

LUBRICATION SYSTEM

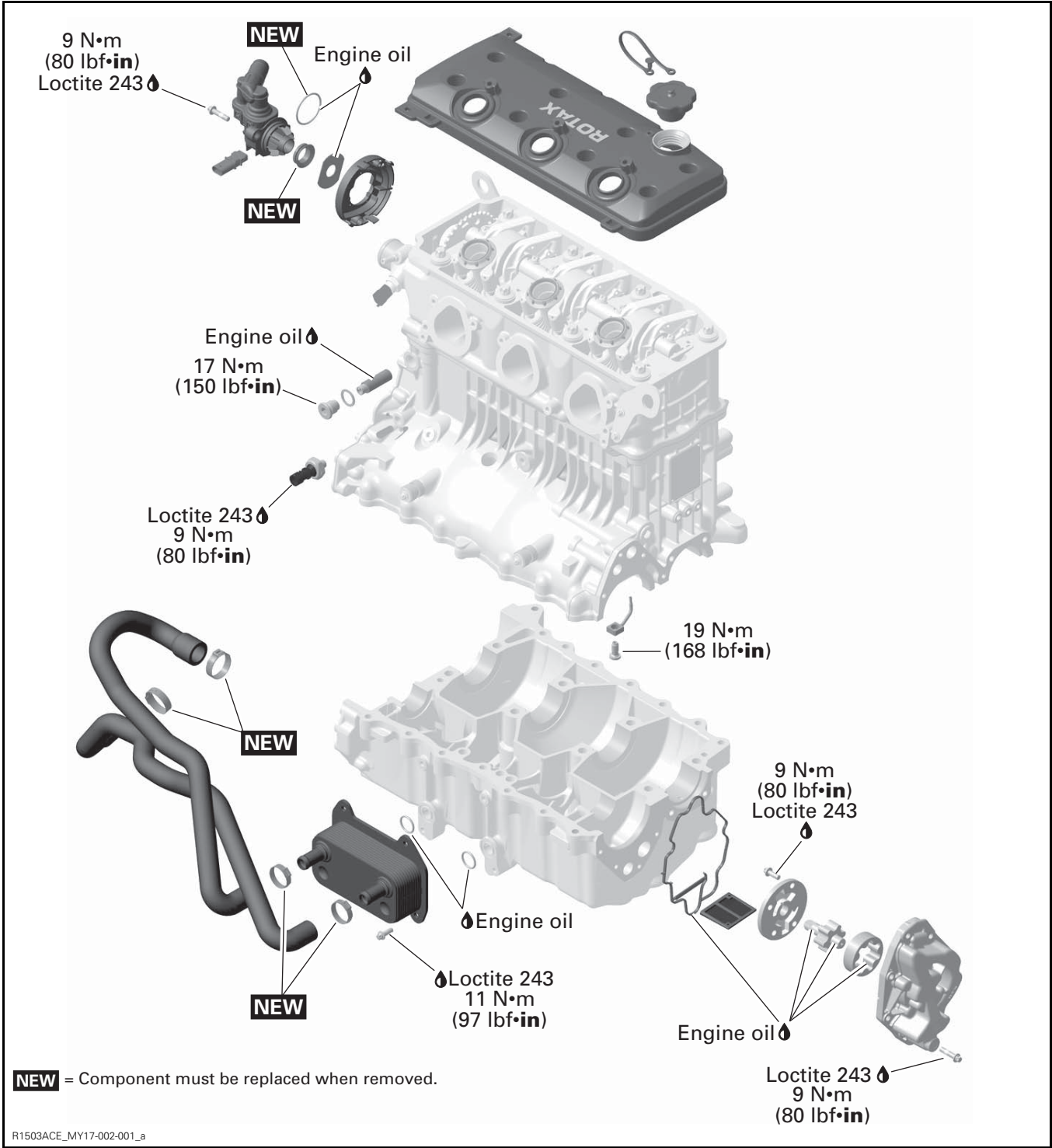
SERVICE TOOLS

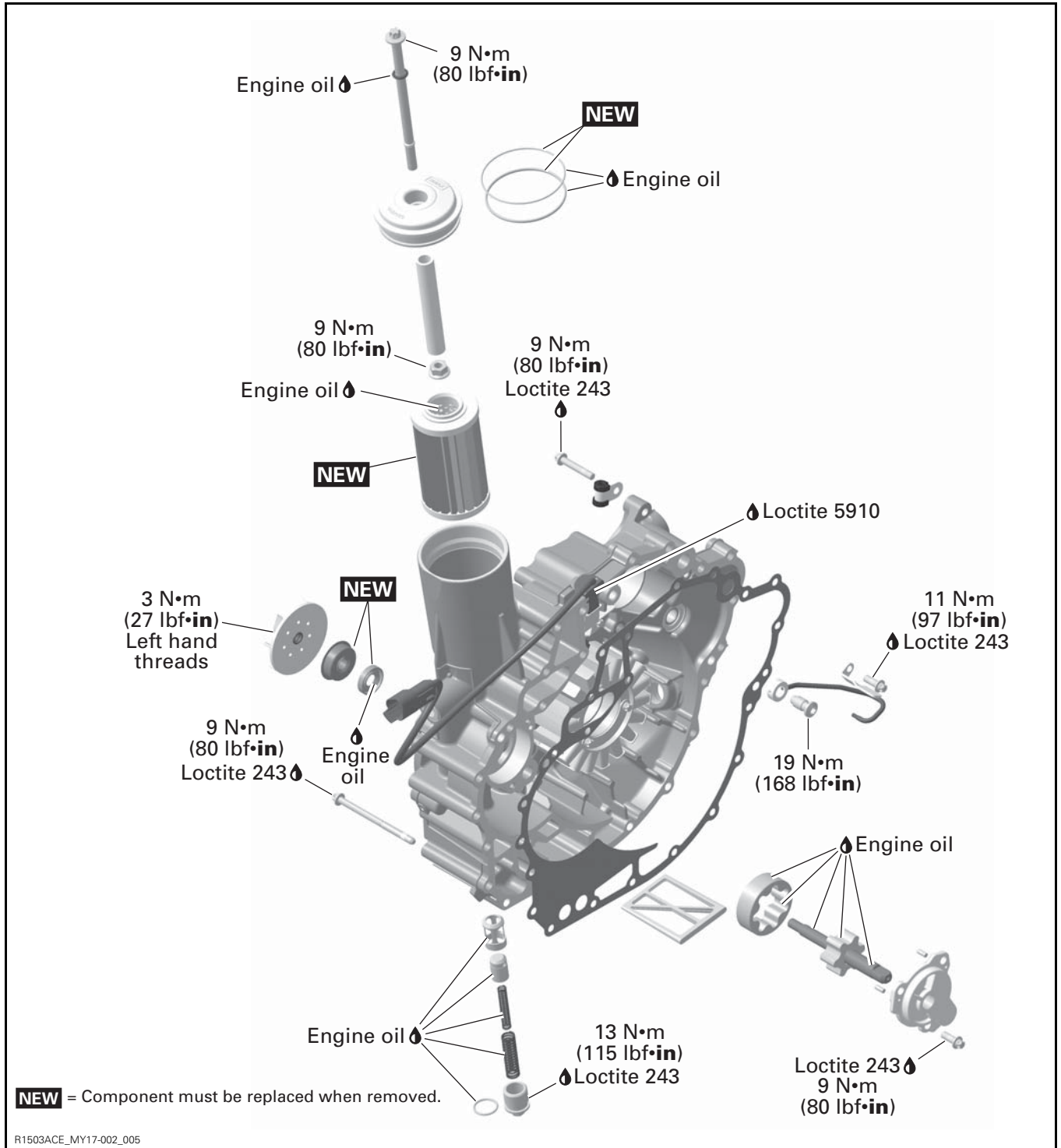
Description	Part Number	Page
ADAPTER HOSE	529 035 652	8
BACK PROBE TEST WIRES	529 036 063	26
CERAMIC SEAL PULLER	529 036 365	16
ECM ADAPTER TOOL.....	529 036 166	10, 27
FLUKE 115 MULTIMETER	529 035 868	10, 26–27
HANDLE	420 877 650	16
OIL SEAL GUIDE.....	529 035 822	15
OIL SEAL PUSHER.....	529 035 757	16
PRESSURE GAUGE.....	529 035 709	8
SUCTION PUMP	529 035 880	7
SUPERCHARGER OIL SPRAY NOZZLE TOOL	529 036 134	20
WATER PUMP SEAL PUSHER.....	529 035 823	15, 17

SERVICE PRODUCTS

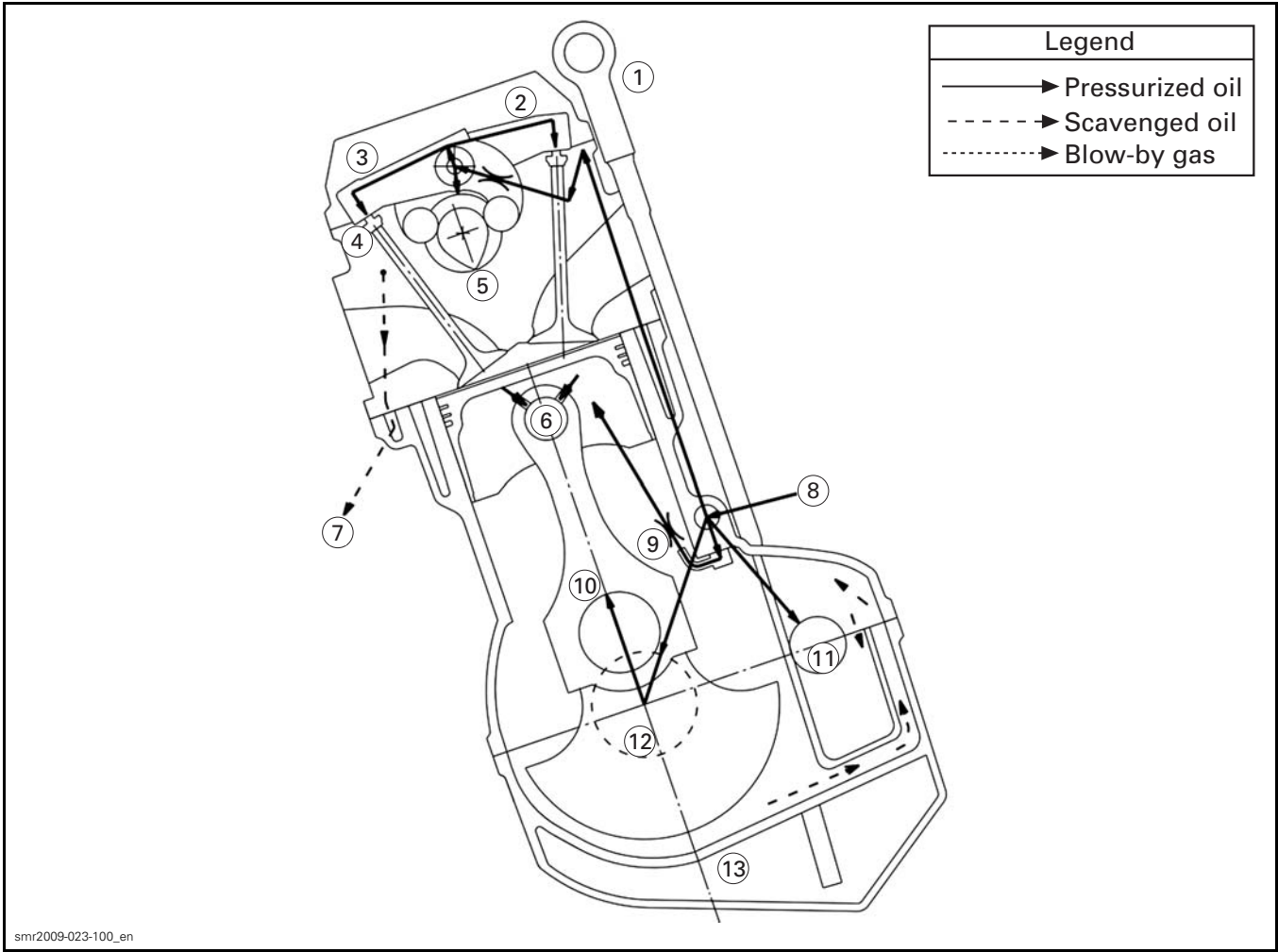
Description	Part Number	Page
LOCTITE 243 (BLUE).....	293 800 060	11, 13, 15, 19–20, 25, 28
PULLEY FLANGE CLEANER	413 711 809	7, 17
SUPER LUBE GREASE.....	293 550 030	8
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Subsection XX (LUBRICATION SYSTEM)



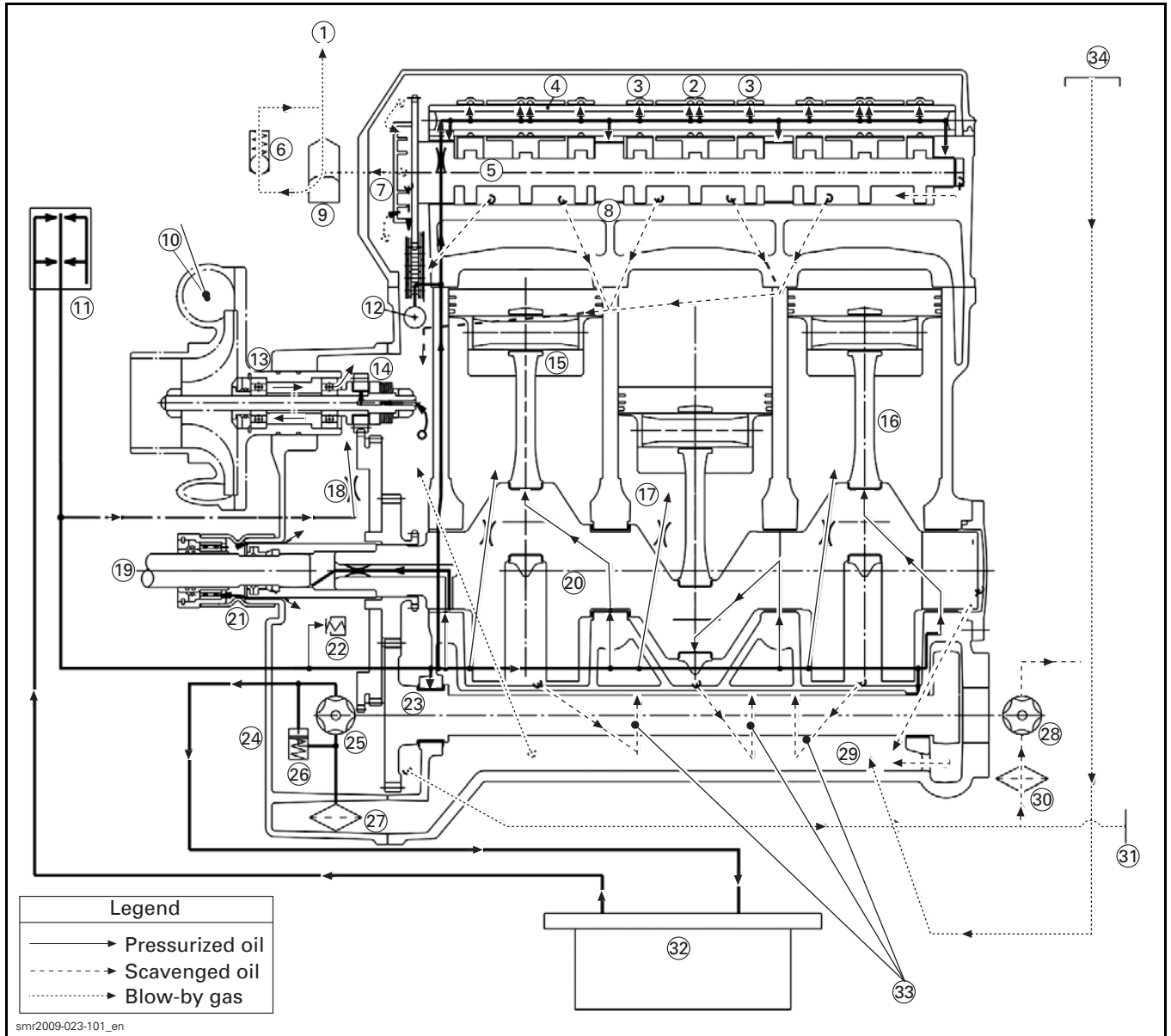


ENGINE LUBRICATION CIRCUIT



- smr2009-023-100_en
1. Oil dipstick
 2. Rocker arm (intake)
 3. Rocker arm (exhaust)
 4. Hydraulic valve lifter
 5. Camshaft
 6. Piston pin
 7. Into PTO housing
 8. From oil filter
 9. Piston cooling
 10. Connecting rod
 11. Balance shaft
 12. Crankshaft
 13. Oil tank

ENGINE LUBRICATION CIRCUIT (CONT'D)



1. To air intake silencer
2. Rocker arm (intake)
3. Rocker arm (exhaust)
4. Rocker arm axle
5. Camshaft
6. Pressure relief valve
7. Oil separator
8. Cylinder head
9. Blow-by valve
10. Supercharger (if so equipped)
11. Oil filter
12. Hydraulic chain tensioner
13. Supercharger bearing (if so equipped)
14. Friction clutch
15. Piston pin
16. Connecting rod
17. Piston cooling

18. Oil spray nozzle
19. Drive shaft
20. Crankshaft
21. PTO seal
22. Oil pressure switch
23. Balance shaft
24. PTO housing
25. Pressure pump
26. Pressure relief valve
27. Oil strainer (pressure pump)
28. Scavenge pump
29. Oil tank
30. Oil strainer (scavenge pump)
31. Oil drainage (PTO housing)
32. Oil cooler
33. Scavenge of oil and blow-by gas
34. Oil filler cap

MAINTENANCE

ENGINE OIL

Recommended Oil

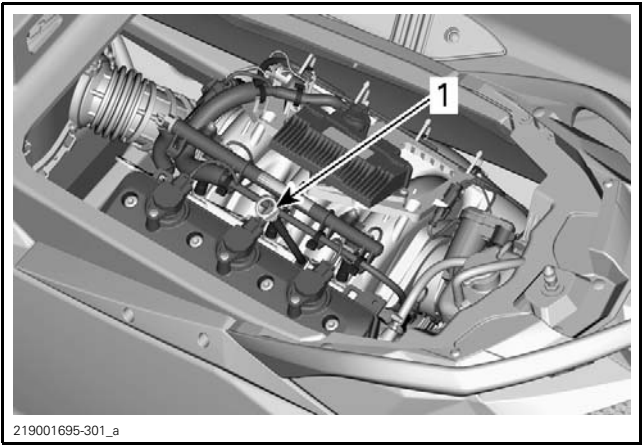
ENGINE OIL	
BRP RECOMMENDED PRODUCT	XPS 4-STROKE SYNTH. BLEND OIL (P/N 293 600 121)
ALTERNATIVE, OR IF NOT AVAILABLE	10W 40 mineral engine oil compatible with wet clutches (JASO MA certified oils)

NOTE: The XPS engine oil has been thoroughly tested to be free of any additives that could impair the functionality of the supercharger clutch.

NOTICE NEVER use synthetic oil. This would impair the proper operation of the supercharger clutch. Do not add any additives to the recommended oil. Mineral oils not recommended by BRP may also contain additives (friction modifiers) that may cause inappropriate slippage of the supercharger and eventually lead to premature wear. For this reason, XPS Synthetic Blend oil (Summer Grade) or a BRP approved equivalent are the only recommended oils. Use of any oil not recommended by BRP may void BRP's limited warranty.

Verifying the Engine Oil Level

NOTICE Check level frequently and refill if necessary. Do not overfill — it would make the engine smoke and reduce its power. Operating the engine with an improper level may severely damage engine. Wipe off any spillage.



TYPICAL
1. Oil dipstick location

Check the oil level as follows:

NOTE: It is of the utmost importance to follow this procedure in order to obtain an accurate reading of the engine oil level.

- 1. Watercraft must be level. Check oil level either with watercraft in water or out of water.

NOTE: If the watercraft is out of water, link a garden hose to the hose adapter. Refer to *FLUSHING THE EXHAUST SYSTEM* in the *EXHAUST SYSTEM* subsection.

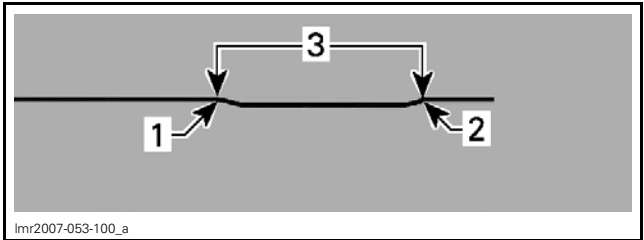
NOTICE When watercraft is out of water:

- Never run engine without supplying water to the exhaust system.
- Never run engine longer than 2 minutes. Drive line seal has no cooling when watercraft is out of water.

- 2. Warm-up engine then let idle for 30 seconds before stopping.
- 3. Stop engine.
- 4. Open or remove seat.
- 5. Wait at least 30 seconds for the oil to settle in the engine, then pull dipstick out and wipe clean.

CAUTION Engine oil may be hot. Certain components in the engine compartment may be very hot. Direct contact may result in skin burn.

- 6. Reinstall dipstick, push in completely.
- 7. Remove dipstick and read oil level. It should be between the FULL and ADD marks.



- 1. Full
- 2. Add
- 3. Operating range

Otherwise, add oil until its level is between marks as required.

To add oil, unscrew oil cap. Place a funnel into the oil filler neck opening and add the recommended oil to the proper level. Do not overfill.

Reinstall oil filler cap.

NOTICE Ensure that oil filler cap is properly closed. Otherwise engine oil could spill out.

Changing the Engine Oil

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

Bring engine to its normal operating temperature.

NOTICE When watercraft is out of water:

- Never run engine without supplying water to the exhaust system.
- Never run engine longer than 2 minutes. Drive line seal has no cooling when watercraft is out of water.

Run engine for 10 seconds at 4000 RPM and shut it off at this RPM. This will move oil from PTO housing to oil tank to allow maximum oil draining.

Remove oil filler cap and dipstick.

CAUTION Engine oil may be hot. Certain components in the engine compartment may be very hot. Direct contact may result in skin burn.

Siphon oil through the dipstick tube.

REQUIRED TOOL	
SUCTION PUMP (P/N 529 035 880)	

NOTICE Never crank or start engine when suction pump hose is in the dipstick tube. Never start engine when there is no oil in engine.

NOTE: To properly position the suction pump hose is located at the proper height to siphon oil, it is suggested to put some electrical tape on hose at 475 mm (18-11/16 in) from its end. Then, insert the hose until you reach the tape.

Pull suction pump hose out of dipstick tube.

Fully depress the throttle lever and HOLD it while cranking engine for 10 seconds. Siphon oil again. Repeat the crank-siphon cycle 2 - 3 times.

Refill engine with the recommended oil, see *RECOMMENDED OIL* in this subsection.

Reinstall oil filler cap and dipstick.

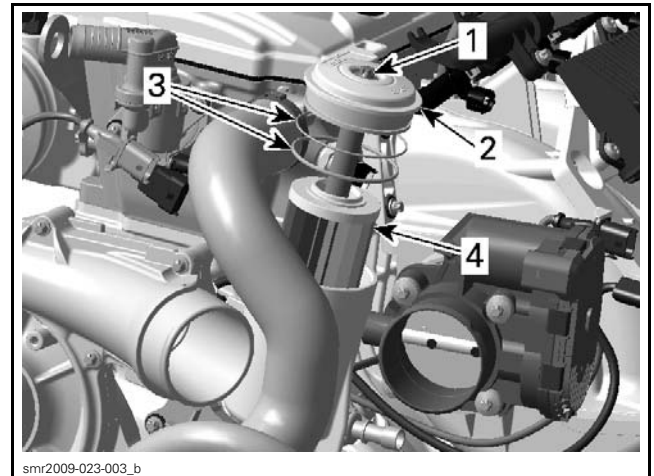
Replace *OIL FILTER*, see procedure in this subsection.

OIL FILTER

Removing the Oil Filter

Remove:

- Oil filter screw
- Oil filter cover
- Oil filter.



TYPICAL

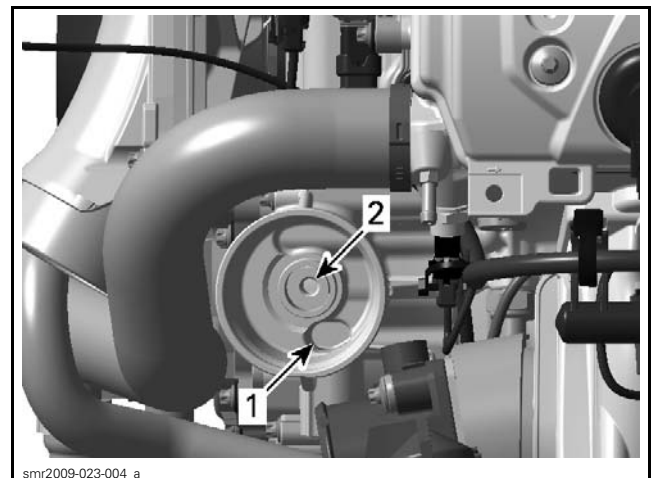
1. Oil filter screw
2. Oil filter cover
3. O-rings
4. Oil filter

Place rags in filler area to prevent spillage. If spillage occurs, clean immediately with the PULLEY FLANGE CLEANER (P/N 413 711 809) to prevent stains.

Inspecting the Oil Filter

Check oil filter screw O-ring, change if necessary.

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



TYPICAL

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

Subsection XX (LUBRICATION SYSTEM)

Installing the Oil Filter

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

- Install a **NEW** oil filter.
- Install **NEW** O-rings on oil filter cover.

- Apply engine oil on:
- Oil filter ring
 - Filter cover O-rings
 - Oil filter screw O-ring

NOTE: In salt water area, it is recommended to coat mating surface of cover with SUPER LUBE GREASE (P/N 293 550 030).

Torque oil filter screw to specification.

TIGHTENING TORQUE	
Oil filter screw	9 N•m (80 lbf•in)

INSPECTION

ENGINE OIL PRESSURE

Oil Pressure Test Requirement

Bring engine to its normal operating temperature.

CAUTION Certain components in the engine compartment may be very hot. Direct contact may result in skin burn.

- NOTICE** When watercraft is out of water:
- Never run engine without supplying water to the exhaust system.
 - Never run engine longer than 2 minutes. Drive line seal has no cooling when watercraft is out of water.

Required Tools for Oil Pressure Test

REQUIRED TOOLS	
PRESSURE GAUGE (P/N 529 035 709)	
ADAPTER HOSE (P/N 529 035 652)	

NOTE: A 1/8 NPT pipe extension may ease the installation.

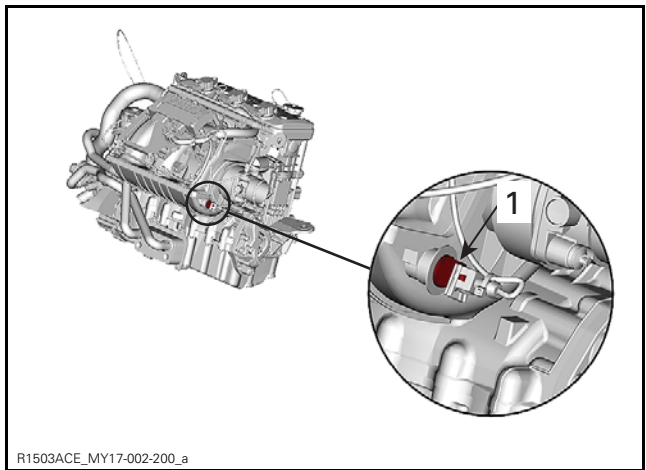
Oil Pressure Specifications

Use the following table to compare the oil pressure at different RPM.

OIL PRESSURE	
Idle (cold)	448 kPa - 648 kPa (65 PSI - 94 PSI) for a very short time
Idle (at 80°C (176°F))	Min. 228 kPa (33 PSI)
4000 - 7500	400 kPa - 496 kPa (58 PSI - 72 PSI)

Test at the Oil Pressure Switch Location

Remove oil pressure switch and install gauge.



INSTALLATION AT PRESSURE SWITCH LOCATION
1. Remove oil pressure switch and install gauge here

To prevent the EMS to go in limp home mode (at 2500 RPM) or to generate a fault code, do the following:

1. Ground OPS to engine.
2. Plug OPS to harness.
3. Start engine.
4. While engine is running, unplug OPS from harness.

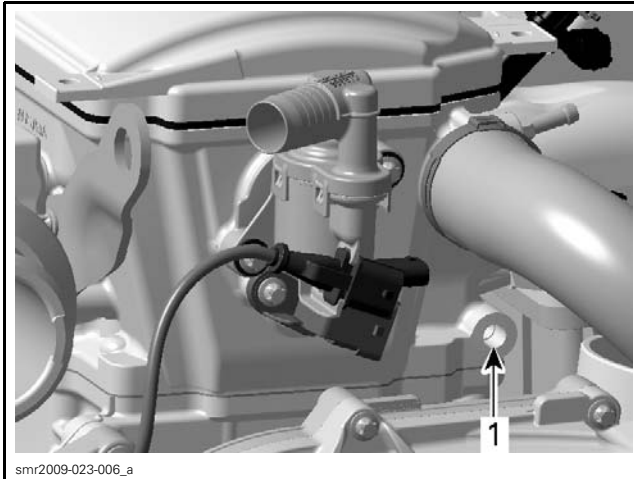
Read oil pressure at different RPM as per table above.

Reinstall oil pressure switch.

Test at the Cylinder Head Location

The oil pressure may be measured from cylinder head if desired.

Remove plug located on cylinder head and install gauge.



INSTALLATION AT CYLINDER HEAD
1. Remove plug and install gauge here

Start engine and read pressure at different RPM as per table above.

Reinstall plug.

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and it should not be assumed to list all possible problems.

Always check for fault codes. If a fault code is detected, service the fault code first. Refer to *ENGINE MANAGEMENT* section.

LOW OR NO ENGINE OIL PRESSURE

1. **Oil level too low.**
 - Refill engine oil.
 - Check for high oil consumption. See below.
 - Check for oil leaks (oil leaking out of leak indicator hole, gaskets, oil seal or O-rings). Repair or replace.
2. **Oil pressure switch defective.**
 - Check and replace if necessary.
3. **Oil filter clogged.**
 - Replace engine oil and oil filter at the same time.
4. **Oil pressure regulator valve sticks open, or spring load is too small.**
 - Clean oil regulator piston and its bore. Replace if necessary.
 - Measure spring free length. Replace if too small.
5. **Oil pump(s) worn or damaged.**
 - Check oil pump rotors and its bore for wear limits. Replace if out of specification.
6. **Engine oil strainers are clogged.**
 - Remove and clean engine oil strainers.

7. **Heavy wear on plain bearings.**

- Check radial clearance of plain bearings. Replace if out of specification.

HIGH OIL CONSUMPTION

1. **Oil in breathing system.**
 - Check if breather V-ring is brittle, hard or damaged. Replace V-ring.
2. **Valve stem seals worn or damaged.**
 - Replace valve stem seals.
3. **Piston rings worn out (blue colored exhaust smoke).**
 - Replace piston rings.

OIL CONTAMINATION (WHITE APPEARANCE)

1. **Water ingestion through drive shaft and floating ring**
 - Check if water is leaking between drive shaft and floating ring. Repair or replace defective parts. Refer to *PTO HOUSING AND MAGNETO* subsection.
 - Change engine oil and filter.
2. **Oil seal and rotary seal on water pump shaft leaking.**
 - Replace oil seal and water pump shaft assembly.
 - Change engine oil and oil filter.
3. **Cylinder head gasket leaking.**
 - Replace cylinder head gasket and tighten cylinder head with recommended torque.
 - Change engine oil and oil filter.
4. **Cylinder head screws not properly tightened.**
 - Retighten screws with recommended torque.
 - Change engine oil.
5. **Oil cooler O-rings are leaking.**
 - Replace O-rings.
 - Change engine oil and oil filter.
6. **Cylinder block or cylinder head casting is leaking.**
 - Check for internal cracks in casting. Replace damaged components.
 - Change engine oil and oil filter.

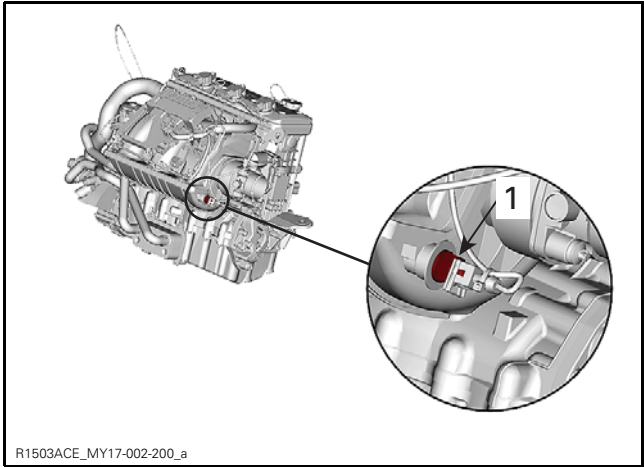
PROCEDURES

OIL PRESSURE SWITCH (OPS)

Oil Pressure Switch Location

The OPS is located on the front of the engine near the throttle body.

Subsection XX (LUBRICATION SYSTEM)



1. OPS

Oil Pressure Switch Operation

The oil pressure switch activates, if the engine oil pressure is lower than following specified pressure range.

OIL PRESSURE SWITCH ACTIVATION RANGE
180 kPa to 220 kPa (26.11 PSI to 31.91 PSI)

Inspecting the Oil Pressure Switch

First, carefully check the condition of the connector terminals. Clean to remove dirt and corrosion that could affect proper operation of the OPS.

IMPORTANT: Do not apply dielectric grease on terminal.

Before checking the function of the OPS, an oil pressure test has to be performed to be sure the oil pressure is not in fault. Refer to *INSPECTION* in this subsection.

When the engine oil pressure tests good but the OIL message in the information center is present and the beeper sounds:

- Ensure OPS connector is plugged to the switch.
- Check the resistance of the OPS while engine is off and while engine is running.

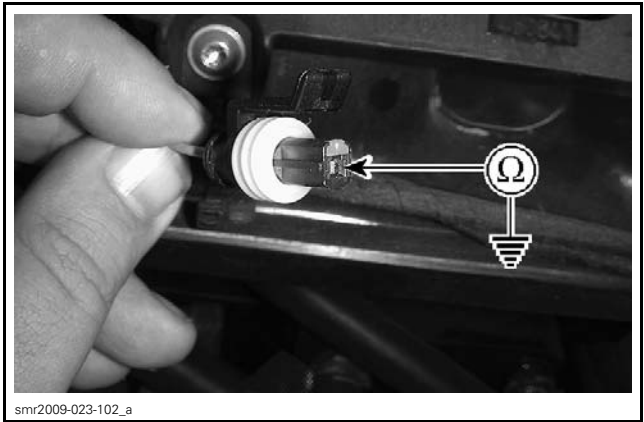
Testing the Resistance of the Oil Pressure Switch

Disconnect the connector from the OPS.

Use a multimeter to check the resistance as shown.

ENGINE NOT RUNNING		
TEST PROBES		RESISTANCE (Ω)
OPS connector (pin 1)	Engine ground	Close to 0 (normally closed switch)

ENGINE RUNNING		
TEST PROBES		RESISTANCE (Ω)
OPS connector (pin 1)	Engine ground	Infinitely high (OL) when pressure reaches 180 kPa (26.11 PSI) and 220 kPa (32 PSI)



TYPICAL

If resistance values are incorrect, replace OPS.

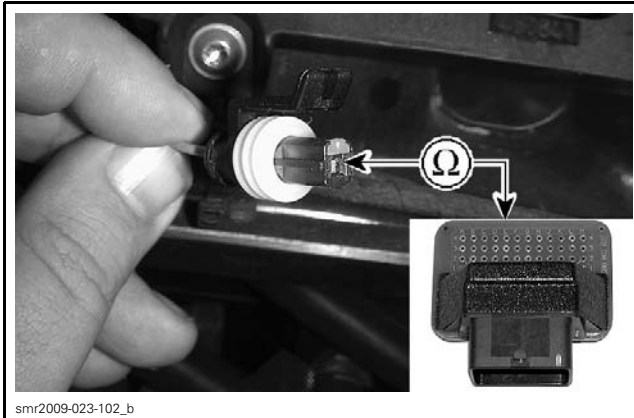
If the values are correct, check the continuity of the wiring harness.

Testing the Continuity of the Oil Pressure Switch Circuit

Disconnect the ECM connector "A" from the ECM. Check continuity of OPS circuit as per following table.

REQUIRED TOOL	
ECM ADAPTER TOOL (P/N 529 036 166)	
FLUKE 115 MULTIMETER (P/N 529 035 868)	

OPS CONNECTOR	ECM ADAPTER	RESISTANCE
Pin 1	Pin E3	Close to 0 Ω (continuity)



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TYPICAL

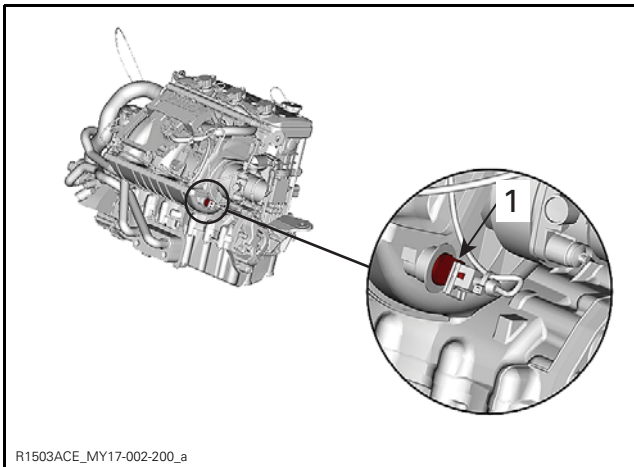
If continuity test failed, repair or replace the connector and wiring between ECM connector and OPS.

If continuity test succeeded, check the ECM. Refer to *ELECTRONIC FUEL INJECTION (EFI)* subsection.

Removing the Oil Pressure Switch

Unplug the OPS connector.

Unscrew and remove the oil pressure switch.



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1. OPS

Installing the Oil Pressure Switch

Torque oil pressure switch to specification.

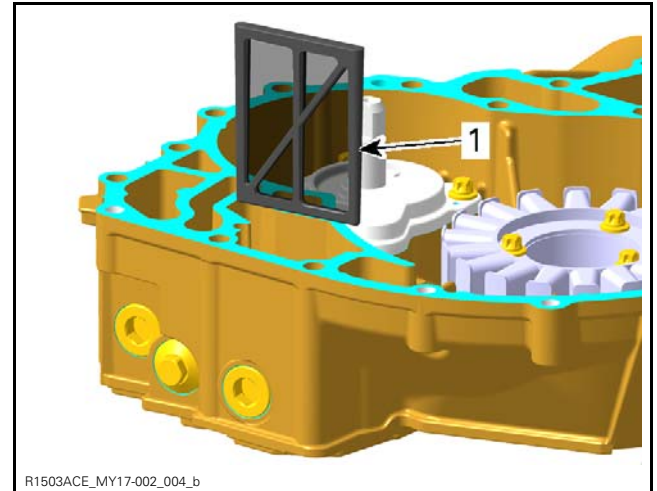
TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Oil pressure switch	9 N•m (80 lbf•in)

PTO OIL STRAINER

Removing the PTO Oil Strainer

Remove the PTO housing. Refer to *PTO HOUSING, MAGNETO AND STARTER* subsection.

Remove the oil strainer.



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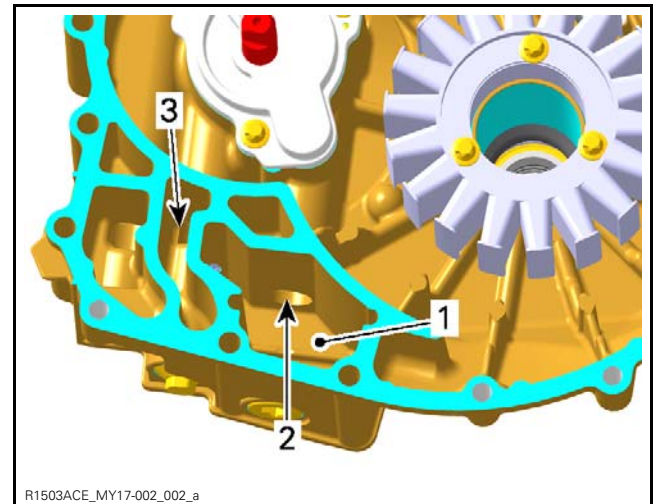
1. PTO oil strainer

Cleaning and Inspecting the PTO Oil Strainer

Clean oil strainer with a part cleaner then use compressed air to dry it.

Check oil strainer for damage, replace if necessary.

Check and clean the oil strainer compartment and oil bores for dirt and other contaminations.

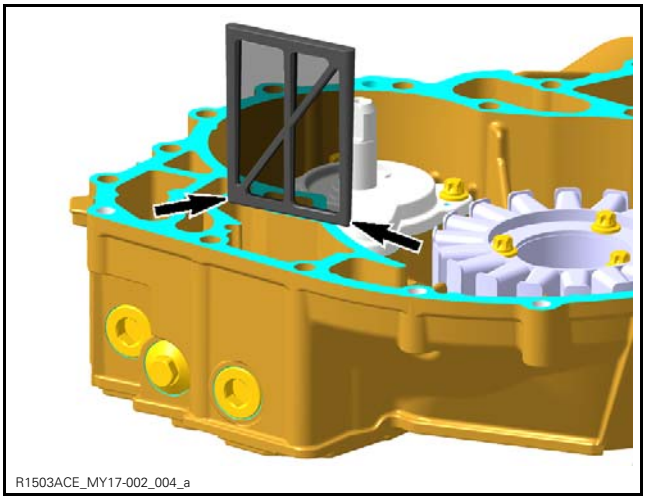


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1. Oil strainer compartment
2. Oil bore to the oil pump
3. Oil bore from the oil pump

Installing the PTO Oil Strainer

The installation is the reverse of the removal procedure. However, pay attention to the following. Apply a small amount of grease on the frame of the oil strainer to keep it in place while installing the PTO cover.

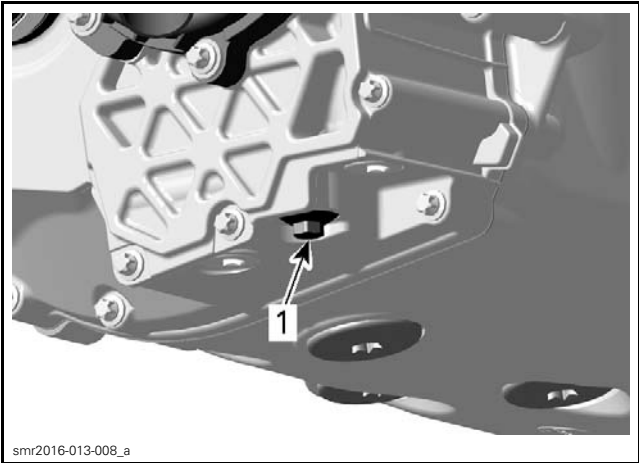


SERVICE PRODUCT
Multi Purpose Grease BP LS 3

Install it in the PTO housing.
Install the PTO housing using the procedure described in the *PTO HOUSING, MAGNETO AND STARTER* subsection.
Refill engine at the proper level with the recommended oil. Refer to *ENGINE OIL* for the procedure.

ENGINE OIL PRESSURE REGULATOR

The oil pressure regulator is located on the bottom of the PTO housing.



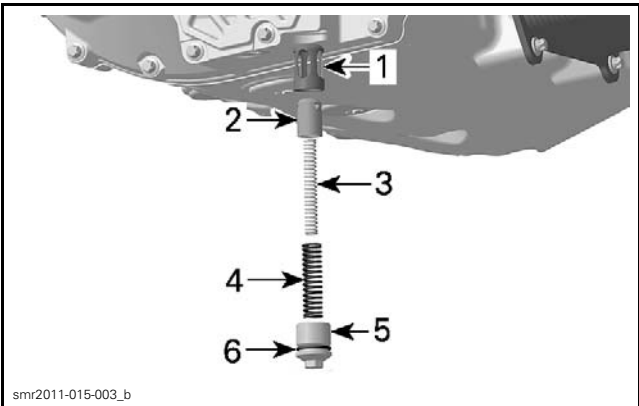
TYPICAL
1. Oil pressure regulator

NOTE: The oil pressure regulator system opens when the oil pressure exceeds 400 kPa (58 PSI).

Removing the Oil Pressure Regulator

Remove engine oil. See procedure in *CHANGING THE ENGINE OIL* in this subsection.

- Remove:
- Oil pressure regulator plug
 - Compression springs
 - Valve piston
 - Valve piston guide.



TYPICAL
1. Valve piston guide
2. Valve piston
3. Inner compression spring
4. Outer compression spring
5. Oil pressure regulator plug
6. O-ring

NOTE: Oil pressure regulator plug on oil pump housing is spring loaded.

Inspecting the Oil Pressure Regulator

Inspect valve piston and valve piston guide for scoring or other damages.
Check outer compression spring for free length.

OUTER COMPRESSION SPRING FREE LENGTH	
NEW NOMINAL	60 mm (2.362 in)
SERVICE LIMIT	57 mm (2.244 in)

Replace inner and outer compression spring as an assembly.

Replace parts if important wear or damage are present.

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

Installing the Oil Pressure Regulator

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

Make sure that the O-ring is on the plug screw.

Torque plug screw to specification.

NOTICE Make sure not over tighten the plug. Damages to springs may cause oil pressure regulator malfunction.

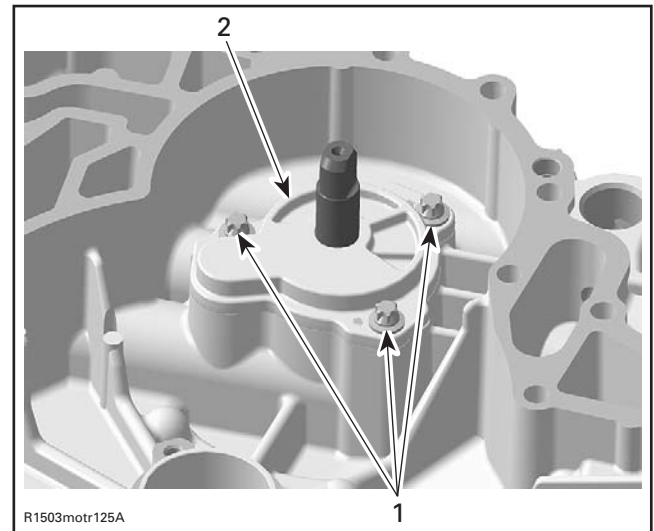
TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Oil pressure regulator plug	13 N•m (115 lbf•in)

OIL PRESSURE PUMP

The oil pressure pump is located in the PTO housing and is driven by the balance shaft.

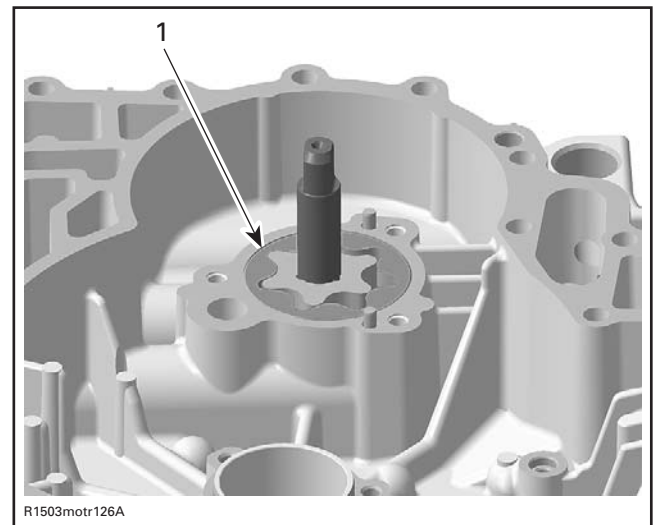
Removing the Oil Pressure Pump

1. Remove the PTO housing. Refer to *PTO HOUSING, MAGNETO AND STARTER* subsection.
2. Remove water pump housing and the impeller. Refer to *COOLING SYSTEM* subsection.
3. Remove screws securing the oil pump cover.



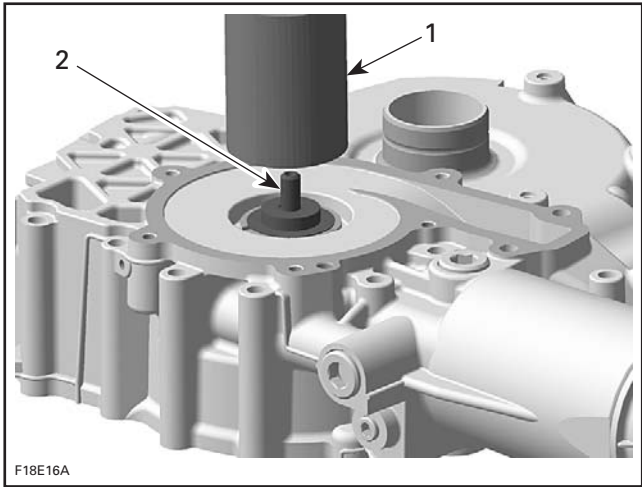
1. Screws
2. Oil pump cover

4. Pull and remove the outer oil pump rotor.



1. Outer oil pump rotor

5. Extract the coolant/oil pump shaft by pushing it from outside PTO housing cover.



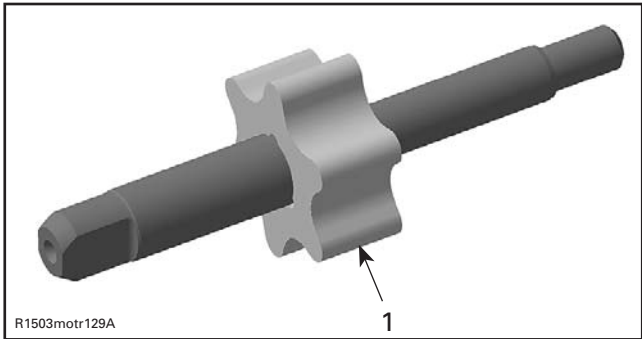
1. Pusher
2. Coolant/oil pump shaft

6. Remove rotary seal and oil seal. Refer to *ROTARY SEAL* further in this subsection.

Inspecting the Oil Pressure Pump

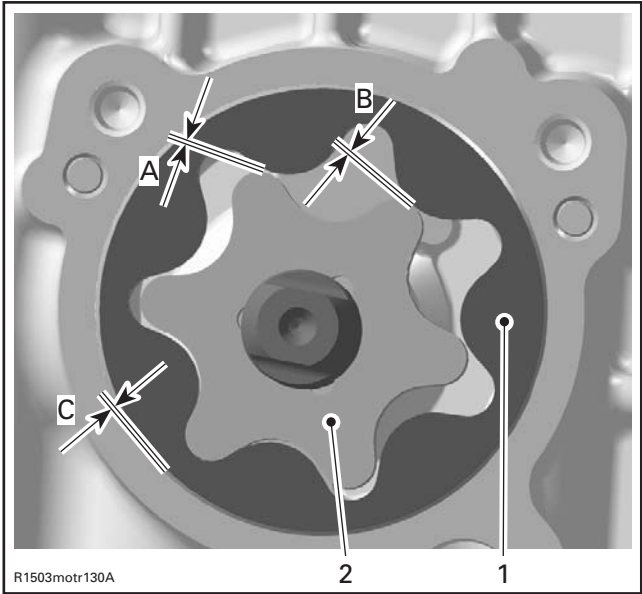
Inspect coolant/oil pump shaft, housing and cover for marks or other damages.

Check inner rotor for corrosion pin-holes or other damages. If so, replace coolant/oil pump shaft. Ensure to also check oil pump housing and cover and replace if damaged.



1. Pittings on the teeth

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



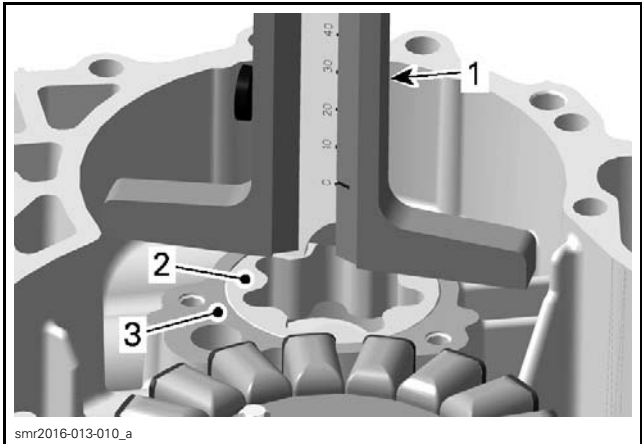
1. Outer rotor
2. Inner rotor

OUTER AND INNER ROTOR CLEARANCE		
SERVICE LIMIT		
A	0.25 mm (.0098 in)	
B		
C		

If clearance between inner and outer rotors exceeds the tolerance, replace coolant/oil pump shaft. Ensure to also check oil pump housing and cover and replace if damaged.

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

Using a depth gauge, measure axial clearance as shown.



1. Depth gauge
2. Oil pump outer rotor surface
3. PTO housing surface

Clearance between pump housing and outer rotor should not exceed the following specification. If so, replace the complete oil pump assembly.

CLEARANCE BETWEEN PUMP HOUSING AND OUTER ROTOR
0.1 mm (.004 in)

NOTE: When the axial clearance of the coolant/oil pump shaft increases, the oil pressure decreases. Check the inside of oil pump housing and its cover for scoring or other damages and replace if damaged.

Installing the Oil Pressure Pump

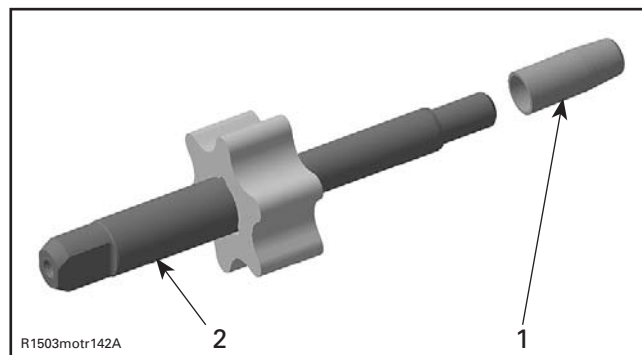
For installation, reverse the removal procedure. Pay attention to the following details.

Install a NEW rotary seal and a NEW oil seal. Refer to *ROTARY SEAL* in this subsection.

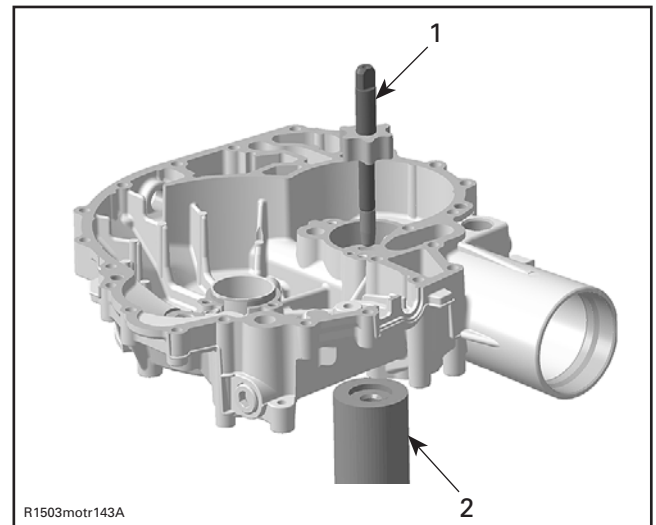
Install the coolant/oil pump shaft.

NOTICE Never use a hammer for the coolant/oil pump shaft installation. Only use a press to avoid damaging the ceramic component of the rotary seal.

REQUIRED TOOL	
OIL SEAL GUIDE (P/N 529 035 822)	
WATER PUMP SEAL PUSHER (P/N 529 035 823)	



1. Oil seal guide
2. Coolant/oil pump shaft



1. Coolant/oil pump shaft with oil seal guide
2. Rotary seal pusher to support PTO housing

Tighten oil pump cover screws and torque to specification.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Oil pump cover screws	9 N•m (80 lbf•in)

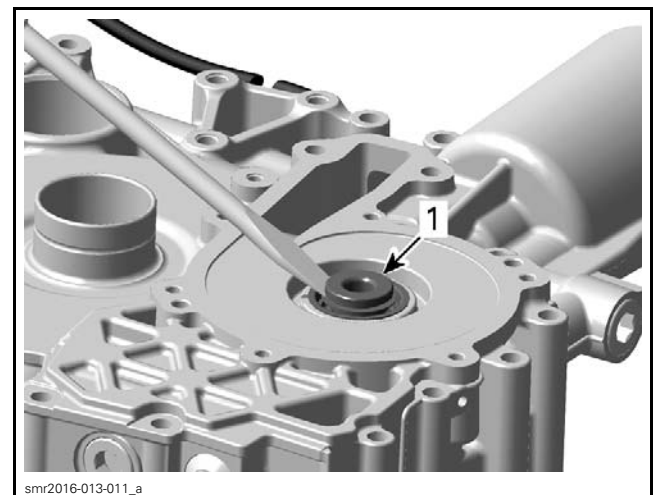
After engine is completely reassembled, start engine and make sure oil pressure is within specifications.

ROTARY SEAL

Removing the Rotary Seal

Remove the coolant/oil pump shaft. Refer to *OIL PRESSURE PUMP* in this subsection.

Carefully remove the inner ring of the rotary seal with a screwdriver.

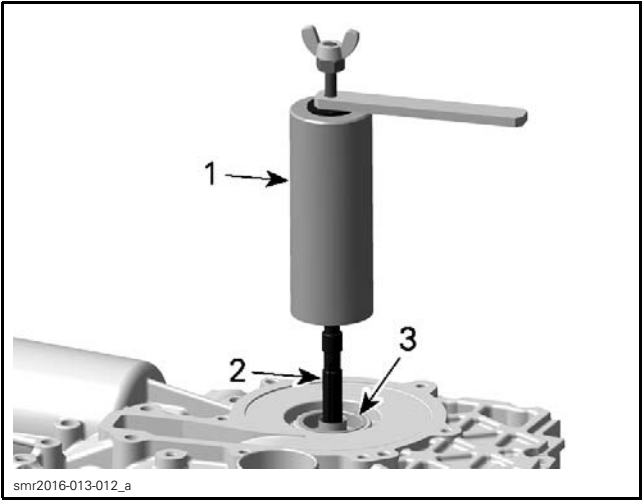


1. Inner ring of rotary seal

NOTICE Be careful not to damage the surface of the rotary seal bore or the sealing surface of the water pump housing in PTO housing.

REQUIRED TOOL	
CERAMIC SEAL PULLER (P/N 529 036 365)	

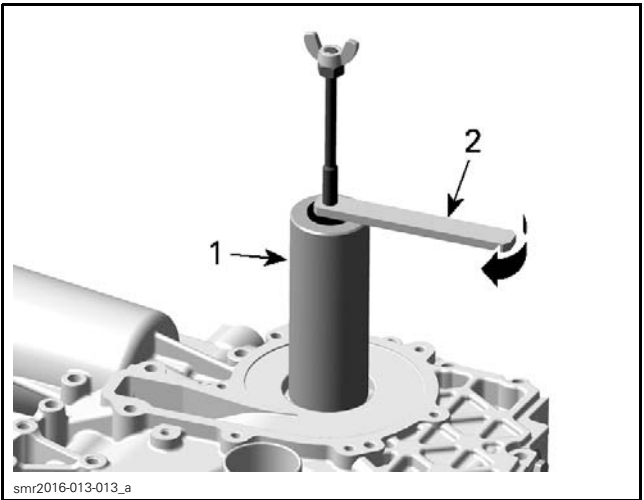
Put ceramic seal puller into the ceramic seal and turn the bearing puller until it's clamping.



- 1. Ceramic seal puller
- 2. Bearing puller
- 3. Ceramic seal

NOTE: Take care that the bearing puller end is exactly positioned between the oil seal and the ceramic seal.

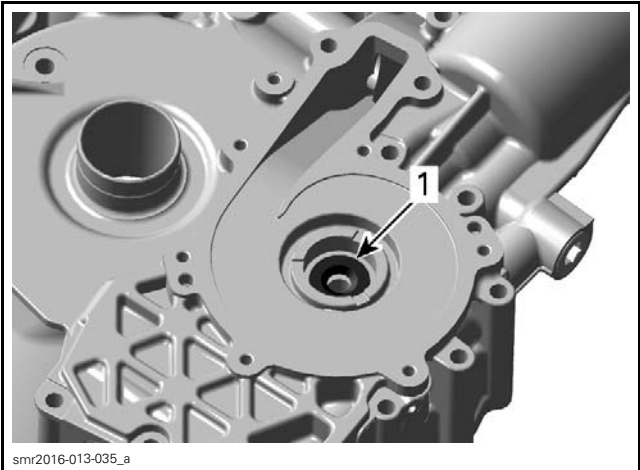
Start turning the lever clockwise until the ceramic seal is completely pulled out the PTO housing.



- 1. Ceramic seal puller
- 2. Bearing puller lever

Remove ceramic seal from bearing puller and discard it.

Remove oil seal behind the rotary seal.



- 1. Oil seal

Discard rotary seal and oil seal.

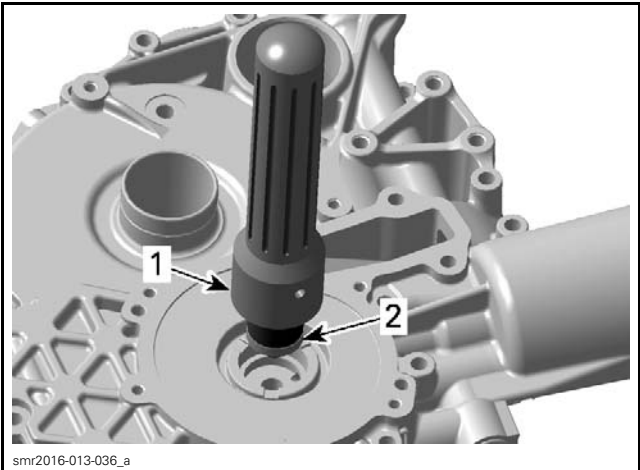
Installing the Rotary Seal

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

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

Install **NEW** oil seal.

REQUIRED TOOL	
OIL SEAL PUSHER (P/N 529 035 757)	
HANDLE (P/N 420 877 650)	



- 1. Handle with oil seal pusher
- 2. Oil seal

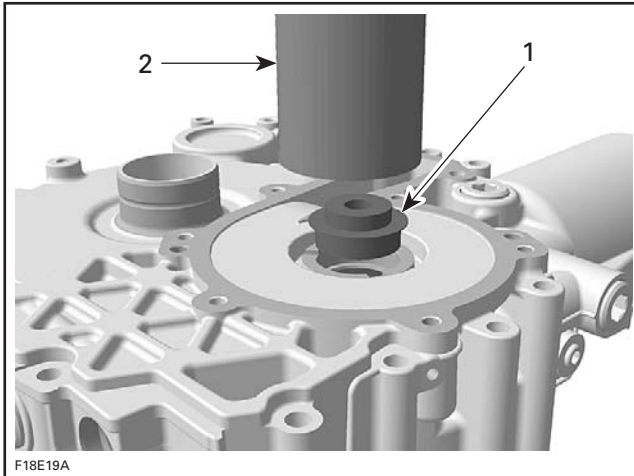
Install the **NEW** rotary seal.

REQUIRED TOOL

WATER PUMP SEAL PUSHER
(P/N 529 035 823)



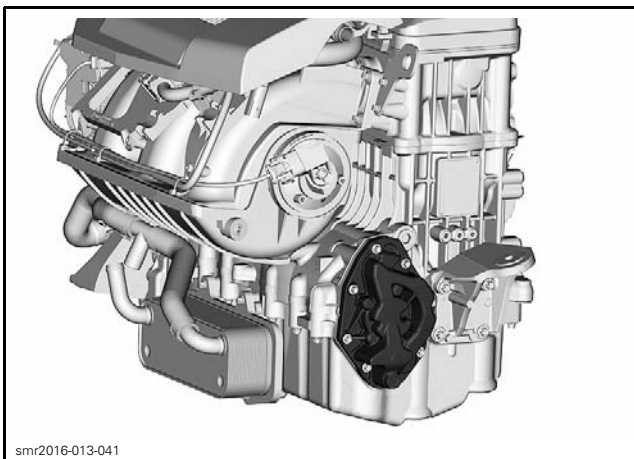
NOTICE Never use a hammer for the rotary seal installation. Only use a press to avoid damaging the ceramic component.



1. Rotary seal
2. Rotary seal installer

Install the coolant/oil pump shaft. Refer to *OIL PRESSURE PUMP* in this subsection.

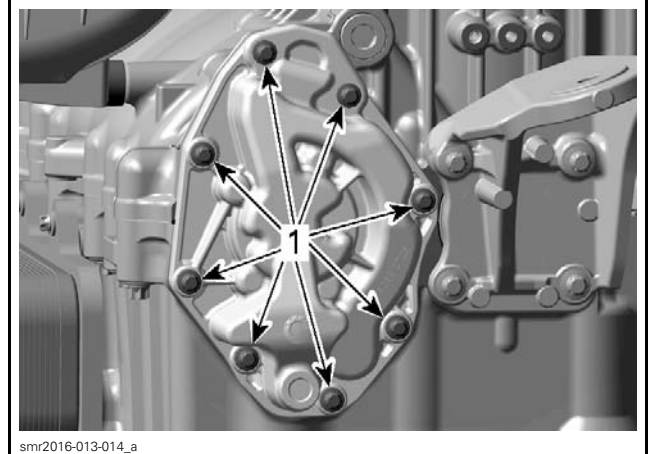
OIL SUCTION PUMP



TYPICAL - LOCATION OF OIL SUCTION PUMP

Removing the Oil Suction Pump

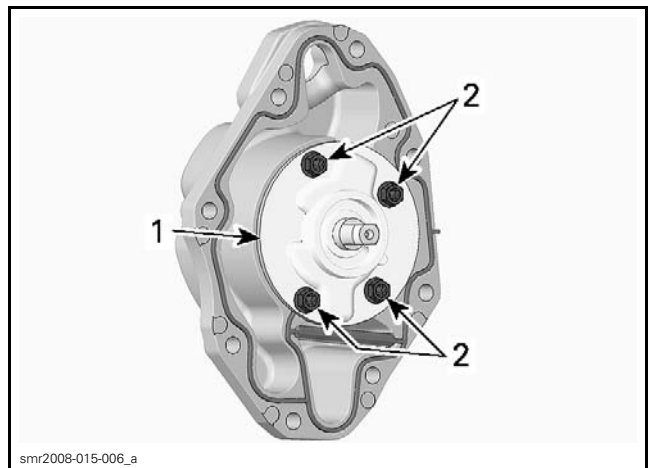
1. Remove retaining screws.



TYPICAL

1. Suction pump cover screws

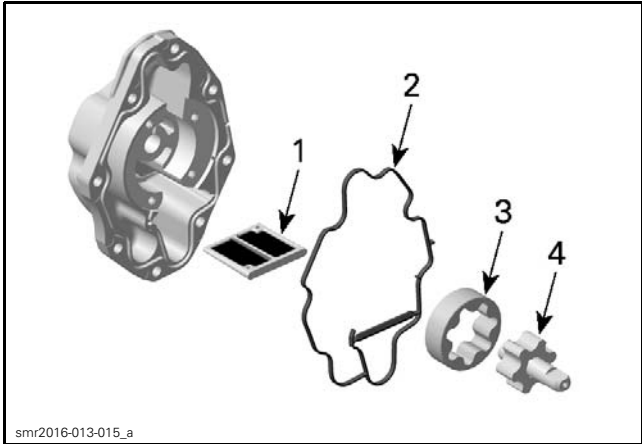
2. Place rags under cover to prevent spillage. If spillage occurs, clean with the PULLEY FLANGE CLEANER (P/N 413 711 809).
3. Remove the oil suction pump housing.
4. Remove:
 - oil pump screw
 - Cover.



TYPICAL

1. Oil pump cover
2. Oil pump screws

5. Remove:
 - Oil strainer
 - Cover gasket
 - Outer rotor
 - Oil pump shaft.

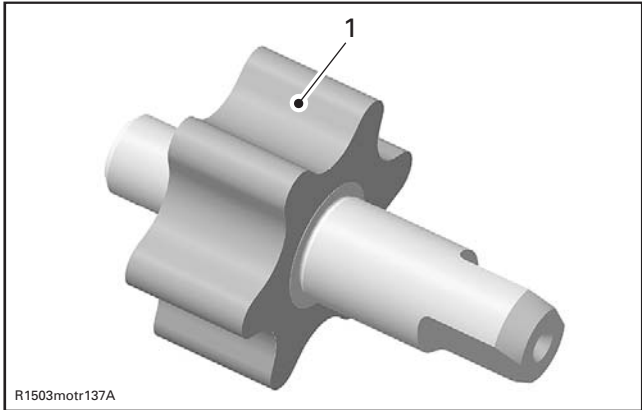


TYPICAL
1. Oil strainer
2. Cover gasket
3. Outer rotor
4. Oil pump shaft

Inspecting the Oil Suction Pump

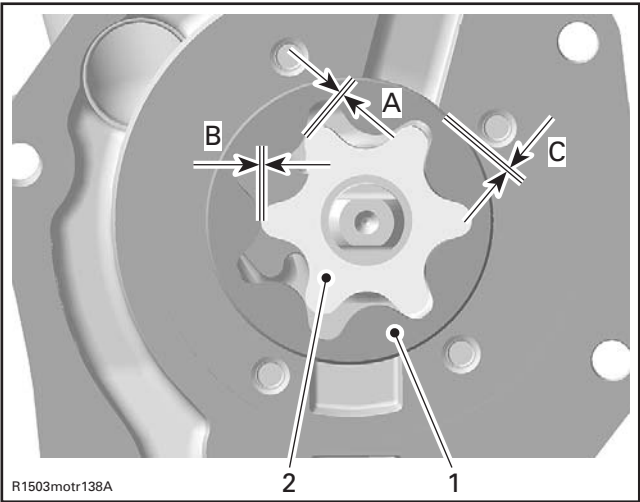
Inspect oil pump shaft, housing and cover for marks or other damages.

Check inner rotor for corrosion, pin-holes or other damages. If so, replace oil pump shaft. Ensure to also check oil pump housing and cover and replace if damaged.



1. Pittings on the teeth

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



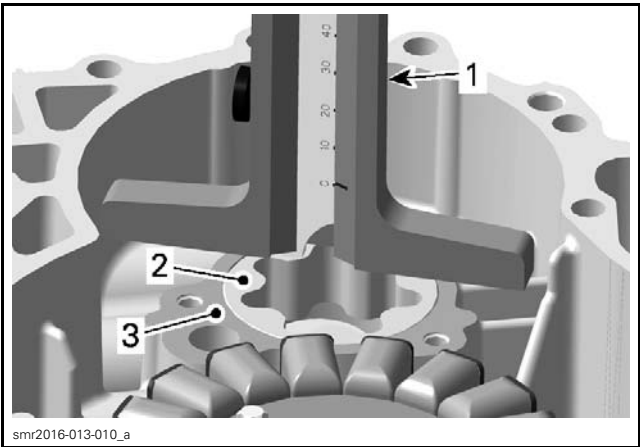
1. Outer rotor
2. Inner rotor

OUTER AND INNER ROTOR CLEARANCE	
SERVICE LIMIT	
A	0.25 mm (.0098 in)
B	
C	

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

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

Using a depth gauge, measure axial clearance as shown.



1. Depth gauge
2. Oil pump outer rotor surface
3. PTO housing surface

Clearance between pump housing and outer rotor should not exceed the following specification. If so, replace the complete oil pump assembly.

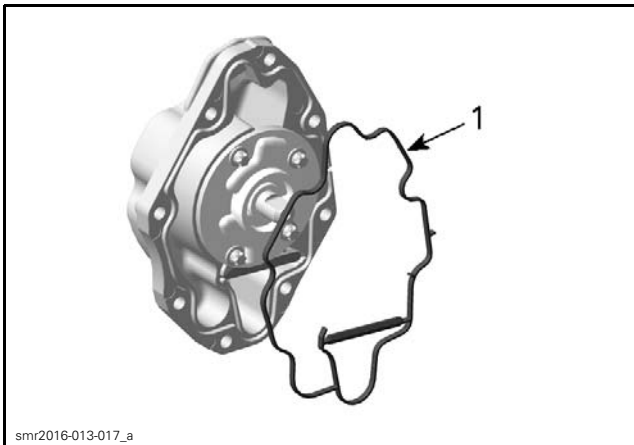
CLEARANCE BETWEEN PUMP HOUSING AND OUTER ROTOR

0.1 mm (.004 in)

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

Check the inside of oil pump housing and its cover for scoring or other damages and replace if damaged.

Inspect rubber ring gaskets.



1. Suction pump cover gasket

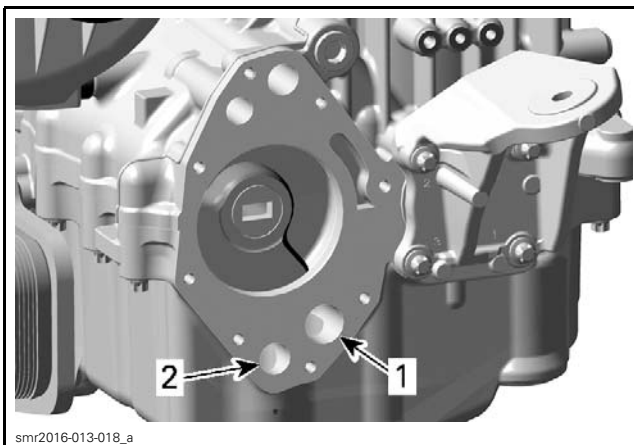
If gasket is brittle, cracked or hard, replace it.

Installing the Oil Suction Pump

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

Clean both contact surfaces of oil suction pump cover.

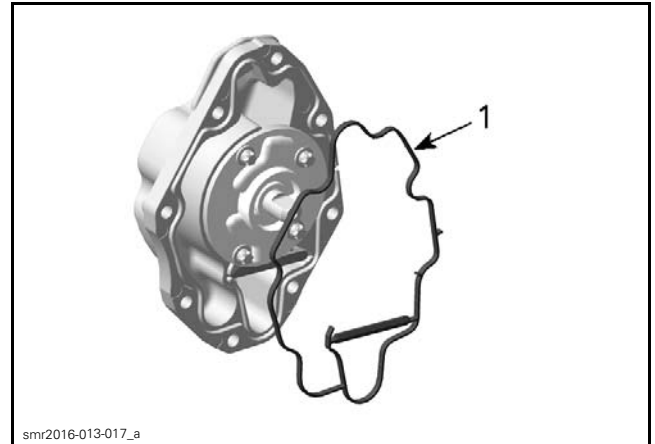
Check and clean the oil inlet and outlet area for dirt and other contaminations.



1. Oil inlet
2. Oil outlet

Make sure oil strainer is properly installed in the oil suction pump cover.

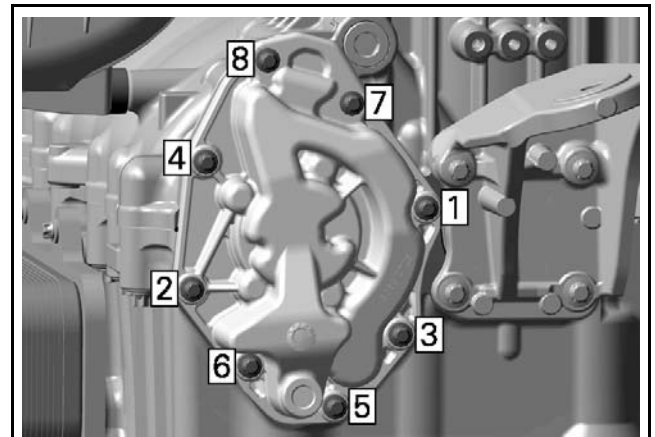
Apply engine oil on rubber ring gasket.



1. Suction pump cover gasket

Tighten suction pump cover screws to specifications as per following sequence.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Suction pump cover screws	9 N•m ± 1 N•m (80 lbf•in ± 9 lbf•in)



TYPICAL - TIGHTENING SEQUENCE

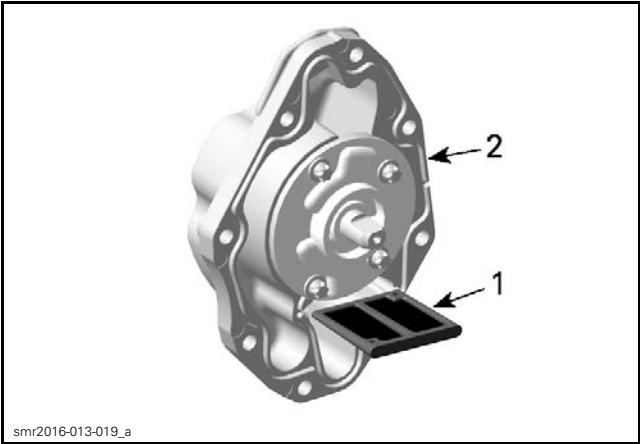
Refer to the appropriate procedures and install all other removed parts.

SUCTION PUMP OIL STRAINER

NOTE: The oil strainer does not need to be cleaned at every oil change. Clean it during other inspections, especially when the engine is disassembled.

Removing the Suction Pump Oil Strainer

Remove oil strainer from the suction pump cover, tefer to *REMOVING THE OIL SUCTION PUMP* in this subsection.



1. Oil strainer
2. Suction pump cover

Inspecting the Suction Pump Oil Strainer

Clean oil strainer with a part cleaner then use compressed air to dry it.
Check oil strainer for tear or other damages. Re-
place it if necessary.

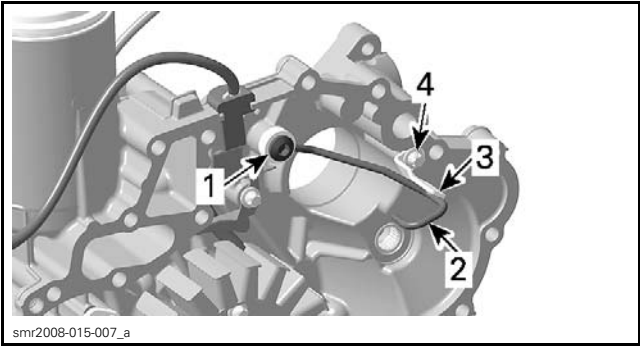
Installing the Suction Pump Oil Strainer

For installation of the suction pump cover, refer to *OIL SUCTION PUMP* in this subsection.

SUPERCHARGER OIL SPRAY NOZZLE

Removing the Supercharger Oil Spray Nozzle

Remove the PTO housing. Refer to *PTO HOUS-
ING, MAGNETO AND STARTER* subsection.
Remove the Torx screw securing the oil spray noz-
zle support.
Unscrew the Banjo bolt.



1. Banjo bolt
2. Supercharger oil spray nozzle
3. Oil spray nozzle support
4. Torx screw

Inspecting the Supercharger Oil Spray Nozzle

Check oil spray nozzle for:
– Dirt
– Bend
– Other damages.

Replace if necessary.

Installing the Supercharger Oil Spray Nozzle

For installation reverse the removal procedure.
However, pay attention to the following.
Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on
threads of Torx screw.

Install the oil spray nozzle support.

TIGHTENING TORQUE	
Oil spray nozzle support (Torx screw)	9 N•m (80 lbf•in)

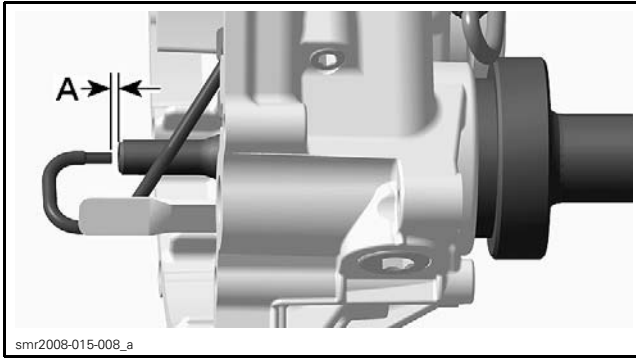
Install oil spray nozzle with Banjo bolt.

TIGHTENING TORQUE	
Oil spray nozzle Banjo bolt	19 N•m (168 lbf•in)

Adjust the position of the oil spray nozzle.

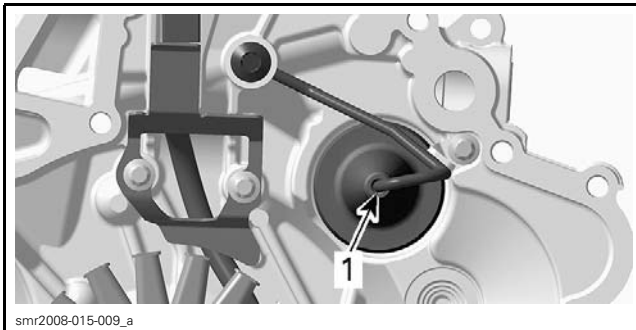
REQUIRED TOOL	
SUPERCHARGER OIL SPRAY NOZZLE TOOL (P/N 529 036 134)	

The distance between the adjustment tool and oil
spray nozzle must be within 1 mm (.039 in).



A. 1 mm (.039 in)

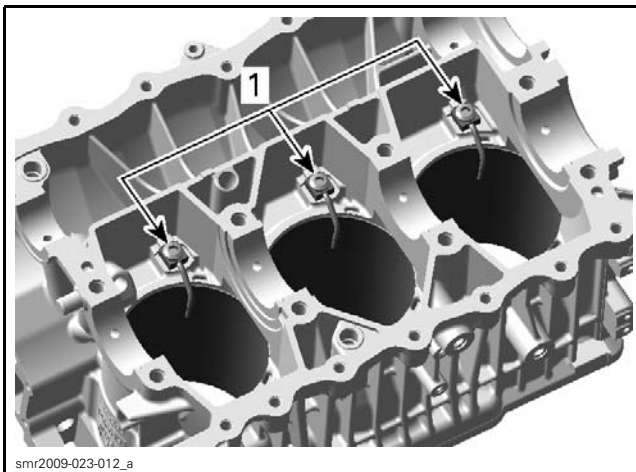
NOTE: Make sure that the oil spray nozzle is facing to the center of the tool. Not following this procedure will lead to an insufficient oiling of the supercharger and a supercharger failure can occur. Adjust the oil spray nozzle if necessary by slightly bending it, take care not to over bend the oil spray nozzle.



1. Center of supercharger oil spray nozzle tool

PISTON OIL SPRAY NOZZLES

The piston oil spray nozzles are located on the upper half of cylinder block.



1. Piston oil spray nozzles

NOTE: When the scope of repair work obligates you to split the cylinder block, take this opportunity to inspect the oil spray nozzles.

Inspecting the Piston Oil Spray Nozzle

Check if the oil spray nozzle is damaged or bent.

Check for cracks at soldering.

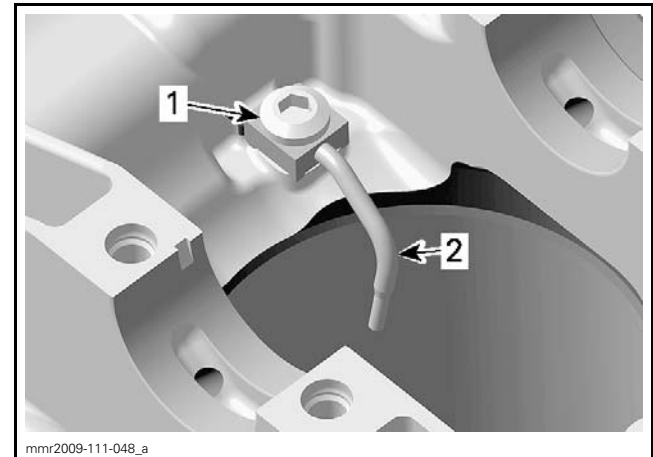
Replace as necessary.

If damaged replace immediately.

Removing the Piston Oil Spray Nozzle

Remove cylinder block lower half. Refer to *CYLINDER BLOCK* subsection.

Remove oil spray nozzle and Banjo fitting and discard it.

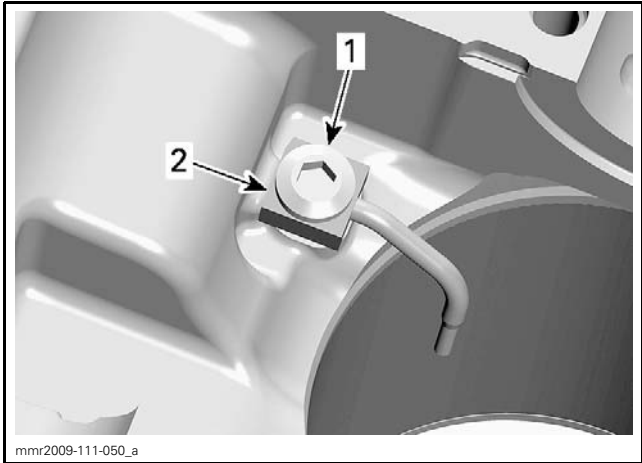


1. Banjo fitting
2. Oil spray nozzle

Installing the Piston Oil Spray Nozzle

Install **NEW** oil spray nozzle and Banjo fitting.

NOTICE At assembly make sure the contact surface of the oil spray nozzle is well fitted onto the cylinder block. If this is not ensured, the oil spray direction will change, causing potential engine damage.



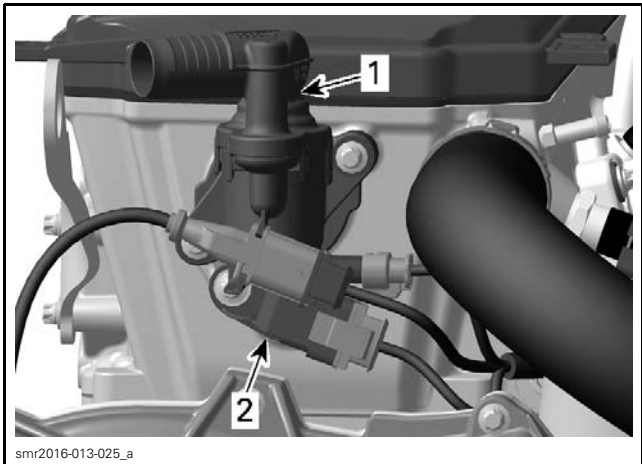
1. Oil spray nozzle
2. Contact surface

TIGHTENING TORQUE	
Piston oil spray nozzle banjo bolt	19 N•m ± 2 N•m (168 lbf•in ± 18 lbf•in)

OIL SEPARATOR COVER

Removing the Oil Separator Cover

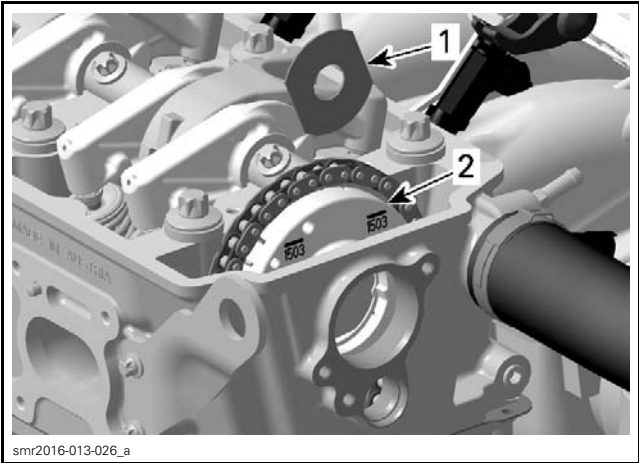
1. Remove the blow-by valve. See procedure in this subsection.
2. Remove camshaft position sensor, refer to *ELECTRONIC FUEL INJECTION (EFI)* subsection.



1. Camshaft position sensor
2. Screw

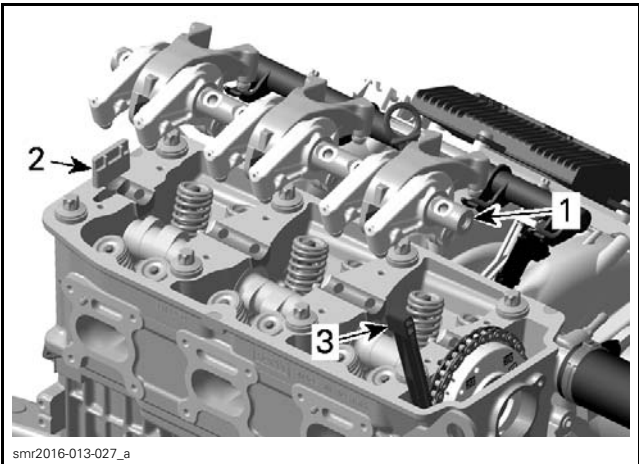
3. Remove valve cover, refer to *CYLINDER HEAD* subsection.
4. Remove thrust washer from oil separator cover.

NOTE: Make sure not to loose thrust washer when removing it from oil separator cover, otherwise thrust washer would fall into the PTO housing.



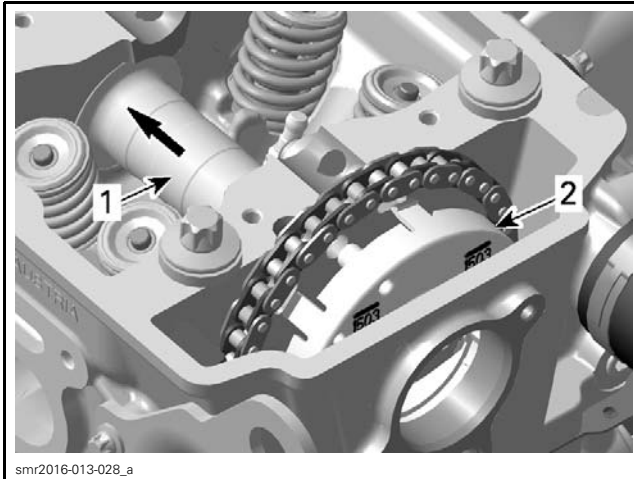
1. Thrust washer
2. Oil separator cover

5. Refer to *CYLINDER HEAD* subsection and remove:
 - Spark plug tubes
 - Rocker arm shaft together with rocker arms
 - Chain guide
 - Camshaft lock.



1. Rocker arm
2. Camshaft guide
3. Chain guide

6. Move camshaft backwards as far as possible.
7. Remove oil separator cover from timing gear by releasing the holding clips.



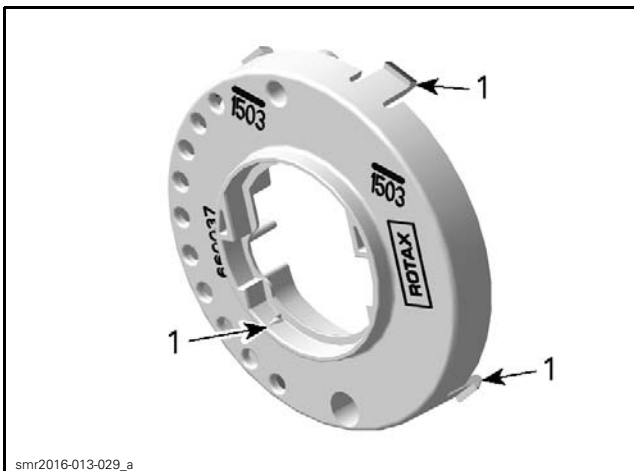
smr2016-013-028_a

1. Camshaft
2. Oil separator cover

NOTE: Be careful not to break the holding clips from oil separator cover when its removed from the timing gear.

Inspecting the Oil Separator Cover

Inspect oil separator cover for marks or other damages. Ensure to check also the holding clips of oil separator cover and for thrust washer. If any damage is visible replace oil separator cover.



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1. Holding clips

Installing the Oil Separator Cover

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

Properly install oil separator cover and thrust washer. They need to be in a perfect even position with timing gear.

NOTE: Make sure not to lose thrust washer when installed on oil separator cover.

Install all other removed parts.

BLOW-BY VALVE

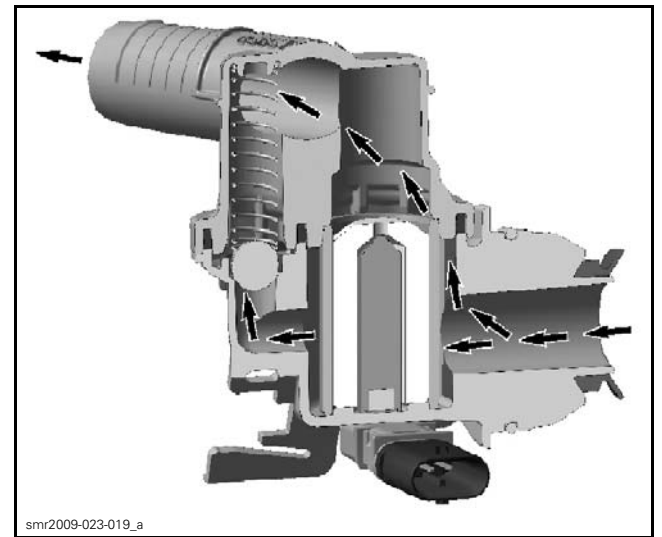
Blow-By Valve Description

The function of the blow-by valve is the circulation of the oil vapors.

Blow-By Valve Operation

Normal Operation

During its normal operation, the blow-by valve allows crankcase vapors to return in the intake system where they are harmlessly burned.

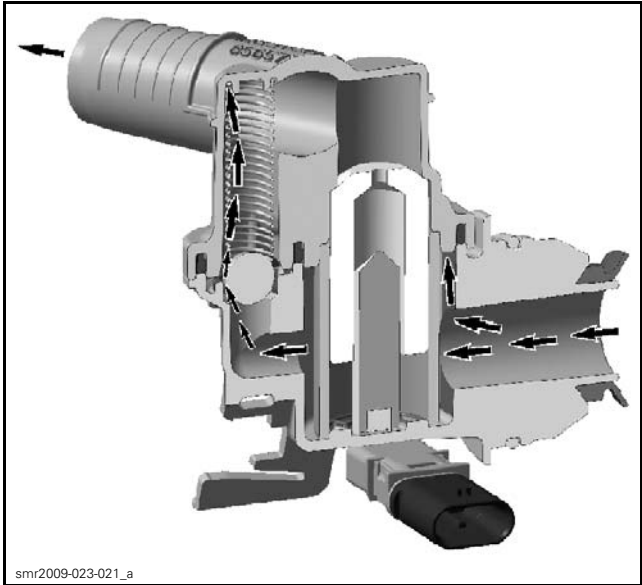


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NORMAL OPERATION

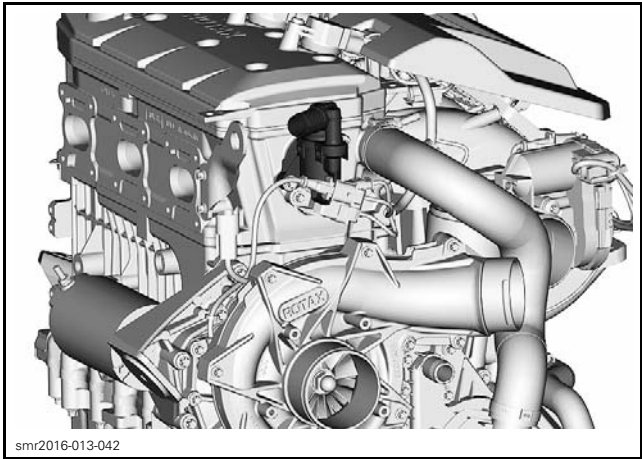
By-Pass Function

If, for any reason, the valve piston gets stuck at normal operation and the crankcase pressure exceeds 40 kPa (6 PSI), the pressure unseats a check ball and crankcase vapors can bypass the valve piston.



BY-PASS FUNCTION

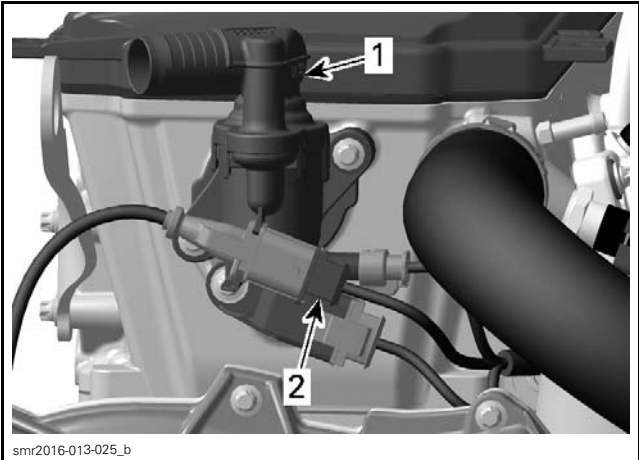
Blow-By Valve Location



TYPICAL

Removing the Blow-By Valve

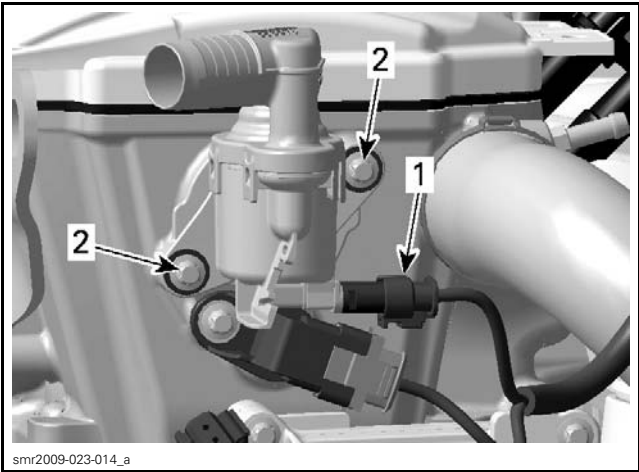
Remove ventilation hose from blow-by valve.
Remove the CPS connector from its support on blow-by valve.



- 1. Blow-by valve
- 2. CPS connector

Disconnect the TOPS switch connector of the blow-by valve.

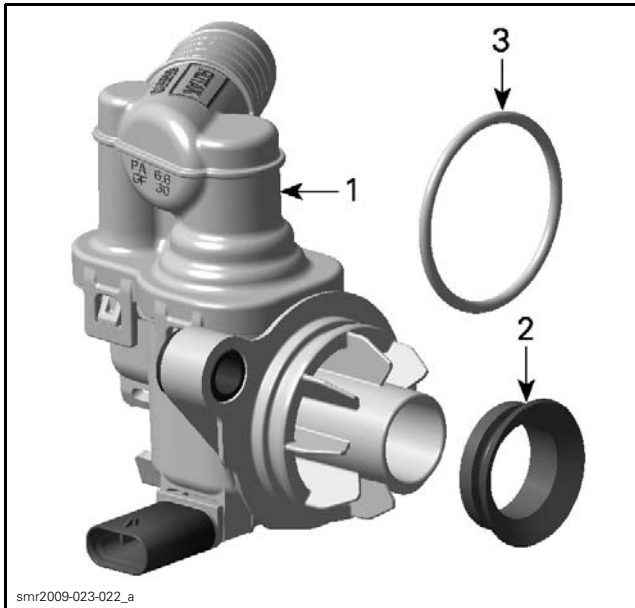
Unscrew and remove the blow-by valve.



- TYPICAL
- 1. TOPS switch connector
 - 2. Retaining screws

Remove and discard O-ring and V-ring.

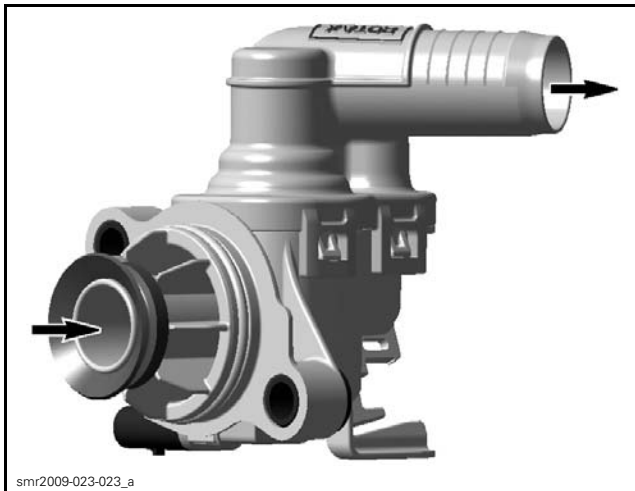
NOTE: The blow-by valve can not be disassembled.



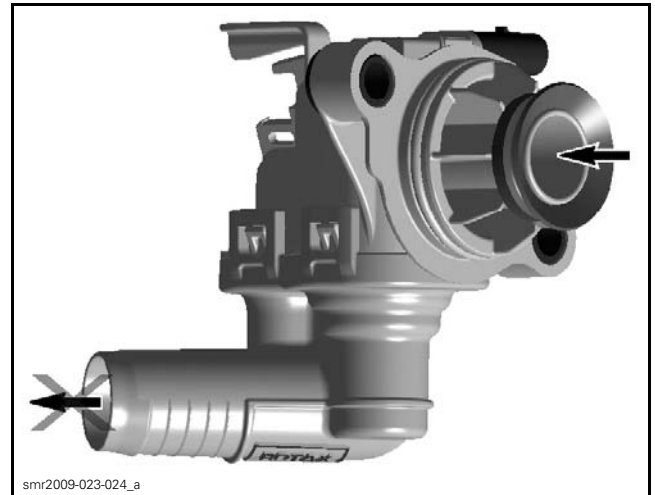
1. Blow-by valve
2. V-ring
3. O-ring

Inspecting the Blow-By Valve

If blow-by valve is damaged, replace it.
Clean all contact surfaces of blow-by valve.
Place a clean rag on valve inlet.
Blow air through inlet port. Air must flow freely to the outlet port.



Turn valve upside down and blow air again. Air must not flow out.



If test fails, replace blow-by valve.

Installing the Blow-By Valve

The installation is the reverse of the removal procedure. However, pay attention to the following. Install the blow-by valve with **NEW** O-ring and V-ring.

Tighten blow-by valve screws to specification.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Blow-by valve screws	9 N•m (80 lbf•in)

Reinstall remaining removed parts.

TOPS SWITCH

Tip Over Protection Switch (TOPS Switch) Function

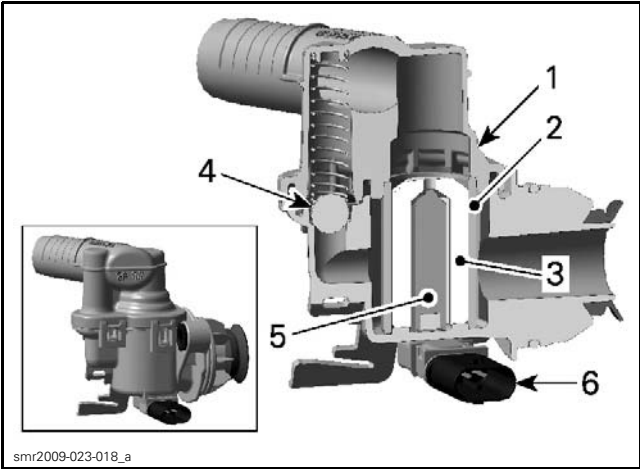
The function of the TOPS switch is the engine protection in the event the watercraft tip over.

During normal operation the TOPS switch state is OFF, no signal to the ECM.

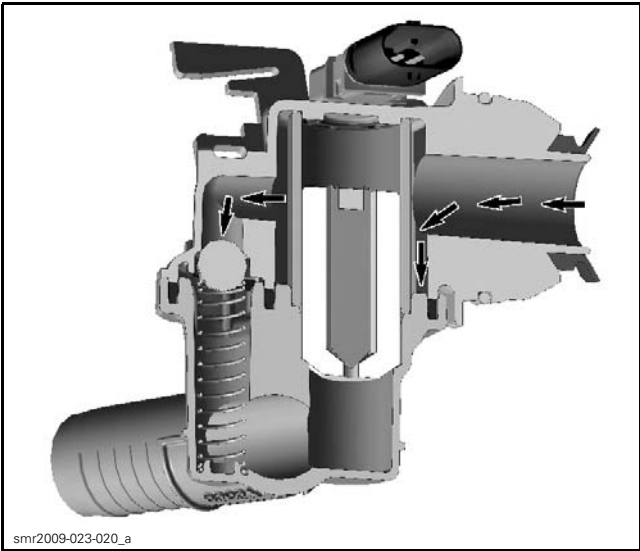
If the watercraft tips over, gravity causes a valve piston to close and no engine oil will leak out of the blow-by valve.

In this event, a pin (with magnet) opens a gap to the TOPS switch (Hall effect sensor) and the TOPS changes its state to ON and sends a signal to the ECM.

The ECM will shut down the engine by cutting the ignition and the fuel injection.



BLOW-BY VALVE CUT-AWAY
1. Valve housing
2. Valve sleeve
3. Valve piston
4. Check ball
5. Valve pin (with magnet)
6. TOPS switch of the blow-by valve



TIP OVER FUNCTION

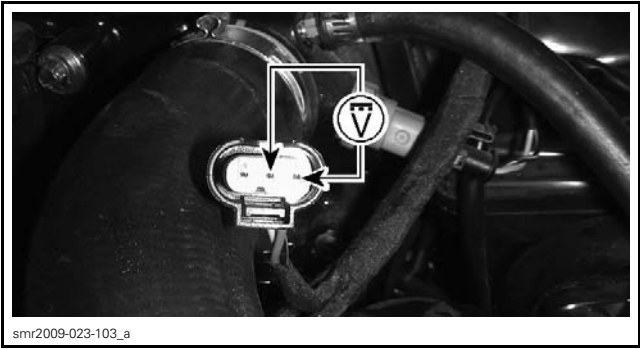
Testing the TOPS Switch Input Voltage

Disconnect the TOPS switch connector of the blow-by valve.

Briefly press the START/STOP button to wake-up the ECM.

Probe terminals as shown to check the voltage output from the ECM.

TOPS SWITCH CONNECTOR	VOLTAGE
Pins 2 and 3	Approximately 5 Vdc



If voltage test is good, check the TOPS switch output voltage.

If voltage test is not good, check the continuity of the blow-by valve TOPS switch circuit.

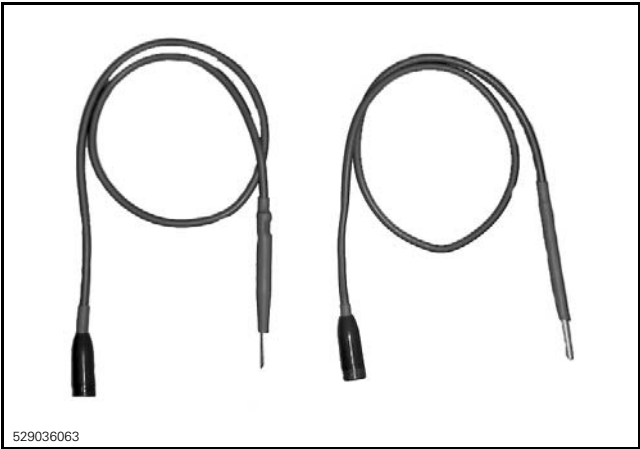
NOTE: After voltage test, clear the fault codes in the ECM using BUDS2.

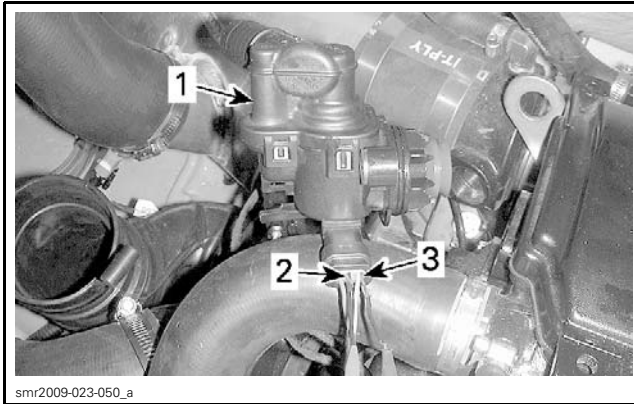
Testing the TOPS Switch Output Voltage

Remove the blow-by valve.
Back-probe TOPS connector and check voltage.

REQUIRED TOOL	
FLUKE 115 MULTIMETER (P/N 529 035 868)	

NOTE: To easily probe wire terminals through the back of the connector, use the BACK PROBE TEST WIRES (P/N 529 036 063) or an equivalent.





BLOW-BY VALVE IN NORMAL POSITION

1. Blow-by valve
2. RED probe into pin 2
3. BLACK probe into pin 1

TOPS SWITCH CONNECTOR	BLOW-BY VALVE POSITION	VOLTAGE
Pin 1 and pin 2	Normal position	0.4 ± 0.1 Vdc
Pin 1 and pin 2	Upside down	4.4 ± 0.2 Vdc
Pin 2 and pin 3	Normal position or upside down	Approximately 5 Vdc

Replace TOPS switch if not within specification.

TOPS Switch Circuit Continuity

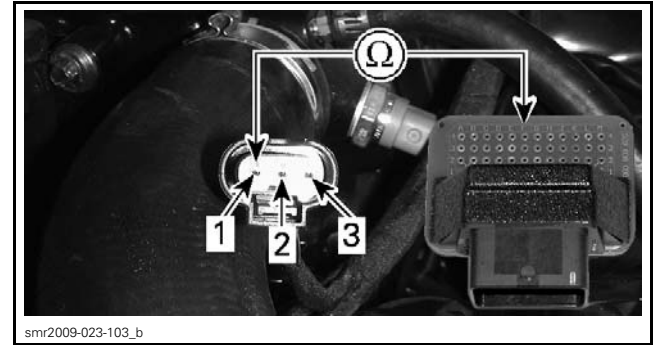
Disconnect the TOPS switch connector of the blow-by valve.

Disconnect the connector "A" from the ECM.

Check continuity of the blow-by valve TOPS switch circuit as per following table.

REQUIRED TOOL	
ECM ADAPTER TOOL (P/N 529 036 166)	
FLUKE 115 MULTIMETER (P/N 529 035 868)	

TOPS SWITCH CONNECTOR	ECM ADAPTER	RESISTANCE
Pin 1	Pin F4	Close to 0Ω (continuity)
Pin 2	Pin G1	
Pin 3	Pin C4	



1. Pin 1
2. Pin 2
3. Pin 3

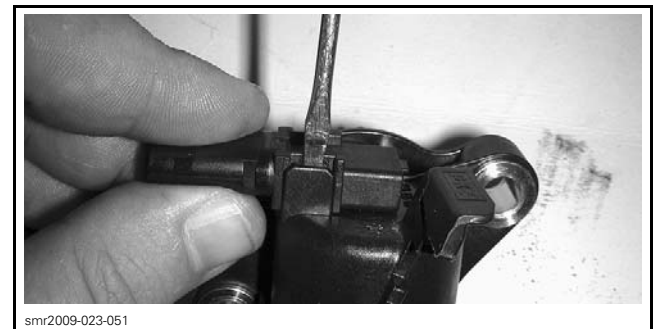
If continuity test is good, check ECM. Refer to *ELECTRONIC FUEL INJECTION (EFI)* subsection.

If continuity test is not good, repair or replace defective wires or connectors.

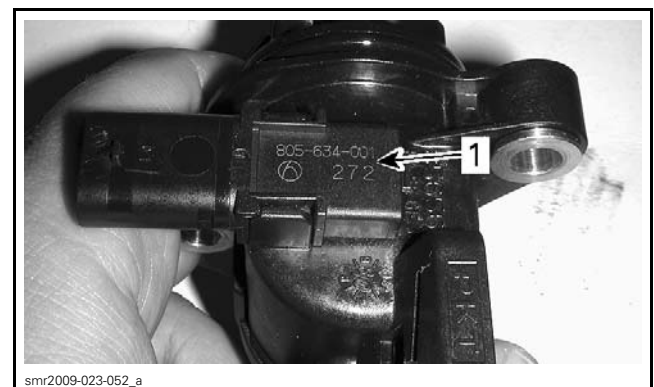
Replacing the TOPS Switch

Remove blow-by valve and turn it upside down.

Insert a small screwdriver between TOPS switch and its retaining tab. Twist and hold the TOPS switch then release the other retaining tab.



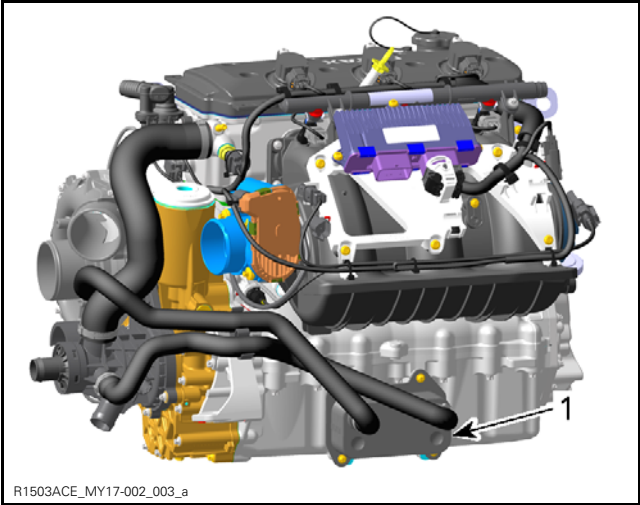
When installing the TOPS switch, make sure printed information is visible.



1. TOPS valve inscriptions

OIL COOLER

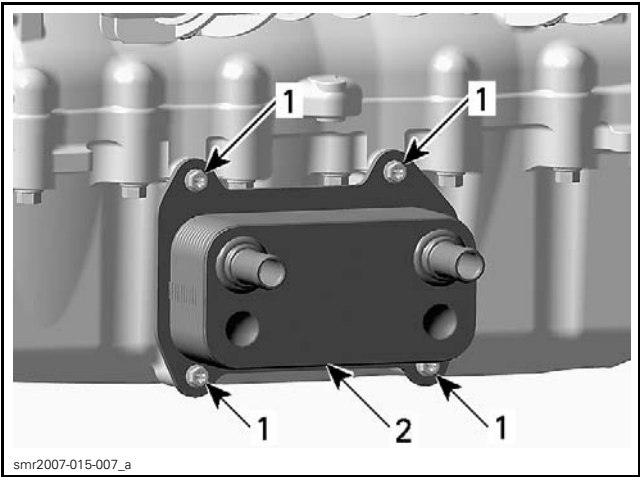
The oil cooler is located below the air intake manifold.



1. Oil cooler

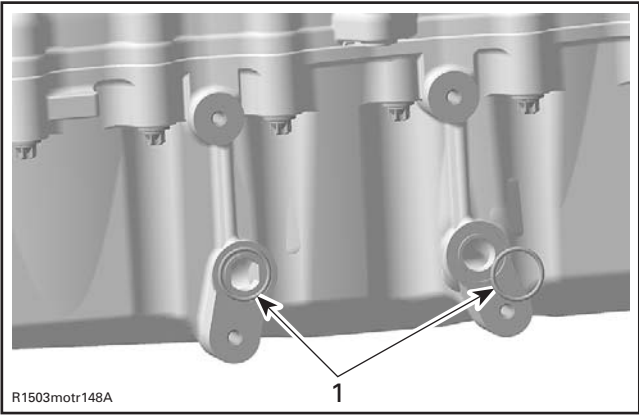
Removing the Oil Cooler

Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
Disconnect cooling hoses from oil cooler.
Remove screws securing oil cooler.



1. Oil cooler screws
2. Oil cooler

Ensure not to lose O-rings located between oil cooler and engine.



1. O-rings

Inspecting the Oil Cooler

If O-rings are brittle, cracked or hard, replace them.
Clean both contact surfaces of oil cooler.
Check and clean the oil inlet and outlet area for dirt and other contaminations.

Installing the Oil Cooler

For installation, reverse the removal procedure. Pay attention to the following details.
Apply engine oil on O-rings.
Tighten oil cooler screws to specification.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Oil cooler screws	11 N•m (97 lbf•in)