

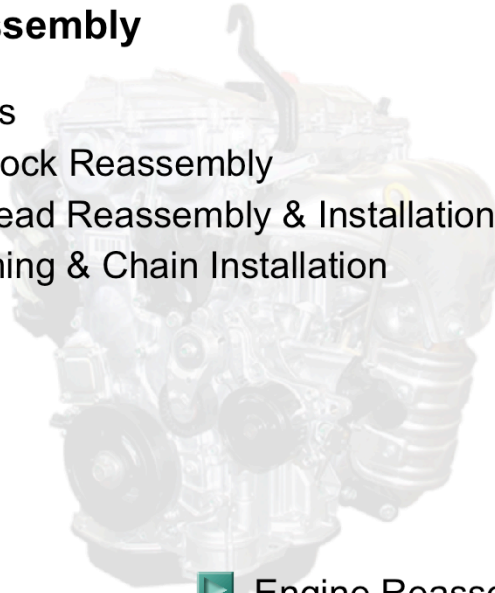


Section 9 Topics

Engine Reassembly

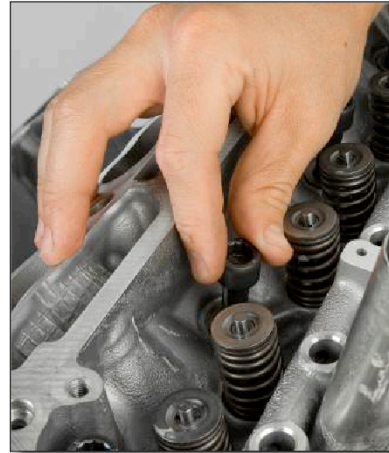
-  Precautions
-  Cylinder Block Reassembly
-  Cylinder Head Reassembly & Installation
-  Engine Timing & Chain Installation



-  Engine Reassembly Worksheet

Precautions

- Keep all parts and tools extremely clean
- Inspect and count all parts before beginning
- Be sure all threaded holes have been chased with a tap and that blind holes do not have liquid in them
- Start all nuts and bolts with your fingers
- Lubricate all moving parts before assembling
- After assembling rotating parts, be sure they can be easily turned by hand without binding



Engine Reassembly Precautions

Keep all parts and tools extremely clean.

- Dirt or contaminants in the engine can cause premature wear or failure.
- When you stop working on the engine, put a clean cover over it.

Inspect and count all parts before beginning to avoid discovering:

- An extra bolt or piston ring AFTER assembly.
- You don't have all the parts you need to complete the job.

Be sure all threaded holes have been chased with a tap.

- Use antiseize on bolts threaded into aluminum to prevent corrosion.

Start all nuts and bolts with your fingers.

- If a bolt or nut won't turn by hand, don't force it.
- Figure out what the problem is.

Lubricate all moving parts before assembling.

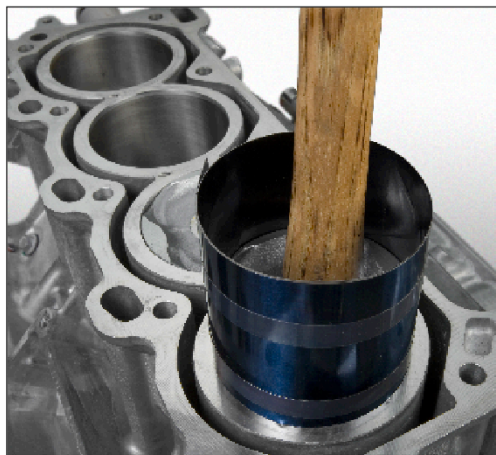
- The engine will have no lubrication for the first few seconds after it is first started.

Cylinder Block Reassembly - Overview

Overview of Procedure

- Install stud bolts
- Install oil jets
- Assemble pistons and connecting rods
- Install piston rings
- Install crankshaft and main bearings
- Install pistons and connecting rod bearings
- Install oil pan

Note: This section does not cover every step in the engine reassembly procedure. It focuses on selected steps only.



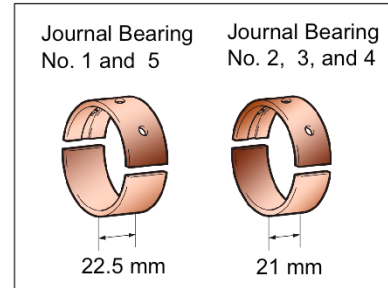
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NOTES:

Crankshaft and Bearing Installation

General

- Clean each main journal and bearing before installation
- Do not apply engine oil to the cylinder block contact surfaces.
- Install 22.5mm bearings at journals No. 1 and 5; install 21mm bearings at journals No. 2, 3, and 4.



Note: Do not allow coolant to come into contact with the bearing inner surface. If any coolant comes into contact with the bearing inner surface, replace the bearing with a new one.

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Crankshaft and Bearing Installation

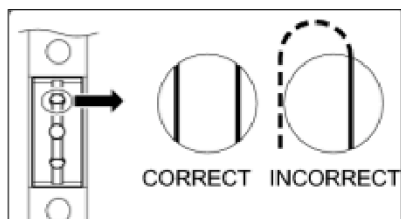
Be sure to use the correct select fit bearings for each journal. Bearings may be different sizes on the front and rear journals compared to the middle journals. Be sure to install the bearing with the oil holes toward the cylinder block and not the bearing cap. This is a crucial step to ensure oil is fed to that journal. Do not apply oil to the back of the bearing surface or to the mating surface of the cylinder block.

When installing the crankshaft, apply a light coat of engine oil to the inner bearing surface and gently install the crankshaft. Once the crankshaft is installed and the bearing caps are temporarily installed, insert the thrust bearings.

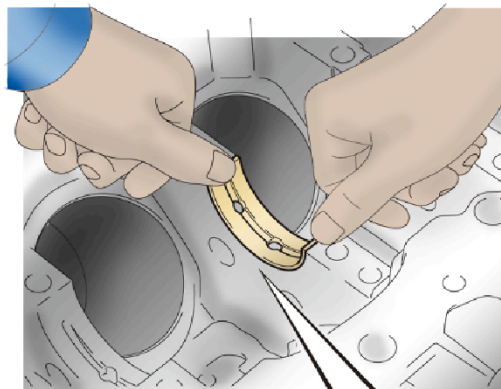
Upper Bearing Alignment

Both sides of the oil groove in the cylinder block should be visible through the oil feed holes in the bearing.

The amount visible on each side of the holes should be equal.



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Dimension A:
Above 0.5 mm
and below
1.0 mm

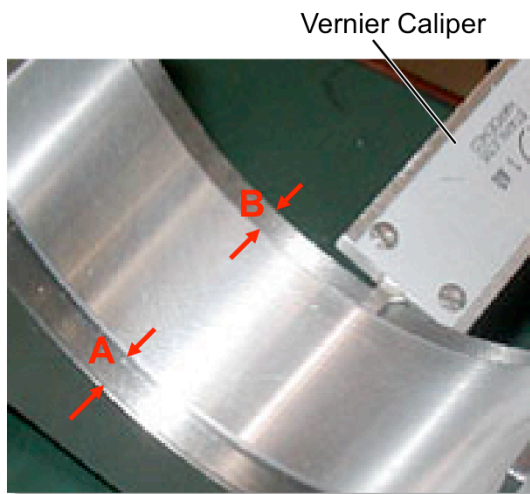
Upper Bearing Alignment

Since bearings no longer have an alignment tang, they must be centered in the journal. Make sure the oil supply hole properly lines up with the feed holes in the bearing. Use a caliper (depth measurement) to center the bearing in the journal.

Lower Bearing Alignment

Using a Vernier caliper, measure the distance between the bearing cap's edge and the lower bearing's edge.

"A" and "B" must be equal or within 0.7mm of being equal.



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Lower Bearing Alignment

Do not apply engine oil to the back side of the bearing. There are no moving parts on the back side of the bearing and the oil will interfere with heat transfer.

Use a caliper to measure the depth on either side of the bearing. The measurement on either side of the bearing should be within 0.7mm of each other.

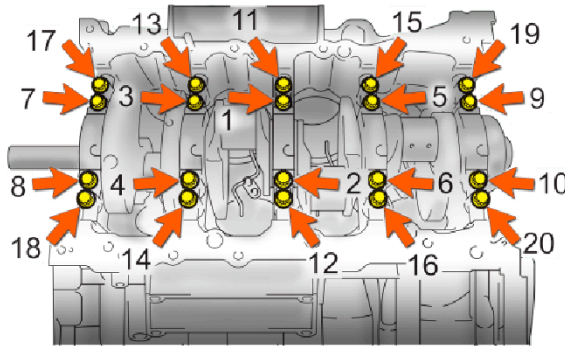
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Bearing Cap Bolt Torque

Torque sequence is important. Follow the order shown in the Repair Manual.

Note that torque specifications for inside and outside bolts are different.

Inside Bolts: 45ft·lbf
Outside Bolts: 20ft·lbf

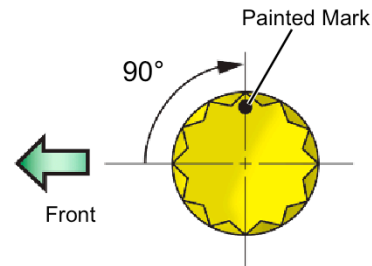


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Bearing caps are not interchangeable. They must be installed to their correct locations

After torquing the bearing cap bolts:

- Mark the front of each one with paint
- Tighten another 90° in the same order as they were originally torqued



Bearing Cap Bolt Torque

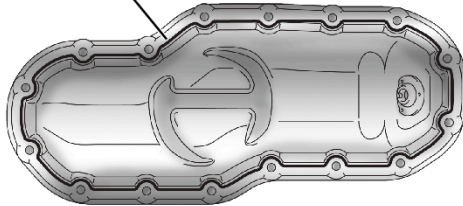
With all main caps temporarily installed, torque the main cap bolts in sequence. This torque procedure ensures the crankshaft is not damaged during installation. Stretching the bolts ensures the proper spring tension to keep the bolt from loosening over time.

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Engine Sealing

When installing the oil pan and heat exchanger cover, note that each uses a different type of seal packing.

Seal Packing



Oil Pan

Seal with Toyota Form-in-Place Gasket – Oil Pan (aka Toyota Seal Packaging 102) (for exposure to oil)

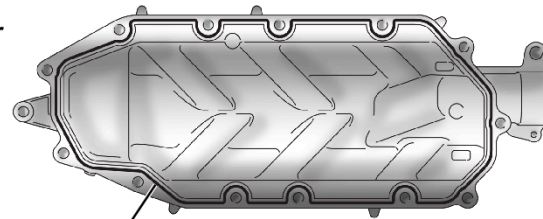
Part No. 00295-00103



Part No. 08826-00100

Heat Exchanger Cover

Seal with Toyota Genuine Seal Packing 1282B (or Three Bond 1282b or equivalent) (for exposure to water)



Seal Packing

Engine Sealing

Make sure the sealing surface is extremely clean and the proper sealant is used. Apply the specified amount of FIPG only in the areas specified in the Repair Manual. Follow the recommendations in the Repair Manual for setup and cure time. Do not fill with fluid or operate engine for at least two hours after applying sealant.

Cylinder Head Installation - Overview

Overview of Procedure

- Install cylinder head gasket
- Install cylinder head
- Install valve train components
- Install camshaft housing subassembly
- Install camshaft



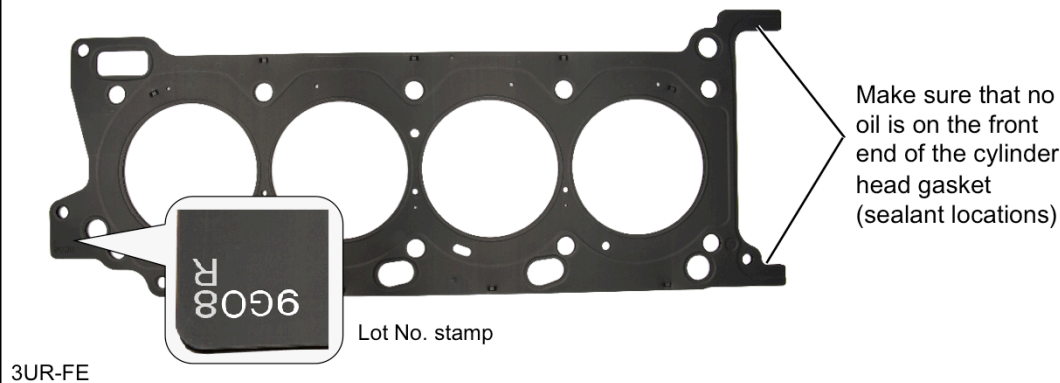
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NOTES:

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Cylinder Head Gasket

- Clean the cylinder block with solvent
- Place the cylinder head gasket on the cylinder block surface with the Lot No. stamp facing upward

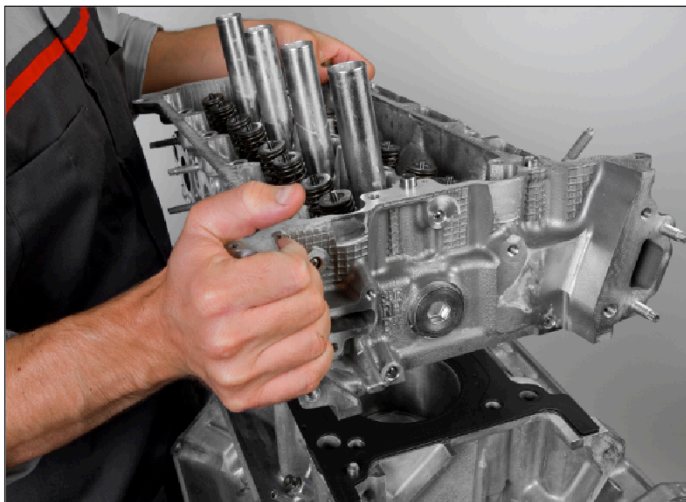


Cylinder Head Gasket

The cylinder head gasket is one of the most important gaskets in the engine. This gasket is under extreme pressure and temperatures. The cylinder head gasket has passages that allow oil and coolant to flow from the cylinder block to the cylinder head and back again which makes installing the correct gasket very important. When installing the cylinder head gasket be sure to reference the Lot No. stamp to determine the side and orientation of the gasket. DO NOT reuse cylinder head gaskets.

Cylinder Head Installation

- Make sure that no oil is on the mounting surface of the cylinder head.
- Gently place the cylinder head on the cylinder block so as not to damage the gasket.



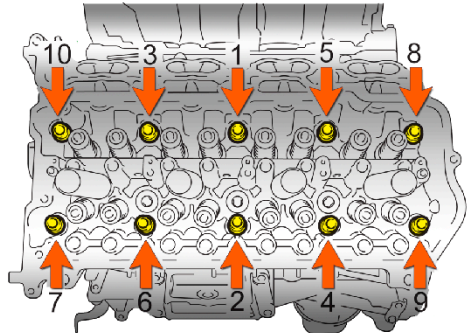
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Cylinder Head Installation

Be sure all surfaces are clean and dry before installing the cylinder head. Make sure the alignment pins are in place and gently place the cylinder head on the cylinder block without causing any damage to the gasket.

Torquing the Head Bolts

- Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts
- In the sequence given in the Repair Manual, install and uniformly tighten the cylinder head bolts with the plate washers in 3 progressive steps

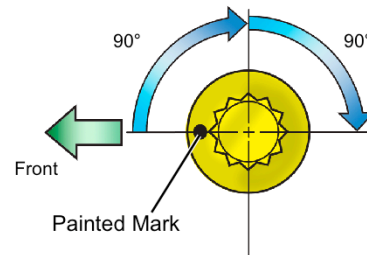


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Torque: 27ft·lbf

After torquing the cylinder head bolts:

- Mark each cylinder head bolt with paint as shown in the illustration.
- Tighten the cylinder head bolts another 90° in the original tightening sequence
- Tighten the cylinder head bolts again an additional 90° in the original tightening sequence

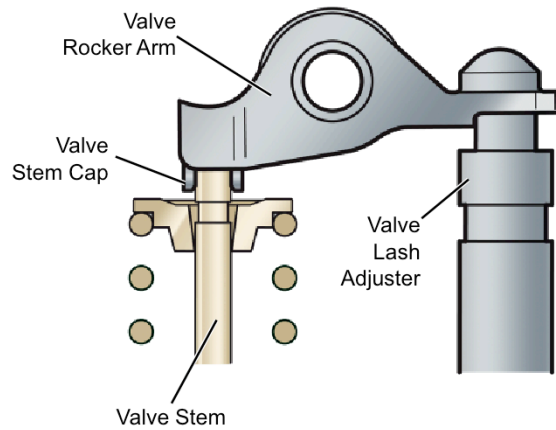


Torquing Head Bolts

DO NOT short cut this step. As mentioned in the beginning of this course, the cylinder head is the roof of the cylinder block and when in operation is under extreme pressure. The torque sequence is divided into three steps to ensure the cylinder head is tightened evenly. This ensures the cylinder head gasket is compressed evenly as well. The 90 degree turns in addition to the torque provides the stretch tension. This stretch or spring tension from the bolts keeps the bolts from working loose over time.

Installing Valvetrain Components

- Apply a light coat of engine oil to the valve stem caps and install them on the valve stems
- After inspecting the valve lash adjusters, install them in the cylinder head
- Apply engine oil to the lash adjuster tips and valve stem cap ends, then install the valve rocker arms



Note: Install the same parts in the same combination to their original locations.

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Installing Valvetrain Components

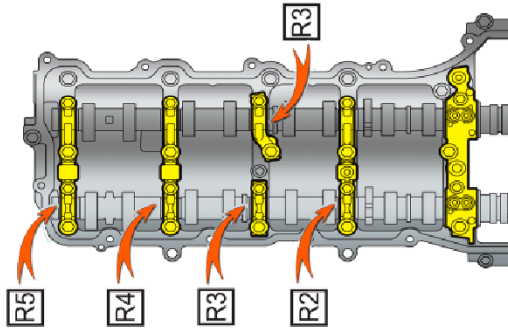
NOTE

Do not use force to install any valvetrain components. Valve lash adjusters should slide easily into the bore. Lightly coat with oil prior to installing.

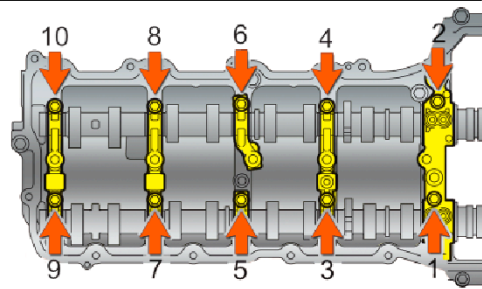
Use extreme caution when installing valve stem caps. They are extremely small and if dropped could fall into oil return holes in the cylinder head.

Installing Camshafts

- Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps
- Install the No. 1 and No. 2 camshafts to the camshaft housing
- Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions



- Temporarily install the bearing cap bolts in the order shown in the Repair Manual.



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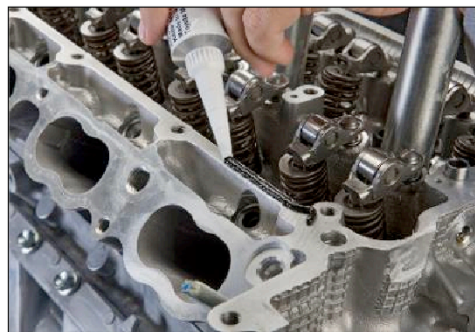
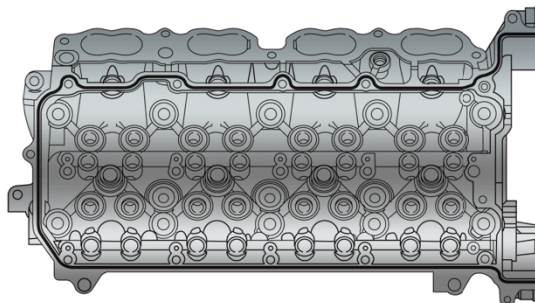
Installing Camshafts

Make sure the intake and exhaust camshafts are installed in the proper orientation. Bearing caps should be installed in the same places from which they were removed. Bearing caps have numbers as well as arrows to aid in installation.

Tighten the bearing cap bolts with the subassembly on the bench, but do not torque. Final torque is done when the subassembly is installed on the cylinder head.

Camshaft Housing Subassembly Sealing

- Remove any oil from the contact surface
- Apply seal packing in a continuous line as specified in the Repair Manual
- Install the camshaft housing within 3 minutes
- Tighten the bolts within 15 minutes after applying seal packing



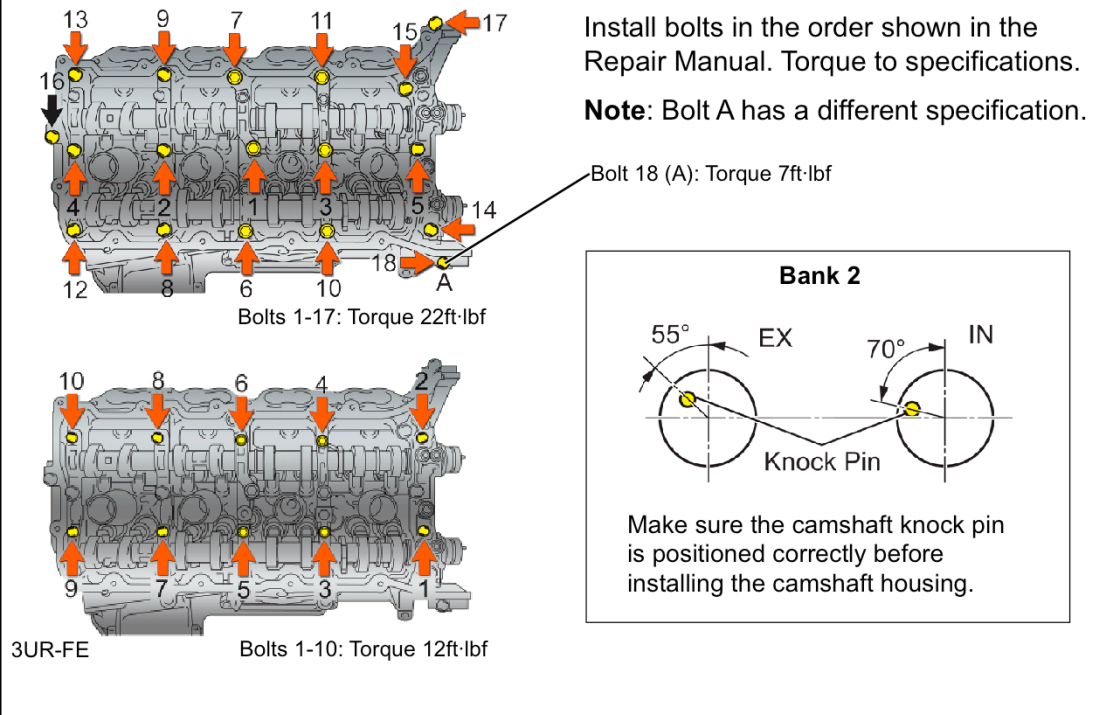
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Camshaft Housing Subassembly Sealing

The cylinder head as well as the camshaft housing subassembly has various oil passages which feed crucial oil to components. It is extremely important to only apply sealer in the areas referenced in the Repair Manual. If sealant is misapplied to areas near oil passages, they may become clogged, and possible component or engine failure may result.

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Camshaft Housing Subassembly Bolts



Camshaft Housing Subassembly Bolts

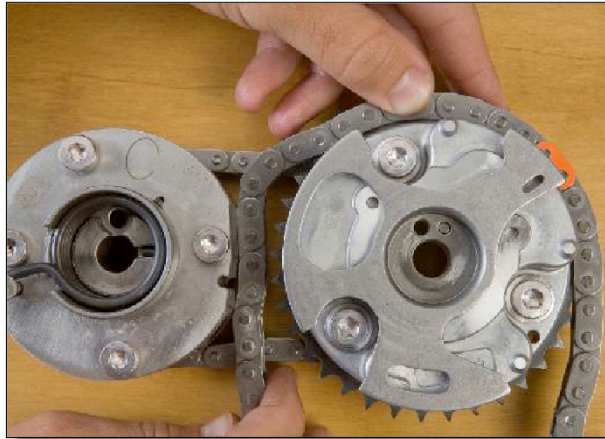
When installing the camshaft housing subassembly, it is extremely important to rotate the camshafts to the positions shown in the Repair Manual. This ensures the lobes on the camshaft are in the relaxed position when they contact the rocker arms. This also minimizes the pressure on the subassembly during the torque sequence.

As with the cylinder head, the camshaft housing must be torqued evenly to avoid warp or possible fracture to the camshafts or the housing itself. Refer to the Repair Manual for proper torque specification and sequence.

Engine Timing & Chain Installation - Overview

Overview of Procedure

- Set no. 1 cylinder to TDC / compression
- Install timing chain and timing gear
- Install timing cover



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Engine Timing & Chain Installation

Engines with timing chains use a slightly different concept for timing compared to earlier engines with timing belts.

Timing belt engines used marks on the cylinder head and block aligned with timing marks on the gears themselves. The gears were then held in place and the belt was installed.

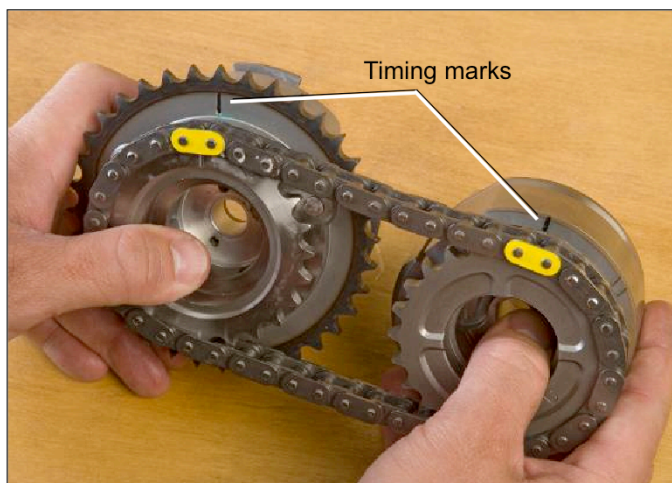
Timing chain engines typically do not align the gears to any particular marks on the cylinder block or heads, but instead focus mainly on the number of links between marks on the timing gears (crankshaft and camshaft gears). If the chain is set to the correct marks on the timing gears then installed on the crankshaft key and camshaft knock pins the engine will be in time regardless of the cylinder or camshaft positions.

CAUTION

Always use caution when rotating camshafts or crankshaft when they are not properly synchronized by the timing chain. Rotating the crankshaft or camshafts independently may cause valves to come in contact with pistons resulting in damage.

Installing No. 2 Timing Chain

- Align the No. 2 chain's mark plates (yellow) with the timing marks of the camshaft timing gear and camshaft timing exhaust gear
- Attach the No. 2 chain to the gears



Note: The crankshaft timing gear and camshaft exhaust gear will be installed to the camshaft with the No. 1 and No. 2 chains connected to the gears.

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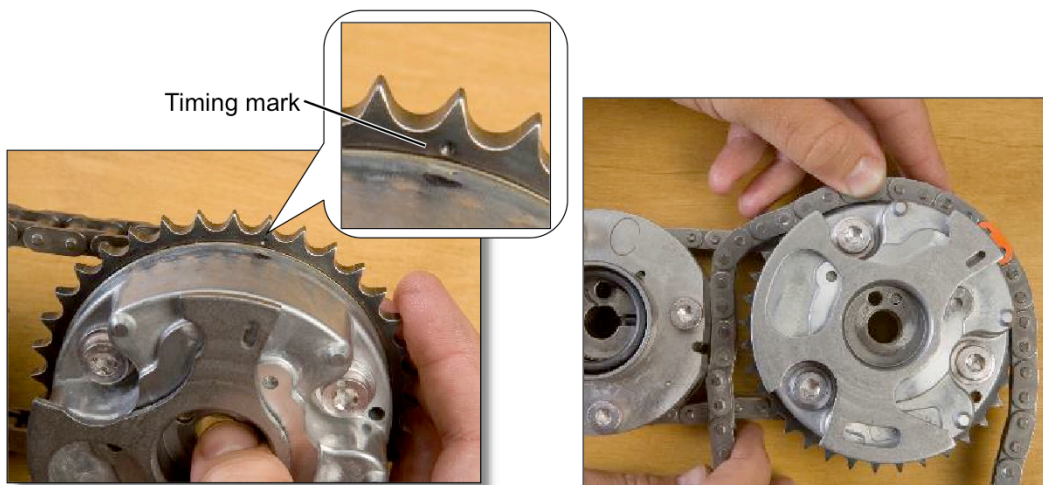
Installing No. 2 Timing Chain

The No. 2 chain times the intake camshaft to the exhaust camshaft. Some timing gear actuators are used on multiple engine lines and have multiple timing marks. The correct timing mark to use depends on the particular engine model, and may vary between cylinder banks. Be sure to use the proper timing marks illustrated in the Repair Manual, or verify the correct marks before disassembly.

Installing No. 1 Timing Chain

Install on Camshaft Gear

Align the No. 1 chain's orange mark plate with the camshaft timing gear's timing mark, and attach the chain to the gear.



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Installing No. 1 Timing Chain

The No. 1 chain (the primary timing chain) times the camshaft timing gears to the crankshaft. This chain may have two orange links or four orange links.

As with the No. 2 chains, it is highly advisable to note which timing marks are used before disassembly.

Installing No. 1 Timing Chain

Install on Crankshaft Gear

Align the No. 1 chain's second orange mark plate with the crankshaft timing gear's timing mark, and attach the chain to the gear.



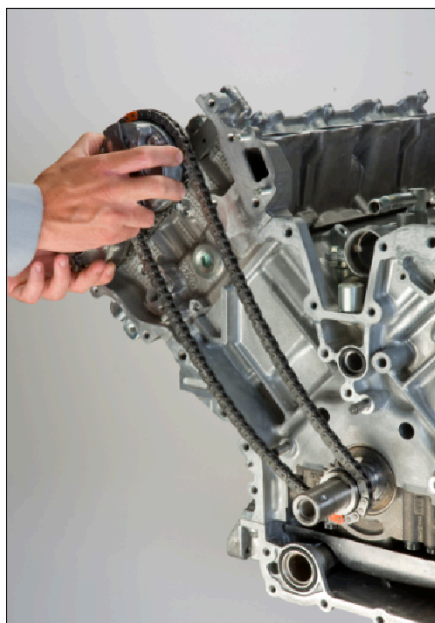
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Install Crankshaft Gear

Be sure to install the crankshaft gear with the alignment dot facing out. Do not lubricate the timing gear or apply any sealers. The timing gear should slide onto crankshaft easily. Do not force the timing gear onto the shaft. Be sure the crankshaft is clean and the crankshaft keys are properly in place.

Installing Timing Gears

- Install the crankshaft timing sprocket to the crankshaft
- Align and attach the knock pin of the No. 1 camshaft with the pin hole of the camshaft timing gear



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Installing Timing Gears

With the camshaft knock pins in the orientation stated in the Repair Manual, they will not always be in perfect alignment with both timing gears. Therefore, when placing both timing gears on the camshaft, first apply slight pressure to the intake timing gear while rotating it back and forth slightly until you feel the knock pin slide into the gear.

Installing Timing Gears

- Using the hexagonal portion of the No. 2 camshaft, align and attach the knock pin of the No. 2 camshaft with the pin hole of the camshaft timing exhaust gear



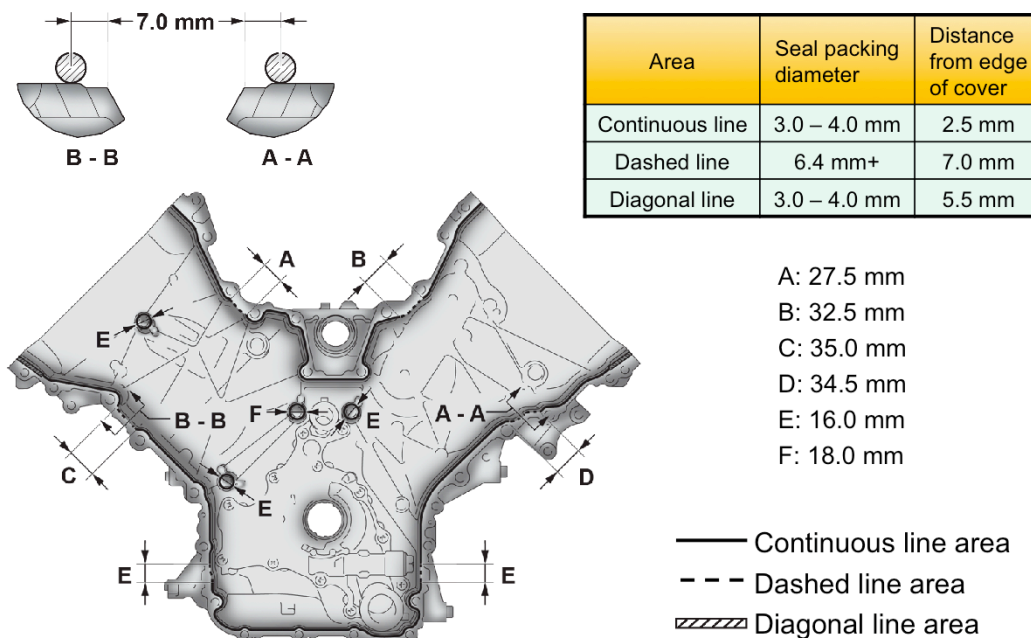
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Installing Timing Gears (cont'd)

After the intake timing gear is properly placed on its camshaft, rotate the exhaust camshaft back and forth with a wrench while applying slight pressure to the exhaust timing gear until the knock pin slides into place.

When tightening the timing gear bolts, DO NOT use air tools. Always support the camshaft with a wrench to keep the camshaft from turning, and refer to the Repair Manual for the proper torque specification.

Timing Chain Cover Seal Packing



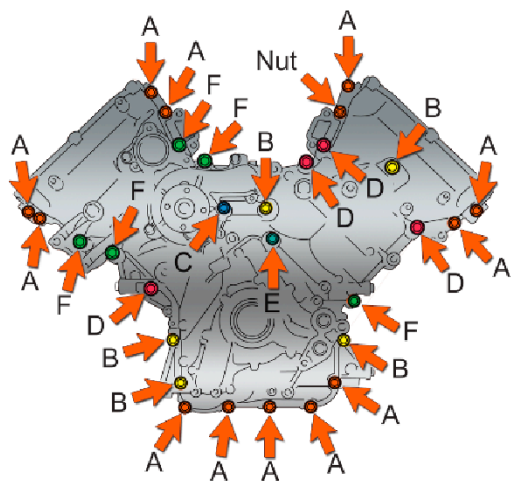
Timing Cover Installation

When installing the timing cover, be sure (as with all other mating parts) that the mating surfaces are clean and dry.

Timing covers house several integral components that may need new o-rings or additional gaskets.

It is advisable to do a trial fitting of the timing cover to the engine before applying sealer. This allows you to align the oil pump rotor spline and crankshaft without having to work around sealer.

Installing Timing Chain Cover



Note the different bolt sizes.

Item	Length	Thread Diameter	Qty
Bolt A	25 mm (0.984 in.)	8 mm (0.315 in.)	12
Bolt B	55 mm (2.17 in.)	8 mm (0.315 in.)	5
Bolt C	70 mm (2.76 in.)	8 mm (0.315 in.)	1
Bolt D	35 mm (1.38 in.)	10 mm (0.394 in.)	4
Bolt E	55 mm (2.17 in.)	10 mm (0.394 in.)	1
Bolt F	80 mm (3.15 in.)	10 mm (0.394 in.)	4

- Make sure that there is no oil on the bolt threads
- Follow the tightening sequence specified in the Repair Manual
- After the installation, if the seal packing has seeped out at the areas labeled A in the illustration, wipe it off.

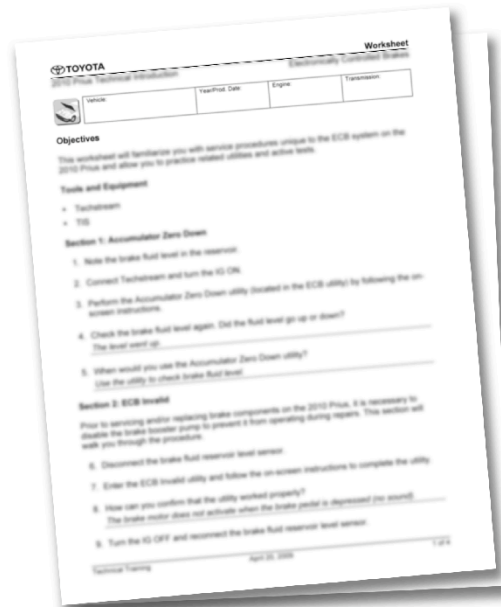
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Bolt Chart The Repair Manual includes a bolt placement chart that is extremely helpful for making sure bolts are installed in their correct locations.

Worksheet

Engine Reassembly

In this worksheet you will use Repair Manual procedures to reassemble the engine unit.



Use this space to write any questions you may have for your instructor.

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