SUBARU

Confidence in Motion

Technician Reference Booklet

Chain Drive Valve Train
Boxer Engine

April 2017

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This Technician Reference Booklet (TRB) is designed to be used in a classroom environment or as a guide for self study.
The TRB is not intended to be used as a supplement or substitute for the Subaru Service Manual. Always consult the appropriate Service Manual when performing any diagnostics, maintenance or repair to any Subaru vehicle.

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General Information

The 105 module, "Chain Driven Valve Train Boxer Engines", provides an introduction to the 3.0, 3.6 and 2.5 liter engines using a chain rather than a belt to drive the Camshafts.

The 3.0 liter, (EZ 30) designation number, was first introduced in 2001. This engine was equipped in applicable models from 2001 to 2004 model years.

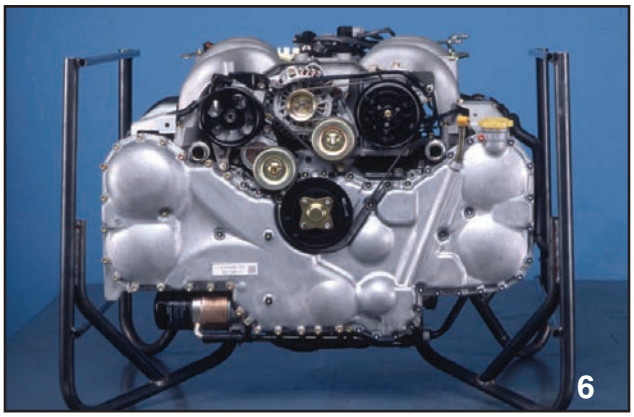
2005 applicable models introduced the Intake AVCS (Advanced Valve Control System) and VVL (Variable Valve Lift) 3.0 engine. The early 3.0 was equipped with a metal intake manifold and the later version utilized a molded resin intake manifold.

(2009 was the last model year for the 3.0 liter engine).

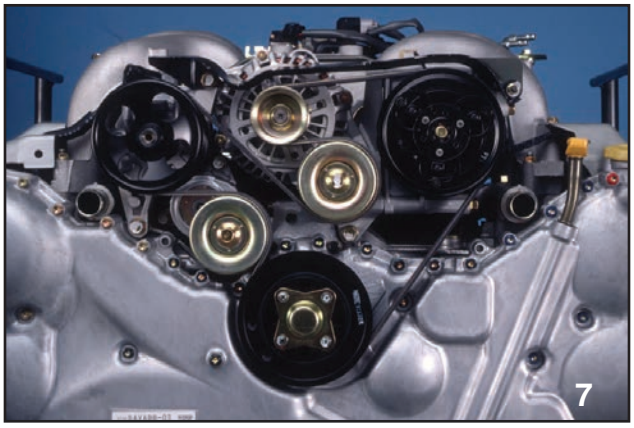
3.6 liter engines (EZ 36) were first introduced in the 2008 model year and are equipped with Dual AVCS, controlling both the intake and exhaust Camshafts. This engine does not utilize the VVL system.

The 2.5 engine (FB 2.5) was introduced on applicable 2011 models and provides Intake AVCS only.

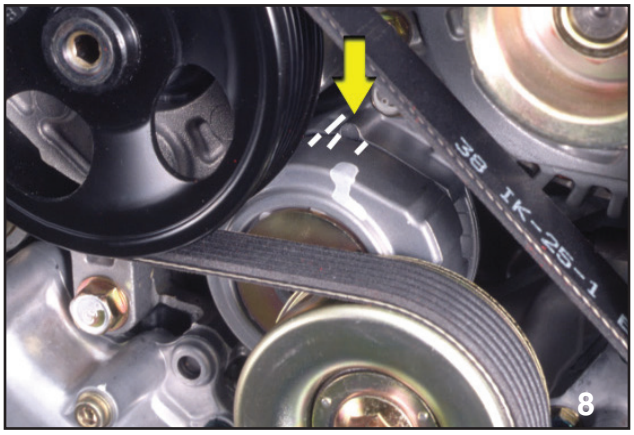
3.0 Liter Engine



3.0 Liter Engine with Stands



Single Serpentine Belt



Belt Wear Indicator

3.0 Liter Engine Features

The front of the engine displays the large front timing chain cover. It is secured to the inner cover with 59 bolts. There are 4 different lengths used and is sealed to the inner cover with Three Bond (1280B). Special care must be used when servicing the timing chain covers to ensure the proper length bolt and sealing procedures are used. A single serpentine belt provides the power to turn all engine accessories.

Tension to the belt is controlled with an automatic tensioner.

Replace the serpentine belt when the indicator is at or beyond this line.

3.0 Specifications

Bore and stroke 89.2 x 80 millimeters (3.51 x 3.14 inches)

Length 465 millimeters (18.3 inches)

Height 635 millimeters (24.99)

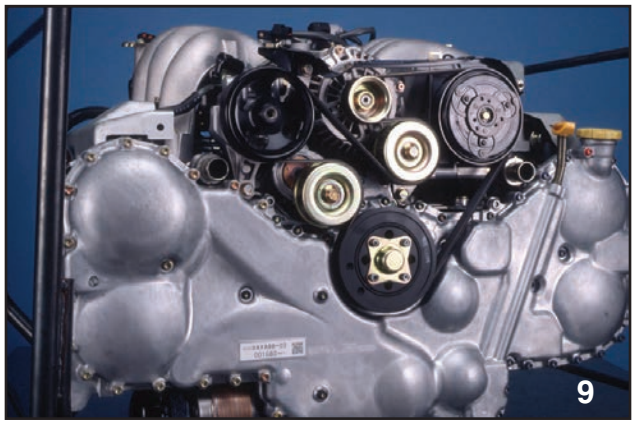
Displacement 3.0 liters (183 cubic inches)

Compression Ratio 10.7 to 1

Gasoline for use Unleaded Premium

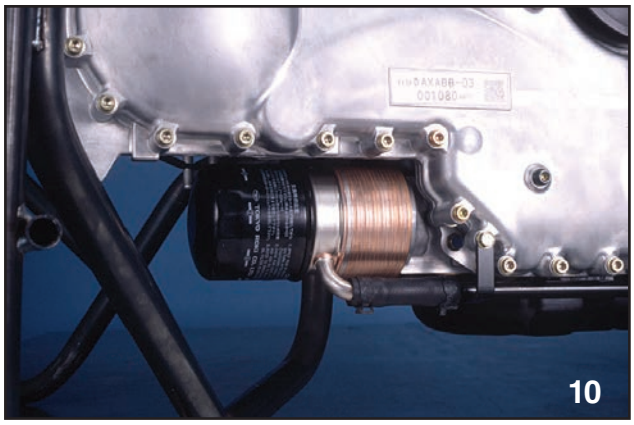
Maximum Horsepower 212 at 6,000 RPM

Maximum torque 210 at 4,400 RPM



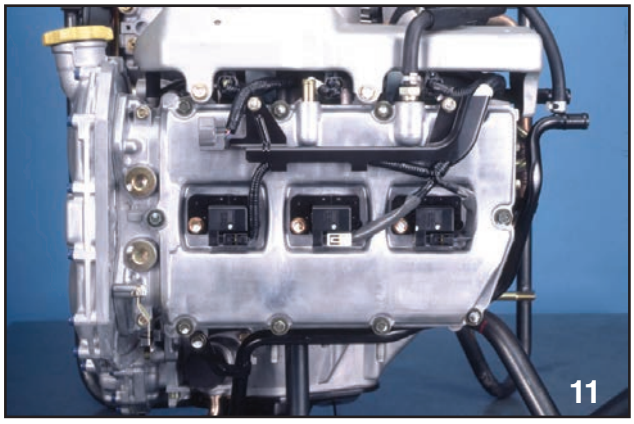
Upper Radiator Hose Connections

Two radiator hose connections are located at the top of the engine block connecting to each of the cylinder heads.

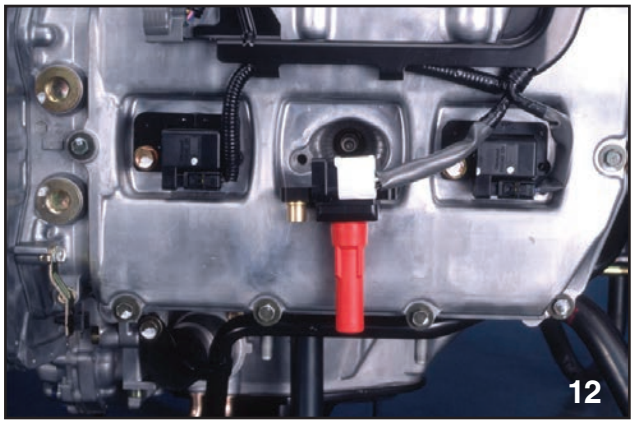


Oil Cooler

An oil cooler is used to assist with bringing the oil to operating temperature.

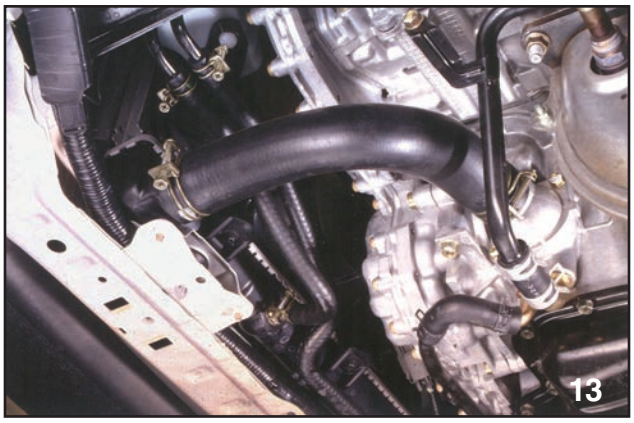


Individual Coils



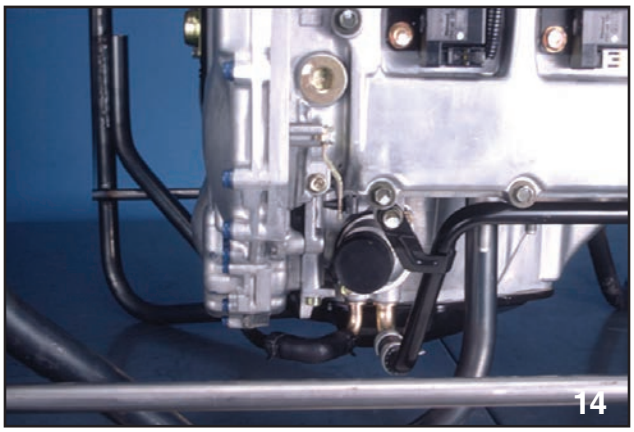
Coil and Igniter Assembly

The view of the left bank side shows the use of direct ignition coils. The igniter and current control circuits are integrated.



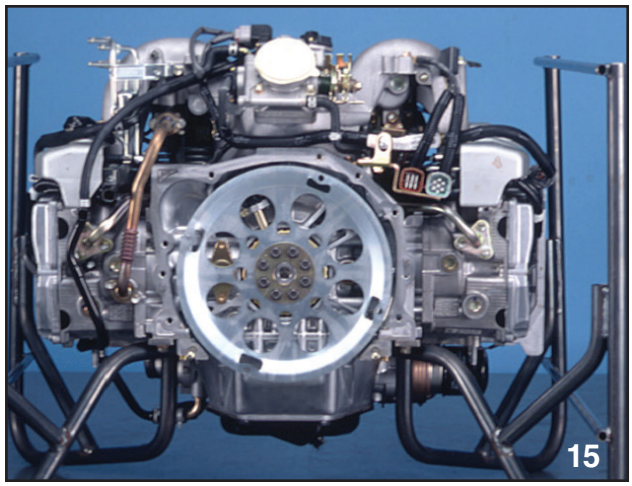
Lower Radiator Hose

The lower hose is located on the thermostat housing, connecting to the lower section of the radiator.



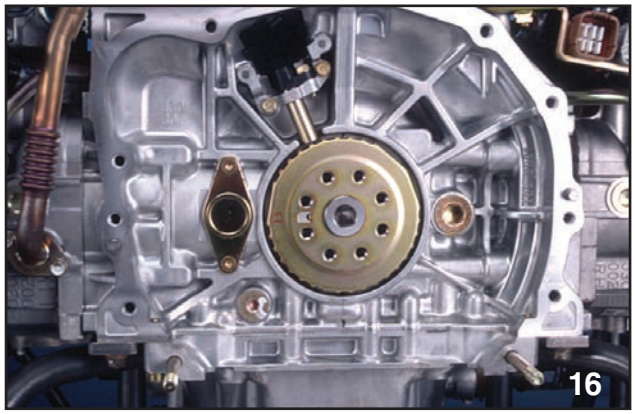
Oil Pan and Extension Case

The thermostat is housed in the Oil Pan extension case. The Oil Pan itself is much smaller than previous model engines and contains a small magnet to collect metallic debris.



Crankcase Ventilation System

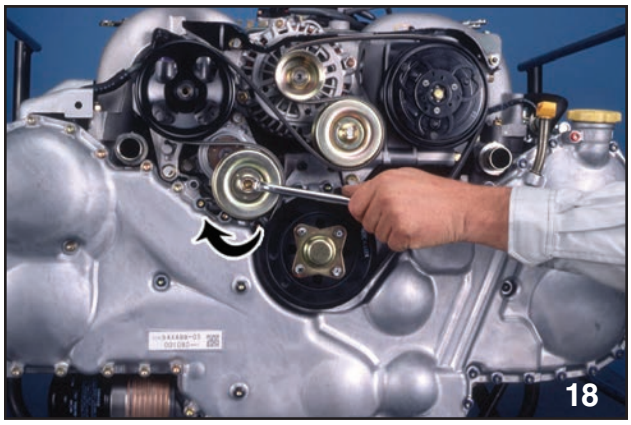
Connections for the crankcase ventilation system are located at the top of the valve cover. Pressure is equalized from the right bank with a cross over tube.



Crank Angle Sensor with Reluctor

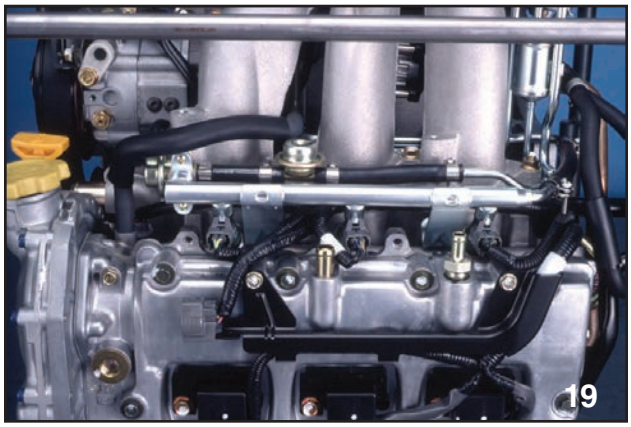
The crank angle sensor and reluctor have been moved to the rear of the crankshaft. The EGR pipe is mounted on the left bank of the engine.

3.0 Liter Engine Disassembly



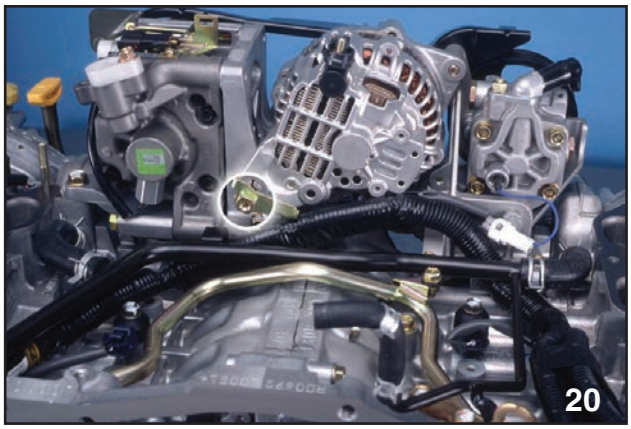
Unloading Tensioner

Begin disassembly by unloading and removing the serpentine belt.



Fuel Rail Assembly

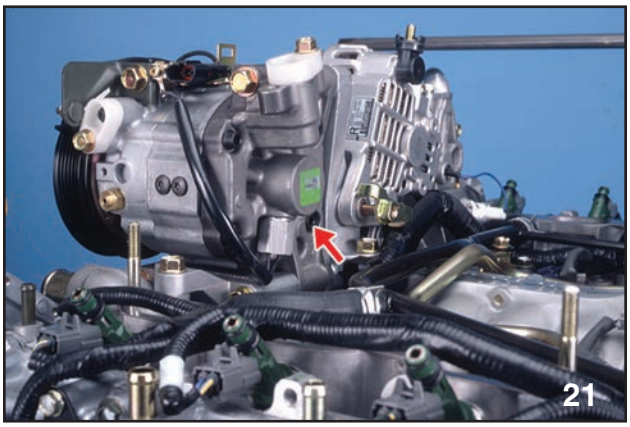
Remove the fuel rail protectors from both sides.



Lower Alternator Bolt

The lower alternator bolt must be backed out before the manifold can be removed.

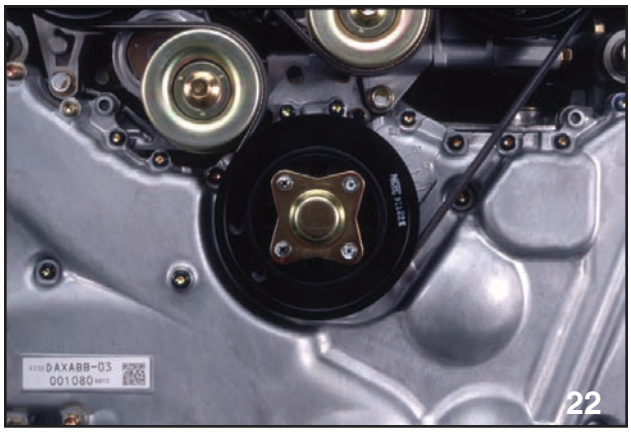
Remove the intake manifold.



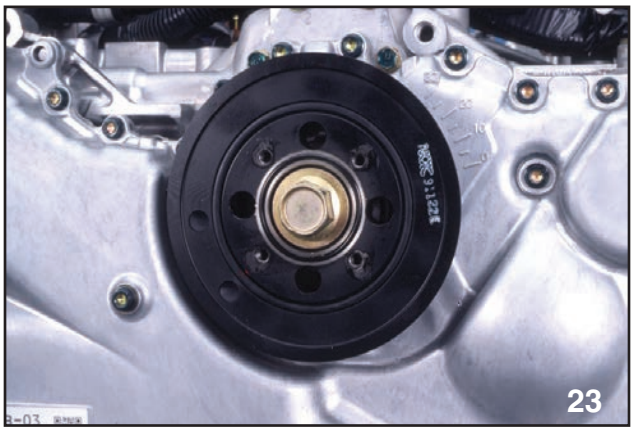
Remove Accessories

Remove the alternator, compressor and power steering pump.

Note: ***The compressor is equipped with a speed sensor that sends a signal to the ECM. If the compressor speed drops more than 20% compared to the engine speed, the ECM turns the compressor off through the A/C relay. The refrigerant must be evacuated before removing the sensor.***



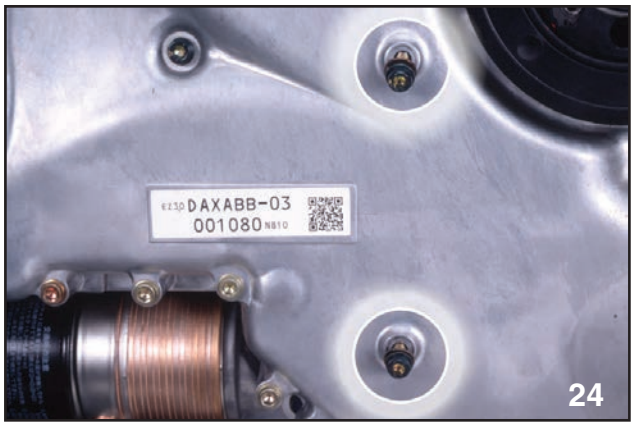
Crankshaft Bolt Cover



Crankshaft Bolt Seal

Remove the crankshaft bolt cover, bolt and harmonic balancer. Replace the O-ring that seals the crank shaft bolt cover to the harmonic balancer.

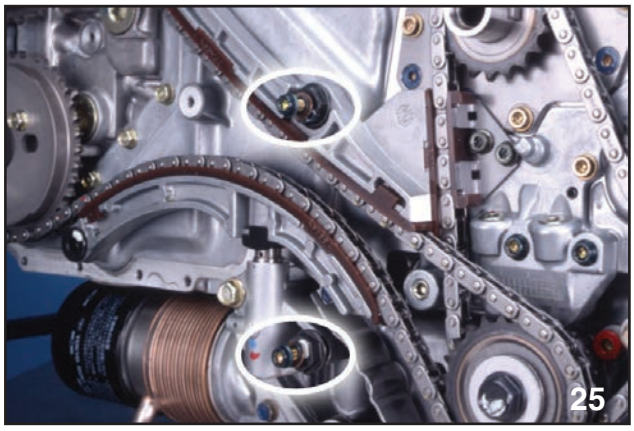
Begin removing the outer cover bolts. Keep them organized to ease reassembly. The bolts must be removed in the proper sequence to avoid warping the outer case.



Outer Cover Seals

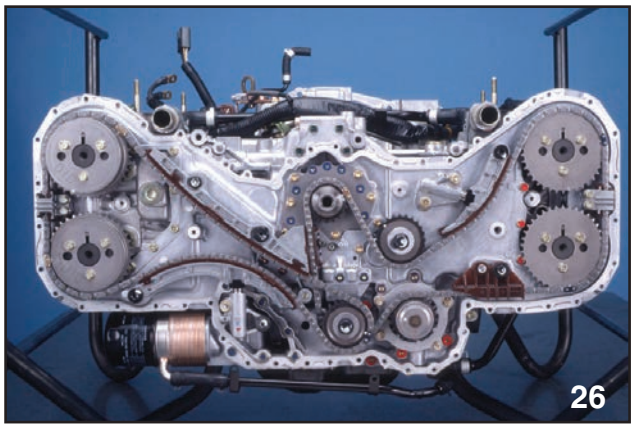
These two bolts use sealing washers to prevent engine oil from leaking to the outside.

The seals are not reusable.



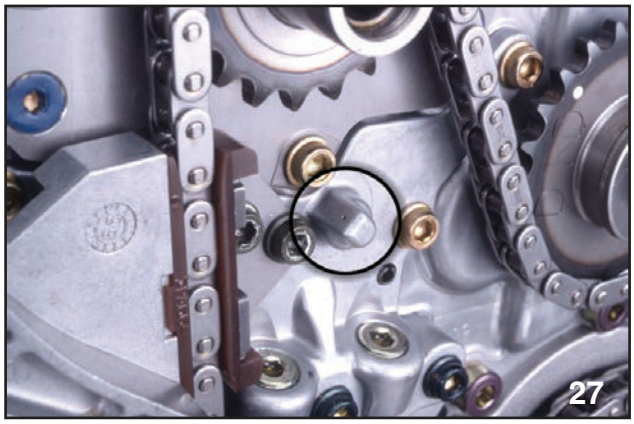
Outer Cover Bolts

The bolts circled in the above picture secure the outer cover to special bolts that have internal threads. These bolts assist with supporting the outer chain cover along the middle where there is no support from the inner case.



Timing Chain Routing

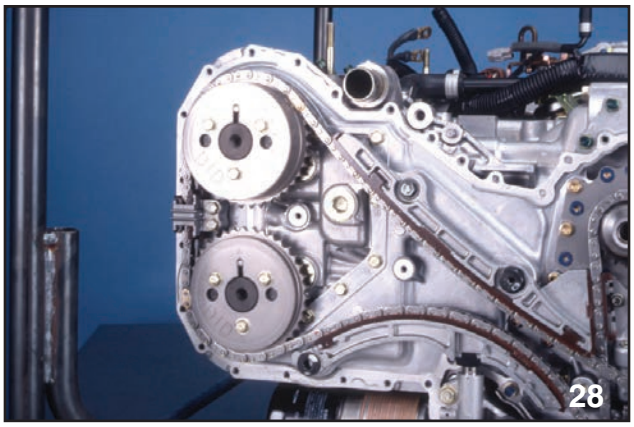
The timing chain on the EZ-3.0 is designed to last the life of the engine. Proper engine oil maintenance is necessary to ensure it lives up to its design. Two chains are used. Four (4) Camshaft sprockets, one (1) crankshaft sprocket, two (2) idler sprockets and the water pump complete the timing chain routing.



Timing Chain Oil Jet

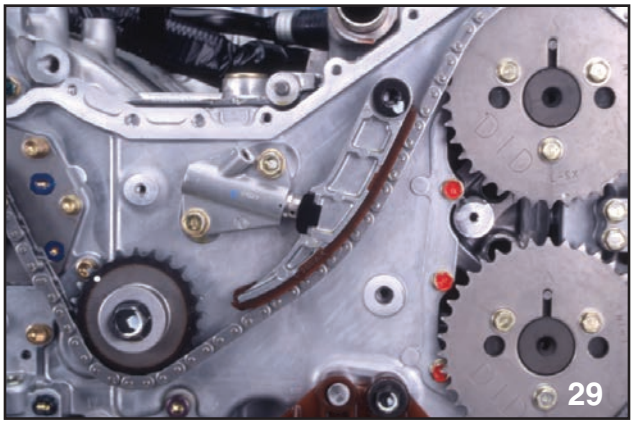
The timing chain is sprayed with oil from this jet located on the Oil Pump relief valve housing.

CAUTION: THE SPROCKET TEETH ARE SHARP SO USE EXTREME CARE WHEN WORKING NEAR THEM.



Right Bank Camshafts

The right bank Camshafts are in a loaded state when the keyways are at 12:00. They must be unloaded in the proper way to prevent damage to the pistons and valves.



Left Bank Timing Marks

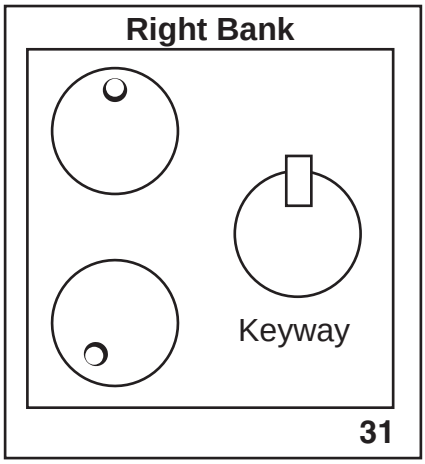
Timing marks are located on the Camshaft sprockets and the crankshaft sprocket. Marks and letters on the idlers are manufactures markings and are used only to establish which side faces outward. Do not use them to establish proper chain timing.

3.0 Liter Timing Chain Removal

Note: ***The following timing chain removal and installation procedure applies to the original 3.0 liter and 3.0 liter with VVL and VVT.***

Timing chain removal

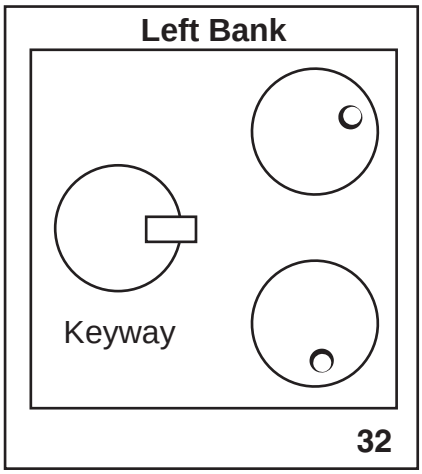
Turn the engine clockwise until the Keyway of the crankshaft and the right bank intake Camshaft timing mark are at 12:00 o'clock. The right bank exhaust Camshaft timing mark should be at 7:00 o'clock. The right bank Camshaft will now be unloaded. **The left bank is still loaded.**



Right Bank (3.0L)

Remove the right bank tensioner, chain and chain guides.

Turn the engine clockwise until the Keyway of the crankshaft is at 3:00 o'clock. The left bank intake Camshaft timing mark should be at 2:00 o'clock. The left bank exhaust Camshaft timing mark should be at almost 6:00 O'clock.

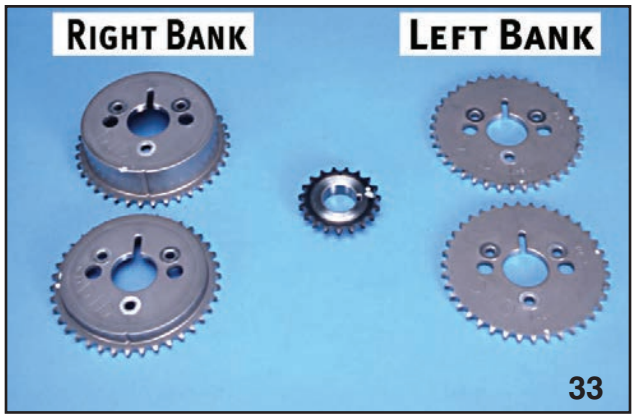


Left Bank (3.0L)

The left bank Camshafts are now unloaded. Remove the left bank tensioner, upper chain idler, chain and chain guides.

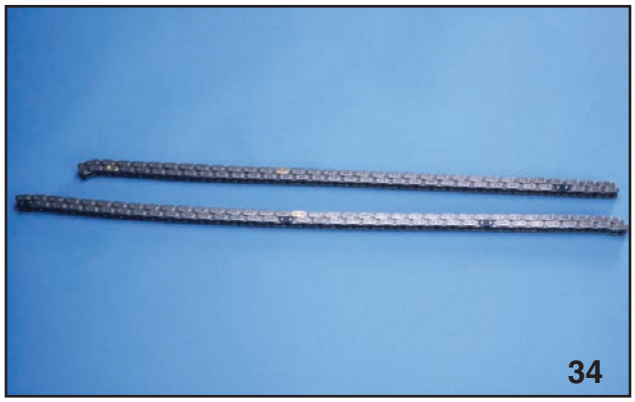
Note: ***When removing the left bank tensioner be prepared to hold the tensioner together as the spring loaded parts will try to escape from the tensioner body.***

Turn the crankshaft counter clockwise until the Keyway is at 12:00 O'clock. This will move all pistons away from top dead center and prevent accidental piston to valve contact.



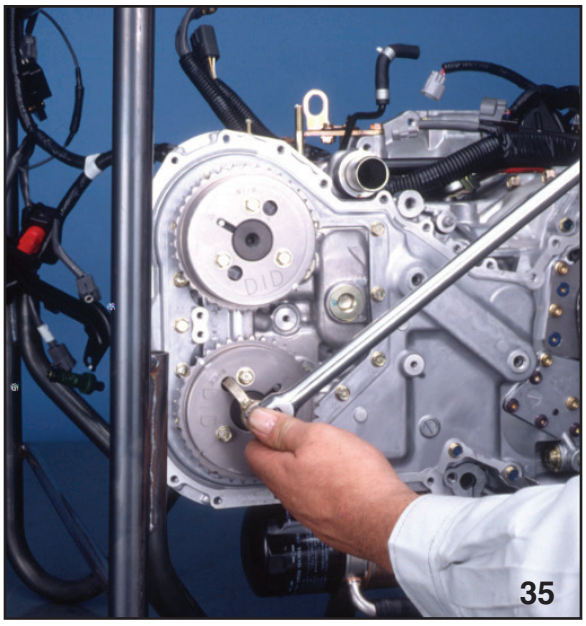
Camshaft Sprockets

The left bank Camshaft sprockets are interchangeable when new. It is recommended they be returned to their original positions to maintain wear patterns after being used.

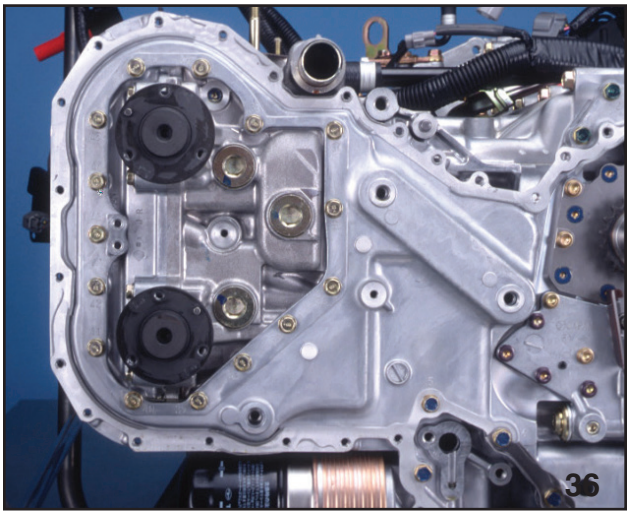


Timing Chains

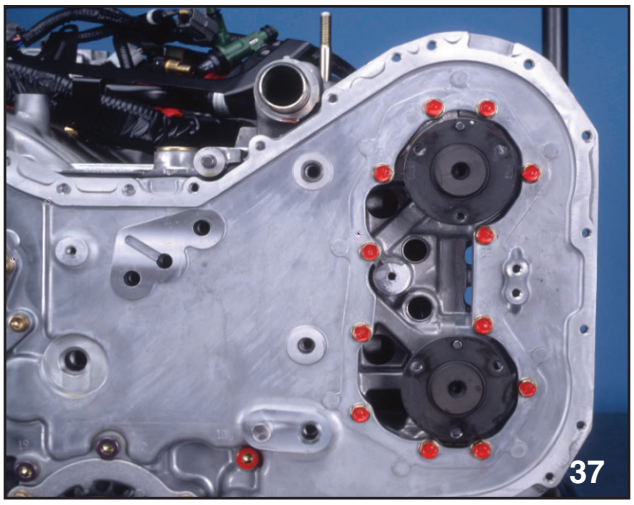
The left bank timing chain is the longer of the two with 148 links. The right chain has 134 links.



Unloading Exhaust Camshaft

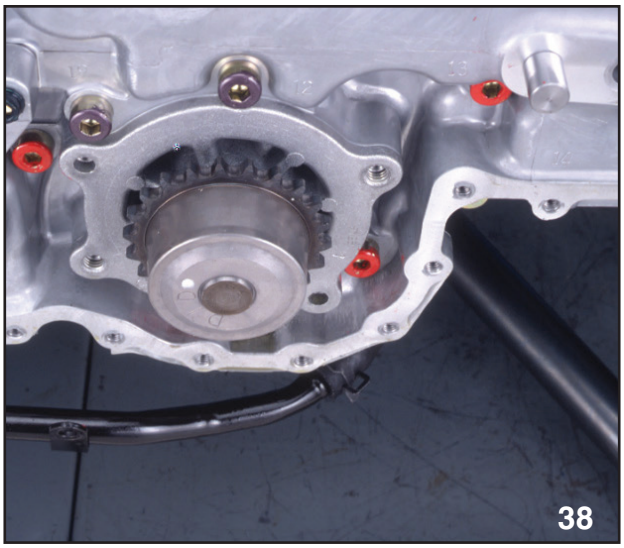


Remove Camshaft Sprockets (Right Bank)



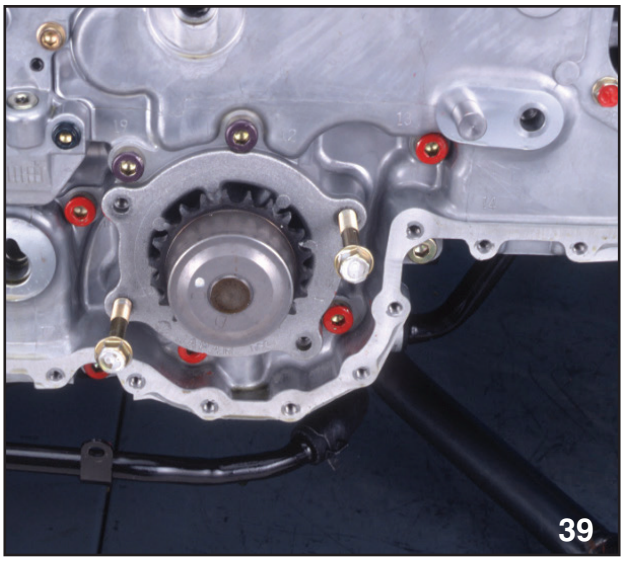
Remove Camshaft Sprockets (Left Bank)

Remove both the intake and exhaust Camshaft sprockets on the left and right banks.



Water Pump Assembly

Remove the bolts from the water pump.



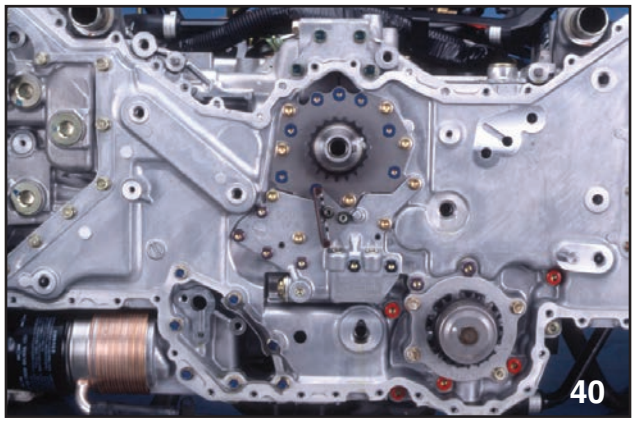
Insert Bolts for Pump Removal

Thread two eight millimeter bolts as shown and equally turn them in. This will assist with the removal of the pump.

Remove the O-ring that seals the water pump to the inner cover.

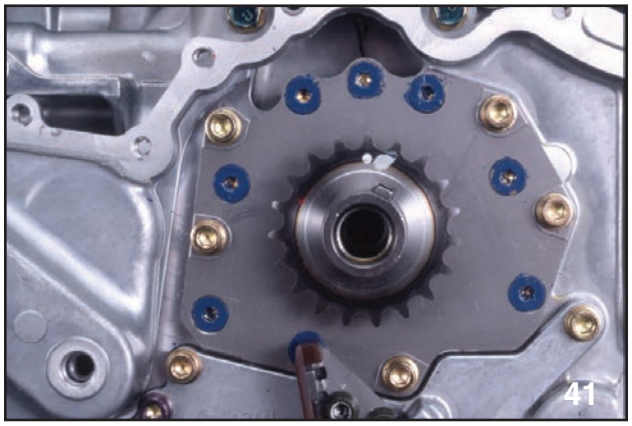
Note: Replace all O-rings during assembly.

Removal of Oil Pump



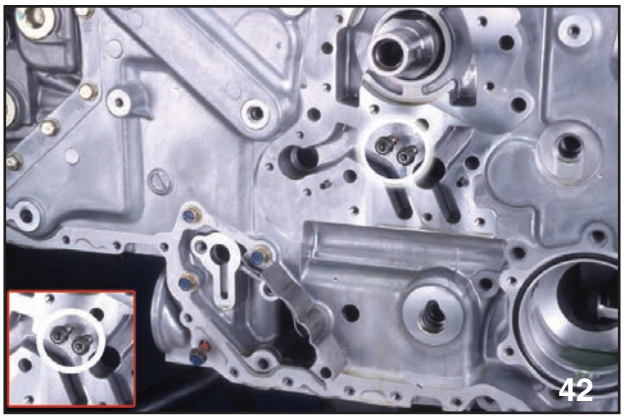
Oil Pump Cover

Remove the Oil Pump cover and Oil Pump gears.



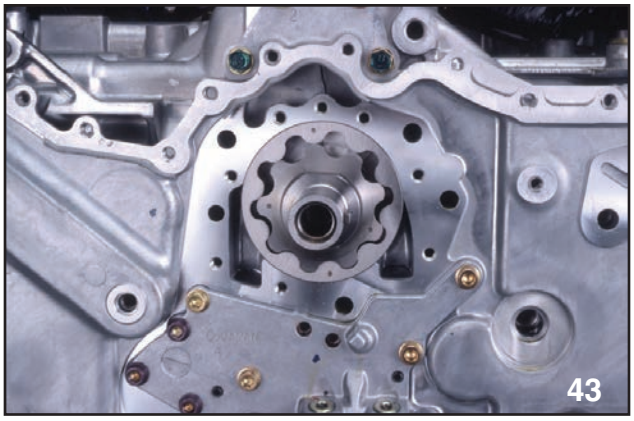
Chain Guide

Note: ***The chain guide must be removed before removing the Oil Pump cover.***



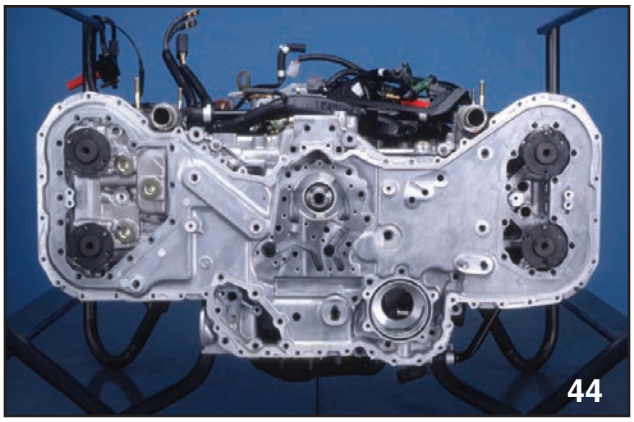
Chain Guide Bolts

The two bolts that secure the chain guide at the crankshaft pulley are pretreated with Locktite. (See insert)



Oil Relief Valve Housing

Remove the relief valve housing bolts and housing.

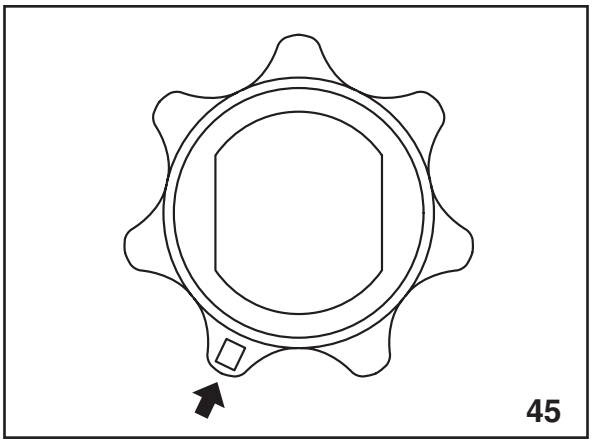


Inner Cover

Note: Please follow proper sequence.

Remove the 46 bolts that secure the inner chain cover to the engine block. The numbers are embossed on the cover and must be removed in reverse order. (Start at bolt 46)

The Oil Pump inner and outer rotors are selective. The inner timing chain cover which serves as the Oil Pump housing, is also selective. When changing these selective parts due to wear or clearance conditions always use parts with the same identification mark.



Inner Rotor

Inner rotor

Classification	Parts	Rotor thickness mm (in)
A	15015AA250	12.993 - 13.006 (0.51153 - 0.51205
None	15015AA300	12.980 - 12.993 (0.51102 - 0.51153)
C	15015AA310	12.967 - 12.980 (0.51051 - 0.51102)

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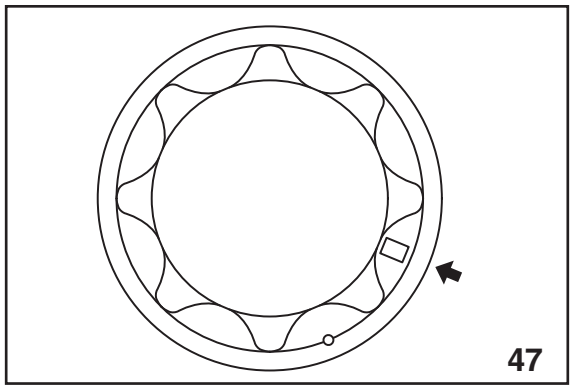
Inner Rotor Chart



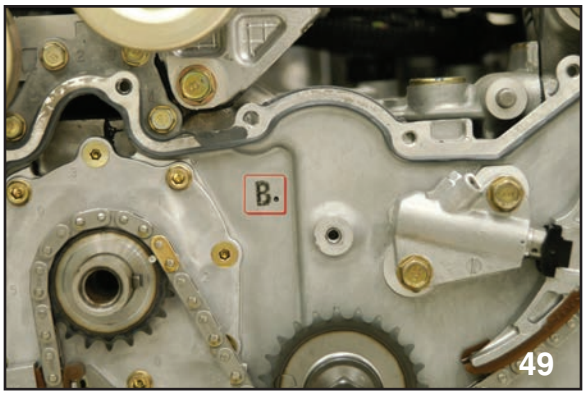
Outer Rotor

Outer rotor

Classification	Parts	Rotor thickness mm (in)
A	15016AA250	12.993 - 13.006 (0.51153 - 0.51205
None	15016AA300	12.980 - 12.993 (0.51102 - 0.51153)
C	15016AA310	12.967 - 12.980 (0.51051 - 0.51102)

48

Outer Rotor Chart



Inner Timing Chain Cover

Rear chain cover

Classification	Parts	Rotor thickness mm (in)
A	13119AA020	13.026 - 13.039 (0.51295 - 0.51335
B	13119AA050	13.013 - 13.026 (0.51232 - 0.51284)
C	13119AA060	13000 - 13.013 (0.51181 - 0.51232)

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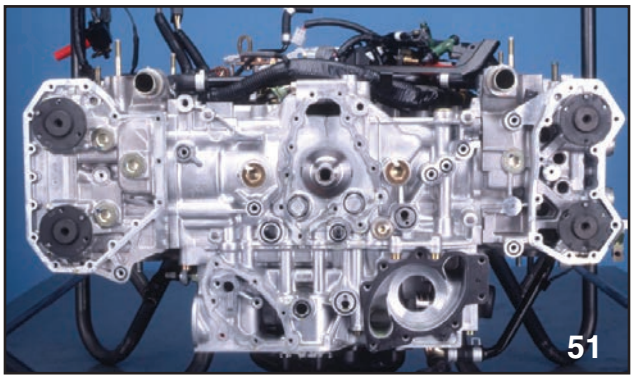
Rear Chain Cover Chart

O-ring Placement Inner Cover



O-ring Locations

Remove the inner cover and observe the location of the O-rings. There are fifteen (15) in total.

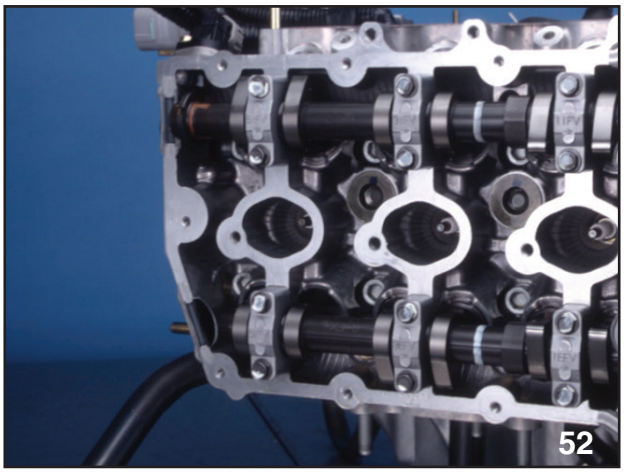
Care must be taken to ensure proper installation of all seals.

There are 6 different length bolts in this area so use care to keep them organized. Your 6 cylinder Service Manual Supplement illustrates correct order and size of the bolts.

Note: Color of rings are different from previous models observe proper placement.

Note: The paper-type water pump gasket.

Removal of Cylinder Head



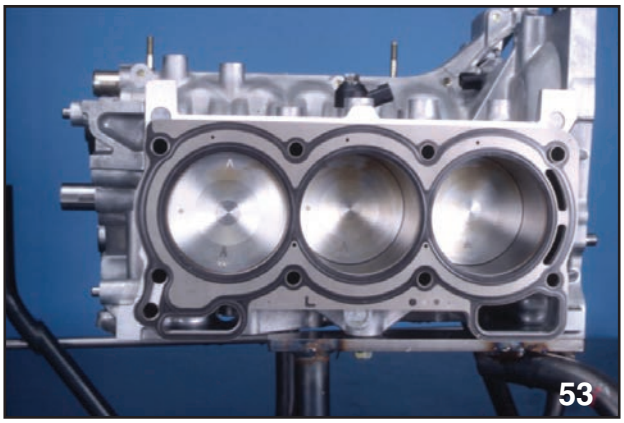
Valve Train Assembly

Note: Please follow the proper sequence. Also note they are hex design bolts.

Remove the cylinder head bolts. Use care to prevent rubbing the hex socket on the Camshafts during removal.

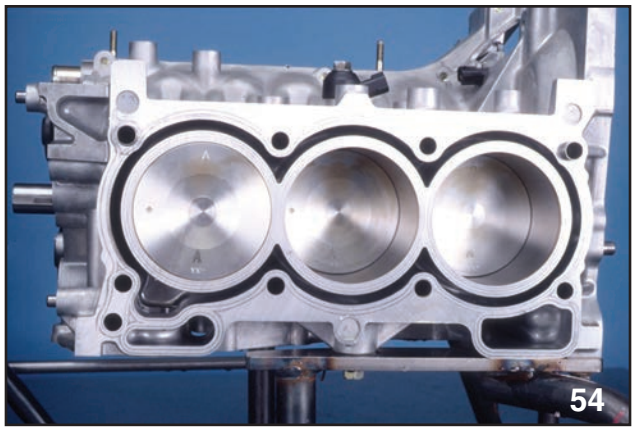
Remove the cylinder head and gasket.

Repeat this procedure on the opposite side.



Cylinder Block with Head Gasket

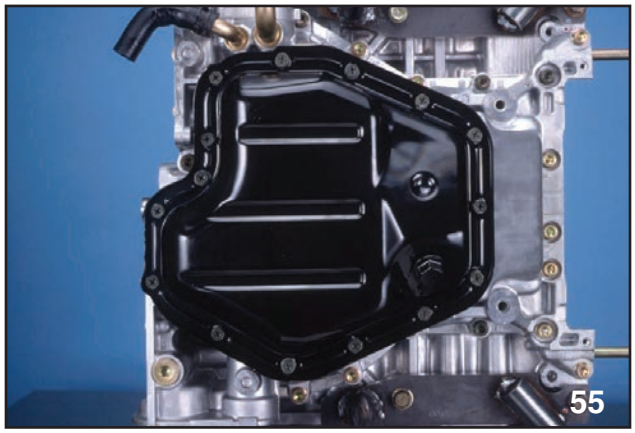
The cylinder block is made from aluminum die casting with monoblock casting cast iron cylinder liners. Water jackets are independent for the RH and LH block halves.



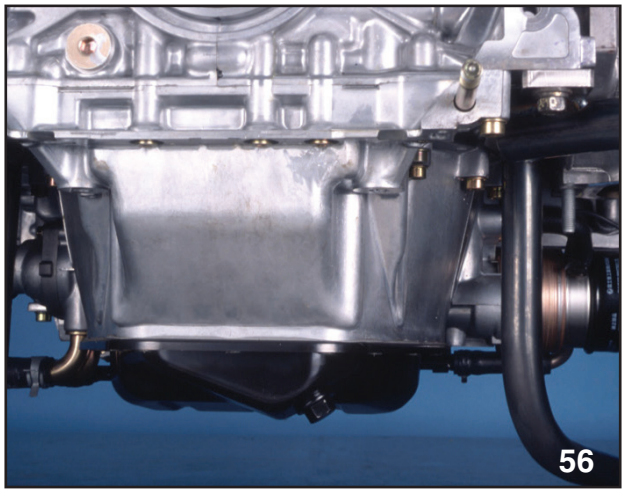
Open Deck Design

The block utilizes open deck design.

Removal of Oil Pan

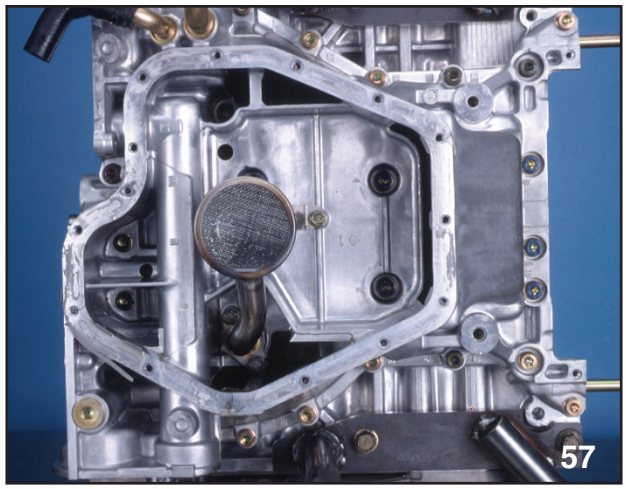


Oil Pan (Lower)



Oil Pan (Upper)

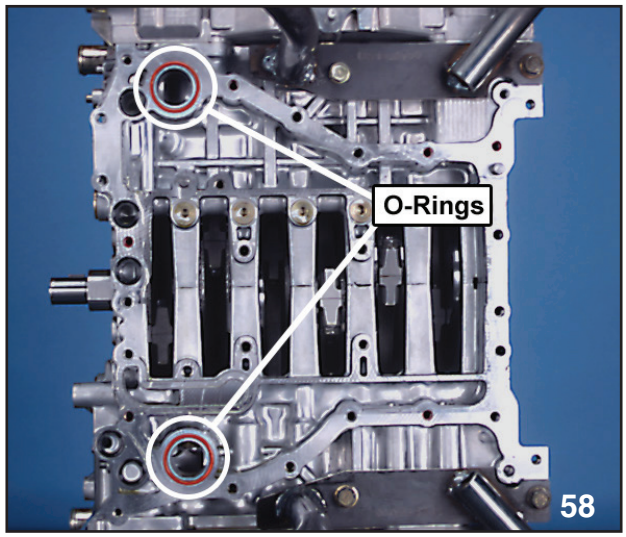
Remove the Oil Pan bolts and Oil Pan. Observe that the Oil Pan has a different design from 4 cylinder Subaru engines.



Oil Pan Bolt Locations

Note: Placement of bolts.

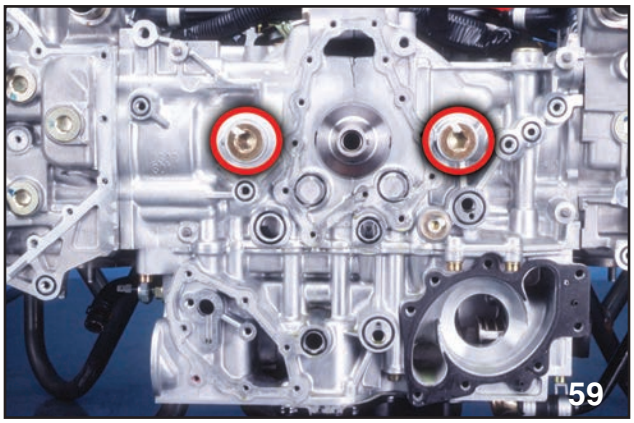
Remove the Oil Pan extension housing bolts. There are 28 bolts with five different lengths. Follow the proper sequence to prevent warping the case.



Block O-ring Locations

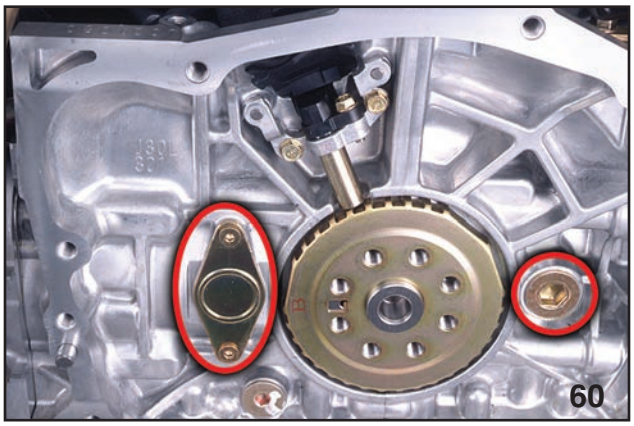
Note: Confirm placement of O-rings

Piston Pin Access



Piston Pin Access (Front View)

The piston pin access is gained from the front at these two positions.

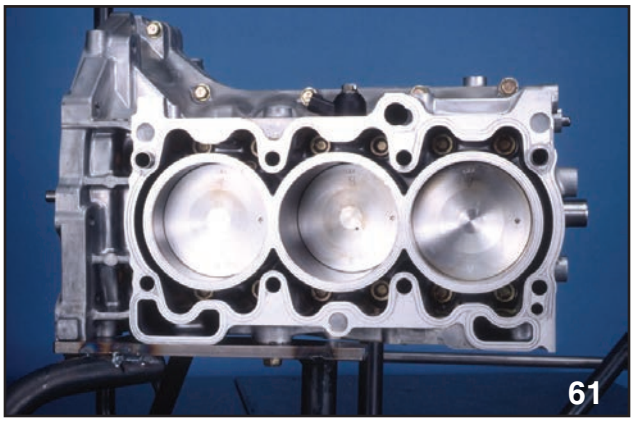


Piston Pin Access (Rear View)

Rear piston pin access is gained at these two points.

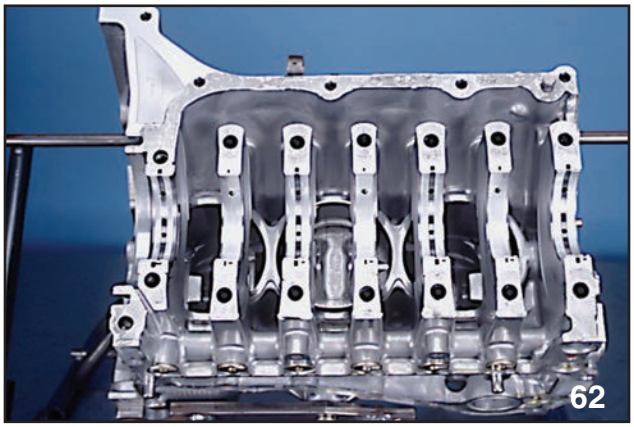
Remove the piston pins and organize them for assembly to their original positions.

Splitting Block Halves

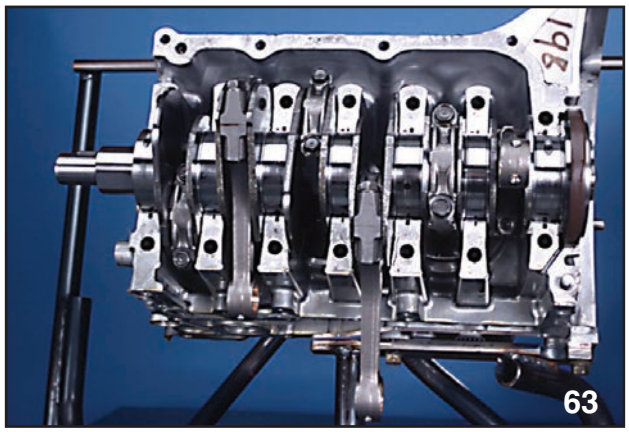


Engine Block Assembly Bolts (Right Bank)

The engine block halves are bolted together with 19 bolts. They are all located on the right bank of the engine. Remove the bolts in the proper sequence and split the engine block.

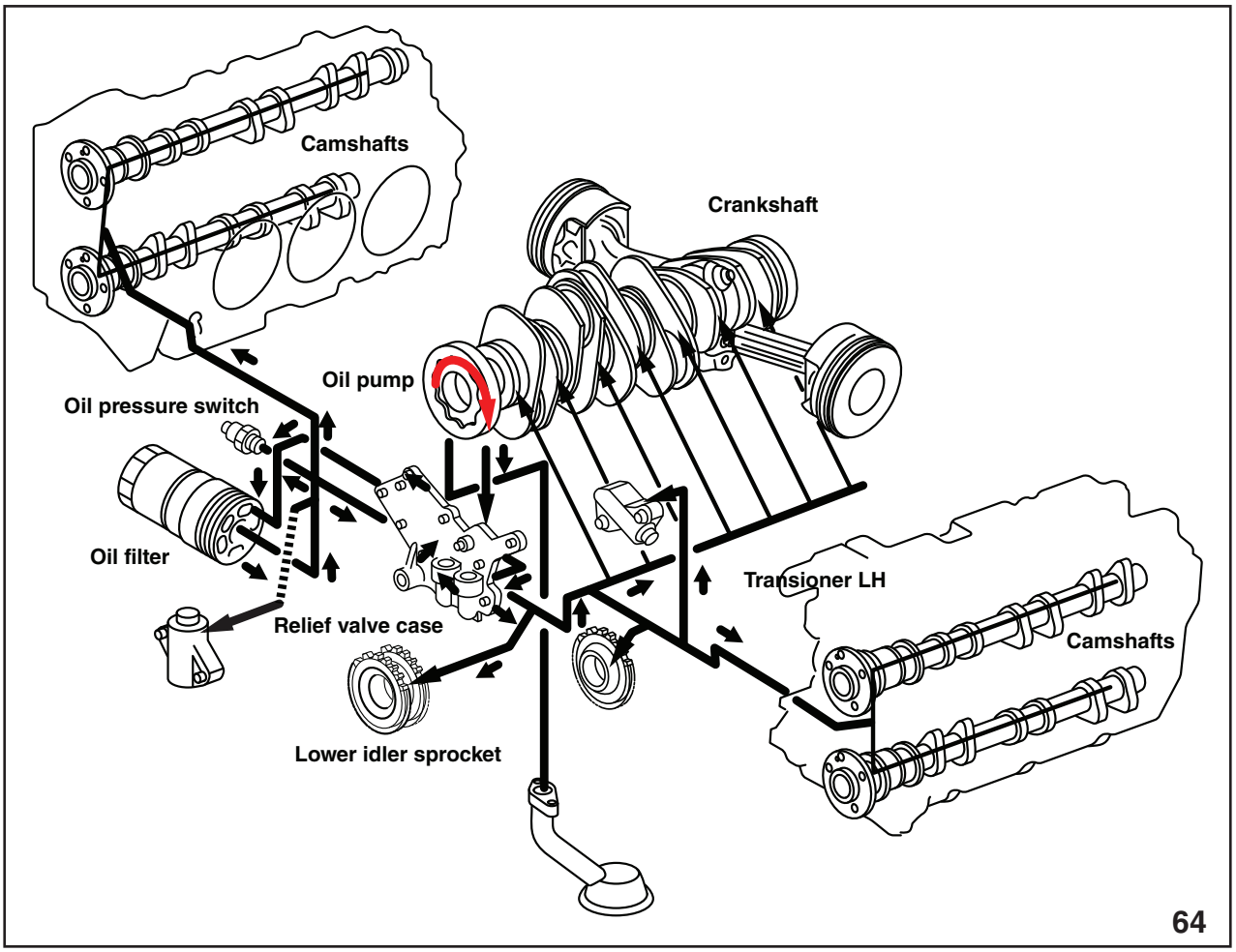


Main Bearings



Crankshaft and Connecting Rods

Lubrication System

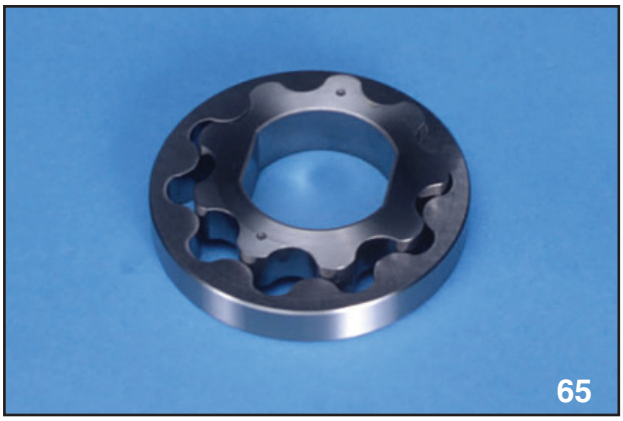


Oil Flow

Oil is drawn from the Oil Pan to the Trochoid Oil Pump and on to the following:

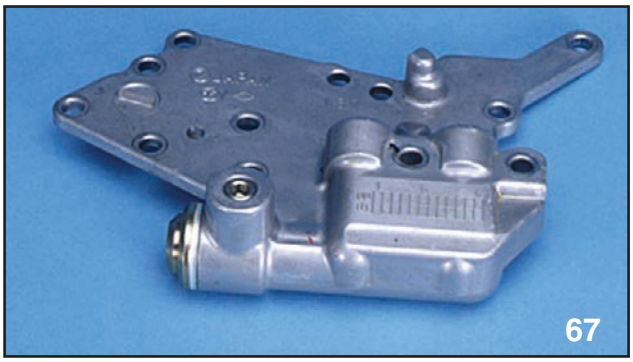
- Oil cooler and filter
- Relief valve case. (Oil pressure is regulated and oil is supplied to the oil jet that lubricates the timing chain)
- Right bank cylinder head
- Crank shaft
- Timing chain components
- Left bank cylinder head

Note: For further information consult the lubrication (LU) section of the 6 Cylinder Supplement.



Pump Gears (Front Side)

Pump Gears (Back Side)



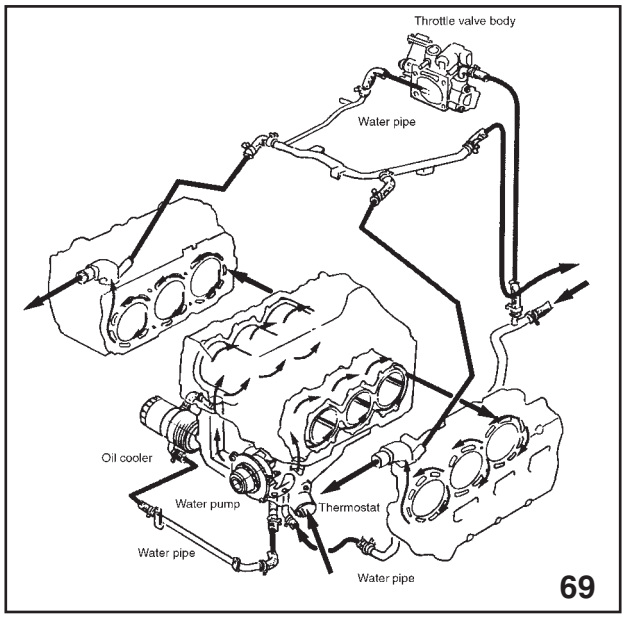
Relief Valve Case (Front Side)

Relief Valve Case (Back Side)

A new gasket must be used upon installation.

Note: ***The Screen or filter in gasket. Confirm that it is not restricted.***

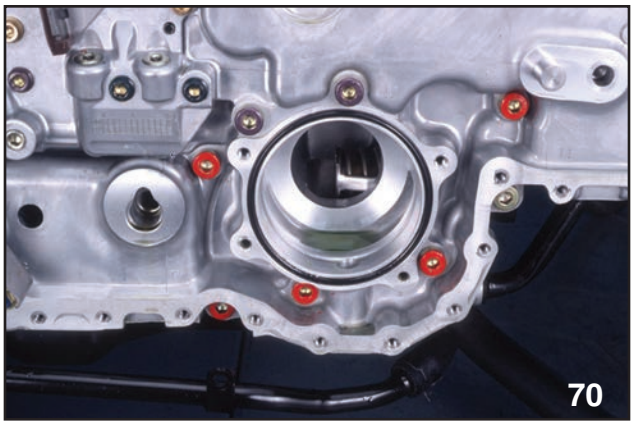
Coolant System



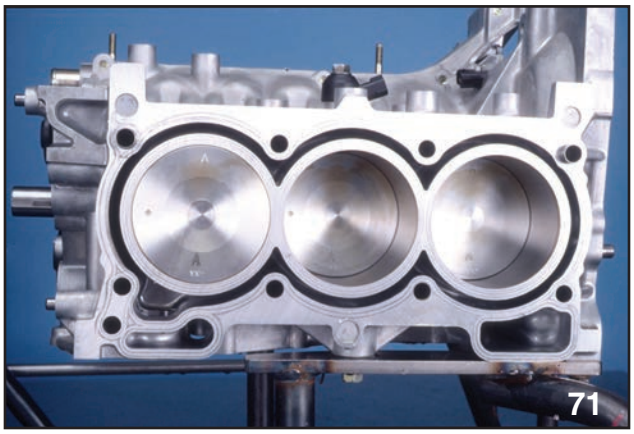
Coolant Flow

The coolant flow begins at the lower radiator hose and continues to the following:

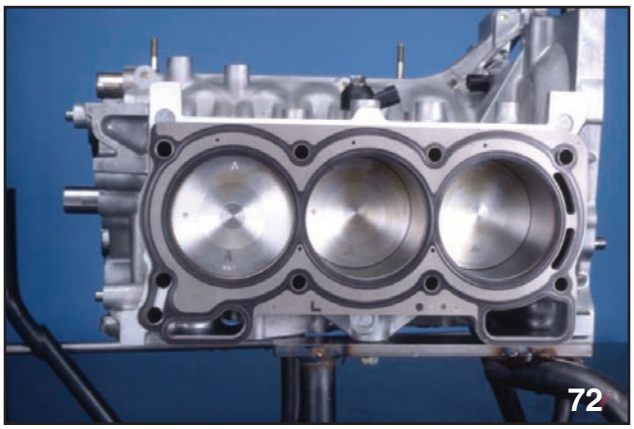
- Thermostat
- Water pump
- Internal block passages that carry coolant through the front of the block halves continuing on to the rear of the block halves.
- From around the rear cylinders of the block halves to the head gasket of the rear cylinders. A passage in the head gasket allows coolant to the cylinder heads.
- Around the cylinder heads to the upper radiator hose connections.



Water Pump Housing

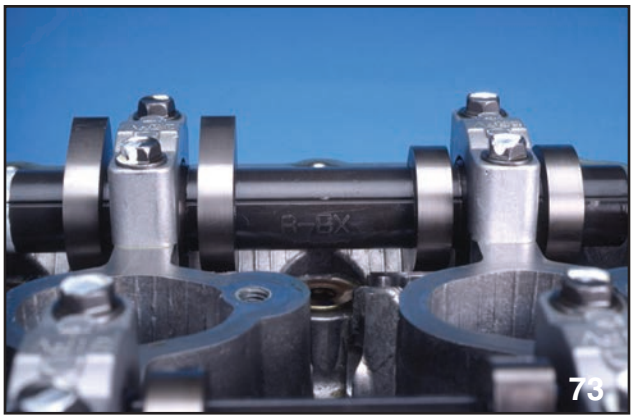


Water Jackets (Left Bank)



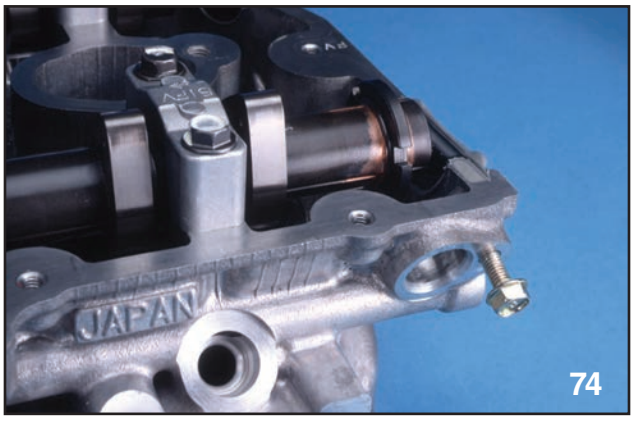
Head Gasket Coolant Passages

Note: ***For further information, consult the cooling section (CO) of the 2001 Legacy and Outback 6 Cylinder Supplement.***



Sintered Camshaft Lobes

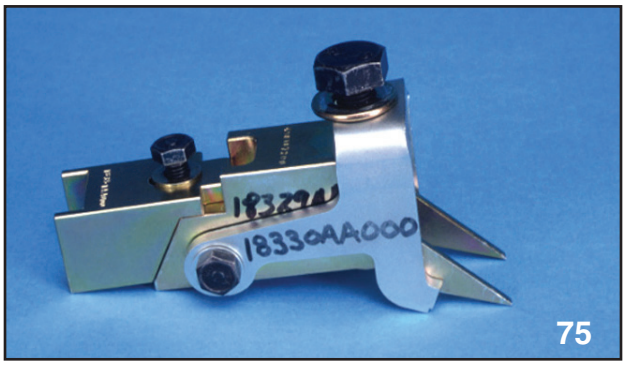
The Camshafts are composed of carbon steel pipes with Sintered metal lobes. During construction, the lobes are positioned on the pipe using a Sintered metal paste. The Camshafts are then baked until the paste is hardened. The lobes of the Camshafts are offset by 1 millimeter to rotate the Camshaft bucket and shim which will reduce wear.



Camshaft Sensor Reluctor

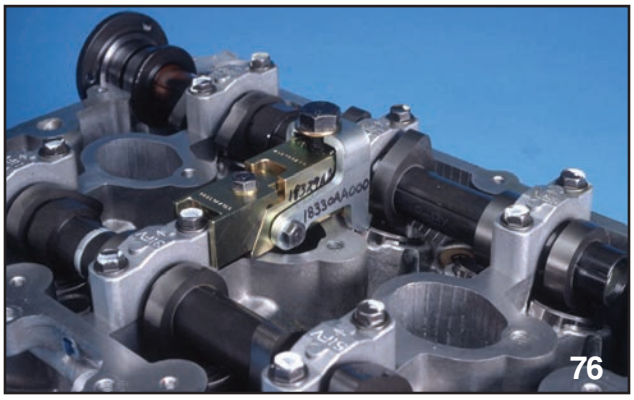
The right bank intake Camshaft has a reluctor built onto the end. The new Camshaft sensor uses this reluctor to help determine injection and ignition timing.

Valve Adjustment



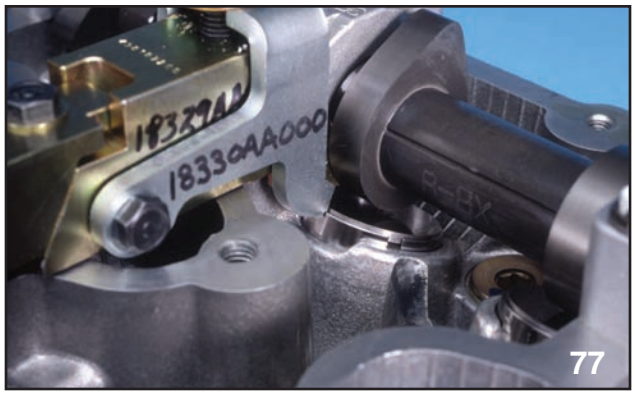
Valve Adjustment Tool

The valve adjustment procedure is the same as other DOHC Subaru engines however a new tool has been designed to work specifically on the EZ-3.0 Engine.



Valve Adjustment Tool Placement

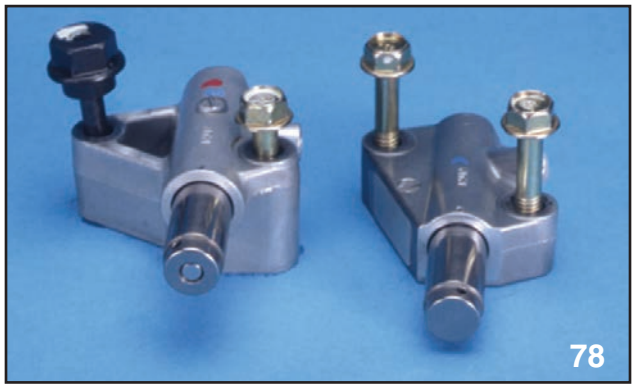
The tool is wedge fitted into place over the two shims requiring removal.



Adjusting Bucket Depression Finger

Some adjustment will be required to properly seat the bucket depression finger. Turning the top bolt pushes the fingers down allowing room for the shim to be removed.

Chain Tensioners



Chain Tensioners (Left and Right Bank)

The chain tensioners are fed oil pressure from the engine oiling system. The supplied pressure combined with spring tension keeps the timing chains operating at the correct tension.

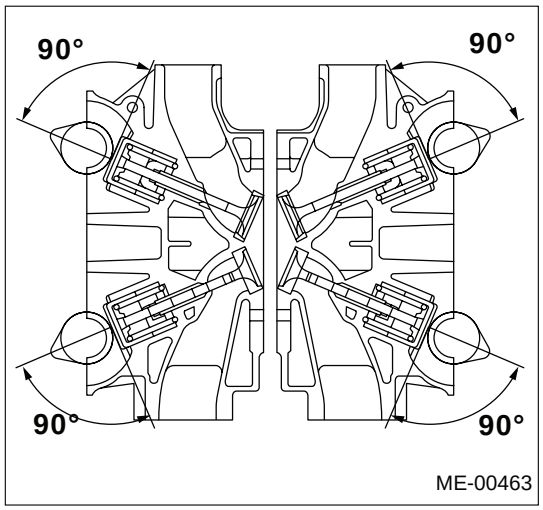
Note: Left bank and right bank tensioners are not interchangeable.

Worm Gear Assembly

The worm gear assembly and spring tension keep tension on the chains with the engine off, eliminating any tension problems that could occur during engine start up.

The tensioners are turned in by hand for reassembly. Observe the order of the worm gear assemble. Make sure your hands are dry when depressing the tensioners. A rivet or large paper clip will hold tensioner in place. Do not use a press to depress tensioner.

3.0 Liter Valve Clearance Adjustment- 2001~2004



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Valve Arrangement

1. Measure intake valve and exhaust valve clearances by using thickness gauge (A).

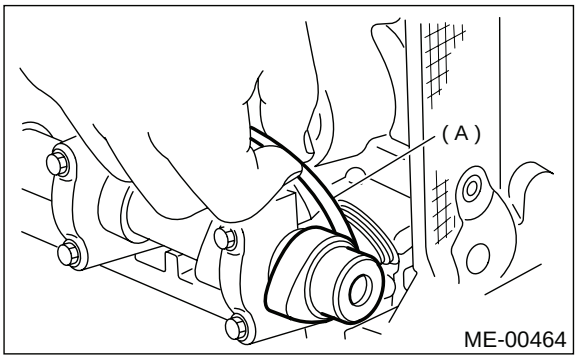
CAUTION: INSERT THE THICKNESS GAUGE IN AS HORIZONTAL A DIRECTION AS POSSIBLE WITH RESPECT TO THE SHIM.

Valve clearance:

INTAKE: 0.20 +0.04/0.06 MM (0.0079 +0.0016/ 0.0024 IN)

EXHAUST: 0.25 0.05 MM (0.0098 0.0020 IN)

NOTE: IF THE MEASURED VALUE IS NOT WITHIN SPECIFICATION, TAKE NOTES OF THE VALUE IN ORDER TO ADJUST THE VALVE CLEARANCE LATER ON.



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Measuring Valve Clearance

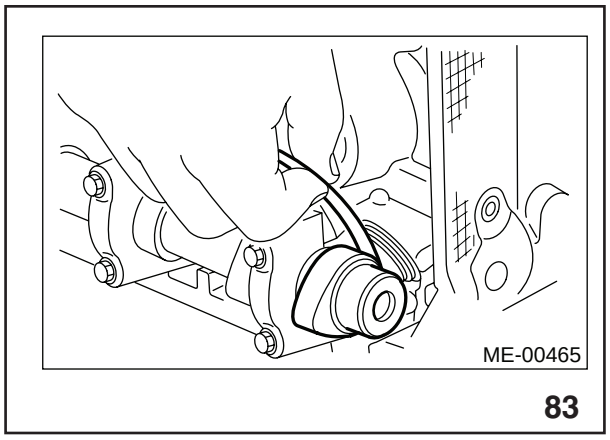
2. If necessary, adjust the valve clearance. <Ref. to ME(H6DO), ADJUSTMENT, Valve Clearance.>
3. Further turn crankshaft pulley clockwise. Using the same procedure described previously, then measure valve clearances again.
4. After inspection, install the related parts in the reverse order of removal.

Adjustment

CAUTION: ADJUSTMENT OF VALVE CLEARANCE SHOULD BE PERFORMED WHILE ENGINE IS COLD.

1. Measure all valve clearances. <Ref. to ME(H6D0), INSPECTION, Valve clearance.>

Note: Record each valve clearance after it has been measured.



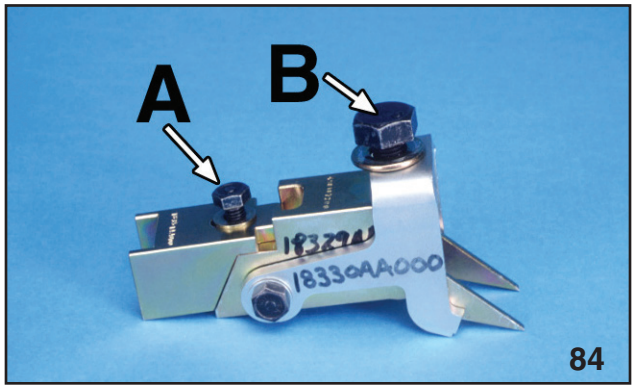
Measuring Valve Clearance

2. Remove shim from valve lifter.

   (1) Prepare the ST.

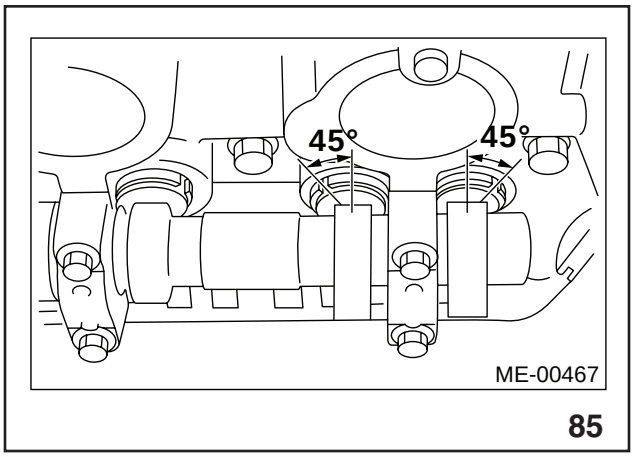
   ST 18329AA000 SHIM REPLACER

   <Ref. to ME(H6D0), PREPARATION TOOL, General Description.>



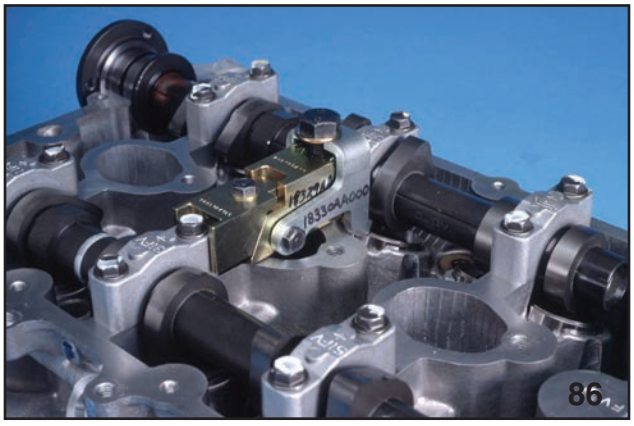
Valve Adjustment Tool

   (2) Rotate the notch of the valve lifter outward by 45°.



Shim Replacer Notch

   (3) Adjust SHIM REPLACER notch to valve lifter and set it.

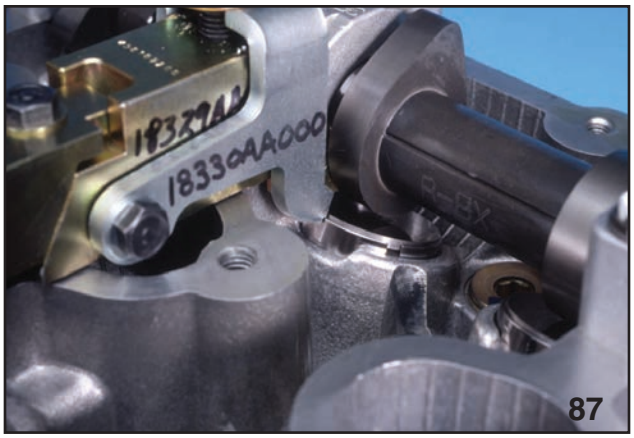


Valve Adjustment Tool Placement

NOTE: When setting, be careful SHIM REPLACER edge does not touch shim.

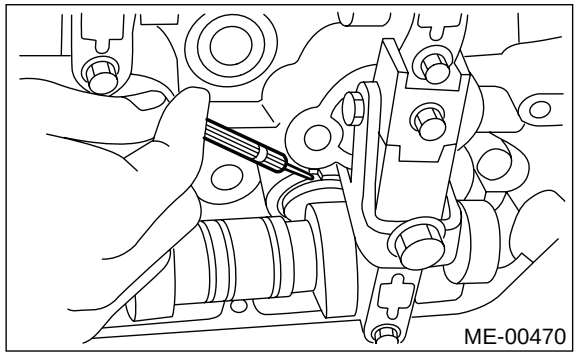
   (4) Tighten bolt (A) and install it to the cylinder head.

   (5) Tighten bolt (B) and insert the valve lifter.



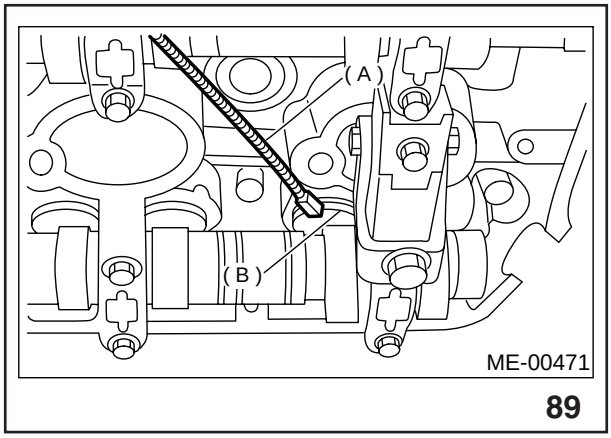
Adjusting Bucket Depression Finger

(6) Insert tweezers into the notch of the valve lifter, and take the shim out.

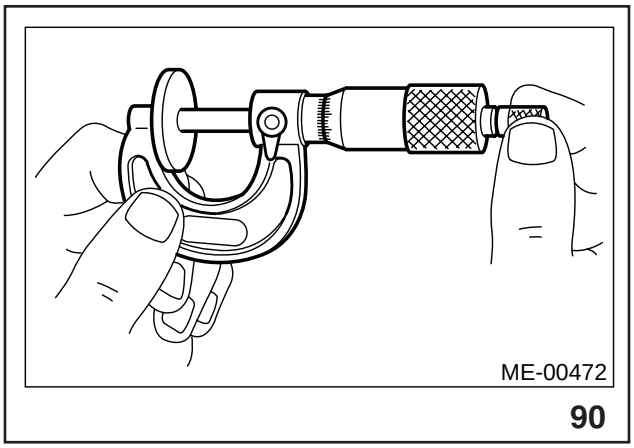


Use of Magnet

Note: By using a magnet (A), the shim (B) can be taken out without dropping it.



Shim Placement



Micrometer

3. Measure thickness of shim with micrometer.
4. Select a shim of suitable thickness using measured valve clearance and shim thickness, by referring to the following table.
5. Set suitable shim selected in step 4 to valve lifter.

Unit: mm
Intake valve: S = (V + T) - 0.20 Exhaust valve: S = (V + T) - 0.25
S: Shim thickness to be used V: Measured valve clearance T: Current Shim thickness

Part No.	Thickness mm (in)
13218AK010	2.00 (0.0787)
13218AK020	2.02 (0.0795)
13218AK030	2.04 (0.0803
13218AK040	2.06 (0.0811)
13218AK050	2.08 (0.0819)
13218AK060	2.10 (0.0827)
13218AK070	2.12 (0.0835)
13218AK080	2.14 (0.0843)
13218AK090	2.16 (0.0850)
13218AK100	2.18 (0.0858)
13218AK110	2.20 (0.0866)
13218AE710	2.22 (0.0874)
13218AE720	2.23 (0.0878
13218AE730	2.24 (0.0882)
13218AE740	2.25 (0.0886)
13218AE750	2.26 (0.0890)
13218AE760	2.27 (0.0894)
13218AE770	2.28 (0.0898)
13218AE780	2.29 (0.0902)
13218AE790	2.30 (0.0906)
13218AE800	2.31 (0.0909)
13218AE810	2.32 (0.0913)
13218AE820	2.33 (0.0917)
13218AE830	2.34 (0.0921)
13218AE840	2.35 (0.0925)
13218AE850	2.36 (0.0929)
13218AE860	2.37 (0.0933)
13218AE870	2.38 (0.0937)
13218AE880	2.39 (0.0941)
13218AE890	2.40 (0.0945)
13218AE900	2.41 (0.0949)
13218AE910	2.42 (0.0953)
13218AE920	2.43 (0.0957)
13218AE930	2.44 (0.0961)
13218AE940	2.45 (0.0965)
13218AE950	2.46 (0.0969)
13218AE960	2.47 (0.0972)
13218AE970	2.48 (0.0976)
13218AE980	2.49 (0.0980)

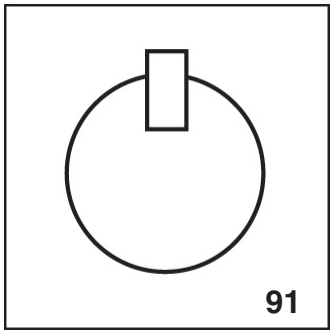
Part No.	Thickness mm (in)
13218AE990	2.50 (0.0984)
13218AF000	2.51 (0.0988)
13218AF010	2.52 (0.0992)
13218AF020	2.53 (0.0996)
13218AF030	2.54 (0.1000)
13218AF040	2.55 (0.1004)
13218AF050	2.56 (0.1008)
13218AF060	2.57 (0.1012)
13218AF070	2.58 (0.1016)
13218AF090	2.60 (0.1024)
13218AF100	2.61 (0.1028)
13218AF110	2.62 (0.1031)
13218AF120	2.63 (0.1035)
13218AF130	2.64 (0.1039)
13218AF140	2.65 (0.1043)
13218AF150	2.66 (0.1047)
13218AF160	2.67 (0.1051)
13218AF170	2.68 (0.1055)
13218AF180	2.69 (0.1059)
13218AF190	2.70 (0.1063)
13218AF200	2.71 (0.1067)
13218AF210	2.72 (0.1071)
13218AF220	2.73 (0.1075)
13218AF230	2.74 (0.1079)
13218AF240	2.75 (0.1083)
13218AF250	2.76 (0.1087)
13218AF260	2.77 (0.1091)
13218AF270	2.78 (0.1094)
13218AF280	2.79 (0.1098)
13218AF290	2.80 (0.1102)
13218AF300	2.81 (0.1106)

6. Inspect all valves for clearance again at this stage. If the valve clearance is not correct, repeat the procedure over again from the first step.

7. After inspection, install the related parts in the reverse order of removal.

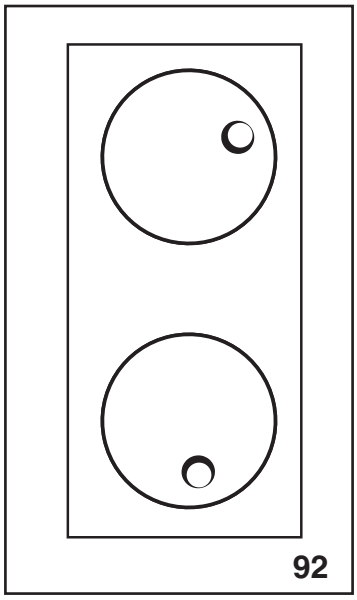
Timing Chain Installation

Confirm the crankshaft keyway is at 12:00.



Keyway 12:00 O'clock

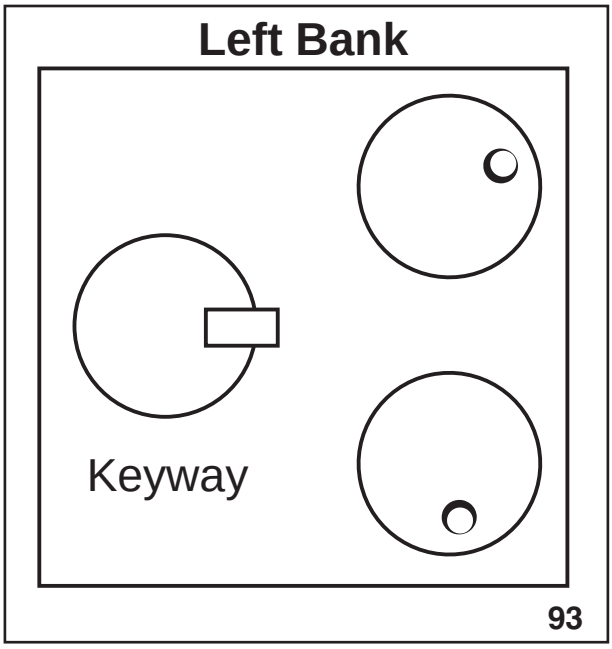
Position the left bank intake Camshaft timing mark at 2:00 O'clock and the left bank exhaust Camshaft timing mark at 6:00 O'clock.



Timing Chain Installation Configuration

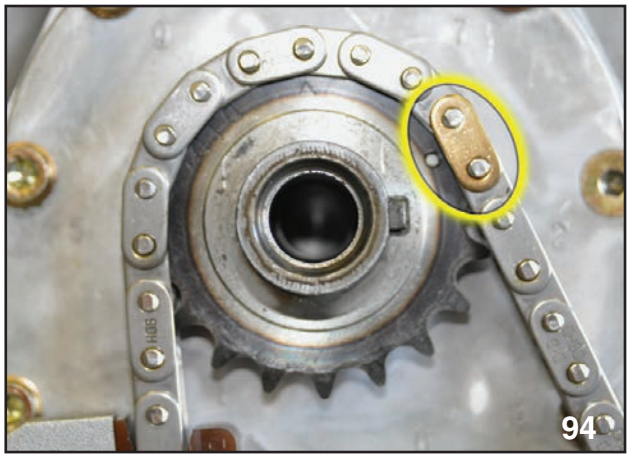
Turn the crankshaft clockwise until the keyway is at 3:00 O'clock.

Note: ***Camshaft timing marks and alignment marks are not the same.***



3.0L Left Bank

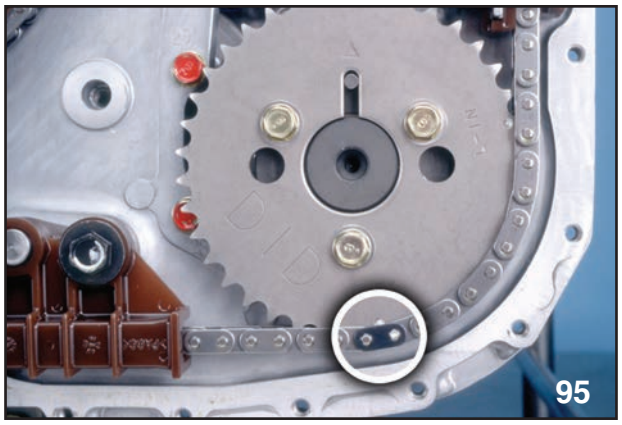
Locate the gold colored link of the left bank timing chain. Place the gold link over the timing mark of the crankshaft sprocket.



Gold Colored Link Timing Chain

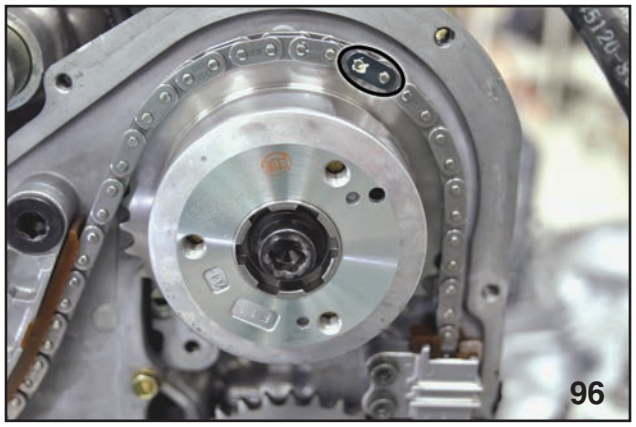
Position the chain over the lower idler and over the water pump.

Place the black colored link over the timing mark of the left bank exhaust Camshaft sprocket.



Left Bank Exhaust

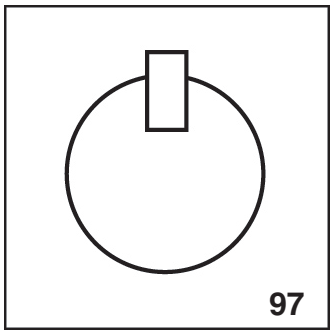
Place the other black link over the left bank intake Camshaft sprocket timing mark.



Left Bank Intake Camshaft

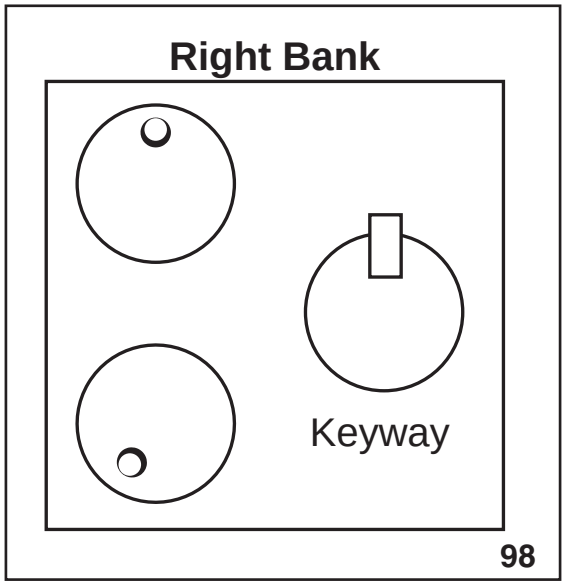
Install the upper idler, chain guides and tensioner. Check all timing marks and pull the pin on the tensioner.

Turn the crankshaft counterclockwise until the keyway is at 12:00 O'clock.



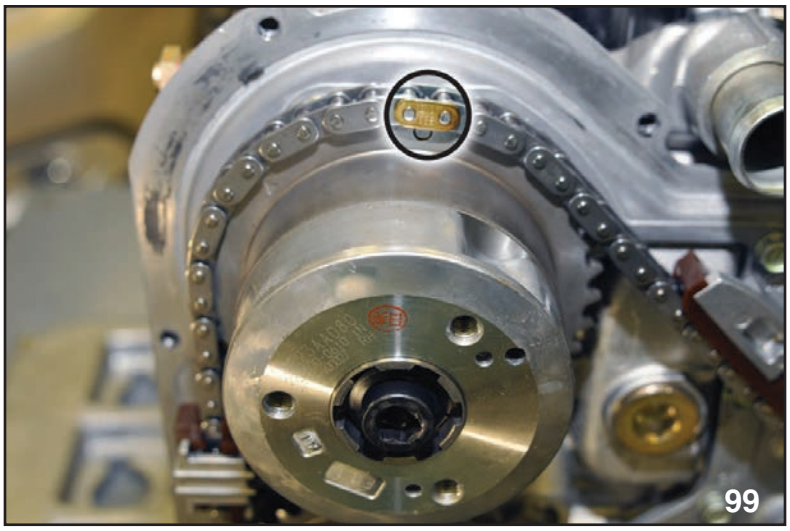
Keyway 12:00 O'clock

The right bank intake Camshaft timing mark must be at 12:00 O'clock. The right bank exhaust Camshaft timing must be at 7:00 O'clock.

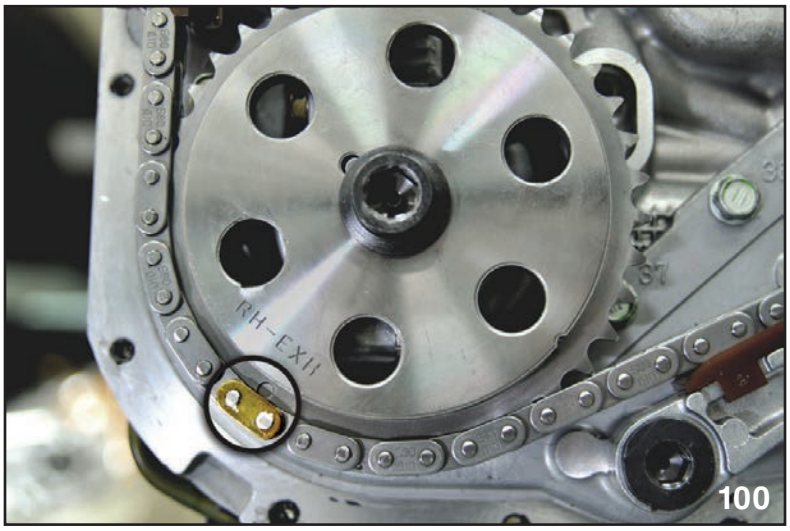


3.0L Right Bank

Locate the two gold colored links of the right bank timing chain and position these two marks over the timing marks of the right bank intake and exhaust Camshaft sprocket timing marks.



Right Bank Intake

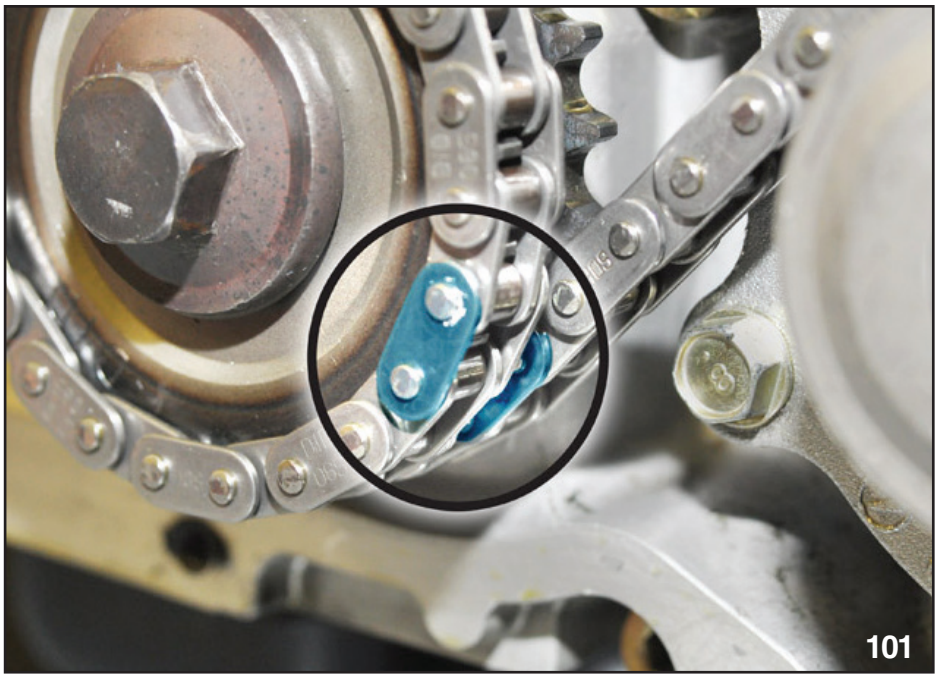


Right Bank Exhaust

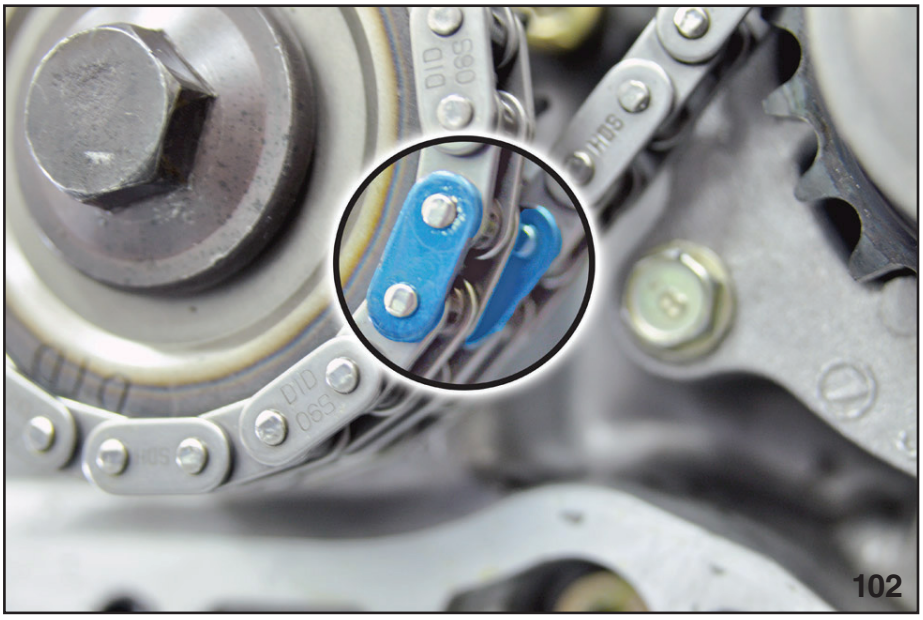
Working from the top side of the chain, route the chain over the lower idler. Install the chain guides and tensioner. **Do not pull the pin.**

Slowly turn the engine clockwise until the black colored links of the two chains come together. The right bank link must be directly over the left bank link.

If the two links are not directly over each other, turn the engine counterclockwise until the crankshaft Keyway is at 12:00 O'clock.



Showing Wrong Line up



Links should look like this (Lined up right)

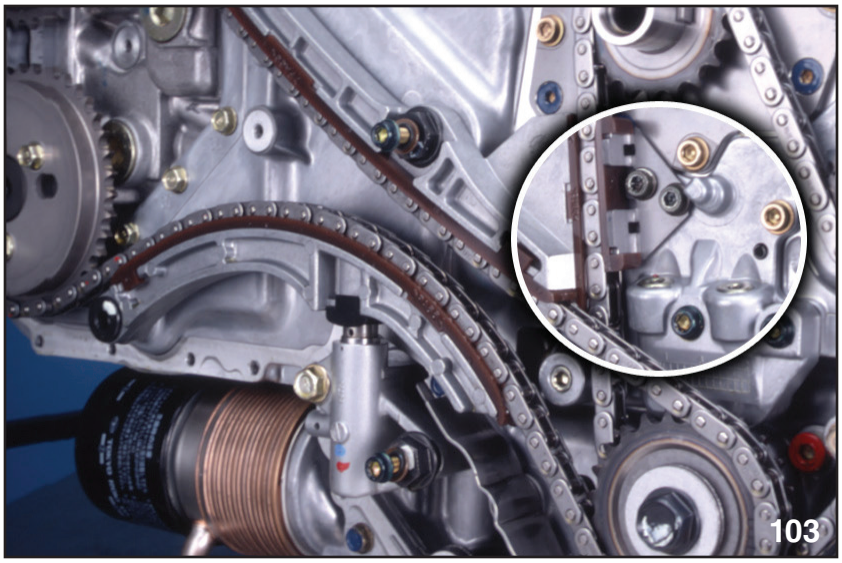
Note: Determine if the chain needs to move forward or backward one tooth.

Remove the tensioner from the right bank and move the chain as needed. It may be necessary to rotate the crankshaft in the direction needed to obtain link over link timing.

Install the tensioner and slowly rotate the engine clockwise until the right bank link is directly over the left bank. Re-check all timing marks.

Pull the pin on the tensioner. Make one more inspection of all timing marks.

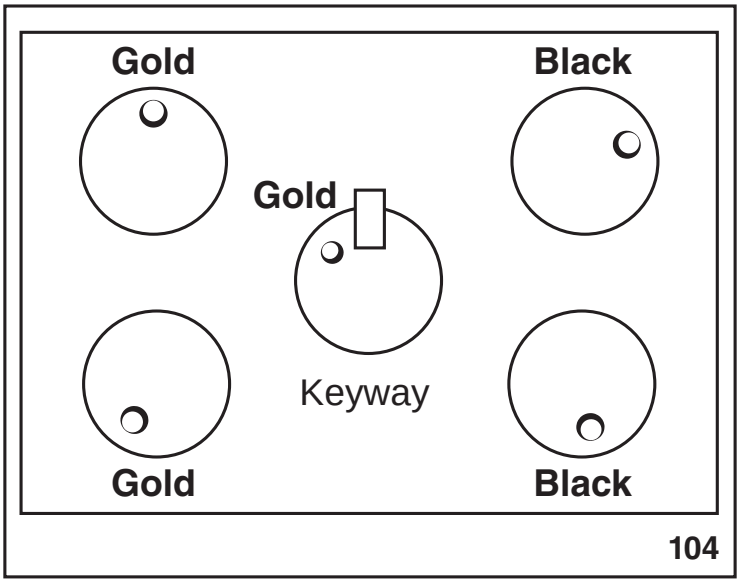
Note: ***It is critical that timing marks are confirmed to be correct. If the marks are off more than 1 (one) tooth on the intake or 2 (two) teeth on the exhaust, valve and piston damage will occur.***



Chain Guides and Idlers (3.0L Right Bank)

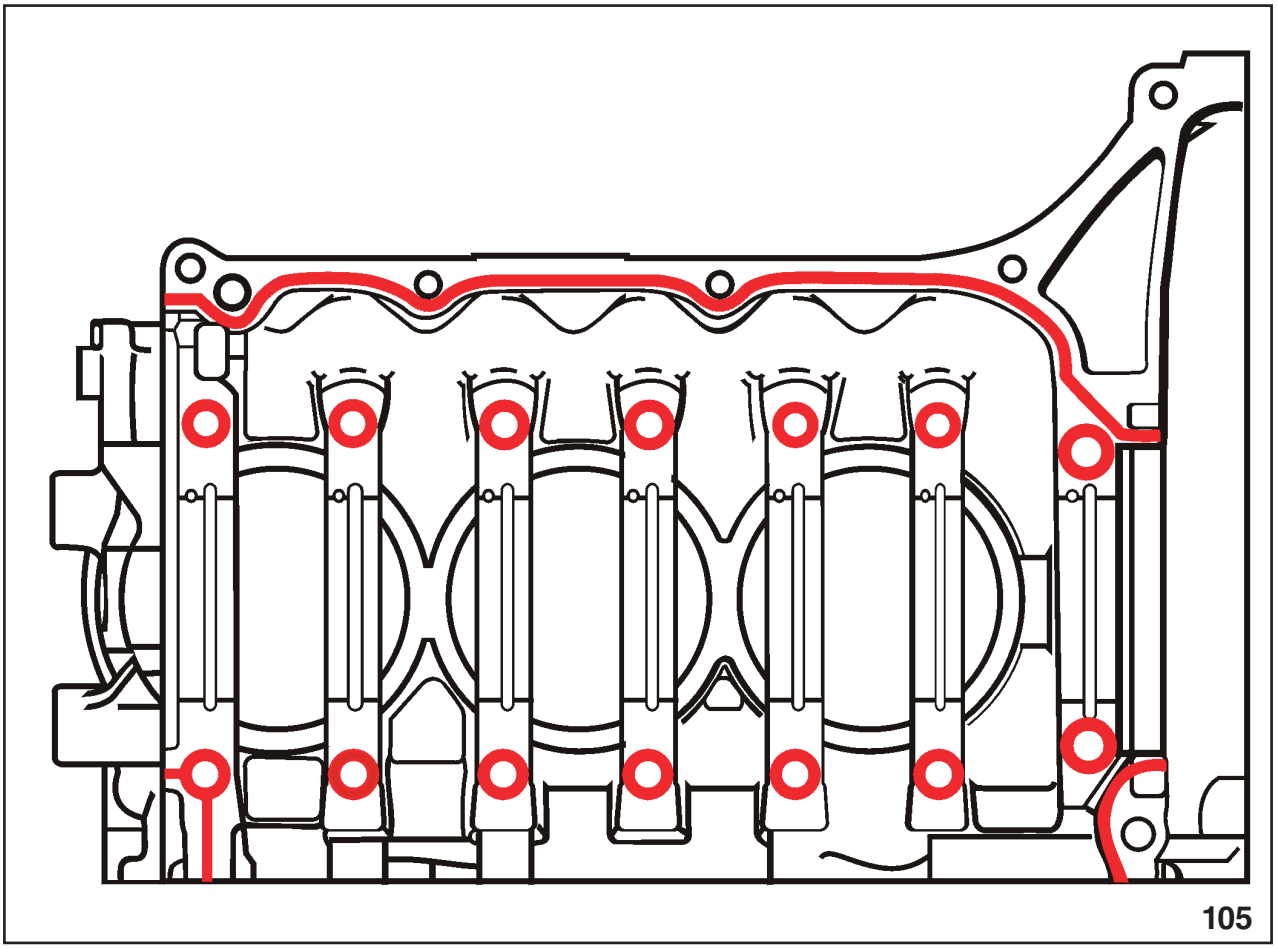
Note: ***The chain guide located on the oil pressure relief housing must be adjusted AS CIRCLED ABOVE.***

Follow procedures in the appropriate Subaru Service Manual on the STIS web site, during reassembly and for checking chain guide clearances.



Showing Positions

FUJI BOND APPLICATION GUIDE FOR BLOCK HALVES

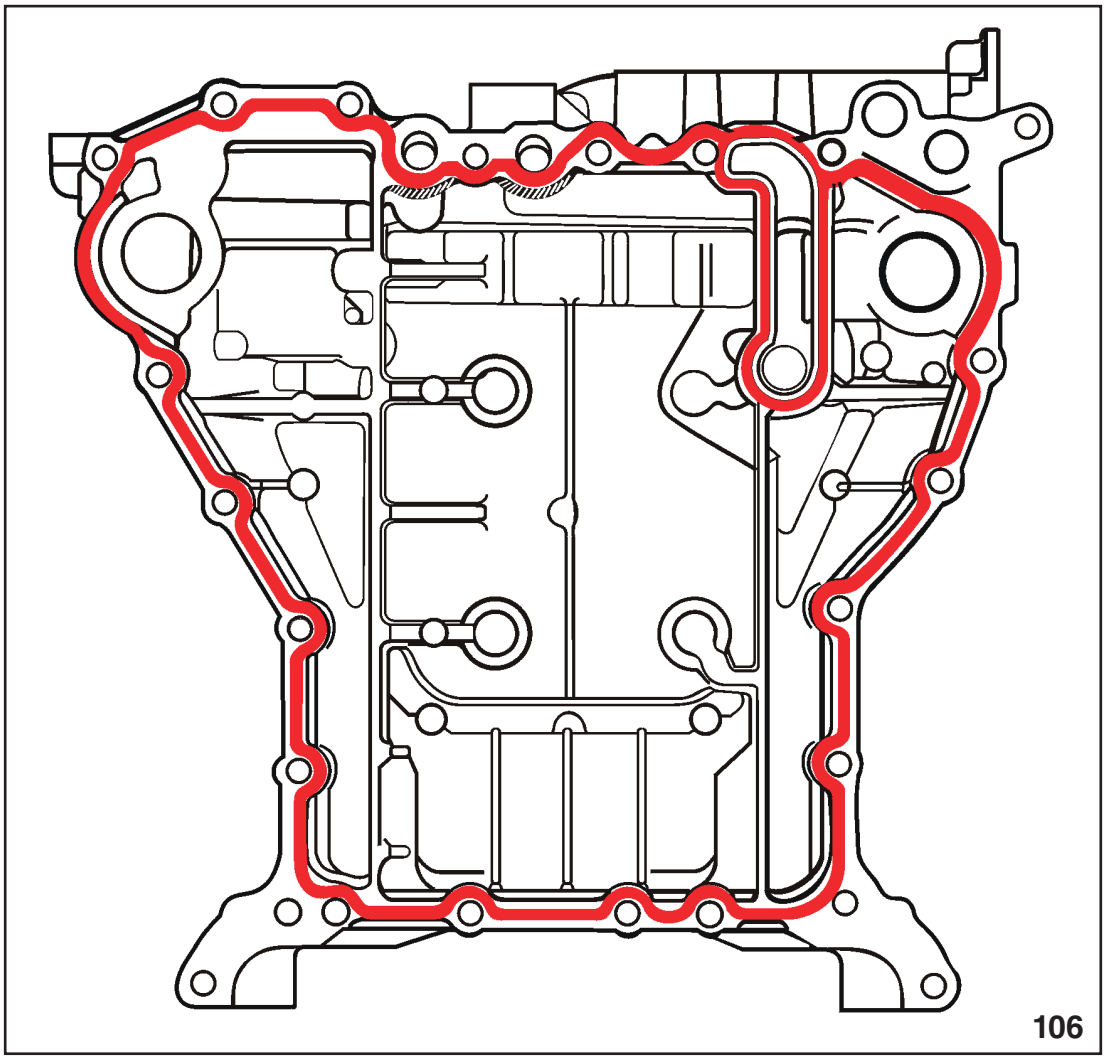


Cylinder Block

Refer to the Legacy and Outback 2001 Subaru Service Manual on the STIS web site 6 Cylinder Supplement.

ME (H6) 65 to 69 for proper sealing, bolt sizes and sequence. Torque to proper specifications.

OIL PAN EXTENSION HOUSING (UPPER OIL PAN)

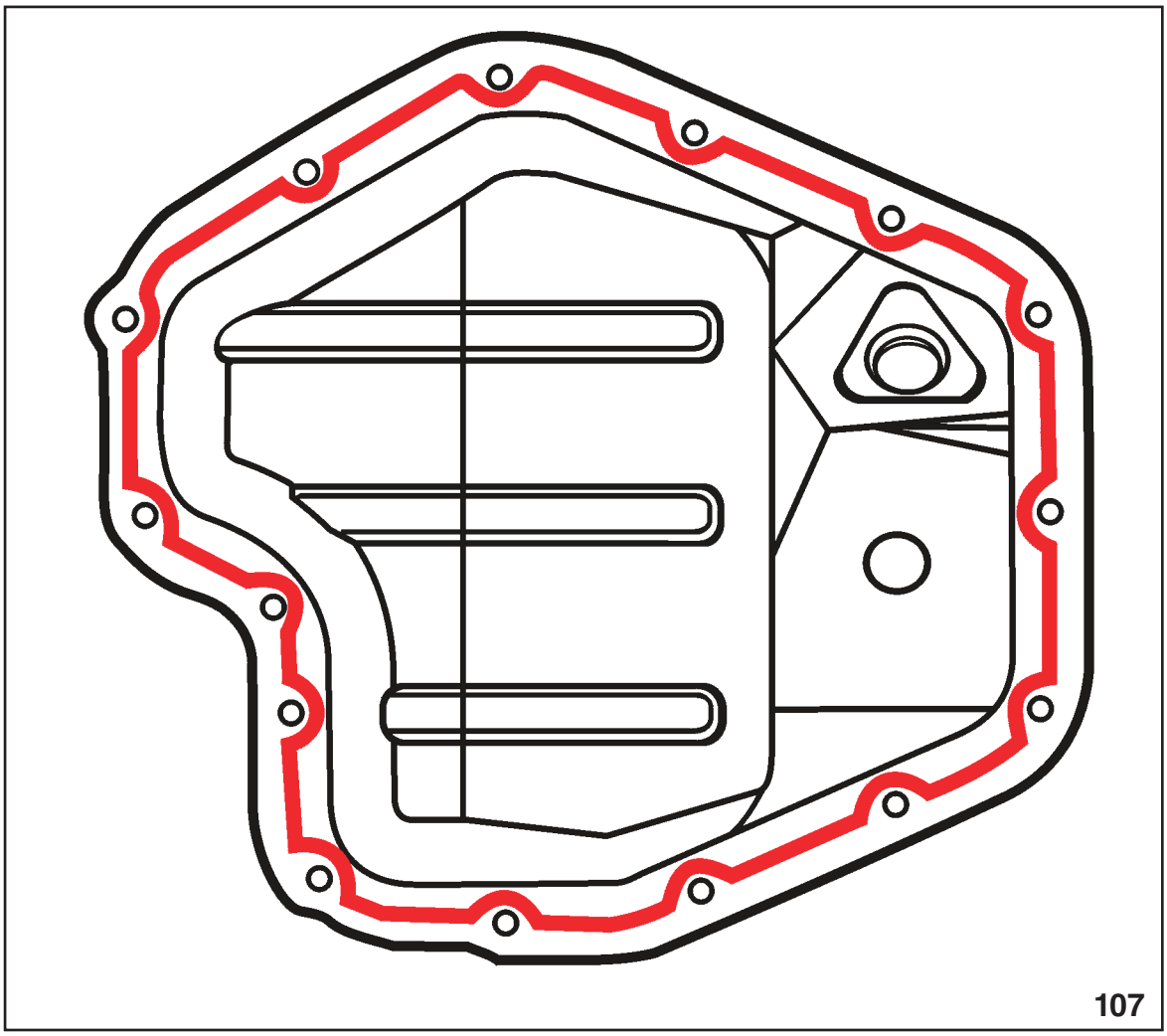


Lower Case

Refer to the Legacy and Outback 2001 to 2004 Subaru Service Manual on the STIS web site 6 Cylinder Supplement.

ME (H6) for proper sealing, bolt sizes and sequence. Torque to proper specifications.

FUJI BOND APPLICATION GUIDE FOR OIL PAN (LOWER)

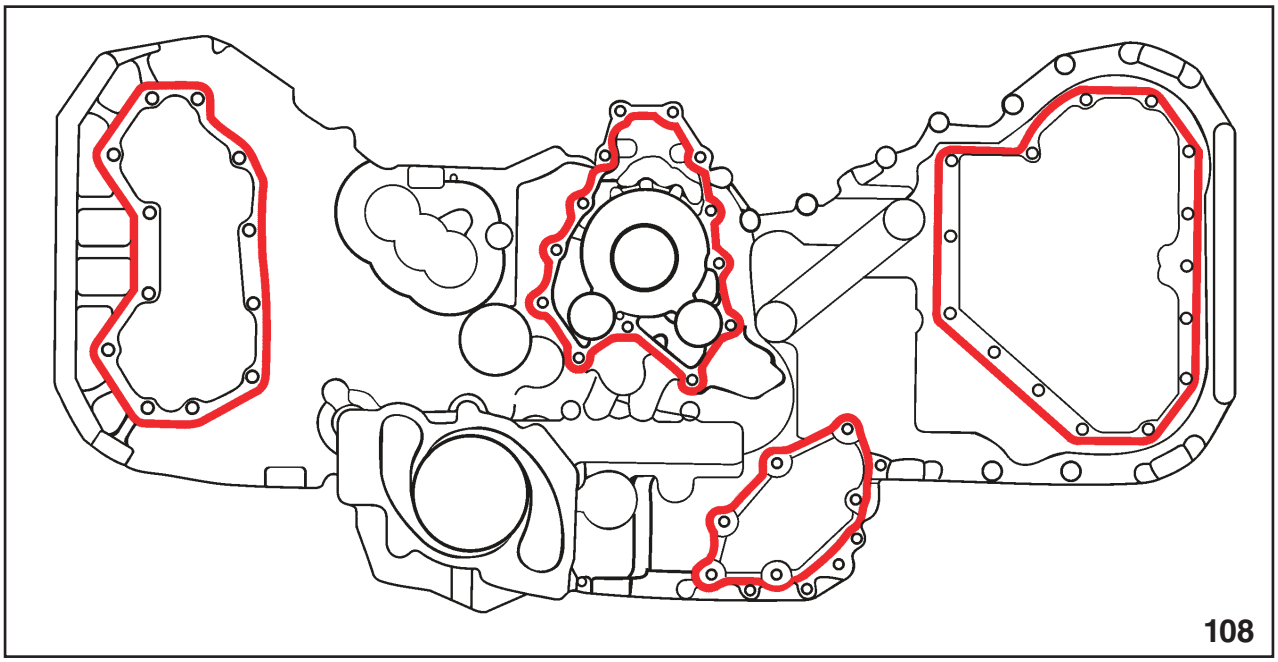


Oil Pan

Refer to the Legacy and Outback 2001 Subaru Service Manual on the STIS web site 6 Cylinder Supplement.

ME (H6) 65 to 69 for proper sealing, bolt sizes and sequence. Torque to proper specifications.

FUJI BOND APPLICATION GUIDE FOR INNER COVER

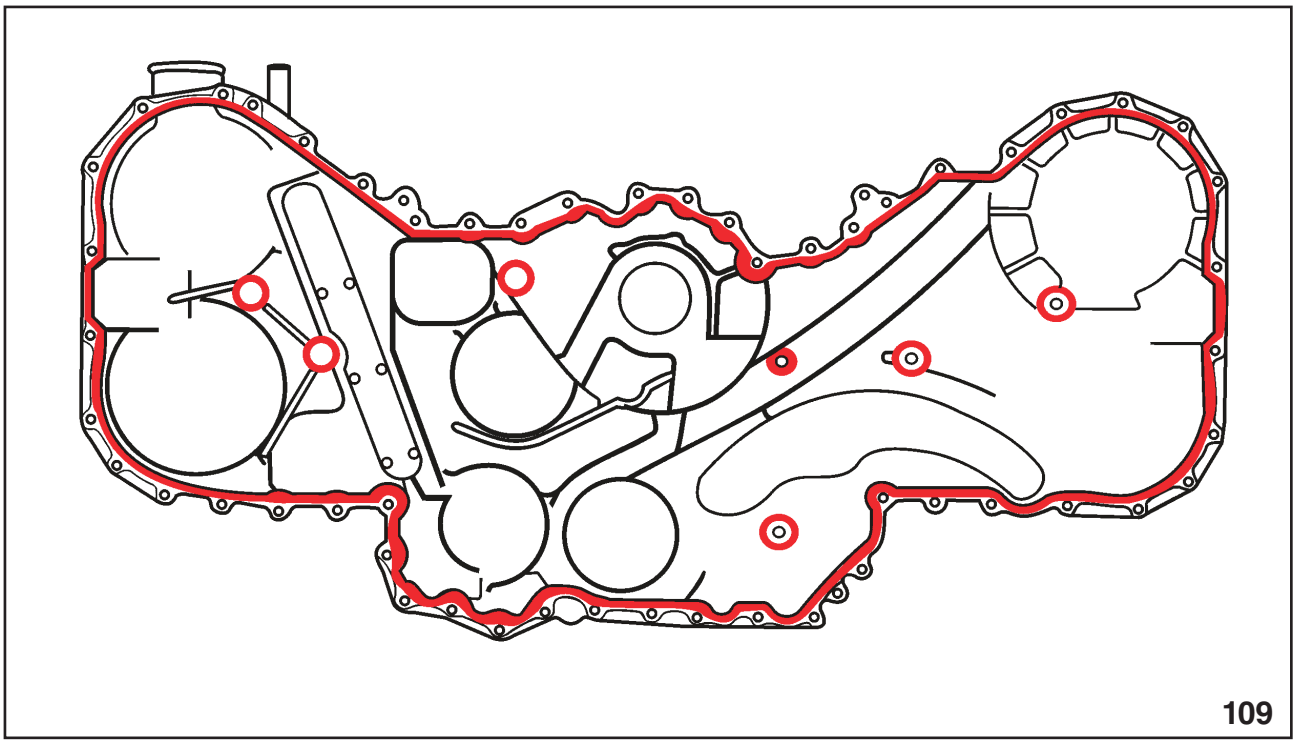


Rear Chain

Refer to the Legacy and Outback 2001 Subaru Service Manual on the STIS web site 6 Cylinder Supplement.

ME (H6) for proper sealing, (including O-ring placement) bolt sizes and sequence. Torque to proper specifications.

FUJI BOND APPLICATION GUIDE FOR OUTER COVER (FRONT CHAIN COVER)

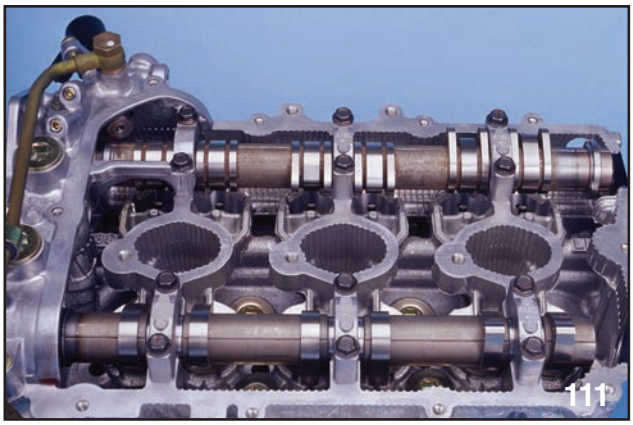


Front Chain

Refer to the Legacy and Outback 2001 Subaru Service Manual on the STIS web site 6 Cylinder Supplement.

ME (H6) for proper sealing, bolt sizes and sequence. Torque to proper specifications.

2005 Variable Valve Lift System

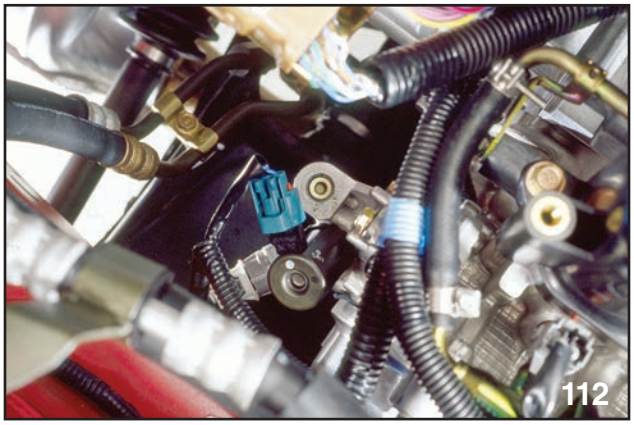


Cylinder Head

The 2005MY 3.0 Liter Engine is equipped with Variable Valve Timing and Variable Valve Lift. The Variable intake control has been replaced with a high efficiency composite resin intake manifold with electronic throttle control. The variable valve timing performs and operates the same as the system that was introduced on the 2004 model year turbo vehicles. The Variable Valve Lift system is designed to provide fuel economy at lower engine speeds and higher engine power output at higher engine speeds. The variable valve lift system optimizes the intake valve lift by switching to the use of low lift cam lobes or high lift cam lobes in accordance with engine speed.

The Camshaft is machined with a split lobe for each intake valve. The center of the lobe is described as the low speed cam lobe. The outer cam lobes are described as the high speed cam lobe.

In response to the signals from the ECM, the oil switching solenoid valve operates to switch the valve lift.

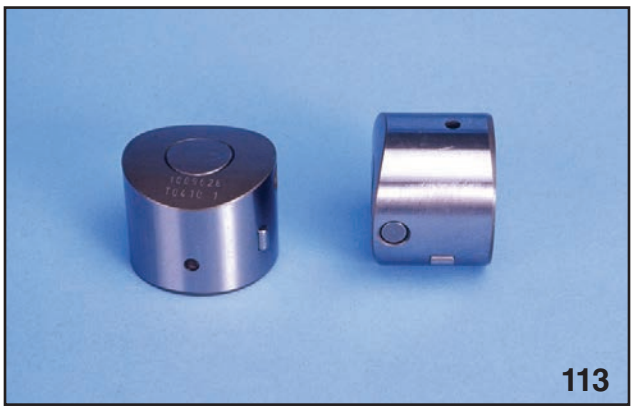


Oil Switching Valve

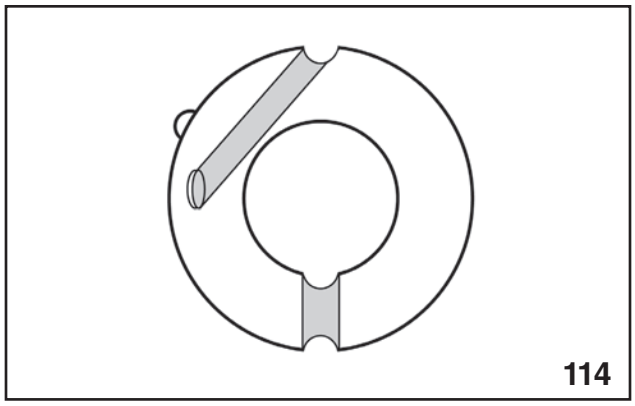
At low engine speeds, the lift is reduced to increase intake air speed and to obtain effective combustion and higher torque output. The lift of the two valves are different from each other. By differentiating the intake air volume in this way, a swirl occurs in the combustion chamber and combustion is improved.

At high engine speeds, the lift is increased to reduce intake resistance and to obtain higher power.

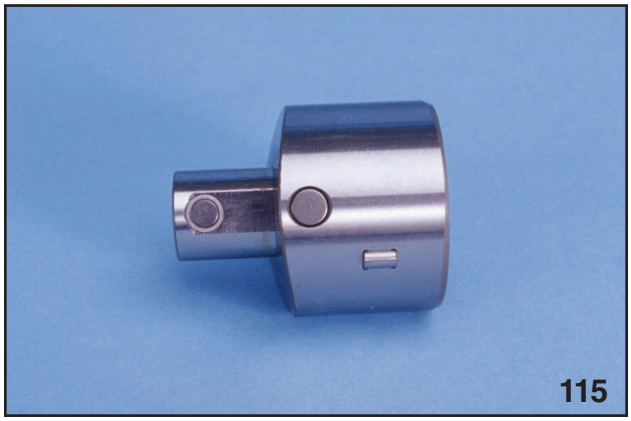
To protect the engine, the system does not allow racing up the engine to high speeds in P or N range.



Two Lifters

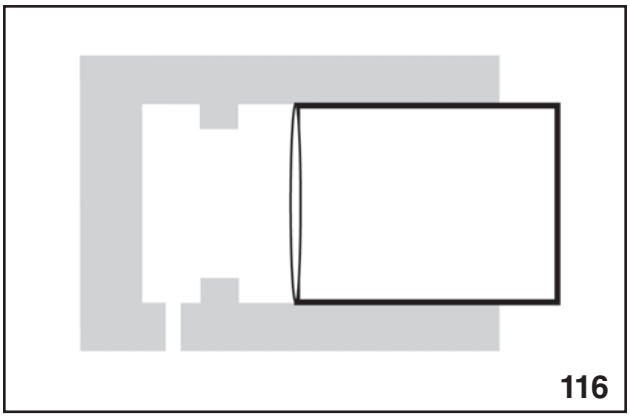


Two Oil Ports (Artwork)



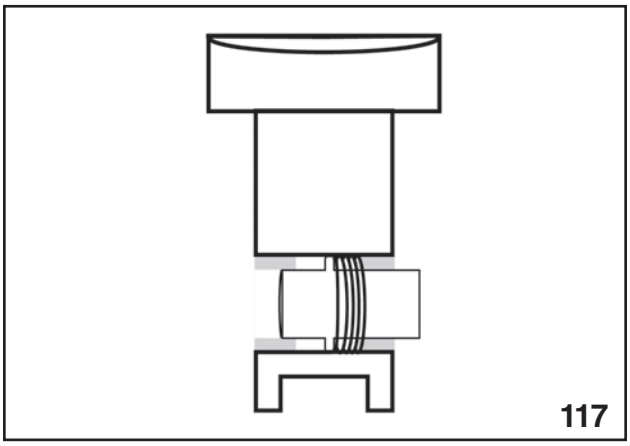
Outer and Inner Lifter

The intake valve lifter is equipped with a location guide that ensures the lifter does not rotate in the lifter bore as it is operated. Two oil pressure ports are visible on the outside of the lifter. The oil port closest to the location guide is used to supply working pressure to the outer lifter locking pin. The other oil port is used to supply lubrication to the inner lifter. The straight sides of the inner lifter ensure the inner lifter does not rotate inside the outer lifter. The lifter is not serviceable and must be replaced as a unit.

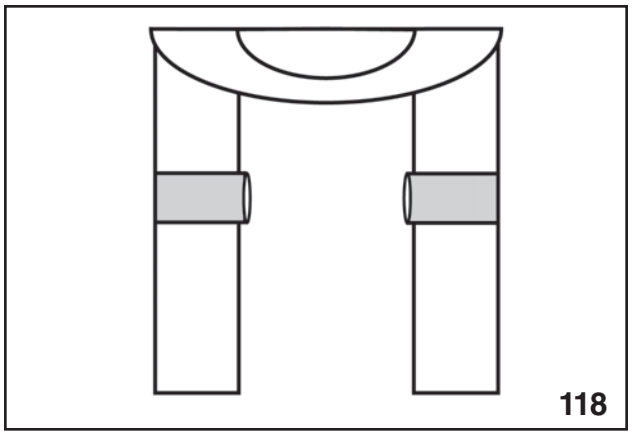


Outer Lifter Locking Pin (Artwork)

Oil pressure delivered into the outer lifter from the oil pressure port of the intake lifter bore pushes the outer lifter locking pin into the inner lifter locking pin. This locks the left side of the outer lifter into the left side of the inner lifter.

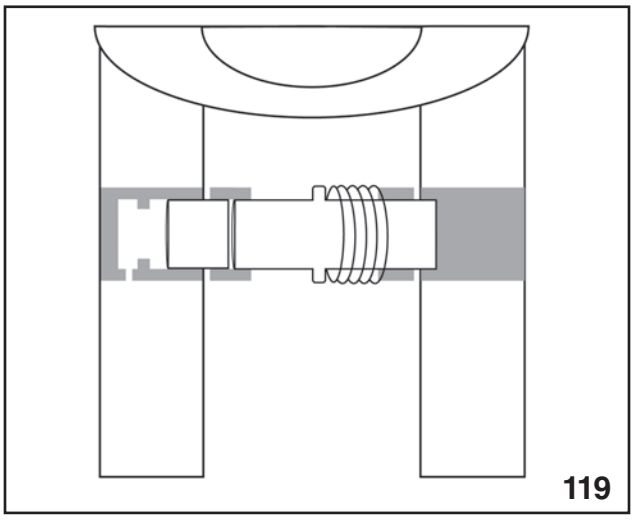


Inner Lifter Locking Pin (Artwork)



Outer Lifter (Artwork)

The force from this action compresses the return spring of the inner lifter locking pin and pushes the inner lifter locking pin to the right. This locks the right side of the inner lifter to the right side of the outer lifter.



(Artwork)

As the lifter is moved downward by the movement of the intake cam lobe the outer lifter moves away from the oil pressure port. However the mechanical force placed on the internal parts of the lifter keep it locked together until the intake valve is allowed to close.

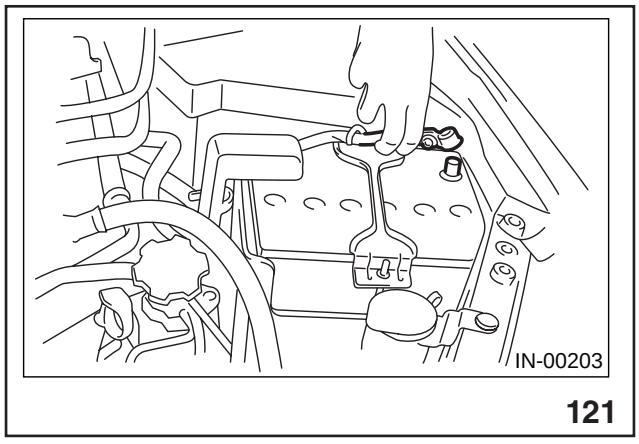
Valve Clearance 3.0 H6

Valve clearance 3.0 H6 on 2005 and newer engines with Variable Valve Lift requires checking with a feeler gauge and then measuring with a micrometer the small lifter placed on top of the valve stem in order to obtain proper clearance.

Inspection

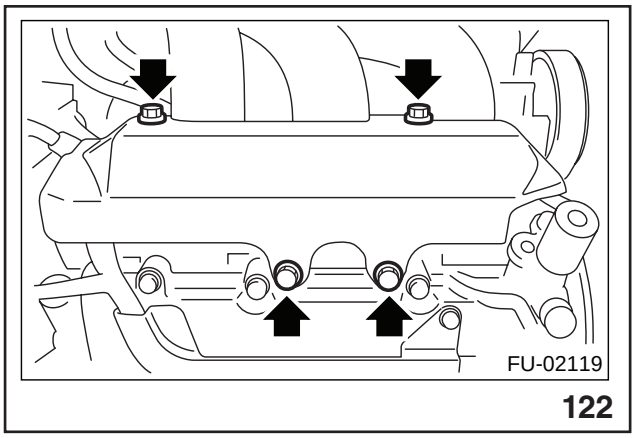
Inspection and adjustment of valve clearance should be performed while engine is cold.

1. Set the vehicle on a lift.
2. Remove the collector cover.



Disconnecting the Battery

3. Disconnect the ground cable from battery.
4. Lift-up the vehicle.
5. Remove the under cover.
6. Lower the vehicle.
7. When inspecting RH side cylinders:
   (1) Remove the air intake duct and air cleaner case. <Ref. to IN(H6DO), REMOVAL, Air Intake Duct.> <Ref. to IN(H6DO), REMOVAL, Air Cleaner Case.>



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Fuel Pipe Protector (RH)

(2) Remove the fuel pipe protector (RH)

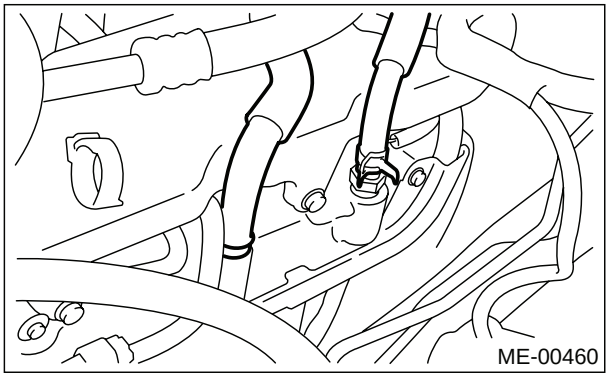
(3) Disconnect the connector of oil pressure switch.

(4) Remove the ignition coil. <Ref. to IG(H6D0), REMOVAL, Ignition Coil and Ignitor Assembly.>

(5) Remove the rocker cover (RH)

8. When inspecting LH side cylinders:

(1) Disconnect the battery cable, and then remove the battery and battery carrier.



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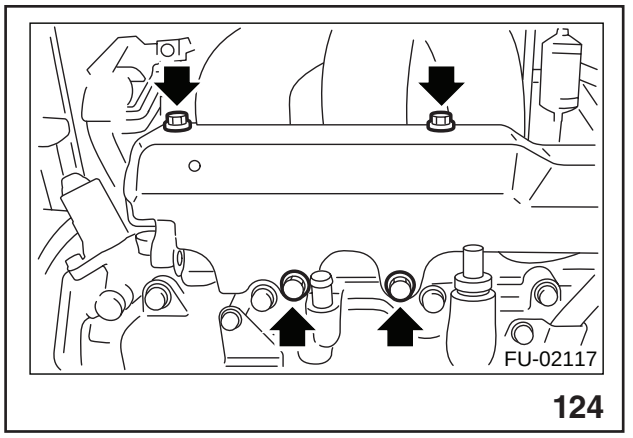
Disconnecting Hoses from Rocker Cover

(2) Disconnect the PCV hose and blow by hose from rocker cover (LH).



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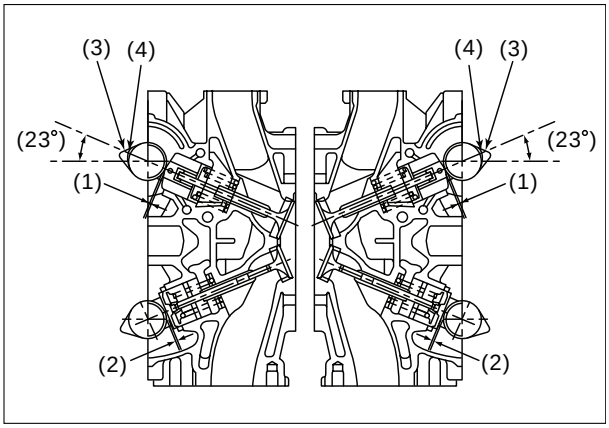
Fuel Pipe Protector (LH)

(3) Remove the fuel pipe protector (LH).

(4) Remove the ignition coil. <Ref. to IG(H6DO)-7, REMOVAL, Ignition Coil and Ignitor Assembly.>

(5) Remove the rocker cover (LH).



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Cam set to Position

9. Turn the crankshaft clockwise until the cam is set to position shown in the figure.

(1) Valve clearance (Intake side)

(2) Valve clearance (Exhaust side)

(3) High lift cam

(4) Low lift cam

10. Measure the clearance of intake valve and exhaust valve using thickness gauge (A).

NOTE: ***Measure Valve Clearance within the range of ±30° that shown in the figure.***

Measure valve clearance on low lift cam for intake side.

Insert the thickness gauge in as horizontal a direction as possible with respect to the valve lifter.

Valve clearance

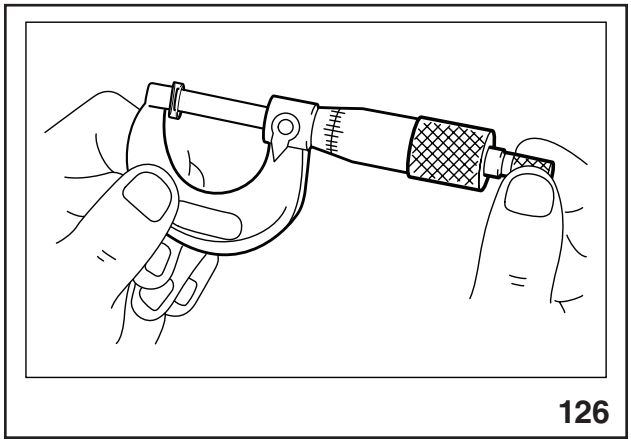
Intake:

$0.20+^{0.04}_{-0.06}$ mm ($0.0079+^{0.0016}_{-0.00024}$ in)

Exhaust:

0.35 ± 0.05 mm (0.0138 ±0.0020 in)

- If the measured valve is not within specification, take notes of the value in order to adjust the valve clearance later on.



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Measuring Valve Clearance

11. If necessary, adjust the valve clearance. <Ref. to ME(H6D0), ADJUSTMENT, Valve Clearance.>
12. Further turn the crank pulley clockwise and then measure the valve clearances again.
13. After inspection, install the related parts in the reverse order of removal.

Adjustment

Intake side

CAUTION: **ADJUSTMENT OF VALVE CLEARANCE SHOULD BE PERFORMED WHILE ENGINE IS COLD.**

DO NOT WEAR GLOVES DURING REMOVAL AND INSTALLATION OF VALVE LIFTER.

DO NOT USE A VALVE LIFTER WHICH RECEIVED HIGH IMPACT DUE TO DROP, ETC.

WHEN INSTALLING THE VALVE LIFTER, ALIGN THE ANTI-ROTATION OF VALVE LIFTER WITH GROOVE ON CYLINDER HEAD, AND THEN INSERT THE VALVE LIFTER.

1. Measure all valve clearances.

   <Ref. to ME(H6D0)-28, INSPECTION, Valve Clearance.>

NOTE: ***Record each valve clearance after it has been measured.***

2. Remove the Camshaft. <Ref. to ME(H6DO)-53, REMOVAL, Camshaft.>
3. Remove the valve lifter.
4. Remove the adjustable shim (cap) from the top of the intake valve stem.
5. Check the thickness of the shim (cap) by stamped mark on the side of shim (cap) which is removed.
6. Select a shim (cap) of suitable thickness using measured valve clearance and shim (cap) thickness, by referring to the following table.

Unit: (mm)
S = (V + T) - 0.20
S: Required shim (cap) thickness V: Measured valve clearance T: Current Shim (cap) thickness

Chain Driven Valve Train Boxer Engines (Module 105)

Part No.	Thickness mm (in)
13218AK890	1.92 (0.0756)
13218AK900	1.94 (0.0764)
13218AK910	1.96 (0.0772)
13218AK920	1.98 (0.0780)
13218AK930	2.00 (0.0787)
13218AK940	2.02 (0.0795)
13218AK950	2.04 (0.0803)
13218AK960	2.06 (0.0811)
13218AK970	2.07 (0.0815)
13218AK980	2.08 (0.0819)
13218AK990	2.09 (0.0823)
13218AL000	2.10 (0.0827)
13218AL010	2.11 (0.0831)
13218AL020	2.12 (0.0835)
13218AL030	2.13 (0.0839)
13218AL040	2.14 (0.0843)
13218AL050	2.15 (0.0846)
13218AL060	2.16 (0.0850)
13218AL070	2.18 (0.0858)
13218AL080	2.18 (0.0858)
13218AL090	2.19 (0.0862)
13218AL100	2.20 (0.0866)
13218AL110	2.21 (0.0870)
13218AL120	2.22 (0.0874)
13218AL130	2.23 (0.0878)
13218AL140	2.24 (0.0882)
13218AL150	2.25 (0.0886)
13218AL160	2.26 (0.0890)
13218AL170	2.27 (0.0894)
13218AL180	2.28 (0.0898)
13218AL190	2.29 (0.0902)
13218AL200	2.30 (0.0906)
13218AL210	2.31 (0.0909)
13218AL220	2.32 (0.0913)
13218AL230	2.33 (0.0917)
13218AL400	2.34 (0.0921)
13218AL250	2.35 (0.0925)
13218AL260	2.36 (0.0929)

Part No.	Thickness mm (in)
13218AL270	2.28 (0.0937)
13218AL280	2.38 (0.0937)
13218AL290	2.39 (0.0941)
13218AL300	2.41 (0.0945)
13218AL310	2.41 (0.0949)
13218AL320	2.42 (0.0953)
13218AL330	2.43 (0.0957)
13218AL340	2.44 (0.0961)
13218AL350	2.45 (0.0965)
13218AL360	2.46 (0.0969)
13218AL370	2.47 (0.0972)
13218AL380	2.48 (0.0976)
13218AL390	2.49 (0.0980)
13218AL400	2.50 (0.0984)
13218AL410	2.51 (0.0988)
13218AL420	2.52 (0.0992)
13218AL430	2.53 (0.0996)
13218AL440	2.54 (0.1000)
13218AL450	2.55 (0.1004)
13218AL460	2.56 (0.1008)
13218AL470	2.57 (0.1012)
13218AL480	2.58 (0.1016)
13218AL490	2.59 (0.1024)
13218AL500	2.60 (0.1024)
13218AL510	2.61 (0.1028)
13218AL520	2.62 (0.1032)
13218AL530	2.64 (0.1039)
13218AL540	2.66 (0.1047)
13218AL550	2.68 (0.1055)
13218AL560	2.70 (0.1063
13218AL570	2.72 (0.1071)
13218AL580	2.74 (0.1079)
13218AL590	2.76 (0.1087)

Exhaust side

CAUTION: ADJUSTMENT OF VALVE CLEARANCE SHOULD BE PERFORMED WHILE ENGINE IS COLD.

DO NOT WEAR GLOVES DURING REMOVAL AND INSTALLATION OF VALVE LIFTER.

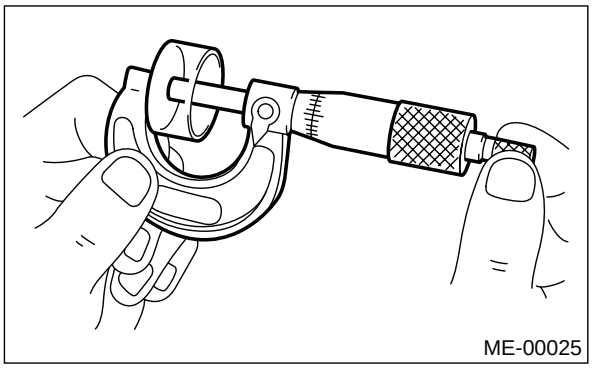
DO NOT USE A VALVE LIFTER WHICH RECEIVED HIGH IMPACT DUE TO DROP, ETC.

1. Measure all valve clearances. <Ref. to ME(H6DO), INSPECTION, Valve clearance.>

Note: Record each valve clearance after it has been measured.

2. Remove the Camshaft. <Ref. to ME(H6D0), REMOVAL, Camshaft.>

3. Remove the valve lifter.



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Micrometer Measuring Valve Lifter

4. Measure the thickness of valve lifter with a micrometer.

5. Select a valve lifter of suitable thickness using measured valve clearance and valve lifter thickness, by referring to the following table.

Unit: (mm)
S = (V + T) - 0.35
S: Valve lifter thickness required V: Measured valve clearance T: Current valve lifter thickness

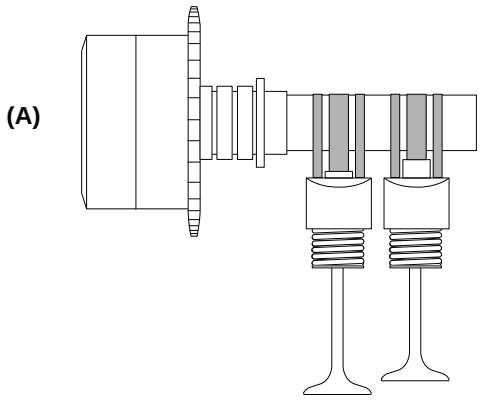
Part No.	Thickness mm (in)
13228AD180	4.32 (0.1701)
13228AD190	4.34 (0.1709)
13228AD200	4.36 (0.1717)
13228AD210	4.38 (0.1724)
13228AD220	4.40 (0.1748)
13228AD230	4.42 (0.1740)
13228AD240	4.44 (0.1748)
13228AD250	4.46 (0.1756)
13228AD260	4.48 (0.1764)
13228AD270	4.50 (0.1772)
13228AD280	4.52 (0.1780)
13228AD290	4.45 (0.1787)
13228AD300	4.56 (0.1795)
13228AD10	4.58 (0.1803)
13228AD320	4.60 (0.1881)
13228AC580	4.62 (0.1819)
13228AC590	4.63 (0.1823)
13228AC600	4.64 (0.1827)
13228AC610	4.65 (0.1831)
13228AC620	4.66 (0.1835)
13228AC630	4.67 (0.1839)
13228AC640	4.68 (0.1843)
13228AC650	4.69 (0.1846)
13228AC660	4.70 (0.1850)
13228AC670	4.71 (0.1854)
13228AC680	4.72 (0.1858)
13228AC690	4.73 (0.1862)
13228AC700	4.74 (0.1866)
13228AC710	4.75 (0.1870)
13228AC720	4.76 (0.1874)
13228AC730	4.77 (0.1878)
13228AC740	4.78 (0.1882)
13228AC750	4.79 (0.1886)
13228AC760	4.80 (0.1890)
13228AC770	4.81 (0.1894)
13228AC780	4.82 (0.1898)
13228AC790	4.83 (0.1902)
13228AC800	4.84 (0.1906)

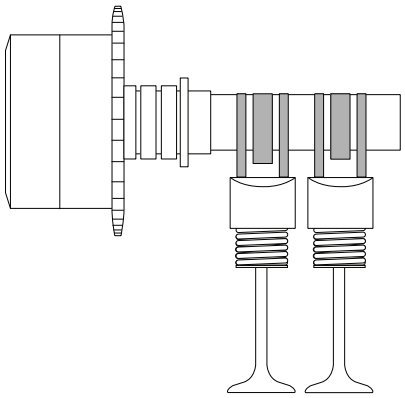
Chain Driven Valve Train Boxer Engines (Module 105)

Part No.	Thickness mm (in)
13228AC810	4.85 (0.1909)
13228AC820	4.86 (0.1913)
13228AC830	4.87 (0.1917)
13228AC840	4.88 (0.1921)
13228AC850	4.89 (0.1925)
13228AC860	4.90 (0.1929)
13228AC870	4.91 (0.1933)
13228AC880	4.92 (0.1937)
13228AC890	4.93 (0.1941)
13228AC900	4.94 (0.1945)
13228AC910	4.95 (0.1949)
13228AC920	4.96 (0.1953)
13228AC930	4.97 (0.1957)
13228AC940	4.98 (0.1961)
13228AC950	4.99 (0.1965)
13228AC960	5.00 (0.1969)
13228AC970	5.01 (0.1972)
13228AC980	5.02 (0.1976)
13228AC990	5.03 (0.1980)
13228AD000	5.04 (0.1984)
13228AD010	5.05 (0.1988)
13228AD020	5.06 (0.1992)
13228AD030	5.07 (0.1996)
13228AD040	5.08 (0.2000)
13228AD050	5.09 (0.2004)
13228AD060	5.10 (0.2008)
13228AD070	5.11 (0.2012)
13228AD080	5.12 (0.2016)
13228AD090	5.13 (0.2020)
13228AD100	5.14 (0.2024)
13228AD110	5.15 (0.2028)
13228AD120	5.16 (0.2032)
13228AD130	5.17 (0.2035)
13228AD140	5.18 (0.2039)
13228AD150	5.19 (0.2043)
13228AD160	5.20 (0.2047)
13228AD170	5.21 (0.2051)
13228AD330	5.23 (0.2059)
13228AD340	5.25 (0.2067)
13228AD350	5.27 (0.2075)

Part No.	Thickness mm (in)
13228AD360	5.29 (0.2083)
13228AD370	5.31 (0.2091)
13228AD380	5.33 (0.2098)
13228AD390	5.35 (0.2106)
13228AD400	5.37 (0.2114)
13228AD410	5.39 (0.2122)
13228AD420	5.41 (0.2130)
13228AD430	5.43 (0.2138)
13228AD440	5.45 (0.2146)
13228AD450	5.47 (0.2154)
13228AD460	5.49 (0.2161)
13228AD470	5.51 (0.2169)
13228AD480	5.53 (0.2177)
13228AD490	5.55 (0.2185)
13228AD500	5.57 (0.2193)
13228AD510	5.59 (02201)

When the oil pressure ports align the pressure is reapplied or released dependant on the duty ratio from the OSV. If the pressure is released the return spring of the inner lifter locking pin moves the inner lifter locking pin to the left. This action will move the outer lifter locking pin to the left resulting in the separation of the inner and outer lifter.





(A) During low speed operation

(B) During high speed operation

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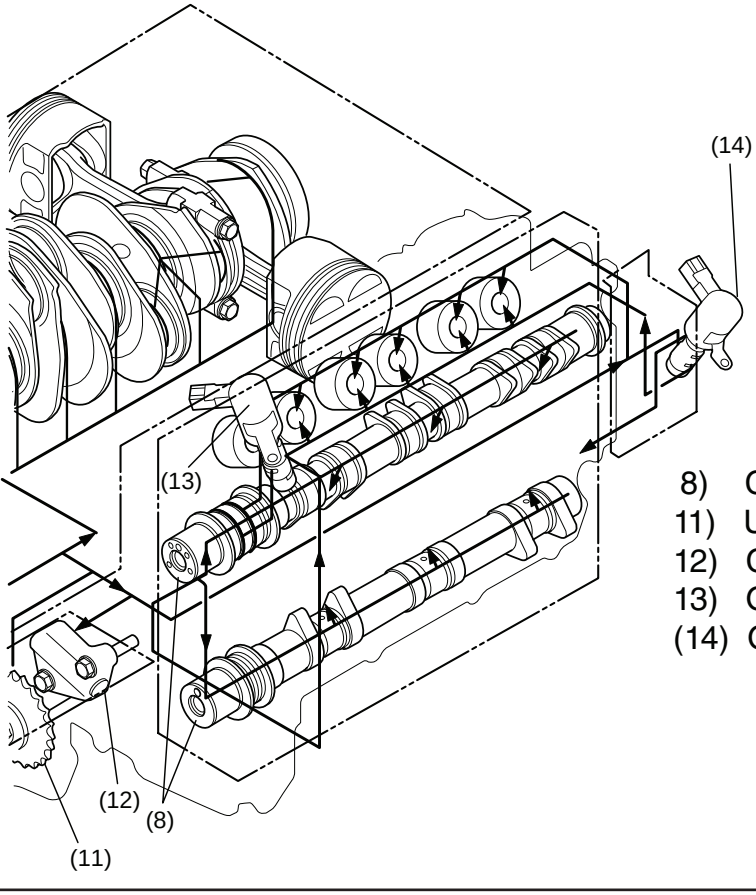
Camshafts



8) Camshaft
11) Upper idler sprocket
12) Chain tension adjuster LH
13) Oil flow control solenoid valve
(14) Oil switching solenoid valve

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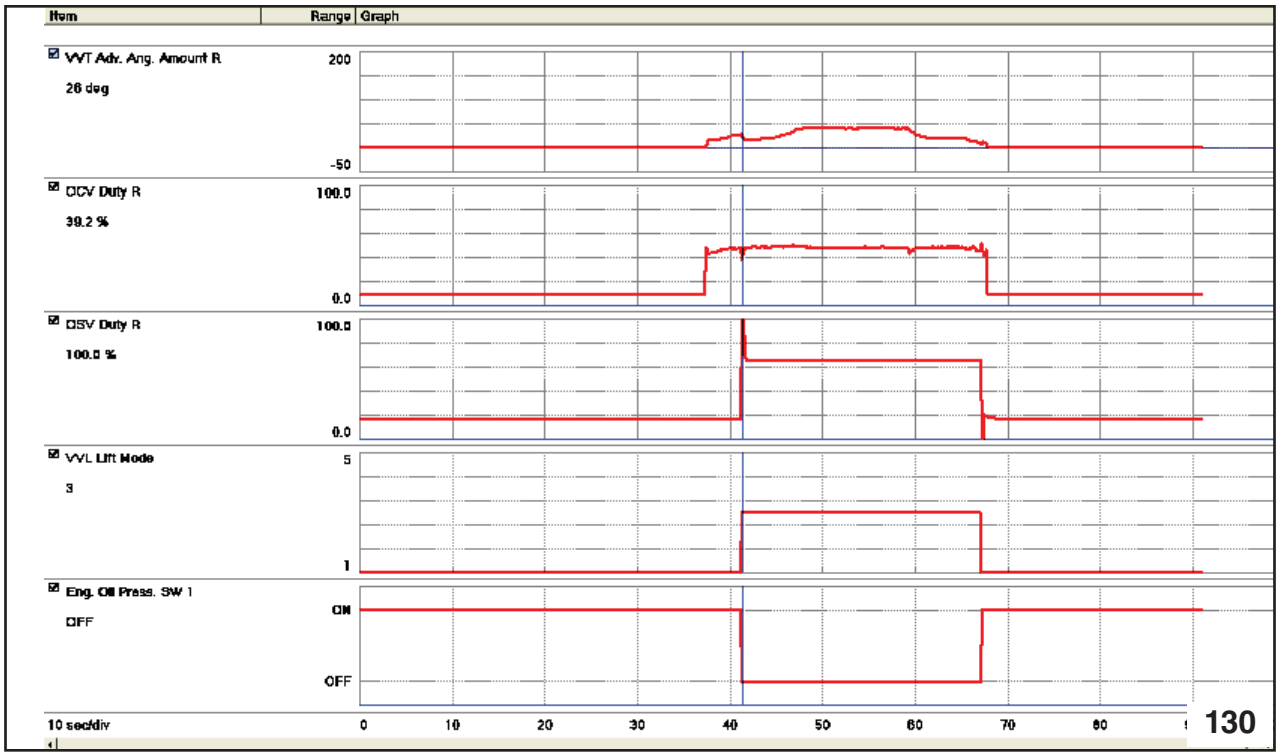
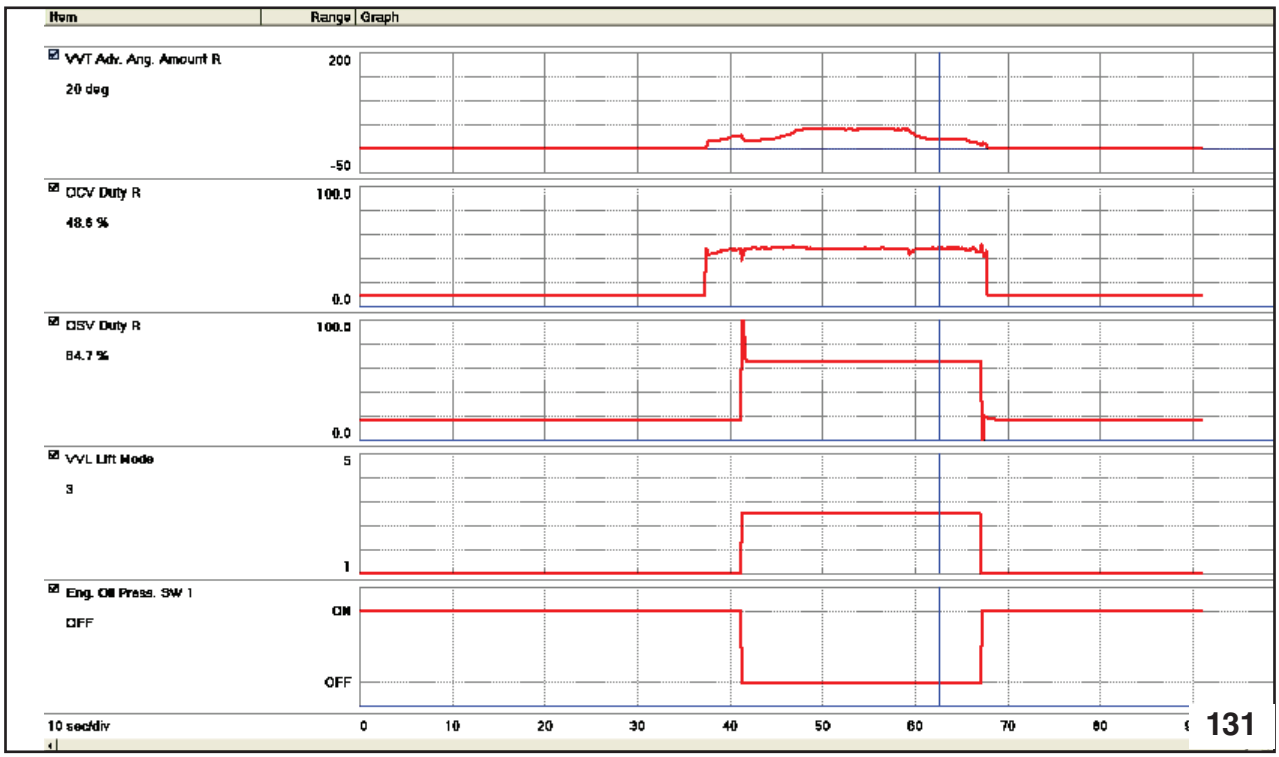
Oil Pressure Schematic



NSM GRAPH 100% OSV DUTY



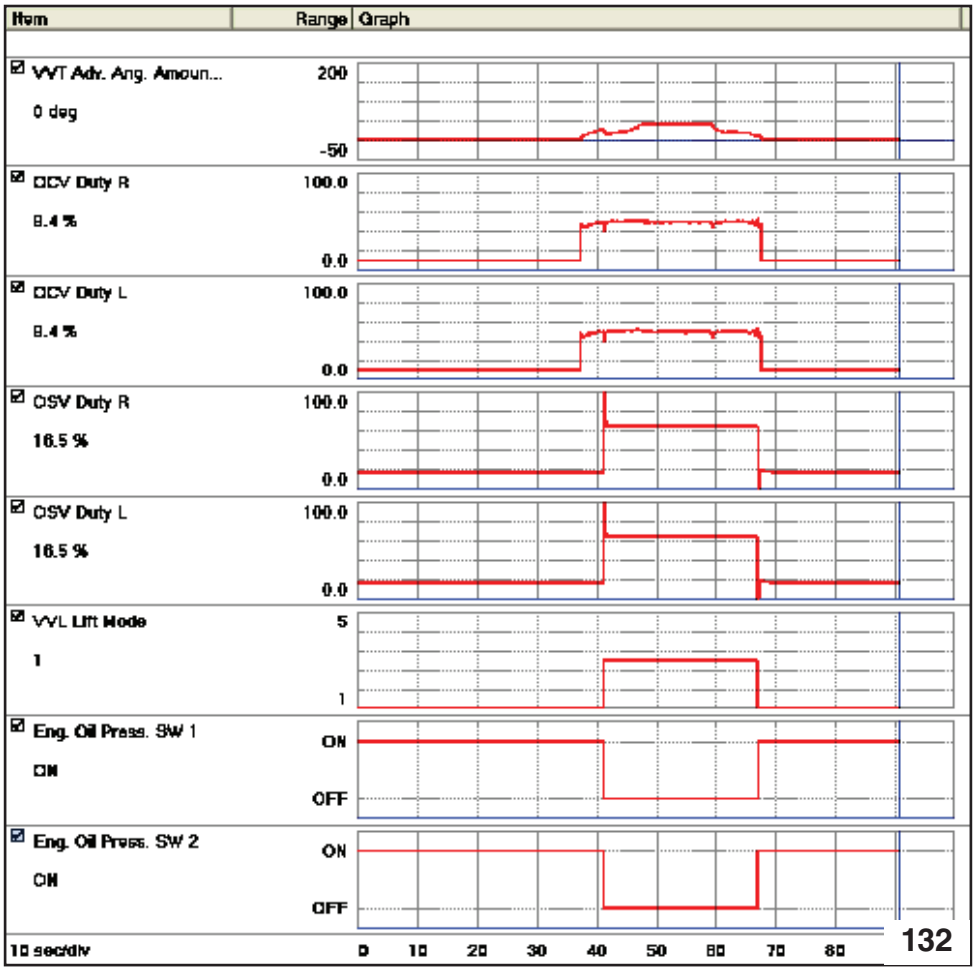
NSM GRAPH OSV DUTY RATIO 64.7%

The Variable Valve Lift (VVL) is controlled by a duty ratio signal from the ECM to the Oil Switching Valve (OSV). An OSV is located on each cylinder head to operate the VVL components on their respective sides of the engine. An oil pressure diagnosis switch is located on each OSV.

The right side is **"Engine Oil Pressure SW 1"** and the left side is **"Engine Oil Pressure SW 2"** when viewing data on the Select Monitor. Both switches monitor the oil pressure in the application circuits of the OSVs. When the oil pressure in the application circuit is **low**, the oil pressure diagnosis switch is grounded and is displayed as **"On"** when viewing Select monitor data. When the pressure is **high,** the oil pressure switch is open and is displayed as **"Off"** when viewing Select Monitor data.

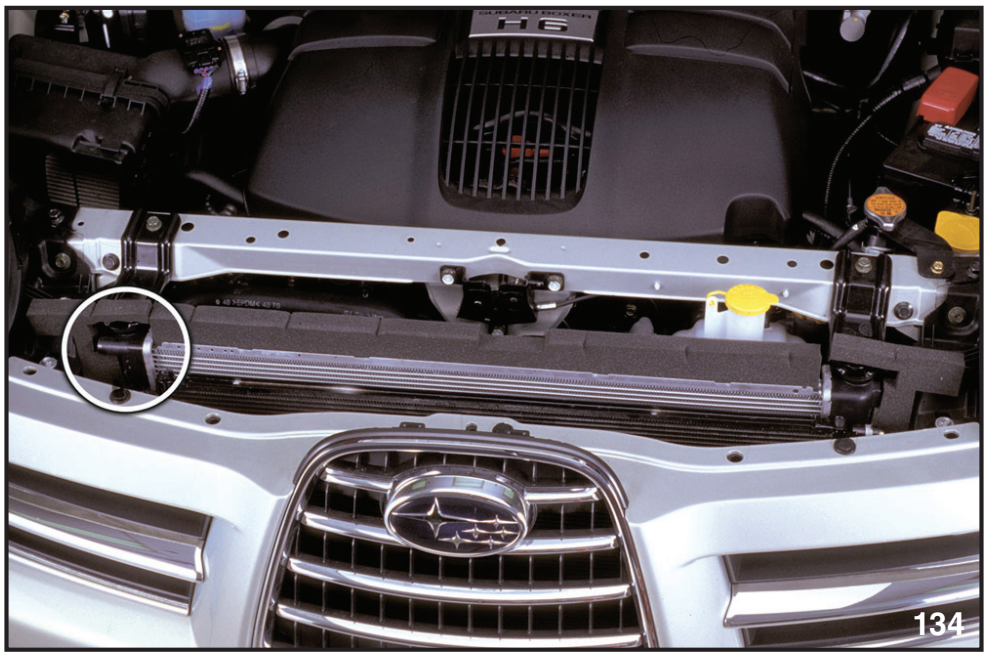
The OSV duty ratio at idle is approximately 18%. This short "On Time" is allowing more oil pressure to drain rather than build up in the application circuit. The resulting pressure reaching the VVL lifters is not strong enough to overcome spring tension so the VVL lifter remains in a low speed operation mode, allowing the center lifter to work with the low speed cam lobes. The Select monitor will display this action as **"VVL Lift Mode 1"**.

The OSV duty ratio will initially increase to 100% when the ECM decides to change to high speed operation. After pressure has been established in the application circuit, the duty ratio will decrease to approximately 86 %. This longer on time, as compared to the duty ratio at idle, will allow more oil pressure to build up in the application circuit rather than drain. The resulting pressure will be strong enough to overcome spring tension and lock the outer lifter to the inner lifter, allowing operation with the split high speed cam lobes. The Select monitor will display this action as **"VVL Lift Mode 3".**

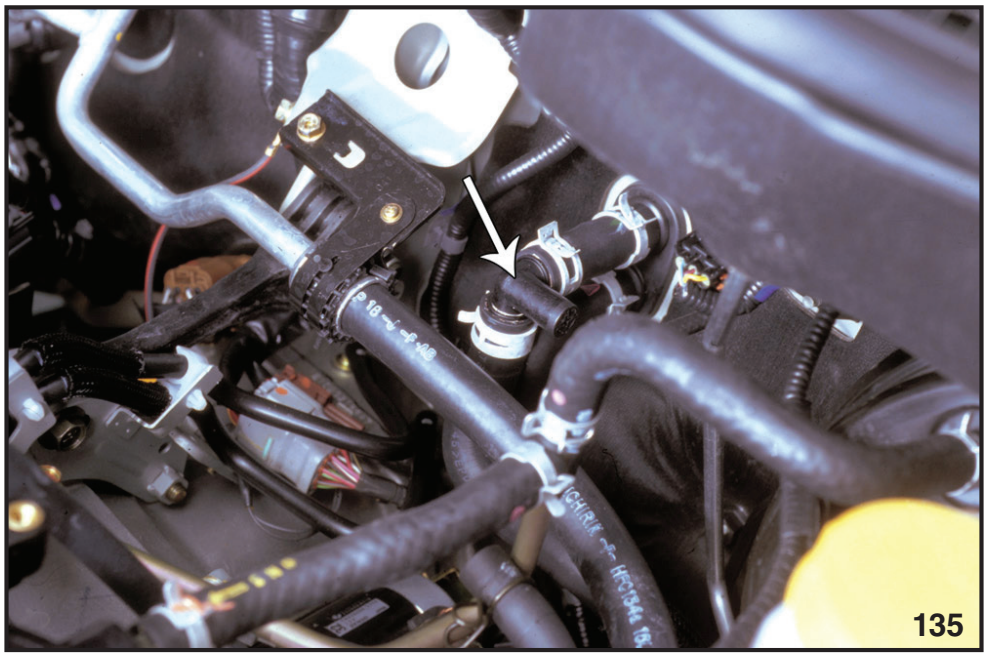


OCV AND CAM ANGLE SMIII DATA

6 Cylinder Air Bleed Procedure 05MY and Newer



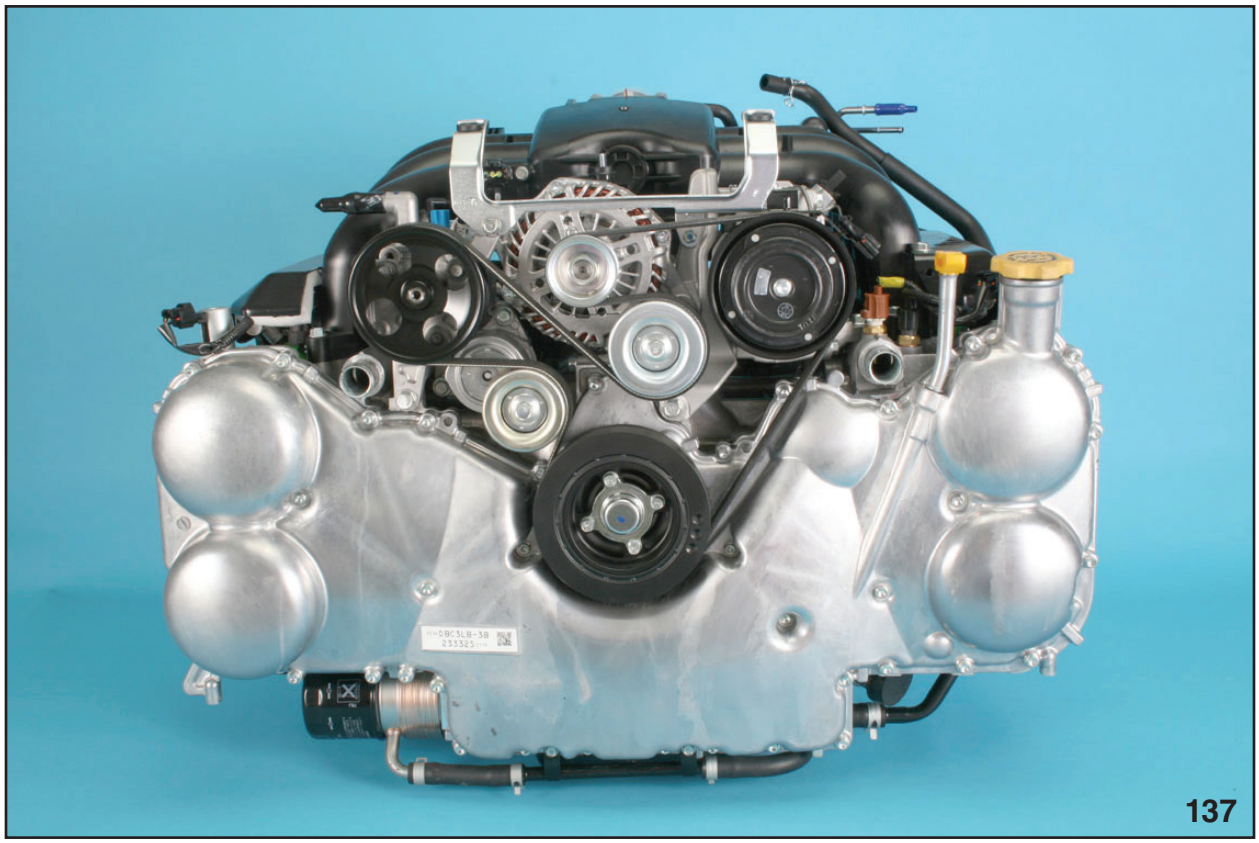
Circled Air Bleed



Arrow and Air Bleed

When refilling the coolant system, open the rear and forward air bleeds and continue to add coolant until coolant begins to flow from the air bleeds. Close the air bleeds. Run the engine until the fans cycle and add adequate coolant to the coolant reservoir that will ensure proper radiator coolant level as the coolant system cools.

Introduction 3.6 Liter Engine



3.6 Liter Engine

The new 3.6 liter engine introduced in the 2008 Model year Tribeca, produces 256 horsepower at 6000 RPM and 247 foot pounds of torque at 4400 RPM. Designed to operate on regular fuel and with no changes to the external engine dimensions, this engine operates cleaner and provides more fuel efficiency than the 3.0 liter engine.

	3.6 Engine	3.0 Engine
Bore	92 mm	89.2 mm
Stroke	91 mm	80 mm
Displacement	3,630 cc	2,999 cc
Weight	395 lbs.	397 lbs.
Fuel	87 aki	91 aki
Compression ratio	10.5:1	10.7:1

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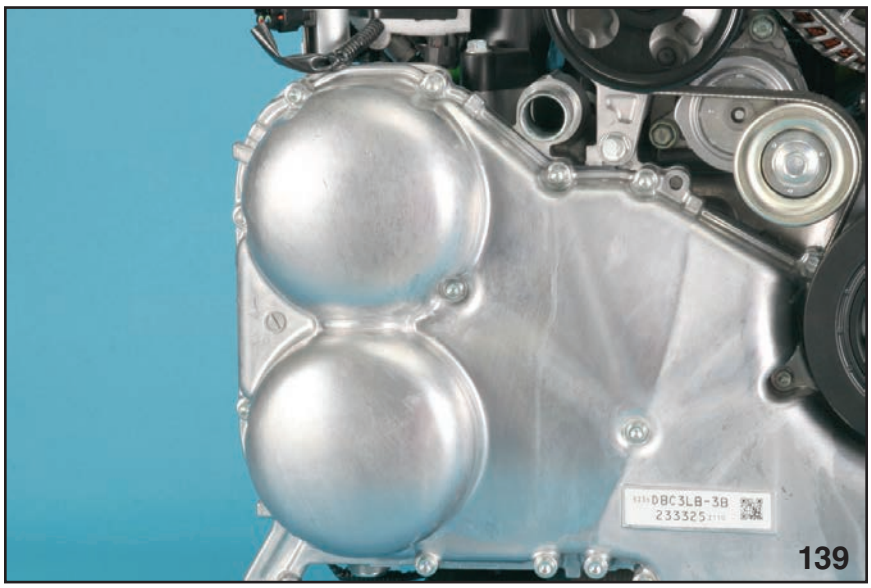
Engine Chart

Engine designation is EZ 36.

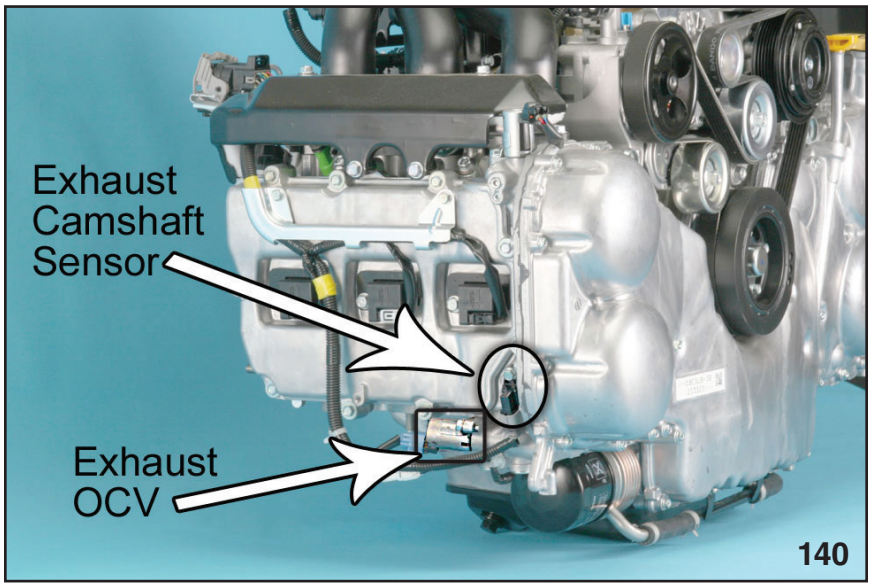
Enhancements / Changes

- Introduction of the Dual Active Valve Timing System
- Deletion of the Variable Valve Lift System
- Cooling System design
- Timing Chain design



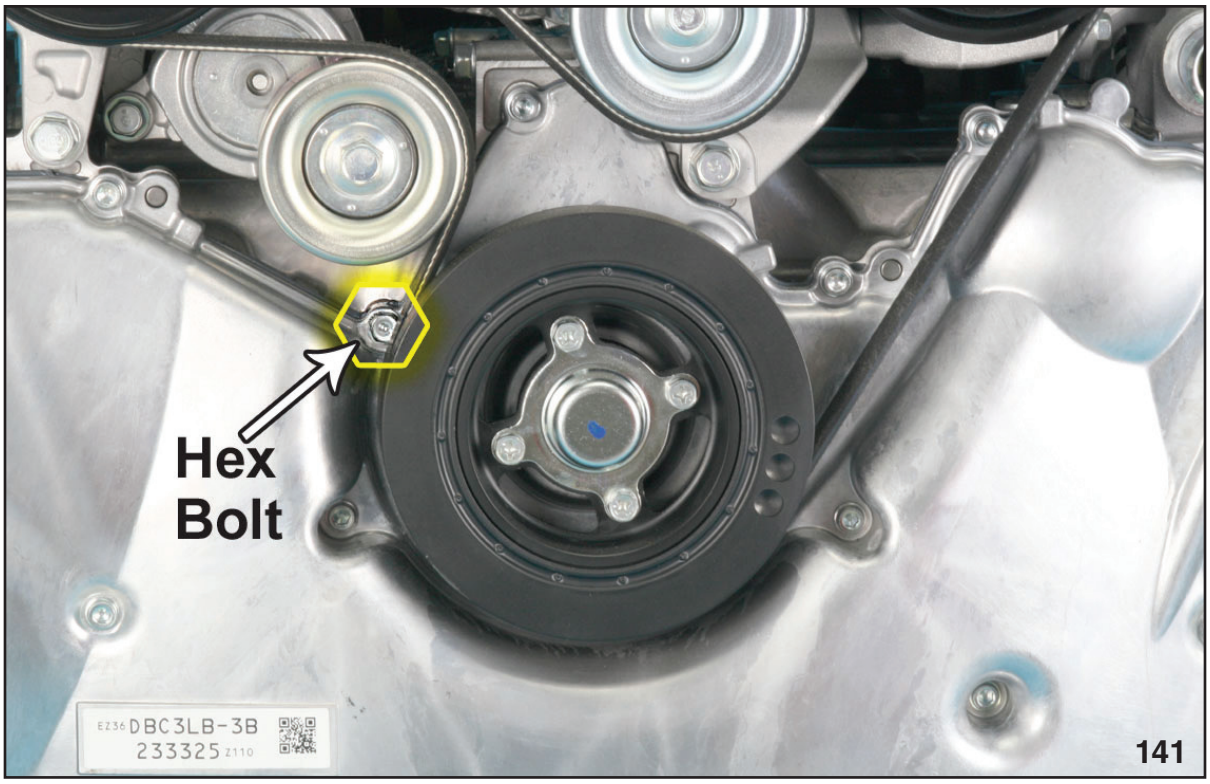
Timing Chain Cover

The dual active valve timing system requires additional space in the timing chain cover to allow room for the exhaust sprocket.



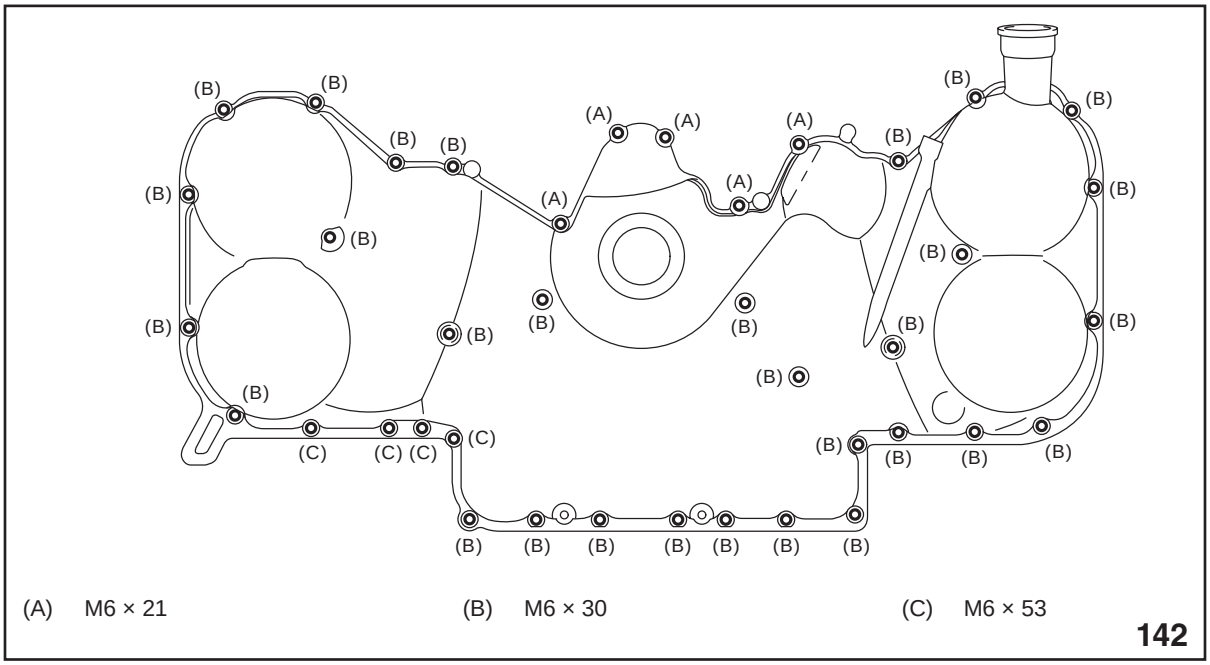
Exhaust Camshaft Sensor and Exhaust OCV

The shape of the valve cover and the front Camshaft cap allows for the installation of the exhaust Oil Charge Valve (OCV) and the Exhaust Camshaft sensor.



Placement of Hex Bolt

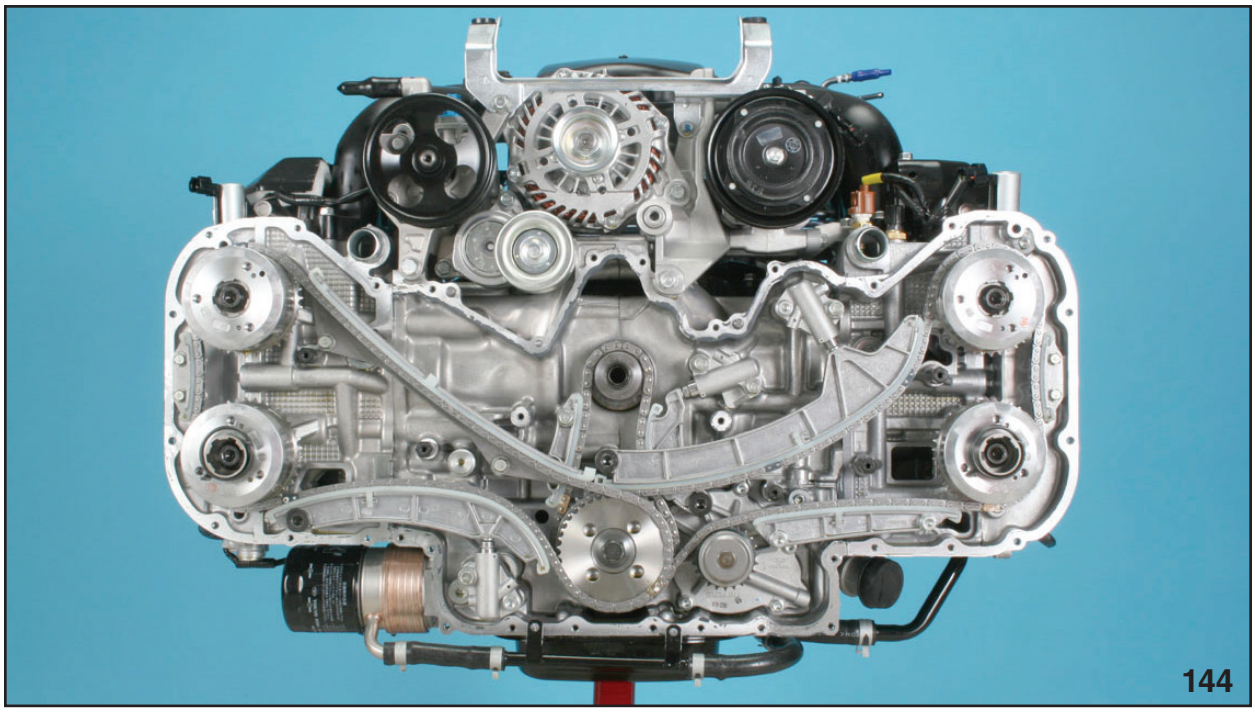
Three different length bolts are used to secure the timing chain cover, all of which are 6mm Allen except one 6mm hex bolt located at the upper right side behind the Crankshaft pulley.



Inner Timing Chain Cover

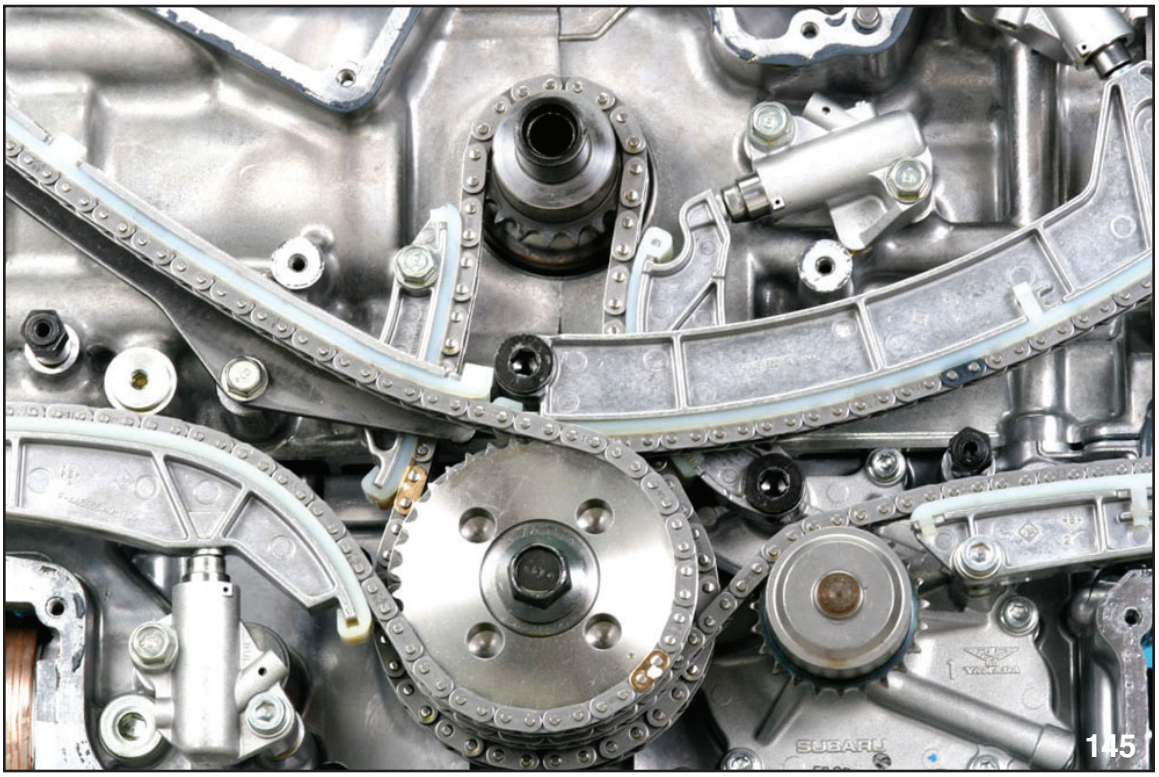
The 3.6 liter engine is designed with the inner timing chain cover incorporated on the front surface of the engine block and cylinder heads while the outer timing chain cover is secured to the engine with 39 bolts and sealed with three bond.

3.6 Liter Timing Chains

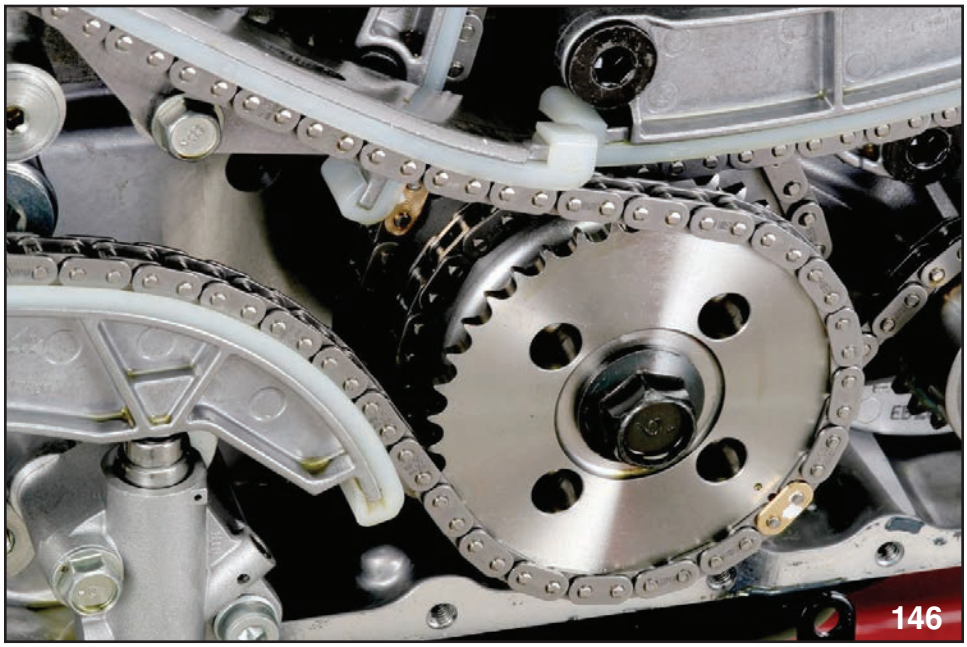


3.6 Liter Engine Showing Timing Chains

This engine uses three (3) timing chains.

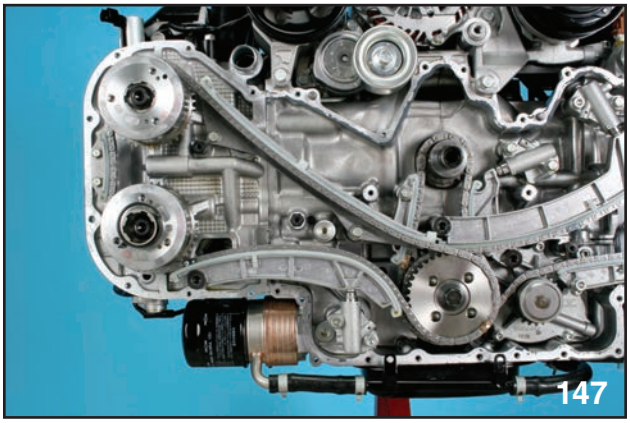


Crank Gear and Idler Gear

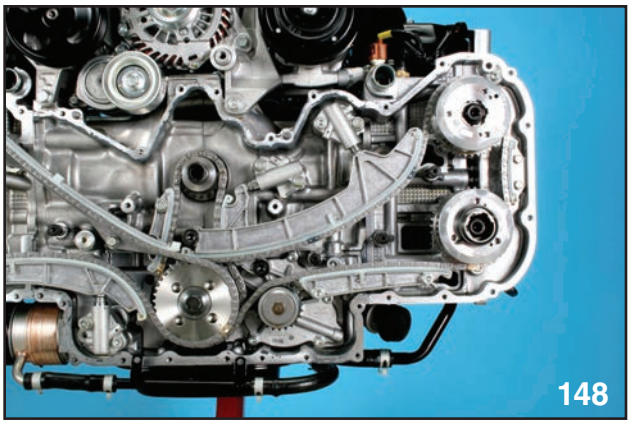


Idler Sprocket

A 10mm chain drives an idler from the Crankshaft sprocket and two 8mm chains driven from the idler operate the left and right bank Camshafts.



Right Bank Camshafts



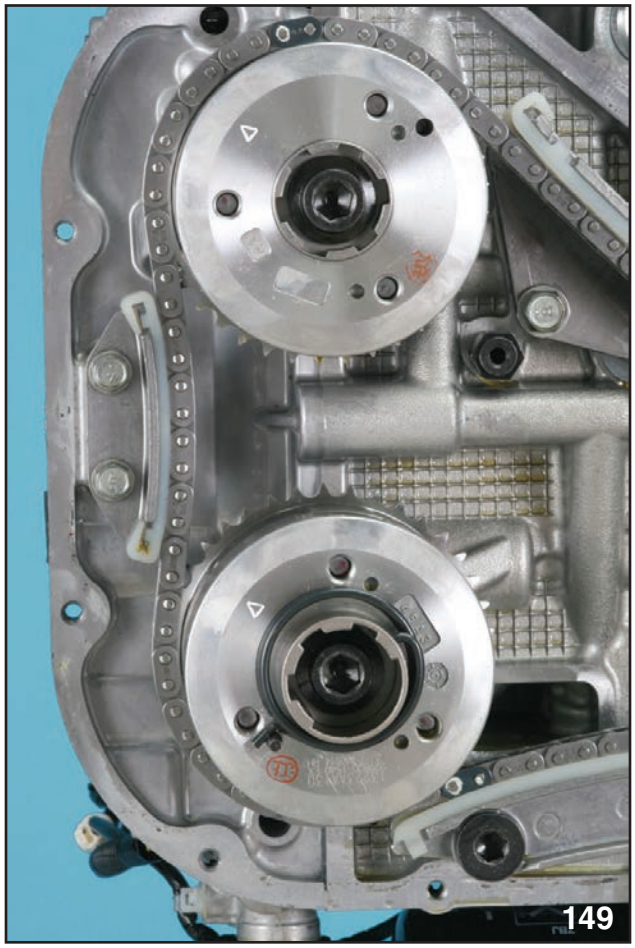
Left Bank Camshafts

The 3.6 liter engine is an interference type. Incorrect chain installation or turning of the Camshafts will result in valve to piston contact. Follow the correct procedures for working on the timing chain components.

THE CHAIN REMOVAL PROCEDURE IN THIS TRB DIFFERS FROM THE SERVICE MANUAL AND MUST BE FOLLOWED STEP BY STEP TO PREVENT PERSONAL INJURY AND DAMAGE TO THE ENGINE.

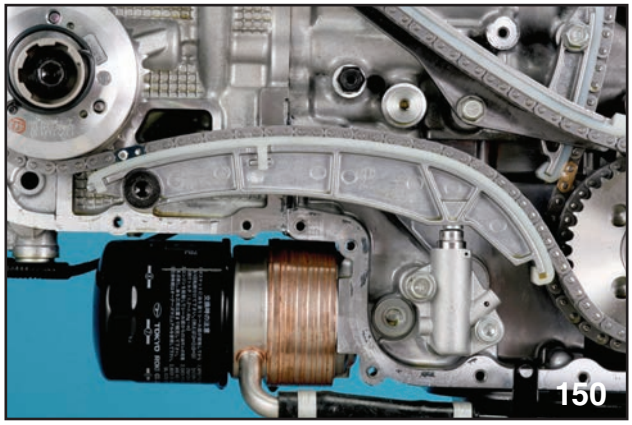
Timing Chain Removal

Right Bank



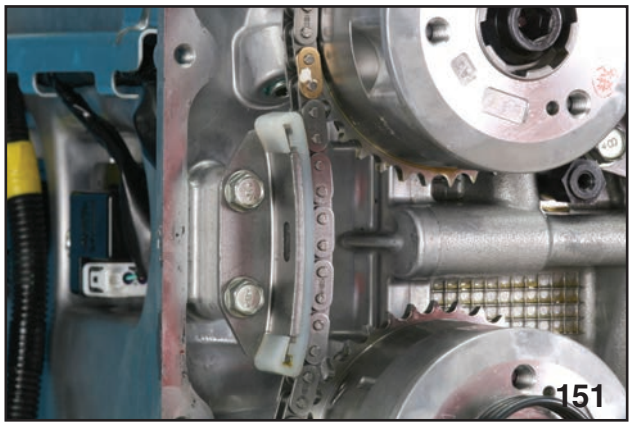
Right Bank Intake and the Exhaust Cam Sprockets 10:00 O'clock position

1. Align the arrow marks of the Intake and the exhaust cam sprockets to 10:00 O'clock.
   - The timing mark of the Intake sprocket will be at 12:00 O'clock.
   - The timing mark of the Exhaust cam sprocket will be at 4:00 O'clock.
   - The timing mark of the crank sprocket will be at 9:00 O'clock.
   - The Keyway on the crank sprocket will be at 12:00 O'clock.
   - The timing mark on the idler will be at 4:00.
   - This will result in the right bank Camshafts resting in an unloaded state.



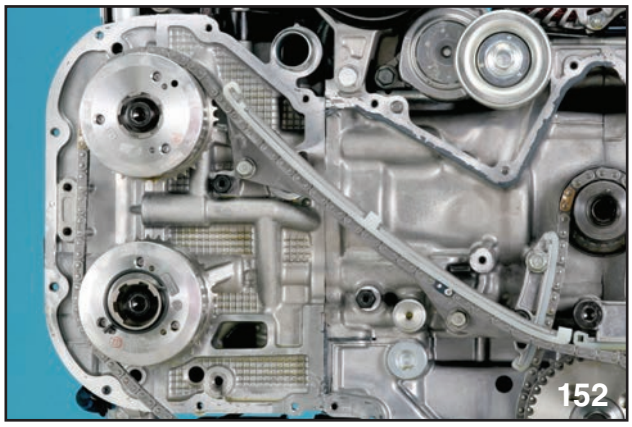
Right Bank Chain Tensioner

2. Remove the chain tensioner.
3. Remove the chain tensioner lever.



Right Bank Short Chain Guide

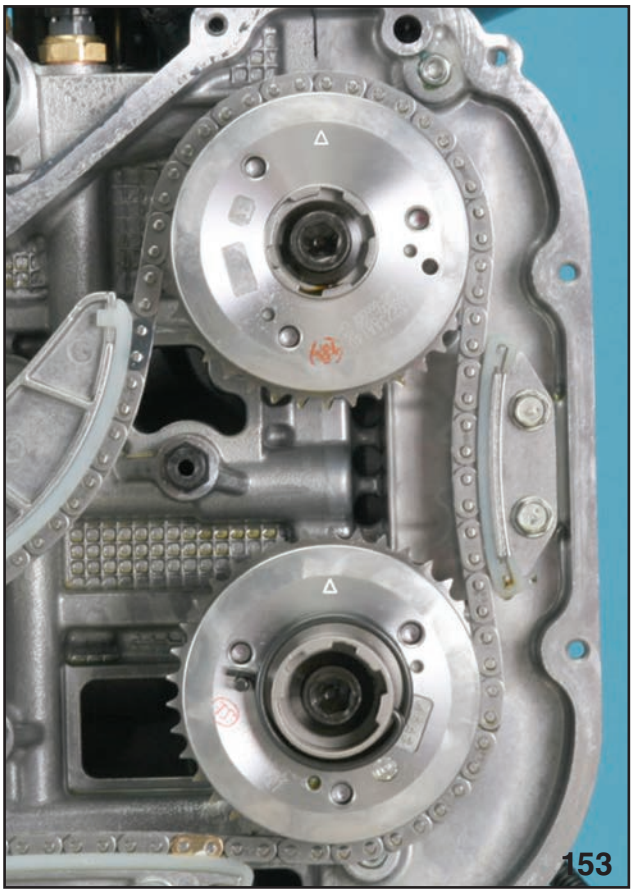
4. Remove the short chain guide.



Right Bank Long Chain Guide

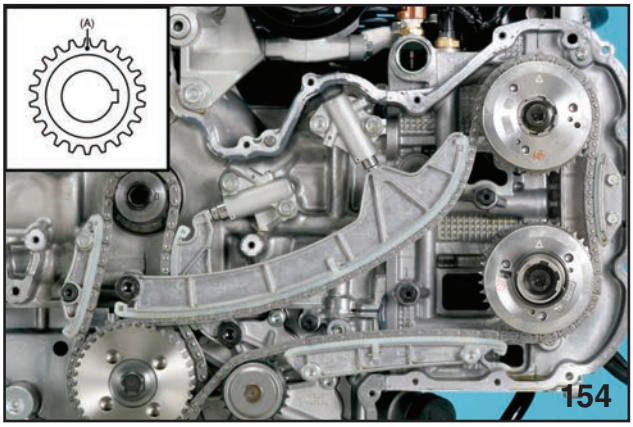
5. Remove the long chain guide.
6. Remove the chain.

Left Bank



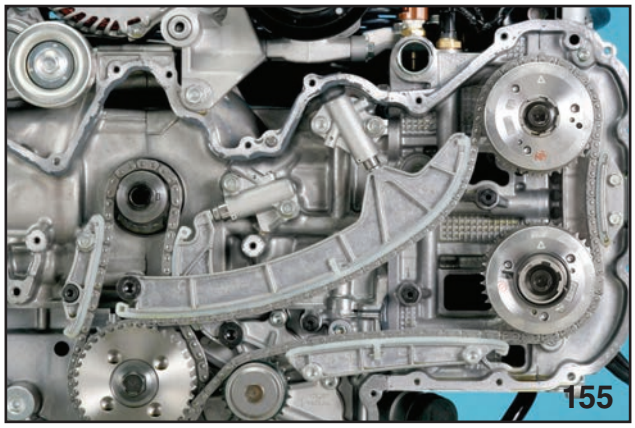
Left Bank Camshaft at 12:00 o'clock Position

7. Rotate the Crankshaft 90 degrees.
   - The Crankshaft timing mark will be at 12:00 o'clock.



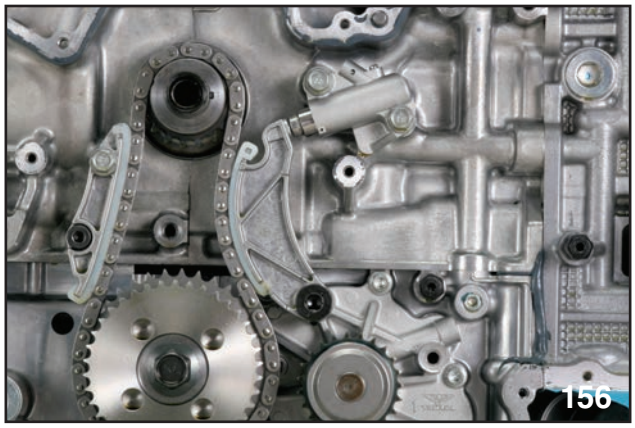
Crankshaft Keyway at 3:00 O'clock

- The Crankshaft Keyway will be at 3:00.
- The arrow marks of the Intake and Exhaust cam sprockets will be at 12:00.
- The timing mark of the Intake sprocket will be at 3:00 o'clock.
- The timing mark of the exhaust cam sprocket will be at 3:00 o'clock.
- The timing mark on the idler will be at 6:00.
- This will result in the left bank Camshafts resting in an unloaded state.



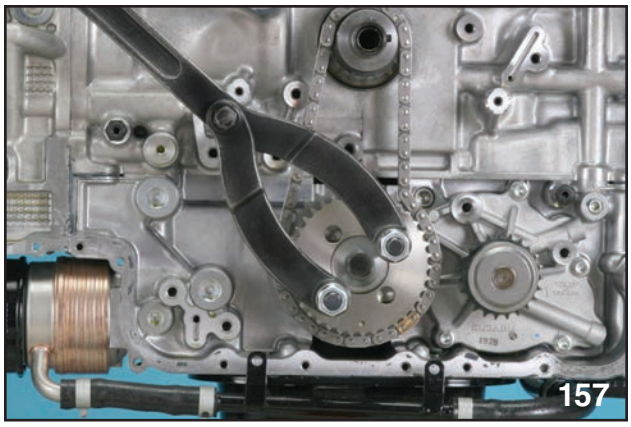
Left Bank Guides

8. Remove the tensioner.
9. Remove the short chain guide.
10. Remove the chain tensioner lever.
11. Remove the long chain guide.
12. Remove the chain.

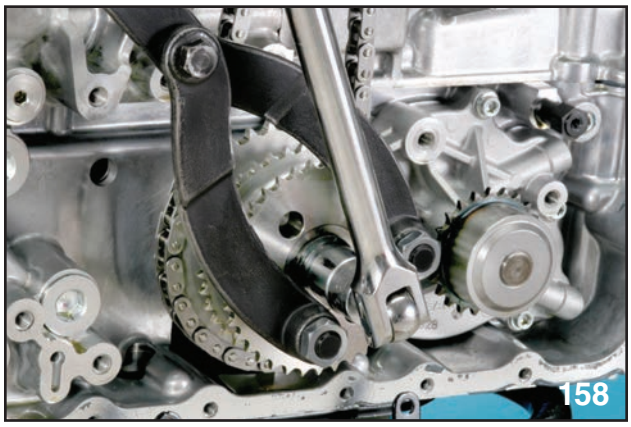


Idler Chain

13. Remove the tensioner.
14. Remove the chain guide.
15. Remove the chain tensioner lever.

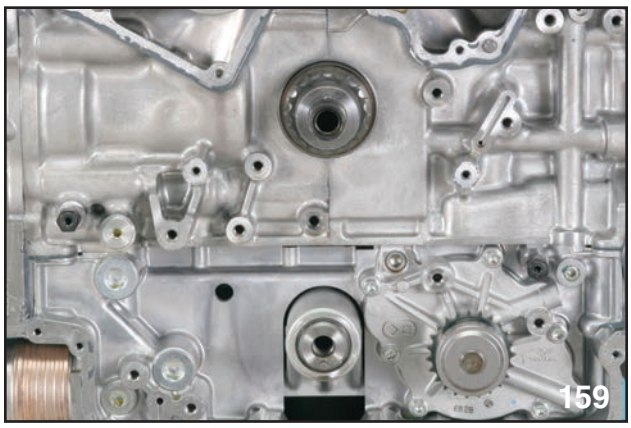


ST18355AA000 Pulley Wrench and ST18334AA000 Pin Set



Breaker Bar and Socket

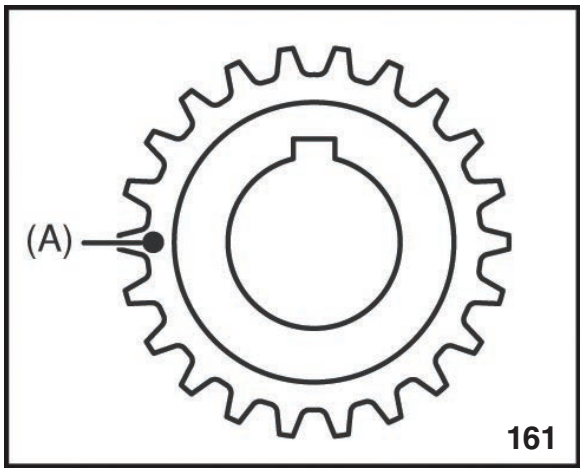
Use ST18355AA000 and ST18334AA000 to hold the idler stationary and remove the idler bolt. Remove the Crankshaft sprocket, chain and the idler together.



Idler Sprocket and Oil Pump

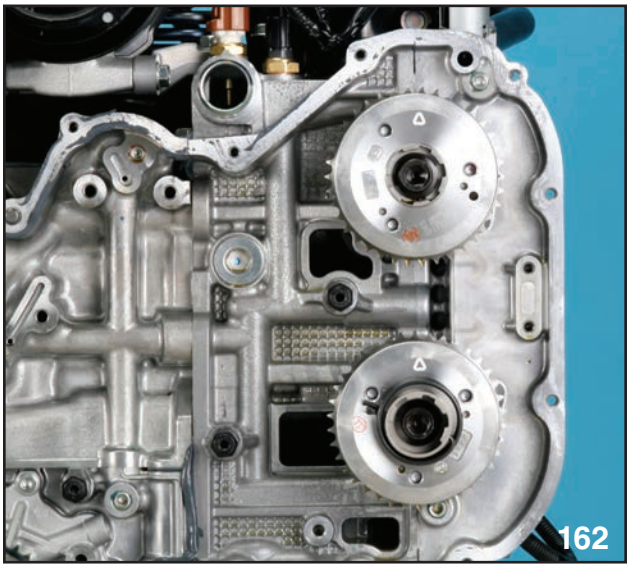
The idler sprocket also serves as the drive for the Oil Pump.

Timing Chain Installation

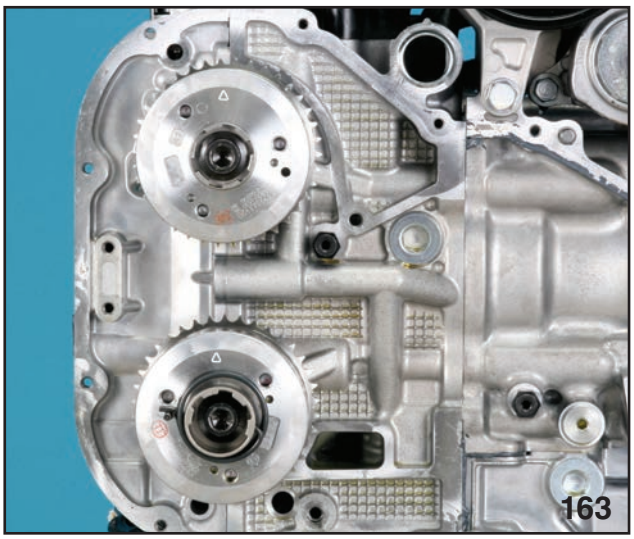


Crankshaft Keyway at 12:00 O'clock

1. Position the Crankshaft Keyway at 12:00 O'clock (timing mark at 9:00 O'clock.)

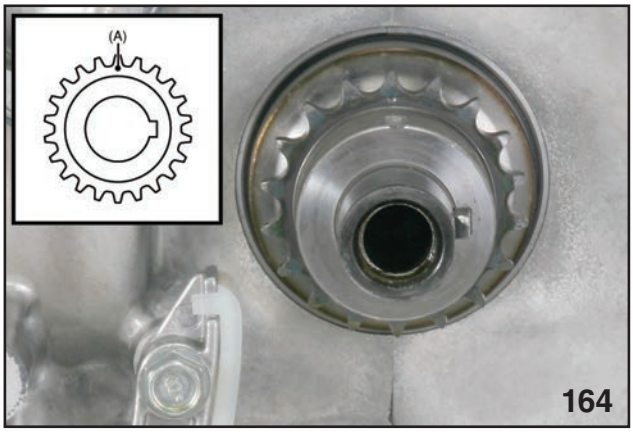


Intake and Exhaust Camshaft Sprockets Arrows 12:00 O'clock



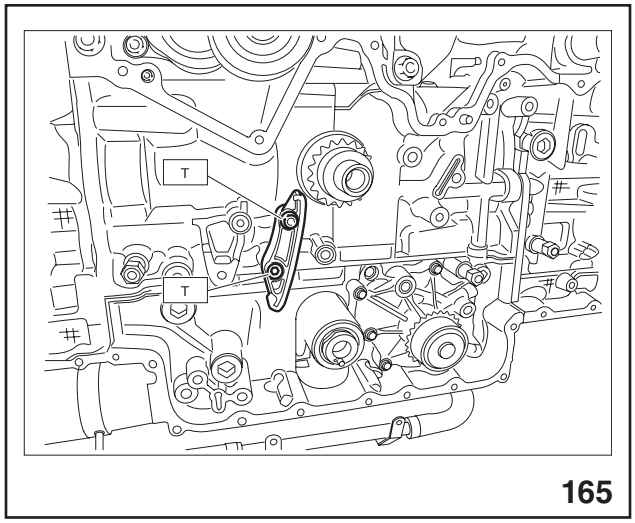
Intake Sprocket Arrows 12:00 o'clock

2. Align the arrow marks of the intake and exhaust cam sprockets to 12:00 o'clock.



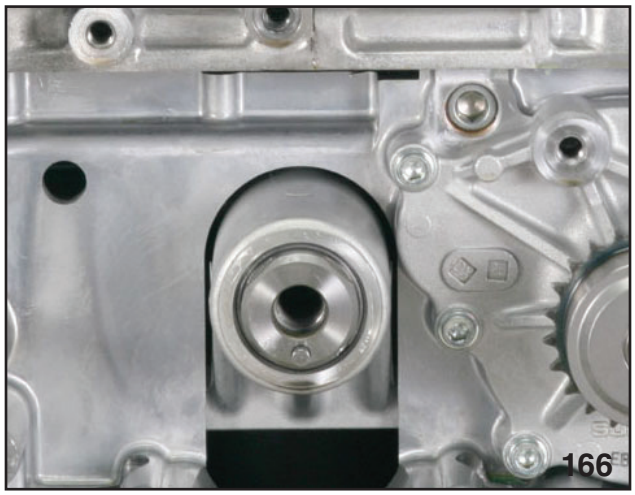
Crankshaft Keyway at 3:00 o'clock

3. Position the Crankshaft Keyway to 3:00 o'clock (timing mark to 12:00 o'clock.)



Chain Guide

4. Install the chain guide.
5. Remove the Crankshaft Sprocket and assemble the timing chain, idler and Crankshaft Sprocket together. Position the parts on the Crankshaft and Oil Pump drive.

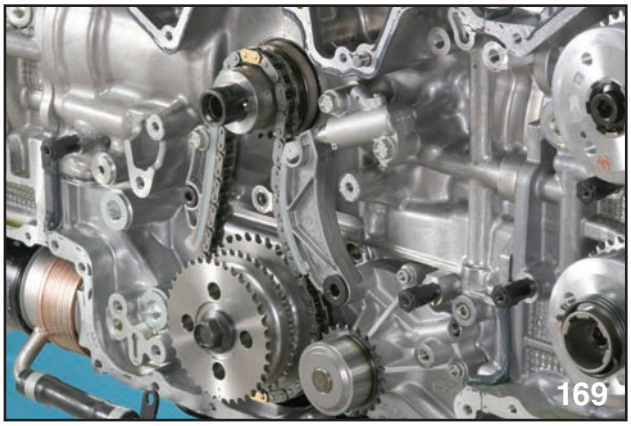


Oil Pump

Note: The oil pump drive pin must be positioned at 6:00 O'clock.

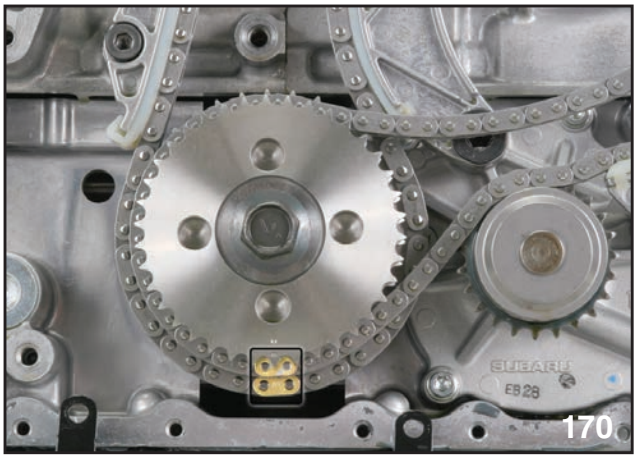
Crank to Idler

Chains

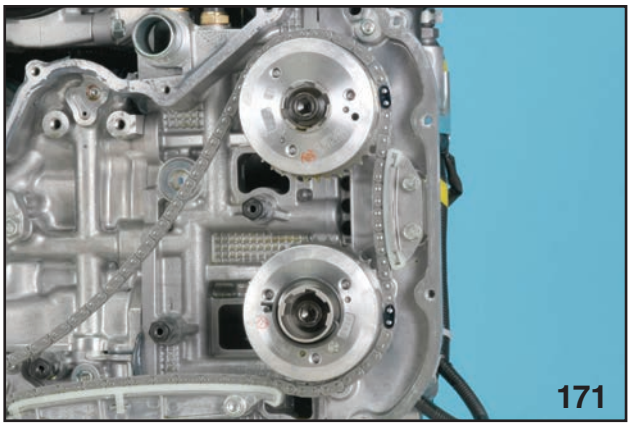


Idler Chain

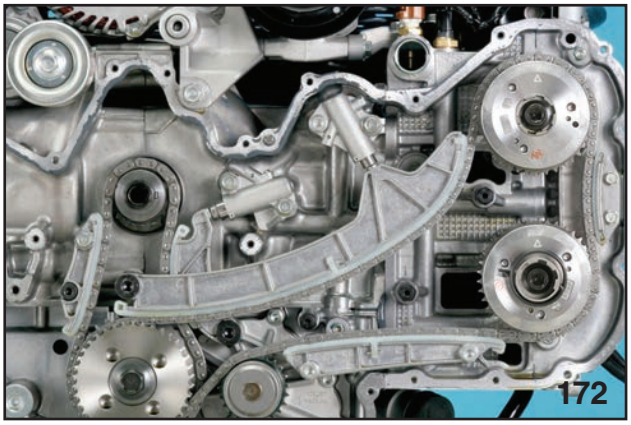
6. Install the chain tensioner lever and tensioner.
   Confirm the timing marks for the Crankshaft gear and idler are correctly positioned and release the captured tensioner.
7. Install the left bank long and short chain guides. Install the timing chain ensuring the timing marks on the idler gear and intake and Exhaust Camshaft sprockets are properly engaged with the timing chain.



Idler Timing Marks

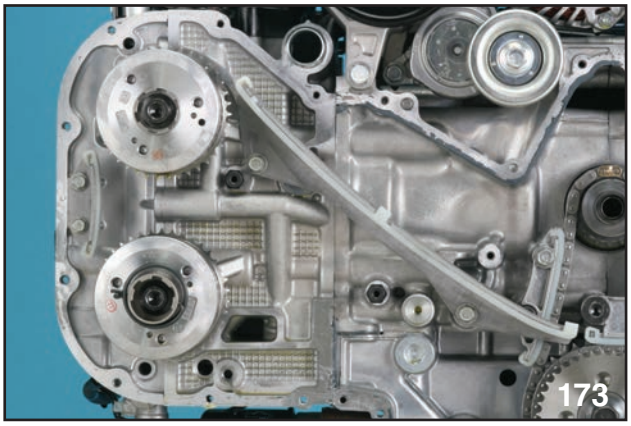


Camshaft Sprocket Timing Marks



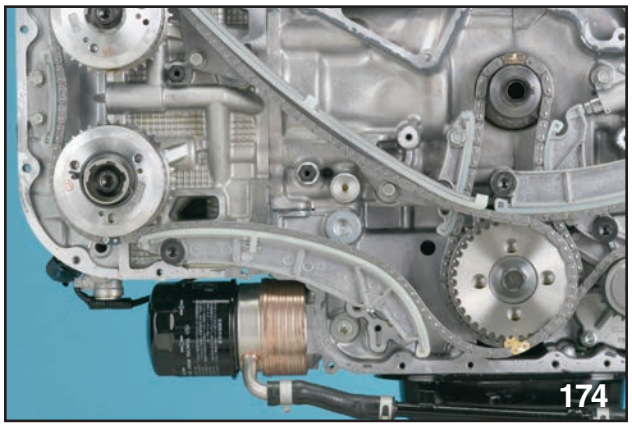
Chain Tensioner Lever and Tensioner

8. Install the chain tensioner lever and the tensioner. Release the captured tensioner.



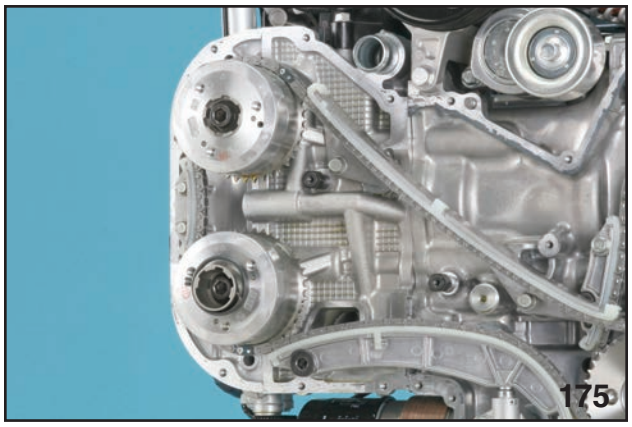
Long and Short Chain Guide

9. Install the right bank long and short chain guide.



Right Bank Chain

10. Install the timing chain ensuring the marks of the chain align with the marks on the intake and Exhaust Camshaft sprockets and idler. Install the chain tensioner lever and tensioner.



Camshaft Sprocket Timing Marks

11. Release the captured tensioner.

The Dual Active Valve Timing System

The Dual Active Valve Timing System controls both the Intake and Exhaust Camshafts. The Intake Camshaft is advanced. The Exhaust Camshaft is retarded.

Intake and Exhaust OCV

Both Camshafts are operated by an Oil Charge Valve (OCV) that receives a duty ratio from the ECM. The higher the duty ratio, the higher the degree of operation.

The Intake Camshaft can advance up to 51 degrees ahead of its basic idle setting. When it advances it is rotated in the same direction as the engine operates (clockwise as viewed from the front of the engine).

The Exhaust Camshaft can retard up to 21 degrees behind its basic idle setting. When it retards it is rotated in the opposite direction of engine rotation (counter clockwise as viewed from the front of the engine).

Item	Value	Unit	Maximum
☑ OCV Duty R	39.6	%	46.7
☑ VVT Adv. Ang. Amount R	20	deg	51
☑ Exh OCV Duty R	47.8	%	51.0
☑ Exh. VVT Retard Ang. R	12	deg	21

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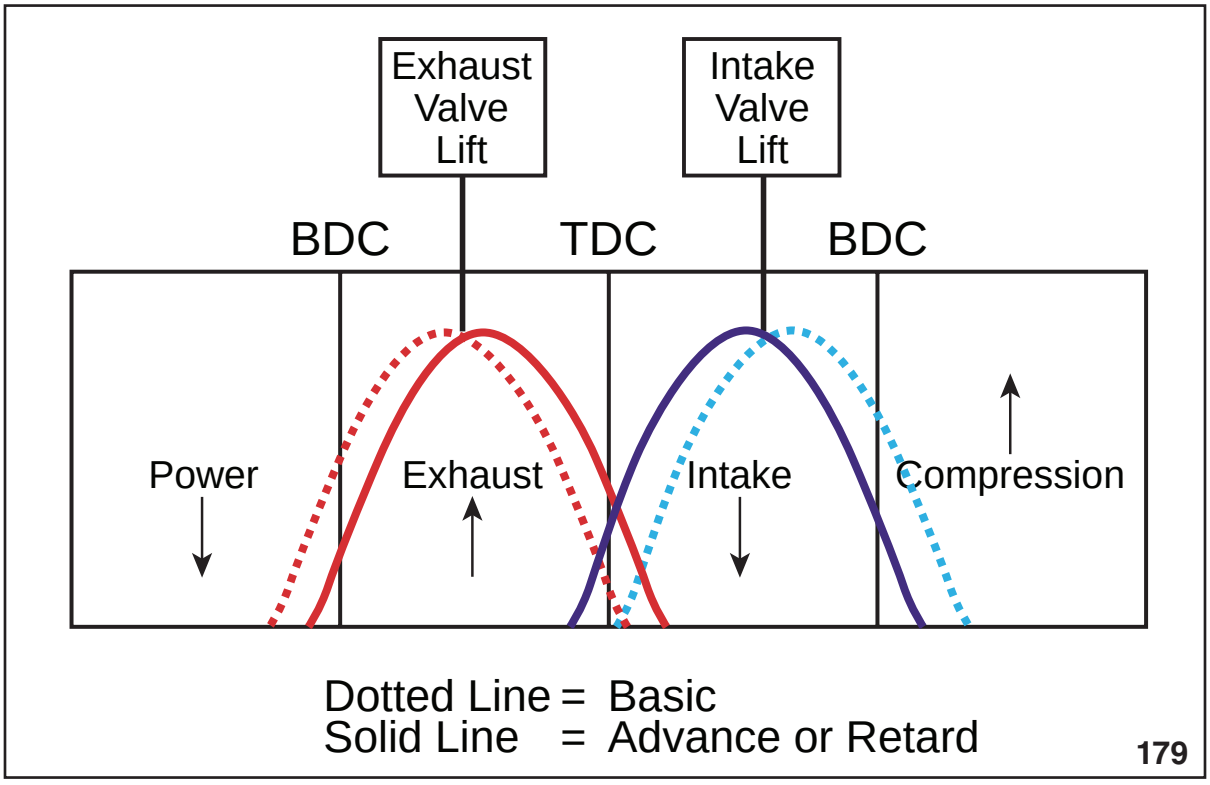
Chart

When the Intake Camshaft is advanced it allows more air and fuel to enter the cylinder and results in more power from combustion.

When the Exhaust Camshaft is retarded it allows the expanding gases of the power stroke to push on the piston for a longer period of time resulting in better fuel efficiency.

By combining the precise control of both Camshafts together a condition is created where the Intake and Exhaust valves work together to create better scavenging of the cylinders, reduced pumping loss and a better internal EGR affect.



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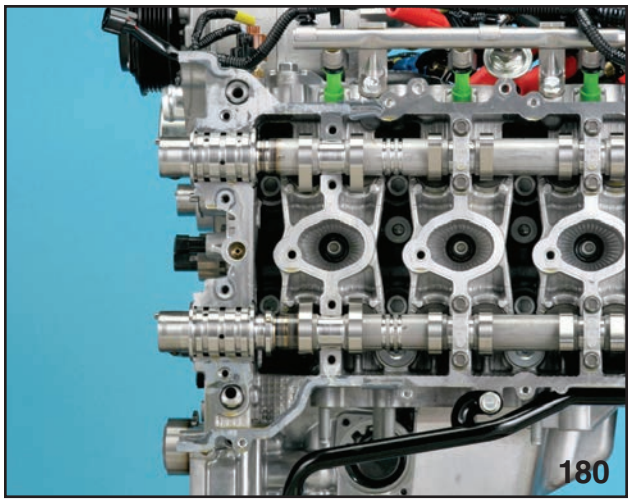
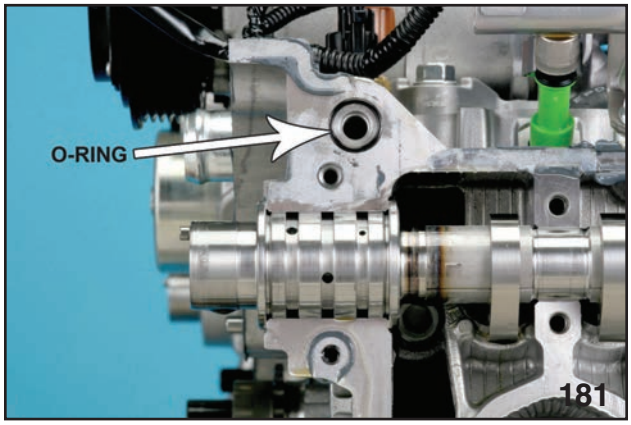
Graph

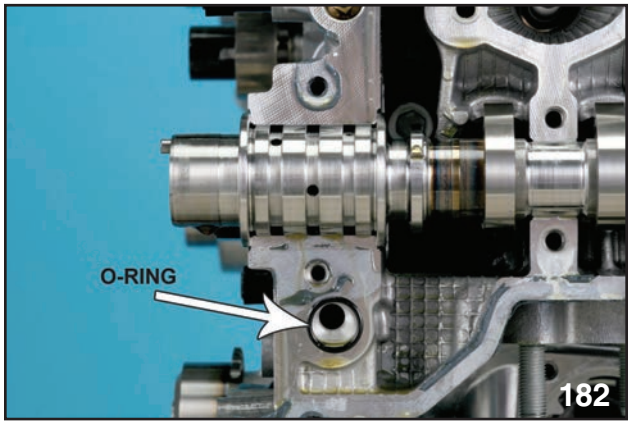


Camshaft OCV Oil Ports

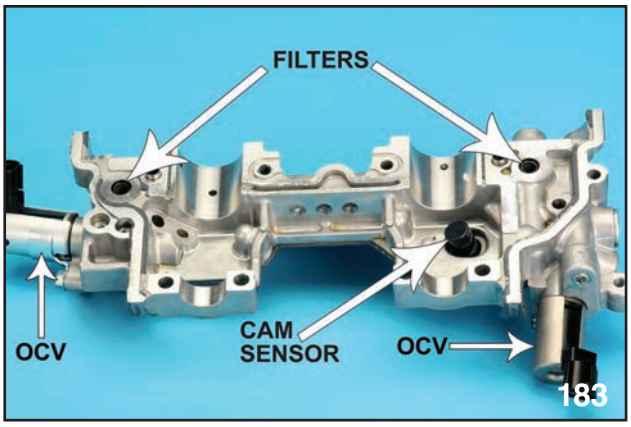


O-ring

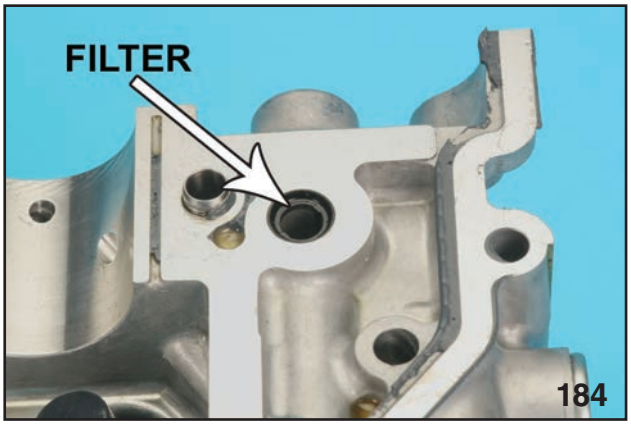
Oil pressure is delivered to the apply and release side of actuators of the intake and exhaust sprockets through oil ports made into the end of each Camshaft.



O-ring



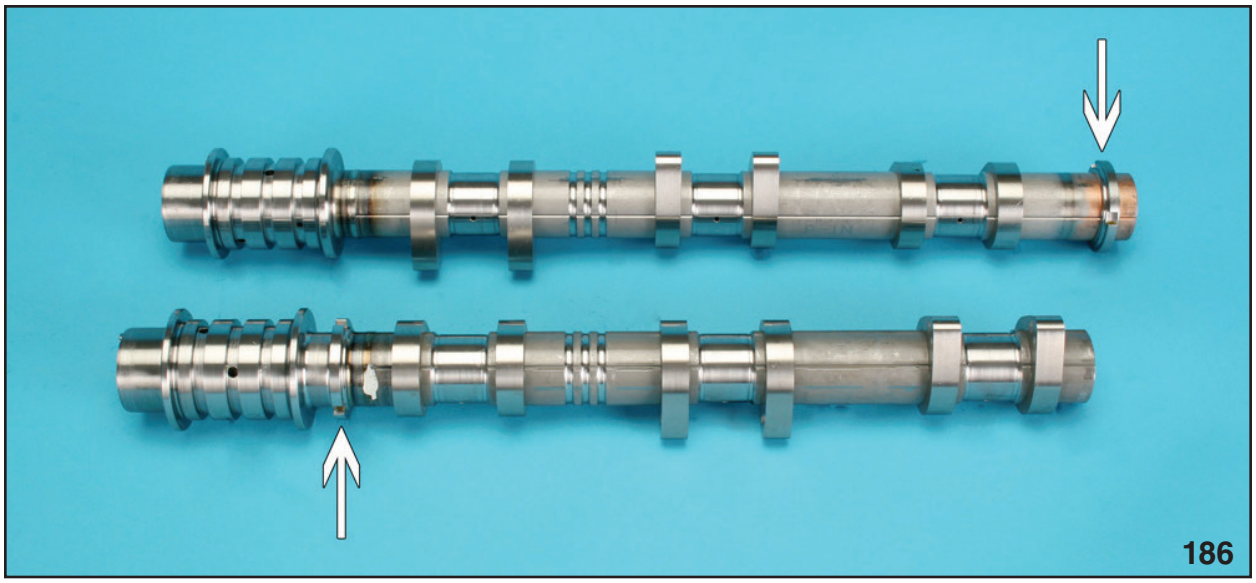
Placements of Filters, OCV, Cam Sensor on Camshaft Cap



Placement of Oil Filter

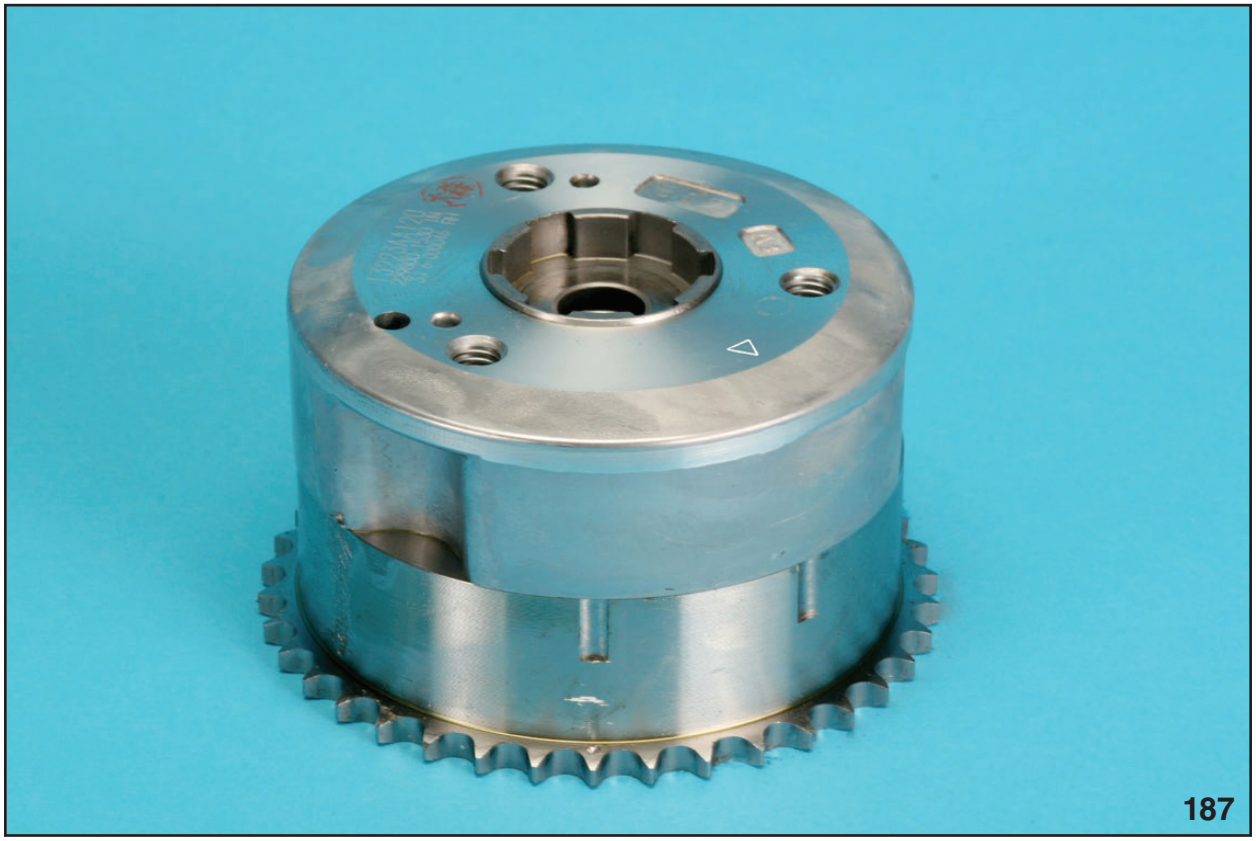
The Camshaft cap houses the OCV of each Camshaft and a small oil filter is installed into the Camshaft cap that filters oil before entering the OCV.

Oil Filter

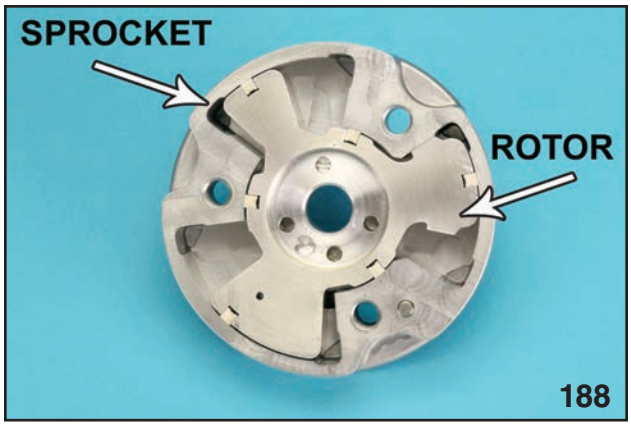


Camshaft Sensor Reluctors

The intake and Exhaust Camshafts both have a reluctor for the Camshaft sensors.

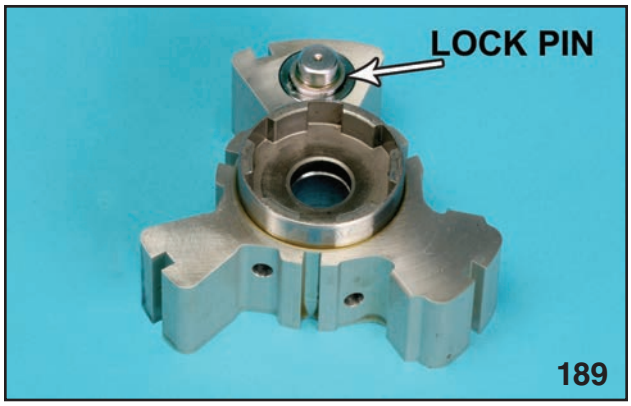


Intake Camshaft Sprocket

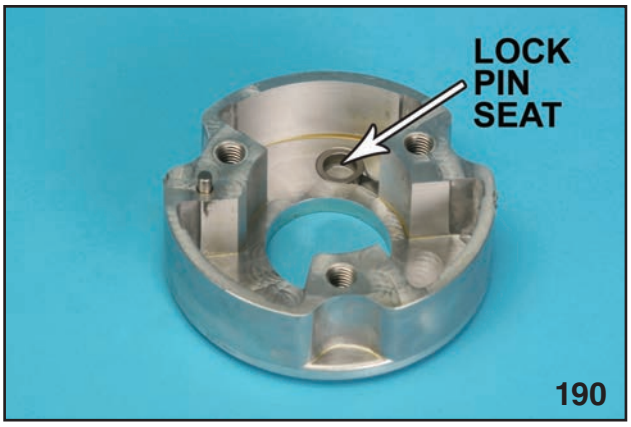


Sprocket and Rotor Attached to Camshaft

The variable valve timing is possible because of the ability of independent movement of the chain sprocket and the inner rotor which is attached to the Camshaft. As oil pressure is applied to one side or the other of the rotor the Camshaft will rotate, in or opposite engine rotation direction.



Inner Rotor Built In Lock Pin

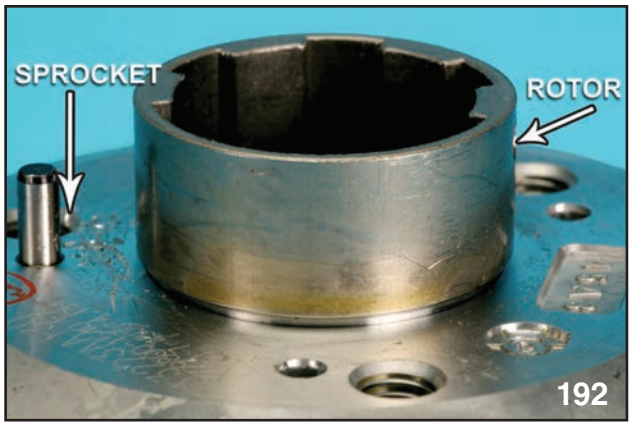


Lock Pin Seat

Each inner rotor has a built in lock pin which is spring loaded to keep the inner rotor locked to the chain sprocket. This is needed for engine start up and fail-safe operation. When the ECM decides to adjust the valve timing the lock pin is pushed into the rotor with oil pressure from the OCV and the lock pin is released from the chain sprocket.

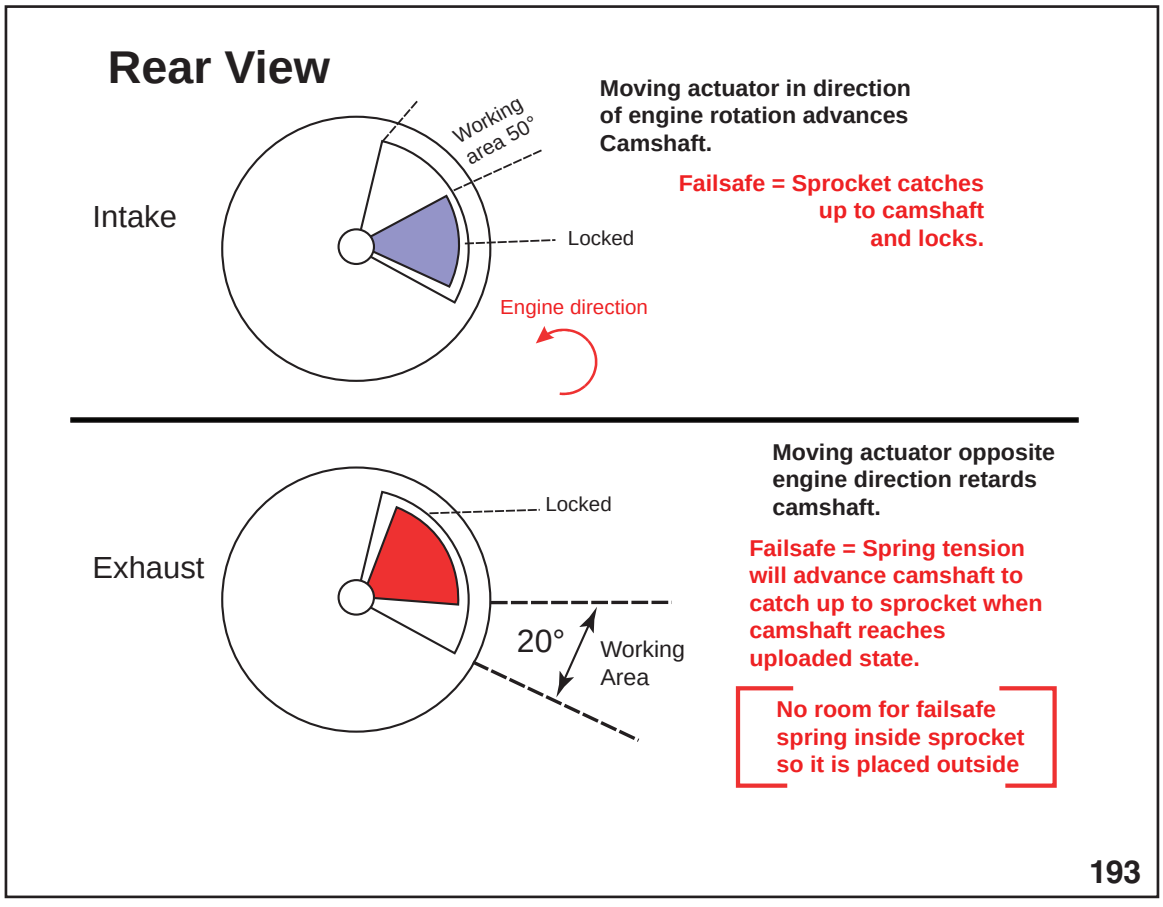
The Intake Camshaft is always at a basic level (locked) or advanced (moving ahead of the chain sprocket). When fail-safe occurs the chain sprocket will catch up to the rotor and the lock pin will engage into the lock pin seat made on the chain sprocket.

Exhaust Camshaft Sprocket and Return Spring



Sprocket and Rotor location

The Exhaust Camshaft is always at a basic level (locked) or retarded (moving opposite of the chain sprocket rotation). When fail-safe occurs it is necessary to use a return spring to move the Camshaft rotor in the direction of rotation of the chain sprocket. During deceleration or when the Camshaft reaches an unloaded state the force of the spring will move the rotor and Camshaft clockwise until the lock pin reaches the lock pin seat and the spring loaded lock pin will lock into the chain sprocket.



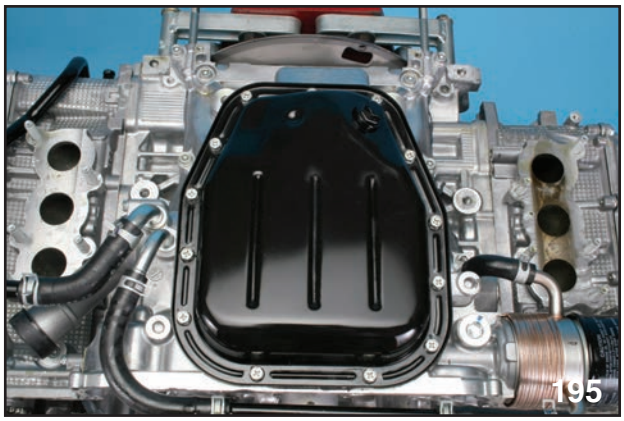
Rear View Chart

New 2008 3.6 Liter Engine Trouble Codes

DTC	Item	Reference
P0014	Exhaust AVCS system 1 (range/performance)	<Ref. to EN (H6DO) (diag)-93, DTC P0014 EXHAUST AVCS SYSTEM 1 (RANGE/PERFORMANCE), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P0017	Crank and Cam timing B system failure (Bank 1)	<Ref. to EN(H6DO)(diag-95, DTC P0017 CRANK AND CAM TIMING B SYSTEM FAILURE - (BANK 1), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P0019	Crank and Cam timing B system failure (Bank 2)	<Ref. to EN(H6DO)(diag)-97, DTC P0019 CRANK AND CAM TIMING B SYSTEM FAILURE (BANK 2), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P0024	Exhaust AVCS system 2 (range/performance)	<Ref. to EN(H6DO)(diag)-99, DTC P0024 EXHAUST AVCS SYSTEM 2 (RANGE/PERFORMANCE), Diagnostic Procedure with diagnostic Trouble Code (DTC).>
P0365	Camshaft Position Sensor “B” Circuit (Bank 1)	<Ref. to EN(H6DO)(diag)-256, DTC P0365 Camshaft POSITION SENSOR “B” CIRCUIT (BANK 1), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P0390	Camshaft Position Sensor “B” Circuit (Bank 2)	<Ref. to EN(H6DO)(diag)-258, DTC P0390 Camshaft POSITION SENSOR “B” CIRCUIT (BANK 2), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P0400	Exhaust Gas Recirculation Flow	<Ref. to EN(H6DO)(diag)-260, DTC P0400 EXHAUST GAS RECIRCULATION FLOW. Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P1492	EGR Solenoid Valve Signal #1 Circuit Malfunction (Low Input)	<Ref. to EN(H6DO)(diag)-315, DTC P1492 EGR SOLENOID VALVE SIGNAL #1 CIRCUIT MALFUNCTION (LOW INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P1493	EGR Solenoid Valve Signal #1 Circuit Malfunction (High Input)	<Ref. to EN(H6DO)(diag)-315, DTC P1493 EGR SOLENOID VALVE SIGNAL #1 CIRCUIT MALFUNCTION (HIGH INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P1494	EGR Solenoid Valve Signal #2 Circuit Malfunction (Low Input)	<Ref. to EN(H6DO)(diag)-315, DTC P1494 EGR SOLENOID VALVE SIGNAL #2 CIRCUIT MALFUNCTION (LOW INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P1495	EGR Solenoid Valve Signal #2 Circuit Malfunction (High Input)	<Ref. to EN(H6DO)(diag)-315, DTC P1495 EGR SOLENOID VALVE SIGNAL #2 CIRCUIT MALFUNCTION (HIGH INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P1496	EGR Solenoid Valve Signal #3 Circuit Malfunction (Low Input)	<Ref. to EN(H6DO)(diag)-315, DTC P1496 EGR SOLENOID VALVE SIGNAL #3 CIRCUIT MALFUNCTION (LOW INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>

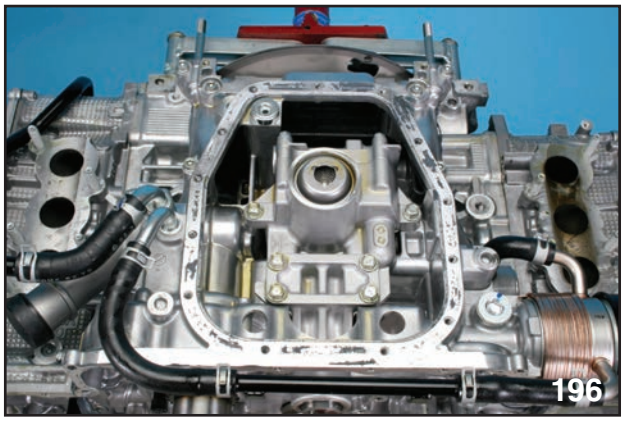
DTC	Item	Reference
P1497	EGR Solenoid Valve Signal #3 Circuit Malfunction (High Input)	<Ref. to EN(H6DO)(diag)-315, DTC P1497 EGR SOLENOID VALVE SIGNAL #3 CIRCUIT MALFUNCTION (HIGH INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P1498	EGR Solenoid Valve Signal #4 Circuit Malfunction (Low Input)	<Ref. to EN(H6DO)(diag)-316, DTC P1498 EGR SOLENOID VALVE SIGNAL #4 CIRCUIT MALFUNCTION (LOW INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P1499	EGR Solenoid Valve Signal #4 Circuit Malfunction (High Input)	<Ref. to EN(H6DO)(diag)-319, DTC P1499 EGR SOLENOID VALVE SIGNAL #4 CIRCUIT MALFUNCTION (HIGH INPUT), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P2090	Exhaust Camshaft Position Actuator Control Circuit Low (Bank 1)	<Ref. to EN(H6DO)(diag)-338, DTC P2090 EXHAUST Camshaft POSITION ACTUATOR CONTROL CIRCUIT LOW (BANK 1), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P2091	Exhaust Camshaft Position Actuator Control Circuit High (Bank 1)	<Ref. to EN(H6DO)(diag)-340, DTC P2091 EXHAUST Camshaft POSITION ACTUATOR CONTROL CIRCUIT HIGH (BANK 1), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P2094	Exhaust Camshaft Position Actuator Control Circuit Low (Bank 2)	<Ref. to EN(H6DO)(diag)-346, DTC P2094 EXHAUST Camshaft POSITION ACTUATOR CONTROL CIRCUIT LOW (BANK 2), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
P2095	Exhaust Camshaft Position Actuator Control Circuit High (Bank 2)	<Ref. to EN(H6DO)(diag)-348, DTC P2095 EXHAUST Camshaft POSITION ACTUATOR CONTROL CIRCUIT HIGH (BANK 2), Diagnostic Procedure with Diagnostic Trouble Code (DTC).>

Oil Pump Removal



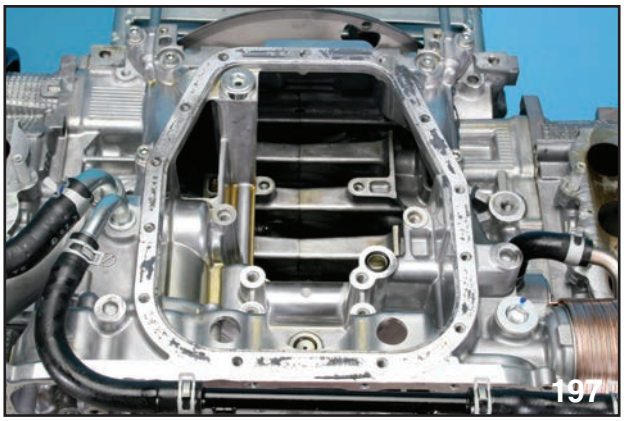
Lower Oil Pan

The lower Oil Pan is attached to the upper Oil Pan with 13 bolts and sealed with liquid gasket.

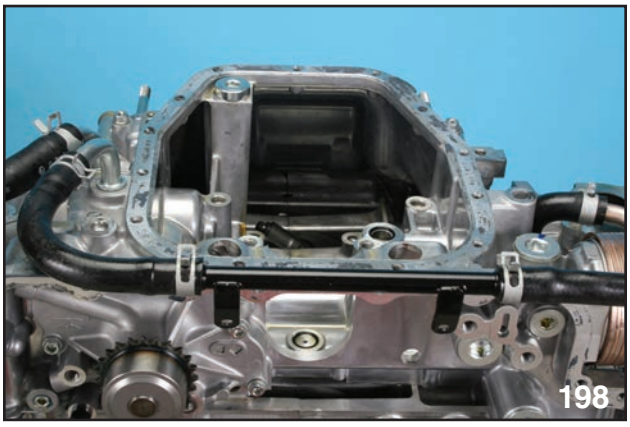


Oil Pump

Six (6) bolts secure the Oil Pump to the upper Oil Pan and 2 O-rings seal the Oil Pump to the upper Oil Pan.



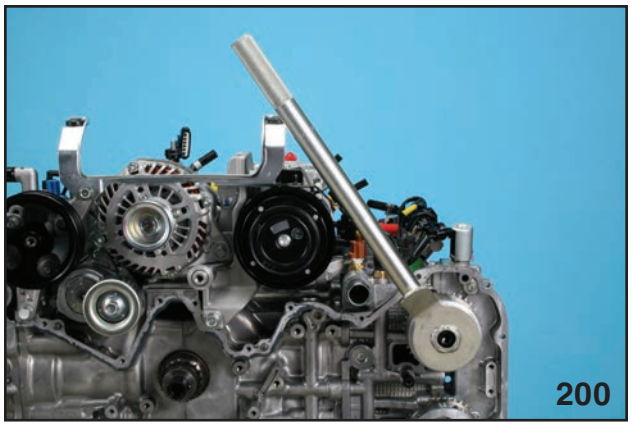
O-rings (2)



Oil Pump R &R is an in car procedure

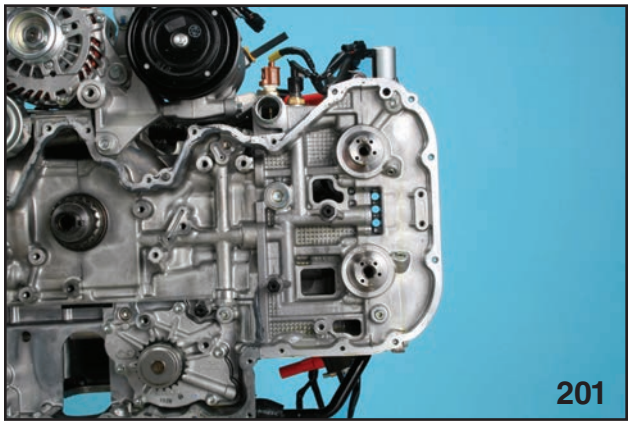
Cylinder head removal is required to remove the upper Oil Pan.

Cylinder Head Removal

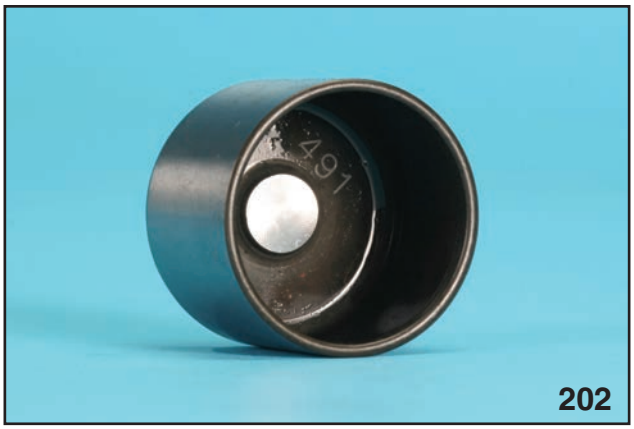


ST499977500

Remove the Camshaft sprockets using ST499977500 and a 10 mm Allen Wrench.



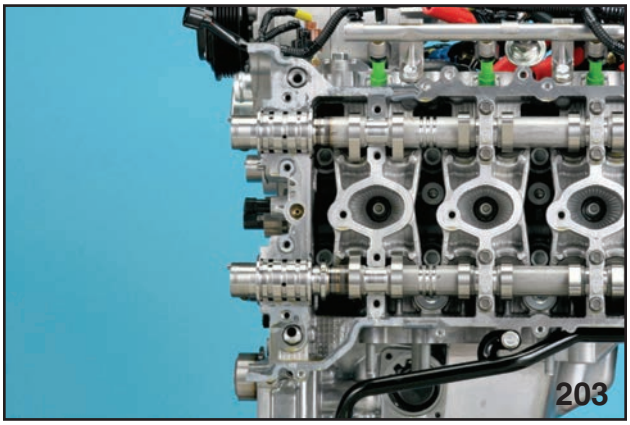
Camshaft Sprockets Removed



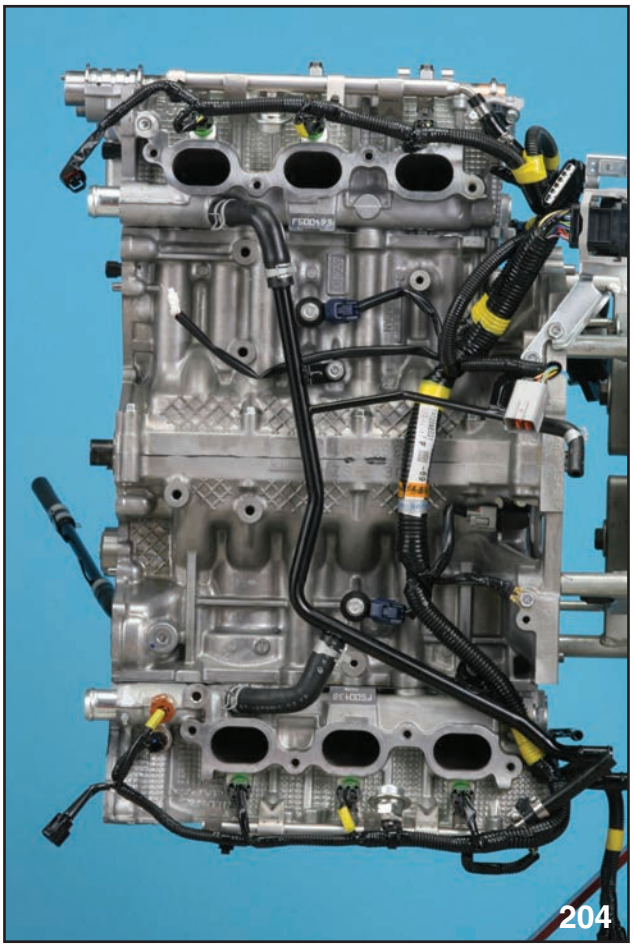
Shim Bucket

Remove the valve cover, Camshaft caps and Camshafts. (Valve Shim Buckets will fall when the Camshafts are removed. Carefully remove and maintain position for reassembly.)

Remove the cylinder head bolts and cylinder heads.

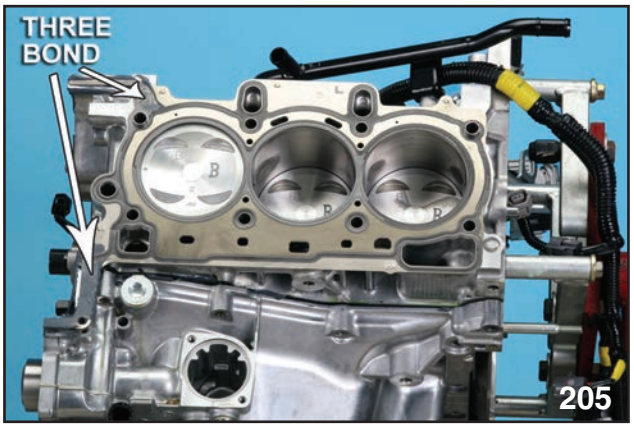


Cylinder Head Bolts

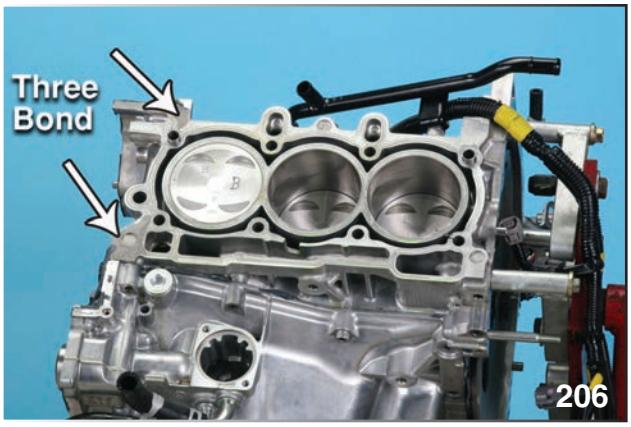


Wiring Harnesses, Coolant Lines and Hoses on Cylinder Heads

Remove wiring harnesses, coolant lines and hoses from the cylinder heads.

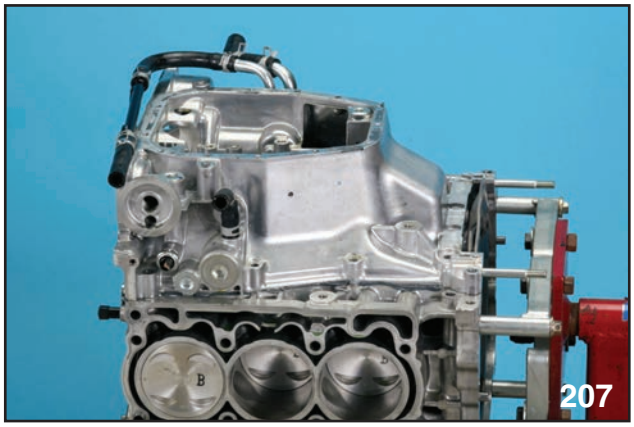


Head Gaskets Upper



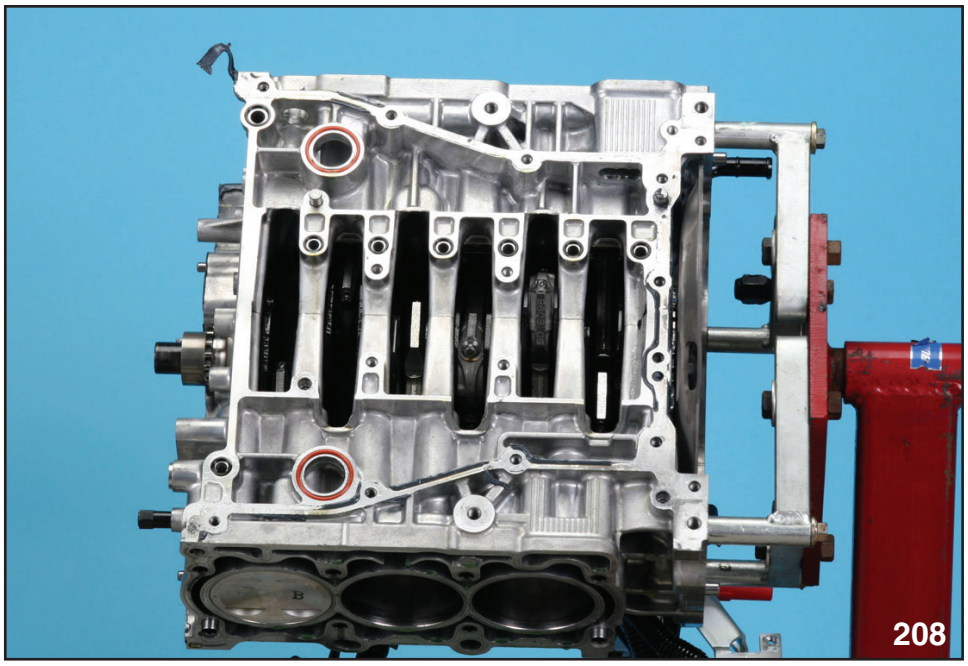
Head Gaskets Lower

The head gaskets receive three bond on and below the head gasket at the indicated points.



Upper Oil Pan

Remove the bolts from the upper Oil Pan and remove the upper Oil Pan from the cylinder block.

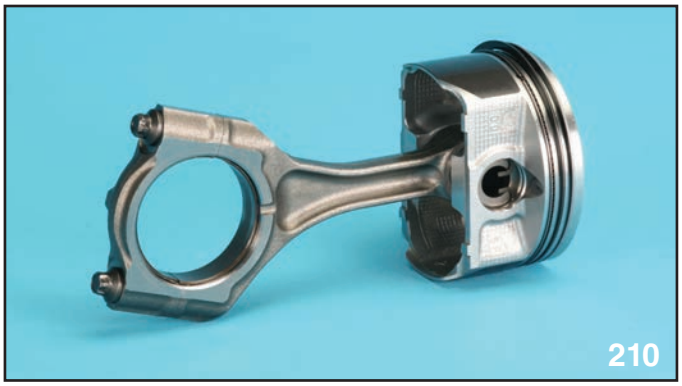


Showing O-rings

There are 10 O-rings that seal the coolant and oil passages between the upper Oil Pan and the engine block.

Connecting Rod

The shape and design of the Connecting Rod provides strength and allows for the increase in stroke.



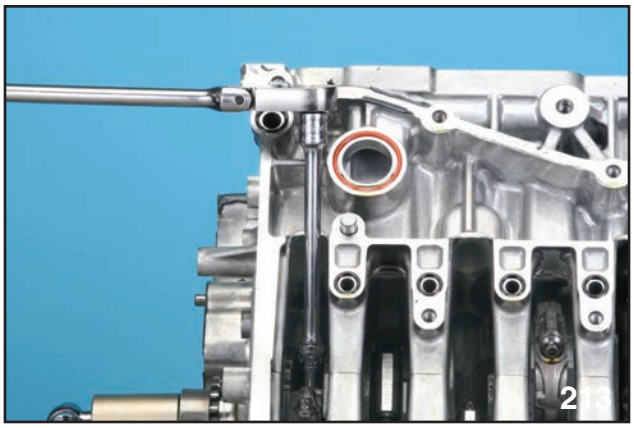
Connecting Rod Side View

Connecting Rod Cap Seam

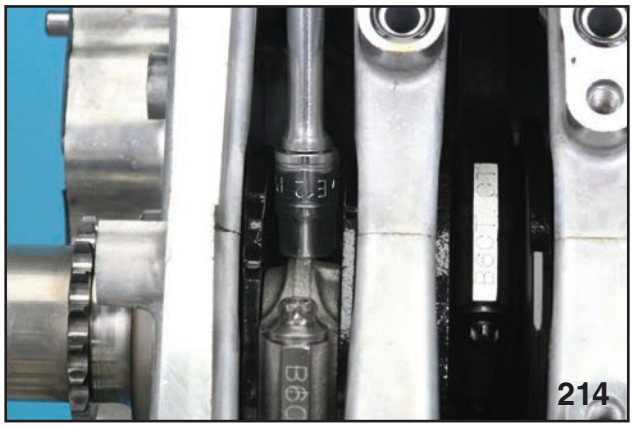
Connecting Rod Cap Separated from Rod

The Connecting Rod cap is snapped from the Connecting Rod during construction which allows for a perfect fit to the Connecting Rod. This eliminates the need for dowel pins or other alignment devices.

The overall length of the Connecting Rod is shorter than the 3.0 liter but the Connecting Rod journal is 5.5 mm longer. The shape of the Connecting Rod ensures clearance between the Connecting Rod end cap and the bottom of the piston of a companion cylinder.



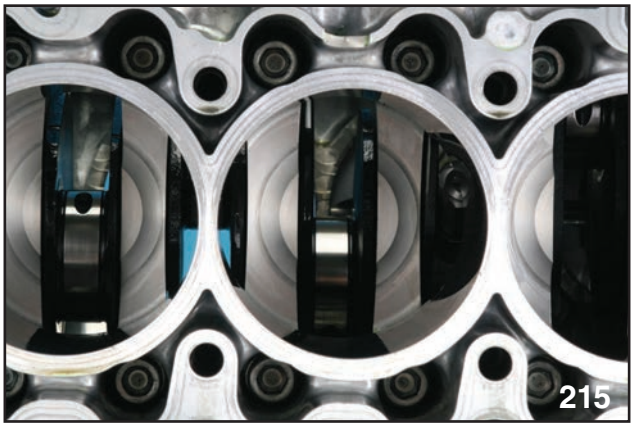
E 12 Torx® Socket on Connecting Rod Bolt



Removal of Connecting Rod Bolt

The Connecting Rods are accessed from the bottom of the engine block. An E 12 Torx® socket is necessary to remove the Connecting Rod bolts.

Removal of the Connecting Rod caps and pistons should be performed in three stages. First, remove the # 1, # 4 Connecting Rod caps and pistons at the same time, then remove the # 2, # 5 Connecting Rod caps and pistons at the same time, then # 3, # 6 Connecting Rod caps and pistons at the same time.



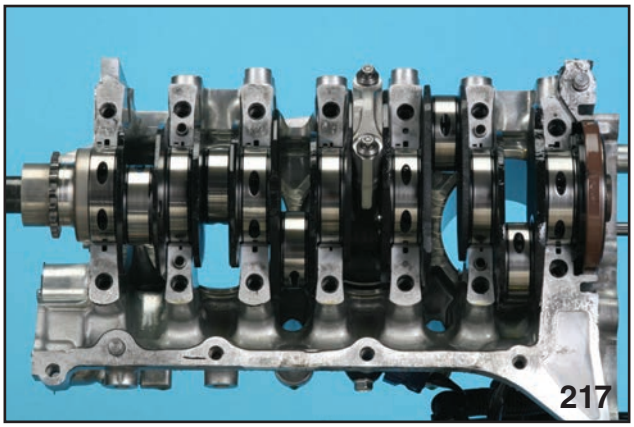
Connecting Rods

Remove the pistons with thumb pressure to the bottom of the Connecting Rods.

NOTES:

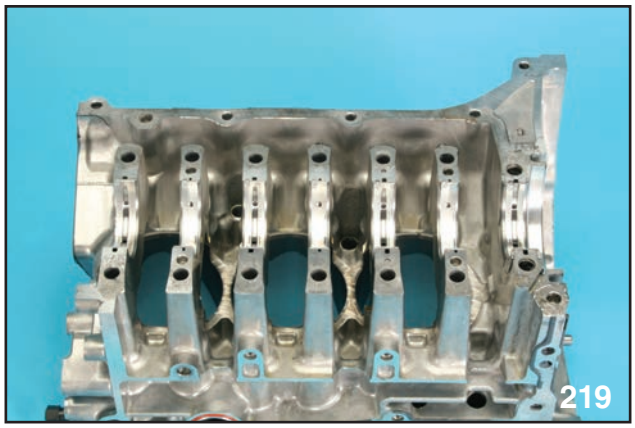
Cylinder Block

Remove the cylinder block bolts and split the block. The washers of the cylinder block bolts use a rubber inlay. The 2 most rear block bolts do not use rubber inlaid washers.



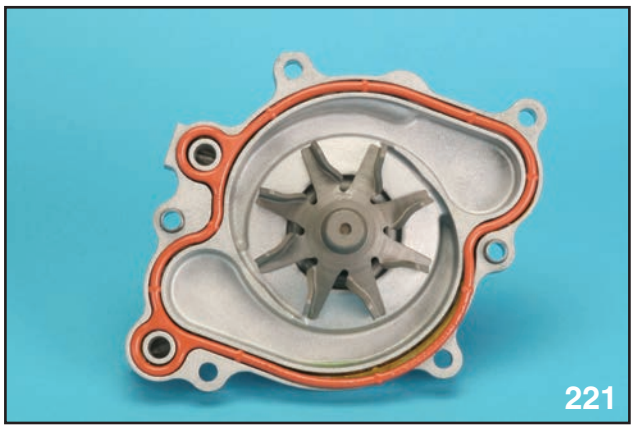
Cylinder Block

Crankshaft

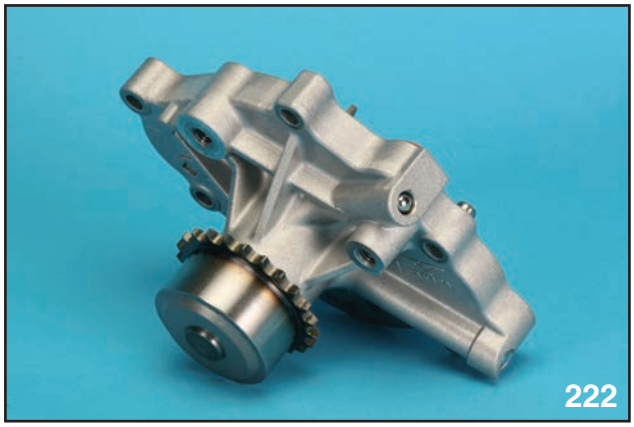


Split Block Case

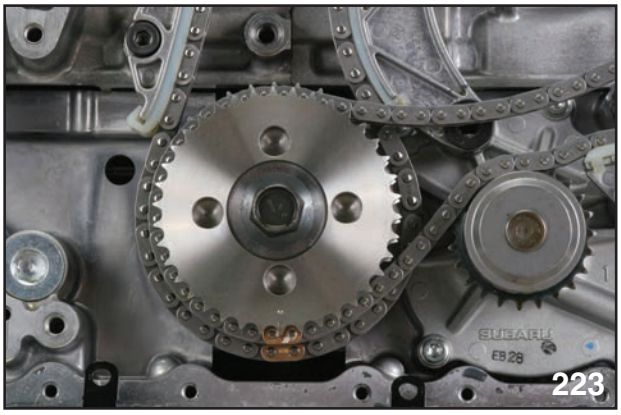
Water Pump



Impeller View



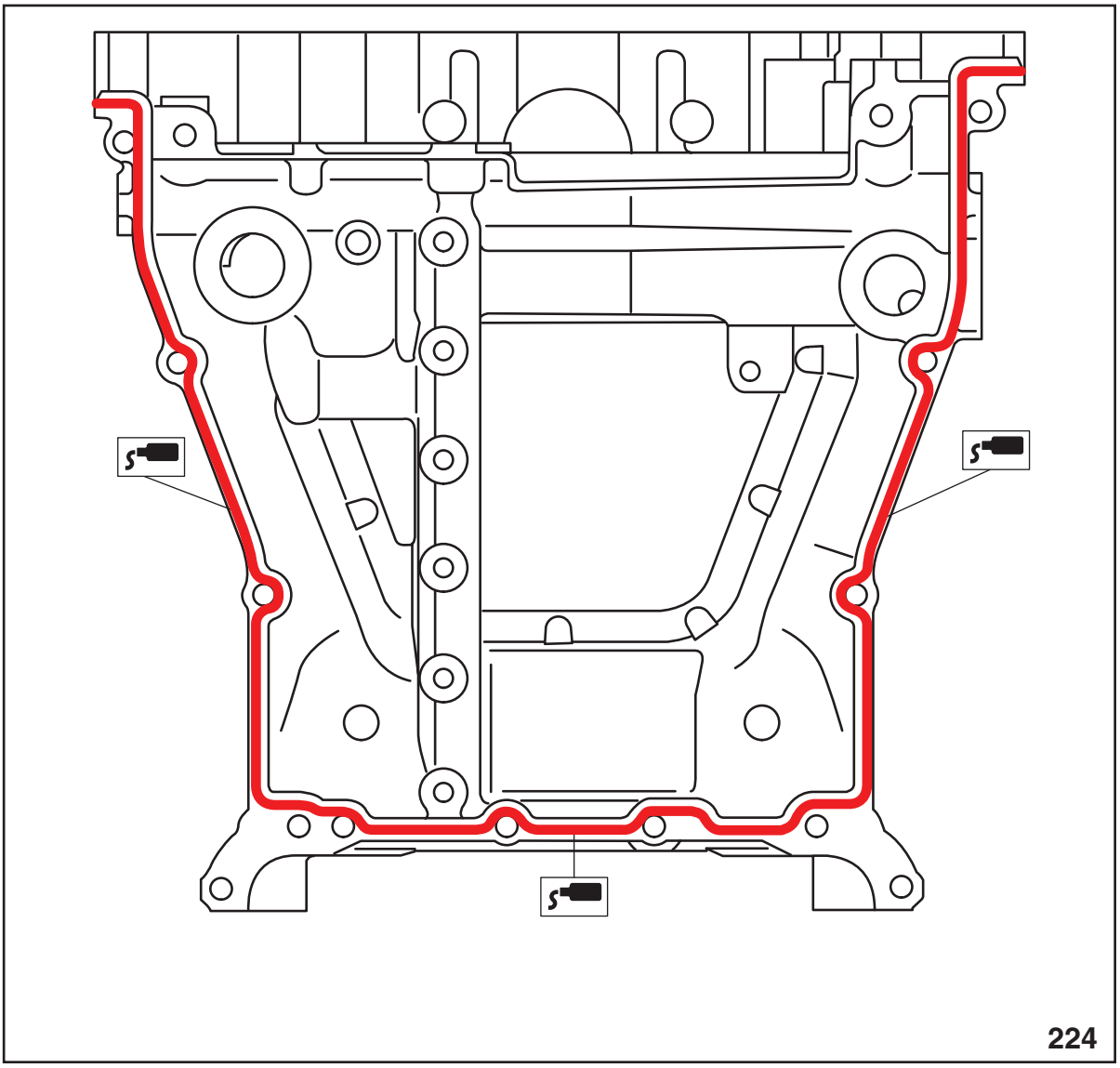
Drive Sprocket View



Chain Driving Water Pump Sprocket

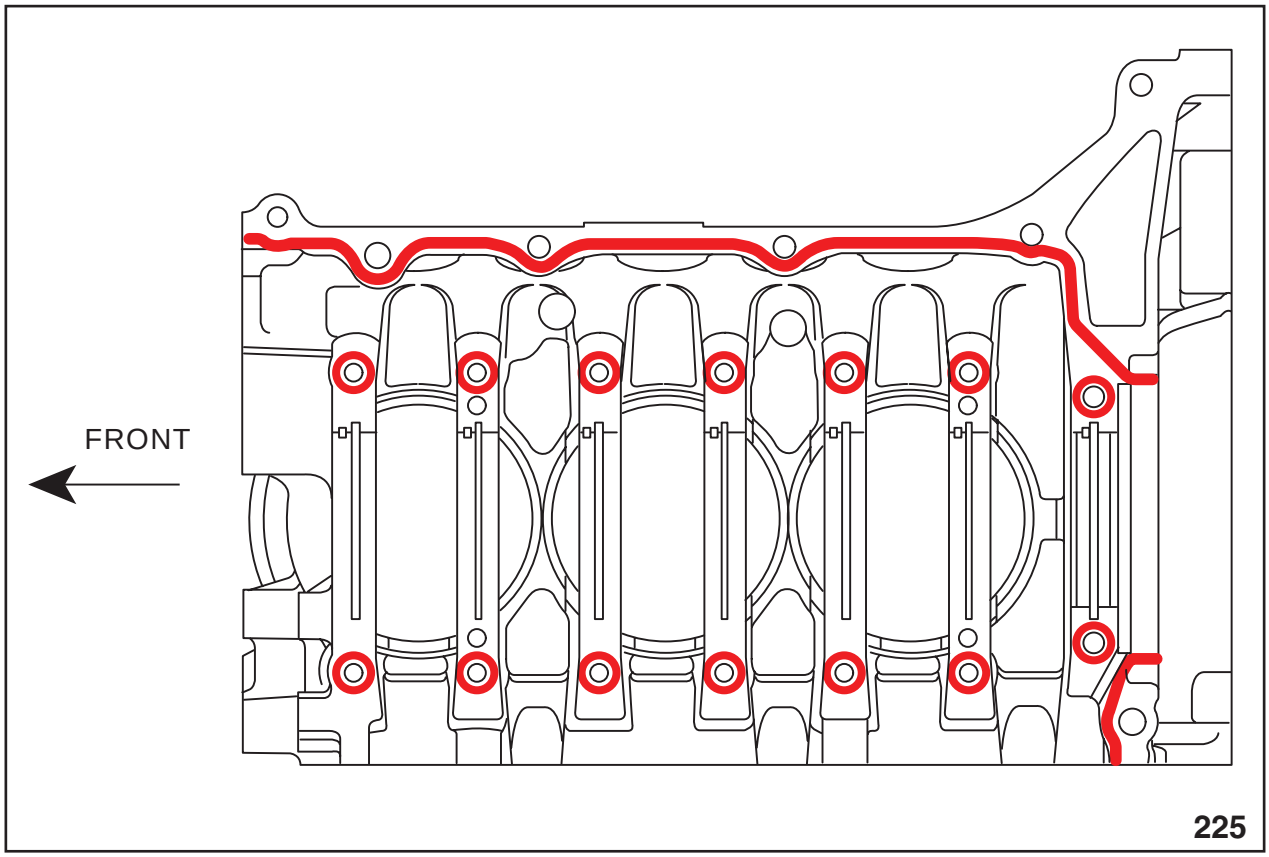
Follow procedures in the appropriate Subaru Service Manual on STIS web site, during reassembly and for checking chain guide clearances.

FUJI BOND APPLICATION GUIDE FOR OIL PAN EXTENSION HOUSING (UPPER OIL PAN)



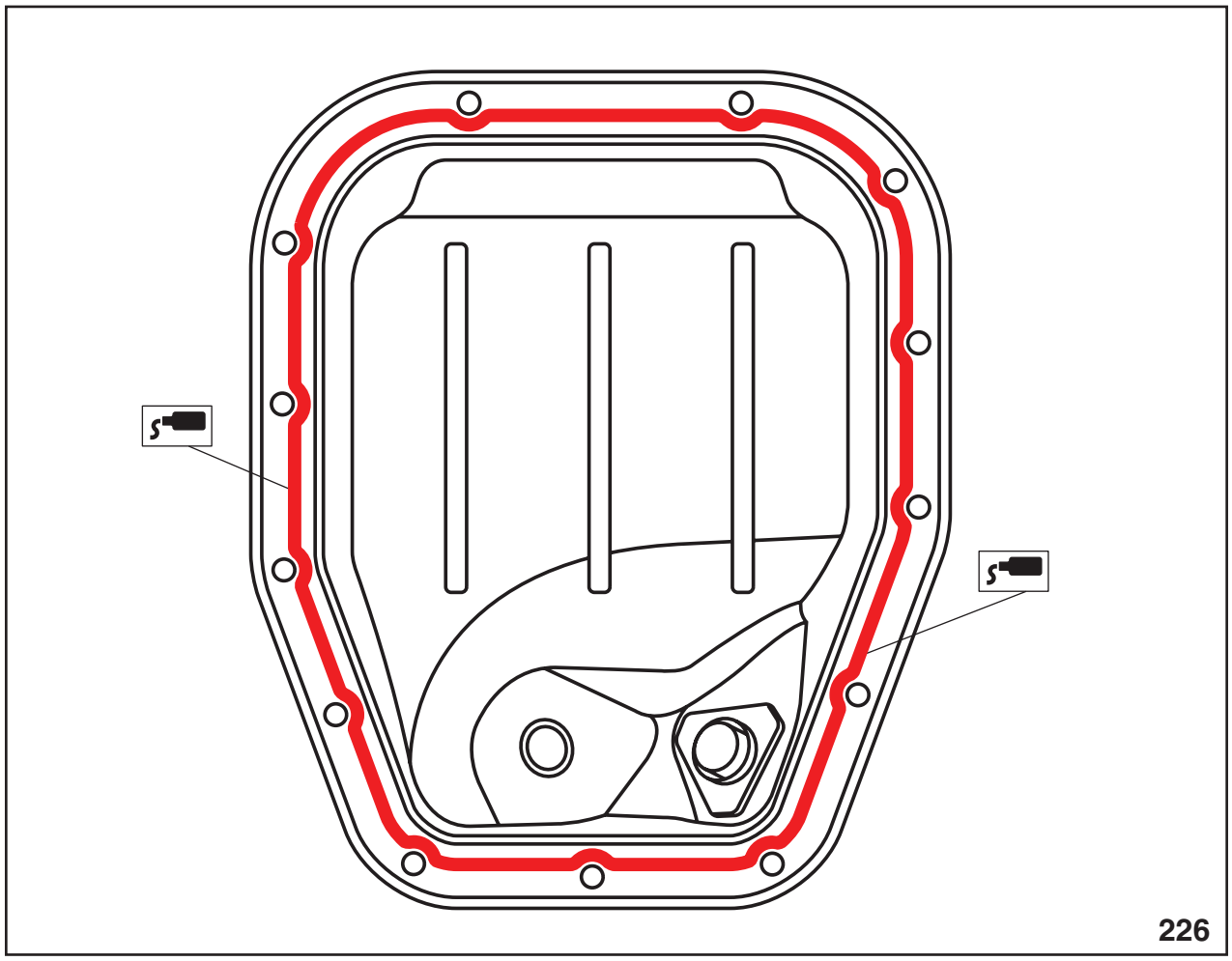
Lower Case

FUJI BOND APPLICATION GUIDE FOR BLOCK HALVES



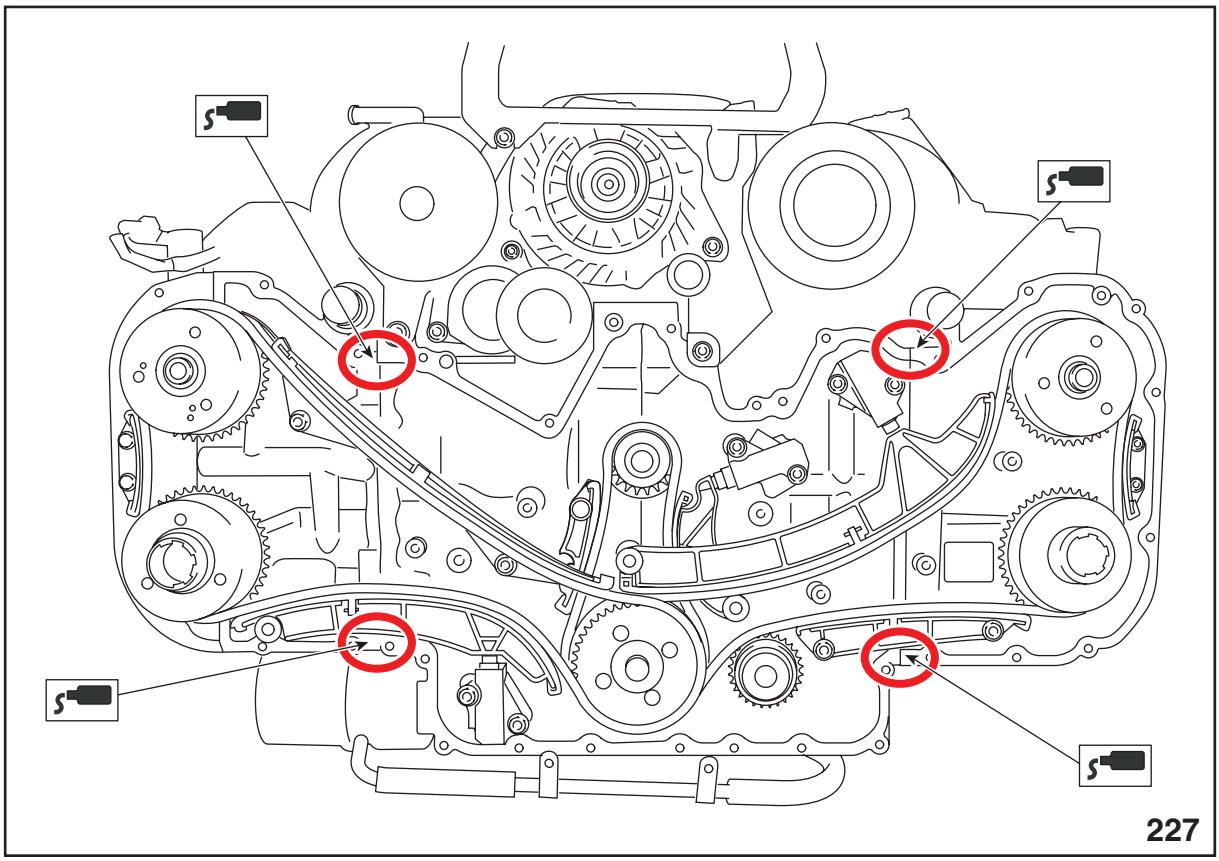
Block Halves

FUJI BOND APPLICATION GUIDE FOR OIL PAN (LOWER)



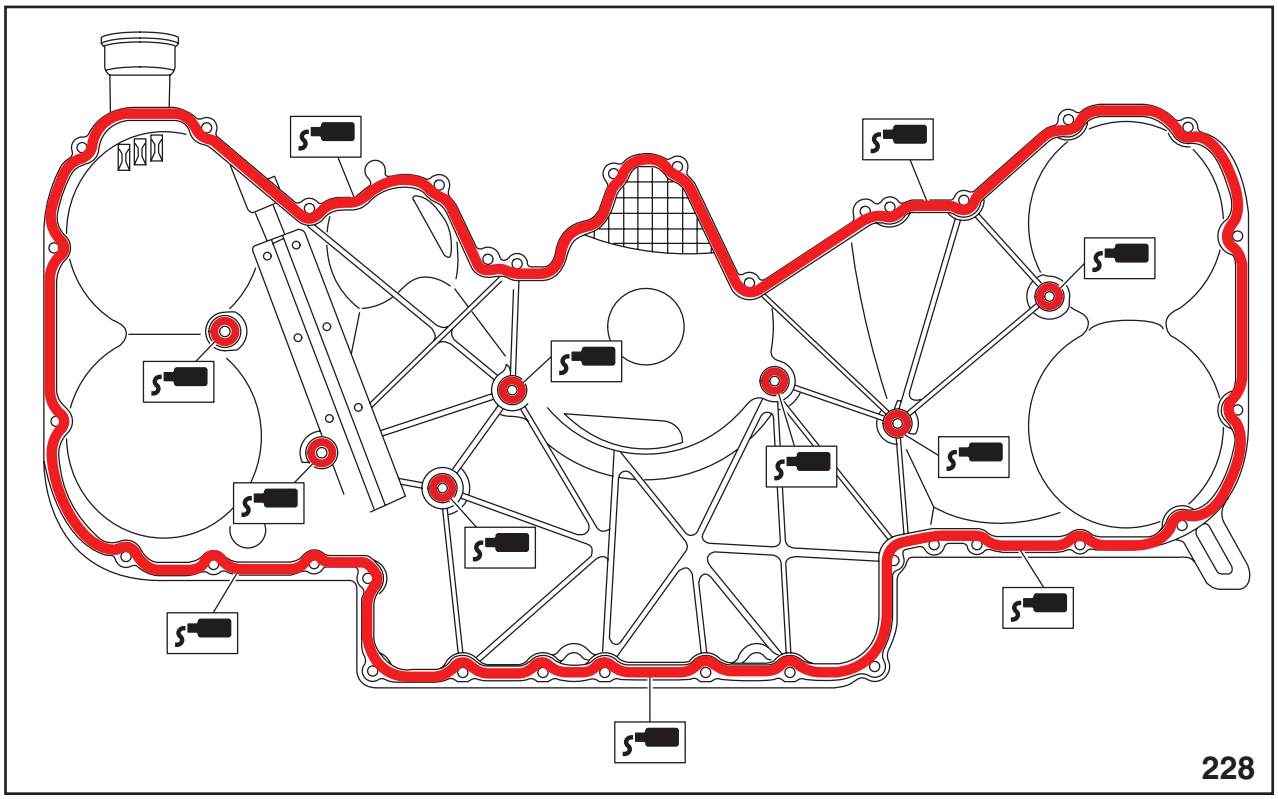
Oil Pan

FUJI BOND APPLICATION GUIDE CYLINDER BLOCK, CYLINDER HEAD AND OIL PAN UPPER



Cylinder Block, Cylinder Head and Oil Pan Upper

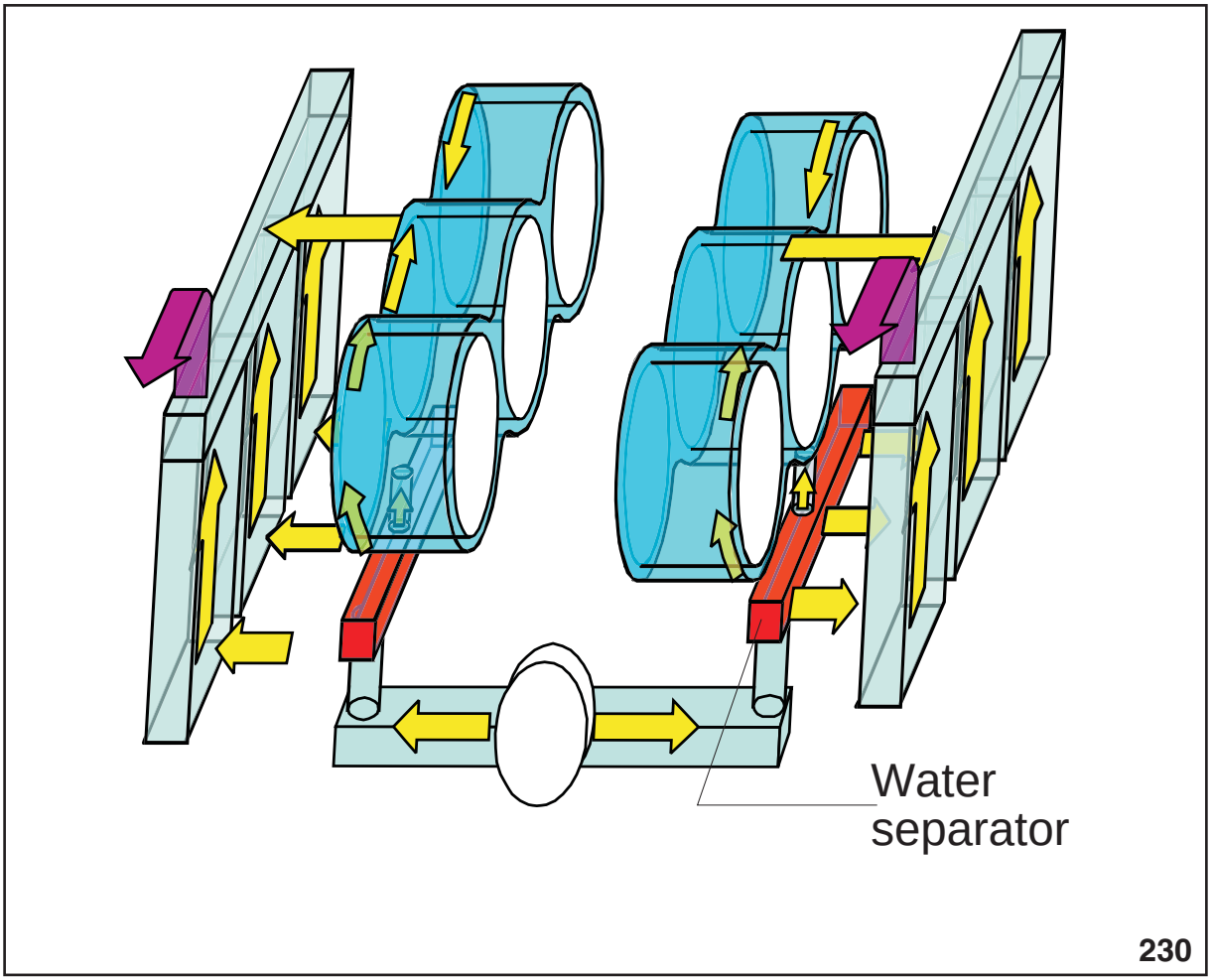
FUJI BOND APPLICATION GUIDE
CHAIN COVER



Chain Cover

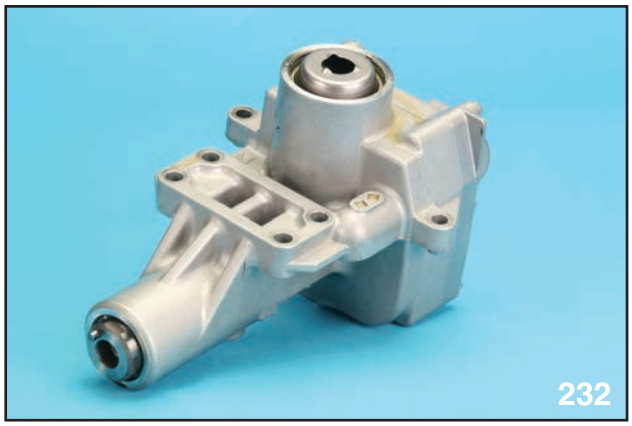
Cooling System

The cooling system has been changed to a parallel flow. This design utilizes a water separation chamber in the engine block that allows coolant to flow to and across the cylinders and to and through the cylinder heads simultaneously. This produces a more even engine coolant temperature throughout the entire engine and assists with controlling engine knock. (Ignition timing can stay more advanced as cooler temperatures do not promote engine knock).

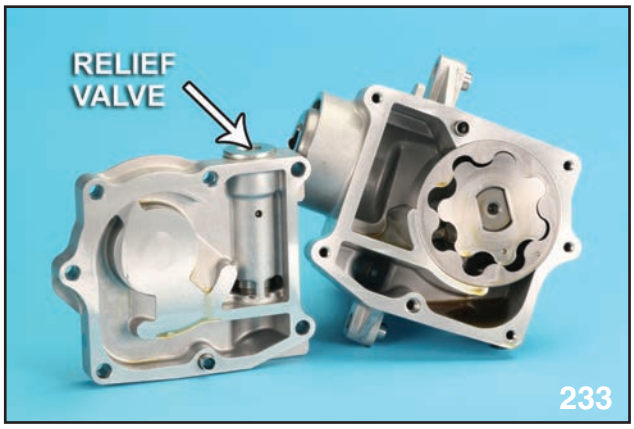


Parallel Flow Cooling System

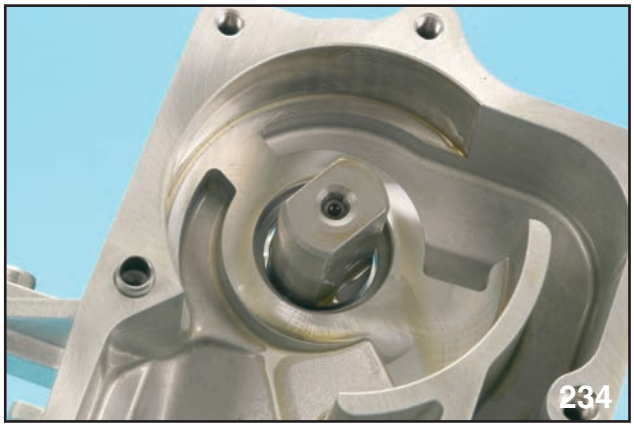
Oil Pump



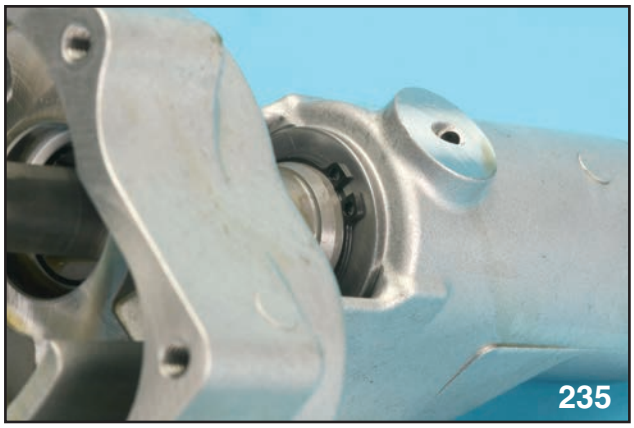
Oil Pump Front View



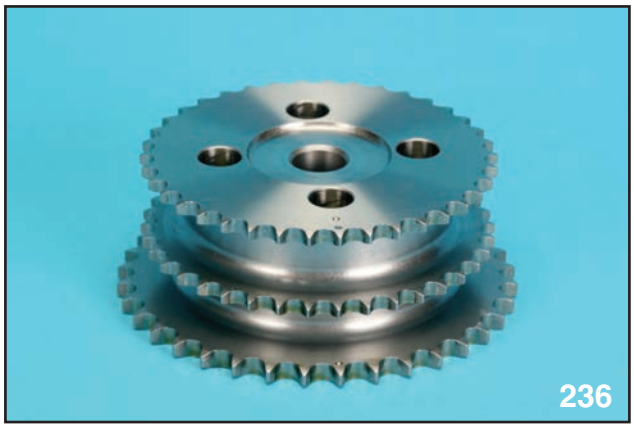
Oil Pump Construction



Oil Pump Housing

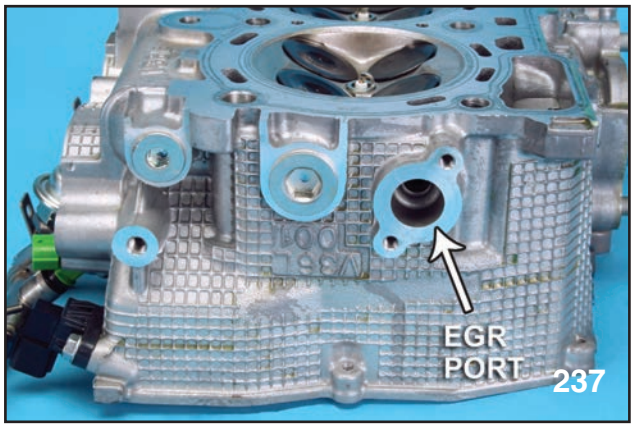


Thrust Washer and Snap Ring



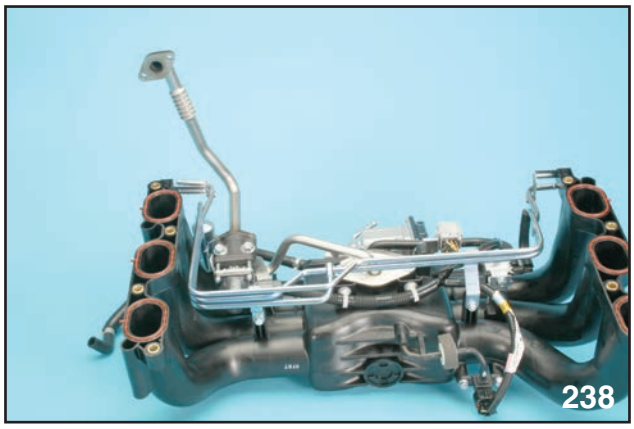
Idler Sprocket

The 3.6 liter engine is equipped with EGR.

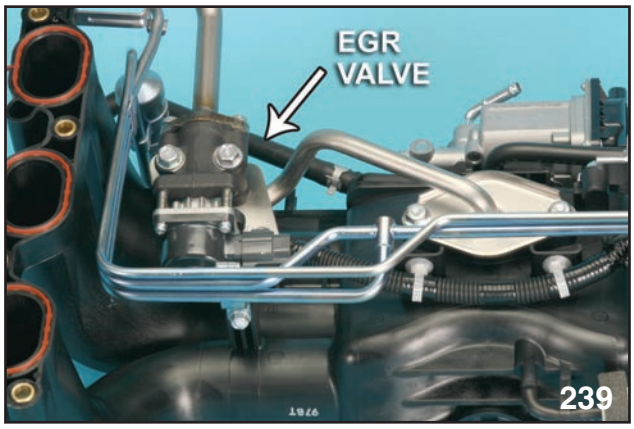


EGR Port

An exhaust port located on the rear of the left bank cylinder head supplies the exhaust gas through a metal pipe to an electronic EGR valve.

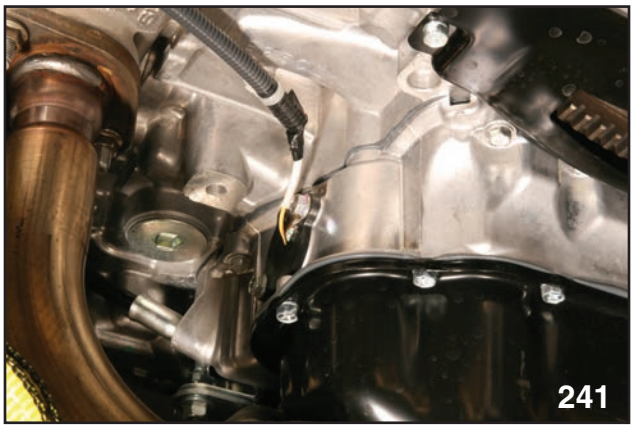


EGR Pipe



EGR Valve

Oil Level Sensor



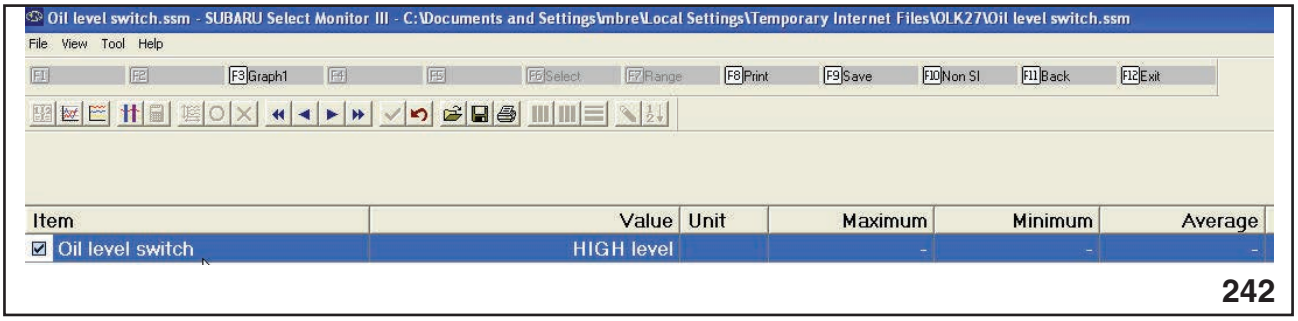
Upper Oil Pan

A new oil level sensor system has been added to all engines. This system will check the oil level at idle only. The light will illuminate when the oil level falls to the following levels:

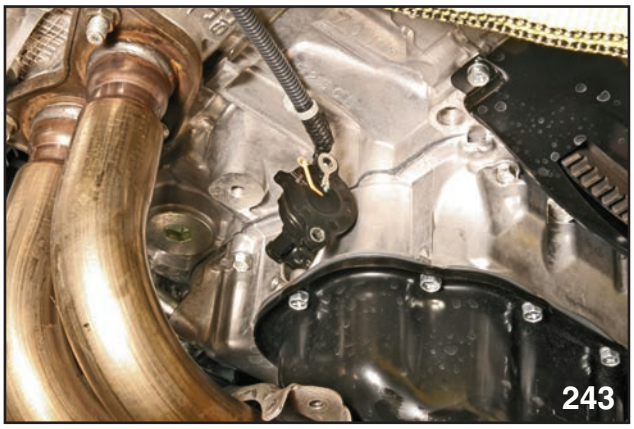
6 cylinder engines 5.3 to 5.6 quarts

A float type sensor is utilized that is equipped with a small magnet. The magnet keeps a reed switch closed when the oil level is not low.

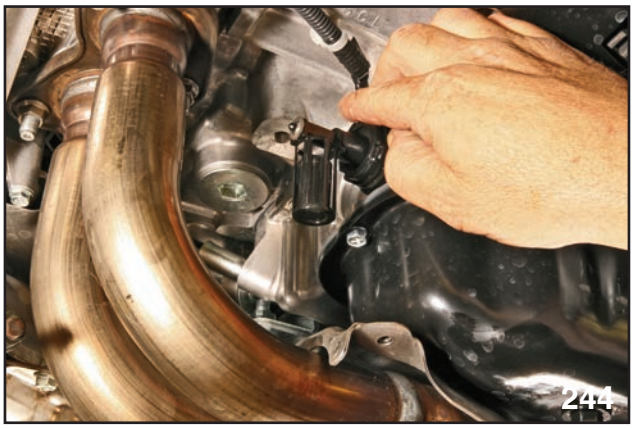
Once the light is ON the ECM memory must be cleared to extinguish the light, or allow the engine to operate until warm. There is no DTC when the light is illuminated. A PID on the SMIII engine menu will indicate “High” if the oil level is above the light on threshold and “Low” when it is at or below the threshold.



PID Oil Level Switch



Removal



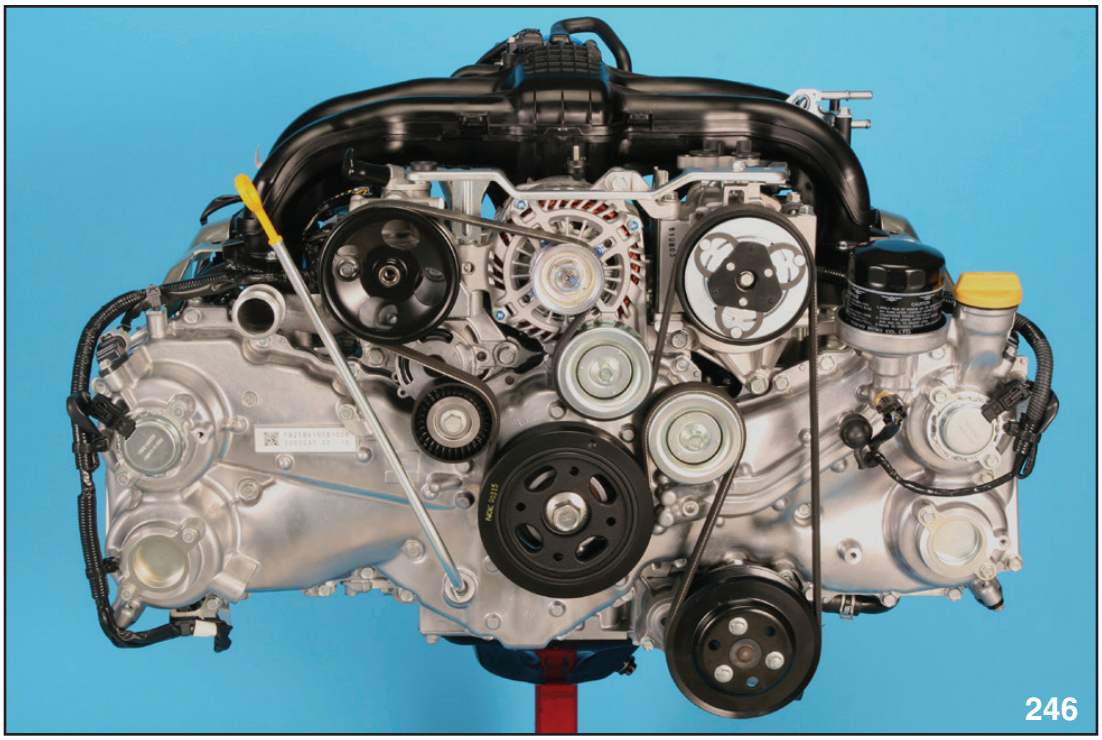
Float

When replacing the sensor the oil must be drained from the engine. During removal the sensor must be lifted slightly and then turned approx. 90 degrees towards the rear so that the float chamber will clear. The sensor has one wire leading to the ECM. The ground for the sensor is attached at the rear mounting bolt.

NOTE: Do not apply a high pressure wash directly onto the sensor as damage may result.

NOTES:

2011 FB 2.5 Liter Engine



FB Engine Front View

The "FB" series engine, introduced on the 2011 Forester, was designed to improve fuel economy, reduce exhaust emissions and reduce service costs over the life of the engine.

North American Forester vehicles that are naturally aspirated will be equipped with the FB 2.5 liter. This engine is equipped with Intake AVCS, water cooled EGR system, TGV and a chain driven valve train.

The "FB" series for North America for 2011 is classified as "FB-B". An "FB-A"[1] and "FB-C"[2] will be introduced in other markets around the world, each having a different AVCS, EGR and TGV system configuration.

The FB-2.5 engine produces 170 HP at 5800 RPM and 174 ft lbs. of Torque at 4100 rpm.

The engine bore is 94mm and the stroke is 90mm. Compared to the "EJ" 2.5 liter engine, this is a reduction in bore size and an increase in the stroke. Design changes to the cylinder head and engine block enabled the overall width of the engine to increase by only 8mm. This enables the FB 2.5 liter to be installed in the existing Forester design.

Note: The 2012 Impreza is equipped with the FB 2.0 liter engine. This engine utilizes Dual AVCS and produces 148 horsepower at 6,200 RPM. 145 pounds of Torque is created at 4200 PPM.

Bore and stroke measures 84.0 x 90.0 millimeters.

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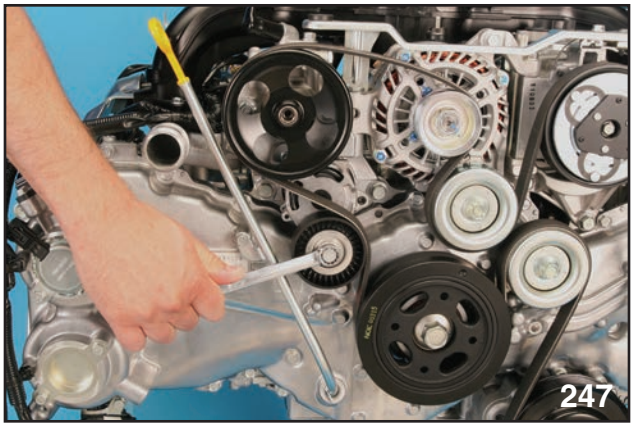
1 "FB-A" is a 2.0 liter engine equipped with a top mounted oil filter
2 "FB-C" is a 2.5 liter engine equipped with a top mounted oil filter

Construction

The following text describes how to disassemble the engine intermixed with explanations on the new systems and enhancements over previous engine designs.

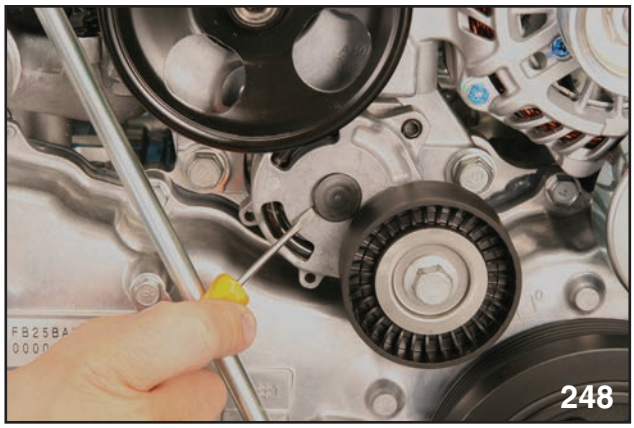
THE PROCEDURES AND EXPLANATIONS ARE FOR CLASSROOM OR SELF STUDY AND MUST NOT BE USED IN PLACE OF THE APPROPRIATE SUBARU SERVICE MANUALS.



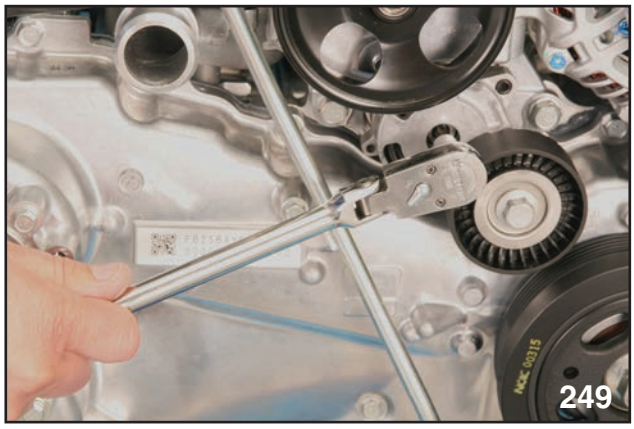
Releasing Belt Tension

A single serpentine belt drives the alternator, power steering pump, water pump and rotary vane air conditioning compressor. The tension of the belt is automatically set and maintained by the belt tensioner. There is no wear indicator on the belt tensioner. The belt will show signs of fatigue (cracks) before the effective length creates an auxiliary drive issue. Replace the belt when cracks are visible.

Pull upward on the tensioner with a 14 mm wrench to remove the belt.

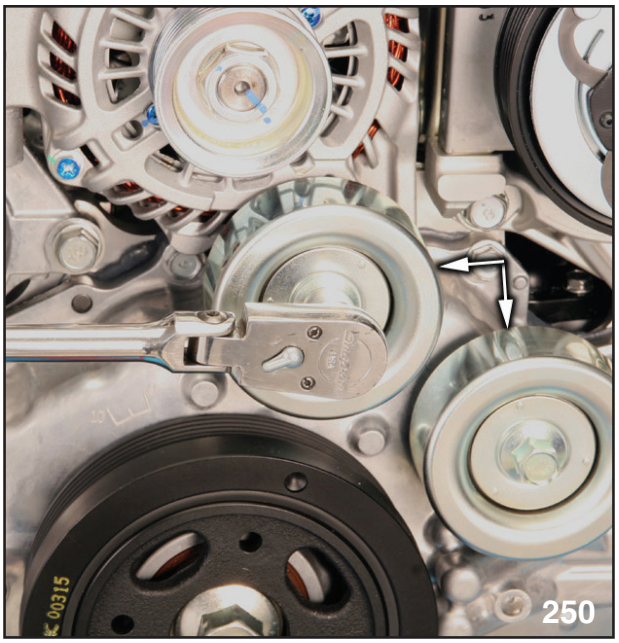


Accessing Belt Tensioner Mounting Bolt Cover



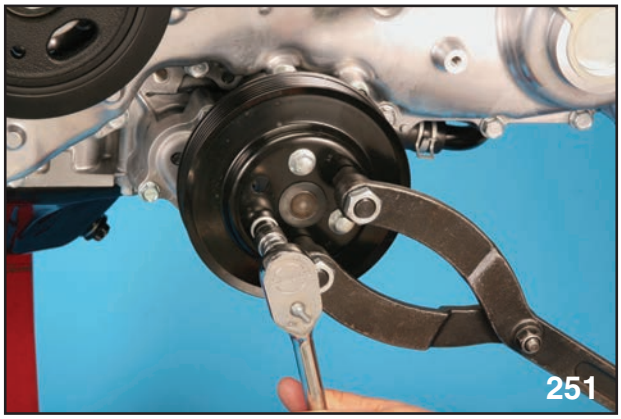
Accessing Belt Tension Mounting Bolt

The tensioner can be removed from the engine by first removing the mounting bolt plug and engaging an 8mm hex wrench to the bolt.



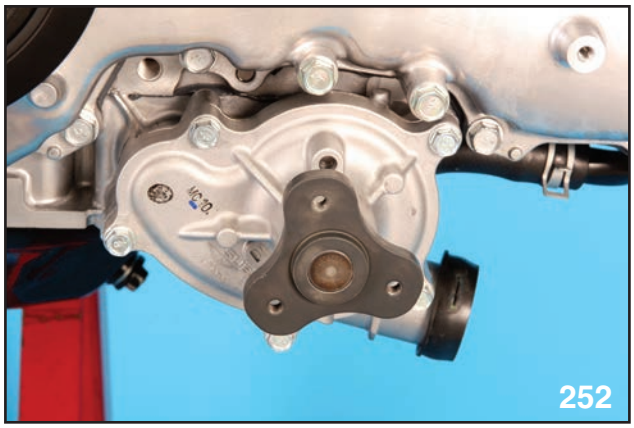
Removing Belt Idler

Continue disassembly by removing the two auxiliary belt idler pulleys.



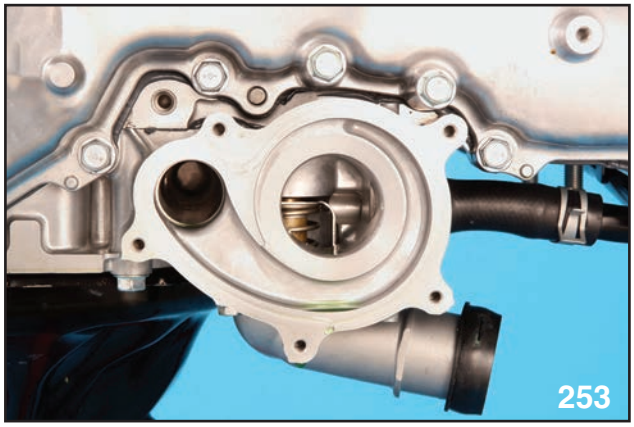
Water Pump Pulley

Remove the water pump drive pulley using 18334AA030 (2 piece set) and 18355AA000 wrench.



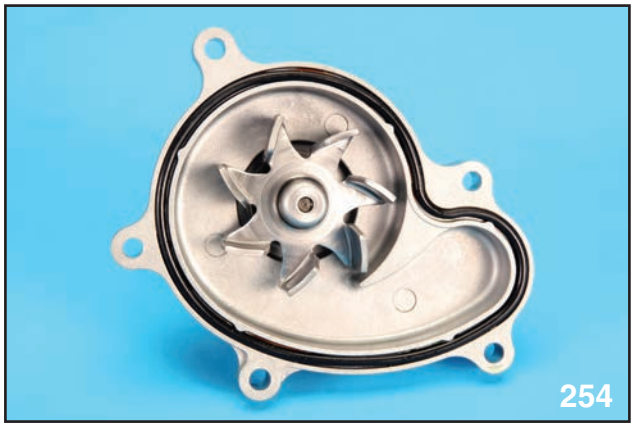
Water Pump Front View

Inspect the water pump for damage to the hub and front seal.



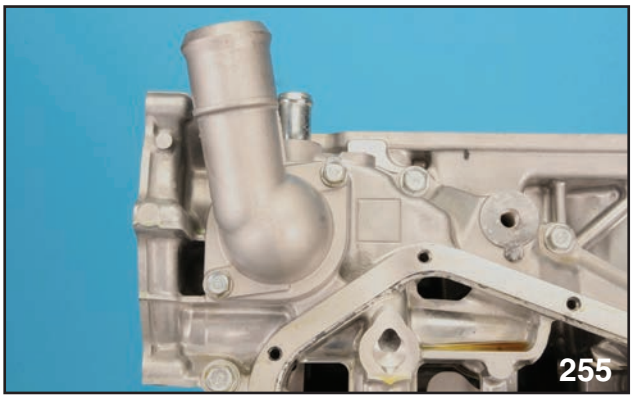
Water Pump Mount

Remove the water pump.



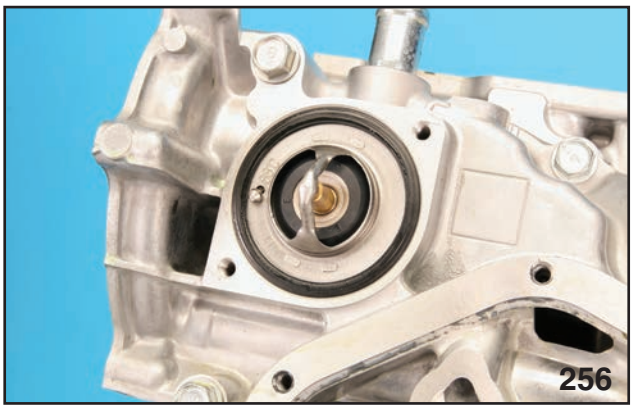
Water Pump Rear View

Inspect the water pump impeller. Replace the O-ring during reassembly.



Thermostat Housing

Remove the thermostat housing.



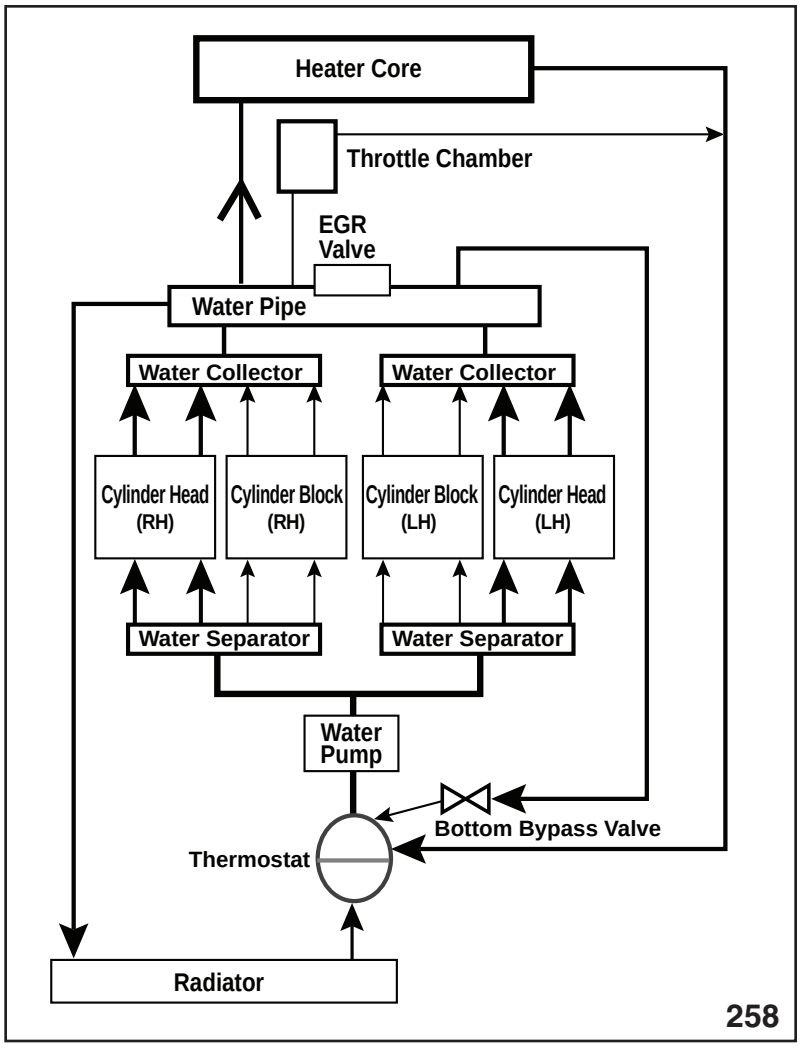
Thermostat in Block

The “jiggle” pin of the thermostat breaks up air bubbles.

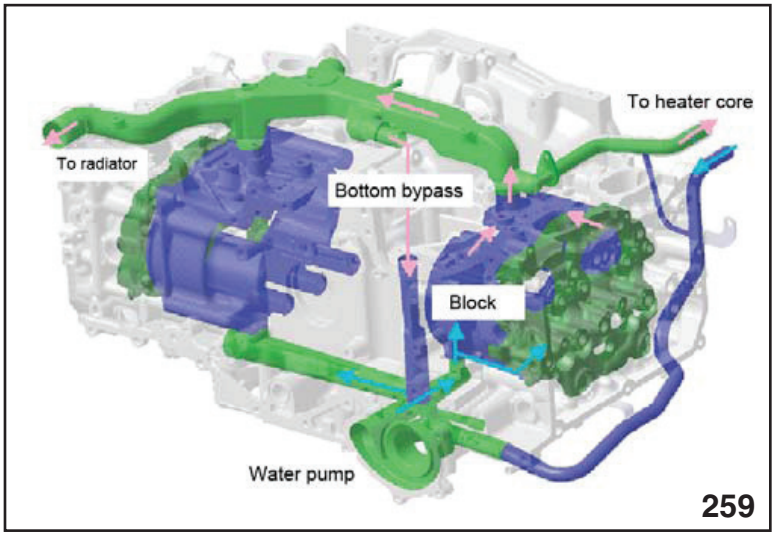
Thermostat

The thermostat is equipped with a bottom bypass passage switching valve. When the coolant is below operating temperature and the thermostat is closed, the bottom bypass passage is open directing coolant through the block and heads. Coolant flow is reduced through the heater core. This quickens the warm up of the engine. As the engine reaches operating temperature and the thermostat opens the bottom bypass switching valve closes and normal coolant flow begins.

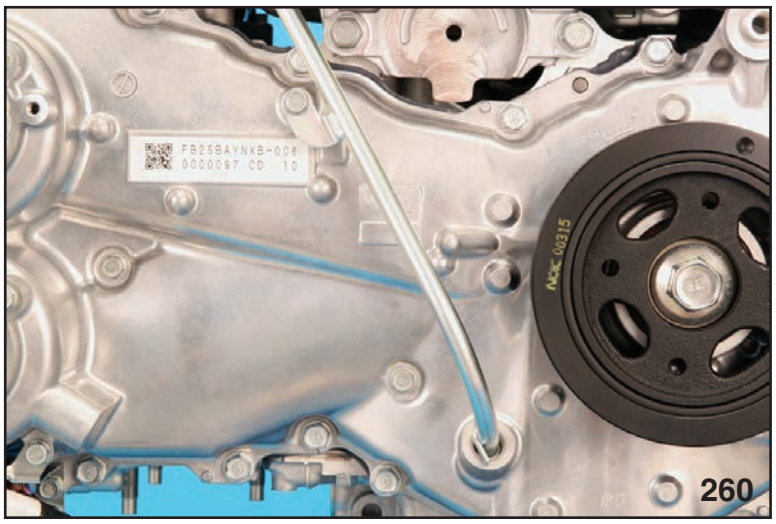
The design of the new coolant system provides 85% of the available coolant to the heads and 15% to the engine block. This keeps combustion chamber temperatures lower, allowing for more advanced ignition timing. The oil temperature rises faster and maintains a higher temperature than previous engine designs. This higher oil temperature reduces friction at the piston rings.



Cool and Flow Diagram

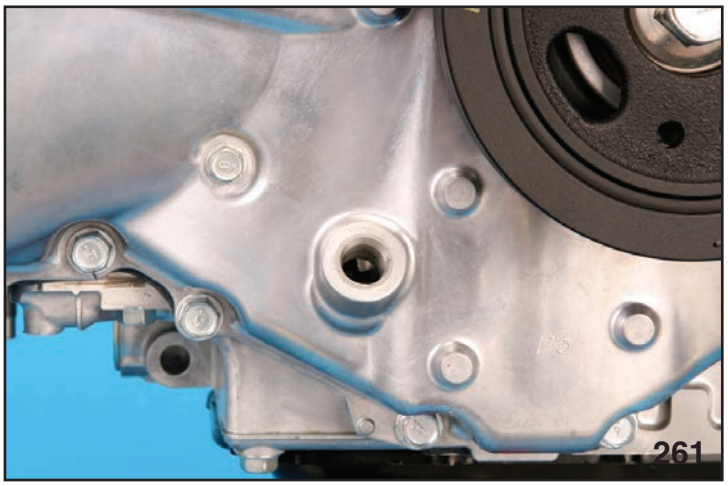


Coolant Flow

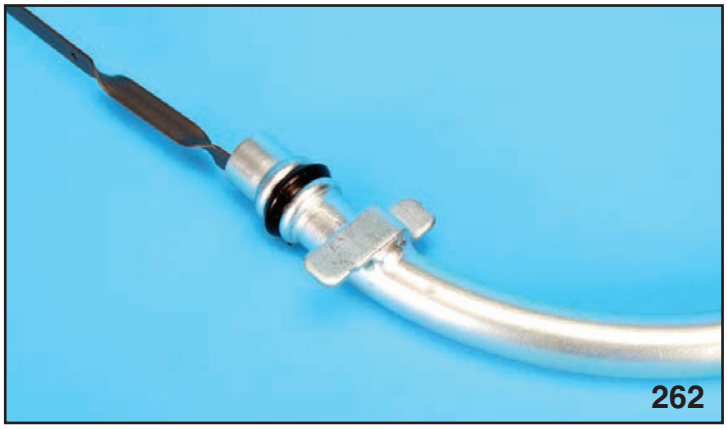


Oil Dipstick Mounting

Remove the oil dipstick tube.

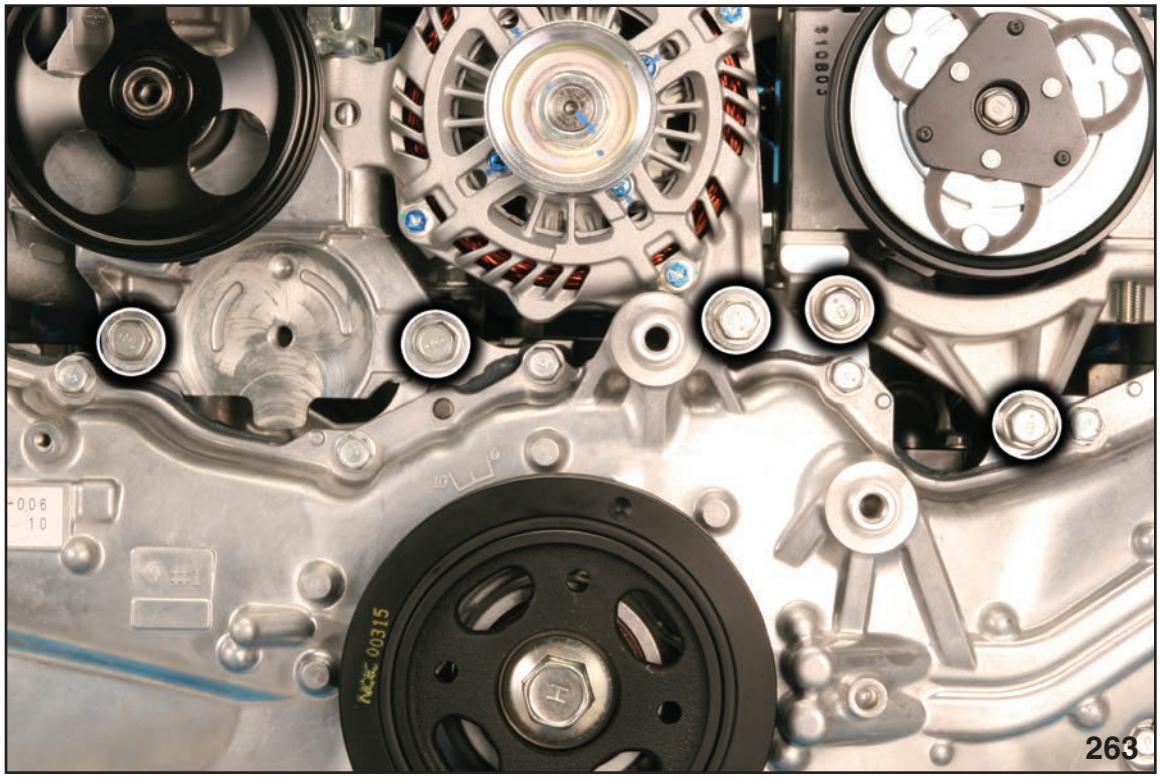


Oil Dipstick Port



Dipstick O-ring

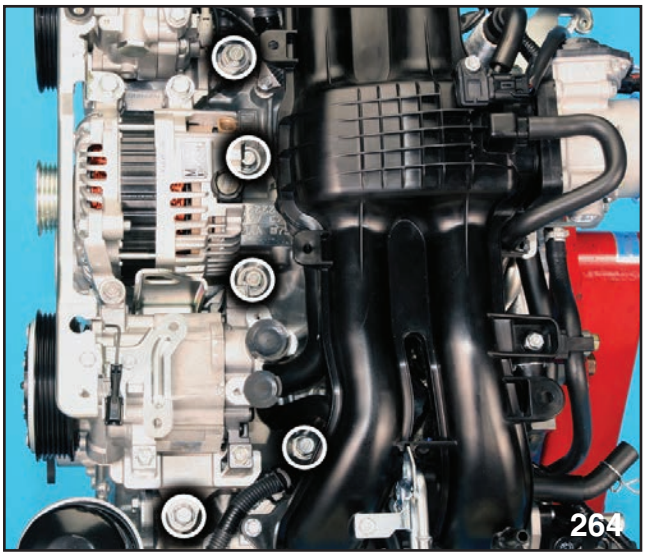
The dipstick tube is secured to the timing chain cover with one bolt and an O-ring. Replace the O-ring when the dipstick tube has been removed.



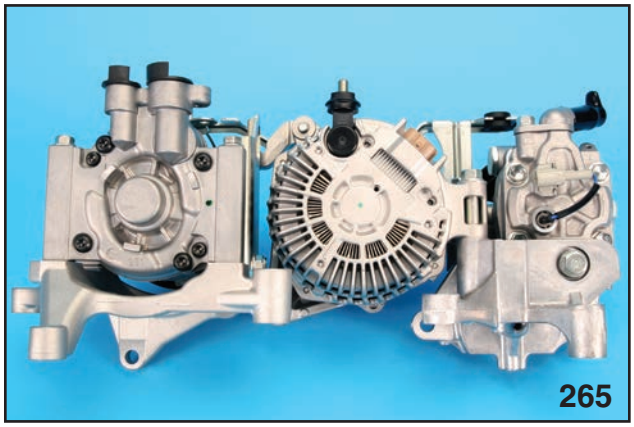
Auxiliary Package Front Mounting Bolts

Remove the 5 bolts from the front on the auxiliary package.

NOTE: DISCONNECT THE POWER STEERING SWITCH.

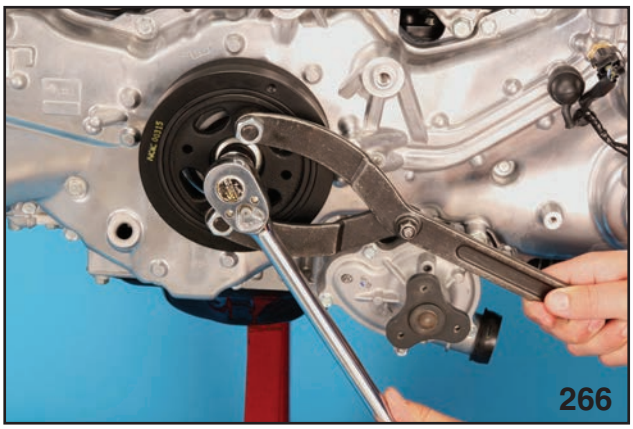


Auxiliary Package Rear Mounting Bolts



Auxiliary Package Rear View

Remove the 5 bolts from the back side of the auxiliary package. Carefully remove the AC compressor, alternator and power steering pump as a single unit.



Removing Crankshaft Pulley

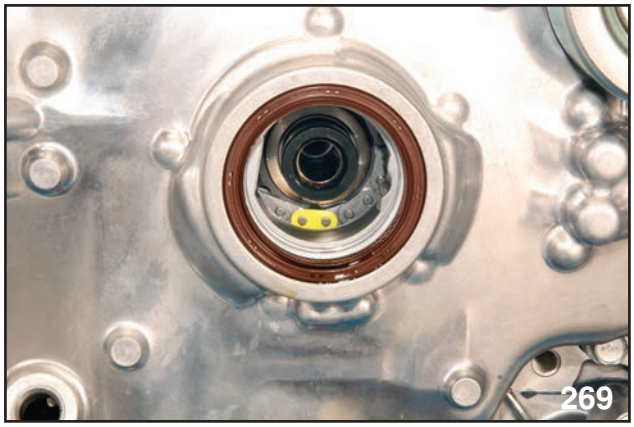
Hold the crankshaft pulley using 18334AA000 (2 piece set) and 18355AA000 wrench. Remove the bolt with a 22mm socket and breaker bar.

Crankshaft Extension Front View

Replace the front crankshaft oil seal and O-ring upon reassembly.

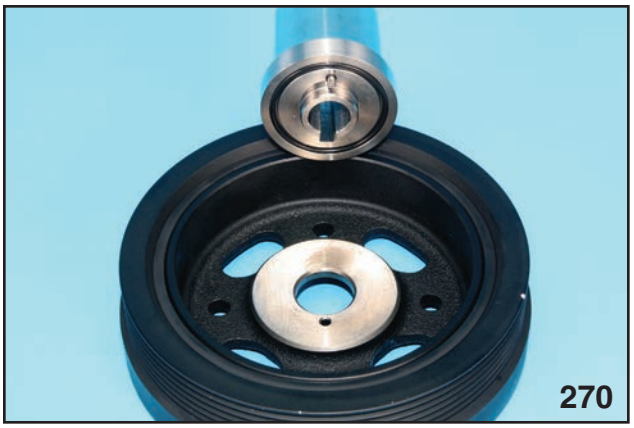
Removing Crankshaft Extension

The crankshaft is equipped with a front extension. Remove the extension using expanding snap ring pliers.



Crankshaft Front Oil Seal

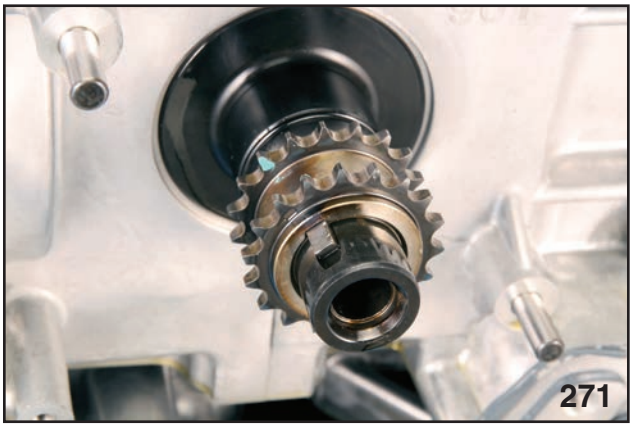
The flat sides of the crankshaft extension drive the oil pump.



Crankshaft Extension Drive Pin

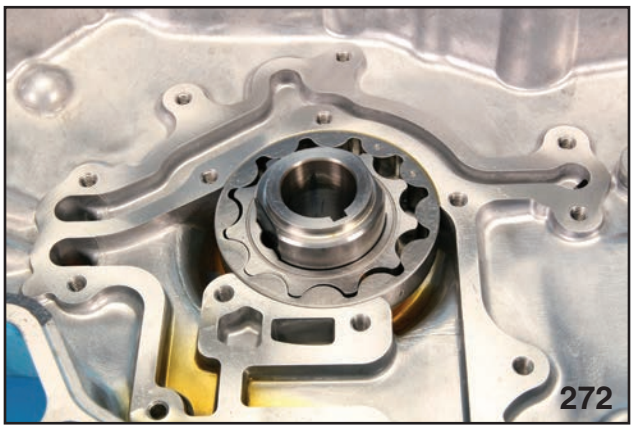
The crankshaft pulley drive pin and the crankshaft pulley bolt transfer the power from the crankshaft to the pulley.

Note: Inspect the crankshaft drive pin and the rear of the crankshaft pulley for wear. Replace the crankshaft extension and pulley as a set.



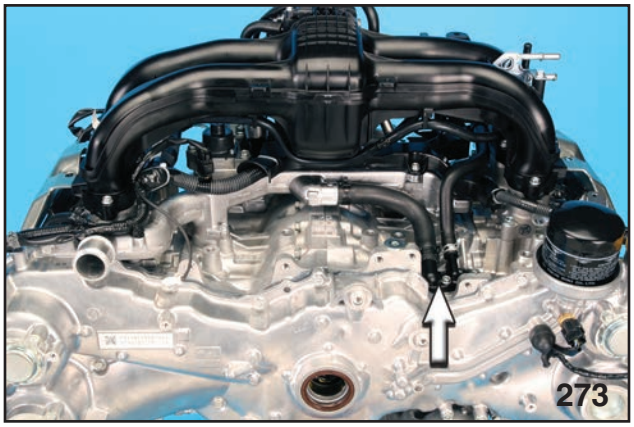
Timing Chain Crankshaft Sprockets

The extension engages with the crankshaft key.



Oil Pump

A two stage oil relief valve is incorporated into the back side of timing chain cover[3] with a lower opening pressure than previous models.



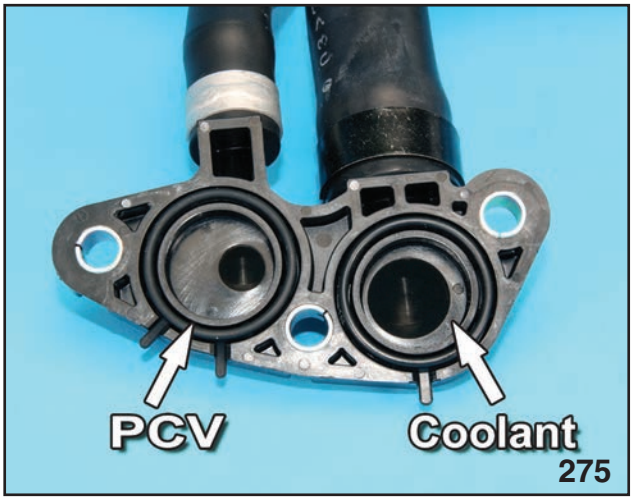
Engine Block Front View

The view under the auxiliary package shows the unified connection for the bottom bypass coolant passage hose and PCV system hose.

3 ***Details of the Timing Chain Cover and Oil Pump begin on page 135.***

Coolant and PCV Hoses Mounted

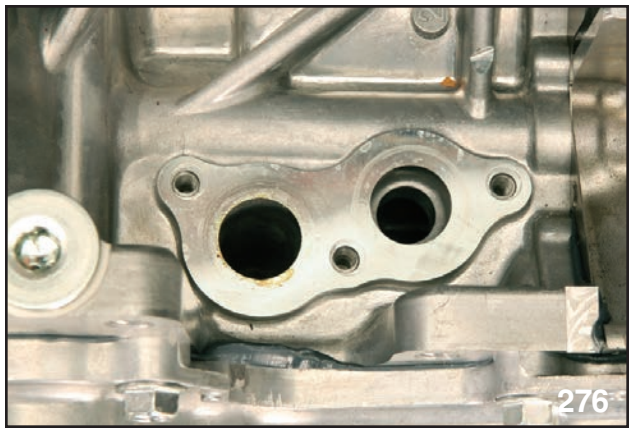
The unified connector is secured to the block with three bolts. Remove the three bolts.



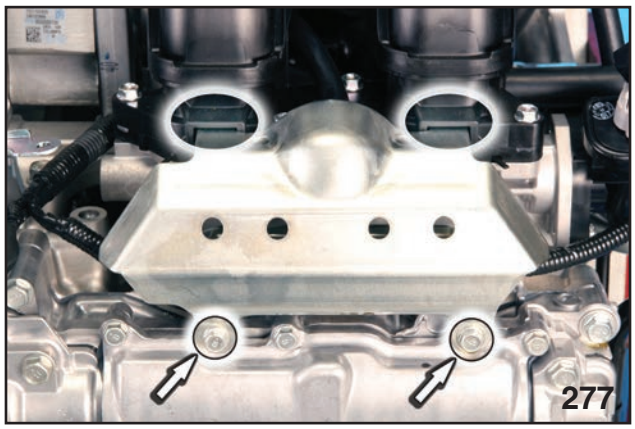
Coolant and PCV Hoses Bottom View

Each hose is sealed to the block passages with O-rings. Replace the O-rings upon assembly.

The unified connector is made with a relief to show leaking coolant and prevent coolant from entering the PCV system if a common seal failure to both hoses occurred.

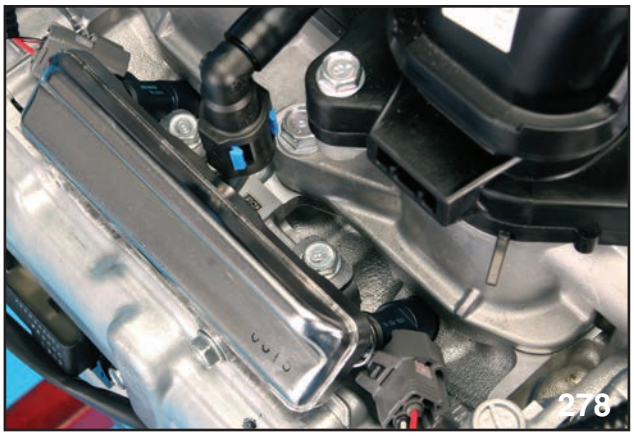


Coolant and PCV Passages



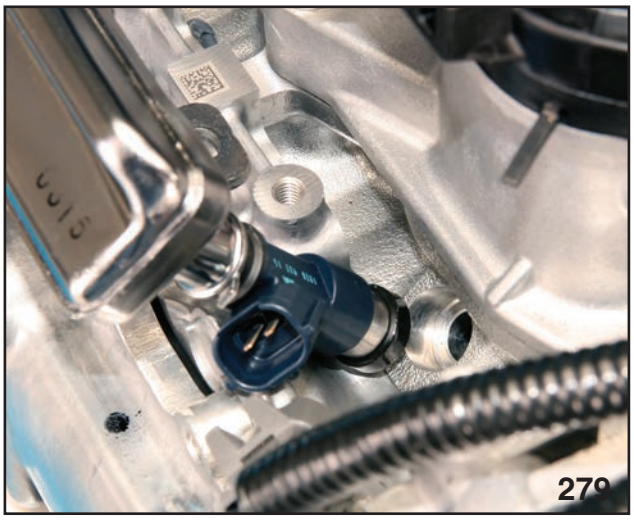
Injector Protector Shield

The injector protector is mounted to the intake by using two guide tangs and two valve cover bolts.



Fuel Runner Connector

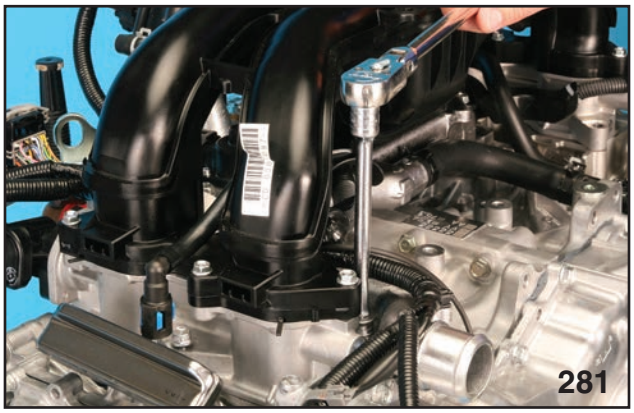
The injector runner is secured with two bolts and holds the injectors into place.



Removing TGV Manifold Bolts

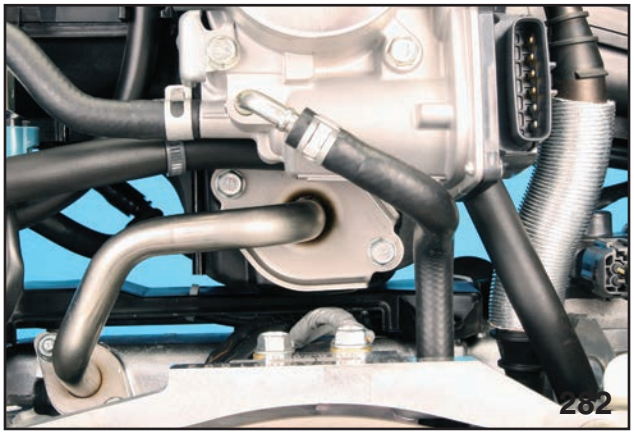
The injectors are equipped with an upper and lower seal. The injector is mounted into the cylinder head on the low pressure side of the intake valve. This new mounting improves fuel delivery and prevents the condensation of fuel onto the intake manifold runners.

Bottom View of Injector



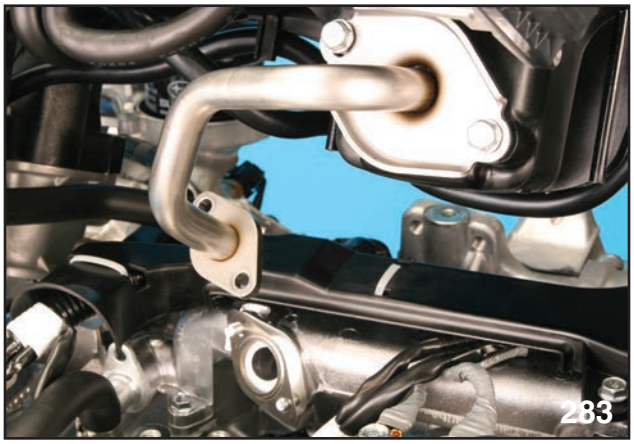
TGV Runner Bolt

The intake manifold is mounted to the TGV assembly and can be removed along with the TGV assembly. Remove the three bolts from each side.

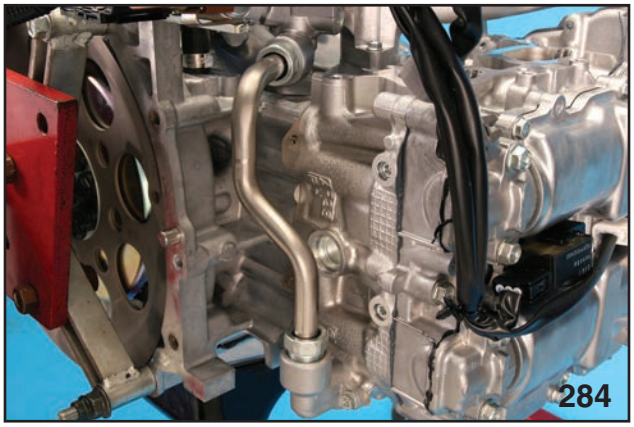


EGR Delivery Pipe Top Bolts

Before the intake manifold can be removed, the EGR delivery pipe must be removed from the coolant crossover pipe and the supply pipe must be removed or loosened from the intake manifold.



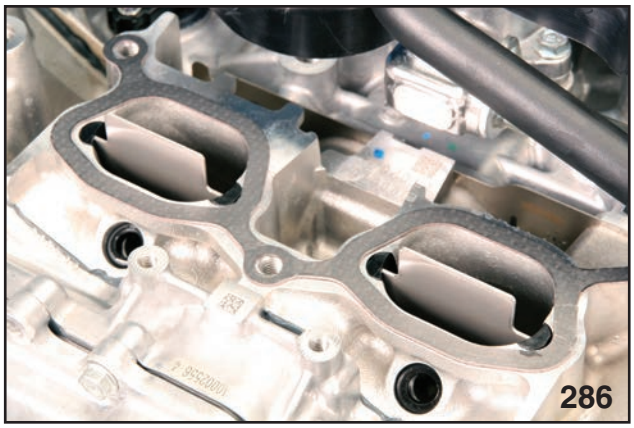
EGR Delivery Pipe Lower Bolts



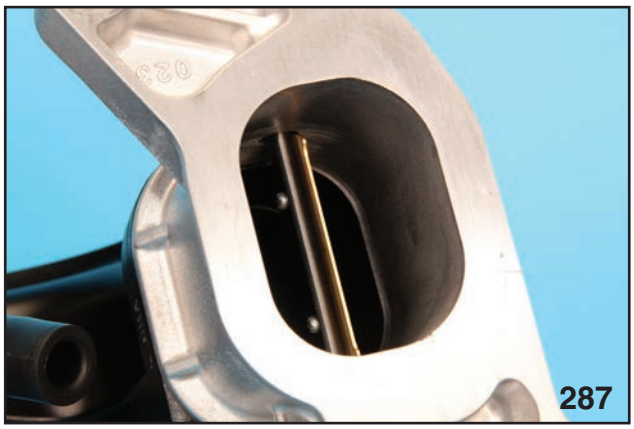
EGR Supply Pipe Mounted

PCV Valve

Also disconnect the ETC throttle body connector, throttle body coolant supply / return hoses and PCV hose.

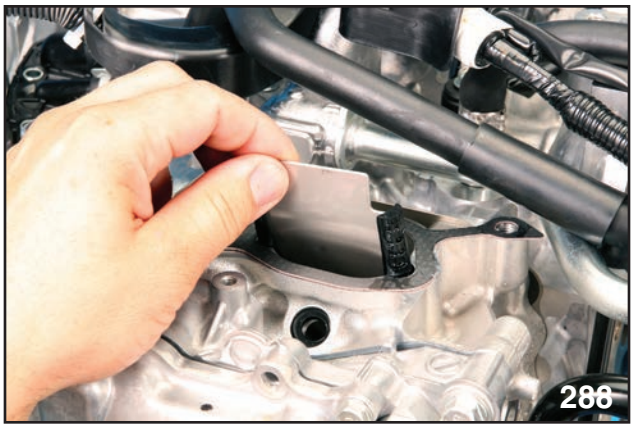


TGV Gasket and TGV separator Plate



TGV Actuator Plate

TGV separator plates are now a separate part from the intake manifold and are located in the cylinder head below the intake manifold.

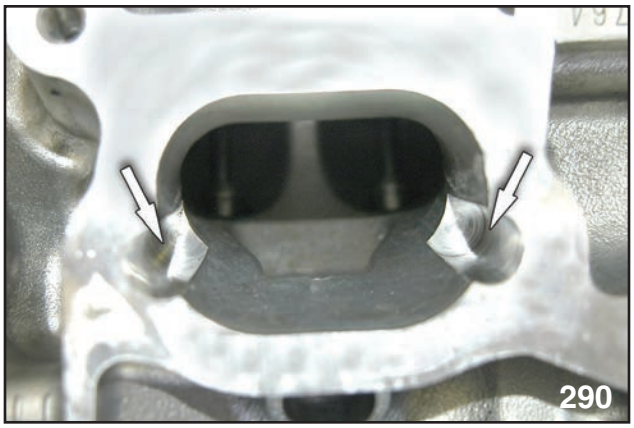


Removing Separator Plate

The TGV assembly presses down on the resin positioning dowels of the separator plates. This secures the plates firmly in the cylinder head.

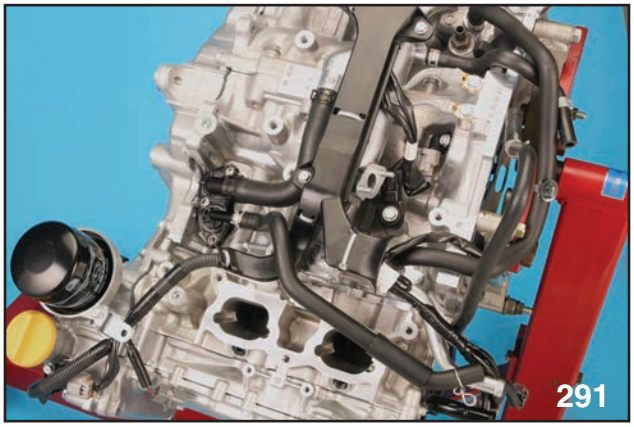
TGV Separator Plate Bottom side

The M shape at the delivery end of the plate helps to swirl the air as it directed to the back side of the intake valve.



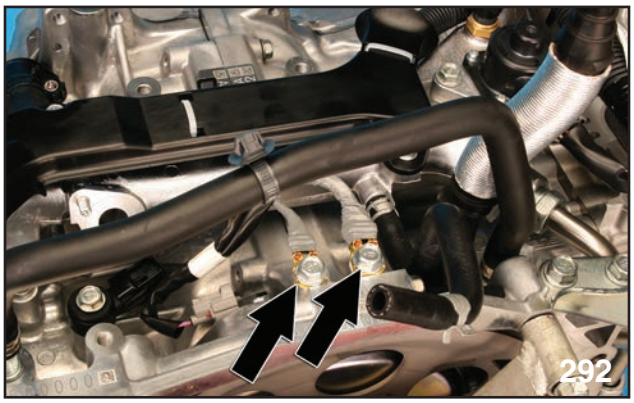
TGV Separator Plate Positioning Channels

The separator plate is directional and cannot be installed incorrectly. The plate resin locator dowels and the locating bores in the head are different lengths.



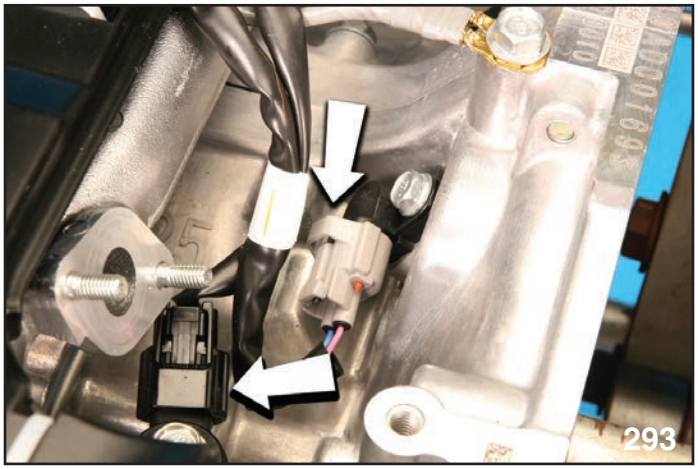
Engine Block Top View Intake Manifold removed

The wiring harness housing secures the engine wiring harness to the coolant crossover pipe. This protects the wiring harness and prevents accidental damage during assembly.



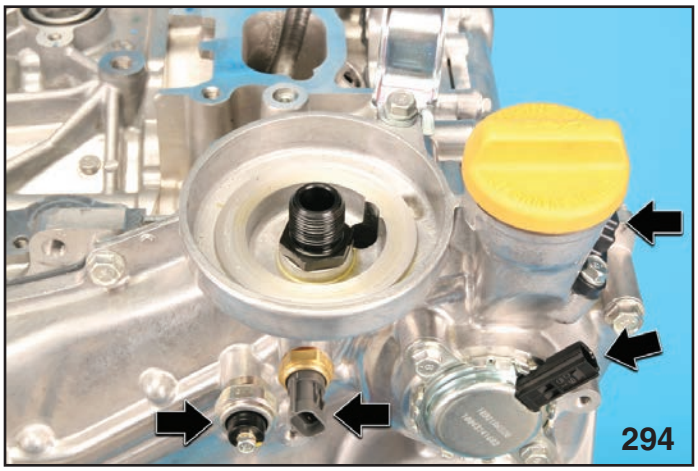
Engine Harness Ground Connections

Remove ground connection bolts.



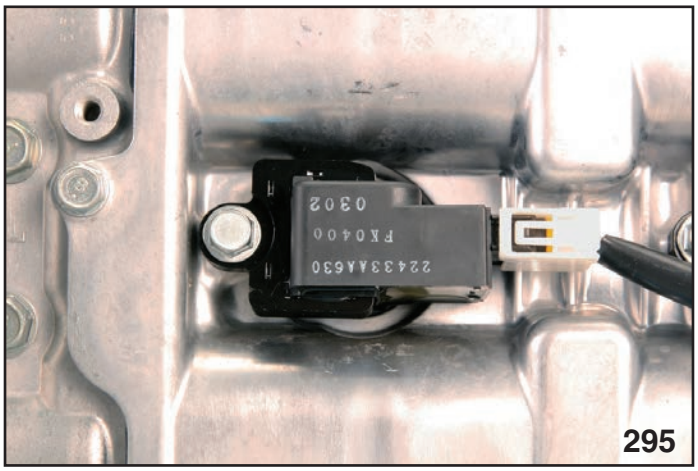
Crank Angle Sensor and Knock Sensor

Disconnect the crank angle and knock sensor connectors.

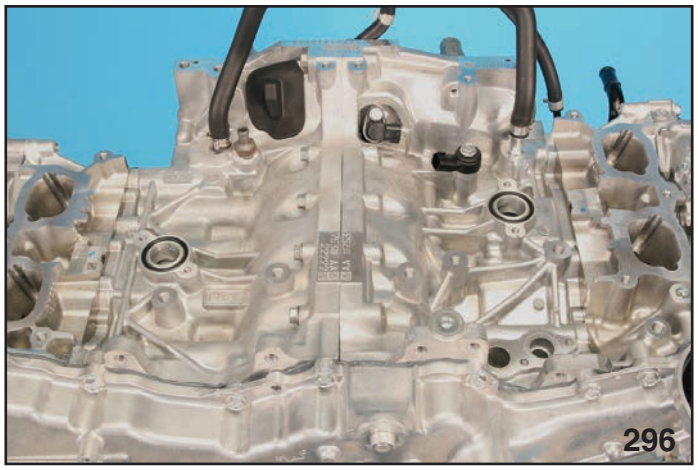


Oil Filter Removed

Disconnect the oil pressure switch and oil temperature sensor.
Disconnect the Variable Force Solenoids (VFS) (OCV) and cam angle sensor from each side of engine.



Disconnect the Four (4) Ignition Coils

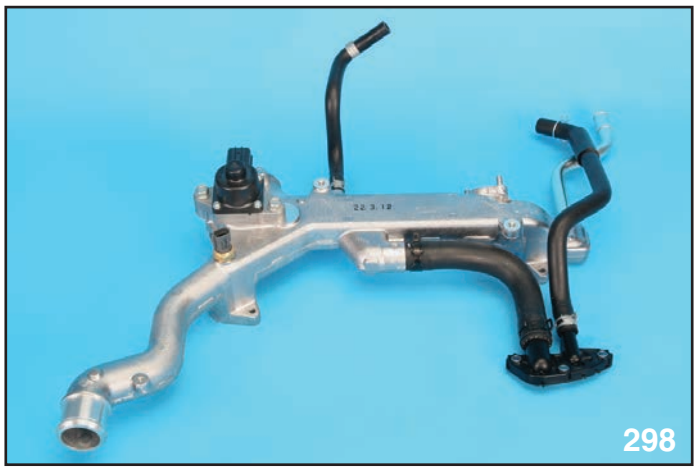


Engine Block Top View Coolant Crossover Pipe Removed

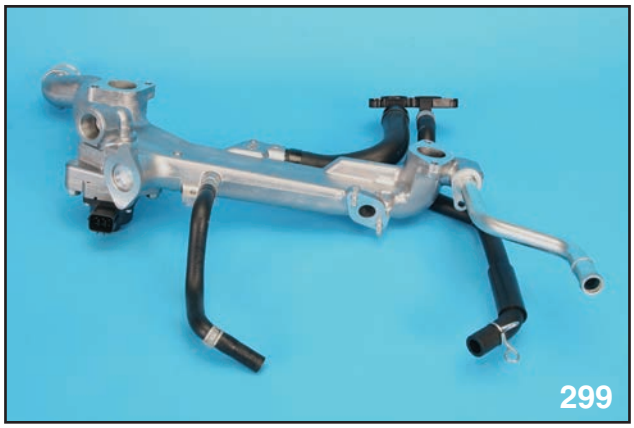
Remove the bolts securing the coolant crossover pipe to the engine block and remove the wiring harness, housing and coolant crossover pipe as an assembly.

Coolant Crossover Pipe and Engine Harness

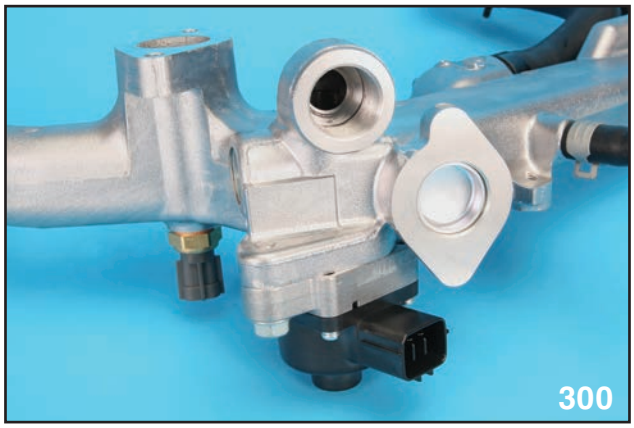
Replace the coolant crossover pipe O-rings during reassembly.



Coolant Crossover Pipe Front View



Coolant Crossover Pipe Rear View



EGR Valve and EGR Supply Pipe Connection

EGR Supply Pipe

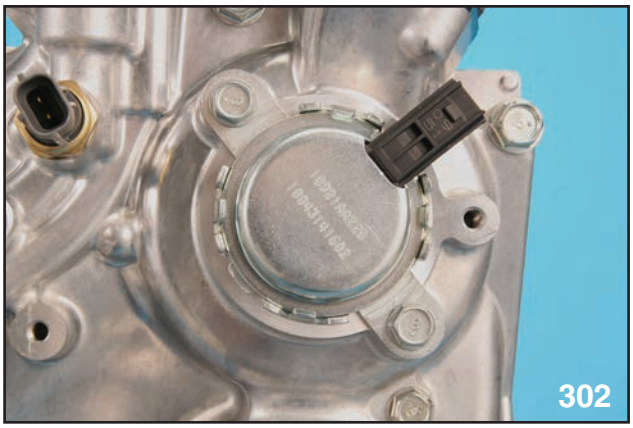
The coolant crossover pipe also serves to house the water cooled EGR valve system. Exhaust gas from the right bank cylinder head supplies EGR gas to the EGR valve. The EGR valve when opened, routes the controlled amount of EGR gas through the cooling chamber that is incorporated inside the coolant crossover pipe. The cooled EGR gas then travels through the delivery pipe to the intake manifold. The cooled EGR gas reduces the combustion chamber temperature and assists with the reduction of oxides of nitrogen more effectively than previous engine designs. This will allow for more advanced ignition timing. EGR gas flow rate has increased to 750 L/minute from 550 L/minute on previous engine designs.

Conditions needed for EGR Operations

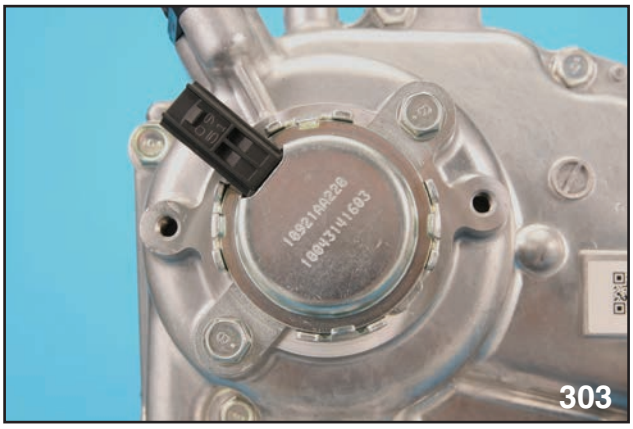
Ambient temperature greater than 32°F

Engine speed less than 4000 rpm

Manifold pressure less than -4 in Hg (-100 mmHg)

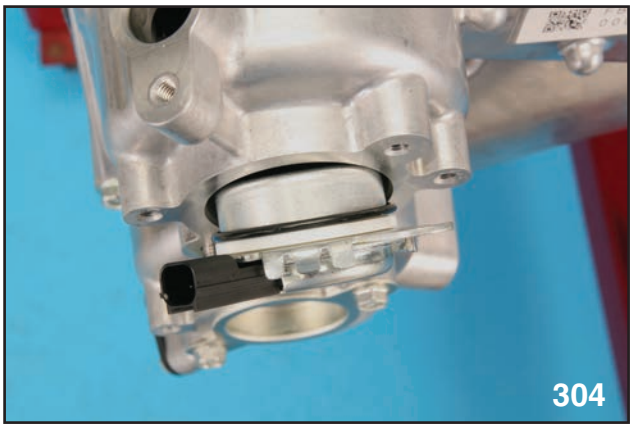


VFS (OCV) Solenoid Left Bank



VFS (OCV) Solenoid Right Bank

Remove the AVCS solenoids from the timing chain cover. The solenoids are sealed with an O-ring and a nylon backer ring. Replace both pieces on any removed solenoid.



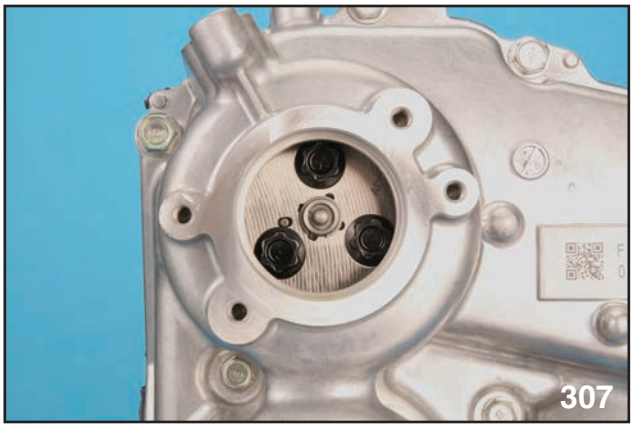
VFS (OCV) Solenoid O-ring and Back Ring

AVCS Plug O-ring and Backer Ring

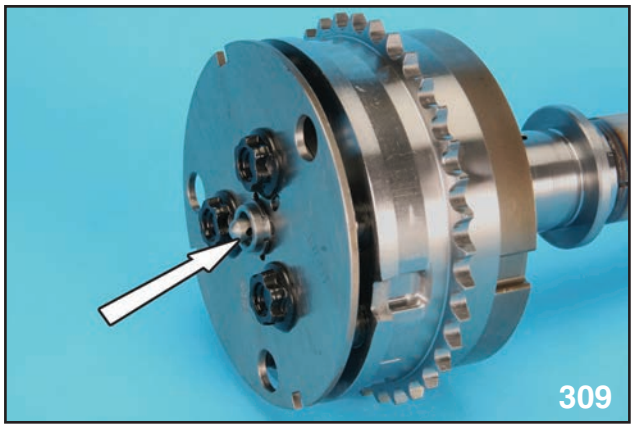
The AVCS solenoid blanks over the end of the exhaust Camshafts are sealed the same as the actual solenoids.

Exhaust VFS

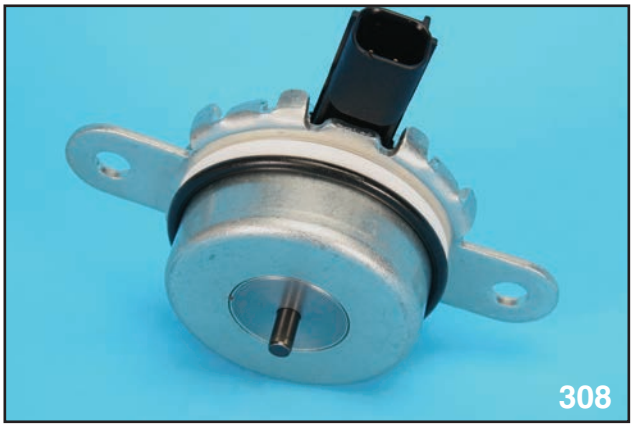
NOTE: ***The 2012 2.0 Liter is equipped with dual AVCS. This system is the same type equipped on the FB 2.5 which utilizes the tension of the valve springs to retard and advance the camshafts. Additional DTCs for the Exhaust Variable Force Solenoid and Exhaust cam angle sensor are included in the ECM logic.***



VFS (OCV) Removed Solenoid



AVCS Spool Valve Stem

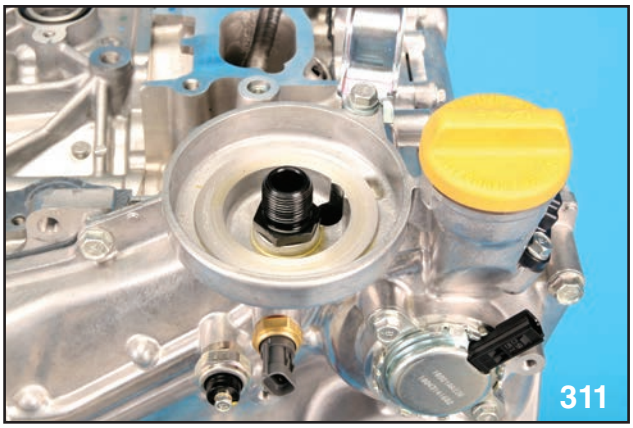


VFS (OCV) Solenoid On Position

During AVCS operation the solenoid pin pushes the end of the AVCS spool valve which is located in the Camshaft.

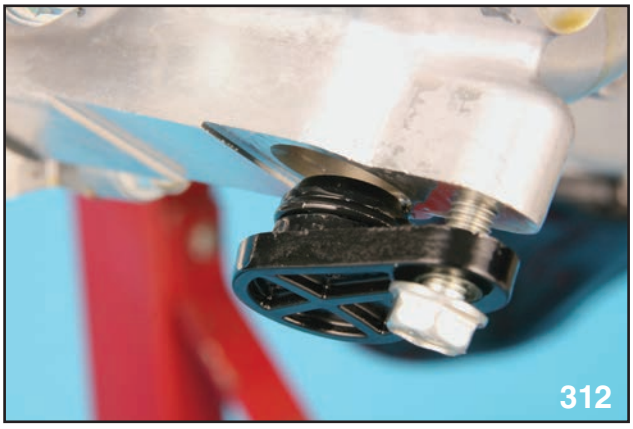
VFS (OCV) Solenoid Off Position

The Solenoid pin is pushed inside the solenoid when the AVCS is off by the tension of the spool valve spring.



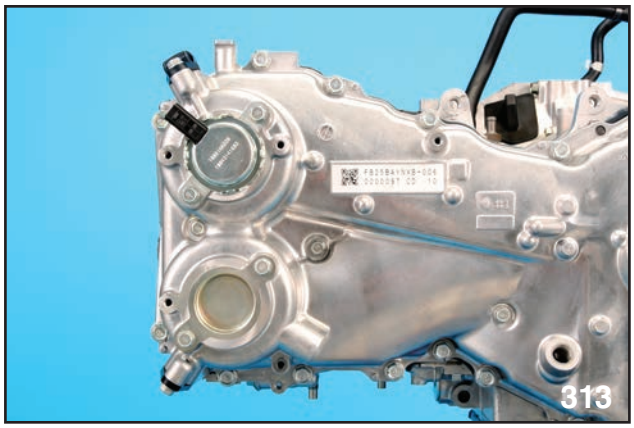
Oil Filter Seat

Remove the oil filter. The oil will drain into the oil filter supply and discharge galleys and back to the oil pan. The FB 2.5 is designed to operate with 0 W 20 synthetic oil.

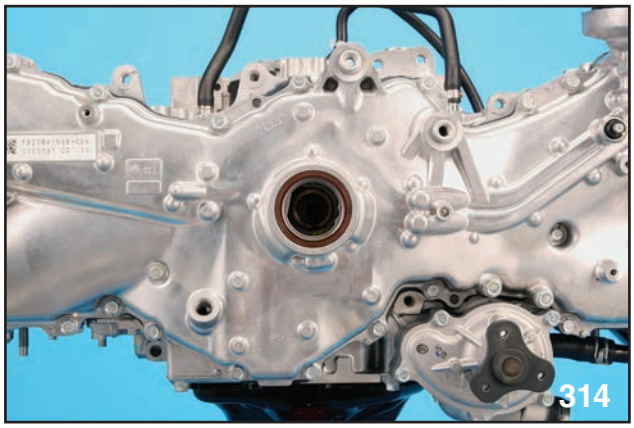


Cam Angle Sensor Plug

Remove the Camshaft sensors. The Camshaft sensors and blanks are sealed with O-rings.



Timing Chain Cover Right Bank



Timing Chain Cover Center View

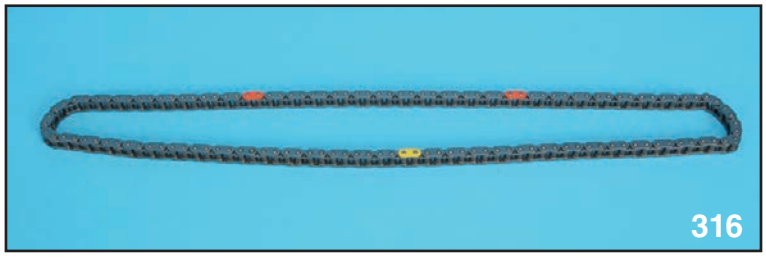
Timing Chain Cover Left Bank

Remove the timing chain cover bolts.

L = Long
All “L” bolts are identical

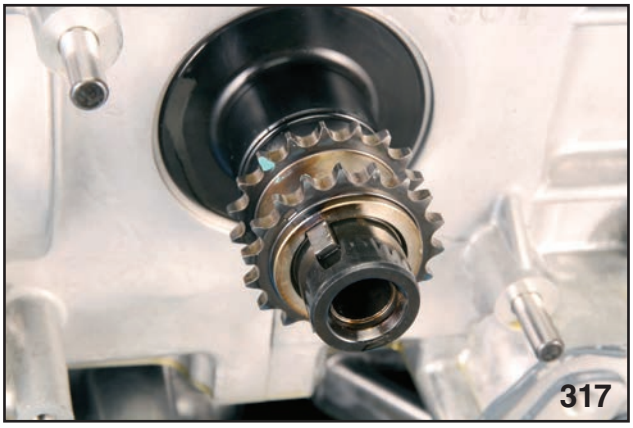
S = Short
All “S” bolts are identical

Number of Bolts	Pattern		Bolt Size
11	L SSSSSSSS	LL	8mm
5	L SSS	L	6mm
16	L SSSSSSSS	LLSSSL	8mm



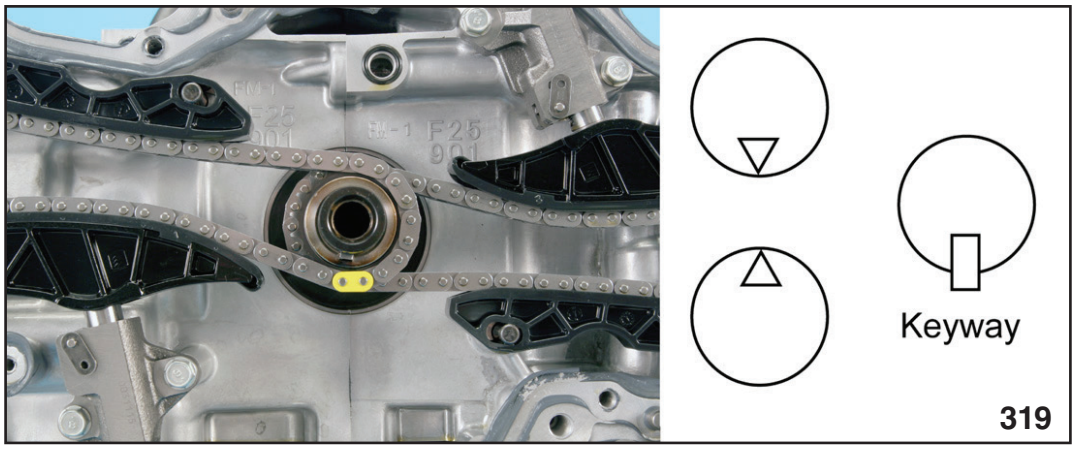
Timing Chain Bench View

The timing chains driving the Camshafts are identical and are provided with color coded timing marks. Chain guides for the left and right banks are also identical. It is recommended to mark the parts and return them to their original positions to maintain wear patterns.



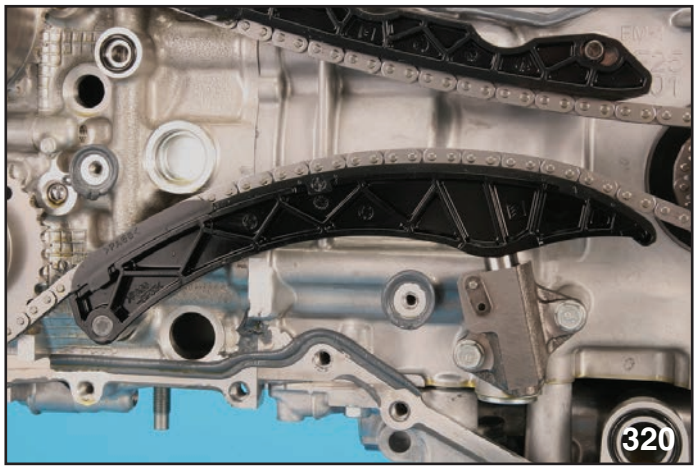
Timing Chain Crankshaft Sprockets

FB 2.5 Liter Timing Chain Removal

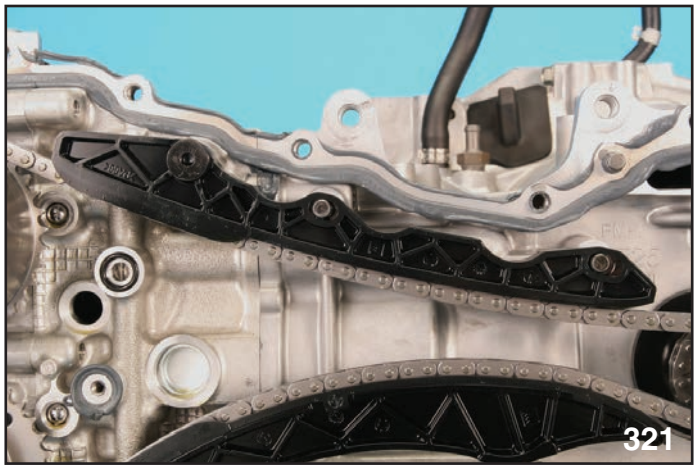


Crankshaft Keyway

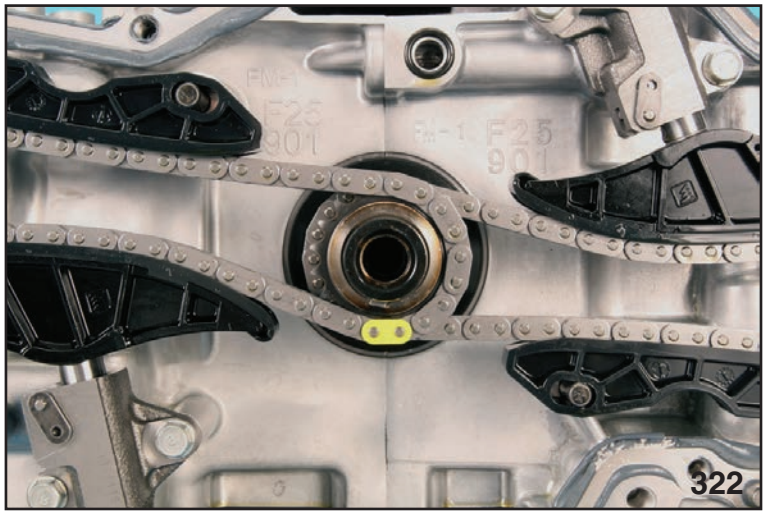
Begin timing chain removal by positioning the crankshaft keyway to 6 O'clock. The right bank intake Camshaft alignment mark must be on 6:00 O'clock with right bank exhaust alignment mark at 12:00 O'clock (Camshafts will be unloaded.)



Right Bank Chain Tensioner and Lower Chain Guide



Right Bank Upper Chain Guide



Tensioners

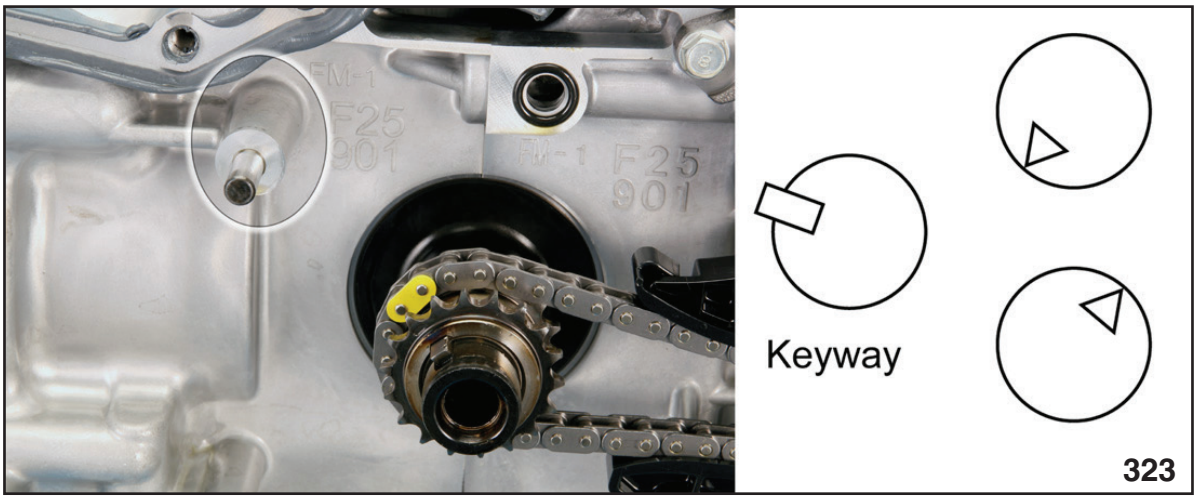
Insert a stopper pin into the chain tensioner.

Remove the chain tensioner.

Remove the chain tensioner lever.

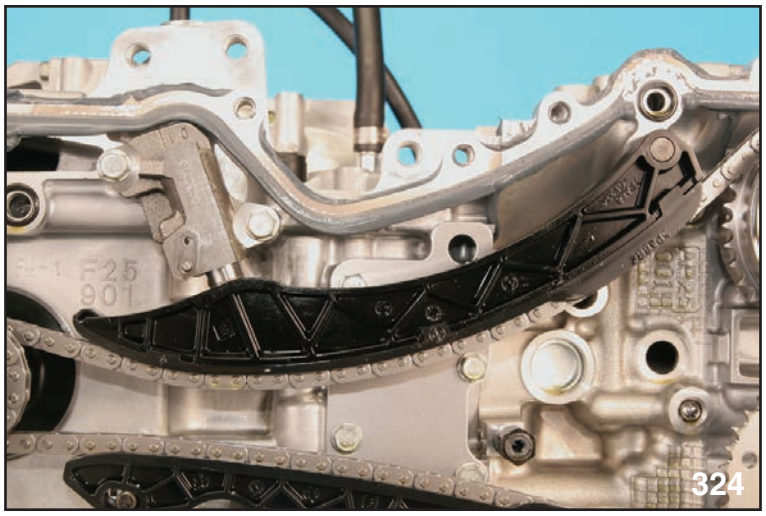
Remove the chain guide.

Remove the timing chain.



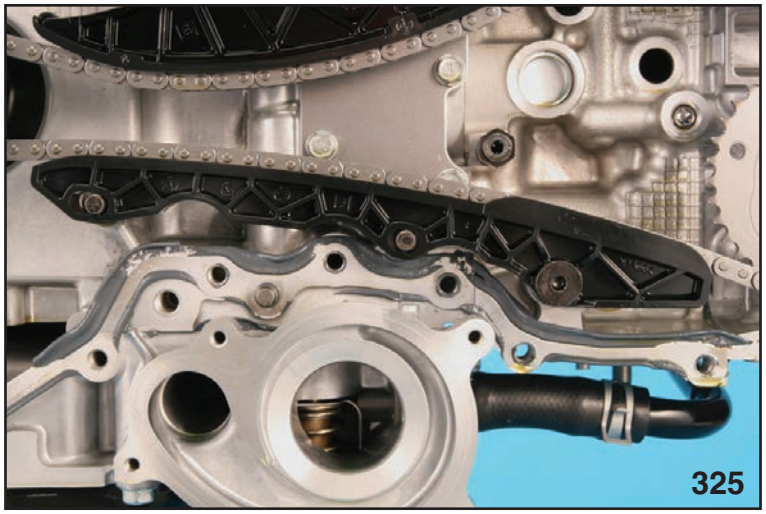
Left Bank Crankshaft Keyway and Chain Guide Dowel

Turn the crankshaft CLOCKWISE until the crankshaft keyway lines up with the right bank chain guide dowel. The left bank intake Camshaft alignment mark must be at 8 O'clock. The left bank exhaust alignment mark must be at 1 O'clock.



Left Bank Chain Tensioner and Upper Chain Guide

Insert a stopper pin into the chain tensioner.



Left Bank Lower Chain Guide

Remove the tensioner.

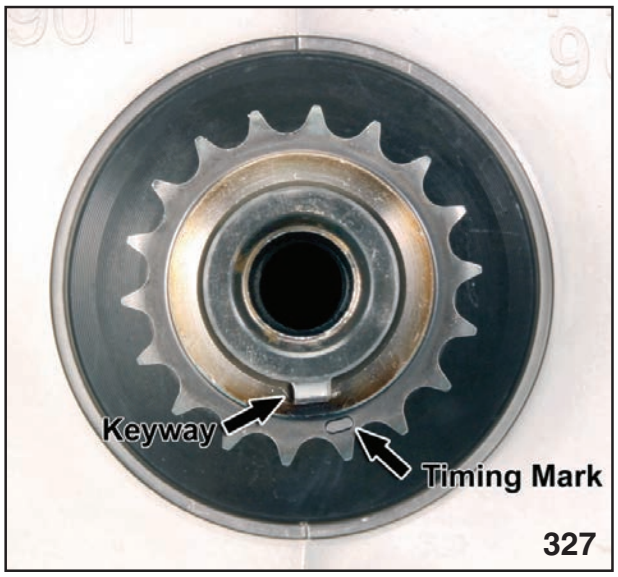
Remove the chain tensioner lever.

Remove the chain guide.

Remove the timing chain.

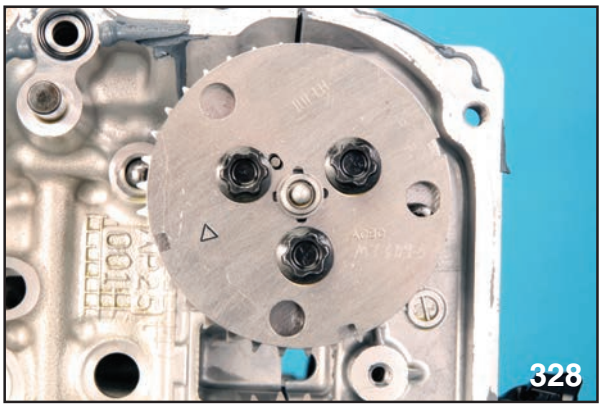
Turn the crankshaft in a **COUNTER CLOCKWISE** direction until the timing mark is back to 6 O'clock. This positions all the pistons off of TDC and prevents the accidental contact of pistons and valves.

Timing Chain Installation



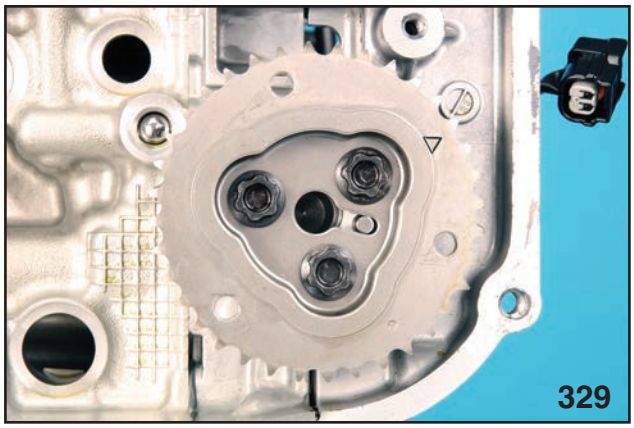
Crankshaft Timing Mark

Turn the crankshaft in a COUNTER CLOCKWISE direction until the keyway is back to 6 O'clock. This positions the pistons off of TDC and prevents the accidental contact of pistons and valves.



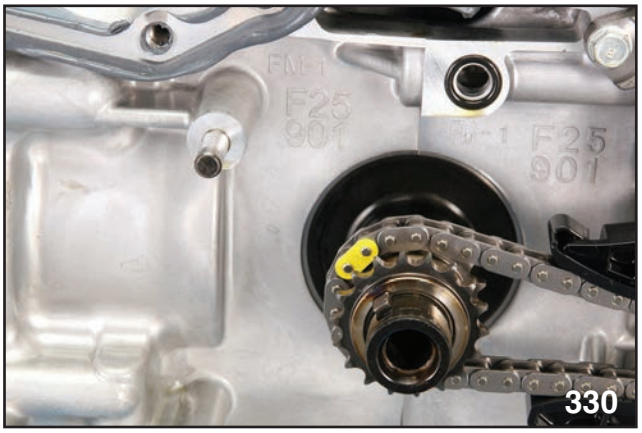
Left Bank Intake Camshaft

Turn the left bank intake Camshaft until the alignment mark is at 8 O'clock.



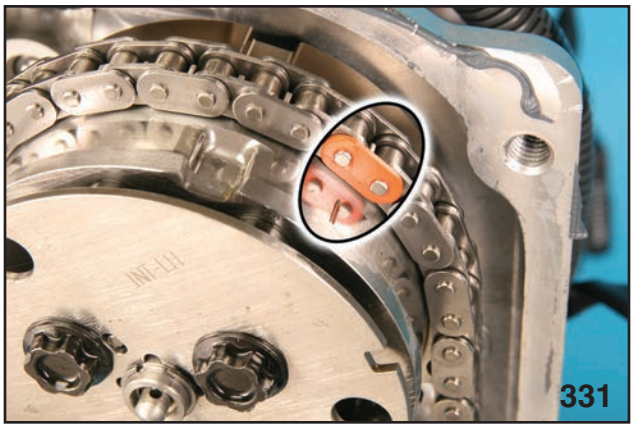
Left Bank Exhaust Camshaft

Turn the left bank exhaust Camshaft until the alignment mark is at 1 O'clock.

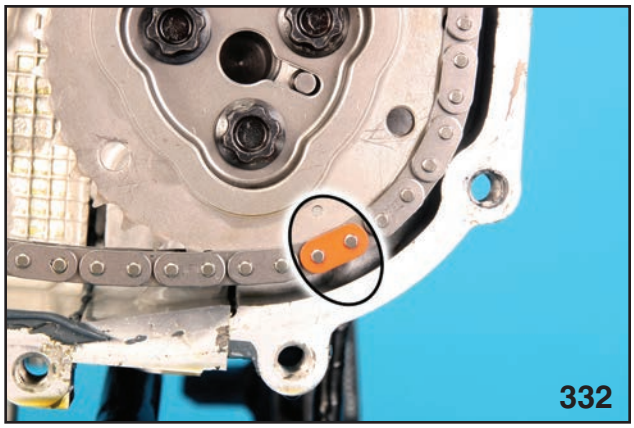


Left Bank Crankshaft Timing Mark

Turn the crankshaft in a CLOCKWISE ROTATION until the timing mark is in line with the chain guide pin of the right bank.



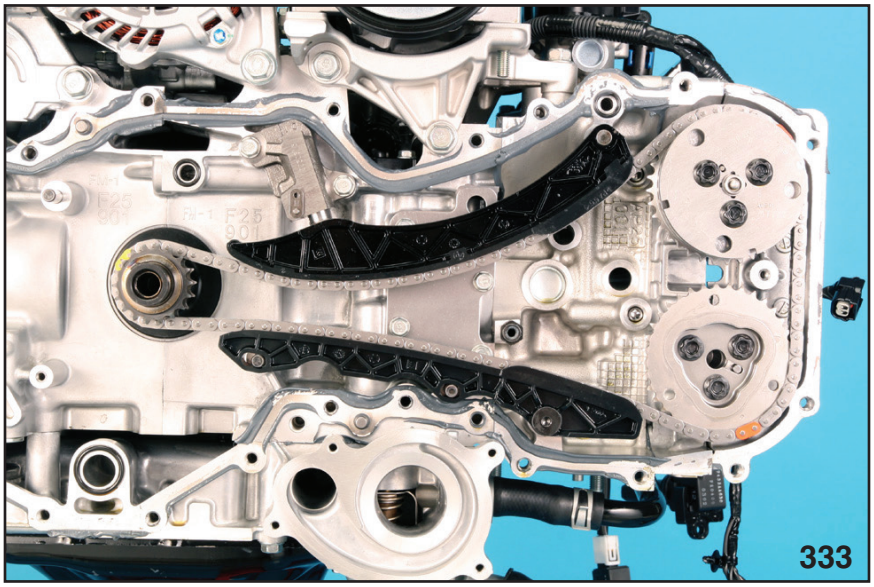
Orange Link on Intake Camshaft



Orange Link on Exhaust Camshaft

Install the chain guide.

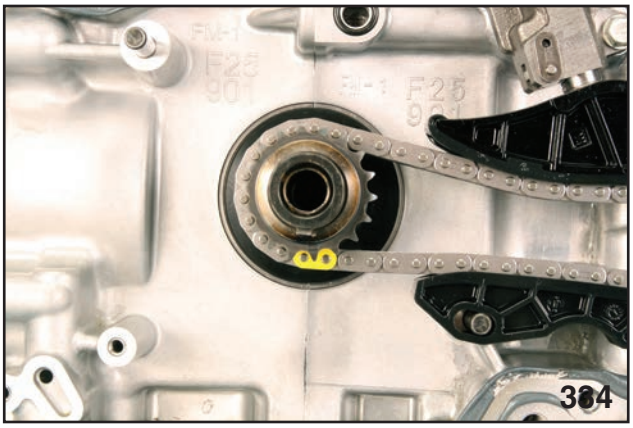
Install the chain with the yellow chain link over the crankshaft timing mark and the orange links on the Camshaft timing marks.



Left Bank Chain Installed

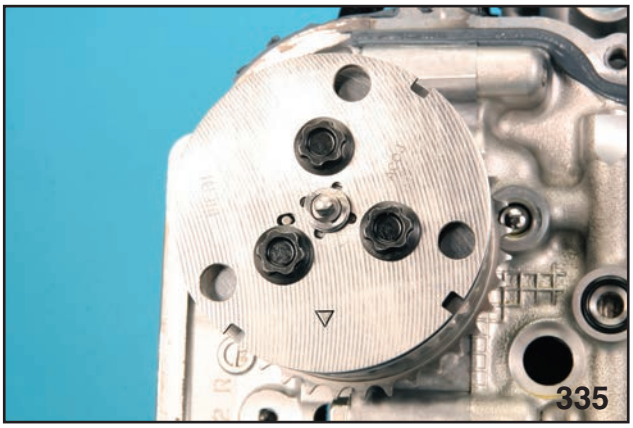
Install the chain tensioner lever and tensioner.

Check all marks and pull the pin from the tensioner.



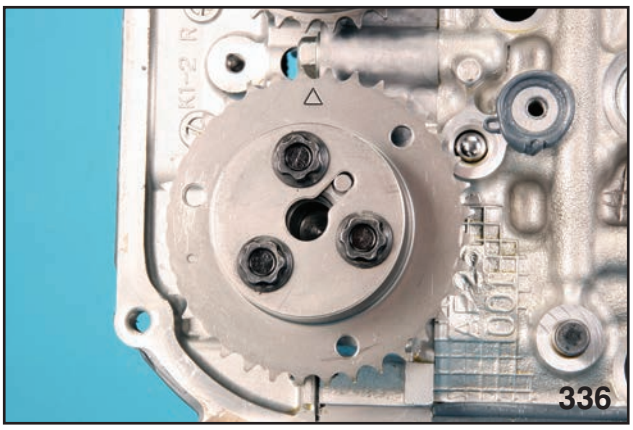
Crankshaft

Rotate the crankshaft COUNTER CLOCKWISE until the timing mark is at 6 o'clock.



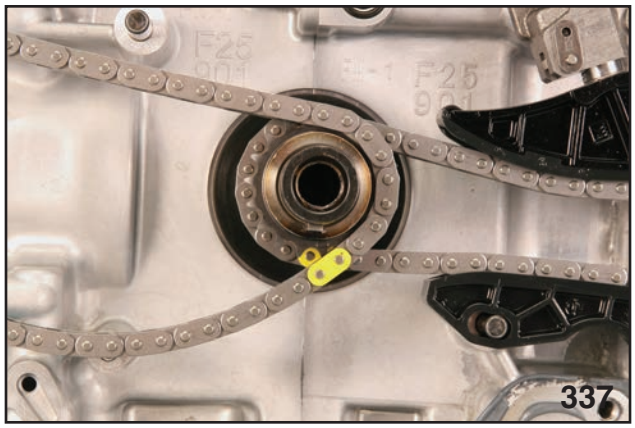
Right Bank Intake Camshaft

Position the right bank intake Camshaft alignment mark to 6 o'clock.



Right Bank Exhaust Camshaft

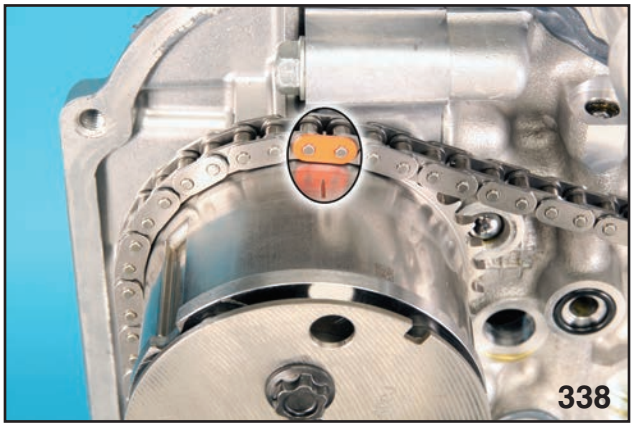
Position the right bank exhaust Camshaft alignment mark to 12 o'clock.



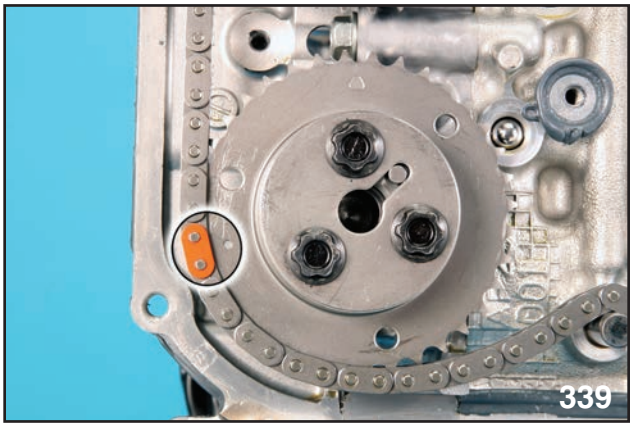
Yellow Chain Link over the Crankshaft Timing Mark

Install the chain guide.

Install the chain with the yellow chain link over the crankshaft timing mark and the orange links on the Camshaft timing marks.

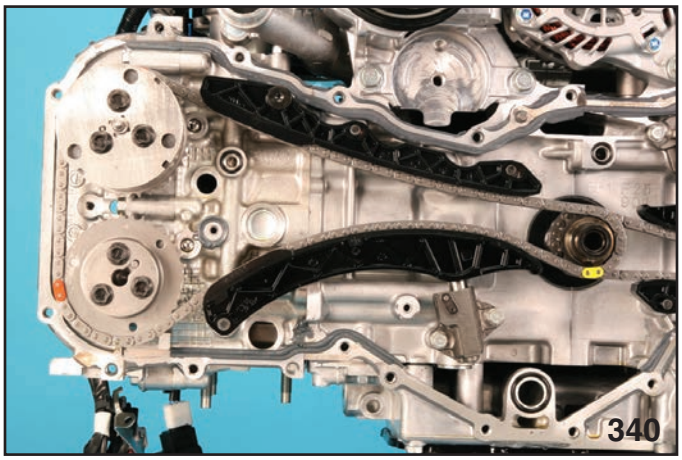


Right Bank Intake Cam Sprocket



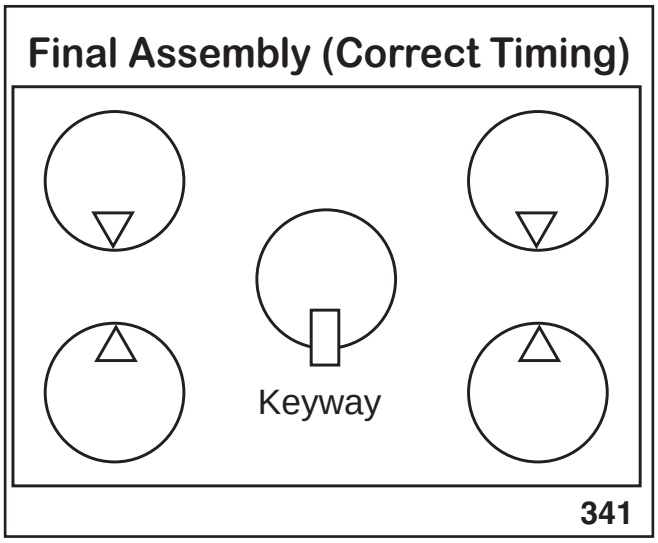
Right Bank Exhaust Cam Sprocket

Install the chain tensioner lever and tensioner.



Right Bank Chain Installation

Check all marks and pull the pin from the tensioner.



Final Assembly (Correct Timing 2.5L)

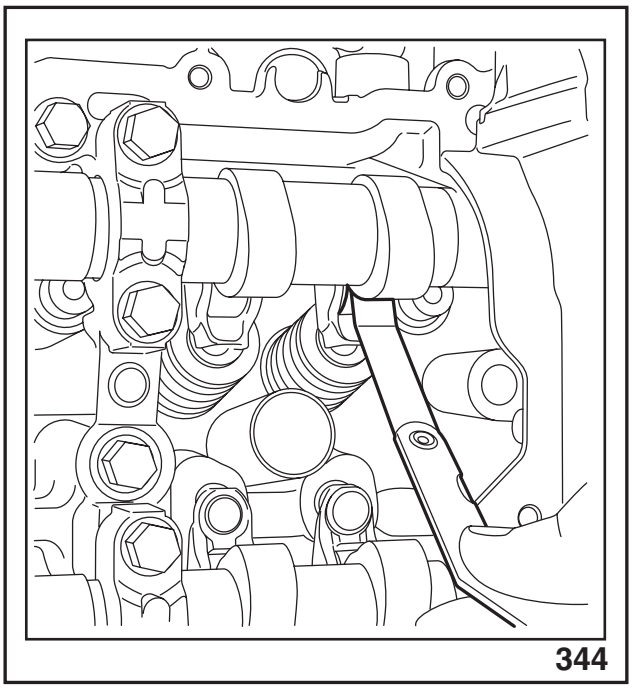
Cylinder Head

Rocker Arm, Pivot, and Shim

The FB 2.5 is equipped with roller rockers. This configuration reduces friction.

The valve clearance is set with a stem type shim. Valve clearance may be checked in the vehicle but adjustment requires engine removal.

Keep all parts organized by cylinder to ease reassembly.

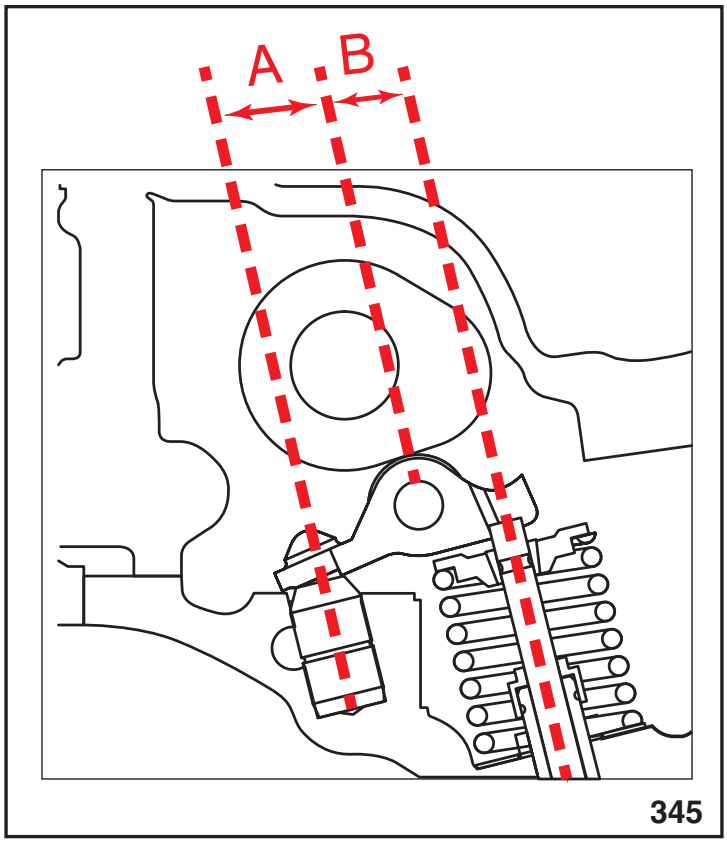


Camshaft Lobe

Beginning with the 2015 model year FA and FB engines Camshaft lobe profiles has been enhanced to more effectively operate with a new turbocharger.

Rocker arms, pivots and valve springs have also been redesigned to match the new camshaft lobe profile.

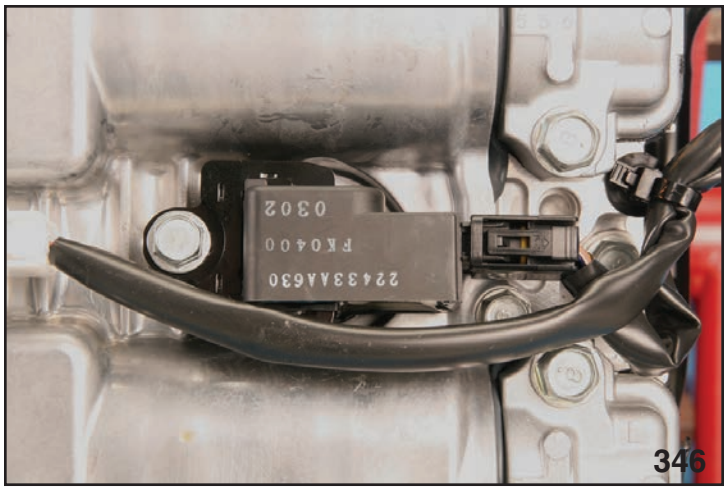
Note: The valve adjustment formulas have been changed.



Rocker Arm

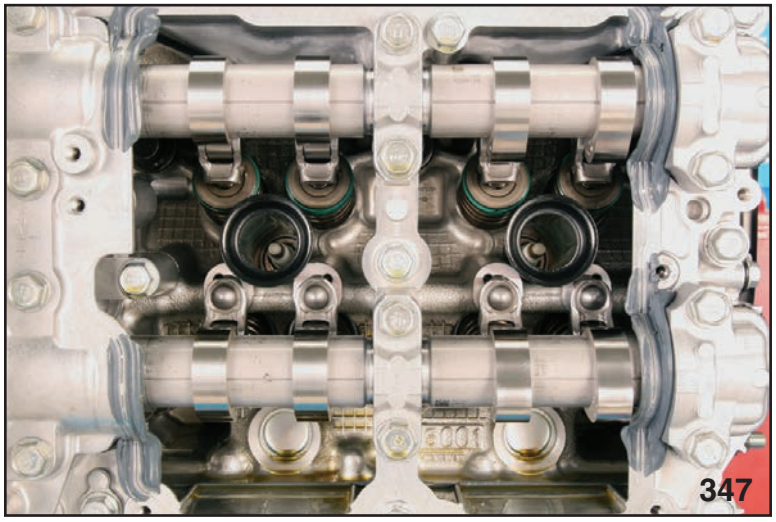
Note: The highlighted numbers in the charts reflect the ratio of difference in movement between points A and B. This is applicable to all FA and FB engine designs.

2014 formula Intake side: S = T + 1.54 x (V - 0.13 mm (0.0051 in)) Exhaust side S = T + 1.69 x (V - 0.22 mm (0.0087 in))	S: Valve shim thickness required V: Measured cam clearance T: Current valve shim thickness
2015 formula Intake side: S = T + 1.69 x (V - 0.13 mm (0.0051 in)) Exhaust side: S = T + 1.87 x (V - 0.22 mm (0.0087 in))	



Ignition Coil

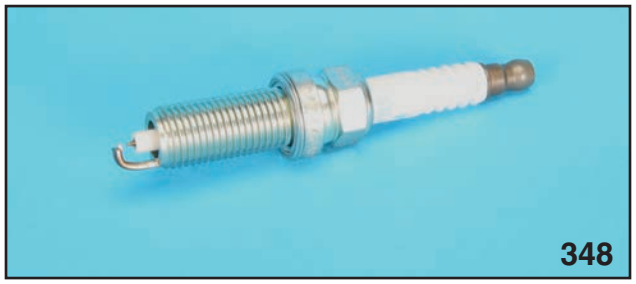
Remove the ignition coils.



Rocker Arms

Remove the valve covers, and Camshaft journal caps.

Remove the Camshafts.

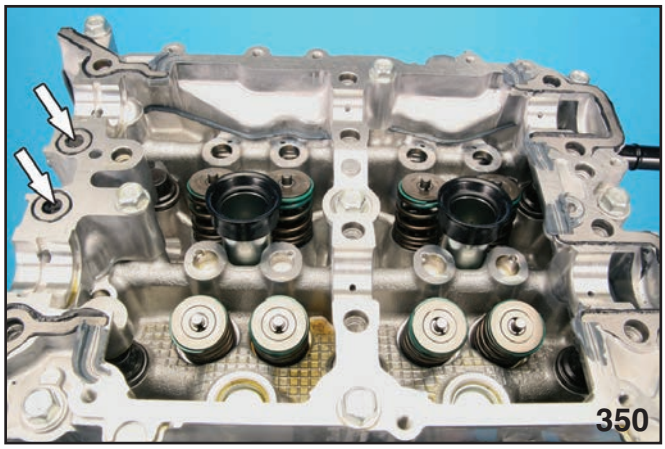


Spark Plug

The spark plugs for the FB 2.5 are removed with a 14 mm spark plug socket and 3/8” drive wobble extension.

Crankshaft Degree Marks

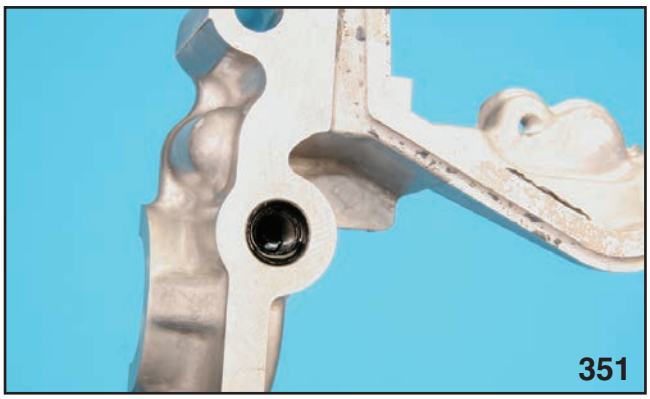
NOTE: These numbers are used during valve cover removal and cam clearance (valve clearance) inspection.



Camcase Without Camshafts

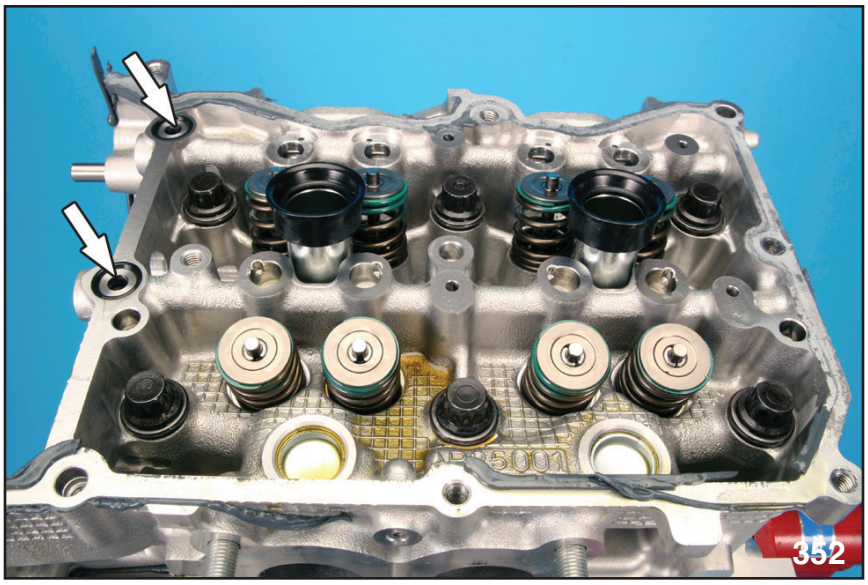
Replace the indicated O-rings during assembly.

Remove the Camcase.



AVCS Filter in Camcase

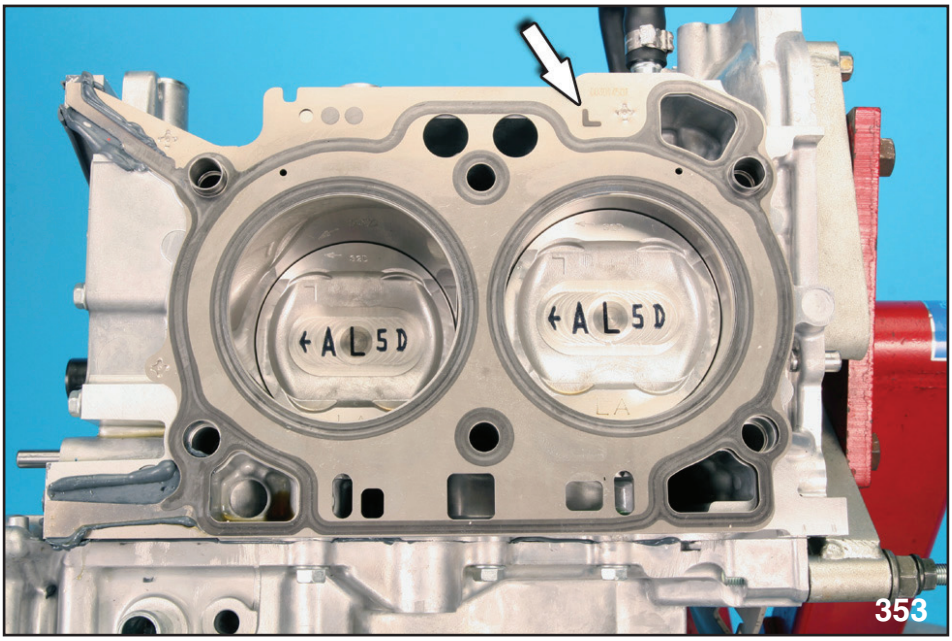
The Camcases are equipped with a filter screen insert that filters oil to the AVCS spool valve. (One on each Camcase)



Cylinder Head

Replace the indicated O-rings during assembly.

Remove the cylinder head bolts.

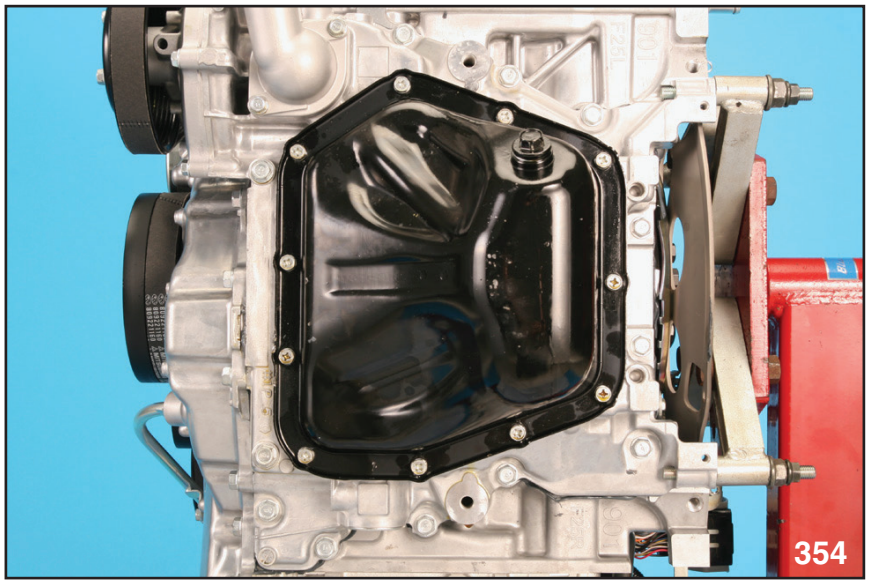


Cylinder Head Gasket

Remove the cylinder head gasket.

The indicated “L” or “R” will be visible and must face up.

Oil Pan



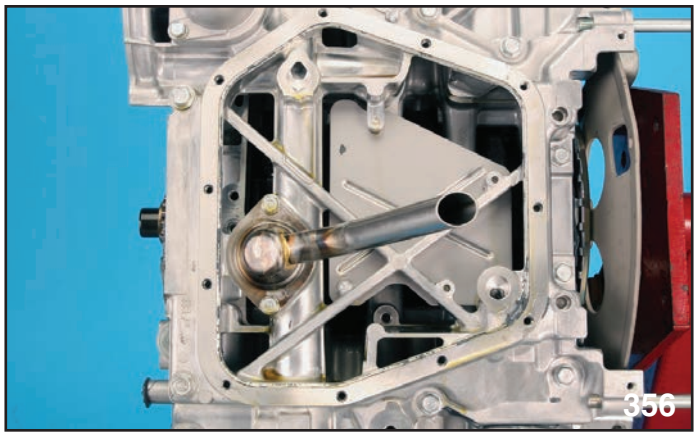
Oil Pan

Remove the lower oil pan.

Oil Pan Inside View

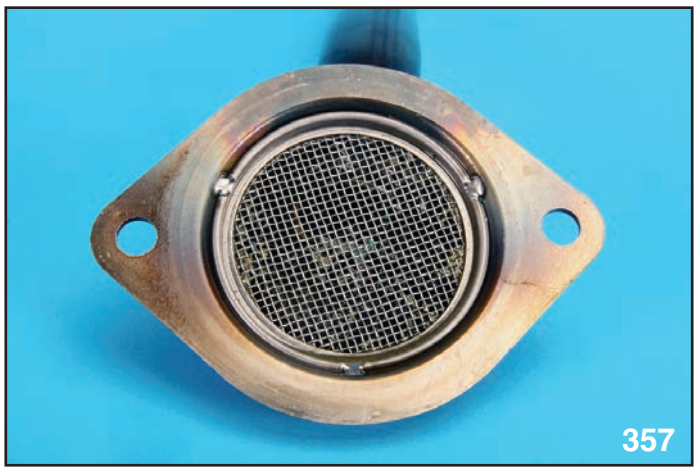
Note the location of the oil pan O-rings on the return side of the lubrication system.

Replace with new O-rings during assembly.



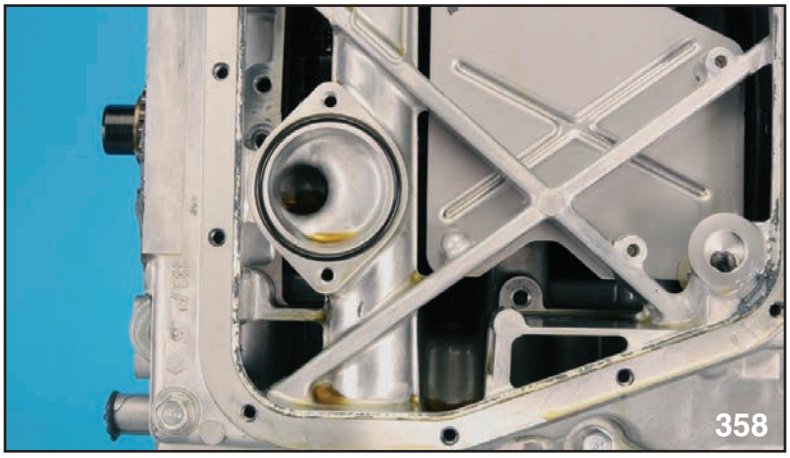
Lower Oil Pan Removed

Remove the two bolts for the oil pick up tube.



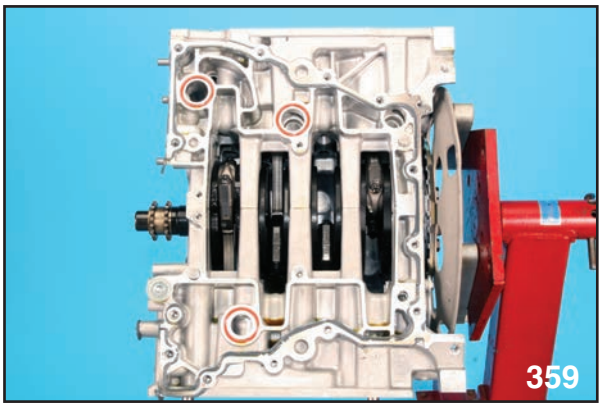
Oil Pick-Up Screen

A screen is built into the mounting base of the pickup tube.



Oil Pick-Up Screen Removed

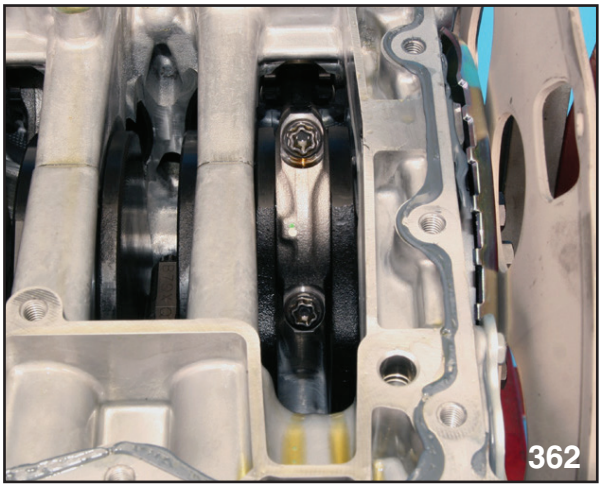
Replace the O-ring upon assembly.



Upper Oil Pan Removed

Remove the upper oil pan. Replace the O-rings during assembly.

Connecting Rod and Piston



Connecting Rod Bolts

Remove the connecting rod bolts with a Torx® Socket E12.

Push the piston out through the top of the cylinder.

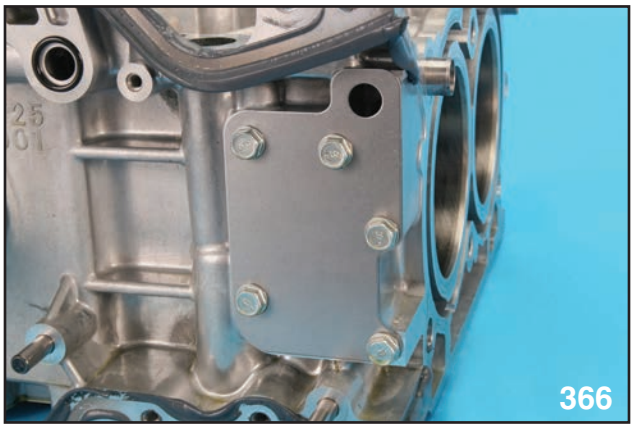
Piston and Connecting Rod

Piston Rings

A special tool has been designed to compress the piston rings during assembly.

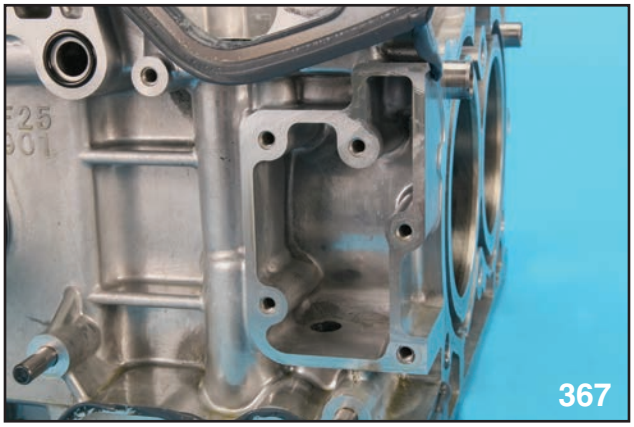
Special tool J-50553.

Engine Block



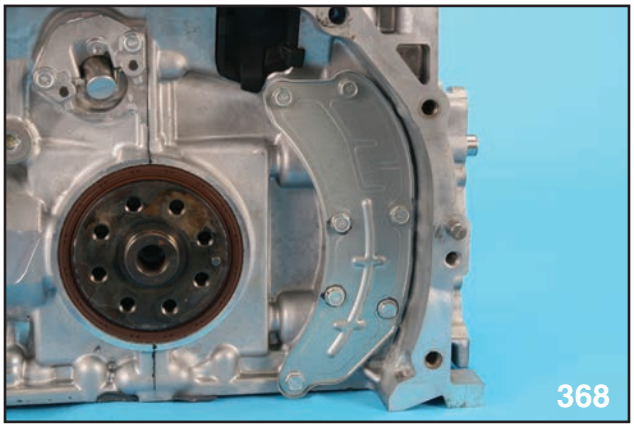
Front PCV Baffle Plate

The front PCV baffle plate is not sealed on to the engine block.



Front PCV Baffle Plate Removed

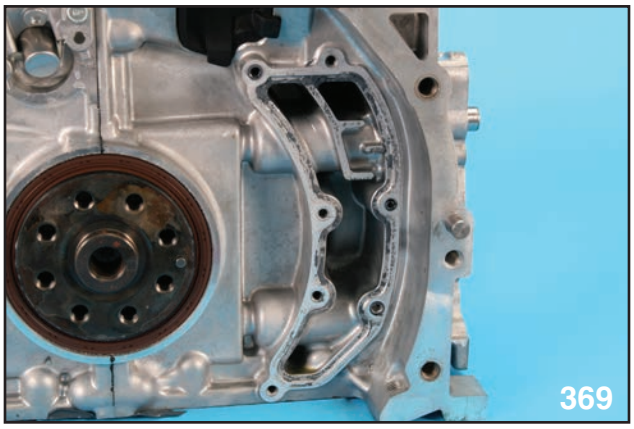
Remove the front PCV baffle plate and check area for any contamination.



Rear PCV Baffle Plate

The rear PCV baffle plate is sealed to the engine block.

Remove the rear PCV baffle plate and check for any contamination.

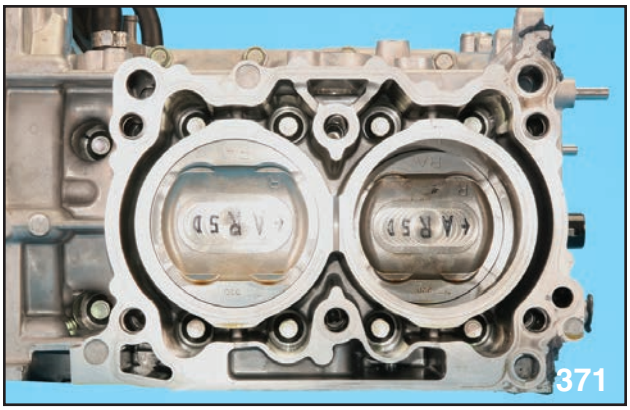


Rear PCV Baffle Plate Removed

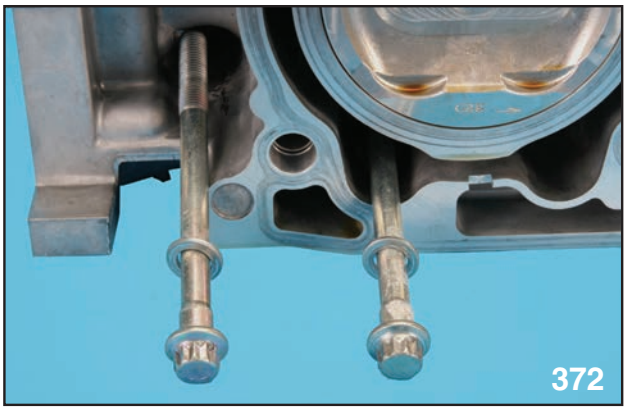
Thoroughly clean the sealing surface before applying the recommended sealant.

Rear PCV Baffle Plate Sealing Side

If the rear PCV baffle plate is distorted during removal, replace it with a new plate.

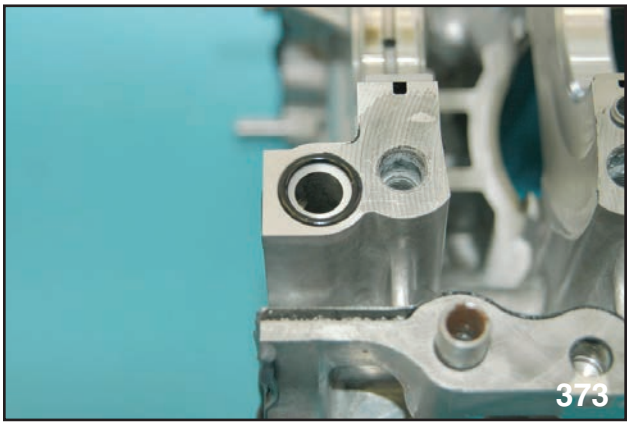


Case Bolts and Washers

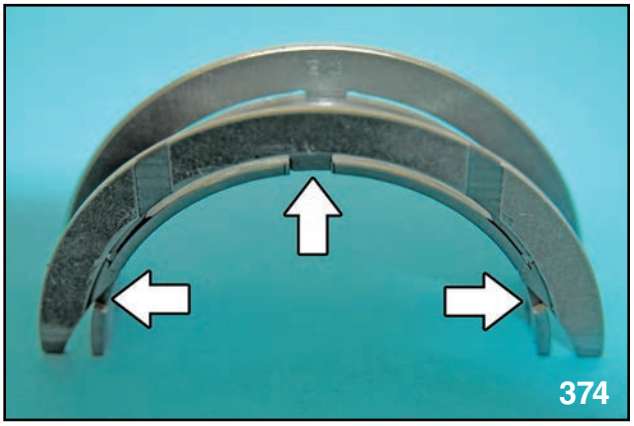


Case Bolts

All case bolts use metal washers (No rubber inlay). The case halves are joined with 15 bolts.

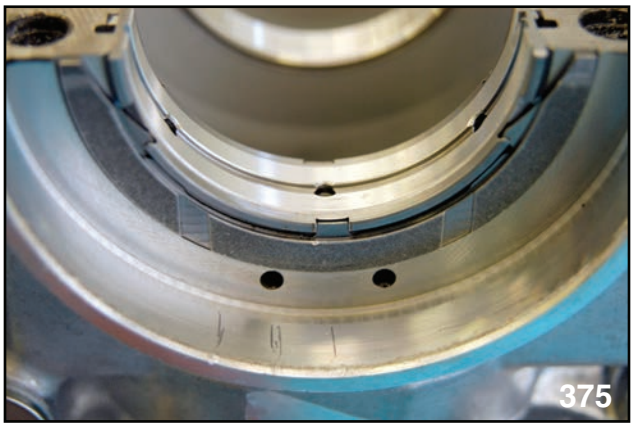


Engine Case Half O-ring



3 Piece Rear Main Bearing

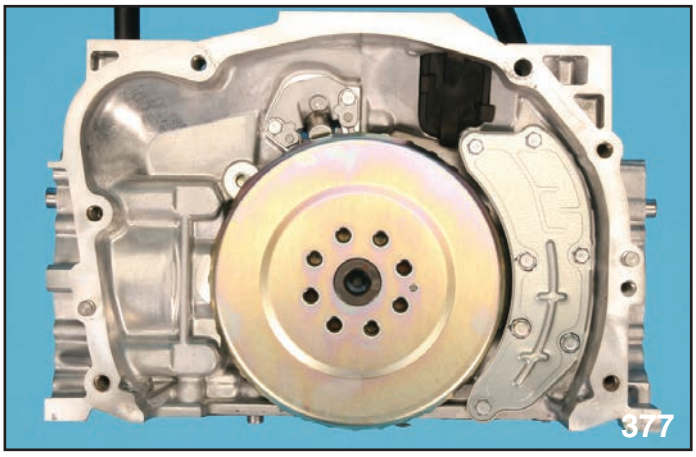
A single O-ring is used to seal an oil passage on one case half against the solid surface of the opposite case half.



Rear Main Bearing Installed

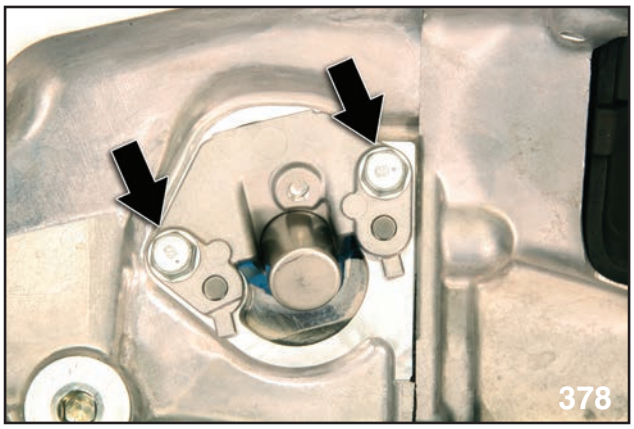
Crankshaft Thrust Surface

The three piece rear main bearing (thrust) cannot be disassembled.



Crankshaft Reluctor

The FB-2.5 utilizes a large crankshaft reluctor that assists with producing a more precise crank angle signal.

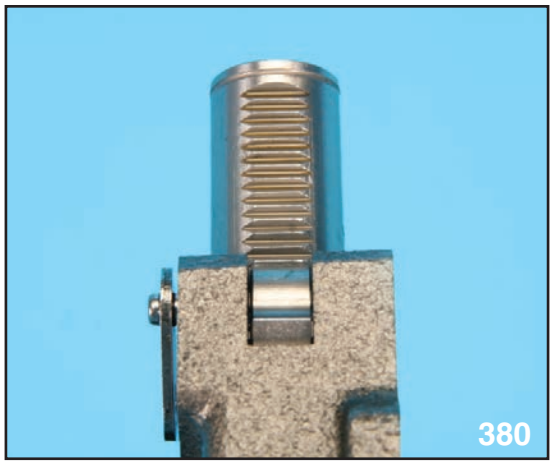


Crank Angle Sensor Mounting Bracket

During reassembly ensure the crank angle mounting bracket bolts are properly torqued.

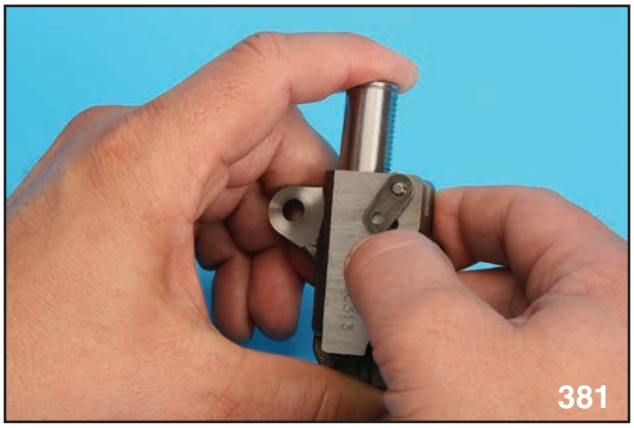
Timing Chain Tensioner

The timing chain tensioner functions similar to previous tensioners. Tension is maintained with the engine off with a rack gear.

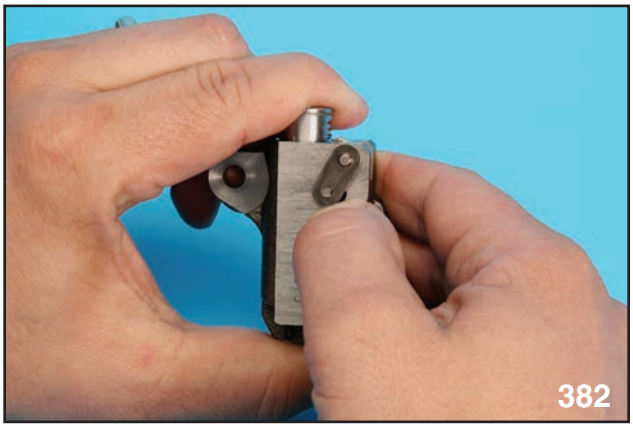


Chain Tensioner Rack

The rack gear works with a catch gear that can be positioned to a neutral setting during reassembly.

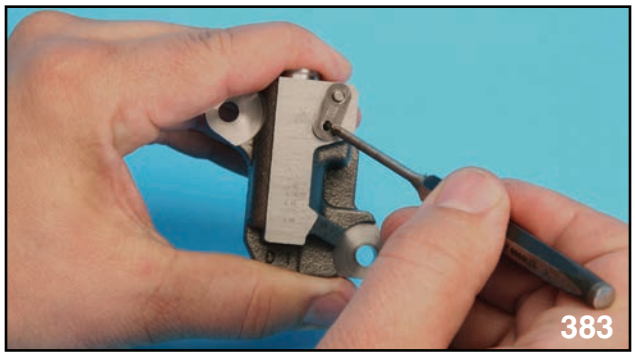


Setting Tensioner



Tensioner Set

Push the catch gear to the left until the rack gear and piston can be pushed down.

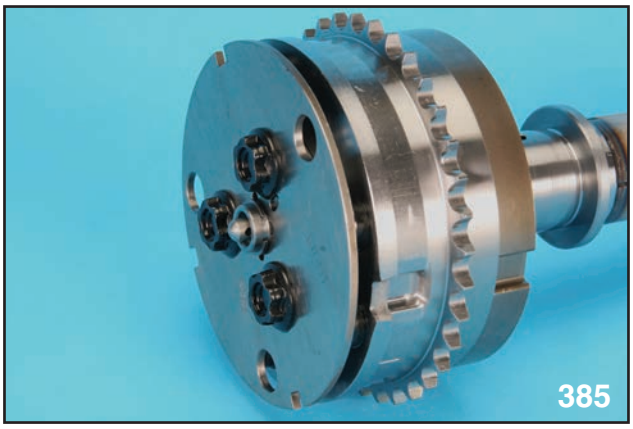


Inserting Punch

When the rack gear and piston are fully compressed, insert a punch or pin into the catch gear lever.

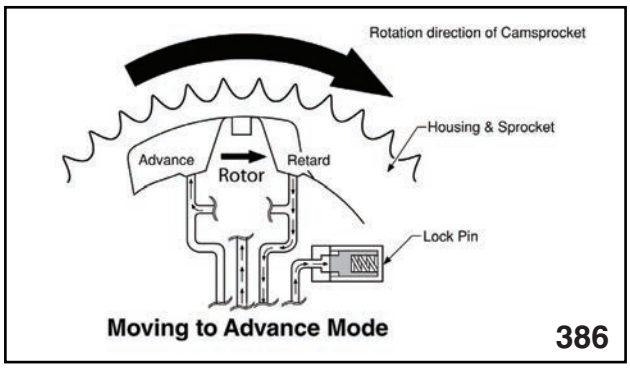
NOTE: ***If the hole in the lever and the tensioner will not align, allow the rack gear and piston to rise slightly. Check for proper alignment.***

Active Valve Control System (AVCS)

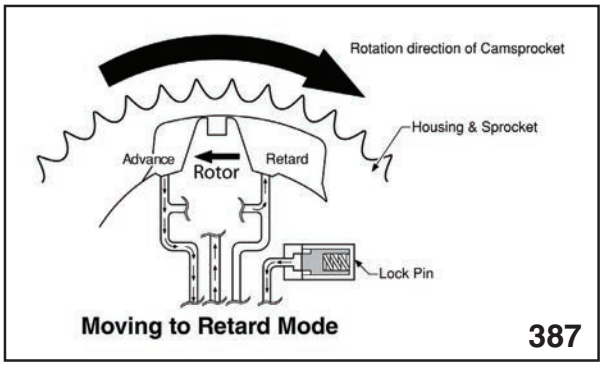


New AVCS

The FB 2.5 engine is equipped with a new Active Valve Control System (AVCS). This system is designed to advance and retard the Camshaft, similar to previous designs, while minimizing the demand from the oil pump.

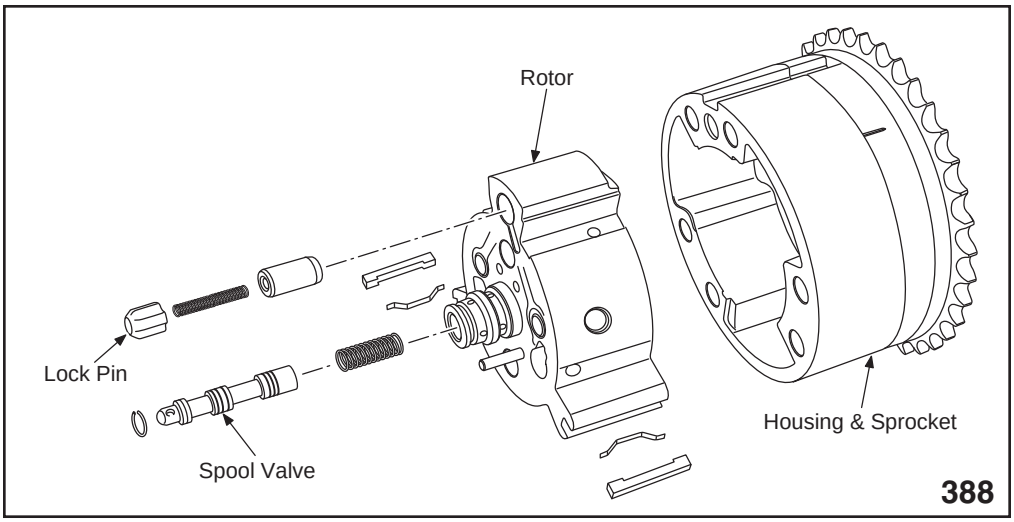


Advance



Retard

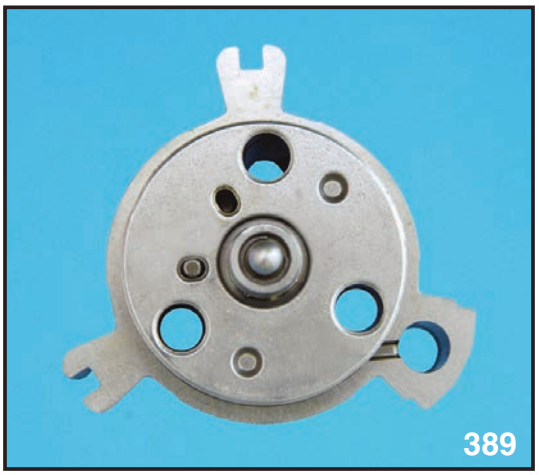
The new system does not depend on a hydraulic rotor to function. Instead oil is moved from one chamber to the other which reduces the volume of oil needed to operate the AVCS.



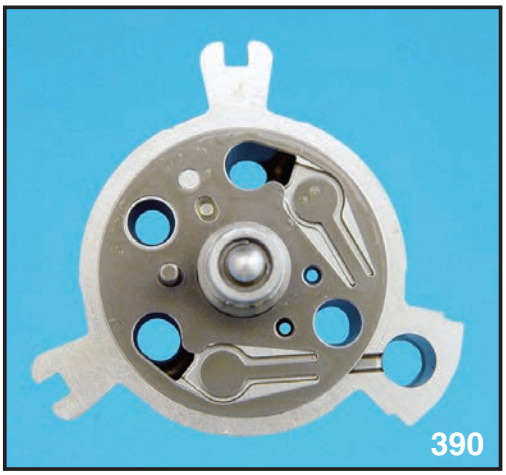
New AVCS Actuator

A spool valve pressed into the Camshaft rotor controls the oil flow into and out of the Advance and Retard chambers. The force needed to rotate the Camshaft within the Camshaft sprocket is delivered by the valve springs.

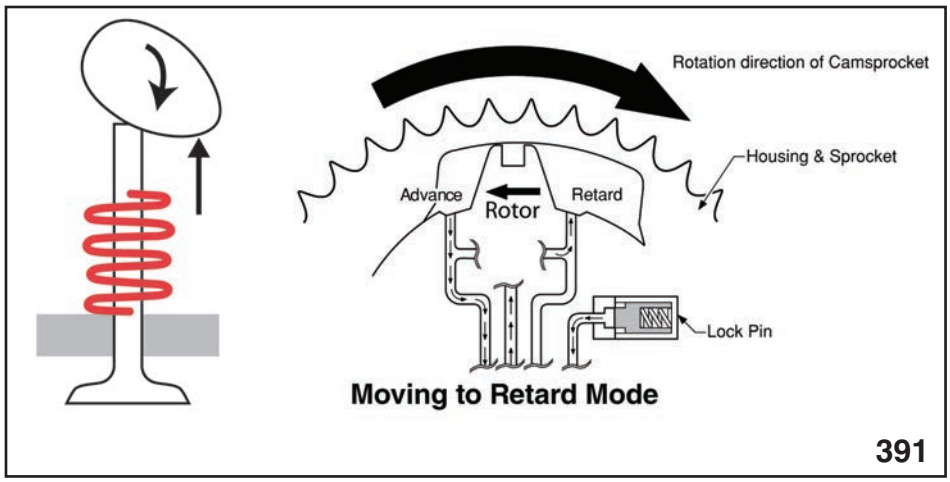
The oil in the sealed chambers holds the Camshaft rotor into a fixed position. If oil is transferred from one chamber to the other, the Camshaft rotor and Camshaft rotate within the Camshaft sprocket.



New AVCS Rotor

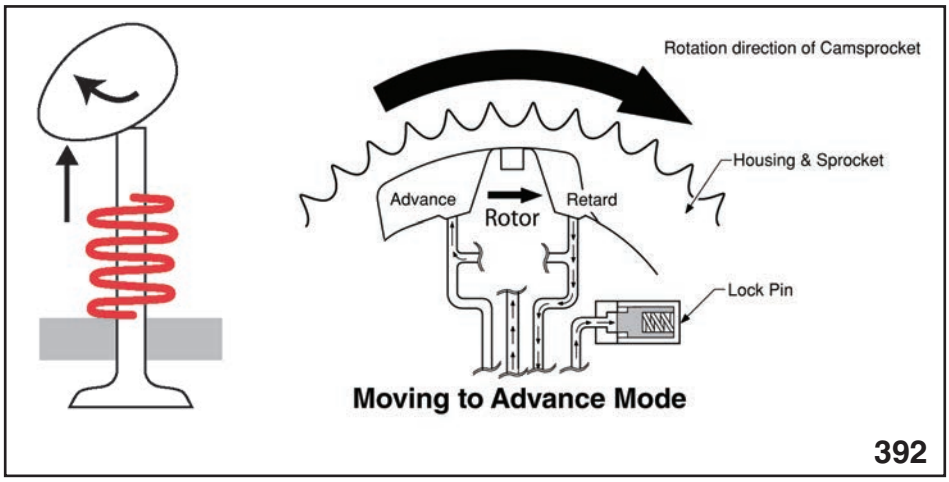


Advance and Retard Check Valves



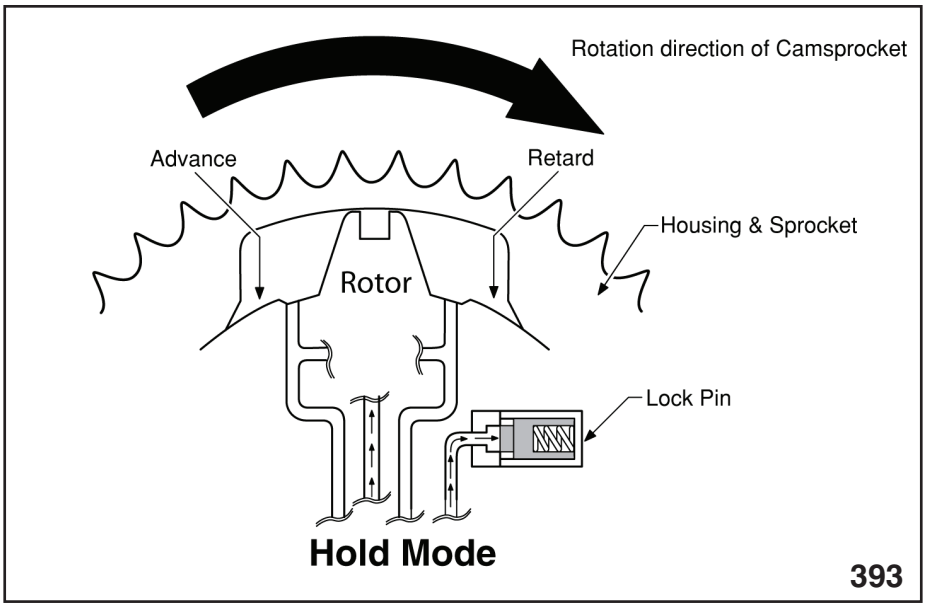
Start of Intake Stroke *Retard*

As the Camshaft intake lobe comes into contact with the intake valve, the intake valve spring produces a force opposite to Camshaft rotation. If oil is allowed to transfer from the Advance chamber while opposing valve spring tension, the Camshaft sprocket moves ahead of the Camshaft. This produces the Retard mode of the AVCS.



End of Intake Stroke *Advance*

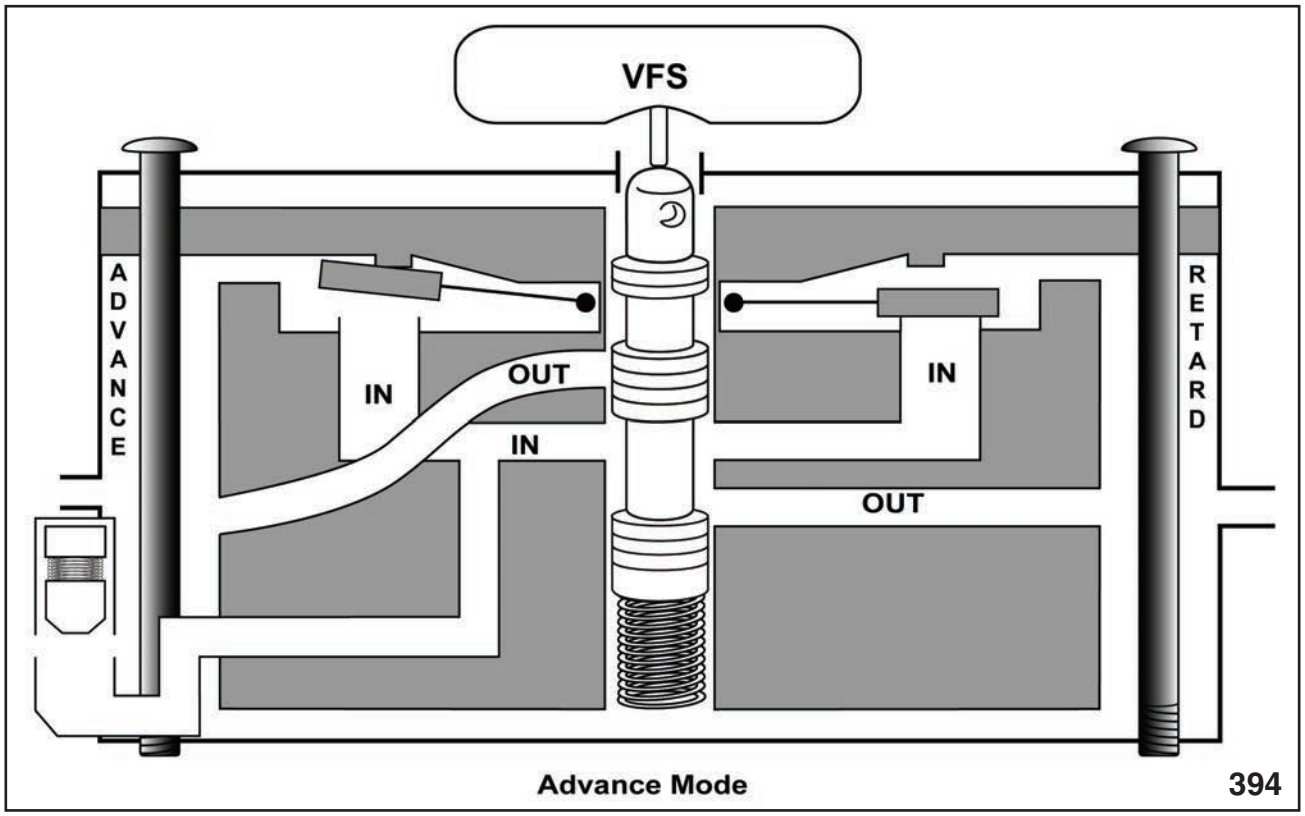
As the Camshaft intake valve begins to close, the intake valve spring produces a force in the direction of Camshaft rotation. If oil is allowed to transfer from the Retard chamber while the valve spring tension is pushing on the Camshaft lobes, the Camshaft rotates in the same direction as the Camshaft sprocket. This produces the Advance mode of the AVCS.



Hold Mode

Hold mode occurs when the ECM produces a duty ratio that traps oil in both chambers. This will hold the Camshaft in the current position.

Advance Mode



Advance Mode

The Variable Force Solenoid (VFS) duty ratio is increased and the spool valve is compressed. This provides a path that will allow oil currently in the retard chamber to transfer to the advance chamber.

Note: ***The oil flowing through the AVCS is always being replenished. A controlled return and replenish oil circuit is machined into the rotor and spool valve assembly. This will control the heat in the AVCS actuator.***

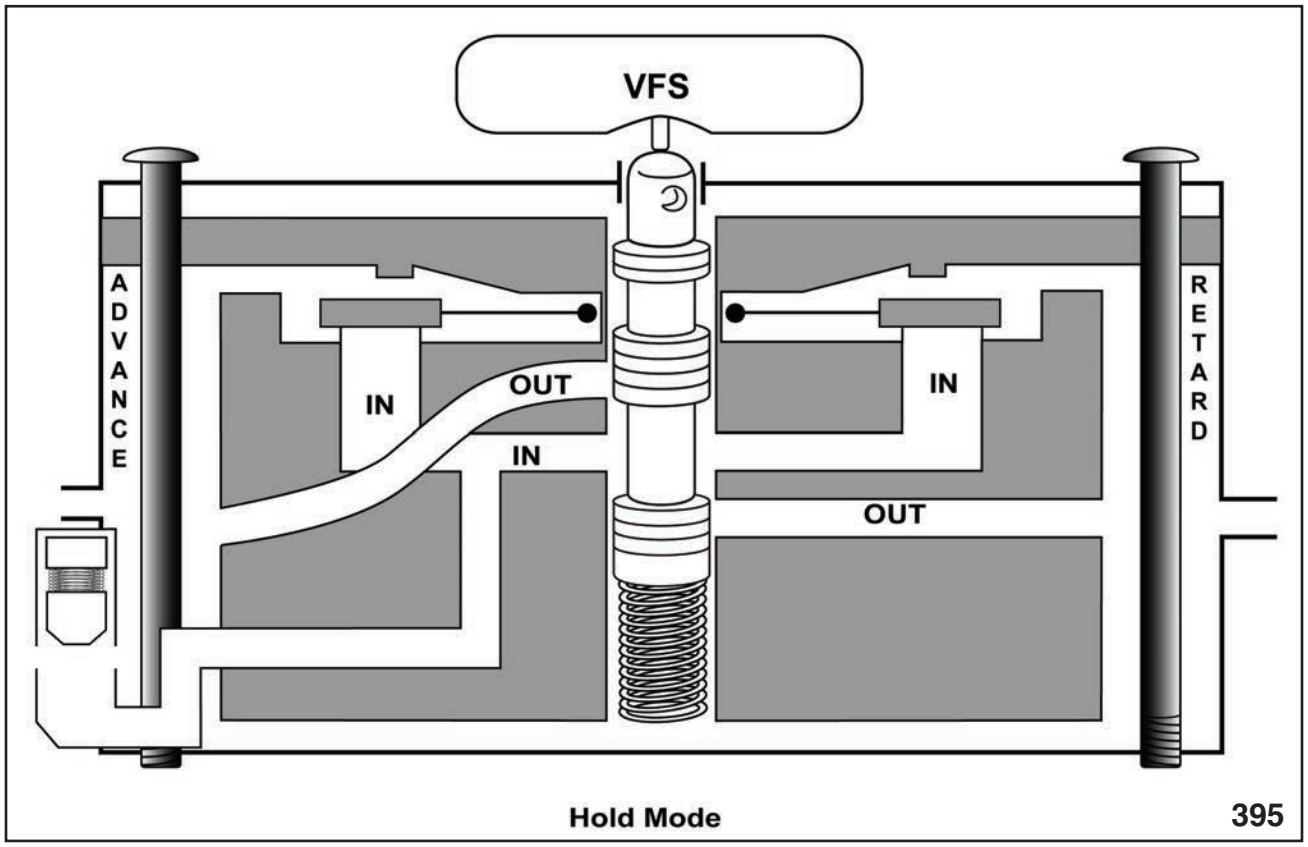
The repositioned spool valve also provides a path to the lock pin. The oil pushes up on the lock pin which will allow the rotor and the sprocket to turn independently.

Note: ***The replenish oil supply circuit pressure is not strong enough to rotate the Camshaft rotor.***

The now unlocked rotor receives mechanical operating power from the tension of the valve springs pushing up on the Camshaft lobes (roller rocker assembly). This force is in the same direction of the Camshaft rotation. The timing chain is rotating the Camshaft sprocket in the direction of engine rotation. When these two conditions exist the Camshaft rotor turns faster than the Camshaft sprocket and a pumping action takes place. The Camshaft rotor pumps or pushes the oil from the retard chamber to the advance chamber. The complete transition from Retard to Advance will take a few engine revolutions.

The moving oil unseats the advance check valve, allowing the oil to fill the advance chamber and empty the retard chamber. The oil replenish circuit refills the retard chamber but the pressure will always be lower than the force created by the pumping action of the moving rotor.

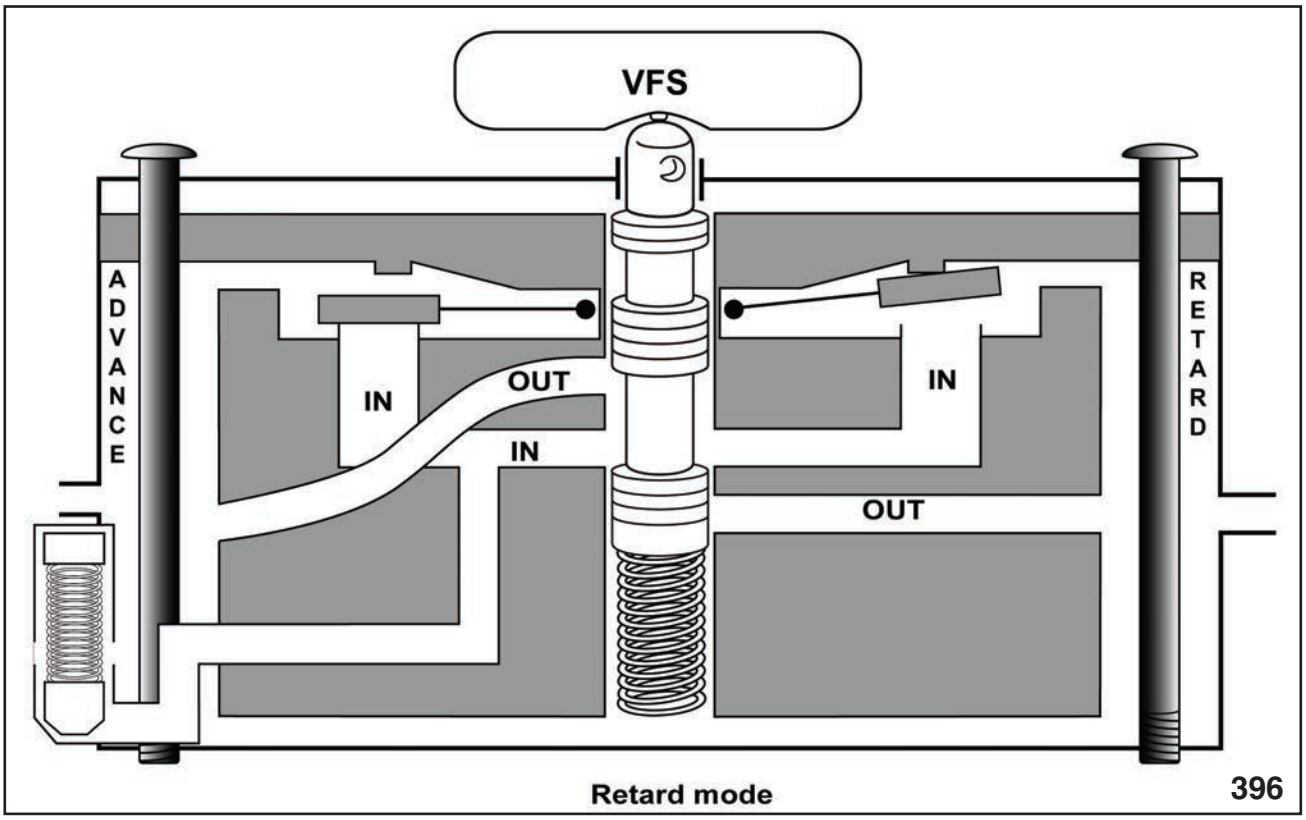
Hold Mode



Hold Mode

When the ECM decides to maintain the present Camshaft positioning, the VFS duty ratio will reposition the spool valve to trap the oil in one or both chambers. The oil circuit that allows oil to exit a chamber is blocked by the spool valve. The oil under a pressure slightly higher than the replenish circuit keeps the check valve closed and the Camshaft position is maintained.

Retard Mode



Retard Mode

The Variable Force Solenoid (VFS) duty ratio is decreased and the spool valve is released. This provides a path that will allow oil currently in the advance chamber to transfer to the retard chamber.

The rotor receives mechanical operating power from the tension of the valve springs pushing on the Camshaft lobes (roller rocker assembly). This force is in opposition to the direction of the Camshaft rotation. The timing chain is rotating the Camshaft sprocket in the direction of engine rotation. When these two conditions exist a pumping action takes place and the Camshaft rotor pumps or pushes the oil from the advance chamber to the retard chamber. The complete transition from Advance to Retard will take a few engine revolutions.

When the Camshaft reaches the maximum retard angle, the lock pin return spring will push the lock pin down and lock the Camshaft rotor to the Camshaft sprocket.

Operating logic -The oil temperature of the engine must be above 14°F (-10° C), before AVCS can operate.

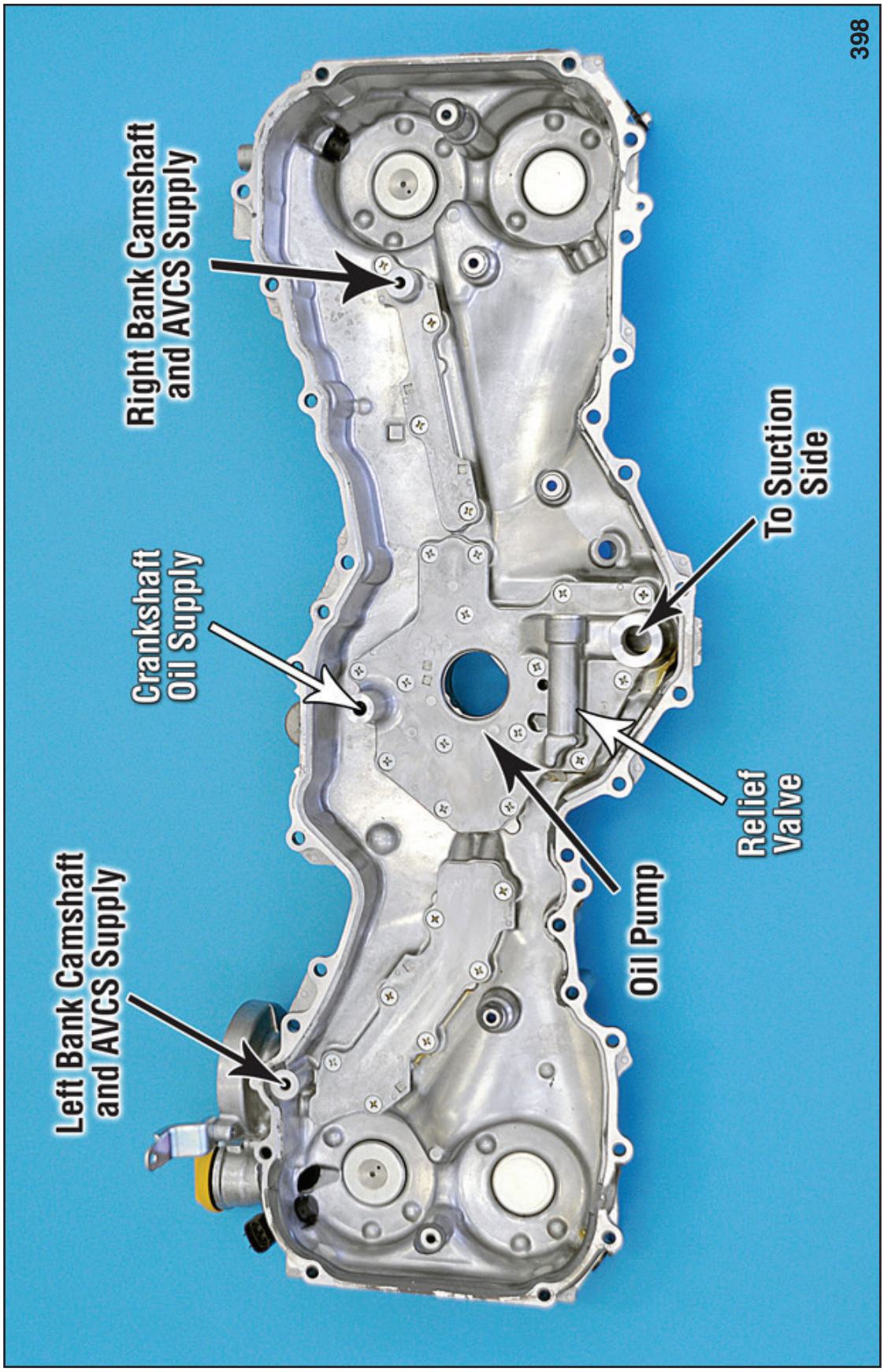
SMIII PID information

- The Camshaft can vary 0 to 50°.
- VFS duty ratio is displayed as OCV duty ratio.
- VFS current is displayed as OCV current.

NOTES:

Timing Chain Cover

The oil pump is located in the timing chain cover. Oil enters the suction side of the oil pump cover and is pressurized by rotation of the inner and outer rotors. During engine start up the oil pressure at 600RPM is 5.8 P.S.I.



Timing Chain Inside View

Oil Pump Cover

Relief Valve, Spring and Plug

Oil Pump Inner and Outer Rotor

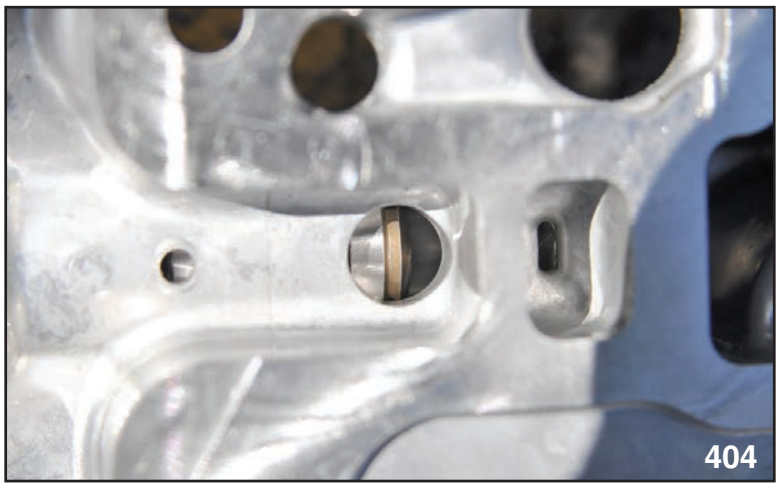
The oil pump of the FB 2.5 engine is a Trochoid type pump. The inner rotor has 11 teeth and the outer rotor has 12 teeth. A two stage relief valve is equipped on the pump that provides full oil pressure at engine start and lowers the pressure during engine operation. This process reduces the engine power necessary to turn the oil pump and increases fuel economy.

Relief Valve at Engine Start

Relief Valve at 1st Opening

As the engine speed and the oil pressure increases the two stage relief valve is acted upon by the high pressure side of the oil pump. The 1st opening of the relief valve occurs at 21.7 P.S.I. This pressure pushes the piston of the relief valve into the relief valve bore and uncovers the 1st opening exhaust port. Oil pressure will continue to increase with advancing engine speed with a maximum of 46.8 P.S.I. at 6,000 RPM.

If the oil pressure reaches 82.6 P.S.I. the relief valve will be pushed deeper into the relief valve bore and will uncover the 2nd opening or main relief exhaust port. This will bring the oil pressure down to a lower value but above the normal maximum value.



Relief Valve at 2nd Opening

FB 2.5

Relief valve working pressure (2-step relief)

1st opening pressure 21.7 P.S.I.

Main opening pressure 82.6 P.S.I.

600 rpm Discharge pressure 5.8 P.S.I.

Discharge rate (US qt, Imp qt)/min. 5.8 (6.1, 5.1) or more

6,000 rpm Discharge pressure 46.8 P.S.I.

Discharge rate (US qt, Imp qt)/min. 55 (58.1, 48.4) or more

EJ 2.5

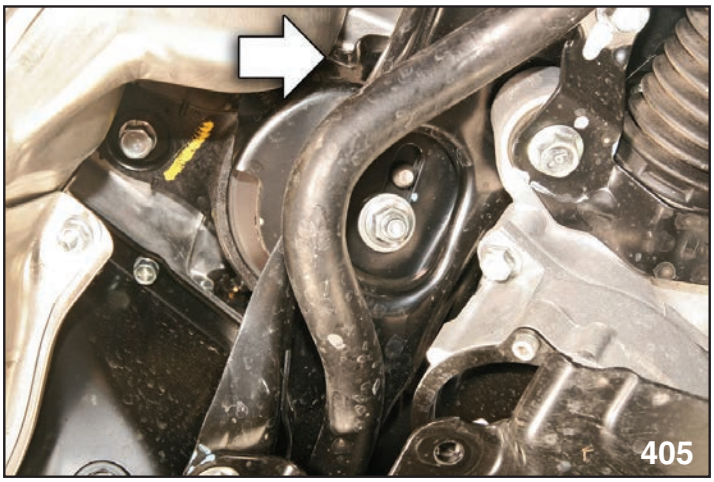
600 rpm Discharge pressure 14 P.S.I.

Discharge rate (US qt, Imp qt)/min. 4.6 (4.9, 4.0) or more

5,000 rpm Discharge pressure 43 P.S.I.

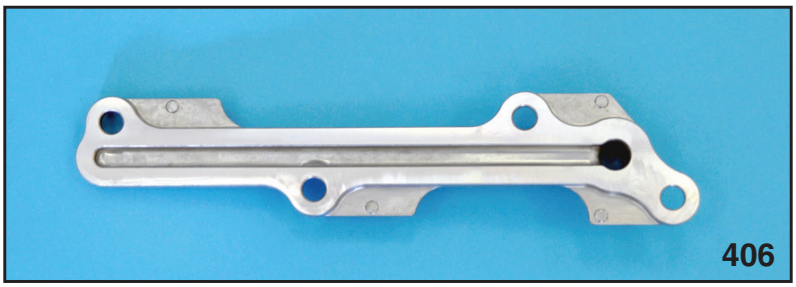
Discharge rate (US qt, Imp qt)/min. 47.0 (49.7, 41.4) or more

Single stage Relief Valve working pressure 85 P.S.I.

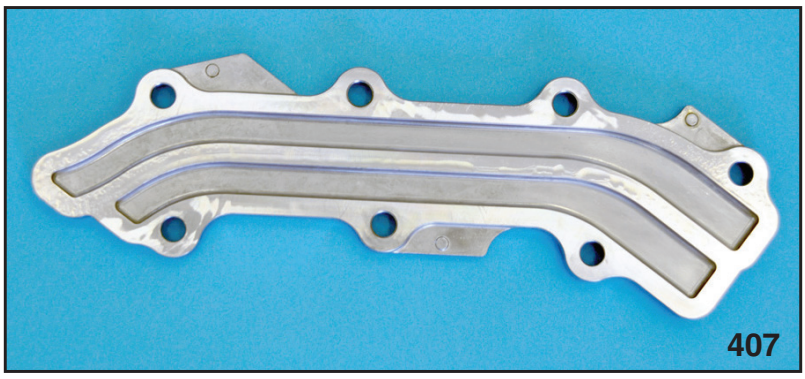


Oil Level Sensor

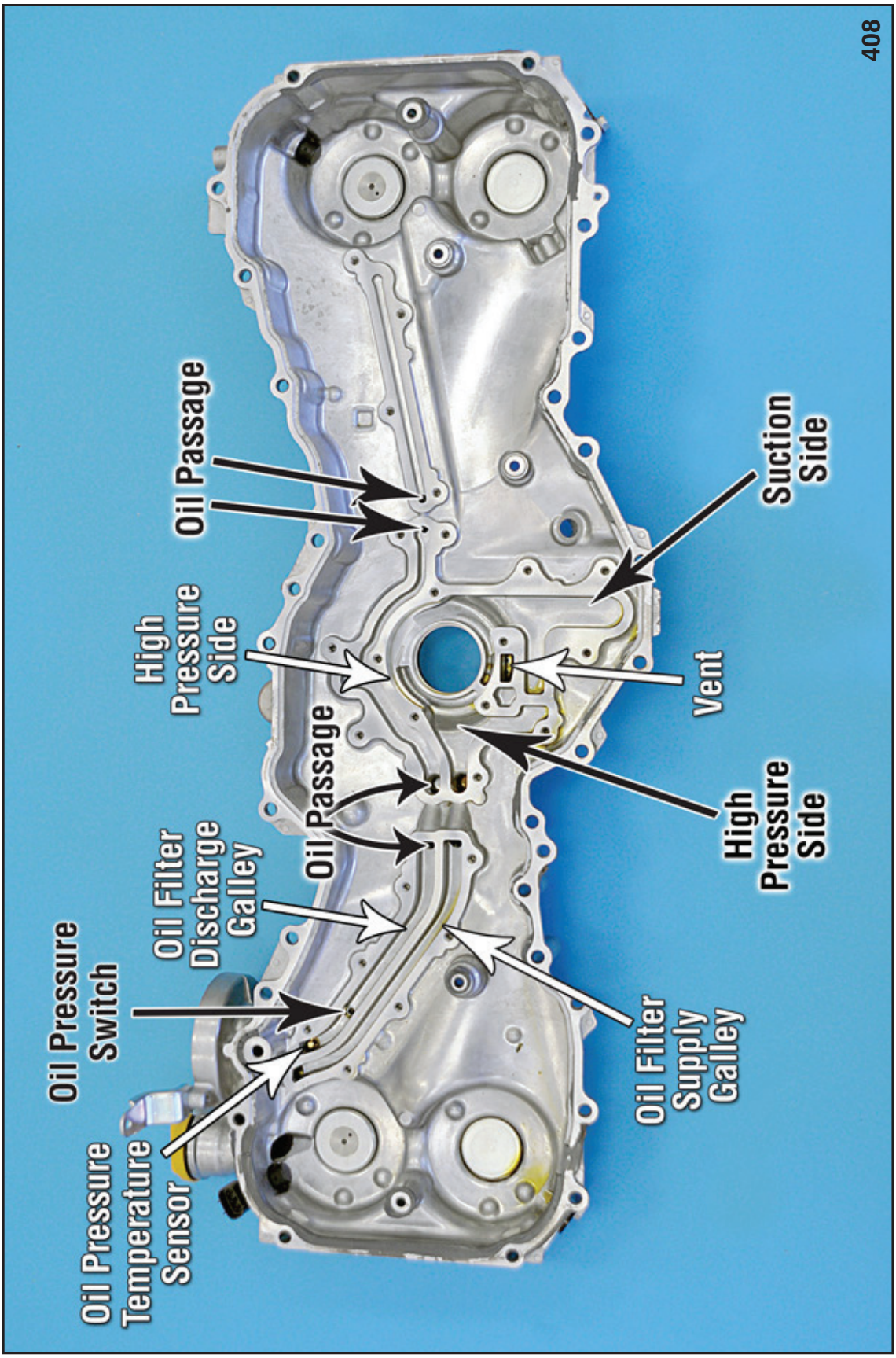
The FB 2.0 includes an oil level sensor that requires engine lifting and removal of the engine mount for replacement. Do not use pressure washers in the oil level sensor mounting area.



AVCS Galley Cover-Right Bank



Oil Filter Supply and Discharge Galley Cover



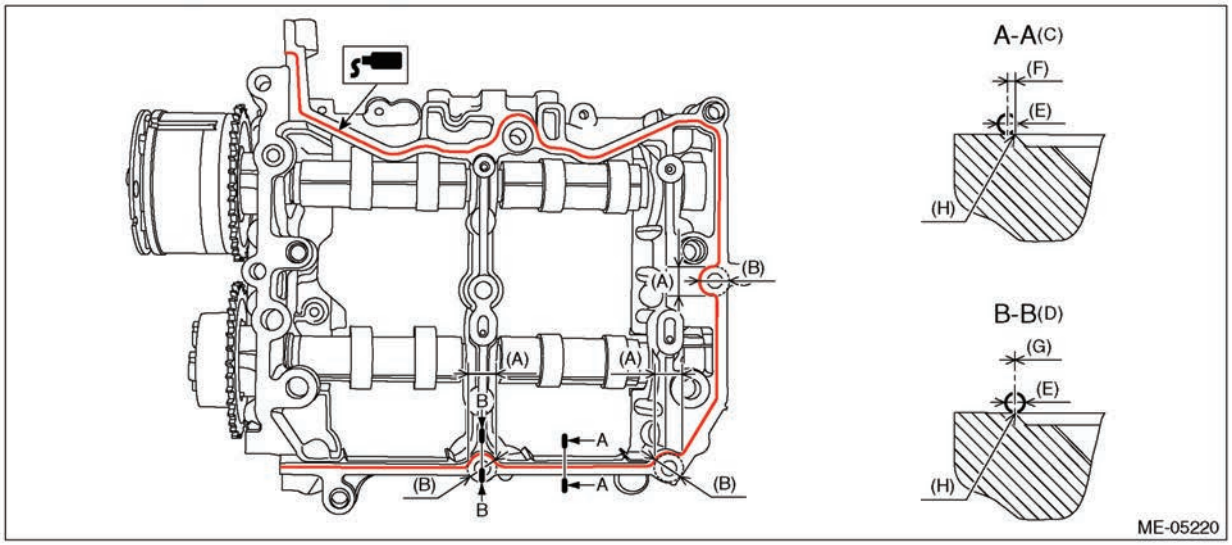
Timing Chain Cover Inside View Pump and Galley Covers Removed

The oil then travels to the Oil Filter Supply Galley and to the oil filter. After the oil is filtered a portion of the oil is diverted to the Left Bank Camshaft and AVCS supply port. The remaining volume of oil then travels down the Oil Filter Discharge Galley where the Oil Pressure Switch is closed and the oil temperature is observed by the Oil Temperature Sensor. The oil is then delivered to the Crankshaft Oil Supply Port and finally to the Right Bank Camshaft and AVCS Supply Port.

FUJI BOND APPLICATION GUIDE FOR CAM CARRIER

Liquid gasket:
THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter:
2.5±0.5 mm (0.0984±0.0197 in)



(A)	Range A	(D)	Liquid gasket applying position of mating surfaces other than range A	(G)	0±0.5 mm (0±0.0197 in)
(B)	ϕ18 mm (0.7087 in)	(E)	ϕ2.5±0.5 mm (0.0984±0.0197 in)	(H)	Chamfer edge
(C)	Liquid gasket applying position of mating surfaces of range A	(F)	1 mm (0.0394 in) or less		

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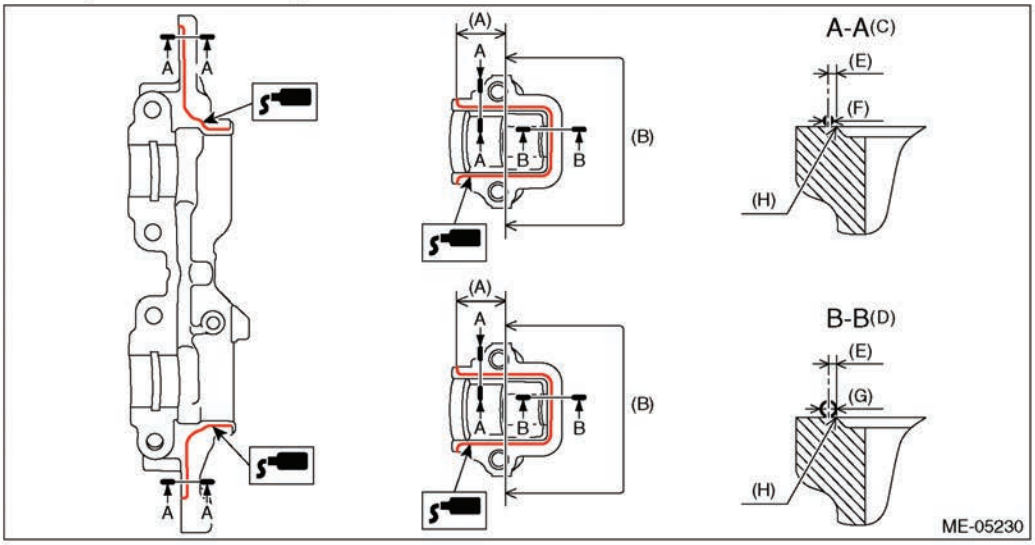
Cam Carrier

FUJI BOND APPLICATION GUIDE FOR CAM CARRIER

Liquid gasket applying diameter:
Mating surfaces other than range A
1±0.5 mm (0.0394±0.0197 in)
Mating surfaces of range A
2±0.5 mm (0.0787±0.0197 in)



(A)	28.5 mm (1.122 in)	(D)	Liquid gasket applying position of mating surfaces of range A	(G)	ϕ2±0.5 mm (0.0787±0.0197 in)
(B)	Range A	(E)	1 mm (0.0394 in) or less	(H)	Chamfer edge
(C)	Liquid gasket applying position of mating surfaces other than range A	(F)	ϕ1±0.5 mm (0.0394±0.0197 in)		

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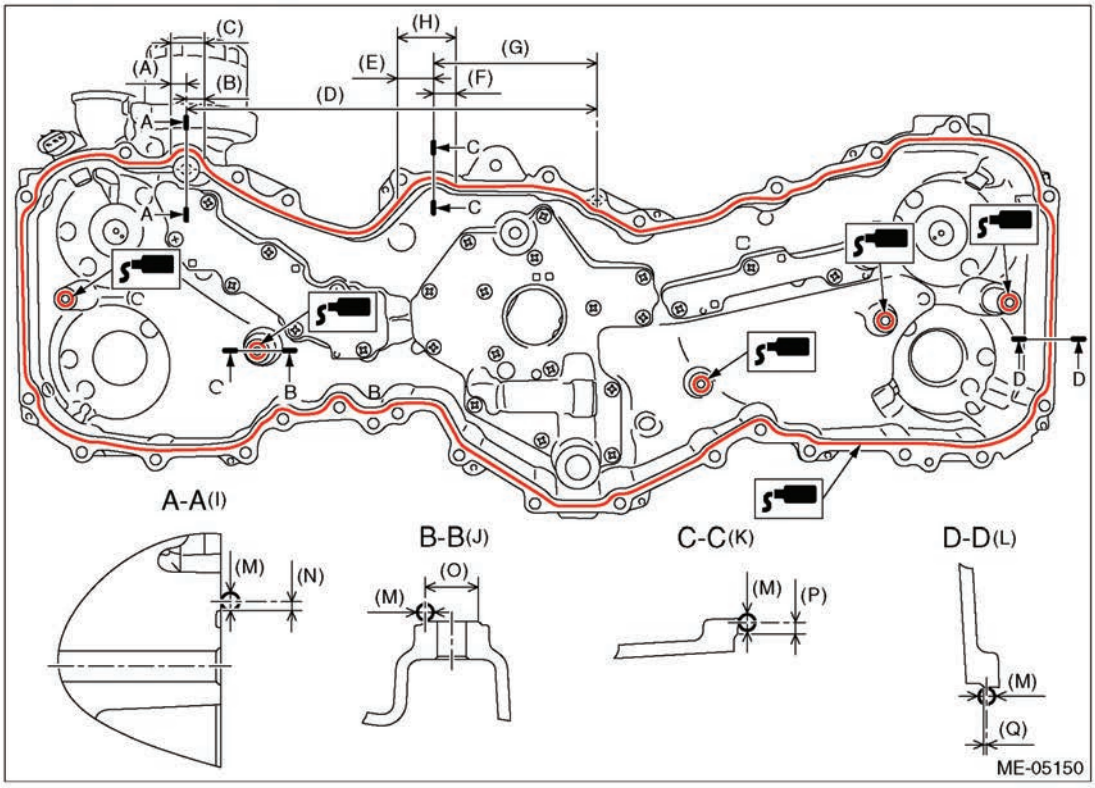
Cam Carrier

FUJI BOND APPLICATION GUIDE FOR CHAIN COVER

Liquid gasket:
THREE BOND 1217G (Part No. K0877Y0100) or equivalent

Liquid gasket applying diameter:
4±0.5 mm (0.1575±0.0197 in)



(A)	14.5 mm (0.5709 in)	(G)	127 mm (5.0000 in)	(M)	4±0.5 mm (0.1575±0.0197 in)
(B)	17.5 mm (0.6890 in)	(H)	Range B	(N)	2 mm (0.0787 in)
(C)	Range A	(I)	Liquid gasket applying position of mating surfaces of range A	(O)	ϕ12 mm (0.4724 in)
(D)	316.2 mm (12.4488 in)	(J)	Liquid gasket applying position of center boss (5 places)	(P)	2.5 mm (0.0984 in)
(E)	24.5 mm (0.9646 in)	(K)	Liquid gasket applying position of mating surfaces of range B	(Q)	0.5 mm (0.0197 in)
(F)	18.5 mm (0.7283 in)	(L)	Liquid gasket applying position of mating surfaces other than range A and range B		

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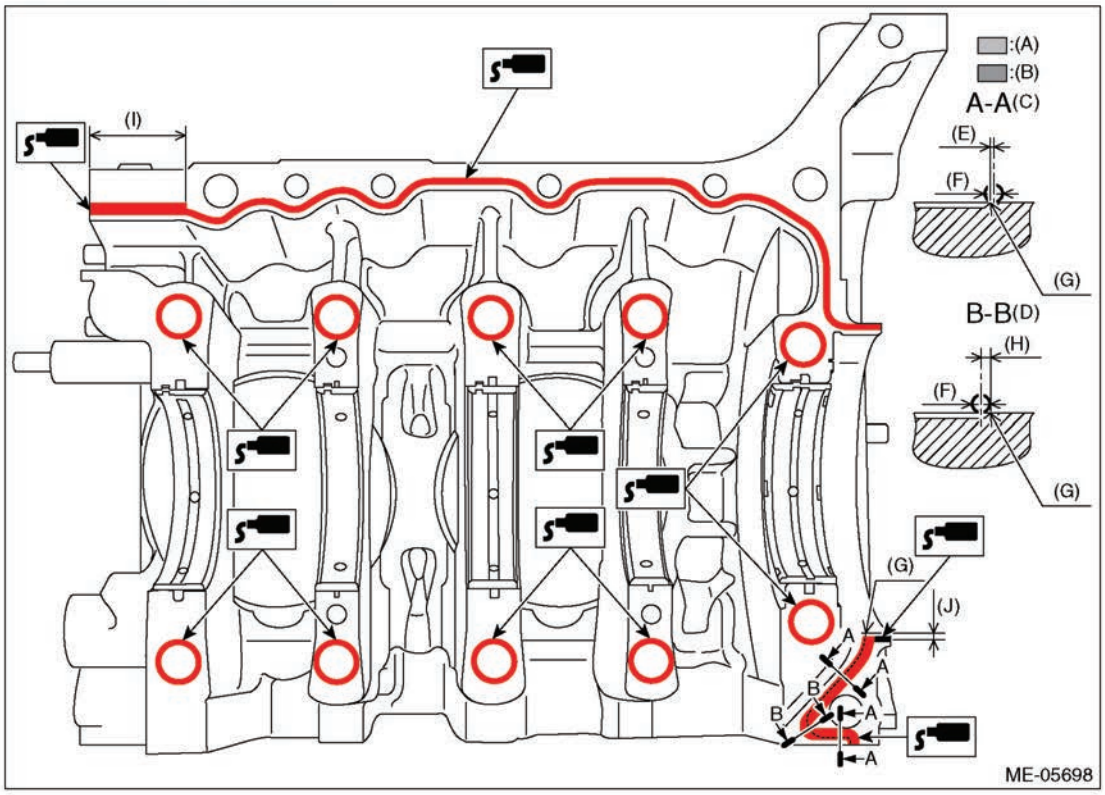
CHAIN COVER

FUJI BOND APPLICATION GUIDE FOR CYLINDER BLOCK

Liquid gasket:
THREE BOND 1217G (Part No. K0877Y0100) or equivalent

Liquid gasket applying diameter:
Mating surfaces other than ranges A and B
1±0.5 mm (0.0394±0.0197 in)
Mating surfaces of ranges A and B
4±0.5 mm (0.1575±0.0197 in)



(A)	Range A	(E)	1 mm (0.0394 in) or less	(I)	36 mm (1.4173 in)
(B)	Range B	(F)	ϕ4±0.5 mm (0.1575±0.0197 in)	(J)	2.5 mm (0.0984 in)
(C)	Liquid gasket applying position of mating surfaces (other than the edge) of range B	(G)	Chamfer edge		
(D)	Liquid gasket applying position of mating surfaces (the edge) of range B	(H)	2 mm (0.0787 in)		

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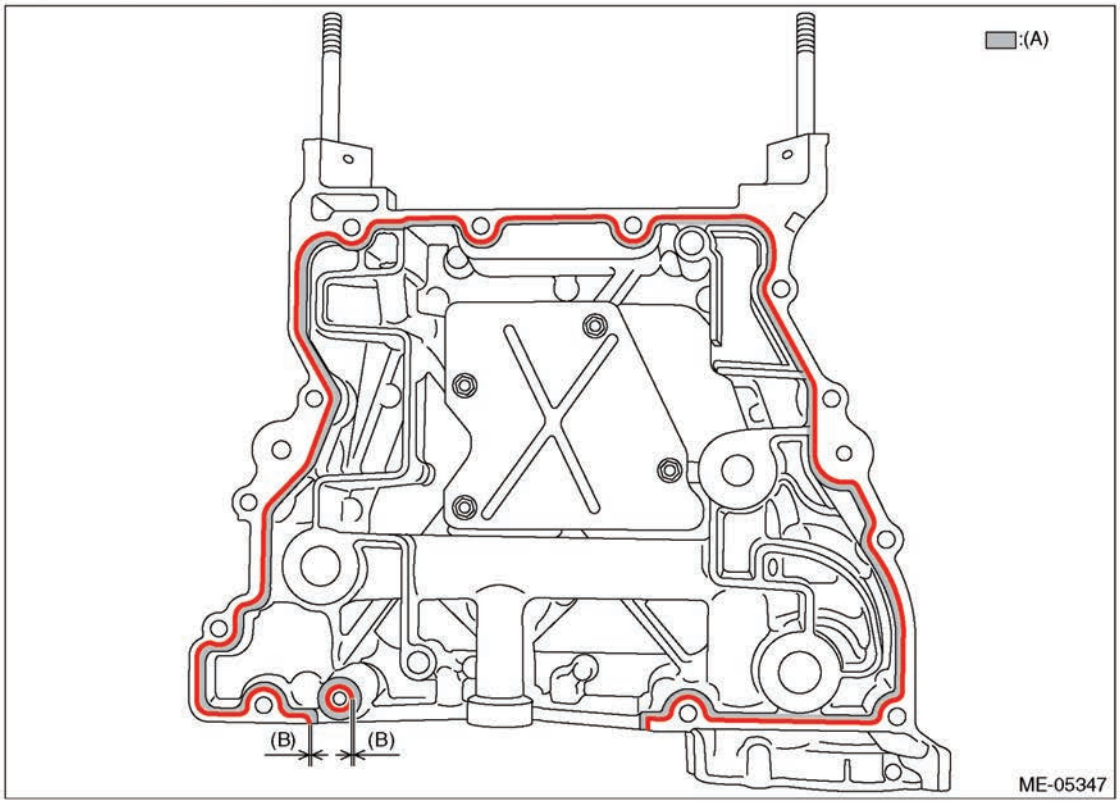
Cylinder Block

FUJI BOND APPLICATION GUIDE FOR CYLINDER BLOCK (UPPER OIL PAN)

Liquid gasket:
THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter:
5±1 mm (0.1969±0.0394 in)



(A) Chamfer surface (B) 1.5 mm (0.0591 in)

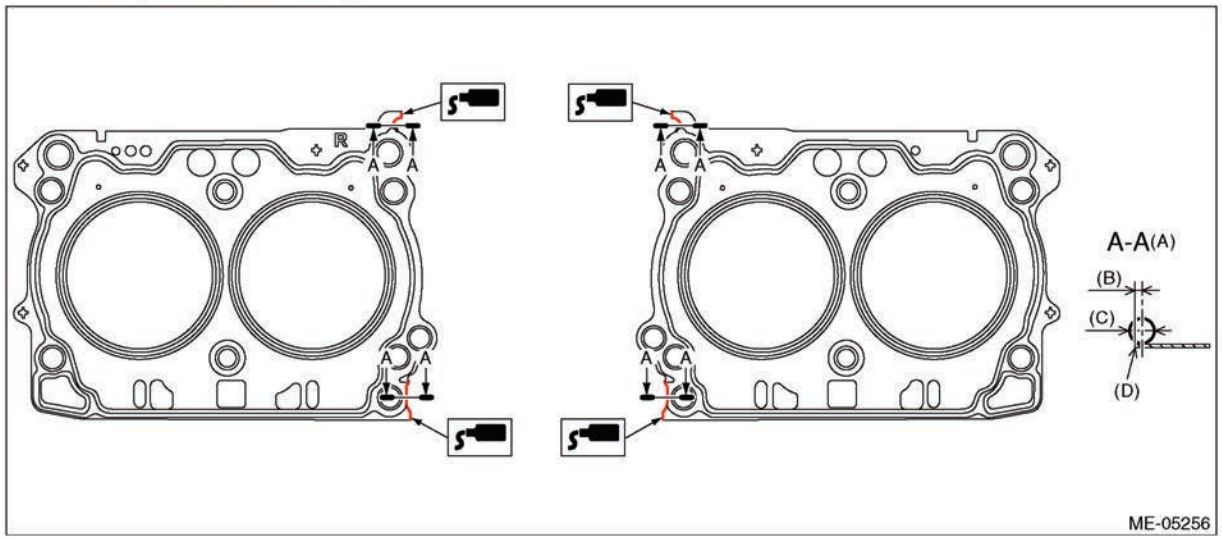
413

Cylinder Block (Upper Oil Pan)

FUJI BOND APPLICATION GUIDE FOR CYLINDER HEAD (CYLINDER HEAD RH)

Liquid gasket:
THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter:
3±1 mm (0.1181±0.0394 in)



(A) Liquid gasket applying position
(B) 1 mm (0.0394 in) or less
(C) ϕ3±1 mm (0.1181±0.0394 in)
(D) Cylinder head gasket edge

414

Cylinder Block (Right Hand)

FUJI BOND APPLICATION GUIDE FOR CYLINDER HEAD (CYLINDER HEAD LH)

CYLINDER HEAD LH

1) Clean the bolt holes in the cylinder block LH.

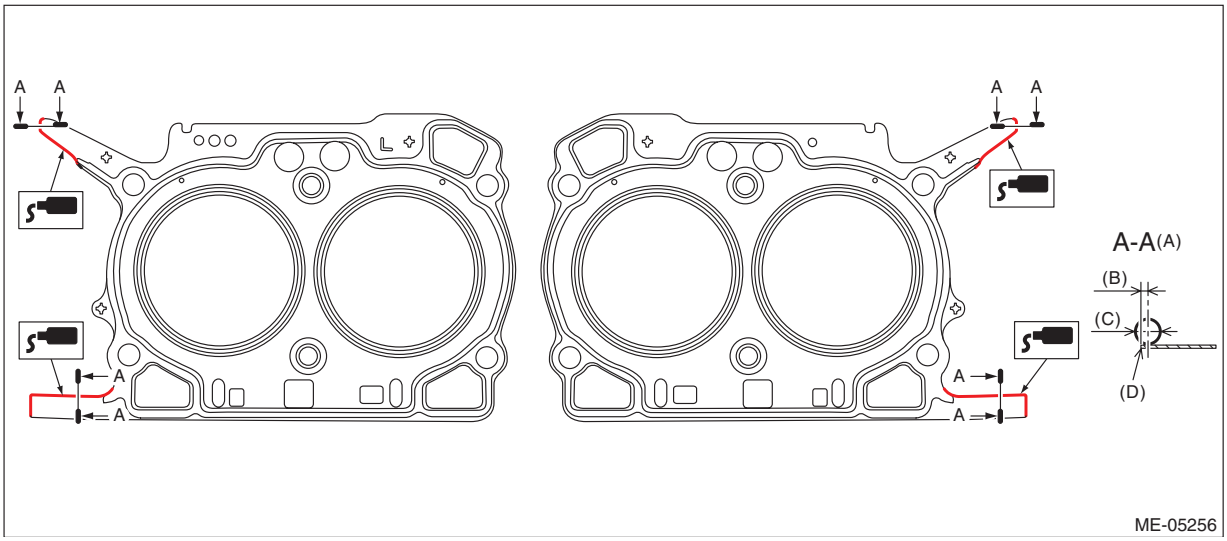
CAUTION:
To avoid erroneous tightening of the bolts, clean out the bolt holes sufficiently by blowing with compressed air to eliminate engine coolant etc.

2) Apply liquid gasket to both sides of the cylinder head gasket LH as shown in the figure.

NOTE:
- Use a new cylinder head gasket LH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket:
THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter:
3±1 mm (0.1181±0.0394 in)



(A) Liquid gasket applying position
(B) 1 mm (0.0394 in) or less
(C) ϕ3±1 mm (0.1181±0.0394 in)
(D) Cylinder head gasket edge

3) Attach the cylinder head gasket LH.

NOTE:
Check that liquid gasket is squeezed out from the cylinder head gasket LH.

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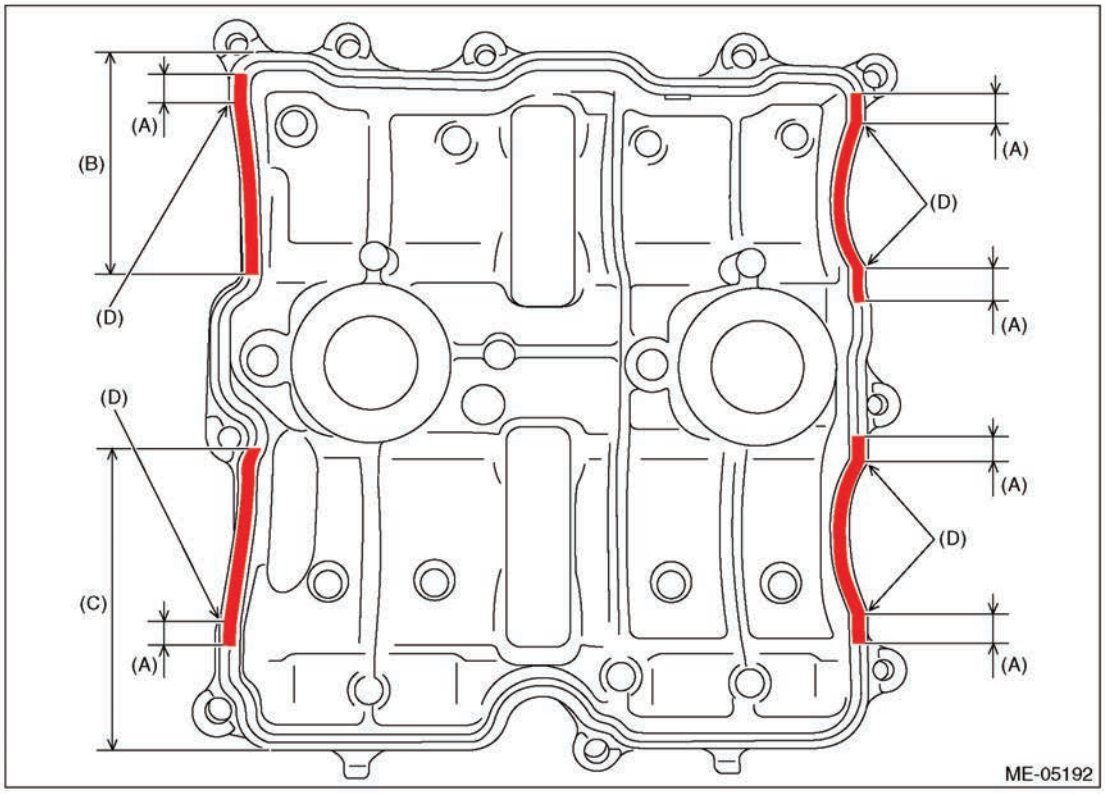
CYLINDER BLOCK (LEFT HAND)

FUJI BOND APPLICATION GUIDE FOR ROCKER COVER

Liquid gasket:
THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter:
3.5±0.5 mm (0.1378±0.0197 in)



(A) 10 mm (0.394 in) or more
(B) 68 mm (2.677 in) or more
(C) 89 mm (3.504 in) or more
(D) Arch starting point

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Rocker Cover

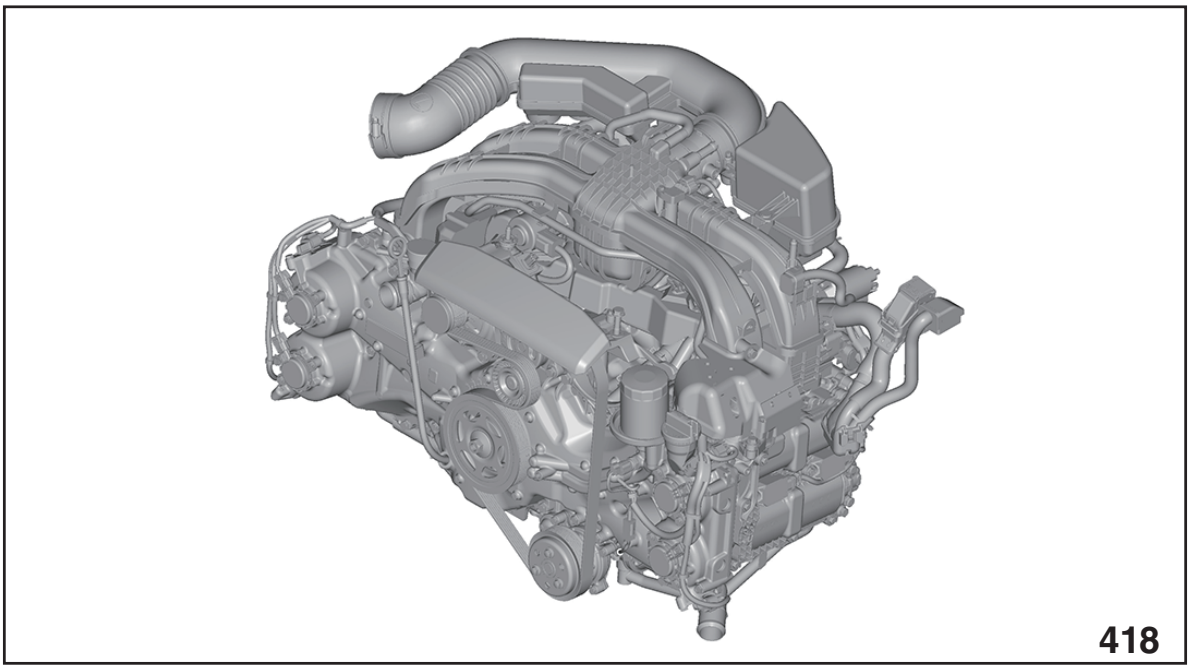
NOTES:

Chain Driven Valve Train Boxer Engines (Module 105)

2017MY Direct Injection Naturally Aspirated (DINA) Engine

Overview

The 2017 Impreza is equipped with a new generation 2.0L NA engine. This engine is improved from the FB architecture introduced in 2011, receiving refinements to numerous components to improve fuel efficiency and emissions performance while reducing weight. Many of the enhancements also support the newly adopted Direct Injection Naturally Aspirated (DINA) system.



418

FB 2.0L Direct Injection Naturally Aspirated (DINA)

POWER UNIT SPREADSHEET

Engine	Transmission type	Maximum output [kW (HP)/(r/min)]	Maximum torque [N-m (kgf-m, ft-lb)/{r/min}]
2.0L DOHC	CVT	[113 (152)/{6000}]	[196 (20.0, 145)/{4000}]
2.0L DOHC	5MT	[113 (152)/{6000}]	[196 (20.0, 145)/{4000}]

MAJOR CHARACTERISTICS

	New Impreza
Engine type	FB20
Location	Horizontally opposed
Cylinders	4
Displacement cm^3 (cu in)	1,995 (121.73)
Intake system	Naturally aspirated
Valve system mechanism	DOHC4 Valve
Driving Type	Timing chain
Valve train system	Intake/exhaust AVCS
Bore × stroke mm (in)	84.0 × 90 (3.31 × 3.54)
Compression ratio	12.5:1
Fuel supply system	Direct injection

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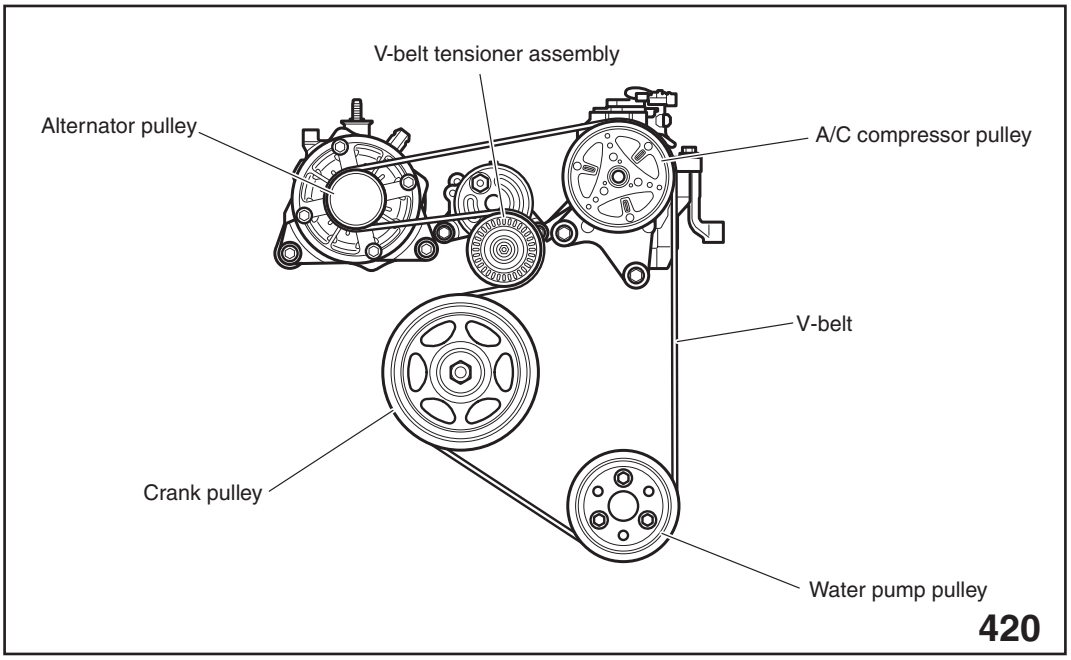
Engine Specs

Accessories

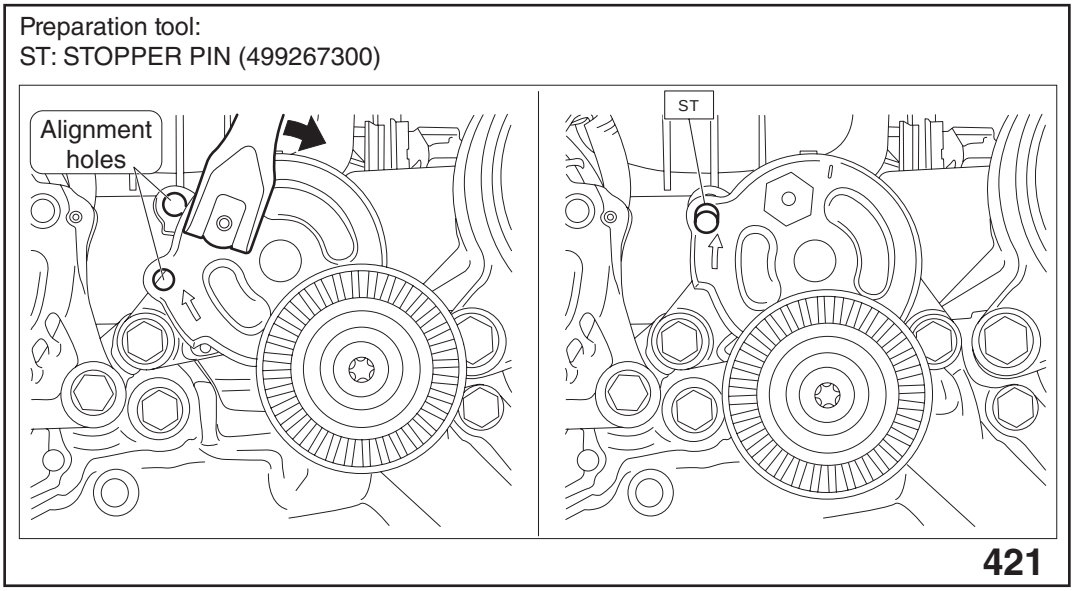
V-belt

The idler pulley was eliminated and the pulley angle decreased for reduced friction and increased fuel economy. Additionally, the alternator and V-belt tensioner assembly are directly attached to the cylinder block. The belt system was made more compact, lowering the overall engine center of gravity and reducing weight.

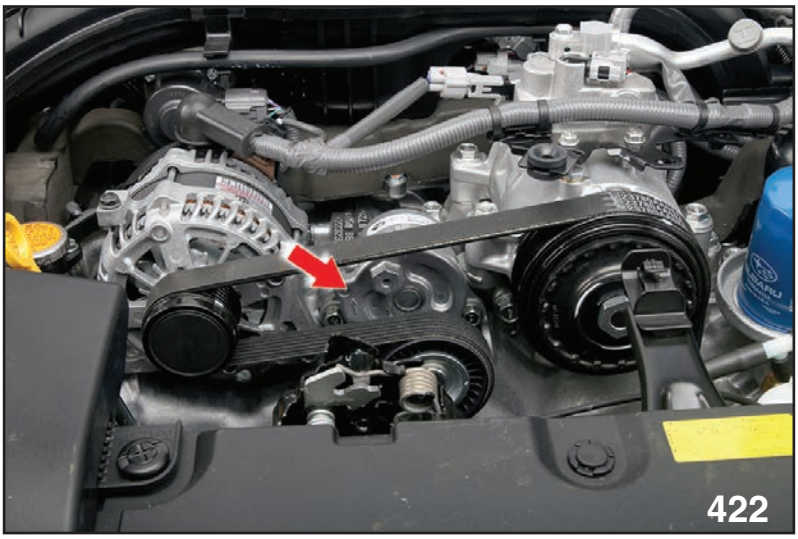


V-BELT COMPONENTS

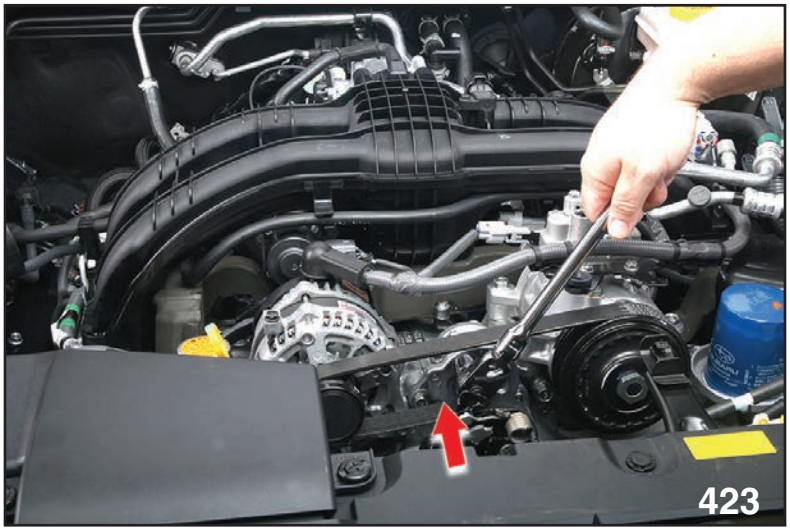
Removal of the V-belt is accomplished by rotating the tensioner assembly clockwise and installing an SST Stopper Pin or 6mm hex wrench into the alignment holes.



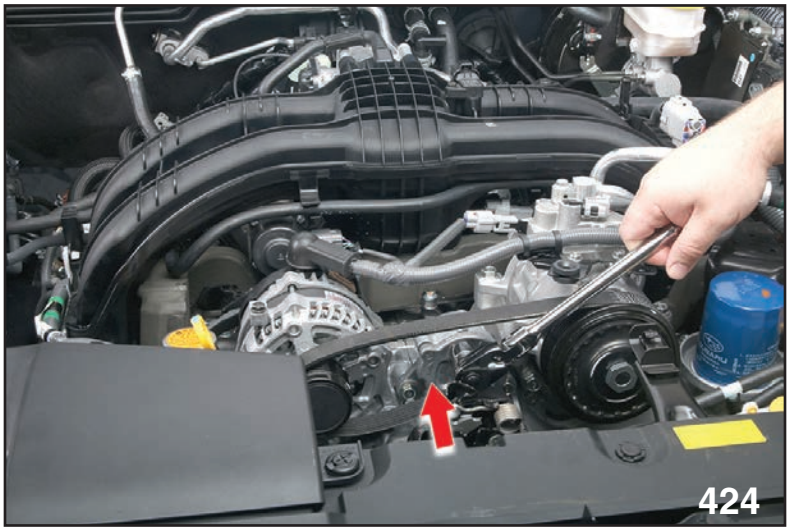
V-BELT REMOVAL



V-belt Tensioner



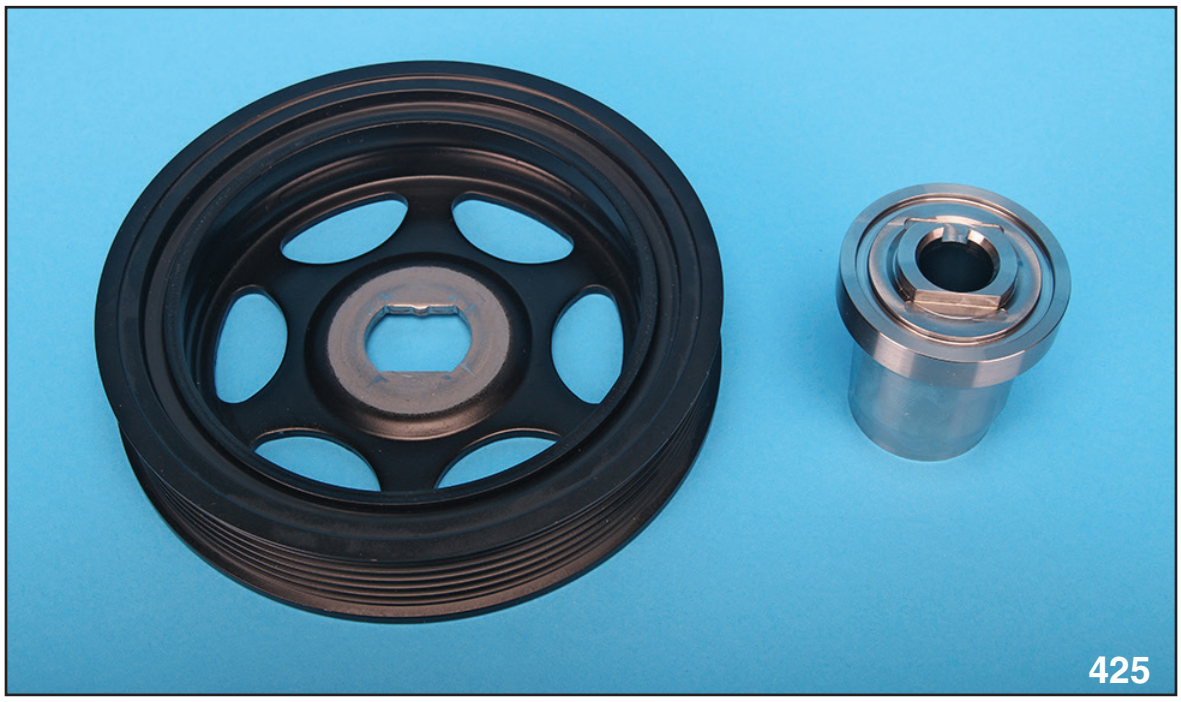
Tensioner — Not Aligned



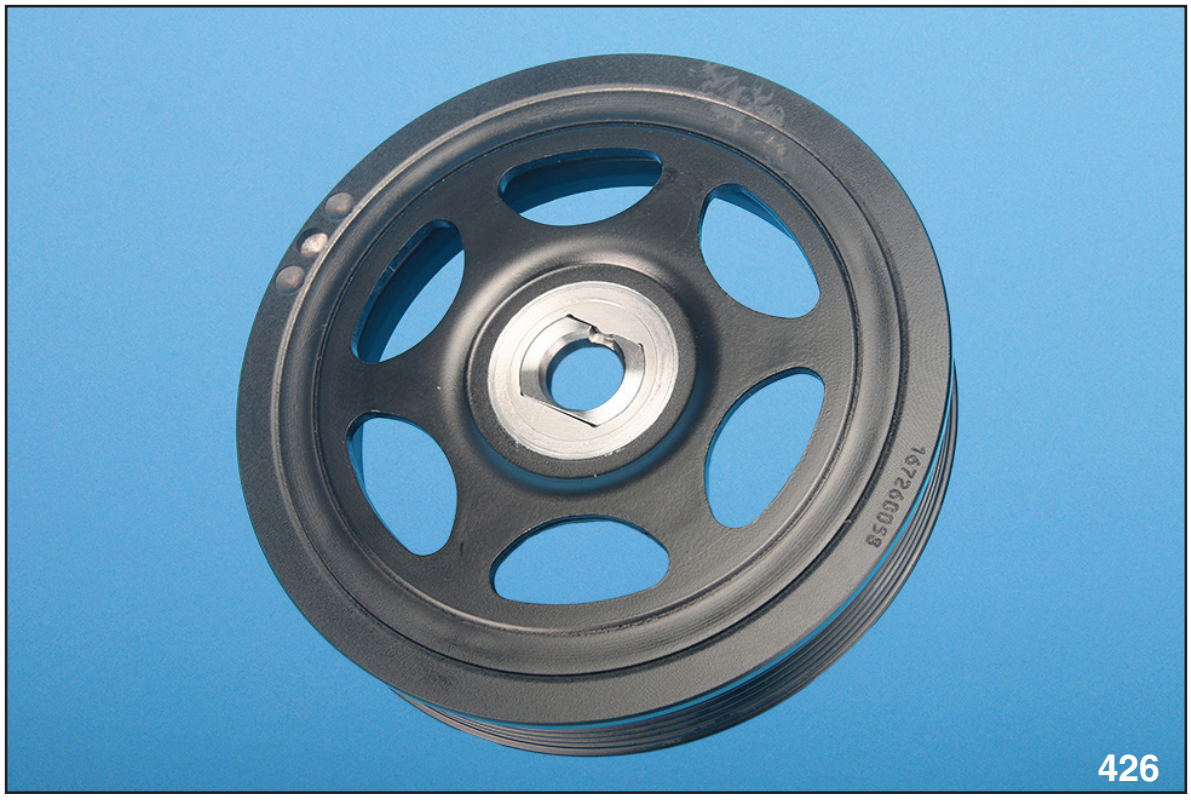
Tensioner — Aligned

Crankshaft Pulley

The crankshaft pulley material has changed to plate steel. Additionally, the engagement to the pulley boss (oil pump drive) has been changed from a pin style to parallel flat style.



Crankshaft Pulley



Pulley Boss Engagement

Charging System

Battery Sensor

A new generation battery sensor is used to measure battery charge/discharge current, voltage, and temperature. The new sensor has improved ignition-ON performance and determines the battery State of Health (SOH) and State of Charge (SOC).

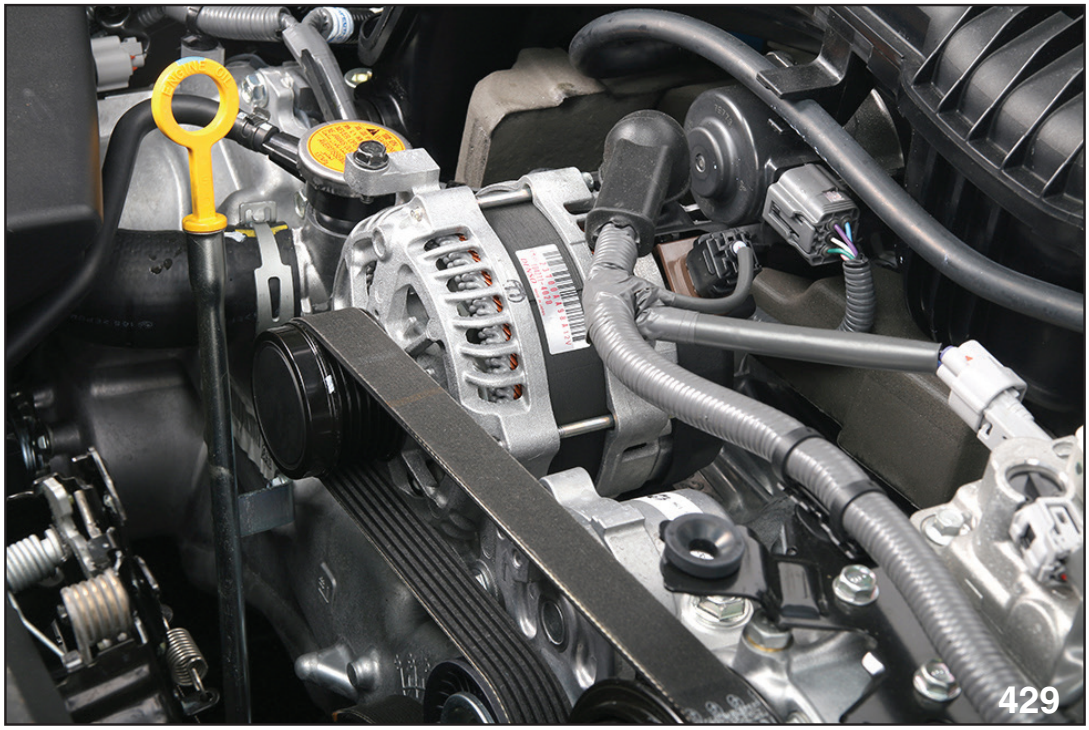
Battery Sensor

		Item	Value	Unit
☐	EGI	Estimated Battery Temperature	70.7	°F
☐	EGI	Remaining Battery Capacity	15.3	%
☐	EGI	Battery Terminal Voltage	11.7	V
☐	EGI	Battery Charge/Discharge Current	-8.6	A
☐	EGI	Alternator control mode	High	**428**

Battery Sensor — SSM Data

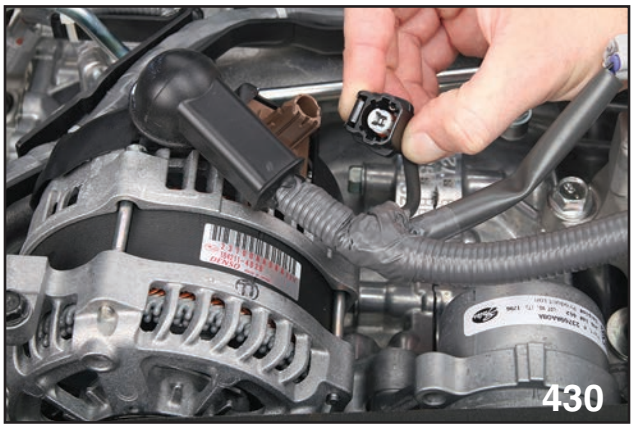
Alternator

Improved battery condition information has allowed for better alternator control. Additionally, the physical size of the alternator has been reduced for weight savings.

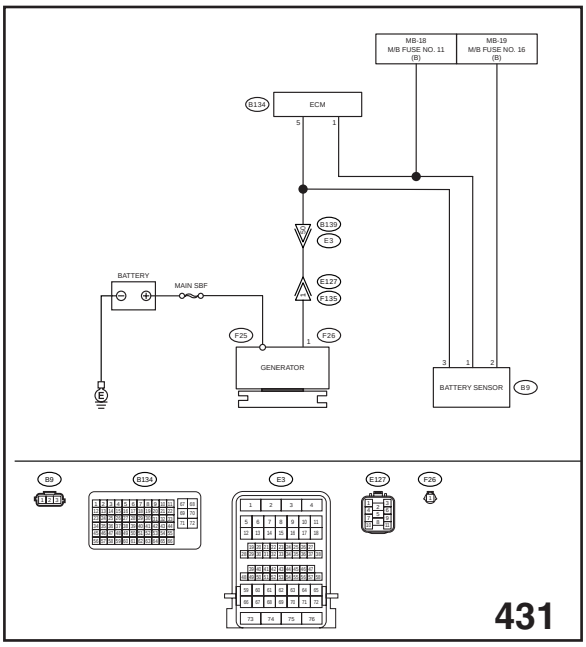


Alternator

The alternator uses a LIN communication line (from the ECM) as the only source of output control. The connection at the alternator for voltage regulation and control has been reduced to a single terminal.



LIN Communication (Connector)

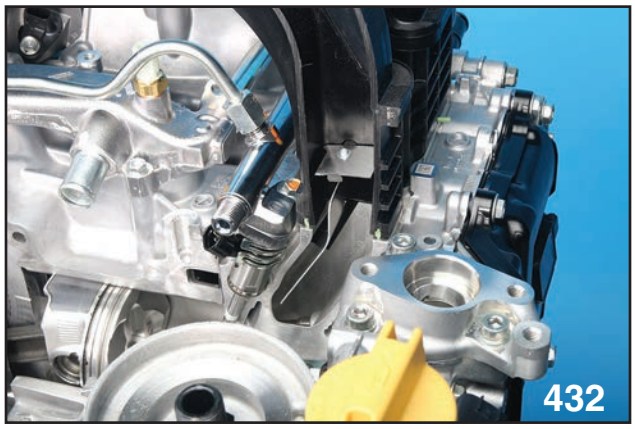


Charging System Wiring Diagram

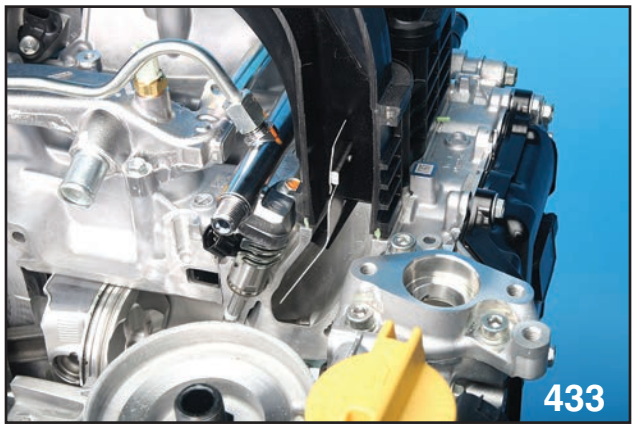
Intake Tract

Tumble Generator Valves (TGV)

The Tumble Generator Valves (TGVs) have been integrated into the intake manifold assembly. This reduces possible leak points, strengthens the overall assembly, and reduces weight. The air flow path when the TGV butterfly valve is closed has been moved to the engine “interior” side.

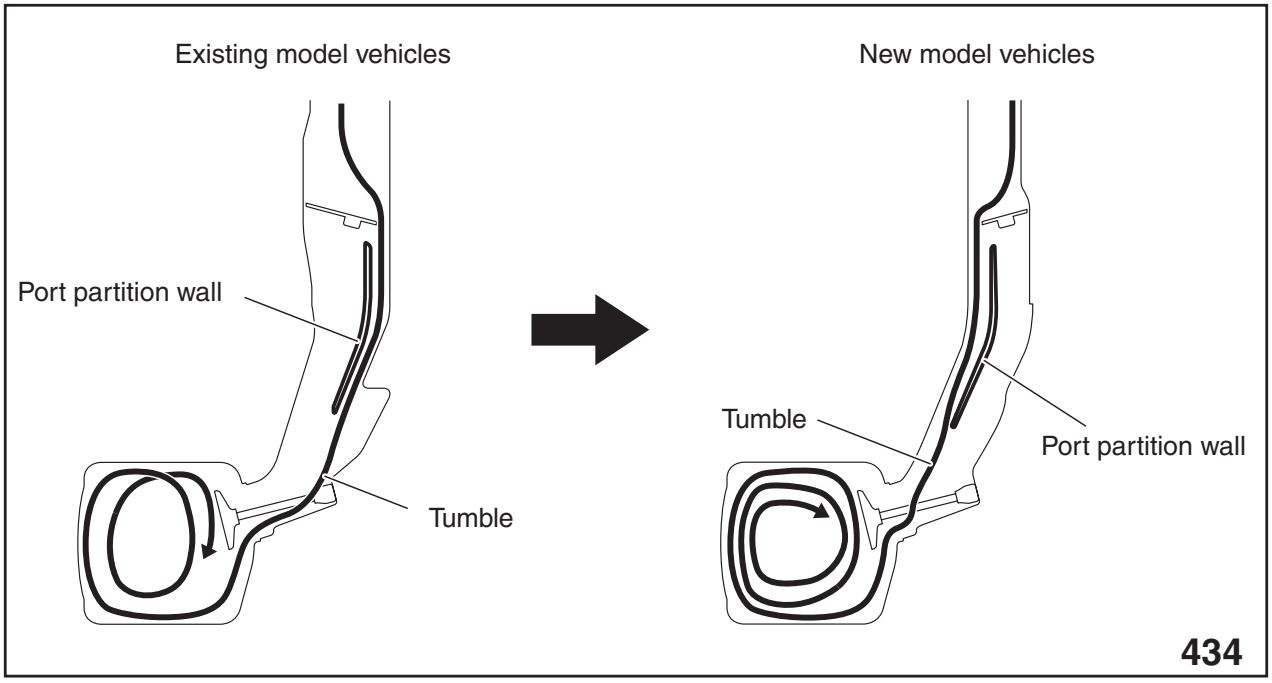


TGV Closed



TGV Open

Additionally, the cylinder head intake ports and combustion chambers are specifically designed to strengthen the tumble. These changes result in improved power, fuel economy, and reduced emissions.

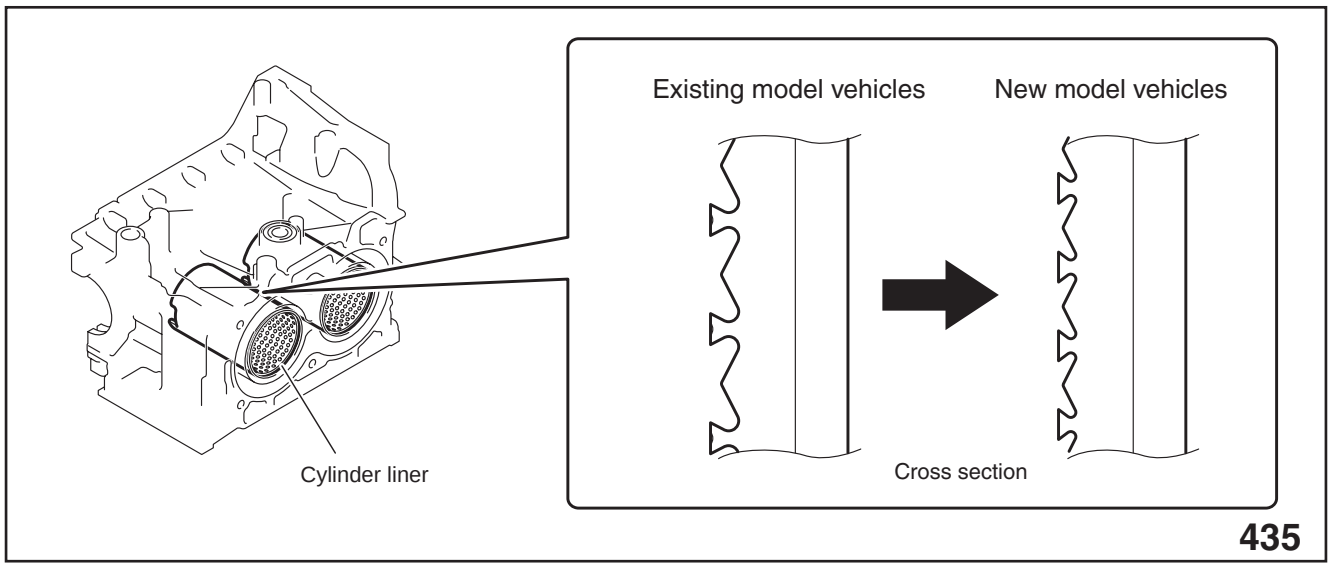


TGV — Tumble Comparison

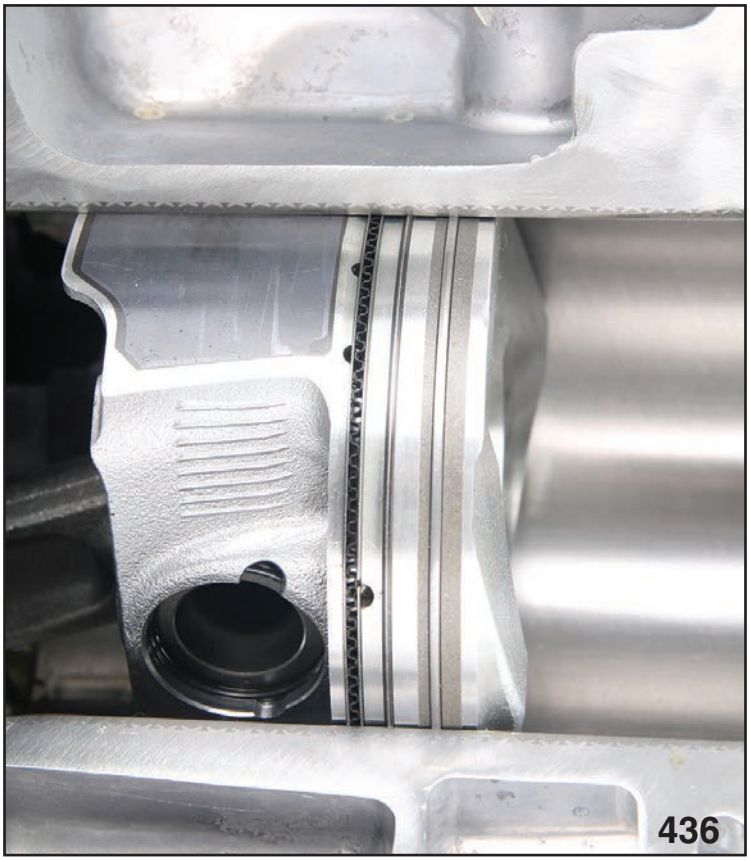
Mechanical

Cylinder Block

Cylinder liners were made thinner to reduce weight. Additionally, the aluminum contact/interface surface was reshaped to reduce bore deformation and oil consumption.

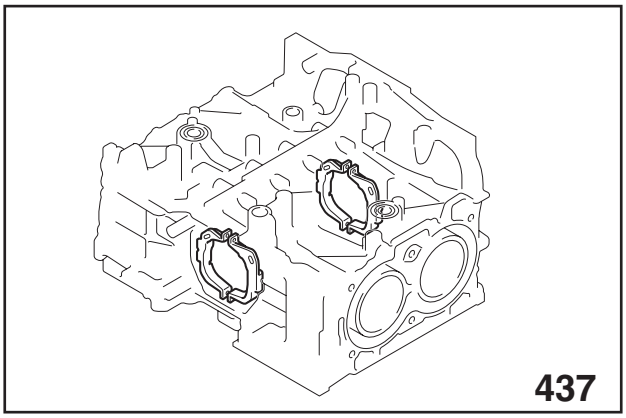


Cylinder Block — Comparison

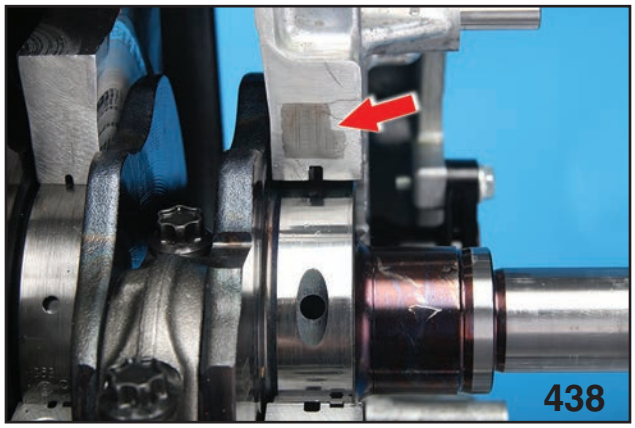


Cylinder Sleeve Contact Surface (Cutaway)

Steel reinforcements have been added around the #1 and #5 main bearing positions in the cylinder block to reduce noise and vibration. These inserts are not serviceable.

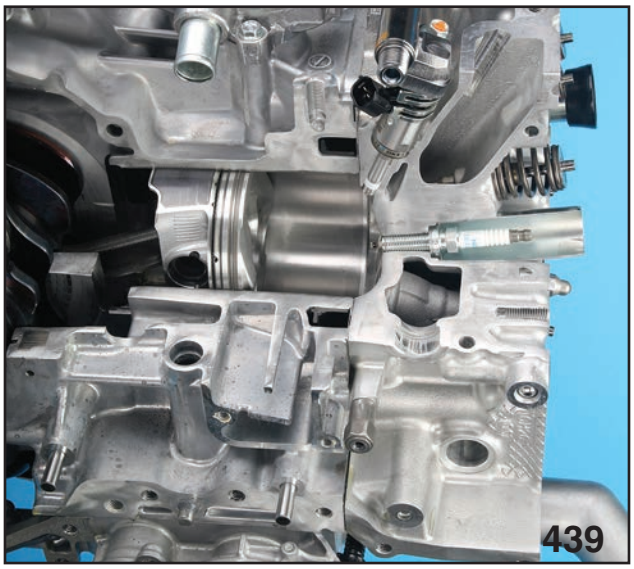


Block Reinforcement (Artwork)

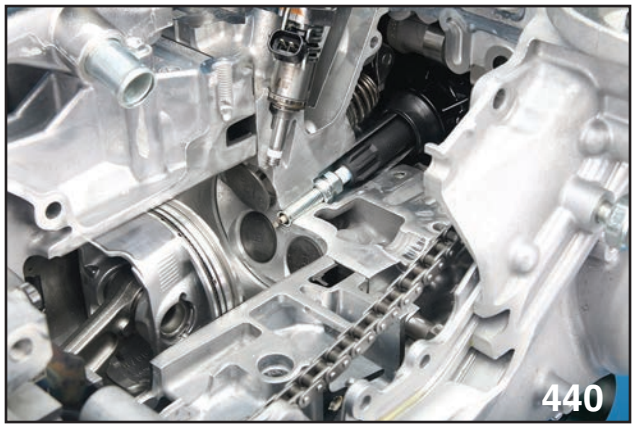


Block Reinforcement (Cutaway)

To support the new Direct Injection Naturally Aspirated system, the combustion chambers have been optimized. Compression ratio for this DINA engine is 12.5:1 and is designed to operate using unleaded gasoline with an octane rating of 87 AKI (90 RON) or higher

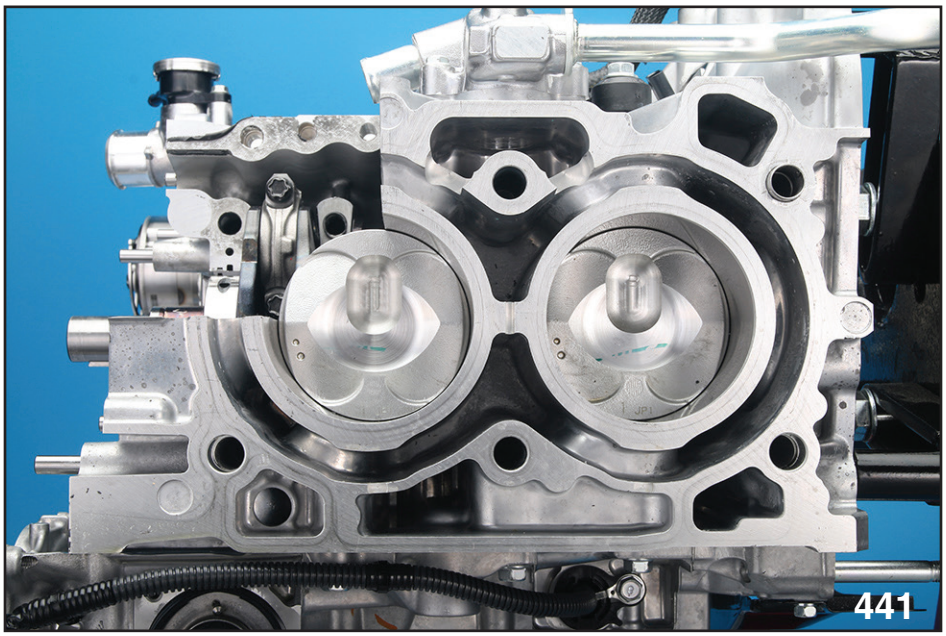


Combustion Chamber (Cutaway)



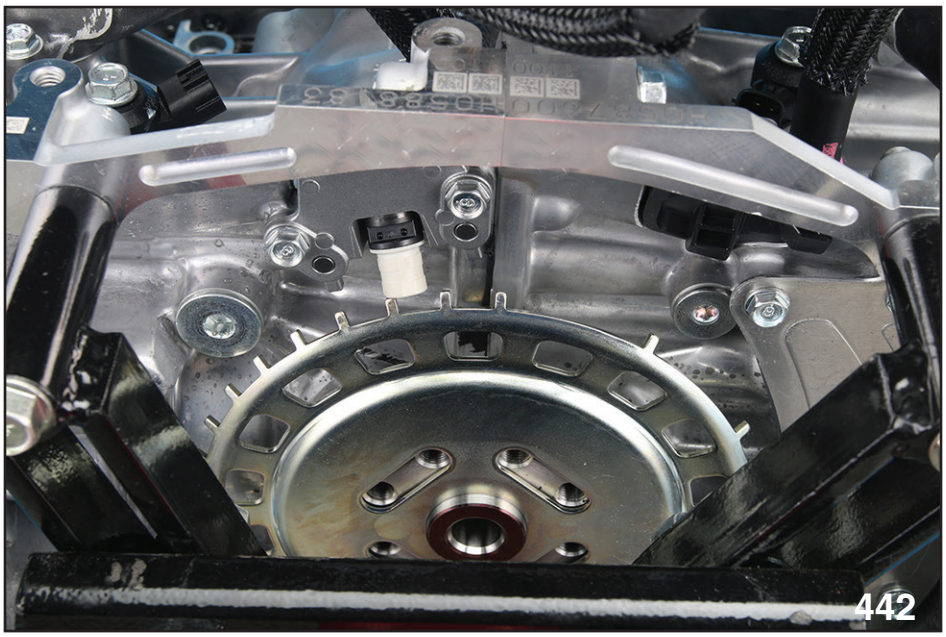
Combustion Chamber (Cutaway)

The piston crowns are shaped so that fuel spray from the injectors gathers around the spark plug electrode for improved start-up performance. The top compression ring has been changed to a material with high thermal conductivity to avoid increased combustion chamber temperatures. Additionally, tension has been reduced on the top and second compression rings.



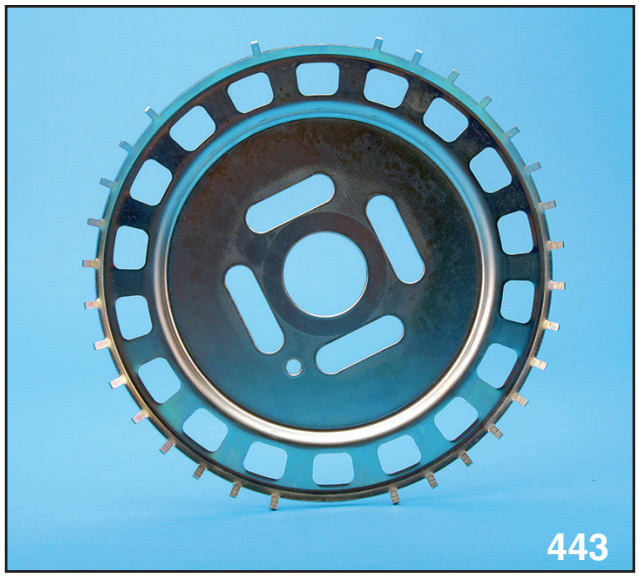
Piston Crowns

The Crankshaft Position Sensor Plate has been made smaller and lighter to improve signal detection performance.

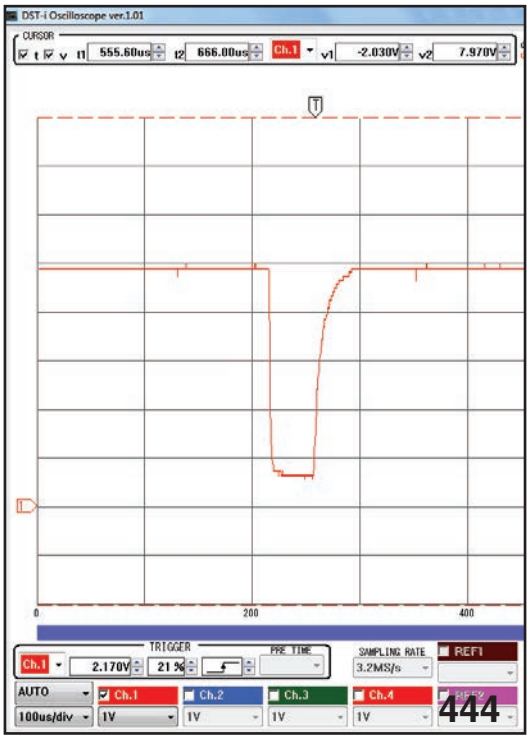


Crankshaft Position Sensor Plate

Each tooth on the crankshaft position sensor plate produces a 0 – 5V square wave pattern that is sent to the Engine Control Module (ECM).



Crankshaft Position Sensor Plate



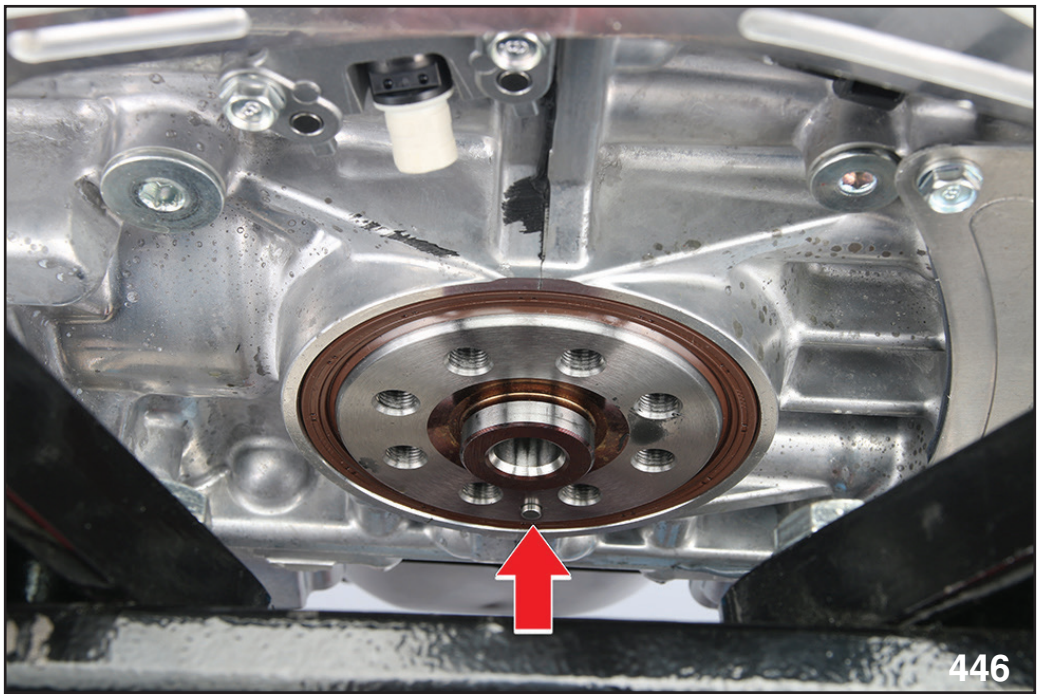
Single Tooth — Waveform

Using the SSM oscilloscope, the pattern of the crankshaft position sensor can be measured.

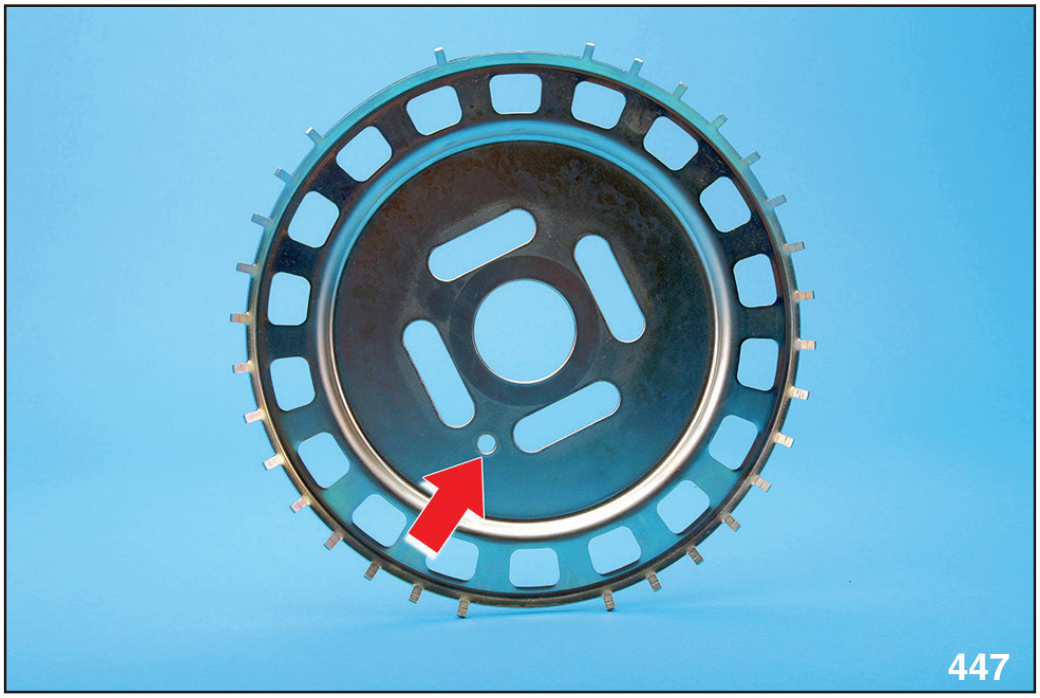
Note: Minor noise and chattering in the waveform is expected and normal.

Complete Rotation — Waveform

Always ensure the knock pin on the crankshaft is correctly aligned with the knock pin hole on the crankshaft position sensor plate.



Knock Pin — Crankshaft

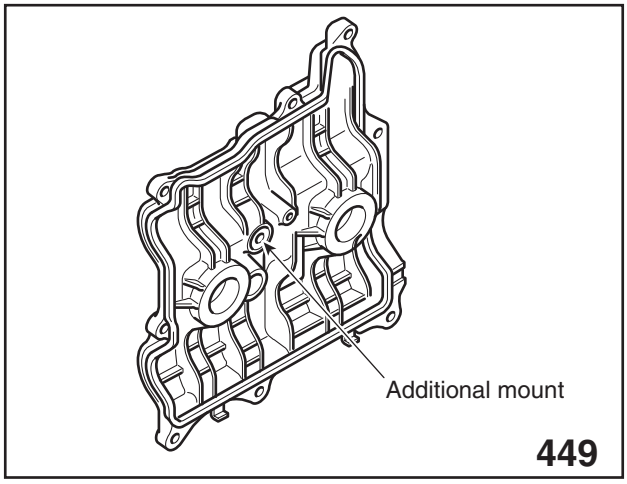


Knock Pin Hole

Rocker Cover

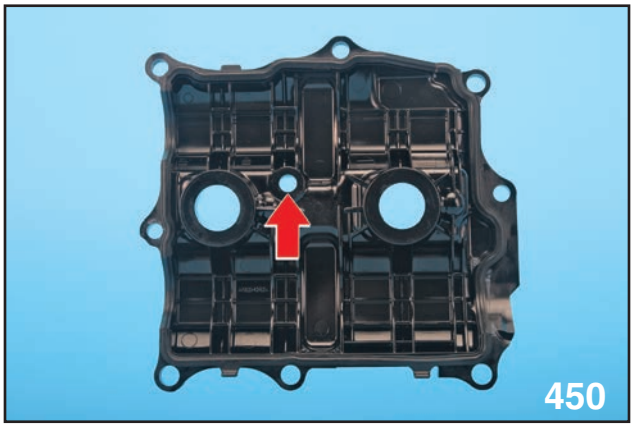
New resin rocker covers are used to reduce weight. An additional mounting bolt has also been added to the center of the rocker cover to reduce vibration.

Resin Rocker Cover

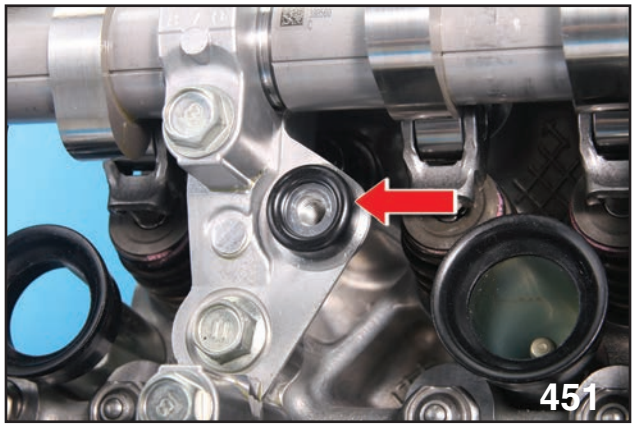


Additional Mounting Bolt

The additional mounting location on the rocker cover is sealed to the cylinder head using a new O-ring.



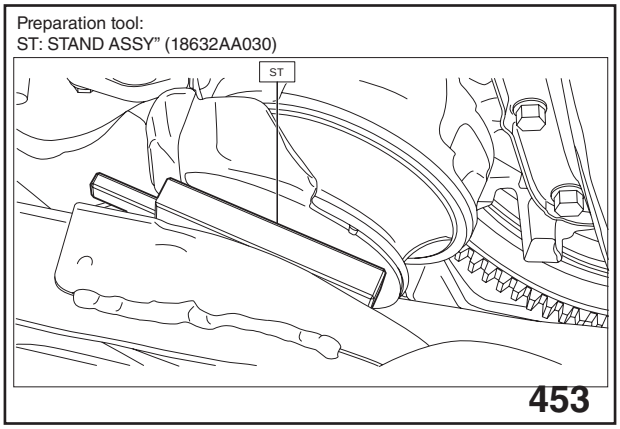
Mounting Hole



Rocker Cover O-ring

Removal of the rocker covers is possible with the engine assembly installed in the body when SST 18632AA030 Stand Assy is used to slightly raise the engine. Consult the appropriate service manual for complete details.

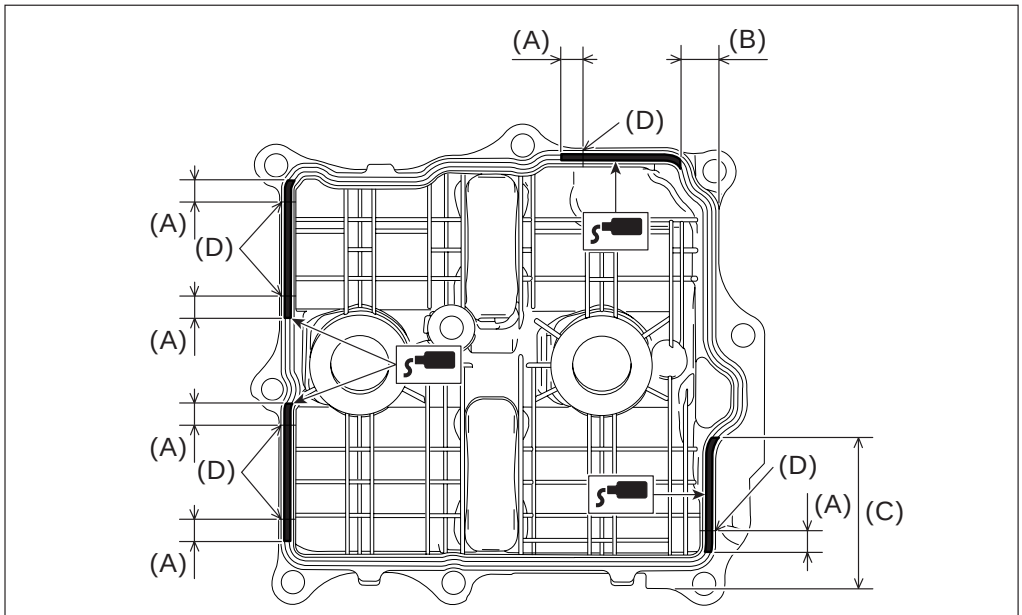
Rocker Cover Access



Stand Assy — 18632AA030

Due to the material change, proper installation of the rocker cover (sealant, torque value, and sequence) is critical to prevent leaks. Always refer to the appropriate Subaru service manual for specific directions.

Liquid gasket:
THREE BOND 1217G (Part No. K0877Y0100, THREE ND 1217H or equivalent
Liquid gasket applying diameter:
3 ±1 mm (0.1181 ± 0.0394 in)



(A) 10 mm (0.397 in) or more
(B) 17.3 mm (0.6811 in)
(C) 70.7 mm (2.7835 in) or more
(D) Arch starting point

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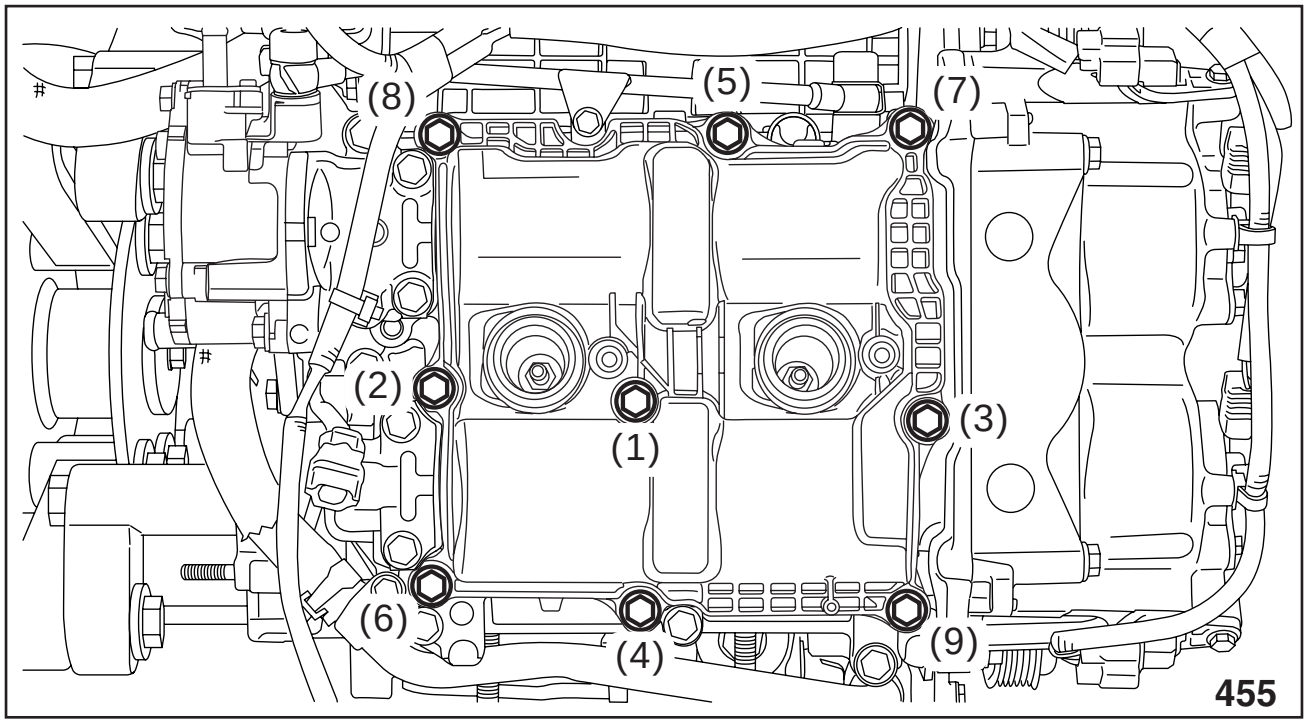
Sealant Application Areas

Example Procedure:

Install the rocker cover LH to the cam carrier LH.

1. Set the rocker cover LH on the cam carrier LH, and start all bolts until two full threads engage.
2. Tighten all bolts with a torque of 6.4N·m (0.7kgf-m, 4.7ft-lb) in numerical order as shown in the figure.
3. **Once again,** tighten all bolts with a torque of 6.4N·m (0.7kgf-m, 4.7ft-lb) in numerical order as shown in the figure.

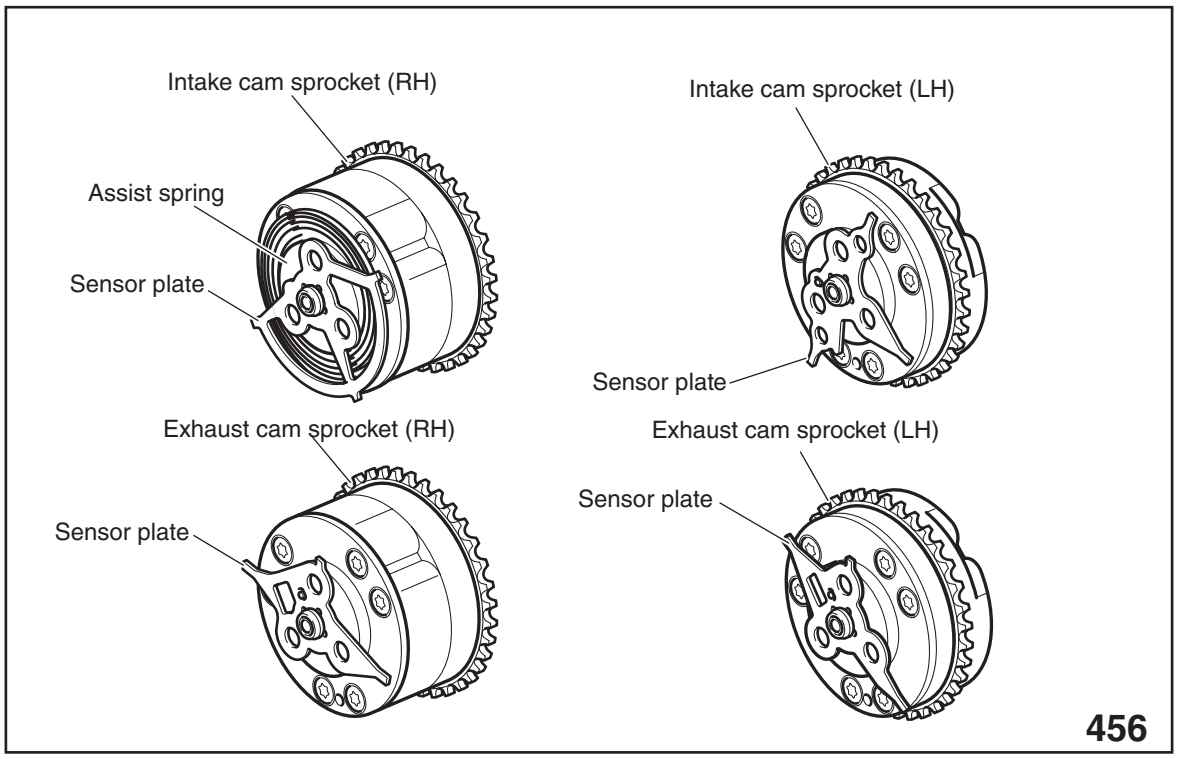
Note: This procedure is necessary to stabilize torque.



Torque Sequence

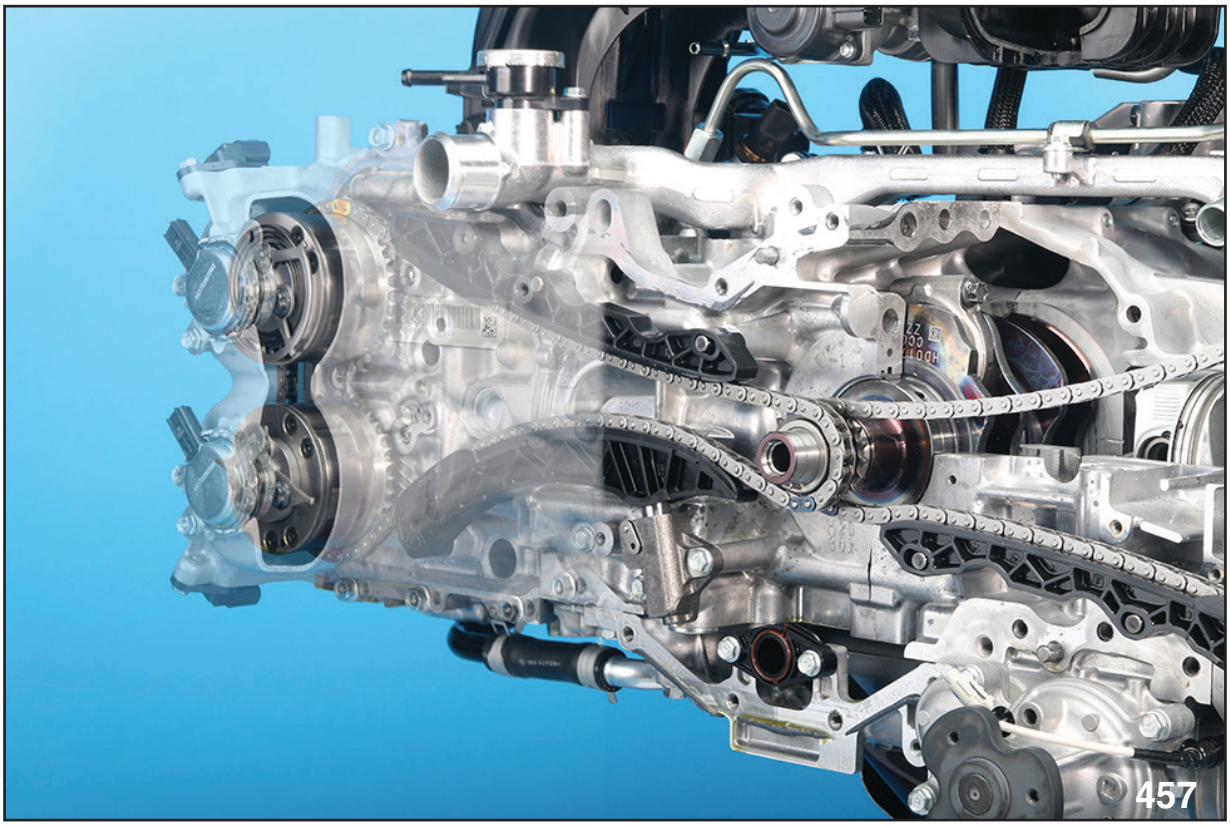
Camshafts & Sprockets

Intake and Exhaust cam sprockets have been redesigned to reduce weight. Each sprocket has a new sensor plate that contains tabs for the camshaft position sensor and timing chain installation.



Camshaft Sprockets

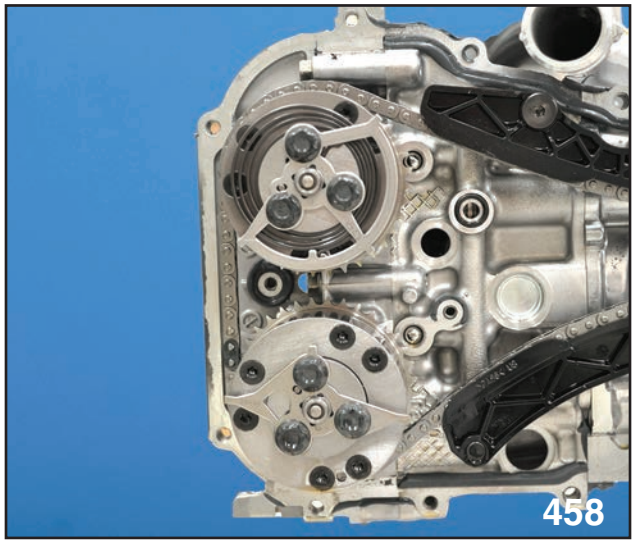
An assist spring has been installed on the RH Intake sprocket to maintain camshaft speed during AVCS operation and to overcome resistance from the mechanical vacuum pump.



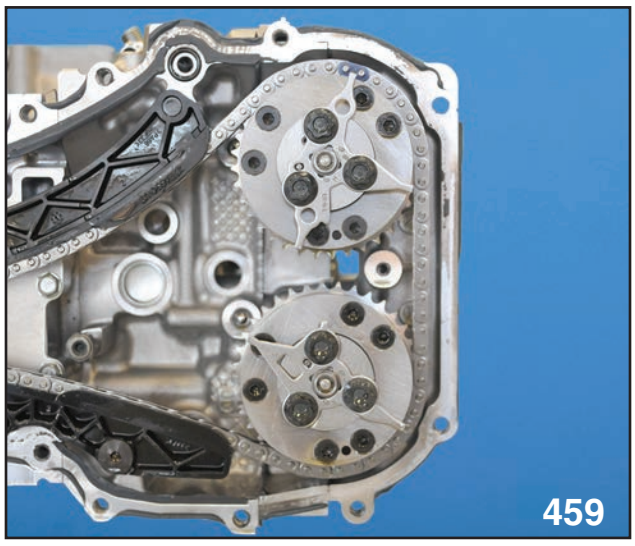
Timing Chain — Right Bank

The external tabs on the Cam Sprocket Sensor Plates produce an identical square wave signal as previous models.

Caution: Take care when working with or around the sensor plates as to not cause damage such as chipping or bending.

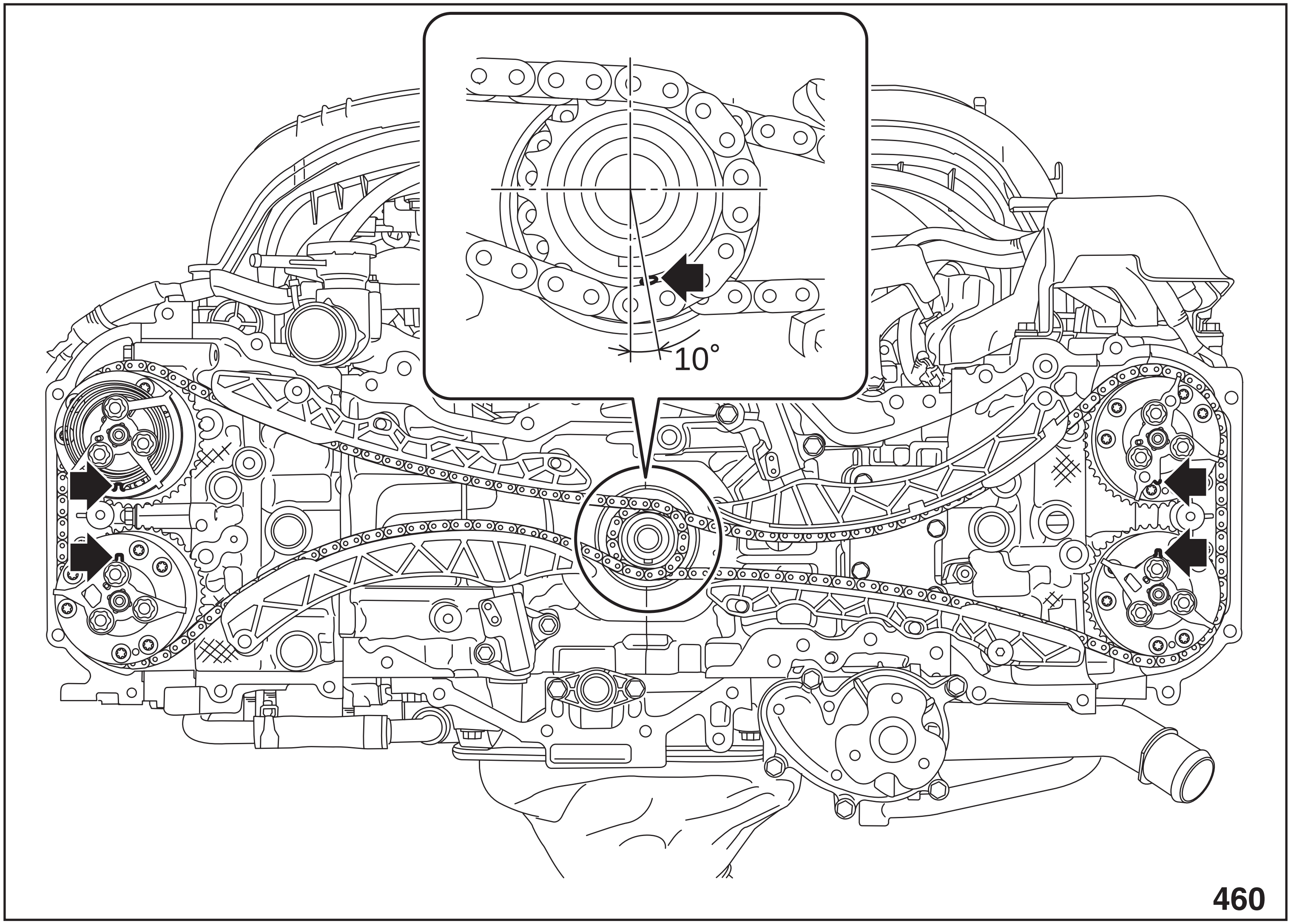


RH Sprockets



LH Sprockets

The general procedure for correctly installing the timing chains remains the same from previous models. However, because of the redesigned Sprocket Sensor Plates, the timing marks are different. However, the chain link alignment marks are the same as previous models. Always consult the appropriate service manual for specific details on the engine timing procedure.

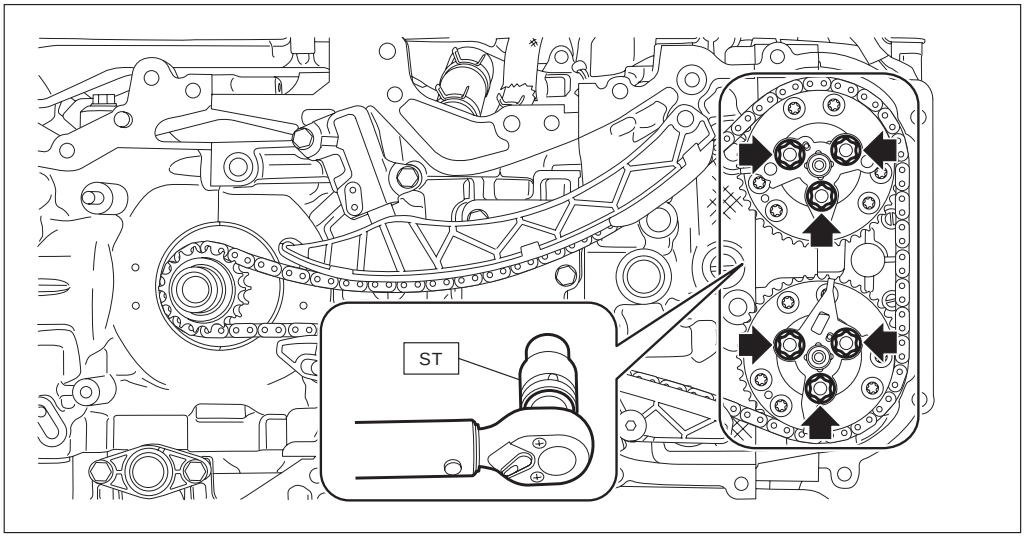


Chain Timing Marks

As a result of the redesign of the sensor plate, loosening and final torqueing of the Cam Sprockets bolts are performed without the use of the ST Pulley Wrench as is common with previous models. On this engine, loosening and final torqueing is performed with the timing chains and tensioners installed to provide sufficient resistance.

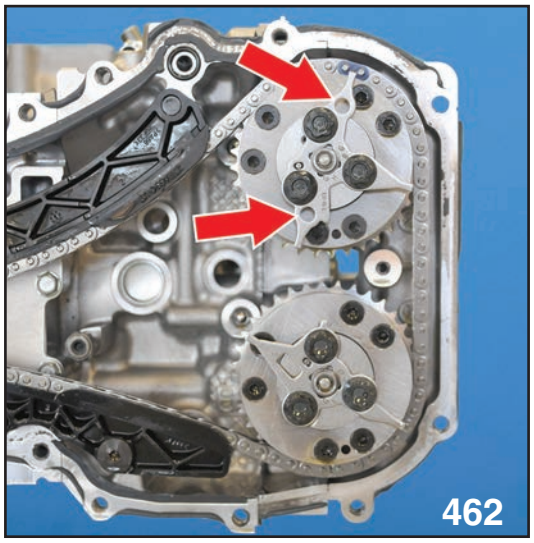
Note: ***Always ensure the Cam Sprockets are properly aligned with the "knock pins" on the camshaft. Additionally, check that there is no foreign matter on the mating or lubrication surfaces/ports.***

Preparation tool:
ST: SOCKET (18270KA010)
Tightening torque:
18N·m (1.8kgf-m, 13.3 ft-lb)



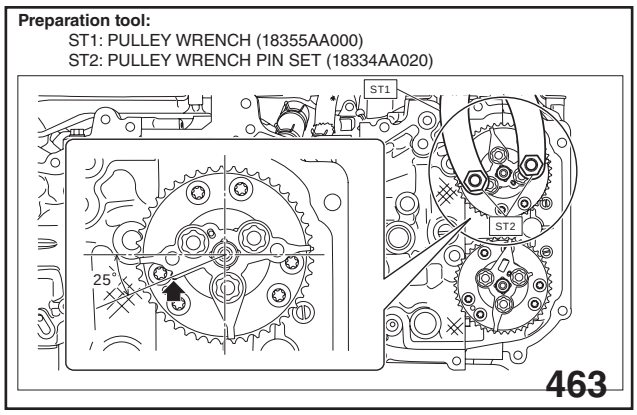
Cam Sprocket — Torque

The LH Intake Cam Sprocket has two holes for fitment with the SST Pulley Wrench and Pin Set. This allows the technician to rotate the sprocket when aligning the timing marks prior to chain installation.



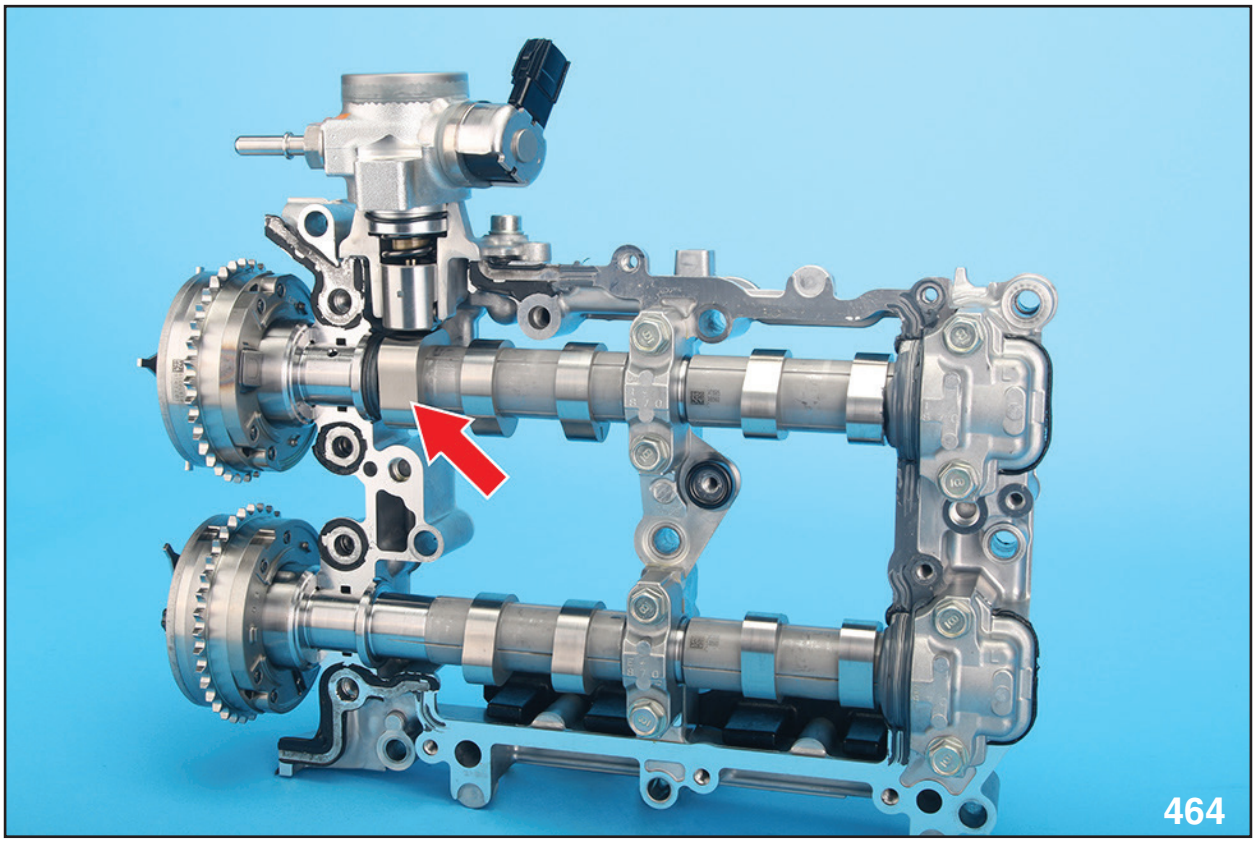
LH Intake Sprocket — Pin Holes

Preparation tool:
ST1: PULLEY WRENCH (18355AA000)
ST2: PULLEY WRENCH PIN SET (18334AA020)



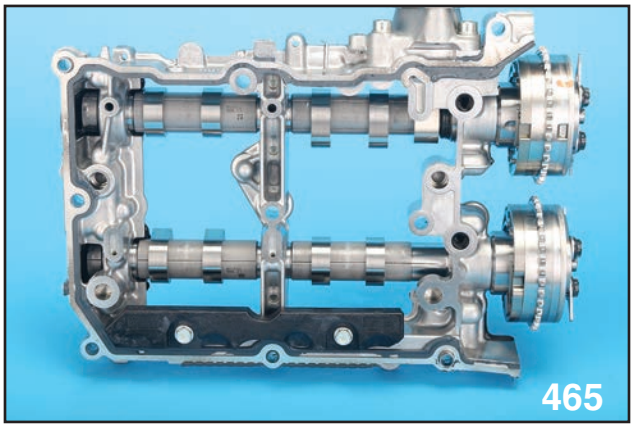
LH Intake Sprocket — SST Use

The direct injection system (DINA) uses the driver side intake cam shaft to drive the high-pressure pump. An additional cam lobe with four peaks rides along a roller-tip cam follower.

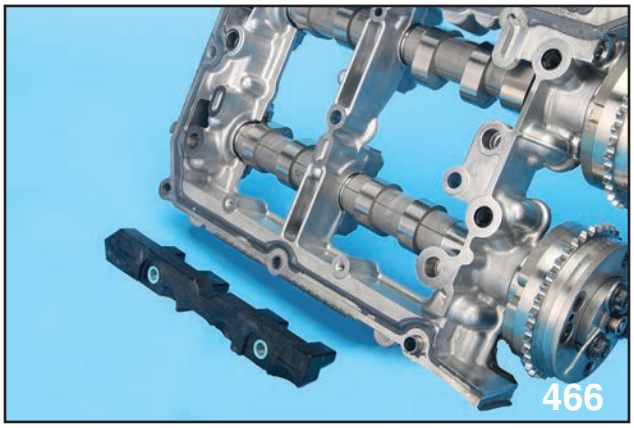


Cam Lobe — High Pressure Fuel Pump

Each Camshaft Carriers features a new oil spacer to reduce oil levels and improve warm-up performance.



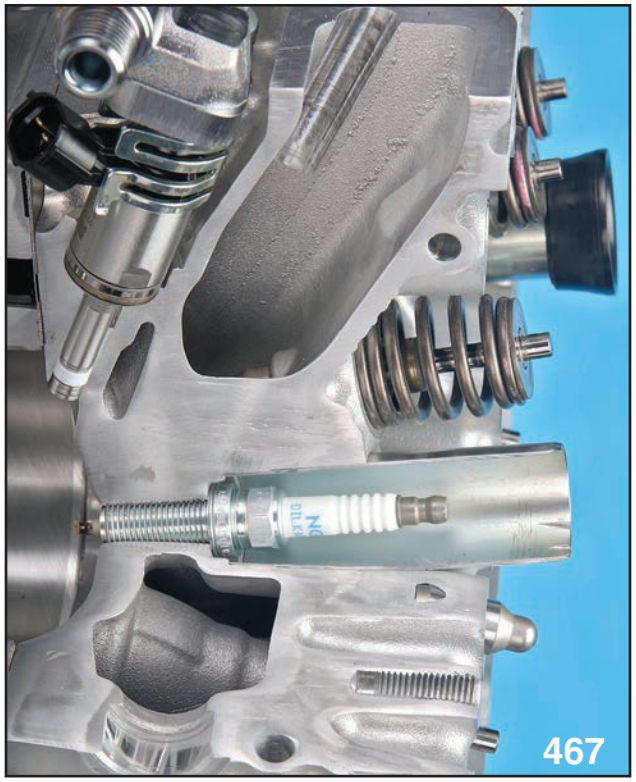
Oil Spacer — Installed



Oil Spacer — Removed

The shape of the valve springs has been changed to a cone-shape to reduce weight and optimize spring load.

Caution: Exhaust valves are sodium filled. Handle with care and dispose of in accordance with local regulations.



Valve and Spring — Installed (Cutaway)

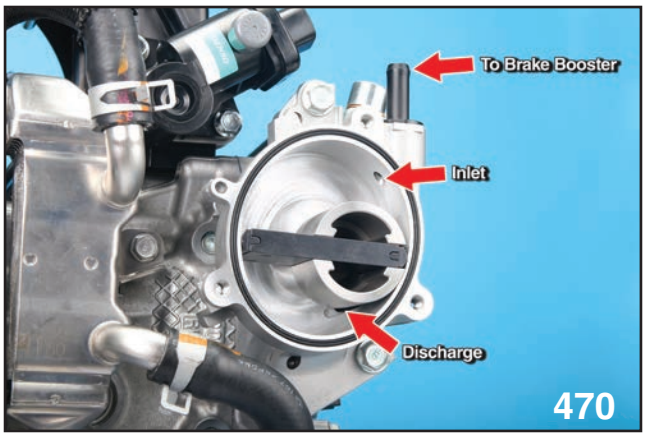
Valve, Spring, Retainer, and Seat

Brake Vacuum Pump

A mechanical Brake Vacuum Pump (similar to BRZ models) has been added to improve braking performance at high altitudes and/or immediately after starting the engine (cold).

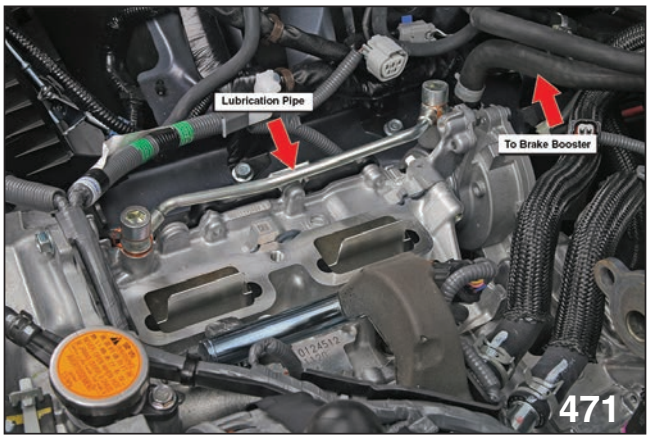
Brake Vacuum Pump

The pump is installed in the rear of the passenger side cylinder head and is driven by the intake camshaft. As the pump rotates, air is drawn in through the inlet and discharged into the crank case.



Vacuum Pump — Ports

The pump receives engine oil lubrication via a hard line located on top of the cylinder head.

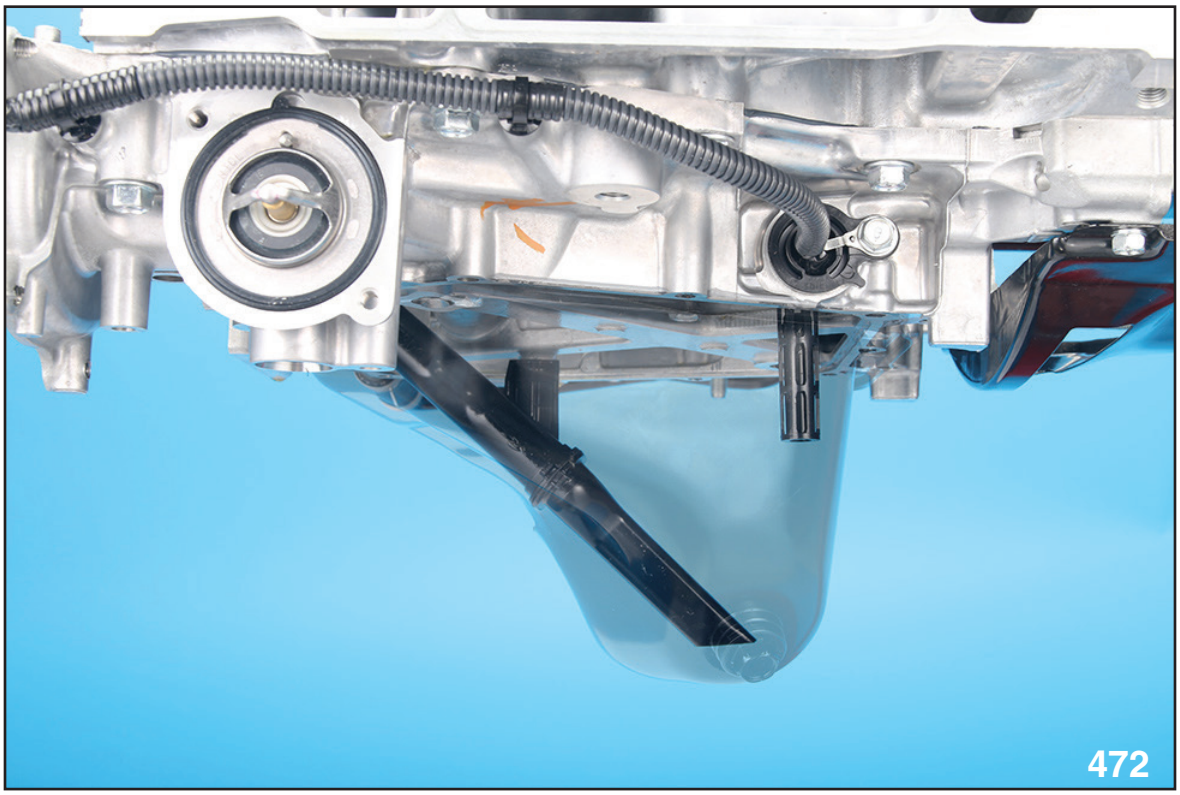


Brake Vacuum Pump — Plumbing

Lubrication System

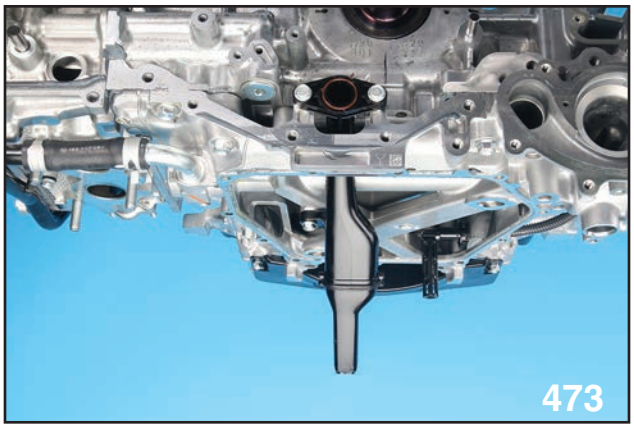
The construction of the oil strainer (pick-up tube) has been change to a resin type for weight reduction.

Caution: When removing the oil pan, remove the front side first in order to avoid interference with the oil strainer.

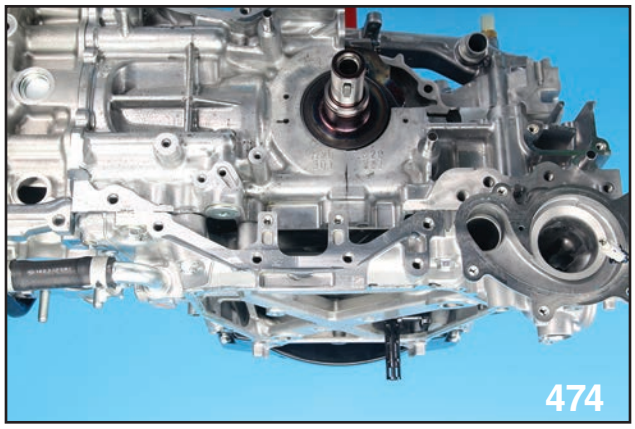


Oil Pan and Strainer

If removal or replacement is necessary, the oil strainer is partially serviced from the front of the engine behind the timing cover.



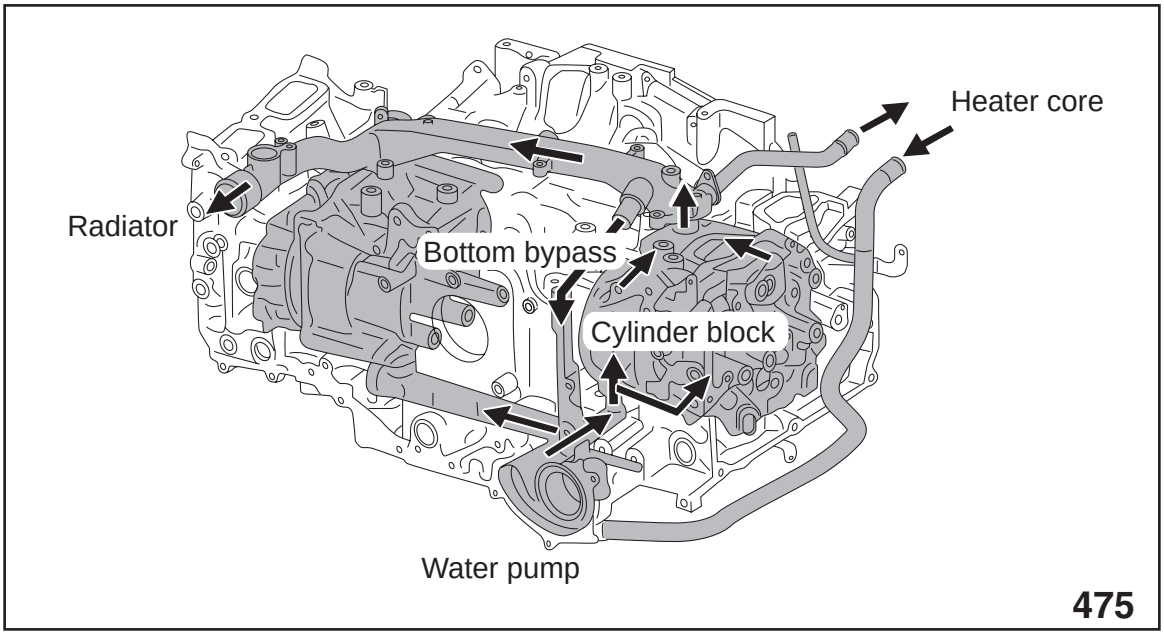
Oil Strainer — Installed



Oil Strainer — Removed

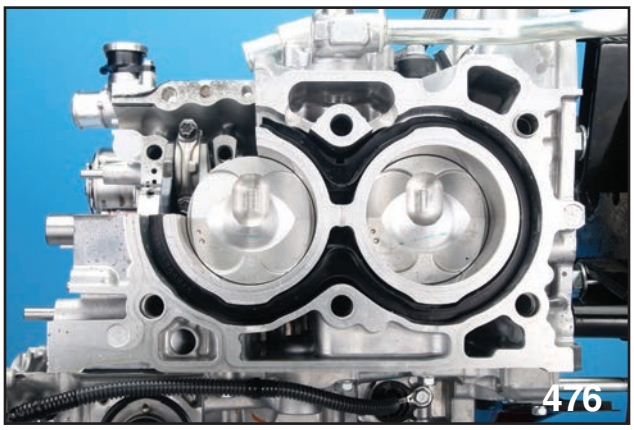
Cooling System

To accommodate the Subaru Global Platform (SGP) and new engine features, the cooling system has been revamped to improve thermal discharge by approximately 6%.

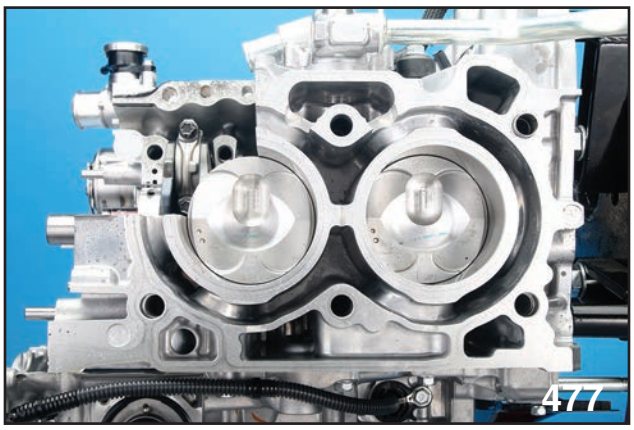


Cooling System Flow

A Water Jacket Spacer is used to reduce friction and cooling system capacity to improve fuel economy and create faster warm-up times.

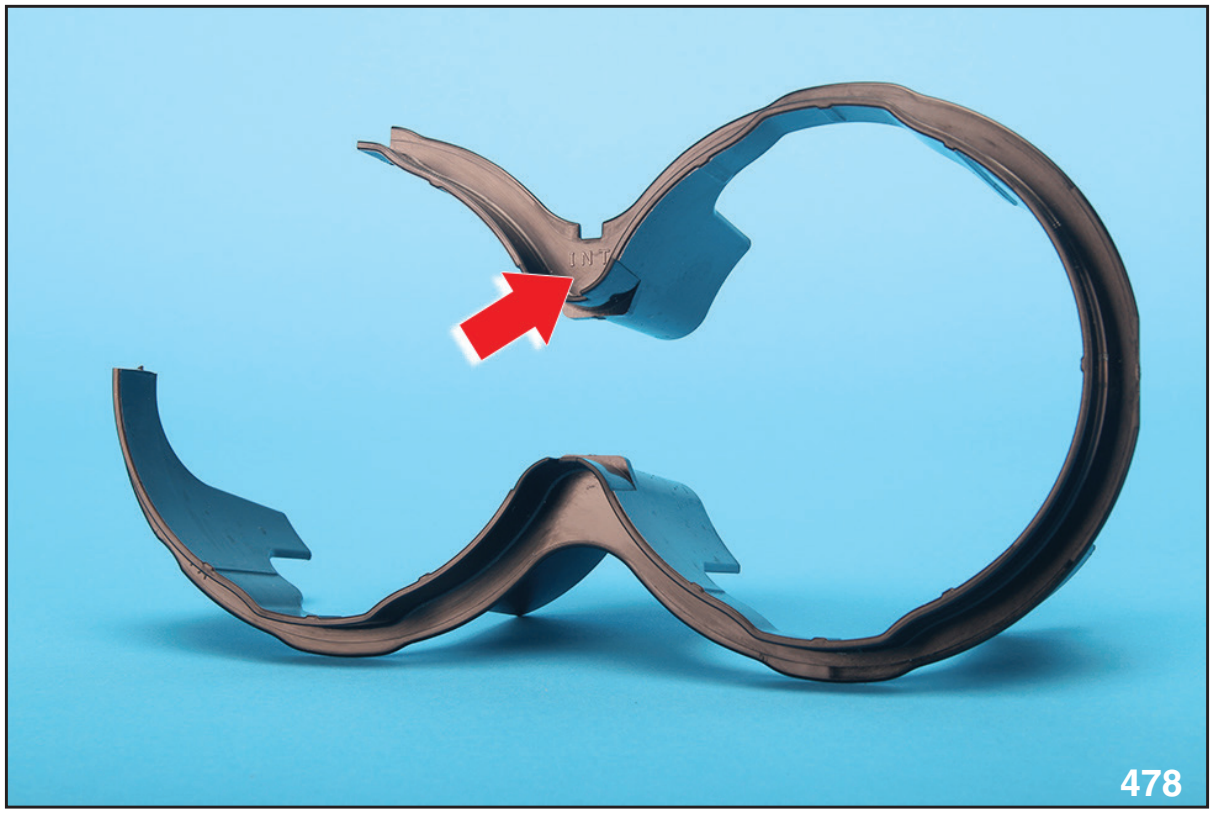


Water Jacket Spacer – Installed



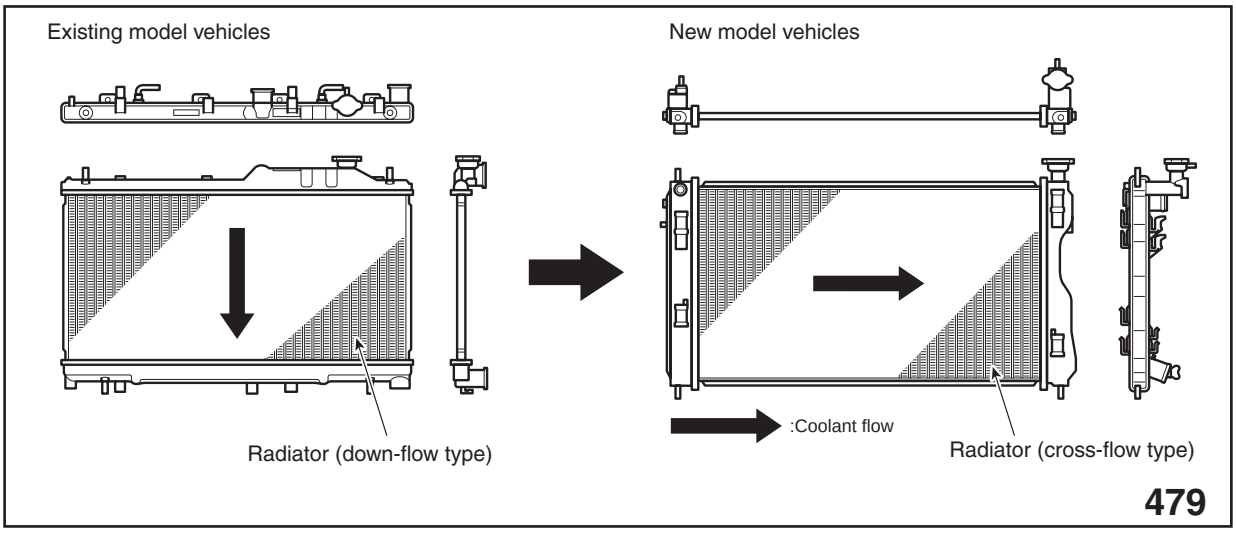
Water Jacket Spacer – Removed

Water jacket spacer orientation is indicated by “INT” (Intake) molded into the side that is closest to the intake side of the engine.



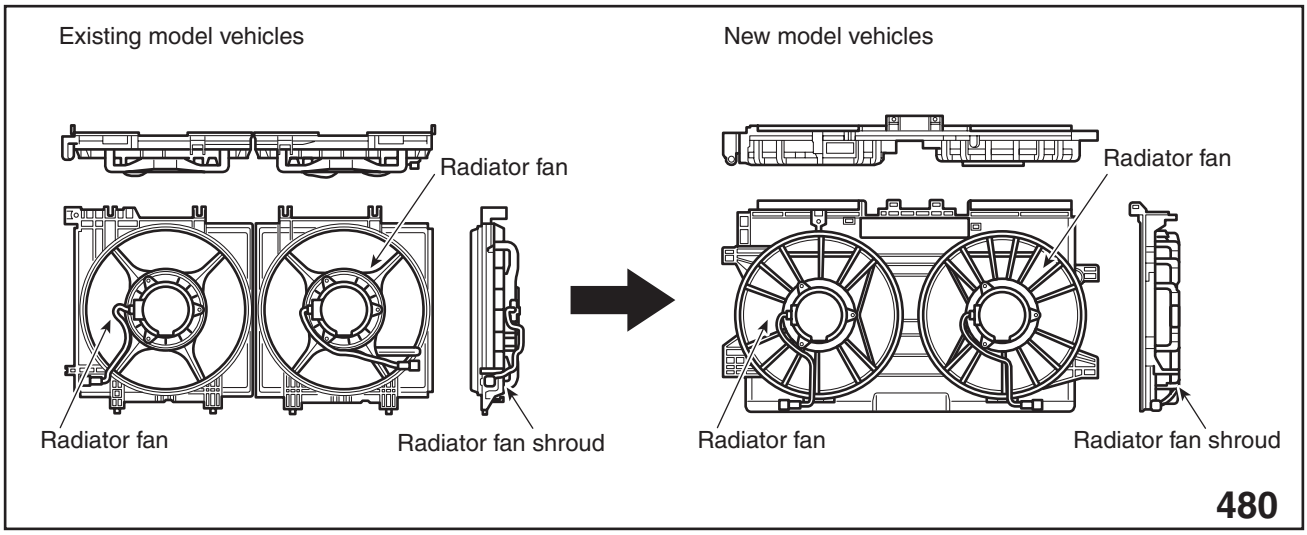
Orientation Mark (Cutaway)

The Radiator flow has been changed from a “down-flow” to a “cross-flow” configuration. Additionally, the core thickness has been reduced by approximately 4mm.



Radiator Flow Comparison

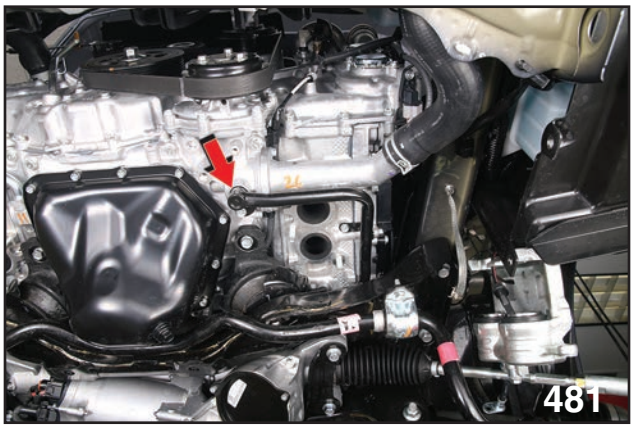
High-efficiency radiator fans are used to improve air flow. Each fan is approximately 20mm smaller in diameter. During service the fans are removed as an assembly.



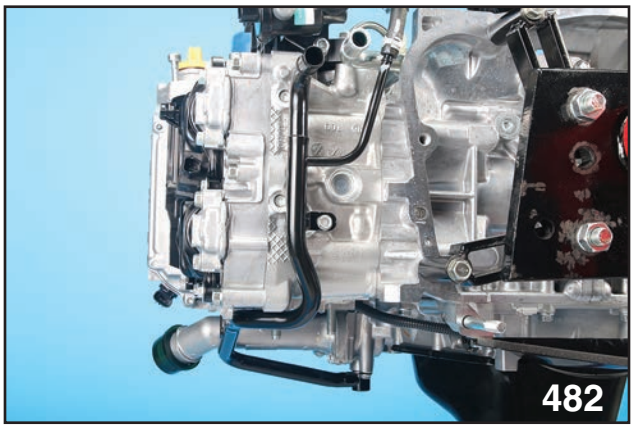
Radiator Fan Comparison

Water Pipe

As a result of the front exhaust pipe relocation to the left side of the vehicle, the construction of the lower water pipe has been changed from rubber to metal. Additionally, this pipe is sealed to the engine block with an O-ring.

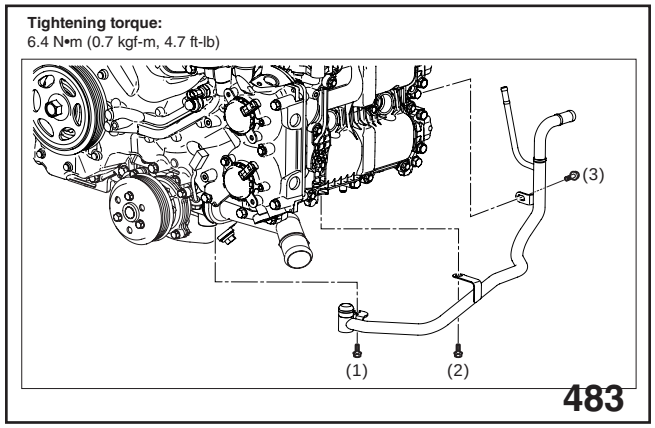


Lower Water Pipe

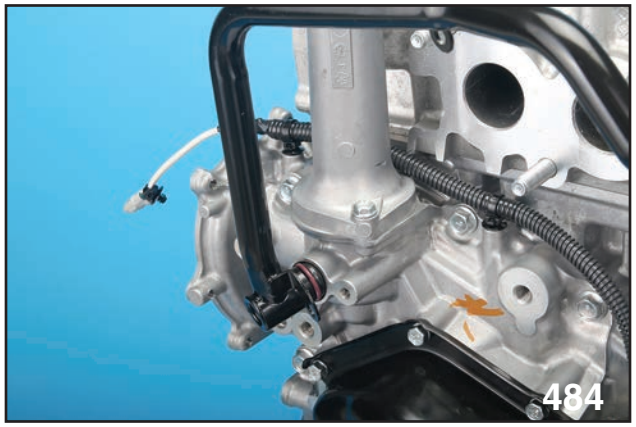


Lower Water Pipe (Rear View)

During installation of the water pipe, it is critical to use a new O-ring and follow the specified torque sequence to ensure proper sealing. To prevent damage to the new O-ring it is recommended to apply a small amount of soapy water to aid in installation. Consult the appropriate service manual for specific details.

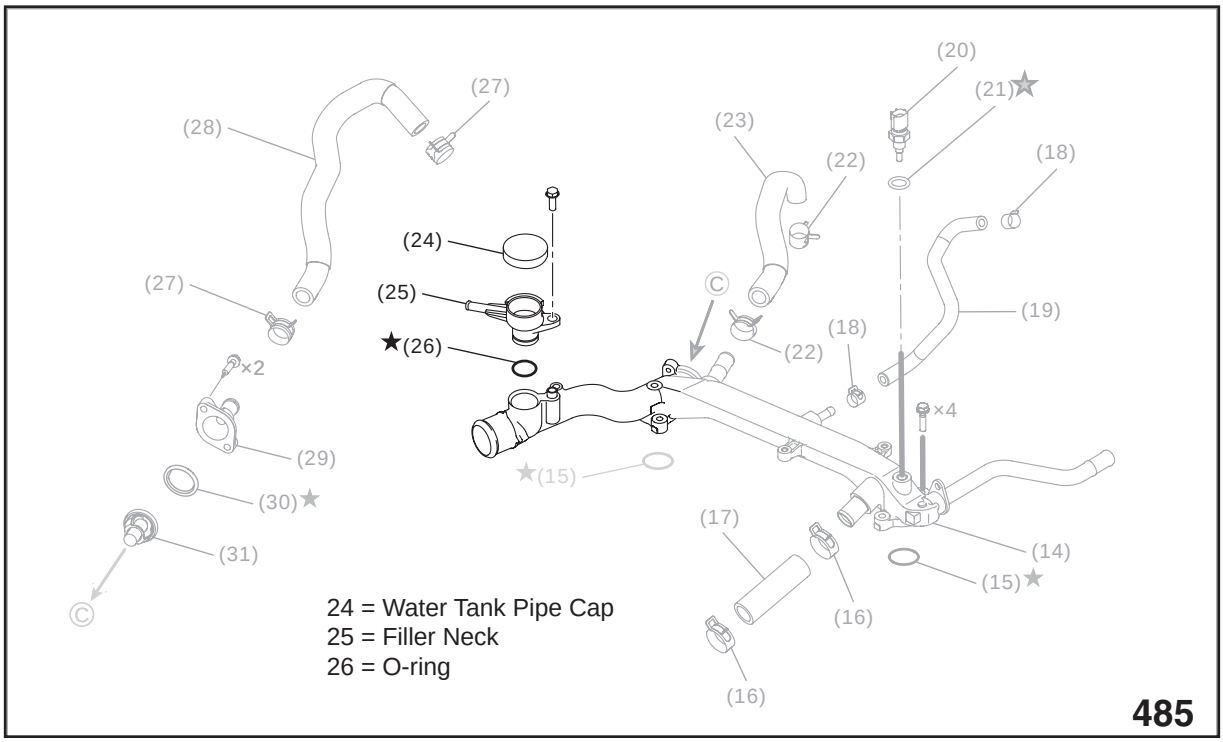


Water Pipe



Water Pipe O-ring

As a result of the new radiator flow and lower system height (appx. 40mm lower), a new “Filler Neck” and “Water Tank Pipe Cap” have been added to the cooling system.

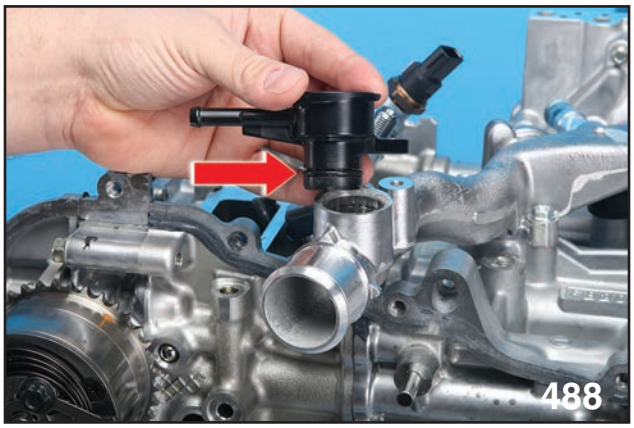


Filler Neck and Water Tank Pipe Cap (Artwork)

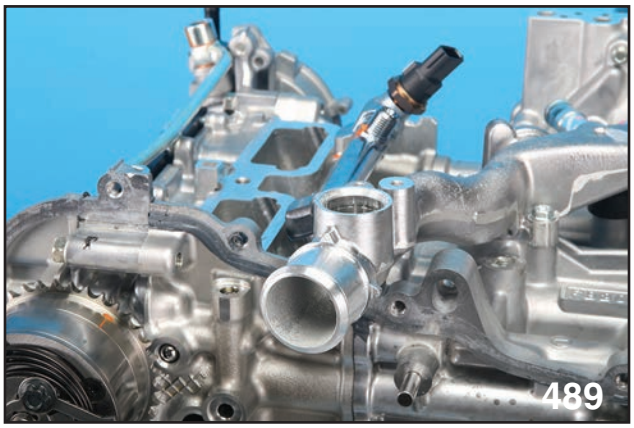
The Water Tank Pipe Cap functions as a relief valve to adjust internal pressure throughout the system. The neck portion is sealed to the coolant crossover pipe using an O-ring.

Filler Neck — Complete

Filler Neck — Cap Removed



Filler Neck — O-ring

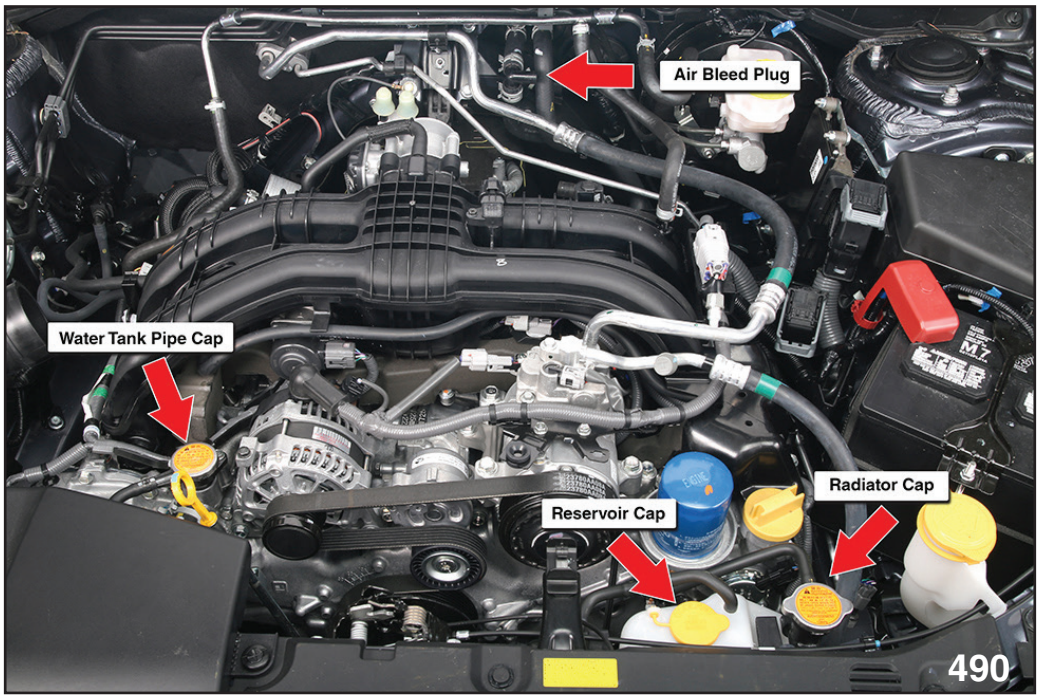


Filler Neck — Removed

During service procedures that require the cooling system to be drained/refilled, it is important to follow the service manual procedures to ensure air is purged from the system to prevent overheating.

Example Filling Procedure:

1. Remove Water Tank Pipe Cap
2. Loosen Air Bleed Plug on heater outlet hose
3. Pour in Cooling System Conditioner (into Radiator)
4. Pour in Engine Coolant (into Radiator)
5. Install Water Tank Pipe Cap
6. Close the Air Bleed Plug when coolant begins to come out from the plug
7. Pour coolant into the radiator up to the filler neck
8. Fill coolant into the Reservoir Tank up to “FULL” level
9. Install Reservoir Tank cap
10. Install the Radiator Cap



System Fill and Bleeding Points

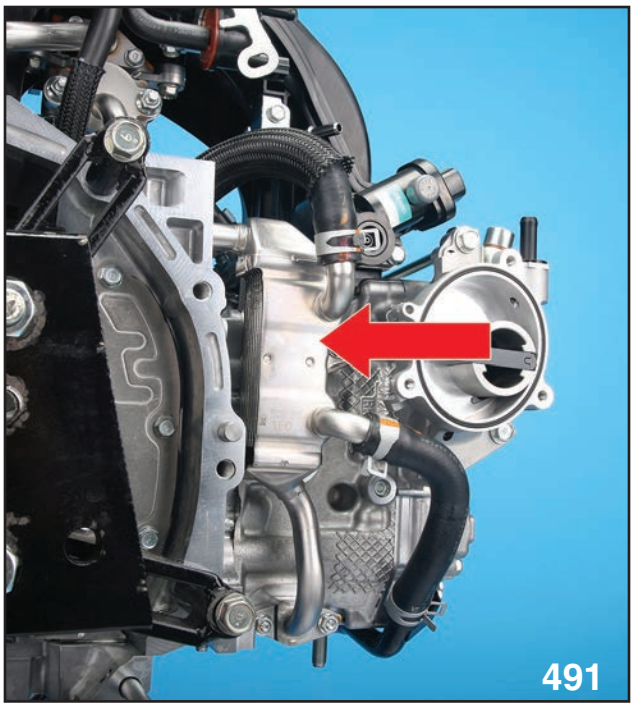
11. Start the engine, and race 5 to 6 times at 3,000 rpm or less, then stop the engine
    a. Complete within 40 seconds
12. Wait for at least 1 minute, then remove the Radiator Cap [Add coolant as necessary]
13. Repeat steps 10-12
14. Install the Radiator Cap
15. Start the engine and operate the heater to “maximum hot”, blower speed to “LO”, and A/C switch to “OFF”
16. Run the engine at 3,000 rpm or less until the radiator fan starts then stops

Caution: Frequently check the engine coolant temperature to avoid overheating

17. Stop the engine and wait until the coolant temperature falls below 86°F
18. Remove the Radiator Cap [Add coolant as necessary]
19. Remove the Reservoir Cap [Add coolant as necessary]
20. Install both Radiator and Reservoir caps
21. Start the engine and operate the heater to “maximum hot”, blower speed to “LO”, and A/C switch to “OFF”. Race the engine at 3,000 rpm or less. If the flowing (bubbling) sound is heard from the heater core, repeat the procedures from step 16).

Exhaust Gas Recirculation (EGR)

Fuel economy is increased by adopting a high-efficiency EGR core, shortening the pipe length and reducing pressure loss.



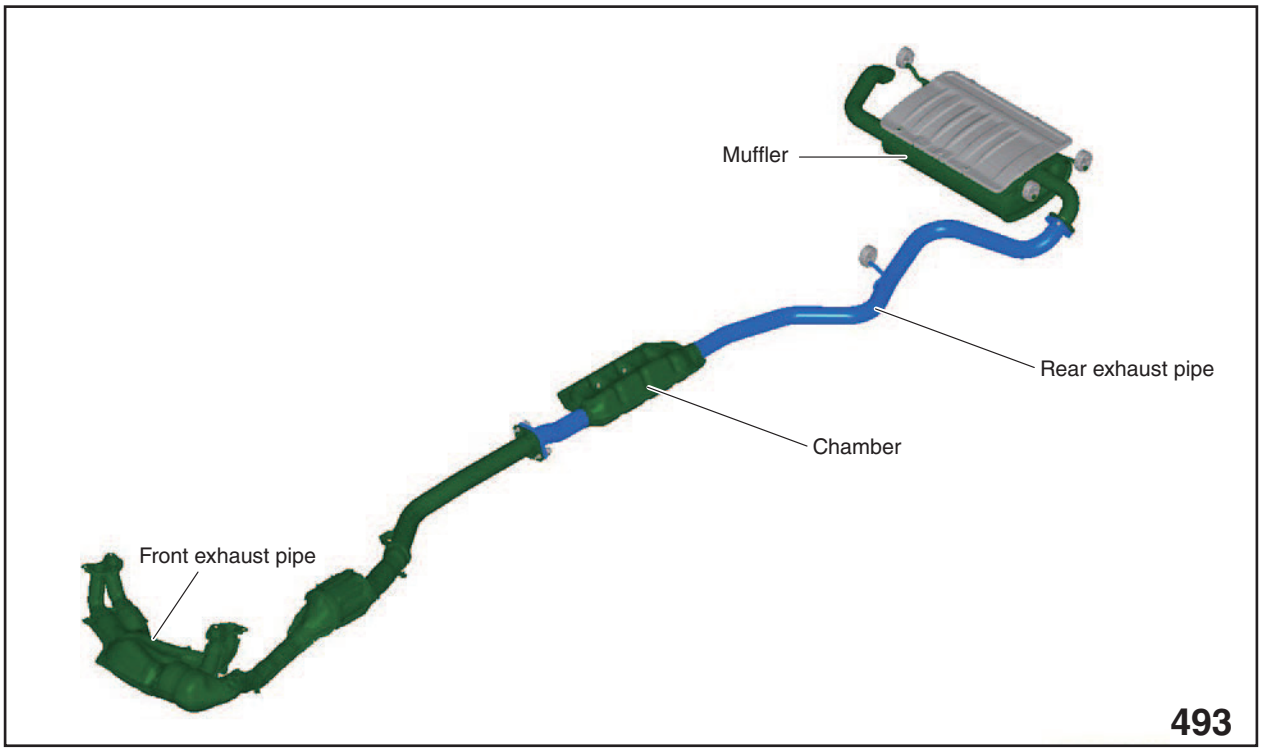
EGR Cooler — Installed

EGR Cooler — (Bench/Cutaway)

Exhaust System

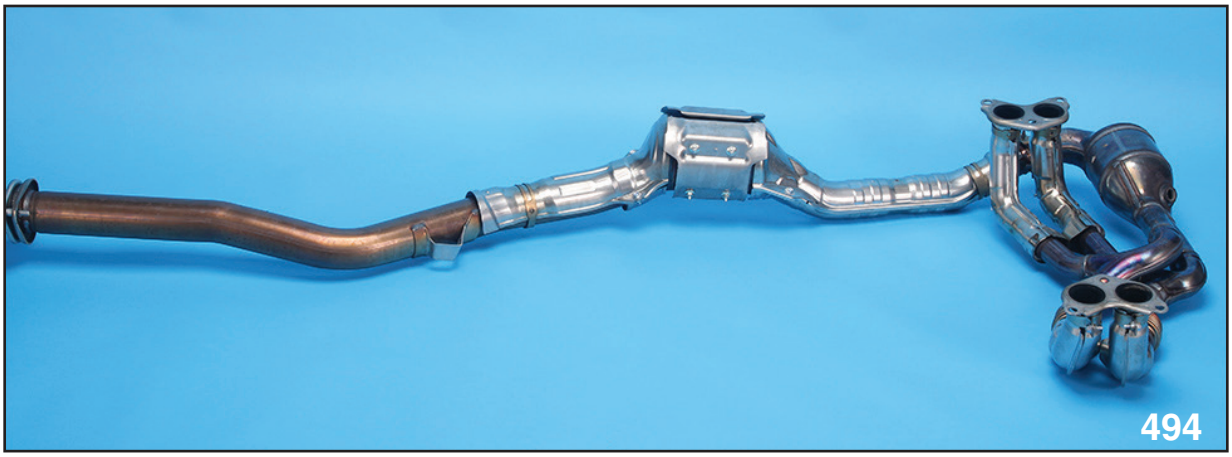
Front Exhaust Pipe

The front exhaust pipe configuration was changed to a 4-2-1 configuration with extended pipe lengths, thinner pipe walls, and optimized precious metals in the catalytic converter. These changes have improved torque, power, and emissions performance.



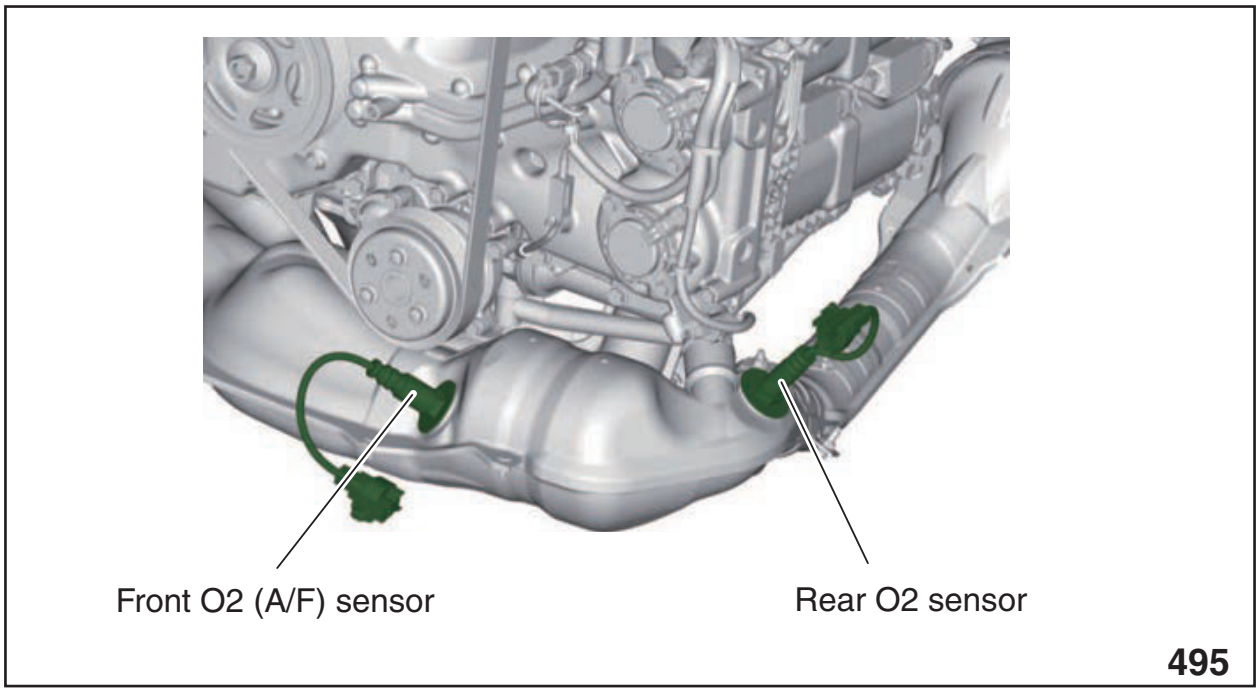
Exhaust System (Artwork)

The front exhaust pipe now incorporates the previous “center” exhaust pipe section. The front exhaust pipe joins directly to the rear exhaust pipe.

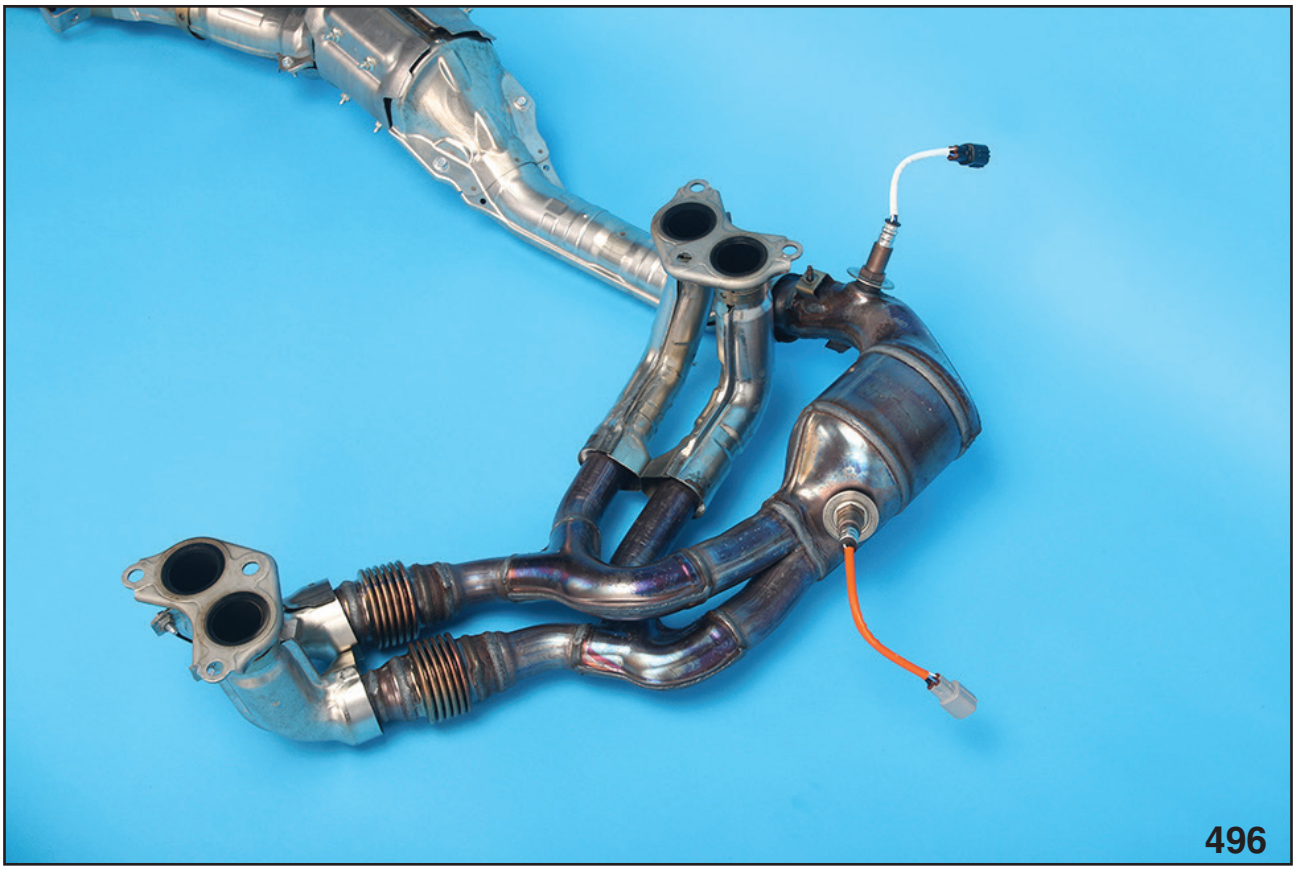


Front Exhaust Pipe

Air Fuel Ratio (A/F) and Oxygen (O2) sensors are located in the front exhaust pipe assembly.

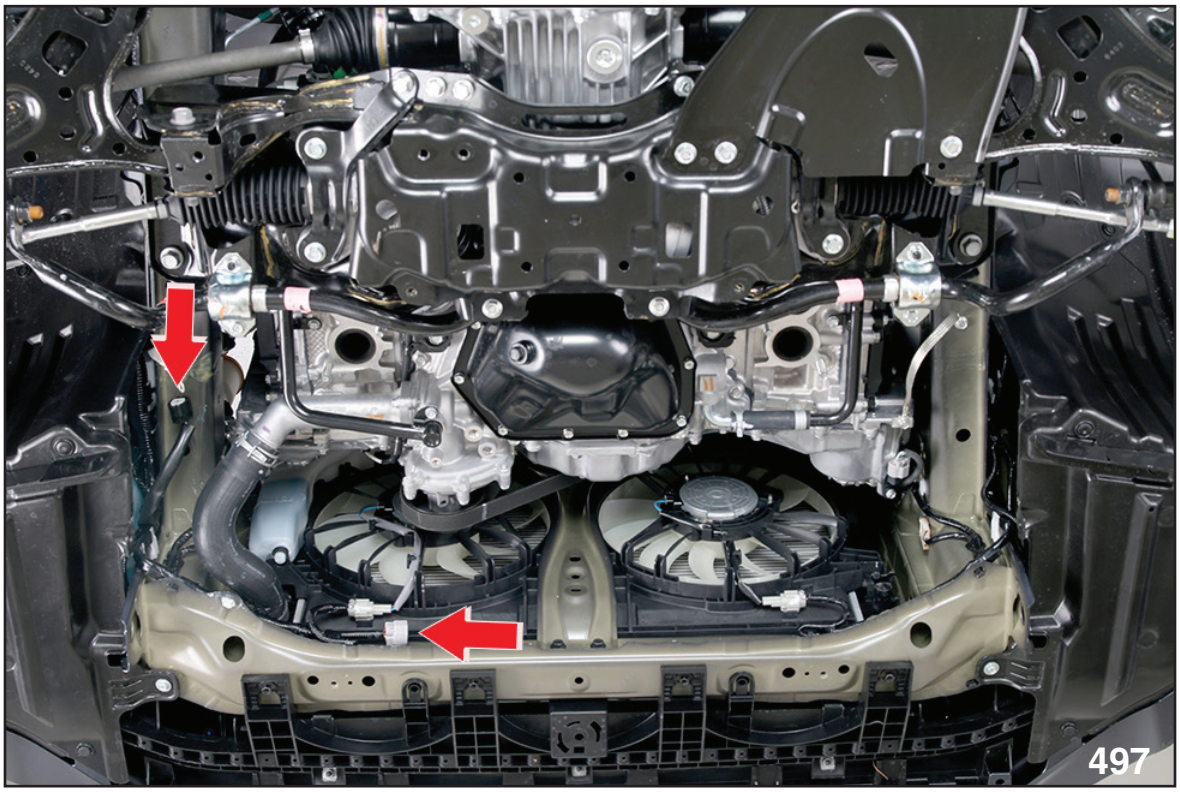


A/F and 02 Sensors (Artwork)



A/F and 02 Sensors (Heat Shields Removed)

Connectors for the A/F and O2 sensors are located along the lower body structure in close proximity to the sensors.



A/F and 02 Sensor Connectors

NOTES:

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