

TABLE OF CONTENTS

TROUBLESHOOTING	03-02-1
COOLING SYSTEM	03-02-1
ALTERNATOR	03-02-2
LUBRICATION	03-02-2
CYLINDER AND CYLINDER HEAD	03-02-4
CRANKSHAFT	03-02-5
ELECTRIC STARTER	03-02-5
ENGINE GENERAL	03-02-7

LEAK TEST	03-03-1
VERIFICATION	03-03-1
LEAK TEST PROCEDURE	03-03-1
PREPARATION AND TEST	03-03-1
PREPARATION	03-03-1
INSTALLATION	03-03-2

REMOVAL AND INSTALLATION	03-04-1
ENGINE REMOVAL	03-04-2
ENGINE INSTALLATION	03-04-4

COOLING SYSTEM	03-05-1
COOLING SYSTEM LEAK TEST	03-05-3
INSPECTION	03-05-3
COOLANT REPLACEMENT	03-05-3
COOLANT HOSES	03-05-4
WATER PUMP HOUSING/ THERMOSTAT	03-05-4
WATER PUMP IMPELLER	03-05-5
IGNITION COVER	03-05-6
WATER PUMP SHAFT	03-05-7
PRESSURE CAP	03-05-9
RADIATORS	03-05-9

LUBRICATION SYSTEM	03-06-1
GENERAL	03-06-3
OIL LEVEL CHECK	03-06-3
ENGINE OIL PRESSURE TEST	03-06-3
OIL CHANGE	03-06-4
OIL FILTER	03-06-4
OIL TANK	03-06-5
OIL FILTER HOUSING	03-06-5
ENGINE OIL PRESSURE REGULATOR	03-06-6

Section 03 ENGINE


Subsection 01 (TABLE OF CONTENTS)

OIL PUMPS	03-06-7
PRESSURE OIL PUMP	03-06-7
SUCTION OIL PUMP	03-06-9
OIL NOZZLE	03-06-10
OIL SIEVES	03-06-11
REED VALVE	03-06-11
<hr/>	
CYLINDER AND CYLINDER HEAD	03-07-1
CYLINDER/CYLINDER HEAD 1 (FRONT-SIDE)	03-07-1
CYLINDER/CYLINDER HEAD 2 (REAR-SIDE)	03-07-2
GENERAL	03-07-3
SPARK PLUG	03-07-3
TEMPERATURE SENSOR	03-07-4
VALVE COVER	03-07-4
ROCKER ARM	03-07-4
CHAIN TENSIONER	03-07-7
BREATHER	03-07-8
DECOMPRESSOR	03-07-9
CAMSHAFT SPROCKET/TIMING GEAR	03-07-10
TIMING CHAIN	03-07-11
CYLINDER HEAD	03-07-11
CAMSHAFT	03-07-12
VALVE SPRINGS	03-07-14
VALVE	03-07-15
CYLINDER	03-07-18
PISTON	03-07-19
<hr/>	
CRANKSHAFT/DRIVE GEARS	03-08-1
TIMING CHAIN	03-08-3
DRIVE GEARS	03-08-3
TRIGGER WHEEL	03-08-5
CRANKSHAFT	03-08-5
CRANKSHAFT LOCKING BOLT	03-08-10
PISTON	03-08-10
PISTON RINGS	03-08-13
<hr/>	
CRANKCASE	03-09-1
GENERAL	03-09-2
PTO COVER	03-09-2
CRANKCASE	03-09-4

TROUBLESHOOTING

The following charts are provided to help in diagnosing the probable source of troubles. It should be used as a guideline. This section pertains to engine mechanical components only. Some related problems can come from other systems such as ignition system, fuel system etc. and have an impact on the engine. Ensure to check the other systems before concluding that the engine is faulty.


COOLING SYSTEM

SYMPTOM	HIGH ENGINE OPERATING TEMPERATURE.
CONDITION	NORMAL USE.
	1. Check coolant level. a. Coolant level lower than recommended. <i>Refill.</i>
	2. Check temperature sensor for electrical/mechanical failure. a. Temperature sensor defective. <i>Replace.</i>
	3. Check thermostat (located in the thermostat housing on the alternator side cover). a. Thermostat defective (does not open when engine gets hot). <i>Replace thermostat.</i>
	4. Check control bore (beside thermostat housing) if coolant leaks. a. Coolant leaking from control bore means a damaged water pump rotary seal. <i>Replace rotary seal (refer to COOLING SYSTEM and CRANKCASE).</i>
	5. Check condition of hoses and hose clamps fixation. a. Hoses are brittle and/or hard. <i>Replace.</i> b. Hose clamps are loose. <i>Retighten clamps.</i>
	6. Check condition of impeller located on the water pump shaft. a. Impeller wings broken and/or impeller threads are damaged. <i>Replace.</i>
	7. Check gasket on water pump housing. a. Gasket on water pump housing leaks. <i>Retighten screws and/or replace gasket.</i>
	8. Check cylinder head and/or cylinder base gasket. a. Worn out gasket(s) is(are) causing coolant leakage. <i>Replace.</i>


Section 03 ENGINE


Subsection 02 (TROUBLESHOOTING)


ALTERNATOR

SYMPTOM	NOT CHARGING AT ALL OR CHARGING VOLTAGE INADEQUATE.
CONDITION	NORMAL USE.
 Test/Inspection	1. Check the alternator and measure the charging voltage. a. Defective alternator. <i>Replace the alternator (refer to ALTERNATOR).</i>
	2. Inspect the alternator; check if it is turning along during starting. a. Generator gear damaged. <i>Replace the generator gear (refer to CRANKSHAFT/DRIVE GEARS).</i>
	3. Check wire harness for cracks or other damages. a. Harness shows electrical failure and/or other damages. <i>Replace wire harness.</i>
	4. Check the alternator charging light on the dashboard for proper functioning. a. Alternator charging light defective. <i>Replace the alternator charging light.</i>

LUBRICATION

SYMPTOM	LOW OR NO OIL PRESSURE.
CONDITION	NORMAL USE.
 Test/Inspection	1. Check oil level and search for leakage on crankcase and/or sealing parts. a. Crankcase is leaking due to damage. <i>Rebuild engine with new crankcase and gasket parts. Use Bombardier's recommended oil (refer to TECHNICAL DATA).</i> b. Crankcase is leaking due to loose screws. <i>Retighten screws with recommended torque.</i> c. Sealing rings, O-rings and/or gaskets are brittle and/or hard or damaged. <i>Replace damaged parts.</i> d. Piston rings worn out (blue coloured engine exhaust emission). <i>Replace piston rings (refer to CRANKSHAFT/DRIVE GEARS).</i> e. Piston rings are broken (low compression). <i>Replace piston rings (refer to CRANKSHAFT/DRIVE GEARS)).</i> f. Valve stem seal damaged and/or sealing lip is hard and/or brittle. <i>Replace all valve stem seals.</i>
	2. Check oil drain plug on engine bottom. a. Plug is loosed and/or gasket ring is missing. <i>Retighten the plug and/or place gasket ring.</i>
	3. Check control bore if oil leaks (beside thermostat housing). a. Oil leaking from control bore means a damaged oil seal on water pump shaft. <i>Replace oil seal (refer to COOLING SYSTEM).</i>
	4. Check oil pressure switch function. a. Oil pressure switch damaged. <i>Replace oil pressure switch.</i>

SYMPTOM	LOW OR NO OIL PRESSURE.
CONDITION	NORMAL USE.
	<p>5. Check oil orifice(s) on the oil pump suction side.</p> <p>a. Oil orifice(s) is(are) clogged. <i>Clean from contamination. Replace oil and oil filter if necessary (refer to MAINTENANCE or LUBRICATION SYSTEM).</i></p>
	<p>6. Check oil pump function.</p> <p>a. Oil pump rotor is out of wear limit. <i>Replace oil pump shaft (refer to LUBRICATION SYSTEM).</i></p> <p>b. Oil pump seized due to oil leakage and/or air inclusion. <i>Replace oil pump (refer to LUBRICATION SYSTEM).</i></p> <p>c. Gears driving oil pump are broken or otherwise damaged. <i>Replace gears.</i></p> <p>d. Incorrect oil being used. <i>Use Bombardier's recommend oil (refer to TECHNICAL DATA).</i></p>
	<p>7. Check oil pressure regulator valve (spring) function.</p> <p>a. Valve spring damaged (valve always open). <i>Replace spring.</i></p> <p>b. Valve piston is stuck in oil pump housing. <i>Repair valve piston.</i></p>
	<p>8. Check plain bearings in crankcase for heavy wear.</p> <p>a. Plain bearings out of specification (increased clearance). <i>Replace plain bearings.</i></p>

SYMPTOM	OIL CONTAMINATION (WHITE APPEARANCE).
CONDITION	NORMAL USE.
	<p>1. Check control bore (beside thermostat housing) if water and oil leaks.</p> <p>a. Leakage of oil/water mixture from bore means damaged water pump seal ring and rotary seal. <i>Replace sealing ring, rotary seal and refill with recommended oil and/or coolant (refer to COOLING SYSTEM and CRANKCASE).</i></p>
	<p>2. Check cylinder head and/or cylinder base gasket.</p> <p>a. Gasket damaged or leaking. <i>Retighten cylinder head with recommended torque and/or replace gasket.</i></p>
	<p>3. Check tightening torque of cylinder head screws.</p> <p>a. Screws not properly tightened. <i>Retighten screws to recommended torque and replace oil.</i></p>
	<p>4. Check oil for particles (may indicate possible engine internal damages).</p> <p>a. Oil contamination due to metal or plastic particles. <i>Replace possibly damaged parts. Use Bombardier's recommended oil (refer to TECHNICAL DATA).</i></p>

Section 03 ENGINE

Subsection 02 (TROUBLESHOOTING)

CYLINDER AND CYLINDER HEAD

SYMPTOM	UNUSUAL ENGINE NOISE AND/OR VIBRATION.
CONDITION	NORMAL USE.
Test/Inspection	1. Check noise coming from cylinder head area. <ul style="list-style-type: none">a. Faulty chain tensioner. <i>Replace spring and/or mechanism.</i>b. Chain guide worn out. <i>Replace chain guide.</i>c. Stretched chain and/or worn out sprockets. <i>Replace chain and sprockets.</i>d. Sprocket screws got loose. <i>Retighten screws with recommended torque.</i>e. Hydraulic element inside rocker arm(s) is(are) worn out (valve adjustment). <i>Replace rocker arm(s).</i>f. Rocker arm screws not tightened. <i>Replace screws and perform the torque procedure (refer to CYLINDER AND CYLINDER HEAD).</i>

SYMPTOM	OIL CONTAMINATION ON CYLINDER AND/OR CYLINDER HEAD.
CONDITION	NORMAL USE.
Test/Inspection	1. Check screws for torque. <ul style="list-style-type: none">a. Loose screws. <i>Retighten screws with recommended torque.</i>b. Gaskets are brittle, hard, worn out or otherwise damaged. <i>Replace damaged gaskets, O-rings or the V-ring on breather.</i>c. Contact area between spark plug and stick coils fouled by oil. <i>Clean spark plug area and replace spark plug tube.</i>

CRANKSHAFT

SYMPTOM	UNUSUAL ENGINE NOISE AND/OR VIBRATIONS.
CONDITION	NORMAL USE.
Test/Inspection	<p>1. Check noise coming from crankshaft area.</p> <p>a. Crankshaft bushings are damaged. <i>Replace the crankshaft bushings. (refer to CRANKSHAFT/DRIVE GEARS).</i></p> <p>b. Connecting rod bushings are damaged. <i>Replace the connecting rod bushings. (refer to CRANKSHAFT/DRIVE GEARS).</i></p> <p>2. Check if drive gears are loosen.</p> <p>a. Crankshaft nut retaining drive gear is loose. <i>Retighten retaining nut with recommended torque.</i></p>

ELECTRIC STARTER

SYMPTOM	STARTER DOES NOT TURN.
CONDITION	NORMAL USE.
Test/Inspection	<p>1. Check the battery voltage.</p> <p>a. Battery discharged. <i>Charge the battery.</i></p> <p>2. Check wiring harness for cracks or other damages.</p> <p>a. Harness shows electrical failure and/or other damages. <i>Replace wire harness.</i></p> <p>3. Check 30 A and 5 A fuses.</p> <p>a. Burnt fuse. <i>Check wiring condition and replace fuse.</i></p> <p>4. Check continuity of starter switch contact points.</p> <p>a. Poor contact of starter switch contact points. <i>Repair or replace switch.</i></p> <p>5. Check continuity between starter switch and ECM.</p> <p>a. Open circuit. <i>Repair.</i></p> <p>6. Check continuity between ECM and solenoid switch.</p> <p>a. Open circuit. <i>Repair.</i></p>

Section 03 ENGINE

Subsection 02 (TROUBLESHOOTING)

SYMPTOM	STARTER TURNS, BUT ENGINE DOES NOT CRANK.
CONDITION	NORMAL USE.
Test/Inspection	1. Check the starter gear. a. Starter gear and/or intermediate gear is worn or damaged. <i>Replace starter gear and/or intermediate gear (refer to CRANKSHAFT/DRIVE GEARS).</i>
	2. Check the sprag clutch. a. Sprag clutch is worn or otherwise damaged. <i>Replace sprag clutch (refer to CRANKSHAFT/DRIVE GEARS).</i>
	3. Check battery capacity. a. Shorted battery cell(s). <i>Replace.</i>
	4. Check battery charge. a. Low battery. <i>Recharge battery and check recharge system and wires.</i>
	5. Check wire connection. a. Inadequate connection (too much resistance). <i>Clean and reconnect.</i>
	6. Check brushes. a. Poor contact of brushes. <i>Replace starter.</i>
	7. Check commutator. a. Burnt commutator. <i>Replace starter.</i>
	8. Check engine. a. Engine seized. <i>Overhaul the engine.</i>
	9. Check field coil resistance. a. Shorted field coil. <i>Replace starter.</i>
	10. Check armature resistance. a. Shorted armature. <i>Replace starter.</i>
	11. Check tension of brush springs. a. Weak brush spring tension. <i>Replace starter.</i>
	12. Check if bushings are worn. a. Worn bushings. <i>Replace starter.</i>

ENGINE GENERAL

SYMPTOM	ENGINE BACKFIRES.
CONDITION	NORMAL USE.
Test/Inspection	<p>1. Check spark plug.</p> <p>a. Carbon accumulation caused by defective spark plug. <i>Clean carbon accumulation and replace spark plug.</i></p>
	<p>2. Check leakage on intake manifold.</p> <p>a. Air leak on intake system. <i>Retighten screws and/or replace intake manifold gasket.</i></p>
	<p>3. Check exhaust air leaking.</p> <p>a. Exhaust gasket is leaking. <i>Retighten screws and/or replace exhaust gasket.</i></p>
	<p>4. Check intake valve(s) for leaking.</p> <p>a. Intake valve(s) is(are) leaking. <i>Repair or replace valve(s).</i></p>
	<p>5. Check if fuel supply is sufficient at high RPM.</p> <p>a. Fuel line is contaminated and/or bent (engine gets lean). <i>Clean and/or replace defective part(s).</i></p>
	<p>6. Check fault codes in B.U.D.S. system.</p> <p>a. Check if electrical actuator(s) is/are defective. <i>Replace defective part(s) (refer to COMPONENT INSPECTION AND ADJUSTMENT).</i></p>

Section 03 ENGINE

Subsection 02 (TROUBLESHOOTING)

SYMPTOM	ENGINE SUDDENLY TURNS OFF.
CONDITION	NORMAL USE.
Test/Inspection	1. Perform engine leak test. Refer to ENGINE LEAK TEST procedure. Check for possible piston seizure. a. Damaged head gasket and/or seal and/or leaking inlet/exhaust valve(s). <i>Replace and/or repair defective parts.</i>
	2. "Four-corner" seizure of piston. a. Accelerating too fast when engine is cold. Piston expands faster than cylinder. <i>Replace pistons. Ask driver to refer to warm-up procedure in Operator's Guide.</i>
	3. Piston seizure (from arrow to piston exhaust side). a. Spark plug heat range is too hot. <i>Install spark plug with appropriate heat range (refer to TECHNICAL DATA).</i> b. Compression ratio is too high. <i>Install genuine parts.</i> c. Poor oil quality. <i>Use BOMBARDIER oil.</i> d. Leaks at air intake manifold (engine gets too lean). <i>Retighten screws or replace air intake manifold gasket.</i>
	4. Melted and/or perforated piston dome; melted section at ring end gap. a. When piston reaches TDC, mixture is ignited by heated areas in combustion chamber. This situation is due to an incomplete combustion of a poor oil quality. <i>Clean residue accumulation in combustion chamber and replace piston. Use Bombardier's recommended oil.</i> b. Spark plug heat range is too hot. <i>Install recommended spark plug (refer to TECHNICAL DATA).</i>
	5. Piston color is dark due to seizure on intake and exhaust sides. a. Cooling system leaks and lowers coolant level. <i>Tighten clamps or replace defective parts. Add antifreeze in cooling system until appropriate level is reached. Replace damaged parts.</i>
	6. Cracked or broken piston. a. Cracked or broken piston due to excessive piston/cylinder clearance or engine overrevving. <i>Replace piston. Check piston/cylinder clearance (refer to CRANKSHAFT/DRIVE GEARS).</i>
	7. Check piston rings and cylinder surface for grooves. a. Poor oil quality. <i>Use Bombardier's recommended oil.</i> b. Contamination through engine intake. <i>Replace defective part(s) and use new air filter.</i>
	8. Check crankshaft, rocker arms movement. a. Oil pump failure due to leak of oil. <i>Repair and replace defective parts and use Bombardier's recommended oil.</i> b. Oil contamination due to clogged oil filter/oil sieve. <i>Replace oil, replace defective part(s) (refer to MAINTENANCE CHART and LUBRICATION SYSTEM).</i>

SYMPTOM	ENGINE SUDDENLY TURNS OFF.
CONDITION	NORMAL USE.
Test/Inspection	<p>9. Check valve springs exhaust/intake.</p> <p>a. Broken valve spring damages the cylinder head, valve(s), rocker arm(s)/piston/piston rings and connecting rod. <i>Replace defective part(s).</i></p> <p>10. Check if fuel supply is sufficient at high RPM.</p> <p>a. Fuel line is contaminated and/or bent. <i>Clean and/or replace defective part(s).</i></p> <p>11. Check fault codes in B.U.D.S. system</p> <p>a. Check if electrical actuator(s) is/are defective. <i>Replace defective part(s) (refer to COMPONENT INSPECTION AND ADJUSTMENT).</i></p>

SYMPTOM	ENGINE DOES NOT OFFER MAXIMUM POWER AND/OR DOES NOT REACH MAXIMUM OPERATING RPM.
CONDITION	NORMAL USE.
Test/Inspection	<p>1. Check spark plug condition and/or gap.</p> <p>a. Fouled spark plug or wrong spark plug gap. <i>Readjust gap and clean spark plug or replace.</i></p> <p>2. Check spark plug type.</p> <p>a. Improper spark plug heat range. <i>Install recommended spark plug (refer to TECHNICAL DATA).</i></p> <p>3. Perform engine leak test. Refer to ENGINE LEAK TEST procedure. Check for possible piston seizure.</p> <p>a. Damaged head gasket and/or seal and/or leaking intake/exhaust valve(s). <i>Replace and/or repair defective parts.</i></p> <p>4. Check for water in fuel (wrong fuel).</p> <p>a. There is water in fuel or wrong fuel. <i>Drain fuel system, search for leakage and refill it with appropriate fuel.</i></p> <p>5. Check engine compression.</p> <p>a. Worn piston(s) and/or piston ring(s). <i>Replace (refer to CYLINDER AND HEAD).</i></p> <p>6. Check fuel pressure.</p> <p>a. Low fuel pressure. <i>Perform fuel pressure test (refer to COMPONENT INSPECTION AND ADJUSTMENT).</i></p> <p>7. Check fault codes in B.U.D.S system.</p> <p>a. Check if electrical actuator(s) is/are defective. <i>Replace defective part(s) (refer to COMPONENT INSPECTION AND ADJUSTMENT).</i></p>

Section 03 ENGINE

Subsection 02 (TROUBLESHOOTING)

SYMPTOM	ENGINE CRANKS BUT FAILS TO START.
CONDITION	NORMAL USE.
Test/Inspection	1. Check if stick coil fits on spark plug (refer to SPARK PLUG).
	2. Check spark plug. a. Define spark plug (no spark) or wrong spark plug gap. <i>Readjust gap and clean spark plug or replace.</i>
	3. Check for fuel on spark plug. a. Flooded engine (spark plug wet when removed). <i>Activate engine drowned mode and crank engine with rags over the spark plug holes (refer to OVERVIEW in EMS system).</i>
	4. Check engine compression. a. Insufficient engine compression. <i>Replace defective part(s) (ex.:piston, ring(s), etc.).</i>
	5. In cold weathers, check engine decompressor (located on camshaft sprocket/ timing gear). a. Centrifugal weight spring is not engaged and/or damaged. <i>Readjust spring or replace centrifugal weight if damaged.</i>
	6. Check battery voltage a. Battery is discharged and starter works not properly. <i>Charge battery.</i>
	7. Check fault codes in B.U.D.S system a. Check if electrical actuator(s) is/are defective. <i>Replace defective part(s) (refer to COMPONENT INSPECTION AND ADJUSTMENT).</i>

SYMPTOM	HIGH ENGINE OPERATING TEMPERATURE.
CONDITION	NORMAL USE.
Test/Inspection	1. Check if cooling system shows any failure (see COOLING SYSTEM). a. System is leaking. <i>Repair and/or replace damaged part(s).</i>
	2. Check function of lubrication system (see LUBRICATION SYSTEM). a. Lubrication is not working properly. <i>Repair and/or replace damaged part(s).</i>
	3. Check condition and heat range of spark plug. a. Melted spark plug tip or inadequate heat range. <i>Replace.</i>
	4. Check water temperature sensor. a. Temperature sensor is defective. <i>Replace temperature sensor (refer to COMPONENT INSPECTION AND ADJUSTMENT).</i>

SYMPTOM	ENGINE DOES NOT START-NO SPARK AT SPARK PLUG (REFER TO ENGINE MANAGEMENT SYSTEM).
CONDITION	AT ENGINE CRANKING.
Test/Inspection	<p>1. Verify spark plug condition.</p> <p>a. Defective, improperly set, worn out, fouled. <i>Identify source of problem and correct. Replace spark plug.</i></p> <p>2. Check stick coil (refer to COMPONENT INSPECTION AND ADJUSTMENT).</p> <p>a. Defective part. <i>Replace stick coil.</i></p> <p>3. Check crankshaft position sensor (refer to COMPONENT INSPECTION AND ADJUSTMENT).</p> <p>a. Defective crankshaft position sensor. Corroded connector terminals. <i>Replace crankshaft position sensor. Clean terminals and apply silicone dielectric grease.</i></p> <p>4. Check condition of wiring harness and connectors.</p> <p>a. Cables and/or connectors are damaged and/or corroded. <i>Replace connectors or complete wiring harness (refer to COMPONENT INSPECTION AND ADJUSTMENT). Clean terminals and apply silicone dielectric grease.</i></p> <p>5. Check fault codes in B.U.D.S. system.</p> <p>a. Check if electrical actuator(s) is/are defective. <i>Replace defective part(s) (refer to COMPONENT INSPECTION AND ADJUSTMENT).</i></p>

LEAK TEST

VERIFICATION

Before performing the cylinder leak test, verify the following:

- clamp(s) tightness
- radiator and hoses
- oily contamination on leak indicator hole means a damaged oil seal on water pump shaft
- coolant out of leak indicator hole means a damaged rotary seal on water pump shaft (refer to COOLING SYSTEM)
- coolant escaping from water pump housing means damaged gasket(s) and/or loosened screws (refer to COOLING SYSTEM).

NOTE: For all the checkpoints mentioned above, see the appropriate engine section to diagnose and repair the engine.

LEAK TEST PROCEDURE

NOTE: The following instructions are valid for both cylinders.

PREPARATION AND TEST

NOTE: The following procedures should be done with a cold engine.

PREPARATION

Disconnect battery.

⚠ WARNING

Always respect this order for disassembly; disconnect BLACK (-) cable first. Electrolyte or fuel vapors can be present in engine compartment and a spark may ignite them and possibly cause personal injuries.

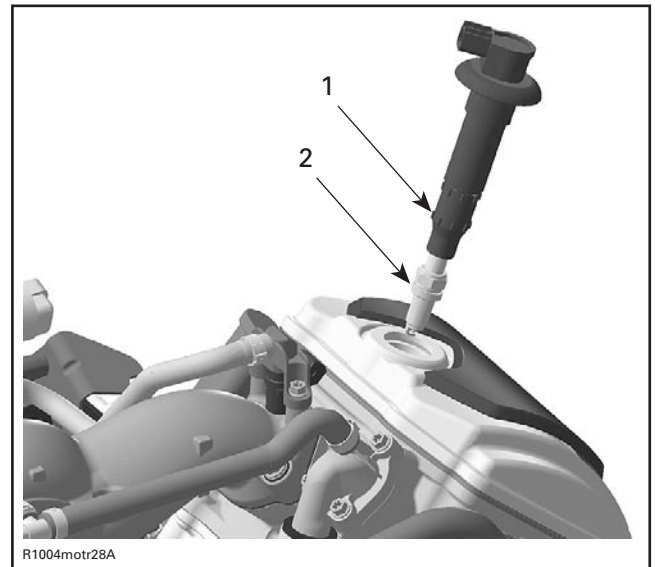
Remove:

- radiator cap.

Unplug and remove ignition coil.

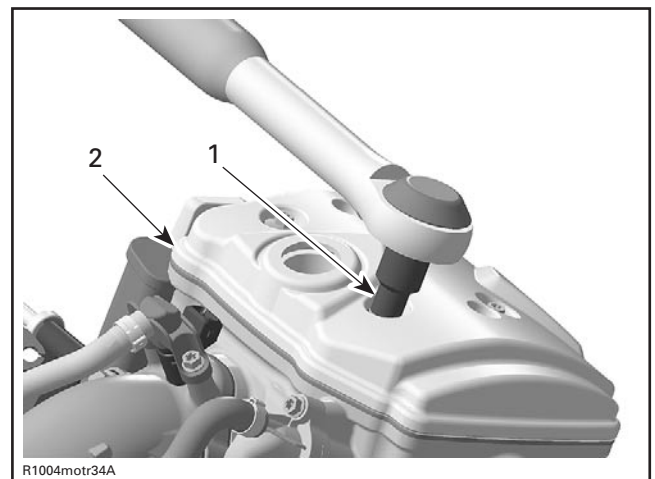
Remove spark plug from cylinder head.

NOTE: Ignition coil can help removing spark plug.



1. Ignition coil
2. Spark plug

Remove valve cover.



1. Ratchet wrench
2. Valve cover

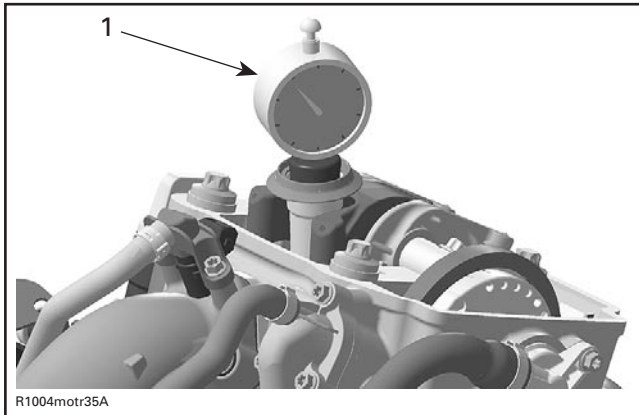
Section 03 ENGINE

Subsection 03 (LEAK TEST)

Preparation

Using a dial gauge set the crankshaft and the piston to precisely ignition TDC. If a dial gauge is not available, use a screwdriver or another similarly suitable tool.

NOTE: The engine must be set to precisely ignition TDC; if this is not ensured the engine will continue to rotate when pressure builds up.



1. Dial gauge

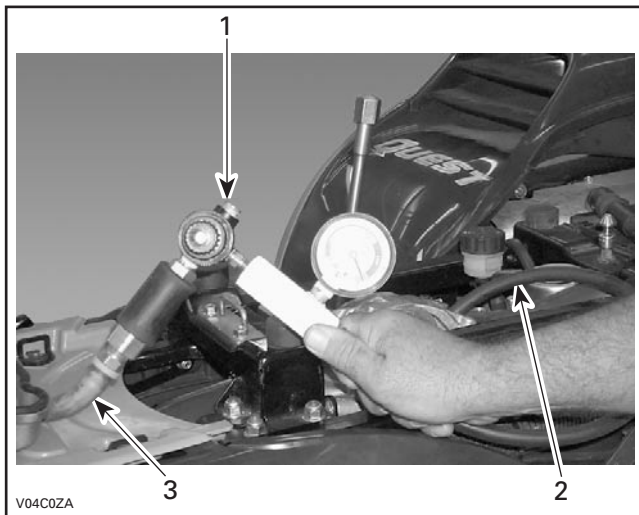
Connect to adequate air supply.

Set needle of measuring gauge to zero.

NOTE: All testers have specific instructions on gauge operation and required pressure.

Install gauge adapter into previously cleaned spark plug hole.

Supply combustion chamber with air pressure.



1. Leak tester
2. Adequate adapter for spark plug hole
3. Air supply hose

Note the amount or percentage of leakage (depending on tester).

LEAKAGE PERCENTAGE	ENGINE CONDITION
0% to 7%	Excellent condition
8% to 15%	Fair condition; proceed with tune-up or adjustment
16% to 30%	Poor condition; engine will run but performance might be down in some cases.
30% and higher	Very poor condition, diagnose and repair engine.

Diagnose

Listen for air leaks.

- air escaping on intake port/carburetor means leaking intake valve(s)
- air escaping on exhaust port means leaking exhaust valve(s)
- air bubbles out of radiator means leaking cylinder head gasket
- air/oil escaping from crankcase means damaged gasket and/or loosened screws (refer to CRANKCASE)
- air/coolant escaping from cylinder/head means damaged gasket(s) and/or loosened screws (refer to CYLINDER AND HEAD)
- air escaping into crankcase area means excessively worn cylinder and/or broken piston rings.

NOTE: For all the checkpoints mentioned above see the appropriate engine section to diagnose and repair the engine.

INSTALLATION

NOTE: Within the course of the assembly, always replace the valve cover gasket.

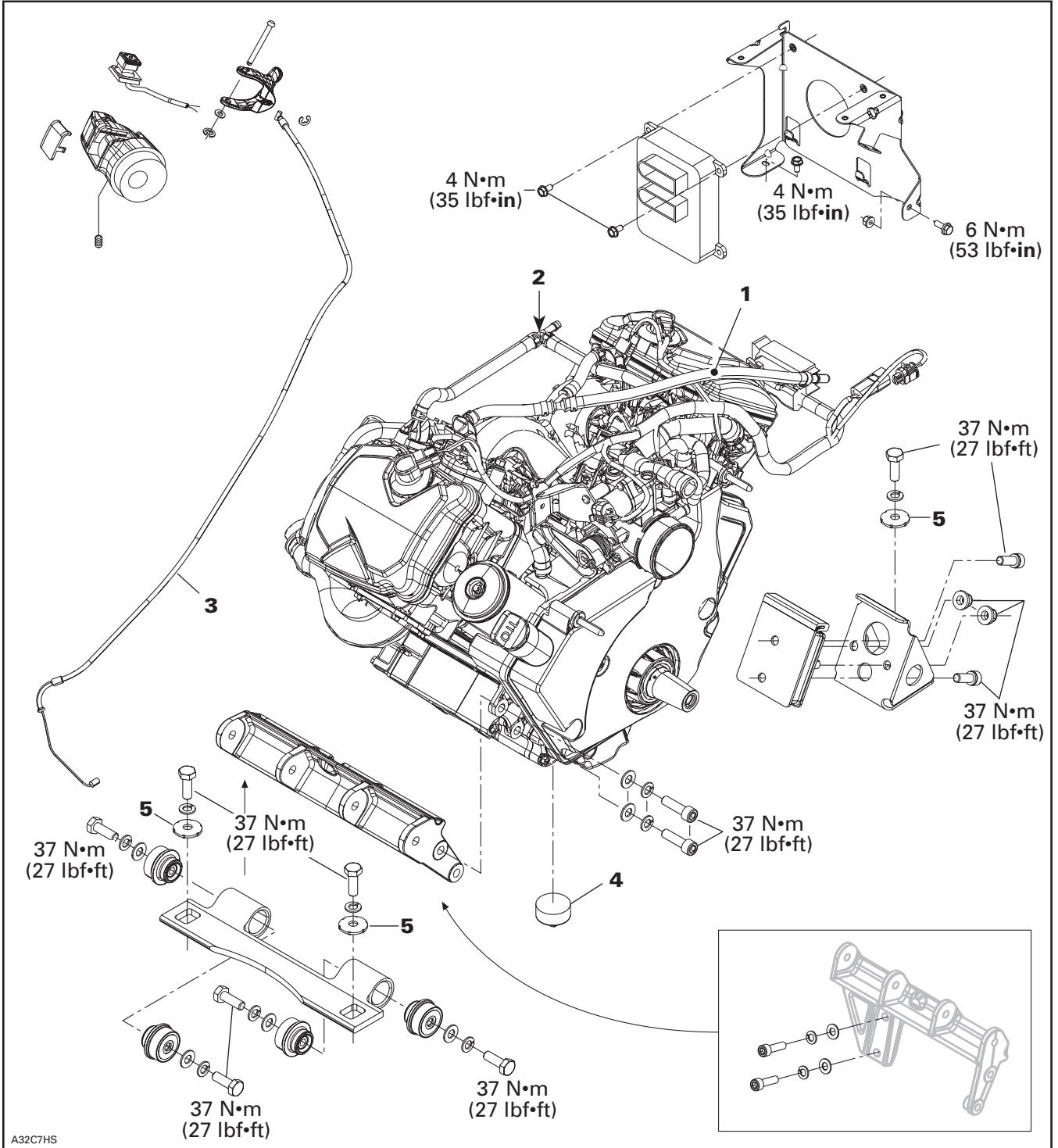
Torque valve cover screws to 9 N•m (80 lbf•in).

Torque spark plugs to 17 N•m (150 lbf•in).

Slightly oil the bottom outer part of the stick coil. This will simplify installation.

For installation, reverse the preparation procedure.

REMOVAL AND INSTALLATION



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Section 03 ENGINE

Subsection 04 (REMOVAL AND INSTALLATION)

ENGINE REMOVAL

Use B.U.D.S. to release fuel pressure. Refer to B.U.D.S. instructions.

Disconnect and remove battery.

⚠ WARNING

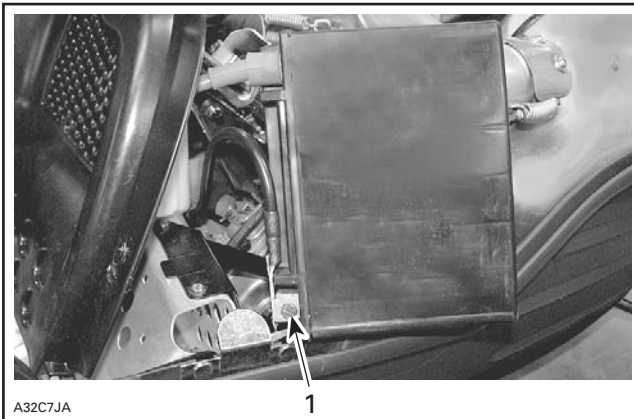
Battery BLACK (-) cable must always be disconnected first and connected last.

⚠ WARNING

Never charge or boost battery while installed. Battery contains sulfuric acid which is corrosive and poisonous. In case of contact with skin, flush with water and call a physician immediately.

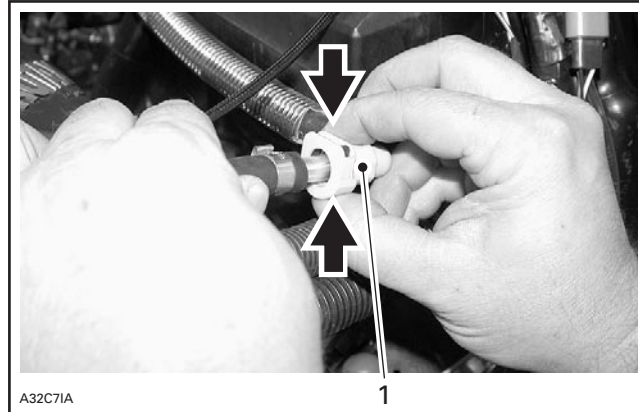
⚠ WARNING

Should the battery casing be damaged, wear a suitable pair of non-absorbent gloves when removing the battery by hand.



1. BLACK (-) cable

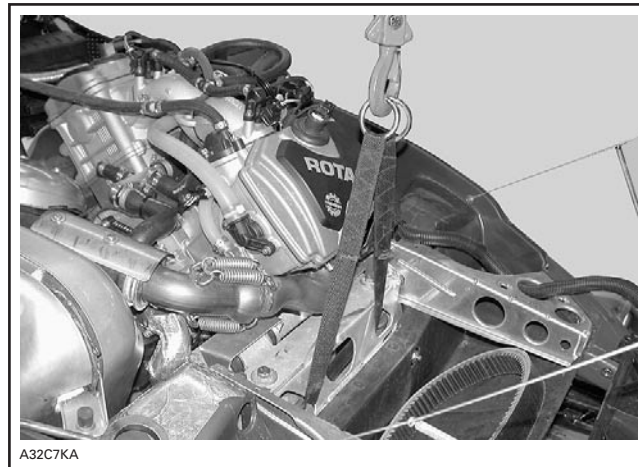
Unplug fuel supply line no. 1 by squeezing spring lock of plastic female coupling.



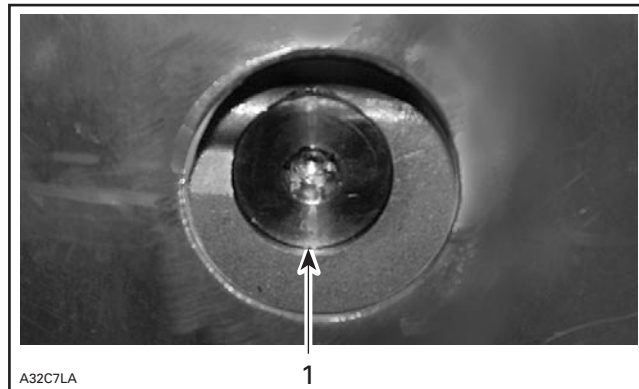
1. Plastic female coupling

Lift front of vehicle by the front cross member.

CAUTION: Never lift front of 4-TEC models by the front bumper.



Working underneath bottom pan remove oil drain plug then lift oil filter cover.



1. Oil drain plug

Section 03 ENGINE

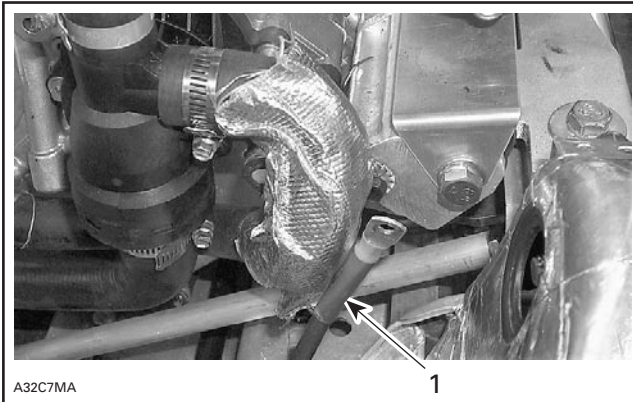
Subsection 04 (REMOVAL AND INSTALLATION)

Remove muffler and pipes.

Remove coolant reservoir cap. Siphon as much coolant as possible. Disconnect bottom hose from thermostat housing. Disconnect side hose from thermostat housing.

Disconnect air bleed hose from T-fitting no. 2.

Disconnect alternator, then ground cable from engine support.



1. Ground cable

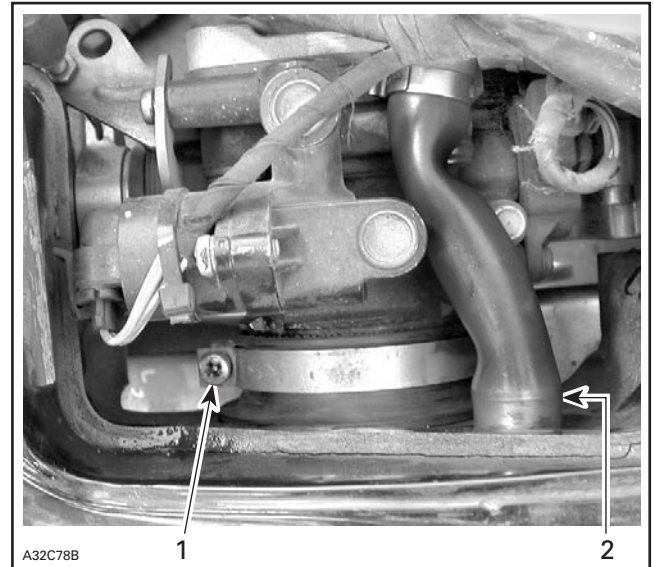
Remove air silencer access panel.



1. Access panel

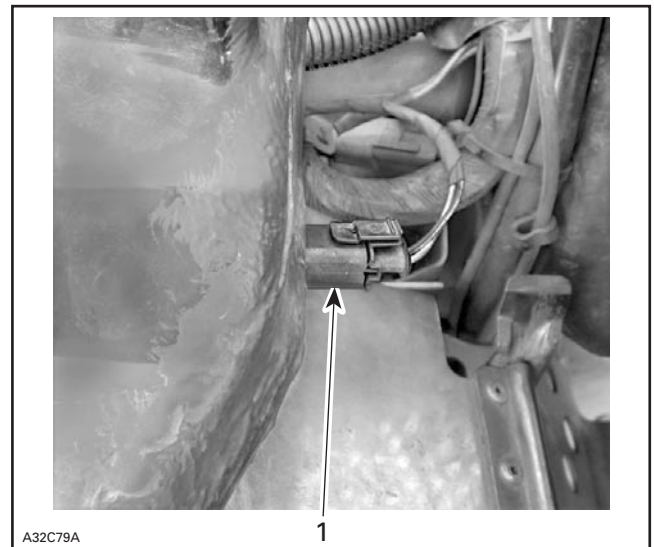
Loosen collar screw on air silencer grommet.

Disconnect blow-by hose from air silencer.



1. Collar screw
2. Blow-by hose

Disconnect air temperature sensor at rear of air silencer.



1. Air temperature sensor

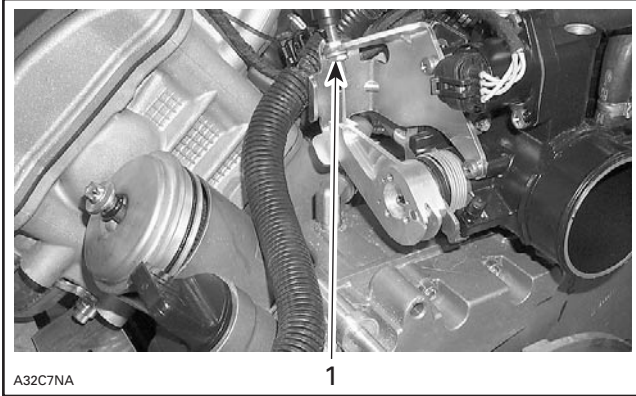
Remove air silencer.

Remove guard, drive belt, drive pulley, driven pulley.

Section 03 ENGINE

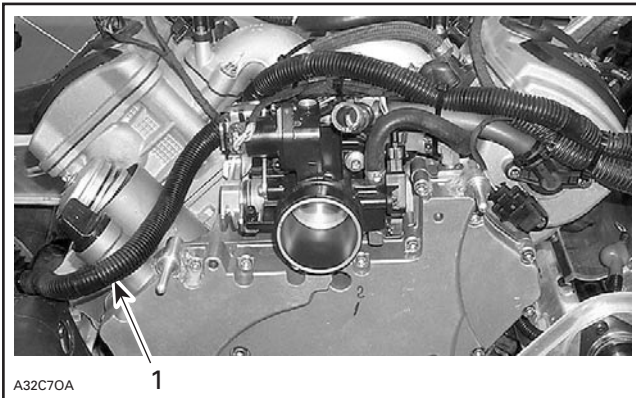
Subsection 04 (REMOVAL AND INSTALLATION)

Disconnect RED (+) cable from starter solenoid.
Disconnect throttle cable housing **no. 3** from throttle body.



1. Throttle cable housing attachment

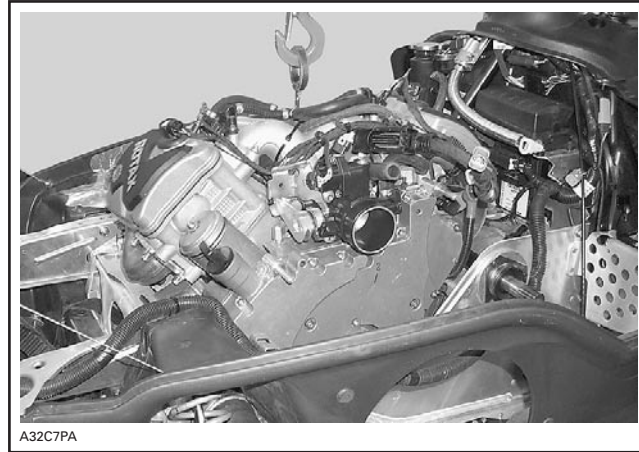
Cut the locking ties retaining vehicle harness to engine. Move the vehicle harness away from engine.



1. Vehicle harness

Disconnect engine harness connector (bottom one) from ECM (engine control module).

Hook up engine by lifting eye located on intake manifold. Using appropriate lifting device, remove engine from vehicle.



ENGINE INSTALLATION

Before engine installation make sure a good condition stopper **no. 4** is in place.

To install engine on vehicle, reverse removal procedure. However, pay attention, to all appropriate component/system reinstallation procedures described throughout this *Shop Manual Supplement* and to the following:

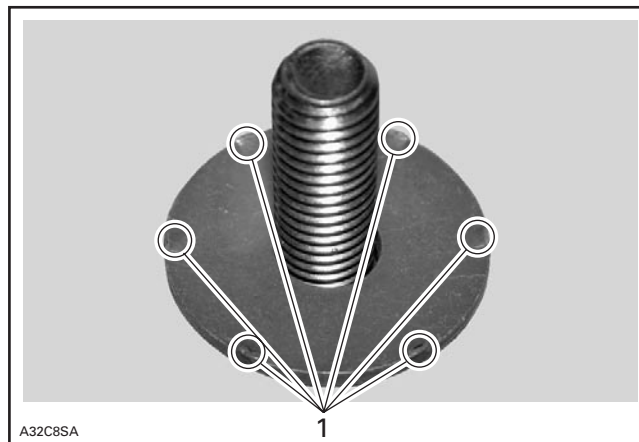
Check pulley alignment and drive belt height.

Install doughnut shaped exhaust gasket with both notches aligned with Y-manifold protrusions.

NOTE: No sealant required on doughnut shaped exhaust gasket.

Torque screws of engine supports to 37 N•m (27 lbf•ft).

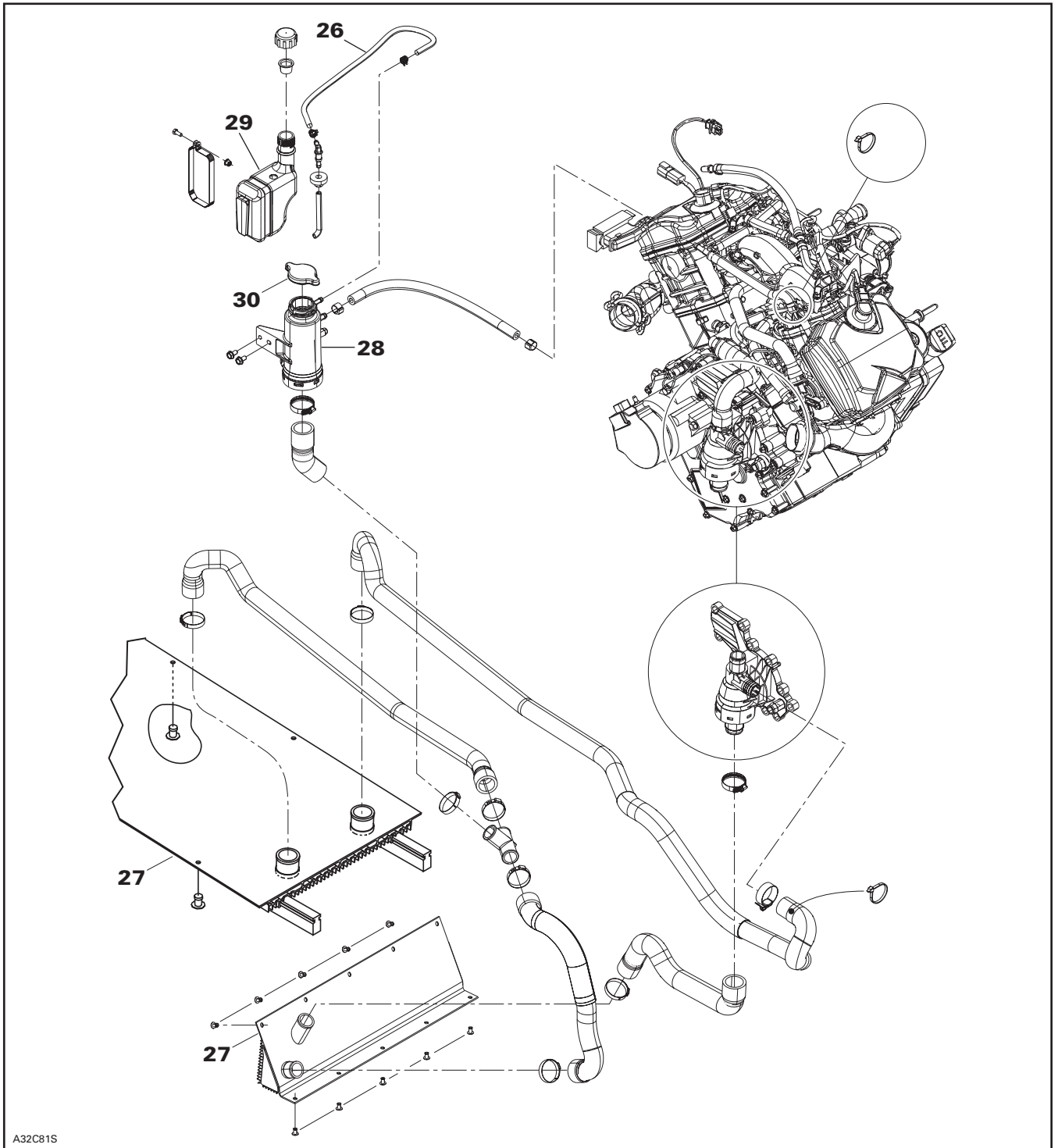
NOTE: Install washers **no. 5** with the teeth toward the support.



1. Teeth

Do not forget to connect air temperature sensor to air silencer otherwise a trouble code will appear.

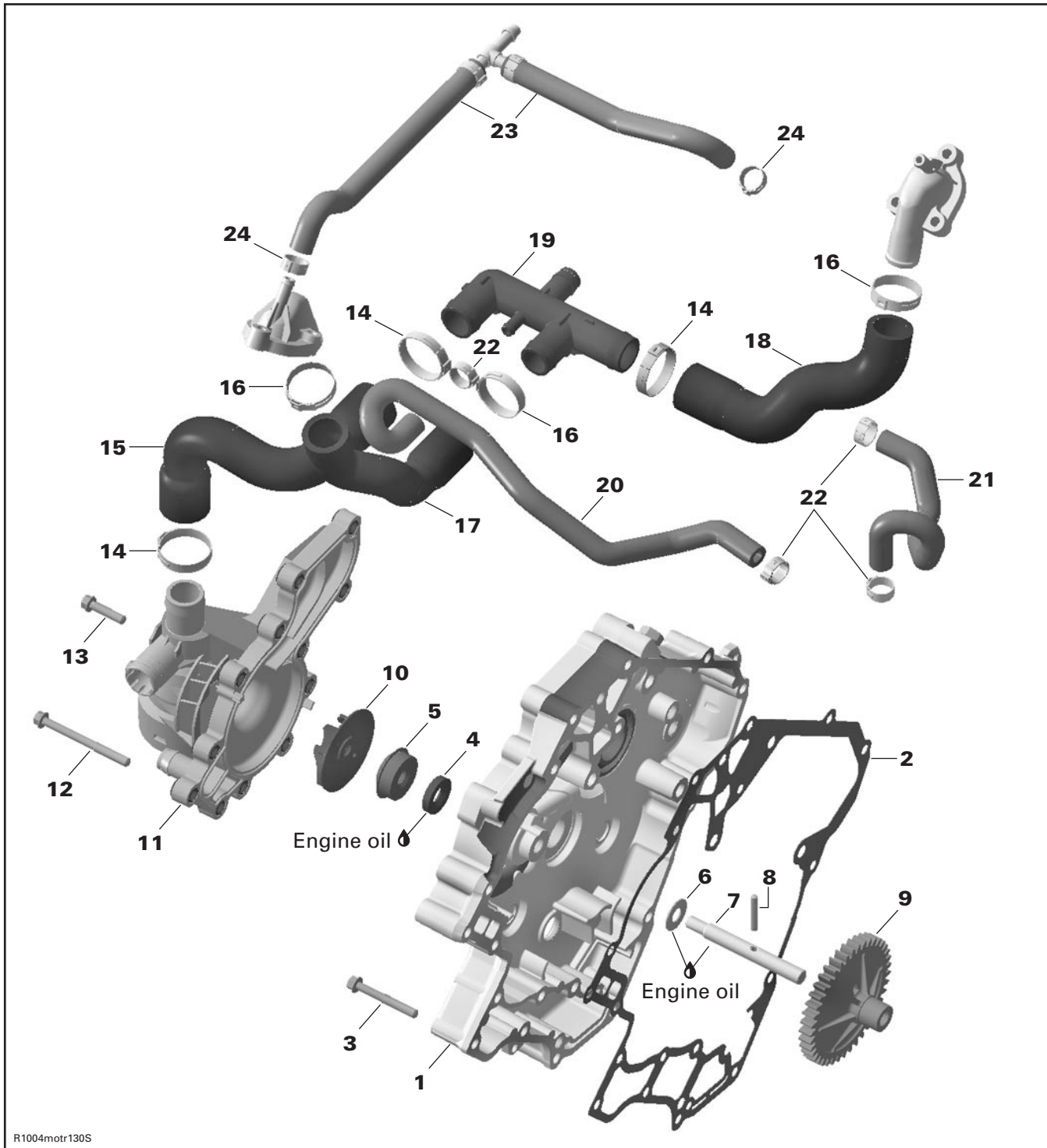
COOLING SYSTEM



A32C81S

Section 03 ENGINE

Subsection 05 (COOLING SYSTEM)



R1004motr130S

COOLING SYSTEM LEAK TEST

⚠ WARNING

To prevent burning yourself, do not work on cooling system when the engine is hot.

Remove pressure cap no. 30.

Install special radiator cap (P/N 529 021 400) included in engine leak tester kit (P/N 861 749 100) on coolant tank no. 28. Install hose pincher (P/N 295 000 076) on overflow hose no. 26. Using pump also included in the kit, pressurize all system through coolant tank to 120 kPa (17 PSI).

Check all hoses, radiators no. 27 and cylinder/base for coolant leaks.



INSPECTION

Check general condition of hoses and clamp tightness.

Check leak indicator hole to see if there is oil or water.

NOTE: Flowing water indicates a damaged rotary seal no. 5. Oil out of the leak indicator hole indicates a defective oil seal no. 4.

COOLANT REPLACEMENT

Recommended Coolant

IMPORTANT: USE THE 50/50 PREMIXED COOLANT - 37°C (- 35°F) (P/N 293 600 038).

CAUTION: To prevent rust formation or freezing condition, always replenish the system with the recommended coolant.

System Capacity

Refer to TECHNICAL DATA.

Draining the System

⚠ WARNING

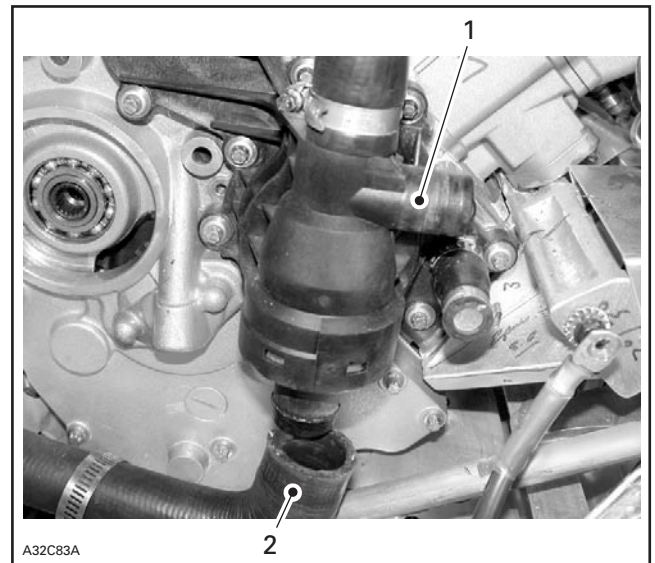
To prevent burning yourself do not work on cooling system when the engine is hot.

Remove pressure cap no. 30.

Siphon as much coolant through coolant tank no. 28.

Empty the overflow coolant tank no. 29.

Disconnect side hose and bottom hose from thermostat housing.



1. Side hose location
2. Bottom hose

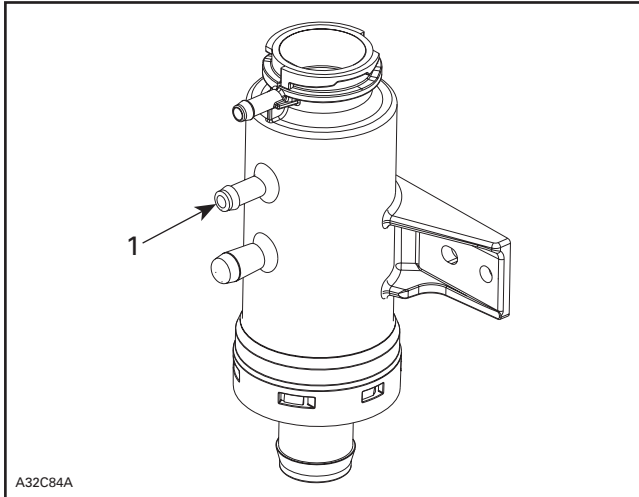
Let coolant drain.

Section 03 ENGINE

Subsection 05 (COOLING SYSTEM)

Refilling the System

With vehicle on a flat surface, engine cold, slowly half fill coolant tank no. 28. Coolant level must not reach bleed hose nipple to allow air to escape from the system.



1. Bleed hose nipple

Coolant level will be stable once coolant tank is half filled.

Do not install the pressure cap no. 30.

Start engine. Check level in coolant tank. Refill with coolant to keep coolant tank half filled.

CAUTION: Never allow coolant tank to be empty during the filling procedure.

Let engine idling for about 10 minutes or until radiators are warm — which means that the thermostat is open.

Keep engine idling for an additional 5 minutes maximum or until coolant temperature reaches 100°C (212°F). Always keep coolant tank half filled but the bleed hose free.

CAUTION: Never allow coolant to exceed 100°C (212°F). Put a thermometer in coolant tank to monitor the temperature.

Stop engine. Fill up both coolant tank no. 28 and overflow coolant tank no. 29. Install their respective caps.

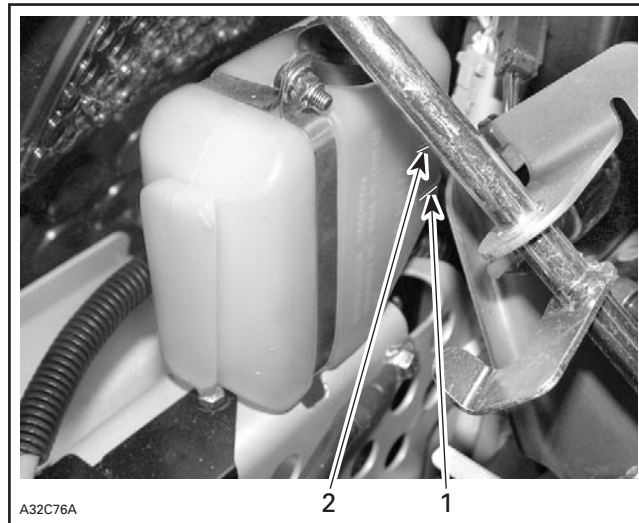
Let vehicle cool down for at least 30 minutes.

Check coolant level in overflow coolant tank no. 29. Some coolant should have been sucked through the overflow hose up to the coolant tank. If not repeat refilling procedure.

If some coolant have been siphoned from the overflow coolant tank no. 29, remove pressure cap no. 30 and fill up the coolant tank no. 28. Reinstall pressure cap no. 30.

Fill overflow coolant tank no. 29 to maximum level line.

Recheck coolant level after vehicle has completely cooled down. Coolant tank no. 28 must be full and the level in overflow coolant tank no. 29 must be between the minimum and maximum marks.



1. Minimum
2. Maximum

After the first few kilometers (miles) of running re-check level.

COOLANT HOSES

Any damaged/leaky or brittle coolant hose or component must be replaced. When replacing a hose, also replace the clamps.

At installation, do not twist or bend the hoses.

WATER PUMP HOUSING/ THERMOSTAT

The thermostat is a dual action type.

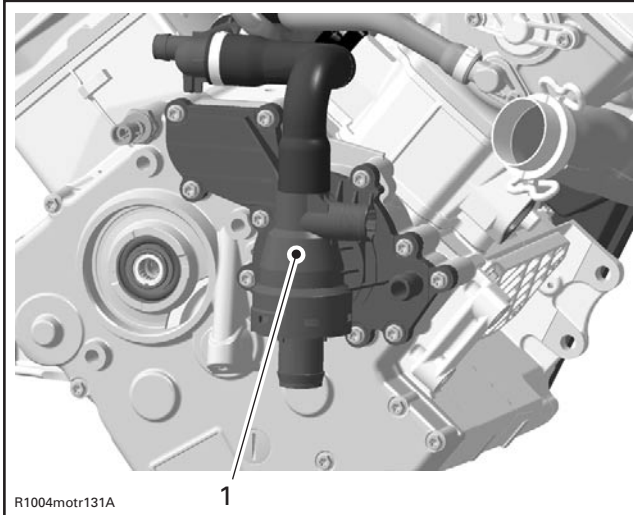
Removal

NOTE: The thermostat is located on the ignition cover. Thermostat and water pump housing form one unit and can only be replaced as one complete component.

Drain cooling system (refer to DRAINING THE SYSTEM above).

Remove:

- water pump housing screws **no. 12** and **no. 13** and pull water pump housing **no. 11**.



1. Water pump housing with screws and thermostat inside

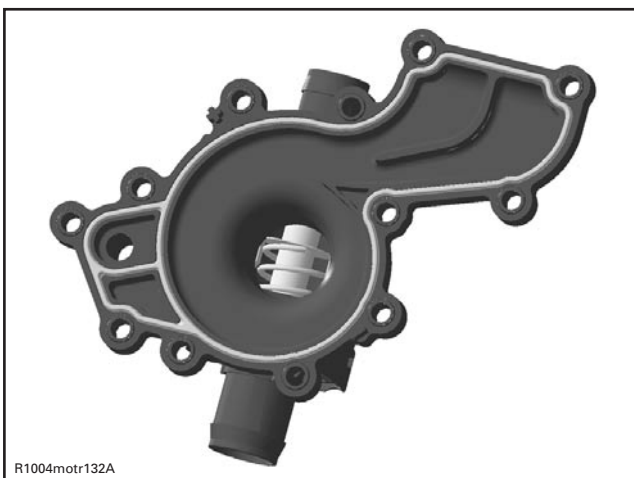
Test

To check thermostat, put in water and heat water. Thermostat should open when water temperature reaches 80°C (176°F).

Inspection

Check the water pump housing for cracks or other damage.

Replace water pump housing if damaged.



WATER PUMP HOUSING WITH GASKET

Installation

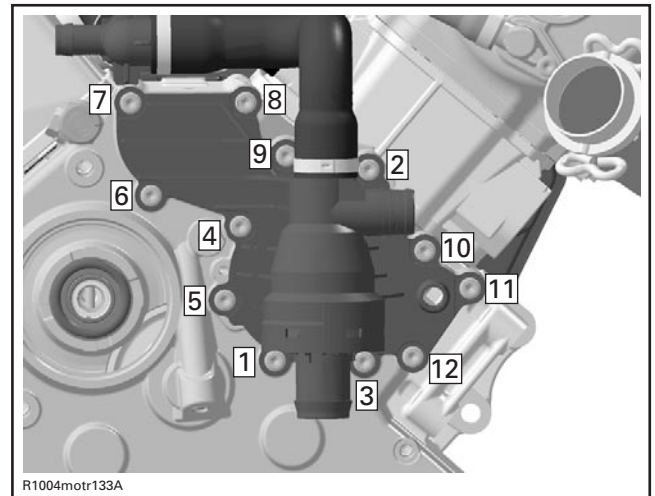
The installation is the opposite of the removal procedure.

NOTE: At installation, replace the gasket of the water pump housing.

Torque water pump housing screws to 9 N•m (80 lbf•in).

CAUTION: To prevent leakage, make sure the gasket is exactly in the groove when the water pump housing is reinstalled.

Tightening sequence for screws on water pump housing is as per following illustration.



WATER PUMP IMPELLER

Removal

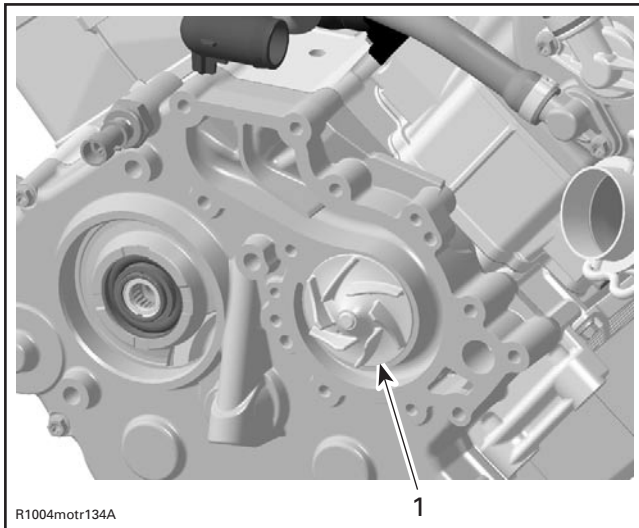
Remove:

- water pump housing **no. 11**
- impeller **no. 10**.

Using pliers, carefully turn the impeller anti-clockwise to remove it from the water pump shaft without any damage. The thread of the water pump shaft is right-hand.

Section 03 ENGINE

Subsection 05 (COOLING SYSTEM)



1. Impeller

Inspection

Check impeller for cracks or other damage. Replace impeller if damaged.

Installation

The installation is the opposite of the removal procedure. Pay attention to the following details.

CAUTION: Be careful not to damage impeller wings during installation. Tighten impeller to 7 N•m (62 lbf•in).

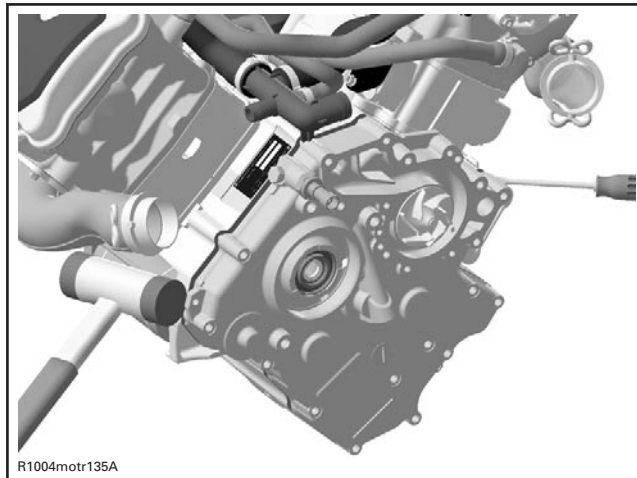
IGNITION COVER

Removal

Remove:

- drain lubrication system (refer to OIL CHANGE)
- alternator (refer to ALTERNATOR)
- water pump housing no. 11
- impeller no. 10
- screws no. 3 and pull ignition cover no. 1.

Carefully remove the ignition cover using a screwdriver and a plastic hammer.



Ball Bearing Removal Procedure

NOTE: Heat ignition cover up to 100°C (212°F) before removing ball bearings.

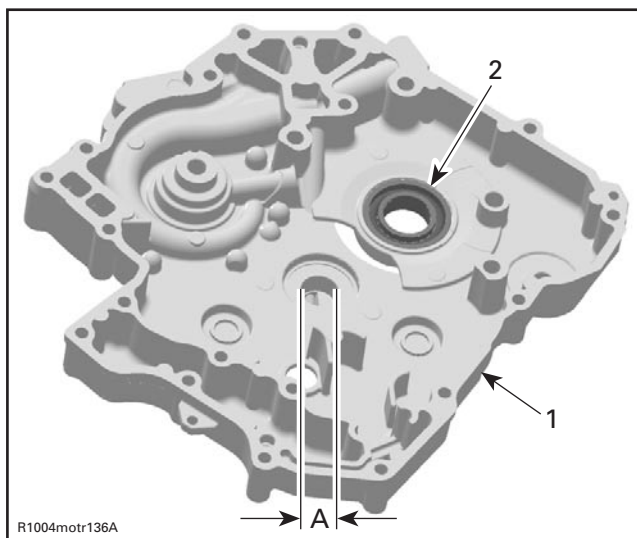
⚠ WARNING

Clean oil, outside and inside ignition cover before heating it.

NOTE: Using a suitable arbor, eject the ball bearing with slight hammer blows towards the inside. The ignition cover has to be supported from below in order to prevent damage of the sealing surface.

Inspection

Check oil supply hole/support bearing for scorings or other damages. There are no plain bearings in the ignition cover.



1. Ignition cover
2. Ball bearing
A. Oil supply hole/support bearing diameter

NOTE: Measure oil supply hole/support bearing diameter. Compare to crankshaft journal diameter on alternator (refer to CRANKSHAFT). Replace the ignition cover if the measurement is out of specification.

DIAMETER OF OIL SUPPLY HOLE/ SUPPORT BEARING	
SERVICE LIMIT	20.040 mm (0.7889 in)

NOTE: Check ball bearing for excessive play and smooth operation. Replace if necessary.

Installation

The installation is the opposite of the removal procedure. Pay attention to the following details.

Ball Bearing Installation Procedure

NOTE: Heat ignition cover up to 100°C (212°F) before installing ball bearing.

⚠ WARNING

Clean oil, outside and inside housing before heating it.

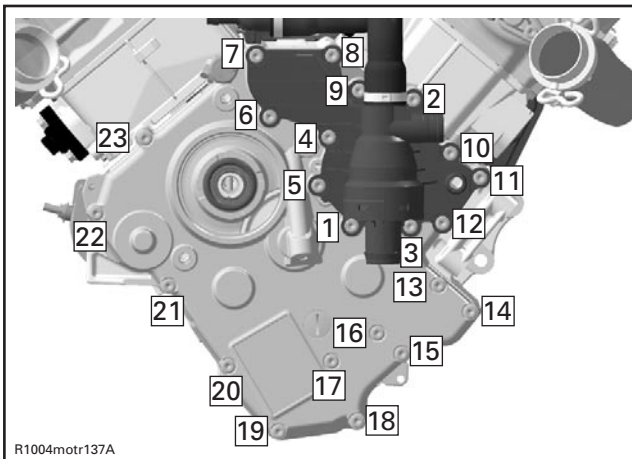
Place new ball bearing in freezer for 10 minutes before installation.

NOTE: Do not use any striking tool to insert the ball bearing. The bearing must be mounted manually with moderate (thumb) pressure into the ignition cover.

Replace gasket **no. 2**.

Torque ignition cover screws to 9 N•m (80 lbf•in).

Tighten screws in the following sequence.

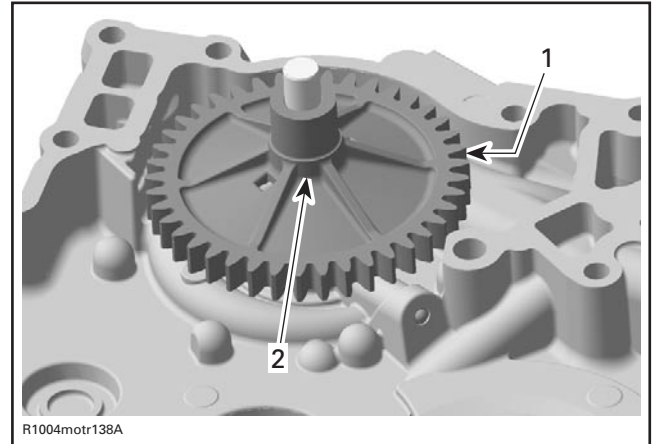


WATER PUMP SHAFT

Removal

Remove:

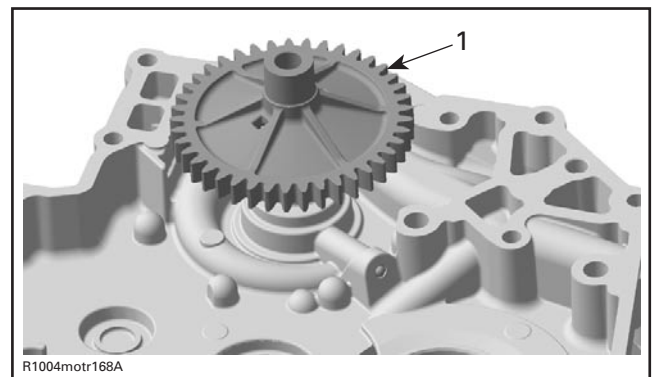
- water pump housing **no. 11**
- impeller **no. 10**
- ignition cover



1. Water pump gear
2. Thrust washer behind water pump gear

- water pump gear **no. 9**

NOTE: The water pump gear is held by a needle pin on the water pump shaft.

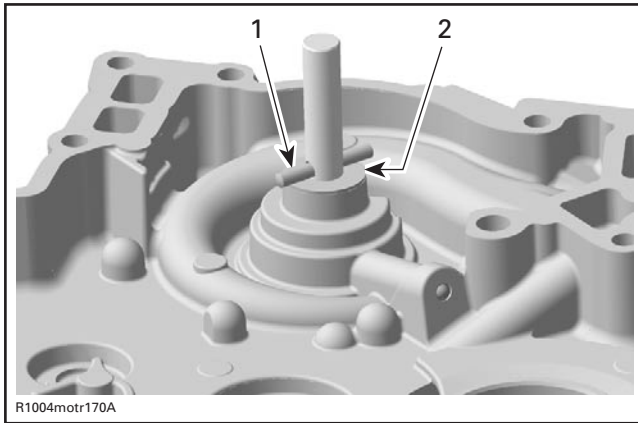


1. Water pump gear

Section 03 ENGINE

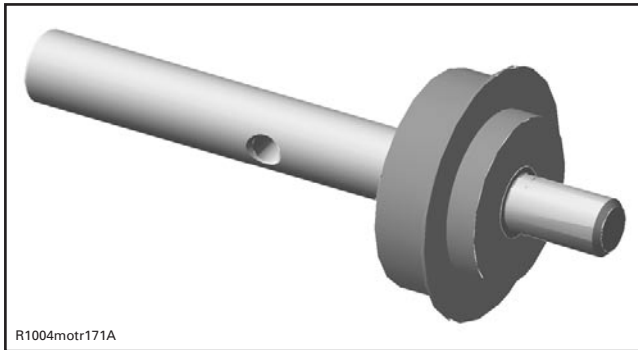
Subsection 05 (COOLING SYSTEM)

- needle pin no. 8 and thrust washer no. 6.

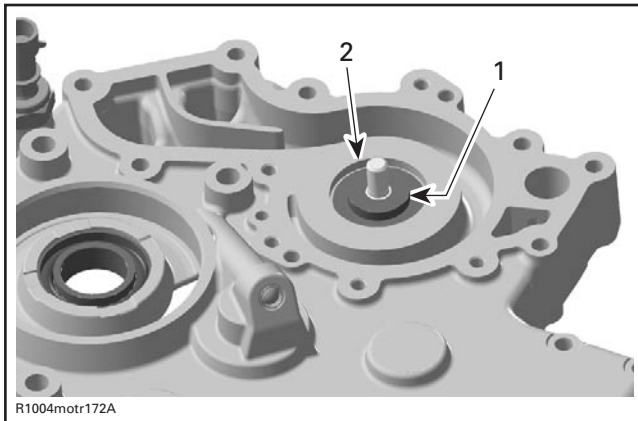


1. Needle pin
2. Thrust washer

CAUTION: When removing water pump shaft, always replace rotary seal with water pump shaft no. 7 and oil seal no. 4 (behind rotary seal).



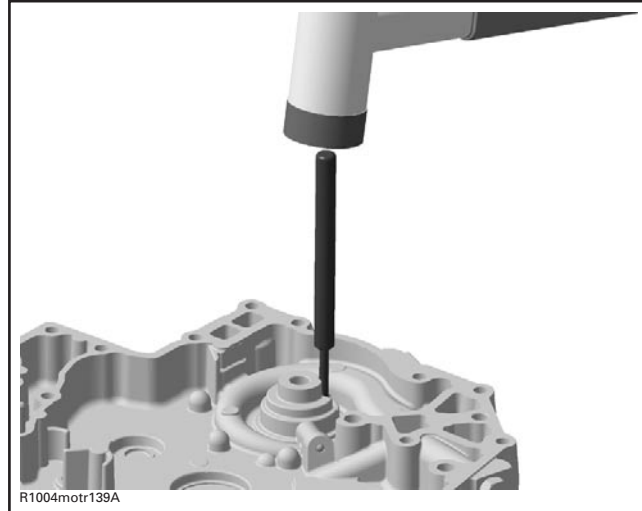
WATER PUMP SHAFT WITH ROTARY SEAL



1. Oil seal behind the rotary seal
2. Rotary seal bore

Extract the water pump shaft with rotary seal no. 5 together with oil seal no. 4 from inside ignition cover with a pusher.

CAUTION: Be careful not to damage the surface of the rotary seal bore in ignition cover.



Inspection

Inspect water pump gear for wear and damage on the snap mechanism to the needle pin. Replace if damaged.

Water pump shaft with rotary seal must rotate freely. Otherwise, replace it.

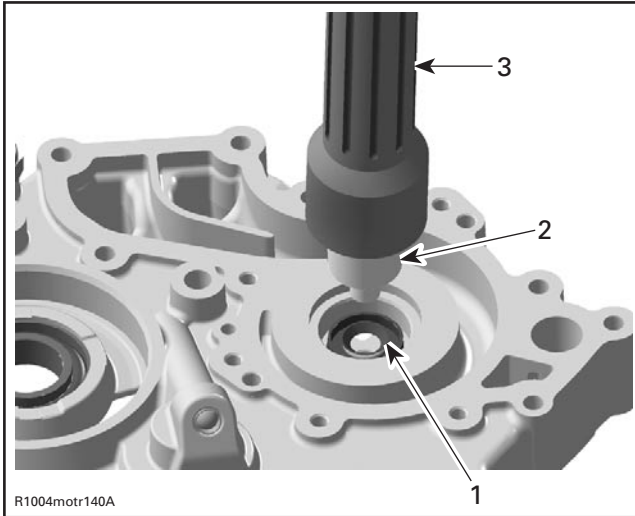
NOTE: When removing water pump shaft, always replace together retaining ring, oil seal, water pump shaft with rotary seal with new parts.

Installation

For installation, reverse the removal procedure.

NOTE: Never use oil in the press fit area of the oil seal and rotary seal.

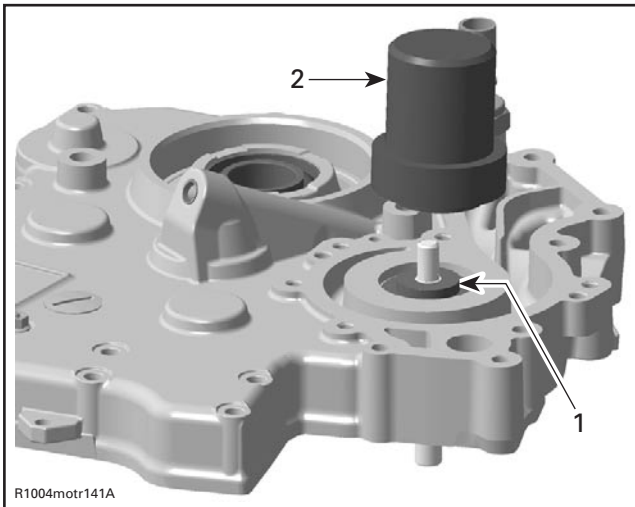
Push water pump shaft oil seal in place by using the oil seal pusher (P/N 529 035 757).



1. Oil seal for the water pump shaft
2. Oil seal pusher (P/N 529 035 757)
3. Handle for insertion jig (P/N 420 877 255)

Install the water pump shaft assembly using the water pump ceramic seal installer (P/N 529 035 766).

CAUTION: Never use a hammer for the rotary seal installation. Only use a press to avoid damaging the ceramic component.



1. Water pump shaft with rotary seal
2. Water pump ceramic seal installer (P/N 529 035 766)

Mount thrust washer no. 6 and needle pin no. 8.

NOTE: The water pump shaft must be slightly pre-loaded by the spring of the rotary seal.

Use Multi-purpose grease in water pump shaft bore.

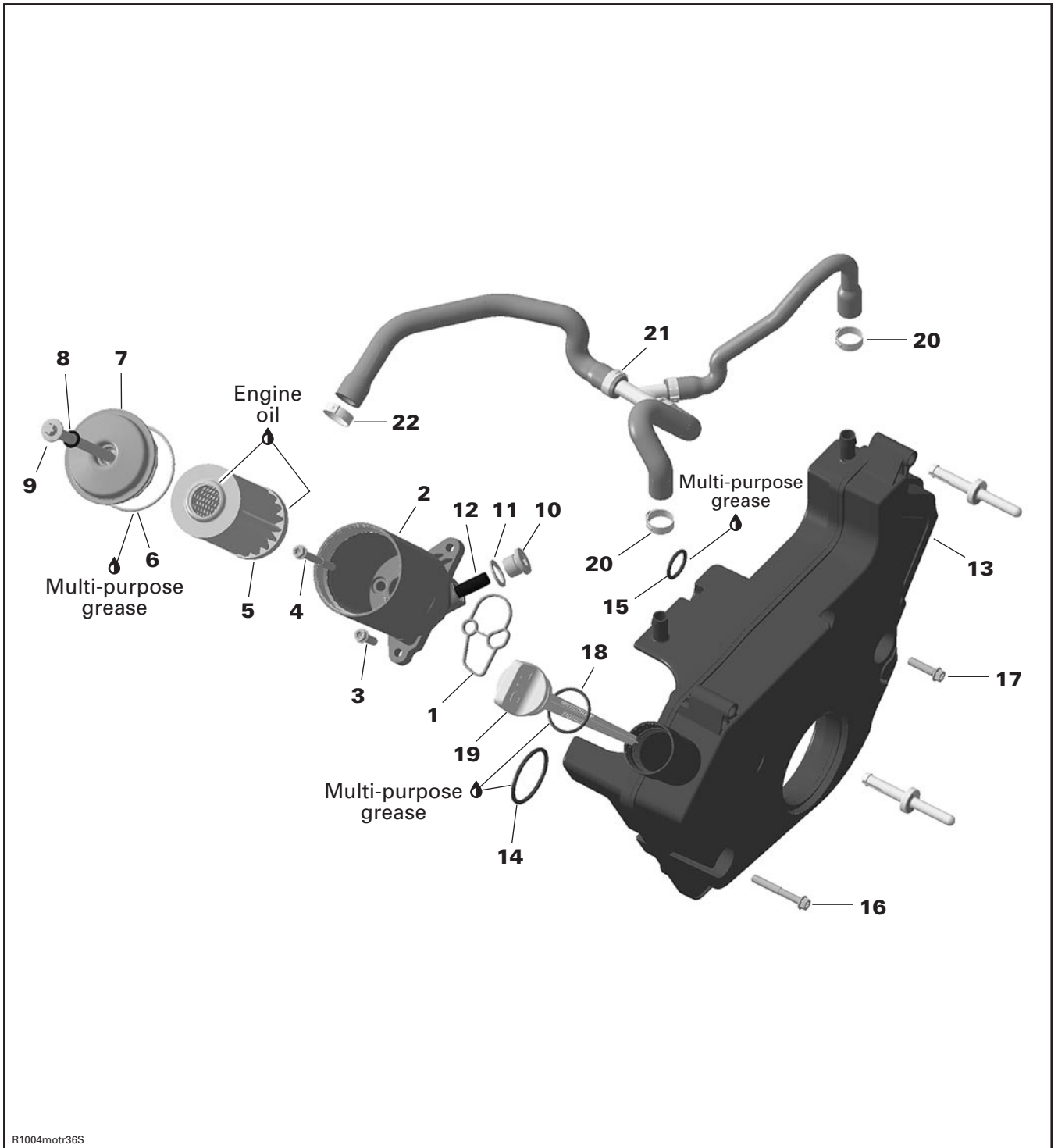
PRESSURE CAP

Check if cap pressurizes the system. If not, install a new 110 kPa (16 PSI) cap (do not exceed this pressure).

RADIATORS

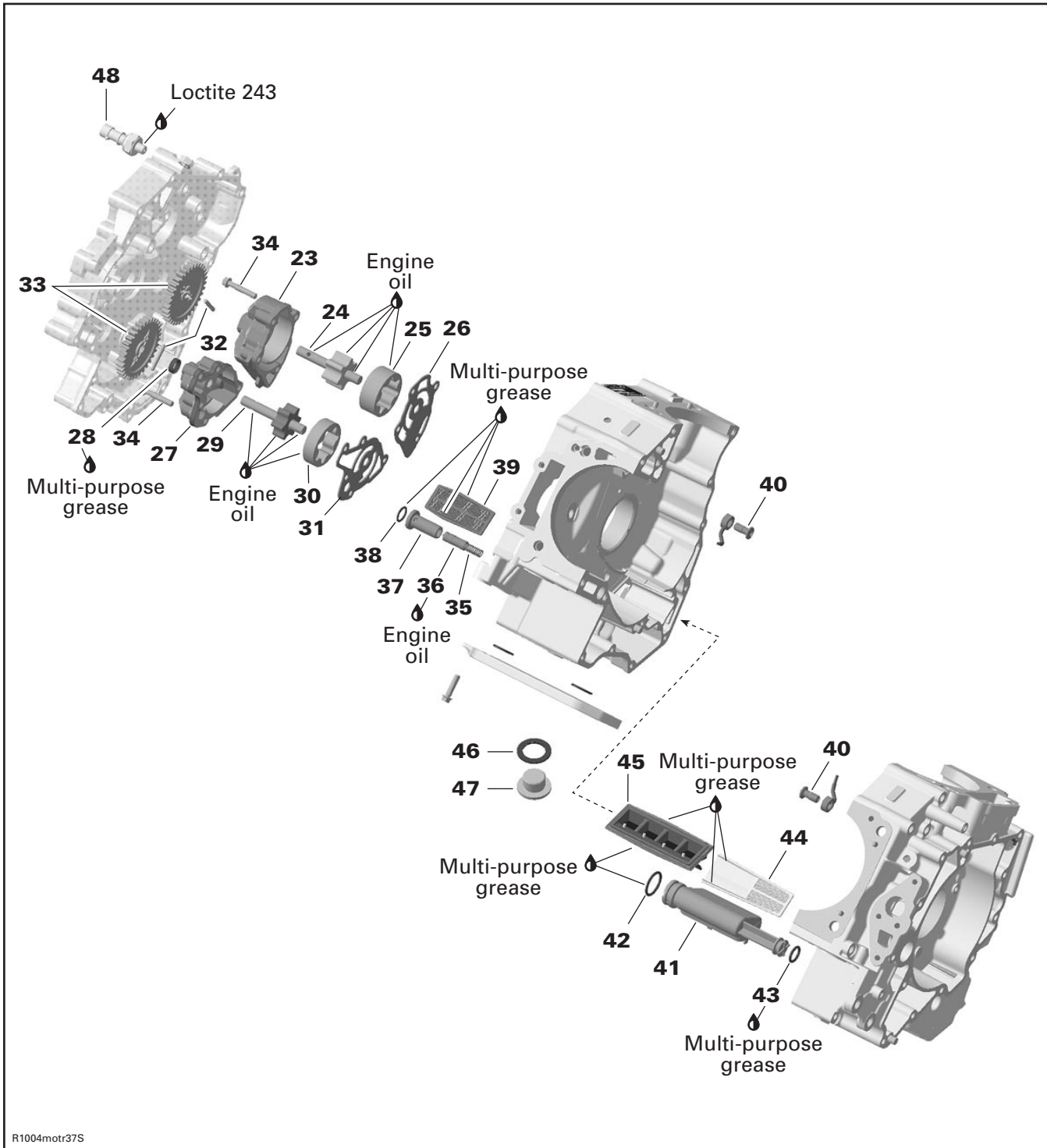
Refer to CHASSIS for radiators no. 27 removal and installation.

LUBRICATION SYSTEM



Section 03 ENGINE

Subsection 06 (LUBRICATION SYSTEM)



R1004motr37S

GENERAL

Prior to changing the oil, ensure vehicle is on a level surface.

Oil and oil filter must be replaced at the same time. Oil change and oil filter replacement should be done with a warm engine.

⚠ **WARNING**

The engine oil can be very hot. Wait until engine oil is warm.

At installation, use torque values and Loctite products from the exploded view. Clean threads before using Loctite products when installing screws.

Dispose oil and filter as per your local environmental regulations.

OIL LEVEL CHECK

Snowmobile must be on a level surface.

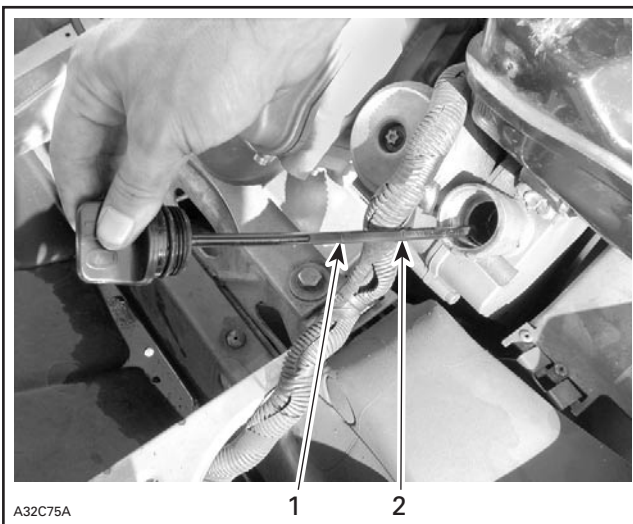
Leave engine running at idle for at least 30 seconds.

Stop engine and wipe the dipstick.

Dipstick must be completely screwed in before checking oil level.

Oil level must be between minimum and maximum marks on dipstick.

There is a capacity of 500 mL (17 U.S. oz) between the two marks.



1. Maximum
2. Minimum

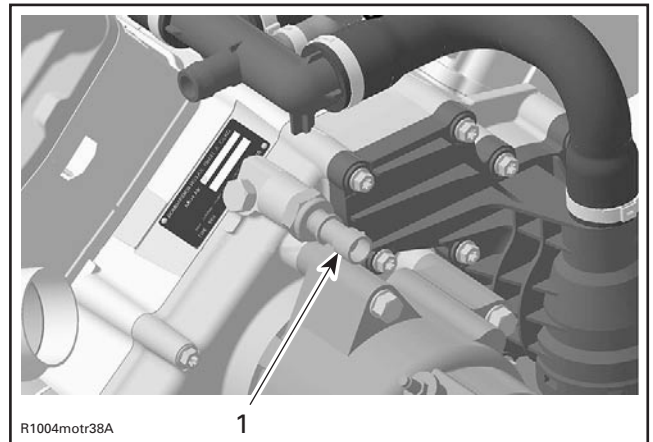
Add BOMBARDIER synthetic oil 0W40 through dipstick hole as required.

Reinstall dipstick.

ENGINE OIL PRESSURE TEST

NOTE: The engine oil pressure test should be done with a **warm engine** 80°C (176°F) and the **recommended oil**.

Remove the oil pressure switch **no. 48** in the area of the cylinder head (intake side), mounted on the ignition cover and install the oil pressure gauge (P/N 529 035 709) and oil pressure adapter (P/N 529 035 652). Use fuel line remover (P/N 529 035 714) to unplug oil pressure adapter from oil pressure gauge.



1. Oil pressure switch

NOTE: Oil pressure switch works between 20 kPa (2.9 PSI) and 40 kPa (5.8 PSI).

The engine oil pressure should be within the following values.

OIL PRESSURE	1300 RPM	7250 RPM
MINIMAL	150 kPa (22 PSI)	400 kPa (58 PSI)
NOMINAL	200 kPa (29 PSI)	450 kPa (65 PSI)
MAXIMAL	250 kPa (36 PSI)	550 kPa (80 PSI)

If the engine oil pressure is out of specifications, check the points described in TROUBLESHOOTING section.

To install oil pressure switch, reverse the removal procedure.

Section 03 ENGINE

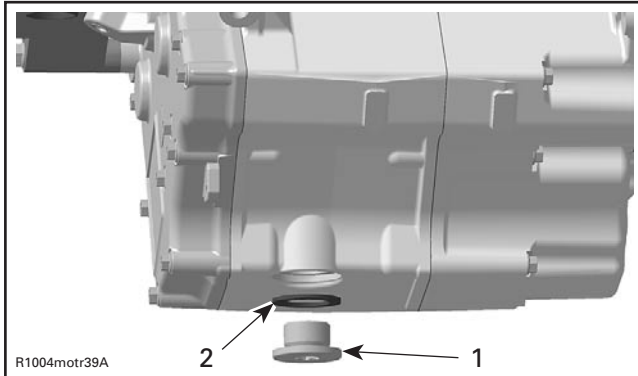
Subsection 06 (LUBRICATION SYSTEM)

OIL CHANGE

Removal

Place a drain pan under the engine drain plug area.
Clean the drain plug area.

Unscrew drain plug **no. 47** then remove dipstick **no. 19**.



1. Drain plug
2. Gasket ring

- Unscrew retaining screw **no. 9** to drain the oil filter housing.
- Wait a while to allow oil to flow out of oil filter.

Inspection

Oil condition gives information about the engine condition. See TROUBLESHOOTING section.

Installation

The installation is the reverse of removal procedure. Pay attention to the following details.

NOTE: At installation, remember to replace the gasket ring **no. 46** of the drain plug.

Torque drain plug to 55 N•m (40 lbf•ft).

System Capacity

Refer to TECHNICAL DATA.

NOTE: After filling, warm up the engine to 80°C (176°F) and check the oil level with the dipstick. Refer to OIL LEVEL CHECK above.

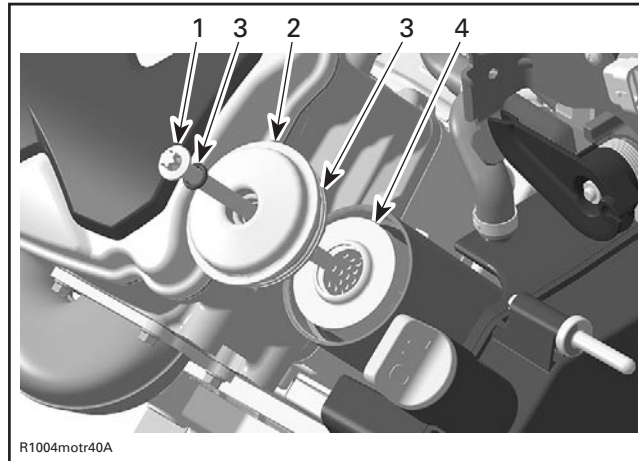
OIL FILTER

Removal

Remove:

- engine oil (refer to OIL CHANGE)
- oil filter screw **no. 9**

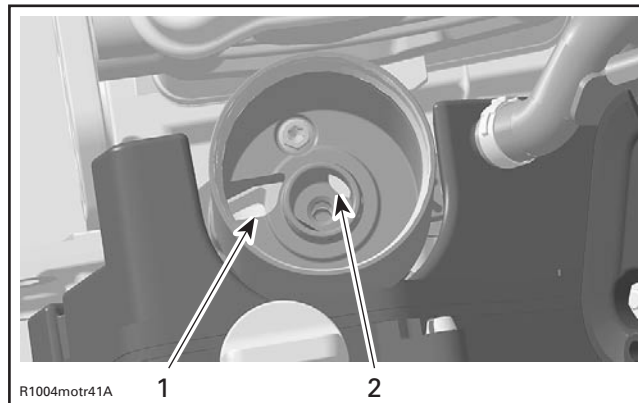
- oil filter cover **no. 7**
- oil filter **no. 5**.



1. Oil filter screw
2. Oil filter cover
3. Gaskets
4. Oil filter

Inspection

Check and clean the oil filter inlet and outlet area for dirt and other contaminations.



1. Inlet bore from the oil pump to the oil filter
2. Outlet bore to the engine oil providing system

Installation

The installation is the opposite of the removal procedure. Pay attention to the following details.

NOTE: Slightly oil the two gaskets at the top and bottom sides of the oil filter before assembly. This will ease assembly and prevent displacement of the gasket during installation.

At assembly, remember to replace the two O-rings **no. 6** and **no. 8** of the oil filter screw.

Slightly grease the O-ring **no. 6** of the oil filter cover before assembly using multi-purpose grease. This will ease assembly and prevent displacement of the gasket during installation.

Torque oil filter screw to 9 N•m (80 lbf•in).

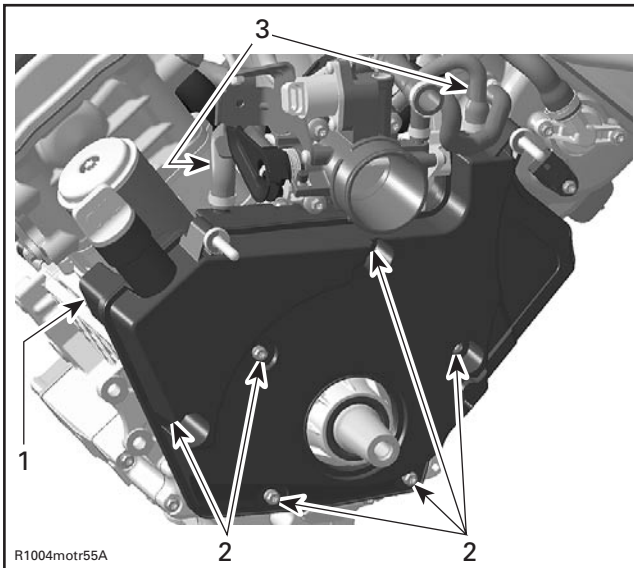
OIL TANK

Removal

First drain the lubrication system (refer to OIL CHANGE).

Remove:

- hose clamps **no. 20** and pull hoses
- oil tank screws **no. 16** and **no. 17** and pull oil tank **no. 13**.



1. Oil tank
2. Six screws
3. Hoses

CAUTION: Make sure that the O-rings **no. 14** and **no. 15** do not get stuck in the crankcase.

Inspection

Inspect the oil tank for cracks/fractures or other damage/leakage.

NOTE: If necessary, replace the oil tank.

Installation

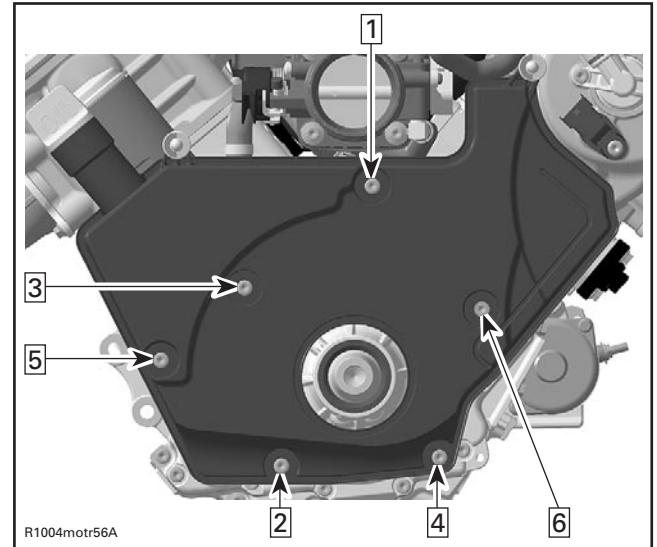
The installation is the opposite of the removal procedure. Pay attention to the following details.

NOTE: At assembly, replace both O-rings **no. 14** and **no. 15**.

Before assembly, slightly grease the O-rings. This will ease assembly and prevent displacement of the gasket during installation.

Torque oil tank screws to 9 N•m (80 lbf•in).

Tighten oil tank screws as per following sequence.



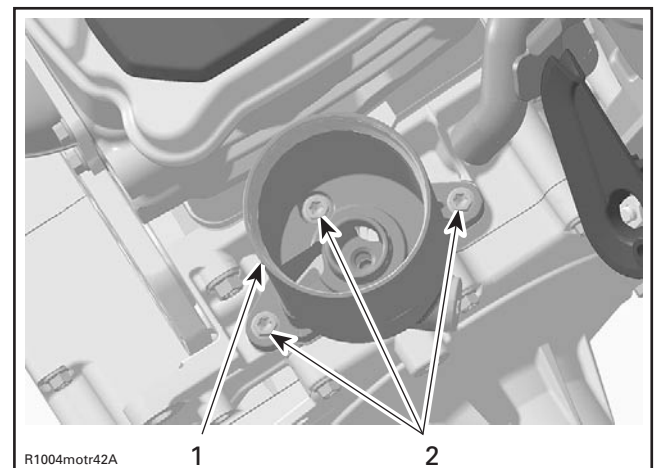
OIL FILTER HOUSING

Removal

First drain the lubrication system (refer to OIL CHANGE).

Remove:

- oil tank (refer to OIL TANK)
- oil filter (refer to OIL FILTER)
- oil filter housing screws **no. 3** and **no. 4** and pull oil filter housing **no. 2**.



1. Oil filter housing
2. Three screws

Section 03 ENGINE

Subsection 06 (LUBRICATION SYSTEM)

Inspection

Check the oil filter housing for cracks or other damage.

Replace oil filter housing if damaged.

Installation

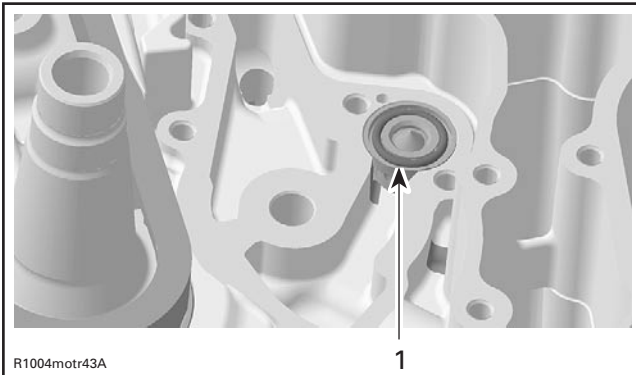
The installation is the opposite of the removal procedure. Pay attention to the following details.

NOTE: Always replace gasket no. 1.

Torque oil filter housing screws to 9 N•m (80 lbf•in).

ENGINE OIL PRESSURE REGULATOR

The oil pressure regulator is located on the engine alternator side (behind ignition cover/pressure oil pump cover).



1. Engine oil pressure regulator

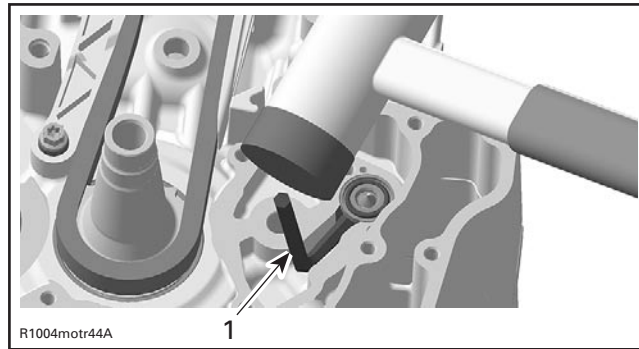
NOTE: The oil pressure regulator system works between 240 kPa (35 PSI) and 430 kPa (62 PSI).

Removal

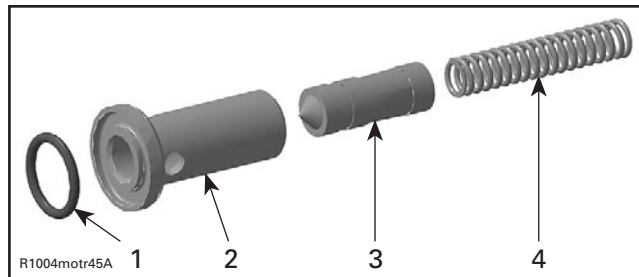
Remove:

- water pump housing (refer to COOLING SYSTEM)
- ignition cover (refer to COOLING SYSTEM)
- oil pump cover no. 5 (refer to PRESSURE OIL PUMP)
- O-ring no. 38, valve seat no. 37, pressure regulating piston no. 36 and spring no. 35.

Put a suitable Allen wrench or another 90° angle tool under the engine oil pressure regulator. By slight hammer blows against the Allen wrench carefully drive out the oil pressure regulator.



1. Allen wrench



1. O-ring
2. Valve seat
3. Pressure regulator piston
4. Spring

Inspection

Inspect pressure regulator piston and valve seat for scoring or other damages.

Check spring for free length.

SPRING FREE LENGTH	
NEW NOMINAL	46 mm (1.811 in)
SERVICE LIMIT	45 mm (1.771 in)

NOTE: Replace worn or damaged components. Pressure regulator piston and valve seat may only be replaced together.

Clean bore and threads in the oil pump housing from metal shavings and other contaminations.

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: Oil the pressure regulator piston before installation.

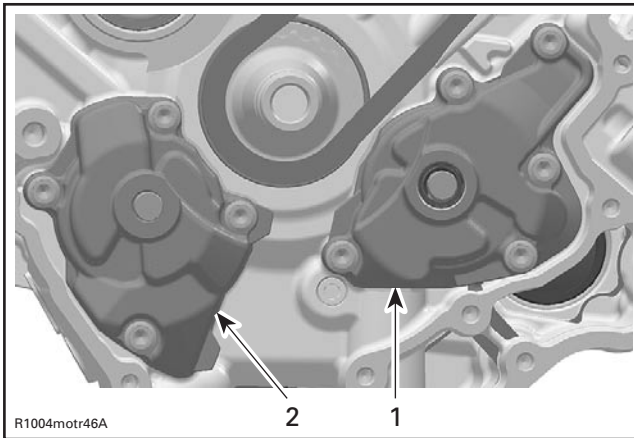
Fit the engine oil pressure regulator by pushing it carefully with an aluminum or brass rod. The engine oil pressure regulator must be flush with the crankcase. Following installation check the pressure regulator piston for easy movement.

NOTE: At installation always replace the O-ring no. 38, and fit it with grease.

OIL PUMPS

The oil pumps are located on the engine alternator side (behind ignition cover).

The engine is equipped with two oil pumps, a pressure oil pump and a suction oil pump.



1. Pressure oil pump
2. Suction oil pump

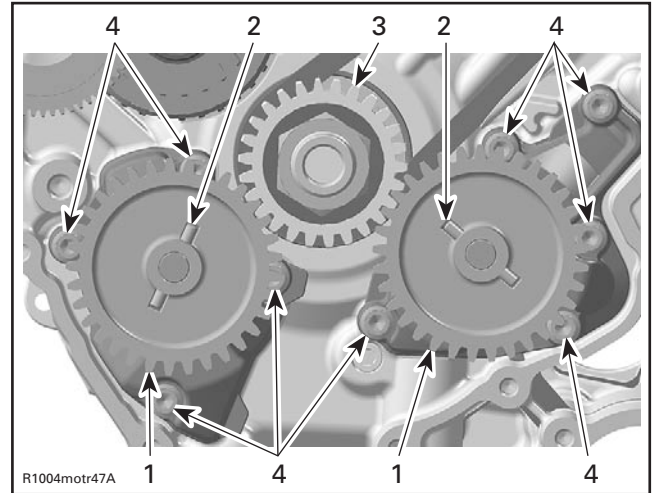
PRESSURE OIL PUMP

Removal

Remove:

- water pump housing (refer to COOLING SYSTEM)
- ignition cover (refer to COOLING SYSTEM)
- oil pump gear no. 33
- needle pin no. 32
- drive gear of crankshaft (refer to CRANKSHAFT)
- oil pump cover screws no. 34 and pull oil pump cover no. 27

- oil pump shaft with inner rotor no. 29 and outer rotor no. 30
- intermediate plate no. 31.

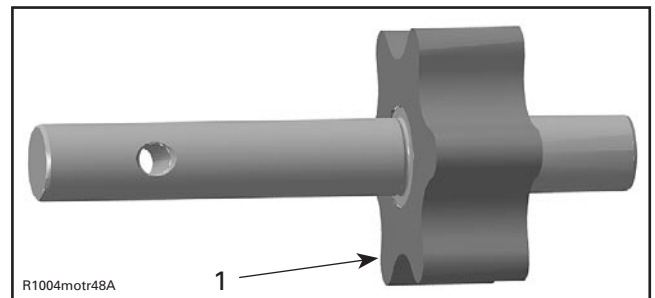


1. Oil pump gear
2. Needle pin
3. Drive gear of crankshaft
4. Oil pump cover screws

Inspection

Inspect oil pump shaft assembly and the oil pump cover for marks or other damages.

Check inner rotor for corrosion pin-holes or other damages. If so, replace oil pump shaft assembly. Also check the oil pump cover. If damaged, replace the complete oil pump assembly.

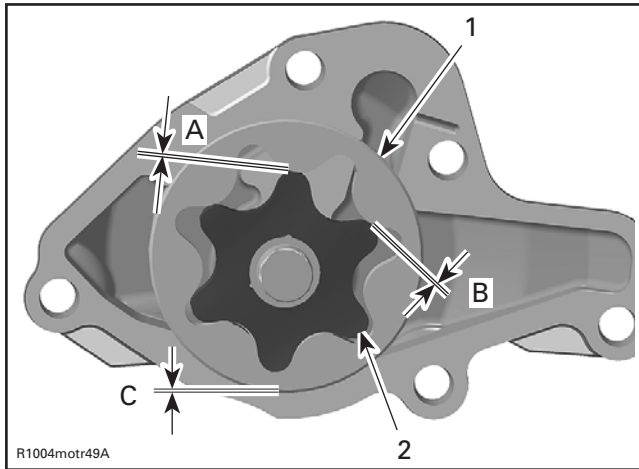


1. Pittings on the teeth

Section 03 ENGINE

Subsection 06 (LUBRICATION SYSTEM)

Using a feeler gauge, measure the clearance between inner and outer rotors.



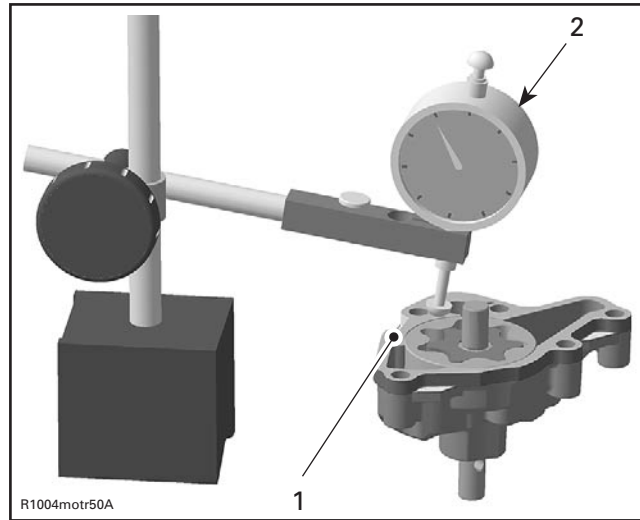
1. Outer rotor
2. Inner rotor

OUTER AND INNER ROTORS CLEARANCE mm (in)	
SERVICE LIMIT	
A	0.25 mm (.009 in)
B	
C	

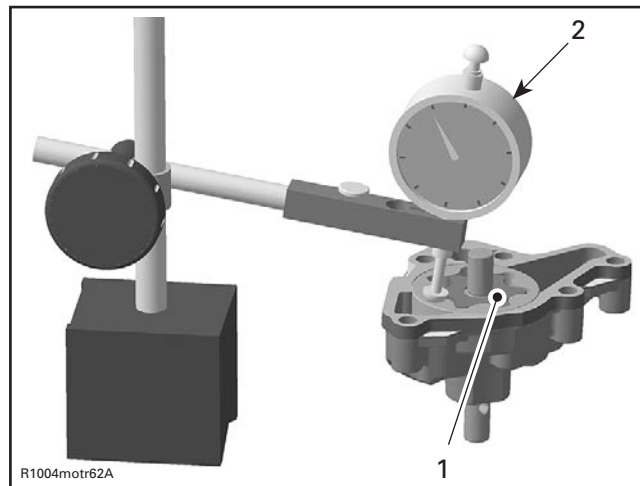
If clearance between inner and outer rotors exceeds the tolerance, replace oil pump shaft assembly. Ensure to also check oil pump cover. If damaged, replace the complete oil pump assembly.

If clearance between outer rotor and its bore in oil pump exceeds the tolerance, replace the complete oil pump assembly.

Using a dial indicator, measure side wear as shown.



1. Oil pump cover surface
2. Dial indicator



1. Oil pump outer rotor surface
2. Dial indicator

Difference between oil pump cover and outer rotor should not exceed 0.1 mm (.004 in). If so, replace the complete oil pump assembly.

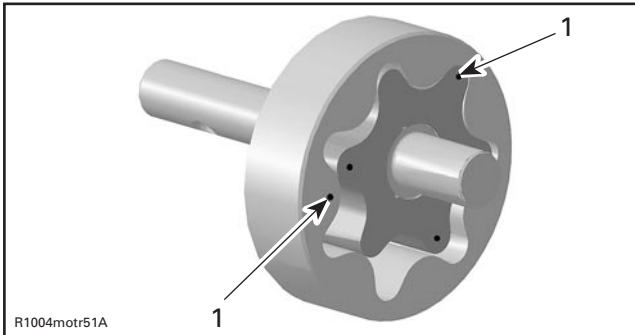
NOTE: When the axial clearance of the oil pump shaft assembly increases, the oil pressure decreases.

Check the inside of oil pump cover for scoring or other damages. If so, change the complete oil pump assembly.

Installation

For installation, reverse the removal procedure.
Pay attention to the following details.

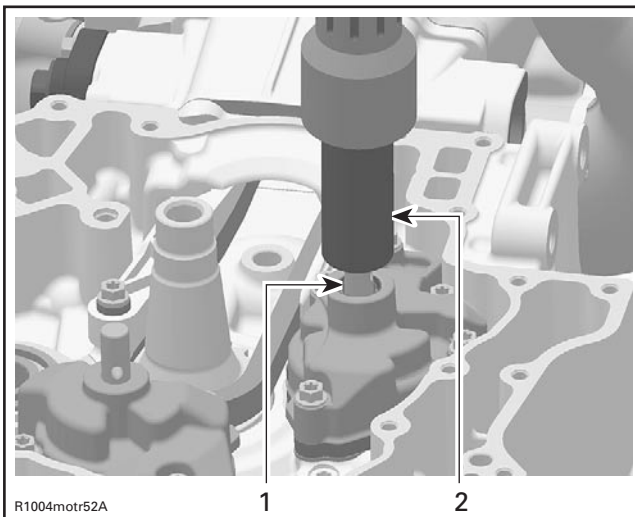
CAUTION: The outer rotor **no. 30** and the oil pump shaft with inner rotor **no. 29** are marked on the upper side. When installing, make sure that the position of the outer rotor is not reversed.



1. Marking

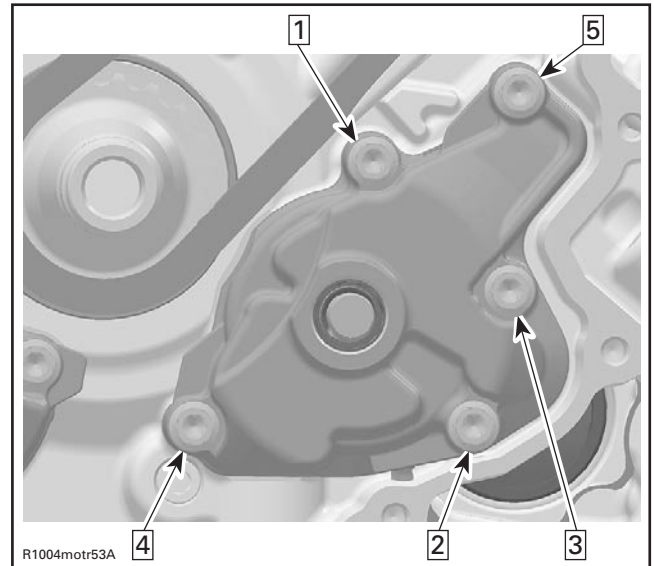
NOTE: At installation always replace the oil seal **no. 28** fitted in the oil pump cover.

Push oil seal in place by using the oil seal pusher (P/N 529 035 911).



1. Oil seal
2. Oil seal pusher (P/N 529 035 911)

Torque oil pump housing screws to 9 N•m (80 lbf•in).
Tighten oil pump housing screws as per following sequence.



Final Test

After engine is completely reassembled, start engine and make sure oil pressure is within specifications.

SUCTION OIL PUMP

Removal

For information about disassembly of the suction oil pump please refer to PRESSURE OIL PUMP. Disassembly is the same for both pumps.

Inspection

For information about inspection of the suction oil pump please refer to PRESSURE OIL PUMP. Inspection is the same for both pumps.

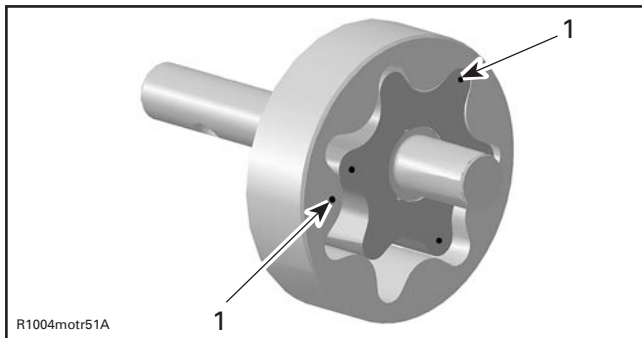
Installation

For installation, reverse the removal procedure.
Pay attention to the following details.

CAUTION: The outer rotor **no. 25** and the oil pump shaft with inner rotor **no. 24** are marked on the upper side. When installing, make sure that the position of the outer rotor is not reversed.

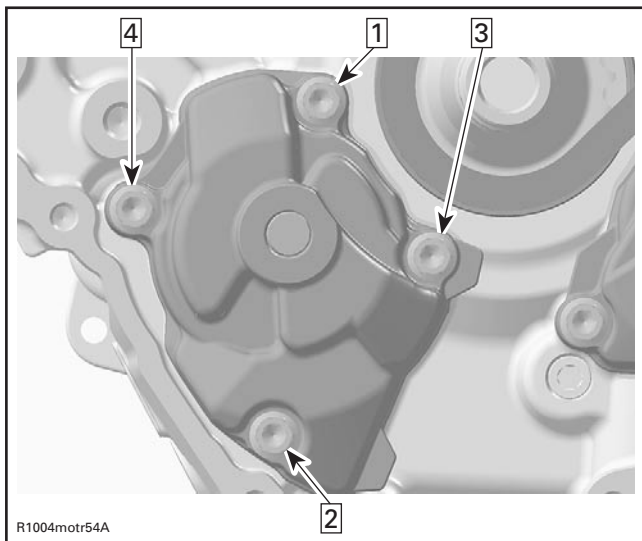
Section 03 ENGINE

Subsection 06 (LUBRICATION SYSTEM)



1. Marking

Torque oil pump housing screws to 9 N•m (80 lbf•in).
Tighten oil pump housing screws as per following sequence.

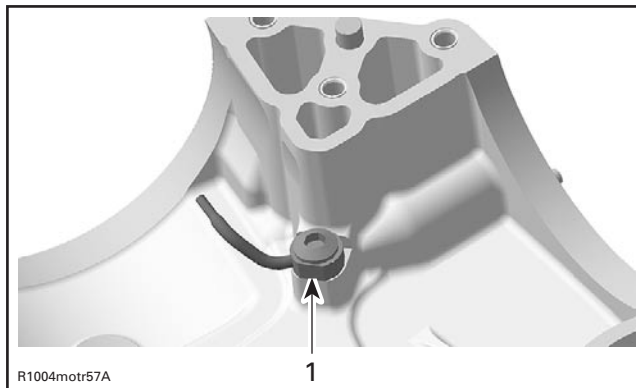


Final Test

After engine is completely reassembled, start engine and make sure oil pressure is within specifications.

OIL NOZZLE

The oil nozzles no. 40 are located within the crankcase. Each piston is equipped with a separate oil nozzle.



1. Oil nozzle

NOTE: If the engine has to be disassembled within the scope of repair work, take this opportunity to clean the oil nozzles.

Cleaning and Inspection

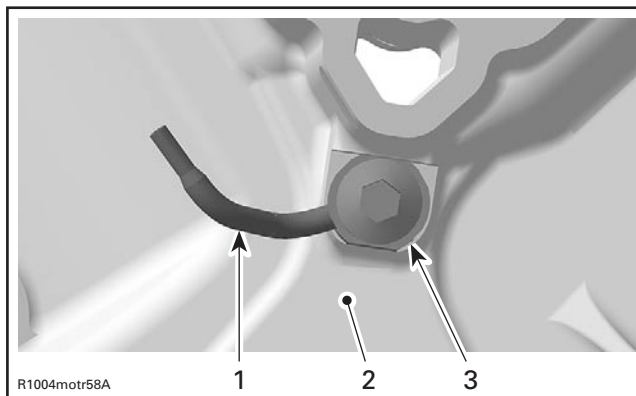
Clean oil nozzle with a part cleaner then use an air gun to dry it.

⚠ WARNING

Always wear eye protector. Chemicals can cause a rash break out and injure your eyes.

Installation

CAUTION: At assembly, make sure the contact surfaces of the oil nozzle are well fitted onto the crankcase. If this is not ensured, the spray direction will change, causing potential damage to the engine.



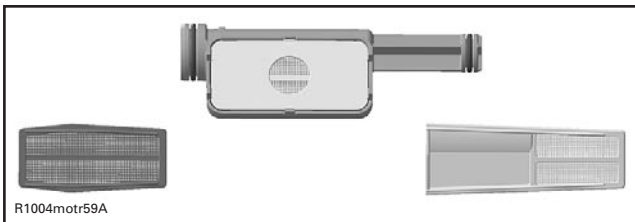
1. Oil nozzle
2. Crankcase
3. Contact surface

NOTE: If the oil nozzles are damaged or bent during installation work in the crankcase, they must be replaced immediately.

Torque oil nozzle screws to 19 N•m (170 lbf•in).

OIL SIEVES

The engine is equipped with 3 oil sieves **no. 39**, **no. 41** and **no. 44** for filtering dirt and abraded particles from the oil circuit. The sieves are fitted into the crankcase.



3 OIL SIEVES

NOTE: Cleaning of the oil sieves is only possible if the engine is disassembled. So, if the engine has to be disassembled within the scope of repair work, clean the sieves at the same time.

Cleaning and Inspection

Clean oil sieves with a part cleaner then use an air gun to dry it.

WARNING

Always wear eye protector. Chemicals can cause a rash break out and injure your eyes.

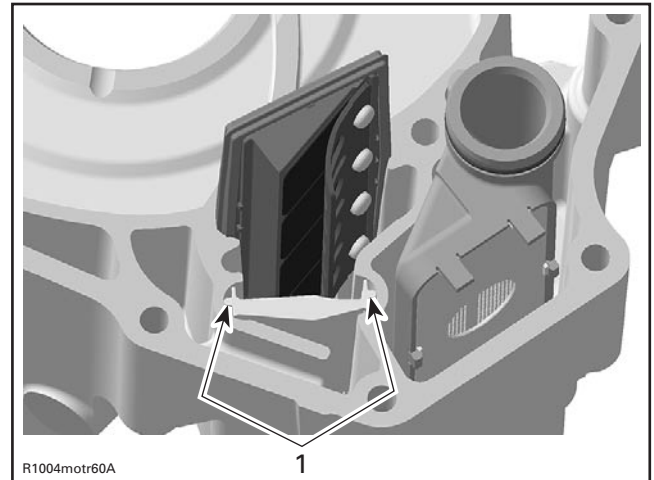
Check sieves for cracks or other damage.

NOTE: Replace sieves if damaged.

Installation

NOTE: During assembly always replace both O-rings **no. 42** and **no. 43**.

CAUTION: Take particular care with oil sieve **no. 44** to ensure that it is re-installed in exactly the same position.

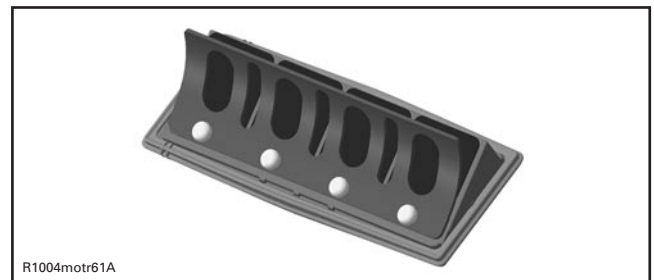


1. Correct installation position of oil sieve

NOTE: Before assembly, slightly oil the O-rings and the sieves at the outside using multi-purpose grease. This will ease assembly and prevent displacement of the gasket during installation.

REED VALVE

The engine is equipped with a reed valve **no. 45** which prevents accumulation of larger oil quantities in the crankcase. The reed valve is fitted into the crankcase.



REED VALVE

NOTE: If the engine has to be disassembled within the scope of repair work, take this opportunity to clean the reed valve, using a rag.

Inspection

Check reed valve for cracks or other damage.

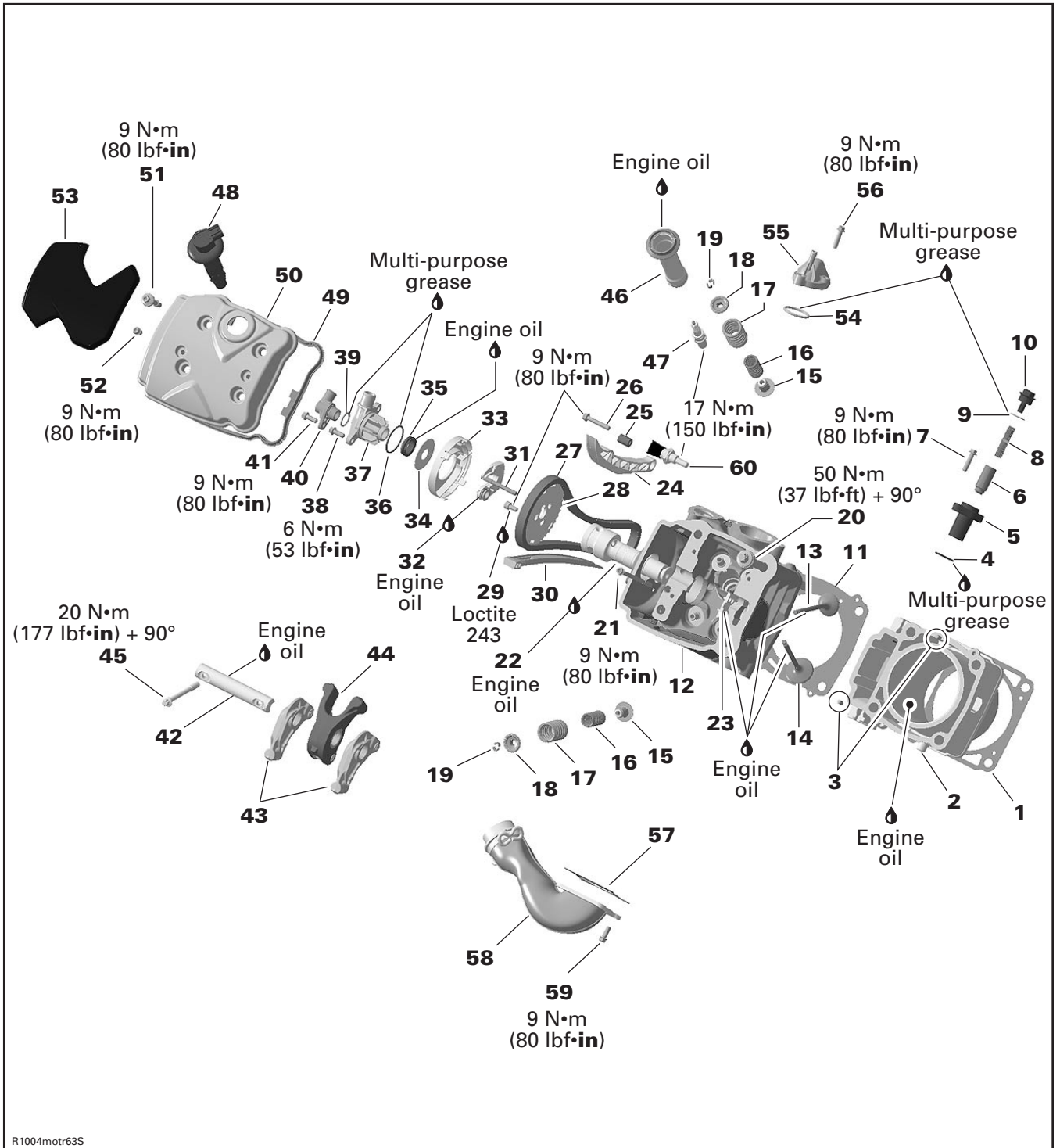
NOTE: Replace reed valve if damaged.

Installation

NOTE: Before assembly slightly grease the rubber gasket of the reed valve with multi purpose grease.

CYLINDER AND CYLINDER HEAD

CYLINDER/CYLINDER HEAD 1 (FRONT-SIDE)

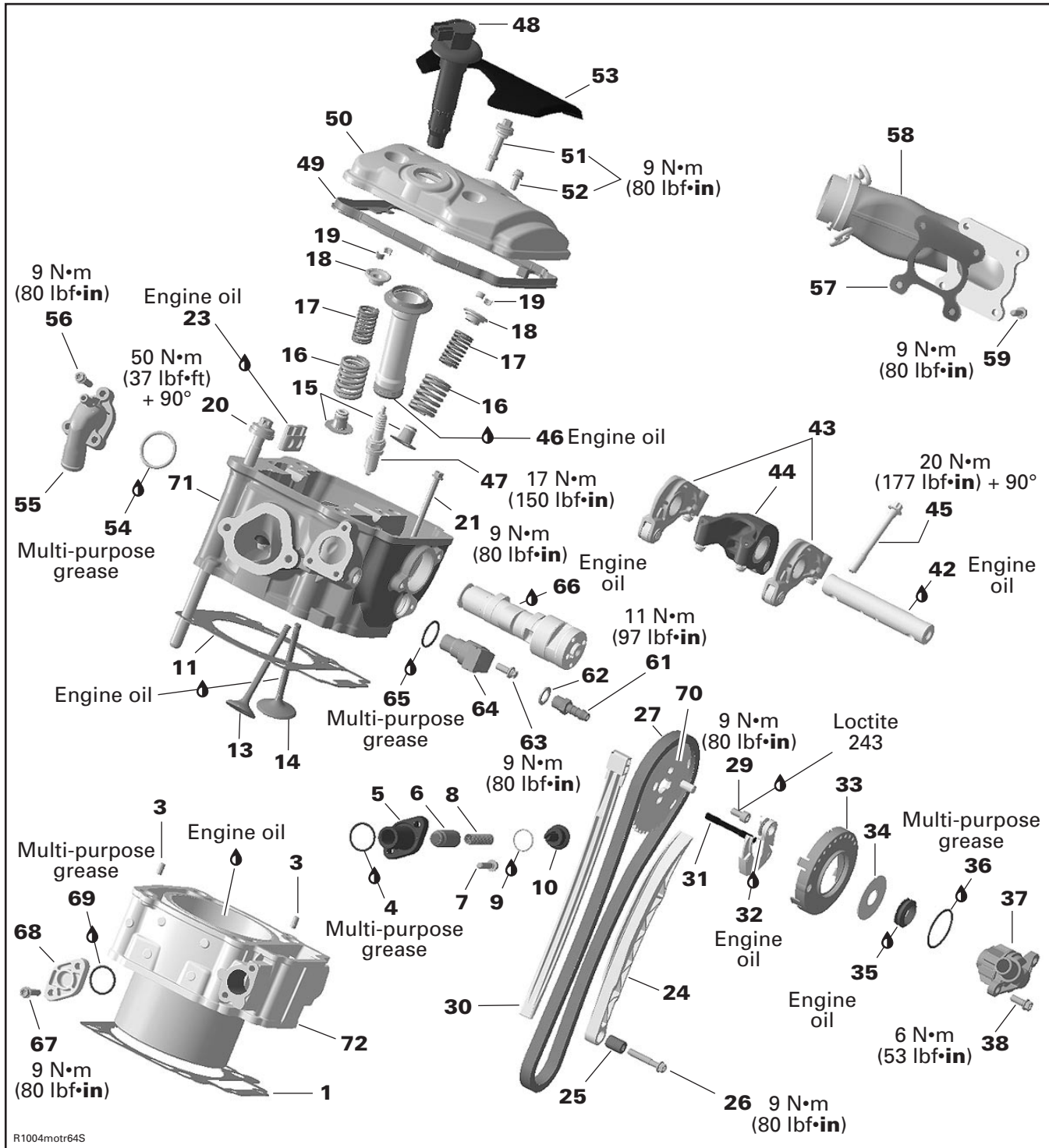


R1004motr63S

Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

CYLINDER/CYLINDER HEAD 2 (REAR-SIDE)



R1004motr64S

GENERAL

NOTE: Components which are identical for both cylinders/cylinder heads are identified in the two exploded views by the same number. Components which are different or which are, for instance, present on one of the cylinders/cylinder heads but not on the other, have different numbers. The information given below always relates to both cylinders/cylinder heads as a general rule.

Special reference is made in the text to work instructions which are not the same for cylinder 1 and cylinder 2.

NOTE: For cylinder head, cylinder and piston removal, it is not necessary to remove engine from vehicle.

NOTE: When diagnosing an engine problem, always perform a cylinder leak test. This will help pin-point the problem. Refer to the instructions included with your leak tester and LEAK TEST section for procedures.

Always place the vehicle on a level surface.

NOTE: For a better understanding, the following illustrations are taken with engine out of vehicle. However, it is not necessary to remove engine from vehicle to perform the following instructions.

Always disconnect the negative wire from the battery before working the engine.

Even though many parts do not need to be removed to reach other parts, it is recommended to remove these parts anyway in order to check them.

For installation, use the torque values and Loctite products from exploded views. Clean threads before using Loctite product when installing screws.

When disassembling parts that are duplicated in the engine, (e.g.: valves), it is strongly recommended to note their position (PTO, alternator side) and to keep them as a "group". If you find a defective component, it will be much easier to find the cause of the failure among its group of parts (e.g.: you found a worn valve guide. A bent spring could be the cause. It will be easy to know which one among the springs is defective if you grouped them at disassembly). Besides, since used parts have matched together during the engine operation, they will keep their matched fit when you reassemble them together within their "group".

SPARK PLUG

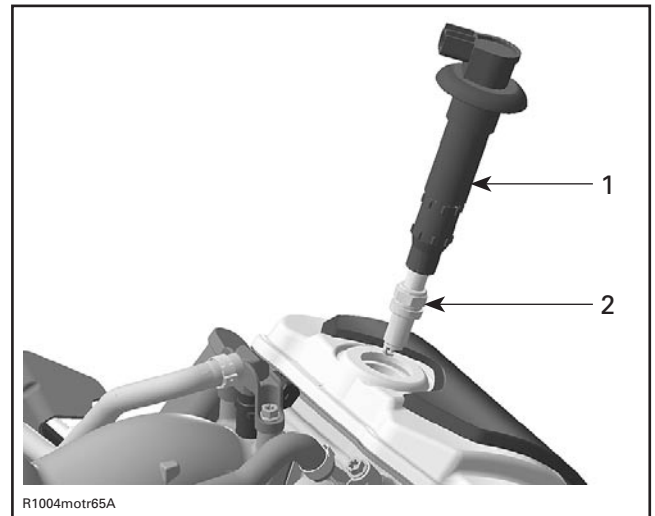
Removal

Unplug the stick coil connector.

Remove the stick coil **no. 48**.

Clean spark plug and stick coil area before disassembly.

Unscrew spark plug **no. 47** then use the stick coil to take spark plug out of spark plug hole.



1. Stick coil
2. Spark plug

Inspection

Check spark plug and stick coil condition (refer to COMPONENT INSPECTION AND ADJUSTMENT).

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

Check spark plug gap.

Slightly oil the bottom outer part of the stick coil. This will ease installation.

Place spark plug into stick coil, screw spark plug then remove the stick coil. Torque spark plug to 17 N•m (150 lbf•in). Reinstall the stick coil.

Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

TEMPERATURE SENSOR

Temperature sensor **no. 60** is located in the cylinder head 1 (front-side).

Inspection

Check the temperature sensor for damage or leakage. For electrical inspection refer to COMPONENT INSPECTION AND ADJUSTMENT.

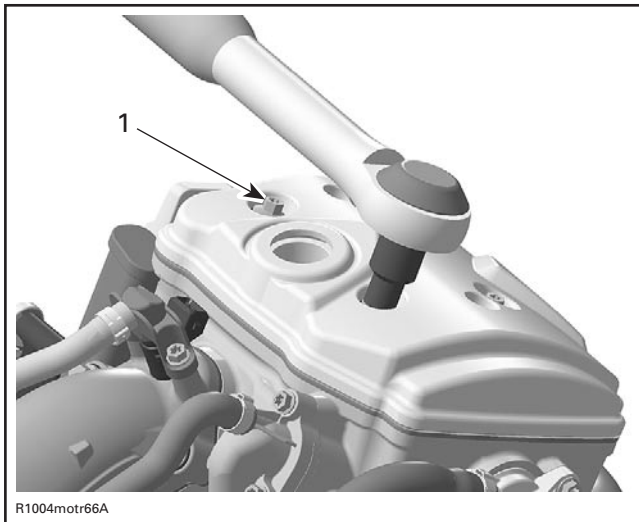
Torque temperature sensor to 17 N•m (150 lbf•in).

VALVE COVER

Removal

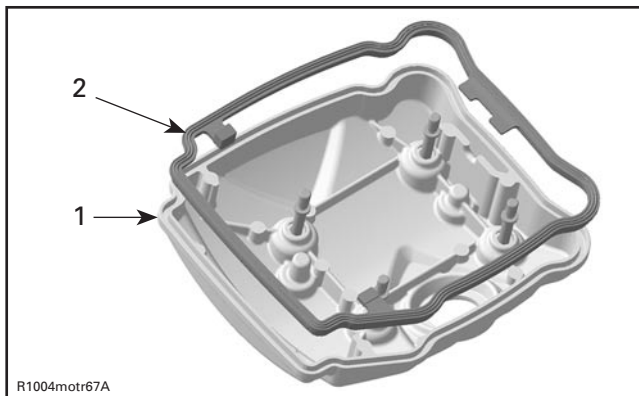
Remove:

- valve cover shield **no. 53**
- valve cover screws **no. 51**



1. Valve cover screws

- valve cover **no. 50** and profile sealing ring **no. 49**.



1. Valve cover
2. Profile sealing ring

Inspection

Check the profile sealing ring on the valve cover and the rubber bushing on the valve cover screws if they are brittle, cracked or hard. If so, replace the profile sealing ring or the valve cover screw accordingly.

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: At installation, replace the profile sealing ring **no. 49**.

NOTE: Install the valve cover screws in a criss-cross sequence.

Torque valve cover screws to 9 N•m (80 lbf•in).

ROCKER ARM

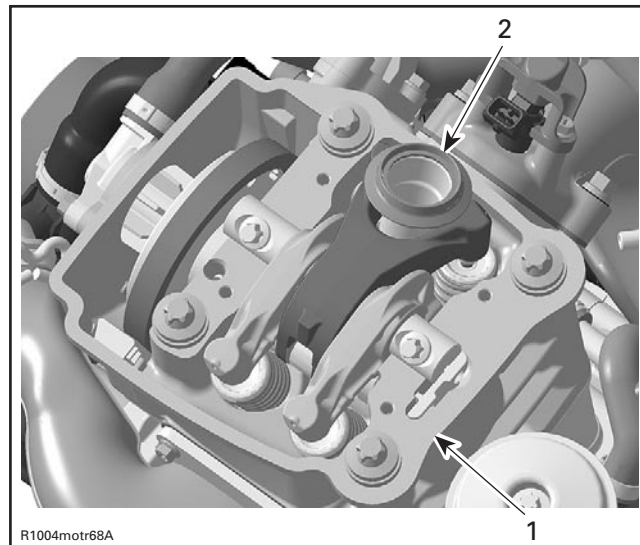
When disassembling the rocker arms, the specified sequence must be followed. Start with cylinder 1, continue with cylinder 2.

Removal Cylinder 1 (front-side)

Lock crankshaft with crankshaft locking bolt (P/N 529 035 900), refer to CRANKSHAFT/DRIVE GEARS.

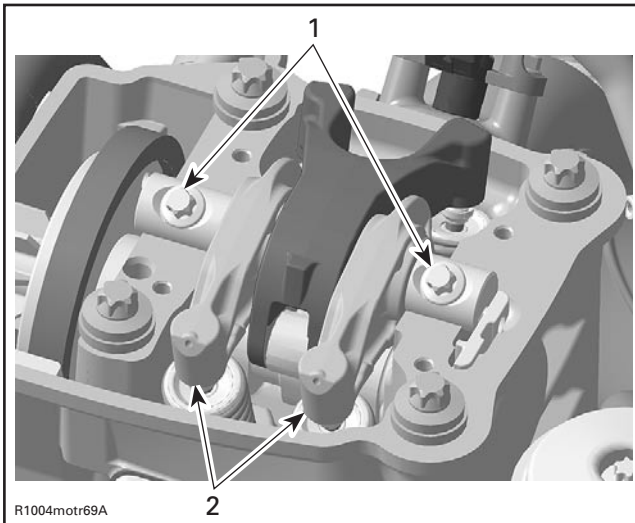
Remove:

- spark plug (refer to SPARK PLUG)
- valve cover (refer to VALVE COVER)
- spark plug tube **no. 46**



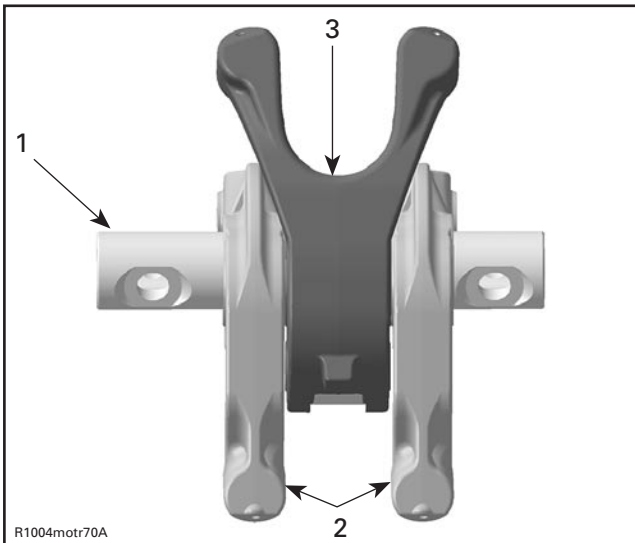
1. Cylinder head
2. Spark plug tube

- rocker arm shaft screws no. 45 (discard screws)

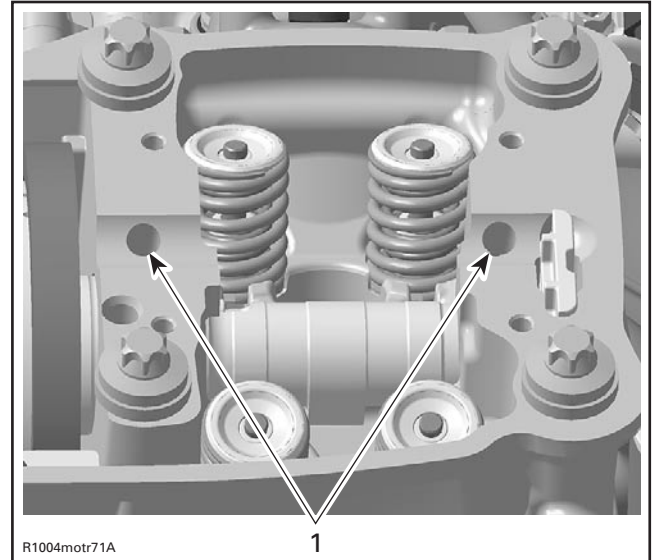


1. Rocker arm shaft screws
2. Rocker arms

- rocker arm shaft no. 42 with rocker arm assembly (exhaust side no. 43 and intake side no. 44).



1. Rocker arm shaft
2. Rocker arms (exhaust side)
3. Rocker arm (intake side)



1. Oil supply from the camshaft to the rocker arm shaft, then to the rocker arms and finally to the valve adjustment

Removal Cylinder 2 (rear-side)

Remove:

- spark plug (refer to SPARK PLUG)
- valve cover (refer to VALVE COVER)
- spark plug tube no. 46

Remove the crankshaft locking bolt (P/N 529 035 900).

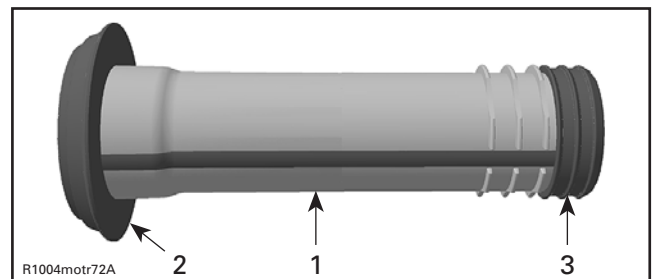
Crank the engine further until the second cylinder is positioned at ignition TDC.

- rocker arm shaft screws no. 45 (discard screws)
- rocker arm shaft no. 42 with rocker arm assembly (exhaust side no. 43 and intake side no. 44).

Inspection

Spark Plug Tube

Check seals on spark plug tube. If seals are brittle, cracked or hard, replace spark plug tube.



1. Spark plug tube
2. Seal to the valve cover
3. Seal to the cylinder head

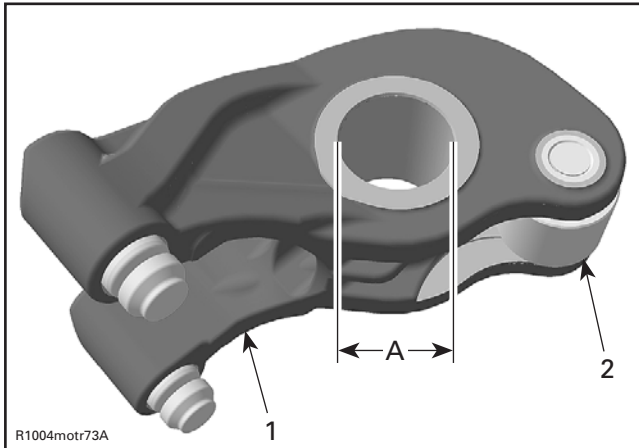
Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

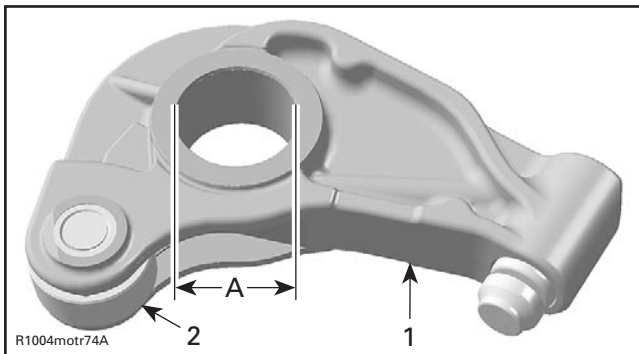
Rocker Arm

Inspect each rocker arm for cracks and scored friction surfaces. If so, replace rocker arm assembly.

Check the rocker arm rollers for free movement, wear and excessive radial play. Replace rocker arm assembly as necessary.



1. Rocker arm (intake side)
2. Roller
- A. Bore for rocker arm shaft

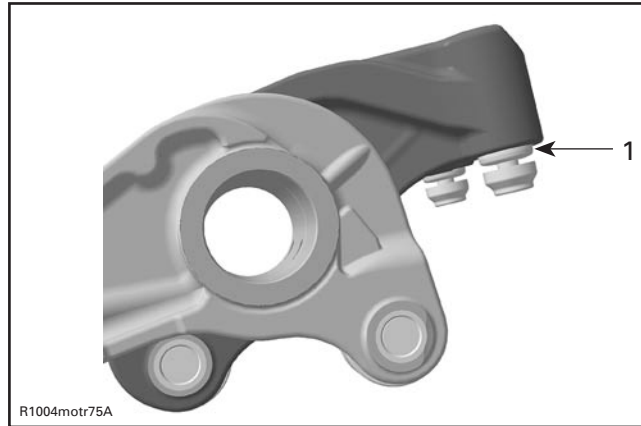


1. Rocker arm (exhaust side)
2. Roller
- A. Bore for rocker arm shaft

Measure rocker arm bore diameter. If diameter is out of specification, change the rocker arm assembly.

ROCKER ARM BORE DIAMETER	
MINIMUM (NEW)	20.007 mm (.7877 in)
MAXIMUM (NEW)	20.020 mm (.7881 in)
SERVICE LIMIT	20.035 mm (.7887 in)

Press the hydraulic lifter with your thumb. If the hydraulic lifter groove disappears inside rocker arm casting, replace rocker arm assembly. Lifter must turn freely in rocker arm bore. Otherwise, replace.

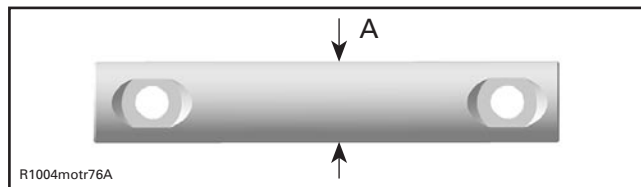


1. Hydraulic lifter groove

Rocker Arm Shaft

Check for scored friction surfaces, if so, replace parts. Measure rocker arm shaft diameter.

ROCKER ARM SHAFT DIAMETER	
MINIMUM (NEW)	19.980 mm (.7866 in)
MAXIMUM (NEW)	19.993 mm (.7871 in)
SERVICE LIMIT	19.965 mm (.7860 in)



- A. Measure rocker arm shaft diameter here

Replace any part that shows excessive wear.

Installation

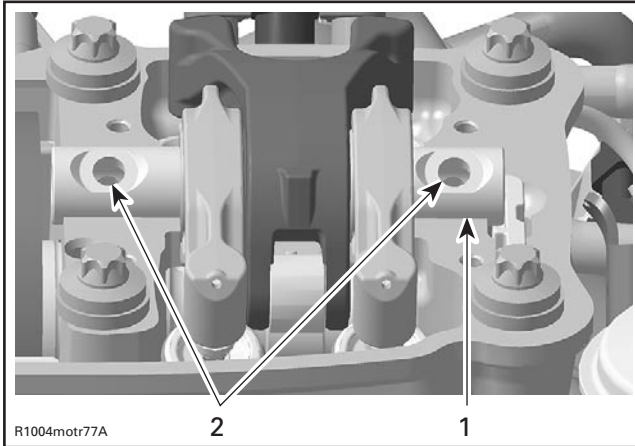
For installation, reverse the removal procedure. Pay attention to the following details.

CAUTION: Make sure to observe the correct matching of rocker arm shaft and rocker arm. When installing the components, make sure they are fitted exactly in their original position on their respective cylinder head. Any inversion of the components may cause damage to the engine.

NOTE: At assembly, position the cylinder to ignition TDC. This will ensure stress-free installation of the rocker arm shaft.

Apply engine oil on rocker arm shaft.

Position the rocker arm shaft with the notches on top.

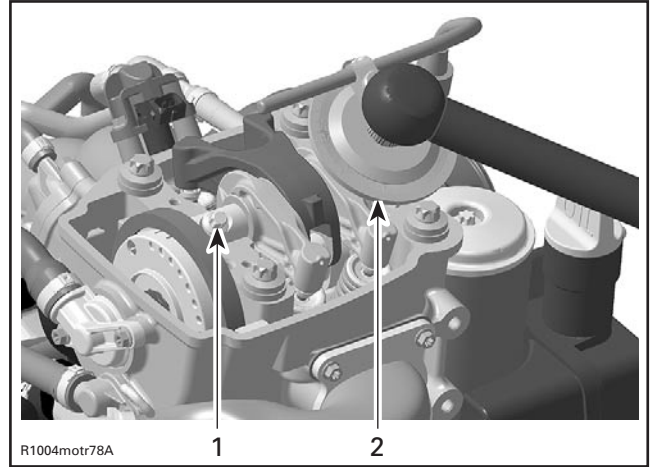


1. Rocker arm shaft
2. Rocker arm shaft notches

Install **NEW** rocker arm shaft screws no. 45. Torque as per following procedure:

CAUTION: For this assembly, stretch screws are used. As the screws have been stretched from the previous installation, it is very important to **use new screws at assembly**. Failure to replace screws and to strictly follow the torque procedure may cause screws to loosen and lead to engine damage.

- Torque rocker arm shaft screws to 10 N•m (88 lbf•in).
- Torque rocker arm shaft screws to 20 N•m (177 lbf•in).
- Finish tightening screws turning an additional **90° rotation** with a torque angle gauge.



1. Rocker arm shaft screw
2. Torque angle gauge

CHAIN TENSIONER

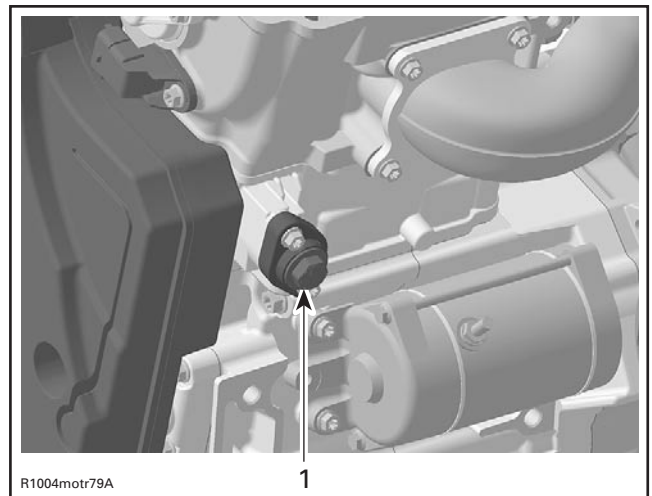
Removal

⚠ WARNING

Chain tensioner is spring loaded. Take that into account when removing chain tensioner plug.

Remove:

- air silencer, guard and driven pulley to gain access to cylinder 2 chain tensioner
- chain tensioner plug no. 10



1. Chain tensioner plug

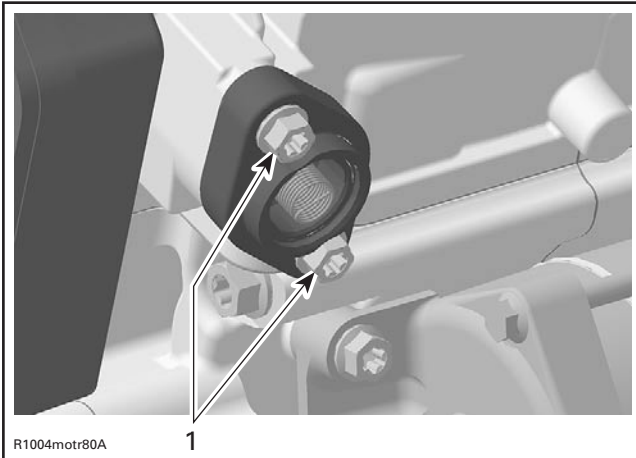
Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

WARNING

Never perform this operation immediately after the engine has been run because the exhaust system can be very hot. Wait until exhaust system is warm or cold.

- spring no. 8
- screws no. 7

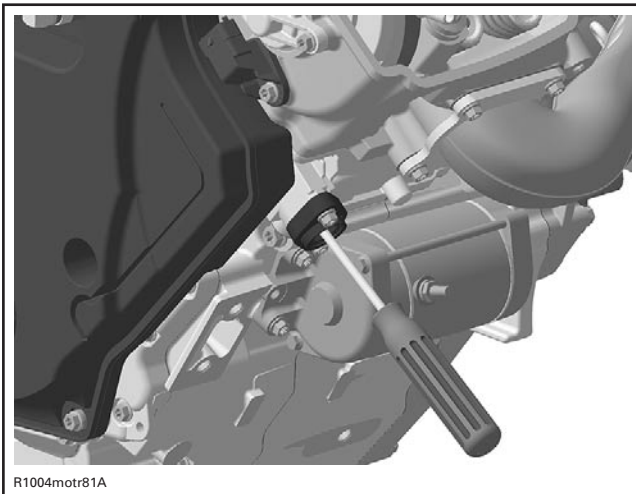


1. Chain tensioner screws

- chain tensioner housing no. 5.

Inspection

Using a flat screwdriver, unscrew chain tensioner plunger no. 6. Check chain tensioner plunger for free movement in the threads of chain tensioner housing.



Check chain tension guides no. 24 for wear. Replace as necessary.

Check spring condition. Replace if broken or worn.

NOTE: At installation, replace the O-rings no. 4 and no. 9. Slightly grease the O-rings before assembly using multi purpose grease.

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

Torque chain tensioner housing screws to 9 N•m (80 lbf•in).

NOTE: Screw the plunger until it touches the chain tension guide.

Install a spring end in plunger groove and the other in the plug groove. Screw plug. There must be no distortion of the spring during installation.

BREATHER

Removal

Remove:

- exhaust pipe and muffler
- air silencer then move vehicle harness away from engine
- remove breather hose then unscrew breather screws no. 38
- pull out the breather no. 37.

NOTE: Pull out the breather with utmost care. Thrust washer no. 34 may get caught on the breather and drop into the crankcase.

Inspection

Inspect the breather for cracks/fractures or other damage/leakage.

If necessary, replace the breather.

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: At installation, replace the O-ring no. 36, and fit it with grease.

Take care during installation that the groove in the thrust washer precisely fits in groove of cover no. 33.

Torque breather screws to 6 N•m (53 lbf•in).

DECOMPRESSOR

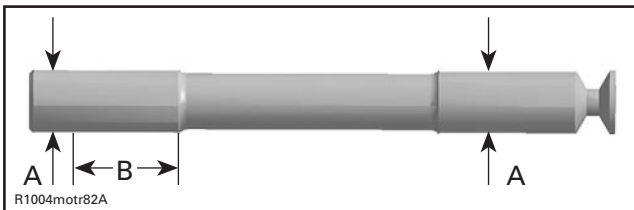
Removal

Remove:

- breather (refer to BREATHER)
- valve cover (refer to VALVE COVER)
- thrust washer **no. 34**
- cover **no. 33**
- centrifugal weight **no. 32**
- decompressor shaft **no. 31**.

Inspection

Check decompressor shaft for service limit, replace if it out of specifications.

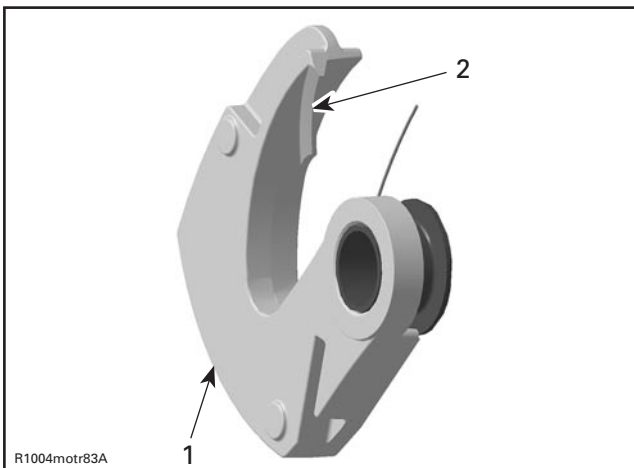


DECOMPRESSOR SHAFT

- A. Measure here
- B. Measurement area

DECOMPRESSOR SHAFT MEASUREMENT A	
MINIMUM (NEW)	5.978 mm (.235 in)
MAXIMUM (NEW)	5.990 mm (.236 in)
SERVICE LIMIT	5.850 mm (.230 in)

Check torsion spring and edge of the centrifugal weight for visible wear. If so, replace them together.

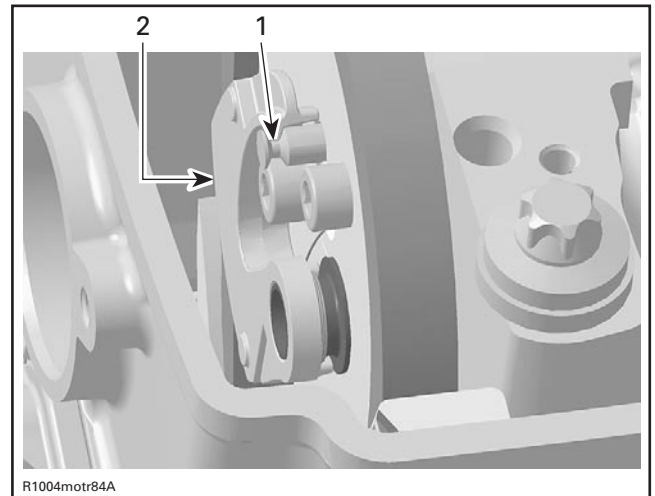


- 1. Centrifugal weight with torsion spring
- 2. Edge of centrifugal weight

Installation

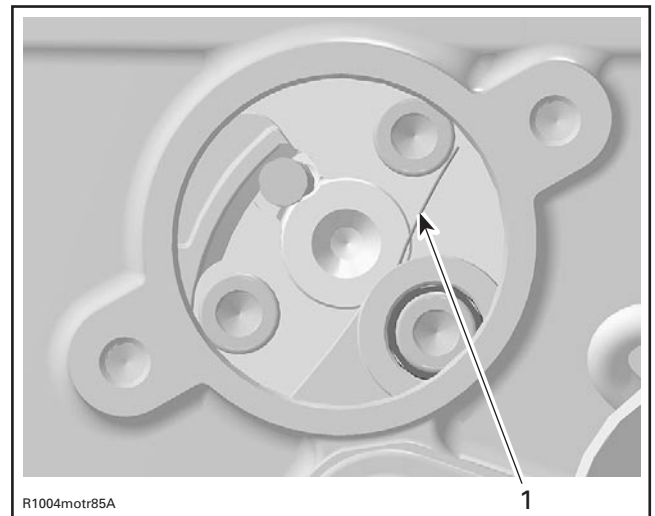
The installation is essentially the reverse of the removal procedure but, pay attention to the following details.

NOTE: Engage the edge of centrifugal weight into the decompressor shaft groove then put the parts in place.



- 1. Decompressor shaft groove
- 2. Centrifugal weight

Place the torsion spring end under socket screw head.

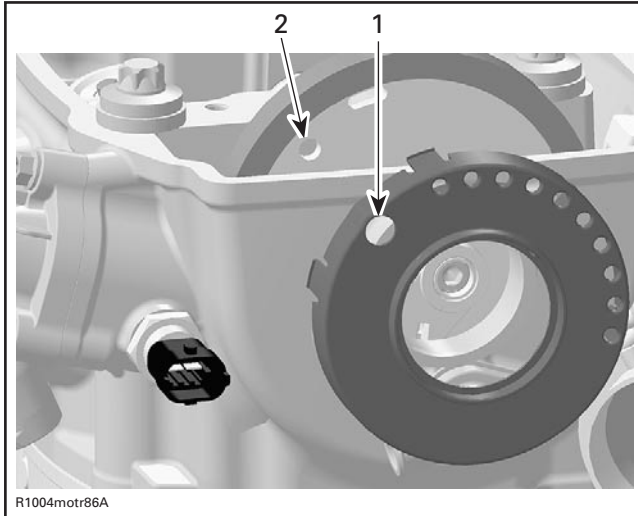


- 1. Position of torsion spring end

Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

Install the cover no. 33. Position the cover on the timing gear so that the holes are aligned.

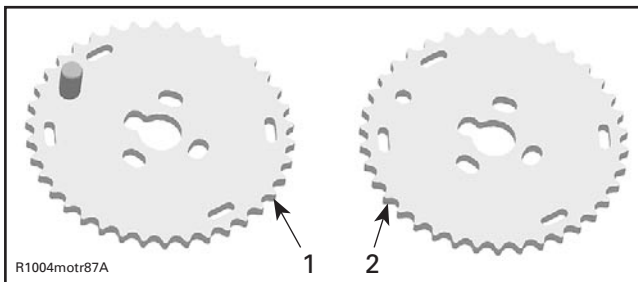


1. Hole in cover
2. Hole in camshaft timing gear

CAUTION: Before and after cover installation, make sure the centrifugal system works properly.

CAMSHAFT SPROCKET/TIMING GEAR

The engine is equipped with two camshaft sprockets. Camshaft sprocket no. 28 and timing gear no. 70. The timing gear provides the signals for the camshaft position sensor and is located in the cylinder head of the cylinder 2.



1. Timing gear
2. Camshaft sprocket

NOTE: Although it is not necessary to position crankshaft to TDC for disassembly, it is a good practice to do it, as a troubleshooting step, to know before disassembly if valve timing was appropriate.

Removal

The procedure for disassembly of the two camshaft sprockets, camshaft sprocket no. 28 and timing gear no. 70, is the same.

Lock crankshaft with crankshaft locking bolt (P/N 529 035 900), refer to CRANKSHAFT AND DRIVE GEARS.

Remove:

- valve cover (refer to VALVE COVER)
- breather (refer to BREATHER)
- chain tensioner (refer to CHAIN TENSIONER)
- decompressor (refer to DECOMPRESSOR)
- chain guide no. 30
- screws no. 29
- camshaft timing gear no. 70.

NOTE: Secure camshaft chain no. 27 with a retaining wire.

Inspection

Check camshaft sprocket/timing gear for wear or deterioration.

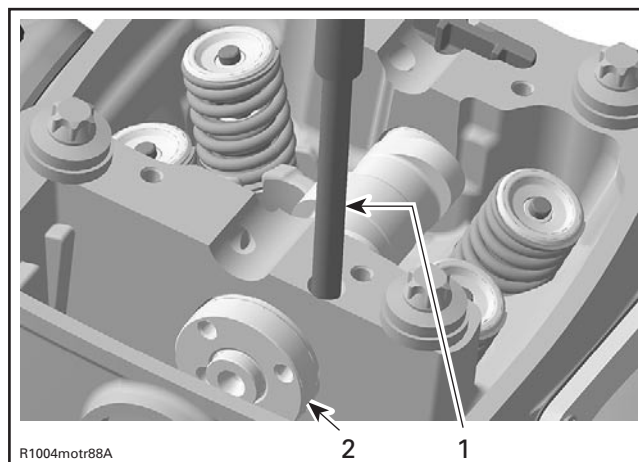
If gear is worn or damaged, replace it as a set (camshaft sprocket/timing gear and timing chain).

For crankshaft timing gear, refer to CRANKSHAFT AND DRIVE GEARS.

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

Using the clutch puller (P/N 529 035 746), lock camshaft on TDC position.



1. Clutch puller
2. Camshaft on TDC position

Install the camshaft timing gear with the writing visible.

NOTE: The camshaft sprockets are not of identical design. At assembly, make sure not to invert the camshaft sprockets as they must be reinstalled in their respective cylinder.

IMPORTANT: Make sure that tensioner is in place and properly preloaded before tightening sprocket screws.

Fit the screws with Loctite 243.

Torque screws to 9 N•m (80 lbf•in).

CAUTION: Crankshaft and camshaft must be locked on ignition TDC position of cylinder 1 (front-side) to place camshaft timing gear and timing chain in the proper position.

TIMING CHAIN

Refer to CRANKSHAFT/DRIVE GEARS.

CYLINDER HEAD

Removal

The removal procedure is the same for both cylinder heads **no. 12** and **no. 71**.

Lock crankshaft with crankshaft locking bolt (P/N 529 035 900), refer to CRANKSHAFT/DRIVE GEARS.

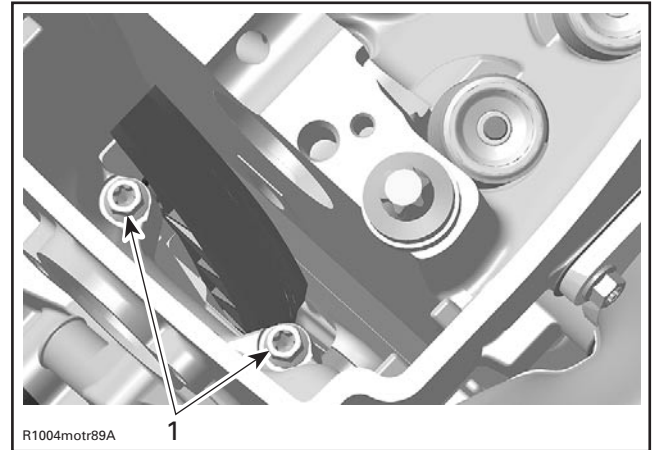
Drain coolant (refer to COOLING SYSTEM).

Disconnect temperature sensor and/or camshaft position sensor.

Remove:

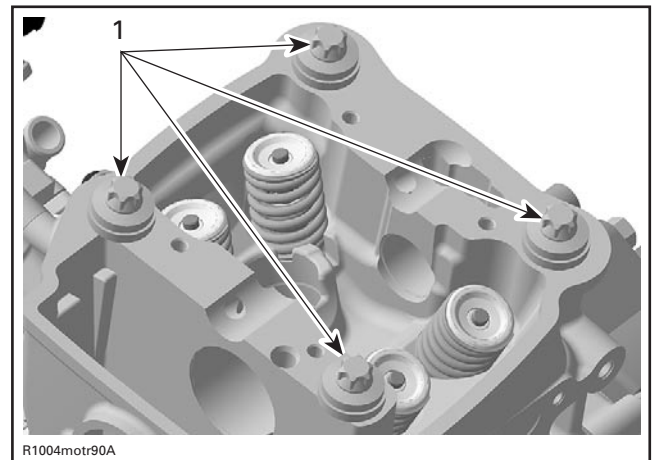
- RH side cover
- seat support
- exhaust pipe and upper engine support (refer to REMOVAL AND INSTALLATION)
- engine outlet hose
- air intake manifold (refer to COMPONENT INSPECTION AND ADJUSTMENT)
- chain tensioner (refer to CHAIN TENSIONER)
- valve cover (refer to VALVE COVER)
- valve cover and profile sealing ring (see VALVE COVER above)
- breather (refer to BREATHER)

- decompressor (refer to DECOMPRESSOR)
- camshaft sprocket/timing gear (refer to CAM-SHAFT SPROCKET/TIMING GEAR)
- cylinder head screws M6 **no. 21**



1. Cylinder head screws M6

- cylinder head screws M11 **no. 20** retaining cylinder head and cylinder to cylinder base.



1. Cylinder head screws M11

Pull up cylinder head **no. 71**.

Remove gasket **no. 11**.

Inspection

Check for cracks between valve seats, if so, replace cylinder head.

Check gasket for cracks or other damages.

Check mating surface between cylinder and cylinder head for contamination. If so, clean both surfaces.

Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

Installation

NOTE: The cylinder heads are not identical in design. Do not invert the cylinder heads at assembly. For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: At installation, replace gasket no. 11.

Ensure dowel pins are in place.

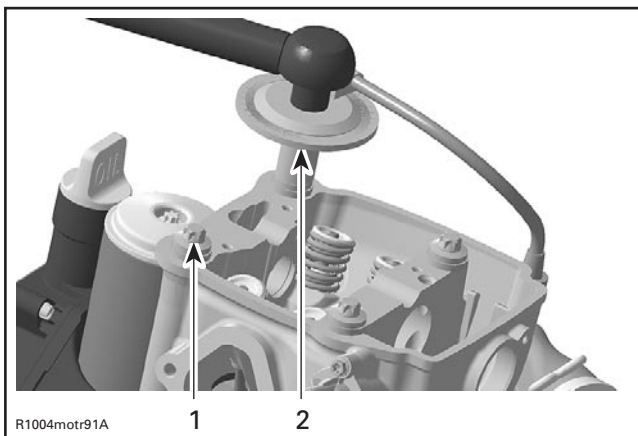
Install cylinder head screws M6 and M11.

Torque screws as per following procedure.

CAUTION: This assembly uses stretch screws. As the screws have been stretched from the previous installation, **it is very important to measure each screw at assembly. If screws are out of specification, replace by a new ones.** Failure to replace screws and to strictly follow the torque procedure may cause screws to loosen and lead to engine damage.

CYLINDER HEAD SCREW M11	
SERVICE LIMIT	216.5 mm (8.524 in)

- Torque cylinder head screws M11 in criss-cross sequence to 25 N•m (18 lbf•ft).
- Torque cylinder head screws M11 in criss-cross sequence to 50 N•m (37 lbf•ft).
- Finish tightening screws turning an additional 90° rotation with a torque angle gauge then, torque cylinder head screws M6 to 9 N•m (80 lbf•in).

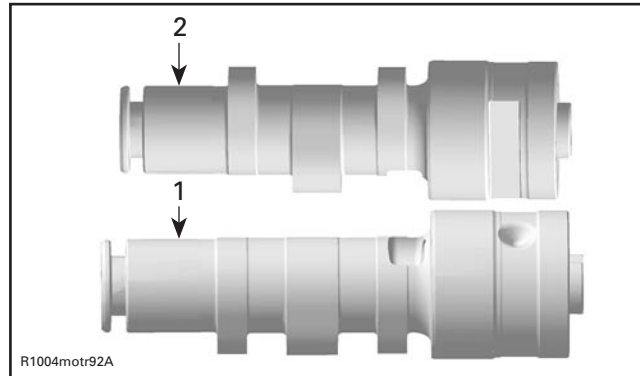


1. Cylinder screws M11
2. Angle torque wrench

Remove crankshaft locking bolt then install plug with sealing ring.

CAMSHAFT

NOTE: The engine is equipped with two different camshafts no. 22 and no. 66.



1. Camshaft of cylinder 1
2. Camshaft of cylinder 2

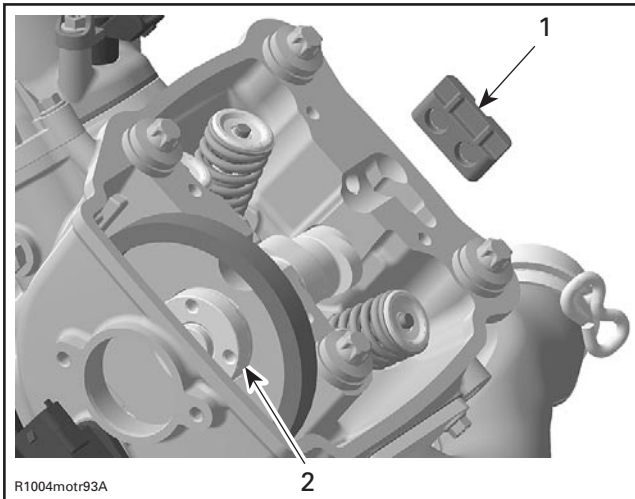
Removal

The removal procedure is the same for both camshafts.

Each cylinder is different in design. Thus, it is important not to mix up any parts of the camshaft assembly with that of the other cylinder. Keep parts as a "group".

Remove:

- valve cover (refer to VALVE COVER)
- chain tensioner (refer to CHAIN TENSIONER)
- breather (refer to BREATHER)
- decompressor (refer to DECOMPRESSOR)
- rocker arms (refer to ROCKER ARMS)
- camshaft sprocket/ timing gear (refer to CAM-SHAFT SPROCKET/TIMING GEAR)
- camshaft lock no. 23
- camshaft no. 22 and/or no. 66.



- 1. Camshaft lock
- 2. Camshaft

Cleaning

Remove carbon deposits from combustion chamber, exhaust port and piston top.

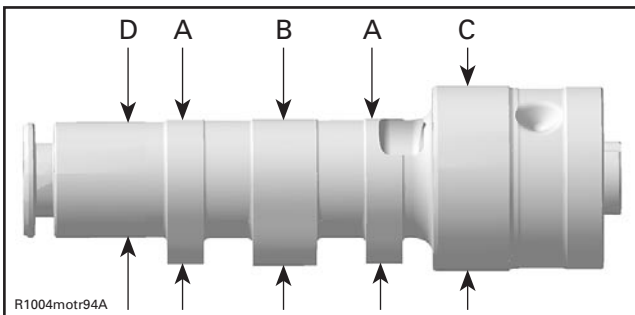
Inspection

Check each lobe and bearing journal of camshaft for scoring, scuffing, cracks or other signs of wear.

Measure camshaft bearing journal diameter and lobe height using a micrometer.

Measure clearance between both ends of camshaft and cylinder head.

NOTE: The data in the following tables are valid for both camshafts.



- A. Camshaft lobe (exhaust valves)
- B. Camshaft lobe (intake valves)
- C. Camshaft bearing journal (big end)
- D. Camshaft bearing journal (small end)

CAMSHAFT LOBE - EXHAUST VALVE	
MINIMUM (NEW)	31.435 mm (1.237 in)
MAXIMUM (NEW)	31.635 mm (1.245 in)
SERVICE LIMIT	31.400 mm (1.236 in)
CAMSHAFT LOBE - INTAKE VALVE	
MINIMUM (NEW)	31.654 mm (1.246 in)
MAXIMUM (NEW)	31.854 mm (1.254 in)
SERVICE LIMIT	31.600 mm (1.244 in)
CAMSHAFT BEARING JOURNAL - BIG END	
MINIMUM (NEW)	39.927 mm (1.5719 in)
MAXIMUM (NEW)	39.935 mm (1.5722 in)
SERVICE LIMIT	39.920 mm (1.5716 in)
CAMSHAFT BEARING JOURNAL - SMALL END	
MINIMUM (NEW)	24.967 mm (.9829 in)
MAXIMUM (NEW)	24.980 mm (.9835 in)
SERVICE LIMIT	24.960 mm (.9827 in)
CAMSHAFT BORE - BIG END MEASURED IN DIAMETER	
MINIMUM (NEW)	39.984 mm (1.5742 in)
MAXIMUM (NEW)	40.000 mm (1.5748 in)
SERVICE LIMIT	40.020 mm (1.5756 in)
CAMSHAFT BORE - SMALL END MEASURED IN DIAMETER	
MINIMUM (NEW)	24.987 mm (.9837 in)
MAXIMUM (NEW)	25.000 mm (.9842 in)
SERVICE LIMIT	25.020 mm (.9850 in)

Replace parts that are not within specifications.

Installation

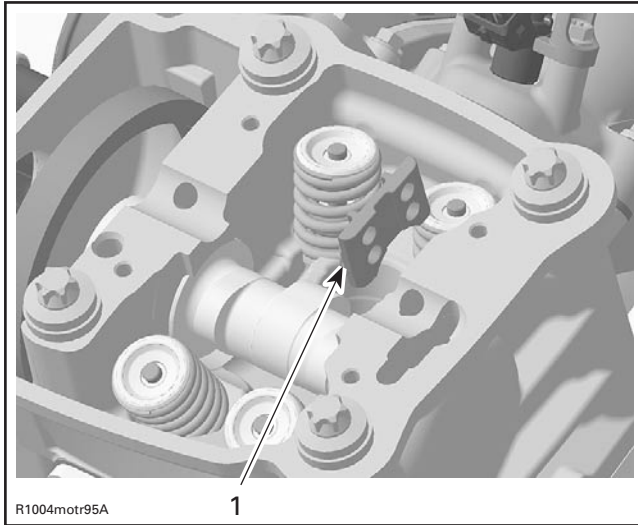
For installation, reverse the removal procedure. Pay attention to the following details.

CAUTION: The camshafts are not identical in design. Do not invert the camshafts during assembly. Any mix-up of the components will lead to engine damage.

Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

Install camshaft then place the camshaft lock in the slot.



1. Camshaft lock

For other parts, refer to proper installation procedure.

VALVE SPRINGS

NOTE: The engine is equipped with two different valve springs no. 16 (inner) and no. 17 (outer) for every valve.

Removal

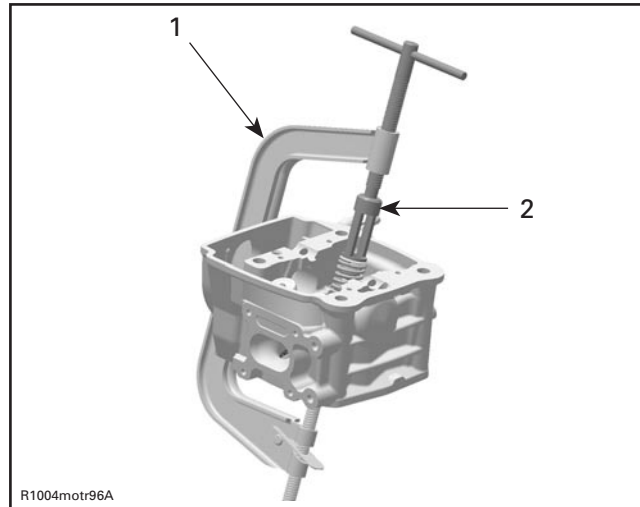
Remove:

- rocker arms (refer to **ROCKER ARMS**)
- cylinder head (refer to **CYLINDER HEAD**).

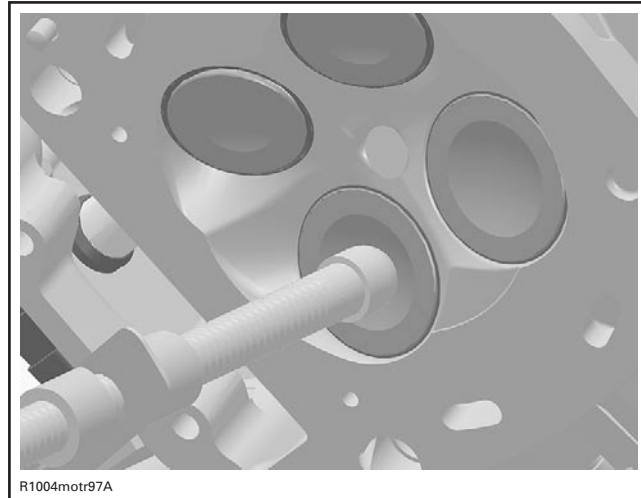
Compress valve springs no. 16 and no. 17, use valve spring compressor clamp (P/N 529 035 764) and valve spring compressor cup (P/N 529 035 724).

⚠ WARNING

Always wear safety glasses when disassembling valve springs. Be careful when unlocking valves. Components could be expelled under pressure from preloaded spring.



1. Valve spring compressor clamp (P/N 529 035 764)
2. Valve spring compressor cup (P/N 529 035 724)



LOCATE VALVE SPRING COMPRESSOR CLAMP IN CENTER OF THE VALVE

Remove valve cotters no. 19.

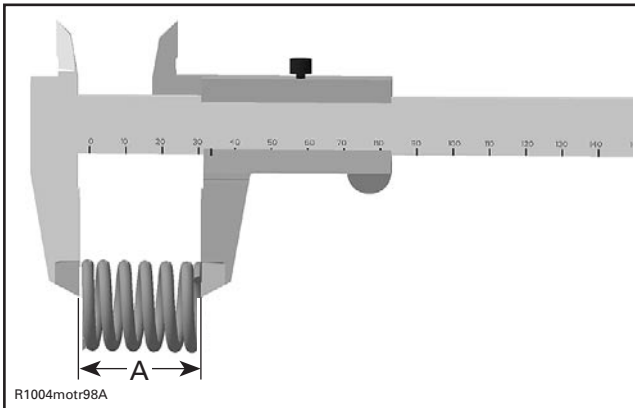
Withdraw valve spring compressor, valve spring retainer no. 18 and valve springs.

Inspection

Check valve springs for rust, corrosion or other visible damages. If so, replace valve springs.

Check valve springs for free length and straightness.

Replace valve springs if not within specifications.



A. Valve spring length

VALVE SPRING FREE LENGTH	
OUTER VALVE SPRING	
NOMINAL (NEW)	45.45 mm (1.789 in)
SERVICE LIMIT	43 mm (1.693 in)
INNER VALVE SPRING	
NOMINAL (NEW)	41.02 mm (1.615 in)
SERVICE LIMIT	38.80 mm (1.528 in)

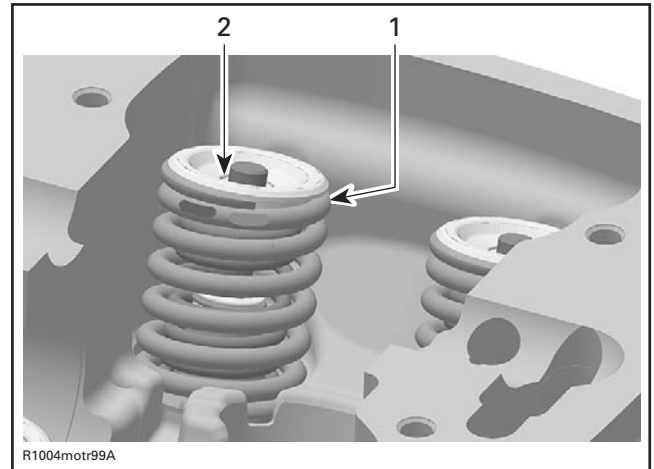
Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: Colored area of the valve spring must be placed on top.

If the color cannot be identified any more, orientation is possible, based on the shape of the spring. The spacing of the coils is smaller at one end. At installation, this end must be directed towards the cylinder head.

NOTE: Valve cotters must be properly engaged in valve stem grooves.



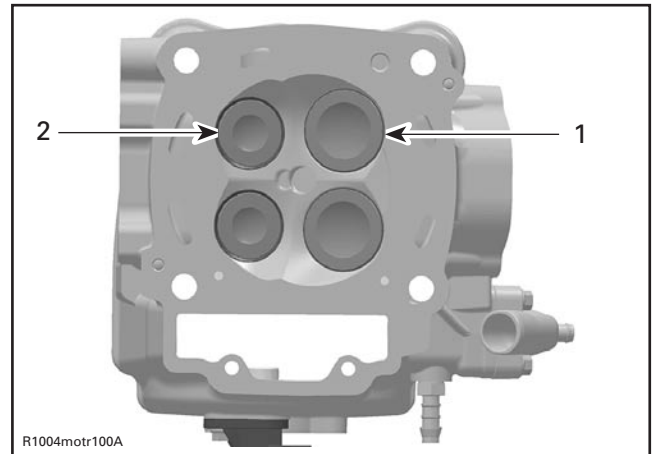
1. Position of the valve spring
2. Valve cotters

VALVE

Removal

Remove valve springs.

Push valve stem then pull valves **no. 13** and **no. 14** out of valve guide.

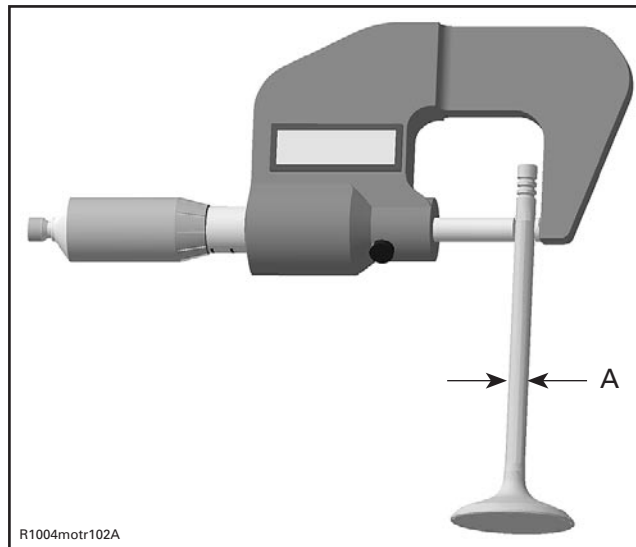
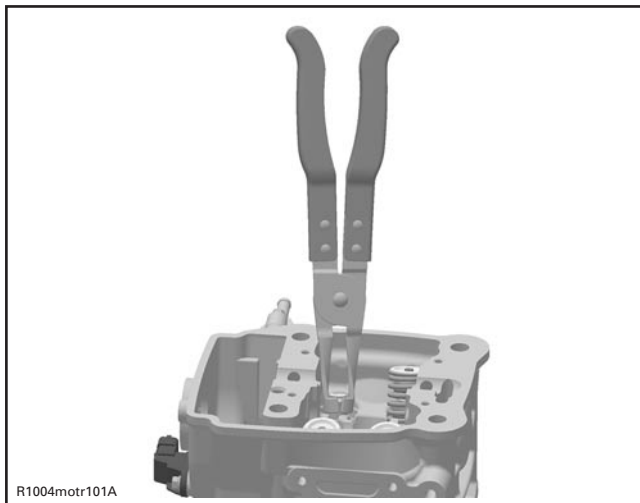


1. Intake valve 38 mm
2. Exhaust valve 31 mm

Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

Remove valve stem seal no. 15 with special pliers such as Snap-ON YA 8230.



A. Valve stem diameter

Inspection

Valve Stem Seal

NOTE: Inspection of valve stem seals is not needed because new seals should always be installed whenever cylinder head is removed.

Valve

Inspect valve surface, check for abnormal stem wear and bending. If so, replace by a new one.

Valve Stem and Valve Guide Clearance

Measure valve stem and valve guide in three places, using a micrometer and a small bore gauge.

NOTE: Clean valve guide to remove carbon deposits before measuring.

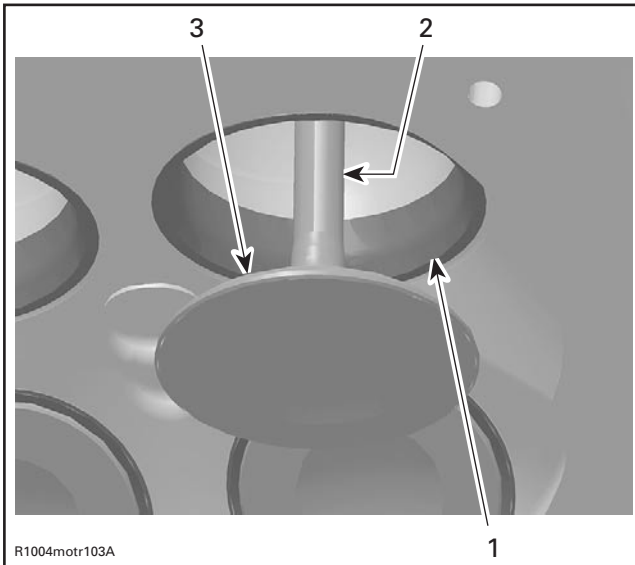
Change valve if valve stem is out of specification or has other damages such as wear or traces of friction.

VALVE STEM DIAMETER mm (in)	
MINIMUM (NEW)	
Exhaust	5.946 mm (.2341 in)
Intake	5.961 mm (.2347 in)
MAXIMUM (NEW)	
Exhaust	5.960 mm (.2346 in)
Intake	5.975 mm (.2352 in)
SERVICE LIMIT	
Exhaust	5.93 mm (.233 in)
Intake	

Replace cylinder head if valve guide is out of specification or has other damages such as wear or traces of friction.

VALVE GUIDE DIAMETER mm (in)	
SERVICE LIMIT	
Exhaust	6.060 mm (.2386 in)
Intake	

Valve Face and Seat



- 1. Valve seat
- 2. Exhaust valve contaminated area
- 3. Valve face (contact surface to valve seat)

Check valve face and seat for burning or pittings and replace valve or cylinder head if there are signs of damage.

Ensure to seat valves properly. Apply some lapping compound to valve face and work valve on its seat with a lapping tool.

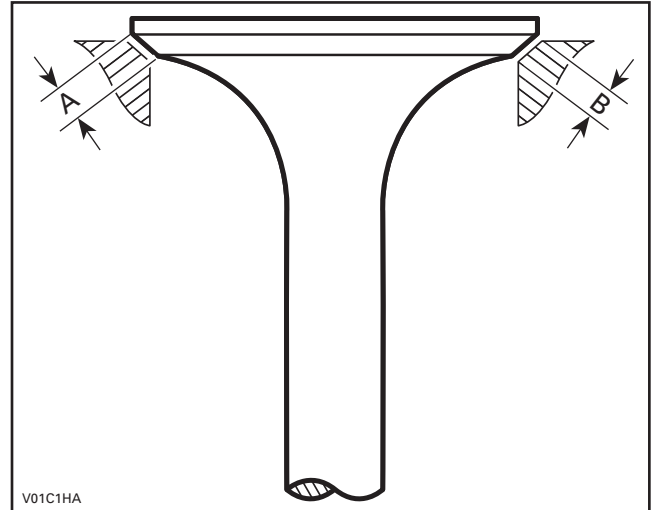
Measure valve face contact width.

NOTE: The location of contact area should be in center of valve seat.

Measure valve seat width, using a caliper.

VALVE SEAT CONTACT WIDTH mm (in)	
NEW	
Exhaust	1.25 to 1.55 mm (.049 to .061 in)
Intake	1.10 to 1.30 mm (.043 to .051 in)
SERVICE LIMIT	
Exhaust	1.8 mm (.071 in)
Intake	1.6 mm (.063 in)

If valve seat contact width is too wide or has dark spots, replace the cylinder head.

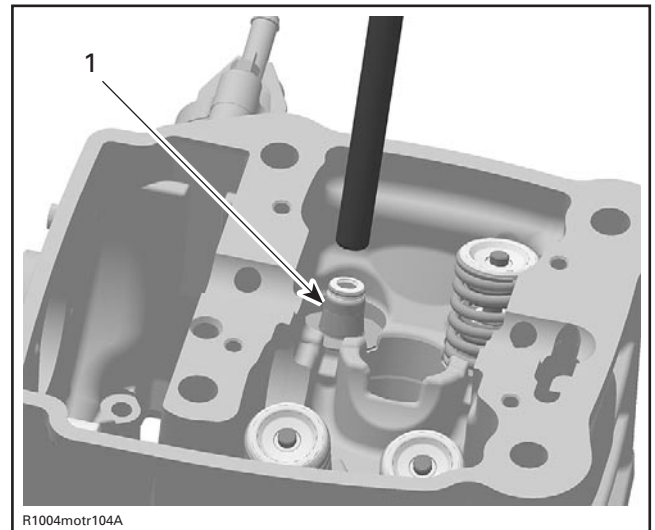


- A. Valve face contact width
- B. Valve seat contact width

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: At installation, replace the valve stem seal no. 15.



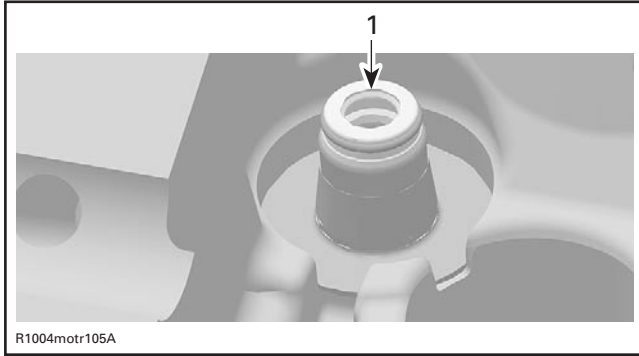
- 1. Valve stem seal

Section 03 ENGINE

Subsection 07 (CYLINDER AND CYLINDER HEAD)

Apply engine oil on valve stem and install it.

CAUTION: Be careful when valve stem is passed through sealing lips of valve stem seal.



1. Sealing lips of valve stem seal

To ease installation of cotters, apply oil or grease on them so that they remain in place while releasing the spring.

After spring is installed, ensure it is properly locked by tapping on valve stem end with a soft hammer so that valve opens and closes a few times.

CAUTION: An improperly locked valve spring will cause engine damage.

CYLINDER

NOTE: The engine is equipped with two different cylinders no. 2 and no. 72.

Removal

Lock crankshaft with locking bolt (P/N 529 035 900), refer to CRANKSHAFT/DRIVE GEARS.

Remove:

– cylinder heads (refer to CYLINDER HEAD).

Pull cylinder no. 2 and no. 72.

Discard cylinder gaskets no. 1.

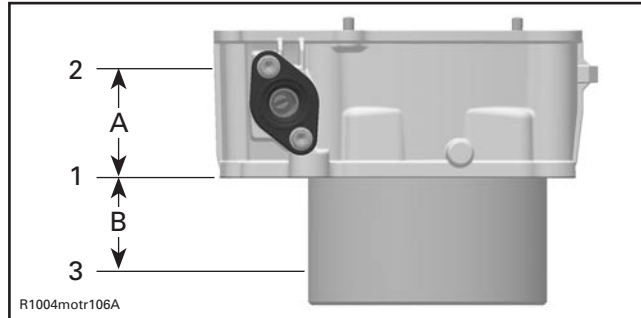
Inspection

Cylinder

Check cylinder for cracks, scoring and wear ridges on the top and bottom of the cylinder. If so, replace cylinder.

Cylinder Taper

Measure cylinder bore at 3 recommended positions. See the following illustration.



1. First measuring diameter in line with cylinder bottom
 2. Second measuring diameter
 3. Third measuring diameter
- A. 60 mm (2.362 in)
B. 50 mm (1.968 in)

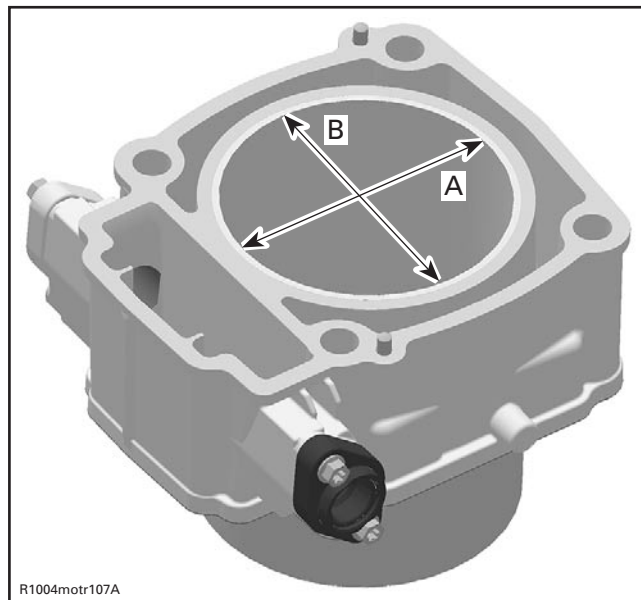
CYLINDER TAPER mm (in)	
MAXIMUM (NEW)	0.038 mm (.001 in)
SERVICE LIMIT	0.090 mm (.004 in)

Difference between measurements should not exceed the service limit mentioned above.

Cylinder Out of Round

Measure cylinder diameter in piston axis direction from top of cylinder. Take another measurement 90° from first one and compare.

NOTE: Take the same measuring points like described in CYLINDER TAPER above.



- A. Parallel to piston axis
B. Perpendicular to piston axis

CYLINDER OUT OF ROUND mm (in)	
MAXIMUM (NEW)	0.01 mm (.0002 in)
SERVICE LIMIT	0.02 mm (.0008 in)

CAUTION: Always replace gasket **no. 1** before installing the cylinder.

Installation

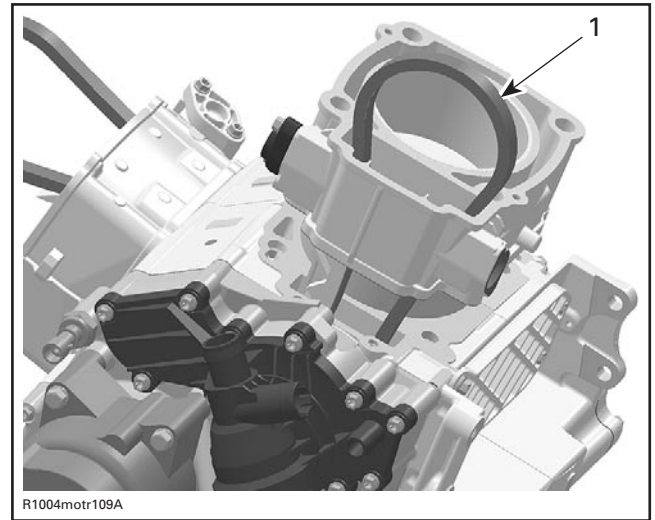
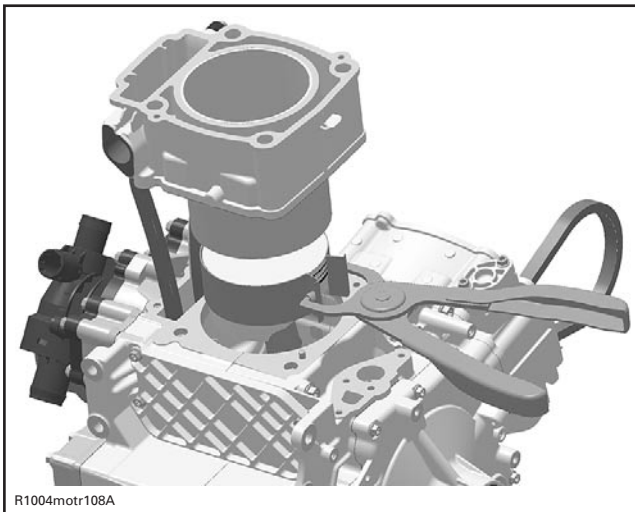
For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: The cylinders are not identical in design. Do not invert the cylinders during assembly.

First mount cylinder 1. Then remove the locking bolt (P/N 529 35 900). Crank the engine further and position piston 2 at TDC. Mount cylinder 2. The cylinder cannot be pushed fully over the piston unless the piston is located at TDC.

Apply engine oil in the bottom area of the cylinder bore and also on the band of the piston ring compressor tool.

Using a piston ring compressor plier, such Snap-On RC-980, slide piston into cylinder.



1. Timing chain

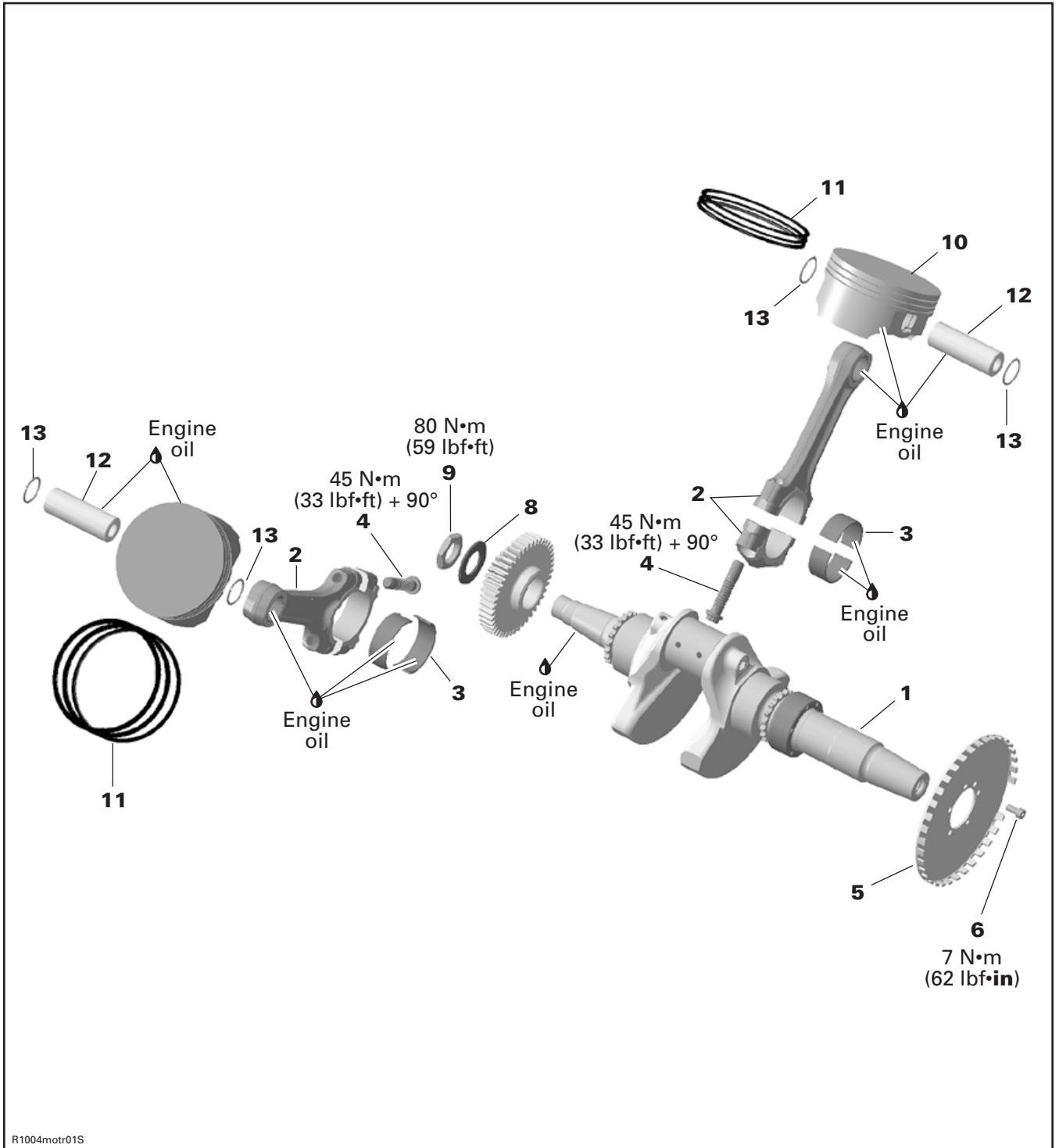
NOTE: Put timing chain through the chain pit then put the cylinder in place.

Install cylinder head and the other parts in accordance with the proper installation procedures.

PISTON

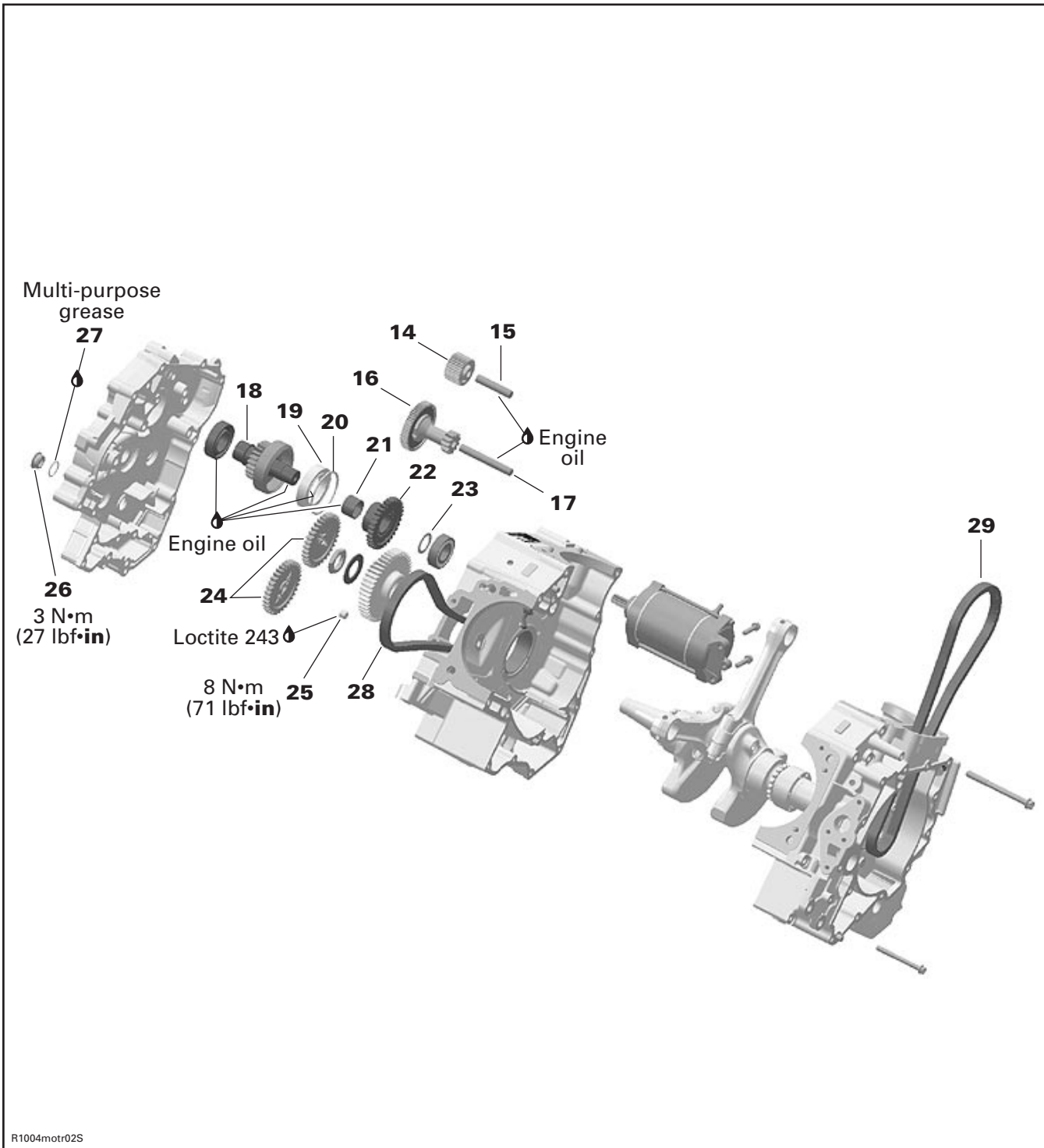
Refer to CRANKSHAFT/DRIVE GEARS.

CRANKSHAFT/DRIVE GEARS



Section 03 ENGINE

Subsection 08 (CRANKSHAFT/DRIVE GEARS)



R1004motr02S

TIMING CHAIN

The engine is equipped with two timing chains **no. 28** and **no. 29**. One of the timing chains is located on the engine alternator side behind the ignition cover. The second is located on the PTO side behind the PTO cover.

Removal of Alternator Side Timing Chain

Remove:

- ignition cover (refer to COOLING SYSTEM)
- chain tensioner and chain guide (refer to CYLINDER AND CYLINDER HEAD)
- camshaft sprocket (refer to CYLINDER AND CYLINDER HEAD)
- oil pump gears **no. 24** (refer to LUBRICATION SYSTEM)
- crankshaft drive gear **no. 7** (refer to DRIVE GEARS).

Carefully pull the timing chain sideward and down from the crankcase.

Removal of PTO Side Timing Chain

Remove:

- engine from vehicle (refer to REMOVAL AND INSTALLATION)
- oil tank (refer to LUBRICATION SYSTEM)
- chain tensioner and chain guide (refer to CYLINDER AND CYLINDER HEAD)
- camshaft timing gear (refer to CYLINDER AND CYLINDER HEAD)
- PTO cover (refer to CRANKCASE)
- trigger wheel **no. 6** (refer to TRIGGER WHEEL).

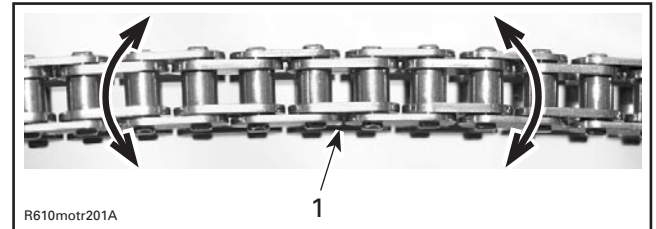
Carefully pull the timing chain sideward and down from the crankcase.

Inspection

Inspection is the same for both timing chains **no. 28** and **no. 29**. Pay attention to the following details.

NOTE: Check timing chain on camshaft sprocket/timing gear for excessive radial play.

Check chain condition for wear and rollers condition.



1. Timing chain

If chain is excessively worn or damaged, replace it as a set (camshaft sprocket/timing gear and timing chain).

Installation

Installation is the same for both timing chains **no. 28** and **no. 29**.

The installation is essentially the reverse of the removal procedure but, pay attention to the following details.

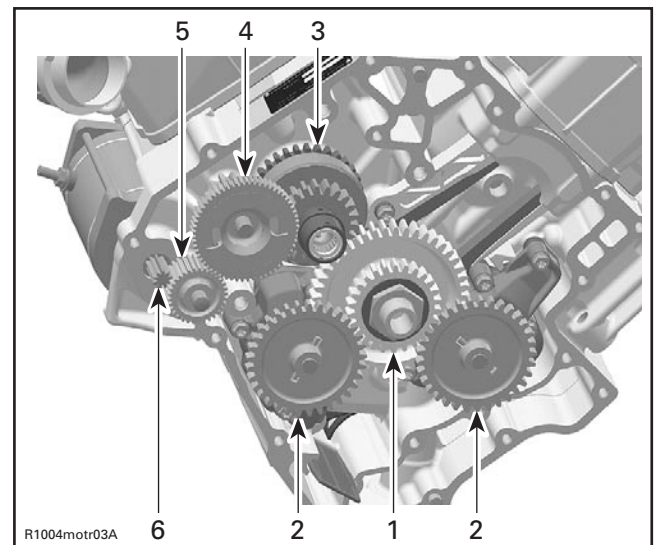
NOTE: Ensure to perform proper valve timing. Lock crankshaft and camshaft at TDC (refer to CYLINDER AND CYLINDER HEAD).

Install chain then, adjust chain tension (refer to CYLINDER AND CYLINDER HEAD).

CAUTION: Improper valve timing will damage engine components.

DRIVE GEARS

The drive gears are located on the engine alternator side behind the ignition cover.



1. Crankshaft drive gear
2. Oil pump gears
3. Generator gear
4. Double gear
5. Intermediate gear
6. Starter gear

Section 03 ENGINE

Subsection 08 (CRANKSHAFT/DRIVE GEARS)

Removal

Lock crankshaft with crankshaft locking bolt (P/N 529 035 900) (refer to CRANKSHAFT LOCKING BOLT).

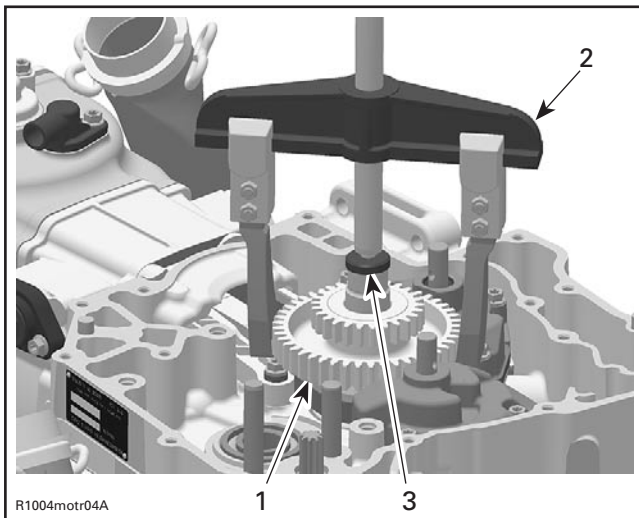
Remove:

- ignition cover (refer to COOLING SYSTEM)
- oil pump gears **no. 24** (refer to LUBRICATION SYSTEM)
- crankshaft nut **no. 9**
- crankshaft drive gear **no. 7**.

Remove crankshaft drive gear with gear puller (after-market tool). Also use the protection mushroom (P/N 420 876 552) to avoid damage of the crankshaft.

⚠ WARNING

The gear puller and the crankshaft drive gear are highly tensioned. When the crankshaft drive gear is loosened, the puller may forcefully swing up.



1. Crankshaft drive gear
2. Gear puller
3. Protection mushroom (P/N 420 876 552)

- generator gear **no. 18** and thrust washer **no. 23**
- double gear **no. 16**
- intermediate gear **no. 14**.

Inspection

Double Gear/Intermediate Gear/ Crankshaft Drive Gear

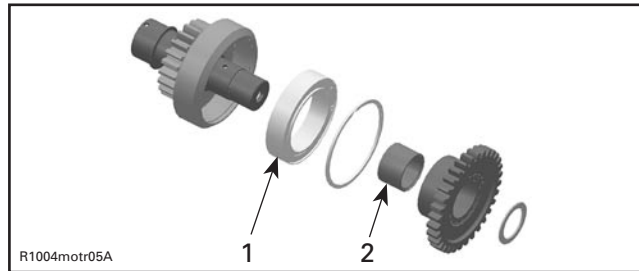
NOTE: Inspect the gears for wear and damage.

Oil Pump Gears

Refer to LUBRICATION SYSTEM.

Generator Gear

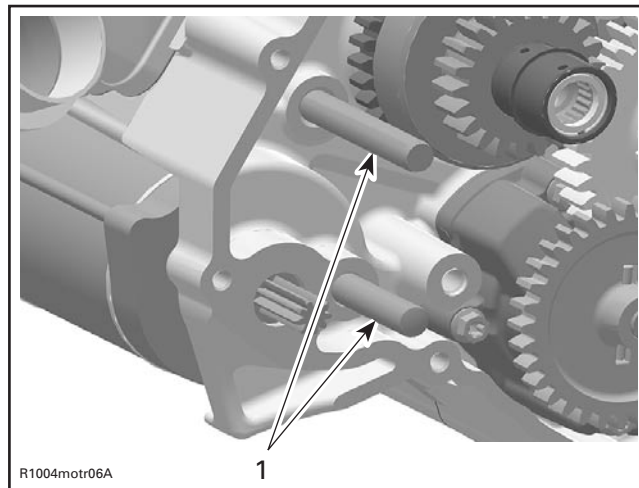
Completely disassemble the generator gear.



1. Sprag clutch
2. Needle bearing

NOTE: Inspect all components, especially the needle bearing, for wear and damage. Perform a function test of the sprag clutch.

Location Pins



1. Location pins

NOTE: Inspect all pins for wear and damage. The pins are firmly pressed into the crankcase but may work loose during the course of time. If the pins can be rotated, there is no need for repair work.

Installation

The installation is essentially the reverse of the removal procedure, but pay attention to the following details.

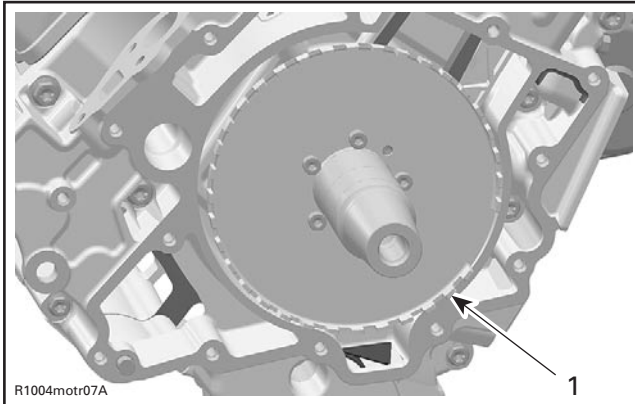
NOTE: Adequately oil all components prior to installation. The oil pump gears and the crankshaft drive gear do not need to be oiled.

The generator gear and the double gear must be installed at the same time on their respective location pin.

Torque crankshaft nut **no. 9** to 80 N•m (59 lbf•ft).

TRIGGER WHEEL

The trigger wheel is located on the engine PTO side behind the PTO cover.



1. Trigger wheel

Removal

Remove:

- oil tank (refer to LUBRICATION SYSTEM)
- PTO cover (refer to CRANKCASE)
- trigger wheel screws **no. 6** and pull trigger wheel **no. 5**.

Inspection

NOTE: Refer to COMPONENT INSPECTION AND ADJUSTMENT in ENGINE MANAGEMENT section.

Installation

For installation, reverse the removal procedure.

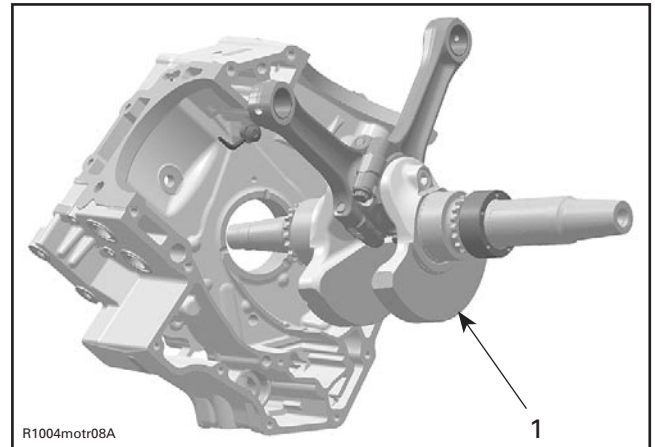
Torque trigger wheel screws to 7 N•m (62 lbf•in).

CRANKSHAFT

Removal

Remove:

- drive gears (refer to DRIVE GEARS above)
- crankcase (refer to CRANKCASE)
- crankshaft **no. 1**



1. Crankshaft

- connecting rods **no. 2**.

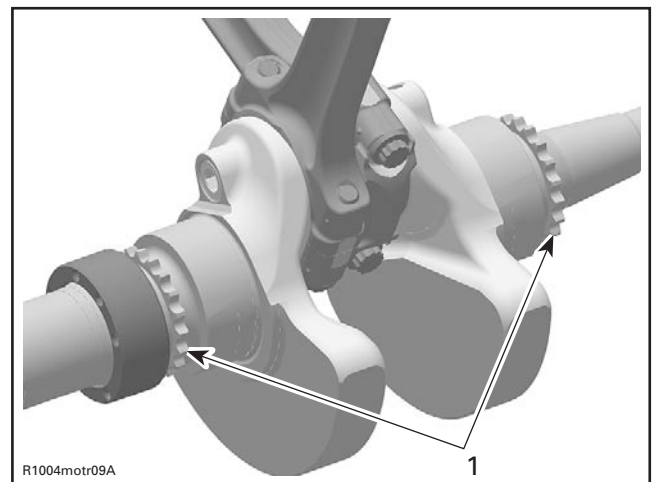
NOTE: Mark the connecting rods prior to dismantling. The connecting rods must be reinstalled in exactly the same position and running direction.

Inspection

NOTE: Check each bearing journal of crankshaft for scoring, scuffing, cracks or other signs of wear.

NOTE: Replace crankshaft if the gears are worn or otherwise damaged.

CAUTION: Components with less than the service limit always have to be replaced. If this is not observed, severe damage may be caused to the engine.



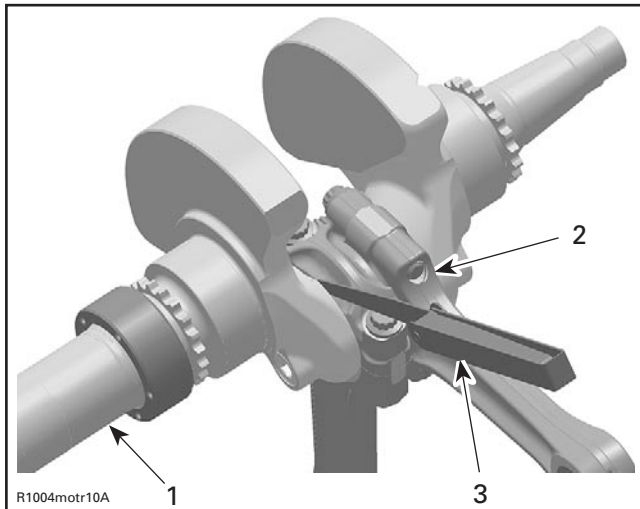
1. Crankshaft timing gear

Section 03 ENGINE

Subsection 08 (CRANKSHAFT/DRIVE GEARS)

Connecting Rod Big End Axial Play

Using a feeler gauge, measure distance between butting face of connecting rods and crankshaft counterweight. If the distance exceeds specified tolerance, replace the crankshaft.

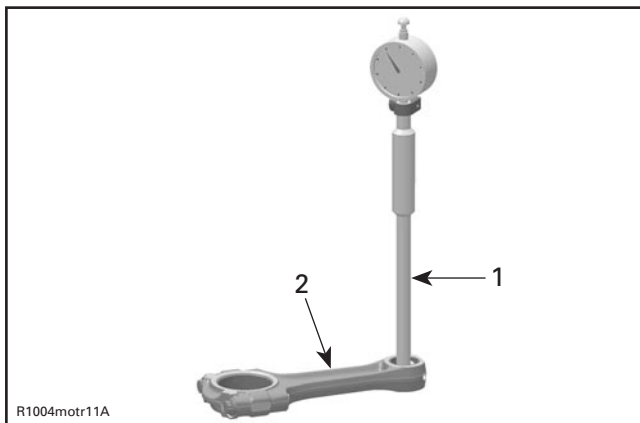


1. Crankshaft
2. Connecting rods
3. Feeler gauge

CONNECTING ROD BIG END mm (in)	
NEW MINIMUM	0.150 mm (.006 in)
NEW MAXIMUM	0.450 mm (.017 in)
SERVICE LIMIT	0.5 mm (.020 in)

Connecting Rod/Piston Pin Clearance

Measure piston pin. Compare to inside diameter of connecting rod no. 2.



1. Bore gauge
2. Connecting rod



A. Piston pin diameter in the area of the bushing

CONNECTING ROD SMALL END DIAMETER	
NEW MINIMUM	23.01 mm (.9059 in)
NEW MAXIMUM	23.02 mm (.9063 in)
SERVICE LIMIT	23.07 mm (.908 in)

PISTON PIN DIAMETER	
NEW MINIMUM	22.996 mm (.9053 in)
NEW MAXIMUM	23.000 mm (.9055 in)
SERVICE LIMIT	22.990 mm (.904 in)

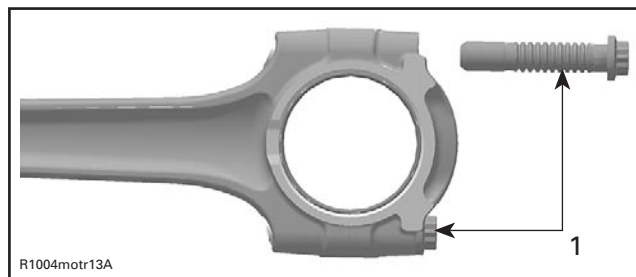
PISTON PIN BORE CLEARANCE	
SERVICE LIMIT	0.080 mm (.0035 in)

NOTE: If the connecting rod small end diameter is out of specification, replace connecting rod.

Connecting Rod Big End Radial Play

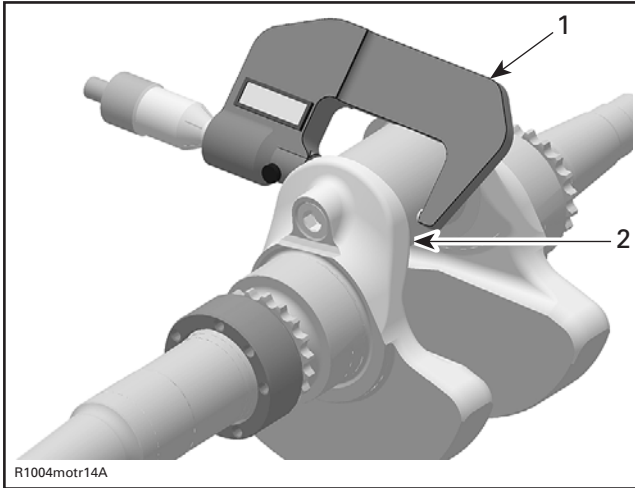
Remove connecting rod no. 2 from crankshaft no. 1.

CAUTION: Always replace connecting rod screws no. 4 if removing the connecting rod. It is recommended to replace bushings no. 3, in case of installing the connecting rod.



1. Connecting rod screw

Measure crankpin. Compare to inside diameter of connecting rod big end.

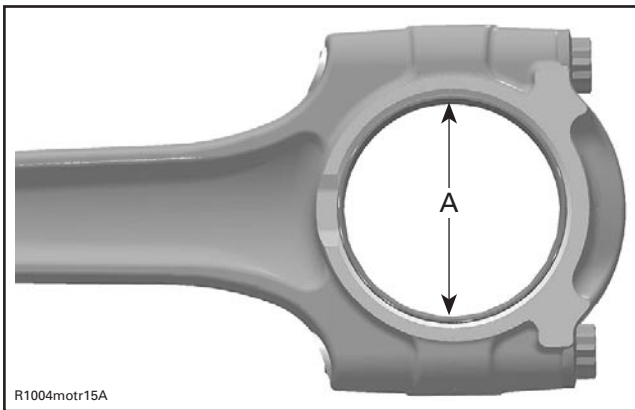


- 1. Micrometer
- 2. Crankpin area for bushings

To measure the connecting rod big end diameter, use the **OLD** screws no. 4.

Install the **OLD** bushings no. 3 as they were mounted initially.

Do the torque procedure as described further.



A. Connecting rod big end bushing

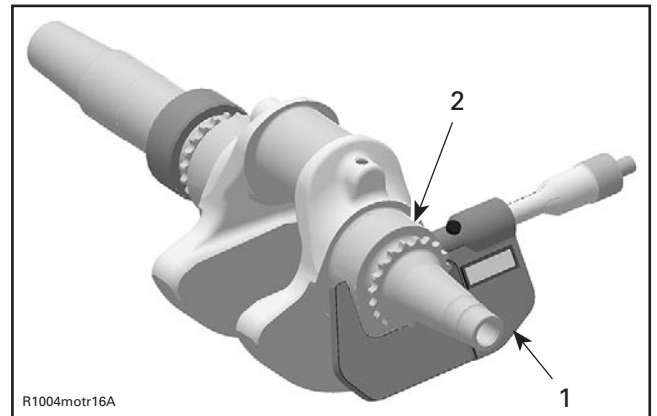
CRANKSHAFT PIN DIAMETER	
NEW MINIMUM	45.017 mm (1.7723 in)
NEW MAXIMUM	45.033 mm (1.7729 in)
SERVICE LIMIT	45.000 mm (1.772 in)

CONNECTING ROD BIG END DIAMETER	
SERVICE LIMIT	45.090 mm (1.775 in)

CONNECTING ROD BIG END CLEARANCE	
SERVICE LIMIT	0.09 mm (.0035 in)

Crankshaft Radial Play Alternator Side

Measure crankshaft on alternator side. Compare to inside diameter of alternator bushing (refer to CRANKCASE).



- 1. Micrometer
- 2. Crankshaft area for alternator bushing

CRANKSHAFT ALTERNATOR SIDE DIAMETER	
NEW MINIMUM	54.961 mm (2.1638 in)
NEW MAXIMUM	54.980 mm (2.1645 in)
SERVICE LIMIT	54.940 mm (2.1629 in)

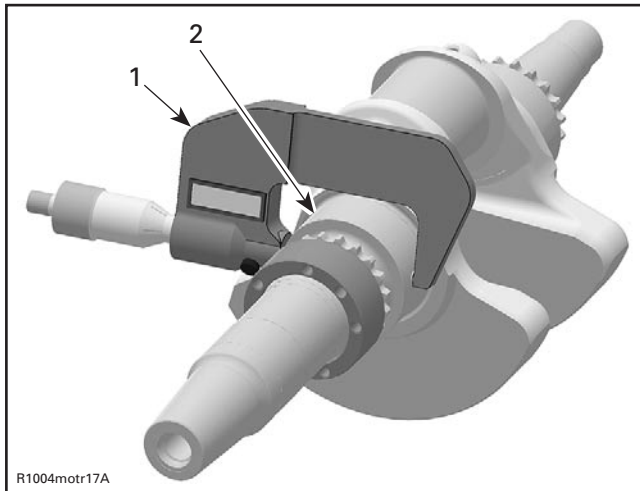
CRANKSHAFT ALTERNATOR SIDE RADIAL CLEARANCE	
SERVICE LIMIT	0.08 mm (.0031 in)

Section 03 ENGINE

Subsection 08 (CRANKSHAFT/DRIVE GEARS)

Crankshaft Radial Play (PTO side)

Measure crankshaft on PTO side. Compare to inside diameter of PTO bushing (refer to CRANKCASE).



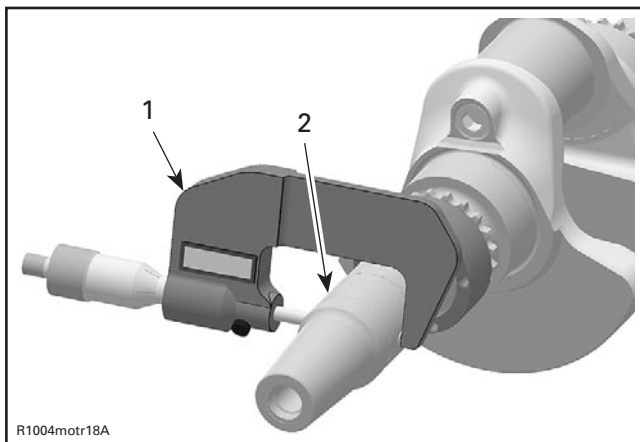
1. Micrometer
2. Crankshaft area for PTO bushing

CRANKSHAFT JOURNAL PTO DIAMETER	
NEW MINIMUM	54.961 mm (2.1638 in)
NEW MAXIMUM	54.980 mm (2.1645 in)
SERVICE LIMIT	54.940 mm (2.1629 in)

CRANKSHAFT PTO RADIAL CLEARANCE	
SERVICE LIMIT	0.08 mm (.0031 in)

Crankshaft Radial Play (PTO side support bearing)

Measure crankshaft on PTO side journal for support bearing. Compare to inside diameter of PTO support bearing (refer to PTO COVER in CRANKCASE section).



1. Micrometer
2. Crankshaft area (PTO support bearing)

CRANKSHAFT JOURNAL DIAMETER (PTO support bearing)

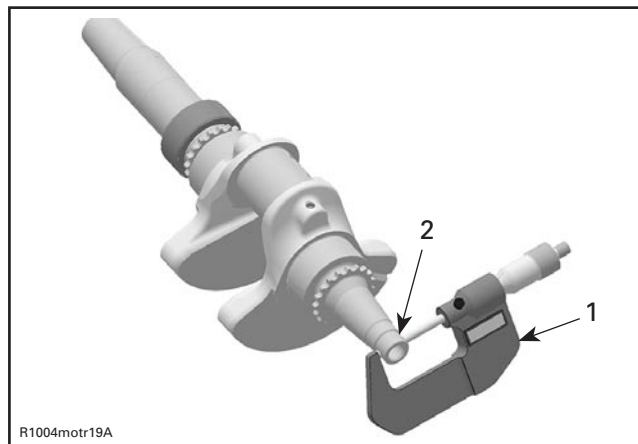
NEW MINIMUM	37.984 mm (1.4954 in)
NEW MAXIMUM	38.000 mm (1.4960 in)
SERVICE LIMIT	37.960 mm (1.4945 in)

CRANKSHAFT PTO SUPPORT BEARING RADIAL CLEARANCE

SERVICE LIMIT	0.08 mm (.0031 in)
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Crankshaft Radial Play (alternator side — oil supply hole)

Measure crankshaft on alternator side journal for oil supply hole. Compare to inside diameter of oil supply hole in ignition cover (refer to IGNITION COVER in COOLING SYSTEM).



1. Micrometer
2. Crankshaft area (journal for oil supply hole)

CRANKSHAFT JOURNAL DIAMETER (oil supply hole)

NEW MINIMUM	19.987 mm (0.7869 in)
NEW MAXIMUM	20.00 mm (0.7874 in)
SERVICE LIMIT	0.08 mm (.0031 in)

CRANKSHAFT OIL SUPPLY HOLE RADIAL CLEARANCE

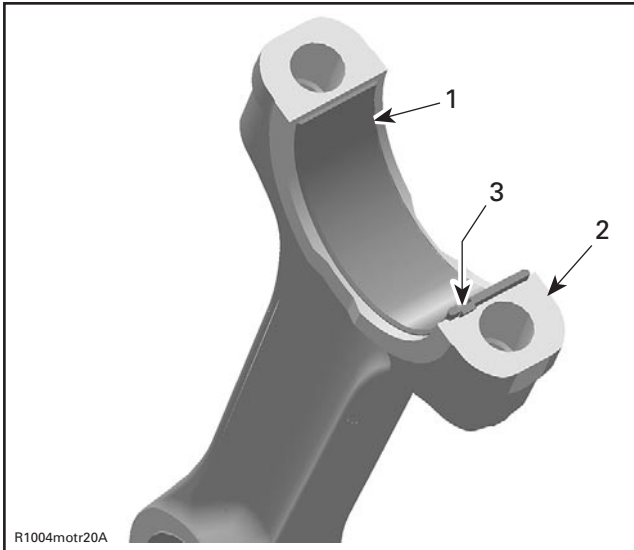
SERVICE LIMIT	0.080 mm (.0031 in)
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Installation

For installation, reverse the removal procedure. Pay attention to following details.

NOTE: Use **NEW** bushings no. 3, when connecting rod big end diameter is out of specification.

Put bushings correctly in place and clean the split surface on both sides (cracked area) carefully.



1. Half bushing of connecting rod big end
2. Split surface of the connecting rod
3. Nose of bushing in line with connecting rod groove

NOTE: Oil the plain bearing of the connecting rod before installation.

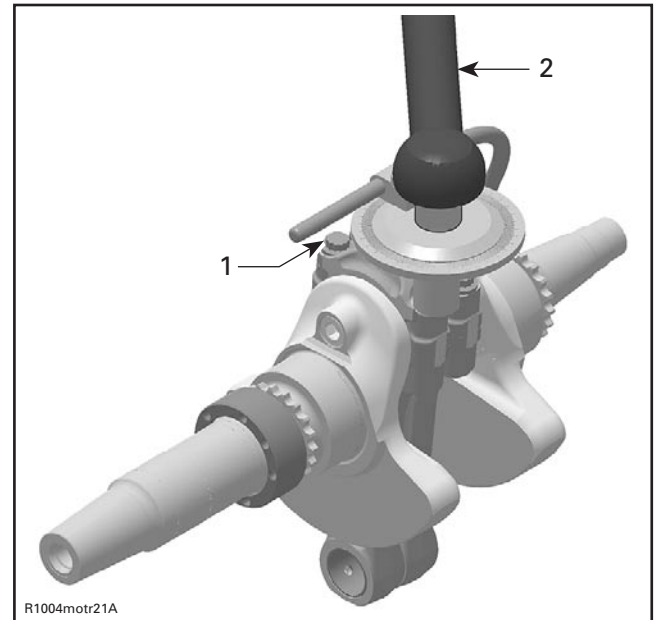
Torque **NEW** connecting rod screws no. 4 as per following procedure:

- Torque connecting rod screws to 20 N•m (177 lbf•in). Do not apply any thread locker product.
- Torque connecting rod screws to 45 N•m (33 lbf•ft).
- Finish tightening the screws with an additional 90° turn using an angle torque wrench.

CAUTION: Failure to strictly follow this procedure may cause screw to loosen and lead to engine damage. The bushing tapered end must be against the counterweight. Besides, as the “crankpin” screw has been stretched from the previous installation, it is very important to **use a new screw at assembly.**

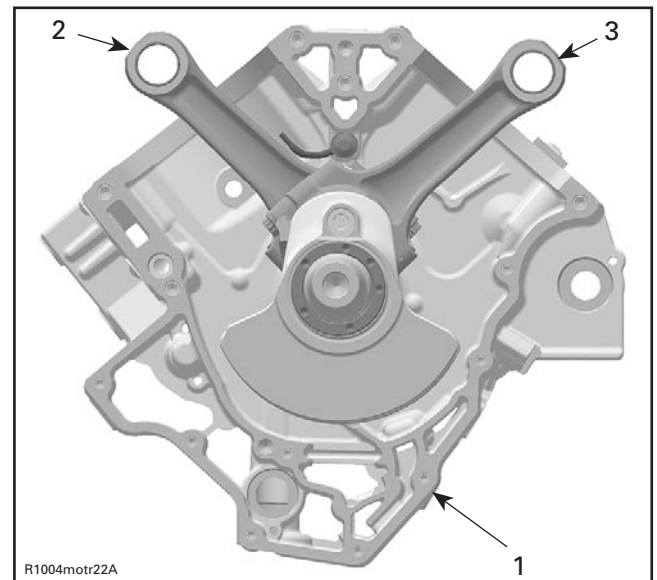
Take care during installation that the connecting rods are not installed with a twist. The running direction of the big end bearings and of the piston pins must not change.

Do not mix up the connecting rods of cylinders 1 and 2 during installation.



1. Connecting rod screws
2. Angle torque wrench

CAUTION: Observe the correct installation position when fitting the crankshaft with the connecting rods. The connecting rod alternator side has to face to cylinder 1.



1. Crankcase alternator side
2. Connecting rod cylinder 1
3. Connecting rod cylinder 2

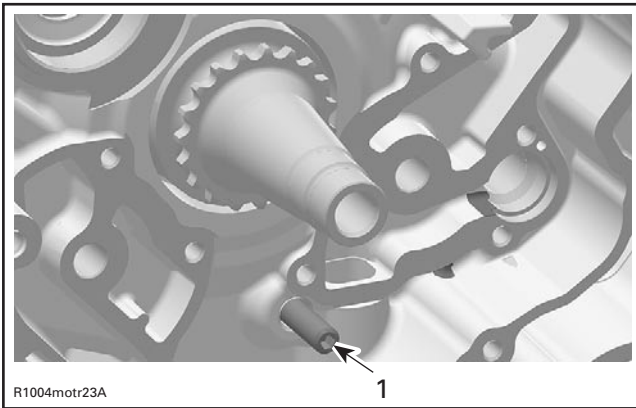
Section 03 ENGINE

Subsection 08 (CRANKSHAFT/DRIVE GEARS)

CAUTION: Install crankshaft locking bolt (P/N 529 035 900) (refer to CRANKSHAFT LOCKING BOLT) right away to put crankshaft in TDC position before installing the camshaft and rockers (refer to CYLINDER AND CYLINDER HEAD).

CRANKSHAFT LOCKING BOLT

The engine must be locked for removal and installation work on crankshaft and camshaft. The opening for the crankshaft locking bolt is located in the ignition cover and in crankcase alternator side.



1. Crankshaft locking bolt (P/N 529 035 900)

Removal

Remove:

- plug screw no. 26
- plug screw no. 25.

CAUTION: Pull out the plug screw with utmost care to prevent it from being dropped into the crankcase during dismantling.

Installation

Fit the plug screw no. 25 with Loctite 243.

Torque plug screw no. 25 to 8 N•m (71 lbf•in).

Replace O-ring no. 27 during installation and grease it with multi-purpose grease.

Torque plug screw no. 26 to 3 N•m (26 lbf•in).

PISTON

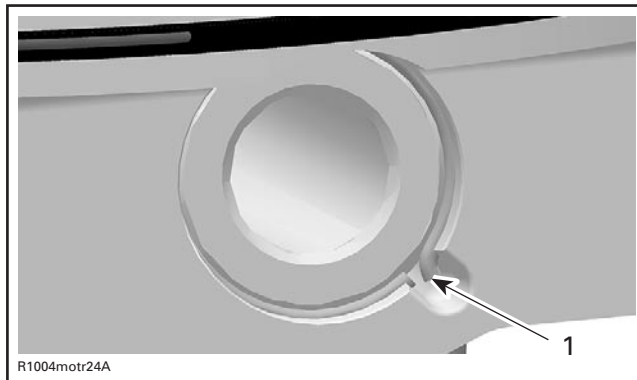
Removal

Remove:

- cylinder head
(refer to CYLINDER AND CYLINDER HEAD)
- cylinder
(refer to CYLINDER AND CYLINDER HEAD).

Place a rag under piston.

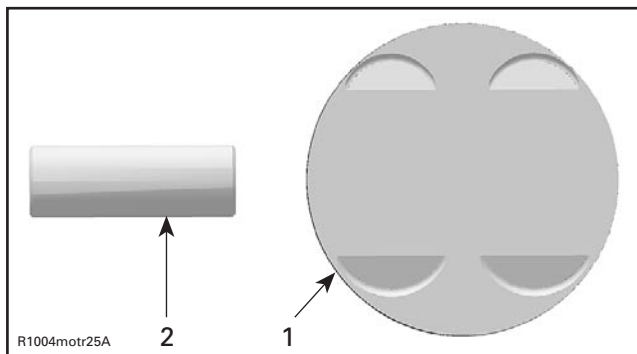
Remove one piston circlip no. 13 and discard it.



1. Piston circlip

NOTE: The removal of both piston circlips is not necessary to remove piston pin.

Push piston pin no. 12 out of piston.



1. Piston
2. Piston pin

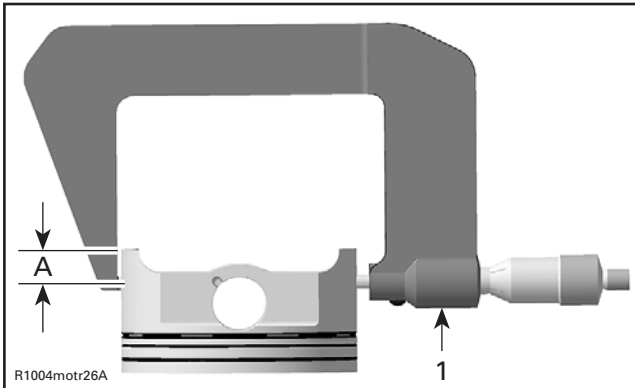
Detach piston no. 10 from connecting rod.

Inspection

Piston

NOTE: Inspect piston for scoring, cracking or other damages. Replace piston and piston rings if necessary.

Using a micrometer, measure piston at 18 mm (.709 in) perpendicularly (90°) to piston pin.



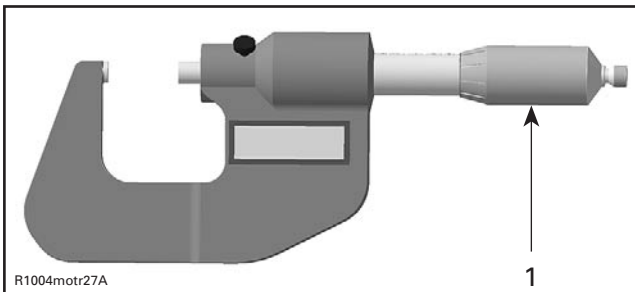
1. Measuring perpendicularly (90°) to piston pin
A. 18 mm (.709 in)

The measurement should be as in the following table. If not, replace piston.

PISTON MEASUREMENT	
NEW NOMINAL	99.951 to 99.969 mm (3.935 to 3.936 in)
SERVICE LIMIT	99.80 mm (3.929 in)

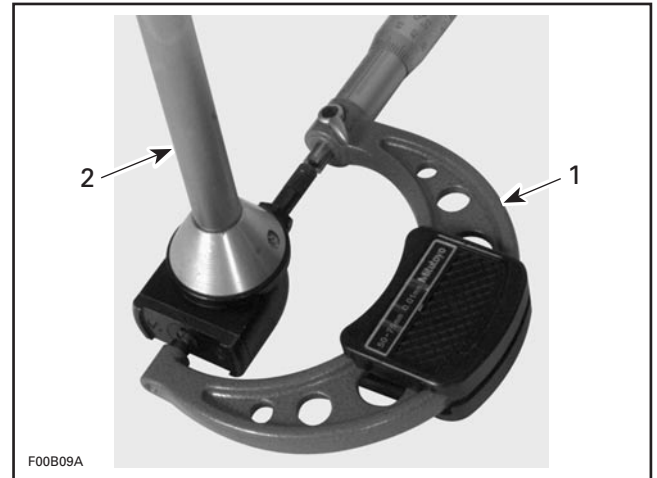
Piston/Cylinder Clearance

Adjust and lock a micrometer to the piston dimension.

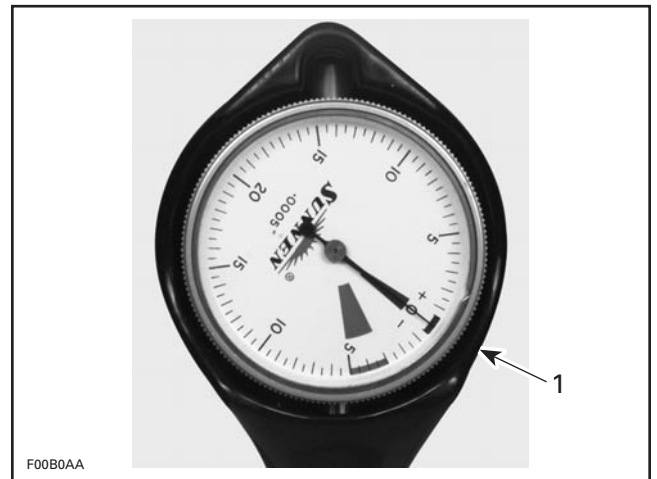


1. Micrometer set to the piston dimension

With the micrometer set to the dimension, adjust a cylinder bore gauge to the micrometer dimension and set the indicator to 0 (zero).



1. Use the micrometer to set the cylinder bore gauge
2. Dial bore gauge



TYPICAL

1. Indicator set to 0 (zero)

Position the dial bore gauge 50 mm (2 in) above cylinder base, measuring perpendicularly (90°) to piston pin axis.

Read the measurement on the cylinder bore gauge. The result is the exact piston/cylinder wall clearance.

PISTON/CYLINDER CLEARANCE	
NEW NOMINAL	0.024 to 0.056 mm (.001 to .002 in)
SERVICE LIMIT	0.090 mm (.004 in)

NOTE: Make sure used piston is not worn. See PISTON MEASUREMENT above.

If clearance exceeds specified tolerance, replace cylinder.

Section 03 ENGINE

Subsection 08 (CRANKSHAFT/DRIVE GEARS)

NOTE: Make sure the cylinder bore gauge indicator is set exactly at the same position as with the micrometer, otherwise the reading will be false.

Piston Pin

Using synthetic abrasive woven, clean piston pin from deposits.

Inspect piston pin for scoring, cracking or other damages.

Measure piston pin. See the following illustration for the proper measurement position.



A. Piston pin diameter

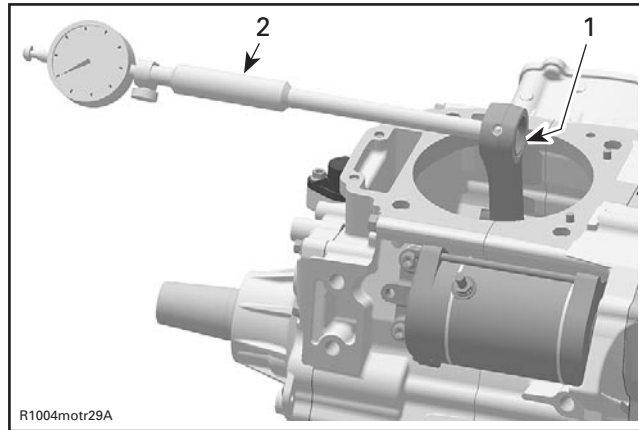
PISTON PIN	
NEW MINIMUM	22.996 mm (.9053 in)
NEW MAXIMUM	23.000 mm (.9055 in)
SERVICE LIMIT	22.990 mm (.9051 in)

NOTE: Replace piston pin if diameter is out of specifications.

Piston Pin/Connecting Rod Bushing Clearance

Measure inside diameter of connecting rod.

CONNECTING ROD SMALL END DIAMETER	
NEW MINIMUM	23.01 mm (.9059 in)
NEW MAXIMUM	23.02 mm (.9063 in)
SERVICE LIMIT	23.07 mm (.908 in)



1. Bushing of the connecting rod
2. Bore gauge

NOTE: Replace connecting rod if diameter of connecting rod small end is out of specifications.

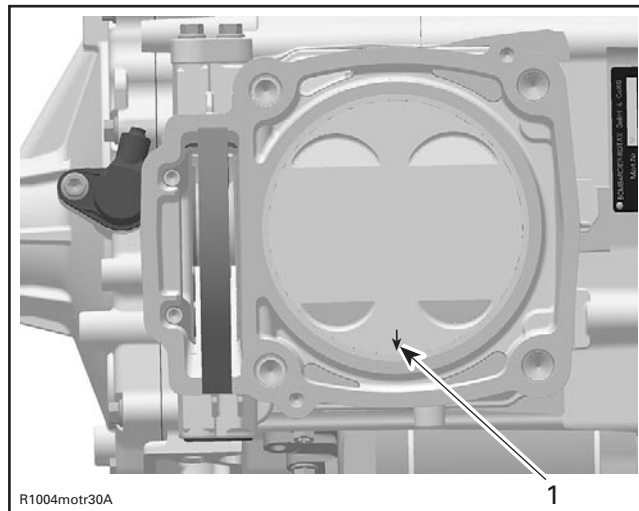
Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: Apply engine oil on the piston pin.

Insert piston pin into piston and connecting rod.

CAUTION: Take care that piston will be installed with the punched arrow on piston top to the exhaust side.

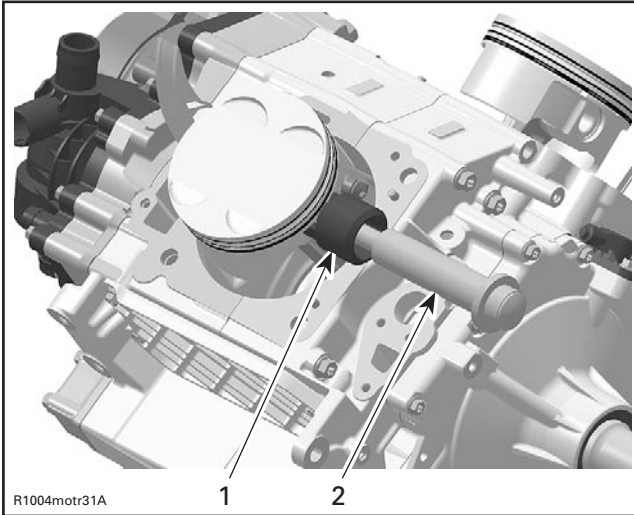


1. Arrow should indicate to the exhaust side

Use the piston circlip installer (P/N 529 035 765) to assemble the piston circlip.

CAUTION: Secure piston pin with new piston circlips.

NOTE: Take care that the hook of the piston circlip is positioned properly.



1. Sleeve with piston circlip inside
2. Assembly jig from piston clip installer

RING/PISTON GROOVE CLEARANCE mm (in)	
NEW MINIMUM	
UPPER COMPRESSION RING (rectangular)	0.025 mm (.001 in)
LOWER COMPRESSION RING (taper-face)	0.015 mm (.0006 in)
OIL SCRAPER RING	0.020 mm (.0008 in)
NEW MAXIMUM	
UPPER COMPRESSION RING (rectangular)	0.070 mm (.0028 in)
LOWER COMPRESSION RING (taper-face)	0.060 mm (.0024 in)
OIL SCRAPER RING	0.055 mm (.0021 in)
SERVICE LIMIT	
ALL	0.15 mm (.006 in)

PISTON RINGS

Removal

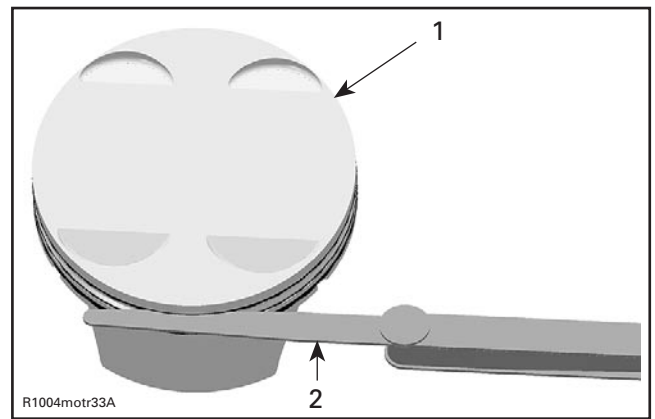
Remove:

- cylinder head (refer to CYLINDER AND CYLINDER HEAD)
- cylinder (refer to CYLINDER AND CYLINDER HEAD)
- piston pin no. 12 (refer to PISTON above)
- piston no. 10.

Inspection

Ring/Piston Groove Clearance

NOTE: Using a feeler gauge measure each ring/piston groove clearance. If the clearance is too large, the piston and the piston rings should be replaced.



1. Piston
2. Feeler gauge

Section 03 ENGINE

Subsection 08 (CRANKSHAFT/DRIVE GEARS)

Ring End Gap

RING END GAP	
NEW MINIMUM	
UPPER COMPRESSION RING (rectangular)	0.15 mm (.006 in)
LOWER COMPRESSION RING (taper-face)	0.15 mm (.006 in)
OIL SCRAPER RING	0.15 mm (.006 in)
NEW MAXIMUM	
UPPER COMPRESSION RING (rectangular)	0.35 mm (.014 in)
LOWER COMPRESSION RING (taper-face)	0.35 mm (.014 in)
OIL SCRAPER RING	0.30 mm (.012 in)
SERVICE LIMIT	
ALL	1.5 mm (.060 in)

Measure position for ring end gap in the area of 8 to 16 mm (.315 to .630 in) from top of cylinder.

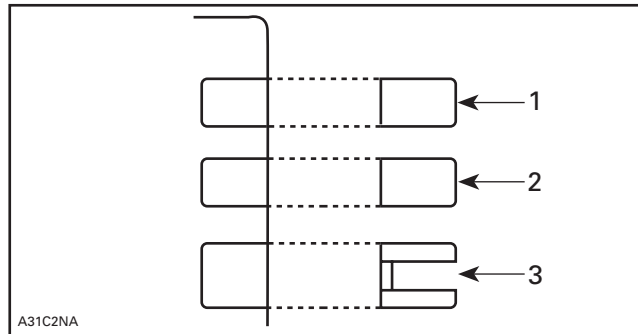
NOTE: In order to correctly position the ring in the cylinder, use piston as a pusher.

Using a feeler gauge, check ring end gap. Replace ring if gap exceeds above described specified tolerance.

Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: Install the oil scraper ring first with "O" facing up, then the lower compression (taper-face) ring with the word "TOP" facing up, then the upper compression (rectangular) ring with the word "TOP" facing up.

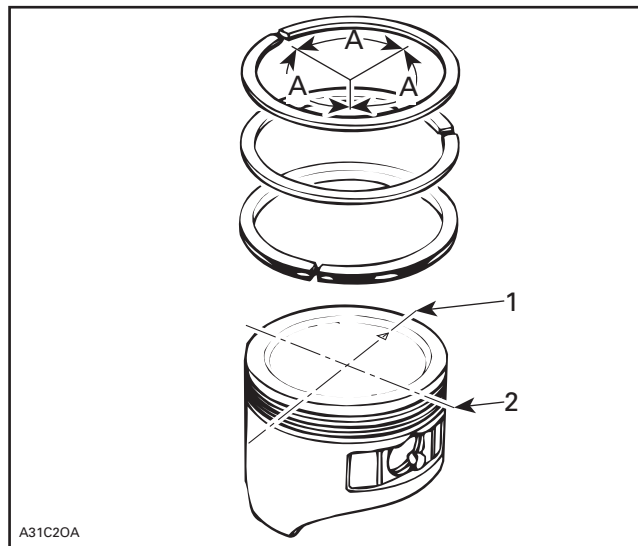


1. Rectangular ring
2. Taper-face ring
3. Oil scraper ring

CAUTION: Ensure that top and second rings are not interchanged.

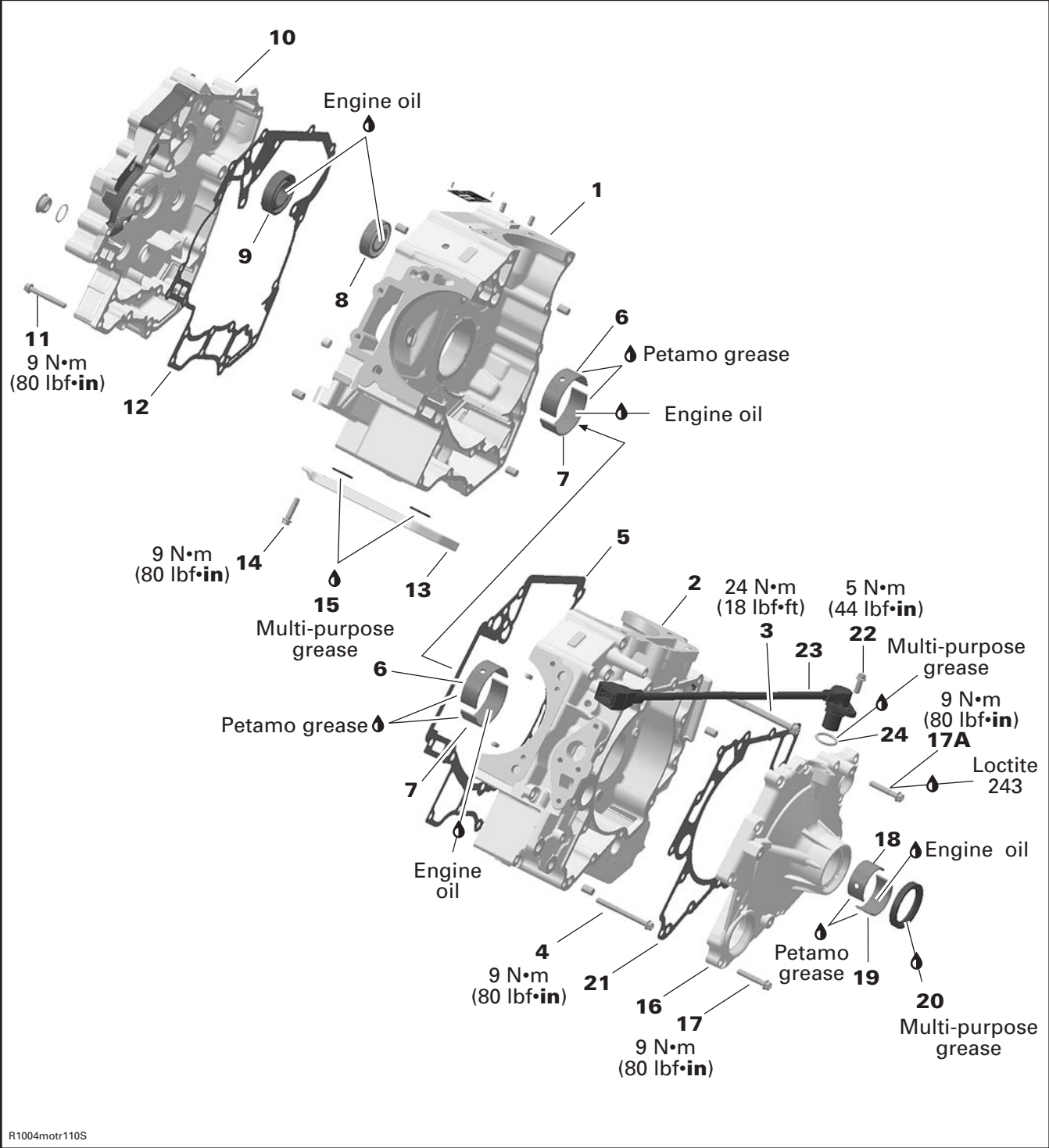
NOTE: Use a ring expander to prevent breakage during installation. The oil ring must be installed by hand.

Check that rings rotate smoothly after installation. Space the piston ring end gaps 120° apart and do not align the gaps with the piston pin bore or the thrust side axis.



1. DO NOT align ring gap with piston thrust side axis
2. DO NOT align ring gap with piston pin bore axis
- A. 120°

CRANKCASE



Section 03 ENGINE

Subsection 09 (CRANKCASE)

GENERAL

To remove crankcase, the engine removal is necessary.

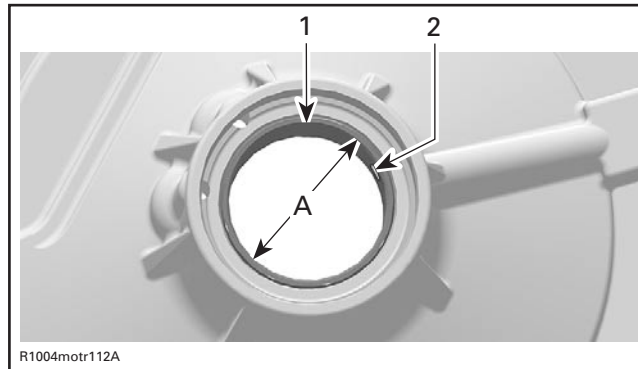
For installation, use the torque values and Loctite products indicated in the exploded view. Clean threads before using Loctite when installing screws.

PTO COVER

Removal

Remove:

- engine from the vehicle (refer to REMOVAL AND INSTALLATION)
- oil tank (refer to LUBRICATION SYSTEM)
- disconnect crankshaft position sensor **no. 23**
- PTO cover screws **no. 17** and **no. 17A** and pull PTO cover **no. 16**.



1. Plain bearing
2. Oil bore
- A. Plain bearing inside diameter to be measured in area of oil bore

PLAIN BEARING INSIDE DIAMETER (PTO side support bearing)

SERVICE LIMIT	38.040 mm (1.4976 in)
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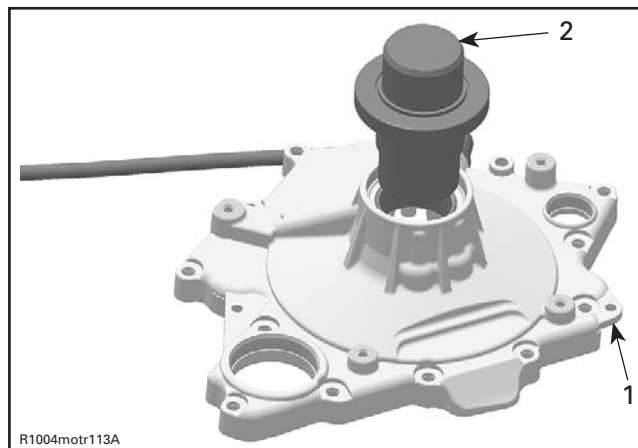
Bearing Removal Procedure

Carefully remove the oil seal **no. 20** with a screwdriver, without inflicting damage to the PTO cover.

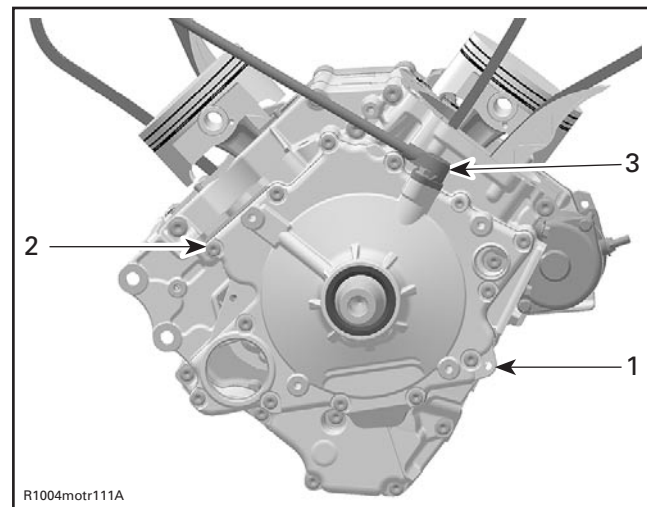
TOOLS P/N TO REMOVE PTO SIDE PLAIN BEARING

PTO side plain bearing remover	529 035 913
Support sleeve	529 035 944

NOTE: Carefully push-out the plain bearings **no. 18** and **no. 19** from the outside towards the inside. The PTO cover has to be supported from below with support sleeve (P/N 529 035 944), in order to prevent damage of the sealing surface.



1. PTO cover
2. Plain bearing remover (P/N 529 035 913)



1. PTO cover
2. PTO cover screws
3. Crankshaft position sensor

Inspection

Check the PTO cover for cracks or other damage. Replace PTO cover if damaged.

Check plain bearings **no. 18** and **no. 19** for scorings or other damages.

NOTE: Measure plain bearing inside diameter and compare to crankshaft journal diameter (PTO support bearing). Refer to CRANKSHAFT/DRIVE GEARS. Replace if the measurement is out of specification.

Bearing Installation Procedure

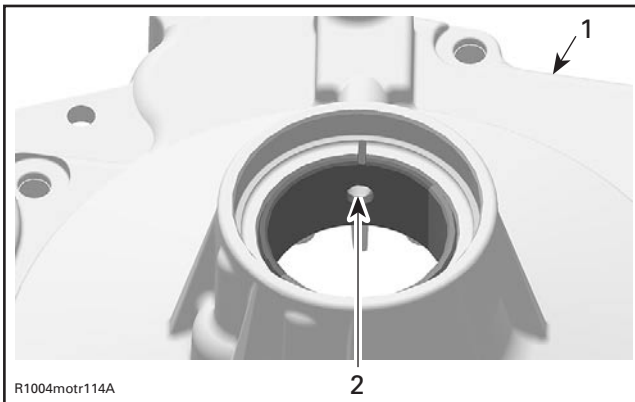
NOTE: Unless otherwise instructed, never use hammer to install plain bearings. Use press machine only.

Install plain bearings with the proper plain bearing installer/remover (P/N 529 035 913) and support sleeve (P/N 529 035 944).

Fit the plain bearings with Petamo grease (P/N 420 899 271).

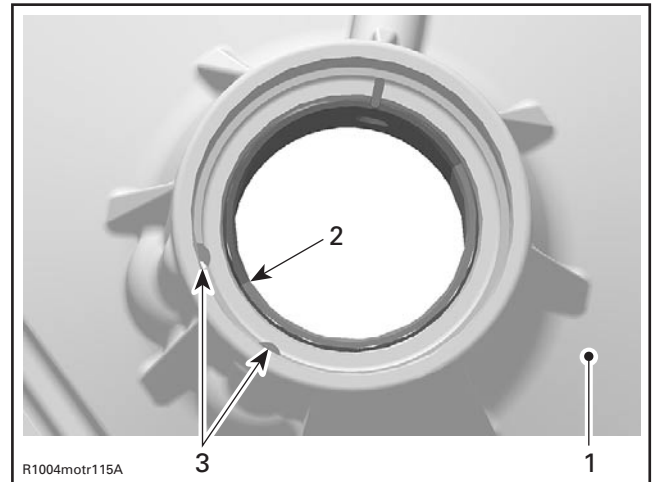
NOTE: Carefully press-in the plain bearings no. 18 and no. 19 in the same direction as during disassembly, from the outside towards the inside.

CAUTION: Mark position of oil bore in plain bearing on crankcase half. Align mark on plain bearing installer/remover with mark on crankcase half. Wrong oil bore position will stop oil supply to plain bearing and will damage the engine.



1. PTO cover
2. Oil bore

CAUTION: The partition of the plain bearings must be positioned between the oil return holes (refer to no. 3 in next illustration) in the PTO cover.

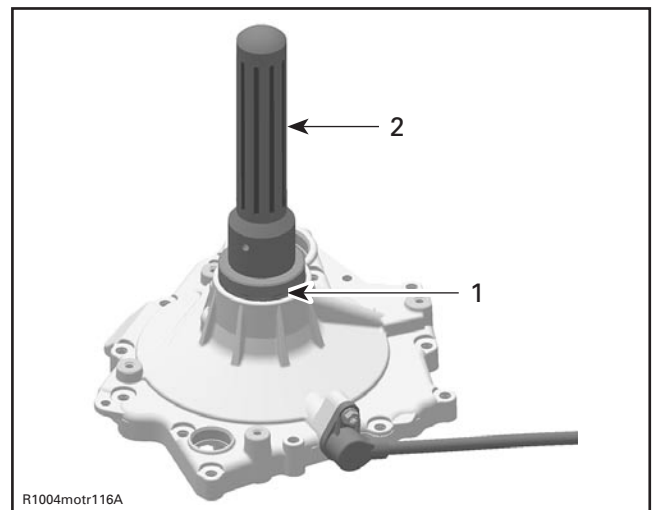


1. PTO cover
2. Partition
3. Oil return holes

Oil Seal Installation Procedure

NOTE: At installation, replace PTO cover oil seal no. 20.

Push PTO cover oil seal in place by using the oil seal pusher (P/N 529 035 910).



1. Oil seal for the PTO cover
2. Oil seal pusher (P/N 529 035 910)

Installation

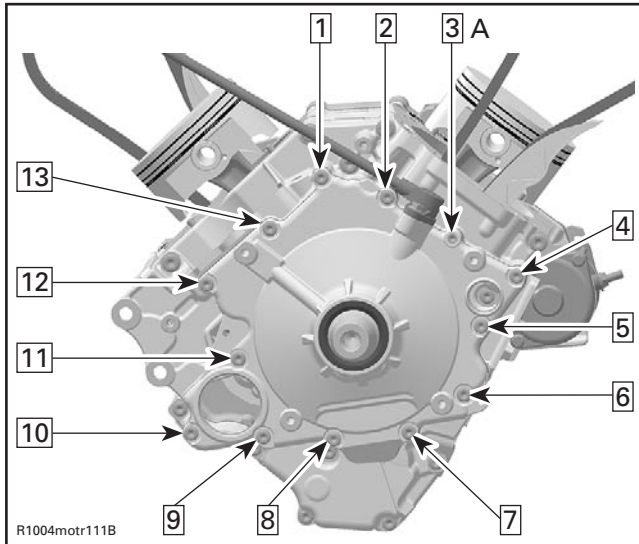
For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: At installation, replace gasket no. 21. Torque PTO cover screws to 9 N•m (80 lbf•in).

Section 03 ENGINE

Subsection 09 (CRANKCASE)

Tightening sequence for screws on PTO cover is as per following illustration. Fit the screw no. 17A with Loctite 243.



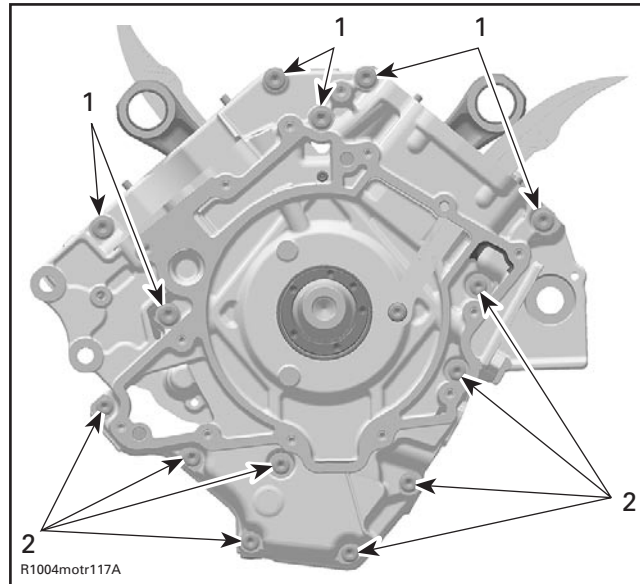
A. Screw 17A with Loctite 243

CRANKCASE

Disassembly

Remove:

- engine from vehicle (refer to REMOVAL AND INSTALLATION)
- oil tank and oil filter housing (refer to LUBRICATION SYSTEM)
- PTO cover (refer to PTO COVER above)
- trigger wheel (refer to CRANKSHAFT/DRIVE GEARS)
- electric starter (refer to ELECTRIC STARTER)
- alternator side cover (refer to COOLING SYSTEM)
- drive gears (refer to CRANKSHAFT/DRIVE GEARS)
- cylinder head and cylinder (refer to CYLINDER AND CYLINDER HEAD)
- timing chains (refer to CRANKSHAFT/DRIVE GEARS)
- cover no. 13
- screws no. 3 and no. 4 retaining crankcase halves.

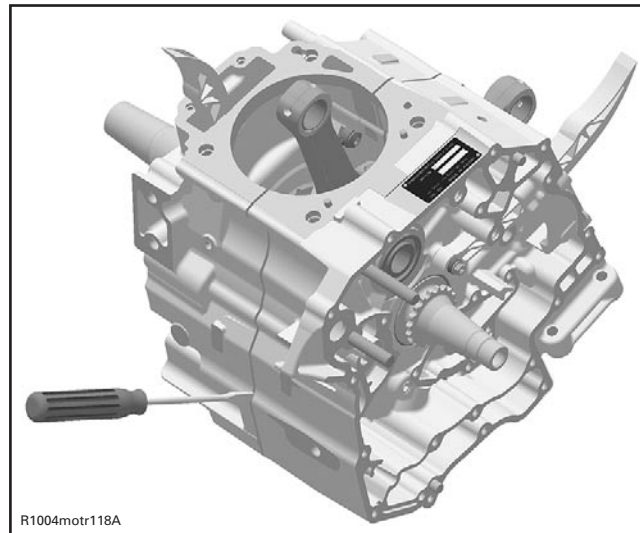


1. Six screws M8 x 90
2. Eight screws M6 x 65

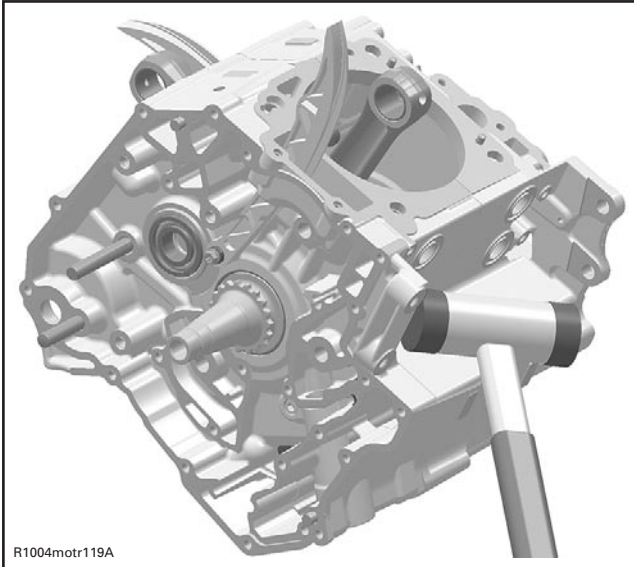
Place the crankcase on a wood stand, PTO side upwards.

Carefully separate crankcase halves by using a screwdriver and a plastic hammer.

NOTE: During disassembly, do not damage the sealing surfaces of the crankcase halves.



POSITION FOR SCREWDRIVER



POSITION FOR PLASTIC HAMMER

Inspection

NOTE: Remove all remaining parts from the crankcase halves; they could get damaged during the repair work.

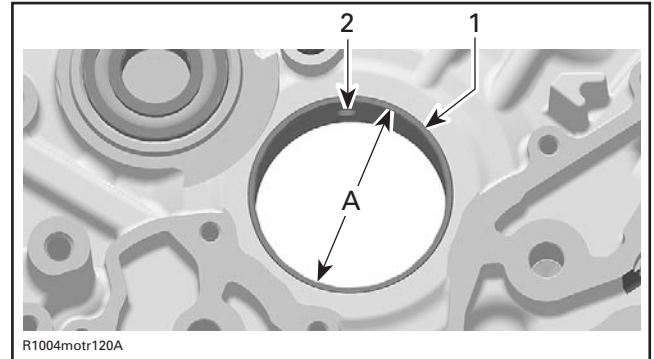
Clean crankcase halves from contaminations and blow the oil supply lines with compressed air.

⚠ WARNING
Use safety goggles to avoid eye injuries.

Check bearing **no. 8**, for excessive play and smooth operation. Replace if necessary.

Check plain bearings **no. 6** and **no. 7** for scorings or other damages.

NOTE: Measure plain bearing inside diameter and compare to PTO/alternator side journal diameters (refer to CRANKSHAFT/DRIVE GEARS). Replace if the measurement is out of specification.



- 1. Plain bearing
- 2. Oil bore
- A. Plain bearing inside diameter to be measured in area of oil bore

PLAIN BEARING INSIDE DIAMETER (alternator side)	
SERVICE LIMIT	55.020 mm (2.1661 in)
PLAIN BEARING INSIDE DIAMETER (PTO side)	
SERVICE LIMIT	55.020 mm (2.1661 in)

Bearing Removal Procedure

Always heat crankcase half up to 100°C (212°F) before removing ball bearings.

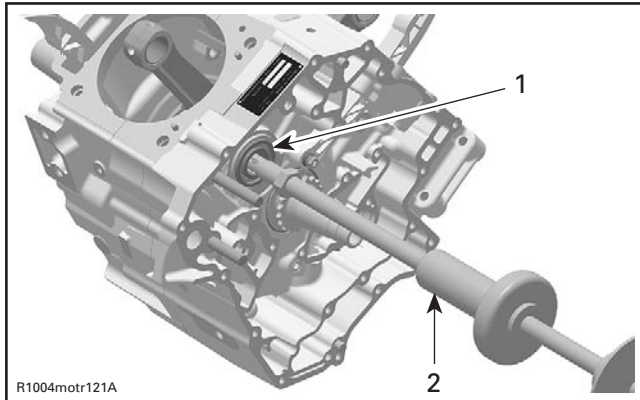
⚠ WARNING
Clean oil, outside and inside of crankcase half before heating it.

CAUTION: Always support crankcase halves properly when ball bearings or plain bearings are removed. Damages to crankcase halves may occur if this procedure is not performed correctly.

Section 03 ENGINE

Subsection 09 (CRANKCASE)

The generator gear ball bearing no. 8 in alternator side crankcase half is removed with a suitable bearing puller.



1. Ball bearing
2. Bearing puller

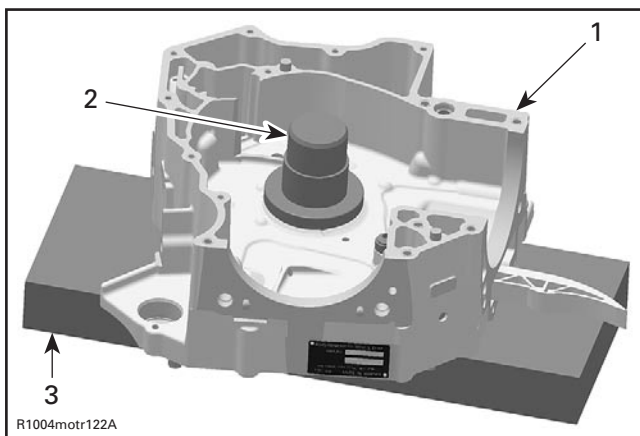
Remove plain bearings no. 6, no. 7, no. 18 and no. 19 with the proper plain bearing remover.

NOTE: Carefully push the plain bearings out, from the crankcase half inside towards the outside.

NOTE: Place the proper support sleeve under PTO crankcase half before removing plain bearings. There is no support sleeve for alternator side crankcase half. To brace the crankcase half, use a suitable wooden block or other support.

CAUTION: Suitable support sleeve must have straight surface.

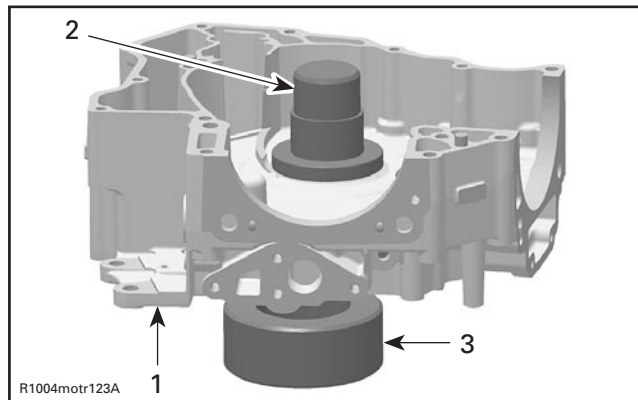
During disassembly, make sure not to damage the sealing surfaces of the crankcase halves.



PUSH PLAIN BEARINGS OUTSIDE

1. Crankcase half alternator side
2. Plain bearing remover
3. Wooden block

PLAIN BEARING REMOVER	
Alternator side	529 035 913
PTO side	
SUPPORT SLEEVE	
PTO side	529 035 944



PUSH PLAIN BEARINGS OUTSIDE

1. Crankcase half PTO side
2. Plain bearing remover
3. Support sleeve (P/N 529 035 944)

Bearing Installation Procedure

Unless otherwise instructed, never use hammer to install ball bearings or plain bearings. Use press machine only.

Always heat crankcase half up to 100°C (212°F) before installing ball bearing.

WARNING

Clean oil, outside and inside of crankcase half before heating it.

NOTE: Place new ball bearing in freezer for 10 minutes before installation.

NOTE: No striking tools are to be used to insert the ball bearing. With moderate (thumb) pressure the bearing has to be mounted manually into the alternator side cover.

Install plain bearings no. 6, no. 7, no. 18 and no. 19 with the proper plain bearing installer/remover.

Fit the plain bearings with Petamo grease (P/N 420 899 271).

NOTE: Carefully press-in the plain bearings in the same direction as during disassembly, from the case inside towards the outside.

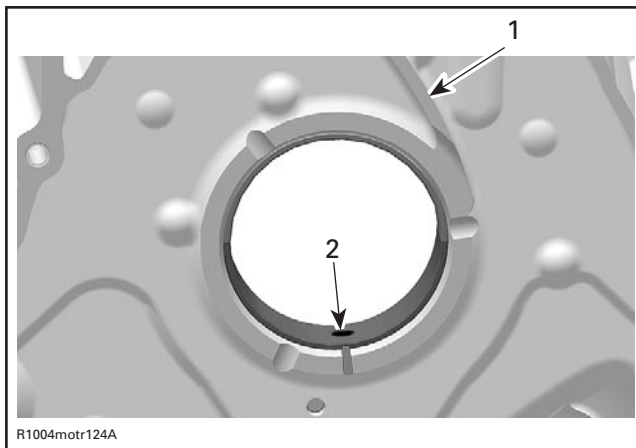
NOTE: Place the proper support sleeve under PTO crankcase half before installing the plain bearings. There is no support sleeve for alternator side crankcase half. For bracing of the crankcase half use a suitable wooden block or other support (refer to BEARING REMOVAL PROCEDURE above).

CAUTION: Suitable support sleeve must have straight surface.

During reassembly, make sure not to damage the sealing surfaces of the crankcase halves.

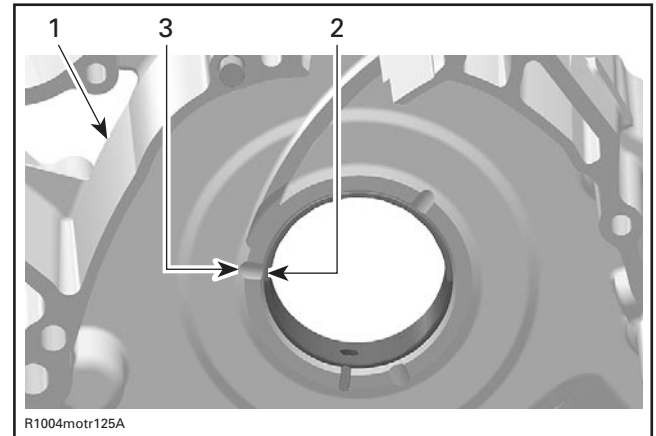
PLAIN BEARING INSTALLER/REMOVER	
Alternator side	529 035 913
PTO side	
SUPPORT SLEEVE	
PTO side	529 035 944

CAUTION: Mark position of oil bore in plain bearing on crankcase half. Align mark on plain bearing installer/remover with mark on crankcase half. Wrong oil bore position will stop oil supply to plain bearing and will damage the engine.



1. Crankcase
2. Oil bore

CAUTION: The partition of the plain bearings must be positioned near the groove (refer to no. 3 in next illustration) of the crankcase.



1. Crankcase
2. Partition
3. Groove

NOTE: Use an O-ring (Ø55 x 1 to 1.5 mm (.04 to .06 in) thickness) to hold plain bearings in place during installation. The O-ring will disappear in the groove of the plain bearing installer/remover.

Assembly

The assembly of crankcase is essentially the reverse of removal procedure. However, pay attention to the following details.

NOTE: Clean oil passages and make sure they are not clogged.

Clean all metal components in a solvent.

NOTE: At installation, replace gasket no. 5.

NOTE: Oil the plain bearings before mounting the crankshaft.

Reinstall all other parts (refer to LUBRICATION SYSTEM).

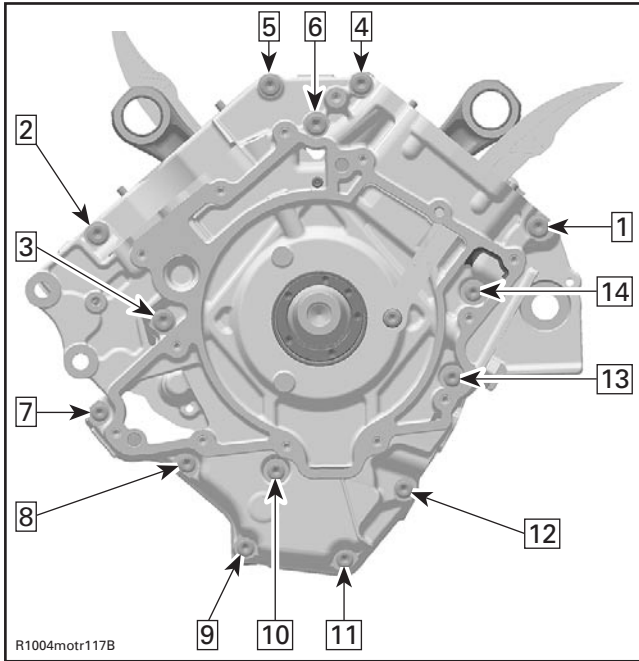
Torque screws no. 4 M6 x 65 to 9 N•m (80 lbf•in).

Torque screws no. 3 M8 x 90 to 24 N•m (18 lbf•ft).

Section 03 ENGINE

Subsection 09 (CRANKCASE)

Tightening sequence for screws on crankcase is as per following illustration.



NOTE: At installation, replace gasket rings no. 15.

Slightly grease the gasket rings no. 15 before assembly using multi purpose grease. Torque cover screws no. 14 to 9 N•m (80 lbf•in).