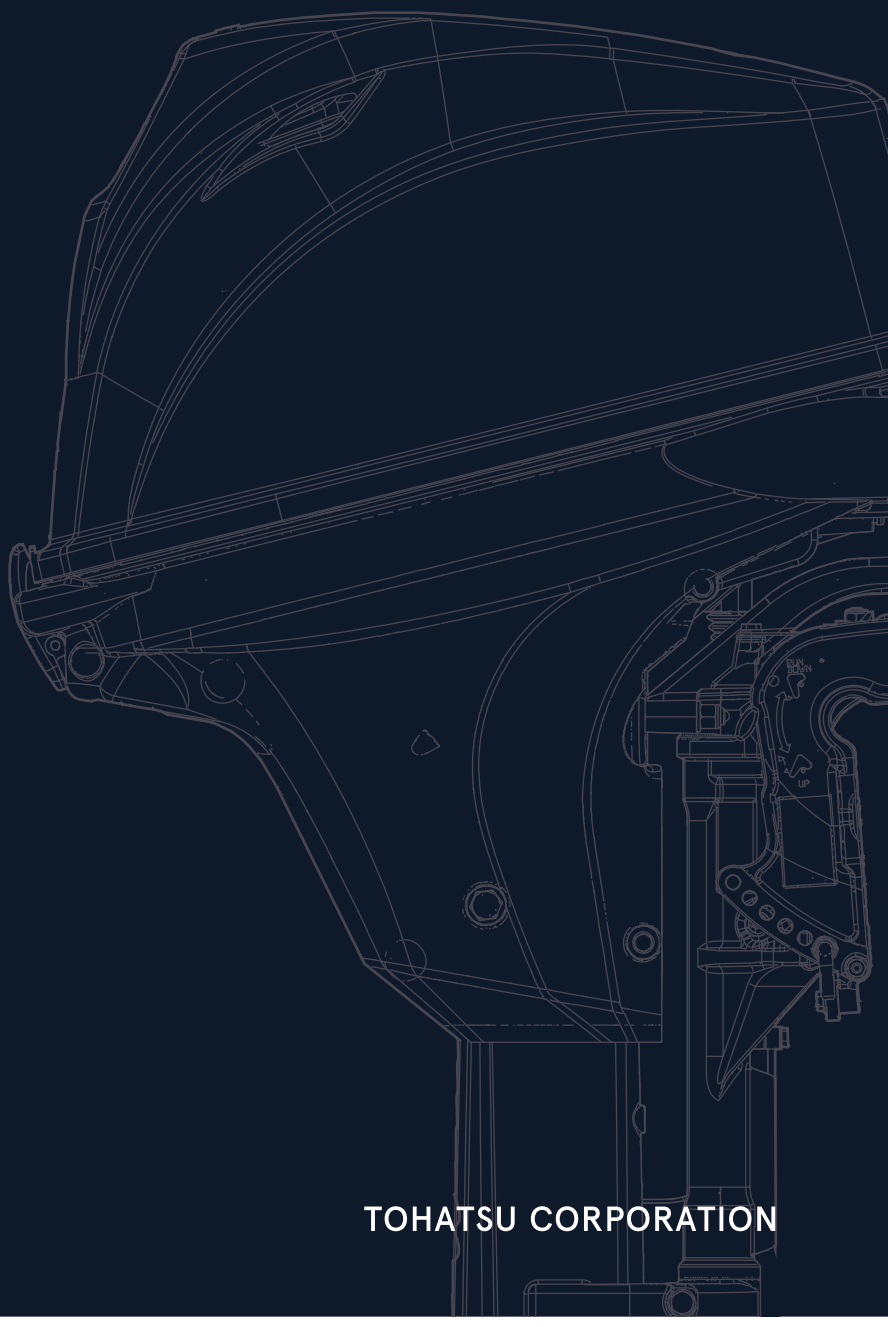
SERVICE MANUAL

TOHATSU
Feel the Wind™

4 STROKE MFS 9.9E MFS 15E MFS 20E Models

OB No.003-21062-2AH1 | 01-18 NB



BACKS YOU UP™

TOHATSU CORPORATION

Introduction

Before reading this manual

This service manual provides information that is needed for inspection, service and repair of applicable outboard motors. For information about operation of the products that are not described in this document, refer to the owners manual. For our customers' safe and dependable use of the product for long term, it is essential to maintain the performance and quality of the outboard. To ensure this, the maintenance and service have to be done properly by service technicians with fundamental knowledge and skills. This manual is utilized so that our customers can always use their outboard motor with full satisfaction.

Safety Information

Safety Statements

The following safety statements are found throughout this manual and indicate information which, if ignored, could result in fatal safety hazards or property damage:

⚠ DANGER

Indicates the presence of a hazard which, if ignored, will result in severe injury or death.

⚠ WARNING

Indicates the presence of a hazard or an unsafe activity which, if ignored, could result in severe injury or death.

⚠ CAUTION

Indicates the presence of a hazard or an unsafe activity which, if ignored, could result in minor personal injury or damage to the products or facilities.

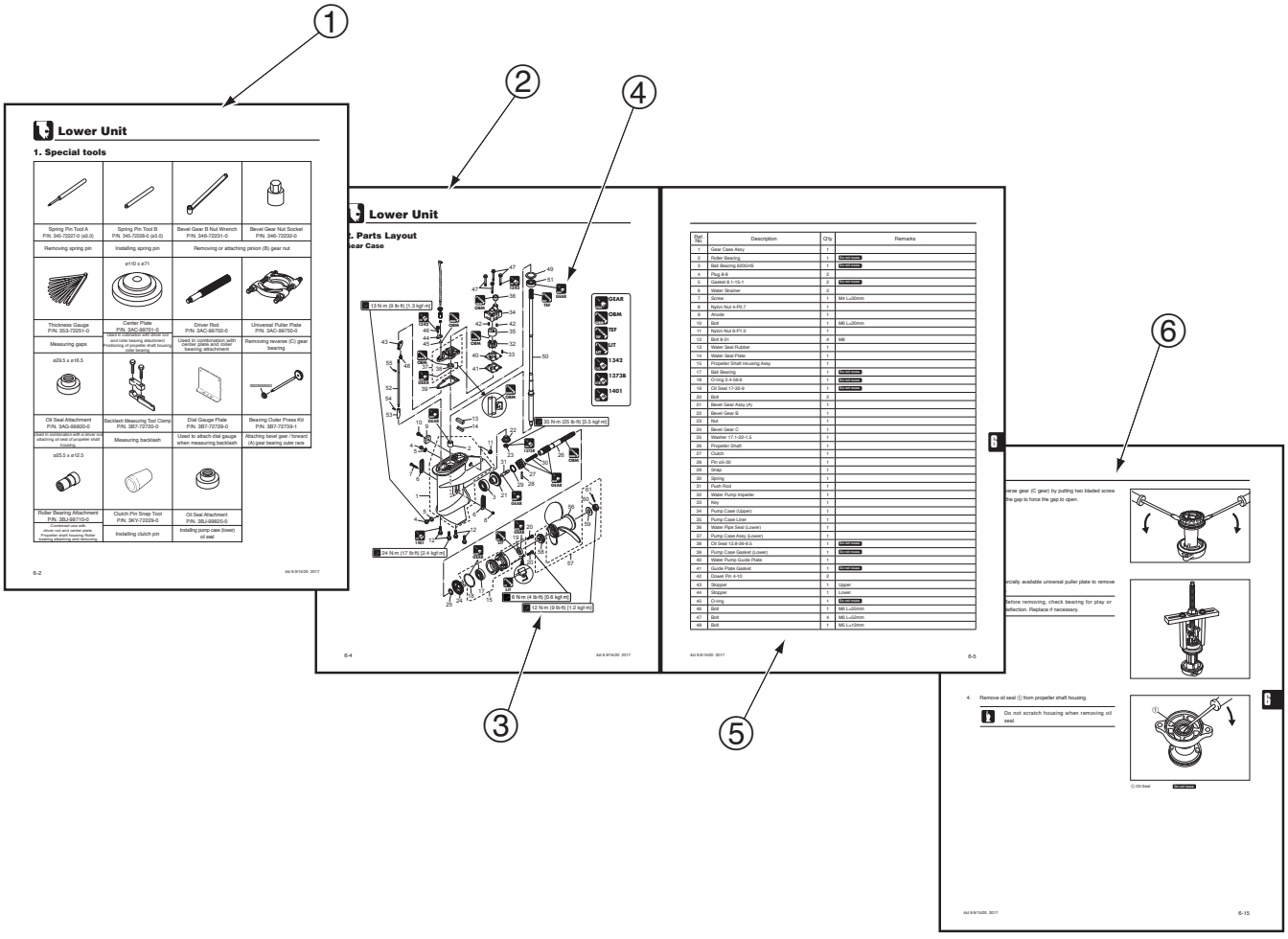
Attention:

About this manual

Composition and use of this manual

This service manual is designed so that service persons are able to perform repairs correctly.
Understand the following matters well for efficient service and repair.

① Each chapter begins with the introduction of special tools that are used for the work described.
② Parts that are serviced in each chapter and their details are presented by using a component composition diagram.
③ Fastening torques are described in the component composition diagram. In the body text are critical points of the applicable work.
④ Pictograms indicate that there is an important work instruction for the relevant parts. It also shows the type of lubricant and its application point(s).
⑤ The component composition diagrams describe the names of the parts, the number of pieces of the parts used, size of fasteners and special notes.
⑥ Specific works are described in detail by using illustrations and adding advice on the work.



This manual uses SI unit system (International System of Units) for pressure, force (load), torque and stress. This manual newly adopts the international unit construction system (SI unit system) followed by the conventional imperial and metric systems enclosed by ( ) and [ ] as described below.

Example : <Pressure>

0.90 MPa (128 psi) [9.0 kgf/cm^2]

- [9.0 kgf/cm^2] — Conventional system (kilo-gram meter unit)
- (128 psi) — Conventional system (US pound inch unit)
- 0.90 MPa — SI unit (1 kgf/cm^2 = 0.0980665 MPa)

* Measurements are shown using SI unit followed by conventional units (US unit) and [Japanese domestic unit].

Example : <Torque>

18 N·m (13lb·ft) [1.8 kgf·m]

*

* The conventional unit for measurement of force uses "kgf (kilogram force)" to discriminate it from "kg (mass kilogram)" of SI unit system.

Example : <Volume>

900 cm^3 (30.4 fl.oz)

Example : <Length>

10 mm (0.39 in)

<Reference>

What is the SI unit system?

Although the measurement unit is standardized mostly with metric system in the world, the metric system includes different kinds of unit systems.

Though the metric system was established expecting that a single unit system would be used in the world, various physical units were established later, resulting in branching the metric system in different unit systems.

The new unit system is called "International System of Units" because it was established for the purpose of unifying the different unit systems.

Since the metric system was initially established in France, and International Bureau of Weights and Measures (IBWM) is located in Paris, General Conference of Weights and Measures (GCWM) passed a resolution of the international unit system as "Systéme International d'Unités (French)" that is abbreviated as "SI unit".

For example, conventional metric system uses the unit of mass (kg) and unit of force (kg or kgf) without discriminating them, but the SI unit system uses, for example, "kg" as the unit of mass, and "N" as the unit of force, aiming to apply a kind of unit for a kind of physical quantity.

Description of Pictograph

The following symbols represent the contents of individual chapters.

Service Information 	Service Data 	Inspections and Adjustments 	Fuel System (Fuel Injection) 
Power Unit 	Lower Unit 	Bracket 	Electrical System 
Troubleshooting 	Rigging 	Wiring Diagrams 	

The following symbols indicate items needed for the service.

Special Tool 	Lubrication Oil 	Engine RPM 	Tightening Torque 
Specified Electrical Value 	Specified Measurement Value 	Use Limit 	Test Run Adjustment 
Specified Part 			

The following symbols indicate a point to which lubrication oil, sealing agent or screw-locking agent is to be applied.

4 stroke engine oil 	Gear oil 	ATF DEXRON Ⅲ 	OBM Grease 
Teflon® Grease TEFLON 	Low Temperature Lithium Grease LITHIUM 	Oil Compound [Shietsu Silicon] S.O.C 	[Konishi Bond] • G17 
Molybudenium Greese ·Moly Paste 500 	Screw Locking Agent [Loctite®] • 263 (271) 	Sealant [Loctite®] • 581 	Screw Locking Agent [Loctite®] • 1327 
Screw Locking Agent [Three Bond®] • 1342 	Screw Locking Agent [Three Bond®] • 1373B 	Screw Locking Agent [Three Bond®] • 1401 	Heat Resistant Grease ·Liquid O-Ring 

1.Service Information

2.Service Data

3.Maintenance

4.Fuel System (Fuel Injection)

5.Power Unit

6.Lower Unit

7.Bracket

8.Electrical System

9.Troubleshooting

10.Rigging

11.Wiring Diagram

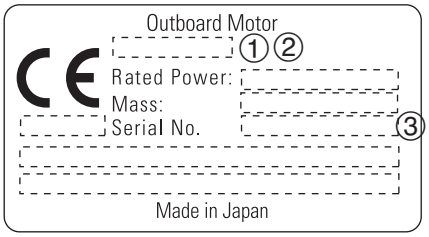
INDEX

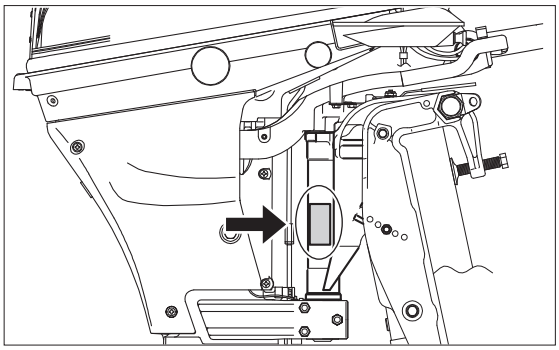
1
Service Information

1. Identification (Engine Serial Number)

Engine serial number is stamped on the Swivel bracket of outboard motor body.

① Model Name
② Model Type
③ Serial Number

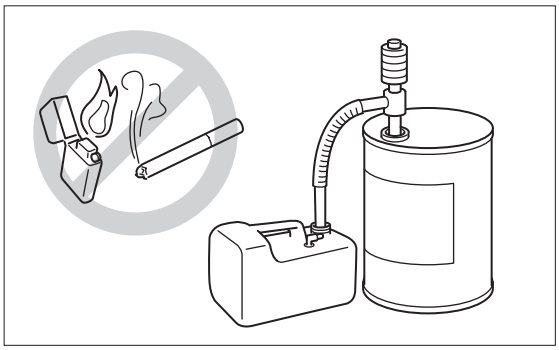




2. Securing of work safety

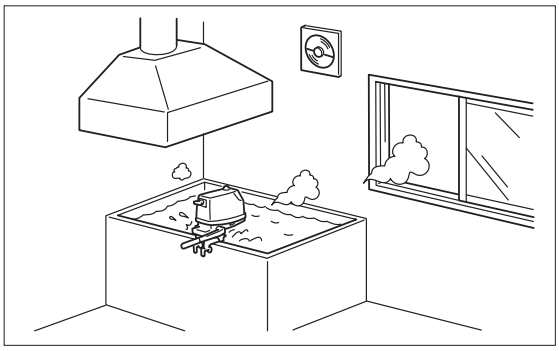
1) Fire Prevention

Gasoline is hazardous material and very flammable. Do not handle gasoline near ignition source such as spark or static electricity.



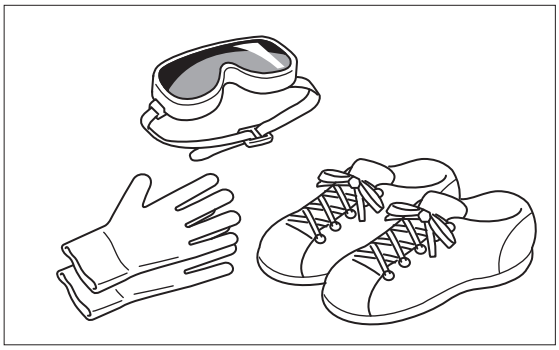
2) Ventilation

Exhaust gas or gasoline vapor is hazardous for human health. Be sure to ventilate well when working indoors.



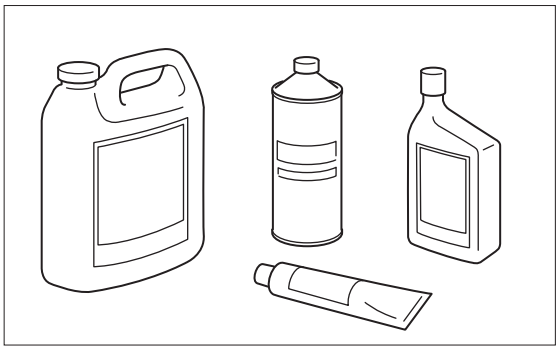
3) Protection

Wear a pair of goggles, working gloves and safety shoes to protect human body from chemicals and oils and eyes from particles generated by grinding or polishing works. Avoid adhesion of matters such as oil, grease or sealing agent to the skin. In case of exposure to such matters, wash away with soap or warm water immediately.



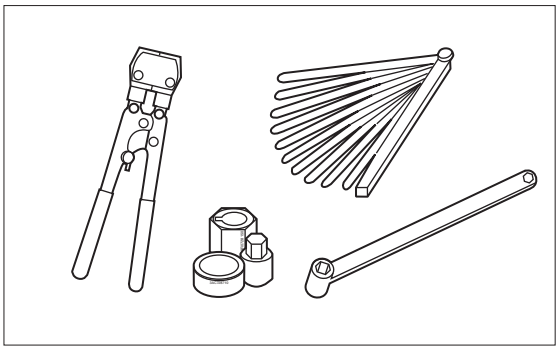
4) Genuine Parts

Use parts and/or chemicals that are genuine items or recommended.



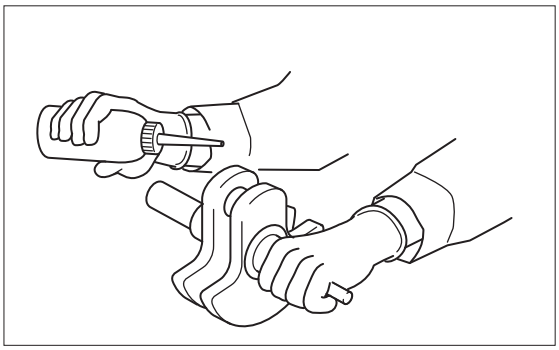
5) Tools

Use specified special tools to prevent damaging to parts and to perform work safely and surely. Be sure to follow installation procedures described in this manual and use tightening torque specified.



6) Recommendations on service

Remove foreign substances and dirt from outboard motor body and individual parts by cleaning. Apply recommended oil or grease to rotating areas and sliding surfaces. After individual works, always perform verifications such as ensuring smooth movement and sealing.



7) Cautions in disassembling and assembling components

(1) Secure outboard motor to dedicated stand firmly.

(2) Take special care not to scratch painted surface or mating surfaces of cylinder and crankcase.

(3) Replace unreusable parts such as packings, gaskets, O rings, oil seals, spring pins or split pins with new ones after they were removed . Replace deformed snap rings with new ones.

(4) When replacing parts, be sure to use genuine parts. For fluids such as gear oil, use genuine product.

(5) Be sure to use special tools that are specified, and perform the works properly.

(6) When reassembling parts, use their mating marks. For parts without mating marks, simple marking makes reassembling easier. Use applicable parts list for reference.

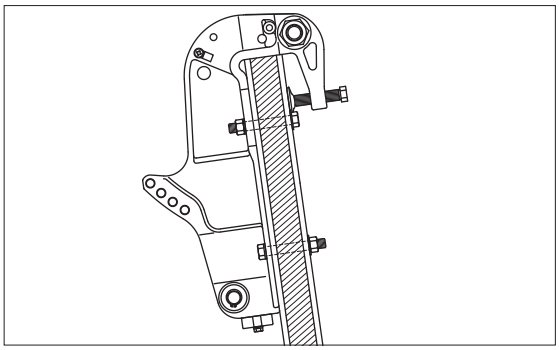
(7) Clean individual parts that have been removed, and check their conditions.

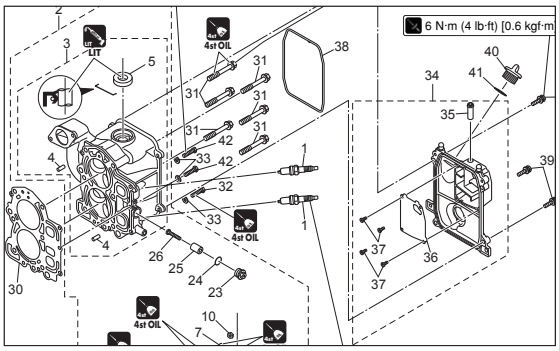
(8) When reassembling parts, take sufficient care also for details such as fits, repair limits, air tight, clogging of oil holes for lubrication and greasing, packings, wirings and piping. For components using many bolts and nuts for assembling, such as cylinder head and crankcase, tighten all the fasteners evenly to their specified torques clockwise in two or three stages, inner ones first and then outer ones. (Reverse the order when disassembling.)

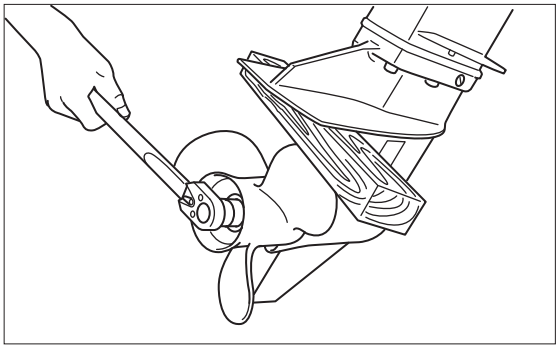
(9) When installing bearings, face the flat (numbered) side to the special assembling tool.

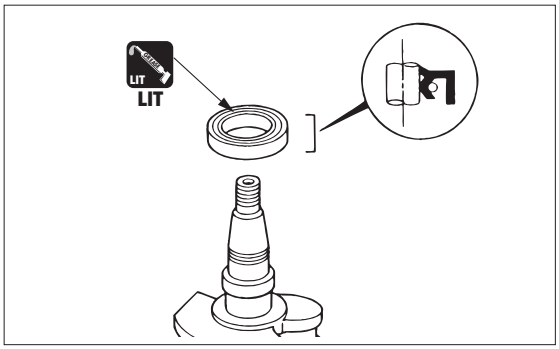
(10) When installing oil seals, be careful not to scratch the surface of the lip that contacts with the shaft, and install them in correct orientation. Apply recommended grease to the lip before installation.

(11) When applying liquid packing, take sufficient care for the thickness and quantity. Excessive application may be oozed out, adversely affecting interior of the crankcase. Use adhesive after thoroughly reading the instructions.









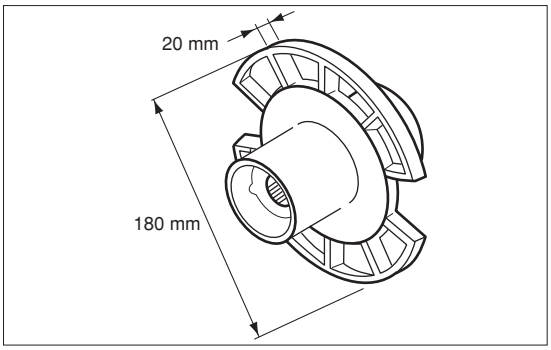
3. Tools and Instruments

1) Test Propeller

P/N. 3RS-64110-0

Outer diameter : 130 mm

With : 20 mm



Outboard motor model	Rotational speed at WOT (Wide Open Throttle) (r/min)
MFS9.9E	Approx. 4000
MFS15E	Approx. 5000
MFS20E	Approx. 5800

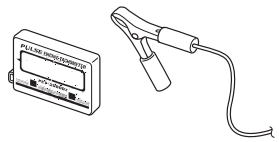
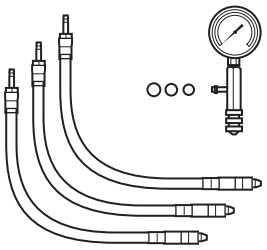
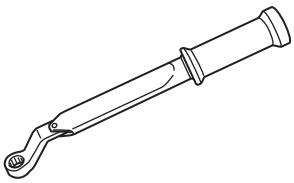
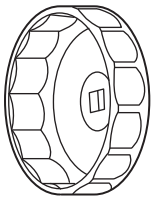
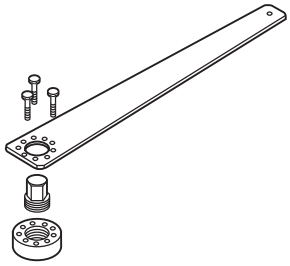
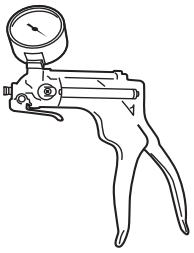
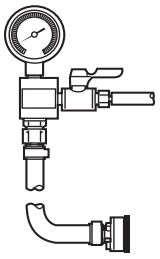
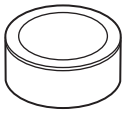
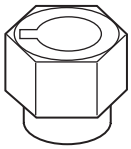
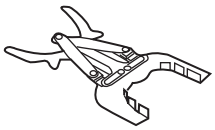
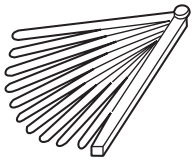
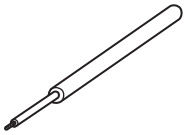
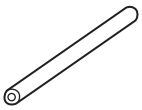
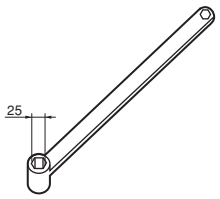
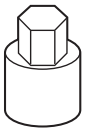
2) Measuring instruments

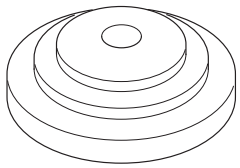
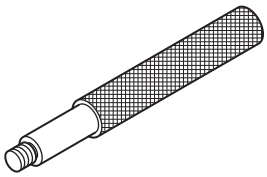
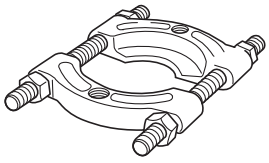
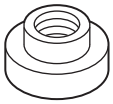
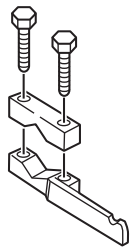
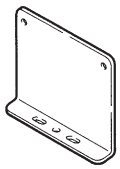
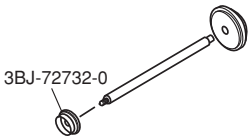
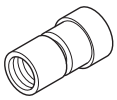
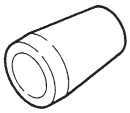
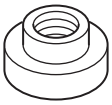
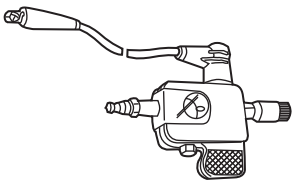
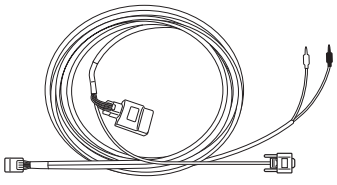
For the following measuring instruments, use commercially available ones.

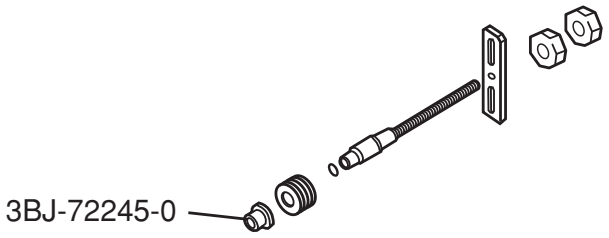
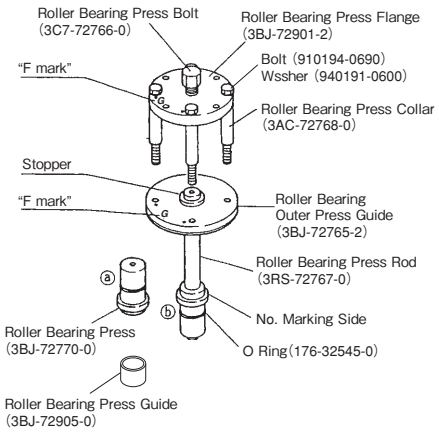
Circuit tester	(HIOKI 3000 Serise : Resistance : 1Ω, 10Ω, 10 kΩ, AC voltage : 30 to 300V, DC voltage : 30V)
Vernier calipers	(M1 type, 300 mm)
Micrometer	(minimum graduation of 0.01, outer, 0 to 25 mm, 25 to 50 mm, 50 to 75 mm)
Cylinder gauge	(4 to 6 mm, 10 to 25 mm, 25 to 30 mm, 50 to 75 mm)
Ring gauge	(ø5.5, ø17, ø42, ø70)
Dial gauge	(minimum graduation of 0.01)
Thickness gauge	(0.03 to 0.3 mm)
V block	
Surface plate	(500 mm x 500 mm)

Dial gauge magnet base or dial gauge stand

3) Special Tools

			
Tachometer P/N. 3AC-99010-0	Compression Gauge P/N. 3AC-99030-0	Torque Wrench P/N. 3AC-99070-0	Valve Clearance Driver P/N. 3AC-99071-0
Measuring engine revolution speed	Measuring compression pressure	Adjusting valve clearance	Adjusting valve clearance
			
Oil Filter Wrench P/N. 3AC-99090-0	Flywheel Puller Kit P/N. 369-72211-0	Vacuum/Pressure Gauge P/N. 3AC-99020-1	Pressure Gauge Ass'y P/N. 3T5-72880-0
Removing/installing oil filter	Removing/installing flywheel	Inspecting pressure	Measuring fuel pressure
			
Piston Slider P/N. 3AC-72871-0	Crank Shaft Holder P/N. 3BJ-72815-0	Piston Ring Tool P/N. 353-72249-0	Thickness Gauge P/N. 353-72251-0
Installing piston	Holding crank shaft	Removing or attaching piston rings	Measuring gaps
			
Spring Pin Tool A P/N. 345-72227-0 (ø3.0)	Spring Pin Tool B P/N. 345-72228-0 (ø3.0)	Bevel Gear B Nut Wrench P/N. 346-72231-0	Bevel Gear B Nut Socket P/N. 346-72232-0
Removing spring pin	Installing spring pin	Removing/installing Pinion Nut (B Gear Nut)	

ø110 x ø71 			ø29.5 x ø16.5 
Center Plate P/N. 3AC-99701-0	Driver Rod P/N. 3AC-99702-0	Universal Puller Plate P/N. 3AC-99750-0	Oil Seal Attachment P/N. 3AG-99820-0
Used in combination with driver rod and roller bearing attachment Positioning of propeller shaft housing roller bearing	Used in combination with center plate and roller bearing attachment	Removing reverse (C) gear bearing	Used in combination with a driver rod attaching oil seal of propeller shaft housing.
			ø25.5 x ø12.5 
Backlash Measuring Tool Clamp P/N. 3B7-72720-0	Dial Gauge Plate P/N. 3B7-72729-0	Bearing Outer Press Kit P/N. 3B7-72739-1	Roller Bearing Attachment P/N. 3BJ-99710-0
Measuring backlash	Used to attach dial gauge when measuring backlash	Attaching bevel gear / forward (A) gear bearing outer race	Combined use with driver rod and center plate. Propeller shaft housing Roller bearing attaching and removing
			
Clutch Pin Snap Tool P/N. 3KY-72229-0	Oil Seal Attachment P/N. 3BJ-99820-0	Spark Tester P/N. 3F3-72540-0	
Installing clutch pin	Installing pump case (lower) oil seal	Inspecting Ignition	
			
Diagnostic Tool kit P/N. 3RS-72920-0			
Used to engine diagnosis			

	
Backlash Measuring Tool Kit P/N. 3C8-72234-2	Roller Bearing Press Kit P/N. 3AC-72900-1
Measuring backlash between forward (A) gear and pinion (B) gear	Installing/attaching drive shaft housing roller bearing

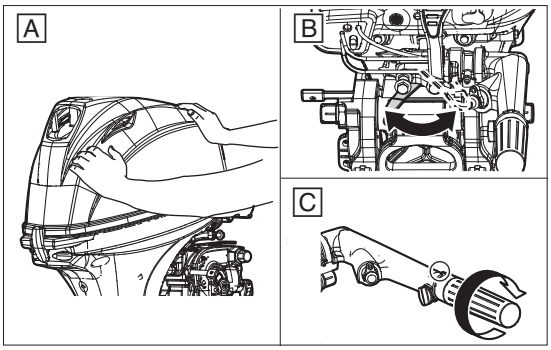
4. Pre-delivery Inspection

1) Steering Handle

A Check installations for clattering and play.

B Adjust steering friction.

C Check throttle grip for movement. (full open/full close).
Adjust throttle friction.

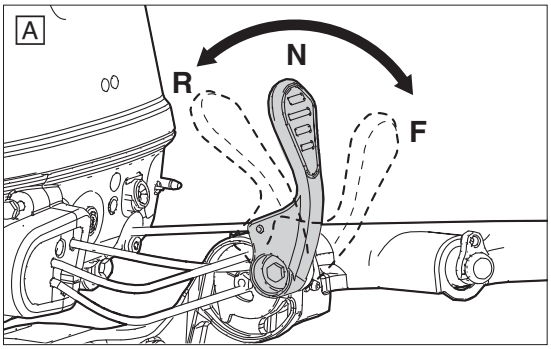


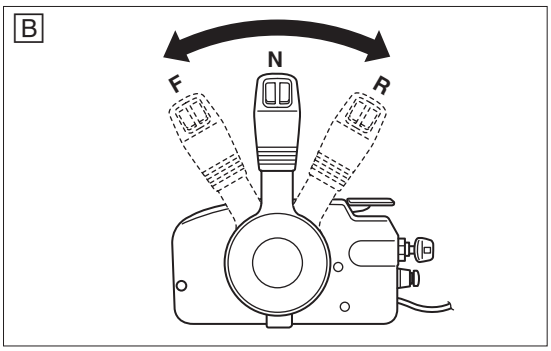
2) Gear Shift

Check that gear shifts from neutral (N) to forward (F) and reverse (R) smoothly.

A Tiller Handle Model

B Remote Control Model





3) Engine Oil

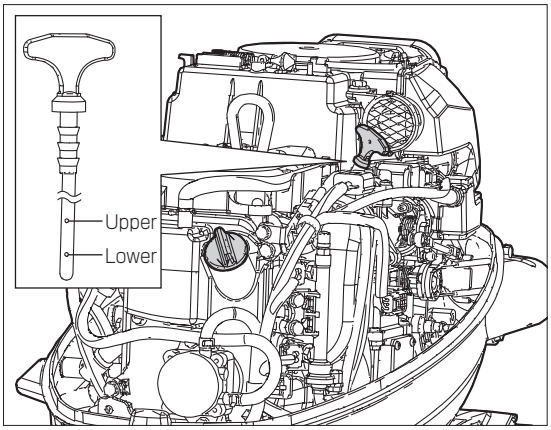
⚠ CAUTION

Engine oil is removed before shipment to prevent leakage.

Fill engine with engine oil.

4 Stroke Engine Oil :
1.0 L (1.05 US.qt) [without oil filter replacement]
1.2 L (1.26 US.qt) [oil filter replaced]

Use oil level gauge to check oil quantity.

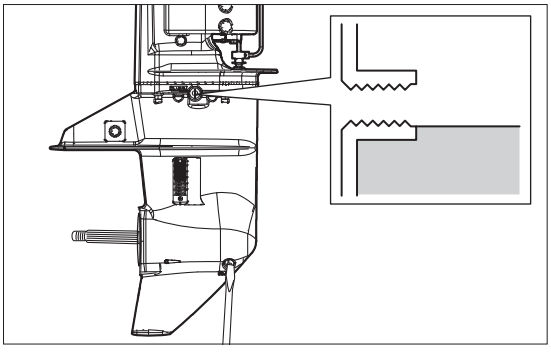


4) Gear Oil

Check quantity of gear oil.

Gear Oil :
465 cm^3 (15.7 fl.oz)

Spill of some oil from upper plug hole as plug is removed indicates that gear case is filled with specified quantity of gear oil.

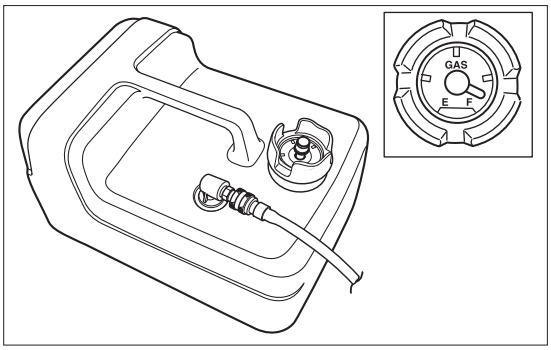


5) Fuel Line

Check that fuel tank contains sufficient amount of gasoline, fuel line is connected and is free of leak.

⚠ CAUTION

Since this is a four stroke engine model, do not use fuel mixed with engine oil. Use of fuel mixed with engine oil will cause engine trouble.

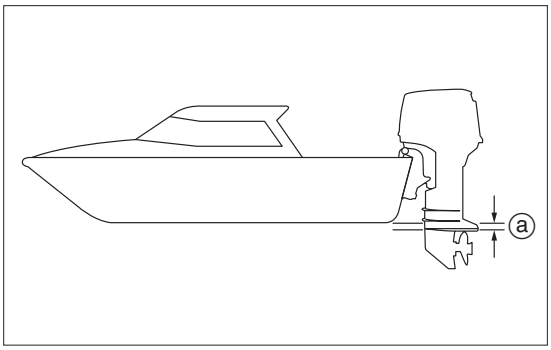


6) Rigging

Check that clamp bracket is fixed securely to hull. Check location of cavitation plate relative to boat bottom, and, if necessary, adjust to prevent decrease in propulsive force and engine overheating.

Test-run to determine the best installation height.

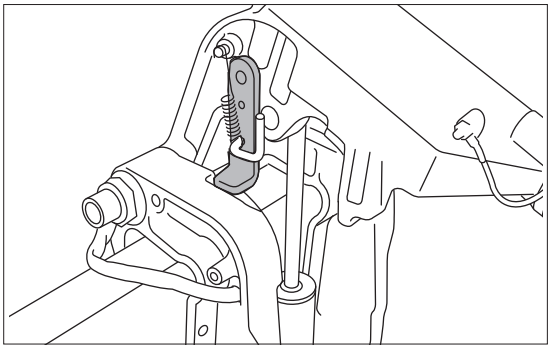
Standard installation height :
Cavitation plate located 5 to 25 mm (0.2 to 1 in) below boat bottom



ⓐ 5 to 25 mm (0.2 to 1 in)

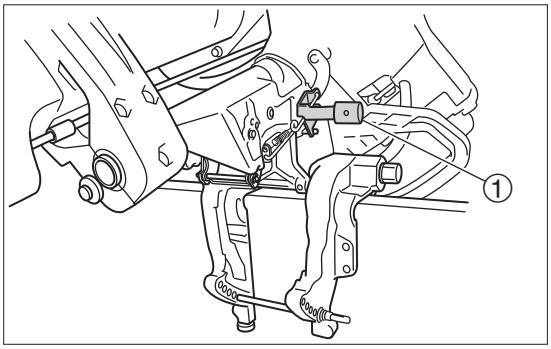
7) Inspection of PT unit (EFT, EPT)

1. Operate PT switch to check that outboard motor tilts up/down smoothly.
2. Operate PT switch to check that tilting up/down outboard makes no abnormal noise.
3. Tilt up outboard motor and steer fully to the right and left to check that cables and hoses do not interfere with each other and with any part of hull.



8) Inspection of Manual Tilt (Except for EFT, EPT)

1. Check that outboard motor tilts up/down smoothly.
2. Tilt up outboard motor and lock it with tilt lock lever ① to check that manual holding mechanism functions normally.

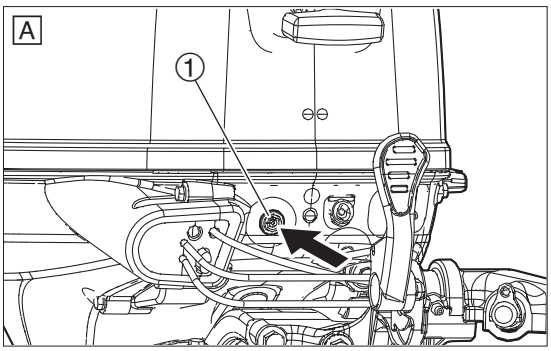


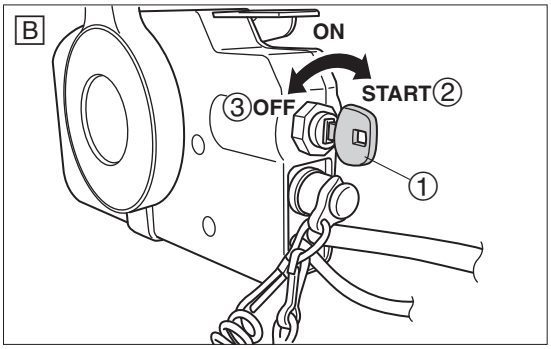
9) Inspection of Starting Switch and Stop Switch

1. Press start switch ① or turn main switch to START ② to check that engine starts.

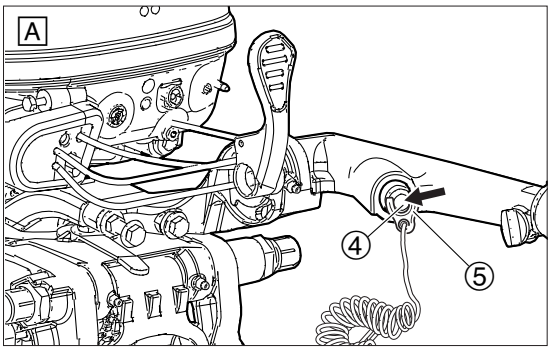
2. Turn main switch to OFF ③ to check that engine stops.

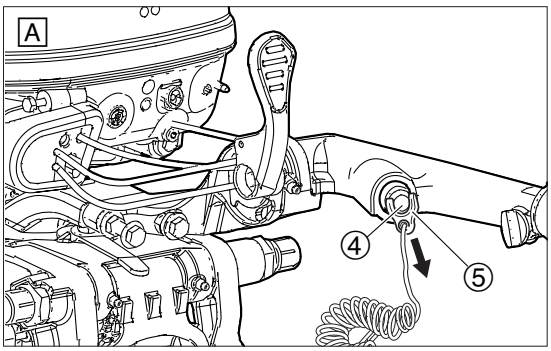
   A Tiller Handle Model
   B Remote Control Model

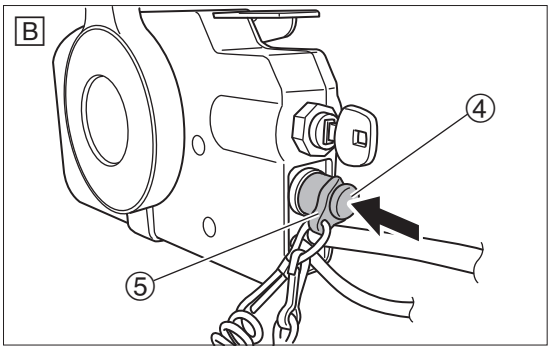




3. Press stop switch ④ hard or pull out lock ⑤ from stop switch ④ to check that engine stops.
   A Tiller Handle Model
   B Remote Control Model

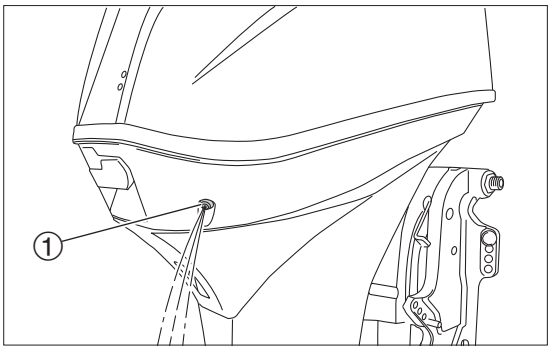






10) Cooling Water Check Port

Check that cooling water check port ① discharges water during engine runs should be operation.

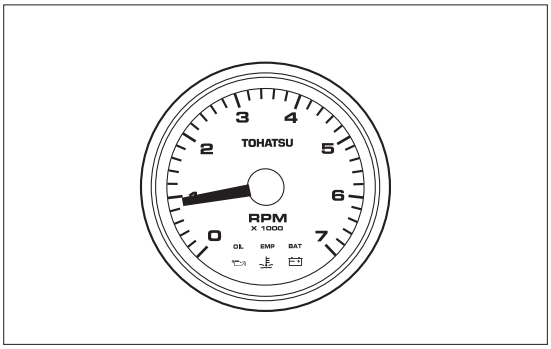


11) Idling

After engine has warmed up, use tachometer or diagnostic program to check idle speed is as specified.

Idle Speed :
950 r/min

Tachometer :
P/N. 3AC-99010-0



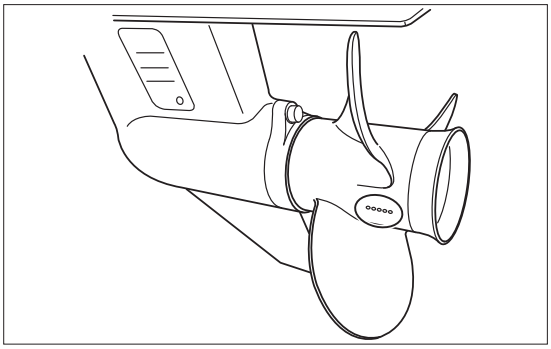
12) Propeller Selection

⚠ CAUTION

Miss-selection of propeller can cause adverse effects on engine life, fuel consumption, etc. as well as on performance.

Select a propeller that is best-suited to type of boat and application.

Range of operating engine speed at WOT
5400 - 6100 r/min



Propeller Table

Name	Propeller (No. of Blades x Pitchx Diameter) [mm/in]		Remarks
	(mm)	(in)	
11.5	(3 × 292 × 235)	(3 × 11.5 × 9.25)	
10	(3 × 254 × 235)	(3 × 10 × 9.25)	MFS15/20E : Standard for S transom.
9	(3 × 229 × 235)	(3 × 9 x 9.25)	MFS9.9E : Standard for S transom. MFS15/20E : Standard for L, UL transom.
8	(3 × 203 × 235)	(3 × 8 × 9.25)	MFS9.9E : Standard for L transom.
7	(3 × 174 × 234)	(3 × 7 × 9.21)	
6	(3 × 155 × 234)	(3 × 6 × 9.21)	
7	(4 × 178 × 254)	(4 × 7 × 9.21)	

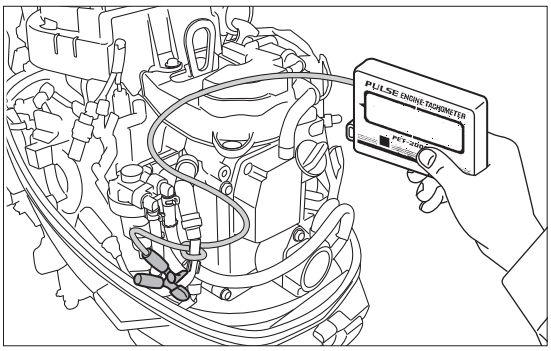
4. Break-in Operation

Break-in operation is needed for the purpose of smoothening sliding surfaces between components such as pistons and cylinder, piston rings, piston pins, crank shaft, connecting rods, and intake and exhaust valves.

Break-in Operation…10 hours

Time	0	10 minutes	2 hours	3 hours	10 hours
Operation	Dead Slow or Idling	1/2 of WOT or less at approximately 3,000 r/min	3/4 of WOT or less at approximately 4,000 r/min	3/4 of WOT at approximately 4,000 r/min	Regular Operation
	Running at the slowest possible speed		WOT run for approximately 1 minute can be included every 10 minutes of run.	Short period WOT run can be included.	

5. Test Run



1. Start engine and check if gear shift can be made smoothly.
2. After completing warm-up operation, check idling revolution speed.

Idling Revolution Speed :
950 r/min

Tachometer :
P/N. 3AC-99010-1

3. Shift gear into forward (F) and run dead slow for approximately 10 minutes.

Dead Slow Revolution Speed :
950 r/min

4. Run at 3,000 r/min or half of WOT for initial 2 hours, then at 4,000 r/min or 3/4 of WOT for 1 hour.
5. Check that shifting into reverse (R) will not tilt up outboard motor and allow water to run into boat.

Complete test run during break-in operation.

6. Checks After Test Run

1. Check that no water is present in gear oil.

2. Check that no fuel leaks in the cowl.

3. Check that no oil and water leak in the cowl and no water is present in engine oil.

4. After test run, use hose joint and fresh water to wash cooling water path.

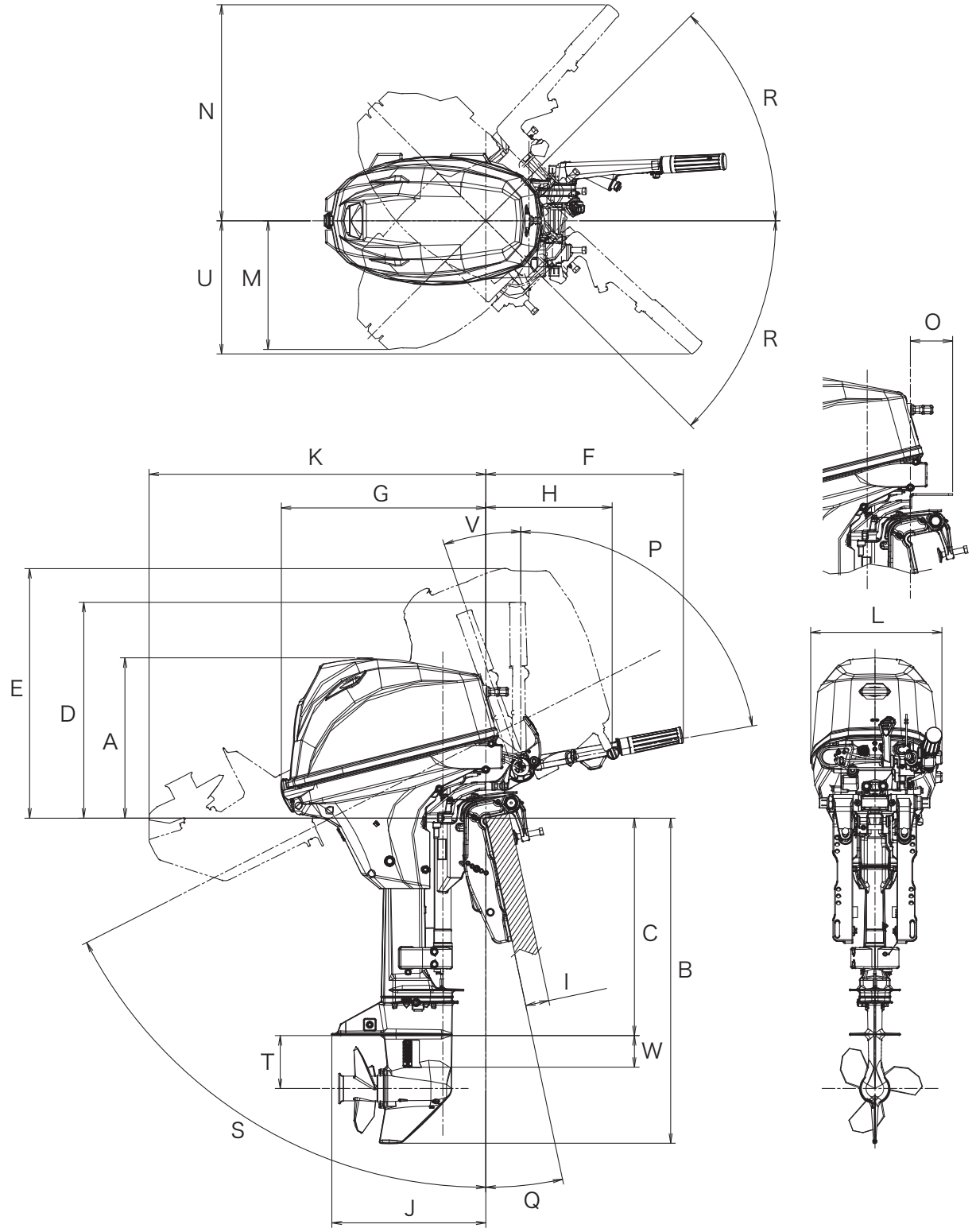
⚠ CAUTION

- **Be sure engine is stopped, at the cooling water path flushing. The water pump may be damaged.**
- **Remove the stop switch lock to prevent engine starting.**

2
Service Data

1. Outline Dimensions

1) Engine Dimensions



Maual Tilt Model

Item	Type	Unit	MFS9.9/15/20E	
			mm	in
A		mm/in	417	16.42
B	S	mm/in	689	27.13
	L	mm/in	838	32.99
	UL	mm/in	965	37.99
C	S	mm/in	413	16.26
	L	mm/in	562	22.13
	UL	mm/in	689	27.13
D		mm/in	558	21.97
E		mm/in	620	24.41
F		mm/in	540	21.26
G		mm/in	498	19.61
H		mm/in	343	13.50
I		mm/in	40 to 60	1.57 to 2.36
J		mm/in	370	14.57
K	S	mm/in	722	28.43
	L	mm/in	859	33.82
	UL	mm/in	975	38.39
L		mm/in	343	13.50
M		mm/in	333	13.11
N		mm/in	560	22.05
O		mm/in	137	5.39
P		deg.	80	
Q		deg.	12	
R		deg.	45	
S		deg.	64	
T		mm/in	137	5.39
U		mm/in	345	13.58
V		deg.	19	
W		mm/in	82	3.23
Trim Angle (Position)		deg. *1	-8 to +12 (6)	

* 1: Trim angle to horizontal when transom 12 °.

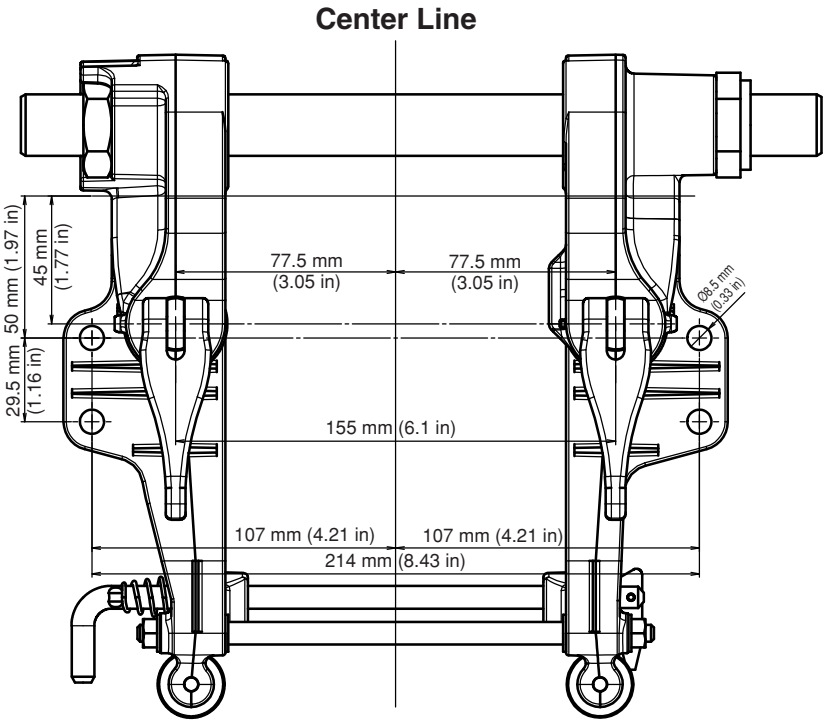
Power Tilt Model

Item	Type	Unit	MFS9.9/15/20E	
			mm	in
A		mm/in	417	16.42
B	S	mm/in	689	27.13
	L	mm/in	838	32.99
	UL	mm/in	965	37.99
C	S	mm/in	413	16.26
	L	mm/in	562	22.13
	UL	mm/in	689	27.13
D		mm/in	558	21.97
E		mm/in	645	25.39
F		mm/in	512	20.16
G		mm/in	526	20.71
H		mm/in	326	12.83
I		mm/in	30 to 63	1.18 to 2.48
J		mm/in	370	15.67
K	S	mm/in	735	28.94
	L	mm/in	872	34.33
	UL	mm/in	988	38.90
L		mm/in	339	13.35
M		mm/in	333	13.11
N		mm/in	560	22.05
O		mm/in	137	4.29
P		deg.	80	
Q		deg.	12	
R		deg.	45	
S		deg.	63	
T		mm/in	137	5.39
U		mm/in	345	13.58
V		deg.	19	
W		mm/in	82	3.23
Trim Angle (Position)		deg. *1	-8 to +12 (5)	

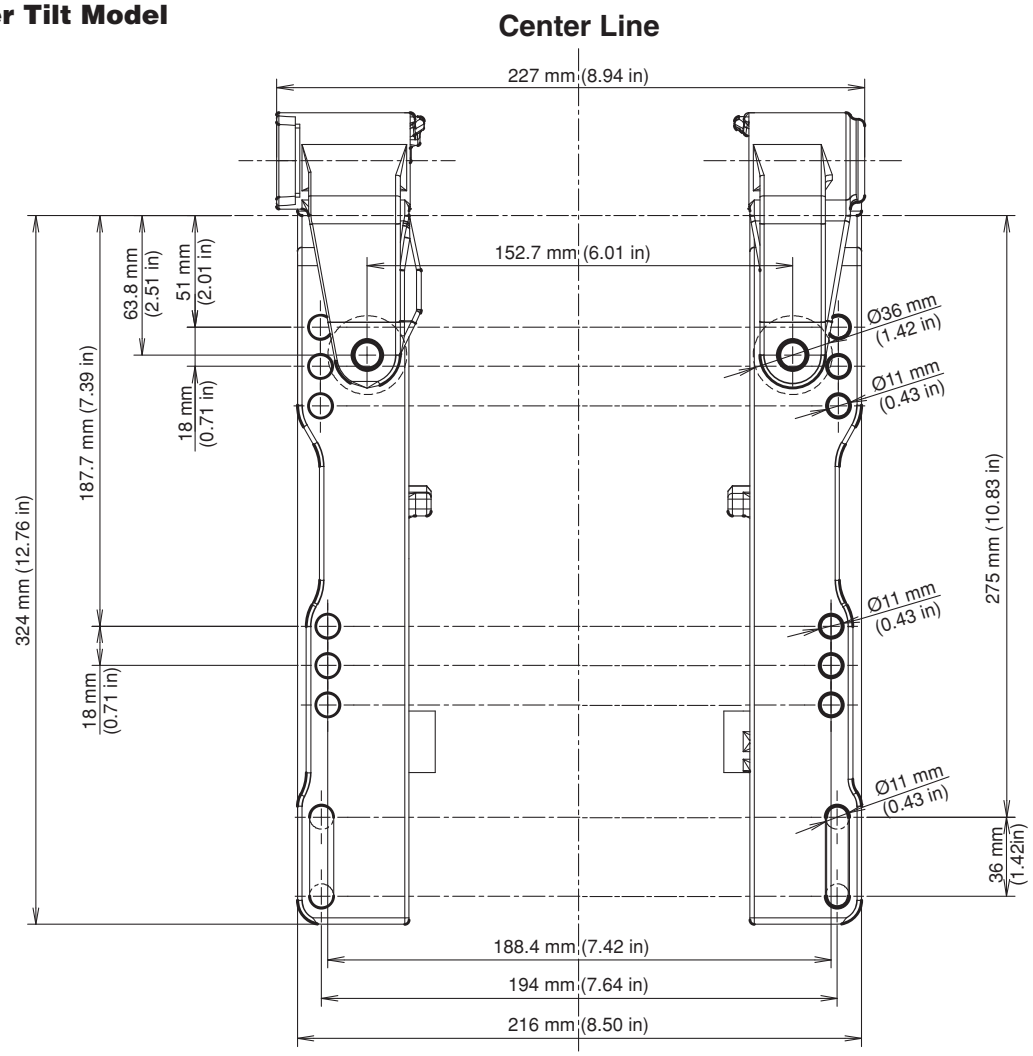
* 1: Trim angle to horizontal when transom 12 °.

2) Transom Bolts

Manual Tilt Model



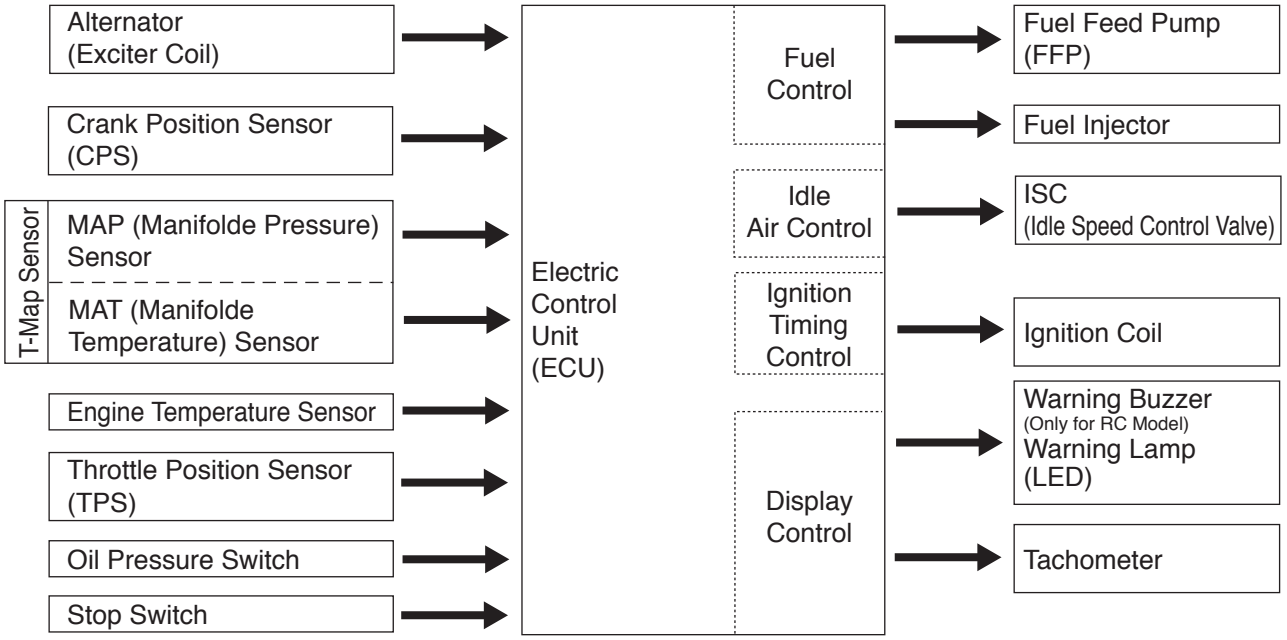
Power Tilt Model

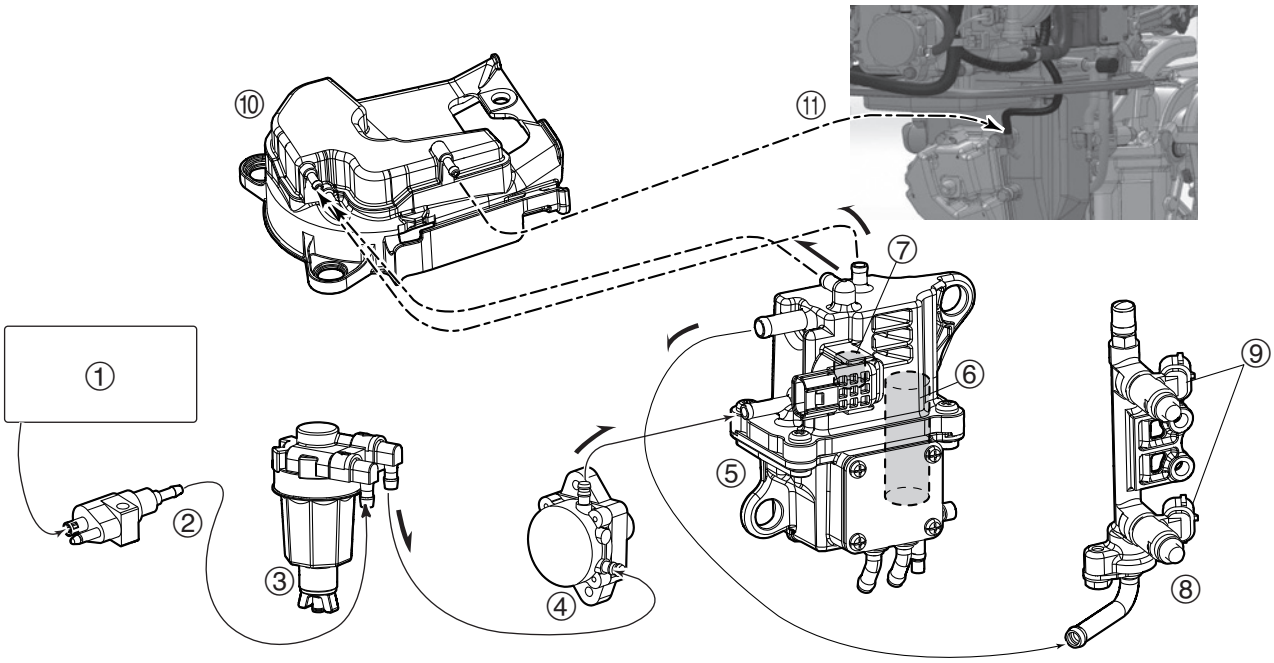


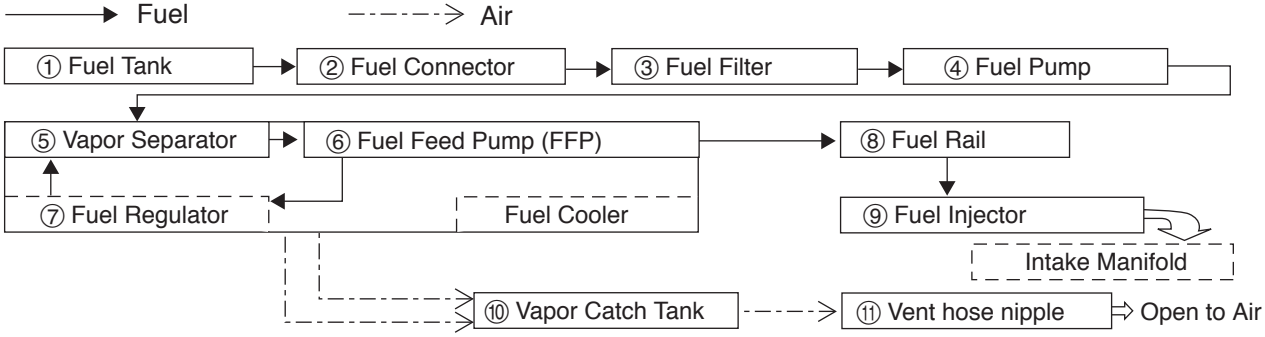
2.Fuel Injection System

1) ECU Fuel Feed System

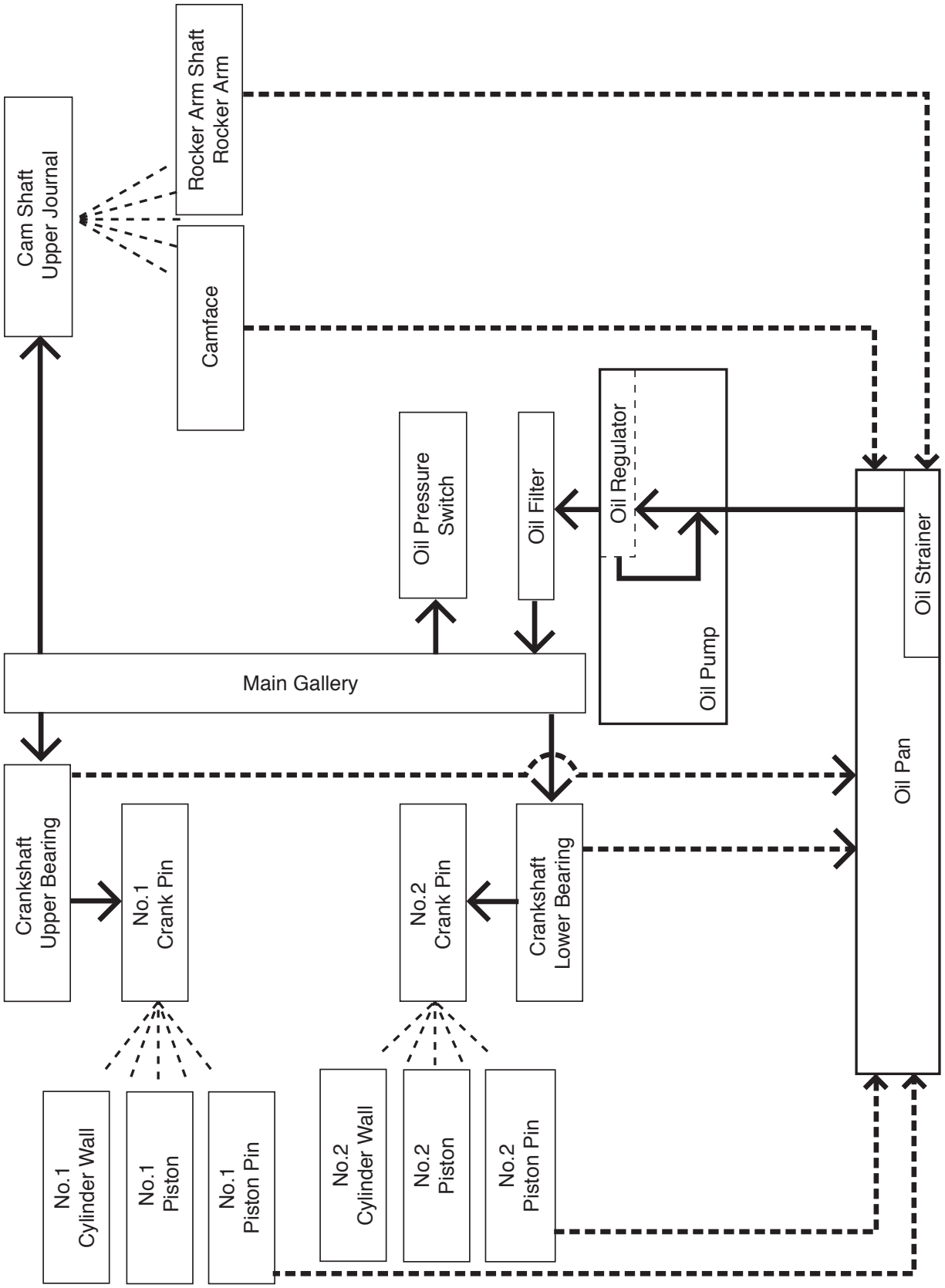
ECU uses various sensors to precisely control injected fuel amount and ignition timing.



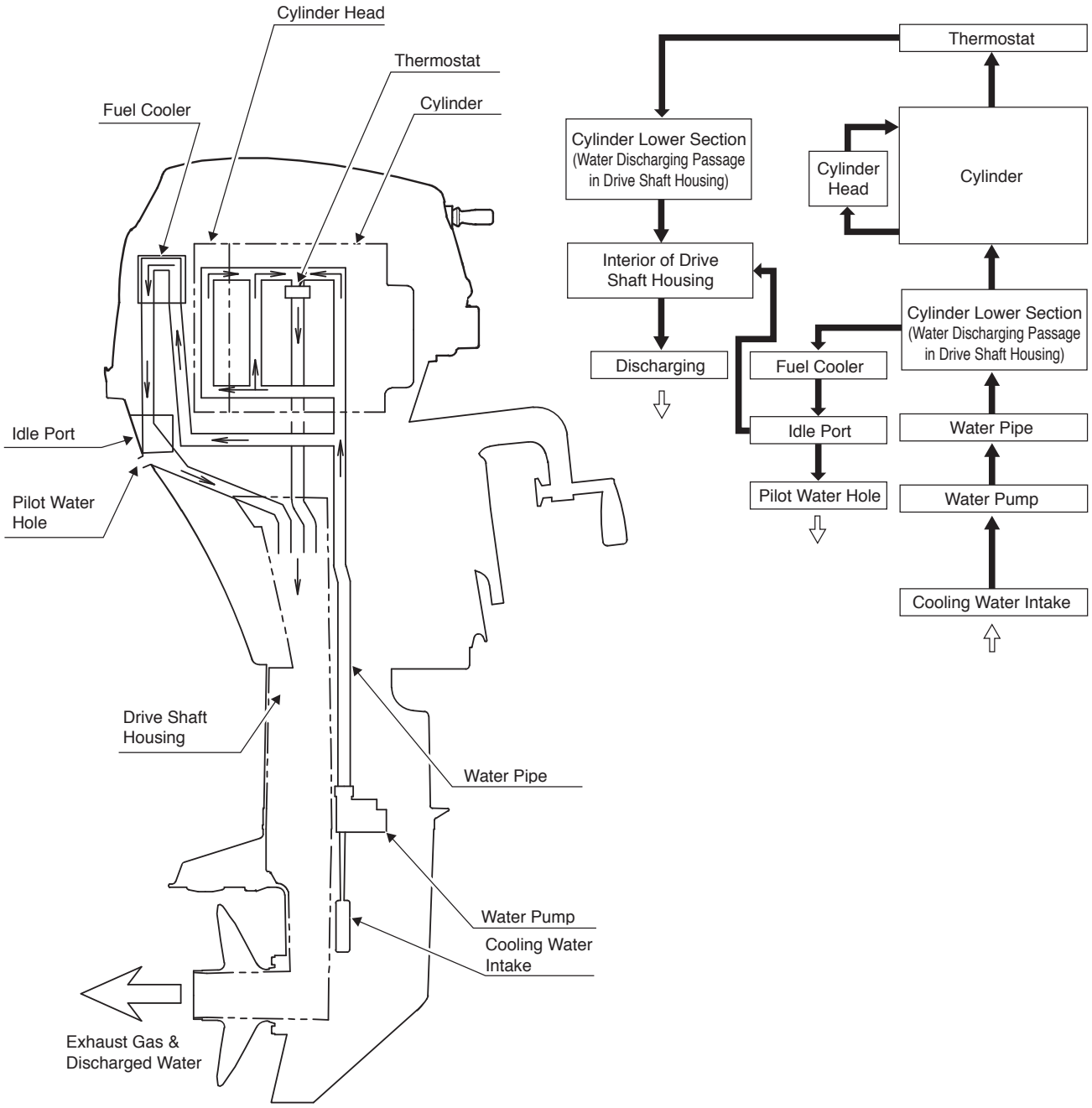




3.Engine Lubrication System Diagram



4.Cooling Water System Diagram



5.Specifications

Item		Unit	Model				
			MFS9.9/15/20E Fi				
			MF (with Tiller Handle)	EF (with Tiller Handle)	EFT (with Tiller Handle)	EPT (with Remote Control)	EP (with Remote Control)

Dimensions (approx.)

Overall Length		mm (in)	with Remote Control : 635 (25.0) with Tiller Handle : 1,038 (40.9)
Overall Width		mm (in)	Manual Tilt Model : 343 (13.5) Power Tilt Mode : 339 (13.4)
Overall Height	S	mm (in)	1,116 (43.9)
	L	mm (in)	1,258 (49.5)
	UL	mm (in)	1,386 (54.5)
Transom Length	S	mm (in)	413 (16.3)
	L	mm (in)	562 (22.1)
	UL	mm (in)	689 (27.1)

Weight (approx.)

	S	kg (lb)	43 (95)	47 (104)	52.5 (116)	51.5 (114)	46 (101)
	L	kg (lb)	44 (97)	48 (106)	53.5 (118)	52.5 (116)	47 (104)
	UL	kg (lb)	45.5 (100)	49.5 (109)	55 (121)	54 (119)	48.5 (107)

Performance

Maximum Output		kW (ps)	9.9E : 7.3 (9.9) 15E :11.0 (15) 20E :14.7 (20)
Full-throttle revolution speed range		min^{-1}(r/min)	5,400 to 6,100
Full-throttle Fuel Consumption		L (gal.)/hr	9.9E : 4.3 (1.14) 15E : 5.3 (1.40) 20E : 6.3 (1.66)
Idling (Neutral [N])		min^{-1}(r/min)	950
Trolling (Forward [F])		min^{-1}(r/min)	950

Power Unit

Engine Type			4 stroke Fuel Injection		
No. of Cylinders			2		
Piston Displacement		cm^3 (cui)	333 (20.32)		
Valve System			SOHC		
Bore x Stroke		mm (in)	61 x 57 (2.40 x 2.24)		
Compression Ratio			10.2		
Shift Operation System			Front Shift (Manual)		Remote Control
Starting System			Manual Start	Manual Start & Electric Start	
Lubrication System			Wet Sump		
Cooling System			Water Cooling (Impeller System)		
Exhaust System			Through-the-prop Exhaust		
Ignition System			CD Ignition		
Range of Ignition Angle			9.9E : 5° to 25° 15-20E : 5° to 30° (ECU timing control)		
Spark Plugs			DCPR6E [NGK]		
Alternator Output			12V–145W		
Fuel Feed System			Fuel Injection		

Item	Unit	Model				
		MFS9.9/15/20E Fi				
		MF (with Tiller Handle)	EF (with Tiller Handle)	EFT (with Tiller Handle)	EPT (with Remote Control)	EP (with Remote Control)

Fuel & Oil

Type of Fuel			Unleaded Gasoline (Research Octane Number 90 or over, Pump posted Octane Number 87 or over)	
Fuel Tank Capacity		L (gal)	12 (3.17)	
Fuel Priming System			ECU (Electronic Control Unit)	
Fuel Pumping System			Mechanical (Plunger) pump + Electric System	
Engine Oil – Type			4 Stroke Engine (Motor) Oil	
Engine Oil – Grade		API	SH, SJ, SL	
Engine Oil – Grade		SAE	10W-30, 10W-40	
Engine Oil – Quantity		L	1.2 (when oil filter is replaced with new one)	
Gear Oil – Type			Hypoid Gear Oil	
Gear Oil – Grade	*1	API	GL-5	
Gear Oil – Grade	*1	SAE	#80-90	
Gear Oil – Quantity		cm³ (Fl.oz)	465 (15.7)	

Lower Unit

Gear Shift Positions			F – N – R	
Gear Ratio			2.15 (13 : 28)	
Type of Gears			Spiral Bevel Gear	
Clutch			Dog Clutch	
Propeller Shaft Driving			Spline	
Propeller Rotation Direction			Clockwise at forward (F) shift as viewed from rear	
Propeller (Standard)		Marking	9.9 S : 9", L : 8" 15/20 S : 10", L, UL : 9"	

Bracket

No. of Trim Steps		Steps	6	5	6
Trim Angle (Transom 12)	*2	Degrees	–8 to +12	–8 to +8	–8 to +12
Shallow Water Drive Angle (Transom 12)	*2	Degrees	1st stage : 17 2nd stage : 31	Adjustable	1st stage : 17 2nd stage : 31
Max. Tilt Angle	*3	Degrees	76	75	76
Steering Angle	*4	Degrees	45+45		
Max. Allowable Transom Thickness		mm (in)	40 to 60 (1.57 to 2.36)	30 to 63 (1.18 to 2.48)	40 to 60 (1.57 to 2.36)

*1 Both API and SAE requirements shall be met.
*2 Angle relative to horizon when transom angle is 12 degrees.
*3 Tilting Range
*4 Full Steering Angle Range to Starboard and Port

Item	Unit	Model				
		MFS9.9/15/20E Fi				
		MF (with Tiller Handle)	EF (with Tiller Handle)	EFT (with Tiller Handle)	EPT (with Remote Control)	EP (with Remote Control)

Warning System

Over-revolution Protection			Controls engine speed to approximately 6,300 r/min or less (High Speed ESG). Warning lamp lits, and warning buzzer*2 sounds continuously.
Engine Hydraulic Pressure Low	*1		Controls engine speed to approximately 2,800 r/min or less (Low Speed ESG). Warning lamp lits, and warning buzzer*2 sounds continuously.
Engine Cooling Water Temperature Abnormally High.	*1		Controls engine speed to approximately 2,800 r/min or less (Low Speed ESG). Warning lamp lits, and warning buzzer*2 sounds continuously.
Each Engine Sensor Malfunction	*1		Controls engine speed to approximately 2,800 r/min or less (Low Speed ESG). Warning lamp blinks, and warning buzzer*2 sounds Intermittently.
Warning System Operation Check			Warning buzzer sounds (only 0.5 seconds), and warning lamp is brinks (approximately 5 seconds).

*1 Stop engine to cancel warning system operation.
*2 Warning buzzer is equipped with remote control model only.

6. Maintenance Data

	Parts Name	Item	Standard Value
Engine Parts	**Cylinder Head**	Build up of carbon in combustion chamber	
		Measure the cam journal clearance	Pully side : Ø 18.010 to 18.025 mm (0.7091 to 0.7096 in) Oil Pump side : Ø 32.00 to 32.05 mm (1.2598 to 1.2618 in)
		Distortion or damage on mating surface	Distortion Limit : 0.05 mm (0.0020 in) or less
		Corrosion on the mating surface	
		Cooling water passage clogged	
	Cylinder	Deposition in water jacket	
		Wear of bore : Use cylinder gauge to measure inner diameter.	61.00 mm (2.4016 in)
		Seizure, cylinder liner damage, or wear Taper Out-of-roundness	
		Distortion or damage on cylinder head mating surface	Distortion Limit : 0.05 mm (0.0020 in) or less
		Engine Anode	
	Piston	Outer Diameter Measure outer diameter at 11 mm (0.43 in) above lower end of piston skirt (at right angle to piston pin).	60.960 mm (2.4000 in)
		Piston Clearance	0.020 to 0.055 mm (0.00079 to 0.00217 in)
		Carbon build up on piston crown and in ring grooves	
		Scratch on the sliding surface	
		Measure side clearance between piston ring and ring groove.	Top Ring : 0.03 to 0.08 mm (0.0012 to 0.0031 in)
			Second Ring : 0.02 to 0.06 mm (0.0008 to 0.0024 in)
			Oil Ring :0.03 to 0.13 mm (0.0012 to 0.0051 in)
		Measure piston pin hole diameter.	16.002 to 16.008 mm (0.6300 to 0.6302 in)
		Clearance between piston pin and pin hole	0.002 to 0.012 mm (0.00008 to 0.00047 in)
	Piston Pin	Outer Diameter	16.00 mm (0.62992 in)
	Piston Ring	Applicable Gage — Note : Measurement of ring end gap : If ring gauge is not available, use cylinder bore top or bottom with small wear.	Ring Gage 61.000 mm (2.40157 in)
		Top Ring	Top Ring : 0.15 to 0.30 mm (0.0059 to 0.0118 in)
		Second Ring	Second Ring : 0.35 to 0.50 mm (0.0138 to 0.0197 in)
		Oil Ring	Oil Ring : 0.20 to 0.70 mm (0.0079 to 0.0276 in)
	Connecting Rod	Small End Inner Diameter	16.010 to 16.021 mm (0.63031 to 0.63075 in)
		Big End Oil Clearance	0.015 to 0.041 mm (0.00059 to 0.00161 in)
		Big End Side Clearance	0.10 to 0.25 mm (0.0039 to 0.0098 in)
	Crankshaft	Crankshaft runout : Use V blocks to supportcrankshaft at journals of both ends.	Less than 0.03mm (0.0012 in) at both ends and at the center.
		Crank pin outer diameter	28.972 to 28.985 mm (1.1406 to 1.1411 in)
		Main journal outer diameter	33.988 to 33.996 mm (1.3381 to 1.3384 in)
		Metal bearing oil clearance	0.012 to 0.044 mm (0.0005 to 0.0017 in)
		Crankshaft side clearance	0.1 to 0.2 mm (0.0039 to 0.0079 in)

Functional Limit	Action To Be taken
	Clean to remove.
18.050 mm (0.7016 in)	Replace if more than specified limit.
0.1 mm (0.004 in)	Correct. (Use water proof sand paper of #240 to 400 on the surface plate to level. Use #600 to finish.)
	Correct if possible, or replace.
	Clean to remove.
	Clean to remove.
61.06 mm (2.4039 in)	Replace if more than specified limit.
0.08 mm (0.0031 in) 0.06 mm (0.0024 in)	Replace if severely damaged on the piston sliding surface, which cannot be repaired with sand paper of No. 400 to 600, or damaged over specified limit.
0.1 mm (0.004 in)	Correct. (Use water proof sand paper of #240 to 400 on the surface plate to level. Use #600 to finish.)
2/3 or less of new one	Replace if severely consumed.
60.90 mm (2.3976 in)	Replace if less than specified limit.
0.150 mm (0.00591 in)	Replace if more than specified limit.
	Clean to remove.
	Correct if possible (with #400 to 600 water proof sand paper), or replace.
Top Ring : 0.10 mm (0.0039 in)	Replace if more than specified limit. Replace oil ring when top ring or second ring is replaced.
Second Ring : 0.09 mm (0.0035 in)	
Oil Ring : 0.15 mm (0.0059 in)	
16.012 mm (0.6304 in)	
0.040 mm (0.00157 in)	Replace if more than specified limit.
15.97 mm (0.62874 in)	Replace if less than specified limit.
Top Ring : 0.50 mm (0.0197 in)	Replace if the gap is over specified limit only if cylinder inner wear is less than specified limit. Replace oil ring when top ring or second ring is replaced.
Second Ring : 0.70 mm (0.0276 in)	
Oil Ring : 0.90 mm (0.0354 in)	
16.040 mm (0.6315 in)	Replace if more than specified limit.
0.060 mm (0.00236 in)	Replace if more than specified limit.
0.60 mm (0.0236 in)	Replace if more than specified limit.
0.03 mm (0.0012 in)	Replace if more than specified limit.
28.94 mm (1.1378 in)	Replace if less than specified limit.
33.97 mm (1.3374 in)	Replace if less than specified limit.
0.06 mm (0.00236 in)	Replace if more than specified limit.
0.6 mm (0.0236 in)	Replace if more than specified limit.

	Parts Name	Item		Standard Value
Engine Parts	Intake Valve Exhaust Valve	Valve Clearance	IN	0.13 to 0.17 mm (0.0051 to 0.0067 in)
			EX	0.18 to 0.22 mm (0.0071 to 0.0087 in)
		Valve Stem Outer Diameter	IN	5.48 mm (0.2157 in)
			EX	5.46 mm (0.2150 in)
		Valve Guide Inner Diameter	IN	5.51 mm (0.2169 in)
			EX	5.51 mm (0.2169 in)
		Clearance between valve guide	IN	0.008 to 0.040 mm (0.00031 to 0.00157 in)
		and valve stem	EX	0.025 to 0.057 mm (0.00098 to 0.00224 in)
		Width of contact with valve seat	IN	1.0 mm (0.04 in)
			EX	1.0 mm (0.04 in)
	Valve Spring	Free Length		32.85 mm (1.29 in)
	Cam Shaft	Cam Height (Both IN and EX)		IN : 23.63 mm (0.9303 in) EX : 23.80 mm (0.9370 in)
		Journal Outer Diameter		Pulley Side : 17.975 to 17.990 mm (0.7077 to 0.7083 in) Oil Pump Side : 15.965 to 15.980 mm (0.6285 to 0.6291 in)
		Clearance between cam shaft and holder (journal area)		0.02 to 0.05 mm (0.00079 to 0.000197 in)
	Rocker Arm & Shaft	Rocker Arm Inner Diameter		13.01 mm (0.5129 in)
		Shaft Outer Diameter		12.99 mm (0.5114 in)
		Shaft Clearance		0.006 to 0.035 mm (0.00024 to 0.00138 in)
	Timing Belt	External Appearance		
	Engine Block	Compression Pressure (Reference) at 500r/min		Without Decompression : 0.50 MPa (73 psi) [5.1 kgf/cm^2] With Decompression : 0.93 MPa (135 psi) [9.5 kgf/cm^2]
Fuel and Lubrication Parts	Fuel Regulator	Fuel Pressure		
	Vapor Separator	Seal Ring Wear and Damage		
		Float Height		Float Height :44 to 50 mm (1.732 to 1.969 in)
		Float Valve		Float Drop (Reference) 30.0 mm (1.181 in)
	Oil Pump	Pump Body Inner Diameter		29.09 to 29.15 mm (1.145 to 1.15 mm)
		Clearance between Outer Rotor and Body		0.09 to 0.18 mm (0.004 to 0.007mm)
		Height of Outer Rotor		14.96 to 14.98 mm (0.589 to 0.590 mm)
		Clearance between sides of rotor and body		0.06 to 0.11 mm (0.002 to 0.004mm)
		Clearance between outer and inner rotors		0.07 to 0.13 mm (0.003 to 0.005 mm)

Functional Limit	Action To Be taken
	Adjust into specified range.
5.46 mm (0.2150 in) 5.44 mm (0.2142 in)	Replace if less than specified limit.
5.55 mm (0.2185 in) 5.57 mm (0.2193 in)	Replace if more than specified limit.
0.070 mm (0.00276 in) 0.100 mm (0.00394 in)	Replace if more than specified limit.
2.0 mm (0.08 in) 2.0 mm (0.08 in)	Replace if more than specified limit.
31.5 mm (1.24 in)	Replace if less than specified limit.
IN : 23.5 mm (0.9252 in) EX : 23.5 mm (0.9252 in)	Replace if less than specified limit.
Pulley Side : 17.95 mm (0.7067 in) Oil Pump Side : 15.95 mm (0.6280 in)	Replace if less than specified limit.
0.09 mm (0.0354 in)	Replace if more than specified limit.
13.05 mm (0.5138 in)	Replace if more than specified limit.
12.94 mm (0.5094 in)	Replace if less than specified limit.
0.060 mm (0.00236 in)	Replace if more than specified limit.
Wear, Damage, Elongation	Replace if necessary.
	Check if rotating parts, sliding parts and sealing parts cause compression leakage.
	Replace if out of specified range.
Wear, Damage, Deterioration Due To Gasoline	Replace if necessary.
	Replace if out of specified range.
Wear, Deterioration, Damage	Replace if necessary.
29.04 mm (1.143 in)	Replace if more than specified limit.
0.36 mm (0.0142 in)	Replace if more than specified limit.
14.96 mm (0.5890 in)	Replace if less than specified limit.
0.11 mm (0.0043 in) (Including oil pump cover wear)	Replace if more than specified limit.
0.16 mm (0.0063 in)	Replace if more than specified limit.

	Parts Name	Item		Standard Value
Electric Parts	**Magneto**	Ignition Timing : BTDC 5°±5°	(at 950 r/min)	9.9E : 5° to 25° 15-20E : 5° to 30°
		Spark Performance (Use genuine spark tester.)	(at 500 r/min)	10mm (0.4in) or over
		Alternator Output	(at 5,500 r/min)	12 V 145 W
		Alternator Resistance	Between White and Yellow (at 20°C)	0.17 to 0.25Ω
		Exciter Coil Resistance	Between Black/Red and Blue (at 20°C)	1.04 to 1.56Ω
	Pulser Coil	Resistance Between Terminals	Between Red/White and Black (at 20°C)	148 to 222Ω
		Encoder Ring (Flywheel) Clearance		0.7 to 0.9 mm (0.028 to 0.035 in)
	Ignition Coil	Primary Coil Resistance	Between Black and Orange (at 20°C)	0.26 to 0.35Ω
		Secondary Coil Resistance	(Between High Tension Cable and High Tension Cable) (at 20°C)	6.8 to 10.2 kΩ
		[kΩ Range]	Between Plug Cap and Plug Cap	11.8 to 15.2 kΩ
	Plug Cap	Resistance Between Terminals [kΩ Range]		3.0 to 7.0 kΩ
	Spark Plugs	Plug Type		DCPR6E [NGK]
		Spark Gap		0.8 to 0.9 mm (0.032 to 0.035 in)
	Fuel Injector	Resistance Between Terminals		12 ± 0.5Ω
	Throttle Position Sensor	Resistance Between Terminals[kΩRange]	Between Blue and Black	5 kΩ ± 0.5 %
	ISC Valve	Resistance Between Terminals		24 ± 3Ω
	T-MAT (Manifold Temp. & Press.) Sensor	Resistance Between Terminals [kΩ Range]		6.0 ± 0.6 kΩ (0°C) 1.849 to 2359 kΩ (25°C)
	Engine Temperature Sensor	Resistance Between Terminals [kΩRange]	(at 5°C) (at 25°C) (at 100°C)	4.24 to 4.86 KΩ 1.90 to 2.10 kΩ 0.166 to 0.204 kΩ
	Rectifier	Resistance Between Terminals		Refer to Chapter 8.
	Starter Motor	Battery		12 V-70 AH to 12 V-100 AH
		Output		12 V 0.6 kW
		Clutch		Overrunning Clutch
		Brush Length		12.5 mm (0.49 in)
		Commutator Undercut		0.5 to 0.8 mm (0.020 to 0.032 in)
		Commutator Outer Diameter		30.0 mm (1.181 in)
	Fuse	Capacity		20 A x 1

Functional Limit	Action To Be taken
10 mm (0.4 in)	Replace if less than specified value.
	Replace if out of specified range.
	Replace if out of specified range.
	Replace if out of specified range. Adjust to specified range.
	Replace if out of specified range.
	Replace if out of specified range.
	Clean to remove carbon build up and dirt. Adjust with side electrode.
1.2 mm (0.047 in)	Replace if electrodes are severely worn.
	Replace if out of specified range.
	Replace throttle body ass'y if out of specified range.
	Replace if out of specified range.
	Replace if out of specified range.
	Replace if out of specified range.
	Replace if out of specified range.
9.5 mm (0.374 in)	Replace if less than specified value.
0.2 mm (0.008 in)	Replace if less than specified value.
29.0 mm (1.142 in)	Replace if less than specified value.
Burn out	

	Parts Name	Item		Standard Value
Coolong System Parts	**Thermostat**	Valve Operation Starting Temperature (Submerged)		52°C ± °C (126 ± 36°F)
		Valve Full Open Temperature (Submerged)		65°C (149°F)
		Valve Full Open Lift (Submerged)		3.0 mm (0.12 in) or more
	Pump Impeller	Wear, Crack		
	Pump Case (Liner)	Wear		
	Guide Plate	Wear		
Lower Unit Parts	**Anode**	Gear Case Anode Consumption		
	Clutch Spring	Free Length		60 mm (2.36 in)
	Propeller Shaft	Bearing Wear and Damage		
		Oil Seal Wear		
		Propeller Shaft Runout		
	Bevel Gears	Backlash between forward gear and pinion (A and B gears) "Refer to Chapter 6."		0.05 to 0.15 mm (0.0020 to 0.0059 in)
		Reverse Gear (C Gear) Washer Thickness		1.5 mm (0.059 in)
	Propeller	Wear, Bend, Crack, Break		
	Drive Shaft	Spline (Upper) Base Tangent Length, 2 Gears		5.03 mm (0.198 in)
		Bearing Damage		
		Oil Seal Wear and Damage		
		Drive Shaft Runout		
Power Tilt Parts	**Oil Pump**	Type		Gear Pump
		Oil Capacity		184 cc
		Recommended Oil		ATF (DEXRON III)
	PT Motor	Voltage		DC 12V
		Continuous Run		60 seconds
		Output		120 W
		Direction of Revolution		Forward, Reverse
		Circuit Breaker	Type	Bimetal
			ON/Reset Time	40 sec or more (25 A)/30 sec or less [25°C (77°F)]
	Tilt Cylinder	Piston Diameter		Ø 30 mm (1.181 in)
		Tilt Rod Diameter		Ø 12.5 mm (0.492 in)
		Stroke		128.2 mm (5.047 in)
	PT Switch			Paddle Rocker Switch (3A)
				Toggle Switch (20A)
Other Parts	**Oil Seals**	Damage, Wear		

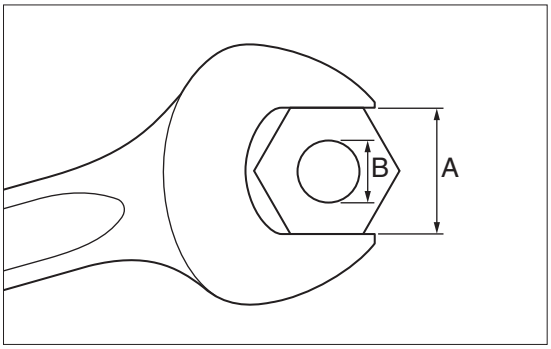
Functional Limit	Action To Be taken
Any opening under ambient temperature	Replace if out of specified range.
65°C (149°F) because thermostat operation is delayed. Measure valve open lift after 5 minutes.	
3.0 mm (0.12 in)	Replace if less than specified limit.
Wear, crack or damage on tips and upper and lower surface lips	Replace pump case liner and guide plate as a set.
	Replace if severely worn
	Replace if severely worn
	Replace if severely worn
58 mm (2.28 in) or less	
	Replace if necessary.
0.4 mm (0.015 in)	Replace if more than specified limit.
0.05 mm (0.0020 in)	Replace if more than specified limit.
0.05 mm (0.0020 in) or less	Adjust, or replace.
1.35 mm (0.053 in) or less	Replace if less than specified limit.
Severe Damage	Replace if out of specified range
4.99 mm (0.196 in)	Replace if less than specified limit.
	Replace if necessary.
0.4 mm (0.015 in)	Replace if necessary.
0.05 mm (0.002 in)	Replace if more thanspecified limit.
Lip deteriorated, degraded or damaged, or tightening margin reduced to 0.5 mm (0.020 in) due to wear	Replace if out of specified range

7. Tightening Torque Data

	Fastened Components	Wrench A	Screw B x Pitch	Type of Fastener	Tightening Torque N·m		
					N·m	lb·ft	kg·m
Engine	Cylinder Head Cover	10	M6×1.0	Bolt	6	4	0.6
	Cylinder Block and Cylinder Head	12	M8×1.25	Bolt	First Tightening Torque :		
					10	7	1.0
					Final Tightening Torque :		
					30	22	3.0
		10	M6×1.0	Bolt	First Tightening Torque :		
					6	4	0.6
					Final Tightening Torque :		
					10	7	1.0
	Spark Plug	16	M12×1.25	—	18	13	1.8
	Cylinder Block-Crankcase	12	M8×1.25	Bolt	First Tightening Torque :		
					10	7	1.0
					Final Tightening Torque :		
					23.5	18	2.4
		10	M6×1.0	Bolt	First Tightening Torque :		
					6	4	0.6
					Final Tightening Torque :		
					11.5	9	1.2
	Exhaust Cover	10	M6×1.0	Bolt	9	7	0.9
	Connecting Rod	—	M7×1.0	Bolt	First Tightening Torque :		
					6	4	0.6
					Final Tightening Torque :		
					10	7	1.0
	Tapet Adjusting Nut	10	M6×0.75	—	7	5	0.7
	Flywheel	19	M16×1.5	Nut	80	58	8.0
	Drive Pully	36	M30×1.5	Nut	70	51	7
	Driven Pully	10	M6×1.0	Bolt	11	8	1.1
	Oil Filter	—	M20×1.5	—	18	13	1.8
	Oil Pressure Switch	—	PT1/8	—	8	6	0.8
	Oil Pump Assy	10	M6×1.0	Bolt	6	4	0.6
	Power Unit	13	M8×1.25	Bolt	First Tightening Torque :		
					15	11	1.5
					Final Tightening Torque :		
					30	22	3.0
Stern Bracket	Braket Bolt	—	7/8-14UNF-2A	Nut	Fixed by incomplete thread		
		—	7/8-14UNF-2A	Nylon Nut	24	17	2.4
	Distance Piece	—	M6x1.0	Nut	6	4	0.6
Stern Bracket (PT)	Bracket Bolt	—	7/8-14UNF-2A	Nut	Fixed by incomplete thread		
		—	7/8-14UNF-2A	Nylon Nut	24	17	2.4
	Trim Lock Bolt	—	M8×1.25	Nylon Nut	13	9	1.3
Swivel Bracket	Tilt Stopper Plate	—	M8×1.25	Bolt	13	9	1.3
	Tilt Lock Lever Bolt	—	M8×1.25	Shoulder bolt	13	9	1.3
	Co Pilot Handle	—	M8×1.25	Nylon Nut	11	8	1.1
Arm Steering Shaft	Co Pilot Plate	—	M6×1.0	Bolt	6	4	0.6
	Mount Rubber Upper	—	M10×1.25	Nylon Nut	27	20	2.7
	Mount Bracket Lower	—	M8×1.25	Bolt, Nut	13	9	1.3
	Steering Plate	—	M10×1.25	Bolt	26	20	2.6
	Drag Link Assy	—	3/8-24UNF-2A	Bolt	27	20	2.7

	Fastened Components	Wrench A	Screw B x Pitch	Type of Fastener	Tightening Torque N·m		
					N·m	lb·ft	kg·m
Drive Shaft	Mount Rubber Upper	—	M8 x 1.25	Bolt	13	9	1.3
	Idle Port Cover	—	M6 x 1.0	Bolt	6	4	0.6
	Drain Bolt	—	M14 x 1.5	Bolt	24	17	2.4
Gear Case	Oil Plug (Gear Oil)	—	M8 x 1.25	Bolt	4	3	0.4
	Bevel Gear B Nut	—	M10 x 1.0	Nut	35	25	3.5
	Propeller Shaft Housing	—	M6 x 1.0	Bolt	6	4	0.6
	Pump Case Bolt	—	M6 x 1.0	Bolt	6	4	0.6
	Gear Case Bolt	—	M8 x 1.25	Bolt	24	17	2.4
	Propeller Nut	—			12	9	1.2
Motor Cover	Motor Cover Lower	—	M6 x 1.0	Bolt	6	4	0.6

		Wrench A	Screw B x Pitch	Type of Fastener	Tightening Torque N·m		
					N·m	lb·ft	kg·m
Standard Tightening Torque	M4	—	M4 x 0.7	Bolt, Nut	1.5	1.1	0.15
	M5	8	M5 x 0.8	Bolt, Nut	3	2.2	0.3
	M6	10	M6 x 1.0	Bolt, Nut	6	5	0.6
	M8	13	M8 x 1.25	Bolt, Nut	13	10	1.3
	M10	17	M10 x 1.25	Bolt, Nut	27	20	2.7
	M4	—	M4 x 0.7	Screw	1.5	1.1	0.15
	M5	—	M5 x 0.8	Screw	2.5	1.8	0.25
	M6	—	M6 x 1.0	Screw	3.5	2.5	0.35
	M8	—	M8 x 1.25	Screw	4.5	3.3	0.5



8. Sealant Application Locations

Part Name		High-strength screw locking agent	Low-strength screw locking agent	Middle-strength screw locking agent	High-strength screw locking agent	Anti-leakage, Anti-rust screw locking agent	Sealing Agent	Bond	Low Temperature Resistant Lithium Grease	OBM Grease	Teflon Grease	Silicon Grease	Molybudenium Grease	4 Stroke Engine Oil	Gear Oil	PT Fluid	Remarks
		Loctite	Three Bond				Loctite	Konishi	Tyuoh Yuka			Shinetsu	Suniko				
		263 (271)	1342	1327	1373 B	1401	518	G17	Sentax L2	FM-531	LM-902	KS-64	Mory past 500			ATF	
Engine Block	Camshaft												●	●			Cam Head (When New, Apply Molybdenum Grease)
														●			Bearing
	Oil Seal (Cam Shaft)								●								Lip
														●			Outer Surface, Press Fit
	Camshaft Pully Bolt		●														Thread
	Rocker Arm													●			Bearing, Slipper Face
	Rocker Arm Shaft													●			Outer Face
	Rocker Arm Spring													●			Entire Surface
	Washer (Rocker Arm)													●			Entire Surface
	Valve (INT, EX)													●			Shaft, Stem Head
	Valve Spring													●			Entire Surface
	Valve Spring Seat													●			Entire Surface
	Retainer • Cotter													●			Entire Surface
	Valve Stem Seal (INT, EX)													●			Lip and Inside
	Tappet Adjusting Screw													●			Entire Surface
	Oil Pump													●			Approx. 2 cm^3 From Intake Port
	Fuel Pump													●			Plunger Tip
	O-Ring (Fuel Pump)													●			Outer Face
	Head Bolt													●			Thread
	O-Ring (Filler Cap)													●			Outer Face
	Cylinder Liner													●			Inner Wall
	Piston													●			Ring Grooves, Outer Face
	Piston Ring													●			Entire Surface
	Piston Pin													●			Outer Face
	Connecting Rod													●			Small Ends Inside
	Crankshaft													●			Sliding Face, Thrust Face
	Crankshaft Metal Bearing													●			Only for Bearing, Remove Grease of Outside.
	Oil Seal (Crankshaft Upper, Lower)								●								Lip
	Cylinder Block, Crankcase Mating Surface						●										
	Bolt (Oil Filter)		●														Thread
	Oil Filter													●			Seal
	Plug Cap											●					Spark Plug Insertion Area
								●									High Tension Cable
	Oil Pressure Switch			●													Thread
												●					Terminals
	Starter Motor											●					Terminals
										●							Thin Coat to Pinion Part
	Startr Solenoid											●					Terminals
	Rubber Mount (Electrical Bracket)									●							Mount and Collar Outside

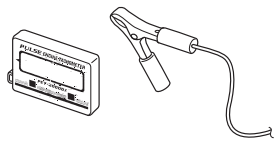
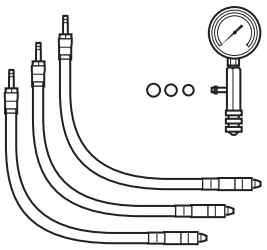
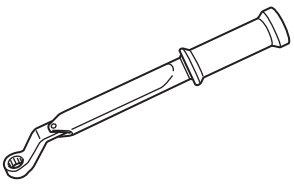
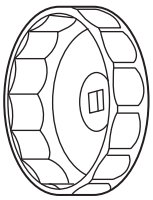
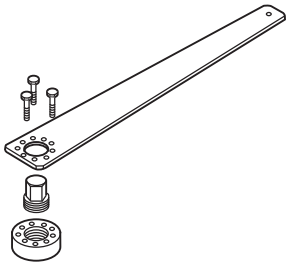
	Part Name	High-strength screw locking agent	Low-strength screw locking agent	Middle-strength screw locking agent	High-strength screw locking agent	Anti-leakage, Anti-rust screw locking agent	Sealing Agent	Bond	Low Temperature Resistant Lithium Grease	OBM Grease	Teflon Grease	Silicon Grease	Molybudenium Grease	4 Stroke Engine Oil	Gear Oil	PT Fluid	Remarks
		Loctite	Three Bond				Loctite	Konishi	Tyuoh Yuka			Shinetsu	Suniko				
		263 (271)	1342	1327	1373 B	1401	518	G17	Sentax L2	FM-531	LM-902	KS-64	Mory past 500			ATF	
Drive Shaft Housing	Bolt (Drain Cover)		●														Thread
	Bolt (Idle Exhaust Cover)		●														Thread
	Water Pipe Seal (Upper)									●							Outer Face
	Auxiliary Water Pipe									●							Inner Face
	Bolt (Engine)									●							Thread
Lower Unit	Drive Shaft (Crank Side Spline)										●						Crankshaft Side Spline
	Nut (B Gear)				●												Thread
	Bolt (Gear Case)					●											Thread
	Bolt (Pump Case)		●														Thread
	Pump Case (Liner)									●							Impeller Sliding Area
	Oil Seal (Pump Case, Lower)								●								Lip
															●		Outer Surface, Press Fit
	Water Pipe Seal (Lower)									●							Inner Face
	O-Ring (Cam Rod Bushing)									●							
	Bolt (Cam Rod Bushing)									●							Thread
	Roller Bearing														●		Outer Surface, Press Fit
	Propeller Shaft (Propeller Side Spline)									●							Spline
	Clutch														●		Spline
	Push Rod														●		Entire Surface
	Spring														●		Entire Surface
	O-Ring														●		
	Oil Seal								●								Lip
															●		Outer Surface, Press Fit
	Ball Bearing														●		Outer Surface, Press Fit
Swivel & Starn Blacket	Swivel Bracket (Steering Shaft)									●							Apply Grease to Inside
	Swivel Bracket (Bracket Bolt)									●							Apply Grease
	Tilt Stopper Bush									●							Sliding Face
	Tilt Stopper Grip							●									
	Tilt Stopper (Shaft)									●							Sliding Face
	Mount Bracket									●							Spline
	O-Ring (Steering Bracket)									●							At Assembly
	Co-Pilot Bolt									●							Stud Bolt Thread
	Nut 7/8 (Bracket Bolt)		●														Locking Side Nut
	Upper Mount Bolt Nut	●															Thread, After Remove Grease

Part Name		High-strength screw locking agent	Low-strength screw locking agent	Middle-strength screw locking agent	High-strength screw locking agent	Anti-leakage, Anti-rust screw locking agent	Sealing Agent	Bond	Low Temperature Resistant Lithium Grease	OBM Grease	Teflon Grease	Silicon Grease	Molybudenium Grease	4 Stroke Engine Oil	Gear Oil	PT Fluid	Remarks
		Loctite	Three Bond				Loctite	Konishi	Tyuoh Yuka			Shinetsu	Suniko				
		263 (271)	1342	1327	1373 B	1401	518	G17	Sentax L2	FM-531	LM-902	KS-64	Mory past 500			ATF	
PT Unit	Cylinder Pin Bush (Upper, Lower)									●							Sliding Face
	PT Fluid															(●)	
	O-Ring															(●)	
Bottom Cowl	Throttle Arm								●								Sliding Face
	Throttle Cam								●								Sliding Face
	Shift Lever Rod								●								Sliding Face
	Shift Lever Shaft								●								Sliding Face, Shift Rod Insert Part
Grease Nipples, Seal Plug			●														Press Fit
Reuse Pre-coated Bolt			●														Thread

3

Maintenance

1. Special Tools

			
Tachometer P/N. 3AC-99010-0	Compression Gauge P/N. 3AC-99030-0	Torque Wrench P/N. 3AC-99070-0	Valve Clearance Driver P/N. 3AC-99071-0
Measuring engine revolution speed	Measuring compression pressure	Adjusting valve clearance	Adjusting valve clearance
			
Oil Filter Wrench P/N. 3AC-99090-0	Flywheel Puller Kit P/N. 369-72211-0		
Removing/installing oil filter	Removing/installing flywheel		

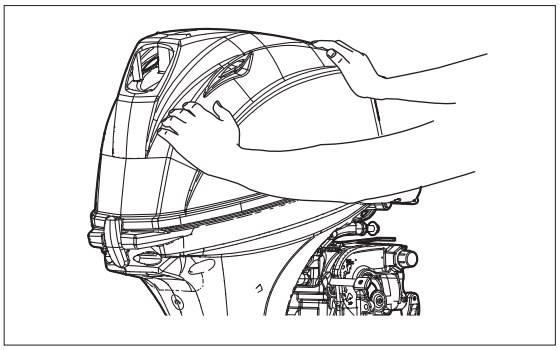
2. Inspection Schedule

	Description	Inspection intervals					Inspection procedure	Remarks
		First 20 hours of 1 month	Every 50 hours of 3 months	Every 100 hours of 6 months	Every 200 hours of 1 year	Every 400 hours of 2 year		
Fuel System	Fuel Filter			❍			Check and Clean/Replace if Necessary	
	High Pressure Fuel Hose	❍	❍				Check/Replace if Necessary	
	Fuel Filter (vapor Separator)					❍	Check, Clean or Replace if Necessary	
	Fuel Tank	❍	❍				Check and Clean	
	Fuel Tank Cap	❍	❍				Check /Replace if Necessary	
	Fuel Pump					❍	Check /Replace if Necessary	
	Fuel Pressure				❍		Check	
	Fuel Hoses	❍	❍				Check /Replace if necessary	
Ignition System	Spark Plug			❍			Check and Clean/ Replace if Necessary	Gap 0.8-0.9 mm (0.032-0.035 in)
	Spark Plug Cap/ High Tension Cord	❍		❍			Check /Replace if Necessary	
Starting System	Starter Rope	❍	❍				Check /Replace if Necessary	
	Starter Motor				❍		Check	
	Battery/ Cable Connection	❍	❍				Check Fluid Quantity/Check Terminal	
Engine	Engine Oil	Replace		Replace			Replace	Oil Filter Replacement: 1.2 L (1.26 US qt.) Without Filter Replacement:1.0 L (1.05 US qt.)
	Oil Filter (4 stroke)				Replace		Replace (Every 200 hours or 2 years)	
	Oil Strainer				❍		Check and Clean	
	Valve Clearance			❍			Check and Adjustment	IN : 0.13-0.17 mm (0.0051-0.0067 in) EX : 0.18-0.22 mm (0.0071-0.0087 in)
	Timing Belt			❍			Check /Replace if Necessary	
	Idling Speed	❍	❍				Check	
	Compression Preasure				❍		Check	
	Combustion Chamber					❍	Check	
	Thermostat				❍		Check /Replace if necessary	
Lower Unit	Propeller	❍	❍				Check /Replace if necessary	
	Split Pin	❍	❍				Check /Replace if necessary	
	Gear Oil	Replace	❍	Replace			Check and replace	Approx. 465ml (15.7 fl. oz)
	Water Strainer	❍	❍				Check	
	Water Pump Impeller		❍		Replace		Check /Replace if Necessary	
	Water Pump Housing					❍	Check /Replace if Necessary	
Shift/ Throttle	Throttle Cable			❍			Check /Replace if Necessary	
	Throttle Link	❍	❍				Check and Adjustment	
	Shift Cable		❍				Check /Replace if Necessary	
	Shift Link	❍	❍				Check and Adjustment	
Power Tilt		❍		❍			Check /Replenish	
Warning System			❍				Check	
Stop Switch		❍	❍				Check	
Meters		❍	❍				Check	
Bolt, Nut		❍	❍				Retighten	
Sliding Part/Rotation Part		❍	❍				Apply Grease	
Grease Nipple		❍	❍				Pump in Grease	
Outer Equipment		❍	❍				Check	
Anode (Engine)				❍			Check /Replace if Necessary	
Anode (Lower/Bracket)			❍				Check /Replace if Necessary	
Top Cowl/Latch					❍		Check and Adjustment	

3. Inspection Items

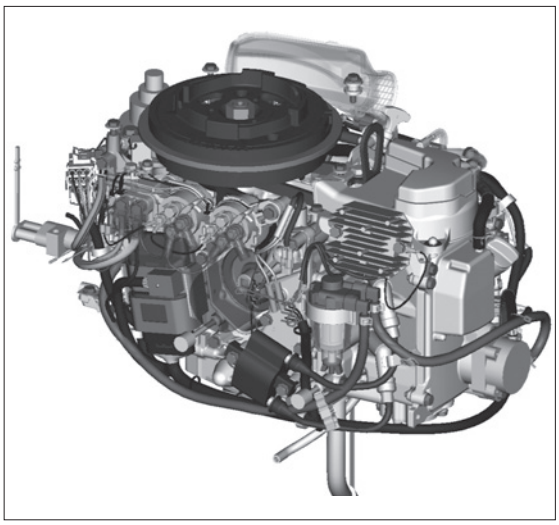
1) Inspection of Top Cowl

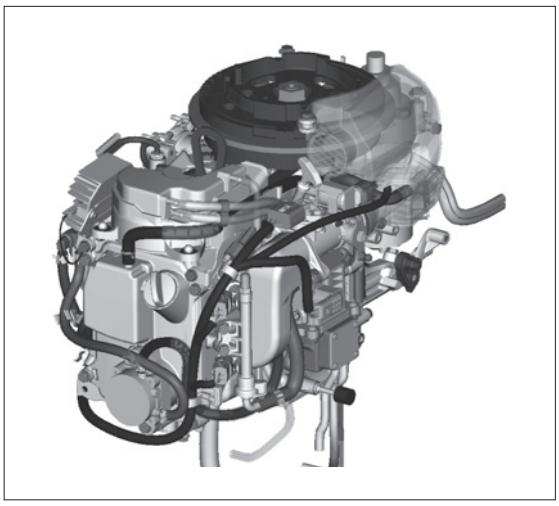
Push top cowl to check for looseness and state of closing.



2) Inspection of Fuel Hoses

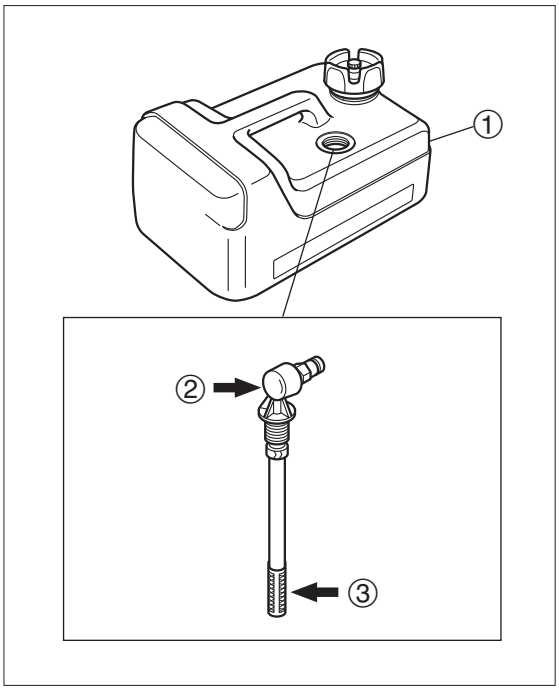
Check the fuel system piping for fuel leak, dirt, deterioration and damage, and replace or repair parts if necessary.





3) Inspection of Fuel Tank

Remove fuel pick up elbow ② of fuel tank ① counterclockwise to remove the part, and clean the filter ③. Remove dirt and water from fuel tank ① if any.



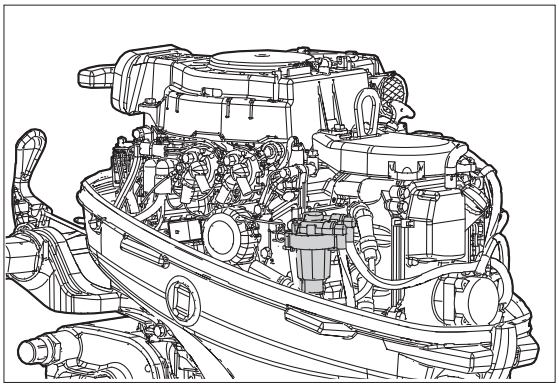
② Fuel Pick Up Elbow
③ Filter

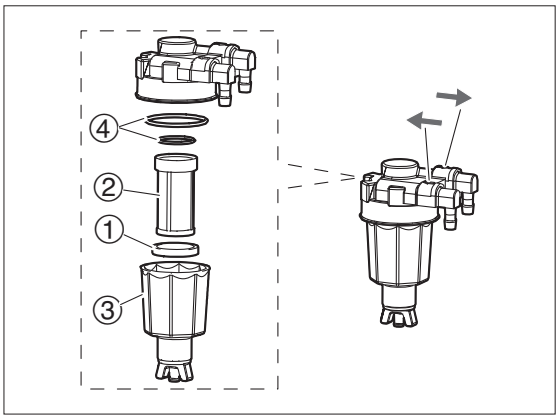
4) Inspection of Fuel Filter

⚠ CAUTION

- **If the red float ① in the fuel filter is floating, loosen the drain screw so water is drained, drain it by priming the primer valve several times.**
- **Be careful not to spill fuel during cup removal and dispose of properly.**

Check fuel filter ② for dirt, build up of fuel slag, and fuel filter cup ③ for invasion of foreign matter and cracks. Clean fuel filter cup with gasoline, and replace fuel filter ② if necessary.

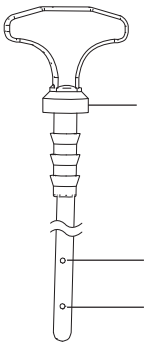




④ O-ring **Do not reuse.**

5) Replacement of Engine Oil

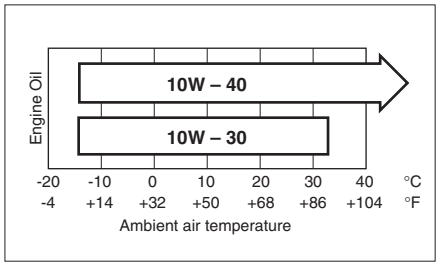
1. Oil Level



	Quantity of Oil for Full Replacement	
	When oil filter is replaced	When oil filter is not replaced
Upper Limit	1.2L (1.26 US qt.)	1.0L (1.05 US qt.)
Lower Limit	0.95L (1.00 US qt.)	0.75L (0.79 US qt.)

2. Oil Specification

Recommended Engine Oil :
4 Stroke Engine Oil
API : SH, SJ, SL
SAE : 10W-30, 10W-40
Quantity of Engine Oil :
When oil filter is replaced: 1.2L (1.26 US qt.)
When oil filter is not replaced: 1.0L (1.00 US qt.)

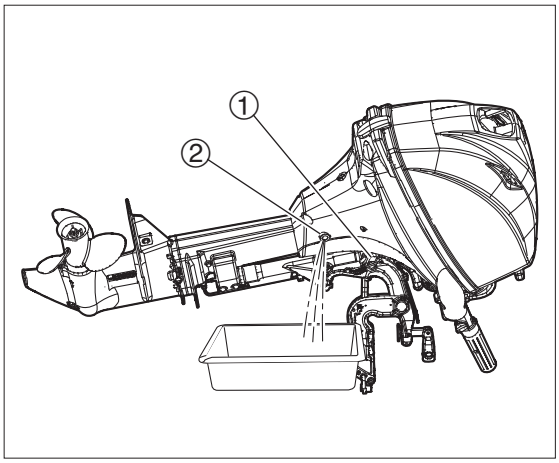


Use oil with viscosity that is suited to ambient air temperature of the operating region.

3. Oil Replacement Procedure

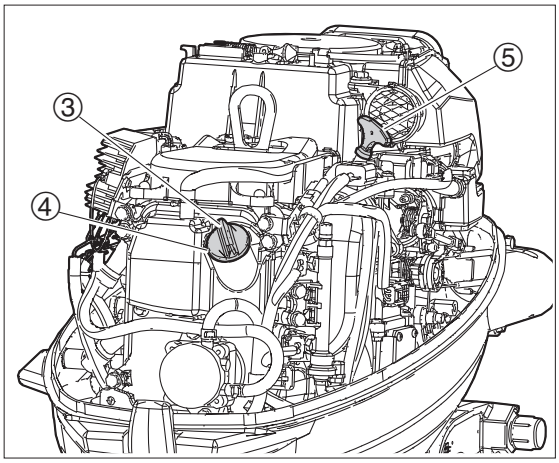
Use of engine containing dirt or water can significantly shorten the lives of rotating and sliding parts of engine.
Oil replacement procedure:

1. Stop engine, tilt-up outboard motor, and lock with tilt stopper ①.
2. Incline outboard motor so that drain bolt ② is directed downward.
3. Remove top cowl and then oil filler cap ③.
4. Place drain oil pan below drain bolt ②.
5. Remove drain bolt ② to drain oil.
6. Tighten drain bolt ② .
   Note: Apply engine oil to the washer (gasket) of drain bolt ②.



Drain Bolt :
24 N·m (18 lb·ft) [2.4 kgf·m]

7. Disengage tilt lock and tilt down outboard motor straighten. Repeat the steps 4 to 8 several times.
8. Pour new engine oil into oil inlet ④ until oil level reaches upper limit mark of oil level gauge ⑤.

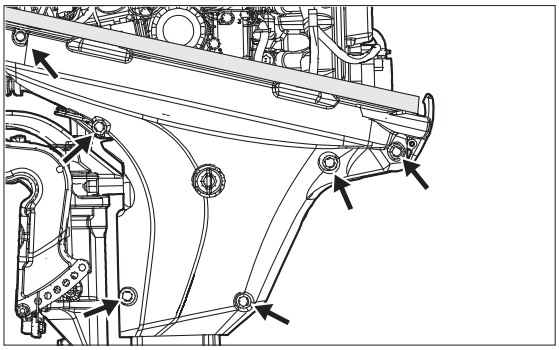


⚠ CAUTION
Do not overfill or running problems can occur.

9. Attach oil filler cap ③ and oil level gauge ⑤, start and run engine for 5 minutes to warm up.
10. Stop engine and check oil level and oil leak after 5 minutes.

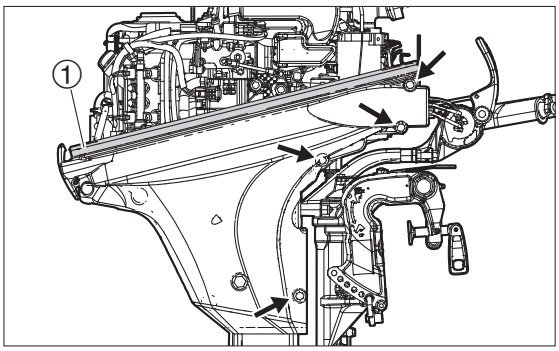
6) Replacement of Oil Filter

1. Drain engine oil.

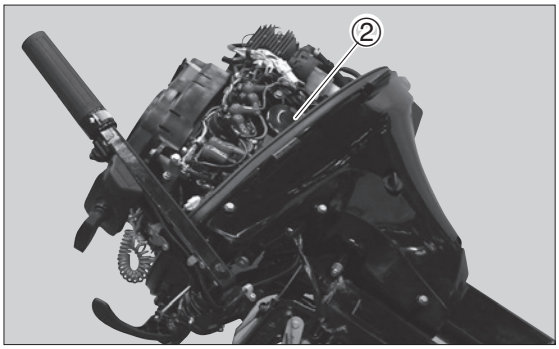


2. Place a piece of rag below oil filter area, and remove it by using oil filter wrench ①.

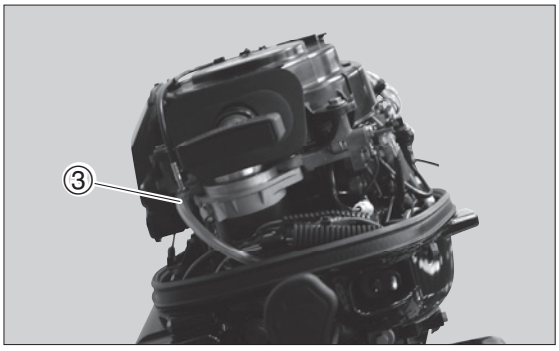
- Completely loosen the port side bolts first, then fully loose the starboard side bolts.
- This bolt has a falling prevention structure, it can not be removed.
- The oil filter can be replaced without removing drive shaft housing cover and cowl seal.



3. Tilt up outboard motor and turn steering so that oil filter ② is on the upper side.



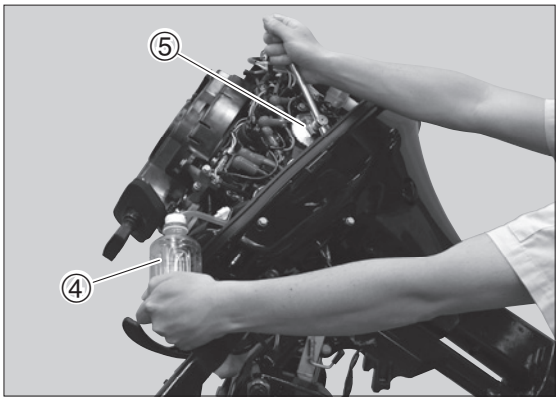
4. Disconnect clear-pink hose ③ on coil bracket.



5. Set oil pan ④ and slowly loosen oil filter.
   Check that oil has been drained and remove oil filter.

Oil Filter Wrench ⑤ :
P/N. 3AC-99090-0

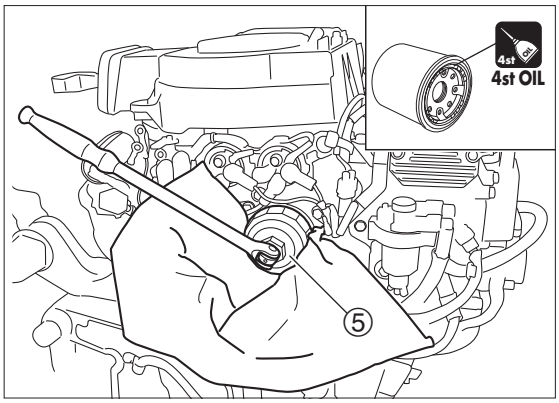
- Replace oil filter after 5 minutes or more after stopping engine.
- Wipe off clean, spilled oil.



6. Apply thin coat of engine oil to O-ring of filter before installing filter. Clean the cylinder at the location where the oil filter is installed.

7. Install oil filter and tighten it to specified torque by using oil filter wrench ⑤.

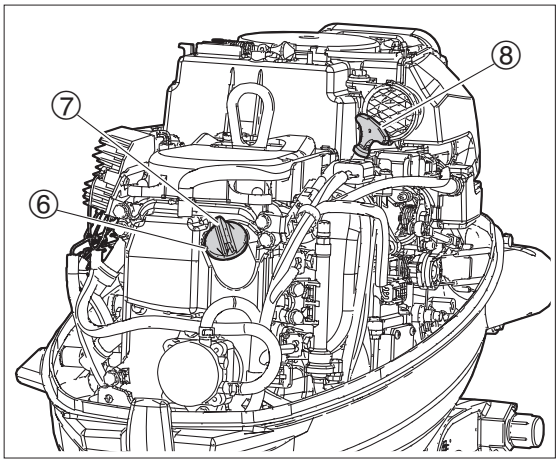
Oil Filter :
18 N·m (13 lb·ft) [1.8 kgf·m]



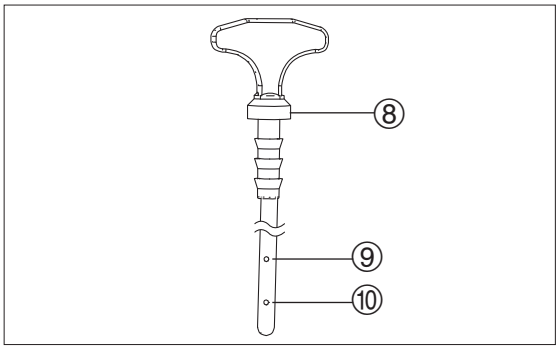
8. Pour engine oil into oil inlet ⑥.

Recommended Engine Oil :
4 Stroke Engine Oil
API : SH, SJ, SL
SAE : 10W-30, 10W-40
Quantity of Engine Oil :
When oil filter is replaced : 1.2L (1.25 US qt.)
When oil filter is not replaced: 1.0L (1.05 US qt.)

9. Attach oil filler cap ⑦ and oil level gauge ⑧, start and run engine for 5 minutes to warm up.

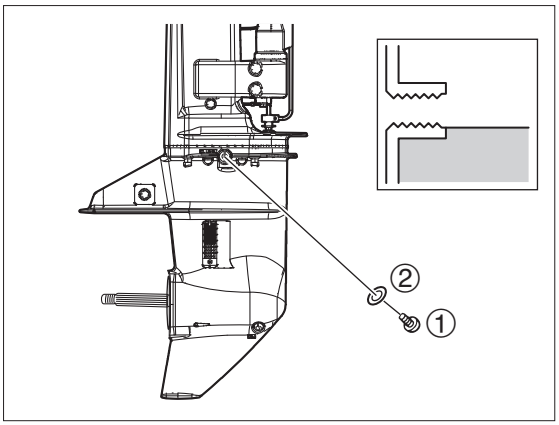


10. Stop engine and check oil level and oil leak after 5 minutes.



⑤ Oil Level Gauge ⑥ Upper Limit (MAX) ⑦ Lower Limit (MIN)

7) Inspection of Gear Oil Quantity



② Washer **Do not reuse.**

1. Tilt down outboard motor to make it vertical.

2. Remove upper oil plug ① and check level of gear oil in the gear case.

   Some oil may spill from plug hole as plug is removed indicates that gear case is filled with specified quantity of gear oil.

3. Add recommended gear oil to specified level if it is lacking.

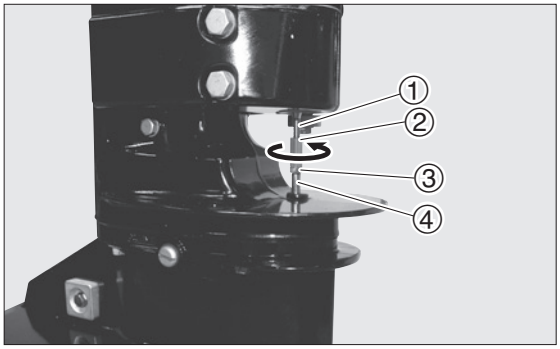
   Recommended Gear Oil :
   Hypoid Gear Oil
   API : GL-5 SAE : # 80 - 90

   If the oil is lacking much, add through lower oil plug hole.

4. Attach upper oil plug ①.

8) Inspection of Water Pump

Inspection of water pump does not require removal of power unit from outboard motor body.



1. Set the shift lever to "Foward (F)" position to pull up shift rod.

2. Loosen nut ③, and then turn shift rod ② allow direction to disconnect shift rod ① and shift rod ④.

⚠ CAUTION

Be sure to loosen the nut ③ and shift rod joint ② both, otherwise broken inner parts of the gear case will occur.

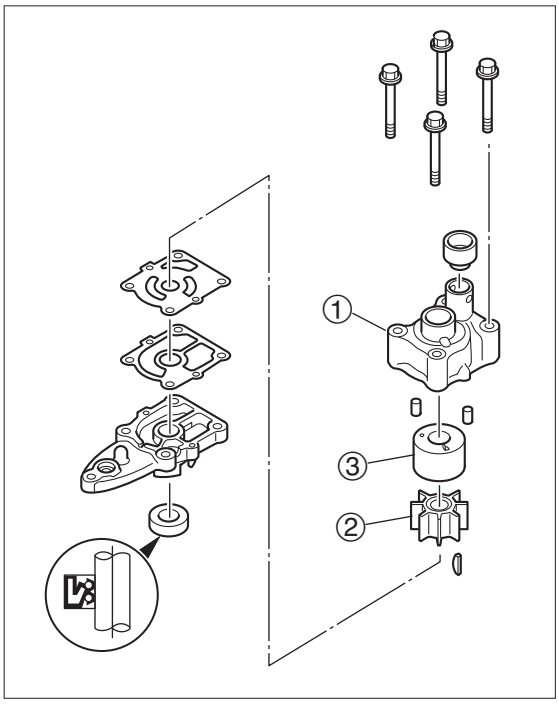
3. Remove lower unit installation bolts, and pull lower unit ass'y downward to remove.

4. Remove pump upper case ①.

5. Remove impeller ② and check it.

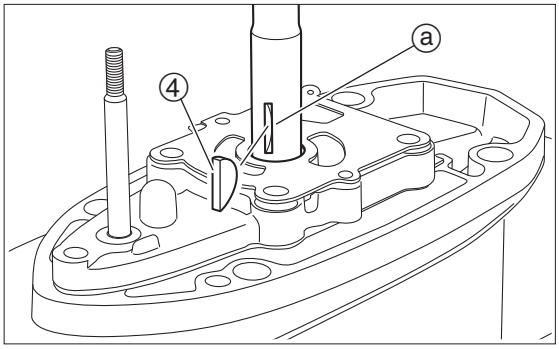
6. Check upper pump case for deformation. Replace if necessary.

7. Check impeller ② and pump case liner ③ for crack and wear. Replace if necessary.



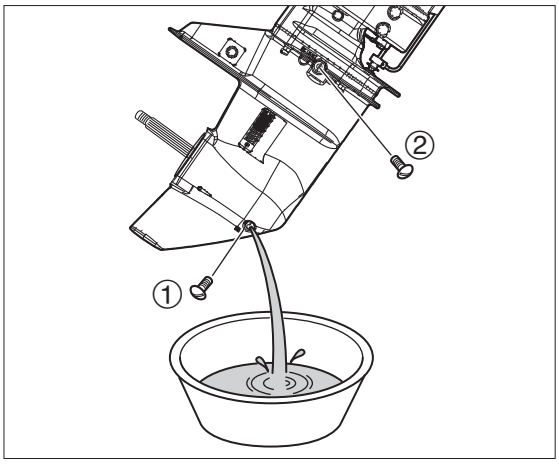
8. Check key ④ and drive shaft groove ⓑ for wear. Replace if necessary.

9. Reinstall the components removed. For details, refer to Chapter 6.



9) Replacement of Gear Oil

1. Tilt outboard motor a little as shown.

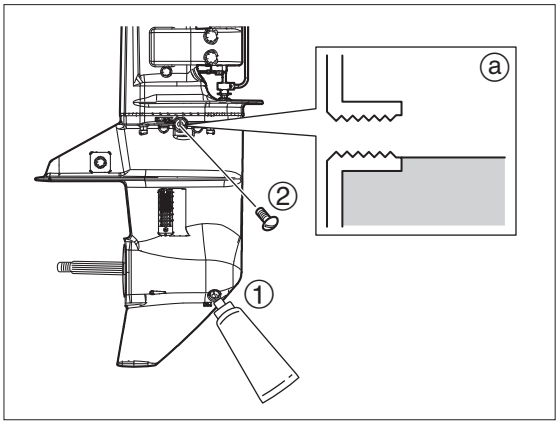


2. Place drain oil pan below drain bolt ①, remove lower oil plug ① and then upper oil plug ② to drain oil.

Remove lower oil plug first when draining.

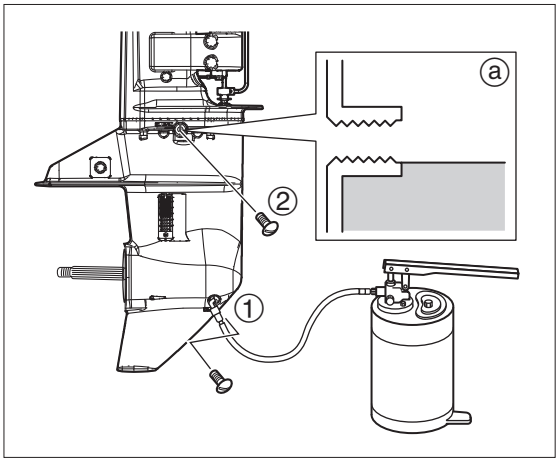
3. Check gear oil for presence of metal particles, change of color (abnormal if clouded), and viscosity. Check lower unit internal components if necessary.

4. Tilt down outboard motor to vertical position, and fill with gear oil (from oil tube or pump) through lower plug hole ① until gear oil starts to spill from upper oil plug hole ⓐ without air bubble.



Recommended Gear Oil :
Hypoid Gear Oil
API : GL-5 SAE : #80 - 90
Quantity of Gear Oil :
465 cm^3 (15.7 fl.oz.)

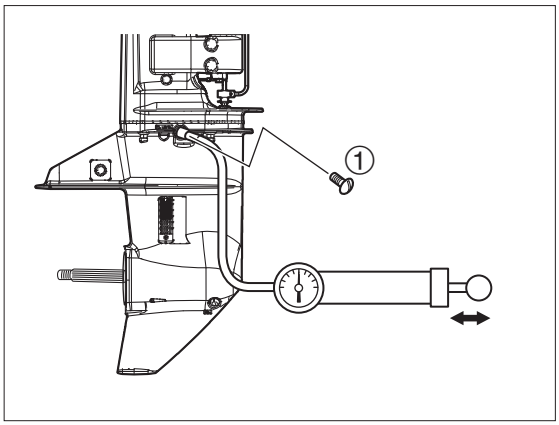
- Use lower plug hole when filling with gear oil. Upper hole cannot be used because doing so will not allow air to evacuate from gear case.
- Be sure to set outboard motor vertical position and fill specified quantity.



5. Attach new gasket and upper oil plug ②, and then new gasket and lower oil plug ① immediately.

When fully filled with oil, attach upper oil plug first.

10) Inspection of Gear Case (for leakage)



1. Drain gear oil.

2. Remove upper oil plug ① and connect a commercially available leakage tester to this hole.

3. Apply specified pressure to gear case, and check if the pressure is maintained without further compression for 10 seconds.

⚠ CAUTION

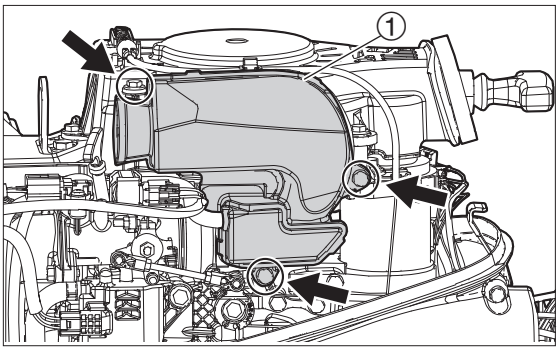
Do not apply pressure to gear case over specified value.
Doing so can cause damage to oil seal.

Specified Gear Case Maintained Pressure :
0.05 MPa (7 psi) [0.5 kgf/cm^2]

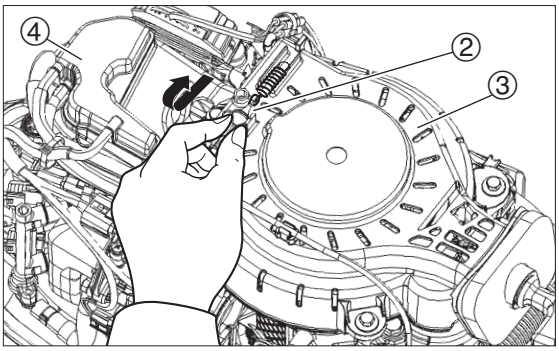
- Rotating propeller shaft while maintaining pressure and testing with gear oil drained make it easy to find leakage due to wear of oil seal lip.
- Depressurize gear case and cover oil plug area with a piece of rag before disconnecting leakage tester.

4. If the specified pressure cannot be maintained, check oil seals of drive shaft and propeller shaft and O-ring of shift shaft , propeller shaft housing, and water pump case lower for damages.

11) Inspection of Timing Belt



1. Remove intake silencer ① (3 bolts).

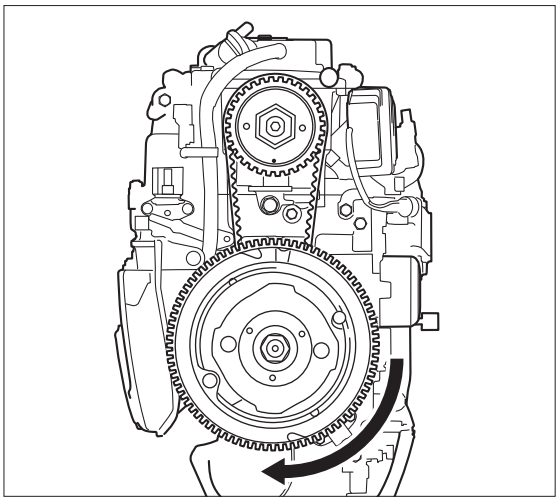


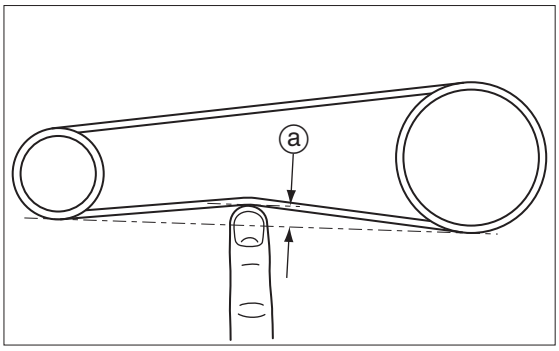
2. Remove starter lock cable ②, then remove recoil starter ③ (3 bolts).

3. Remove driven pully cover ④.

4. Check timing belt inner and outer surfaces for crackes, damages, and wear while roating flywheel clockwise with hands. Replace if necessary.

Bend limit ⓐ :
Push belt center as shown. Replace if timing belt deflects more than 10 mm (0.394 in).



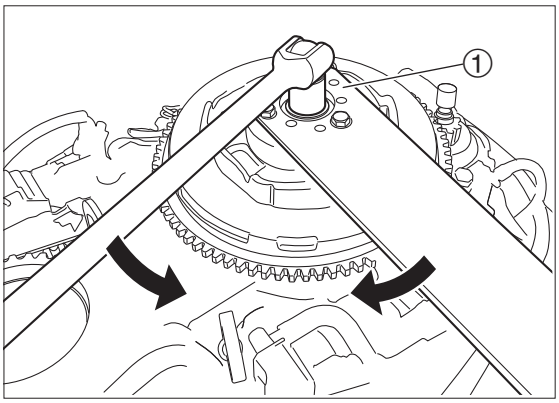


12) Replacement of Timing Belt

1. Remove manual starter

2. Loosen flywheel nut.

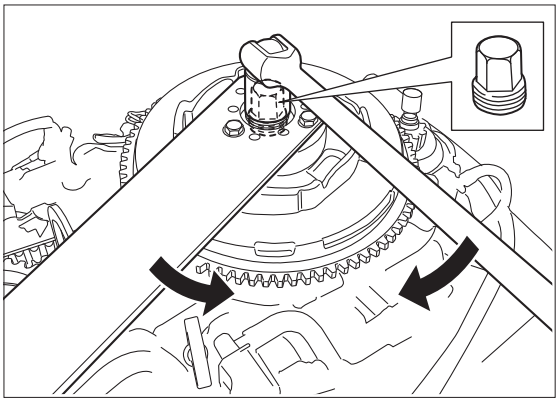
Flywheel Puller Kit ①:
P/N. 369-72211-0



3. Remove flywheel and key.

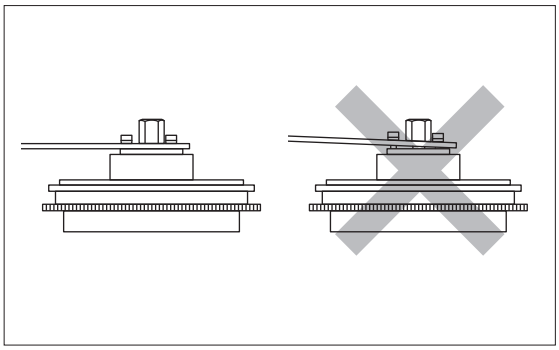
Flywheel Puller Kit :
P/N. 369-72210-0

Turn the puller into the end of the crankshaft until the flywheel comes out of the taper of the crankshaft.

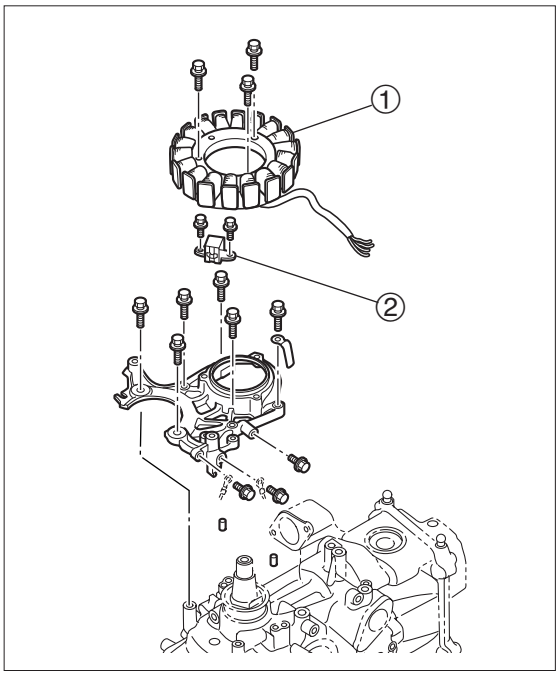


⚠ CAUTION

To prevent damages to engine and special tools, tighten flywheel puller set bolts evenly and keep flywheel puller parallel to flywheel while working.

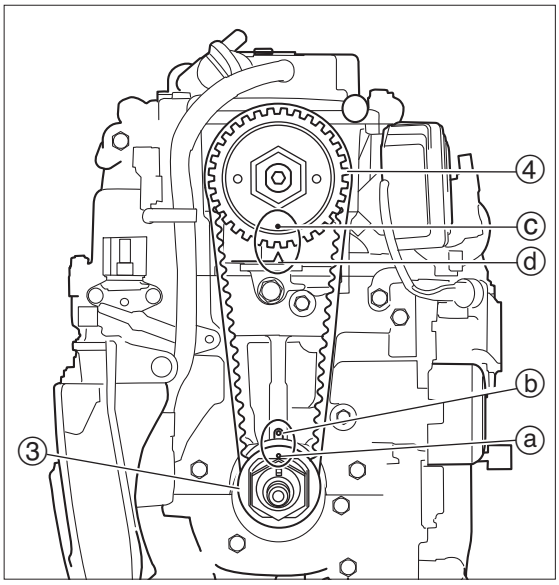


4. Disconnect alternator coupler ①, pulser coil ② coupler, and connector and ground cable (three place), and then remove alternator and coil bracket ass'y.

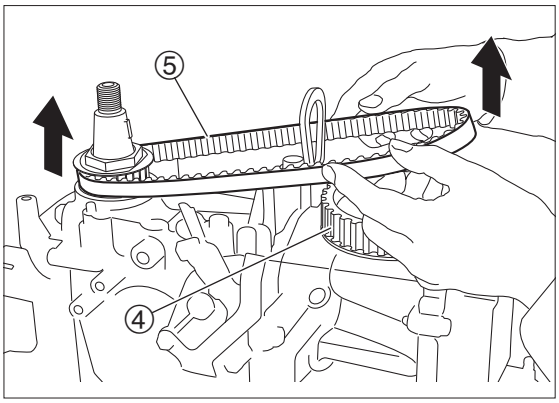


5. Turn the drive pulley ③ in the clockwise, align the "● " mark ⓐ of the drive pulley with the "▲" mark ⓑ of the cylinder block, and move the "● 1" mark ⓒ of the driven pulley ④ and the "▲" mark Make sure ⓓ alignes.

No.1 piston is to be at top dead center of compression stroke.



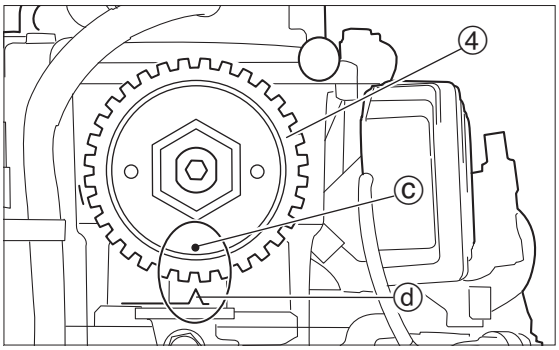
6. Remove timing belt ⑤ from driven pulley ④ side, and then, from timing pulley side.



⚠ CAUTION

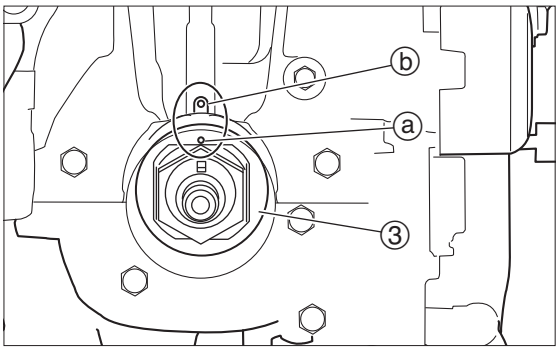
Do not turn timing pulley (crank shaft) or cam shaft pulley with timing belt removed. Doing so can make pistons and valves interfere with each other, resulting in damage to these parts.

7. Check that "● 1" mark ⓒ of driven pulley ④ and "▲" mark ⓓ of cylinder head are aligned

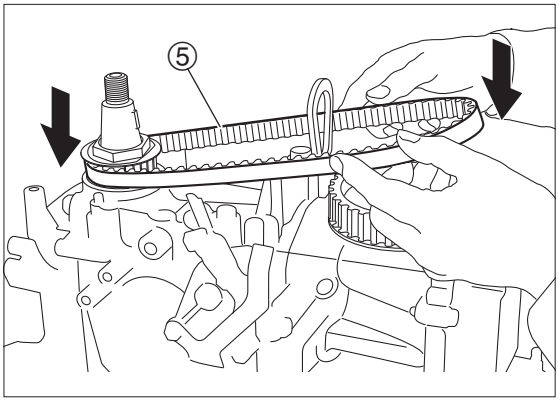


8. Check that "●" mark ⓐ of drive pulley ③ and "●" mark ⓑ of cylinder block are aligned with each other.

No.1 piston is to be at top dead center of compression stroke.



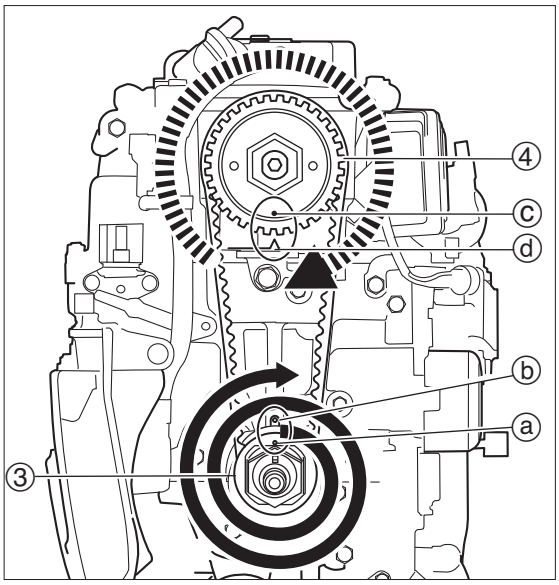
9. Attach new timing belt ⑤ to timing pulley with its part number side facing upward, and then to cam shaft pulley.



⚠ CAUTION

- **Be careful not give damage to timing belt when installing.**
- **Do not twist timing belt, bring inside out, or bend sharp, or it may be damaged.**
- **Be careful not to allow oil or grease to adhere to timing belt.**

10. Turn drive pulley ③ clockwise twice to adapt, and check that locating marks ⓐ and ⓑ, and ⓒ and ⓓ of pulleys ③ and ④ are aligned with each other respectively.

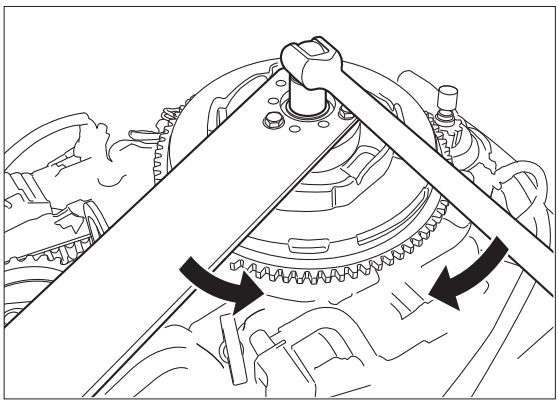


11. Secure align key slot of flywheel and crankshaft, and then install flywheel.

12. Tighten flywheel nut to specified torque.

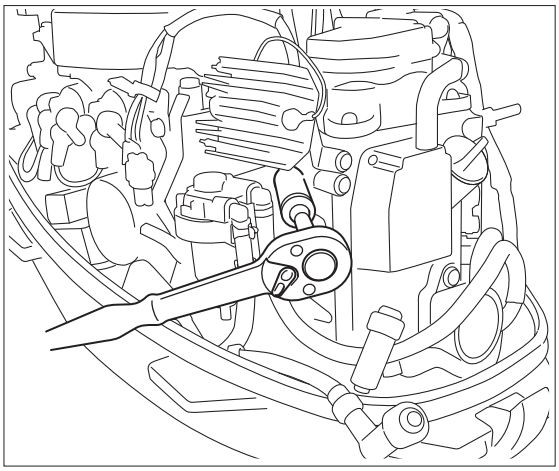
Flywheel Puller Kit :
P/N. 369-72211-0

Flywheel Puller Nut :
80 N·m (58 lb·ft) [8 kgf·m]



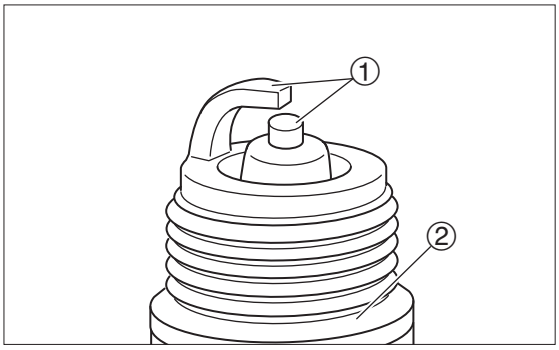
13) Inspection of Spark Plugs

1. Remove plug cap and then spark plugs.



2. Use spark plug cleaner or wire brush to clean spark plug electrodes ① . Replace if necessary.

3. Check electrodes ① for corrosion or excessive build up of carbon, and washer ② for damage. Replace if necessary.

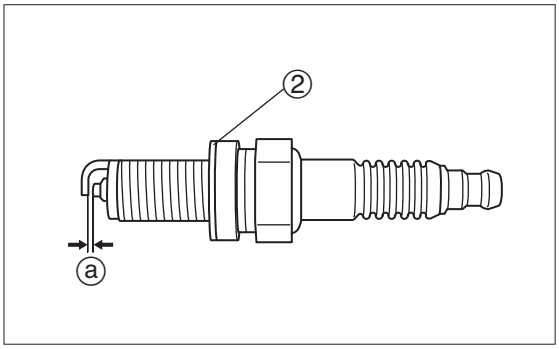


4. Check spark plug gap ⓐ. Replace if gap is over specified value. Adjust gap if it is less than specified value.

Spark Plug Gap ⓐ : Standard
0.8 to 0.9mm (0.032 to 0.035 in)

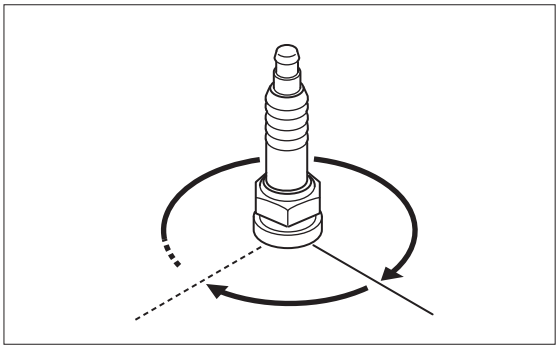
Functional Limit :
1.2 mm (0.047 in)

Specified Spark Plug :
DCPR6E [NGK]



5. Install spark plug, fully hand-tighten, and then use plug wrench to tighten to specified torque.

Spark Plugs :
18 N·m (13 lb·ft) [1.8 kgf·m]



14) Inspection of Compression Pressure

1. Start and run engine for 5 minutes to warm up, and then stop.

2. Shift gear into neutral (N).

3. Remove lock plate (stop switch lanyard) from stop switch.

⚠ CAUTION

Remove lock plate (stop switch lanyard) from stop switch before measuring compression pressure. This will prevent engine from accidental starting.

4. Remove all plug caps and then all spark plugs.

⚠ CAUTION

Clean areas around spark plugs on the cylinder before removing spark plugs to prevent dirt from entering cylinder.

5. Install compression gauge to plug hole.

Compression Gauge :
P/N. 3AC-99030-0

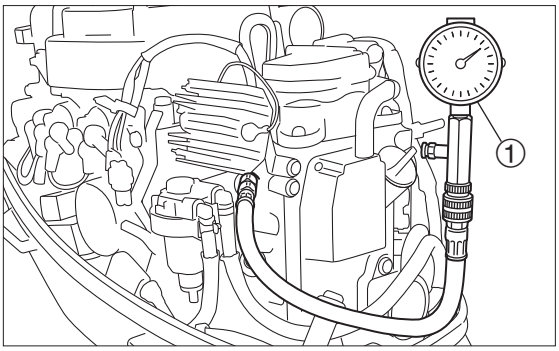
6. Fully open throttle, crank engine until compression gauge indication stabilizes, and then measure compression pressure.

Compression Pressure (Reference) : at 500 r/min
with decompresser : 0.50 MPa (73 psi) [5.1 kgf/cm²]
without decompresser : 0.93 MPa (135 psi) [9.5 kgf/cm²]

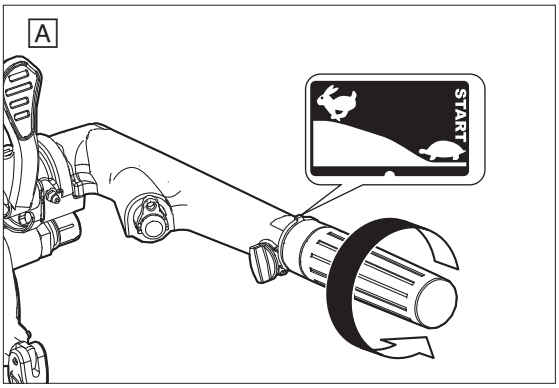
- Compression pressure is affected much by cranking speed, and normally changes in the range from 10 % to 20 %.
- For remote control model :
  Remove cable joint and fully open throttle cam by finger, and then measure compression pressure.

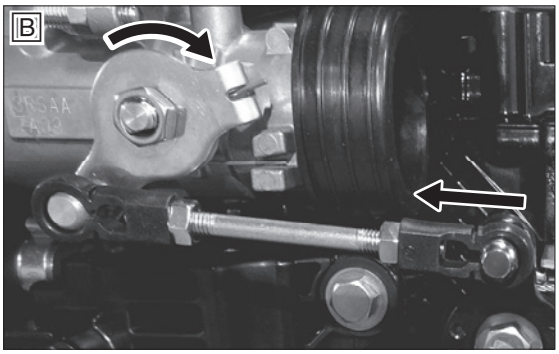
7. If compression pressure is below specified value or varies much among cylinders, put small amount of engine oil into cylinders, and perform compression test again.

- If compression pressure increases after the above measure, check pistons and piston rings for wear. Replace if necessary.
- If compression pressure does not increase after the above measure, check valve clearances, valves, valve seats, cylinder sleeves, cylinder head gaskets and cylinder head. Adjust or replace if necessary.



① Compression gauge





A Tiller-handel Type
B Remote Control Type

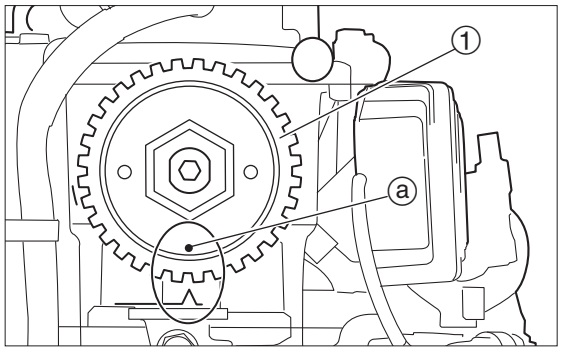
15) Inspection and Adjustment of Valve Clearance

- Perform inspection and adjustment of valve clearances when engine is cold.
- No.1 piston is to be at top dead center of compression stroke (make sure both valves are closed).

1. Remove staerter lock cable, intake silencer, recoil starter, timing belt cover, spark plug.

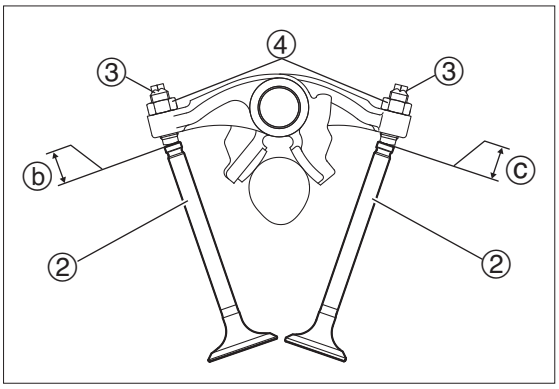
2. Remove cylinder head cover.

3. Rotate flywheel clockwise to bring "● 1" mark of driven pulley ① to "▲" mark ⓐ of cylinder head.



① Driven Pulley

4. Check and adjust No. 1 cylinder's intake and exhaust valve clearances.
   - Insert thickness gauge in the gap between valve end ② and adjust screw ③.
   - Loosen lock nut ④.
   - Turn adjust screw ③ to adjust valve clearance.
   - Tighten lock nut ④.
   - Check valve clearance again.

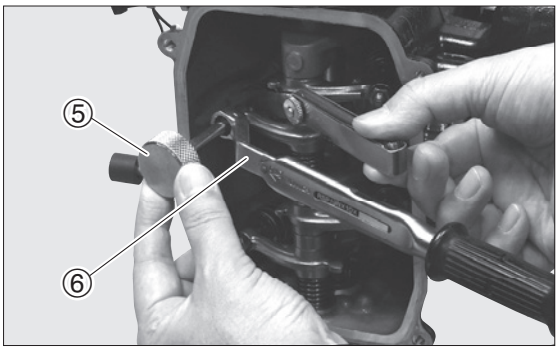


Valve Clearance :
Intake valve : 0.13 - 0.17 mm (0.0051 - 0.0067 in) ⓑ
Exhaust valve : 0.18 - 0.22mm (0.0071 - 0.0067 in) ⓒ

- When loosening or tightening lock nut, tighten adjust screw by using valve clearance driver.
- Be sure to use torque wrench.

Lock nut :
7 N·m (5 lb·ft) [0.7 kgf·m]

Valve Clearance Driver ⑤ :
P/N. 3AC-99071-0
Torque Wrench ⑥ :
P/N. 3AC-99070-0



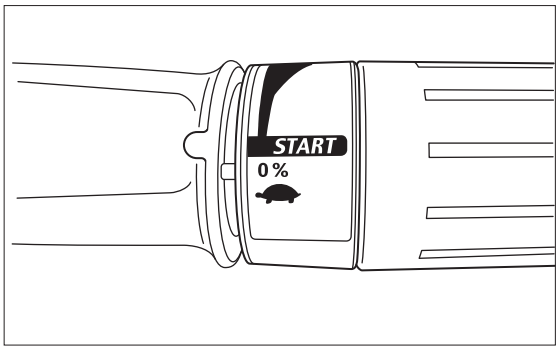
⑤ Valve Clearance Driver (Concaved Tip, Square, Width Between Two Opposing Sides : 3mm)
⑥ Torque Wrench (10mm tip wrench)

5. Rotate flywheel clockwise to bring "2" mark of driven pulley ① to "▲" mark ⓐ of cylinder head.

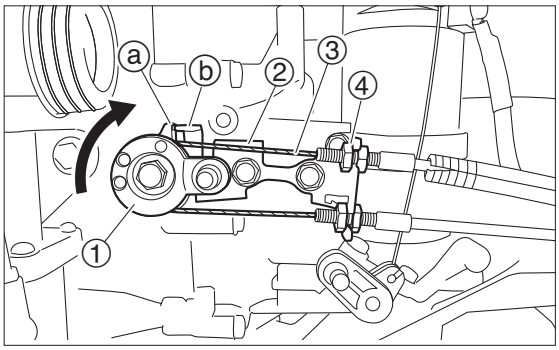
6. Check and adjust No. 2 cylinder's valve clearances in the same procedure as No. 1 cylinder.

16) Adjustment of Throttle Cable (Tiller handle model)

1. Set throttle cable to start (START) position.

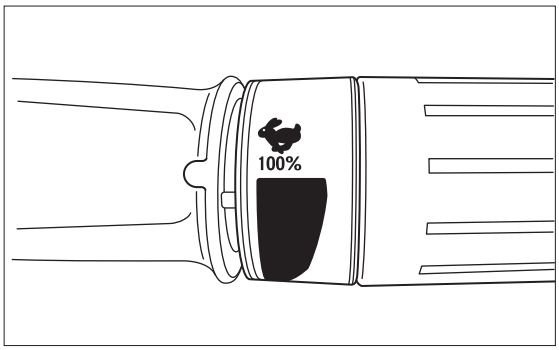


2. Set stopper ⓐ on the throttle drum ① contact to stopper ⓑ on the throttle bracket ②, then adjust throttle cable ③ properly and tighten by the nut ④.

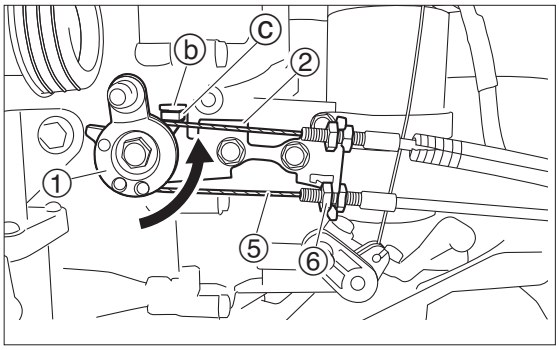


> Make sure that the tension of the cable moves about 1 mm when lightly pressing with a finger.

3. Set throttle grip to fully opened position.

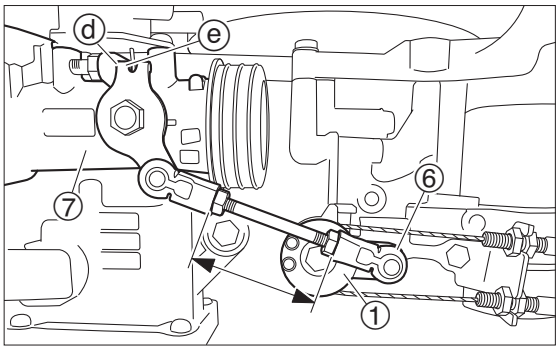


4. Check stopper ⓒ on the throttle drum contact to stopper ⓓ on the throttle bracket ②.
   If not contacting, adjust throttle cable ⑤ properly and tighten by the nut ⑥.



5. Install throttle link ⑥ to throttle drum ①.
   Check stopper ⓔ on the throttle valve contact to stopper ⓓ on the throttle body ⑦.
   If not contacting, check standard length of throttle link.

6. Turn throttle grip to wide open several times to fully close throttle position, then check throttle valve propery position.

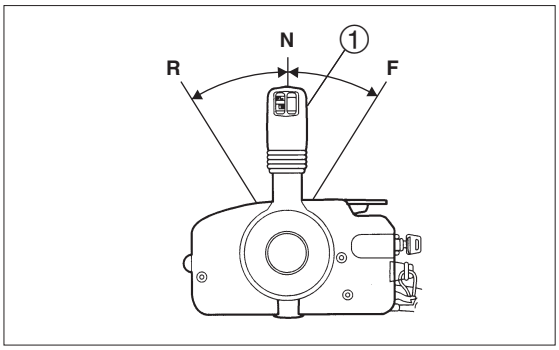


17) Adjustment of Shift • Throttle Cable (Remote control model)

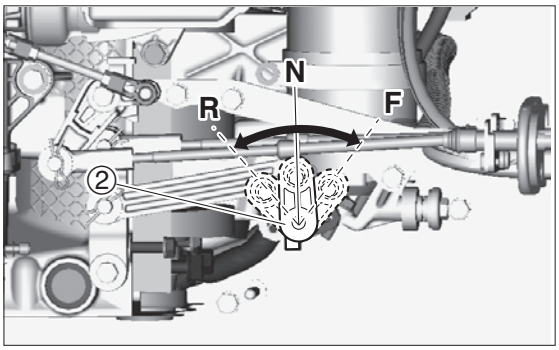
⚠ CAUTION

To operate shift lever on tiller models, make sure the throttle is closed to ensure no damage occurs to the throttle link.

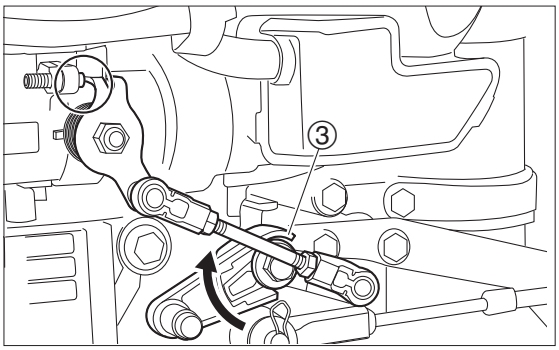
1. Set control lever ① to neutral (N) position.



2. Set shift arm ② to forward (F) to neutral (N) to reverse (R), and check position, then set to neutral (N).



3. Set throttle drum ③ to fully close position.

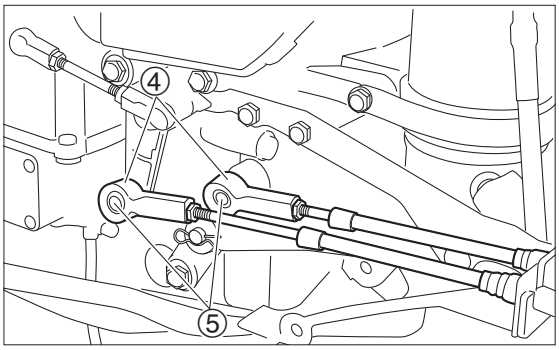


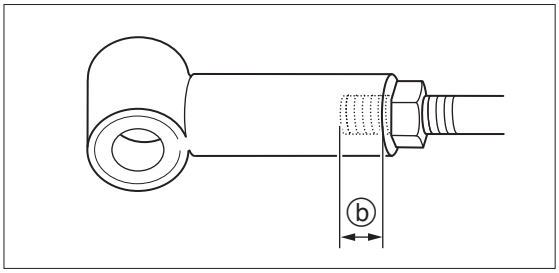
4. Adjust screw-in length of cable joint ④ so that hole of cable joint is brought to throttle arm and shift arm pin ⑤.

⚠ WARNING

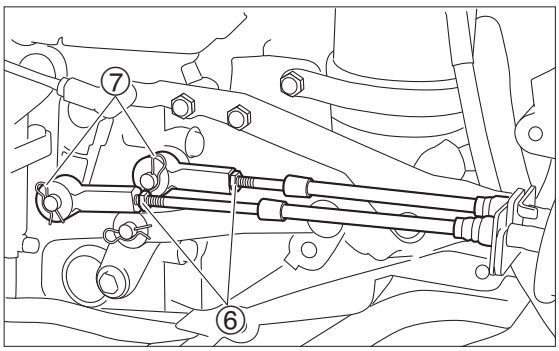
Screw-in remote control cable joint at least 10 mm ⓑ.

- Cable joint is shipped in the outboard motor packing box.
- When adjusting cable joint, adjust it with cable fully pushed in.

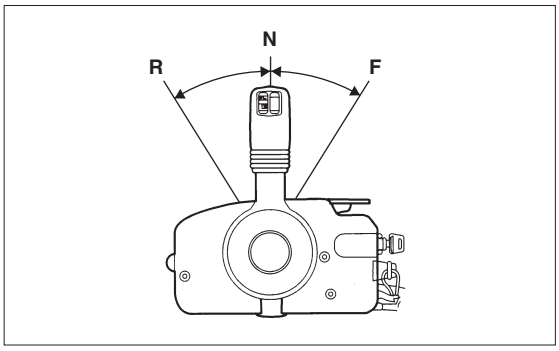




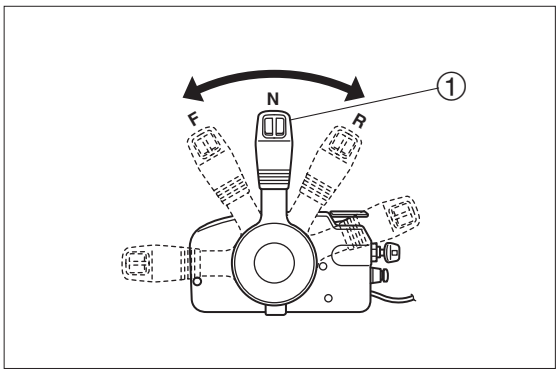
5. Tighten nut ⑥, put it on the pin, and secure with washer and snap pin ⑦.



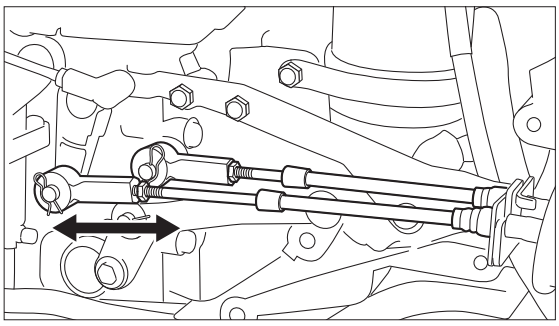
6. Check shift lever opration to foward (F) to neutral (N) to reverse (R).



7. Check that shifting control lever ① forward (F) by approximately 32 degrees , where it is stopped once, makes the gear engage, and fully shifting the lever makes throttle valve fully open. (for tiller handle model, check that throttle grip operate to throttle valve fully open.),
Then, check that, when control lever is returned to neutral position (N), throttle valve is fully closed. If throttle valve does not contact with full close stopper with the valve fully closed, readjust cable joint position at outboard motor side and reinstall it if the valve does not contact with full close stopper in this case.



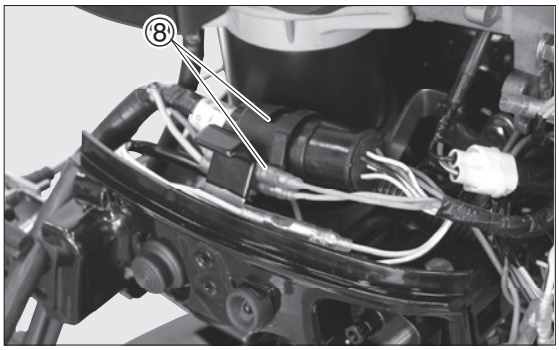
8. Check if throttle valve operates smoothly, and repeat steps 1. to 7. as necessary.



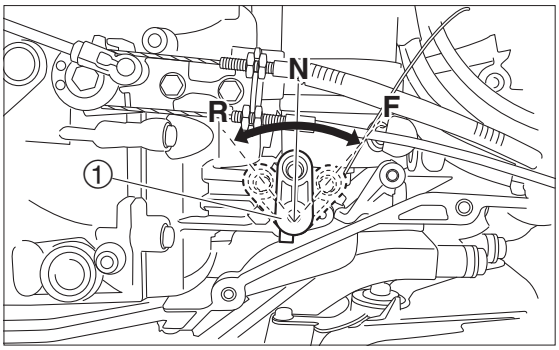
9. Reconnect main harness connector ⑧ .

⚠ CAUTION

Do not disconnect cord ass'y while engine operates.



18) Inspection of Shift Lever Gear Operations

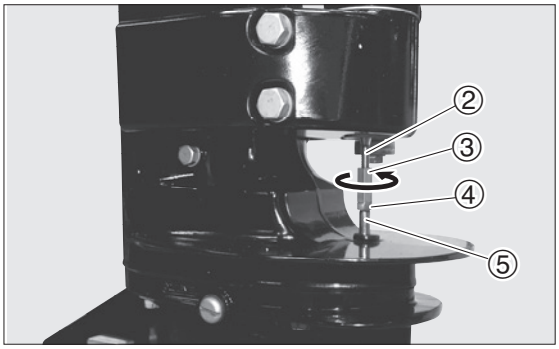


⚠ CAUTION

When adjusting gearshift, reconnect the shift rod and tighten both nuts with a wrench whenever tightening the nut. Otherwise it will cause damage to the parts, If only one side is tightened.

Shift gear from neutral (N) to forward (F), neutral (N), and then to reverse (R) while rotating propeller slowly to allow clutch engagement to check that shift operation is performed smoothly. Adjust shift link rod ① length, shift rod and cam rod position if necessary.

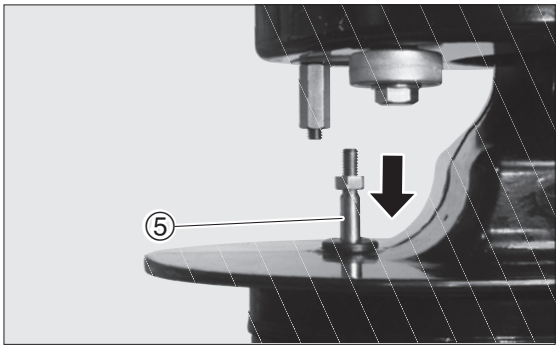
1. Shift gear into reverse (R) to down the shift rod position.



2. Loosen joint nut ④ and shift rod joint ③ arrow direction, then disconnect shift rod ② and camrod ⑤.

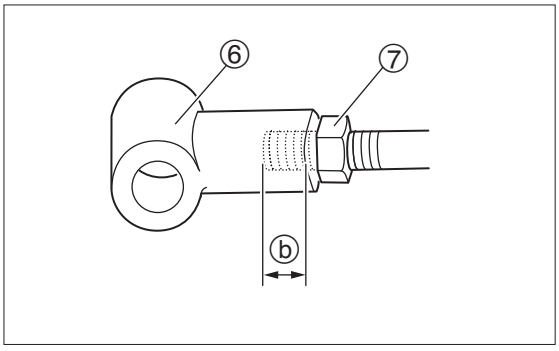
⚠ CAUTION

When adjusting gearshift, loosen both nut ④ and shift joint ③ with a wrench. Otherwise it will cause damage to the parts, If only one side is tightened.



3. With the shift rod disconnected, fully shift completely reverse (R) and push down the cam rod completely downward.

4. Reconnect cam rod and shift rod, and then check that gear shift operation is performed smoothly.



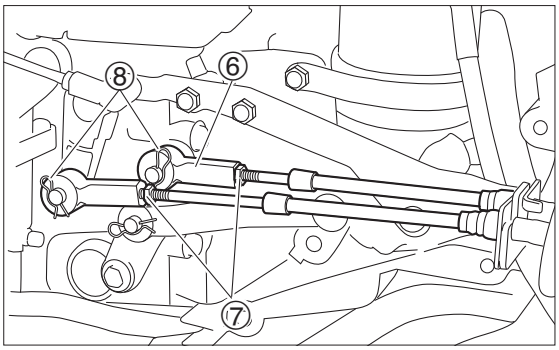
5. Adjust length so that remote control cable joint ⑥ hole aligns with set pin. (Remote Control Model)

⚠ CAUTION

Screw-in remote control cable joint at least 10 mm ⓑ.

When adjusting remote control cable joint, adjust it with remote control cable fully pushed in.

6. Reconnect remote control cable joint ⑥, attach snap pin ⑧, and tighten lock nut ⑦. (Remote Control Model)

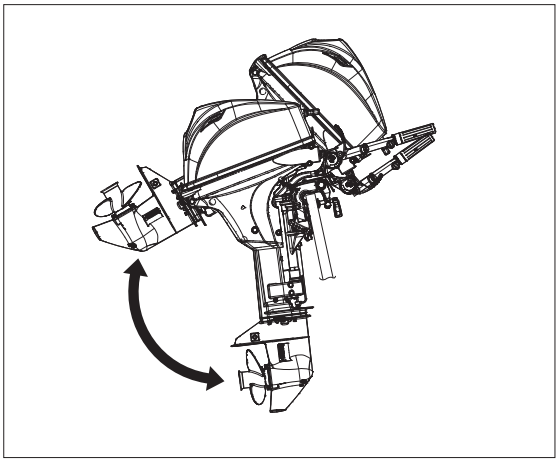


7. Check if gear shifts smoothly, and repeat steps 2. to 8. as necessary.

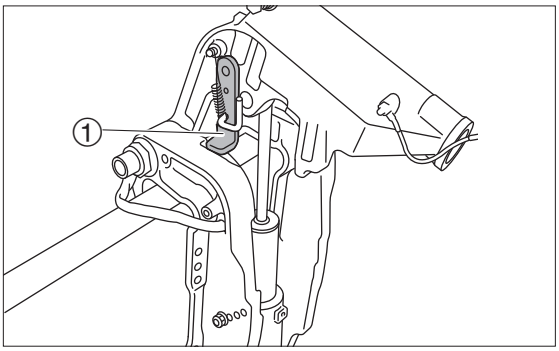
19) Inspection of PT Unit Operation

1. Tilt up and down outboard motor several times to check that PT unit operates smoothly in full range. Check PT fluid quantity if necessary. Refer to "Inspection of PT Fluid Quantity" described in the next page.

Check that PT motor produces noise of normal revolution.



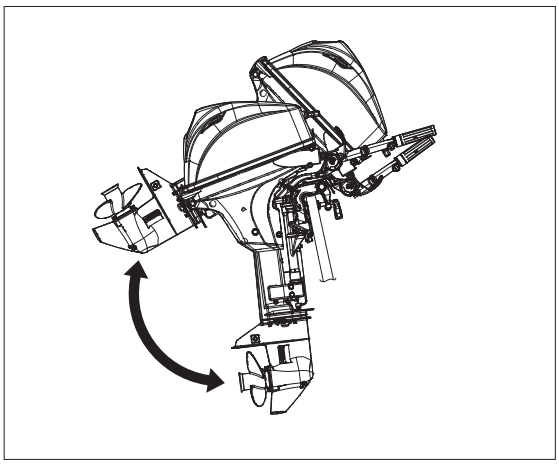
2. Fully tilt up outboard motor, lock with tilt stopper ①, and check that stopper ① lock mechanism functions normally.



20) Inspection of Manual Tilt Operations

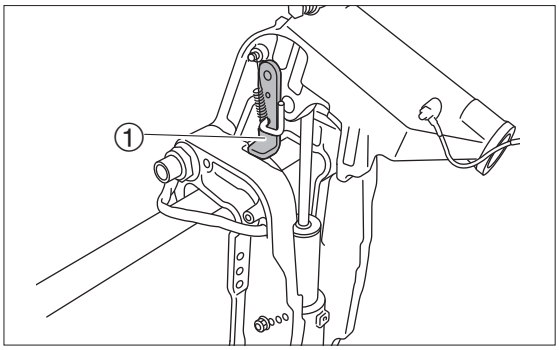
1. Tilt up and down outboard motor several times to check that mamual tilt operates smoothly in full range.

2. Fully tilt up outboard motor, lock with tilt stopper ②, and check that stopper ② lock mechanism functions normally.



21) Inspection of PT Fluid Quantity

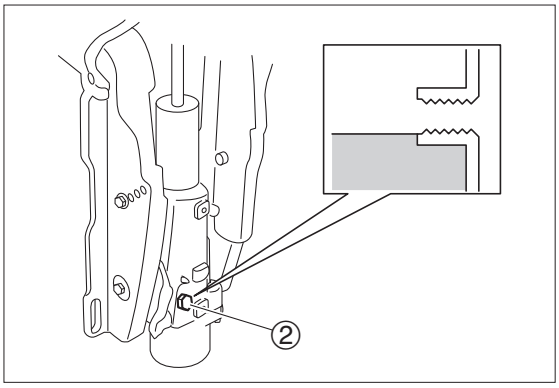
1. Fully tilt up outboard motor and lock with tilt stopper ①.



⚠ WARNING

Be sure to lock outboard motor with tilt stopper after fully tilting up. Leaving outboard motor without locking may lead to accidental descent due to reduction of PT hydraulic pressure.

2. Remove reserve tank cap ② and check quantity of PT fluid contained in the tank.



⚠ WARNING

Check PT fluid level with outboard motor fully tilted up. Removing reserve tank cap at halfway position can cause blasting out of PT fluid, which is dangerous, and also result in inaccurate fluid level reading.

Quantity of PT fluid is normal when some fluid spills out of cap hole when cap is removed.

3. Add recommended PT fluid to specified level if it is low.

Recommended PT Fluid :
ATF DEXRON III

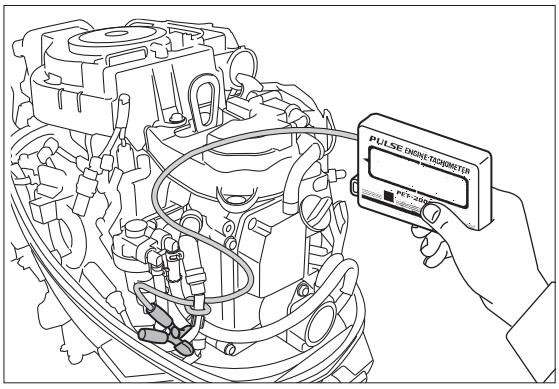
4. Attach reserve tank cap ② and tighten to specified torque.

Reserve Tank Cap :
1.5 N·m (1.1 lb·ft) [0.15 kgf·m]

22) Inspection of Idle Speed

1. Start engine and run for 5 minutes to warm up.

2. Check idle speed using a tachometer or diagnostic program.



Tachometer :
P/N. 3AC-99010-0

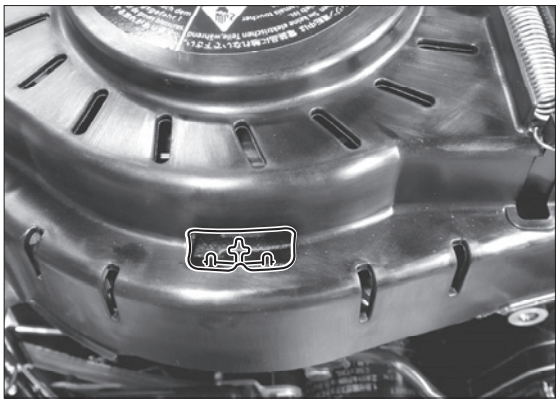
Idle Speed :
950 r/min

23) Inspection of Ignition Timing

Adjusting system : Automatic control, requiring no manual adjustment.

Run engine and use timing light to check ignition timing.

9 timings marks are found on the side of flywheel (TDC0°, ATDC5°, 10°, BTDC5°, 10°, 15°, 20°, 25°, 30°), and ignition timing is read with mark on the center of starter case window.



Outboard Model	Range of Ignition Angle	Engine Starting	Idling
MFS15/20E	BTDC 5˚ to BTDC 30˚	BTDC 5˚	BTDC 5˚± 5˚
MFS9.9E	BTDC 5˚ to BTDC 25˚	BTDC 5˚	BTDC 5˚± 5˚

24) Inspection of Anodes

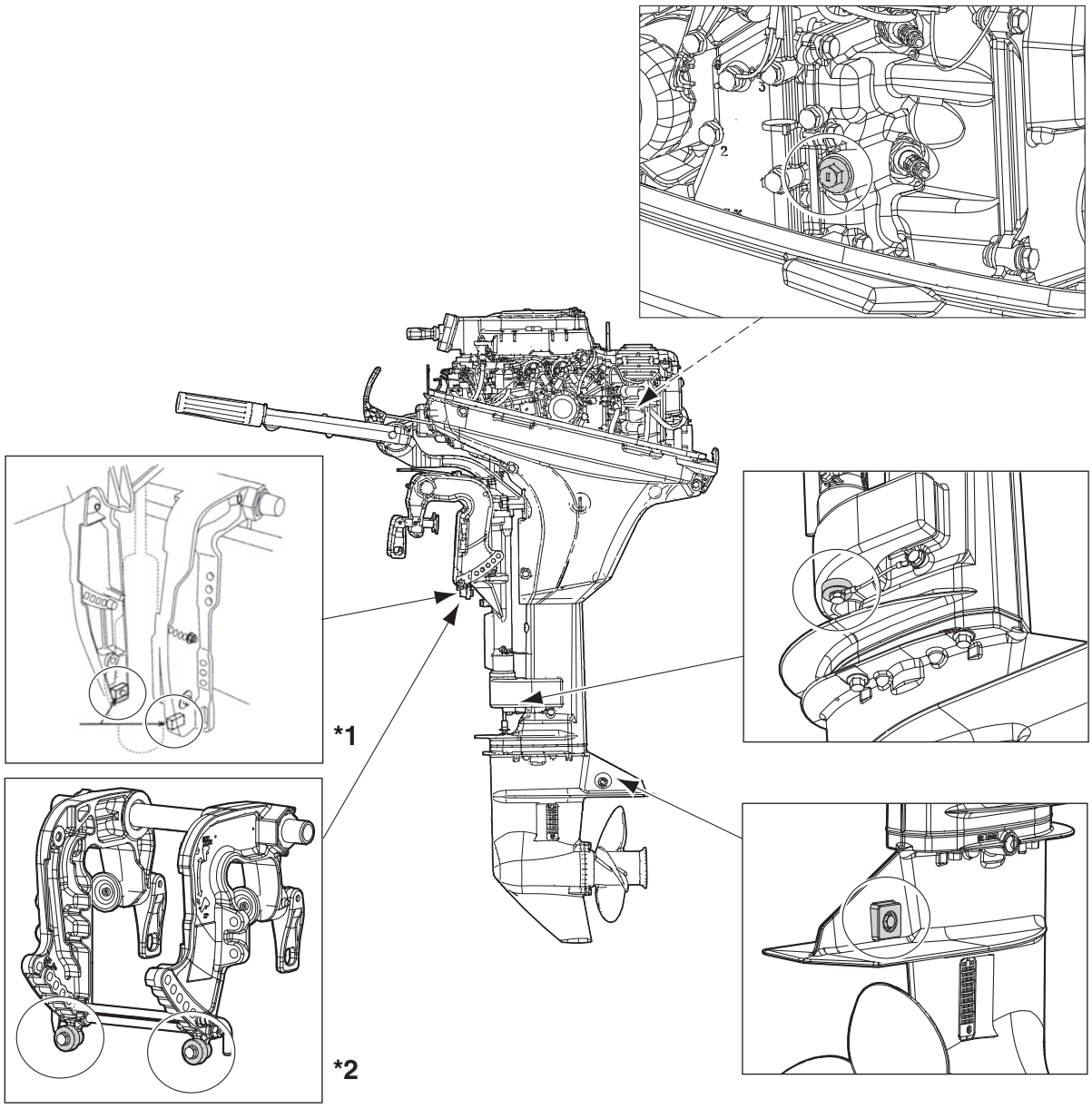
1. Check anodes and trim tab for build up of scale and adherence of grease and oil. Clean or replace if necessary.

2. Replace anode and/or trim tab if they are corroded excessively.

⚠ CAUTION

Do not coat anode and trim tab with oil, grease or paint, or their anti-corrosion function does not work normally.

When it is necessary to disassemble outboard motor for inspection of anode, refer to disassembly described in this manual.



*1 PT model
*2 Manual tilt model

25) Replacement of Anodes

Anodes protect outboard motor from galvanic corrosion (corrosion of metal due to very weak electric current).

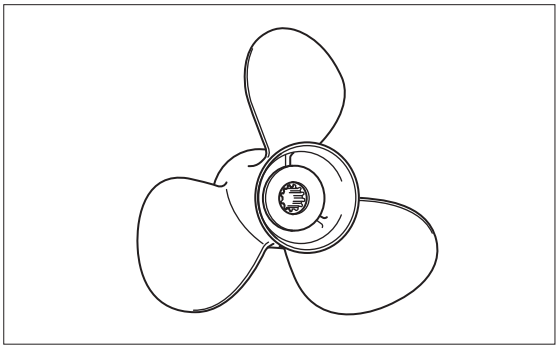
Anodes are used in the gear case, clamp bracket, and power unit cylinder.

Replace anode if volume is reduced to 2/3 of new part.

- Do not coat anode with oil or paint.
- Since periphery of anode installation bolt is corroded more than other areas, be sure to retighten bolt at every inspection.

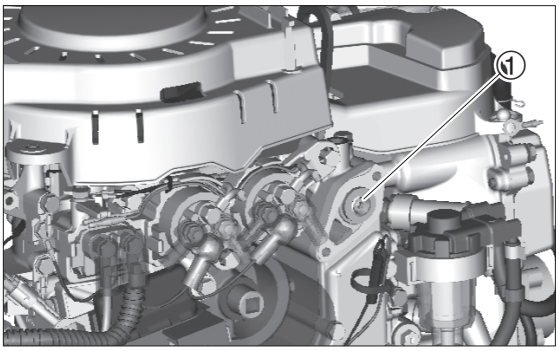
26) Inspection of Propeller

1. Check propeller blades and spline for cracks, damages, wear and corrosion. Replace if necessary.



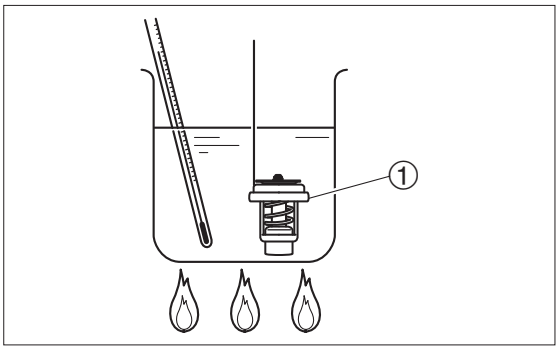
27) Inspection of Thermostat

1. Remove cover and thermostat ①.



2. Hang thermostat ① in the water contained in vessel.

3. Put thermometer in the water, and warm up water to measure valve opening temperature.



Put a piece of thread in the closed valve gap and hang it in the water. Valve opening moment can be known when thermostat is released to drop due to opening with rise of temperature.

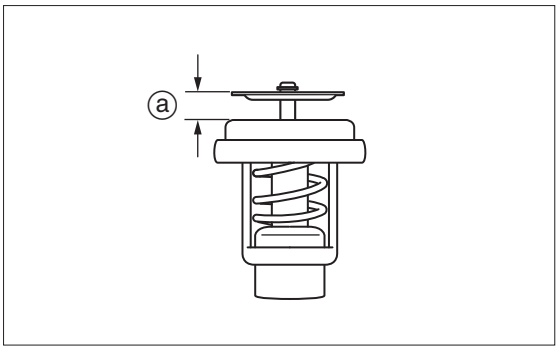
Valve Opening Temperature :
52±2C° (126±36°F)

4. Measure valve lift of thermostat when prescribed temperature has been reached. Replace if valve lift is less than specified value.

Water Temperature	Valve Lift ⓐ
65°C (149°F)	3.0 mm (0.118 in) or over

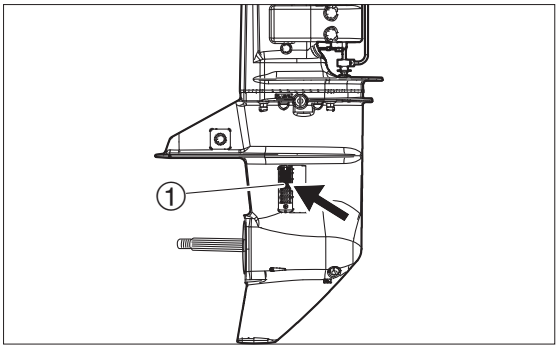
5. Install thermostat, new gasket and cover.

Thermostat Cover Bolt :
9 N·m (7 lb·ft) [0.9 kgf·m]



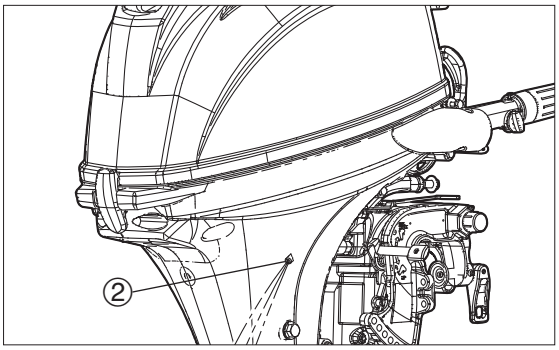
28) Inspection of Cooling Water Passage

1. Check water strainer ① for clogging. Clean if necessary.



2. Set outboard motor in the water and start engine.

3. Check that cooling water is discharged from cooling water check port ②. If not, check water pump and cooling water passage in the engine.



29) Inspection of Cooling Water Pressure

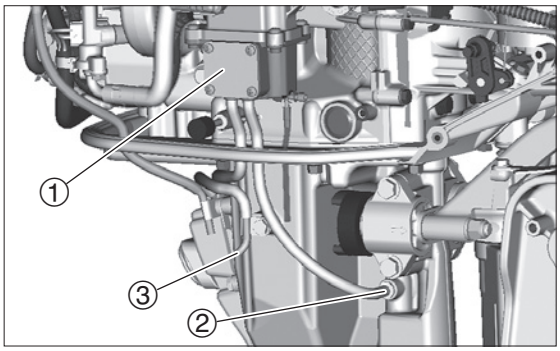
1. Measure cooling water pressure directly from cooling water check port.

2. Start engine and check water pressure at each engine speed.

Engine Speed	Water Pressure
950 r/min	10 kPa (1.54 psi) [0.102 kgf/cm²]
1500 r/min	15 kPa (2.18 psi) [0.153 kgf/cm²]
3000 r/min	32 kPa (4.64 psi) [0.326 kgf/cm²]
5000 r/min	40 kPa (5.80 psi) [0.41 kgf/cm²]
5750 r/min	45 kPa (6.53 psi) [0.46 kgf/cm²]

Shown water pressure values are reference.

3. Check cooling water passage of water pump and inside the engine if water pressure is very low.



① Fuel coolor
② Cooling water check port

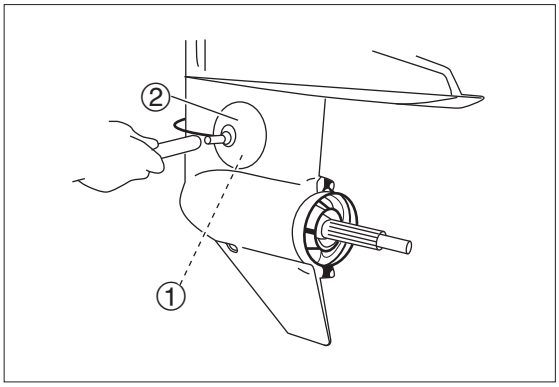
30) Flushing with Water

⚠ CAUTION

Touching rotating propeller could lead to injury. Be sure to remove propeller before running engine on the land.

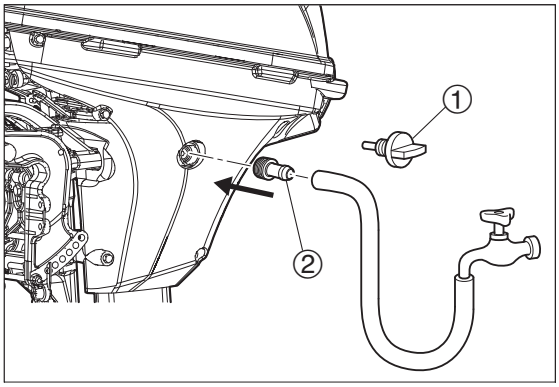
⚠ WARNING

Exhaust gas contains carbon monoxide, which will cause gas poisoning. Do not start engine with outboard motor placed in a closed area such as boat house.



Flushing with water using drive cleaner ②

1. Remove propeller and thrust holder.
2. Attach driver cleaner ② to water strainer ① area.
3. Put water hose to drive cleaner ② and run water.
4. Set gear shift to neutral (N) and start engine.
5. Check that cooling water check port discharges water, and run engine for 3 to 5 minutes at low speed.
6. Stop engine and stop water supply, remove drive cleaner ②, and then, reinstall propeller parts removed.



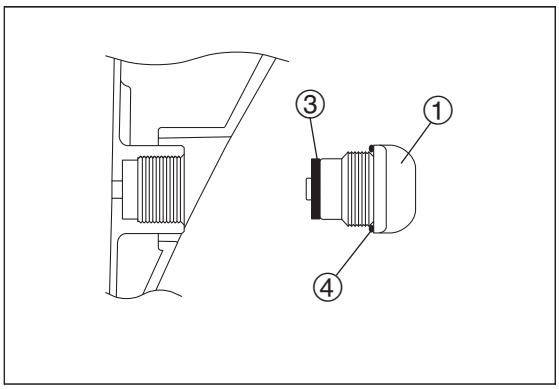
Flushing with water using hose joint

1. Tilt down the outboard motor.
2. Remove the flushing connector cap ① from the outboard motor, and screw in the hose joint ②.
3. Attach the hose joint and connect a water hose. Turn on the water and adjust the flow. Continue flushing the outboard motor for 3 to 5 minutes.

⚠ CAUTION

Do not operate the engine.

4. Remove hose joint.
5. Check for damage or crack in the seal ③ and O-ring ④, then install flushing connector cap.

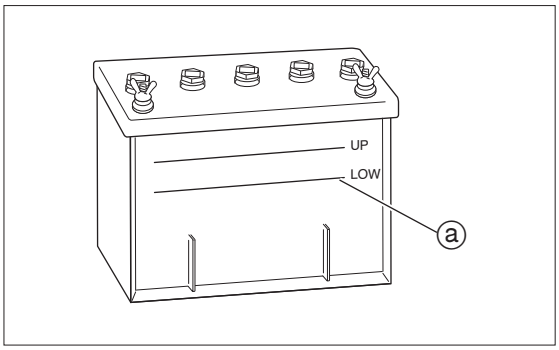


⚠ CAUTION

Leak of cooling water flow could lead to engine over heating. Be sure to reattach the flushing connector cap.

31) Inspection of Battery

1. Inspect electrolyte level. If lower than "LOW" mark ⓐ, add distilled water until the level goes in between "UP" and "LOW" marks.



2. Measure specific gravity of electrolyte. Charge battery if specific gravity is less than specified value.

⚠ WARNING

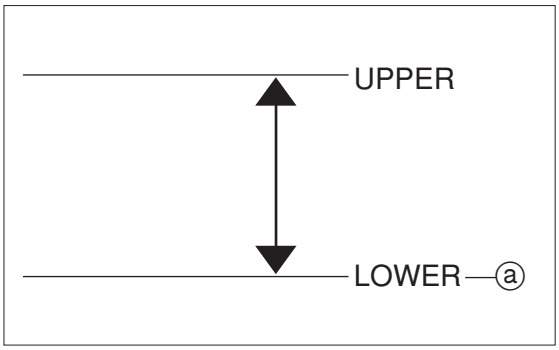
Electrolyte contains sulfuric acid that is poisonous and highly corrosive, which is dangerous. Always be careful of the following matters to prevent accident.
- **Handle electrolyte carefully not to allow adherence to any part of body, or it could cause serious chemical burn or blindness.**
- **Wear protective glasses when working near battery or handling battery.**

First Aid in Emergency (if electrolyte adhered to body)
- **Flush well with fresh water if adhered to skin.**
- **If gets in eye, flush well with fresh water for 15 minutes, and have doctor's evaluation immediately.**

First Aid in Emergency (if swallowed)
- **Drink much water, magnesium hydrate solution (magnesium milk), fresh egg, or salad oil, and have doctor's evaluation immediately.**

Battery produces highly inflammable hydrogen gas. Always be careful of the following matters to prevent accident.
- **Charge battery in well ventilated place.**
- **Keep battery away from fire, sparks or flame. (such as live cigarette or operating welding machine)**
- **Do not allow smoking when handling or charging battery.**

Keep battery and electrolyte out of reach of children.



- Batteries are available with various types, varying among manufacturers. For any unclear matters, refer to manual attached to battery.
- When removing battery, disconnect negative lead first and then positive lead.

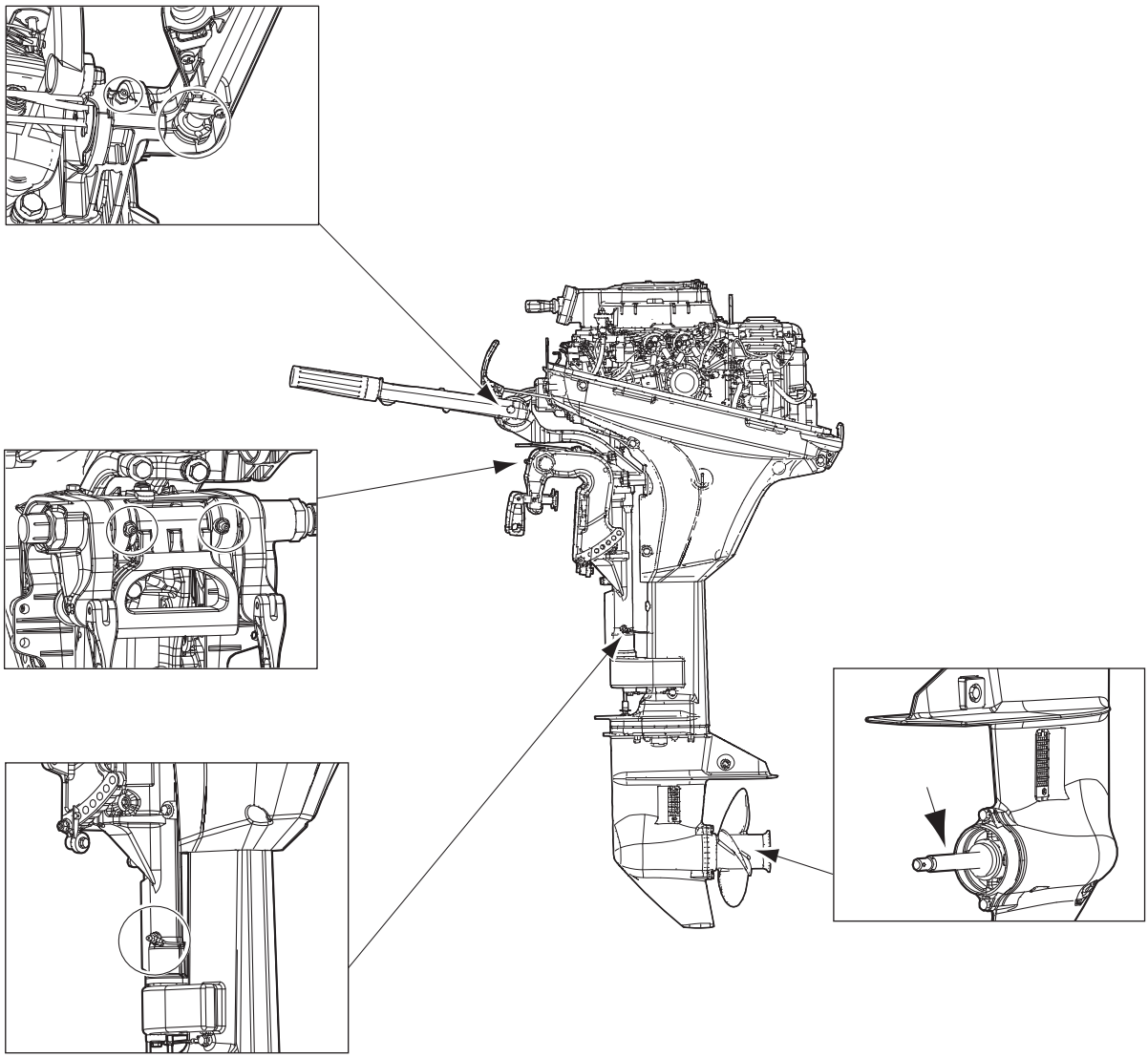
Recommended Battery :
12V 40AH/5HR 350CCA
(12V 70AH/5HR at below freezing temperature)
650CCA

Specific Gravity of Electrolyte :
1.280 (at 20˚C)

3

32) Grease points

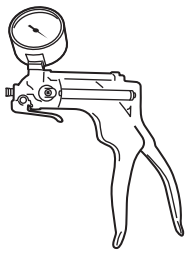
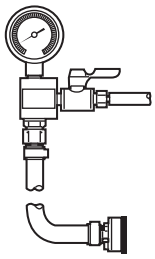
Apply water proof grease to the parts shown below.



4

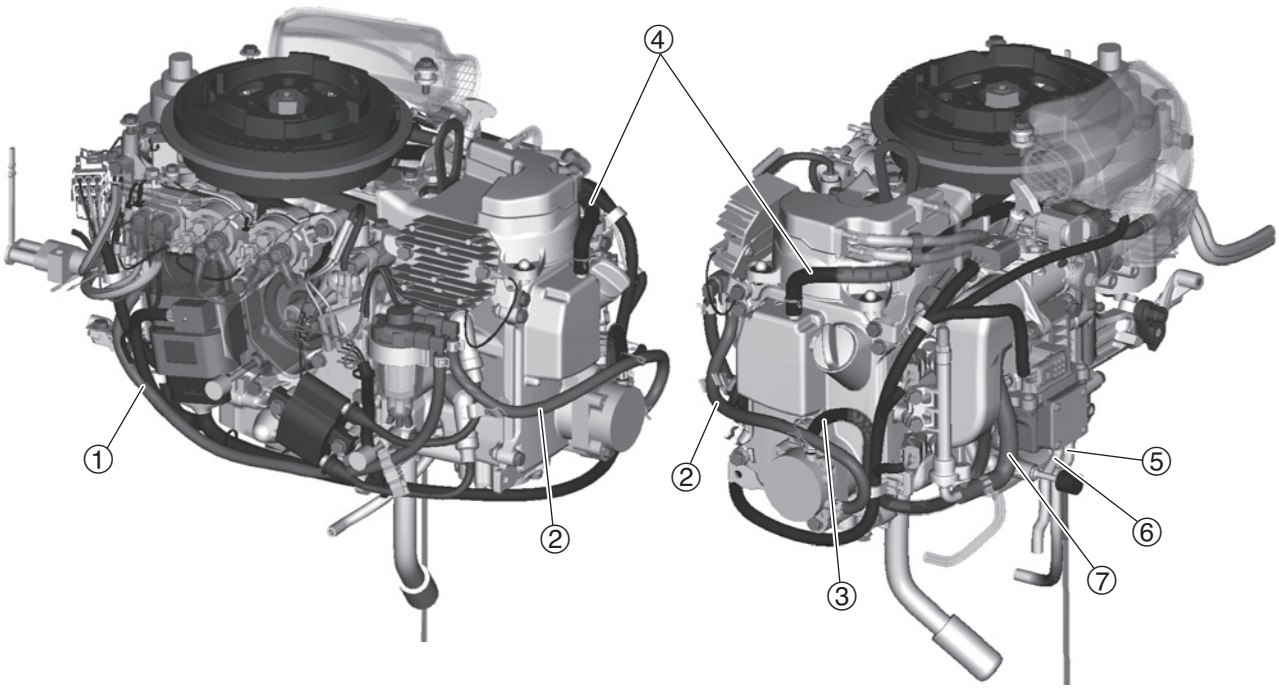
Fuel System (Fuel Injection)

1. Special Tools

	
Vacuum/Pressure Gauge P/N. 3AC-99020-1	Pressure Gauge Ass'y P/N. 3T5-72880-0
Inspecting pressure	Measuring fuel pressure

2. Piping Arrangement Diagram
Fuel Hose, Vent Hose, Breather Hose, Cooling Water Hose

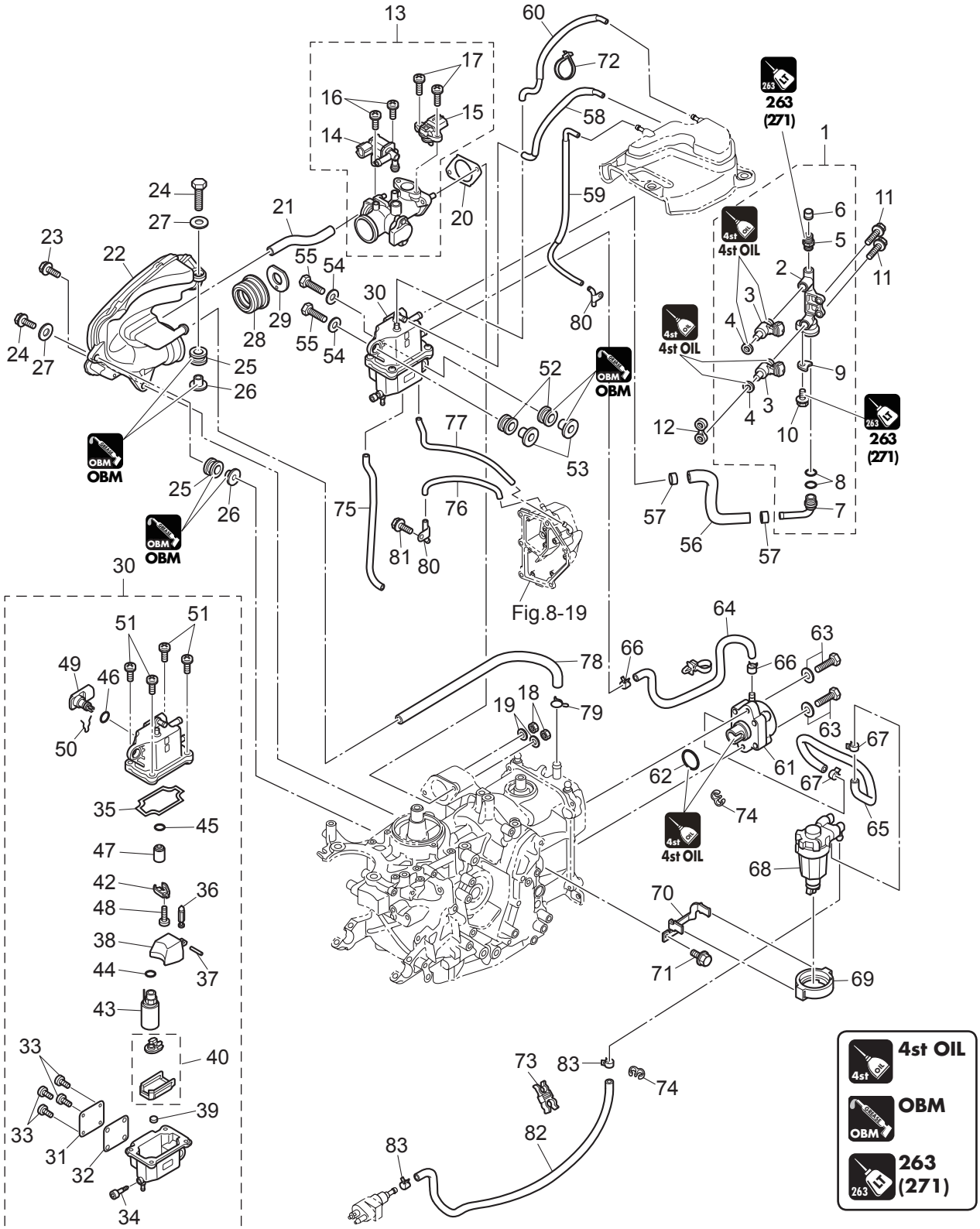
Port Side **Starboard Side**



Ref. No..	Description
①	Fuel Hose (Fuel Connector to Fuel Filter)
②	Fuel Hose (Fuel Filter to Fuel Pump)
③	Fuel Hose (Fuel Pump to Vapor Separator)
④	Breather Hose (Cylinder Head to Throttle Body)
⑤	Cooling Water Hose (Engine Base to Fuel Cooler)
⑥	Cooling Water Hose (Fuel Cooler to Idle Port)
⑦	High Pressure Fuel Hose (Vapor Separator to Fuel Rail)

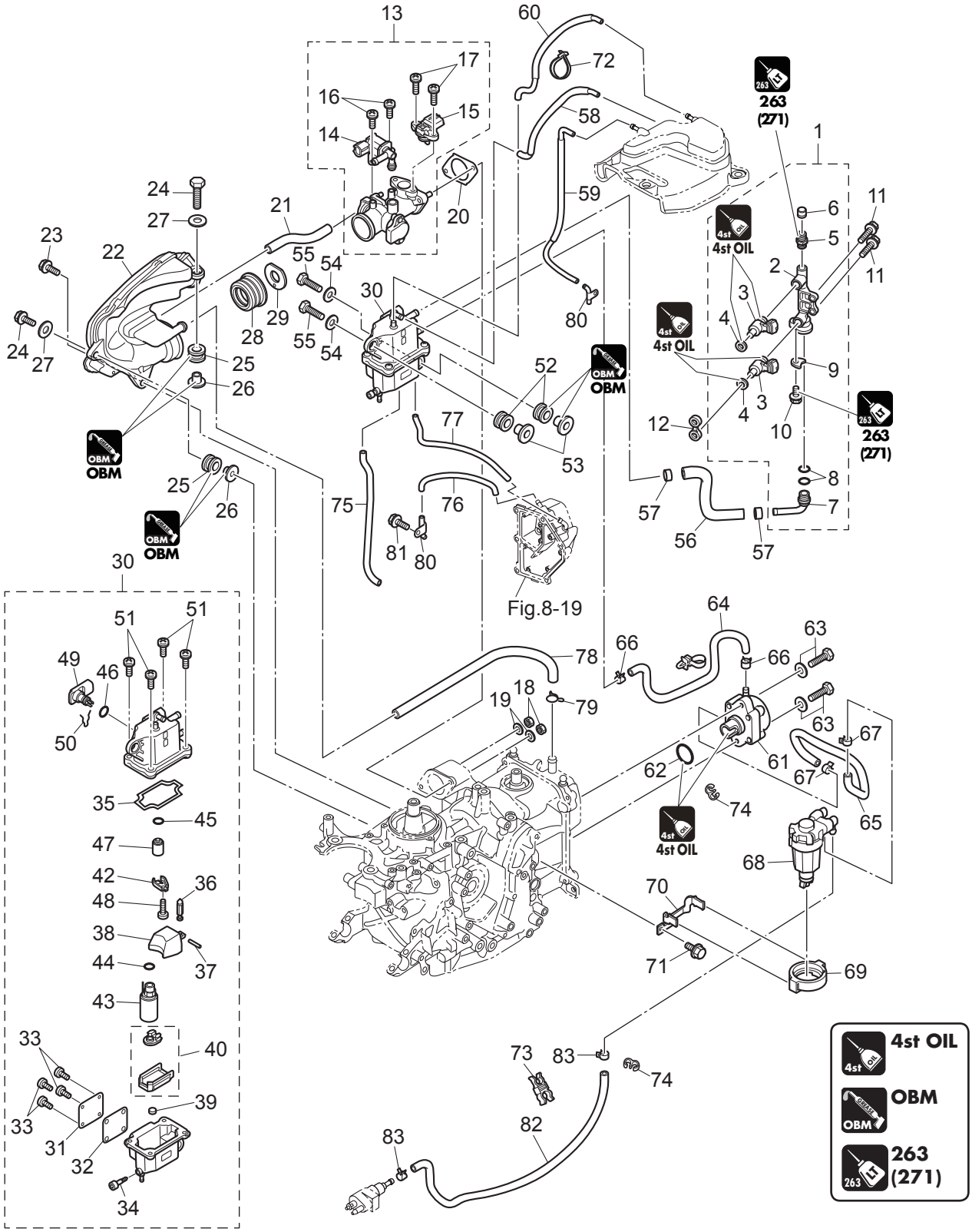
3. Parts Layout

Intake Manifold



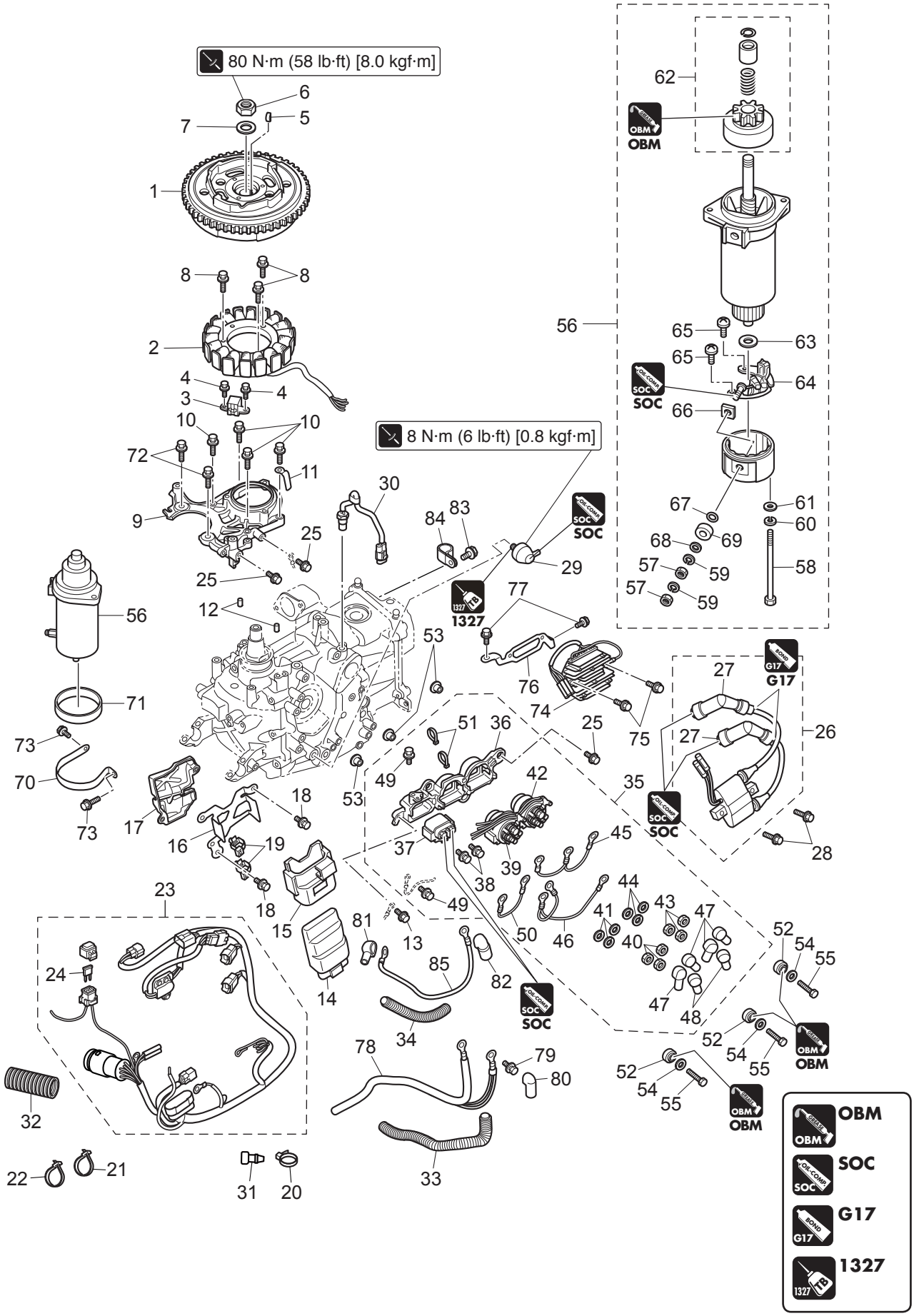
Ref. No.	Description	Q'ty	Remarks
1	Fuel Rail Assy	1	
2	Fuel Rail	1	
3	Fuel Injector Assy	2	
4	Seal Ring	2	
5	Valve Assy (Pressure Check)	1	
6	Cap	1	
7	Nipple 8-6-13L	1	
8	O-ring 1.9-9.8	2	Do not reuse.
9	Holding Plate	1	
10	Bolt	1	M6 L=12 mm
11	Bolt	2	M6 L=25 mm
12	Insulator	1	
13	Throttle Body Assy	1	
14	ISC Valve	1	
15	Map Sensor	1	T-Map Sensor
16	Screw	2	M5 L=10 mm
17	Screw	2	M5 L=16 mm
18	Nut	2	M6
19	Washer	2	M6
20	Carburetor Gasket	1	Do not reuse.
21	Hose	1	ISC Valve-Intake Silencer
22	Intake Silencer Assy	1	
23	Bolt	1	M6 L=30 mm
24	Bolt	2	M6 L=20 mm
25	Rubber Mount	2	
26	Collar	2	
27	Washer 6-16-1.5	2	M6
28	Gasket	1	
29	Restrictor	1	
30	Vapor Separator Assy	1	
31	Cover	1	
32	Seal	1	Do not reuse.
33	Screw	4	M4 L=8 mm
34	Drain Screw	1	
35	Gasket	1	
36	Float Valve Assy	1	
37	Float Arm Pin	1	
38	Float	1	
39	Grommet	1	
40	Filter (Inlet)	1	
42	Holder	1	Regulator
43	Fuel Feed Pump	1	
44	O-ring	1	FFP Out Side Do not reuse.
45	O-ring	1	Connector Do not reuse.
46	O-ring	1	Regulator Do not reuse.
47	Fuel Regulator	1	
48	Screw	1	M4 L=8mm
49	VST Connector	1	

Fuel System (Fuel Injection)

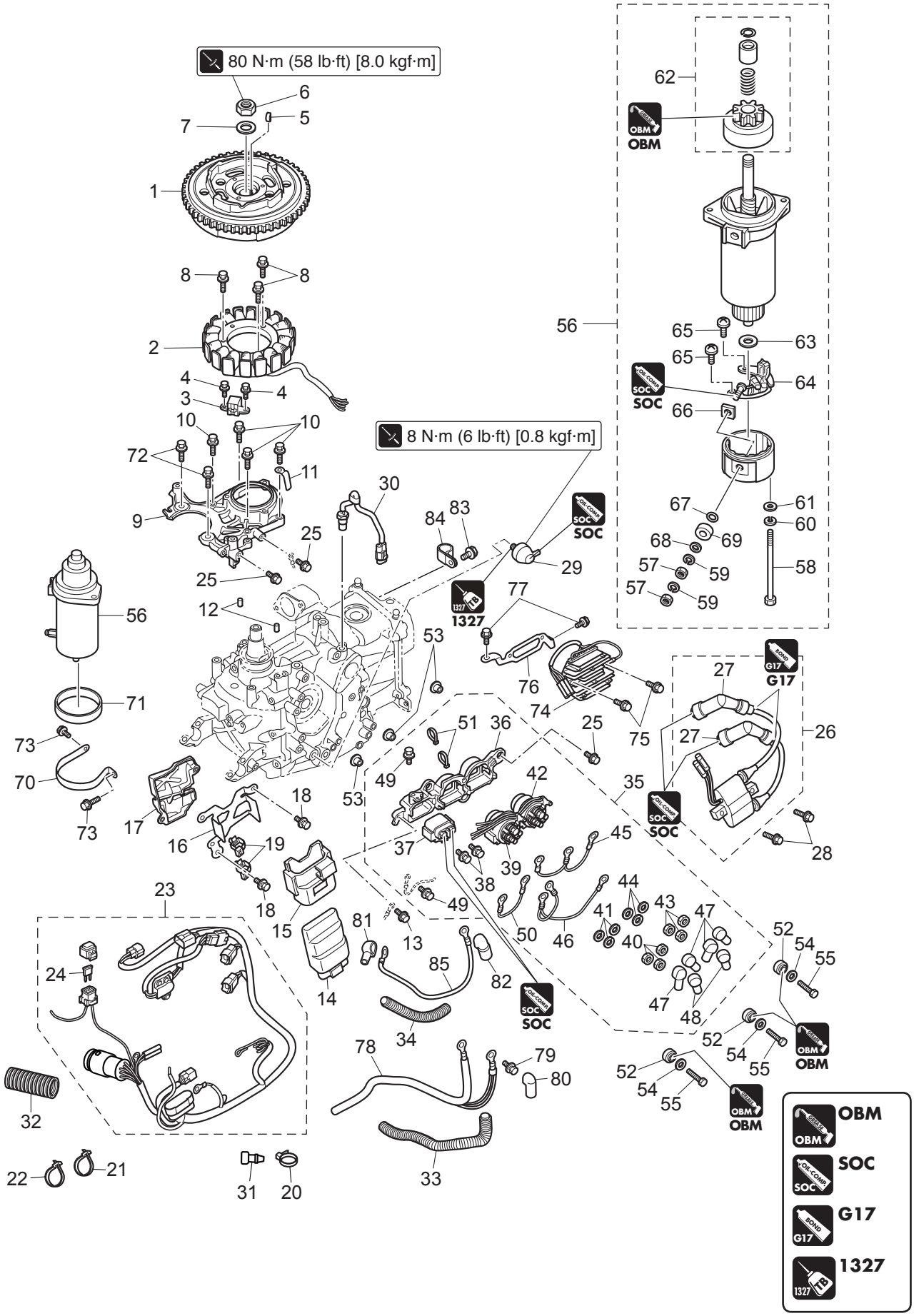


Ref. No.	Description	Q'ty	Remarks
50	Clip	1	
51	Screw	4	
52	Rubber Mount	2	
53	Collar	2	
54	Washer 6-16-1.5	2	M6
55	Bolt	2	M6 L=25mm
56	Fuel Hose W/Protector	1	VST-Fuel Rail
57	Clamp ø16.8	2	
58	Vent Hose W/Protector	1	VST-Catch Tank
59	Vent Hose W/Protector	1	Catch Tank-Vent
60	Vent Hose W/Protector	1	Catch Tank-Exposure
61	Fuel Pump Assy	1	
62	O-ring 3.5-25.7	1	Do not reuse.
63	Bolt	2	M6 L=25mm
64	Fuel Hose W/Protector	1	Fuel Pump-VST
65	Fuel Hose W/Protector	1	Fuel Filter-Fuel Pump
66	Clip ø9.4	2	Fuel Pump-VST
67	Clip ø9.4	2	Fuel Filter-Fuel Pum
68	Fuel Filter Assy	1	
69	Fuel Filter Holder	1	
70	Plate	1	
71	Bolt	1	M6 L=12mm
72	Clamp	1	
73	Clamp ø10	1	
74	Clamp ø10	1	
75	Water Hose	1	Drive Shaft Housing-Fuel Cooler
76	Cooling Hose	1	Idle Port Cover-Nipple
77	Cooling Hose	1	Fuel Cooler-Idle Port Cover
78	Breather Hose W/Protector	1	Head Cover-Intake Silencer
79	Clip ø12	1	Head Side
80	Nipple	2	Drive Shaft Housing
81	Bolt	1	
82	Fuel Hose W/Protector	1	
	Fuel Hose W/Protector 455-25	1	USA Model
83	Clip ø9.4	2	

Electric Parts



Ref. No.	Description	Q'ty	Remarks
1	Flywheel	1	M Type
	Flywheel W/Ring Gear	1	EF/EP Type
2	Alternator Assy	1	M Type
	Alternator Assy	1	EF/EP Type
3	Pulsar Coil	1	
4	Bolt	2	Pulsar M5 L=12 mm
5	Key t=4	1	
6	Nut	1	
7	Washer 16-27-3.2	1	
8	Bolt	3	Alternator M6 L=25 mm
9	Coil Bracket	1	
10	Bolt	4	Coil Bracket M6 L=25 mm
11	Clamp 6.5-47.5P	1	
12	Dowel Pin 6-12	2	
13	Bolt	1	M6 L=12 mm
14	ECU Assy	1	
15	ECU Holder	1	
16	Plate	1	
17	Plate	1	
18	Bolt	2	M6 L=16 mm
19	Band 135	2	
20	Band 158	1	Do not reuse.
21	Band 158	1	Do not reuse.
22	Band 158	1	Do not reuse.
23	Cord Assy	1	MF
	Cord Assy	1	EF, EFT
	Cord Assy	1	EP, EPT
24	Fuse 20A	1	
25	Bolt	2	M6 L=12 mm
26	Ignition Coil W/R-cap	1	
27	Plug Cap W/Resistance	2	
28	Bolt	2	M6 L=25 mm
29	Oil Pressure Switch	1	
30	Engine Temp Sensor	1	
31	Cable Terminal Plug	2	
32	Protector ø24-70	1	
33	Protector ø10.7-320	1	
34	Protector ø10.7-180	1	
35	Electric Bracket Assy	1	EF, EP
	Electric Bracket Assy	1	EFT, EPT
36	Bracket	1	
37	Starter Solenoid	1	
38	Bolt	2	M6 L=10 mm
39	PT Solenoid Switch (A)	1	
40	Nut	3	
41	Spring Washer	3	
42	PT Solenoid Switch (B)	1	
43	Nut	3	


80 N·m (58 lb·ft) [8.0 kgf·m]
8 N·m (6 lb·ft) [0.8 kgf·m]
OBM
SOC
G17
1327
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2
3
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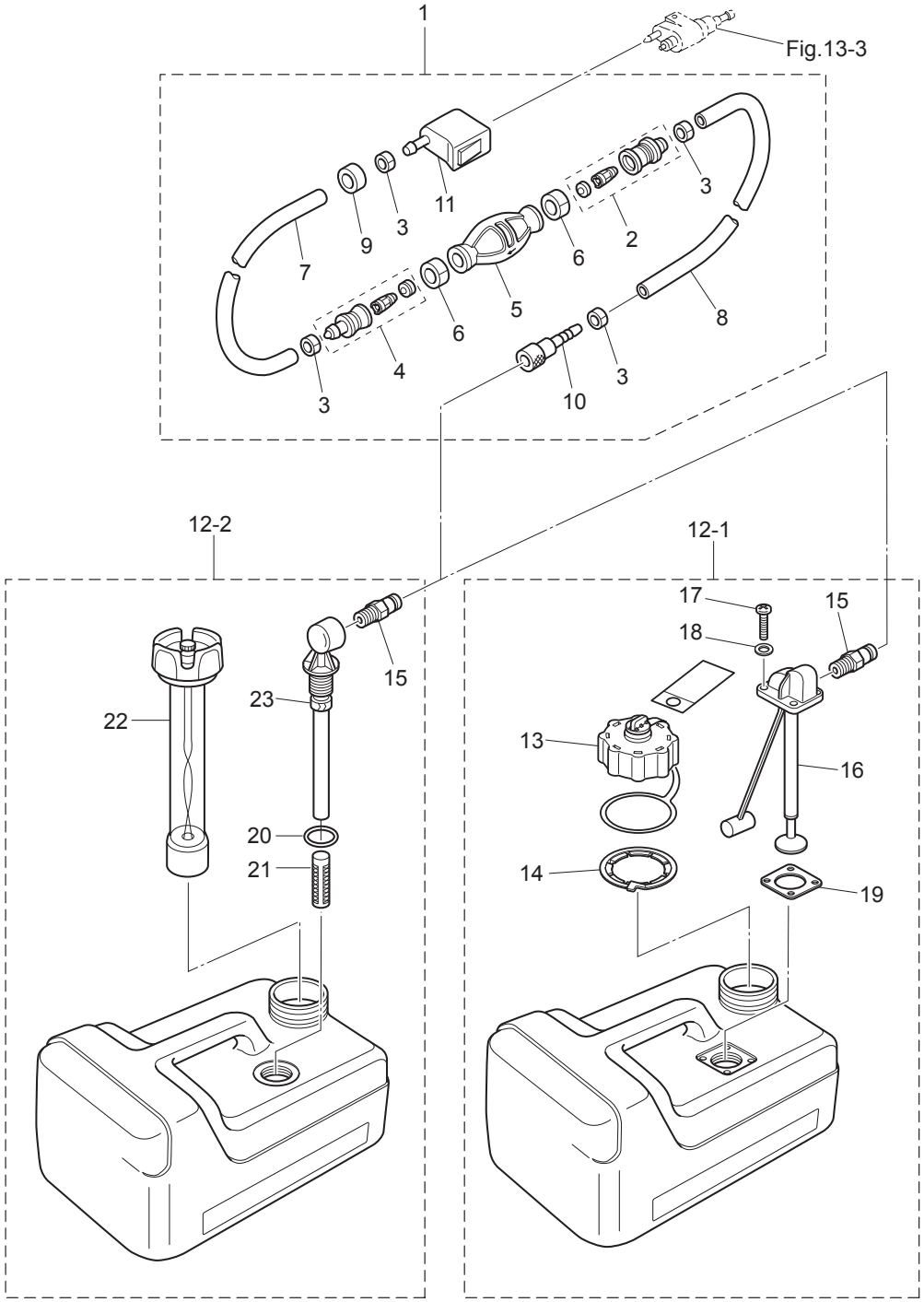
Ref. No.	Description	Q'ty	Remarks
44	Spring Washer	3	
45	Solenoid Switch Cord (A)	1	Red
46	Solenoid Switch Cord (B)	1	
47	Terminal Cap 8-13-28	4	Red
48	Terminal Cap 8-13-28	2	Black
49	Bolt	2	M6 L=12 mm
50	Ground Cable L=120	1	
51	Band 104	2	Do not reuse.
52	Rubber Mount	3	
53	Collar	3	
54	Washer 6-16-1.5	3	
55	Bolt	3	M6 L=25 mm
56	Starter Motor Assy	1	
57	Nut	2	
58	Bolt	2	
59	Spring Washer	2	
60	Spring Washer	2	
61	Washer	2	M5
62	Pinion Assy	1	
63	Washer	1	
64	Brush Holder Assy	1	
65	Screw	2	M4 L=8 mm
66	Bushing 2	1	
67	O-ring	1	Do not reuse.
68	Washer	2	M6
69	Bushing 1	1	
70	Starter Motor Band	1	
71	Damper	1	M8 L=25 mm
72	Bolt	2	M6 L=12 mm
73	Bolt	2	
74	Rectifier Complete	1	
75	Bolt	2	
76	Rectifier Bracket	1	
77	Bolt	2	M6 L=12 mm
78	Battery Cable	1	
79	Bolt	1	M6 L=12 mm
80	Terminal Cap 15.5-20-28	1	
81	Terminal Cap 8-18-28	1	Red
82	Terminal Cap 13-13-28	1	Red
83	Bolt	1	M6 L=12 mm
84	Clamp 6.5-14L	1	
85	Starter Cable	1	Starter Solenoid-Starter Motor

Separate Fuel Tank



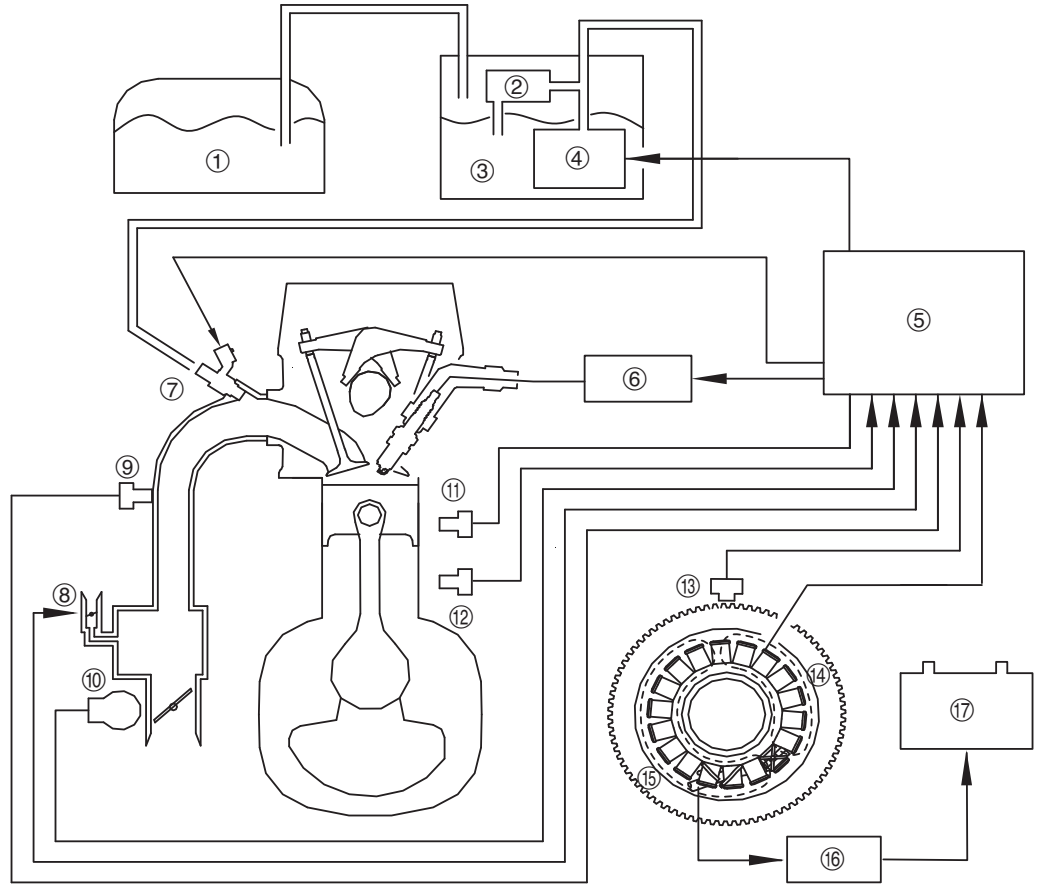
Ref. No.	Description	Q'ty	Remarks
1	Primer Bulb Assy	1	for USA Model
2	Joint Assy (Inlet)	1	
3	Clamp	4	
4	Joint Assy (Outlet)	1	
5-1	Primer Bulb	1	for USA Model
5-2	Primer Bulb	1	
6	Clamp	2	
7	Low Permeation Hose L=700	1	for USA Model
	Hose	1	
8	Low Permeation Hose L=1600	1	for USA Model
	Hose	1	
9	Fuel Connector Mark	1	for USA Model
10	Fuel Connector	1	
11	Fuel Connector	1	

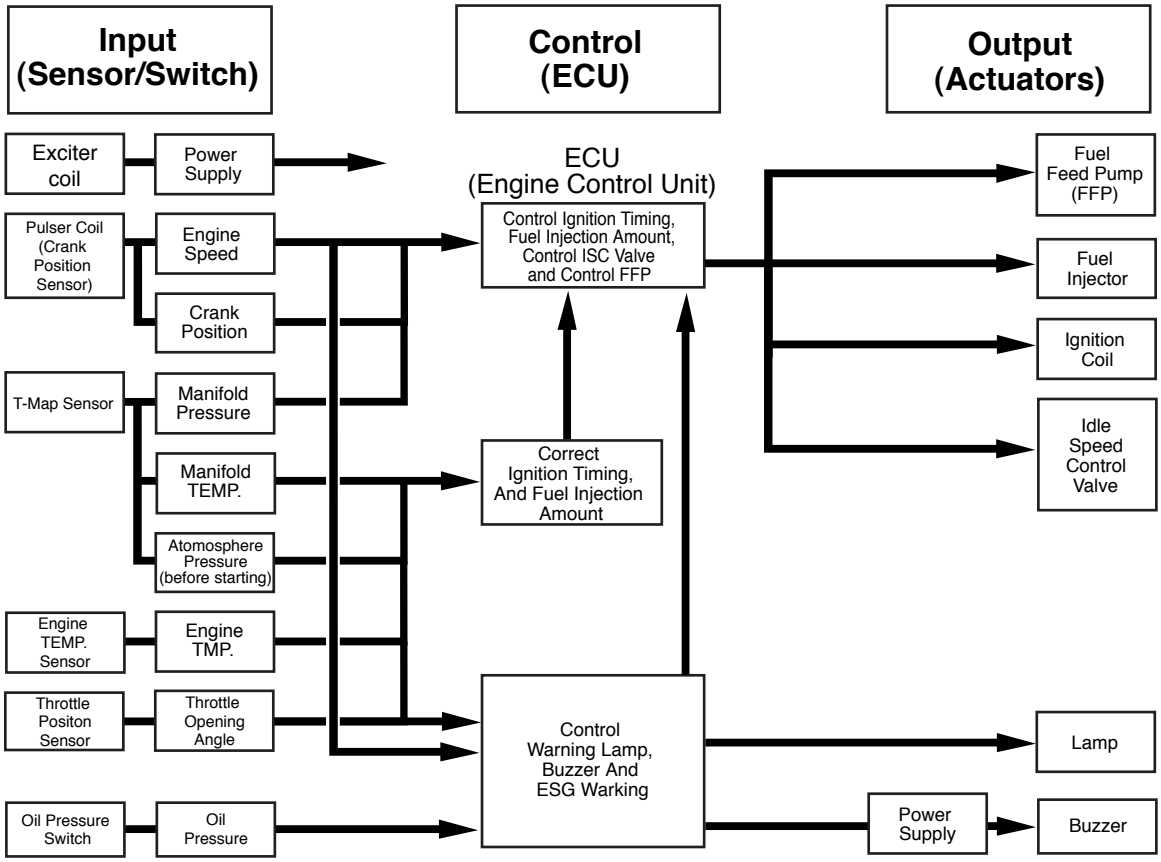
Ref. No.	Description	Q'ty	Remarks
12-1	Fuel Tank Assy 12L	1	for USA Model
12-2	Fuel Tank Assy 12L	1	
13	Fuel Tank Cap Assy	1	for USA Model
14	Retaining Ring	1	for USA Model
15	Quick-connector (Male)	1	
16	Fuel Pick-up Assy W/Gauge	1	for USA Model
17	Screw	4	for USA Model
18	Washer	4	for USA Model
19	Gasket	1	for USA Model **Do not reuse.**
20	O-ring	1	**Do not reuse.**
21	Filter	1	
22	Fuel Gauge Vent Cap Assy (12L)	1	
23	Pick-up Elbow Assy (12L)	1	

4. ECU System

(1) Configuration of ECU System

ECU uses various sensors to precisely control injected fuel amount and ignition timing.





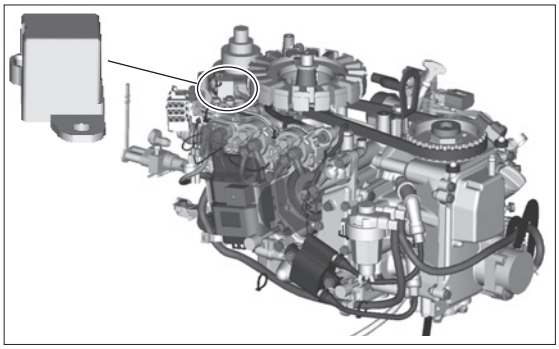
1) Sensors

Individual sensors detect engine operating conditions and sends signals regarding the information to ECU.

1. Pulser Coil [Crank Position Sensor]

   Pulser coils function as crank position sensors. As flywheel rotates, pulser coil sends the crank position signals to ECU.

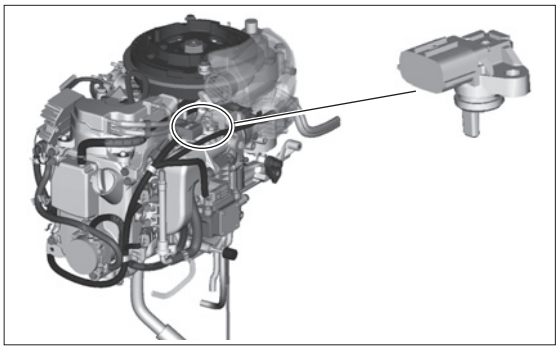
   ECU uses this signal to establish fuel injection amount and ignition timing.



2. T - MAP (Manifold Pressure and Temp.) Sensor

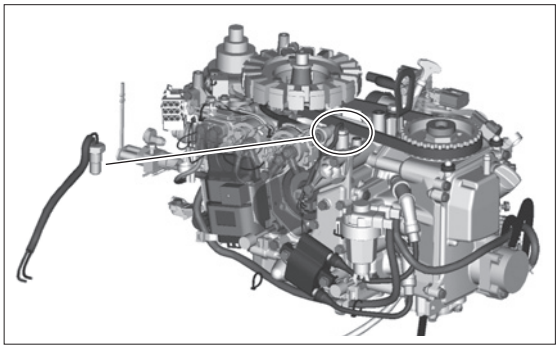
   T-Map sensor is located on the upper area of intake manifold to detect intake manifold inner pressure (intake vacuum pressure and intake temperature) and send the signal to ECU.

   ECU uses this signal to establish fuel injection amount and ignition timing.



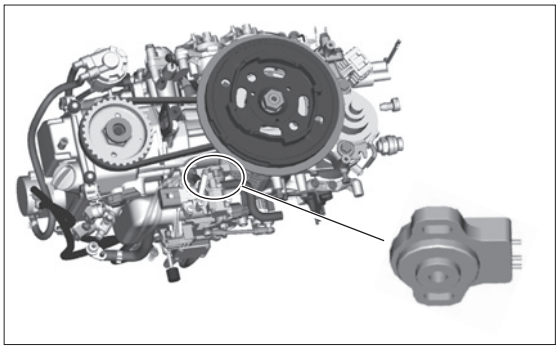
3. Engine Temperature Sensor

   Engine temperature sensor is located on the upper area of cylinder block. The sensor detects temperature of cooling water passage wall of which flow through engine is controlled with thermostat and sends the signal to ECU.



4. Throttle Position Sensor (TPS)

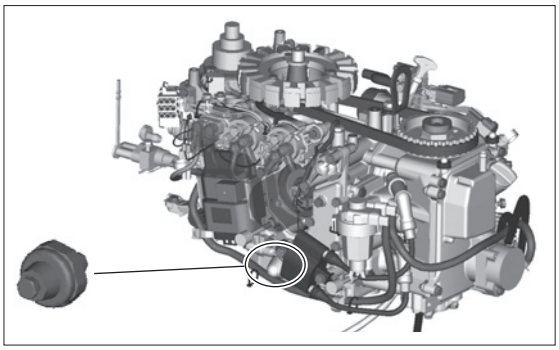
   Throttle position sensor is located on the top of throttle body, and is connected to throttle shaft. Throttle position sensor sends throttle opening angle information to ECU.



5. Oil Pressure Switch

Oil pressure switch is located on the port side of engine block below oil filter, and is projected into oil passage. Oil pressure switch sends oil pressure low signal to ECU.

ECU operates low speed ESG, warning lamp based on this information.



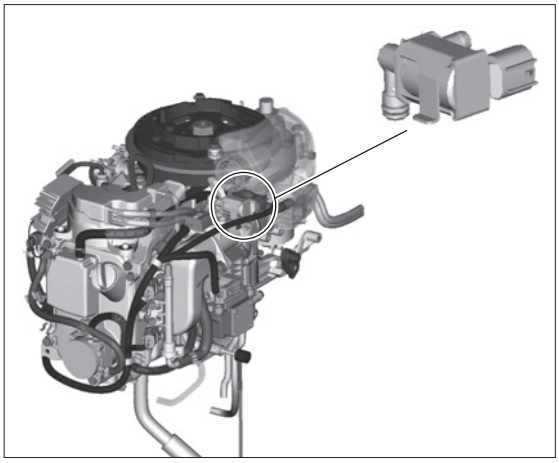
2) Actuators

Actuator section receives signals from ECU to control air/fuel ratio, ignition timing and idle revolution speed.

1. ISC (Idle Speed Control) Valve

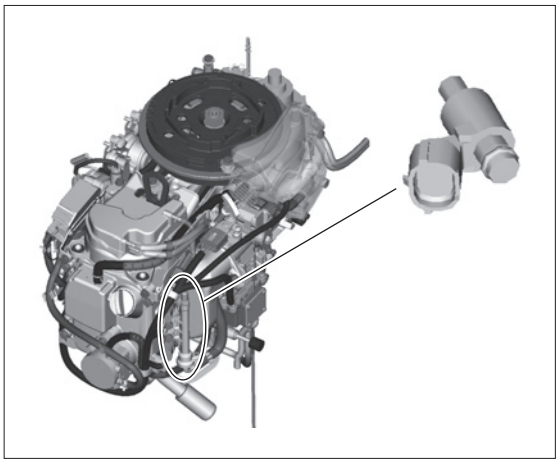
   ISC is also referred to as IAC (Idle Air Control). ISC valve is the electrically operated spring built-in type solenoid valve, and controls amount intake air that bypasses closed throttle valve. Signal from ECU controled opening angle of ISC valve varies between 0% to 100% to control the following three functions.

   1. To increase idle revolution speed during engine warm-up by adding intake air amount at engine starting.
   2. To control idle revolution speed according to varying engine load and operating conditions.
   3. To prevent engine from stalling by adding intake air amount (bypass), functioning as dash pot, when throttle is closed quickly for rapid deceleration.



2. Fuel Injector

   Fuel injector is an electrical solenoid valve with built-in spring, and feeds fuel into intake manifold passage. It injects high pressure fuel when engine starts, electricity is supplied from ECU charge coil into injector, and then ECU closes ground circuit to lift solenoid. Fuel injector closes to stop its operation when ECU opens ground circuit.



3. Fuel Feed Pump (FFP)

   Refer to description of vapor separator in Chapter 4.

4. Ignition Coil

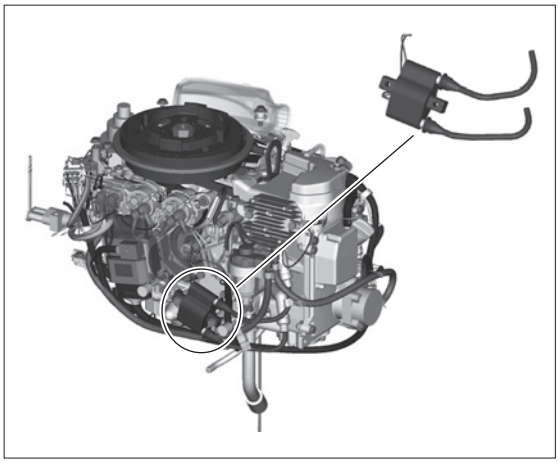
   Refer to Chapter 8.

5. Warning Lamp (LED)

   Refer to Chapter 4.

6. Tachometer

   Refer to Chapter 10.



3) Control System (ECU)

Accidental malfunction of ECU stops engine.

ECU (Engine Control Unit) provides the following functions.

1. Calculates the most suitable fuel injection amount and ignition timing based on engine revolution speed, throttle position, intake vacuum, intake air temperature and engine cooling water temperature.
2. Controls fuel injectors, ignition coils and ISC (Idle Speed Control) valve.
3. Controls warning lamp (LED).
4. Control engine low speed ESG function.
5. Control engine high speed ESG function.
6. Memorizes engine operation information.

Operations of engine can be monitored and malfunction diagnosis can be made by using a personal computer installed with 3AC DIAGNOSTICS (software) and diagnostics harness.

(2) Control System

ECU is installed on the electric blacket. Data received from sensors such as pulser coil, T - MAP (Manifold Pressure, Manifold Temperature) sensor and water temperature sensor are processed with computer to drive actuators (fuel injector, ISC valves, etc.) corresponding to current operating conditions to control fuel injection amount and ignition timing.

Principal control items are as follows.

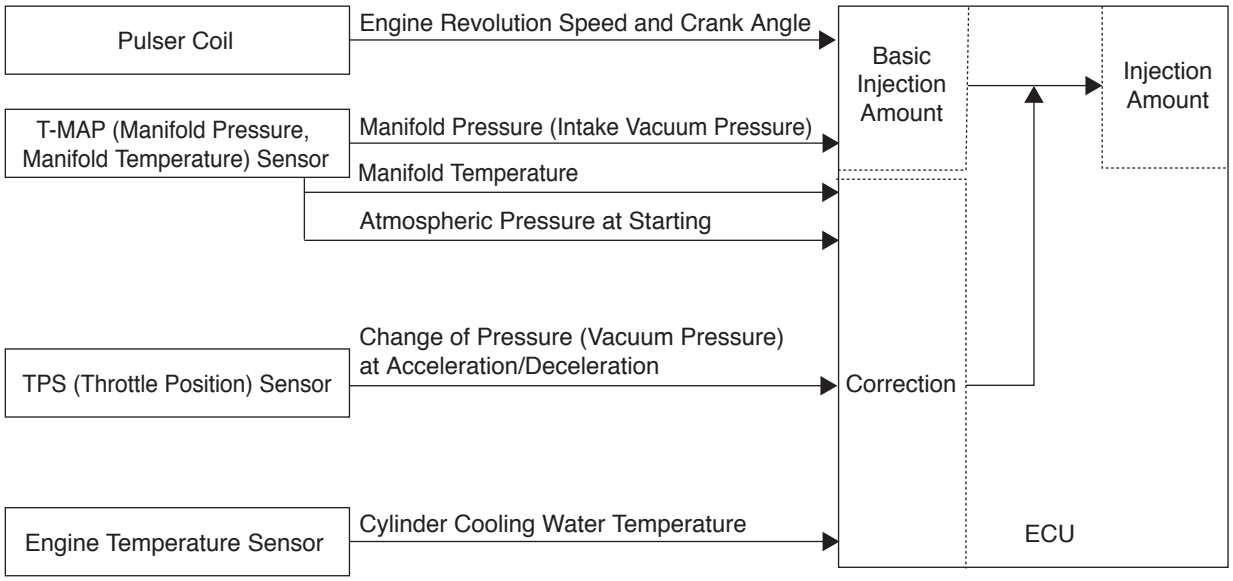
Control Item	Description
Ignition Timing	Sets the most suitable ignition timing according to current operating conditions.
Fuel Injection Amount	Sets the most suitable fuel injection amount according to current operating conditions
ISC (Idle Speed Control)	Stabilizes engine revolution speed during idling or low speed running by driving ISC valve to control air flow in bypass passage.
Fuel Feed Pump	Controls driving of fuel feed pump (FFP)
Tachometer	Outputs tachometer driving pulses. Number of pulses per one revolution of crankshaft : 6 pulses (12 poles)
Warning Buzzer*1	Makes buzzer sound when an abnormality is detected. • Short period beep : For 2 seconds at Key turned "ON" to notify of normal system operation, meaning no problem. • Continuous sound : When engine high speed ESG is "ON". When engine temperature is abnormally high (over 85°) When engine oil pressure is abnormally low. • Intermittent sound : When water temperature sensor or T-Map (Manifold Pressure) sensor is defective or sensor circuit is disconnected.
Warning Lamp (LED) (Tachometer warning lamp synchronizes and light ON, blinking.)	Makes the lamp light or blink when an abnormality is detected. • Short period lighting : For 5 seconds after starting engine to notify of normal system operation, meaning no problem. • Continuous lighting : When engine high speed ESG is "ON". When engine temperature is abnormally high (over 85°) • Intermittent lighting : When electrical component is defective or sensor circuit is disconnected.
Memorizing operational data	Manages the following engine operation information. • Engine operating hours • Maximum water temperature record (Maximum water temperature and time of occurrence) • Engine high speed ESG operation record • Engine low speed ESG operation record • Malfunction records

*1: Only For Remote Control Model

(3) Fuel Injection Control

ECU calculates intake air amount based on engine revolution speed and intake manifold pressure (intake vacuum pressure) to determine fuel injection amount.

At engine starting, during warm-up, acceleration/deceleration, and idling, ECU performs correction control based on information from sensors.



1) Fuel Injection Timing

Fuel injection timing at starting and during normal operation are described in the following table.

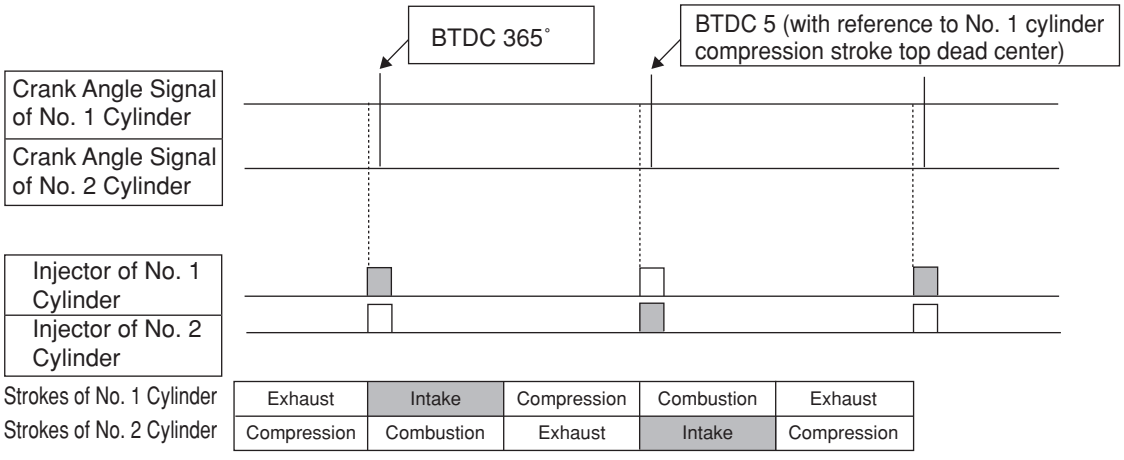
Cylinder No.	Reference Signal	Injection Timing (with reference to individual cylinders)
1	#1 Crank Angle Signal	BTDC 365° and BTDC 5°
2	#2 Crank Angle Signal	BTDC 365° and BTDC 5°

Remarks 1) Number of fuel injections : Once per revolution per cylinder (around the end of compression and exhaust strokes)

2) Injection order : #1→#2→#1→#2→#1 (every 180 degrees of crank angle)

3) Combustion order : #1 → #2 → #1 (every 360 degrees of crank angle)

4) Injection timing diagram is shown below.



Injection Timing Diagram

2) Start Up Fuel Mapping

At engine starting (cranking), amount of fuel injection of each cylinder is increased to facilitate starting.

In addition to this basic correction, information including cooling water temperature, atmospheric pressure and intake air temperature in the manifold from individual sensors are used to correct the engine operation to the best operating conditions.

3) Acceleration Fuel Mapping

When pressure in the intake manifold is reduced below a certain setting value, ECU determines that engine is accelerated and increases fuel injection amount.

4) Deceleration Fuel Mapping

When pressure in the intake manifold is increased over a certain setting value, ECU determines that engine is decelerated and decreases fuel injection amount.

5) Correction Based On Intake Air Temperature

ECU adjusts fuel injection amount for correction according to manifold intake air temperature that depends much on outboard motor operating conditions and whether engine is cold or warm.

6) Correction Based On Cylinder Cooling Water Temperature

ECU adjusts fuel injection amount for correction according to cylinder cooling water temperature when engine is rotating at low speed or high speed.

ECU increases the amount when engine is cold, and resumes standard basic amount as engine warms up.

(4) Control of Fuel Feed Pump (FFP)

During normal operation : ECU performs on/off control for fuel feed pump (FFP) by using output signal from its pump control circuit.

At starting : Pump control circuit outputs signal to pump (FFP), and power is supplied to pump driving DC motor to operate pump (FFP).

When stopping : Power supply to motor is shut off to stop pump (FFP).

(5) Control of Tachometer

ECU performs on/off control for tachometer by using pulse input signal (On-off signal).

Pulse output rate is 4 pulses per crank revolution (18 poles).

When using accessory tachometer, set selector switch to 12 P (poles).

(6) Warning Buzzer and Lamp (LED), and Control of Engine Revolution Speed

Warning System

When an abnormality occurs on the engine, warning buzzer sounds and warning lamp (LED) is lit or blinks.

In such case, engine speed is controlled but engine is not stopped.

1) Location of Warning Buzzer and Lamp (LED)

• Warning buzzer : In the remote control box for remote control model. (only for remote control model)

• Warning lamp (LED) : In the tachometer or on the tiller handle.

Remarks: The lamp of the tachometer (option) with warning lamp operates synchronously with the lamp (LED) of the engine side.

2) Waring Notification, Abnormality and Action to be taken

Warning Indicators				Description of faults or notice	Remedy
Buzzer (*3)	Lamp (LED)	Low-Speed ESG	High-Speed ESG		
Short sound: 0.5 Sec.only	ON: 5 Sec.			Normal operation is an operation check of warning system at the starting	
Continuous (*2)	ON (*2)	ON (*2)		Engine temp. abnormally high	(1)
Continuous (*2)	ON (*2)	ON (*2)		Low oil pressure (*1)	(2)
Continuous	ON		ON	Engine speed exceeds maximum allowable RPM	(3)
Beep (*2)	Flashing (*2)	ON (*2)		Engine temp sensor or T-MAP (manifold pressure, intake air temperature) sensor is malfunction or short circuit.	(4)

Remarks) *1 : When engine switch is ON.
*2 : To cancel the warning display, stop the engine once.
*3 : Warning Buzzer is equip only for Remote Control Model.

Note : When engine low speed ESG goes on, the speed is reduced to 2,800 r/min or lower.
Continuous operation in this state should be avoided.
When engine high speed ESG goes on, the speed is set to 6,300 r/min.
ECU stops feeding of fuel to control the speed to 6,300 r/min.
Continuous operation in this state should be avoided.

Action to be taken

(1) : Run immediately to a safe location, set throttle to slow speed, shift into neutral (N), check that cooling water is discharged to check port, and then stop engine.
Remove dirt, plastic sheet, or other matters that clogs water intake port, if any.
If no water is discharged from the port, check each section of the outboard motor.

(2) : Run immediately to a safe location and stop engine.
Check engine oil level and add oil if necessary.
If engine oil level is within specified range, check other sections.

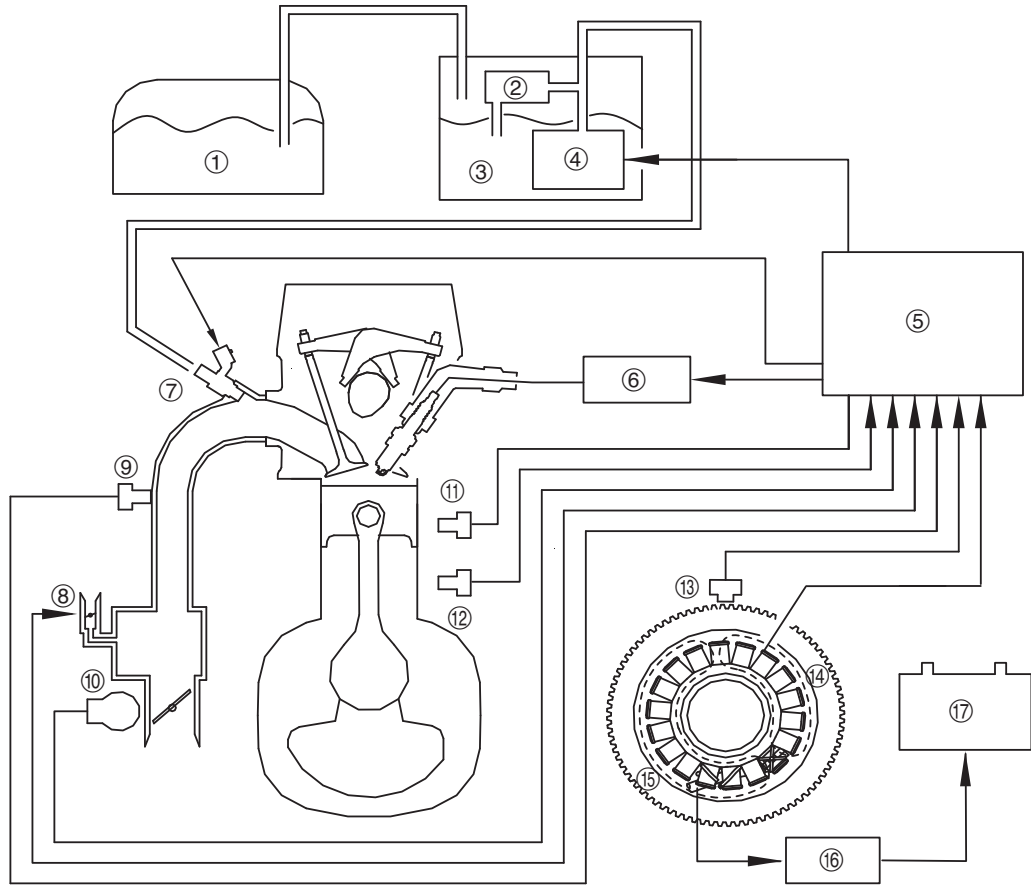
(3) : Set throttle to slow speed, run immediately to a safe location, and stop engine.
Check propeller blades for bend or damages.
If do not improved it even after propeller is replaced with new one, check other sections.

(4) : Go to the nearest port immediately and check each section after stopping engine.

5. Ignition System

For ignition system, CD ignition system is adopted, and ECU's electronic ignition timing control system controls the timing to the most suitable state according to current operating conditions.

As engine is started, electric current is generated in the exciter coil of alternator. Which is input to ECU's regulator to feed power needed for operations of ignition coil, fuel injector and fuel feed pump (FFP).



① Fuel Tank
② Fuel Regulator
③ Vapor Separator
④ Fuel Feed Pump (FFP)
⑤ ECU
⑥ Ignition Coil
⑦ Fuel Injector
⑧ ISC Valve
⑨ T-MAP Sensor
⑩ TPS
⑪ Engine TEMP. Sensor
⑫ Oil Pressure Switch
⑬ Pulser Coil
⑭ Exciter coil
⑮ Charge coil
⑯ Rectifier / Regulator
⑰ Battery
* ⑮⑯⑰ : for Electric Starter Model

(1) Configuration of Ignition System

Ignition system consists mainly of the following components.

(1) Sensors and switches that transmit engine operating states to ECU.

(2) ECU that performs electronic control.

(3) Ignition coils and spark plugs that operate in accordance with control by ECU.

The following 6 components are included in the sensors and switches of (1).

• Pulser coil	Crank position (Crank Position Sensor)
• Throttle Position Sensor (TPS)	Throttle opening angle
• Engine Temperature Sensor	Temperature of Cooling Water (Crankcase)
• T-Map Sensor	Intake air vacuum pressure and temperature
• Oil Pressure Switch	Reduction of hydraulic pressure

(2) Ignition Control

ECU's microcomputer is programmed with ignition timings best suited to engine's operating conditions. ECU obtains information about engine operating state such as revolution speed, throttle opening, manifold pressure (air intake vacuum pressure) and cooling water temperature based on the signals from the above mentioned sensors to generate ignition timing signal at the most suitable timings.

1) Ignition Timing Controls

Controls of ignition timing is classified into two controls, which are correction of ignition timing during normal operation and fixing of ignition timing (at engine starting and when an abnormality has occurred). In either case, ECU corrects ignition time or fixes it to the base.

- Basically, ignition timing is determined on engine revolution speed and manifold pressure (intake air vacuum pressure).
- Signals that are used for correction of ignition timing includes cooling water temperature, manifold intake air temperature, change of pressure at acceleration/deceleration under atmospheric pressure, and engine revolution speed.
- Ignition timing is fixed to the base at acceleration, deceleration, when high speed ESG is on, low speed ESG is on, or when hydraulic pressure is reduced.

2) Ignition and Combustion Orders

No. of Ignitions : Once per revolution per cylinder (around the end of compression and exhaust strokes)
Ignition Order : #1→#2 (simultaneous ignition)
Combustion Order : #1 → #2 → #1 (every 360 degrees of crank angle)

3) Ignition Timing

Ignition timing is set as described below.

Model	Range of Ignition Angle	Engine Starting	Engine Idling
MFS15/20E	BTDC 5° to BTDC 30°	BTDC 5°	BTDC 5°±5°
MFS9.9E	BTDC 5° to BTDC 25°	BTDC 5°	BTDC 5°±5°

4) Operations

- At Engine Starting and During Warm-up
  The engine is started, the ignition timing is fixed to the BTDC5°.
  The input signal and the engine temperature, manifold intake air temperature, engine speed and atmospheric pressure, on the basis of the programs stored in the ECU, the microcomputer determines the ignition timing after starting.

- During idling and low speed running
  When ECU receives manifold pressure (intake air vacuum pressure) signal and input signal from pulser coil (engine revolution speed signal), it controls ignition timing so that idling and low speed revolution speeds stabilize.

- During normal operation
  Microcomputer determines ignition timing in accordance with ECU's program by using cooling water temperature, manifold intake air temperature, atmospheric pressure and engine revolution speed as input signals. The maximum timing during normal operation is BTDC 30°.

- During acceleration/Deceleration
  When engine revolution speed changes much and is reduced below (or exceed) a setting value, ECU determines that engine is accelerating (or decelerating), and microcomputer determines the ignition timing based on the program installed in ECU.

- At engine over-revolution high speed ESG is "ON"
  When engine revolution speed exceeds the maximum allowable value (6,300r/min), ECU stops feeding of fuel to control the revolution based on pulser coil signals. This is the state that engine high speed ESG is "ON".

- Engine low speed ESG is "ON".
  When any of the following state has been detected, engine revolution speed is controlled to 2,800r/min to prevent or reduce engine damage. This is the state that engine low speed ESG is "ON".
  - Engine is overheating. : Engine temperature sensor detects 85°C or higher.
  - Engine hydraulic pressure is low. : Oil pressure switch is ON (0.0245MPa (3.6PSi) [0.25kg/cm^2] or less) is detected.

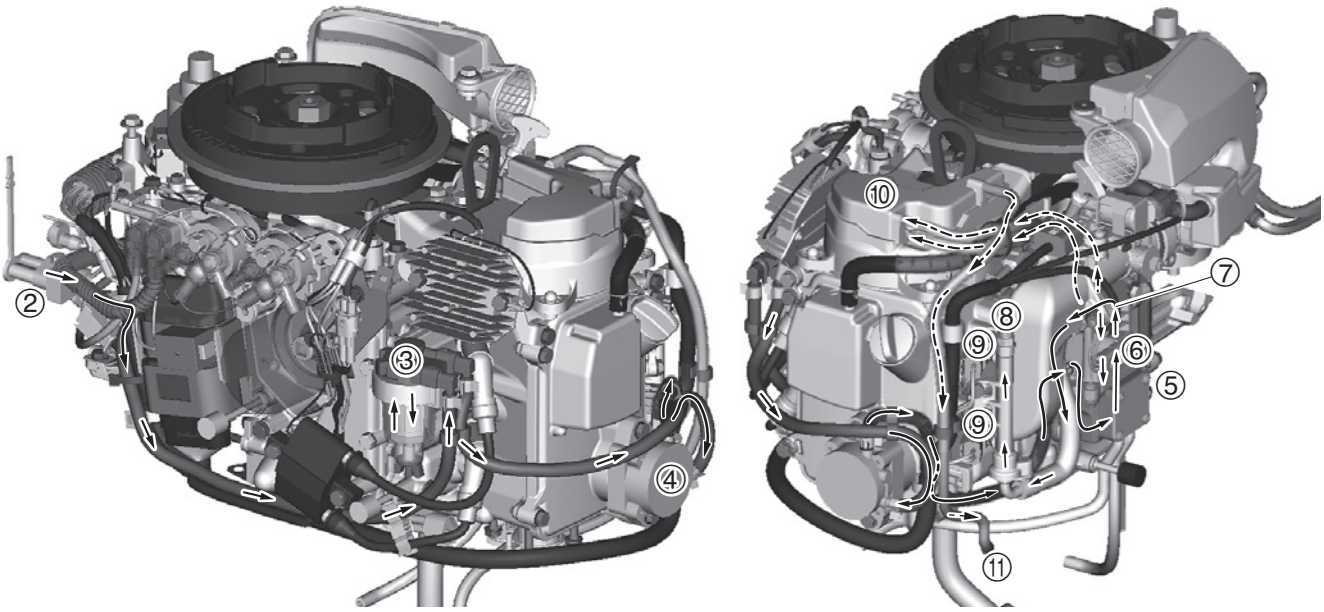
(3) Fuel Feed System

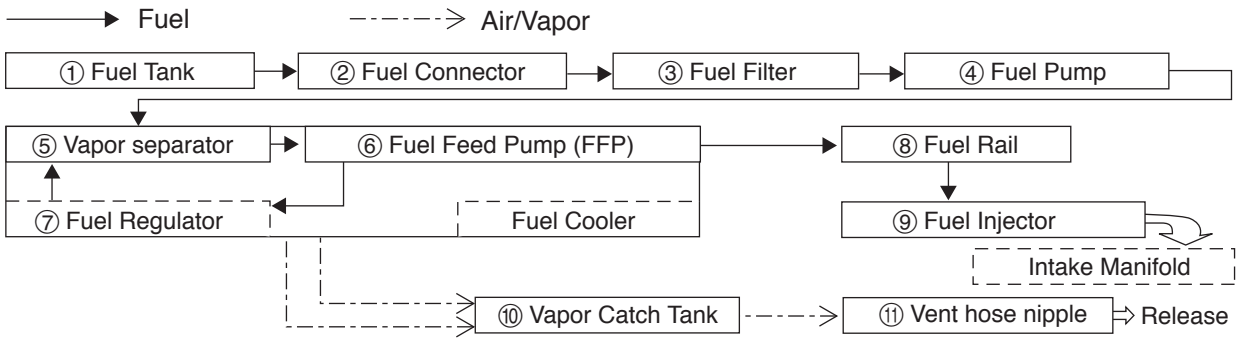
Fuel pump ④ (low pressure mechanical type) draws fuel from fuel tank, and feeds it to fuel feed pump ⑥ (FFP) located in the vapor separator ⑤ through fuel connector ② and fuel filter ③.

Highly pressurized fuel, fed into fuel rail ⑧ and fuel injector, and then, injected into intake manifold.

Excessive fuel that is not used by fuel injector passes through fuel regulator ⑦, and circulated in the vapor separator ⑤ to keep fuel pressure constant.

Stabilization of fuel pressure is performed by fuel regulator that is built into the vapor separator.



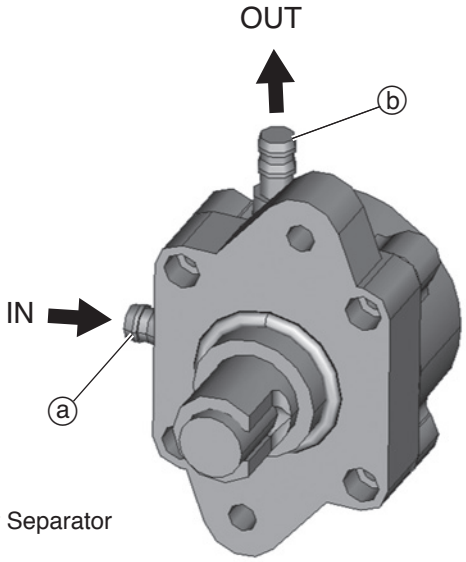


6. Components of Fuel Feed System

1) Fuel Pump (Low Pressure Mechanical Pump)

Fuel pump is diaphragm pump that is operated mechanically by camshaft and lifter.

Pump base is plastic and insulates heat from the engine block to protect fuel pump and reduce vapor.



ⓐ IN : Fuel from Filter/Tank

ⓑ OUT : Fuel Outlet to Vapor Separator

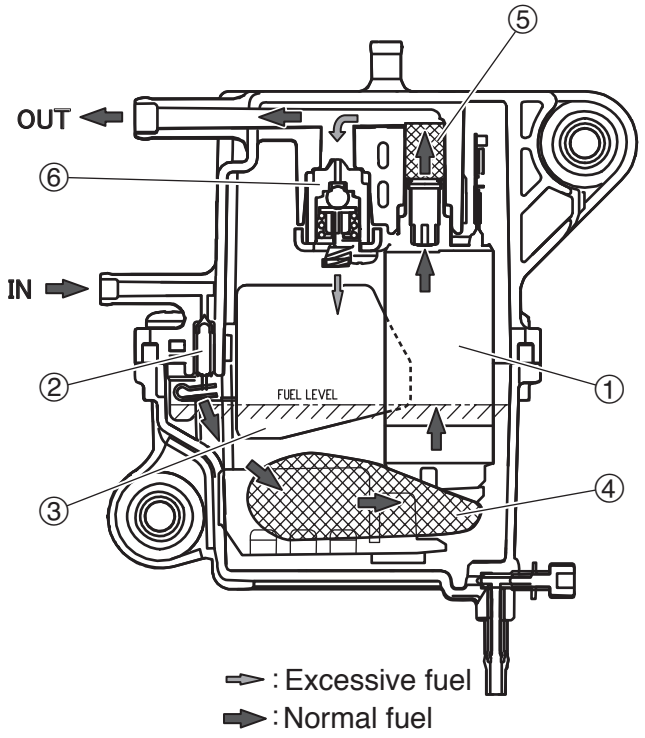
2) Vapor Separator

Vapor separator feeds only liquid fuel for internal fuel feed pump (FFP) ① (electrical high pressure pump). Fuel that is fed from fuel pump (low pressure mechanical pump) is sent to upper part of vapor separator, where it is controlled with needle valve ② /float ③ ass'y.

Removes trash and fuel filter (suction side) ④ Fuel filter (discharge side) ⑤ when passing through the Fuel Feed Pump (FFP).

Filters inside the vapor separator to remove dust from the fuel. Fuel filter ④ (Inlet filter) and fuel filter ⑤ (outlet filter) privent dust to enter the fuel flow.

High pressure fuel from fuel feed pump (FFP) is fed to fuel rail and fuel injector. Excessive fuel is returned to chamber by fuel regulator that is built into the vapor separator. In addition, fuel cooler is mounted in the vapor separator, thereby suppressing an increase in fuel temperature.



① Fuel Feed Pump (FFP)

② Needle Valve

③ Float

④ Fuel Filter (suction side)

⑤ Fuel Filter (discharge side)

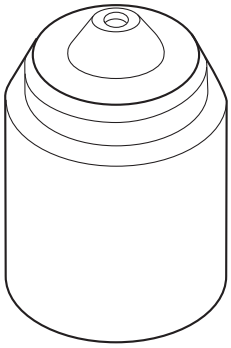
⑥ Fuel Regulator

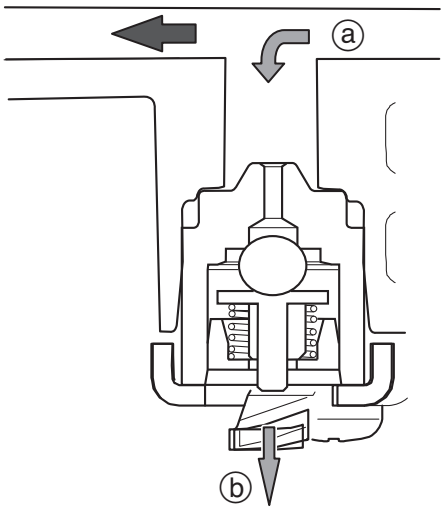
3) Fuel Regulator

Fuel regulator located on the inside section of vapor separator serves to keep regular fuel pressure.

Fuel regulator consists of check valve that actuates valve/seat, and returns (pressurized) excessive fuel ⓐ to vapor separator ⓑ when the pressure exceeds certain value.

Excessive fuel is returned to vapor separator through internal pipe below fuel level to prevent it from bubbling.



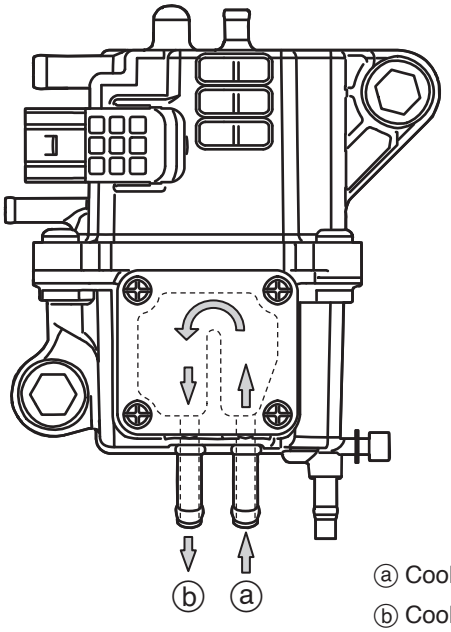


ⓐ High Pressure Fuel from Fuel Feed Pump

ⓑ Excessive fuel returns to vapor separator.

4) Fuel Cooler

Fuel cooler (heat exchanger) is built into the vapor separator to cool the fuel in the vapor separator, which also uses the cooling water of the engine. It is possible to remove heat from the fuel, which serves to protect from wear (FFP) fuel feed pump and the fuel vapor. Cooling water that has been sent from the water pump is divided into two passages by the engine base, headed to the fuel cooler and inside the engine. Cooling water from the engine enters the base of the cooling water inlet of ⓐ fuel cooler and out from the cooling water outlet ⓑ, and directed to the cooling water pilot hole, and discharged.



ⓐ Cooling Water Inlet

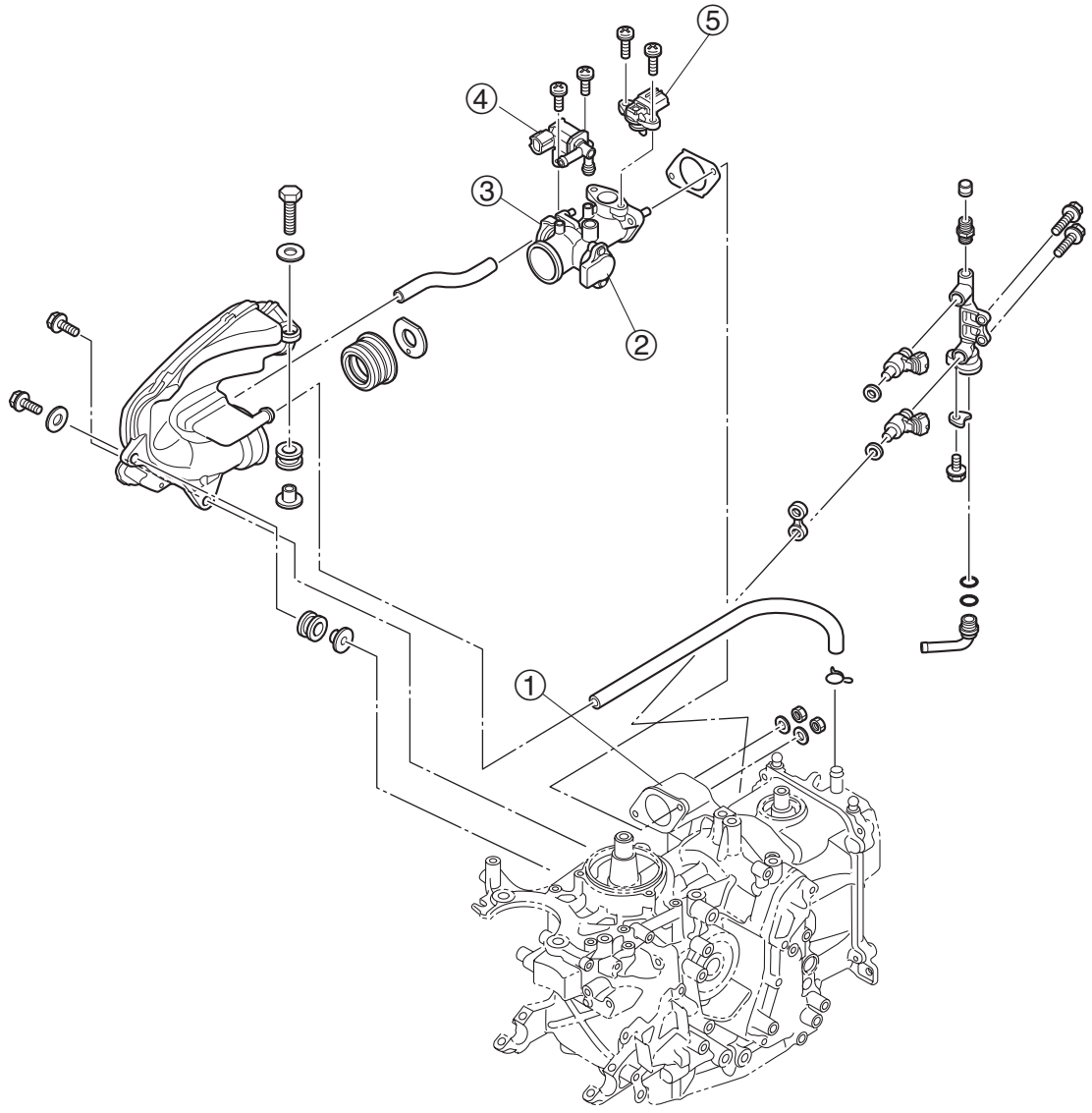
ⓑ Cooling Water Outlet

7. Outline of Fuel Injection System

1) Air Intake System

Air intake system consists of components including intake manifold ① (passage to cylinders that is coupled with common air chamber), throttle position sensor ②, throttle body/shutter ③, ISC (idle speed control) valve ④, T-Map (manifold pressure and temperature) sensor ⑤.

Intake manifold ① is provided with fuel rail and fuel injectors.

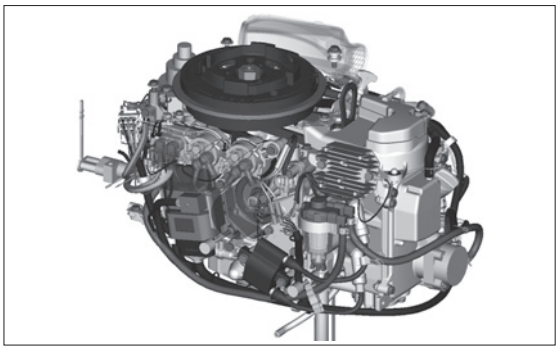


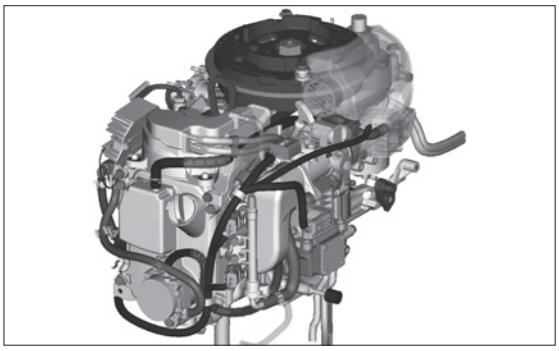
① Intake Manifold
② Throttle Body/Shutter
③ Throttle Position Sensor
④ ISC (Idle Speed Control) Valve
⑤ T-Map Sensor

8. Inspection Items

1) Inspection of Fuel Supply System Piping

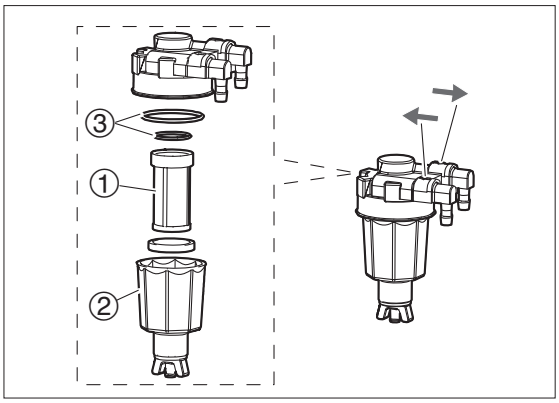
Check the fuel system piping for fuel leak, dirt, deterioration and damage, and replace or repair parts if necessary.





2) Inspection of Filter

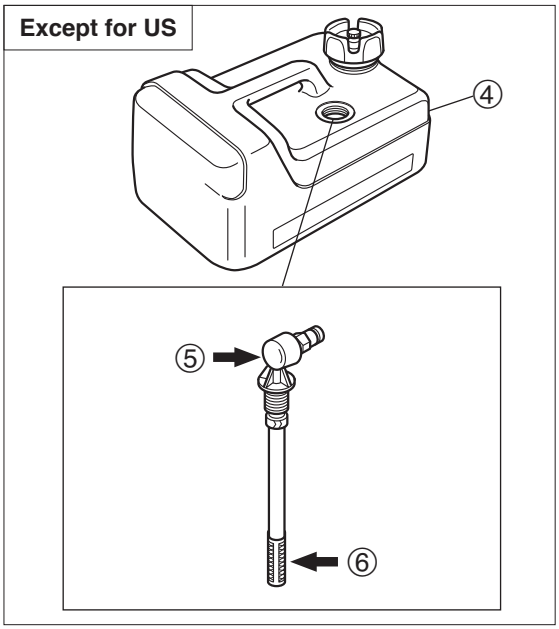
1. Check fuel filter ① for dirt, build up of fuel slag, and fuel filter cup ② for invasion of foreign matter and crack. Clean fuel filter cup with gasoline, and replace fuel filter ① if necessary.



③ O-ring **Do not reuse.**

2. Cleaning Fuel Tank Filter (Except for US)
   Remove fuel pick up elbow ⑤ of fuel tank ④ counterclockwise to remove the part, and clean the filter ⑥.

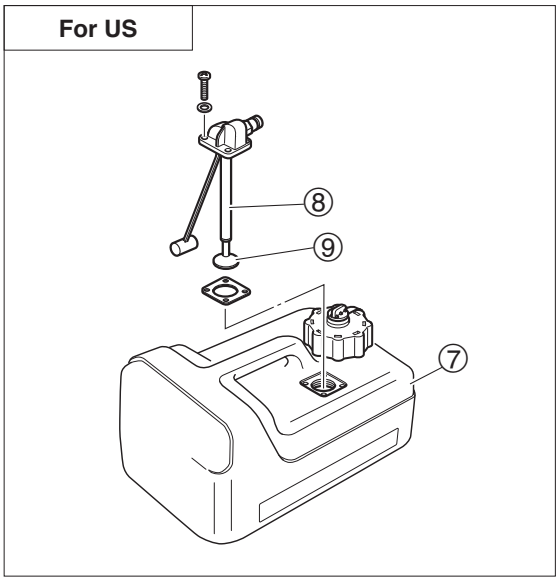
3. Cleaning Fuel Tank
   Remove dirt and water from fuel tank ④ if any.



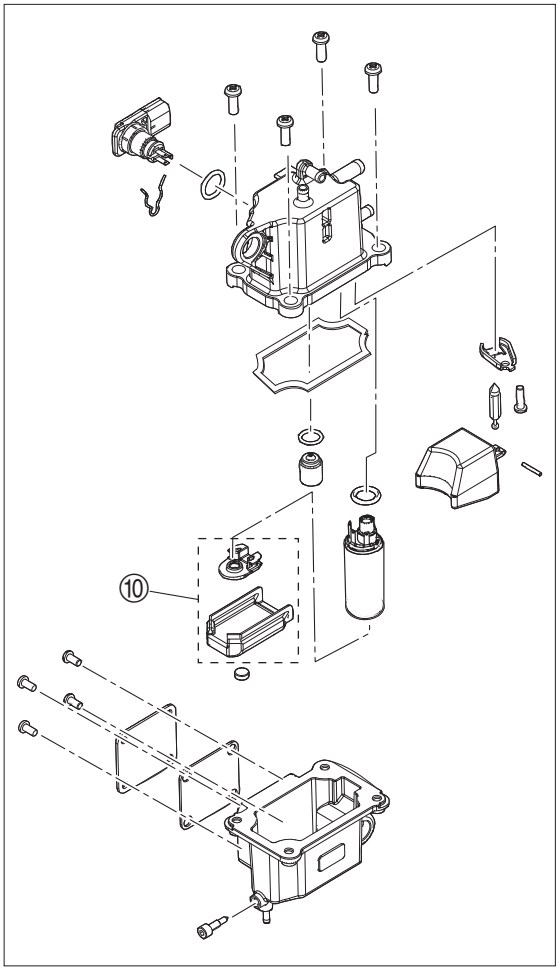
④ Fuel Tank ⑤ Fuel Pick Up Elbow
⑥ Filter

4. Cleaning Fuel Tank Filter (for US)
   Remove the fuel pick up elbow ⑧ of the fuel tank ⑦ by turning it counterclockwise to remove the part, and clean the filter ⑨.

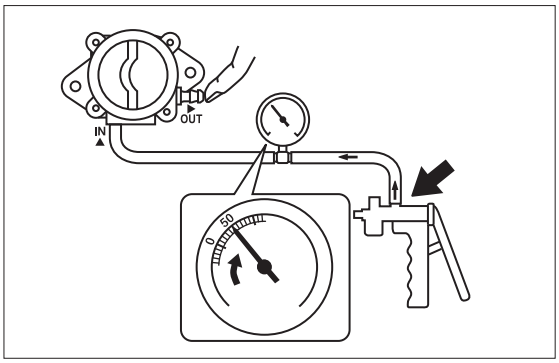
5. Cleaning Fuel Filter
   Remove dirt and water from fuel tank ⑦ if any.



6. Cleaning Fuel Feed Pump (FFP) Filter
   Remove and clean fuel filter ⑩ from fuel feed pump (FFP) built in vapor separator.



3) Inspection of Fuel Pump



1. Remove fuel hoses (2) from fuel pump.

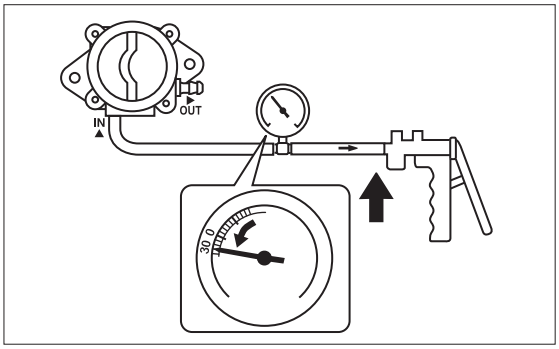
2. Connect vacuum/pressure gauge to inlet of fuel pump.

3. Close fuel pump outlet with a finger and apply specified pressure. Check if no air leaks.

Vacuum/Pressure Gauge :
P/N. 3AC-99020-1

Specified Pressure :
0.05 MPa (7 psi) [0.5 kgf/cm^2]

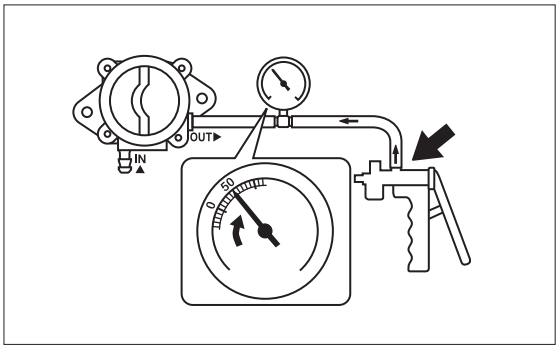
4. With the outlet closed, apply specified vacuum pressure to check that no air leaks.



Specified vacuum pressure :
−0.03 MPa (−4 psi) [−0.3 kgf/cm^2]

5. Connect vacuum/pressure gauge to outlet of fuel pump.

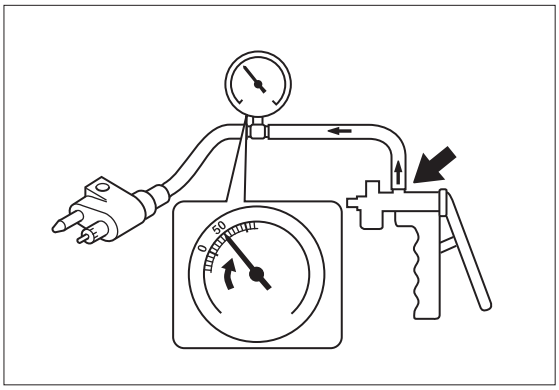
6. Apply specified pressure to check if no air leaks. Replace if necessary.



Air-tightness of fuel pump can be increased by making the interior wet with gasoline.

Specified Pressure :
0.05 MPa (7 psi) [0.5 kgf/cm^2]

4) Inspection of Fuel Connector



1. Check fuel connector for crack and damage.

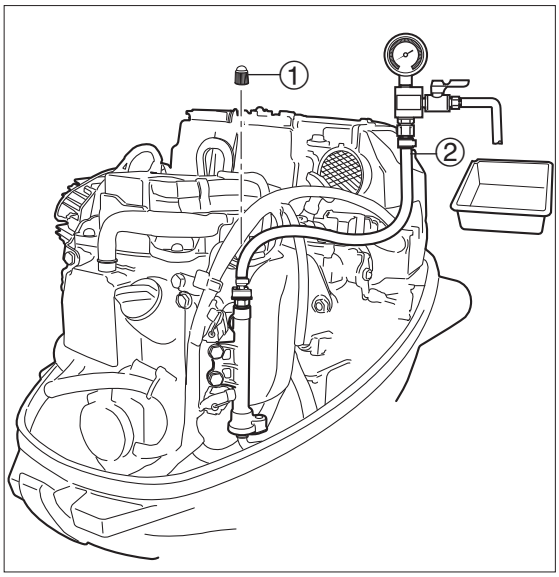
2. Connect vacuum/pressure gauge to outlet of fuel connector.

3. Apply specified pressure, and check if the pressure is maintained for 10 seconds. Replace if necessary.

Vacuum/Pressure Gauge :
P/N. 3AC-99020-1

Specified Pressure :
0.029 MPa (4 psi) [0.3 kgf/cm^2]

5) Measuring fuel pressure



1. Remove cap ①.

2. Connect pressure gauge ② as shown.

⚠ WARNING

- **Before measurement, check that pressure relief valve is fully closed.**
- **Before connecting pressure gauge, cover connection between pressure gauge and valve with clean and dry cloth to prevent fuel from releasing.**
- **Connect pressure gauge securely.**

Pressure Gauge Ass'y :
P/N. 3T5-72880-0

3. Start engine run 5 minutes to warm up, and then measure fuel pressure. If the pressure is below specified value, check high pressure fuel passage and vapor separator.

⚠ WARNING

- **Before measurement, be sure to check that pressure relief valve is fully closed.**
- **Do not open pressure relief valve during measurement. Opening the valve allows fuel to spew out, possibly causing fire.**
- **After measurement, cover hose tip with rag, and open pressure relief valve to drain fuel from discharge hose and the instrument.**
- **Before storing pressure gage, fully close pressure relief valve.**

Fuel Pressure (Reference) :
250± 5 kPa
(35.5 ±0.724 psi) [2.5 ±0.05 kgf/cm²] (10 L/h)

To measure the fuel pressure without operating the engine, remove lock plate of engine stop switch and pull recoil starter 4 to 5 times to measure the fuel pressure (manual start models).

6) Draining Fuel

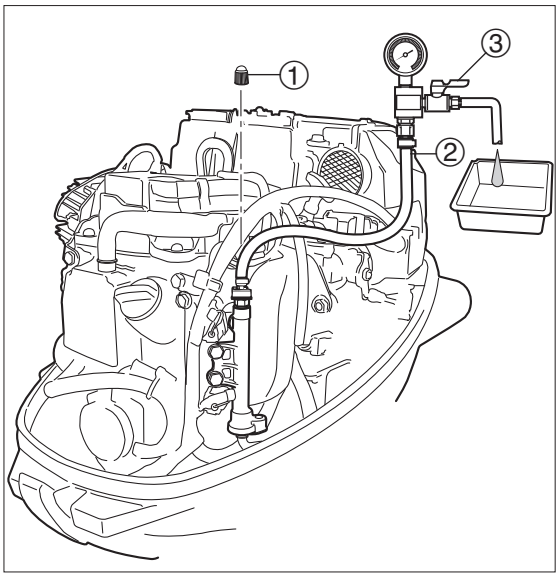
1. Remove cap ①.

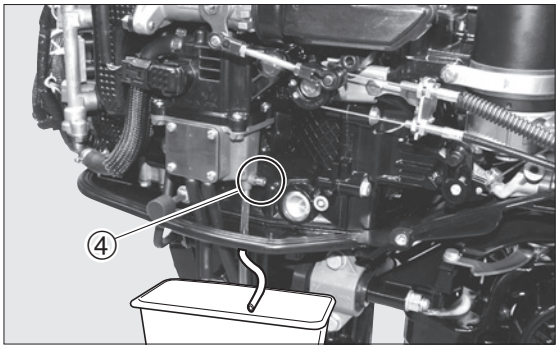
2. Connect pressure gauge ass'y ② as shown, place a vessel below pressure relief hose, and open pressure relief valve ③ to release fuel pressure.

⚠ WARNING

Be sure to reduce fuel pressure in high pressure fuel passage before servicing fuel passage and/or vapor separator. Performing the service without releasing pressure allows compressed fuel to blast out, possibly causing hazard.

3. Place a vessel below vapor separator drain hose, and loosen drain screw ④ to drain fuel from vapor separator drain hose.



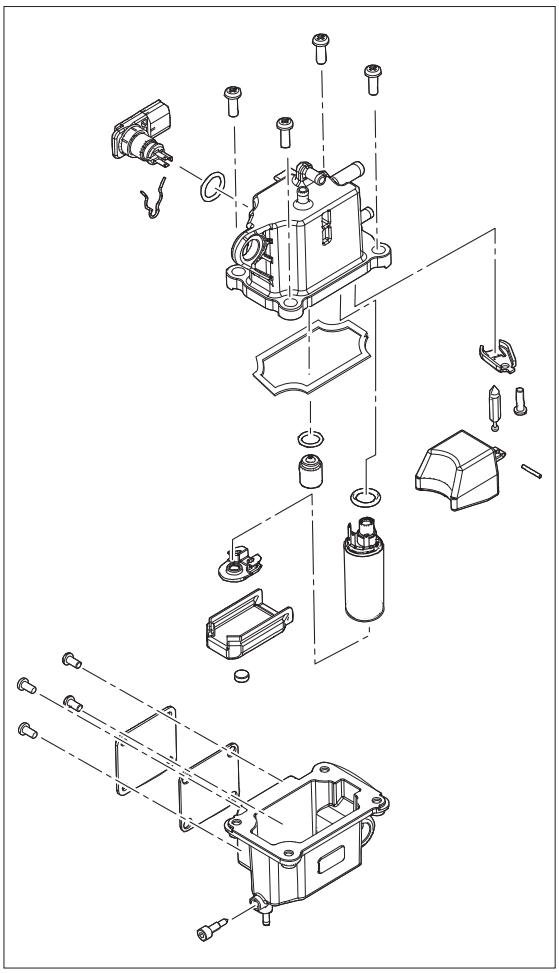


7) Disassembly of Vapor Separator

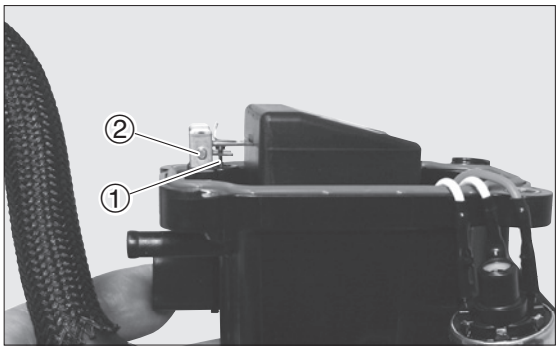
⚠ WARNING

Be sure to reduce fuel pressure in high pressure fuel passage before servicing fuel passage and/or vapor separator. Performing the service without releasing pressure allows compressed fuel to blast out, possibly causing hazard.

1. Remove float chamber of vapor separator.

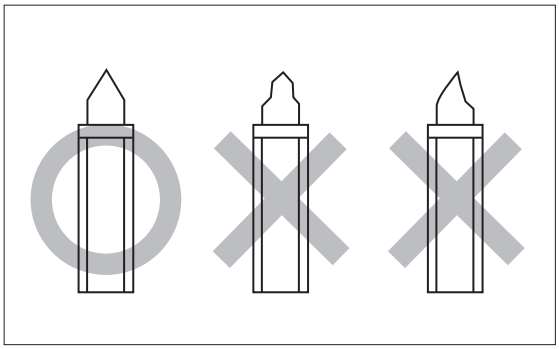


2. Remove needle valve, float pin and float.



8) Inspection of Vapor Separator

1. Check needle valve for bend and wear. Replace if necessary.



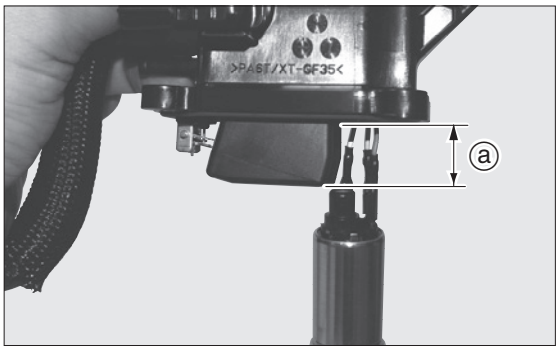
2. Check float for deformation. Replace if necessary.

3. Check filter for inlet and outlet for dirt and clogging. Clean if necessary.

4. Reinstall needle valve , float and float pin, and check that the parts moves smoothly.

6. Check float drop ⓐ as shown.

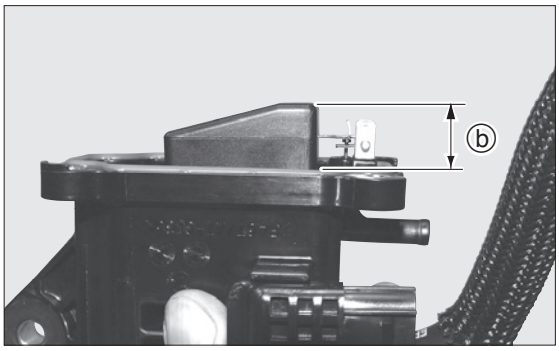
Float Drop (Reference) ⓐ :
18.5 mm (0.782 in)



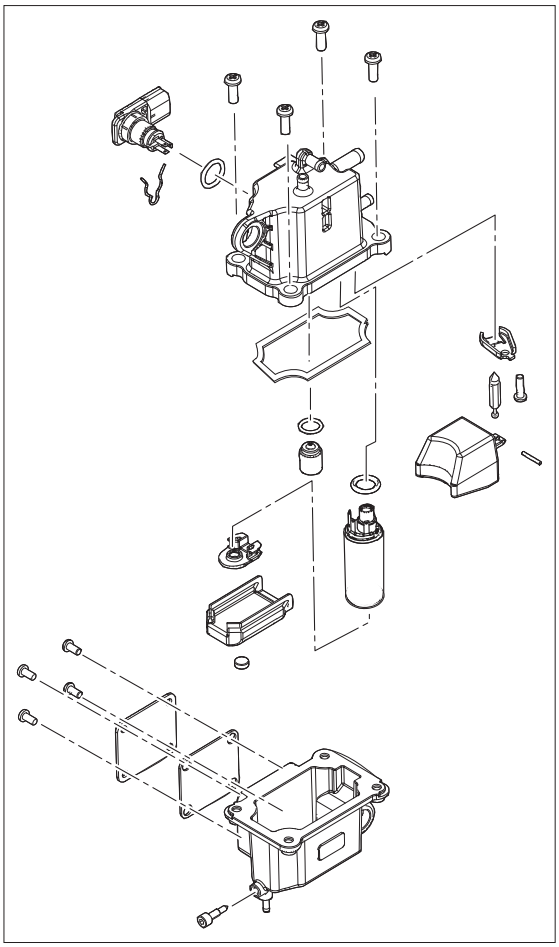
7. Check float height ⓑ as shown. Replace float or needle valve if the height is out of the specified range.

Do not press needle valve with float.

Float Height ⓑ :
15.2 mm (0.598 in)



9) Reassembly of Vapor Separator

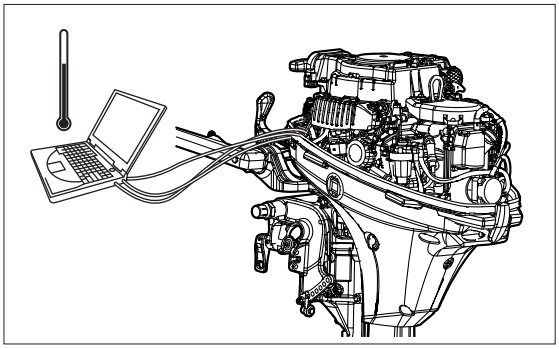


1. Attach float chamber to vapor separator.

2. Reassemble all parts that were removed.

Check that hose is reconnected correctly.

10) Inspection of ISC (Idle Speed Control)

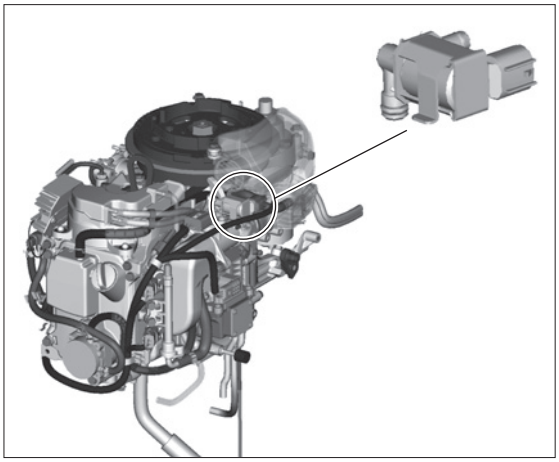


1. Use diagnosis system to check operation of ISC (Idle Speed Control) valve.

ISC Duty Rethio
10 to 20 % (at idling speed)

2. Disconnect hose at intake silencer side of ISC valve, close the hole from which the hose was disconnected with a finger to check if engine speed is reduced. Replace ISC valve if not.

11) Inspection of Idle Speed



1. Start engine and run for 5 minutes to warm up.

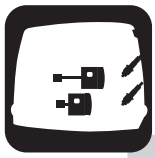
2. Check idle speed.

Tachometer :
P/N. 3AC-99010-0

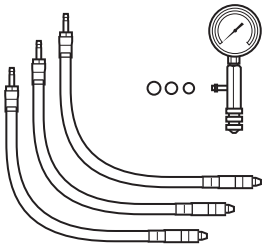
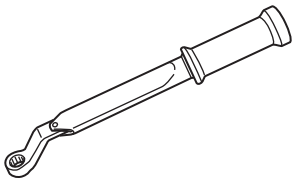
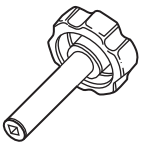
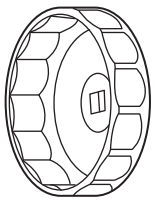
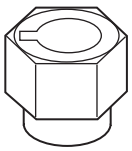
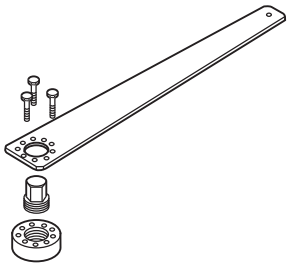
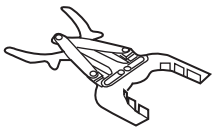
Idle Speed :
950 r/min

5

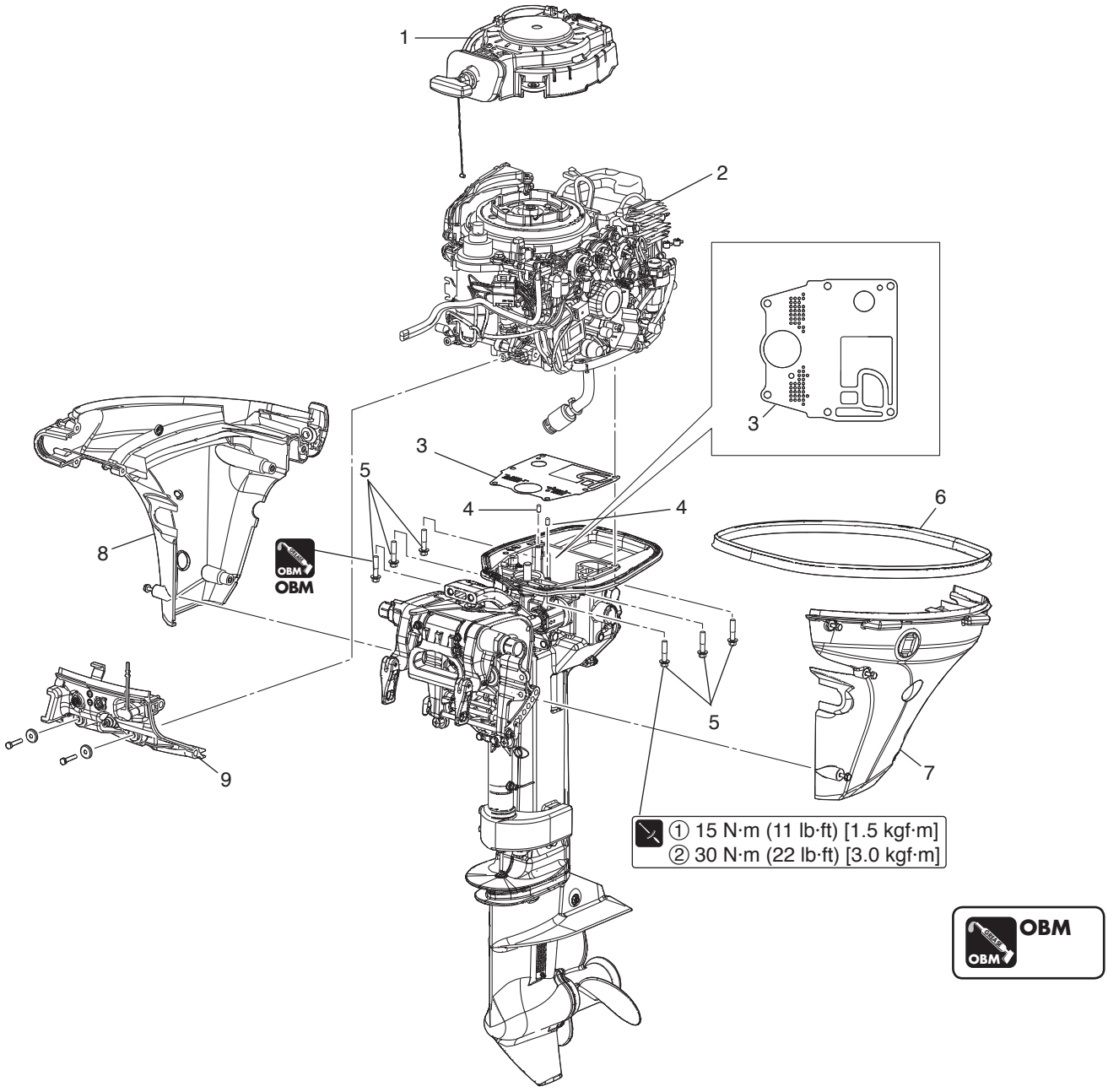
Power Unit



1.Special Tools

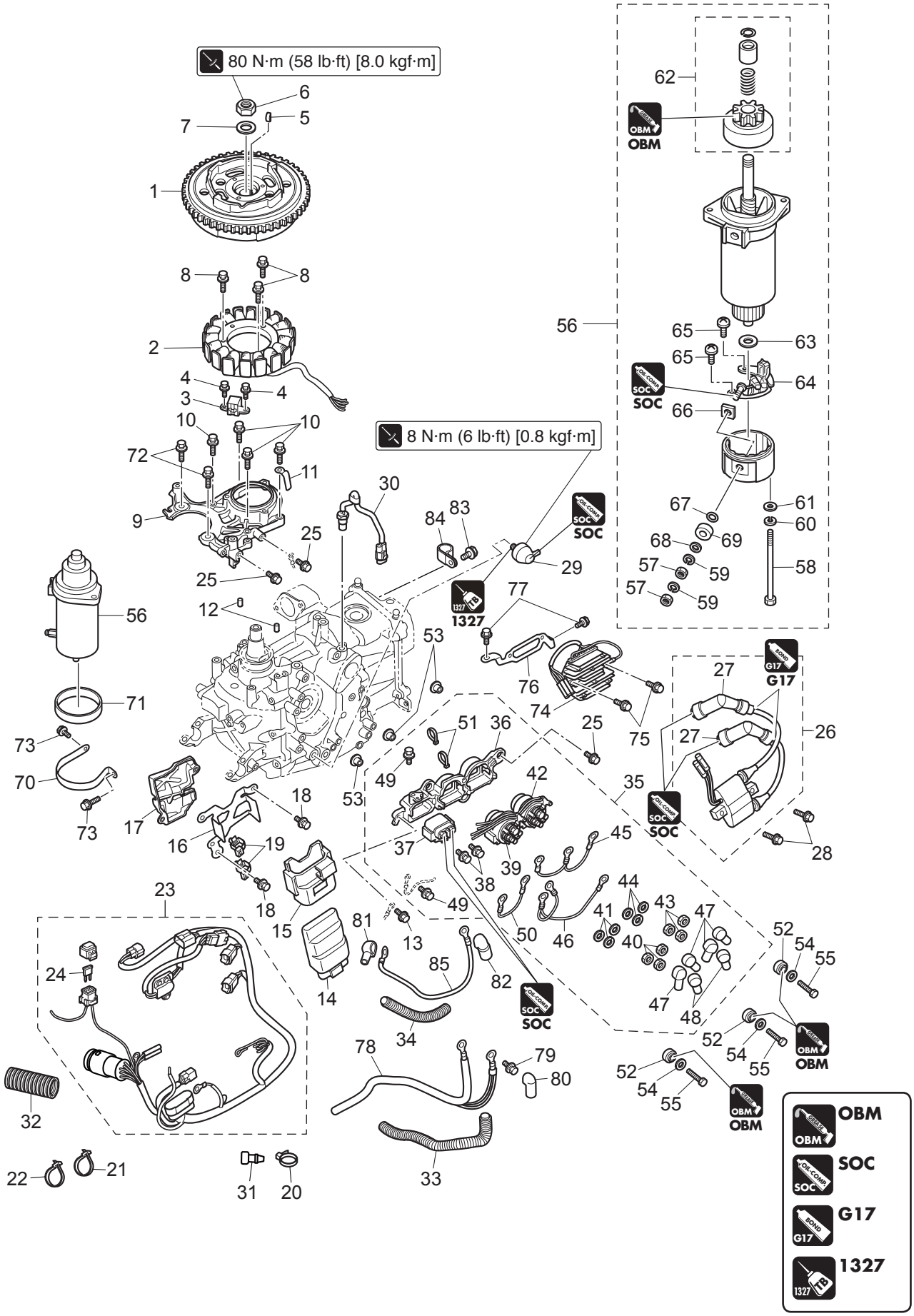
			
Piston Slider P/N. 3AC-72871-0	Compression Gauge P/N. 3AC-99030-0	Torque Wrench P/N. 3AC-99070-0	Valve Clearance Driver P/N. 3AC-99071-0
Installing piston	Measuring compression pressure	Adjusting valve clearance	Adjusting valve clearance
			
Oil Filter Wrench P/N. 3AC-99090-0	Crank Shaft Holder P/N. 3BJ-72815-0	Flywheel Puller Kit P/N. 369-72211-0	Piston Ring Tool P/N. 353-72249-0
Removing/installing oil filter	Holding crank shaft	Removing/installing flywheel	Removing/installing piston rings

2.Parts Layout
Engine

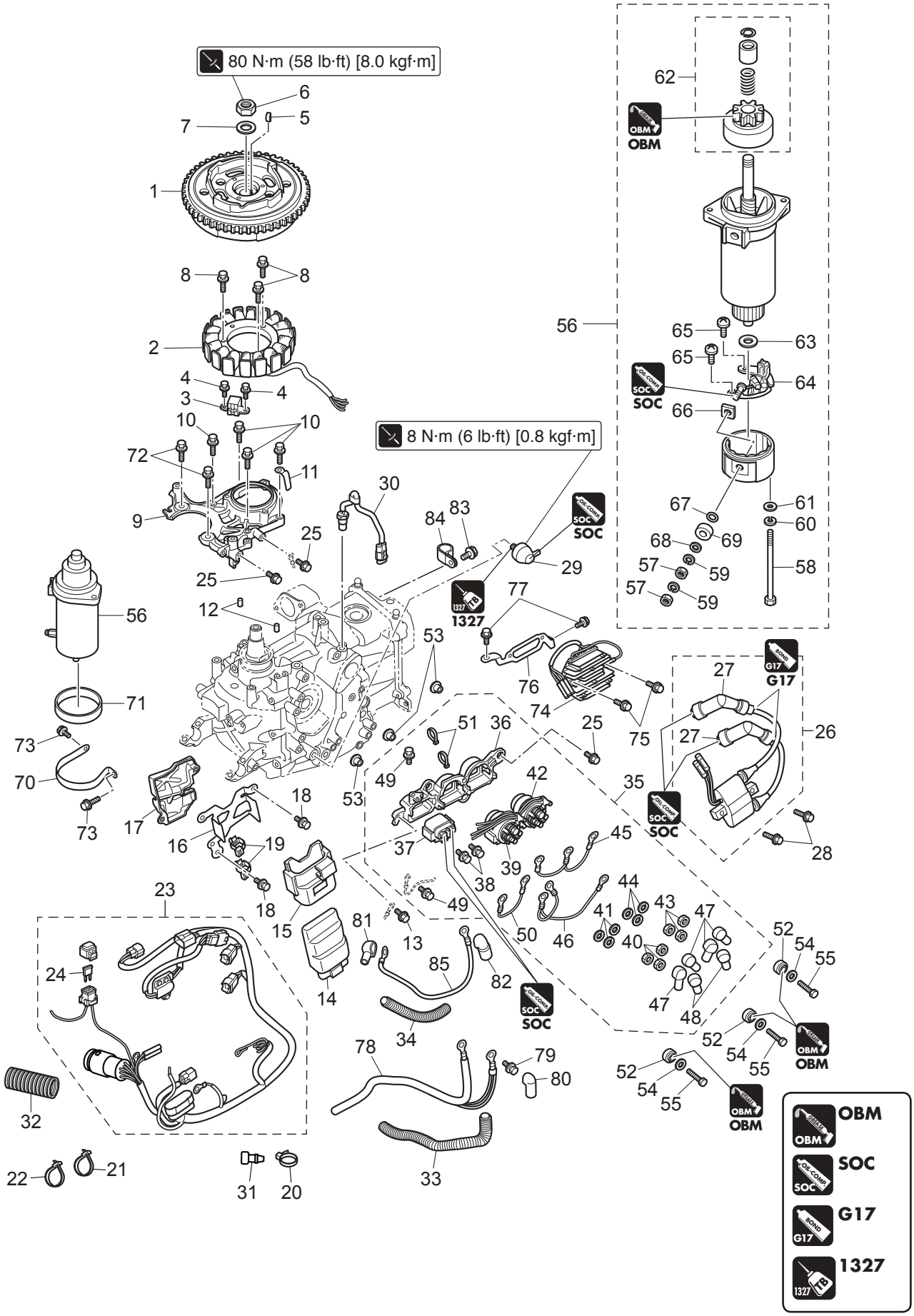


Ref. No.	Description	Q'ty	Remarks
1	Recoil Starater	1	
2	Power Unit	1	
3	Engine Base Gasket	1	Do not reuse.
4	Dowell Pin	2	
5	Bolt	6	M8
6	Top Cowl Seal	1	
7	Drive Shaft Housing Cover (L)	1	
8	Drive Shaft Housing Cover (R)	1	
9	Front Panel	1	

Magneto & Electric Parts

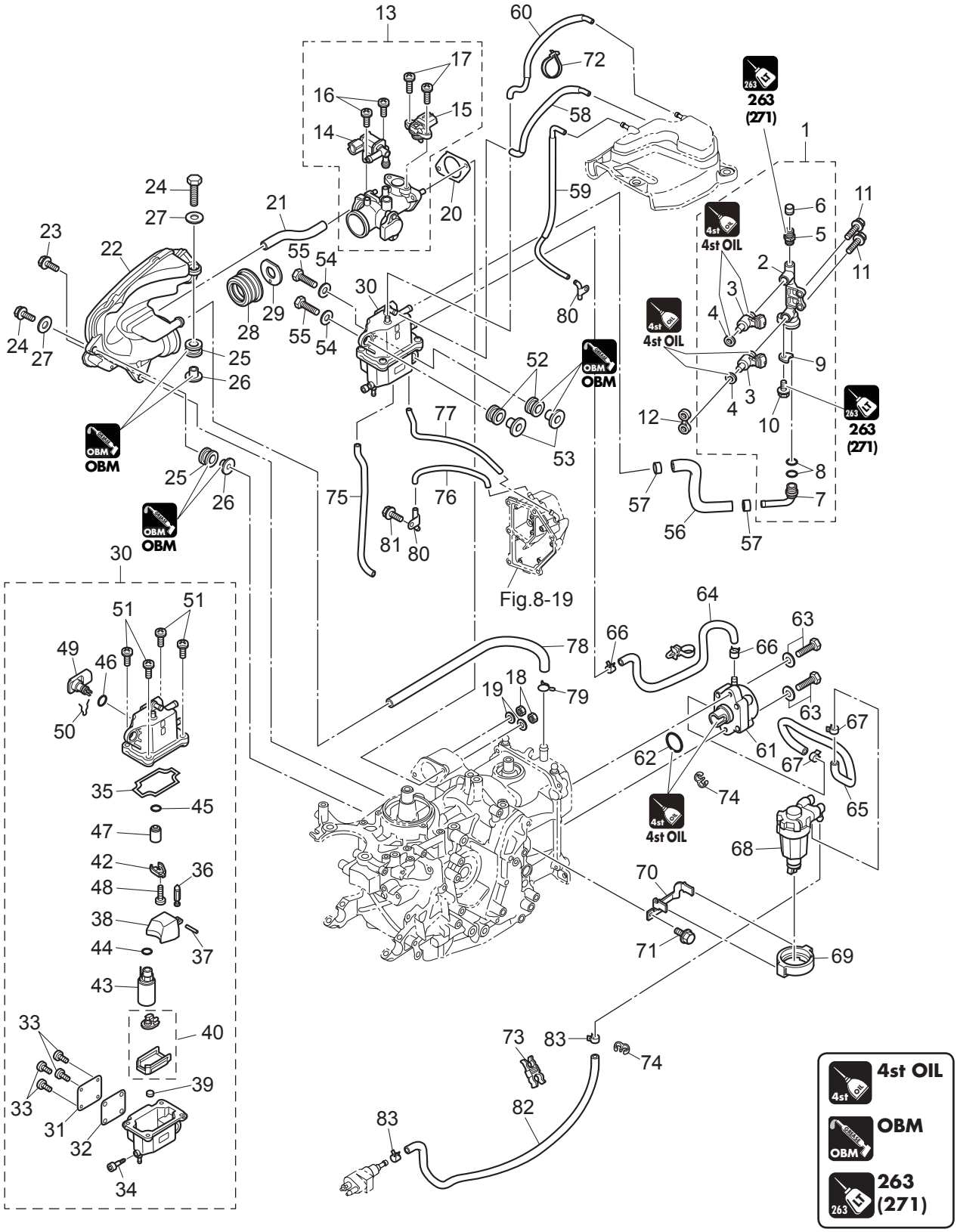


Ref. No.	Description	Q'ty	Remarks
1	Flywheel	1	M Type
	Flywheel W/Ring Gear	1	EF/EP Type
2	Alternator Assy	1	M Type
	Alternator Assy	1	EF/EP Type
3	Pulsar Coil	1	
4	Bolt	2	Pulsar M5 L=12 mm
5	Key t=4	1	
6	Nut	1	
7	Washer 16-27-3.2	1	
8	Bolt	3	Alternator M6 L=25 mm
9	Coil Bracket	1	
10	Bolt	4	Coil Bracket M6 L=25 mm
11	Clamp 6.5-47.5P	1	
12	Dowel Pin 6-12	2	
13	Bolt	1	M6 L=12 mm
14	ECU Assy	1	
15	ECU Holder	1	
16	Plate	1	
17	Plate	1	
18	Bolt	2	M6 L=16 mm
19	Band 135	2	
20	Band 158	1	Do not reuse.
21	Band 158	1	Do not reuse.
22	Band 158	1	Do not reuse.
23	Cord Assy	1	MF
	Cord Assy	1	EF, EFT
	Cord Assy	1	EP, EPT
24	Fuse 20A	1	
25	Bolt	2	M6 L=12 mm
26	Ignition Coil W/R-cap	1	
27	Plug Cap W/Resistance	2	
28	Bolt	2	M6 L=25 mm
29	Oil Pressure Switch	1	
30	Engine Temp Sensor	1	
31	Cable Terminal Plug	2	
32	Protector ø24-70	1	
33	Protector ø10.7-320	1	
34	Protector ø10.7-180	1	
35	Electric Bracket Assy	1	EF, EP
	Electric Bracket Assy	1	EFT, EPT
36	Bracket	1	
37	Starter Solenoid	1	
38	Bolt	2	M6 L=10 mm
39	PT Solenoid Switch (A)	1	
40	Nut	3	
41	Spring Washer	3	
42	PT Solenoid Switch (B)	1	
43	Nut	3	

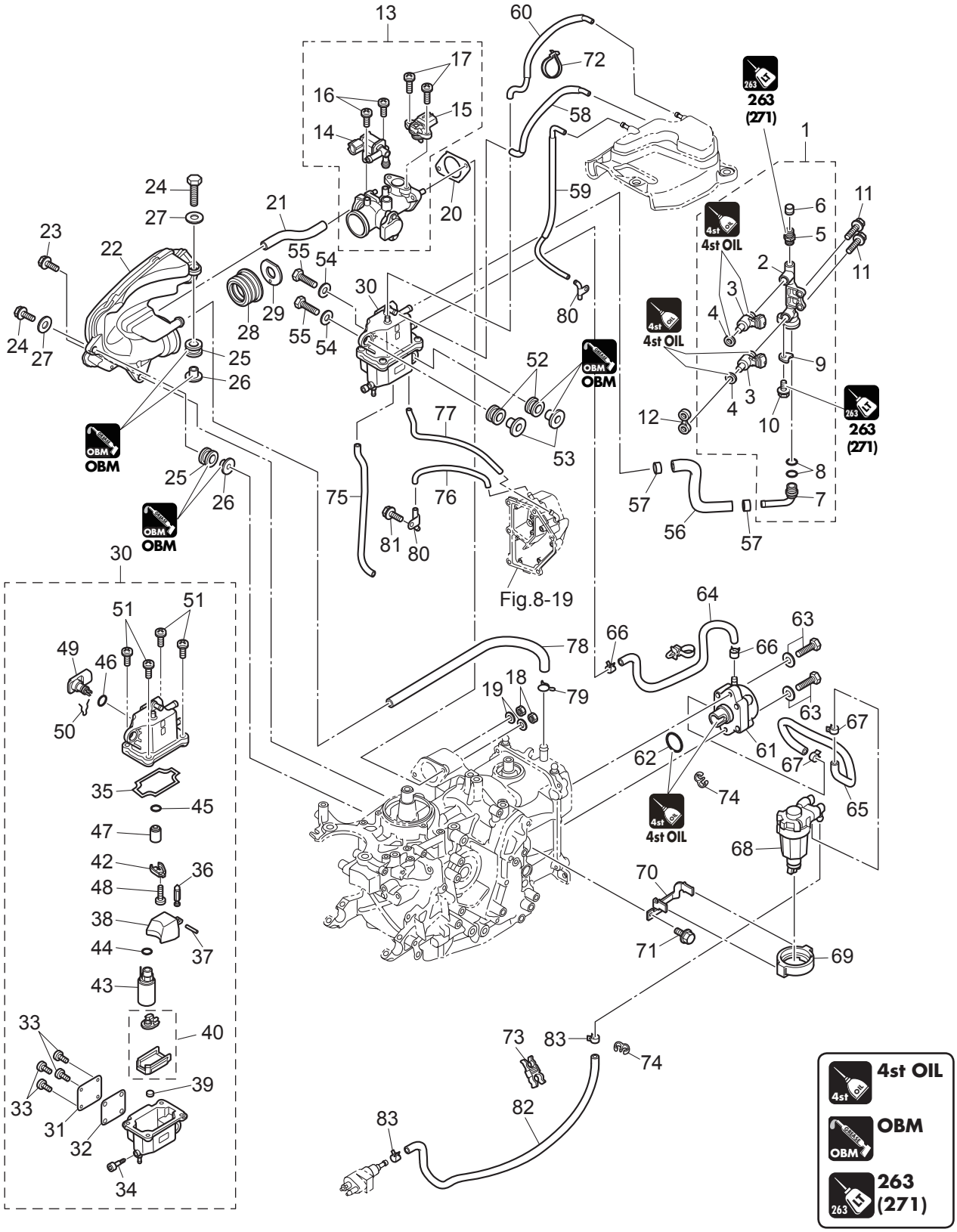

80 N·m (58 lb·ft) [8.0 kgf·m]
8 N·m (6 lb·ft) [0.8 kgf·m]
OBM
SOC
G17
1327
OBM
SOC
G17
1327

Ref. No.	Description	Q'ty	Remarks
44	Spring Washer	3	
45	Solenoid Switch Cord (A)	1	Red
46	Solenoid Switch Cord (B)	1	
47	Terminal Cap 8-13-28	4	Red
48	Terminal Cap 8-13-28	2	Black
49	Bolt	2	M6 L=12 mm
50	Ground Cable L=120	1	
51	Band 104	2	Do not reuse.
52	Rubber Mount	3	
53	Collar	3	
54	Washer 6-16-1.5	3	
55	Bolt	3	M6 L=25 mm
56	Starter Motor Assy	1	
57	Nut	2	
58	Bolt	2	
59	Spring Washer	2	
60	Spring Washer	2	
61	Washer	2	M5
62	Pinion Assy	1	
63	Washer	1	
64	Brush Holder Assy	1	
65	Screw	2	M4 L=8 mm
66	Bushing 2	1	
67	O-ring	1	Do not reuse.
68	Washer	2	M6
69	Bushing 1	1	
70	Starter Motor Band	1	
71	Damper	1	M8 L=25 mm
72	Bolt	2	M6 L=12 mm
73	Bolt	2	
74	Rectifier Complete	1	
75	Bolt	2	
76	Rectifier Bracket	1	
77	Bolt	2	M6 L=12 mm
78	Battery Cable	1	
79	Bolt	1	M6 L=12 mm
80	Terminal Cap 15.5-20-28	1	
81	Terminal Cap 8-18-28	1	Red
82	Terminal Cap 13-13-28	1	Red
83	Bolt	1	M6 L=12 mm
84	Clamp 6.5-14L	1	
85	Starter Cable	1	Starter Solenoid-Starter Motor

Fuel Pump

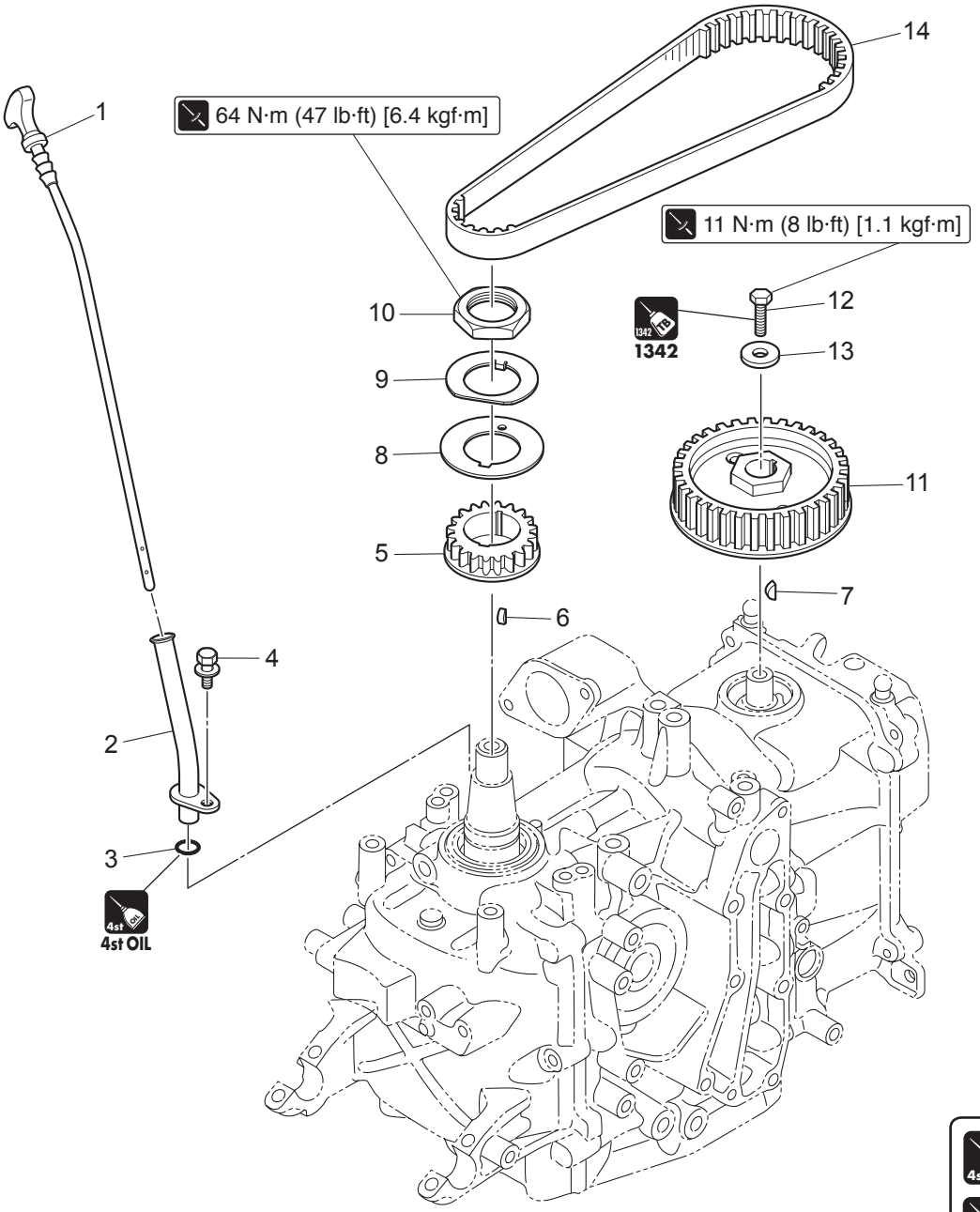


Ref. No.	Description	Q'ty	Remarks
1	Fuel Rail Assy	1	
2	Fuel Rail	1	
3	Fuel Injector Assy	2	
4	Seal Ring	2	
5	Valve Assy (Pressure Check)	1	
6	Cap	1	
7	Nipple 8-6-13L	1	
8	O-ring 1.9-9.8	2	Do not reuse.
9	Holding Plate	1	
10	Bolt	1	M6 L=12 mm
11	Bolt	2	M6 L=25 mm
12	Insulator	1	
13	Throttle Body Assy	1	
14	ISC Valve	1	
15	Map Sensor	1	T-Map Sensor
16	Screw	2	M5 L=10 mm
17	Screw	2	M5 L=16 mm
18	Nut	2	M6
19	Washer	2	M6
20	Carburetor Gasket	1	Do not reuse.
21	Hose	1	ISC Valve-Intake Silencer
22	Intake Silencer Assy	1	
23	Bolt	1	M6 L=30 mm
24	Bolt	2	M6 L=20 mm
25	Rubber Mount	2	
26	Collar	2	
27	Washer 6-16-1.5	2	M6
28	Gasket	1	
29	Restrictor	1	
30	Vapor Separator Assy	1	
31	Cover	1	
32	Seal	1	Do not reuse.
33	Screw	4	M4 L=8 mm
34	Drain Screw	1	
35	Gasket	1	
36	Float Valve Assy	1	
37	Float Arm Pin	1	
38	Float	1	
39	Grommet	1	
40	Filter (Inlet)	1	
42	Holder	1	Regulator
43	Fuel Feed Pump	1	
44	O-ring	1	FFP Out Side Do not reuse.
45	O-ring	1	Connector Do not reuse.
46	O-ring	1	Regulator Do not reuse.
47	Fuel Regulator	1	
48	Screw	1	M4 L=8mm
49	VST Connector	1	


263
(271)
4st OIL
OBM
Fig.8-19
4st OIL
OBM
263
(271)

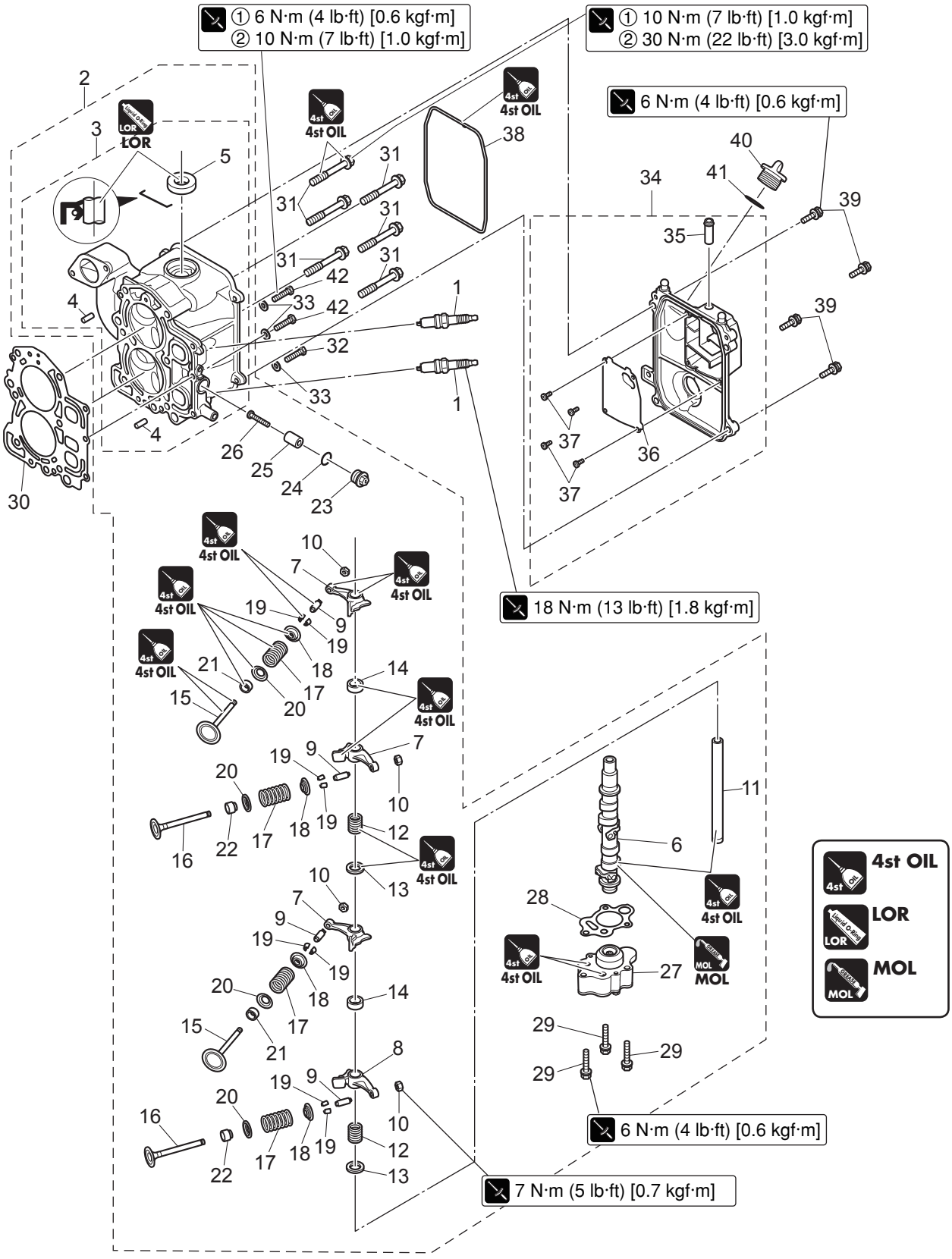
Ref. No.	Description	Q'ty	Remarks
50	Clip	1	
51	Screw	4	
52	Rubber Mount	2	
53	Collar	2	
54	Washer 6-16-1.5	2	M6
55	Bolt	2	M6 L=25mm
56	Fuel Hose W/Protector	1	VST-Fuel Rail
57	Clamp ø16.8	2	
58	Vent Hose W/Protector	1	VST-Catch Tank
59	Vent Hose W/Protector	1	Catch Tank-Vent
60	Vent Hose W/Protector	1	Catch Tank-Exposure
61	Fuel Pump Assy	1	
62	O-ring 3.5-25.7	1	Do not reuse.
63	Bolt	2	M6 L=25mm
64	Fuel Hose W/Protector	1	Fuel Pump-VST
65	Fuel Hose W/Protector	1	Fuel Filter-Fuel Pump
66	Clip ø9.4	2	Fuel Pump-VST
67	Clip ø9.4	2	Fuel Filter-Fuel Pum
68	Fuel Filter Assy	1	
69	Fuel Filter Holder	1	
70	Plate	1	
71	Bolt	1	M6 L=12mm
72	Clamp	1	
73	Clamp ø10	1	
74	Clamp ø10	1	
75	Water Hose	1	Drive Shaft Housing-Fuel Cooler
76	Cooling Hose	1	Idle Port Cover-Nipple
77	Cooling Hose	1	Fuel Cooler-Idle Port Cover
78	Breather Hose W/Protector	1	Head Cover-Intake Silencer
79	Clip ø12	1	Head Side
80	Nipple	2	Drive Shaft Housing
81	Bolt	1	M6 L=12mm
82	Fuel Hose W/Protector	1	
	Fuel Hose W/Protector 455-25	1	USA Model
83	Clip ø9.4	2	

Pulley & Timing Belt



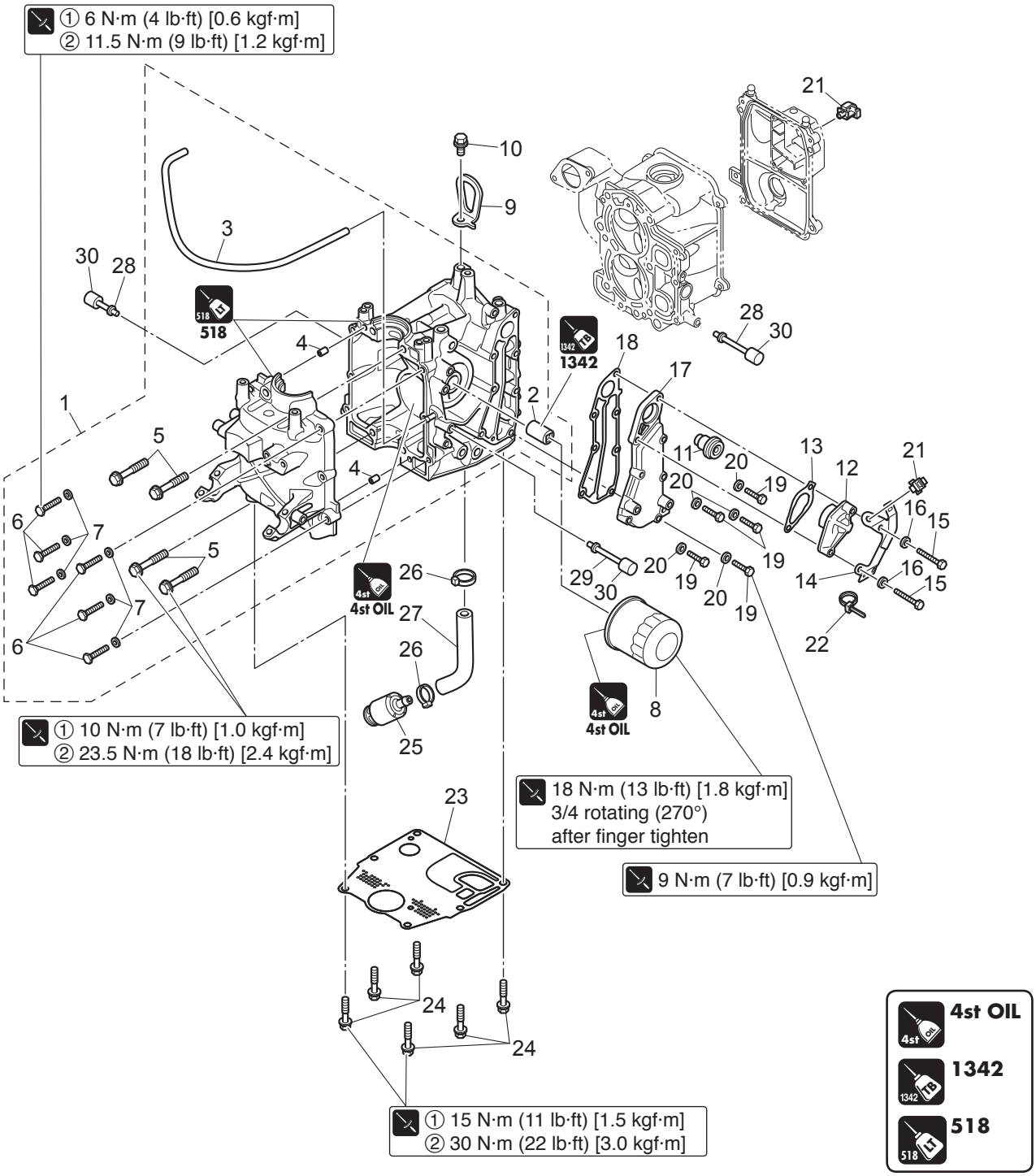
Ref. No.	Description	Q'ty	Remarks
1	Oil Level Gauge	1	
2	Oil Level Gauge Guide	1	
3	O-ring 1.9-9.8	1	Do not reuse.
4	Bolt	1	
5	Drive Pulley (Timing Pulley)	1	
6	Key 10-3.7-3	1	
7	Key 10-3.7-3	1	
8	Belt Guide	1	
9	Lock Washer	1	
10	Nut Pulley	1	
11	Driven Pulley	1	
12	Pre-coated Bolt 6-20	1	M6 L=20mm
13	Washer 6.5-19-3.2	1	
14	Timing Belt	1	

Cylinder Head & Oil Pump



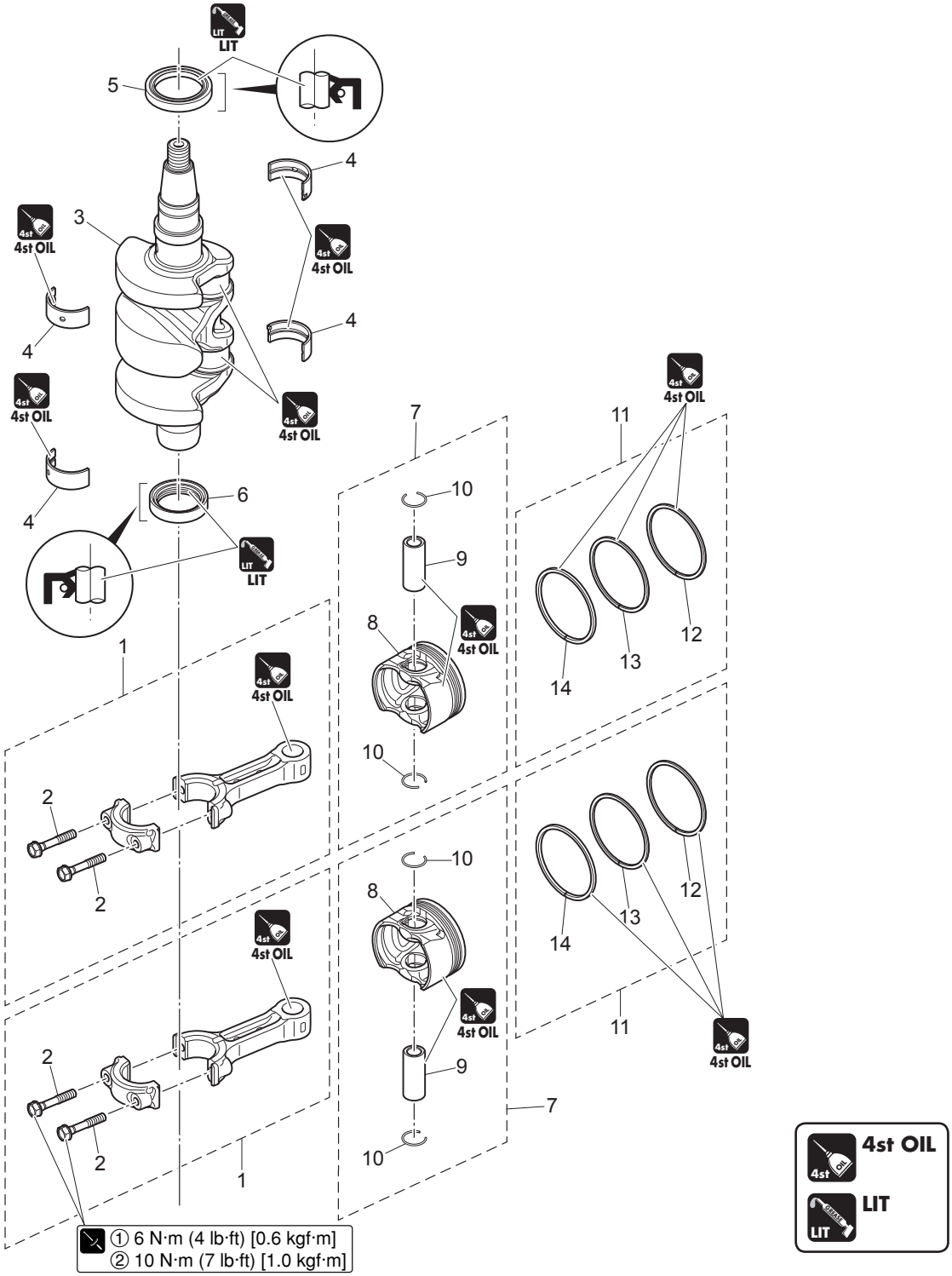
Ref. No.	Description	Q'ty	Remarks
1	Spark Plug (DCPR6E)	2	
2	Cylinder Head Complete	1	
3	Cylinder Head Assy	1	
4	Dowel Pin 6-12	2	
5	Oil Seal 18-35-8	1	Do not reuse.
6	Camshaft Assy	1	
7	Rocker Arm	3	
8	Rocker Arm	1	
9	Adjusting Screw	4	
10	Adjusting Nut	4	
11	Rocker Arm Shaft	1	
12	Rocker Shaft Spring L=25	2	
13	Washer 13.2-21.8-2	2	
14	Collar	2	
15	Intake Valve	2	k
16	Exhaust Valve	2	
17	Valve Spring	4	
18	Retainer	4	
19	Cotter	8	
20	Valve Spring Seat	4	
21	Intake Valve Stem Seal	2	Black
22	Exhaust Valve Stem Seal	2	Green
23	Anode Plug	1	
24	O-ring 1.9-13	1	Do not reuse.
25	Anode	1	
26	Screw	1	
27	Oil Pump Assy	1	
28	Oil Pump Gasket	1	Do not reuse.
29	Bolt	3	M6 L = 35 mm
30	Cylinder Head Gasket	1	Do not reuse.
31	Cylinder Head Bolt 8-60	6	M8 L = 60 mm
32	Bolt	1	M6 L = 40 mm
33	Washer	3	M6
34	Cylinder Head Cover Assy	1	
35	Nipple 10-32	1	
36	Breather Chamber Cover	1	
37	Screw	4	M6 L = 6 mm
38	Cylinder Head Cover Gasket	1	Do not reuse.
39	Bolt	4	M6 L = 25 mm
40	Oil Filler Cap	1	
41	O-ring 3.1-24.4	1	Do not reuse.
42	Bolt 25mm	2	M6 L = 25 mm

Cylinder & Crankcase



Ref. No.	Description	Q'ty	Remarks
1	Cyl Block & Crankcase Assy	1	
2	Oil Filter Bolt	1	
3	Pipe	1	
4	Dowel Pin 6-12	2	
5	Cylinder Head Bolt 8-50	4	Crankcase
6	Bolt	6	M6 L = 30 mm
7	Washer	6	M6
8	Oil Filter	1	
9	Hanger	1	
10	Bolt	1	M8 L = 20 mm
11	Thermostat	1	
12	Thermostat Cap	1	
13	Thermostat Cap Gasket	1	Do not reuse.
14	Bracket	1	
15	Bolt 40mm	2	M6 L = 40 mm
16	Washer	2	M6
17	Exhaust Cover (Outer)	1	
18	Exhaust Cover Gasket	1	Do not reuse.
19	Bolt 25mm	5	M6 L = 25 mm
20	Washer	5	M6
21	Band	2	
22	Band 158	1	Do not reuse.
23	Engine Basement Gasket	1	Do not reuse.
24	Bolt 8-P1.25	6	
25	Oil Strainer Assy	1	
26	Band 158	2	Do not reuse.
27	Hose	1	
28	Cowl Support	2	
29	Cowl Support	1	
30	Cowl Support Rubber	3	

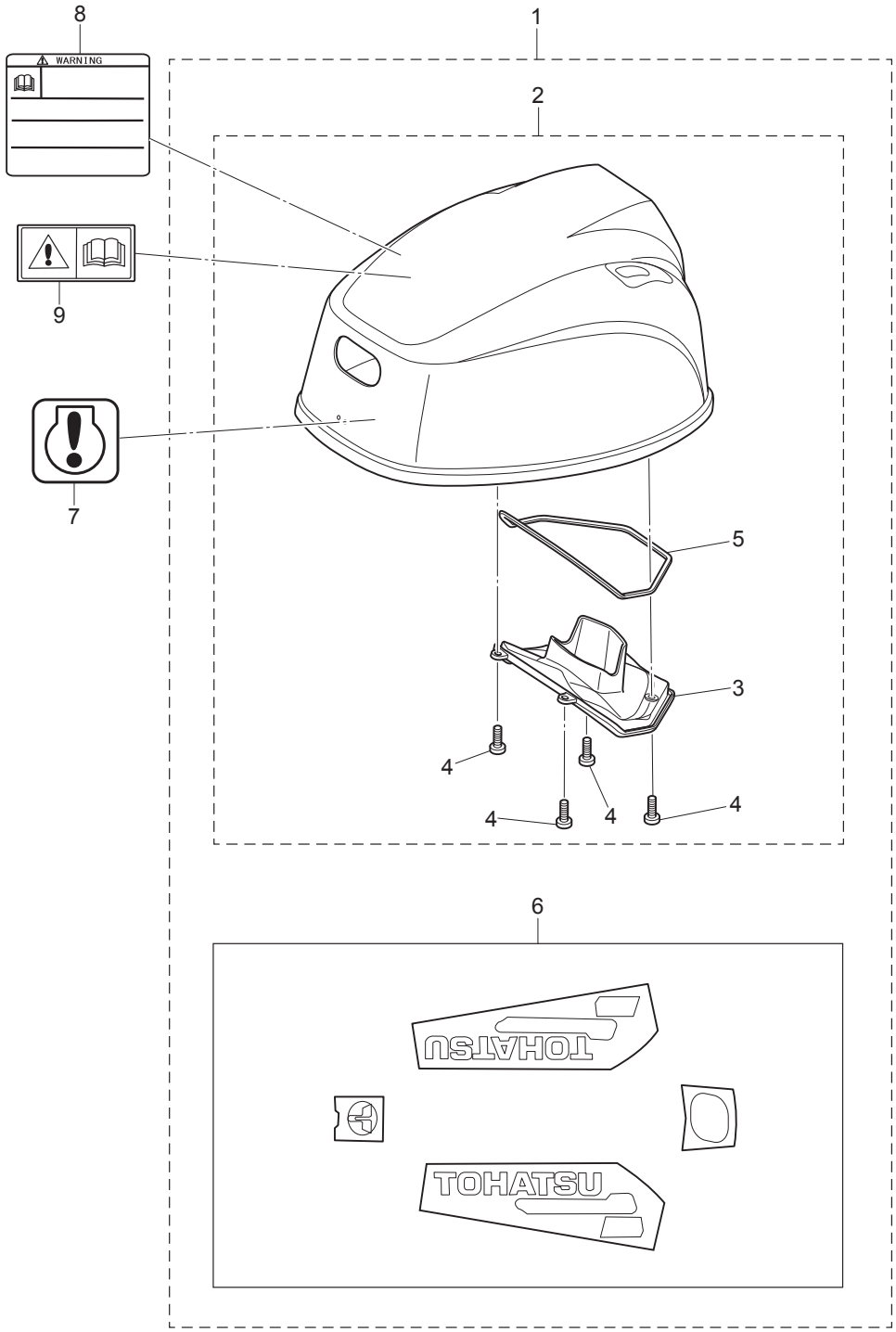
Piston & Crankshaft



Ref. No.	Description	Q'ty	Remarks
1	Connecting Rod Assy	2	
2	Connecting Rod Bolt	2	
3	Crankshaft Assy	1	
4-1	Plain Shaft Bearing	A	BLUE See page 5-54
4-2	Plain Shaft Bearing	A	RED See page 5-54
5	Oil Seal 32-44-9	1	Upper Do not reuse.
6	Oil Seal 36-50-7	1	Lower Do not reuse.
7	Piston Repair Kit	2	

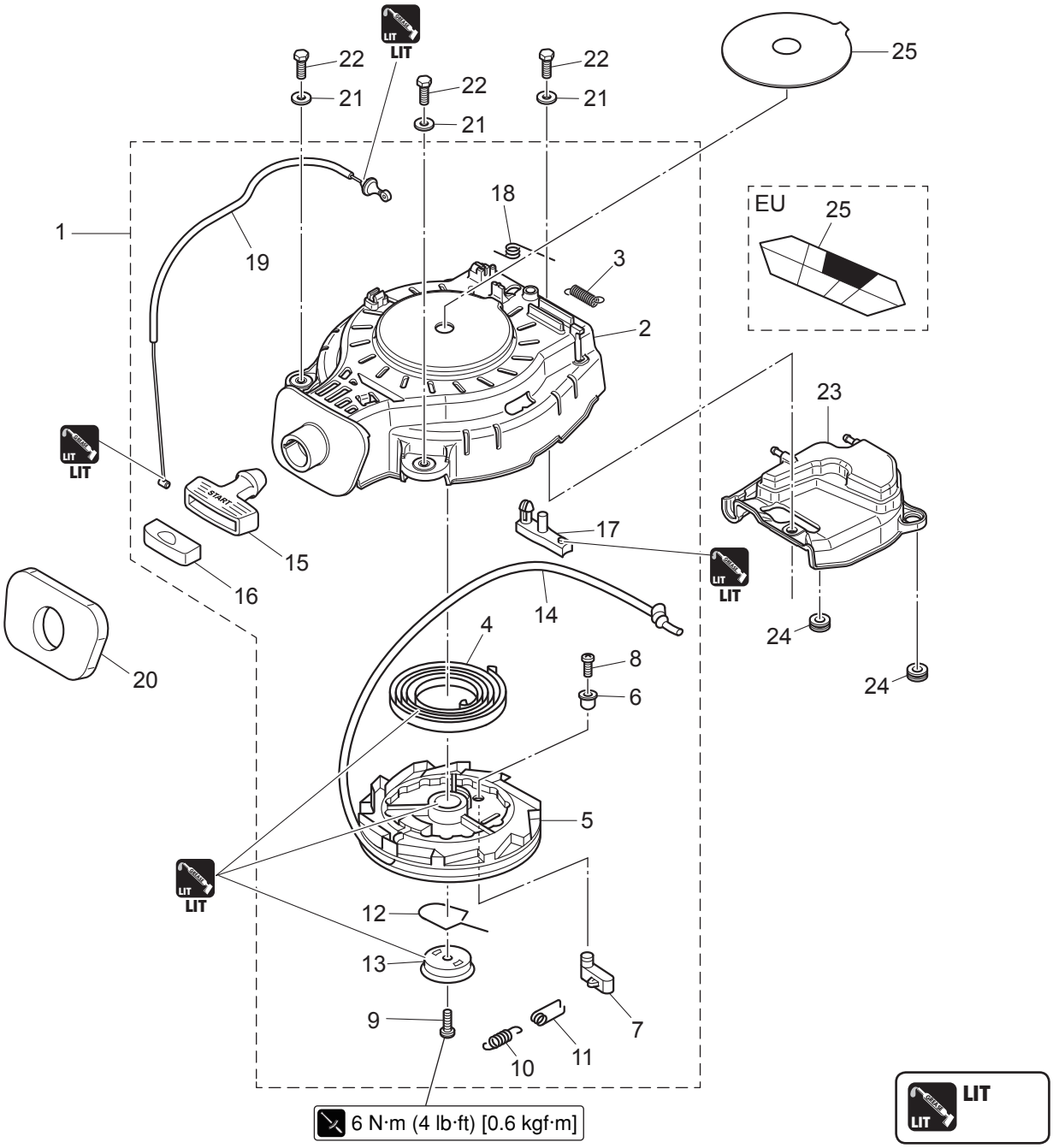
Ref. No.	Description	Q'ty	Remarks
8	Piston	1	
9	Piston Pin	1	
10	Piston Pin Clip	2	Do not reuse.
11	Piston Ring Set	2	
12	Piston Ring	1	
13	Piston Ring	1	
14	Piston Ring-Oil	1	

Top cowl



Ref. No.	Description	Q'ty	Remarks
1	Top Cowl Assy	1	
2	Top Cowl Sub-assy	1	
3	Air Guide	1	
4	Tapping Screw 6-16	4	M6 L = 16 mm
5	Seal Rubber	1	
6-1	Decal Set	1	9.9ps
6-2	Decal Set	1	15ps
6-3	Decal Set	1	20ps
7	Warning Decal	1	
8	Caution Decal (A)	1	
9	Caution Decal	1	

Recoil Starter



Ref. No.	Description	Q'ty	Remarks
1	Recoil Starter Assy	1	
2	Starter Case	1	
3	Starter Lock Cam Spring	1	
4	Starter Spring	1	
5	Reel	1	
6	Bushing	1	
7	Ratchet	1	
8	Tapping Screw	1	
9	Tapping Screw	1	
10	Return Spring	1	
11	Return Spring	1	
12	Friction Spring	1	
13	Friction Plate	1	

Ref. No.	Description	Q'ty	Remarks
14	Starter Rope ø5-1800	1	L = 1800 mm
15	Starter Handle	1	
16	Rope Anchor	1	
17	Starter Lock	1	
18	Starter Lock Spring	1	
19	Starter Lock Wire	1	
20	Starter Seal	1	
21	Washer 6-16-1.5	3	
22	Pre-coated Bolt 6-20	3	M6 L = 20 mm
23	Belt Cover	1	
24	Grommet 13-2 13-2	2	
25-1	Caution Decal (B)	1	EU Model
25-2	Caution Decal (B)	1	

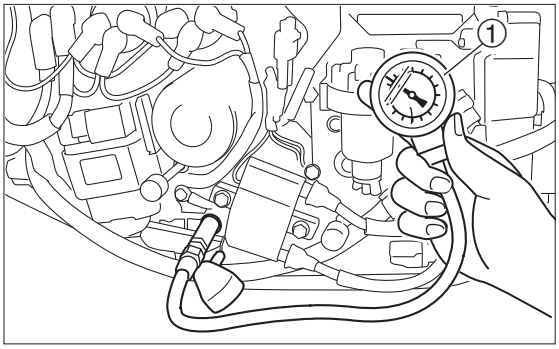
3. Inspection Items

1) Inspection of Compression Pressure

1. Refer to "Inspection of Compression Pressure" in chapter 3.

Compression Pressure (Reference) :
1.4 MPa (203 PSI) [14.3 kgf/cm²] ±10 %

2) Inspection of Oil Pressure



1. Spread rag below oil pressure switch.

2. Remove oil pressure switch and connect oil pressure gauge ① to switch hole.

Use commercially available oil pressure gauge (Thread spec : R 1/8).
Use the instrument applicable to 1 Mpa (142 psi) [10 kgf/cm²].

3. Start engine and run 5 minutes to warm up at idling revolution speed.

4. Measure hydraulic pressure. If the pressure is below specified value, check oil pump for oil leak, and oil strainer and plunger.

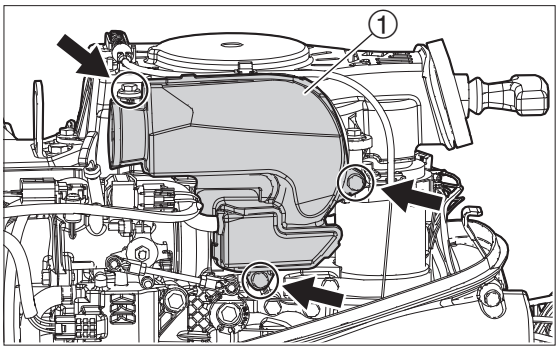
Hydraulic Pressure (Reference) :
0.04 kPa (5.8 psi) [0.4 kgf/cm²] or higher at 950 r/min
0.20 MPa (29 psi) [2.0 kgf/cm²] or higher at 5750 r/min

3) Inspection of Valve Clearance

1. Refer to "Inspection of Valve Clearance" in chapter 3.

Valve Clearance (when engine is cold)
(IN) Intake valve ⓓ :
0.15 – 0.17 mm (0.0051 – 0.0067 in)
(EX) Exhaust valve ⓔ :
0.18 – 0.22 mm (0.0071 – 0.0087 in)

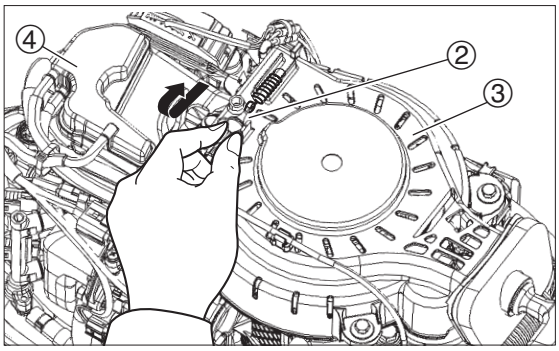
4) Removing Power Unit



Loosen flywheel nut before removing power unit to make the work easier.

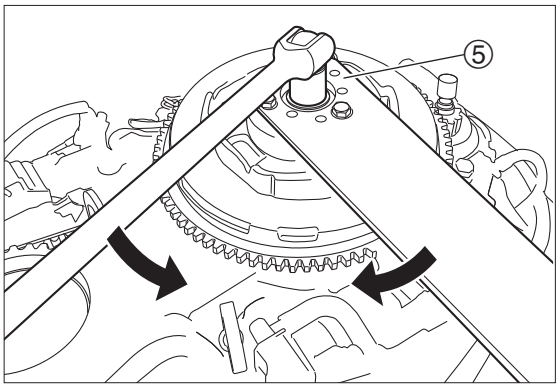
1. Remove intake silencer ① (three bolts).

2. Remove starter lock cable ②, recoil starter ③ (three bolts) and driven Pulley cover ④.



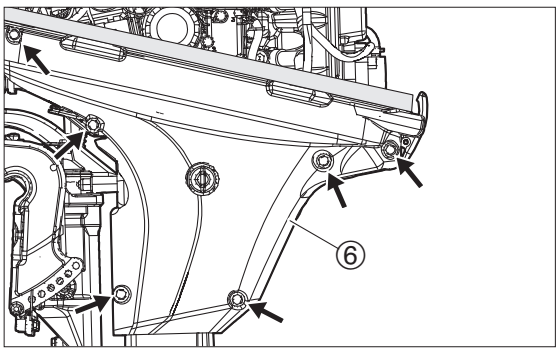
3. Loosen flywheel nut.

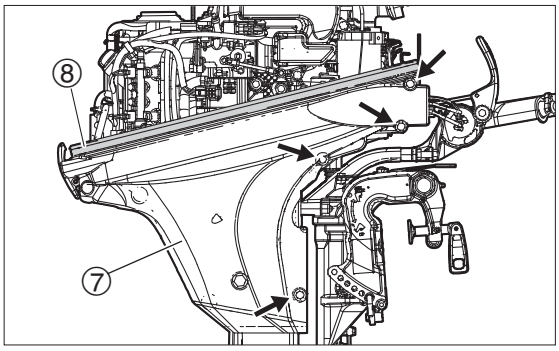
Flywheel Puller Kit ⑤:
P/N. 369-72211-0



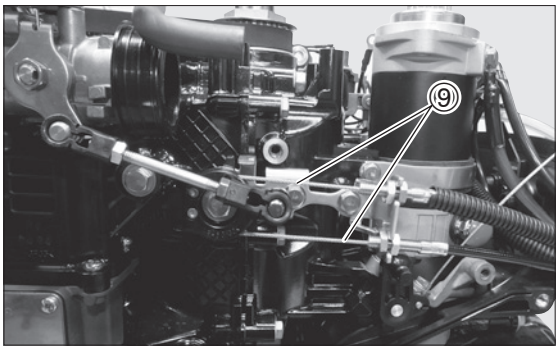
4. Remove drive shaft housing cover ⑥, ⑦ and cowl seal ⑧.

· Loosen the port side bolt completely, then fully loose the starboard side bolt.
· This bolt has a falling prevention structure so it can not be removed..

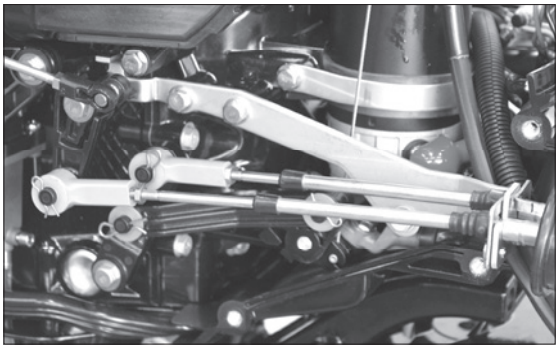




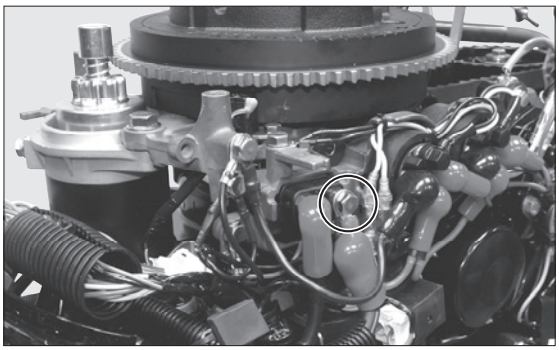
5. Disconnect throttle cable ⑨ (for MF, EF, EFT models).

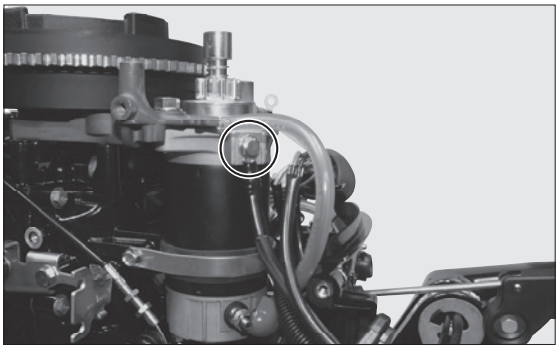


5. Remove pin and then remove cable joint. (for EP, EPT models)

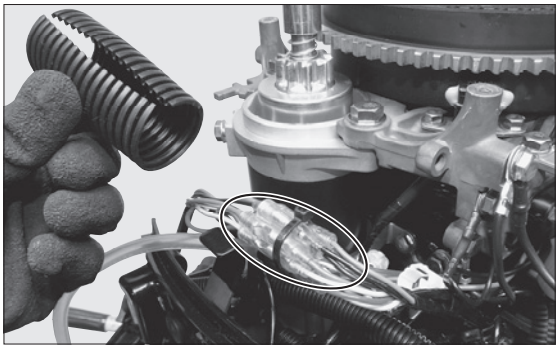


7. Disconnect battely cables (two places). (except for MF model)

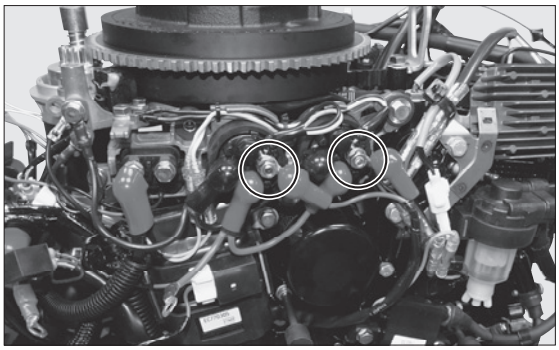




8. Remove cable protector, then disconnect connetors (four places). (for EF, EFT models)

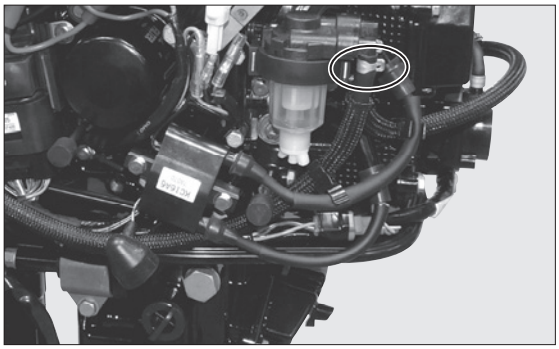


9. Remove lock tie, then disconnect PT motor leads (L, G) from PT solenoide. (for EFT, EPT models)

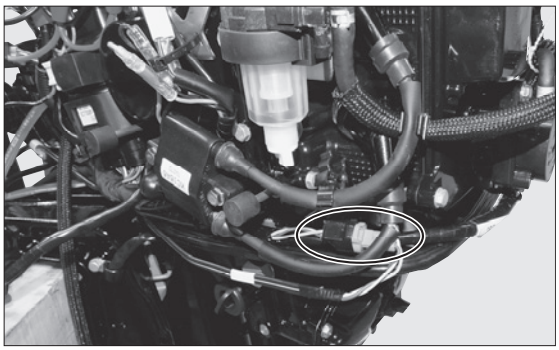


10. Disconnect fuel hose.

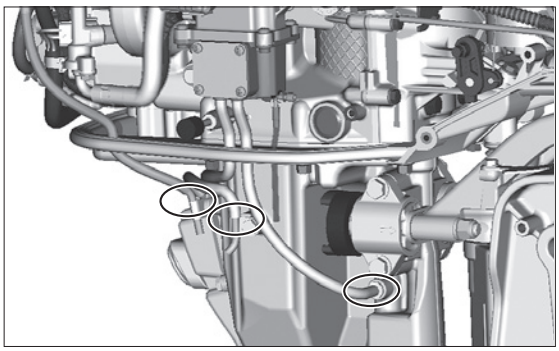
11. Remove oil level gauge.



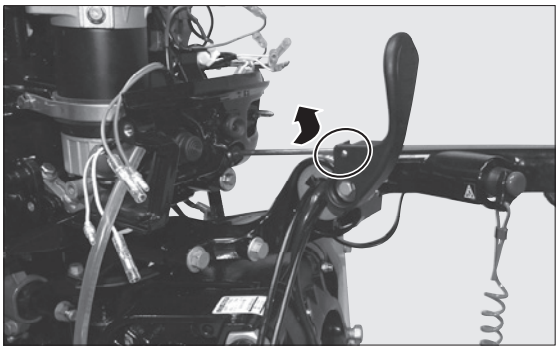
12. Disconnect PT switch couplers. (for EFT, EPT models)

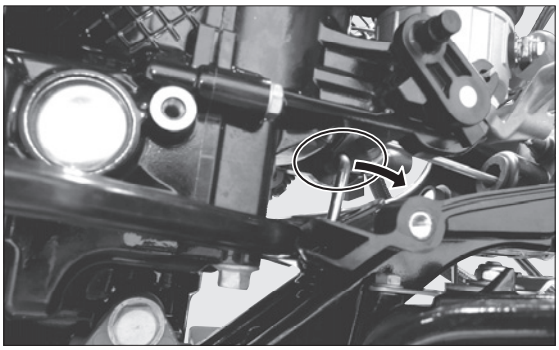


13. Disconnect cooling watrer hose (fuel cooler).

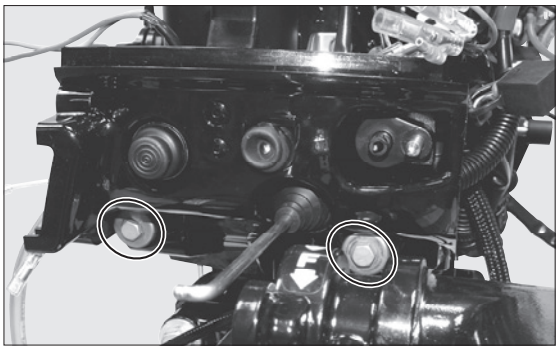


14. Disconnect shift rod (tiller handle side) (power unit side).



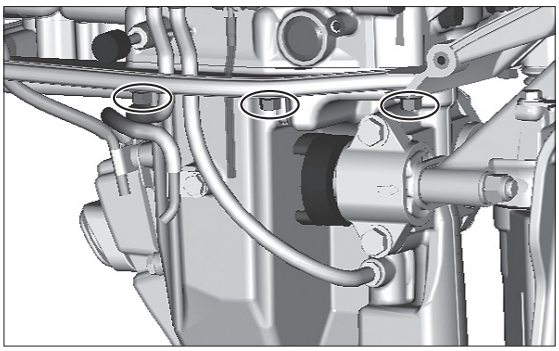


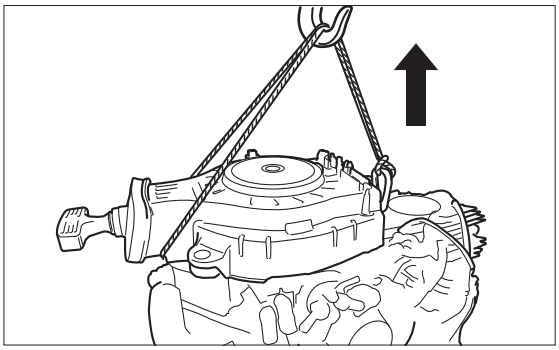
15. Remove bolts (two bolts), then remove housing cover (front).



16. Remove power unit by removing bolts (six bolts) and then hoisting it.

- When hoisting power unit, perform the work carefully while checking if wires and hoses are caught by other parts.
- Before removing power head ass'y, note arrangement of oil strainer hose.
- Loosen power unit mounting bolts in the order reverse of tightening.
- Install recoil stater, then hoist as illustration.

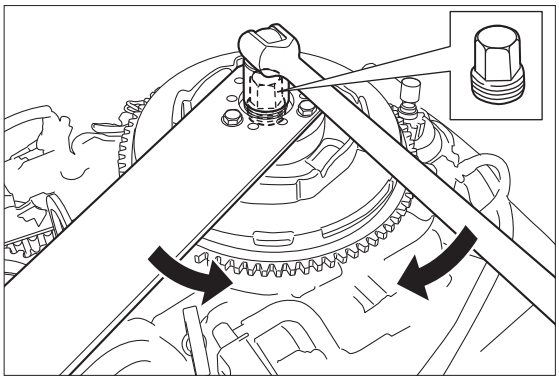




17. Remove flywheel, and then remove key.

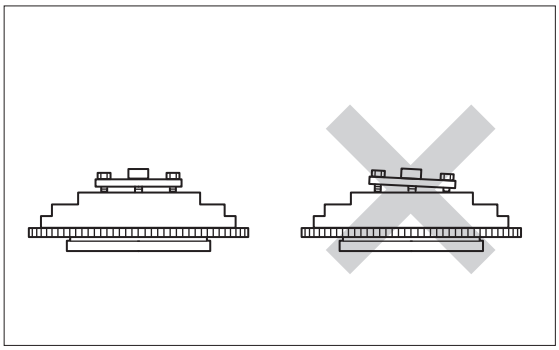
Flywheel Puller Kit :
P/N. 369-72211-0

Screw puller onto crankshaft end until flywheel is disengaged from tapered section of crankshaft.



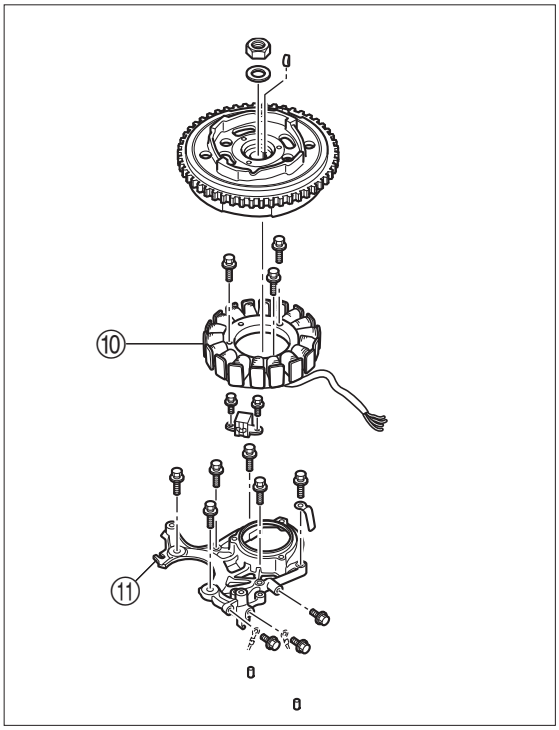
⚠ CAUTION

To prevent damages to engine and special tools, tighten flywheel puller set bolts evenly and keep flywheel puller parallel to flywheel while working.



18. Disconnect alternator coupler ⑩.

19. Remove bolts of alternator bolt and coil bracket bolt ⑪, then remove alternator and coil bracket.

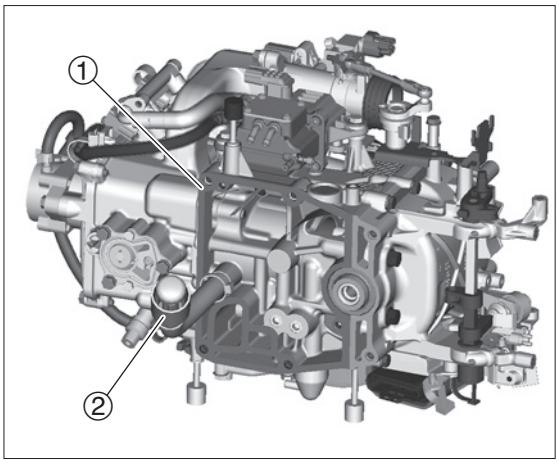


5) Removing Oil Strainer

1. Place the removed power unit ass'y ① on table with left side (port side) facing down.

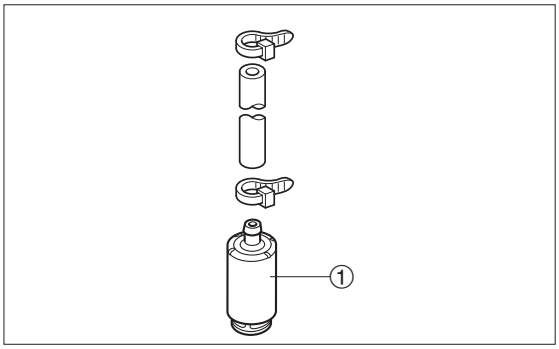
2. Remove oil strainer ② from power unit ass'y ①.

> Before removing oil strainer hose, note arrangement of the hose.



6) Inspection of Oil Strainer

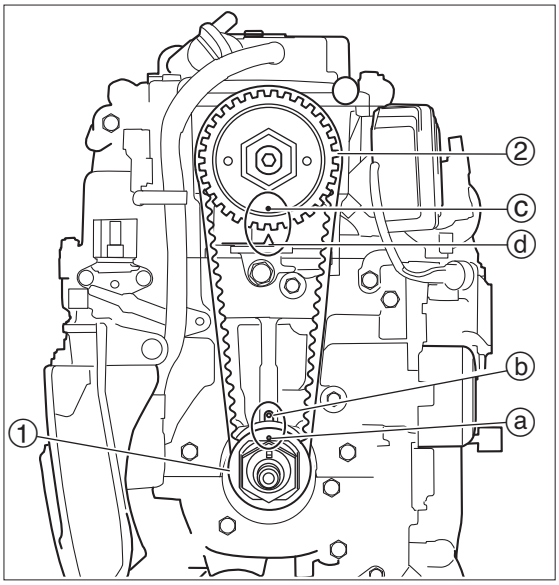
1. Check oil strainer ① for dirt and clogging. Clean, or replace if necessary.



7) Removing Timing Belt and Pulley

1. Turn drive pulley ① clockwise to bring "●" mark ⓐ of belt guide to "●" mark ⓑ of cylinder block, and check that "● 1" mark ⓒ of driven pulley ② and "▲" mark ⓓ of cylinder head are aligned with each other.

> No.1 piston is to be at top dead center of compression stroke.



5

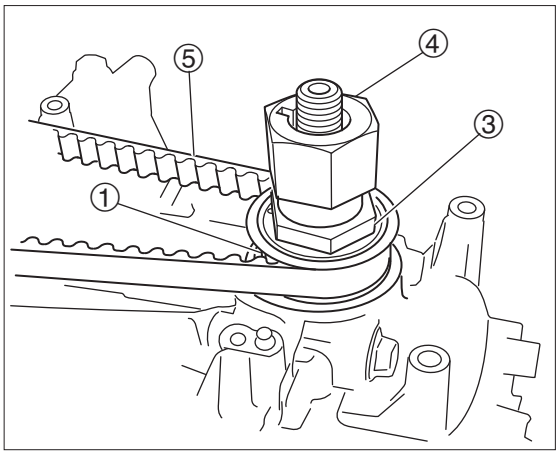
2. Flatten down drive pulley nut ③ lock washer's tab.

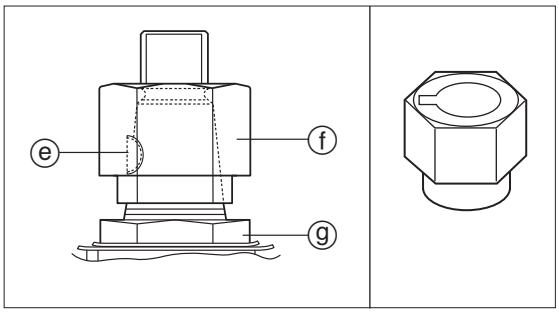
3. Attach crankshaft holder ④ to crankshaft and secure it.

4. Loosen drive pulley nut ③.

· Use 36mm socket wrench and ring wrench for this step.
· When loosening nut ③ of drive pulley ①, hold driven pulley ② to prevent it from being turned.
· Keep timing belt ⑤ engaged as a means of precaution.

Crank Shaft Holder ④ :
P/N. 3BJ-72815-0

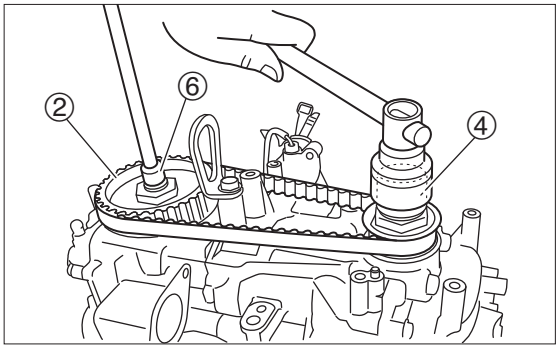




ⓔMagneto key
ⓕCrankshaft holder
ⓖPulley nut

5. Remove driven pulley bolt ⑥.

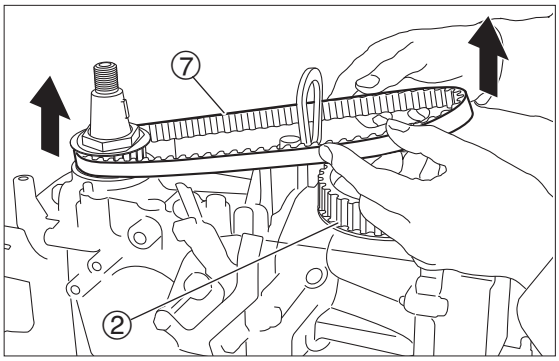
When loosening driven pulley bolt, be careful not to turn driven pulley.



6. Remove timing belt ⑦ from driven pulley ② side, and then, from drive pulley side.

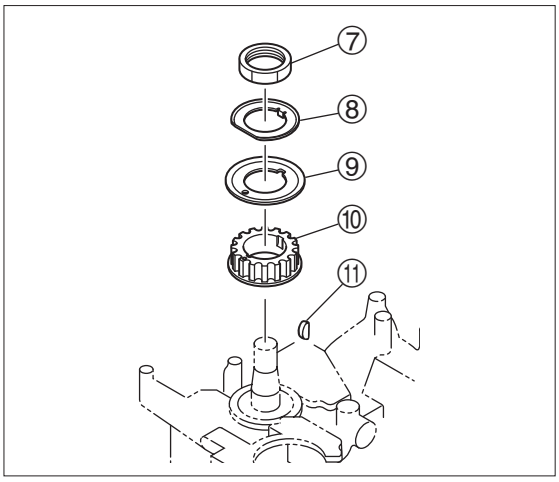
⚠ CAUTION

Do not turn drive pulley (crank shaft) or driven pulley with timing belt removed. Doing so can make pistons and valves interfere with each other, possibly resulting in damages to these parts.



7. Remove driven pulley ②.

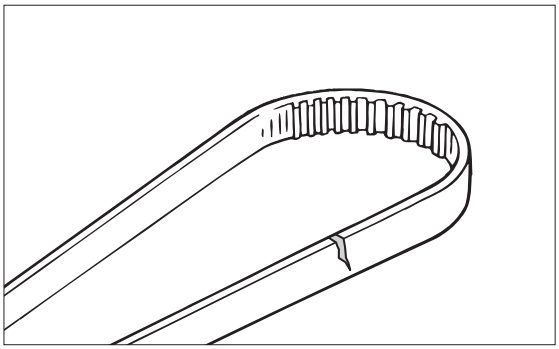
8. Remove nut ⑦, lock washer ⑧, belt guide ⑨, timing pulley ⑩ and key ⑪.



8) Inspection of Timing Belt

1. Check timing belt for crack, damage and wear on both faces. Replace if necessary.

2. Check drive pulley and driven pulley for crack, damage and wear. Replace if necessary.

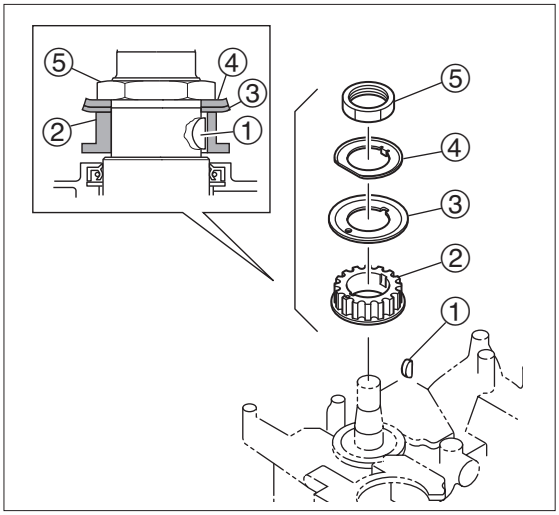


9) Installation of Pulley and Timing Belt

⚠ CAUTION

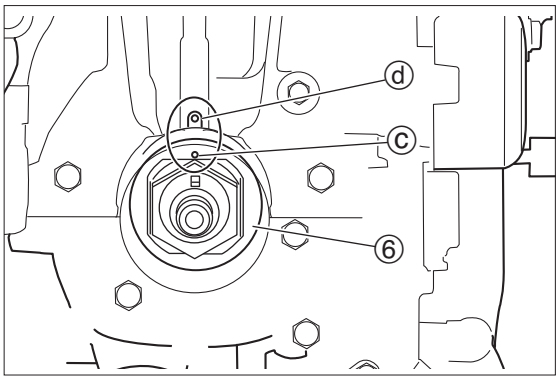
Do not turn drive pulley or driven pulley with timing belt removed. Doing so can make pistons and valves interfere with each other, possibly resulting in damages to these parts.

1. Install key ①, drive pulley ②, belt guide ③, lock washer ④ and nut ⑤ in this order. Tightening to specified torque is performed later.

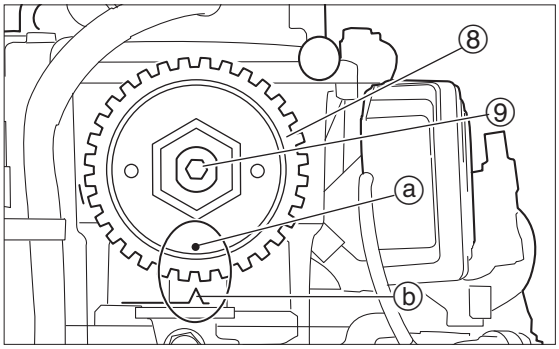


2. Check that "●" mark ⓒ of belt guide ⑥ and "●" mark ⓓ of cylinder block are aligned with each other.

This position is compression top dead center of No. 1 cylinder.



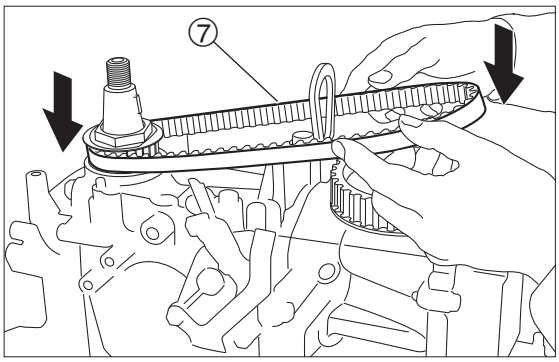
3. Install driven pulley, check that "●" mark ⓐ of drive pulley ⑧ to "▲" mark ⓑ of cylinder head are aligned with each other.



4. Attach timing belt ⑦ to drive pulley with its part number side facing upward, and then to driven pulley.

⚠ CAUTION

- **Be careful not give damage to timing belt when installing.**
- **Do not twist timing belt, bring inside out, or bend sharp, as it may be damaged.**
- **Be careful not to allow oil or grease to adhere to timing belt.**

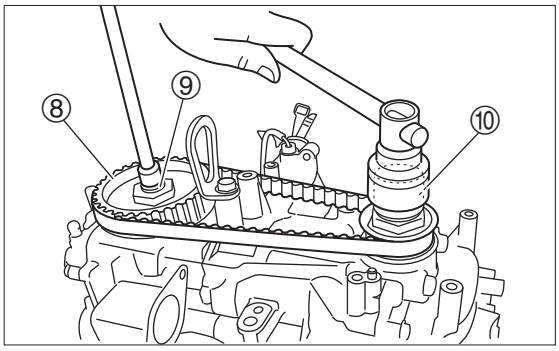


5. Tighten driven Pulley bolt ② to specified torque.

When tightening driven pulley bolt, be careful not to turn driven pulley.

Crankshaft holder ⑩ :
P/N. 3BJ-72815-0

Driven pulley bolt ⑨ :
11 N · m (8 lb · ft) [1.1 kgf · m]

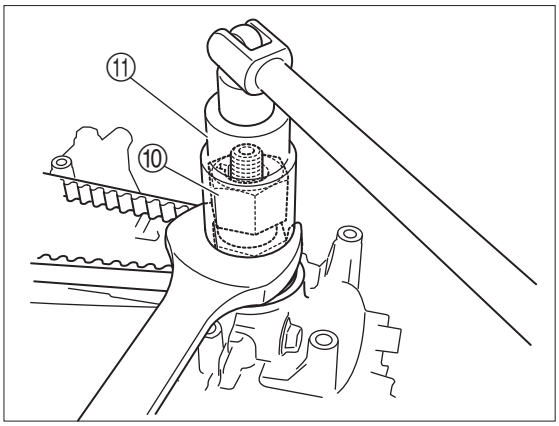


6. Tighten timing pulley nut to specified torque. Bend up the tab of the lock washer.

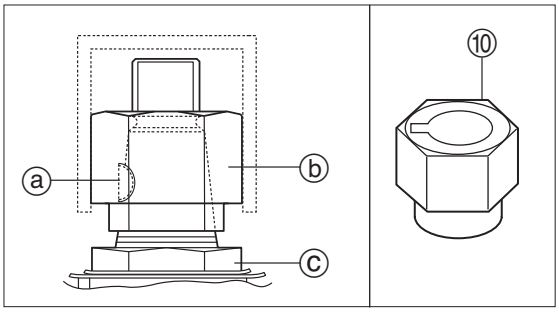
Use two 36mm wrenches for this step.
(Spanner wrench and socket wrench)

Crankshaft holder ⑩ :
P/N. 3BJ-72815-0

Drive Pulley Nut :
64 N · m (47 lb · ft) [6.4 kgf · m]

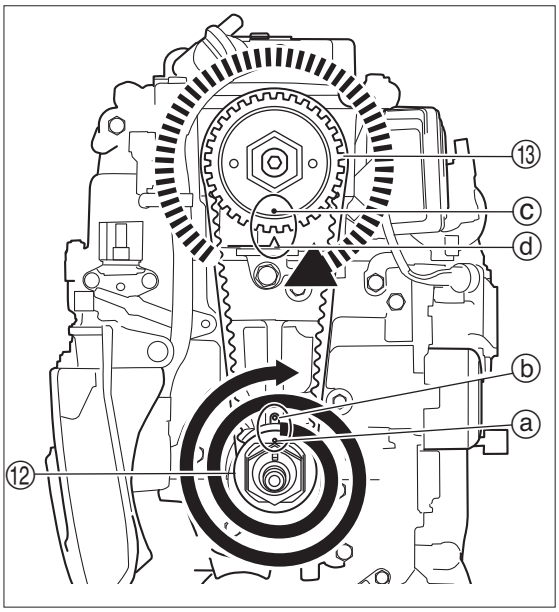


⑩Crankshaft holder
⑪Deep socket 36mm



ⓐMagneto key
ⓑCrankshaft holder
㉝Pulley nut

7. Turn drive pulley ⑫ clockwise twice, and check that locating marks ⓐⓑ and ⓒⓓ of pulleys ⑫ and ⑬ are aligned with each other respectively.



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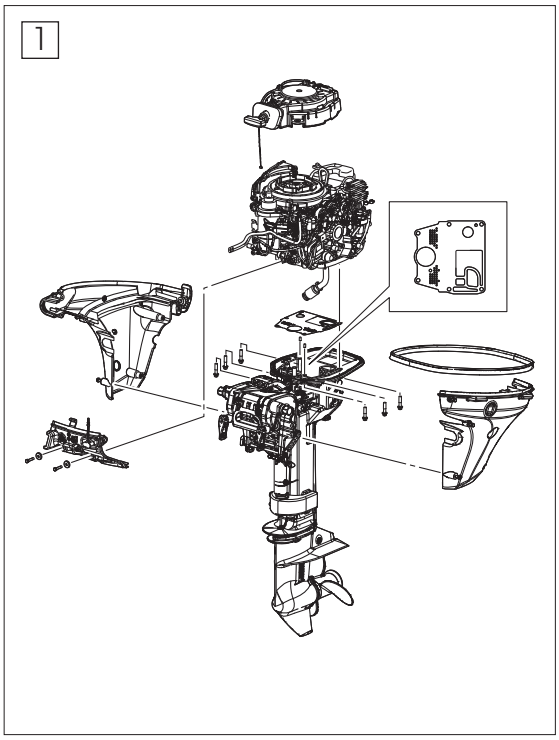
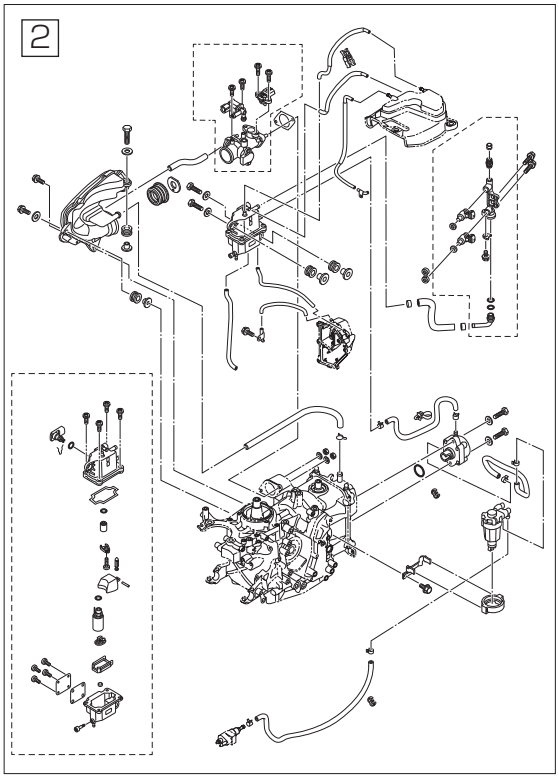
10) Removing Cylinder Head

- No.1 piston is to be at top dead center of compression stroke.
- Removal or installation of parts can be made easier when some of them are assembled together.

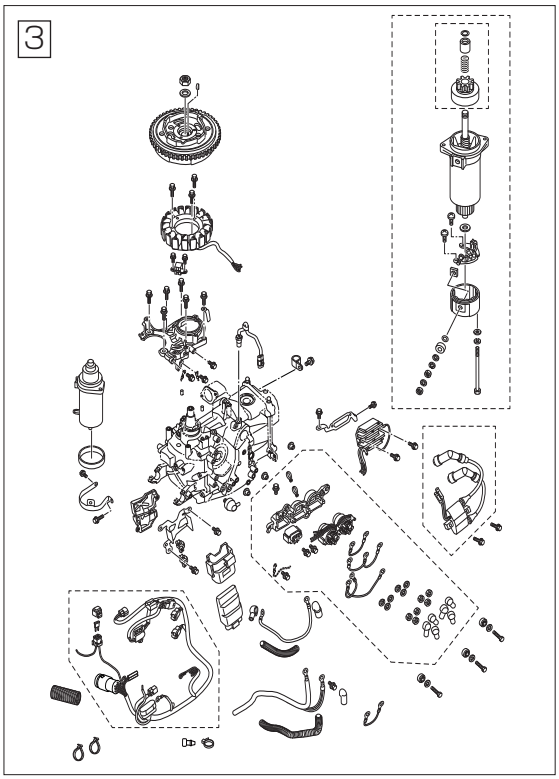
1. Remove power unit. (Refer to the section for removing power unit.)



2. Remove fuel system parts from power unit.

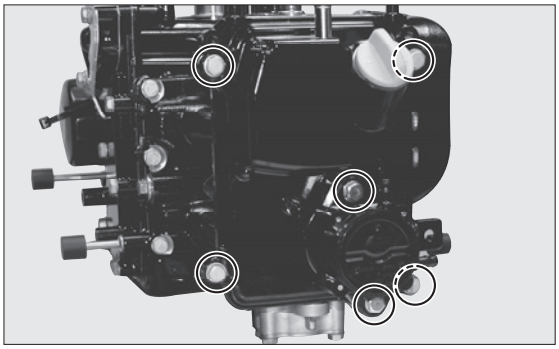


3. Remove electrical system parts from power unit.



4. Remove driven pulley, fuel pump, cylinder head cover and hose.

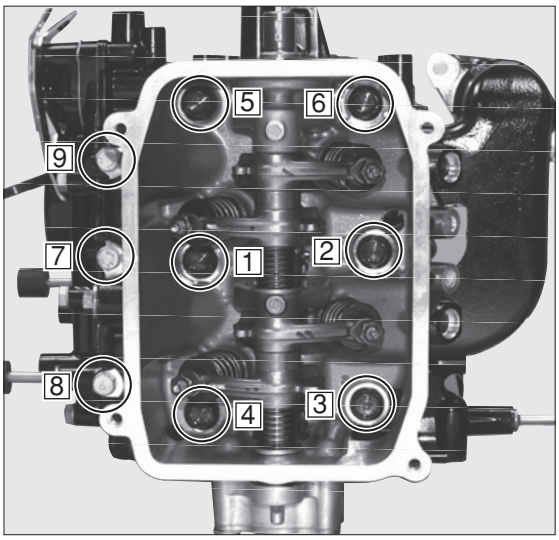
To remove, refer to the "Removing Timing Belt and Pulley" section in Chapter 5.



5. Remove cylinder head bolts in the reverse sequence of order shown, and remove cylinder head.

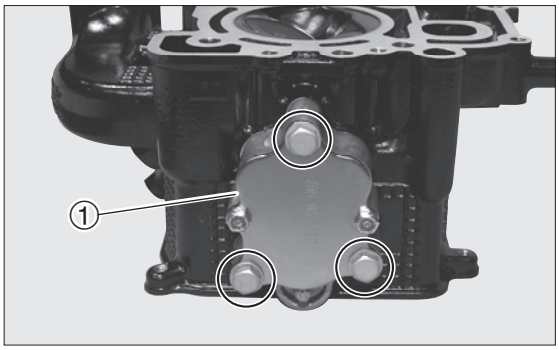
⚠ CAUTION

Do not scratch or damage mating surfaces of cylinder head and cylinder block.



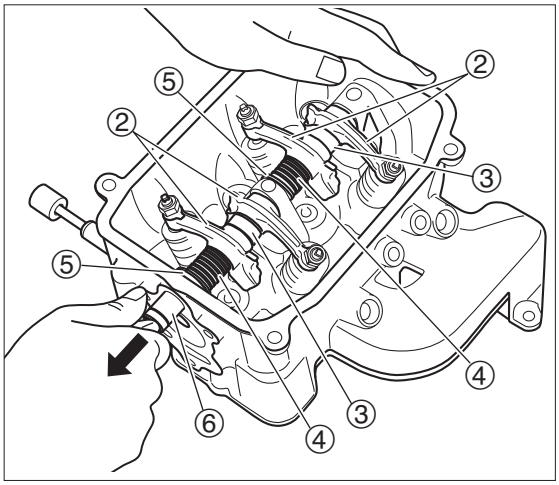
6. Loosen rocker arm lock nut, and loosen adjusting screw as much as possible.

7. Remove oil pump ass'y ①.



8. Remove rocker arm shaft ass'y ②, collar ③, spring ④, washer ⑤ and rocker arm shaft ⑥.

- Use a flat-blade screwdriver as a guide tool and slowly pull out rocker arm shaft.
- When pulling out work while holding each part by hand.

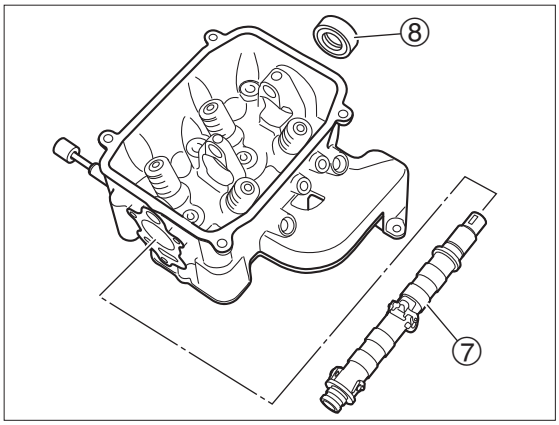


9. Remove cam shaft ⑦.

⚠ CAUTION

Pull out slowly so as not to hit the journal part.

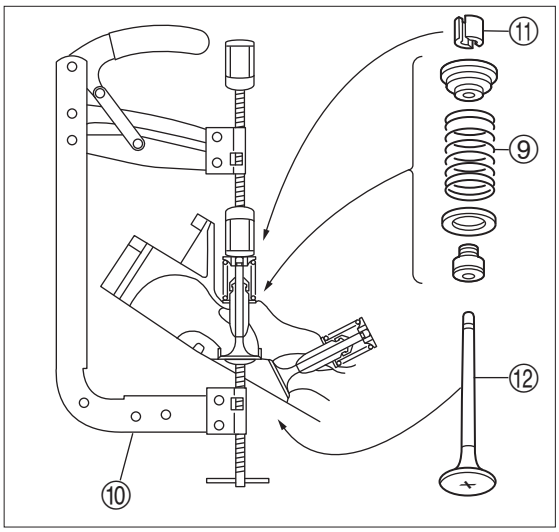
10. Remove oil seal ⑧.



11. Compress valve spring ⑨ by using compressor ⑩, remove cotter ⑪, and then, spring and valve ⑫.

Valves, springs and other related parts should be arranged in the order they are removed.

Valve Spring Compressor ⑩ :
Commercially available item

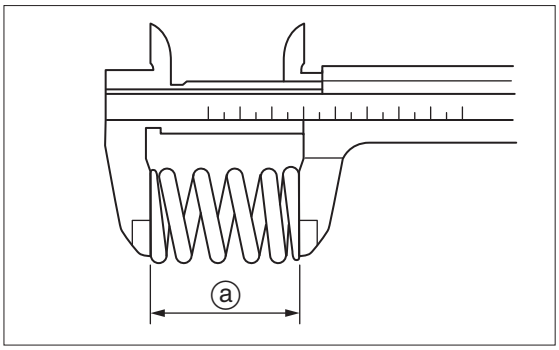


11) Inspection of Valve Spring

1. Measure valve spring free length ⓐ. Replace if the length is less than specified value.

Valve Spring Free Length ⓐ : Standard Value
32.85 mm (1.29 in)

Functional Limit :
31.5 mm (1.24 in)



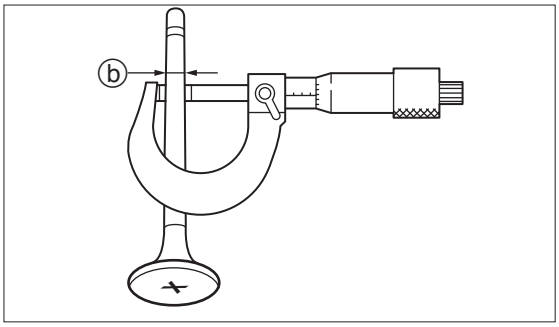
12) Inspection of Valve

1. Check valve for dent and wear on the face. Replace if necessary.

2. Measure valve stem outer diameter ⓑ. Replace if the diameter is less than specified value.

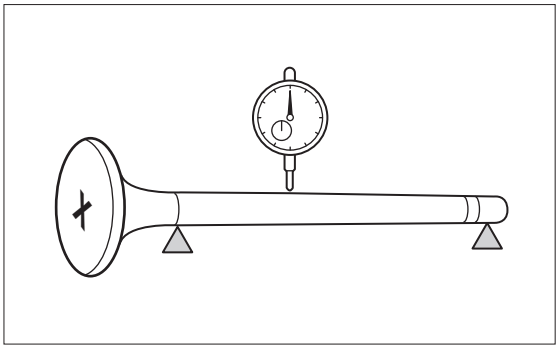
Valve Stem Outer Diameter ㉟ : Standard Value
Intake Side : 5.48 mm (0.2157 in)
Exhaust Side : 5.46 mm (0.2150 in)

Functional Limit :
Intake Side : 5.46 mm (0.2150 in)
Exhaust Side : 5.44 mm (0.2142 in)



3. Measure valve stem runout. Replace if the runout is over specified value.

Valve Stem Runout Limit :
Intake Side : 0.05 mm (0.0020 in)
Exhaust Side : 0.03 mm (0.0012 in)



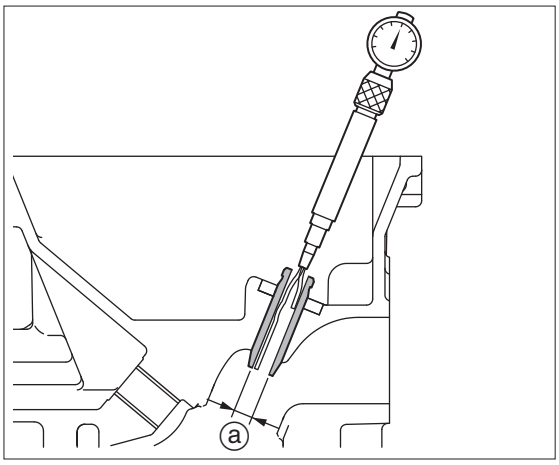
13) Inspection of Valve Guide

Before inspecting valve guide, check that valve stem outer diameter is within specified limit.

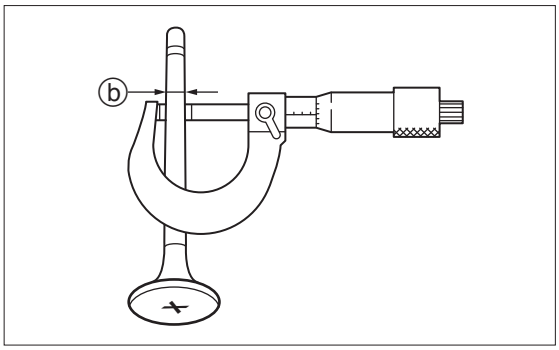
1. Measure valve guide inner diameter ⓐ. Replace cylinder head if the inner diameter is over specified value.

Valve Guide Inner Diameter ⓐ : Standard Value
Intake/Exhaust Side : 5.51 mm (0.2169 in)

Functional Limit :
Intake Side : 5.55 mm (0.2185 in)
Exhaust Side : 5.57 mm (0.2193 in)



2. Obtain clearance between valve guide and valve stem by calculating as described below. Replace cylinder head and/or valve if the clearance is over specified value.

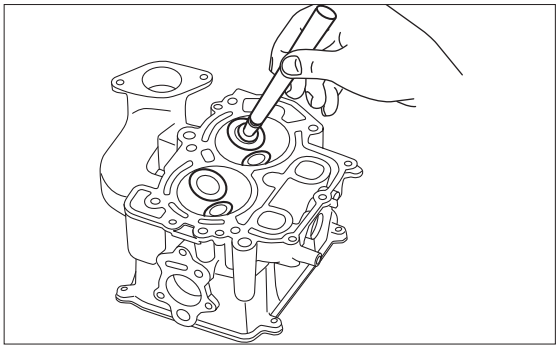


Clearance between valve guide and valve stem = Valve Guide Inner Diameter ⓐ - Valve Stem Outer Diameter ⓑ :
Intake Side : 0.008-0.040 mm (0.00031-0.00157 in)
Exhaust Side : 0.025-0.057 mm (0.00098-0.00224 in)

Functional Limit :
Intake Side : 0.070mm (0.00276 in)
Exhaust Side : 0.100 mm (0.00394 in)

14) Inspection of Valve Seat

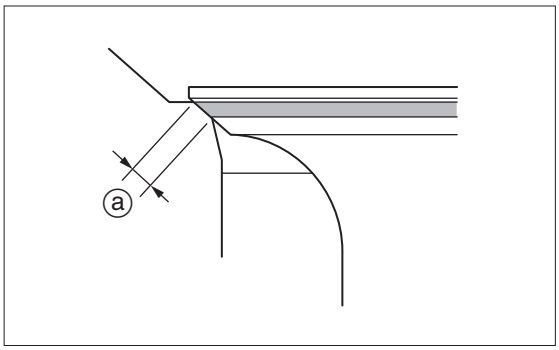
1. Remove carbon built up on the valve.



2. Apply thin coat of red lead on the valve seat evenly.

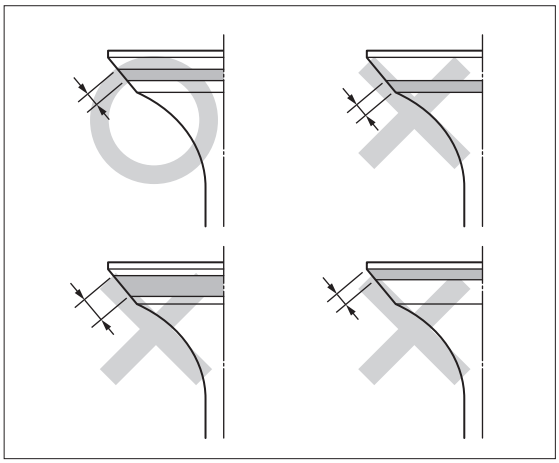
3. Use valve lapper (commercially available item) as shown to push valve onto valve seat lightly.

4. Measure width of area where valve face contacted with valve seat a that can be identified with red lead adhered to valve face. Correct valve seat if contact area is above or below the center or contact area of valve seat is over specified limit.



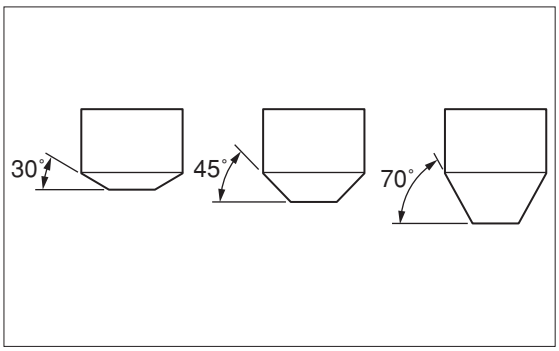
Valve Seat Contact Width ⓐ : Standard Value
Intake/Exhaust Side : 1.0 mm (0.04 in)

Functional Limit :
Intake/Exhaust Side : 2.0 mm (0.08 in)



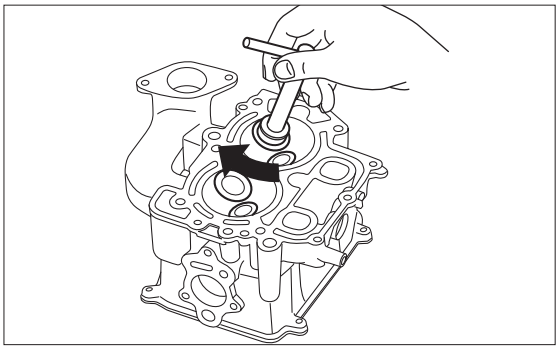
15) Correction of Valve Seat

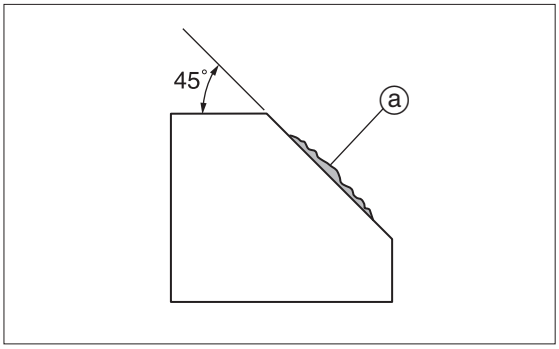
1. Use valve seat cutter (commercially available item) to correct valve seat.



2. Turn 45 degree cutter clockwise to cut valve seat surface to make it smooth.

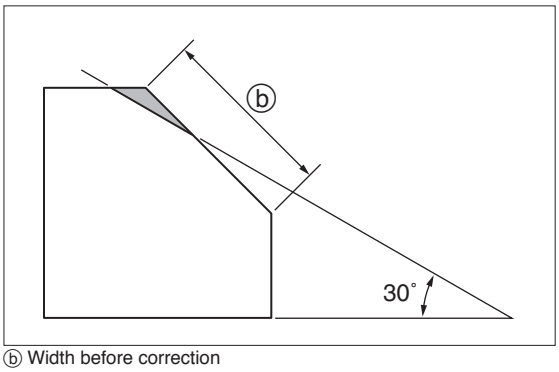
> Be careful not to over-cut valve seat. Turn valve seat cutter while pushing down evenly.





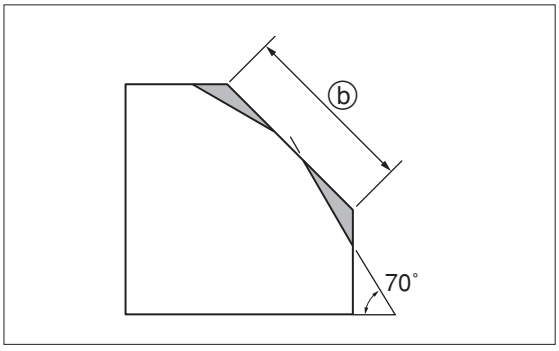
ⓐ Carbon build-up or uneven surface.

3. Use 30 degree cutter to adjust contact position of valve seat upper end.



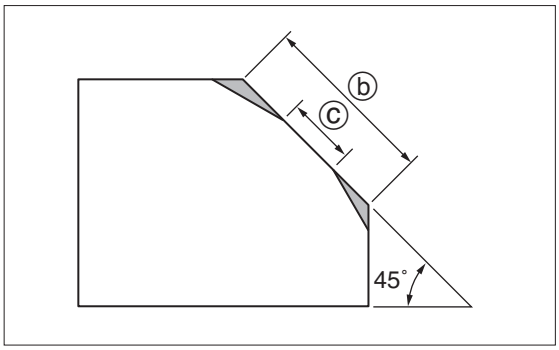
ⓑ Width before correction

4. Use 70 degree cutter to adjust contact position of valve seat lower end.



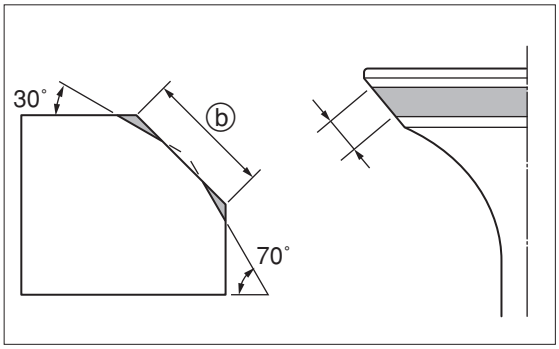
ⓑ Width before correction

5. Use 45 degree cutter to adjust contact width of valve seat ㉝ to specified value.



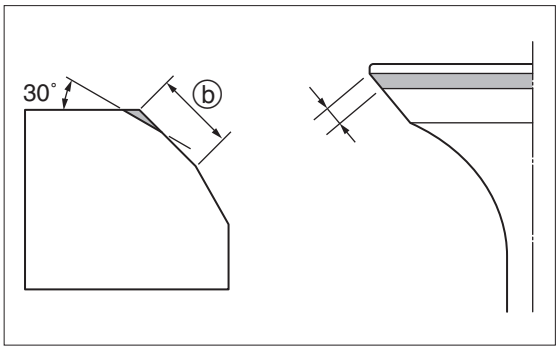
ⓑ Width before correction
ⓒ Specified width

6. Valve seat contact area is located on the center, which should be adjusted to specified value by cutting upper and lower ends by using 30 degree and 70 degree seat cutters respectively if the area is too wide.



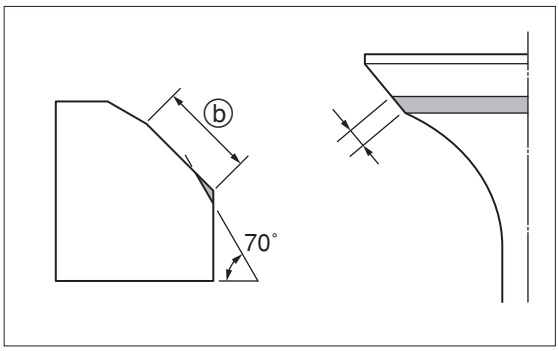
ⓑ Width before correction

7. If valve seat contact area is too narrow and is located nearer valve face upper end, use 30 degree seat cutter to cut upper end. Use 45 degree cutter to adjust contact width of valve seat to specified value.



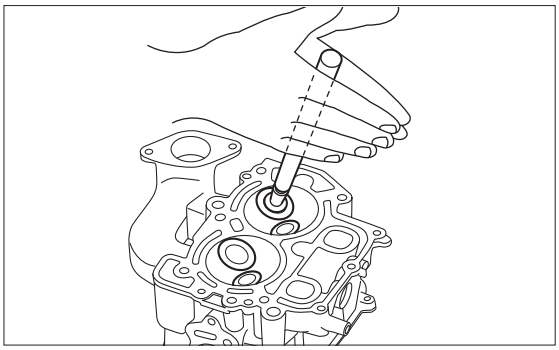
ⓑ Width before correction

8. If valve seat contact area is too narrow and is located nearer to valve face lower end, use 70 degree seat cutter to cut lower end. Use 45 degree cutter to adjust contact width of valve seat to specified value.



ⓑ Width before correction

9. Apply thin coat of abrasive compound on the overall valve seat contact area, and turn valve lapper (commercially available item) while lapping valve.



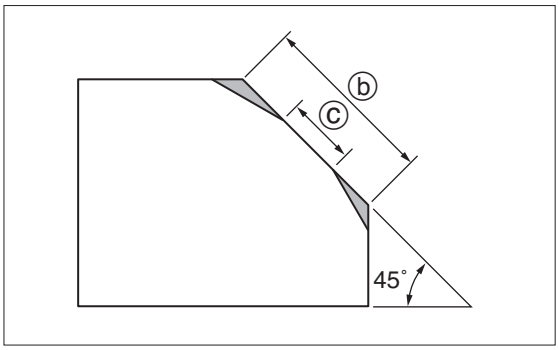
⚠ CAUTION

Perform the work by taking care not to allow abrasive compound to adhere to valve stem and valve guide.

- Use finer abrasive compound to finish.
- When changing abrasive compound to finer one, remove present one completely.
- After completion of lapping, wipe off the compound and then clean.

10. After ending the work, remove the compound completely from cylinder head and valve.

11. Check valve seat contact width ⓒ.

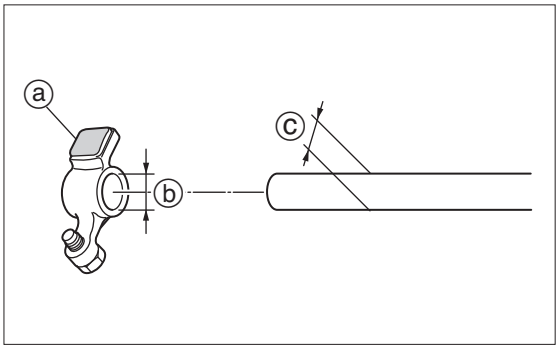


Valve Seat Contact Width ⓒ : Standard Value
1.0 mm (0.04 in)

16) Inspection of Locker Arm and Locker Arm Shaft

1. Check rocker arm, rocker arm shaft and rocker arm contact area ⓑ for wear. Replace if necessary.

2. Measure rocker arm inner diameter ⓑ and rocker arm shaft outer diameter ⓒ. Calculate oil clearance ⓓ (ⓓ = ⓑ - ⓒ). Replace if out of specification.



ⓓ = ⓑ – ⓒ

Rocker Arm Inner Diameter ⓑ : Standard Value
13.01 mm (0.5122 in)
Rocker Arm Shaft Outer Diameter ⓒ : Standard Value
12.99 mm (0.5114 in)
Oil Clearance Between Rocker Arm Hole and Shaft ⓓ :
0.006 - 0.035 mm (0.00024 - 0.00138 in)

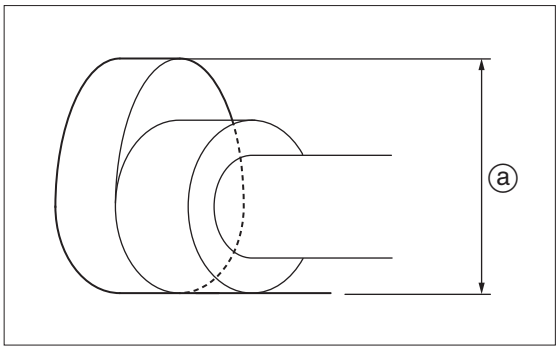
Functional Limit :
ⓑ Replace if ⓑ is over 13.05 mm (0.5138 in).
ⓒ Replace if ⓒ is less than 12.94 mm (0.5094 in).
ⓓ Replace if ⓑ is over 0.060 mm (0.00236 in).

17) Inspection of Cam Shaft

1. Measure cam height. Replace if it is less than specified value.

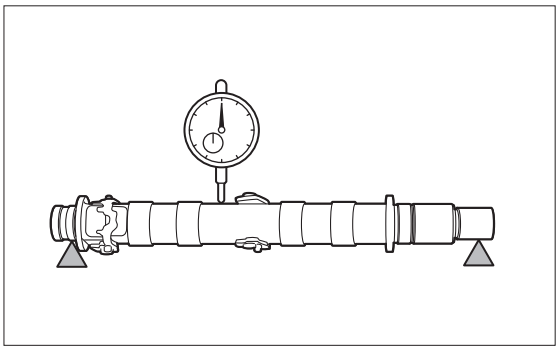
Cam Height at Both Intake and Exhaust Sides ⓐ : Standard Value
Intake side : 23.63 mm (0.9303 in)
Exthoust side : 23.80 mm (0.9370 in)

Functional Limit : Cam Height at Both Intake and Exhaust Sides ⓐ
Intake side : 23.5 mm (0.9252 in)
Extaust side : 23.5 mm (0.9252 in)



2. Measure cam shaft runout. Replace if it is over specified value.

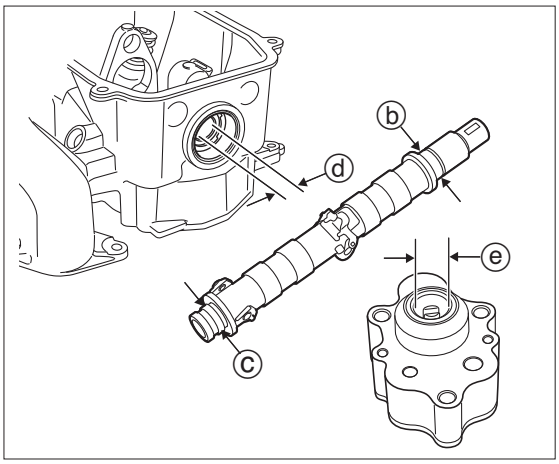
Cam Shaft Runout Limit :
0.05mm (0.0020 in)



3. Measure cam shaft journal outer diameters ⓒ and ⓓ. Replace cam shaft or cylinder head if either of the diameters is less than specified value.

Cam Shaft Outer Diameter (pulley side bearing) ⓑ : Standard Value
17.975 - 17.990 mm (0.7077 - 0.7083 in)
Cam Shaft Outer Diameter (oil pump side and center bearing) ⓒ : Standard Value
15.965 - 15.980 mm (0.6285 - 0.6291 in)

Functional Limit :
ⓒ 17.95 mm (0.7067 in)
ⓓ 15.95 mm (0.6280 in)



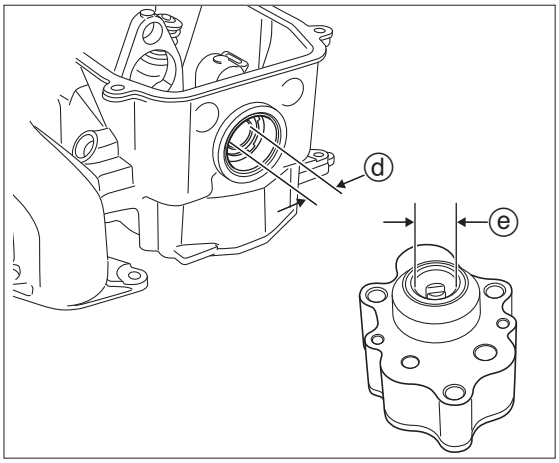
4. Measure cylinder head journal inner diameter ⓔ and oil pump journal inner diameter ⓕ. Calculate oil clearance. Oil clearances are obtained by ⓔ - ⓒ and ⓕ - ⓓ respectively. Replace cam shaft, cylinder head or oil pump if either of the clearances is over specified value.

Cylinder head jounal inside diameter ⓓ (upper): Standard Value
18.010 - 18.025 mm (0.7091 - 0.7096 in)

Functional Limit :
18.050 mm (0.7106 in)

Oil Clearance ⓓ-ⓑ : Standard Value
0.02 - 0.05 mm (0.0008 - 0.0020 in)

Functional Limit :
0.09 mm (0.0035 in)



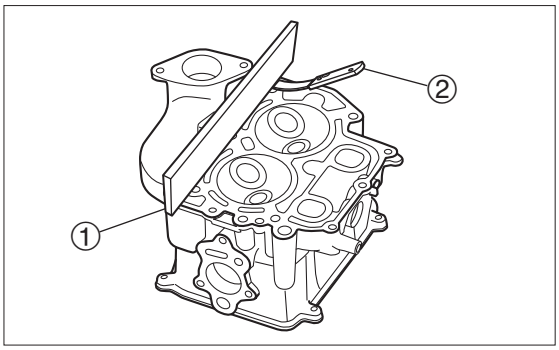
If oil clearance is over functional limit, replace any of cylinder head, cam shaft and oil pump or all of them as a set, and check that the clearance is within specified range.

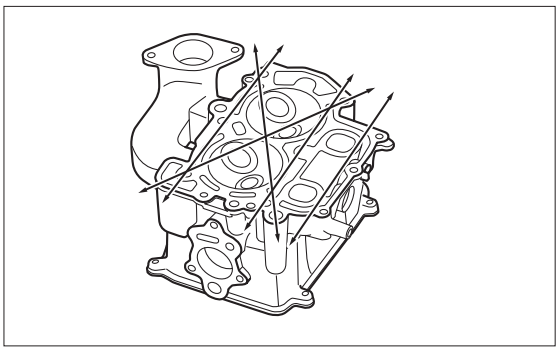
18) Inspection of Cylinder Head

1. Remove carbon build-up of combustion chamber, and check for deterioration.

2. Use straight edge ① and thickness gauge ② to check distortion of cylinder head in the directions shown. Replace if the distortion is over specified value.

Cylinder Head Distortion Limit :
0.1 mm (0.004 in)





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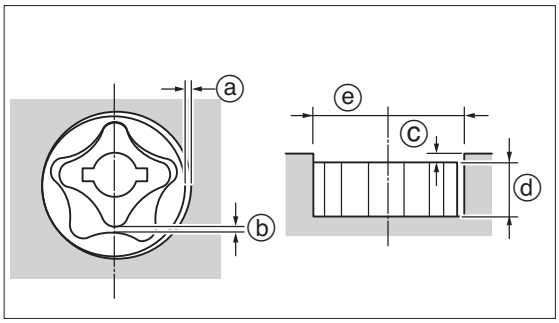
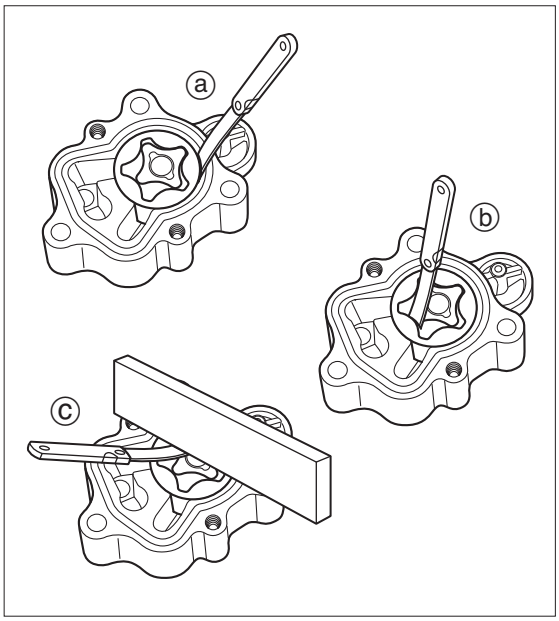
19) Inspection of Oil Pump

1. Use micrometer, cylinder gauge, depth gauge and thickness gauge to measure dimensions shown below. Replace oil pump if over specified value.

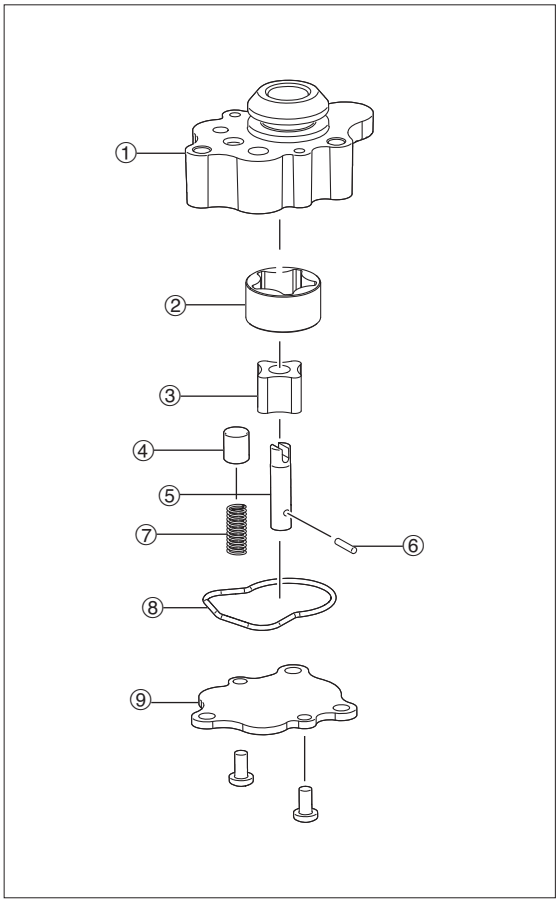
Functional Limit :
Clearance between Outer Rotor and Body ⓐ :
0.36 mm (0.0142 in)
Clearance between outer and inner rotors ⓑ :
0.16 mm (0.0063 in)
Clearance between sides of rotor and body ⓒ :
0.11 mm (0.0043 in) (including wear of oil pump cover)
Height of Outer Rotor ⓓ :
14.96 mm (0.5890 in)
Pump Body Inner Diameter ⓔ :
29.04 mm (1.143 in)



2. Push plunger piston and check that it moves smoothly. If it can not be pressed or does not return, replace oil pump.

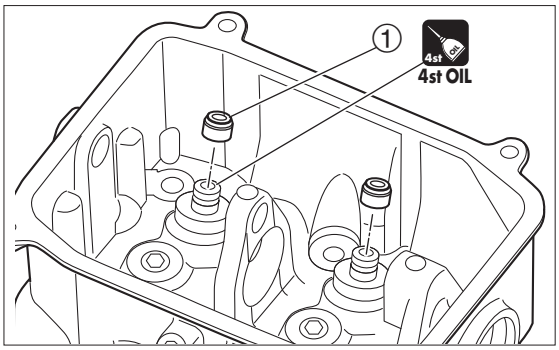


① Pump body
② Outer rotor
③ Inner rotor
④ Shaft
⑤ Pin
⑥ Plunger piston
⑦ Plunger spring
⑧ Gasket
⑨ Oil pump cover



20) Installation of Valves

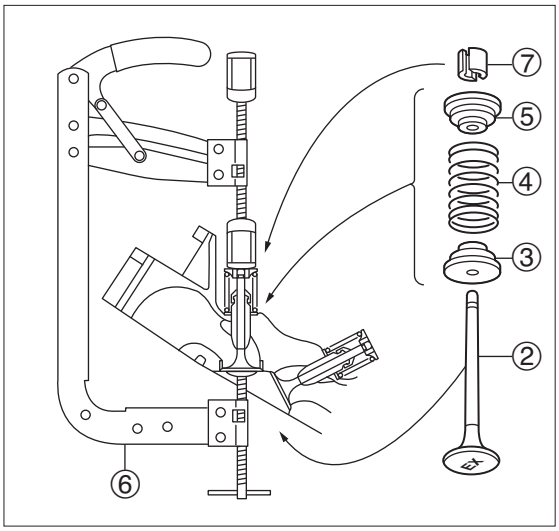
1. Apply oil to valve guide and attach new valve stem seal.



Intake Side : Black
Exhaust Side : Green

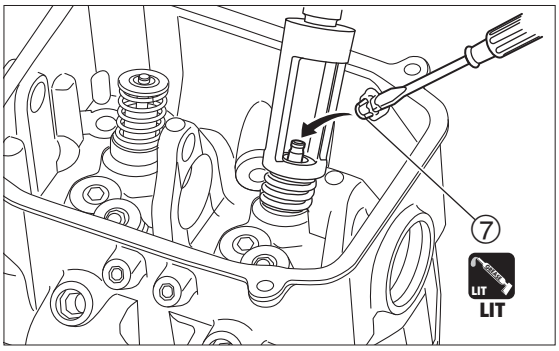
2. Install valve ②, valve spring seat ③, valve spring ④ and retainer ⑤ in the order shown, and then, attach valve spring compressor ⑥.

Valve Spring Compressor ⑥ :
Commercially available item

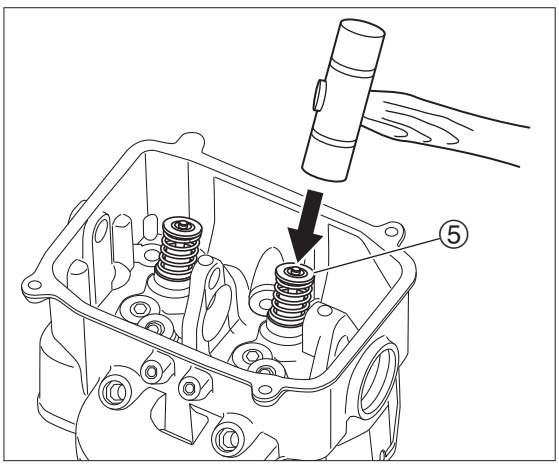


- Valves, springs and other power unit related parts should be arranged in the order they are removed.
- Use attachment with inner diameter of 16.5 mm.
- If valve spring compressor is not used, put cylinder head on the folded rag to prevent valves from being damaged.

3. With valve spring ④ being compressed, use small screw driver with small amount of grease at the tip to put cotter ⑦.



4. Tap retainer ⑤ with plastic hammer to fix cotter ⑦ securely.



21) Installation of Cam Shaft

1. Apply engine oil to periphery of new oil seal ① and install it.

Oil Seal Attachment :
Commercially available item

Apply seal grease to lip of oil seal before installing it.

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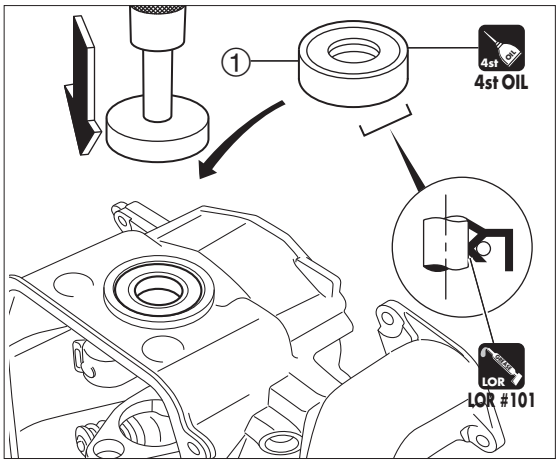
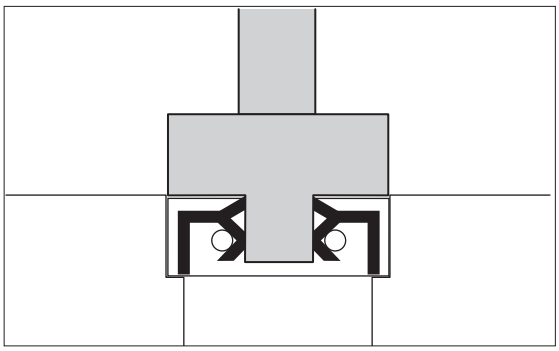
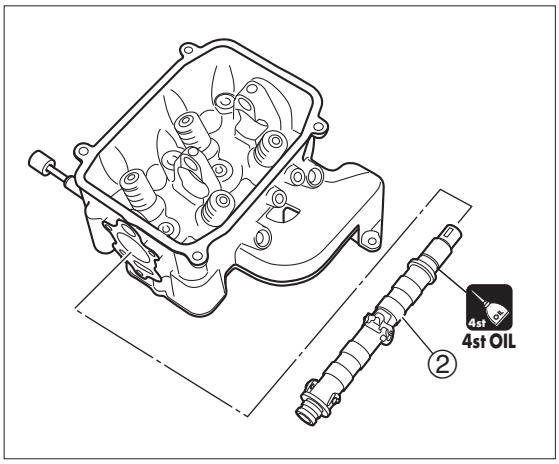


①オイルシール 50-68-9

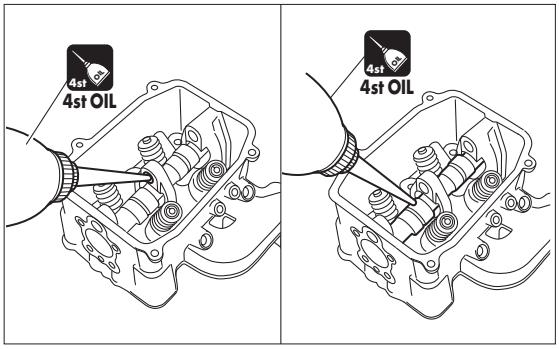


2. Apply engine oil to camshaft, install cam shaft ② from direction shown.

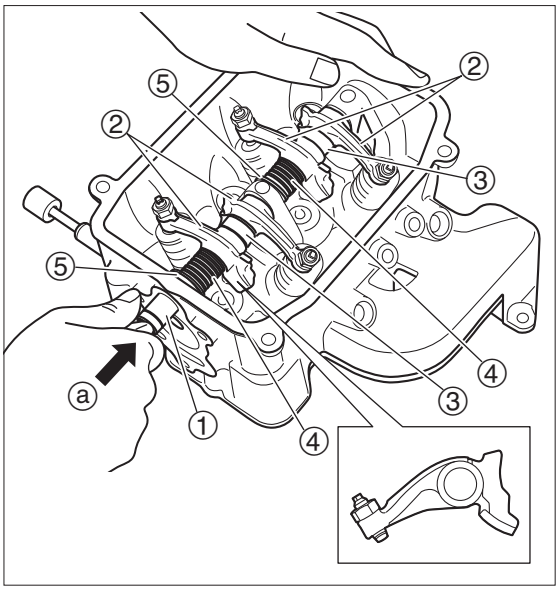


22) Installation of Rocker Arm Shaft

1. Apply sufficient amount oil to cam surface of cam shaft and journal of rocker arm shaft.



2. Install rocker arms ②, collar ③, springs ④, and washers ⑤ from lower side of cylinder head ⓐ while installing rocker arm shaft ①.

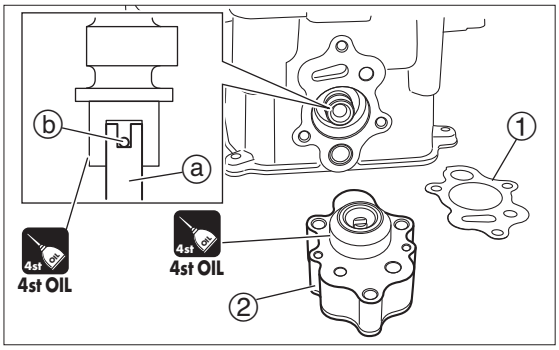


- Only for # 2 EX rocker arm on oil pump side is different in shape.
- Apply sufficient amount of engine oil to rocker arm and adjust screw after installing rocker arm.

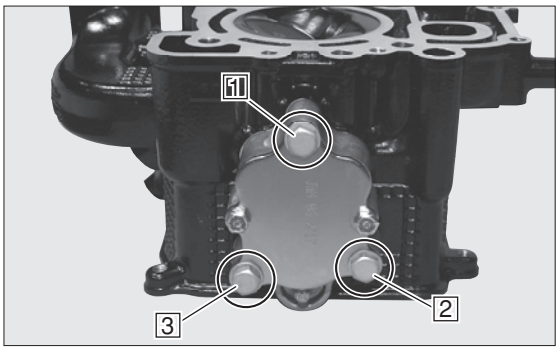
4st OIL

23) Installation of Oil Pump

1. Set gasket ①, then align cuts of oil pump drive shaft ⓐ and cam shaft pin ⓑ with each other to install oil pump ②.

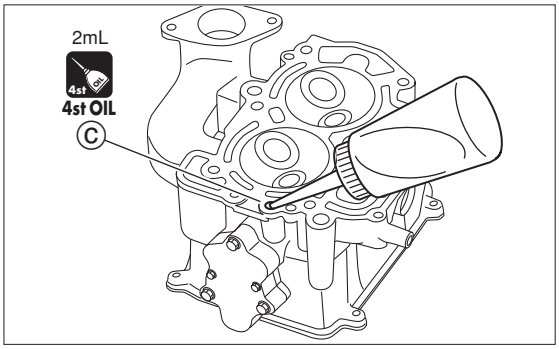


2. Secure oil pump using Four M6 bolts by tightening them to specified torque in the order specified below.
Bolt tightening order : 1→2→3



Oil Pump Bolts :
6 N·m (4 lb·ft)[0.6 kg·m]

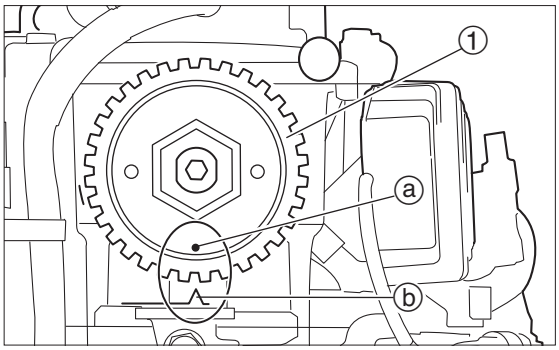
3. Apply engine oil to cam shaft lower side journal ⓒ (approx. 2 ml), and install oil pump.



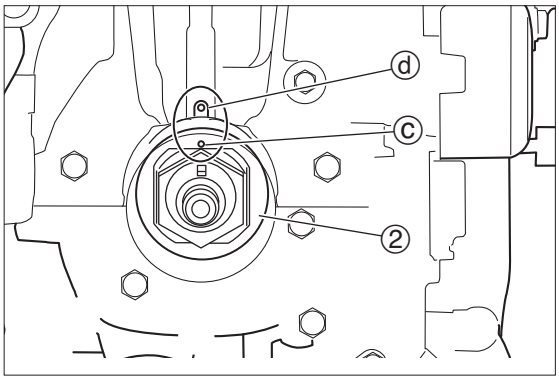
24) Installation of Cylinder Head

No.1 piston is to be at top dead center of compression stroke.

1. After installing driven pulley, bring "●1" mark ⓐ of pulley ① to "▲" mark ⓑ of cylinder head.



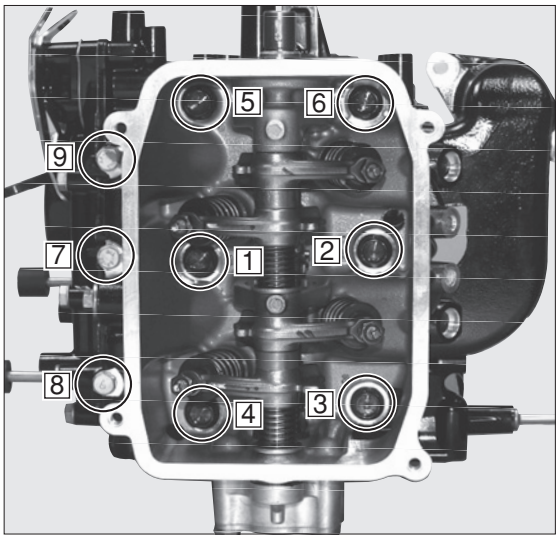
2. Check that "●" mark ⓒ of drive Pulley ② and "●" mark ⓓ of cylinder block are aligned with each other.



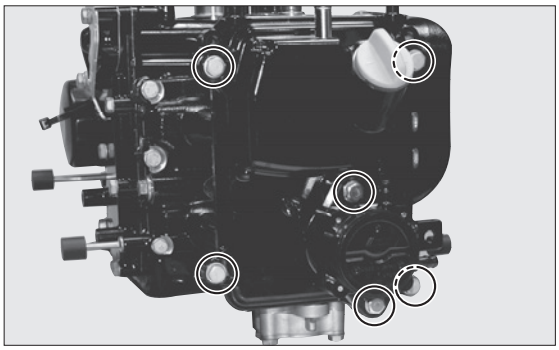
3. Install cylinder head with new gasket, and tighten bolts in the order shown in two steps to specified torque.

⚠ CAUTION

- **Do not reuse cylinder head gasket. Be sure to replace with new one.**
- **Do not turn timing pulley or cam shaft pulley with timing belt removed. Doing so can make pistons and valves interfere with each other, possibly resulting in damages to these parts.**



- First, tighten M8 bolts in two steps to specified torque.
- Then, tighten M6 bolts in two steps to specified torque.
- After installing cylinder head, install timing belt and check valve clearance. Refer to “Chapter 5 Checking Valve Clearance" (P3-19).



First step:
Cylinder Head Bolts (M8) 1 ~ 6
10 N·m (7 lb·ft) [1.0 kgf·m]
Cylinder Head Bolts (M6) 7 ~ 9
6 N·m (4 lb·ft) [0.6 kgf·m]
Second step:
Cylinder Head Bolts (M8) 1 ~ 6
30 N·m (22 lb·ft) [3 kgf·m]
Cylinder Head Bolts (M6) 7 ~ 9
10 N·m (7 lb·ft) [1.0 kgf·m]

4. Install cylinder head cover, and tighten them.

5. Install fuel pump.

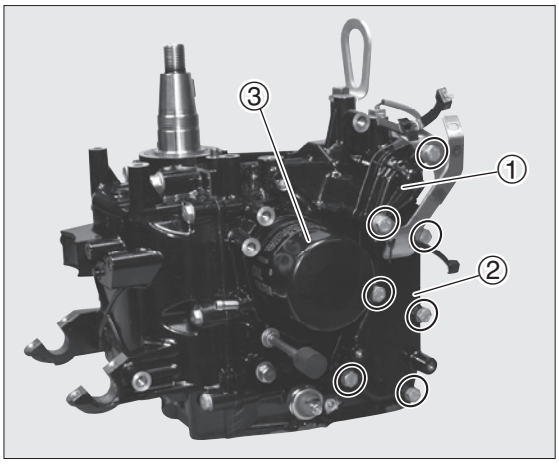
25) Disassembly of Cylinder Block

1. Remove thermostat cover bolt and the cover ① and exhaust cover ②.

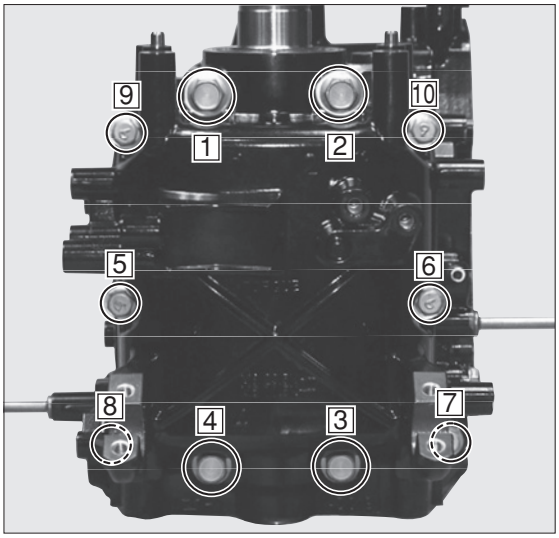
2. Remove oil filter ③.

Wipe off spilled oil completely.

Oil Filter Wrench :
P/N. 3AC-99090-0



3. Loosen crank case bolts in several steps in the reverse sequence of order shown, and remove crank case. 10 ~ 1

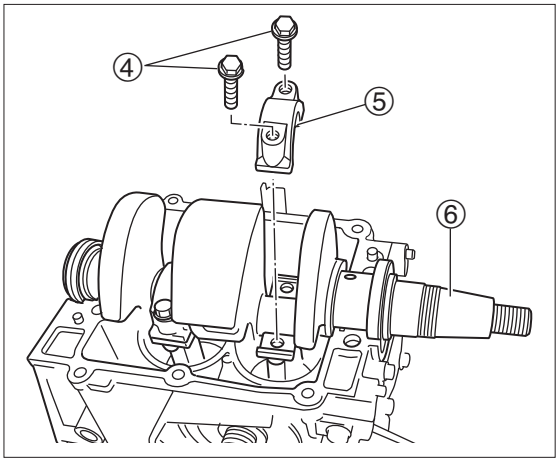


4. Remove connecting rod bolts ④ and connecting rod cap ⑤, and then, crankshaft ⑥ and oil seal.

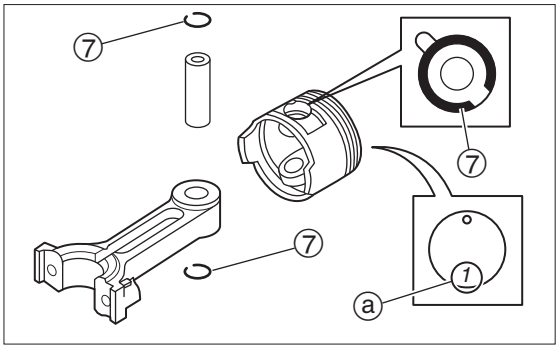
5. Remove bearings from cylinder block and crankcase.

6. Remove connecting rods and piston assemblies from cylinder block.

- Removed bearings should be arranged in the order they are removed.
- Mark individual pistons with number ⓐ corresponding to their cylinders.
- Connecting rods and caps should be arranged as pairs in the order they are removed. Removes parts should be arranged so that they can be reassembled in their original positions and orientations.
- Do not reuse piston pin clips. Be sure to replace with new ones.



7. Remove piston pin clips ⑦ and piston pin, and then, piston.



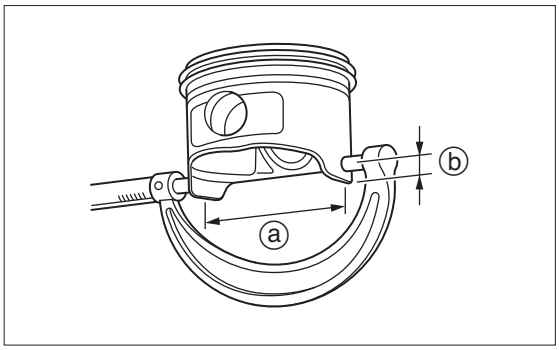
⑦ piston pin clips **Do not reuse.**

26) Inspection of Piston Outer Diameter

1. Measure piston outer diameter between points specified. Replace if the diameter is less than specified value.

Piston Outer Diameter ⓐ : Standard Value
60.960 mm (2.4000 in)
Measurement Points ⓑ :
12 mm (0.47 in) above piston skirt bottom

Functional Limit :
69.90 mm (2.7520 in)



27) Inspection of Cylinder Inner Diameter

1. Measure cylinder inner diameters (D1 to D6) at ⓐ, ⓑ and ⓒ in crankshaft directions ⓓ (D1, D3 and D5 respectively), and in crank web directions ⓔ (D2, D4 and D6 respectively).

Cylinder Inner Diameters (D1 to D6) : Standard Value
61.00 mm (2.4016 in)

Functional Limit :
Replace if over 61.06 mm (2.4039 in).

Note : Measure at the maximum wear points.

2. Obtain taper through calculation described below. Replace cylinder block if taper is over specified value.

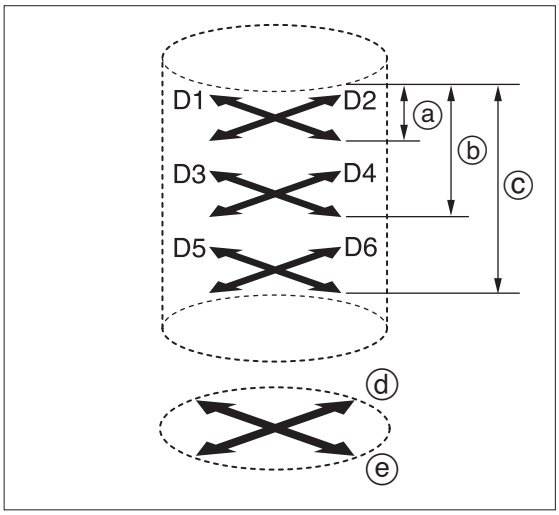
Taper :
D1–D5 (Measurement Point ⓐ)
D2–D6 (Measurement Point ⓒ)

Functional Limit :
0.08 mm (0.0031 in)

3. Obtain out-of-roundness through calculation described below. Replace cylinder block if out-of-roundness is over specified value.

Out-of-roundness :
D2–D1 (Direction ⓐ)
D6–D5 (Direction ⓒ)

Functional Limit :
0.06 mm (0.0024 in)



ⓐ 15 mm (0.6 in)
ⓑ 40 mm (1.6 in)
ⓒ 65 mm (2.6 in)
ⓓ Crankshaft direction
ⓔ Crank web direction

28) Inspection of Piston Clearance

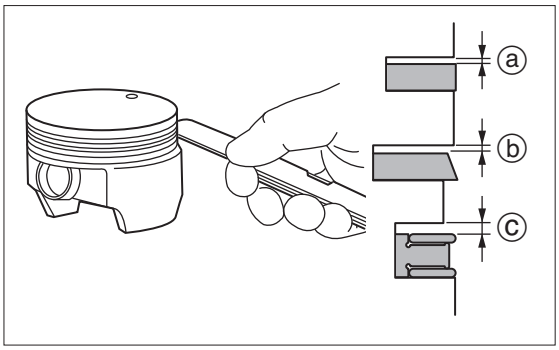
1. If piston clearance is over specified limit, replace cylinder block, piston and piston rings as a set, or both.

Piston Clearance (Cylinder inside diameter – Piston outside diameter):
0.020 to 0.055 mm (0.00079 to 0.00217 in)

Functional Limit :
0.150 mm (0.00591 in)

29) Inspection of Piston Ring Side Clearance

1. Measure piston side clearance. Replace piston and piston rings as a set if the clearance is over specified value.



Piston Side Clearance :
Top Ring ⓐ : 0.03 to 0.08 mm (0.0012 to 0.0031 in)
Second Ring ⓑ : 0.02 to 0.06 mm (0.0008 to 0.0024 in)
Oil Ring ⓒ : 0.03 to 0.13 mm (0.0012 to 0.0051 in)

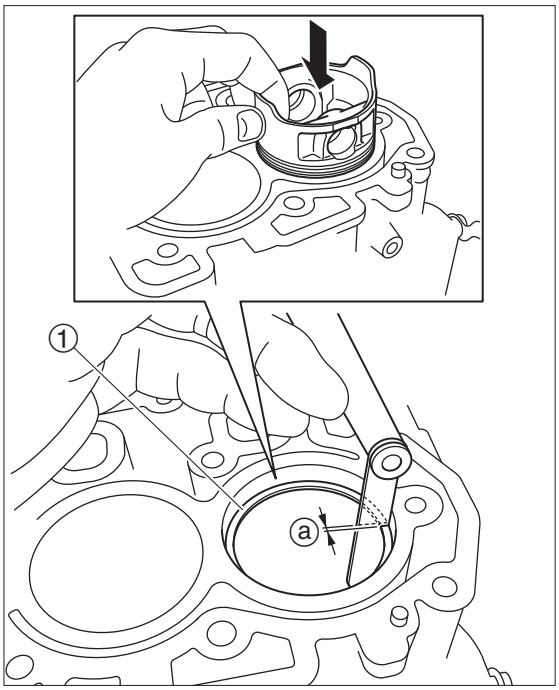
Functional Limit :
Top Ring ⓐ : 0.10 mm (0.0039 in)
Second Ring ⓑ : 0.09 mm (0.0035 in)
Oil Ring ⓒ : 0.15 mm (0.0059 in)

30) Inspection of Piston Rings

1 Push piston ring ① into ring gauge parallel to top edge. Measure at the top or bottom of cylinder bore with no wear.

2. When ring gauge is not available, use piston crown to push piston ring ① into to cylinder.

3. Measure piston ring closed gap ⓐ. Replace if the gap is over specified value.



Piston Ring Closed Gap ⓐ :
Top Ring : 0.15 to 0.30 mm (0.0056 to 0.0118 in)
Second Ring : 0.35 to 0.50 mm (0.0138 to 0.0197 in)
Oil Ring : 0.20 to 0.70 mm (0.0079 to 0.0276 in)

Functional Limit :
Top Ring : 0.50 mm (0.0197 in)
Second Ring : 0.70 mm (0.0276 in)
Oil Ring : 0.90 mm (0.0354 in)

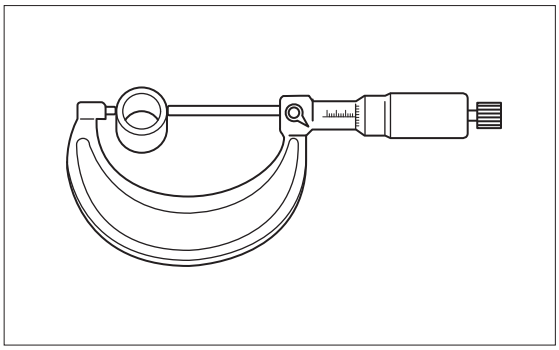
Replace oil ring when top ring or second ring is replaced.

5

31) Inspection of Piston Pins

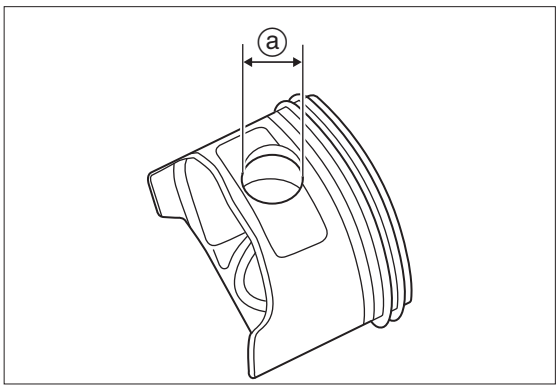
1. Measure piston pin outer diameter. Replace piston pin if outer diameter is less than specified value.

Piston Pin Outer Diameter : Standard Value 16.00 mm (0.62992 in)
Functional Limit : 15.97 mm (0.62874 in)



2. Measure piston pin inner diameter ⓐ. Replace piston pin if the inner diameter is over specified value.

Piston Pin Inner Diameter ⓐ : Standard Value 16.002 to 16.008 mm (0.6300 to 0.6302 in)
Functional Limit : 16.012 mm (0.6304 in)



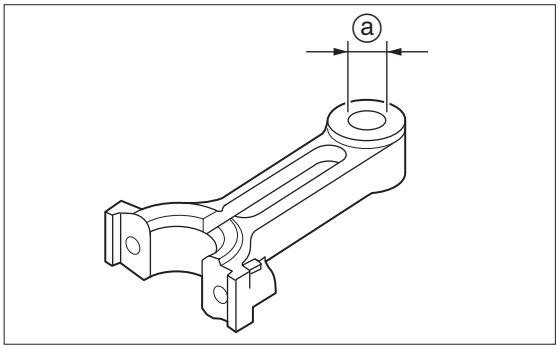
3. Obtain clearance between piston pin and pin boss. Replace piston pin or piston if the clearance is over specified value.

Clearance Between Piston Pin and Pin Boss : 0.002 to 0.012 mm (0.00008 to 0.00047 in)
Functional Limit : 0.040 mm (0.00157 in)

32) Inspection of Connecting Rod Small End Inner Diameter

1. Measure connecting rod small end inner diameter ⓐ. Replace connecting rod if the diameter is over specified value.

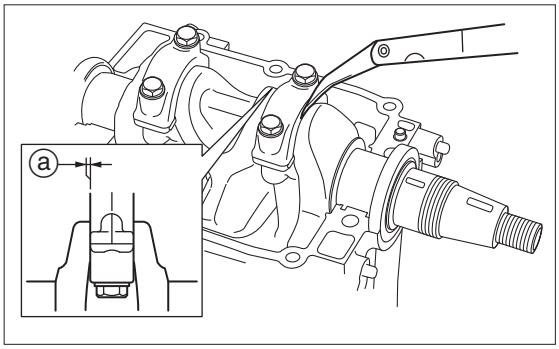
Connecting Rod Small End Inner Diameter ⓐ : Standard Value 16.010 to 16.021 mm (0.63031 to 0.63075 in)
Functional Limit : 16.040 mm (0.6315 in)



33) Inspection of Connecting Rod Big End Side Clearance

1. Measure connecting rod big end side clearance ⓐ. Replace connecting rod and/or crankshaft if the clearance is over specified value.

Connecting Rod Big End Side Clearance ⓐ : 0.10 to 0.25 mm (0.0039 to 0.0098 in)
Functional Limit : 0.60 mm (0.0236 in)

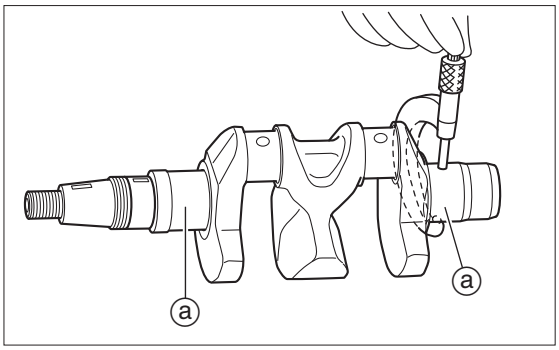


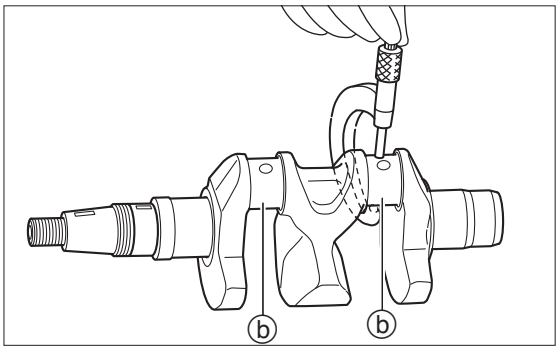
34) Inspection of Crankshaft

1. Measure crankshaft journal outer diameter ⓐ and crank pin outer diameter ⓑ. Replace crankshaft if either outer diameter is less than specified value.

Crankshaft Journal Outer Diameter ⓐ :
Standard Value
39.988 to 33.996 mm (1.3381 to 1.3384 in)
Crank Pin Outer Diameter ⓑ : Standard Value
28.927 to 28.985 mm (1.1406 to 1.1411 in)

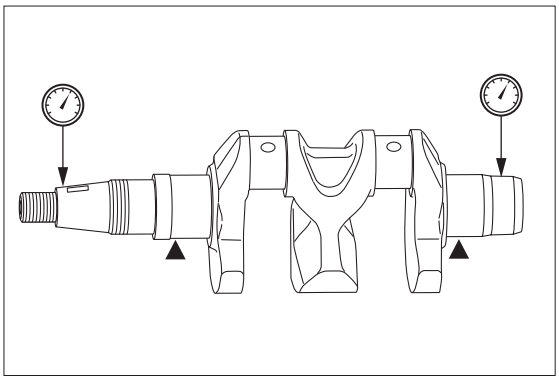
Functional Limit :
Crankshaft Journal Outer Diameter ⓐ :
Replace if ⓐ is less than 33.97 mm (1.3374 in).
Crank Pin Outer Diameter ⓑ :
Replace if ⓑ is less than 28.94 mm (1.1411 in).





2. Measure crankshaft runout. Replace crankshaft if runout is over specified value.

Crankshaft Runout Limit :
0.03 mm (0.0012 in)



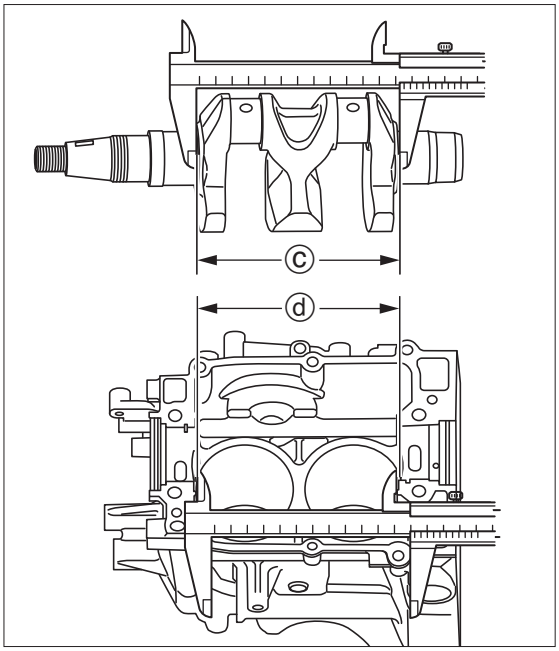
3. Side Clearance

Side Clearance :
0.1 to 0.20 mm (0.0039 to 0.0079 in)

Functional Limit :
0.6 mm (0.0236 in)

If side clearance is out of specified range, measure crank case (cylinder side) width ⓓ and crankshaft width ⓒ, and replace the part of which width is out of specified range.

Crankshaft Width ⓒ : Standard Value
126.90 to 126.95 mm (4.9961 to 4.99808 in)
Crank Case Width ⓓ : Standard Value
127.05 to 127.10 mm (5.0020 to 5.0039 in)



35) Inspection of Crank Pin (rod journal) Oil Clearance

1. Clean connecting rod and metal bearing, and then install metal bearing.

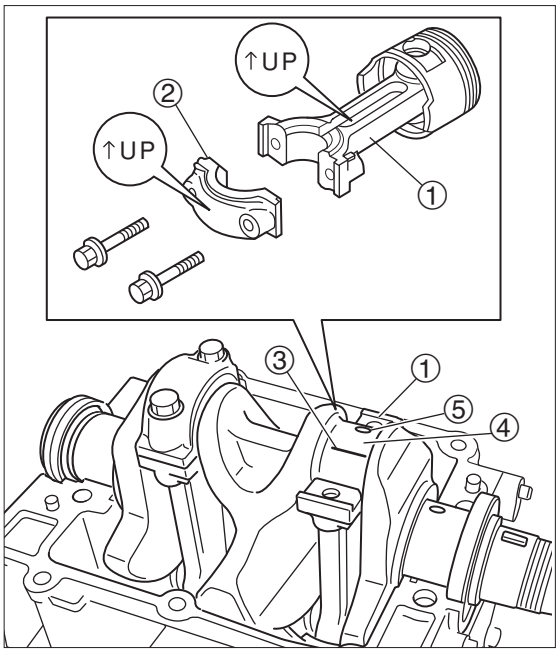
2. Place cylinder block upside down on the work bench. Install piston to connecting rod ①.

> Do not attach piston rings.

3. Install crankshaft on the cylinder block.

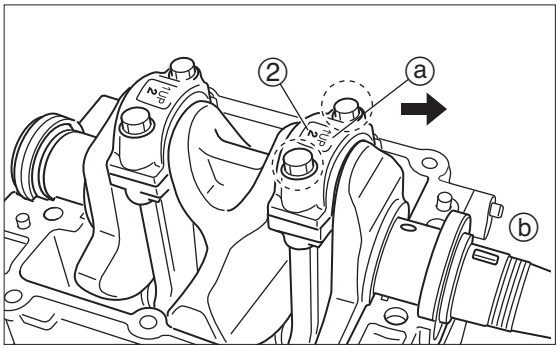
4. Place plasti-gauge ③ on each crank pin ④ parallel to crankshaft.

> Do not place plasti-gauge ③ on the oil hole of crank pin ④.



5. Install connecting rod and cap ② to crank pin ④.

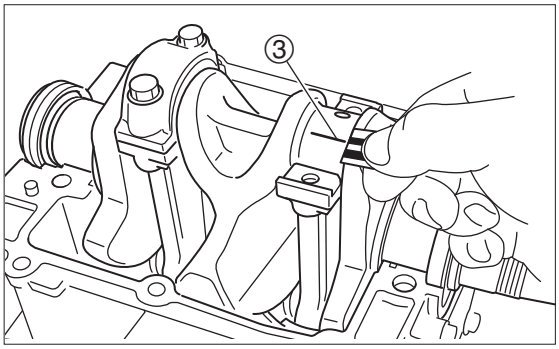
> · Be sure that individual cap is installed to their original connecting rod.
> · Check that "UP" mark ⓐ of connecting rod is at crankshaft flywheel side ⓑ.



6. Tighten connecting rod bolts in two steps to specified torque.

> Do not move connecting rod and crankshaft until oil clearance measurement is completed.

Connecting Rod Bolts :
First Tightening Torque : 6 N·m (4 lb·ft) [0.6 kgf·m]
Final Tightening Torque : 10 N·m (7 lb·ft) [1.0 kgf·m]

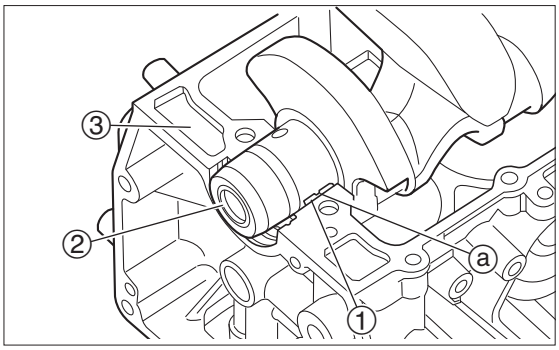


7. Remove connecting rod cap and measure width of crushed plasti-gauge on each crank pin. Replace connecting rod or crankshaft if the width is over specified value.

Crank Pin Oil Clearance :
0.012 to 0.044 mm (0.00047 to 0.00173 in)

Functional Limit :
0.060 mm (0.00236 in)

36) Inspection of Crank Shaft Main Journal Oil Clearance

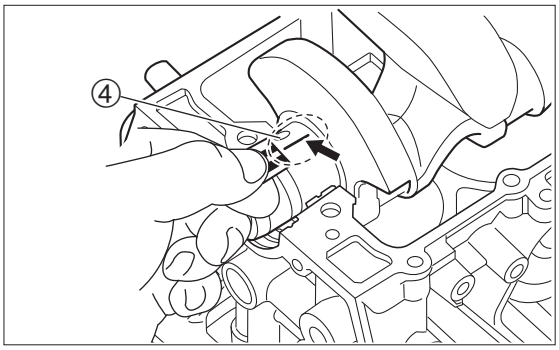


1. Clean bearings, crankshaft main journal, and bearing installation areas of crank case and cylinder block.

2. Place cylinder block on the work bench with cylinder head side facing downward.

3. Install bearing ① and crankshaft ② to cylinder block ③.

> • Be sure that individual bearings are installed to their original locations.
> • Install bearings with their projection ⓐ fit into cylinder block groove.



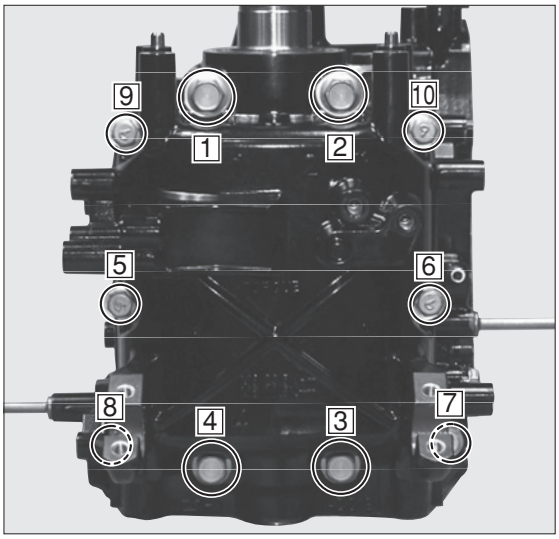
4. Place plasti-gauge ④ on each crankshaft main journal parallel to crankshaft.

> Do not place plasti-gauge on the oil hole of crankshaft main journal.

5. Install bearings to crank case.

> • Be sure that individual bearings are installed to their original locations.
> • Install bearings with their projection fit into crank case groove.

6. Install crank case to cylinder block.



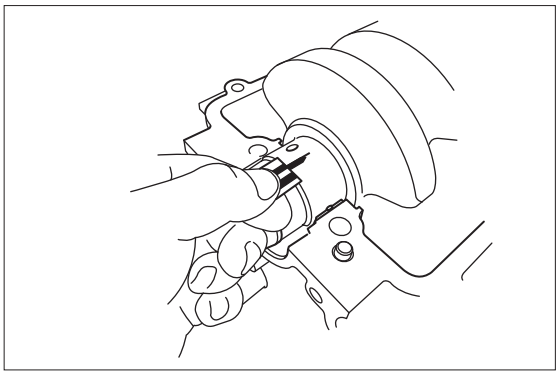
7. Tighten crank case bolts in two steps to specified torque in the order shown.

> **First Tightening Torque :**
> 1 ~ 4 **: Crank Case Bolts (M8)**
> 10 N·m (7 lb·ft) [1.0 kgf·m]
> 5 ~ 10 **: Crank Case Bolts (M6)**
> 6 N·m (4 lb·ft) [0.6 kgf·m]
> **Final Tightening Torque :**
> 1 ~ 4 **: Crank Case Bolts (M8)**
> 23.5 N·m (18 lb·ft) [2.4 kgf·m]
> 5 ~ 10 **: Crank Case Bolts (M6)**
> 11.5 N·m (8.5 lb·ft) [1.15 kgf·m]

8. Loosen bolts in reverse order in several steps. Remove crank case and measure width of crushed plasti-gauge on each main journal. Replace bearing if the width is over specified value.

Crankshaft Main Journal Oil Clearance :
0.012 to 0.044 mm (0.00047 to 0.00173 in)

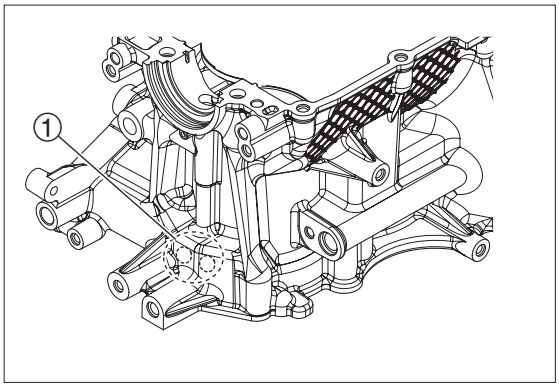
Functional Limit :
0.060 mm (0.00236 in)



If the clearance is less than specified value, check that inner diameter code is as shown below.

37) Inner Diameter of Cylinder/Crank Case Bearing Holder (Inner Diameter Code)

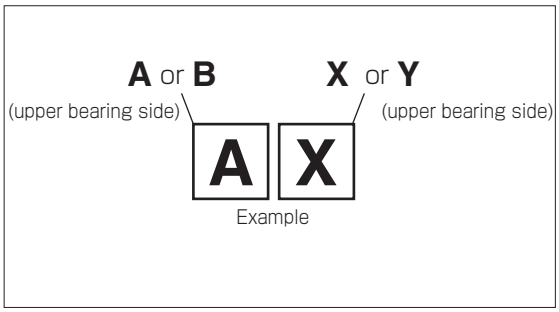
Cylinder is marked on its upper section with inner diameter code ① that indicates inner diameter of each bearing holder. There are the following two types of bearings that are indicated with the inner diameter code, which is to be used for identification of proper size bearing.



① Inner diameter code

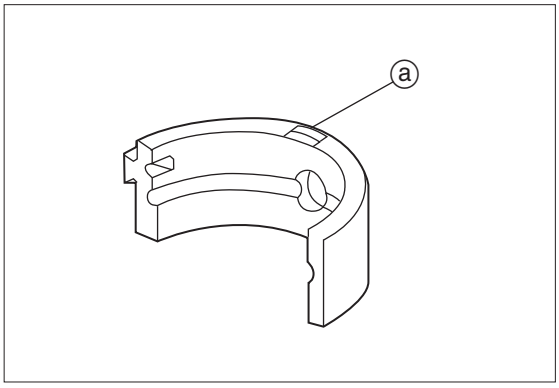
Inner diameter code ①	Standard value	Coloring of bearing
A or X	37.000 to 37.008 mm (1.45669 to 1.45701 in)	Blue
B or Y	37.008 to 37.016 mm (1.45701 to 1.45732 in)	Red

Inner diameter codes A and B or X and Y represent size of each bearing section.



38) Thickness of Metal Bearing (Color of Inner Diameter Code)

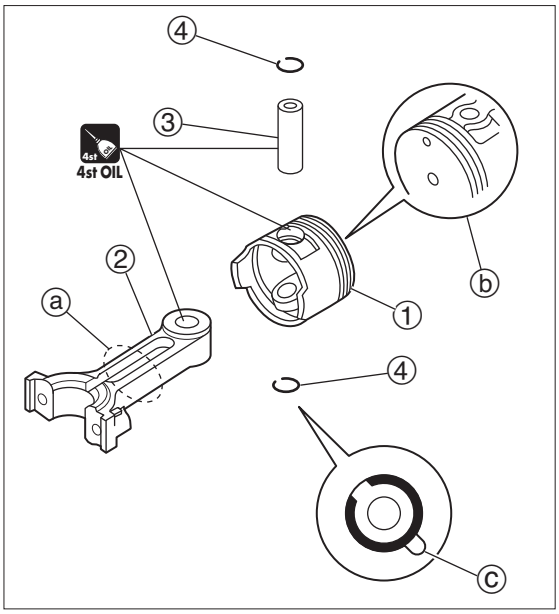
Bearing is painted with color ⓐ that represents thickness. There are the following two types of bearings that are to be selected properly.



[Coloring (Inner Diameter Code)]	Thickness
Blue	1.488 to 1.494 mm (0.05858 to 0.05882 in)
Red	1.494 to 1.500 mm (0.05882 to 0.05906 in)

39) Assembling Piston and Connecting Rod

1. Install connecting ②, piston pin ③, and piston pin clip ④ to piston ①.

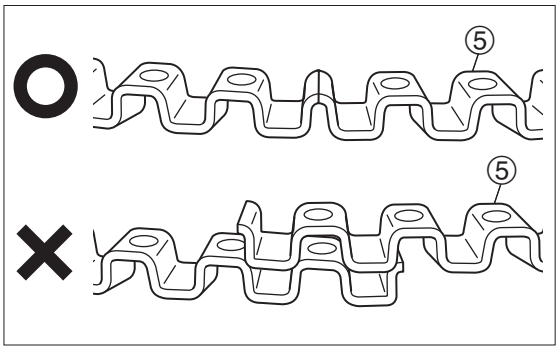


- Point "❍" mark of connecting rod ⓐ and "UP" mark ⓑ of piston at the same direction.
- Be sure to use new piston pin clip, and place clip gap away from piston pin groove ⓒ as shown.
- Be sure that individual connecting rod cap is installed to their original connecting rod.

2. Put expander ⑤ (#4) into oil ring groove, and check that ring ends meets correctly as shown.

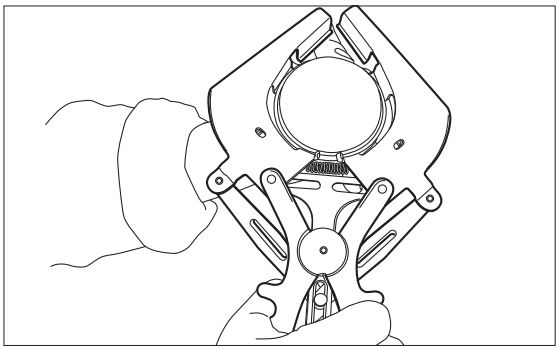
3. While holding expander ⑤ (#4) gap with thumb, put upper side rail (#3) into the groove so that the gap is away from gap of expander ⑤ (#4) to the left by 90 degrees.

4. In similar way, put lower side rail (#5) into the groove so that the gap is away from gap of expander 5 (#4) to the right by 90 degrees.



5. Install second ring (#2 taper) and top ring (#1) to piston. Install the rings so that their side with manufacturer's identification ⓓ (T) faces upward.

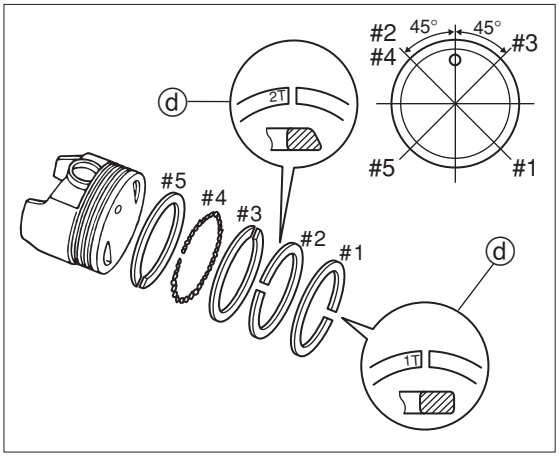
Piston Ring Tool :
P/N. 353-72249-0



6. Install piston ring so that their gaps are away from each other.

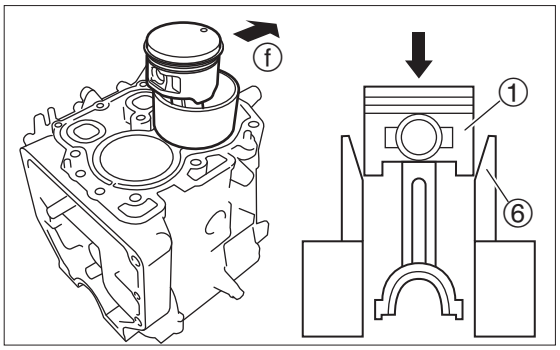
⚠ CAUTION

Be careful not to scratch piston surface and damage rings.



- Install piston rings so that their gaps are away also from thrust direction of piston and direction piston pin.
- After installing piston rings, check that they move smoothly.

7. Put pistons into cylinder with piston ① "❍" mark directing flywheel side ⓕ and piston slider ⑥ set on the pistons ①.

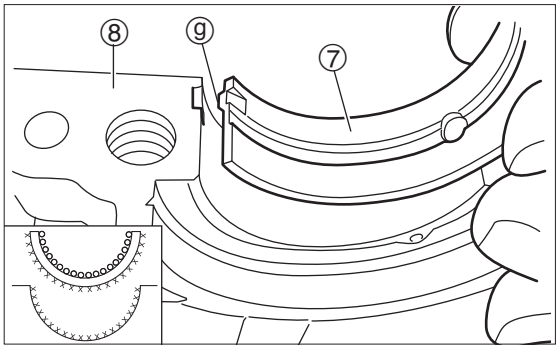


- Before installing, apply engine oil to piston peripheral surfaces, piston rings and piston sliders.
- Clean and remove piston carbon.

Piston Slider ⑥ :
P/N. 3KY-72871-0

8. Clean and remove grease on bearing holder of crankscase (x).

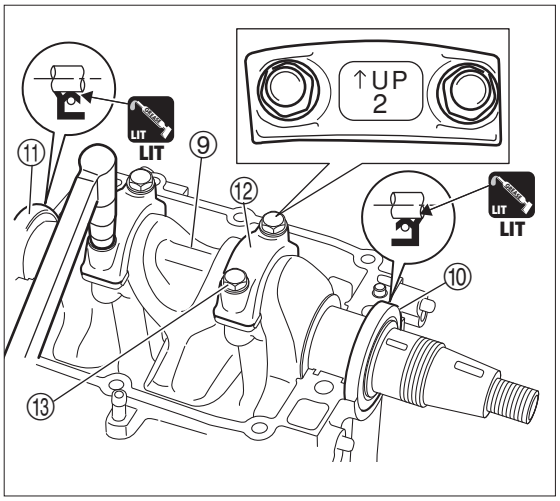
9. Install bearing half ⑦ to cylinder block ⑧ and connecting rod.



- Be sure that individual bearings are installed to their original locations.
- Install bearings with their projection ⓖ fit into cylinder block groove.

10. Apply engine oil to bearings and crankshaft (❍).

11. Install crankshaft ⑨ and oil seals ⑩ and ⑪ on the cylinder block.



- Apply grease to lip of oil seal before installing it.
- Be sure that individual connecting rod cap is installed to their original connecting rod.

12. Attach connecting rod cap ⑫ with metal bearing to connecting rod, and tighten connecting rod bolts ⑬ in two steps to specified torque.

Connecting Rod Bolts ⑬ :
First Tightening Torque : 6 N·m (4 lb·ft) [0.6 kgf·m]
Final Tightening Torque : 10 N·m (7 lb·ft) [3.0 kgf·m]

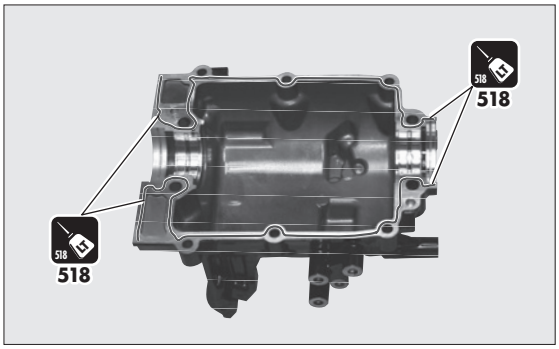
13. Degrease bearing holder surface of the crankcase and the bearing contact surface, and install bearing half to crank case.

- Be sure that individual bearings are installed to their original locations.
- Install bearings with their projection fit into crank case groove.
- Remove grease from surface of crankcase and outside of bearing half.

14. Apply 4 stroke engine oil to bearings.

15. Apply sealing agent to mating surface of crank case (halves).

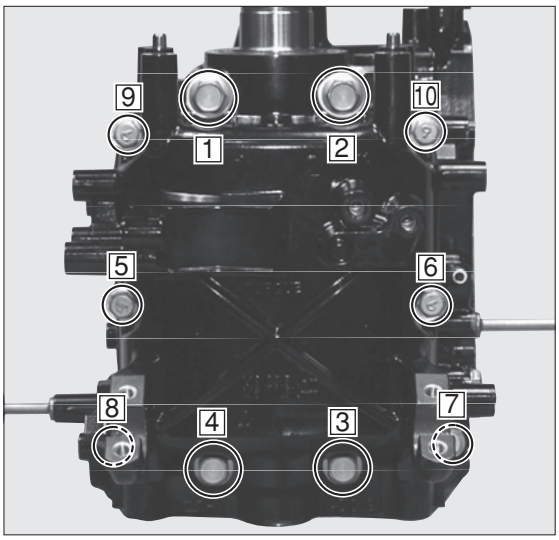
- Degrease mating surfaces of cylinder and crank case.
- Be careful not to allow sealing agent to adhere to bearing.
- Apply Loctite 518 to mating surfaces of crankcase halves, taking care that no excessive agent protrudes.
- Be sure apply Loctite 518 constantly and to be approximately 2 mm width.



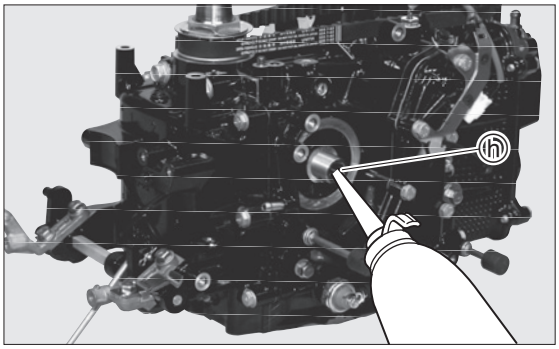
16. Install crank case to cylinder block.

17. Tighten crank case M8 bolts, and then tighetn M6 bolts to first specified torque in the order shown. Then tighten final specified torque.

First Tightening Torque :
[1] ~ [4] **: Crank Case Bolts (M8)**
10 N·m (7 lb·ft) [1.0 kgf·m]
[5] ~ [8] **: Crank Case Bolts (M6)**
6 N·m (4 lb·ft) [0.6 kgf·m]
Final Tightening Torque :
[4] ~ [4] **: Crank Case Bolts (M8)**
23.5 N·m (18 lb·ft) [2.4 kgf·m]
[5] ~ [8] **: Crank Case Bolts (M6)**
11.5 N·m (8 lb·ft) [1.2 kgf·m]



18. Put some engine oil into oil passage ⓗ of oil filter bolt before installing oil filter.

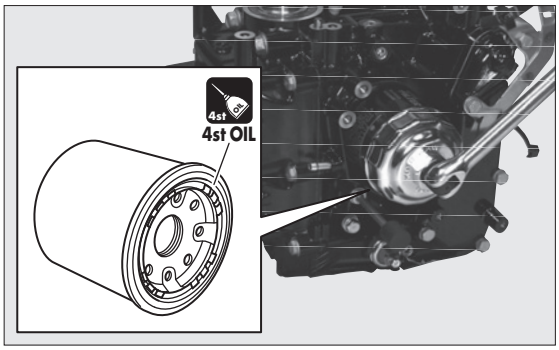


19. Install oil filter and tighten it to specified torque by using oil filter wrench.

Apply thin coat of engine oil to O-ring before installing oil filter.

Oil Filter Wrench :
P/N. 3AC-99090-0

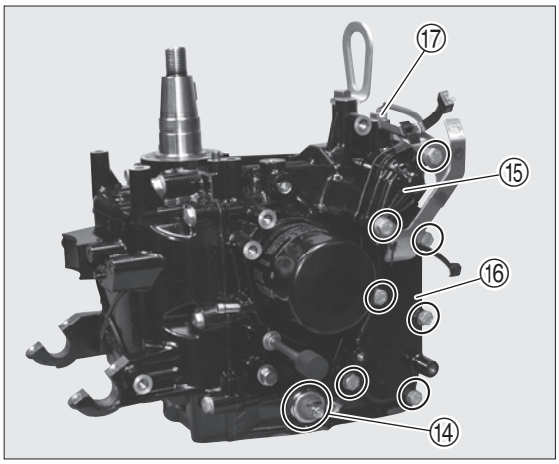
Oil Filter :
18 N·m (13 lb·ft) [1.8 kgf·m]



20. Install oil pressure switch ⑭.

- Apply ThreeBond 1327 on to thread of oil pressure switch, before installation.
- Use 24 mm Socket wrench.

Oil Pressure Switch :
8 N·m (6 lb·ft) [0.8 kgf·m]



21. Install thermostat, new gasket, thermostat cover ⑮, exhaust cover ⑯ and engine temp. sensor ⑰.

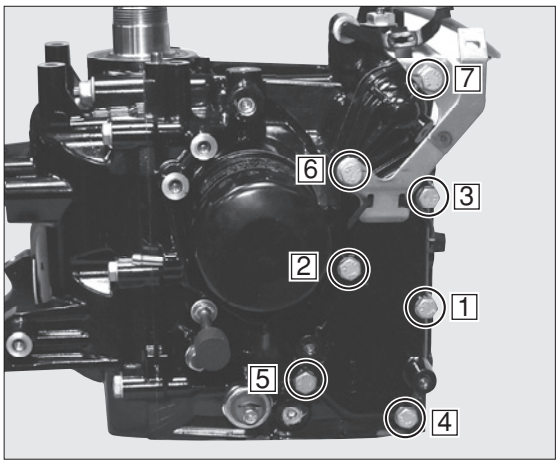
Exhaust cover Bolt :
9 N·m (7 lb·ft) [0.9 kgf·m]

22. Install cylinder head.

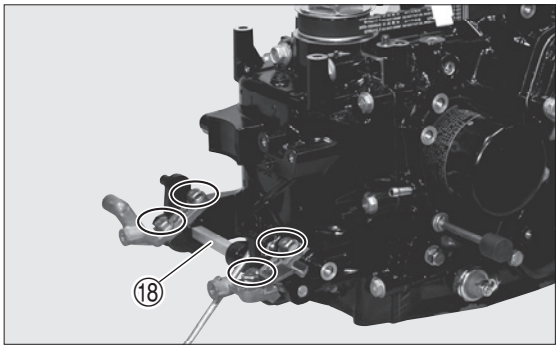
For installation procedure, refer to "Installation of Cylinder Head".

23. Install pulley and timing belt.

For installation procedure, refer to "Installation of Pulley and Timing Belt".

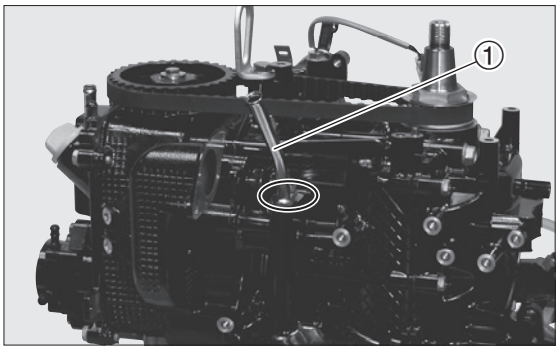


24. Install shift lever ⑱.



40) Assembling Fuel system Parts

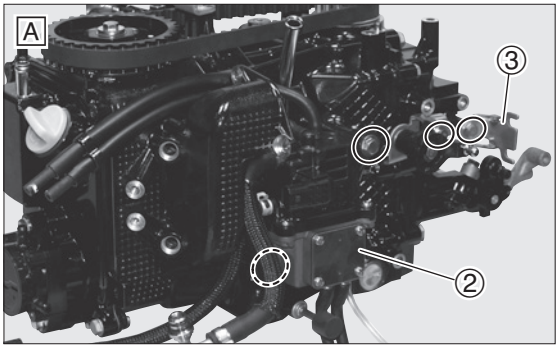
1. Install oil level gauge ①.

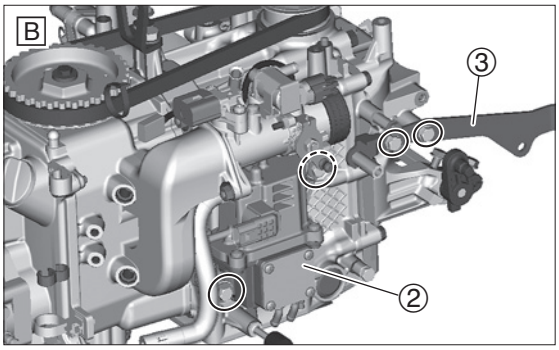


Do not reuse O-ring.

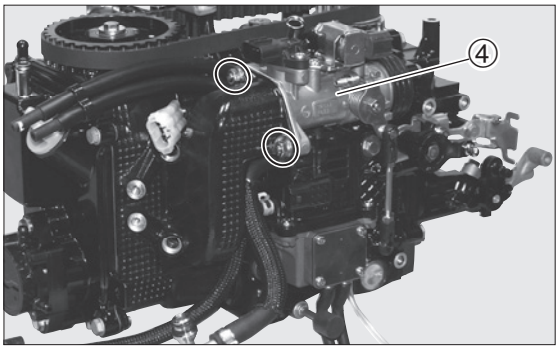
2. Install vapor separator Ass'y ② and throttle bracket ③.

A Tiller Handle Model
B Remote Control Model





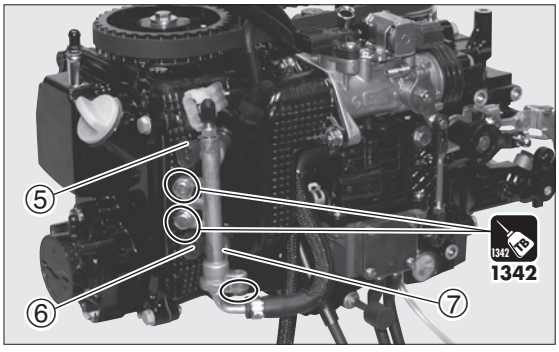
3. Install throttle body Ass'y ④.



Do not reuse gasket.

4. Install injector No.1 ⑤, No.2 ⑥ and fuel rail ⑦.

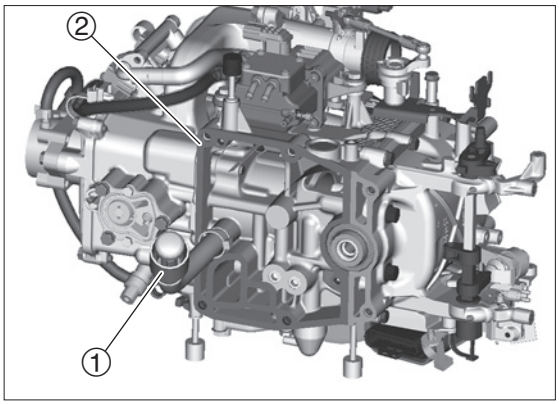
1342 **1342**



5. Connect fuel system hose and pipes.

41) Installation of Oil Strainer

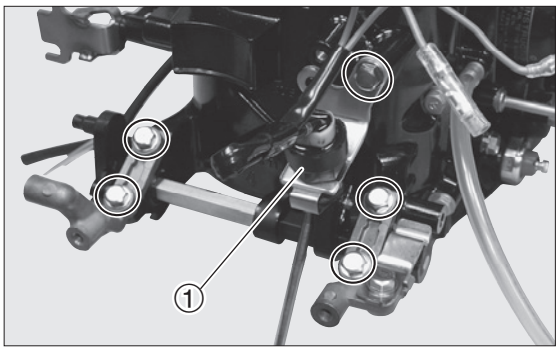
1. Install oil strainer ①.



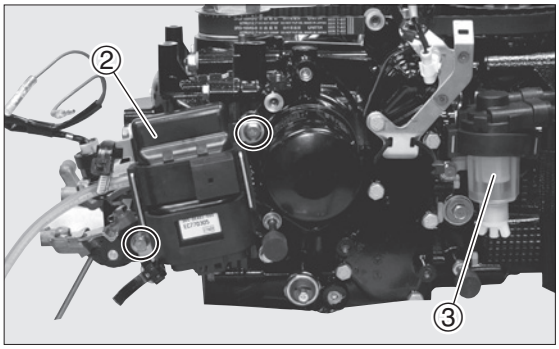
- Place power unit Ass'y ② on the table with left side (port side) facing downward, and install oil strainer ①.
- Complete this work in a short period. Doing this work for long time can cause engine oil to flow from breather pipe.

42) Installation of Electrical Parts

1. Install neutral switch ①. (except for MF model)

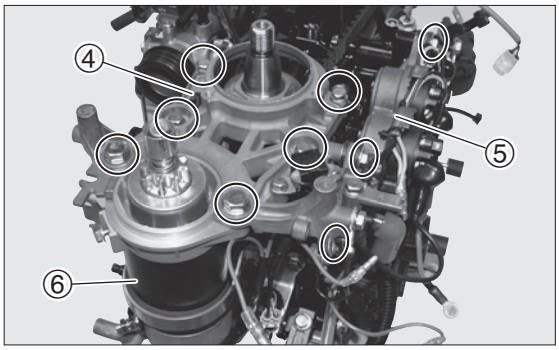


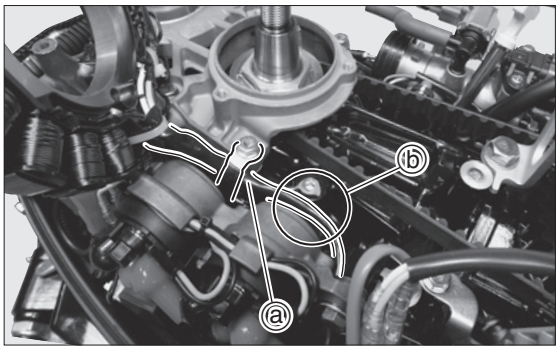
2. Install ECU ② and fuel filter ③.



Be sure to install heat shield plate between crankcase and ECU.

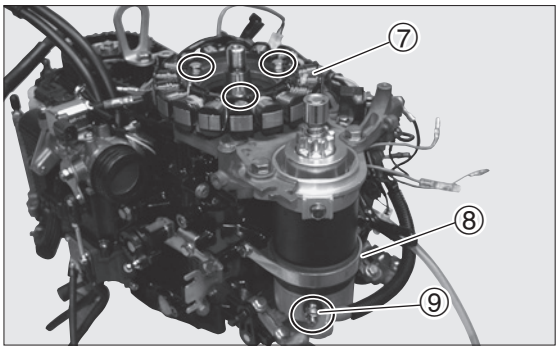
3. Install coil bracket ④, electrical bracket ⑤ and starter motor ⑥ (except for MF model).





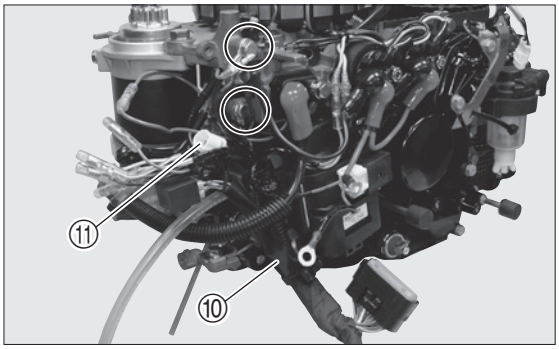
- Pass through alternator cord into lower ⓐ of the clamp .
- When installing electric bracket, be careful not to pinch alternator cord between bracket and oil passage boss ⓑ.

4. Install alternator ⑦.



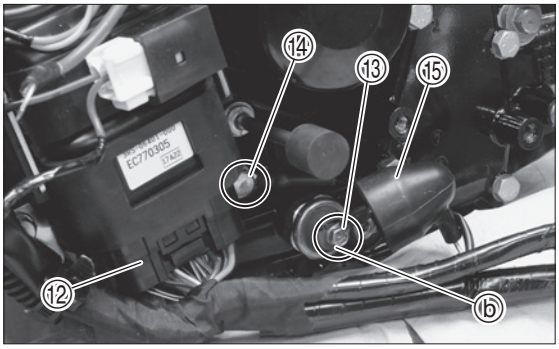
5. Install motor band ⑧ and starter cable ⑨ to the starter motor (except for MF model).

6. Connect main harness – ground lead ⑩ and pulser coil coupler ⑪.



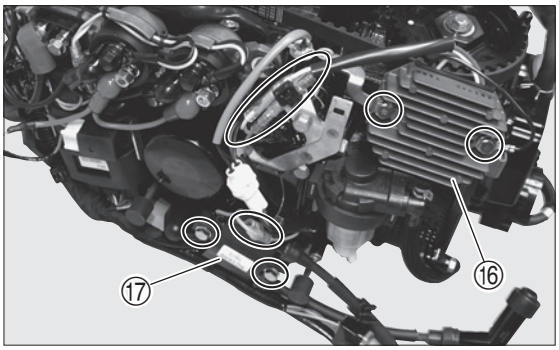
7. Connect ECU cpupler ⑫, oil pressure switch sensor cord ⑬, ground lead ⑭ and cover grommet ⑮.

> When installing grommet ⑮, be careful not to plug the small hole ⓐ in the switch with grease.

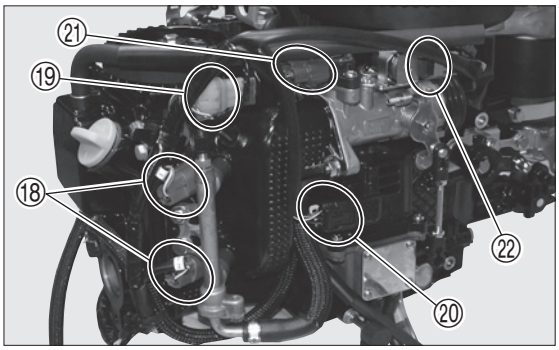


8. Install rectifier regulator ⑯ (except for MF model) and ignition coil ⑰, then connect each leads.

> When connecting engine temp. sensor coupler, the main harness passes the back side of the ignition coil.



9. Connect injector coupler ⑱, TPS coupler ⑲, vapor separator coupler ⑳, T-MAP sensor coupler ㉑ and ISC coupler ㉒.



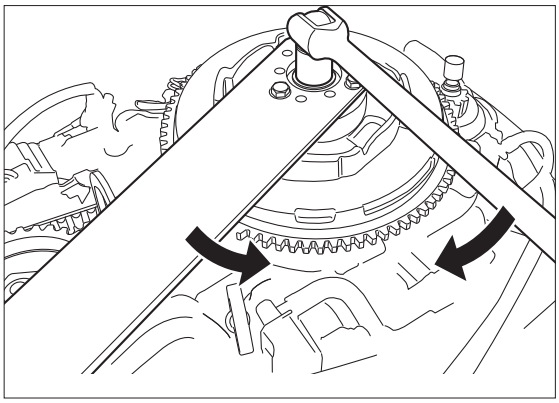
43) Installation of Flywheel

1. Install flywheel with flywheel engaged with crankshaft key.

2. Tighten flywheel nut to specified torque.

Flywheel Puller Kit :
P/N. 369-72211-0

Flywheel Nut :
80 N · m (58 lb · ft) [8.0 kgf · m]

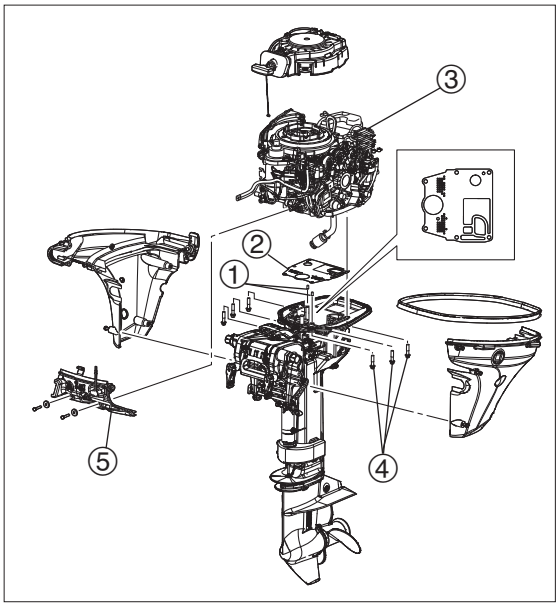


44) Installation of Power Unit

1. Clean power unit mating surface, and install dowel pin ① and gasket ②.

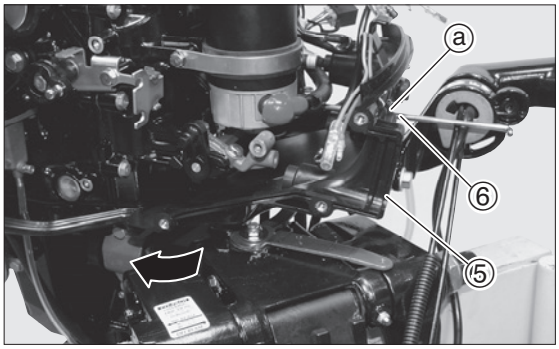
2. Install power unit ③, and tighten bolts ④ in two or three steps to specified torque.

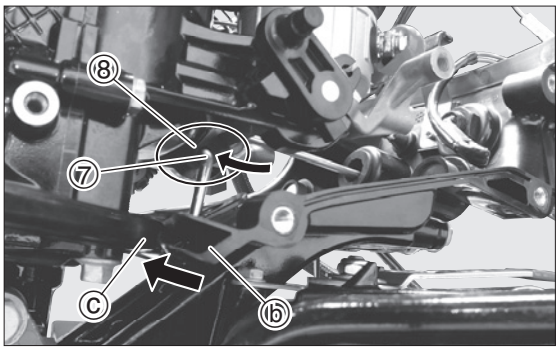
Power Unit Installation Bolt :
First Tightening Torque :
15 N·m (11 lb·ft) [1.5 kgf·m]
Final Tightening Torque :
30 N·m (22 lb·ft) [3.0 kgf·m]



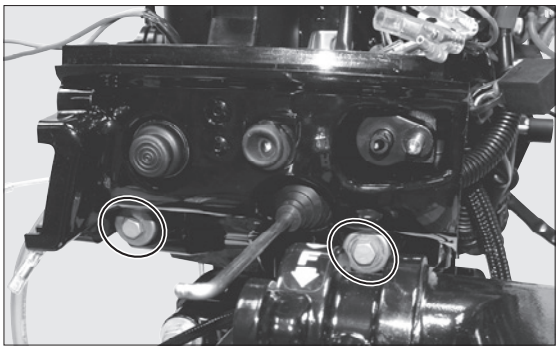
3. Install housing cover ⑤.

· Pass the shift rod (tiller handle model) ⑥ into the grommet part ⓐ (for MF, EF, EFT models).
· Place the rib ⓑ of the drive shaft housing in the seal ⓒ at the lower end of the housing cover.
· Connect shift rod ⑦ (drive shaft housing) to shift lever ⑧.

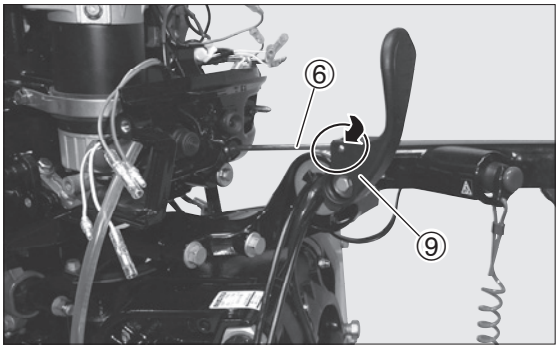




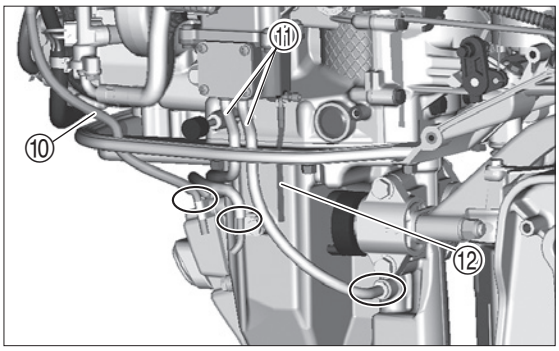
4. Tighten housing cover (front) bolts.



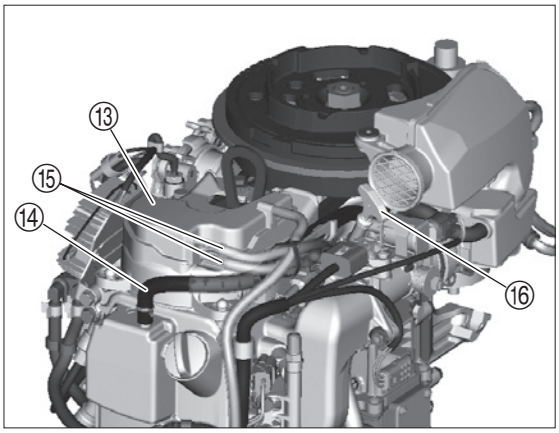
5. Install shift rod ⑥ (power unit side) to shift lever ⑨ (handle side) (for MF, EF, EFT models).



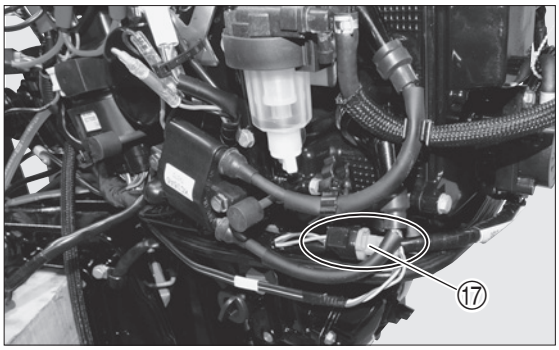
6. Connect vent hose ⑩, cooling water hose ⑪ (fuel cooler) and drain hose ⑫.



7. Install timing belt cover ⑬, connect breather hose ⑭, vent hoses ⑮ to timing belt cover, and then install oil level gauge ⑯.



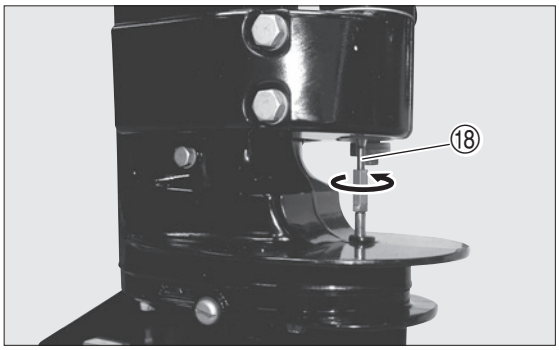
8. Connect PT switch coupler ⑰ (For EFT model).



9. Connect shift rod ⑱ (lower unit).

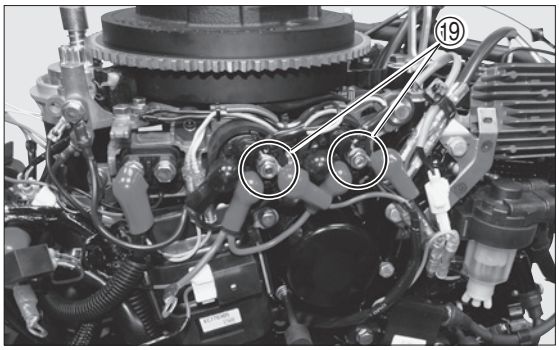
⚠ CAUTION

Be sure to loosen the nut and shift rod joint both, otherwise broken inner parts of the gear case can occur.

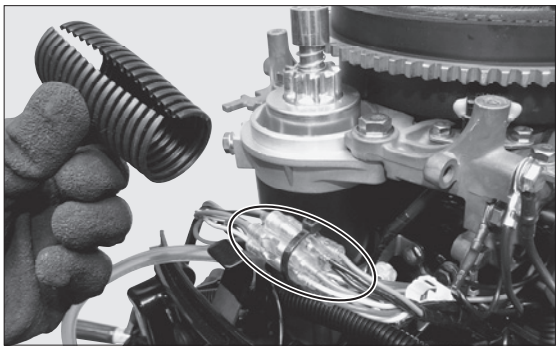


10. Connect PT motor leads ⑲ and clamp to electrical bracket with band (for EFT, EPT models).

PT Motor Lead Nut :
4 N · m (3 lb · ft) [0.4 kgf · m]

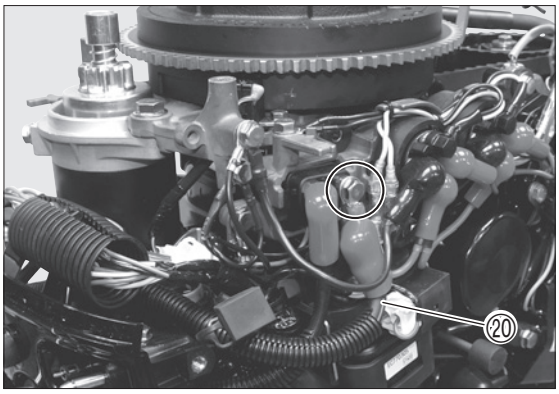


11. Connect starter switch leads, neutral switch leads (for EF, EFT models), engine stop switch leads (for MF, EF, EFT models) and engine oil warning lamp leads, then bundle with band and cover them the cable protector.



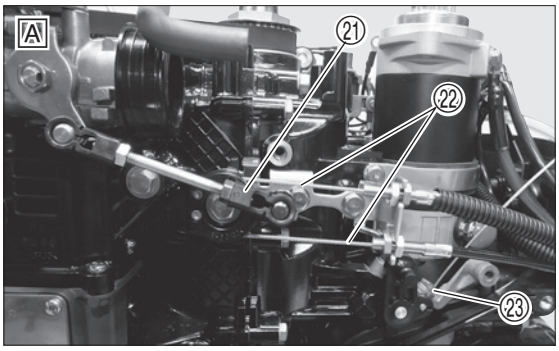
12. Connect (+) battery cable ⑳ (except for MF model). Connect main harness cable (for EF, EP models), PT solenoid jumper cord and battery cord.

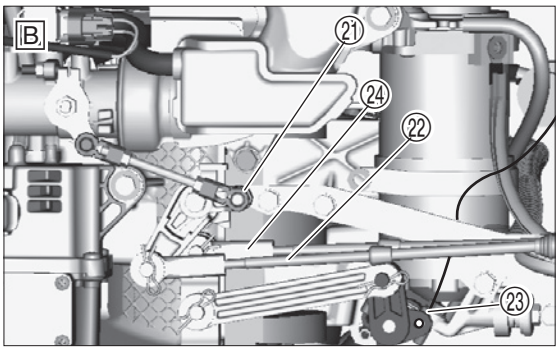
(+) Battery Cord Nut :
4 N · m (3 lb · ft) [0.4 kgf · m]



13. Connect throttle joint ㉑, throttle cable ㉒ and starter lock cable ㉓. Connect shift cable ㉔ (for remote control model).

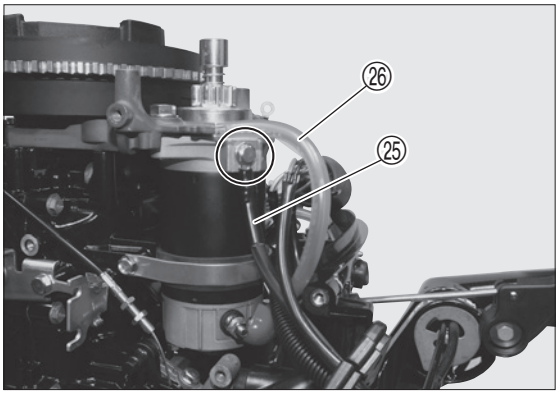
Ⓐ Tiller Handle Model
Ⓑ Remote Control Model



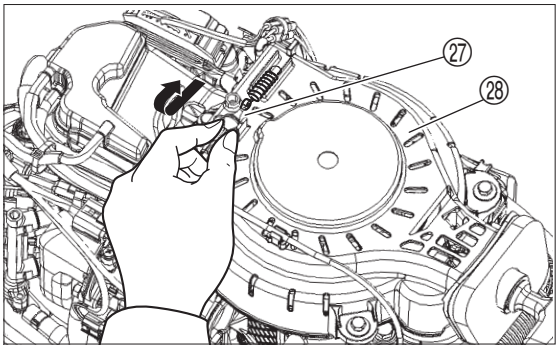


14. Connect minus battery cord ㉕ and oil drain hose ㉖.

(–) Battery Cord Bolt :
6 N · m (4 lb · ft) [0.6 kgf · m]

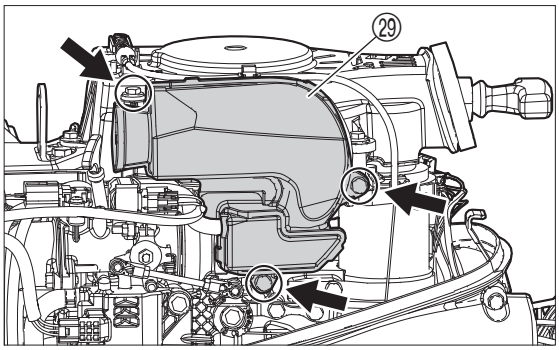


15. Install recoil starter ㉗ (three bolts) and starter lock cable ㉘.



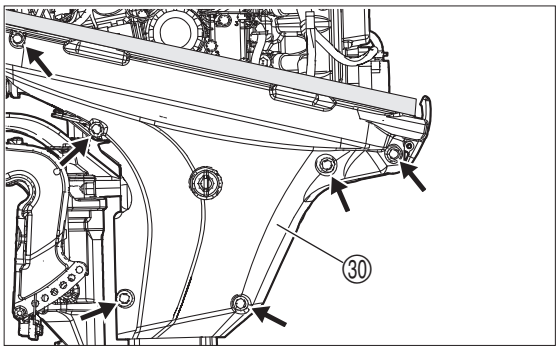
5

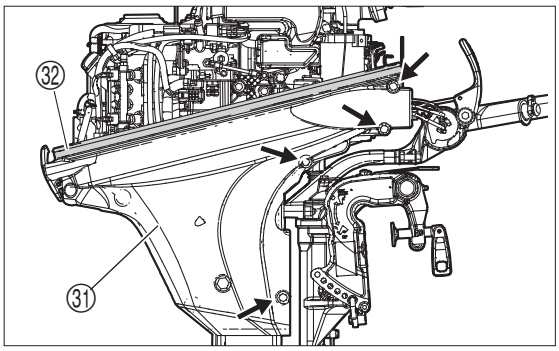
16. Install intake silencer ㉙ (three bolts).



17. Install housing cover ㉚, ㉛ and seal ㉜.

Check the mating surface of housing covers with it completely.





18. Fill with specified amount of engine oil.

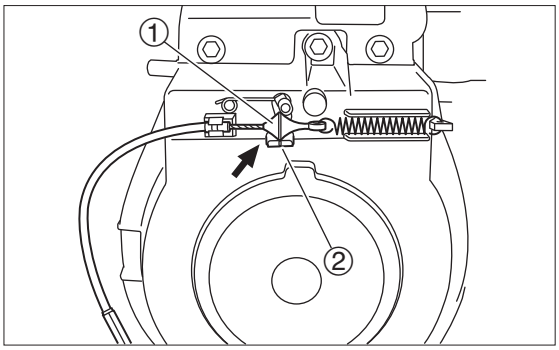
Recommended Engine Oil :
4 Stroke Engine Oil
API : SH, SJ, SL
SAE : 10W-30 , 10W-40

Quantity of Engine Oil:
When oil filter is not replaced : 1.0 L (1.05 US qt).
When oil filter is replaced : 1.2 L (1.26 US qt.)

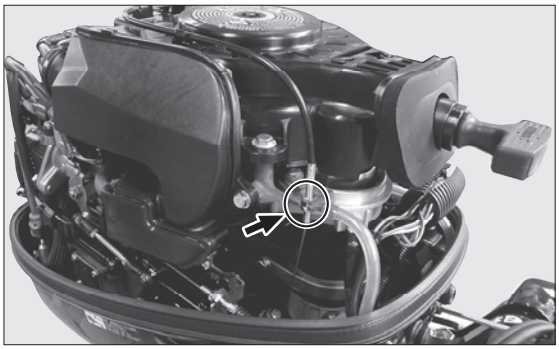
45) Removing Recoil Starter

Adjustment of Starter Lock Cable

1. Shift gear into neutral (N).
2. Check that maximum diameter section of slide ① is at neutral start mark ②.
3. If not, adjust lower side of cable (power unit side).
4. Perform shift operation to check that recoil starter is locked at other than neutral (N) position.

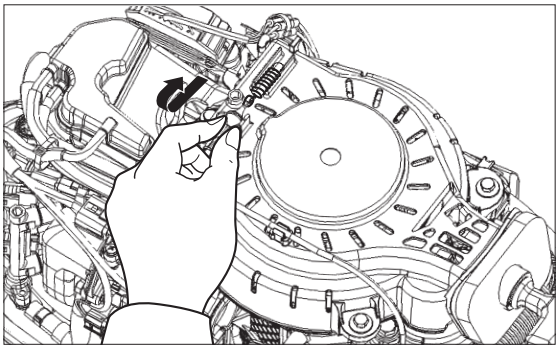


① Slide
② Neutral start mark

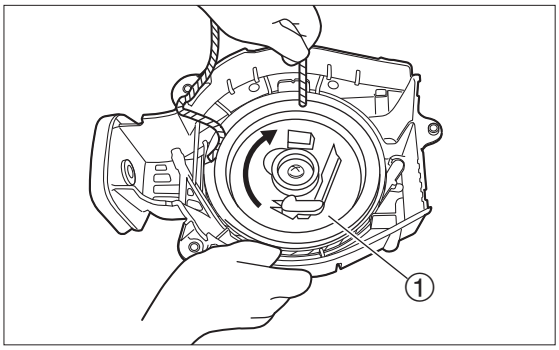


46) Disassembly of Recoil Starter

1. Disconnect upper starter lock cable.
2. Remove bolts, and then, recoil starter and belt cover.



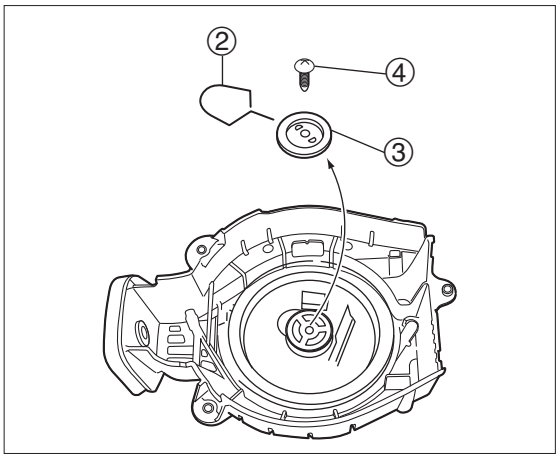
3. Put rope in the groove of reel ① and gently turn reel 1 clockwise to release tension of starter spring.



① Reel

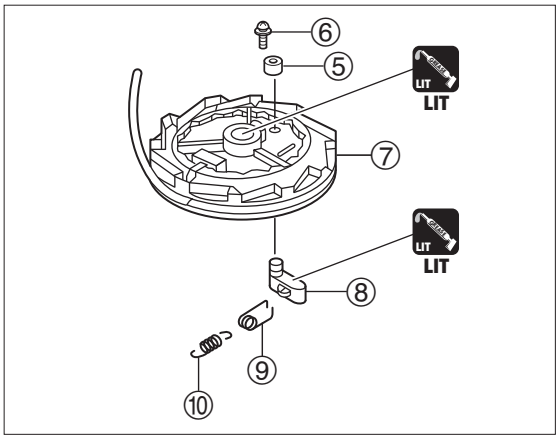
4. Remove start shaft bolt ④, and then, friction plate ③ and spring ②.

5. Take out reel carefully.



② Friction Spring
③ Friction Plate
④ Starter Shaft Bolt

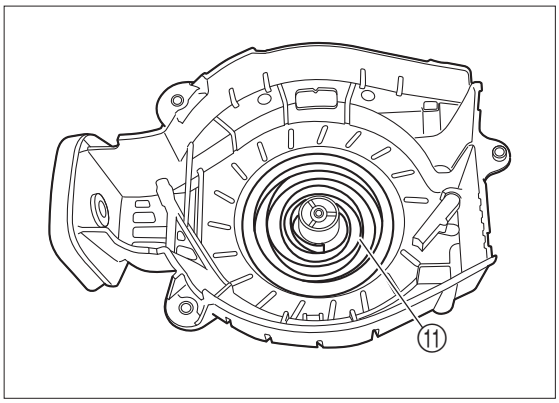
6. Remove bushing ⑤ and tapping screw ⑥, and then, ratchet ⑦, ratchet guide ⑧, and return spring ⑨.



⑤ Bushing
⑥ Tapping screw
⑦ Reel
⑧ Ratchet
⑨ Ratchet Guide
⑩ Return Spring

7. Remove starter spring ⑪.

It is not necessary to remove starter spring from starter case if it is not necessary to replace it. Starter spring can be inspected without removing from starter case.



⑪ Starter Spring

47) Inspection of Recoil Starter

1. Check ratchet, starter lock and all springs. Replace if any deformation, wear or damage is found.

2. Check reel and starter case. Replace if any crack or damage is found.

3. Check starter rope. Replace if any wear, unraveling or damage is found.

48) Installation of Recoil Starter

Reverse disassembly procedure to assemble by taking care of the following matters.

- When setting starter spring into starter case, face starter spring outer edge hook to the right and set it into peripheral cut of starter case.

- Run starter rope through rope guide ①.

- When installing reel into starter case, set projection of reel in the internal hook of starter spring.

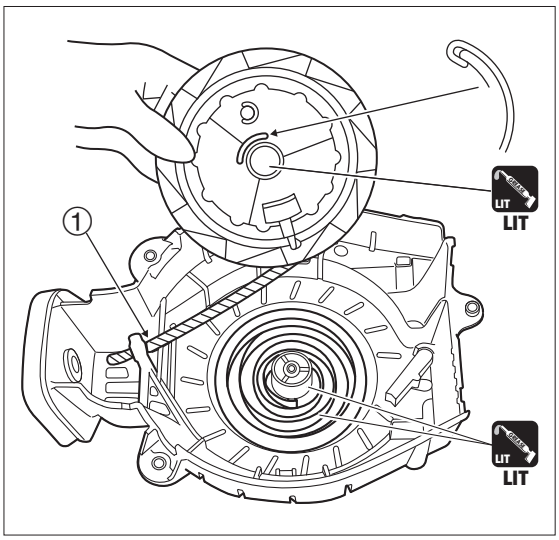
- Apply cold resistance lithium grease to the following parts.
  - · Starter Spring
  - · Reel Center Hole
  - · Ratchet
  - · Starter Lock
  - · Friction Plate

- Apply "Three Bond" 1342 to starter shaft bolt, and tighten the bold to specified torque.

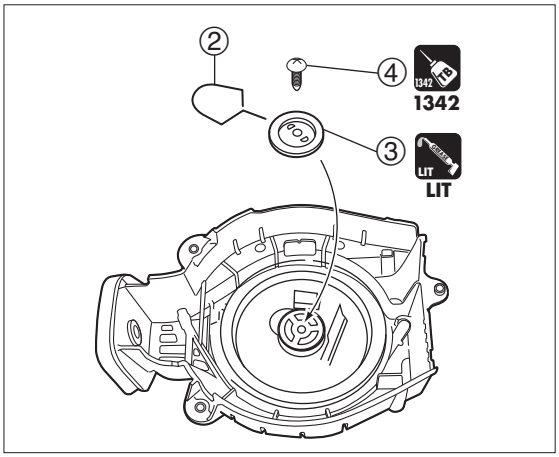
Starter Shaft Bolt :
6 N · m (4 lb · ft) (0.6 kgf · m)

- When applying tension to starter spring, turn reel ④ to ⑤ times to direction to which the reel rotates when pulling out starter rope (counterclockwise). When applying tension to starter spring, turn reel ④ to ⑤ times to direction to which the reel rotates when pulling out starter rope (counterclockwise).

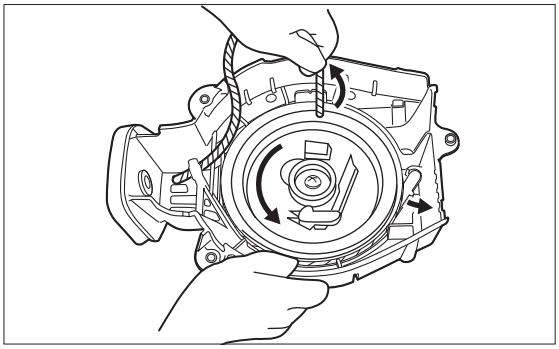
- Perform shift operation to check that recoil starter is locked at other than neutral (N) position.



① Rope Guide



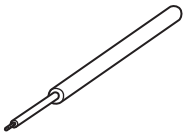
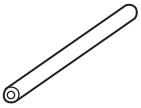
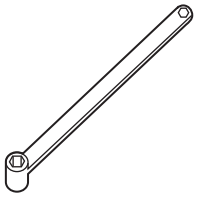
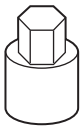
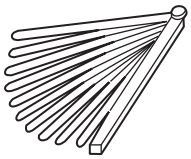
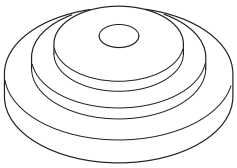
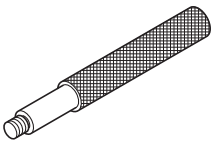
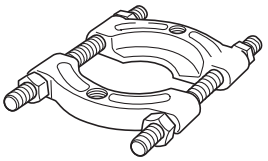
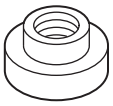
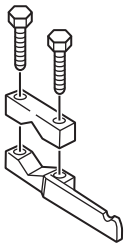
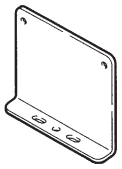
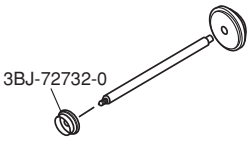
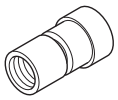
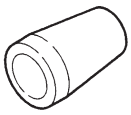
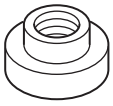
② Friction Spring
③ Friction Plate
④ Starter Shaft Bolt

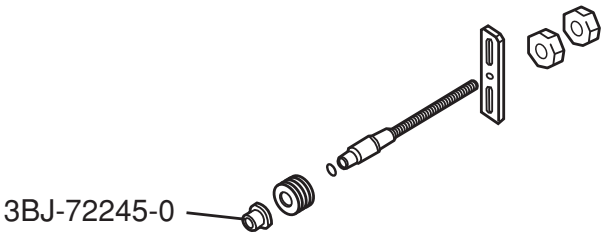
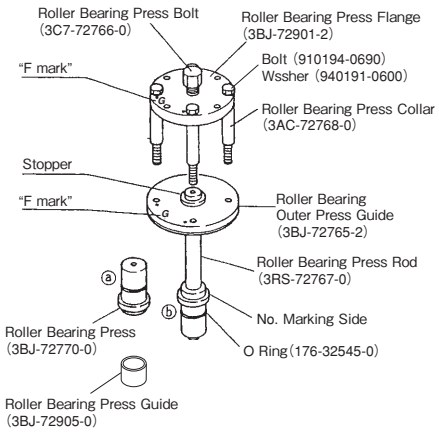


6

Lower Unit

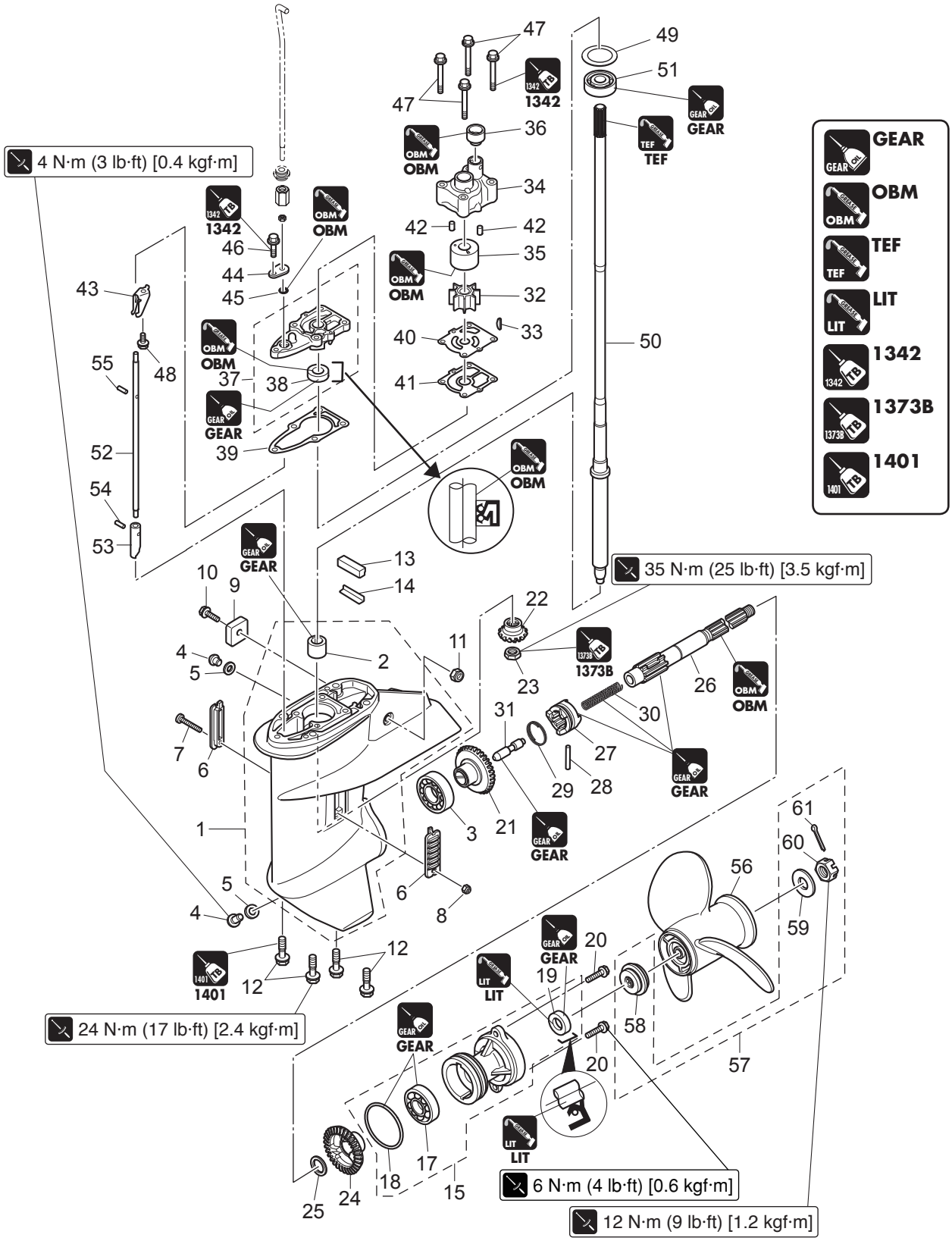
1. Special Tools

			
Spring Pin Tool A P/N. 345-72227-0 (ø3.0)	Spring Pin Tool B P/N. 345-72228-0 (ø3.0)	Bevel Gear B Nut Wrench P/N. 346-72231-0	Bevel Gear Nut Socket P/N. 346-72232-0
Removing spring pin	Installing spring pin	Removing or attaching pinion (B) gear nut	
	ø110 x ø71 		
Thickness Gauge P/N. 353-72251-0	Center Plate P/N. 3AC-99701-0	Driver Rod P/N. 3AC-99702-0	Universal Puller Plate P/N. 3AC-99750-0
Measuring gaps	Used in combination with driver rod and roller bearing attachment Positioning of propeller shaft housing roller bearing	Used in combination with center plate and roller bearing attachment	Removing reverse (C) gear bearing
ø29.5 x ø16.5 			3BJ-72732-0 
Oil Seal Attachment P/N. 3AG-99820-0	Backlash Measuring Tool Clamp P/N. 3B7-72720-0	Dial Gauge Plate P/N. 3B7-72729-0	Bearing Outer Press Kit P/N. 3B7-72739-1
Used in combination with a driver rod attaching oil seal of propeller shaft housing.	Measuring backlash	Used to attach dial gauge when measuring backlash	Attaching bevel gear / forward (A) gear bearing outer race
ø25.5 x ø12.5 			
Roller Bearing Attachment P/N. 3BJ-99710-0	Clutch Pin Snap Tool P/N. 3KY-72229-0	Oil Seal Attachment P/N. 3BJ-99820-0	
Combined use with driver rod and center plate. Propeller shaft housing Roller bearing attaching and removing	Installing clutch pin	Installing pump case (lower) oil seal	

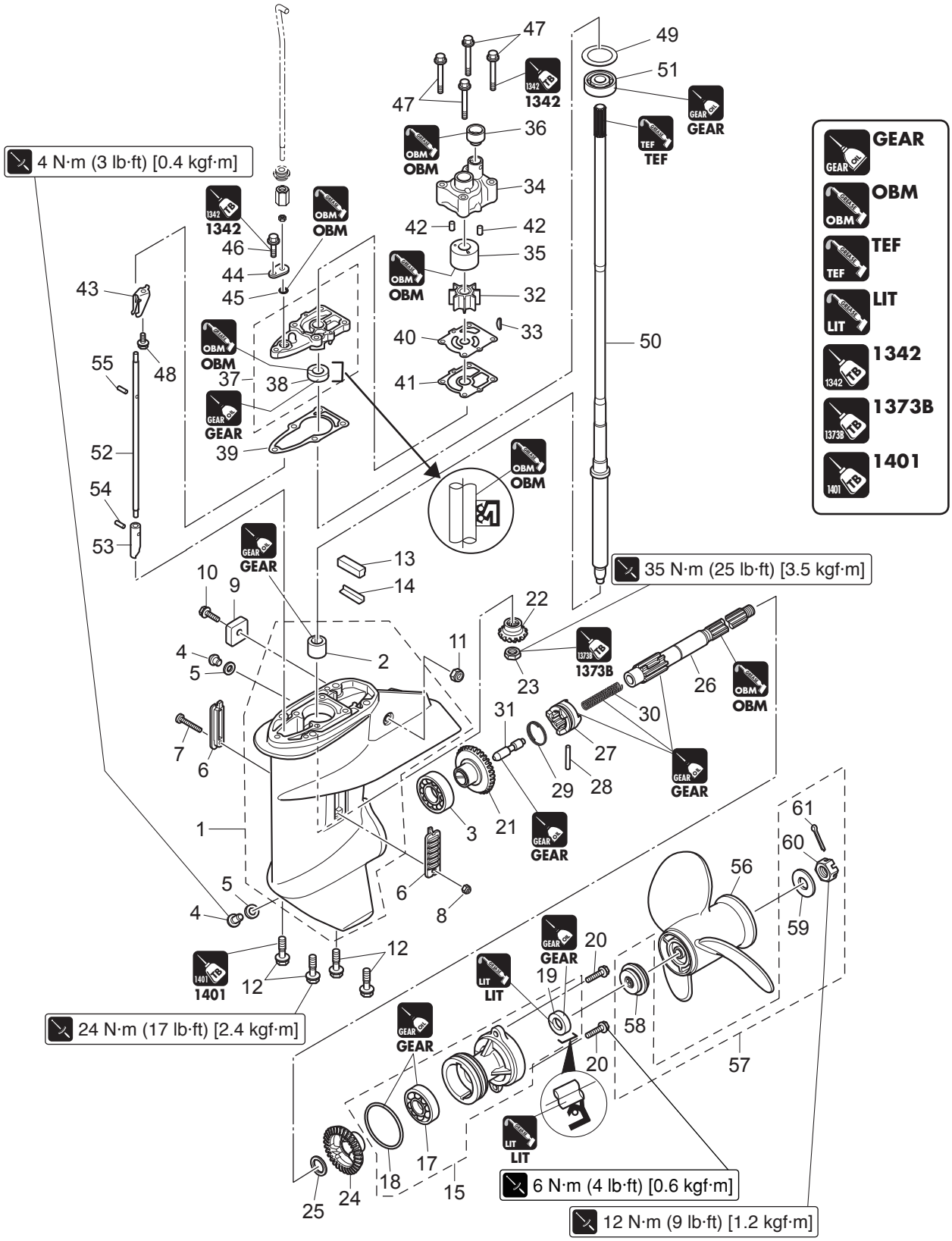
	
Backlash Measuring Tool Kit P/N. 3C8-72234-2	Roller Bearing Press Kit P/N. 3AC-72900-1
Measuring backlash between forward (A) gear and pinion (B) gear	Installing/attaching drive shaft housing roller bearing

2. Parts Layout

Gear Case



Ref. No.	Description	Q'ty	Remarks
1	Gear Case Assy	1	
2	Roller Bearing	1	Do not reuse.
3	Ball Bearing 6205HS	1	Do not reuse.
4	Plug 8-8	2	
5	Gasket 8.1-15-1	2	Do not reuse.
6	Water Strainer	2	
7	Screw	1	M4 L=30mm
8	Nylon Nut 4-P0.7	1	
9	Anode	1	
10	Bolt	1	M6 L=20mm
11	Nylon Nut 6-P1.0	1	
12	Bolt 8-31	4	M8 L=31mm
13	Water Seal Rubber	1	
14	Water Seal Plate	1	
15	Propeller Shaft Housing Assy	1	
17	Ball Bearing	1	Do not reuse.
18	O-ring 2.4-59.6	1	Do not reuse.
19	Oil Seal 17-30-9	1	Do not reuse.
20	Bolt	2	
21	Bevel Gear Assy (A)	1	
22	Bevel Gear B	1	
23	Nut	1	
24	Bevel Gear C	1	
25	Washer 17.1-22-1.5	1	
26	Propeller Shaft	1	
27	Clutch	1	
28	Pin ø5-30	1	
29	Snap	1	
30	Spring	1	
31	Push Rod	1	
32	Water Pump Impeller	1	
33	Key	1	
34	Pump Case (Upper)	1	
35	Pump Case Liner	1	
36	Water Pipe Seal (Lower)	1	
37	Pump Case Assy (Lower)	1	
38	Oil Seal 13.8-26-9.5	1	Do not reuse.
39	Pump Case Gasket (Lower)	1	Do not reuse.
40	Water Pump Guide Plate	1	
41	Guide Plate Gasket	1	Do not reuse.
42	Dowel Pin 4-10	2	
43	Stopper	1	Upper
44	Stopper	1	Lower
45	O-ring	1	Do not reuse.
46	Bolt	1	M6 L=25mm
47	Bolt	4	M6 L=52mm
48	Bolt	1	M5 L=12mm


4 N·m (3 lb·ft) [0.4 kgf·m]
35 N·m (25 lb·ft) [3.5 kgf·m]
24 N·m (17 lb·ft) [2.4 kgf·m]
6 N·m (4 lb·ft) [0.6 kgf·m]
12 N·m (9 lb·ft) [1.2 kgf·m]
GEAR
OBM
TEF
LIT
1342
1373B
1401

Ref. No.	Description	Q'ty	Remarks
49	Shim 35-41.9-0.1	1	t = 0.1
	Shim 35-41.9-0.15	1	t = 0.15
	Shim 35-41.9-0.3	1	t = 0.3
	Shim 35-41.9-0.5	1	t = 0.5
50	Drive Shaft (S)	1	
	Drive Shaft (L)	1	
	Drive Shaft (UL)	1	
51	Ball Bearing	1	Do not reuse.
52	Cam Rod	1	Transom S&L
	Cam Rod (UL)	1	
53	Clutch Cam	1	
54	Spring Pin 3-10	1	
55	Spring Pin	1	
56	Propeller Assy (6")	1	OPT 3 x 234 x 155
	Propeller Assy (7")	1	OPT 3 x 174 x 234
	Propeller Assy (8")	1	OPT 3 x 235 x 203
	Propeller Assy (9")	1	OPT 3 x 235 x 299
	Propeller Assy (10")	1	OPT 3 x 235 x 254
	Propeller Assy (11.5")	1	OPT 3 x 235 x 299
	Propeller Assy (7")	1	OPT 4 x 178 x 234
57	Propeller Hardware Kit	1	
58	Thrust Holder	1	
59	Washer 12.5-32-2.5	1	
60	Propeller Nut	1	
61	Split Pin 3-22	1	Do not reuse.

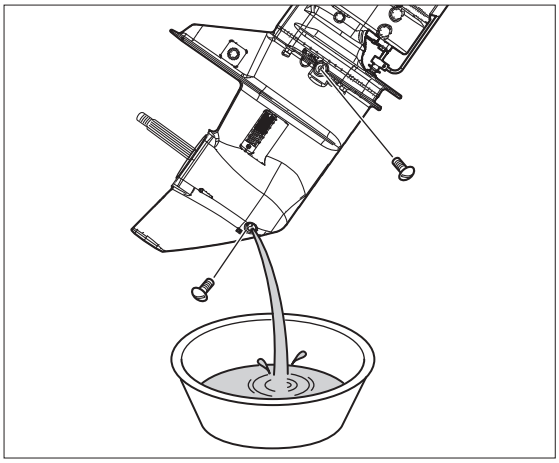
Select as necessary.

6

3. Inspection Items

1) Draining Gear Oil

1. Drain gear oil. Refer to “Replacement of Gear Oil” in Chapter 3.



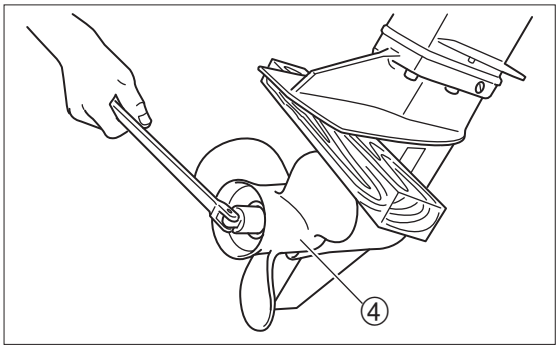
· Drain all gear oil, and check if any metal particle is found in the drained oil.
· Check gear oil color. White or cream color possibly indicates that water is contained in the gear oil.
· Note the above matters and use them as a reference if disassemble is required.

2) Removing Propeller

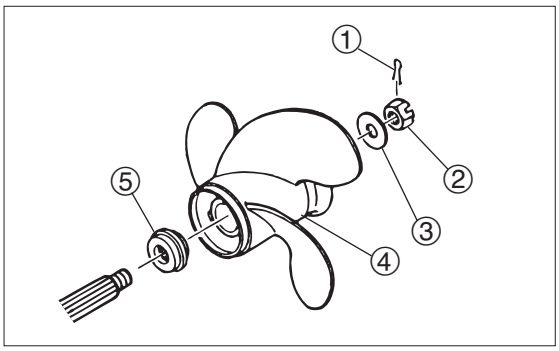
⚠ WARNING

- **Before removing or installing propeller, be sure to disconnect battery cables from battery and remove stop switch lock plate.**
- **When removing or installing propeller, do not handle propeller with bare hands.**
- **Put a piece of wooden block between anti-ventilation plate and propeller to prevent rotation of propeller when removing or installing propeller.**

1. Shift gear into forward (F).



2. Put a piece of wood between anti-ventilation plate and propeller ④ to prevent the propeller ④ from accidental rotation. Pull out split pin ①, loosen propeller nut ②, and then, propeller ④.



① Split Pin
② Propeller Nut
③ Washer
④ Propeller
⑤ Thrust Holder

3) Removing Lower Unit

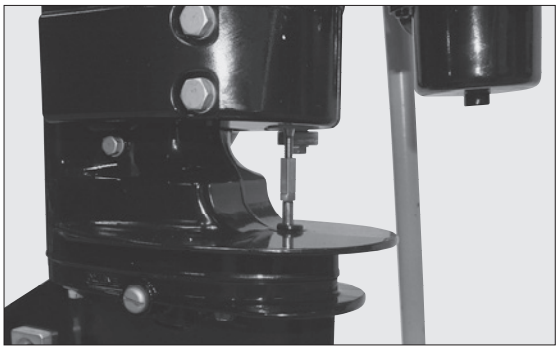
⚠ WARNING

When working with outboard motor in tilt up position, be sure to lock with tilt stopper.

- Removal of lower unit does not require removal of power unit from outboard motor body.
- When removing lower unit from outboard motor, tilting the outboard motor makes the work easier.

1. Shift the gear into forward (F) to set shift rod to upper position.

2. Loosen shift rod joint nut, and then disconnect shift rod and cam rod.



⚠ CAUTION

Loosen both nut and shift rod joint by pressing with spanner wrench. Otherwise gear case internal parts may damaged.

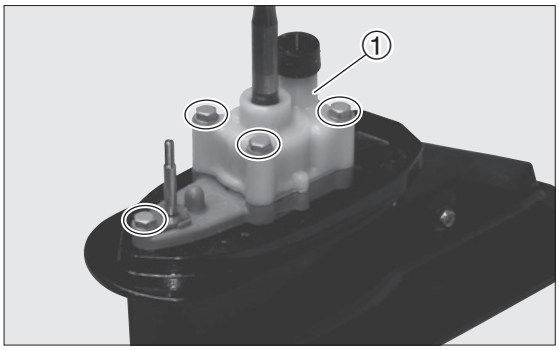
3. Remove trim tab and lower unit mount bolt (four bolts), and then remove lower unit ass'y by pulling down.

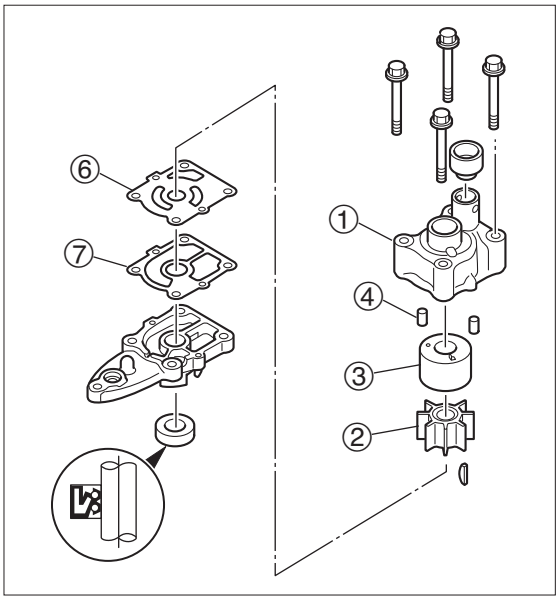
⚠ CAUTION

Hold lower unit while removing it to prevent it dropping on the floor.

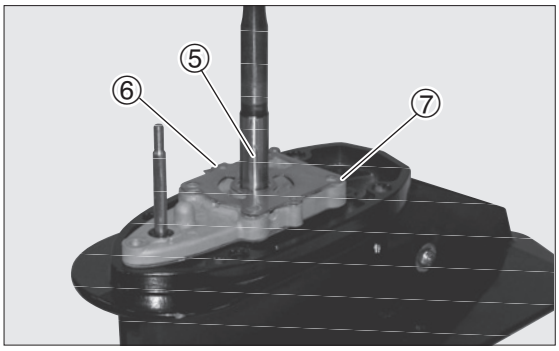
4) Removing of Water Pump and Cam Rod

1. Loosen mounting bolt in the pump case (upper), then remove pump case (upper) ①-②-③-④.



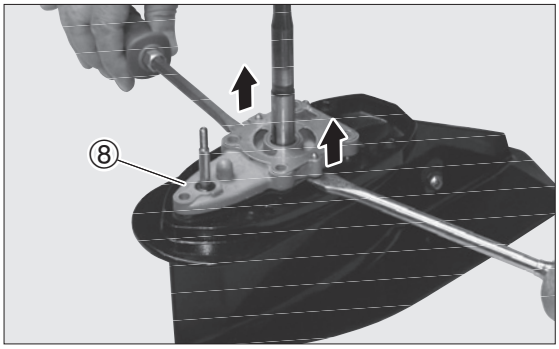


2. Remove water pump impeller key ⑤.

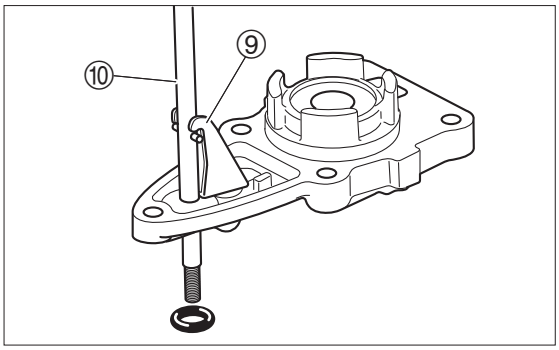


3. Remove guide plate ⑤, gasket ⑦ and pump case (lower) ⑧ from gear case.

When removing pump case (lower), insert bladed screw driver into the groove of the case, and pry slowly to separate the part.



4. Remove stopper ⑨ and cam rod ⑩, and then remove O-ring from pump case (upper).



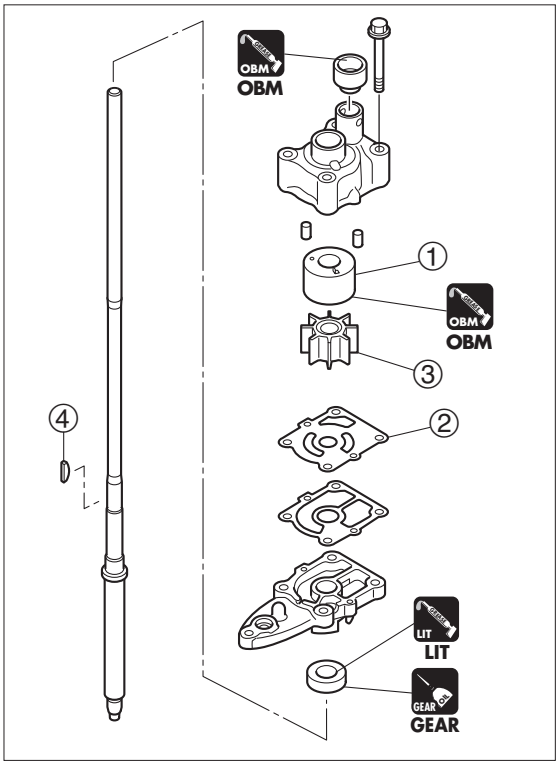
5) Inspection of Water Pump

1. Check pump case liner ① and guide plate ② for deformation and wear.
   Replace if necessary.

2. Check pump impeller ③ for crack, damage, and wear.
   Replace if necessary.

   · The impeller may show gloss or have melted area if it is rotated with insufficient water.
   · Even if impeller shows no abnormality on its surface, the blade(s) may be separated from the hub.
   · Replace guide plate if a groove(s) of 0.5 mm or over is produced on it due to wear by impeller.

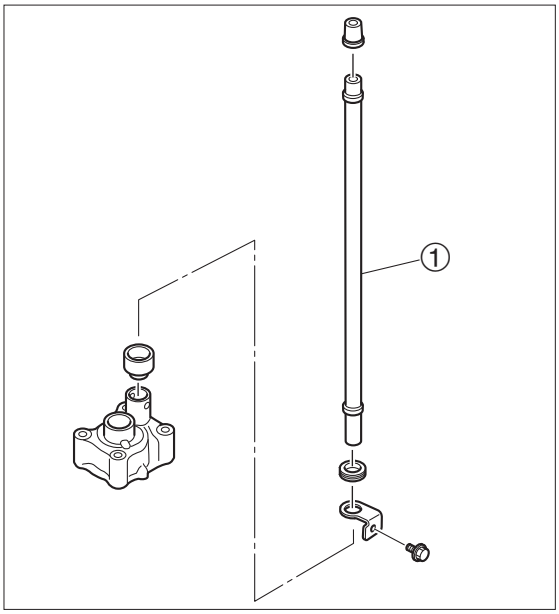
3. Check impeller key ④ and key groove for wear.
   Replace if necessary.



6) Inspection of Water Pipe

1. Remove water pipe ① from drive shaft housing.
   Refer to "Disassembling Draive Shaft" in chapter 7.

2. Check water pipe ① for corrosion, deformation, and restriction.

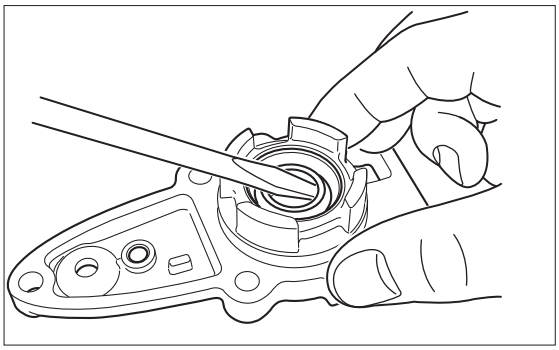


6

7) Disassembly of Water Pump Case (Lower)

1. Remove oil seal ①.

Be careful not to damage the seal mating surface on the case.



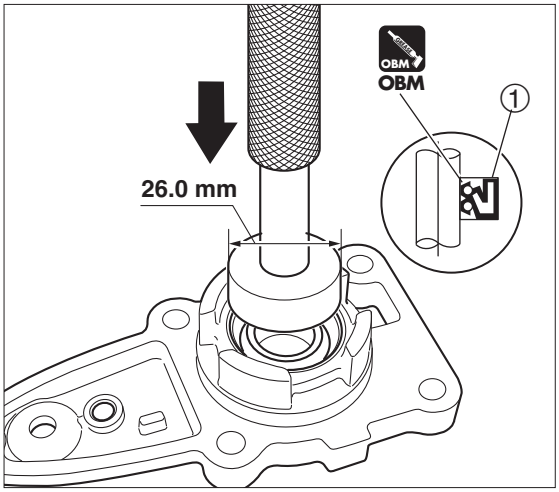
8) Assembly of Water Pump Case (Lower)

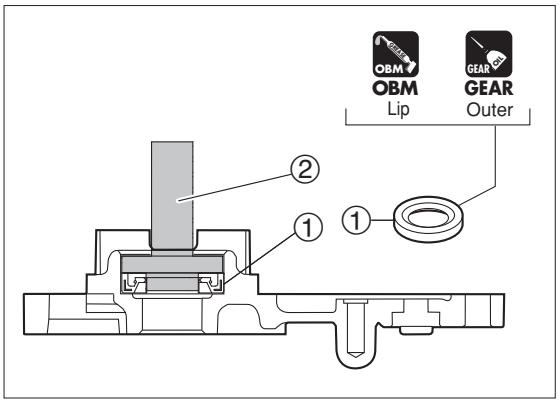
1. Install oil seal ① by using suitable press ② and then press-fit perpendicularly.

· Apply gear oil to oil seal circumference before installing oil seal.
· Apply OBM grease to oil seal lip.

OBM

GEAR

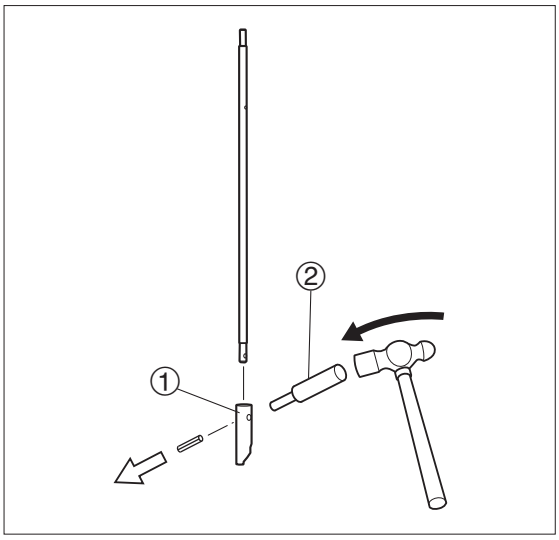




9) Disassembly of Cam Rod

1. Remove clutch cam ①.

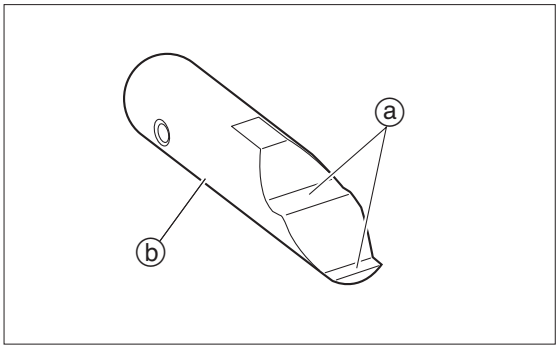
Spring Pin Tool A ② (ø3.0) :
P/N. 345-72227-0



10) Inspection of Clutch Cam

1. Check the part for wear and damage.
   Replace if necessary.

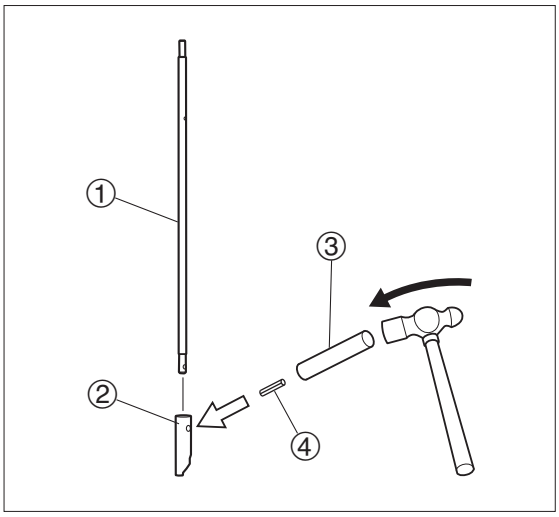
Check especially for wear on the face ⓐ that scrapes against push rod and flaws on the circumference ⓑ.



11) Assembly of Clutch Cam Parts

1. Attach clutch cam ② to cam rod ①.

Spring Pin Tool B ③ (ø3.0) :
P/N. 345-72228-0

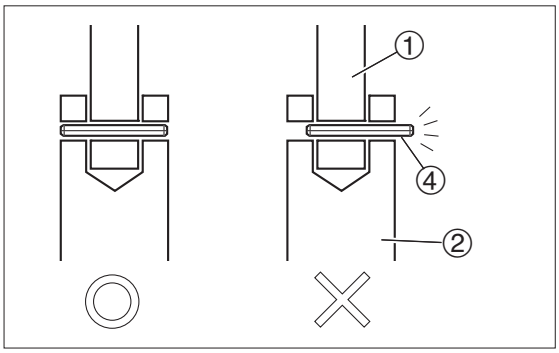


② Spring Pin **Do not reuse.**

2. Install spring pin ④.

⚠ CAUTION

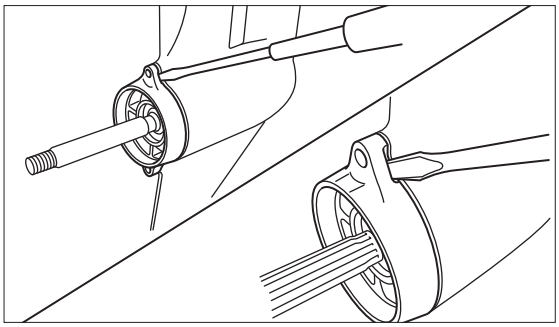
Install spring pin ④ so that it is flush with clutch cam surface as shown.



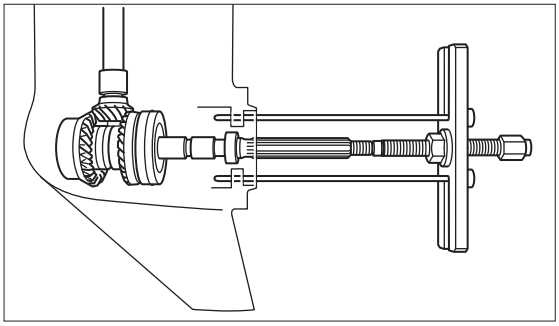
12) Removing Propeller Shaft Housing Ass'y

1. Remove propeller shaft ass'y.

> Use a plastic hammer to remove the part if it cannot be removed by inserting a bladed screw driver. When using commercially available puller, refer to 2.

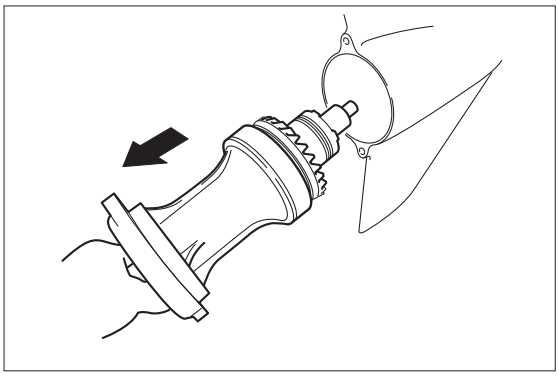


2. Use commercially available puller to remove as following illustration.



3. Hold propeller shaft and remove propeller shaft housing ass'y.

> When pulling out propeller shaft housing ass'y, remove clutch push rod and steel balls together with the housing ass'y.



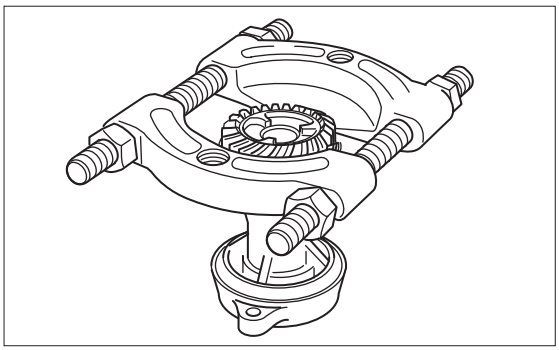
13) Disassembly of Propeller Shaft Housing

⚠ CAUTION

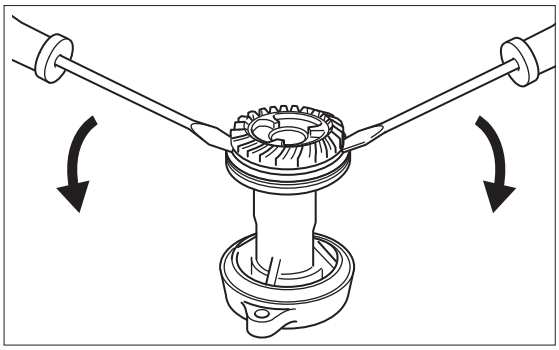
Do not reuse removed bearing.

1. Tighten universal puller plate to make gap between reverse gear (C gear) and propeller shaft housing.

Universal Puller Plate :
P/N. 3AC-99750-0

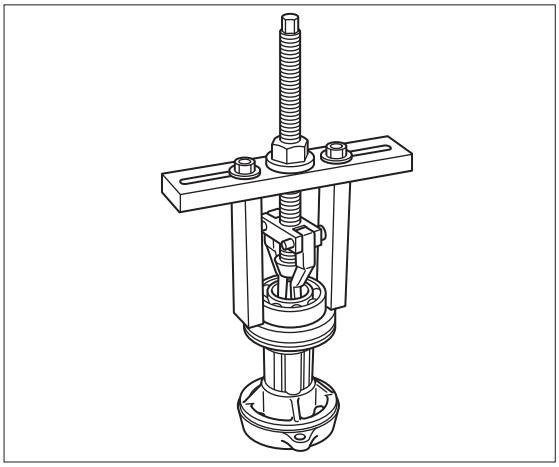


2. Remove reverse gear (C gear) by putting two bladed screw drivers into the gap to force the gap to open.



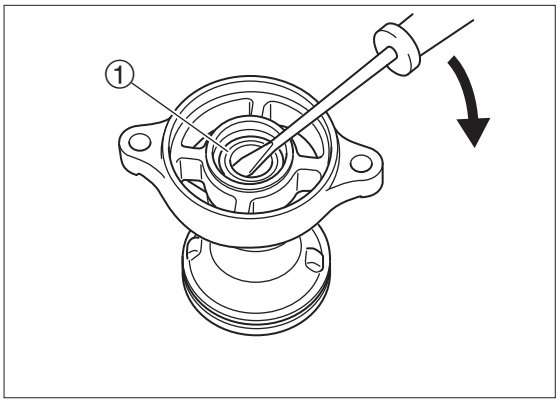
3. Use commercially available universal puller plate to remove ball bearing.

Before removing, check bearing for play or deflection. Replace if necessary.



4. Remove oil seal ① from propeller shaft housing.

Do not scratch housing when removing oil seal.



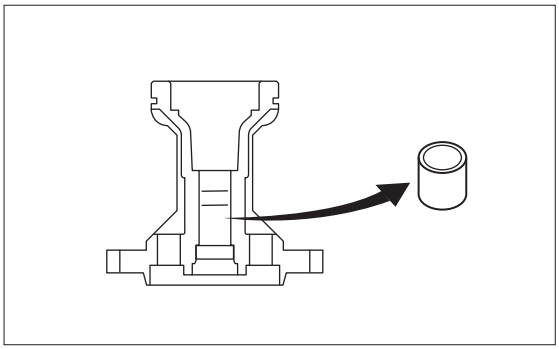
① Oil Seal **Do not reuse.**

14) Inspection of Propeller Shaft Housing

1. Use cleaning oil and cleaning brush to clean propeller shaft housing, and check it for crack or damage. Replace if necessary.

2. Check reverse (C) gear teeth and clutch for crack or damage. Replace if necessary.

3. When reusing bearing without removing it, check it for play or deflection. Replace if necessary.



15) Assembly of Propeller Shaft Housing

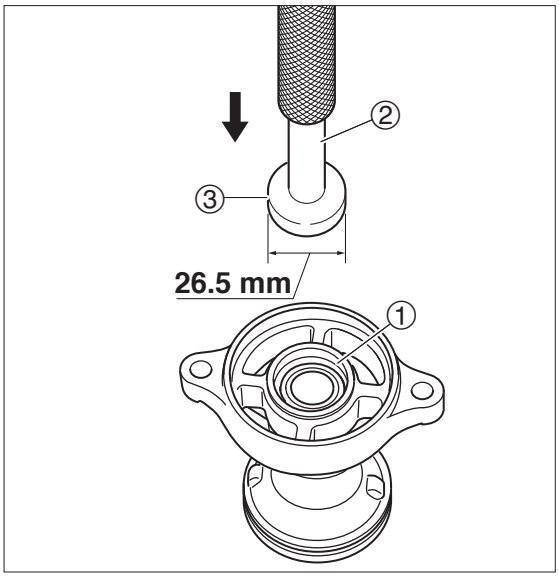
1. Install oil seal ① to propeller shaft housing.

Driver Rod ② :
P/N. 3AC-99702-0
Oil seal Attachment ③ :
P/N. 3AC-99820-0

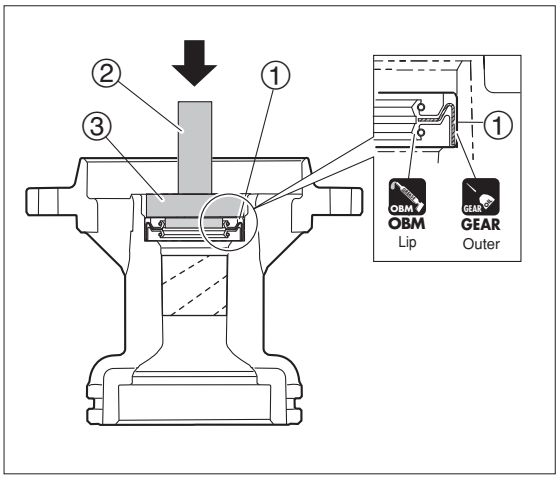
· Install oil seal with the marking facing tool side.
· Clean oil seal installation face and apply gear oil before installation.
· Apply grease to lip of oil seal after installing it.

LIT

GEAR



⑤ Oil seal **Do not reuse.**

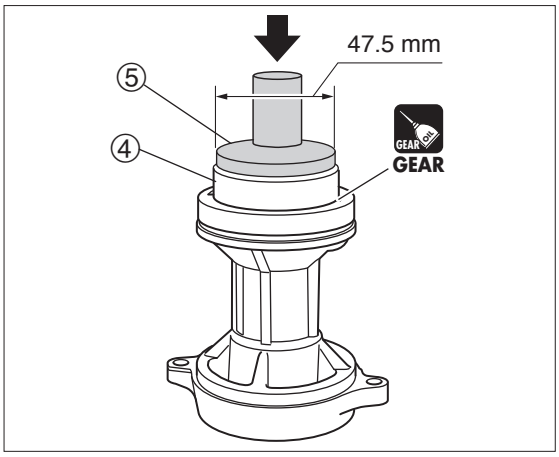


① Oil Seal **Do not reuse.**

2. Install bearing ④ to propeller shaft housing.
Use a suitable mandrel ⑤ to install new bearing to propeller shaft housing.

· Clean reverse (C) gear bearing installation face and apply gear oil before installation.
· Install ball bearing with manufacturer's marking facing attachment side.

GEAR

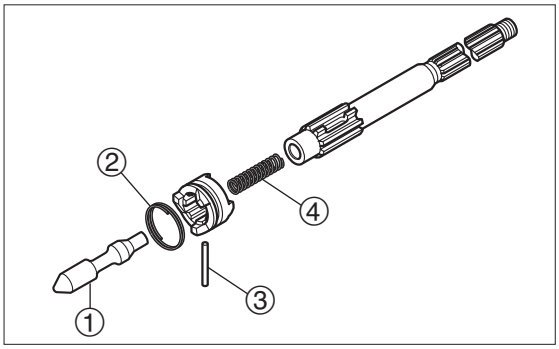


④ Bearing **Do not reuse.**

3. Install reverse (C) gear ass'y into propeller shaft housing.

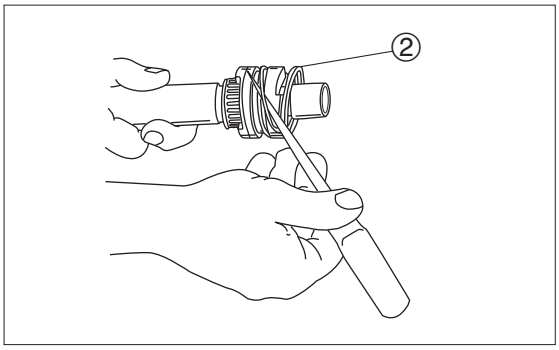
16) Disassembly of Propeller Shaft Ass'y

1. Remove push rod ①.



② Clutch Pin Snap **Do not reuse.**

2. Put a bladed screw driver into one of clutch pin snap ② end, and take the snap out from the clutch groove while winding it.

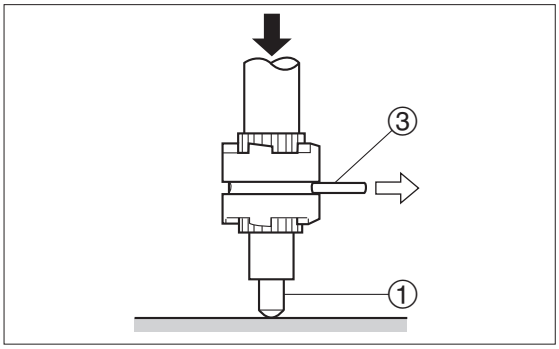


② Clutch Pin Snap **Do not reuse.**

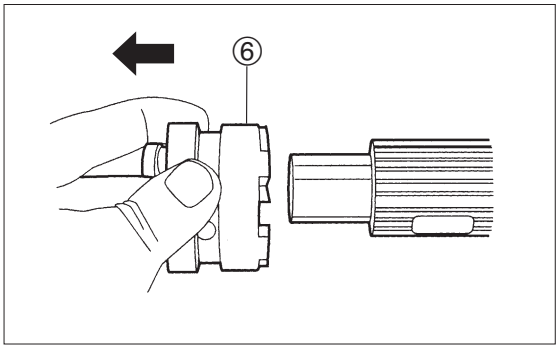
3. Pull out clutch pin ③, and remove clutch spring ④ by referring to the figure.

⚠ WARNING

- **When removing clutch pin, wear protective glasses, and do not point opening of propeller shaft to your face or body while holding the propeller shaft. Clutch pin or spring holder may fly out very quickly.**
- **Install push rod ①, and pull out pin ③ while pushing propeller shaft onto a plane to prevent spring ④ from flying out.**



4. After taking out clutch spring ⑤, remove clutch ⑥ from propeller shaft.

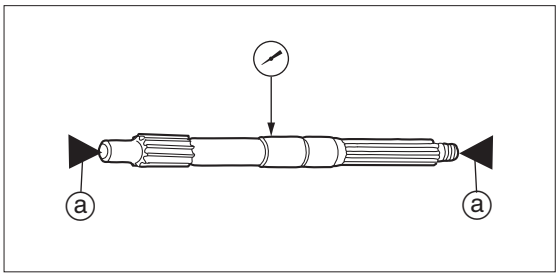


17) Inspection of Propeller Shaft Ass'y

1. Check propeller shaft for bend, wear and damage. Replace if necessary.

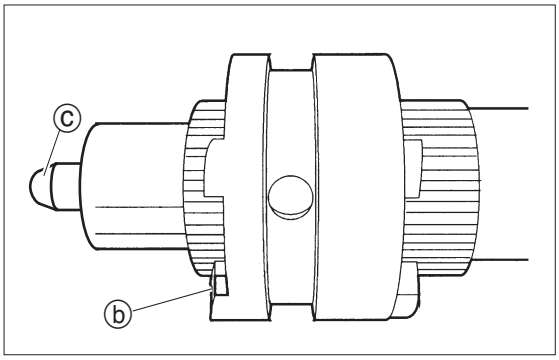
2. Measure propeller shaft runout.

Runout Limit :
0.05 mm (0.0020 in)



ⓐ Supporting Points

3. Check clutch claw ⓑ and push rod ⓒ for crack and wear. Replace if necessary.

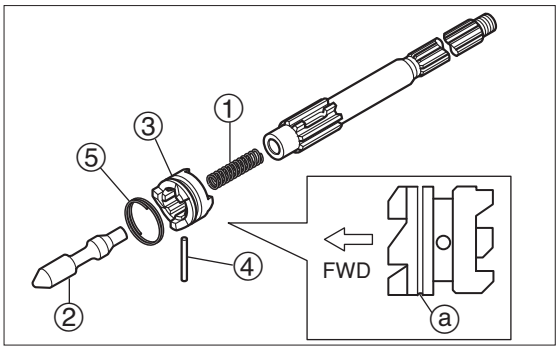


18) Assembly of Propeller Shaft Ass'y

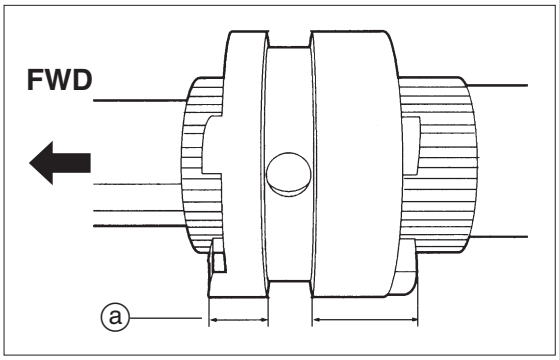
1. Attach spring ①, push rod ②, clutch ③ and clutch pin ④ to propeller shaft.

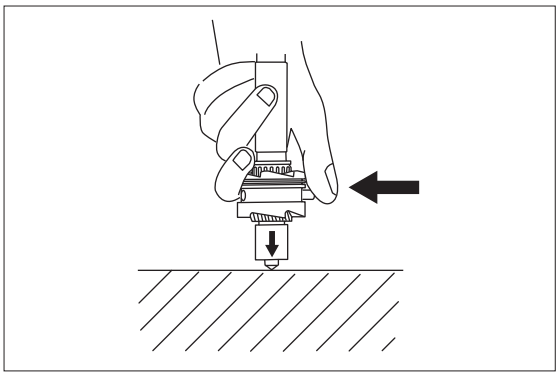
· When attaching clutch, face the narrower claw ⓐ to push rod side.
· Install clutch pin while applying preload to push rod.
· Be careful not to allow ball to fly out by spring tension.

GEAR



⑤ Clutch Pin Snap **Do not reuse.**





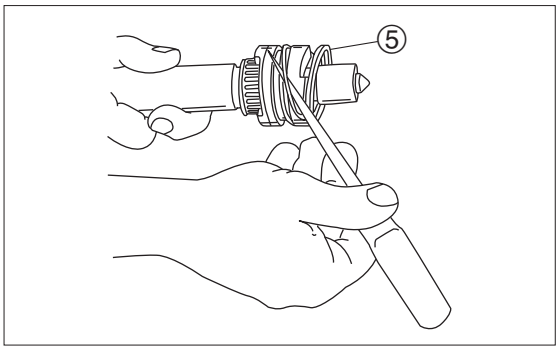
6

2. Attach new clutch pin snap ⑤ by using a bladed screw driver to turn the snap.

· When attaching clutch pin snap, do not apply excessive force to the part, or the snap may expand during operation of the engine, resulting in damaging gear and/or other parts severely.
· This work can also be done by using the following tool.

Clutch Pin Snap Tool :
P/N. 3KY-72229-0

3. After assembling, check that clutch can be operated smoothly, taking care not to allow push rod to drop out.



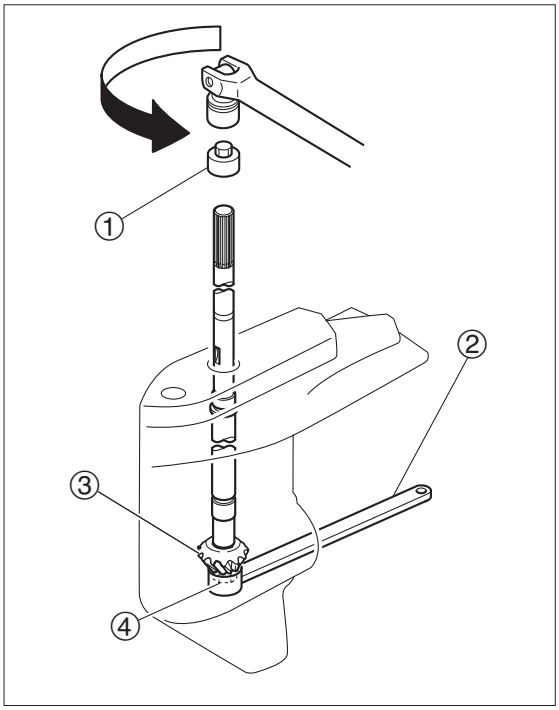
⑤ Clutch Pin Snap **Do not reuse.**

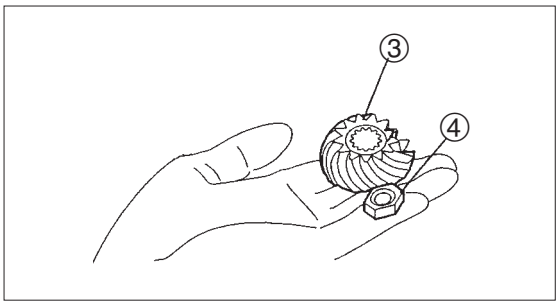
19) Removing Drive Shaft Ass'y

1. Remove pinion (B) gear nut ④, and then, remove pinion (B) gear ③ and drive shaft.

· Degrease pinion (B) gear nut completely so that the nut wrench does not slip on the nut.
· Loosen and remove the nut by using a drive shaft socket and a wrench and turning the wrench counterclockwise. Cover the wrench ② with rag to prevent it from hitting the case directly.
· This work can be made easier when the opening of gear case of propeller shaft side is faced upward and fixed horizontally with a holder.

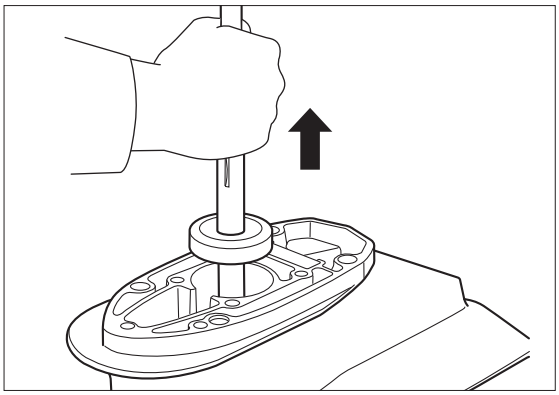
Bevel Gear Nut Socket ① :
P/N. 346-72232-0
Bevel Gear B Nut Wrench ② :
P/N. 346-72231-0





2. Pull out drive shaft from gear case.

· When removing drive shaft, be careful not to give damage to shim on the bearing outer race and not to lose the part.
· Replace shim with new one of the same thickness if any deformation or damage is found on it.



20) Disassembly of Drive Shaft Ass'y

1. Remove outer shim ①.

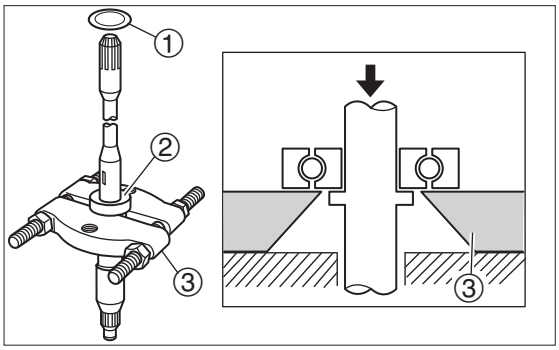
3. Remove taper ball bearings ③ by using press and universal puller ③.

⚠ CAUTION

Do not reuse removed bearing.
Be sure to replace with new one.

· Check bearing for play or deflection before removing, and replace if necessary.
· When putting universal puller plate on the bearing, hook the tip of puller's claw on the inner race of bearing correctly.

Universal Puller Plate ③ :
P/N. 3AC-99750-0



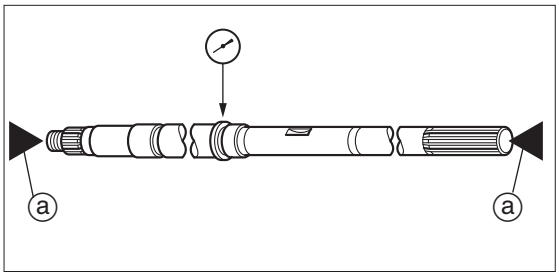
② Bearings **Do not reuse.**

21) Inspection of Drive Shaft

1. Check drive shaft for bend and wear.
Replace if necessary.

2. Measure drive shaft runout.

Runout Limit :
0.5 mm (0.020 in)



ⓐ Supporting Points

22) Inspection of Pinion (B) Gear

1. Check gear teeth and dog for crack, wear and damage. Replace if necessary.

23) Assembly of Drive Shaft Parts

⚠ CAUTION

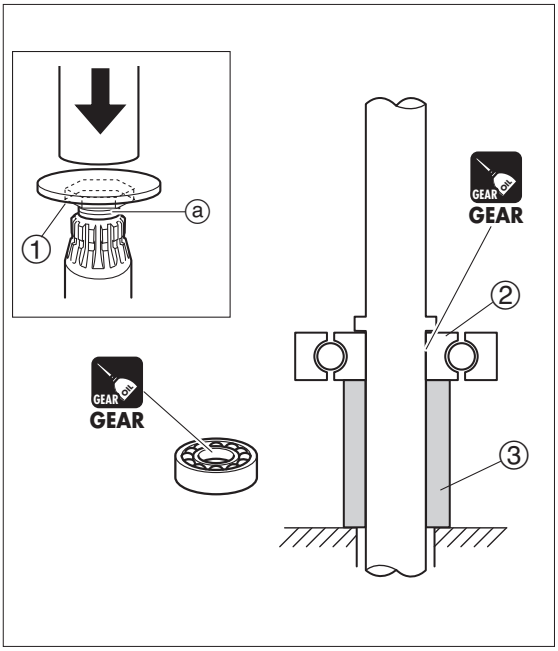
Do not press drive shaft thread ⓐ directly. Put piece of protector (steel plate) on the tip of the shaft.

1. Attach pinion (B) gear nut ① to drive shaft temporarily.

2. Install bearing ② by using press and a suitable pipe ③. Before installing bearing, be sure to clean drive shaft installation face and apply gear oil.

A nut that fits the thread can be used to protect the shaft tip when pressing.

GEAR

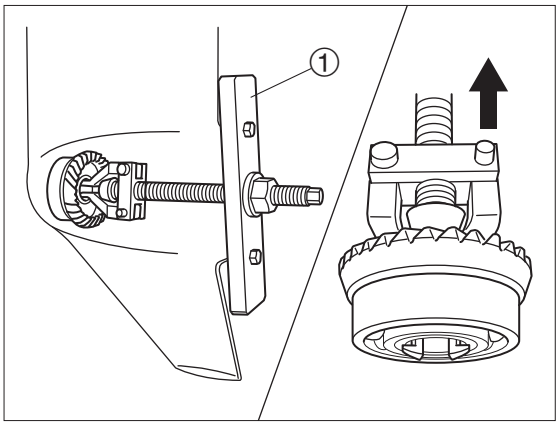


② Bearing **Do not reuse.**

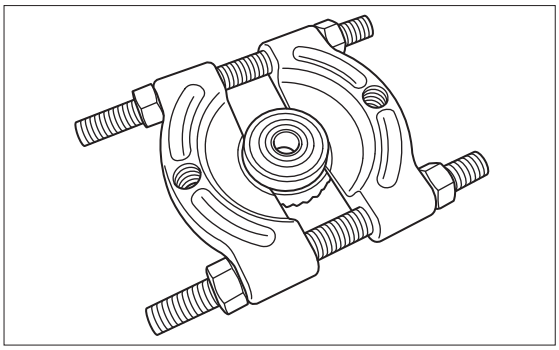
24) Removing Forward (A) Gear

1. Remove pinion (B) gear (Refer to P6-20).

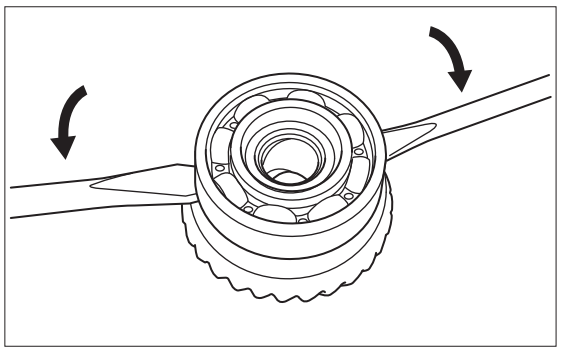
2. Use commercially available bearing puller ① to remove forward (A) gear from gear case.



25) Disassembly of Forward (A) Gear



1. Use universal puller plate to make gap between ball bearing and forward gear.



3. Put two bladed screw drivers in the gap and pry out forward (A) gear from bearing.

Before removing, check bearing for play or deflection. Replace if necessary.

26) Inspection of Forward (A) Gear

1. Check forward (A) gear teeth and clutch claws for crack, damage, and wear.
   Replace if necessary.

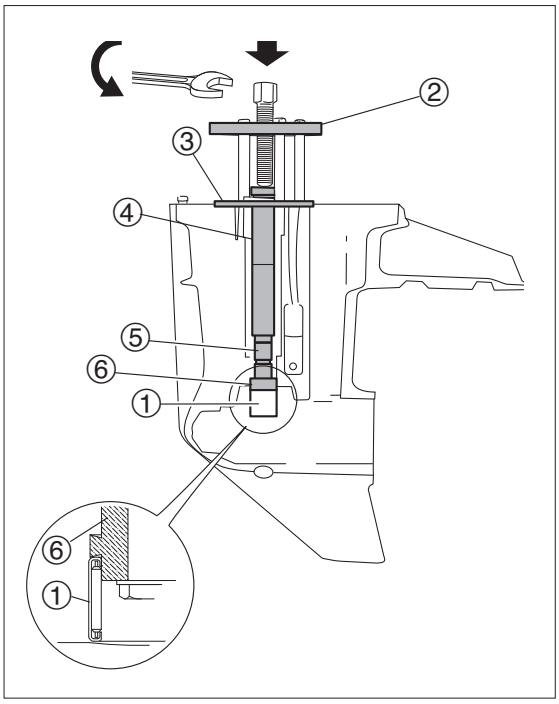
27) Disassembly of Gear Case

1. Remove roller bearing ① by using the following tools.

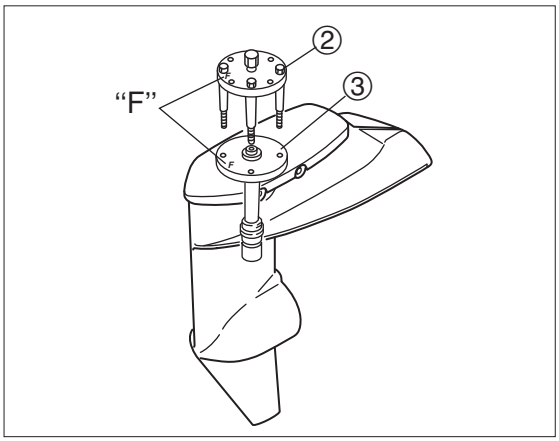
Roller Bearing Press Kit :
P/N. 3AC-72900-1
Bearing Outer Press Flange ② :
P/N. 3AC-72900-2
Bearing Outer Press Guide ③ :
P/N. 3AC-72765-2
Roller Bearing Press Rod ④ :
P/N. 3RS-72769-0
Roller Bearing Press ⑤ :
P/N. 3BJ-72770-0
Roller Bearing Press Guide ⑥ :
P/N. 3BJ-72905-0

⚠ CAUTION

When installing flange ② and guide ③, face "F" mark forward direction.

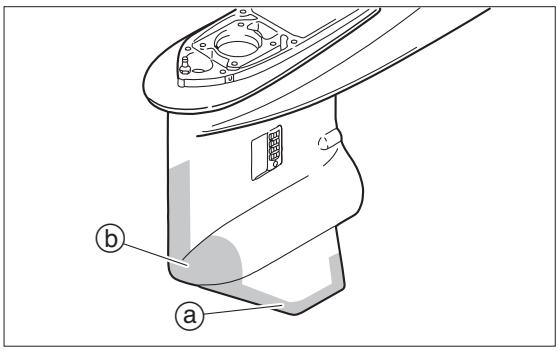


① Roller Bearing **Do not reuse.**

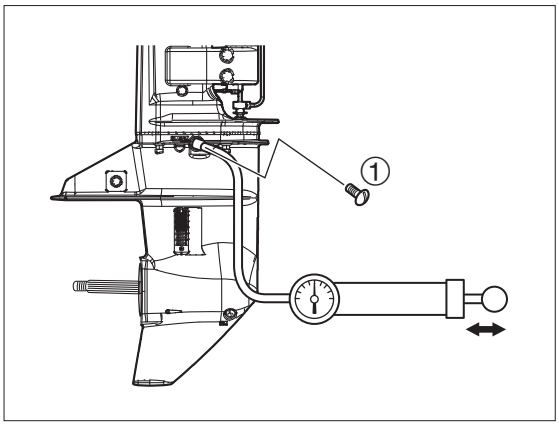


28) Inspection of Gear Case

1. Check skeg ⓐ and torpedo-like area ⓑ for crack and other damage.
   Replace if necessary.



29) Inspection of Gear Case (for leakage)



1. Drain gear oil.

2. Remove upper oil plug ① and connect a commercially available leakage tester to this hole.

3. Apply specified pressure to gear base, and check if the pressure is maintained without further compression for 10 seconds.

⚠ CAUTION

Do not apply pressure to gear case over specified value.
Doing so can cause damage to oil seal.

Specified Gear Case Maintained Pressure :
0.05 MPa (7 PSi) [0.5 kgf/cm^2]

- Rotating propeller shaft while maintaining pressure and testing with gear oil drained make it easy to find leakage due to wear of oil seal lip.
- Depressurize gear case and cover oil plug area with a piece of rag before disconnecting leakage tester.

4. If the specified pressure cannot be maintained, check oil seals of drive shaft and propeller shaft and O-ring of propeller shaft housing and water pump case lower for damages.

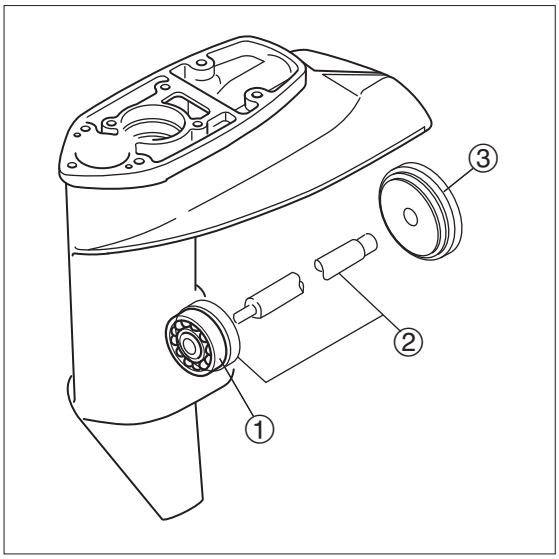
30) Assembly of Gear Case Parts

⚠ CAUTION

When gear case, forward (A) gear or bearing is replaced, measure backlash and attach a proper shim.
Refer to "Chapter 6 Shim Adjustment".

1. Use the following tools to install ball bearing ①.

Bearing Outer Press Kit ② :
P/N. 3B7-72739-1
Bearing Outer Press Plate ③ :
P/N. 3BJ-73723-0



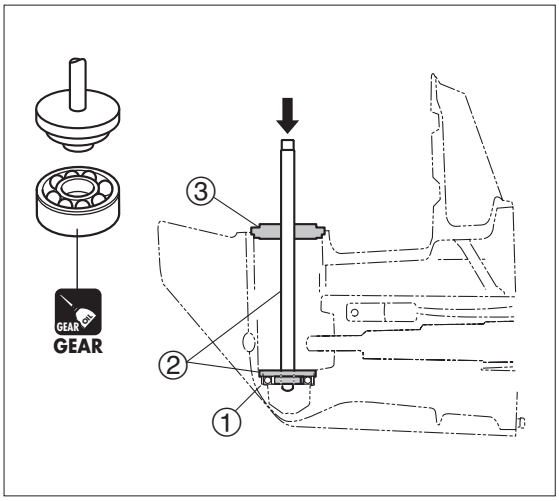
2. Fix gear case on a holder with its propeller shaft opening facing upward.

3. Clean outer race installation face in the gear case and apply gear oil.

4. Apply gear oil to external face of outer race, and put the outer race in the center of the housing with the marked face of the race facing in the housing.

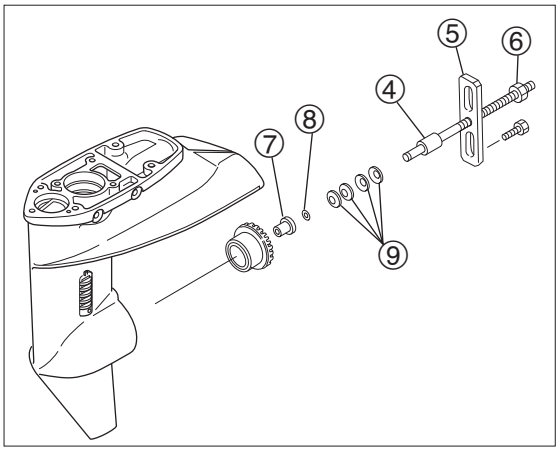
GEAR

5. Press the end of the rod to press-fit the outer race in the housing securely using a press.

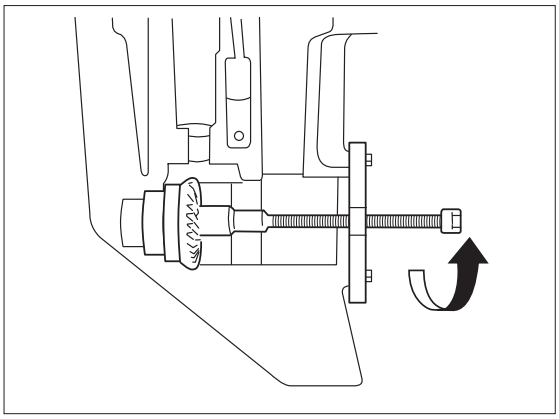


6. Check that ball bearing is press-fit in the housing securely, and then press-fit gear A by using the following tools.

Backlash Measuring Tool Kit :
P/N. 3C8-72234-1
Backlash Measuring Tool Shaft ④ :
Backlash Measuring Tool Plate ⑤ :
Nut M12P1.5 ⑥ :
Measuring Tool Set Piece ⑦ :
P/N. 3BJ-72245-0
O-Ring ⑧ :
Cone Disk Spring ⑨ :



Fixing gear case on the vice with its propeller shaft opening facing upward makes the work easier.



7. Install roller bearing ⑩ by using the following tools.

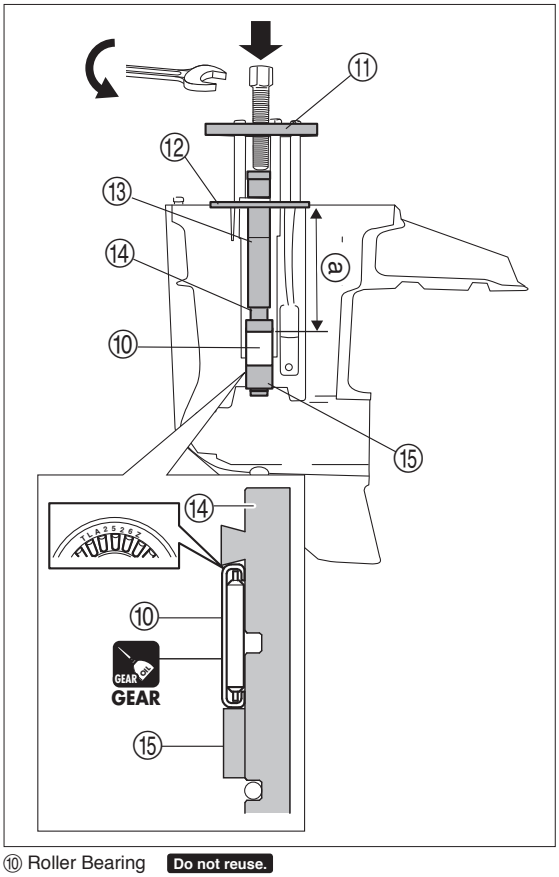
Roller Bearing Press Kit :
P/N. 3AC-72900-1
Bearing Outer Press Flange ⑪ :
P/N. 3AC-72900-2
Bearing Outer Press guide ⑫ :
P/N. 3AC-72765-2
Roller Bearing Press Rod ⑬ :
P/N. 3RS-72769-0
Roller Bearing Press ⑭ :
P/N. 3BJ-72770-0
Roller Bearing Press Guide ⑮ :
P/N. 3BJ-72905-0

⚠ CAUTION

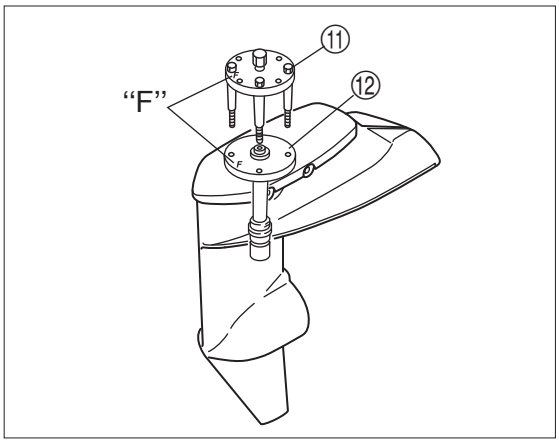
When installing flange ⑪ and guide ⑫, face "F" mark forward direction.

· Before installing roller bearing, be sure to clean bearing installation face and apply gear oil.
· Do not reuse roller bearing. Use new item.

Push In Depth ⓐ :
170.0 ± 0.2 mm (6.69 ± 0.01 in)



⑩ Roller Bearing **Do not reuse.**



6

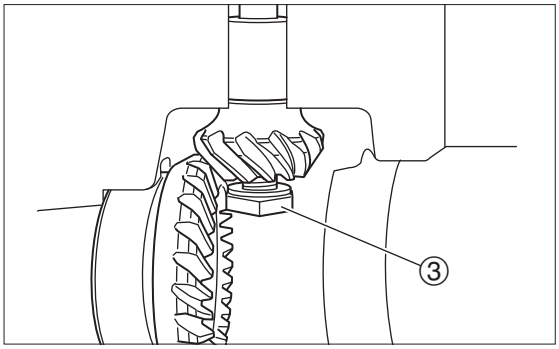
31) Installation of Pinion (B) Gear

1. Clean gear case interior.

2. After installing forward (A) gear into bear case, install drive shaft ass'y ①, pinion (B) gear ② and pinion (B) gear nut ③, and tighten the nut to specified torque.

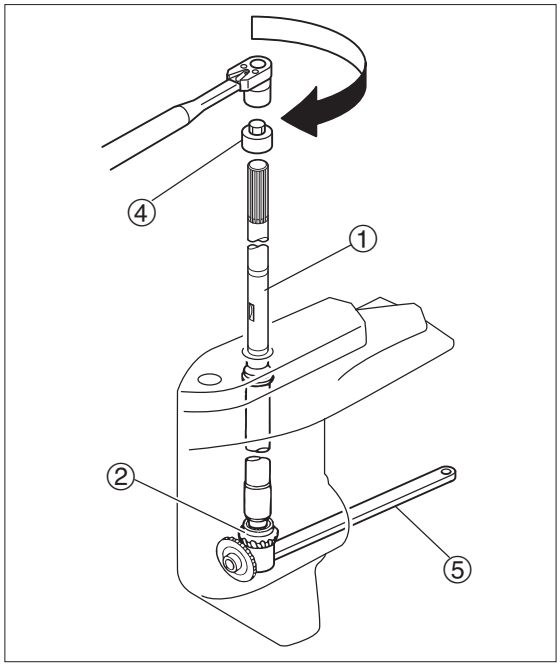
Pinion (B) Gear Nut :
35 N · m (25 lb · ft) [3.5 kgf · m]

Bevel Gear B Nut Socket ④ :
P/N. 346-72232-0
Bevel Gear B Nut Wrench ⑤ :
P/N. 346-72231-0



3. Stand gear case vertically. (Make drive shaft vertical.)

Take case of direction of pinion (B) gear nut seating surface.



32) Measurement of Back Lash between Forward (A) and Pinion (B) Gears and Shim Selection

Backlash Measuring Tool Kit :
P/N. 3C8-72234-2
Measuring Tool Set Piece :
P/N. 3BJ-72245-0
Backlash Measuring Tool Clamp :
P/N. 3B7-72765-2
Dial Gauge Plate :
P/N. 3B7-72729-0

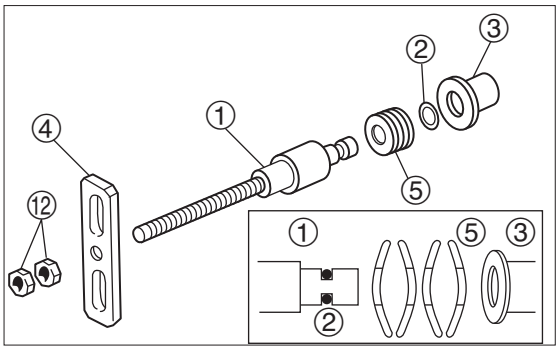
1. Assemble the pump case (lower) refer to procedure in "Chapter 6 Assembling the lower unit".

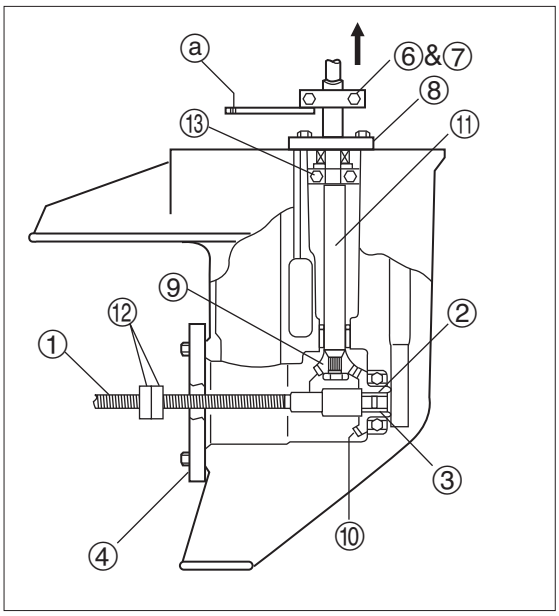
2. Perform measurement of backlash between forward (A) gear and pinion (B) gear with propeller shaft housing, propeller shaft and reverse (C) gear removed from gear case.
   Put conical disk springs ⑤ on the groove side of shaft ① getting their concave sides face to face, put O-ring ② in the groove, and then, collar ③. Then, screw plate ④ fully onto shaft ①. Put collar ③ side of shaft ① into bearing of forward (A) gear ⑩, and secure plate ④ to gear case with bolts.
   Put two nuts (M10) ⑫ on the aft-end of shaft ①, and screw the nuts onto the shaft with wrench. When drive shaft ⑪ starts to rotate as the nuts are turned, screw the nuts 45 degrees additionally. Keep shaft ① in this state.

3. Secure clamps ⑥ and ⑦ with bolt. Preload the bearing by turning drive shaft ⑪ several time while pulling it up toward direction shown by arrow to adapt it. Use dial gauge to read backlash at location of notch groove ⓐ.

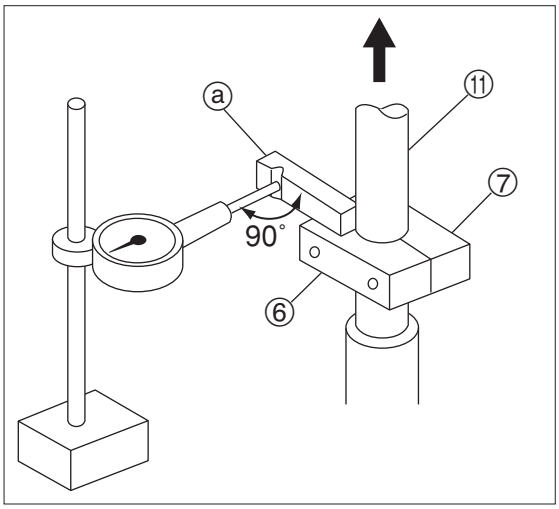
Proper Backlash Obtained from Gauge Reading :
0.8 - 1.2 mm (0.0315 - 0.0472 in)

Sizes of Adjusting Shims :
For Pinion (B) Side : 0.1, 0.15, 0.3, 0.5 mm





⑧ Pump Case (lower)
⑨ Pinion (B) Gear



4. Perform shim adjustment as necessary based on the gauge value obtained. The table shows relation between dial gauge readings and shim adjustments.

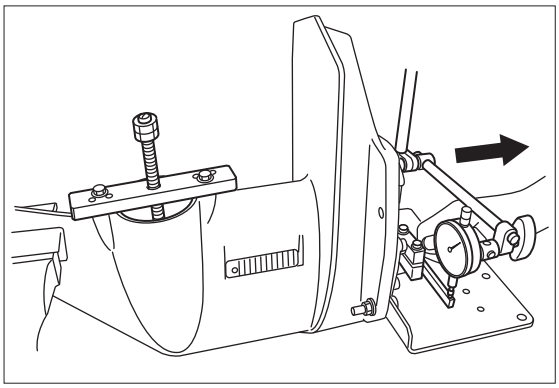
1. Values in this table indicate dial gauge readings that are obtained when using special tool.
2. Change gear engagement position and measure backlash again.

Dial Gauge Reading mm	Shim thickness to increase / decrease mm
0.00 to 0.25	– 0.15
0.26 to 0.52	– 0.10
0.53 to 0.79	– 0.05
0.80 to 1.20	0
1.21 to 1.47	+ 0.05
1.48 to 1.74	+ 0.10
1.75 to 1.99	+ 0.15

5. After the adjustment, remove backlash measuring tool, and turn drive shaft while pulling it up to see if it turns smoothly.
If not, reduce shim thickness 0.05mm and adjust backlash again.

If engagement of bevel (A) gear with pinion (B) gear is imperfect, they may produce abnormal noise when turning drive shaft while pulling it up. In such case, reduce shim thickness 0.05 mm.

Keep the following matters in mind when performing the measurement.
- Shaft ① that secures forward (A) gear has been tightened so that drive shaft ⑪ cannot be turned over backlash if it is turned lightly.
- Fixing of drive shaft bearing ⑬ is performed only with pump case (lower) ⑧. Clamp halves ⑥ and ⑦ should be attached as close to pump case (lower) ⑧ as possible.
- When performing the measurement by using dial gauge, gear case and dial gauge are fixed and drive shaft ⑪ is turned while it is pulled up. During the measurement, be sure that other parts do not produce play (play of drive shaft ⑪ itself and the one between drive shaft ⑪ and bearing).



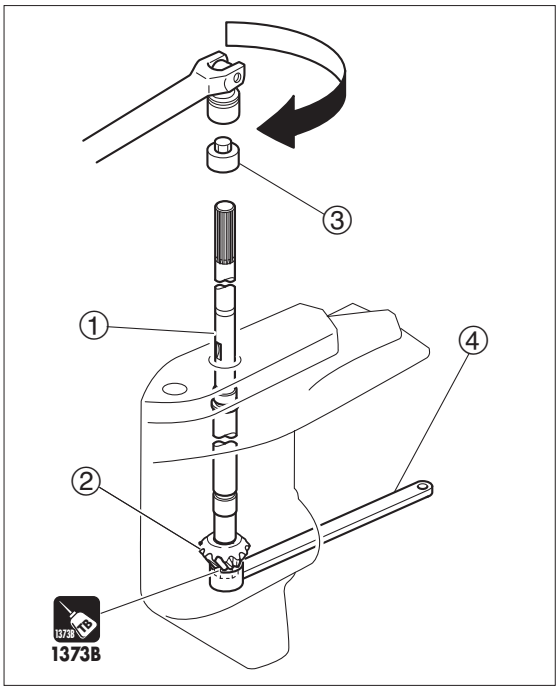
33) Reassembly of Pinion (B) Gear Nut

1. Assemble drive shaft ass'y ①, pinion (B) gear ② and pinion (B) gear nut, and tighten the nut to specified torque.

Bevel Gear B Nut Socket ③ :
P/N. 346-72232-0
Bevel Gear B Nut Wrench ④ :
P/N. 346-72231-0

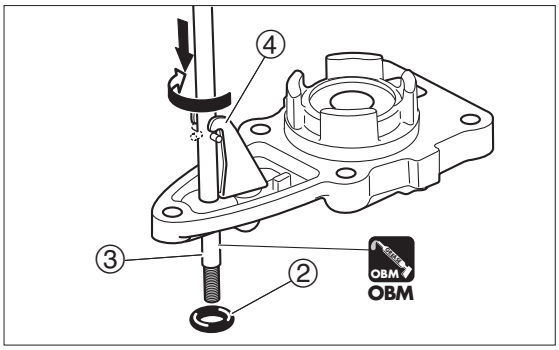
Pinion (B) Gear Nut :
35 N · m (25 lb · ft) [3.5 kgf · m]

- Tighten the nut by using a drive shaft socket ③ and a wrench and turning the wrench clockwise. Cover the wrench ④ with rag to prevent it from hitting the case directly.
- This work can be made easier when the opening of gear housing of propeller shaft side is faced upward and fixed horizontally with a holder.
- Before tightening pinion (B) gear and nut, apply ThreeBond 1373B to the thread.
- Degrease taper area of drive shaft pinion (C) gear installation section and thread of gear nut completely.



6

34) Assembly of Pump Case

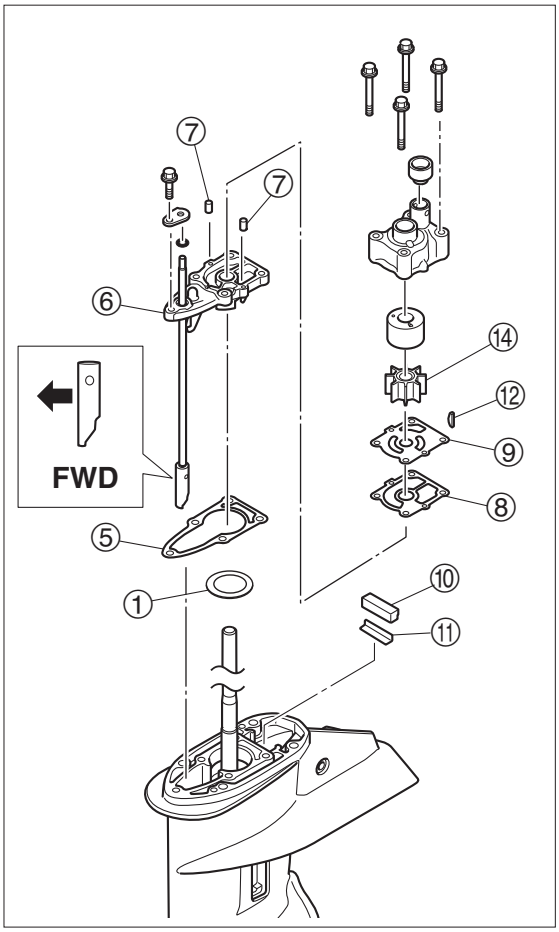


1. Install shim ① that is removed when disassembly.

2. Install O-ring ②, camrod ③, stopper ④ and gasket ⑤ to pump case (lower) ③ and install pump case (lower) to gear case.

- Insert cam rod into pump case (lower) and turn it by 90 °.
- Apply OBM grease to O-ring of the cam rod.
- Pay attention in direction of cam rod, after assembling.

OBM

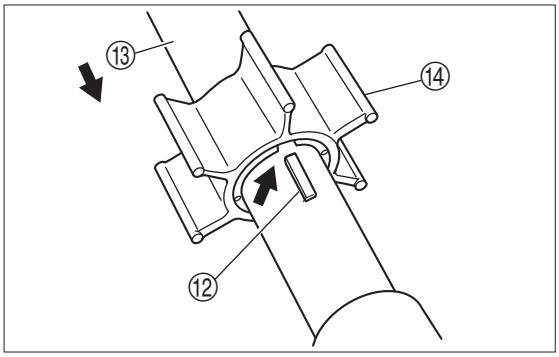


3. Install pump case (lower) ⑥ to gear case.

4. Install dowel pin ⑦ on the pump case (lower) ⑥, and insatall pump case guide plate gasket ⑧, pump case guide plate ⑨, water seal rubber ⑩ and water seal rubber plate ⑪.

Do not forget to install the water seal rubber ⑩ and water seal plate ⑪. Otherwise could result to engine over heating.

. Install water pump impeller key ⑫ to drive shaft ⑬, align the key with the water pump impeller ⑭ side key groove, and install the impeller.



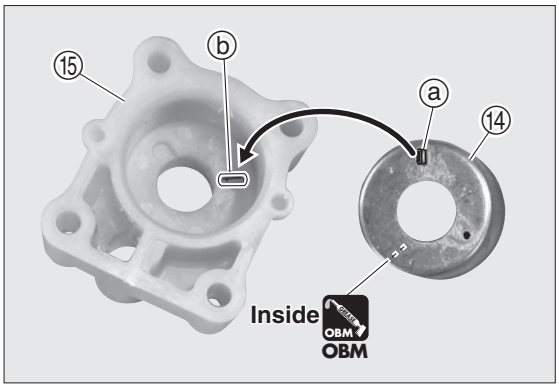
6. Attach water pump liner ⑭ to pump case (upper) ⑮.

⚠ CAUTION

Align pump liner ⑭ protrusion ⓐ with pump case (upper) ⑮ concave ⓑ.

Apply OBM grease to inside of water pump liner.

OBM

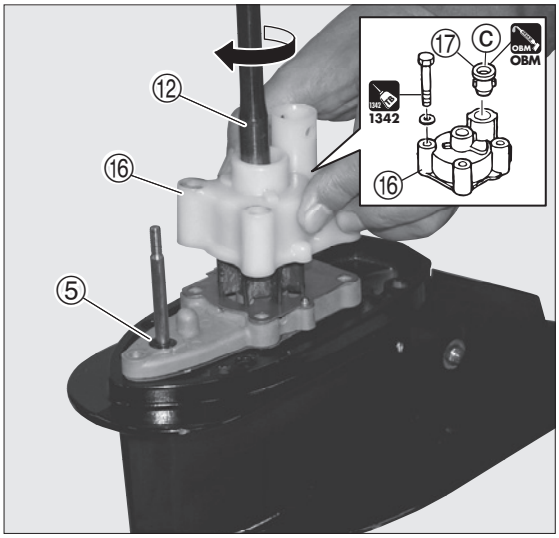


7. Install pump case (upper) ⑯ and gasket on the drive shaft, and install them on the pump case (lower) ⑤.

⚠ CAUTION

While installing pump case ⑯, turn drive shaft ⑩ clockwise to bend all impeller blades in counterclockwise on power unit direction.

OBM



8. Attach water pipe seal ⑰.

Apply OBM grease thinly on the inside ⓒ of water pipe seal so that water pipe can be inserted smoothly.

35) Installing Propeller Shaft Housing Ass'y

1. Istall O-ring ② to propeller shaft housing ①.

Apply gear oil to O-ring.

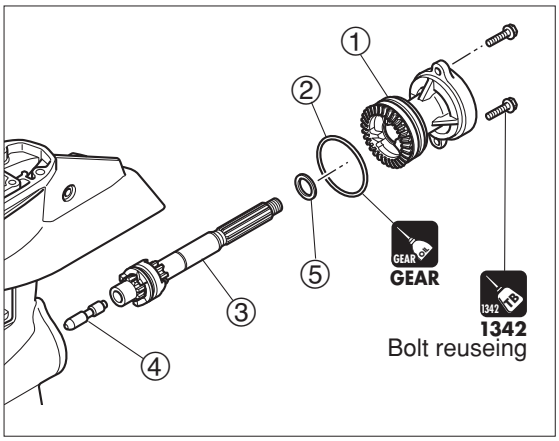
2. Install clutch push rod ④ and washer ⑤ that was removed when disassembling to propeller shaft ③.

3. Install propeller shaft ③ to propeller shaft housing ①, and install the assembly to gear case.

· Install propeller shaft housing to gear case securely, and tighten the securing bolts after confirming that O-ring is set in the case properly.
· Apply ThreeBond 1342 to thread of propeller shaft housing installation bolts.

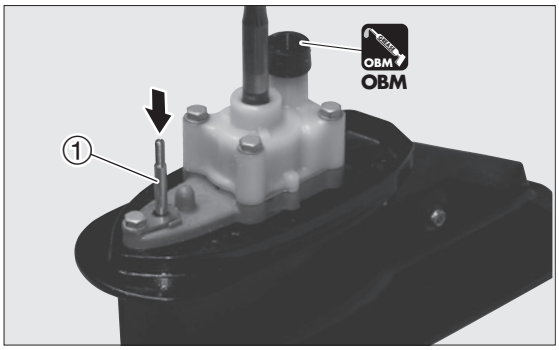
Propeller Shaft Housing Bolts :
6 N · m (4 lb · ft) [0.6 kgf · m]

1342



② O-ring **Do not reuse.**

36) Installation of Lower Unit



1. Tilt-up outboard motor and lock with tilt stopper.

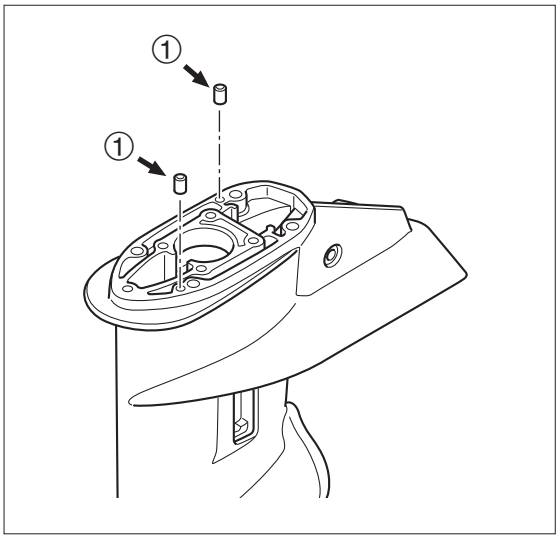
2. Set shift rod ① to up position (into Reverse position).

- Apply thin coat of TEFLON grease to spline of drive shaft before assembling.
- Apply thin coat of OBM grease to water pipe seal rubber.
- Lower unit installation can be made easier with the outboard motor tilted up.
- When installing the lower unit, insert water pipe into seal rubber properly.

TEF

OBM

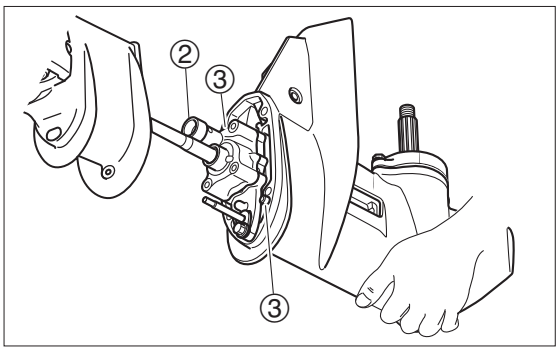
3. Install dowell pins ① (2 pieces).



① Dowell pin

4. Put lower unit ass'y into drive shaft housing.
   Align the position of water pipe, water pipe seal ② and dowel pin ③.

Apply OBM grease to O-ring.



5. Tighten lower unit ass'y installation bolts to specified torque.

Lower Unit Bolt :
24 N · m (17 lb · ft) [2.4 kgf · m]

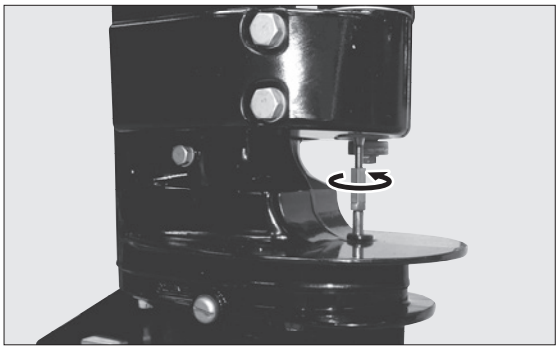
1401

6. Tighten the shift cam joint nut, and then connect shift rod and camrod.

⚠ CAUTION

Tighten both nut and shift rod joint by pressing with spanner wrench. Otherwise gear case internal parts may damaged.

Make sure to check for shift rod pulling completely. And check for shift lever is shifted in forward (F). If joint is tightened when not in forward, it will not shift correctly.

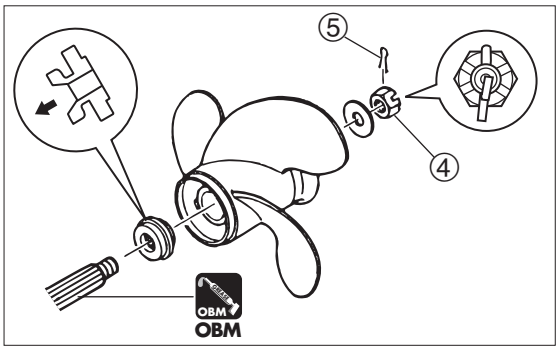


7. Attach propeller and tighten propeller nut ④ to specified torque.

⚠ CAUTION

- **Before removing or installing propeller, be sure to remove stop switch lock plate.**
- **When removing or installing propeller, do not handle propeller with bare hands.**
- **Put a piece of wooden block between anti-ventilation plate and propeller to prevent rotation of propeller when removing or installing propeller.**

Propeller Nut ④ :
12 N · m (9 lb · ft) [1.2 kgf · m]

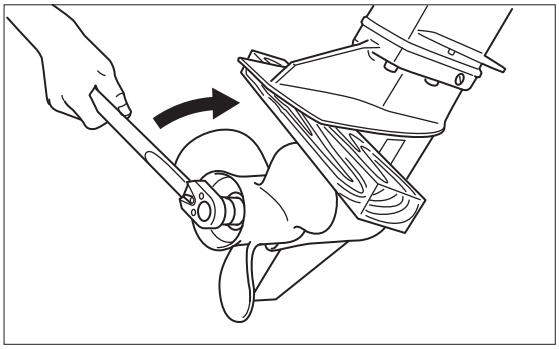


⑤ Split Pin Do not reuse.

8. Attach split pin ⑤.

⚠ CAUTION

If propeller shaft pin hole and propeller nut pin groove do not align, additionally tighten the nut until they align.

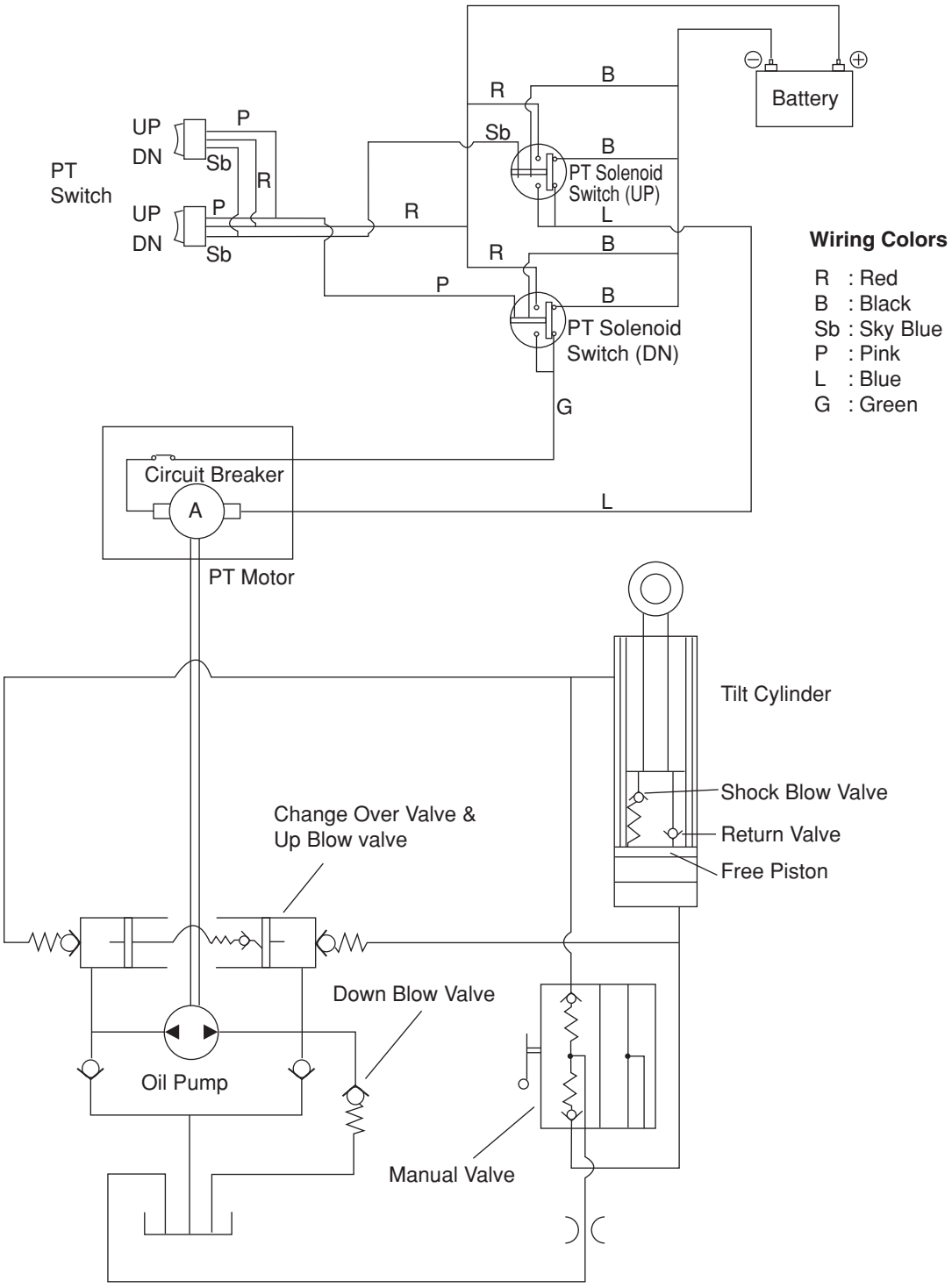


9. Fill gear case with gear oil to specified level.
Refer to "Replacement of Gear Oil" in Chapter 3.

6

7
Bracket

1. PT Wiring and Layout Diagram



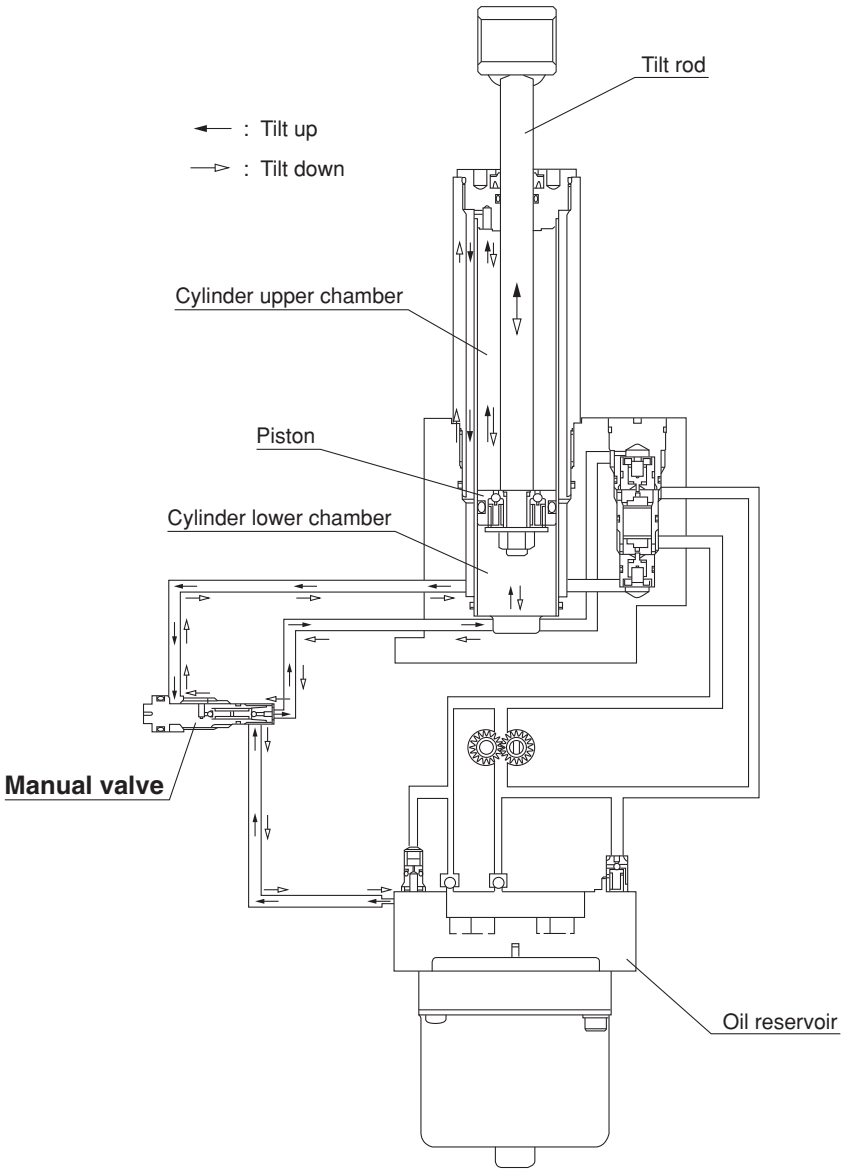
Mark

- Oil Reservoir
- Release Valve
- Check Valve
- Orifice

2. Operation of Power Tilt

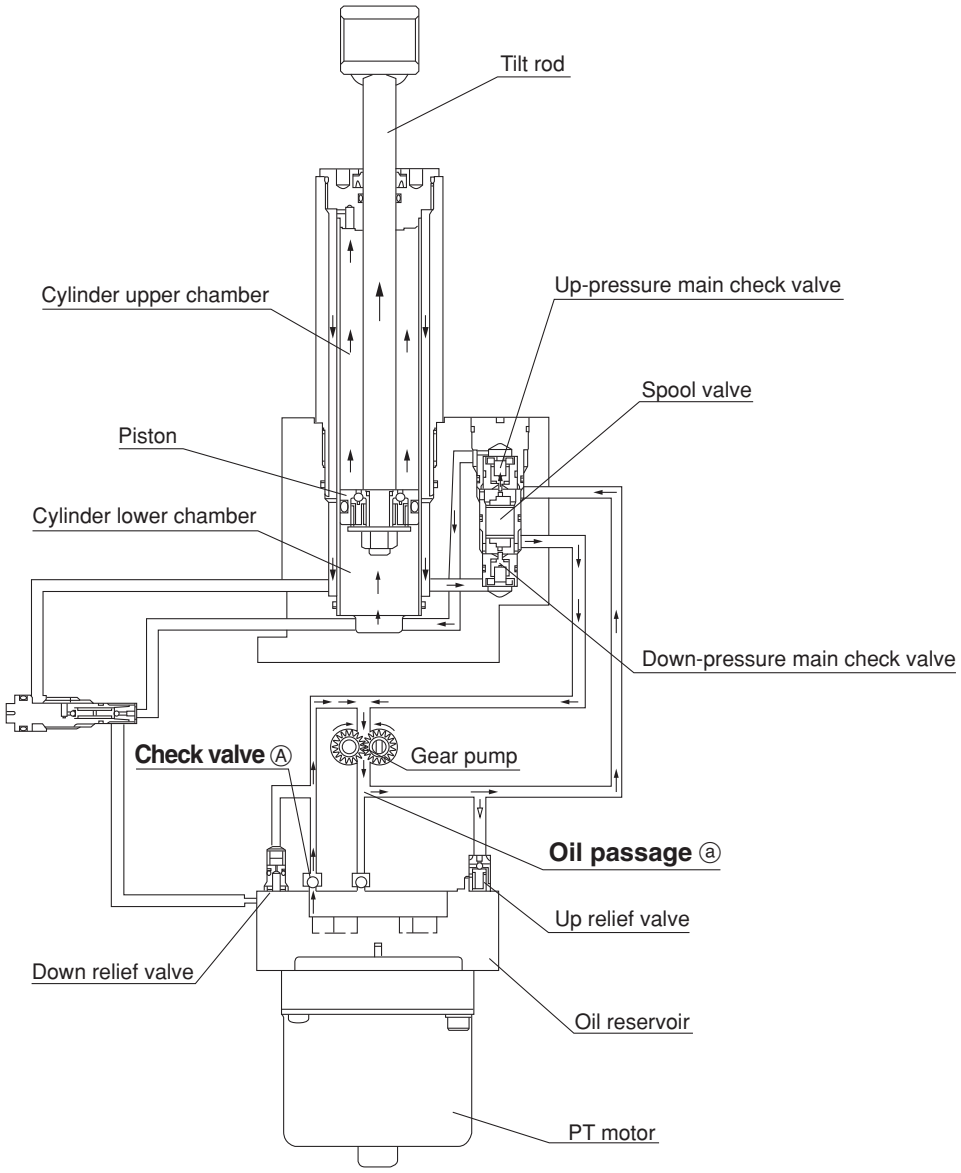
- The power tilt system has an electric motor built in the system that drives the hydraulic pump to feed pressurized oil into the tilt cylinder.
- The power tilt switch located on the tiller handle or remote control box is used to tilt-up or down the outboard motor.

3. Operations of Hydraulic Circuit



Manual Tilt Operation

Turning the manual operation valve counterclockwise to open completely the manual operation circuit.
The outboard motor can now be tilted up or down easily by hand.
When the manual circuit is closed completely by turning the manual valve clockwise before the outboard motor reaches completely tilted up or down position, the outboard motor holds the position at the time.



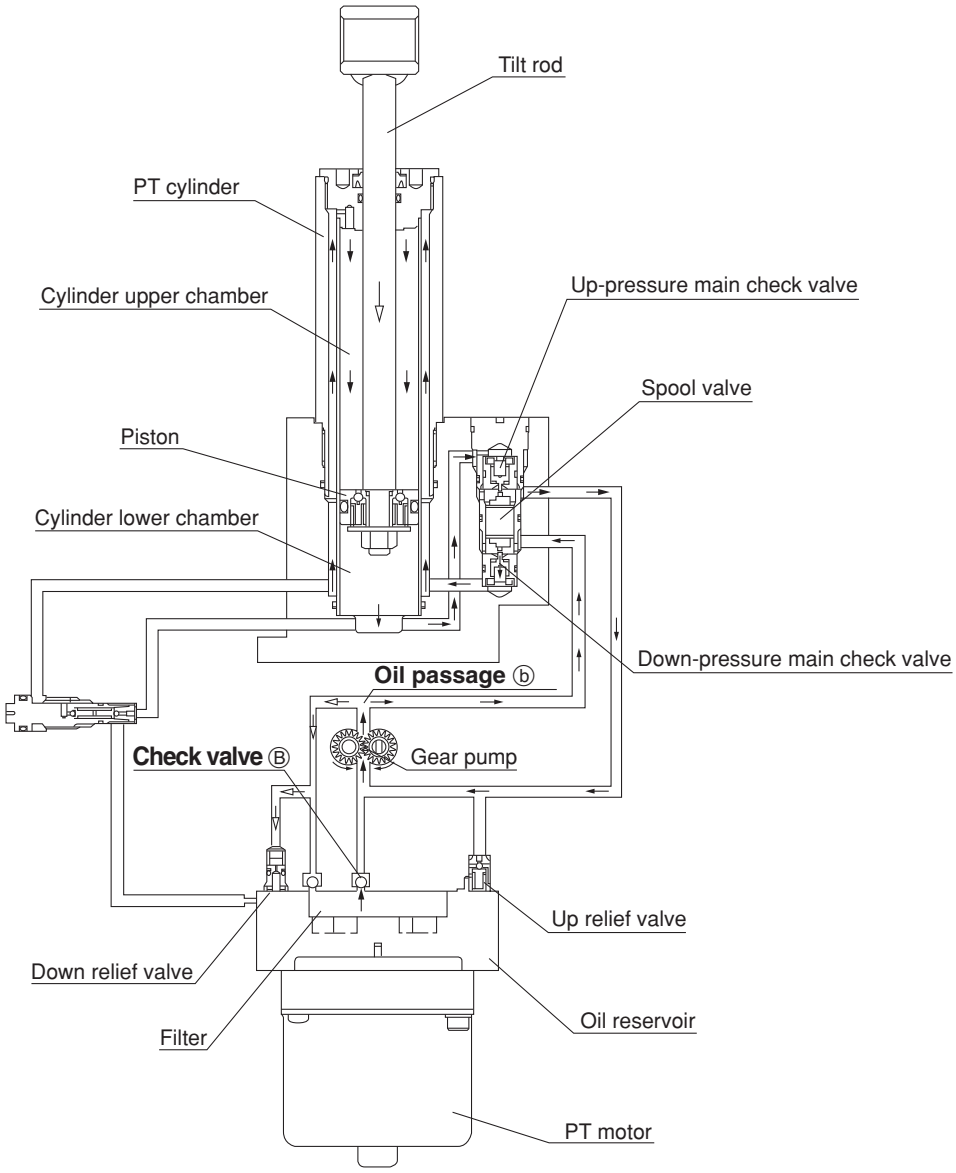
Tilt Up Operation

Pressing "UP" side of PT switch causes the PT motor (gear of gear pump) to rotate clockwise.

Check valve Ⓐ opens to cause oil to flow from reservoir toward gear pump and spool valve. This oil flow shifts spool valve downward to open down-pressure main check valve. Oil in the cylinder upper chamber is returned to gear pump, hydraulic pressure of oil passage ⓐ is increased to open up-pressure main check valve, and the oil flows into cylinder lower chamber. As a result of the above operations, piston rod is pushed up to tilt up the outboard motor. The oil in the cylinder upper chamber returns to gear pump through down pressure main check valve.

Because of difference of capacity difference between cylinder upper chamber and lower chamber (piston rod at upper chamber side), oil flows into the pump through check valve Ⓐ to compensate for the lack of the oil. When the motor stops, down/up pressure main check valve closes, and spool valve moves to the center. As a result, piston rod is held at a position at the time.

When tilt rod fully extends, up relief valve opens to prevent increase of hydraulic pressure of cylinder lower chamber by relieving the pressure to protect PT unit.



Tilt Down Operation

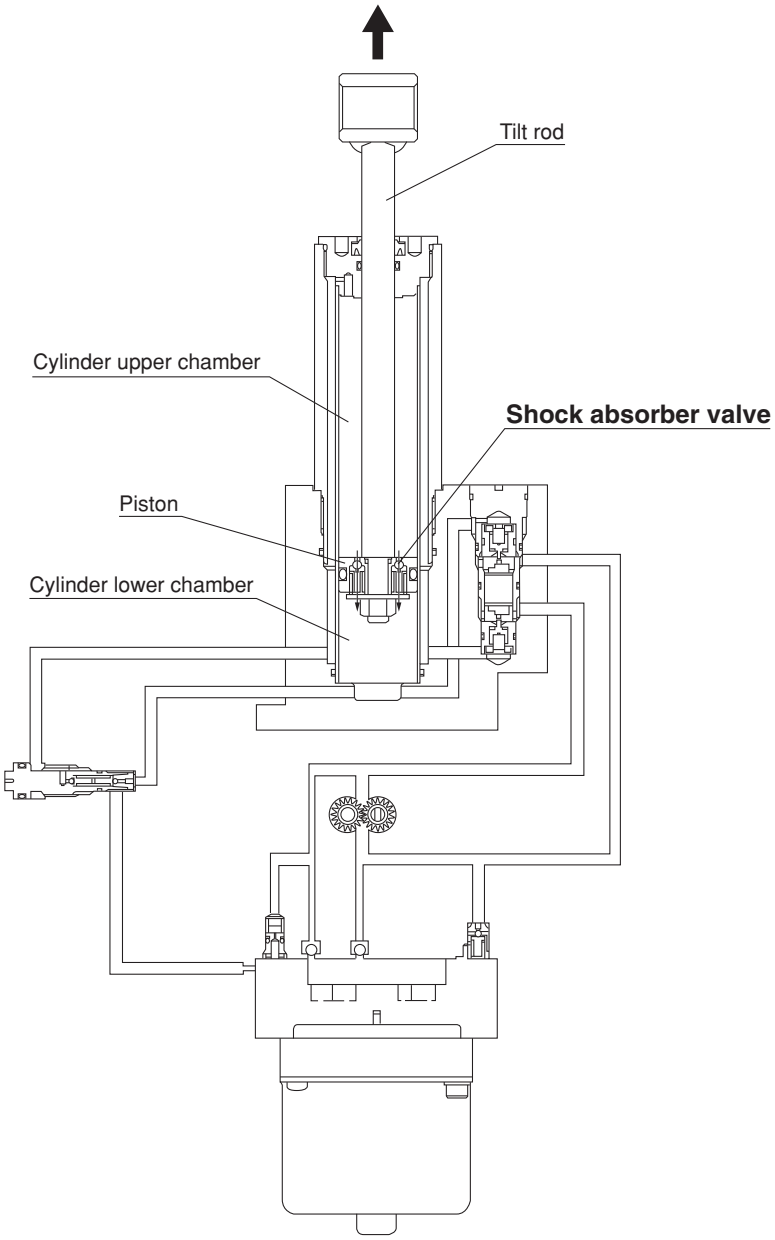
Pressing "DOWN" side of PT switch causes the PT motor (gear pump) to rotate counterclockwise.

Check valve Ⓑ opens to cause oil to flow from reservoir toward gear pump and spool valve. This oil flow shifts spool valve upward to open up-pressure main check valve. Oil in the cylinder lower chamber is returned to gear pump, hydraulic pressure of oil passage ⓑ is increased to open down-pressure main check valve, and the oil flows into cylinder upper chamber. As a result of the above operations, piston rod is pushed down to tilt down the outboard motor.

The oil in the cylinder lower chamber returns to gear pump through up-pressure main check valve.

Because of difference of capacity difference between cylinder upper chamber and lower chamber, oil of amount exceeding upper chamber requirement returns to gear pump.

When piston rod is drawn-in completely, all of oil discharged from the pump returns from down relief valve to the reservoir.



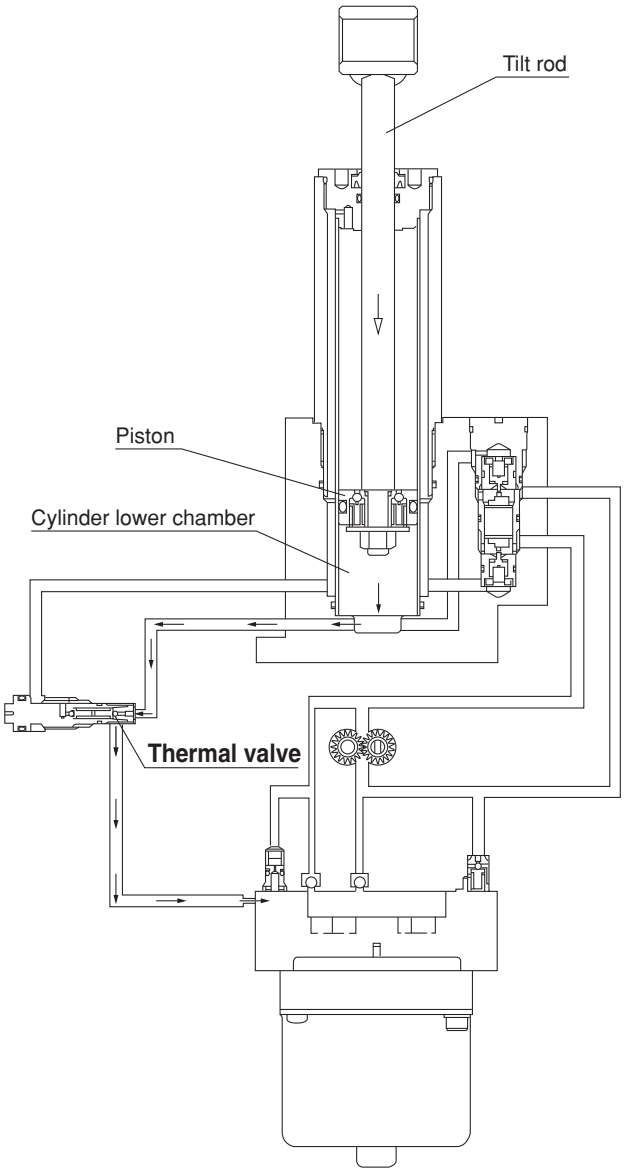
Shock Absorber Valve

The PT unit is provided with a shock absorber that protects the drive unit from an impact in case it hits underwater obstacle during cruising.

In case drive unit hits an underwater obstacle, the hydraulic pressure in the cylinder upper chamber is increased suddenly.

The high pressure opens shock valve of piston.

When shock valve opens, oil in the cylinder upper chamber flows into the lower cylinder chamber to extend tilt rod upward to absorb the shock.



Thermal Valve

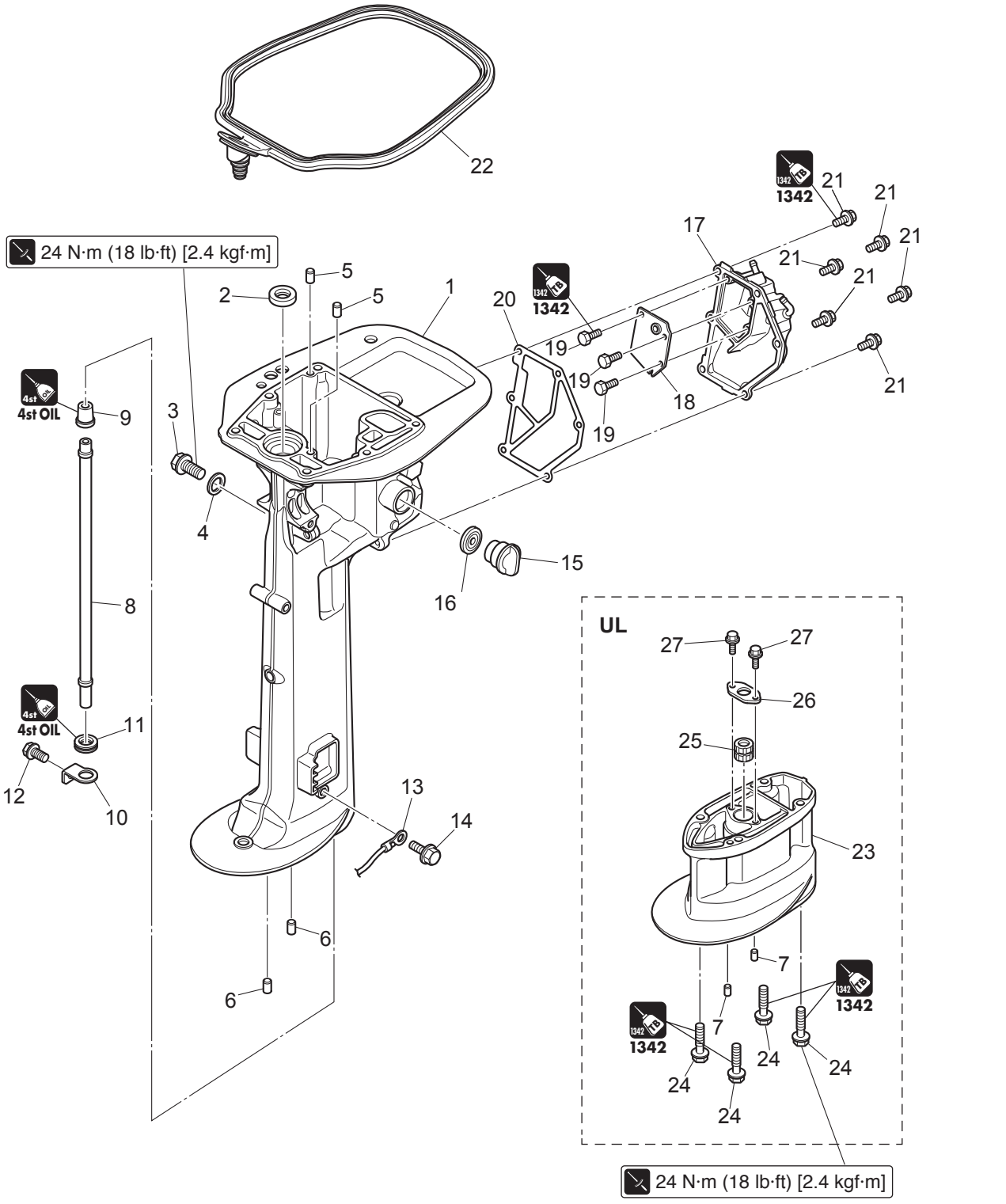
Thermal valve protects drive unit from excessive force that attempts to push down tilt rod when the outboard motor is at full tilt up position.

The piston rod to which excessive force is applied is pressed into the cylinder, resulting in increasing hydraulic pressure in the lower cylinder chamber over a rated value.

The increased hydraulic pressure reaches the thermal valve, resulting in opening the valve to dissipate itself.

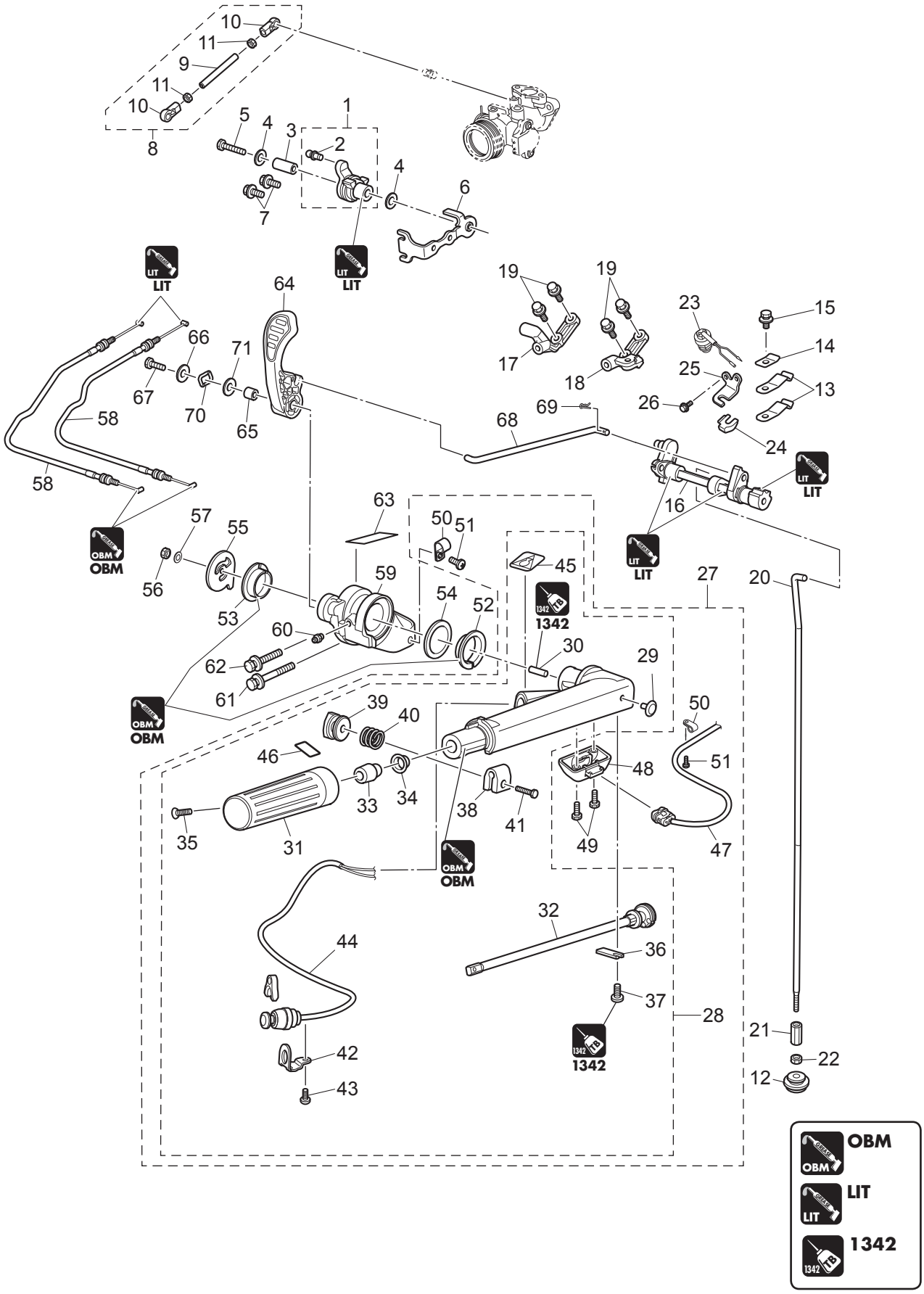
4.Parts Layout

Drive Shaft Housing

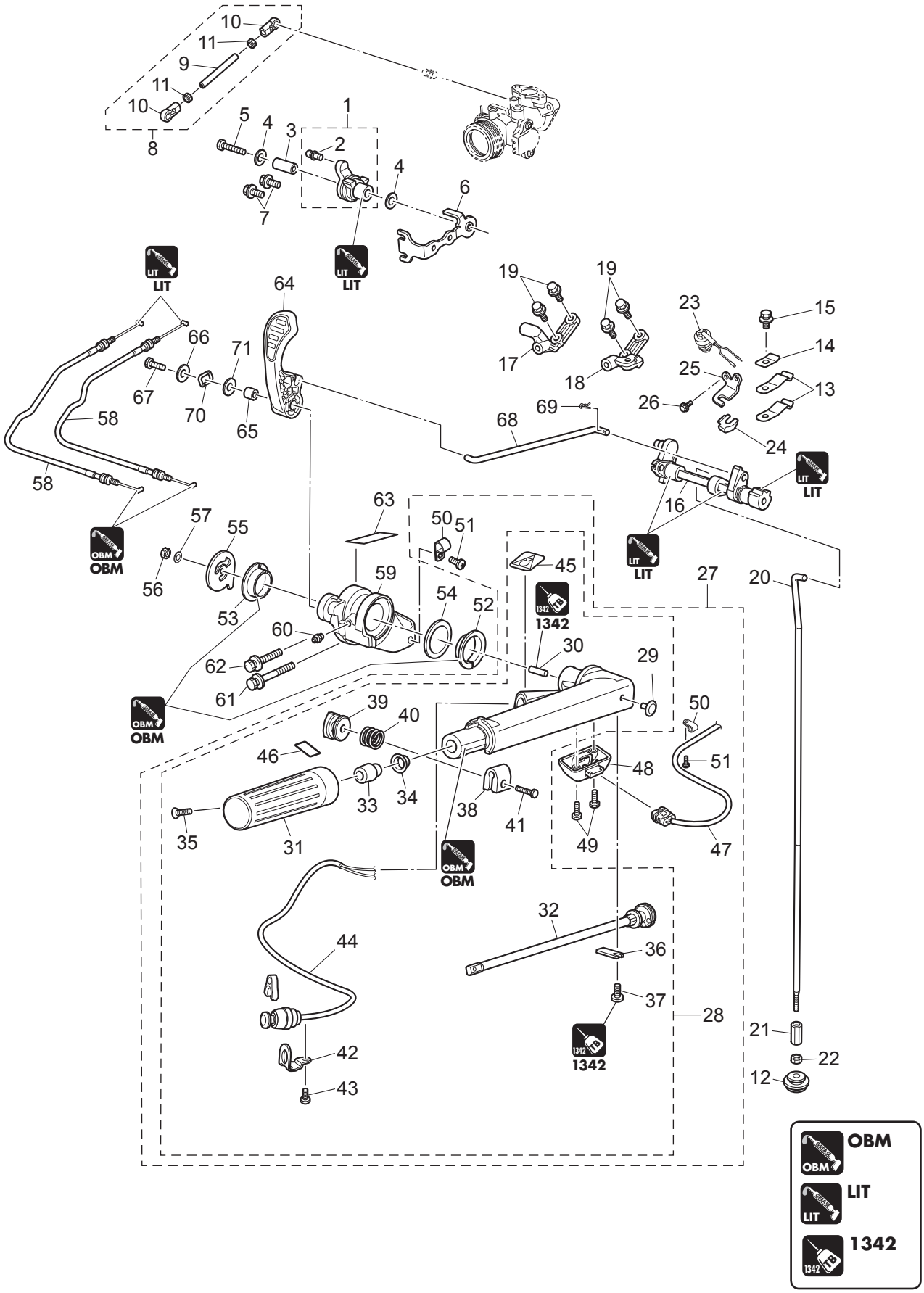


Ref. No.	Description	Q'ty	Remarks
1	Drive Shaft Housing Assy (S)	1	
	Drive Shaft Housing Assy (L)	1	
	Drive Shaft Housing Assy (S)	1	PT Type
2	Oil Seal 12.8-25-7	1	Do not reuse.
3	Drain Bolt 14-14	1	M14 L=14mm
4	Washer 14.5-24-1	1	M14
5	Dowel Pin 6-12	2	
6	Dowel Pin 6-12	2	
7	Dowel Pin 6-12	2	Extension Housing
8	Water Pipe (S)	1	
	Water Pipe (L)	1	
	Water Pipe (UL)	1	
9	Water Pipe Seal (Upper)	1	
10	Lock Plate	1	
11	Water Pipe Auxiliary Mount 13-2.5	1	
12	Bolt	1	M6 L=12mm
13	Ground L=210	1	Drive Shaft Housing-Mount Bracket
14	Bolt	1	M6 L=12mm
15	Flushing Connector Cap	1	
16	Seal Ring	1	
17	Idle Exhaust Port Cover Assy	1	
18	Plate	1	
19	Bolt	3	M5 L=12mm
20	Idle Exhaust Port Gasket	1	Do not reuse.
21	Bolt	6	M6 L=16mm
22	Engine Basement Seal	1	
23	Extension Housing UL	1	
24	Bolt 8-31	4	M8 L=31mm
25	Drive Shaft Bushing	1	
26	Stopper	1	
27	Bolt	2	M6 L=12mm

Tiller Handle & Shift



Ref. No.	Description	Q'ty	Remarks
1	Throttle Drum Assy	1	
2	Ball Joint	1	
3	Collar	1	
4	Washer 6-16-1.5	2	
5	Bolt	1	M6 L = 40 mm
6	Throttle Wire Bracket	1	
7	Bolt	2	M6 L = 16 mm
8	Link Rod Assy (Throttle)	1	
9	Throttle Rod	1	
10	Ball Joint Connector	2	
11	Nut	2	M5
12	Grommet	1	
13	Shift Lever Stopper	2	
14	Shift Lever Stopper t=0.8	1	
15	Bolt	1	M6 L = 12 mm
16	Shift Lever Shaft Assy	1	
17	Holder	1	
18	Holder	1	
19	Bolt	4	M6 L = 20 mm
20	Shift Rod (S)	1	
	Shift Rod (L)	1	
21	Shift Rod Joint	1	
22	Nut	1	
23	Neutral Switch	1	
24	Neutral Switch Actuator	1	
25	Neutral Switch Bracket	1	
26	Bolt	1	M6 L = 16 mm
27	Tiller Handle Assy	1	PT Type
28	Tiller Handle Assy	1	
29	Plastic Rivet 6.5	1	
30	Stud	1	
31	Grip	1	
32	Throttle Shaft	1	
33	Throttle Shaft Damper	1	
34	Bushing 14-15.8-7	1	
35	Screw	1	M5 L= 20 mm
36	Throttle Shaft Support	1	
37	Screw	1	M6 L = 12 mm
38	Friction Piece	1	
39	Adjusting Nut	1	
40	Spring	1	
41	Bolt	1	M6 L = 25 mm
42	Bracket	1	
43	Screw	1	M6 L = 12 mm
44	Stop Switch Assy	1	
45	Stop Switch Decal	1	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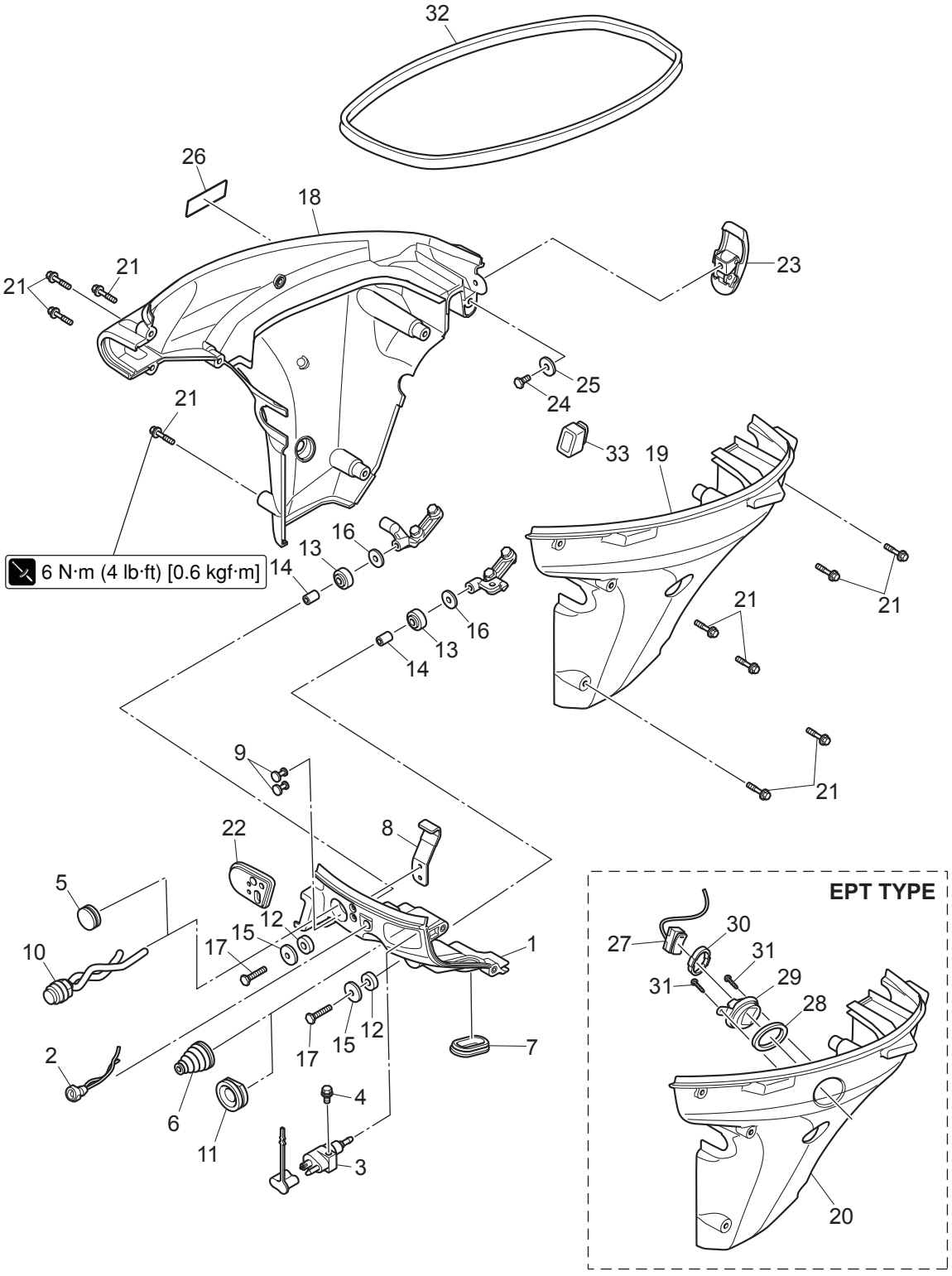
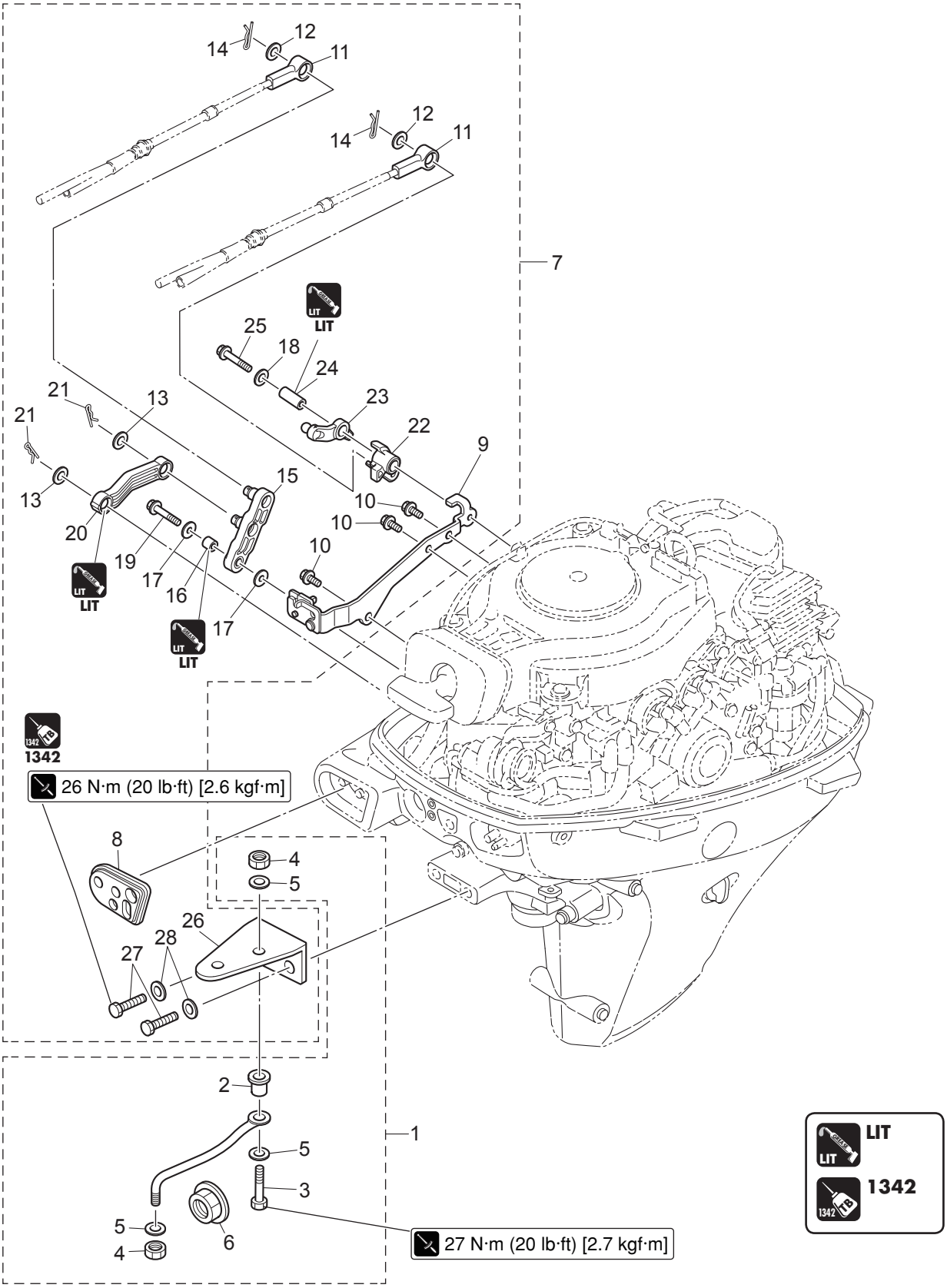
Ref. No.	Description	Q'ty	Remarks
46	Throttle Decal	1	
47	PT Switch Assy	1	PT Type
48	Switch Box	1	PT Type
49	Screw	2	PT Type M5 L = 16 mm
50	Clamp 6-9.5L	2	PT Type
51	Screw	2	PT Type M5 L = 12 mm
52	Bushing	1	
53	Bushing	1	
54	Washer	1	
55	Cover	1	
56	Nut	1	M6
57	Washer	1	M6
58	Throttle Wire	2	
59	Steering Bracket	1	
60	Grease Fitting	1	
61	Bolt	1	
62	Bolt	1	
63	Shift Decal	1	
64	Shift Lever	1	
65	Collar 6.5-10.5-10	1	
66	Washer 6.5-21-1	1	
67	Bolt	1	M6 L = 20 mm
68	Shift Lever Rod	1	
69	Snap Pin d=5	1	
70	Wave Washer	1	
71	Washer	1	

Front Panel & Drive Shaft Housing Cover



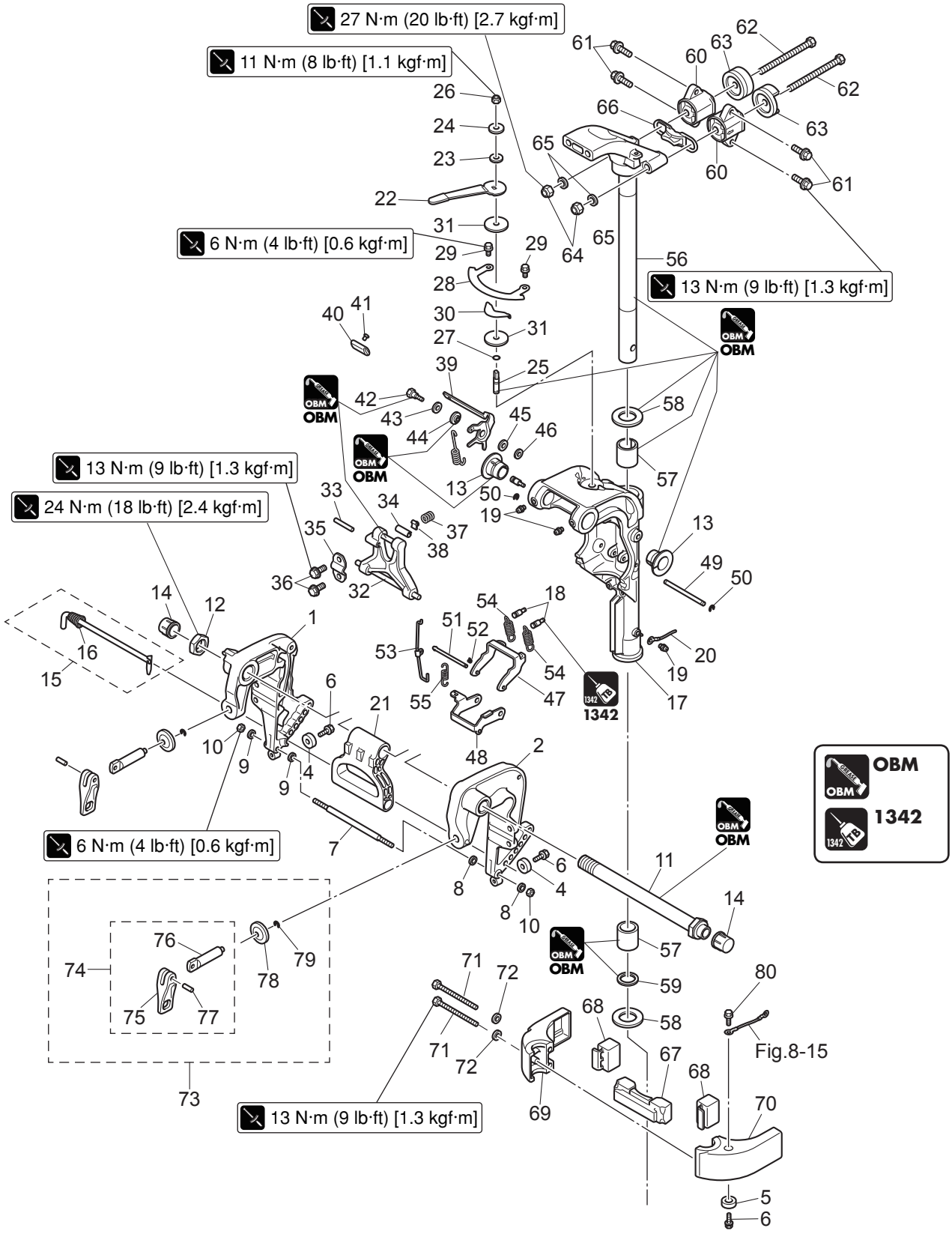
Ref. No.	Description	Q'ty	Remarks
1	Front Panel	1	
2	Pilot Lamp Assy	1	
3	Fuel Connector (Male)	1	
4	Bolt	1	M6 L = 16 mm
5	Grommet 17-2.7	1	Main Switch Hole M type
6	Grommet	1	Shift Rod Hole F type
7	Grommet 40-18-3	1	
8	Cover Stay (Front)	1	
9	Rivet 4-12.9-2.4	2	
10	Main Switch Assy	1	E type
11	Grommet 22-3	1	Shift Rod Hole P type
12	Mount 8.5-14-2.5	2	
13	Rubber Mount 8.5-14-2.5	2	
14	Collar	2	
15	Washer 6.5-20.5-1	2	
16	Washer 6.5-21-1	2	
17	Bolt	2	M6 L = 30 mm
18	Drive Shaft Housing Cover (R)	1	
19	Drive Shaft Housing Cover (L)	1	
20	Drive Shaft Housing Cover (L)	1	PT type
21	Bolt	10	
22	Grommet	1	F type
23	Cowl Latch Assy	1	
24	Bolt	1	M6 L = 12 mm
25	Washer 6.5-23-1.5	1	
26	Storage Decal	1	
27	PT Switch Assy	1	
28	Gasket	1	
29	Switch Box	1	
30	Switch Box Grommet	1	
31	Screw	2	M5 L = 12 mm
32	Top Cowl Seal	1	
33	Grommet	1	

Remote Control Parts



Ref. No.	Description	Q'ty	Remarks
1	Drag Link Assy	1	
2	Spacer 9.6-19-13	1	
3	Bolt 3/8-35	1	
4	Nylon Nut 3/8-24UNF	2	
5	Washer 9.6-18-2	3	
6	Seal Ring	1	
7	Remote Control Fitting Assy	1	
8	Grommet	1	P type
9	Cable Clip Assy	1	
10	Bolt	3	M6 L=16mm
11	Cable Joint	2	
12	Washer 8.5-18-1.6	2	
13	Washer 8.5-18-1.6	2	
14	Snap Pin d=8	2	
15	Shift Arm	1	
16	Collar 6.5-10.5-9.3	1	
17	Washer 6-16-1.5	2	
18	Washer 6-16-1.5	1	
19	Bolt	1	M6 L=25mm
20	Shift Lever Rod	1	
21	Snap Pin d=8	2	
22	Throttle Arm	1	
23	Throttle Opener	1	
24	Collar	1	
25	Bolt	1	M6 L=40mm
26	Steering Hook Plate	1	
27	Bolt	2	M10 L=30mm
28	Washer	2	M10

Brcket (Manual)



Ref. No.	Description	Q'ty	Remarks
1	Clamp Bracket (R)	1	
2	Clamp Bracket (L)	1	
3	Co-pilot Decal	1	
4	Anode	2	
5	Anode	1	
6	Bolt	3	M6 L = 20 mm
7	Distance Piece	1	
8	Washer	2	M6
9	Washer	2	M6
10	Nut	2	M6
11	Swivel Bracket Shaft Assy	1	
12	Nylon Nut 7/8-14	1	
13	Bushing	2	
14	Cap Nut	2	
15	Thrust Rod Assy	1	
16	Thrust Rod Spring	1	
17	Swivel Bracket	1	Transom S
	Swivel Bracket	1	Transom L & UL
18	Pin	2	
19	Grease Fitting	3	
20	Ground L=110	1	Swivel Bracket-Mount Bracket
21	Carrying Handle	1	
22	Friction Lever	1	
23	Washer 8.1-20-0.8	1	
24	Washer 8.5-24-1.5	1	
25	Bolt	1	
26	Nylon Nut 8-P1.25	1	
27	O-ring 1.9-6.8	1	**Do not reuse.**
28	Plate	1	
29	Bolt	2	M6 L = 12 mm
30	Washer	1	
31	Disc 8.5-38-2	2	
32	Tilt Stopper	1	
33	Spring Pin	1	
34	Bushing 8.2-10-26.5	1	
35	Setting Plate	1	
36	Bolt	2	M8 L = 18 mm
37	Friction Spring	1	
38	Setting Piece	1	
39	Reverse Lock Lever	1	
40	Reverse Lock Lever Grip	1	
41	Stopper	1	
42	Shoulder Bolt	1	
43	Washer	1	M8
44	Bushing 8.1-20	1	
45	Washer 8.5-18-1.6	1	

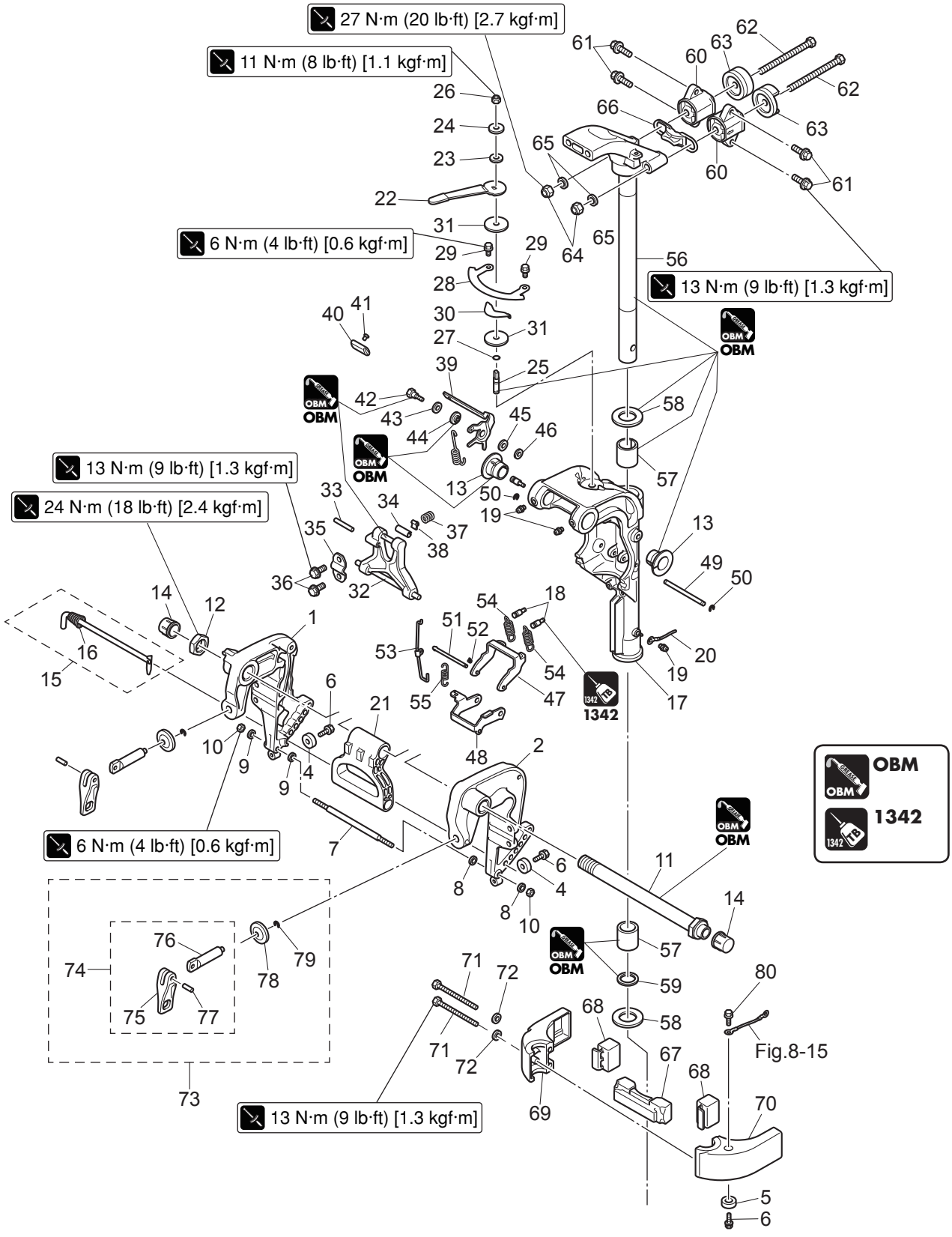

27 N·m (20 lb·ft) [2.7 kgf·m]
11 N·m (8 lb·ft) [1.1 kgf·m]
6 N·m (4 lb·ft) [0.6 kgf·m]
13 N·m (9 lb·ft) [1.3 kgf·m]
24 N·m (18 lb·ft) [2.4 kgf·m]
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Fig.8-15

Ref. No.	Description	Q'ty	Remarks
46	Washer 6-16-1.5	1	
47	Reverse Lock (R)	1	
48	Reverse Lock Arm	1	
49	Reverse Lock Shaft	1	
50	E-ring d=6	2	
51	Reverse Lock Rod	1	
52	Split Pin 2-12	2	
53	Reverse Lock Link	1	
54	Reverse Lock Spring (S)	2	
55	Reverse Lock Spring	1	
56	Steering Shaft Assy	1	
	Steering Shaft Assy (L & UL)	1	
57	Bushing 28-31-35	2	
58	Thrust Plate (Upper)	2	
59	O-ring 3.5-25.7	1	**Do not reuse.**
60	Rubber Mount (Upper)	2	
61	Bolt	4	M8 L = 30 mm
62	Bolt	2	
63	Upper Damper Rubber A	2	
64	Nylon Nut 10-p1.25	2	
65	Washer	2	
66	Damper (Upper)	1	
67	Damper (Lower)	1	
68	Rubber Mount (Lower)	2	
69	Mount Bracket (R)	1	
70	Mount Bracket (L)	1	
71	Bolt	2	M8 L = 85 mm
72	Washer 8.1-16-1.5	2	
73	Clamp Screw Kit	2	
74	Clamp Screw Assy	1	
75	Clamp Screw Handle	1	
76	Clamp Screw	1	
77	Spring Pin	1	
78	Clamp Screw Pad	1	
79	E-ring d=6	1	
80	Bolt	1	M6 L = 12 mm

Bracket (PT)

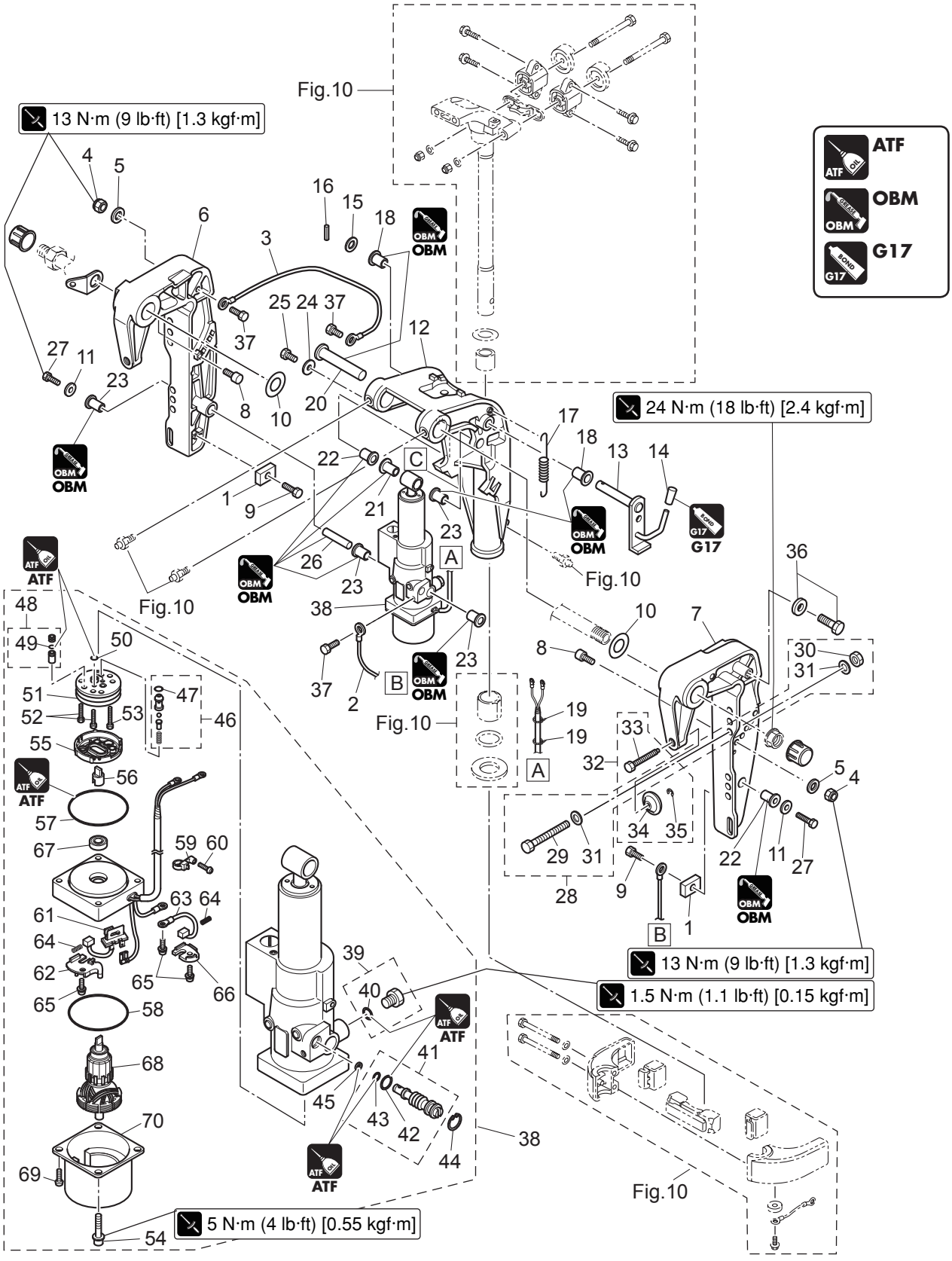


Fig.10
13 N·m (9 lb·ft) [1.3 kgf·m]
24 N·m (18 lb·ft) [2.4 kgf·m]
ATF
OBM
G17
5 N·m (4 lb·ft) [0.55 kgf·m]
1.5 N·m (1.1 lb·ft) [0.15 kgf·m]

Ref. No.	Description	Q'ty	Remarks
1	Anode	2	
2	Ground L=130	1	Clamp Bracket (L)-PT
3	Ground L=130	1	Clamp Bracket (R)-Swivel Bracket
4	Nylon Nut 8-P1.25	2	
5	Washer 8.1-16-1.5	2	
6	Clamp Bracket (PT-R)	1	
7	Clamp Bracket (PT-L)	1	
8	Trim Lock Pin	2	
9	Bolt	2	M6 L = 16 mm
10	Washer 22-36-1	2	Nylon
11	Washer 8.5-28-1	2	
12	Swivel Bracket Assy	1	
13	Tilt Stopper	1	
14	Tilt Stopper Grip	1	
15	Washer	1	
16	Spring Pin 3.5-16	1	
17	Tilt Stopper Spring	1	
18	Collar 10.2-12-12	2	
19	Band 203	2	Do not reuse.
20	Cylinder Pin (Upper)	1	
21	Bushing 13-16-31	1	
22	Bushing 13-17-19.5 13-17-19.5	2	
23	Bushing 13-16-31	4	
24	Washer 6.5-23-1.5	1	
25	Bolt	1	M6 L = 12 mm
26	Cylinder Pin (Lower)	1	
27	Bolt	2	M6 L = 12 mm
28	Rigging Bolt Set	1	
29	Bolt	4	M8 L = 85 mm
30	Nut	4	M8
31	Washer	8	M8
32	Clamp Screw Kit	2	
33	Clamp Screw (PT)	1	
34	Clamp Screw Pad	1	
35	E-ring d=6	1	
36	Bolt	1	M6 L = 16 mm
37	Bolt	4	M6 L = 12 mm
38	PT Assy	1	
39	Cap Assy	1	
40	O-ring	1	Do not reuse.
41	Manual Valve Assy	1	
42	O-ring 2.4-9.8	1	Do not reuse.
43	O-ring	1	Do not reuse.
44	C-ring	1	
45	Seal Washer	1	
46	Relief Valve Assy	1	

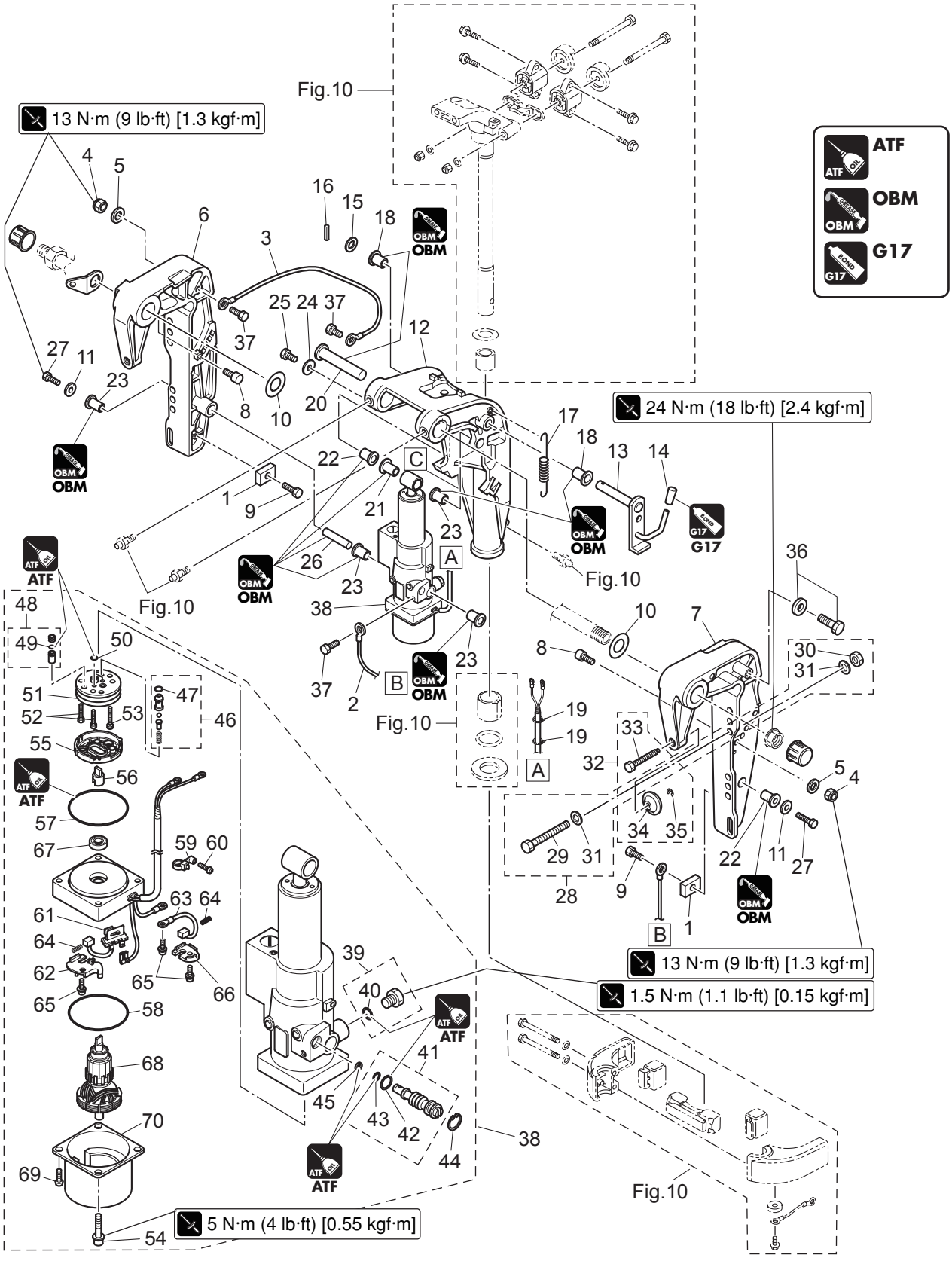


Fig.10
13 N·m (9 lb·ft) [1.3 kgf·m]
24 N·m (18 lb·ft) [2.4 kgf·m]
ATF
OBM
G17
5 N·m (4 lb·ft) [0.55 kgf·m]
1.5 N·m (1.1 lb·ft) [0.15 kgf·m]

Ref. No.	Description	Q'ty	Remarks
47	O-ring	1	Do not reuse.
48	Valve Assy	1	
49	O-ring 1.5-3.5	1	Do not reuse.
50	O-ring 1.5-3.5	1	Do not reuse.
51	Pump	1	
52	Bolt	1	
53	Bolt	1	
54	Bolt	2	
55	Filter	1	
56	Coupling	1	
57	O-ring 2-62.5	1	Do not reuse.
58	O-ring	1	Do not reuse.
59	Band	1	Do not reuse.
60	Pre-coated Screw	1	M5 L = 12 mm
61	Breaker	1	
62	Breaker Holder	1	
63	Brush	1	
64	Brush Spring	2	
65	Screw	3	M5 L = 12 mm
66	Brush Holder	1	
67	Oil Seal	1	Do not reuse.
68	Armature Assy	1	
69	Screw	2	M5 L = 12 mm
70	Yoke Assy	1	

5. Inspection Items

1) Inspection of Throttle Cable

1. Check operation of throttle cable.

2. Check throttle cable inner wire and outer wire for bend and damage. Replace if necessary.

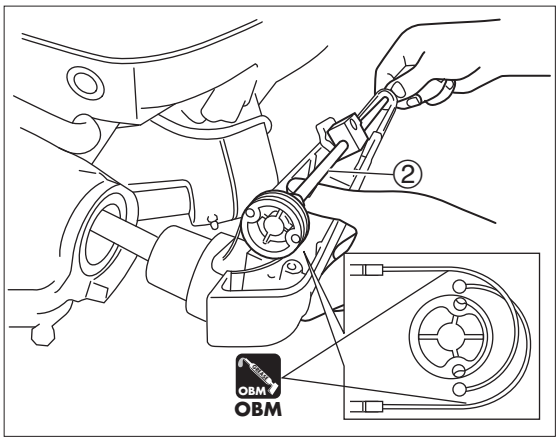
3. Operate throttle fully closed and fully opened, and it is confirmed whether throttle drum is fully closed or fully opened. (Since the cam is fully closed when adjustment of throttle cable, cam may not be fully opened even if the throttle is fully opened)

2) Installation of Tiller Handle

1. Install the stop switch lead ① first.

2. Attach cables to throttle shaft ② as shown.

OBM

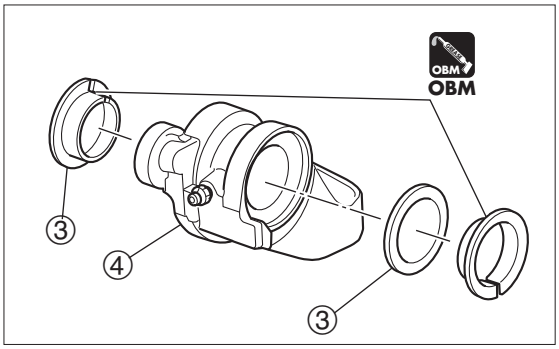


3. Install throttle shaft ② with cable attached to tillar handle. Pay attention to installation position of throttle friction ③.

1342

4. Install the bushing ③ to steering bracket ④.

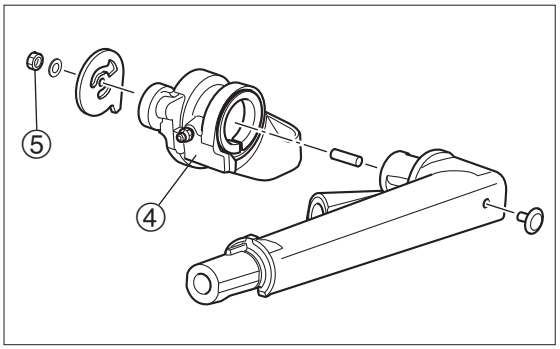
OBM



4. Attach tiller handle ass'y to steering bracket ④, and tighten nut ⑤ to specified torque.

Arrange throttle cable as shown.

1342

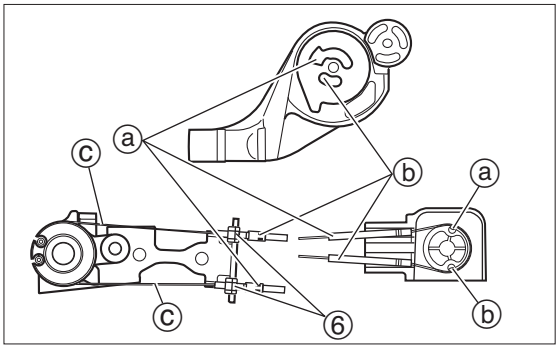


5. Install cable ⓑ of which inner wire is stretched when acceleration grip is set to full closed position.

6. Then, install another cable ⓐ (of which inner wire is stretched when acceleration grip is set to full open position.)

7. Adjust position of lock nuts ⑥ of throttle cable so that throttle grip can reach full open and full close positions.

Adjust cable tension so that it moves approximately 1 mm when pushed lightly with a finger.



7

3) Adjustment of Friction Lever

⚠ WARNI NG

- **Do not release tiller handle while operating. Friction lever is not for holding steering completely.**
- **Do not overtighten the steering friction or it could result in difficulty of movement resulting in the loss of control causing an accident and could lead to severe injury.**

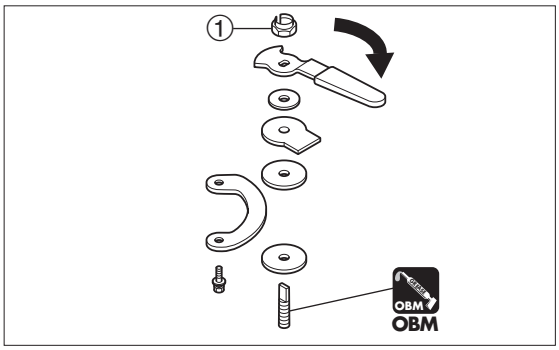
1. Install friction plate and tiller handle ass'y.

   OBM

2. Move friction lever to left to slide it to tightening position.

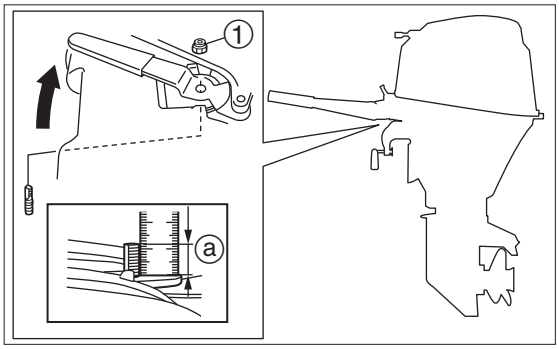
3. Tighten nylon nut ① until steering load becomes heavy.

   Tighten nylon nut ① to approximately 6 N · m (4 lb · ft) [0.6 kgf · m] and check steering load.



4. Move friction lever to the right to slide it to release position, and check that steering can be made lightly. If not, repeat steps 2. to 4. to finely adjust.

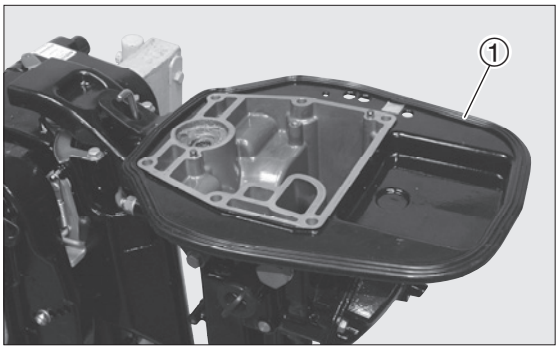
   To prevent nylon nut from falling, tighten nut until more than one thread of bolt ⓐ 17.5 to 18.5 mm (06689 to 0.728 in) can be seen above the nut.



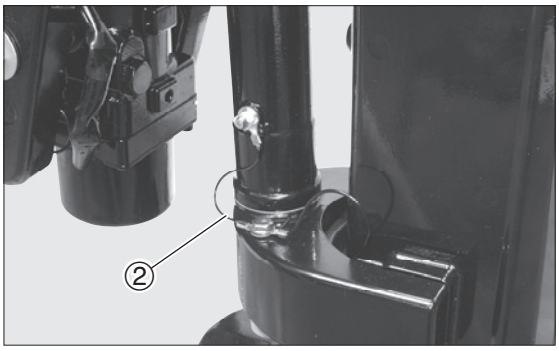
4) Removing Drive Shaft Housing

1. Drain engine oil completely by referring to “Chapter 5) Remove power head" and remove power unit.

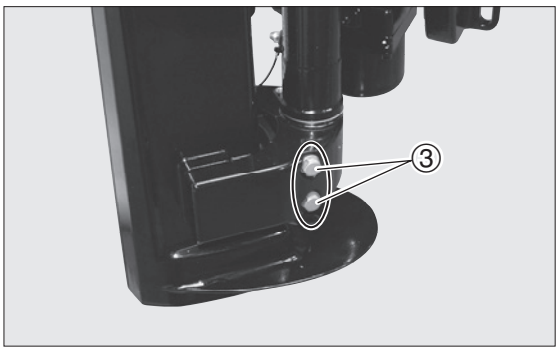
2. Remove cowl seal ① from drive shaft housing.



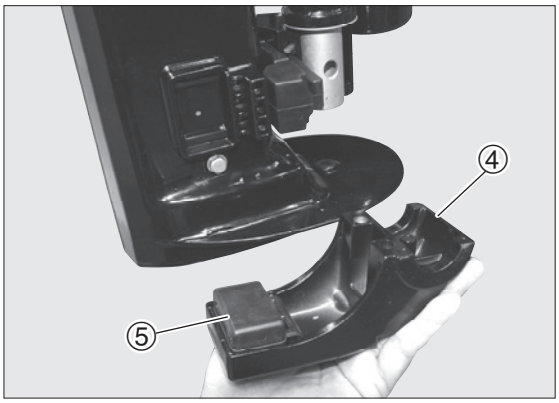
3. Remove grounding wires ②.



4. Remove bolts ③ lower mount bracket.



5. Check that damper ④ and rubber mount ⑤ are normal. Replace if abnormal.



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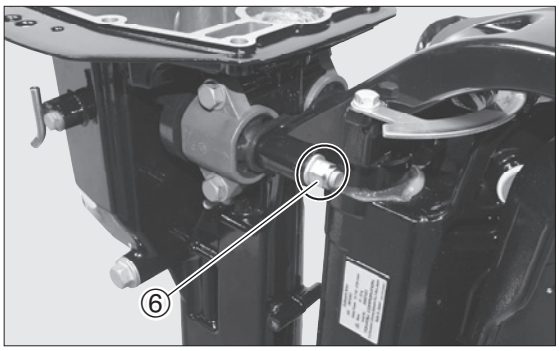
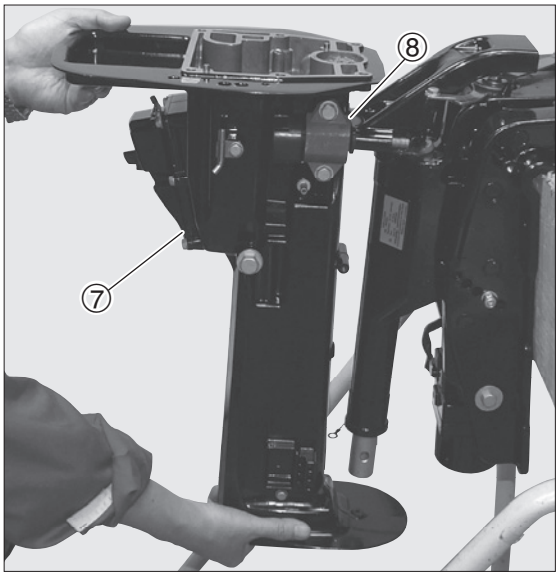
6. Remove nuts of upper rubber mount ⑥.



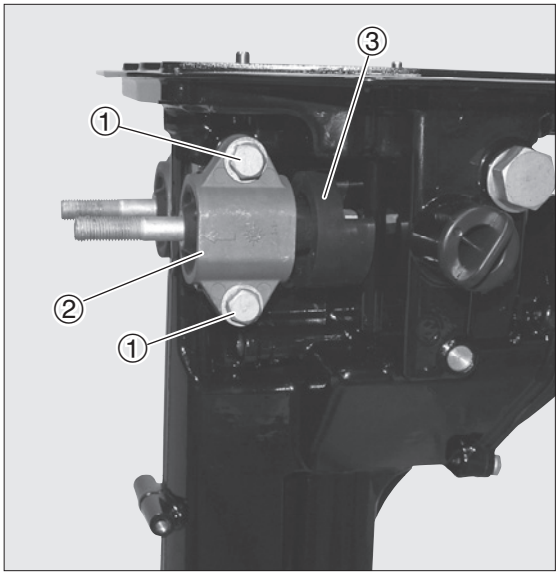
7. Remove drive shaft housing ⑦ from clamp bracket ass'y.

> Be careful not to drop drive shaft housing when removing the housing from clamp bracket.

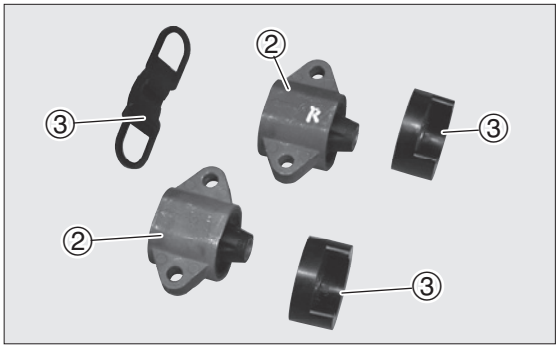


5) Disassembly of Drive Shaft Housing

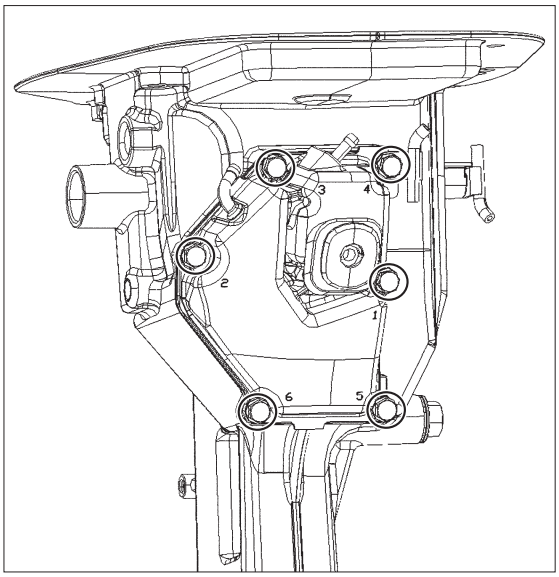
1. Remove upper rubber mount installation bolts ① and then remove rubber mount ②, damper ③ from drive shaft housing.

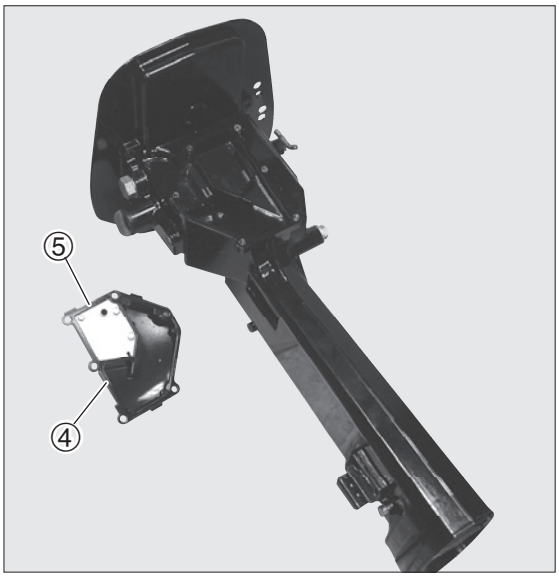


2. Check rubber mount ② and damper ③ for abnormality such as crack. Replace if any abnormality is found.

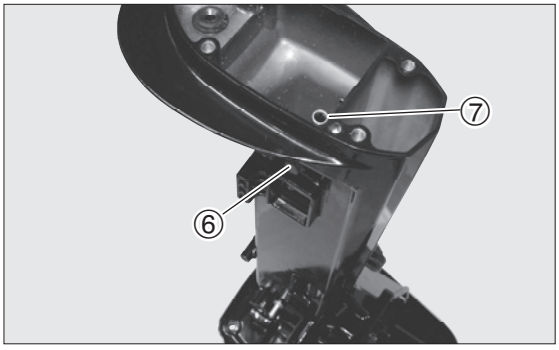


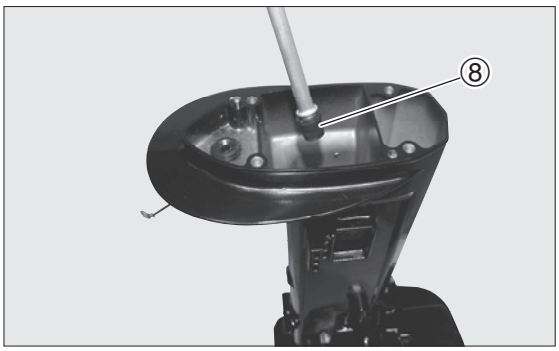
3. Remove idle exhaust cover ④ , gasket ⑤ and check that idle exhaust cover has no abnormality such as cracks or flaws and internal sludge .





4. Remove bolts ⑥, and then remove water pipe ⑦ from drive shaft housing. Check water pipe auxiliary mount ⑧ for abnormality such as crack.





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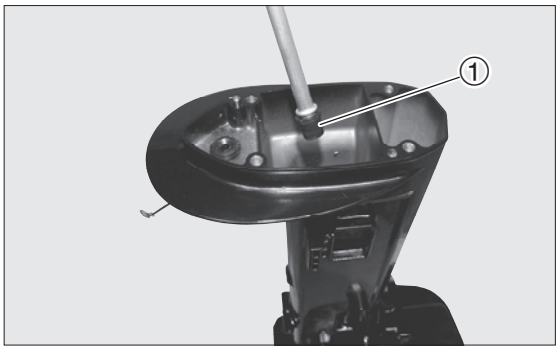
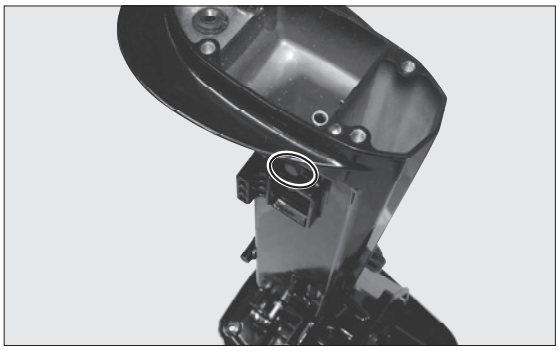
6) Assembly of Drive Shaft Housing

1. Install water pipe ① into drive shaft housing.

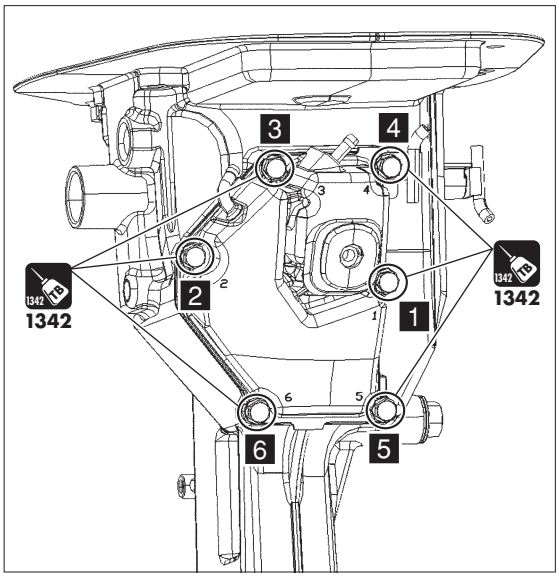




2. Attach new gasket and exhaust cover securing bolts and tighten them in the order of their numbers shown to specified torque.

Idle Exhaust Installation Bolt :
6.0 N · m (4.3 lb · ft) [0.6 kgf · m]

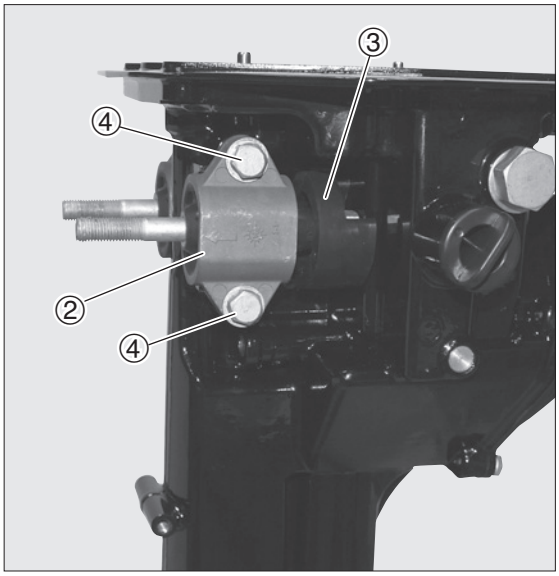
1342



3. Install upper mount ② and damper ③ on the drive shaft housing and tighten bolt ④ to specified torque.

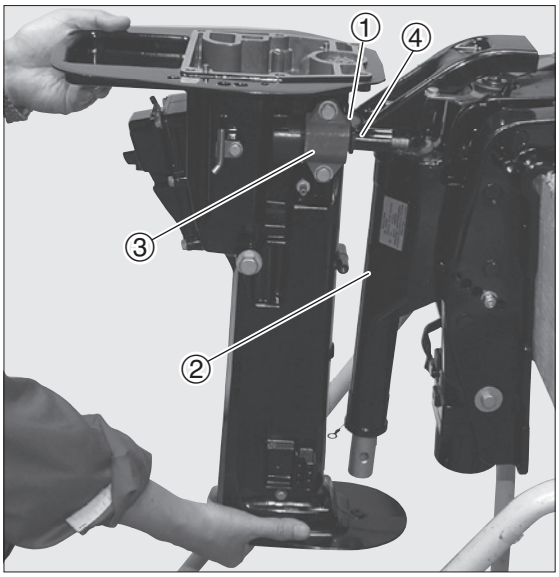
Assemble the damper in the direction [A] of the illustration

Mount Rubber (Upper) Installation Bolt :
13 N · m (9 lb · ft) [1.3 kgf · m]



7) Installation of Drive Shaft Housing Ass'y

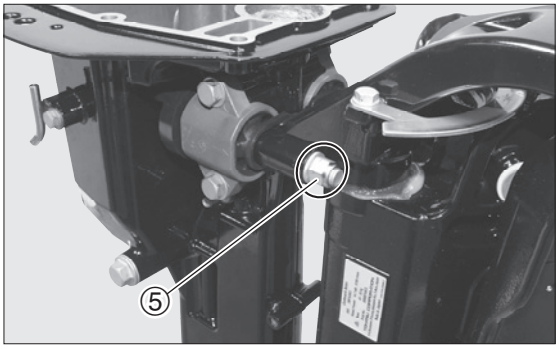
1. Insert damper ① and drive shaft housing ass'y into stud bolt hole ④ of upper rubber mount ③ of swivel bracket ②.



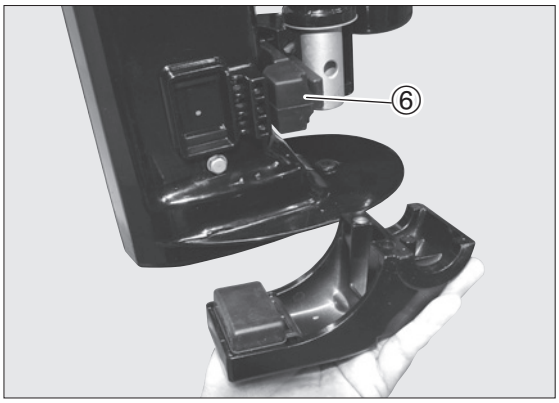
> Correctly align bolt hole position of damper when installing.

2. Install rubber mount and lower dumper and mount bracket to drive shaft housing. Tighten bolts ⑦ and nuts ⑤ to specified torque.

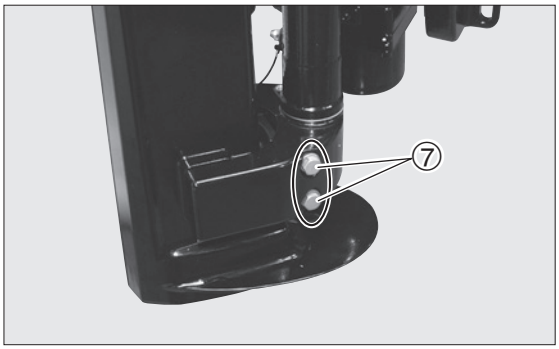
Upper Rubber Mount Nut ⑤ :
M10 27 N · m (20 lb · ft) 2.7 kgf · m]



Lower Rubber Mount Bolt ⑦ :
M8 13 N· m (9 lb · ft) [1.3 kgf · m]



- When installing lower rubber mount, be careful that ground lead is not caught by the part.
- When installing steering shaft, watch spigot joint for installation on the mount bracket.
- Tighten lower rubber mount bolts in several steps to 13N · m.
- The lower rubber mount ⑥ is installed so that the one having a circle faces upward.



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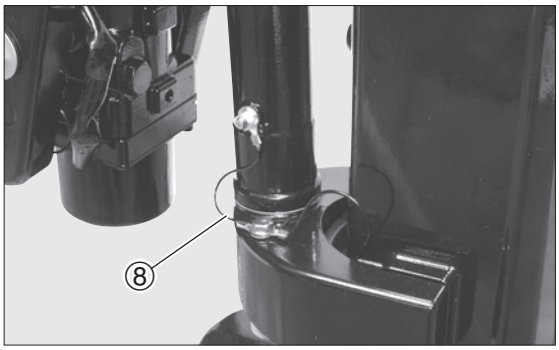
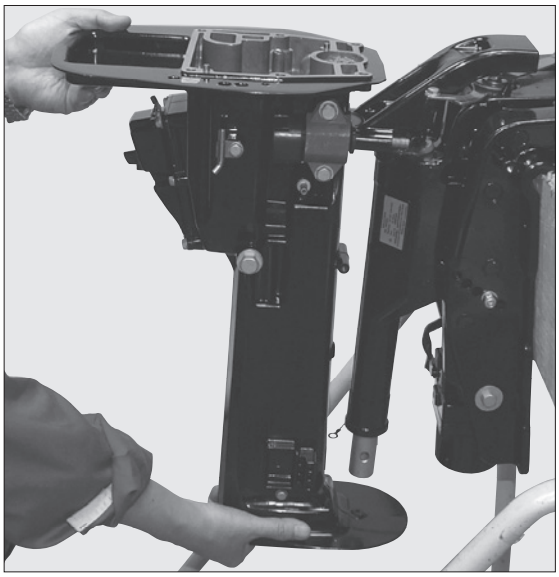
3. Attach ground wire ⑦.

Be careful not to paint ground wire attaching surface or the anti-corrosion effect will be disabled.



8) Removing Steering Shaft

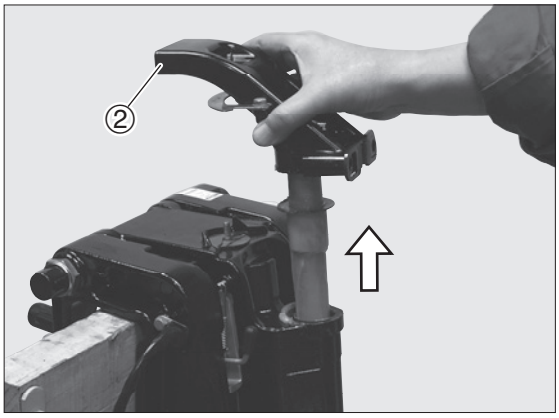
1. Remove drive shaft housing by referring to “Chapter 7 Removing Drive Shaft Housing”.



2. Loosen co-pilot handle nut and remove handle ①.

3. Pull out steering shaft ② from swivel bracket ass'y to remove.

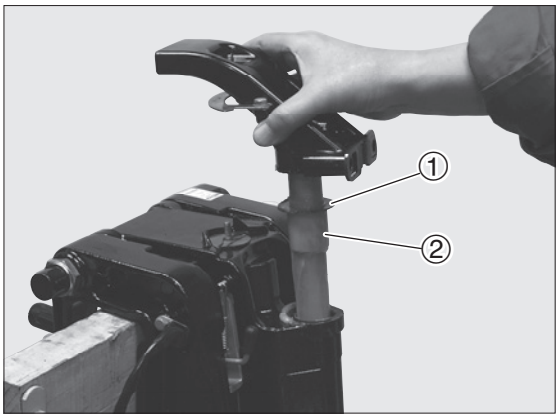
Remove washer, then, O-ring and collar from steering bracket.



4. Check individual parts.

9) Installing Steering Shaft

1. Attach thrust plate ① and bushing ② to steering shaft.

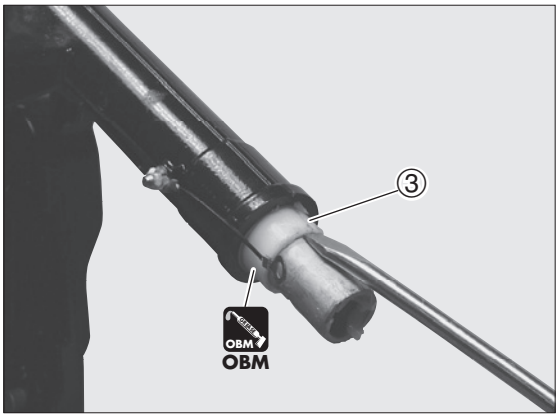


2. Stand swivel bracket ass'y vertically, and insert steering shaft into swivel bracket ass'y.

3. Attach bushing ③, new O-ring ④, and thrust plate ⑤ to swivel bracket.

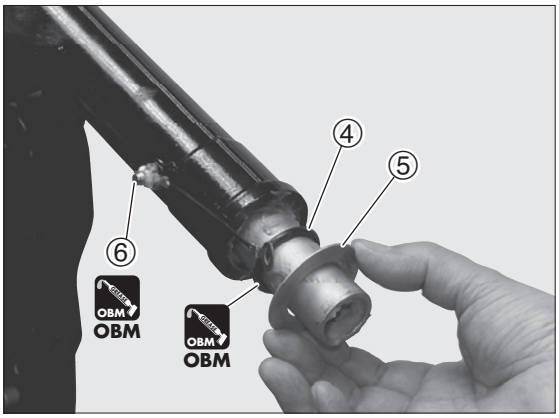
· Push bushing by using flat head screw driver until it stops.
· Put O-ring until it contacts bushing.

OBM



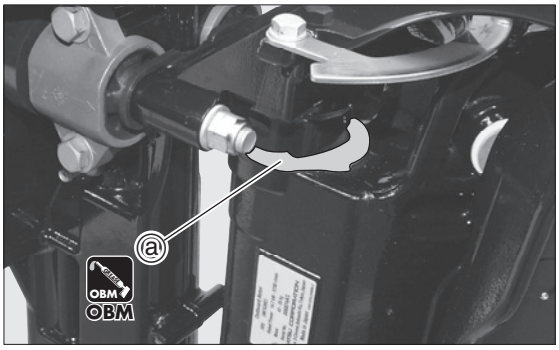
4. Put bushing and O-ring into swivel bracket surely.

OBM



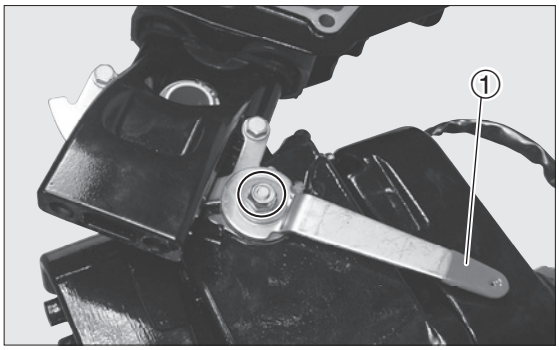
5. Put OBM grease into bushing ⓐ through grease nipple ⑥ until it overflows.

OBM



7

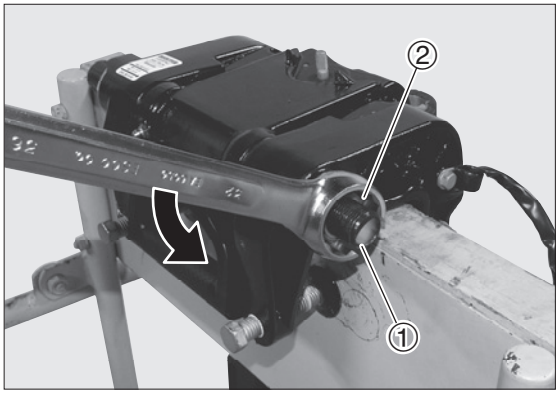
6. Install co-pilot handle, and adjust co-pilot.



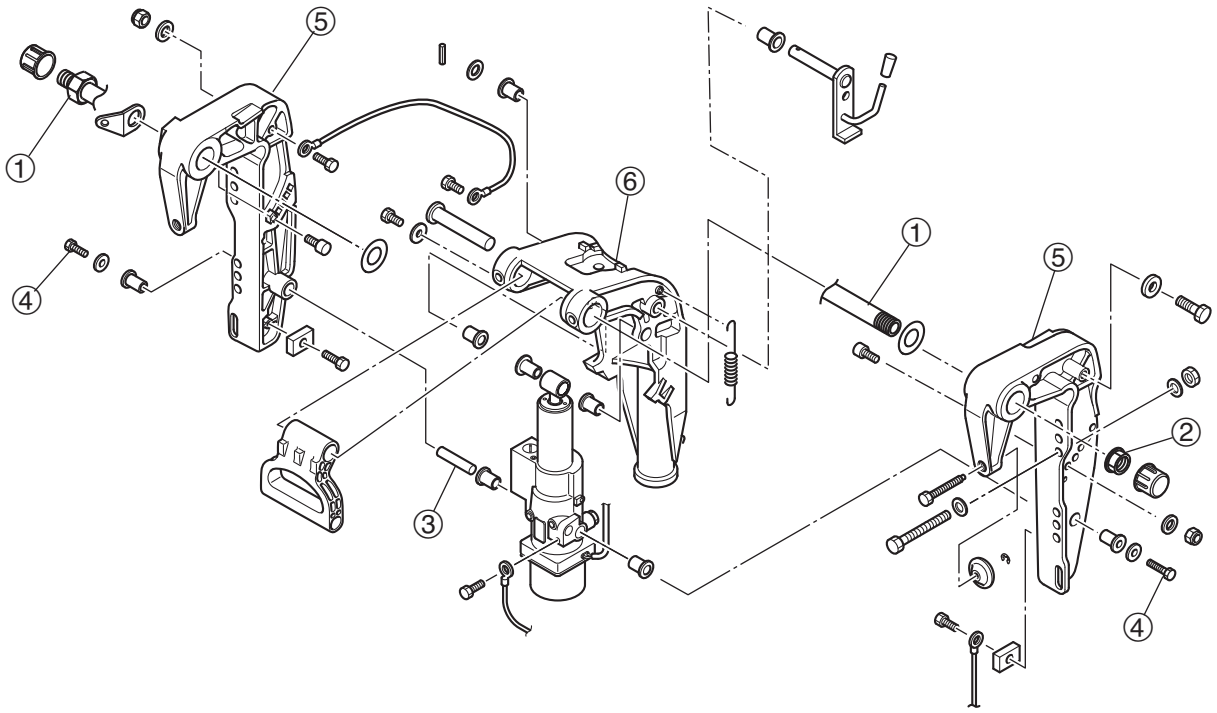
10) Disassembling Clamp Bracket (EFT, EPT models)

1. Remove drive shaft housing, steering shaft and co-pilot before beginning this procedure.

2. Loosen nut ② of swivel bracket shaft ①. Loosen bolt ④ of distance piece ③ and remove bolt ④. Pull out swivel bracket shaft, and then, remove clamp bracket ⑤ from swivel bracket ⑥.

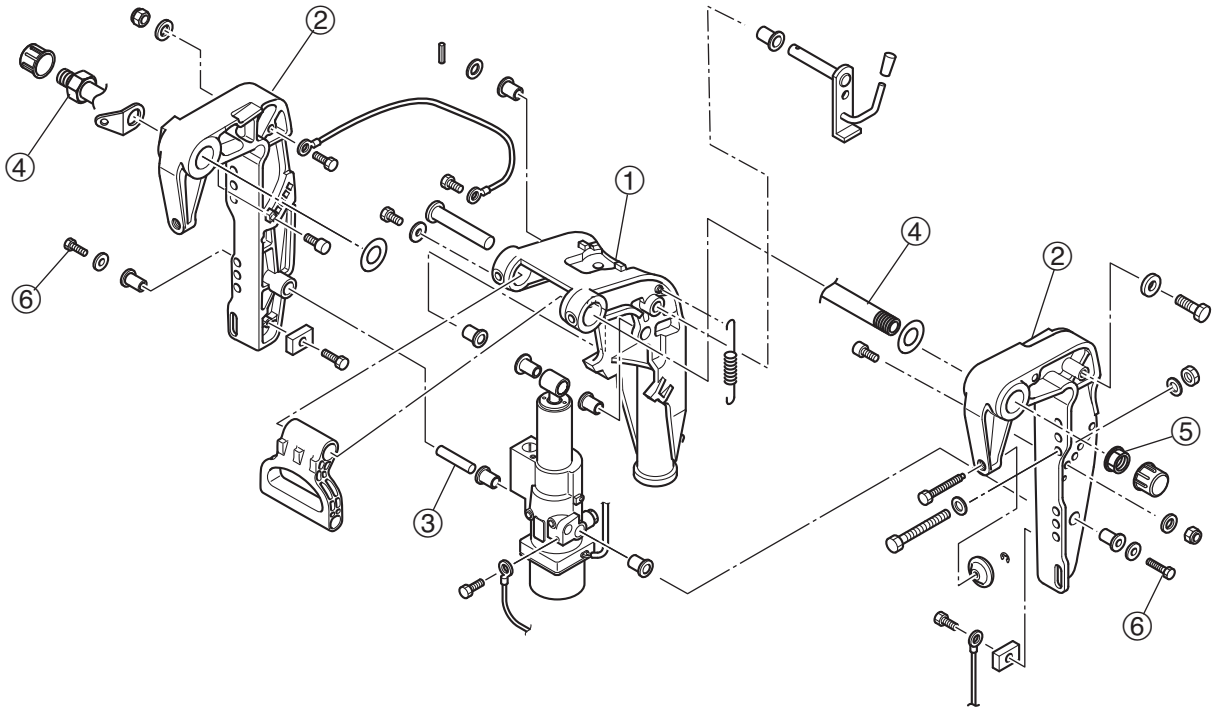


3. Check swivel bracket shaft and other parts for abnormality, and replace if necessary.



11) Assembling Clamp Bracket (EFT, EPT models)

1. Reassemble components of swivel bracket ①, and then insert distance piece ③ into clamp brackets ②.



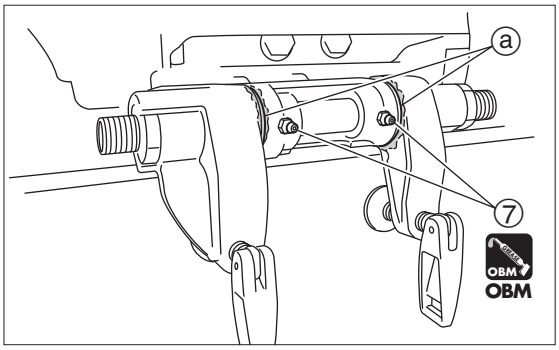
2. Install clamp bracket ① to swivel bracket ③, insert swivel bracket shaft ④, and then tighten nylon nut ⑤, and nut to their specified torque respectively.

Nylon Nut ⑤ :
24 N · m (17lb · ft) [2.4 kgf · m]

Bolt ⑥:
6 N · m (4 lb · ft) [0.6 kgf · m]

3. Put grease into bushing ⓐ through grease nipple ⑦ until it overflows.

OBM



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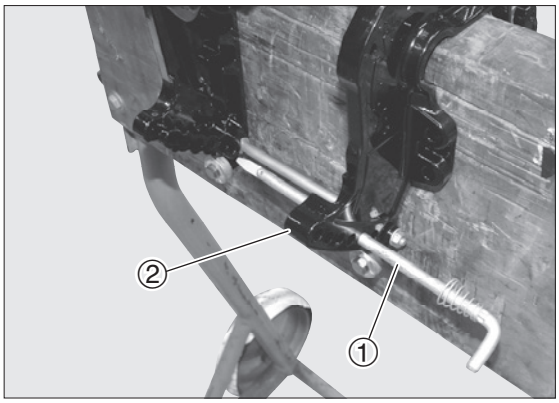
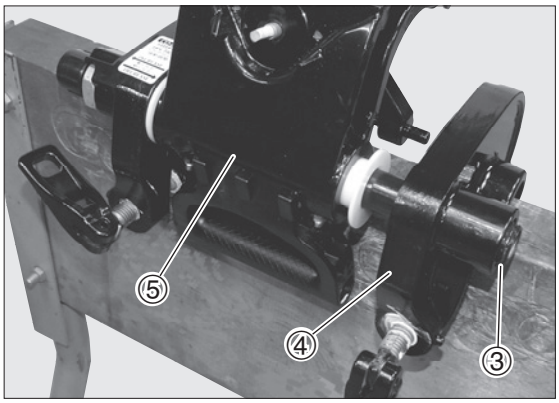
12) Disassembling Clamp Bracket (MF, EF models)

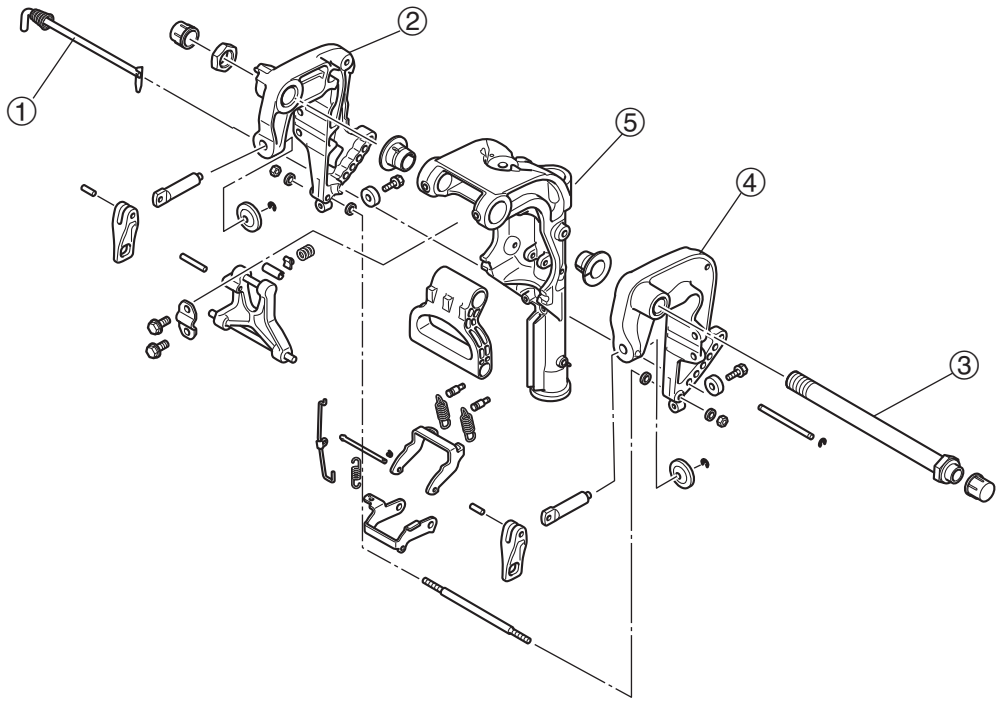
1. Remove thrust rod ① from clamp bracket ②.



2. Loosen and remove nut of swivel bracket shaft ③.
   Pull out swivel bracket shaft then remove clamp bracket ④ from swivel bracket ⑤.

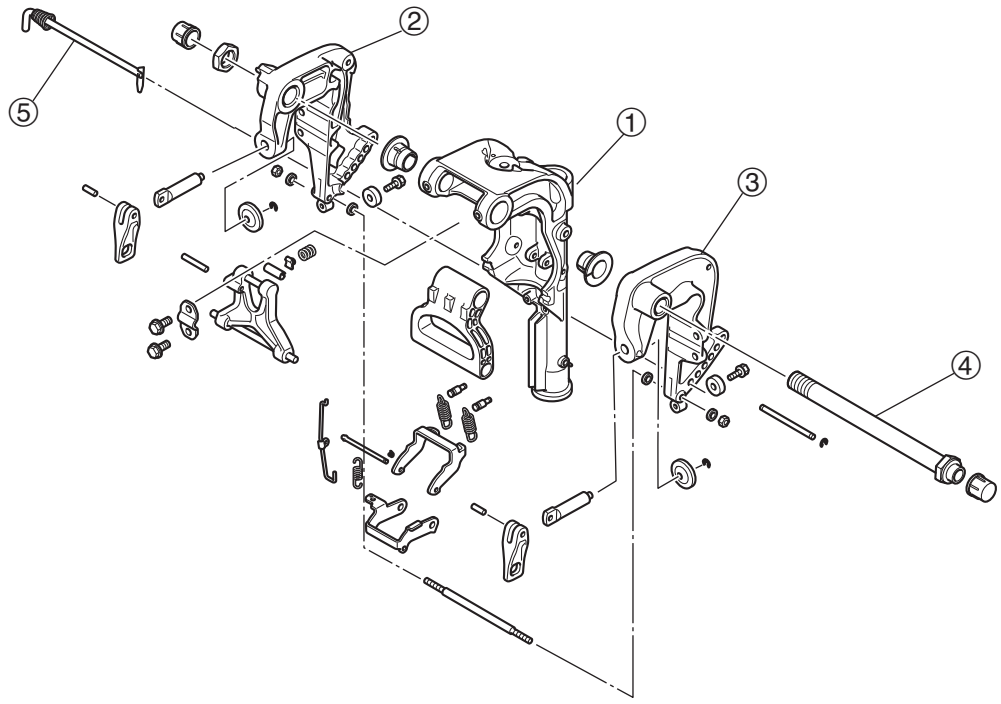


3. Check swivel bracket shaft and other parts for abnormality, and replace if necessary.



13) Assembling Clamp Bracket (MF, EF models)

1. Reassemble components of swivel bracket ① then install clamp brackets ②.

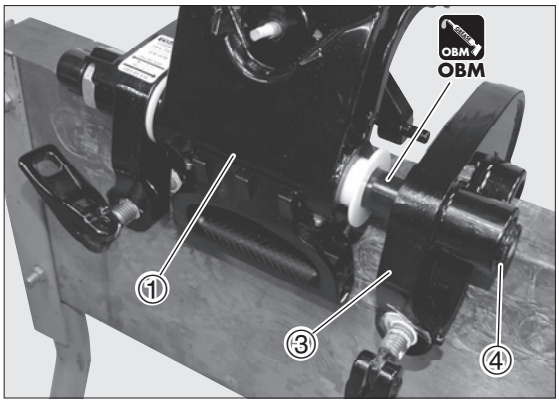


2. Install clamp bracket ③ to swivel bracket, insert swivel bracket shaft ④, and then tighter nylon nut to specified torque.

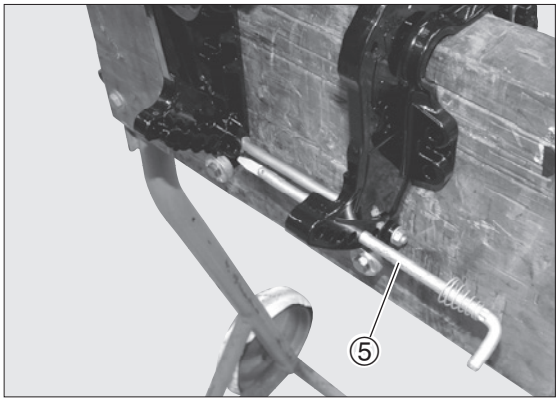
Nylon Nut :
24 N · m (17lb · ft) [2.4 kgf · m]

Apply OBM grease to swivel bracket shaft sufficiently.

OBM

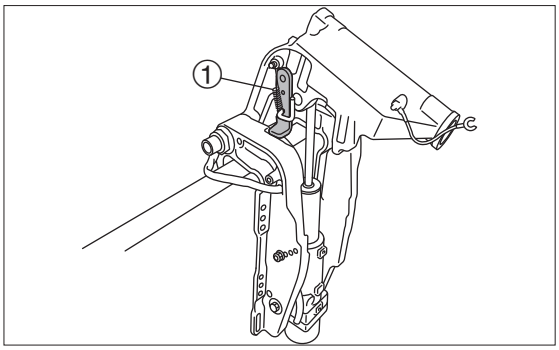


3. Insert thrust rod ⑤.



6. Removing PT Unit

1. Fully tilt up outboard motor and lock with tilt stopper ①.

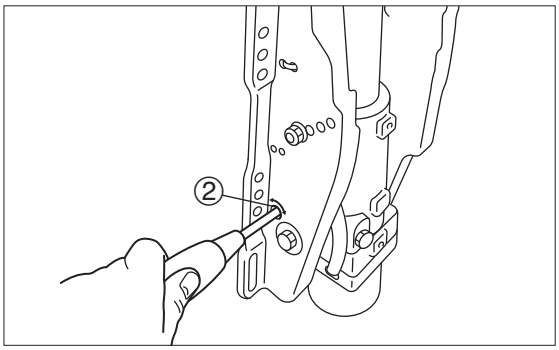


⚠ WARNING

- **The outboard motor may suddenly fall and it is dangerous, as hydraulic pressure of PT unit lowers. Be sure to support it with a stopper when tilting up outboard motor.**
- **The outboard motor may fall and it is dangerous. Hang and support outboard motor with a hoist, when removing and installing PT unit without removing power unit.**

⚠ CAUTINO

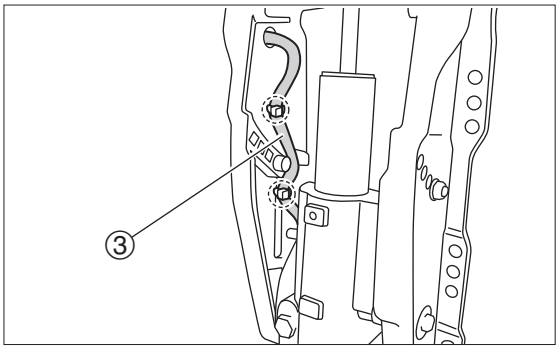
Do not tighten manual valve with outboard motor tilted up in the middle position. Manual valve may be damaged.

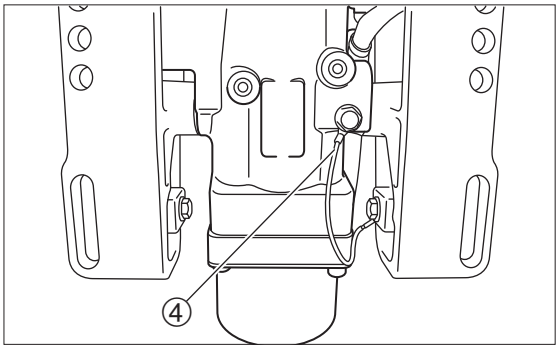


If PT unit will not operate, open manual valve and lift up outboard motor with hands. When manual valve is opened, be sure to tighten it with specified torque after tilting up outboard motor.

Manual valve ② :
2 N · m (1.5 lb · ft) [0.2 kgf · m]

2. Disconnect PT cable ③ from PT relay, and ground code ④ from power tilt unit.

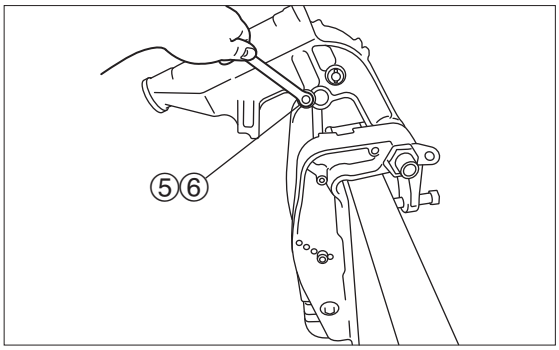


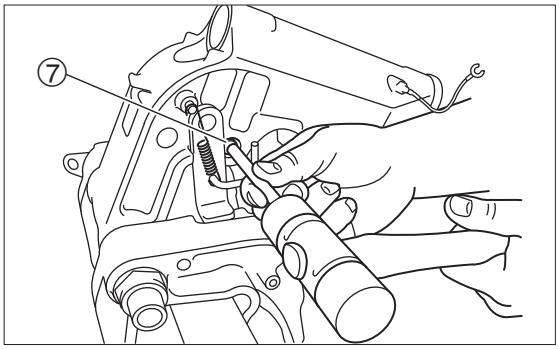


7

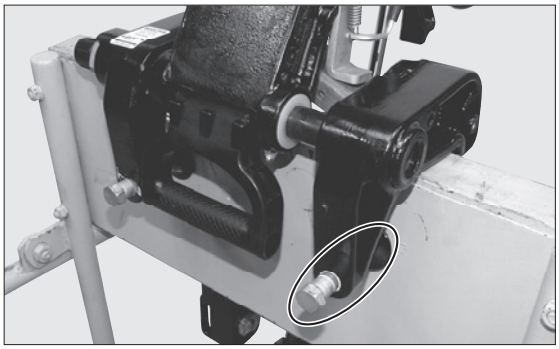
3. Remove bolt ⑤ and washer ⑥ located on the starboard side of the outboard motor then upper cylinder pin ⑦.

Upper cylinder pin can be removed easily when tilt rod is retracted a little by performing tilt down operation.



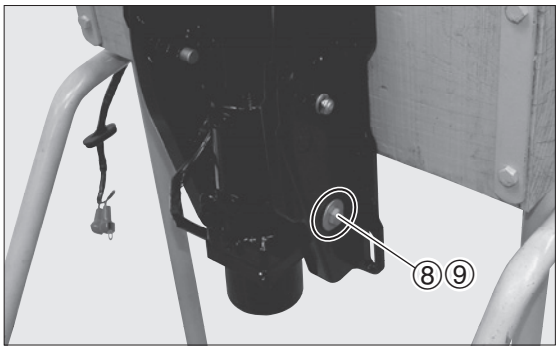


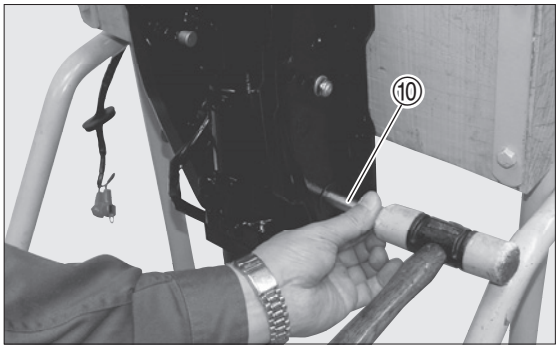
4. Remove cap, loosen nylon nut of the port side bracket and clamp screw, and make the bracket clearance.



5. Remove bolt ⑧ and washer ⑨, remove lower cylinder pin using the appropriate pinch-punch ⑩.

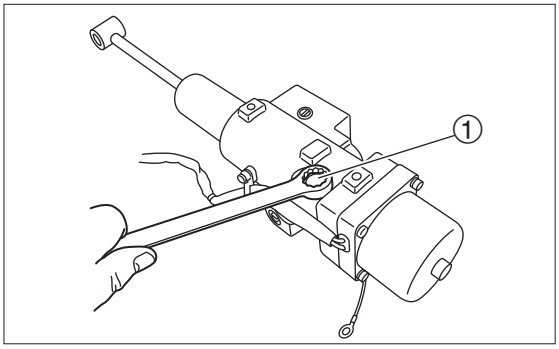
- Be careful not to drop PT assembly
- Expand port side clamp slowly, pushing in plastic hammer handle etc until PT assembly is easy to remove it.





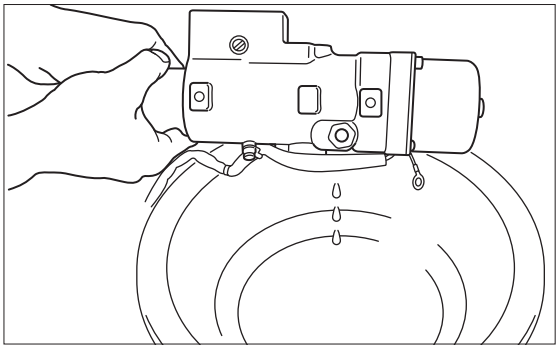
7. Removing and Repairing Manual Release Valve

1. Loosen fill cap ① of PT unit slowly, and then remove it.

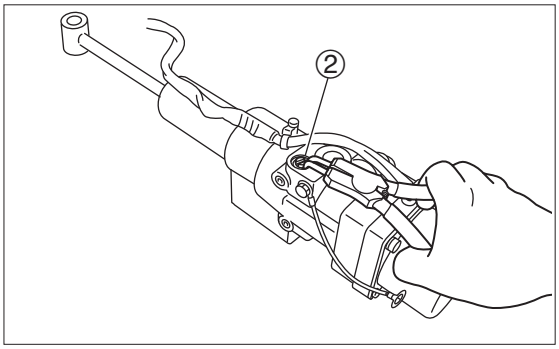


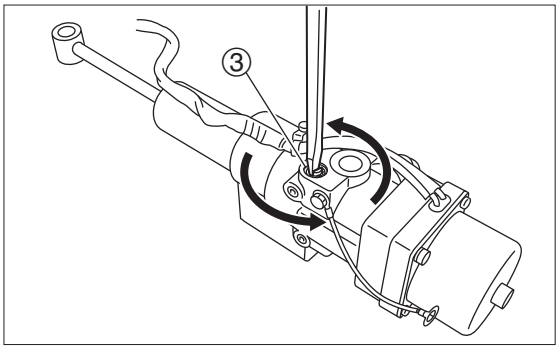
> Fully extend tilt rod before removing fill cap.

2. Drain power tilt fluid from filler cap outlet.



3. Remove manual valve C-ring ② and turn manual valve ③ counterclockwise to remove.

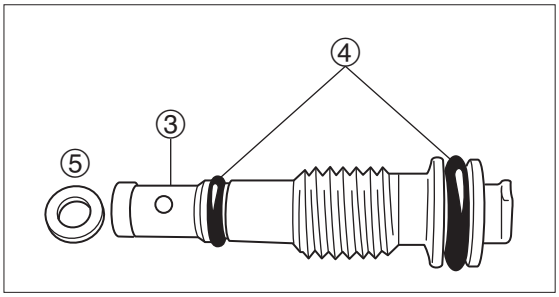




4. Remove O-ring (2 pcs) ④ from manual valve ③, check O-ring for damages and deterioration, and replace with new part if necessary.

5. Remove seal washer ⑤ and replace with new part if necessary.

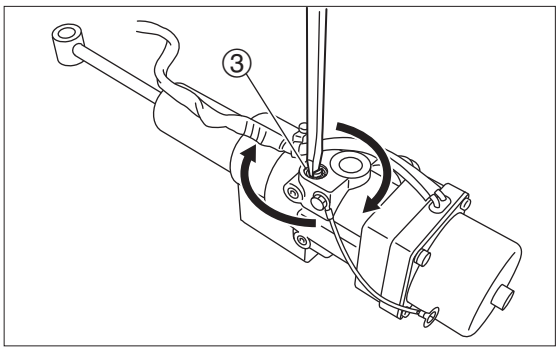
> Apply PT fluid to new O-ring before attaching it to power tilt assembly.



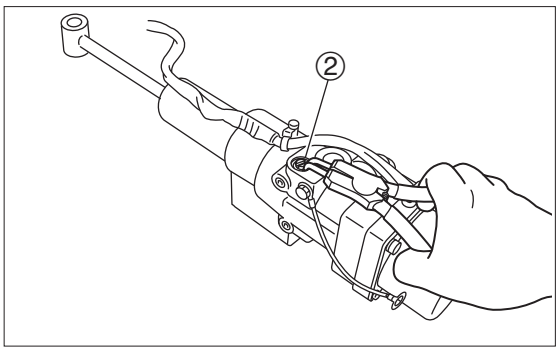
③ Manual valve
④ O-ring
⑤ Seal washer

6. Attach O-rings (2 pcs) ④ to manual valve.

7. Attach manual valve ③ to power tilt ass'y.



8. Attach C-ring ②.

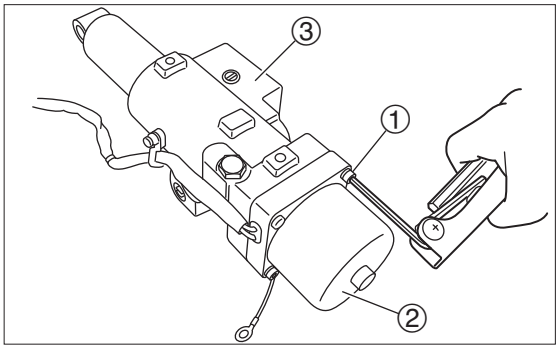


8. PT Motor

1) Removal, Check and Repair of PT Motor

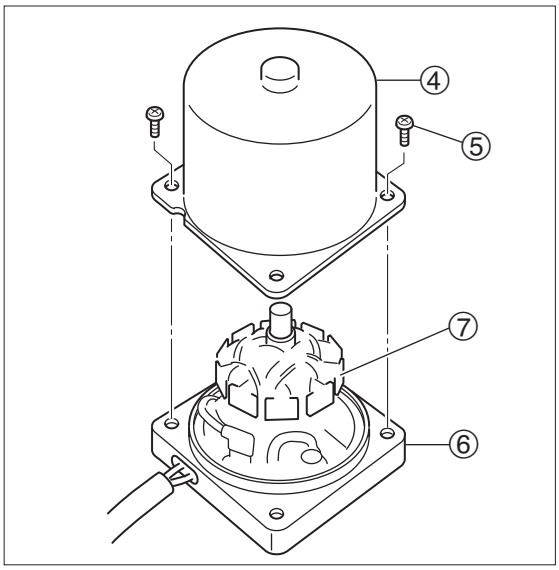
1. Remove two inner hex bolts ①, and then remove motor ass'y ② from PT pump and cylinder ass'y ③.

Before disassembling power tilt motor, drain power tilt fluid. <Refer to section 7.>



2. Remove two screws ⑤, and then remove yoke ass'y ④ from motor bracket ass'y ⑥.

3. Remove armature ass'y ⑦ from yoke ass'y ④.

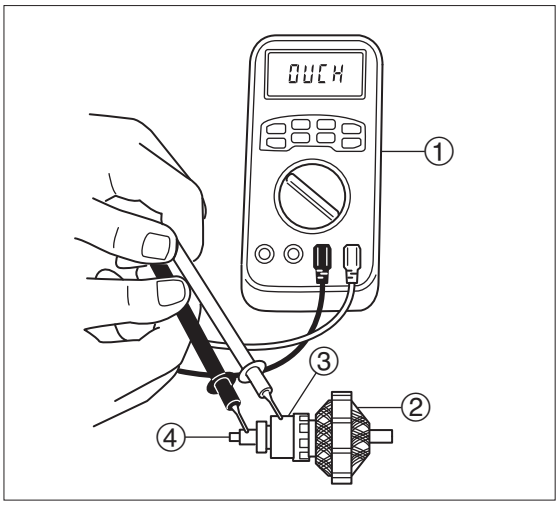


①Yoke ass'y
②Screw
③Motor bracket
④Armature ass'y

2) Continuity Test

1. Check electrical conductivity of armature ②. Replace armature ass'y if other than specification.

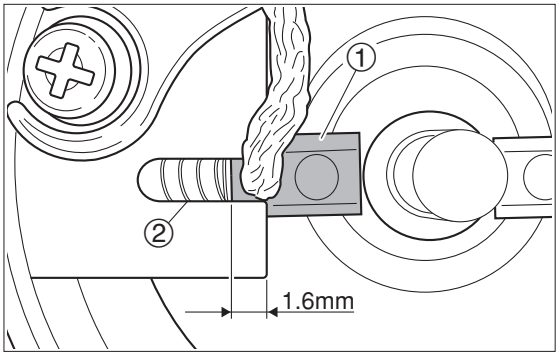
Armature Conductivity : ③ Commutator ④ Armature shaft	Non-conductive ∞



①Meter
②Armature
③Commutator
④Armature ass'y

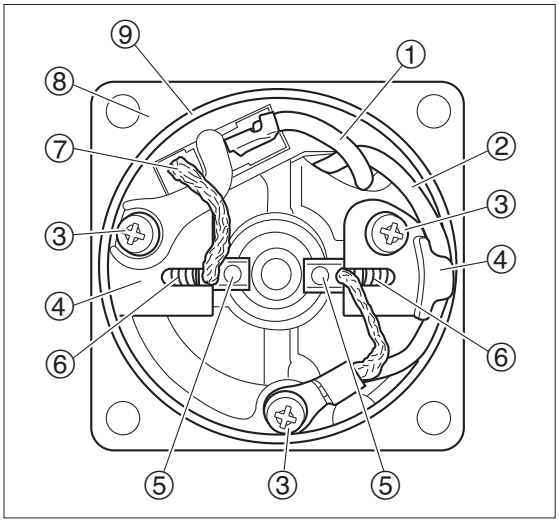
3) Inspection of Motor

1. Replace brush ① if it is damaged or if gap between brush end in the groove of brush holder ② and brush holder end is 1.6 mm or less.



4) Replacement of Motor

1. Remove three screws ③, remove brush ⑤, and circuit breaker ⑦ from motor bracket ⑧.
2. Remove circuit breaker ⑦.
3. Remove brush holder ④ and brush ⑤.

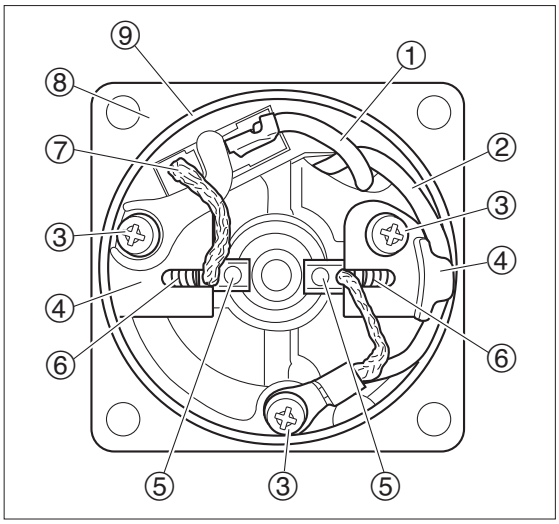


①Wire (blue)
②Wire (green)
③Screw
④Brush holder
⑤Brush
⑥Spring
⑦Circuit breaker
⑧Motor bracket
⑨O-ring

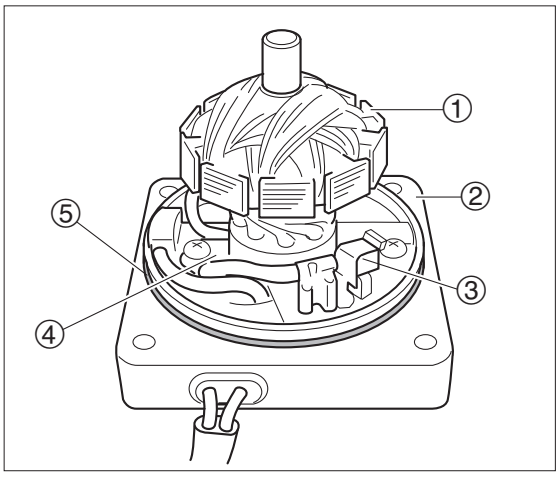
7

5) Assembling PT Motor

1. Attach circuit breaker ⑦ to motor bracket ⑧.
2. Attach circuit breaker holder securely by using screws.
3. Attach blue wire ① to terminal post of circuit breaker ⑦.
4. Place green wire ② along bore of bracket.
5. Attach brush holder ④ by using screw ③.
6. Attach green wire ② and brush wire end to motor bracket ⑧ securely by using screw ③.
7. Attach ② springs ⑥ in the brush.
8. Attach circuit breaker ⑦ and brush ⑤ in the groove.
9. Attach armature ① while holding brush ③ located in the groove during installation of armature ① to motor bracket ②.
10. Attach O-ring ⑤ to motor bracket ②.

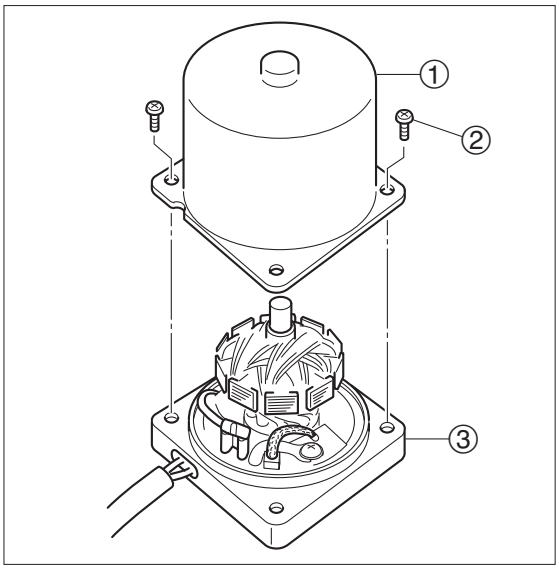


①Wire (blue)
②Wire (green)
③Screw
④Brush holder
⑤Brush
⑥Spring
⑦Circuit breaker
⑧ Motor bracket
⑨O-ring



①Armature
②Motor bracket
③Brush
④Brush
⑤O-ring

11. Attach yoke ass'y ① by using two screws ②.



①Yoke ass'y
②Screw (2)
③Motor bracket

9. PT Pump

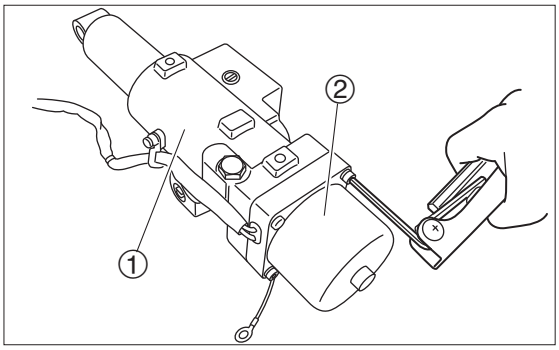
1) Disassembly of PT Pump

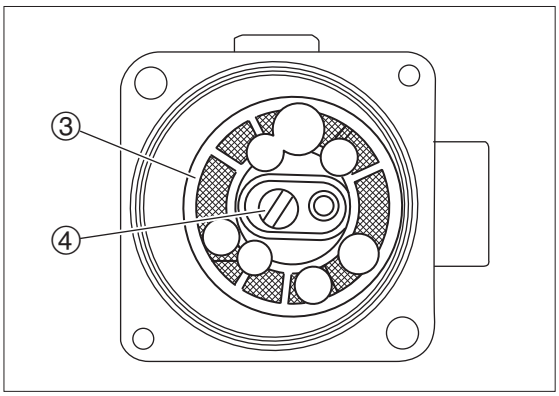
⚠ WARNING

Contamination of hydraulic system can result in damage to the components and circuits, possibly resulting in serious damage to the product.
Before inspecting hydraulic circuit and parts, organize working space and tools.
Do not use cloth for inspection and servicing of parts.
Hydraulic circuit may be clogged.
Remove oil feed plug before beginning the work.
Keeps parts in the plastic bags during disassembly.

1. Remove PT ass'y from outboard motor.
2. Remove PT motor ass'y ② from PT ass'y ①.
3. Remove pump coupling ④.
4. Remove filter ③ from PT ass'y.

Relief valve ass'y is located in the PT pump. When removing pump, be careful not to lose its parts.

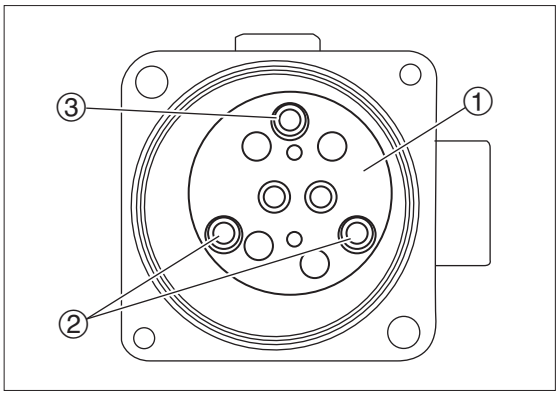




③Filter
④Pump/motor coupling

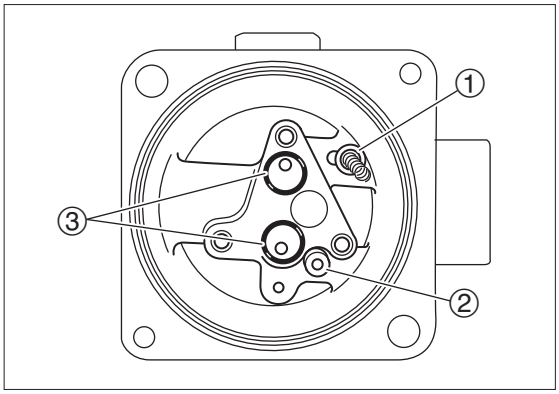
7

5. Remove three screws ②, ③ that secure PT pump ① and assembly.



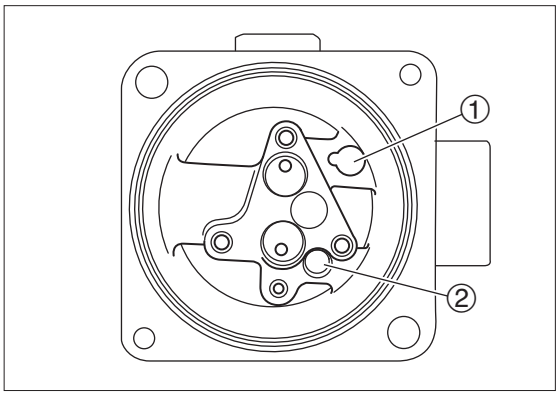
①Power tilt pump
②Internal hex screw (5mm × 20)
③Internal hex screw (5mm × 25)

6. Remove UP side relief valve ①, DOWN relief orifice ② and O-ring (2 pcs) ③ from power tilt housing.



①Up relief valve component
②Down relief orifice
③O-ring

7. Check down side orifice screen ② and up side relief valve seat face ①. Replace parts if necessary.



①Up relief valve seat
②Down orifice screen

2) Assembling PT Pump

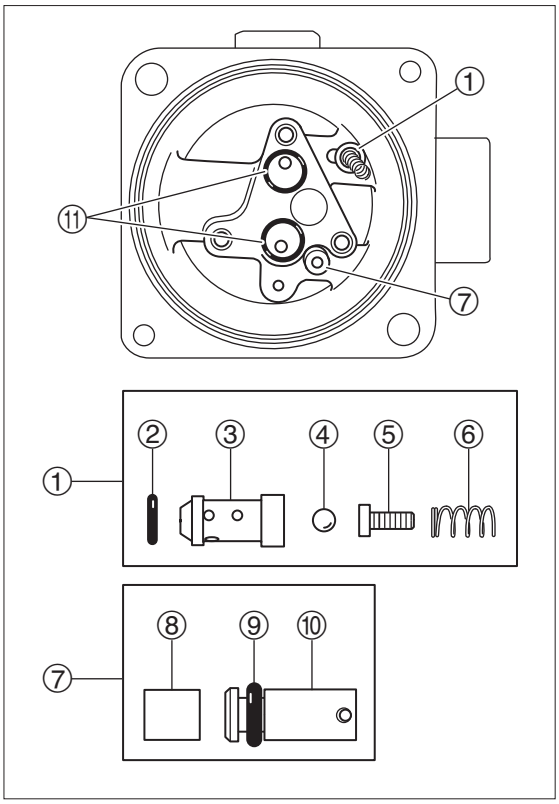
1. Coat new O-rings (2 pcs) ⑪ with oil and attach it to PT housing.

2. Coat new O-ring ⑨ with oil and attach it to orifice ⑩.

3. Attach filter ⑧ and orifice ⑩.

4. Attach up side relief valve ① to PT pump housing.

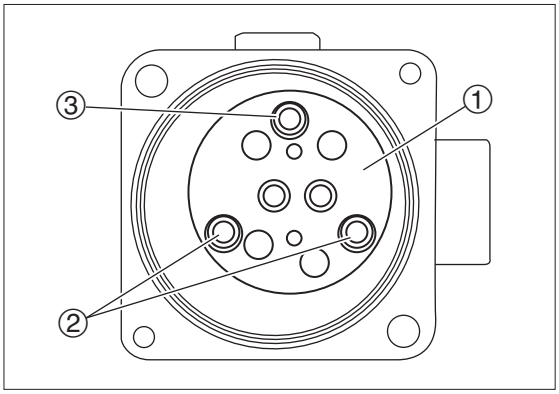
Recommended PT Fluid :
ATF DEXRON III



①Up relief valve ass'y
②O-ring
③Valve seat
④Ball
⑤Spring guide
⑥Spring
⑦Down orifice ass'y
⑧Filter
⑨O-ring
⑩orifice
⑪O-ring

5. Secure pump with screws ②, ③.
Tighten screws to specified torque.

Pump mounting screw :
5 N · m (4 lb · ft) [0.5 kgf · m]



①Power tilt pump
②Internal hex screw (5mm × 20)
③Internal hex screw (5mm × 25)

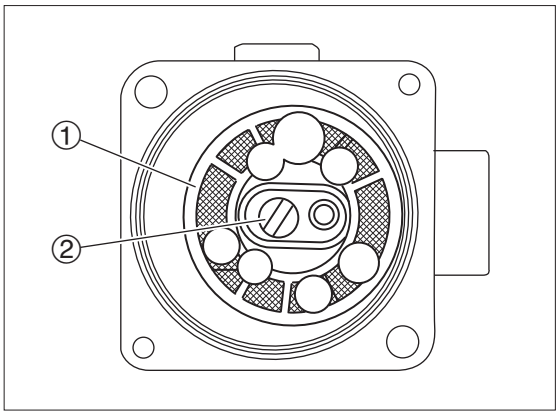
7

6. Attach cleaned screen ①.

7. Attach pump coupling ② to pump.

8. Install motor ass'y to PT pump and cylinder ass'y.

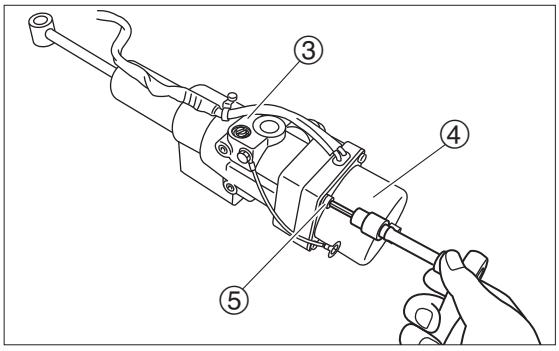
9. Attach wireharness mounting screws.



①Pump filter
②Pump/motor coupler

10. Install motor ass'y ④ to cylinder ass'y and PT pump ③ by using screws ⑤, and tighten screws to specified torque.

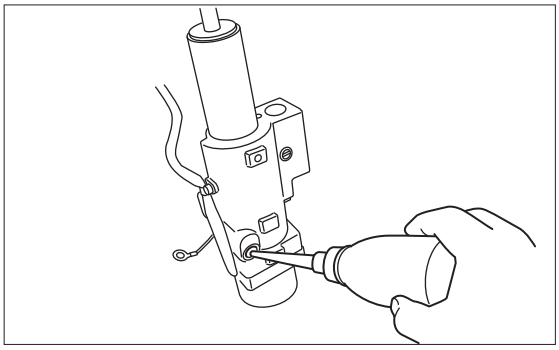
Motor ass'y installation screws:
5 N · m (4 lb · ft) [0.5 kgf · m]



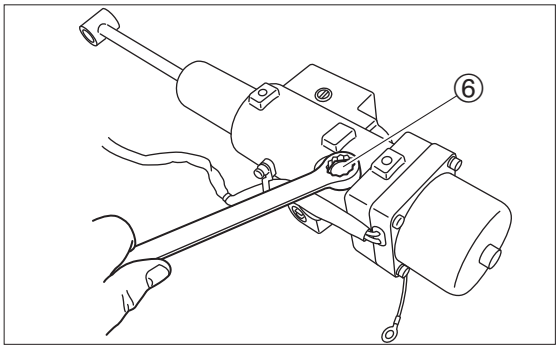
11. Fill power tilt system with PT fluid.

Recommended PT Fluid :
ATF DEXRON II

Extend tilt rod and put PT unit vertically. Pour fluid until it overflows from inlet.

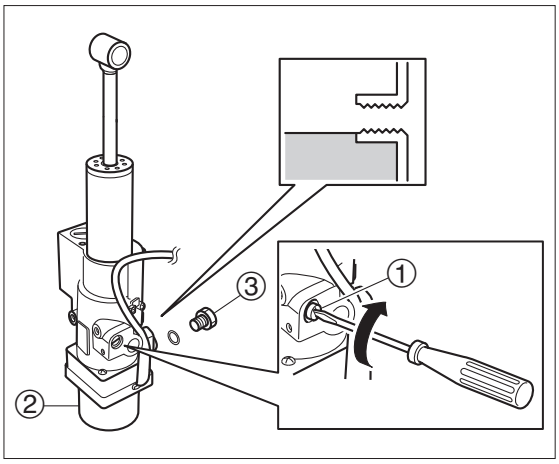


12. Attach the cap ⑥.



3) Air-Purging PT Unit

(Separated from Outboard Motor)



1. Turn manual valve ① clockwise fully.

2. Put PT unit ② on the work bench vertically, remove cap ③ and check level of fluid in the reservoir.

⚠ WARNING

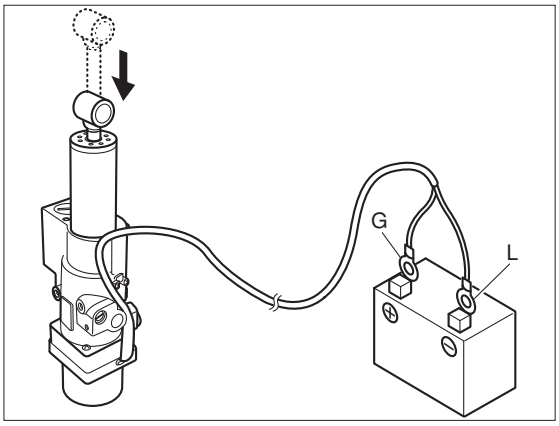
Check fluid level with tilt rod fully extended. Removing reserve tank cap with tilt rod at halfway position can cause blasting out of PT fluid, which is dangerous, and also result in inaccurate fluid level reading.

3. Add recommended PT fluid to specified level if it is lacking.

Recommended PT Fluid :
ATF DEXRON III

4. Put cap ③ and tighten to specified torque.

Reserve Tank Cap :
1.5 N · m (1.1 lb · ft) [1.5 kgf · m]

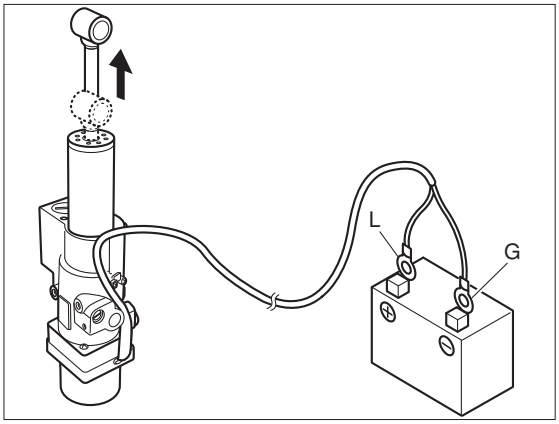


5. Reconnect PT motor lead wires to battery terminals to fully retract tilt rod.

Tilt Rod	PT Motor Lead Wires	Battery Terminals
DOWN	Green (G)	+ : Positive Terminal
	Blue (L)	− : Negative Terminal

6. Reconnect PT motor lead wires to battery terminals to fully extend tilt rod.

Tilt Rod	PT Motor Lead Wires	Battery Terminals
UP	Blue (L)	+ : Positive Terminal
	Green (G)	− : Negative Terminal



Repeat above steps 4 to 5 times to move up and down tilt rod (When reversing motor lead wire connection, keep the connection open for two or three seconds.).

7. Check fluid level with tilt rod fully extended.
Add recommended PT fluid to specified level if it is low.

Recommended PT Fluid :
ATF DEXRON III

8. Repeat steps 2. to 7. until fluid reaches specified level.

9. Reattach cap.

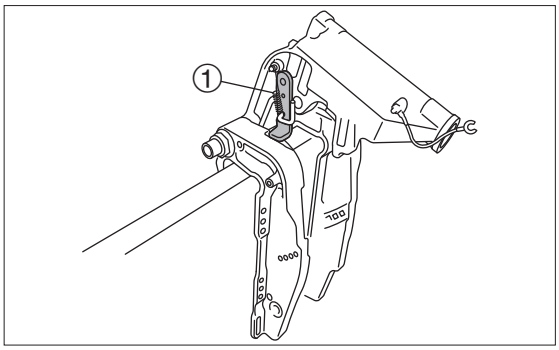
7

4) Installation of PT Ass'y

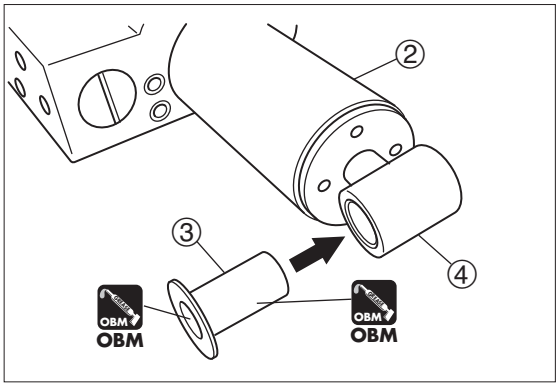
1. Fully tilt up outboard motor and lock with tilt stopper ①.

⚠ WARNING

- **Be sure to lock outboard motor with tilt stopper after tilting up. Leaving outboard motor up without locking may lead to accidental descent due to reduction of PT hydraulic pressure.**
- **When removing and installing PT unit without remove power unit, hang and support outboard motor with a hoist. The outboard motor may fall and it is dangerous.**



2. Install bushing ③ on the tilt cylinder rod ④.

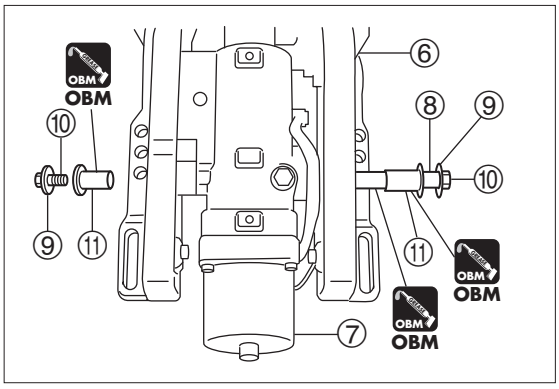


①Power tilt cylinder
②Cylinder rod eye
③Bushing

3. Attach pivot bushings ⑤ (2) to clamp bracket ⑥.

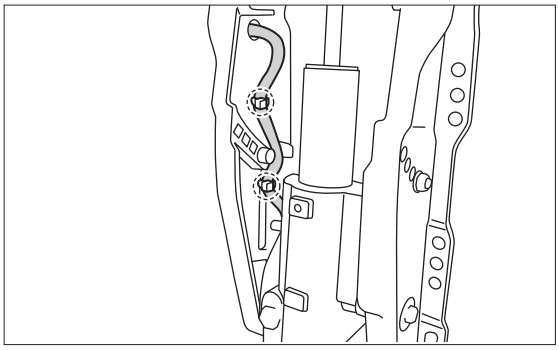
4. Expand the port side clamp bracket slightly and position PT assembly ⑦ between clamp bracket ⑥.

5. Put tilt cylinder pivot pin (lower) ⑨ in the hole of clamp bracket ⑥ to secure power tilt ass'y ⑦.



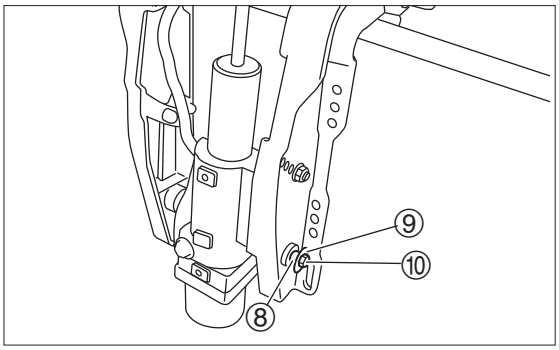
①Clamp bracket
②Pivot pin
③Washer (2)
④Retaining screw
⑤Pivot bushings (2)
⑥Power tilt ass'y

6. Route PT cable as shown in illustration and fix it with a lock tie.



7. Put washer ⑨ and bolt ⑩ on the pin (lower) ⑧ then tighten the bolt to specified torque.

Retaining bolt :
13 N · m (1.9 lb · ft) [1.3 kgf · m]

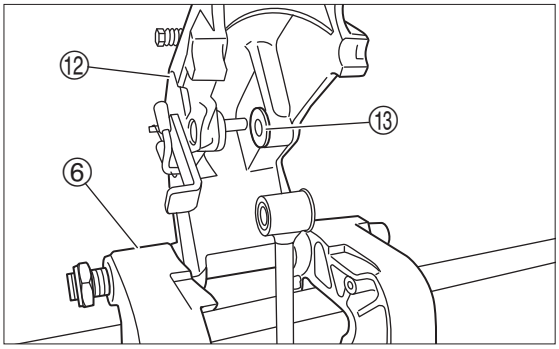


8. Attach bushings (2) ⑬ to swivel bracket ⑫.

9. Extend power tilt cylinder rod to align tilt cylinder rod and swivel bracket.

10. Fit tilt cylinder rod by using cylinder pin (upper).

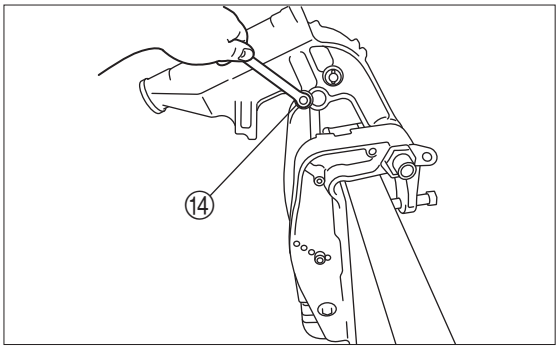
Apply OBM grease to cylinder pin (upper) sliding surface then install PT unit ass'y.



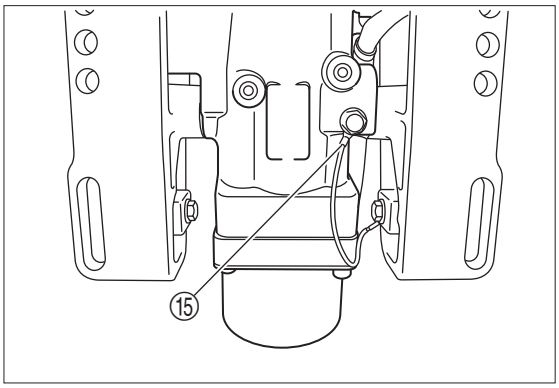
①Bushings (2)
②Swivel bracket
③Clamp bracket

11. Tighten tilt cylinder pin (upper) securing screw ⑭ to specified torque.

Tilt cylinder pin (upper) mounting bolt :
13 N · m (1.9 lb · ft) [1.3 kgf · m]

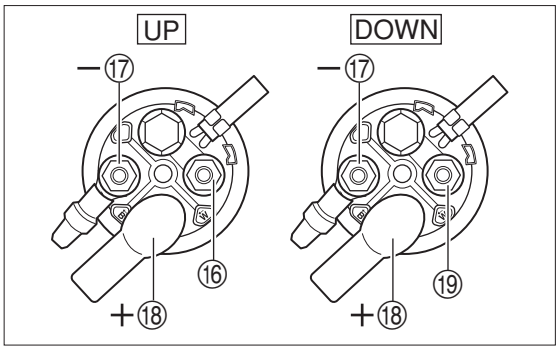


12. Secure ground cord ⑮ by using bolt.



7

13. Attach electrical cord of power tilt unit to PT relay ⑯, ⑲.



14. Unlock tilt stopper, and repeat tilting up and down outboard motor to bleed air from hydraulic circuit.
< Refer to 3) Air-Purging PT Unit >

15. Check power tilt fluid level, and replenish if necessary.

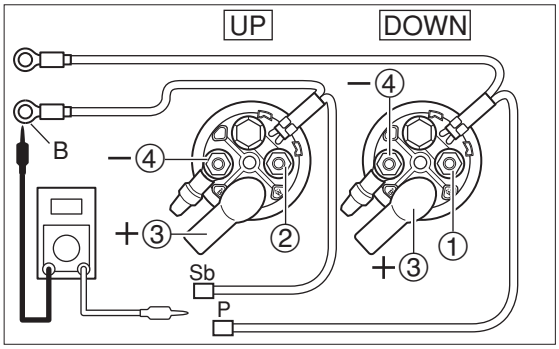
5) Inspection of PT Relay

This test can be made without removing parts.

1. Disconnect positive ③ and negative cables ④ from battery.

2. Remove PT lead wire connector from terminal ① and ②.

3. Check PT relay wires in accordance with the following table.
Replace if out of specification.



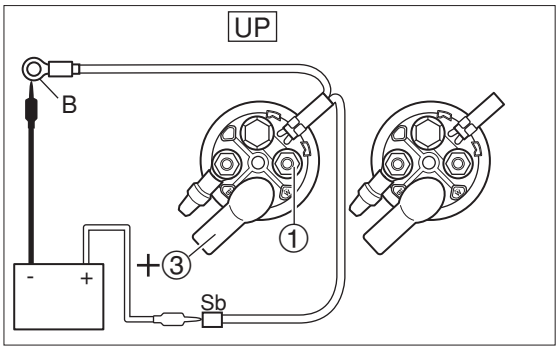
Conductivity of PT relay

Sky blue (Sb) - Black (B) Pink (P) - Black (B)	Conductive
Terminal ① - Terminal ④ (-) Terminal ② - Terminal ④ (-)	Conductive
Terminal ① - Terminal ③ (+) Terminal ② - Terminal ③ (+)	Non-conductive

Inspection of UP side relay

4. As shown in the figure, connect blue terminal (L) in the coupler to battery positive terminal and black terminal (B) to negative terminal, and then, connect circuit tester leads to PT relay terminals ① and ③.

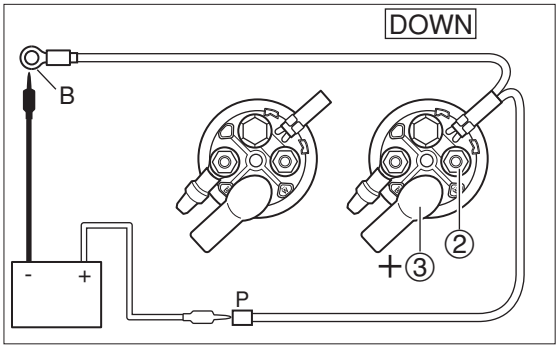
5. Check electrical conductivity between terminals ① and ③. Replace relay if non-conductive.



Inspection of Down side relay

6. As shown in the figure, connect green terminal (G) in the coupler to battery positive terminal and black terminal (B) to negative terminal, and then, connect circuit tester leads to PT relay terminals ② and ③.

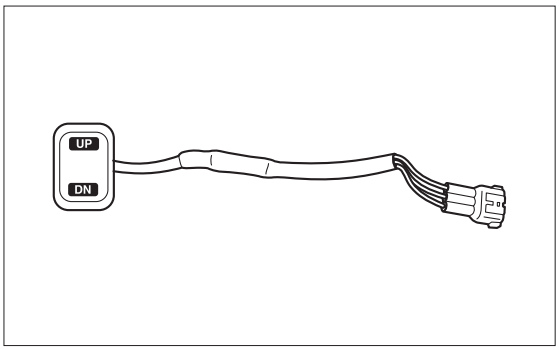
7. Check electrical conductivity between terminals ② and ③. Replace relay if non-conductive.



6) Inspection of PT Switch

1. Check electrical conductivity of PT switch. Replace if out of specification.

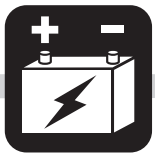
Lead Wires			
Switch Position	Sky Blue (Sb)	Red (R)	Pink (P)
UP (Tilt Up)	○	○	
Free			
DOWN (Tilt Down)		○	○



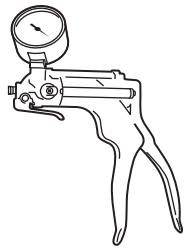
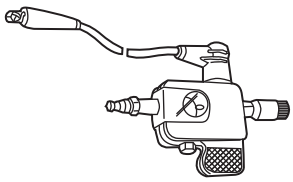
7

8

Electrical System

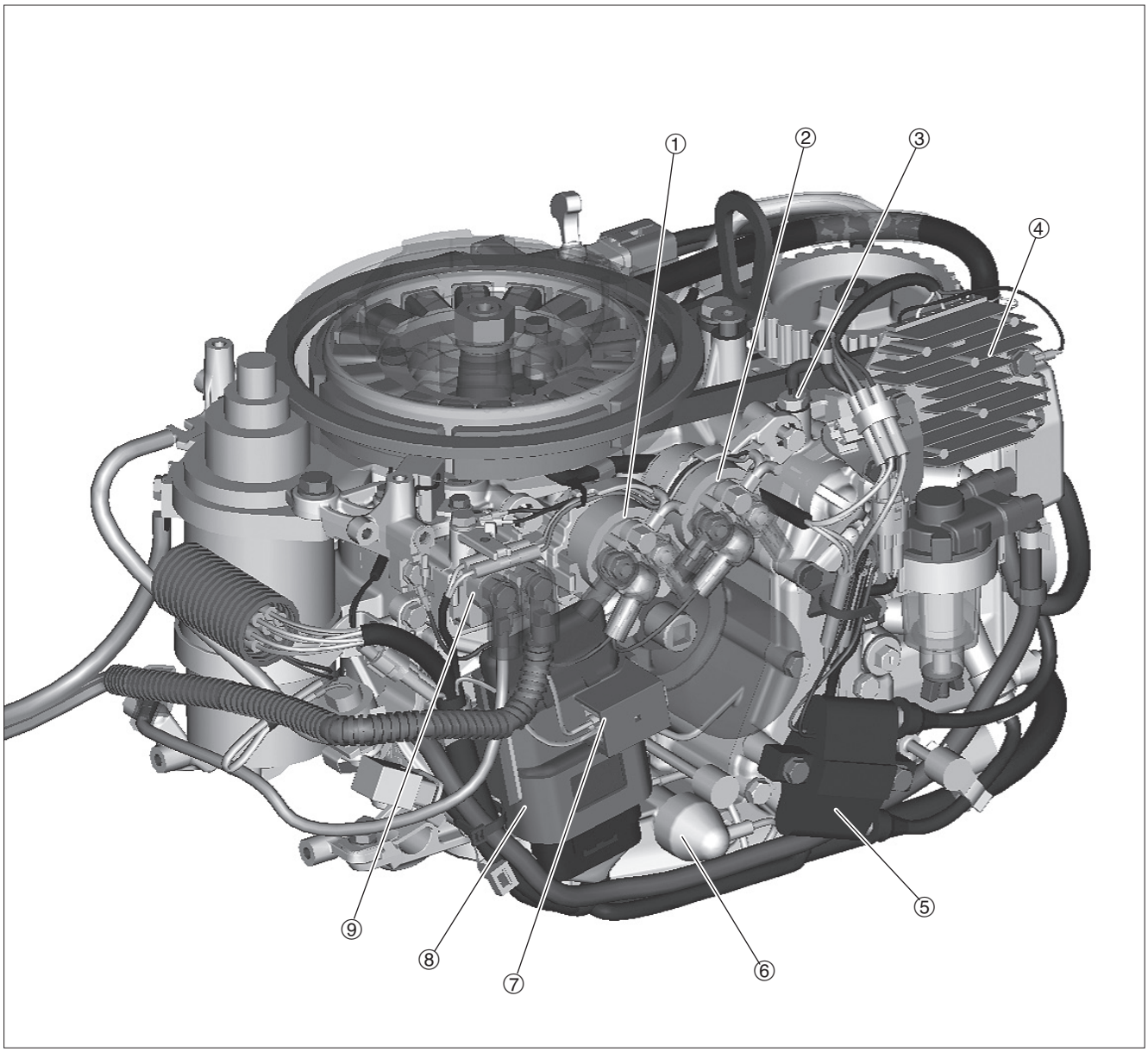


1. Special Tools

	
Vacuum/Pressure Gauge P/N. 3AC-99020-1	Spark Tester P/N. 3F3-72540-0
Inspecting pressure	Inspecting Ignition

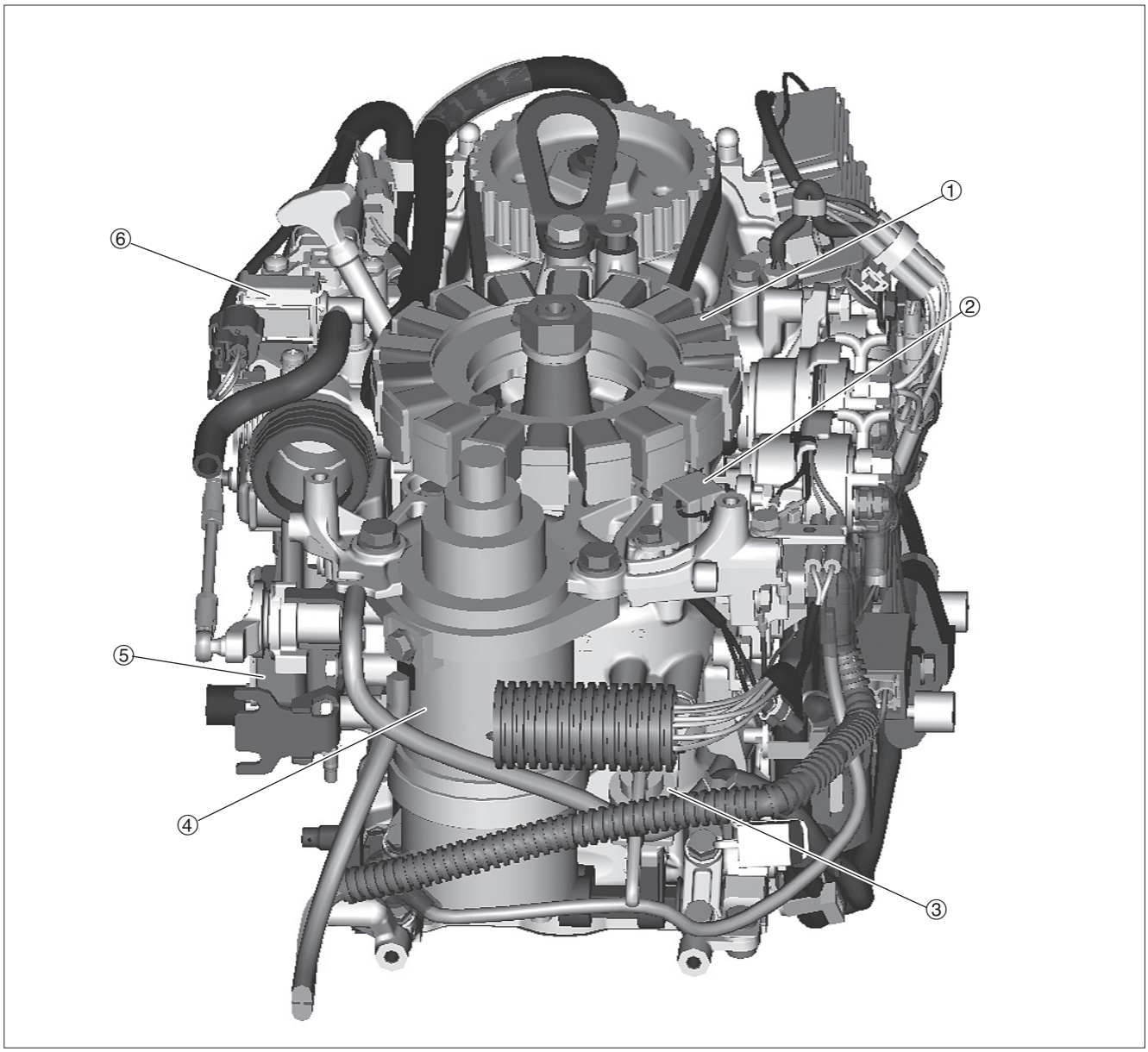
2.Electrical Component Layout

Port Side View



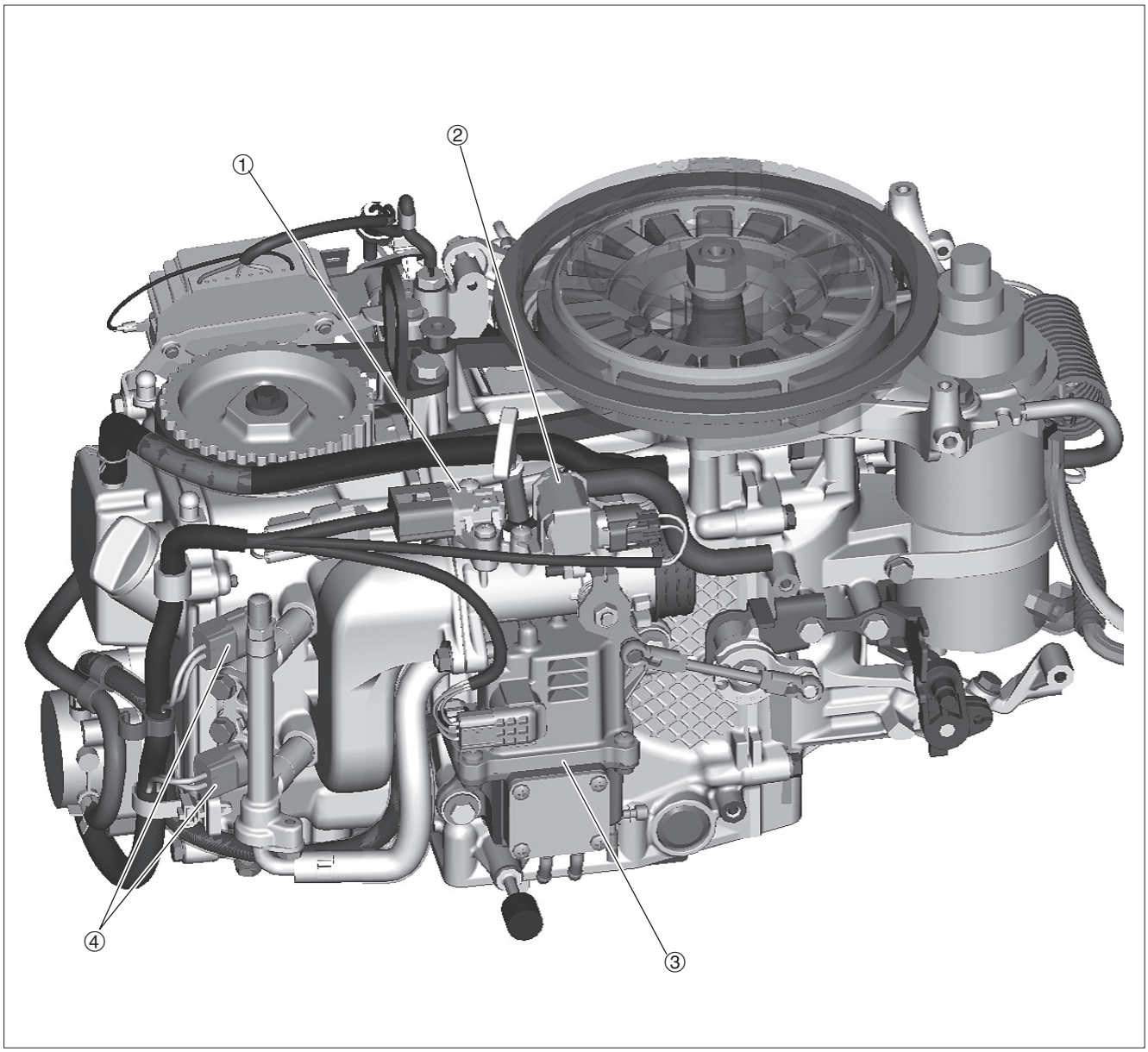
① PT Solenoid Switch A (tilt up side) (for EFT, EPT models)
② PT Solenoid Switch B (tilt down side) (for EFT, EPT models)
③ Engine Temperature Sensor
④ Rectifier (except for MF model)
⑤ Ignition coil
⑥ Oil Pressure Switch
⑦ Fuse (20A) (except for MF model)
⑧ ECU (Electronic Control Unit)
⑨ Starter Solenoid (except for MF model)

Bow Side View



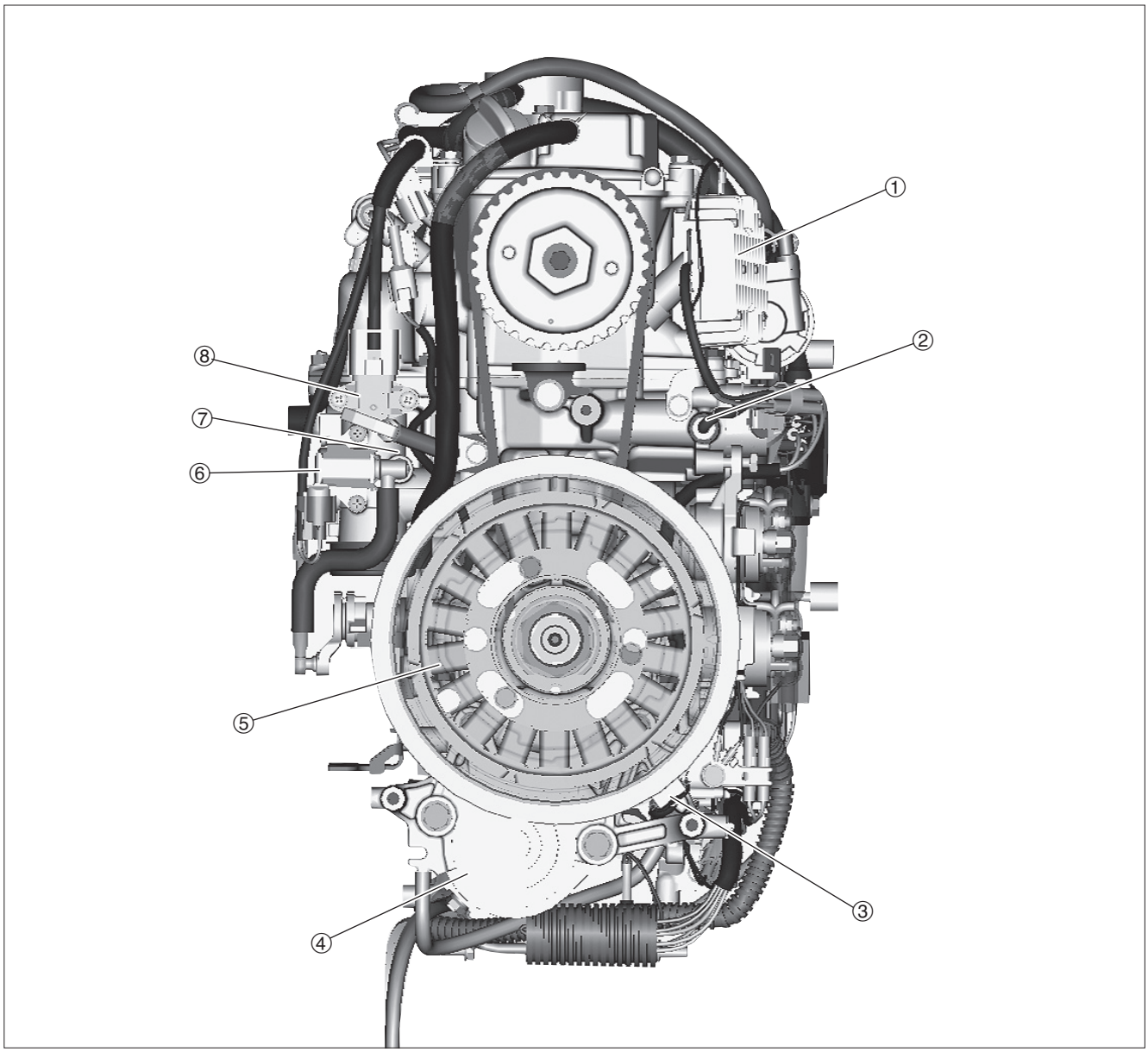
① Exciter Coil / Charge Coil (charge coil : except for MF model)
② Pulser Coil
③ Neutral Switch (only for EF, EFT models)
④ Starter Motor (except for MF model)
⑤ Vapor Separator
⑥ ISC (Idle Speed Control) Valve

Starboard Side View



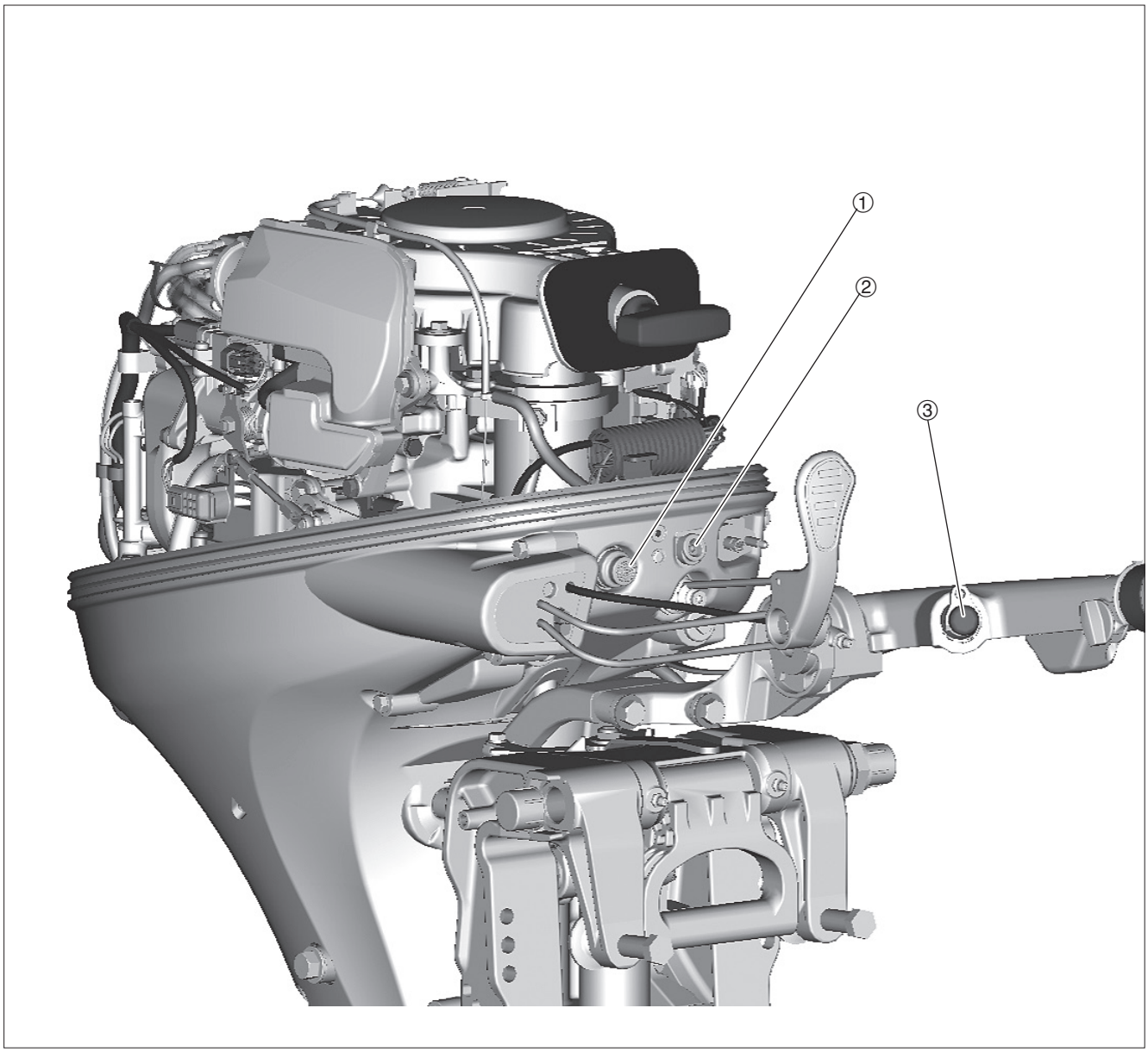
① T-Map Sensor
② ISC (Idle Speed Control) Valve
③ Vapor Separator
④ Fuel Injector

Top View



① Rectifier (except for MF model)
② Engine Temperature Sensor
③ Pulser Coil
④ Starter Motor (except for MF model)
⑤ Exciter Coil / Charge Coil (charge coil : except for MF model)
⑥ ISC (Idle Speed Control) Valve
⑦ TPS (Throttle Position Sensor)
⑧ T-Map Sensor

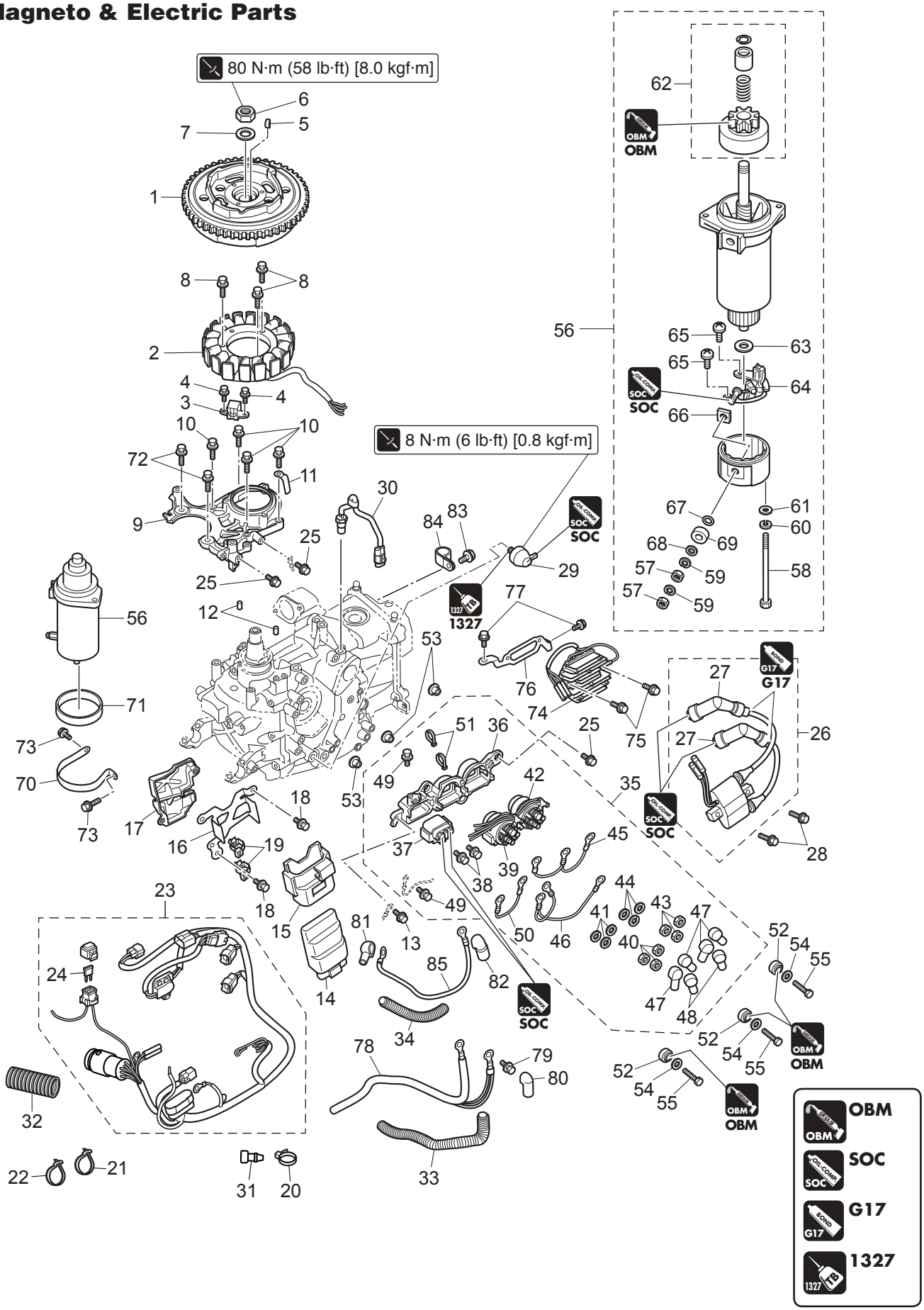
Housing Cover (Front)



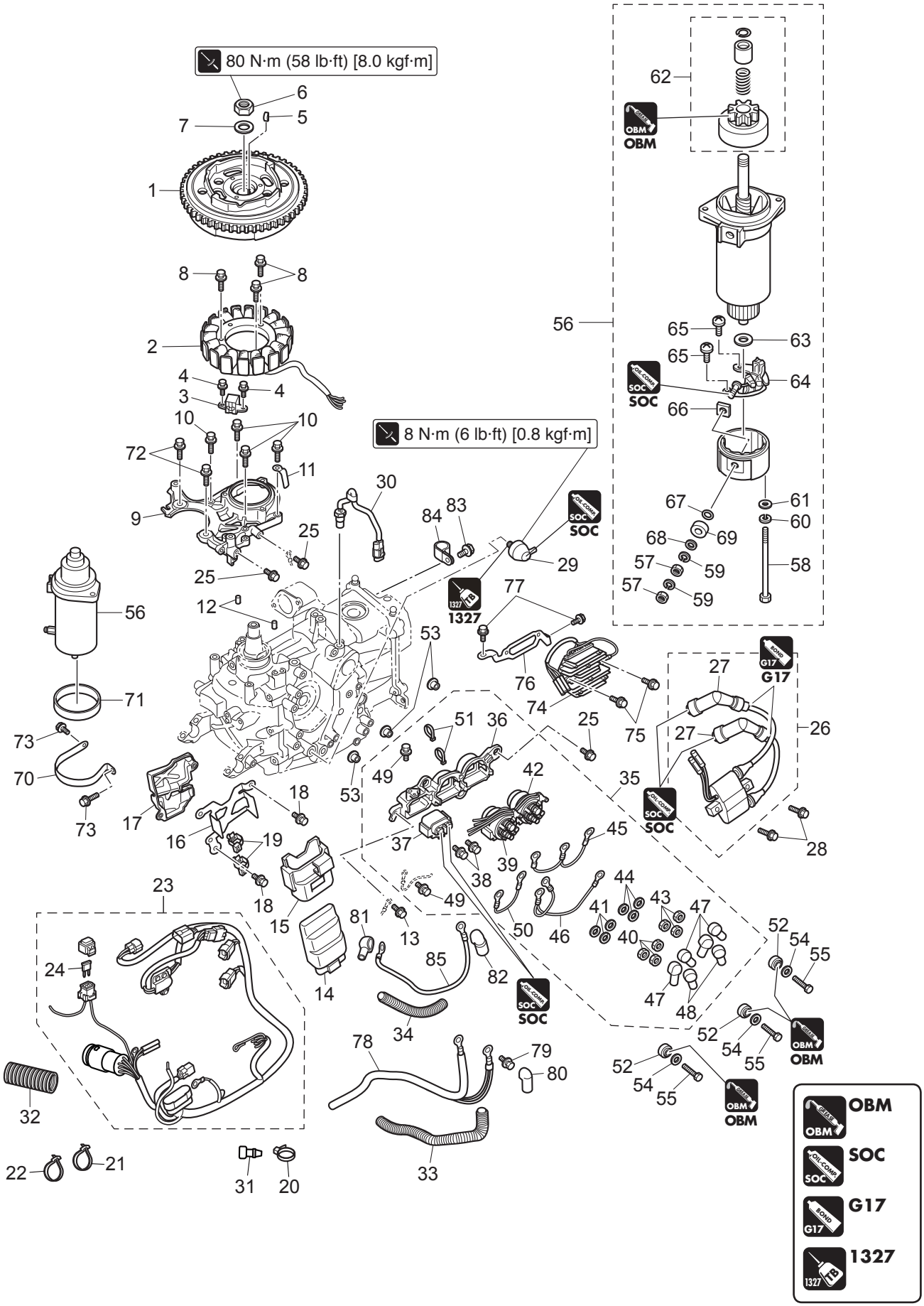
① Start Switch (only for EF, EFT models)
② Warning Lamp
③ Engine Stop Switch (for MF, EF, and EFT models)

3.Parts Layout

Magneto & Electric Parts

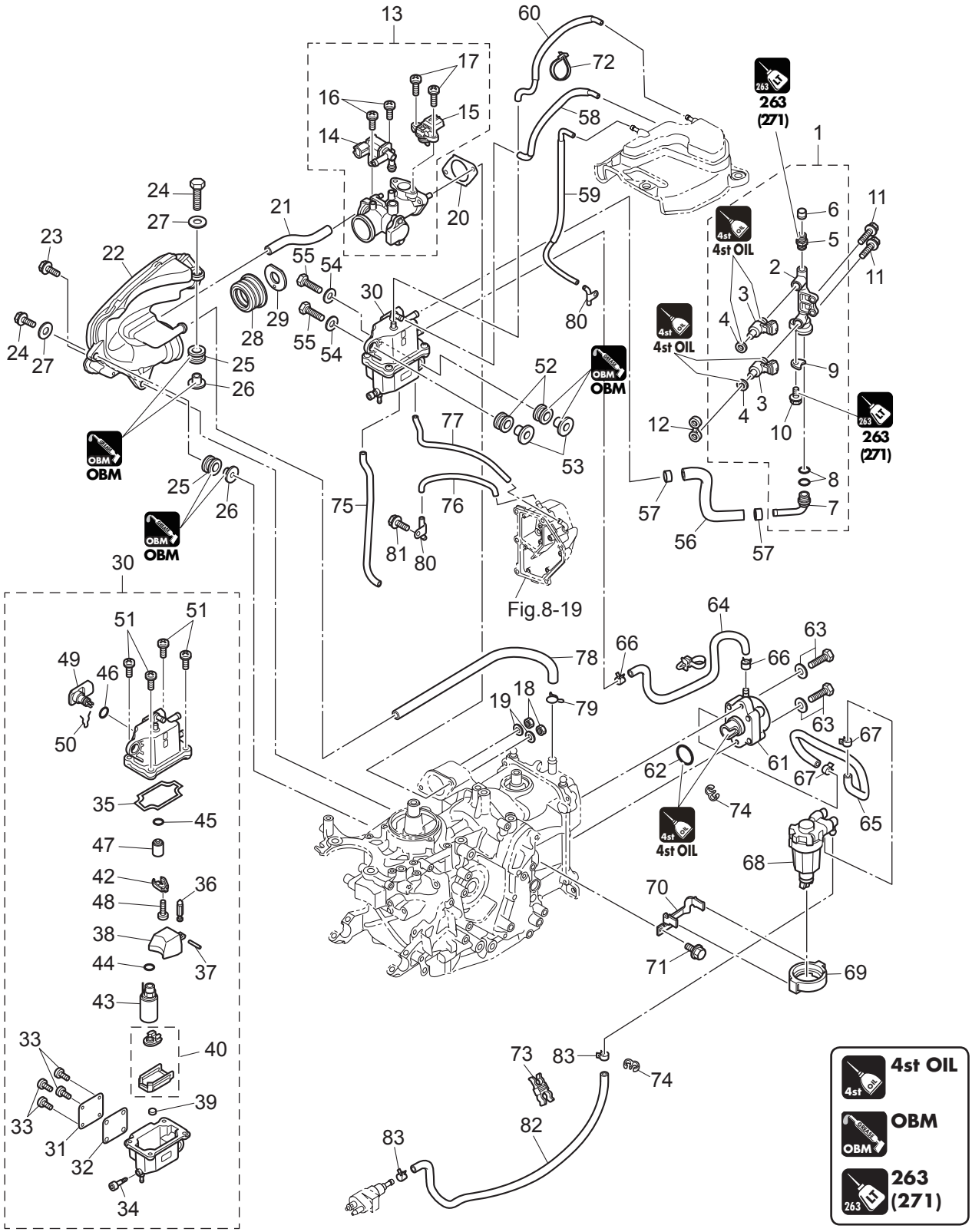


Ref. No.	Description	Q'ty	Remarks
1	Flywheel	1	M Type
	Flywheel W/Ring Gear	1	EF/EP Type
2	Alternator Assy	1	M Type
	Alternator Assy	1	EF/EP Type
3	Pulsar Coil	1	
4	Bolt	2	Pulsar M5 L=12 mm
5	Key t=4	1	
6	Nut	1	
7	Washer 16-27-3.2	1	
8	Bolt	3	Alternator M6 L=25 mm
9	Coil Bracket	1	
10	Bolt	4	Coil Bracket M6 L=25 mm
11	Clamp 6.5-47.5P	1	
12	Dowel Pin 6-12	2	
13	Bolt	1	M6 L=12 mm
14	ECU Assy	1	
15	ECU Holder	1	
16	Plate	1	
17	Plate	1	
18	Bolt	2	M6 L=16 mm
19	Band 135	2	
20	Band 158	1	Do not reuse.
21	Band 158	1	Do not reuse.
22	Band 158	1	Do not reuse.
23	Cord Assy	1	MF
	Cord Assy	1	EF, EFT
	Cord Assy	1	EP, EPT
24	Fuse 20A	1	
25	Bolt	2	M6 L=12 mm
26	Ignition Coil W/R-cap	1	
27	Plug Cap W/Resistance	2	
28	Bolt	2	M6 L=25 mm
29	Oil Pressure Switch	1	
30	Engine Temp Sensor	1	
31	Cable Terminal Plug	2	
32	Protector ø24-70	1	
33	Protector ø10.7-320	1	
34	Protector ø10.7-180	1	
35	Electric Bracket Assy	1	EF, EP
	Electric Bracket Assy	1	EFT, EPT
36	Bracket	1	
37	Starter Solenoid	1	
38	Bolt	2	M6 L=10 mm
39	PT Solenoid Switch (A)	1	
40	Nut	3	
41	Spring Washer	3	
42	PT Solenoid Switch (B)	1	
43	Nut	3	


80 N·m (58 lb·ft) [8.0 kgf·m]
8 N·m (6 lb·ft) [0.8 kgf·m]
OBM
SOC
G17
1327

Ref. No.	Description	Q'ty	Remarks
44	Spring Washer	3	
45	Solenoid Switch Cord (A)	1	Red
46	Solenoid Switch Cord (B)	1	
47	Terminal Cap 8-13-28	4	Red
48	Terminal Cap 8-13-28	2	Black
49	Bolt	2	M6 L=12 mm
50	Ground Cable L=120	1	
51	Band 104	2	Do not reuse.
52	Rubber Mount	3	
53	Collar	3	
54	Washer 6-16-1.5	3	
55	Bolt	3	M6 L=25 mm
56	Starter Motor Assy	1	
57	Nut	2	
58	Bolt	2	
59	Spring Washer	2	
60	Spring Washer	2	
61	Washer	2	M5
62	Pinion Assy	1	
63	Washer	1	
64	Brush Holder Assy	1	
65	Screw	2	M4 L=8 mm
66	Bushing 2	1	
67	O-ring	1	Do not reuse.
68	Washer	2	M6
69	Bushing 1	1	
70	Starter Motor Band	1	
71	Damper	1	M8 L=25 mm
72	Bolt	2	M6 L=12 mm
73	Bolt	2	
74	Rectifier Complete	1	
75	Bolt	2	
76	Rectifier Bracket	1	
77	Bolt	2	M6 L=12 mm
78	Battery Cable	1	
79	Bolt	1	M6 L=12 mm
80	Terminal Cap 15.5-20-28	1	
81	Terminal Cap 8-18-28	1	Red
82	Terminal Cap 13-13-28	1	Red
83	Bolt	1	M6 L=12 mm
84	Clamp 6.5-14L	1	
85	Starter Cable	1	Starter Solenoid-Starter Motor

Fuel Pump



Ref. No.	Description	Q'ty	Remarks
1	Fuel Rail Assy	1	
2	Fuel Rail	1	
3	Fuel Injector Assy	2	
4	Seal Ring	2	
5	Valve Assy (Pressure Check)	1	
6	Cap	1	
7	Nipple 8-6-13L	1	
8	O-ring 1.9-9.8	2	Do not reuse.
9	Holding Plate	1	
10	Bolt	1	M6 L=12 mm
11	Bolt	2	M6 L=25 mm
12	Insulator	1	
13	Throttle Body Assy	1	
14	ISC Valve	1	
15	Map Sensor	1	T-Map Sensor
16	Screw	2	M5 L=10 mm
17	Screw	2	M5 L=16 mm
18	Nut	2	M6
19	Washer	2	M6
20	Carburetor Gasket	1	Do not reuse.
21	Hose	1	ISC Valve-Intake Silencer
22	Intake Silencer Assy	1	
23	Bolt	1	M6 L=30 mm
24	Bolt	2	M6 L=20 mm
25	Rubber Mount	2	
26	Collar	2	
27	Washer 6-16-1.5	2	M6
28	Gasket	1	
29	Restrictor	1	
30	Vapor Separator Assy	1	
31	Cover	1	
32	Seal	1	Do not reuse.
33	Screw	4	M4 L=8 mm
34	Drain Screw	1	
35	Gasket	1	
36	Float Valve Assy	1	
37	Float Arm Pin	1	
38	Float	1	
39	Grommet	1	
40	Filter (Inlet)	1	
42	Holder	1	Regulator
43	Fuel Feed Pump	1	
44	O-ring	1	FFP Out Side Do not reuse.
45	O-ring	1	Connector Do not reuse.
46	O-ring	1	Regulator Do not reuse.
47	Fuel Regulator	1	
48	Screw	1	M4 L=8mm
49	VST Connector	1	

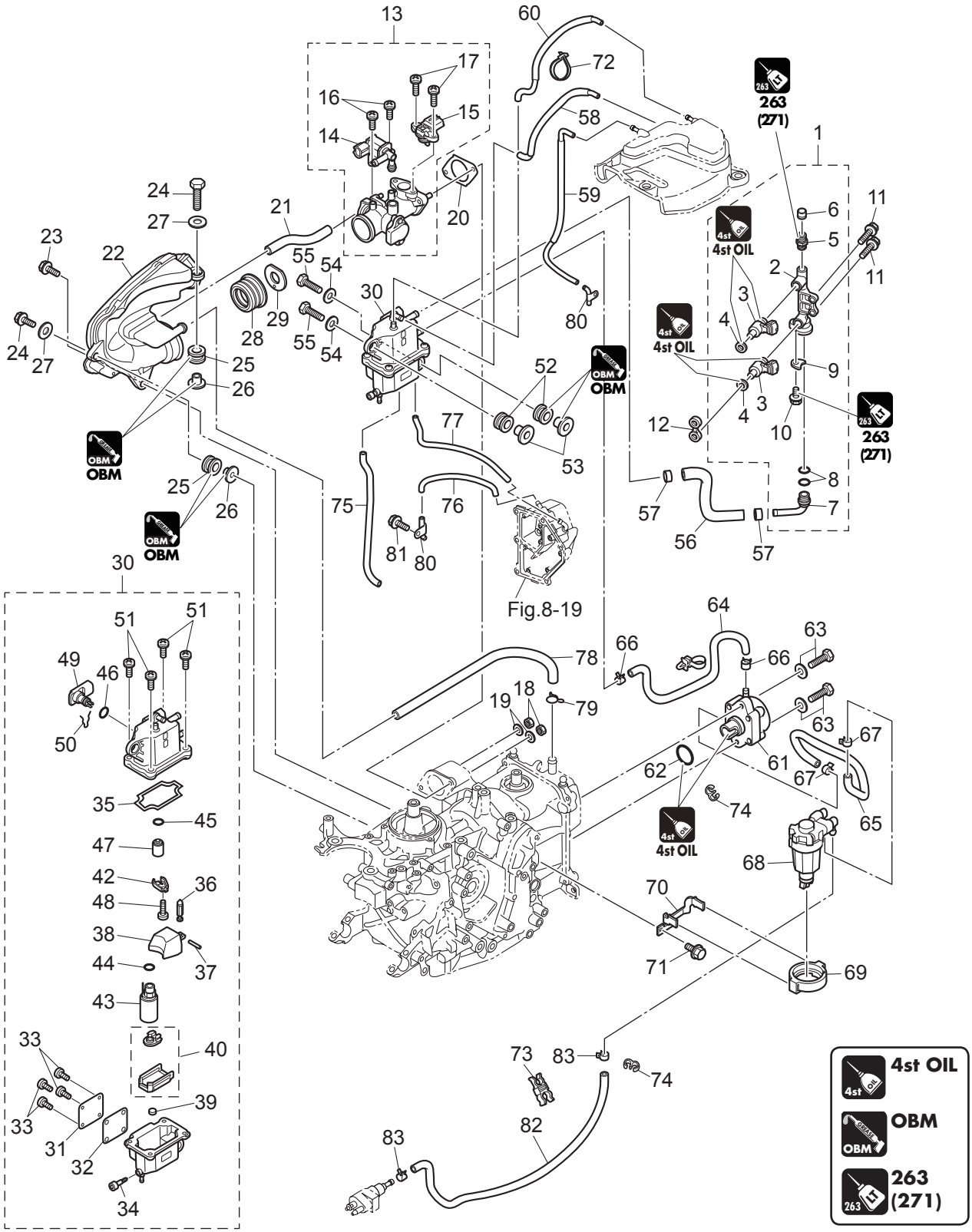
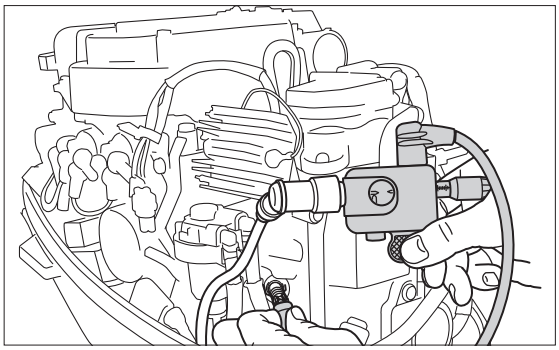


Fig.8-19

Ref. No.	Description	Q'ty	Remarks
50	Clip	1	
51	Screw	4	
52	Rubber Mount	2	
53	Collar	2	
54	Washer 6-16-1.5	2	M6
55	Bolt	2	M6 L=25mm
56	Fuel Hose W/Protector	1	VST-Fuel Rail
57	Clamp ø16.8	2	
58	Vent Hose W/Protector	1	VST-Catch Tank
59	Vent Hose W/Protector	1	Catch Tank-Vent
60	Vent Hose W/Protector	1	Catch Tank-Exposure
61	Fuel Pump Assy	1	
62	O-ring 3.5-25.7	1	Do not reuse.
63	Bolt	2	M6 L=25mm
64	Fuel Hose W/Protector	1	Fuel Pump-VST
65	Fuel Hose W/Protector	1	Fuel Filter-Fuel Pump
66	Clip ø9.4	2	Fuel Pump-VST
67	Clip ø9.4	2	Fuel Filter-Fuel Pum
68	Fuel Filter Assy	1	
69	Fuel Filter Holder	1	
70	Plate	1	
71	Bolt	1	M6 L=12mm
72	Clamp	1	
73	Clamp ø10	1	
74	Clamp ø10	1	
75	Water Hose	1	Drive Shaft Housing-Fuel Cooler
76	Cooling Hose	1	Idle Port Cover-Nipple
77	Cooling Hose	1	Fuel Cooler-Idle Port Cover
78	Breather Hose W/Protector	1	Head Cover-Intake Silencer
79	Clip ø12	1	Head Side
80	Nipple	2	Drive Shaft Housing
81	Bolt	1	
82	Fuel Hose W/Protector	1	
	Fuel Hose W/Protector 455-25	1	USA Model
83	Clip ø9.4	2	

4. Ignition System, Ignition Control System

1) Inspection of Ignition Firing



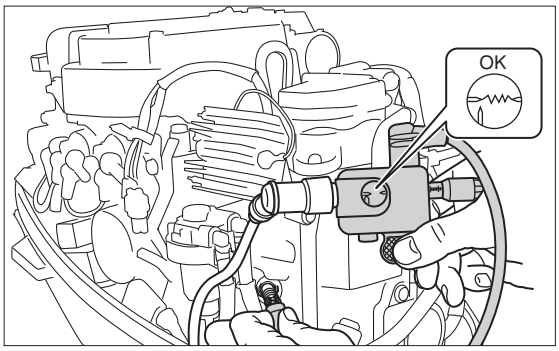
⚠ WARNING

- **When testing, put electrode cap Firmly to prevent direct contact with spark tester wiring and leak of electrical current, and perform test carefully.**
- **Keep flammable gas, fuel, oil and grease away from tester to prevent them from catching fire.**

1. Disconnect plug caps from spark plugs.
2. Connect plug cap to spark tester.
3. Connect spark tester clip to spark plug tip electrode.

Spark Tester :
P/N. 3F3-72540-0

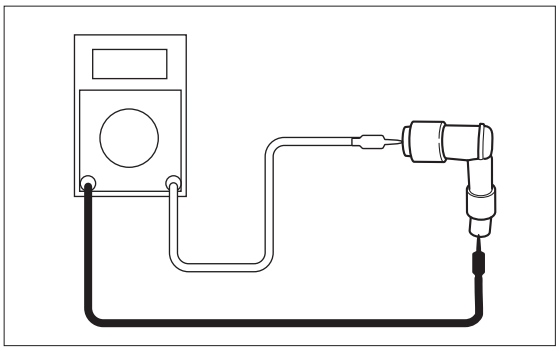
Spark Performance :
10 mm (0.4 in) or over



4. Start engine and check spark. Check ignition system when sparks are weak.

- This test can be made without removing parts.
- Ignition coil operation test can be made by using "Running (Drop) Test" of diagnosis system.

2) Inspection of Plug Cap



Remove plug cap to test it as a separate unit.

1. Disconnect plug caps from spark plugs.
2. Remove plug caps from their high tension cables by turning caps counterclockwise.
3. Measure plug cap resistance. Replace if other than specified value.

Plug Cap Resistance :
3.0 to 7.0 kΩ

3) Inspection of Ignition Coils

1. Remove ignition coil coupler.

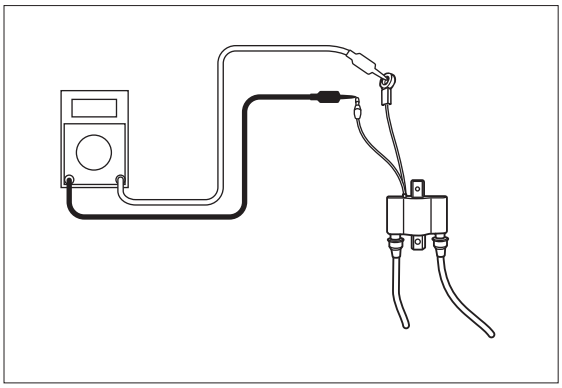
2. Measure ignition coil resistance. Replace if other than specified value.

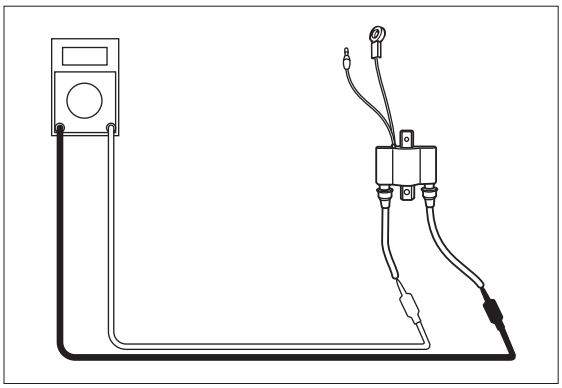
This test can be made without removing parts.

Ignition Coil Resistance :
Primary Coil : Between Black(B) - Orange(Or)
0.26 - 0.35 Ω (at 20°C)
Secondary Coil :
Between High Tension Cord - High Tension Cord
6.8 to 10.2 kΩ (at 20°C)

3. Install plug cap onto high tension cord by turning clockwise.

4. Connect plug cap to spark plug.





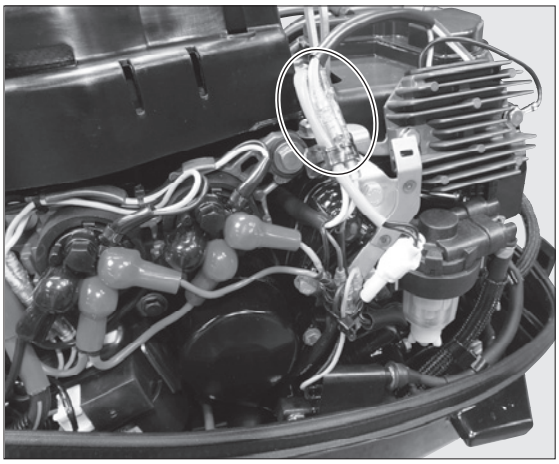
4) Inspection of Exciter Coil

1. Disconnect exciter coil (2 pin connector).

2. Measure exciter coil resistance. Replace if other than specified value.

This test can be made without removing parts.

Exciter Coil Resistance :
Between Red/Black (R/B) - Blue (L)
1.04 to 1.56 Ω (at 20°C)



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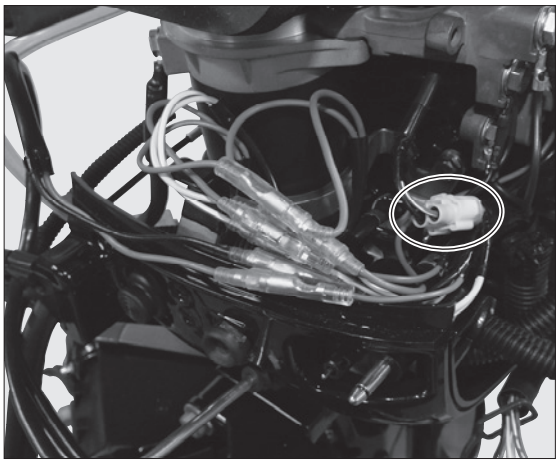
5) Inspection of Pulser Coil



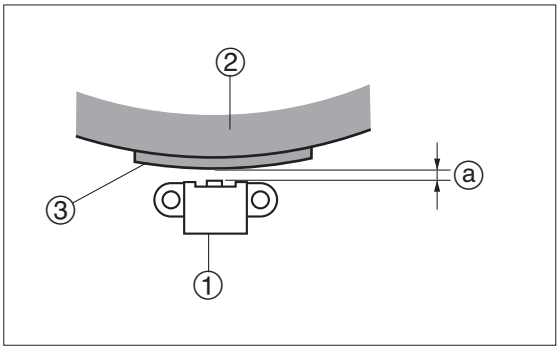
1. Disconnect pulser coil coupler (2 pin) of Bow side.

2. Measure pulser coil resistance. Replace if other than specified value.

This test can be made without removing parts.

Pulser Coil Resistance (Reference Value) :
Between Red/White (R/W) - Black (B)
148 to 222 Ω

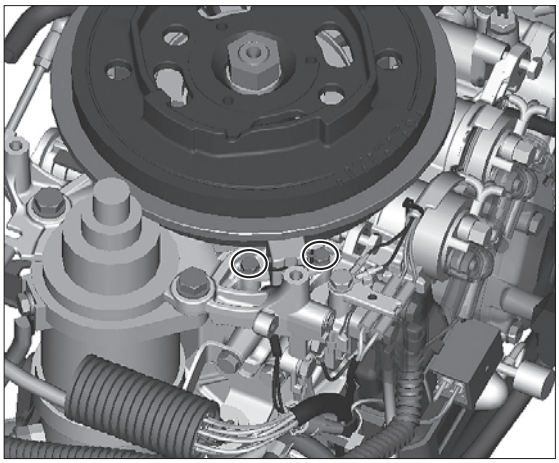
6) Adjustment of Pulser Coil Air Gap



1. Loosen pulser coil ① mounting screw, and insert the thickness gauge between pulser coil ① and encorder ring ③ of flywheel ②.

Pulser Coil Air Gap : ⓐ
0.7 to 0.9 mm (0.028 to 0.035 in)

2. Tighten pulser coil mounting screw.



Keep parallel the pulser coil air gap of pulser coil and encorder ring, to tighten the screw while pushing up.

7) Inspection of Oil Pressure Switch

Remove oil pressure switch to test it as a separate unit.

1. Remove oil pressure switch ①.

2. Check electrical conductivity of oil pressure switch ① (Between the terminal connection and the threaded area of the switch base.). Replace if no conductivity.

3. Connect vacuum/pressure gauge to oil pressure switch.

Vacuum/Pressure Gauge :
P/N. 3AC-99020-1

4. Apply pressure slowly with vacuum/pressure gauge.

5. Check that oil pressure switch is not conductive with specified pressure applied. Replace if conductive.

Oil Pressure Switch pressure :
0.020 to 0.030 MPa (2.8 to 4.0 PSi)
[0.2 to 0.3 kgf/cm²]

6. Reinstall the removed component.

Oil Pressure Switch :
8 N · m (6 lb · ft) [0.8 kgf · m]

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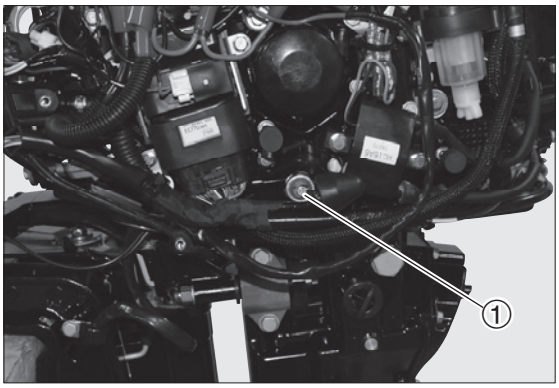
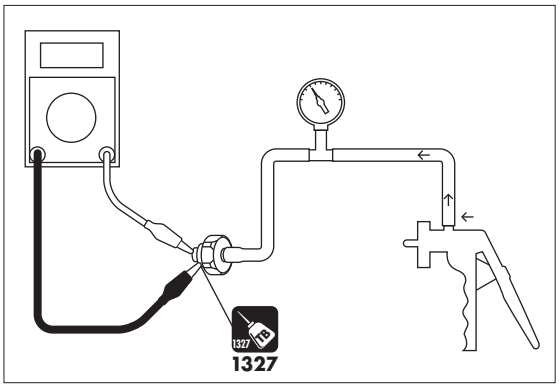




8

8) Inspection of Engine Temperature Sensor

Remove engine temperature sensor to test it as a separate unit.

1. Remove engine temperature sensor ① from engine.

2. Test sensor when cold and then place in warm water and increase the temperature slowly while conducting your test.

3. Measure the engine temperature sensor resistance. Replace if out of specifications.

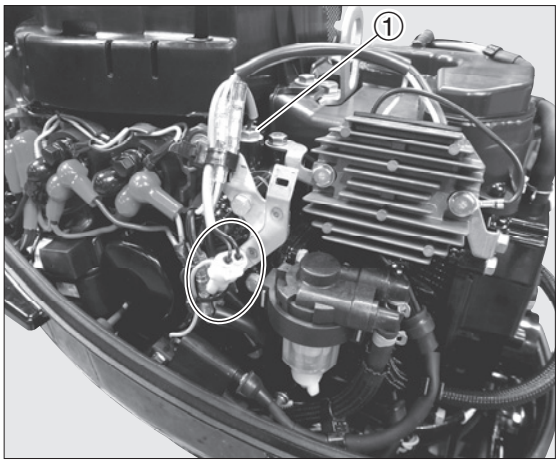
Engine Temperature Resistance (Reference Value) :

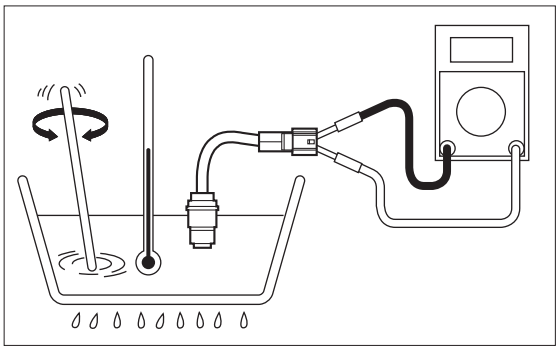
Between terminal

about at 5°C : 4.24 to 4.86 kΩ

about at 25°C : 1.90 to 2.10 kΩ

about at 100°C : 0.166 to 0.204 kΩ



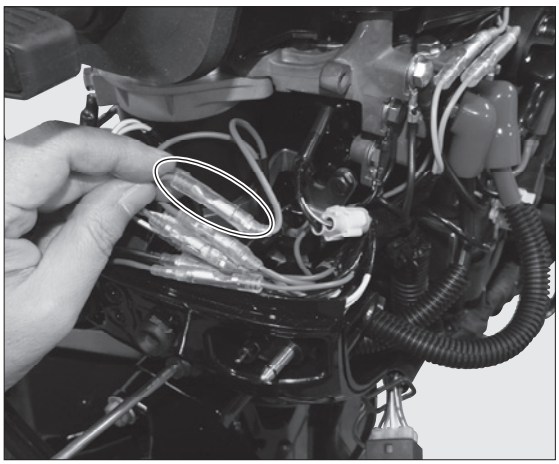


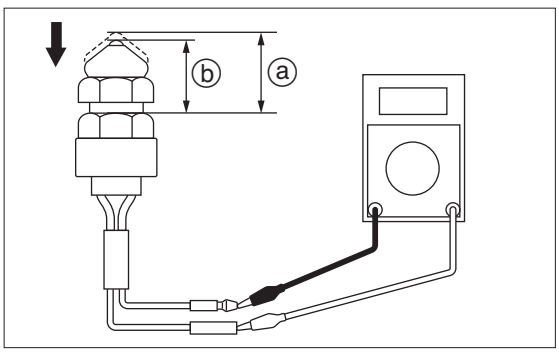
9) Inspection of Neutral Switch (Except MF)

This test can be made without removing parts.

1. Check electrical conductivity of neutral switch. Replace if no conductivity.

Switch Position	Lead Wire Color	
	Green (G)	Green (G)
Free ⓐ		
Pushed (shift in) ⓑ	○	○



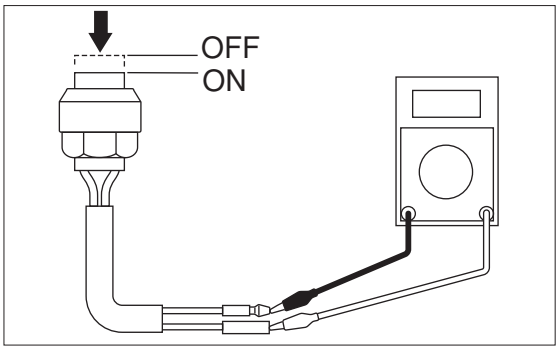


10) Inspection of Start Switch (EF, EFT)

1. Check electrical conductivity of start switch. Replace if no conductivity.

This test can be made without removing parts.

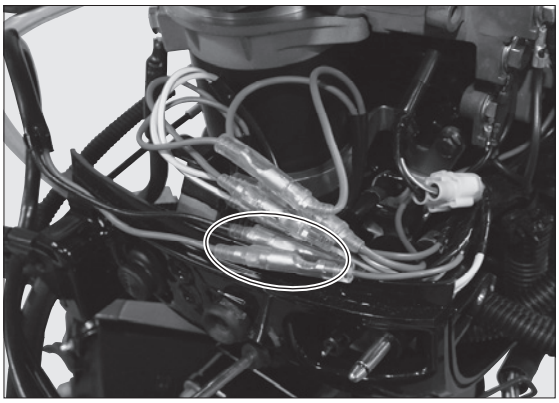
Switch Position	Lead Wire Color	
	Green (G)	Red (R)
Free : OFF		
Pushed : ON	○	○

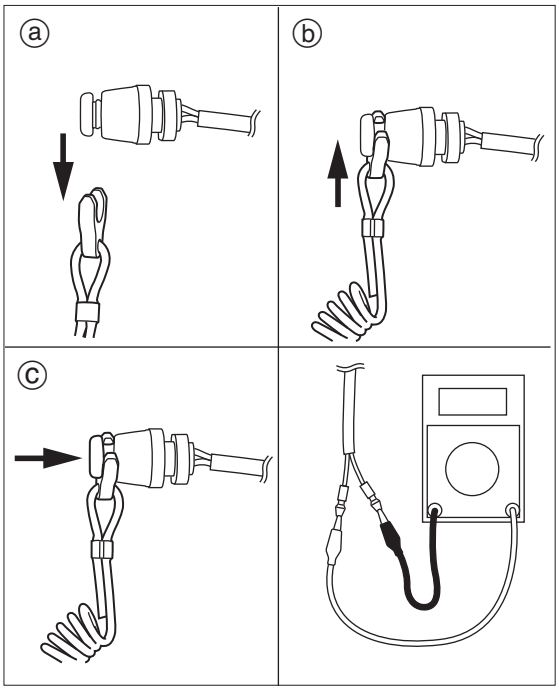


11) Inspection of Stop Switch

1. Check electrical conductivity of stop switch. Replace if no conductivity.

Switch Position	Lead Wire Color	
	Brown (Br)	Black (B)
Remove lock. ⓐ	○	○
Install lock. ⓑ		
Press switch. ⓒ	○	○

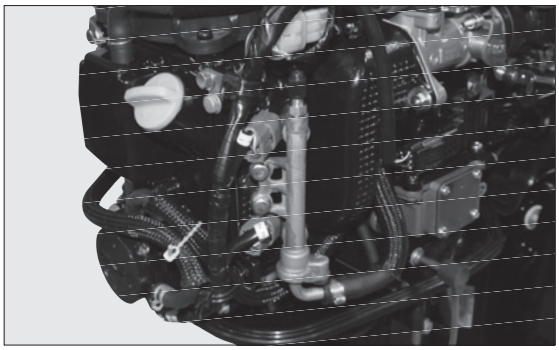




5. Fuel Control System

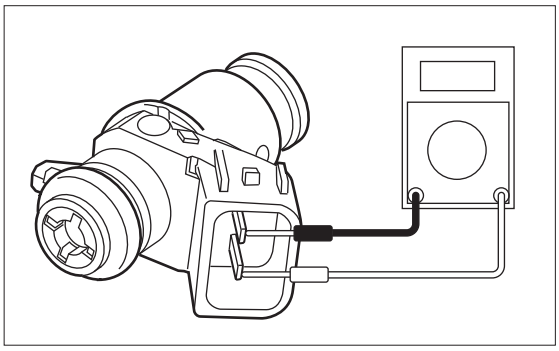
1) Inspection of Injectors

1. Measure injector resistance.



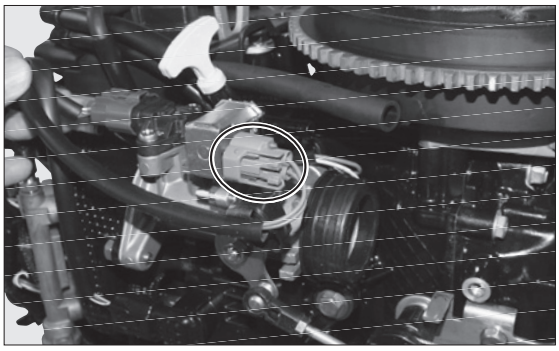
• This test can be made without removing parts.
• Injector operation test can be made by using "Function, or Running (Drop) Stop Test" of diagnosis system.

Injector Resistance (Reference Value) : (at 25°C)
12.0 ± 0.5 Ω



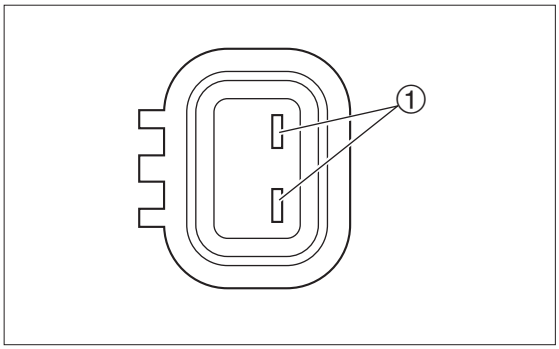
2) Inspection of ISC Valve

1. Measure ISC valve between terminal ① resistance.



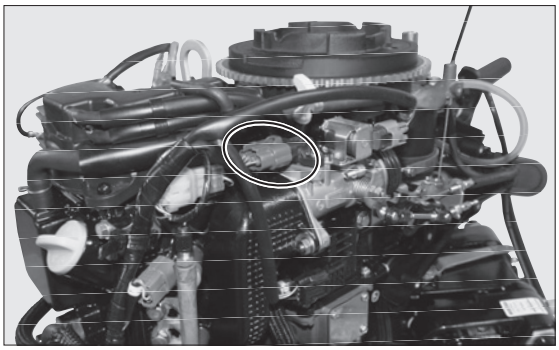
ISC Valve Resistance (Reference Value) : (at 20°C)
24 ± 3 Ω

ISC valve operation test can be made by using "Function, or Running (Drop) Stop Test" of diagnosis system.



3) Inspection of T-MAT Sensor

MAP (manifold pressure) sensor and MAT (intake air temperature) sensor are integrated in this sensor.



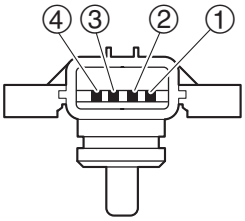
Inspection of MAT Sensor

1. Measure ambient temperature.

2. Connect computer to outboard motor, and use diagnosis system to display "Air Temperature (Intake Air Temperature)".

3. Replace T-MAP sensor if difference between ambient temperature and "Air Temperature (Intake Air Temperature)" is over ± 5°C.

Perform inspection MAT sensor when engine is cold.



4. Measure MAT sensor resistance. Replace T-MAP sensor if out of specification.

This test can be made without removing parts.

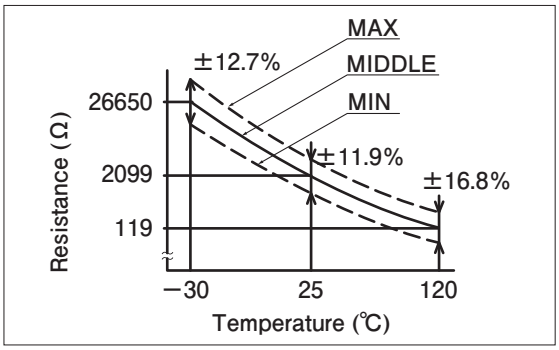
MAT (Intake Air TEMP) Sensor Resistance (Reference Value) :

Between Vout TEMP ④ to GND ② :

0.6 ± 0.6 kΩ (0°C)

0.282 to 0.388 kΩ (80°C)

* If ambient temperature is different use the illustration shown to the right.



Inspection of MAP Sensor

1. Measure MAP sensor resistance. Replace T-Map sensor if out of specification.

MAP (Intake Air Pressure) Sensor Resistance (Reference Value) :

Between Vout TEMP ④ to Vout MAP ①: No conductivity

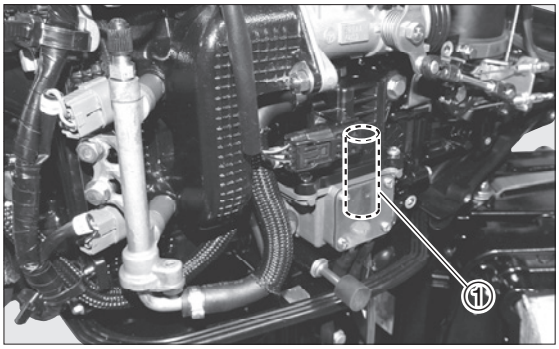
Between Vout TEMP ④ to Vcc ③ : No conductivity

4) Inspection of Fuel Feed Pump (EP, EPT)

1. Turn the main switch to "ON" and check for operate fuel feed pump (FFP).

2. Check that fuel feed pump (FFP) ① operation sound is heard. If not, check fuel system.

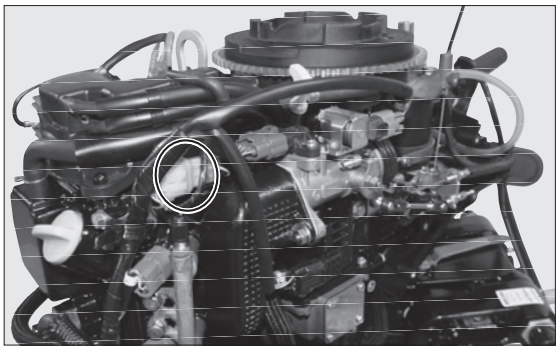
This test can be made without removing parts.



5) Inspection of Throttle Position Sensor (TPS)

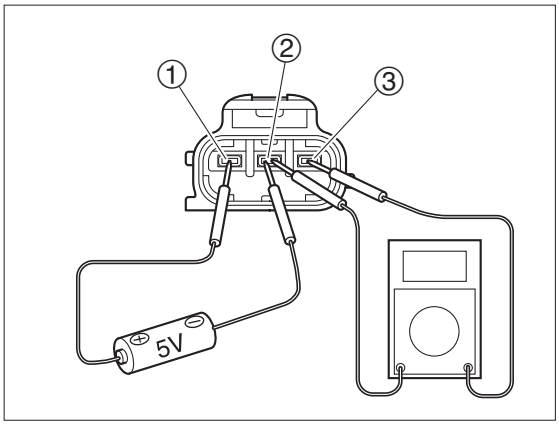
1. Check throttle position sensor resistance. Replace throttle body with throttle position sensor if other than specified value.

   Throttle Position Sensor Resistance :
   5 kΩ or less



2. Apply 5V between terminals Vta ① and E2 ②, and measure output voltage between terminals E2 ② and Vc ③.

   TPS output is proportional to the degree of opening the main valve fully closed - fully open.

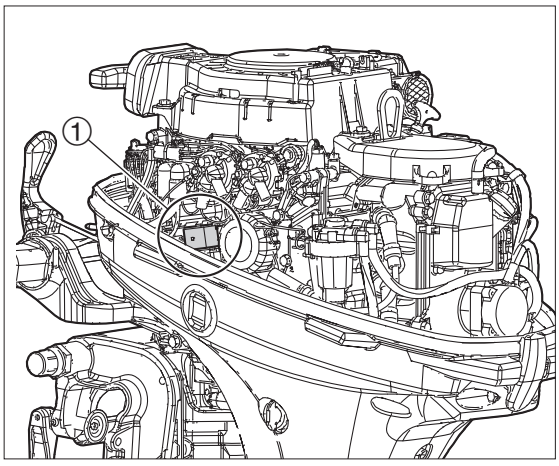


6. Starting System (Except MF)

1) Inspection of Fuse

1. Check electrical conductivity of fuse. Replace if no conductivity.

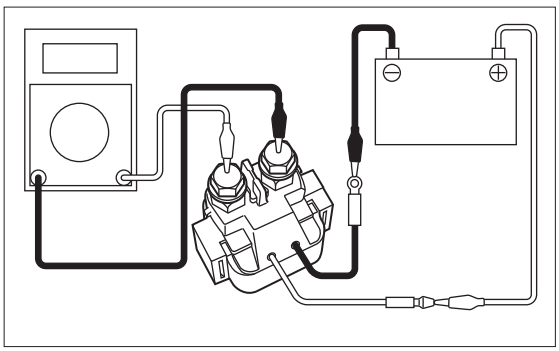
   Small blade fuse of the flat type is used.



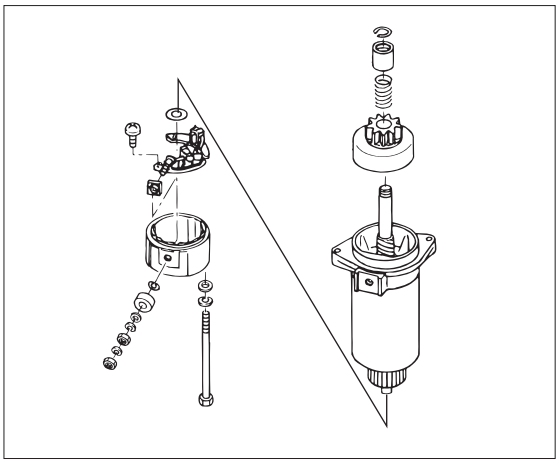
① Fuse Box

2) Inspection of Starter Solenoid

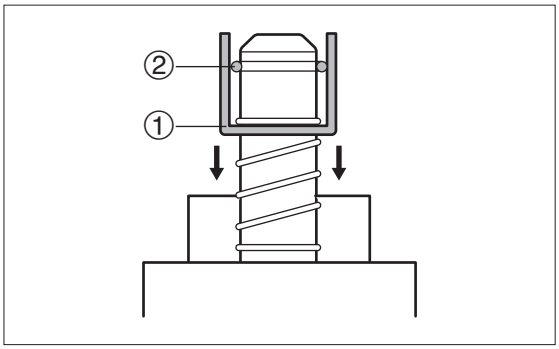
1. Connect tester lead wires to both terminal of starter solenoid.
2. Connector green (G) lead wire to battery positive terminal.
3. Connector black (B) lead wire to battery negative terminal.
4. Check electrical conductivity between terminals of starter solenoid. Replace if no conductivity.
5. Remove battery terminal from green (G) or black (B) lead wire, and check there is no conductivity between starter solenoid terminals. Replace if conductive.



3) Disassembly of Starter Motor



1. Put locating mark between starter motor body and cap. (This mark facilitates reassembly.)

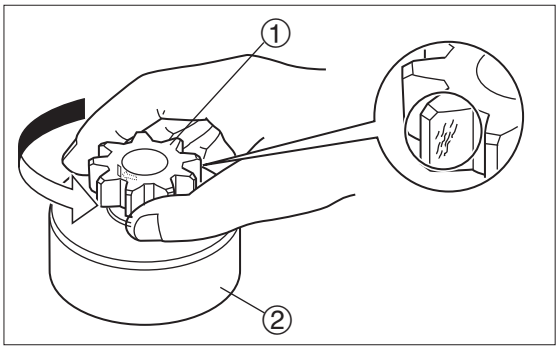


2. Slide pinion stopper ① downward as shown and remove clip ②.

> Use small bladed screw driver to remove clutch. Be careful not to cut hand because clip is secured firmly.

3. Remove bolt and disassemble starter motor.

4) Inspection of Starter Motor Pinion

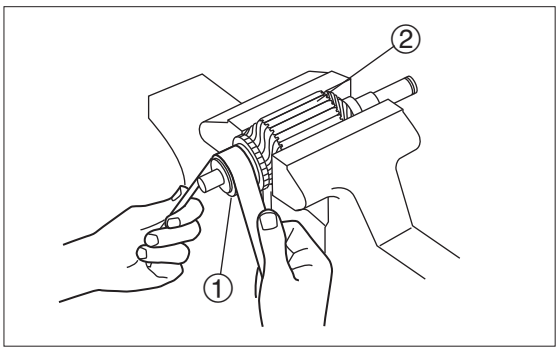


1. Check pinion teeth for crack and wear. Replace if necessary.

2. Fix clutch ②, and turn only pinion ① to check that it can be rotated smoothly in one direction. Replace if necessary.

> Turn pinion ① counterclockwise to check that it can be rotated smoothly. Also, check that pinion is locked when turned clockwise.

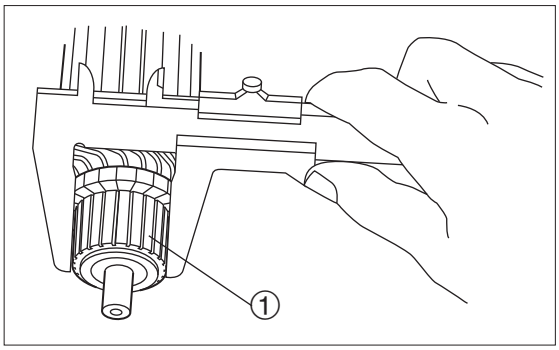
5) Inspection of Armature



1. Check commutator ① for dirt. If necessary, clean by using sand paper of No. 600 or by air-blowing.

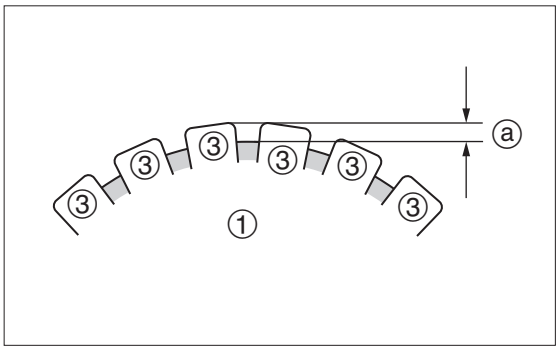
2. Measure commutator ① outer diameter. Replace starter motor ass'y if outer diameter is less than specified value.

Commutator Outer Diameter : Standard Value	30.0 mm (1.181 in)
Wear Limit :	29.0 mm (1.142 in)



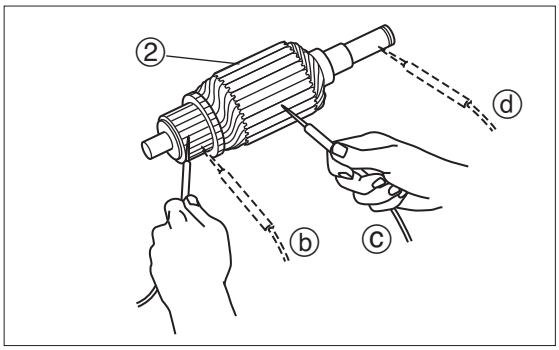
3. Measure undercut ⓐ of commutator ①. Replace starter motor ass'y if less than specified value.

Commutator Undercut : Standard Value	0.5 to 0.8 mm (0.020 to 0.031 in)
Wear Limit ⓐ :	0.2 mm (0.008 in)



4. Check electrical conductivity of armature ②. Replace starter motor ass'y if other than specified condition.

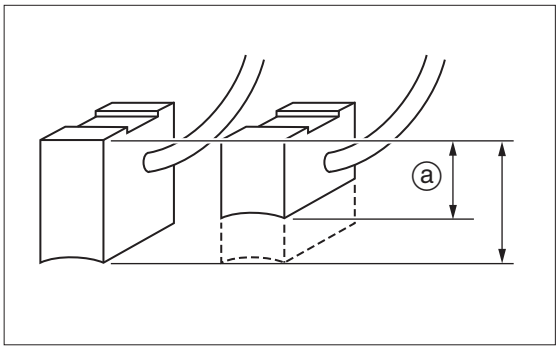
Armature Conductivity :	
ⓑ Between Commutator Segments ③ - ③	Conductive
ⓒ Between Segment - Armature Core	Non-conductive
ⓓ Between Segment - Armature Shaft	Non-conductive



6) Inspection of Brushes

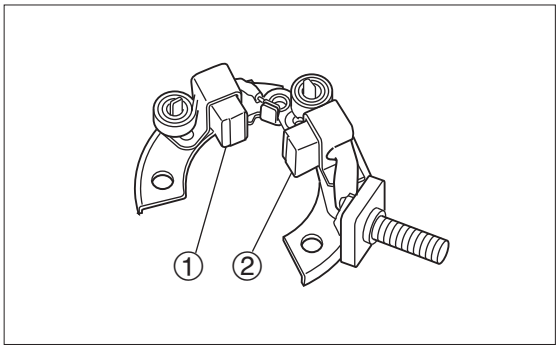
1. Measure brush length. Replace brush holder ass'y if brush length is less than specified value.

Brush Length ⓐ : Standard Value	12.5 mm (0.492 in)
Wear Limit ⓐ :	9.5 mm (0.374 in)

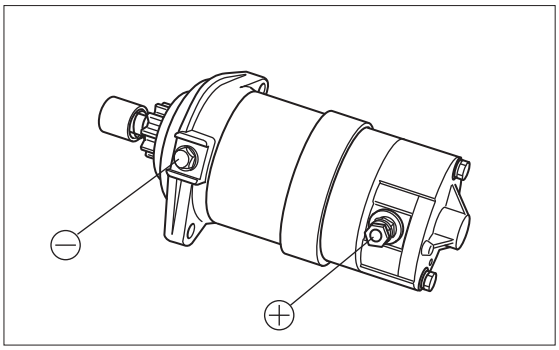


2. Check conductivity of brush holder ass'y. Replace if other than specified value.

Conductivity Between Brushed	
Between Brush ① – Brush ②	Non-conductive
Between Brush ①, ② – Ground	Non-conductive



7) Inspection of Starter Motor Operation

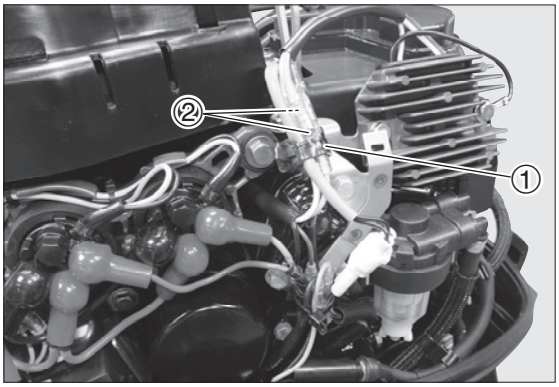


1. Assemble starter motor and check before and after installing it on the power unit by applying voltage between points "+" and "-" that it operates normally.

Energizing starter motor produces sparks, and thus, any inflammable matter must be kept away from the motor.

7.Battery Charging System (Except MF)

1) Inspection of Charge Coil



1. Remove wire band ① of cable that comes from alternator located on the rectifier bracket.

2. Disconnect cable coupler from charge coil, and measure resistance.

This test can be made without removing parts.

Alternator (Charge Coil) Resistance
: Reference Value (at 20°C)
White (W) – Yellow (Y)
0.17- 0.25 Ω

2) Inspection of Rectifier

- Check wire harness for disconnection of lead wire and defective connection.
- Check conductivity between each point by referring to the following table. Value in ( ) is reference value.
- Perform the measurement with all connections disconnected to make the component a separated unit.

This test can be made without removing parts.

Rectifier Tester Check Chart

"ON" means "conductive", and "OFF" means "non-conductive".

		Tester Lead Positive (+) Side (Red)			
		Red R	White W	Black B	Yellow Y
Tester Lead Negative (-) Side (Black)	Red R		OFF	OFF	OFF
	White W	ON (3.7kΩ)		ON (2.3kΩ)	ON (4.6kΩ)
	Black B	ON (5.0kΩ)	ON (2.3kΩ)		ON (2.3kΩ)
	Yellow Y	ON (3.7kΩ)	ON (4.6kΩ)	ON (2.3kΩ)	

· Measurement condition Circuit tester to be used
: HIOKI3030
Measurement Range : 1kΩ
· Permissible Error of Resistance : ±20%

Note) ① It is recommended to use "HIOKI HiTESTER MODEL 3030" for this measurement. Use of other instrument model for the measurement can cause indication of abnormal value for normal condition, resulting in inaccurate measurement.
② Disconnect all connections to measure as an independent unit.
③ Any movement of pointer indicates "ON" or "conductive" state.
④ "CON" means that the pointer moves once and then returned to the value shown in ( ) because of characteristic of capacitor.
⑤ The value in ( ) is the condition applied when "1kΩ" range is used. The measurement varies widely among types of instrument, situations (such as inner power supply), or measurement ranges due to diodes used in the unit.

8.ECU Coupler

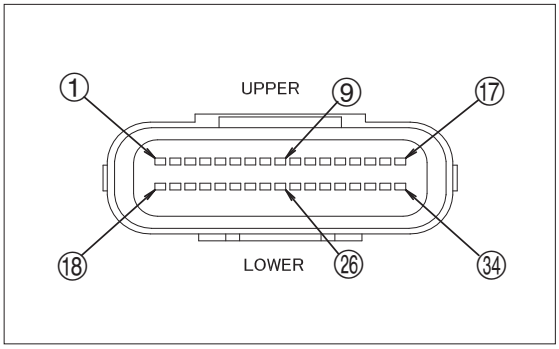
• Check wire harness for disconnection of lead wire and defective connection.

• Terminals are arranged and numbered as shown.

• The following table names of terminals, their numbers and lead wire colors.

Terminal	Name	Leads Wire (Color)	
A1	Ignition Coil	Or	Orange
A2	Warning Buzzer (*)	Y	Yellow
A3	ECU Coil (+)	B/R	Black/Red
A4	Injector Power Supply (12 V)	L	Blue
A5	ECU Coil (–)	L	Blue
A6	T-MAP Sensor (MAP)	G/Or	Green/Orange
A7	Sensor Power Supply (5 V)	R/W	Red/White
A8	Pulser Coil (+)	R/W	Red/White
A9	Pulser Coil (–)	B	Black
A10	Ground	B	Black
A11	COM. (RxD)	W	White
A12	Com. Power Supply (5V)	R/W	Red/White
A13	Power Supply (COM.)	R	Red
A14	COM. (mode)	L	Blue
A15	Fuel Feed Pump (FFP) W	B/G	Black/Green
A16	Fuel Feed Pump (FFP) V	B/Y	Black/Yellow
A17	Fuel Feed Pump (FFP) U	B/W	Black/White
A18	#1 Fuel Injector	Lg/R	Light green/Red
A19	#2 Fuel Injector	Lg/B	Light green/Black
A20	I S C Valve	G/R	Green/Red
A21	Tachometer	W	White
A22	Tachometer Lamp (*)	Lg	Light green
A23	T P S	L/W	Blue/White
A24	Engine TEMP Sensor	G/Y	Green/Yellow
A25	T-MAP Sensor (MAT)	G/W	Green/White
A26	Blank		
A27	Ground (sensor)	B/L	Black/Blue
A28	COM. (TxD)	Y	Yellow
A29	Engine Stop Switch	Br	Brown
A30	Oil Pressure Switch	Br/W	Brown/White
A31	Blank		
A32	Blank		
A33	Warning Lamp (LED)	Lg	Light green
A34	Blank		

* P model



①②③④⑤⑥⑦⑧⑨⑩⑪⑫⑬⑭⑮⑯⑰

⑱⑲⑳㉑㉒㉓㉔㉕㉖㉗㉘㉙㉚㉛㉜㉝㉞

ECU A connector

9

Troubleshooting

1.Troubleshooting List

* Low speed ESG operates.

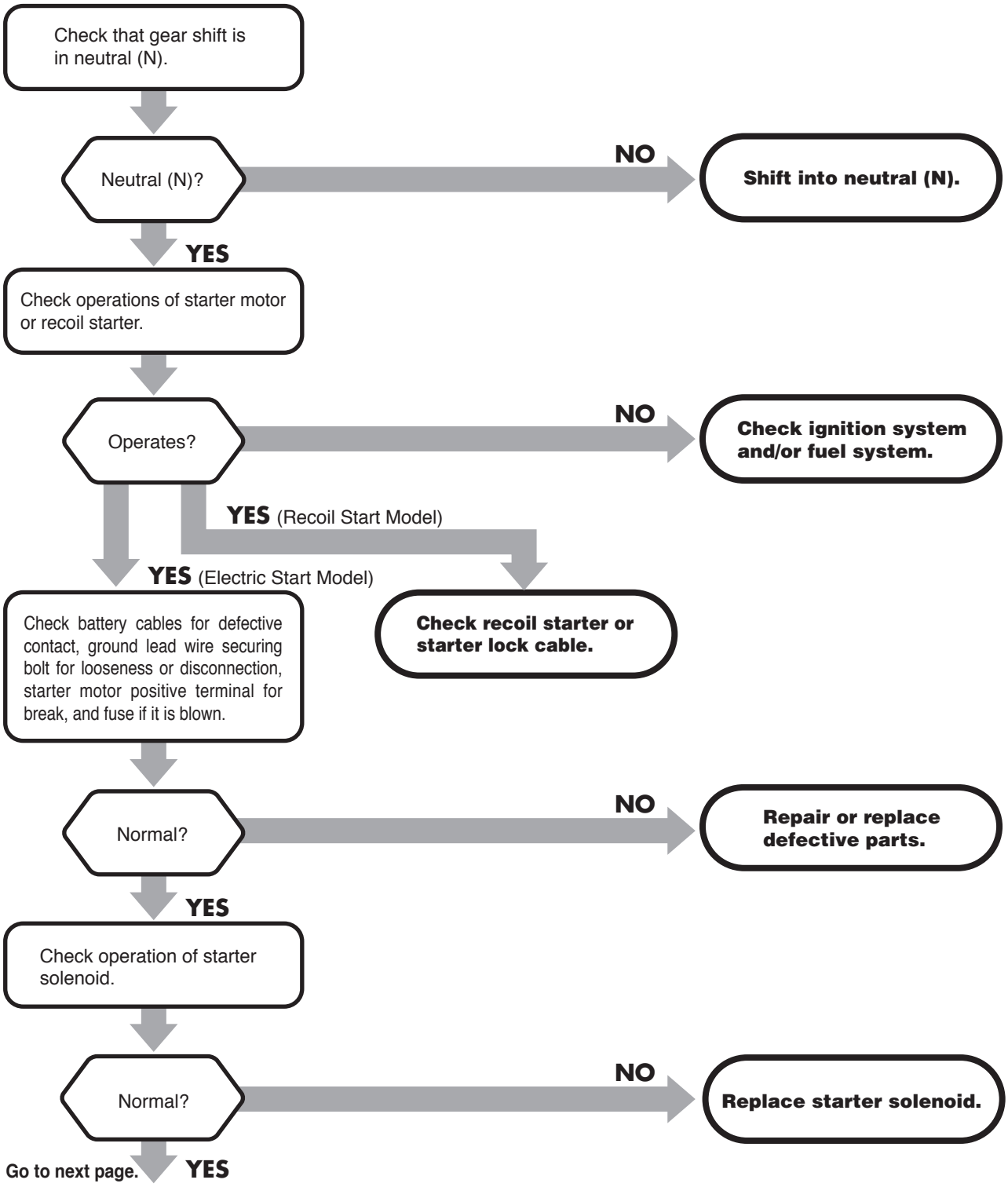
	Engine will not start.	Engine stalls immediately after starting.	Defective idling	Defective acceleration	Engine speed is very high causing high speed ESG to operate.	Engine speed is very low, causing low speed ESG to operate.	Boat cannot run at high speed.	Engine overheats.	Battery is not charging.	Starter motor will not operate.	Power tilt will not operate.	Warning lamp is lit.	Warning lamp blinks.	Probable Cause
Fuel and Lubrication Systems	o	o												Fuel level is low in the tank.
	o	o	o	o		o	o	o						Fuel system connection is incomplete.
	o	o	o	o		o	o	o						Fuel system sucks air.
	o	o	o	o		o	o	o						Fuel pipe is twisted.
	o	o	o	o		o	o	o						Cap vent is closed.
	o	o	o	o		o	o	o						Fuel filter, fuel pump or injector is clogged.
	o		o	o			o	o						Low quality gasoline is used.
	o													Primer bulb is clogged.
	o	o	o	o		o	o	o						Fuel feed pump (FFP) malfunctions or is clogged.
						o*							o*	Engine temparature sensor is defective or the sensor circuit is disconnected.
			o	o		o	o	o						Low quality engine oil is used.
			o	o										Engine oil quantity excessive (Exhaust smoke is generated.)
						o*		o				o*		Engine oil is lacking (Oil pressure switch operates).
						o*		o				o*		Oil filter is clogged (Oil pressure switch operates).
						o*		o				o*		Oil pump is defective (Oil pressure switch operates).
Electrical System	o	o	o	o		o	o	o						Use of spark plugs not specified.
	o	o	o	o		o	o							Spark plug is contaminated.
	o	o	o	o		o	o							No spark or weak spark.
	o													Stop switch short-circuited.
	o													Stop switch lock is not installed.
	o								o	o	o			Defective wiring, ground, wire disconnected or loosened.
	o								o	o	o			Battery charging is defective, or rectifier malfunctions.
	Cell (o)								o	o	o			Battery is dead, connection is loose or corroded. Battery electrolyte level is low.
	o								o	o	o			20A fuse is blown.
	o									o				Shift lever neutral (N) position is not proper position.
	o									o	o			Start switch or main switch is defective.
	o									o				Starter motor or starter solenoid operation is defective.
											o			PT switch or solenoid is defective.
											o			Air is mixed in PT fluid.
Compression System	o	o	o	o			o							Valve timing is not correct (Belt is stretched or installed incorrectly).
	o	o	o	o			o							Valve clearance is defective.
	o	o	o	o			o							Valve seat sealing is defective.
	o	o	o	o			o							Piston, piston ring and/or cylinder is worn excessively.
			o					o						Combustion chamber carbon deposition is too much.
			o	o			o	o						Spark plug is loose.
Others			o			o*	o	o				o*		(Cooling water is lacking.) Pump is defective or clogged.
						o*	o	o				o*		Thermostat operation is defective.
				o	o		o	o				o		Anti-ventilation plate is damaged.
				o	o	o	o	o				o		Use of mismatched propeller.
			o	o	o	o	o	o				o		Propeller is damaged or deformed.
				o	o		o	o				o		Thrust rod position is not correct.
				o	o	o	o	o				o		Boat is unbalanced by load position.
				o	o	o	o	o				o		Transom installation height is too high or too low.
				o		o	o							Throttle link adjustment is defective.

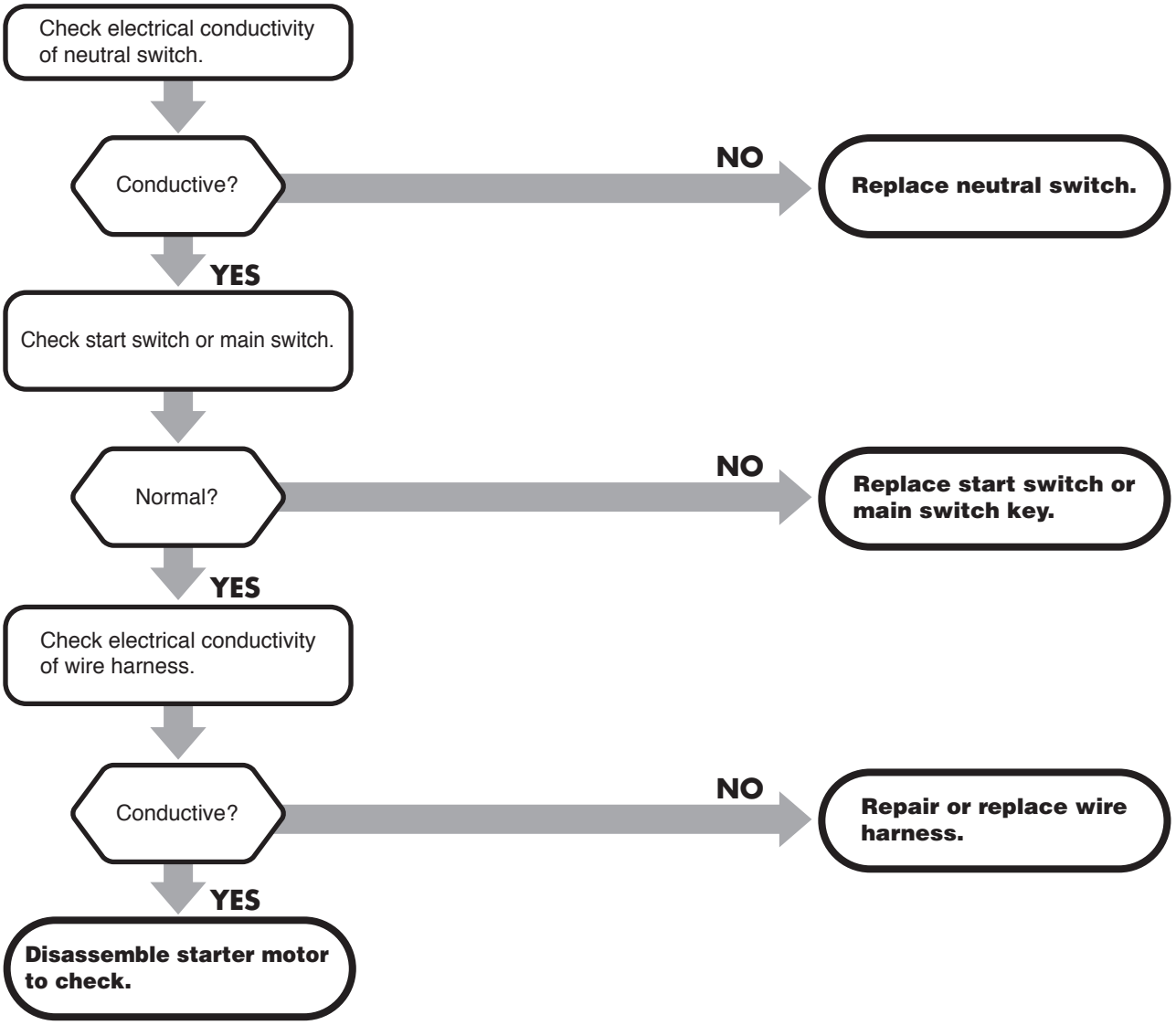
Before working on the engine check that full rigging and engine installation are normal and battery is fully charged. For mechanical troubleshooting, refer to relevant troubleshooting section in this chapter. For checking and servicing outboard motor, refer to service procedures described in this manual to perform the work safely.

Power Unit

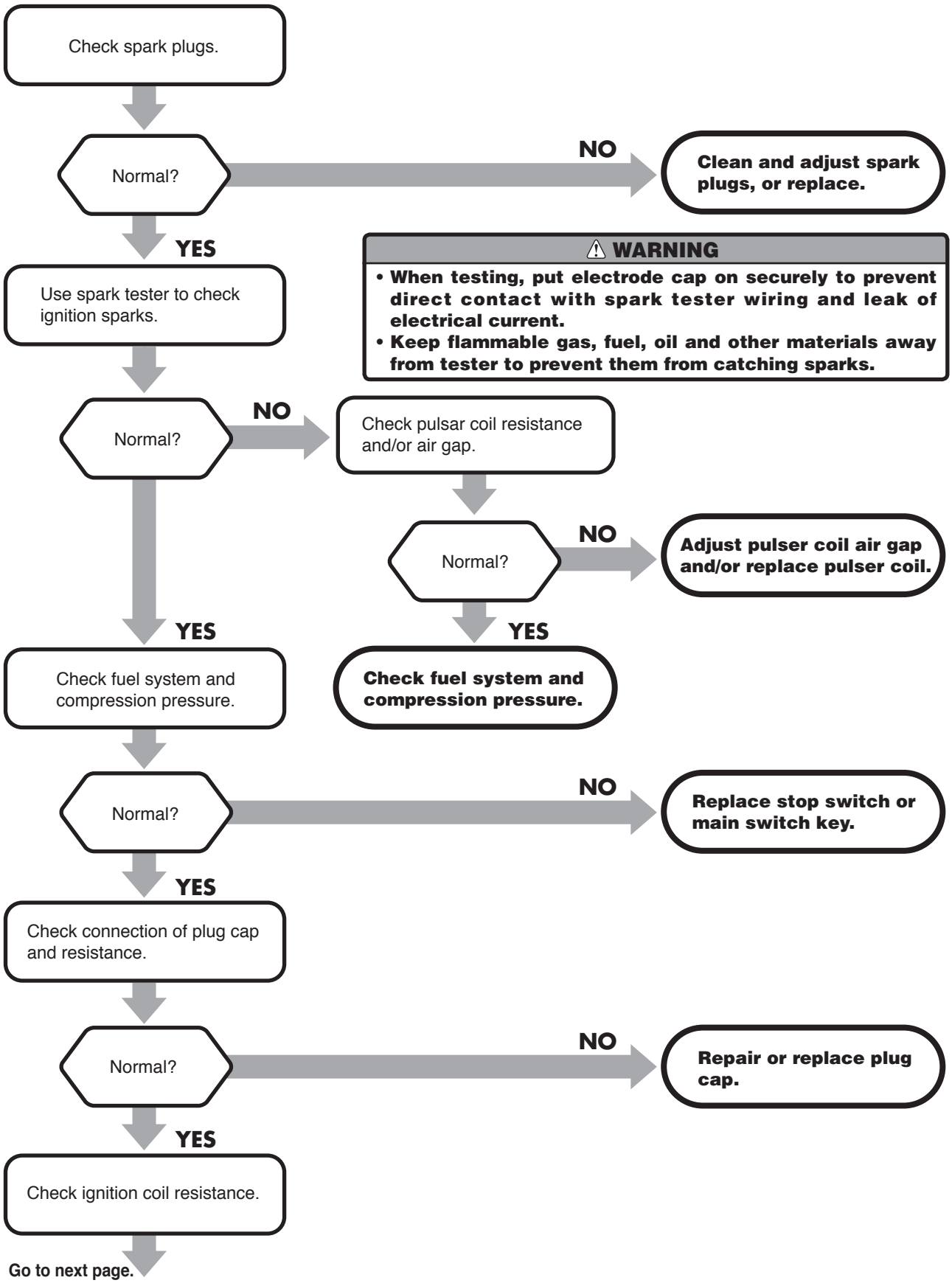
State 1 **Engine will not start or is hard to start.**

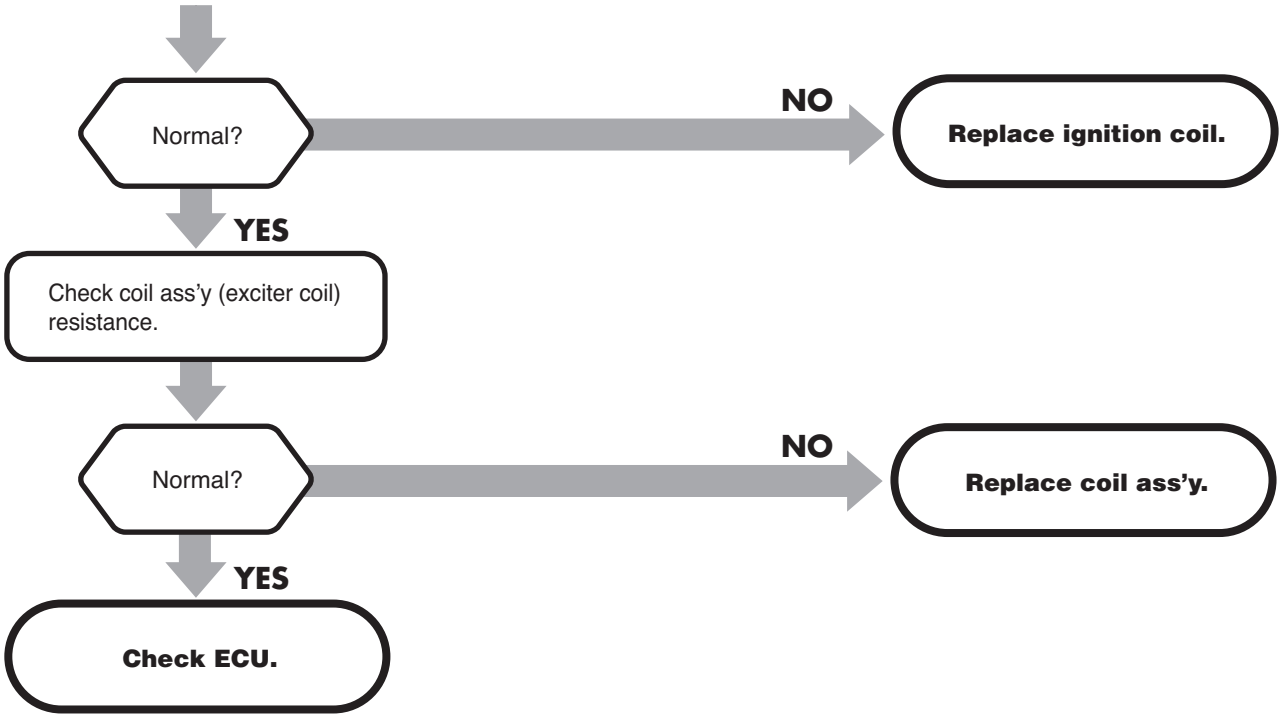
Starting System

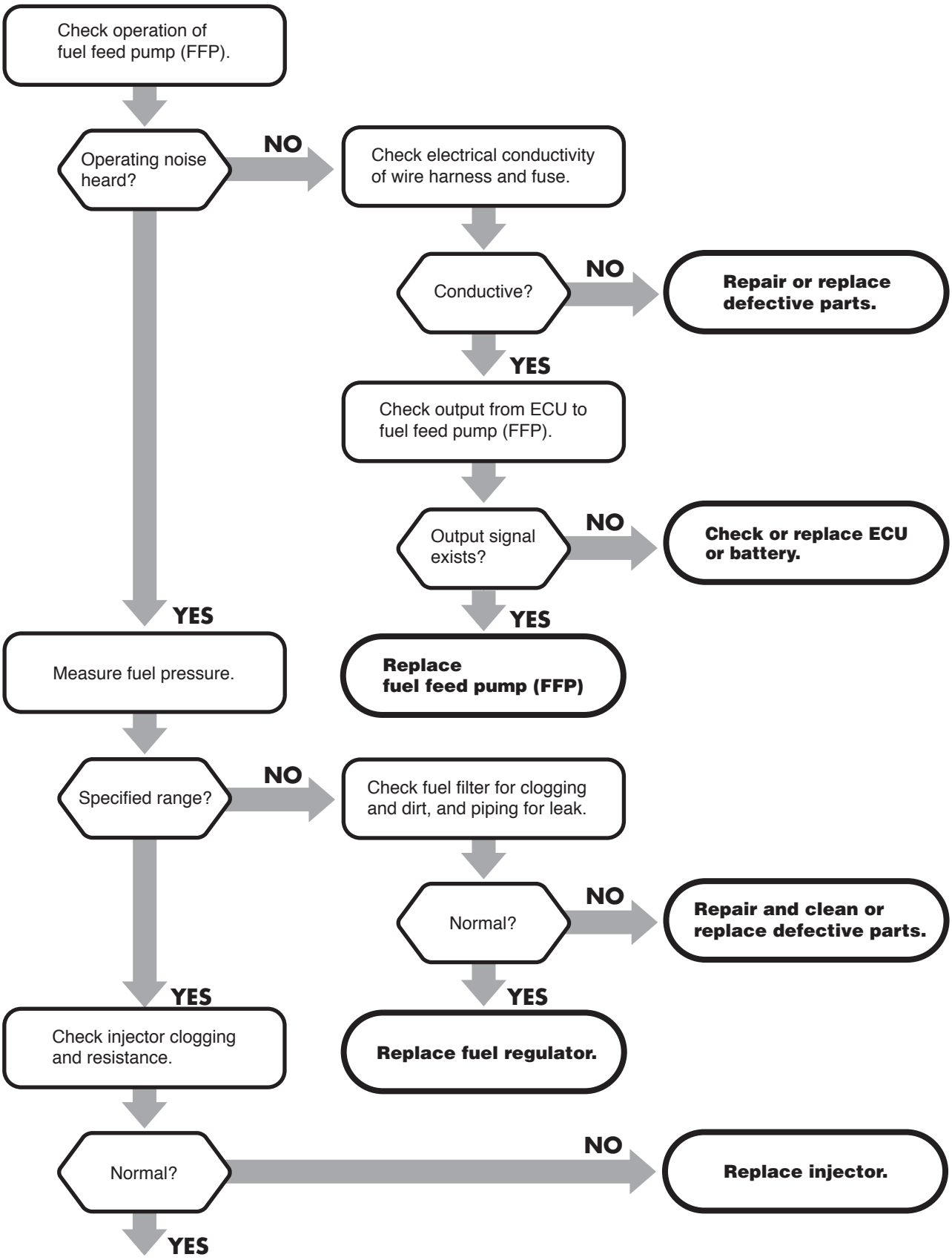



Check electrical conductivity of neutral switch.
Conductive?
NO
Replace neutral switch.
YES
Check start switch or main switch.
Normal?
NO
Replace start switch or main switch key.
YES
Check electrical conductivity of wire harness.
Conductive?
NO
Repair or replace wire harness.
YES
Disassemble starter motor to check.

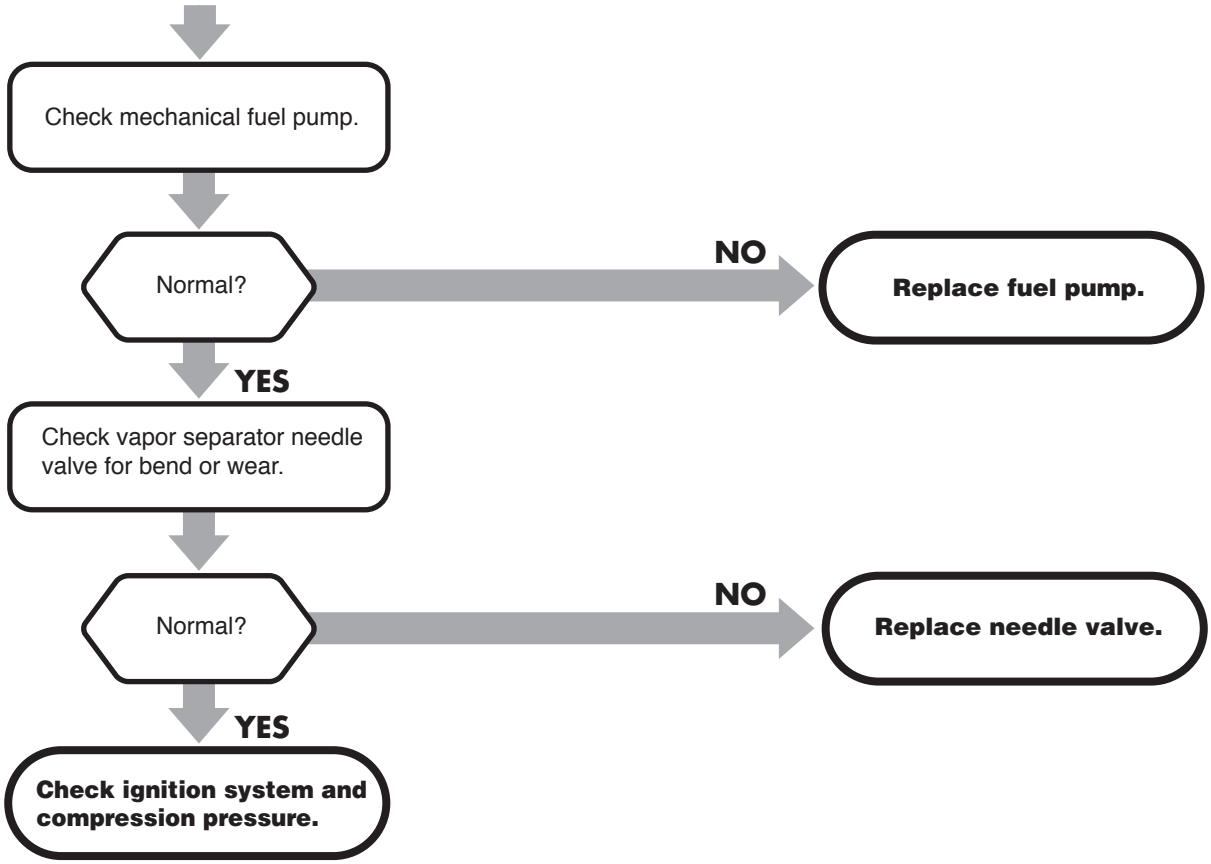
Ignition System



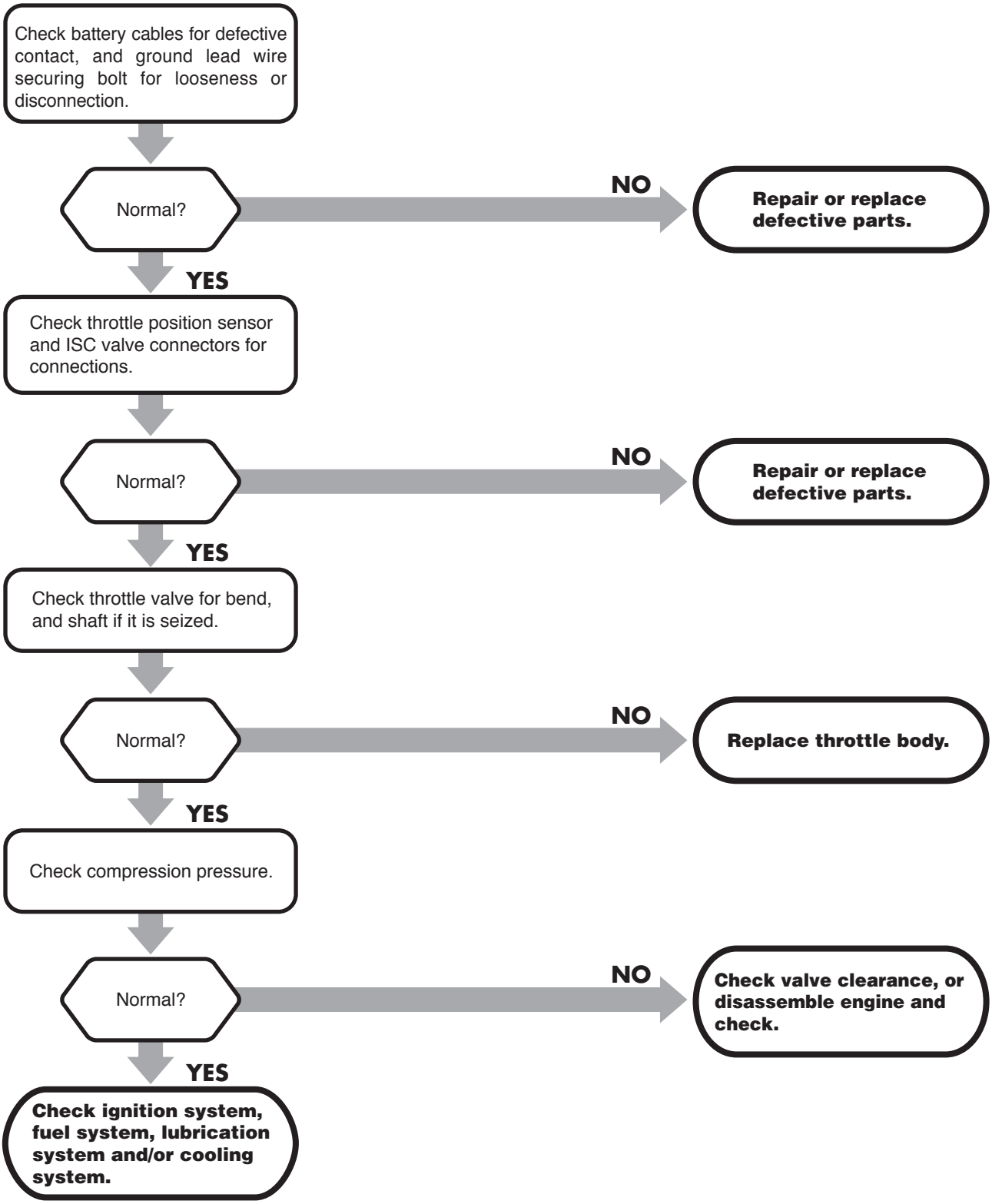

Normal?
NO
Replace ignition coil.
YES
Check coil ass'y (exciter coil) resistance.
Normal?
NO
Replace coil ass'y.
YES
Check ECU.



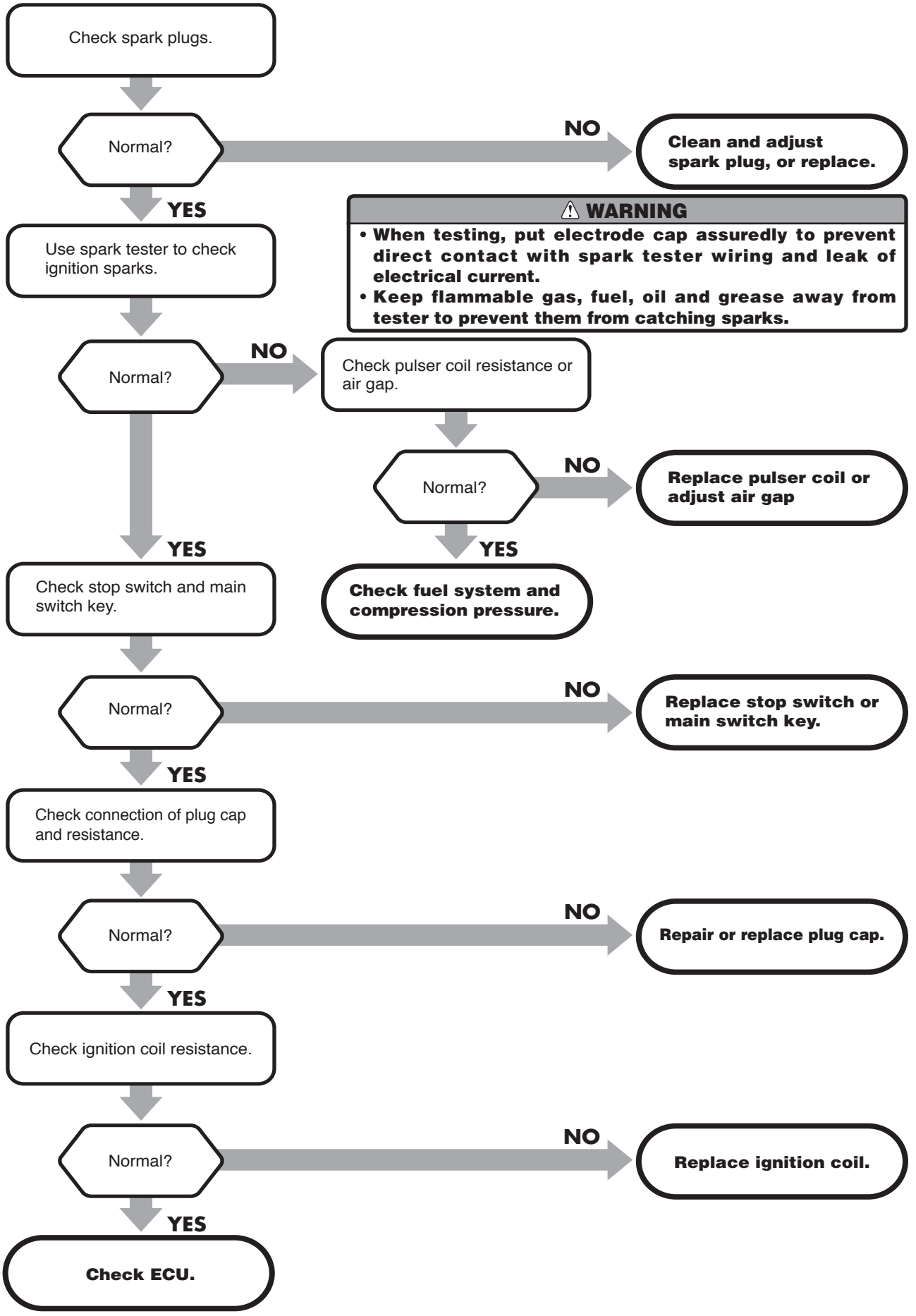
Go to next page.


Check mechanical fuel pump.
Normal?
NO
Replace fuel pump.
YES
Check vapor separator needle valve for bend or wear.
Normal?
NO
Replace needle valve.
YES
Check ignition system and compression pressure.

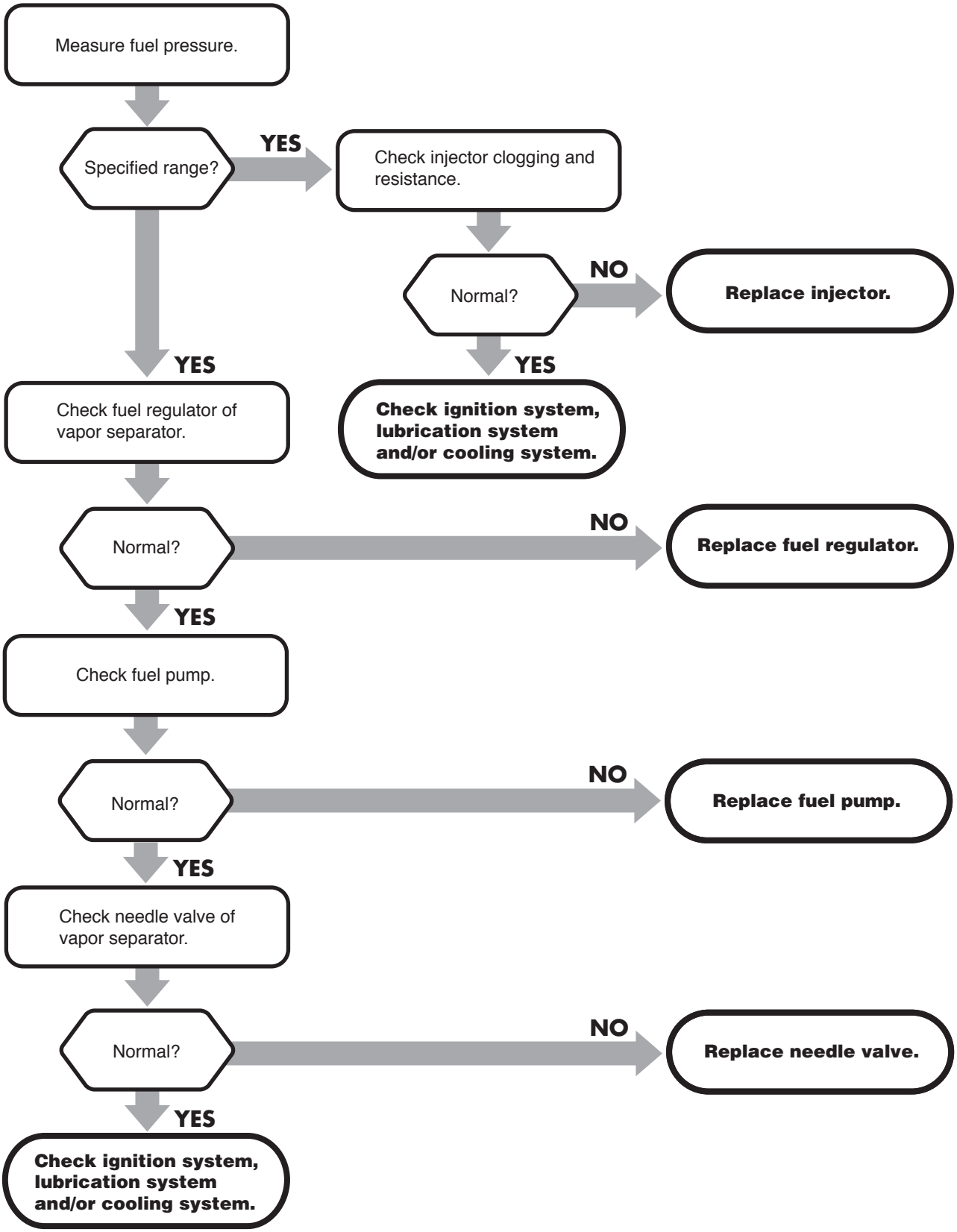
State 2 Full throttle engine revolution speed is low. Engine revolution speed fall off. Engine stalls. (Defective acceleration or deceleration)



Ignition System



Fuel System



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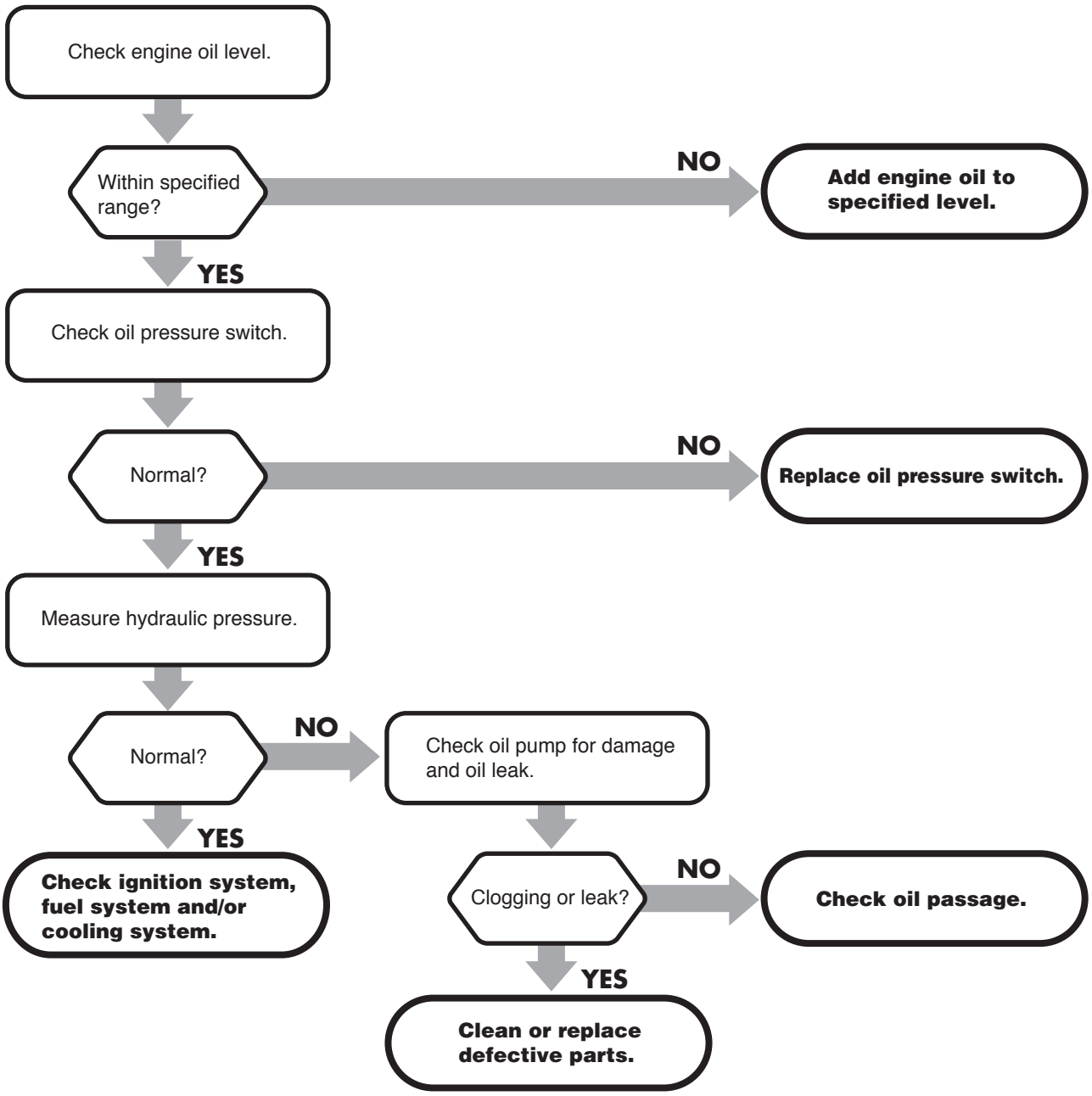
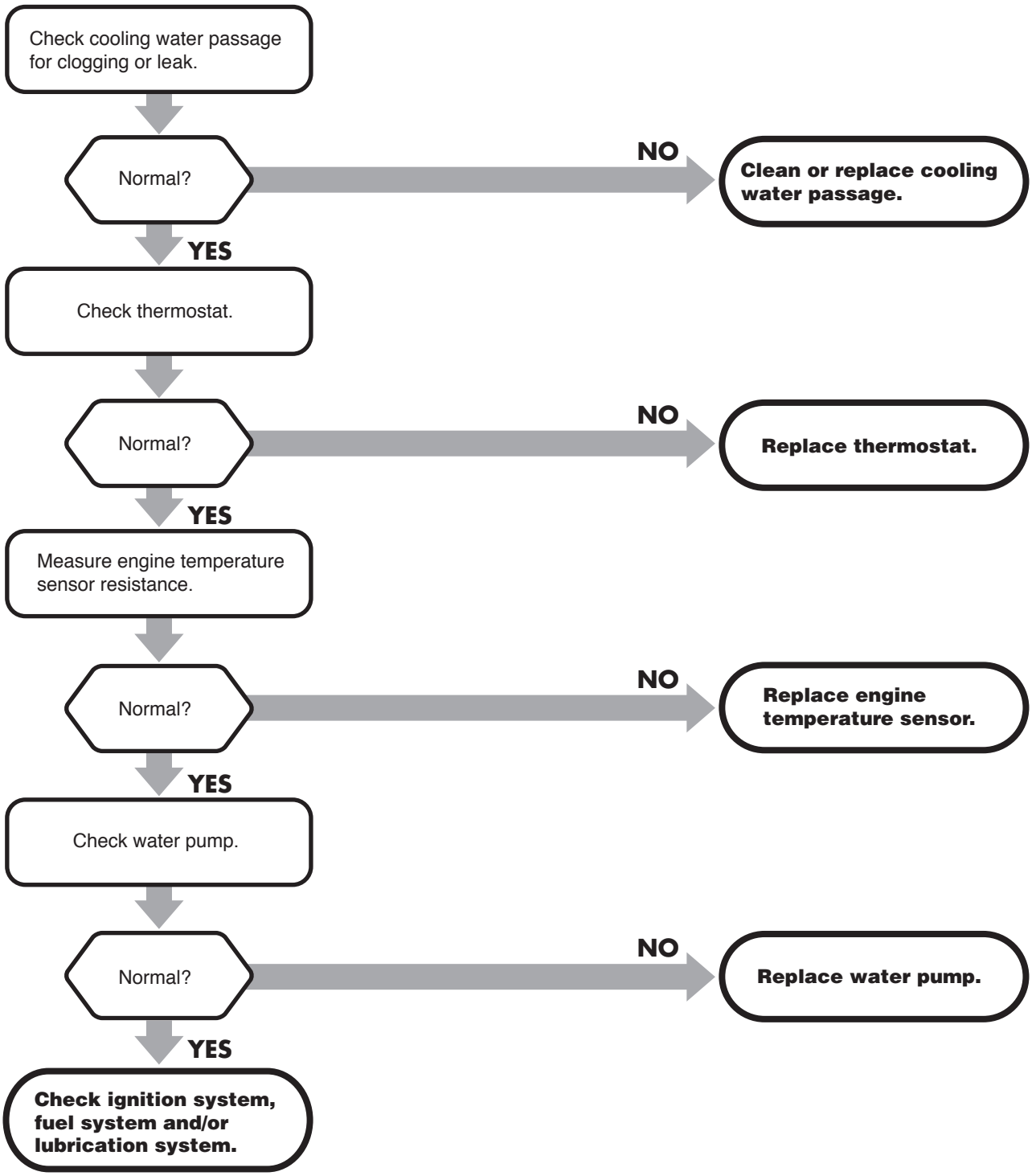
Lubrication System

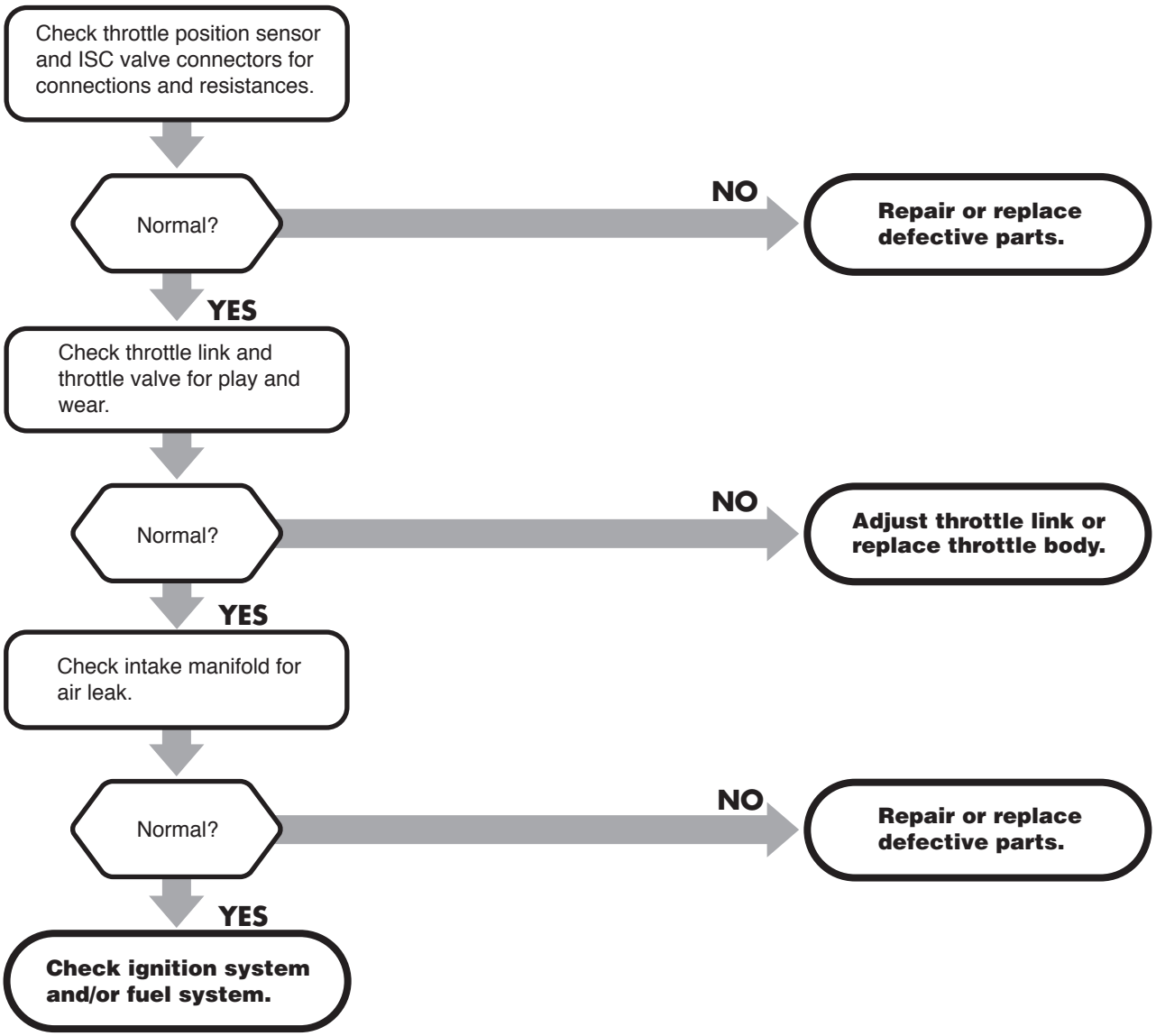


Cooling System

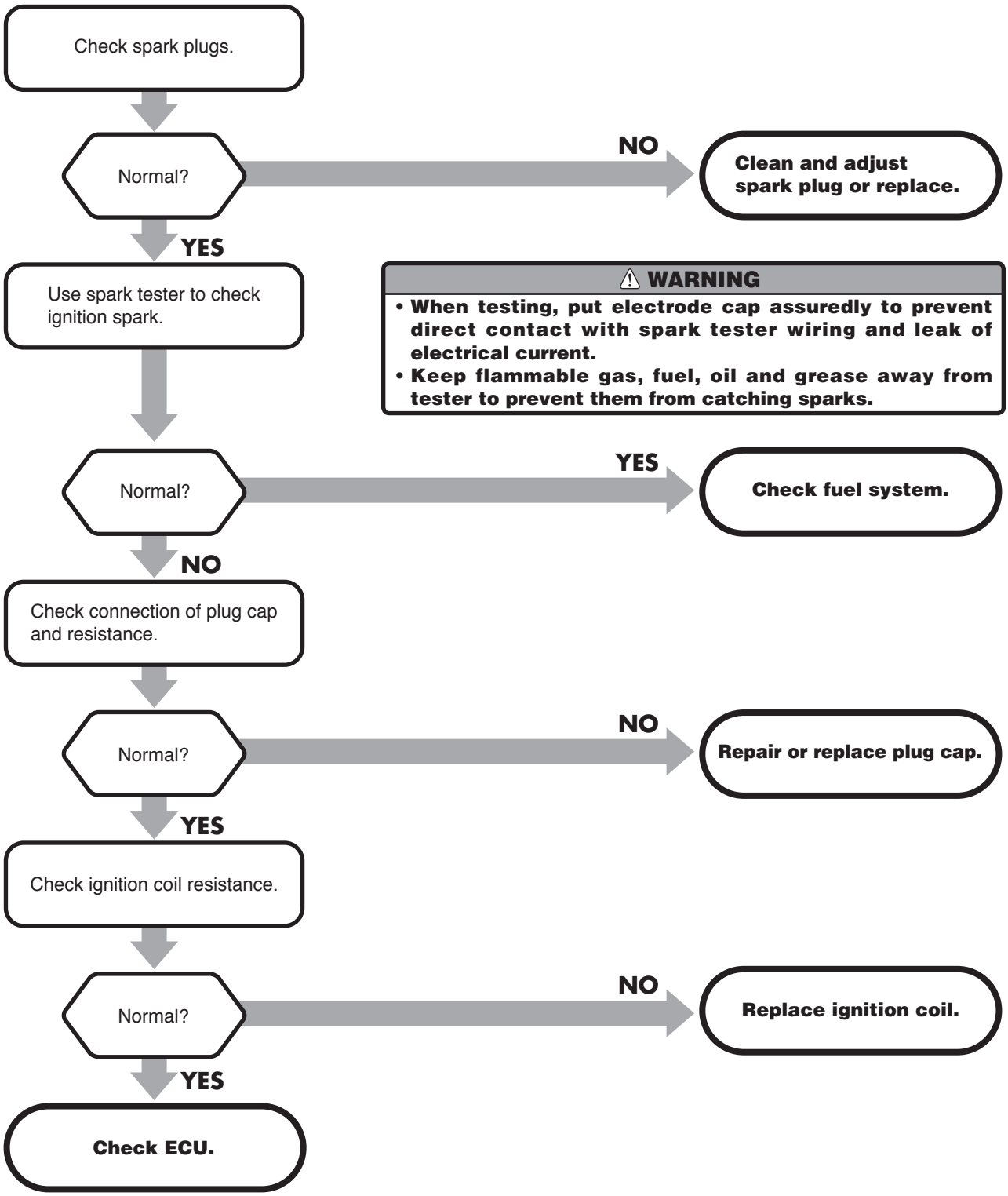


9

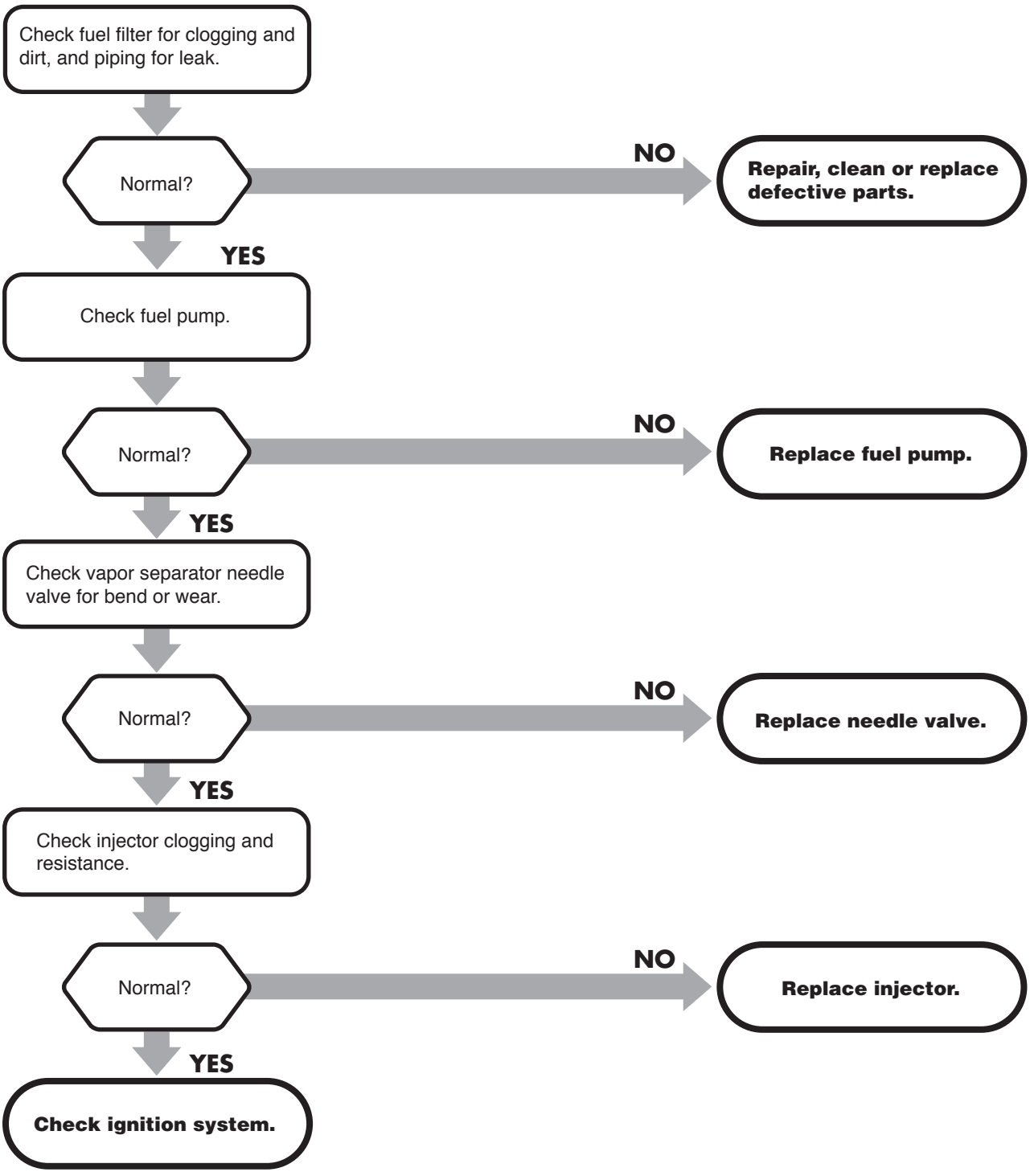
State 3 **Engine rotation is unstable or hunting occurs in low speed range.**



Ignition System

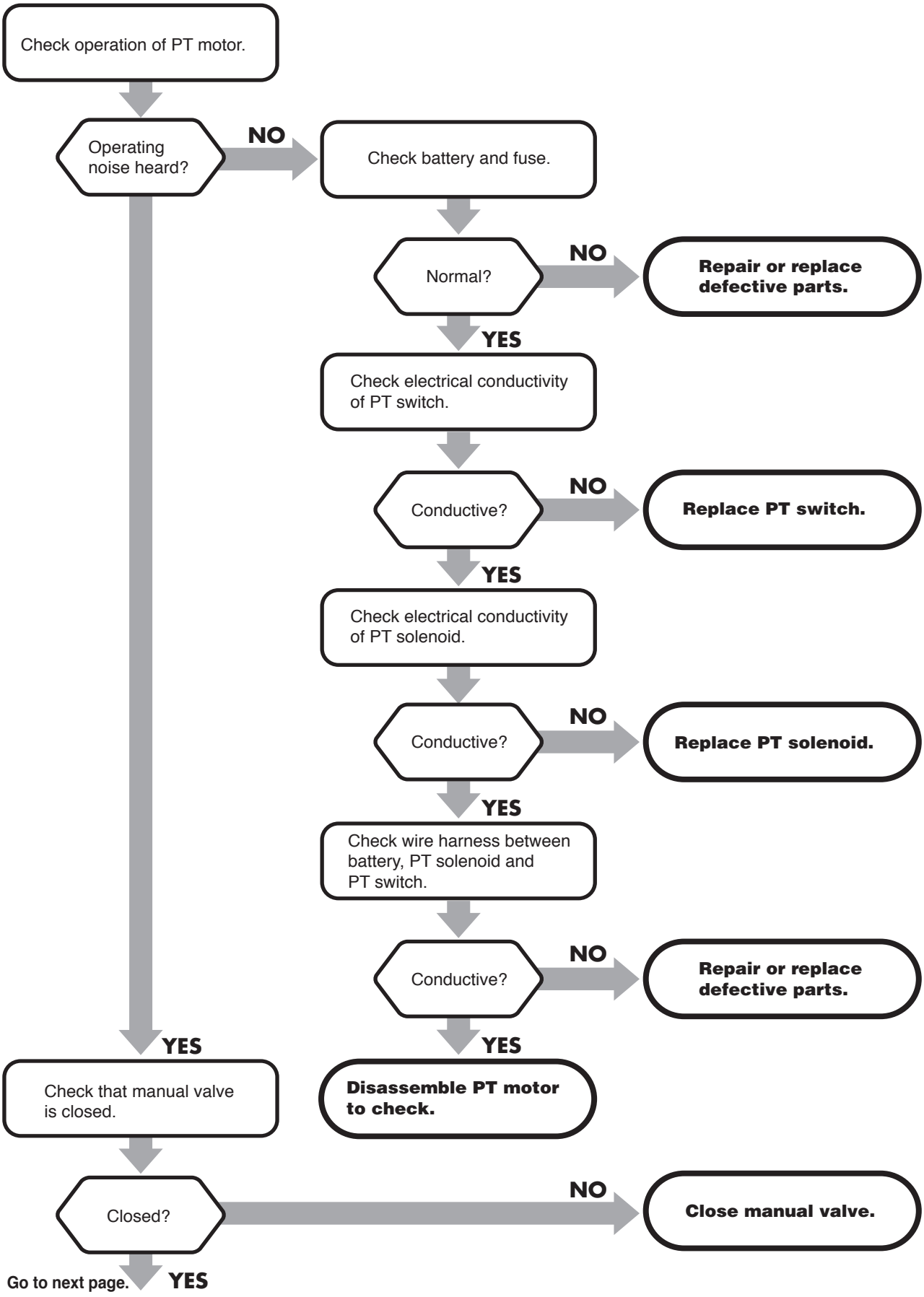


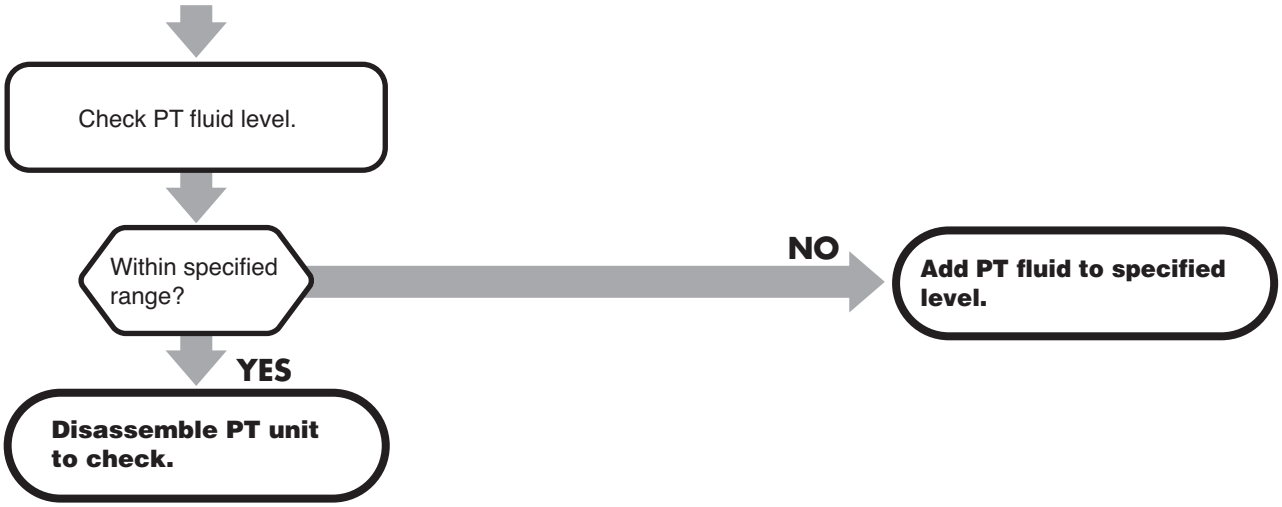
Fuel System


Check fuel filter for clogging and dirt, and piping for leak.
Normal?
NO
Repair, clean or replace defective parts.
YES
Check fuel pump.
Normal?
NO
Replace fuel pump.
YES
Check vapor separator needle valve for bend or wear.
Normal?
NO
Replace needle valve.
YES
Check injector clogging and resistance.
Normal?
NO
Replace injector.
YES
Check ignition system.

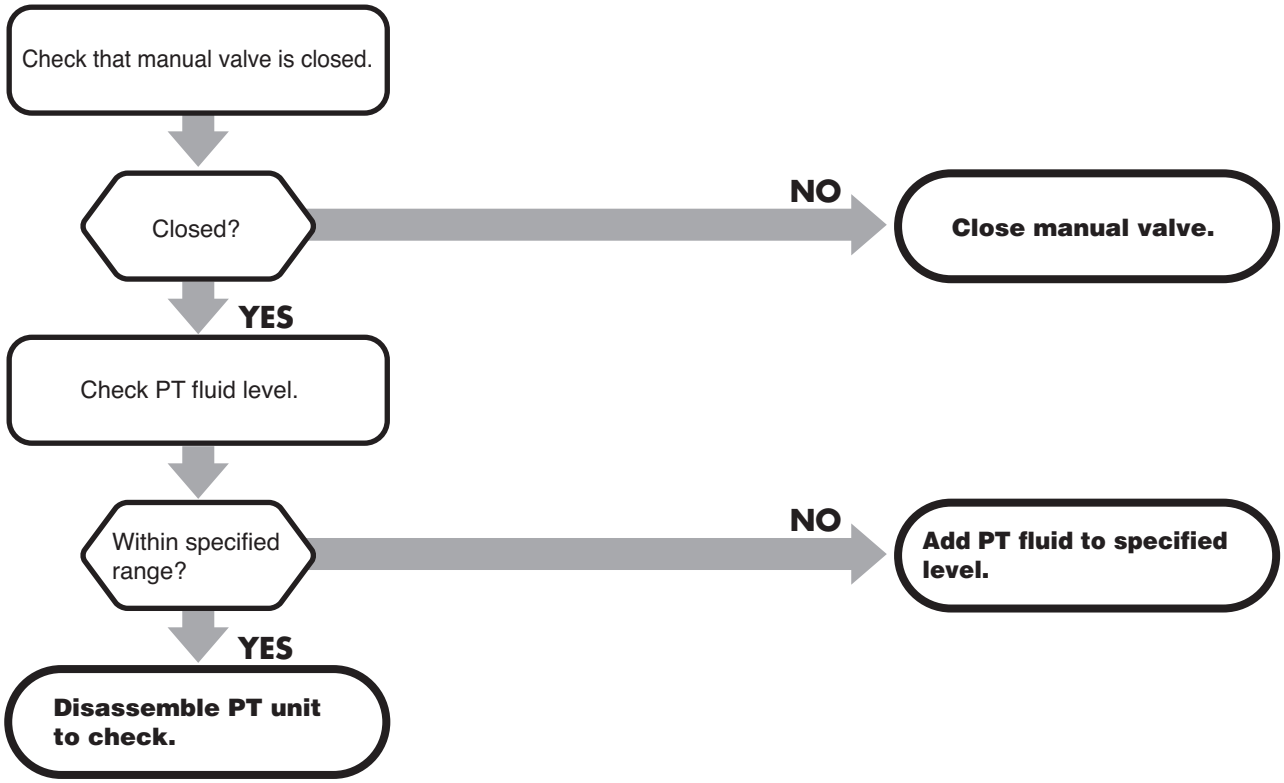
PT Unit

State 1 **PT unit will not operate.**





State 2 **PT is not capable of sustaining outboard motor.**



Diagnosis

⚠ WARNING

- **Before using Diagnosis Tool, read notes described in this chapter.**
- **Do not use Diagnosis Tool while operating boat.**

⚠ WARNING

Be careful not to expose computer and cables to water spray.

1. Set Up

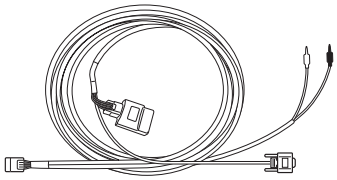
Read this manual thoroughly, connect diagnosis cable to computer, and then, perform software operations.

- Check that computer is normal.
- Fully charge battery (12 V or more).
- Clean battery terminal to remove dirt and corrosion, and connect battery cables securely.
- Check diagnosis cable and other cables for connection.
- Shift gear into neutral (N).

Applicable Models

Diagnosis is applicable to the following models. (Special cable can be use for each model.)

- **MFS9.9/15/20E**
- **MFS25/30**
- **MFS40/50**



Diagnosis Tool Kit
P/N. 3RS-72920-0

Used to engine diagnosis

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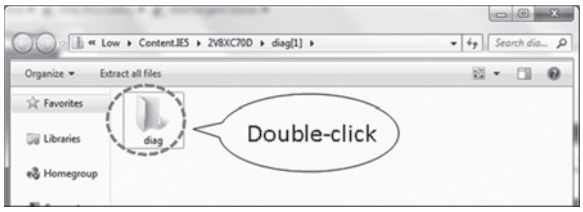
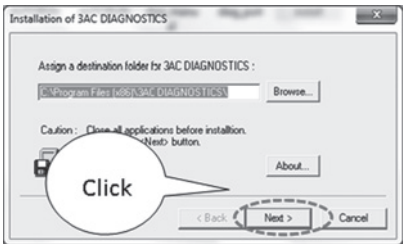
1) Diagnosis Software Install

1. After entering the dealer-only page, then click the download of diagnostic software.

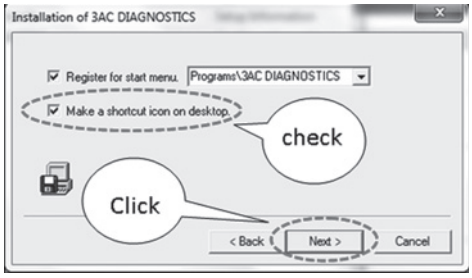


2. Double-click the "diag".

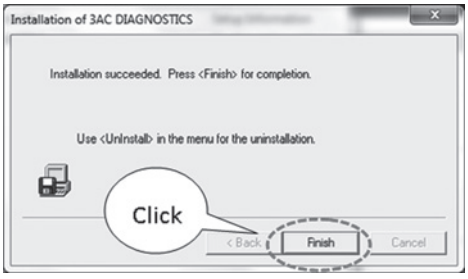
3. Double-click the "install".



4. Click "Next".



5. Click "Next" put a check in "to create a shortcut to Desktop."



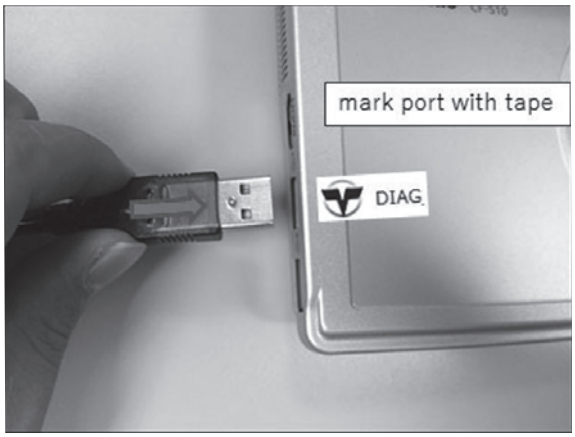
6. Shortcut of diagnostic software is created on the desktop by clicking the "Finish".

7 Double-click the shortcut of Desktop, activate the diagnostic software.

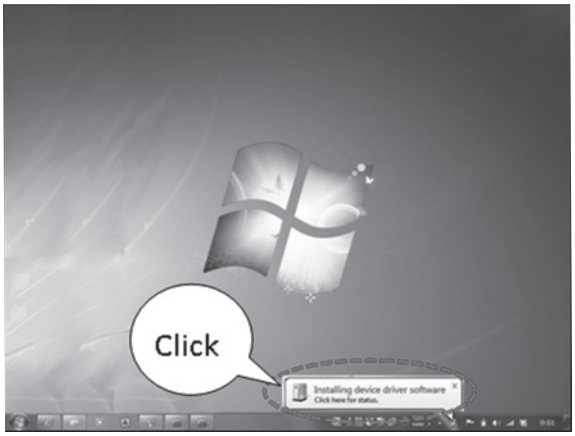
2) Installing USB to serial converter driver (If there is no RS232 port)

The manufacture of the serial converter will provide instructions for that serial converter and may vary depending on the computer being used.

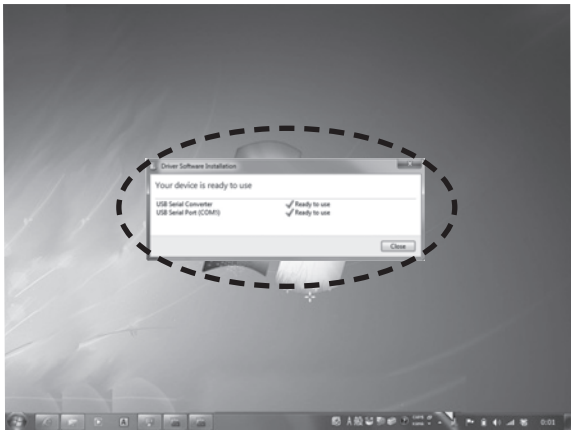
The following is an example, for a detailed procedure of converter installation refer to the instruction manual of converter being used.



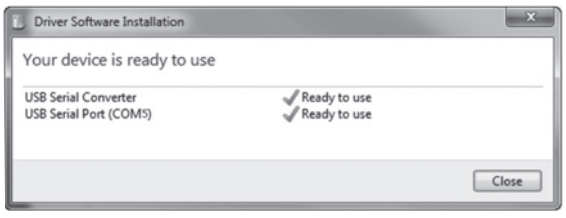
1. Connect serial adapter to USB port (It should be marked on the USB port which port connects for easier future use).
2. Click, explanatory text that appears in lower.



3. Window appears, the drivers will automatically set.



4. Note the infomation of COM ports required for diagnostic software when connected.



If the window does not appear, then (refer to "Checking the COM port" of diagnostic software within) check the COM port from the "Device Manager".

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2.Diagnosis Software Connection

⚠ CAUTION

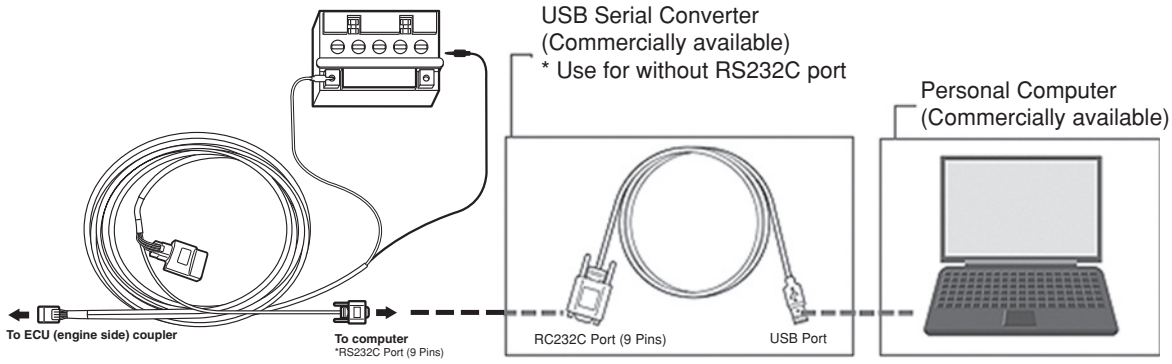
- **Disconnect battery cable for diagnostic tool, then connect diagnostic tool cable to power unit.**
- **Be sure disconnect battery cable for diagnostic tool, otherwise may cause damege to sensors and electronic components.**

1) Preparation

Diagnosis Harness

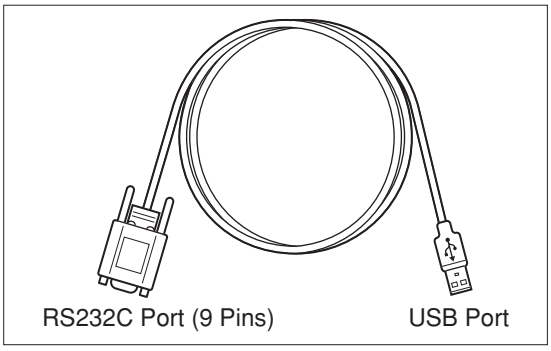
Battery (12V)

Computer



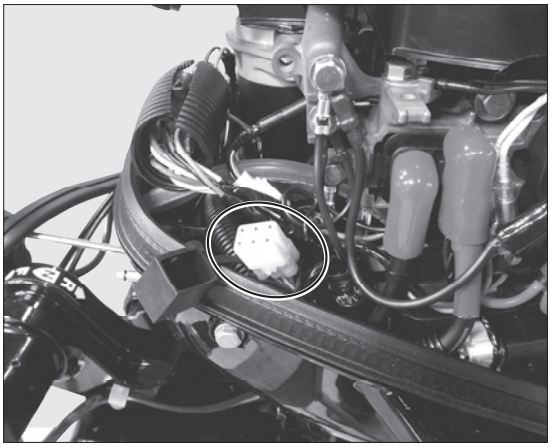
If your computer is not provided with RS232C Port (9 Pins), use USB conversion cable as shown.

- When using USB conversion cable, install necessary software in accordance with the instructions, and then proceed to next operation.
- USB cable operates only on OS of Windows 98 and after. (It will not operate on Windows 95.)



DIAGNOSIS connection point (engine)

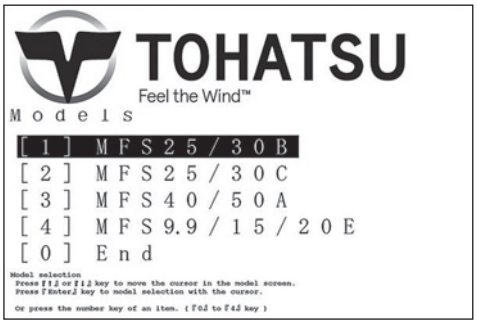
- Connect to connector as right illustration.



3.Operating Procedure

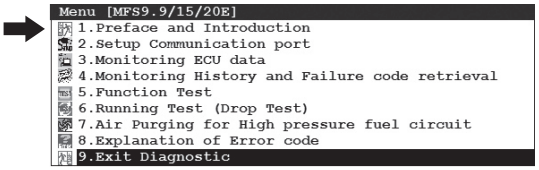
1) Start Up

Double-click "3AC_DIAGNOSTICS" in "PROGRAM" or its short-cut icon. Model selection appears.



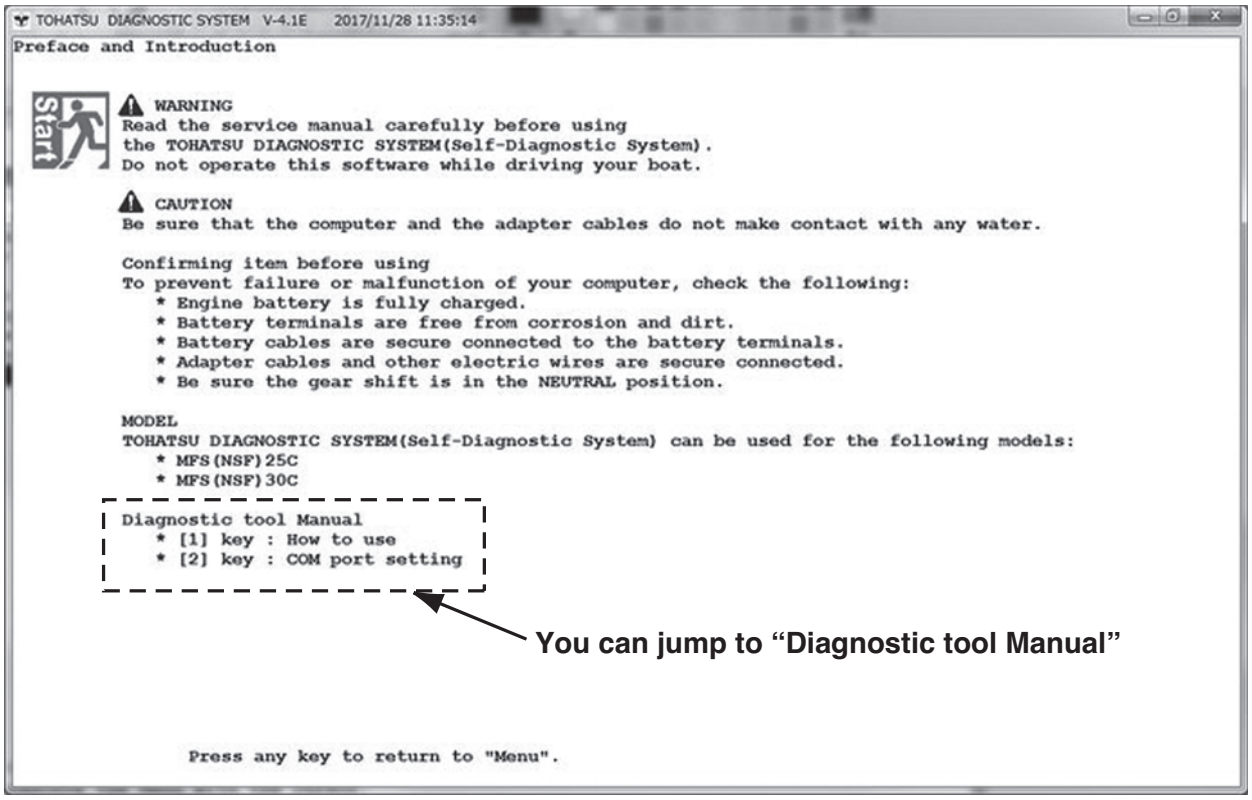
2) Models and Menu Selection

Use " ↑ " or " ↓ " key on the keyboard or press the "1" to "9" number to move cursor to list to be executed, and press "Enter" key.



3) Preface and Introduction

Thoroughly read notes described in "Set Up" section of Chapter 9 before operation.



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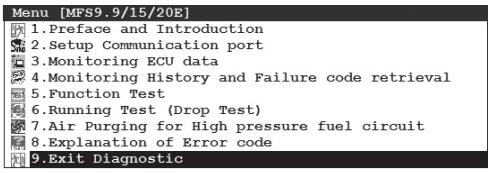
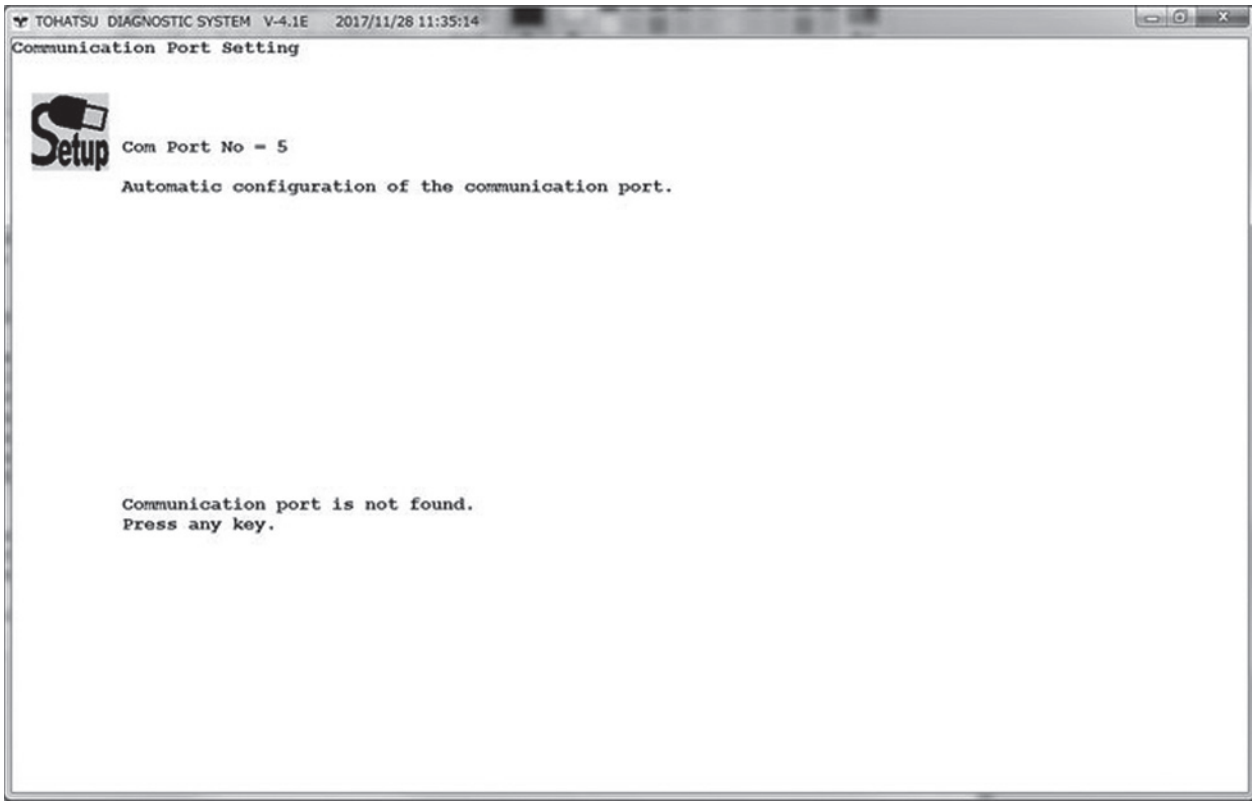
4) Setting Communication (COM) Port



- COM port of the following "5" in the automatic is assigned.
- COM port of 5 or less is used when all the diagnostic cable is not connected switches to manual setup screen (next page).

* it is necessary to turn ON the engine key.



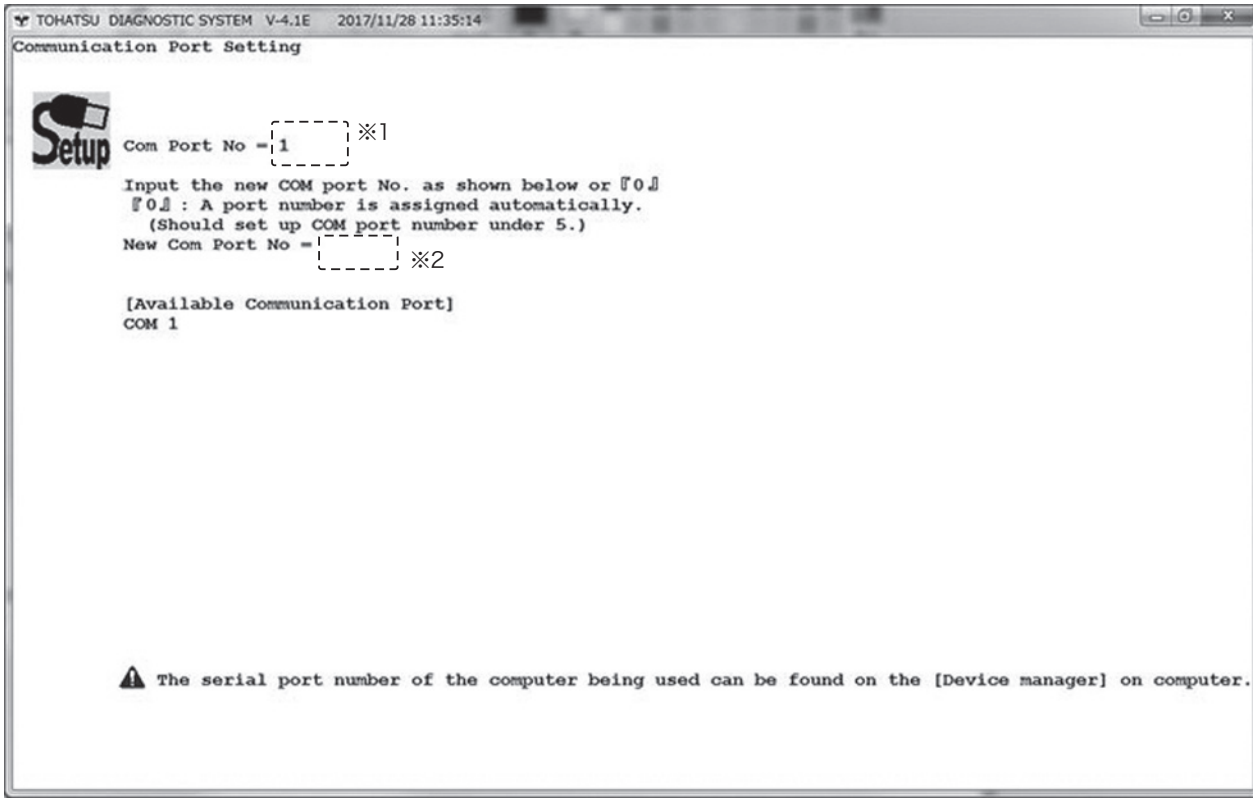
"Com port No = ☐ "
Current COM port number appears.

"New Com Port No = ☐ "
New COM port number can be input.

Input COM port number of your computer.

Press "Enter" key to return to "Menu" screen.

- Current COM port number can be known by going through "Control Panel" → "Hardware" → "Device Manager".
- Only one of numbers "1" to "5" can be input to COM port.
- If COM port number of USB port of computer on which USB adapter is used is one of numbers aborve "6", change it to a vacant COM port of one of numbers from "1" to "5", and set new COM port number.



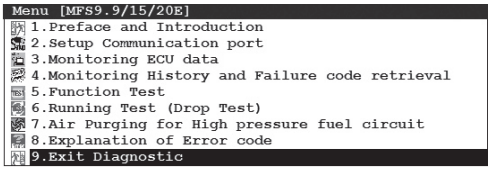
*1 Current COM port number

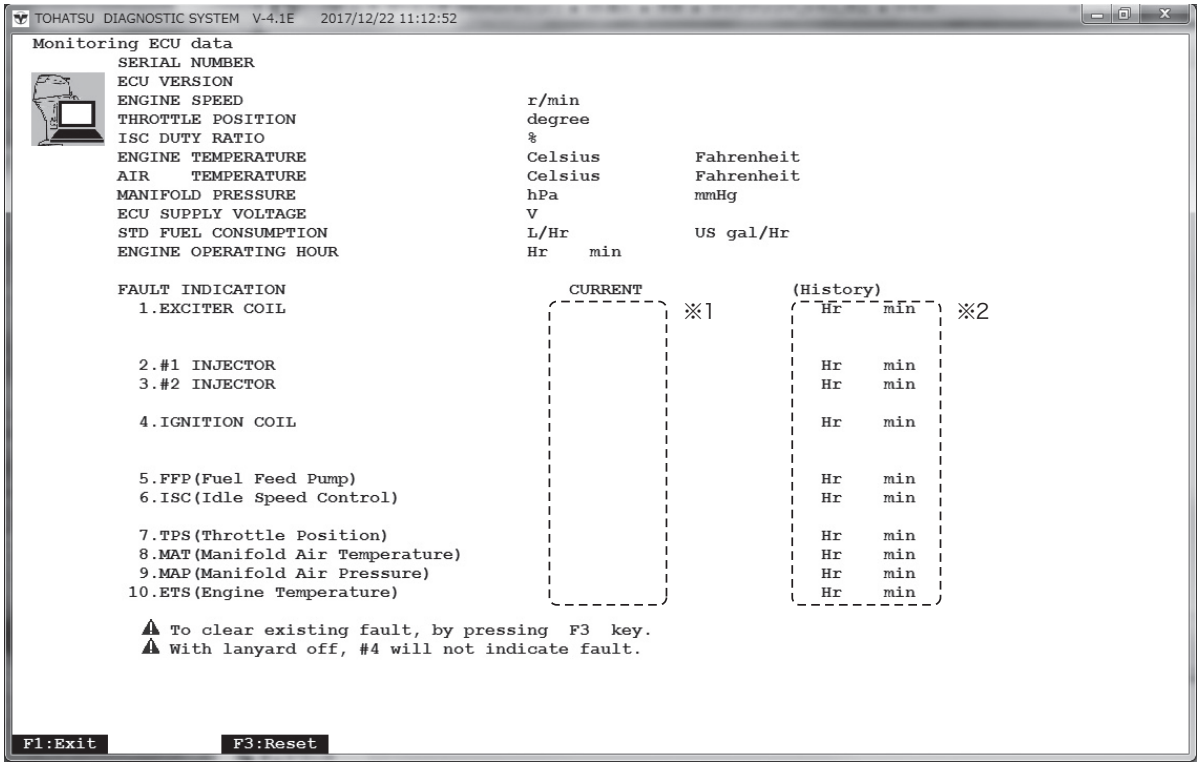
*2 Enter the COM port number to use. Refer to "setting - the diagnostic tool manual ~ COM port".

5) Engine Monitor

Current status of engine can be seen on the screen.

Press "F1" key to return to "Menu" screen.



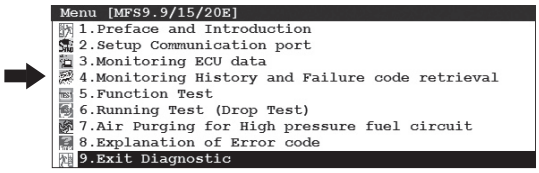


*1 Currently, it is displayed as "failure" if the problem has occurred.

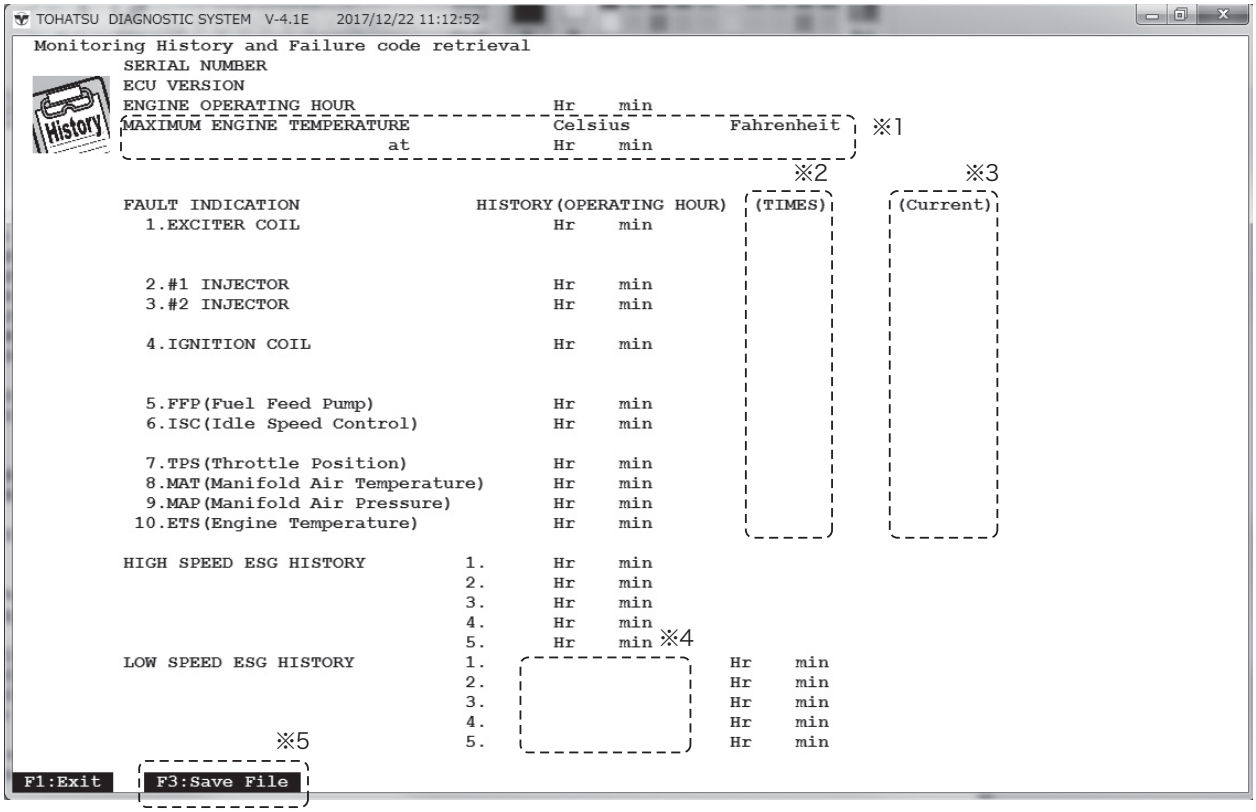
*2 If there is a problem in the past it indicates the time at which the failure occurred at the end.

6) Diagnostic History

Malfunction history of engine can be seen on the screen.



Press "F1" key to return to "Menu" screen.



*1 Engine temperature shows highest recorded temperature and at what time it occurred.

*2 Number of times that failure occurred.

*3 Problem is active failure.

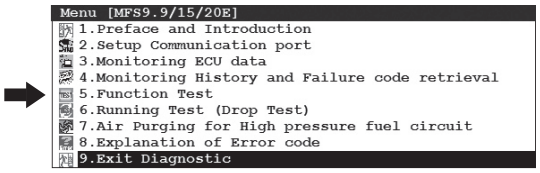
*4 Last 5 slow ESG occurrences are recorded and which sensor was activated. (example: oil pressure switch)

*5 Screen shot can be saved by pressing the F3.

9

7) At Engine Shut-down Test

Malfunction of injectors or their operating state can be checked.



Enter the number of item to be checked.

"1" : Operation (on/off) of #1 injector

"2" : Operation (on/off) of #2 injector

"3" : Operation (on/off) of ISC valve

"4" : Operation (on/off) of fuel feed pump (FFP).

"5" : Operation of warning buzzer

"6" : Lighting of warning lamp

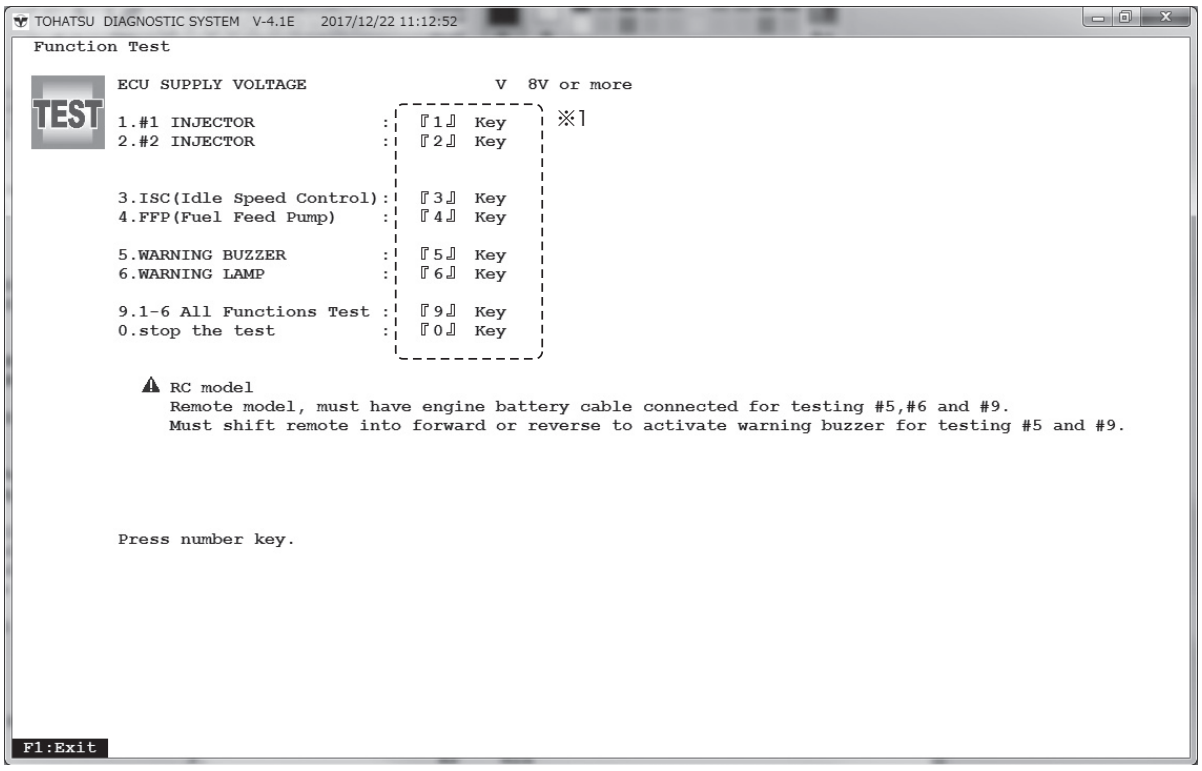
Tiller Handle Model : Warning lamp (LED) on the front panel.

Remote control model : Warning lamp (oil) on the tachometer (if equipped).

"9" : "1" to "7" of all item to be checked.

"0" : Cancelling

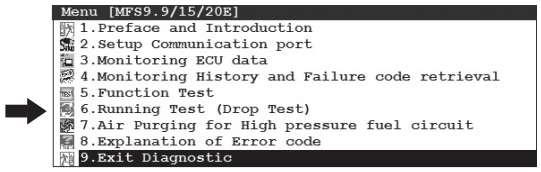
Press "F1" key to return to "Menu" screen.



*1 Press the key of each component, normal decision to check the operation function.

8) At Engine Running Test

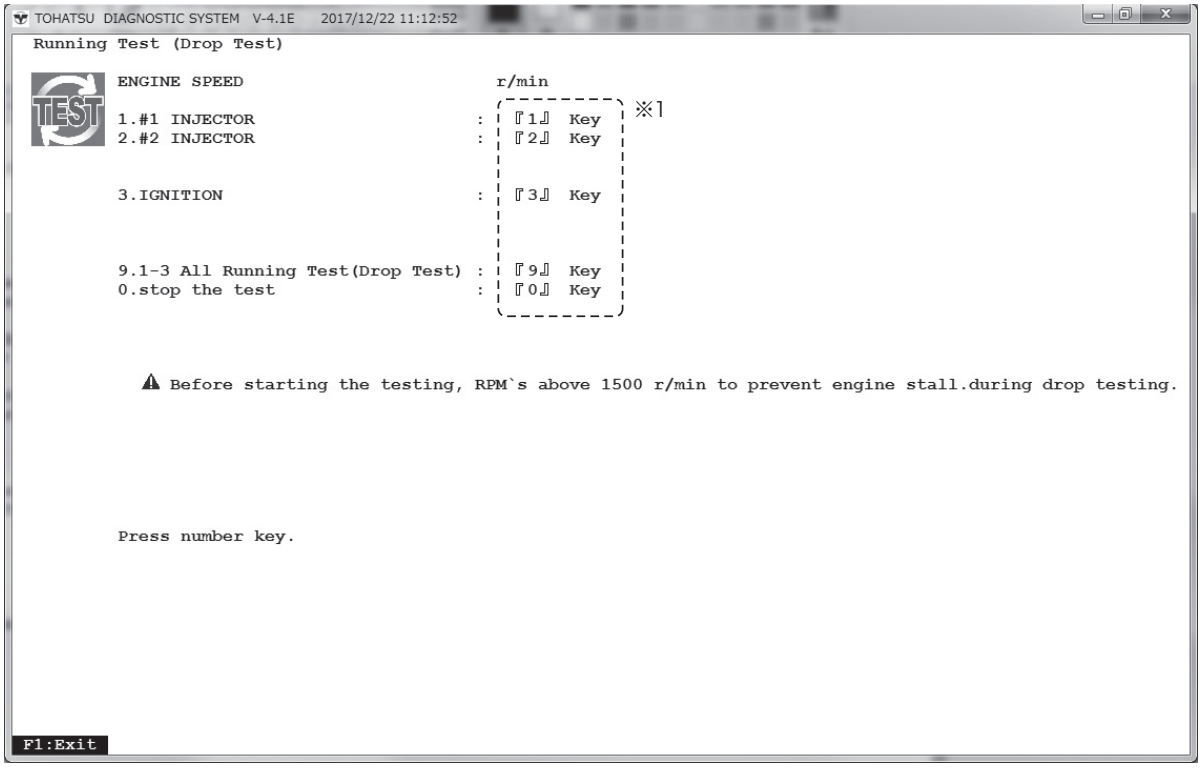
This test stops operation injector or ignition coil temporarily during engine operation for checking operating state according to reduction or operating noise level and engine speed.



Enter the number of item to be diagnosed.
"1" : Temporary stop of #1 injector
"2" : Temporary stop of #2 injector
"3" : Temporary stop of "1" ignition coil

"9" : "1" to "6" of all item to be checked.
"0" : Cancelling

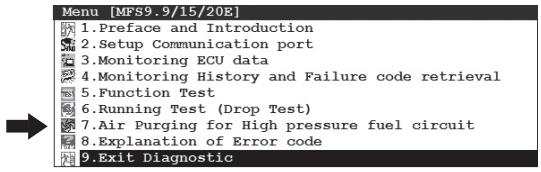
Press "F1" key to return to "Menu" screen.



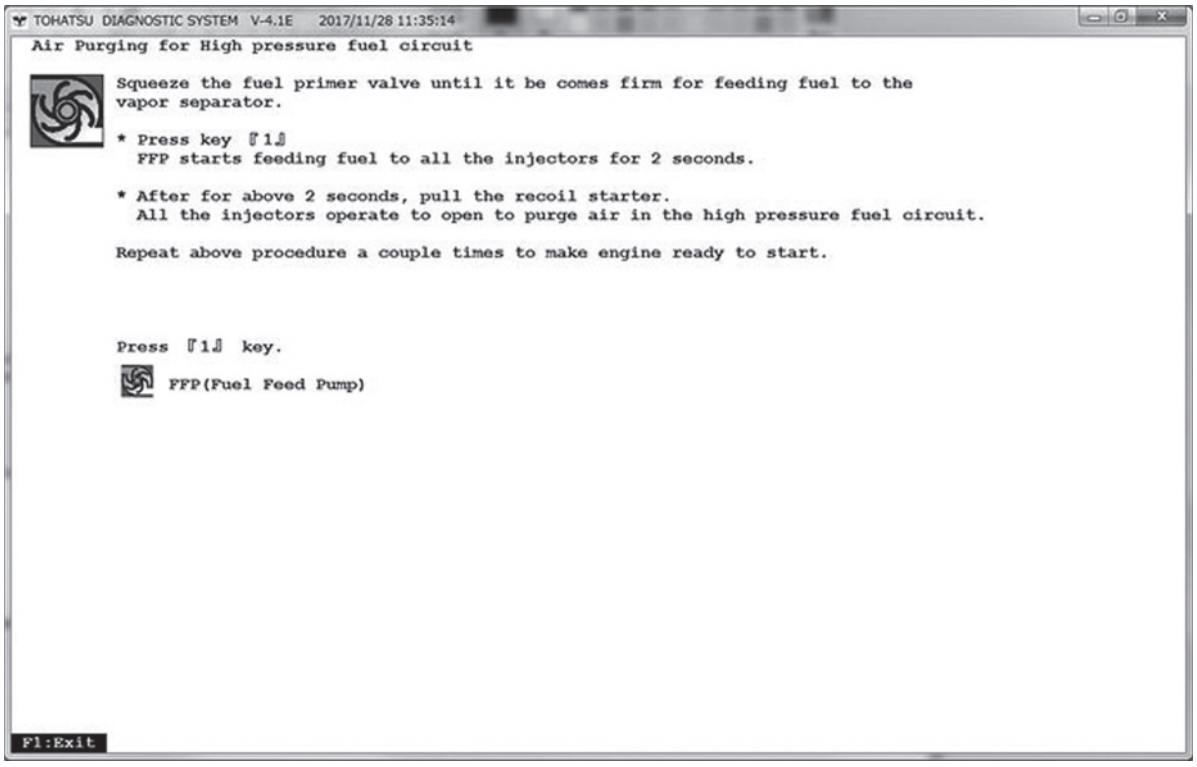
*1 Press the key of each component, the operation of the component will be temporarily interrupted. To check the operating condition from the change in RPM and sound when stopping the operation of each component.
(Stop #1 injector operation, the engine speed decreased. → # 1 injector was operating normally.)

9) Air Purging for High Pressure fuel circuit

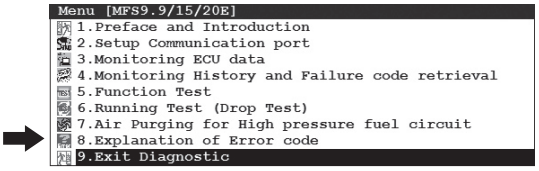
When operating a new engine or a long-term storage engine, electromagnetic FFP is operated to fill the fuel line with fuel



Press "F1" key to return to "Menu" screen.



10) Explanation of Error code



Description of error code appears on the screen.

Example :

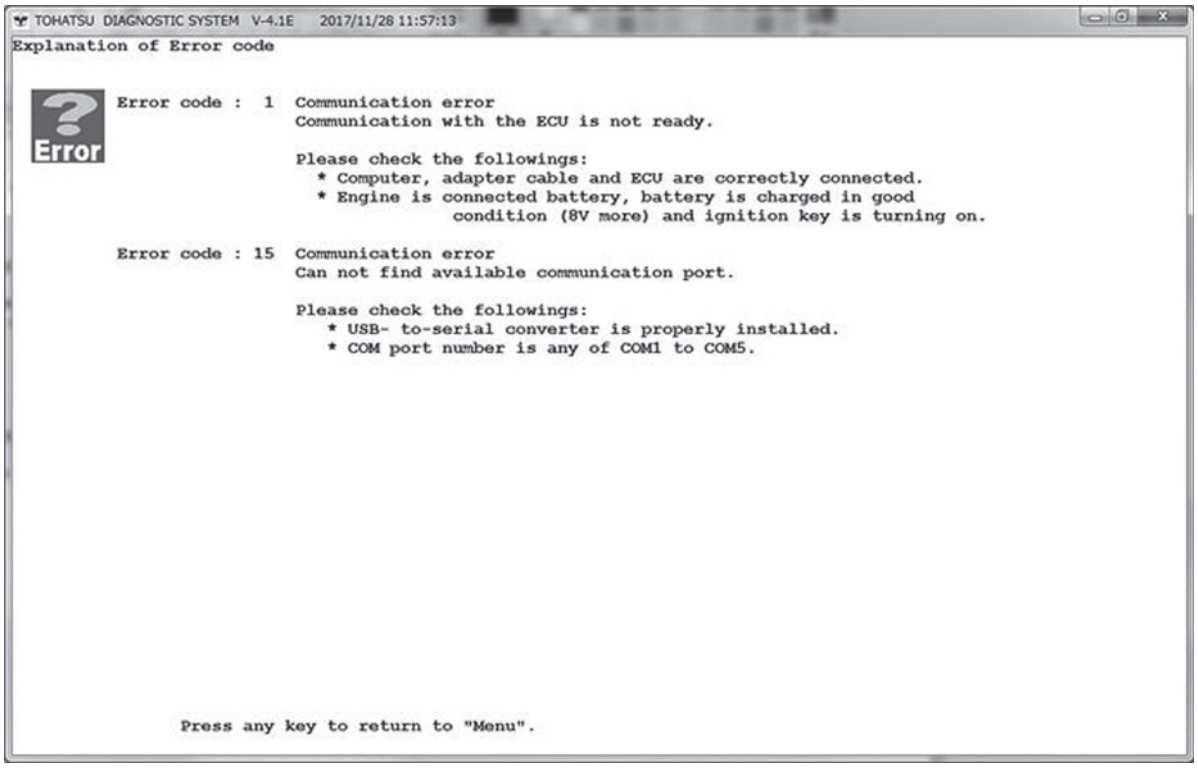
Error code : 1 Communication Error

Communication with ECU is not ready.

Check following items.

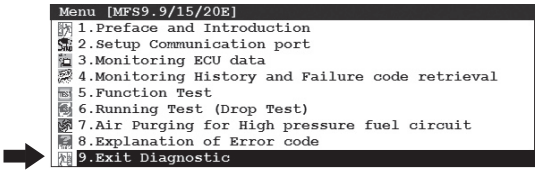
* Connection between computer and ECU
* Connection with battery
* Setting of computer COM port number. Use "Setup Communication port" on the "Menu" screen to set COM port number.

Press any key to return to "Menu" screen.



11) Exit Diagnostic

Select "Exit Diagnostic" to end DIAGNOSIS.



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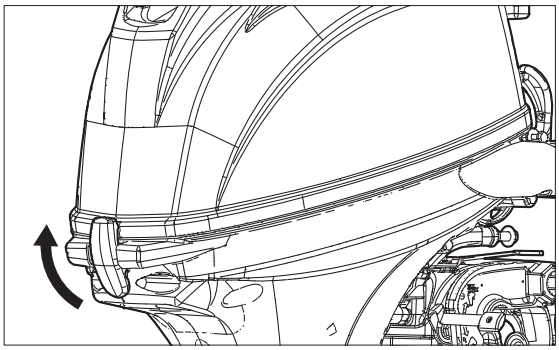
Accessories

1.Remote Control Components

1) Installation of Remote Control Cable (Engine Side)

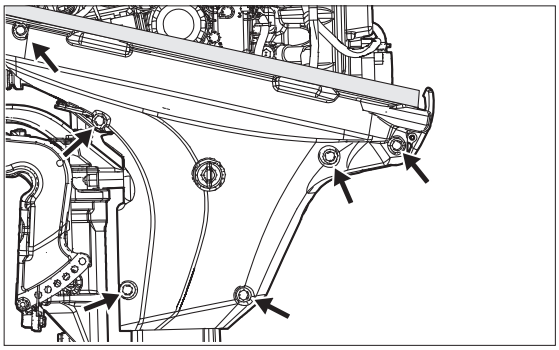
Remote Control Model

1. Release drive shaft housing cover latch and remove top cowl.

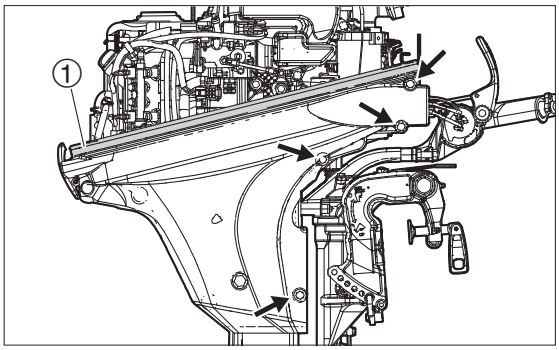


2. Loosen drive shaft housing cover bolts (Port side).

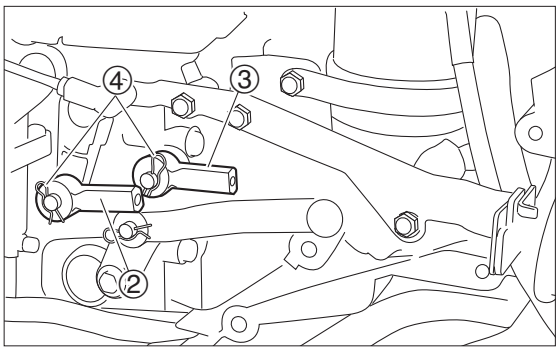
> · Loosen the port side bolts completely, then fully loose the starboard side bolts.
> · There bolts are a falling prevention structure it can not be removed.



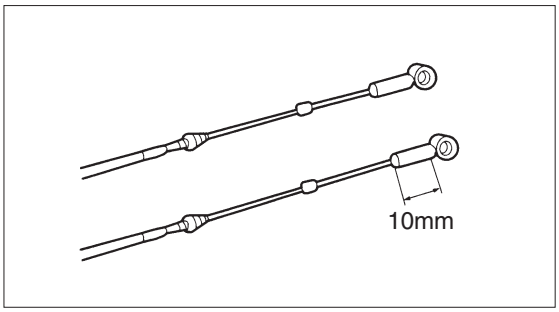
3. Remove cowl seal ① then loosen drive shaft housing cover bolts (Starboard side) and remove driveshaft housing cover bolts (Starboard side).

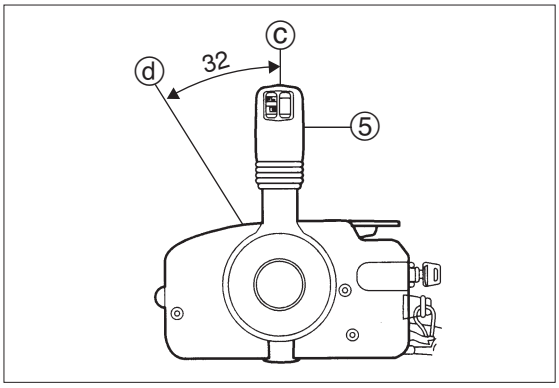


4. Remove cable joint snap pin ④ and wassher of throttle side ② and shft side ③ then remove cable joints (2 pieces).

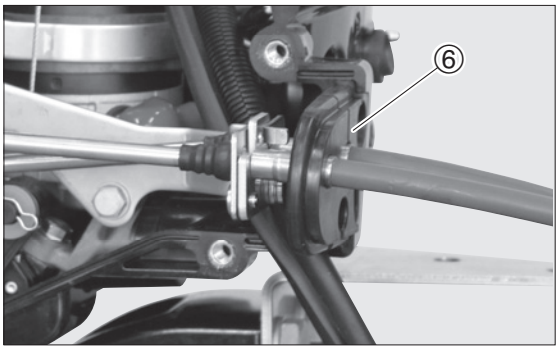


5. Screw cable joint on the end of remote control cable by approximately 10mm. (10mm is equivalent to 9 threads.)
Shift cable is the one of which tip is moved earlier than throttle cable when remote control lever ⑤ is set to forward (F) side ⓓ until it stops once (approx. 32 degrees).





6. After inserting remote control cable through grommet ⑥ at front part of front panel, attach grooved part of remote control cable to bracket.

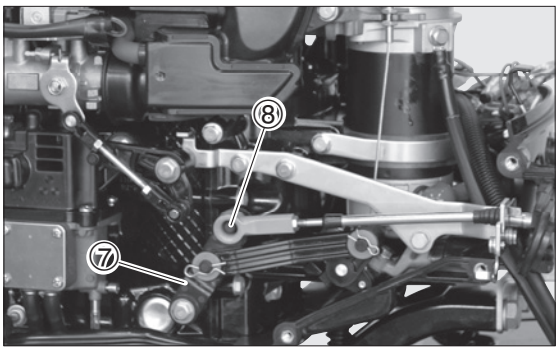


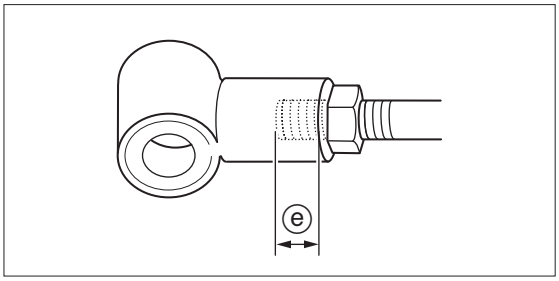
7. Set shift arm ⑦ forward (F), adjust screw-in length of cable joint so that hole of cable joint is brought to shift arm pin ⑧, and install remote control cable.

⚠ WARNING

Screw-in remote control cable joint at least 10mm ⓔ.

After adjusting remote control cable joint, fix it with remote control cable fully pushed in.





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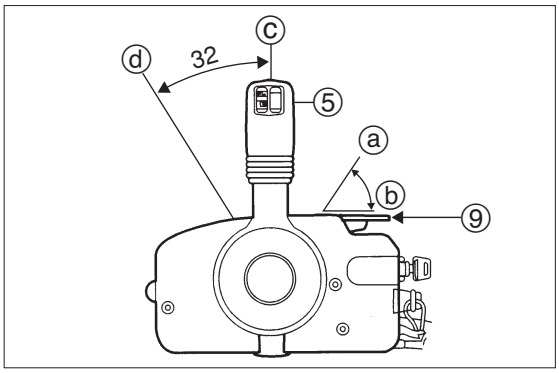
8. Set remote control lever ⑤ to neutral (N) ⓒ, and check that neutral throttling lever ⑨ is at full close position ⓑ.

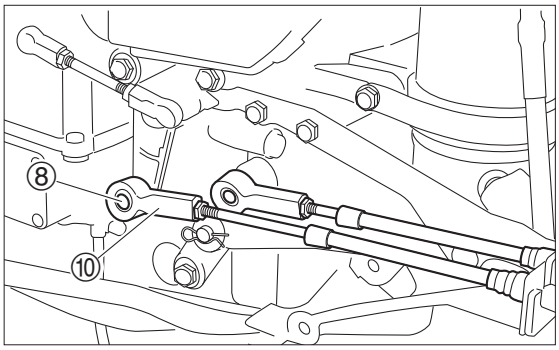


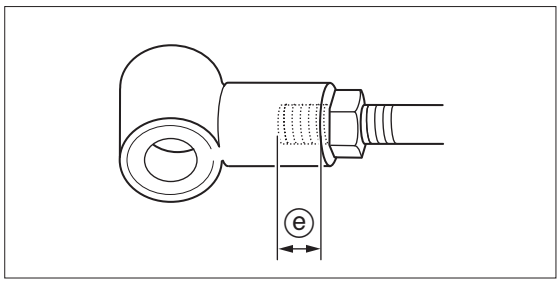
9. Adjust screw-in length of cable joint ⑩ so that hole of cable joint is brought to shift arm pin ⑧.

⚠ WARNING

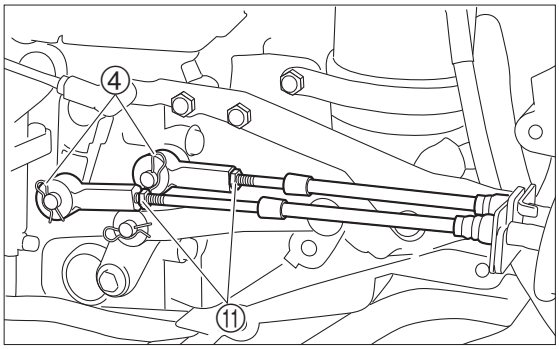
Screw-in remote control cable joint at lease 10mm ⓔ.

After adjusting remote control cable joint, fix it with remote control cable fully pushed in.

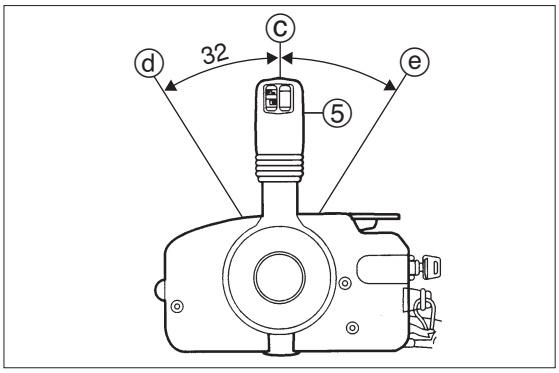


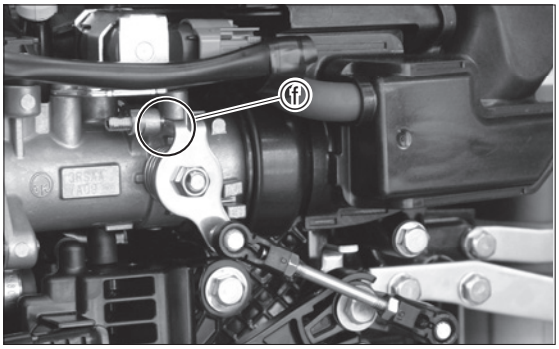


10. Lock joint with nut ⑪, put it on the pin, and secure with washer and snap pin ④.



11. Check that shifting control lever ⑤ forward (F) by approximately 32 degrees (ⓓ), where it is stopped once, makes the gear engage, and fully shifting the lever makes throttle valve fully open, and then check that shifting the lever reverse (R) by approximately 32 degrees (ⓔ), where it is stopped once, makes the gear engage, and fully shifting the lever makes throttle valve fully open.
Then, check that when control lever is returned to neutral position (N) ⓒ, throttle valve is fully closed ⓕ. Adjust position and reinstall cable joint of outboard motor side, if the valve does not contact with full close stopper in this case

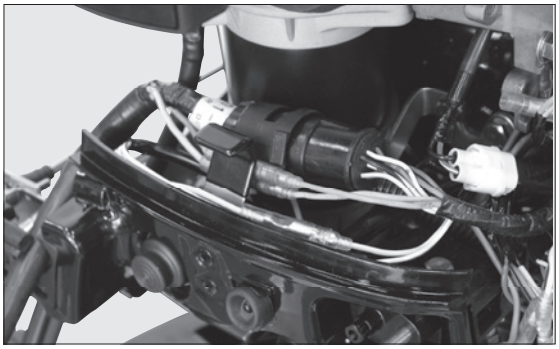




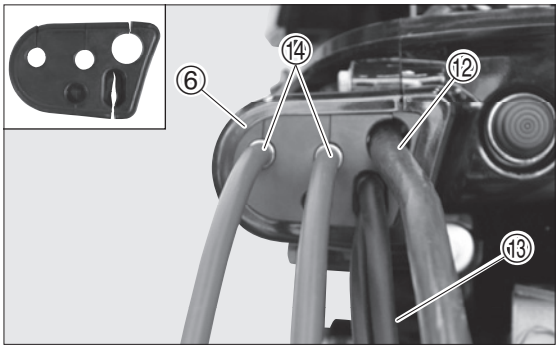
12. Connect cord ass'y connectors.

⚠ CAUTION

Do not disconnect cord ass'y while engine operates.



13. Pass cord ass'y ⑫ and remote control cables ⑬ through grommet ⑥ located on the front pannel. Install remote control cable groove to bracket, and then fix it to front panel.
Pass cord ass'y through grommet, then install drive shaft housing cover.



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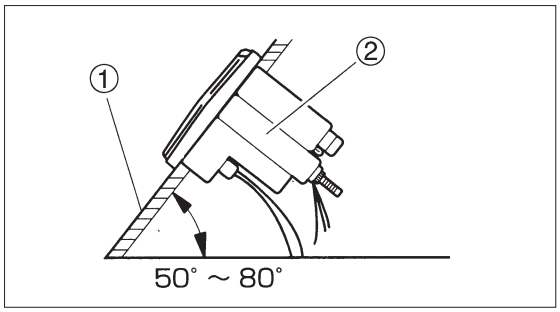
2.Installation of Meters and Battery

1) Installation of Meters

When installing meters, select a place on the dash board ① where operator can watch them easily and they are not exposed to water spray.

The meters can be installed on the dash board ① of 2 to 11mm thick. When the thickness is over 11mm, cut fitting plate ② so that the meters can be installed.

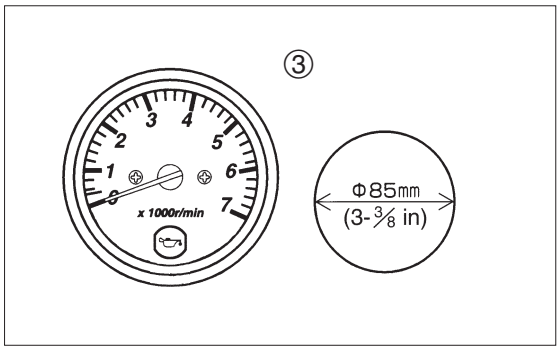


• Angle of Installation

Install meters so that the angle is in between 50 to 80 degrees from horizontal plane.

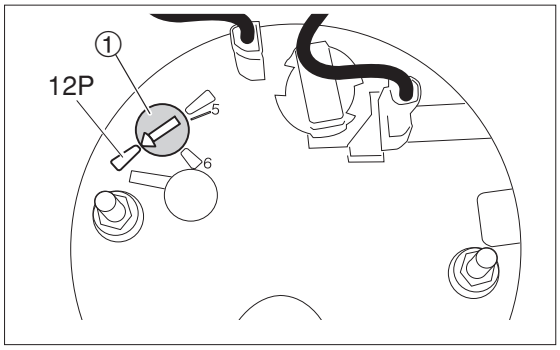
③ Large Sized Meters : Tachometer ③ and Speedometer

Installation Opening Diameter : 85mm (3-3/8 in)



• Tachometer

Set selector ⑤ to "12P" on the back of the meter.



2) Installation of Battery

⚠ CAUTION

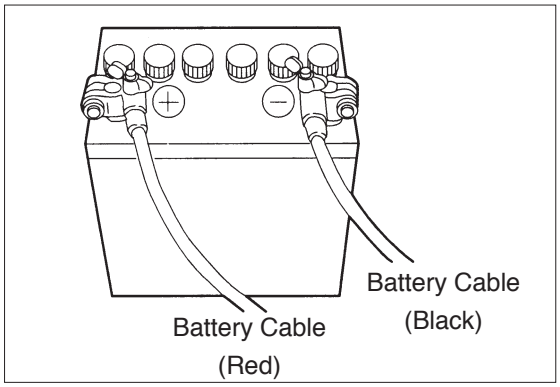
- **Before using battery, thoroughly read warning label.**
- **Do not disconnect battery cable during engine operation.**

When using battery, select the one with capacity ranging from 12V 40AH to 12V 70AH.

① Battery should be stored in battery storage box and secured to hull to prevent it from falling due to rolling or pitching or any shock in the place where it is protected from water spray.

② When connecting battery cables, connect positive cable (red) and then negative cable (black). (Reverse the order when disconnecting.)

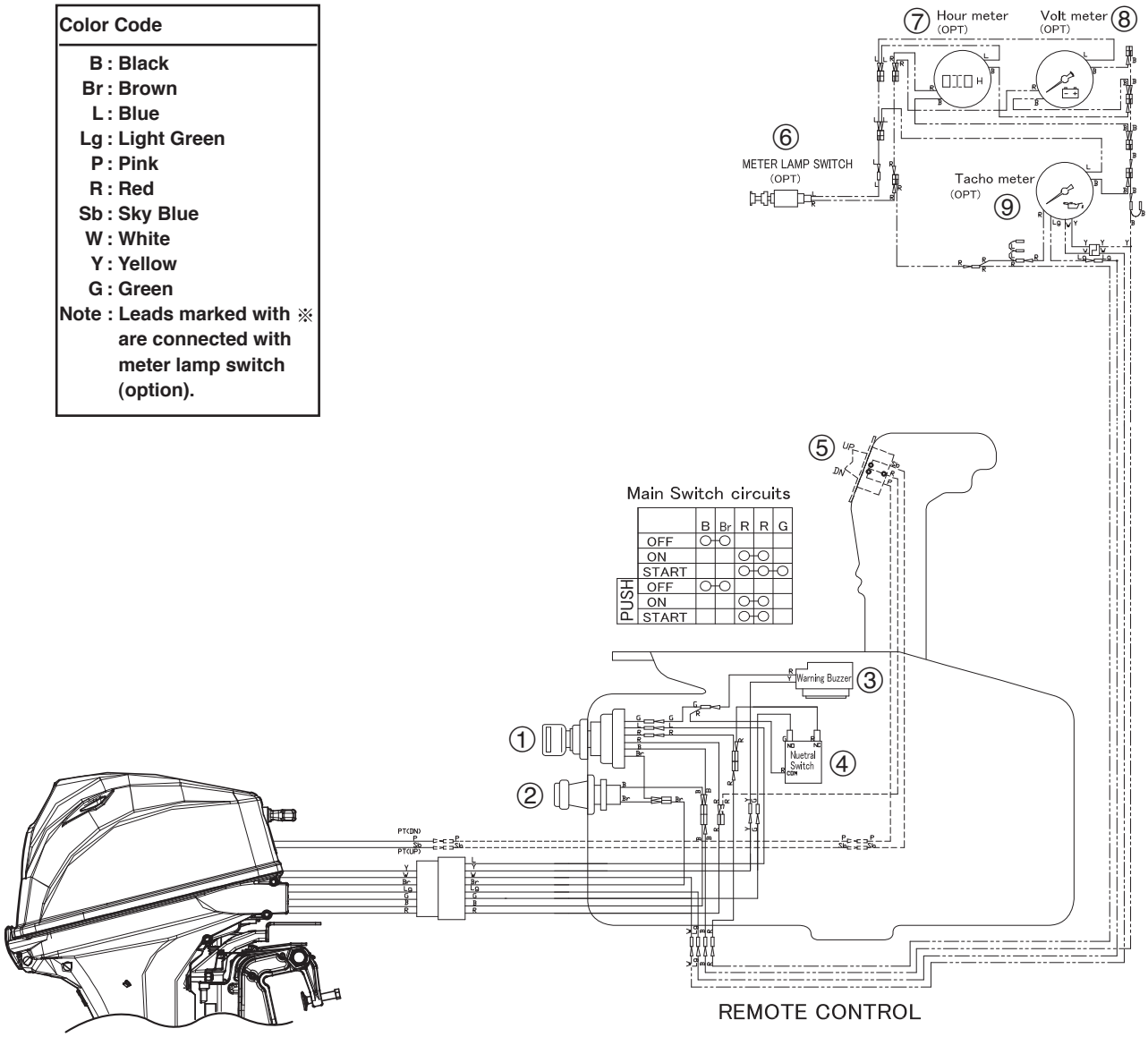
Positive cable is the one with red tube on the terminal end.



3) Wiring Diagram of Remote and Control Meters

Color Code

B : Black
Br : Brown
L : Blue
Lg : Light Green
P : Pink
R : Red
Sb : Sky Blue
W : White
Y : Yellow
G : Green
Note : Leads marked with ※ are connected with meter lamp switch (option).



① Main Switch Key
② Stop Switch Key
③ Warning Buzzer
④ Neutral Switch
⑤ PT Switch
⑥ Meter Lamp Switch
⑦ Hour Meter
⑧ Volt Meter
⑨ Tachometer

10

3.Operation

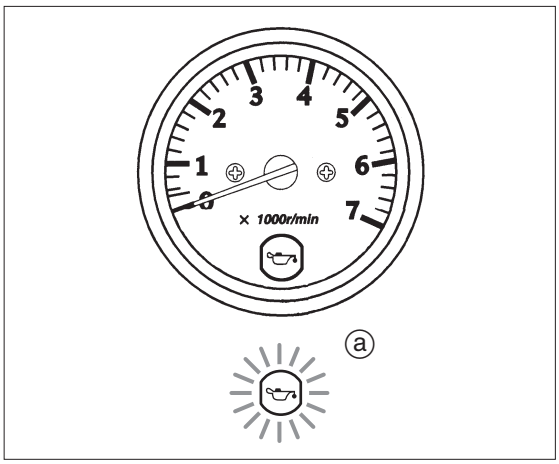
1) Warning Indication

When an abnormality occurs on the engine, warning buzzer sounds and warning lamp is lit or blinks.

Take actions described below if abnormal state has occurred.

* Remote control model only, warning buzzer inside remote control is equipped. Warning lamp is inside tachometer and drive shaft housing cover of outboard motor.

1. When engine started, warning lamp is lit for 5 seconds and warning buzzer operates for 0.5 seconds (generating intermittent sound) indicating that operation warning system is operating normally.



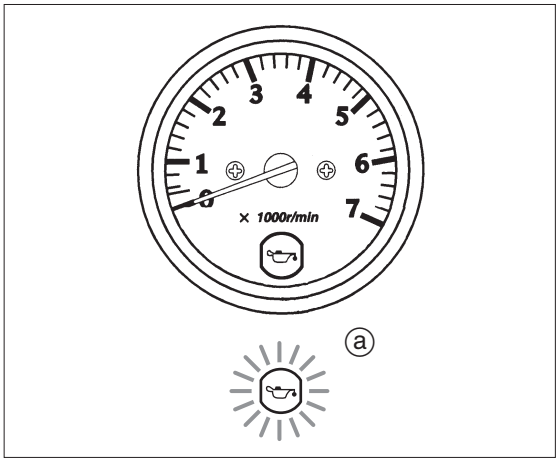
ⓐ Lamp is lit.

2. Over revolution Prevention System (High Speed ESG)
   If engine load is reduced for some reason, the revolution speed may increase abnormally. In such case, warning buzzer operates (generating continuous sound), warning lamp is lit, and at the same time, high speed ESG operates to reduce the speed to 6,300r/min.

Sensor Detection Level	Speed Controlled to
Over revolution	Approximately 6,300 r/min

3. Overheat Warning
   When engine cooling water temperature exceeds setting value during operation, warning buzzer operates (generating continuous sound), warning lamp is lit, and at the same time, low speed ESG operates to reduce the speed to 2,800r/min or less.

Sensor Detection Level	Speed Controlled to
Overheat	2,800 r/min



ⓐ Lamp is lit.

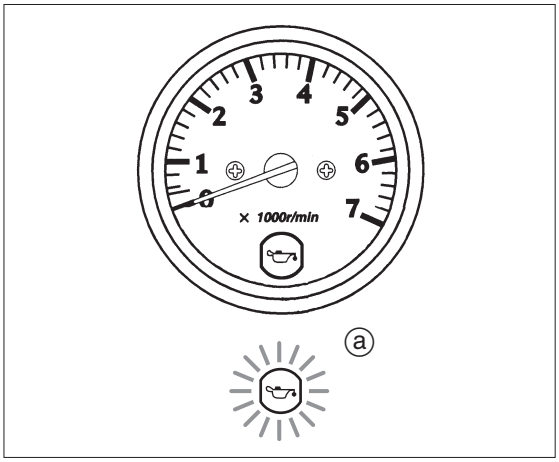
- Run immediately to safe place, and set throttle grip or control lever to slow. Set shift lever or control lever to neutral (N), check if cooling water check port discharges water, and then, stop engine. Remove plastic sheet or other matters that clogs water intake port, if any.
- The revolution control continues until engine is stopped even if the operation temperature returns to normal state, and in throttle range of 2,800 r/min or over, the engine speed increases gradually.
- This warning is effective only for overheating, and not effective for combustion or lubrication.

4. Oil Pressure Warning

When Oil pressure is reduced below setting value during operation, warning buzzer operates (generating continuous sound), warning lamp is lit, and at the same time, low speed ESG operates to reduce the speed to 2,800r/min or less.

- Reduce engine speed and run to safe place, set main switch key to "OFF" to stop engine, and then, check oil level and add oil if necessary. After adding oil, start engine and check that warning lamp on the tachometer and bottom cowl is not lit and warning buzzer does not go on.
- Even after oil pressure returns to normal state, engine speed control for oil pressure cannot be cancelled unless engine is stopped.
- This warning is effective only for oil pressure detection at oil pressure switch section, and is not effective for overall oil pressure detection.

Sensor Detection Level	Speed Controlled to
Reduction of oil pressure	2,800 r/min



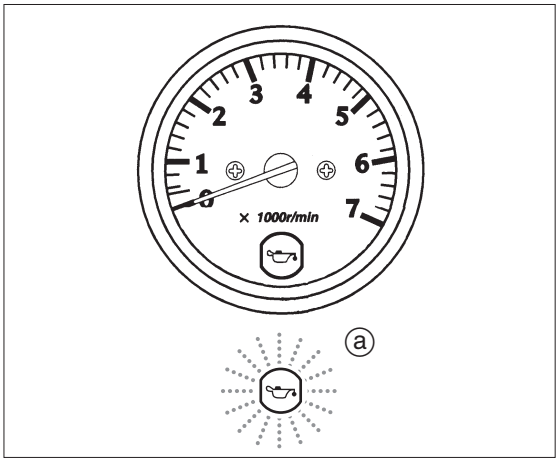
ⓐ Lamp is lit.

5. Engine Trouble Warning

When water temperature sensor or MAP (manifold pressure) sensor detects abnormality, warning lamp blinks, warning buzzer operates (generating intermittent sound), and at the same time, low speed ESG operates to reduce the speed to 2,800r/min or less

Sensor Detection Level	Speed Controlled to
Engine Trouble	2,800 r/min

- Engine revolution is reduced to 2,800r/min, warning lamp blinks and warning buzzer sounds (generating intermittent sound).
  1. Water temperature sensor defective
  2. MAP sensor defective
  3. Wire defective contact or disconnected
- Even after sensor returns to normal state, engine speed control for malfunction cannot be cancelled unless engine is stopped.



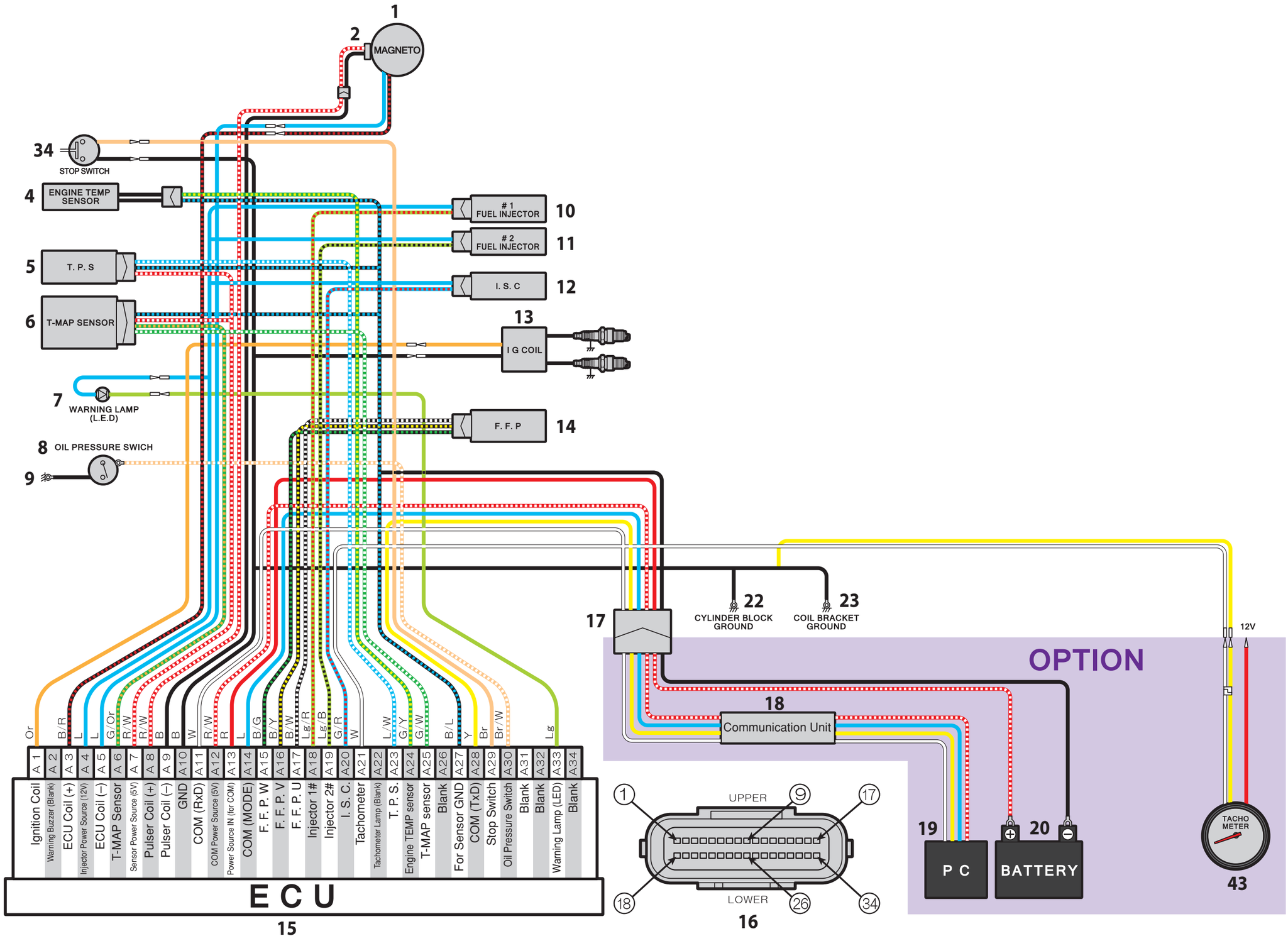
ⓐ Light blinks.

11
Wiring Diagram

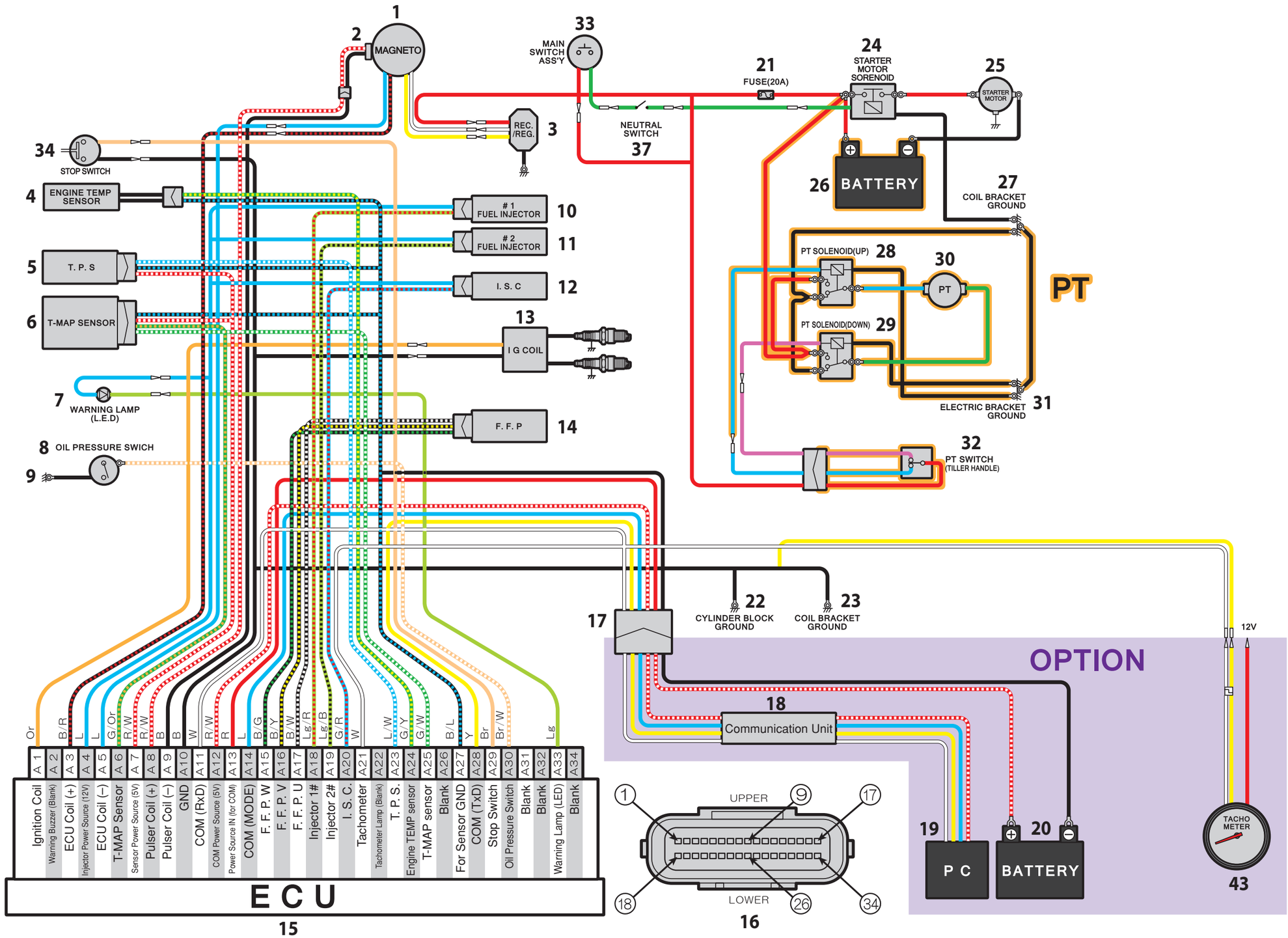
Wiring Chart

NO.	Name	Remarks	ECU	Lead Wire Color				ECU
1	Magneto	Exciter Coil	A5	L	Blue	B/R	Black/Red	A3
		Charge Coil (except for MF model)	–	Y	Yellow	B	Black	–
2	Pulser Coil		A8	R/W	Red/White	B	Black	A9
3	Rectifier/Regulator	(except for MF model)	–	Y	Yellow	R	Red	–
4	Engine Temperature Sensor		A24	G/Y	Green/Yellow	B/L	Black/Blue	A27
5	Throttle Position Sensor	TPS	A7	R/W	Red/White	L/W	Blue/White	A23
6	T-MAP Sensor	MAP	A6	G/Or	Green/Orange	B/L	Black/Blue	A27
		MAT	A25	G/W	Green/White	R/W	Red/White	A7
7	Warning Lamp	LED	A3	Lg	Light Green	L	Blue	A4
8	Oil Pressure Sensor		A30	Br/W	Brown/White	Ground		–
9	Crankcase	Ground	–	Ground				–
10	Fuel Injector	#1	A18	Lg/R	Light Green/Blue	L	Blue	A4
11	Fuel Injector	#2	A19	Lg/B	Light Green/Black	L	Blue	A4
12	Idle Speed Control Valve	ISC Valve	A20	G/R	Green/Red	L	Blue	A4
13	Ignition Coil		A1	Or	Orange	B	Black	A10
14	Fuel Feed Pump	FFP	A15	B/G	Black/Green	B/Y	Black/Yellow	A16
			A17	B/W	Black/White	–	–	–
15	ECU	Electronic Control Unit	–	–				–
16	ECU Connector	Main Harness	–	–				–
17	Service Connector	Diagnostic Port	A11	W	White	R/W	Red/White	A12
			A28	Y	Yellow	R	Red	A13
			A14	L	Blue	B/L	Black/Blue	A27
18	Communication Unit	Diagnostic Tool/Option	–	–				–
19	Personal Computer	Option	–	–				–
20	Battery	Option	–	–				–
21	Fuse	20A (except for MF model)	–	R	Red	R	Red	–
22	Crankcase	Ground	–	B	Black	B	Black	–
23	Coil Bracket	Ground	–	B	Black	B	Black	–
24	Starter Solenoid	(except for MF model)	–	G	Green	R	Red	–
25	Starter Motor	(except for MF model)	–	R	Red	B	Black	–
26	Battery	(except for MF model)	–	R	Red	B	Black	–
27	Coil Bracket	Ground	–	B	Black	B	Black	–
28	PT Solenoid	UP Side / PT Model	–	Sb	Sky Blue	L	Blue	–
29	PT Solenoid	DOWNSide / PT Model	–	P	Pink	G	Green	–
30	PT Motor	PT Model	–	L	Blue	G	Green	–
31	Electrical Bracket	Ground	–	B	Black	B	Black	–
32	PT Switch	Tiller Handle / PT Model	–	Sb	Sky Blue	P	Pink	–
33	Main Switch Key	Remote Control Model	–	R	Red	G	Green	–
34	Stop Switch		A29	Br	Brown	B	Black	A10
35	PT Switch	PT Model	–	Sb	Sky Blue	P	Pink	–
36	Warning Buzzer	Remote Control Model	A2	Y	Yellow	R	Red	–
37	Neutral Switch	Crankcase	–	G	Green	G	Green	–
38	Remote Control	Remote Control Model	–	–				–
39	Main Switch Circuit	Remote Control Model	–	–				–
40	Neutral Switch	Remote Control Model	–	G	Green	R	Red	
41	Neutral Switch Circuit	Remote Control Model	–	–				–
42	Volt Meter	Option	–	R	Red	B	Black	–
43	Hour Meter	Option	–	R	Red	B	Black	–
44	Tachometer	Option	–	W	White	Y	Yellow	–
45	Meter Lamp Switch	Option	–	L	Blue	R	Red	–

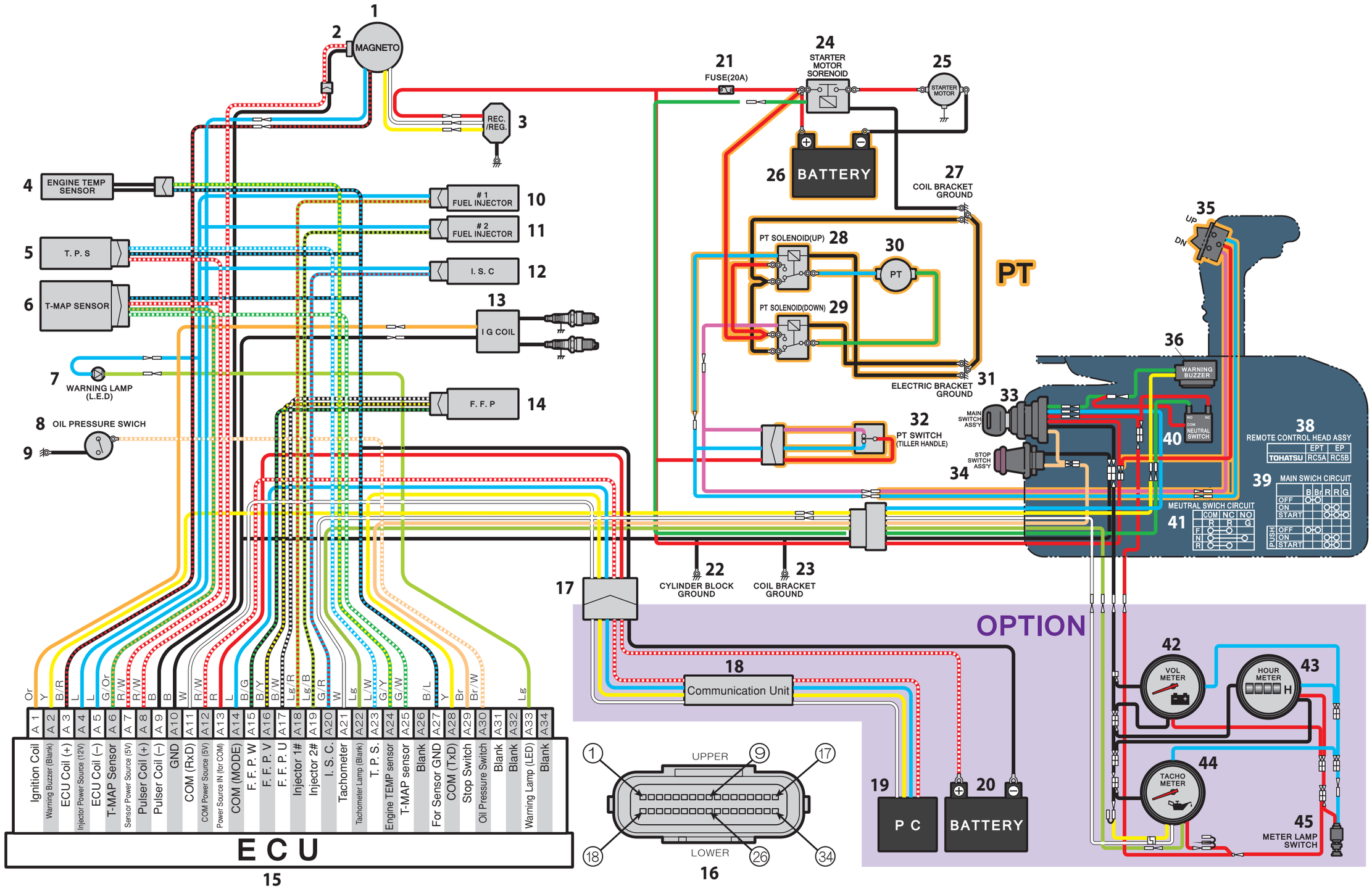
MFS9.9/15/20E MF Electric Circuit



MFS9.9/15/20E EF/EFT (tiller Handle Type) Electric Circuit

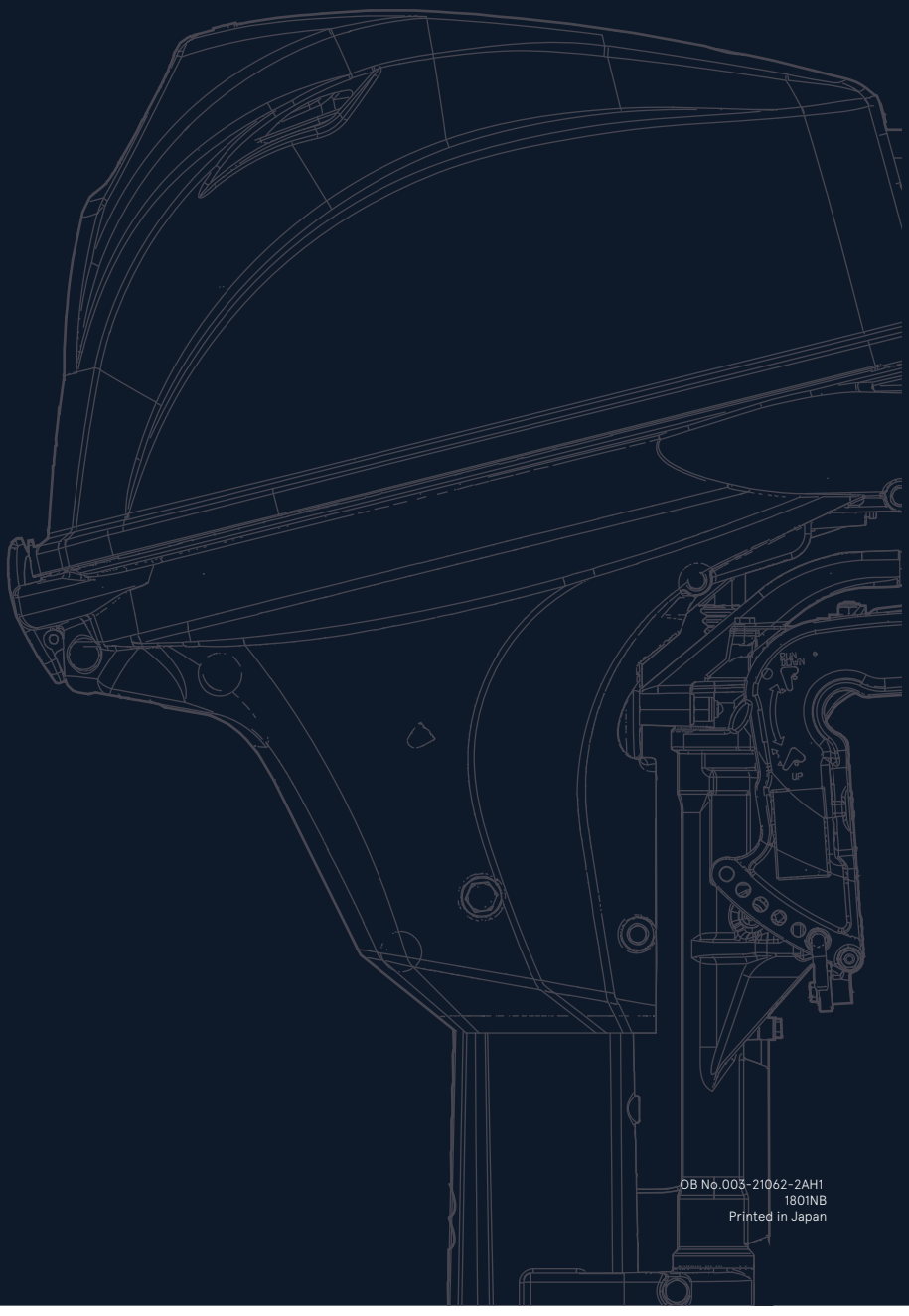


MFS9.9/15/20E EP/EPT (Remote Control Type) Electric Circuit



SERVICE MANUAL

4 STROKE
MFS 9.9E
MFS 15E
MFS 20E
Models



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