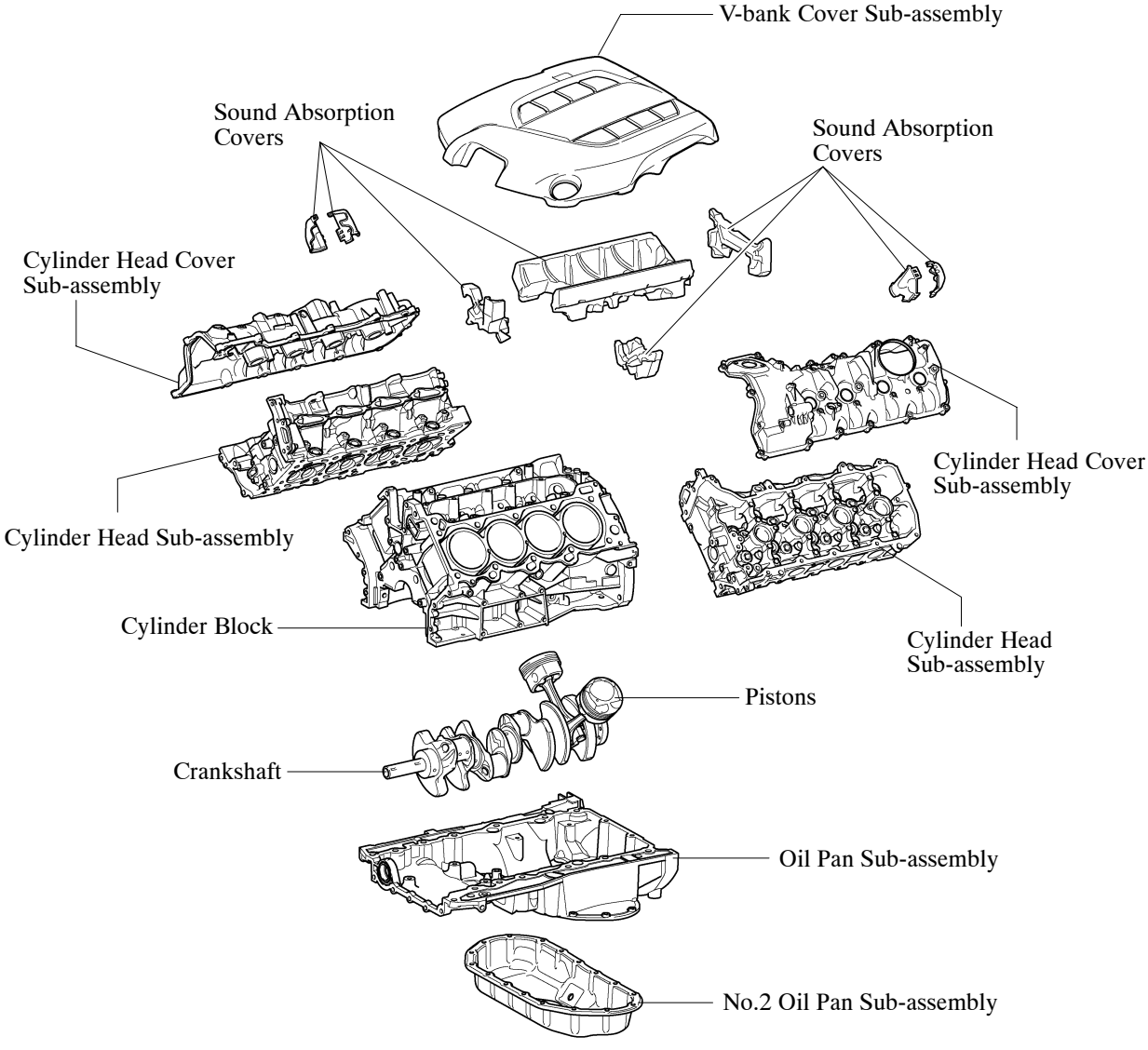
■ENGINE PROPER

1. General

The 2UR-GSE engine achieves weight reduction and low noise through the use of the following items.

Weight Reduction	Aluminum Cylinder Head Covers	
	Aluminum Cylinder Heads	
	Aluminum Cylinder Block	
	Aluminum oil pan sub-assembly with Integrated Stiffeners	
Noise Reduction	V-bank Cover with Sound Insulation Material	
	Sound Absorption Covers	Five locations inside V-bank of cylinder block
		Between injector drivers (EDUs) and intake manifold
		High-pressure Fuel Pumps



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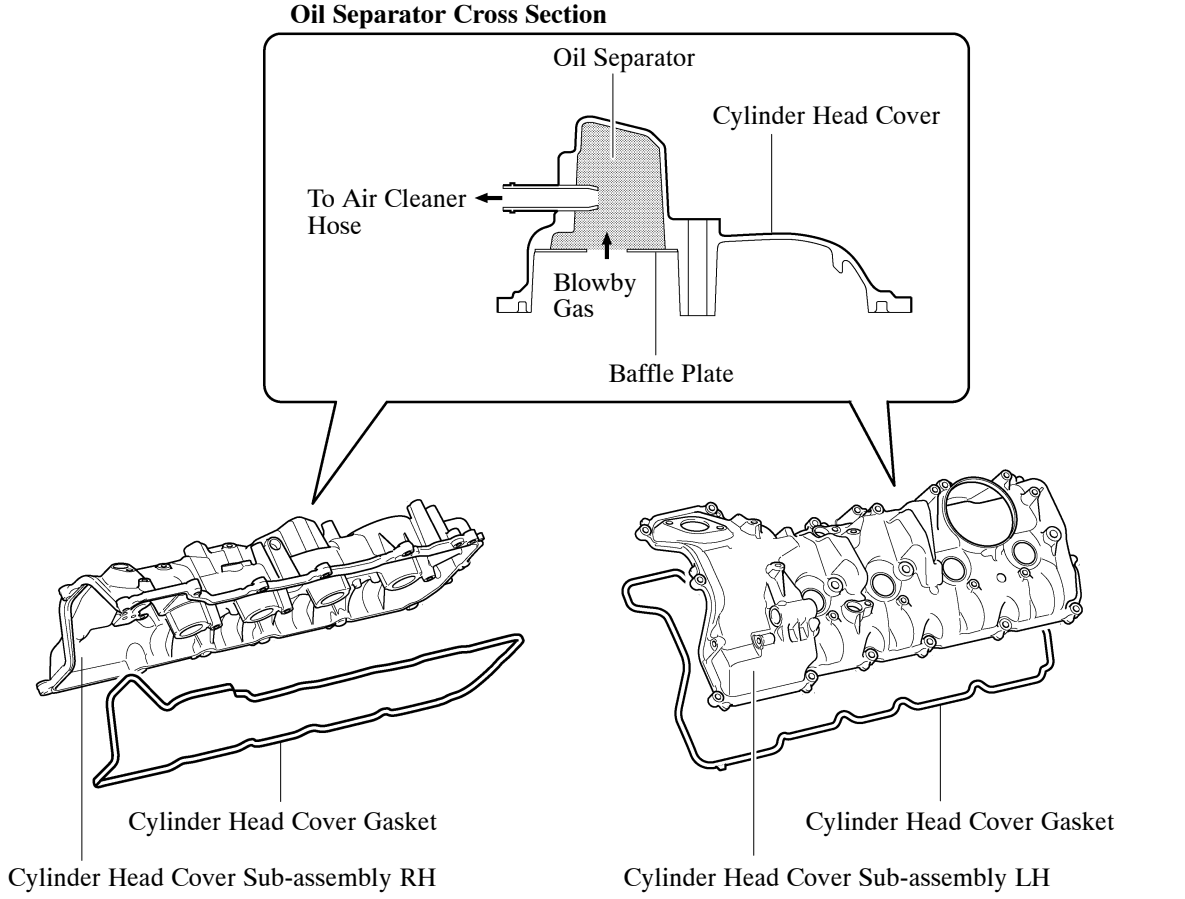
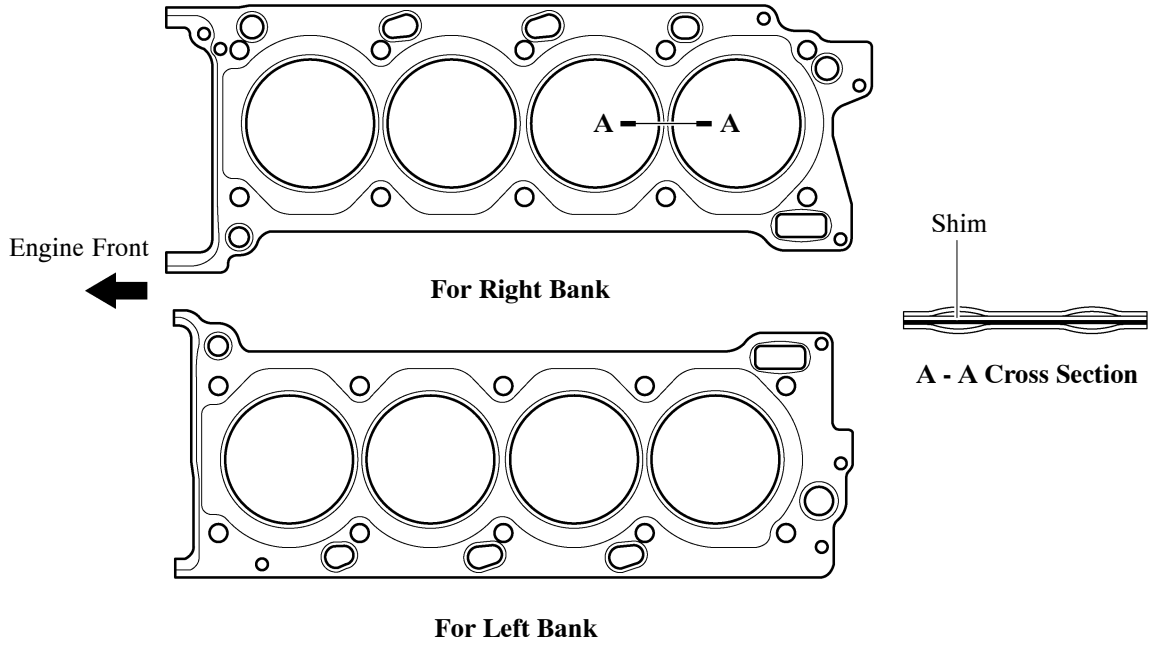
2. Cylinder Head Cover

- Lightweight aluminum alloy diecast cylinder head cover sub-assemblies are used.
- A compact oil separator is used to achieve a compact cylinder head cover sub-assembly.



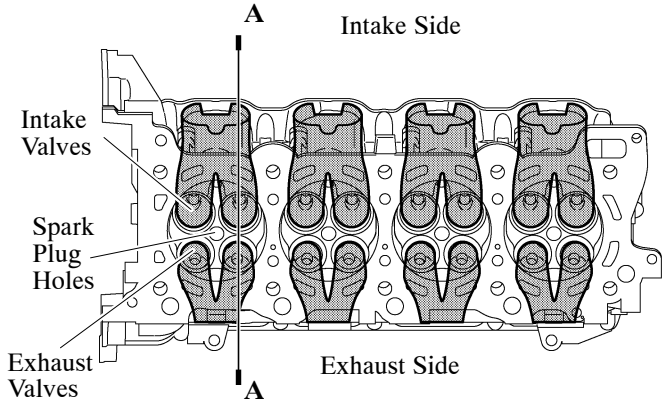
3. Cylinder Head Gasket

- Cylinder head gaskets with a three-layer metal construction are used. A shim is used around each cylinder bore to help enhance sealing performance and durability.
- The surface is coated with highly heat resistant fluoro rubber to support high power output.

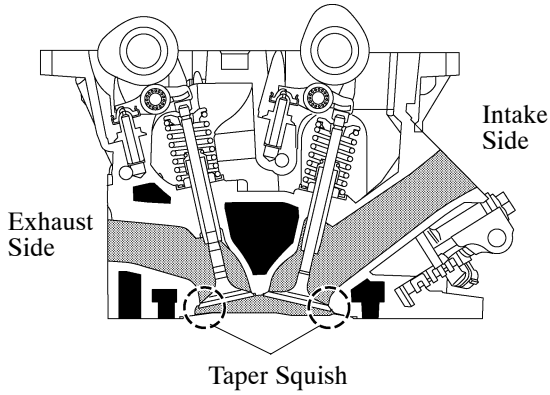


4. Cylinder Head

- The camshaft journal part has been integrated with the cylinder head, and high flow ports have been adopted, achieving high power output.
- Due to the optimization of the port shape, intake pulsation efficiency has been improved, high pressure loss areas have been minimized, and intake air volume has been increased, improving engine output.
- The cylinder head sub-assembly, which is made of aluminum, contains a pentroof-type combustion chamber. The spark plug is located in the center of the combustion chamber in order to improve the engine's anti-knocking performance.
- A taper squish combustion chamber is used to improve anti-knocking performance and intake efficiency. In addition, engine performance and fuel economy have been improved.
- By maximizing the valve diameter, intake air volume has been increased, improving output.
- The port configuration is an efficient cross-flow type in which the intake ports face the inside of the V-bank and the exhaust ports face the outside.
- A siamese type intake port is used. The port diameter gradually decreases toward the combustion chamber to optimize the airflow speed and intake pulsation.



View from Bottom Side



A - A Cross Section

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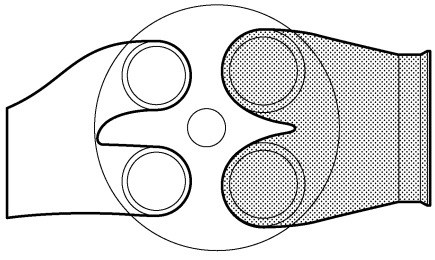
— REFERENCE —

Siamese Type



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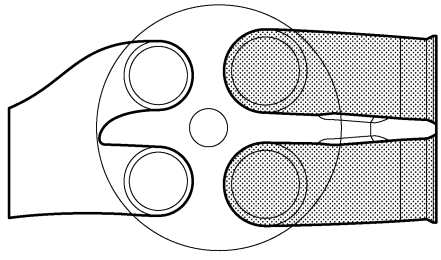
Independent Type



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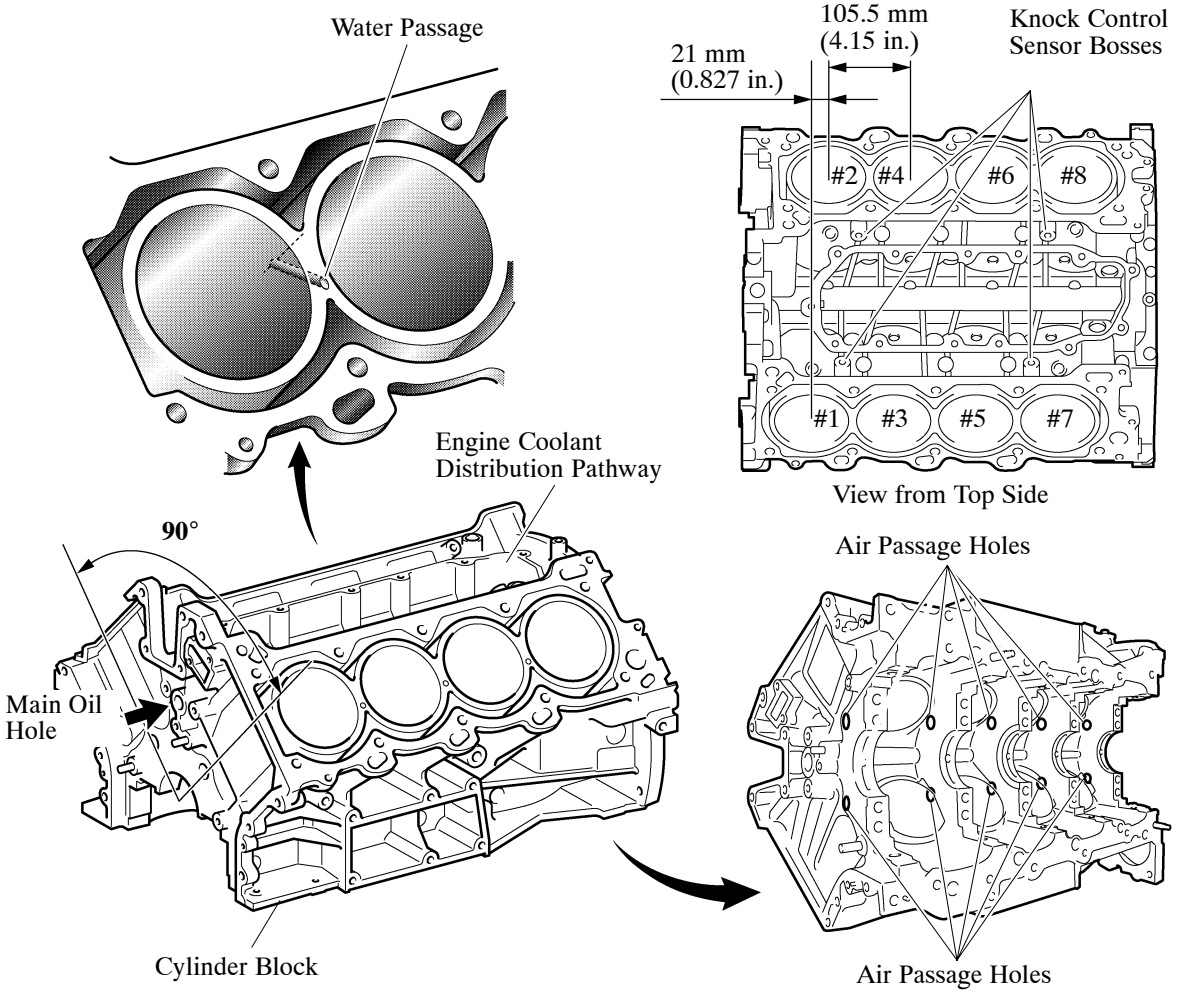
5. Cylinder Block

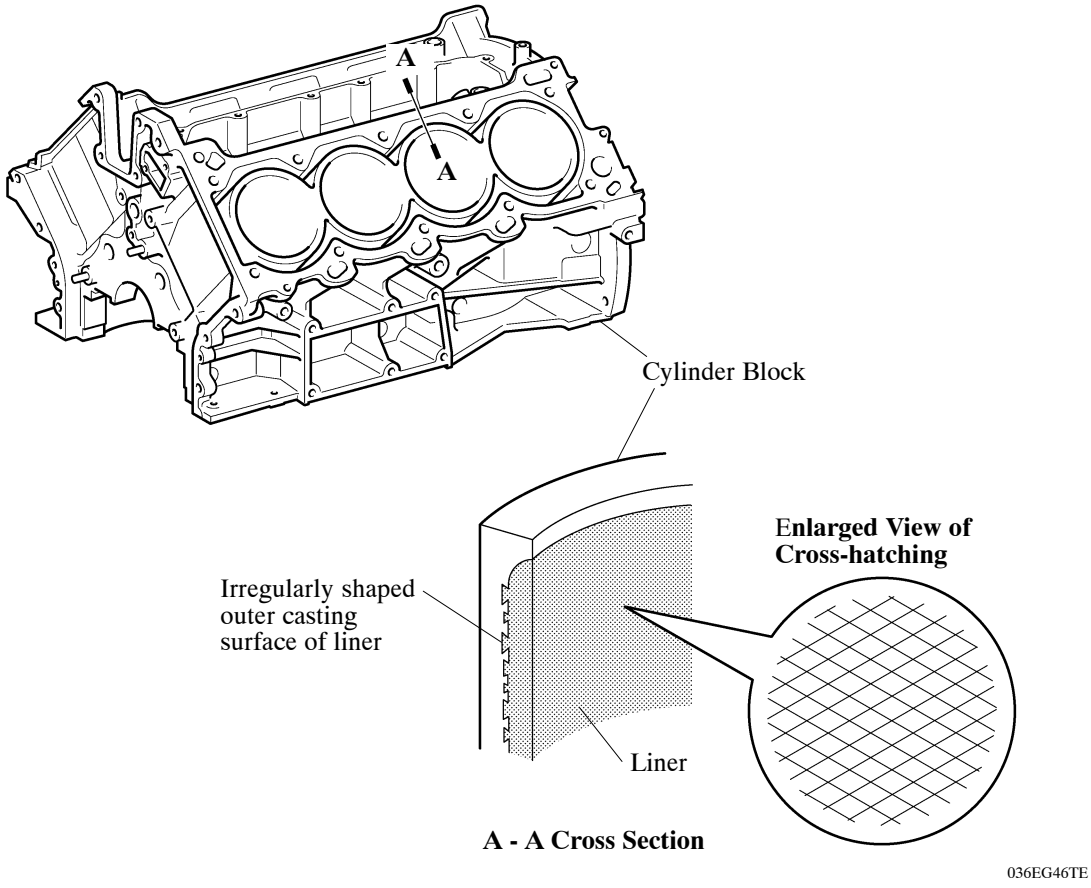
General

- Lightweight aluminum alloy is used.
- The cylinder block has a bank angle of 90°, a bank offset of 21 mm (0.827 in.) and a bore pitch of 105.5 mm (4.15 in.), resulting in a compact block (length and width) for its displacement.
- Spiny-type liners are used.
- An engine coolant distribution pathway is provided between the left and right banks. The engine coolant sent by the water pump passes through the engine coolant distribution pathway and flows to the cylinder heads and block water jackets of both banks. The engine coolant distribution pathway also cools the engine oil in the main oil hole located directly below the pathway.
- Water passages have been provided between the cylinder bores. By allowing the engine coolant to flow between the cylinder bores, this enables the temperature of the cylinder walls to be kept uniform.
- Plastic cylinder block water jacket spacers are inserted in the water jacket. They control the flow of the engine coolant in order to attain a uniform temperature around the combustion chambers.
- Installation bosses of the four knock sensors are located on the inner side of left and right banks. A rib is also adopted between the left and right banks to enhance the accuracy of the knock sensors.
- Air passage holes are provided in the crankshaft bearing area of the cylinder block. As a result, the air at the bottom of the cylinder flows smoother, and pumping losses (pumping losses include back pressure at the bottom of the piston generated by the reciprocating movement of the pistons) is reduced to improve engine output.



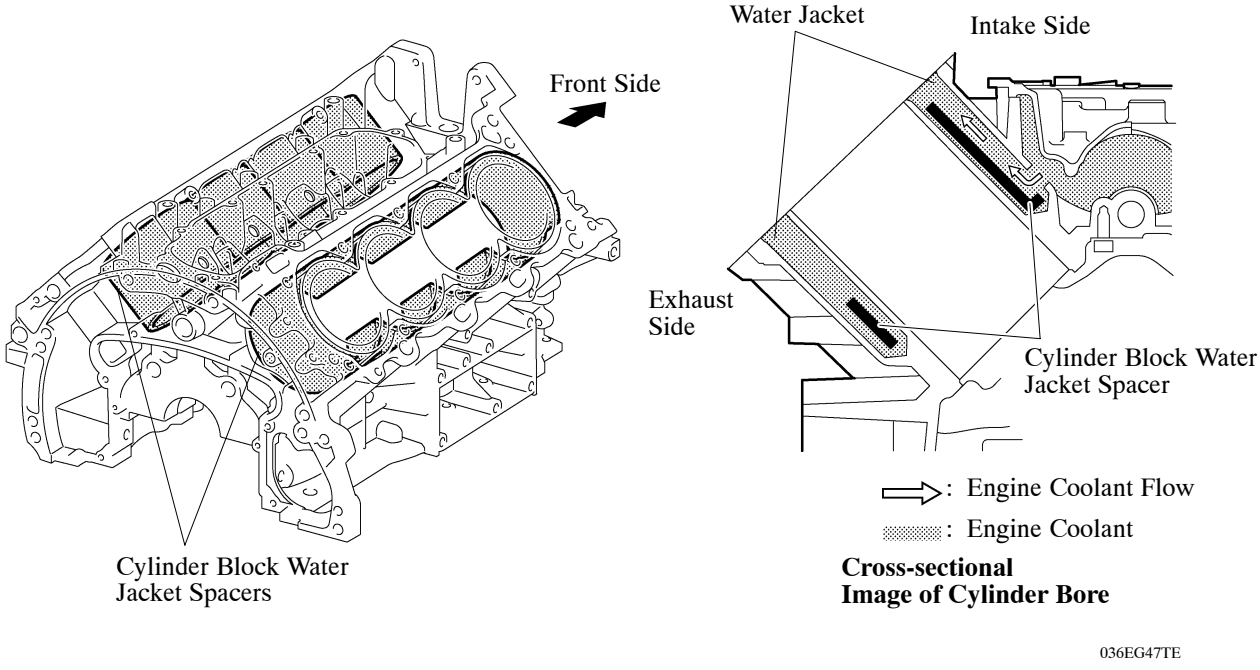
Spiny-type Liner

- The liners are the spiny-type which have been manufactured so that their casting exteriors form large irregular surfaces in order to enhance the adhesion between the liners and the aluminum cylinder block. The enhanced adhesion helps heat dissipation, resulting in a lower overall temperature and heat deformation of the cylinder bores.
- The shape of the cross-hatching of the liner surface has been optimized to improve oil retention performance, resulting in reduced friction.



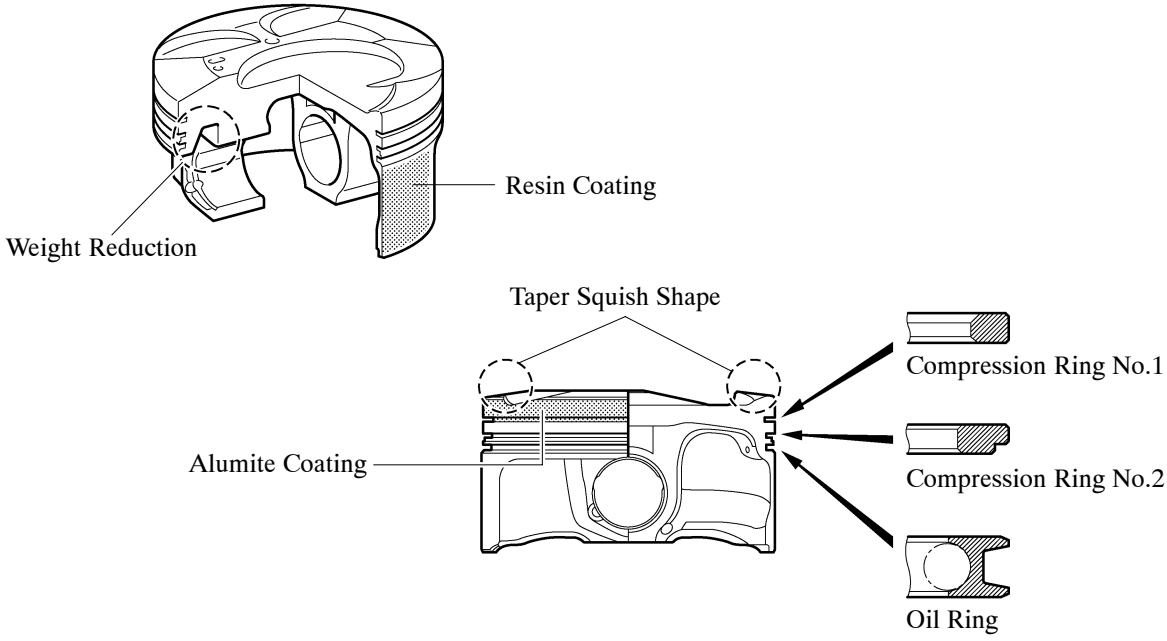
Cylinder Block Water Jacket Spacer

The temperature of the intake side of a cylinder bore tends to be lower. For this reason, a wide cylinder block water jacket spacer covers the cylinder bores in order to suppress the flow of the engine coolant and prevent excessive cooling. On the other hand, the temperature of the exhaust side of a cylinder bore tends to be higher. A cylinder block water jacket spacer covers the lower area of the cylinder bores in order to direct the engine coolant to the upper area of the cylinder bores where the temperature is higher. This makes the temperature around the cylinder bores more uniform. As a result, the viscosity of the engine oil (which lubricates the area between the wall surface of the cylinder bore and the piston) decreases, thus reducing friction between the cylinder bore and the piston.



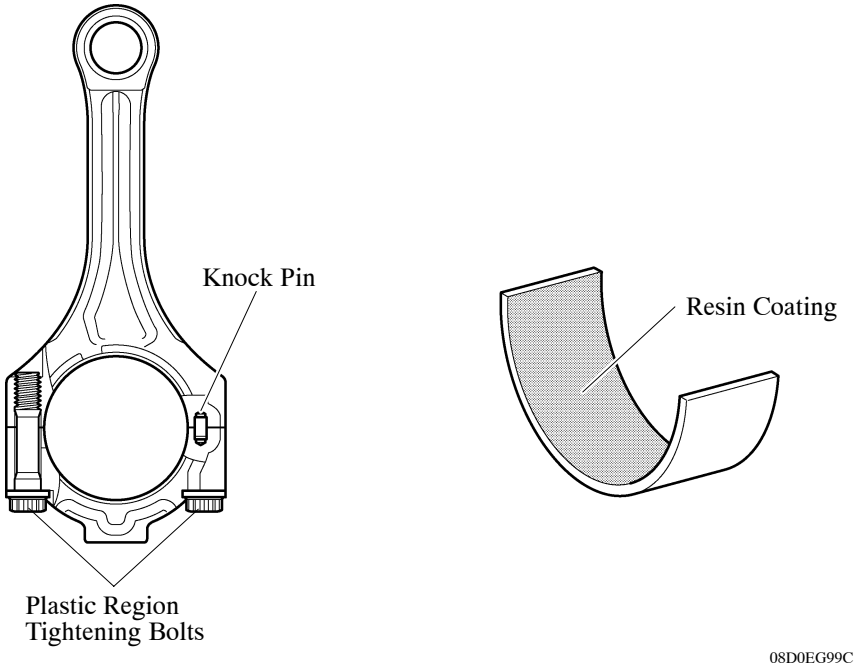
6. Piston

- The pistons are made of aluminum alloy.
- A compact combustion chamber is provided on top of the piston to realize stable combustion. Together with the pentroof type combustion chamber of the cylinder head, this realizes a high compression ratio, resulting in both high performance and excellent fuel economy.
- In order to reduce weight, cast holes have been provided on the bottom of the piston head near the pin bosses as shown in the illustration below.
- The piston skirt is coated with resin to reduce friction losses.
- The groove of the top ring is coated with alumite (anodic oxide coating) to ensure abrasion resistance.
- By increasing the machining precision of the cylinder bore diameter in the block, only one size piston is required.



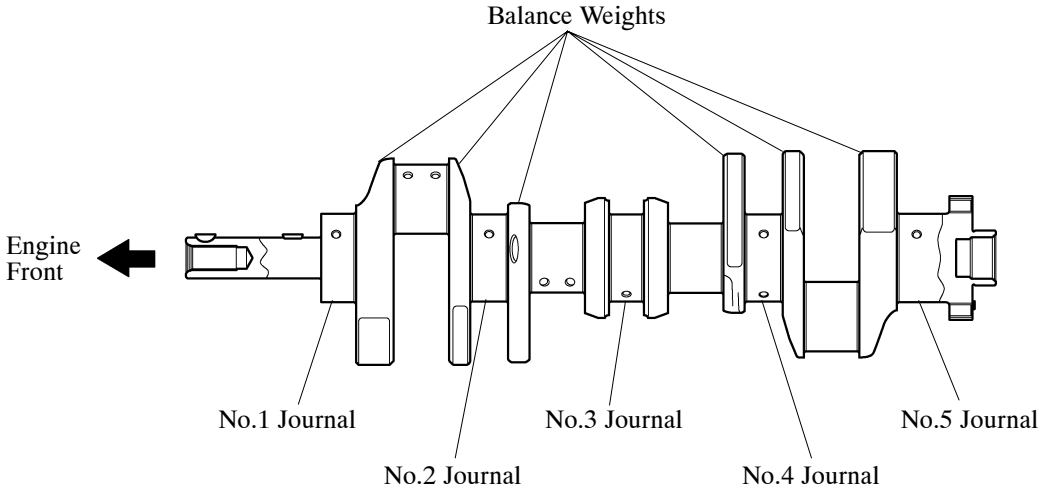
7. Connecting Rod and Connecting Rod Bearing

- Connecting rods that have been forged for high strength are used for weight reduction.
- Knock pins are used at the mating surfaces of the bearing caps of the connecting rod to minimize the shifting of the bearing caps during assembly.
- Nutless-type plastic region tightening bolts are used on the connecting rods for a lighter design.
- Resin coated aluminum bearings are used for the connecting rod bearings. The connecting rod bearings are reduced in width to reduce friction.



8. Crankshaft

- A crankshaft made of forged steel, which excels in rigidity and wear resistance, is used.
- The crankshaft has 5 main bearing journals and 6 balance weights.



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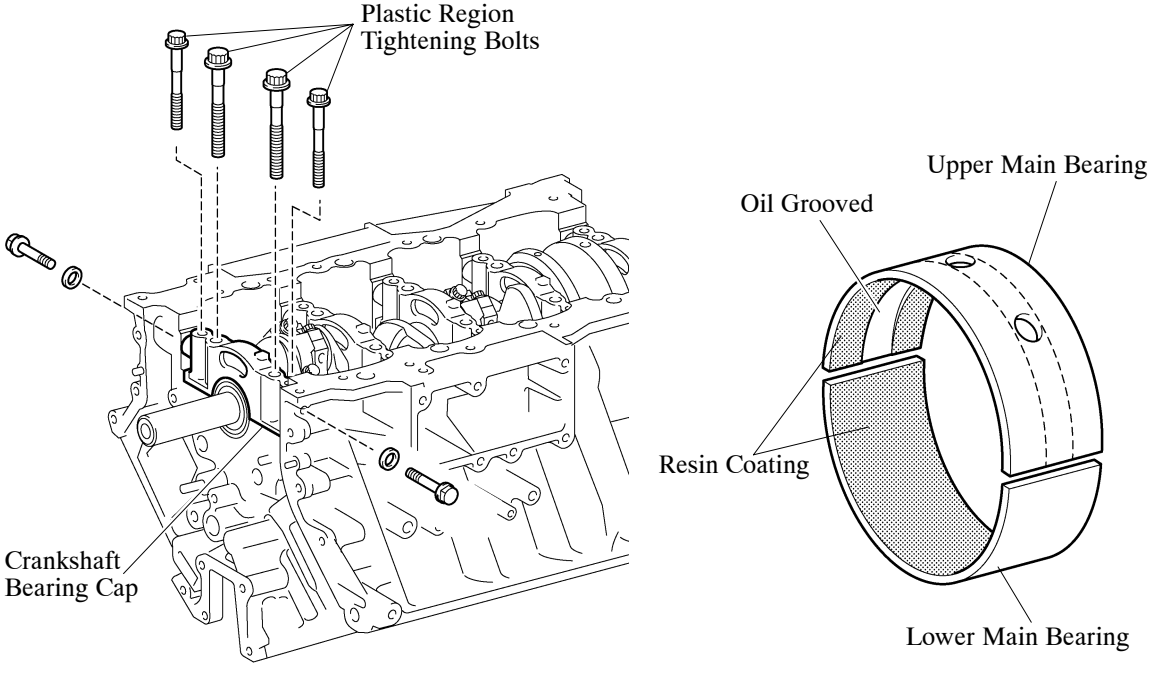
9. Crankshaft Bearing and Crankshaft Bearing Cap

- The crankshaft main bearings are made of aluminum alloy.
- The crankshaft bearings are reduced in width to reduce friction. The bearing lining surface is coated with resin to improve wear and seizure resistance.
- The upper main bearings have an oil groove around the inside circumference.
- The crankshaft bearing caps use 4 plastic-region tightening bolts of different sizes for the inner and outer sides to secure the journals. This makes the crankshaft bearing caps more compact and lightweight. In addition, each cap is tightened laterally to improve its reliability.



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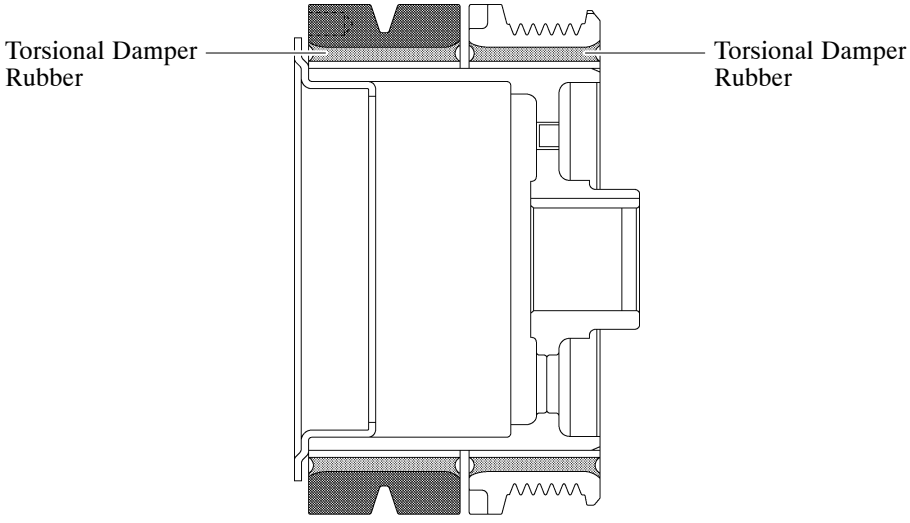
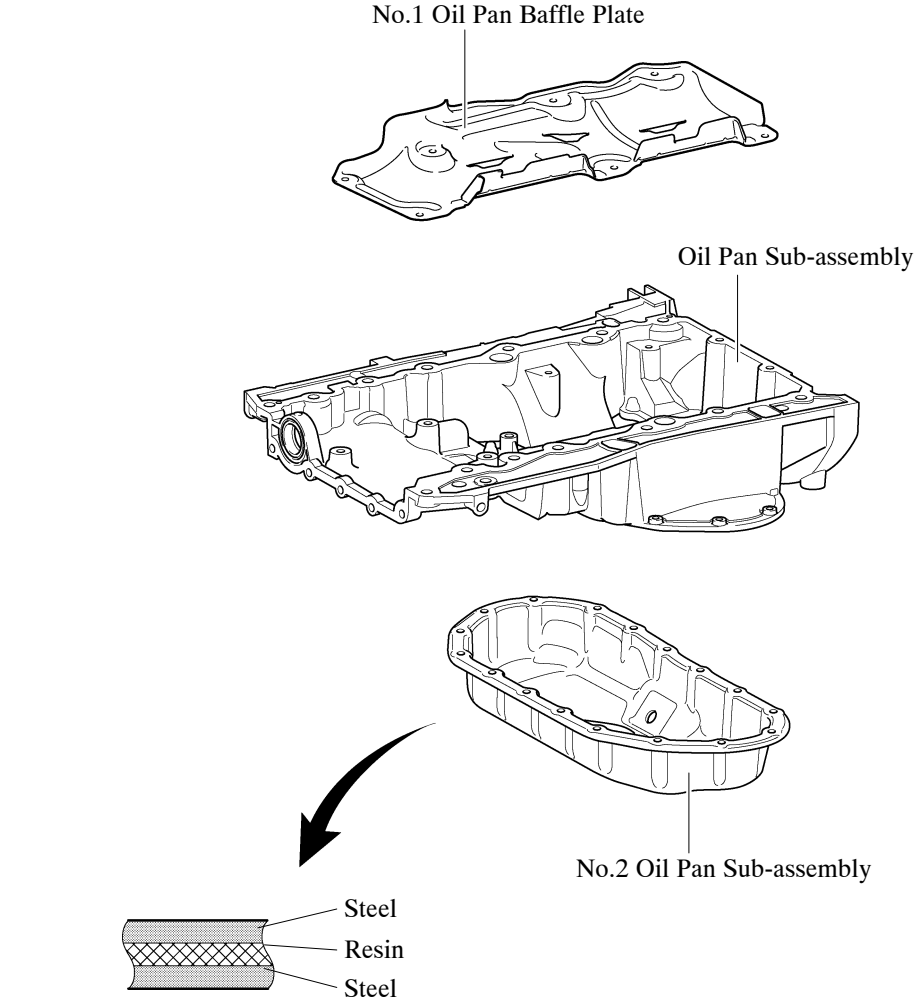
10. Crankshaft Pulley

A torsional damper rubber is adopted for the crankshaft pulley, reducing vibration and noise in the area of the crankshaft.



11. Oil Pan

- The shape of the No.1 oil pan baffle plate has been optimized to ensure the proper space between the crankshaft and the engine oil surface. This prevents the crankshaft from beating the engine oil surface, which prevents the engine oil from foaming. As a result, it reduces friction and improves lubrication performance.
- To improve quietness, No.2 oil pan sub-assembly is made up of vibration damping sheet steel which is made up of a resin layer sandwiched in between two sheets of steel.
- The oil pan sub-assembly is made of aluminum alloy.
- The oil pan sub-assembly is secured to the cylinder block and the transmission housing to increase rigidity.



No.2 Oil Pan Sub-assembly Cross Section

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