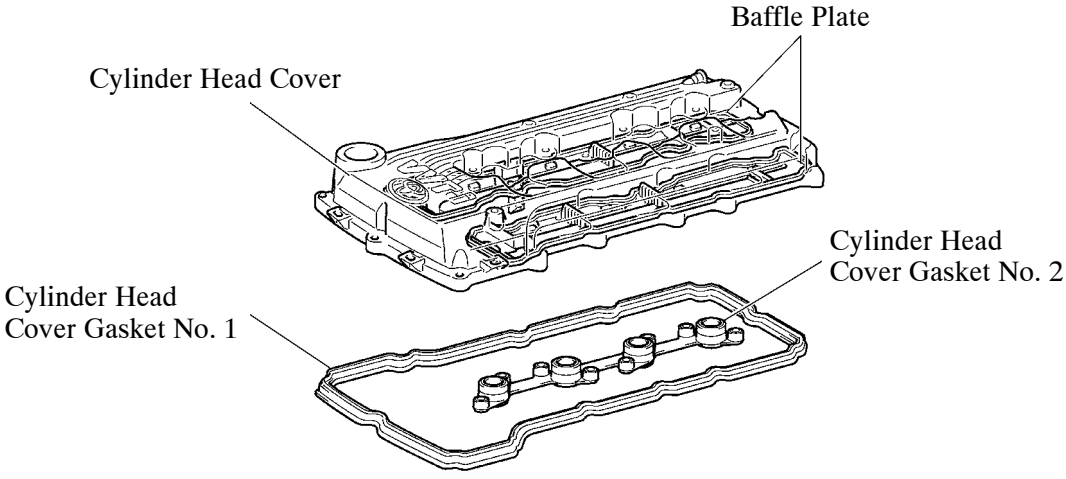
4. Engine Proper

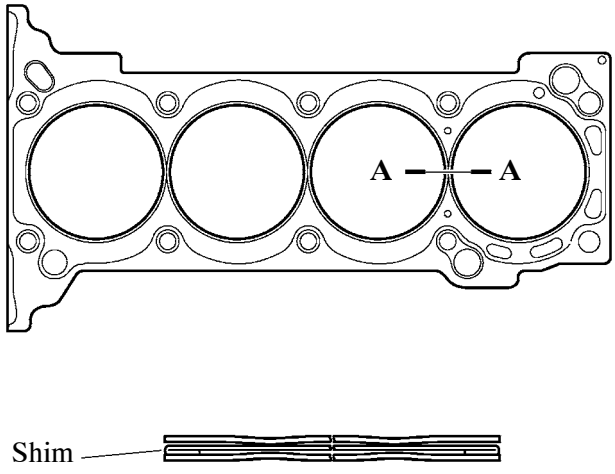
Cylinder Head Cover

- The cylinder head cover is made of plastic to reduce weight and noise.
- Acrylic rubber, which excels in heat resistance and reliability, is used for the cylinder head cover gasket.
- Baffle plates made of plastic are provided inside the cylinder head cover to reduce the consumption of engine oil through blow-by gas. The baffle plates are welded onto the cylinder head cover, and cannot be removed.



Cylinder Head Gasket

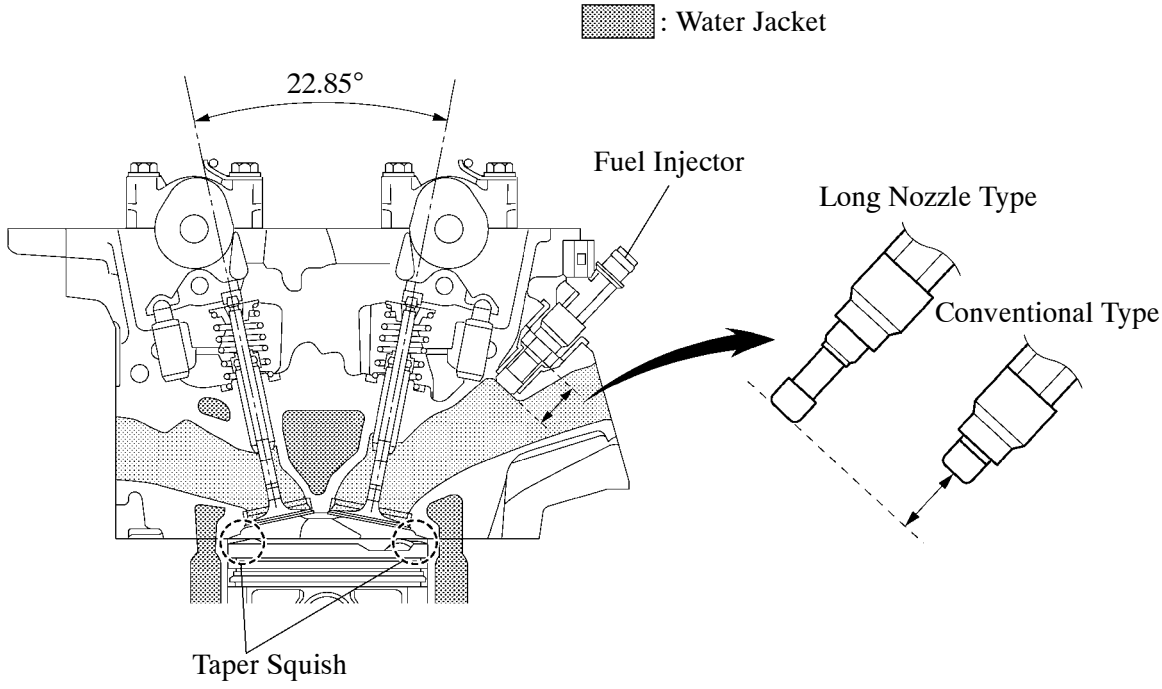
- A steel-laminate type cylinder head gasket is used.
- A shim is provided around the cylinder bore to increase the sealing surface, thus improving the sealing performance and durability.



A – A Cross Section

Cylinder Head

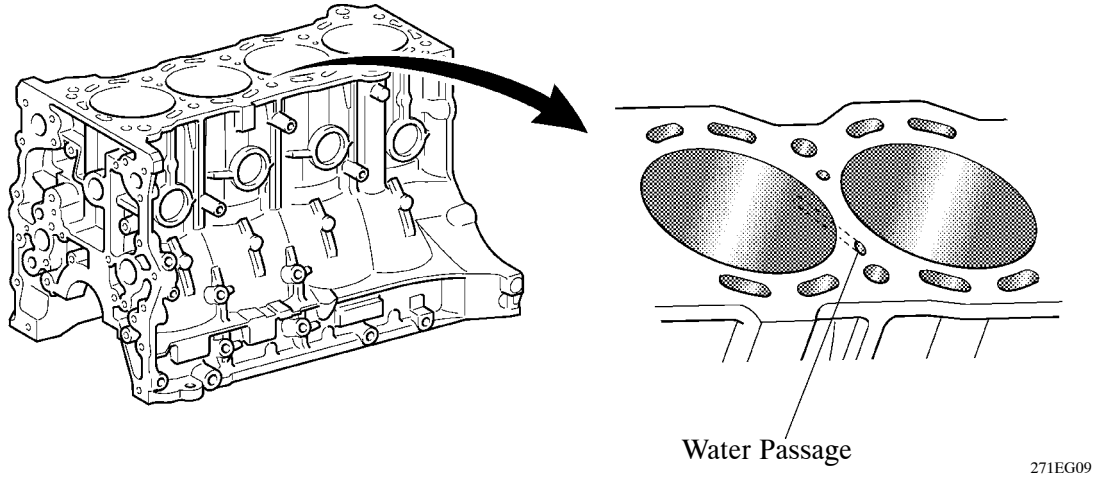
- The cylinder head, which is made of aluminum alloy, contains a pentroof-type combustion chamber. The spark plug has been located in the center of the combustion chamber in order to improve the engine's anti-knocking performance.
- The angle of the intake and exhaust valves is narrowed and set at 22.85° to permit a compact cylinder head.
- A cross-flow intake and exhaust layout is used to improve intake and exhaust efficiency.
- 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.
- Plastic region tightening bolts are used for the cylinder head.
- Long nozzle type fuel injectors are installed in the cylinder head to reduce the distance from the fuel injector to intake valve, thus it prevents the fuel from adhering to the intake port walls, and reduces exhaust emissions.
- The routing of the water jacket in the cylinder head is optimized to achieve high cooling performance.



00MEG20Y

Cylinder Block

- The cylinder block is made of cast iron, with the rib shape of each part optimized to increase rigidity while reducing vibration and noise.
- Water passages have been provided between the cylinder bores. By allowing the engine coolant to flow between the cylinder bores, this construction enables the temperature of the cylinder walls to be kept uniform.



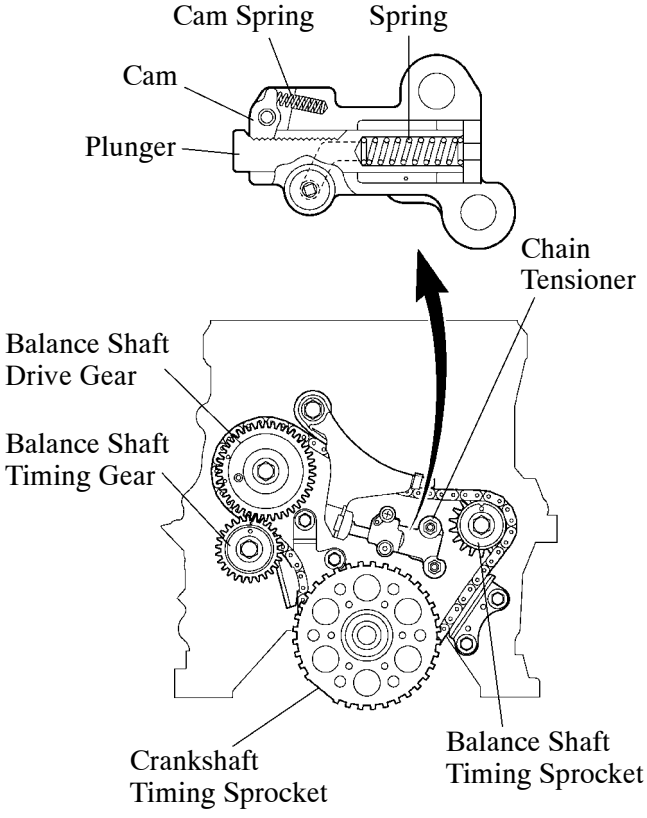
Balance Shaft

1) General

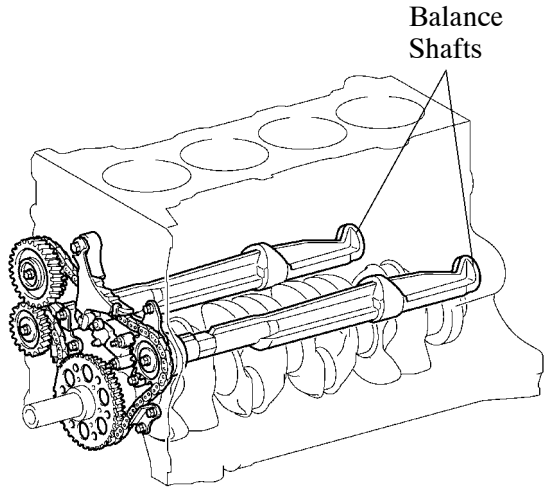
For in-line 4 cylinder engines, the main cause of vibration is imbalanced inertial force of reciprocating parts such as the pistons and connecting rods. The 2TR-FE engine vibration has been reduced by using 2 balance shafts to cancel the imbalanced inertial force, thereby reducing engine noise (booming noise).

2) Construction

- 2 balance shafts are built into the cylinder block. Using a chain, crankshaft timing sprocket, balance shaft timing sprocket, balance shaft drive gear and balance shaft timing gear, both balance shafts rotate at twice the speed of the crankshaft with each balance shaft rotating in the opposite direction of the other.
- The chain tensioner uses a spring and oil pressure to maintain proper chain tension at all times. A ratchet type non-return mechanism is also included.



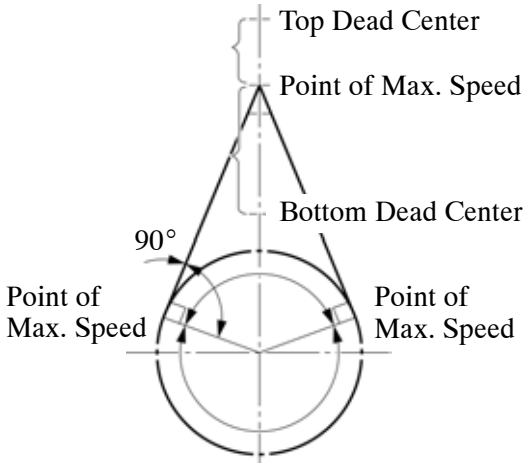
271EG10



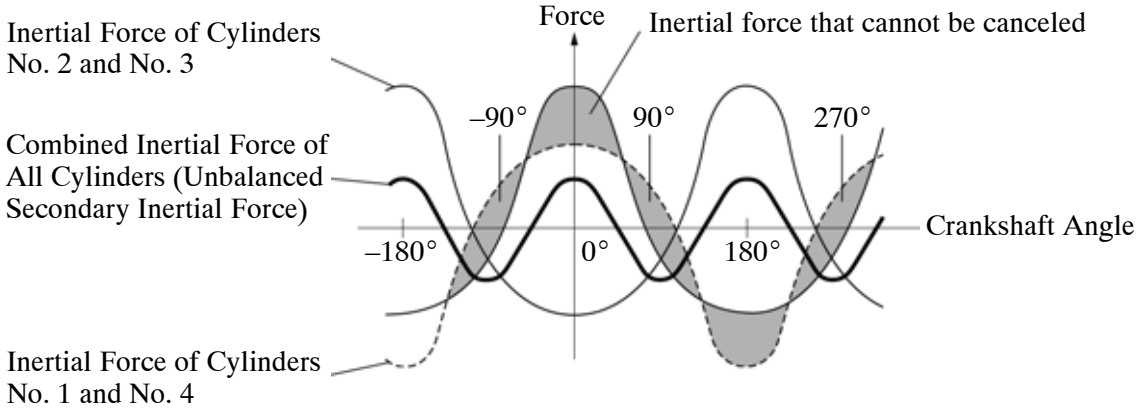
271EG11

3) Operation

In the in-line 4-cylinder engine, the crankshaft angle for cylinders No. 1 and No. 4 are exactly at the opposite (180°) position of cylinders No. 2 and No. 3. Therefore, the inertial force of the pistons and the connecting rods of the former 2 cylinders and of the latter 2 cylinders almost cancel each other. However, because the position at which the piston reaches its maximum speed is located toward the top dead center from the center of the stroke, the upward inertial force is greater than the downward inertial force. This unbalanced secondary inertial force is generated twice for each rotation of the crankshaft.



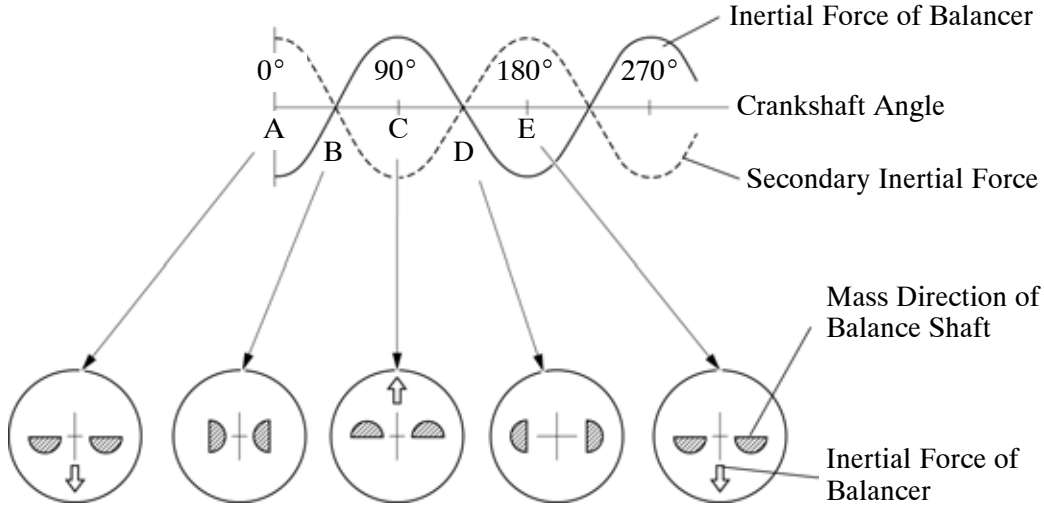
288EG104C



288EG105C

Inertial Force Generated by In-line 4 Cylinders

To cancel the unbalanced secondary inertial force, 2 balance shafts are rotated twice for each rotation of the crankshaft and generate inertial force in the opposite direction. Also, in order to cancel the inertial force generated by the balance shaft itself, the balance shaft actually consists of 2 shafts rotating in opposite directions.

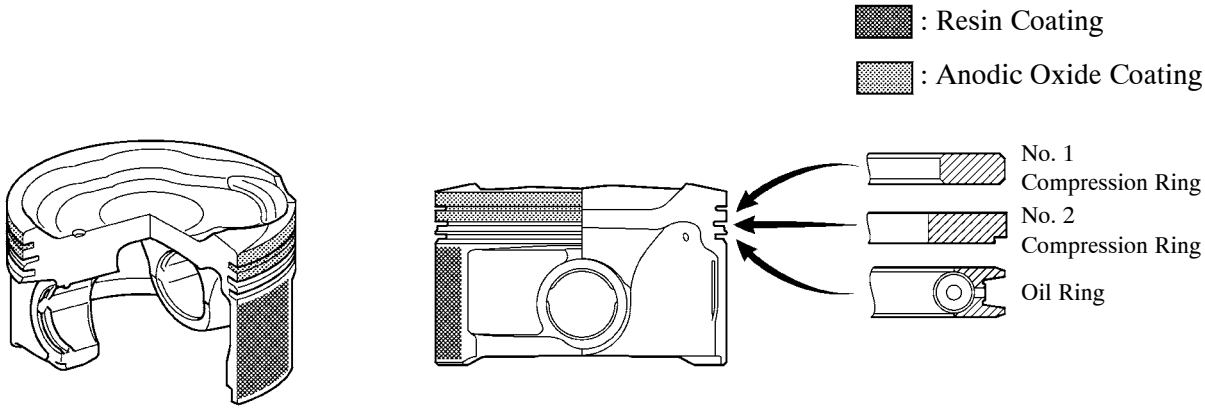


288EG106C

Mass Direction of Balance Shaft at Crankshaft Angle

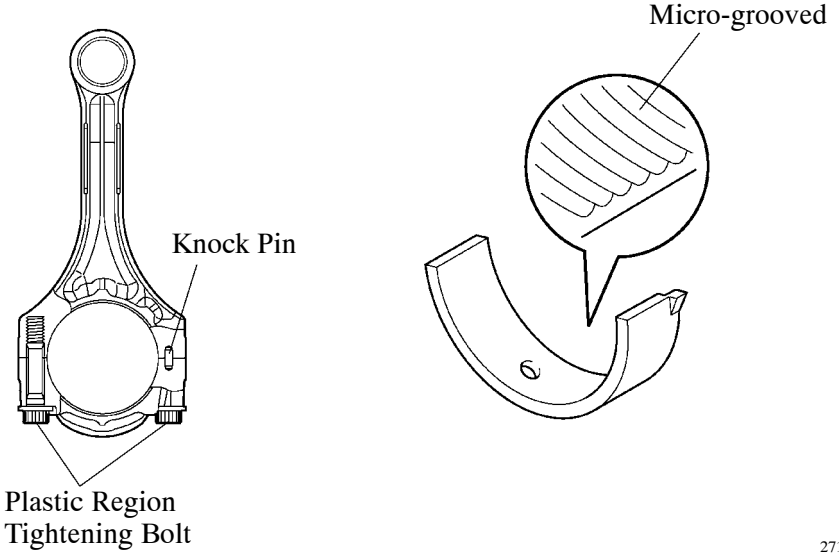
Piston

- The piston is made of aluminum alloy.
- The piston head portion uses a taper squish shape to accomplish fuel combustion efficiency.
- The piston skirt has been coated with resin to reduce the friction loss.
- The groove of the top ring has been coated with anodic oxide to improve wear resistance and rust resistance.
- On the leaded gasoline model, a PVD (Physical Vapor Deposition) coating has been applied on the surface of the No. 1 compression ring, and the surface of the No. 2 compression ring has been chrome-plated to improve their wear resistance.



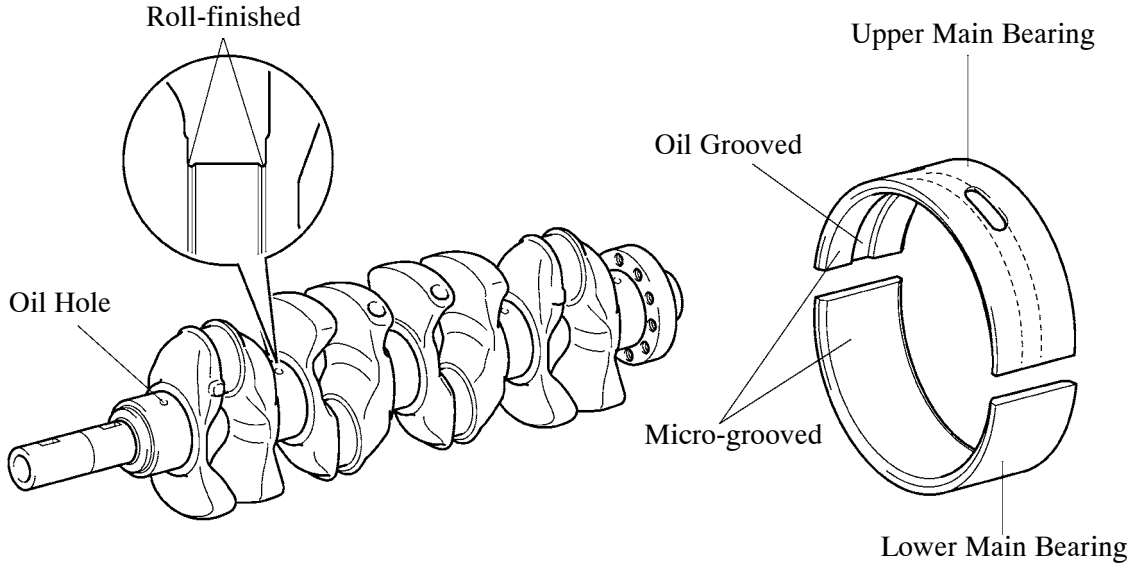
Connecting Rod and Connecting Rod Bearing

- 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.
- Plastic region tightening bolts are used.
- The lining surface of the connecting rod bearing has been micro-grooved to realize an optimal amount of oil clearance. As a result, cold-engine cranking performance has been improved and engine vibrations have been reduced.



Crankshaft and Crankshaft Bearing

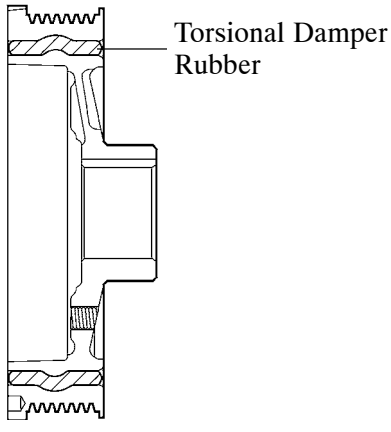
- The crankshaft has 5 journals and 8 balance weights.
- All pins and journal fillets are roll-finished to maintain adequate strength.
- The crankshaft bearing is made of aluminum alloy.
- The crankshaft bearing caps are tightened by 2 plastic-region tightening bolts for each journal.
- Similar to the connecting rod bearings, the lining surface of the crankshaft bearings has been micro-grooved to realize an optimal amount of oil clearance. As a result, cold-engine cranking performance has been improved and engine vibrations have been reduced.
- The upper main bearing has an oil groove around its inside circumference.



271EG14

Crankshaft Pulley

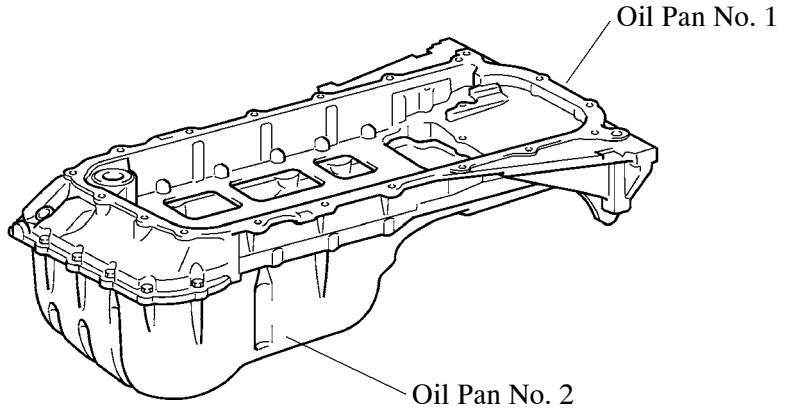
The rigidity of the torsional damper rubber has been optimized to reduce noise.



271EG15

Oil Pan

- The oil pan No. 1 is secured to the cylinder block and the transmission, thus increasing rigidity.
- The oil pan No. 1 material is made of aluminum alloy.
- The oil pan No. 2 material is made of steel.



047EG66Y