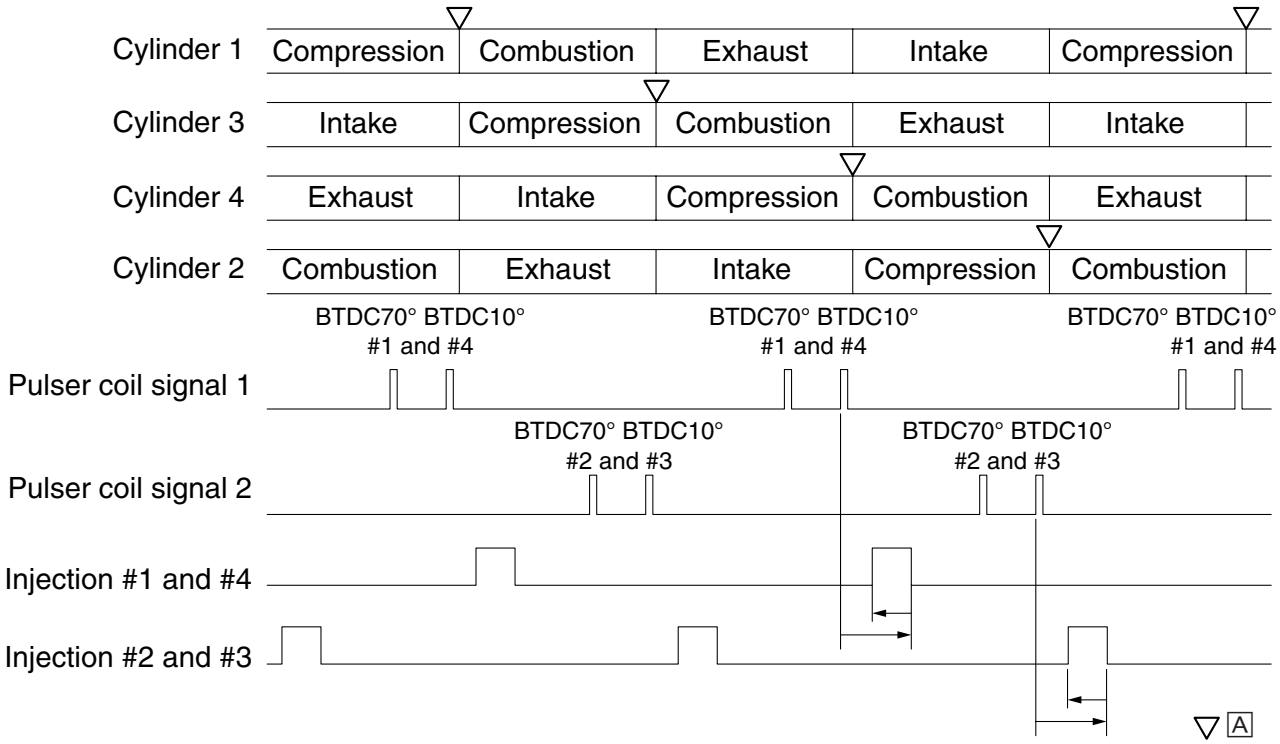
Synchronous injection	Simultaneous injection for a group of cylinders at engine start-up	The fuel injection timing control applicable to the start-up mode after the cylinder identification is completed by the pulser coil. Fuel injectors are turned on simultaneously for each cylinder group (#1 and 4, #2 and 3), synchronized at the crankshaft angle signal reference point (BTDC 370° CA) or at BTDC 70° CA in reference to the exhaust TDC.
	Group injection in normal operation	Fuel injectors are turned on in reference to the exhaust (compression) TDC when only the cylinder group identification is completed and the engine is not in the start-up mode. The fuel injectors for a group of cylinders are turned on simultaneously. Fuel is injected two times in every two rotations of crankshaft.
Asynchronous injection	Asynchronous injection at acceleration	When the increment of throttle opening gets larger than the set value in the course of acceleration, for instance, the fuel is injected immediately and simultaneously at all cylinders, rather than synchronizing with the engine rotation signal transmitted by the pulser coil. This prevents the lean air/fuel ratio, and assures the sharp throttle response in acceleration.

Simultaneous injection of group cylinders upon starting



A Compression TDC

Normal group injection



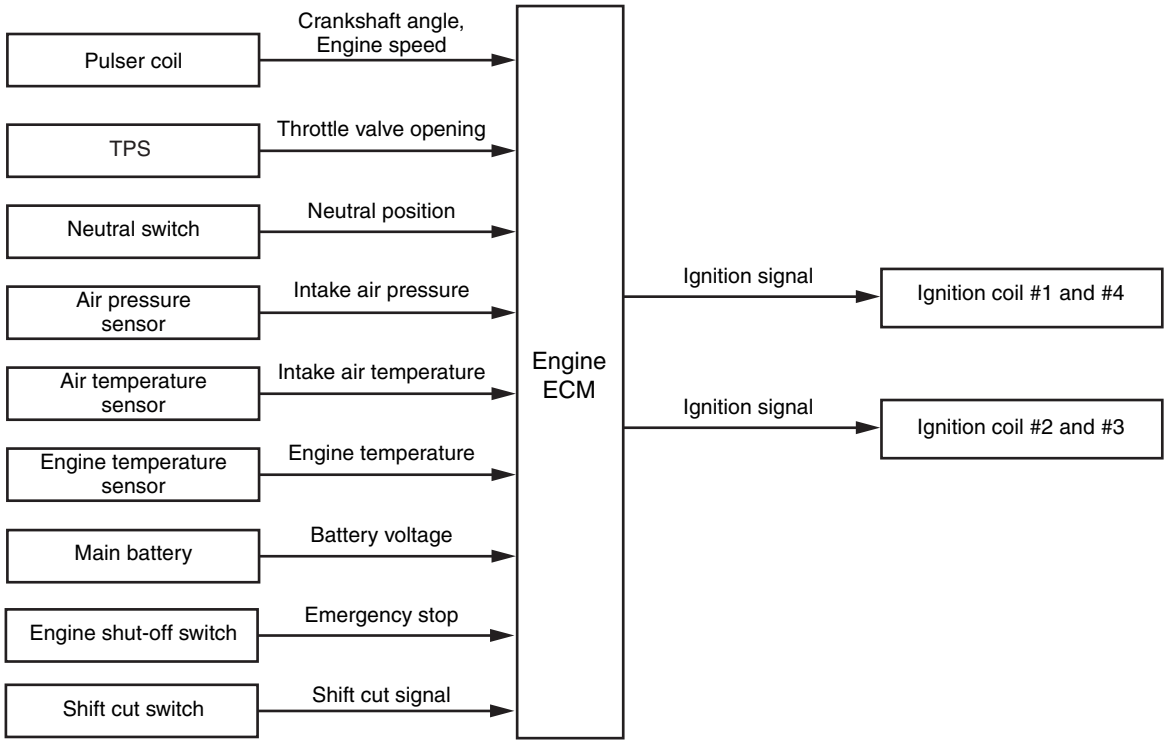
A Compression TDC

Ignition timing control system

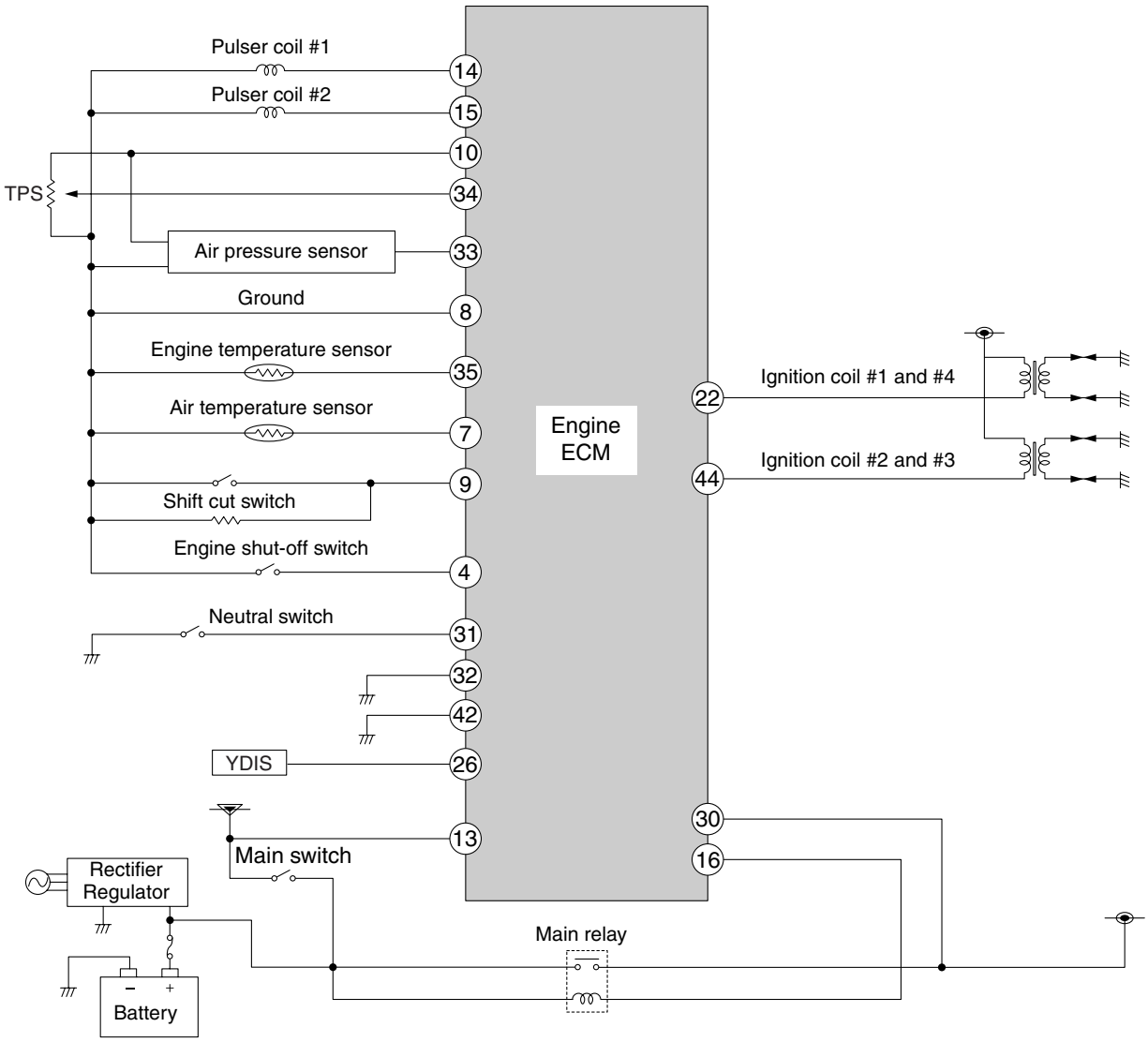
F150B uses ignition timing control system to control the ignition timing and the duration of ignition coil energization. High output power, improved fuel economy, and low exhaust emissions are attained by properly controlling the ignition timing and the duration of ignition coil energization in response to every engine operating conditions, based on the signals from each sensor and the map data.

Basic ignition timing computation	Optimal ignition timing is selected from the map data in accordance with the signals from each sensor.	
Computation for compensation	Ignition timing is advanced or retarded in response to the engine operating conditions determined by the signals from each sensor.	
	Stable idle speed	As the idle speed drops, ignition timing is advanced to make it stable. Ignition timing is retarded as the idle speed gets higher.
	Start-up operation	Engine startability is improved by applying the advanced ignition timing at the engine start-up. Subsequently, the ignition timing is controlled to go back to the standard angle gradually.
	compensation for acceleration	Ignition timing is temporarily retarded at acceleration to improve the throttle response.
	Shift-cutout	When the conditions are met for implementing the shift cut-out control, the specified angle is added to the ignition timing at every updating cycle until it reaches the shift-cutout compensation angle. Otherwise, the specified angle is subtracted from the ignition timing at every updating cycle until it reaches 0°CA.
Ignition timing restriction	Engine temperature restriction	Optimal ignition timing is selected from the map data depending on the cooling water temperature detected by the engine temperature sensor.
	Ignition timing upper and lower limits restriction	Limit values for advancing and retarding the ignition timing are computed by the map data in accordance with the engine speed detected by the pulser coil.
Computing the duration of energization	The duration of ignition coil energization is controlled based on the engine speed and the supply voltage to the ignition coil.	

Block diagram



Circuit diagram



Same marks are connected by each other.

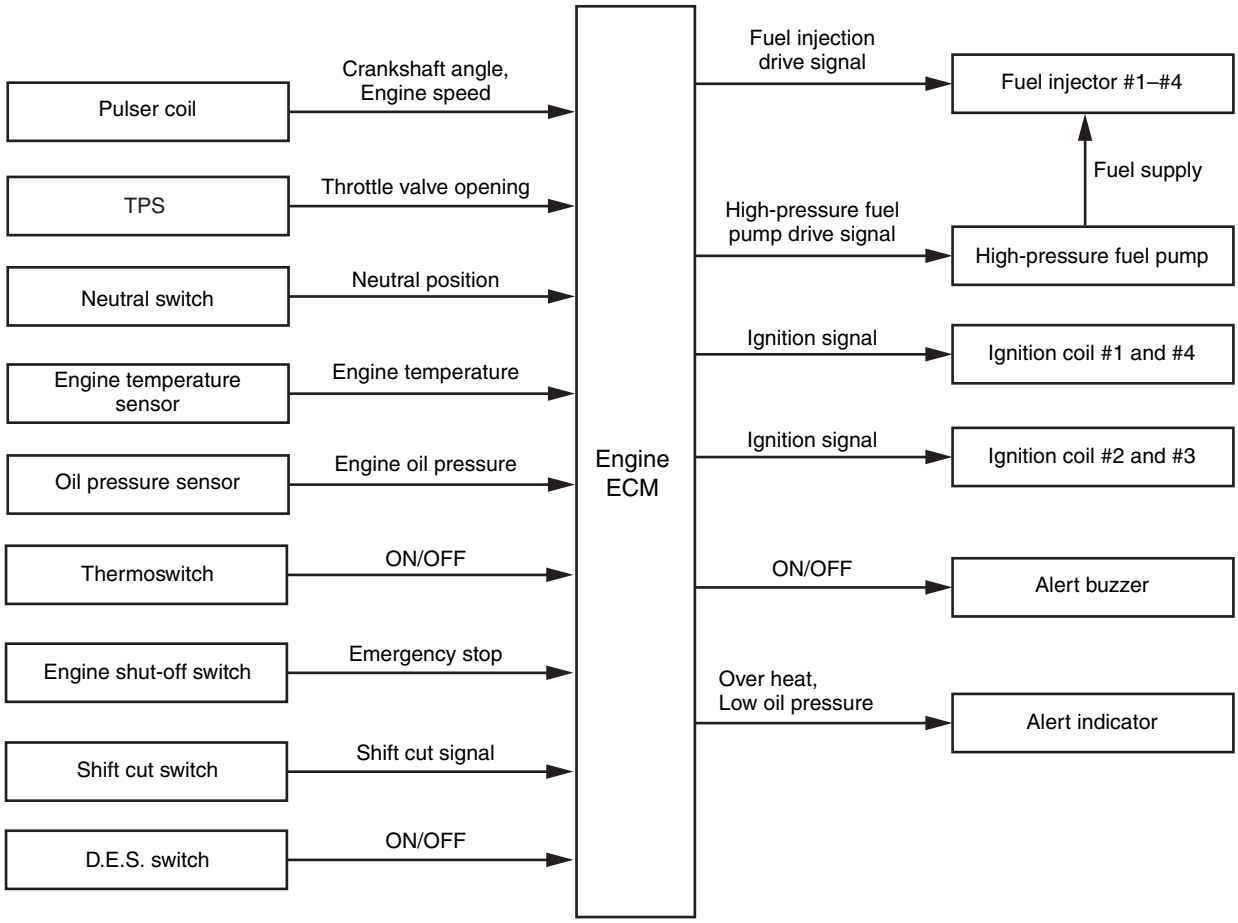
Engine speed control system

Engine speed control system on F150B reduces the engine speed in case of overheat and low oil pressure to prevent possible engine damages.

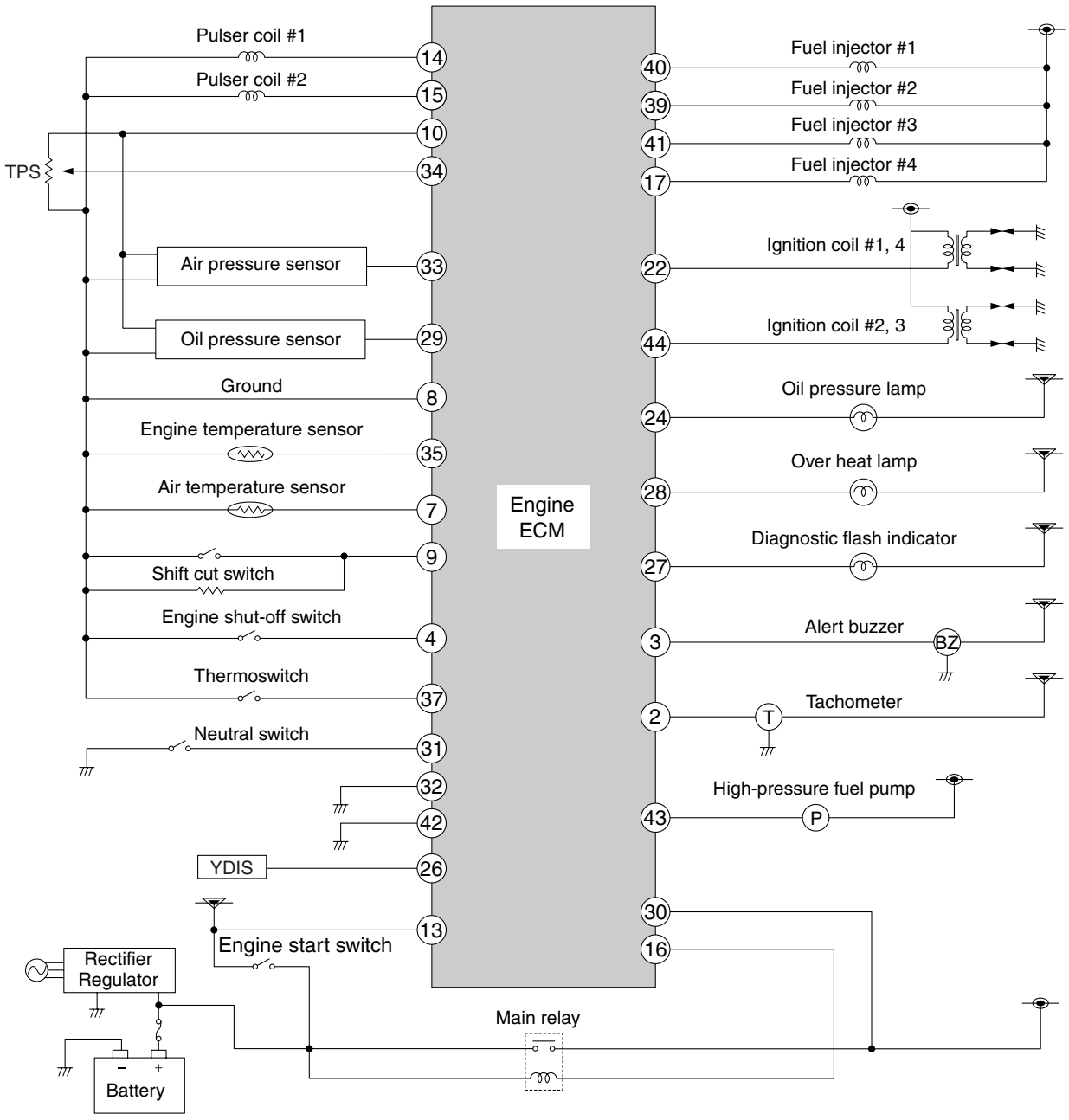
<table>
<tr><th>Control Name</th><th>Description</th><th colspan="3">Engine condition</th></tr>
<tr><td rowspan="2">Overheat control</td><td rowspan="2">Detects the overheat event and controls the engine speed.</td><td colspan="3">Overheat is identified when thermoswitch is turned on and the engine temperature is at 130 °C (266 °F) or higher.</td></tr>
<tr><td colspan="3">Engine ECM stops the fuel injection to reduce the engine speed to 2000 r/min or lower. At the same time, engine ECM activates the alert buzzer and lights the overheat alert indicator.</td></tr>
<tr><td rowspan="2">Low oil pressure control</td><td rowspan="2">Detects the low oil pressure and controls the engine speed.</td><td colspan="3">Low oil pressure is identified when it drops to 250.0 kPa (2.50 kgf/cm^2) or lower at engine starting. It is also identified when the pressure drops blow the specified value for each speed range.</td></tr>
<tr><td colspan="3">Engine ECM stops the fuel injection to reduce the engine speed to 2000 r/min or lower. At the same time, engine ECM activates the alert buzzer and lights the low oil pressure alert indicator.</td></tr>
<tr><td rowspan="2">D.E.S. Control</td><td rowspan="2">Detects the activation of D.E.S. and controls the engine speed.</td><td colspan="3">D.E.S switch is turned on in the event of an overheat alert or a low oil pressure alert, and the alert buzzer goes off.</td></tr>
<tr><td colspan="3">Once the above event takes place, engine ECM stops the fuel injection to reduce the engine speed to 2000 r/min or lower.</td></tr>
<tr><td rowspan="7">Shift cutout control</td><td rowspan="7">Detects the shift-cutout control activation and controls the engine speed.</td><td colspan="3">This device misfires and retards the ignition of some cylinders to fluctuate the engine speed instantly when the engine is running from 400–2000 r/min. This allows smooth engagement and disengagement of the dog clutch.</td></tr>
<tr><td colspan="3">When shifting, the ignition is shut off as shown in the table.</td></tr>
<tr><td>Shift cut switch</td><td>ON</td><td>OFF</td></tr>
<tr><td>Less than 400 r/min</td><td>No misfire control</td><td>No misfire control</td></tr>
<tr><td>400–729 r/min</td><td>Retards ignition timing</td><td>No misfire control</td></tr>
<tr><td>730–2000 r/min</td><td>Misfires the #1 and #4 cylinders, and then retards ignition timing</td><td>No misfire control</td></tr>
<tr><td>Over 2001 r/min or more</td><td>No misfire control</td><td>No misfire control</td></tr>
<tr><td>Engine shut-off switch ON</td><td colspan="4">Cancels the fuel injection control and the ignition control at all cylinders.</td></tr>
<tr><td rowspan="6">Over-revolution control</td><td rowspan="6">Controls the engine speed when an over-revolution condition is detected.</td><td colspan="3">Engine ECM controls the engine speed by carrying out the fuel injection stop control over 5750 r/min.</td></tr>
<tr><td colspan="2">Engine speed</td><td>Fuel injection stop</td></tr>
<tr><td colspan="2">Less 5750 r/min</td><td>None</td></tr>
<tr><td colspan="2">5750–5852 r/min</td><td>#1 and #4</td></tr>
<tr><td colspan="2">5852–6102 r/min</td><td>#1, #3, and #4</td></tr>
<tr><td colspan="2">6102 r/min or more</td><td>All cylinders</td></tr>
</table>

For the shift cutout control, fuel injection is shut off in the cylinder order #1, #4, and #3 at 2.5-second intervals when the engine is running at 2000 r/min or more. Fuel injection to the #2 cylinder is not shut off. When the throttle-opening angle is 30 degrees or less, fuel injection to the #3 cylinder will begin again. When the engine speed decreases to less than 2000 r/min, fuel injection will begin again in the cylinder order #3, #4, and #1 at 0.2-second intervals.
Concerning both overheat alert and low oil pressure alert control mode deactivate when the engine speed is less than 1600 r/min or the throttle-opening angle is less than 7 degrees.

Block diagram



Circuit diagram



Same marks are connected by each other.

Idle speed control

Engine ECM controls the amount of intake air into the engine at idle by driving the ISC stepper motor based on the signals from each sensor to regulate the area of the passage bypassing the main pipe where the throttle valve is installed.

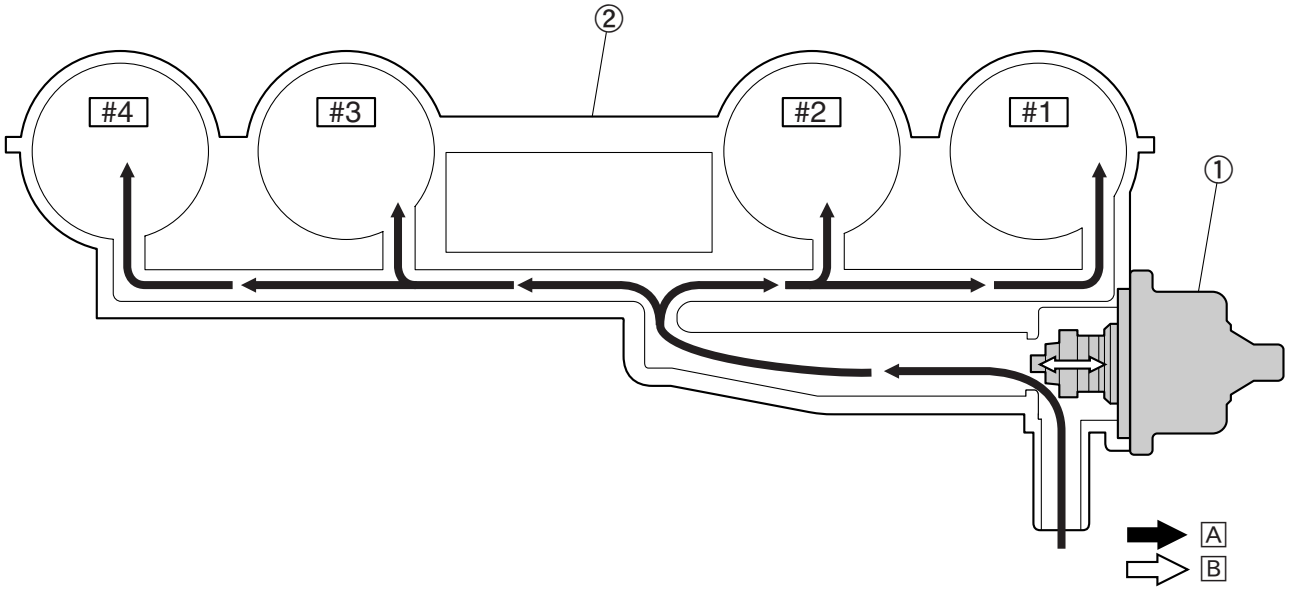
Determination of the ISC valve opening

Based on the signals from each sensor, engine ECM determines the extent to which the ISC valve must be opened, and controls the ISC stepper motor operation to obtain the target ISC valve opening.

ISC valve opening	Engine condition
ISC valve opening at engine start	At engine start, ISC valve is opened relatively wider depending on the engine temperature. This increases the amount intake air and improves the engine startability.
ISC valve opening immediately after engine start	After engine start, the initial ISC valve opening determined by the engine temperature is reduced in steps and at constant interval until the idle speed is obtained.
Dashpot ISC valve opening	When the throttle lever is pulled back, ISC valve opening is controlled to prevent the engine speed from dropping off sharply.
ISC valve opening with engine speed compensation	The difference between the actual engine idle speed and the target engine speed is calculated, and ISC valve opening is altered so that the target engine speed is obtained.

ISC valve

Engine ECM controls the amount of intake air at idle by driving the stepper motor, and changing the area of the passage bypassing the main pipe where the throttle valve is installed. The stepper motor moves the ISC valve in 120 steps from fully open position to fully closed position. The ISC valve opens when the stepper motor is driven in reverse direction, and closes when the stepper motor is driven in forward direction.



A Intake air flow
B Movement of ISC valve
① ISC valve
② Intake manifold

Fail-safe control

If the electrical components malfunction, the engine ECM controls the ignition and fuel injection as shown in the table.

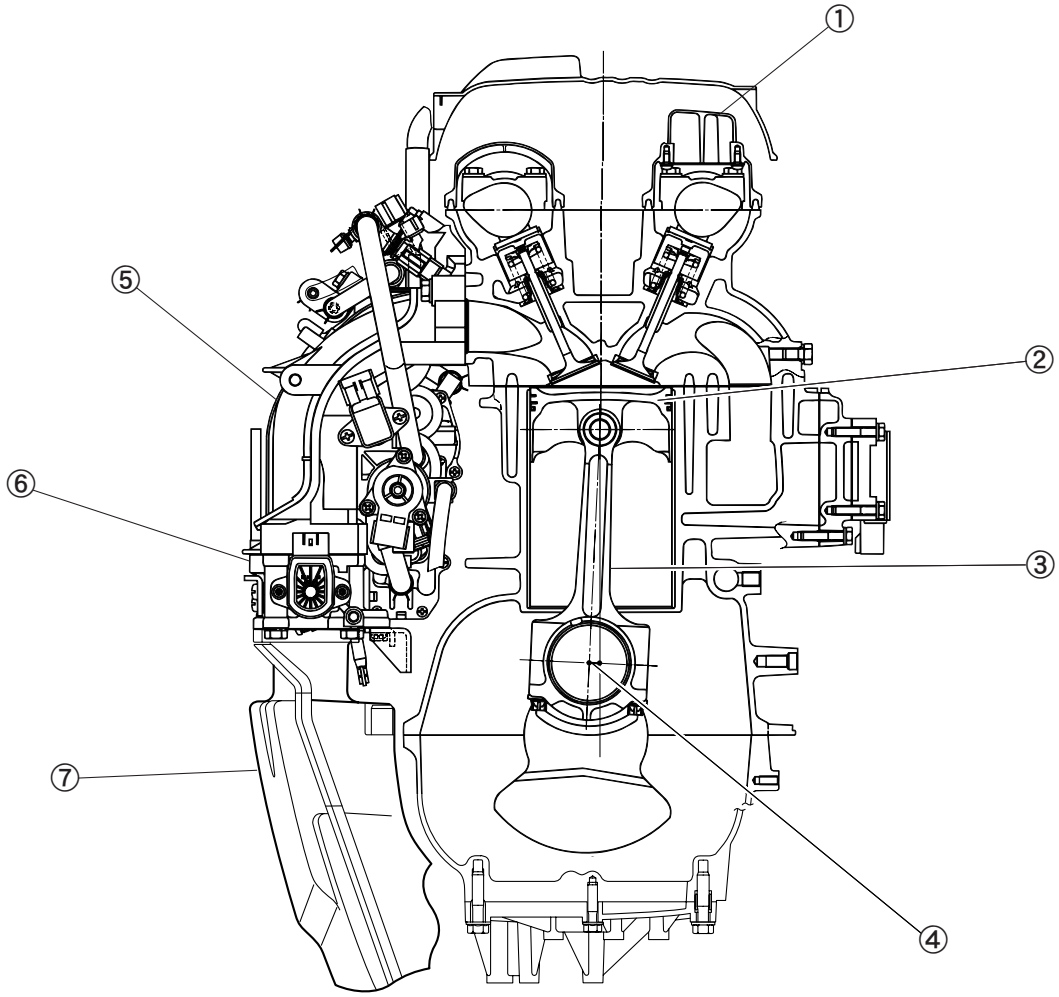
Trouble code	Malfunction components	Criterion	Ignition control	Fuel injection control
13	Pulser coil	No signal received during four consecutive crankshaft rotations	Fixed to BTDC 10°	Fixed to BTDC 10°
15	Engine temperature sensor	Output voltage is less 0.18 V or more 4.93 V	Normal control	Normal control
18	TPS	Output voltage is less 0.3 V or more 4.7 V	Controlled according to the basic ignition map	Controlled by intake air pressure and engine speed
23	Air temperature sensor	Output voltage is less 0.10 V or more 4.61 V	Normal control	Normal control
28	Neutral switch	Switch is off when starting the engine	Normal control	Normal control
29	Air pressure sensor	Output voltage is less 0.2 V or more 4.5 V	Normal control	Fuel injection volume is controlled by the TPS
39	Oil pressure sensor	Output voltage is less 0.3 V or more 4.8 V	Normal control	Normal control
45	Shift cut switch	Output voltage is more 4.5 V, the switch is on when the engine is started, or both the shift cut switch and neutral switch are on for 5 seconds	Normal control	Normal control
46	Thermoswitch	The switch is on when the engine temperature is less 40 °C (104 °F) or the switch is off when the engine temperature is more 130 °C (266 °F)	Normal control	Normal control

During fail-safe control, the engine idle speed increases to 900 r/min except if the neutral switch is off when the outboard motor is started.

Power unit system

Outline of system

F150B is equipped with L 4, 4-stroke engine.
The offset crank shaft is used, in which the crankshaft centerline is offset by 10.0 mm (0.39 in) from the cylinder centerline.
The long intake manifold made from plastic is used for higher intake efficiency to obtain higher output power.
The larger intake silencer is useful to suppress the noise.

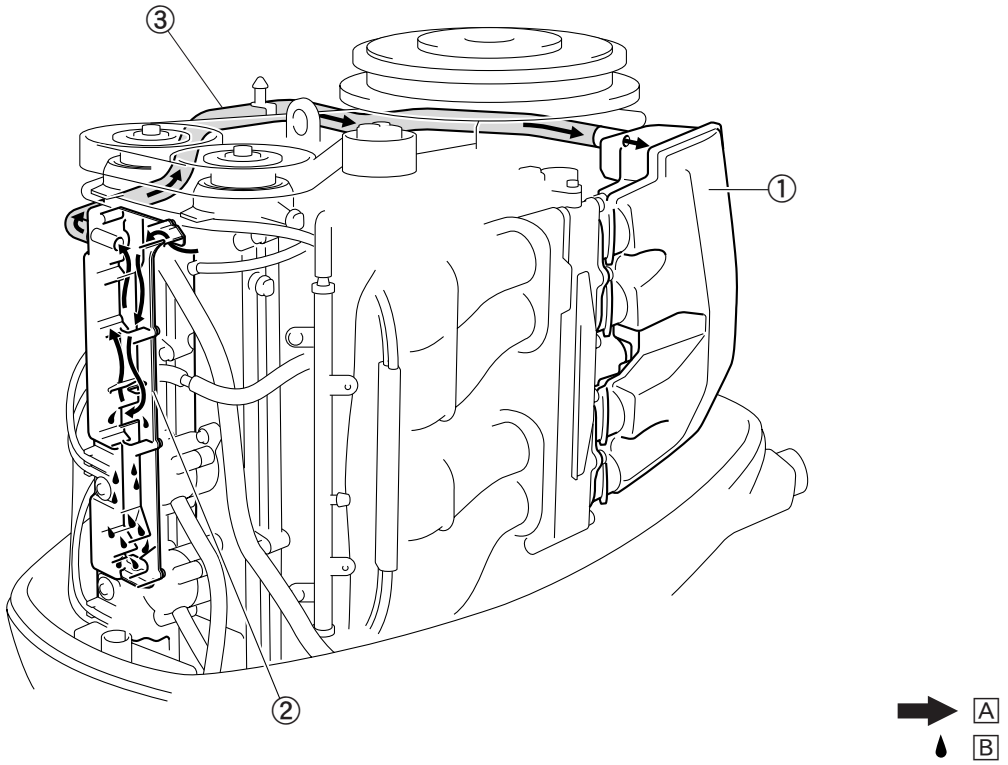


① Oil/gas separator
② Piston
③ Connecting rod
④ Offset crankshaft
⑤ Intake manifold
⑥ Throttle body
⑦ Intake silencer

Cylinder head cover

The blowby gas separator is used to obtain low emissions and is built into the cylinder head cover to obtain a compact design.

The gas and oil flow is shown below.

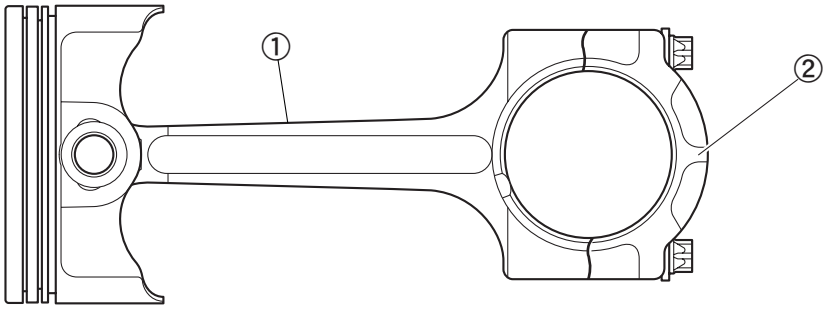


A Blowby gas
B Oil

① Intake silencer
② Blowby gas separator (integrated with cylinder head cover)
③ Blowby hose

Connecting rod

The connecting rod and connecting rod cap are manufactured as a single piece. Then, they are split using impact force. Only use the connecting rods and connecting rod caps in their original combinations, do not interchange them.

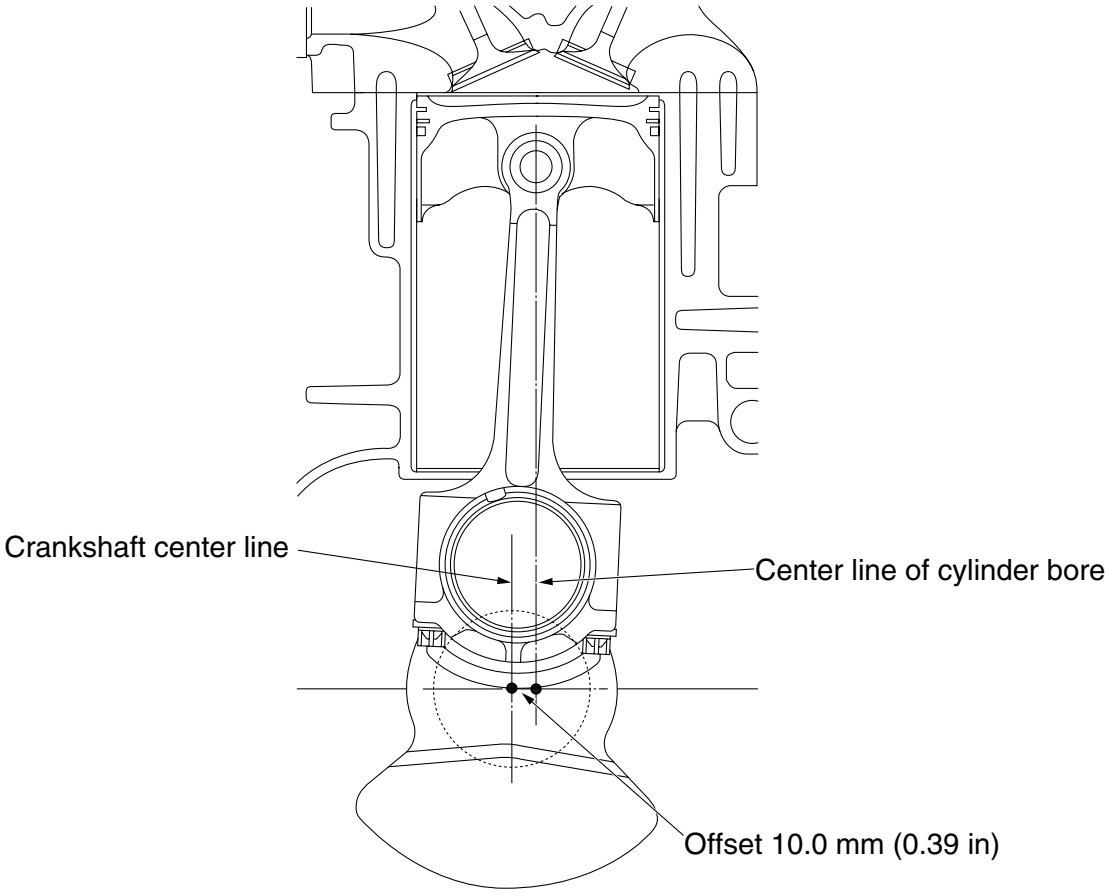


① Connecting rod
② Connecting rod cap

Offset crankshaft

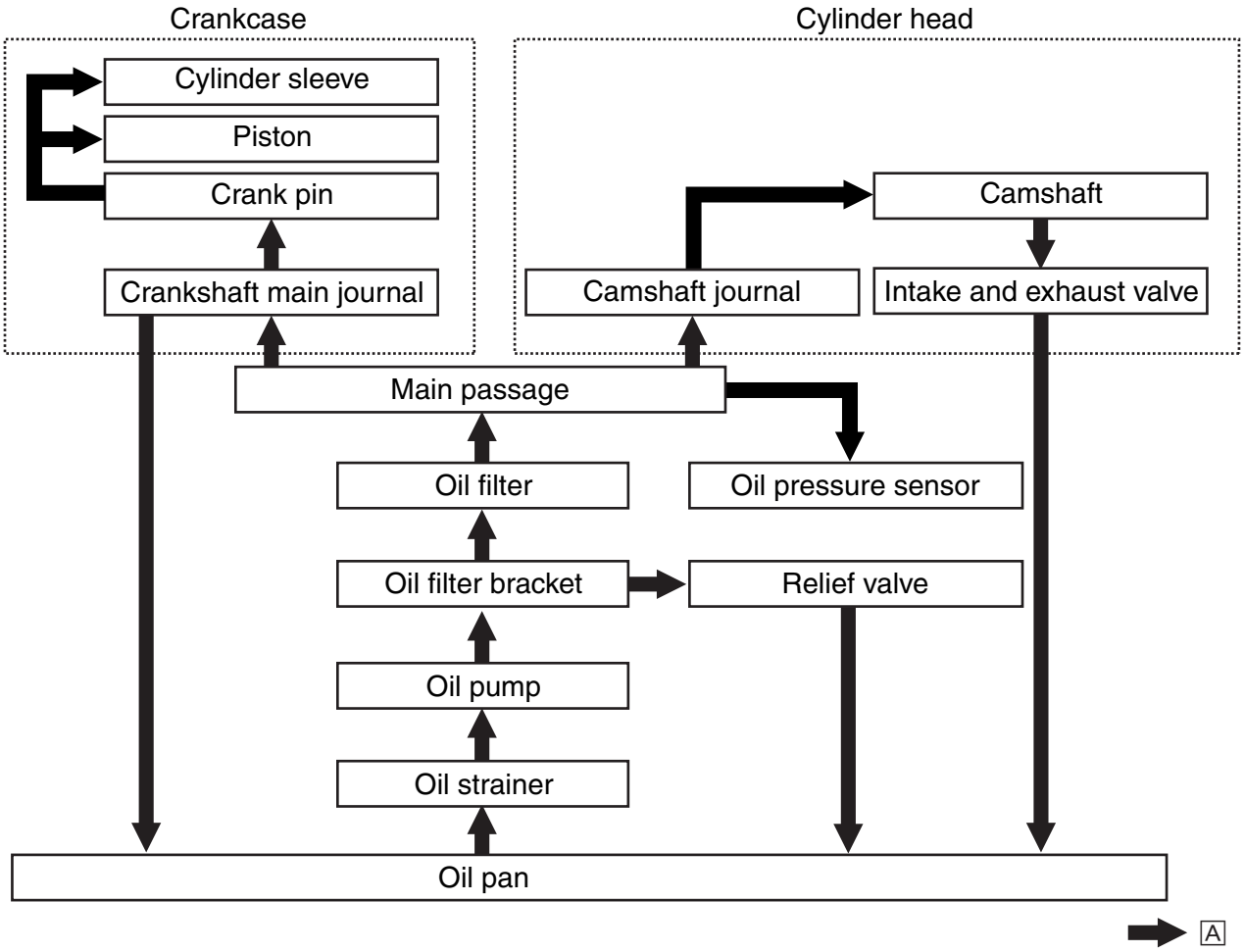
The crankshaft centerline is offset by 10.0 mm (0.39 in) from the centerline of the cylinder bore. The offset positioning results in the disagreement of crankshaft TDC with piston TDC, and allows the different duration of compression stroke from that of combustion stroke. Such difference in compression stroke and combustion stroke makes it possible to cause the earlier expansion and to keep the piston longer at around TDC after the ignition, leading to more effective use of combustion pressure and improved combustion efficiency.

It is also useful to reduce the frictional loss because the piston side force, the force in the thrusting direction generated on the piston during the combustion stroke, becomes smaller.

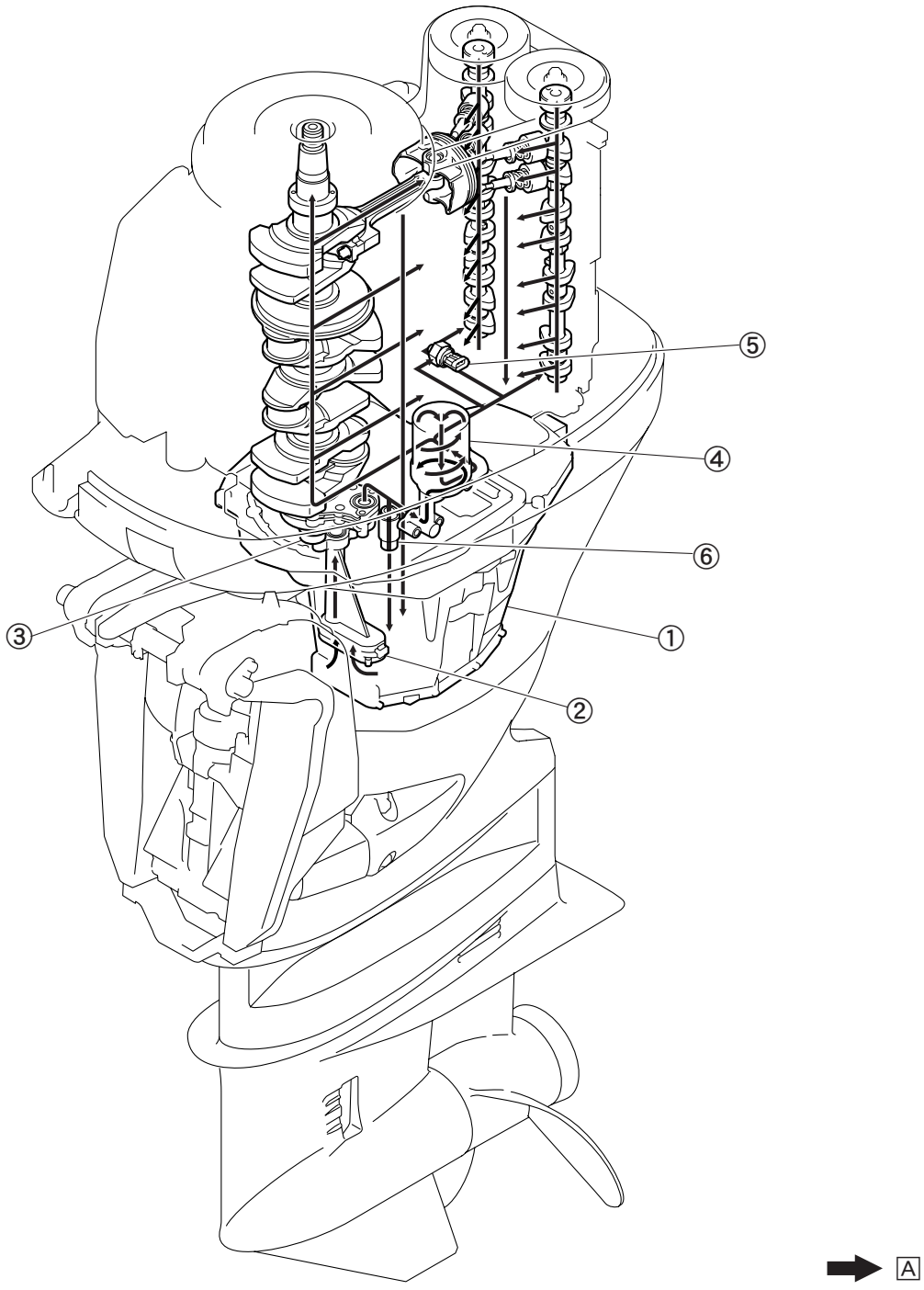


Lubrication system

The lubrication oil flow diagram is as follows.



A Engine oil flow

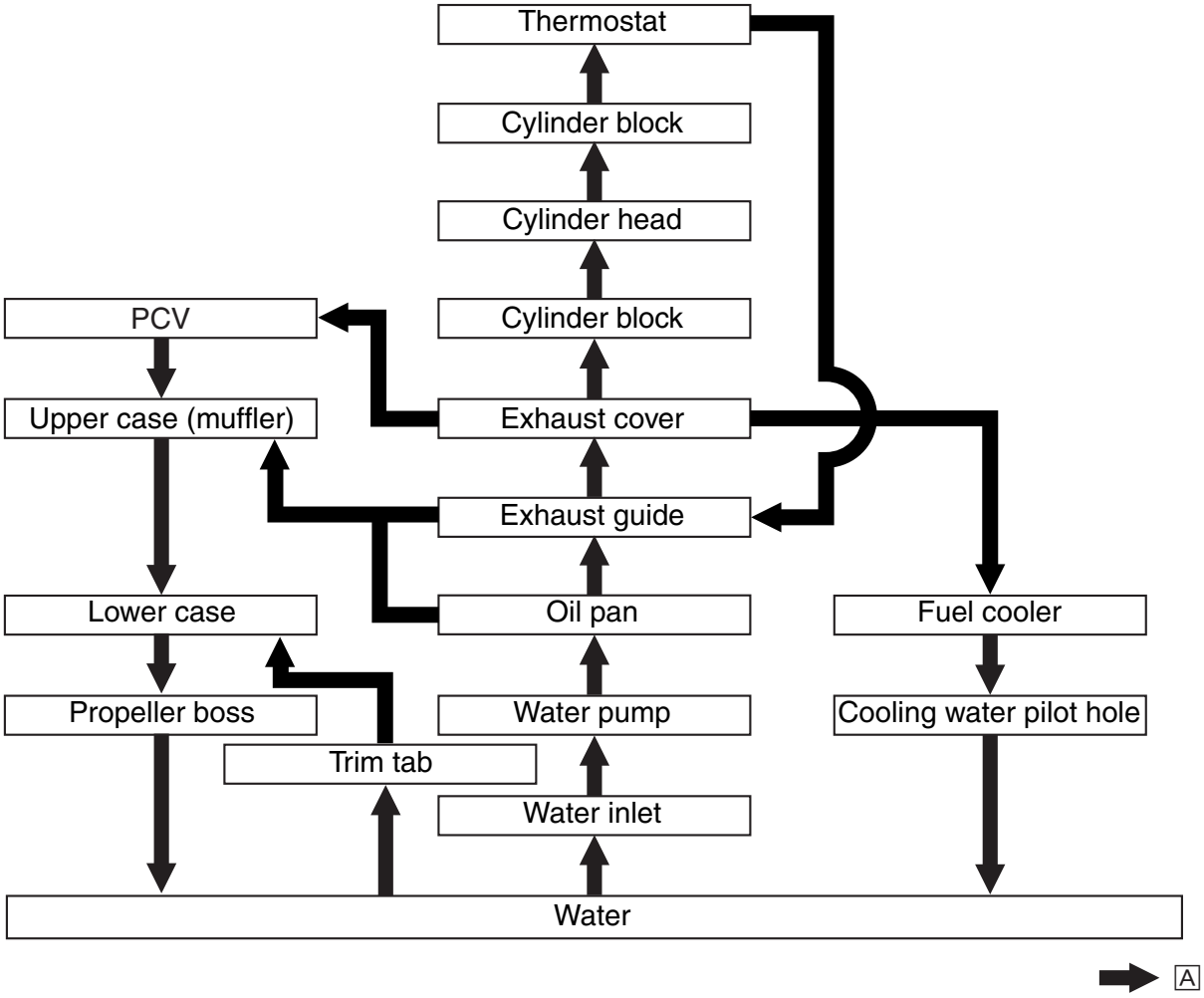


A Engine oil flow

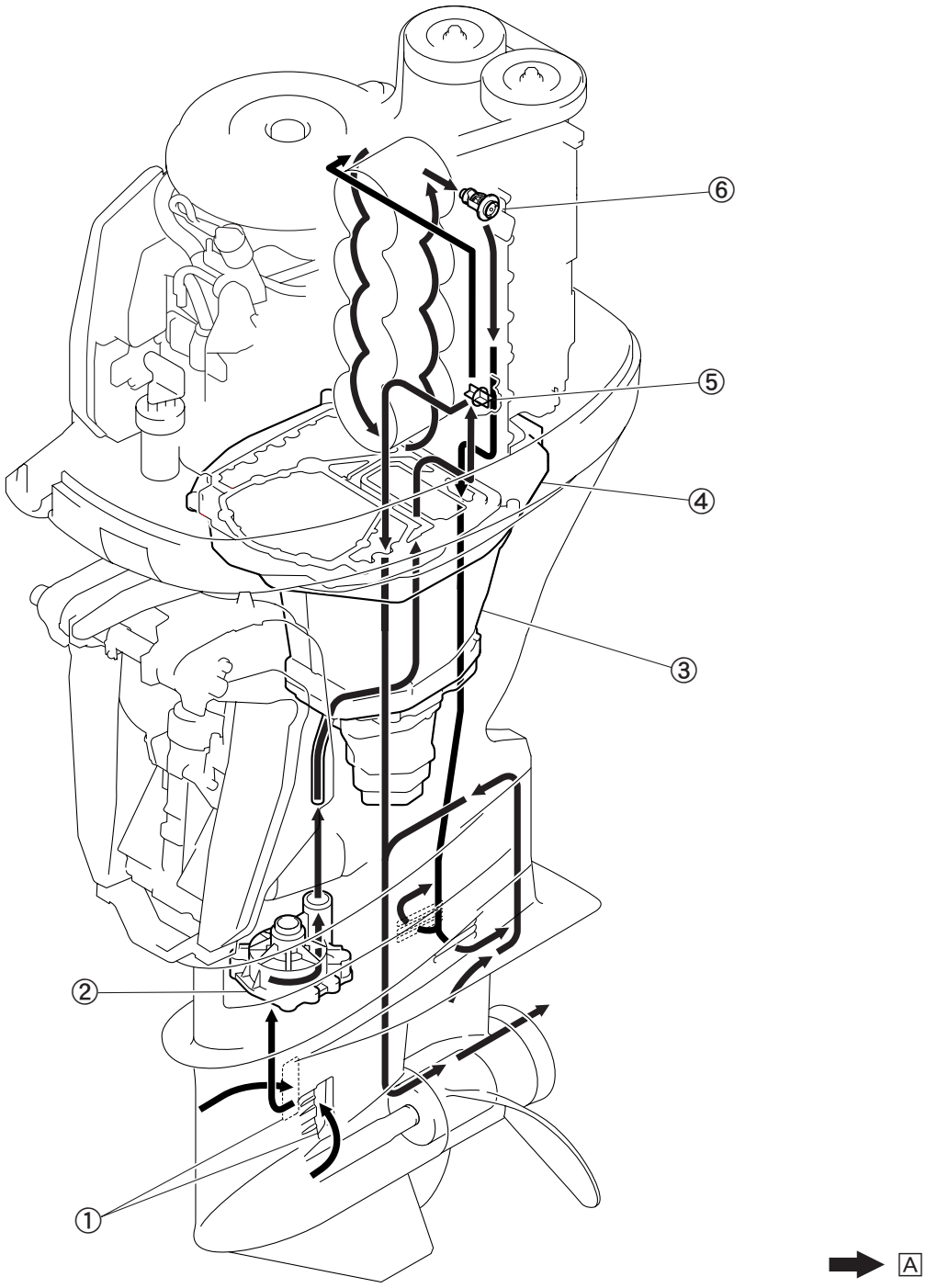
① Oil pan
② Oil strainer
③ Oil pump
④ Oil filter
⑤ Oil pressure sensor
⑥ Relief valve

Cooling system

The fresh cooling water is taken into the front of the trim tab and supplied to the exhaust passage of the lower case to cool the exhaust gas.
Cooling water also flows around the muffler to cool the upper case and reduce exhaust noise.

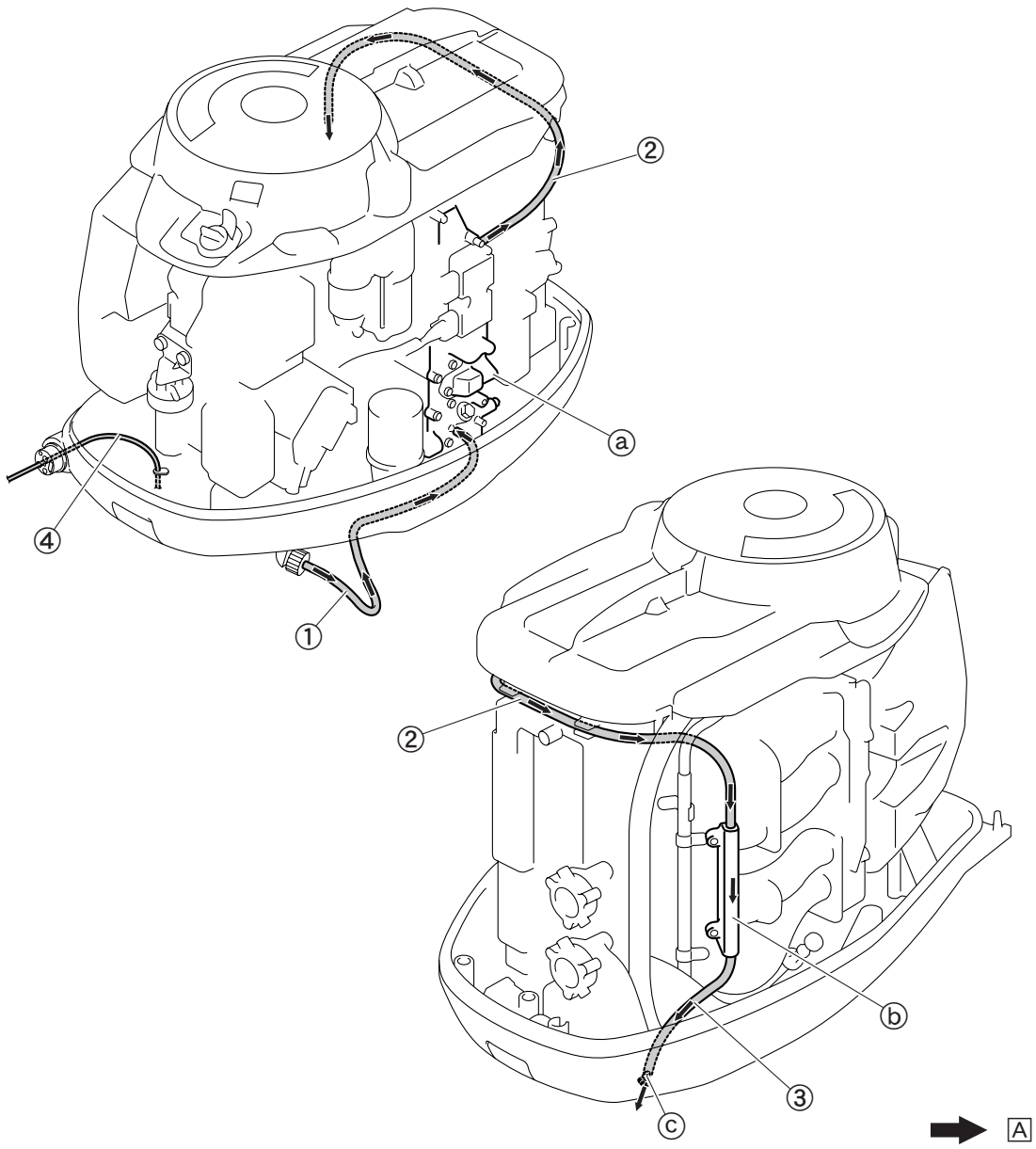


A Cooling water flow



A Cooling water flow

① Water inlet
② Water pump
③ Oil pan
④ Exhaust guide
⑤ Exhaust cover
⑥ Thermostat

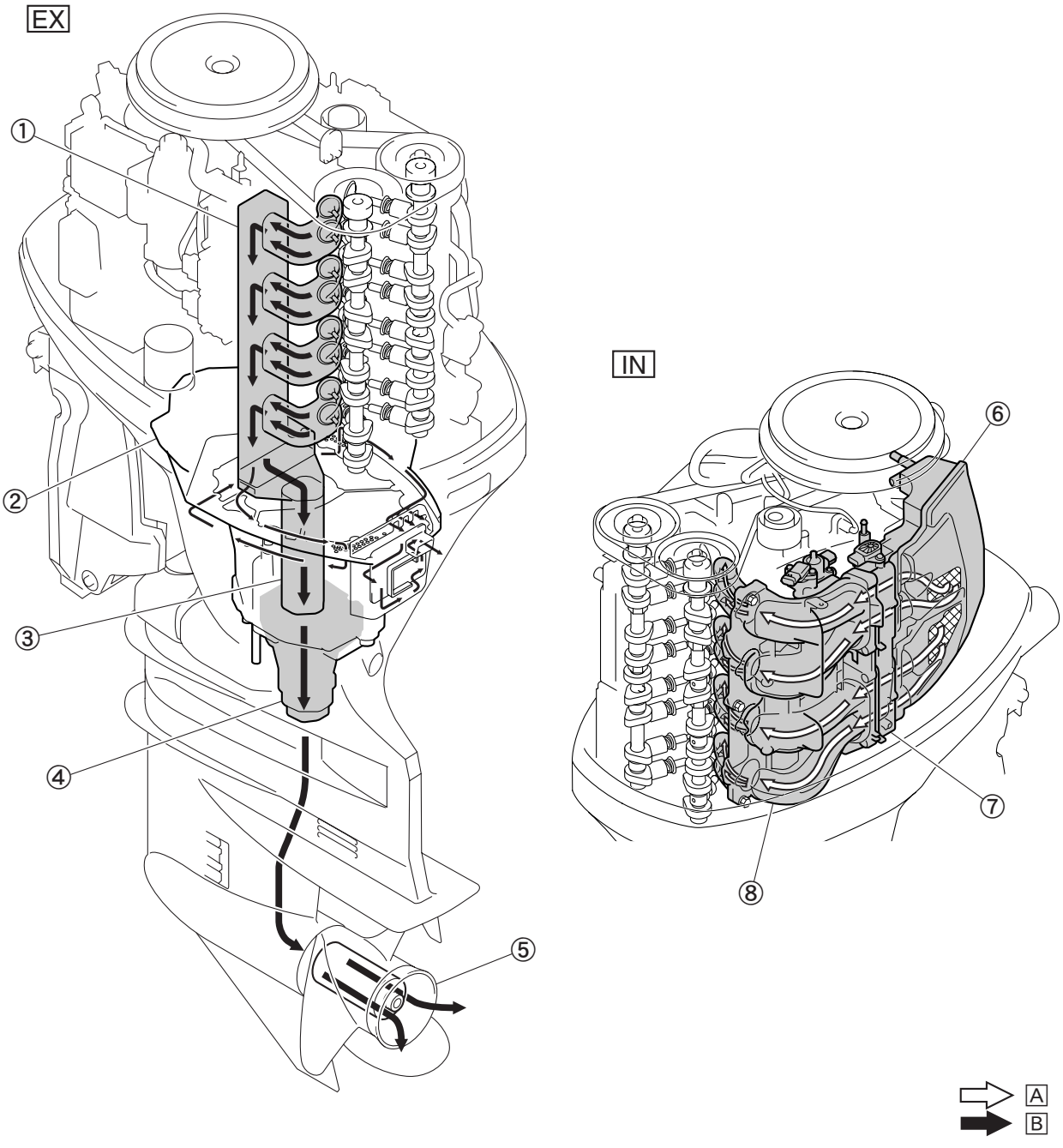


A Cooling water flow

① Flushing hose (exhaust cover-to-garden hose adapter)
② Cooling water hose (exhaust cover-to-fuel cooler)
③ Cooling water hose (fuel cooler-to-cooling water pilot hole)
④ Speedometer hose
ⓐ Exhaust cover
ⓑ Fuel cooler
ⓒ Pilot hole (on the bottom cowling)

Intake and exhaust system

The intake and exhaust air flow diagram.

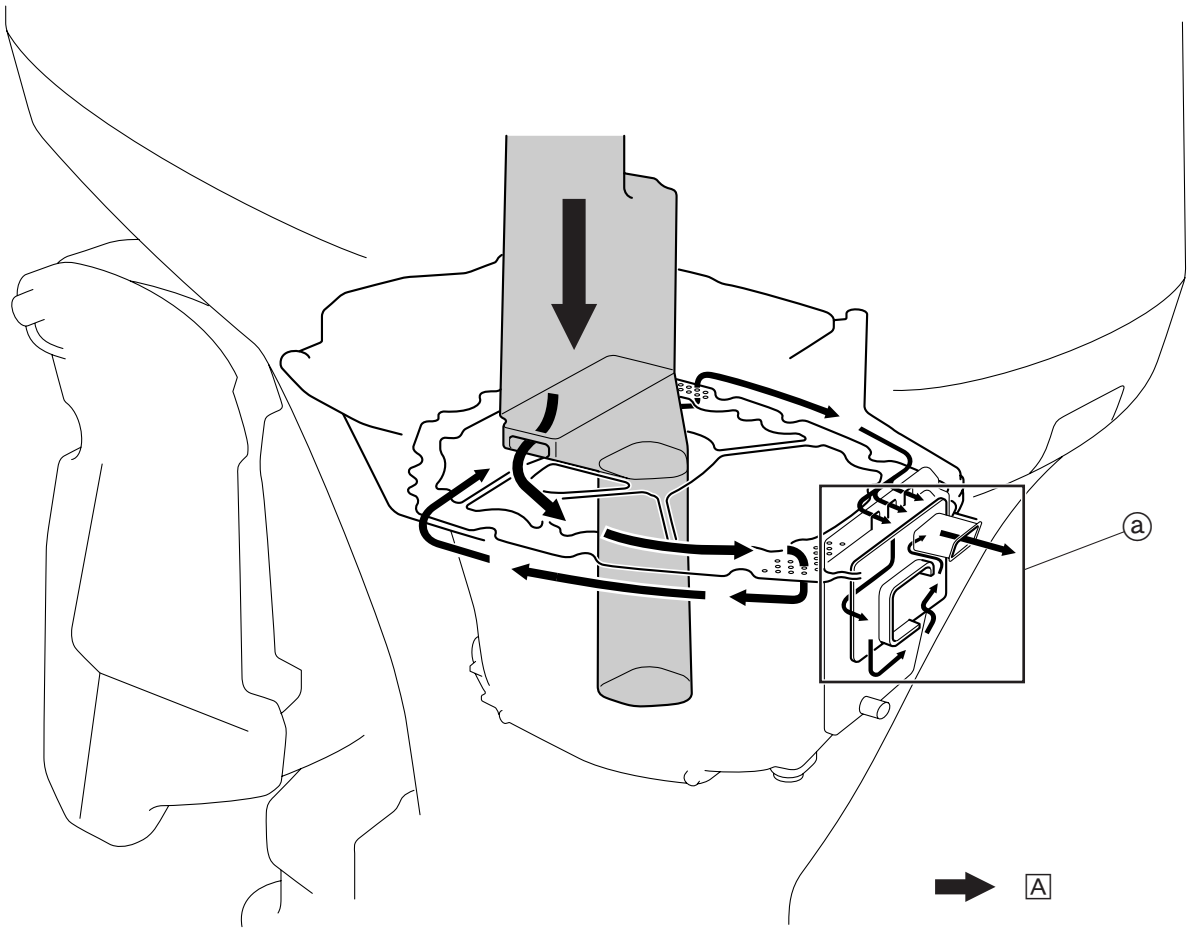


A Intake air flow
B Exhaust gas flow

① Exhaust cover
② Exhaust guide
③ Exhaust manifold
④ Muffler
⑤ Propeller
⑥ Intake silencer
⑦ Throttle body
⑧ Intake manifold

Idle exhaust system

The exhaust gas runs out through the idle exhaust port at idle engine speed.
The labyrinth structure is used to reduce the exhaust noise.



A Exhaust gas flow
ⓐ Labyrinth structure

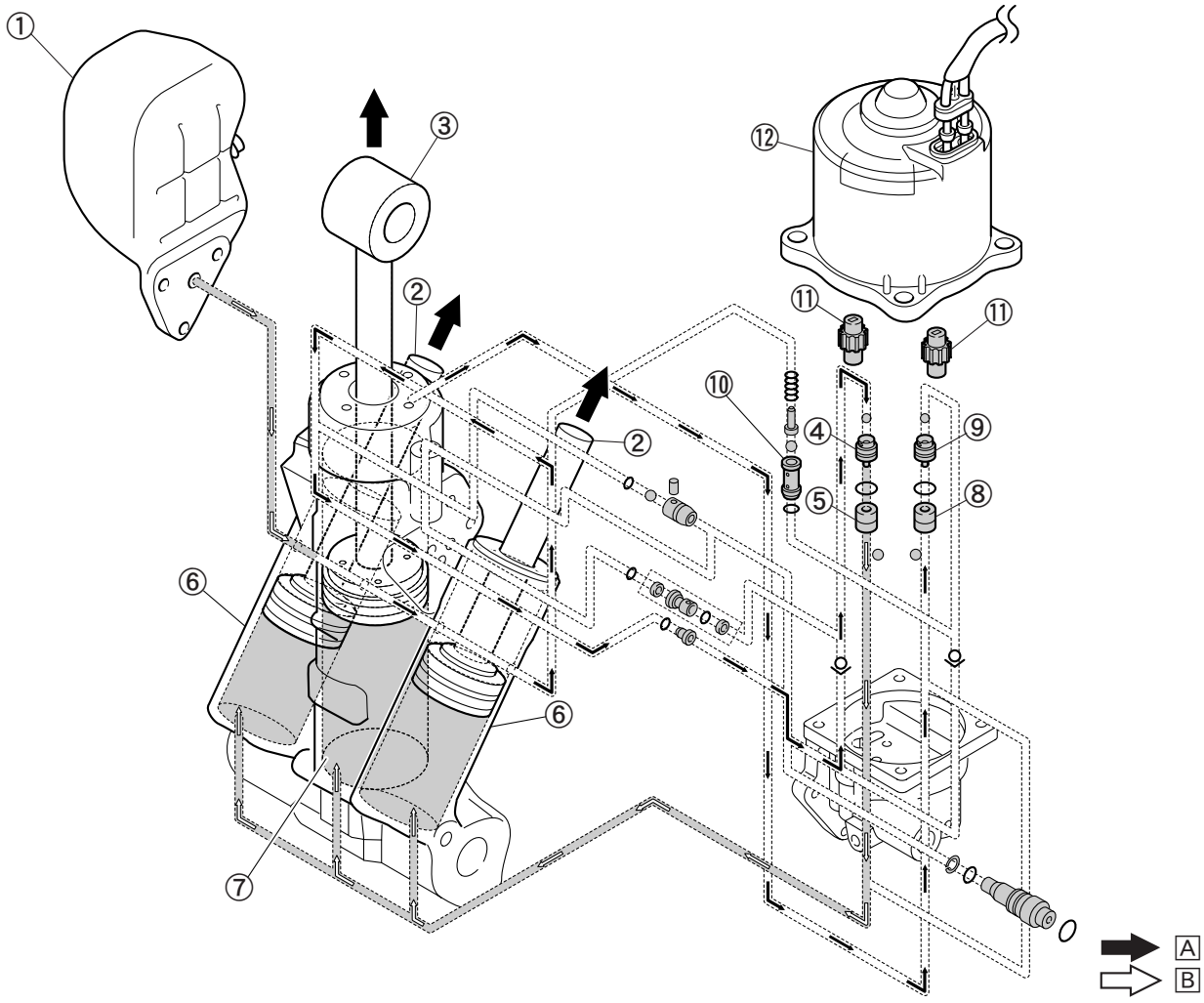
PTT unit

Trim-up and tilt-up function

When the PTT switch is pressed to “UP,” the PTT motor operates the gear pump and fluid pressure is generated. As a result, the fluid pressure pushes the up-shuttle piston, enters the trim cylinder and tilt cylinder lower chambers through the up-main valve, and then pushes the trim ram and tilt ram upward.

In addition, the fluid pushes the down-shuttle piston, opens the down-main valve, and returns from the tilt cylinder upper chamber to the gear pump.

After the trim ram has extended completely, the tilt ram operates to tilt up.



A Return
B Send

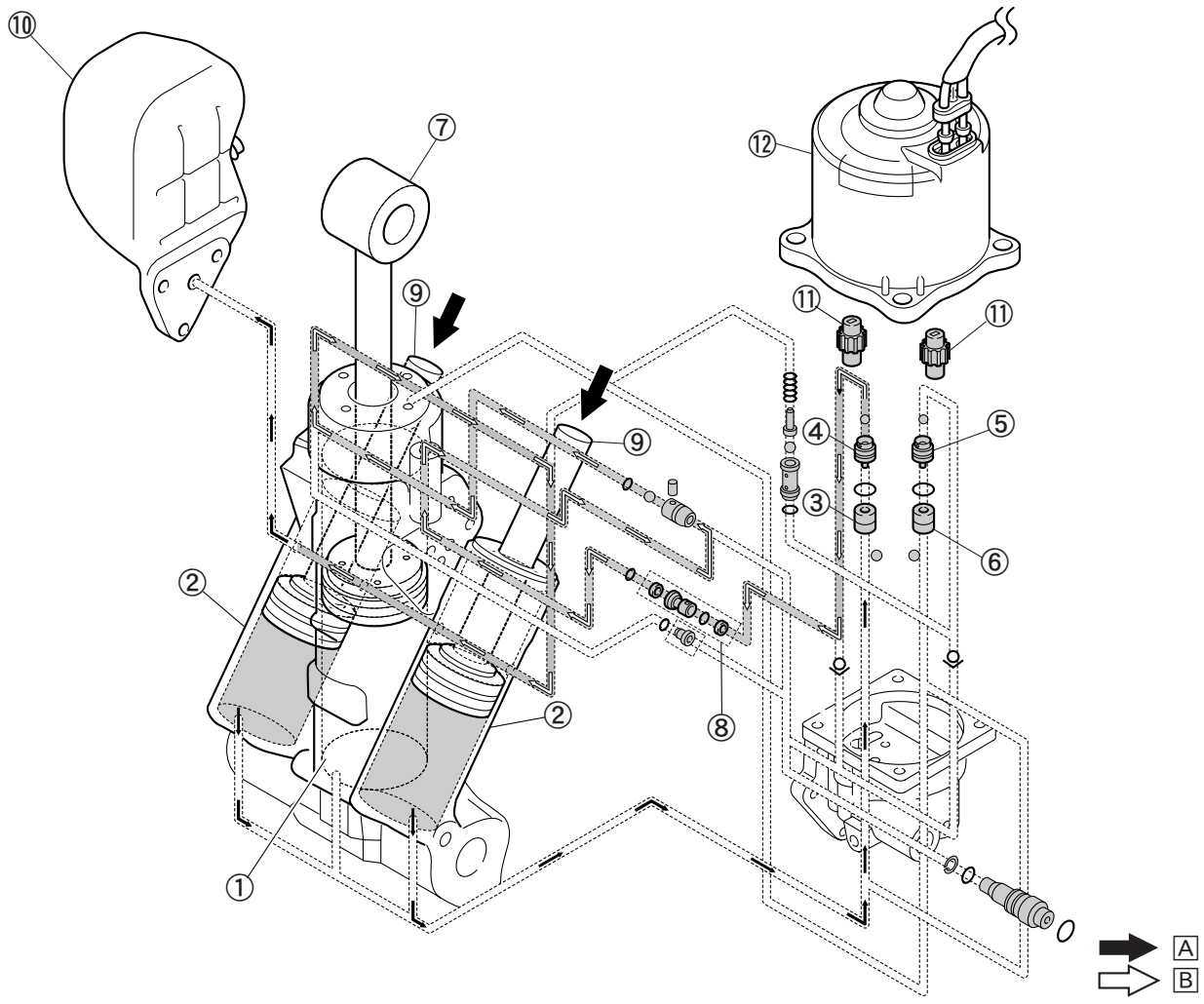
⑫ PTT motor

① Reservoir
② Trim ram
③ Tilt ram
④ Up-shuttle piston
⑤ Up-main valve
⑥ Trim cylinder
⑦ Tilt cylinder
⑧ Down-main valve
⑨ Down-shuttle piston
⑩ Up-relief valve
⑪ Gear pump

Trim ram retraction function

When the outboard motor is tilted up and held in place with the tilt stop lever and the PTT switch is pressed to “DN,” the trim ram will be retracted.

Although the gear pump attempts to draw fluid from the tilt cylinder and trim cylinder lower chambers, after the PTT switch has been pressed, fluid cannot be drawn from the tilt cylinder lower chamber because the tilt ram is secured in place by the tilt stop lever. Only the PTT fluid from the trim cylinder lower chamber can be drawn, and as the fluid pressure decreases, the trim ram retracts into the trim cylinder. Since the tilt ram is secured in place, the PTT fluid pumped by the gear pump flows into the tilt cylinder upper chamber to increase fluid pressure. As a result, the down-relief valve opens, and the PTT fluid is released into the reservoir.



A Return
B Send

⑪ Gear pump
⑫ PTT motor

① Tilt cylinder
② Trim cylinder
③ Up-main valve
④ Up-shuttle piston
⑤ Down-shuttle piston
⑥ Down-main valve
⑦ Tilt ram
⑧ Down-relief valve
⑨ Trim ram
⑩ Reservoir

Trim-down and tilt-down function

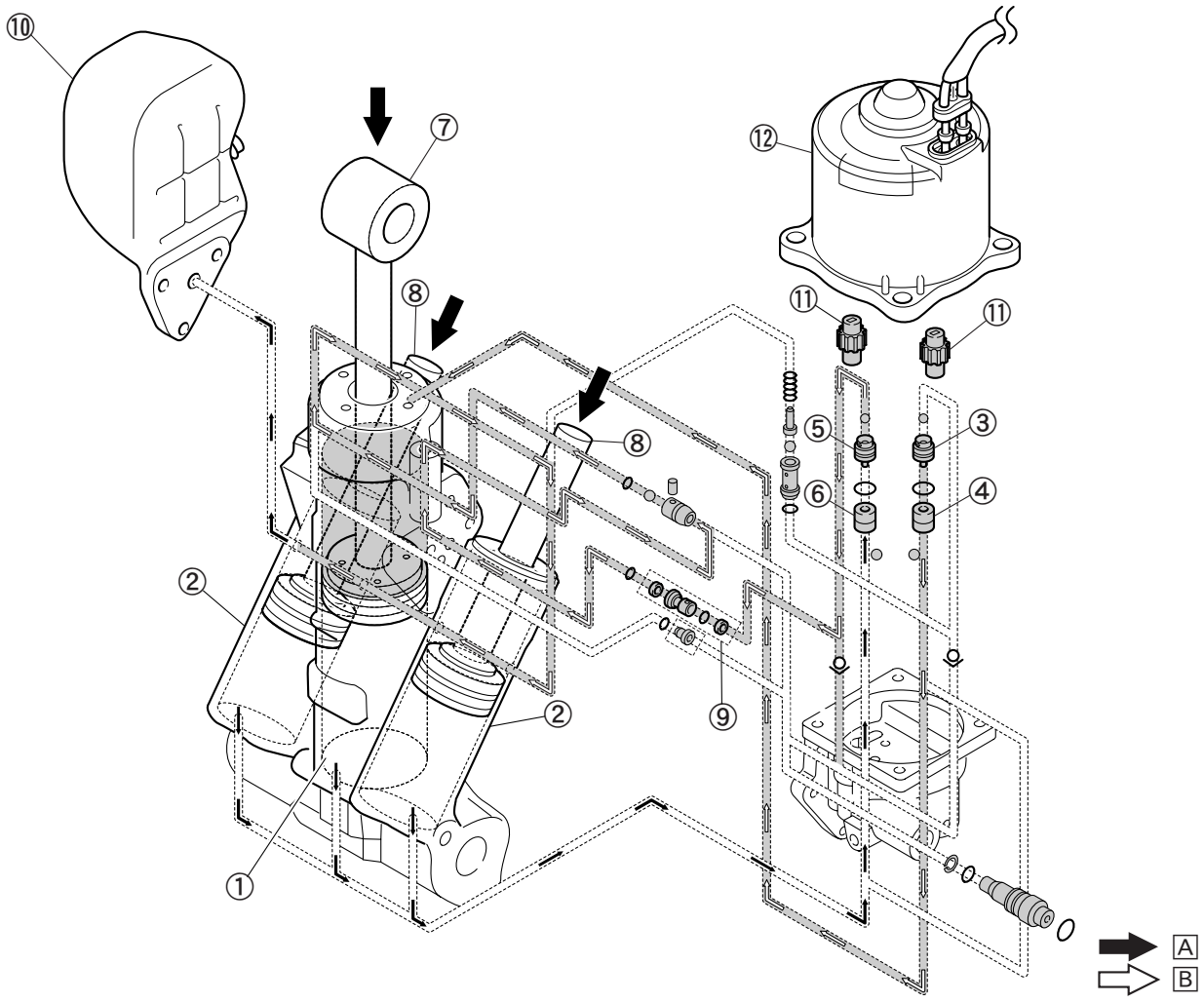
When the PTT switch is pressed to “DN,” the power trim and tilt motor operates the gear pump and fluid pressure is generated. As a result, the fluid pressure pushes the down-shuttle piston, enters the tilt cylinder upper chamber through the down-main valve, and then pushes the tilt ram downward.

In addition, the fluid pushes the up-shuttle piston to open the up-main valve.

The gear pump draws the PTT fluid from the tilt cylinder and trim cylinder lower chambers, and then retracts the tilt ram and the trim ram.

Since the fluid pressure from the gear pump is applied to the tilt cylinder upper chamber, the tilt ram moves downward first.

When the outboard motor comes in contact with the trim ram, the trim ram moves downward simultaneously with the tilt ram, due to its own weight and the suction of the PTT fluid by the trim cylinder lower chamber.



A Return
B Send

① Tilt cylinder
② Trim cylinder
③ Down-shuttle piston
④ Down-main valve
⑤ Up-shuttle piston
⑥ Up-main valve
⑦ Tilt ram
⑧ Trim ram
⑨ Down-relief valve
⑩ Reservoir
⑪ Gear pump
⑫ PTT motor

Stationary condition

When the PTT switch is not pressed, the gear pump will not pump the fluid, the up-main valve and the down-main valve will remain closed, and the PTT unit in the system remains constant. This will allow the tilt ram and the trim ram to maintain their positions until the PTT fluid flows through the system again.

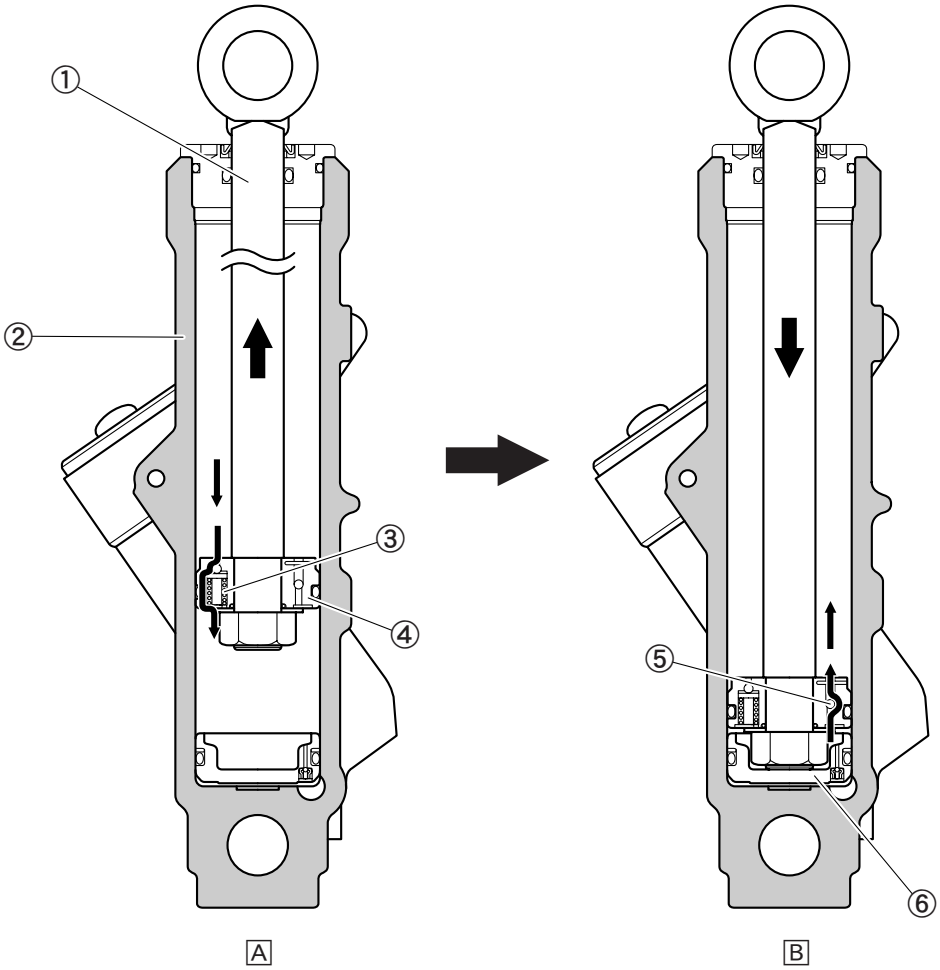
When the outboard hits something in the water

If the lower casing comes in contact with an obstacle while the boat is in operation, a sudden extension force becomes applied to the tilt ram. This force causes the fluid pressure in the tilt cylinder upper chamber to increase, and the tilt piston absorber to open and release the fluid pressure into the space between the tilt piston and the free piston. As a result, the damping effect of the tilt piston absorber and the oil lock mechanism prevent the PTT unit from damage, before the tilt piston comes in contact with the top of the tilt cylinder.

After the collision, a force to return the outboard motor to its original position is generated due to the weight of the outboard motor and the thrust of the propeller.

The PTT fluid passes through the shock return valve of the tilt piston, via the free piston, and into the tilt cylinder upper chamber.

When the tilt piston comes in contact with the free piston, the tilt piston stops.



A The outboard motor hit the object.
B The outboard motor returned to the original position.

① Tilt ram
② Tilt cylinder
③ Tilt piston absorber
④ Tilt piston
⑤ Shock return valve
⑥ Free piston

Rigging information

Outboard motor installation 3-1

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Selection 3-26

Outboard motor installation

⚠ WARNING

• Overpowering a boat could cause severe instability. Do not install an outboard motor with more horsepower than the maximum rating on the capacity plate of the boat. If the boat does not have a capacity plate, consult the boat manufacturer.
• Improper mounting of the outboard motor could result in hazardous conditions such as poor handling, loss of control, or fire hazards. Consult your dealer or a Yamaha trained person experienced in proper rigging should mount the motor.

⚠ WARNING

Too much weight on the transom can change the boat's center of gravity, buoyancy, operating balance, or performance which could cause loss of control or swamping. Consult the boat manufacturer for the maximum engine weight allowable on the transom, which is different from the overall boat capacity. Overloading the transom with a motor that is too heavy could also damage the hull, the transom, the deck, or the helm area, as well as the motor and other equipment.

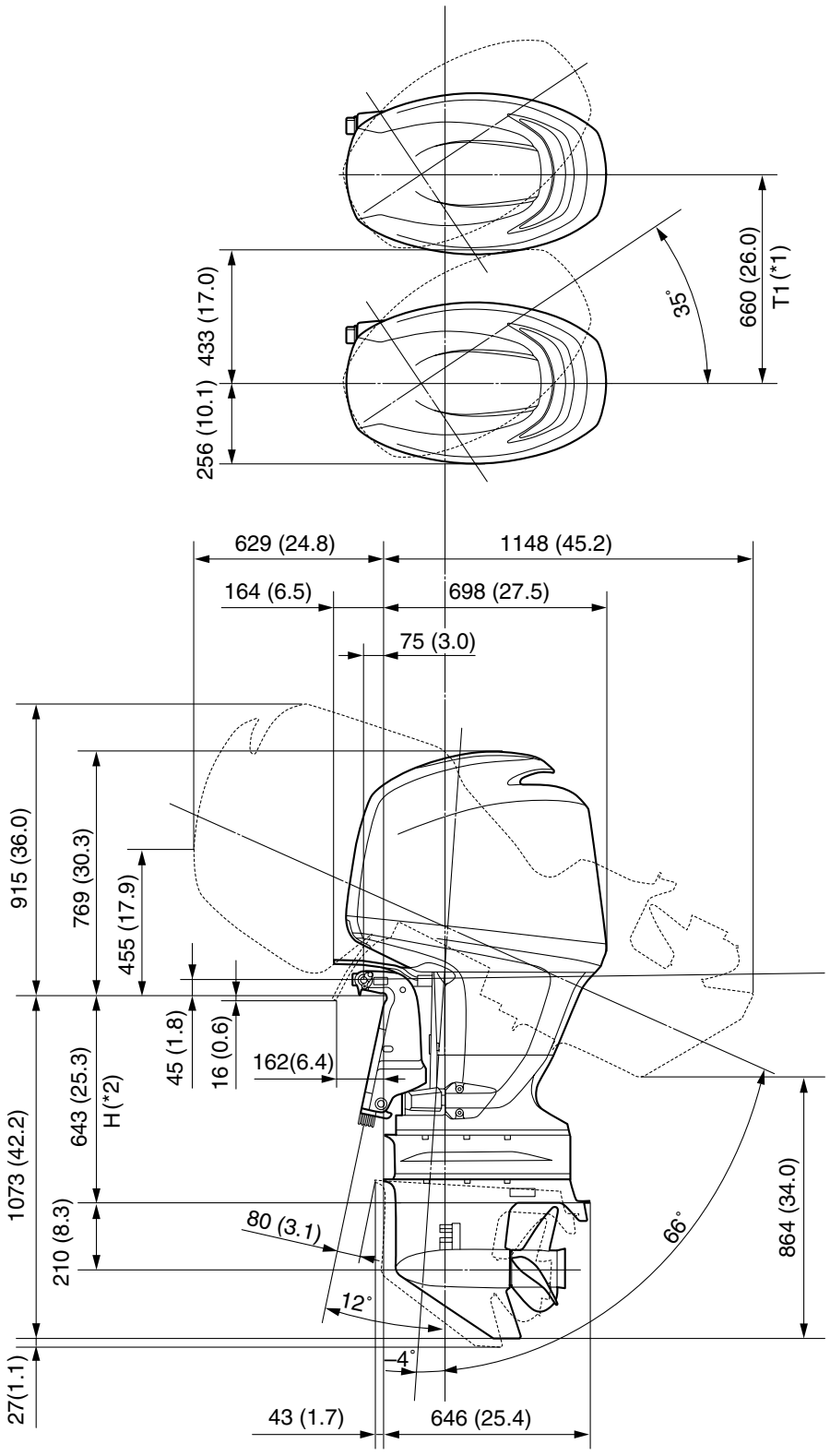
⚠ WARNING

Consult the manufacturer of engine jack plates or brackets before mounting. Excessive loads could damage the plates or brackets, the boat's transom, steering system, or the engine. This could cause loss of control.

Dimensions

Exterior

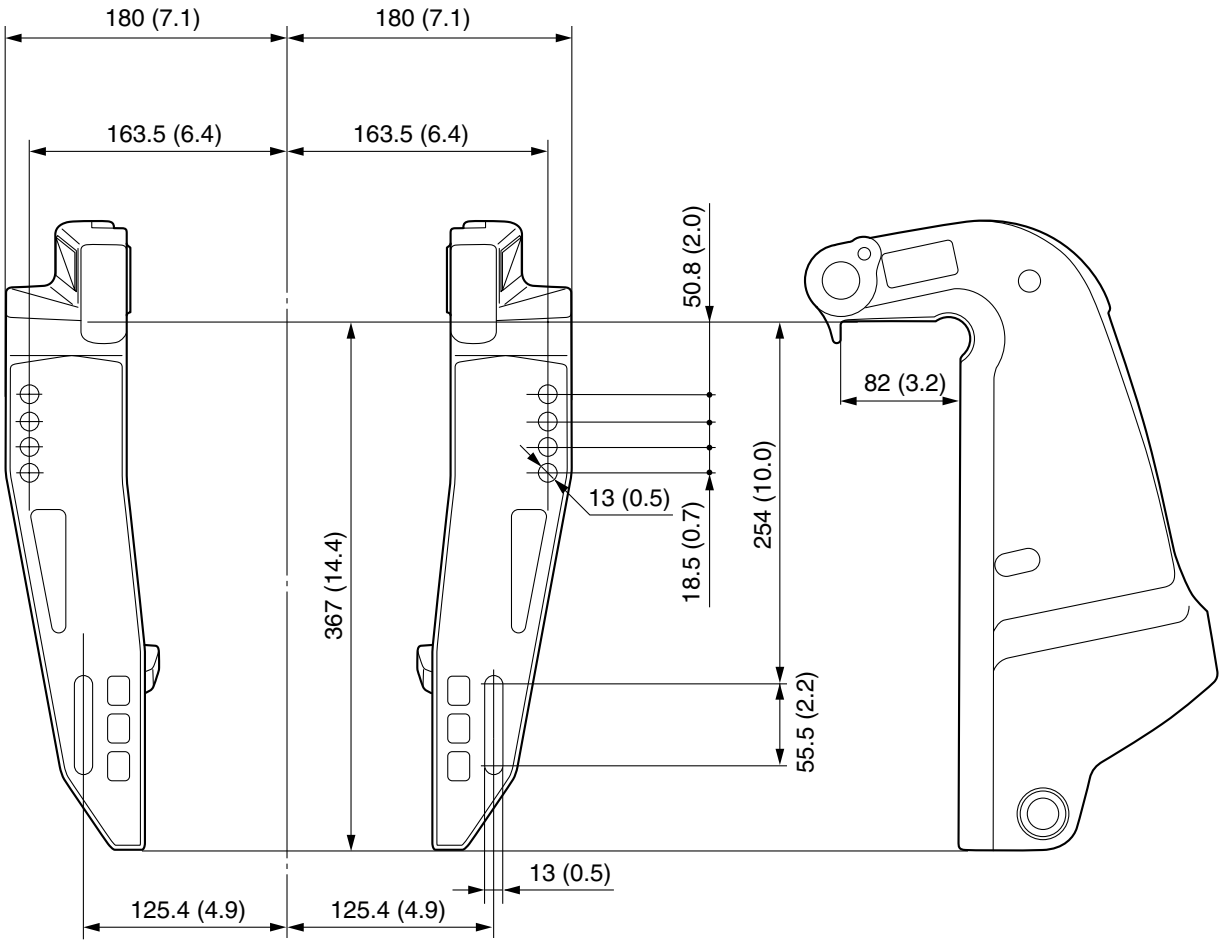
mm (in)



(*1) The distance between the center of PORT outboard motor and the center of STBD outboard motor.
(*2) Transom height

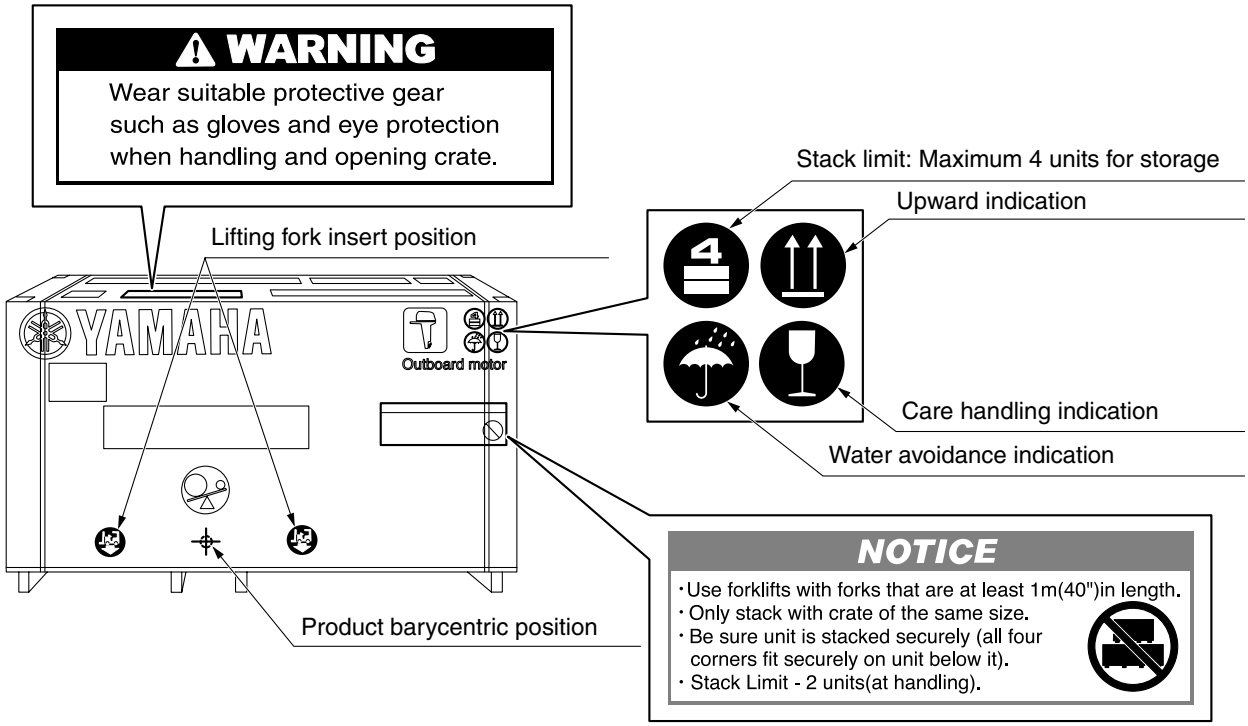
Clamp bracket

mm (in)



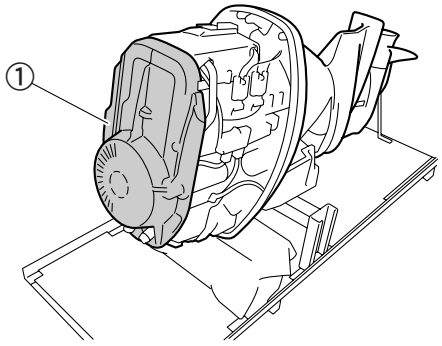
Crate top cover pictograph description

The following pictographs are important signs to handle the crate.
Read the notice and understand what pictographs mean to avoid a damage to the product when handling, transporting and/or keeping the crate.

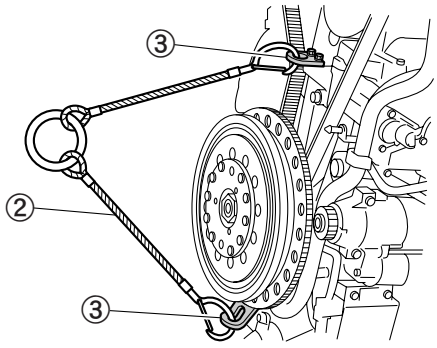


Uncrate procedure

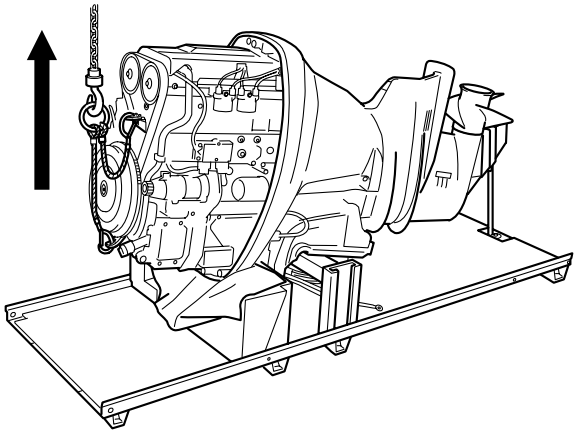
1. Check for any shipping damage.
2. Remove the top cover.
3. Remove all bolts from the bottom plate, and remove the frame. ***NOTICE:*** **Be careful not to cause any damage to the outboard motor.**
4. Remove the wrapping, and check the outboard motor for concealed damage. If any damage is found, use the concealed crate damage claim procedure.
5. Remove the top cowling and the flywheel magnet cover ①.



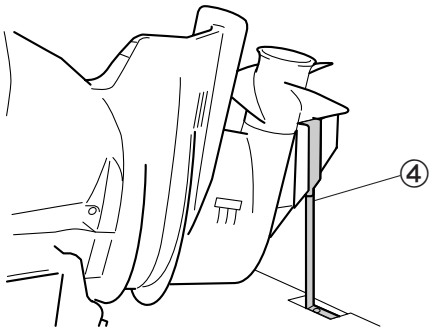
6. Install a lifting harness ② to the engine hangers ③.



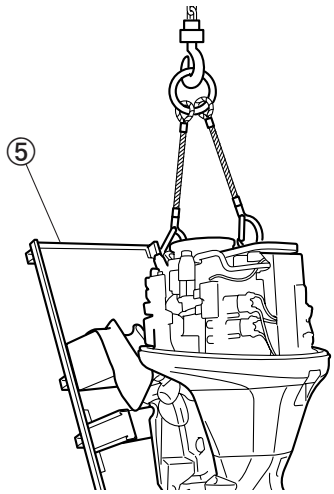
7. Tension the lifting harness.



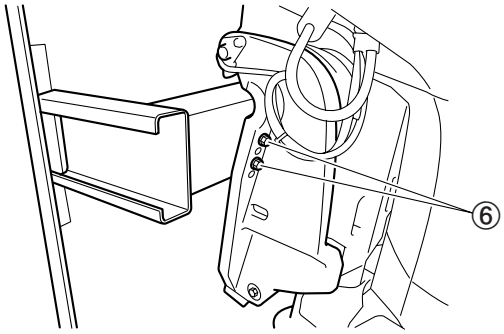
8. Remove the skeg holder ④.



9. Carefully lift up the outboard motor together with the bottom frame ⑤. ***NOTICE:*** **Do not allow the lifting harness to damage any parts of the outboard motor.**



10. Remove the bolts ⑥.

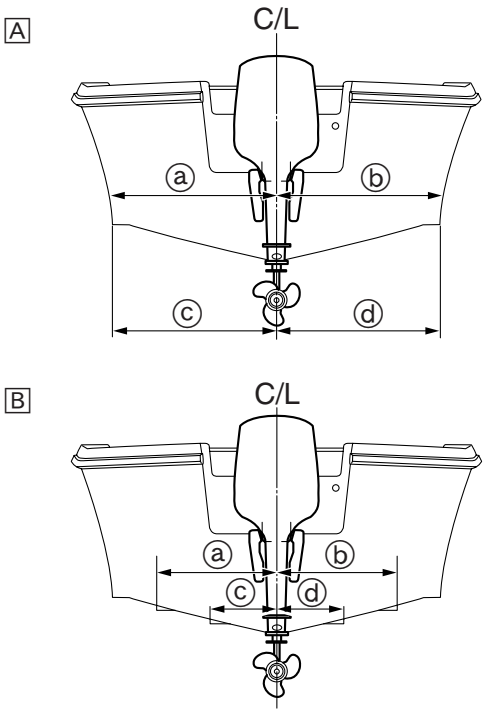


11. Remove the steering retainer, and install a hydraulic steering cylinder and steering cable following the manufacture's recommendation before the outboard motor is mounted.

Outboard motor mount

Proper mounting of the outboard motor will mean better performance, maximum reliability, and maximum customer satisfaction. This chapter contains the specifications necessary for the outboard motor mounting, and may vary slightly depending on application.
When mounting the outboard motor, also make sure the outboard motor has the clearance to provide full movement, from both PORT to STBD, as well as during trim and tilt functions. See "Dimensions" (3-2).

1. Set the outboard motor on the vertical centerline of the boat transom.

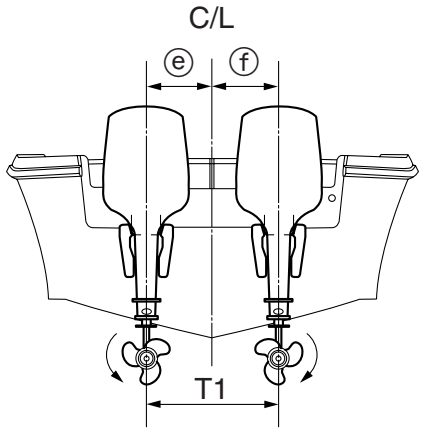


A No strakes hull
B Strakes hull
C/L: Centerline of the transom

TIP:

Double check the measurement distance to verify that the vertical centerline is straight. The distance ⓐ and ⓑ are equal length. Also, ⓒ and ⓓ are too.

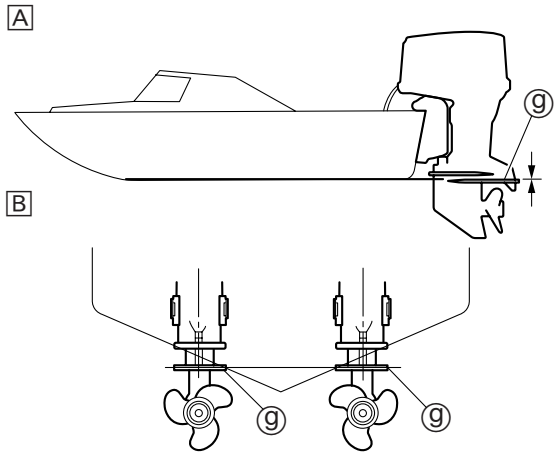
Mount twin outboard motors so the distance from the center line of each outboard motor to the centerline of the boat transom are equal on both sides.



C/L: Centerline of the transom

TIP:
- The distance ⓔ and ⓕ are equal length.
- A minimum distance (T1) that is ⓔ plus ⓕ is recommended. See "Dimensions" (3-2) for the distance (T1).

2. Adjust the outboard motor so the height of the anti-cavitation plate ⓖ is equal to or slightly above the bottom of the boat transom.



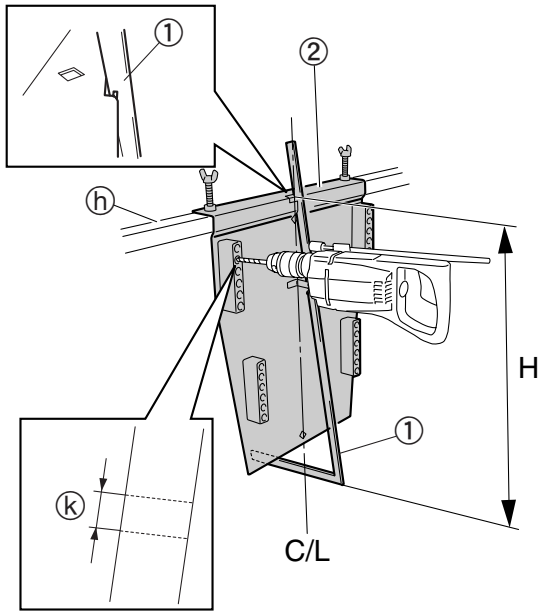
A Single outboard motor
B Twin outboard motors

TIP:
This mounting height information is for reference only. It is impossible to provide complete instructions for every possible boat and outboard motor combination.

3. Adjust the scale ① to the transom height (H), and set it on the special service tool ②. Secure the service tool ② to the boat transom by means of a screw or a vise.

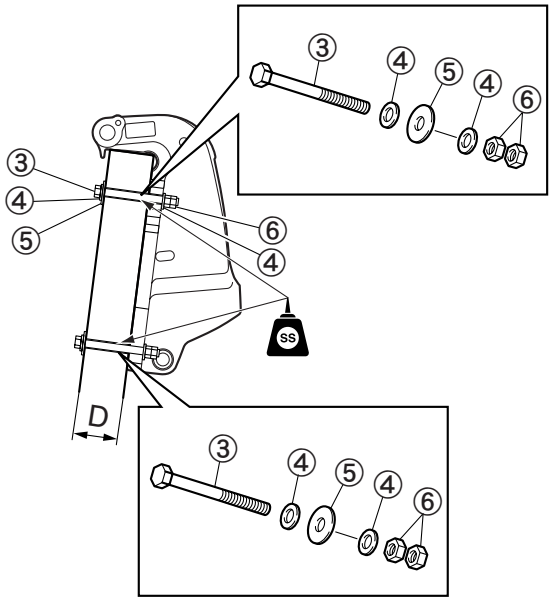
TIP:
See "Dimensions" (3-2) for the distance (H).

4. When the outboard motor mount position has determined, mark the best suited 4 symmetrical mounting holes to the boat transom ⓗ. Drill the mounting holes vertically on the boat transom using 13.0 mm (0.5 in) ⓚ drill.



Drilling plate ②: 90890-06783

5. Apply a sealant to the mounting holes and secure the outboard motor with supplied mounting bolts ③, small washers ④, large washers ⑤, and nuts ⑥. ***NOTICE:*** **Make sure there is no clearance on the surfaces between the transom and the clamp bracket. Otherwise, the clamp bracket or boat transom may be damaged.**

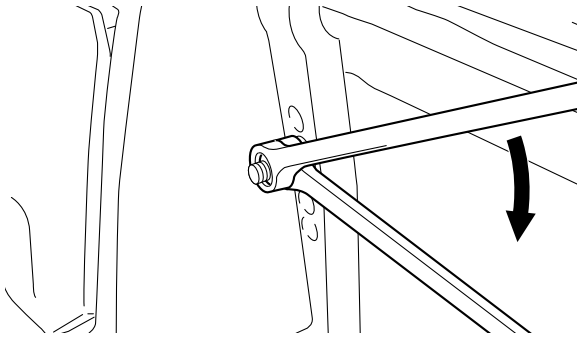


Boat transom thickness (D)	Mounting bolt
55–65 mm (2.17–2.56 in)	M12 × 115 mm (4.53 in)
65–75 mm (2.56–2.95 in)	M12 × 130 mm (5.12 in)
75–95 mm (2.95–3.74 in)	M12 × 150 mm (5.91 in)

TIP:
The second hole from the clamp bracket top is recommended for the upper mounting bolt.

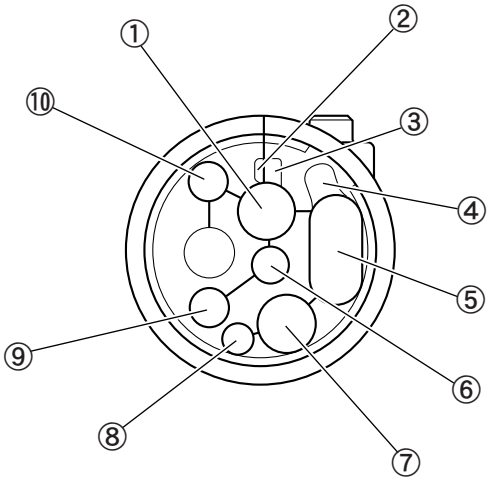
6. Secure the bolts, and firmly tighten the nut to the extent that the clamp bracket does not bite into the boat transom.

7. Firmly tighten the locknuts.



Mounting the rigging grommet

Rigging grommet description



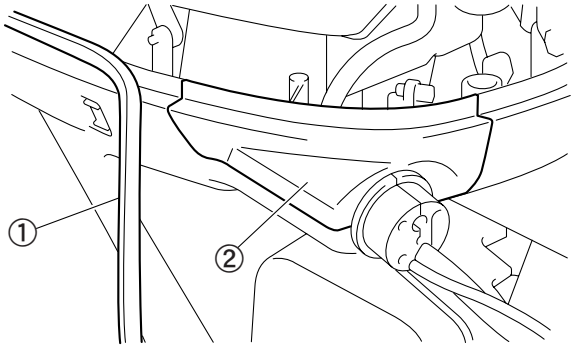
① Main wiring harness
② Water temperature lead (option)
③ Water pressure hose (option)
④ Isolator lead (option)
⑤ Battery cable
⑥ Gauge harness
⑦ Fuel hose
⑧ Speedometer hose
⑨ Shift cable
⑩ Throttle cable

Installing the shift cable

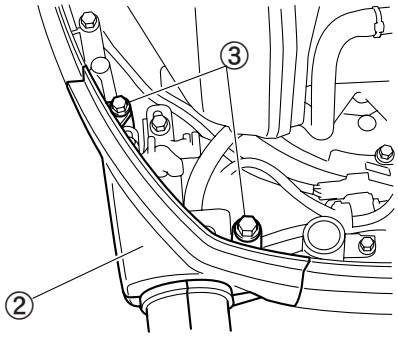
⚠ WARNING

Always perform the cable adjustment in advance, following the procedures in the remote control operation manual.

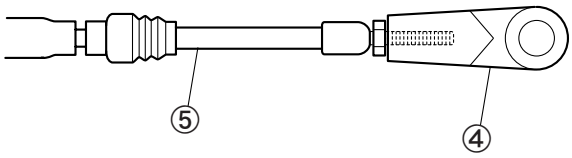
1. Remove the rubber seal ① at the retaining plate ② portion.



2. Remove the bolts ③, and then remove the retaining plate ②.

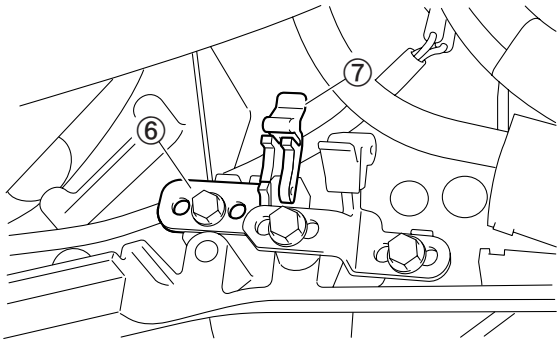


3. Fully screw in the cable joint ④ to the shift cable ⑤.



4. Set the remote control lever in the N position.

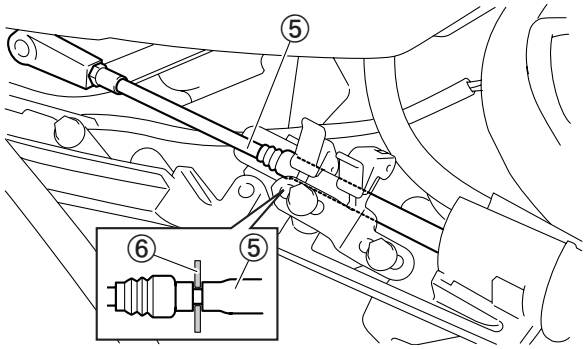
5. Open the clamp ⑦ of the shift cable holder ⑥.



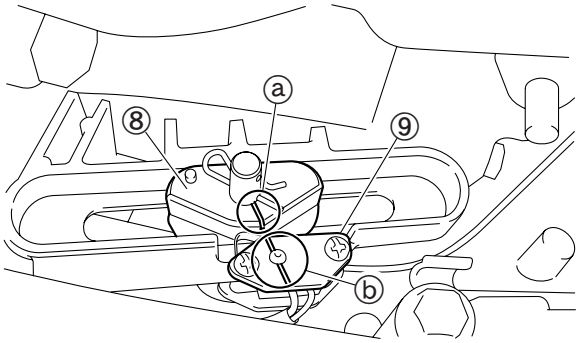
TIP:

Shift cable position is adjustable by using the shift cable holder ⑥.

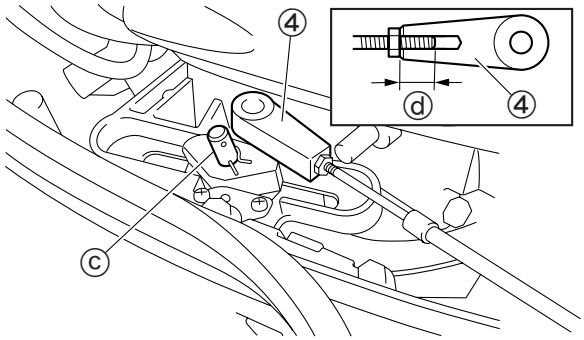
6. Pass the shift cable ⑤ through the rigging grommet, fit the cable groove onto the projection on the cable holder ⑥ for installation.



7. Align the mark ⓐ on the bushing ⑧ with the mark ⓑ on the plate ⑨.

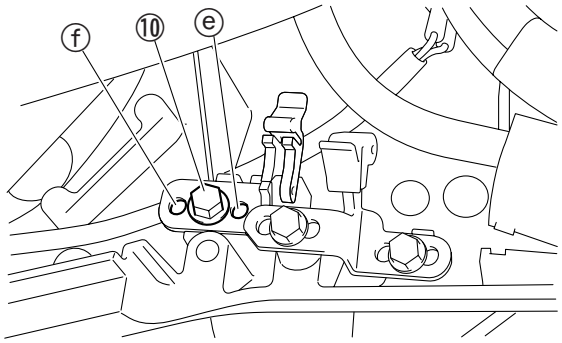


8. Adjust the cable joint ④ to the pin ⓒ of shift lever. **WARNING! The shift cable joint must be screwed in a minimum of 8.0 mm (0.31 in).**



Dimension ⓓ: 8.0 mm (0.31 in)

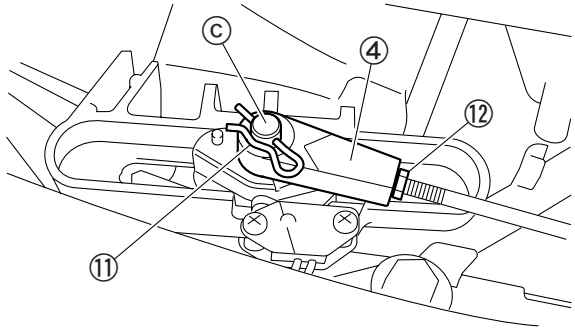
9. If the cable joint is not maintained the engagement of minimum 8.0 mm (0.31 in) ⓓ, remove the bolt ⑩ and remount the holder with the hole ⓔ or ⓕ.



10. Install the cable joint ④ to the pin ⓒ, and secure it with the clip ⑪.

TIP:
Pull the inner cable to avoid the free play (backlash) of the cable, and install it to the pin.

11. Tighten the locknut ⑫ to the specified torque.

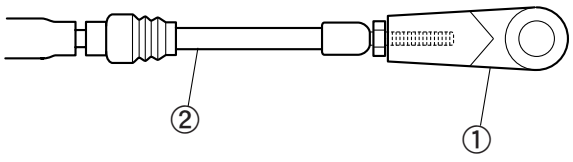


Locknut ⑫: 5 N·m (0.5 kgf·m, 3.7 ft·lb)

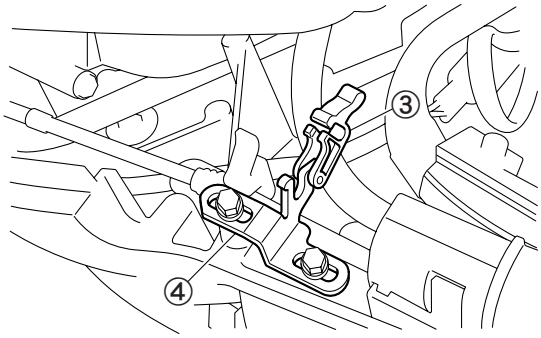
12. Check the shift cable for proper operation.

Installing the throttle cable

1. Fully screw in the cable joint ① to the throttle cable ②.

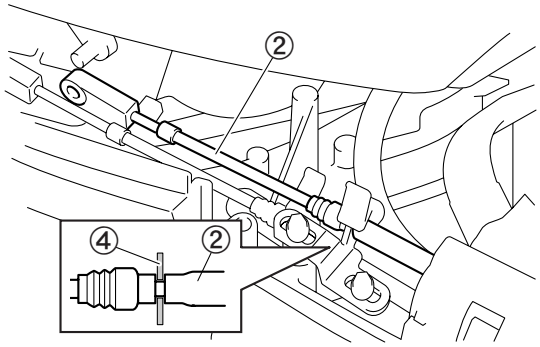


2. Open the clamp ③ of the throttle cable holder ④.

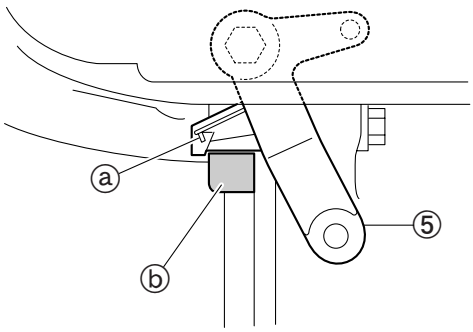


TIP:
Throttle cable position is adjustable by using the throttle cable holder ④.

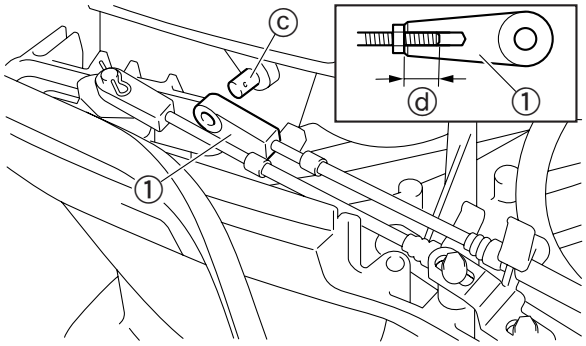
3. Pass the throttle cable ② through the grommet, fit the cable groove onto the projection on the cable holder ④ for installation.



4. Contact the stopper ⓐ of the throttle cam ⑤ to the crankcase boss ⓑ.

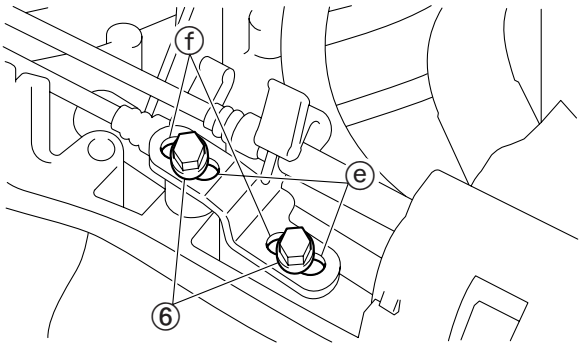


5. Adjust the cable joint ① to the pin ⓒ of the throttle cam. **WARNING! The throttle cable joint must be screwed in a minimum 8.0 mm (0.31 in).**



Dimension ⓓ: 8.0 mm (0.31 in)

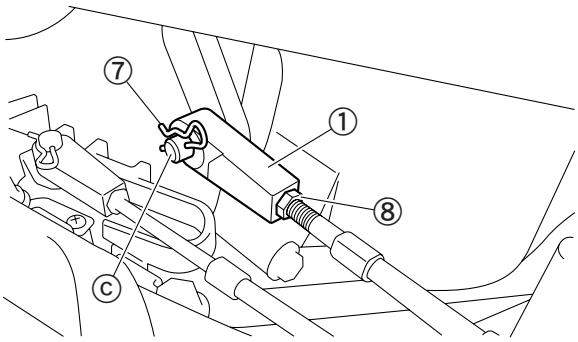
6. If the cable joint is not maintained the engagement of minimum 8.0 mm (0.31 in) ⓓ, remove the bolts ⑥ and remount the holder with the holes ⓔ or ⓕ.



7. Install the cable joint ① to the pin ⓒ, and secure it with the clip ⑦.

TIP:
Pull the inner cable to avoid the free play (backlash) of the cable, and install it to the pin.

8. Tighten the locknut ⑧ to the specified torque.



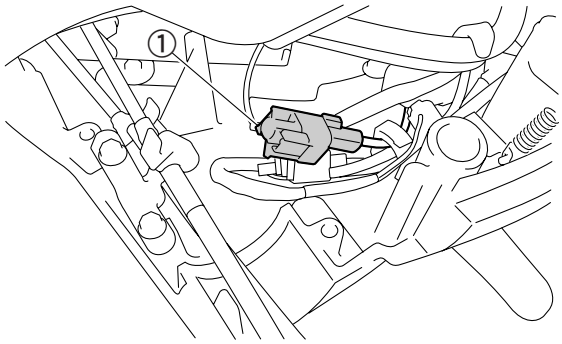
Locknut ⑧: 5 N·m (0.5 kgf·m, 3.7 ft·lb)

9. Check the throttle cable for proper operation.

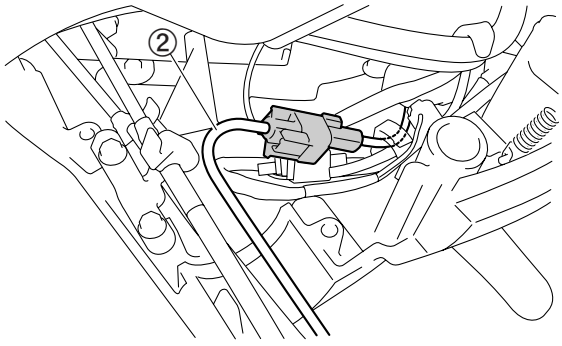
Installing the isolator lead (option)

Carry out the following procedures only when the isolator lead (option) is used.

1. Remove the cap ① from the isolator coupler.



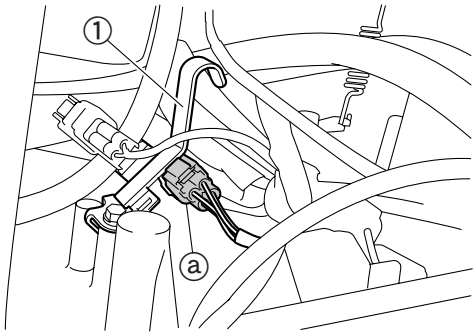
2. Connect the isolator lead ② it's coupler.



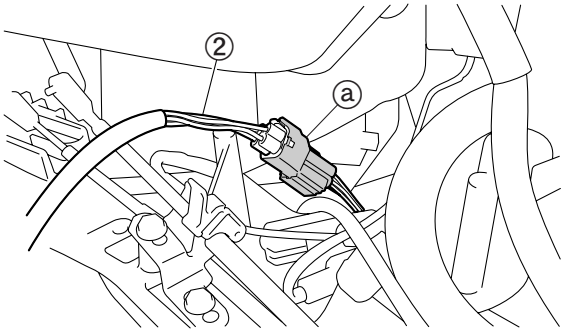
Installing the gauge harness

See "Rigging guide" for the installation of the gauge to the boat.

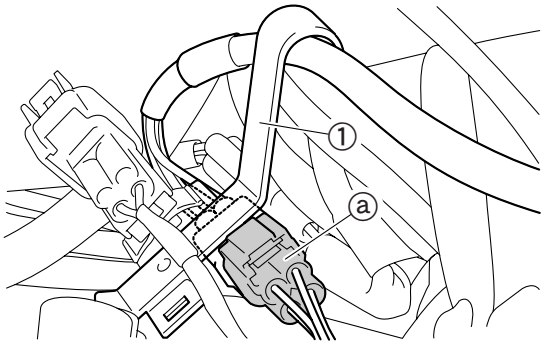
1. Remove the coupler ⓐ from the bracket ①.



2. Connect the gauge harness ② to the coupler ⓐ.



3. Install the coupler ⓐ to the bracket ①.



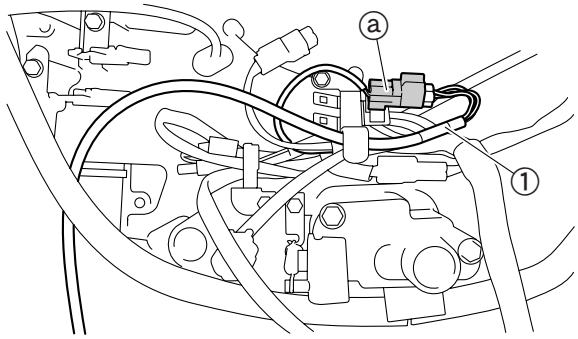
Installing the water temperature sensor (option)

See “Rigging guide” for the installation procedures of water temperature sensor.

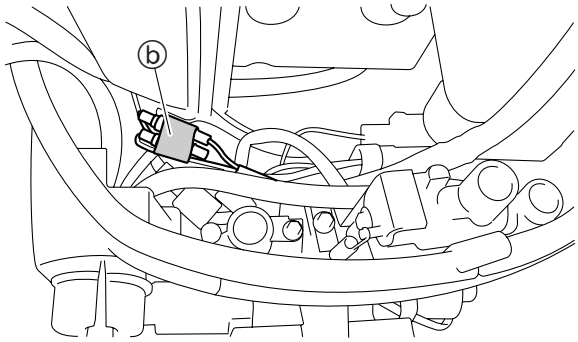
Installing the 6Y8 Multifunction Meter harness (option)

- See “6Y8 Multifunction Meter set up manual” for the installation of 6Y8 Multifunction Meter to the boat.
- Perform the following procedure when the optional 6Y8 Multifunction Meter is used.

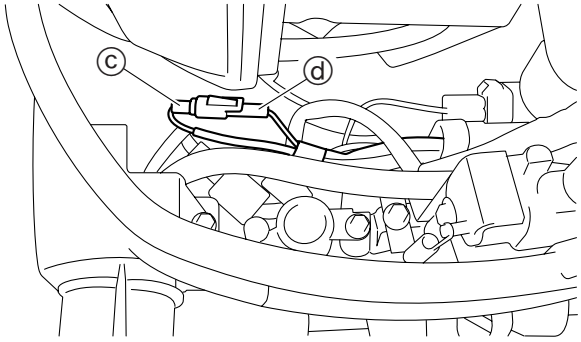
1. Remove the cap from the coupler ⓐ, and then connect the meter harness ① to the coupler ⓐ.



2. Remove the yellow tape ⓑ to make the wires loose.

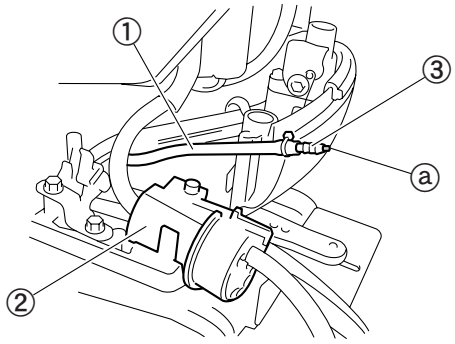


3. Remove the each caps, and then connect the couplers ⓒ and ⓓ.

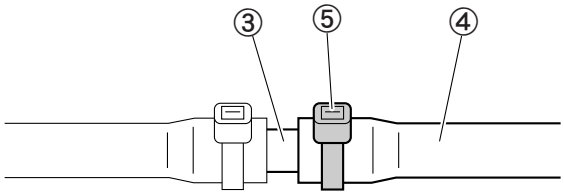


Install the speed sensor (option for 6Y8 Multifunction Meter)

1. Remove the speedometer hose ① from grommet ②, and then cut off the tip ⓐ of the nipple ③.

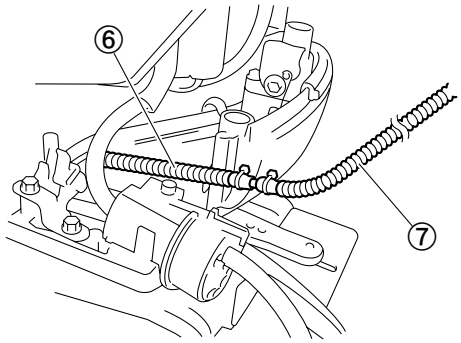


2. Install the extension hose ④ to the nipple ③, and then fasten it with the plastic tie ⑤.



TIP:
Cut the extension hose ④ to 300 mm (11.8 in).

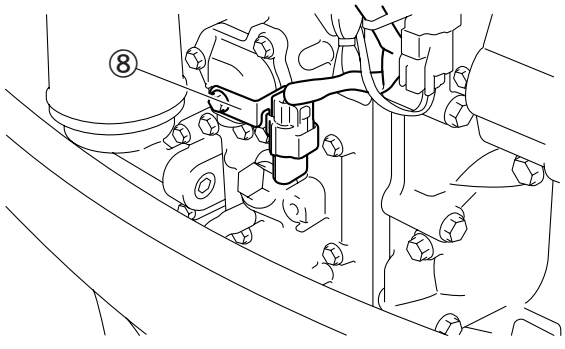
3. Install the tubes ⑥ and ⑦.



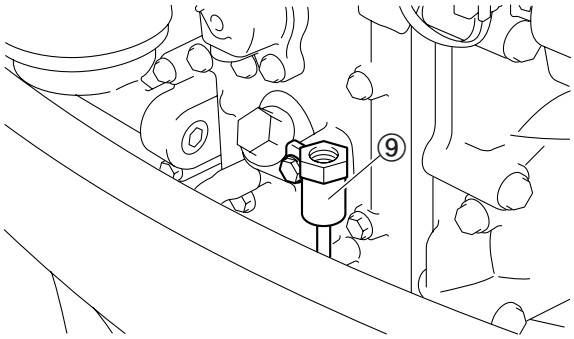
TIP:
- Cut the tube ⑥ to 300 mm (11.8 in).
- Cut the tube ⑦ to 270 mm (10.6 in).

4. Connect the extension hose ④ to the speed sensor adapter.

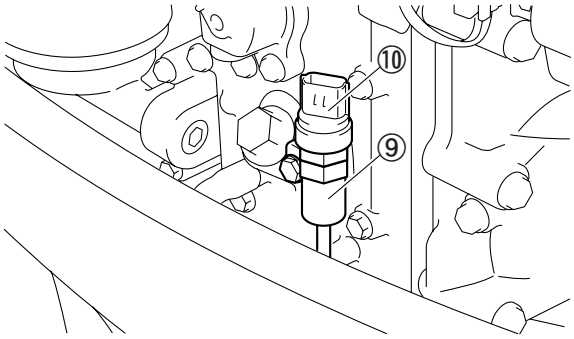
5. Remove the bracket ⑧.



6. Install the speed sensor adapter ⑨.

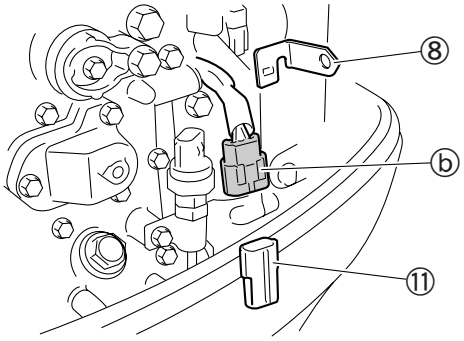


7. Install the speed sensor ⑩ onto the speed sensor adapter ⑨, and then tighten the speed sensor to the specified torque.

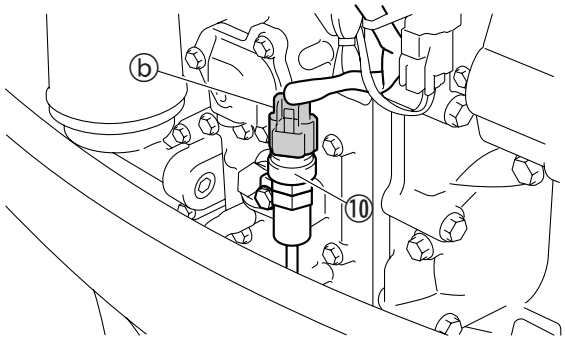


Speed sensor ⑩:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

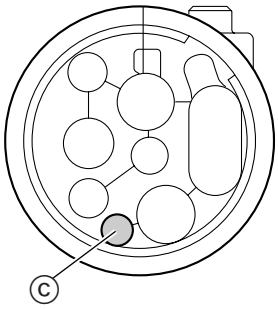
8. Remove the bracket ⑧ and cap ⑪ from the speed sensor coupler ⓑ.



9. Connect the speed sensor coupler ⓑ to the speed sensor ⑩.

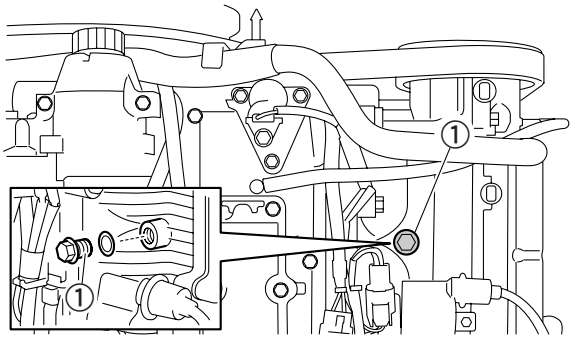


10. Install the rubber seal in the area ⓒ of the rigging grommet.

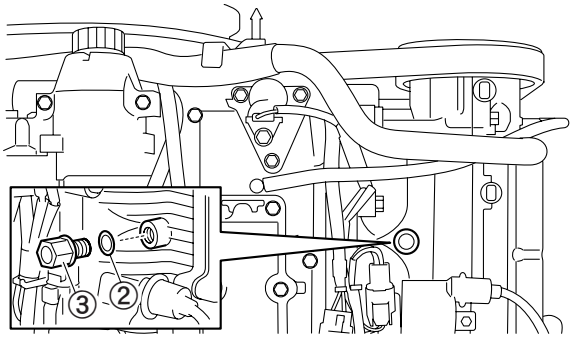


Installing the water pressure sensor (option for 6Y8 Multifunction Meter)

1. Remove the plug ①.

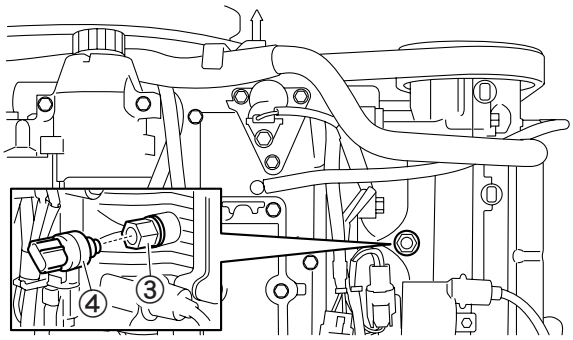


2. Install the gasket ②, adapter ③, and then tighten the adapter ③ to the specified torque.



Adapter ③:
23 N·m (2.3 kgf·m, 17.0 ft·lb)

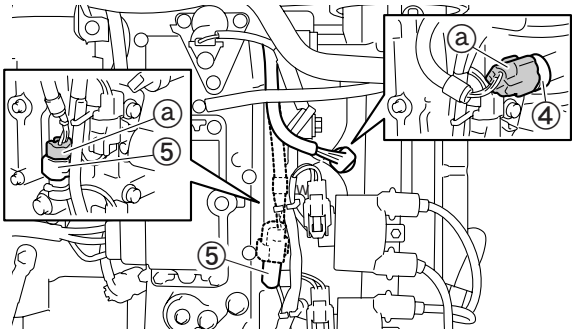
3. Install the water pressure sensor ④ onto the adapter ③, and then tighten the water pressure sensor ④ to the specified torque.



Water pressure sensor ④:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

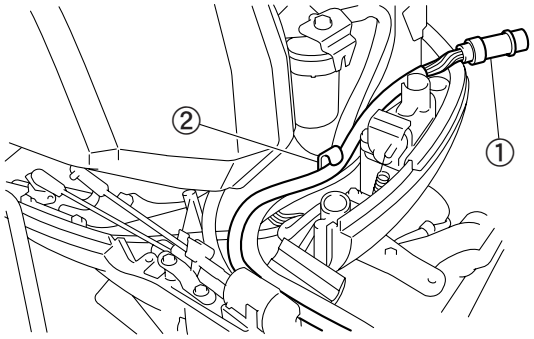
4. Remove the water pressure sensor coupler ⓐ from the cap ⑤.

5. Connect the water pressure sensor coupler ⓐ to the water pressure sensor ④.

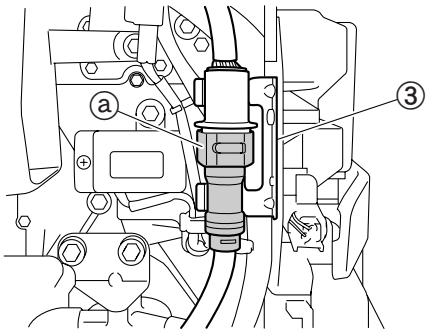


Installing the main wiring harness

1. Route the main wiring harness ① in front of the bracket ②.



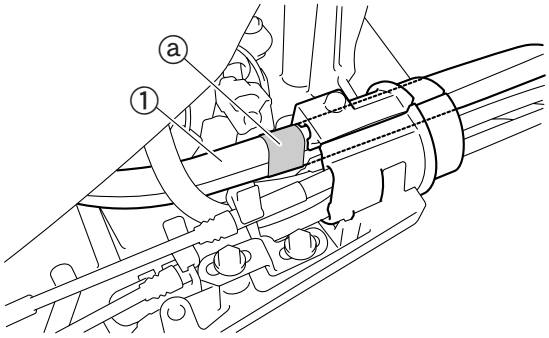
2. Connect the main wiring harness coupler ⓐ, and then secure the main wiring harness coupler ⓐ with the holder ③.



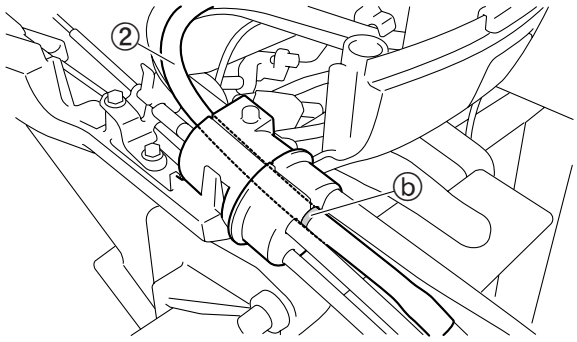
Installing the rigging grommet

1. Install each harness in the relevant position on the rigging grommet. See “Rigging grommet description” (3-8) for the detailed description of the rigging grommet.

2. Align the white tape ⓐ on the battery cable ① with the inner end of the rigging grommet.

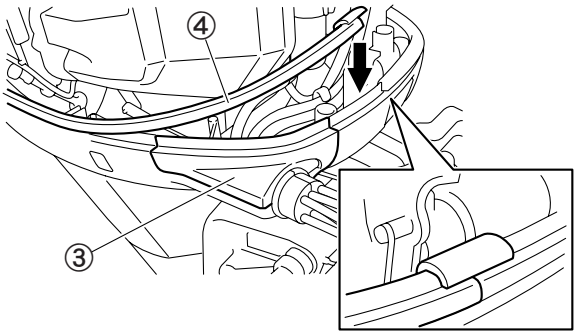


3. Align the white mark ⓑ on the fuel hose ② with the outer end of the rigging grommet.



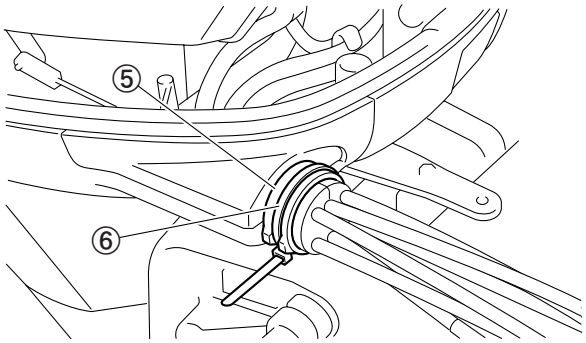
4. Install the retaining plate ③.

5. Install the rubber seal ④.



TIP:
Make sure that the rubber seal is installed securely.

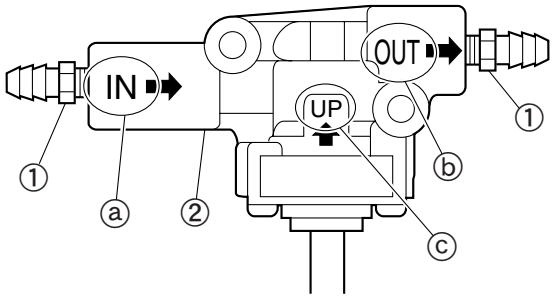
6. Install the rigging tube retainer ⑤, and fasten it with a plastic tie ⑥.



Installing the fuel flow sensor

1. Install the fuel joints ① to the fuel flow sensor ②.

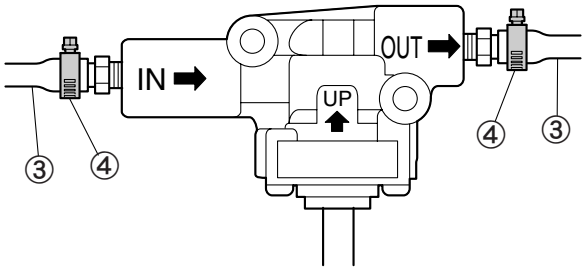
2. Install the fuel flow sensor ② between the fuel tank and primer pump.



TIP:

- Install the fuel flow sensor so that "IN" mark ⓐ comes to the fuel tank side, and "OUT" mark ⓑ comes to the primer pump side.
- Install the fuel flow sensor with the "UP" mark ⓒ facing upward.
- If a fuel filter is used, install fuel flow sensor between the fuel filter and primer pump.

3. Install the fuel hoses ③, and then fasten them with the clamps ④.



Remote control box and switch panel installation

See "Remote control box operation manual" or "Rigging guide" for the installation procedures of remote control box and the switch panel.

Installing the battery

⚠ WARNING

- **Improper battery connections or cable size selection may result in a fire.**
- **When installing an isolator lead to the positive battery terminal or battery switch, over-current protection in compliance with ABYC (E-11) must be provided.**

NOTICE

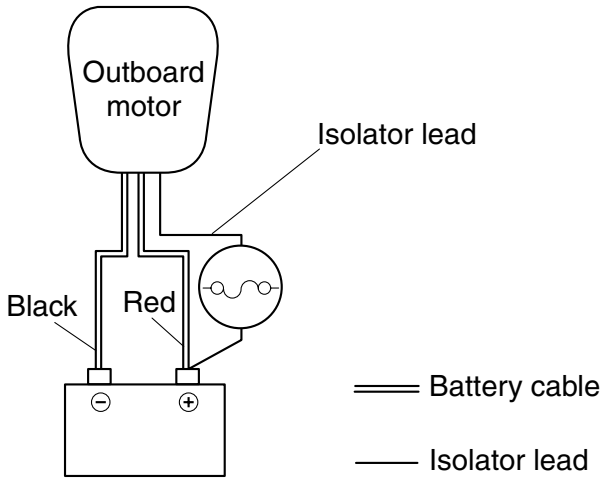
If battery connections are reversed, thorough charging system testing is required, replace damaged components. See "Charging units and components" (5-26).

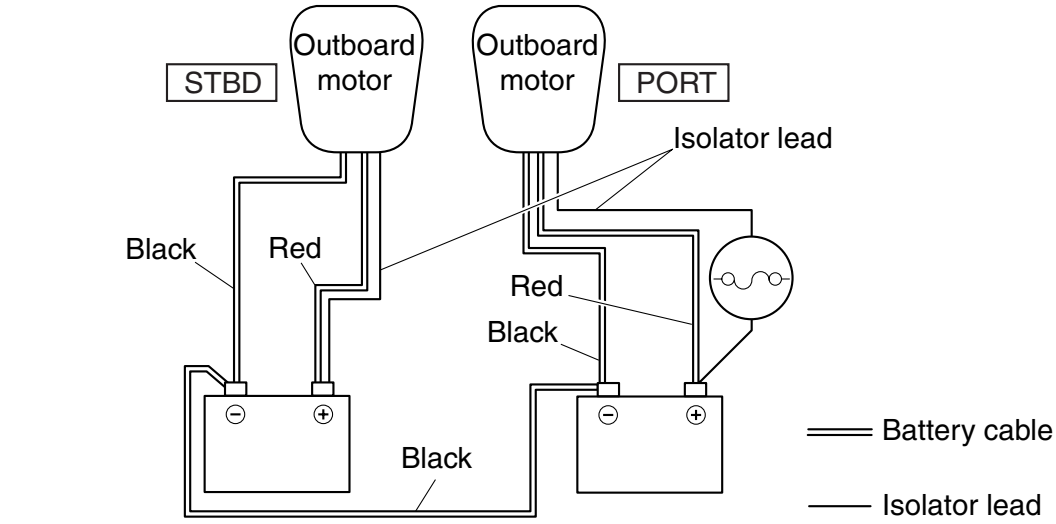
See "Rigging recommendations" (3-25) for the extension battery cable length.

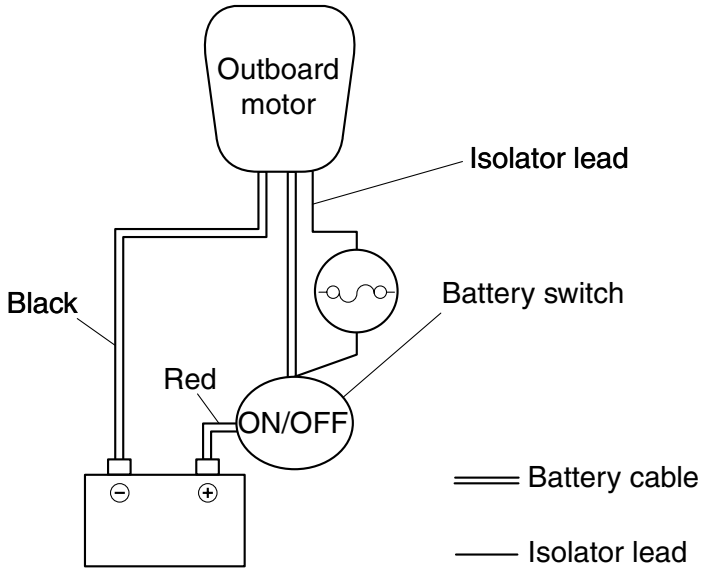
Battery wiring without house (accessory) battery

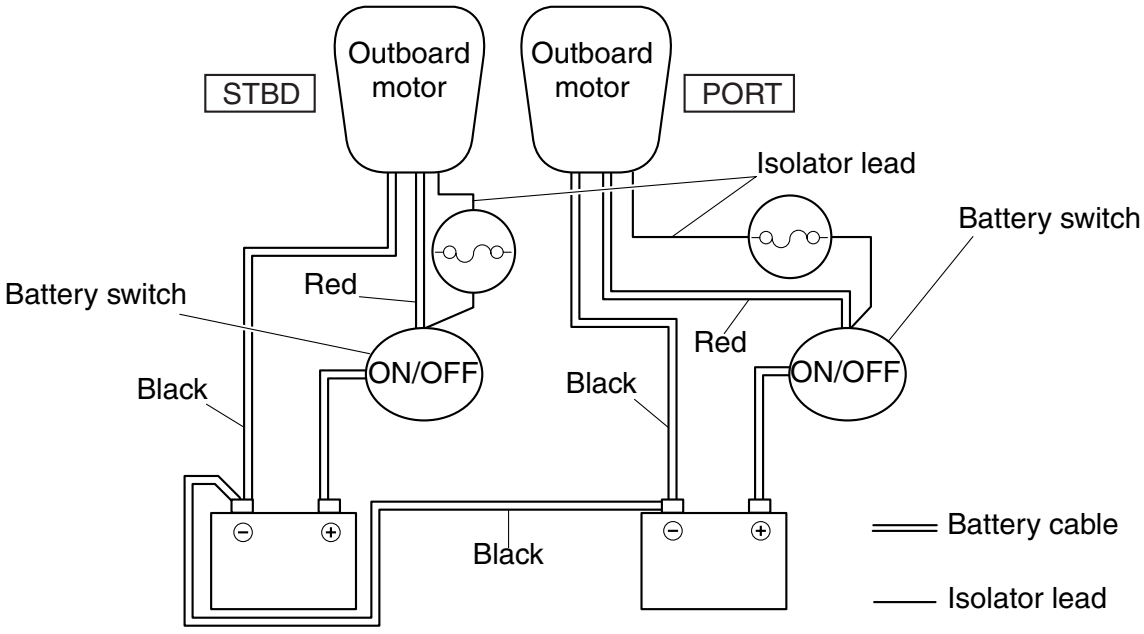
⚠ WARNING

- **When only one battery is used for one engine, connect the positive battery cable and the isolator lead to the positive battery terminal. If the isolator lead is left unconnected, accidental contact of the isolator lead with the negative terminal of the battery can cause a short circuit which may result in a fire.**
- **When using a dual battery installation, a negative battery cable must be installed between the both engine batteries. This cable must be sized equivalent to the engine battery cables or larger AWG cable size in accordance with ABYC specifications.**




Outboard motor
STBD
Outboard motor
PORT
Isolator lead
Black
Red
Red
Black
Black
Battery cable
Isolator lead

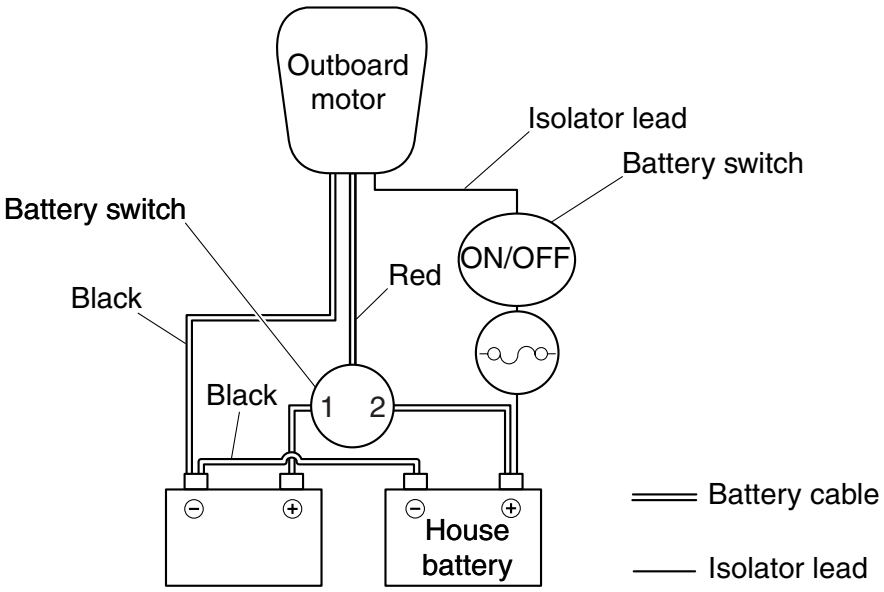

Outboard motor
Isolator lead
Battery switch
Black
Red
ON/OFF
Battery cable
Isolator lead

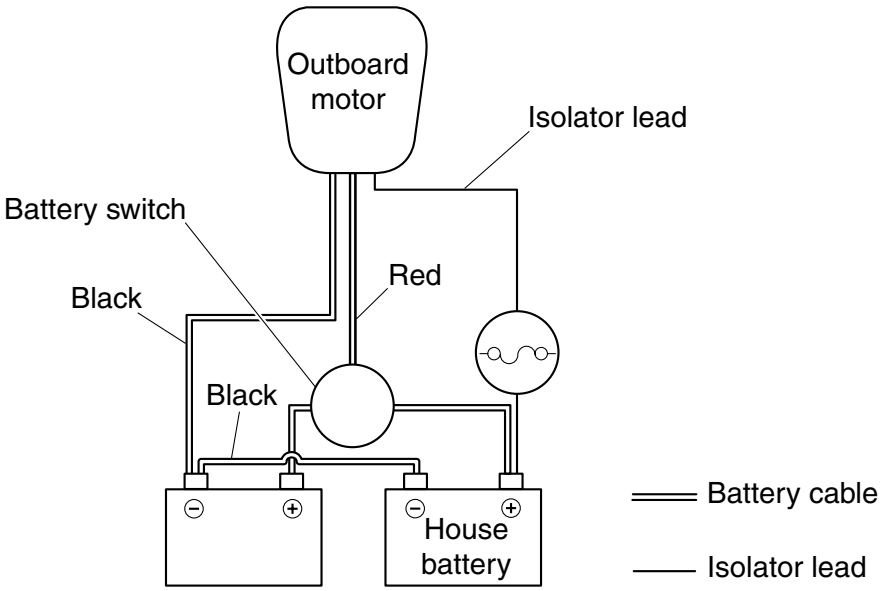

Outboard motor
STBD
Outboard motor
PORT
Isolator lead
Battery switch
Red
Battery switch
Red
ON/OFF
ON/OFF
Black
Black
Black
Battery cable
Isolator lead

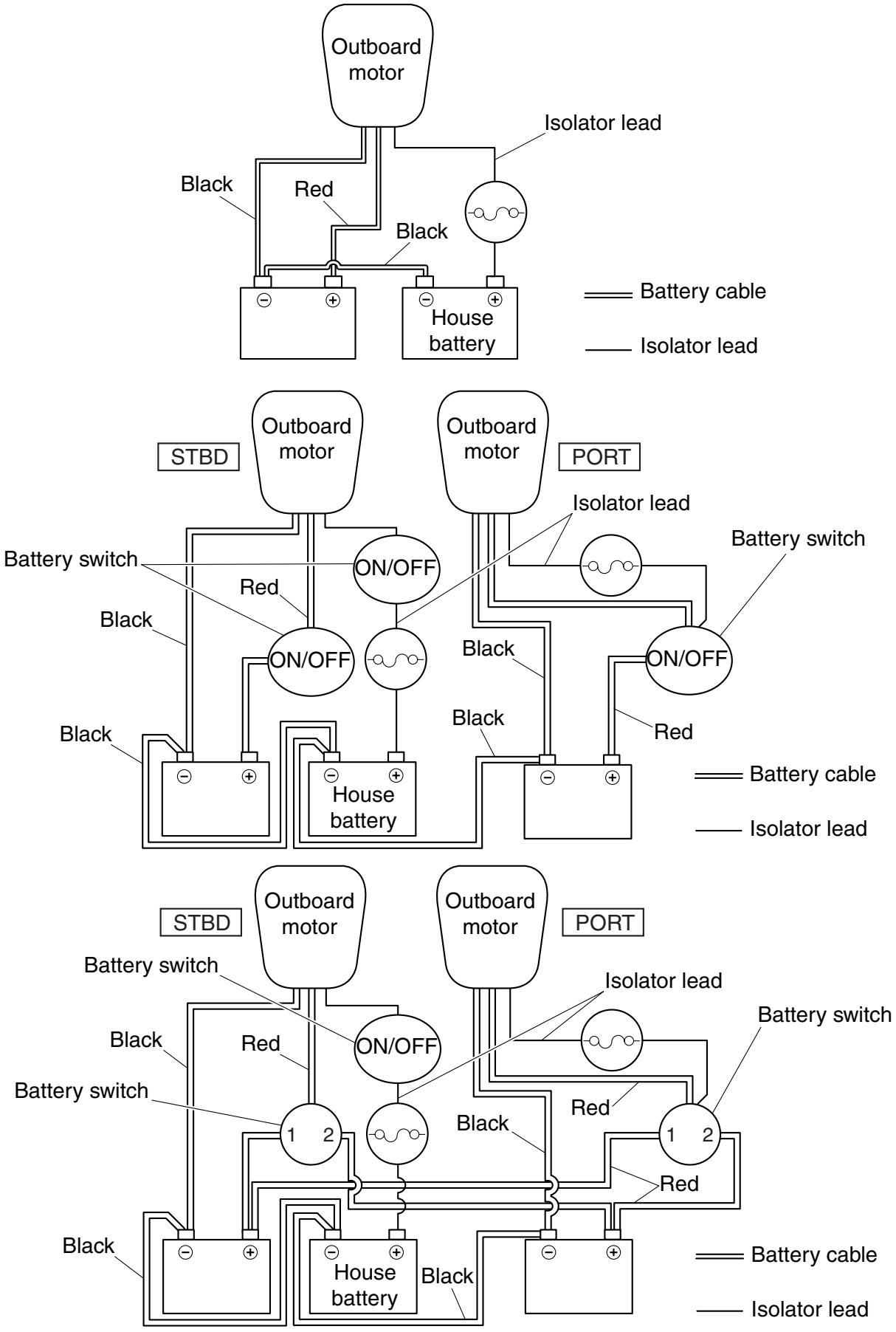
Battery wiring with house (accessory) battery

⚠ WARNING

- **When only one battery is used for one engine, connect the positive battery cable and the isolator lead to the positive battery terminal. If the isolator lead is left unconnected, accidental contact of the isolator lead with the negative terminal of the battery can cause a short circuit which may result in a fire.**
- **When using a house battery, a negative battery cable must be installed between the house battery and the engine battery. This cable must be sized equivalent to the engine battery cables or larger AWG cable size in accordance with ABYC specifications.**
- **Battery switches must be capable of meeting intermittent and continuous current ratings for engines and accessories.**






Outboard motor
Isolator lead
Black
Red
Black
House battery
Battery cable
Isolator lead
STBD
Outboard motor
Outboard motor
PORT
Isolator lead
Battery switch
Battery switch
ON/OFF
Red
Black
ON/OFF
ON/OFF
Black
Black
Red
Black
House battery
Battery cable
Isolator lead
STBD
Outboard motor
Outboard motor
PORT
Battery switch
Isolator lead
Battery switch
Black
Red
ON/OFF
Battery switch
1 2
Red
Black
1 2
Red
Black
House battery
Black
Battery cable
Isolator lead

System diagram

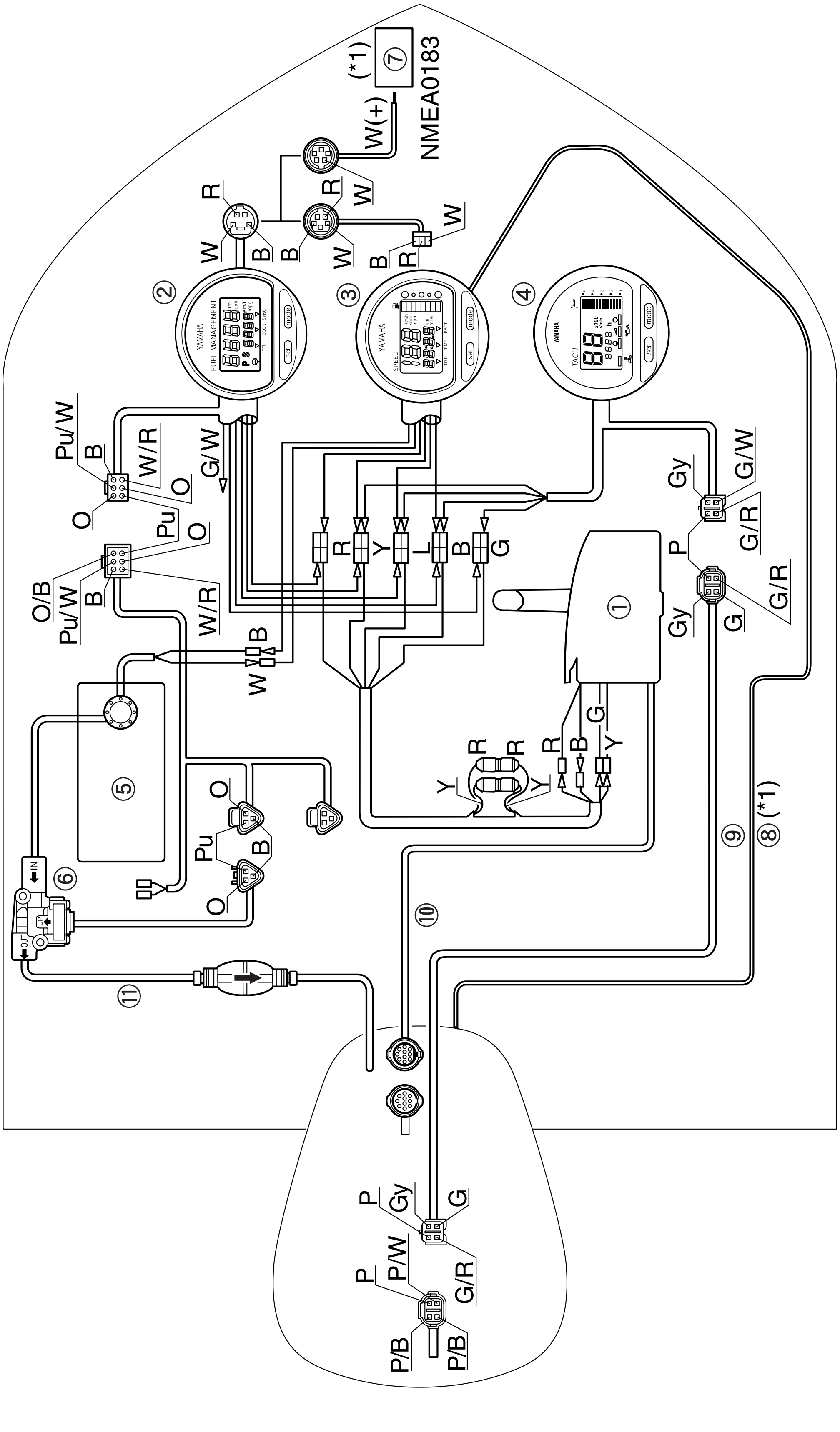
Single outboard motor application

(*1) When a GPS (NMEA0183) is used, a speedometer hose is not required.

① Remote control box
② Fuel management meter unit
③ Speedometer unit
④ Tachometer unit
⑤ Fuel tank (fuel level sensor)
⑥ Fuel flow sensor
⑦ GPS (option)
⑧ Speedometer hose
⑨ Gauge harness
⑩ Main wiring harness
⑪ Fuel hose

Color code

B	: Black
G	: Green
Gy	: Gray
L	: Blue
O	: Orange
P	: Pink
Pu	: Purple
R	: Red
W	: White
Y	: Yellow
G/R	: Green/Red
G/W	: Green/White
O/B	: Orange/Black
P/B	: Pink/Black
P/W	: Pink/White
Pu/W	: Purple/White
W/R	: White/Red



(*1)
⑦
NMEA0183
W(+)
R
W
B
①
②
③
④
⑤
⑥
⑧ (*1)
⑨
⑩
⑪
Pu/W
W/R
G/W
O
Pu
O/B
Gy
G/R
P
G
Y
L
P/W
P/B
IN
OUT
UP

3

Twin outboard motor application

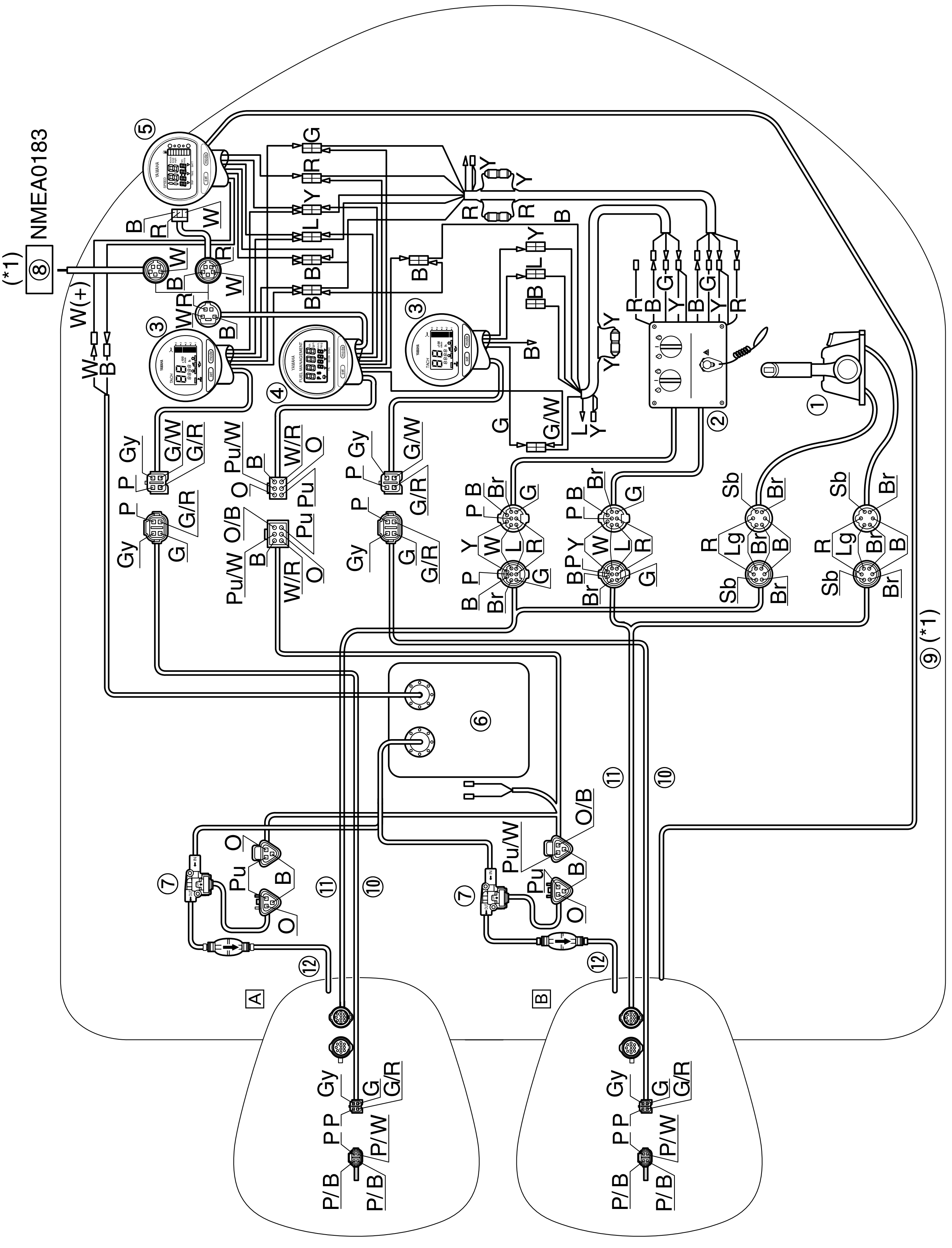
(*1) When a GPS (NMEA0183) is used, a speedometer hose is not required.

① Remote control box
② Switch panel
③ Tachometer unit
④ Fuel management meter unit
⑤ Speedometer unit
⑥ Fuel tank (fuel level sensor)
⑦ Fuel flow sensor
⑧ GPS (option)
⑨ Speedometer hose
⑩ Gauge harness
⑪ Main wiring harness
⑫ Fuel hose

Ⓐ PORT
Ⓑ STBD

Color code

B	: Black
Br	: Brown
G	: Green
Gy	: Gray
L	: Blue
Lg	: Light green
O	: Orange
P	: Pink
Pu	: Purple
R	: Red
Sb	: Sky blue
W	: White
Y	: Yellow
G/R	: Green/Red
G/W	: Green/White
O/B	: Orange/Black
P/B	: Pink/Black
P/W	: Pink/White
Pu/W	: Purple/White
W/R	: White/Red


(*1)
8
NMEA0183
9 (*1)
W(+)
A
B
P/B
P/W
Gy
G
G/R
G/W
Pu/W
O/B
W/R

Rigging recommendations

Extension length recommendation of battery cable

NOTICE

Exceeding the recommended extension length of battery cable may cause poor electrical system performance or damage.

To extend the length of battery cables, follow the requirements in the tables for your battery capacity, cable size, and ambient temperature.
The extension length of battery cable means the total combined length of positive and negative cables.
Select an extension battery cable and terminal which meets ABYC requirements or equivalent.
Select a stud of battery which is best-suited to the terminal size.
Solder the connection of terminals and cables to prevent them from corroding.

Ambient temperature above 0 °C (32 °F)				
Battery requirements		Cable specifications		
Unit	Minimum capacity	Maximum total extension length (Positive cable + Negative cable)		
		20 mm^2 AWG4	30 mm^2 AWG2	50 mm^2 AWG1/0
CCA/EN	711 Amps	6.0 m (19.7 ft)	10.0 m (32.8 ft)	16.0 m (52.5 ft)
20HR/IEC	100 Ah			

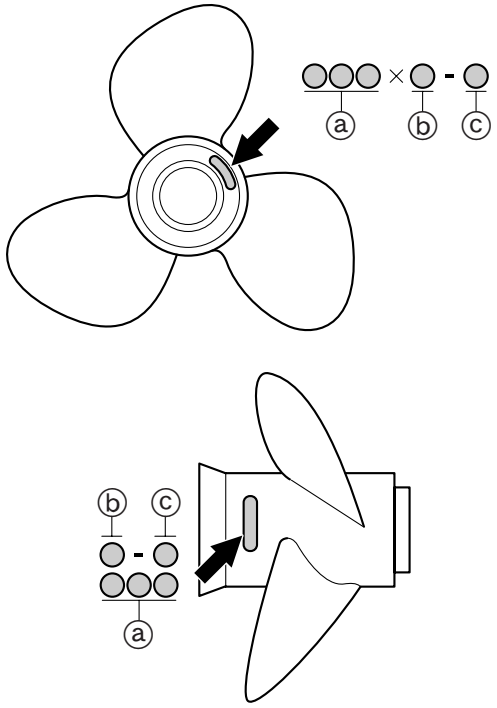
CCA: Cold Cranking Amperage
EN: European Norm (European standard)
IEC: International Electro-technical Commission

Propeller selection

The performance of a boat and outboard motor will be critically affected by the size and type of propeller you choose. Propellers greatly affect boat speed, acceleration, engine life, fuel economy, and even boating and steering capabilities. An incorrect choice could adversely affect performance and could also seriously damage the engine.
Use the following information as a guide for selecting a propeller that meets the operating conditions of the boat and the outboard motor.

Propeller size

The size of the propeller is indicated on the propeller boss end, on the side of the propeller boss.



ⓐ : Propeller diameter (in inches)
ⓑ : Propeller pitch (in inches)
ⓒ : Propeller type (propeller mark)

Selection

When the engine speed is at the full throttle operating range (4500–5500 r/min), the ideal propeller for the boat is one that provides maximum performance in relation to boat speed and fuel consumption.

Regular rotation model

Propeller size (in)	Material
13 1/2 × 23 - M	Aluminum
13 3/4 × 21 - M	
14 × 19 - M	
14 1/2 × 17 - M	
15 1/4 × 15 - M	
13 3/4 × 17 - M2	Stainless
13 3/4 × 19 - M2	
13 3/4 × 21 - M	
13 3/8 × 23 - M	
13 3/8 × 25 - M	
14 1/2 × 15 - M	
14 1/2 × 21 - M1	
14 1/2 × 23 - M	
14 1/2 × 23 - M2	
14 1/2 × 25 - M2	
14 1/2 × 27 - M1	
14 7/8 × 21 - M	
15 × 19 - M	
15 1/4 × 15 - M	
15 1/4 × 17 - M	
15 1/4 × 19 - M	
15 3/4 × 13 - M	

Counter rotation model

Propeller size (in)	Material
14 × 19 - ML	Aluminum
14 1/2 × 17 - ML	
13 3/4 × 17 - ML1	Stainless
13 3/4 × 19 - ML1	
13 3/4 × 21 - ML	
13 3/8 × 23 - ML	
14 1/2 × 23 - ML	
14 7/8 × 21 - ML	
15 1/4 × 15 - ML	
15 1/4 × 17 - ML	
15 1/4 × 19 - ML	

Troubleshooting

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Troubleshooting procedure 4-4
Troubleshooting the power unit using the YDIS 4-4
Trouble code and checking step 4-6
Troubleshooting the power unit using the diagnostic flash indicator 4-10
Troubleshooting the power unit (trouble code not detected) ... 4-11
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YDIS

This manual contains the model-specific information. See “YDIS Instruction Manual” for detailed information.

Feature

The newly developed YDIS provides quicker detection and analysis of engine malfunctions.
By connecting your computer to the engine ECM of an outboard motor using the communication cable, this software can be used to display sensor data and data stored in the engine ECM on the computer’s monitor.
If this software is run on Microsoft Windows 2000, Windows XP or Windows Vista, the information can be displayed in colorful graphics. Also, the software can be operated using either a mouse or a keyboard.
In addition, the data for the main functions (Diagnosis, Diagnosis record, Engine monitor, Data logger, and Record of engine oil exchange) can be saved on a disk or printed out.

Hardware requirement

Make sure that your computer meets the following requirements before using this software.

Computer:	IBM PC/AT compatible computer
Operating system:	Microsoft Windows 2000, Windows XP or Windows Vista
CPU:	
Windows 2000:	Pentium, 166 MHz or higher (Pentium 233 MHz or higher recommended)
Windows XP:	Pentium, 300 MHz or higher (Pentium 500 MHz or higher recommended)
Windows Vista:	Core family, 1.6 GHz or higher (Core family 2.0 GHz or higher recommended)
Memory:	
Windows 2000:	64 MB or more (128 MB or more recommended)
Windows XP:	128 MB or more (256 MB or more recommended)
Windows Vista:	1 GB or more
Hard disk free space:	20 MB or more (40 MB or more recommended)
Drive:	CD-ROM drive
Display:	VGA (640 × 480 pixels) 256 or more colors SVGA (800 × 600 pixels or more recommended) 256 or more colors
Mouse:	Compatible with the operating systems mentioned above
Communication port:	RS232C (Dsub-9 pin) port, USB port
Printer:	Compatible with the operating systems mentioned above

TIP:

- The amount of memory and the amount of free space on the hard disk differs depending on the computer.
- Using this software while there is not enough free space on the hard disk could cause errors and result in insufficient memory.
- This software will not run properly on some computers.
- When starting up this program, do not start other software applications.
- Do not use the screen saver function or the energy saving feature when using this program.
- If the ECM is changed, restart the program.
- Windows XP and Windows Vista are multiuser operating system, therefore, make sure to end this program if the login user is changed.

Function

- **Diagnosis**

  Displays each part name, and the engine ECM trouble codes and status when the engine start switch is turned to "ON." This allows you to quickly specify malfunctioning parts. The trouble codes displayed are the same as those described. See "Trouble code and checking step" (4-6).

- **Diagnosis record**

  Displays each part name and the engine ECM trouble codes that have been registered. This allows you to check the outboard motor's record of malfunctions. The trouble codes displayed are the same as those described. See "Trouble code and checking step" (4-6).

- **Engine monitor**

  Each sensor status and the engine ECM data are displayed while the engine start switch is "ON." This enables you to find malfunctioning parts quickly. In addition, the data displayed using the Engine monitor function can be displayed in a graph.

Engine speed	Throttle valve opening	Engine stop lanyard switch (*3)
Intake pressure (*1)	ISC valve opening	Shift position switch (*4)
Atmospheric (ambient) pressure	Fuel injection duration	Dual engine system switch
Ignition timing	Intake temperature	Main switch (*5)
Battery voltage	Engine temperature	Overheat thermoswitch
TPS voltage	Oil pressure (*2)	Shift cut-off switch

(*1) Intake air pressure
(*2) Engine oil pressure
(*3) Engine shut-off switch
(*4) Neutral switch
(*5) Engine start switch

- **Stationary test**

  Operation tests can be performed with the engine off.

Ignite ignition coils #1 & #4	Operate injector (#1–#4)	Operate ISC valve
Ignite ignition coils #2 & #3	Operate electric fuel pump	

- **Active test**

  The tests can be carried out while the engine is running and the shift is in the N position. It is not possible to carry out the test while the boat is running.

Fully open ISC valve	Angle of ISC valve opening

- **Data logger**

  Displays 13 minutes of recorded data for 2 or more of the items stored in the engine ECM. In addition, the operating time as compared to the engine speed and the total operating time are displayed. This allows you to check the operating status of the engine. You can also save the engine ECM record data on a file so that you can view and display the graph later.

Engine speed	TPS voltage	Intake pressure
Battery voltage	Engine temperature	Oil pressure

- **Record of engine oil exchange**
  This function can record the history of engine oil exchange.

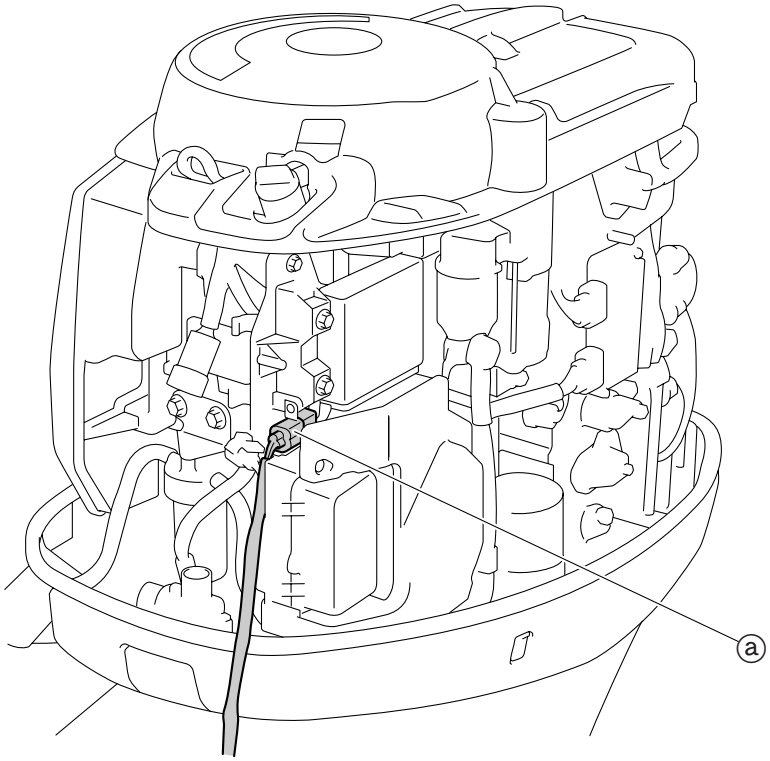
YDIS kit

No.	Item	Q'ty
①	CD-ROM (software + instruction manual)	1
②	Adapter	1
③	Communication cable	1

① ② ③

YDIS (CD-ROM, Ver. 1.30) ①:
60V-WS853-04
YDIS (KIT) ①, ②, ③:
60V-85300-04

Connecting the communication cable to the outboard motor



ⓐ YDIS coupler (gray)

Troubleshooting the power unit

Troubleshooting procedure

1. Before troubleshooting the outboard motor, make sure that fresh fuel of the specified type has been used.
2. Check that all electrical connections are tight and from corrosion, and that the battery is fully charged to 12 V.
3. Check the trouble code using the YDIS first, and then check the electronic control system follow the trouble code chart.
4. When a trouble code is detected, check the data logger of the engine ECM record data graph as well.
5. If a trouble code is not detected, check the power unit according to “Troubleshooting the power unit (trouble code not detected)” (4-11).
6. Before using the YDIS to check the power unit, check the engine ECM circuit. To check the engine ECM circuit, see “Checking the engine ECM circuit” (5-15).

TIP:

- Make sure to check that the couplers and connectors are securely connected.
- When deleting the diagnosis record on the YDIS, make sure to check the time that the trouble codes were detected.
- When checking the input voltage of a part, the coupler or connector must be disconnected. As a result, the engine ECM determines that the part is disconnected and a trouble code is detected. Therefore, make sure to delete the diagnosis record after checking the input voltage.
- Since the main relay comes on for approximately 10 seconds after the engine start switch is turned to “OFF,” the power of the engine ECM cannot be turned off. Therefore, if the engine start switch is turned to “ON” within 10 seconds after it was turned to “OFF,” the trouble codes cannot be deleted.

Troubleshooting the power unit using the YDIS

1. Use the trouble codes displayed by the YDIS to check each part according to the “Trouble code and checking step” table.
2. Delete the trouble codes after checking, repairing, or replacing a part and check that the trouble codes are not detected again. If the same trouble codes are detected, the engine ECM may be faulty.
3. Check the items listed in the table, if all the items are in good condition, and delete the trouble code, and then check the trouble codes again. If the same trouble codes are detected again, the engine ECM is faulty.

Trouble code table

O: Indicate
—: Not applicable

Code No.	Item	Diagnostic test lead code output	Diagnosis code output (YDIS Ver. 1.30)	Diagnosis record (YDIS Ver. 1.30)
1	Normal	O	—	—
13	Pulser coil malfunction	O	O	O
15	Engine temp sensor malfunction (Engine temperature sensor malfunction)	O	O	O
18	Throttle position sensor malfunction	O	O	O
19	Battery voltage malfunction	O	O	O
23	Intake temp sensor malfunction (Air temperature sensor malfunction)	O	O	O
27	Water in fuel	O	O	O
28	Shift position switch malfunction (Neutral switch malfunction)	O	O	O
29	Intake press sensor malfunction (Air pressure sensor malfunction)	O	O	O
37	Intake air passage malfunction	O	O	O
39	Oil press sensor malfunction (Oil pressure sensor malfunction)	O	O	O
44	Engine stop lanyard switch “ON” (Engine shut-off switch “ON”)	O	O	—
45	Shift cut-off switch malfunction (Shift cut switch malfunction)	O	O	O
46	Overheat thermoswitch malfunction	O	O	O

Trouble code and checking step

Description in < > is relevant to the twin and triple engine installation.
—: Not applicable

Trouble code	Item	Condition	Lan gauge display	Symptom	Remarks	Checking steps	Refer to page
13	Pulser coil malfunction	Irregular signal	C/E	Higher idle speed	—	1. Measure the pulser coil output peak voltage.	5-30
						2. Measure the pulser coil resistance.	5-30
						3. Check for wiring continuity between the pulser coil and engine ECM.	5-30 A-5
						4. Check the projections of the plate for damage.	7-17
15	Engine temp sensor malfunction	Out of specification	C/E	Higher idle speed Degraded acceleration performance Declining maximum engine speed	—	1. Measure the engine temperature sensor input voltage.	5-33 A-5
						2. Measure the engine temperature sensor resistance.	5-33
						3. Check for wiring continuity between the engine temperature sensor and engine ECM.	5-33 A-5
18	Throttle position sensor malfunction	Out of specification	C/E	Higher idle speed Degraded acceleration performance Declining maximum engine speed	—	1. Check the TPS using the YDIS.	5-16
						2. Measure the TPS input voltage.	5-16 A-5
						3. Check for wiring continuity between the TPS and engine ECM.	5-16 A-5
						4. Adjust the TPS.	6-21

Trouble code	Item	Condition	Lan gauge display	Symptom	Remarks	Checking steps	Refer to page
19	Battery voltage malfunction	Below specified voltage	C/E	Engine does not restart (*1)	Engine operates normally unless it is stopped (*1) Depends on battery condition	1. Check the battery capacity and specific gravity.	10-4
						2. Check the fuse.	5-2 A-7
						3. Check the battery cable and terminals for proper connection.	—
						4. Check the lighting coil output peak voltage.	5-26
						5. Measure the lighting coil resistance.	5-26
						6. Measure the Rectifier Regulator output peak voltage.	5-26
						7. Check the Rectifier Regulator for continuity.	5-26
						8. Check for wiring continuity between the Rectifier Regulator and fuse.	A-7
23	Intake temp sensor malfunction	Out of specification	C/E	Higher idle speed	—	1. Check the air temperature using the YDIS.	5-31
						2. Measure the air temperature sensor input voltage.	5-31 A-5
						3. Measure the air temperature sensor resistance.	5-31
						4. Check for wiring continuity between the air temperature sensor and engine ECM.	5-31 A-5

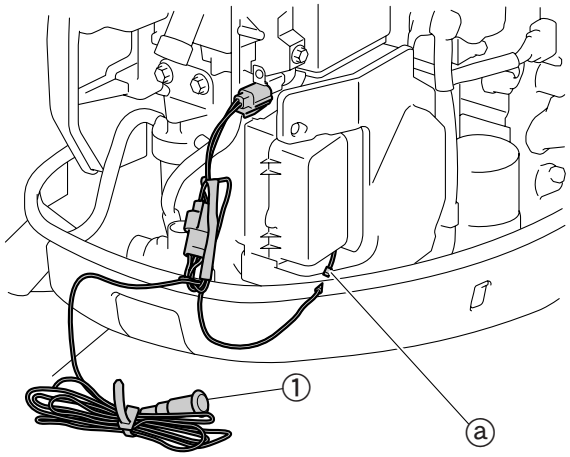
Description of (*1) in the “Symptom” column is shown in the “Remarks.”

Trouble code	Item	Condition	Lan gauge display	Symptom	Remarks	Checking steps	Refer to page
27	Water in fuel	Water in fuel	W/F	Alert buzzer goes out when engine started	—	1. Check for water in fuel filter.	—
						2. Measure the water detection switch input voltage.	5-23 A-3
						3. Check the water detection switch for continuity.	5-23
						4. Check for wiring continuity between the water detection switch and engine ECM.	5-23 A-3
28	Shift position switch malfunction	Irregular signal	C/E	—	—	1. Check the gear shift operation.	10-13
						2. Measure the neutral switch input voltage.	5-37 A-5
						3. Check the neutral switch for continuity.	5-37
						4. Check for wiring continuity between the neutral switch and engine ECM.	5-37 A-5
29	Intake press sensor malfunction	Out of specification	C/E	Higher idle speed Degraded acceleration performance Declining maximum engine speed	—	1. Measure the air pressure sensor input voltage.	5-32 A-5
						2. Measure the air pressure sensor output voltage.	5-32 A-5
						3. Check for wiring continuity between the air pressure sensor and engine ECM.	5-32 A-5
37	Intake air passage malfunction	Air leak	C/E	Higher idle speed Over-revolution at fully opened throttle	—	1. Check the O-rings and gaskets of the intake silencer and intake manifold.	6-16 6-27
						2. Check the intake manifold for cracks.	6-27
						3. Check the vacuum hose.	6-32
						4. Synchronize the throttle valves.	6-23

Trouble code	Item	Condition	Lan gauge display	Symptom	Remarks	Checking steps	Refer to page
39	Oil press sensor malfunction	Out of specification	C/E	Higher idle speed	—	1. Check the oil pressure using the YDIS.	7-2
						2. Measure the oil pressure sensor input voltage.	5-19 A-5
						3. Measure the oil pressure sensor output voltage.	5-19 A-5
						4. Check for wiring continuity between the oil pressure sensor and engine ECM.	5-19 A-5
45	Shift cut-off switch malfunction	Irregular signal	C/E	Higher idle speed	—	1. Measure the shift cut switch input voltage.	5-36 A-5
						2. Measure the shift cut switch resistance.	5-36
						3. Check for wiring continuity between the shift cut switch and engine ECM.	5-36 A-5
46	Overheat thermoswitch malfunction	Irregular signal	C/E	Higher idle speed	—	1. Measure the thermoswitch input voltage.	5-34 A-5
						2. Check the thermoswitch for continuity.	5-34
						3. Check for wiring continuity between the thermoswitch and engine ECM.	5-34 A-5

Troubleshooting the power unit using the diagnostic flash indicator

1. Connect the special service tool ①.



ⓐ Diagnostic test lead (Blue/White)

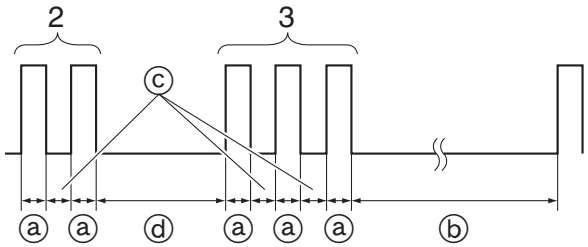
Diagnostic flash indicator B ①: 90890-06865

TIP:

When performing this diagnosis, all of the electrical wires must be properly connected.

2. Start the engine and let it idle.

3. Check the flash pattern for noticing a trouble code. For example, the trouble code is 23.



ⓐ Light on, 0.33 second
ⓑ Light off, 4.95 seconds
ⓒ Light off, 0.33 second
ⓓ Light off, 1.65 seconds

4. If a trouble code is detected, see “Trouble code and checking step” (4-6).

TIP:

When more than one trouble code is detected, the Diagnostic flash indicator B flashes in the pattern of the lowest trouble code. After that trouble code is corrected, the indicator flashes in the pattern of the next lowest the trouble code. This continues until all the trouble codes are detected and corrected.

Troubleshooting the power unit (trouble code not detected)

Troubleshooting when a trouble code is not available consists of the following 4 items.
Symptom 1: Specific trouble conditions.
Symptom 2: Trouble conditions of an area or individual part.
Cause 1: The content considered as the trouble factors of symptom 2.
Cause 2: The content considered as the trouble causes of cause 1 (described if necessary).
— : Not applicable

Symptom 1: Engine does not crank.

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
Starter motor does not operate	Blown fuse	—	Check the fuse.	5-2 A-7
	Starter relay malfunction	—	Check the starter relay.	5-38
	Engine start switch malfunction	—	Check the engine start switch.	5-39
	Neutral switch malfunction	—	Check the neutral switch (remote control).	5-39
	Short, open, or loose connection in starter motor circuit	—	Check the starter relay input voltage.	5-38 A-7
			Check the wiring harness continuity.	A-7
	Starter motor malfunction	—	Disassemble and check the starter motor.	5-43
Starter motor operates, but the engine does not crank	Starter motor malfunction	Clutch assembly malfunction	Disassemble and check the starter motor.	5-43
		Magnet switch malfunction		
	Stuck piston	—	Disassemble and check the power unit.	7-36 7-45
	Piston lock due to water or oil in the combustion chamber			
	Salt buildup on the drive shaft and bushing	—	Disassemble and check the upper case.	9-16

Symptom 1: Engine will not start (engine cranks).

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
Discharged battery	Battery performance decrement	—	Check the battery capacity and specific gravity.	10-4
	Stator assembly malfunction	—	Measure the lighting coil output peak voltage.	5-26
			Measure the lighting coil resistance.	5-26
	Short, open, or loose connection in charging circuit	—	Check the battery cable and terminals for proper connection.	—
			Check the charging circuit wiring connection and damage.	A-7
Engine ECM does not operate	Main relay malfunction	—	Check the main relay.	5-14 A-5
	Blown fuse	—	Check the fuse.	5-2 A-5
	Short, open, or loose connection in engine ECM circuit	—	Check for wiring continuity between the main relay and engine ECM.	5-15 A-5
			Check for wiring continuity between the engine ECM and ground.	5-15 A-5
	Engine ECM malfunction	—	Replace the engine ECM.	7-15
Spark plug does not spark (all cylinders)	Pulser coil malfunction	—	Check the pulser coil resistance.	5-30
	Short, open, or loose connection in pulser coil circuit	—	Check for wiring continuity between the pulser coil and engine ECM.	5-30 A-5
	Short, open, or loose connection in ignition coil circuit	—	Check the ignition coil input voltage.	5-29 A-5
			Check for wiring continuity between the ignition coil and engine ECM.	5-29 A-5
			Check for wiring continuity between the ignition coil and main relay.	5-29 A-5

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
Fuel not supplied (all cylinders)	High pressure fuel pump does not operate	High pressure fuel pump malfunction	Check the high-pressure fuel pump motor resistance.	5-25
		Short, open, or loose connection in high-pressure fuel pump circuit	Check the high-pressure fuel pump input voltage.	5-25 A-3
			Check for wiring continuity between the high-pressure fuel pump and engine ECM.	5-25 A-3
			Check for wiring continuity between the high-pressure fuel pump and main relay.	5-25 A-3
	Fuel pump does not operate	Fuel leakage	Check the fuel pump.	6-10
			Check the diaphragm for torn.	6-11
	Vapor separator malfunction	Clogs the filter	Check the filter.	6-32
	Fuel not supplied to the fuel rails	—	Check the fuel pressure.	6-4

Symptom 1: Unstable engine idle speed, poor acceleration, poor performance, or limited engine speed.

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
—	Throttle valves does not synchronize	—	Synchronize the throttle valves.	6-23
	Throttle link malfunction	—	Check the throttle link for clack or worn.	6-18
	Throttle link and throttle cable are not installed correctly	—	Adjust the throttle link and throttle cable.	10-16
Spark plug does not spark (some cylinders)	Spark plug malfunction	—	Check the ignition spark.	5-28
			Check the spark plugs.	10-15
	Short, open, or loose connection in ignition coil circuit	—	Check the spark plug wires resistance.	5-28
			Check the ignition coil input voltage.	5-29 A-5
			Check the ignition coil output peak voltage.	5-29
			Check for wiring continuity between the ignition coil and engine ECM.	5-29 A-5
			Check for wiring continuity between the ignition coil and main relay.	5-29 A-5
	Ignition coil malfunction	—	Check the ignition coil resistance.	5-29
	Engine ECM malfunction	—	Replace the engine ECM.	7-15
High-pressure fuel line malfunction (fuel pressure is low)	Pressure regulator malfunction	—	Check the pressure regulator.	6-5
	High-pressure fuel pump malfunction	—	Check the fuel pressure.	6-4
Fuel not supplied (some cylinders)	Fuel injector malfunction	—	Check the fuel injector operation using the YDIS.	5-24
			Check the fuel injector resistance.	5-24
	Short, open, or loose connection in fuel injector circuit	—	Check the fuel injector input voltage.	5-24 A-3
			Check for wiring continuity between the fuel injector and main relay.	5-24 A-3
			Check for wiring continuity between the fuel injector and engine ECM.	5-24 A-3
	Clogged fuel injector filter	—	Replace the fuel injector.	6-26
	Engine ECM malfunction	—	Replace the engine ECM.	7-15

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
Low compression pressure	Damaged piston	—	Check the compression pressure. Disassemble and check the power unit.	7-1 7-36 7-45
	Scratched cylinder	—		
	Damaged valve	—		
	Valve stuck to valve guide	—		

Symptom 1: High engine idle speed (below 1200 r/min).

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
—	Air leakage (throttle valve–cylinder head)	—	Check the O-rings and gaskets of the intake silencer and intake manifold.	6-16 6-27
	Throttle link malfunction	—	Check the throttle link for clack or worn.	6-18
	Throttle link and throttle cable are not installed correctly	—	Adjust the throttle link and throttle cable.	10-16

Symptom 1: Limited engine speed (below 2000 r/min).

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
Buzzer comes on, overheat alert indicator comes on, cooling water does not discharge from the cooling water pilot hole	Clogged cooling water inlet	—	Check the cooling water inlet.	8-8 8-53
	Water pump malfunction	Water pump impeller malfunction	Check the impeller.	8-7
			Check the Woodruff key.	8-7
		Water leakage from water pump housing	Check the water pump housing.	8-7
			Check the insert cartridge.	8-7
			Check the outer plate cartridge.	8-7
	Clogged cooling water passage	—	Check the cooling water passage (power unit, EX guide, and upper case).	2-24
	Thermostat malfunction	—	Check the thermostat.	10-16
Buzzer comes on, oil pressure alert indicator comes on	Insufficient engine oil	—	Add sufficient oil.	10-5
	Engine oil pressure decrease	Oil pump malfunction	Check the oil pressure.	7-2
		Clogged oil strainer	Check the oil strainer.	9-21
		Clogged oil passage	Check the oil passage (power unit and oil pump).	2-22
		Engine oil leakage		
		Clogged oil filter	Replace the oil filter.	10-11

Troubleshooting the PTT unit

— : Not applicable

Symptom 1: PTT unit does not operate.

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
PTT motor does not operate	Blown fuse	—	Check the fuse.	5-2 A-7
	Loose connection of the battery terminal	—	Check the battery terminal.	3-17
	PTT switch malfunction	—	Check the PTT switch.	5-49
	PTT relay malfunction	—	Check the PTT relay.	5-48
	Short, open, or loose connection of the wiring harness	—	Check the PTT switch input voltage.	5-49 A-7
			Check the PTT relay input voltage.	5-48 A-7
			Check for wiring continuity between the PTT switch and PTT relay.	5-49 A-7
			Check for wiring continuity between the PTT switch and fuse.	5-49 A-7
	PTT motor malfunction	—	Check the PTT motor.	9-42
	Short, open, or loose connection of the PTT motor lead	—	Check for wiring continuity between the PTT motor and PTT relay terminal.	A-7
PTT fluid pressure does not increase	Manual valve opened	Manual valve malfunction	Check the manual valve.	9-45
	Insufficient PTT fluid	—	Add sufficient fluid.	9-36
	PTT fluid leakage	—	Check the hydraulic pressure.	9-34
	Clogged filter	—	Disassemble and check the PTT unit.	2-29 9-32
	Clogged fluid passage	—		
	Gear pump malfunction	—	Disassemble and check the gear pump assembly.	9-45

Symptom 1: PTT unit does not hold the outboard motor up.

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
—	Manual valve opened	Manual valve malfunction	Check the manual valve.	9-45
—	Insufficient PTT fluid	—	Add sufficient fluid.	9-36
—	PTT fluid leakage	—	Check the hydraulic pressure.	9-34
—	Clogged fluid passage	—	Disassemble and check the PTT unit.	2-29 9-32

Troubleshooting the lower unit

— : Not applicable

Symptom 1: Shift mechanism of the forward gear and reverse gear does not operate properly.

Symptom 2	Cause 1	Cause 2	Checking step	Refer to page
—	Shift rod operation malfunction	Shift rod connection malfunction	Check the detent. Check the shift rod connection.	8-23 8-25 8-65
—	Shift mechanism malfunction (in lower unit)	—	Disassemble and check the lower unit.	8-1 8-47

Electrical system

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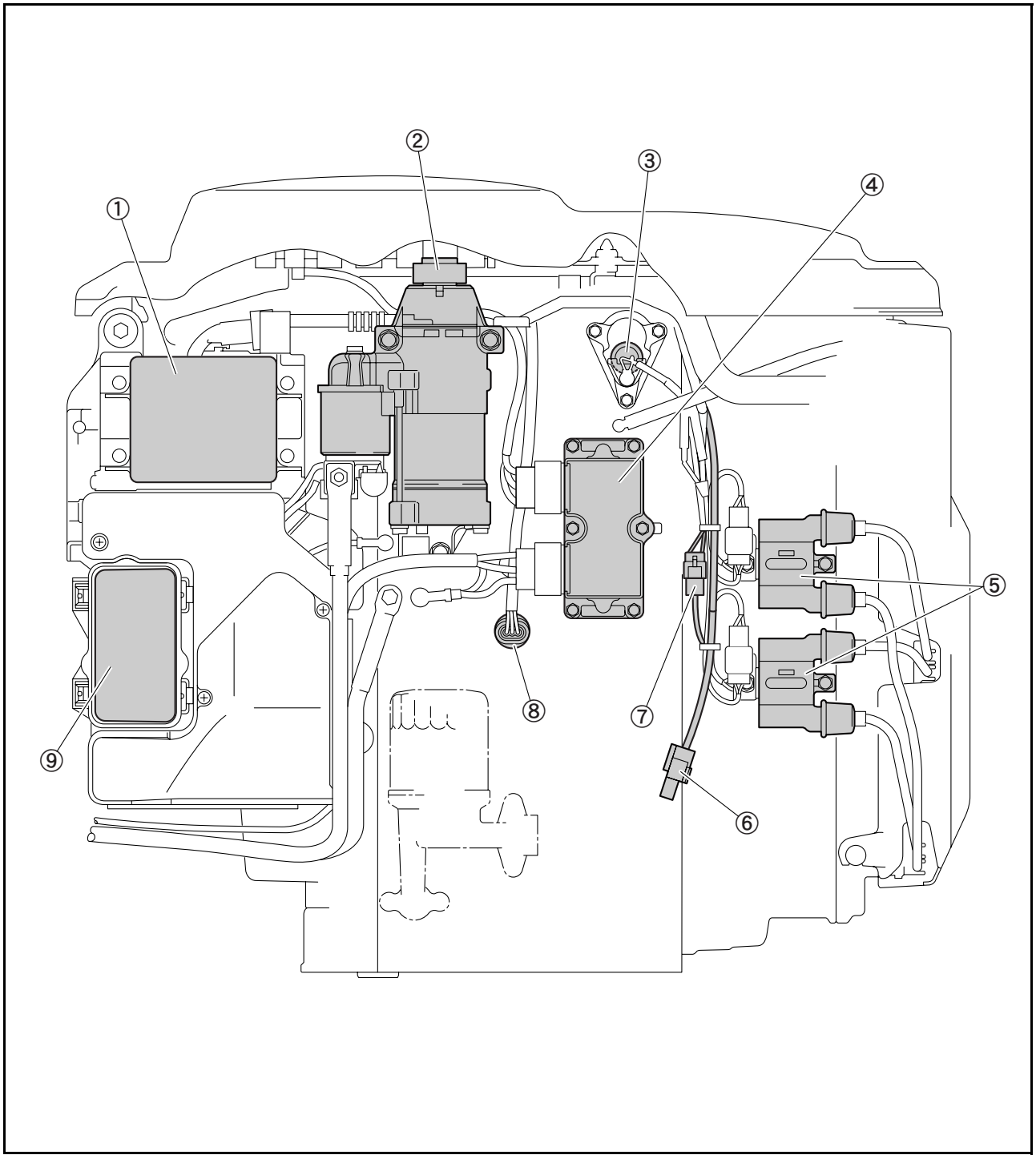
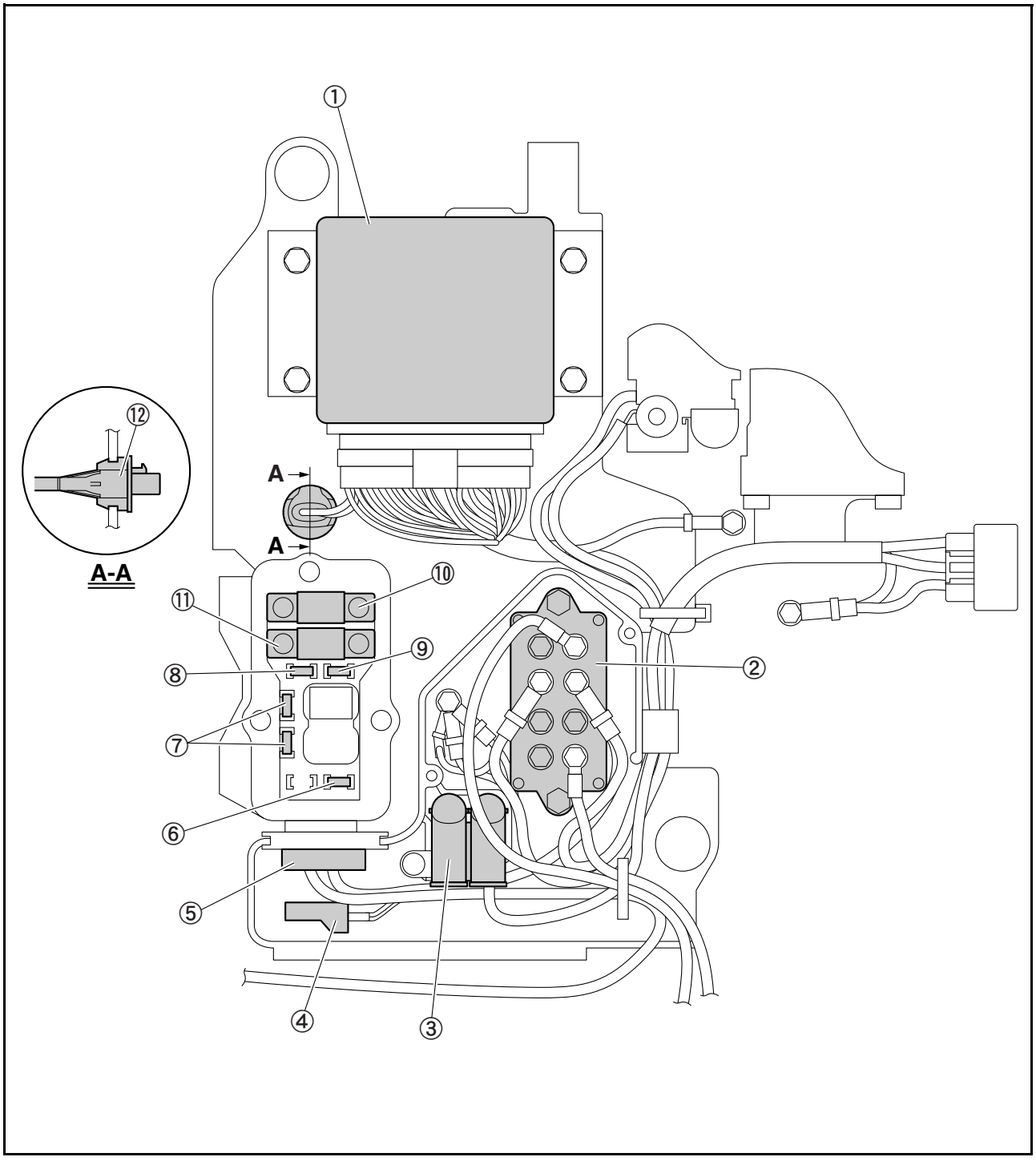
Electrical components

Port view



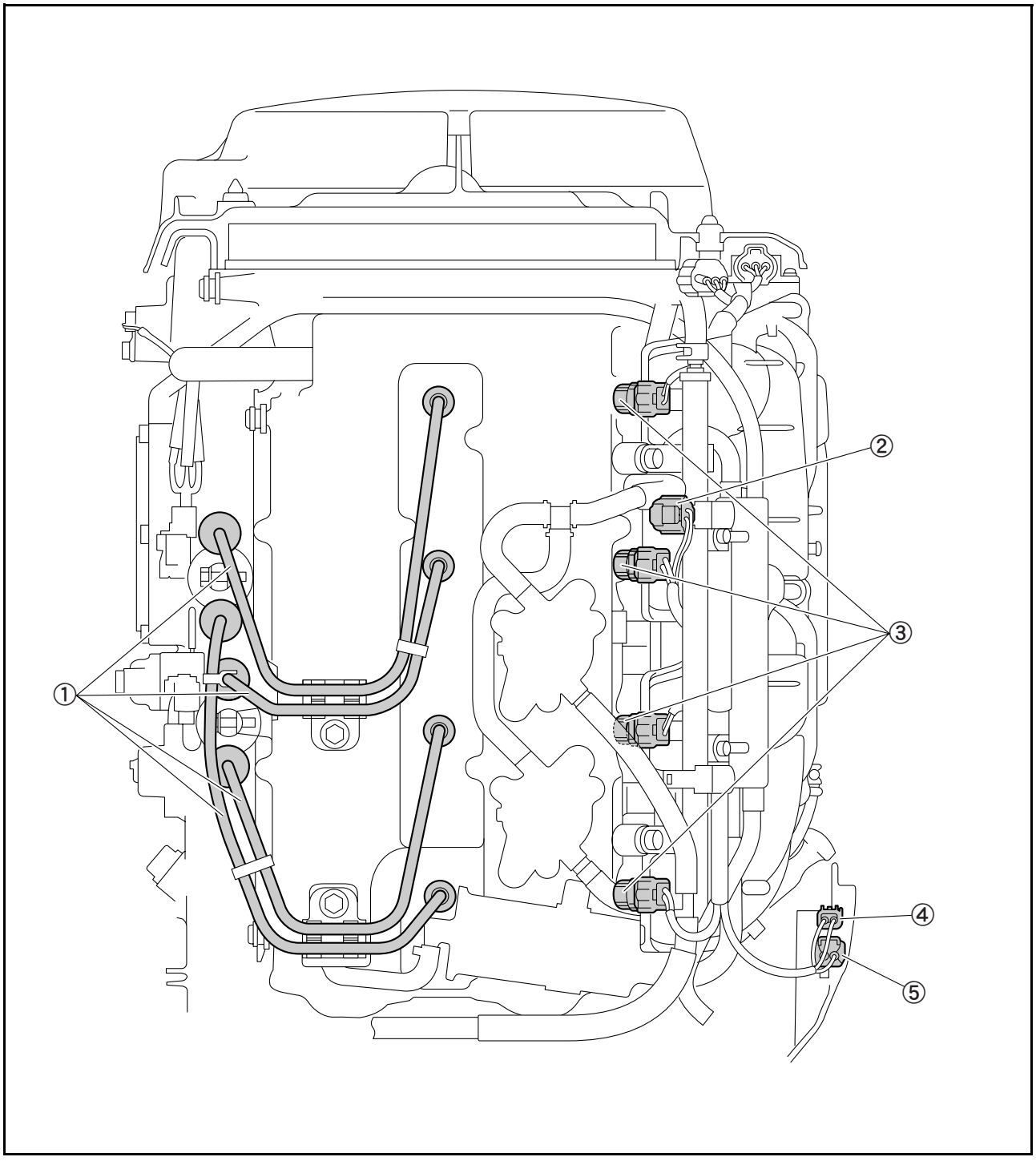
① Engine ECM
② Starter motor
③ Thermoswitch
④ Rectifier Regulator
⑤ Ignition coil
⑥ Speed sensor coupler
⑦ Water pressure sensor coupler
⑧ Oil pressure sensor
⑨ Fuse holder

Junction box assembly



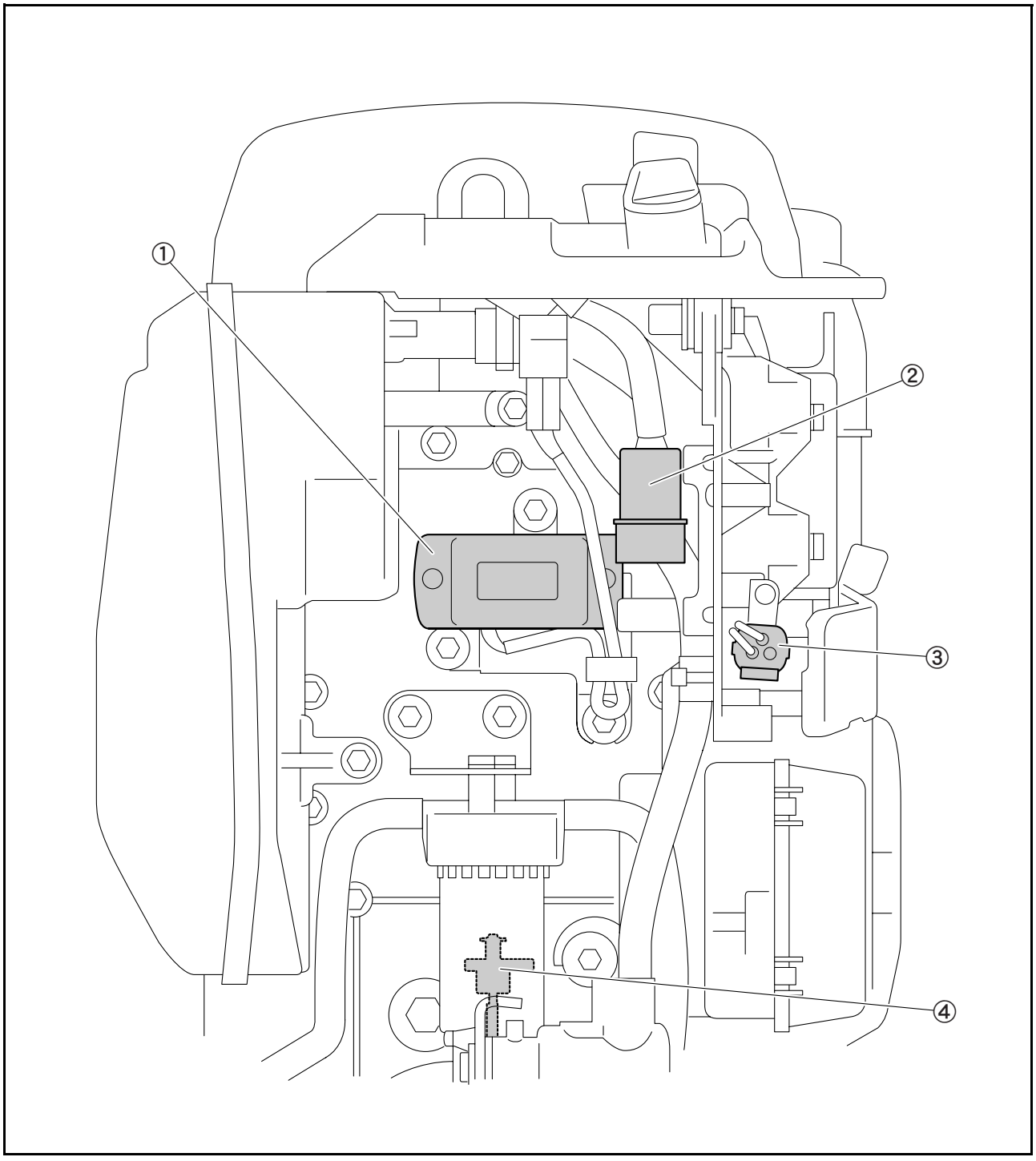
① Engine ECM
② PTT relay
③ Starter relay
④ Diode (connect to the PTT relay)
⑤ Flash indicator connector
⑥ Fuse (30 A) (starter relay)
⑦ Fuse (30 A) (20 A) (spare)
⑧ Fuse (20 A) (engine start switch, PTT switch)
⑨ Fuse (20 A) (engine ECM, ISC, fuel injector, high-pressure fuel pump, ignition coil, YDIS)
⑩ Fuse (50 A) (house battery)
⑪ Fuse (50 A) (engine battery)
⑫ Air temperature sensor

Aft view



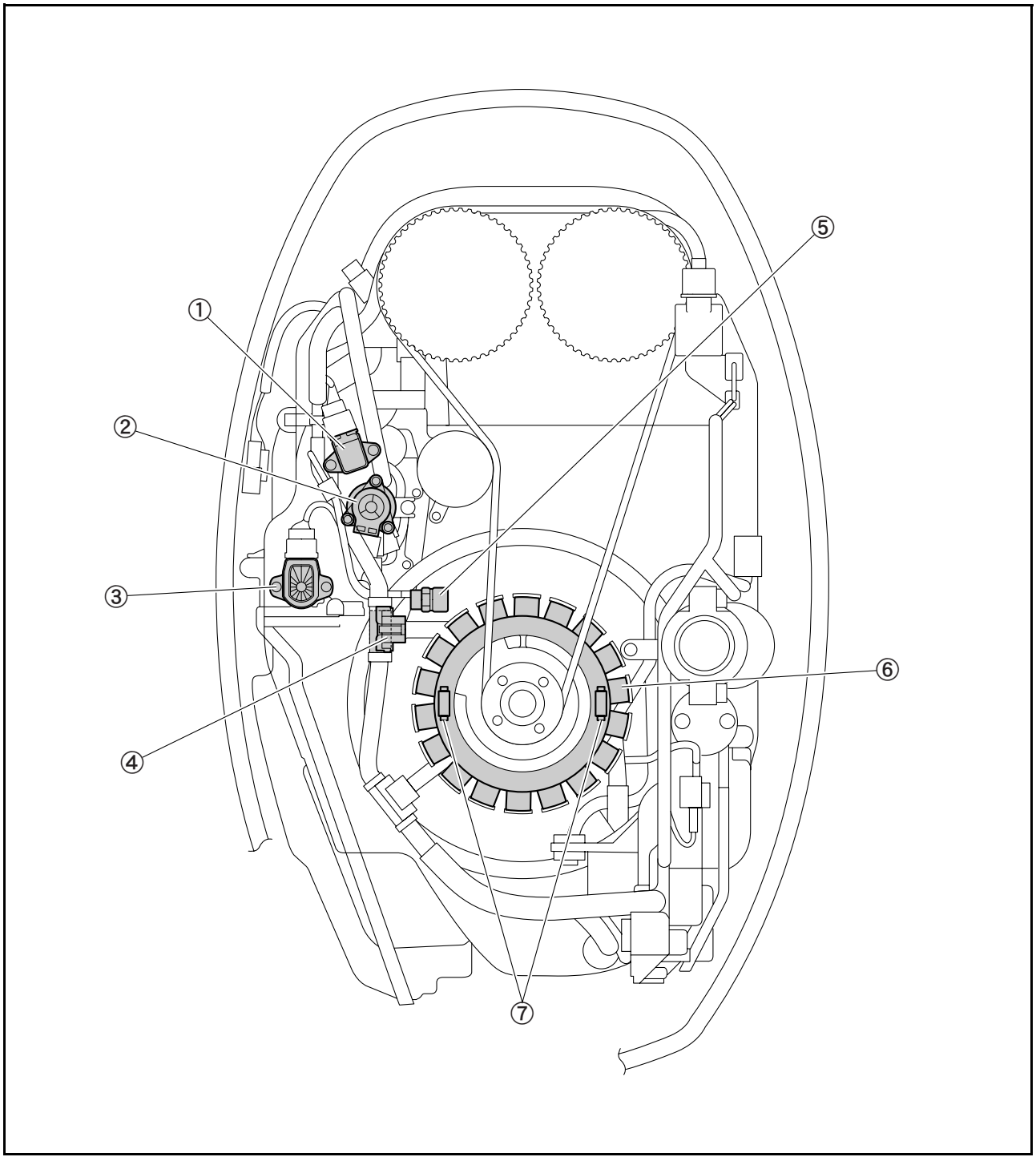
① Spark plug wire
② High-pressure fuel pump coupler
③ Fuel injector
④ Shift cut switch coupler
⑤ Neutral switch coupler

Bow view



① Hour meter
② Main harness coupler
③ YDIS coupler
④ Water detection switch (in fuel filter)

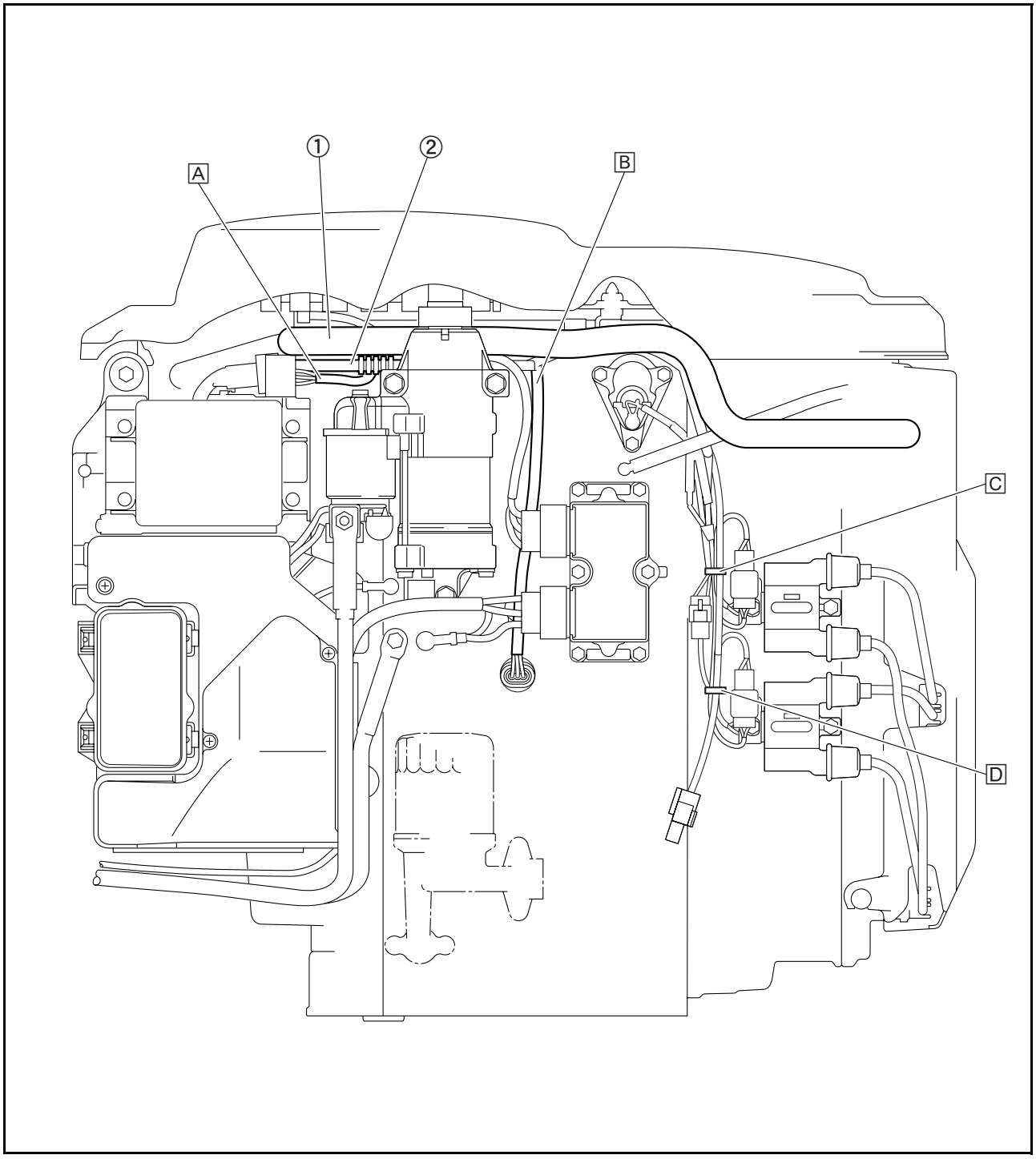
Top view



① Air pressure sensor
② ISC
③ TPS
④ Joint connector
⑤ Engine temperature sensor
⑥ Lighting coil (stator assembly)
⑦ Pulser coil

Wiring harness routing

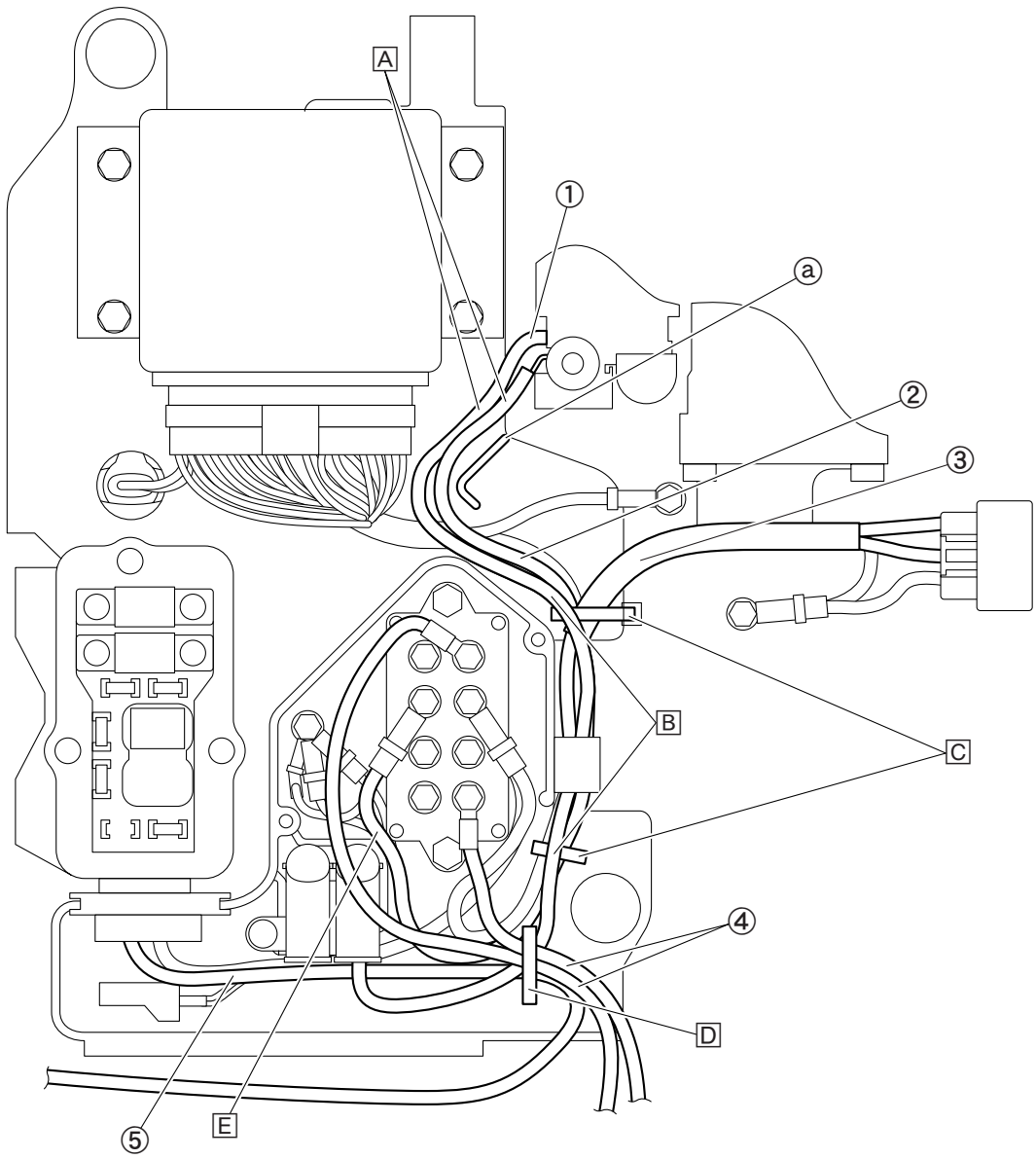
Port view



① Blowby hose
② Wiring harness

A Run the pulser coil lead under the breather hose and the wiring harness.
B Run the oil pressure sensor lead behind the Rectifier Regulator coupler.
C Install the ignition coil lead, water pressure sensor lead and speed sensor lead.
D Install the ignition coil lead and speed sensor lead.

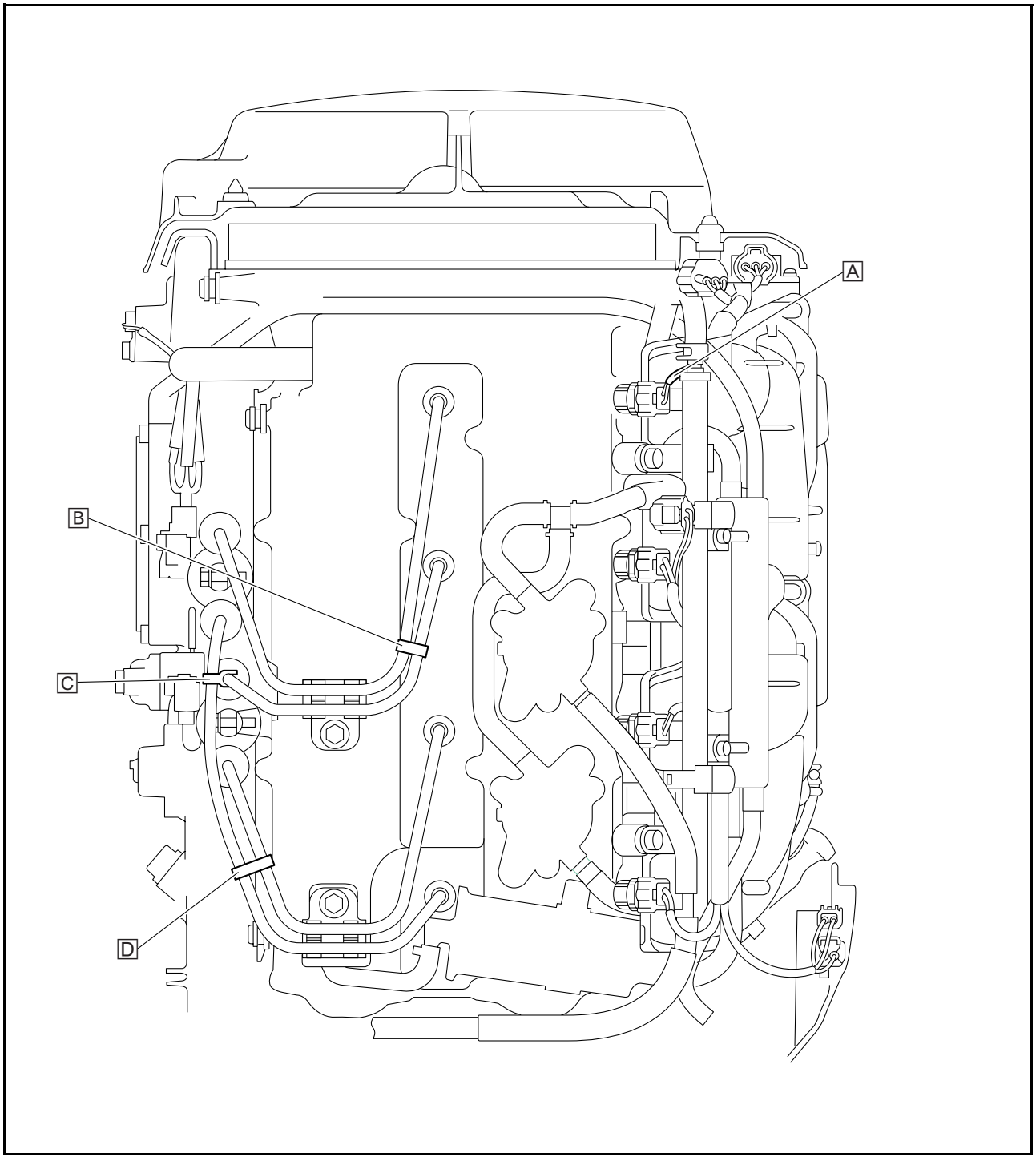
Junction box assembly



① Starter motor lead
② Power supply lead
③ Rectifier Regulator lead
④ PTT motor lead
⑤ Isolator lead

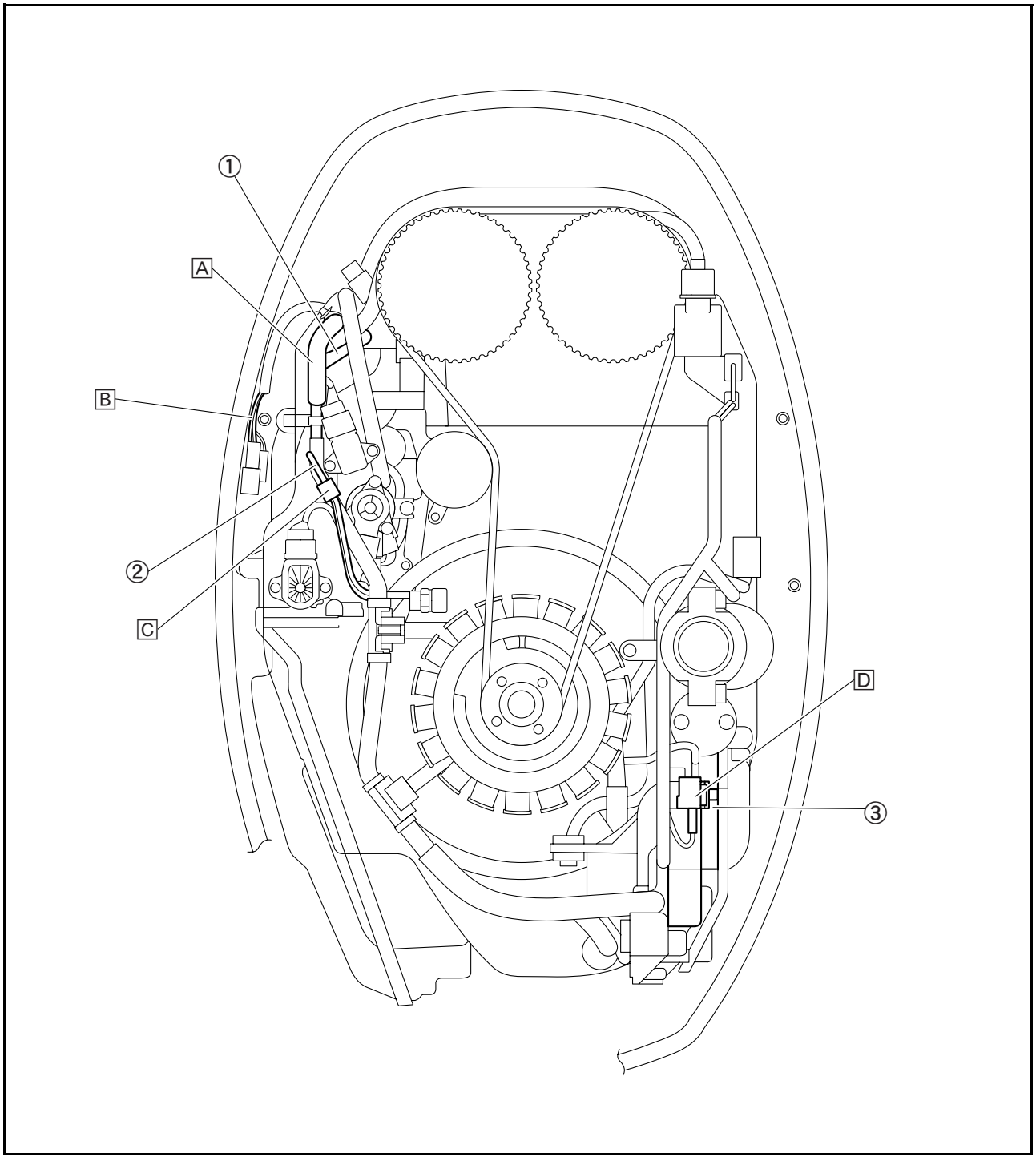
A Run the starter motor lead ① and the power supply lead ② on the left side of the part ⓐ.
B Do not fasten the starter motor lead ① with a plastic tie.
C Fasten the wiring harness, Rectifier Regulator lead ③, and the power supply lead ② with a plastic tie.
D Install the starter motor lead ①, PTT motor lead ④, and isolator lead ⑤ with the holder.
E Run the ground lead between the PTT relay and the starter relay.

Aft view



A Run the fuel injector lead back side the fuel rail.
B Install the clamp to the spark plug wires #1 and #2.
C Install the clamp to the spark plug wires #2 and #4.
D Install the clamp to the spark plug wires #3 and #4.

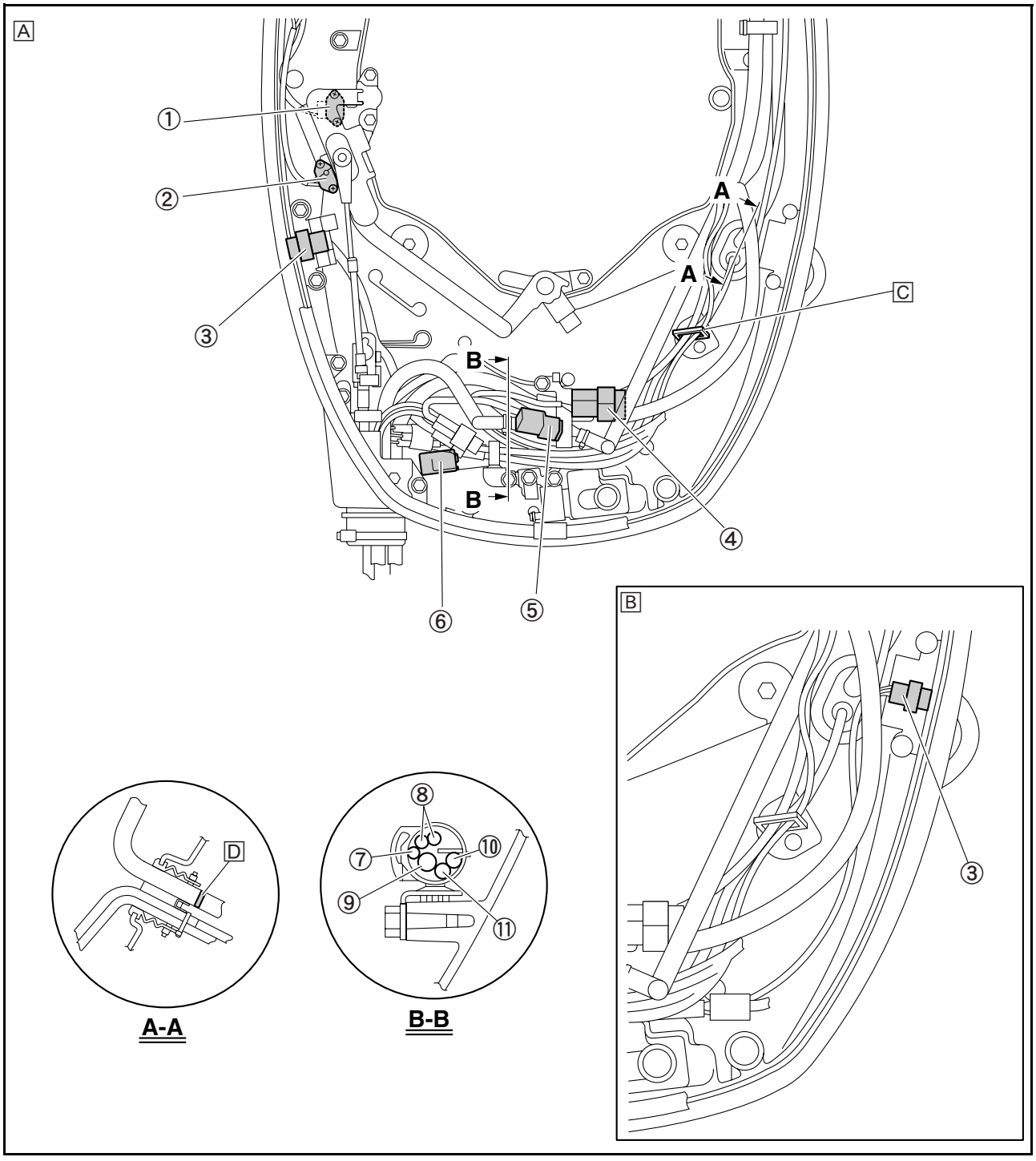
Top view



① Cooling water pilot hose
② Engine temperature sensor lead
③ Junction box

A Run the wiring harness up side the cooling water pilot hose ①.
B Run the wiring harness in the bottom cowling groove.
C Hold the engine temperature sensor lead ② and fasten them by the clamp.
D Install the pulser coil coupler to the junction box ③.

Bottom cowling



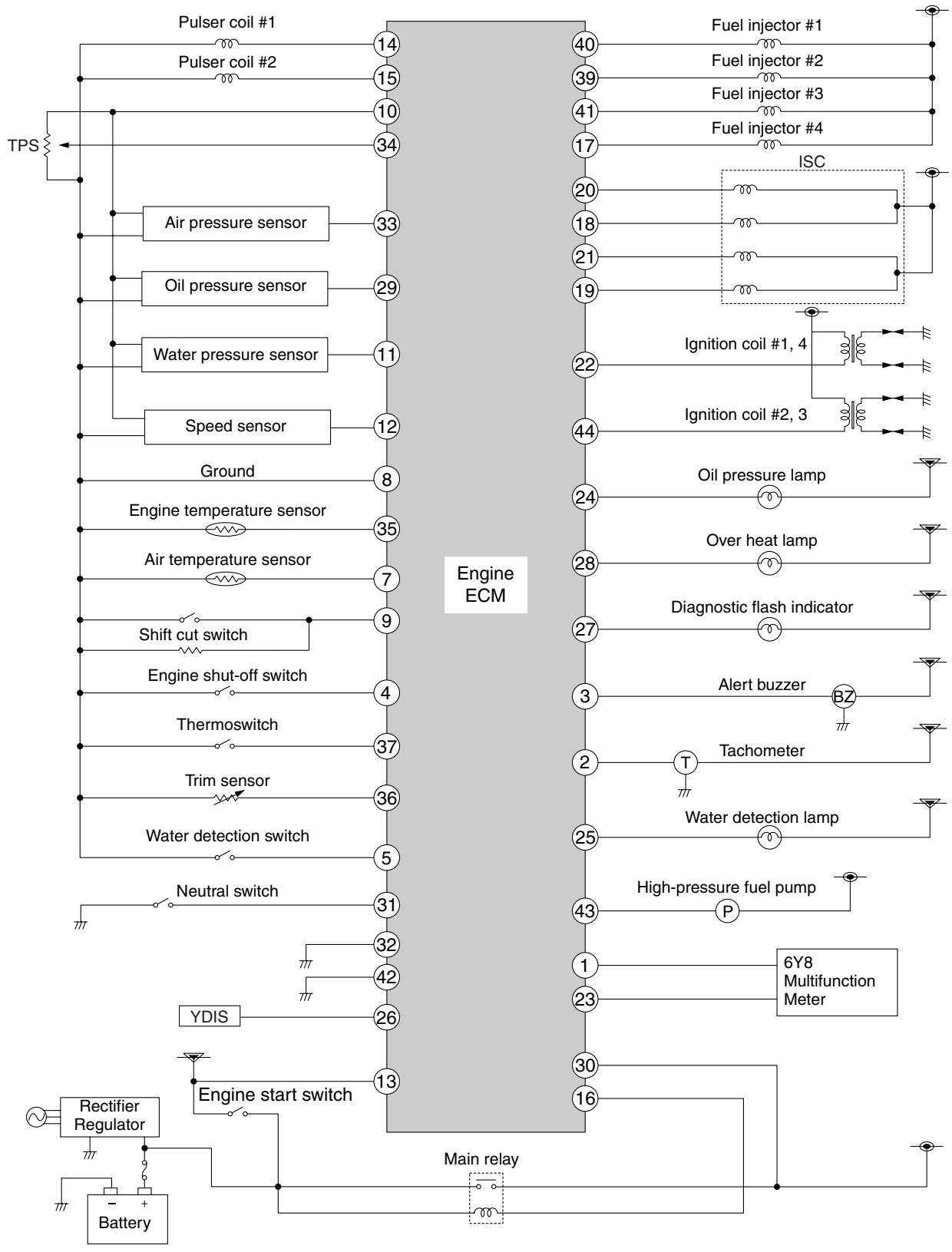
① Shift cut switch
② Neutral switch
③ PTT switch
④ 6Y8 Multifunction Meter communication coupler
⑤ Gauge harness coupler
⑥ Isolator coupler
⑦ 6Y8 Multifunction Meter communication lead
⑧ Trim meter lead
⑨ Isolator lead
⑩ Trim sensor lead
⑪ PTT switch lead

A Regular rotation model
B Counter rotation model
C Install the PTT motor lead and isolator lead with the clamp.
D Align the positioning tape on the flushing hose to the grommet face.

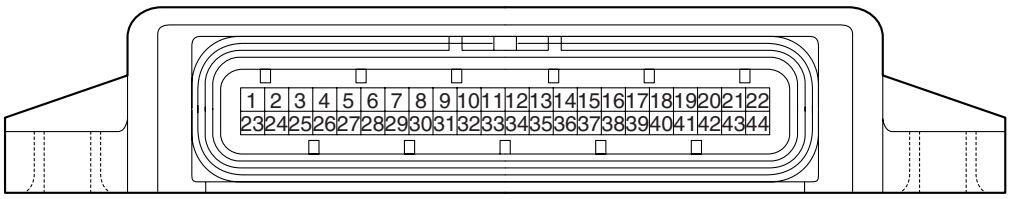
Circuit diagram

TIP:

The circled numbers in the illustration indicate the engine ECM terminal numbers.



ECM coupler layout



No.	Connecting part	Color
1	6Y8 Multifunction Meter	White
2	Remote control	Green
3	Remote control	Pink
4	Remote control	White
5	Water detection switch	Blue/White
6		
7	Air temperature sensor	Black/Yellow
8	Sensor ground	Black
9	Shift cut switch	Blue/Yellow
10	Sensor power source	Orange
11	Water pressure sensor	Blue/White
12	Speed sensor	Blue
13	Engine start switch	Yellow
14	Pulser coil #1	White/Red
15	Pulser coil #2	White/Black
16	Main relay	Yellow/Green
17	Fuel injector #4	Purple/Green
18	ISC	Green/Black
19	ISC	Green
20	ISC	Green/Red
21	ISC	Green/Yellow
22	Ignition coil #1, 4	Black/Orange
23	6Y8 Multifunction Meter	Blue
24	Alert indicator (low oil pressure)	Pink/White
25		
26	YDIS	White/Black
27	Diagnostic flash indicator	Blue/White
28	Alert indicator (overheat)	Pink/Black
29	Oil pressure sensor	Pink/White

No.	Connecting part	Color
30	Battery power source	Red/Yellow
31	Neutral switch	Blue/Green
32	Ground	Black
33	Air pressure sensor	Pink/Green
34	TPS	Pink
35	Engine temperature sensor	Black/Yellow
36	Trim sensor	Pink
37	Thermoswitch	Pink
38		
39	Fuel injector #2	Purple/Black
40	Fuel injector #1	Purple/Red
41	Fuel injector #3	Purple/Yellow
42	Ground	Black
43	High-pressure fuel pump	Blue
44	Ignition coil #2, 3	Black/White

Checking the electrical component

Checking by use of YDIS

When checking the TPS, ISC, high-pressure fuel pump, fuel injector, or each sensor, use the YDIS.

When deleting the diagnosis record in the YDIS, be sure to check the time that the trouble codes were detected.

When checking the input voltage of a part, the coupler or connector must be disconnected. As a result, the engine ECM determines that the part is disconnected and a trouble code is detected. Therefore, be sure to delete the diagnosis record after checking the input voltage.

Since the main relay stays on for approximately 10 seconds after the start switch is turned to "OFF," the power of the engine ECM cannot be turned off. Therefore, if the start switch is turned to "ON" within 10 seconds after it was turned to "OFF," the trouble codes cannot be deleted.

YDIS (CD-ROM, Ver. 1.30):
60V-WS853-04
YDIS (KIT): 60V-85300-04

TIP:

- Before checking the electrical components, make sure that the battery is fully charged.
- Install the proprietary YDIS software in CD-ROM to your computer. Always use the exclusive communication cable for connecting the ECM to the computer. For a description of the communication cable and CD-ROM to be used, see "YDIS" (4-1). Also, be sure to check the CD-ROM version before using it.
- To connect and operate the YDIS, see the YDIS (Ver. 1.30 or later) Instruction Manual.

Measuring the peak voltage

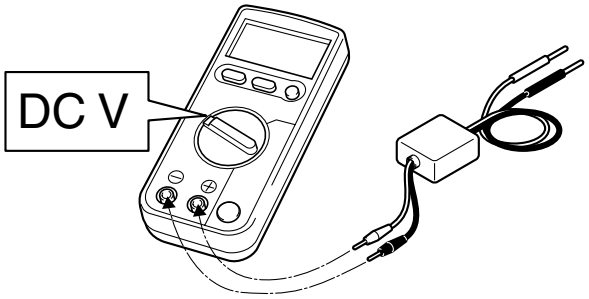
⚠ WARNING

When checking the peak voltage, do not touch any of the connections of the digital tester probes.

NOTICE

When testing the voltage between the terminals of an electrical component with the digital tester, do not allow any of the leads to touch any metal parts. If touched, the electrical component can be short-circuited and be damaged.

To check the electrical components or measure the peak voltage, use the special service tools. A faulty electrical component can be easily checked by measuring the peak voltage. The specified engine speed when measuring the peak voltage is affected by many factors such as fouled spark plugs or a weak battery. If one of these factors is present, the peak voltage cannot be measured properly.



Digital circuit tester: 90890-03174
Peak voltage adapter B: 90890-03172

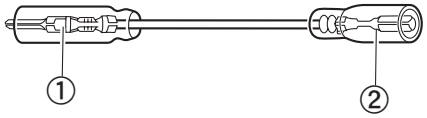
TIP:

- Before measuring the peak voltage, check all wiring for proper connection and corrosion, and check that the battery is fully charged.
- Use the Peak voltage adapter B with the recommended digital circuit tester.
- Connect the positive pin of the Peak voltage adapter B to the positive terminal of the digital tester, and the negative pin to the negative terminal.
- When measuring the peak voltage, set the selector on the digital circuit tester to the **DC voltage mode.**

Checking by use of the digital tester

The electrical technical data apply to the measurements taken by the Yamaha recommendation tester.

The resistance shown is the value taken before the engine start. It may change depending on the environmental conditions and the ambient temperature.
Input voltage changes depending on the battery voltage.
If the tester probe cannot be inserted in the coupler, prepare a test lead suitable for the measurement.

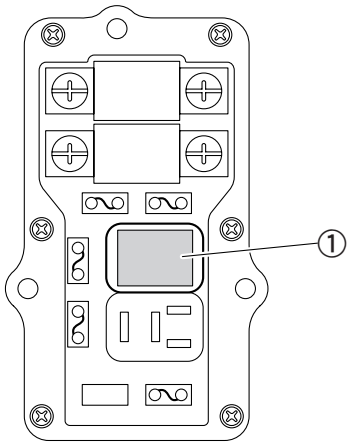


Test lead:
Terminal, male ①: 9E212-10303
Terminal, female ②:
(commercially available)

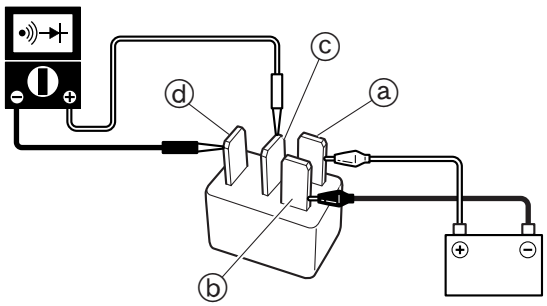
Engine control units and components

Checking the main relay

1. Remove the main relay ①.

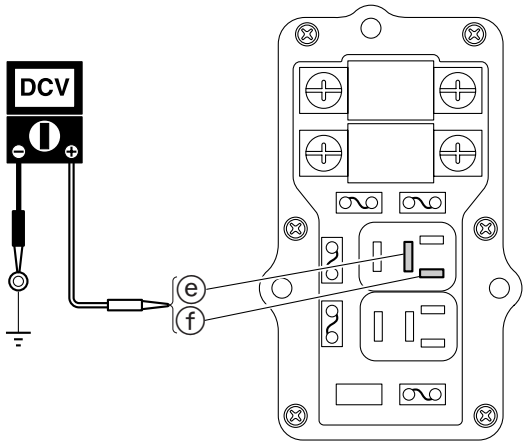


2. Connect the positive battery lead to the relay terminal ⓐ, and the negative battery lead to the relay terminal ⓑ, and then check for continuity between terminals ⓒ and ⓓ. Replace the relay if out of specification. ***NOTICE:*** **Do not reverse the battery leads.**



Battery lead	Relay terminal	
	ⓒ	ⓓ
Connect	O	O
Disconnect		

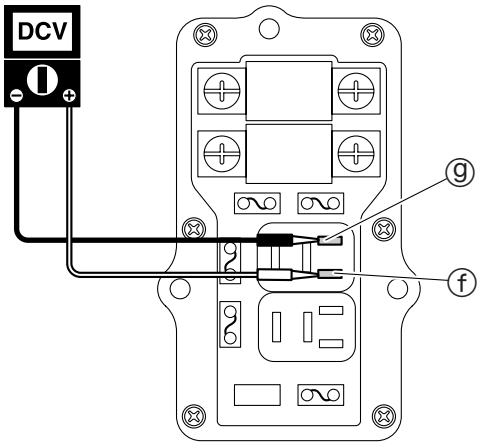
3. Measure the input voltage between the terminal ⓔ and ground, and the terminal ⓕ and ground.



Main relay input voltage:
Terminal ⓔ–Ground
Terminal ⓕ–Ground
12.0 V (battery voltage)

5

4. Turn the engine start switch to “ON,” and then measure the input voltage between terminals ⓕ and ⓖ.

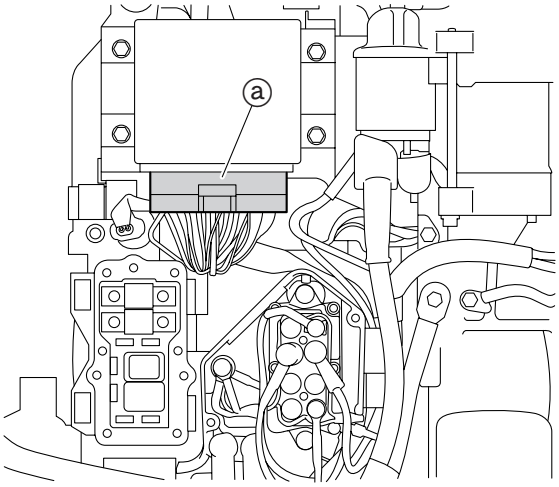


Main relay input voltage:
Terminal ⓕ–Terminal ⓖ
12.0 V (battery voltage)

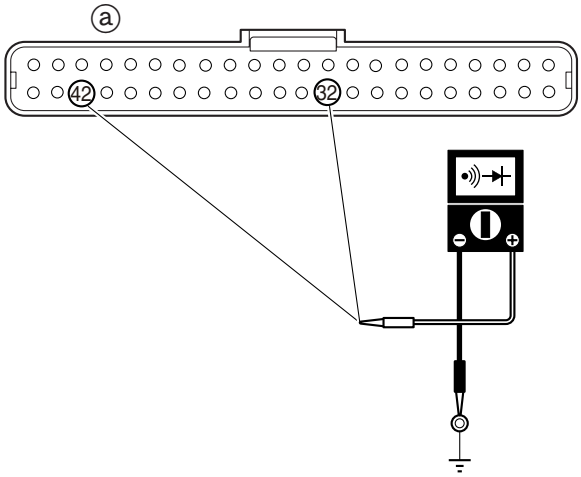
5. Turn the engine start switch to “OFF,” and then install the main relay ①.

Checking the engine ECM circuit

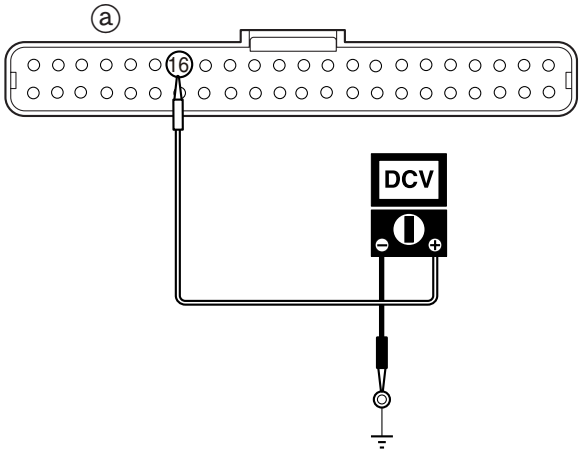
1. Remove the junction box cover, and then disconnect the engine ECM coupler ⓐ.



2. Check for continuity between the engine ECM coupler terminals (32 and 42) and ground.

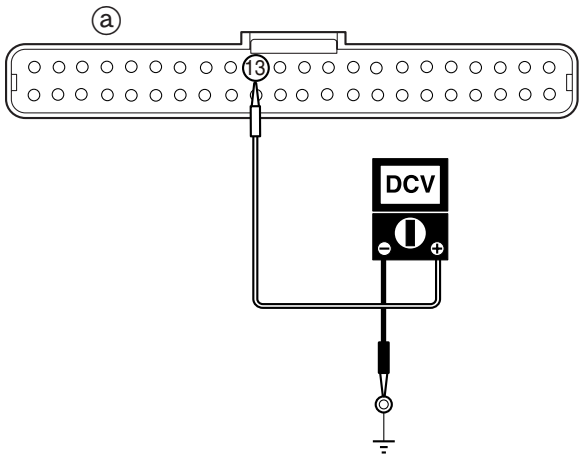


3. Measure the input voltage at the engine ECM coupler terminal 16 and ground.



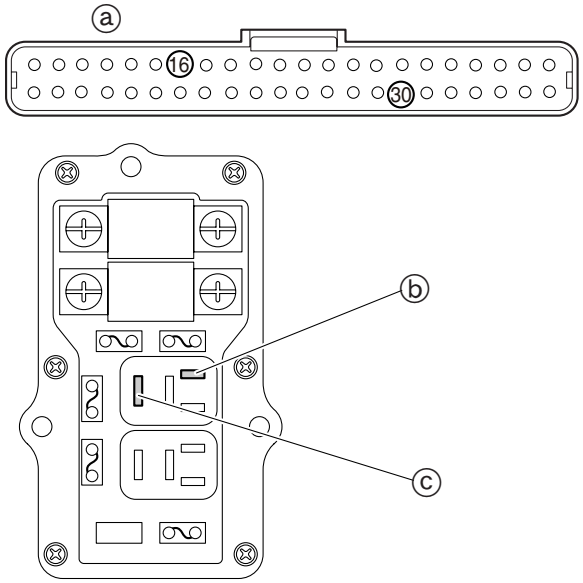
Engine ECM input voltage:
Terminal 16–Ground
12.0 V (battery voltage)

4. Turn the engine start switch to “ON,” and then measure the input voltage at the engine ECM coupler terminal 13 and ground.



Engine ECM input voltage (reference data):
Terminal 13–Ground
11.2 V

5. Turn the engine start switch to “OFF.”
6. Remove the main relay.
7. Check the wiring harness for continuity.

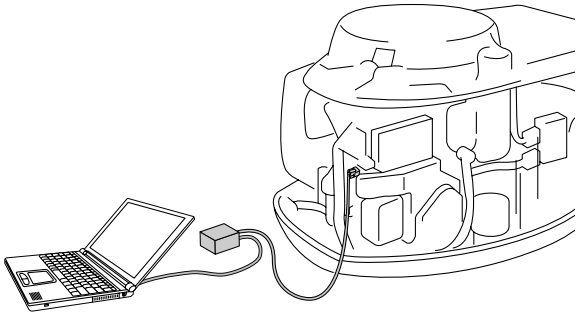


Wiring harness continuity:
Terminal 16–Terminal ⓑ
Terminal 30–Terminal ⓒ

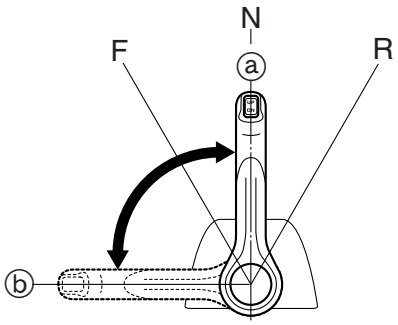
8. Install the main relay.
9. Connect the engine ECM coupler ⓐ, and then install the junction box cover.

Checking the TPS

1. Connect the YDIS to display “Throttle position sensor.”



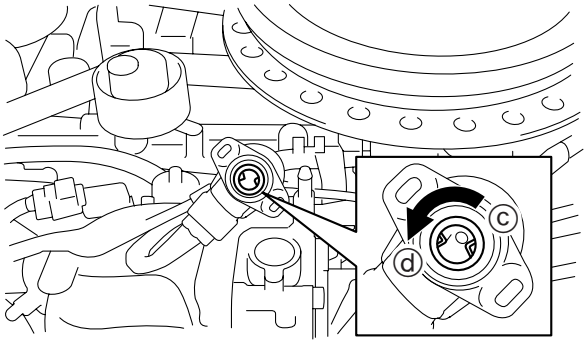
2. Start the engine and warm up, and then turn it off.
3. Turn the engine start switch to “ON,” and then measure the output voltages of TPS and the throttle valve opening angle when the remote control lever is at the fully closed position ⓐ and fully open position ⓑ.



TPS out put voltage and throttle valve opening angle (reference data):		
	Fully closed ⓐ	Fully open ⓑ
Output voltage	0.703 V	4.255 V
Opening angle	0.1°	88.6°

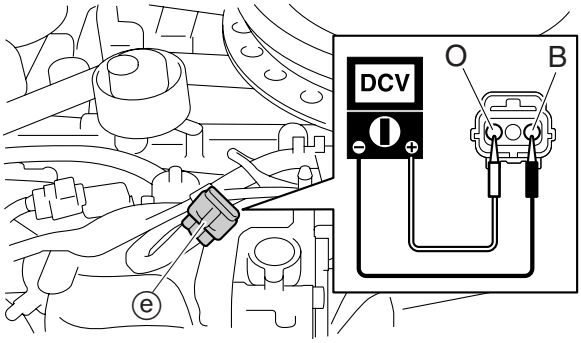
5

4. Remove the TPS, and then measure the output voltages of the TPS when the sensor free position ⓒ to fully turned position ⓓ.



TPS output voltage (reference data):	
Free position ⓒ	Full turn position ⓓ
0.298 V	4.980 V

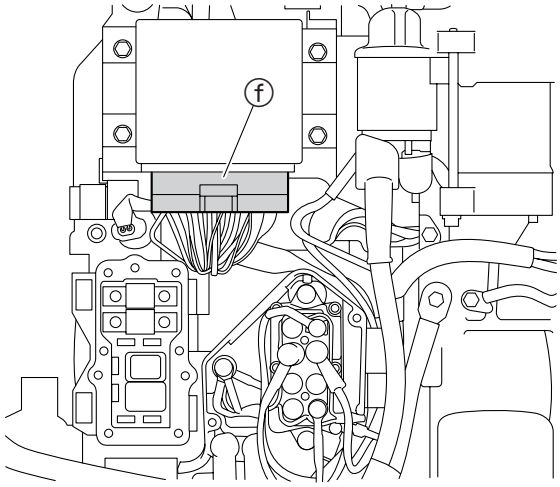
5. Disconnect TPS coupler ⓔ, and then measure the TPS input voltage at the TPS coupler.



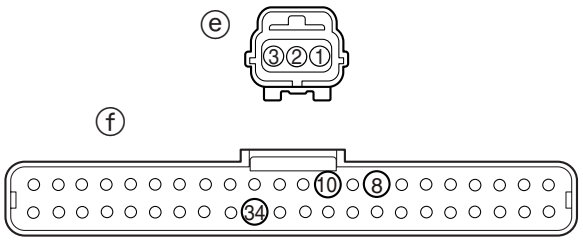
TPS input voltage:
Orange (O)–Black (B)
4.75–5.25 V

6. Turn the engine start switch to "OFF."

7. Remove the junction box cover, and then disconnect the engine ECM coupler ⓕ.



8. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 8
Terminal 2–Terminal 34
Terminal 3–Terminal 10

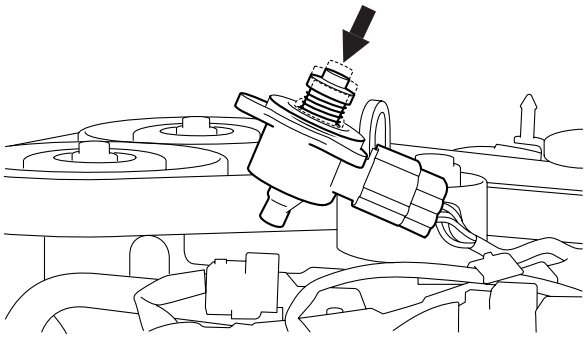
9. Connect the engine ECM coupler ⓕ, and then install the junction box cover.

10. Install the TPS, and then connect the TPS coupler ⓔ.

Checking the ISC

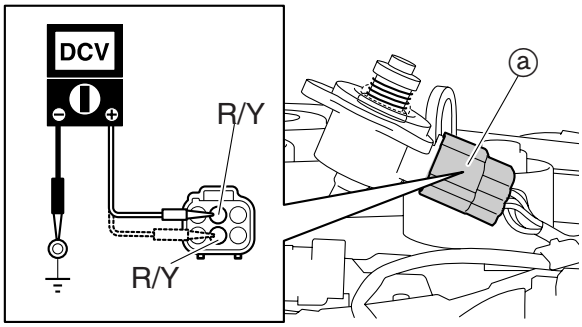
1. Remove the ISC.

2. Check the proper movement of ISC valve using the "Stationary test" of the YDIS.



3. Disconnect the ISC coupler ⓐ.

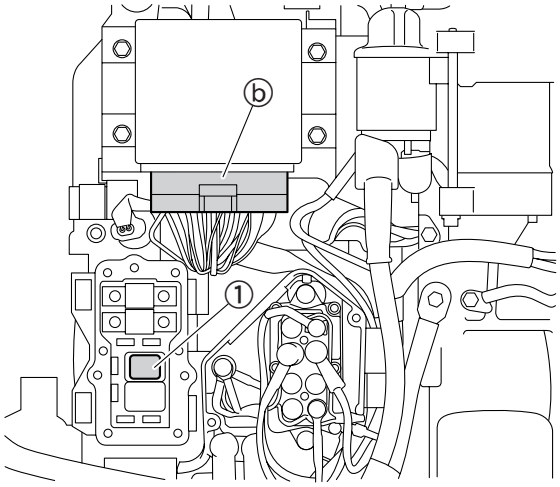
4. Turn the engine start switch to “ON,” and then measure the ISC input voltage at the ISC coupler terminal and ground.



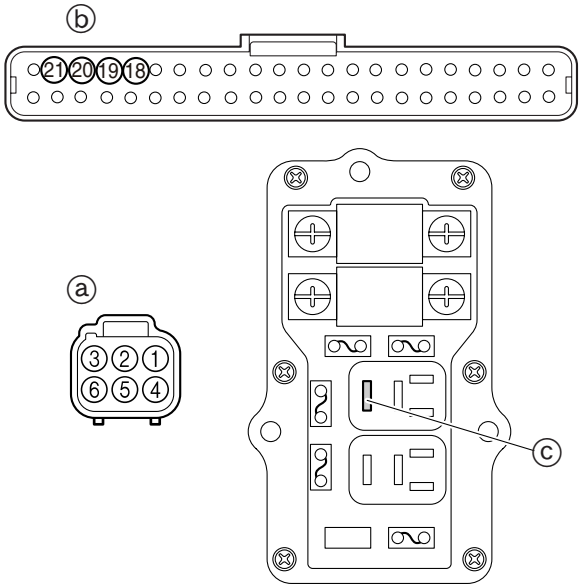
ISC input voltage:
Red/Yellow (R/Y)–Ground
12.0 V (battery voltage)

5. Turn the engine start switch to “OFF.”

6. Remove the junction box cover and the main relay ①, and then disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 20
Terminal 2–Terminal ⓒ
Terminal 3–Terminal 18
Terminal 4–Terminal 21
Terminal 5–Terminal ⓒ
Terminal 6–Terminal 19

8. Install the main relay ①.

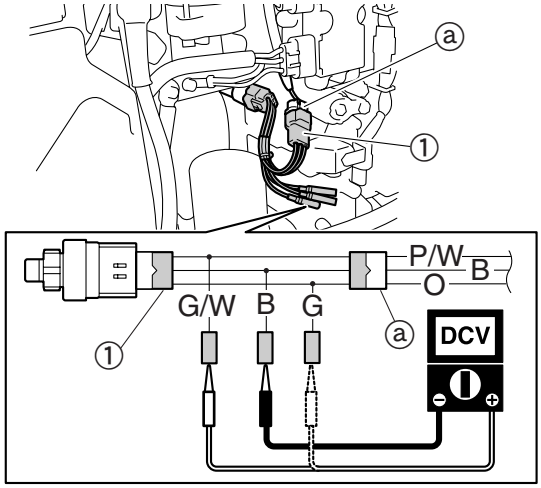
9. Connect the engine ECM coupler ⓑ, and then install the junction box cover.

10. Connect the ISC coupler ⓐ.

5

Checking the oil pressure sensor

1. Disconnect the oil pressure sensor coupler ⓐ, and then connect the test harness (3 pins) ①.



Test harness (3 pins) ①: 90890-06869

2. Turn the engine start switch to "ON," and then measure the oil pressure sensor input voltage.

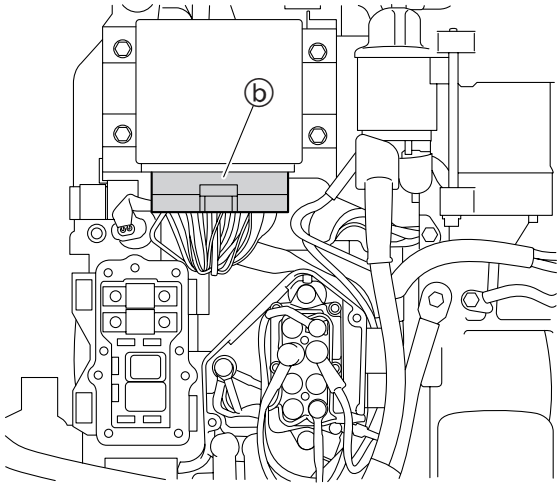
Oil pressure sensor input voltage: Orange (O)–Black (B) 4.75 V–5.25 V

3. Start the engine and warm up, and then measure the oil pressure sensor output voltage at the stable idle condition of 650–750 r/min.

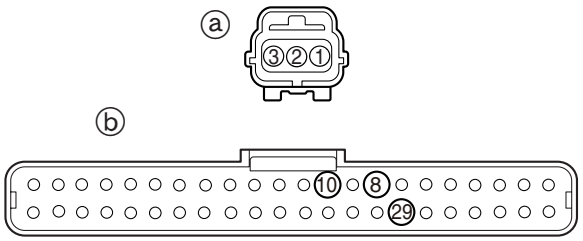
Oil pressure sensor output voltage (reference data): Pink/White (P/W)–Black (B) 2.8 V at 450.0 kPa (4.50 kgf/cm², 65.3 psi) and 60 °C (140 °F) with SL 10W-30 engine oil and at 700 r/min

4. Turn the engine start switch to "OFF," and then disconnect the test harness ①.

5. Remove the junction box cover, and then disconnect the engine ECM coupler ⓑ.



6. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 10 Terminal 2–Terminal 8 Terminal 3–Terminal 29

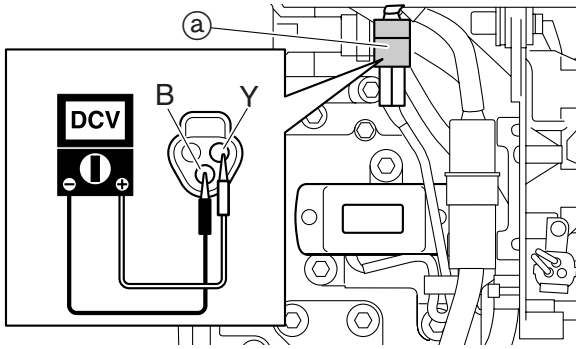
7. Connect the engine ECM coupler ⓑ, and then install the junction box cover.

8. Connect the oil pressure sensor coupler ⓐ.

Checking the hour meter

1. Disconnect the hour meter coupler ⓐ.

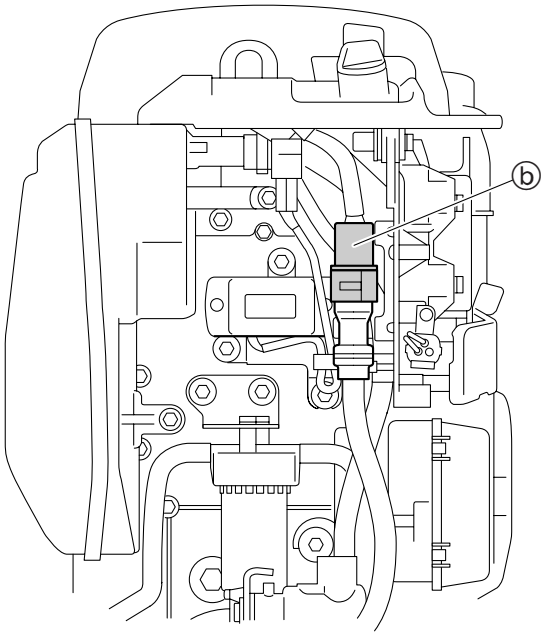
2. Turn the engine start switch to "ON," and then measure the input voltage.



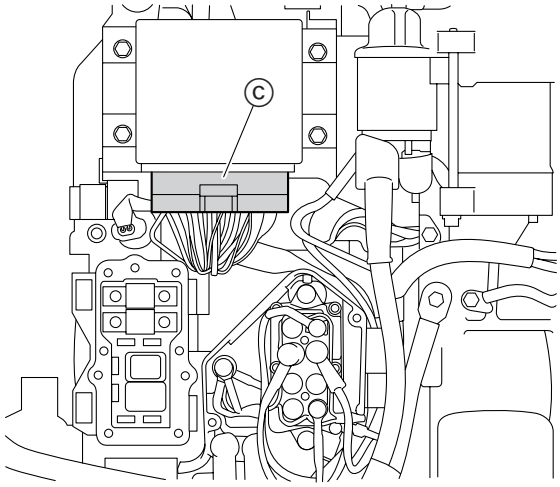
Hour meter input voltage (reference data):
Yellow (Y)–Black (B)
11.2 V

3. Turn the engine start switch to “OFF.”

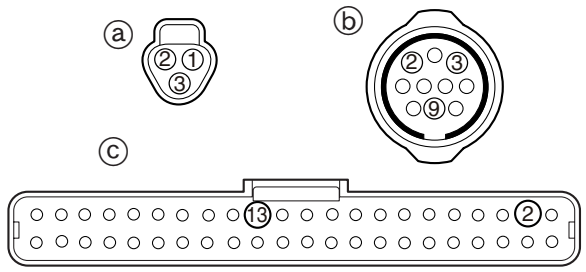
4. Disconnect the 10-pin main harness coupler ⓑ.



5. Remove the junction box cover, and then disconnect the engine ECM coupler ⓒ.



6. Check the wiring harness for continuity.



Wiring harness continuity:
ⓐ Terminal 1–ⓑ Terminal 3
ⓐ Terminal 1–ⓒ Terminal 13
ⓐ Terminal 2–ⓑ Terminal 2
ⓐ Terminal 2–ⓒ Terminal 2
ⓐ Terminal 3–ⓑ Terminal 9
ⓐ Terminal 3–Ground
ⓑ Terminal 2–ⓒ Terminal 2
ⓑ Terminal 3–ⓒ Terminal 13
ⓑ Terminal 9–Ground

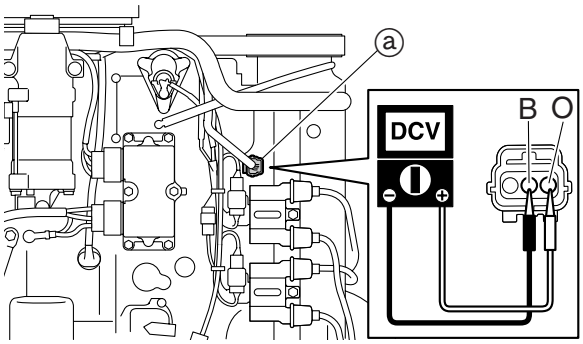
7. Connect the engine ECM coupler ⓒ, and then install the junction box cover.

8. Connect the 10-pin main harness coupler ⓑ and hour meter coupler ⓐ.

Checking the water pressure sensor (option)

1. Disconnect the water pressure sensor coupler ⓐ.

2. Turn the engine start switch to “ON,” and then measure the input voltage at the water pressure sensor coupler.

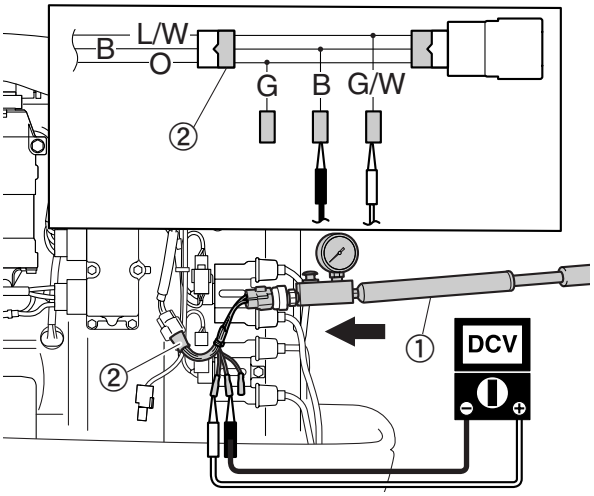


Water pressure sensor input voltage (reference data):
Orange (O)–Black (B)
4.75–5.25 V

3. Remove the water pressure sensor, and then connect the pressure pump ① and test harness (3 pins) ②.

Pressure pump ①:
(commercially available)
Test harness (3 pins) ②: 90890-06869

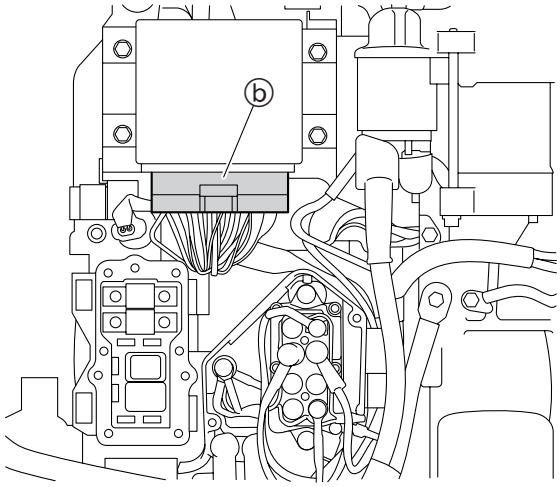
4. Apply positive pressure to the water pressure sensor slowly, and then measure the output voltage.



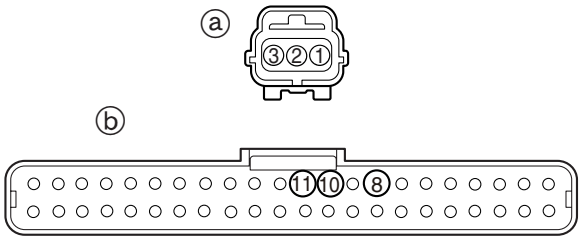
Water pressure sensor output voltage:
Blue/White (L/W)–Black (B)
2.5 V at 392.0 kPa
(3.92 kgf/cm², 56.8 psi)
4.5 V at 784.0 kPa
(7.84 kgf/cm², 113.7 psi)

5. Turn the engine start switch to “OFF,” and then disconnect the test harness ② and pressure pump ①.

6. Remove the junction box cover, and then disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.



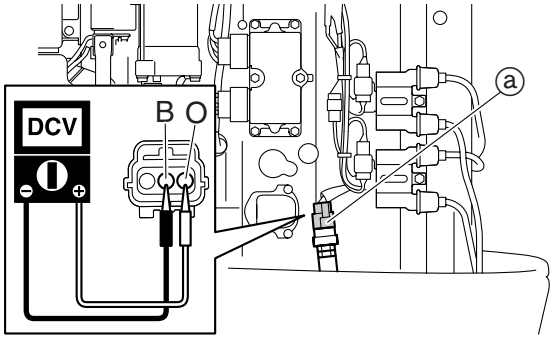
Wiring harness continuity:
Terminal 1–Terminal 10
Terminal 2–Terminal 8
Terminal 3–Terminal 11

8. Install the water pressure sensor, and then connect the water pressure sensor coupler ⓐ.

9. Connect the engine ECM coupler ⓑ, and then install the junction box cover.

Checking the speed sensor (option)

1. Disconnect the speed sensor coupler ⓐ.
2. Turn the engine start switch to "ON," and then measure the input voltage at the speed sensor coupler.

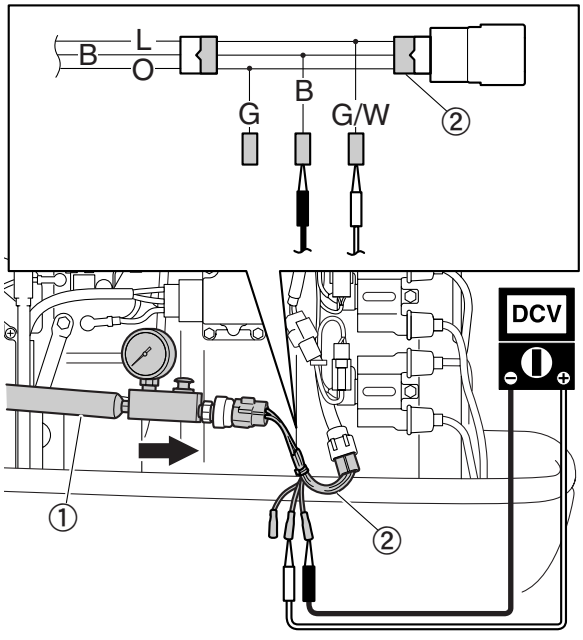


Speed sensor input voltage
(reference data):
Orange (O)–Black (B)
4.75–5.25 V

3. Remove the speed sensor, and then connect the pressure pump ① and test harness (3 pins) ②.

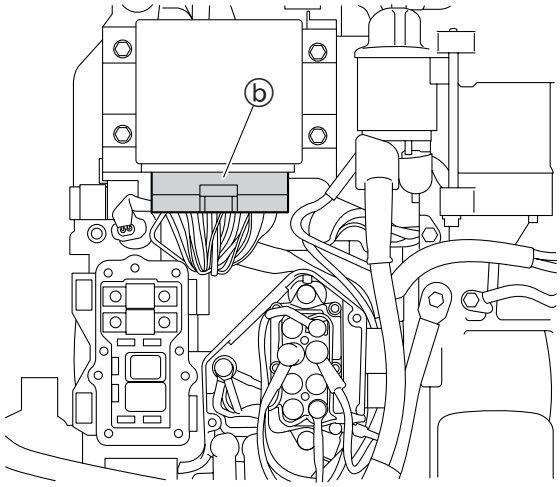
Pressure pump ①:
(commercially available)
Test harness (3 pins) ②: 90890-06869

4. Apply positive pressure to the speed sensor slowly, and then measure the output voltage.

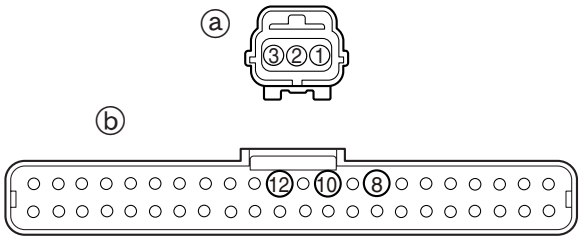


Speed sensor output voltage:
Blue (L)–Black (B)
2.5 V at 392.0 kPa
(3.92 kgf/cm², 56.8 psi)
4.5 V at 784.0 kPa
(7.84 kgf/cm², 113.7 psi)

5. Turn the engine start switch to "OFF," and then disconnect the test harness ② and pressure pump ①.
6. Remove the junction box cover, and then disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 10
Terminal 2–Terminal 8
Terminal 3–Terminal 12

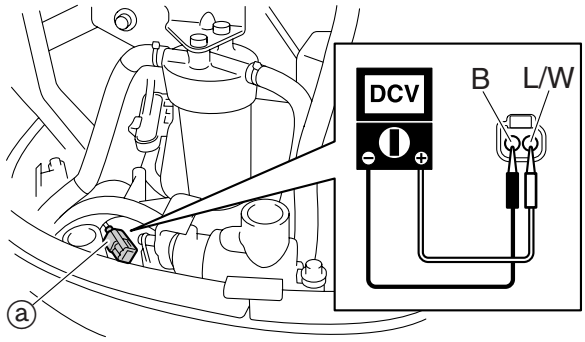
8. Install the speed sensor, and then connect the speed sensor coupler ⓐ.
9. Connect the engine ECM coupler ⓑ, and then install the junction box cover.

Fuel control units and components

Checking the water detection switch

1. Disconnect the water detection switch coupler ⓐ.

2. Turn the engine start switch to “ON,” and then measure the input voltage at the water detection switch coupler.



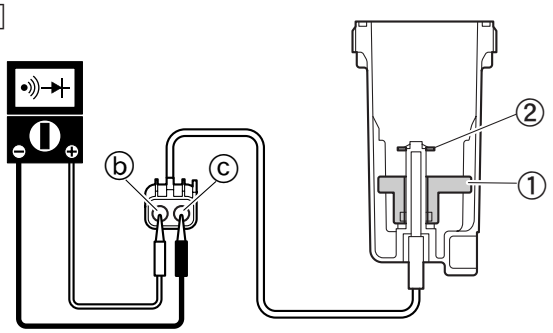
Water detection switch input voltage:
Blue/White (L/W)–Black (B)
4.75–5.25 V

3. Turn the engine start switch to “OFF,” and then remove the filter cup assembly.

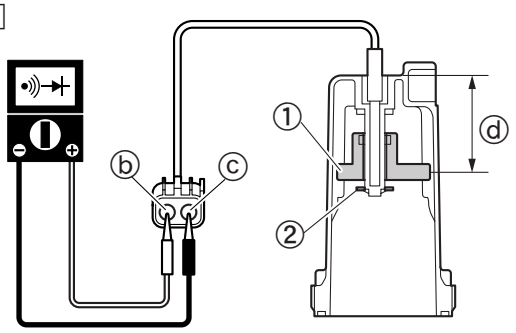
4. Before checking the water detection switch, make sure that the float ① is able to move smoothly.

5. Check the water detection switch for continuity with the float in positions [A] and [B].
NOTICE: **Make sure not to remove the clip ② and float ①.**

[A]



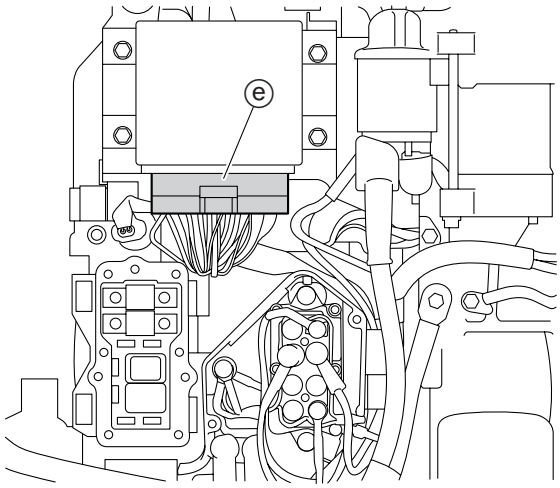
[B]



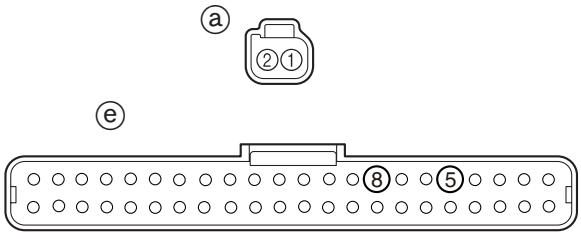
Float position	Terminal	
	ⓑ	ⓒ
[A]		
[B]	○——	——○

Float height ⓓ (reference data):
40.0 mm (1.57 in)

6. Remove the junction box cover, and then disconnect the engine ECM coupler ⓔ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 5
Terminal 2–Terminal 8

8. Connect the engine ECM coupler ⓔ, and then install junction box cover.

9. Install the filter cup assembly. See “Fuel filter” (6-13).

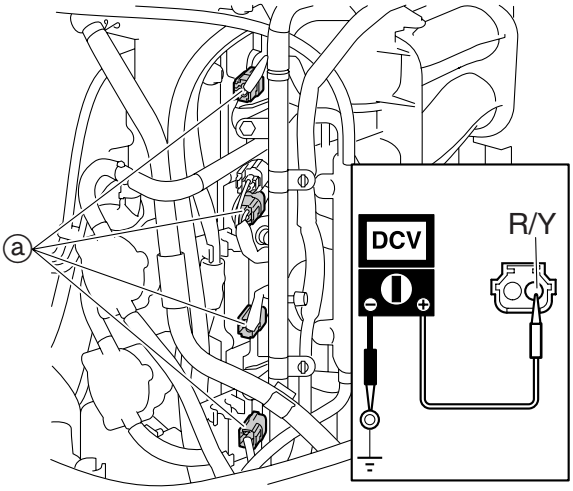
10. Connect the water detection switch coupler ⓐ.

Checking the fuel injector

1. Check the operation of the fuel injectors using the “Stationary test” of the YDIS and listen for the operating sound.

2. Disconnect the fuel injector couplers ⓐ.

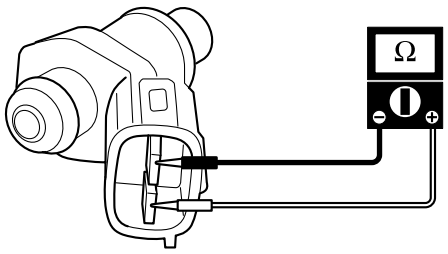
3. Turn the engine start switch to “ON,” and then measure the input voltage between the fuel injector coupler terminal and ground.



Fuel injector input voltage:
Red/Yellow (R/Y)–Ground
12.0 V (battery voltage)

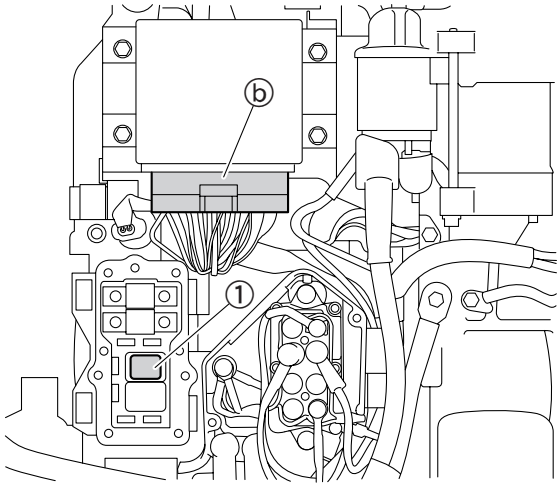
4. Turn the engine start switch to “OFF.”

5. Measure the fuel injector resistance.

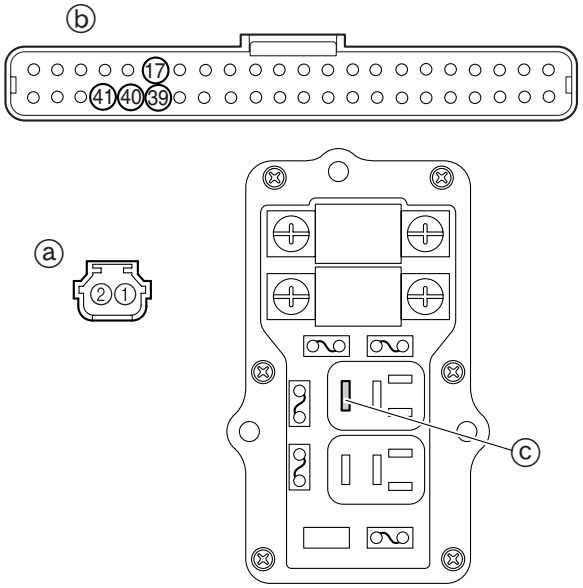


Fuel injector resistance (reference data):
14.0–15.0 Ω at 20 °C (68 °F)

6. Remove the junction box cover and the main relay ①, and then disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.



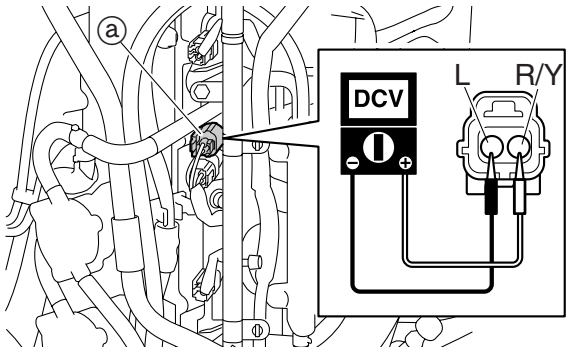
5

Wiring harness continuity:
Fuel injector #1
Terminal 1–Terminal ⓒ
Terminal 2–Terminal 40
Fuel injector #2
Terminal 1–Terminal ⓒ
Terminal 2–Terminal 39
Fuel injector #3
Terminal 1–Terminal ⓒ
Terminal 2–Terminal 41
Fuel injector #4
Terminal 1–Terminal ⓒ
Terminal 2–Terminal 17

8. Install the main relay ①.
9. Connect the engine ECM coupler ⓑ, and then install the junction box cover.
10. Connect the fuel injector couplers ⓐ.

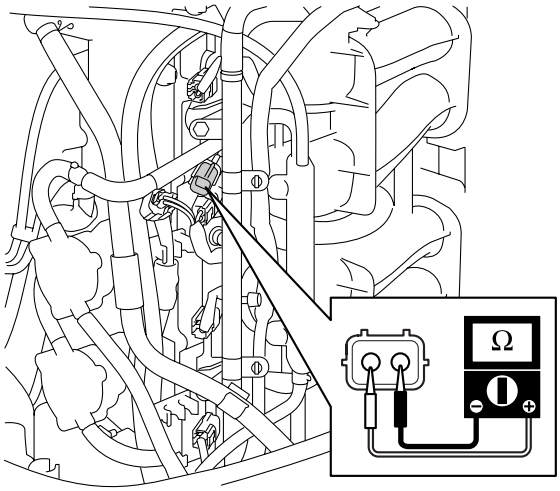
Checking the high-pressure fuel pump

1. Check the operation of the high-pressure fuel pump using the "Stationary test" of the YDIS and listen for the operating sound.
2. Disconnect the high-pressure fuel pump coupler ⓐ.
3. Connect the tester probes to the high-pressure fuel pump coupler terminals, and then measure the input voltage within 3 seconds after turning the engine start switch to "ON."



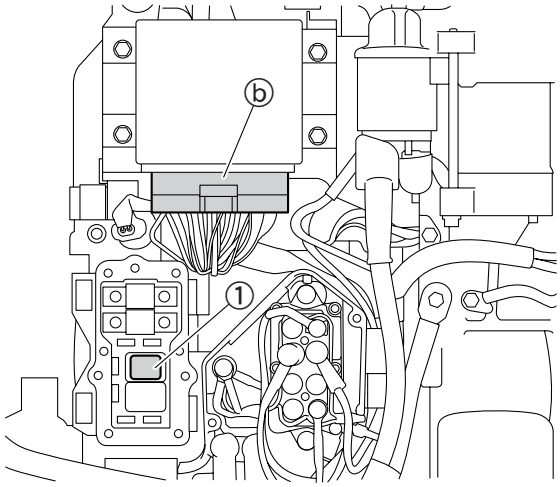
High-pressure fuel pump input voltage:
Red/Yellow (R/Y)–Blue (L)
12.0 V (battery voltage)

4. Turn the engine start switch to "OFF."
5. Measure the resistance of the high-pressure fuel pump motor.

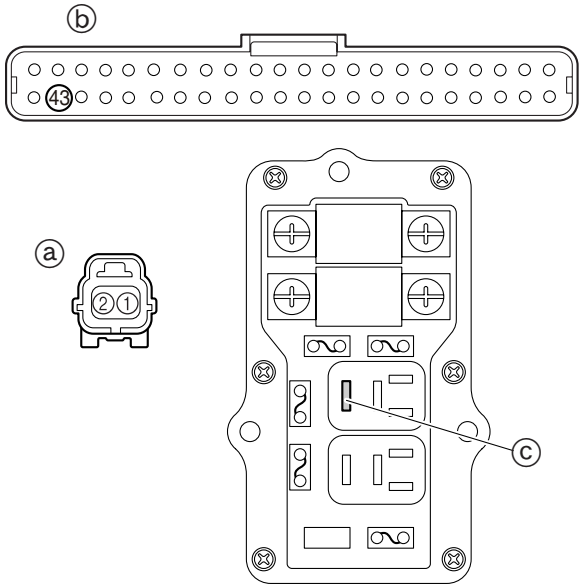


High-pressure fuel pump resistance (reference data):
0.5–10.0 Ω

6. Remove the junction box cover and the main relay ①, and then disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal ⓒ
Terminal 2–Terminal 43

8. Install the main relay ①.
9. Connect the engine ECM coupler ⓑ, and then install the junction box cover.
10. Connect the high-pressure fuel pump coupler ⓐ.

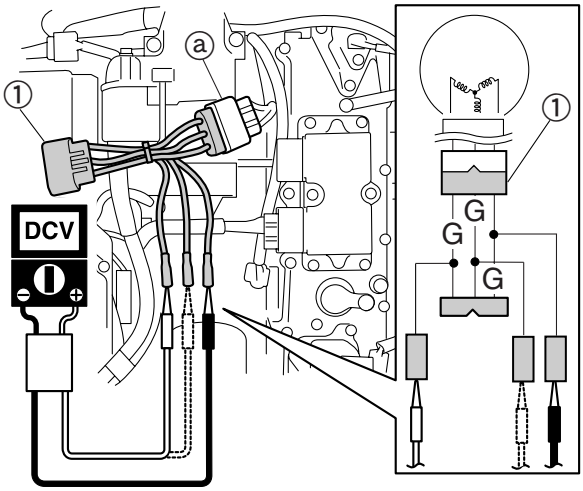
Charging units and components

Checking the lighting coil (stator assembly)

1. Disconnect the lighting coil coupler ⓐ, and then connect the test harness (3 pins) ①.

Test harness (3 pins) ①:
90890-06847

2. Measure the lighting coil output peak voltage between all combinations of the terminals. Replace the lighting coil if below specification.



Lighting coil output peak voltage: Green (G)–Green (G)			
r/min	Unloaded		
	Cranking	1500	3500
DC V	11.0	50.0	110.0

3. Measure the lighting coil resistance.

Lighting coil resistance (reference data):
0.2–0.3 Ω at 20 °C (68 °F)

4. Disconnect the test harness ①, and then connect the lighting coil coupler ⓐ.

5

Checking the Rectifier Regulator

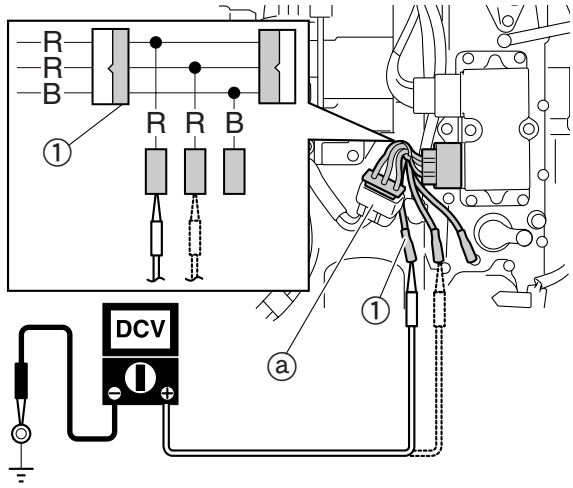
NOTICE

If the battery cables are connected in reverse, the Rectifier Regulator can be damaged.

1. Disconnect the Rectifier Regulator coupler ⓐ, and then connect the test harness (3 pins) ①.

Test harness (3 pins) ①: 90890-06846

2. Measure the Rectifier Regulator output peak voltage.



TIP:

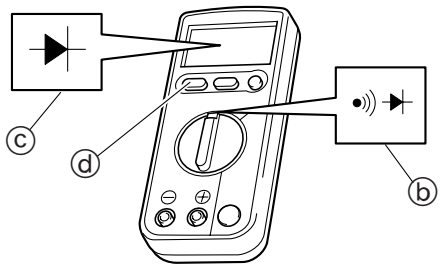
Do not use peak voltage adapter B when measuring the Rectifier Regulator output peak voltage.

Rectifier Regulator output peak voltage: Red (R)–Ground		
r/min	Loaded	
	1500	3500
DC V	13.0	13.0

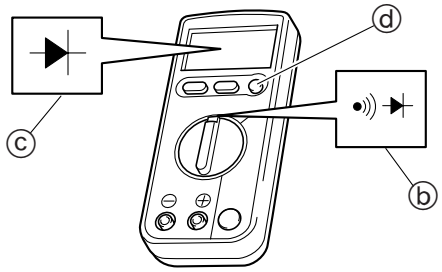
3. Disconnect the test harness ① and lighting coil coupler.

4. Make sure to set the measurement range ⓑ, and display the mark ⓒ by pushing the switch ⓓ.

A

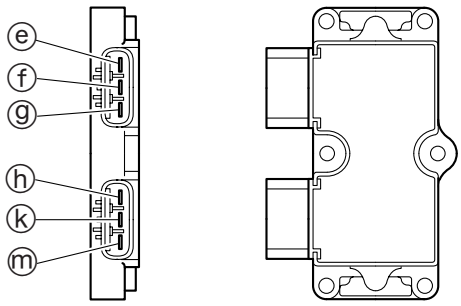


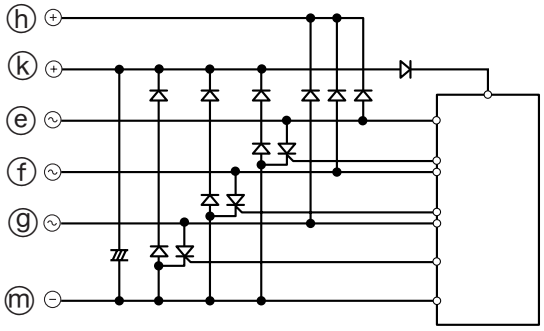
B



A Tester model CD721
B Tester model CD731a

5. Check the Rectifier Regulator for continuity. Replace if out of specification.





Rectifier Regulator continuity (testing diode mode):		
Tester probe		Display value (reference data)
⊕	⊖	
ⓔ	ⓗ	0.468
ⓔ	ⓚ	0.464
ⓕ	ⓗ	0.468
ⓕ	ⓚ	0.469
ⓖ	ⓗ	0.465
ⓖ	ⓚ	0.471
ⓗ	ⓔ	OL
ⓗ	ⓕ	OL
ⓗ	ⓖ	OL
ⓚ	ⓔ	OL
ⓚ	ⓕ	OL
ⓚ	ⓖ	OL
ⓗ	ⓜ	OL
ⓚ	ⓜ	OL
ⓔ	ⓜ	OL
ⓕ	ⓜ	OL
ⓖ	ⓜ	OL
ⓜ	ⓗ	0.815
ⓜ	ⓚ	0.816
ⓜ	ⓔ	0.464
ⓜ	ⓕ	0.472
ⓜ	ⓖ	0.460

OL: Indicates on overload

6. Connect the Rectifier Regulator coupler ⓐ and lighting coil coupler.

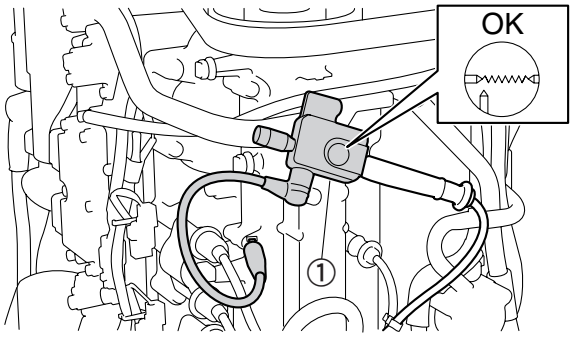
Ignition units and components

Checking the ignition spark

1. Remove the spark plug wire cover.
2. Disconnect the spark plug caps from the spark plugs.
3. Connect a spark plug cap to the special service tool ①.

Ignition tester ①: 90890-06754

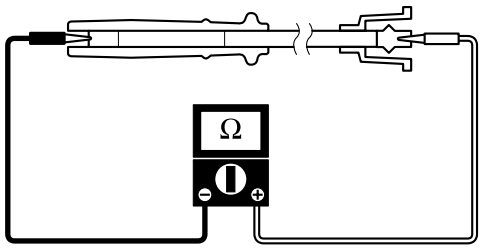
4. Check the ignition spark using the “Stationary test” of the YDIS. **WARNIG! Do not touch any of the connections of the special service tool.**



5. Remove the special service tool ①, and then connect the spark plug caps.
6. Install the spark plug wire cover.

Checking the spark plug wire

1. Remove the spark plug wire cover.
2. Disconnect the spark plug wires.
3. Measure the spark plug wire resistance. Replace if out of specification.



5

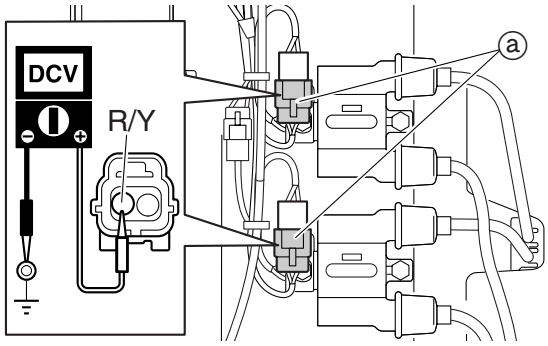
Spark plug wire resistance:
#1: 4.6–10.9 kΩ
#2: 3.3–8.0 kΩ
#3: 3.8–9.3 kΩ
#4: 4.2–10.0 kΩ
at 20 °C (68 °F)

4. Connect the spark plug wires, and then install the spark plug wire cover.

Checking the ignition coil

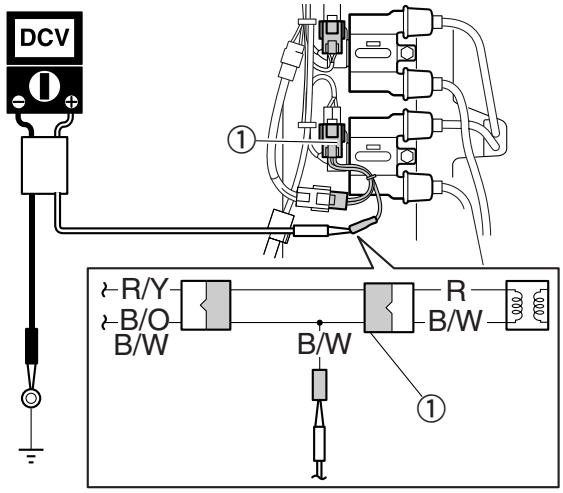
1. Disconnect the ignition coil couplers ⓐ.

2. Measure the input voltage at the ignition coil coupler terminal and ground.



Ignition coil input voltage:
Red/Yellow (R/Y)–Ground
12.0 V (battery voltage)

3. Connect the test harness (2 pins) ①, and then measure the ignition coil output peak voltage.



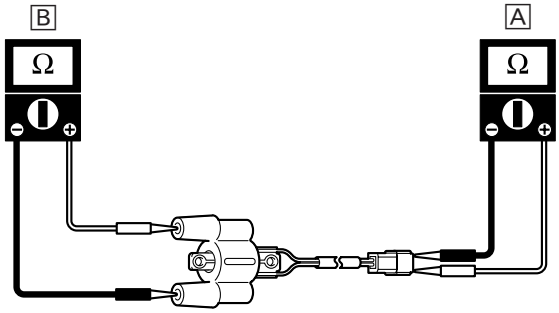
Test harness (2 pins) ①: 90890-06792

Ignition coil output peak voltage:
#1, 4
Black/Orange (B/O)–Ground
#2, 3
Black/White (B/W)–Ground

r/min	Loaded		
	Cranking	1500	3500
DC V	210.0	260.0	270.0

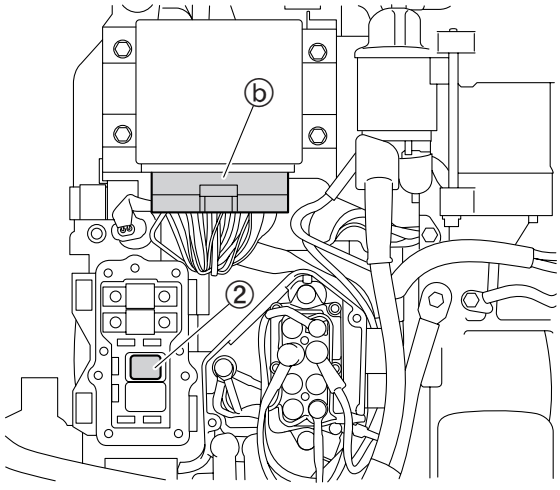
4. Disconnect the test harness ① and spark plug wires from the ignition coils.

5. Measure the ignition coil resistance. Replace if out of specification.

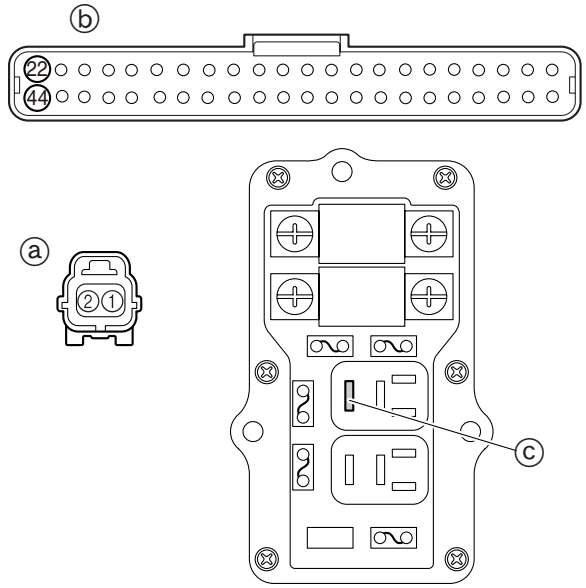


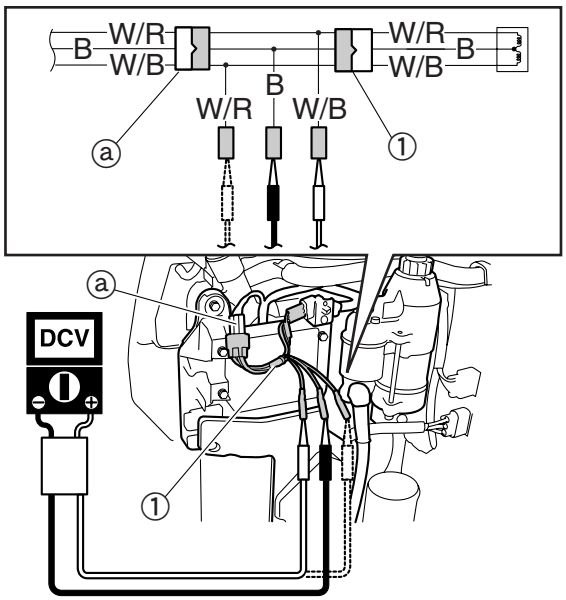
Ignition coil resistance:
A Primary coil:
1.6–2.0 Ω at 20 °C (68 °F)
B Secondary coil:
12.50–16.91 kΩ at 20 °C (68 °F)

6. Remove the junction box cover and main relay ②, and then disconnect the engine ECM coupler ⓑ.



7. Check the wiring harness for continuity.





Wiring harness continuity:
Ignition coil #1, 4
Terminal 1–Terminal 22
Terminal 2–Terminal ⓒ
Ignition coil #2, 3
Terminal 1–Terminal 44
Terminal 2–Terminal ⓒ

8. Install the main relay ②.
9. Connect the engine ECM coupler ⓑ, and then install the junction box cover.
10. Connect the spark plug wires and ignition coil couplers ⓐ.

Checking the pulser coil

1. Disconnect the pulser coil coupler ⓐ, and then connect the test harness (3 pins) ①.

Test harness (3 pins) ①: 90890-06791

2. Measure the pulser coil output peak voltage. Replace the pulser coil if below specification.

Pulser coil output peak voltage: White/Red (W/R)–Black (B) White/Black (W/B)–Black (B)				
r/min	Unloaded	Loaded		
	Cranking		1500	3500
DC V	3.5	3.0	21.0	39.0

TIP:

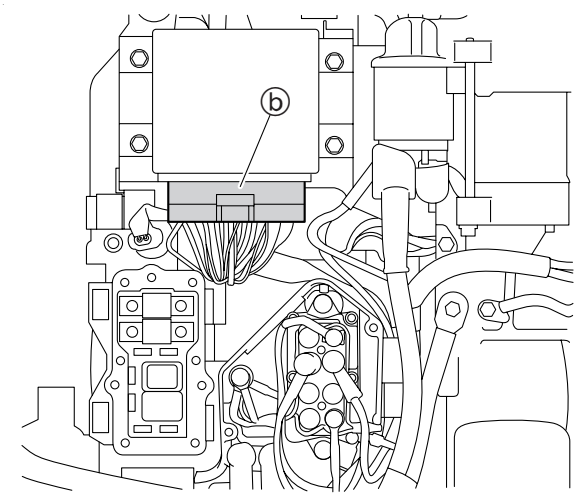
- When measuring the pulser coil output peak voltage under the unloaded cranking condition is done, disconnect the coupler ⓐ.
- When measuring the pulser coil output peak voltage under the loaded cranking condition is done, remove the clip from the engine shut-off switch to prevent the engine from starting.

3. Disconnect the test harness ①, and then measure the pulser coil resistance.

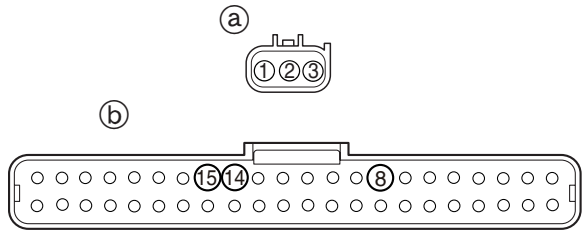
Pulser coil resistance (reference data): 459.0–561.0 Ω at 20 °C (68 °F)

5

4. Remove the junction box cover, and then disconnect the engine ECM coupler ⓑ.



5. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 14 Terminal 2–Terminal 8 Terminal 3–Terminal 15

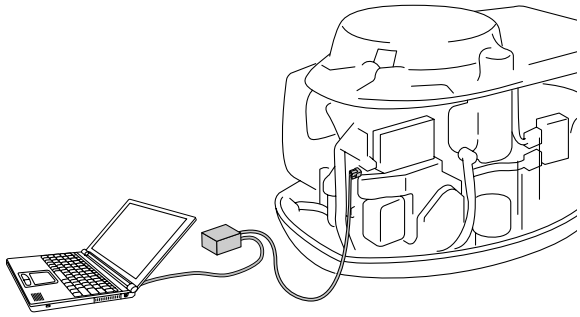
6. Connect the engine ECM coupler ⓑ, and then install junction box cover.

7. Connect the pulser coil coupler ⓐ.

Checking the air temperature sensor

1. Measure the ambient temperature.

2. Connect the YDIS to display “Intake temperature” (air temperature).

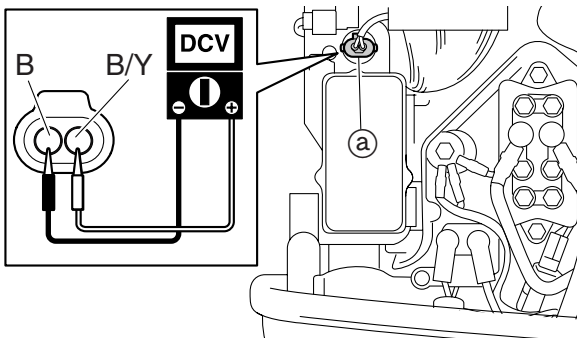


3. Check that the difference between the ambient temperature and the displayed intake temperature is within ± 5 °C (±9 °F).

TIP:
- Check the air temperature sensor when the engine is cold.
- When checking the air temperature sensor, remove the top cowling and do not start the engine.

4. Disconnect the air temperature sensor coupler ⓐ.

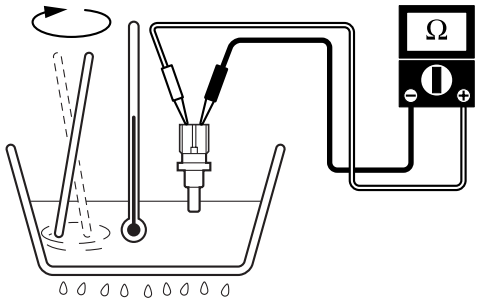
5. Turn the engine start switch to “ON,” and then measure the input voltage at the air temperature sensor coupler.



Air temperature sensor input voltage:
Black/Yellow (B/Y)–Black (B) 4.75–5.25 V

6. Turn the engine start switch to “OFF,” and then remove the air temperature sensor.

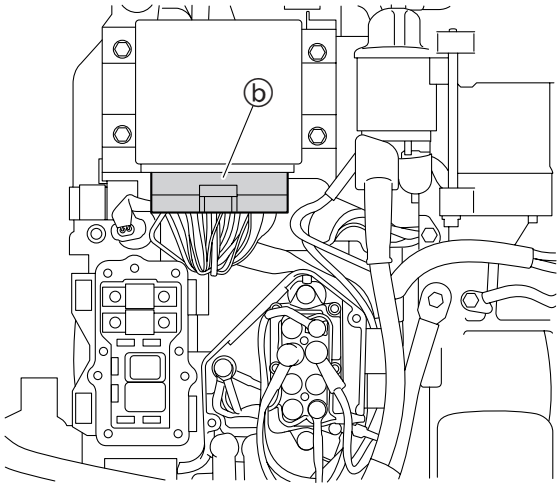
7. Place the air temperature sensor in a container of water and slowly heat the water.



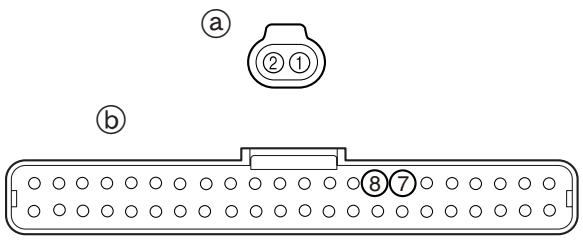
8. Measure the air temperature sensor resistance.

Air temperature sensor resistance (reference data):
2.21–2.69 kΩ at 20 °C (68 °F)
0.32 kΩ at 80 °C (176 °F)

9. Remove the junction box cover, and then disconnect the engine ECM coupler ⓑ.



10. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 7
Terminal 2–Terminal 8

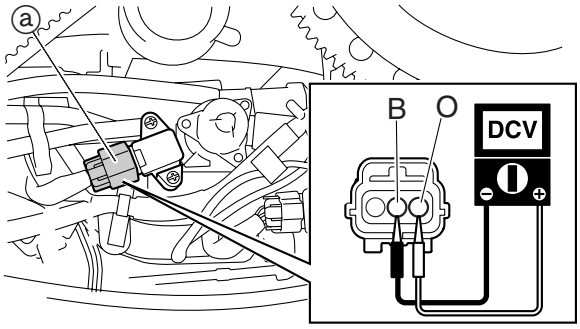
11. Connect the engine ECM coupler ⓑ, and then install the junction box cover.

12. Install the air temperature sensor, and then connect the air temperature sensor coupler ⓐ.

Checking the air pressure sensor

1. Disconnect the air pressure sensor coupler ⓐ.

2. Turn the engine start switch to “ON,” and then measure the input voltage at the air pressure sensor coupler.



Air pressure sensor input voltage:
Orange (O)–Black (B)
4.75–5.25 V

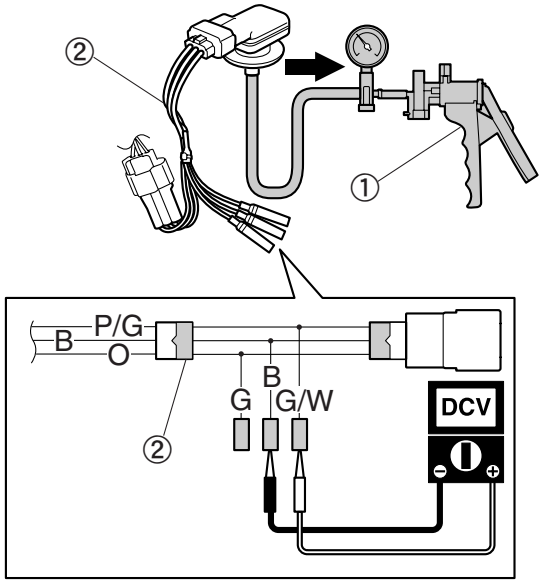
3. Remove the air pressure sensor.

5

4. Connect the special service tool ① and test harness (3 pins) ②.

Vacuum/pressure pump gauge set ①: 90890-06756 Test harness (3 pins) ②: 90890-06869

5. Apply negative pressure to the air pressure sensor slowly, and then measure the output voltage.

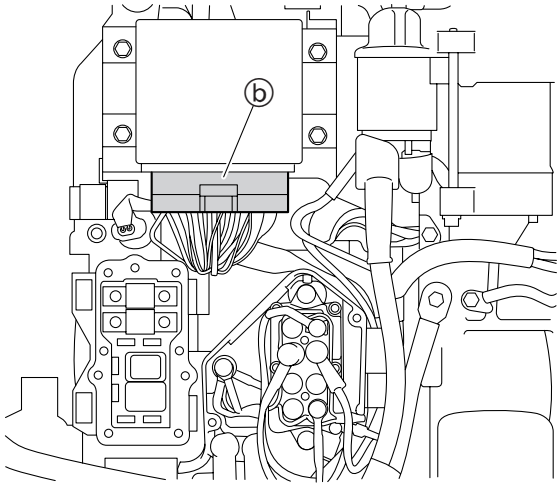


Air pressure sensor output voltage: Pink/Green (P/G)–Black (B) 3.21 V at –20.0 kPa (–0.20 kgf/cm², –2.9 psi) 2.16 V at –46.7 kPa (–0.467 kgf/cm², –6.8 psi)

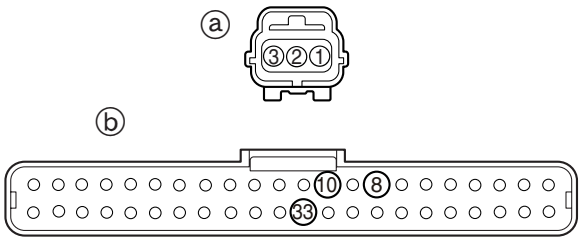
TIP:
When checking the air pressure sensor, do not start the engine.

6. Turn the engine start switch to "OFF," and disconnect the special service tool ① and test harness ②.

7. Remove the junction box cover, and then disconnect the engine ECM coupler ⓑ.



8. Check the wiring harness for continuity.



Wiring harness continuity: Terminal 1–Terminal 10 Terminal 2–Terminal 8 Terminal 3–Terminal 33

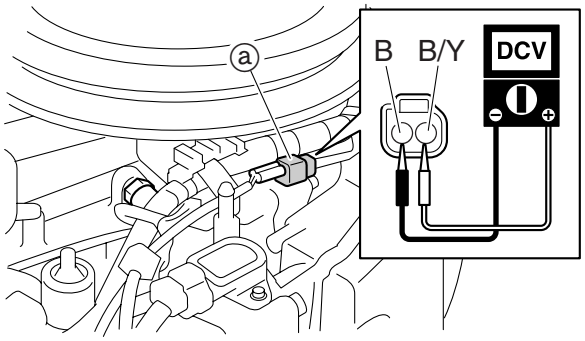
9. Connect the engine ECM coupler ⓑ, and then install the junction box cover.

10. Connect the air pressure sensor coupler ⓐ.

Checking the engine temperature sensor

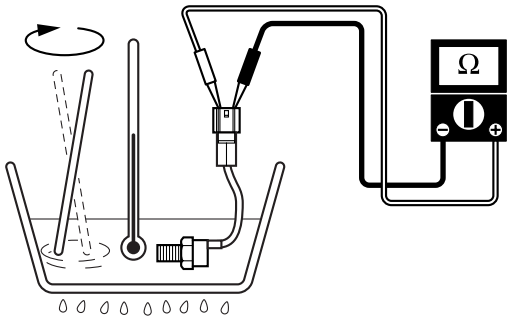
1. Disconnect the engine temperature sensor coupler ⓐ.

2. Turn the engine start switch to "ON," and then measure the input voltage at the engine temperature sensor coupler.



Engine temperature sensor input voltage:
Black/Yellow (B/Y)–Black (B)
4.75–5.25 V

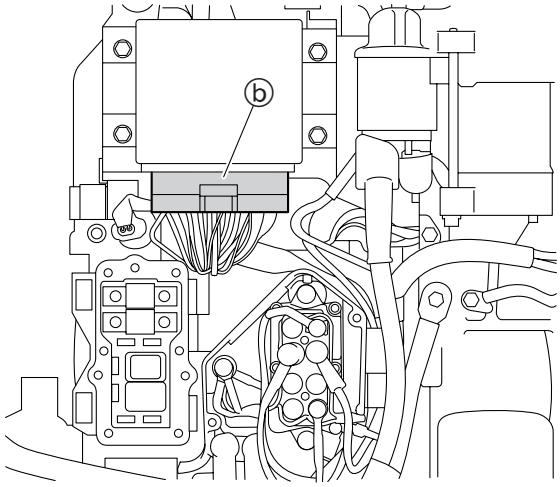
3. Turn the engine start switch to "OFF."
4. Remove the engine temperature sensor.
5. Place the engine temperature sensor in a container of water and slowly heat the water.



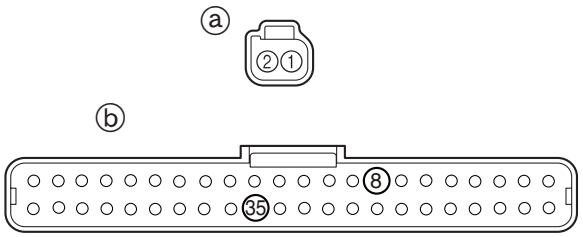
6. Measure the engine temperature sensor resistance. Replace if out of specification.

Engine temperature sensor resistance (reference data):
54.2–69.0 kΩ at 20 °C (68 °F)
3.12–3.48 kΩ at 98 °C (208 °F)

7. Install the engine temperature sensor.
8. Remove the junction box cover, and then disconnect the engine ECM coupler ⓑ.



9. Check the wiring harness for continuity.



Wiring harness continuity:
Terminal 1–Terminal 35
Terminal 2–Terminal 8

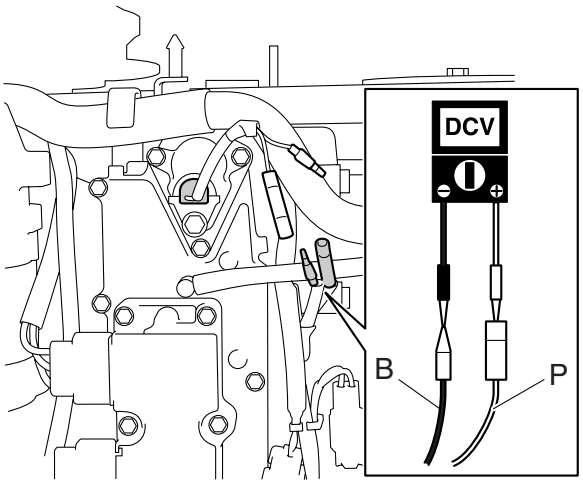
10. Connect the engine ECM coupler ⓑ, and then install the junction box cover.
11. Connect the engine temperature sensor coupler ⓐ.

Checking the thermoswitch

1. Disconnect the thermoswitch connectors.

5

2. Turn the engine start switch to “ON,” and then measure the input voltage at the thermoswitch connectors.

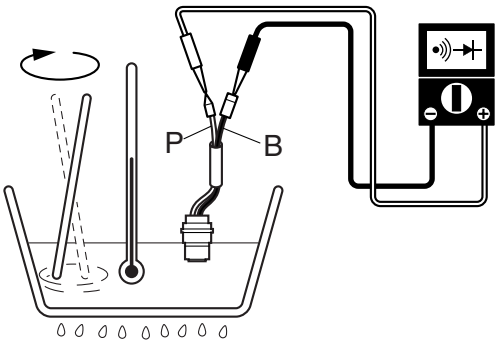


Thermoswitch input voltage:
(reference data)
Pink (P)–Black (B)
11.1V

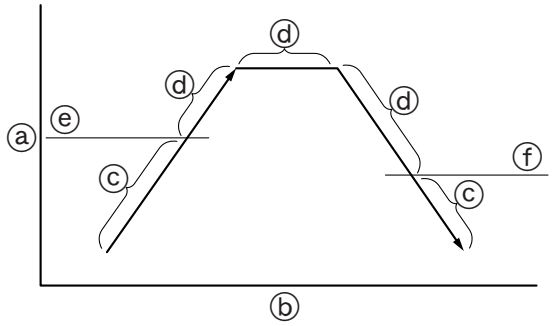
3. Turn the engine start switch to “OFF.”

4. Remove the thermoswitch.

5. Place the thermoswitch in a container of water and slowly heat the water.



6. Check the switch for continuity at the specified temperatures. Replace if out of specification.

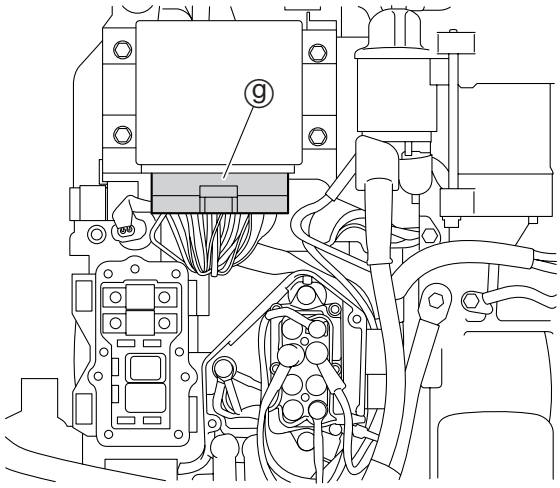


ⓐ Temperature
ⓑ Time
ⓒ No continuity
ⓓ Continuity

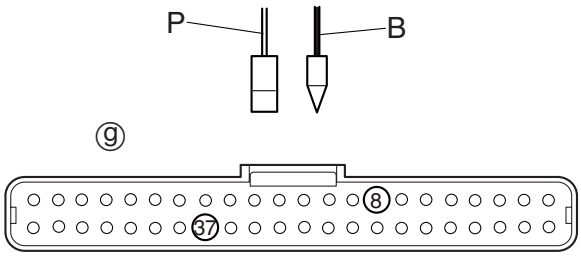
Thermoswitch continuity temperature:
ⓔ: 84–90 °C (183–194 °F)
ⓕ: 68–82 °C (154–180 °F)

7. Install the thermoswitch.

8. Remove the junction box cover, and then disconnect the engine ECM coupler ⓖ.



9. Check the wiring harness for continuity.



Wiring harness continuity:
Pink (P)–Terminal 37 Black (B)–Terminal 8

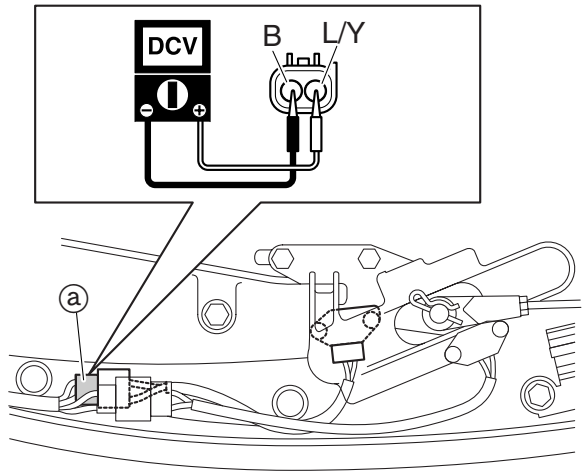
10. Connect the engine ECM coupler ⓖ, and then install the junction box cover.

11. Connect the thermoswitch connectors.

Checking the shift cut switch

1. Disconnect the shift cut switch coupler ⓐ.

2. Turn the engine start switch to “ON,” and then measure the input voltage.

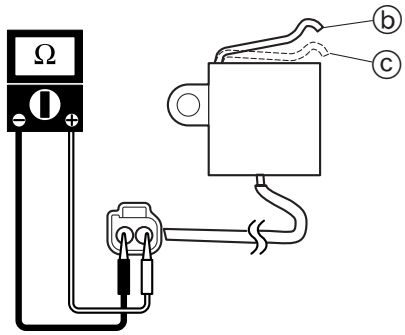


Shift cut switch input voltage:
Blue/Yellow (L/Y)–Black (B) 4.75–5.25 V

3. Turn the engine start switch to “OFF.”

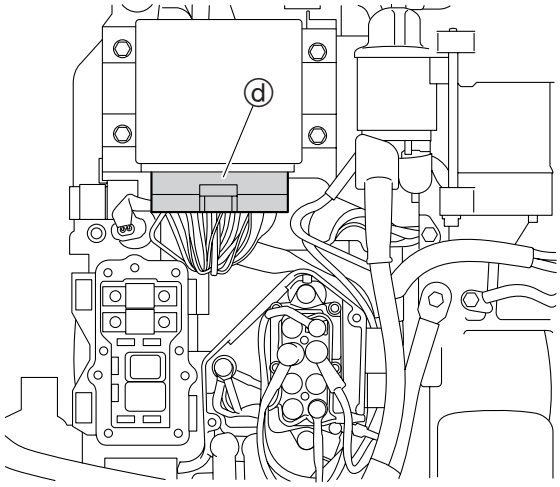
4. Remove the shift cut switch.

5. Measure the shift cut switch resistance.

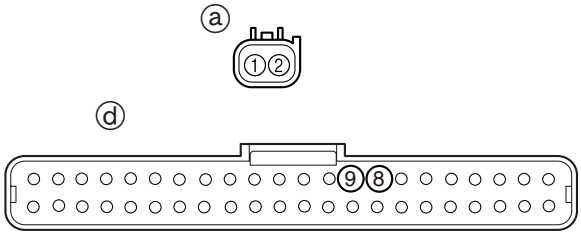


Shift cut switch resistance:
4.465–4.935 kΩ at ⓑ position 0 Ω at ⓒ position at 20 °C (68 °F)

6. Remove the junction box cover, and then disconnect the engine ECM coupler ⓓ.



7. Check the wiring harness for continuity.



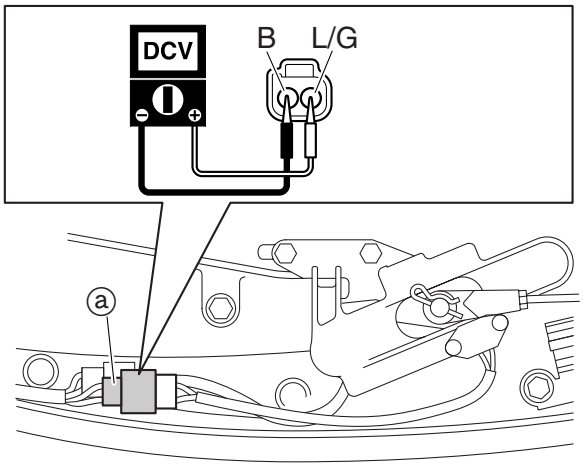
Wiring harness continuity:
Terminal 1–Terminal 8 Terminal 2–Terminal 9

8. Connect the engine ECM coupler ⓓ, and then install the junction box cover.

9. Install the shift cut switch, and then connect the shift cut switch coupler ⓐ.

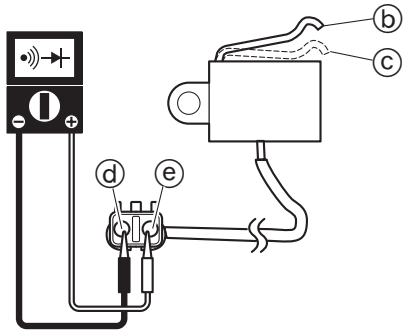
Checking the neutral switch

1. Disconnect the neutral switch coupler ⓐ.
2. Turn the engine start switch to “ON,” and then measure the input voltage.



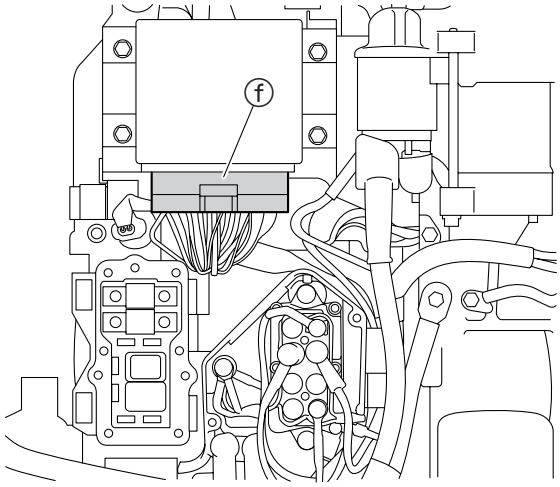
Neutral switch input voltage:
Blue/Green (L/G)–Black (B)
4.75–5.25 V

3. Turn the engine start switch to “OFF.”
4. Remove the neutral switch.
5. Check the neutral switch continuity.

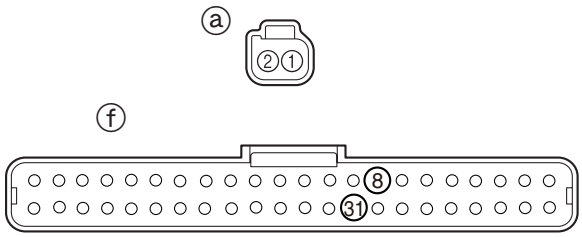


Neutral switch continuity:		
Position	Terminal	
	ⓓ	ⓔ
ⓑ		
ⓒ	O	O

6. Remove the junction box cover, and then disconnect the engine ECM coupler ⓕ.



7. Check the wiring harness for continuity.

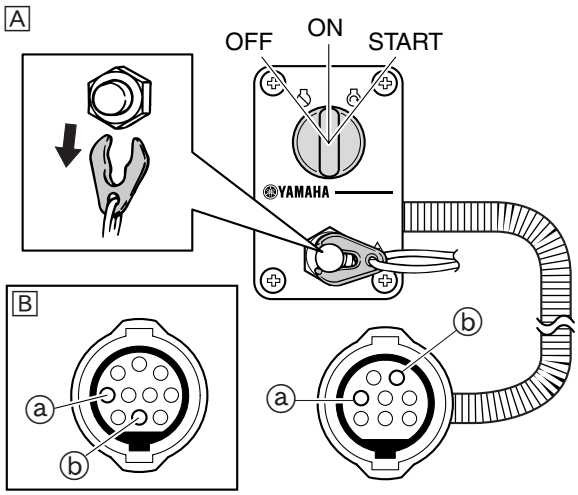


Wiring harness continuity:
Terminal 1–Terminal 31
Terminal 2–Terminal 8

8. Connect the engine ECM coupler ⓕ, and then install the junction box cover.
9. Install the neutral switch, and then connect the neutral switch coupler ⓐ.

Checking the engine shut-off switch

1. Disconnect the engine start switch coupler.
2. Turn the engine start switch to “ON,” and then check the engine shut-off switch for continuity at the engine start switch coupler. Check the wiring harness or replace the engine shut-off switch if out of specification.



A 704 remote control
B 703 remote control

Switch position	Terminal	
	ⓐ	ⓑ
Clip removed	O	O
Clip installed		

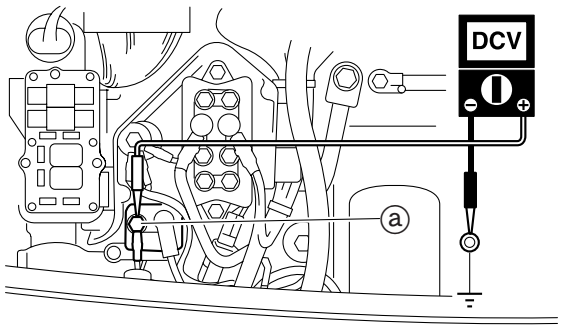
3. Connect the engine start switch coupler.

Starting units and components

Checking the starter relay

1. Remove the junction box cover.

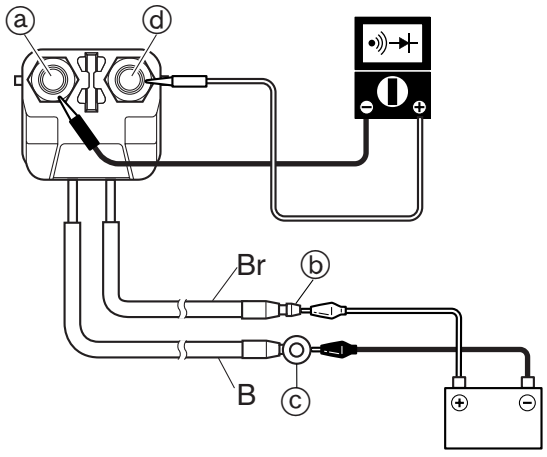
2. Measure the input voltage between the starter relay terminal ⓐ and ground.



Terminal ⓐ–Ground:
12.0 V (battery voltage)

3. Disconnect the starter relay lead, and then remove the starter relay.
NOTICE: **Always disconnect the negative battery terminal before disconnecting the starter relay terminals.**

4. Connect the positive battery lead to the relay connector ⓑ, and the negative battery lead to the relay lead ⓒ, and then check for continuity between terminals ⓐ and ⓓ. Replace the starter relay if out of specification.



5

Battery lead	Terminal	
	ⓐ	ⓓ
Connect	○———	———○
Disconnect		

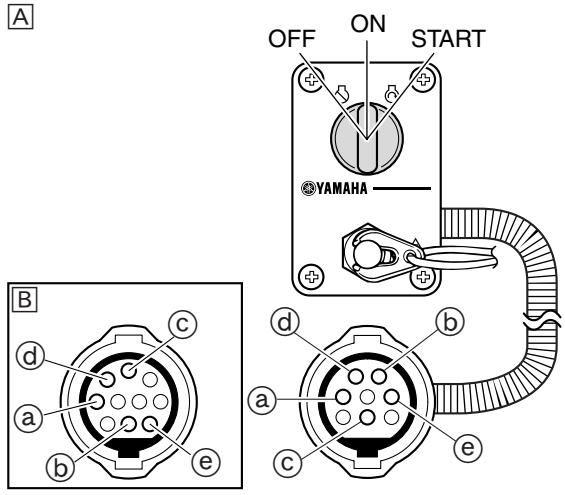
5. Install the starter relay, and then connect the starter relay leads.

6. Install the junction box cover.

Checking the engine start switch

1. Disconnect the engine start switch coupler.

2. Check the engine start switch for continuity at the engine start switch coupler. Replace the engine start switch if out of specification.



A 704 remote control
B 703 remote control

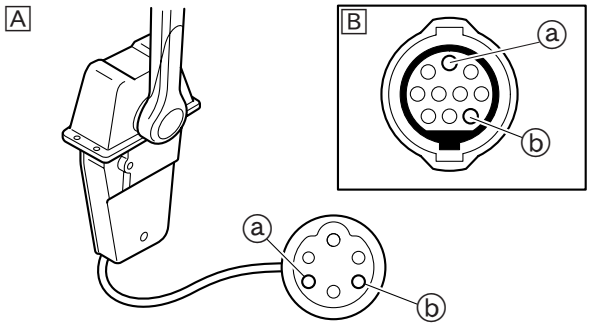
Switch position	Terminal				
	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
OFF	○———	———○			
ON			○———	———○	
START			○———	———○	———○

3. Connect the engine start switch coupler.

Checking the neutral switch (remote control)

1. Disconnect the remote control coupler.

2. Check the neutral switch for continuity.



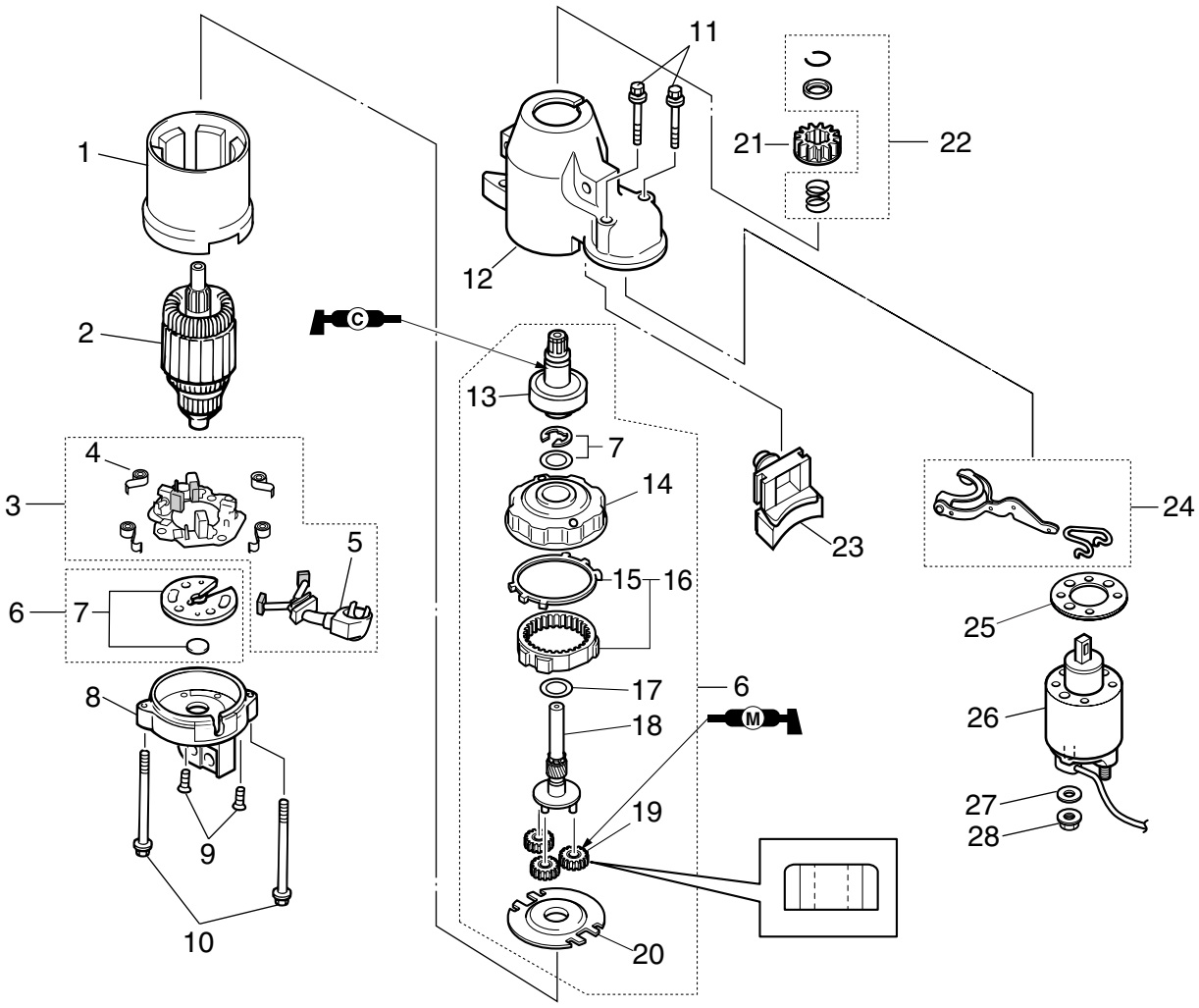
A 704 remote control
B 703 remote control

Lever position	Terminal	
	ⓐ	ⓑ
F		
N	○———	———○
R		

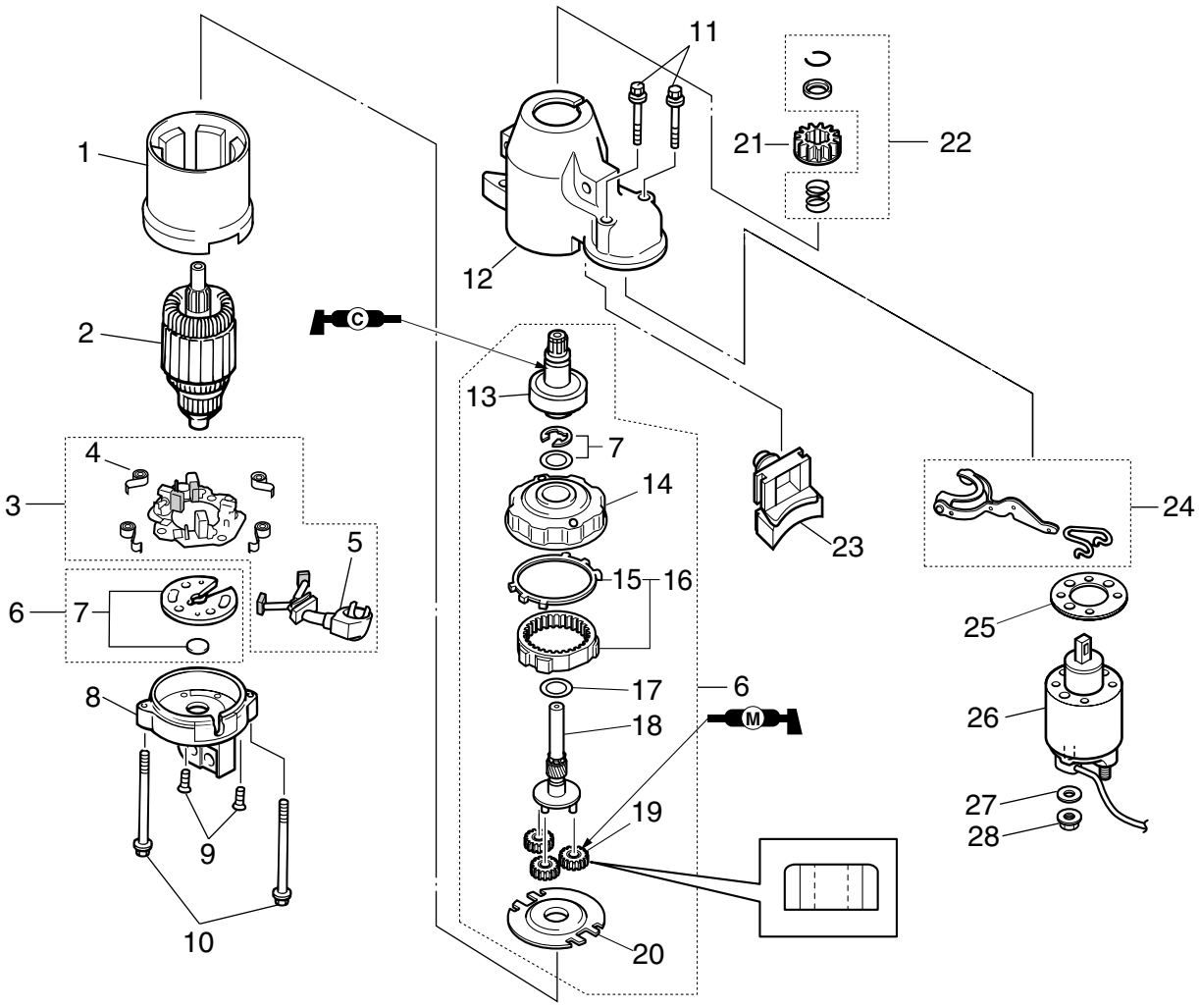
TIP:
Turn the engine start switch to “START” position when checking the continuity on the 703 remote control.

3. Connect the remote control coupler.

Starter motor



No.	Part name	Q'ty	Remarks
1	Stator	1	
2	Armature	1	
3	Brush holder assembly	1	
4	Brush spring	4	
5	Brush assembly	1	
6	Starting motor gear assembly	1	
7	Washer set	1	
8	Bracket	1	
9	Screw	2	M4 × 15 mm
10	Bolt	2	M6 × 117 mm
11	Bolt	2	M6 × 35 mm
12	Cover assembly	1	
13	Clutch assembly	1	
14	Bracket	1	
15	Gasket	1	**Not reusable**
16	Outer gear	1	
17	Washer	1	



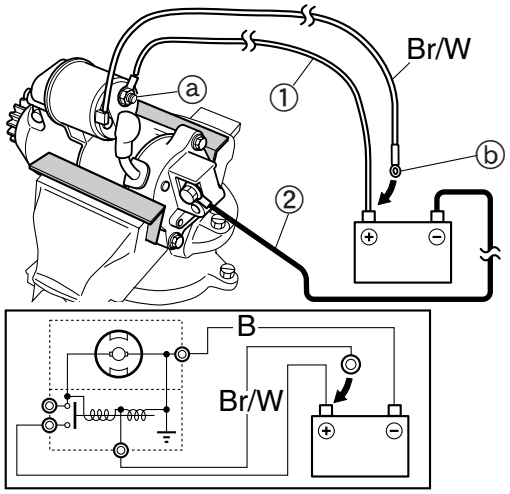
No.	Part name	Q'ty	Remarks
18	Pinion shaft	1	
19	Planetary gear	3	
20	Plate	1	
21	Starter motor pinion	1	
22	Pinion stopper set	1	
23	Rubber seal	1	
24	Lever assembly	1	
25	Gasket	1	**Not reusable**
26	Magnet switch	1	
27	Washer	1	
28	Nut	1	

Removing the starter motor

1. Remove the junction box cover.
2. Remove the starter motor from the power unit.

Checking the starter motor operation

1. Hold the starter motor in a vise using aluminum plates on both sides.
2. Connect the positive battery cable ① to the magnet switch terminal ⓐ, and connect the negative battery cable ② to the starter motor body.
3. Connect the starter motor lead (Brown/White) ⓑ to the positive battery terminal, and then check the starter motor operation. **WARNING! Do not touch the starter motor pinion.**

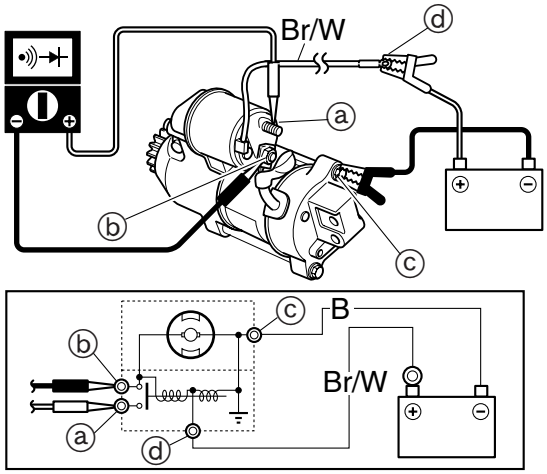


TIP:
- Check the starter motor operation for a few seconds.
- If the starter motor is disassembled for maintenance, make sure to check the operation again after assembling it.

4. Disconnect the negative battery cable and positive battery cable from the battery terminals.

Checking the magnet switch

1. Connect the tester probes to the magnet switch terminals ⓐ and ⓑ.
2. Connect the negative battery cable to the starter motor body ⓒ.
3. Connect the positive battery cable to the starter motor lead (Brown/White) ⓓ, and then check the magnet switch continuity. ***NOTICE:*** **Do not connect the starter motor lead (Brown/White) to the battery for more than 1 second.**



4. Check that there is continuity between the magnet switch terminals ⓐ and ⓑ. Replace the magnet switch if out of specification.

Battery lead	Magnet switch terminal	
	ⓐ	ⓑ
Connect	○	○
Disconnect		

TIP:
The starter motor pinion should be pushed out while the magnet switch is “ON.”

Checking the starter motor pinion

⚠ WARNING

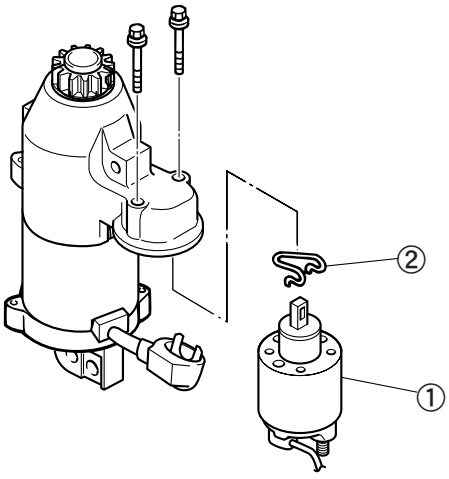
Make sure to disconnect the battery cables before checking the starter motor pinion.

1. Check the pinion teeth. Replace the pinion if cracked or worn.

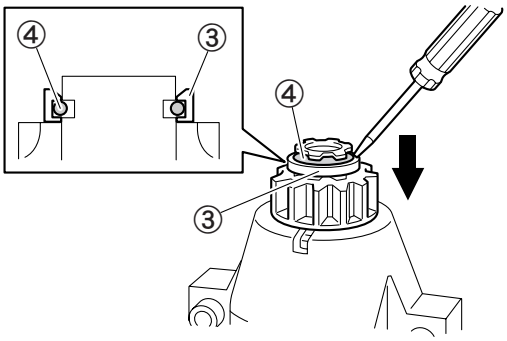
2. Check for smooth operation. Turn the pinion counterclockwise to check that it operates smoothly and turn it clockwise to check that it locks in place.

Disassembling the starter motor

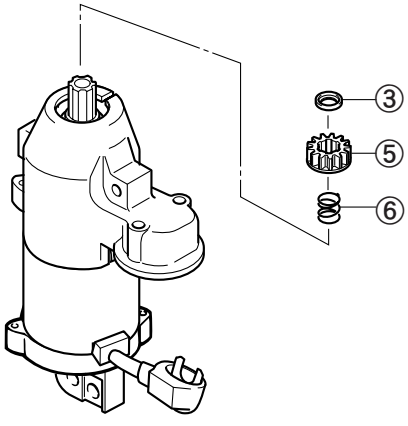
1. Remove the magnet switch ① and spring ②.



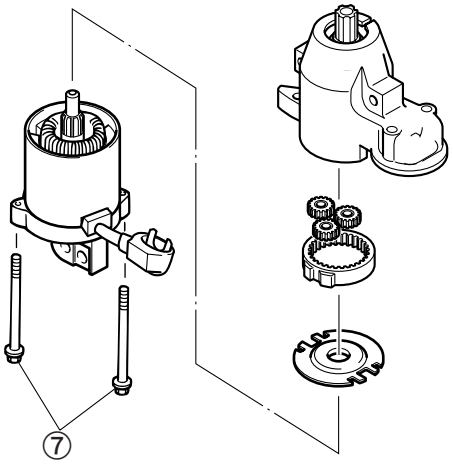
2. Slide the pinion stopper ③ down, and then remove the clip ④.



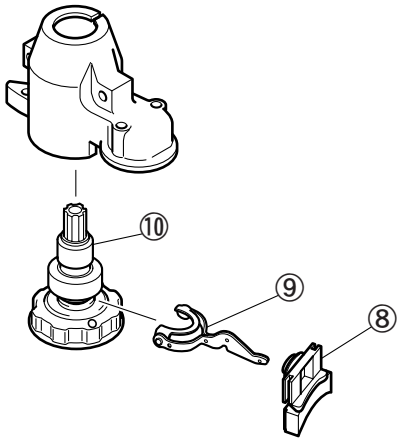
3. Remove the pinion stopper ③, pinion ⑤, and spring ⑥.



4. Remove the bolts ⑦, and then disassemble the starter motor.

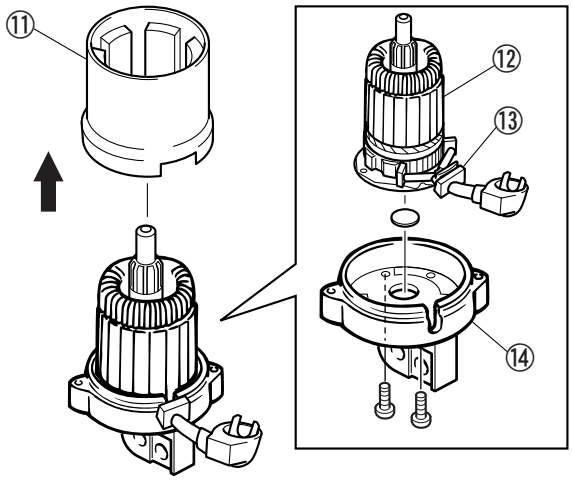


5. Remove the rubber seal ⑧, lever ⑨, and pinion shaft assembly ⑩.

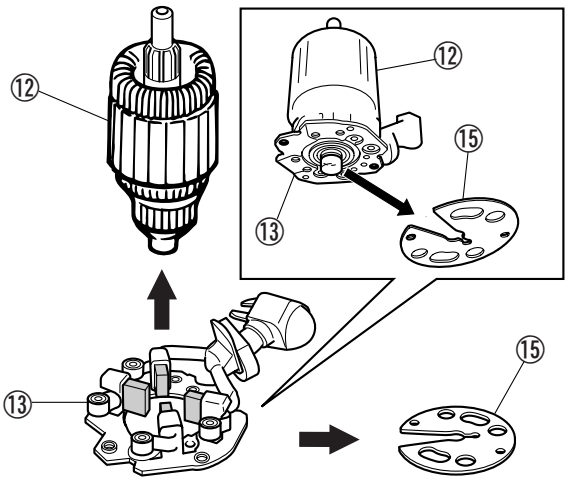


6. Remove the stator ⑪.

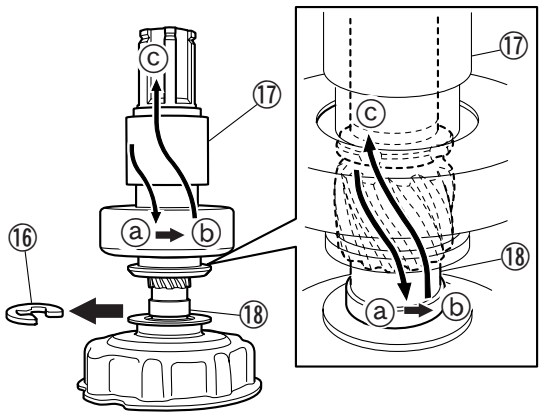
7. Remove the armature ⑫ with the brush holder assembly ⑬ from the bracket ⑭.

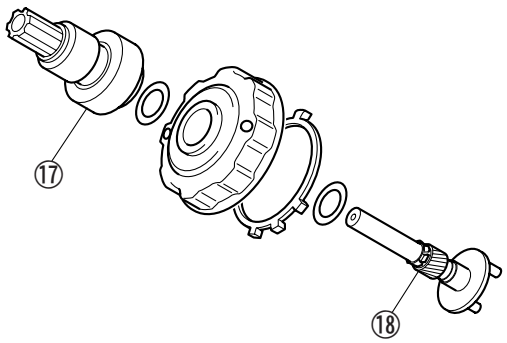


8. Remove the plate ⑮, and then remove the armature ⑫ from the brush holder assembly ⑬.



9. Remove the E-clip ⑯, and then remove the clutch assembly ⑰ from the pinion shaft ⑱.



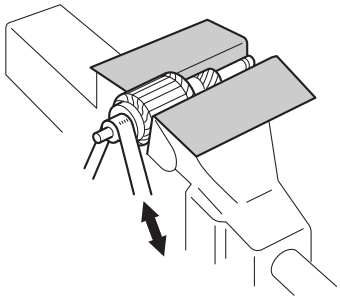


TIP:

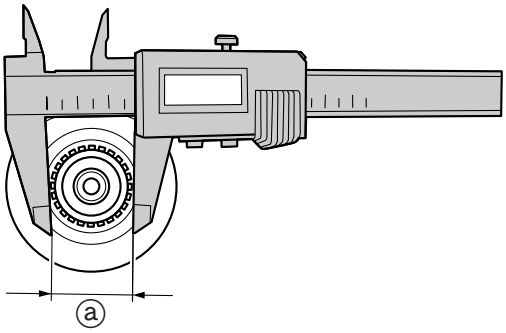
Push the clutch assembly ⑰ completely down onto the pinion shaft ⑱ in direction ⓐ, and rotate it one spline in direction ⓑ, and then remove it in direction ⓒ.

Checking the starter motor

1. Check the commutator. Clean with 600–grit sandpaper and compressed air if dirty.

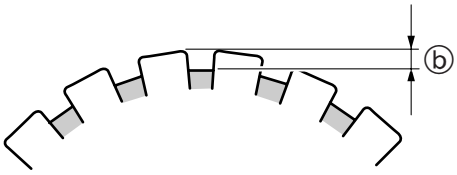


2. Measure the commutator diameter ⓐ. Replace the armature if below specification.



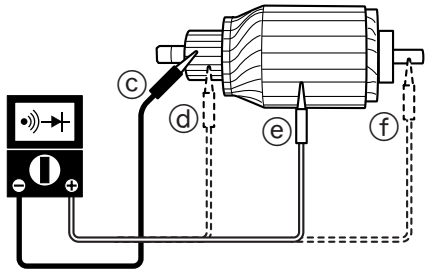
Commutator standard diameter ⓐ: 29.0 mm (1.14 in) Wear limit: 28.0 mm (1.10 in)

3. Measure the commutator undercut ⓑ. Replace the armature if below specification.



Commutator standard undercut ⓑ: 0.8 mm (0.03 in) Wear limit: 0.2 mm (0.01 in)

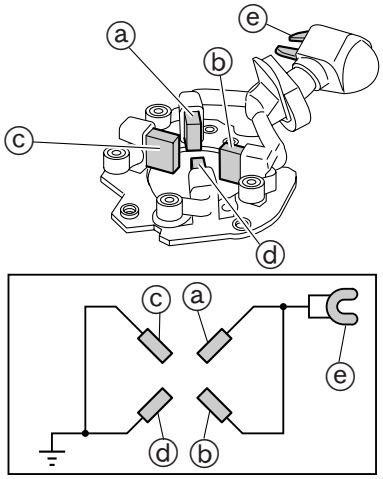
4. Check the armature for continuity. Replace the armature if out of specifications.



Armature continuity:			
ⓒ	ⓓ	ⓔ	ⓕ
○——	——○		

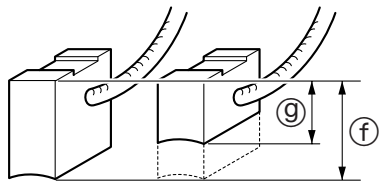
Checking the brush

1. Check the brush holder assembly for continuity. Replace the brush holder assembly if out of specification.



Brush holder assembly continuity:				
ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
○——	——○			
○——				——○
	○——			——○
		○——	——○	

2. Measure the length of each brush. Replace the brush assembly if below specification.



Brush standard length ⓕ:
15.5 mm (0.61 in)
Wear limit ⓖ: 9.5 mm (0.37 in)

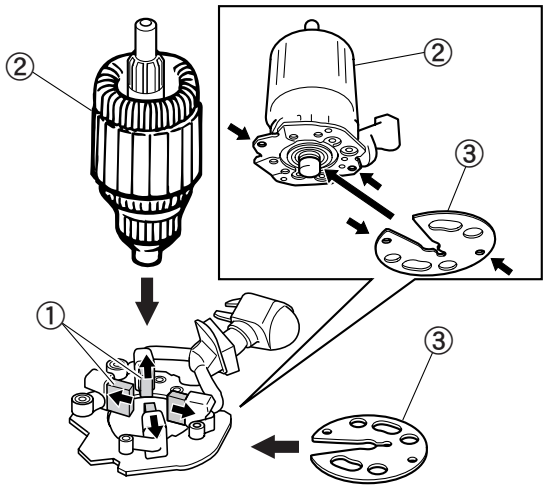
Assembling the starter motor

NOTICE

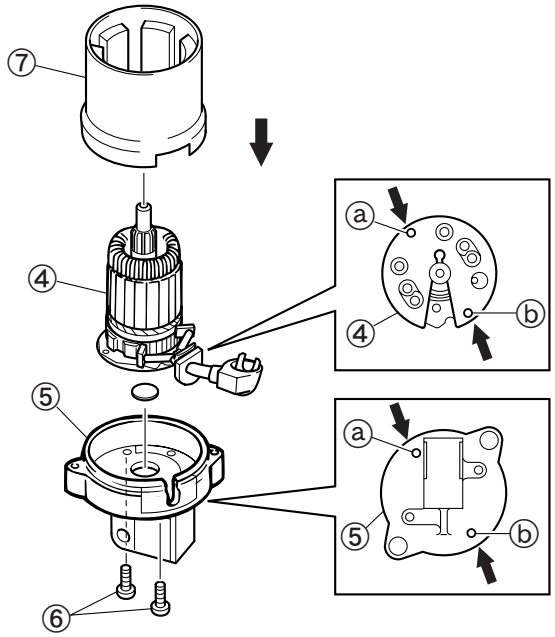
Do not allow grease or oil to contact the commutator of the armature.

1. Push the brushes ① into the holders, and then install the armature ② to the brush holder assembly.

2. Install the plate ③.

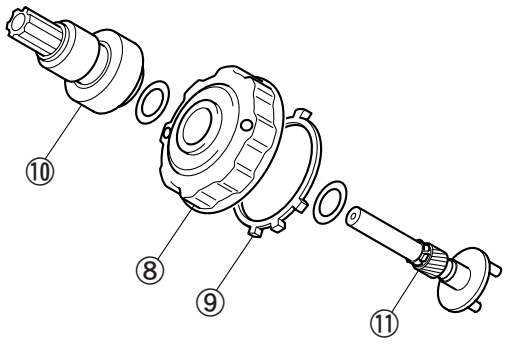


3. Install the armature assembly ④ to the bracket ⑤, and then install the screw ⑥ and stator ⑦.



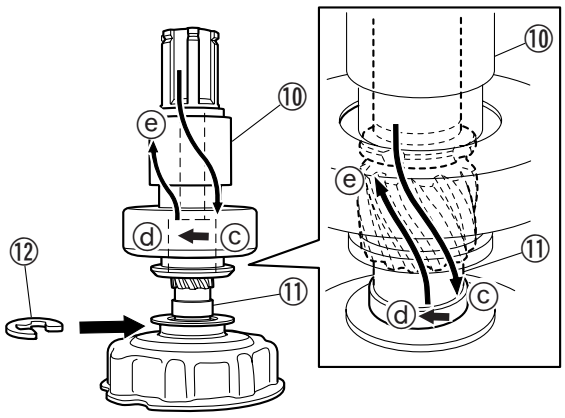
TIP:
Align the holes ⓐ and ⓑ in the plate with the holes ⓐ and ⓑ in the bracket ⑤.

4. Install the bracket ⑧, new gasket ⑨ and clutch assembly ⑩ onto the pinion shaft ⑪.



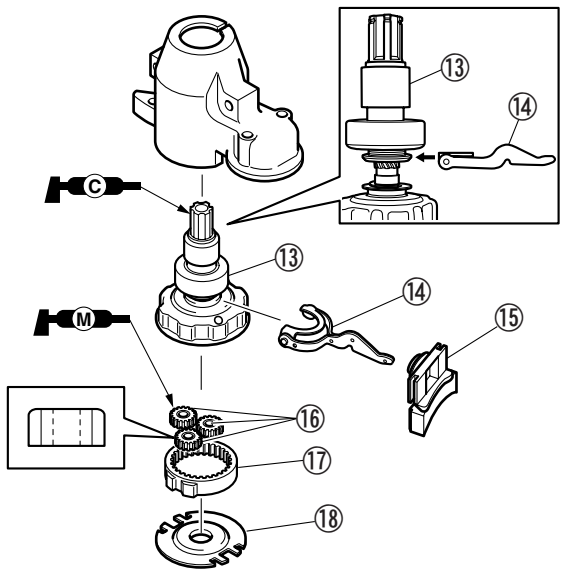
5. Push the clutch assembly ⑩ completely down onto the pinion shaft ⑪ in direction ⓒ, and rotate it one spline in direction ⓓ, and then slide it in direction ⓔ.

6. Install the E-clip ⑫.



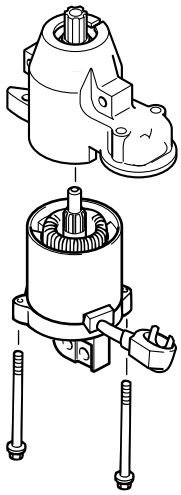
TIP:
Make sure that the clutch assembly ⑩ does not come out from the pinion shaft ⑪.

7. Install the pinion shaft assembly ⑬, lever ⑭, rubber seal ⑮, planetary gears ⑯, outer gear ⑰, and plate ⑱.

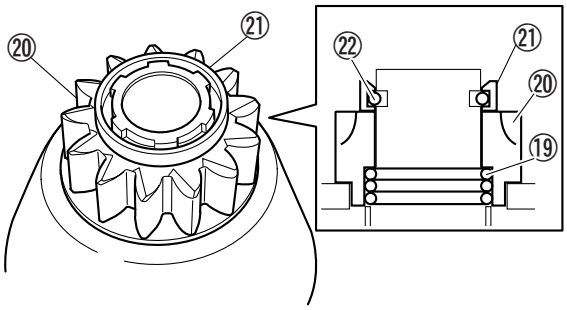


5

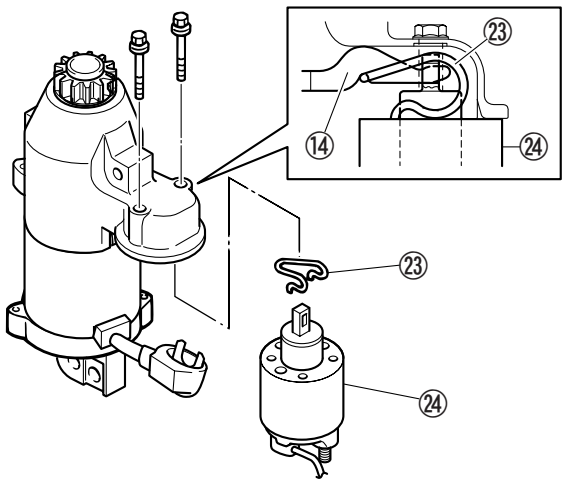
8. Assemble the starter motor.



9. Install the spring ⑲, pinion ⑳, pinion stopper ㉑ and clip ㉒.



10. Install the spring ㉓ and magnet switch ㉔.



TIP:

Check the operation of the starter motor before installing it to the power unit. To check the operation of the starter motor, see "Checking the starter motor operation" (5-42).

Installing the starter motor

1. Install the starter motor to the power unit. See "Starter motor" (7-12).

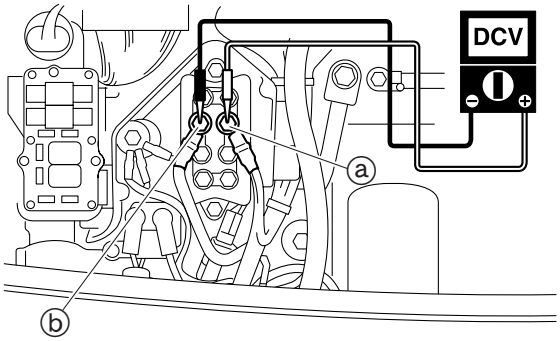
2. Install the junction box cover.

PTT system

Checking the PTT relay

1. Remove the junction box cover

2. Measure the input voltage between the PTT relay terminal ⓐ and terminal ⓑ.



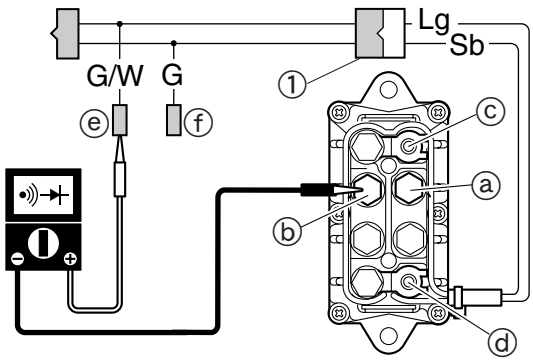
PTT relay input voltage:
Terminal ⓐ–Terminal ⓑ
12.0 V (battery voltage)

3. Disconnect the battery power source, ground lead, PTT motor leads and PTT relay coupler. ***NOTICE:*** **Always disconnect the battery negative terminal before disconnecting the PTT relay terminals.**

4. Connect the test harness (2 pins) ①.

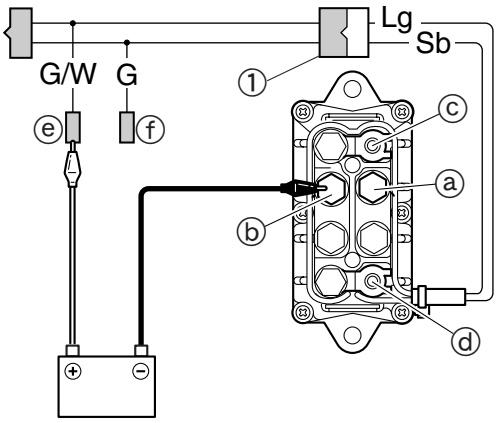
Test harness (2 pins) ①:
90890-06867

5. Check the PTT relay for continuity. Replace the PTT relay if out of specification.



PTT relay continuity:					
ⓐ	ⓑ	ⓒ	ⓓ	ⓔ	ⓕ
	○—○				
	○—	—○			
	○—	—	—	○	
	○—	—	—	—	○

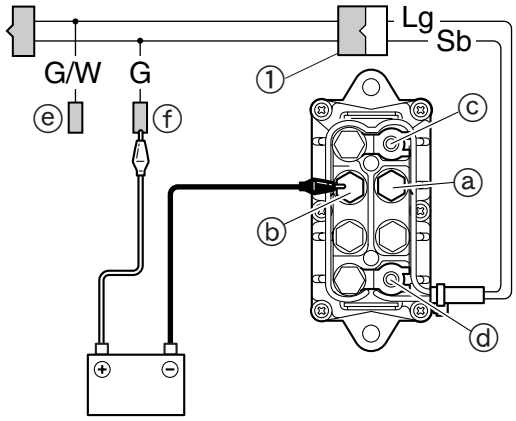
6. Connect the positive battery lead to the terminal ⓔ, and the negative battery lead to the terminal ⓑ, and then check the PTT relay for continuity. Replace the PTT relay if out of specification.



PTT relay continuity:			
ⓐ	ⓑ	ⓒ	ⓓ
○—			—○
	○—	—○	

5

7. Connect the positive battery lead to the terminal ⓕ, and the negative battery lead to the terminal ⓑ, and then check the PTT relay for continuity. Replace the PTT relay if out of specification.



PTT relay continuity:			
ⓐ	ⓑ	ⓒ	ⓓ
○		○	
	○		○

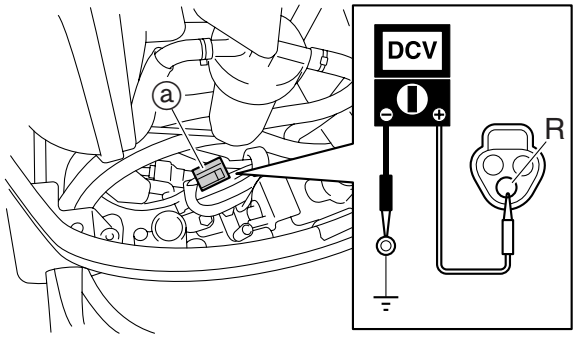
8. Connect the PTT relay coupler, battery power source, ground lead, and PTT motor leads.

9. Install the PTT relay and junction box cover.

Checking the PTT switch (on bottom cowling)

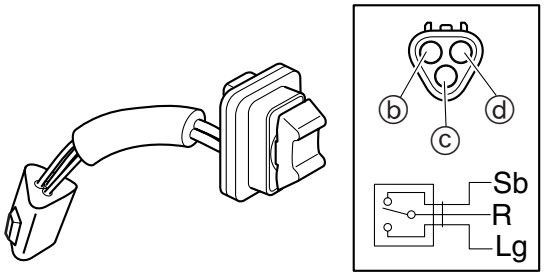
1. Disconnect the PTT switch coupler ⓐ.

2. Measure the input voltage between the PTT switch coupler terminal and ground.



PTT switch input voltage:
Red (R)–Ground
12.0 V (battery voltage)

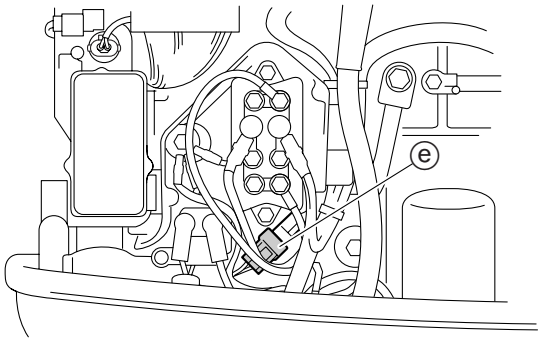
3. Check the PTT switch for continuity. Replace the PTT switch if out of specification.



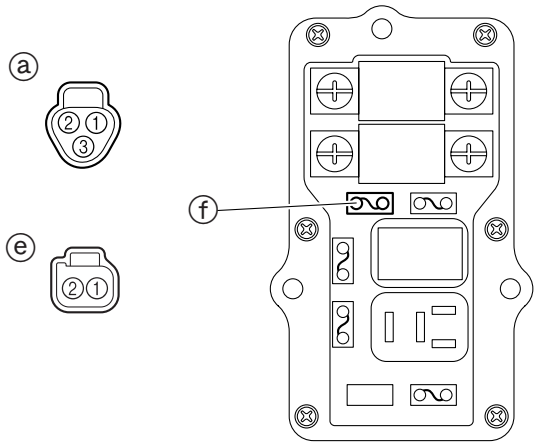
Switch position	Terminal		
	ⓑ	ⓒ	ⓓ
UP		○	○
Free			
DN	○	○	

4. Remove the junction box cover.

5. Disconnect the PTT relay coupler ⓔ.



6. Check the wiring harness for continuity.



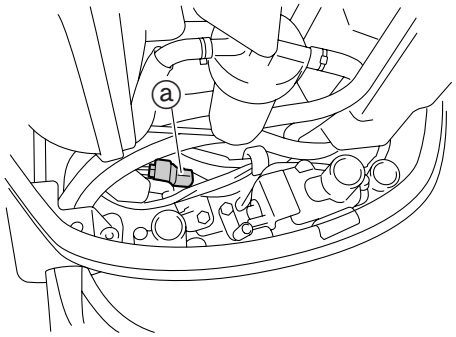
Wiring harness continuity:
ⓐ Terminal 1–ⓔ Terminal 1 ⓐ Terminal 2–ⓔ Terminal 2 ⓐ Terminal 3–Terminal ⓒ

7. Connect the PTT relay coupler ⓔ and PTT switch coupler ⓐ.

8. Install the junction box cover.

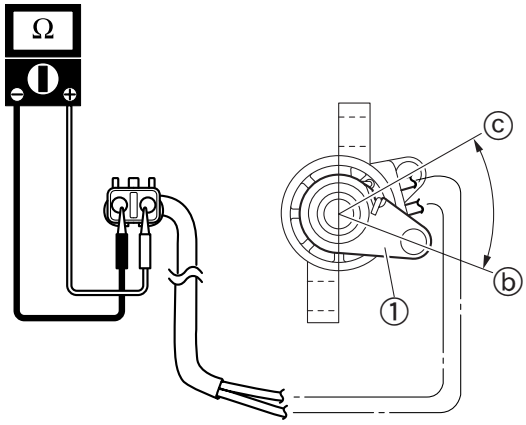
Checking the trim sensor

1. Remove the trim sensor, and then Disconnect the trim sensor coupler ⓐ.



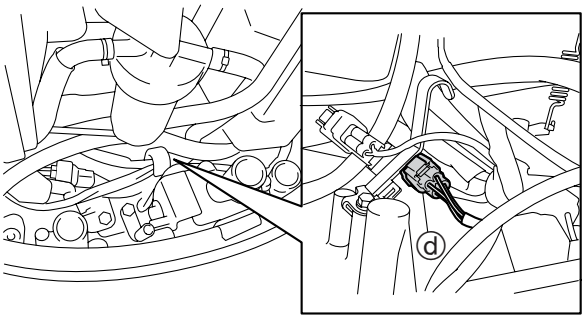
2. Measure the trim sensor resistance.

3. Turn the trim sensor lever ① from ⓑ to ⓒ and measure the resistance as it gradually changes.

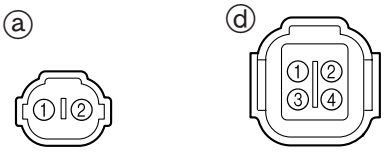


Trim sensor resistance (reference data):
238.8–378.8 Ω at ⓑ 9.0–11.0 Ω at ⓒ (setting resistance)

4. Disconnect the gauge harness coupler ⓓ.



5. Check the wiring harness for continuity.



Wiring harness continuity:
ⓐ Terminal 1–ⓓ Terminal 2 ⓐ Terminal 2–Ground

6. Install the trim sensor.

7. Connect the gauge harness coupler ⓓ, and trim sensor coupler ⓐ.

Fuel system

Hose routing 6-1
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Vapor gas hose 6-2
Cooling water hose 6-3

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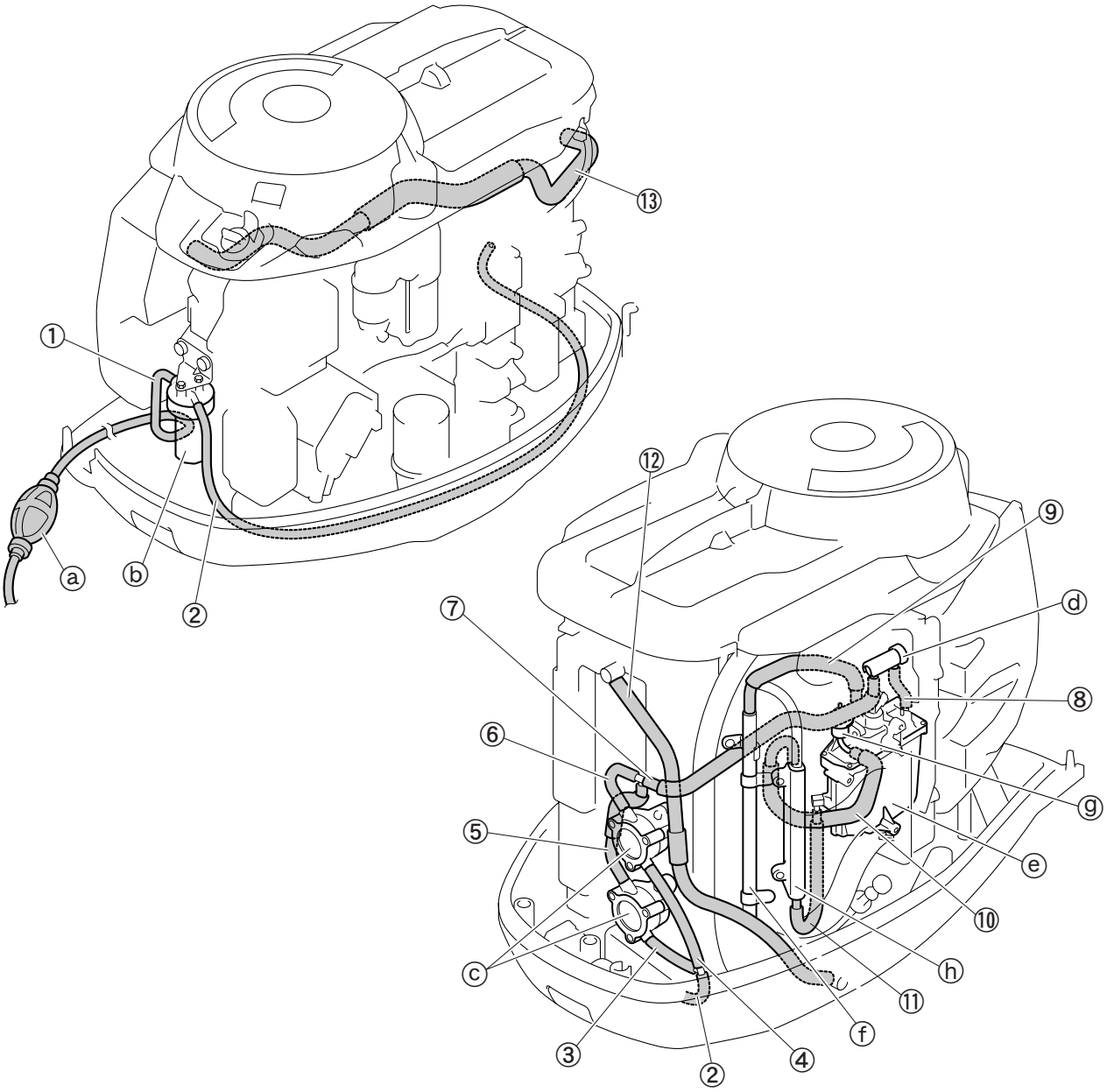
Disassembling the vapor separator 6-32
Checking the high-pressure fuel pump 6-32
Checking the vapor separator 6-32
Assembling the vapor separator 6-33

Hose routing

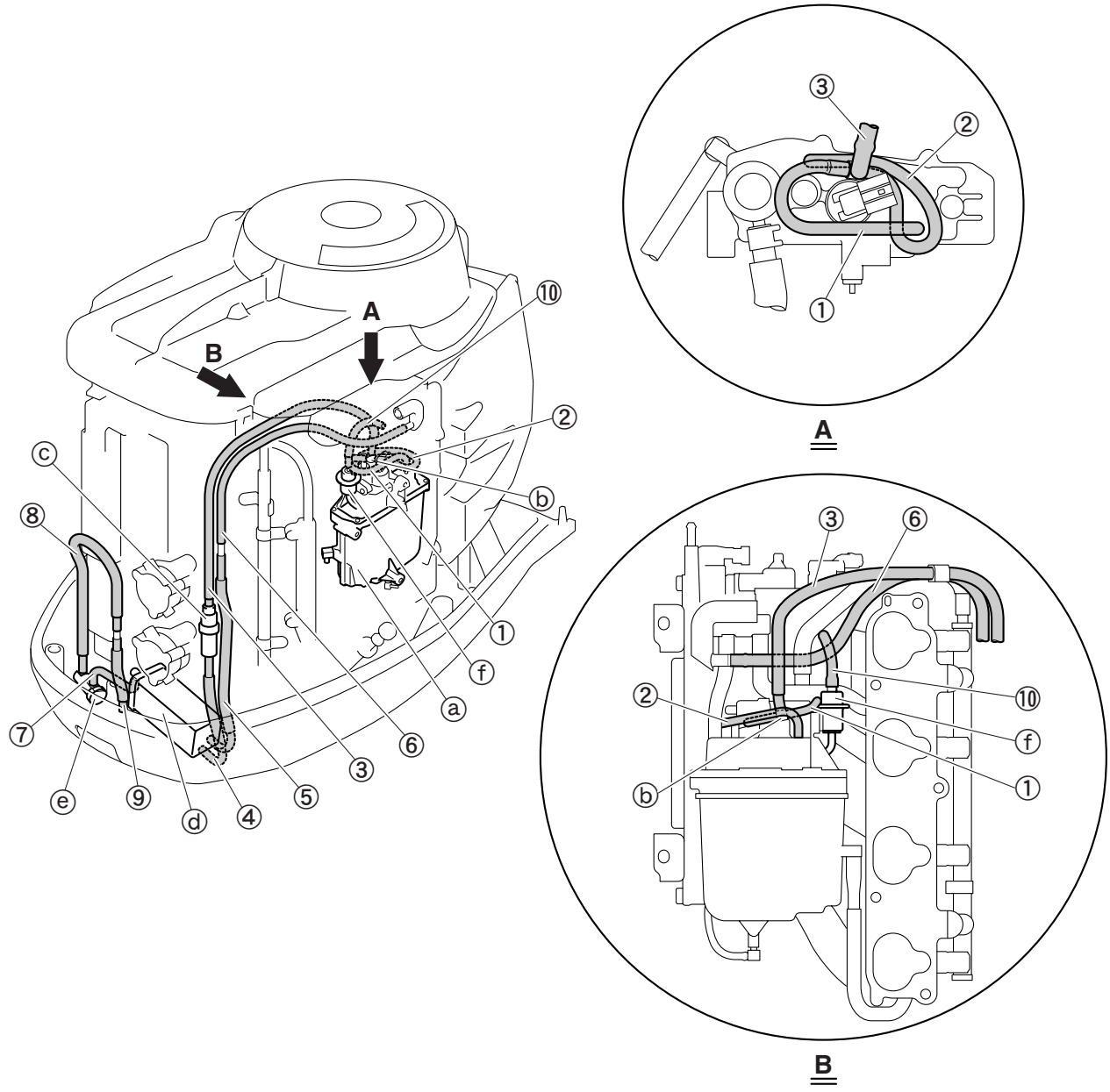
Fuel hose and blowby hose



① Fuel hose (primer pump-to-fuel filter)
② Fuel hose (fuel filter-to-joint)
③ Fuel hose (joint-to-fuel pump)
④ Fuel hose (joint-to-fuel pump)
⑤ Fuel hose (fuel pump-to-joint)
⑥ Fuel hose (fuel pump-to-joint)
⑦ Fuel hose (joint-to-filter)
⑧ Fuel hose (filter-to-vapor separator)
⑨ Fuel hose (vapor separator-to-fuel rail)
⑩ Fuel hose (pressure regulator-to-fuel cooler)
⑪ Fuel hose (fuel cooler-to-vapor separator)
⑫ Blowby hose (cylinder block-to-cylinder head cover)
⑬ Blowby hose (cylinder head cover-to-intake silencer)

ⓐ Primer pump
ⓑ Fuel filter
ⓒ Fuel pump
ⓓ Filter
ⓔ Vapor separator
ⓕ Fuel rail
ⓖ Pressure regulator
ⓗ Fuel cooler

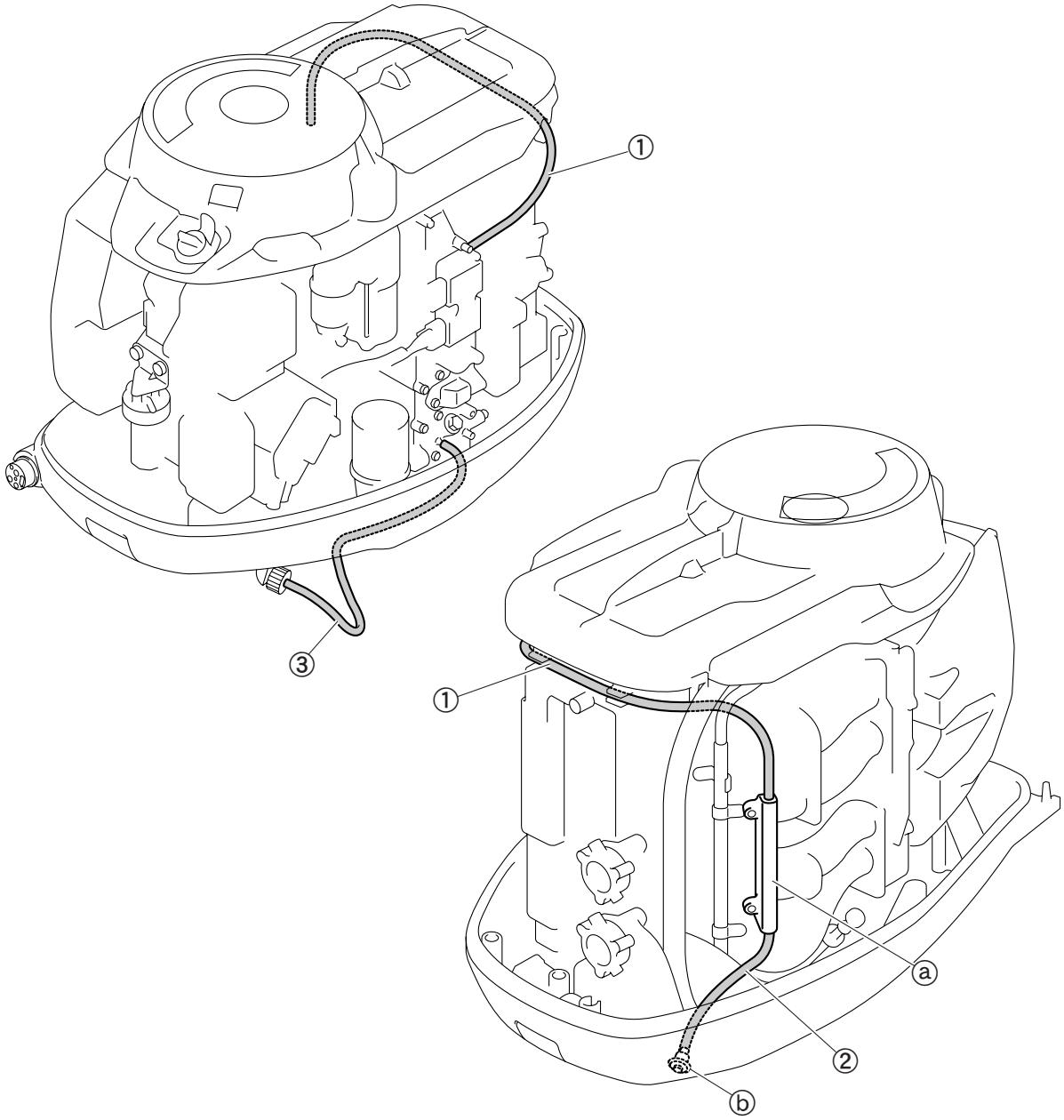
Vapor gas hose



① Vapor gas hose (vapor separator-to-joint)
② Vapor gas hose (vapor separator-to-joint)
③ Vapor gas hose (joint-to-filter)
④ Vapor gas hose (filter-to-canister tank port)
⑤ Vapor gas hose (canister purge port-to-joint)
⑥ Vapor gas hose (joint-to-joint)
⑦ Vapor gas hose (canister atmospheric port-to-filter)
⑧ Vapor gas hose (filter-to-joint)
⑨ Vapor gas hose (joint-to-bottom cowling)
⑩ Vacuum hose (intake manifold-to-pressure regulator)

ⓐ Vapor separator
ⓑ Joint
ⓒ Filter
ⓓ Canister
ⓔ Filter
ⓕ Pressure regulator

Cooling water hose



① Cooling water hose (exhaust cover-to-fuel cooler)
② Cooling water pilot hose (fuel cooler-to-cooling water pilot hole)
③ Flushing hose (exhaust cover-to-flushing hose adapter)

ⓐ Fuel cooler
ⓑ Cooling water pilot hole (on the bottom cowling)

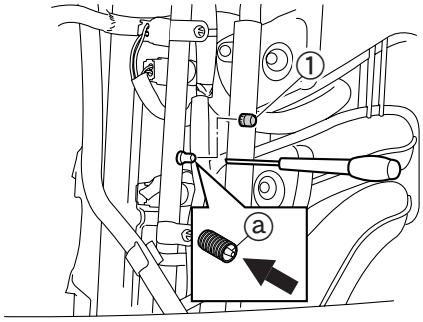
Fuel line

Reducing the fuel pressure

⚠ WARNING

Always reduce the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

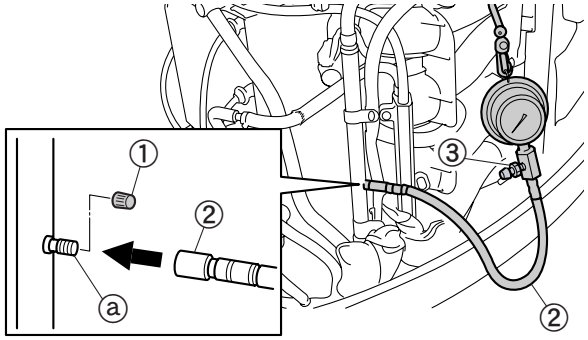
1. Remove the cap ①.
2. Cover the pressure check valve ⓐ of the fuel rail with a rag, and then press in the pressure check valve ⓐ using a flathead screwdriver to release the fuel pressure.



3. Install the cap ①.

Measuring the fuel pressure

1. Reduce the fuel pressure.
2. Remove the cap ①.
3. Connect the special service tool ② to the pressure check valve ⓐ. **WARNING! Gently screw in the gauge until it is firmly connected to prevent fuel from leaking out.**



Fuel pressure gauge ②:
90890-06786

4. Turn the engine start switch to "ON," and then measure the fuel pressure within 3 seconds. **WARNING! Make sure that the drain screw ③ is tightened securely, before measuring the fuel pressure.**

Fuel pressure (reference data):
300.0 kPa (3.00 kgf/cm², 43.5 psi)

TIP:

The fuel pressure decreases after 3 seconds later when the engine start switch is turned to "ON."

5. Start the engine and warm up, and then measure the fuel pressure at the stable idle condition of 650–750 r/min. If below specification, check the high-pressure fuel line and the vapor separator.

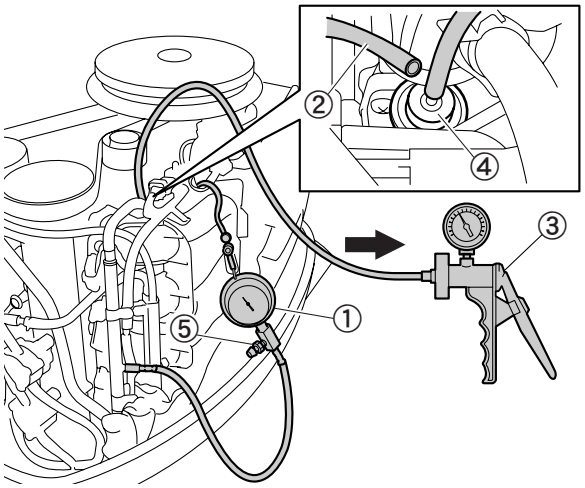
Fuel pressure (reference data):
260.0 kPa (2.60 kgf/cm², 37.7 psi)
at engine idle speed

6. Turn the engine start switch to "OFF."
7. Disconnect the special service tool ②, and then install the cap ①. **WARNING! Before disconnecting the special service tool ②, cover the pressure check valve ⓐ with clean and dry rag, otherwise pressurized fuel may spray out.**
8. After measuring the fuel pressure, cover the end of the hose with a clean and dry rag, point the hose downward. And then loosen the drain screw ③ to drain the remaining fuel from the hose and gauge. **WARNING! When storing the fuel pressure gauge, make sure that the drain screw ③ is tightened securely**.

Checking the pressure regulator

1. To connect the special service tool ①, see “Measuring the fuel pressure” (6-4) step 1–step 3.

2. Disconnect the pressure regulator hose ②, and then connect the special service tool ③ to the pressure regulator ④.



Fuel pressure gauge ①: 90890-06786
Vacuum/pressure pump gauge set ③: 90890-06756

3. Clog the pressure regulator hose end during the measurement.

4. Start the engine and let it idle. **WARNING! Make sure that the drain screw ⑤ is tightened securely, before starting the engine.**

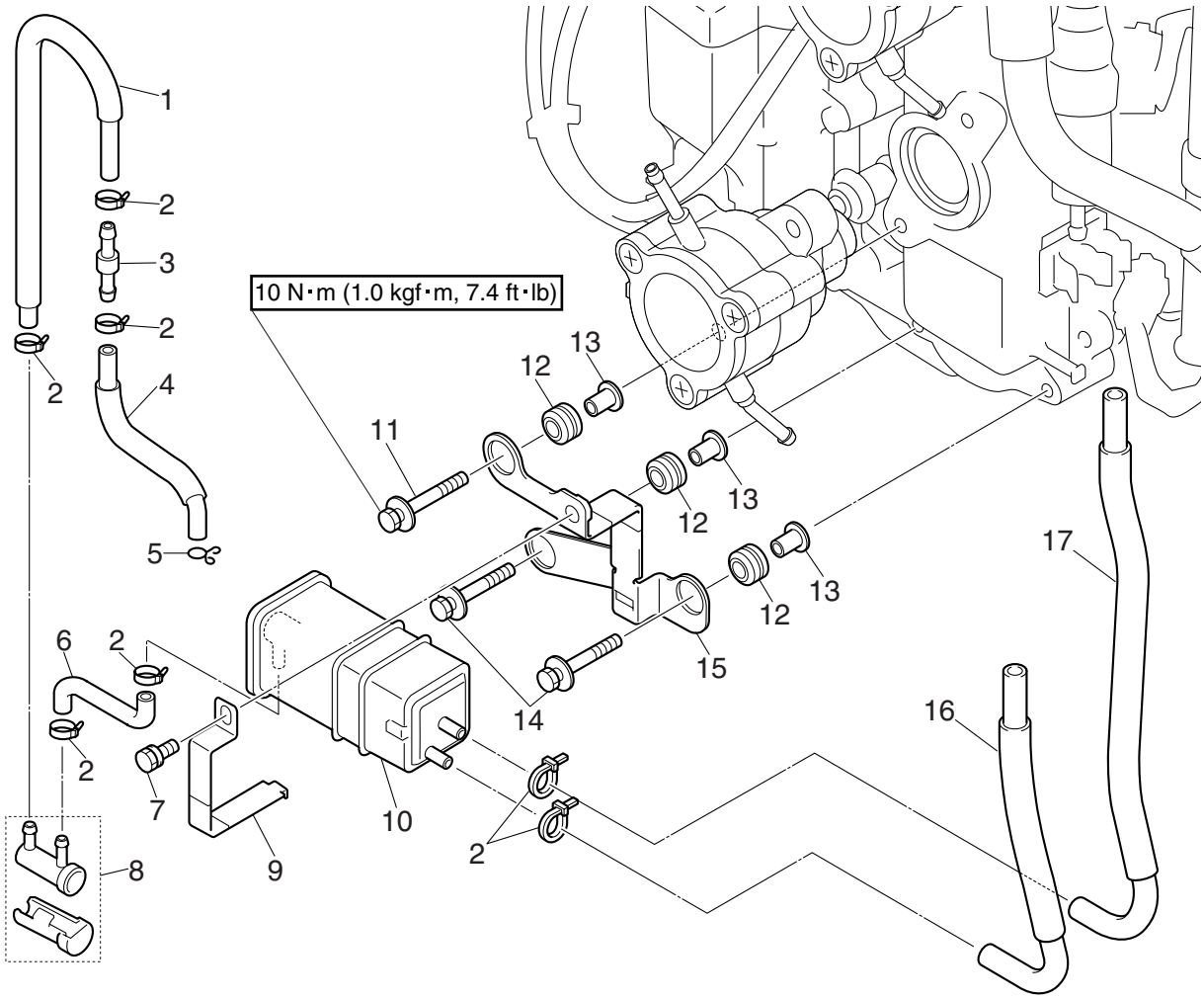
5. Check that the fuel pressure is reduced when vacuum pressure is applied to the pressure regulator. If the fuel pressure is not reduced, replace the pressure regulator.

6. Turn the engine start switch to “OFF.”

7. Disconnect the special service tool ③, and then connect the pressure regulator hose ②.

8. To disconnect the special service tool ①, see “Measuring the fuel pressure” (6-4) step 7–step 8.

Canister

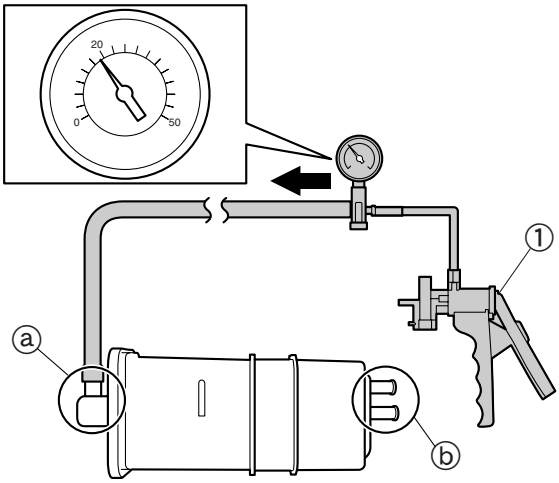


No.	Part name	Q'ty	Remarks
1	Hose	1	
2	Plastic tie	7	**Not reusable**
3	Joint	1	
4	Hose	1	
5	Clamp	1	
6	Hose	1	
7	Bolt	1	M6 × 16 mm
8	Filter	1	
9	Bracket	1	
10	Canister	1	
11	Bolt	1	M6 × 42 mm
12	Grommet	3	
13	Collar	3	
14	Bolt	2	M6 × 30 mm
15	Bracket	1	
16	Hose	1	
17	Hose	1	

Checking the canister

1. Check the canister. Replace the canister if cracked.

2. Connect the special service tool ① to the atmospheric port ⓐ and cover the other ports ⓑ with fingers.



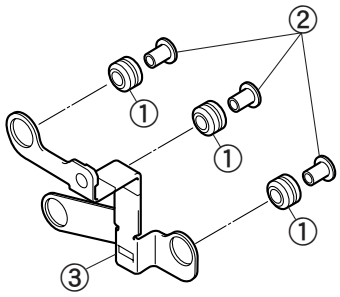
Vacuum/pressure pump gauge set ①:
90890-06756

3. Apply the specified positive pressure and check that there is no air leakage. Replace the canister if there is air leakage.

Specified pressure:
19.6 kPa (0.196 kgf/cm^2, 2.8 psi)

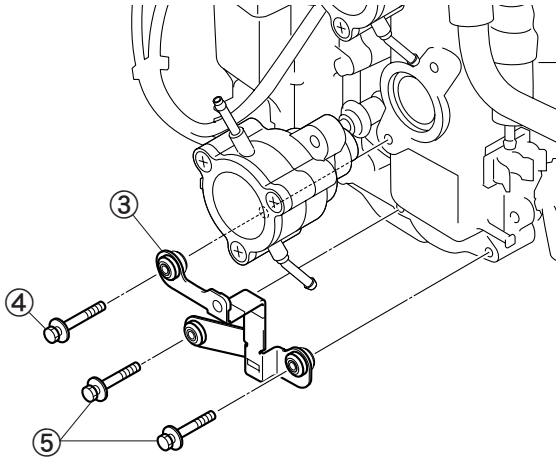
Installing the canister

1. Install the grommets ① and collars ② to the bracket ③.



2. Install the bracket ③, and temporarily tighten the fuel pump assembly bolt ④ and cylinder head cover bolts ⑤.

3. Tighten the fuel pump assembly bolt ④ to the specified torque.

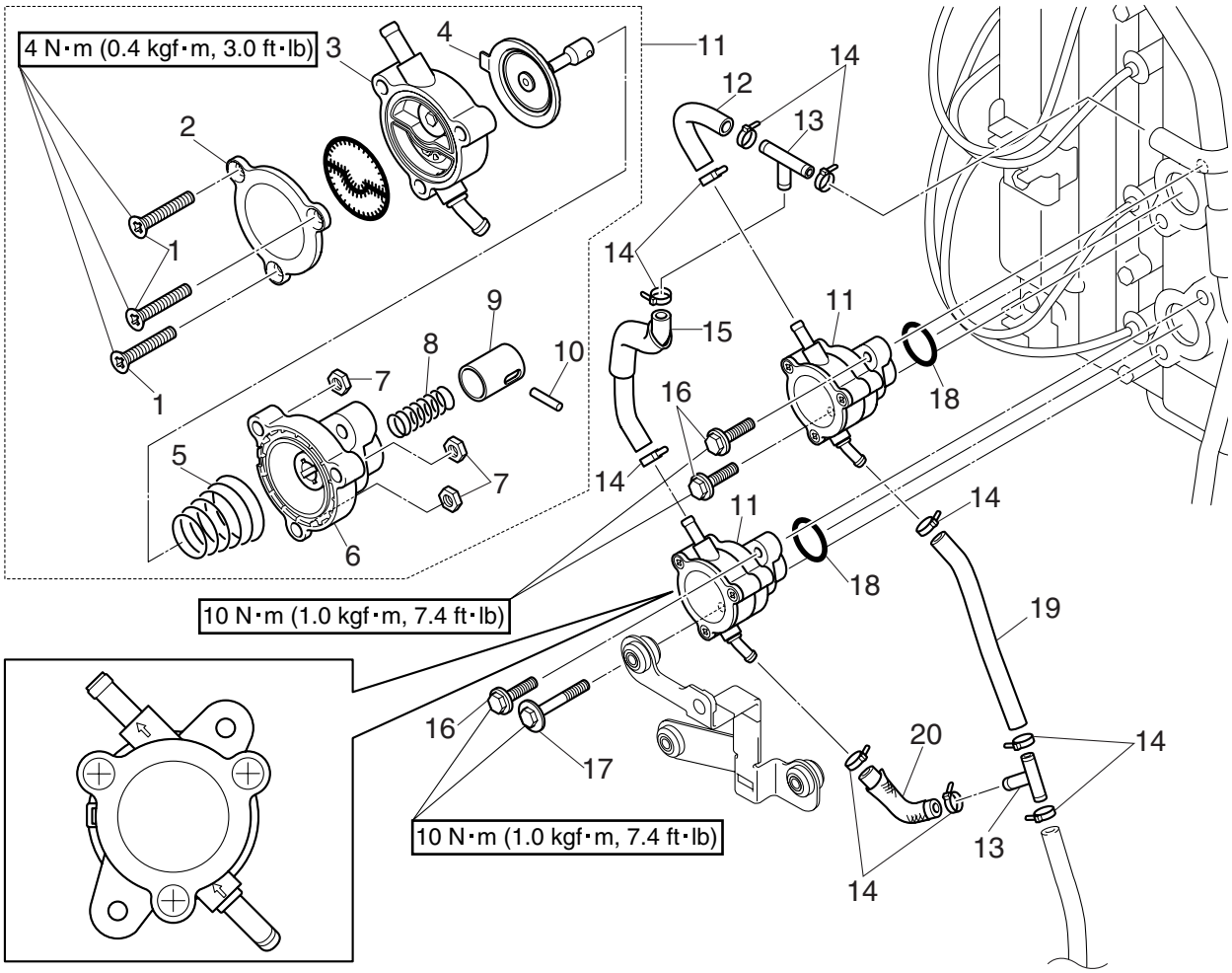


Fuel pump assembly bolt ④:
10 N·m (1.0 kgf·m, 7.4 ft·lb)

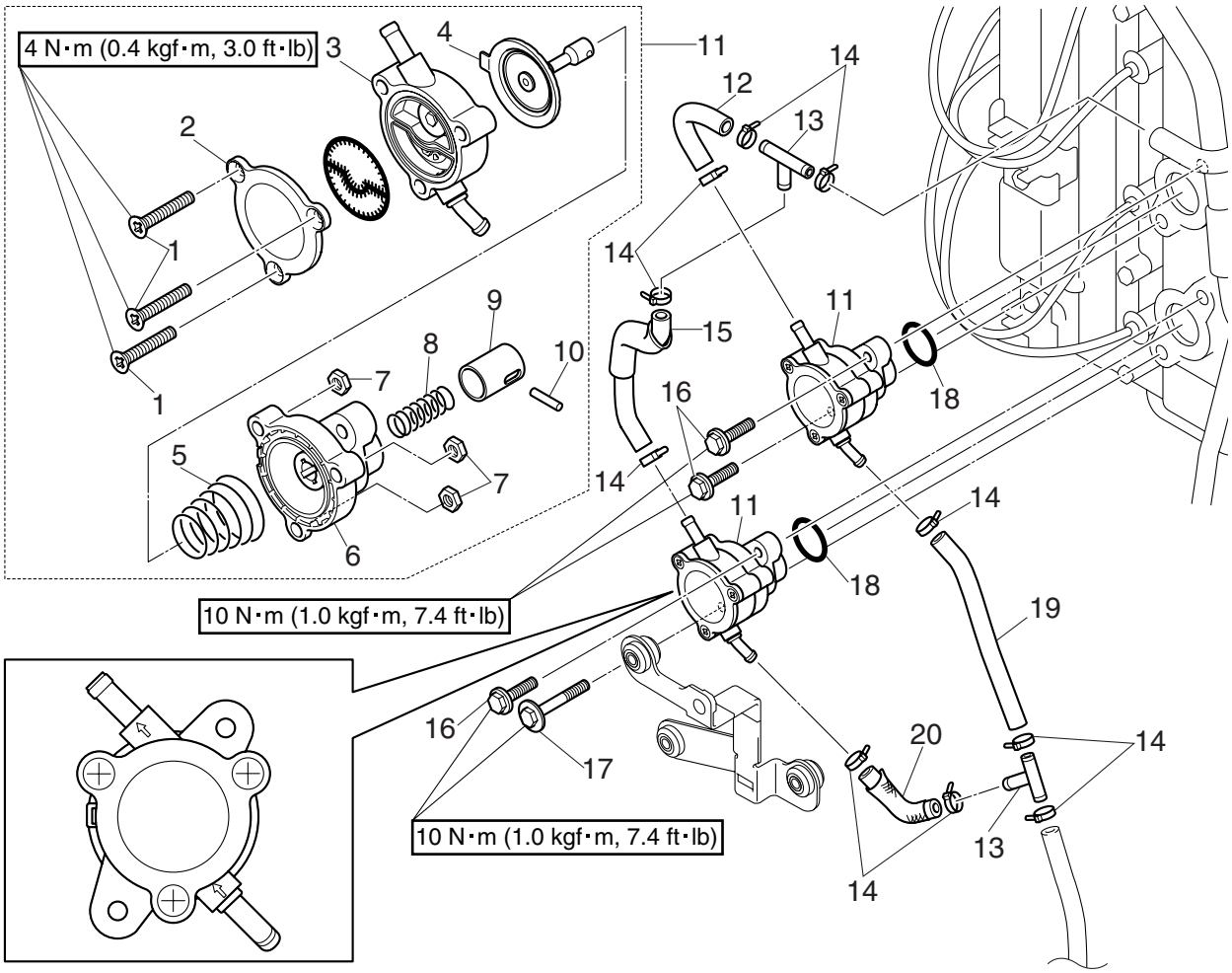
TIP:
Tighten the cylinder head cover bolts ⑤ to the general torque in 2 stages.

4. Install the canister using the bracket and the bolt. See exploded diagram (6-6).

Fuel pump



No.	Part name	Q'ty	Remarks
1	Screw	3	M6 × 35 mm
2	Cover	1	
3	Fuel pump body 2	1	
4	Diaphragm	1	
5	Spring	1	
6	Fuel pump body 1	1	
7	Nut	3	
8	Spring	1	
9	Plunger	1	
10	Pin	1	
11	Fuel pump assembly	2	
12	Hose	1	
13	Joint	2	
14	Plastic tie	10	**Not reusable**
15	Hose	1	
16	Bolt	3	M6 × 30 mm
17	Bolt	1	M6 × 42 mm

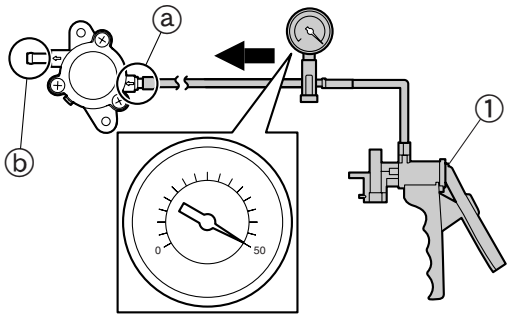


No.	Part name	Q'ty	Remarks
18	O-ring	2	**Not reusable**
19	Hose	1	
20	Hose	1	

Checking the fuel pump

1. Connect the special service tool ① to the fuel pump inlet ⓐ.

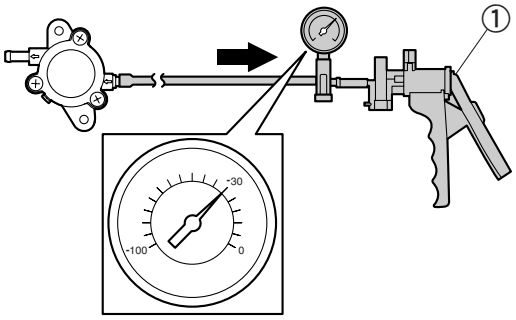
2. Cover the fuel pump outlet ⓑ with a finger, and then apply the specified positive pressure. Check that there is no air leakage.



Vacuum/pressure pump gauge set ①:
90890-06756

Specified positive pressure:
50.0 kPa (0.50 kgf/cm², 7.3 psi)

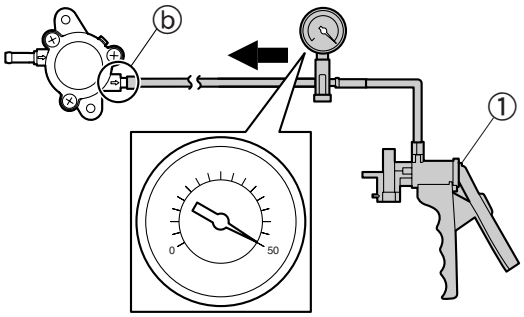
3. Apply the specified negative pressure and check that there is no air leakage.



Specified negative pressure:
30.0 kPa (0.30 kgf/cm², 4.4 psi)

4. Connect the special service tool ① to the fuel pump outlet ⓑ.

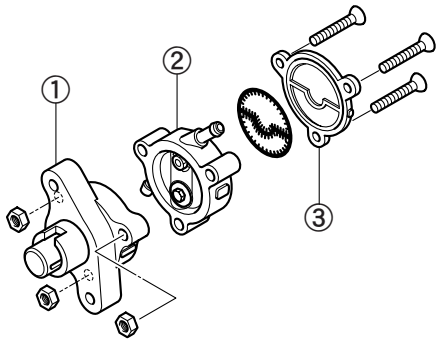
5. Apply the specified positive pressure and check that there is no air leakage.



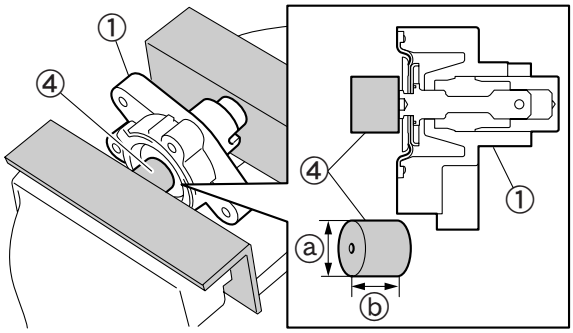
Specified positive pressure:
50.0 kPa (0.50 kgf/cm², 7.3 psi)

Disassembling the fuel pump

1. Disassemble the fuel pump assembly into the fuel pump body 1 assembly ①, the fuel pump body 2 ②, and the cover ③.



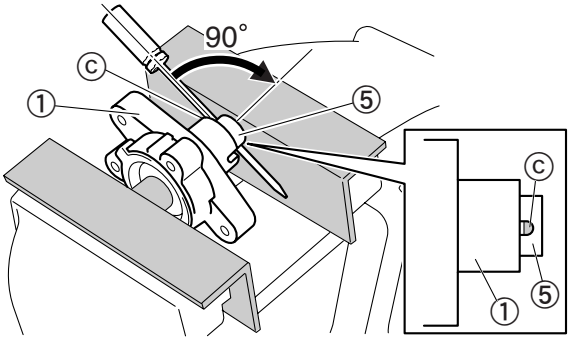
2. Hold the fuel pump body 1 assembly ①.



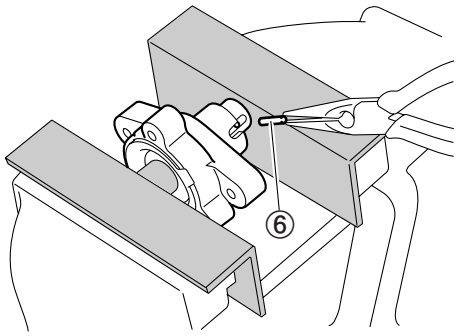
General cylindrical tool ④:
ⓐ = 20.0 mm (0.79 in)
ⓑ = 17.0 mm (0.67 in)

6

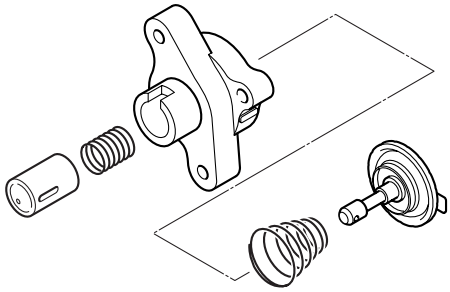
3. While holding the fuel pump body 1 ① in place, insert a flathead screwdriver into the hole ⓒ in the plunger ⑤ and rotate it 90°.



4. Remove the pin ⑥.



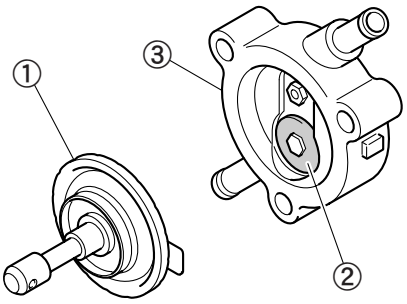
5. Disassemble fuel pump body 1 assembly ①.



Checking the diaphragm and valve

1. Check the diaphragm ①. Replace the diaphragm if torn.

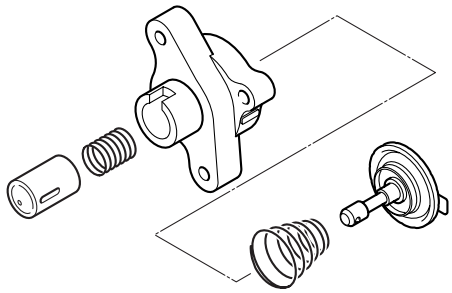
2. Check the valves ②. Replace the fuel pump body 2 ③ if deformed or worn.



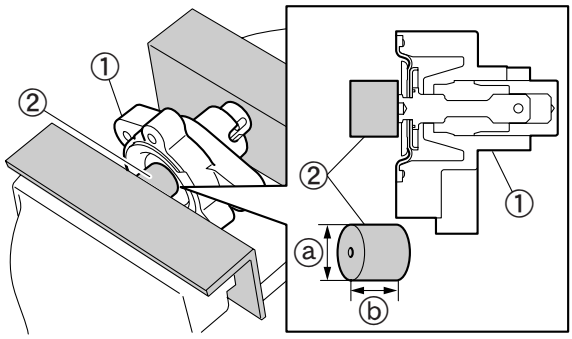
Assembling the fuel pump

Before assemble the fuel pump, clean the parts and soak the valves and diaphragm in gasoline to obtain prompt operation of the fuel pump.

1. Assemble fuel pump body 1 assembly ①

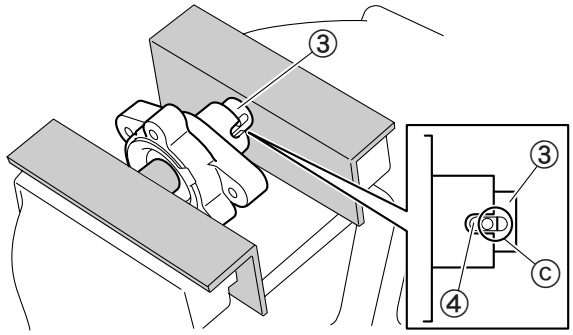


2. Hold the fuel pump body 1 assembly ①.

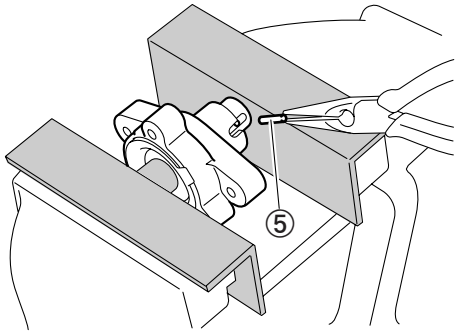


General cylindrical tool ②:
ⓐ = 20.0 mm (0.79 in)
ⓑ = 17.0 mm (0.67 in)

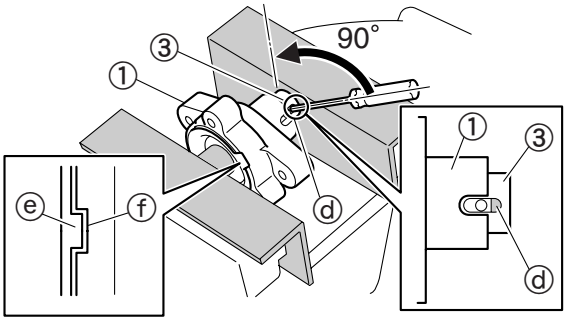
3. Make sure that the holes ⓒ in the plunger ③ and diaphragm ④ are aligned.



4. Install the pin ⑤.

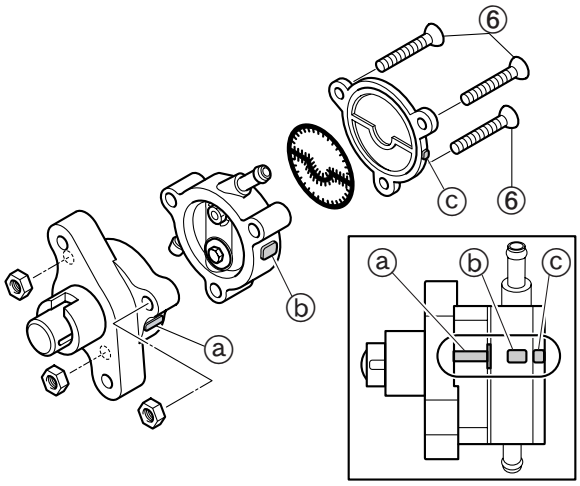


5. While holding the fuel pump body 1 assembly ① in place, insert a flathead screwdriver into the hole ⓓ of the plunger ③ and rotate it 90° until the tab ⓔ on the diaphragm is aligned with the slot ⓕ in the fuel pump body 1 assembly ①.



6. Remove the fuel pump body 1 assembly ① from the vise, and then push down on the plunger several times to make sure that it moves smoothly.

7. Assembly the fuel pump assembly.



Fuel pump screw ⑥: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

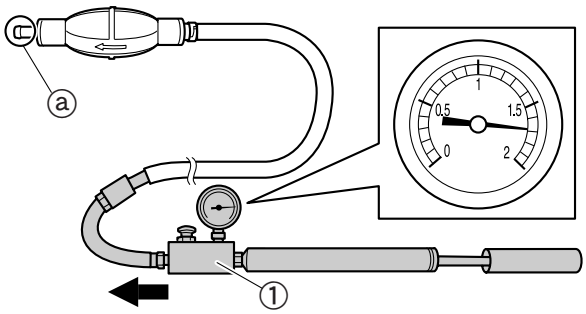
TIP:
Make sure to align the projections ⓐ, ⓑ, and ⓒ.

Checking the primer pump

1. Connect the special service tool ① to the primer pump inlet hose.

2. Cover the fuel outlet ⓐ with a finger.

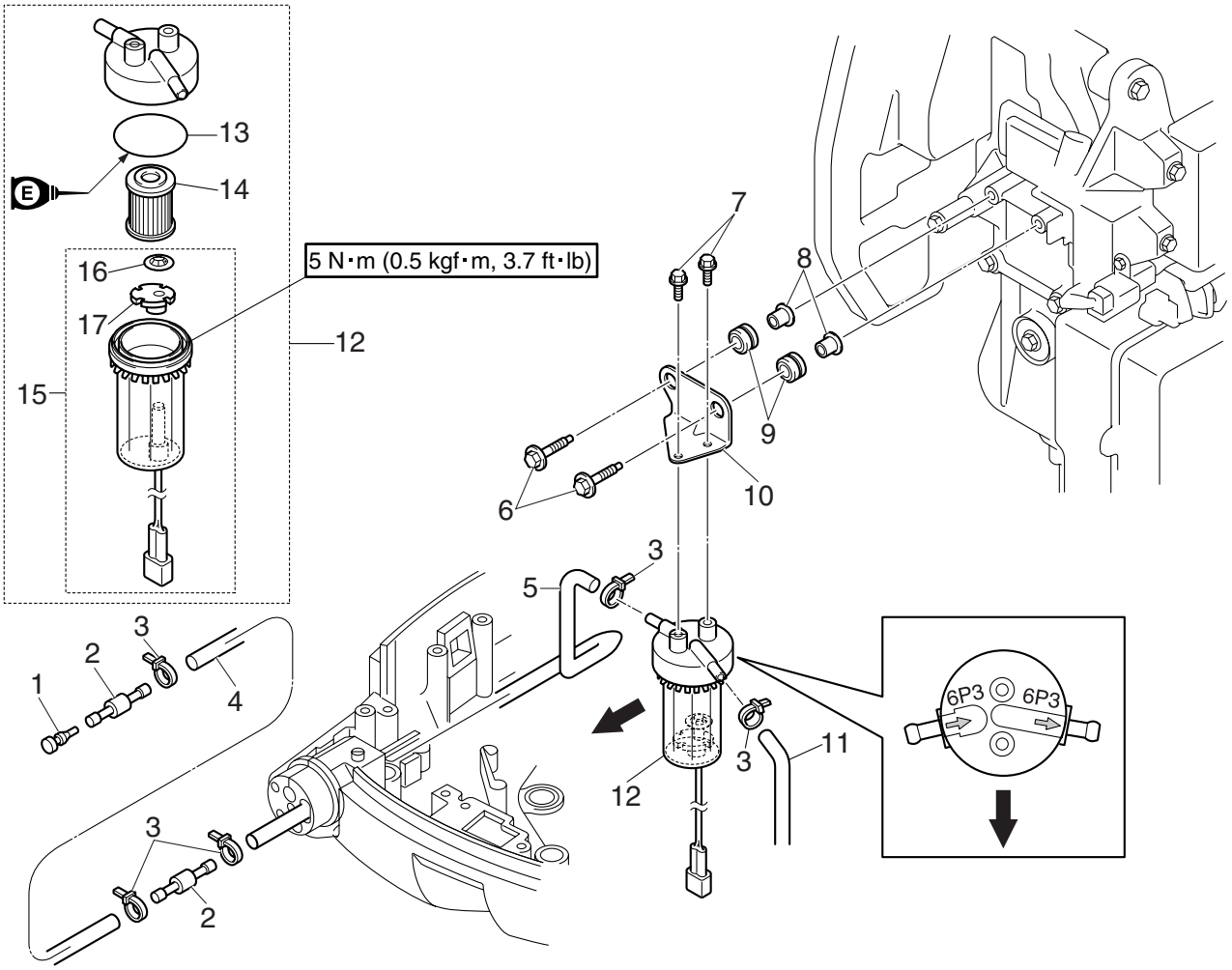
3. Apply the specified positive pressure to check that the pressure is maintained for at least 30 seconds. Replace the primer pump if it does not maintain pressure.



Leakage tester ①: 90890-06840

Specified positive pressure: 170.0 kPa (1.70 kgf/cm^2, 24.7 psi)

Fuel filter

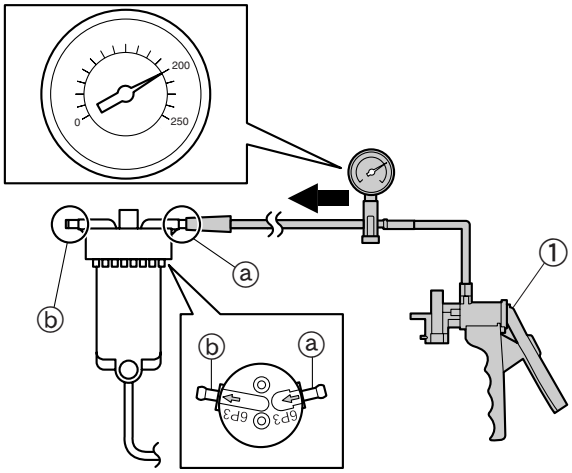


No.	Part name	Q'ty	Remarks
1	Damper	1	
2	Joint	2	
3	Plastic tie	5	**Not reusable**
4	Hose	1	
5	Hose	1	
6	Bolt	2	M6 × 30 mm
7	Bolt	2	M6 × 14 mm
8	Collar	2	
9	Grommet	2	
10	Bracket	1	
11	Hose	1	
12	Fuel filter assembly	1	
13	O-ring	1	**Not reusable**
14	Fuel filter element	1	
15	Fuel cup assembly	1	
16	Clip	1	
17	Float	1	

Checking the fuel filter assembly

1. Connect the vacuum/pressure pump gauge ① to the fuel inlet ⓐ.

2. Cover the fuel outlet ⓑ with a finger, and then apply the specified positive pressure. Replace the O-ring, fuel cup assembly, or fuel filter assembly if the specified pressure cannot be maintained for at least 15 seconds.



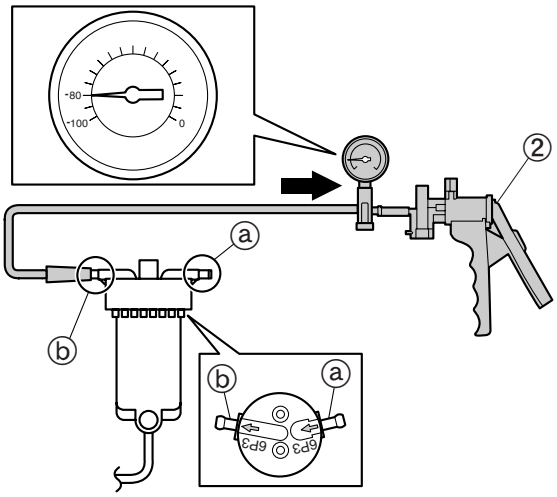
Vacuum/pressure pump gauge ①:
(commercially available)

Specified positive pressure:
200.0 kPa (2.00 kgf/cm², 29.0 psi)

TIP:
Use a commercially available vacuum/pressure pump gauge ① that can be pressurized 200.0 kPa (2.00 kgf/cm², 29.0 psi).

3. Connect the special service tool ② to the fuel outlet ⓑ.

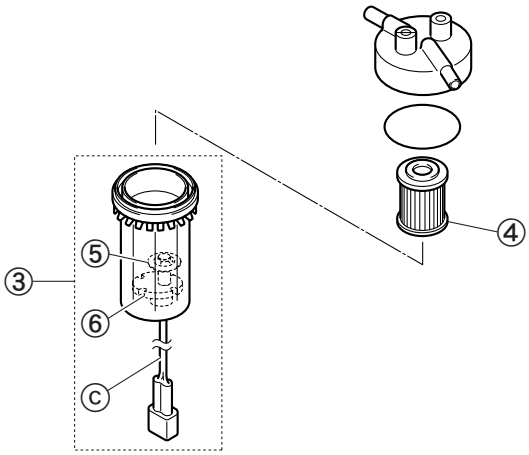
4. Cover the fuel inlet ⓐ with a finger, and then apply the specified negative pressure. Replace the O-ring, fuel cup assembly, or fuel filter assembly if the specified pressure cannot be maintained for at least 15 seconds.



Vacuum/pressure pump gauge set ②:
90890-06756

Specified negative pressure:
80.0 kPa (0.80 kgf/cm², 11.6 psi)

5. Disassemble the fuel filter assembly.



TIP:
Do not twist the water detection switch lead ⓒ when removing the fuel cup assembly ③.

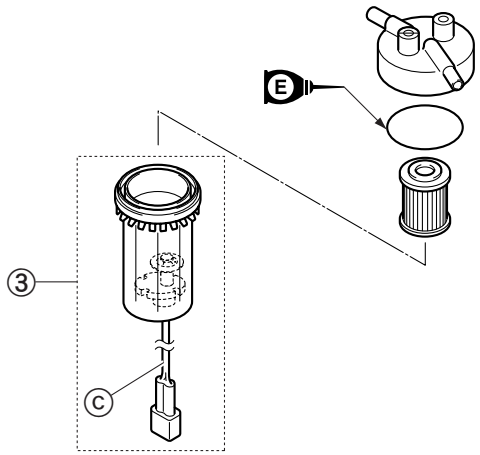
6. Check the fuel filter element ④. Replace the fuel filter element if there is dirt or residue.

6

7. Check the fuel cup assembly ③. Clean with straight gasoline if there are foreign substance or replace if cracked.
NOTICE: **When cleaning the fuel cup assembly ③, make sure not to remove the clip ⑤ and float ⑥, otherwise the water detection switch may be damaged.**

8. Check the water detection switch. See "Checking the water detection switch" (5-23).

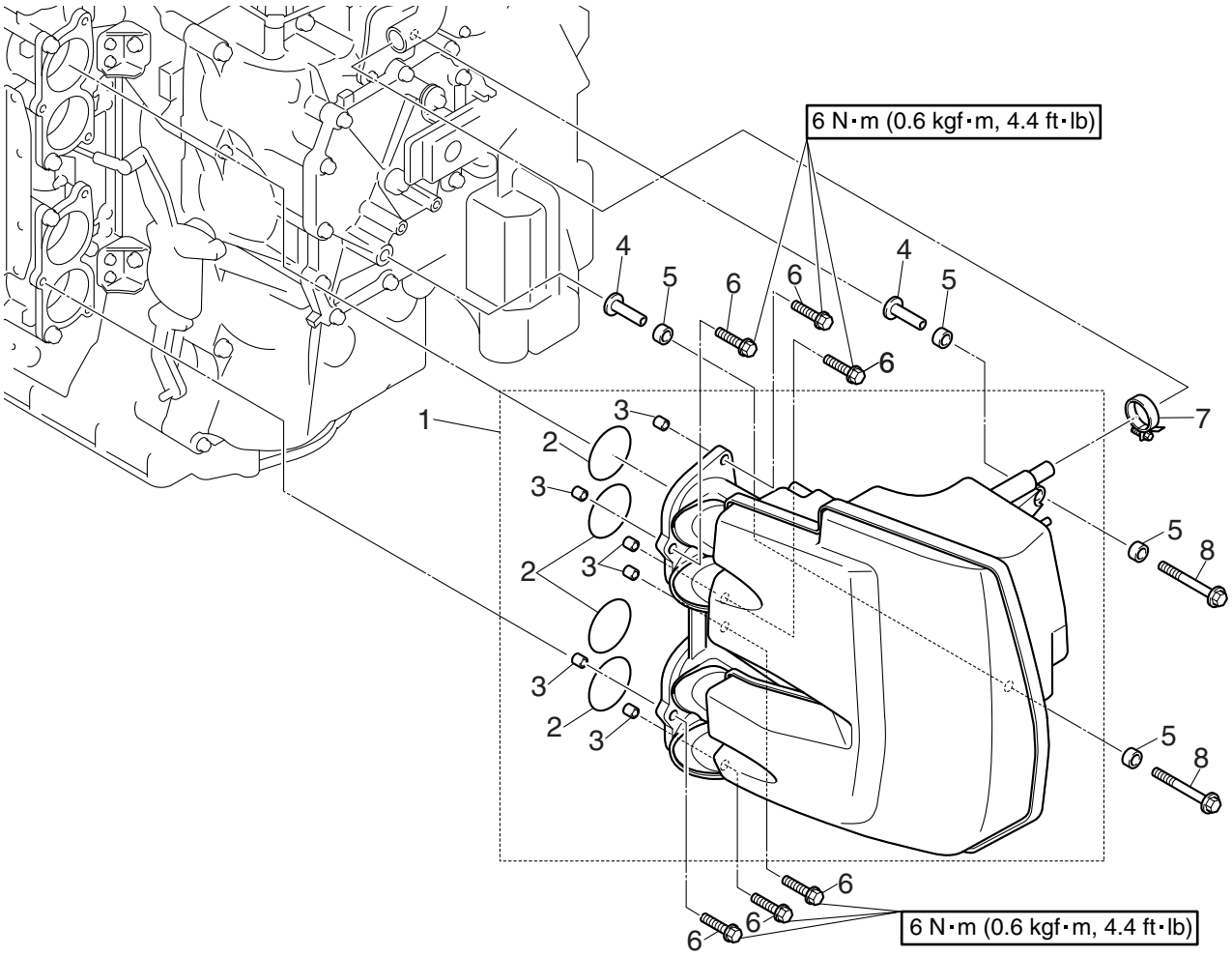
9. Assemble the fuel filter assembly.



Fuel cup assembly ③:
5 N·m (0.5 kgf·m, 3.7 ft·lb)

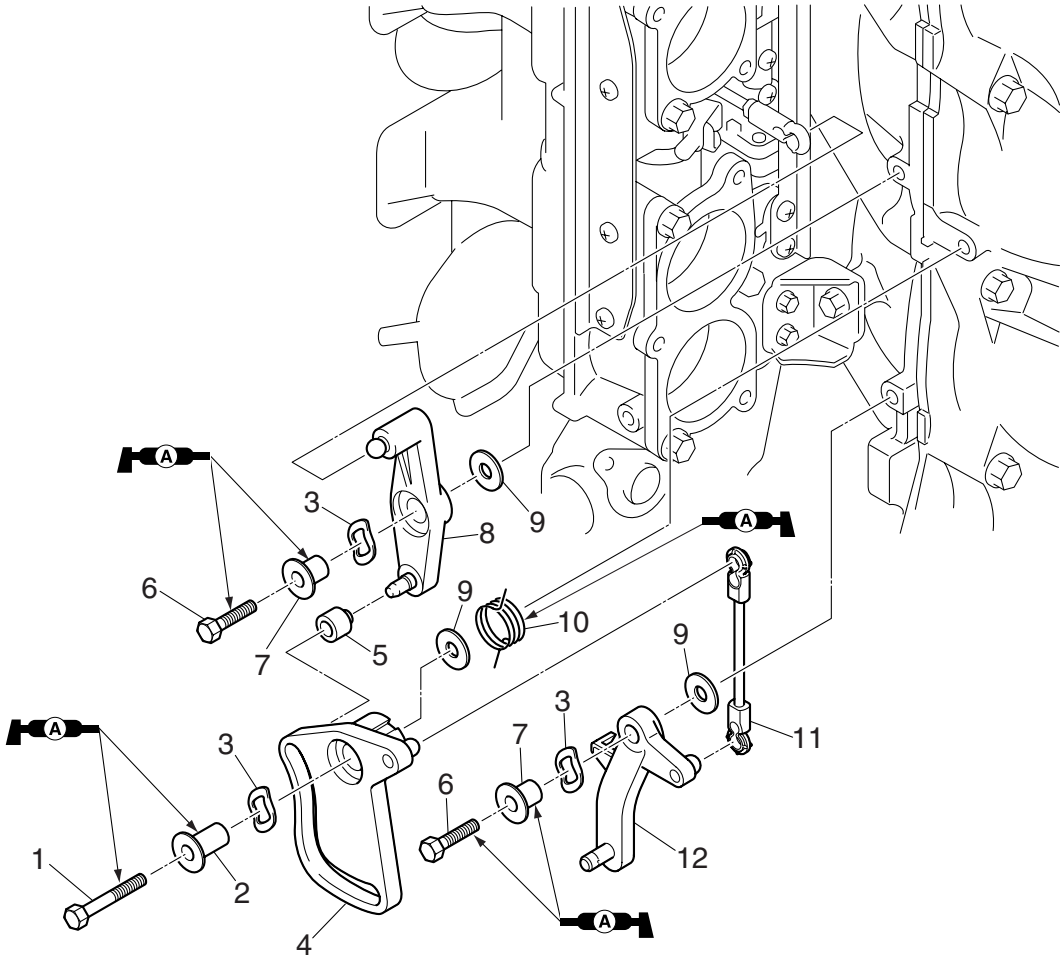
TIP:
Do not twist the water detection switch lead ⓒ when installing the fuel cup assembly ③.

Intake silencer



No.	Part name	Q'ty	Remarks
1	Intake silencer assembly	1	
2	O-ring	4	**Not reusable**
3	Collar	6	
4	Collar	2	
5	Grommet	4	
6	Bolt	6	M6 × 20 mm
7	Clamp	1	
8	Bolt	2	M6 × 45 mm

Throttle link



No.	Part name	Q'ty	Remarks
1	Bolt	1	M6 × 35 mm
2	Collar	1	
3	Wave washer	3	
4	Throttle cam	1	
5	Roller	1	
6	Bolt	2	M6 × 25 mm
7	Collar	2	
8	Throttle lever 1	1	
9	Washer	3	
10	Spring	1	
11	Throttle link rod	1	
12	Throttle lever 2	1	

Checking the throttle link

1. Check the throttle lever 1, roller and throttle cam. Replace if cracked or worn.

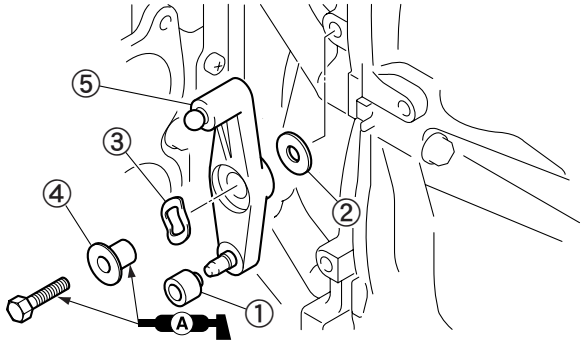
2. Check the throttle lever 2, and throttle link rod. Replace if cracked or worn.

3. Check the spring. Replace if fatigued or deformed.

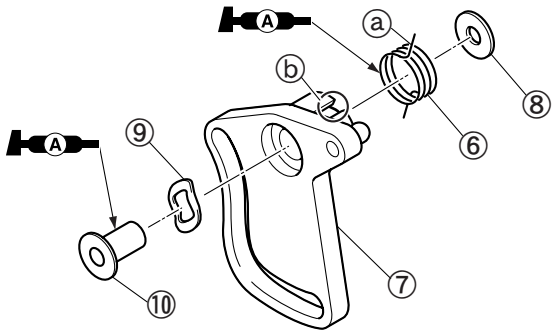
Installing the throttle link

1. Install the roller ①, washer ②, wave washer ③, and collar ④ onto the throttle lever 1 ⑤.

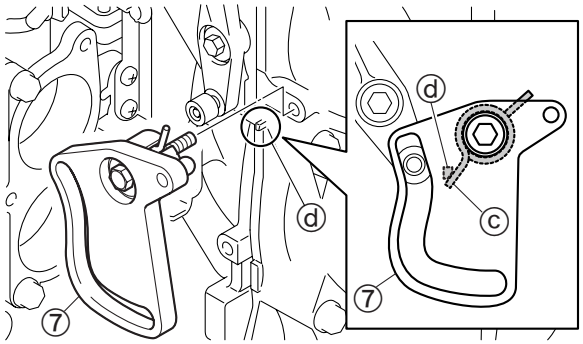
2. Install the throttle lever 1 ⑤ to the cylinder block.



3. When setting the spring ⑥ onto the throttle cam ⑦, make sure to fit the end ⓐ of the spring into the slot ⓑ in the throttle cam ⑦ and then install the washer ⑧, wave washer ⑨, and collar ⑩ onto the throttle cam ⑦.

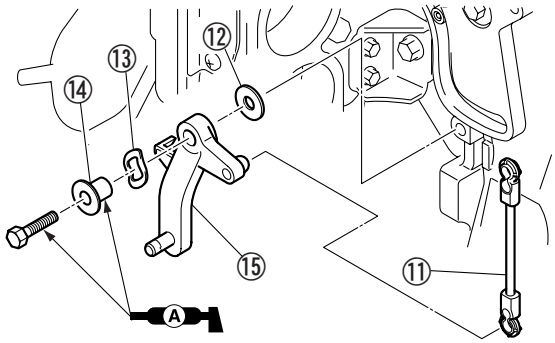


4. Install the throttle cam ⑦ to the cylinder block. Make sure to fit the end ⓒ of the spring on the projection ⓓ in the cylinder block.

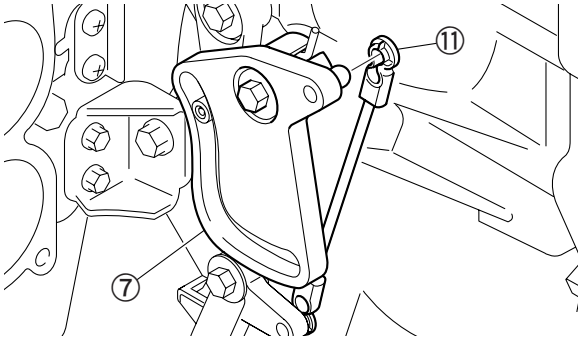


5. Install the throttle link rod ⑪, washer ⑫, wave washer ⑬, and collar ⑭ onto the throttle lever 2 ⑮.

6. Install the throttle lever 2 ⑮ to the cylinder block.



7. Install the throttle link rod ⑪ to the throttle cam ⑦.

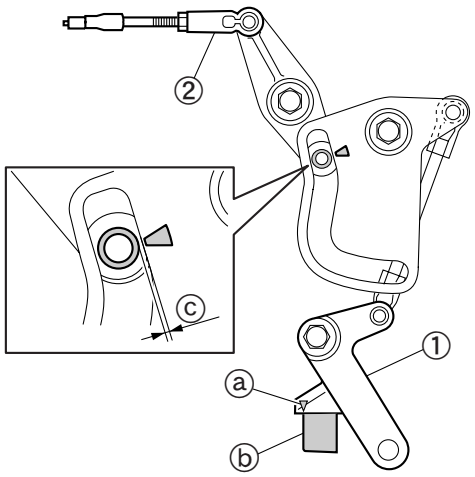


8. Check that the throttle lever 1 ⑤, throttle cam ⑦ and throttle control lever 2 ⑮, move smoothly.

6

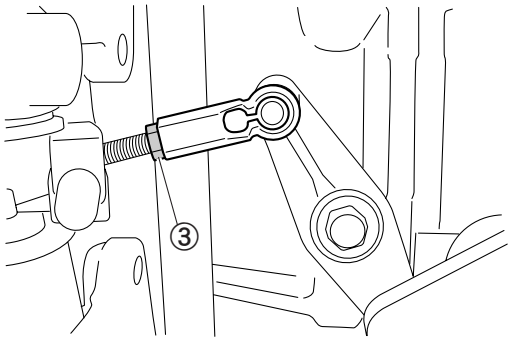
Adjusting the throttle link

1. Contact the stopper ⓐ on the throttle lever 2 ① to the fully closed stopper ⓑ on the cylinder block, and then adjust the throttle link joint assembly ② so that the specified clearance ⓒ is obtained.

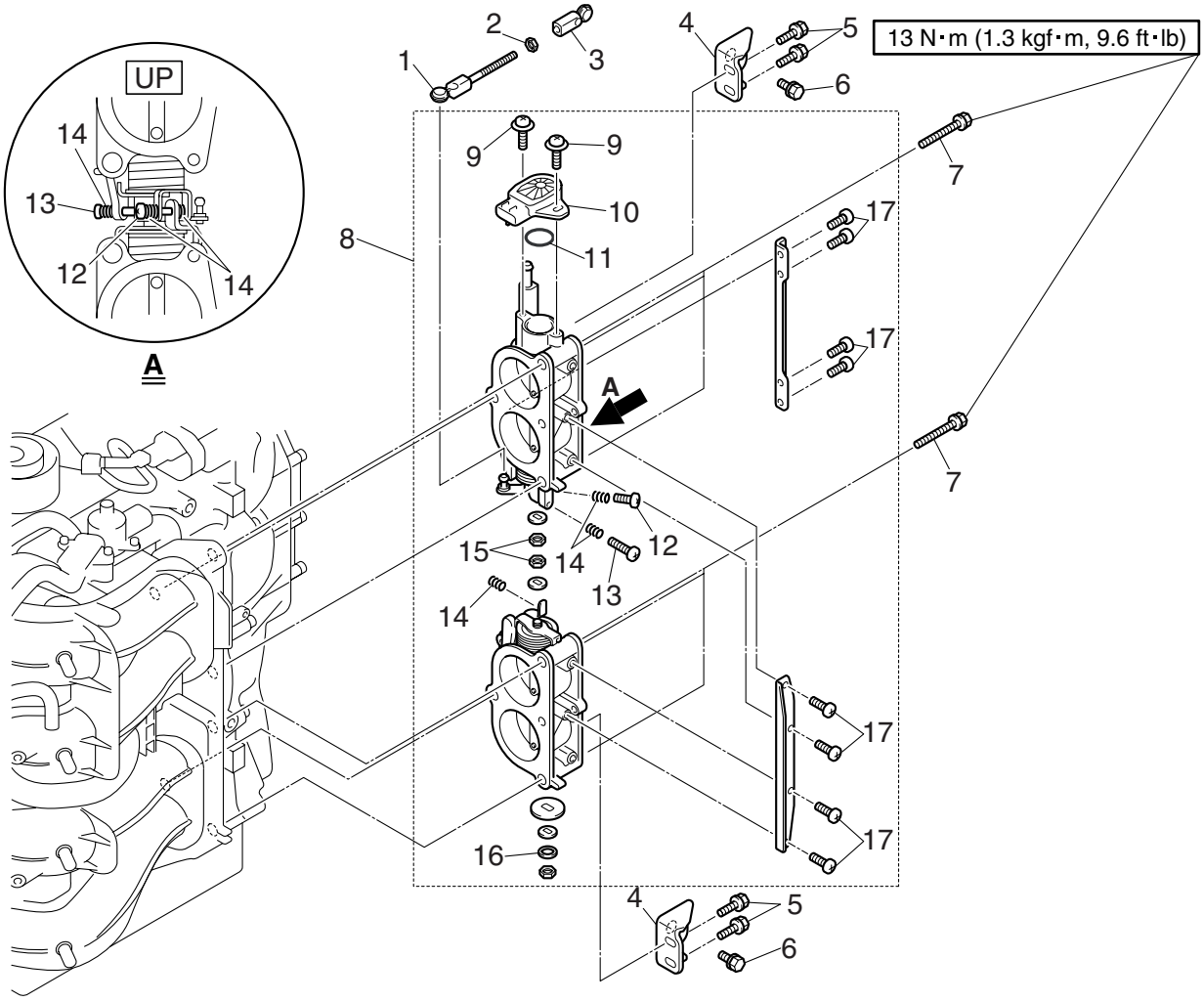


Roller clearance ⓒ: 0.50 mm (0.02 in)

2. Tighten the locknut ③.



Throttle body



No.	Part name	Q'ty	Remarks
1	Throttle link joint 1	1	
2	Nut	1	
3	Throttle link joint 2	1	
4	Bracket	2	
5	Bolt	4	M6 × 16 mm
6	Bolt	2	M8 × 20 mm
7	Bolt	6	M8 × 70 mm
8	Throttle body assembly	1	
9	Screw	2	M4× 12 mm
10	TPS	1	
11	O-ring	1	**Not reusable**
12	Synchronizing screw	1	
13	Throttle stop screw	1	
14	Spring	3	
15	Nut	2	
16	Spring washer	1	
17	Screw	8	M6 × 16 mm

Checking the TPS

1. Check the TPS exterior. Replace if cracked.

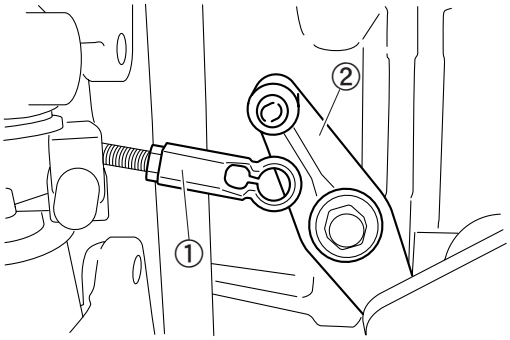
2. Check the TPS electrical performance. See “Checking the TPS” (5-16).

Adjusting the TPS

When adjusting the TPS, the output voltage can also be measured using the “Engine monitor” of the YDIS. To connect and operate the YDIS, see the YDIS (Ver. 1.30 or later) Instruction Manual.

1. Remove the intake silencer. See “Intake silencer” (6-16).

2. Disconnect the throttle link joint assembly ① from the throttle lever 1 ②.



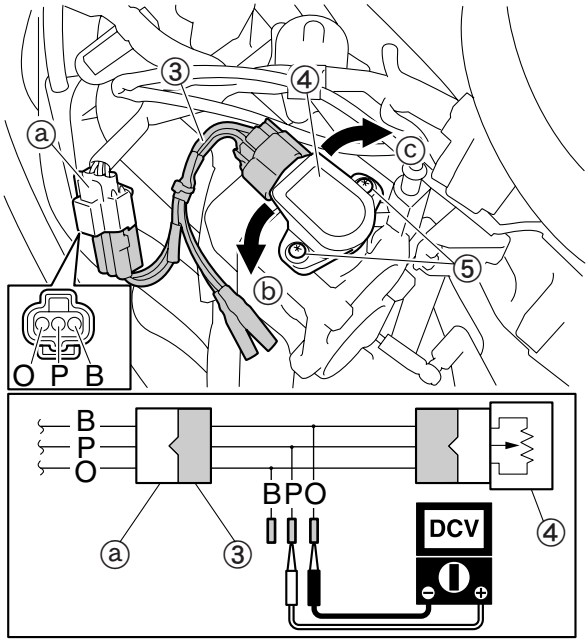
3. Check that the throttle valves are fully closed.

4. Disconnect the TPS coupler ⓐ, and then connect the test harness (3 pin) ③.

5. Turn the engine start switch to “ON.”

6. Measure the TPS output voltage with the throttle valves fully closed. If the output voltage is out of specification, adjust the position of the TPS ④.

7. Loosen the TPS screws ⑤ and adjust the position of the TPS ④ to get the specified output voltage.



Test harness (3 pins) ③: 90890-06793

TPS output voltage:
Pink (P)–Black (B)
0.70 ± 0.02 V

TIP:

- To increase the output voltage, turn the TPS ④ in direction ⓑ.
- To decrease the output voltage, turn the TPS ④ in direction ⓒ.

8. Tighten the TPS screws ⑤.

9. Connect the throttle link joint assembly ① to the throttle lever 1 ②.

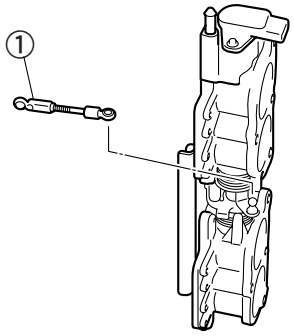
10. Operate the throttle valves several times and make sure that the TPS output voltage is specification.

11. Disconnect the test harness (3 pins) ③, and then connect the TPS coupler ⓐ.

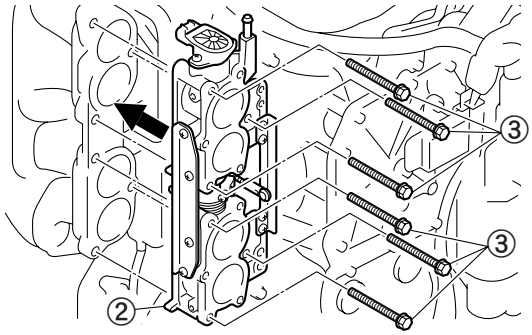
12. Install the intake silencer. See “Intake silencer” (6-16).

Installing the throttle body assembly

1. Install the throttle link joint assembly ①.



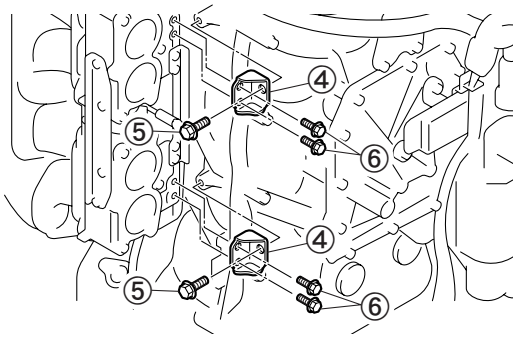
2. Install the throttle body assembly ②, and then tighten the throttle body assembly bolts ③ to the specified torque.



Throttle body assembly bolt ③: 13 N·m (1.3 kgf·m, 9.6 ft·lb)

3. Install the brackets ④ and temporarily tighten the bracket bolts ⑤ and ⑥.

4. Tighten the bracket bolts ⑤ and ⑥.



Adjusting the TPS (when disassembling or replacing the throttle body)

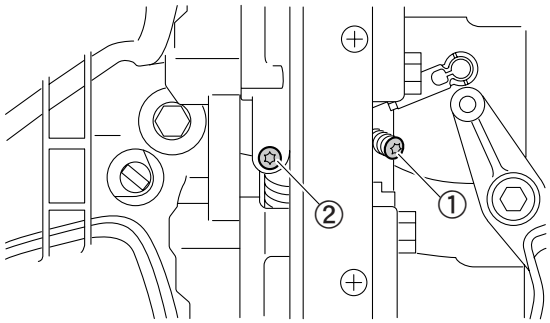
When adjusting the TPS, the output voltage can also be measured using the "Engine monitor" of the YDIS. To connect and operate the YDIS, see the YDIS (Ver. 1.30 or later) Instruction Manual.

1. Install the throttle body assembly.

2. Install the throttle link. See "Installing the throttle link" (6-18).

3. Loosen the synchronizing screw ① to open throttle valves #3 and #4.

4. Loosen the throttle stop screw ② to fully close throttle valves #1 and #2.

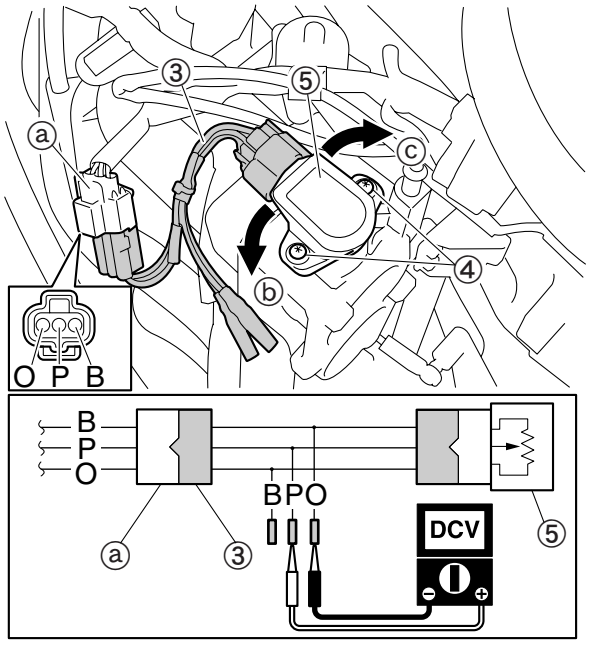


5. Disconnect the TPS coupler ⓐ, and then connect the test harness (3 pins) ③.

6. Turn the engine start switch to "ON."

6

7. Loosen the TPS screws ④ and adjust the position of the TPS ⑤ to get the specified output voltage.



Test harness (3 pins) ③: 90890-06793

TPS output voltage:
Pink (P)–Black (B)
0.66 V

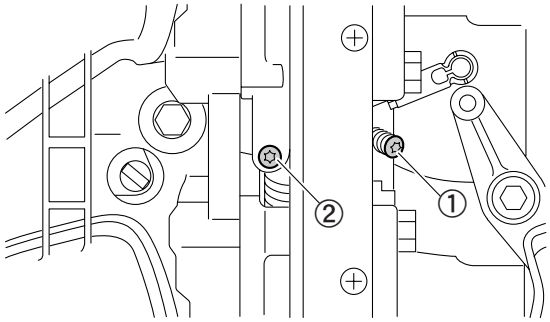
TIP:
- To increase the output voltage, turn the TPS ⑤ in direction ⓑ.
- To decrease the output voltage, turn the TPS ⑤ in direction ⓒ.

8. Tighten the TPS screws ④.

9. Operate the throttle valves several times and make sure that the TPS output voltage is specification.

10. Slowly tighten the synchronizing screw ① and stop when the TPS output voltage begins to change.

11. Slowly tighten the throttle stop screw ②, until the TPS output voltage is within specification.



TPS output voltage:
Pink (P)–Black (B)
0.70 ± 0.02 V

12. Operate the throttle valves several times and make sure that the TPS output voltage is within specification.

13. Adjust the throttle link. See “Adjusting the throttle link” (6-19).

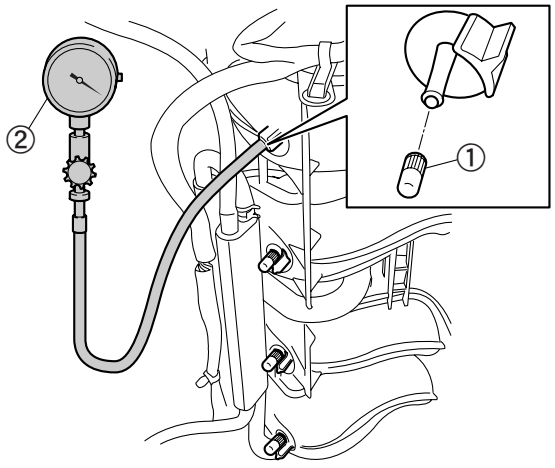
14. Install the intake silencer. See “Intake silencer” (6-16).

Synchronizing the throttle valve

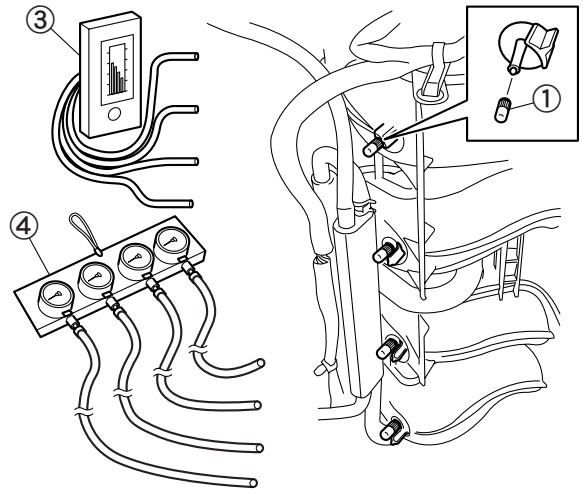
NOTICE

Do not adjust the throttle valves when they are operating properly.

1. Remove the caps ①, and then connect the special service tool ② to the intake manifold.



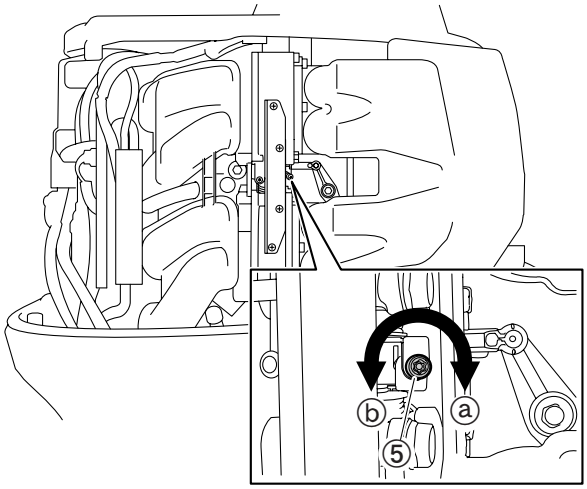
Vacuum gauge ②: 90890-03159



Vacuum gauge ③, ④:
(commercially available)

TIP:
For best results, use a vacuum gauge (commercially available), like ③ or ④ that has four adapters.

2. Start the engine and warm it up for 5 minutes.
3. Check the vacuum pressure of all cylinders.
4. Turn the synchronizing screw ⑤ so that the each vacuum pressure of cylinder #3 or #4 is within 2.0 kPa (15.0 mmHg) of the each vacuum pressure of cylinder #1 or #2.



TIP:
- To increase the vacuum pressure, turn the synchronizing screw ⑤ in direction ⓐ.
- To decrease the vacuum pressure, turn the synchronizing screw ⑤ in direction ⓑ.

Example:
Check results:

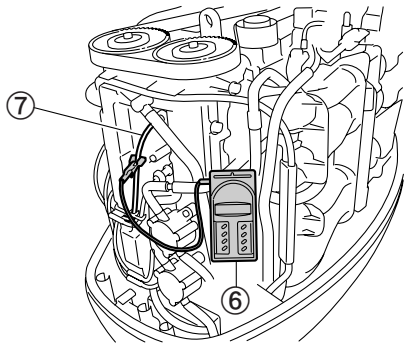
Cylinder	#1	#2	#3	#4
kPa (mmHg)	49.0 (370.0)	48.0 (360.0)	47.0 (350.0)	46.0 (340.0)

Adjust the difference of the vacuum pressure between cylinders #1 and #4 to within 2.0 kPa (15.0 mmHg).
Check results:

Cylinder	#1	#2	#3	#4
kPa (mmHg)	49.0 (370.0)	48.0 (360.0)	50.0 (370.0)	51.0 (380.0)

Adjust the difference of the vacuum pressure between cylinders #2 and #4 to within 2.0 kPa (15.0 mmHg).

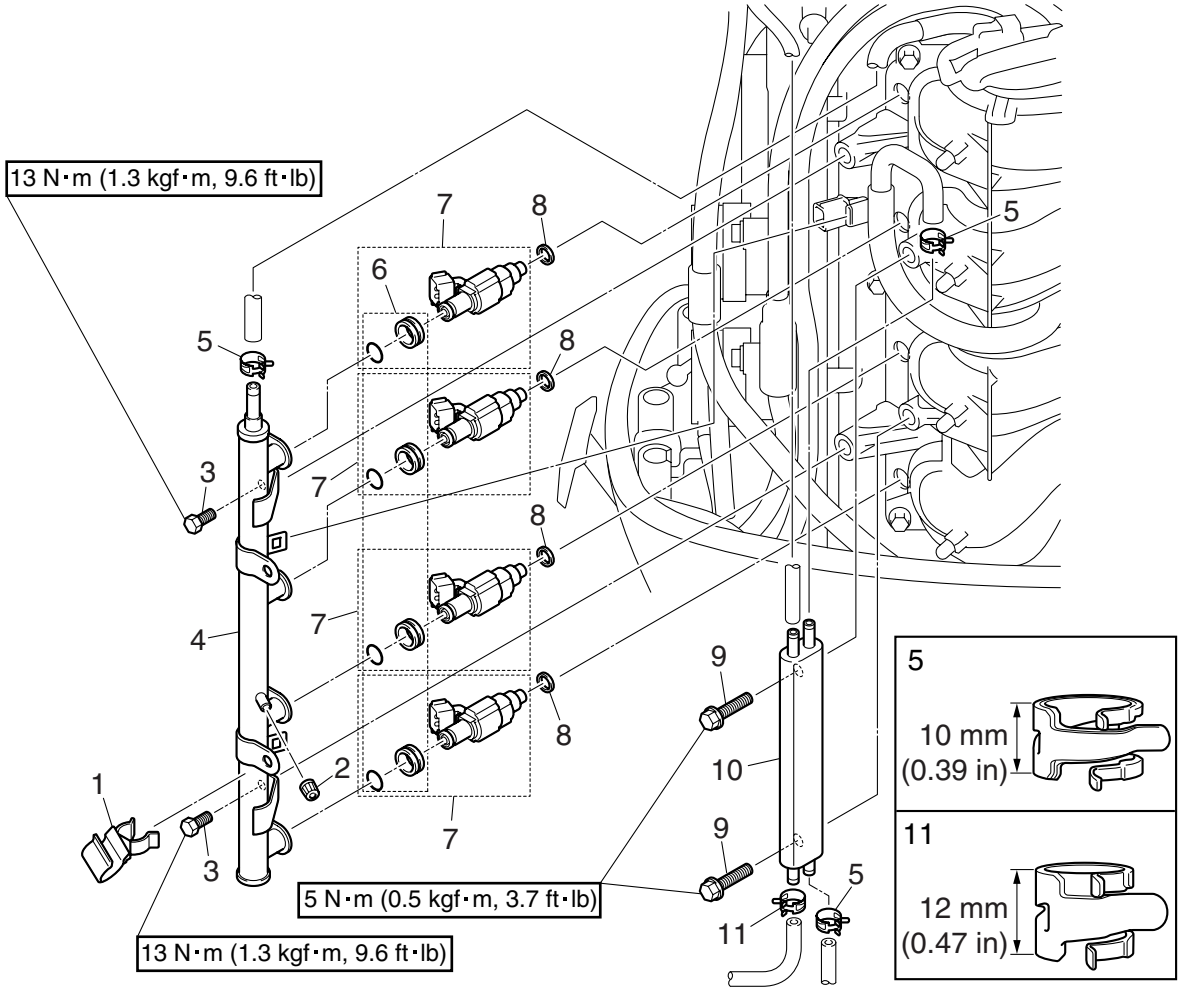
5. Attach the special service tool ⑥ to spark plug wire #1 ⑦, and then check the engine idle speed.



Digital tachometer ⑥: 90890-06760

Engine idle speed: 650–750 r/min

Fuel injector



No.	Part name	Q'ty	Remarks
1	Holder	1	
2	Cap	1	
3	Bolt	2	M8 × 18 mm
4	Fuel rail	1	
5	Clamp	3	
6	O-ring set	1	**Not reusable**
7	Fuel injector	4	
8	Rubber seal	4	**Not reusable**
9	Bolt	2	M6 × 25 mm
10	Fuel cooler	1	
11	Clamp	1	

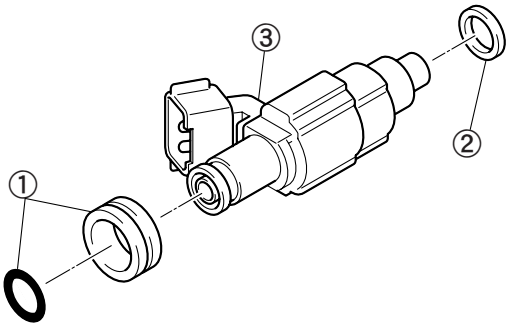
Checking the fuel rail

1. Check the fuel rail. Replace the fuel rail if cracked or deformed.

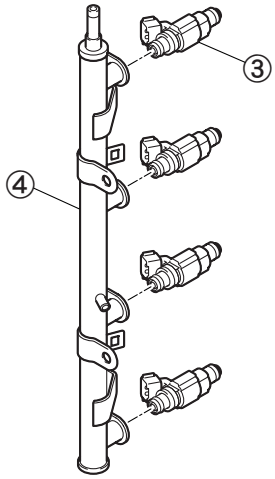
2. Check the fuel injector electrical performance. See “Checking the fuel injector” (5-24).

Installing the fuel injector

1. Install a new O-ring set ① and a new rubber seal ② to the fuel injector ③.

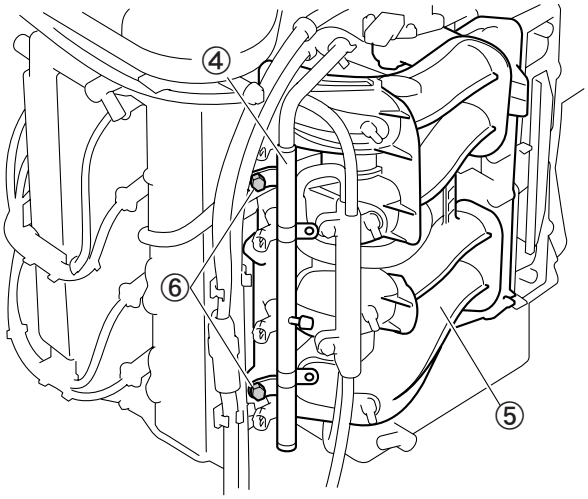


2. Install the fuel injectors ③ onto the fuel rail ④.



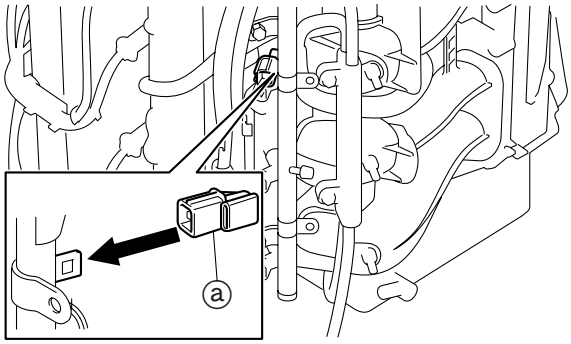
3. Install the fuel rail ④ onto the intake manifold ⑤.

4. Tighten the bolts ⑥ equally and gradually to the specified torque.

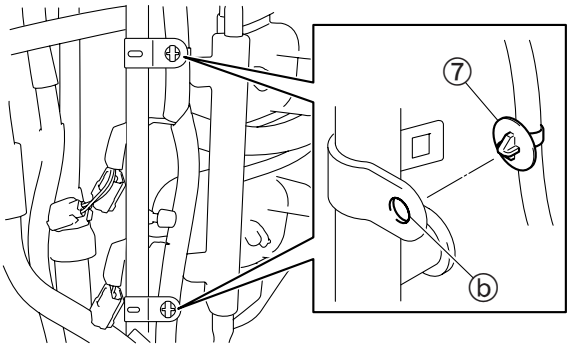


Fuel rail bolt ⑥:
13 N·m (1.3 kgf·m, 9.6 ft·lb)

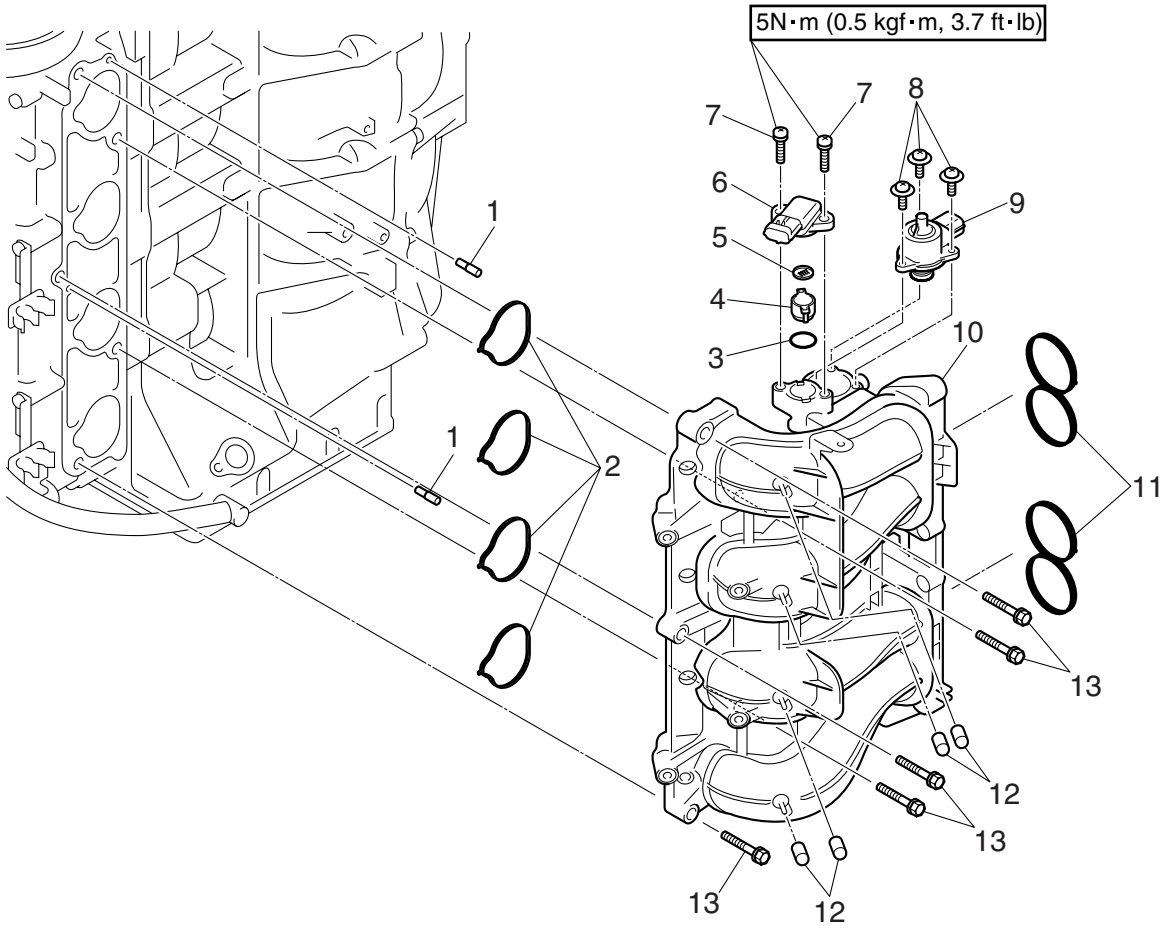
5. Install the wiring harness coupler ⓐ to the holder.



6. Install the wiring harness by fitting the projection of the holders ⑦ into the fuel rail stay hole ⓑ.



Intake manifold



No.	Part name	Q'ty	Remarks
1	Pin	2	
2	Gasket	4	**Not reusable**
3	O-ring	1	**Not reusable**
4	Holder	1	
5	Filter	1	
6	Air pressure sensor	1	
7	Screw	2	M5 × 15 mm
8	Screw	3	M4 × 15 mm
9	ISC	1	
10	Intake manifold	1	
11	Gasket	2	**Not reusable**
12	Cap	4	
13	Bolt	5	M8 × 40 mm

Checking the intake manifold

1. Check the intake manifold. Replace the intake manifold if cracked or deformed.

Checking the air pressure sensor

1. Check the air pressure sensor exterior. Replace if cracked.

2. Check the air pressure sensor electrical performance. See “Checking the air pressure sensor” (5-32).

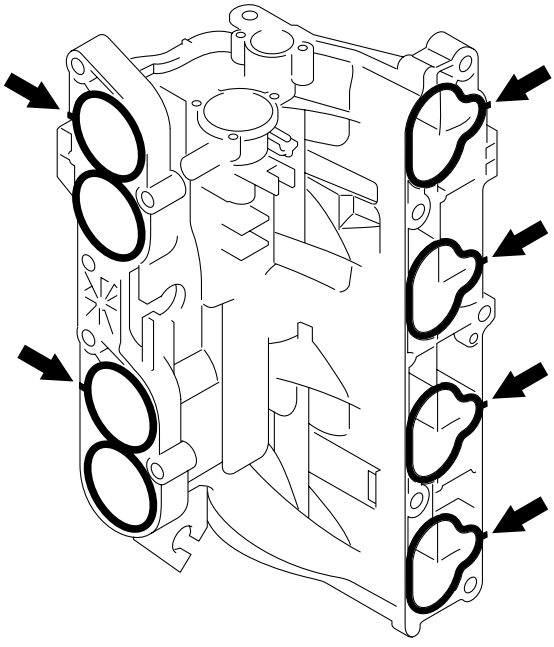
Checking the ISC

1. Check the ISC exterior. Replace if cracked.

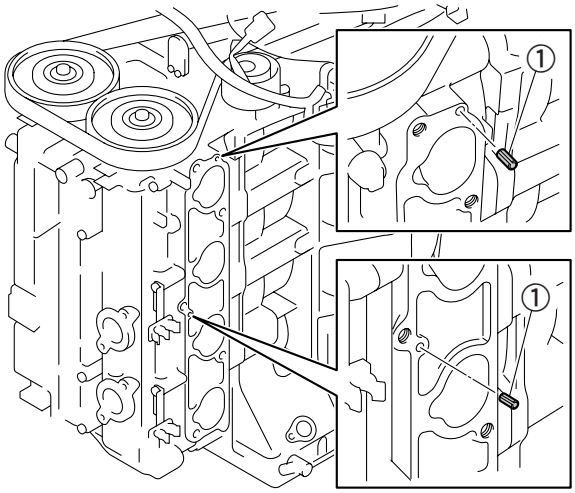
2. Check the ISC electrical performance. See “Checking the ISC” (5-17).

Installing the intake manifold

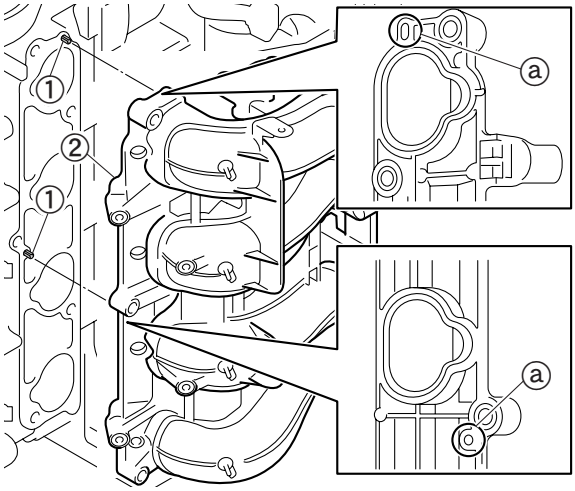
1. Install new gaskets onto the intake manifold. Make sure that tab on the gaskets is properly and firmly fitted into the groove on the intake manifold.



2. Install the pins ①.

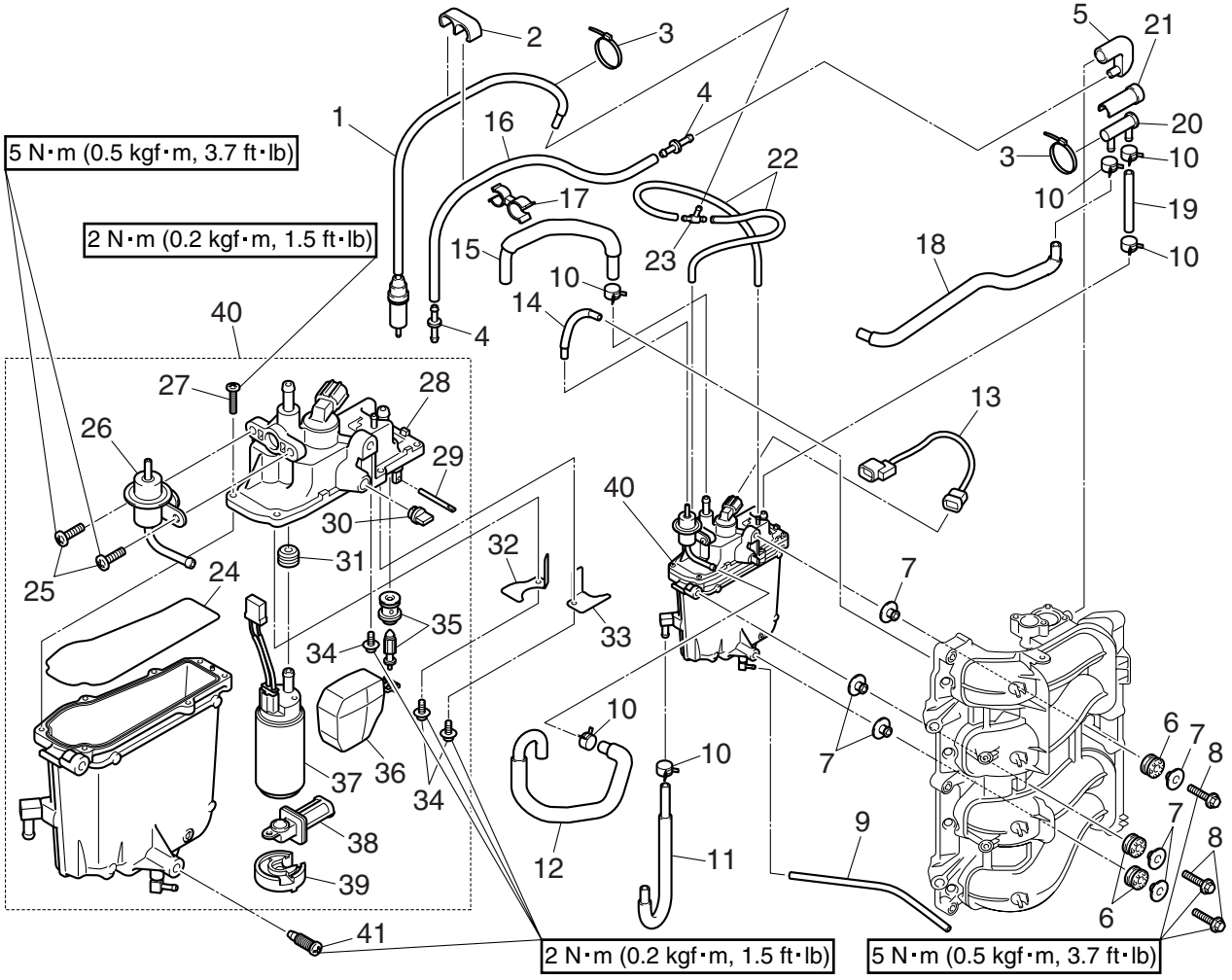


3. Align the positions ⓐ with the pins ① when installing the intake manifold ②.

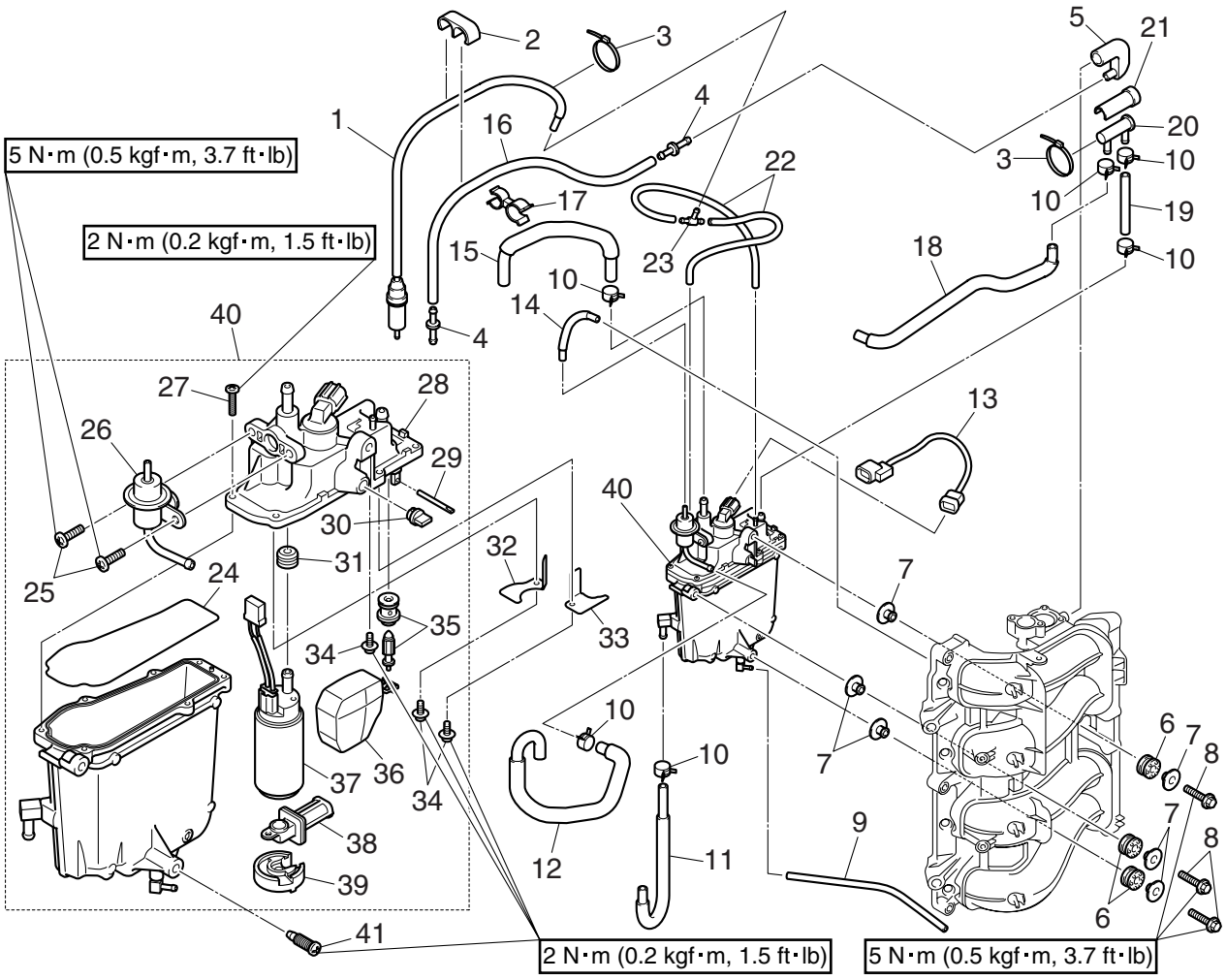


6

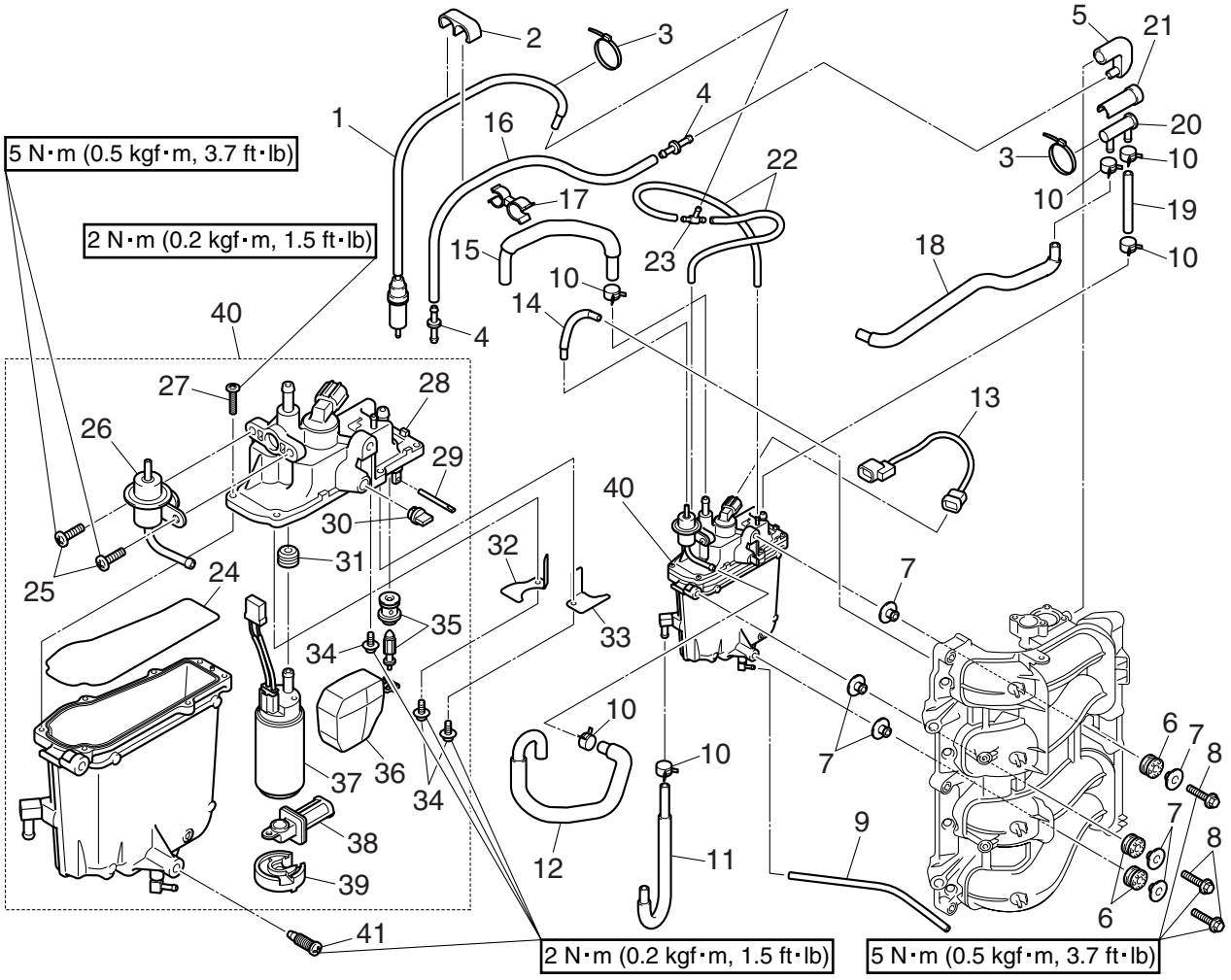
Vapor separator



No.	Part name	Q'ty	Remarks
1	Hose	1	
2	Holder	1	
3	Plastic tie	2	**Not reusable**
4	Joint	2	
5	Hose	1	
6	Damper	3	
7	Collar	6	
8	Bolt	3	M6 × 35 mm
9	Hose	1	
10	Clamp	6	
11	Hose	1	
12	Hose	1	
13	Wiring harness	1	
14	Hose	1	
15	Hose	1	
16	Hose	1	
17	Holder	1	



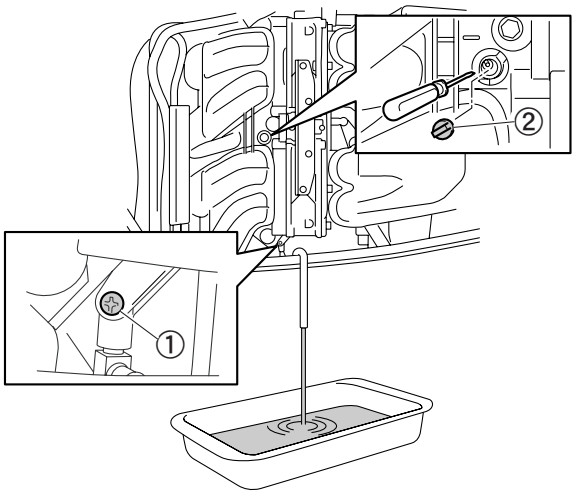
No.	Part name	Q'ty	Remarks
18	Hose	1	
19	Hose	1	
20	Filter	1	
21	Cover	1	
22	Hose	2	
23	Joint	1	
24	Gasket	1	**Not reusable**
25	Screw	2	M6 × 12 mm
26	Pressure regulator	1	
27	Screw	7	M4 × 16 mm
28	Cover assembly	1	
29	Pin	1	
30	Cap	1	
31	Grommet	1	
32	Plate	1	
33	Plate	1	
34	Screw	3	M4 × 8 mm



No.	Part name	Q'ty	Remarks
35	Needle valve assembly	1	
36	Float	1	
37	High-pressure fuel pump	1	
38	Filter	1	
39	Filter holder	1	
40	Vapor separator	1	
41	Drain screw	1	

Draining the fuel

1. Drain the remained gasoline in the vapor separator with a drain pan. Loosen the drain screw ①, and then remove the cap ②. Push in the air valve with a screwdriver.



2. Tighten the drain screw ① to the specified torque.

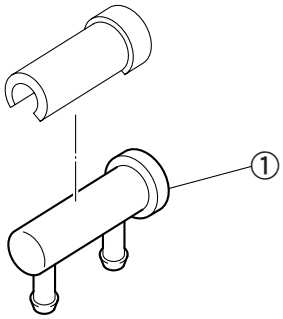
Vapor separator drain screw ①: 2 N·m (0.2 kgf·m, 1.5 ft·lb)

Checking the vacuum hose

1. Check the vacuum hose. Replace the vacuum hose if cracked or damaged.

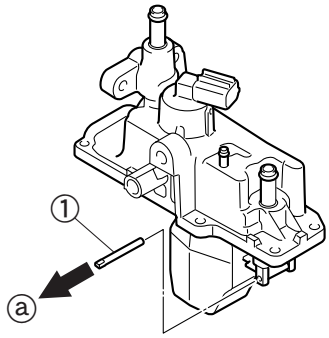
Checking the fuel filter

1. Check the fuel filter ①. Replace the fuel filter if there is dirt, residue, or external damage.



Disassembling the vapor separator

1. Remove the float pin ① in the direction of the arrow ⓐ.



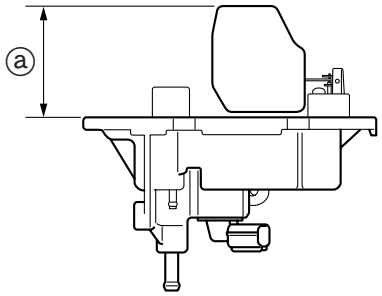
2. Remove the needle valve assembly and other components. See exploded diagram (6-29).

Checking the high-pressure fuel pump

1. Check the high-pressure fuel pump electrical performance. See “Checking the high-pressure fuel pump” (5-25).

Checking the vapor separator

1. Place the cover assembly upside down, and then measure the float height ⓐ.



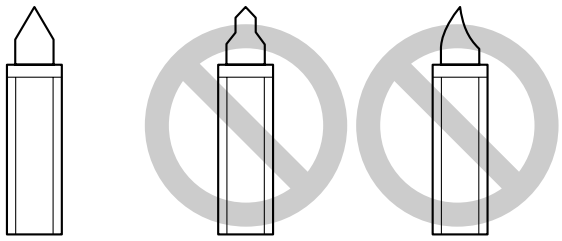
Float height ⓐ: 55.0–61.0 mm (2.2–2.4 in)

TIP:

To measure the height of the float, it should be resting on the needle valve. Do not press the float.

6

2. Check the needle valve. Replace needle valve assembly if bent or worn.

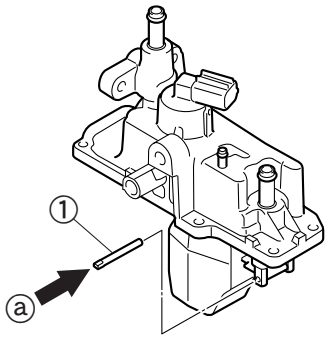


3. Check the float. Replace if there is deterioration.

4. Check the filter. Clean if there is dirt or residue.

Assembling the vapor separator

1. Install the needle valve assembly and float to the cover assembly, and then insert the float pin ① in the direction ⓐ.



2. Check the float for smooth operation.

3. Check the float height. See “Checking the vapor separator” (6-32) step 1.

4. Assemble the vapor separator. See exploded diagram (6-29).

— MEMO —

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Power unit (check and adjustment)

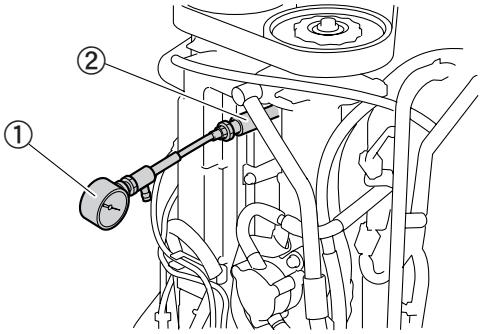
Checking the compression pressure

1. Start the engine and warm up until the engine idle speed is stable at 650–750 r/min, and then turn it off.

2. Remove the clip from the engine shut-off switch.

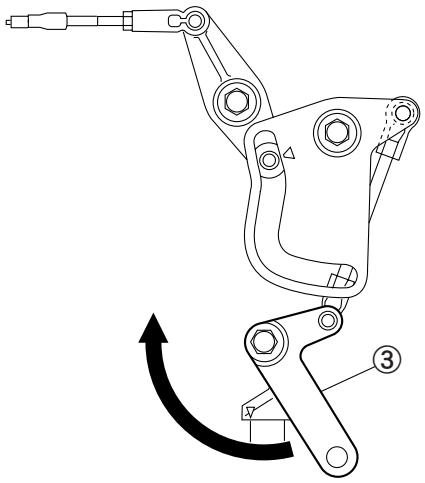
3. Disconnect all fuel injector couplers.

4. Remove the spark plug wire cover and all spark plugs, and then install the special service tools ① and ② into a spark plug hole. ***NOTICE:*** **Before removing the spark plugs, blow compressed air in the spark plug well to clear out any dirt or dust that may fall into the cylinder.**



Compression gauge ①:
90890-03160
Compression gauge extension ②:
90890-06563

5. Disconnect the throttle cable joint from the accelerator lever ③, and then place and hold the lever in the fully open position of the throttle.



6. Crank the engine until the reading on the compression gauge stabilizes, and then measure the compression pressure.

Minimum compression pressure
(reference data):
880.0 kPa (8.80 kgf/cm^2, 127.6 psi)

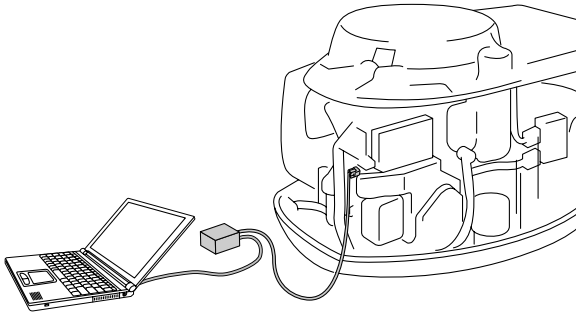
7. If the compression pressure is below specification and the compression pressure for each cylinder is unbalanced, add a small amount of engine oil to the cylinder, and then measure the compression pressure again.

TIP:

- If the compression pressure increases, check the pistons and piston rings. Replace if worn. See “Assembling the cylinder block” (7-61).
- If the compression pressure does not increase, check the valve clearances, valves, valve seats, cylinder head gasket, and cylinder head. Adjust or replace if necessary. See “Cylinder head” (7-36).

Checking the oil pressure

1. Connect a computer to the outboard motor and use the YDIS. To connect and operate the YDIS, see the YDIS (Ver. 1.30 or later) Instruction manual. To display "Oil pressure."



2. Start the engine and warm up until the engine idle speed is stable at 650–750 r/min, and then turn it off.

3. Measure the oil pressure. If it is out of specification, see "Troubleshooting the power unit (trouble code not detected)" (4-11) and perform the troubleshooting again.

Oil pressure (reference data): 450.0 kPa (4.50 kgf/cm², 65.3 psi) at 60 °C (140 °F) with SL 10W-30 engine oil and at 700 r/min

Checking the valve clearance

Measure the valve clearances when the engine is cold.

NOTICE

Do not turn the flywheel magnet counterclockwise, otherwise the water pump impeller may be damaged.

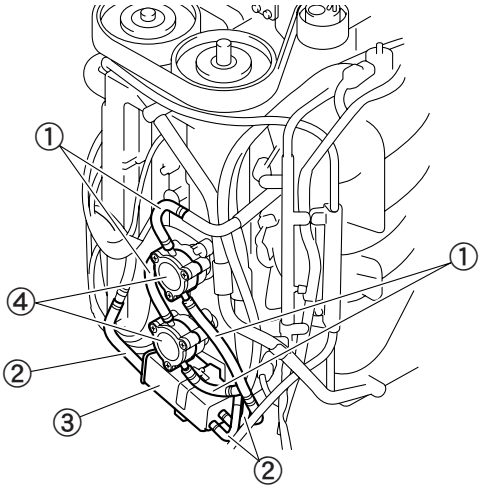
1. Reduce the fuel pressure. See "Reducing the fuel pressure" (6-4).

TIP:

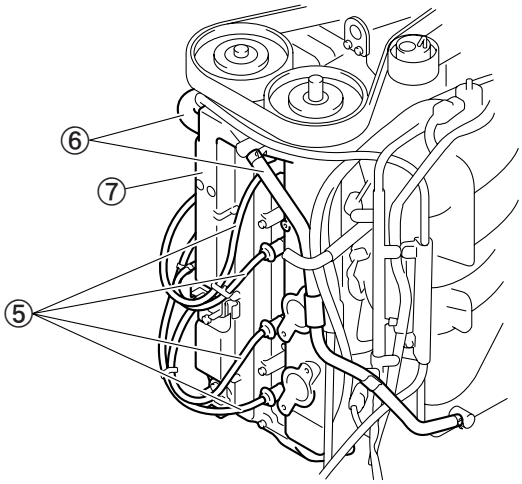
When measuring the valve clearances, the fuel line must be disconnected, so make sure to reduce the fuel pressure before performing the disconnection procedure.

2. Remove the flywheel magnet cover and spark plug wire cover.

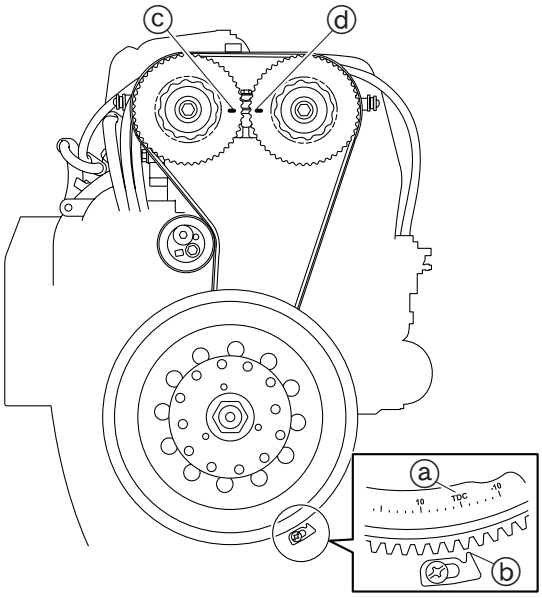
3. Disconnect the fuel hoses ① and vapor gas hoses ②, and then remove the canister ③ and fuel pumps ④.



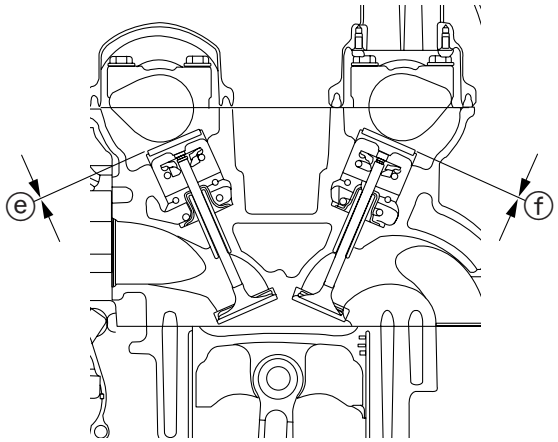
4. Disconnect the spark plug wires ⑤, and then remove the blowby hoses ⑥, all spark plugs, and cylinder head cover ⑦.



5. Turn the flywheel magnet clockwise and align the "TDC" mark ⓐ on the flywheel magnet with the pointer ⓑ, and check that the "I" marks ⓒ and ⓓ on the driven sprockets are aligned.



6. Measure each valve clearance ⓔ and ⓕ according to step 7–step 9.



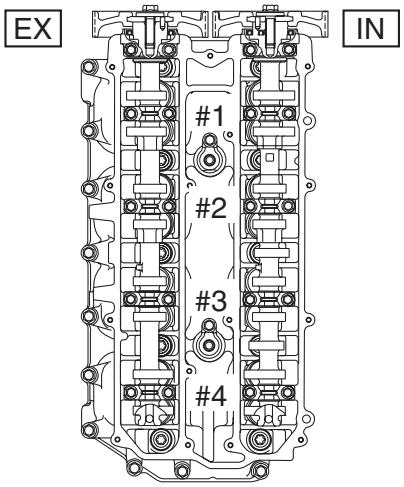
Valve clearance:
Intake ⓔ:
0.20 ± 0.03 mm (0.008 ± 0.001 in)
Exhaust ⓕ:
0.34 ± 0.03 mm (0.013 ± 0.001 in)

TIP:
Note the measurement data.

7. Measure the intake valve clearance for cylinders #1 and #2, and exhaust valve clearance for cylinders #1 and #3. Adjust if out of specification.

8. Turn the flywheel magnet 360° clockwise.

9. Measure the intake valve clearance for cylinders #3 and #4, and exhaust valve clearance for cylinders #2 and #4. Adjust if out of specification.



Adjusting the valve clearance

Adjust the valve clearances when the engine is cold.

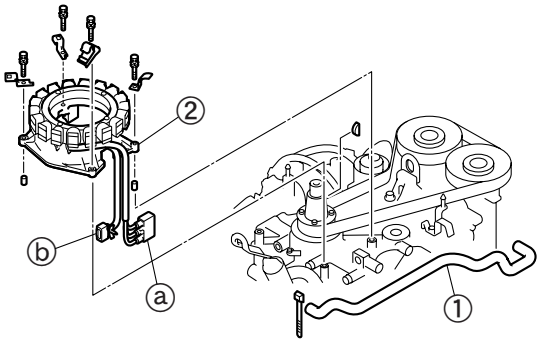
NOTICE

- **Do not turn the flywheel magnet counterclockwise, otherwise the water pump impeller may be damaged.**
- **Do not turn the flywheel magnet or the driven sprockets when the timing belt is not installed. Otherwise the pistons and valves, or intake and exhaust valves will collide with each other and be damaged.**

1. Align the “TDC” mark on the flywheel magnet with the pointer, and check that the “I” marks on the driven sprockets are aligned. See “Checking the valve clearance” (7-2) step 1–step 5.

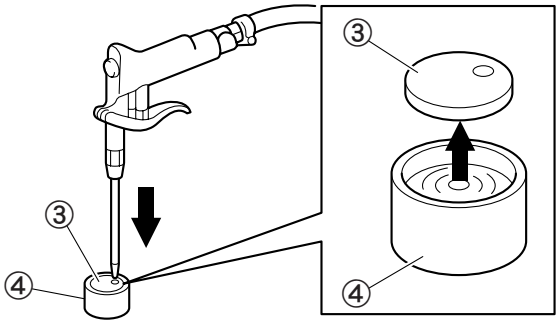
2. Remove the flywheel magnet and Woodruff key. See “Removing the flywheel magnet” (7-6).

3. Disconnect the stator assembly coupler ⓐ and pulser coil coupler ⓑ, and then remove the blowby hose ① and stator assembly (lighting coil) ②.



4. Remove the timing belt, driven sprockets, and camshafts. See “Removing the timing belt, driven sprocket, and camshaft” (7-28).

5. Remove the valve shim ③ from the valve lifter ④ using compressed air.



TIP:
Do not mix the valve train parts. Keep them organized in their proper groups.

6. Measure the valve shim thickness using a micrometer, and then note the measurement data.

7. Select the necessary valve shim by calculating its thickness using the following formula.

Necessary valve shim thickness = Removed valve shim thickness + Measured valve clearance – Specified valve clearance

Example:
If the “Removed valve shim thickness” is 2.10 mm, the “Measured valve clearance” is 0.30 mm and the “Specified valve clearance” is 0.20 mm, then the “Necessary valve shim thickness” = 2.10 + 0.30 – 0.20 = 2.20 mm.

8. Install the necessary valve shim into the valve lifter.

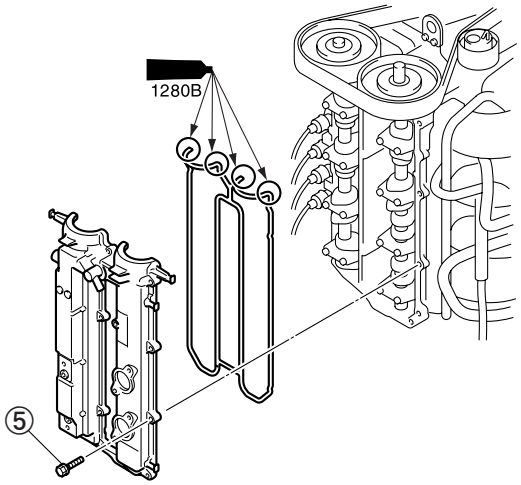
9. Install the camshafts, driven sprockets, and timing belt. See “Installing the timing belt, driven sprocket, and camshaft” (7-30).

10. Install the stator assembly (lighting coil).

11. Install the flywheel magnet. See “Installing the flywheel magnet” (7-6).

12. Measure each valve clearance and adjust again if out of specification.

13. Install the cylinder head cover, and then tighten the bolts ⑤ to the general tightening torque in 2 stages (both stages).



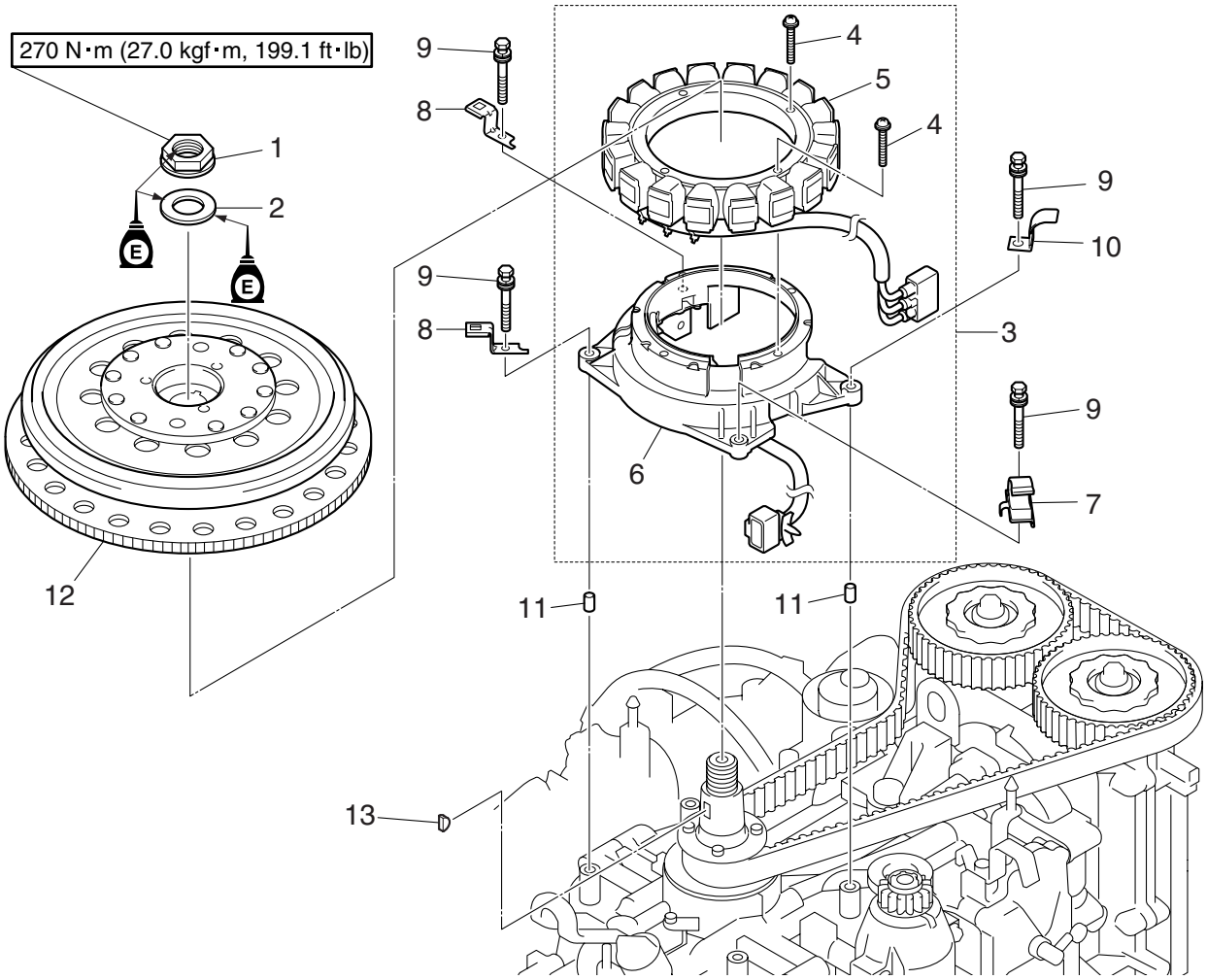
14. Install the all spark plugs, and then tighten spark plugs to the specified torque.

Spark plug: 25 N·m (2.5 kgf·m, 18.4 ft·lb)

15. Connect the all spark plug wires.

16. Install all parts removed during disassembly. ***NOTICE:*** **Check that the wiring harness, hoses, and other parts do not interfere with any moving parts.**

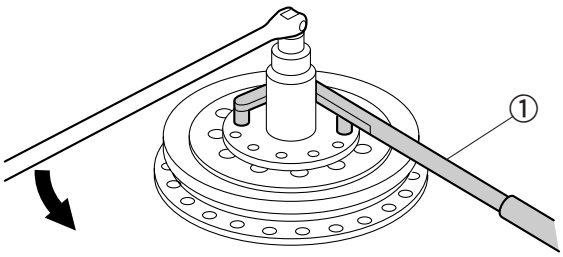
Flywheel magnet



No.	Part name	Q'ty	Remarks
1	Nut	1	Width across flats: 36 mm
2	Washer	1	
3	Base assembly	1	
4	Screw	4	M6 × 30 mm
5	Stator assembly (lighting coil)	1	
6	Pulser coil	1	
7	Holder	1	
8	Bracket	2	
9	Bolt	4	M6 × 35 mm
10	Holder	1	
11	Collar	2	
12	Flywheel magnet	1	
13	Woodruff key	1	

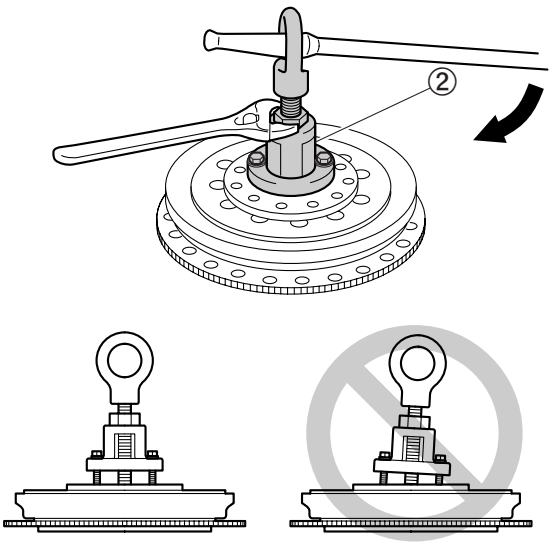
Removing the flywheel magnet

1. Loosen the flywheel magnet nut.
   NOTICE: **Apply force in the direction of the arrows to prevent the flywheel holder ① from slipping off easily.**



Flywheel holder ①: 90890-06522

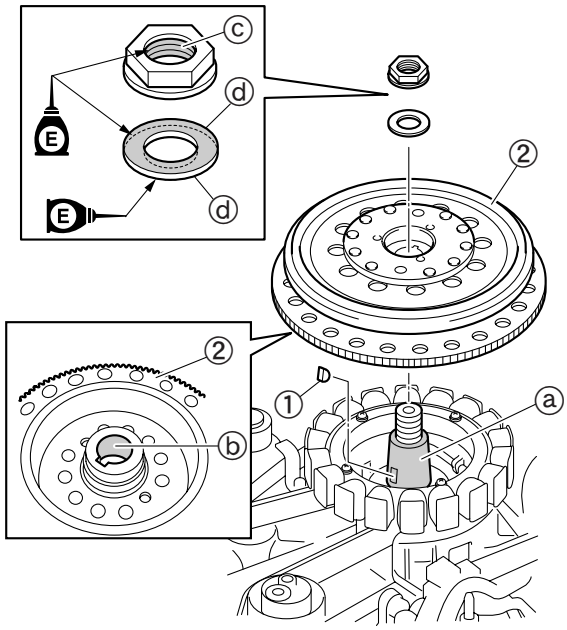
2. Remove the flywheel magnet.
   NOTICE: **To prevent damage to the engine or tools, screw in the flywheel puller set bolts evenly and completely so that the flywheel puller is parallel to the flywheel magnet.**



Flywheel puller ②: 90890-06521

Installing the flywheel magnet

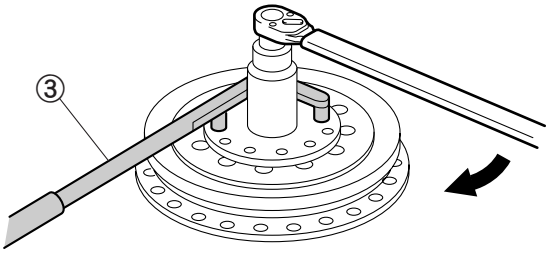
1. Install the Woodruff key ①, and then install the flywheel magnet ②.



TIP:

- Make sure to remove any grease from the tapered portion of the crankshaft ⓐ and the flywheel magnet ⓑ.
- Apply engine oil to the thread ⓒ of the flywheel magnet nut and upper and lower surface ⓓ of the washer before installation.

2. Tighten the flywheel magnet nut to the specified torque.

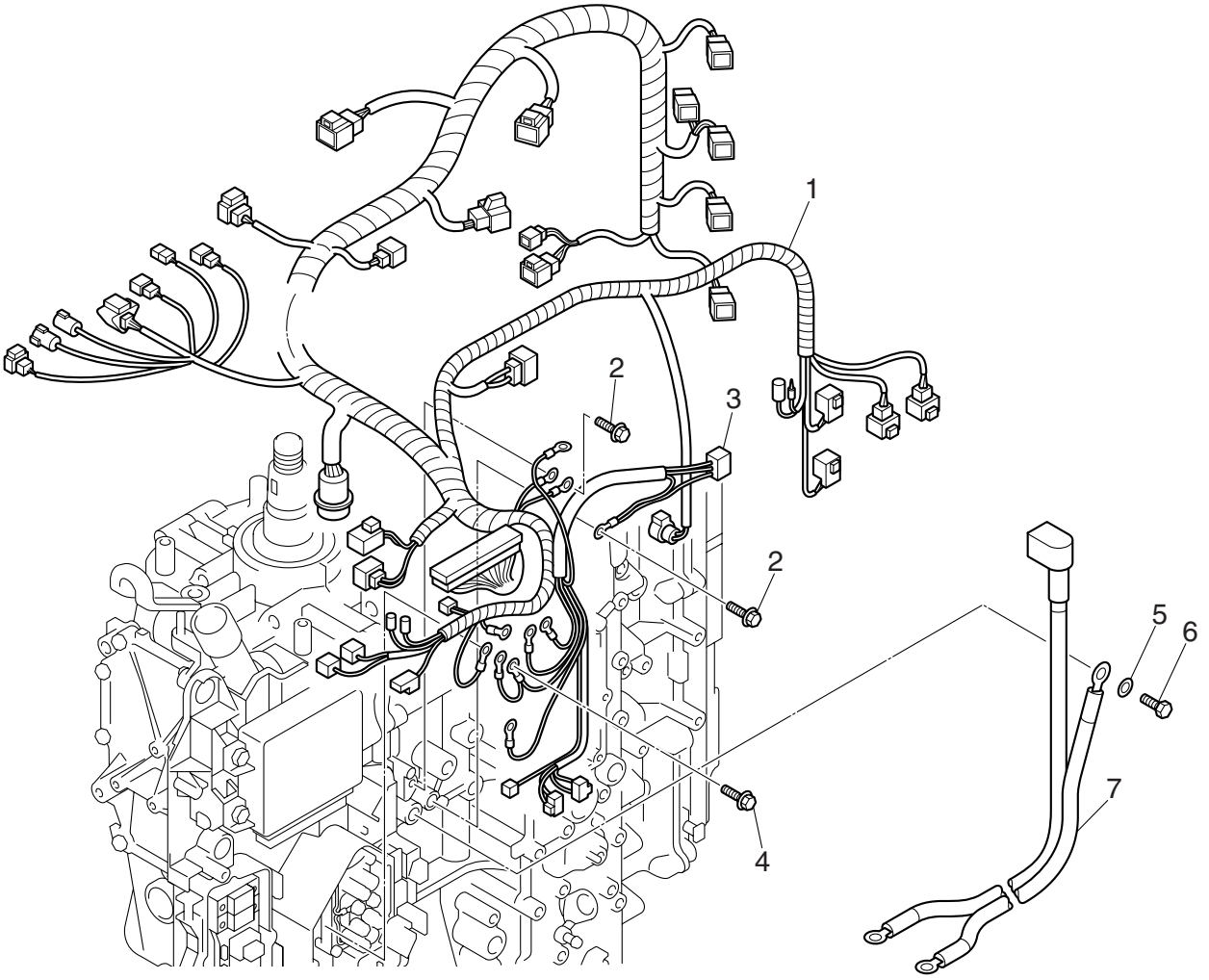


Flywheel holder ③: 90890-06522

Flywheel magnet nut: 270 N·m (27.0 kgf·m, 199.1 ft·lb)

7

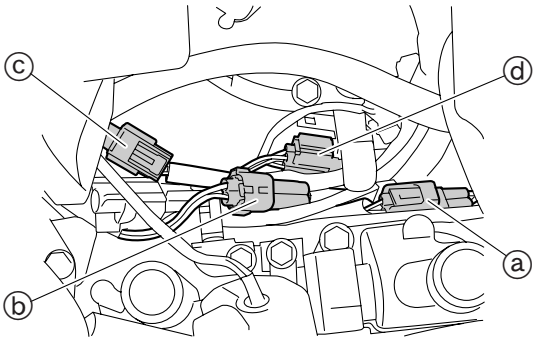
Wiring harness



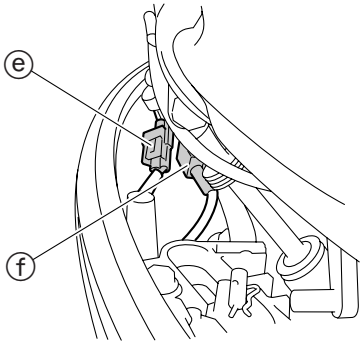
No.	Part name	Q'ty	Remarks
1	Wiring harness	1	
2	Bolt	3	M6 × 20 mm
3	Wiring harness	1	
4	Bolt	1	M6 × 12 mm
5	Washer	1	
6	Bolt	1	M8 × 16 mm
7	Wiring harness	1	

Removing the wiring harness

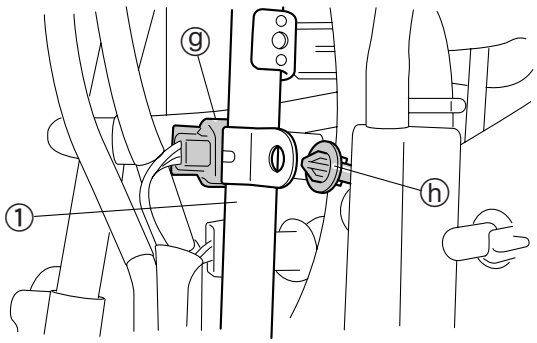
1. Remove the flywheel magnet cover.
2. Remove the flywheel magnet. See “Removing the flywheel magnet” (7-6).
3. Disconnect the PTT switch coupler ⓐ, trim sensor coupler ⓑ, and water detection switch coupler ⓒ.
4. Remove the gauge harness coupler ⓓ from the bracket.



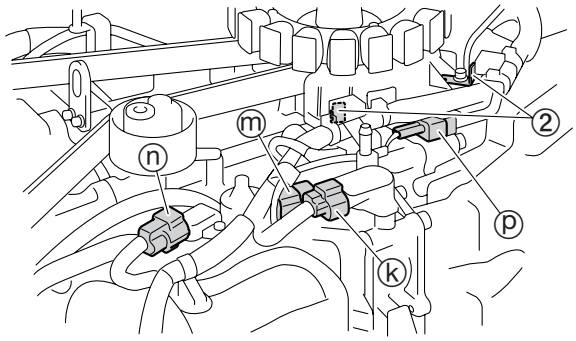
5. Disconnect the shift cut switch coupler ⓔ and neutral switch coupler ⓕ.



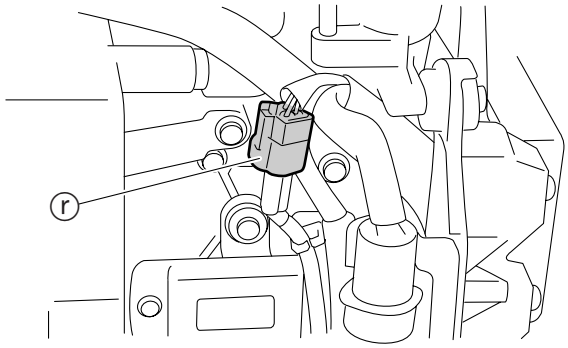
6. Disconnect the all fuel injector couplers.
7. Disconnect the fuel pump coupler ⓖ.
8. Remove the projection ⓗ of the plastic tie from the fuel rail ①.



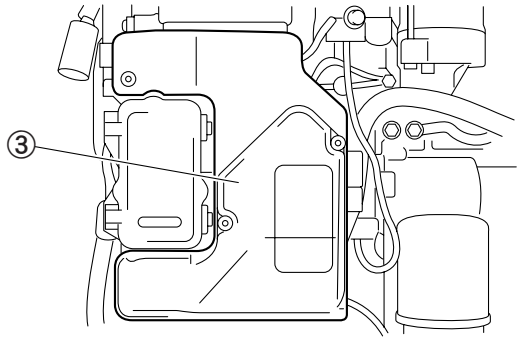
9. Disconnect the TPS coupler ⓚ, ISC coupler ⓜ, air pressure sensor coupler ⓝ, and engine temperature sensor coupler ⓟ, and then remove the wiring harness from the brackets ②.



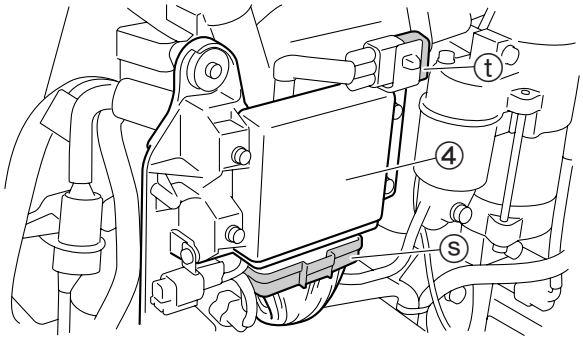
10. Disconnect the hour meter coupler ⓡ.



11. Remove the cover ③.

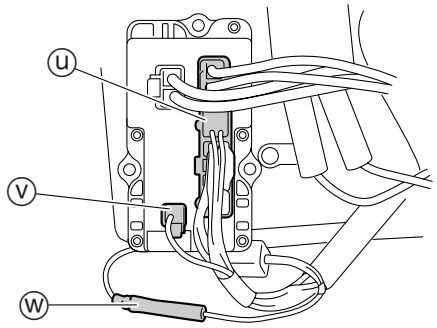


12. Disconnect the engine ECM coupler ⓢ and pulser coil coupler ⓣ, and then remove the engine ECM ④.

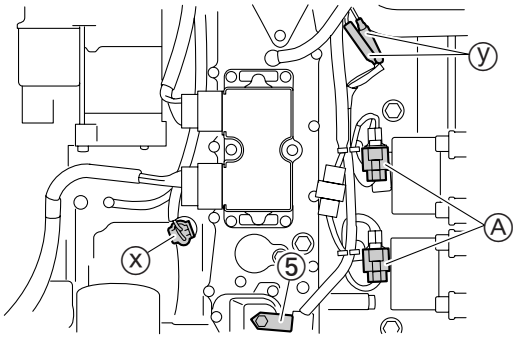


7

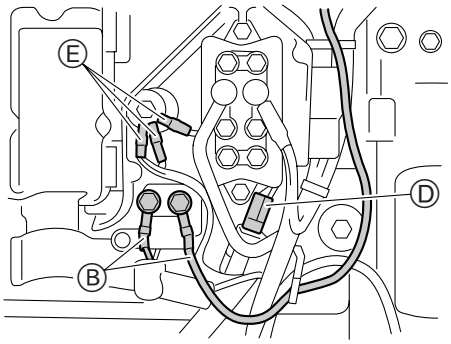
13. Remove the fuse box, and then disconnect the fuse box couplers ⓤ, ⓥ, and connector ⓦ.



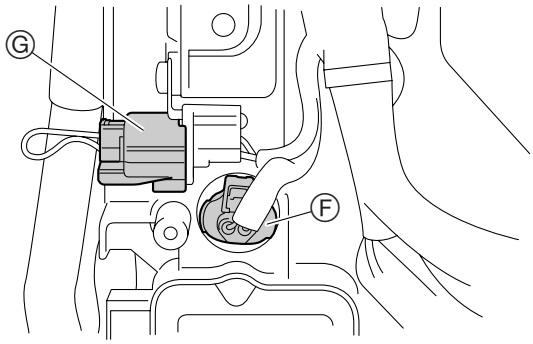
14. Disconnect the oil pressure sensor coupler ⓧ, thermoswitch connectors ⓨ, and ignition coil couplers Ⓐ, and then remove the bracket ⑤.



15. Disconnect the starter relay leads Ⓑ, PTT relay coupler Ⓓ and ground leads Ⓔ.



16. Remove the air temperature sensor coupler Ⓕ and YDIS coupler Ⓖ.

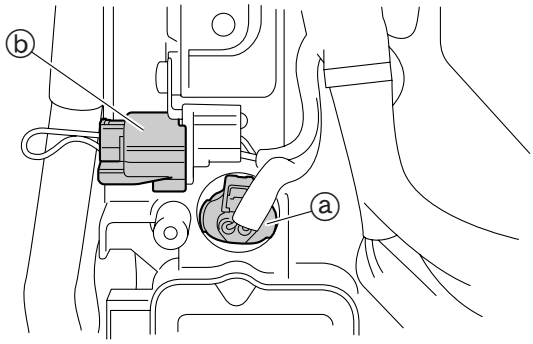


Installing the wiring harness

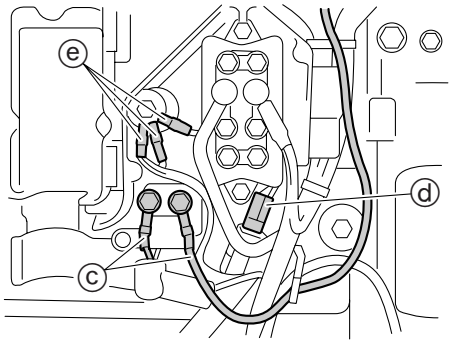
To install all of the wiring harnesses, see “Wiring harness routing” (5-6).

1. Install the sensors and switches that were removed to the power unit.

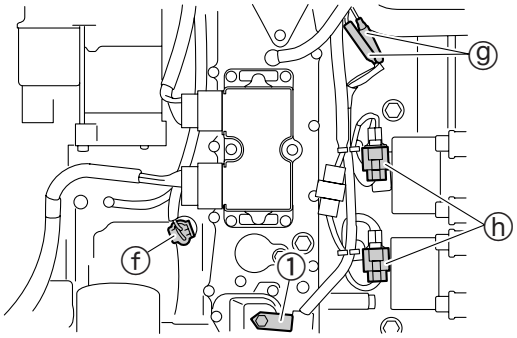
2. Install the air temperature sensor coupler ⓐ and YDIS coupler ⓑ.



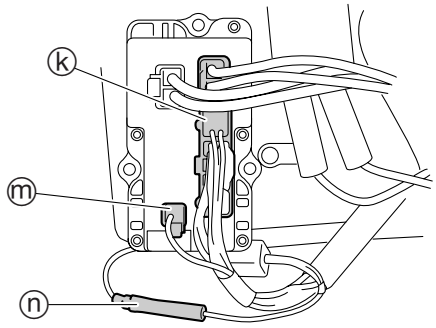
3. Connect the starter relay leads ⓒ, PTT relay couplers ⓓ, and ground leads ⓔ.



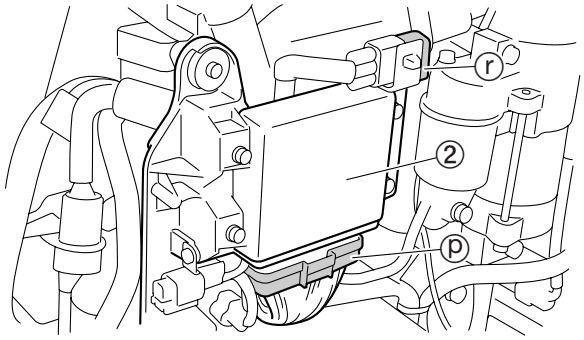
4. Install the bracket ①, and then connect the oil pressure sensor coupler ⓕ, thermoswitch connectors ⓖ and ignition coil couplers ⓗ.



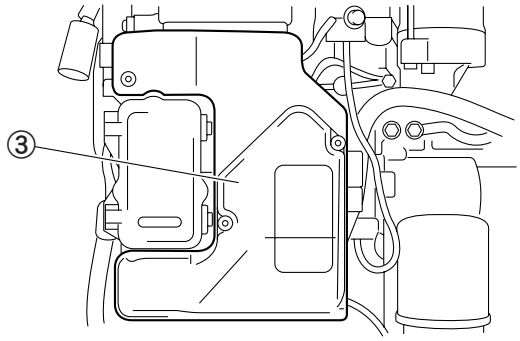
5. Connect the fuse box couplers ⓚ, ⓜ, and connector ⓝ, and then install the fuse box.



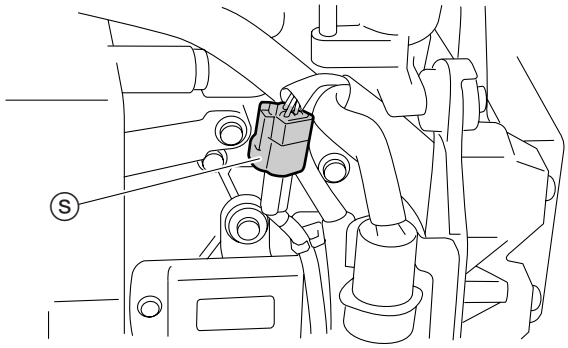
6. Install the engine ECM ②, and then connect the engine ECM coupler ⓟ and pulser coil coupler ⓡ.



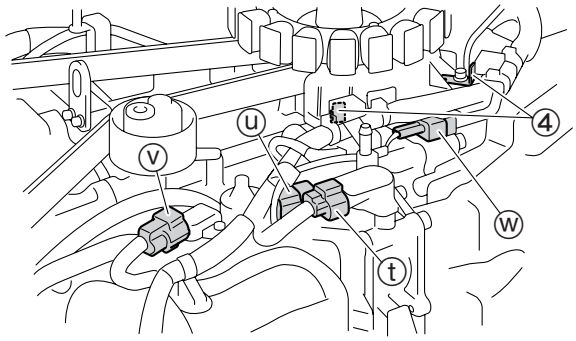
7. Install the cover ③.



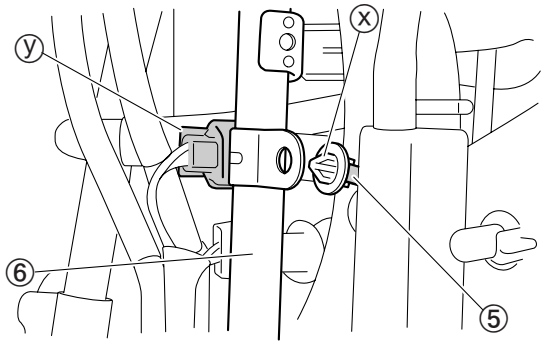
8. Connect the hour meter coupler ⓢ.



9. Install the wiring harness to the brackets ④, and then connect the TPS coupler ⓣ, ISC coupler ⓤ, air pressure sensor coupler ⓥ, and engine temperature sensor coupler ⓦ.

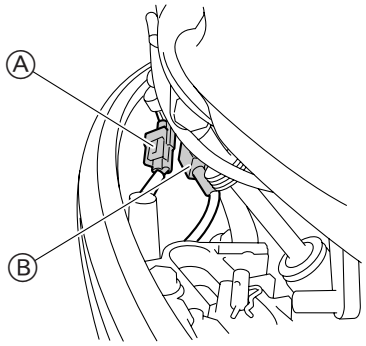


10. Insert the projections ⓧ on the plastic ties ⑤ into the holes in the fuel rail ⑥, and then connect the fuel pump coupler ⓨ.

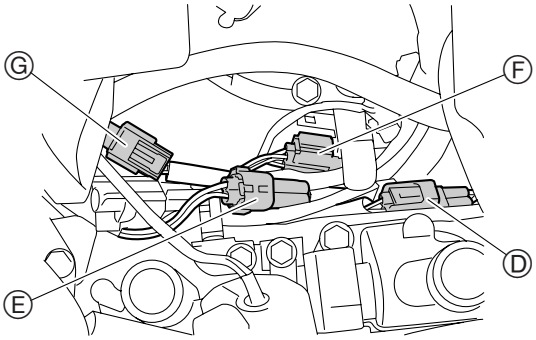


11. Connect the all fuel injector couplers.

12. Connect the shift cut switch coupler Ⓐ and neutral switch coupler Ⓑ.



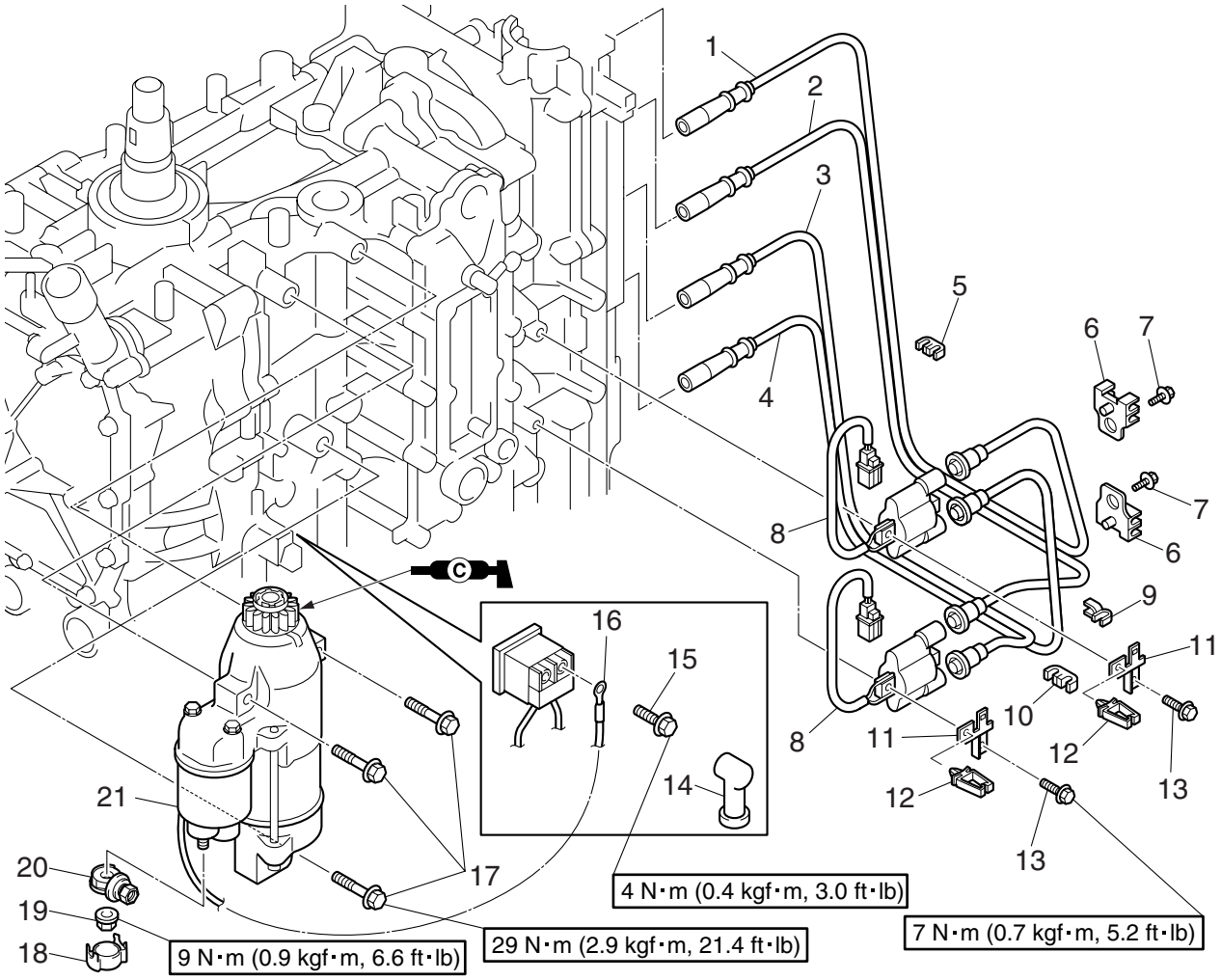
13. Connect the PTT switch coupler Ⓓ, trim sensor coupler Ⓔ, gauge harness coupler Ⓕ, and water detection switch coupler Ⓖ, and then install the gauge harness coupler Ⓕ to the bracket.



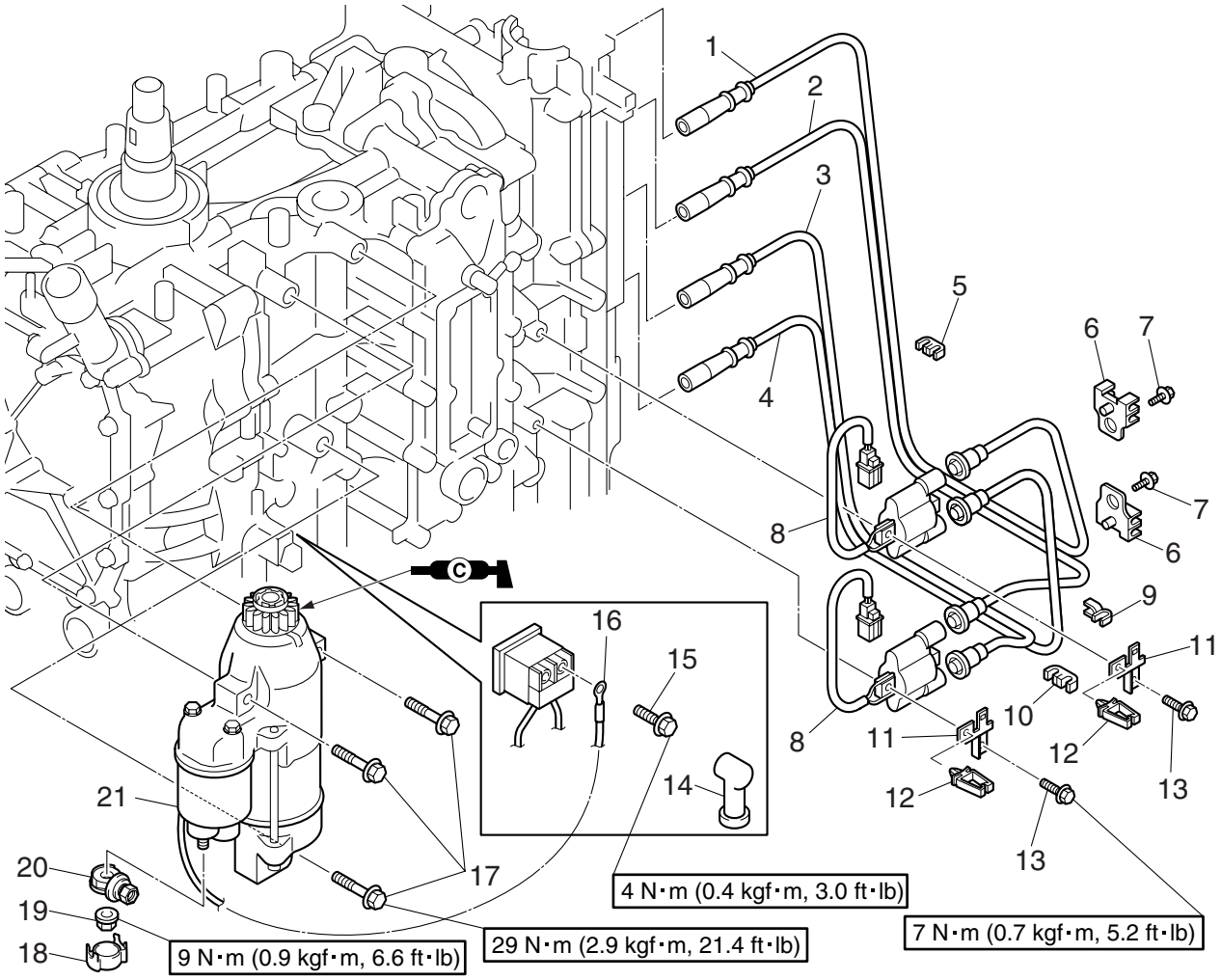
14. Install the flywheel magnet. See “Installing the flywheel magnet” (7-6).

15. Install the flywheel magnet cover.

Starter motor

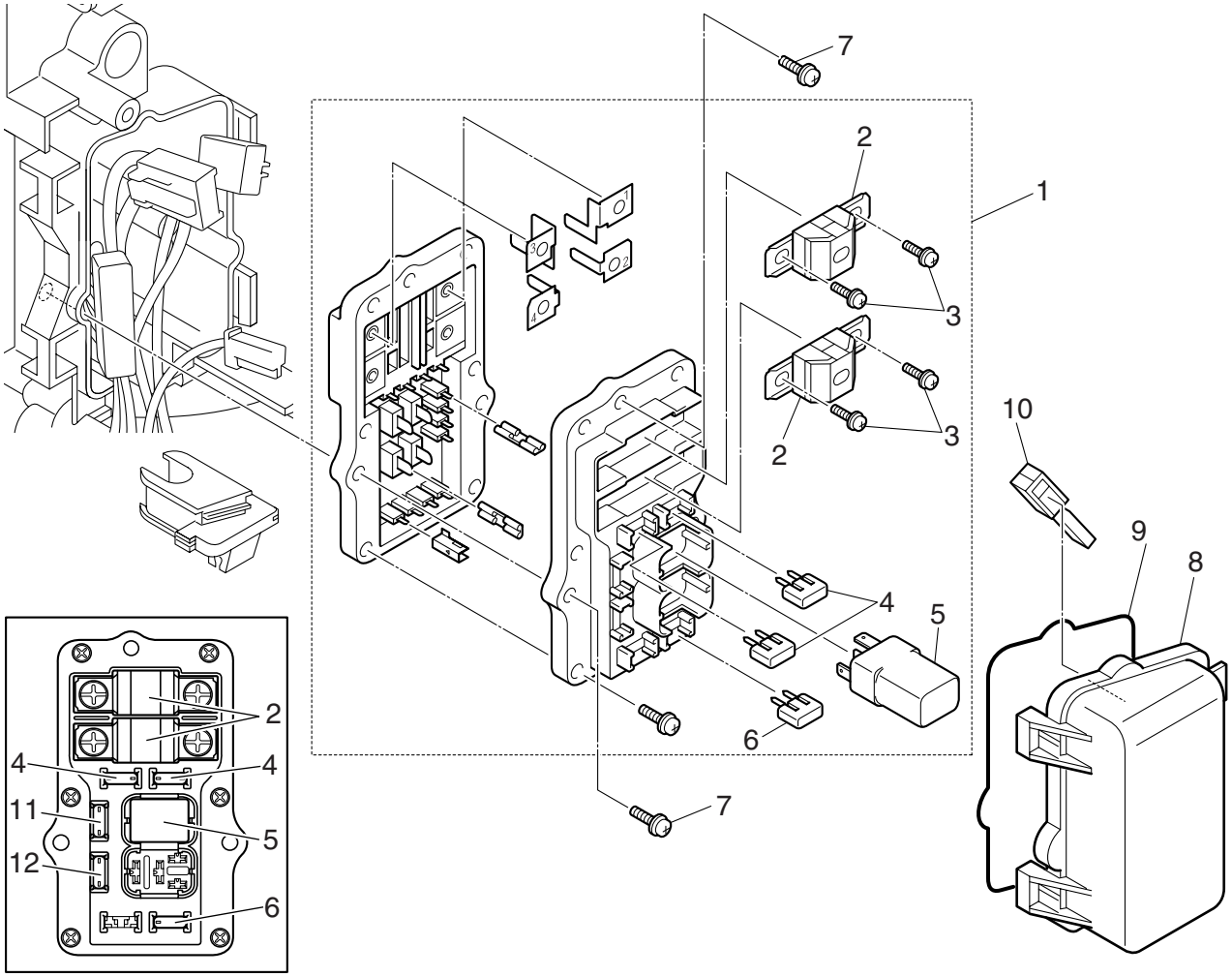


No.	Part name	Q'ty	Remarks
1	Spark plug wire #1	1	
2	Spark plug wire #2	1	
3	Spark plug wire #3	1	
4	Spark plug wire #4	1	
5	Holder	1	
6	Holder	2	
7	Bolt	2	M6 × 12 mm
8	Ignition coil	2	
9	Holder	1	
10	Holder	1	
11	Bracket	2	
12	Holder	2	
13	Bolt	4	M6 × 25 mm
14	Cap	1	
15	Bolt	1	M6 × 10 mm
16	Starter motor lead	1	
17	Bolt	3	M8 × 45 mm



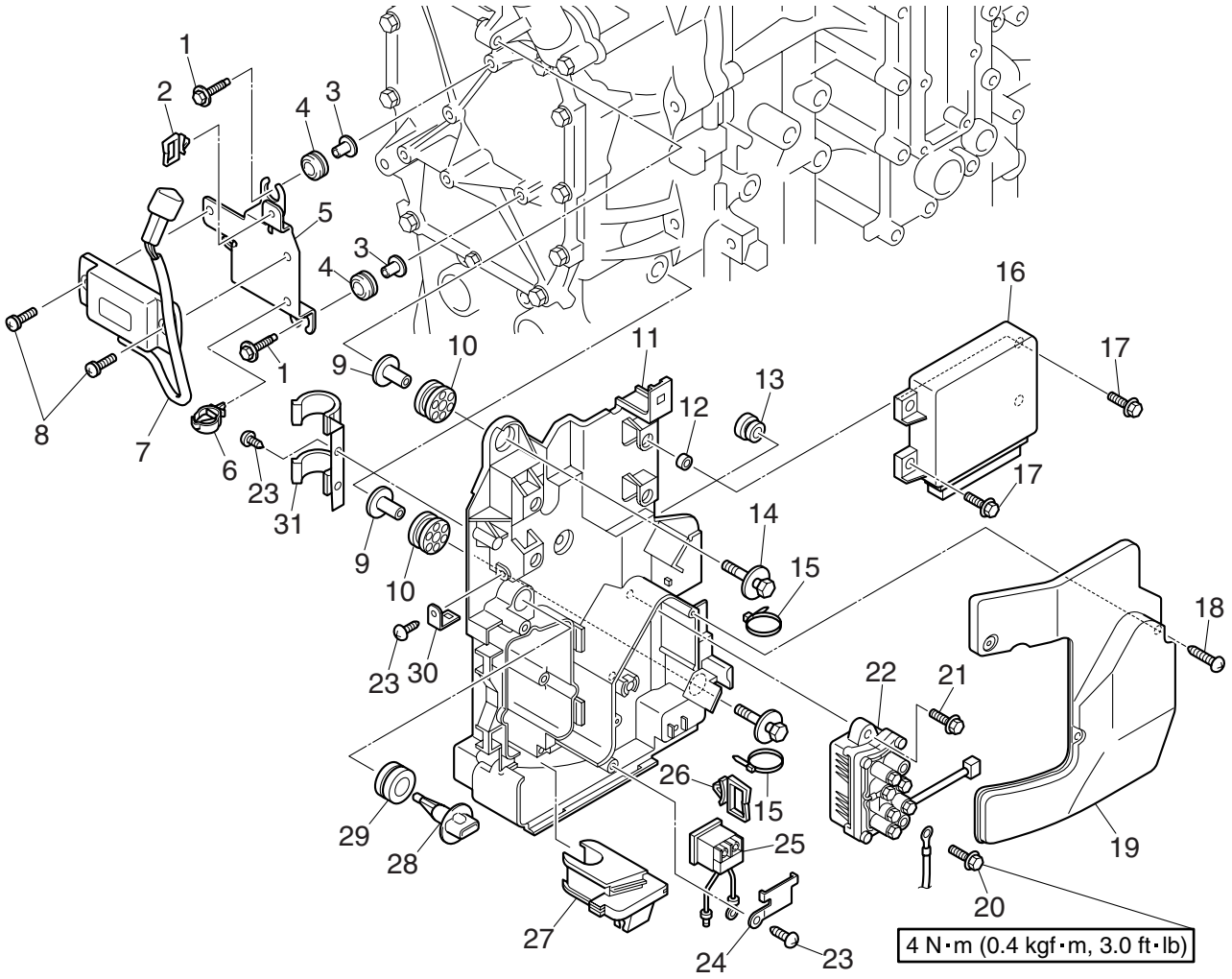
No.	Part name	Q'ty	Remarks
18	Cap	1	
19	Nut	1	
20	Terminal	1	
21	Starter motor	1	

Fuse box

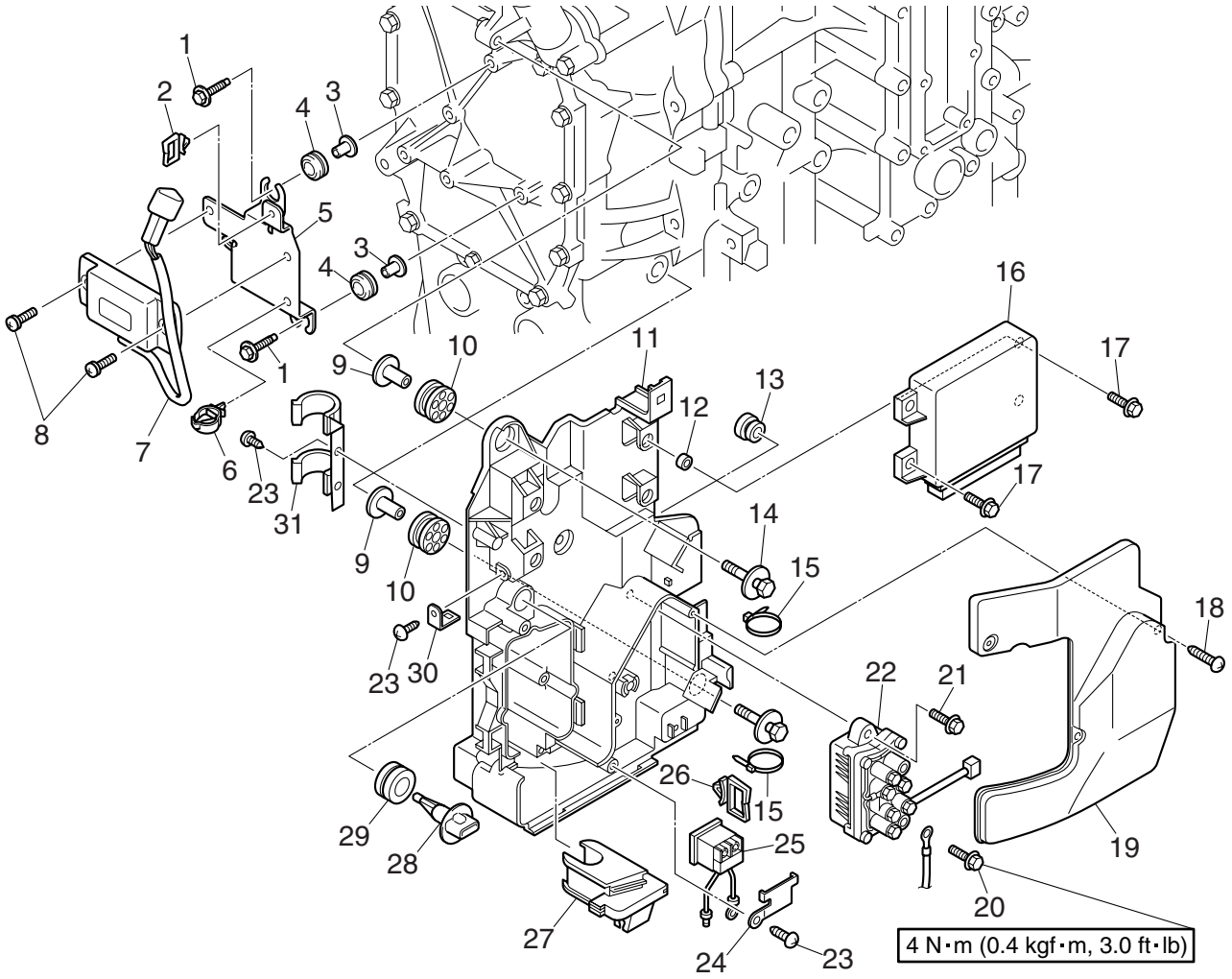


No.	Part name	Q'ty	Remarks
1	Fuse box assembly	1	
2	Fuse	2	50 A
3	Screw	4	M5 × 10 mm
4	Fuse	2	20 A
5	Relay	1	
6	Fuse	1	30 A
7	Screw	3	M5 × 20 mm
8	Cover	1	
9	Gasket	1	
10	Fuse puller	1	
11	Fuse	1	20 A, Spare
12	Fuse	1	30 A, Spare

Junction box

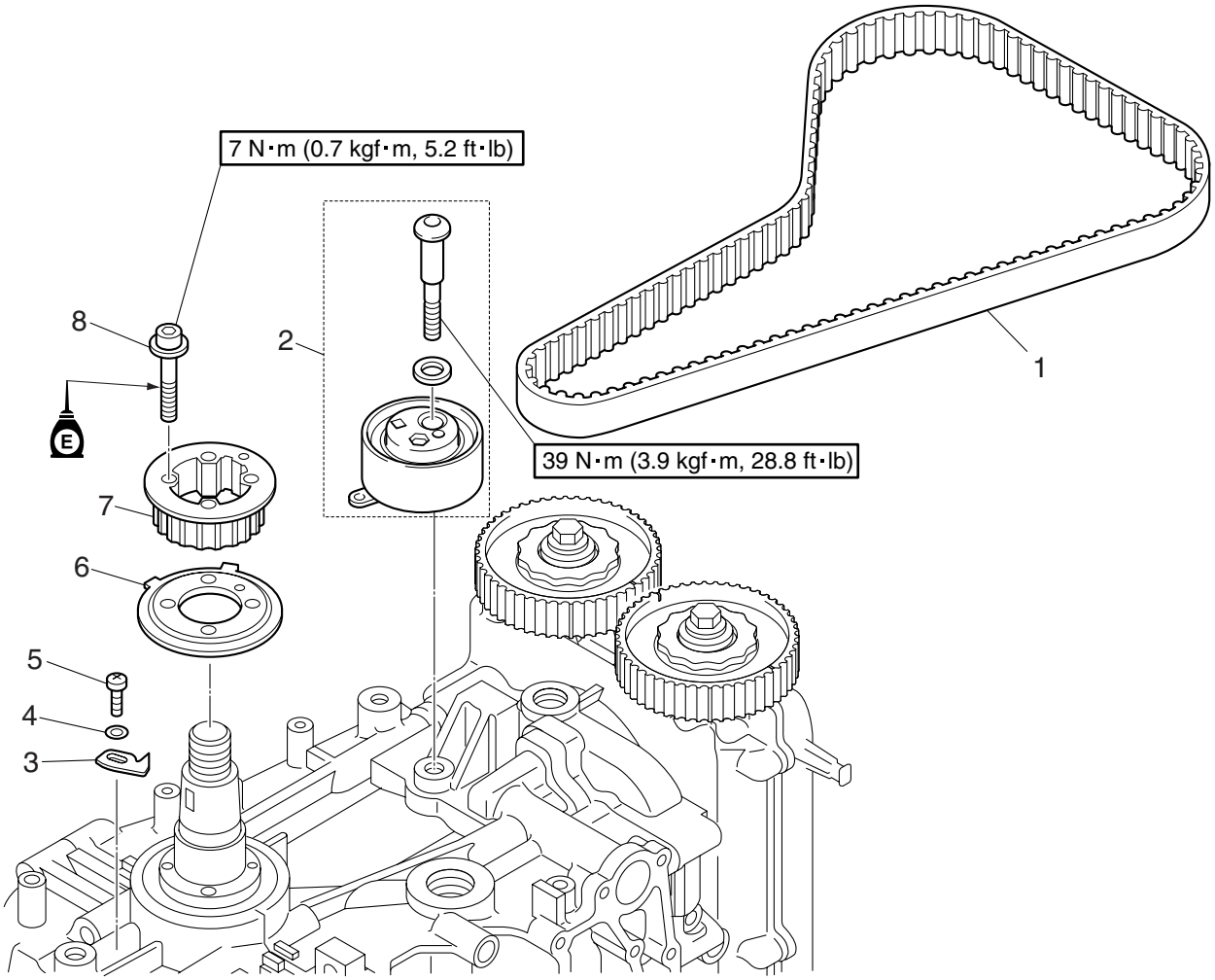


No.	Part name	Q'ty	Remarks
1	Bolt	3	M6 × 28 mm
2	Holder	1	
3	Collar	3	
4	Grommet	3	
5	Bracket	1	
6	Holder	1	
7	Hour meter	1	
8	Screw	2	M5 × 16 mm
9	Collar	3	
10	Grommet	3	
11	Junction box	1	
12	Collar	4	
13	Grommet	1	
14	Bolt	3	M6 × 35 mm
15	Plastic tie	2	
16	Engine ECM	1	
17	Bolt	4	M6 × 16 mm



No.	Part name	Q'ty	Remarks
18	Screw	3	ø6 × 19 mm
19	Cover	1	
20	Bolt	2	M6 × 10 mm
21	Bolt	2	M6 × 20 mm
22	PTT relay	1	
23	Screw	3	ø6 × 19 mm
24	Holder	1	
25	Starter relay	1	
26	Holder	1	
27	Grommet	1	
28	Air temperature sensor	1	
29	Grommet	1	
30	Bracket	1	
31	Holder	1	

Timing belt



No.	Part name	Q'ty	Remarks
1	Timing belt	1	
2	Timing belt tensioner	1	
3	Plate	1	
4	Washer	1	
5	Screw	1	M6 × 10 mm
6	Plate	1	
7	Drive sprocket	1	
8	Bolt	4	M5 × 40 mm

Replacing the timing belt

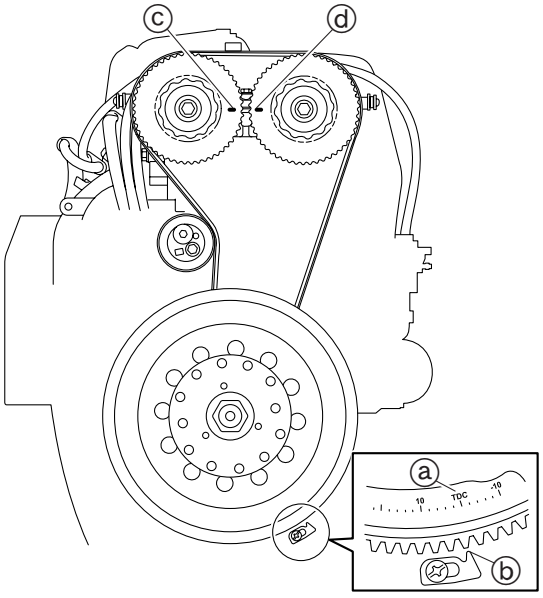
NOTICE

- **Do not turn the flywheel magnet counterclockwise, otherwise the water pump impeller may be damaged.**
- **Do not turn the flywheel magnet or the driven sprockets when the timing belt is not installed. Otherwise the pistons and valves or intake and exhaust valves will collide with each other and be damaged.**
- **Do not twist, turn inside out, or bend the timing belt beyond the maximum limit of 25.0 mm (1.0 in) otherwise it can be damaged.**
- **Do not get oil or grease on the timing belt.**

1. Reduce the fuel pressure. See “Reducing the fuel pressure” (6-4).

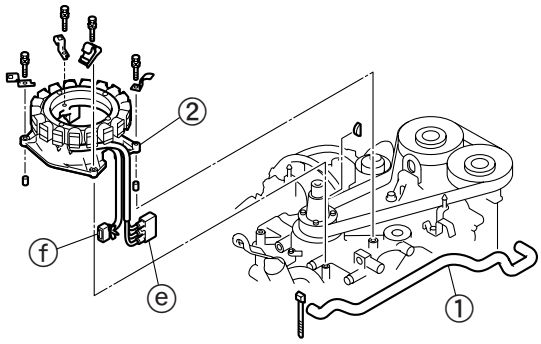
2. Remove the flywheel magnet cover.

3. Turn the flywheel magnet clockwise and align the “TDC” mark ⓐ on the flywheel magnet with the pointer ⓑ, and check that “I” marks ⓒ and ⓓ on the driven sprockets are aligned.



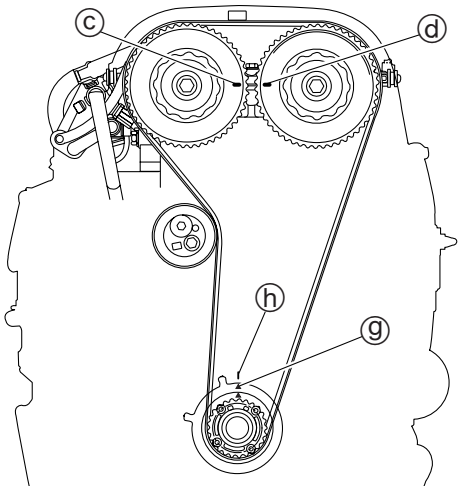
4. Remove the flywheel magnet and Woodruff key. See “Removing the flywheel magnet” (7-6).

5. Disconnect the stator assembly coupler ⓔ and pulser coil coupler ⓕ, and then remove the blowby hose ① and stator assembly (lighting coil) ②.

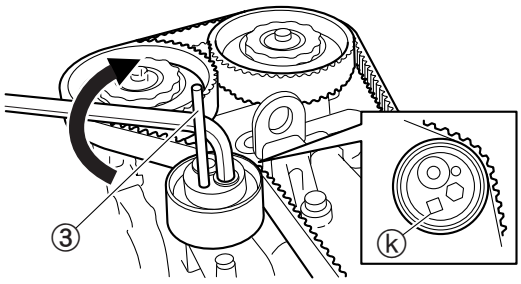


6. Check that the “▲” mark ⓖ on the drive sprocket and the “I” mark ⓗ on the cylinder block are aligned.

7. Check that the “I” marks ⓒ and ⓓ on the driven sprockets are aligned.

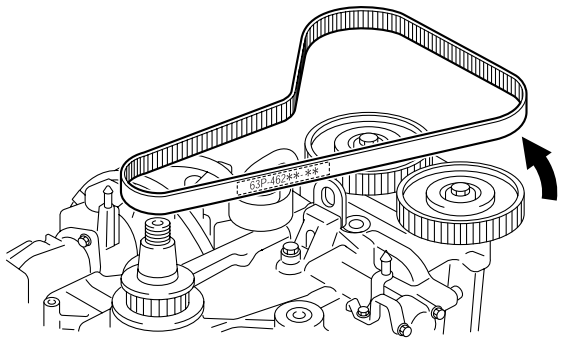


8. Turn the timing belt tensioner gradually clockwise using a hexagon wrench, and then insert a ø5.0 mm (0.2 in) pin ③ into the hole ⓚ.

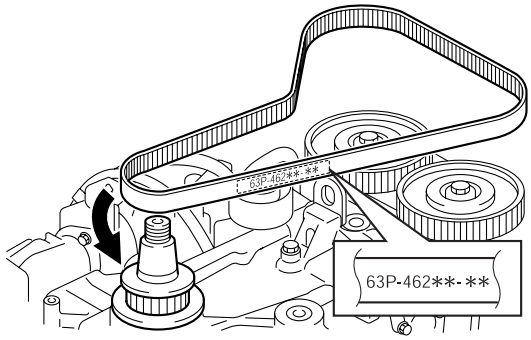


TIP:
Leave the pin inserted into the hole ⓚ of the timing belt tensioner until the timing belt is installed again.

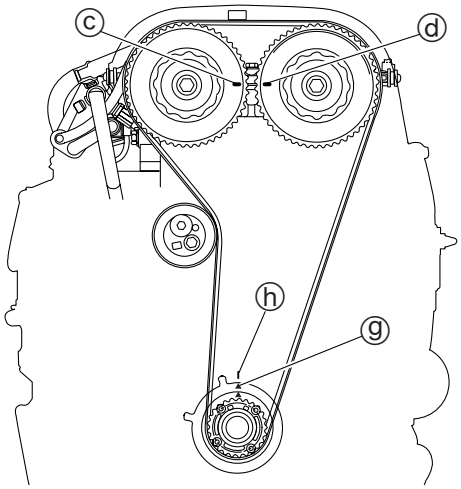
9. Remove the timing belt from the driven sprockets, and then from the drive sprocket.



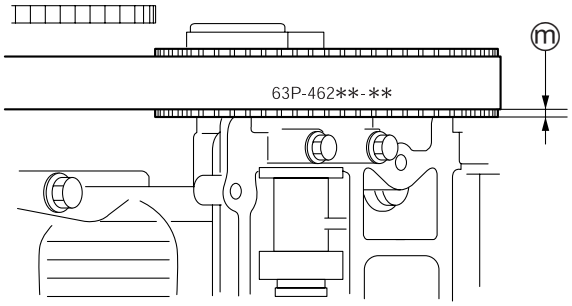
10. Install the new timing belt with its part number in the upright position, from the drive sprocket side to the port side driven sprocket and the starboard driven sprocket, in the counterclockwise direction.



11. Turn the drive sprocket clockwise 2 full turns, and then check that alignment marks ⓒ and ⓓ, ⓖ and ⓗ are aligned.

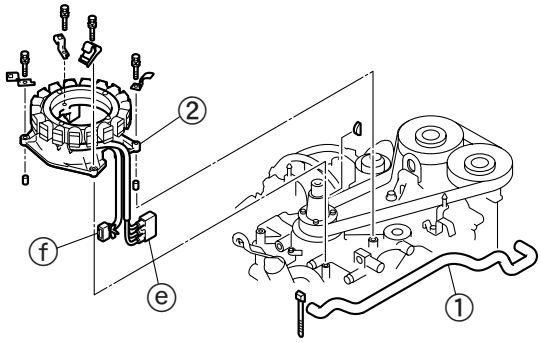


12. Adjust the timing belt to the specified installation height ⓜ.



Timing belt installation height ⓜ: 2.0 mm (0.08 in)

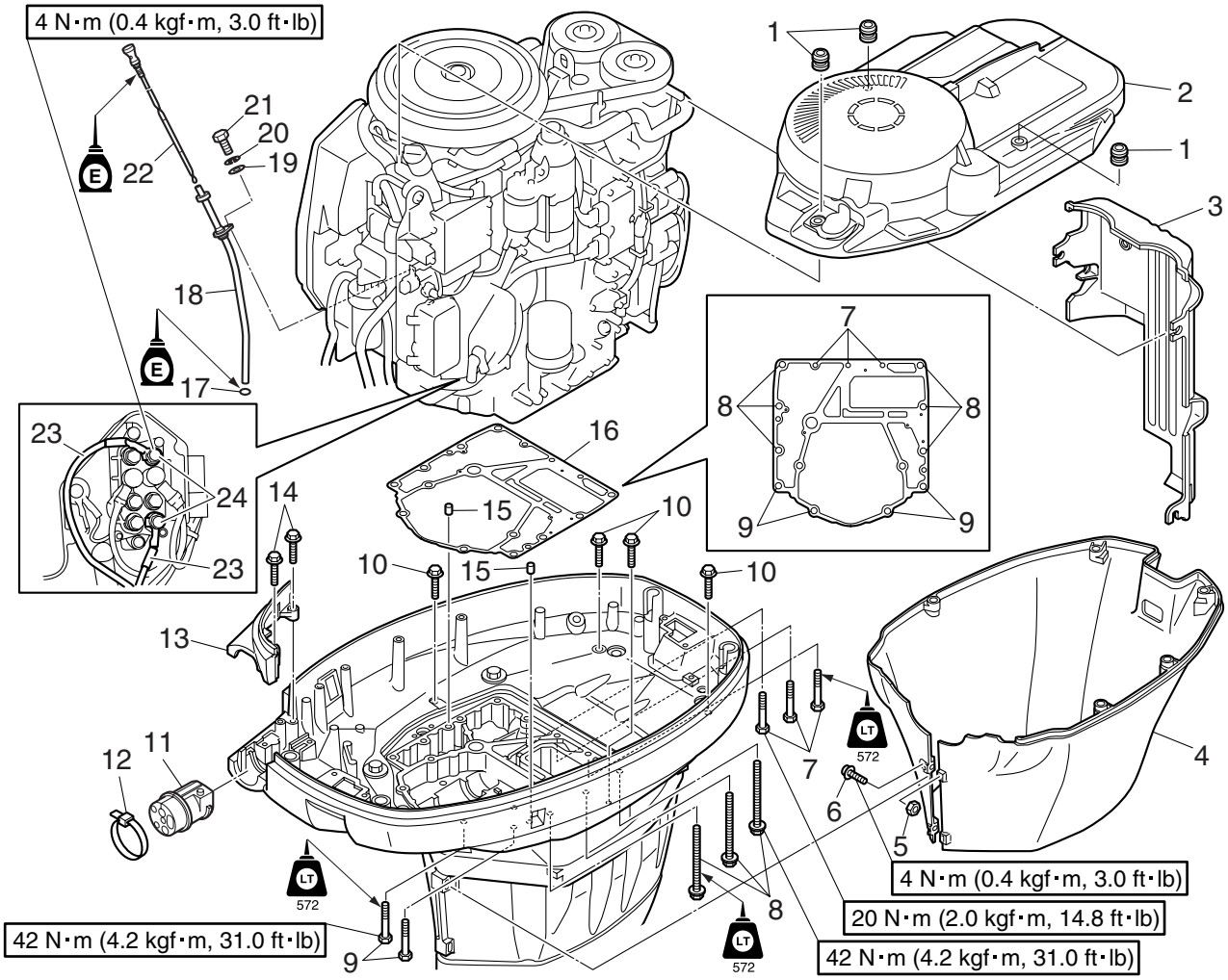
13. Install the stator assembly (lighting coil) ② and blowby hose ①, and then connect the pulser coil coupler ⓕ and stator assembly coupler ⓔ. See exploded diagram (7-5).



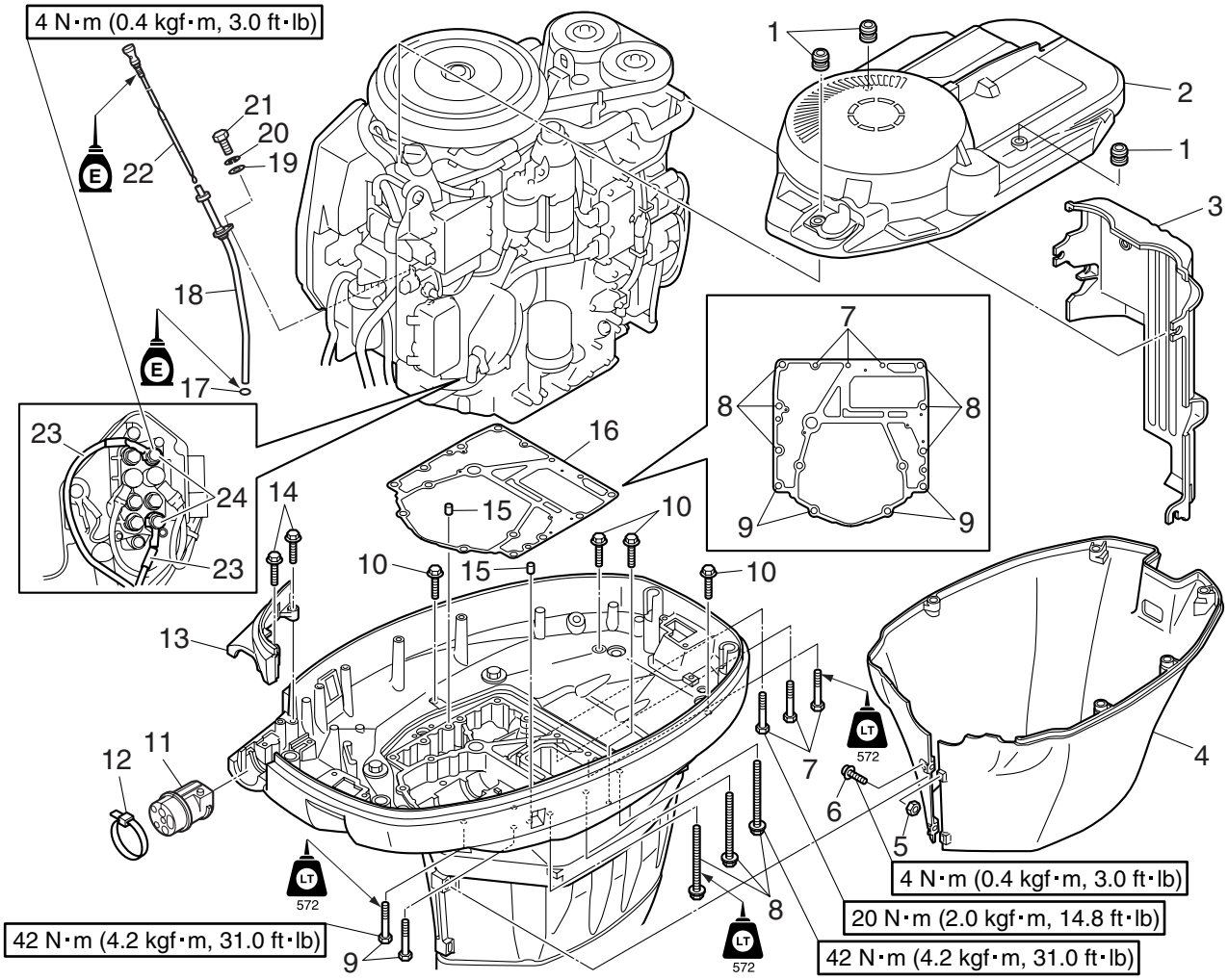
14. Install the Woodruff key and flywheel magnet. See “Installing the flywheel magnet” (7-6).

15. Install the flywheel magnet cover.

Power unit assembly



No.	Part name	Q'ty	Remarks
1	Damper	3	
2	Cover	1	
3	Cover	1	
4	Apron	1	
5	Nut	2	
6	Screw	2	M6 × 40 mm
7	Bolt	3	M8 × 35 mm
8	Bolt	6	M10 × 140 mm
9	Bolt	4	M10 × 35 mm
10	Bolt	4	M6 × 16 mm
11	Grommet	4	
12	Plastic tie	1	
13	Retaining plate	1	
14	Bolt	2	M6 × 30 mm
15	Dowel	2	
16	Gasket	1	**Not reusable**
17	O-ring	1	**Not reusable**



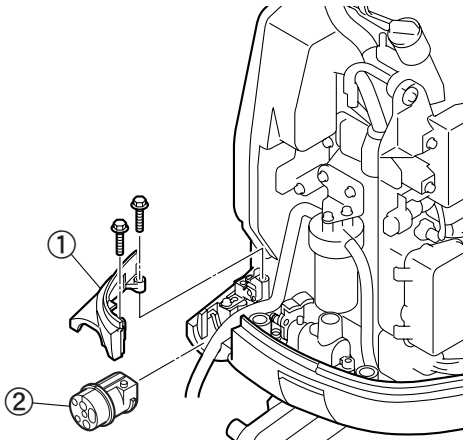
No.	Part name	Q'ty	Remarks
18	Dipstick guide	1	
19	Washer	1	
20	Washer	1	
21	Bolt	1	M6 × 20 mm
22	Dipstick	1	
23	PTT motor lead	1	
24	Bolt	2	M6 × 10 mm

Removing the power unit

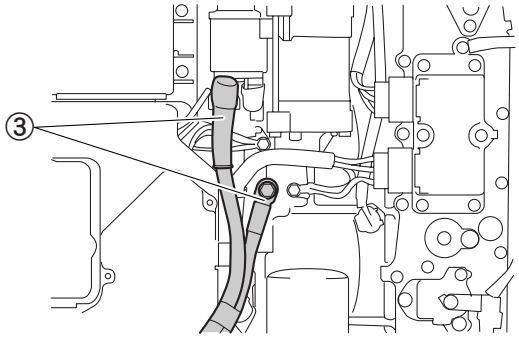
Make sure to reduce the fuel pressure before removing the power unit. See “Reducing the fuel pressure” (6-4).

It is recommended to loosen the flywheel magnet nut before removing the power unit to improve working efficiency. See “Removing the flywheel magnet” (7-6).

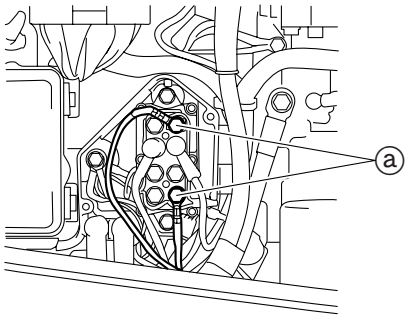
1. Remove the flywheel magnet cover.
2. Remove the retaining plate ① and grommet ②, and then disconnect the remote control cables.



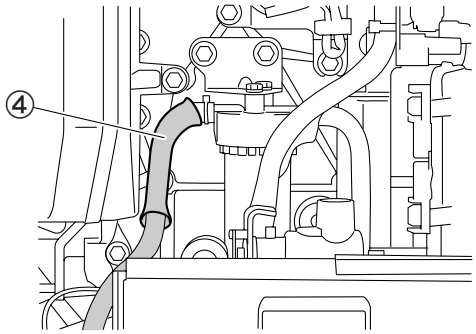
3. Disconnect the battery leads ③



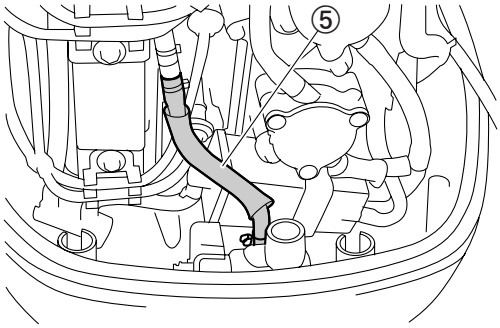
4. Remove the junction box cover, and then disconnect the PTT motor leads ⓐ.



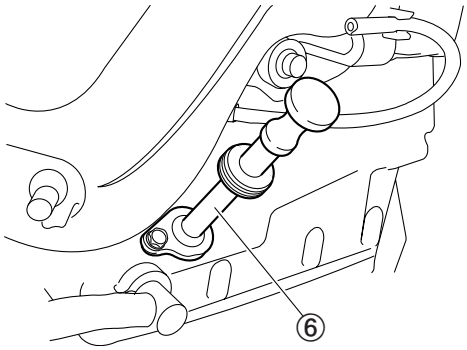
5. Disconnect the fuel hose ④.



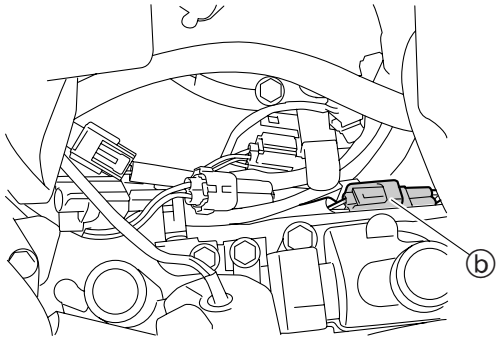
6. Disconnect the vapor gas hose ⑤.



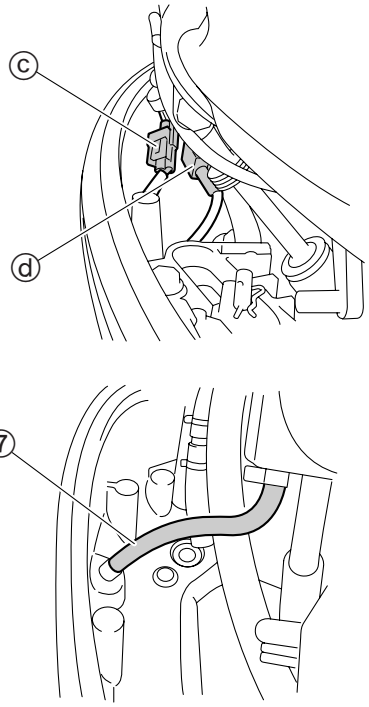
7. Remove the dipstick guide ⑥.



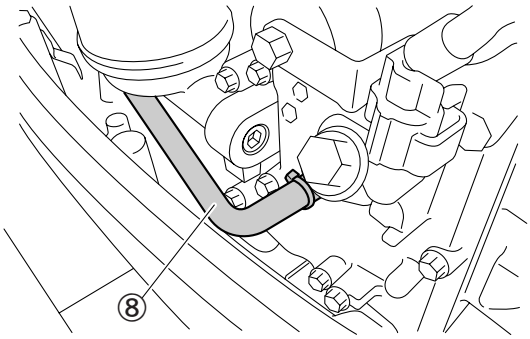
8. Disconnect the PTT switch coupler ⓑ.



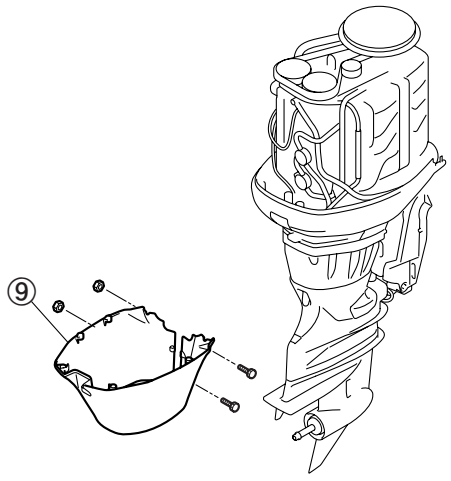
9. Disconnect the shift cut switch coupler ⓒ, neutral switch coupler ⓓ, and cooling water pilot hose ⑦.



10. Disconnect the flushing hose ⑧.

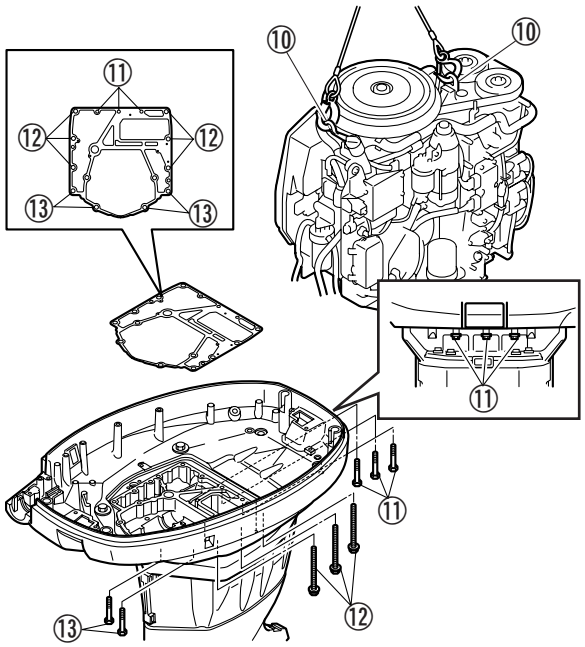


11. Remove the apron ⑨.



12. Install the lifting harness to the engine hangers ⑩, and then suspend the power unit.

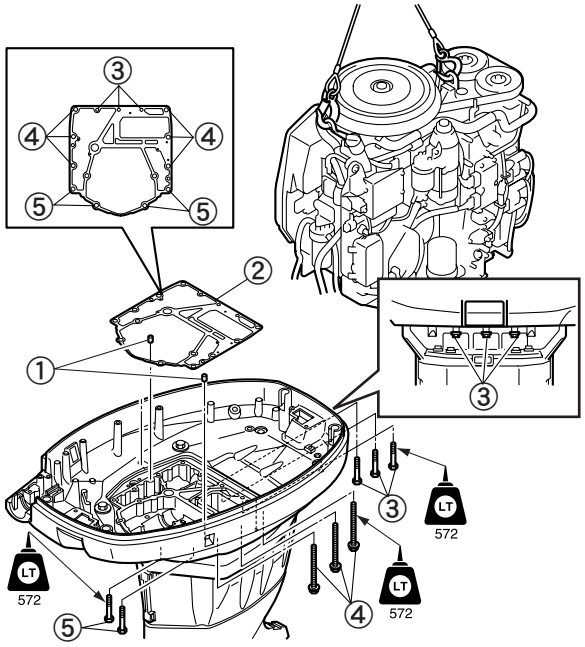
13. Remove the power unit by removing the bolts ⑪, ⑫ and ⑬.



Installing the power unit

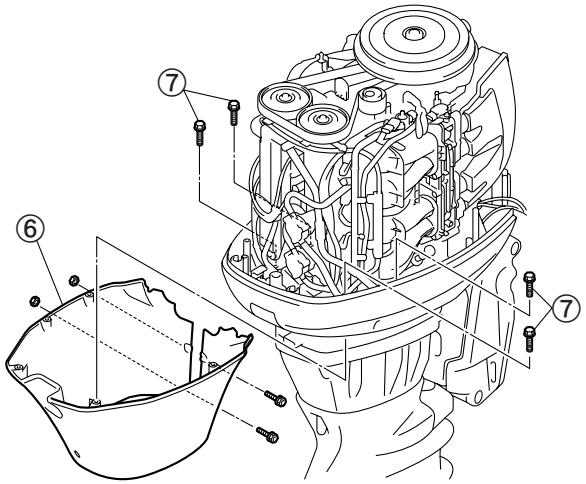
1. Clean the power unit mating surface, and install the dowels ① and a new gasket ②.

2. Install the power unit by installing the bolts ③, ④, and ⑤, and then tightening them to the specified torque.



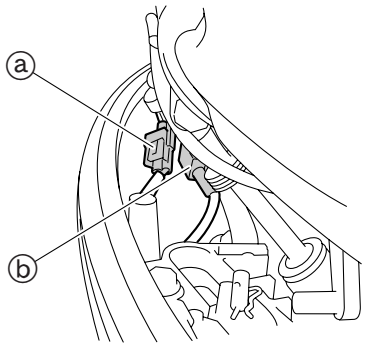
Bolt (M8) ③: 20 N·m (2.0 kgf·m, 14.8 ft·lb) Bolt (M10) ④ and ⑤: 42 N·m (4.2 kgf·m, 31.0 ft·lb)

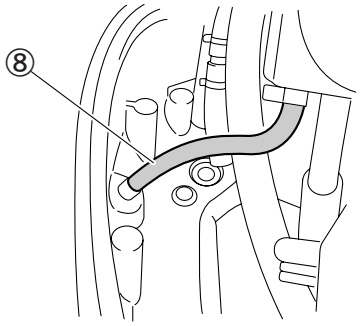
3. Install the apron ⑥, and then tightening the bolts ⑦ to the specified torque.



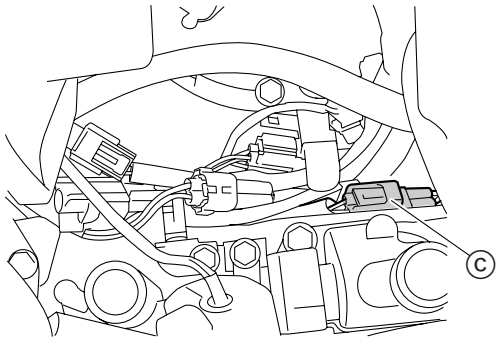
Bolt ⑦: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

4. Connect the shift cut switch coupler ⓐ, neutral switch coupler ⓑ and cooling water pilot hose ⑧.

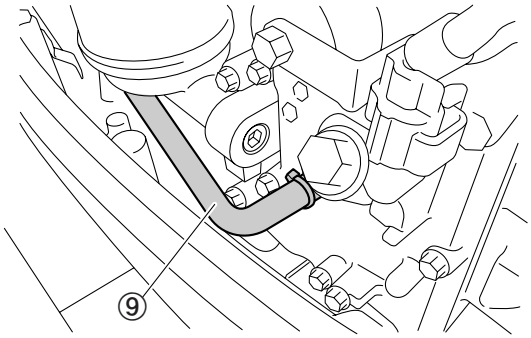




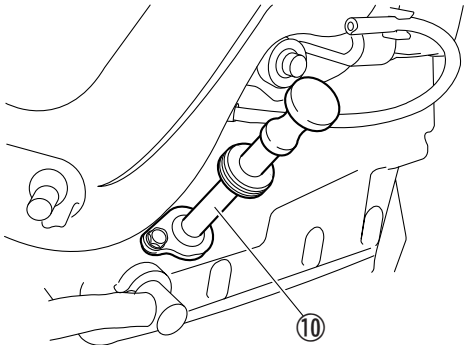
5. Connect the PTT switch coupler ⓒ.



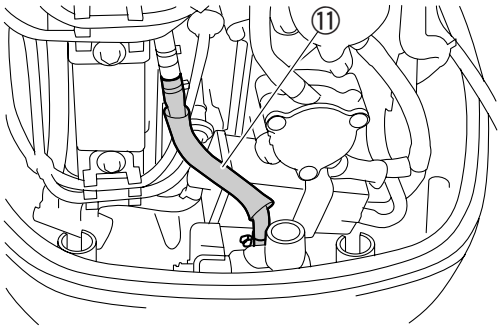
6. Connect the flushing hose ⑨.



7. Install the dipstick guide ⑩.

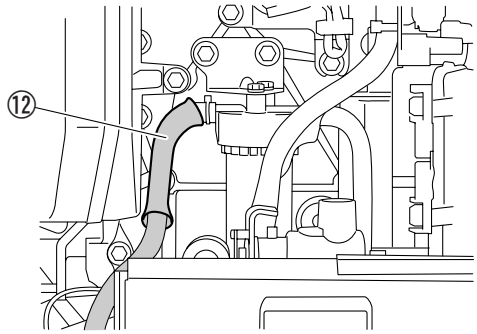


8. Connect the vapor gas hose ⑪.

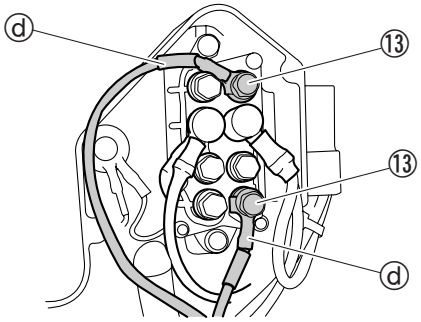


7

9. Connect the fuel hose ⑫.

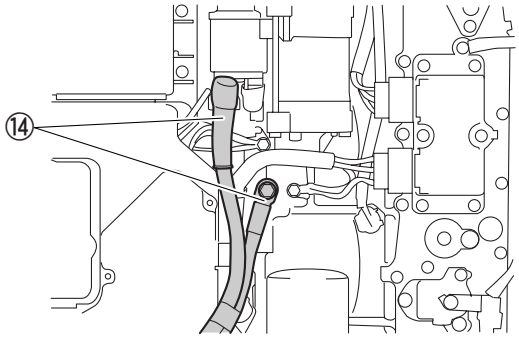


10. Connect the PTT motor leads ⓓ, and then install the junction box cover.



PTT motor lead bolt ⑬:
4 N·m (0.4 kgf·m, 3.0 ft·lb)

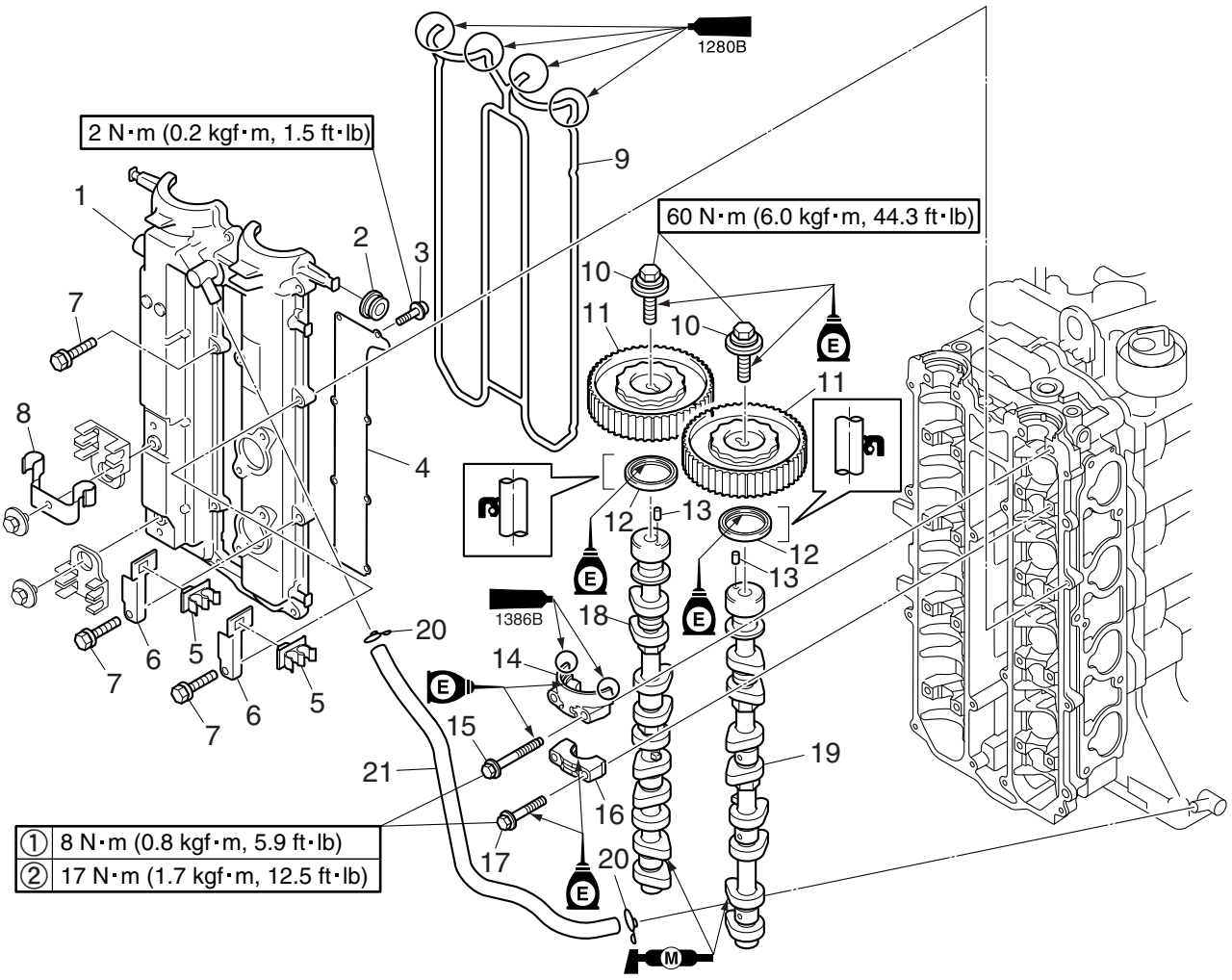
11. Connect the battery leads ⑭.



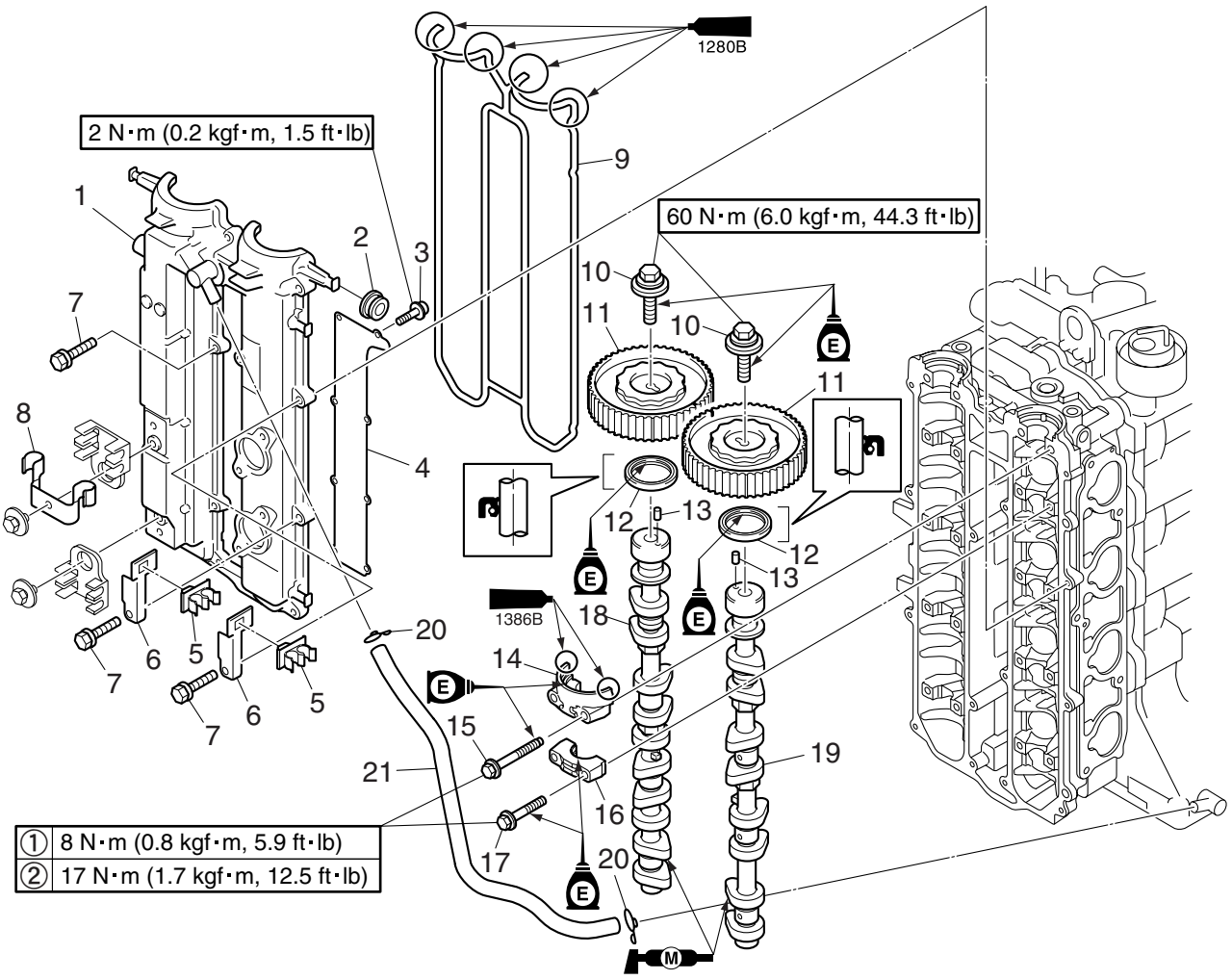
12. Install the rigging grommet, and then connect the shift cable and throttle cable, see “Mounting the rigging grommet” (3-8).

13. Install the flywheel magnet cover.

Camshaft



No.	Part name	Q'ty	Remarks
1	Cylinder head cover	1	
2	Grommet	5	
3	Screw	8	M4 × 8 mm
4	Plate	1	
5	Holder	2	
6	Bracket	2	
7	Bolt	15	M6 × 30 mm
8	Holder	1	
9	Gasket	1	**Not reusable**
10	Bolt	2	M10 × 35 mm
11	Driven sprocket	2	
12	Oil seal	2	**Not reusable**
13	Dowel	2	
14	Camshaft cap	2	
15	Bolt	4	M7 × 48 mm
16	Camshaft cap	8	
17	Bolt	16	M7 × 37 mm



No.	Part name	Q'ty	Remarks
18	Camshaft (EX)	1	
19	Camshaft (IN)	1	
20	Clamp	2	
21	Hose	1	

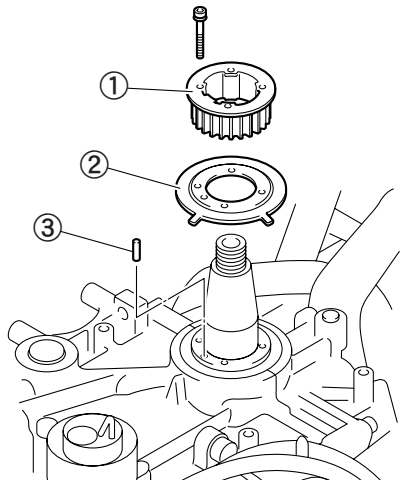
Removing the timing belt, driven sprocket, and camshaft

Check the valve clearances before removing the parts.

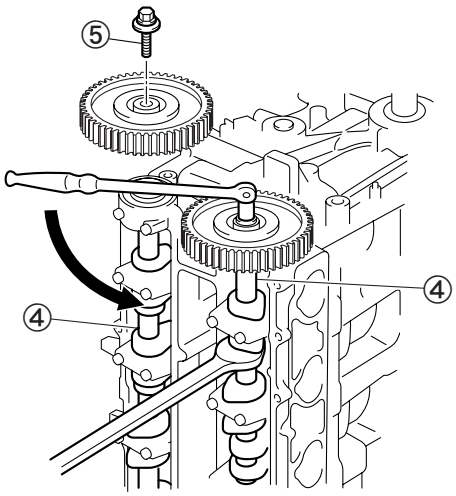
NOTICE

- **Do not turn the crankshaft counterclockwise, otherwise the water pump impeller may be damaged.**
- **Do not turn the crankshaft or the driven sprockets when the timing belt is not installed. Otherwise the piston and valves, or intake and exhaust valves could collide with each other and be damaged.**

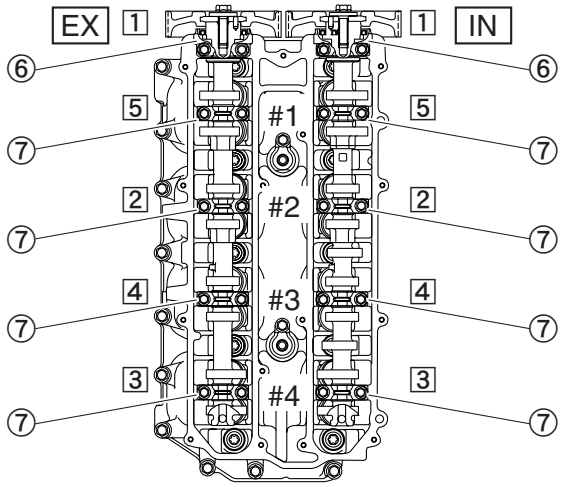
1. Remove the cylinder head cover.
2. Remove the timing belt, see “Replacing the timing belt” (7-18) step 6–step 9.
3. Remove the timing belt tensioner.
4. Remove the drive sprocket ①, plate ②, and dowel ③.



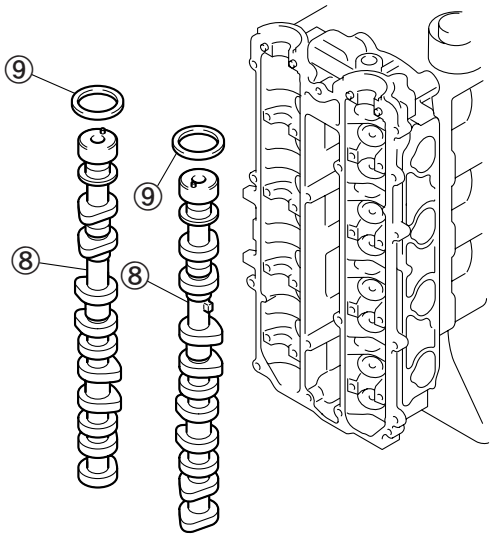
5. Hold the intake and exhaust camshafts ④ using a wrench, and then remove the bolts ⑤.
6. Remove the driven sprockets.



7. Gradually loosen the camshaft caps ⑥ and ⑦ in several stages and in the sequence numbers (1, 2, · · ·). ***NOTICE:*** **Do not to tilt the camshafts.**

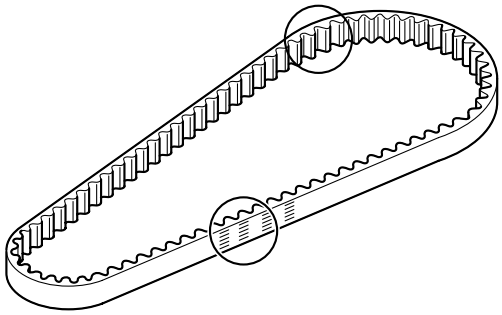


8. Remove the camshafts ⑧ and oil seals ⑨.

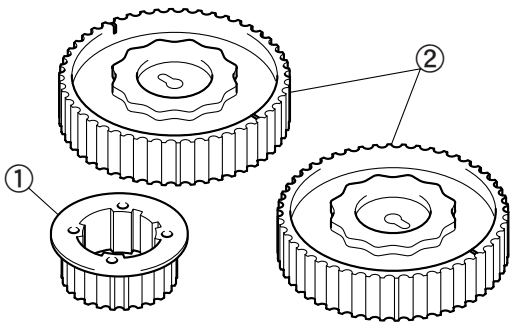


Checking the timing belt and sprocket

1. Check the interior and exterior of the timing belt. Replace if cracked, damaged, or worn.

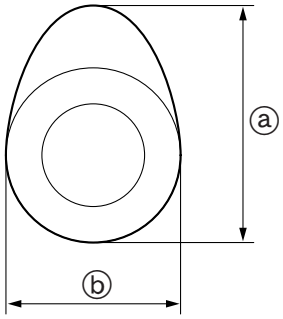


2. Check the drive sprocket ① and driven sprockets ②. Replace if cracked, damaged, or worn.



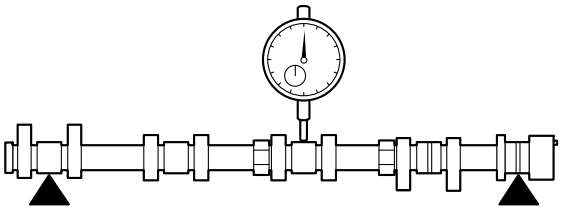
Checking the camshaft

1. Measure the cam lobe height ⓐ and width ⓑ. Replace the camshaft if out of specification.



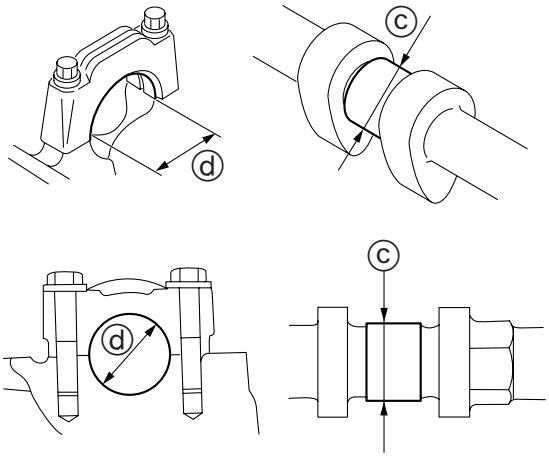
Cam lobe height ⓐ:
  Intake:
    45.300–45.400 mm (1.7835–1.7874 in)
  Exhaust:
    44.350–44.450 mm (1.7461–1.7500 in)
Cam lobe width ⓑ:
  Intake and exhaust:
    35.950–36.050 mm (1.4154–1.4193 in)

2. Measure the camshaft runout. Replace if out of specification.



Camshaft runout limit:
    0.03 mm (0.0012 in)

3. Measure the camshaft journal diameter ⓒ and cylinder head journal inside diameter ⓓ. Replace the camshaft, cylinder head assembly, or both if out of specifications.



Camshaft journal diameter ⓒ: 24.960–24.980 mm (0.9827–0.9835 in) Camshaft cap inside diameter ⓓ: 25.000–25.021 mm (0.9843–0.9851 in)

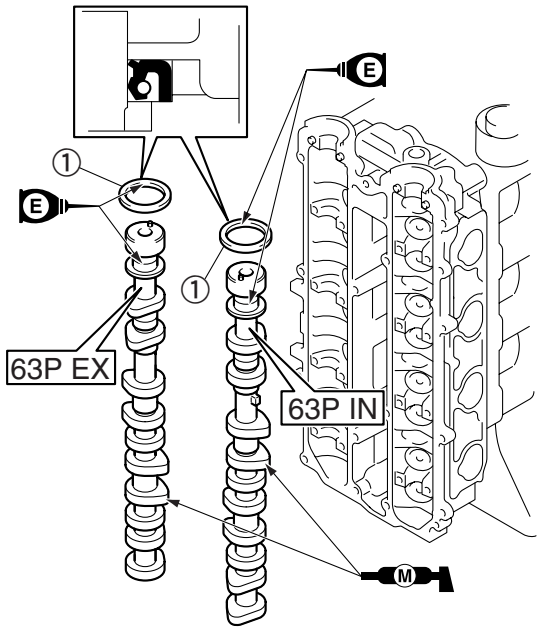
Installing the timing belt, driven sprocket, and camshaft

NOTICE

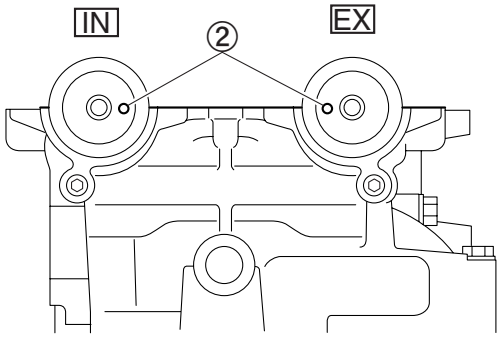
- **Do not turn the crankshaft counterclockwise, otherwise the water pump impeller may be damaged.**
- **Do not turn the crankshaft or the driven sprockets when the timing belt is not installed. Otherwise the piston and valves, or intake and exhaust valves could collide with each other and be damaged.**

1. Make sure that the valve lifters and shims are installed on the cylinder head. Apply engine oil to the valve shims and valve lifters before installation.

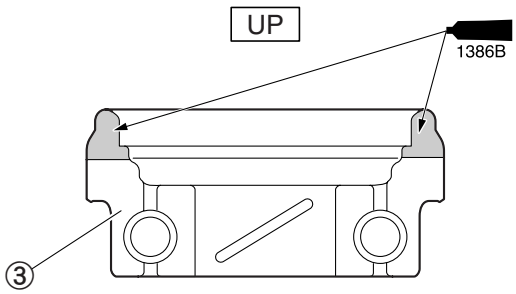
2. Install the camshafts with the new oil seals ①. Make sure the camshafts are installed to the original positions. Apply some molybdenum disulfide grease on the cam lobes.



3. Install the camshafts so that the dowels ② are facing inward and that they are aligned with the mating surface of the cylinder head.



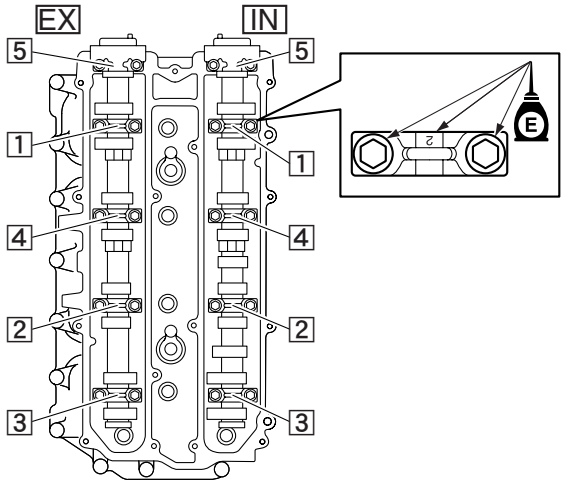
4. Apply a thin, even coat of sealant to the mating surface of the camshaft caps ③.

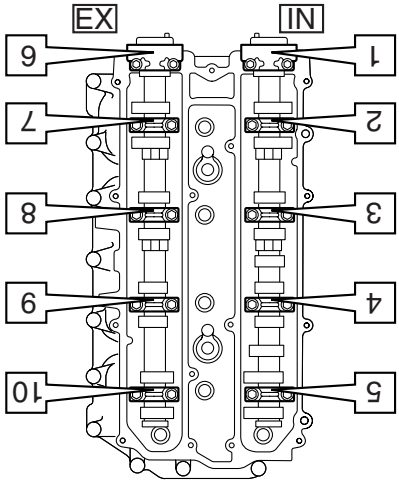


TIP:

When applying the sealant, make sure not to block the oil passages or oil holes.

5. Tighten the camshaft cap bolts to the specified torques in 2 stages and in the sequence numbers (1, 2, · · ·). Apply engine oil to the camshaft caps and camshaft cap bolts before installation.



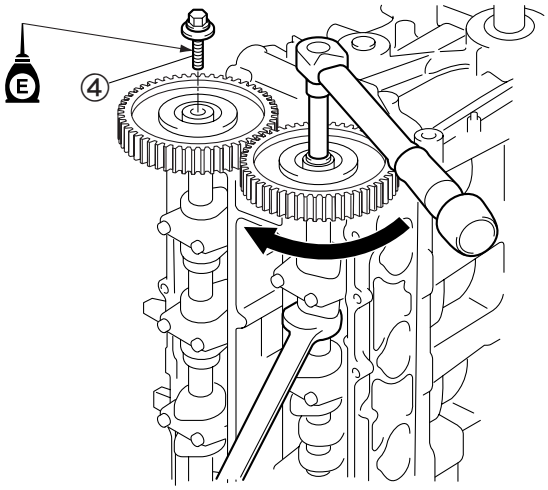


Camshaft cap bolt:
1st: 8 N·m (0.8 kgf·m, 5.9 ft·lb)
2nd: 17 N·m (1.7 kgf·m, 12.5 ft·lb)

TIP:
Install the camshaft caps in their proper positions as shown and with the stamped numbers upside down.

6. Install the driven sprockets.

7. Hold the camshaft using a wrench, and then tighten the driven sprocket bolts ④ to the specified torque. Apply engine oil to the driven sprocket bolts before installation.



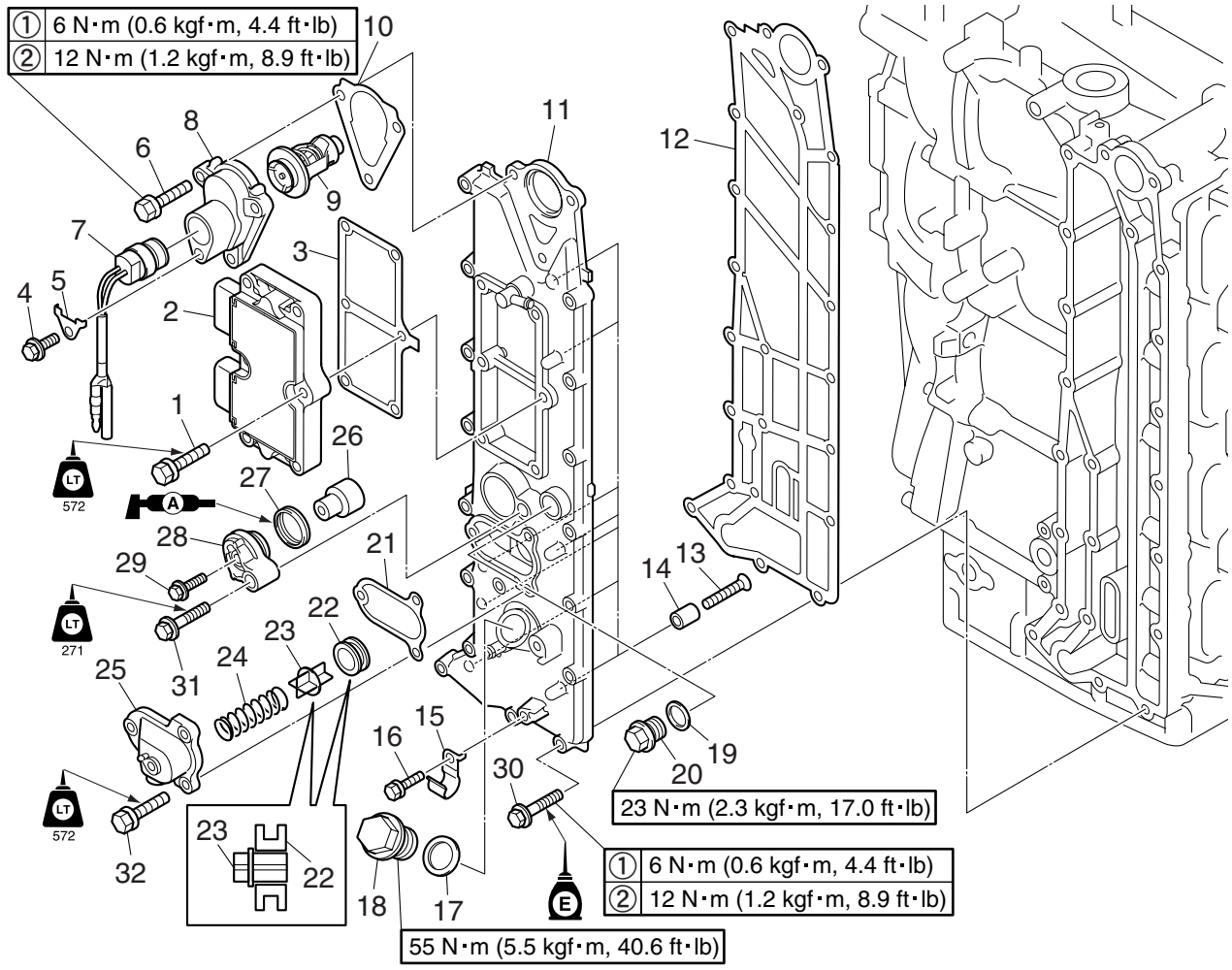
Driven sprocket bolt ④:
60 N·m (6.0 kgf·m, 44.3 ft·lb)

8. Install the dowel, plate, and drive sprocket.

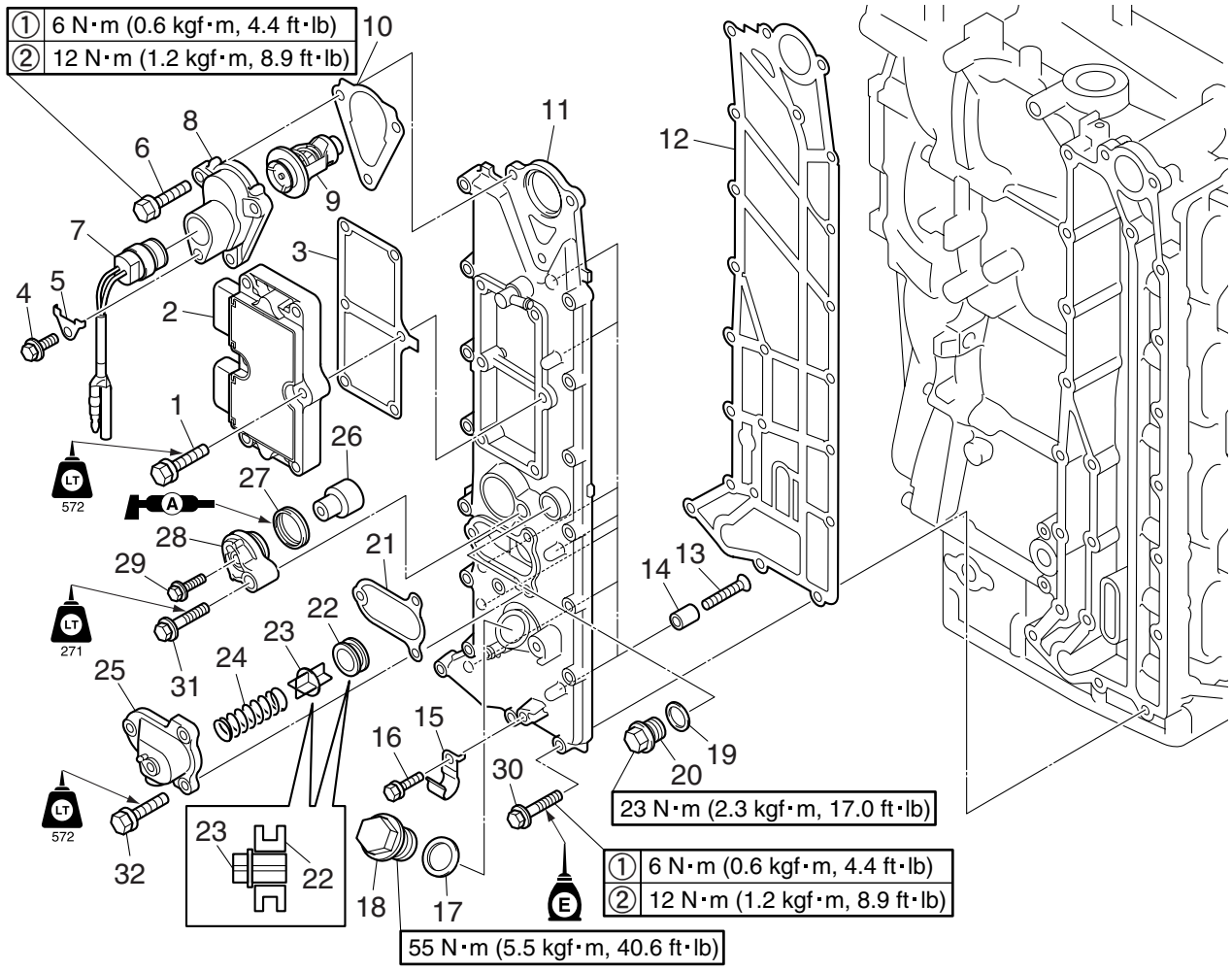
9. Install the cylinder head cover.

10. Install a new timing belt. See “Replacing the timing belt” (7-18) step 10–step 12.

Exhaust cover



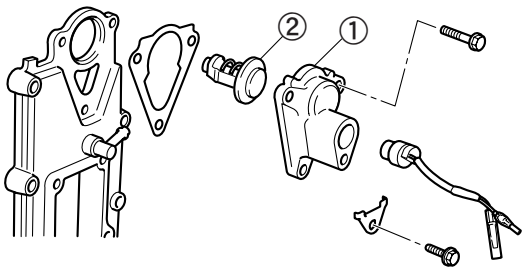
No.	Part name	Q'ty	Remarks
1	Bolt	6	M6 × 30 mm
2	Rectifier Regulator	1	
3	Gasket	1	**Not reusable**
4	Bolt	1	M6 × 16 mm
5	Holder	1	
6	Bolt	3	M6 × 30 mm
7	Thermoswitch	1	
8	Cover	1	
9	Thermostat	1	
10	Gasket	1	**Not reusable**
11	Exhaust cover	1	
12	Gasket	1	**Not reusable**
13	Screw	7	M5 × 27 mm
14	Anode	7	
15	Holder	1	
16	Bolt	1	M6 × 12 mm
17	Gasket	1	**Not reusable**



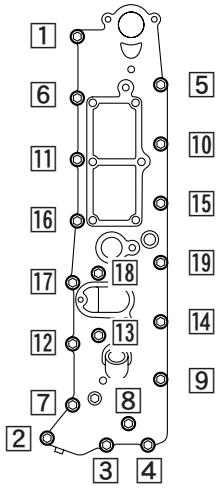
No.	Part name	Q'ty	Remarks
18	Plug	1	M18 × 17 mm
19	Gasket	1	**Not reusable**
20	Plug	1	M14 × 12 mm
21	Gasket	1	**Not reusable**
22	Grommet	1	
23	PCV	1	
24	Spring	1	
25	Cover	1	
26	Anode	1	
27	Grommet	1	
28	Cover	1	
29	Bolt	1	M6 × 20 mm
30	Bolt	19	M6 × 30 mm
31	Bolt	1	M8 × 40 mm
32	Bolt	3	M6 × 20 mm

Removing the exhaust cover

1. Remove the cover ① and thermostat ②.



2. Remove the exhaust cover bolts in the sequence numbers (1, 2, · · ·).



Checking the exhaust cover anode

1. Check the anodes. Clean if there are scales, grease, or oil. ***NOTICE:*** **Do not oil, grease, or paint the anodes, otherwise they will be ineffective.**

2. Replace the anodes if excessively eroded.

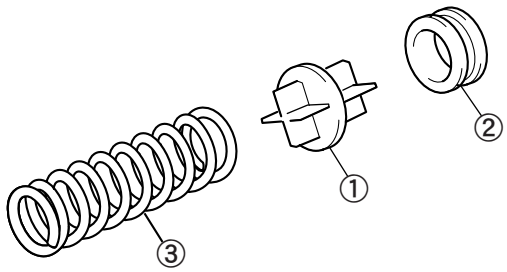
Checking the PCV

1. Remove the PCV ①.

2. Check the PCV ① for wear or damage. Replace if necessary.

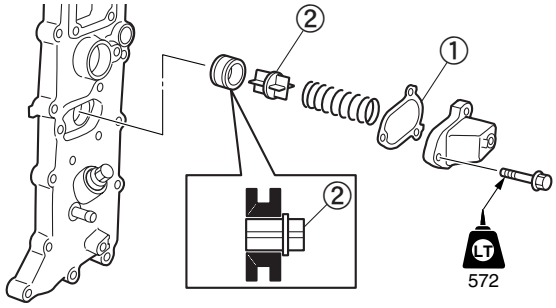
3. Check the grommet ② for deformation. Replace if necessary.

4. Check the spring ③ for fatigue or deformation. Replace if necessary.



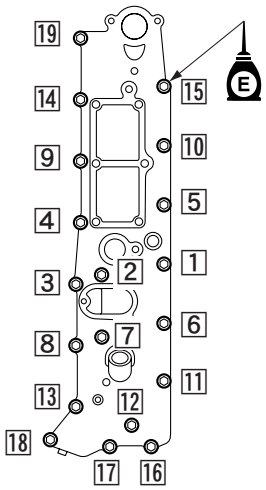
Installing the PCV

Install a new gasket ① and the PCV ②, and then tighten the bolts.



Installing the exhaust cover

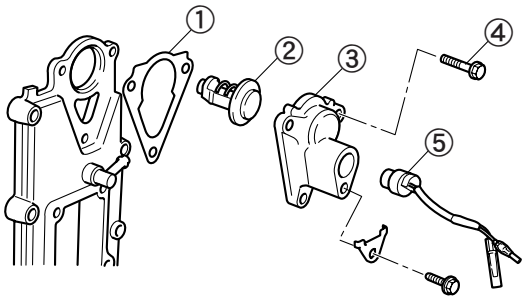
1. Install a new gasket and the exhaust cover, and then tighten the bolts to the specified torques in 2 stages and in the sequence numbers (1, 2, · · ·).



Exhaust cover bolt:
1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb)
2nd: 12 N·m (1.2 kgf·m, 8.9 ft·lb)

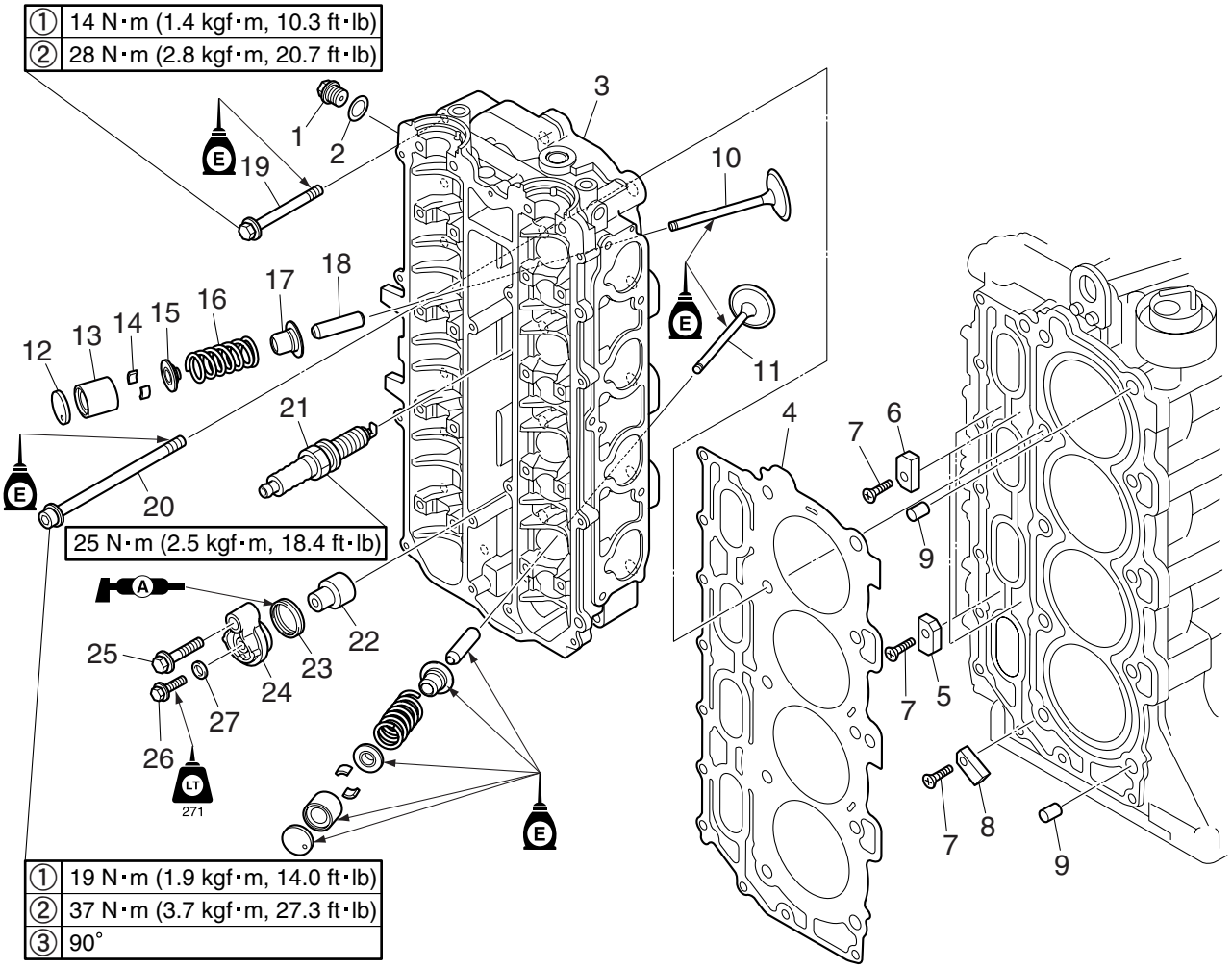
2. Install a new gasket ①, thermostat ②, cover ③, and then tighten the bolts ④ to the specified torques in 2 stages.

3. Install the thermoswitch ⑤.

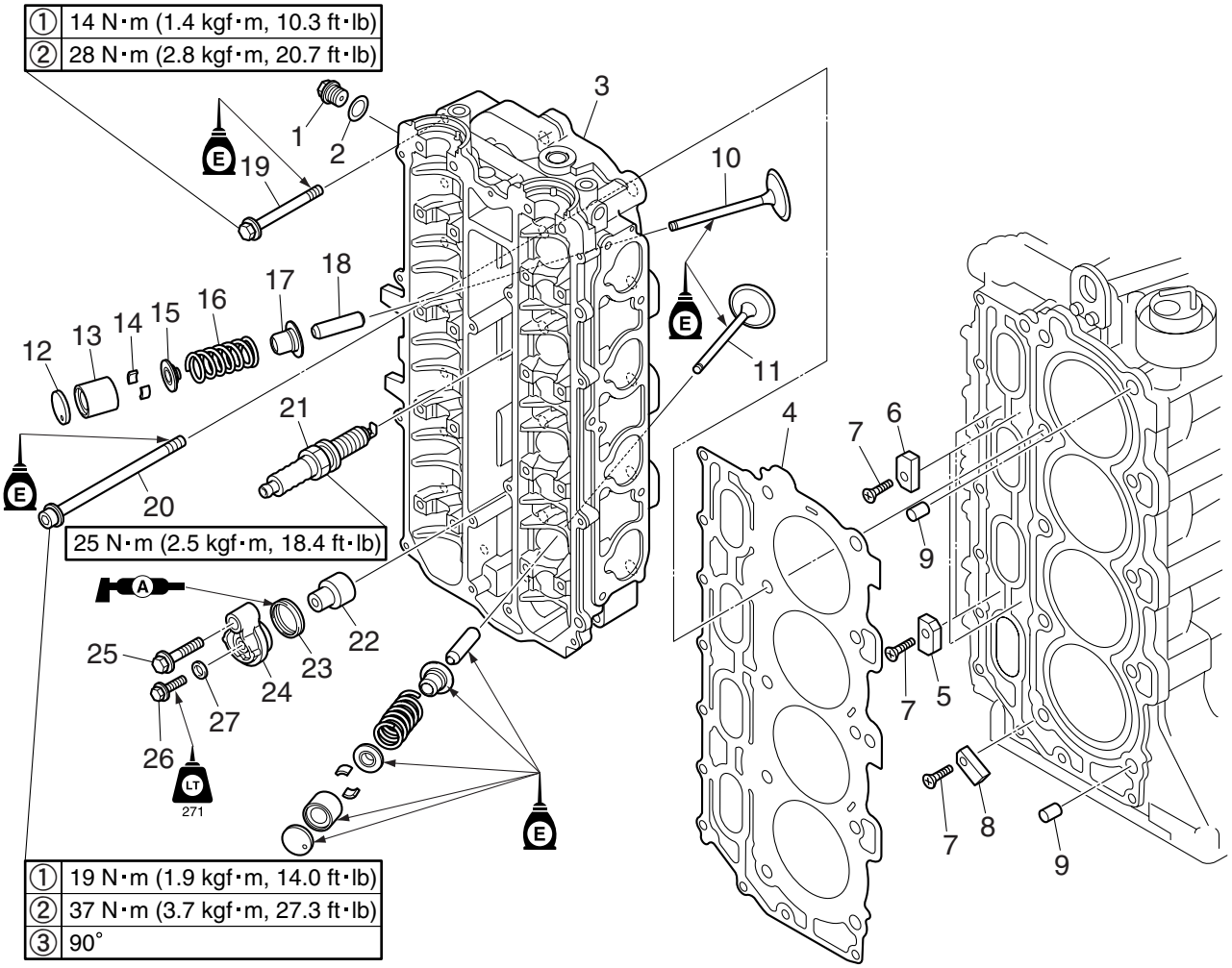


Bolt ④: 1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb) 2nd: 12 N·m (1.2 kgf·m, 8.9 ft·lb)

Cylinder head



No.	Part name	Q'ty	Remarks
1	Plug	2	
2	Gasket	2	**Not reusable**
3	Cylinder head	1	
4	Gasket	1	**Not reusable**
5	Anode	2	
6	Anode	2	
7	Screw	5	M6 × 16 mm
8	Anode	1	
9	Collar	2	
10	Exhaust valve	8	
11	Intake valve	8	
12	Valve shim	16	
13	Valve lifter	16	
14	Valve cotter	32	
15	Valve spring retainer	16	
16	Valve spring	16	
17	Valve seal	16	**Not reusable**

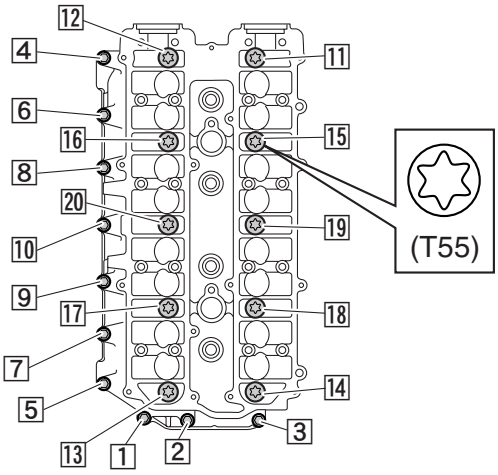


No.	Part name	Q'ty	Remarks
18	Valve guide	16	**Not reusable**
19	Bolt	10	M8 × 55 mm
20	Bolt	10	M10 × 120 mm
21	Spark plug	4	
22	Anode	2	
23	Grommet	2	
24	Cover	2	
25	Bolt	2	M8 × 40 mm
26	Bolt	2	M6 × 20 mm
27	Gasket	2	**Not reusable**

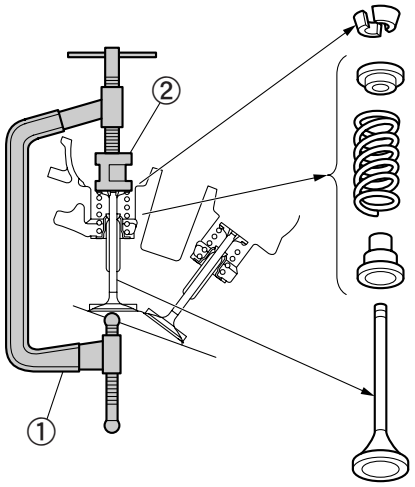
Removing the cylinder head

1. Remove the valve lifters from the cylinder head.

2. Remove the cylinder head bolts in the sequence numbers (1, 2, ···). ***NOTICE:*** **Do not scratch or damage the mating surfaces of the cylinder head and cylinder block.**



3. Remove the intake and exhaust valves.



TIP:

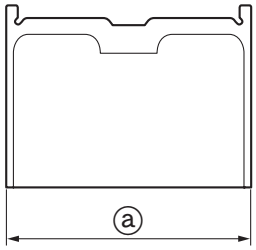
Make sure to keep the valves, springs, and other parts in the order as they were removed.

Valve spring compressor ①:
90890-04019
Valve spring compressor attachment ②:
90890-06320

Checking the valve lifter

1. Check the valve lifters. Replace if damaged, scratched, or worn.

2. Measure the valve lifter outside diameter. Replace if out of specification.

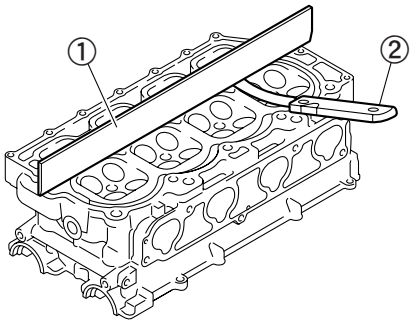


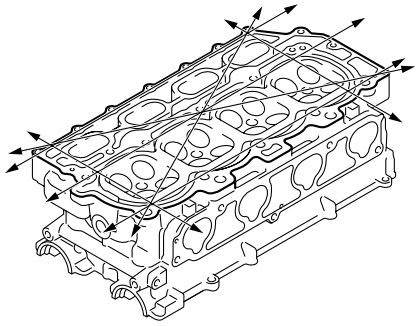
Valve lifter outside diameter ⓐ:
32.982–32.997 mm (1.2985–1.2991 in)

Checking the cylinder head

1. Eliminate carbon deposits from the combustion chambers and check for deterioration.

2. Check the cylinder head warpage using a straightedge ① and thickness gauge ② in the directions shown. Replace the cylinder head assembly if above specification.



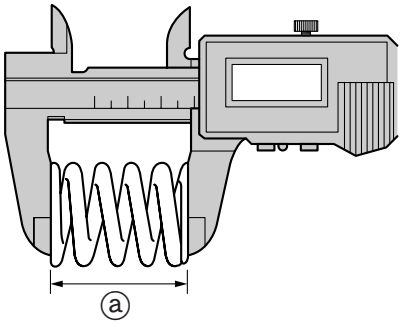


7

Cylinder head warpage limit:
0.1 mm (0.0039 in)

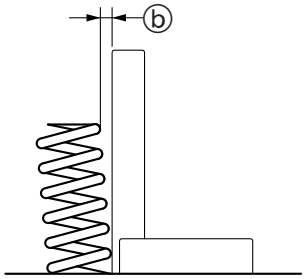
Checking the valve spring

1. Measure the valve spring free length ⓐ. Replace if out of specification.



Valve spring free length ⓐ:
44.2 mm (1.74 in)

2. Measure the valve spring tilt ⓑ. Replace if above specification.

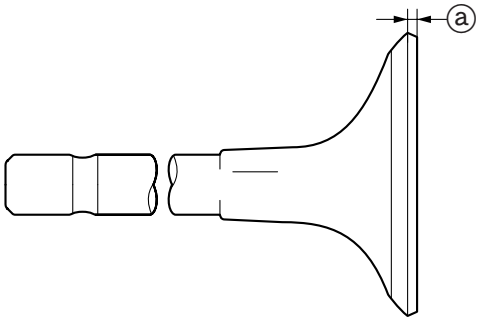


Valve spring tilt limit ⓑ: 1.2 mm (0.05 in)

Checking the valve

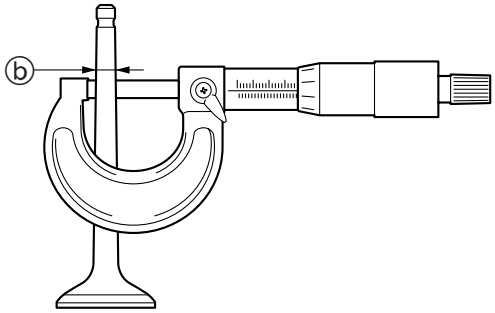
1. Check the valve face. Replace if pitted or worn.

2. Measure the valve margin thickness ⓐ.



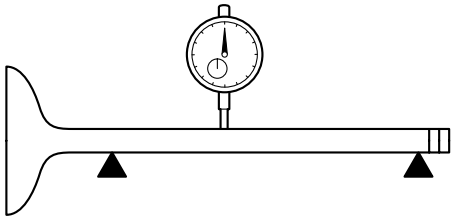
Valve margin thickness ⓐ:
Intake:
0.70 mm (0.0276 in)
Exhaust:
1.00 mm (0.0394 in)

3. Measure the valve stem diameter ⓑ. Replace if out of specification.



Valve stem diameter ⓑ:
Intake:
5.477–5.492 mm (0.2156–0.2162 in)
Exhaust:
5.464–5.479 mm (0.2151–0.2157 in)

4. Measure the valve stem runout. Replace if above specification.

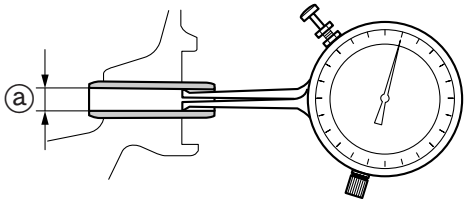


Valve stem runout: 0.01 mm (0.0004 in)

Checking the valve guide

Before checking the valve guides, make sure that the valve stem diameter is within specification.

1. Measure the valve guide inside diameter ⓐ.



Valve guide inside diameter ⓐ: Intake and exhaust: 5.504–5.522 mm (0.2167–0.2174 in)

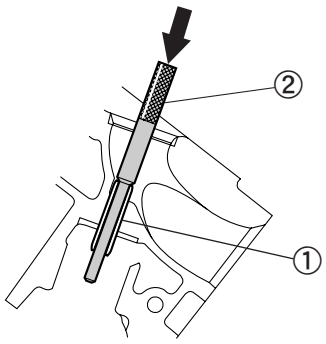
2. Calculate the valve stem-to-valve guide clearance as follows. Replace the valve guide if out of specification.

Valve stem-to-valve guide clearance = valve guide inside diameter – valve stem diameter: Intake and exhaust: 0.025–0.058 mm (0.0010–0.0023 in)

Replacing the valve guide

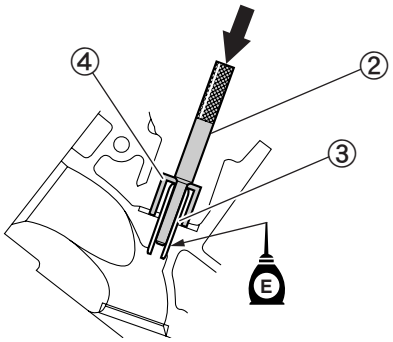
After replacing a valve guide, check the valve seat contact area.

1. Remove the valve guide ① using the special service tool ② from the combustion chamber side.



Valve guide remover/installer ②: 90890-06801

2. Install a new valve guide ③ using the special service tool ② from the camshaft side until the valve guide installer ④ contacts the cylinder head.

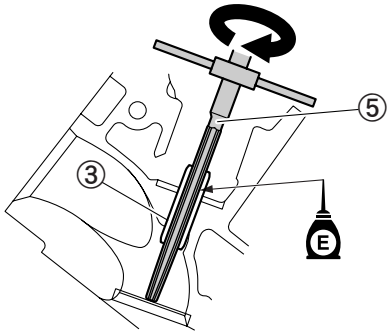


Valve guide remover/installer ②: 90890-06801 Valve guide installer ④: 90890-06810

TIP:

Apply engine oil to the outer surface of new valve guides.

3. Insert the special service tool ⑤ into the valve guide ③, and then ream the valve guide.



Valve guide reamer ⑤: 90890-06804

TIP:

- Apply engine oil to the inner surface of the valve guide.
- Turn the valve guide reamer clockwise to ream the valve guide.
- Do not turn the reamer counterclockwise when removing it.
- Make sure to clean the valve guide after reaming it.

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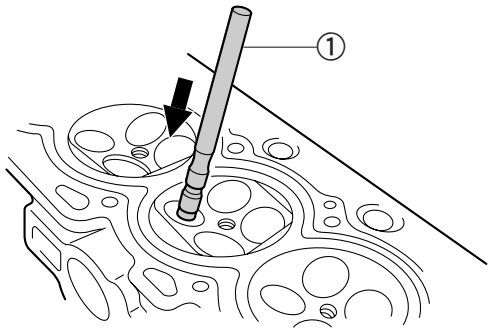
4. Measure the valve guide inside diameter.

Valve guide inside diameter:
5.504–5.522 mm
(0.2167–0.2174 in)

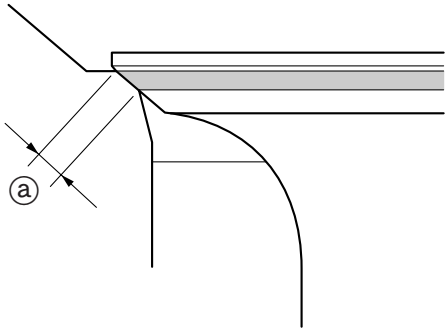
Checking the valve seat

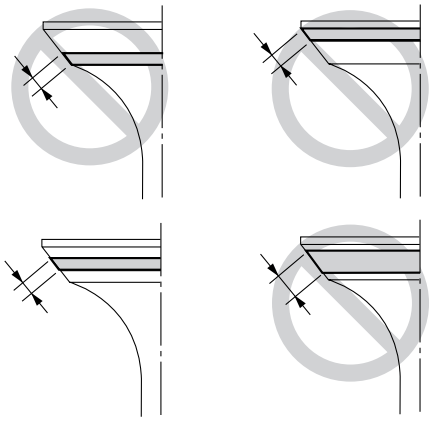
1. Eliminate carbon deposits from the valves.
2. Apply a thin, even layer of Mechanic's blueing dye (Dykem) onto the valve seats.
3. Lap the valve slowly on the valve seat with a special service tool ①.



Valve lapper ①: 90890-04101

4. Measure the valve seat contact width ⓐ where the blueing dye is adhered to the valve face. Reface the valve seat if the valve is not seated properly or if the valve seat contact width is out of specification. Replace the valve guide if the valve seat contact width is uneven.





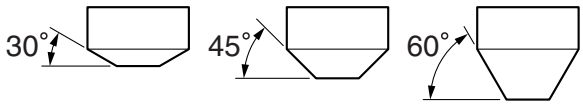
Valve seat contact width ⓐ:
Intake:
1.10–1.40 mm (0.043–0.055 in)
Exhaust:
1.40–1.70 mm (0.055–0.067 in)

Refacing the valve seat

NOTICE

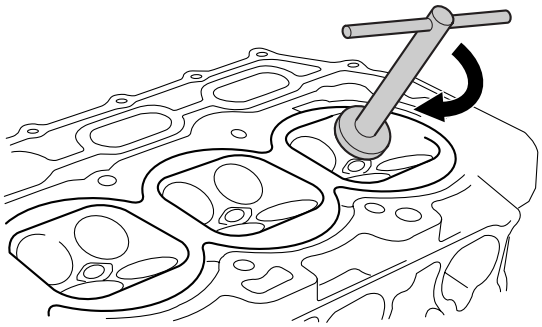
After every lapping procedure, make sure to clean off any remaining lapping compound from the cylinder head and the valves.

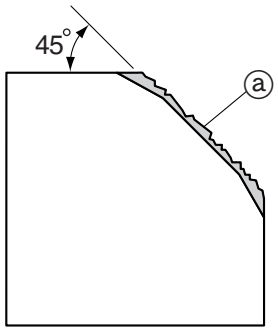
1. Reface the valve seats with the valve seat cutters.



Valve seat cutter holder: 90890-06316
Valve seat cutter:
30° (intake): 90890-06817
30° (exhaust): 90890-06326
45° (intake): 90890-06816
45° (exhaust): 90890-06325
60° (intake and exhaust): 90890-06324

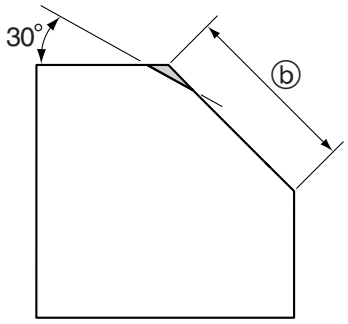
2. Cut the surface of the valve seat with a 45° cutter by turning the cutter clockwise until the valve seat face has become smooth. ***NOTICE:*** **Do not over cut the valve seat. Make sure to turn the cutter evenly downward at a pressure of 40–50 N (4.0–5.0 kgf, 8.8–11.0 lbf) to prevent chatter marks.**





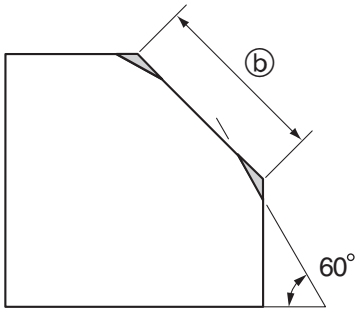
ⓐ Slag or rough surface

3. Use a 30° cutter to adjust the contact width of the top edge of the valve seat.



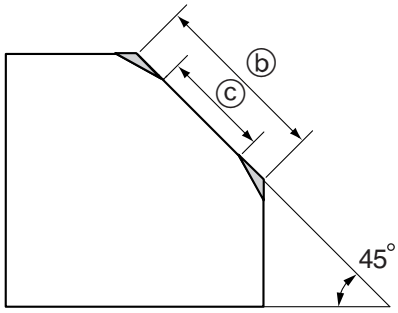
ⓑ Previous contact width

4. Use a 60° cutter to adjust the contact width of the bottom edge of the valve seat.



ⓑ Previous contact width

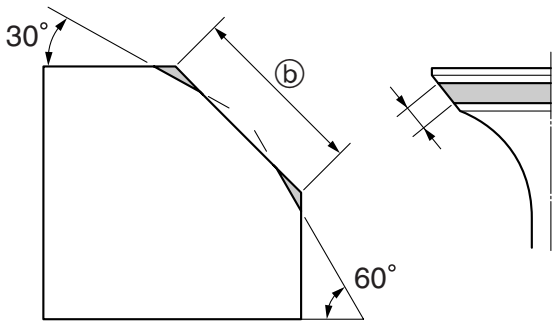
5. Use a 45° cutter to adjust the contact width of the valve seat to specification.



ⓑ Previous contact width
ⓒ Specified contact width

6. Check the valve seat contact area of the valve. See “Checking the valve seat” (7-41).

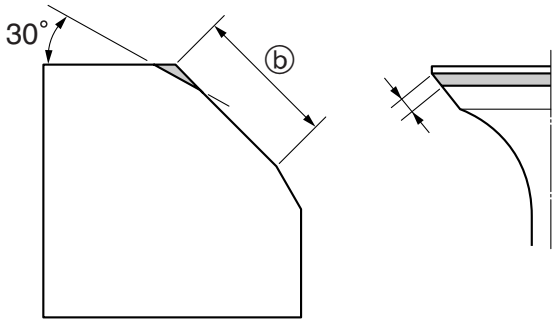
7. If the valve seat contact area is too wide and situated in the center of the valve face, use a 30° cutter to cut the top edge of the valve seat, and then use a 60° cutter to cut the bottom edge to center the area and set its width.



ⓑ Previous contact width

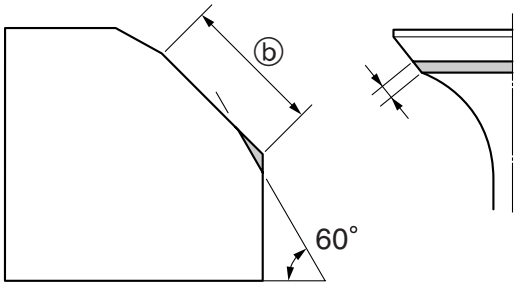
7

8. If the valve seat contact area is too narrow and situated near the top edge of the valve face, use a 30° cutter to cut the top edge of the valve seat, and then use a 45° cutter to center the area and set its width.



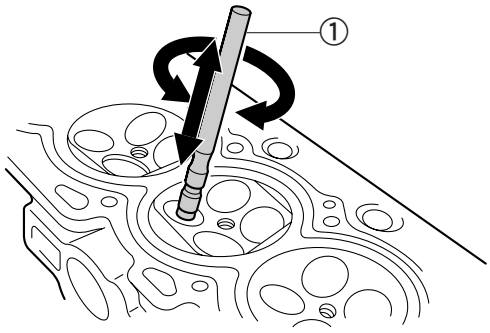
ⓑ Previous contact width

9. If the valve seat contact area is too narrow and situated near the bottom edge of the valve face, use a 60° cutter to cut the bottom edge of the valve seat, and then use a 45° cutter to center the area and set its width.



ⓑ Previous contact width

10. After refacing the valve seat to the specified contact width, apply a thin, even layer of lapping compound onto the valve seat, and then lap the valve using a special service tool ①. ***NOTICE:*** **Do not get the lapping compound on the valve stem or valve guide.**

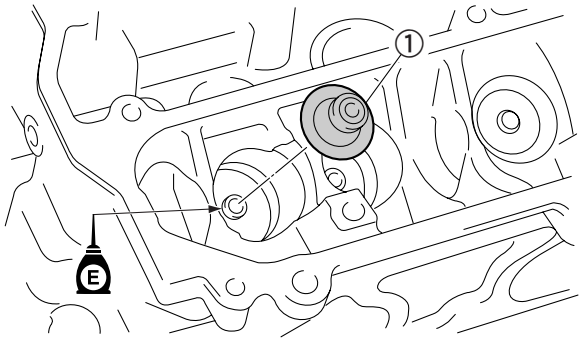


Valve lapper ①: 90890-04101

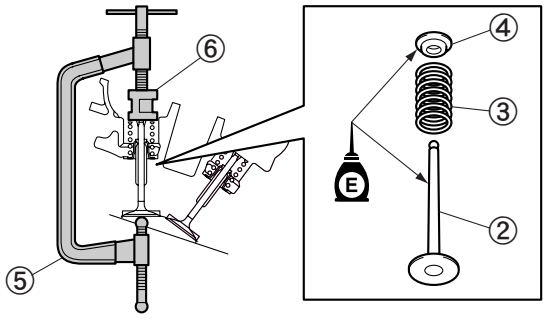
11. Check the valve seat contact area again. See “Checking the valve seat” (7-41).

Assembling the cylinder head

1. Install a new valve seal ① onto the valve guide.



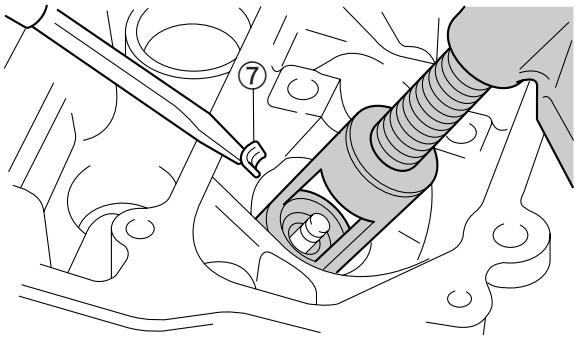
2. Install the valve ②, valve spring ③, and valve spring retainer ④ in this order, and then attach the special service tools ⑤ and ⑥.



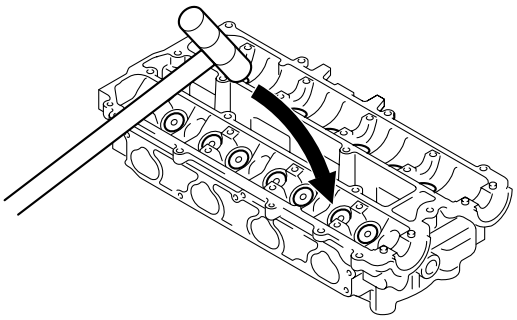
Valve spring compressor ⑤: 90890-04019 Valve spring compressor attachment ⑥: 90890-06320

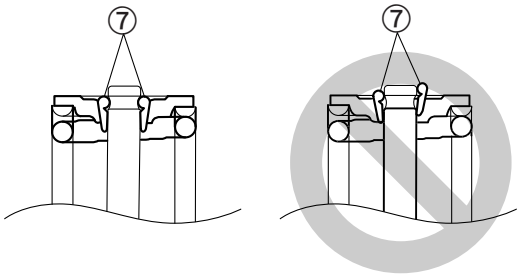
TIP:
The valve spring can be installed in any direction.

3. Compress the valve spring, and then install the valve cotters ⑦.



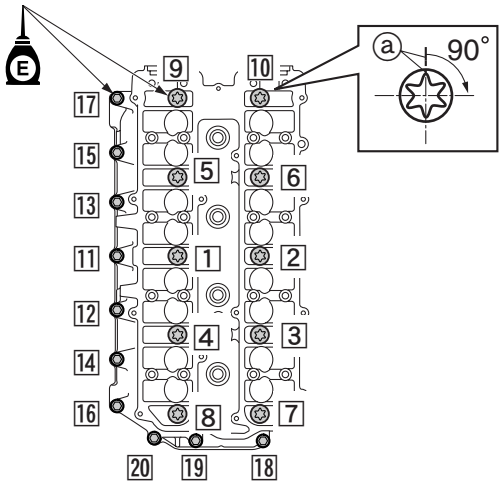
4. Lightly tap the valve spring retainer with a plastic hammer to set the valve cotters ⑦ securely.





Installing the cylinder head

1. Install a new gasket and the cylinder head, and then tighten the bolts to the specified torques in the sequence numbers (1, 2, · · ·). Apply engine oil to the cylinder head bolts before installation. ***NOTICE:*** **Do not reuse the cylinder head gasket, always replace it with a new one.**



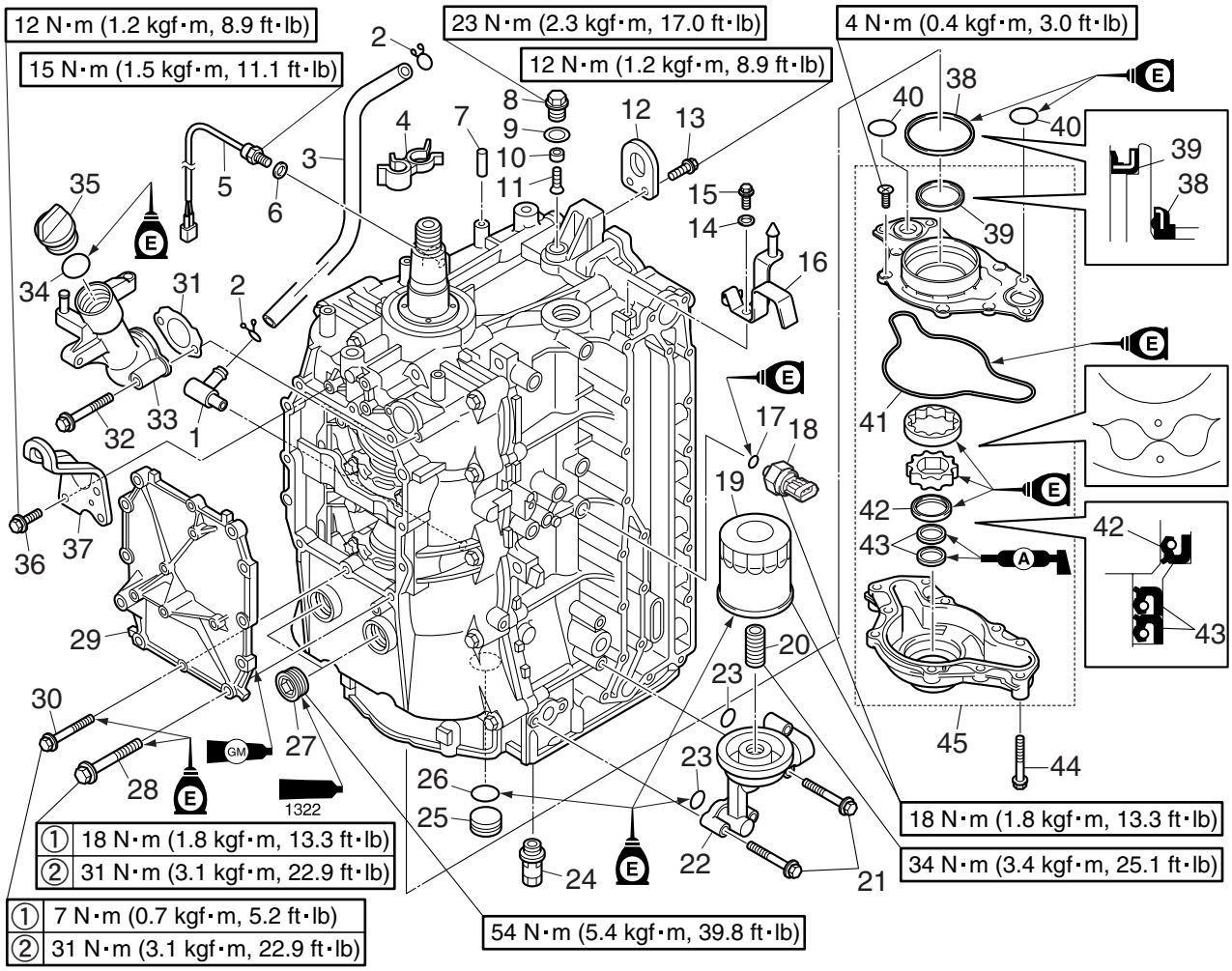
Cylinder head bolt 1–10 (M10): 1st: 19 N·m (1.9 kgf·m, 14.0 ft·lb) 2nd: 37 N·m (3.7 kgf·m, 27.3 ft·lb) 3rd: 90° Cylinder head bolt 11–20 (M8): 1st: 14 N·m (1.4 kgf·m, 10.3 ft·lb) 2nd: 28 N·m (2.8 kgf·m, 20.7 ft·lb)

TIP:
Tighten the M10 bolts to the specified torques in 2 stages first, and then make a mark ⓐ on the M10 bolts and the cylinder head, and then tighten the bolts 90° from the mark.

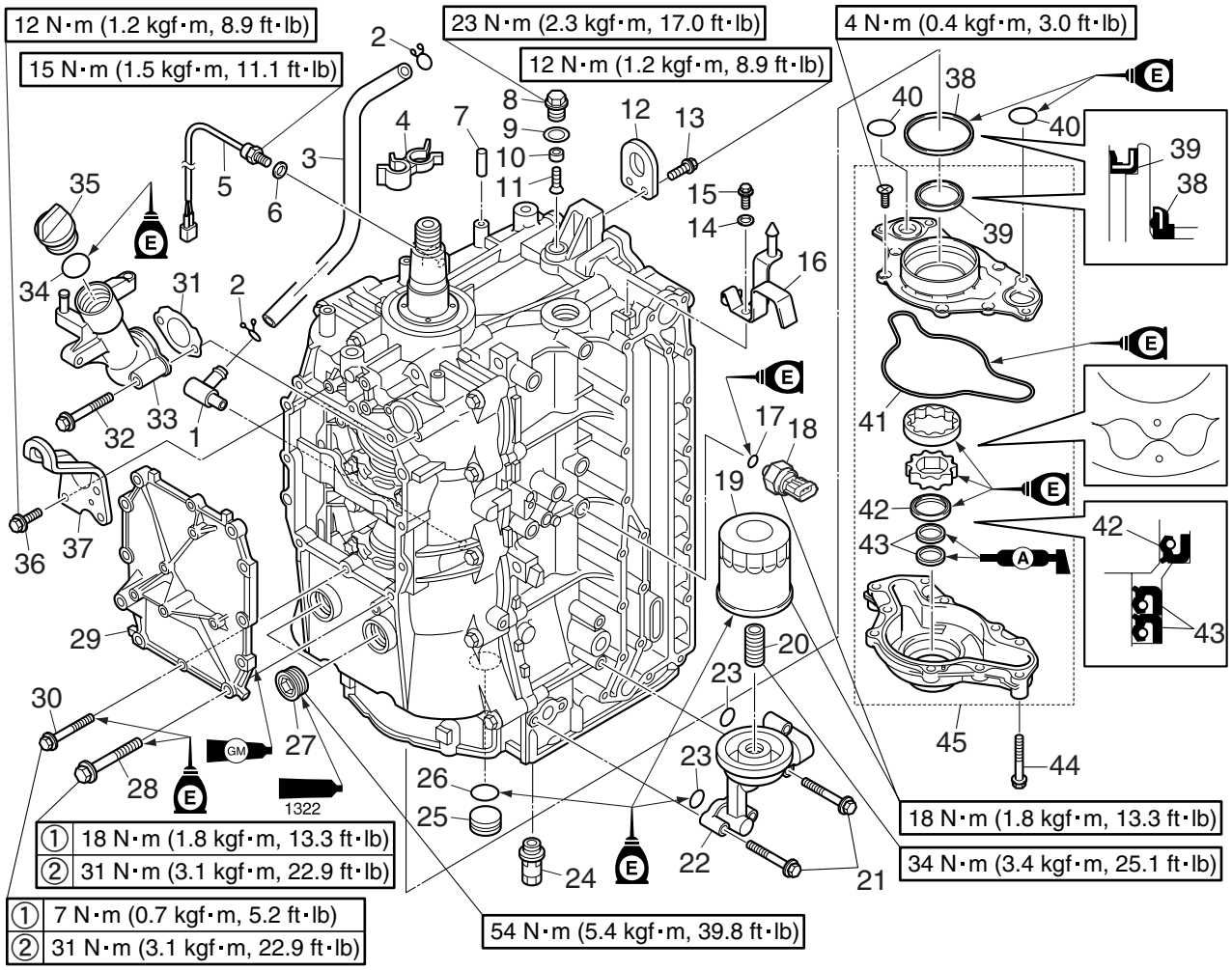
2. Install the camshafts, driven sprockets, and timing belt. See “Installing the timing belt, driven sprocket, and camshaft” (7-30).

7

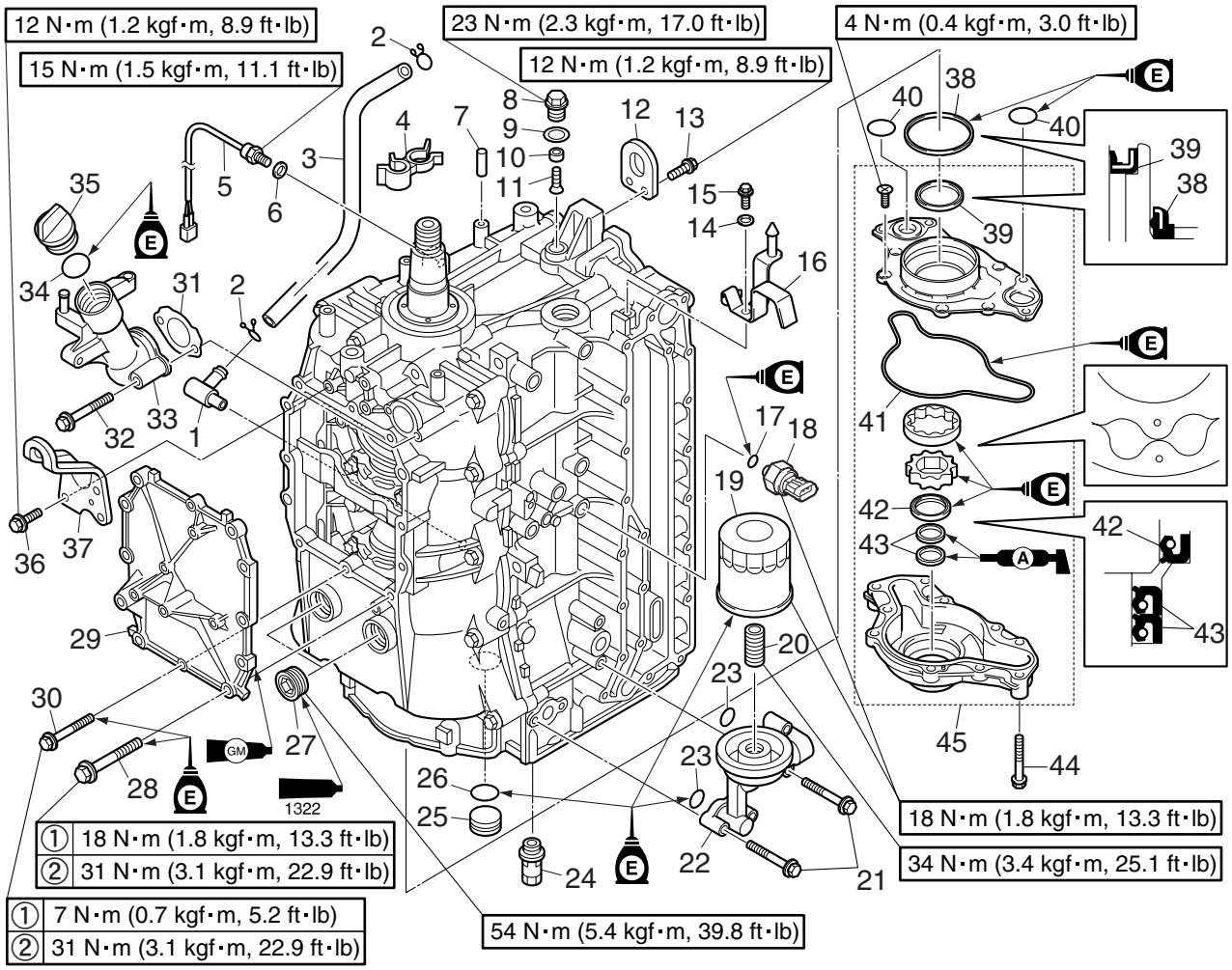
Cylinder block



No.	Part name	Q'ty	Remarks
1	Nipple	1	
2	Clip	2	
3	Hose	1	
4	Holder	1	
5	Engine temperature sensor	1	
6	Washer	1	
7	Dowel	1	
8	Plug	1	M14 × 12 mm
9	Washer	1	
10	Anode	1	
11	Screw	1	M5 × 12 mm
12	Engine hanger	1	
13	Bolt	2	M6 × 20 mm
14	Washer	1	
15	Bolt	1	M6 × 16 mm
16	Bracket	1	
17	O-ring	1	**Not reusable**



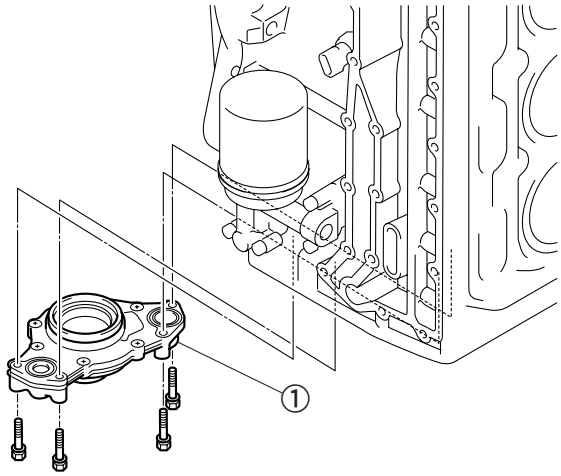
No.	Part name	Q'ty	Remarks
18	Oil pressure sensor	1	
19	Oil filter	1	
20	Joint	1	
21	Bolt	4	M6 × 40 mm
22	Oil filter bracket	1	
23	O-ring	2	**Not reusable**
24	Relief valve	1	
25	Plug	1	
26	O-ring	1	**Not reusable**
27	Plug	2	
28	Bolt	10	M8 × 35 mm
29	Crankcase cover	1	
30	Bolt	2	M6 × 25 mm
31	Gasket	1	**Not reusable**
32	Bolt	2	M6 × 45 mm
33	Oil filler neck	1	
34	O-ring	1	



No.	Part name	Q'ty	Remarks
35	Oil filler cap	1	
36	Bolt	3	M6 × 20 mm
37	Engine hanger	1	
38	Oil seal	1	**Not reusable**
39	Oil seal	1	**Not reusable**
40	O-ring	2	**Not reusable**
41	Gasket	1	**Not reusable**
42	Oil seal	2	**Not reusable**
43	Oil seal	2	**Not reusable**
44	Bolt	4	M6 × 40 mm
45	Oil pump assembly	1	

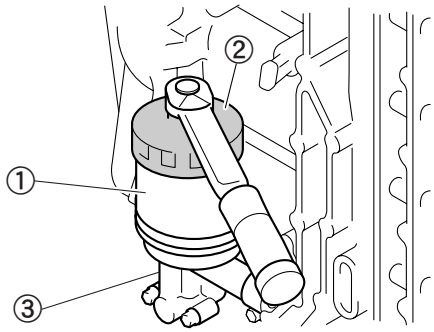
Removing the oil pump assembly

1. Remove the oil pump ①.



Removing the oil filter bracket

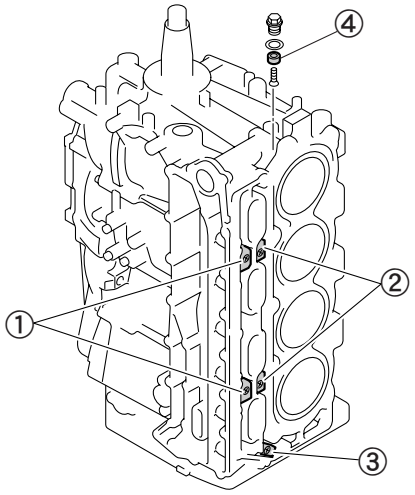
1. Remove the oil filter ① using a 72.5 mm (2.9 in) oil filter wrench ②, and then remove the oil filter bracket ③.



Oil filter wrench ②: 90890-06830

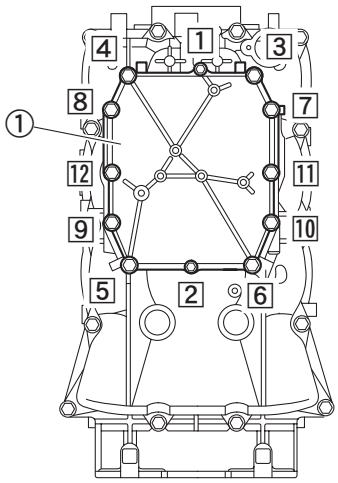
Removing the anode (cylinder block)

1. Remove the anodes ①, ②, ③ and ④.



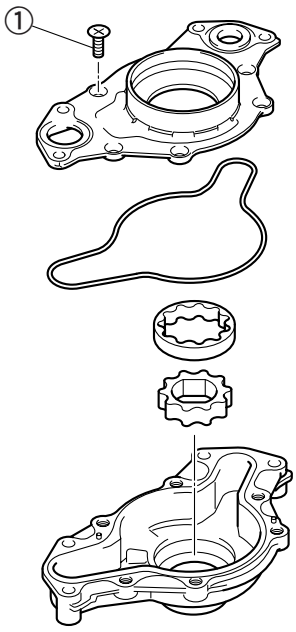
Removing the crankcase cover

1. Remove the crankcase cover ① bolts in the sequence numbers (1, 2, · · ·).



Disassembling the oil pump assembly

1. Remove the screws ① and disassemble the oil pump.

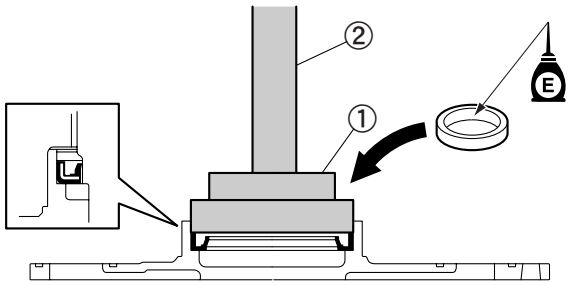


Checking the oil pump assembly

1. Check the gear teeth and inner surface of the oil pump case. Replace the oil pump assembly if the gear teeth are cracked or worn, or if inner surface of the oil pump case is scratched.

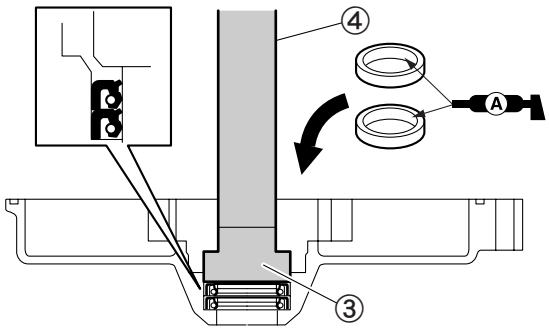
Assembling the oil pump assembly

1. Install a new oil seal into the oil pump cover.



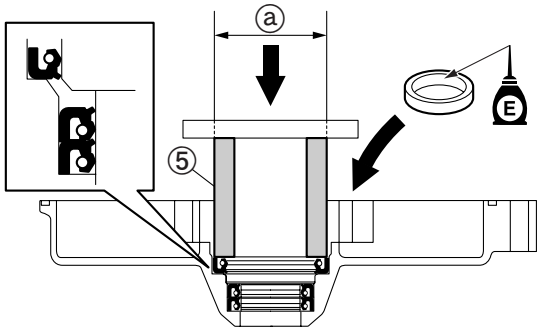
Needle bearing attachment ①: 90890-06654 Driver rod L3 ②: 90890-06652

2. Apply grease to new oil seals, and then install them into the oil pump housing.



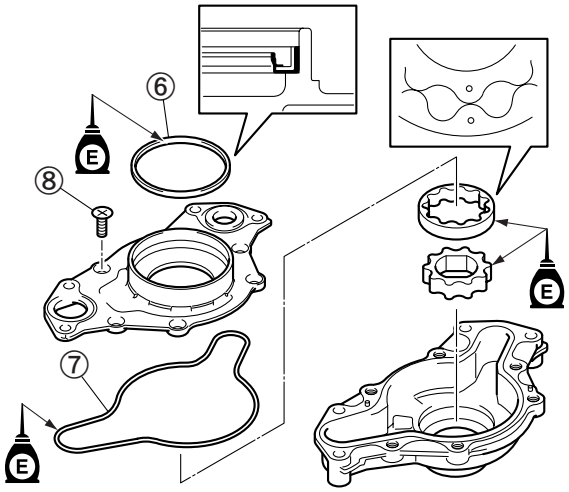
Needle bearing attachment ③: 90890-06611 Driver rod L3 ④: 90890-06652

3. Install a new oil seal into the oil pump housing.



General pipe ⑤: ⓐ = 45.0 mm (1.77 in)

4. Install a new oil seal ⑥ and the gasket ⑦, and then tighten the screws ⑧ to the specified torque.



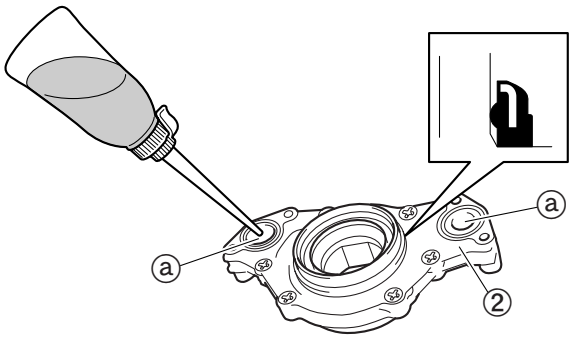
Screw ⑧: 4 N·m (0.4 kgf·m, 3.0 ft·lb)

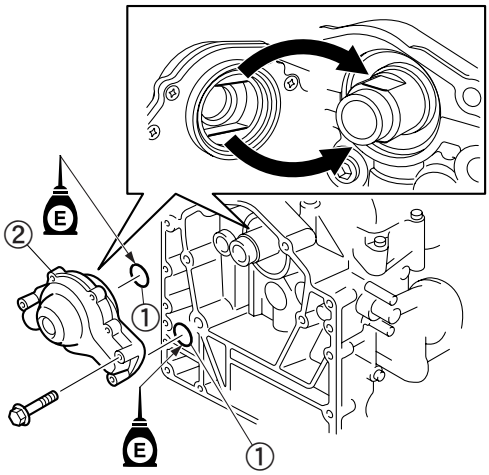
Installing the oil pump assembly

NOTICE

When installing the oil pump assembly, make sure to prevent the oil seal damage.

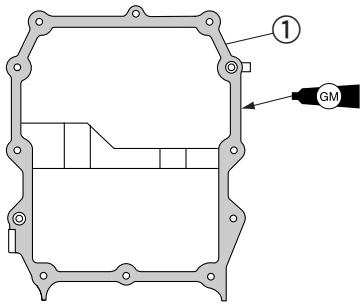
1. Install the new O-rings ① and oil pump ② by aligning the oil pump gear with the crankshaft.
   NOTICE: **Before installing the oil pump, make sure to fill it with engine oil through the oil passage ⓐ.**





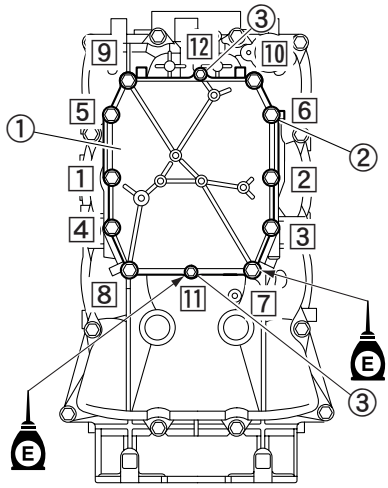
Installing the crankcase cover

1. Apply sealant to the mating surface of the crankcase cover ①.



TIP:
Do not get any sealant inside the crankcase cover ①.

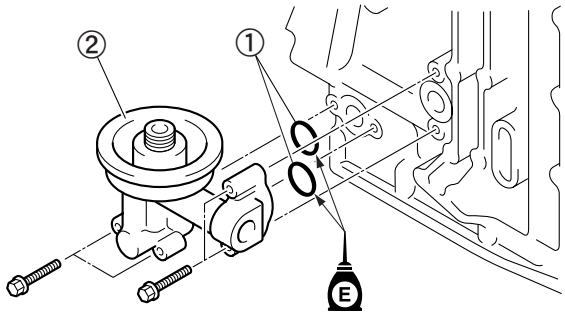
2. Install the crankcase cover ① onto the crankcase, and then tighten the bolts ② and ③ to the specified torques in 2 stages, and in the sequence numbers (1, 2, · · ·). Apply engine oil to the bolts ② and ③ before installation.



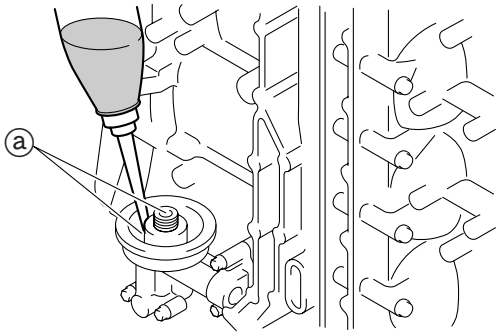
Bolt ② 1–10 (M8):
1st: 18 N·m (1.8 kgf·m, 13.3 ft·lb)
2nd: 31 N·m (3.1 kgf·m, 22.9 ft·lb)
Bolt ③ 11–12 (M6):
1st: 7 N·m (0.7 kgf·m, 5.2 ft·lb)
2nd: 13 N·m (1.3 kgf·m, 9.6 ft·lb)

Installing the oil filter

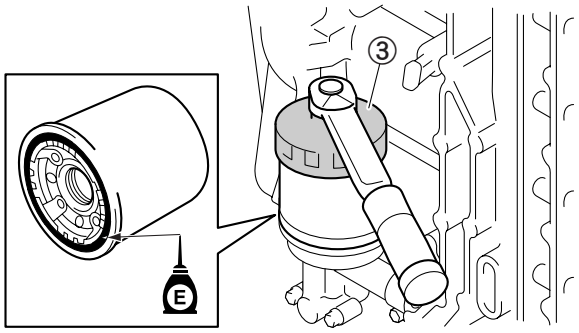
1. Install the new O-rings ① and oil filter bracket ②.



2. Supply engine oil to the oil passage ⓐ of the oil filter bracket.



3. Install the oil filter, and then tighten it to the specified torque using a 72.5 mm (2.9 in) oil filter wrench ③. Apply a thin coat of engine oil to the O-ring of a new oil filter before installation.



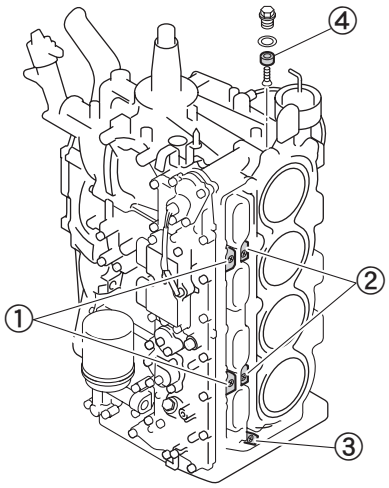
Oil filter wrench ③: 90890-06830

Oil filter: 18 N·m (1.8 kgf·m, 13.3 ft·lb)

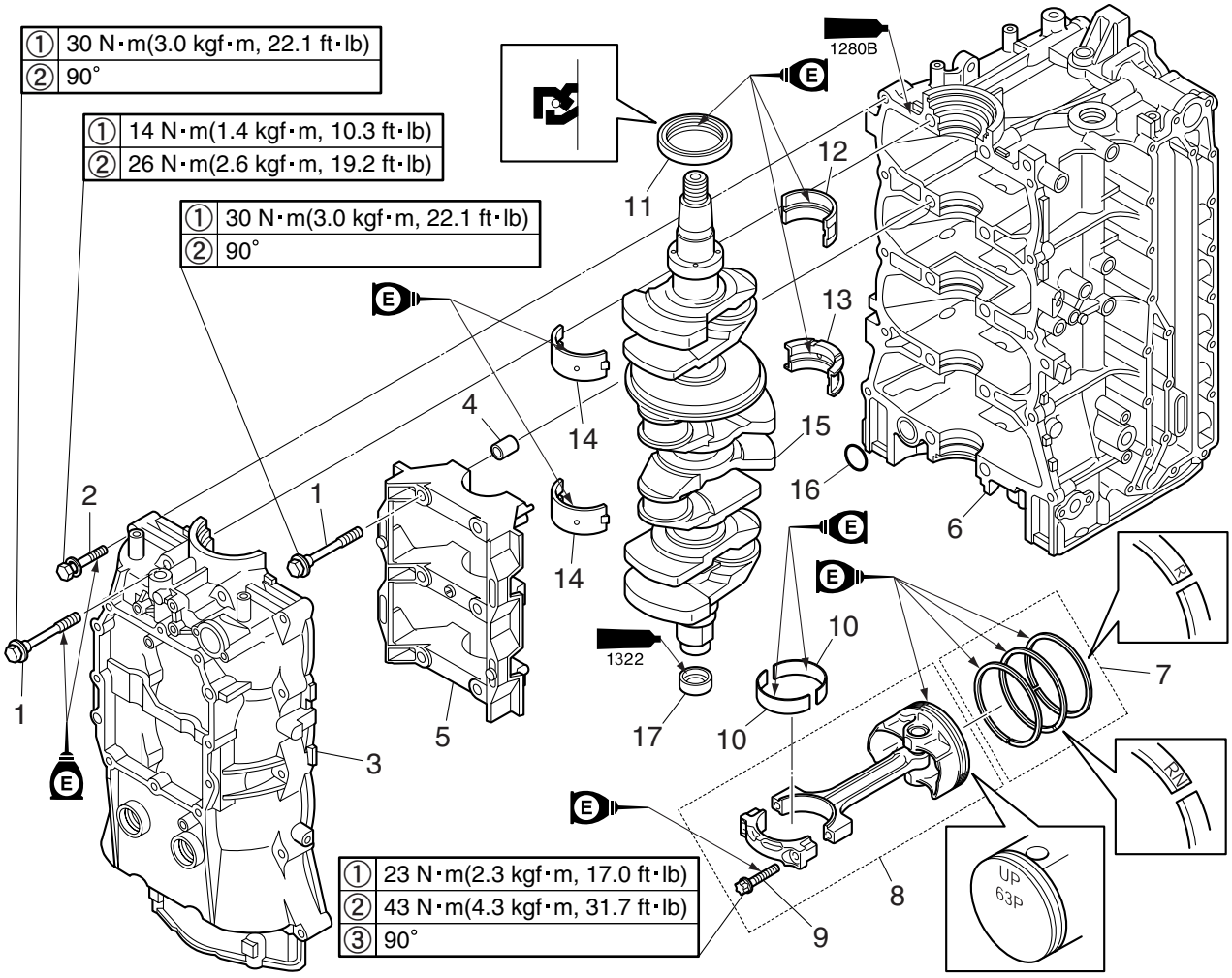
4. Install the exhaust cover. See “Installing the exhaust cover” (7-34).

Installing the anode (cylinder block)

1. Install the anodes ①, ②, ③, and ④.



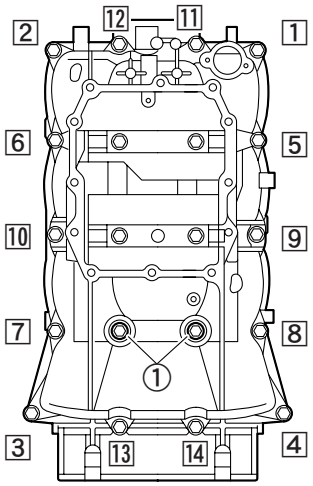
Crankcase



No.	Part name	Q'ty	Remarks
1	Bolt	10	M10 × 85 mm
2	Bolt	10	M8 × 55 mm
3	Crankcase	1	
4	Collar	10	
5	Main bearing cap	1	
6	Cylinder block	1	
7	Piston ring set	4	
8	Piston and connecting rod assembly	4	
9	Bolt	8	M9 × 44 mm **Not reusable**
10	Connecting rod bearing	8	
11	Oil seal	1	**Not reusable**
12	Main bearing	4	
13	Thrust bearing	1	
14	Main bearing	5	
15	Crankshaft	1	
16	O-ring	1	**Not reusable**
17	Collar	1	**Not reusable**

Disassembling the cylinder block

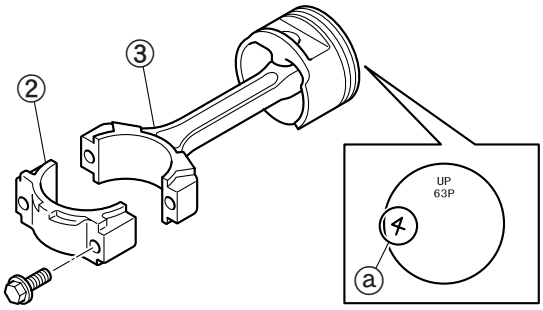
1. Remove the crankcase bolts in the sequence numbers (1, 2, · · ·).



TIP:

Do not remove the plugs ① from the crankcase.

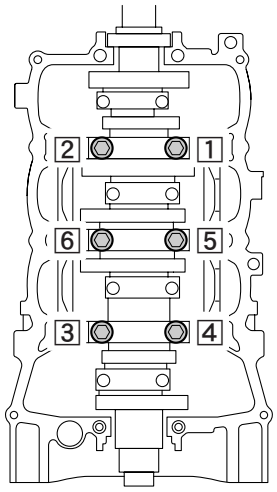
2. Remove the connecting rod bolts and the connecting rod caps ②, and then remove the connecting rod and piston assemblies ③.



TIP:

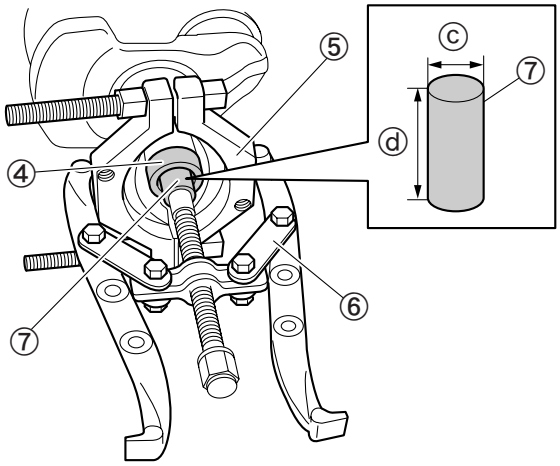
- Make sure to keep the bearings in the order as they were removed.
- Mark each piston with an identification number ⓐ of the corresponding cylinder.
- Do not mix the connecting rods and caps. Keep them organized in their proper groups.

3. Remove the main bearing cap bolts in the sequence numbers (1, 2, · · ·).



4. Remove the crankshaft.

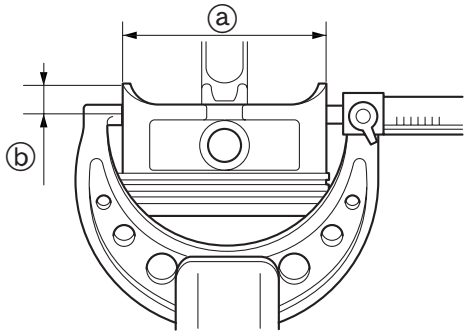
5. Remove the collar ④.



Bearing separator ⑤: 90890-06534
Gear puller ⑥: 90890-06540
General cylindrical tool ⑦:
ⓒ = 19.9mm (0.78 in)
ⓓ = 90.0mm (3.54 in)

Checking the piston diameter

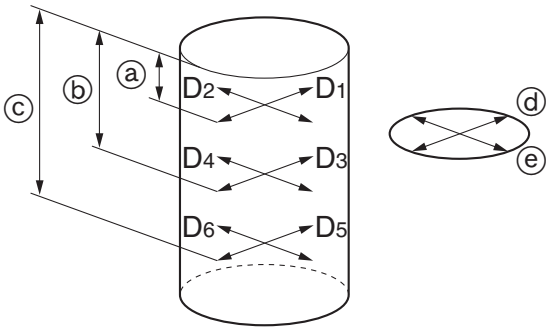
1. Measure the piston outside diameter at the specified measuring point. Replace if out of specification.



Piston diameter ⓐ:
93.921–93.941 mm (3.6977–3.6985 in)
Measuring point ⓑ:
14.0 mm (0.55 in) up from the bottom of the piston skirt

Checking the cylinder bore

1. Measure the cylinder bore (D_1–D_6) at measuring points ⓐ, ⓑ, and ⓒ, and in direction ⓓ (D_1, D_3, D_5), which is parallel to the crankshaft, and direction ⓔ (D_2, D_4, D_6), which is at a right angle to the crankshaft.

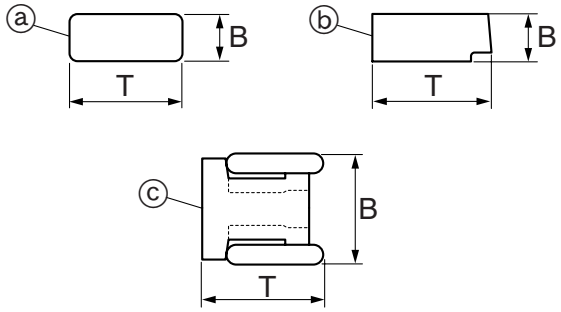


ⓐ 20 mm (0.8 in)
ⓑ 60 mm (2.4 in)
ⓒ 100 mm (3.9 in)

Cylinder bore (D_1–D_6):
94.000–94.017 mm (3.7008–3.7014 in)

Checking the piston ring

1. Check the piston ring dimensions B and T. Replace the piston ring set if out of specification.

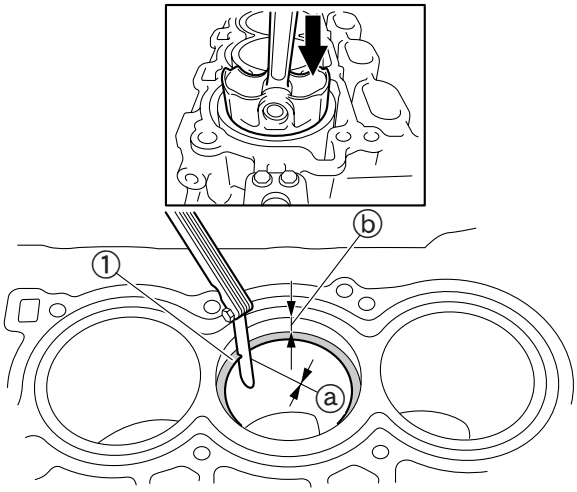


Piston ring dimensions:
Top ring ⓐ:
B:1.17–1.19 mm (0.0461–0.0469 in)
T:2.80–3.00 mm (0.1102–0.1181 in)
Second ring ⓑ:
B:1.17–1.19 mm (0.0461–0.0469 in)
T:3.70–3.90 mm (0.1457–0.1535 in)
Oil ring ⓒ:
B:2.40–2.47 mm (0.0945–0.0972 in)
T:2.30–2.70 mm (0.0906–0.1063 in)

Checking the piston ring end gap (reference)

1. Level the piston ring ① in the cylinder with a piston crown.

2. Check the piston ring end gap ⓐ at the specified measuring point ⓑ.



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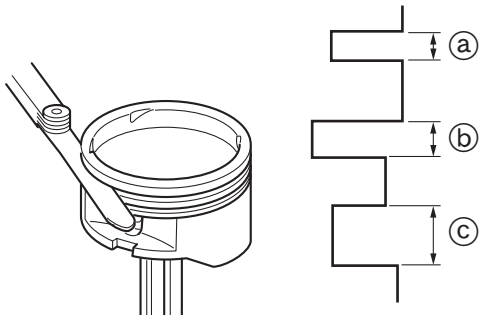
Piston ring end gap ⓐ:
Top ring:
0.15–0.30 mm (0.0059–0.0118 in)
Second ring:
0.30–0.45 mm (0.0118–0.0177 in)
Oil ring:
0.15–0.60 mm (0.0059–0.0236 in)
Measuring point ⓑ:
20 mm (0.8 in)

Checking the piston ring groove

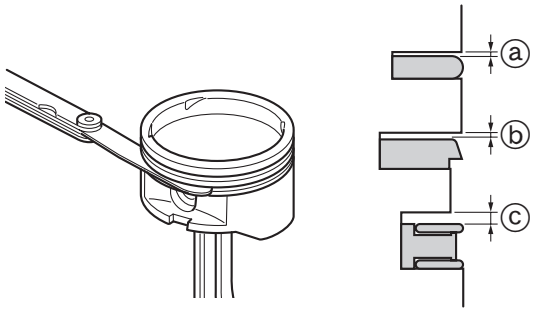
1. Measure the piston ring grooves. Replace the piston and connecting rod assembly if out of specification.



Piston ring groove:
Top ring ⓐ:
1.23–1.25 mm (0.0484–0.0492 in)
Second ring ⓑ:
1.22–1.24 mm (0.0480–0.0488 in)
Oil ring ⓒ:
2.51–2.53 mm (0.0988–0.0996 in)

Checking the piston ring side clearance

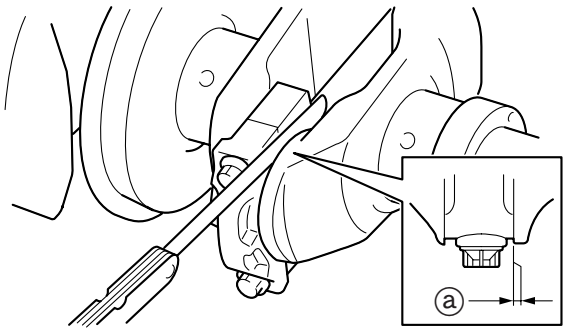
1. Measure the piston ring side clearance. Replace the piston and connecting rod assembly, piston ring set if out of specification.



Piston ring side clearance:
Top ring ⓐ:
0.04–0.08 mm (0.0016–0.0031 in)
Second ring ⓑ:
0.03–0.07 mm (0.0012–0.0028 in)
Oil ring ⓒ:
0.04–0.13 mm (0.0016–0.0051 in)

Checking the connecting rod big end side clearance

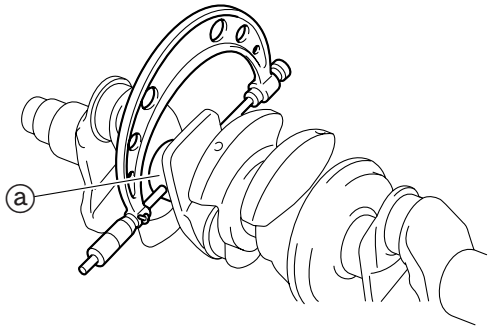
1. Measure the connecting rod big end side clearance ⓐ.

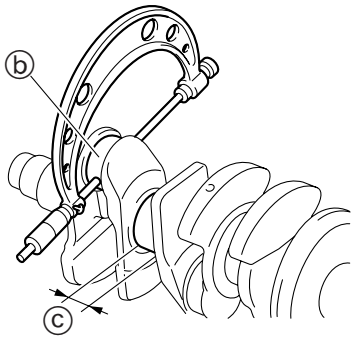


Connecting rod big end
side clearance ⓐ (reference data):
0.14–0.31 mm (0.006–0.012 in)

Checking the crankshaft

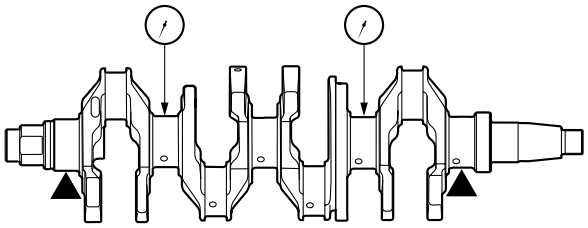
1. Measure the crankshaft journal diameter ⓐ, crankpin diameter ⓑ, and crankpin width ⓒ. Replace the crankshaft if out of specification.





Crankshaft journal diameter ⓐ: 51.980–52.000 mm (2.0465–2.0472 in) Crankpin diameter ⓑ: 49.980–50.000 mm (1.9677–1.9685 in) Crankpin width ⓒ: 22.00–22.10 mm (0.8661–0.8701 in)

2. Measure the crankshaft runout. Replace the crankshaft if out of specification.

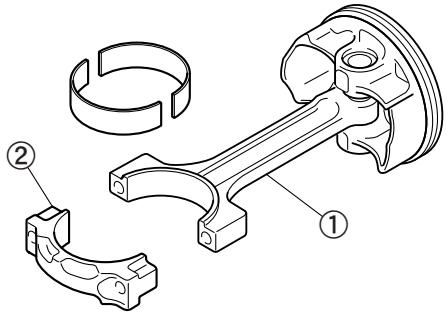


Crankshaft runout limit: 0.03 mm (0.0012 in)

Checking the crankpin oil clearance

1. Clean the bearings and the connecting rod.

2. Install the upper bearing into the connecting rod ① and the lower bearing into the connecting rod cap ②.

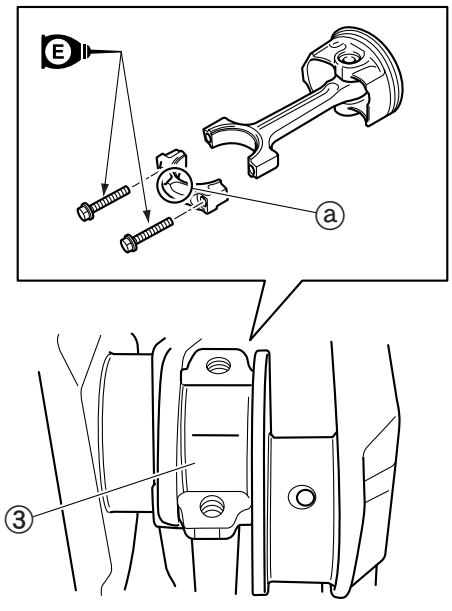


TIP:
Install the connecting rod bearings in their original positions.

3. Put a piece of Plastigauge (PG-1) onto the crankpin, parallel to the crankshaft.

TIP:
Make sure not to put the Plastigauge (PG-1) over the oil hole in the crankpin of the crankshaft.

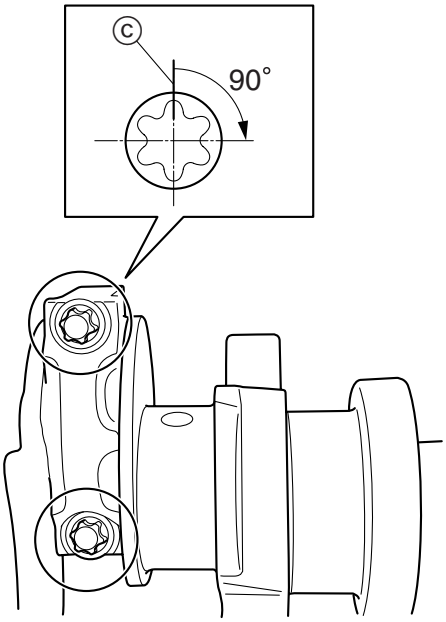
4. Install the connecting rod to the crankpin ③.



TIP:
Make sure that the marks ⓐ of the connecting rod faces towards the flywheel magnet side of the crankshaft.

7

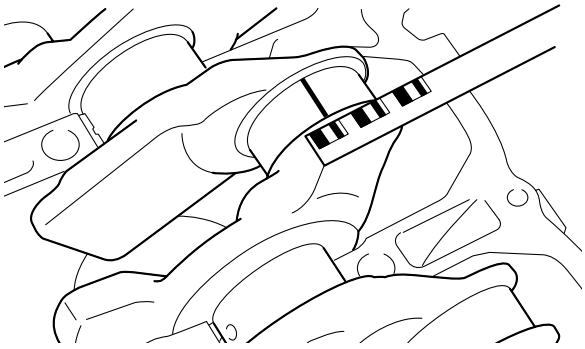
5. Tighten the connecting rod bolts to the specified torques in 3 stages. In the 3rd stage, make a mark ⓑ on the connecting rod cap bolts, connecting rod caps, and then tighten the bolts 90° from the mark.



Connecting rod bolt:
1st: 23 N·m (2.3 kgf·m, 17.0 ft·lb)
2nd: 43 N·m (4.3 kgf·m, 31.7 ft·lb)
3rd: 90°

TIP:
- Reuse the removed connecting rod bolts when checking the oil clearance.
- Do not turn the connecting rod until the crankpin oil clearance measurement has been completed.

6. Remove the connecting rod cap and measure the width of the compressed Plastigauge (PG-1) on each crankpin. Replace the connecting rod bearing if out of specification.

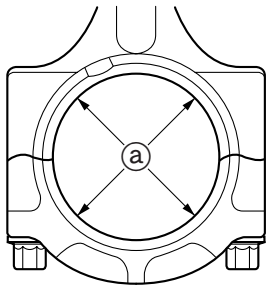


Crankpin oil clearance (reference data):
0.027–0.052 mm (0.0011–0.0020 in)

Selecting the connecting rod bearing

1. When replacing the connecting rod bearing, select the suitable bearing as follows.

2. Measure the connecting rod big end inside diameter ⓐ.

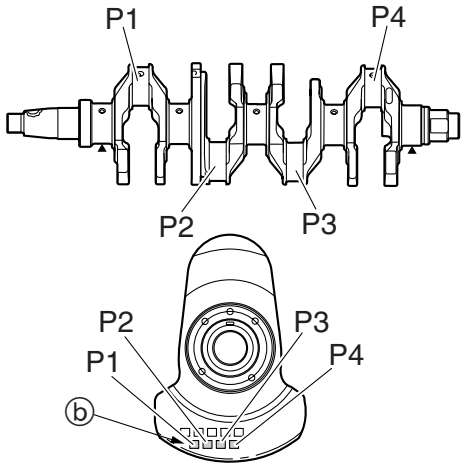


Example:

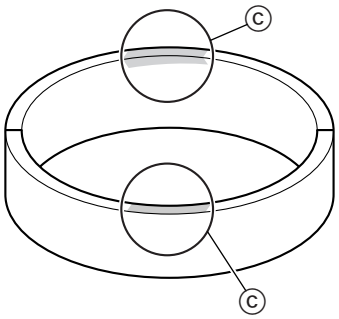
Connecting rod big end inside diameter ⓐ	Numerical value in table
53.035 mm	35

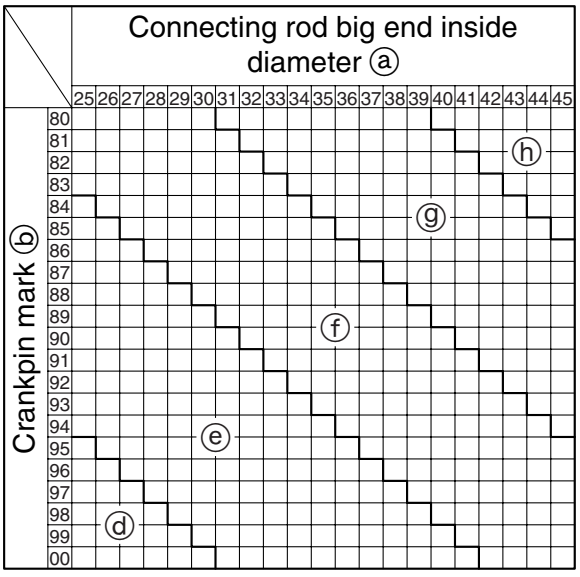
TIP:
Reuse the removed connecting rod bolts when measuring the connecting rod bearing.

3. Check the crankpin mark ⓑ on the crankshaft.



4. Select the suitable color ⓒ for the connecting rod bearing from the table.





	Upper bearing color	Lower bearing color
ⓓ	Green	Green
ⓔ	Green	Blue
ⓕ	Blue	Blue
ⓖ	Blue	Red
ⓗ	Red	Red

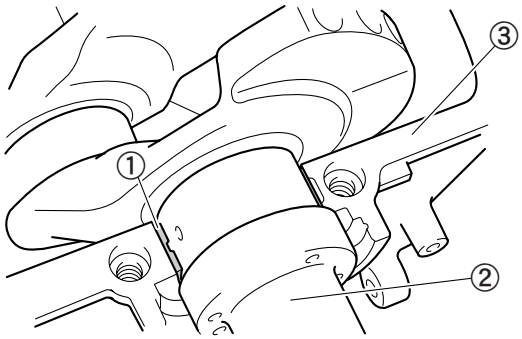
Example:
If the connecting rod big end inside diameter ⓐ is “35” and the crankpin mark ⓑ is “81,” and then select the bearing colors in “ⓖ.”

Checking the crankshaft journal oil clearance

1. Clean the bearings, crankshaft journals, crankcase, cylinder block, and main bearing cap.

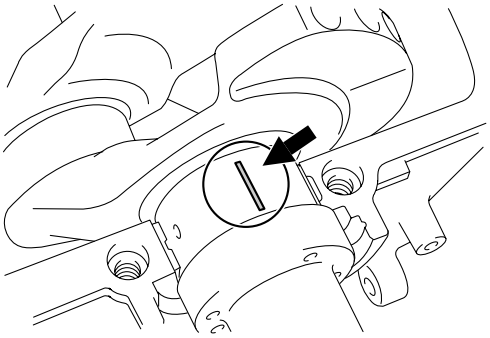
2. Place the cylinder block upside down on a bench.

3. Install half of the main bearings ① and the crankshaft ② into the cylinder block ③.



TIP:
Install the main bearings in their original positions.

4. Put a piece of Plastigauge (PG-1) onto the crankshaft journals, parallel to the crankshaft.



TIP:
Do not put the Plastigauge (PG-1) over the oil hole in the crankshaft journals.

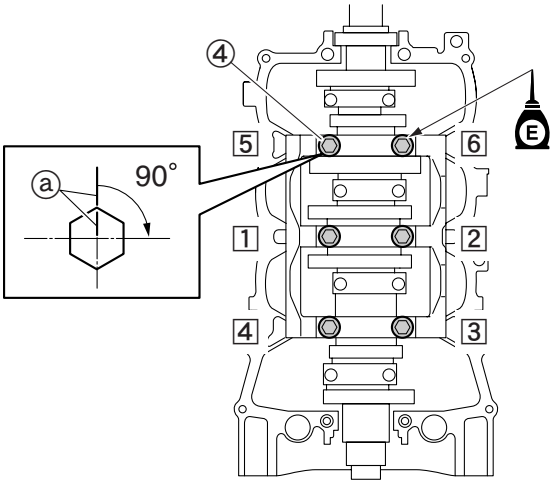
5. Install the remaining half of the main bearings into the crankcase.

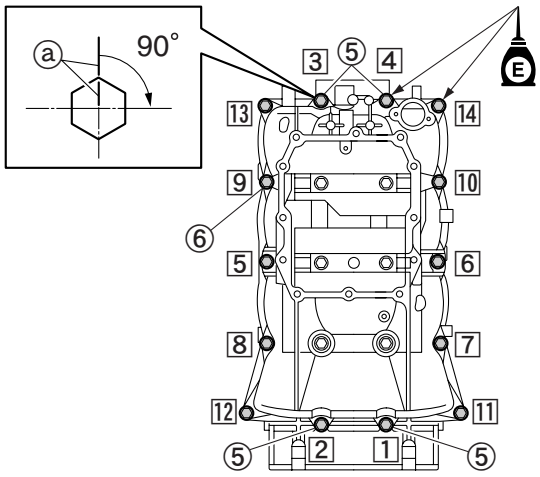
TIP:
Install the main bearings in their original positions.

6. Install the main bearing cap and crankcase onto the cylinder block and apply engine oil to the threads of the main bearing cap bolts ④, crankshaft bolts ⑤, and crankcase bolts ⑥.

7. Tighten the main bearing cap bolts ④ and crankshaft bolts ⑤ to the specified torques in 2 stages and in the sequence numbers (1, 2, · · ·). In the 2nd stage, make a mark ⓐ on the crankcase main bearing cap bolts ④ and crankshaft bolts ⑤, and then tighten the bolts 90° from the mark. ***NOTICE:*** **Main bearing cap bolt ④ 1–6 and crankshaft bolts ⑤ 1–4 can be reused 3 times.**

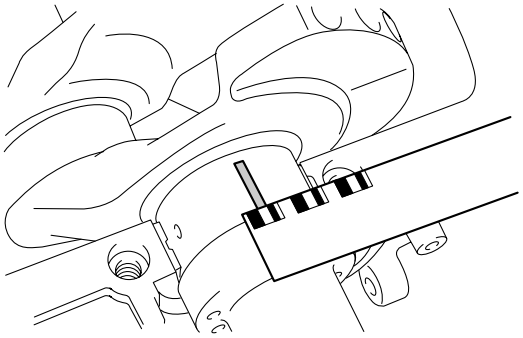
8. Tighten the crankcase bolts ⑥ to the specified torques in 2 stages.





Main bearing cap bolt ④ 1–6 (M10): 1st: 30 N·m (3.0 kgf·m, 22.1 ft·lb) 2nd: 90° Crankshaft bolt ⑤ 1–4 (M10): 1st: 30 N·m (3.0 kgf·m, 22.1 ft·lb) 2nd: 90° Crankcase bolt ⑥ 5–14 (M8): 1st: 14 N·m (1.4 kgf·m, 10.3 ft·lb) 2nd: 26 N·m (2.6 kgf·m, 19.2 ft·lb)

9. Remove the main bearing cap and crankcase, and then measure the width of the compressed Plastigauge (PG-1) on each main journal. Replace the main bearing if out of specification.



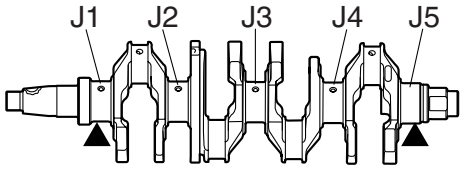
Crankshaft main journal oil clearance:
0.021–0.050 mm (0.0008–0.0020 in)

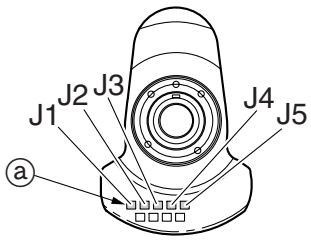
TIP:
When loosening the main bearing bolts and crankcase bolts, loosen them in the opposite order used for tightening.

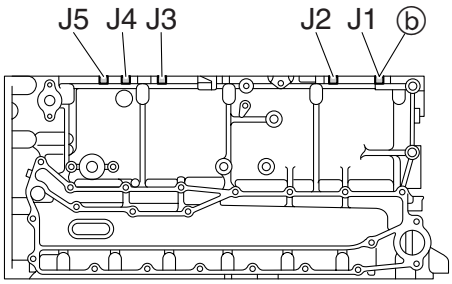
Selecting the main bearing

1. When replacing the main bearing, select the suitable bearing as follows.

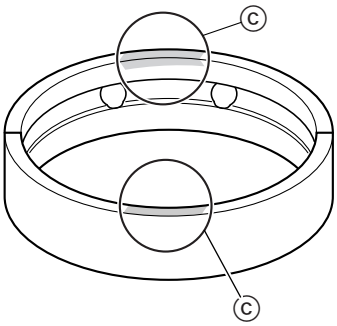
2. Check the crankshaft journal mark ⓐ on the crankshaft and the cylinder block mark ⓑ on the cylinder block.







3. Select the suitable color ⓒ for the main bearing from the table.



Crankshaft journal mark ⓐ \ Cylinder block mark ⓑ	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
80																		ⓘ	
81																			
82																			
83																			
84																			
85															ⓗ				
86																			
87																			
88											ⓖ								
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93																			
94						ⓔ													
95																			
96																			
97			ⓓ																
98																			
99																			
00																			

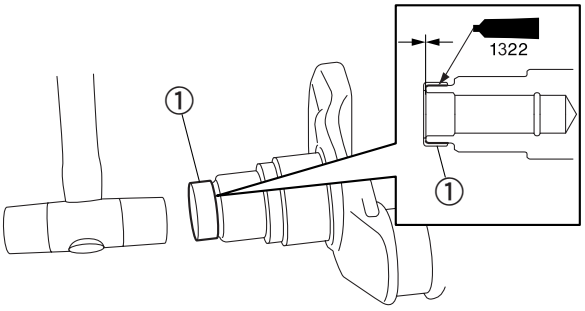
	Upper bearing color	Lower bearing color
ⓓ	Green	Green
ⓔ	Green	Red
ⓕ	Red	Red
ⓖ	Red	Yellow
ⓗ	Yellow	Yellow
ⓘ	Yellow	Blue + Green

Example:
If the crankshaft journal mark ⓐ is “89” and the cylinder block mark ⓑ is “28,” and then select the bearing colors in “ⓖ.”

TIP:
J3 is a thrust bearing.

Assembling the cylinder block

1. Install the collar ① by striking it with a plastic hammer.

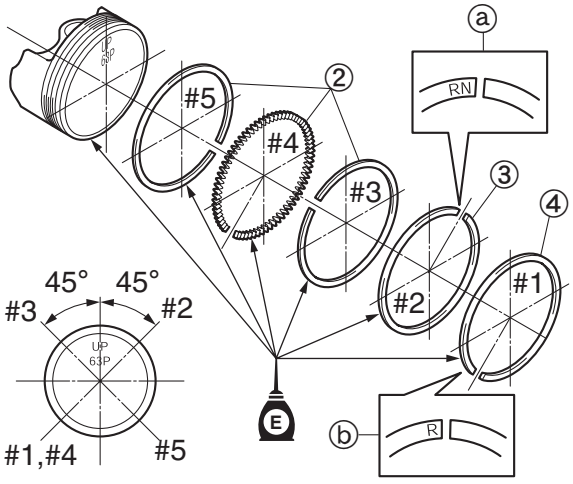


2. Install the oil rings ②, 2nd ring ③, and top ring ④ onto each pistons.

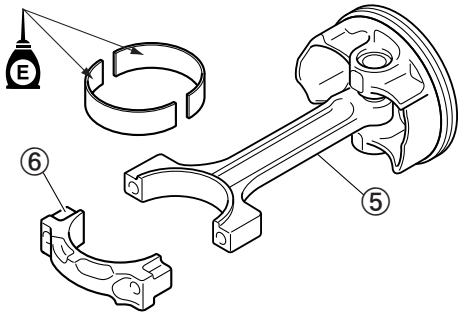
3. Make sure that the “RN” mark ⓐ of the 2nd ring ③ and “R” mark ⓑ of the top ring ④ are facing upward.

TIP:
After installing the piston rings, check that they move smoothly.

4. Offset the piston ring end gaps as shown. ***NOTICE:*** **Do not scratch the pistons or break the piston rings.**

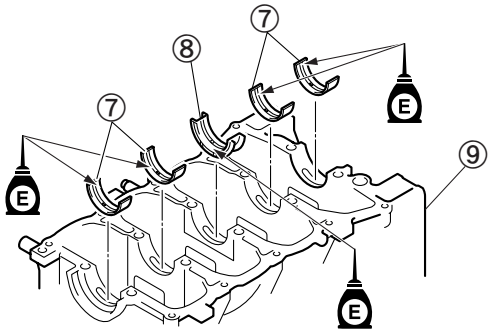


5. Install the upper bearing into the connecting rod ⑤ and the lower bearing into the connecting rod cap ⑥.



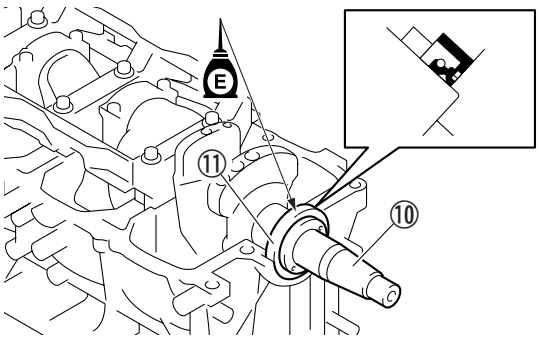
TIP:
Install the connecting rod bearings in their original positions.

6. Install the upper main bearings ⑦ and the thrust bearing ⑧ into the cylinder block ⑨.

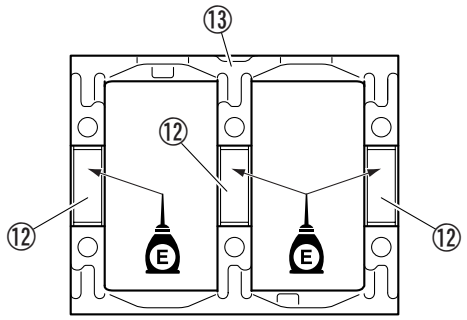


TIP:
Install the main bearings in their original positions.

7. Set the crankshaft ⑩ and oil seal ⑪ into the cylinder block.

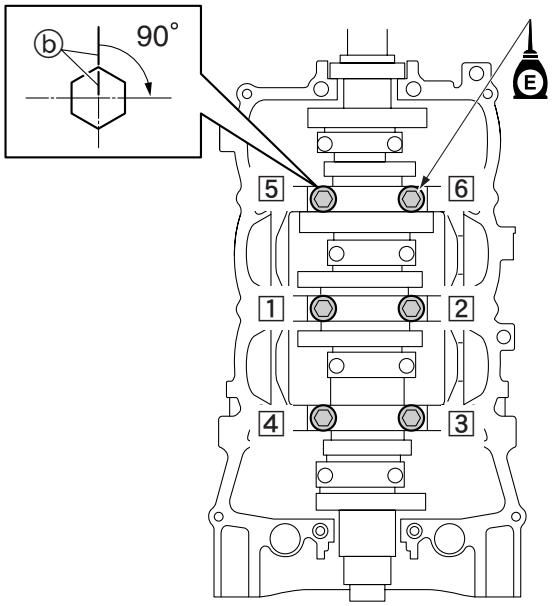


8. Install the lower main bearings ⑫ into the main bearing cap ⑬.



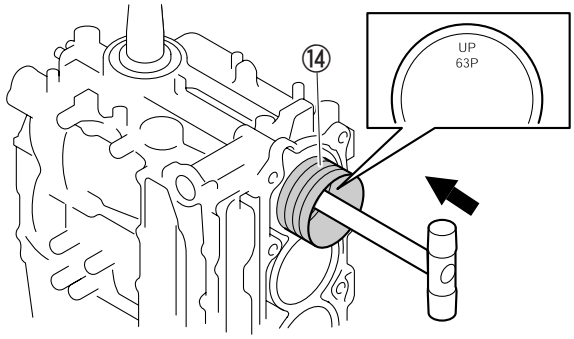
TIP:
Install the main bearings in their original positions.

9. Install the main bearing cap, and then tighten the main bearing cap bolts to the specified torques in 2 stages and in the sequence numbers (1, 2, · · ·). Apply engine oil to the main bearing cap bolts before installation. In the 2nd stage, make a mark ⓑ on the main bearing caps and main bearing cap bolts, and then tighten the main bearing cap bolts 90° from the mark. ***NOTICE:*** **Main bearing cap bolts 1–6 can be reused 3 times.**



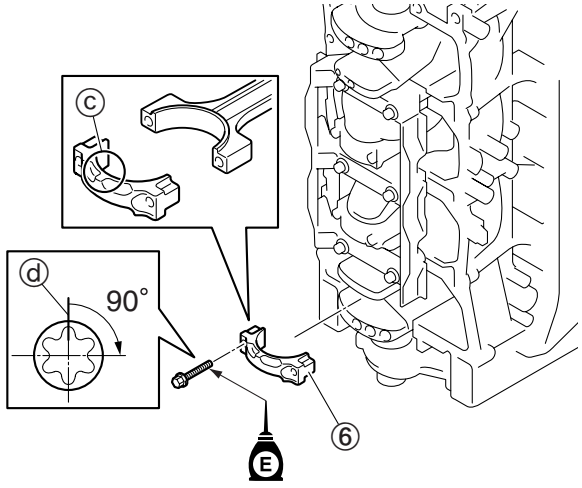
Main bearing cap bolt:
1st: 30 N·m (3.0 kgf·m, 22.1 ft·lb)
2nd: 90°

10. Install the piston with the "UP" mark on the piston crown facing towards the flywheel magnet. Apply engine oil to the side of the pistons and piston rings before installation.



Piston ring compressor ⑭:
90890-05158

11. Install the connecting rod caps ⑥ to the connecting rods, and then tighten the connecting rod bolts to the specified torques in 3 stages. Apply engine oil to the connecting rod bolts before installation. Make sure that the mark ⓒ of the connecting rod faces towards the flywheel side of crankshaft. In the 3rd stage, make a mark ⓓ on the connecting rod bolts. ***NOTICE:*** **Do not reuse the connecting rod bolts, always replace them with new ones.**



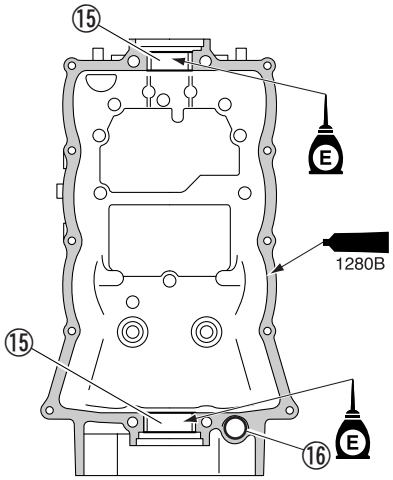
Connecting rod bolt:
1st: 23 N·m (2.3 kgf·m, 17.0 ft·lb)
2nd: 43 N·m (4.3 kgf·m, 31.7 ft·lb)
3rd: 90°

7

TIP:
- After tightening the connecting rod cap bolts, check that the crankshaft rotates smoothly.
- Make sure that the mark ⓒ of the connecting rod faces towards the flywheel magnet side of the crankshaft.

12. Install the lower main bearings ⑮ and new O-ring ⑯ into the crankcase.

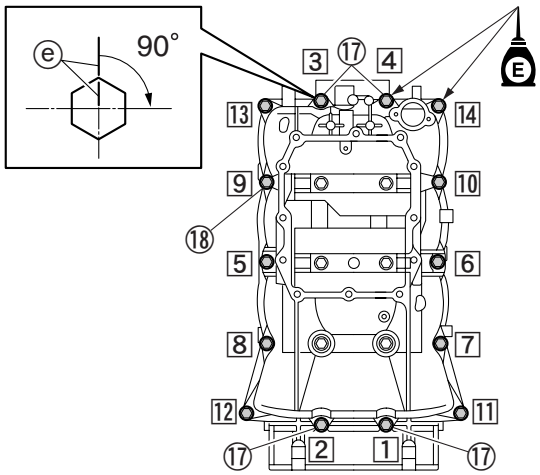
13. Apply sealant to the mating surface of the crankcase.



TIP:
- Install the main bearings in their original positions.
- Do not get any sealant on the main bearings.

14. Install the crankcase onto the cylinder block.

15. Apply engine oil to the crankshaft bolts ⑰ and crankcase bolts ⑱ before installation, and then tighten them to the specified torques in 2 stages and in the sequence numbers (1, 2, · · ·). In the 2nd stage, make a mark ⓔ on the crankcase and crankshaft bolts ⑰, and then tighten crankshaft bolts ⑰ 90° from the mark. ***NOTICE:*** **Crankshaft bolts ⑰ 1–4 can be reused 3 times.**



Crankshaft bolt ⑰ 1–4 (M10):
1st: 30 N·m (3.0 kgf·m, 22.1 ft·lb)
2nd: 90°
Crankcase bolt ⑱ 5–14 (M8):
1st: 14 N·m (1.4 kgf·m, 10.3 ft·lb)
2nd: 26 N·m (2.6 kgf·m, 19.2 ft·lb)

TIP:
After tightening the crankcase bolts, check that the crankshaft rotates smoothly.

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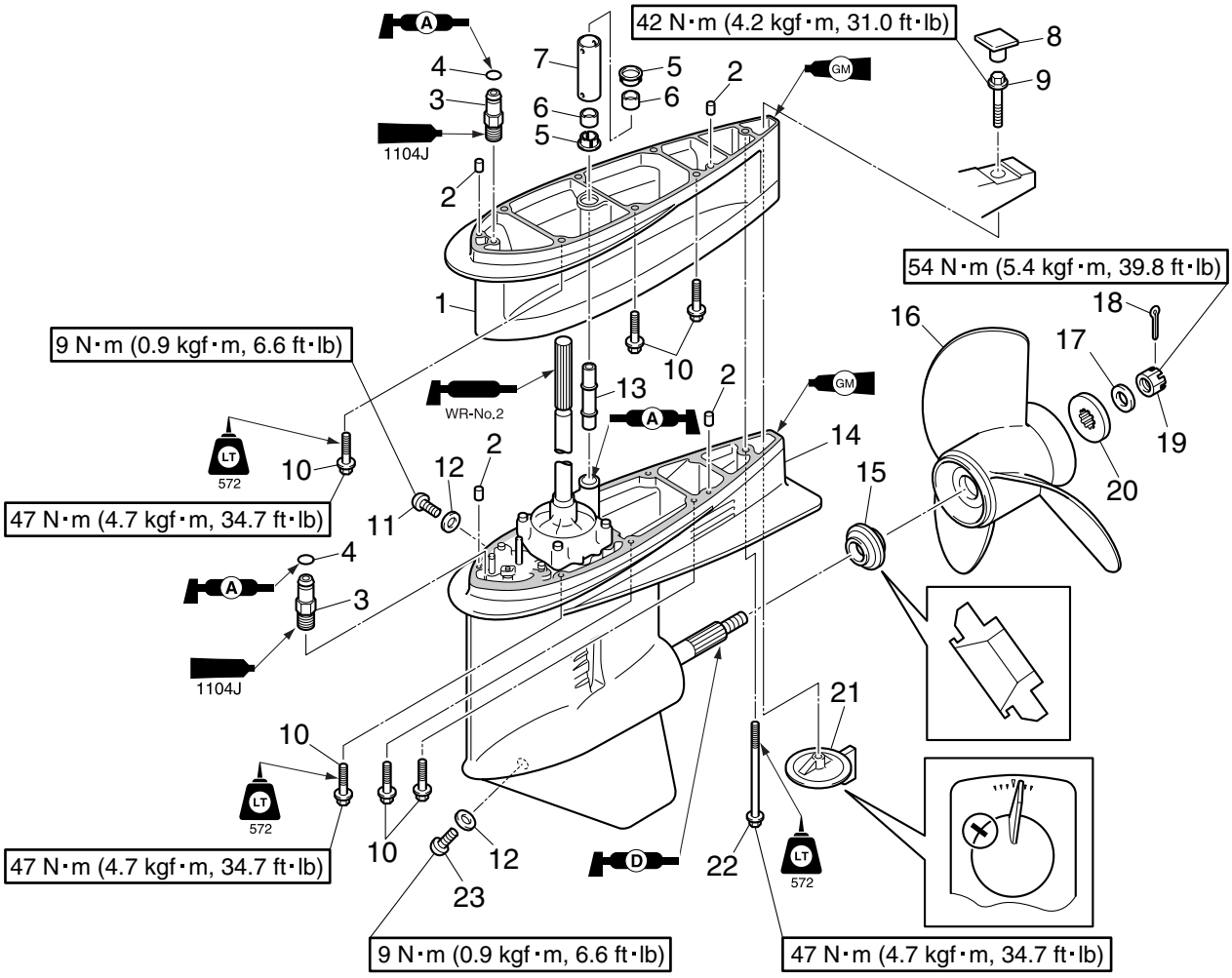
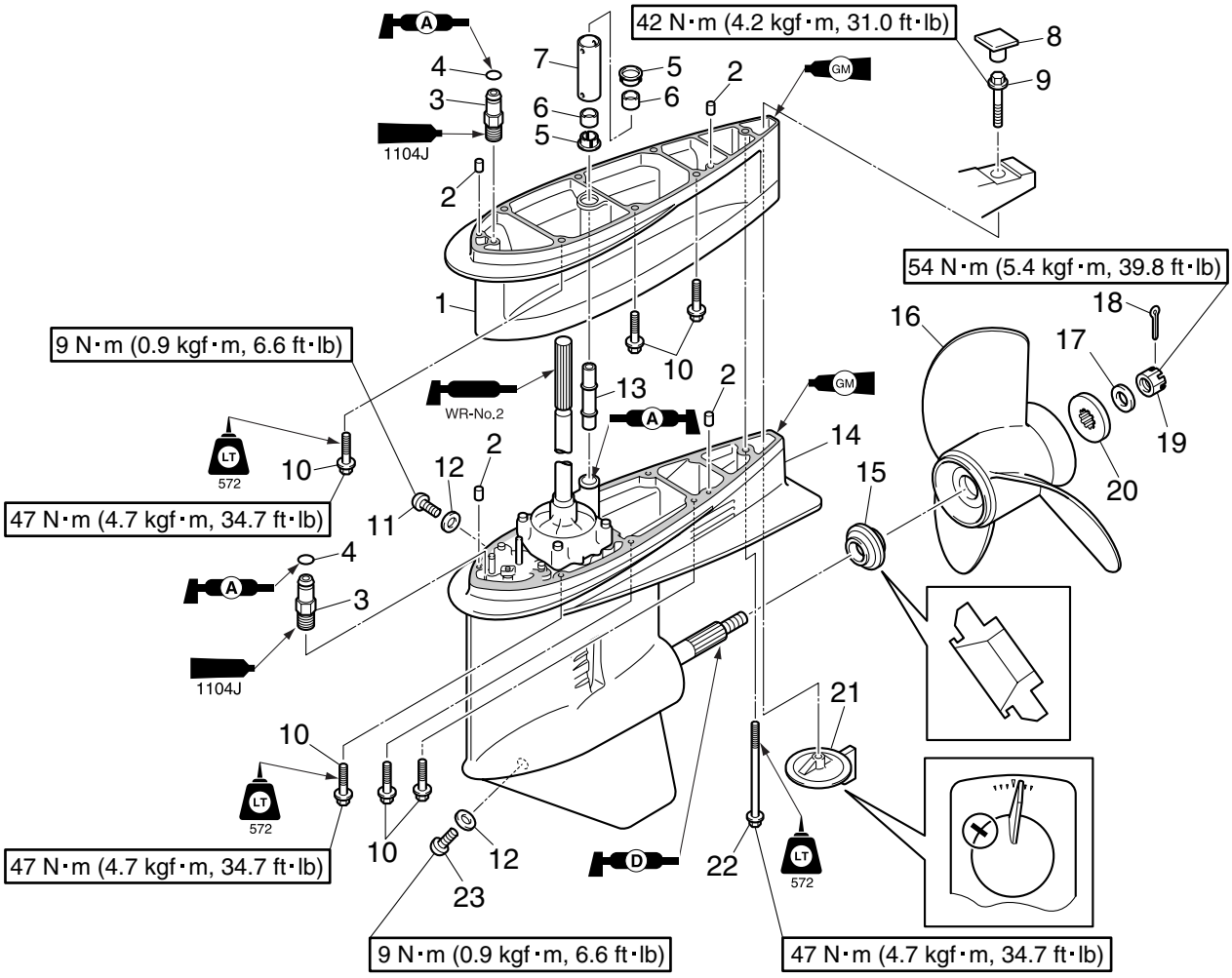
Lower unit (regular rotation model)



No.	Part name	Q'ty	Remarks
1	Extension	1	
2	Dowel	4	
3	Hose nipple	2	
4	O-ring	2	**Not reusable**
5	Cover	2	
6	Seal	2	
7	Water pipe	1	
8	Grommet	1	
9	Bolt	1	M10 × 45 mm
10	Bolt	12	M10 × 45 mm
11	Check screw	1	
12	Gasket	2	**Not reusable**
13	Water pipe	1	
14	Lower unit	1	
15	Spacer	1	
16	Propeller	1	
17	Washer	1	



No.	Part name	Q'ty	Remarks
18	Cotter pin	1	**Not reusable**
19	Propeller nut	1	
20	Spacer	1	
21	Trim tab	1	
22	Bolt	1	M10 × 200 mm
23	Drain screw	1	

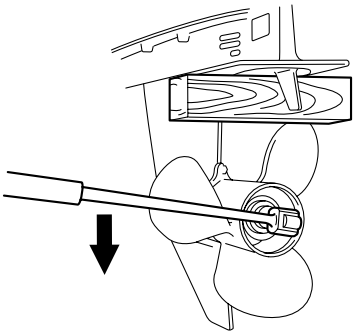
8

Removing the lower unit

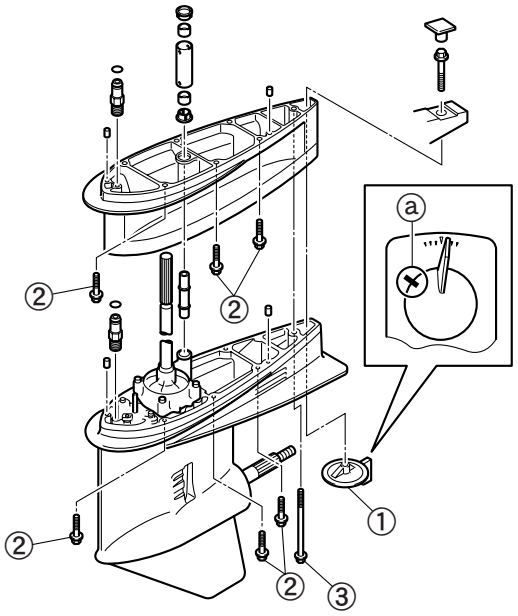
⚠ WARNING

- **Make sure to disconnect the battery cables from the battery and the clip from the engine shut-off switch.**
- **When removing the lower unit with the power unit installed, make sure to suspend the outboard motor. If the outboard motor is not suspended it can fall suddenly and result in severe injury.**
- **Do not hold the propeller with your hands when loosening or tightening it.**

1. Drain the gear oil.
2. Remove the cotter pin.
3. Set the gear shift to the N position, and place a block of wood between the anti-cavitation plate and propeller to keep the propeller from turning, and then remove the propeller nut and propeller.



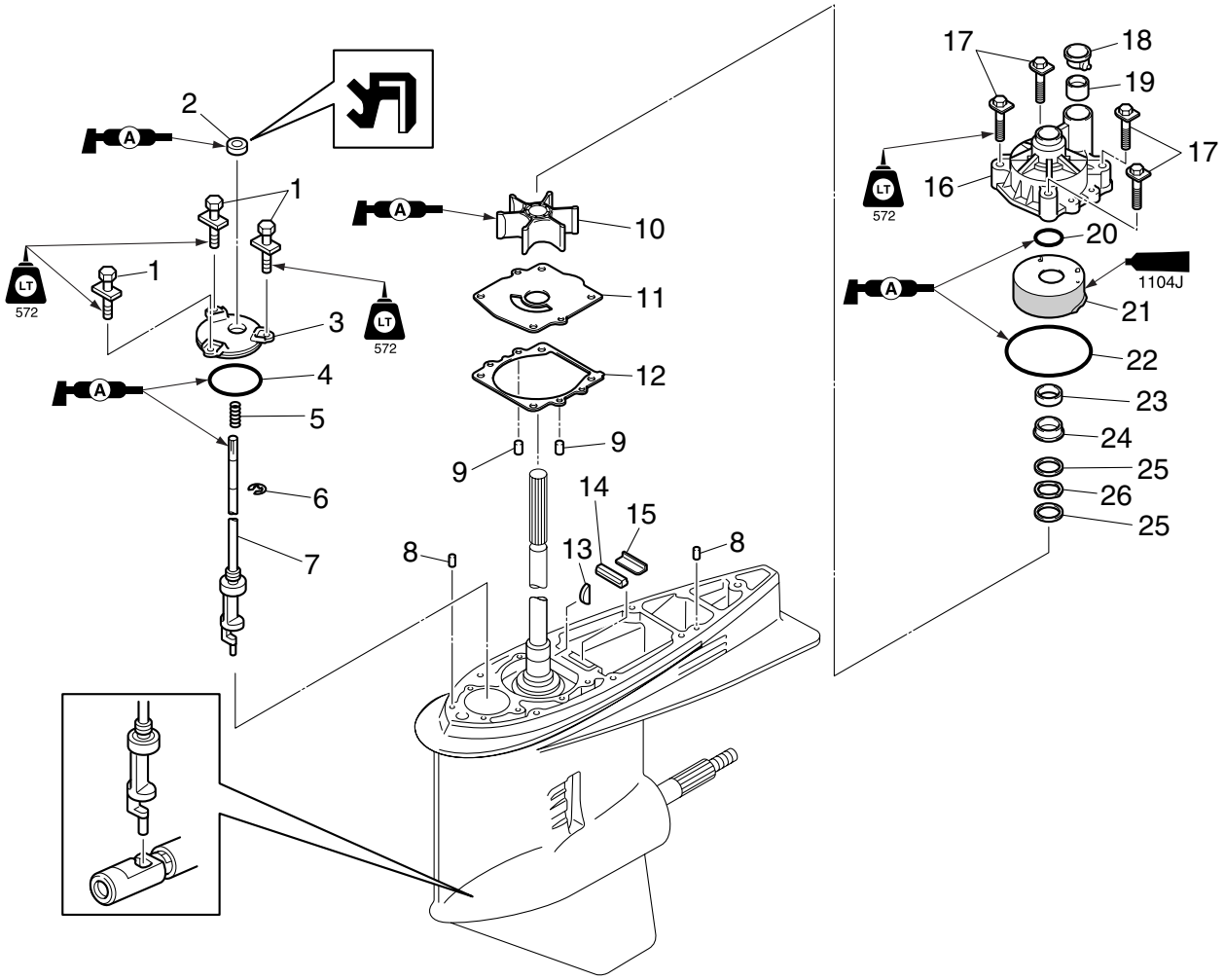
4. Mark ⓐ the trim tab ① at the area shown, and then remove it.
5. Remove the bolts ② and ③, and then remove the lower unit.



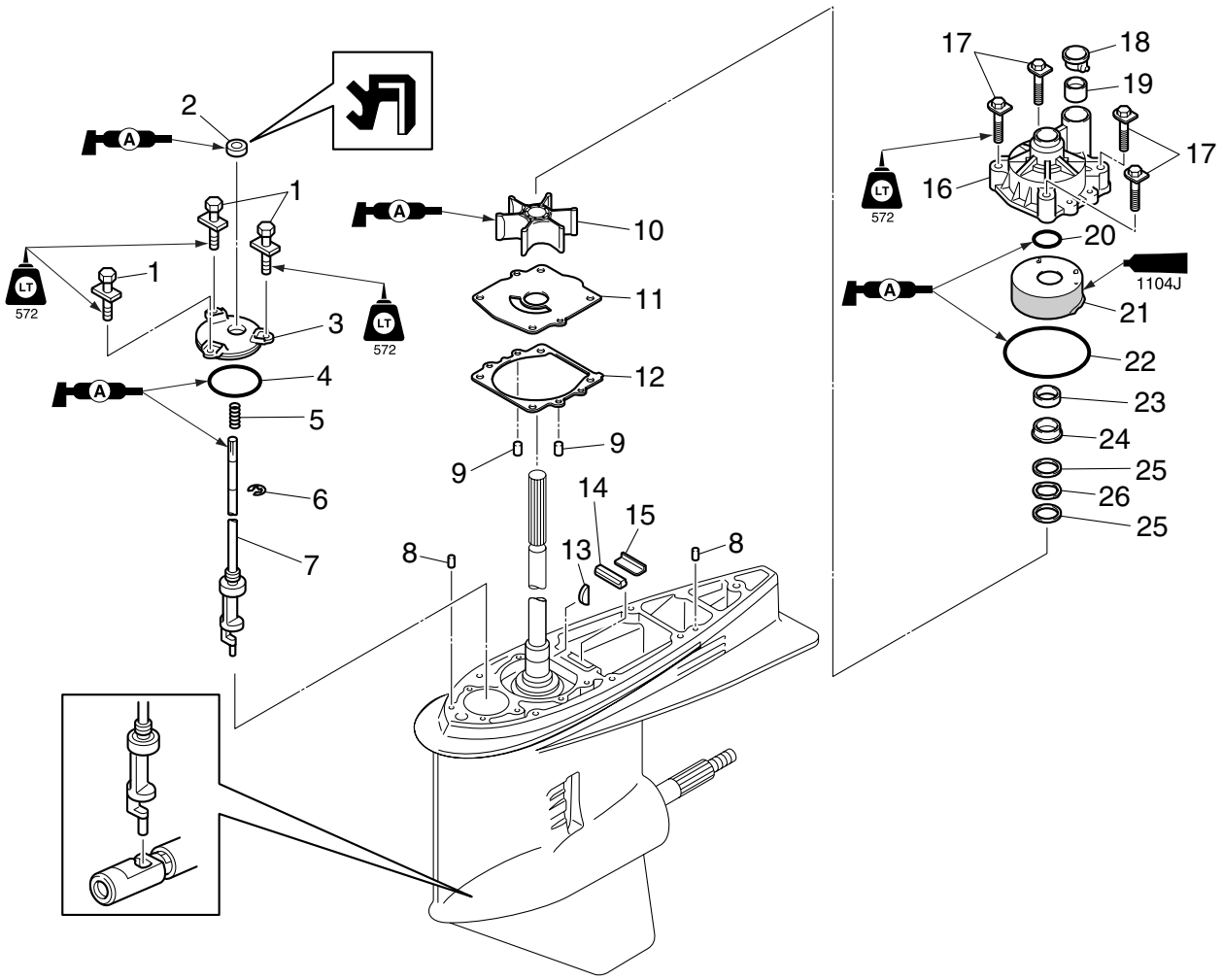
TIP:

When disassembling the lower unit, measure the backlash before disassembly. See “Measuring the forward and reverse gear backlash before disassembly” (8-28).

Water pump and shift rod (regular rotation model)



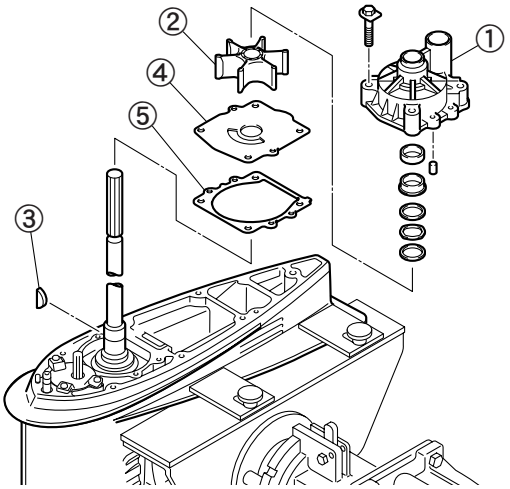
No.	Part name	Q'ty	Remarks
1	Bolt	3	M6 × 20 mm
2	Oil seal	1	**Not reusable**
3	Oil seal housing	1	
4	O-ring	1	**Not reusable**
5	Spring	1	
6	Circlip	1	
7	Shift rod	1	
8	Dowel	2	
9	Dowel	2	
10	Impeller	1	
11	Outer plate cartridge	1	
12	Gasket	1	**Not reusable**
13	Woodruff key	1	
14	Rubber seal	1	
15	Plate	1	
16	Water pump housing	1	
17	Bolt	4	M8 × 45 mm



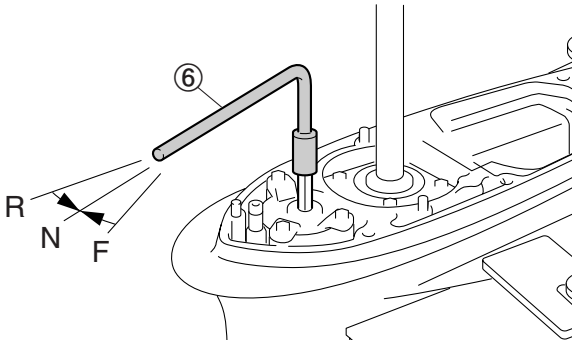
No.	Part name	Q'ty	Remarks
18	Cover	1	
19	Seal	1	
20	O-ring	1	**Not reusable**
21	Insert cartridge	1	
22	O-ring	1	**Not reusable**
23	Collar	1	
24	Spacer	1	
25	Washer	2	
26	Wave washer	1	

Removing the water pump and shift rod

1. Install the lower unit onto a repair stand.
2. Remove the water pump housing ①, impeller ②, and Woodruff key ③.
3. Remove the outer plate cartridge ④ and gasket ⑤.

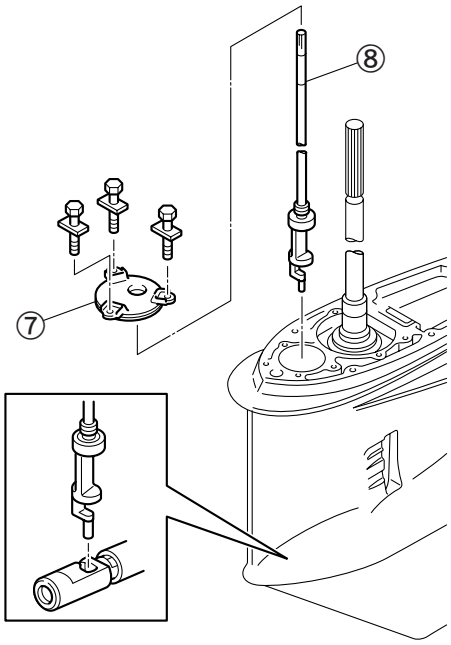


4. Set the gear shift to the N position.



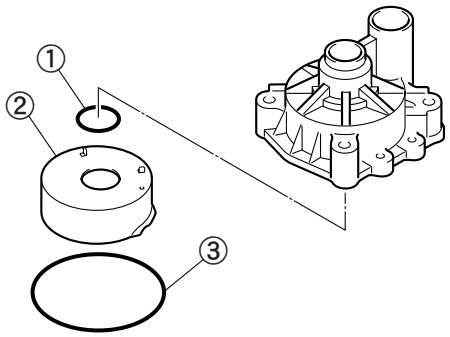
Shift rod push arm ⑥: 90890-06052

5. Remove the oil seal housing ⑦ and shift rod assembly ⑧.

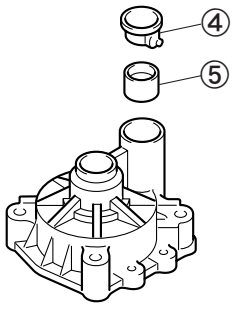


Disassembling the water pump housing

1. Remove the O-ring ①, insert cartridge ②, and O-ring ③.



2. Remove the cover ④ and seal ⑤.



8

Checking the water pump and shift rod

1. Check the water pump housing. Replace if deformation.

TIP:
If the engine overheated, the inside of the water pump housing may be deformed, therefore make sure to remove the insert cartridge when checking the housing.

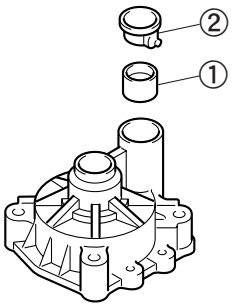
2. Check the impeller, insert cartridge, and outer plate cartridge. Replace if cracked or worn.

3. Check the Woodruff key and the keyway on the drive shaft. Replace if deformed or worn.

4. Check the shift rod. Replace if cracked or worn.

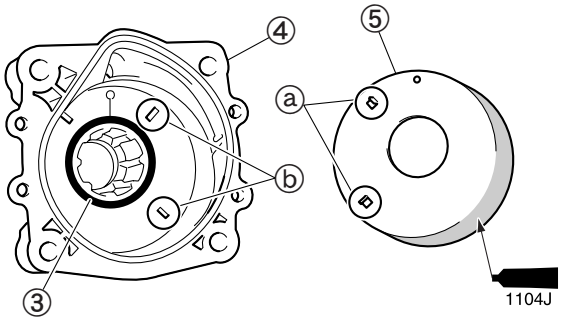
Assembling the water pump housing

1. Install the seal ① and cover ②.

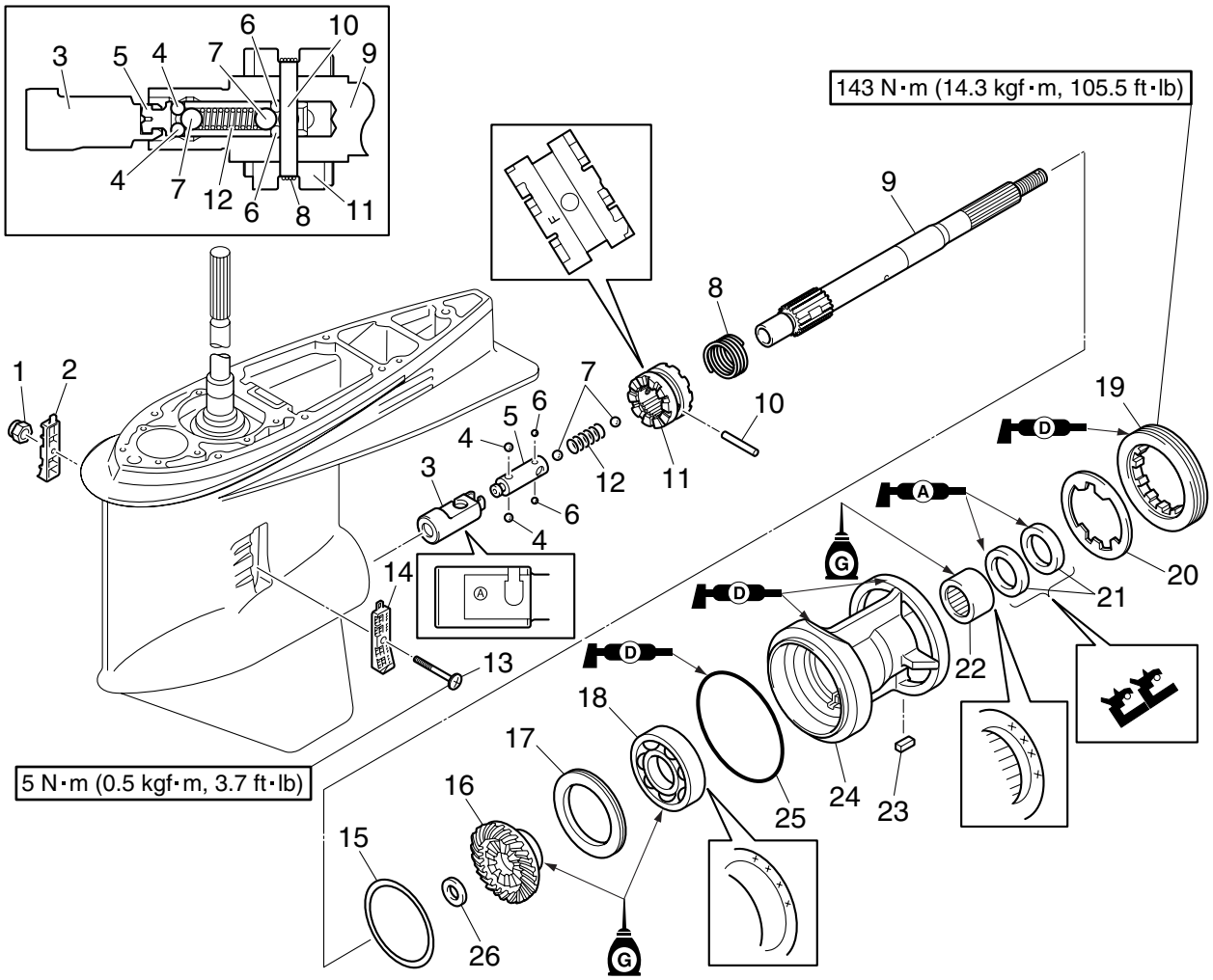


2. Install a new O-ring ③ into the water pump housing ④.

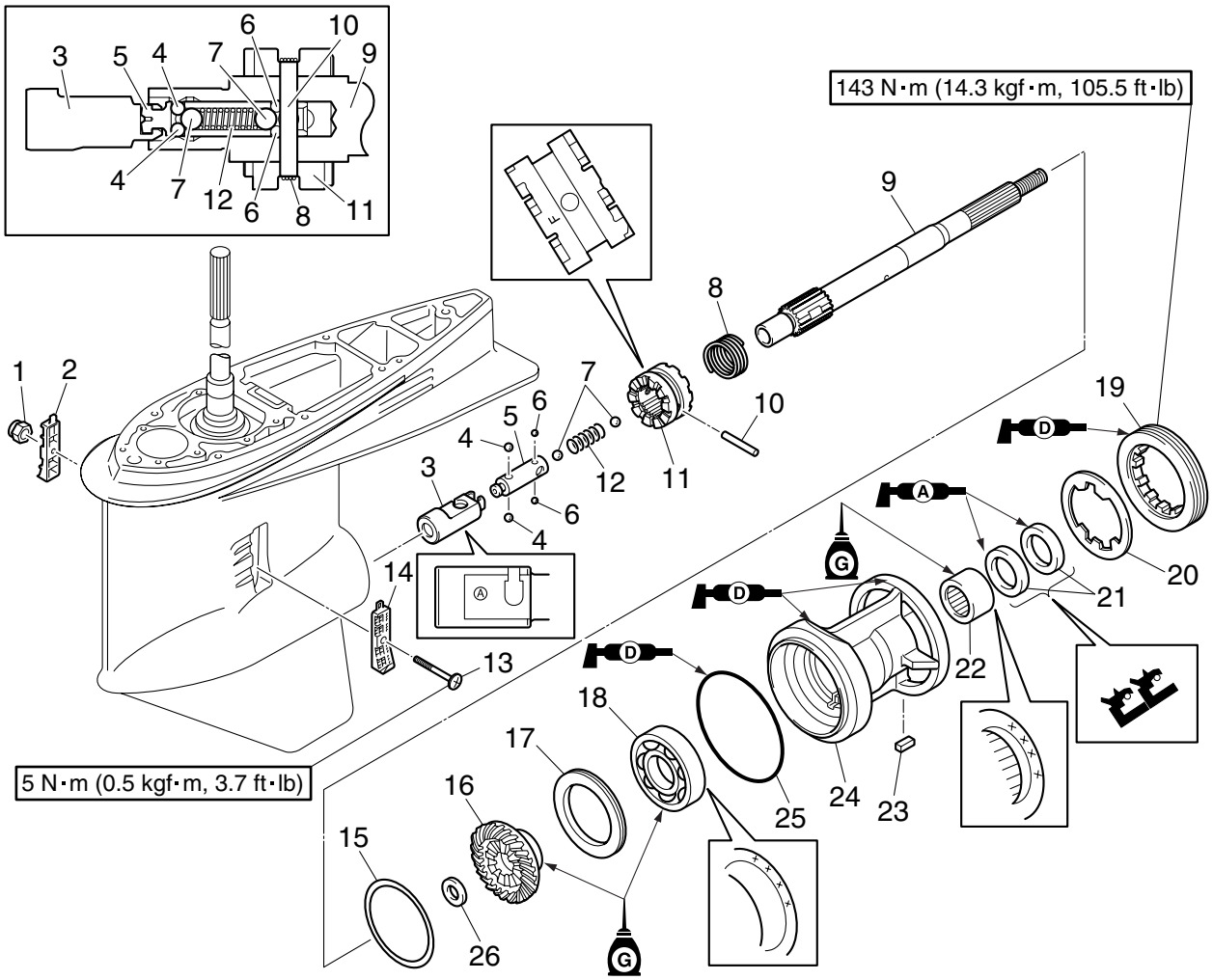
3. Install the insert cartridge ⑤ aligning ⓐ on the insert cartridge with ⓑ on the water pump housing ④.



Propeller shaft housing (regular rotation model)



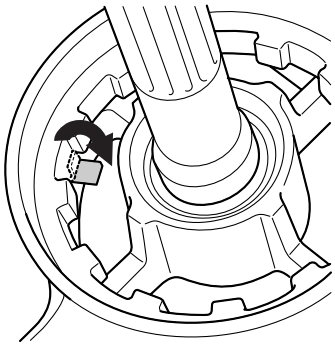
No.	Part name	Q'ty	Remarks
1	Self-locking nut	1	
2	Water inlet cover (STBD)	1	
3	Shift rod joint	1	
4	Ball	2	
5	Shift slider	1	
6	Ball	2	
7	Ball	2	
8	Spring	1	
9	Propeller shaft	1	
10	Cross pin	1	
11	Dog clutch	1	
12	Spring	1	
13	Screw	1	M5 × 54 mm
14	Water inlet cover (PORT)	1	
15	Shim (T2)	—	
16	Reverse gear	1	
17	Thrust washer	1	



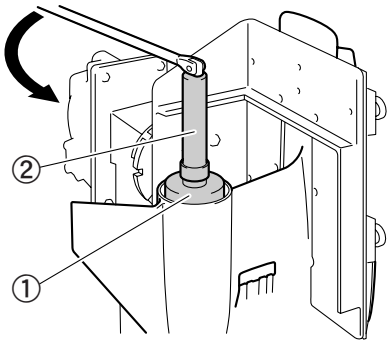
No.	Part name	Q'ty	Remarks
18	Ball bearing	1	**Not reusable**
19	Ring nut	1	
20	Claw washer	1	
21	Oil seal	2	**Not reusable**
22	Needle bearing	1	**Not reusable**
23	Key	1	
24	Propeller shaft housing	1	
25	O-ring	1	**Not reusable**
26	Washer	1	

Removing the propeller shaft housing assembly

1. Fold one tooth of the claw washer that is bent toward the propeller.

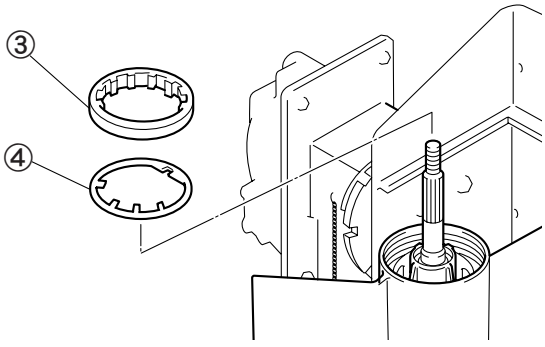


2. Loosen the ring nut.

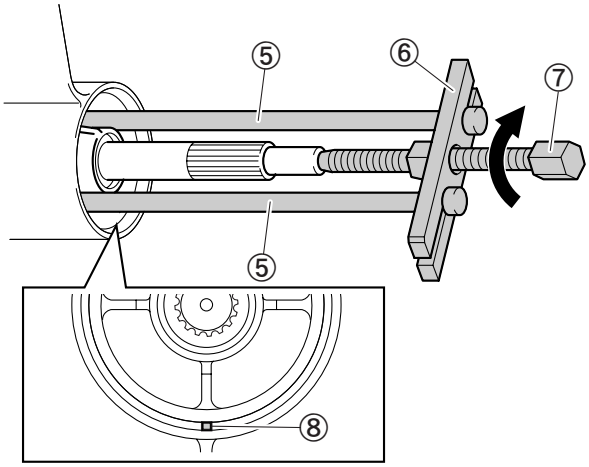


Ring nut wrench 4 ①: 90890-06512 Ring nut wrench extension ②: 90890-06513

3. Remove the ring nut ③ and claw washer ④.



4. Remove the propeller shaft housing assembly, propeller shaft, washers, and shim(s) (T2) using the special service tools ⑤, ⑥, and ⑦.



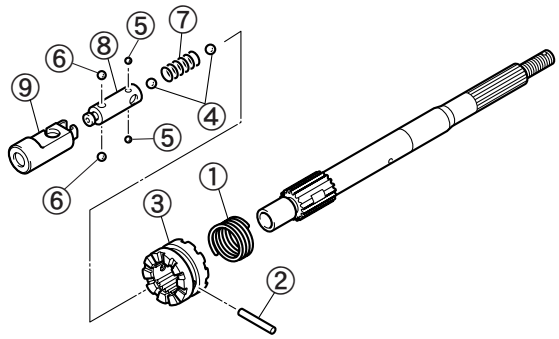
Bearing housing puller claw L ⑤: 90890-06502 Stopper guide plate ⑥: 90890-06501 Center bolt ⑦: 90890-06504

TIP:

Be careful not to lose the key ⑧.

Disassembling the propeller shaft assembly

1. Remove the spring ①, and then remove the cross pin ②, dog clutch ③, balls ④, ⑤, ⑥, spring ⑦, shift slider ⑧, and shift rod joint ⑨.

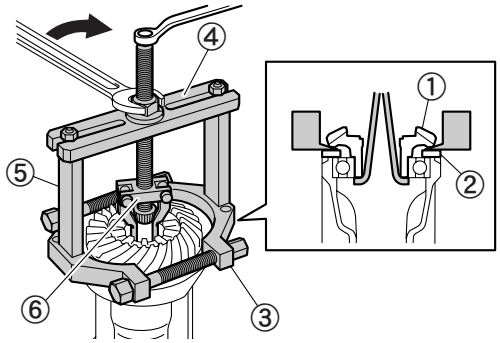


TIP:

Be careful when removing the slider ⑧ as the balls may fall out.

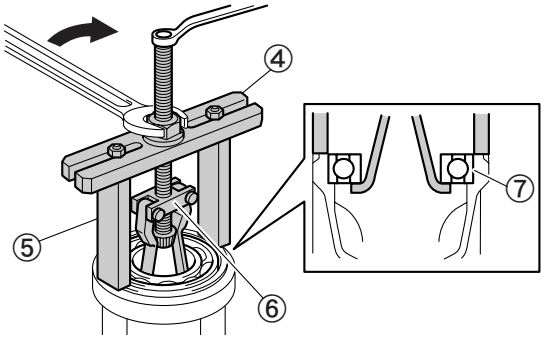
Disassembling the propeller shaft housing assembly

1. Remove the reverse gear ① and thrust washer ②.



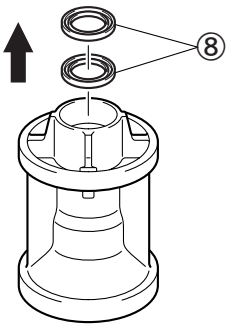
Bearing separator ③: 90890-06534
Stopper guide plate ④: 90890-06501
Stopper guide stand ⑤: 90890-06538
Bearing puller assembly ⑥: 90890-06535

2. Remove the ball bearing ⑦.

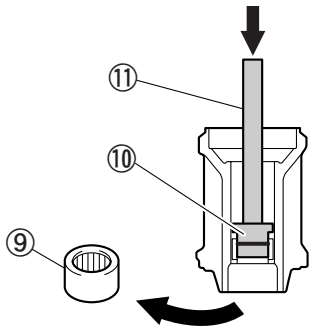


Stopper guide plate ④: 90890-06501
Stopper guide stand ⑤: 90890-06538
Bearing puller assembly ⑥: 90890-06535

3. Remove the oil seals ⑧.



4. Remove the needle bearing ⑨.



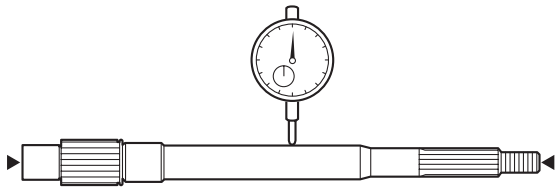
Needle bearing attachment ⑩:
90890-06653
Driver rod L3 ⑪: 90890-06652

Checking the propeller shaft housing

1. Check the propeller shaft housing. Replace if cracked or damaged.
2. Check the reverse gear. Replace if cracked or worn.

Checking the propeller shaft

1. Check the propeller shaft. Replace if damaged or worn.
2. Measure the propeller shaft runout. Replace if above specification.

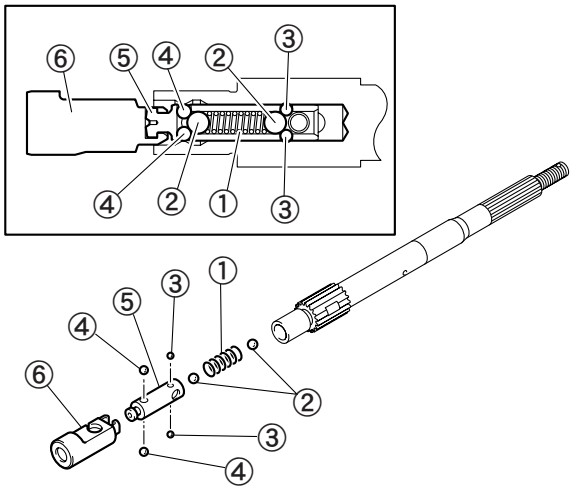


Propeller shaft runout limit:
0.02 mm (0.0008 in)

3. Check the dog clutch, shift rod joint, and slider. Replace if cracked or worn.

Assembling the propeller shaft assembly

1. Install the spring ①, balls ②, ③, ④, shift slider ⑤, and shift rod joint ⑥.

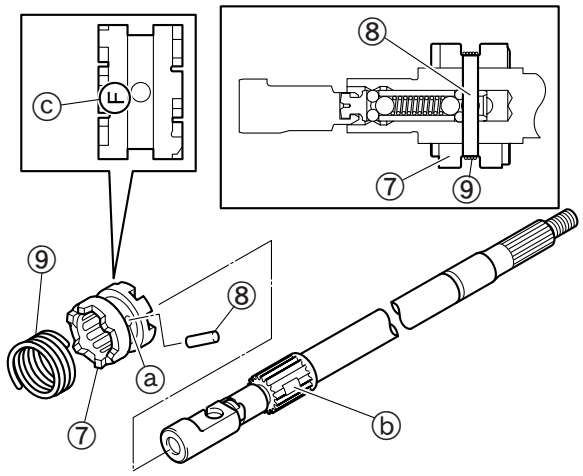


2. Align the hole ⓐ in the dog clutch ⑦ with the hole ⓑ in the propeller shaft.

TIP:

Install the dog clutch ⑦ with the "F" mark ⓒ facing toward the shift rod joint ⑥.

3. Install the cross pin ⑧, and then install the spring ⑨.



Assembling the propeller shaft housing assembly

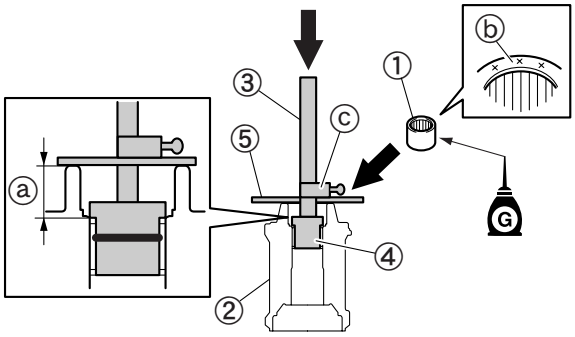
⚠ WARNING

- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the propeller shaft housing in a well-ventilated area.**

NOTICE

Do not reuse the bearing, always replace it with a new one.

1. Install the needle bearing ① into the propeller shaft housing ② to the specified depth ⓐ.



Driver rod SS ③: 90890-06604
Needle bearing attachment ④: 90890-06610
Bearing depth plate ⑤: 90890-06603

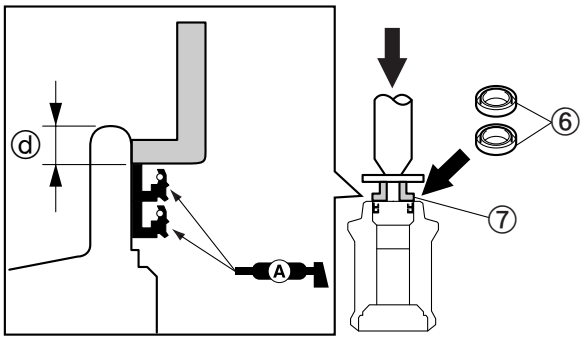
Depth ⓐ:
24.75–25.25 mm (0.974–0.994 in)

TIP:

- Install the needle bearing with the manufacture identification mark ⓑ facing toward the oil seal (propeller side).
- When using the driver rod, do not strike the special service tool in a manner that will force the stopper ⓒ out of place.

8

2. Apply grease to new oil seals ⑥, and then install them into the propeller shaft housing to the specified depth ⓓ.

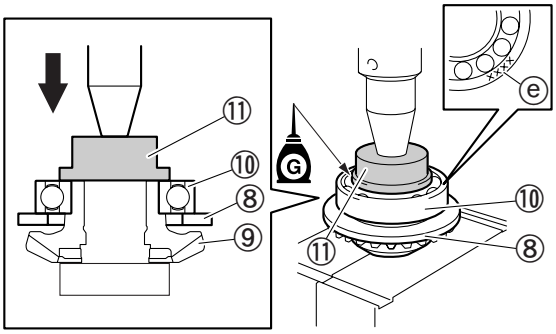


Bearing inner race attachment ⑦:
90890-06640

Depth ⓓ:
4.75–5.25 mm (0.187–0.207 in)

TIP:
Install an oil seal halfway into the propeller shaft housing, and then install the other oil seal.

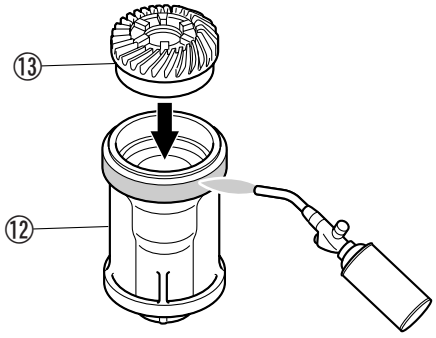
3. Install the thrust washer ⑧ to the reverse gear ⑨, and install a new ball bearing ⑩.



Needle bearing attachment ⑪:
90890-06654

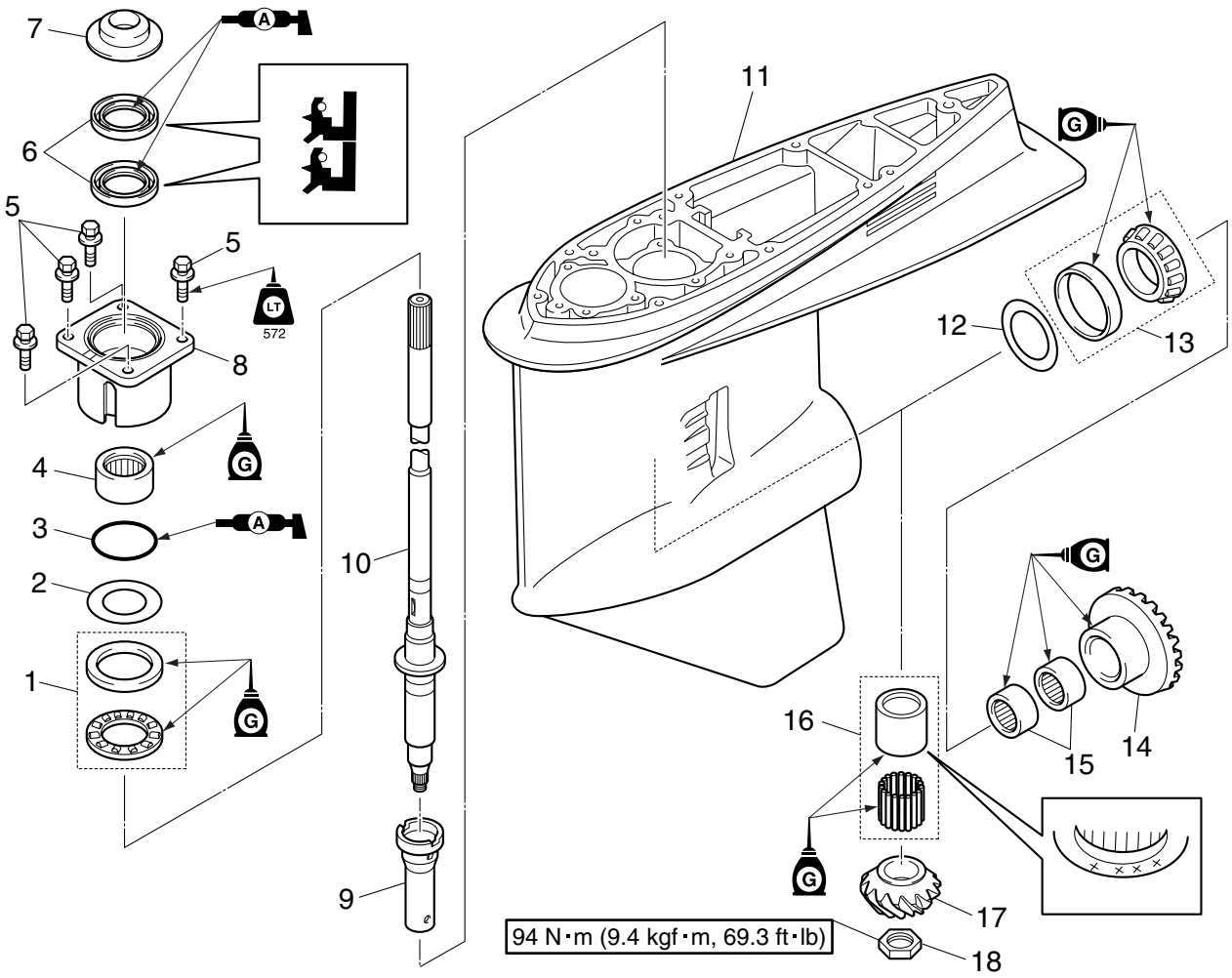
TIP:
Install the ball bearing with the manufacture identification mark ⓔ facing toward the propeller shaft housing (propeller side).

4. Heat the installation area of the ball bearing in the propeller shaft housing ⑫ with a gas torch, and then install the reverse gear assembly ⑬. ***NOTICE:*** **When heating the propeller shaft causing, heat the entire installation area evenly. Otherwise, the propeller shaft housing could be damaged.**

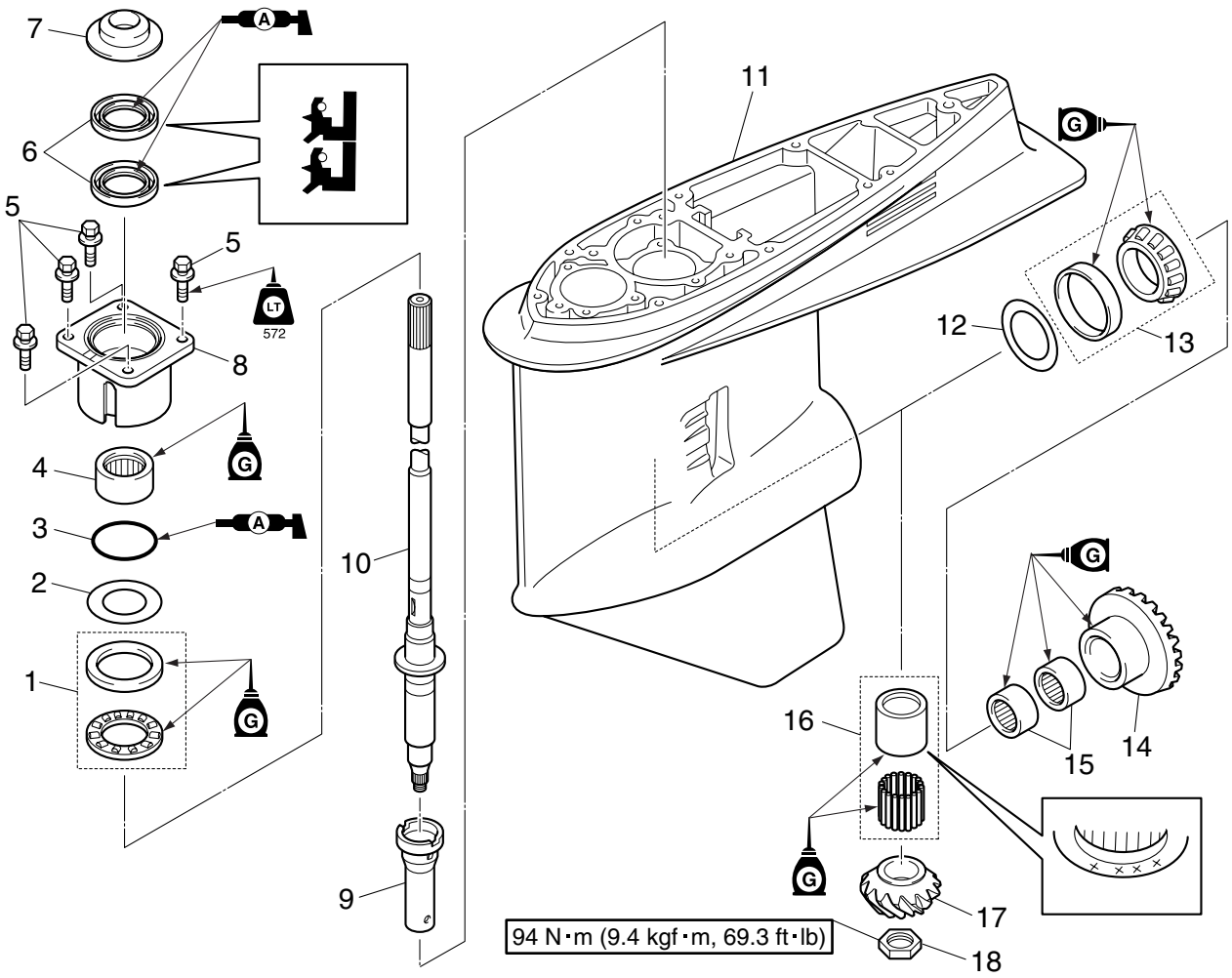


5. After installing the reverse gear assembly, check that the reverse gear rotates smoothly.

Drive shaft and lower case (regular rotation model)



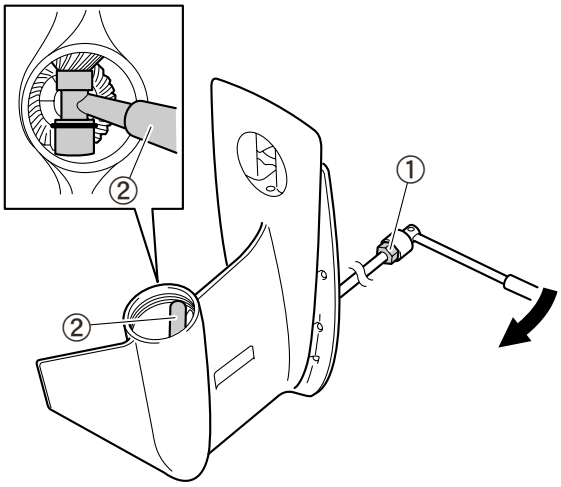
No.	Part name	Q'ty	Remarks
1	Thrust bearing	1	
2	Shim (T3)	—	
3	O-ring	1	**Not reusable**
4	Needle bearing	1	**Not reusable**
5	Bolt	4	M8 × 25 mm
6	Oil seal	2	**Not reusable**
7	Cover	1	
8	Drive shaft housing	1	
9	Sleeve	1	
10	Drive shaft	1	
11	Lower case	1	
12	Shim (T1)	—	
13	Taper roller bearing	1	**Not reusable**
14	Forward gear	1	
15	Needle bearing	2	**Not reusable**
16	Needle bearing	1	**Not reusable**
17	Pinion	1	



No.	Part name	Q'ty	Remarks
18	Pinion nut	1	

Removing the drive shaft

1. Remove the pinion nut.



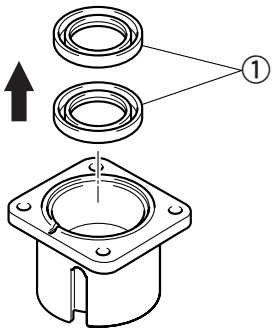
Drive shaft holder 6 ①: 90890-06520
Pinion nut holder ②: 90890-06715

2. Remove the drive shaft housing, shim(s) (T3), thrust bearing, drive shaft, and pinion.

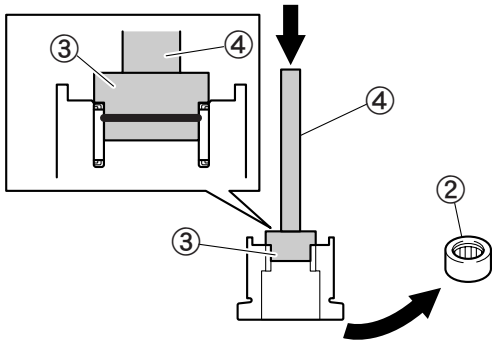
3. Pull out the forward gear assembly.

Disassembling the drive shaft housing

1. Remove the oil seals ①.



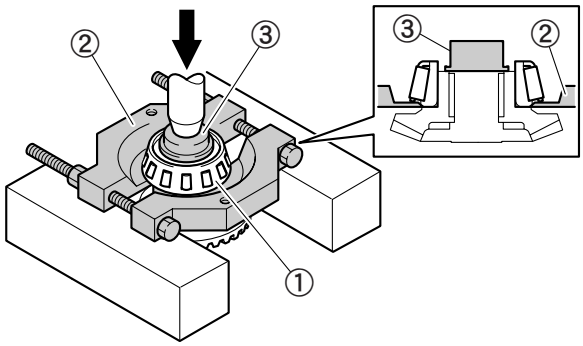
2. Remove the needle bearing ②.



Needle bearing attachment ③:
90890-06610
Driver rod L3 ④: 90890-06652

Disassembling the forward gear

1. Remove the taper roller bearing ①.



Bearing separator ②: 90890-06534
Needle bearing attachment ③:
90890-06608

2. Remove the needle bearings from the forward gear.

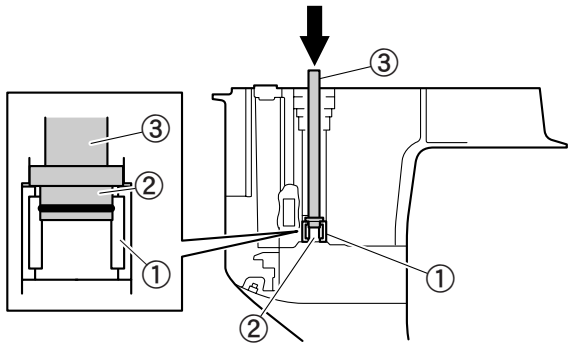
Disassembling the lower case

⚠ WARNING

- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the lower case in a well-ventilated area.**

1. Remove the water inlet covers.

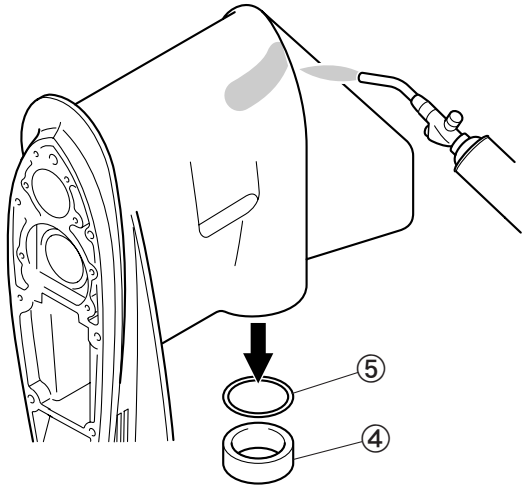
2. Remove the needle bearing ①.



Ball bearing attachment ②: 90890-06636
Driver rod LL ③: 90890-06605

TIP:
Make sure to remove the forward gear before removing the needle bearing.

3. Heat the installation area of the taper roller bearing outer race in the lower case with a gas torch, and then remove the outer race ④ and shim(s) (T1) ⑤.
NOTICE: **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.**



TIP:
- Before removing the taper roller bearing outer race ④, place some cushioning material below the lower case to catch the outer race when it falls out.
- If the taper roller bearing outer race does not come out, lightly tap the lower unit torpedo with a plastic hammer.

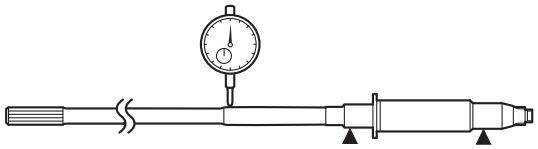
Checking the pinion and forward gear

1. Check the pinion and forward gear. Replace if cracked or worn.

Checking the drive shaft

1. Check the drive shaft. Replace if damaged or worn.

2. Measure the drive shaft runout. Replace if above specification.



Drive shaft runout limit:
0.2 mm (0.008 in)

Checking the lower case

1. Check the lower case. Replace if cracked or damaged.

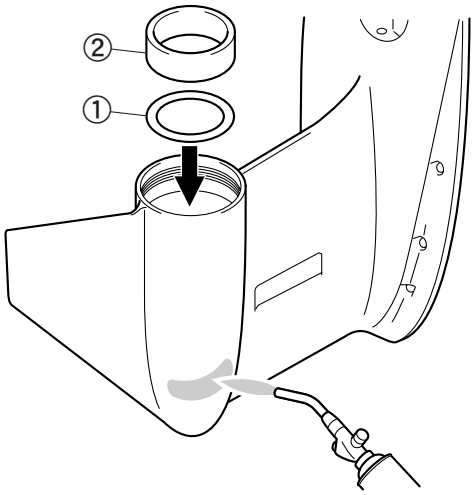
Assembling the lower case

⚠ WARNING
- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the lower case in a well-ventilated area.**

NOTICE
Do not reuse the bearing, always replace it with a new one.

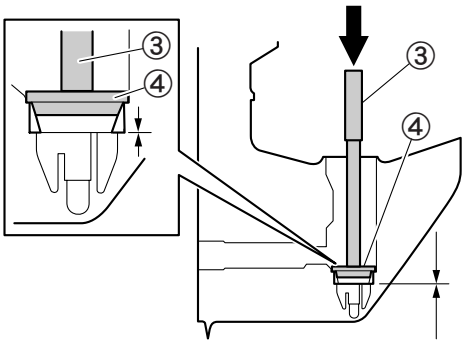
1. Install the original shim(s) (T1) ①.

2. Heat the installation area of the taper roller bearing outer race in the lower case with a gas torch, and then install the outer race ②. ***NOTICE:*** **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.**



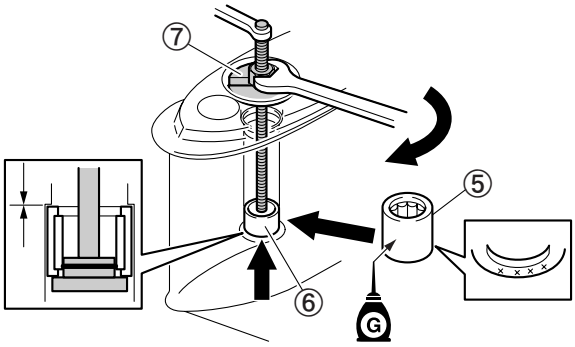
TIP:
Do not reuse a shim if it is any deformed or scratched.

3. While holding the special service tool ③, strike the tool to check that the taper roller bearing outer race is installed properly. If a high-pitched metallic sound is produced when the special service tool is struck, the outer race is installed properly.



Driver rod LL ③: 90890-06605
Bearing outer race attachment ④:
90890-06619

4. Install the rollers into the needle bearing outer race, and install the special service tool into the needle bearing assembly ⑤, and then install the needle bearing assembly ⑤ into the lower case.



Ball bearing attachment ⑥:
90890-06633
Bearing outer race puller assembly ⑦:
90890-06523

TIP:
The needle bearing contains 18 rollers.

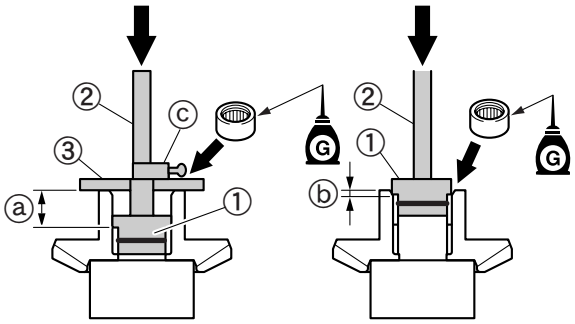
Assembling the forward gear

NOTICE

Do not reuse the bearing, always replace it with a new one.

8

1. Install new needle bearings into the forward gear to the specified depth.

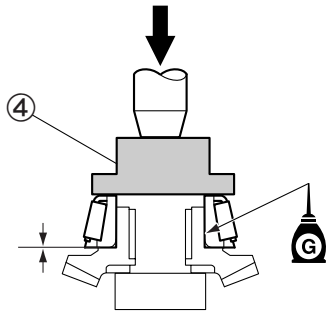


Needle bearing attachment ①:
90890-06612
Driver rod SS ②: 901890-06604
Bearing depth plate ③: 90890-06603

Depth ⓐ:
20.95–21.45 mm (0.825–0.844 in)
Depth ⓑ:
4.45–4.95 mm (0.175–0.195 in)

TIP:
When using the driver rod, do not strike the special service tool in a manner that will force the stopper ⓒ out of place.

2. Install the taper roller bearing.



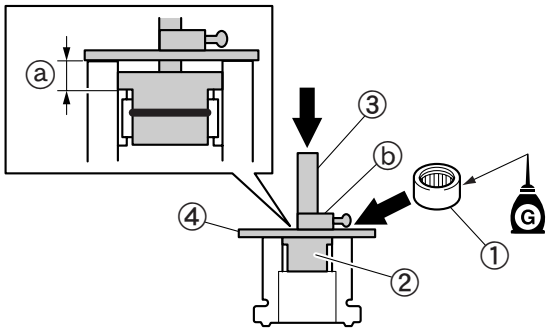
Needle bearing attachment ④:
90890-06654

Assembling the drive shaft housing

NOTICE

Do not reuse the bearing, always replace it with a new one.

1. Install the needle bearing ① into the drive shaft housing to the specified depth ⓐ.

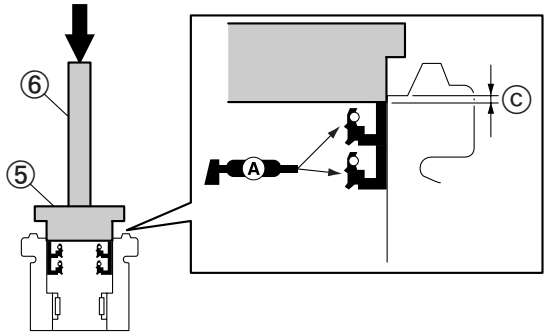


Needle bearing attachment ②:
90890-06610
Driver rod SS ③: 90890-06604
Bearing depth plate ④: 90890-06603

Depth ⓐ:
5.75–6.25 mm (0.226–0.246 in)

TIP:
When using the driver rod, do not strike the special service tool in a manner that will force the stopper ⓑ out of place.

2. Apply grease to new oil seals, and then install them into the drive shaft housing to the specified depth ⓒ.



Ball bearing attachment ⑤:
90890-06633
Driver rod LS ⑥: 90890-06606

Depth ⓒ:
0.25–0.75 mm (0.010–0.030 in)

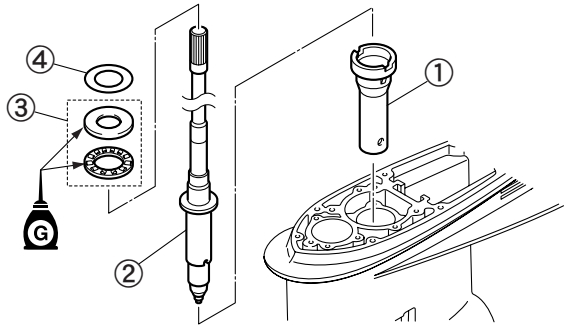
TIP:
Install an oil seal halfway into the drive shaft housing, and then install the other oil seal.

Installing the drive shaft

NOTICE

Do not reuse the bearing, always replace it with a new one.

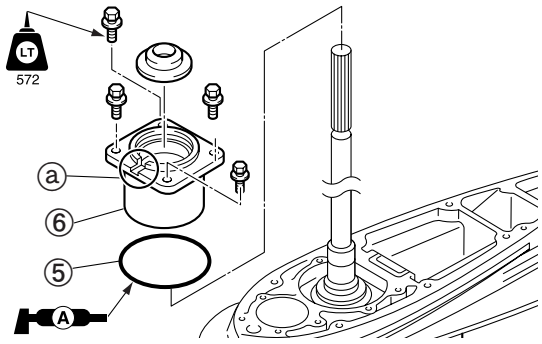
1. Install the forward gear assembly.
2. Install the sleeve ①, drive shaft ②, thrust bearing ③, and original shim(s) (T3) ④.



3. Install the pinion and pinion nut temporarily.

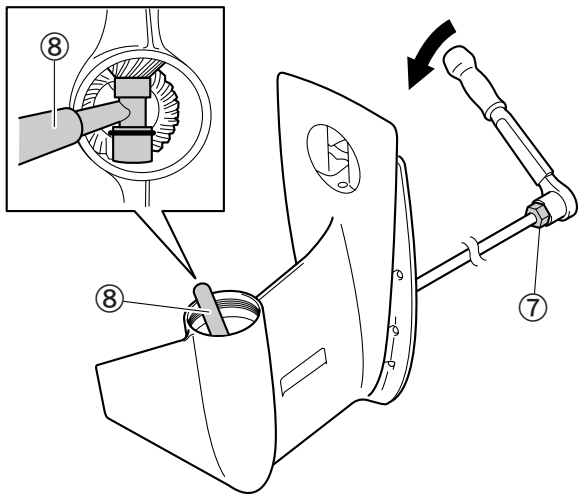
TIP:
When installing the pinion, lift up the drive shaft slightly and align the pinion and shaft splines.

4. Install a new O-ring ⑤ to the drive shaft housing ⑥, and then install the drive shaft housing ⑥ into the lower case.



TIP:
Install the drive shaft housing with the cutout ⓐ in the housing facing forward.

5. Tighten the pinion nut to the specified torque.



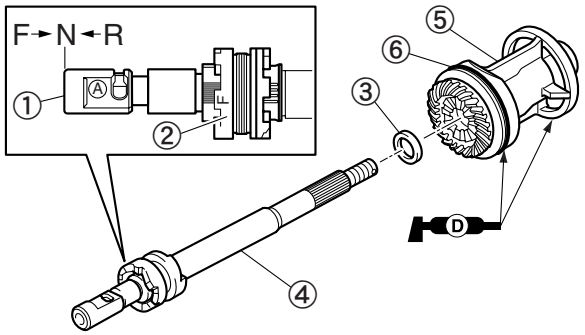
Drive shaft holder 6 ⑦: 90890-06520 Pinion nut holder ⑧: 90890-06715

Pinion nut: 94 N·m (9.4 kgf·m, 69.3 ft·lb)

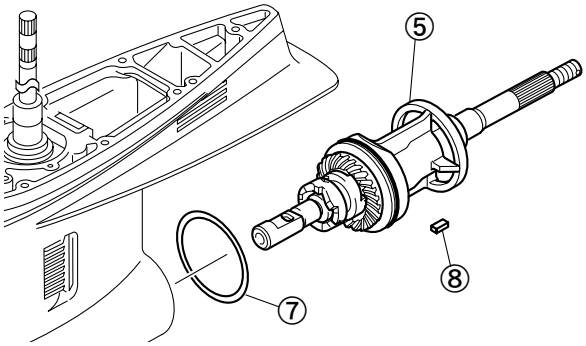
6. Check that the drive shaft rotates smoothly. If the drive shaft does not rotate smoothly, reassemble the lower unit.

Installing the propeller shaft housing assembly

1. Set the shift rod joint ① and dog clutch ② to the N position.
2. Install the washer ③ and propeller shaft assembly ④ into the propeller shaft housing assembly ⑤.
3. Apply grease to a new O-ring ⑥ and propeller shaft housing assembly ⑤.

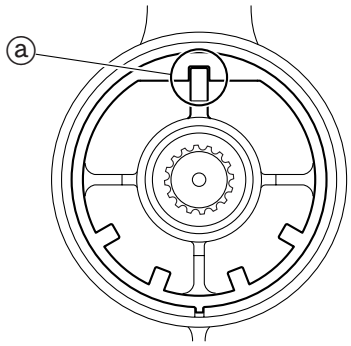


4. Install the original shim(s) (T2) ⑦, the propeller shaft housing assembly ⑤, and key ⑧.

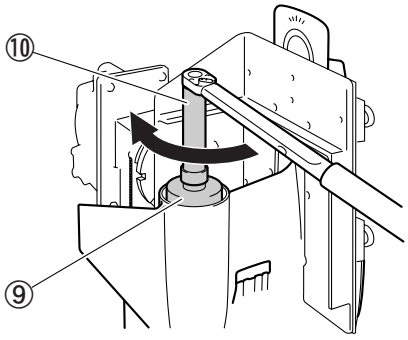


TIP:
Do not reuse a shim if it is any deformed or scratched.

5. Install the claw washer. Check that the positions ⓐ is set in place properly.



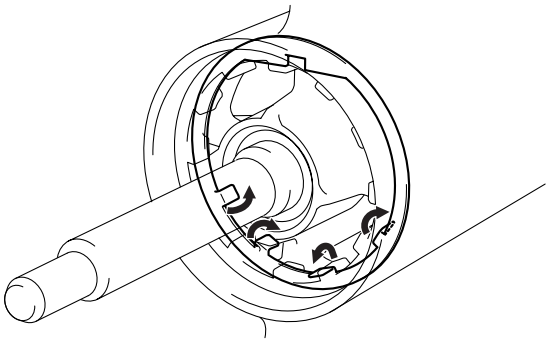
6. Install the ring nut, and then tighten the ring nut to the specified torque.



Ring nut wrench 4 ⑨: 90890-06512 Ring nut wrench extension ⑩: 90890-06513

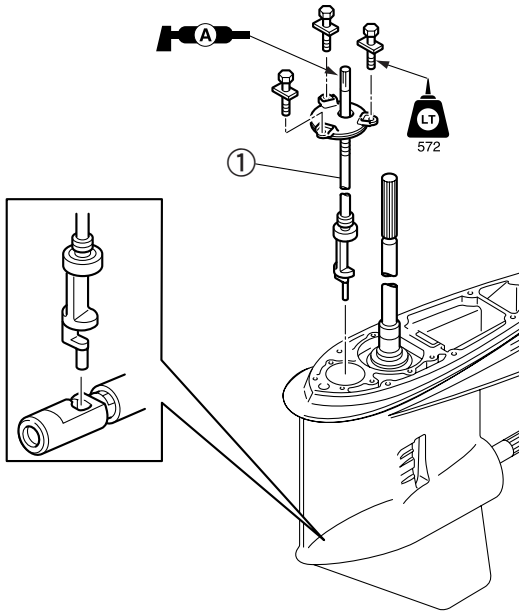
Ring nut: 143 N·m (14.3 kgf·m, 105.5 ft·lb)

7. Bend one claw toward the propeller and the other 3 claws toward the gear.



Installing the shift rod

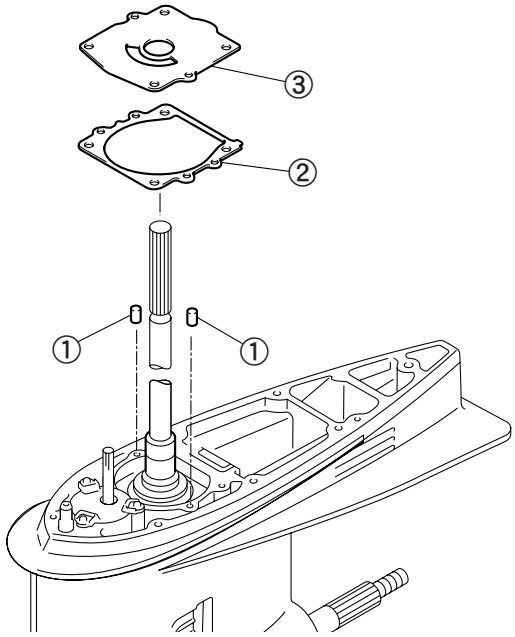
1. Make sure that the gear shift is in the N position, and then install the shift rod assembly ①.



2. Make sure that the drive shaft and the propeller shaft are moving properly when the gear is shifted into F position and into R position.

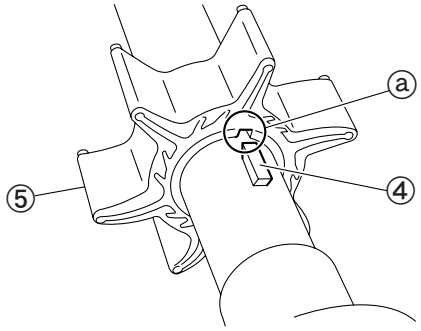
Installing the water pump

1. Install the dowels ①, a new gasket ②, and the outer plate cartridge ③.

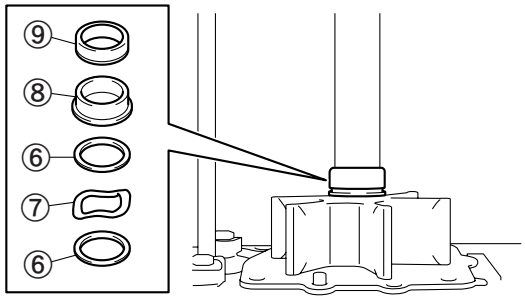


2. Install the Woodruff key ④.

3. Align the key way ⓐ on the impeller ⑤ with the Woodruff key ④, and then install the impeller ⑤.



4. Install the washers ⑥, wave washer ⑦, spacer ⑧, and collar ⑨.

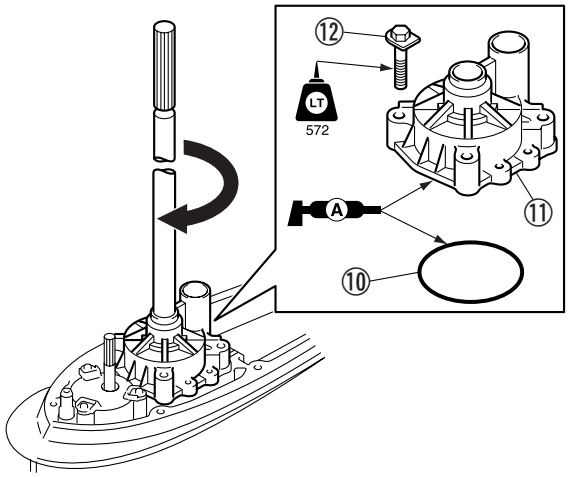


TIP:

The spacer ⑧ and collar ⑨ should fit together firmly.

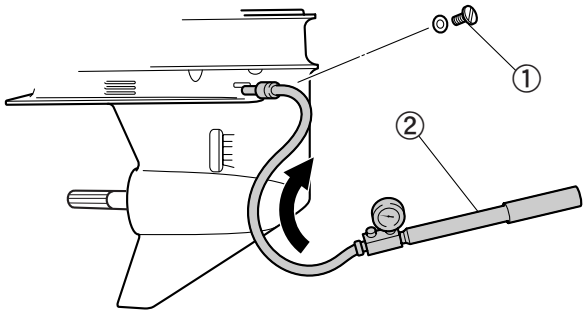
5. When installing the pump housing and a new O-ring ⑩, apply grease to the inside of the insert cartridge, and then turn the drive shaft clockwise while pushing down the pump housing assembly ⑪.
NOTICE: **Do not turn the drive shaft counterclockwise, otherwise the water pump impeller may be damaged.**

6. Install the bolts ⑫.



Checking the lower unit for air leakage

1. Remove the gear oil check screw ①, and then install the special service tool ②.



Leakage tester ②: 90890-06840

8

2. Apply the specified pressure to check that the pressure is maintained in the lower unit for at least 10 seconds.
NOTICE: **Do not over pressurize the lower unit, otherwise the oil seals may be damaged.**

Holding pressure:
68.6 kPa (0.686 kgf/cm², 9.9 psi)

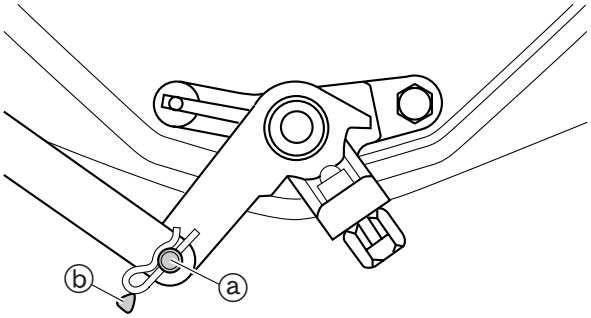
3. If the specified pressure cannot be maintained, check the drive shaft, propeller shaft and shift rod oil seals for damage. If necessary, check each shaft for bends and damage.

Installing the lower unit

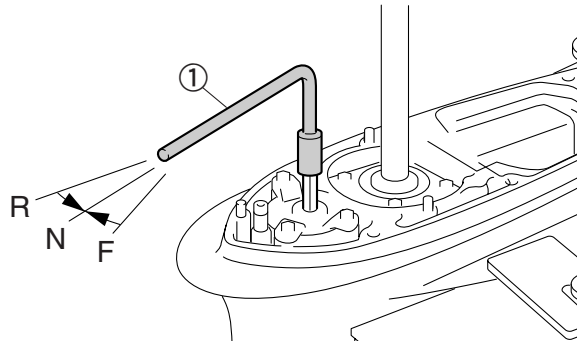
⚠ WARNING

- **Do not hold the propeller with your hands when loosening or tightening it.**
- **Make sure to disconnect the battery cables from the battery and the clip from the engine shut-off switch.**
- **When installing the lower unit with the power unit installed, make sure to suspend the outboard motor. If the outboard motor is not suspended it can fall suddenly and result in severe injury.**

1. Align ⓐ of the shift rod with the alignment mark ⓑ.



2. Set the gear shift to the N position.

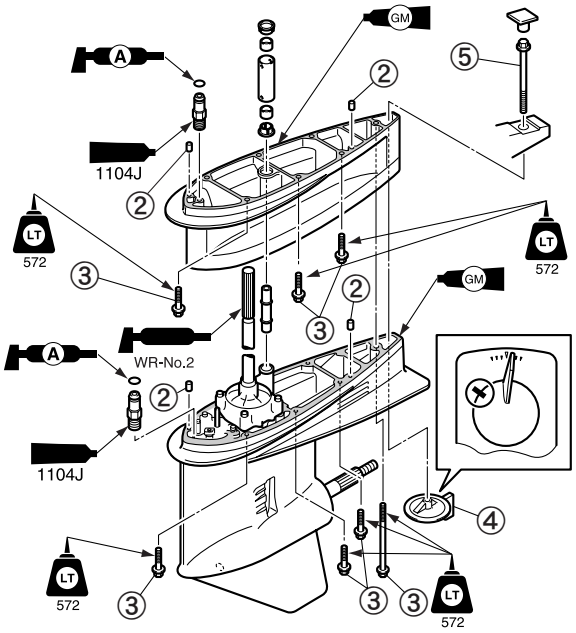


Shift rod push arm ①: 90890-06052

3. Install the dowels ② into the lower unit and extension.

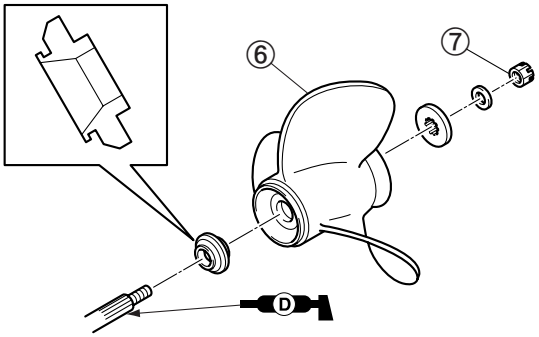
4. Install the lower unit and extension to the upper case, and then tighten the lower case mounting bolts ③ to the specified torque.

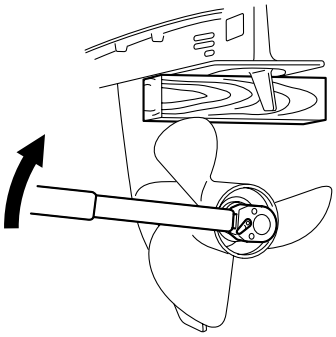
5. Install the trim tab ④ to its original position, and then tighten the trim tab bolt ⑤ to the specified torque.



Lower case mounting bolt ③:
47 N·m (4.7 kgf·m, 34.7 ft·lb)
Trim tab bolt ⑤:
42 N·m (4.2 kgf·m, 31.0 ft·lb)

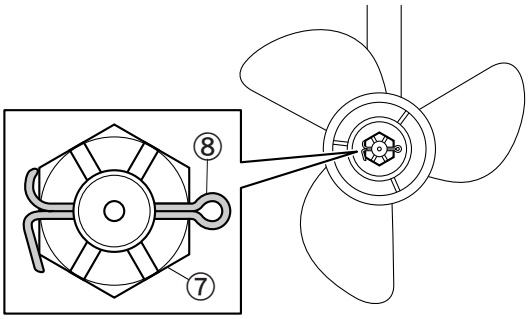
6. Install the propeller ⑥ and propeller nut ⑦. Place a block of wood between the anti-cavitation plate and propeller to keep the propeller from turning, and then tighten the nut to the specified torque.





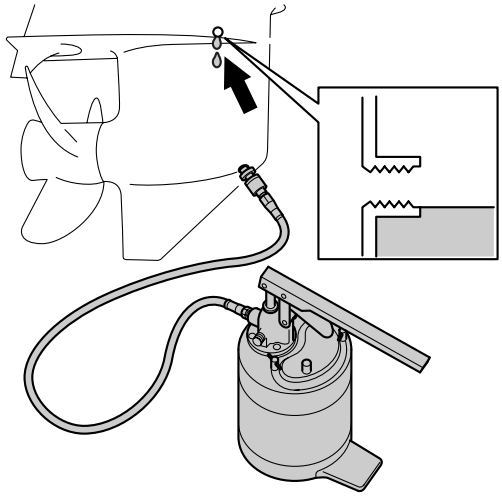
Propeller nut ⑦:
54 N·m (5.4 kgf·m, 39.8 ft·lb)

7. Install a new cotter pin ⑧.



TIP:
If the grooves in the propeller nut ⑦ do not align with the cotter pin hole, tighten the nut until they are aligned.

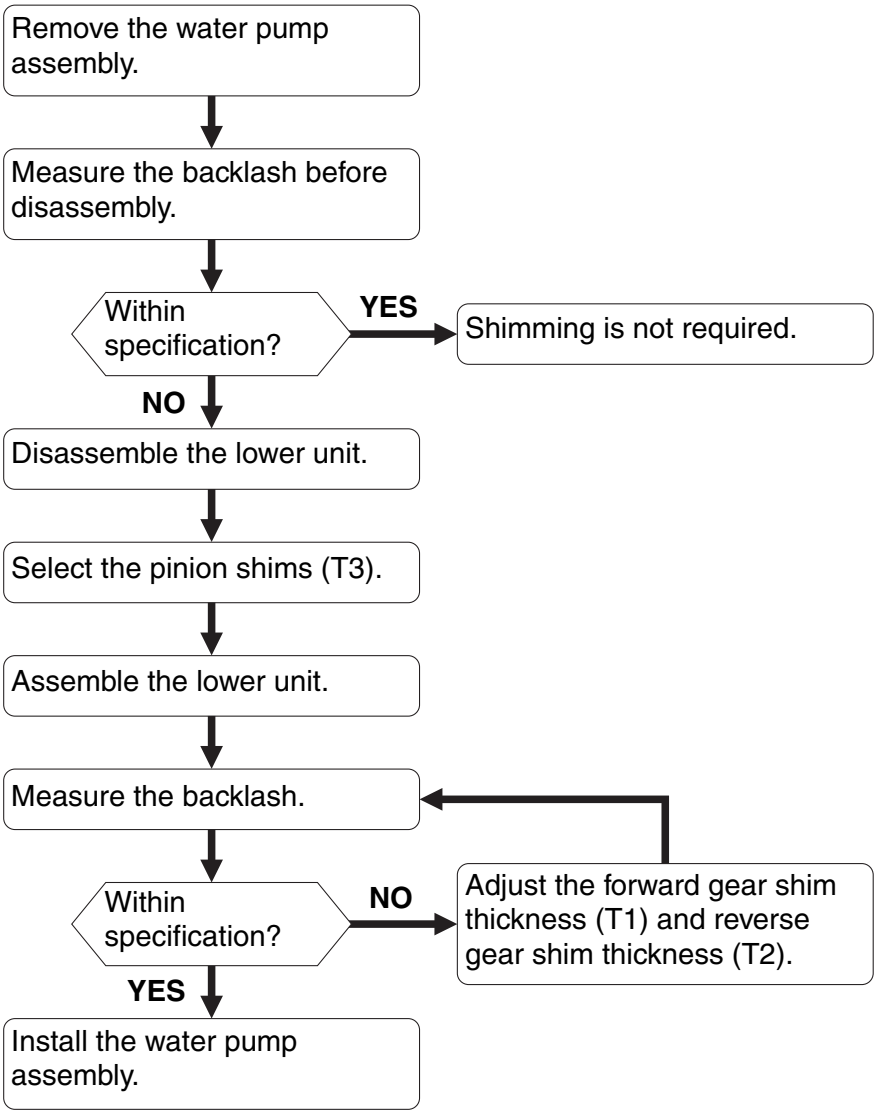
8. Fill the gear oil to the correct level.



Recommended gear oil:
Hypoid gear oil
API: GL-4
SAE: 90
Gear oil quantity:
0.980 L (1.036 US qt, 0.862 Imp qt)

Shimming (regular rotation model)

Shimming workflow



TIP:

- Shimming is not required if the backlash is within specification.
- Shimming is required when assembling the original inner parts and a new lower case.
- Shimming is required when replacing the pinion, forward gear, reverse gear, bearings, shaft, and housing.

Shimming check sheet

Checking the external appearance

The deviation of the lower case dimension from standard.

Serial number	P	F	R	Remarks

Measuring the pinion height

(mm)

	Measurements		
Measurement point ①			
Measurement point ②			
Measurement point ③			
Measurement point ④			
Average			
Truncated average (M)			

Measuring the forward gear backlash

(mm)

	Measurements					
	Before disassembly			After disassembly		
Measurement point ①						
Measurement point ②						
Measurement point ③						
Measurement point ④						
Average						
Truncated average (BL1)						

Measuring the reverse gear backlash

(mm)

	Measurements					
	Before disassembly			After disassembly		
Measurement point ①						
Measurement point ②						
Measurement point ③						
Measurement point ④						
Average						
Truncated average (BL2)						

Adjusting the forward gear shim thickness (T1)
Measure the thickness of each forward gear shim (T1) in 2 places.

(mm)

	Number of shim(s)			Subtotal
0.10				
0.12				
0.15				
0.18				
0.30				
0.40				
0.50				
Total				

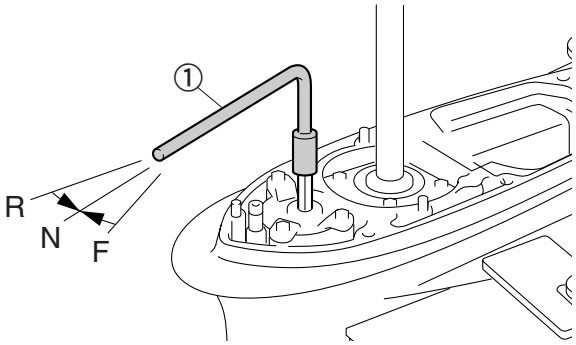
Adjusting the reverse gear shim thickness (T2)
Measure the thickness of each reverse gear shim (T2) in 2 places.

(mm)

	Number of shim(s)			Subtotal
0.10				
0.12				
0.15				
0.18				
0.30				
0.40				
0.50				
Total				

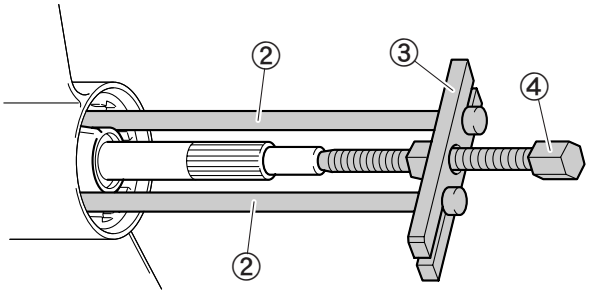
Measuring the forward and reverse gear backlash before disassembly

1. Install the lower unit onto a repair stand.
2. Remove the water pump assembly. See “Removing the water pump and shift rod” (8-6).
3. Set the gear shift to the N position.



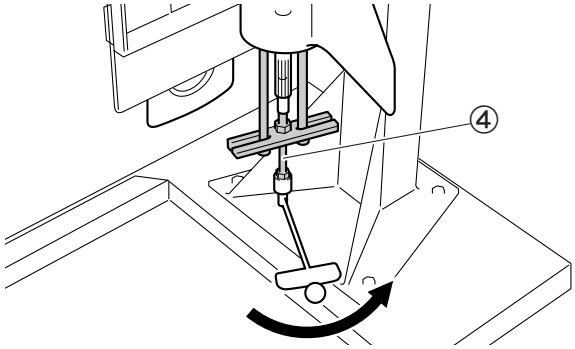
Shift rod push arm ①: 90890-06052

4. Install the special service tools, and then tighten the center bolt ④ temporarily.



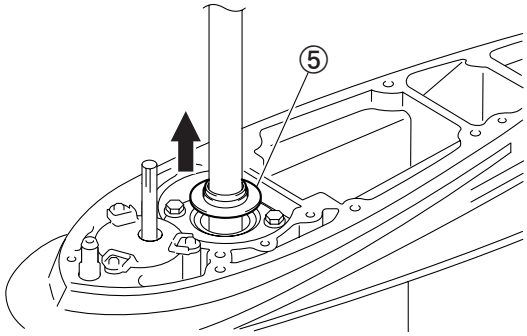
Bearing housing puller claw L ②: 90890-06502 Stopper guide plate ③: 90890-06501 Center bolt ④: 90890-06504

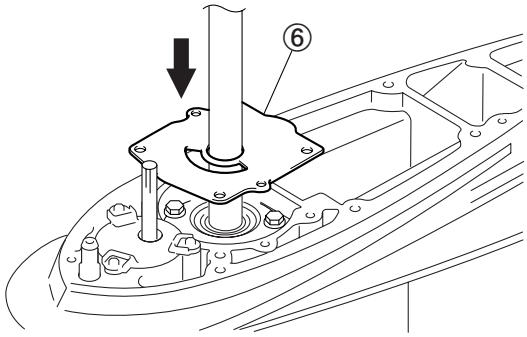
5. Turn the lower unit so that the propeller shaft is pointing downward.
6. Turn the drive shaft 10 times or more to seat the taper roller bearing.
7. Tighten the center bolt ④ to the specified torque while holding the drive shaft not to turn.



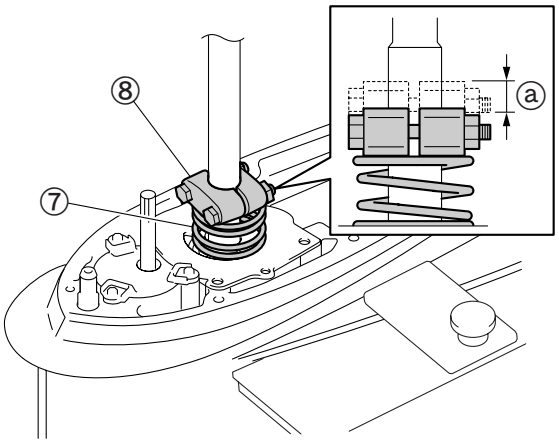
Center bolt (shimming) ④: 5 N·m (0.5 kgf·m,3.7 ft·lb)

8. Turn the lower unit upright.
9. Remove the cover ⑤, and then install the outer plate cartridge ⑥.





10. Set the spring ⑦ on the outer plate cartridge, and then install the handle stopper ⑧ so that the spring is compressed approximately ⓐ from its free length.

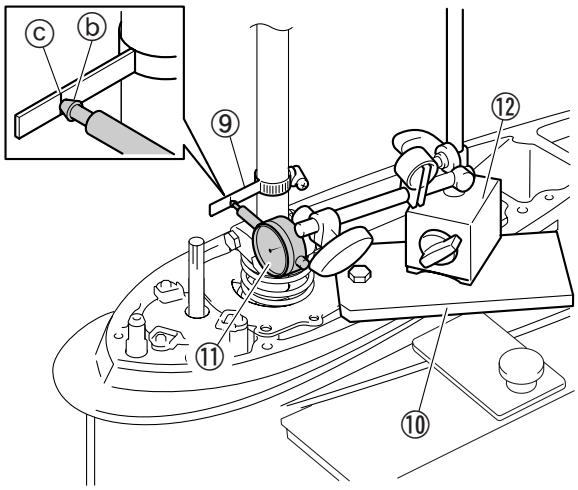


Spring ⑦: 90501-450A2
Handle stopper ⑧: EU0-23814-30

Setting height ⓐ:
3.0–5.0 mm (0.118–0.197 in)

TIP:
- After installing the handle stopper, pull the drive shaft upward to confirm that there is no free play.
- Do not press down the spring by more than 5.0 mm (0.197 in). Otherwise, excessive torque will be required to turn the drive shaft, making it difficult to obtain correct measurements.

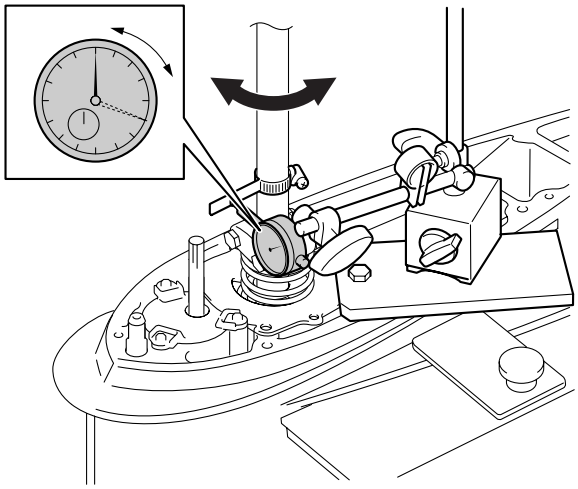
11. Install the special service tool ⑨ onto the drive shaft at the lowest possible position where the shaft diameter is 22.4 mm (0.882 in), and then set up the special service tool ⑪.



Backlash indicator ⑨: 90890-06706
Magnet base plate ⑩: 90890-07003
Dial gauge set ⑪: 90890-01252
Magnet base B ⑫: 90890-06844

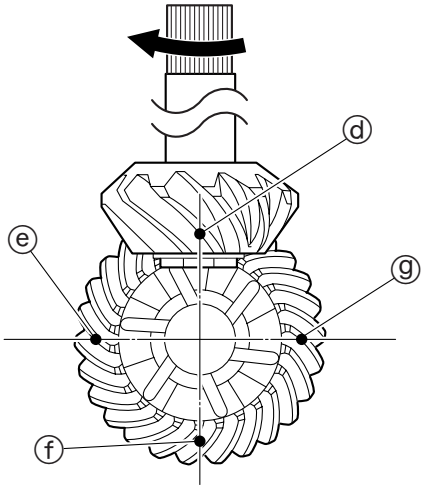
TIP:
Position the special service tool ⑪ so that the plunger tip ⓑ contacts the mark ⓒ on the special service tool ⑨.

12. Slowly turn the drive shaft clockwise and counterclockwise, and then measure the backlash at the position where it stops in each direction.



TIP:
- The resistance of the spring increases the force required to turn the drive shaft. Therefore, to obtain correct measurements, consider the spring resistance force when turning the drive shaft.
- Do not turn the drive shaft with excessive force, otherwise the forward gear will rotate, leading to incorrect measurements.

13. Turn the drive shaft 180° clockwise and measure the backlash again.



TIP:
- Measure the backlash at 4 points: ⓓ, ⓔ, ⓕ, and ⓖ, turning the drive shaft 180° clockwise after each measurement. Note the measurement data in the shimming check sheet.
- When turning the drive shaft, hold it with a little force. A knocking sound may be heard when the drive shaft is rotated, but this is the sound of the pinion contacting the reverse gear and does not affect the backlash measurement.

14. Determine the backlash average, and then truncate it by dropping the numbers after the 1/100 place without rounding.

Example:

(mm)

Measurement point ⓓ	0.60	0.61	0.57
Measurement point ⓔ	0.51	0.53	0.52
Measurement point ⓕ	0.51	0.52	0.52
Measurement point ⓖ	0.55	0.54	0.55
Average	0.5425	0.5500	0.5400
Truncated average (BL1)	0.54	0.55	0.54

15. Check that the forward gear backlash average is within specification.

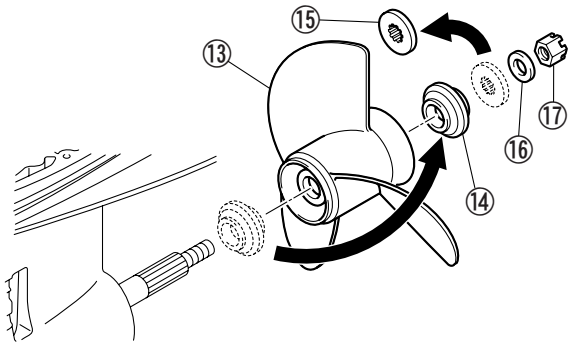
Forward gear backlash:
0.15–0.68 mm (0.0059–0.0268 in)

TIP:
Adjust the shim thicknesses if the forward gear backlash is out of specification.

16. Remove the special service tools from the propeller shaft.

17. Apply a load to the reverse gear by installing the propeller ⑬, spacer ⑭ (without the spacer ⑮), and washer ⑯.

18. Tighten the propeller nut ⑰ to the specified torque.



Propeller nut (shimming) ⑰:
10 N·m (1.0 kgf·m, 7.4 ft·lb)

19. For measuring reverse gear backlash proceed the step 12–step 14 again.

20. Check that the reverse gear backlash average is within specification.

Reverse gear backlash:
0.33–0.74 mm (0.0130–0.0291 in)

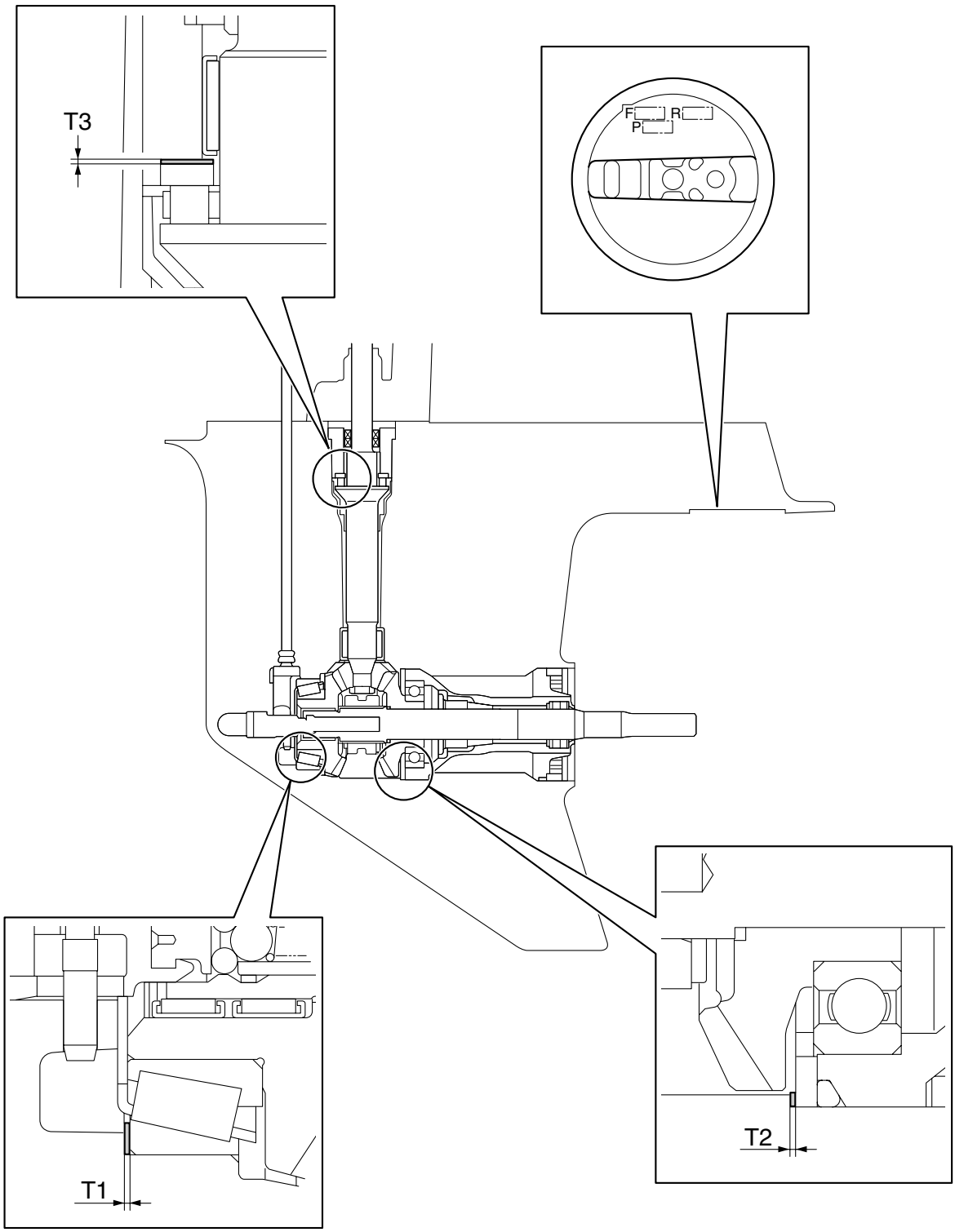
TIP:
Adjust the shim thicknesses if the reverse gear backlash is out of specification.

21. Remove the special service tools, and then install the water pump assembly. See “Installing the water pump” (8-22).

Shimming

- Make sure to select the pinion shim(s) (T3) before selecting the forward gear shim(s) (T1) and reverse gear shim(s) (T2).
- When assembling the lower unit to measure the backlash after selecting the pinion shim(s) (T3), do not apply gear oil, grease, or sealant to the parts.
- When assembling the lower unit after shimming is completed, make sure to apply gear oil, grease, and sealant to the specified areas.

Shim location



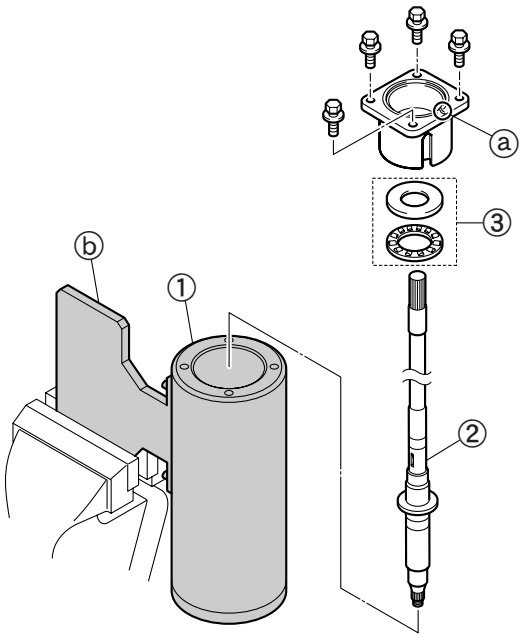
Selecting the pinion shim (T3)

- Spray anti-rust lubricant on the bearing before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.

NOTICE

Do not damage the measurement plane surface of the pinion height gauge, otherwise accurate measurements cannot be obtained.

1. Hold the special service tool ①, and then install the drive shaft ②, thrust bearing ③, and drive shaft housing assembly to the tool.

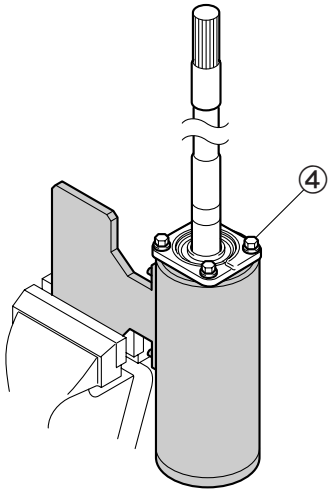


Pinion height gauge ①: 90890-06671

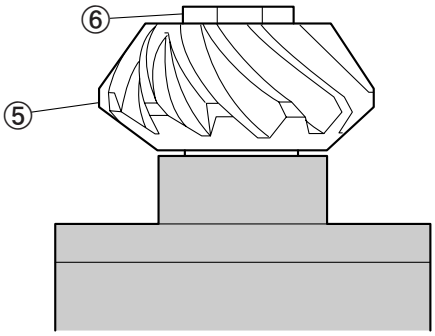
TIP:

- Do not install the shim(s) (T3) or O-ring. Make sure to check the thrust bearing outer race since the shim(s) (T3) sometimes become affixed to the race.
- Make sure to install the thrust bearing outer race so that it is facing in the same direction as when it was removed.
- Make sure that the cutout ⓐ in the drive shaft housing assembly is facing the opposite side from the plate ⓑ of the special service tool.

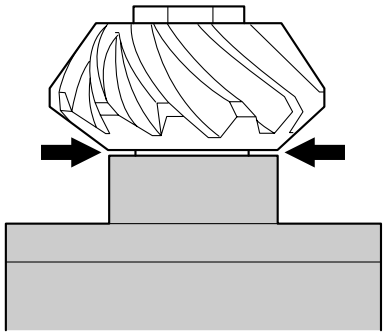
2. Tighten the bolts ④.

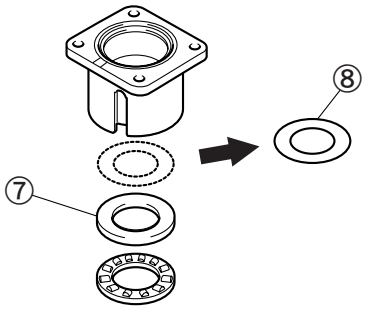


3. Install the pinion ⑤ and pinion nut ⑥, and then tighten the pinion nut temporarily.



4. Check the gap between the pinion and the special service tool. ***NOTICE:*** **When tightening the pinion nut, check that the drive shaft rotates smoothly. Also, make sure that there is a gap between the pinion and the special service tool. If there is no gap and the drive shaft does not rotate, the special service tool could be damaged.**

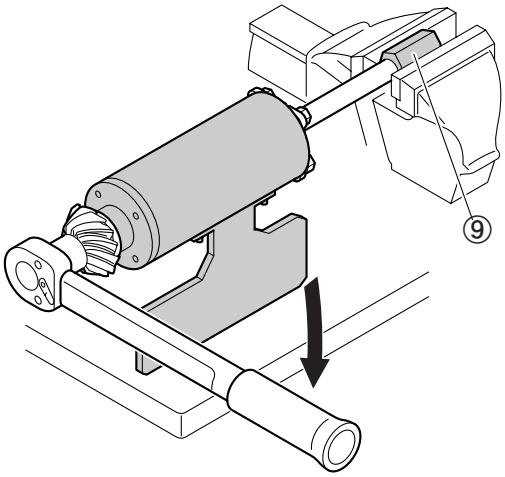




TIP:
If there is no gap, the thrust bearing outer race ⑦ may not have been installed. If the gap is 1 mm (0.04 in) or more, the shim(s) (T3) ⑧ may not have been removed.

5. Install the special service tool ⑨ to the drive shaft, and then hold the tool.

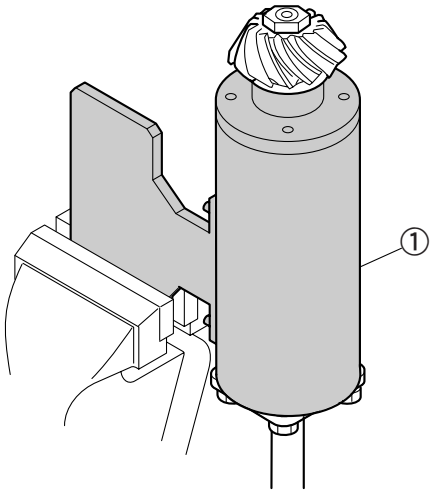
6. Tighten the pinion nut to the specified torque.



Drive shaft holder 6 ⑨: 90890-06520

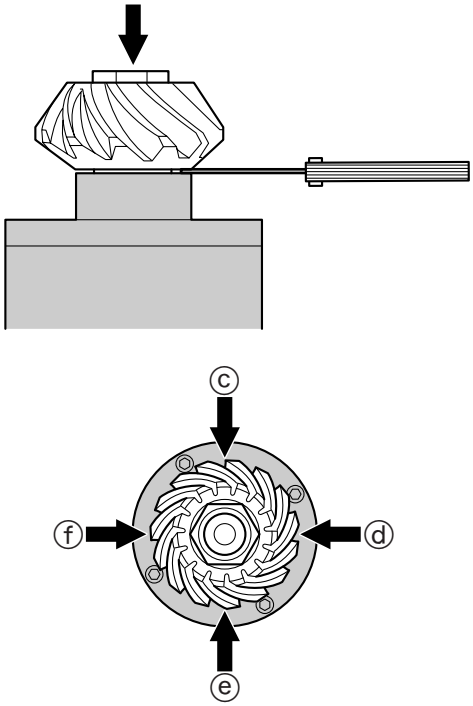
Pinion nut: 94 N·m (9.4 kgf·m, 69.3 ft·lb)

7. Hold the special service tool ① so that the pinion is facing up.



8. Turn the drive shaft 10 times or more to seat the thrust bearing.

9. Push down on the pinion so that it does not lift up, and then measure the gap between the pinion and the special service tool. When measuring the gap, insert the end of the thickness gauge straight into the gap at the measurement point. Do not insert the thickness gauge at an angle.



TIP:
- Measure the gap at 4 points: ⓒ, ⓓ, ⓔ, and ⓕ.
- Note the measurement data in the shimming check sheet.

10. Determine the gap average, and then truncate it by dropping the numbers after the 1/100 place without rounding.

Example:

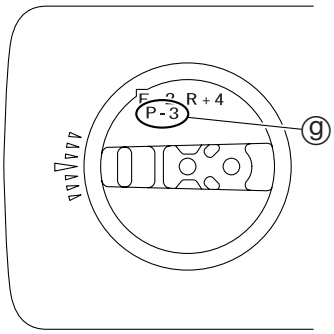
(mm)

Measurement point ⓒ	0.25	0.25	0.24
Measurement point ⓓ	0.24	0.24	0.24
Measurement point ⓔ	0.25	0.25	0.25
Measurement point ⓕ	0.25	0.25	0.25
Average	0.2475	0.2475	0.2450
Truncated average (M)	0.24	0.24	0.24

11. Determine the pinion shim thickness (T3) in the “Pinion shim (T3) selection tables” according to the truncated average (M) and the deviation (P) stamped on the lower case.

Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

Example:
(M) = 0.24
(P) = –3



(T3) = 0.95 mm from the “pinion shim (T3) selection table.”

		Pinion height measurement (M)		
		0.23	0.24	0.25
Stamped value on the lower case (P)	–2		↓	
	–3	→	0.95	
	–4			

TIP:
The (P) mark ⓖ is stamped on the trim tab mounting surface of the lower case in 0.01 mm units. If the (P) mark is unreadable, replace the lower case.

12. Remove the special service tools, and then install the shim(s) (T3) determined.

Pinion shim (T3) selection table

(mm)

P/M		A														
		0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15
B	13	1.32	1.32	1.32	1.30	1.30	1.28	1.28	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20
	12	1.32	1.32	1.30	1.30	1.28	1.28	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18
	11	1.32	1.30	1.30	1.28	1.28	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18
	10	1.30	1.30	1.28	1.28	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15
	9	1.30	1.28	1.28	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15
	8	1.28	1.28	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15
	7	1.28	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12
	6	1.25	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12
	5	1.25	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12
	4	1.25	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10
	3	1.22	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10
	2	1.22	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08
	1	1.22	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08
B	0	1.20	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05
	–1	1.20	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05
	–2	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05
	–3	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02
	–4	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02
	–5	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02
	–6	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00
	–7	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00
	–8	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98
	–9	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98
	–10	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95
	–11	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95
	–12	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95
	–13	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92

P/M		A														
		0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30
B	13	1.18	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05
	12	1.18	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02
	11	1.15	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02
	10	1.15	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02
	9	1.15	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00
	8	1.12	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00
	7	1.12	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98
	6	1.12	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98
	5	1.10	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95
	4	1.10	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95
	3	1.08	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95
	2	1.08	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92
	1	1.05	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92
B	0	1.05	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92
	–1	1.05	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90
	–2	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90
	–3	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88
	–4	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88
	–5	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85
	–6	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85
	–7	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85
	–8	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82
	–9	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82
	–10	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82
	–11	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80
	–12	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80
	–13	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78

A Pinion height measurement (M)
B Stamped value on the lower case (P)

(mm)

P/M		A														
		0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.45
	13	1.02	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90
	12	1.02	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88
	11	1.02	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88
	10	1.00	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85
	9	1.00	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85
	8	0.98	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85
	7	0.98	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82
	6	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82
	5	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82
	4	0.95	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80
	3	0.92	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80
	2	0.92	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78
	1	0.92	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78
B	0	0.90	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75
	–1	0.90	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75
	–2	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75
	–3	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72
	–4	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72
	–5	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72
	–6	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70
	–7	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70
	–8	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68
	–9	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68
	–10	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65
	–11	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65
	–12	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62
	–13	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62

P/M		A														
		0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.60
	13	0.88	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75
	12	0.88	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72
	11	0.85	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72
	10	0.85	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72
	9	0.85	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70
	8	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70
	7	0.82	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68
	6	0.82	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68
	5	0.80	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65
	4	0.80	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65
	3	0.78	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62
	2	0.78	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62
	1	0.75	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62
B	0	0.75	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60
	–1	0.75	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60
	–2	0.72	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58
	–3	0.72	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58
	–4	0.72	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55
	–5	0.70	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55
	–6	0.70	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55
	–7	0.68	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55	0.52
	–8	0.68	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55	0.52	0.52
	–9	0.65	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55	0.52	0.52	0.52
	–10	0.65	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55	0.52	0.52	0.52	0.50
	–11	0.62	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55	0.52	0.52	0.52	0.50	0.50
	–12	0.62	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55	0.52	0.52	0.52	0.50	0.50	0.48
	–13	0.62	0.60	0.60	0.58	0.58	0.55	0.55	0.55	0.52	0.52	0.52	0.50	0.50	0.48	0.48

A Pinion height measurement (M)
B Stamped value on the lower case (P)

Measuring the forward gear backlash

- Spray anti-rust lubricant on the gear and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.
- When measuring the forward gear or reverse gear backlash, use the original bearings and shims.

⚠ WARNING

- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the lower case in a well-ventilated area.**

1. Install the original shim(s) (T1).

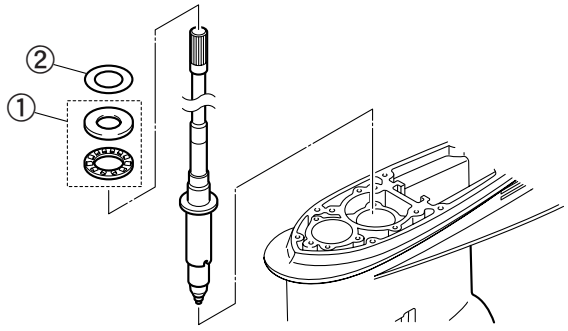
TIP:

- If the original shim(s) (T1) are missing, install new shims with a combined thickness of 0.55 mm.
- Do not reuse a shim if it is any deformed or scratched.

2. Install the taper roller bearing outer race. See “Assembling the lower case” (8-17) step 2 and step 3.

3. Install the forward gear assembly into the lower case.

4. Install the drive shaft, thrust bearing ①, and shim(s) (T3) ②.



TIP:

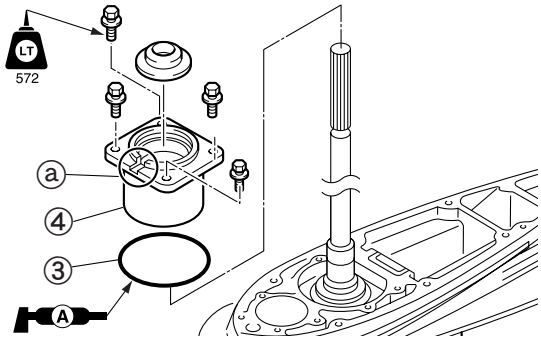
Turn the drive shaft 10 times or more to seat the thrust bearing.

5. Install the pinion and pinion nut temporarily.

TIP:

When installing the pinion, lift up the drive shaft slightly and align the pinion and shaft splines.

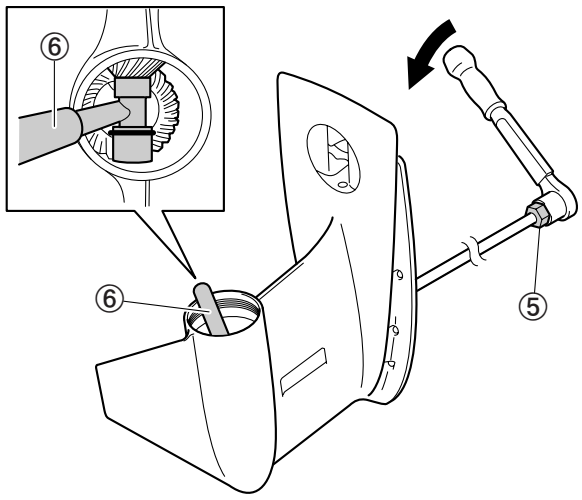
6. Install a new O-ring ③ to the drive shaft housing ④, and then install the drive shaft housing ④.



TIP:

Install the drive shaft housing with the cutout ⓐ in the housing facing forward.

7. Tighten the pinion nut to the specified torque.



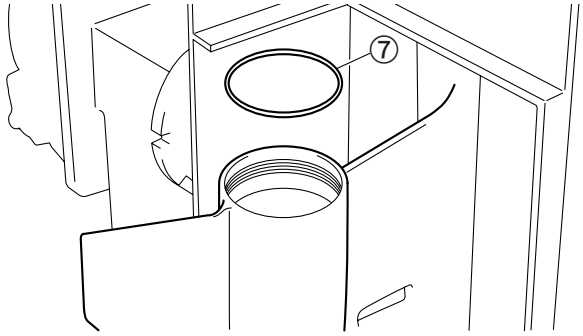
Drive shaft holder 6 ⑤: 90890-06520 Pinion nut holder ⑥: 90890-06715

8

Pinion nut: 94 N·m (9.4 kgf·m, 69.3 ft·lb)

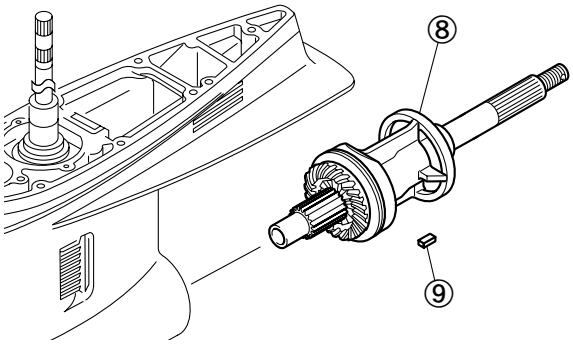
8. Check that the drive shaft rotates smoothly. If the drive shaft does not rotate smoothly, reduce the shim(s) (T1) thickness by 0.1 mm, and then check that the rotation of the shaft again.

9. Install the original shim(s) (T2) ⑦ in the lower case.



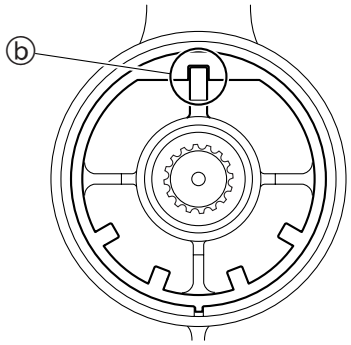
TIP:
- If the original shim(s) (T2) are missing, install new shim(s) (T2) with a combined thickness of 0.62 mm.
- Do not reuse a shim if it is any deformed or scratched.

10. Install the propeller shaft housing assembly ⑧ and key ⑨.

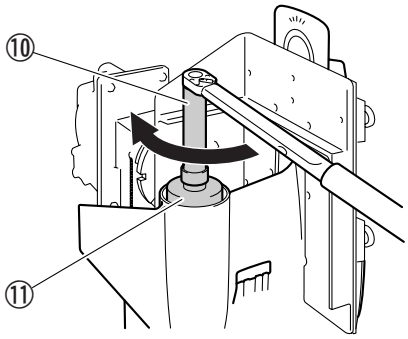


TIP:
When assembling the lower unit to measure the backlash, do not install the dog clutch and O-ring.

11. Install the claw washer. Check that the position ⓑ is set in place properly.



12. Install the ring nut, and then tighten the ring nut to the specified torque.



Ring nut wrench extension ⑩: 90890-06513 Ring nut wrench 4 ⑪: 90890-06512

Ring nut: 143 N·m (14.3 kgf·m, 105.5 ft·lb)

13. Check that the drive shaft rotates smoothly. If the drive shaft does not rotate smoothly, the shim(s) may be installed incorrectly or there may be foreign material on the shim(s).

14. Measure the forward gear backlash. See "Measuring the forward and reverse gear backlash before disassembly" (8-28).

Forward gear backlash: 0.15–0.68 mm (0.0059–0.0268 in)

Adjusting the forward gear shim thickness (T1)

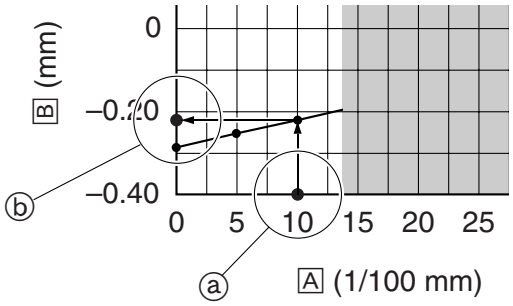
1. Remove the taper roller bearing outer race. See "Disassembling the lower case" (8-16).

2. Measure the thickness of each original shim(s) (T1) in 2 places.

TIP:
Do not reuse a shim if it is deformed or scratched.

3. Determine the forward gear shim thickness (T1) adjustment in the "Forward gear shim (T1) selection chart" according to the truncated average (BL1) from "Measuring the forward gear backlash."

Example:
(BL1) = 0.10 mm ⓐ
(T1) adjustment = –0.21 mm ⓑ from the "Forward gear shim (T1) selection chart."
The current shim thickness must be decreased by 0.21 mm.



A	0	5	10	15	20	25
B	–0.28	–0.25	–0.21			

A Backlash measurement (BL1)
B Shim thickness adjustment

TIP:
- If the shim thickness adjustment value is positive, the current shim thickness must be increased by that amount and, if the value is negative, the current shim thickness must be decreased by that amount.
- The gray-colored area on the selection chart indicates the range of the specified backlash. Shimming is not required if the measured backlash is within the gray-colored area.
- The values for the shim thickness adjustments specified in the selection chart are intended to achieve the median value within the range for the specified forward or reverse gear backlash.
- The selection chart table shows the shim thickness adjustments for marked points on the chart.

4. Calculate the new forward gear shim thickness (T1) as same way in the example.

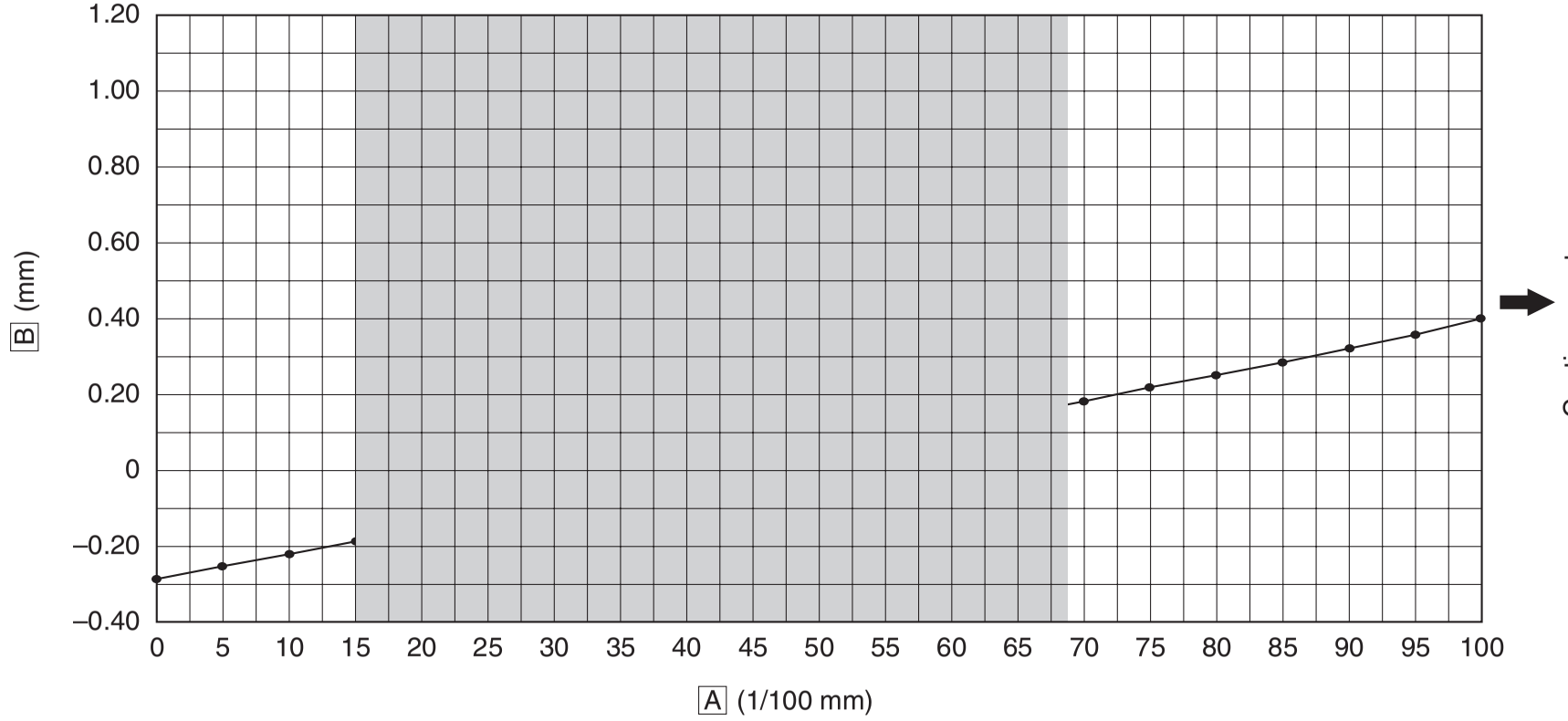
Calculation formula:
New forward gear shim thickness (T1) = Current forward gear shim thickness + Shim thickness adjustment
Example:
If the current forward gear shim thickness is 0.52 and the shim thickness adjustment is –0.22 mm, then
(T1) = 0.52 mm + (–0.22) mm
= 0.52 mm – 0.22 mm
= 0.30 mm

Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

TIP:
- Use the least number of shims to achieve the required shim thickness.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase the shim thickness by 0.01 mm.

5. Install the shim(s) (T1) and taper roller bearing outer race.

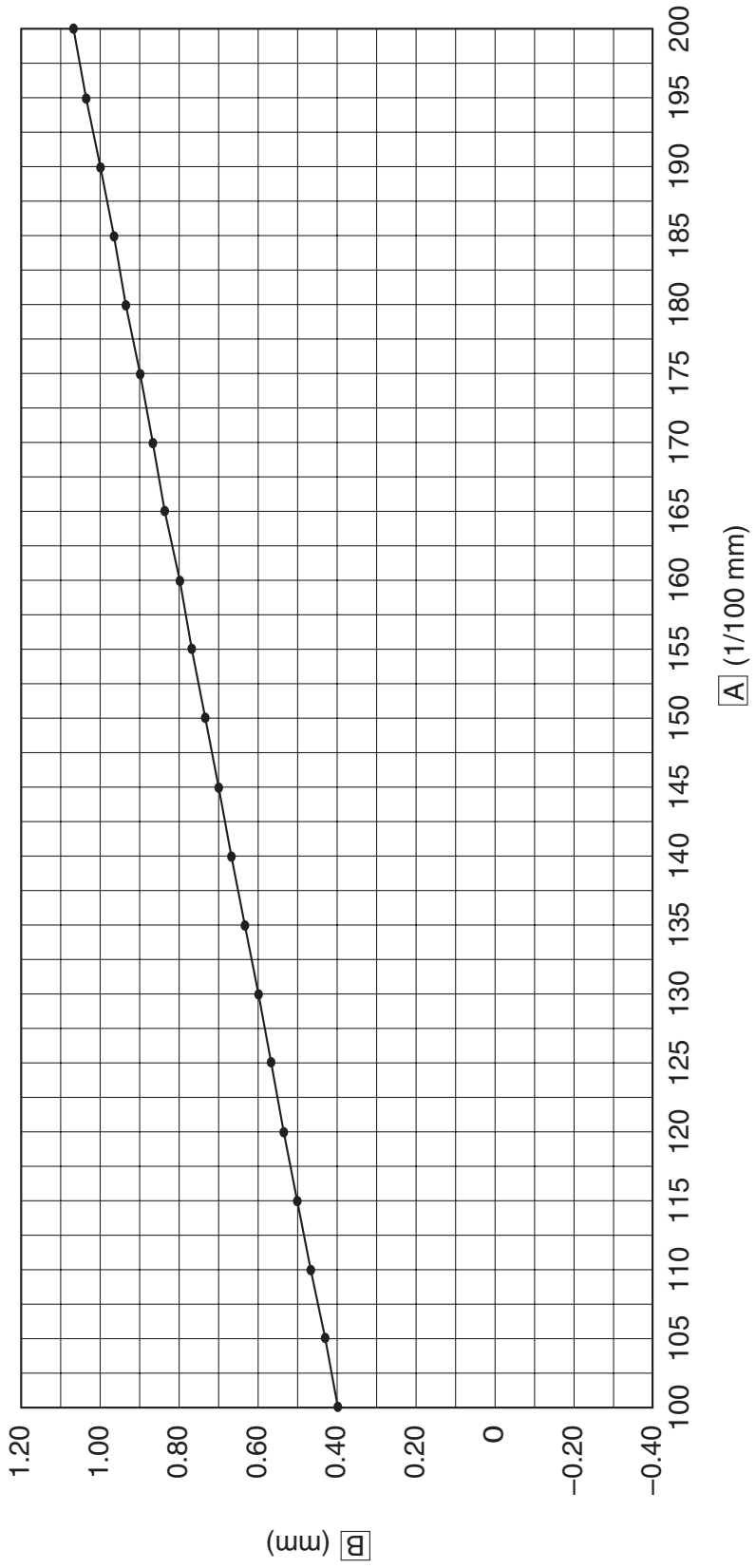
Forward gear shim (T1) selection chart



Continue next page

A	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
B	–0.28	–0.25	–0.21												0.19	0.23	0.26	0.29	0.33	0.36	0.40

A Backlash measurement (BL1)
B Increasing or decreasing of shim thickness



A	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200
B	0.40	0.43	0.46	0.50	0.53	0.56	0.60	0.63	0.67	0.70	0.73	0.77	0.80	0.83	0.87	0.90	0.94	0.97	1.00	1.04	1.07

A Backlash measurement (BL1)
B Increasing or decreasing of shim thickness

Measuring the reverse gear backlash

1. Install the shim(s) (T2) and propeller shaft housing assembly. See “Measuring the forward gear backlash” (8-38) step 9–step 13.

2. Measure the reverse gear backlash. See “Measuring the forward and reverse gear backlash before disassembly” (8-28).

Reverse gear backlash:
0.33–0.74 mm (0.0130–0.0291 in)

Adjusting the reverse gear shim thickness (T2)

1. Remove the propeller shaft housing assembly and shim(s) (T2). See “Removing the propeller shaft housing assembly” (8-10).

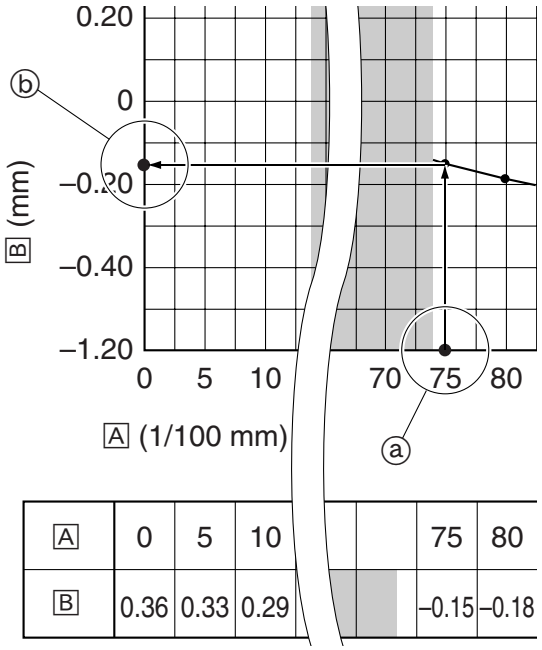
2. Measure the thickness of each original shim(s) (T2) in 2 places.

TIP:

Do not reuse a shim if it is deformed or scratched.

3. Determine the reverse gear shim thickness (T2) adjustment in the “Reverse gear shim (T2) selection chart” according to the truncated average (BL2) from “Measuring the reverse gear backlash.”

Example:
(BL2) = 0.75 mm ⓐ
(T2) adjustment = –0.15 mm ⓑ from the “Reverse gear shim (T2) selection chart.”
The current shim thickness must be decreased by 0.15 mm.



A	0	5	10			75	80
B	0.36	0.33	0.29			–0.15	–0.18

A Backlash measurement (BL2)
B Shim thickness adjustment

TIP:

- If the shim thickness adjustment value is positive, the current shim thickness must be increased by that amount and, if the value is negative, the current shim thickness must be decreased by that amount.
- The gray-colored area on the selection chart indicates the range of the specified backlash. Shimming is not required if the measured backlash is within the gray-colored area.
- The values for the shim thickness adjustments specified in the selection chart are intended to achieve the median value within the range for the specified forward or reverse gear backlash.
- The selection chart table shows the shim thickness adjustments for marked points on the chart.

4. Calculate the new reverse gear shim thickness (T2) as same way in the example.

Calculation formula:
New reverse gear shim thickness (T2) = Current reverse gear shim thickness + Shim thickness adjustment
Example:
If the current reverse gear shim thickness is 0.62 mm and the shim thickness adjustment is –0.20 mm, then
(T2) = 0.62 mm + (–0.20) mm
= 0.62 mm – 0.20 mm
= 0.42 mm

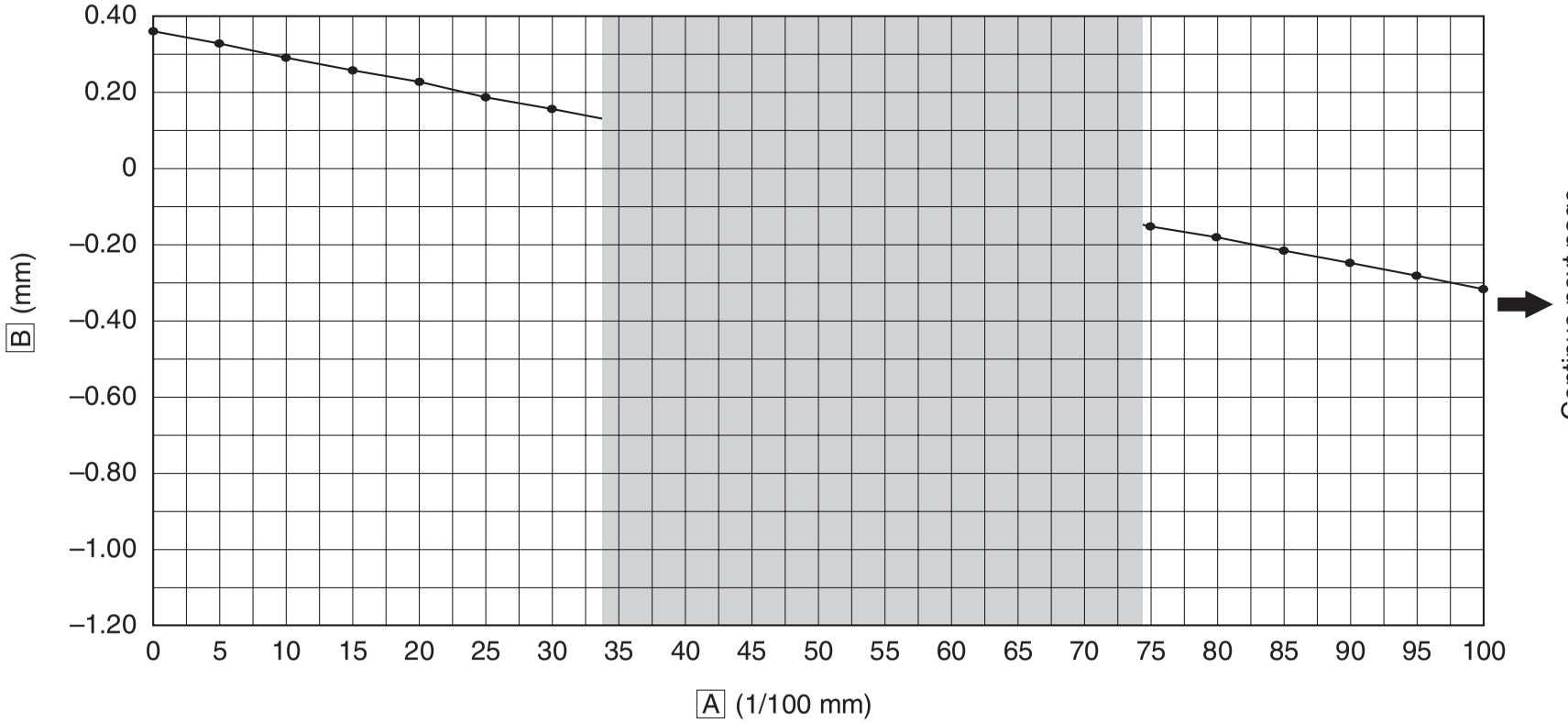
Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

TIP:

- Use the least number of shims to achieve the required shim thickness.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase the shim thickness by 0.01 mm.

5. Install the shim(s) (T2) and propeller shaft housing assembly.

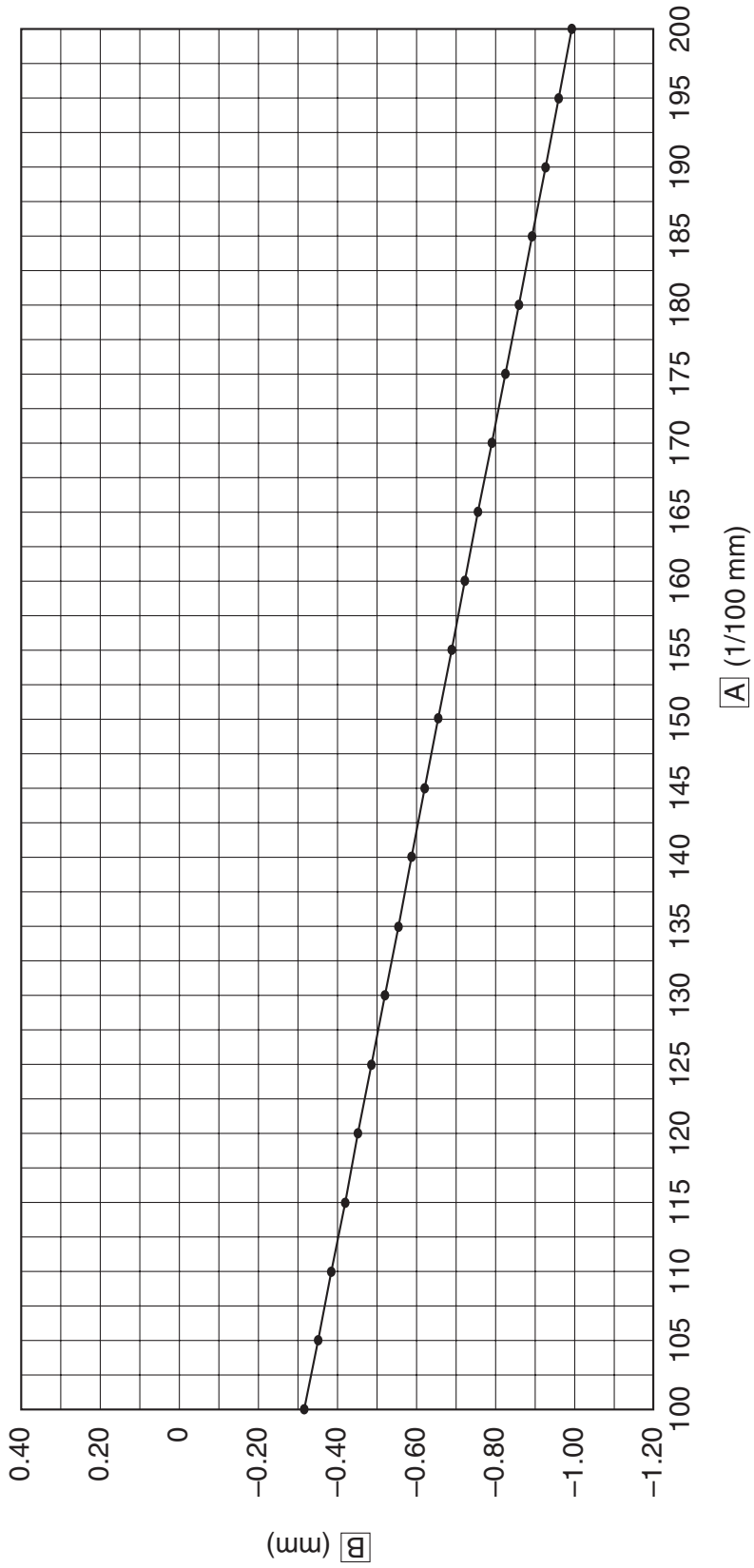
Reverse gear shim (T2) selection chart



Continue next page

A	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
B	0.36	0.33	0.29	0.26	0.22	0.19	0.16									–0.15	–0.18	–0.21	–0.25	–0.28	–0.32

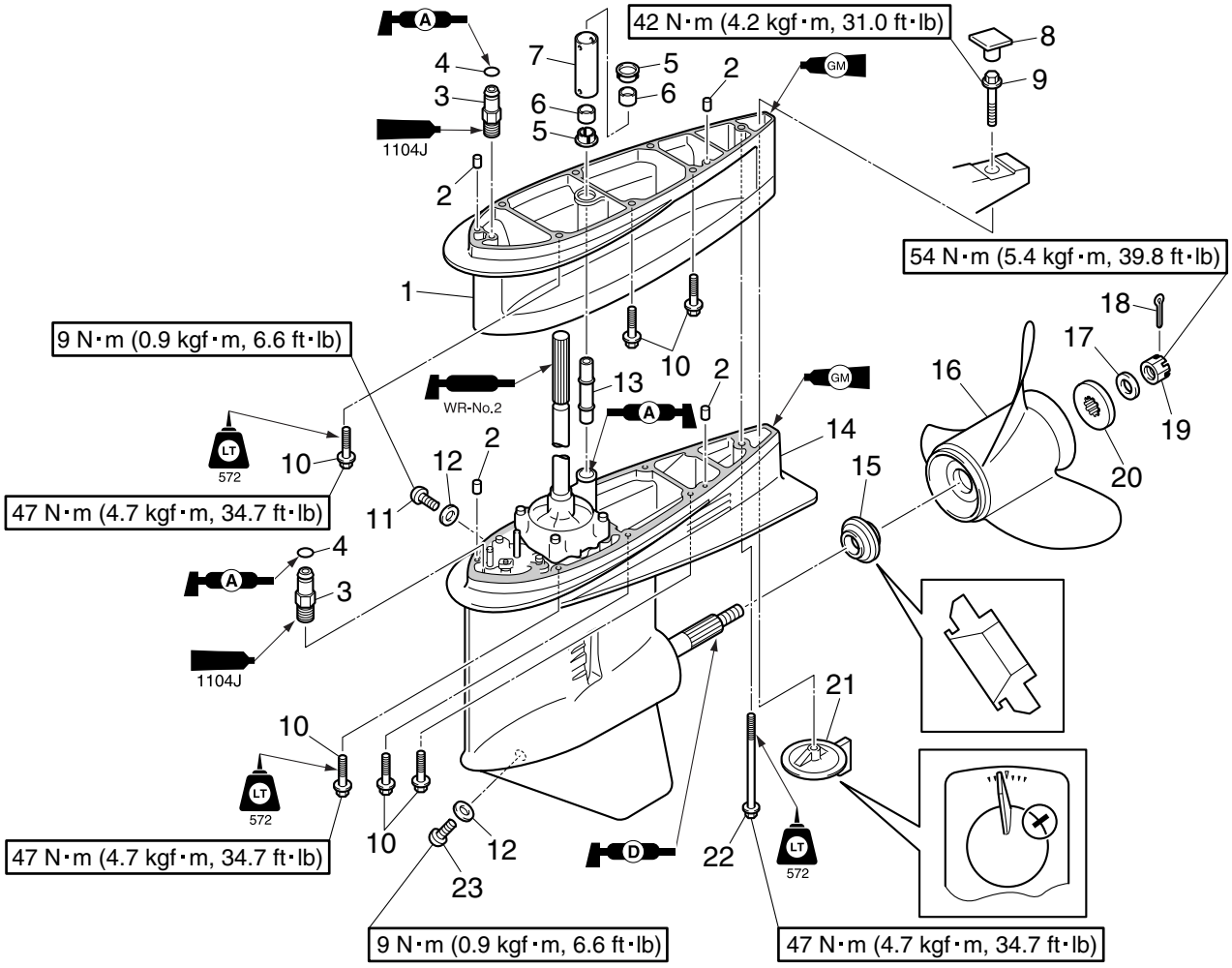
A Backlash measurement (BL2)
B Increasing or decreasing of shim thickness



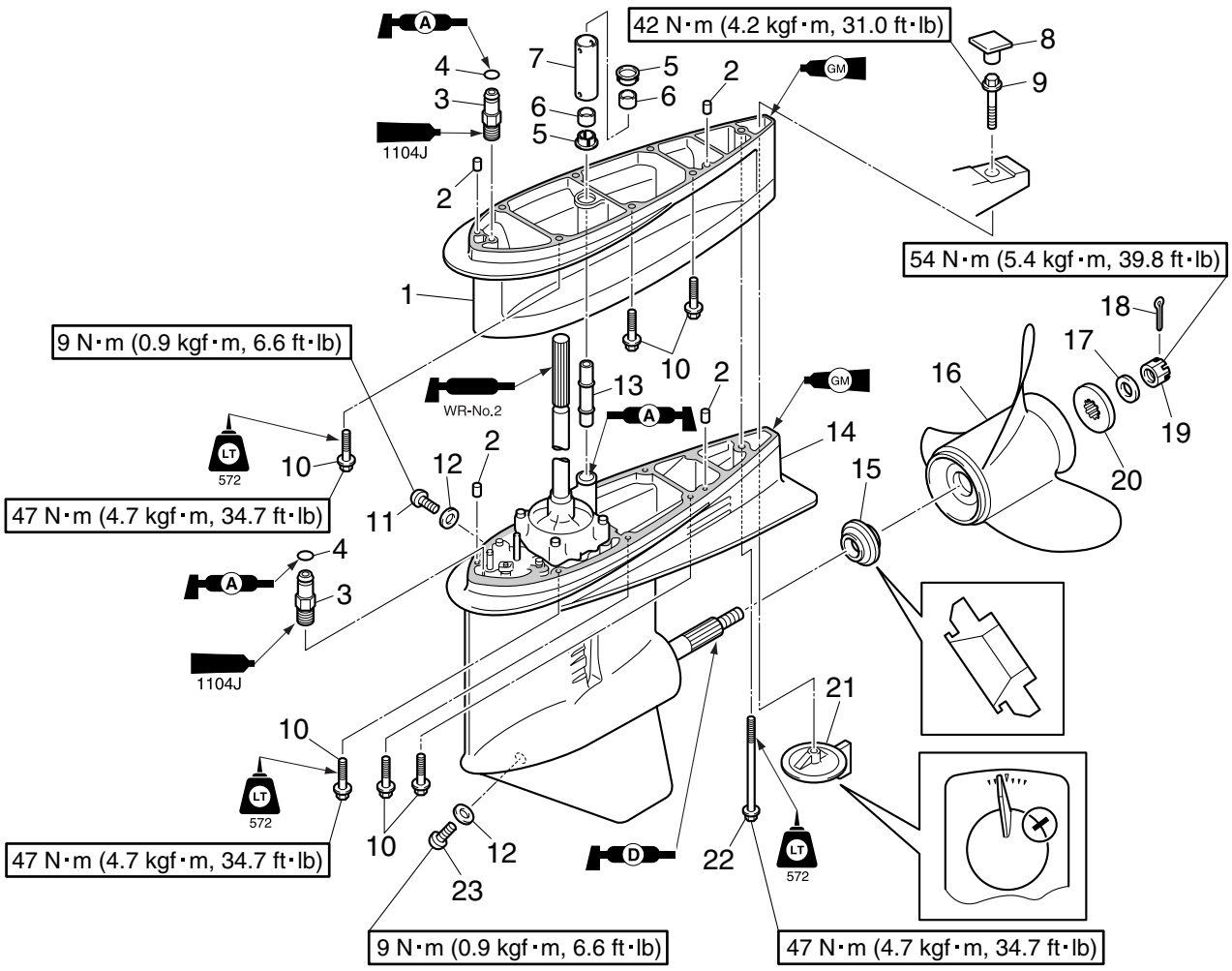
A	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200
B	–0.32	–0.35	–0.38	–0.42	–0.45	–0.48	–0.52	–0.55	–0.59	–0.62	–0.65	–0.69	–0.72	–0.75	–0.79	–0.82	–0.86	–0.89	–0.92	–0.96	–0.99

A Backlash measurement (BL2)
B Increasing or decreasing of shim thickness

Lower unit (counter rotation model)



No.	Part name	Q'ty	Remarks
1	Extension	1	
2	Dowel	4	
3	Hose nipple	2	
4	O-ring	2	**Not reusable**
5	Cover	2	
6	Seal	2	
7	Water pipe	1	
8	Grommet	1	
9	Bolt	1	M10 × 45 mm
10	Bolt	12	M10 × 45 mm
11	Check screw	1	
12	Gasket	2	**Not reusable**
13	Water pipe	1	
14	Lower unit	1	
15	Spacer	1	
16	Propeller	1	
17	Washer	1	



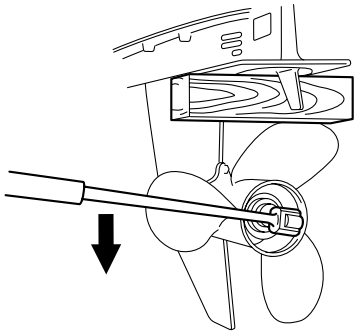
No.	Part name	Q'ty	Remarks
18	Cotter pin	1	**Not reusable**
19	Propeller nut	4	
20	Spacer	2	
21	Trim tab	2	
22	Bolt	2	M10 × 200 mm
23	Drain screw	2	

Removing the lower unit

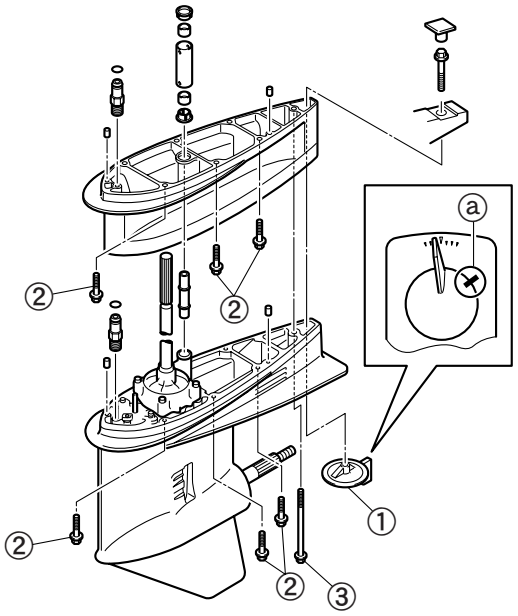
⚠ WARNING

- **Make sure to disconnect the battery cables from the battery and the clip from the engine shut-off switch.**
- **When removing the lower unit with the power unit installed, make sure to suspend the outboard motor. If the outboard motor is not suspended it can fall suddenly and result in severe injury.**
- **Do not hold the propeller with your hands when loosening or tightening it.**

1. Drain the gear oil.
2. Remove the cotter pin.
3. Set the gear shift to the N position, and place a block of wood between the anti-cavitation plate and propeller to keep the propeller from turning, and then remove the propeller nut and propeller.



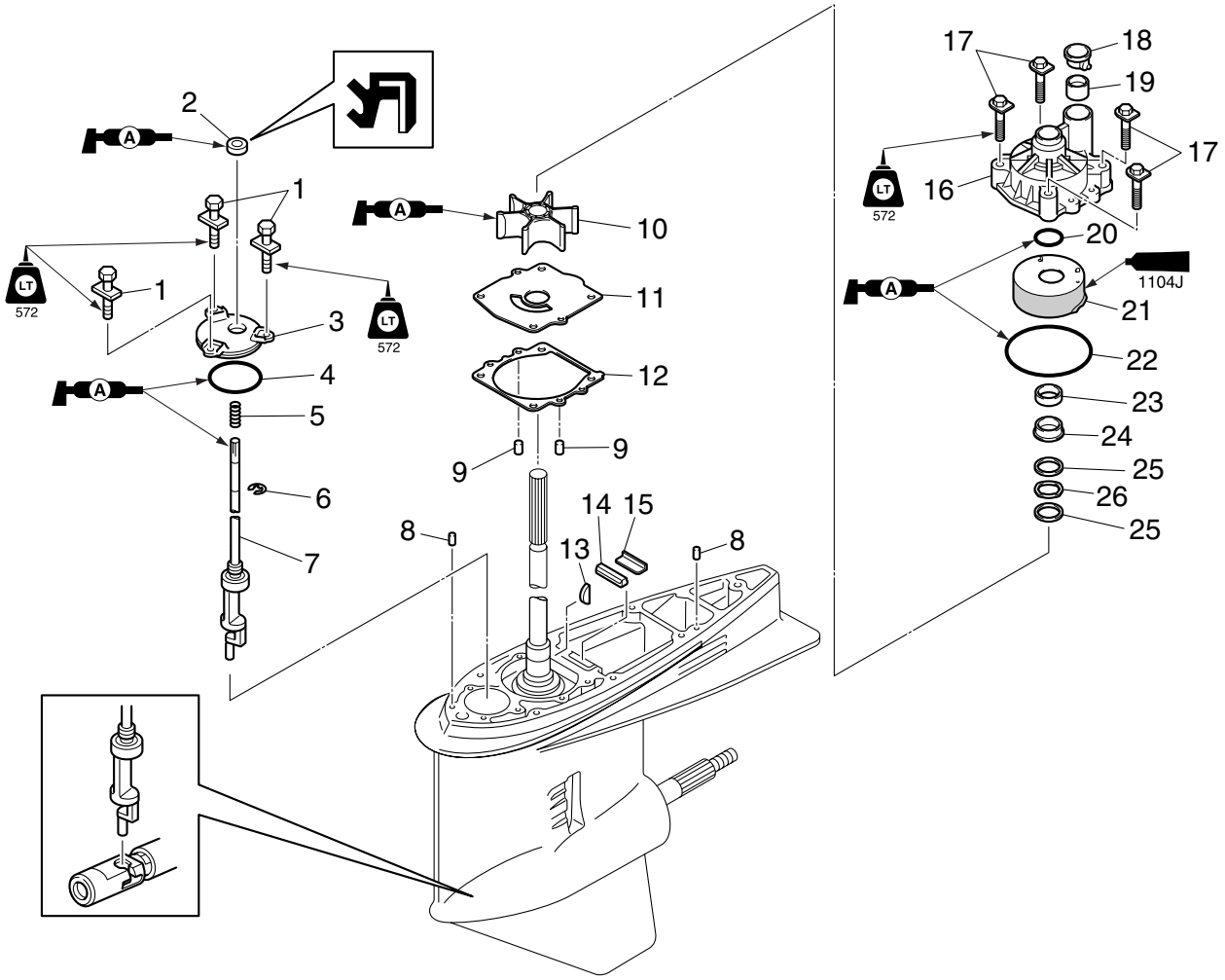
4. Mark ⓐ the trim tab ① at the area shown, and then remove it.
5. Remove the bolts ② and ③, and then remove it.



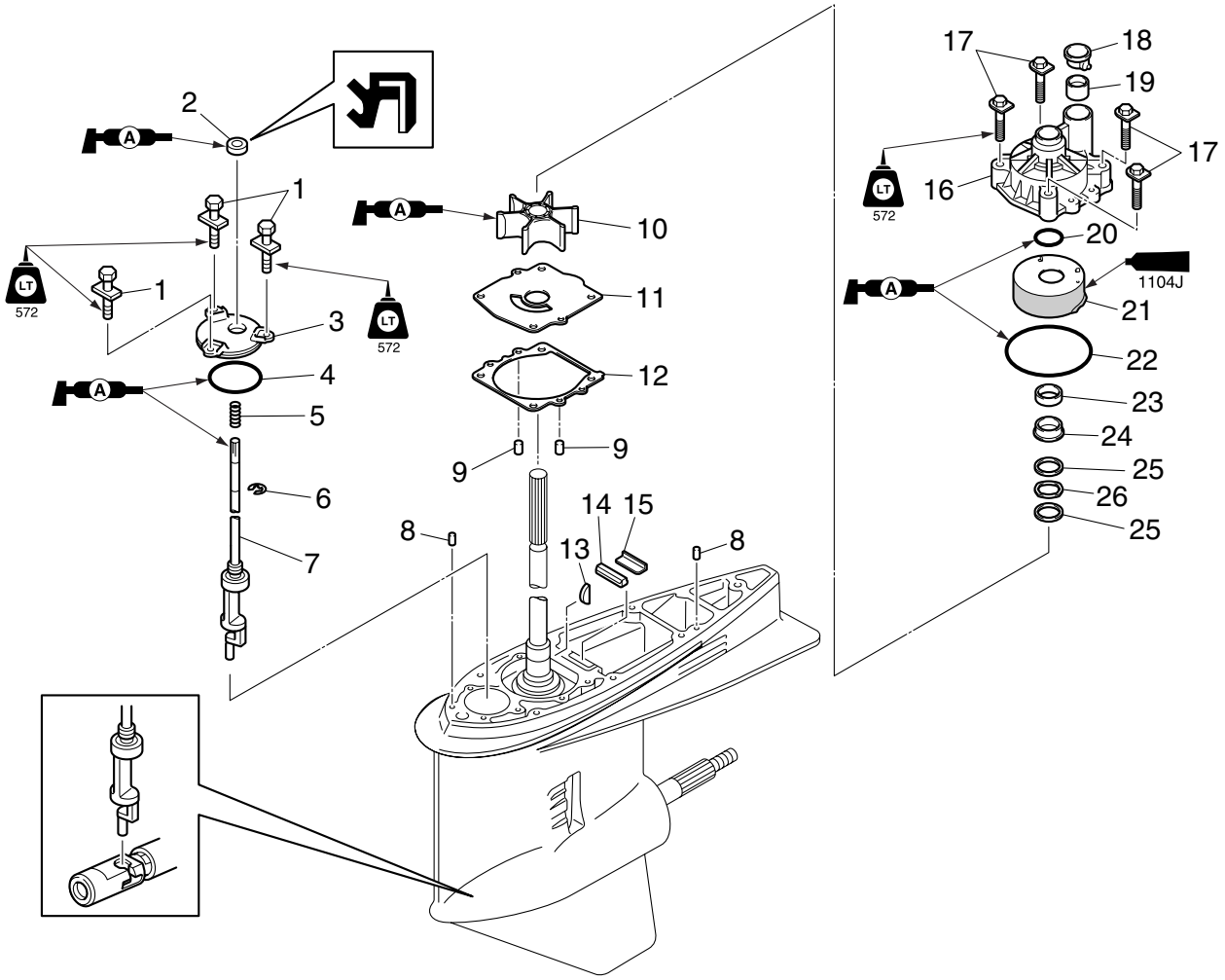
TIP:

When disassembling the lower unit, measure the backlash before disassembly. See “Measuring the forward and reverse gear backlash before disassembly” (8-68).

Water pump and shift rod (counter rotation model)



No.	Part name	Q'ty	Remarks
1	Bolt	3	M6 × 20 mm
2	Oil seal	1	**Not reusable**
3	Oil seal housing	1	
4	O-ring	1	**Not reusable**
5	Spring	1	
6	Circlip	1	
7	Shift rod	1	
8	Dowel	2	
9	Dowel	2	
10	Impeller	1	
11	Outer plate cartridge	1	
12	Gasket	1	**Not reusable**
13	Woodruff key	1	
14	Rubber seal	1	
15	Plate	1	
16	Water pump housing	1	
17	Bolt	4	M8 × 45 mm

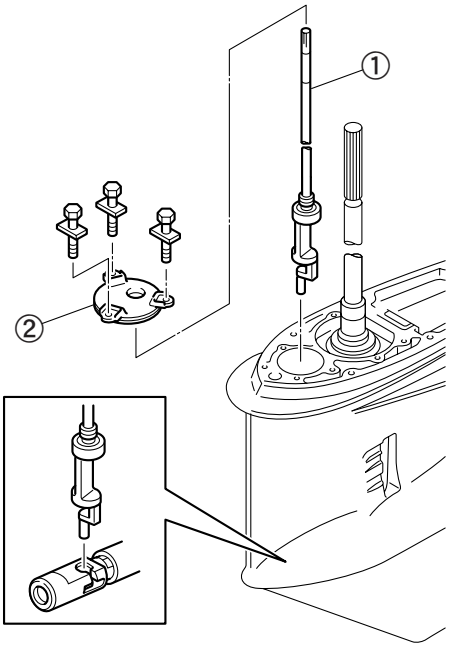


No.	Part name	Q'ty	Remarks
18	Cover	1	
19	Seal	1	
20	O-ring	1	**Not reusable**
21	Insert cartridge	1	
22	O-ring	1	**Not reusable**
23	Collar	1	
24	Spacer	1	
25	Washer	2	
26	Wave washer	1	

Removing the water pump and shift rod

See “Removing the water pump and shift rod” (8-6) step 1–step 4.

1. Remove the oil seal housing ① and shift rod assembly ②.



Disassembling the water pump housing

See “Disassembling the water pump housing” (8-6).

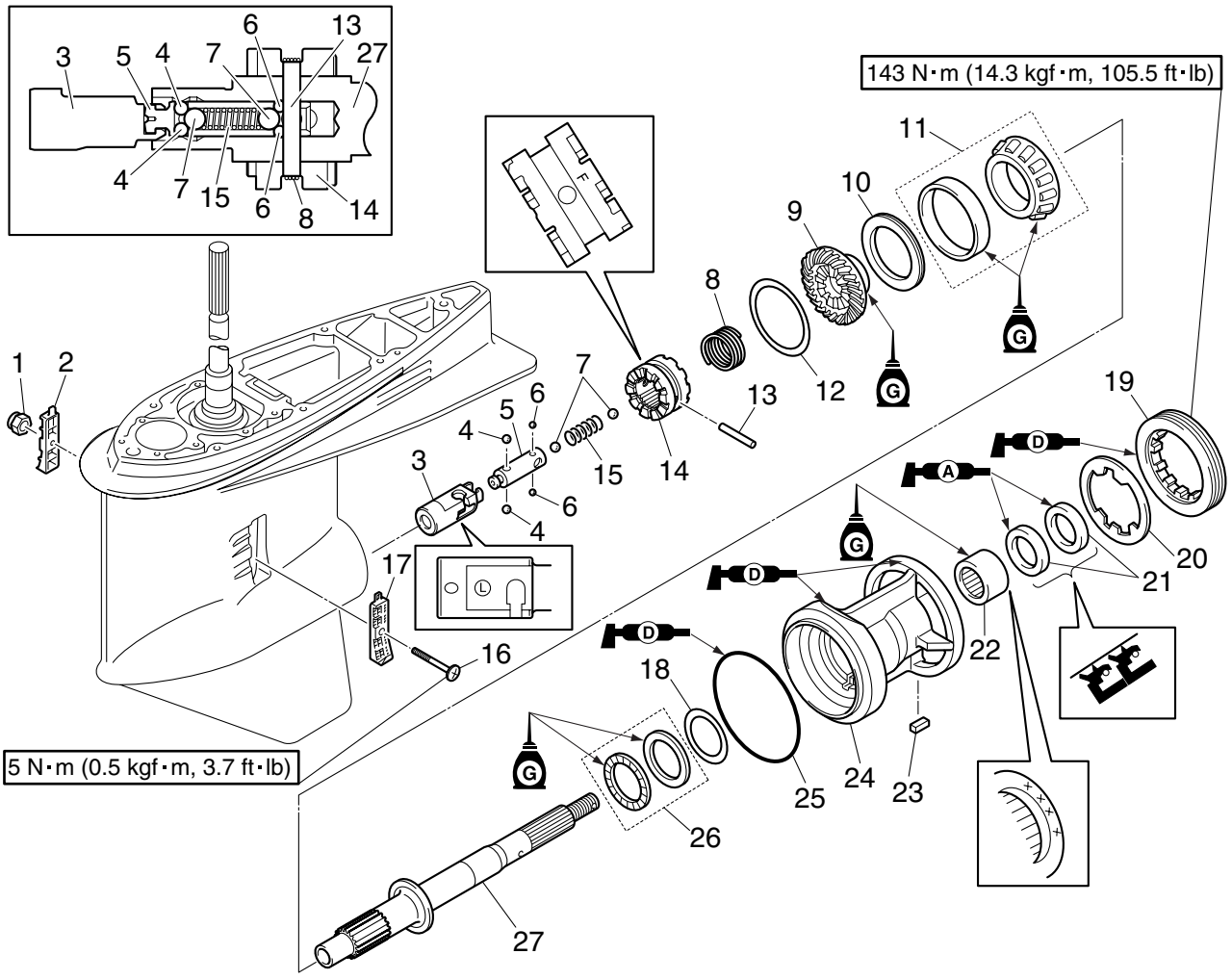
Checking the water pump and shift rod

See “Checking the water pump and shift rod” (8-7).

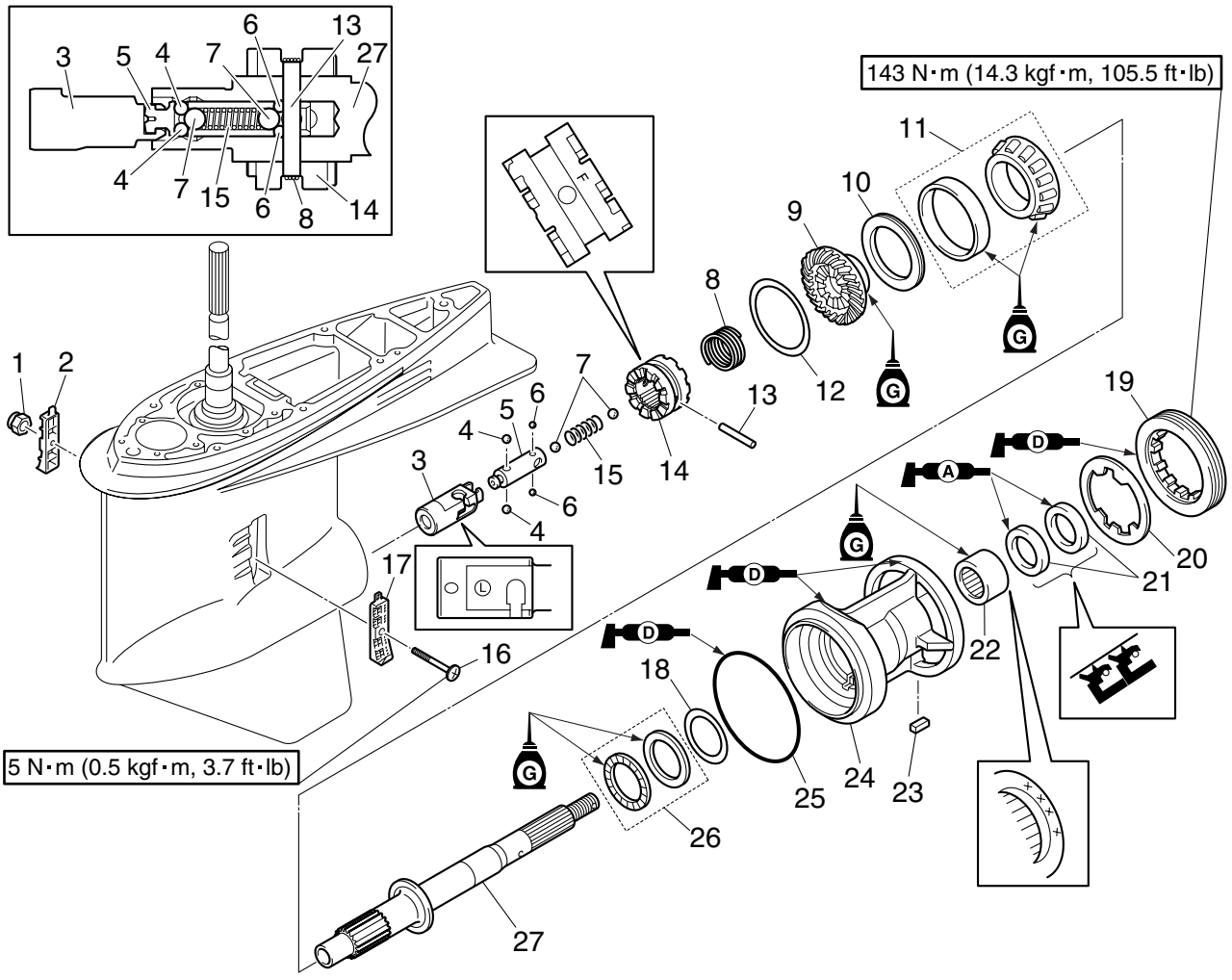
Assembling the water pump housing

See “Assembling the water pump housing” (8-7).

Propeller shaft housing (counter rotation model)



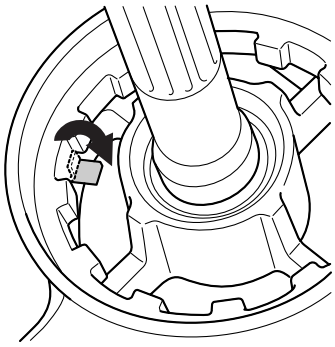
No.	Part name	Q'ty	Remarks
1	Self-locking nut	1	
2	Water inlet cover (STBD)	1	
3	Shift rod joint	1	
4	Ball	2	
5	Shift slider	1	
6	Ball	2	
7	Ball	2	
8	Spring	1	
9	Forward gear	1	
10	Thrust washer	1	
11	Taper roller bearing	1	**Not reusable**
12	Shim (T2)	—	
13	Cross pin	1	
14	Dog clutch	1	
15	Spring	1	
16	Screw	1	M5 × 54 mm
17	Water inlet cover (PORT)	1	



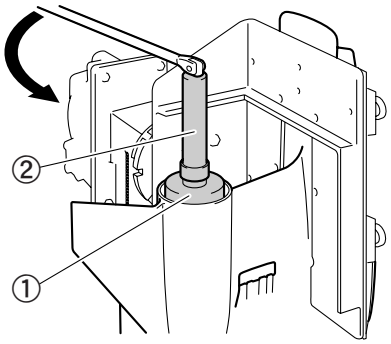
No.	Part name	Q'ty	Remarks
18	Shim (T4)	—	
19	Ring nut	1	
20	Claw washer	1	
21	Oil seal	2	**Not reusable**
22	Needle bearing	1	**Not reusable**
23	Key	1	
24	Propeller shaft housing	1	
25	O-ring	1	**Not reusable**
26	Thrust bearing	1	
27	Propeller shaft	1	

Removing the propeller shaft housing assembly

1. Fold one tooth of the claw washer that is bent toward the propeller.

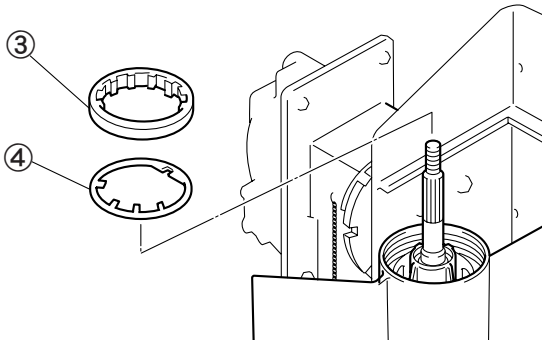


2. Loosen the ring nut.

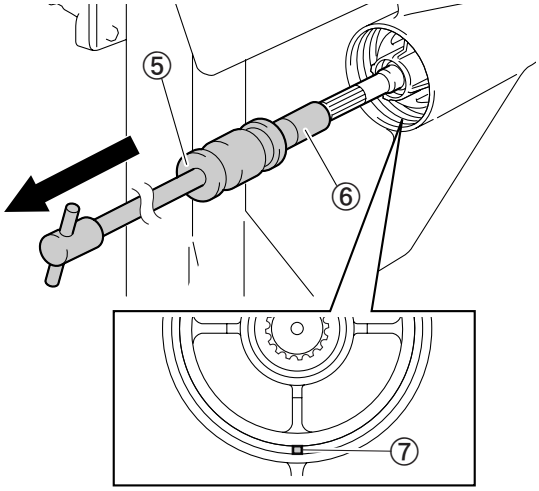


Ring nut wrench 4 ①: 90890-06512 Ring nut wrench extension ②: 90890-06513

3. Remove the ring nut ③ and claw washer ④.



4. Remove the propeller shaft housing assembly, and shim(s) (T2).



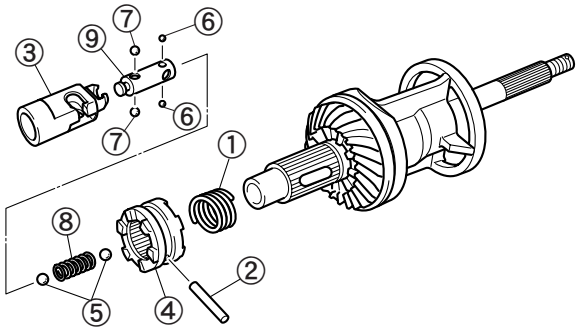
Slide hammer ⑤: 90890-06531 Puller head ⑥: 90890-06514

TIP:

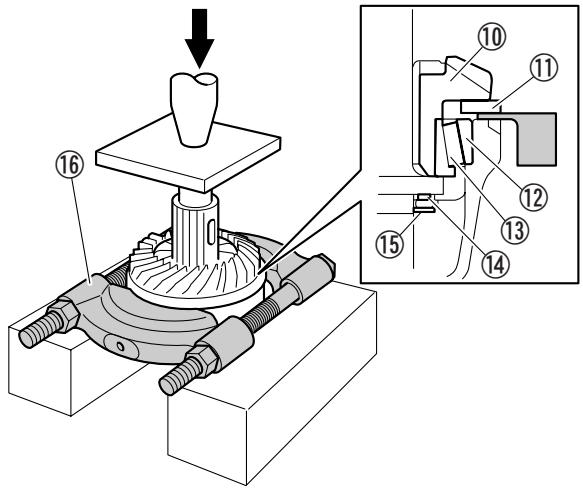
Be careful not to lose the key ⑦.

Disassembling the propeller shaft housing assembly

1. Remove the spring ①, and then remove the cross pin ②, shift rod joint ③, dog clutch ④, balls ⑤, ⑥, ⑦, spring ⑧, and shift slider ⑨.

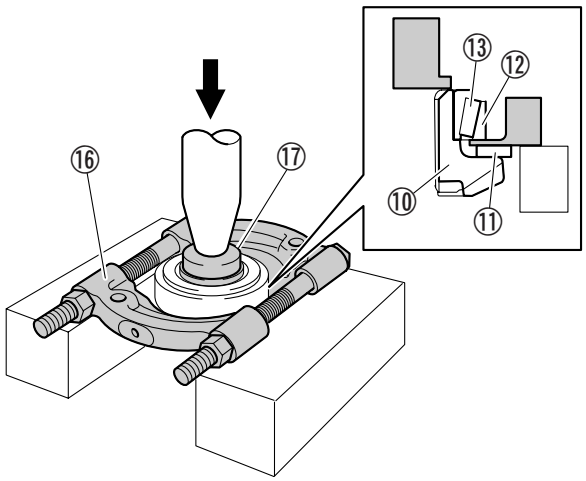


2. Remove the forward gear ⑩, thrust washer ⑪, bearing outer race ⑫, taper roller bearing ⑬, thrust bearing ⑭, and shim(s) (T4) ⑮.



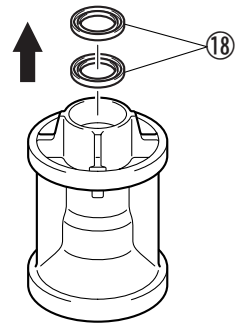
Bearing separator ⑯:
(commercially available)

3. Remove the outer race ⑫, the taper roller bearing ⑬, and the thrust washer ⑪ from the forward gear ⑩.

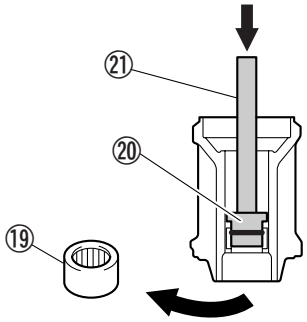


Bearing separator ⑯:
(commercially available)
Needle bearing attachment ⑰:
90890-06607

4. Remove the oil seals ⑱.



5. Remove the needle bearing ⑲.



Needle bearing attachment ⑳:
90890-06653
Driver rod L3 ㉑: 90890-06652

Checking the propeller shaft housing

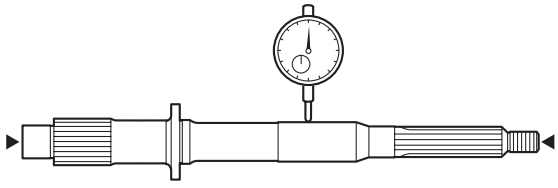
1. Check the propeller shaft housing. Replace if cracked or damaged.

2. Check the forward gear. Replace if cracked or worn.

Checking the propeller shaft

1. Check the propeller shaft. Replace if cracked or damaged.

2. Measure the propeller shaft runout. Replace if above specification.



Propeller shaft runout limit: 0.02 mm (0.008 in)

3. Check the dog clutch, shift rod joint, and slider. Replace if cracked or worn.

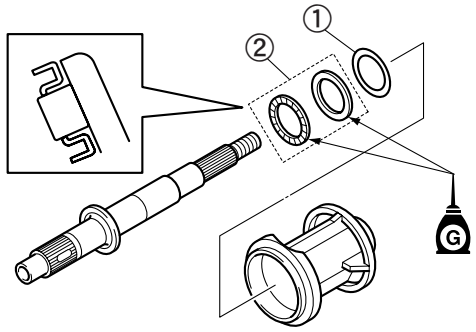
Assembling the propeller shaft housing assembly

NOTICE

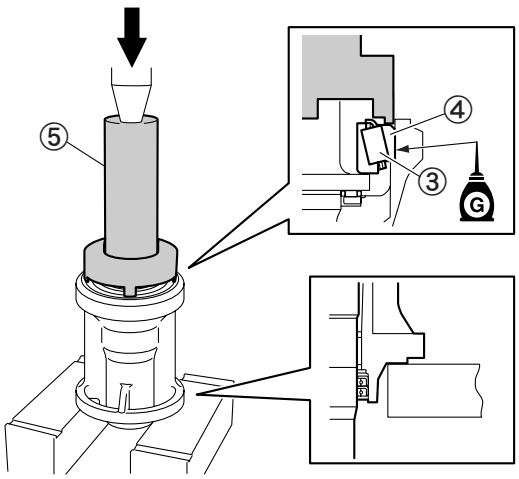
Do not reuse the bearing, always replace it with a new one.

1. Install the needle bearing and oil seals. See “Assembling the propeller shaft housing assembly” (8-12) step 1 and step 2.

2. Install the original shim(s) (T4) ① and thrust bearing ② with the propeller shaft.



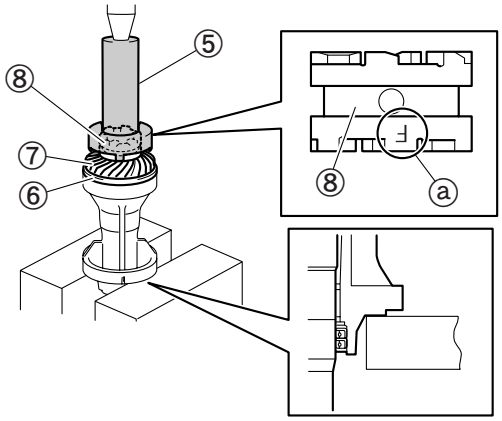
3. Install a new taper roller bearing ③ and the bearing outer race ④ into the propeller shaft housing.



Ring nut wrench ⑤: 90890-06578

4. After installing the taper roller bearing and bearing outer race, check that the propeller shaft rotates smoothly.

5. Install the thrust washer ⑥, forward gear ⑦, and dog clutch ⑧.



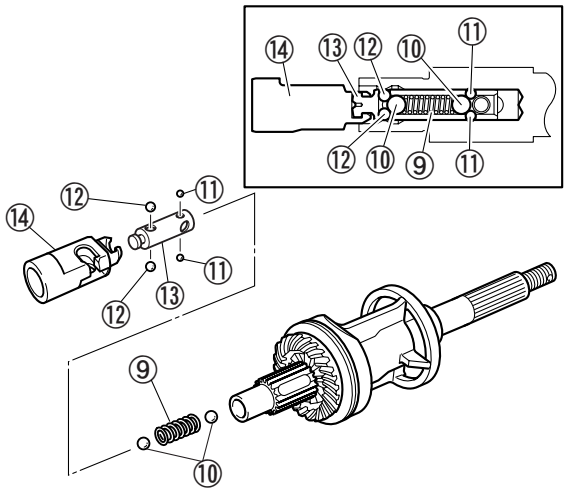
Ring nut wrench ⑤: 90890-06578

TIP:

Install the dog clutch ⑧ with the “F” mark ⓐ facing toward the forward gear.

6. After installing the forward gear, check that the propeller shaft and forward gear rotates smoothly.

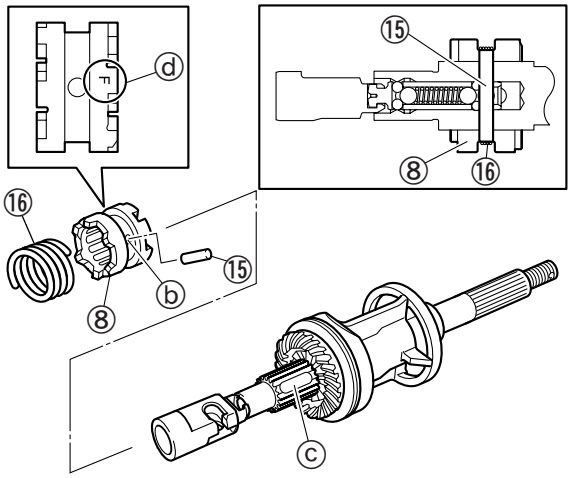
7. Install the spring ⑨, balls ⑩, ⑪, ⑫, shift slider ⑬, and shift rod joint ⑭.



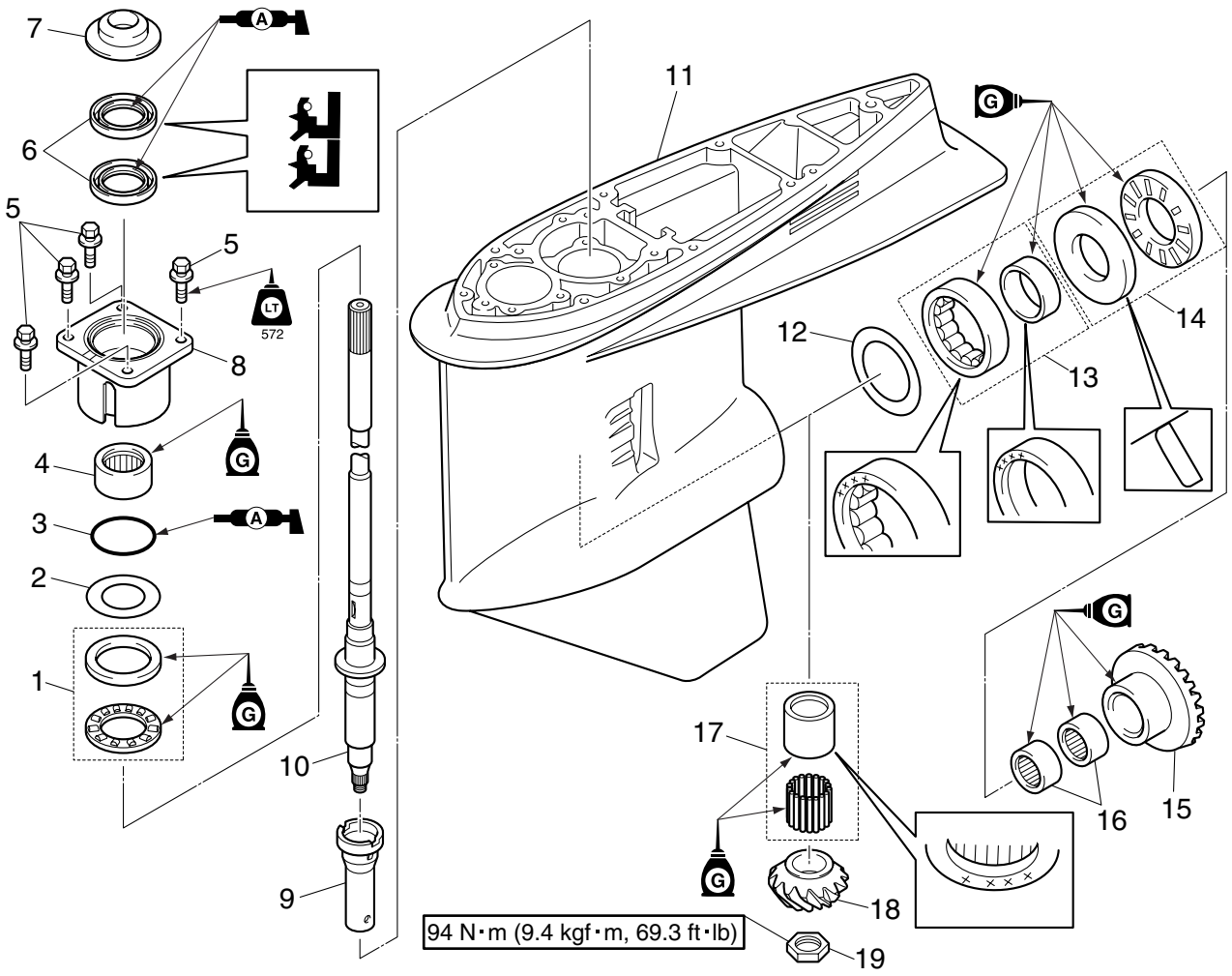
8. Align the hole ⓑ in the dog clutch ⑧ with the hole ⓒ in the propeller shaft.

TIP:
Install the dog clutch ⑧ with the "F" mark ⓓ facing toward the forward gear.

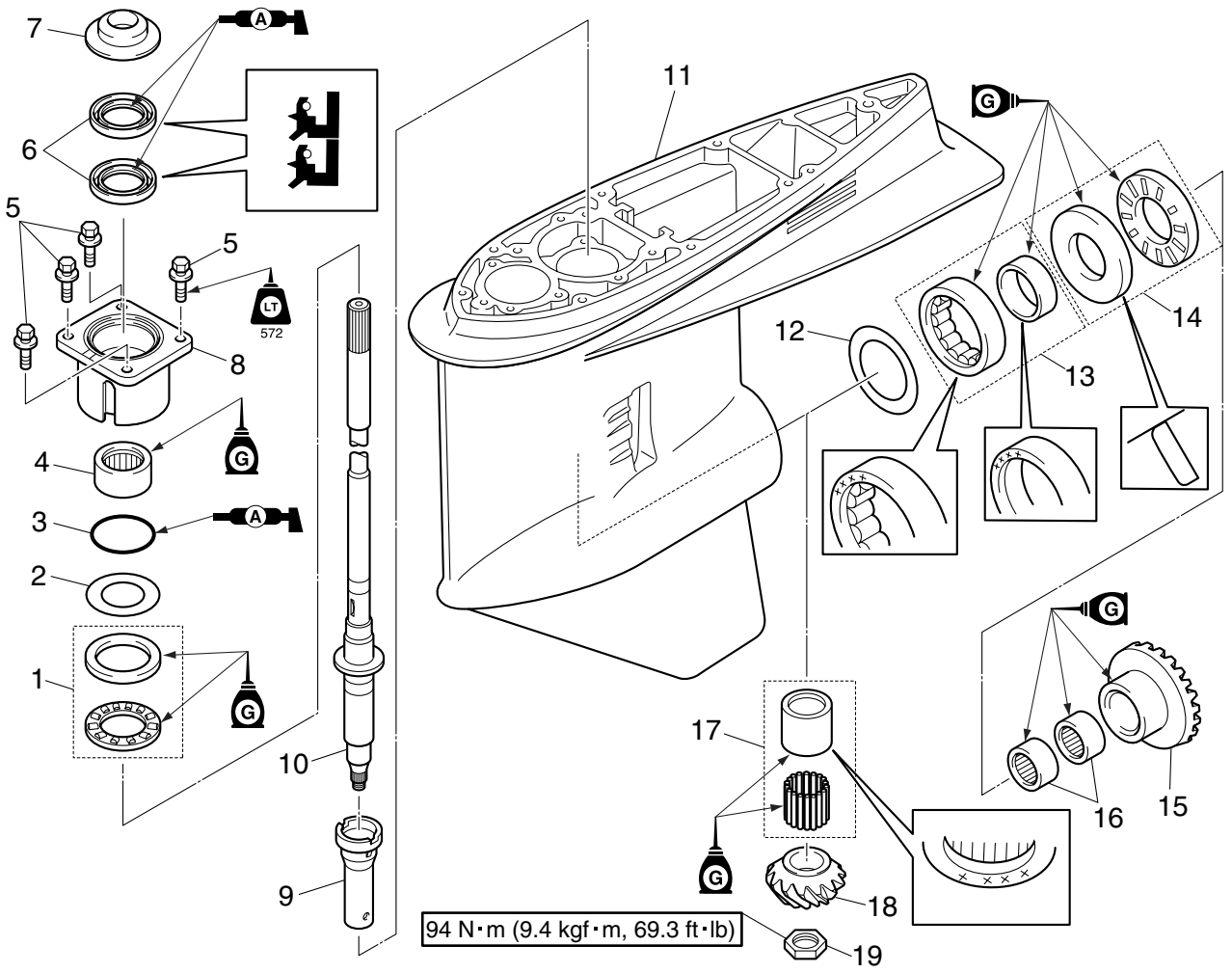
9. Install the cross pin ⑮, and then install the spring ⑯.



Drive shaft and lower case (counter rotation model)



No.	Part name	Q'ty	Remarks
1	Thrust bearing	1	
2	Shim (T3)	—	
3	O-ring	1	**Not reusable**
4	Needle bearing	1	**Not reusable**
5	Bolt	4	M8 × 25 mm
6	Oil seal	2	**Not reusable**
7	Cover	1	
8	Drive shaft housing	1	
9	Sleeve	1	
10	Drive shaft	1	
11	Lower case	1	
12	Shim (T1)	—	
13	Roller bearing	1	**Not reusable**
14	Thrust bearing	1	
15	Reverse gear	1	
16	Needle bearing	2	**Not reusable**
17	Needle bearing	1	**Not reusable**



No.	Part name	Q'ty	Remarks
18	Pinion	1	
19	Pinion nut	1	

Removing the drive shaft

See “Removing the drive shaft” (8-16) step 1 and step 2.

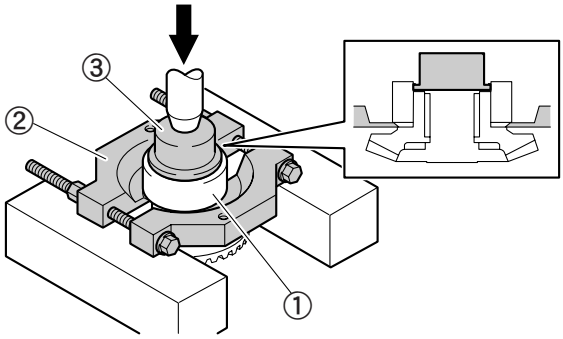
1. Pull out the reverse gear assembly.

Disassembling the drive shaft housing

See “Disassembling the drive shaft housing” (8-16).

Disassembling the reverse gear

1. Remove the roller bearing inner race ①.



Bearing separator ②: 90890-06534
Needle bearing attachment ③: 90890-06608

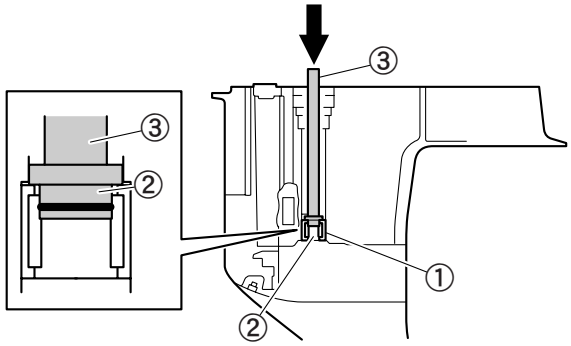
2. Remove the needle bearings from the reverse gear.

Disassembling the lower case

⚠ WARNING

- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the lower case in a well-ventilated area.**

1. Remove the water inlet covers.
2. Remove the needle bearing ①.

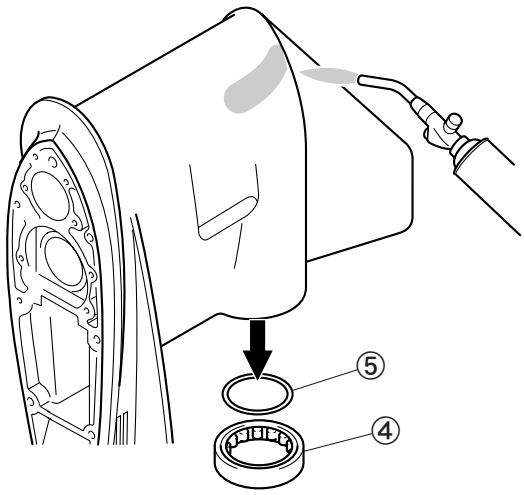


Ball bearing attachment ②: 90890-06636
Driver rod LL ③: 90890-06605

TIP:

Make sure to remove the reverse gear before removing the needle bearing.

3. Heat the installation area of the roller bearing in the lower case with a gas torch, and then remove the roller bearing ④ and shim(s) (T1) ⑤. ***NOTICE:*** **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.**



TIP:

- Before removing the roller bearing ④, place some cushioning material below the lower case to catch the outer race when it falls out.
- If the roller bearing does not come out, lightly tap the lower unit torpedo with a plastic hammer.

Checking the pinion and reverse gear

1. Check the pinion and reverse gear. Replace if cracked or worn.

Checking the drive shaft

See “Checking the drive shaft” (8-17).

Checking the lower case

1. Check the lower case. Replace if cracked or damaged.

Assembling the lower case

⚠ WARNING

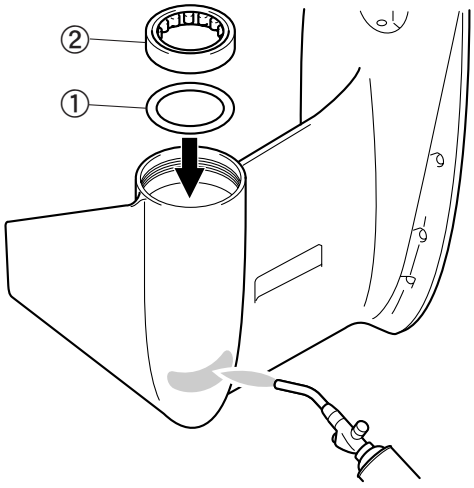
- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the lower case in a well-ventilated area.**

NOTICE

Do not reuse the bearing, always replace it with a new one.

1. Install the original shim(s) (T1) ①.

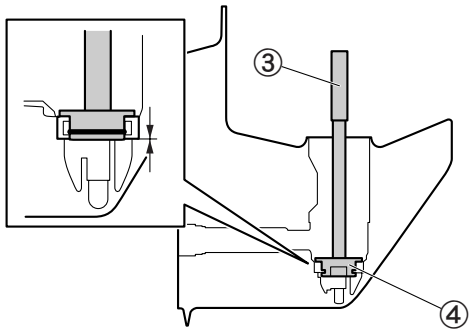
2. Heat the installation area of the roller bearing in the lower case with a gas torch, and then install the roller bearing ②. ***NOTICE:*** **When heating the lower case, heat the entire installation area evenly. Otherwise, the paint on the lower case could be burned.**



TIP:

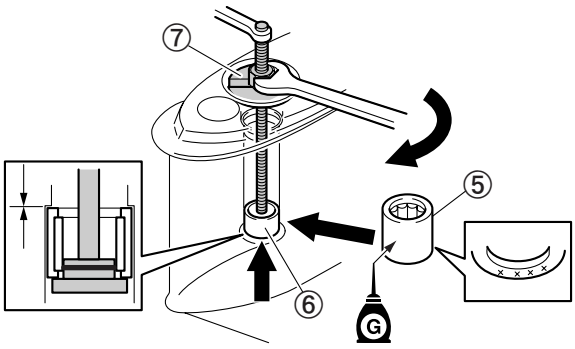
Do not reuse a shim if it is any deformed or scratched.

3. While holding the special service tool ③, strike the tool to check that the roller bearing is installed properly. If a high-pitched metallic sound is produced when the special service tool is struck, the outer race is installed properly.



Driver rod LL ③: 90890-06605
Ball bearing attachment ④:
90890-06629

4. Install the rollers into the needle bearing outer race, and install the special service tool into the needle bearing assembly ⑤, and then install the needle bearing assembly ⑤ into the lower case.



Ball bearing attachment ⑥: 90890-06633
Bearing outer race puller assembly ⑦:
90890-06523

TIP:

The needle bearing contains 18 rollers.

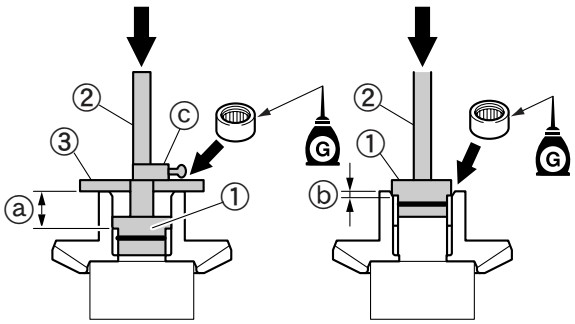
8

Assembling the reverse gear

NOTICE

Do not reuse the bearing, always replace it with a new one.

1. Install needle bearings into the reverse gear to the specified depth.



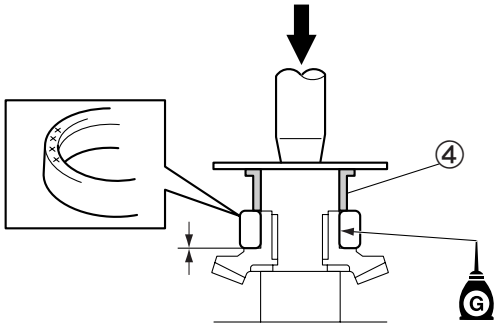
Needle bearing attachment ①:
90890-06612
Driver rod SS ②: 90890-06604
Bearing depth plate ③: 90890-06603

Depth ⓐ:
20.95–21.45 mm (0.825–0.844 in)
Depth ⓑ:
4.45–4.95 mm (0.175–0.195 in)

TIP:

When using the driver rod, do not strike the special service tool in a manner that will force the stopper ⓒ out of place.

2. Install the roller bearing inner race.



Bearing inner race attachment ④:
90890-06660

Assembling the drive shaft housing

See “Assembling the drive shaft housing” (8-63).

Installing the drive shaft

1. Install the reverse gear assembly into the lower case.

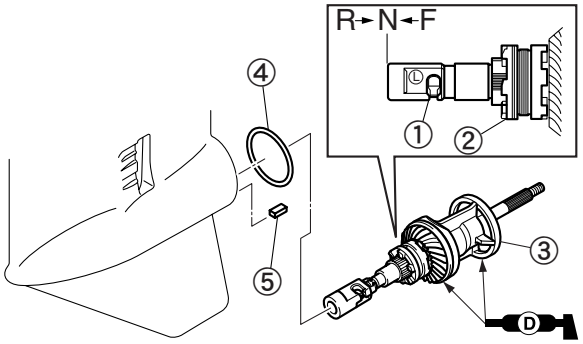
2. For installing the drive shaft, see “Installing the drive shaft” (8-20) step 2–step 6.

Installing the propeller shaft housing assembly

1. Set the shift rod joint ① and dog clutch ② to the N position.

2. Apply grease to a new O-ring and propeller shaft housing assembly ③.

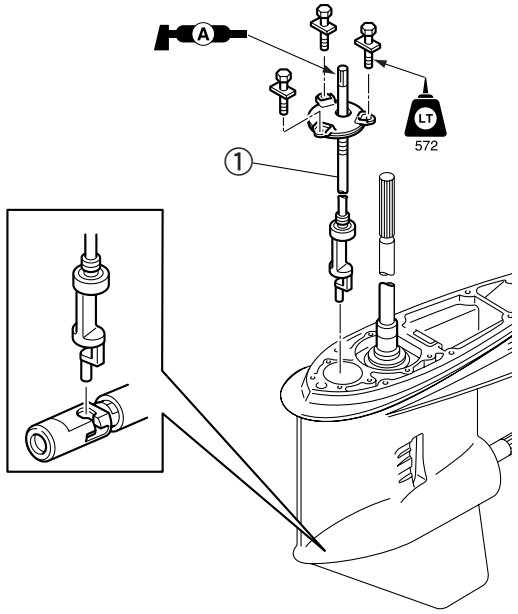
3. Install the original shim(s) (T2) ④, the propeller shaft housing assembly ③, and the key ⑤.



4. For installing the ring nut, see “Installing the propeller shaft housing assembly” (8-20) step 5–step 7.

Installing the shift rod

1. Make sure that the gear shift is in the N position, and then install the shift rod assembly ①.



2. Make sure that the drive shaft and the propeller shaft are moving properly when the gear is shifted into F position and into R position.

Installing the water pump

See “Installing the water pump” (8-22).

Checking the lower unit for air leakage

See “Checking the lower unit for air leakage” (8-22).

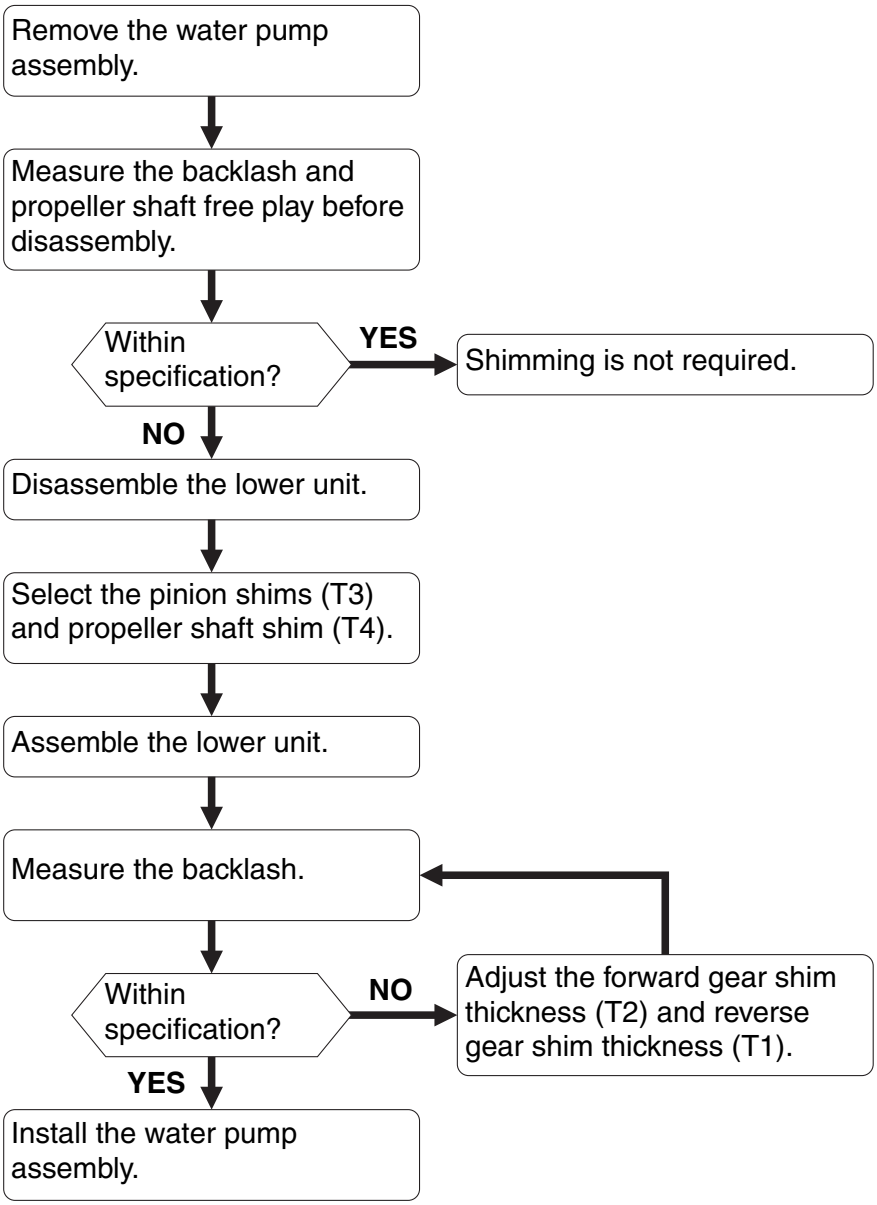
Installing the lower unit

See “Installing the lower unit” (8-23).

Recommended gear oil:
Hypoid gear oil
API: GL-4
SAE: 90
Gear oil quantity:
0.870 L (0.919 US qt, 0.765 Imp qt)

Shimming (counter rotation model)

Shimming workflow



TIP:

- Shimming is not required if the backlash is within specification.
- Shimming is required when assembling the original inner parts and a new lower case.
- Shimming is required when replacing the pinion, forward gear, reverse gear, bearings, shaft, and housing.

Shimming check sheet

Checking the external appearance

The deviation of the lower case dimension from standard.

Serial number	P	F	R	Remarks

Measuring the propeller shaft free play

(mm)

	Measurements		
Free play			

Measuring the pinion height

(mm)

	Measurements		
Measurement point ①			
Measurement point ②			
Measurement point ③			
Measurement point ④			
Average			
Truncated average (M)			

Measuring the forward gear backlash

(mm)

	Measurements					
	Before disassembly			After disassembly		
Measurement point ①						
Measurement point ②						
Measurement point ③						
Measurement point ④						
Average						
Truncated average (BL2)						

Measuring the reverse gear backlash

(mm)

	Measurements					
	Before disassembly			After disassembly		
Measurement point ①						
Measurement point ②						
Measurement point ③						
Measurement point ④						
Average						
Truncated average (BL1)						

Adjusting the forward gear shim thickness (T2)

Measure the thickness of each forward gear shim (T2) in 2 places.

(mm)

	Number of shim(s)			Subtotal
0.10				
0.12				
0.15				
0.18				
0.30				
0.40				
0.50				
Total				

Adjusting the reverse gear shim thickness (T1)

Measure the thickness of each reverse gear shim (T1) in 2 places.

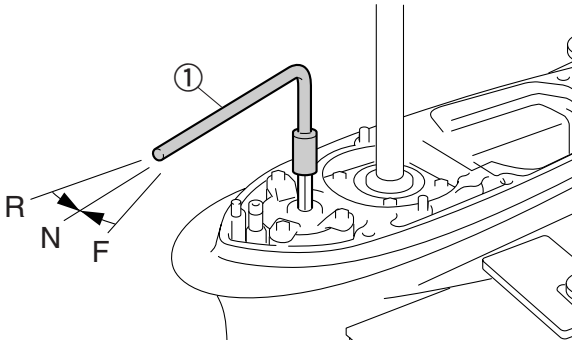
(mm)

	Number of shim(s)			Subtotal
0.10				
0.12				
0.15				
0.18				
0.30				
0.40				
0.50				
Total				

Measuring the forward and reverse gear backlash before disassembly

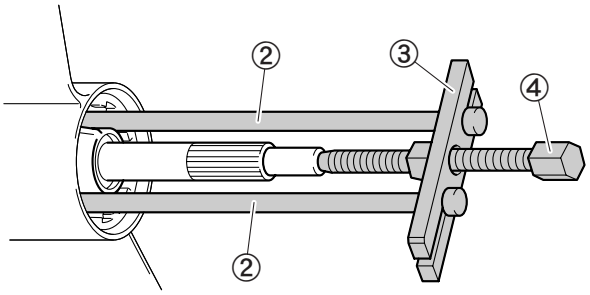
Two pieces of washers (90201-26M00) are required to measure the reverse gear backlash for the shim adjustment on the counter rotation model. Please prepare the washers before starting the shimming procedure.

1. Install the lower unit onto a repair stand.
2. Remove the water pump assembly. See “Removing the water pump and shift rod” (8-6).
3. Set the gear shift to the N position.



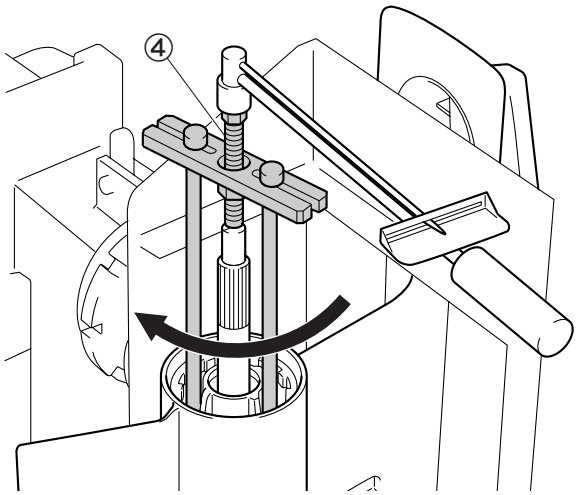
Shift rod push arm ①: 90890-06052

4. Install the special service tools, and then tighten the center bolt ④ temporarily.



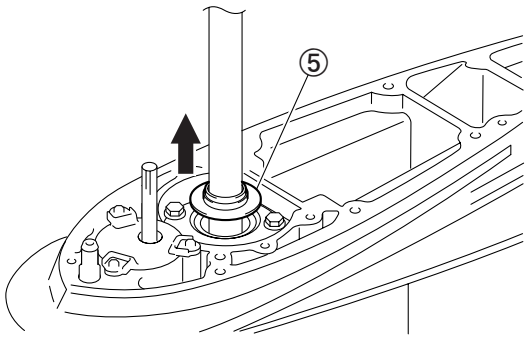
Bearing housing puller claw L ②: 90890-06502
Stopper guide plate ③: 90890-06501
Center bolt ④: 90890-06504

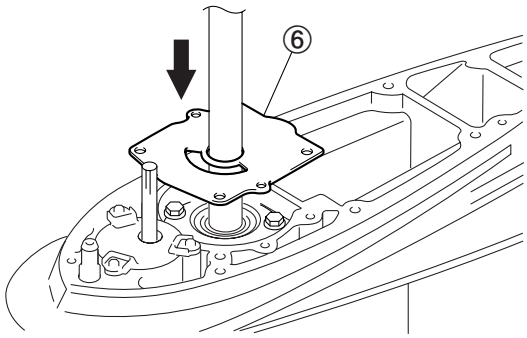
5. Turn the drive shaft 10 times or more to seat the taper roller bearing.
6. Tighten the center bolt ④ to the specified torque while holding the drive shaft not to turn.



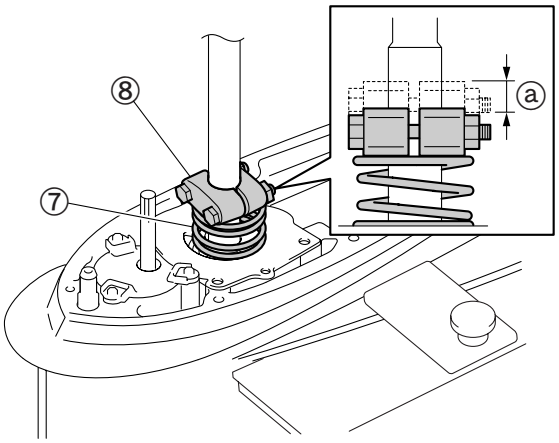
Center bolt ④:
20 N·m (2.0 kgf·m,14.8 ft·lb)

7. Turn the lower unit upright.
8. Remove the cover ⑤, and then install the outer plate cartridge ⑥.





9. Set the spring ⑦ on the outer plate cartridge, and then install the handle stopper ⑧ so that the spring is compressed approximately ⓐ from its free length.

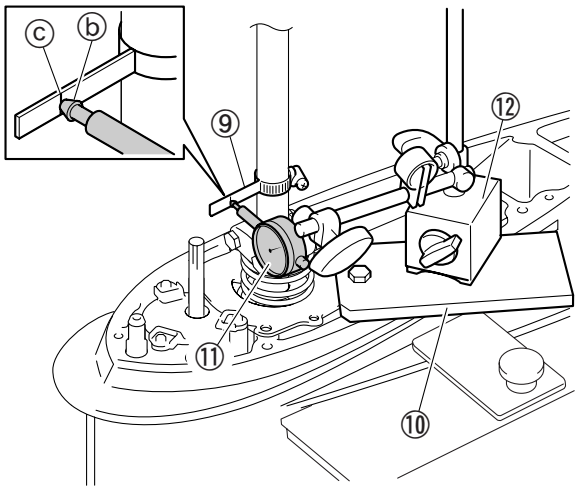


Spring ⑦: 90501-450A2
Handle stopper ⑧: EU0-23814-30

Setting height ⓐ:
3.0–5.0 mm (0.118–0.197 in)

TIP:
- After installing the handle stopper, pull the drive shaft upward to confirm that there is no free play.
- Do not press down the spring by more than 5.0 mm (0.197 in). Otherwise, excessive torque will be required to turn the drive shaft, making it difficult to obtain correct measurements.

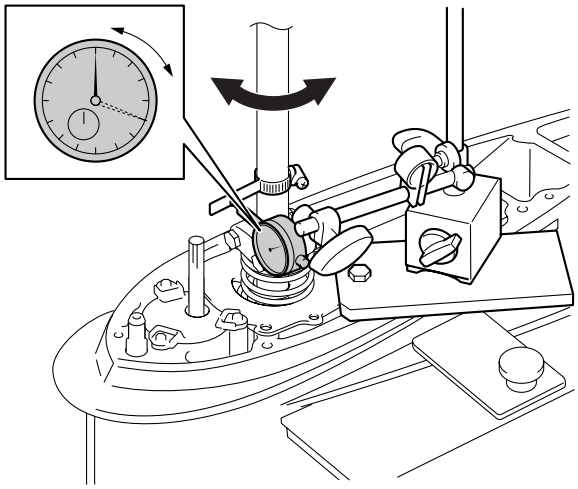
10. Install the special service tool ⑨ onto the drive shaft at the lowest possible position where the shaft diameter is 22.4 mm (0.882 in), and then set up the special service tool ⑪.



Backlash indicator ⑨: 90890-06706
Magnet base plate ⑩: 90890-07003
Dial gauge set ⑪: 90890-01252
Magnet base B ⑫: 90890-06844

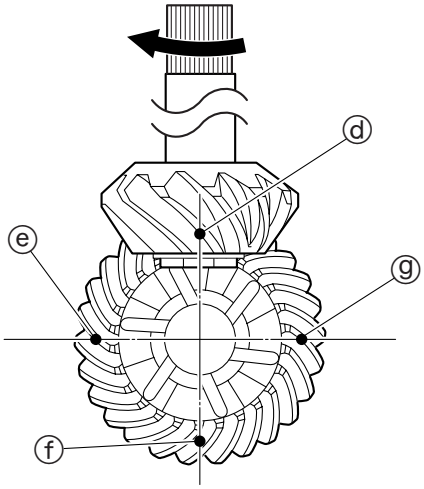
TIP:
Position the special service tool ⑪ so that the plunger tip ⓑ contacts the mark ⓒ on the special service tool ⑨.

11. Slowly turn the drive shaft clockwise and counterclockwise, and then measure the backlash at the position where it stops in each direction.



TIP:
- The resistance of the spring increases the force required to turn the drive shaft. Therefore, to obtain correct measurements, consider the spring resistance force when turning the drive shaft.
- Do not turn the drive shaft with excessive force, otherwise the forward gear will rotate, leading to incorrect measurements.

12. Turn the drive shaft 180° clockwise and measure the backlash again.



TIP:
- Measure the backlash at 4 points: ⓓ, ⓔ, ⓕ, and ⓖ, turning the drive shaft 180° clockwise after each measurement. Note the measurement data in the shimming check sheet.
- When turning the drive shaft, hold it with a little force. A knocking sound may be heard when the drive shaft is rotated, but this is the sound of the pinion contacting the reverse gear and does not affect the backlash measurement.

13. Determine the backlash average, and then truncate it by dropping the numbers after the 1/100 place without rounding.

Example:

(mm)

Measurement point ⓓ	0.24	0.23	0.22
Measurement point ⓔ	0.25	0.25	0.20
Measurement point ⓕ	0.27	0.21	0.20
Measurement point ⓖ	0.25	0.25	0.20
Average	0.2525	0.2350	0.2050
Truncated average (BL2)	0.25	0.23	0.20

14. Check that the forward gear backlash average is within specification.

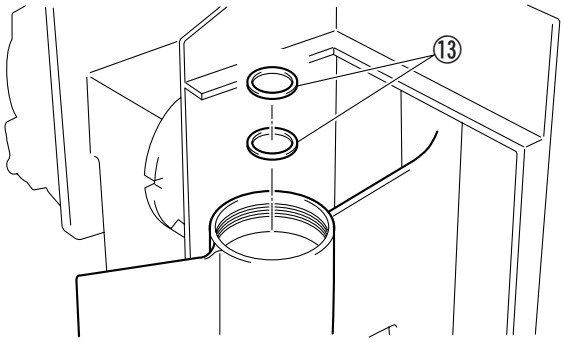
Forward gear backlash:
0.15–0.49 mm (0.0059–0.0193 in)

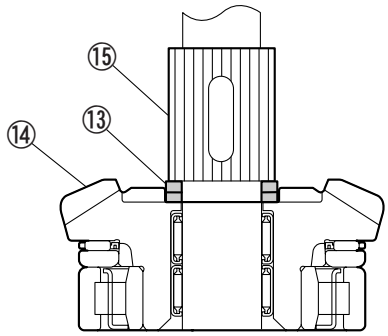
TIP:
Adjust the shim thicknesses if the forward gear backlash is out of specification.

15. Remove the special service tools from the propeller shaft.

16. Remove the propeller shaft housing assembly. See “Removing the propeller shaft housing assembly” (8-55).

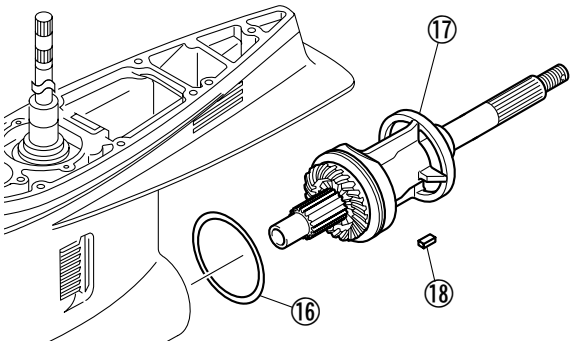
17. Install the washers ⑬ between the reverse gear ⑭ and the propeller shaft ⑮.





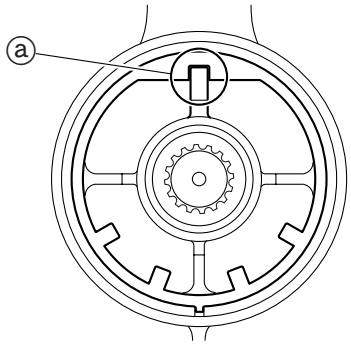
Washer ⑬: 90201-26M00

18. Install the original shim(s) (T2) ⑯, propeller shaft housing assembly ⑰, and key ⑱.

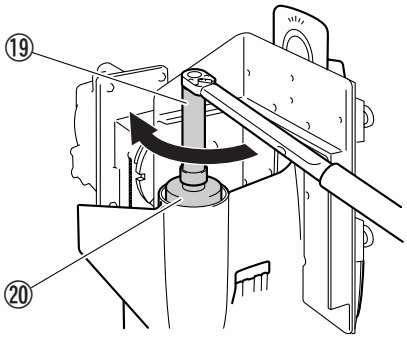


TIP:
- If the original shim(s) (T2) are missing, install new shim(s) (T2) with a combined thickness of 0.52 mm.
- Do not reuse a shim if it is any deformed or scratched.

19. Install the claw washer. Check that the position ⓐ is set in place properly.



20. Install the ring nut, and then tighten the ring nut to the specified torque.



Ring nut wrench extension ⑯:
90890-06513
Ring nut wrench 4 ⑰: 90890-06512

Ring nut (shimming):
70 N·m (7.0 kgf·m, 51.6 ft·lb)

21. For measuring reverse gear backlash proceed the step 11–step 13 again.

22. Check that the backlash average is within specification.

Reverse gear backlash:
0.24–0.65 mm (0.0094–0.0256 in)

TIP:
Adjust the shim thicknesses if the reverse gear backlash is out of specification.

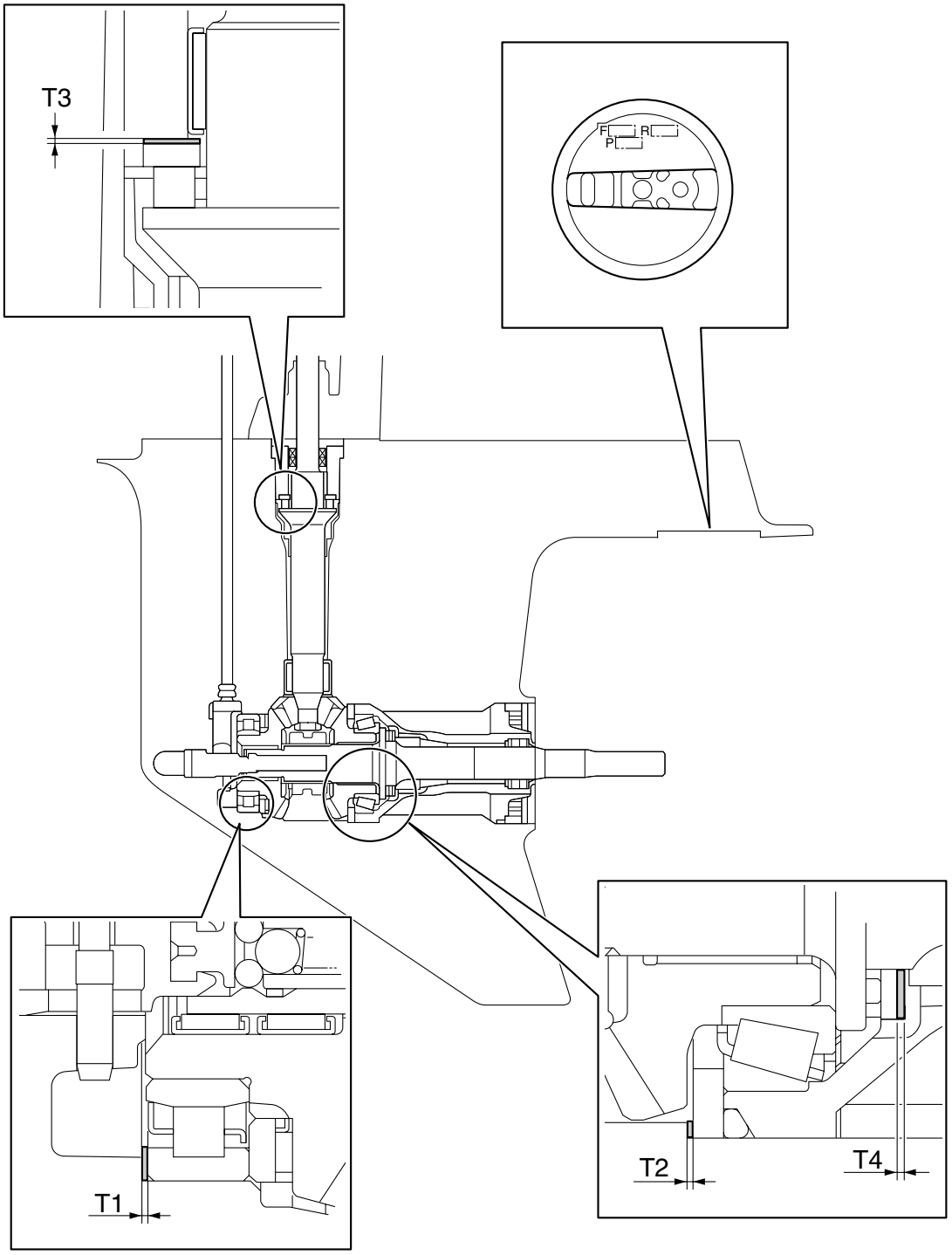
23. Remove the propeller shaft housing assembly, and then remove the washers ⑬.

24. Install the water pump assembly.

Shimming

- Make sure to select the pinion shim(s) (T3) and propeller shaft shim(s) (T4) before selecting the forward gear shim(s) (T2) and reverse gear shim(s) (T1).
- When assembling the lower unit to measure the backlash after selecting the pinion shim(s) (T3), do not apply gear oil, grease, or sealant to the parts.
- When assembling the lower unit after shimming is completed, make sure to apply gear oil, grease, and sealant to the specified areas.

Shim location



Selecting the pinion shim (T3)
See “Selecting the pinion shim (T3)” (8-33).

Pinion shim (T3) selection table
See “Pinion shim (T3) selection table” (8-36).

Selecting the propeller shaft shim (T4)

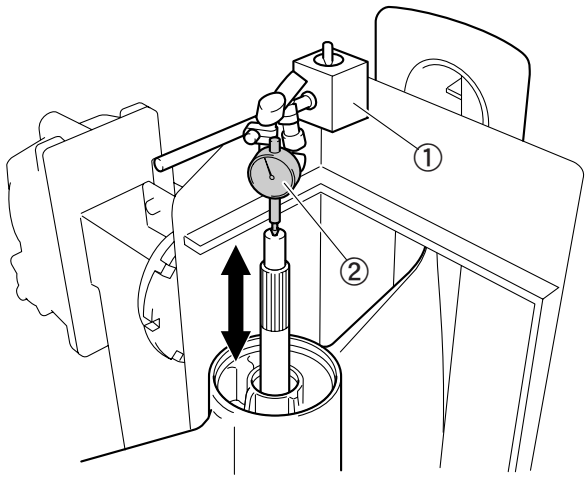
⚠ WARNING

- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the propeller shaft housing in a well-ventilated area.**

1. Install the original shim(s) (T4), and then measure the free play.

TIP:
If the original shim(s) (T4) cannot be identified, measure the free play without any shim(s).

2. When the measurement is out of the specification, select the shim(s) (T4) using “Propeller shaft shim (T4) selection table” (8-75).



Magnet base B ①: 90890-06844
Dial gauge set ②: 90890-01252

Propeller shaft free play:
0.25–0.35 mm (0.0098–0.0138 in)

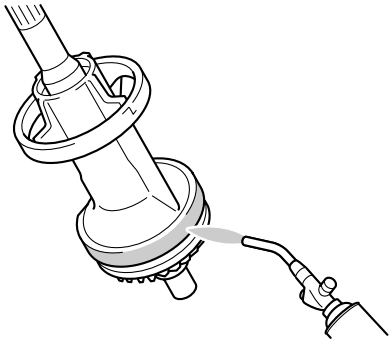
Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

TIP:
No shim (T4) adjustment is required if the measurement falls within specification.

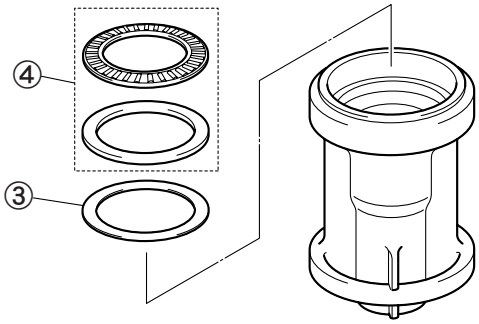
Example:
When the measurement is 0.72 mm, the need for increasing or decreasing the shim is 0.40 mm. This means 0.40 mm thickness must be added to the present shim thickness.

3. Remove the O-ring from the propeller shaft housing.

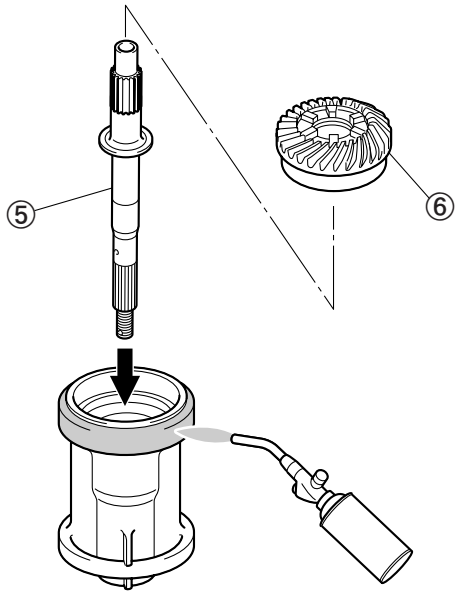
4. Heat the installation area of the taper roller bearing outer race in the propeller shaft housing with a gas torch, and then disassemble the propeller shaft housing assembly. ***NOTICE:*** **When heating the propeller shaft housing, heat the entire installation area evenly. Otherwise, the propeller shaft housing could be damaged.**



5. Install the shim(s) (T4) ③ selected in step 2 and the thrust bearing ④.



6. Heat the installation area of the taper roller bearing outer race in the propeller shaft housing with a gas torch, and then install the propeller shaft ⑤ and forward gear assembly ⑥. ***NOTICE:*** **When heating the propeller shaft housing, heat the entire installation area evenly. Otherwise, the propeller shaft housing could be damaged.**



7. Measure the free play again, to make sure that the free play falls within specification.

TIP:

If the free play is outside of the specified range, it is suspected that the forward gear taper roller bearing may not be installed properly in the propeller shaft housing.

Propeller shaft shim (T4) selection table

(*1) Shim adjustment is unnecessary where is no number.

(mm)

A	0.00	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.16
B	–0.28	–0.25	–0.25	–0.22	–0.20	–0.18	–0.15	–0.15	–0.12

A	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.34
B	–0.10	–0.10	–0.10	–0.10	–0.10	(*1)	(*1)	(*1)	(*1)

A	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52
B	0.10	0.10	0.10	0.10	0.12	0.15	0.15	0.18	0.20

A	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
B	0.22	0.25	0.25	0.28	0.30	0.32	0.35	0.35	0.38

A	0.72	0.74	0.76	0.78	0.80	0.82	0.84	0.86	0.88
B	0.40	0.42	0.45	0.45	0.48	0.50	0.52	0.55	0.55

A	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06
B	0.58	0.60	0.62	0.65	0.65	0.68	0.72	0.72	0.75

A	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24
B	0.75	0.78	0.80	0.82	0.85	0.85	0.88	0.90	0.92

A	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.40	1.42
B	0.95	0.95	0.98	1.00	1.02	1.05	1.05	1.08	1.10

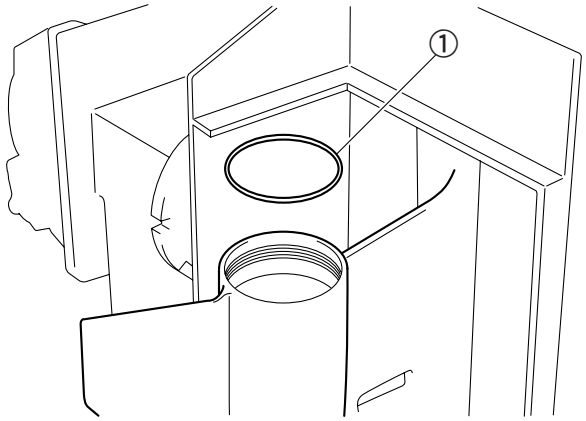
A	1.44	1.46	1.48	1.50	1.52
B	1.12	1.15	1.15	1.18	1.20

A Free play measurement
B Increasing or decreasing of shim thickness

Measuring the forward gear backlash

- Spray anti-rust lubricant on the gear and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.
- When measuring the forward gear or reverse gear backlash, use the original bearings and shims.

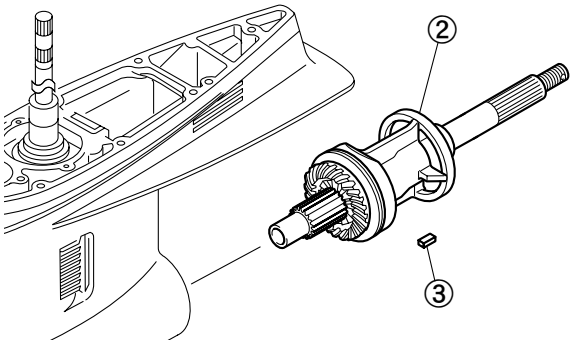
1. Install the original shim(s) (T2) ①.



TIP:

- If the original shim(s) (T2) are missing, install new shim(s) (T2) with a combined thickness of 0.52 mm.
- Do not reuse a shim if it is any deformed or scratched.

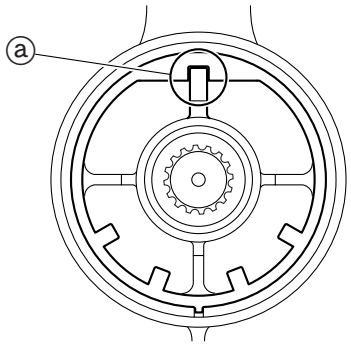
2. Install the propeller shaft housing assembly ②, and key ③.



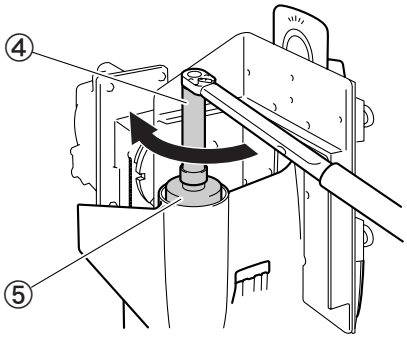
TIP:

When assembling the lower unit to measure the backlash, do not install the dog clutch and O-ring.

3. Install the claw washer. Check that the position ⓐ is set in place properly.



4. Install the ring nut, and then tighten the ring nut to the specified torque.



Ring nut wrench extension ④: 90890-06513 Ring nut wrench 4 ⑤: 90890-06512

Ring nut: 143 N·m (14.3 kgf·m, 105.5 ft·lb)

5. Check that the drive shaft rotates smoothly. If the drive shaft does not rotate smoothly, the shim(s) may be installed incorrectly or there may be foreign material on the shim(s).

6. Measure the forward gear backlash. See "Measuring the forward and reverse gear backlash before disassembly" (8-68).

Forward gear backlash: 0.15–0.49 mm (0.0059–0.0193 in)

Adjusting the forward gear shim thickness (T2)

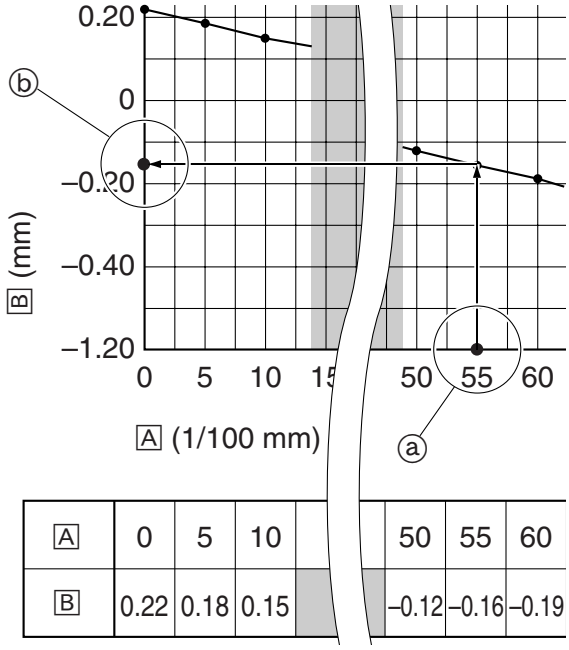
1. Remove the propeller shaft housing assembly and shim(s) (T2). See "Removing the propeller shaft housing assembly" (8-55).

2. Measure the thickness of each original shim(s) (T2) in 2 places.

TIP:
Do not reuse a shim if it is deformed or scratched.

3. Determine the forward gear shim thickness (T2) adjustment in the "Forward gear shim (T2) selection chart" according to the truncated average (BL2) from "Measuring the forward gear backlash."

Example:
(BL2) = 0.55 mm ⓐ
(T2) adjustment = –0.16 mm ⓑ from the "Forward gear shim (T2) selection chart."
The current shim thickness must be decreased by 0.16 mm.



A	0	5	10			50	55	60
B	0.22	0.18	0.15			–0.12	–0.16	–0.19

A Backlash measurement (BL2)
B Shim thickness adjustment

TIP:
- If the shim thickness adjustment value is positive, the current shim thickness must be increased by that amount and, if the value is negative, the current shim thickness must be decreased by that amount.
- The gray-colored area on the selection chart indicates the range of the specified backlash. Shimming is not required if the measured backlash is within the gray-colored area.
- The values for the shim thickness adjustments specified in the selection chart are intended to achieve the median value within the range for the specified forward or reverse gear backlash.
- The selection chart table shows the shim thickness adjustments for marked points on the chart.

4. Calculate the new forward gear shim thickness (T2) as same way in the example.

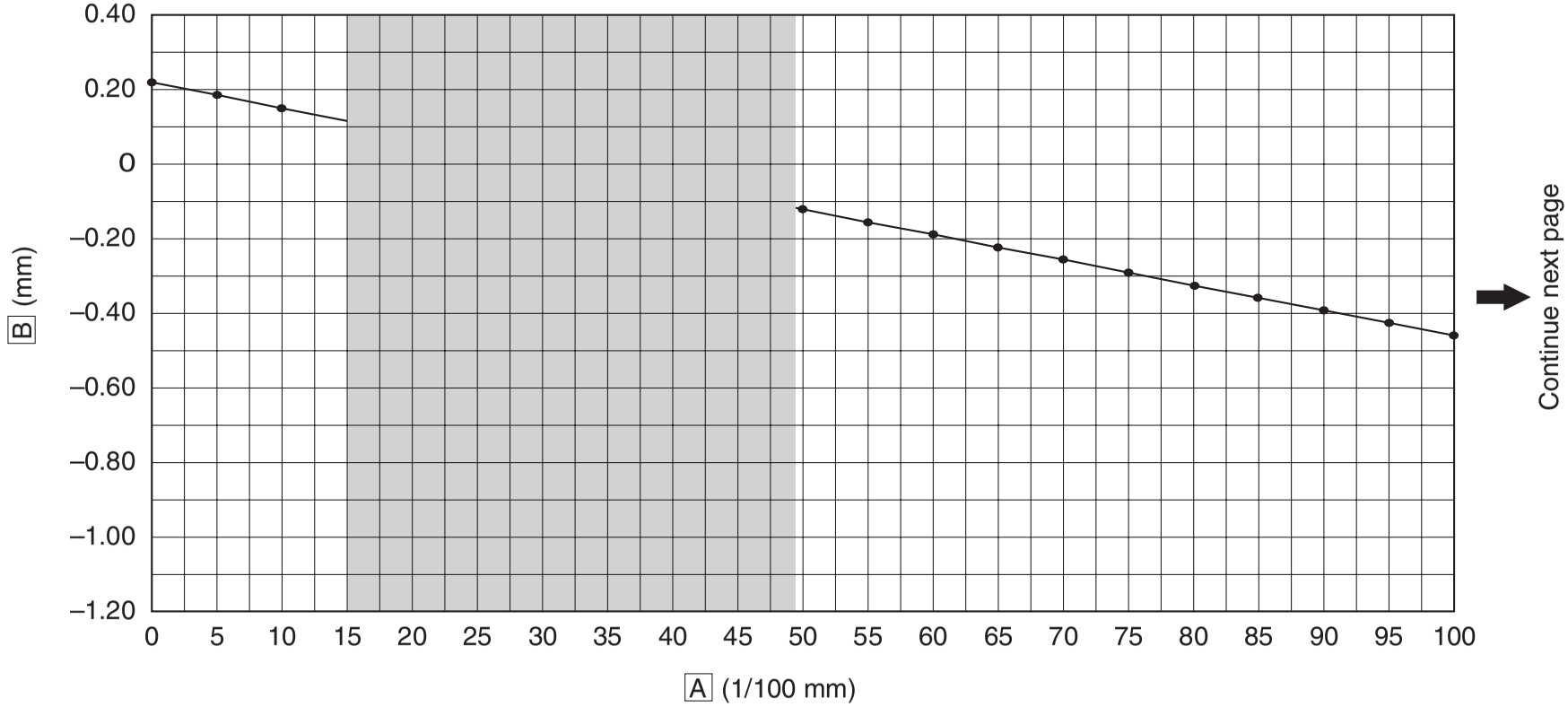
Calculation formula:
New forward gear shim thickness (T2) = Current forward gear shim thickness + Shim thickness adjustment
Example:
If the current forward gear shim thickness is 0.55 and the shim thickness adjustment is –0.20 mm, then
(T2) = 0.55 mm + (–0.20) mm
= 0.55 mm – 0.20 mm
= 0.35 mm

Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

TIP:
- Use the least number of shims to achieve the required shim thickness.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase the shim thickness by 0.01 mm.

5. Install the shim(s) (T2) and propeller shaft housing assembly.

Forward gear shim (T2) selection chart



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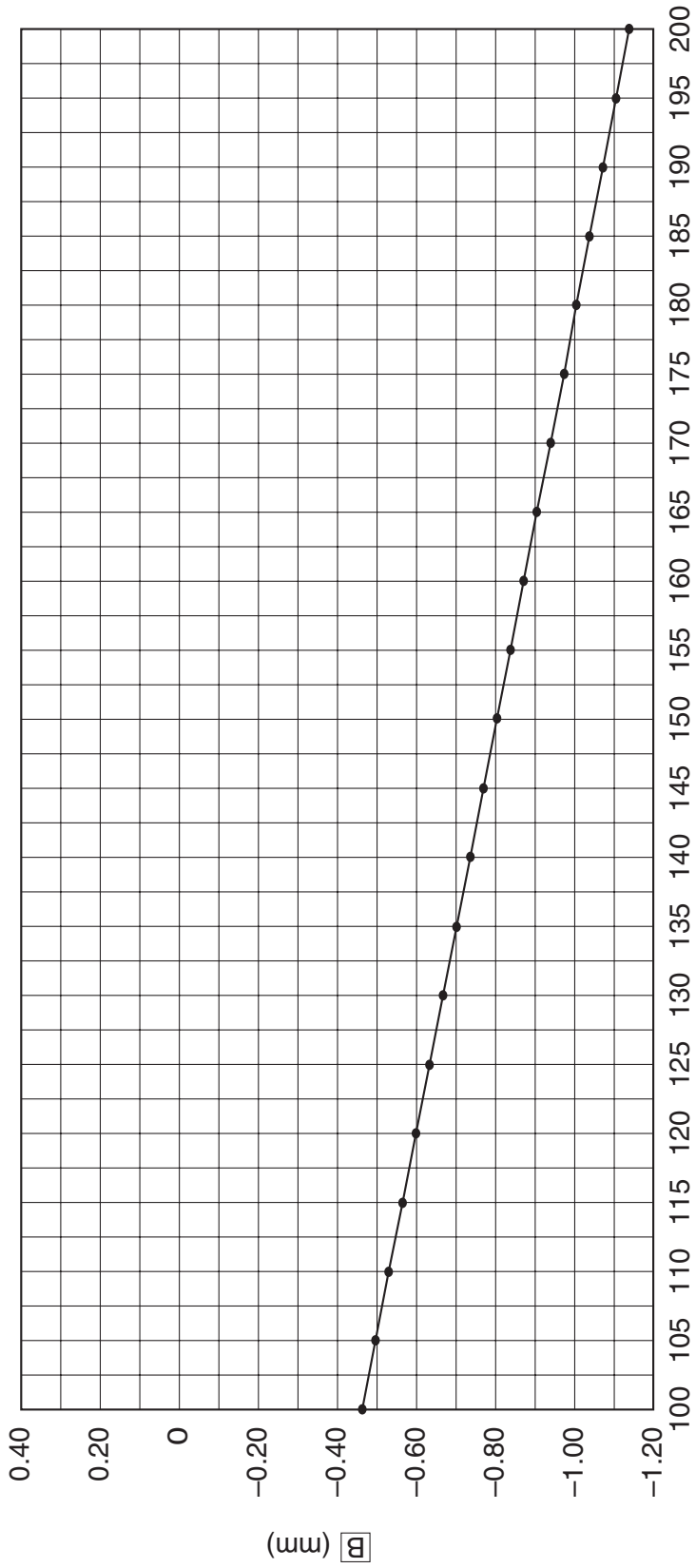
A	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
B	0.22	0.18	0.15								–0.12	–0.16	–0.19	–0.22	–0.26	–0.29	–0.33	–0.36	–0.39	–0.43	–0.46

A Backlash measurement (BL2)
B Increasing or decreasing of shim thickness



A	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200
B	–0.46	–0.49	–0.53	–0.56	–0.60	–0.63	–0.66	–0.70	–0.73	–0.76	–0.80	–0.83	–0.87	–0.90	–0.93	–0.97	–1.00	–1.04	–1.07	–1.10	–1.14

A Backlash measurement (BL2)
B Increasing or decreasing of shim thickness

Measuring the reverse gear backlash

- Spray anti-rust lubricant on the gear and bearings before installation. Do not apply gear oil to the parts. Otherwise, correct measurements cannot be obtained.
- Keep the parts free of foreign material, such as dirt and lint.
- When measuring the forward gear or reverse gear backlash, use the original bearings and shims.

⚠ WARNING

- **Use heat-resistant gloves, otherwise burns could result.**
- **Remove any flammable substances, such as gasoline and oil, around the working area to avoid the risk of fire.**
- **Heat the lower case in a well-ventilated area.**

1. Install the original shim(s) (T1).

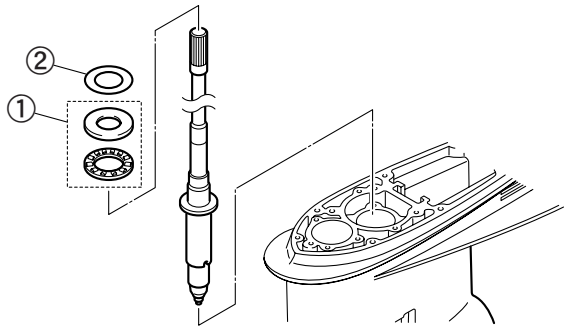
TIP:

- If the original shim(s) (T1) are missing, install new shim(s) (T1) with a combined thickness of 1.00 mm.
- Do not reuse a shim if it is any deformed or scratched.

2. Install the roller bearing. See "Assembling the lower case" (8-62) step 2 and step 3.

3. Install the thrust bearing and the reverse gear into the lower case.

4. Install the drive shaft, thrust bearing ①, and shim(s) (T3) ② into the lower case.



TIP:

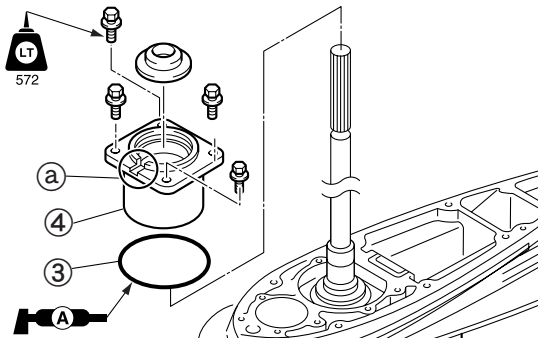
Turn the drive shaft 10 times or more to seat the thrust bearing.

5. Install the pinion and pinion nut, and then tighten the pinion nut temporarily.

TIP:

When installing the pinion, lift up the drive shaft slightly and align the pinion and shaft splines.

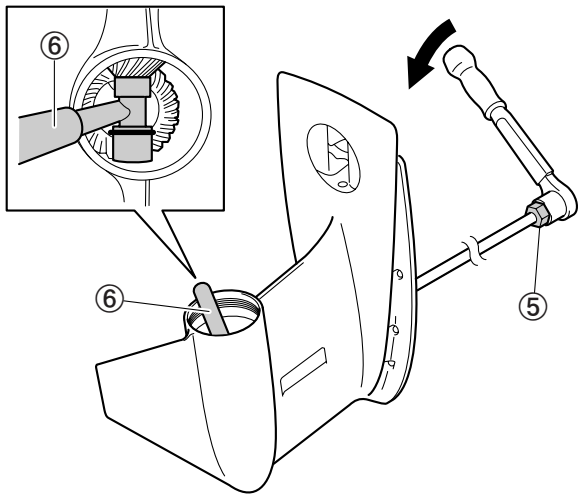
6. Install a new O-ring ③ to the drive shaft housing ④, and then install the drive shaft housing ④ into the lower case.



TIP:

Install the drive shaft housing with the cutout ⓐ in the housing facing forward.

7. Tighten the pinion nut to the specified torque.



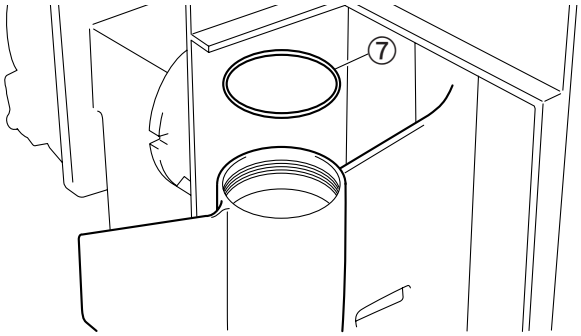
Drive shaft holder 6 ⑤: 90890-06520 Pinion nut holder ⑥: 90890-06715

Pinion nut: 94 N·m (9.4 kgf·m, 69.3 ft·lb)

8

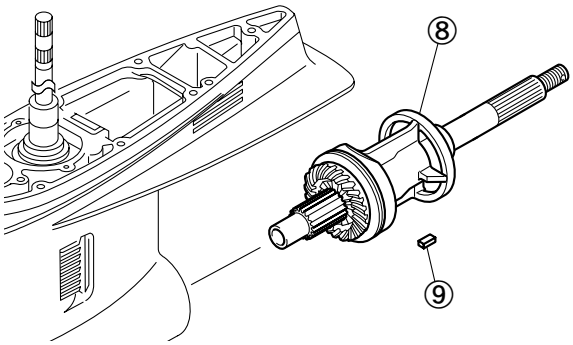
8. Check that the drive shaft rotates smoothly. If the drive shaft does not rotate smoothly, reduce the shim(s) (T1) thickness by 0.1 mm, and then check that the rotation of the shaft again.

9. Install the shim(s) (T2) ⑦ determined in "Adjusting the forward gear shim thickness (T2)" (8-76).



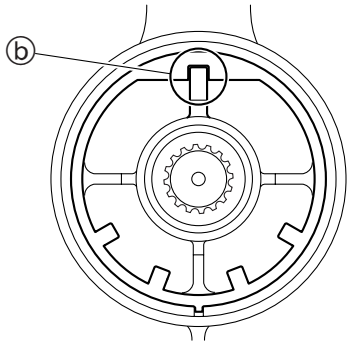
TIP:
Do not reuse a shim if it is any deformed or scratched.

10. Install the propeller shaft housing assembly ⑧, and key ⑨.

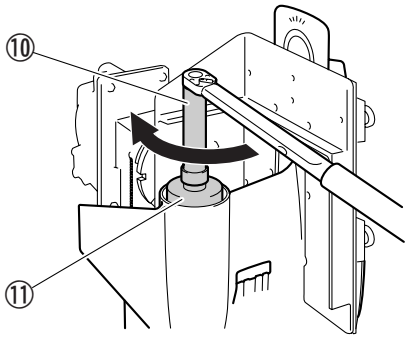


TIP:
When assembling the lower unit to measure the backlash, do not install the dog clutch and O-ring.

11. Install the claw washer. Check that the position ⓑ is set in place properly.



12. Install the ring nut, and then tighten the ring nut to the specified torque.



Ring nut wrench extension ⑩: 90890-06513 Ring nut wrench ⑪: 90890-06512

Pinion nut: 143 N·m (14.3 kgf·m, 105.5 ft·lb)

13. Check that the drive shaft rotates smoothly. If the drive shaft does not rotate smoothly, the shim(s) may be installed incorrectly or there may be foreign material on the shim(s).

14. Measure the reverse gear backlash. See "Measuring the forward and reverse gear backlash before disassembly" (8-68).

Reverse gear backlash: 0.24–0.65 mm (0.0094–0.0256 in)

Adjusting the reverse gear shim thickness (T1)

1. Remove the roller bearing. See "Disassembling the lower case" (8-61).

2. Measure the thickness of each original shim(s) (T1) in 2 places.

TIP:

Do not reuse a shim if it is deformed or scratched.

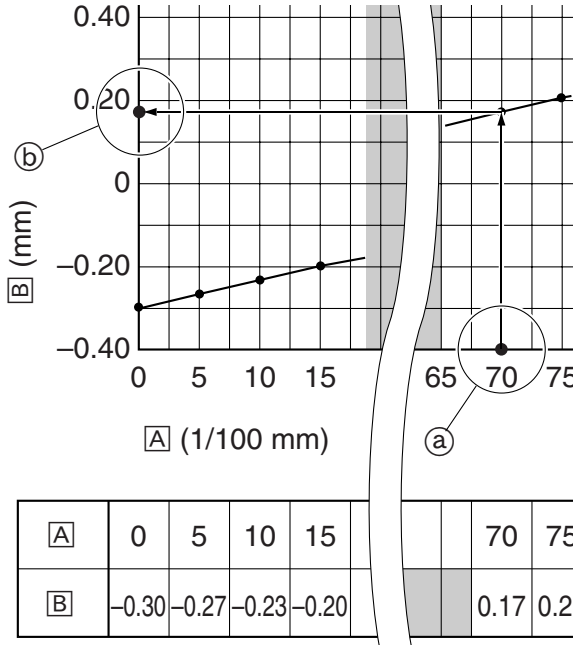
3. Determine the reverse gear shim thickness (T1) adjustment in the "Reverse gear shim (T1) selection chart" according to the truncated average (BL1) from "Measuring the reverse gear backlash."

Example:

(BL1) = 0.70 mm ⓐ

(T1) adjustment = 0.17 mm ⓑ from the "Reverse gear shim (T1) selection chart."

The current shim thickness must be increased by 0.17 mm.



A	0	5	10	15			70	75
B	–0.30	–0.27	–0.23	–0.20			0.17	0.2

A Backlash measurement (BL1)
B Shim thickness adjustment

TIP:

- If the shim thickness adjustment value is positive, the current shim thickness must be increased by that amount and, if the value is negative, the current shim thickness must be decreased by that amount.
- The gray-colored area on the selection chart indicates the range of the specified backlash. Shimming is not required if the measured backlash is within the gray-colored area.
- The values for the shim thickness adjustments specified in the selection chart are intended to achieve the median value within the range for the specified forward or reverse gear backlash.
- The selection chart table shows the shim thickness adjustments for marked points on the chart.

4. Calculate the new reverse gear shim thickness (T1) as same way in the example.

Calculation formula:

New reverse gear shim thickness (T1) = Current reverse gear shim thickness + Shim thickness adjustment

Example:

If the current reverse gear shim thickness is 1.00 mm and the shim thickness adjustment is –0.23 mm, then

(T1) = 1.00 mm + (–0.23) mm
= 1.00 mm – 0.23 mm
= 0.77 mm

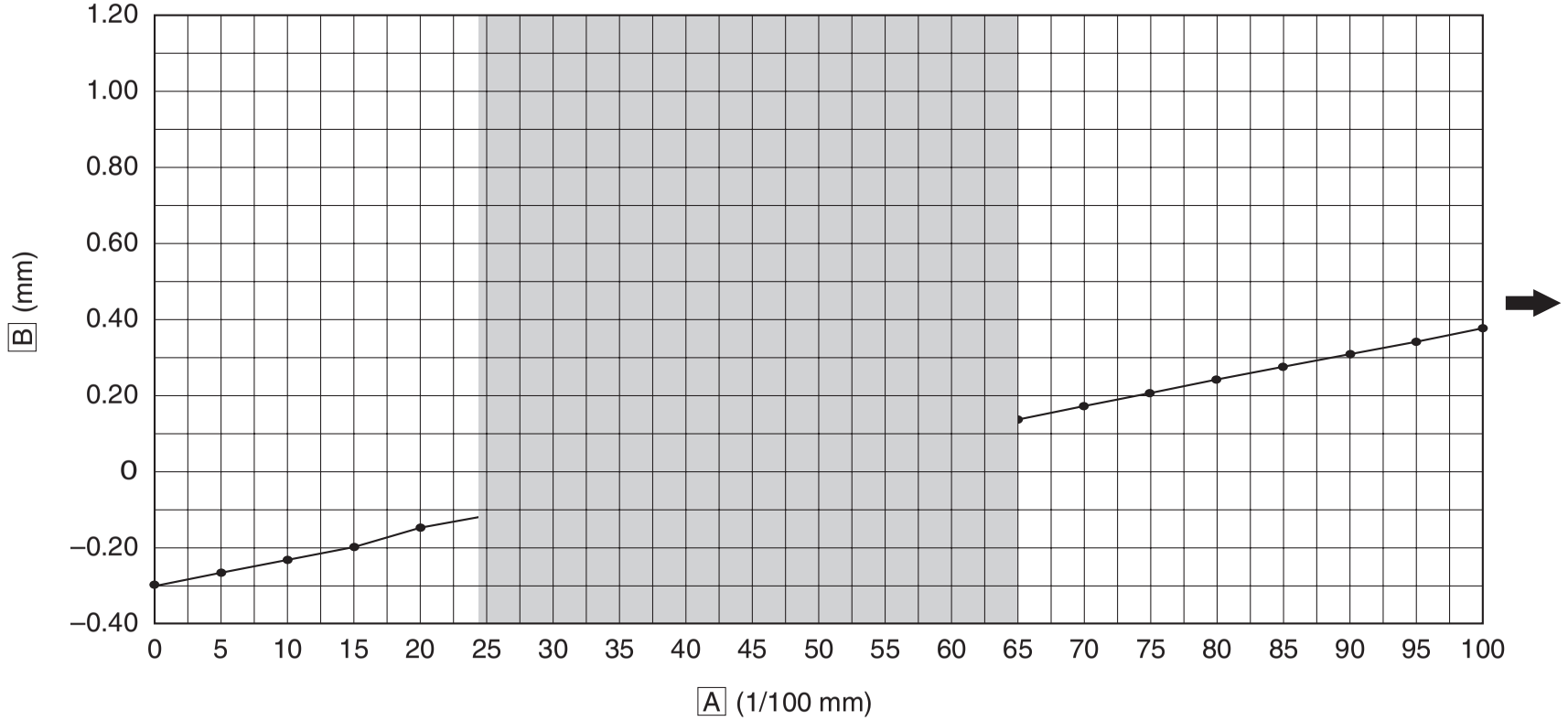
Available shim thicknesses:
0.10, 0.12, 0.15, 0.18, 0.30, 0.40, and 0.50 mm

TIP:

- Use the least number of shims to achieve the required shim thickness.
- If the calculated shim thickness cannot be obtained with a combination of the available shims, increase the shim thickness by 0.01 mm.

5. Install the shim(s) (T1) and roller bearing.

Reverse gear shim (T1) selection chart



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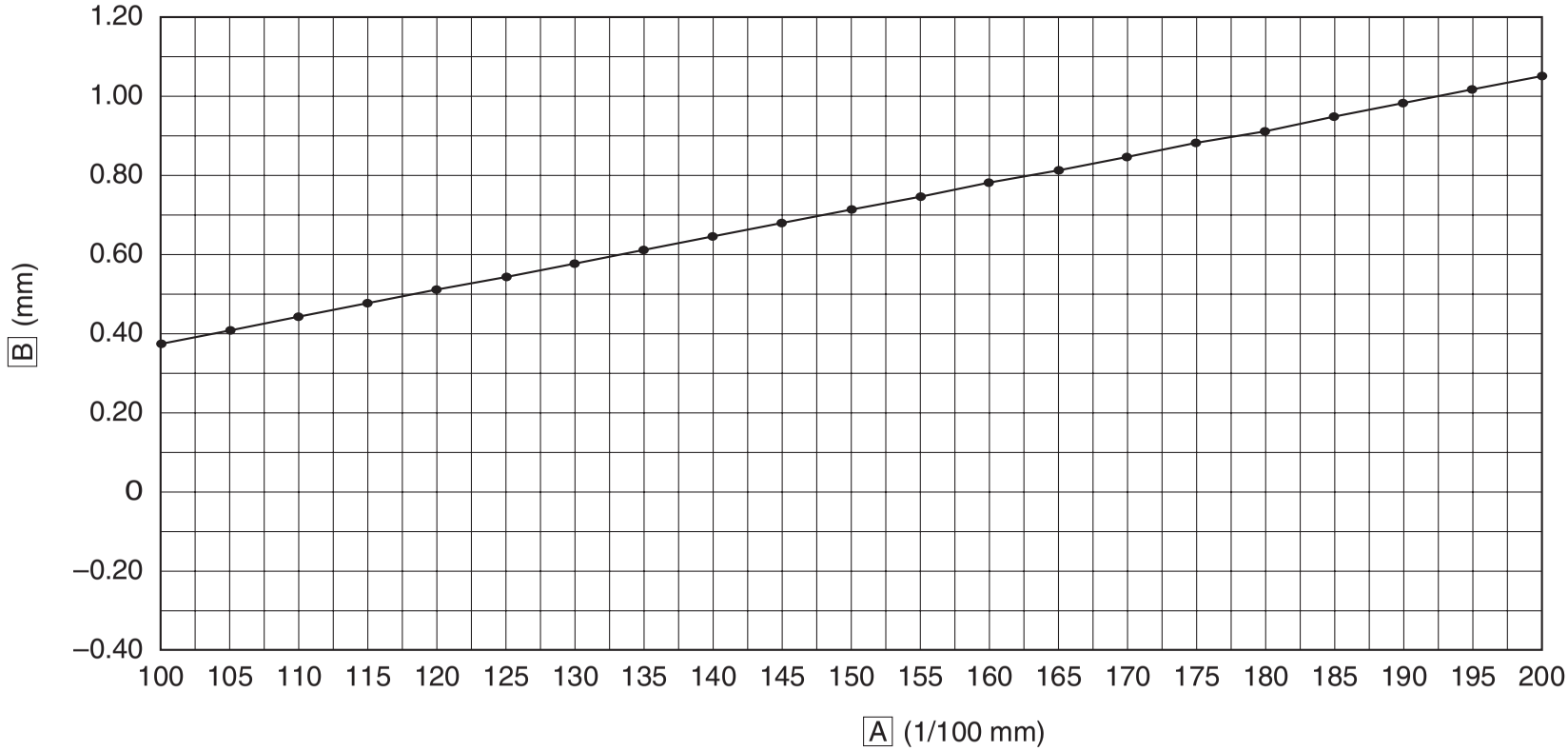
A	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
B	–0.30	–0.27	–0.23	–0.20	–0.16										0.17	0.21	0.24	0.27	0.31	0.34	0.38

A Backlash measurement (BL1)
B Increasing or decreasing of shim thickness



A	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200
B	0.38	0.41	0.44	0.48	0.51	0.54	0.58	0.61	0.65	0.68	0.71	0.75	0.78	0.81	0.85	0.88	0.92	0.95	0.98	1.02	1.05

A Backlash measurement (BL1)
B Increasing or decreasing of shim thickness

Bracket unit

Shift rod and shift bracket 9-1
Removing the shift rod and shift bracket 9-3
Disassembling the shift bracket 9-3
Assembling the shift bracket 9-3
Installing the shift rod and shift bracket 9-5

PTT switch and cowling lock lever 9-6
Removing the PTT switch 9-8
Removing the cowling lock lever 9-8
Removing the flushing hose 9-8
Installing the flushing hose 9-9
Installing the cowling lock lever 9-9
Installing the PTT switch 9-9

Bottom cowling 9-10

Upper case and mounts 9-12
Removing the upper case 9-14
Installing the upper case 9-14

Upper case 9-16
Disassembling the upper case 9-17
Checking the drive shaft bushing 9-17
Assembling the upper case 9-17

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Disassembling the oil pan and exhaust manifold 9-21
Checking the oil pan and exhaust manifold 9-21
Checking the oil strainer 9-21
Assembling the oil pan and exhaust manifold 9-21

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Removing the steering arm 9-24
Installing the steering arm 9-24

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Removing the clamp bracket 9-29
Installing the clamp bracket 9-29
Adjusting the trim sensor cam 9-31

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Bleeding the PTT unit 9-36
Installing the PTT unit 9-36

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Removing the reservoir 9-41
Removing the PTT motor 9-41
Disassembling the PTT motor 9-41
Checking the PTT motor 9-42
Checking the brush 9-42
Assembling the PTT motor 9-43
Installing the reservoir 9-44
Installing the PTT motor 9-44

PTT gear pump 9-45
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Assembling the gear pump assembly 9-48

PTT cylinder 9-50
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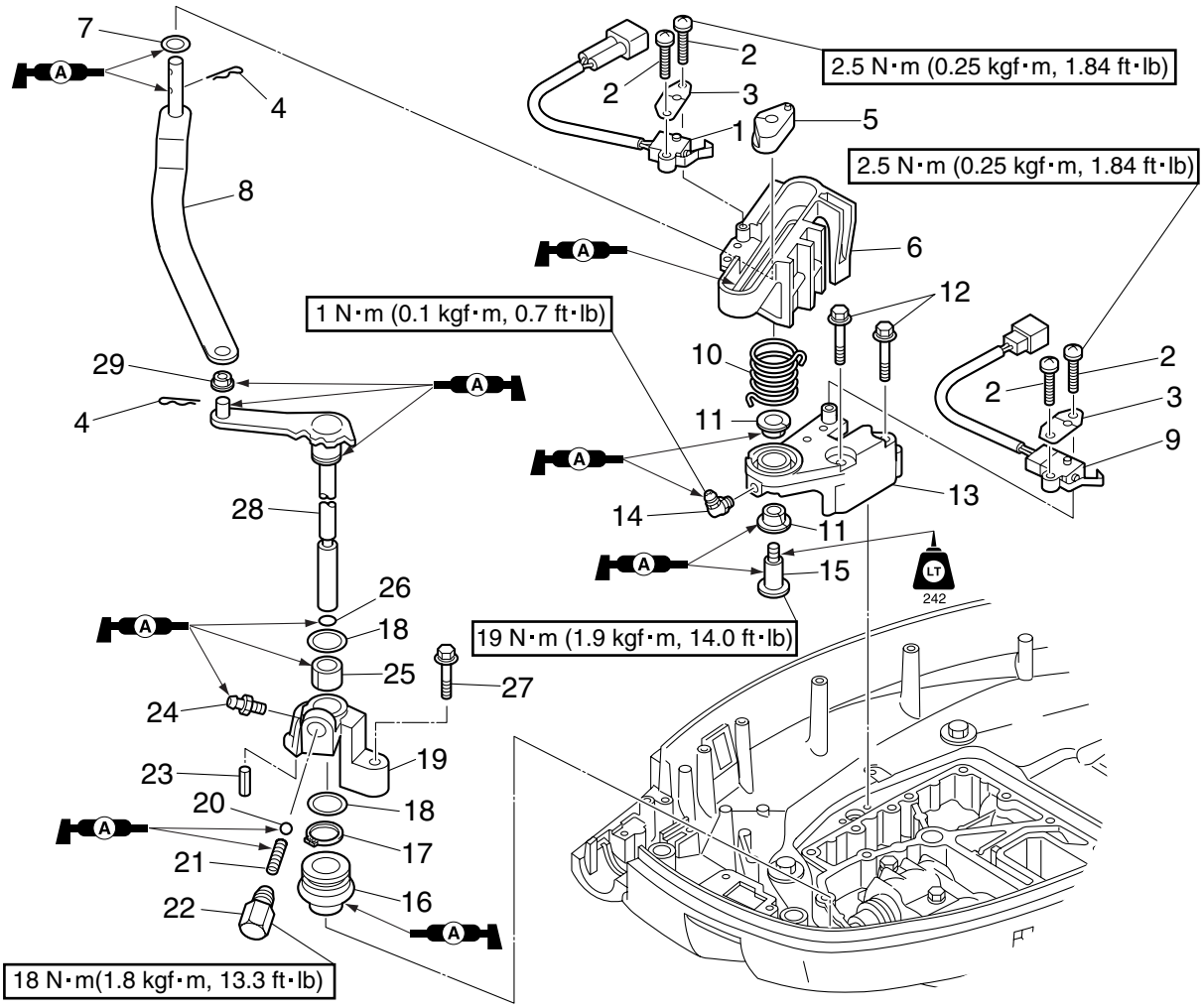
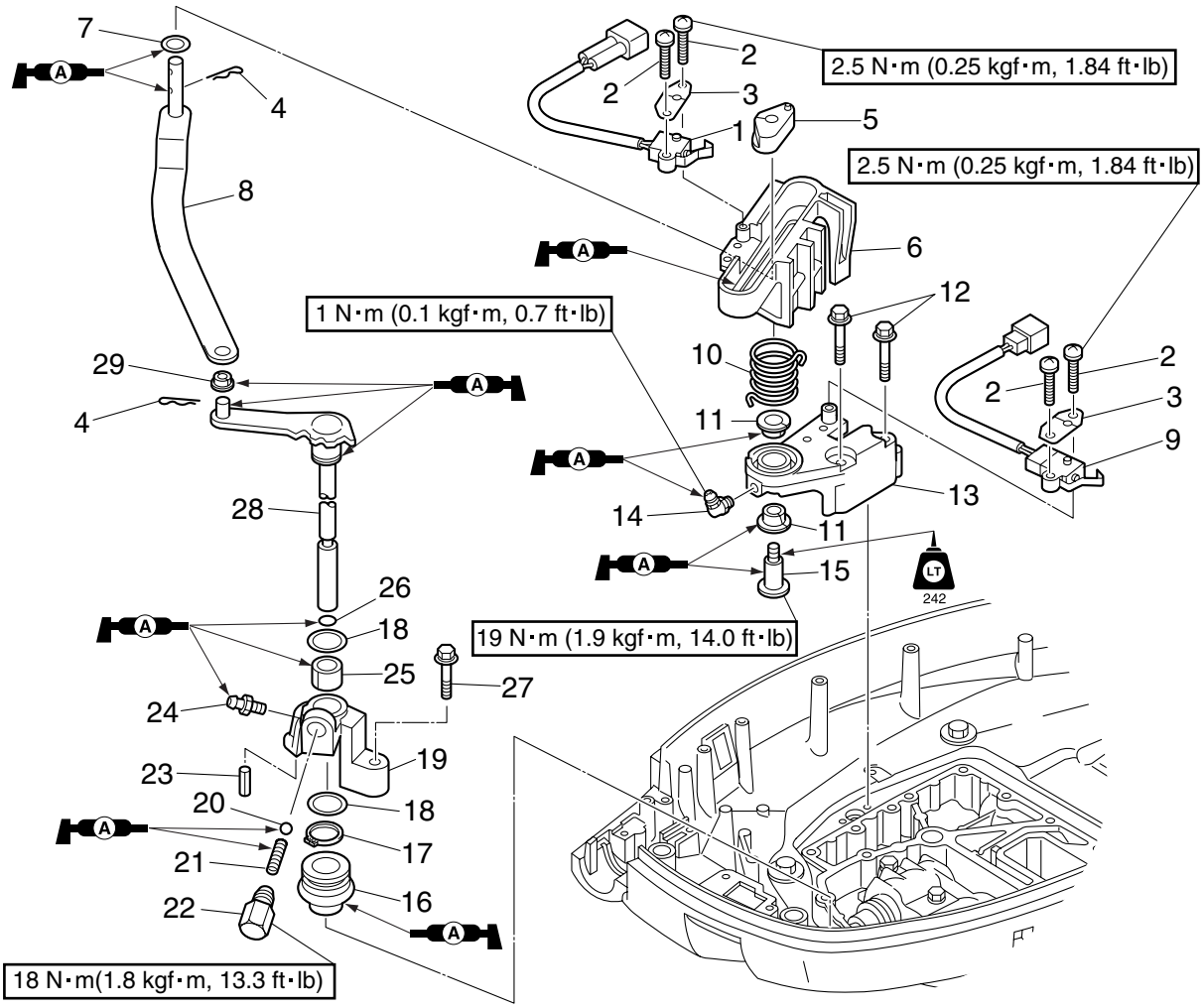
Disassembling the tilt ram 9-52
Checking the tilt cylinder and trim cylinder 9-53
Checking the valve 9-53
Assembling the tilt ram 9-53
Assembling the trim ram 9-54
Installing the trim ram 9-55
Installing the tilt ram 9-56

Shift rod and shift bracket



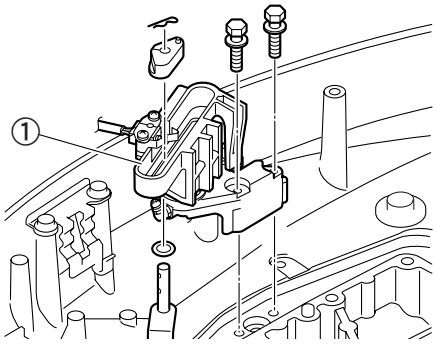
No.	Part name	Q'ty	Remarks
1	Neutral switch	1	
2	Screw	4	M4 × 16 mm
3	Plate	2	
4	Clip	2	
5	Bushing	1	
6	Bracket	1	
7	Washer	1	
8	Shift lever	1	
9	Shift cut switch	1	
10	Spring	1	
11	Bushing	2	
12	Bolt	2	M6 × 50 mm
13	Bracket	1	
14	Grease nipple	1	
15	Bolt	1	
16	Grommet	1	
17	Circlip	1	



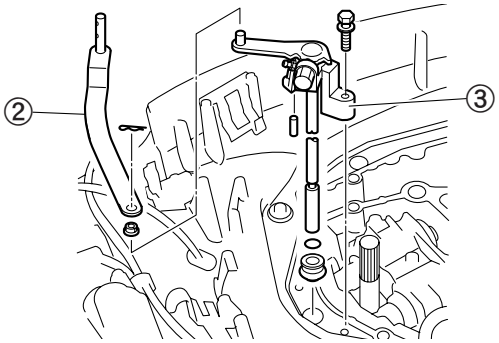
No.	Part name	Q'ty	Remarks
18	Washer	2	
19	Bracket	1	
20	Ball	1	
21	Spring	1	
22	Bolt	1	
23	Pin	1	
24	Grease nipple	1	
25	Bushing	1	
26	O-ring	1	**Not reusable**
27	Bolt	1	M6 × 35 mm
28	Shift rod	1	
29	Bushing	1	

Removing the shift rod and shift bracket

1. Remove the shift bracket assembly ①.

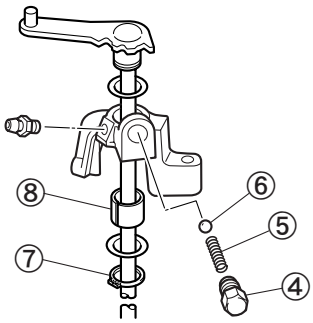


2. Remove the shift lever ② and shift rod assembly ③.



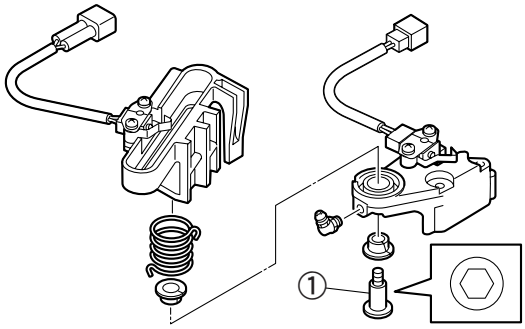
3. Remove the bolt ④, spring ⑤, and ball ⑥.

4. Remove the circlip ⑦ and bushing ⑧.

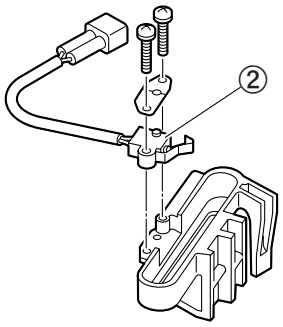


Disassembling the shift bracket

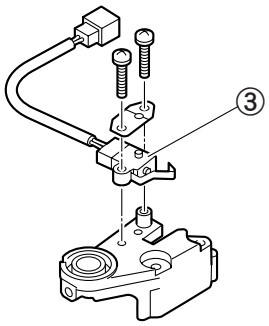
1. Remove the bolt ①, and then disassemble the shift bracket assembly.



2. Remove the neutral switch ②. For checking the neutral switch, see "Checking the neutral switch" (5-37).

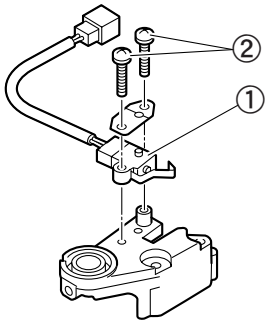


3. Remove the shift cut switch ③. For checking the shift cut switch, see "Checking the shift cut switch" (5-36).



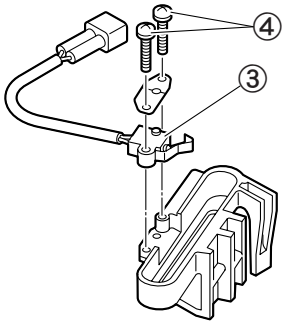
Assembling the shift bracket

1. Install the shift cut switch ①, and then tighten the screws ② to the specified torque.



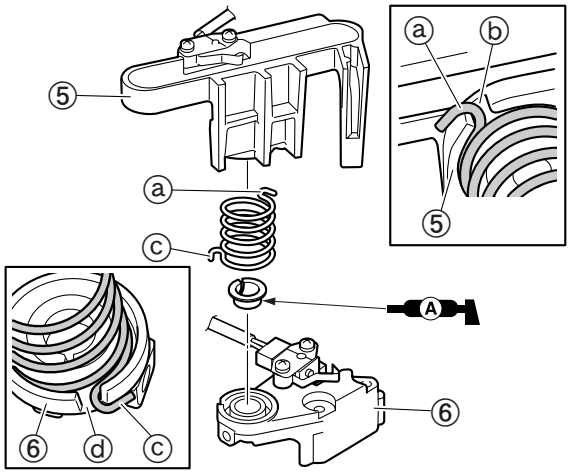
Screw ②:
2.5 N·m (0.25 kgf·m, 1.84 ft·lb)

2. Install the neutral switch ③, and then tighten the screws ④ to the specified torque.



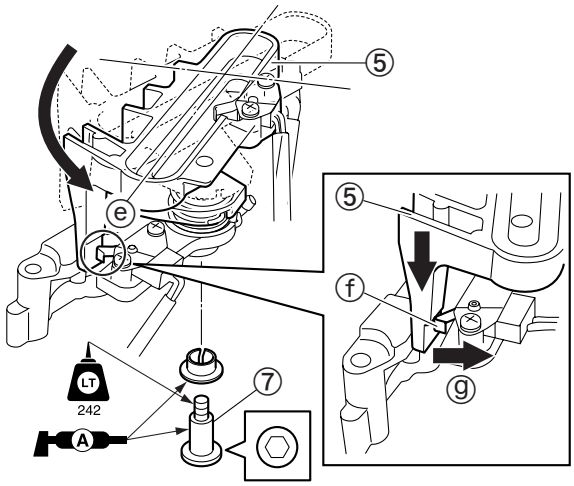
Screw ④:
2.5 N·m (0.25 kgf·m, 1.84 ft·lb)

3. Install the spring end ⓐ into the cutout ⓑ in the bracket ⑤ and the spring end ⓒ into the cutout ⓓ in the bracket ⑥.



4. Turn the bracket ⑤ to the position ⓔ, push it down, and then install the shift bracket bolt ⑦ temporarily. ***NOTICE:*** **Move the shift cut switch lever ⓕ in direction ⓖ when pushing the shift bracket ⑤ down, otherwise the lever may be damaged.**

5. Tighten the shift bracket bolt ⑦ to the specified torque.



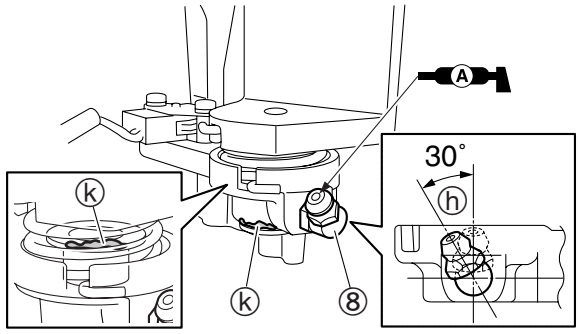
Shift bracket bolt ⑦:
19 N·m (1.9 kgf·m, 14.0 ft·lb)

6. Install the grease nipple ⑧, and then tighten it to the specified torque.

TIP:

Make sure that the installation angle of the grease nipple ⑧ falls within the range ⓗ.

7. Apply grease into the grease nipple until grease comes out of the bushings ⓚ.

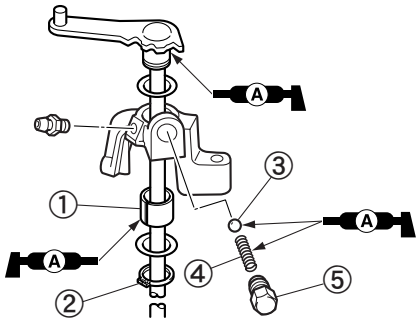


Grease nipple ⑧:
1 N·m (0.1 kgf·m, 0.7 ft·lb)

Installing the shift rod and shift bracket

1. Install the bushing ①, and then install the circlip ②.

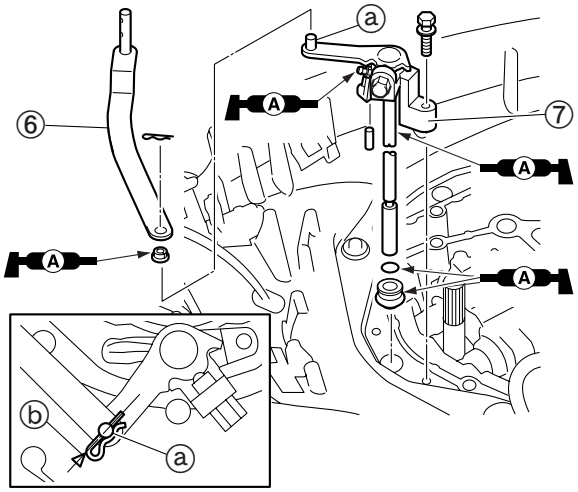
2. Install the ball ③, spring ④, and bolt ⑤, and then tighten the bolt ⑤ to the specified torque.



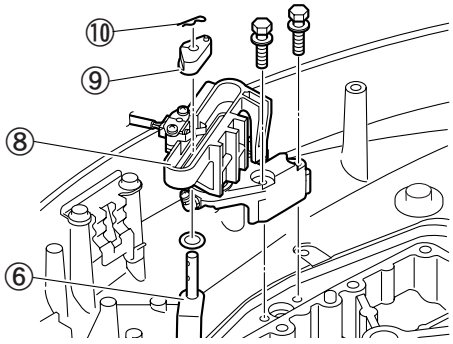
Bolt ⑤: 18 N·m (1.8 kgf·m, 13.3 ft·lb)

3. Install the shift lever ⑥ to the set pin ⓐ of the shift rod assembly ⑦.

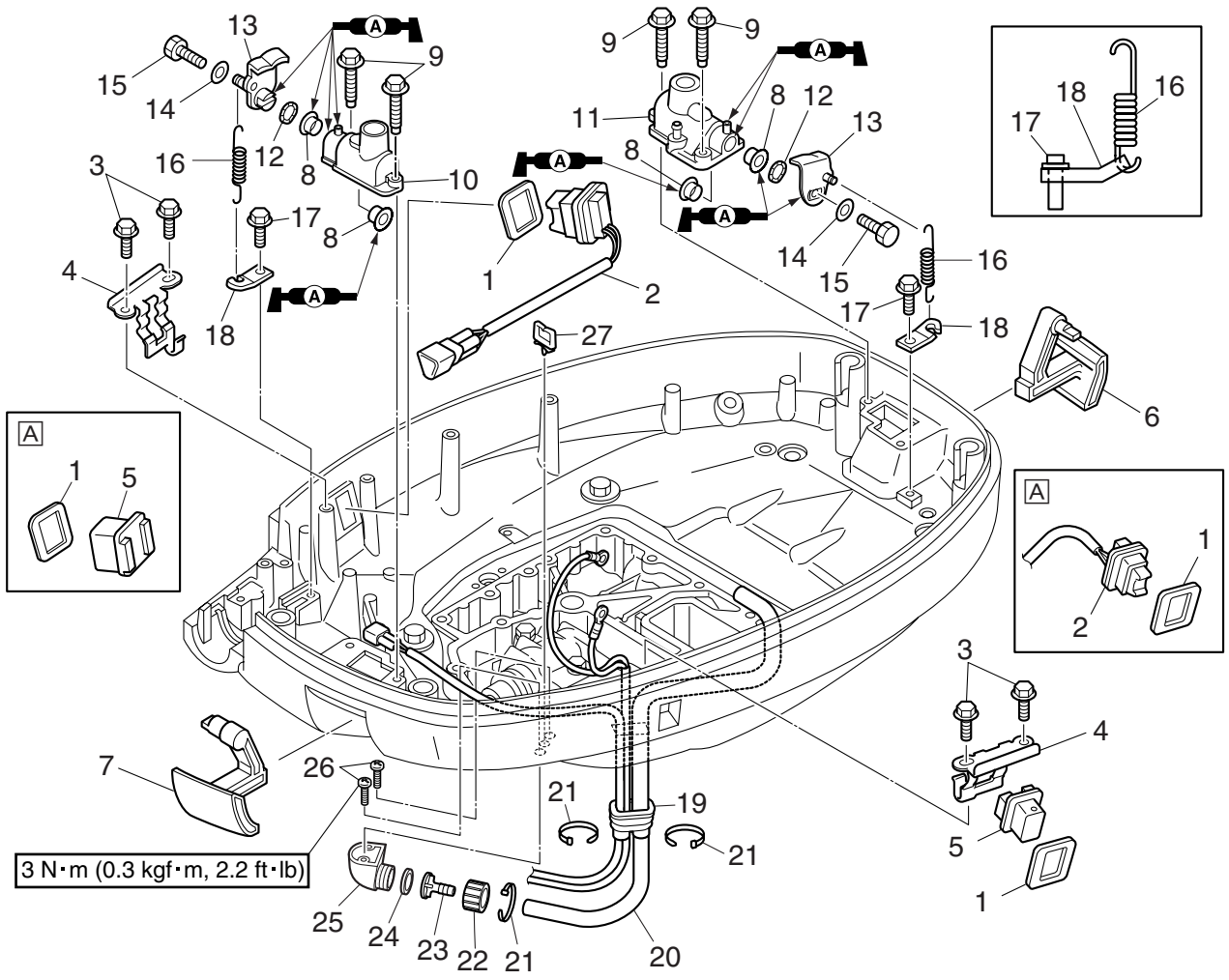
4. Install the shift rod assembly ⑦, and then align the center of the set pin ⓐ with the mark ⓑ on the bottom cowling.



5. Install the shift bracket assembly ⑧, and then install the bushing ⑨ and clip ⑩ to the shift lever ⑥.

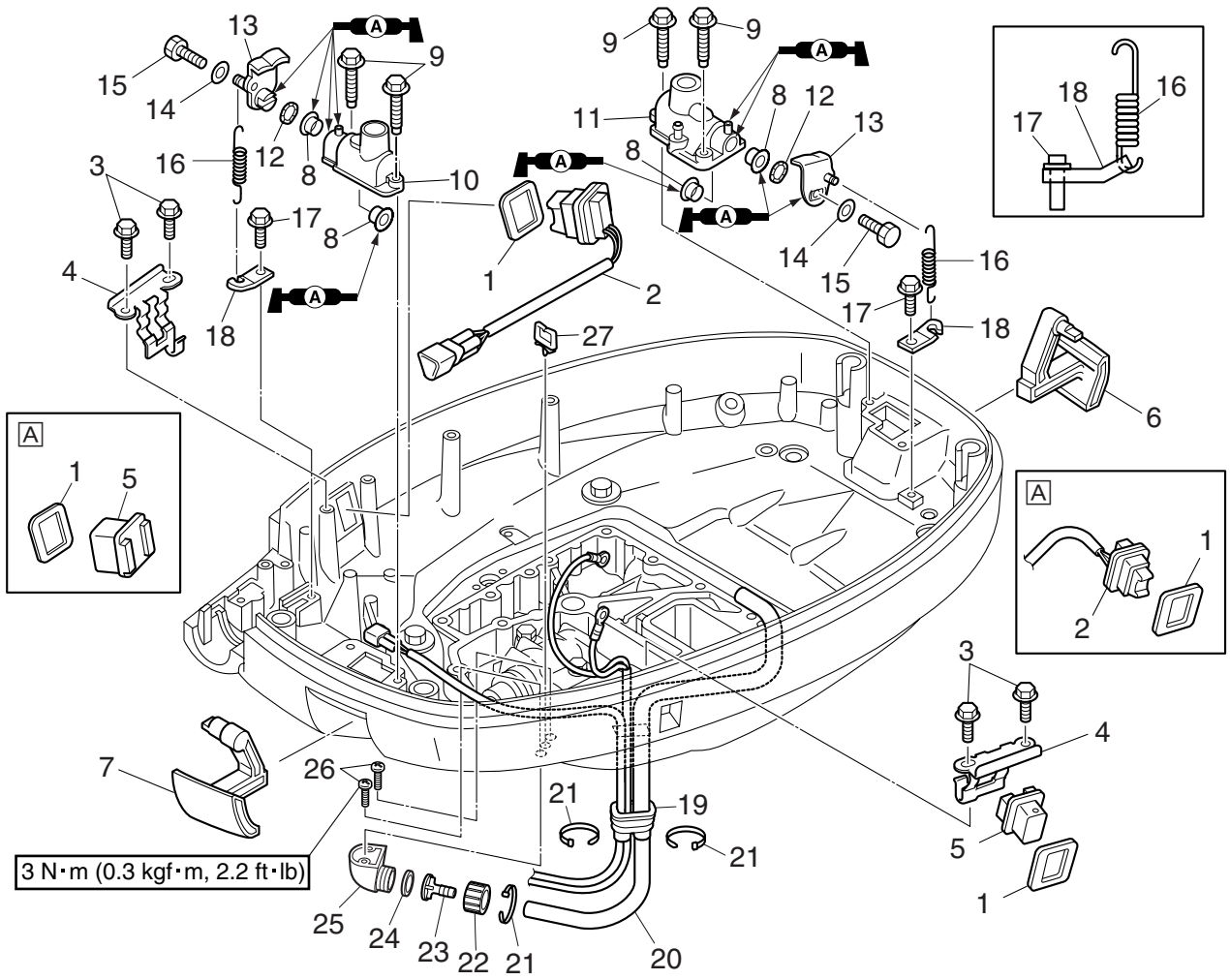


PTT switch and cowling lock lever



No.	Part name	Q'ty	Remarks
1	Gasket	2	
2	PTT switch	1	
3	Bolt	4	M6 × 20 mm
4	Holder	2	
5	Cover	1	
6	Cowling lock lever (AFT)	1	
7	Cowling lock lever (BOW)	1	
8	Bushing	4	
9	Bolt	4	M6 × 30 mm
10	Housing (BOW)	1	
11	Housing (AFT)	1	
12	Wave washer	2	
13	Lever	2	
14	Washer	2	
15	Bolt	2	M6 × 20 mm
16	Spring	2	
17	Bolt	2	M6 × 20 mm

A Counter rotation model

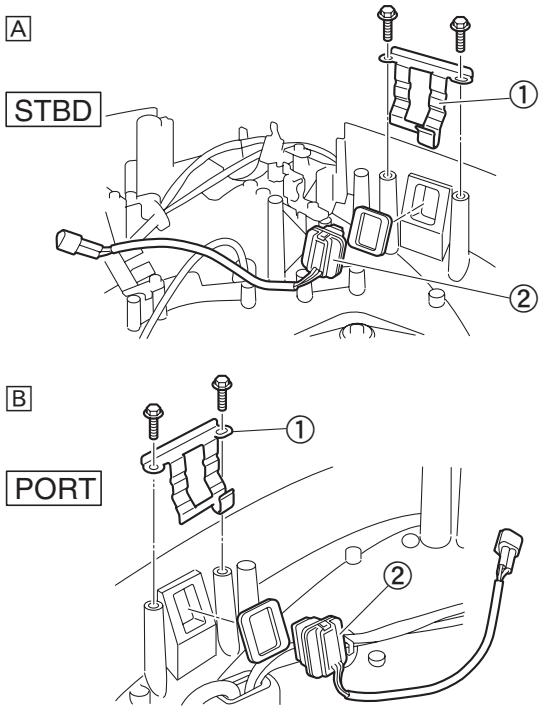


No.	Part name	Q'ty	Remarks
18	Hook	2	
19	Grommet	1	
20	Hose	1	
21	Plastic tie	3	**Not reusable**
22	Hose joint	1	
23	Hose joint	1	
24	Gasket	1	
25	Adapter	1	
26	Screw	2	ø6 × 19 mm
27	Clamp	1	

A Counter rotation model

Removing the PTT switch

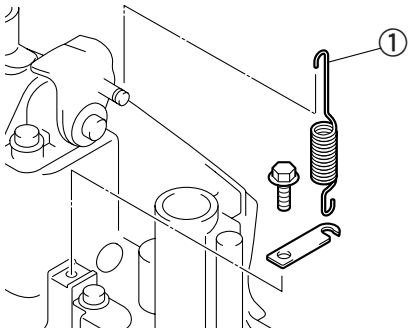
1. Remove the holder ①, and then remove the PTT switch ②. For checking the PTT switch, see “Checking the PTT switch (on bottom cowling)” (5-49).



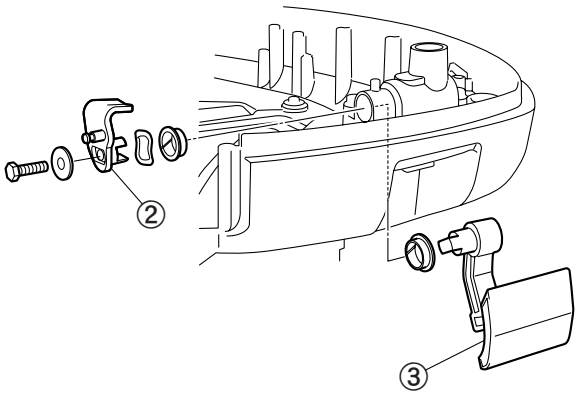
A Regular rotation model
B Counter rotation model

Removing the cowling lock lever

1. Remove the spring ①.

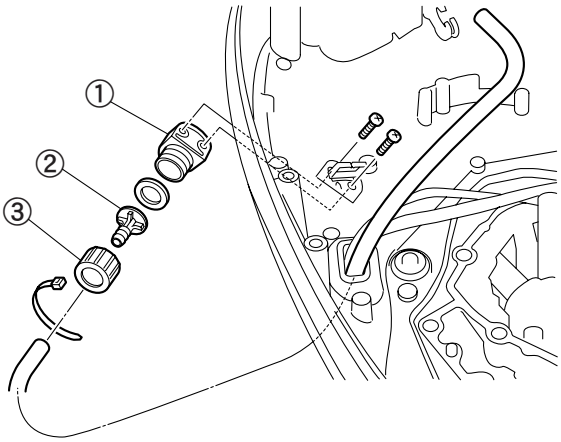


2. Remove the lever ② and cowling lock lever ③.

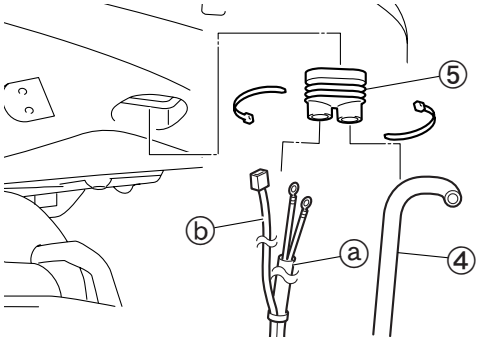


Removing the flushing hose

1. Remove the adapter ① and hose joints ②, ③.



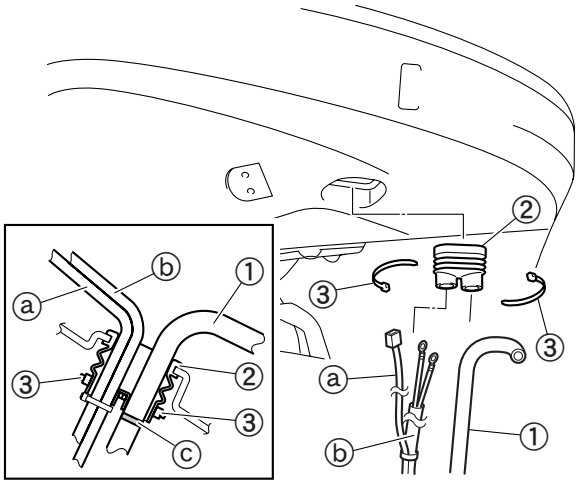
2. Remove the flushing hose ④, PTT motor leads ⓐ, trim sensor lead ⓑ, and grommet ⑤.



9

Installing the flushing hose

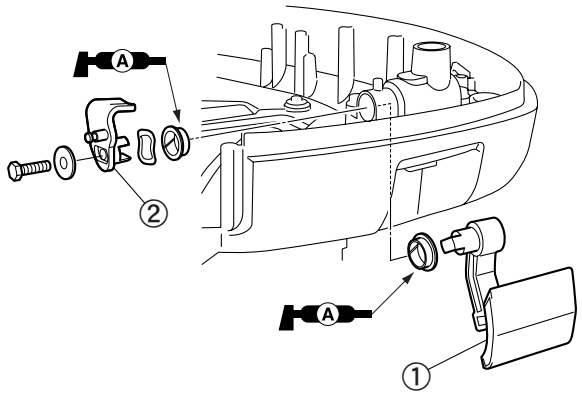
1. Pass the flushing hose ①, trim sensor lead ⓐ, and PTT motor leads ⓑ through the grommet ②, and then fasten them with plastic ties ③ around the grommet ②.



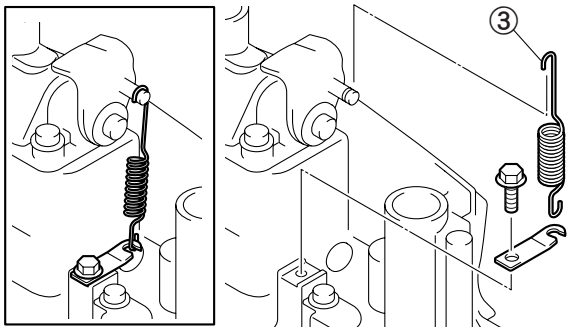
TIP:
Align the white paint mark ⓒ on the flushing hose ① with the outer end of the grommet ④.

Installing the cowling lock lever

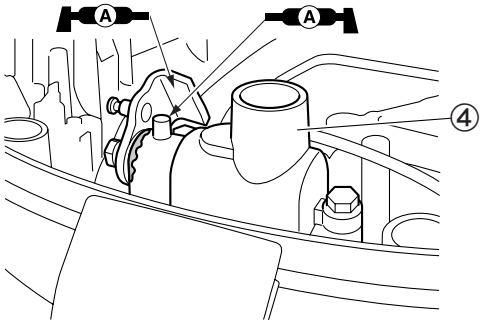
1. Install the cowling lock lever ① and lever ②.



2. Install the spring ③.

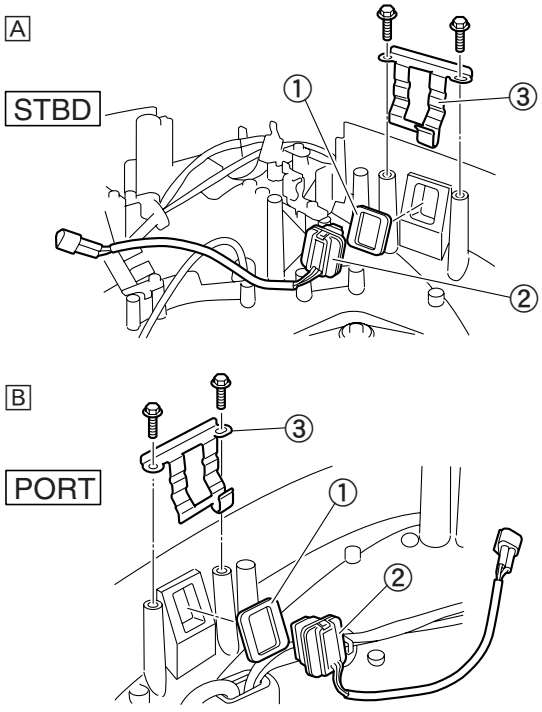


3. Apply grease into the housing ④ until grease comes out from the cowling lock lever bushing.



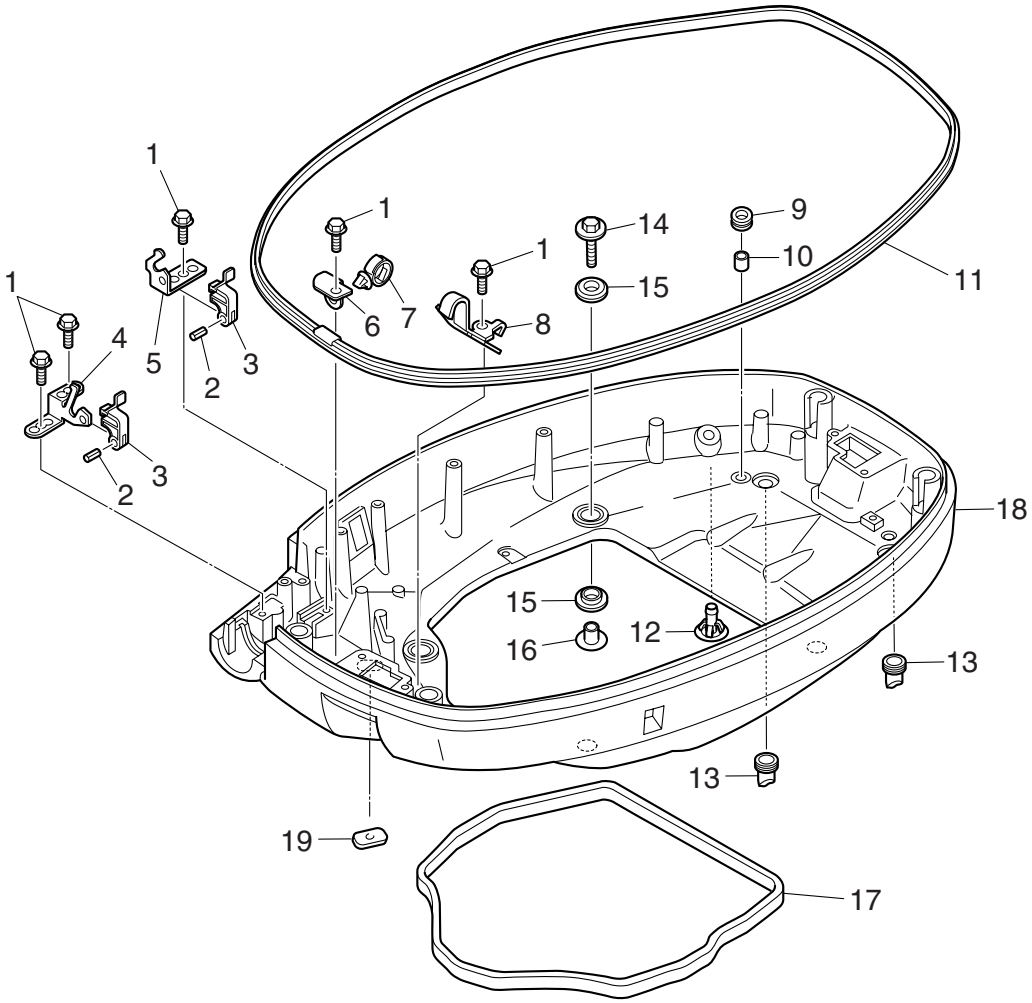
Installing the PTT switch

1. Install the gasket ① and PTT switch ② with in the holder ③ onto the bottom cowling.

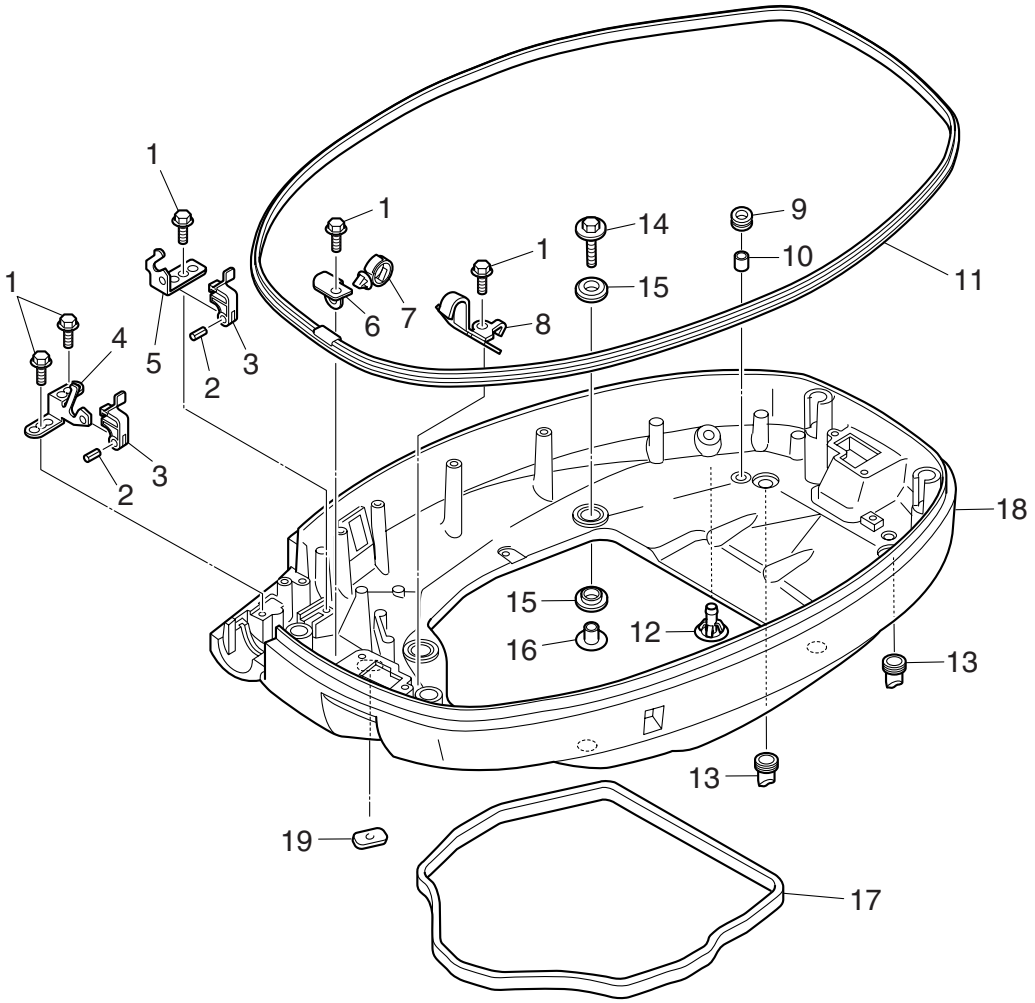


A Regular rotation model
B Counter rotation model

Bottom cowling

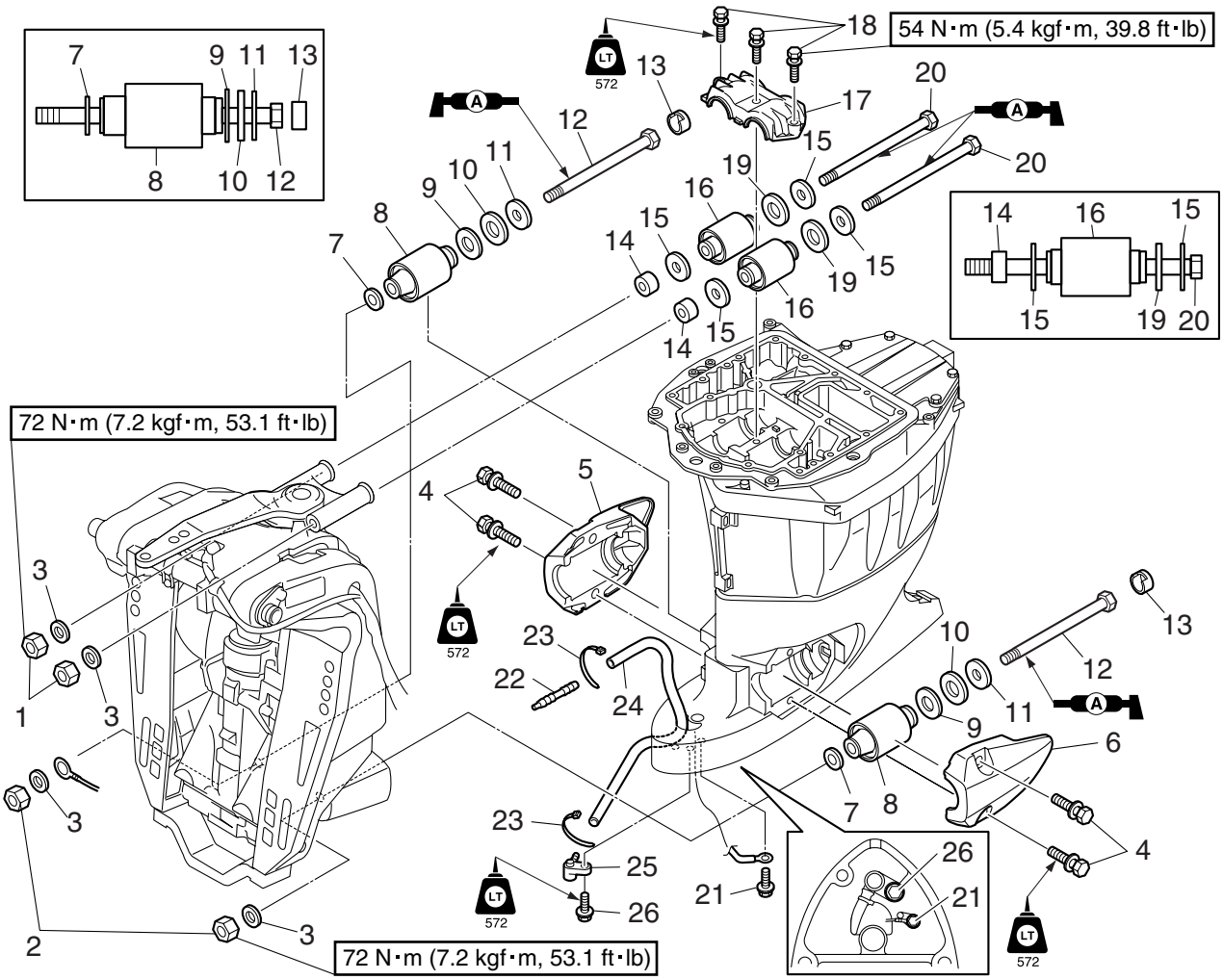


No.	Part name	Q'ty	Remarks
1	Bolt	5	M6 × 20 mm
2	Pin	2	
3	Holder	2	
4	Bracket	1	
5	Bracket	1	
6	Bracket	1	
7	Clamp	1	
8	Holder	1	
9	Grommet	4	
10	Collar	4	
11	Rubber seal	1	
12	Water outlet	1	
13	Grommet	2	
14	Bolt	4	M8 × 35 mm
15	Grommet	8	
16	Collar	4	
17	Rubber seal	1	

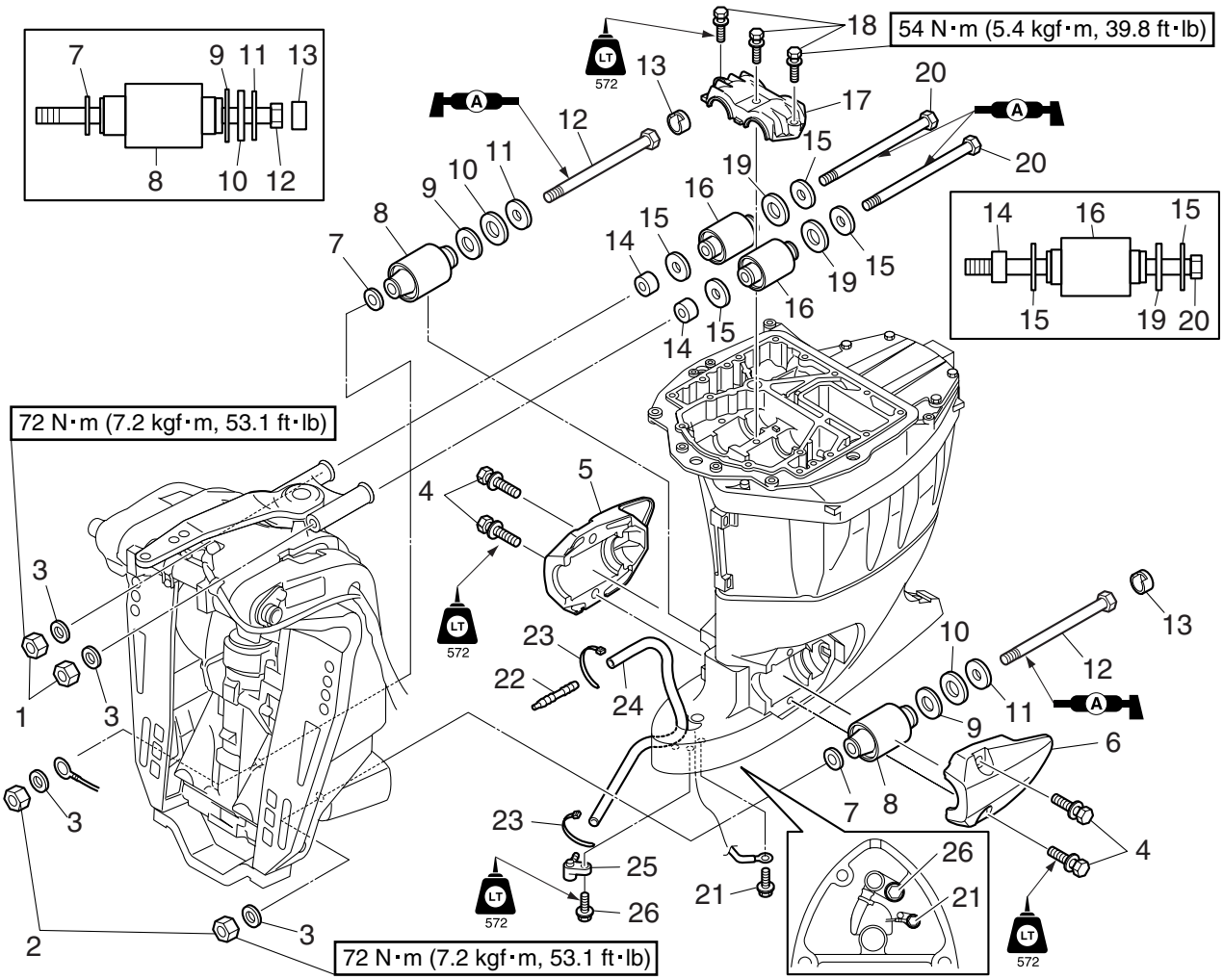


No.	Part name	Q'ty	Remarks
18	Bottom cowling	1	
19	Grommet	1	

Upper case and mounts



No.	Part name	Q'ty	Remarks
1	Self-locking nut	2	
2	Nut	2	
3	Washer	4	
4	Bolt	4	M10 × 40 mm
5	Cover	1	
6	Cover	1	
7	Washer	2	
8	Lower mount	2	
9	Washer	2	
10	Washer	2	
11	Washer	2	
12	Bolt	2	M14 × 225 mm
13	Cap	2	
14	Collar	2	
15	Washer	4	
16	Upper mount	2	
17	Bracket	1	



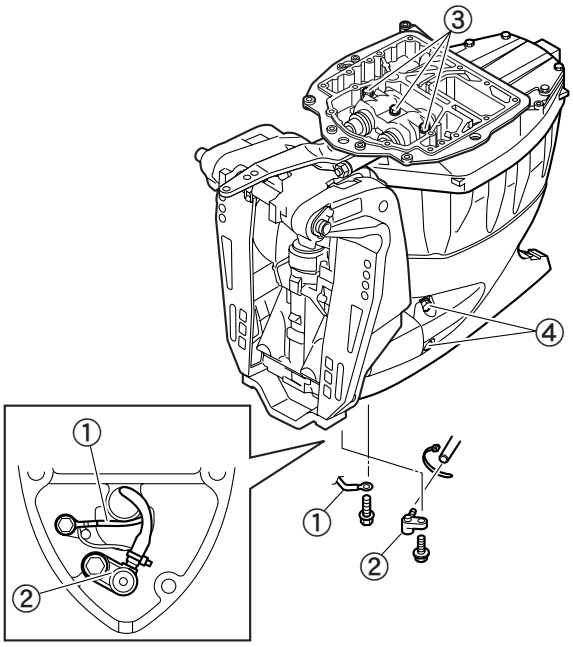
No.	Part name	Q'ty	Remarks
18	Bolt	3	M10 × 45 mm
19	Washer	2	
20	Bolt	2	M14 × 203 mm
21	Bolt	1	M6 × 10 mm
22	Nipple	1	
23	Plastic tie	2	**Not reusable**
24	Hose	1	
25	Adapter	1	
26	Bolt	1	M6 × 20 mm

Removing the upper case

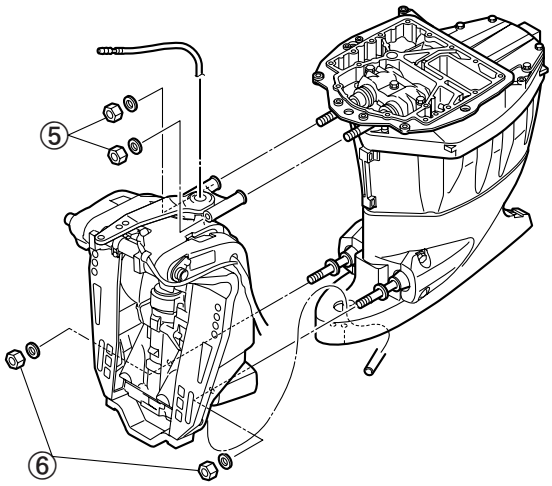
1. Drain the remained engine oil. See “Disassembling the upper case” (9-17) step 1.

2. Disconnect the ground lead ① and adapter ②.

3. Loosen the upper mount bracket bolts ③ and lower mount cover bolts (PORT and STBD) ④.



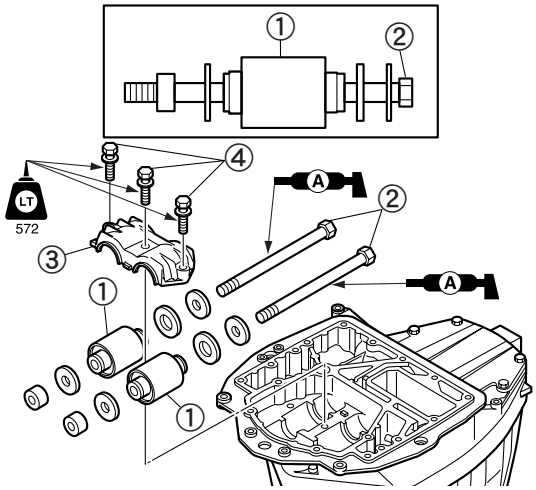
4. Remove the upper mounting nuts ⑤ and lower mounting nuts ⑥, and then remove the upper case assembly.



Installing the upper case

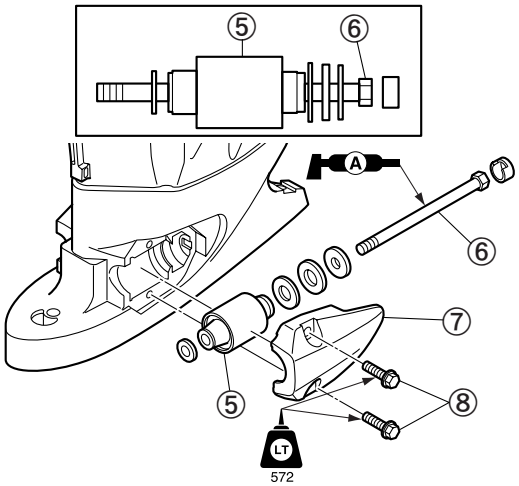
1. Install the upper mounts ① and bolts ②.

2. Install the upper mount bracket ③, and then tighten the upper mount bracket bolts ④ temporarily.



3. Install the lower mounts ⑤ and bolts ⑥.

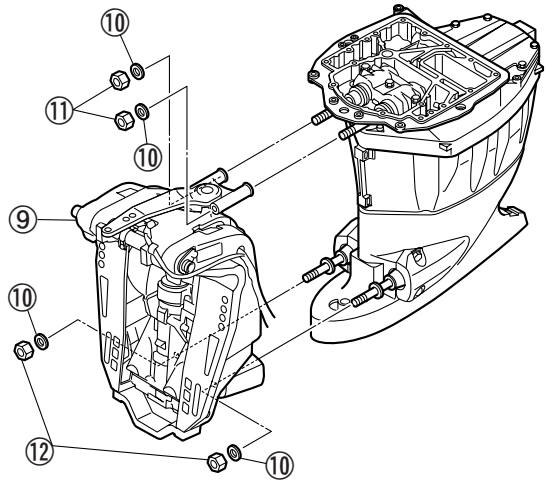
4. Install the lower mount covers ⑦, and then tighten the lower mount cover bolts ⑧ temporarily.



9

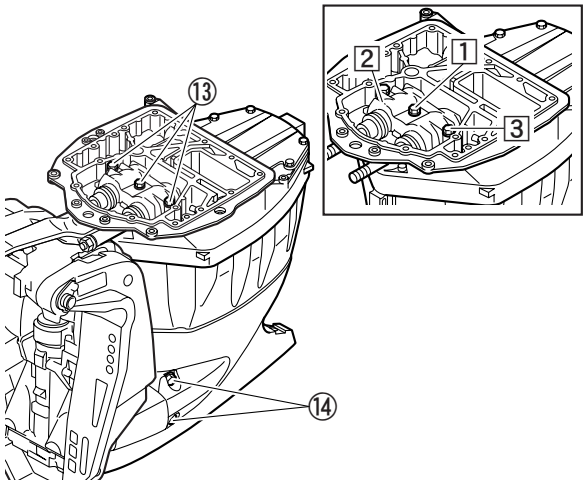
5. Install the upper and lower mounting bolts into the bracket assembly ⑨ simultaneously.

6. Install the washers ⑩, upper mounting nuts ⑪, and lower mounting nuts ⑫, and then tighten each nuts to the specified torque.



Upper mounting nut ⑪: 72 N·m (7.2 kgf·m, 53.1 ft·lb) Lower mounting nut ⑫: 72 N·m (7.2 kgf·m, 53.1 ft·lb)

7. Tighten the upper mount bracket bolts ⑬ to the specified torque in the sequence numbers (1, 2, · · ·).

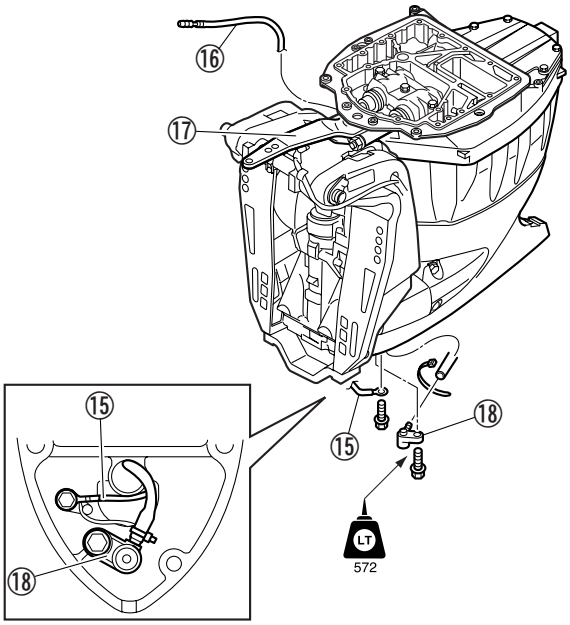


Bracket bolt ⑬: 54 N·m (5.4 kgf·m, 39.8 ft·lb)

8. Tighten the lower mount bracket bolts (PORT and STBD) ⑭.

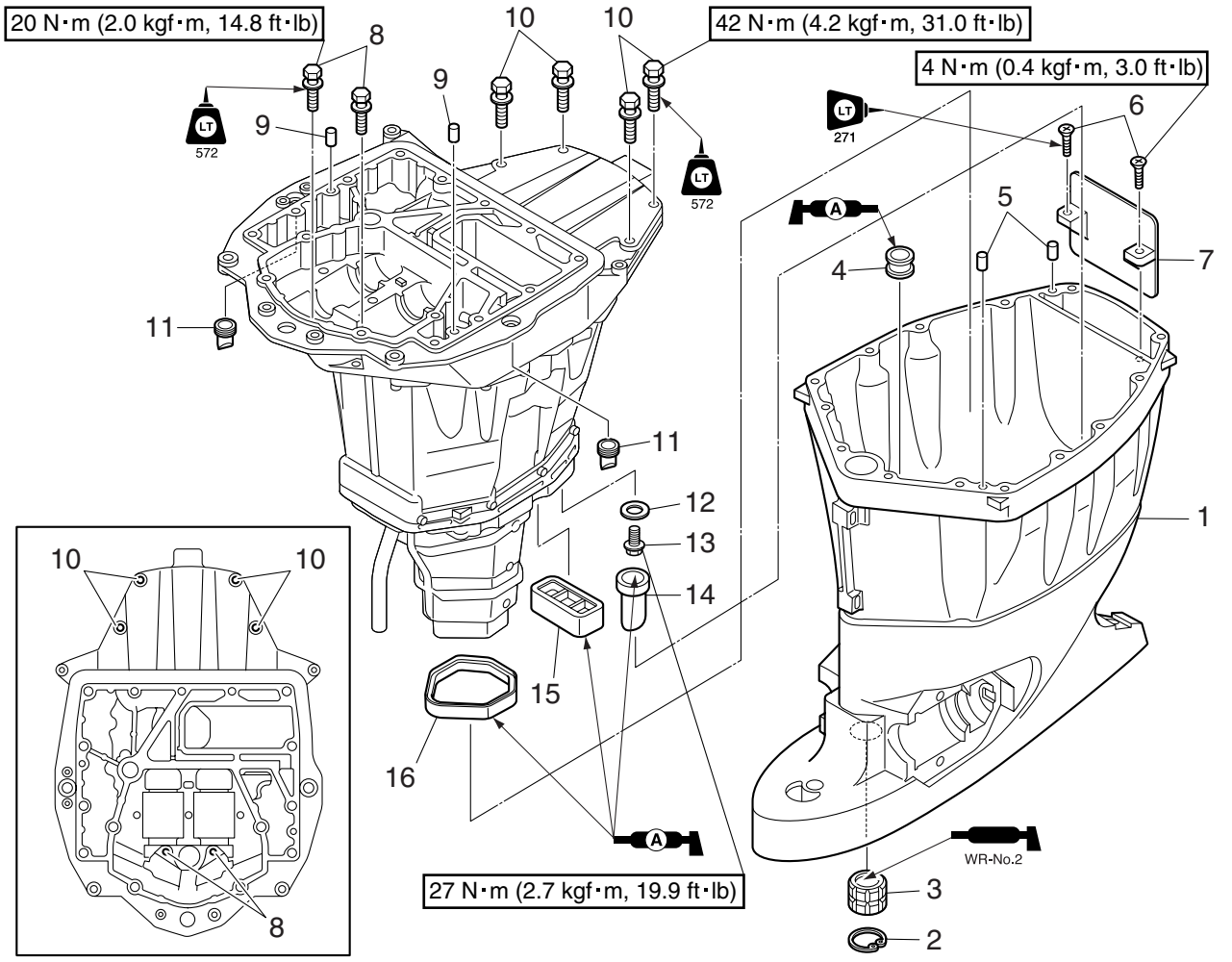
9. Connect the ground lead ⑮.

10. Pass the speedometer hose ⑯ through the steering arm ⑰, and then connect it to the speedometer hose adapter ⑱.



11. Install the drain bolt. See “Assembling the upper case” (9-17) step 7.

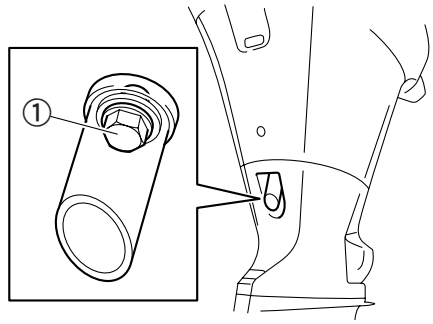
Upper case



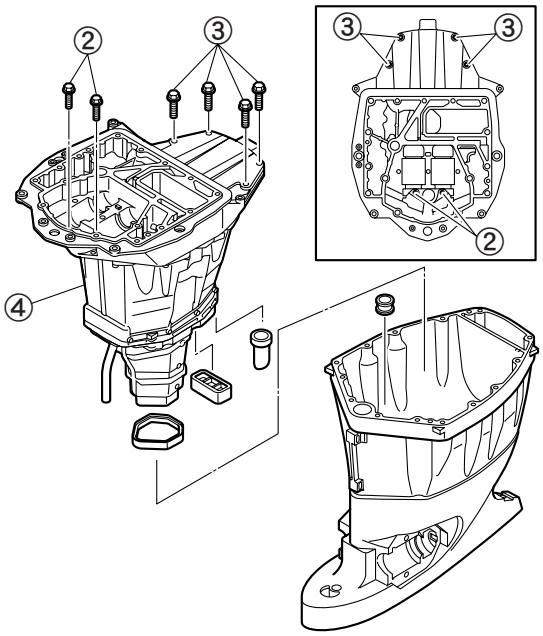
No.	Part name	Q'ty	Remarks
1	Upper case	1	
2	Circlip	1	
3	Bushing	1	
4	Rubber seal	1	
5	Dowel	2	
6	Screw	2	M6 × 15 mm
7	Baffle plate	1	
8	Bolt	2	M8 × 30 mm
9	Dowel	2	
10	Bolt	4	M10 × 45 mm
11	Grommet	2	
12	Gasket	1	**Not reusable**
13	Drain bolt	1	
14	Damper	1	
15	Rubber seal	1	
16	Rubber seal	1	**Not reusable**

Disassembling the upper case

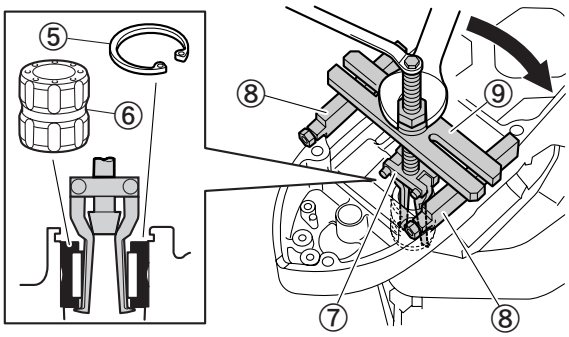
1. Remove the drain bolt ①.



2. Remove the upper case bolts ② and ③, and then remove the oil pan assembly ④.



3. Remove the circlip ⑤, and then remove the bushing ⑥.



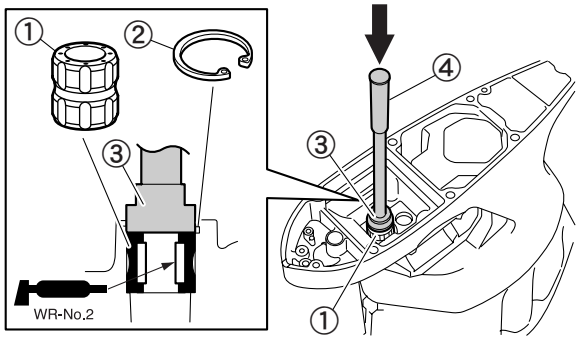
Bearing puller assembly ⑦: 90890-06535 Stopper guide stand ⑧: 90890-06538 Stopper guide plate ⑨: 90890-06501

Checking the drive shaft bushing

1. Check the bushing. Replace if cracked or worn.

Assembling the upper case

1. Install the bushing ①, and then install the circlip ②.



Needle bearing attachment ③: 90890-06653 Driver rod L3 ④: 90890-06652

2. Install the dowels ⑤.

3. Install the baffle plate ⑥, and then tighten baffle plate screws ⑦ to the specified torque.

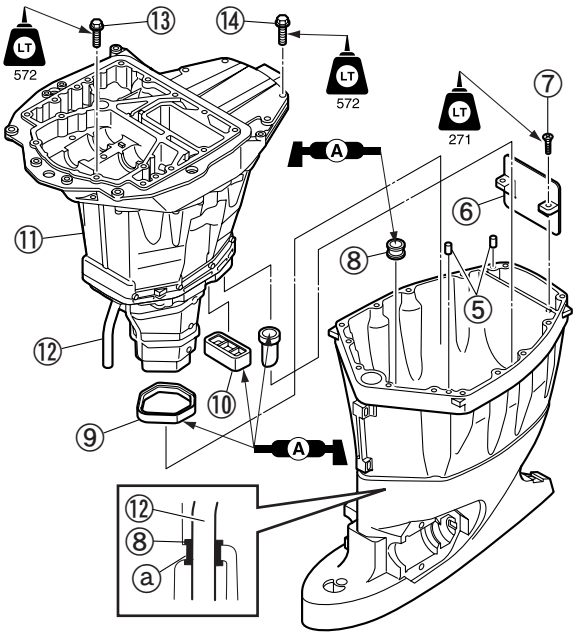
4. Install the rubber seal ⑧ into the joint hole ⓐ of the upper case.

5. Install a new rubber seal ⑨ and the rubber seal ⑩, and then install the oil pan assembly ⑪.

TIP:

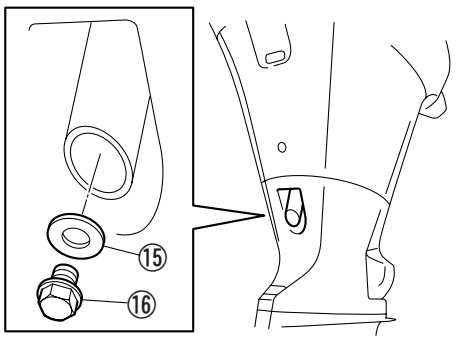
Make sure to insert the tip of the cooling water pipe ⑫ into the joint hole ⓐ of the upper case.

6. Install the oil pan bolts ⑬ and ⑭, and then tighten them to the specified torques.



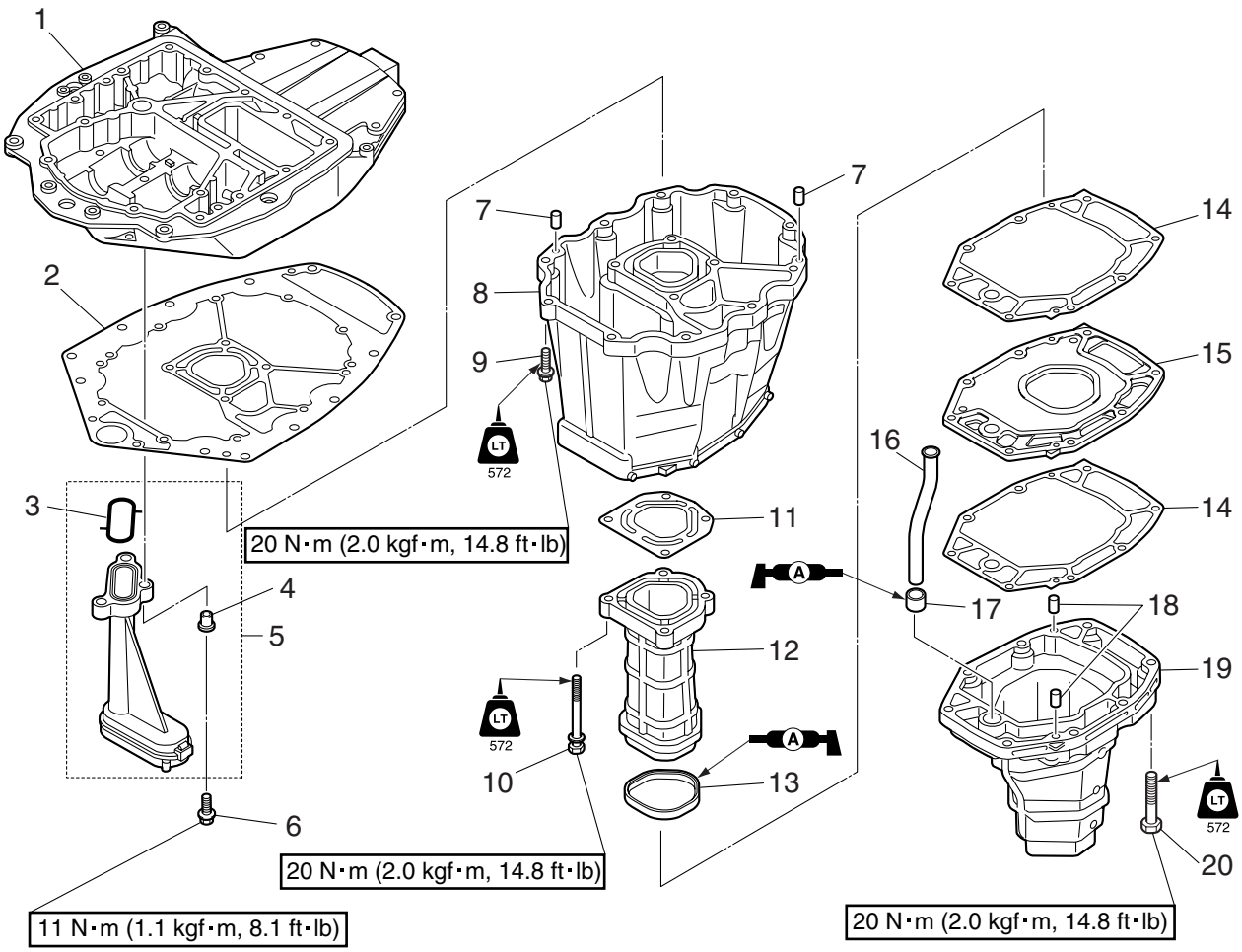
Baffle plate screw ⑦: 4 N·m (0.4 kgf·m, 3.0 ft·lb) Oil pan assembly bolt (M8) ⑬: 20 N·m (2.0 kgf·m, 14.8 ft·lb) Oil pan assembly bolt (M10) ⑭: 42 N·m (4.2 kgf·m, 31.0 ft·lb)

7. Install a new gasket ⑮ and the drain bolt ⑯, and then tighten it to the specified torque.

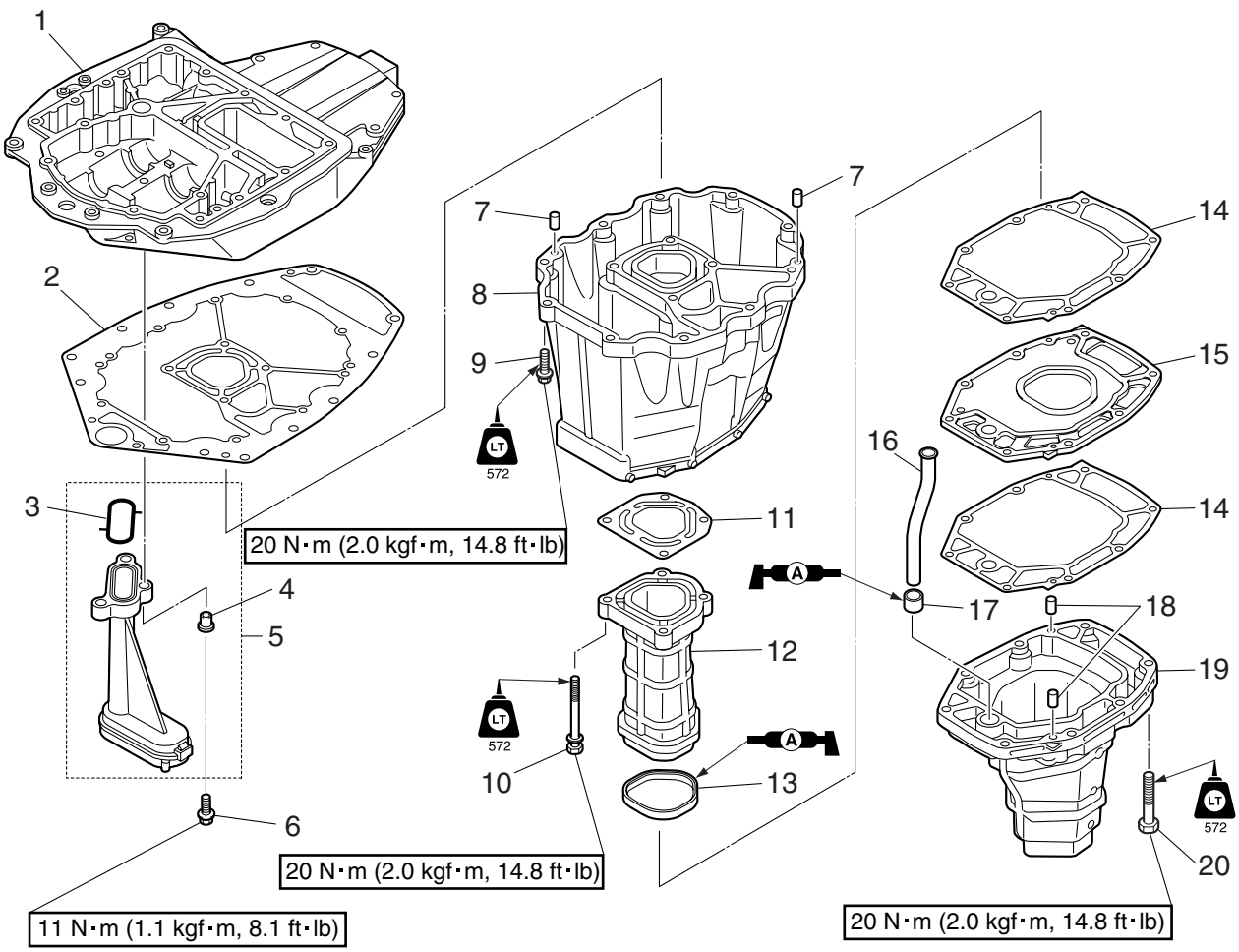


Drain bolt ⑯: 27 N·m (2.7 kgf·m, 19.9 ft·lb)

Oil pan and exhaust manifold



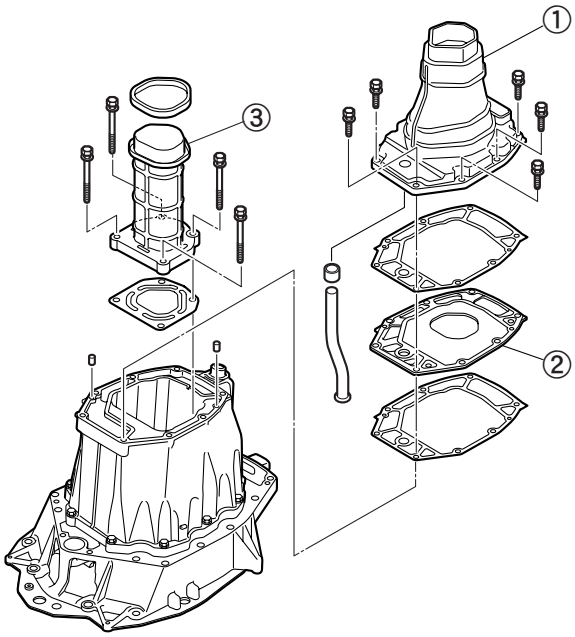
No.	Part name	Q'ty	Remarks
1	Exhaust guide	1	
2	Gasket	1	**Not reusable**
3	Gasket	1	**Not reusable**
4	Collar	3	
5	Oil strainer	1	
6	Bolt	3	M6 × 25 mm
7	Dowel	2	
8	Oil pan	1	
9	Bolt	10	M8 × 35 mm
10	Bolt	4	M8 × 60 mm
11	Gasket	1	**Not reusable**
12	Exhaust manifold	1	
13	Rubber seal	1	
14	Gasket	2	**Not reusable**
15	Plate	1	
16	Water pipe	1	
17	Rubber seal	1	



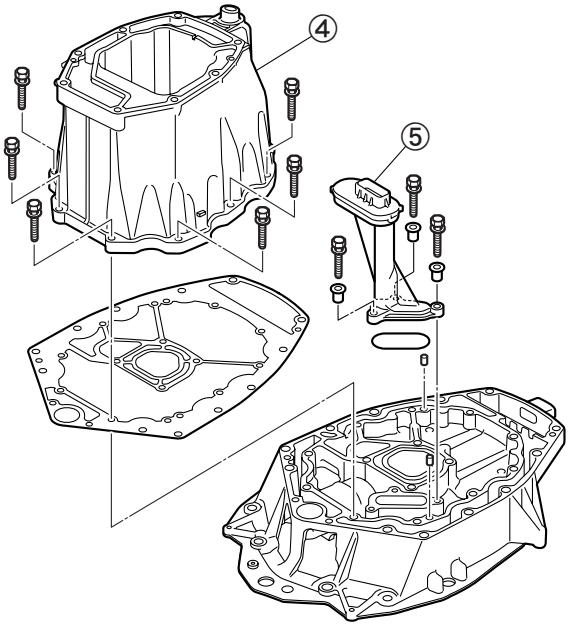
No.	Part name	Q'ty	Remarks
18	Dowel	2	
19	Muffler	1	
20	Bolt	8	M8 × 35 mm

Disassembling the oil pan and exhaust manifold

1. Remove the muffler ①, plate ②, and then remove the exhaust manifold ③.



2. Remove the oil pan ④, and then remove the oil strainer ⑤.



Checking the oil pan and exhaust manifold

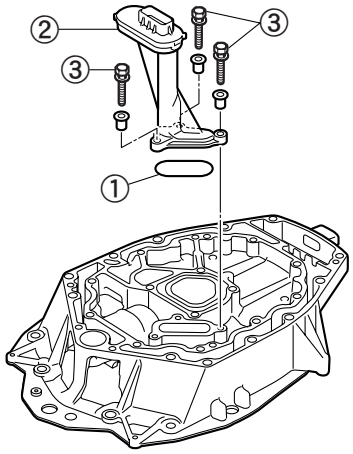
1. Clean the removed parts.
2. Check the exhaust guide, exhaust manifold, and muffler. Replace the exhaust guide, exhaust manifold, and muffler if cracked or if there is corrosion.
3. Check the oil pan. Replace the oil pan if cracked or if there is corrosion.

Checking the oil strainer

1. Check the oil strainer. Clean the oil strainer if there is dirt and residue.

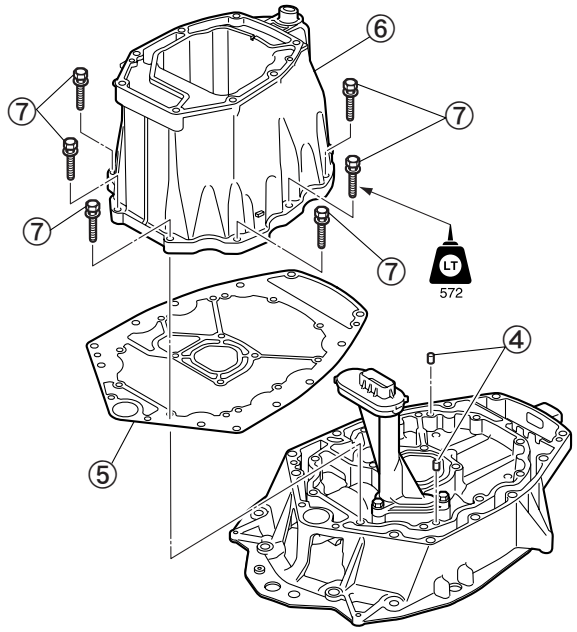
Assembling the oil pan and exhaust manifold

1. Install a new gasket ① and the oil strainer ②, and then tighten the oil strainer bolts ③ to the specified torque.

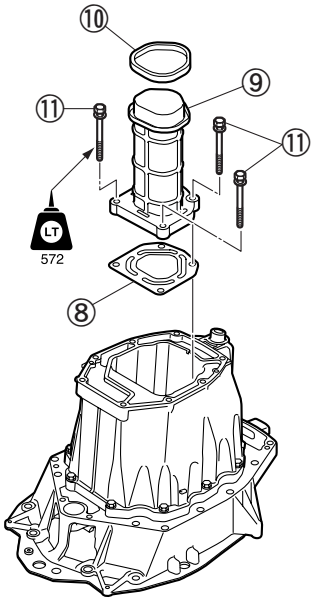


Oil strainer bolt ③:
11 N·m (1.1 kgf·m, 8.1 ft·lb)

2. Install the dowels ④, a new gasket ⑤, and the oil pan ⑥, and then tighten the oil pan bolts ⑦ temporarily.



3. Install a new gasket ⑧, the exhaust manifold ⑨, rubber seal ⑩, and then tighten the exhaust manifold bolts ⑪ temporarily.



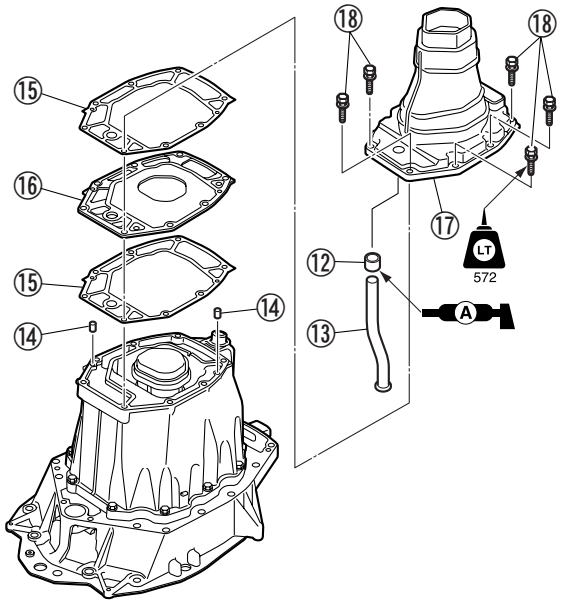
4. Tighten the exhaust manifold bolts ⑪ first, and then tighten the oil pan bolts ⑦ to the specified torques.

Exhaust manifold bolt ⑪: 20 N·m (2.0 kgf·m, 14.8 ft·lb) Oil pan bolt ⑦: 20 N·m (2.0 kgf·m, 14.8 ft·lb)

5. Install the rubber seal ⑫ and cooling water pipe ⑬.

6. Install the dowels ⑭, new gaskets ⑮, and the plate ⑯, and then install the muffler assembly ⑰.

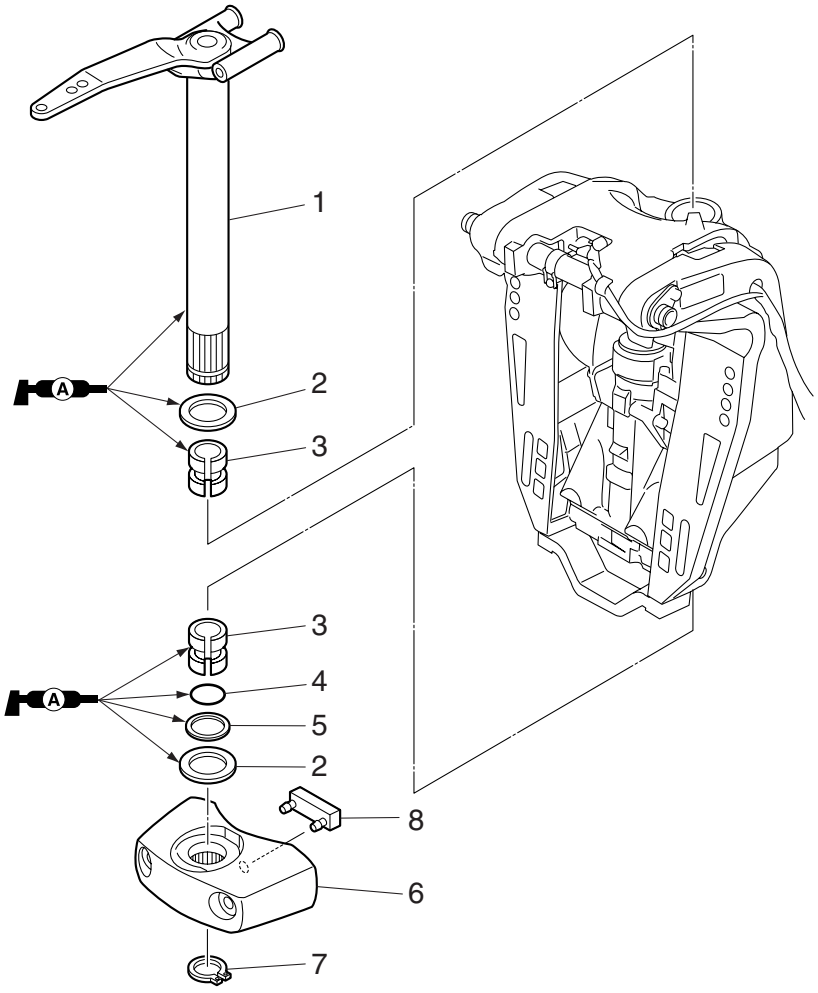
7. Tighten the muffler assembly bolts ⑱ to the specified torque.



Muffler assembly bolt ⑱: 20 N·m (2.0 kgf·m, 14.8 ft·lb)

9

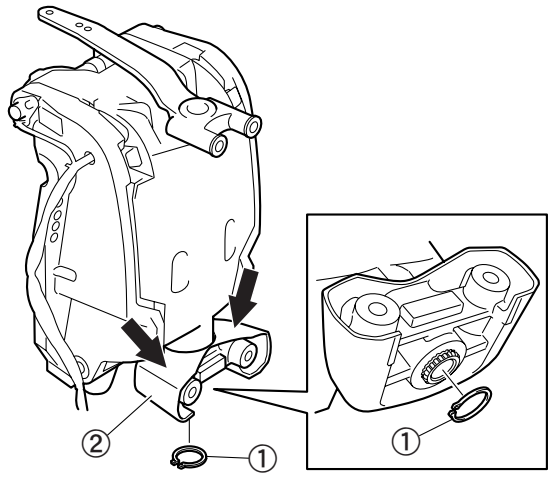
Steering arm



No.	Part name	Q'ty	Remarks
1	Steering arm	1	
2	Washer	2	
3	Bushing	2	
4	O-ring	1	**Not reusable**
5	Bushing	1	
6	Steering yoke	1	
7	Circlip	1	
8	Grommet	1	

Removing the steering arm

1. Remove the circlip ①, and then remove the steering yoke ② by striking it with a copper hammer.

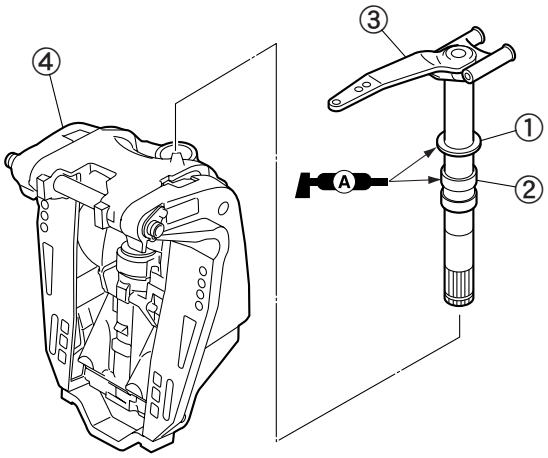


2. Remove the steering arm from the swivel bracket.

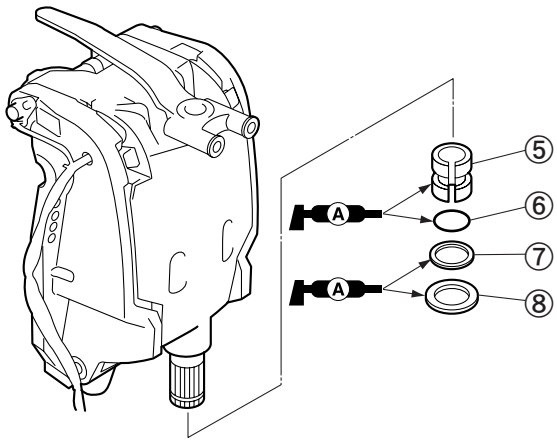
Installing the steering arm

1. Install the washer ① and bushing ② onto the steering arm ③.

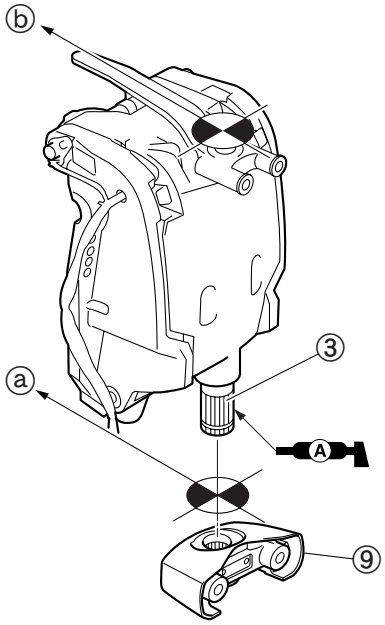
2. Place the swivel bracket ④ in an upright position, and then install the steering arm ③.



3. Install the bushing ⑤, a new O-ring ⑥, the bushing ⑦, and washer ⑧.



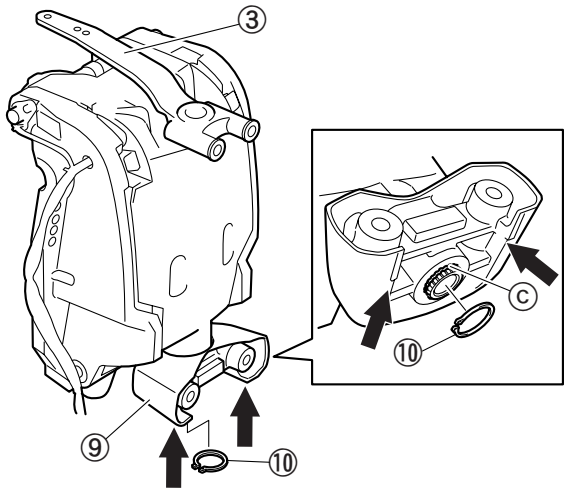
4. Install the steering yoke ⑨, making sure it is facing the same direction as the steering arm (aligning ⓐ with ⓑ).



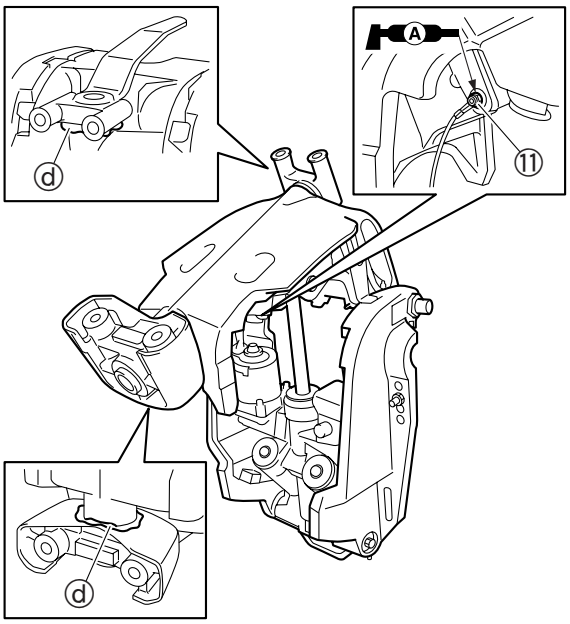
9

5. Hold the steering arm ③, and then strike the steering yoke ⑨ with a copper hammer until the groove ⓒ for installing the circlip is visible.

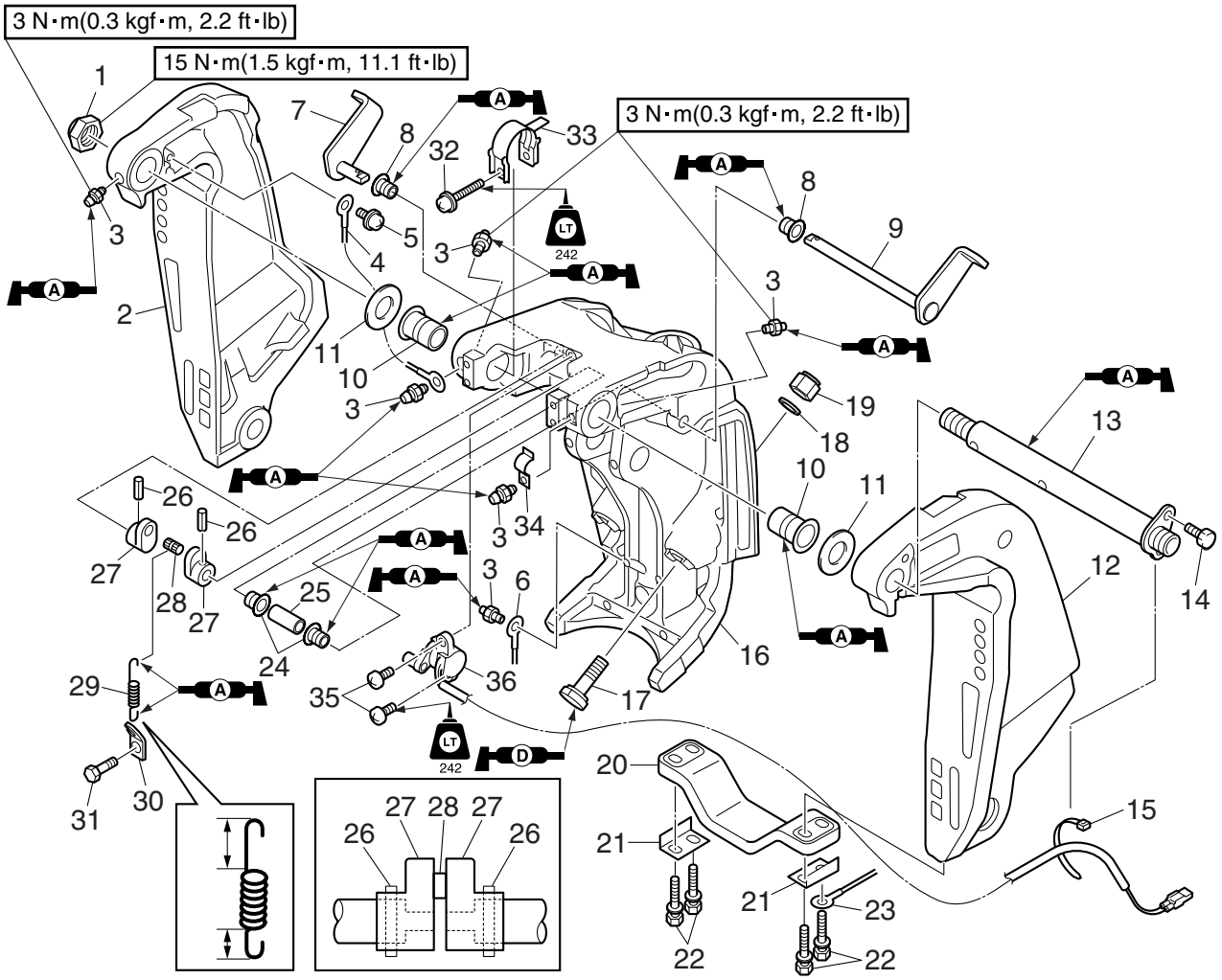
6. Install the circlip ⑩.



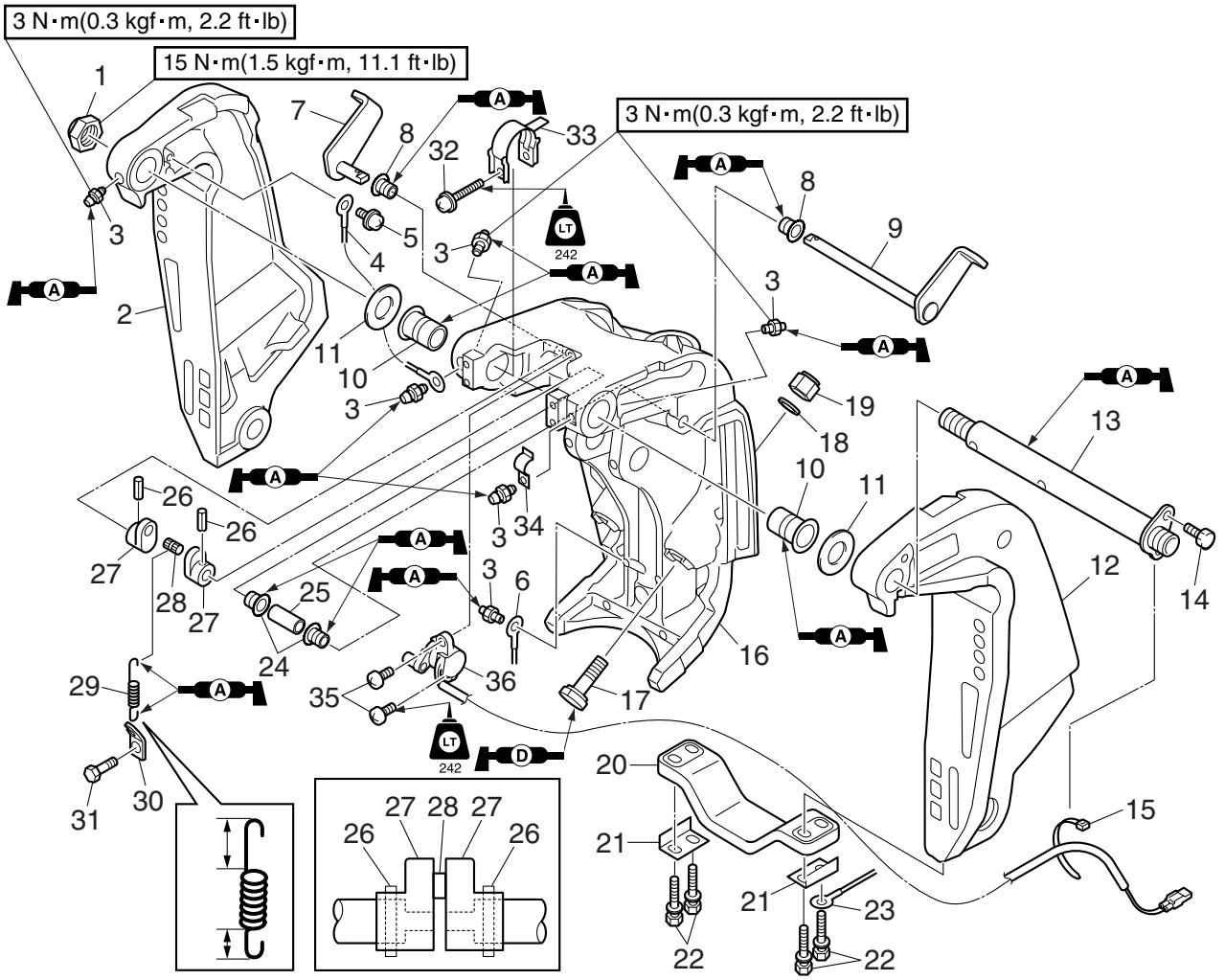
7. Apply grease into the grease nipple ⑪ until it comes out from both the upper and lower bushings ⓓ.



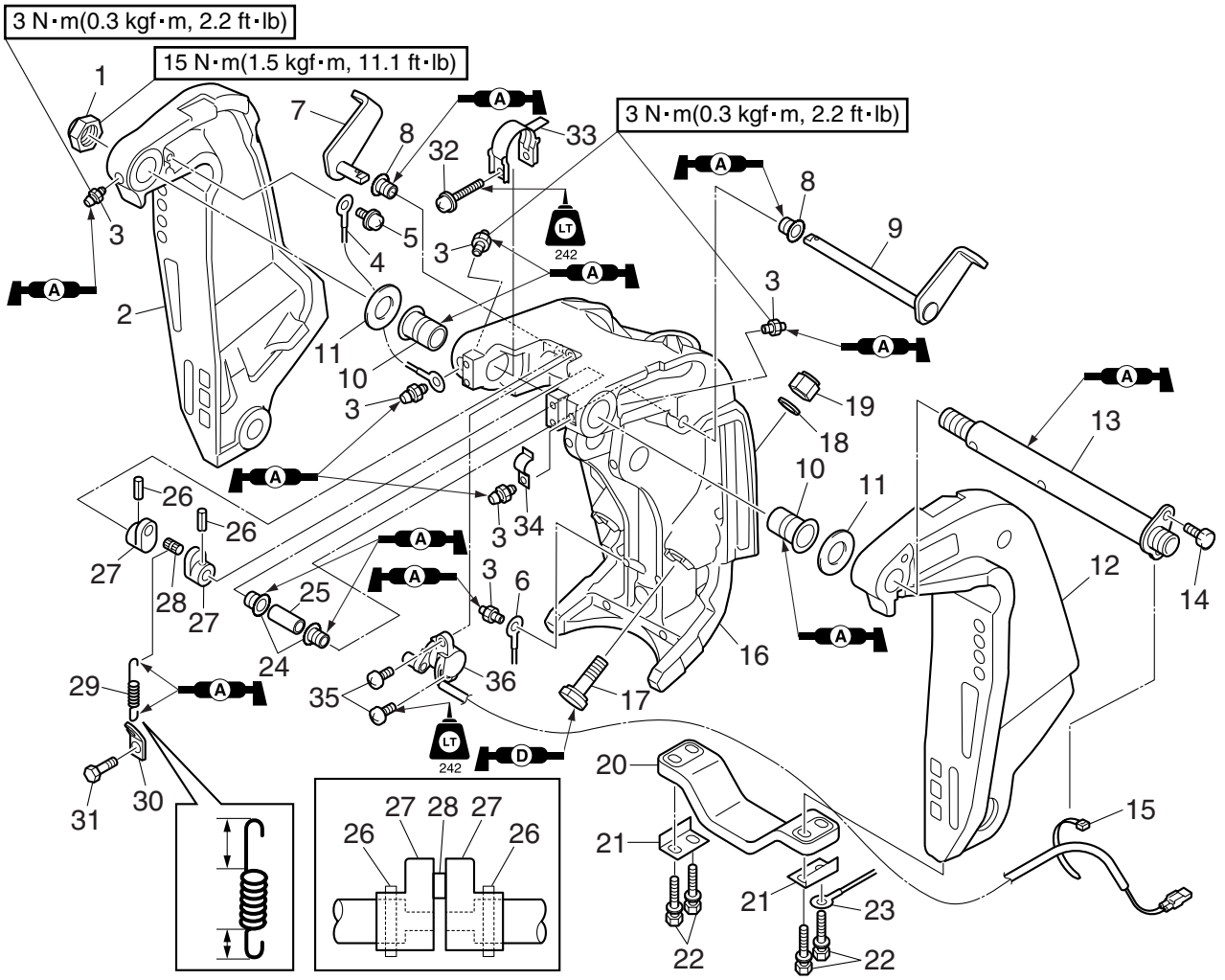
Clamp bracket and swivel bracket



No.	Part name	Q'ty	Remarks
1	Self-locking nut	1	
2	Clamp bracket (STBD)	1	
3	Grease nipple	6	
4	Ground lead	1	
5	Screw	1	M6 × 10 mm
6	Ground lead	1	
7	Tilt stop lever	1	
8	Bushing	2	
9	Tilt stop lever	1	
10	Bushing	2	
11	Washer	2	
12	Clamp bracket (PORT)	1	
13	Through tube	1	
14	Bolt	1	M8 × 20 mm
15	Plastic tie	1	**Not reusable**
16	Swivel bracket	1	
17	Trim stopper	2	



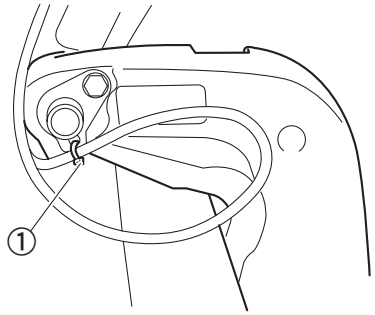
No.	Part name	Q'ty	Remarks
18	Washer	2	
19	Nut	2	
20	Anode	1	
21	Plate	2	
22	Bolt	4	M6 × 30 mm
23	Ground lead	1	
24	Bushing	2	
25	Collar	1	
26	Pin	2	
27	Distance collar	2	
28	Pin	1	
29	Spring	1	
30	Hook	1	
31	Bolt	1	M6 × 10 mm
32	Screw	1	M5 × 35 mm
33	Trim sensor cam	1	
34	Clamp	1	



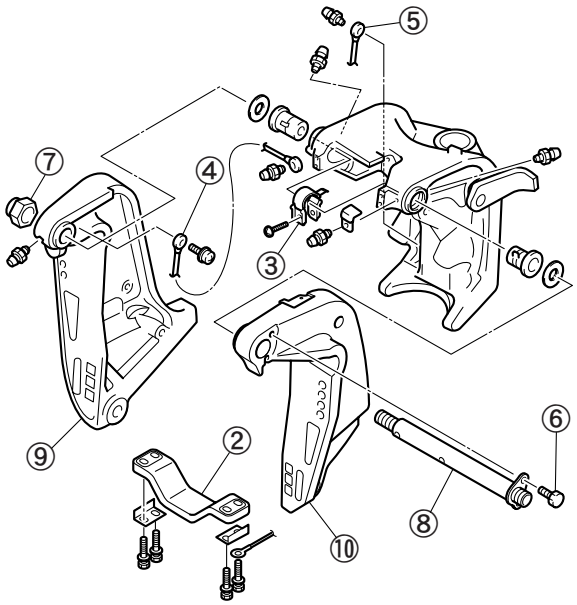
No.	Part name	Q'ty	Remarks
35	Screw	2	M6 × 15 mm
36	Trim sensor	1	

Removing the clamp bracket

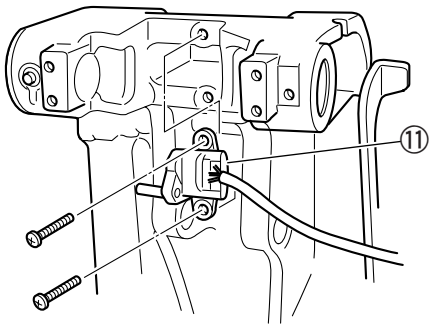
1. Remove the PTT unit. See “Removing the PTT unit” (9-33).
2. Remove the plastic tie ①.



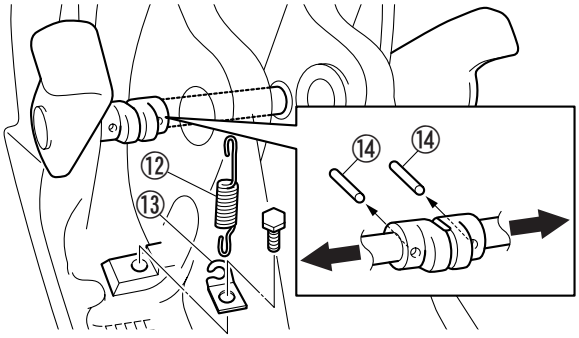
3. Remove the anode ②.
4. Remove the trim sensor cam ③.
5. Disconnect the ground lead ④ and ⑤.
6. Remove the bolt ⑥ and self-locking nut ⑦.
7. Remove the through tube ⑧, and then disassemble the clamp brackets ⑨ and ⑩.



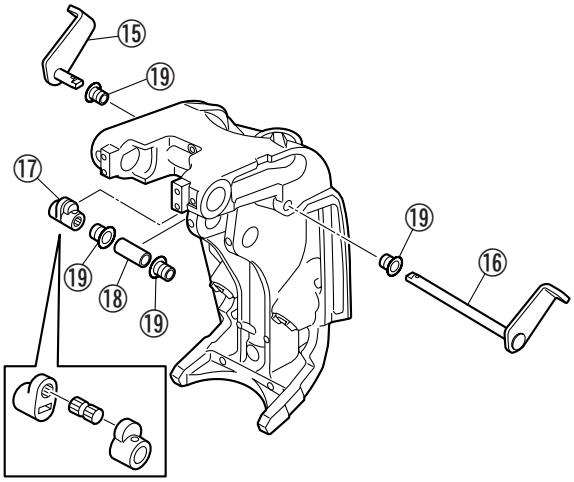
8. Remove the trim sensor ⑪.



9. Remove the spring ⑫, hook ⑬, and pins ⑭.

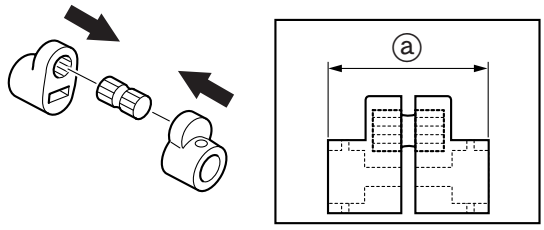


10. Remove the tilt stop levers ⑮, ⑯, distance collar assembly ⑰, collar ⑱, and bushings ⑲.



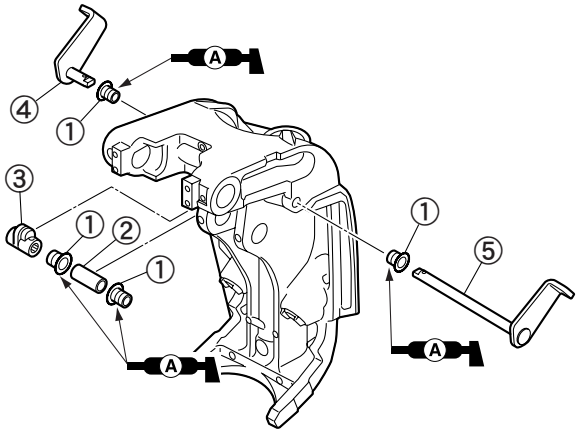
Installing the clamp bracket

1. Assemble the distance collar assembly.

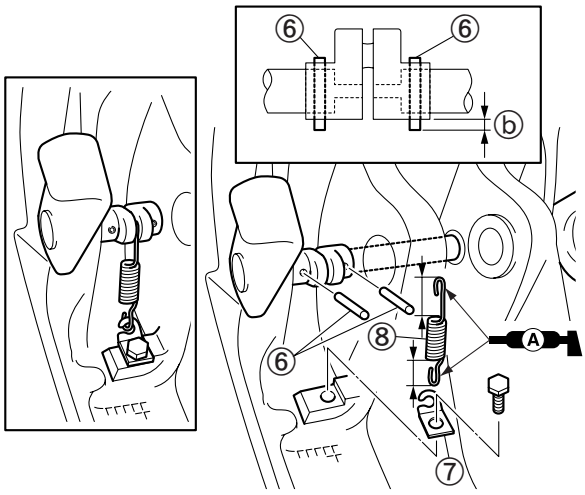


Distance ⓐ:
30.3–30.6 mm (1.19–1.20 in)

2. Install the bushings ①, collar ②, distance collar assembly ③, and tilt stop levers ④, ⑤.

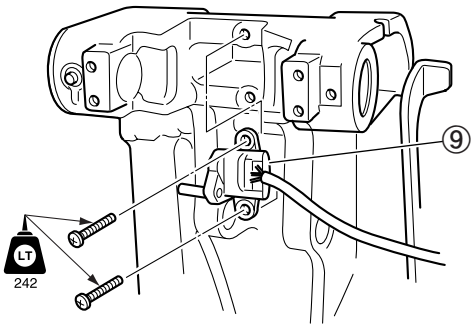


3. Install the pins ⑥, hook ⑦, and spring ⑧.



Distance ⓑ: 3.0 mm (0.12 in)

4. Install the trim sensor ⑨.



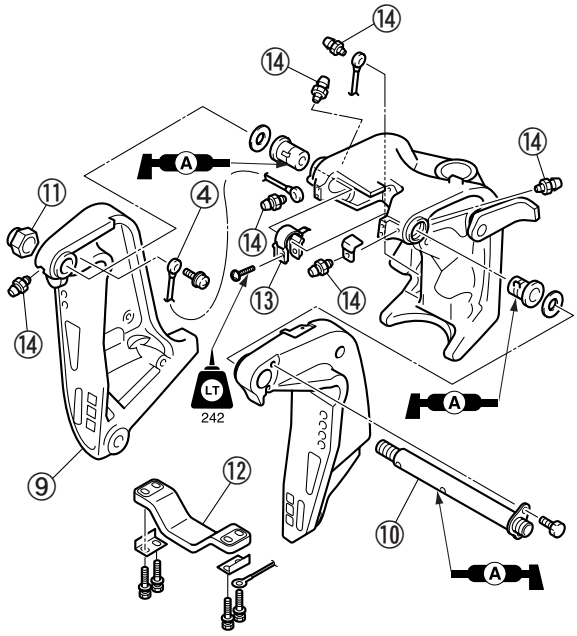
5. Install the through tube ⑩ and temporarily tighten the self-locking nut ⑪.

6. Install the anode ⑫.

7. Tighten the self-locking nut ⑪ to the specified torque.

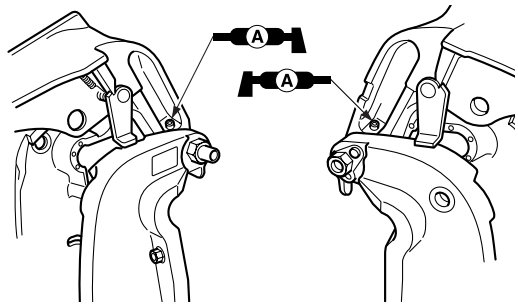
8. Install the trim sensor cam ⑬.

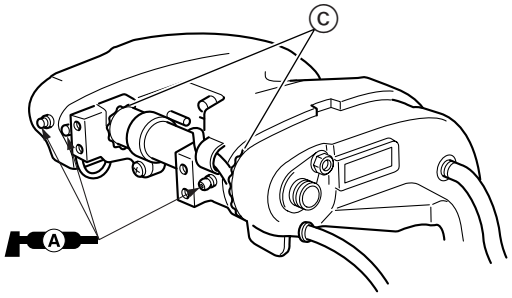
9. Install the grease nipples ⑭, and then tighten them ⑭ to the specified torque.



Self-locking nut ⑪:
15 N·m (1.5 kgf·m, 11.1 ft·lb)
Grease nipple ⑭:
3 N·m (0.3 kgf·m, 2.2 ft·lb)

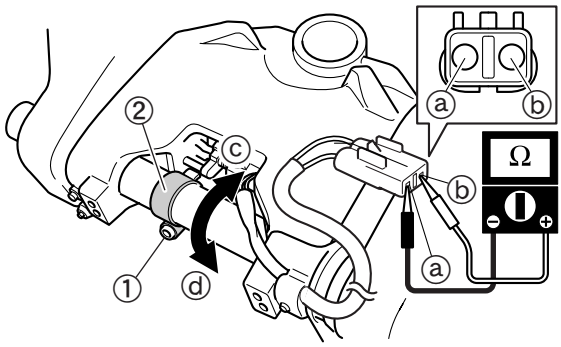
10. Apply grease into the grease nipples until grease comes out from the bushings ⓒ.





Adjusting the trim sensor cam

1. Fully tilt the swivel bracket down.
2. Loosen the trim sensor cam screw ①.
3. Adjust the trim sensor cam ② so that the trim sensor setting resistance is within specification.



Digital circuit tester: 90890-03174

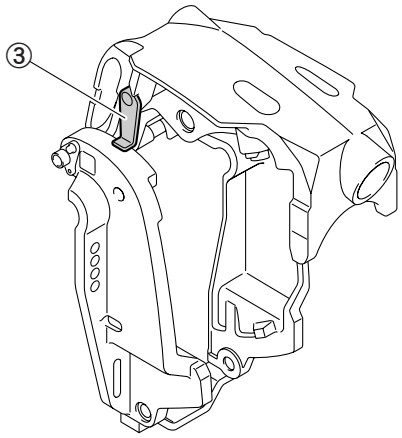
Trim sensor setting resistance
(reference data):
Terminal ⓐ–Terminal ⓑ
9.0–11.0 Ω

TIP:
- To decrease the resistance, turn the trim sensor cam in direction ⓒ.
- To increase the resistance, turn the trim sensor cam in direction ⓓ.

4. Tighten the trim sensor cam screw ①.

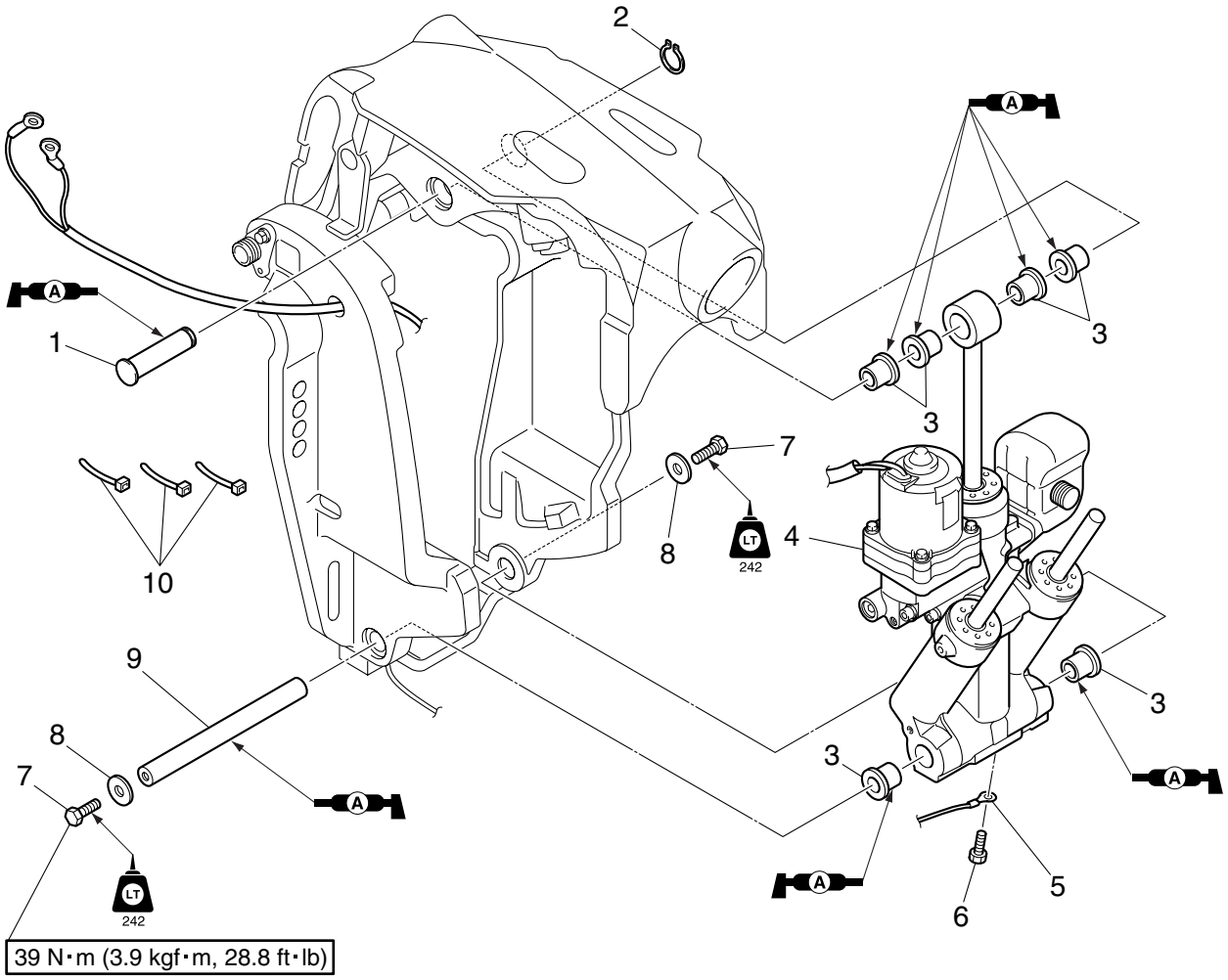
TIP:
Check the trim sensor resistance again after tightening the trim sensor cam screw ①.

5. Fully tilt the swivel bracket up, and then support it with the tilt stop lever ③. **WARNING! After tilting up the swivel bracket, make sure to support it with the tilt stop lever. Otherwise, the swivel bracket could suddenly lower.**



6. Check the trim sensor resistance. If the resistance is out of specification, adjust the trim sensor cam position again and check the trim sensor individually. See “Checking the trim sensor” (5-50).

PTT unit



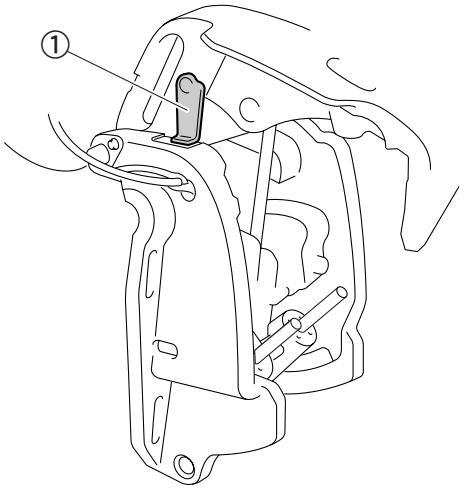
No.	Part name	Q'ty	Remarks
1	Shaft	1	
2	Circlip	1	
3	Bushing	6	
4	PTT unit	1	
5	Ground lead	1	
6	Bolt	1	M6 × 10 mm
7	Bolt	2	M10 × 30 mm
8	Washer	2	
9	Shaft	1	
10	Plastic tie	3	**Not reusable**

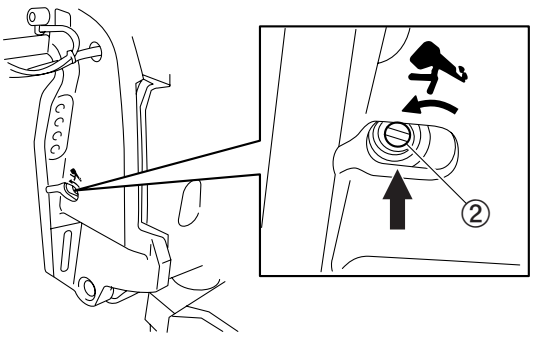
Removing the PTT unit

⚠ WARNING

- **After tilting up the swivel bracket, make sure to support it with the tilt stop lever. Otherwise, the swivel bracket could suddenly lower if the PTT unit should lose fluid pressure.**
- **When removing the PTT unit with the power unit installed, make sure to suspend the outboard motor. If the outboard motor is not suspended it can fall suddenly and result in severe injury.**

1. Fully tilt the swivel bracket up, and then support it with the tilt stop lever ①.

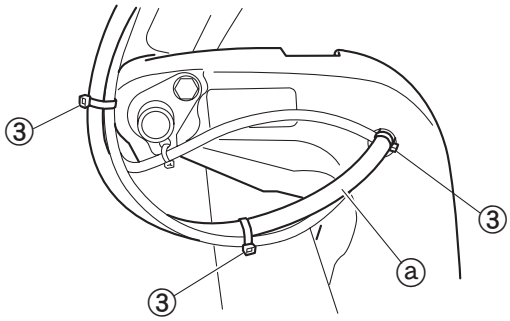




TIP:

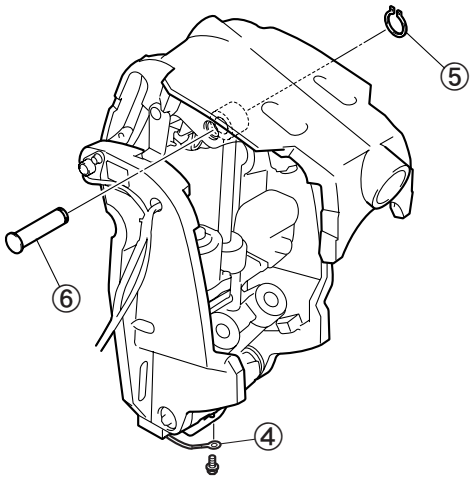
If the PTT unit does not operate, open the manual valve ② by turning it counterclockwise, and then tilt the swivel bracket up manually.

2. Remove the plastic ties ③, and then pull out the PTT motor lead ⓐ from the clamp bracket (PORT).

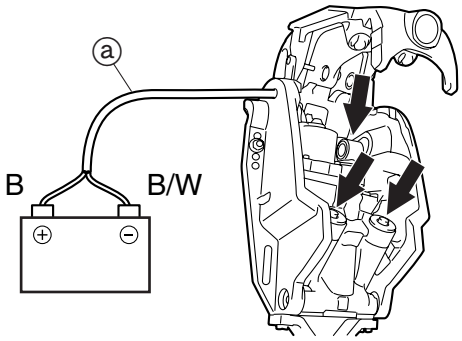


3. Disconnect the ground lead ④.

4. Remove the circlip ⑤, and the shaft ⑥.

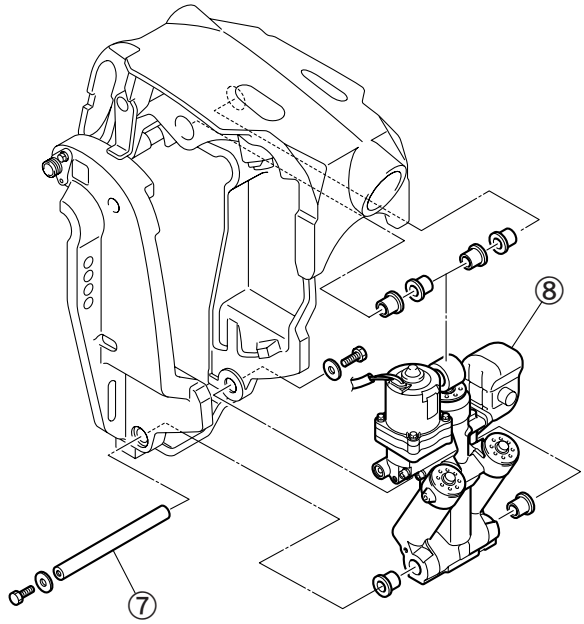


5. Connect the PTT motor leads ⓐ to the battery terminals to retract the PTT rams fully.



Ram	PTT motor lead	Battery terminal
Down	Black (B)	⊕
	Black/White (B/W)	⊖

6. Remove the shaft ⑦, and then remove the PTT unit ⑧.

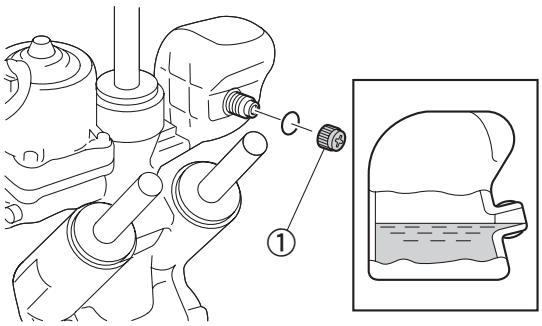


Checking the hydraulic pressure

Check the hydraulic pressure. If out of specification, check the internal parts.

1. Fully extend the PTT rams.

2. Remove the reservoir cap ①, and then check the fluid level in the reservoir. **WARNING! Make sure that the PTT rams are fully extended when removing the reservoir cap ①, otherwise fluid can spurt out from the unit due to internal pressure.**



TIP:

If the fluid is at the correct level, a small amount of fluid should overflow out of the filler hole when the reservoir cap is removed.

3. If the fluid is below the correct level, add the recommended fluid.

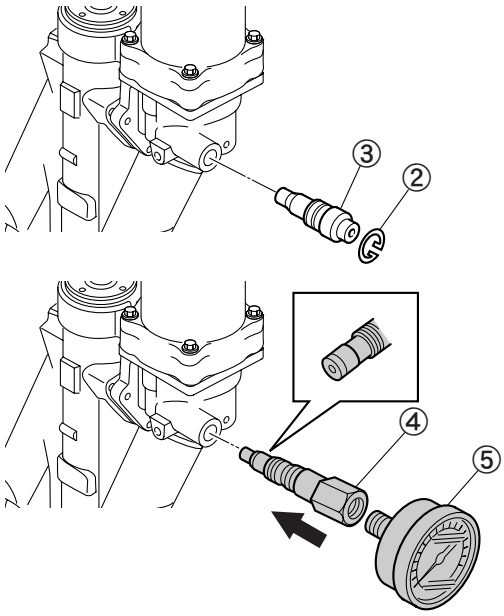
Recommended PTT fluid: ATF Dexron II

4. Install the reservoir cap ①, and then tighten it to the specified torque.

Reservoir cap ①: 0.7 N·m (0.07 kgf·m, 0.5 ft·lb)

5. Remove the circlip ②, and then remove the manual valve ③.

6. Install the special service tools ④ and ⑤.

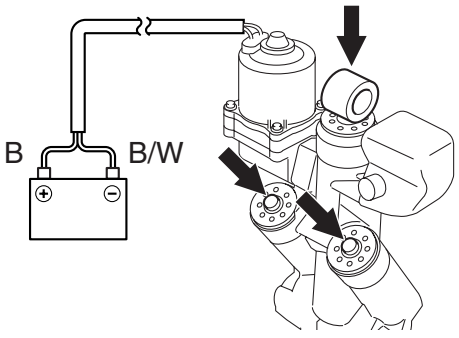


Up relief fitting ④: 90890-06773/06838 Hydraulic pressure gauge ⑤: 90890-06776/06800

TIP:

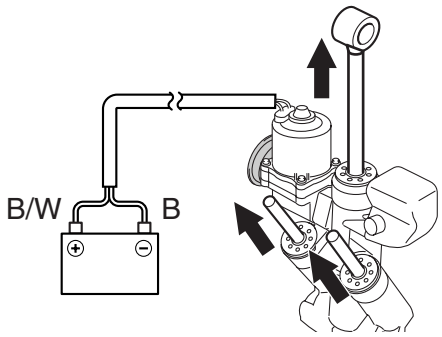
Quickly install the special service tools before any fluid flows out of the hole.

7. Connect the PTT motor leads to the battery terminals to fully retract the PTT rams.



Ram	PTT motor lead	Battery terminal
Down	Black (B)	⊕
	Black/White (B/W)	⊖

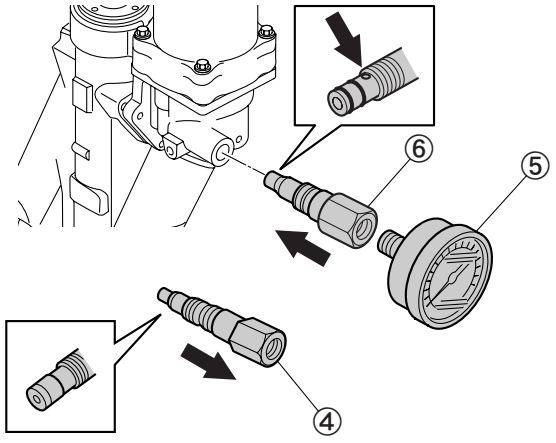
8. Reverse the PTT motor leads between the battery terminals to fully extend the PTT rams, and then measure the hydraulic pressure when the reading on the pressure gauge stabilizes.



Hydraulic pressure (up) (reference data): 9.8–11.8 MPa
(98.0–118.0 kgf/cm², 1421.0–1711.0 psi)

Ram	PTT motor lead	Battery terminal
Up	Black/White (B/W)	⊕
	Black (B)	⊖

9. Replace the special service tool ④ with the special service tool ⑥.

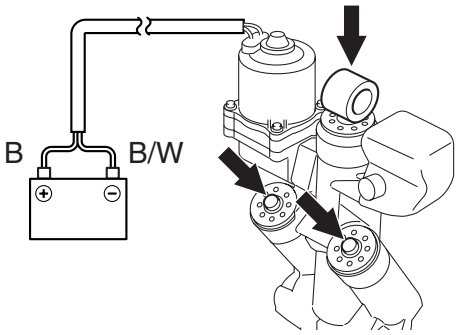


Hydraulic pressure gauge ⑤: 90890-06776/06800
Down relief fitting ⑥: 90890-06774

TIP:
Quickly change the special service tools before any fluid flows out of the hole.

10. For checking the fluid level, proceed the step 2–step 4 again.

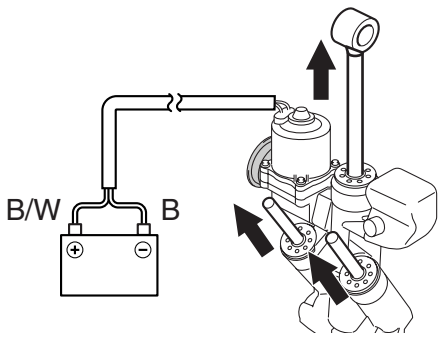
11. Connect the PTT motor leads to the battery terminals to fully retract the PTT rams, and then measure the hydraulic pressure when the reading on the pressure gauge stabilizes.



Hydraulic pressure (down) (reference data): 5.9–8.8 MPa
(59.0–88.0 kgf/cm², 855.5–1276.0 psi)

Ram	PTT motor lead	Battery terminal
Down	Black (B)	⊕
	Black/White (B/W)	⊖

12. Reverse the PTT motor leads between the battery terminals to fully extend the PTT rams.



Ram	PTT motor lead	Battery terminal
Up	Black/White (B/W)	⊕
	Black (B)	⊖

13. Remove the special service tools, and then install the manual valve and circlip.

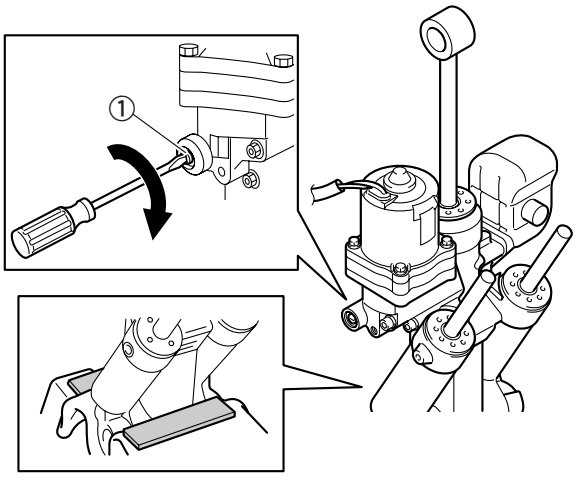
Manual valve: 3.5 N·m (0.35 kgf·m, 2.58 ft·lb)

TIP:
Quickly install the manual valve before any fluid flows out of the hole.

14. For checking the fluid level, proceed the step 2–step 4 again.

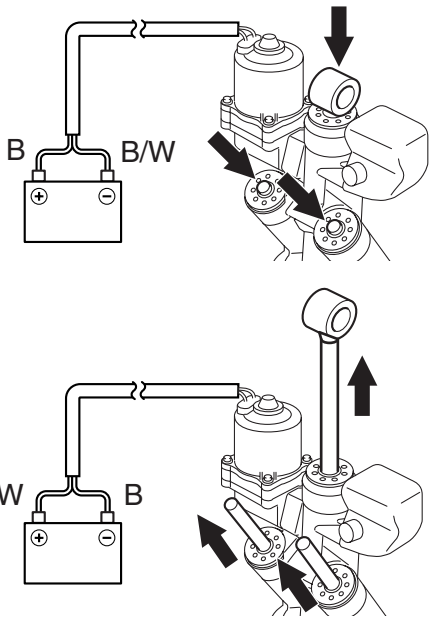
Bleeding the PTT unit

1. Place the PTT unit in an upright position.
2. Close the manual valve ① by turning it clockwise.



Manual valve ①: 3.5 N·m (0.35 kgf·m, 2.58 ft·lb)

3. For checking the fluid level, see "Checking the hydraulic pressure" (9-34) step 2–step 4.
4. Connect the PTT motor leads to the battery terminals to fully retract the PTT rams.
5. Reverse the PTT motor leads between the battery terminals to fully extend the PTT rams.



Ram	PTT motor lead	Battery terminal
Down	Black (B)	⊕
	Black/White (B/W)	⊖
Up	Black/White (B/W)	⊕
	Black (B)	⊖

TIP:
If the PTT rams do not move up and down easily, push and pull the PTT rams to assist operation.

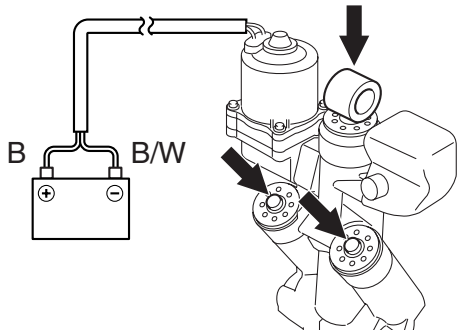
6. Check the fluid level when the PTT rams are fully extended. If the fluid level is low, add sufficient fluid, and then repeat step 3–step 7.

Installing the PTT unit

⚠ WARNING

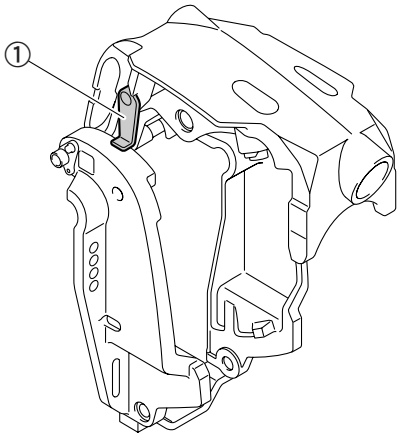
- **After tilting the swivel bracket up, make sure to support it with the tilt stop lever.**
- **When installing the PTT unit with the power unit installed, make sure to suspend the outboard motor. If the outboard motor is not suspended it can fall suddenly and result in severe injury.**

1. Connect the PTT motor leads ⓐ to the battery terminals to retract the PTT rams.



Ram	PTT motor lead	Battery terminal
Down	Black (B)	⊕
	Black/White (B/W)	⊖

2. Fully tilt the swivel bracket up, and then support it with the tilt stop lever ①.

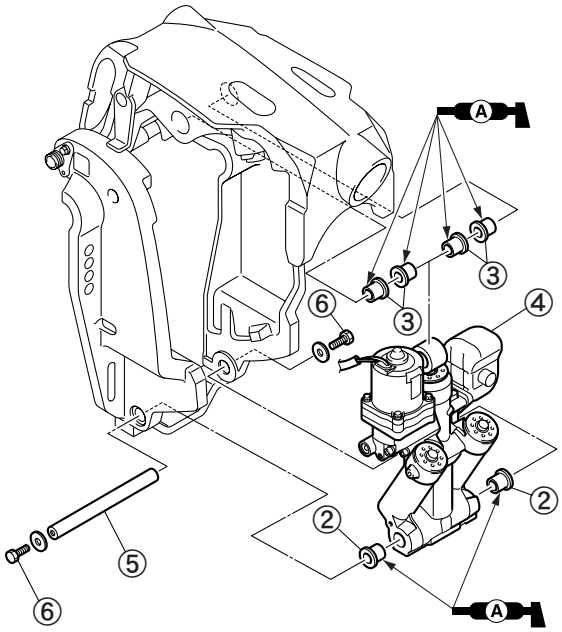


3. Install the bushings ②.

4. Install the bushings ③ to the tilt ram end and swivel bracket.

5. Install the PTT unit ④, and then install the shaft ⑤.

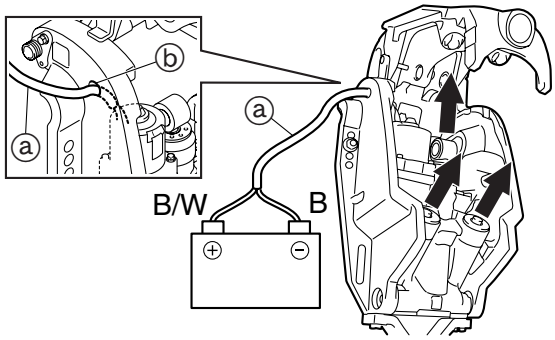
6. Tighten the shaft bolts ⑥ to the specified torque.



Bolt ⑥:
39 N·m (3.9 kgf·m, 28.7 ft·lb)

7. Pass the PTT motor leads ⓐ through the hole ⓑ in the clamp bracket (PORT).

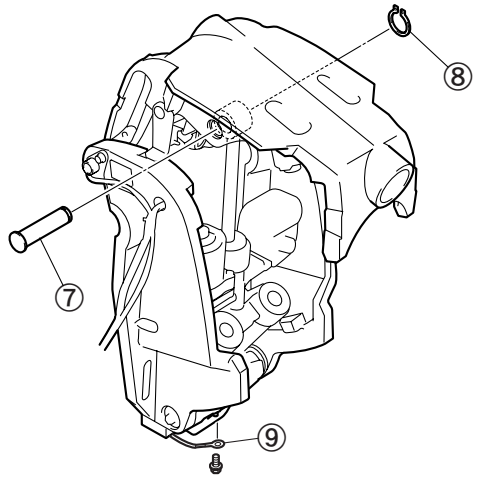
8. Connect the PTT motor leads ⓐ to the battery terminals to extend the PTT rams.



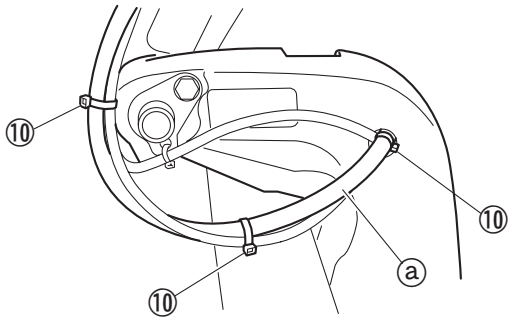
Ram	PTT motor lead	Battery terminal
Up	Black/White (B/W)	⊕
	Black (B)	⊖

9. Insert the shaft ⑦ from the port side and install the circlip ⑧.

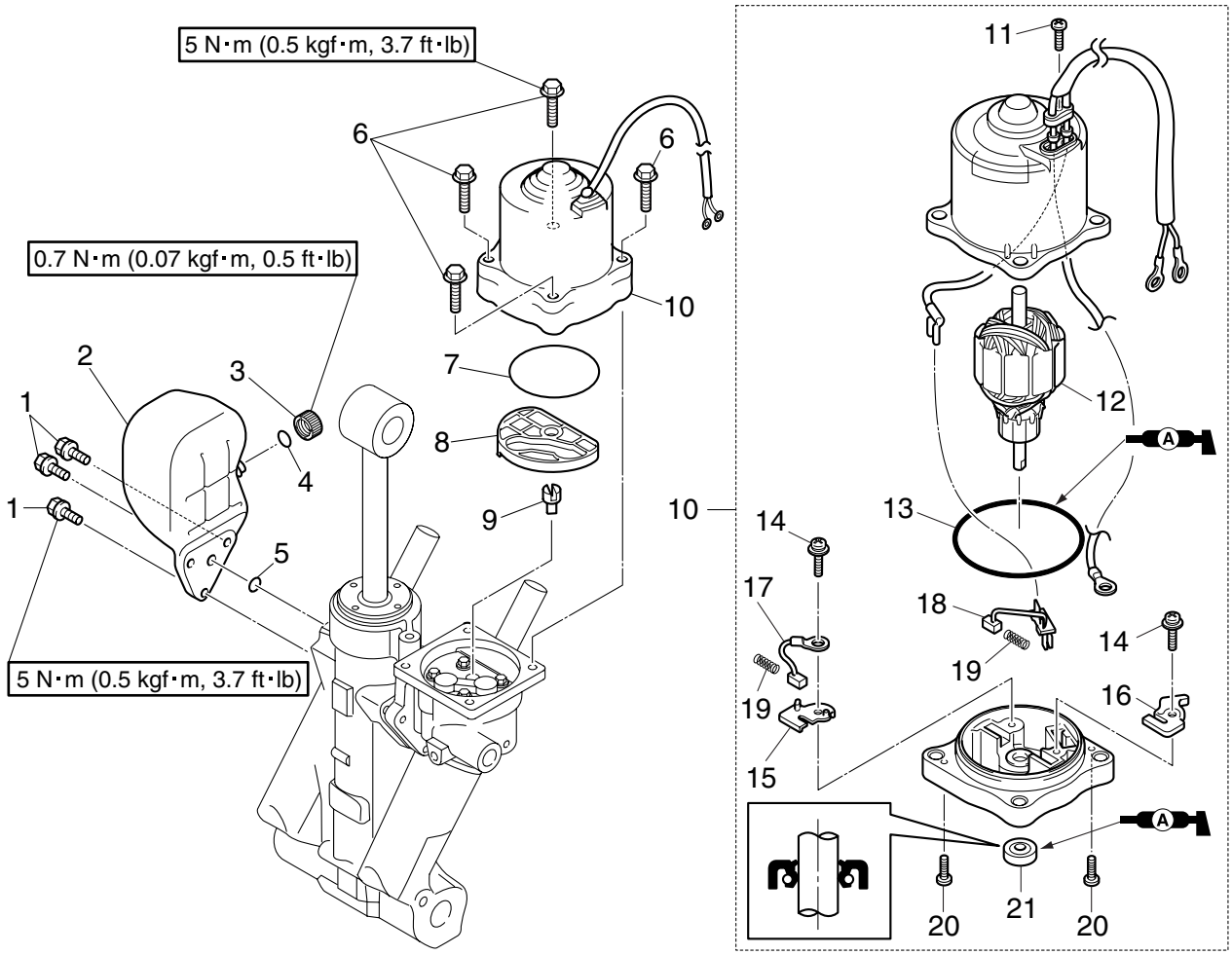
10. Connect the ground lead ⑨.



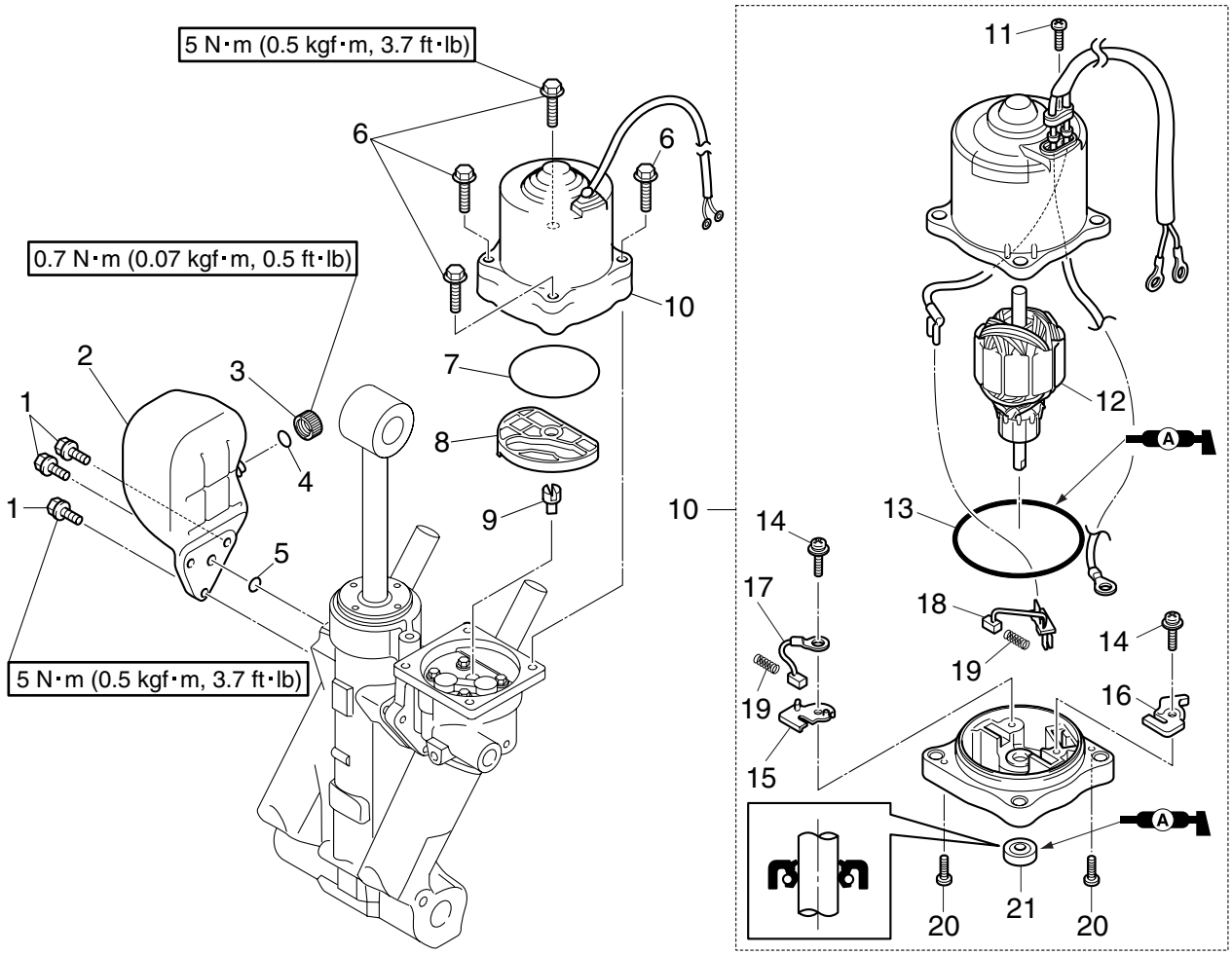
11. Fasten the PTT motor lead ⓐ and trim sensor lead with new plastic ties ⑩.



PTT motor



No.	Part name	Q'ty	Remarks
1	Bolt	3	M6 × 14 mm
2	Reservoir	1	
3	Cap	1	
4	O-ring	1	**Not reusable**
5	O-ring	1	**Not reusable**
6	Bolt	4	M6 × 33 mm
7	O-ring	1	**Not reusable**
8	Filter	1	
9	Joint	1	
10	PTT motor assembly	1	
11	Screw	1	M4 × 15 mm
12	Armature	1	
13	O-ring	1	**Not reusable**
14	Screw	2	M4 × 12 mm
15	Brush holder	1	
16	Brush holder	1	
17	Brush 2	1	



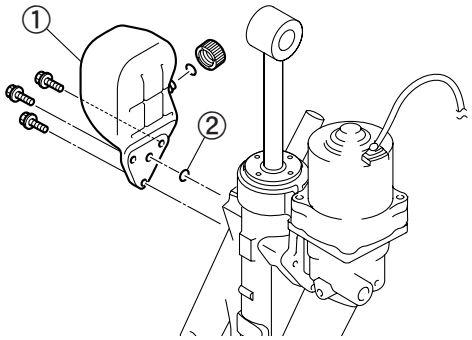
No.	Part name	Q'ty	Remarks
18	Brush 1	1	
19	Spring	2	
20	Screw	2	M4 × 15 mm
21	Oil seal	1	**Not reusable**

Removing the reservoir

⚠ WARNING

- **Make sure that the PTT rams are fully extended when removing the reservoir, otherwise fluid can spurt out from the unit due to internal pressure.**
- **Do not push the PTT rams down while the reservoir is removed from the PTT unit, otherwise fluid can spurt out.**

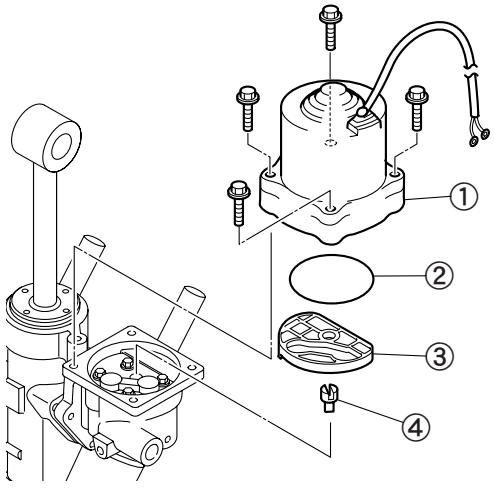
1. Remove the reservoir ① and O-ring ②.



TIP:
Place a container under the PTT unit to catch the fluid.

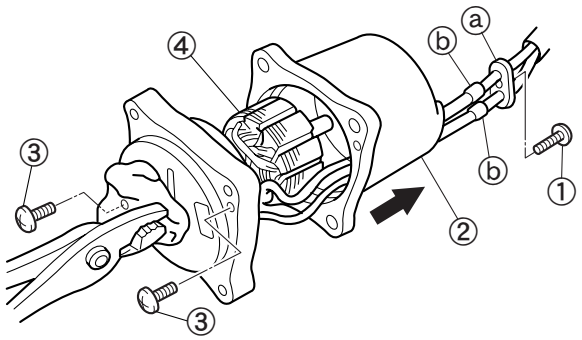
Removing the PTT motor

1. Remove the PTT motor assembly ①, O-ring ②, gear pump filter ③, and joint ④.

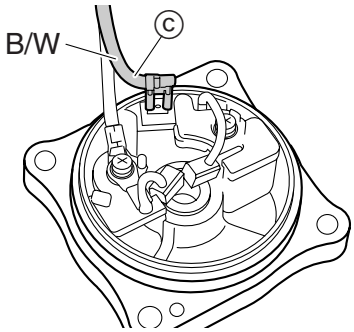


Disassembling the PTT motor

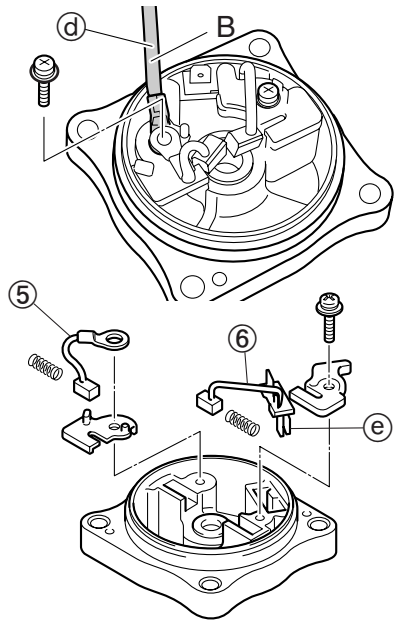
1. Remove the screw ①, and then slide the lead holder ⓐ and rubber seals ⓑ away from the stator ②.
2. Remove the PTT motor screws ③, and then remove the stator ②. ***NOTICE:*** **Hold the end of the armature shaft with a pair of pliers, and then remove the armature together with the motor base assembly, otherwise the armature could separate from the motor base assembly due to the magnetic force of the stator ② and damage the brushes.**



3. Remove the armature ④.
4. Disconnect the PTT motor lead (B/W: Black/White) ⓒ.

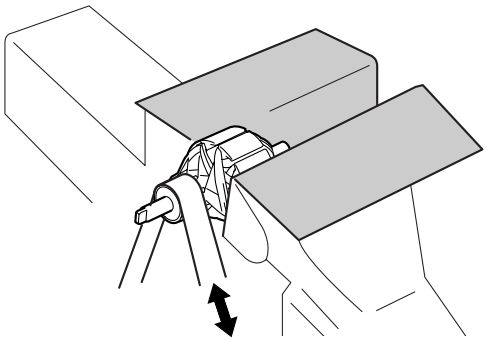


5. Disconnect the PTT motor lead (B: Black) ⓓ, and then remove the brushes ⑤ and ⑥. ***NOTICE:*** **Do not touch the bimetal ⓔ, otherwise the operation of the circuit breaker can be affected.**

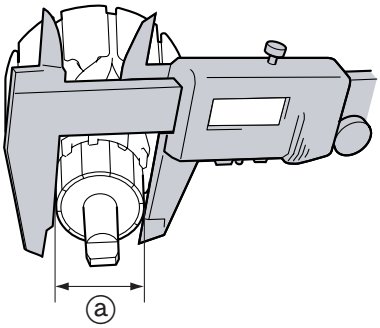


Checking the PTT motor

1. Check the commutator. Clean with 600 grit sandpaper and compressed air if dirty.

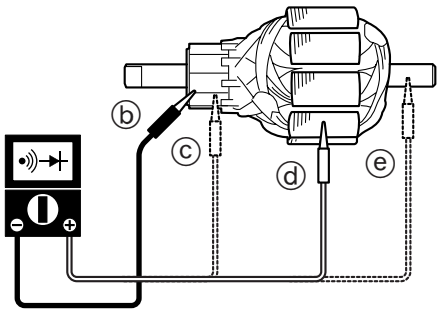


2. Measure the commutator diameter. Replace the armature if below specification.



Motor commutator standard diameter ⓐ:
22.0 mm (0.87 in)
Wear limit: 21.0 mm (0.83 in)

3. Check the armature continuity. Replace if out of specification.

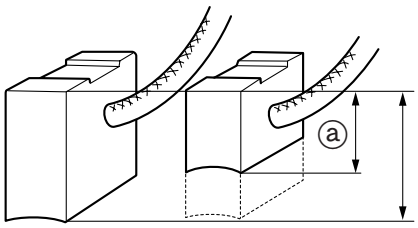


Digital circuit tester: 90890-03174

Armature continuity:			
ⓑ	ⓒ	ⓓ	ⓔ
○——○			

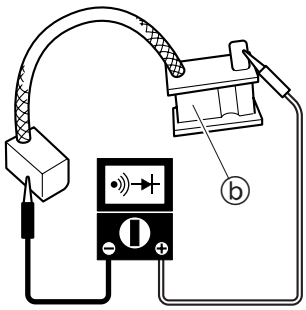
Checking the brush

1. Measure the length of each brush. Replace the brushes if below specification.



Motor brush standard length:
9.8 mm (0.39 in)
Wear limit ⓐ: 4.8 mm (0.19 in)

2. Check the brush and circuit breaker for continuity. Replace if there is no continuity. ***NOTICE:*** **Do not touch the bimetal ⓑ, otherwise the operation of the circuit breaker can be affected.**



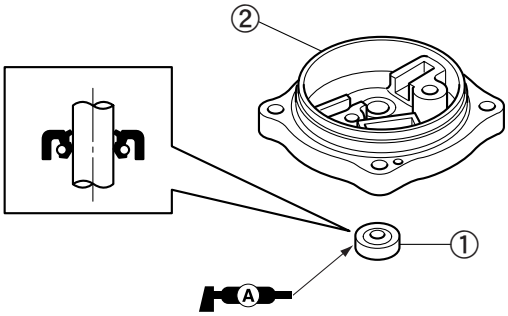
3. Check the motor base and bearing. Replace the PTT motor assembly if the motor base is cracked or damaged, or if the bearing is pitted or if there is rumbling.

Assembling the PTT motor

NOTICE

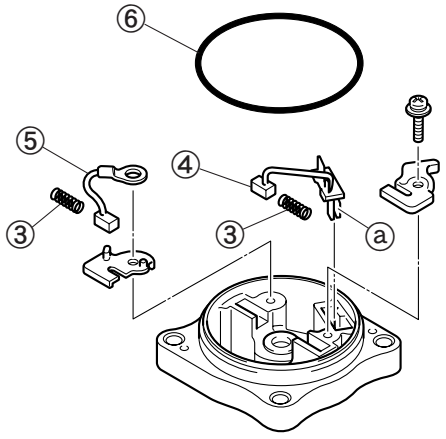
- **Do not reuse the oil seal and O-rings, always replace them with new ones.**
- **Do not allow grease or oil to contact the commutator of the armature.**

1. Install a new oil seal ① into the motor base ②.

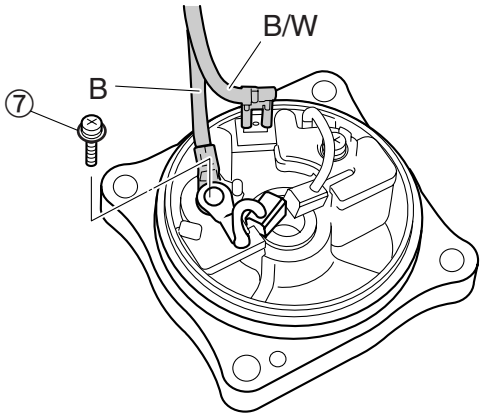


2. Install the brush springs ③ and brushes ④, ⑤.

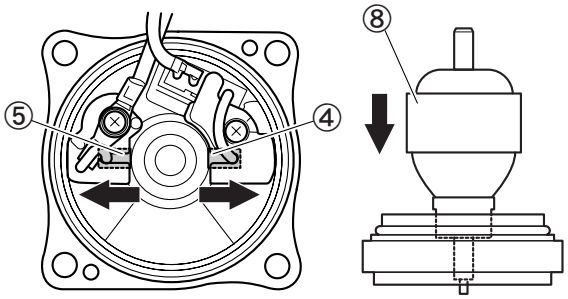
3. Install a new O-ring ⑥. ***NOTICE:*** **Do not touch the bimetal ⓐ, otherwise the operation of the circuit breaker can be affected.**



4. Connect the PTT motor lead (B/W: Black/White) and lead (B: Black), and then tighten the screw ⑦.

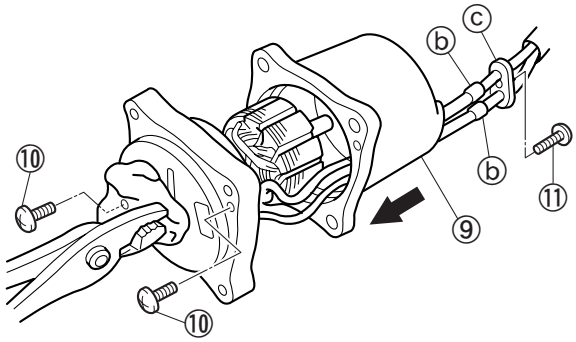


5. Push the brushes ④ and ⑤ into the holders, and then install the armature ⑧.



6. Install the stator ⑨, and then tighten the screws ⑩. ***NOTICE:*** **Hold the end of the armature shaft with a pair of pliers, and then install the armature together with the motor base assembly, otherwise the armature could separate from the motor base assembly due to the magnetic force of the stator ⑨ and damage the brushes.**

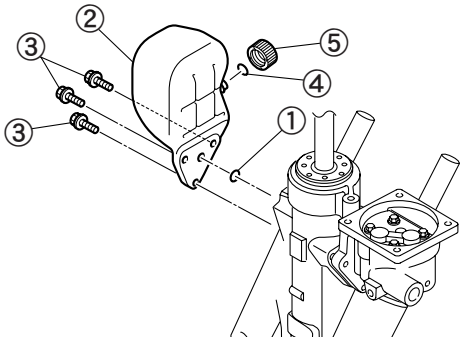
7. Install the rubber seals ⓑ and lead holder ⓒ, and then tighten the screw ⑪.



Installing the reservoir

1. Install a new O-ring ① and the reservoir ②, and then tighten the reservoir mounting bolts ③ to the specified torque.

2. Install a new O-ring ④ and the reservoir cap ⑤, and then tighten the reservoir cap ⑤ to the specified torque.



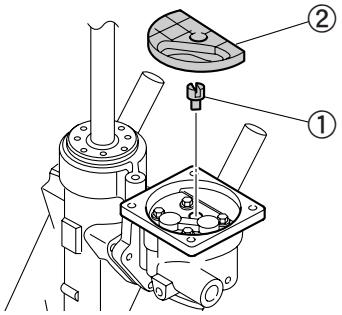
Reservoir mounting bolt ③:
5 N·m (0.5 kgf·m, 3.7 ft·lb)
Reservoir cap ⑤:
0.7 N·m (0.07 kgf·m, 0.5 ft·lb)

Installing the PTT motor

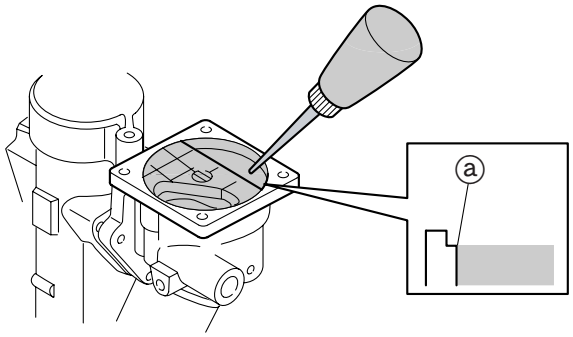
NOTICE

Do not use a rag when assembling the PTT unit because dust and particles on the PTT unit components can lead to poor performance.

1. Install the joint ① and gear pump filter ②.



2. Fill the gear pump housing with the recommended fluid to the correct level ⓐ.

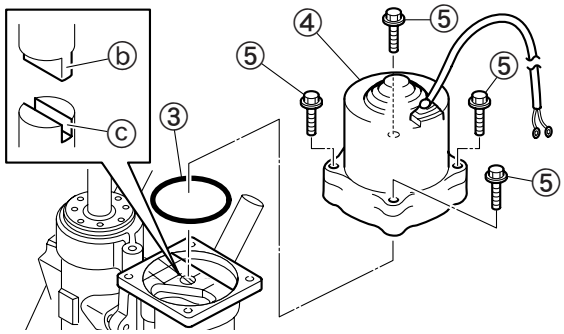


Recommended PTT fluid: ATF Dexron II

3. Turn the joint ① with a screwdriver, and then remove any air between the pump gear teeth.

4. Remove all of the air bubbles with a syringe or suitable tool.

5. Install a new O-ring ③ and the PTT motor assembly ④, and then tighten the PTT motor mounting bolts ⑤ to the specified torque.



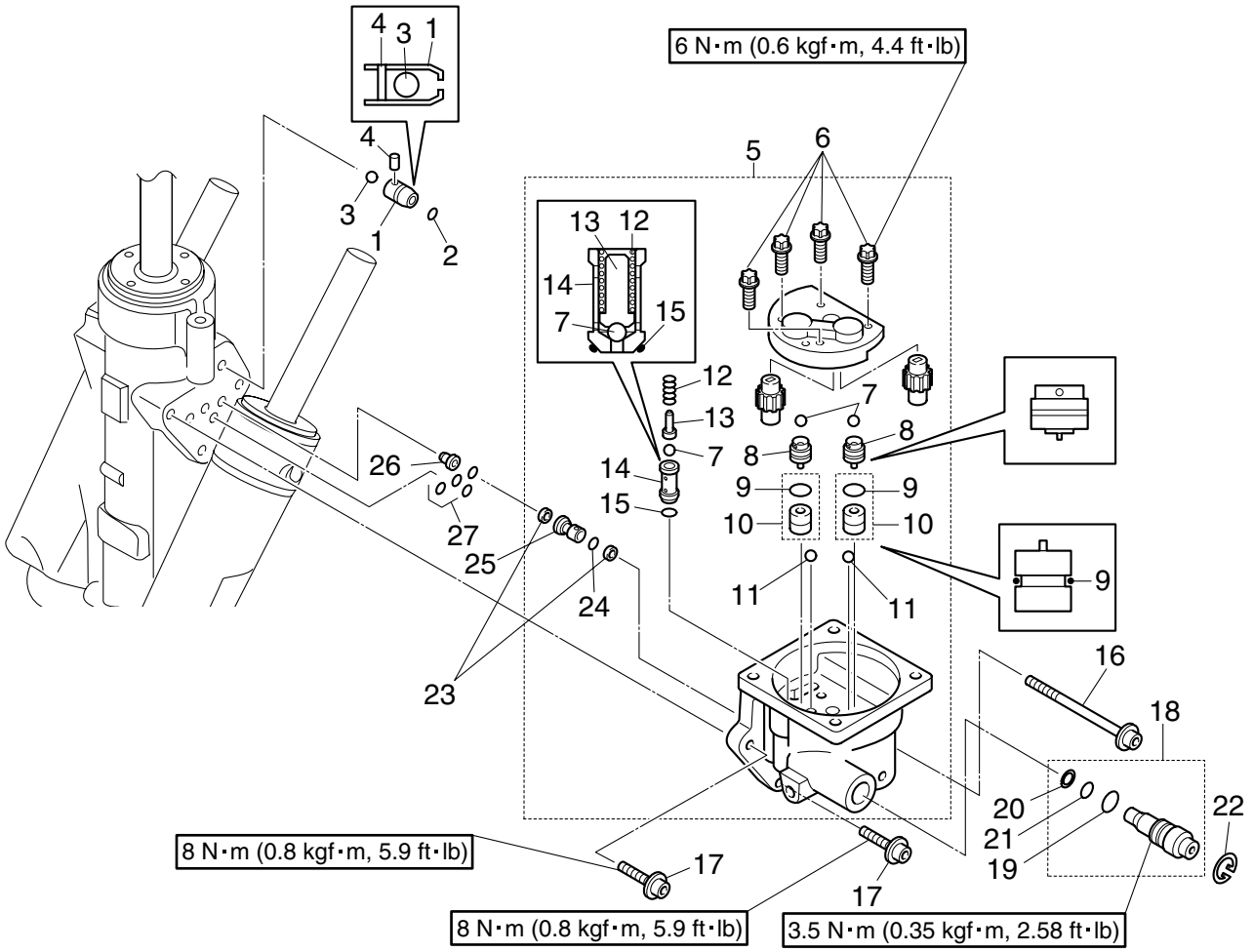
PTT motor mounting bolt ⑤:
5 N·m (0.5 kgf·m, 3.7 ft·lb)

TIP:

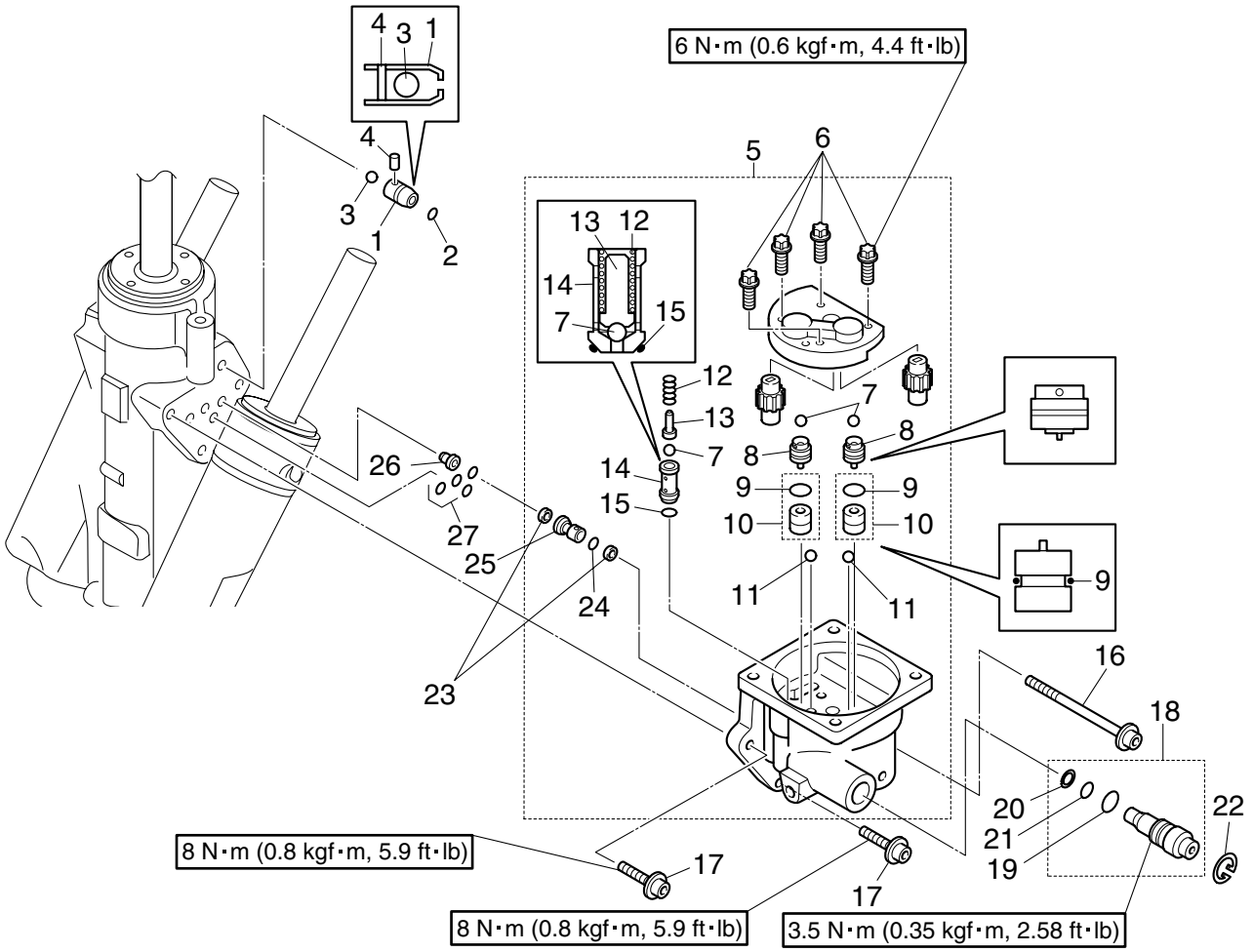
Align the projection ⓑ on the armature shaft with the slot ⓒ in the joint.

9

PTT gear pump



No.	Part name	Q'ty	Remarks
1	Valve seat	1	
2	O-ring	1	**Not reusable**
3	Ball	1	
4	Pin	1	
5	Gear pump assembly	1	
6	Bolt	4	M5 × 16 mm
7	Ball	3	
8	Shuttle piston	2	
9	O-ring	2	**Not reusable**
10	Main valve	2	
11	Ball	2	
12	Spring	1	
13	Absorber valve pin	1	
14	Up-relief valve seat	1	
15	O-ring	1	**Not reusable**
16	Bolt	1	M8 × 85 mm
17	Bolt	2	M8 × 24 mm



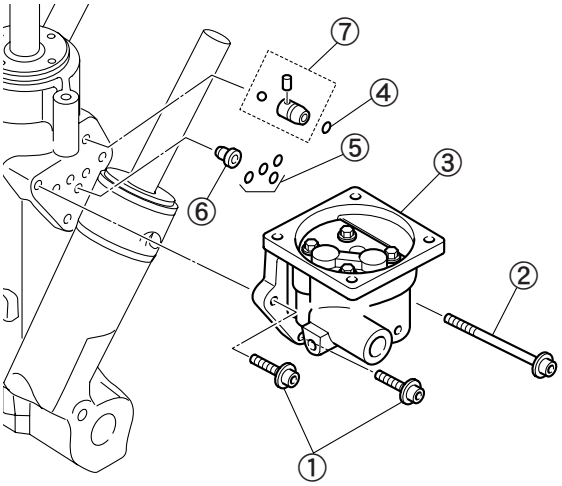
No.	Part name	Q'ty	Remarks
18	Manual valve	1	
19	O-ring	1	**Not reusable**
20	Backup ring	1	
21	O-ring	1	**Not reusable**
22	Circlip	1	
23	Filter	2	
24	O-ring	1	**Not reusable**
25	Down-relief valve	1	
26	Valve pin	1	
27	O-ring	4	**Not reusable**

Disassembling the gear pump assembly

1. Remove the PTT motor assembly. See “Removing the PTT motor” (9-41).

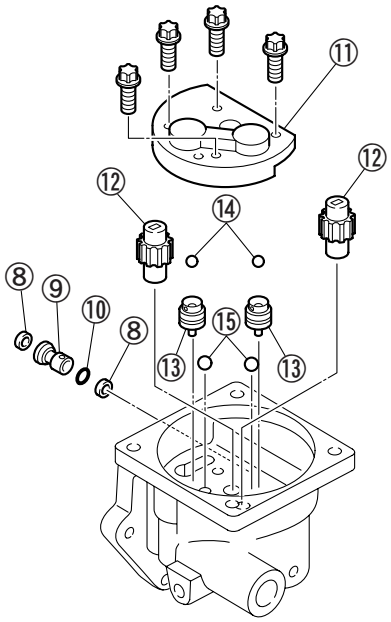
2. Remove the bolts ① and ②, and then remove the gear pump assembly ③.

3. Remove the O-rings ④, ⑤, valve pin ⑥, and valve seat assembly ⑦.

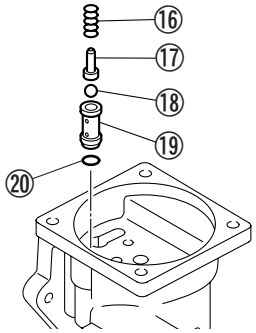


4. Remove the filters ⑧, down-relief valve ⑨, and O-ring ⑩.

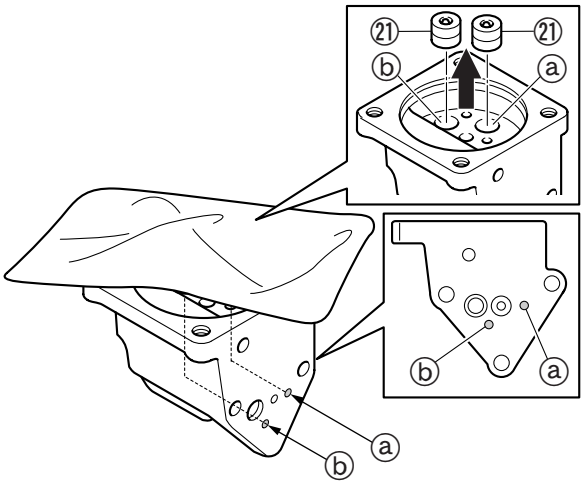
5. Remove the gear pump cover ⑪, and then remove the gears ⑫, shuttle pistons ⑬, and balls ⑭, ⑮.



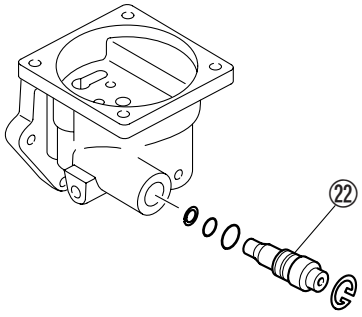
6. Remove the spring ⑯, absorber valve pin ⑰, ball ⑱, and up-relief valve seat ⑲ and O-ring ⑳.



7. Blow compressed air through the holes ⓐ and ⓑ to remove the main valves ㉑. **WARNING! Never look into the gear pump housing opening while removing the main valves because the main valves and PTT fluid could be forcefully expelled out.**



8. Remove the manual valve ㉒.



Checking the gear pump

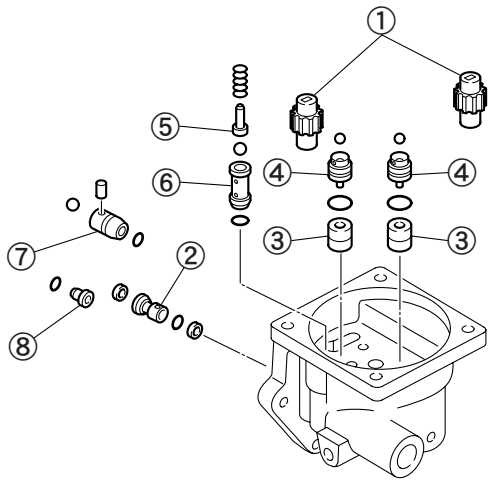
1. Check the gears ①. Replace the gear pump assembly if damaged or excessively worn.

2. Check the down-relief valve ②. Clean if there is dirt or residue.

3. Check the main valves ③ and shuttle pistons ④. Clean if there is dirt or residue.

4. Check the absorber valve pin ⑤ and up-relief valve seat ⑥. Clean if there is dirt or residue.

5. Check the valve pin ⑦ and valve seat ⑧. Clean if there is dirt or residue.

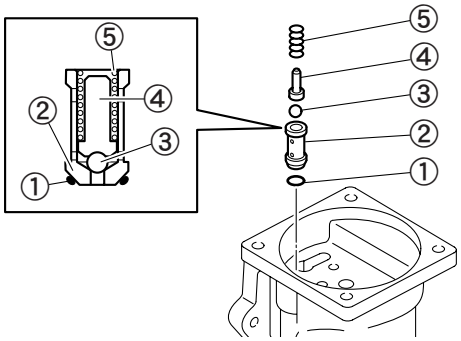


Assembling the gear pump assembly

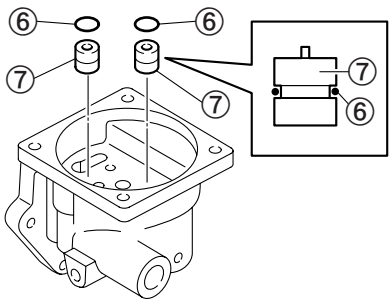
NOTICE

- **Do not use a rag when assembling the PTT unit because dust and particles on the PTT unit components can lead to poor performance.**
- **Do not reuse the O-rings, always replace them with new ones.**

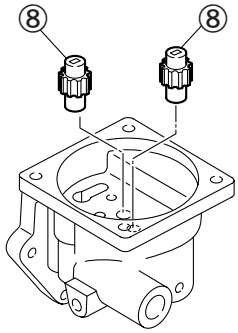
1. Install a new O-ring ①, the up-relief valve seat ②, ball ③, absorber valve pin ④, and spring ⑤.



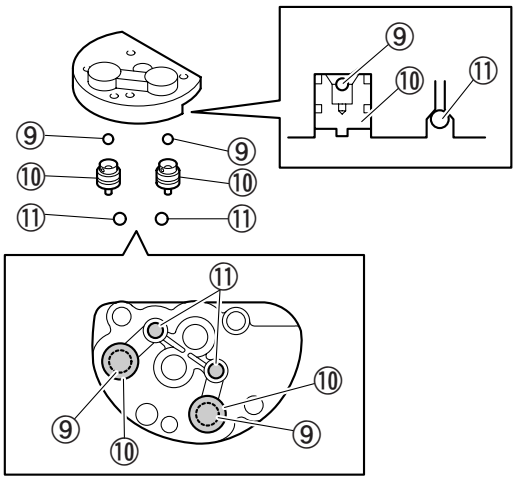
2. Install new O-rings ⑥ onto the main valves ⑦, and then install the main valves.



3. Install the gears ⑧.



4. Install the balls ⑨, shuttle pistons ⑩, and balls ⑪.

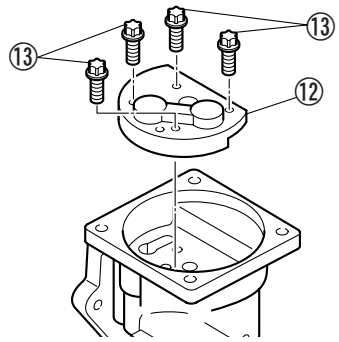


TIP:

Apply grease to the balls and shuttle pistons to prevent them from falling out of the gear pump cover.

9

5. Install the gear pump cover ⑫, and then tighten the gear pump cover bolts ⑬ temporarily.

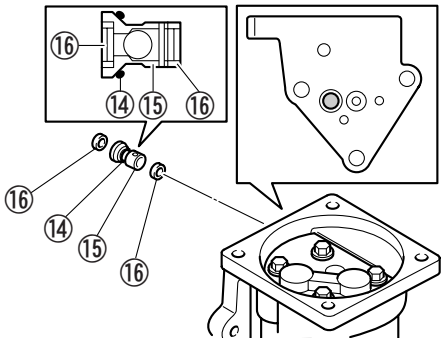


6. Check that the gear pump turns smoothly, and then tighten the gear pump cover bolts ⑬ to the specified torque.

Bolt ⑬: 6 N·m (0.6 kgf·m, 4.4 ft·lb)

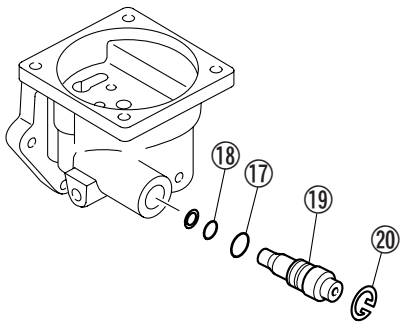
7. Install a new O-ring ⑭ onto the down-relief valve ⑮.

8. Install the filters ⑯ and down-relief valve ⑮.



9. Install new O-rings ⑰ and ⑱ onto the manual valve ⑲.

10. Install the manual valve ⑲ and circlip ⑳, and then tighten the manual valve to the specified torque.

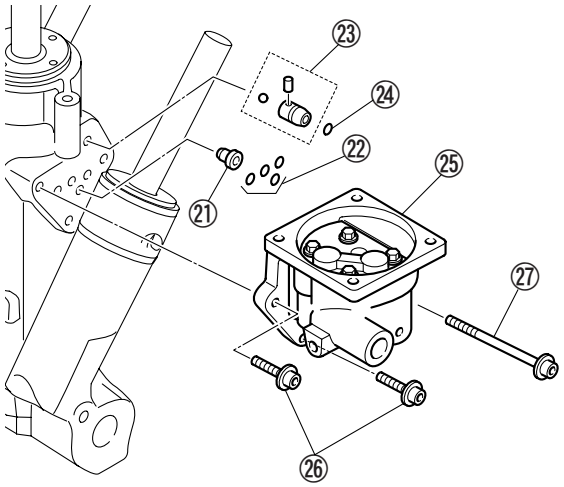


Manual valve ⑲: 3.5 N·m (0.35 kgf·m, 2.58 ft·lb)

11. Install the valve pin ㉑ and new O-rings ㉒.

12. Install the valve seat assembly ㉓, and O-rings ㉔.

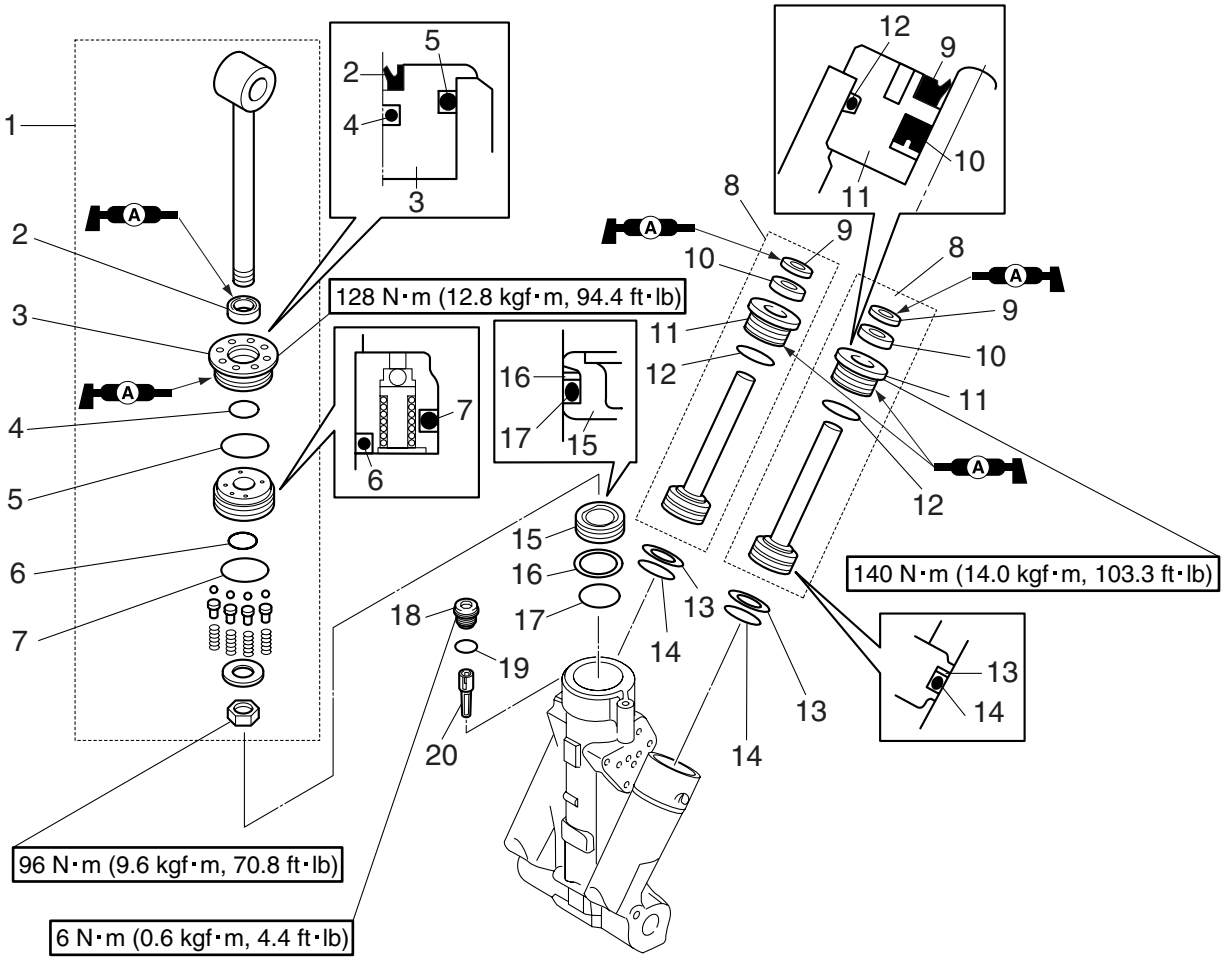
13. Install the gear pump assembly ㉕, and then tighten the gear pump mounting bolts ㉖ and ㉗ to the specified torque.



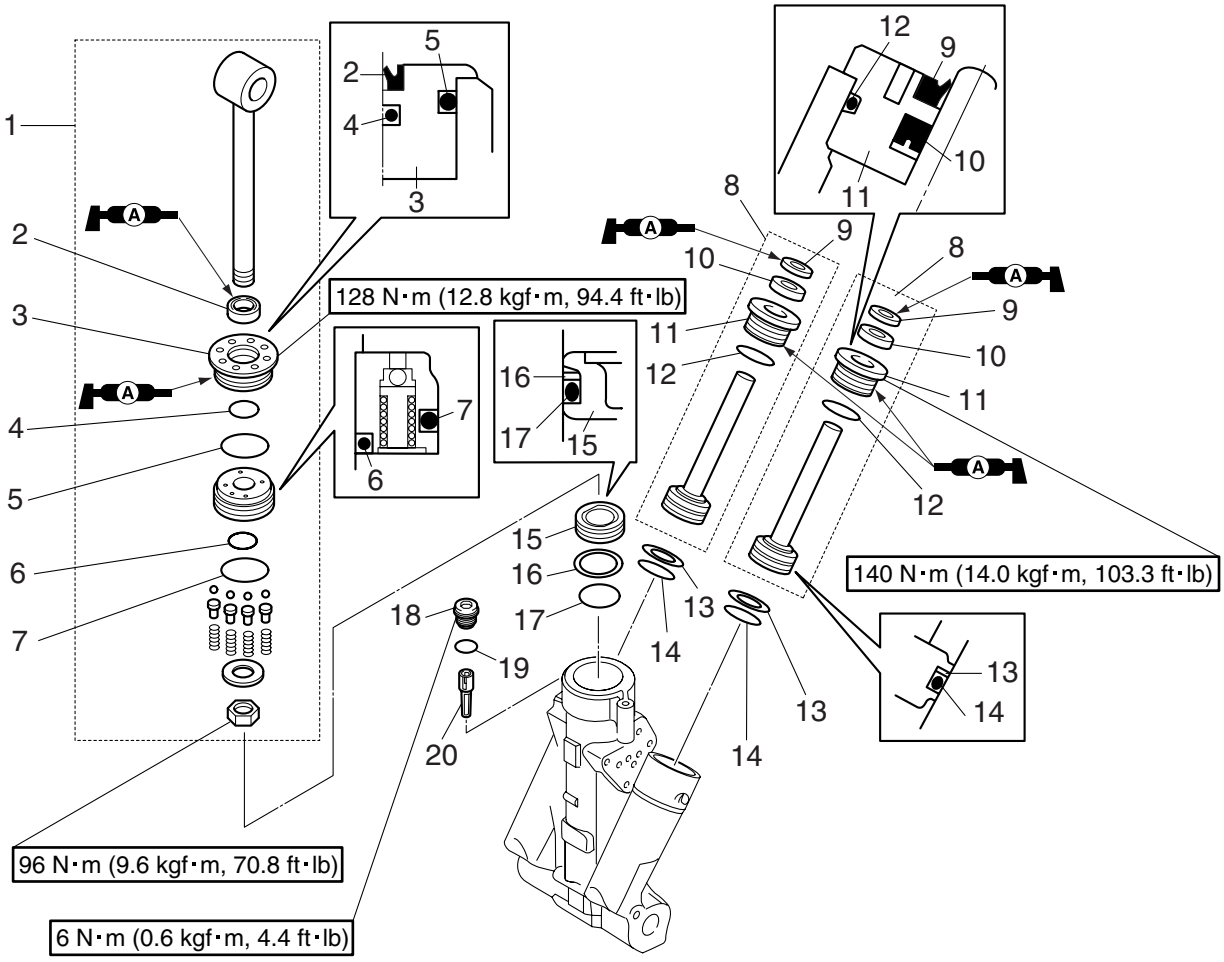
Bolt ㉖ and ㉗: 8 N·m (0.8 kgf·m, 5.9 ft·lb)

14. Install the PTT motor assembly. See “Installing the PTT motor” (9-44).

PTT cylinder



No.	Part name	Q'ty	Remarks
1	Tilt ram assembly	1	
2	Dust seal	1	**Not reusable**
3	Tilt cylinder screw	1	
4	O-ring	1	**Not reusable**
5	O-ring	1	**Not reusable**
6	O-ring	1	**Not reusable**
7	O-ring	1	**Not reusable**
8	Trim ram assembly	2	
9	Dust seal	2	**Not reusable**
10	Seal	2	**Not reusable**
11	Trim cylinder screw	2	
12	O-ring	2	**Not reusable**
13	Backup ring	2	
14	O-ring	2	**Not reusable**
15	Free piston	1	
16	Backup ring	1	
17	O-ring	1	**Not reusable**



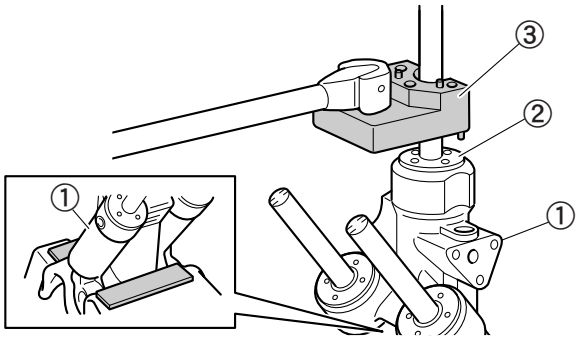
No.	Part name	Q'ty	Remarks
18	Plug	1	
19	O-ring	1	**Not reusable**
20	Filter	1	

Removing the tilt ram and trim ram

⚠ WARNING

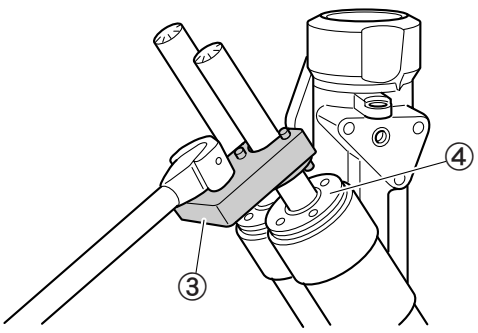
Make sure that the PTT rams are fully extended before removing the tilt cylinder end screw otherwise fluid can spurt out from the unit due to internal pressure.

1. Remove the PTT reservoir. See “Removing the reservoir” (9-41).
2. Remove the PTT motor assembly. See “Removing the PTT motor” (9-41).
3. Remove the PTT gear pump. See “Disassembling the gear pump assembly” (9-47).
4. Hold the PTT body ①.
5. Loosen the tilt cylinder end screw ②, and then remove the tilt ram assembly.



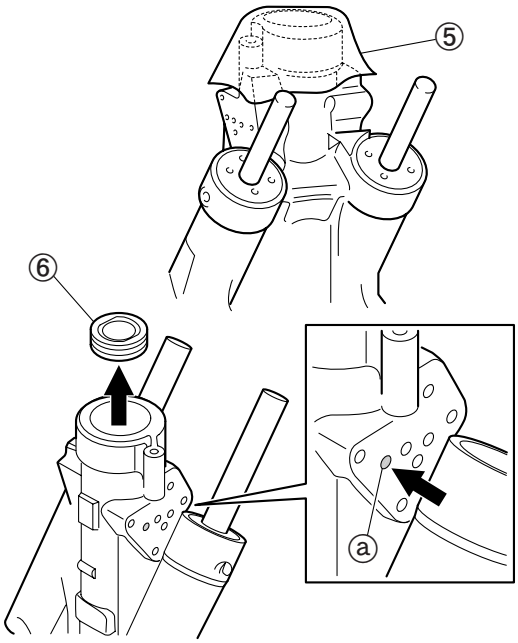
Trim and tilt wrench ③: 90890-06587

6. Loosen the trim cylinder end screws ④, and then remove the trim ram assemblies.

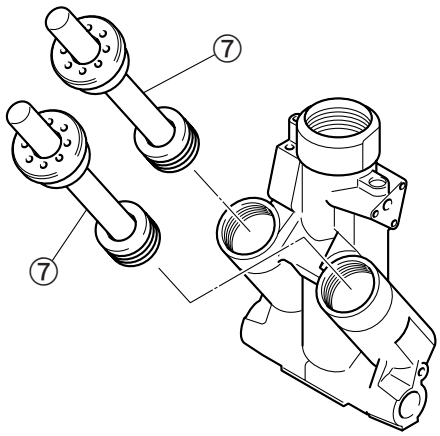


Trim and tilt wrench ③: 90890-06587

7. Drain the fluid.
8. Install the trim ram assemblies, and then tighten the trim cylinder end screws temporarily.
9. Cover the tilt cylinder opening with a rag ⑤, and then blow compressed air through the hole ⓐ to remove the free piston ⑥. **WARNING! Never look into the tilt cylinder opening while removing the free piston because the free piston and PTT fluid could be forcefully expelled out.**



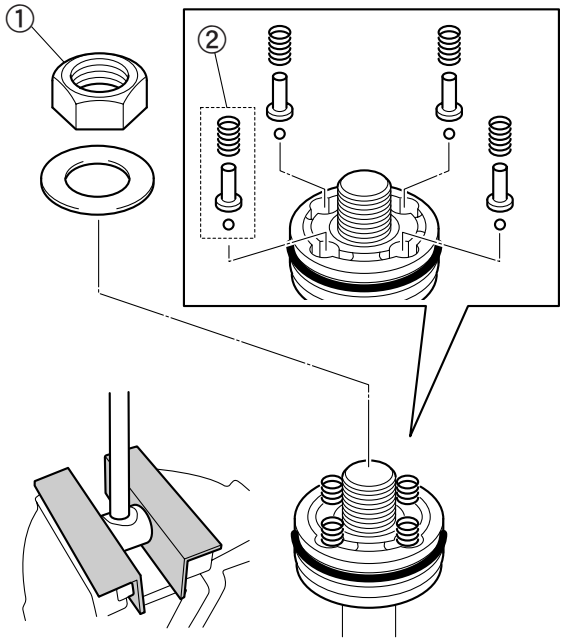
10. Loosen the trim cylinder end screws, and then remove the trim ram assemblies ⑦.



Disassembling the tilt ram

1. Hold the tilt ram end.

2. Remove the nut ①, and then remove the tilt piston absorber valves ②.



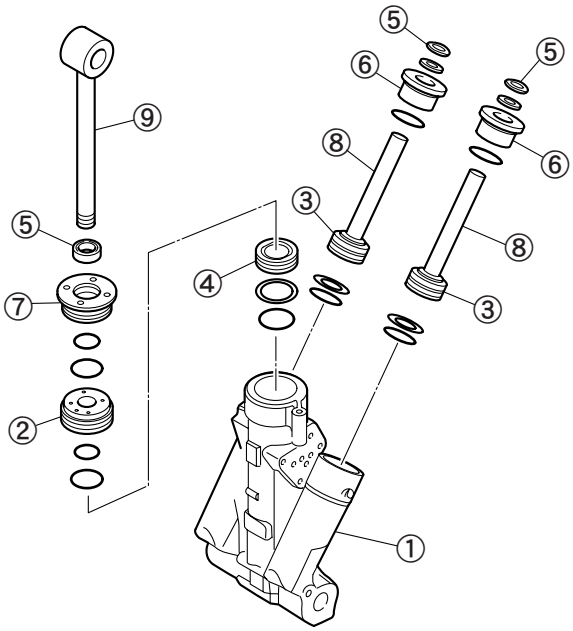
Checking the tilt cylinder and trim cylinder

1. Check the inner surface of the PTT body ①. Replace the PTT body if scratched.

2. Check the outer surface of the tilt piston ②, trim pistons ③, and free piston ④. Replace if scratched.

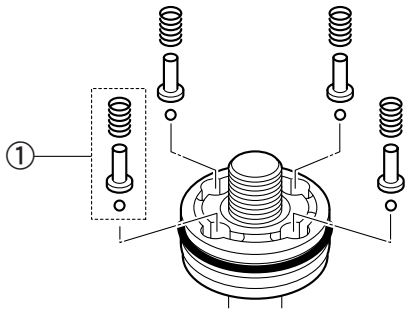
3. Check the dust seals ⑤ of the end screws ⑥ and ⑦. Replace if damaged or worn.

4. Check the trim rams ⑧ and tilt ram ⑨. Polish with 400–600 grit sandpaper if there is light rust or replace if bent or excessively corroded.



Checking the valve

1. Check the tilt piston absorber valves ①. Clean if there is dirt or residue.

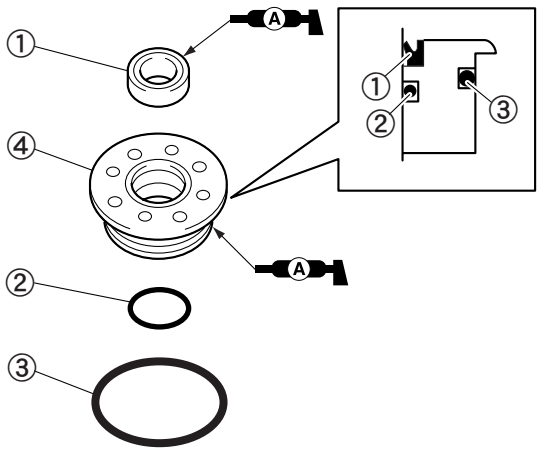


Assembling the tilt ram

NOTICE

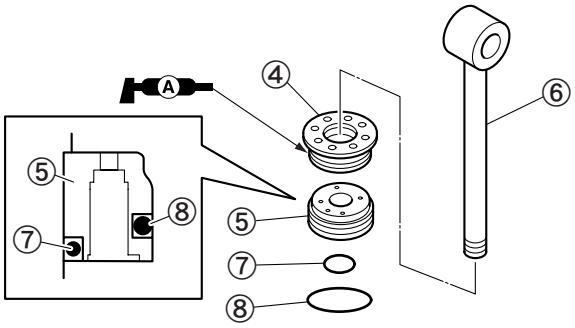
- **Do not use a rag when assembling the PTT unit because dust and particles on the PTT unit components can lead to poor performance.**
- **Do not reuse the dust seal and O-rings, always replace them with a new ones.**

1. Install a new dust seal ① and new O-rings ② and ③ to the tilt cylinder end screw ④.



2. Install the tilt cylinder end screw ④ and tilt piston ⑤ to the tilt ram ⑥.

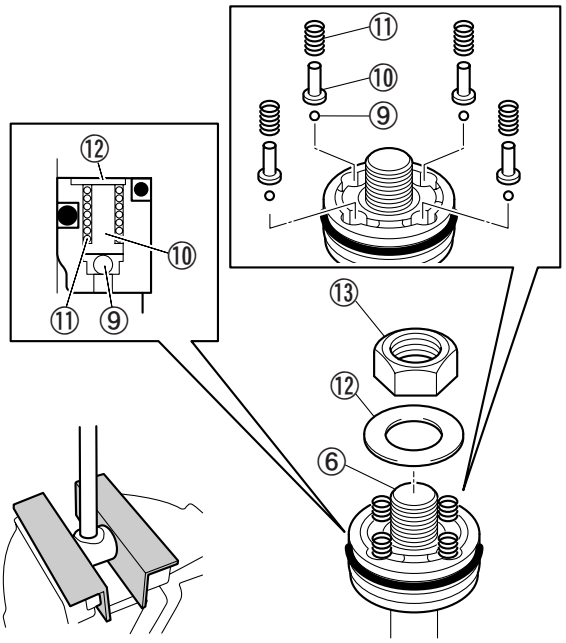
3. Install new O-rings ⑦ and ⑧ to the tilt piston ⑤.



4. Hold the tilt ram end.

5. Install the balls ⑨, absorber valve pins ⑩, and springs ⑪.

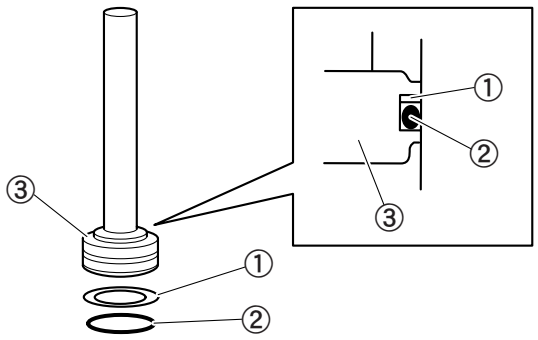
6. Install the washer ⑫ and nut ⑬ to the tilt ram ⑥, and then tighten the nut ⑬ to the specified torque.



Tilt piston nut ⑬:
96 N·m (9.6 kgf·m, 70.8 ft·lb)

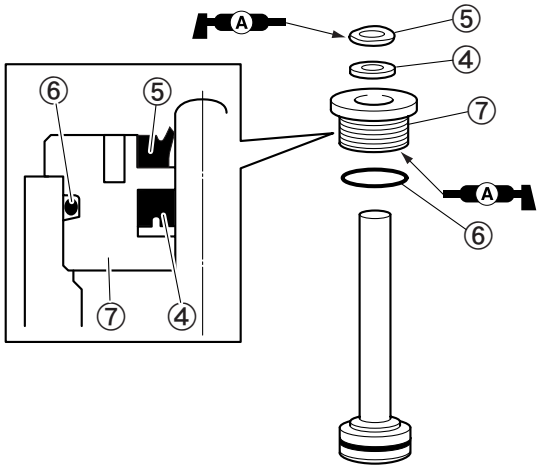
Assembling the trim ram

1. Install the backup ring ① and a new O-ring ② to the trim ram ③.



2. Install a new seal ④, new dust seal ⑤, and new O-ring ⑥ to the trim cylinder end screw ⑦.

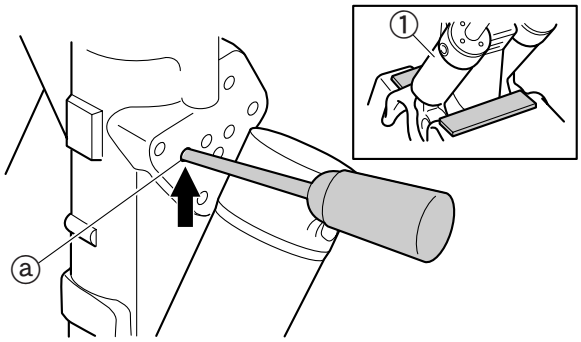
3. Install the trim cylinder end screws ⑦.



Installing the trim ram

1. Hold the PTT body ①.

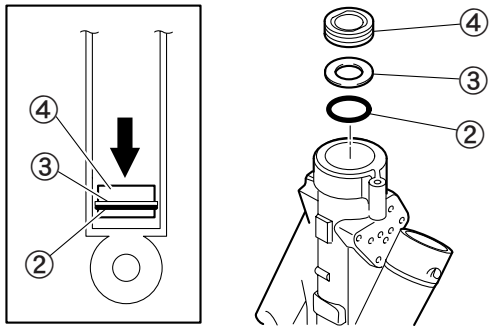
2. Add the recommended fluid through the PTT body hole ⓐ.



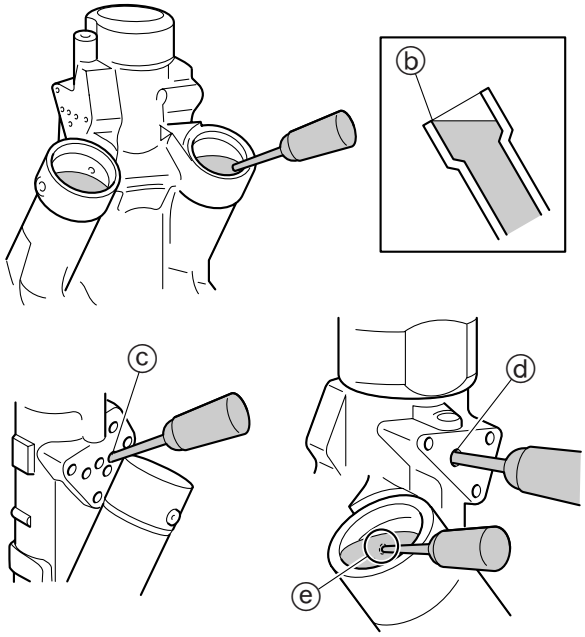
Recommended PTT fluid: ATF Dexron II
Fluid quantity (reference quantity):
30 cm³ (1.0 US oz, 1.1 Imp oz)

3. Install a new O-ring ② and the backup ring ③ to the free piston ④.

4. Push the free piston ④ into the tilt cylinder until it bottoms out.

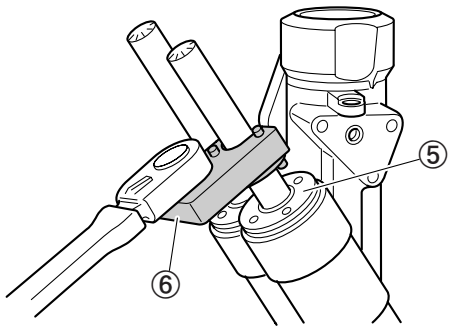


5. Fill the PTT body with the recommended fluid to the correct level ⓑ through holes ⓒ, ⓓ, and ⓔ.



Recommended PTT fluid: ATF Dexron II

6. Install the trim ram assemblies into the PTT body, and then tighten the trim cylinder end screws ⑤ to the specified torque.



Trim and tilt wrench ⑥: 90890-06587

Trim cylinder end screw ⑤: 140 N·m (14.0 kgf·m, 103.3 ft·lb)

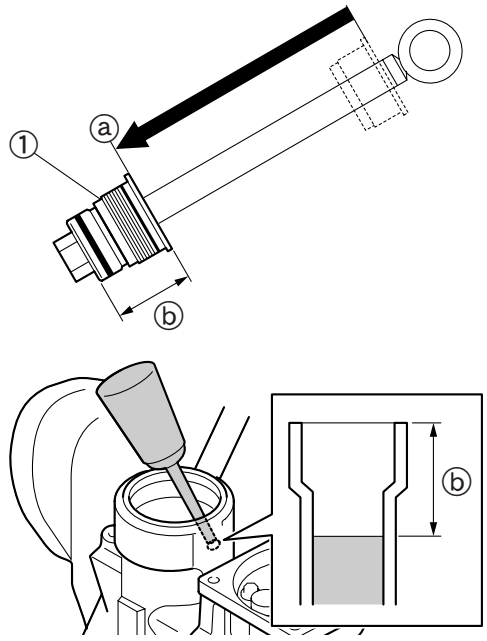
7. Install the PTT gear pump. See “Assembling the gear pump assembly” (9-48).

8. Install the PTT reservoir. See “Installing the reservoir” (9-44).

Installing the tilt ram

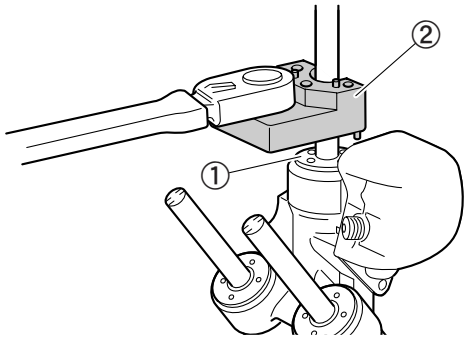
1. Place the tilt cylinder end screw ① at the position ⓐ.

2. Fill the tilt cylinder and PTT body with the recommended fluid to the correct level ⓑ.



Recommended PTT fluid: ATF Dexron II

3. Place the tilt cylinder end screw at position ⓐ, install the tilt ram assembly into the tilt cylinder, and then tighten the tilt cylinder end screw ① to the specified torque.



Trim and tilt wrench ②: 90890-06587

Trim cylinder end screw ①: 128 N·m (12.8 kgf·m, 94.4 ft·lb)

4. Install the PTT motor assembly. See “Installing the PTT motor” (9-44).

Maintenance

Outline 10-1

Predelivery check 10-4
Checking the battery 10-4
Checking the cooling water pilot hole 10-4
Checking the engine oil level 10-5
Checking the engine start switch and engine shut-off switch 10-5
Checking the fuel system 10-5
Checking the gear oil level 10-6
Checking the gear shift and throttle operation 10-6
Checking the outboard motor mounting height 10-6
Checking the PTT system 10-7
Checking the remote control cables 10-7
Checking the steering system 10-7
Test run 10-7
Break-in 10-8
After test run 10-8

General Periodic Maintenance 10-9
Checking the anode 10-9
Checking the battery 10-9
Checking the cooling water passage 10-10
Checking the engine idle speed 10-10
Checking the engine oil level 10-10
Changing the engine oil 10-10
Replacing the oil filter 10-11
Checking the engine start switch and engine shut-off switch 10-12
Checking the fuel joint and fuel hoses (fuel joint-to-fuel injector) 10-12
Checking the fuel filter 10-12
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Checking the gear shift operation 10-13
Lubricating the outboard motor 10-13
Checking the PCV 10-15
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Checking the PTT operation 10-15
Checking the propeller 10-15
Checking the spark plug 10-15
Checking the timing belt 10-16

Replacing the timing belt 10-16
Checking the thermostat 10-16
Adjusting the throttle link and throttle cable 10-16
Checking the top cowling 10-17
Checking the valve clearance 10-17
Checking the water pump 10-17

Outline

- To ensure long product life, Yamaha strongly recommends the specified periodic check and maintenance to be performed according to the maintenance interval chart.
- If replacement parts are necessary, use only genuine Yamaha parts of equivalent design and quality. Any parts of inferior quality may cause malfunction, and the resulting loss of control could endanger the operator and passengers. Yamaha genuine parts and accessories are available from Yamaha dealers.
- The service intervals provided in the Maintenance Chart are based upon “typical” operating conditions that include speed variations, sufficient time for engine warm up and cool-down, medium to light load, and an average cruising speed in 3000 to 4000 r/min range. If your normal operating conditions are more intensive, more frequent servicing will be required, especially the engine oil and gear oil changes. Examples of the intensive operation will be; wide-open-throttle, trolling or idling operations for extended period of time, carrying heavy loads, or frequent starting and stopping or shifting. In most cases, the frequent maintenance pays off in increased engine life and greater owner satisfaction. Consult Yamaha dealer for additional recommendations.
- The maintenance cycle on these charts assume usage of 100 hours per year and regular flushing of the cooling water passages. Maintenance frequency should be adjusted when operating the engine under adverse conditions such as extended trolling.
- Disassembly or repairs may be necessary depending on the outcome of maintenance checks.
- Expendable or consumable parts and lubricants will lose their effectiveness over time and through normal usage regardless of the warranty period.
- When operating in salt water, muddy, turbid (cloudy), or acidic water, the engine should be flushed with clean water after each use.

Maintenance interval chart 1

Item	Actions	Initial	Every			Refer to page
		20 hours (3 months)	100 hours (1 years)	300 hours (3 years)	500 hours (5 years)	
Anode(s) (external)	Check/replace		○			10-9
Anode(s) (cylinder head)	Check/replace		○			10-9
Anodes(s) (exhaust cover, cylinder block)	Replace				○	10-9
Battery (electrolyte level, terminal)	Check/charge/replace	○	○			10-4
Cooling water leakage	Check/replace	○	○			10-10
Cowling clamp	Check		○			10-17
Engine starting condition/ noise	Check	○	○			10-5
Engine idle speed/noise	Check	○	○			10-10
Engine oil	Replace	○	○			10-10
Engine oil filter	Replace		○			10-11
Engine start switch/ engine shut-off switch	Check/replace	○	○			10-5
Fuel filter (can be disassembled)	Check/replace	○	○			6-14
Fuel filter (disposal type)	Replace		○			6-32
Fuel filter (vapor separator)	Check/replace				○	6-29
Fuel hoses (high pressure)	Check/replace	○	○			6-1
Fuel hoses (low pressure)	Check/replace	○	○			6-1
Fuel pump	Check/replace			○		6-10
Fuel/oil leakage	Check	○	○			10-12
Gear oil	Replace	○	○			10-12
Greasing points	Grease	○	○			10-13
Impeller/ water pump housing	Check/replace		○			8-7
Impeller/ water pump housing	Replace			○		8-7 8-22
PCV	Check/replace		○			7-34
PTT unit	Check/replace	○	○			10-15
Propeller/propeller nut/ cotter pin	Check/replace	○	○			10-15
Shift link/shift cable	Check/adjust/replace	○	○			10-6 10-7
Spark plug(s)	Check/replace		○			10-15
Spark plug caps/ spark plug wires	Check/replace	○	○			5-28

Item	Actions	Initial	Every			Refer to page
		20 hours (3 months)	100 hours (1 years)	300 hours (3 years)	500 hours (5 years)	
Pilot water	Check	○	○			10-4
Throttle link/throttle cable/ throttle pick-up timing	Check/adjust/replace	○	○			10-16
Thermostat	Check/replace		○			10-16
Timing belt	Check/replace		○			7-29
Valve clearance	Check/adjust				○	7-2
Water inlet	Check	○	○			10-10
Wiring harness connections/wiring coupler connections	Check/replace	○	○			—
Yamaha meter/gauge	Check	○	○			(*1)

— : Not applicable
(*1): See “6Y8 Multifunction Meter set up manual” for the check of 6Y8 Multifunction Meter.

Maintenance interval chart 2

Item	Actions	Every	Refer to page
		1000 hours	
Guide exhaust/ exhaust manifold	Check/replace	○	9-21
Timing belt	Replace	○	7-18

TIP:
When using lead high-sulfur gasoline, checking the valve clearance may be required more frequently than every 500 hours.

Predelivery check

To make the delivery process smooth and efficient, the predelivery checks should be completed as explained below.

Checking the battery

⚠ WARNING

Battery electrolyte is dangerous; it contains sulfuric acid which is poisonous and highly caustic.

Always follow these preventive measures:

- **Avoid bodily contact with electrolyte as it can cause severe burns or permanent eye injury.**
- **Wear protective eye gear when handling or working near batteries.**

Antidote (EXTERNAL):

- **SKIN - Wash with water.**
- **EYES - Flush with water for 15 minutes and get immediate medical attention.**

Antidote (INTERNAL):

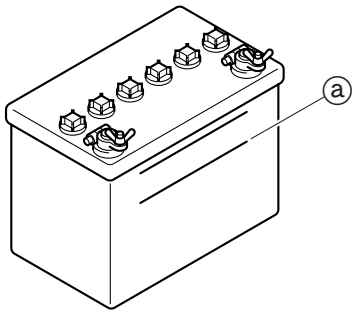
- **Drink large quantities of water or milk followed with milk of magnesia, beaten egg, or vegetable oil. Get immediate medical attention.**

Batteries generate explosive, hydrogen gas. Always follow these preventive measures:

- **Charge batteries in a well-ventilated area.**
- **Keep batteries away from fire, sparks or open flames (example: welding equipment, lighted cigarettes).**
- **DO NOT SMOKE when charging or handling batteries.**

KEEP BATTERIES AND ELECTROLYTE OUT OF REACH OF CHILDREN.

1. Check the battery electrolyte level. If the level is at or below the minimum level mark ⓐ, add distilled water until the level is between the maximum and minimum level marks.



2. Check the specific gravity of the electrolyte. Fully charge the battery if below specification.

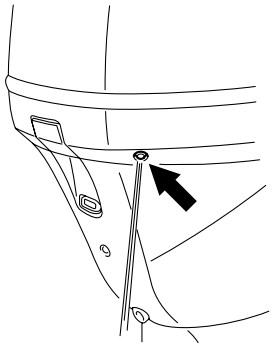
Representative Examples
Recommended battery capacity:
CCA/EN: 711A
20 HR/IEC: 100Ah
Electrolyte specific gravity:
1.280 at 20 °C (68 °F)

TIP:

- Batteries vary per manufacturer. The procedures mentioned in this manual may not always apply, therefore, consult the instruction manual of the battery.
- Disconnect the negative battery cable first, and then the positive battery cable.

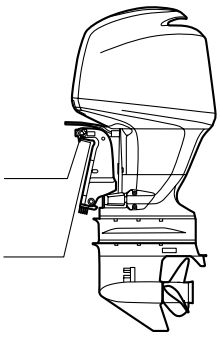
Checking the cooling water pilot hole

1. Start the engine, check that cooling water is discharged from the cooling water pilot hole.

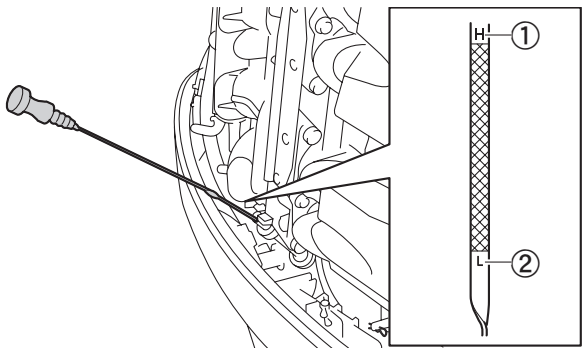


Checking the engine oil level

1. Put the outboard motor in an upright position (not tilted). ***NOTICE:*** **If the motor is not level, the oil level indicated on the dipstick may not be accurate.**

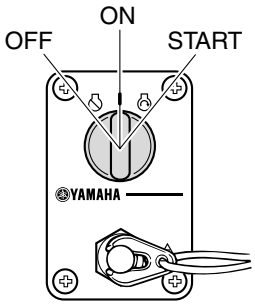


2. Start the engine. Warm it up and keep the idle speed for 5–10 minutes.
3. Stop the engine and leave it for 5–10 minutes.
4. Remove the top cowling.
5. Remove oil dipstick and wipe it clean.
6. Insert the dipstick completely for accurate measurement and remove it again.
7. Check the oil level using the dipstick to make sure the level falls at the center between the upper level mark ① "H" and lower level mark ② "L." Fill with oil if it is below the lower level mark ② "L," or extract to the center level if it is above the upper level mark ① "H."

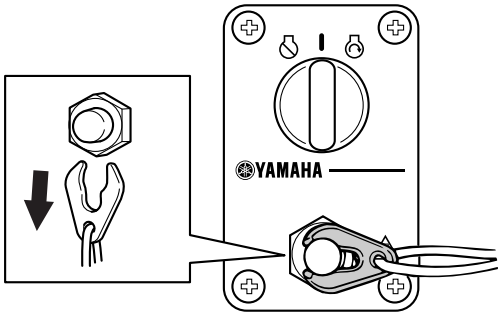


Checking the engine start switch and engine shut-off switch

1. Check that the engine starts when the engine start switch is turned to "START."
2. Check that the engine turns off when the engine start switch is turned to "OFF."

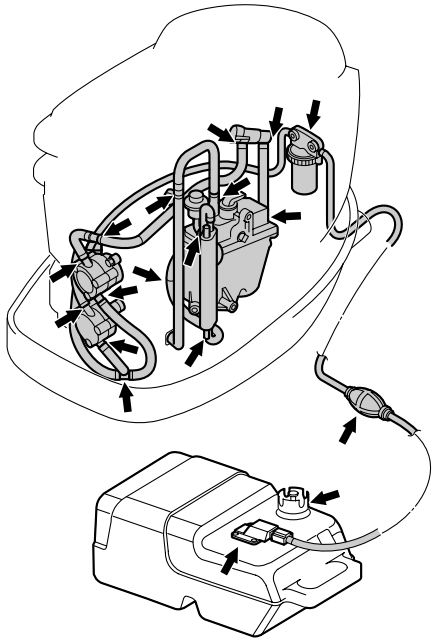


3. Check that the engine turns off when the clip is pulled from the engine shut-off switch.



Checking the fuel system

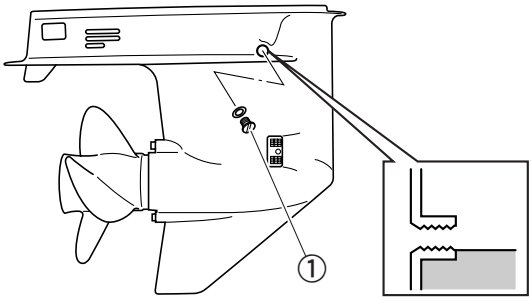
1. Check that the fuel hoses are securely connected and that the fuel tank is full with fuel. ***NOTICE:*** **This is a 4-stroke engine. Never use premixed fuel or 2-stroke outboard motor oil.**



Checking the gear oil level

1. Fully tilt the outboard motor down.

2. Remove the gear oil check screw ①, and then check the gear oil level in the lower case.



TIP:
If the oil is at the correct level, a small amount of oil should overflow out of the check hole when the gear oil check screw is removed.

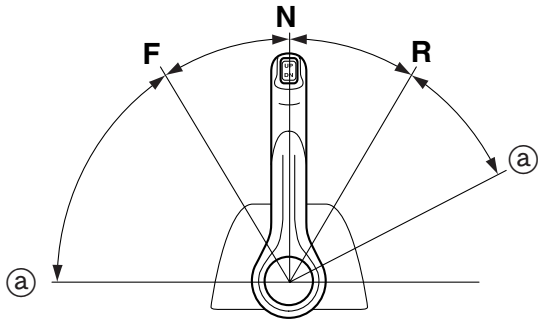
3. Install a new gasket and the gear oil check screw ①, and then tighten the gear oil check screw ① to the specified torque.

Gear oil check screw ①:
9 N·m (0.9 kgf·m, 6.6 ft·lb)

Checking the gear shift and throttle operation

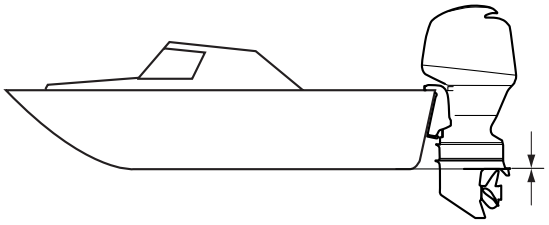
1. Check that the gear shift operates smoothly when the remote control lever is shifted from N to F or R.

2. Check that the throttle operates smoothly when the remote control lever is shifted from F or R to the fully open position ⓐ.



Checking the outboard motor mounting height

1. Check that the anti-cavitation plate is aligned with the bottom of the boat. If the mounting height is too high, cavitation will occur and propulsion will be reduced. Also, the engine speed will increase abnormally and cause the engine to overheat. If the mounting height is too low, water resistance will increase and reduce engine efficiency.



TIP:
The optimum mounting height is affected by the combination of the boat and the outboard motor. To determine the optimum mounting height, test run the outboard motor at different heights.

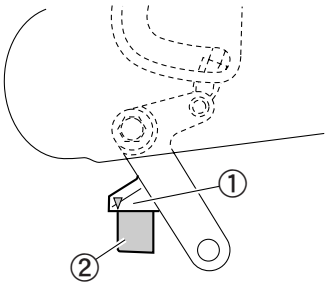
2. Check that the clamp brackets are secured with the clamp bolts.

Checking the PTT system

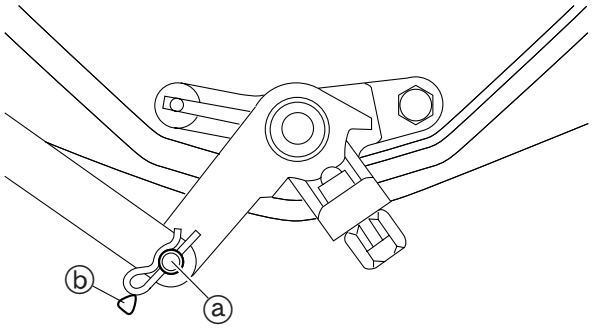
1. Check that the outboard motor tilts up and down smoothly when operating the PTT unit.
2. Check that there is no abnormal noise produced when the outboard motor is tilted up or down.
3. Check that there is no interference with wires or hoses when the tilted-up outboard motor is steered.
4. Check that the trim meter points down when the outboard motor is tilted all the way down.

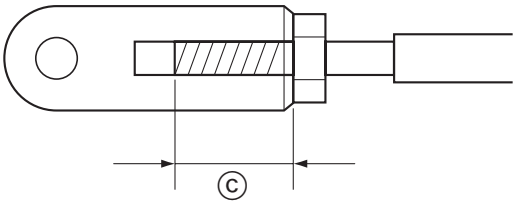
Checking the remote control cables

1. Set the remote control lever to the N position and fully close the throttle lever.
2. Check that the stopper ① on the throttle lever 2 contacts the fully closed stopper ② on the cylinder block.



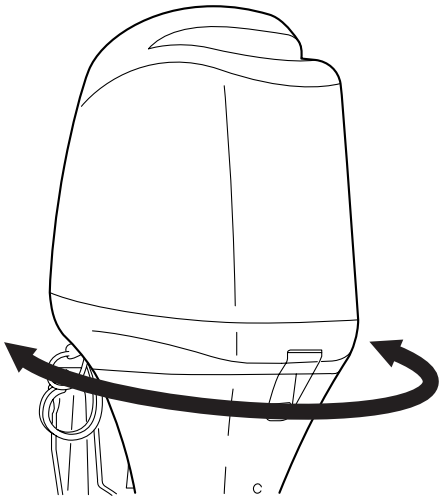
3. Check that the center of the set pin ⓐ is aligned with the alignment mark ⓑ on the bottom cowling. **WARNING! The shift or throttle cable joint must be screwed in a minimum of 8.0 mm (0.31 in) ⓒ.**





Checking the steering system

1. Check that the steering operates smoothly.



2. Check that there is no interference with wires or hoses when the outboard motor is steered.

Test run

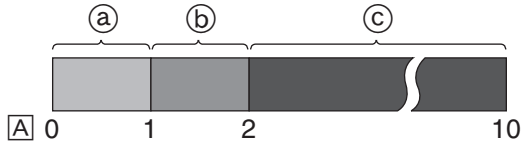
1. Start the engine, and then check that the gear shift operates smoothly.
2. Check the engine idle speed after the engine has been warmed up.
3. Operate at trolling speed.
4. Run the outboard motor according to the break-in procedure.
5. Check that the outboard motor does not tilt up when shifting into reverse and that water does not flow in over the transom.
6. Check that the PTT operates smoothly while the outboard motor is running.

TIP:
The test run is part of the break-in operation.

Break-in

Run the engine under load (in gear with a propeller installed) for 10 hours as follows.

1. For the 1st hour ⓐ of operation, run the engine at varying speeds up to 2000 r/min or approximately half throttle.
2. For the 2nd hour ⓑ of operation, increase engine speed as much as necessary to put the boat on plane (but avoid full-throttle operation), then back off on the throttle while keeping the boat at a planing speed.
3. Remaining 8 hours ⓒ, run the engine at any speed. However, avoid operating at full throttle for more than 5 minutes at a time.
4. After the 1st 10 hours, operate the engine normally.



A Hour

After test run

NOTICE

Do not perform this procedure on land while the engine is running. The water pump may be damaged and severe engine damage from overheating can take place.

1. Check for water in the gear oil.
2. Check for fuel leakage in the cowling.
3. Flush the cooling water passage with fresh water.

TIP:
When using the flushing device (flushing hose joint adapter), flush the cooling water passages without starting the engine.

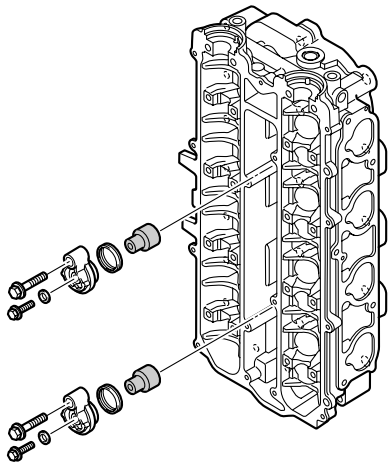
General Periodic Maintenance

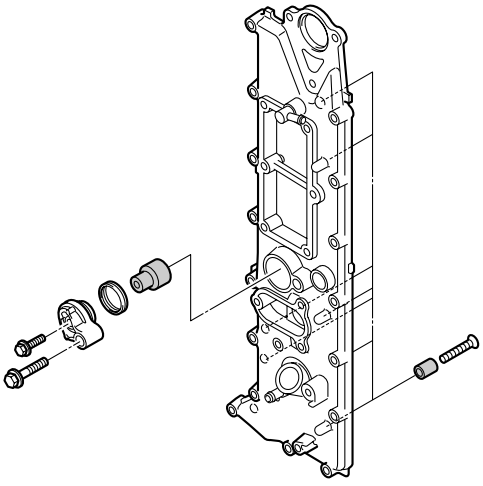
Checking the anode

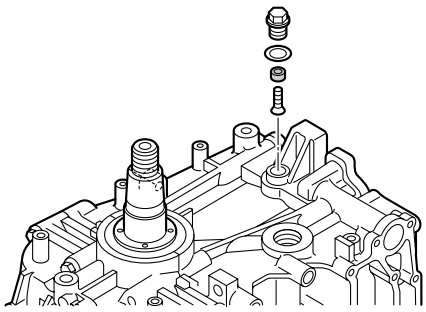
NOTICE

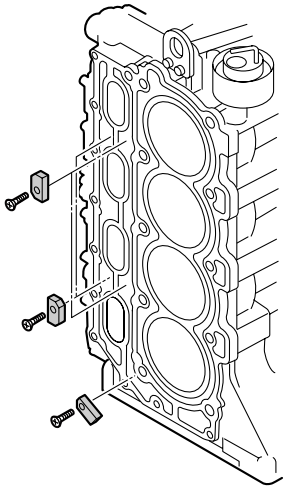
Do not oil, grease, or paint the anodes or the trim tab, otherwise they will be ineffective.

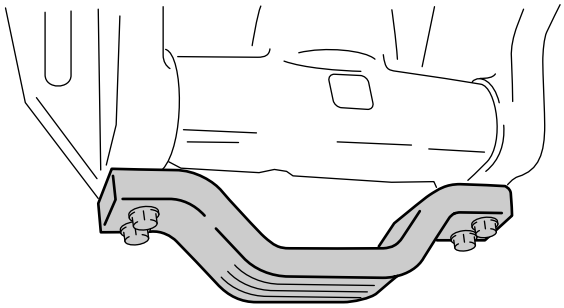
1. Check the anodes and trim tab. Clean the anodes or trim tab if there are scales, grease, or oil.

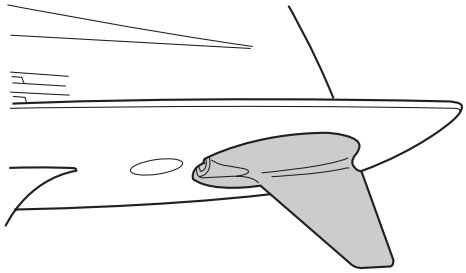












TIP:

- Replace the anodes or trim tab if excessively eroded. In addition, check the ground lead.
- If it is necessary to disassemble the outboard motor to check an anode, refer to the applicable disassembly procedure in this manual.

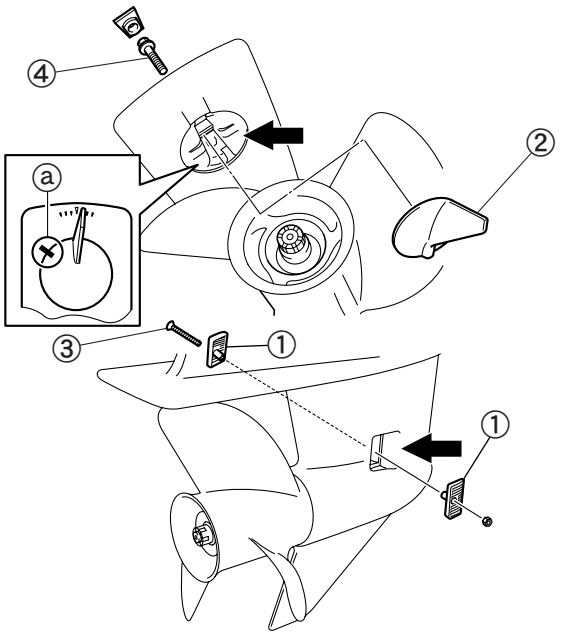
Checking the battery

1. Check the battery. See “Checking the battery” (10-4).

Checking the cooling water passage

1. Remove the cooling water inlet covers ① and trim tab ②.

2. Check the cooling water inlet covers and cooling water inlets. Clean if clogged.



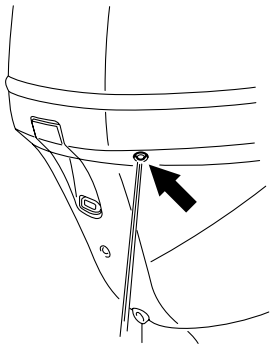
TIP:
Mark ⓐ the trim tab ② at the area shown, and then remove it.

3. Install the cooling water inlet covers ① and trim tab ②, and then tighten the screw ③ and bolt ④ to the specified torque.

Cooling water inlet cover screw ③: 5 N·m (0.5 kgf·m, 3.7 ft·lb) Trim tab bolt ④: 42 N·m (4.2 kgf·m, 31.0 ft·lb)

4. Place the lower unit in water, and then start the engine.

5. Check for water flow at the cooling water pilot hole. If there is no water flow, check the cooling water passage inside the outboard motor.



Checking the engine idle speed

1. Start the engine and warm up until the engine idle speed is stable at 650–750 r/min.

2. Check the engine idle speed using the Yamaha genuine tachometer (on-board meter) or using the YDIS. To connect and operate the YDIS, see the YDIS (Ver. 1.30 or later) Instruction Manual.

Checking the engine oil level

1. Check the engine oil level. See “Checking the engine oil level” (10-5).

Changing the engine oil

NOTICE

Change the engine oil after the first 20 hours of operation or 3 months, and every 100 hours or at 1-year intervals thereafter. Otherwise the engine will wear quickly.

The engine oil should be extracted with an oil changer.

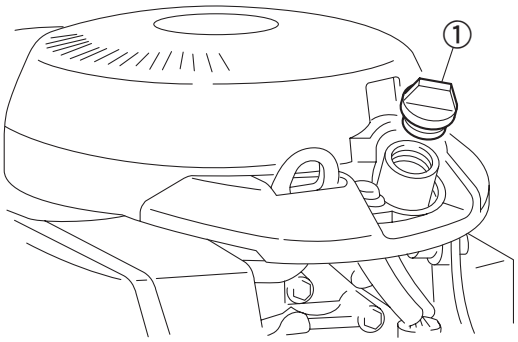
1. Put the outboard motor in an upright position (not tilted). ***NOTICE:*** **If the outboard motor is not level, the oil level indicated on the dipstick may not be accurate.**

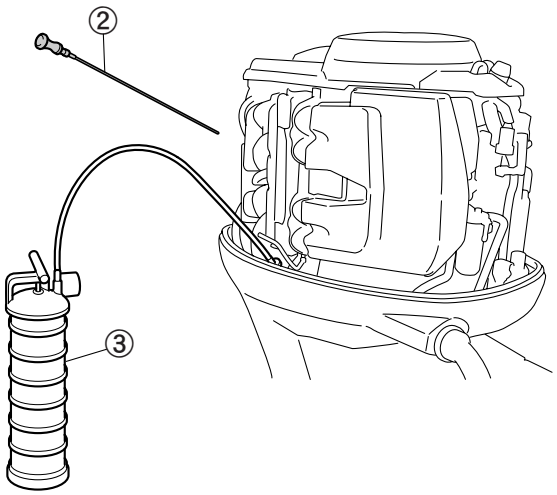
2. Start the engine. Warm it up and keep the idle speed for 5–10 minutes.

3. Stop the engine and leave it for 5–10 minutes.

4. Remove the top cowling.

5. Remove the oil filler cap ①. Pull out the dipstick ② and use the oil changer ③ to extract the oil completely.





6. Add the correct amount of oil through the filler hole. Put back the filler cap ① and the dipstick ②. ***NOTICE:*** **Overfilling the oil could cause leakage or damage. If the oil level is above the upper level mark, extract until the level meets the specified capacity.**

Recommended engine oil: 4-stroke motor oil API: SE, SF, SG, SH, SJ, or SL SAE: 5W-30, 10W-30, or 10W-40 Replacement engine oil quantity (at periodic maintenance): Without oil filter replacement: 4.3 L (4.54 US qt, 3.78 Imp qt)

7. Leave the outboard motor for 5-10 minutes.

8. Remove the dipstick ② and wipe it clean.

9. Insert the dipstick ② and remove it again. Make sure to completely insert the dipstick into the dipstick guide, otherwise the oil level measurement will be incorrect.

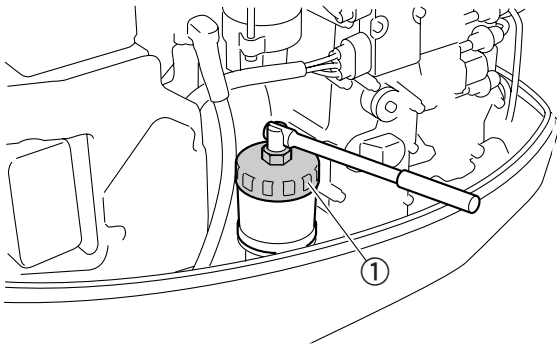
10. Recheck the oil level using the dipstick to make sure the level falls between the upper level mark “H” and lower level mark “L.”

11. Start the engine and make sure that the low oil pressure alert indicator remains off. Also, make sure that there are no oil leaks. ***NOTICE:*** **If the low oil pressure alert indicator comes on or if there are oil leaks, stop the engine and find the cause. Continued operation with a problem could cause severe engine damage.**

Replacing the oil filter

1. Extract the engine oil with an oil changer.

2. Place a rag under the oil filter, and then remove the oil filter using a 72.5 mm (2.9 in) oil filter wrench ①.



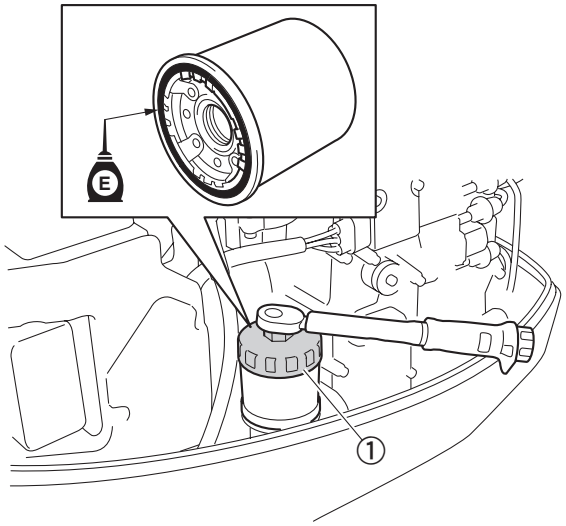
Oil filter wrench ①: 90890-06830

TIP:

- Wait more than 5 minutes after turning the engine off to replace the oil filter.
- Make sure to clean up any oil spills.

3. Apply a thin coat of engine oil to the O-ring of the new oil filter.

4. Install the oil filter, and then tighten it to the specified torque using a 72.5 mm (2.9 in) oil filter wrench ①.



Oil filter:
18 N·m (1.8 kgf·m, 13.3 ft·lb)

5. Pour the specified amount of the recommended engine oil into the oil filler hole.

Recommended engine oil:
4-stroke motor oil
API: SE, SF, SG, SH, SJ, or SL
SAE: 5W-30, 10W-30, or 10W-40
Replacement engine oil quantity (at periodic maintenance):
With oil filter replacement:
4.5 L (4.76 US qt, 3.96 Imp qt)

6. Install the oil filler cap and dipstick, and then start the engine and warm it up for 5 minutes.

7. Turn the engine off, and then check the oil level and that there is no oil leakage.

Checking the engine start switch and engine shut-off switch

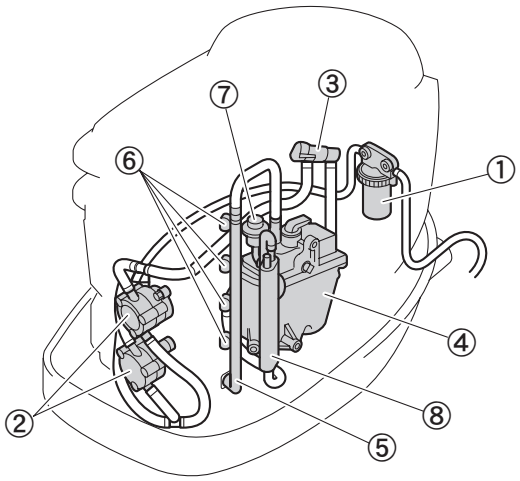
1. Check the engine start switch and engine shut-off switch. See “Checking the engine start switch and engine shut-off switch” (10-5).

Checking the fuel joint and fuel hoses (fuel joint-to-fuel injector)

1. Remove the spark plug wire cover.

2. Check the low-pressure fuel hose connections. Also, check the fuel filter ①, fuel pumps ②, and filter ③. Replace the low-pressure fuel hoses if there is leakage or deterioration.

3. Check the high-pressure fuel hose connections. Also, check the vapor separator ④, fuel rail ⑤, fuel injectors ⑥, pressure regulator ⑦, and fuel cooler ⑧. Replace the high-pressure fuel hoses if there is leakage or deterioration.



Checking the fuel filter

1. Check the fuel filter. See “Checking the fuel filter assembly” (6-14) and “Checking the fuel filter” (6-32).

Checking the gear oil level

1. Check the gear oil level. See “Checking the gear oil level” (10-6).

Changing the gear oil

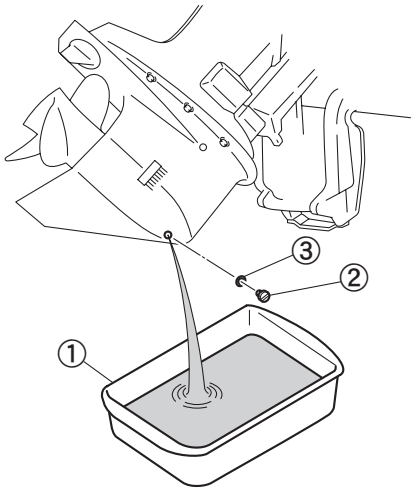
⚠ WARNING

Never get under the lower unit while it is tilted. Otherwise, the outboard motor could suddenly lower if the PTT unit should lose fluid pressure.

1. Tilt the outboard motor so that the gear oil drain screw is at the lowest point possible.

2. Place a drain pan ① under the gear oil drain hole.

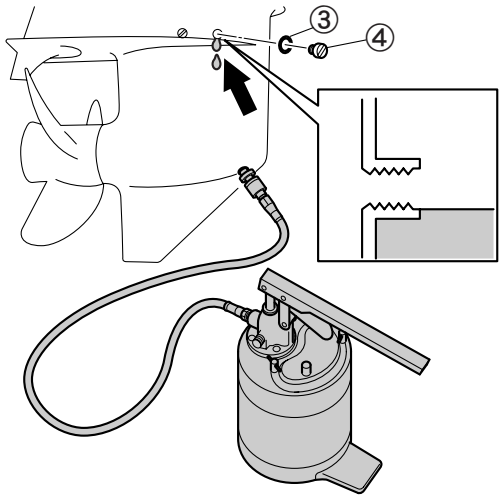
3. Remove the gear oil drain screw ② and gasket ③. ***NOTICE:*** **If there is an excessive quantity of metal particles on the magnetic gear oil drain screw ②, this can indicate lower unit problem.**



TIP:
If a magnetic gear oil drain screw is equipped, remove all metal particles from the screw before installing it.

4. Remove the gear oil check screw ④ and gasket ③ to allow the oil to drain completely. ***NOTICE:*** **Check the used oil after it has been drained. If the oil is milky, water is getting into the gear case which can cause gear damage.**

5. Insert the gear oil pump into the drain hole and slowly fill with gear oil until oil flows out of the check hole and no air bubbles are visible.



Recommended gear oil: Hypoid gear oil API: GL-4 SAE: 90 Oil quantity: Regular rotation model: 0.980 L (1.036 US qt, 0.862 lmp qt) Counter rotation model: 0.870 L (0.919 US qt, 0.765 lmp qt)

6. Install new gaskets ③ and the gear oil check screw ④, quickly install the gear oil drain screw ②, and then tighten them to the specified torque.

Gear oil check screw ④ and gear oil drain screw ②: 9 N·m (0.9 kgf·m, 6.6 ft·lb)

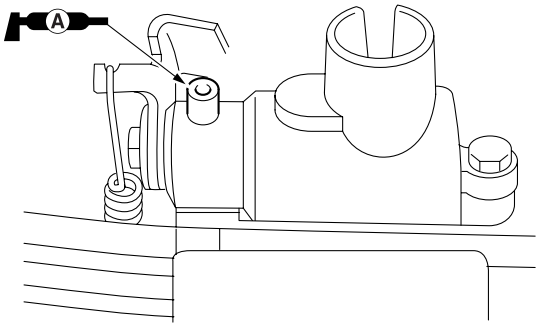
Checking the gear shift operation

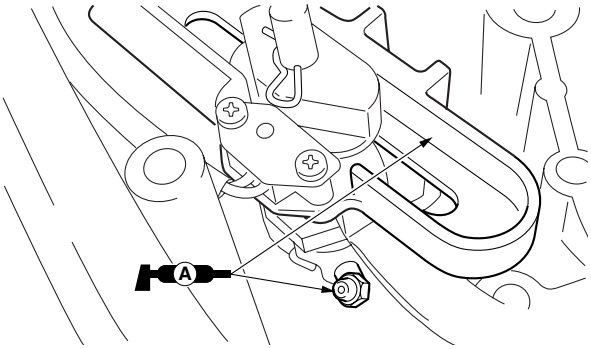
1. Check that the gear shift operates smoothly when shifting it from N position to F or R. Adjust the shift cable length if the gear shift cannot be operated smoothly. For adjusting the shift cable length, see “Installing the shift cable” (3-8) step 7–step 12.

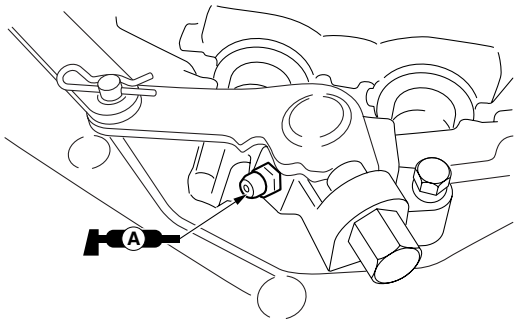
2. Check the neutral switch for continuity. See “Checking the neutral switch” (5-37).

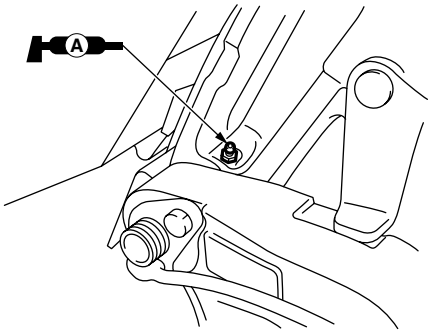
Lubricating the outboard motor

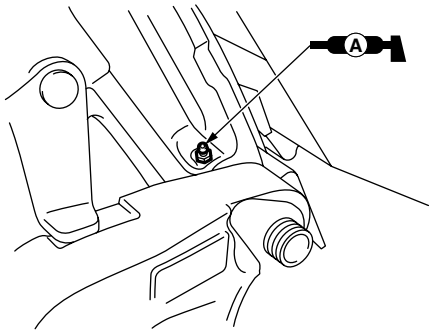
1. Apply water resistant grease to the areas.

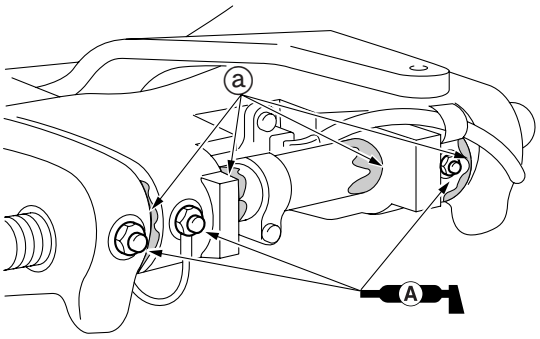


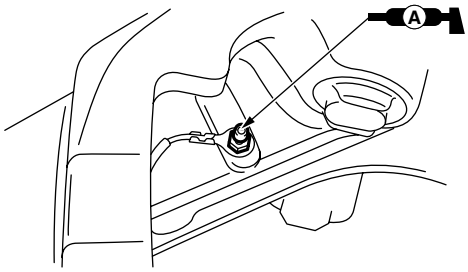








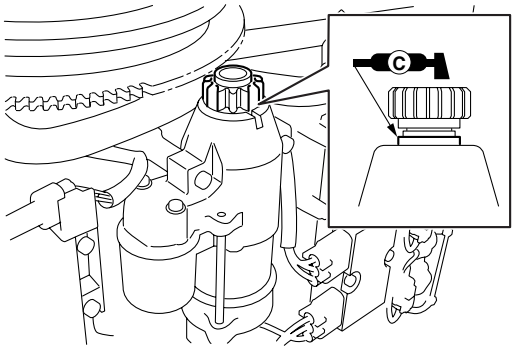




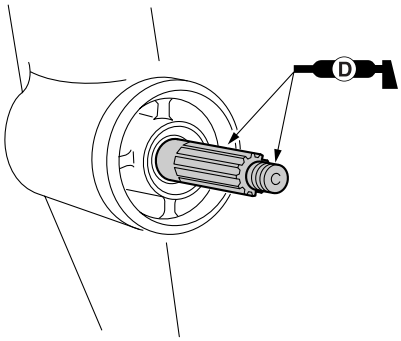
TIP:

Apply grease to the grease nipple until it flows from the bushings ⓐ.

2. Apply low temperature resistant grease to the area.



3. Apply corrosion resistant grease to the area.



10

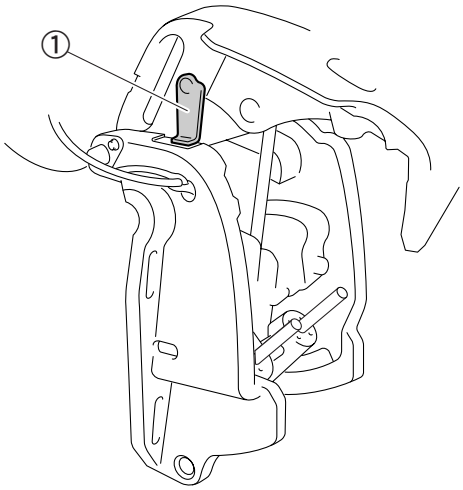
Checking the PCV
1. Check the PCV. See “Checking the PCV” (7-34).

Checking the PTT fluid level
1. Check the PTT fluid level. See “Checking the hydraulic pressure” (9-34).

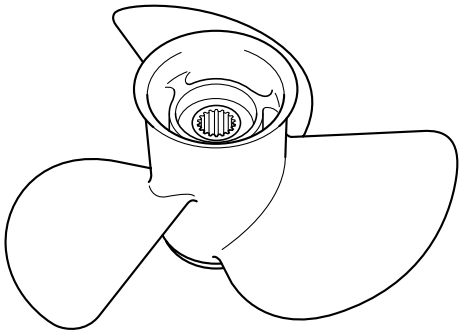
Checking the PTT operation
1. Tilt the outboard motor to the fully up and fully down positions a few times and check the entire trim range for smooth operation. Check the PTT fluid level if the tilt operation is not smooth.

TIP:
Make sure to listen to the winding sound of the PTT motor for smooth operation.

2. Tilt the outboard motor to the fully up position, and then support it with the tilt stop lever ① to check the lock mechanism of the lever.

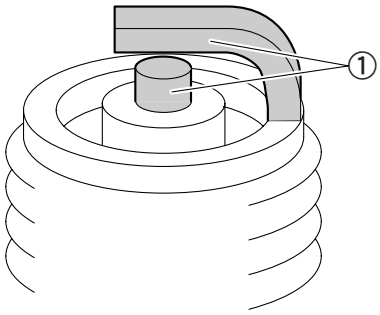


Checking the propeller
1. Check the propeller blades and splines. Replace the propeller if cracked, damaged, or worn.



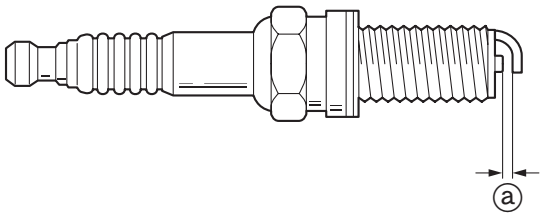
Checking the spark plug
1. Disconnect the spark plug wire, and then remove the spark plug.

2. Clean the electrode ① with a spark plug cleaner or wire brush.



3. Check the spark plug. Replace if the electrodes are eroded, there is excessive carbon or other deposits, or the gasket is damaged.

4. Check the spark plug gap ⓐ. Adjust the spark plug gap if out of specification.



Specified spark plug:
LFR5A-11 (NGK)
Spark plug gap ⓐ:
1.0–1.1 mm (0.039–0.043 in)

5. Install the spark plugs, tighten temporarily, and then tighten to the specified torque using a spark plug wrench.

Spark plug: 25 N·m (2.5 kgf·m, 18.4 ft·lb)

Checking the timing belt

1. Check the timing belt. See “Checking the timing belt and sprocket” (7-29).

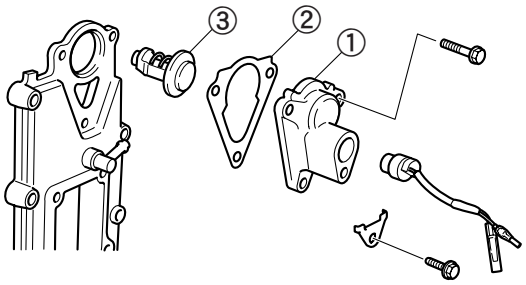
Replacing the timing belt

1. Replace the timing belt. See “Replacing the timing belt” (7-18).

Checking the thermostat

1. Remove the flywheel magnet cover.

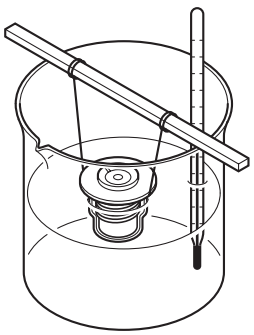
2. Remove the cover ①, gasket ②, and thermostat ③.



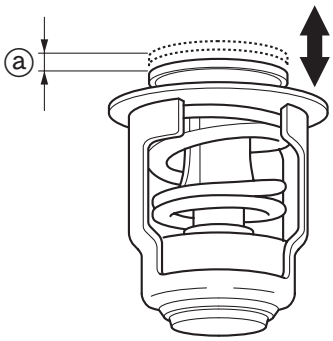
TIP:
Do not reuse the gasket ②, always replace them with a new one.

3. Suspend the thermostat in a container of water.

4. Place a thermometer in the water and slowly heat the water.



5. Measure the thermostat valve opening ⓐ at the specified water temperatures. Replace the thermostat if out of specification.



Water temperature	Valve lift ⓐ
58.0–62.0 °C (136.4–143.6 °F)	0.05 mm (0.0020 in) (valve begins to lift)
Above 70 °C (158 °F)	More than 4.3 mm (0.17 in)

6. Install the thermostat and cover, and then tighten the cover bolts to the specified torques in 2 stages.

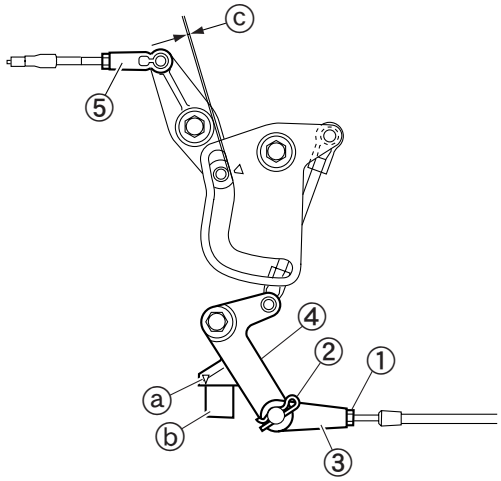
Thermostat cover bolt: 1st: 6 N·m (0.6 kgf·m, 4.4 ft·lb) 2nd: 12 N·m (1.2 kgf·m, 8.9 ft·lb)

Adjusting the throttle link and throttle cable

1. Remove the intake silencer.

2. Loosen the locknut ①, remove the clip ②, and then disconnect the throttle cable joint ③ at fully closed position.

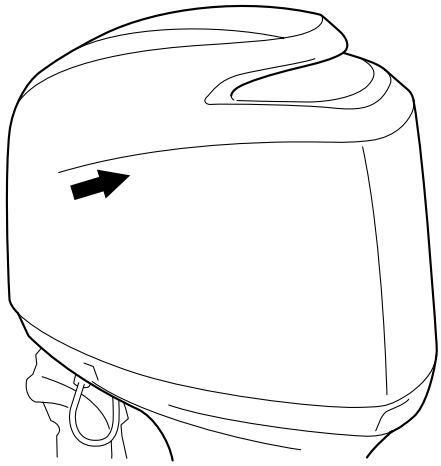
3. Contact the stopper ⓐ on the throttle lever 2 ④ to the fully closed stopper ⓑ on the cylinder block and then adjust the throttle link joint assembly ⑤ so that the specified clearance ⓒ is obtained.



Roller clearance ⓒ:
0.5 mm (0.02 in)

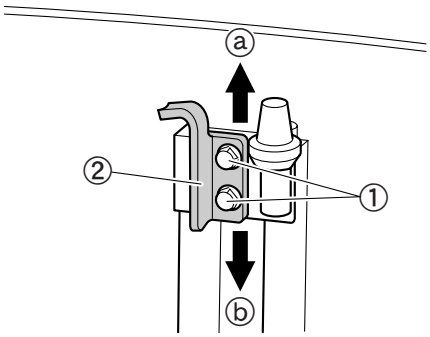
Checking the top cowling

1. Check the fitting by pushing the cowling with both hands. Adjust if there is free-play.



2. Loosen the bolts ①.

3. Move the hook ② up or down slightly to adjust its position.

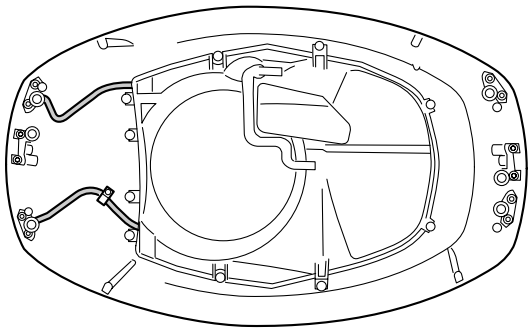


TIP:
- To loosen the fitting, move the hook in direction ⓐ.
- To tighten the fitting, move the hook in direction ⓑ.

4. Tighten the bolts ①.

5. Check the fitting again.

6. Check the top cowling hose for cracks or damage.



Checking the valve clearance

1. Check the valve clearance. See “Checking the valve clearance” (7-2).

Checking the water pump

1. Check the water pump housing and impeller. See “Checking the water pump and shift rod” (8-7).

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Appendix

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— MEMO —

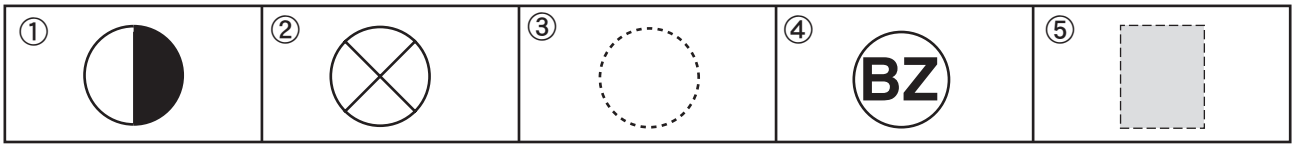
Wiring diagram

How to use the wiring diagram

Composition of the wiring diagrams

The wiring diagram consists of three categories. Fuel unit, Ignition unit, Charging and starting unit.

Legend symbols in the wiring diagrams



① Double colors wire
② No wire connector
③ A wire is not included in the selected wiring unit.
④ Alert buzzer
⑤ Option parts

Color Code

B : Black
Br : Brown
G : Green
L : Blue
Lg : Light green
O : Orange
P : Pink
R : Red
Sb : Sky blue
W : White
Y : Yellow
B/O : Black/Orange
B/W : Black/White
B/Y : Black/Yellow
Br/W : Brown/White
G/B : Green/Black
G/R : Green/Red
G/Y : Green/Yellow
L/G : Blue/Green
L/W : Blue/White
L/Y : Blue/Yellow
P/B : Pink/Black
P/G : Pink/Green
P/W : Pink/White
Pu/B : Purple/Black
Pu/G : Purple/Green
Pu/R : Purple/Red
Pu/Y : Purple/Yellow
R/Y : Red/Yellow
W/B : White/Black
W/R : White/Red
Y/G : Yellow/Green

Fuel unit

ⓐ Fuse (50A) (engine battery)
ⓑ Fuse (50A) (house battery)
ⓒ Fuse (20A) (engine ECM, ISC, fuel injector, high-pressure fuel pump, ignition coil, YDIS)
ⓓ Fuse (20A) (engine start switch, PTT switch)
ⓔ Fuse (30A) (starter motor relay)
ⓕ Main relay

Ⓐ To 10-pin main harness
Ⓑ To gauge

TIP:
Depending on the outboard motor, the location of the coupler terminal may be changed as indicated in the table below.

	Terminal No.	Color
(*1)	6 through 18 (except 8)	Red/Yellow
	19 through 21	Red

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Printed in China
Jul. 2008 – 0.6 × 1 ABE
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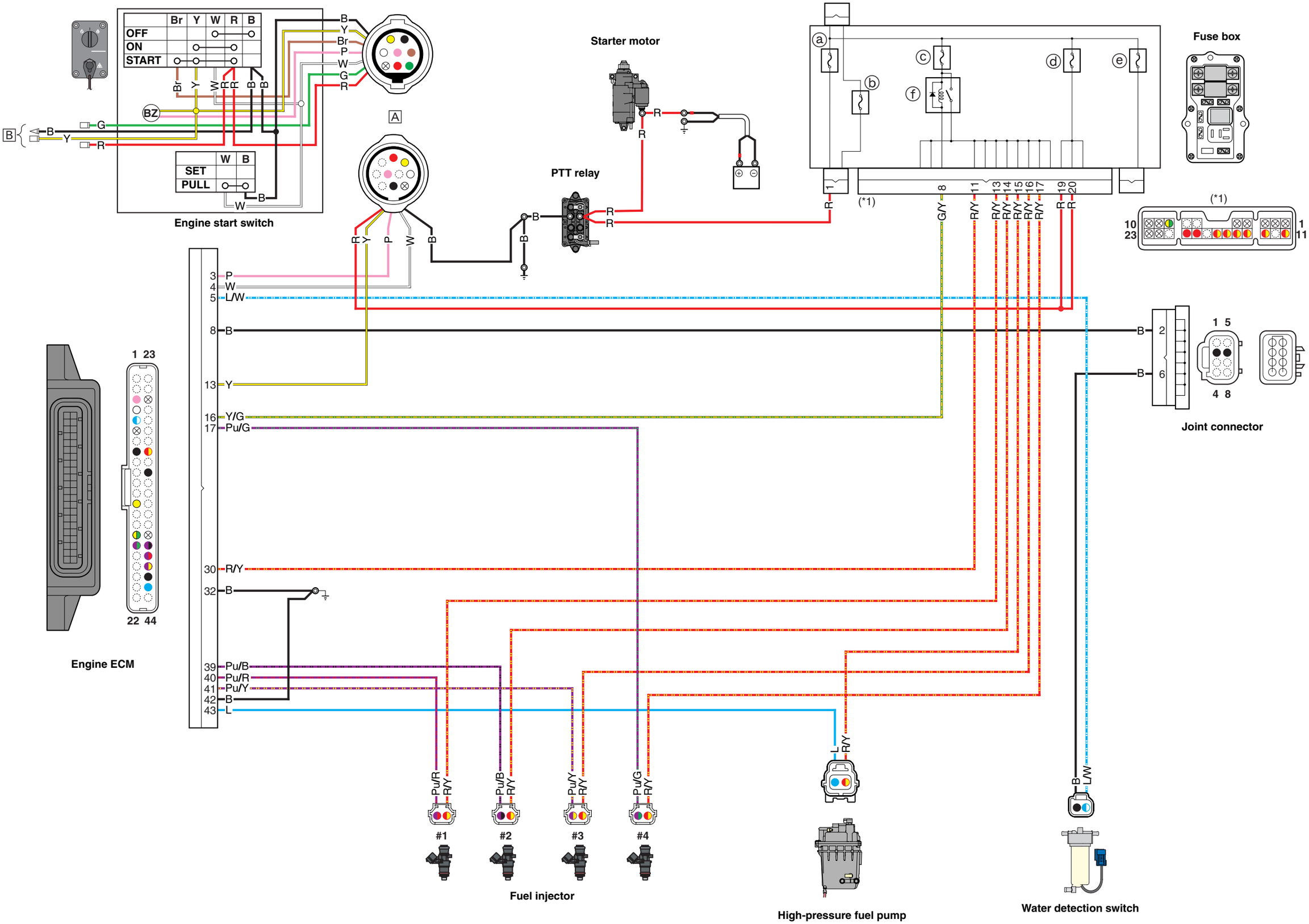
Fuel unit


Br Y W R B
OFF
ON
START
SET PULL
W B
BZ
Engine start switch
A
Starter motor
PTT relay
Fuse box
(*1)
Joint connector
1 23
22 44
Engine ECM
3 P
4 W
5 L/W
8 B
13 Y
16 Y/G
17 Pu/G
30 R/Y
32 B
39 Pu/B
40 Pu/R
41 Pu/Y
42 B
43 L
#1
#2
#3
#4
Fuel injector
High-pressure fuel pump
Water detection switch

Ignition unit

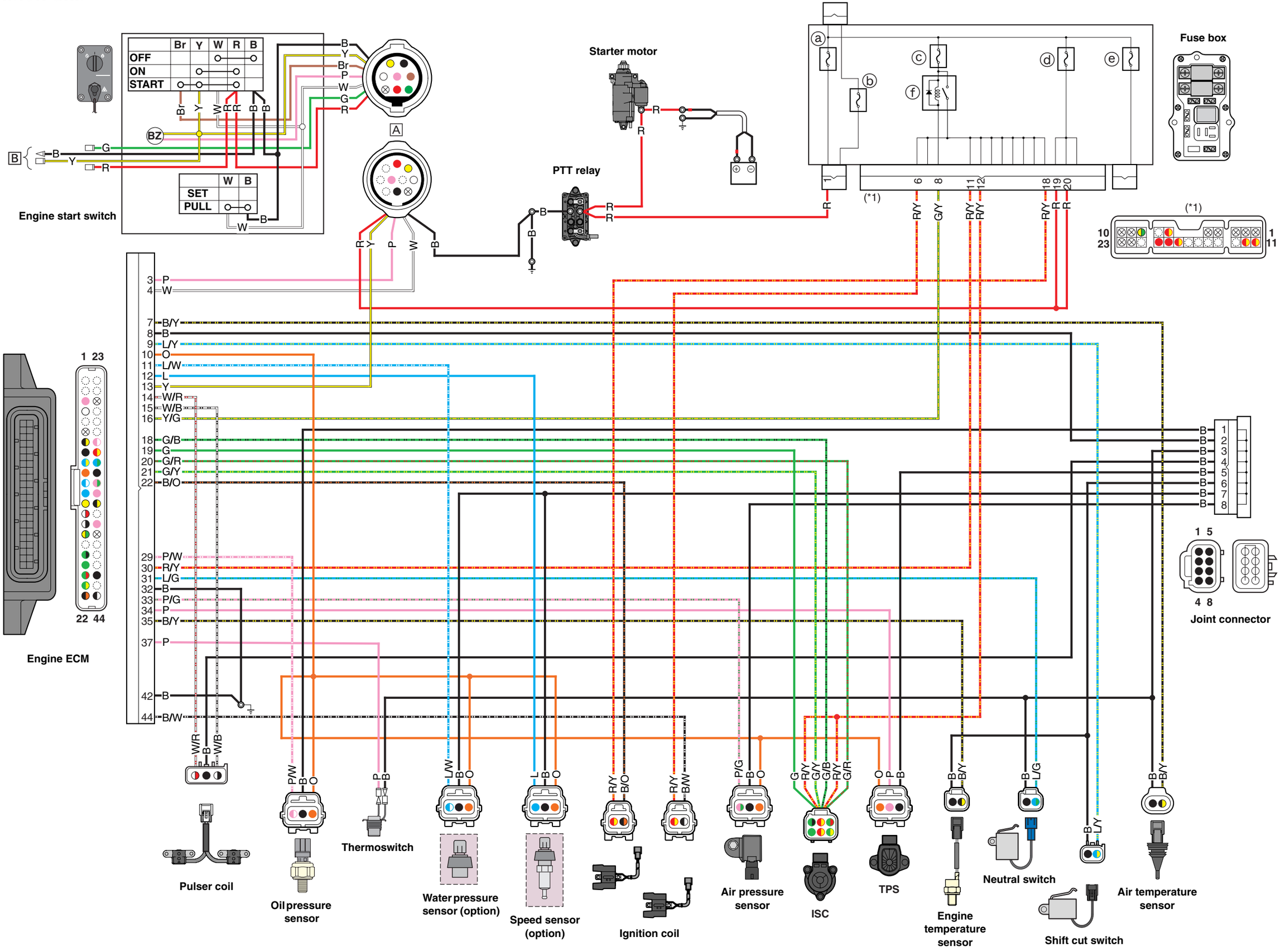
ⓐ Fuse (50A) (engine battery)
ⓑ Fuse (50A) (house battery)
ⓒ Fuse (20A) (engine ECM, ISC, fuel injector, high-pressure fuel pump, ignition coil, YDIS)
ⓓ Fuse (20A) (engine start switch, PTT switch)
ⓔ Fuse (30A) (starter motor relay)
ⓕ Main relay

Ⓐ To 10-pin main harness
Ⓑ To gauge

TIP:
Depending on the outboard motor, the location of the coupler terminal may be changed as indicated in the table below.

	Terminal No.	Color
(*1)	6 through 18 (except 8)	Red/Yellow
	19 through 21	Red

Ignition unit



Charging unit and starting unit

ⓐ Fuse (50A) (engine battery)
ⓑ Fuse (50A) (house battery)
ⓒ Fuse (20A) (engine ECM, ISC, fuel injector, high-pressure fuel pump, ignition coil, YDIS)
ⓓ Fuse (20A) (engine start switch, PTT switch)
ⓔ Fuse (30A) (starter motor relay)
ⓕ Main relay
ⓖ Diode (connect to the PTT relay)

[A] To 10-pin main harness
[B] To gauge
[C] To diagnostic test lead
[D] To gauge
[E] To 6Y8 Multifunction Meter hub
[F] Connect the coupler when the trim meter display is carried out by LAN communication (option).

TIP:
Depending on the outboard motor, the location of the coupler terminal may be changed as indicated in the table below.

	Terminal No.	Color
(*1)	6 through 18 (except 8)	Red/Yellow
	19 through 21	Red

Charging unit and starting unit