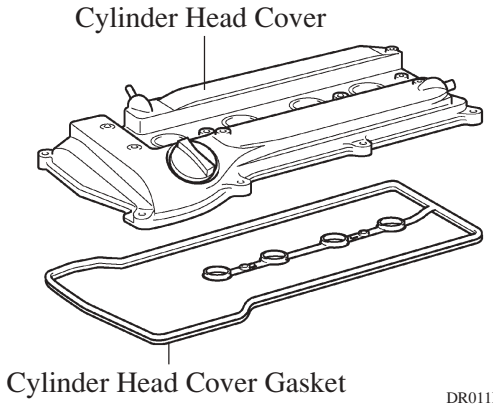
■ENGINE PROPER

1. Cylinder Head Cover

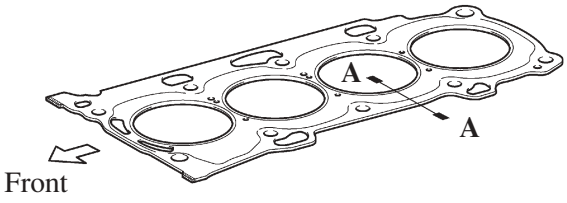
- A lightweight magnesium alloy die-cast cylinder head cover is used.
- Acrylic rubber, which excels in heat resistance and reliability, is used for the cylinder head cover gasket.



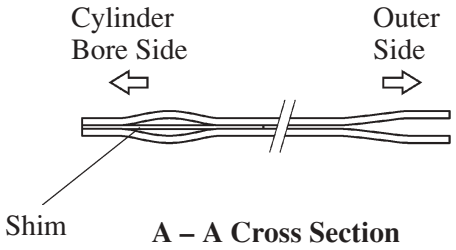
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2. Cylinder Head Gasket

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



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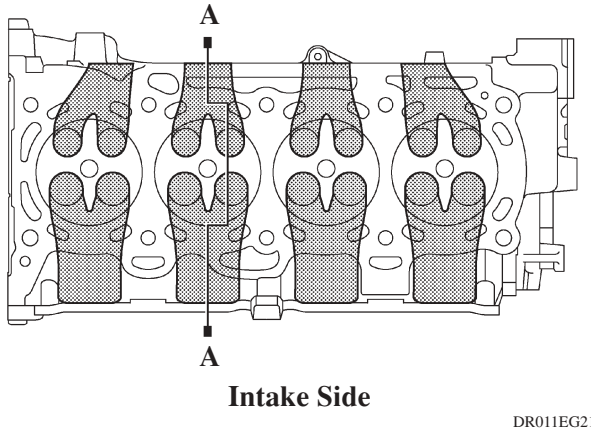


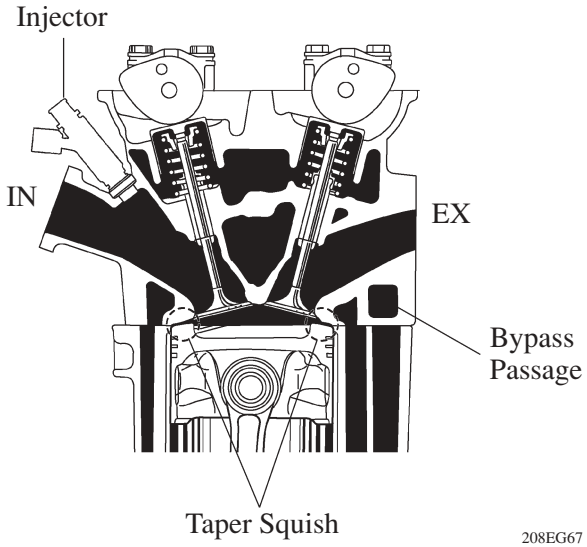
A – A Cross Section

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3. Cylinder Head

- Through the adoption of the taper squish combustion chamber, the engine knocking resistance and fuel efficiency have been improved.
- An upright intake port is used to improve the intake efficiency.
- Installing the injectors in the cylinder head enables the injectors inject fuel as close as possible to the combustion chamber. This prevents the fuel from adhering to the intake port walls, which reduces HC exhaust emissions.
- The routing of the water jacket in the cylinder head has been optimized to realize the high cooling performance. In addition, a water bypass passage has been provided below the exhaust ports to reduce the number of parts and the weight.



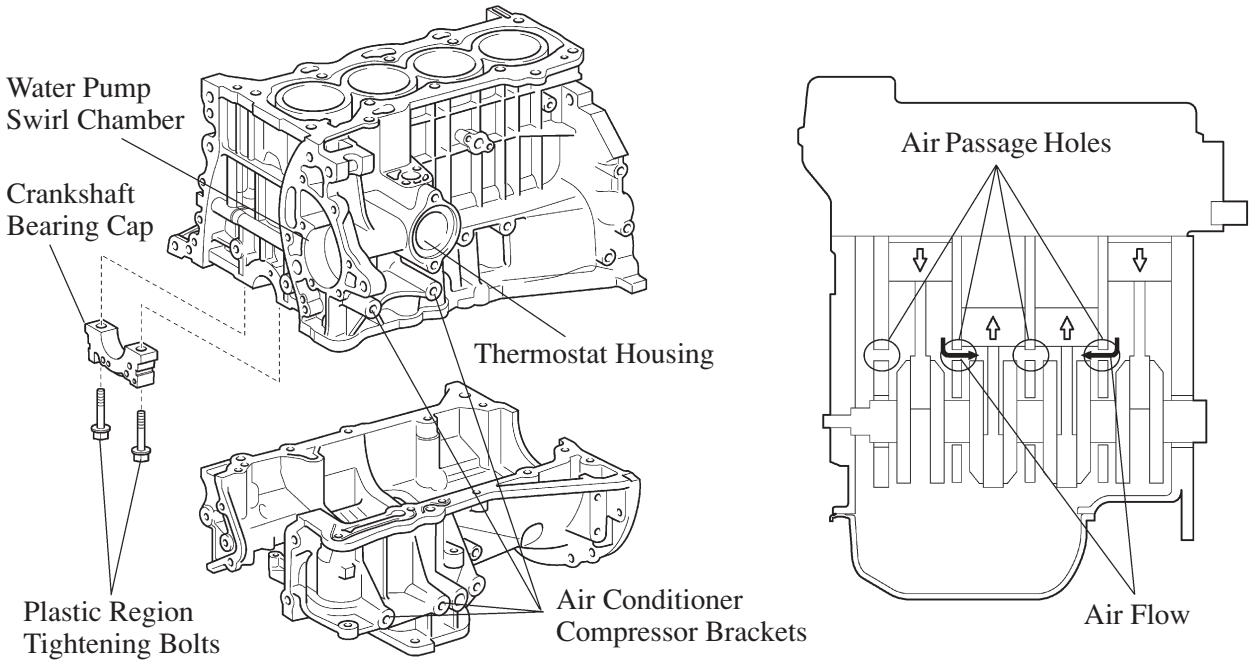


A – A Cross Section

4. Cylinder Block

- Lightweight aluminum alloy is used for the cylinder block.
- By producing the thin cast-iron liners and cylinder block as a unit, compaction is realized.
- 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 loss (back pressure at the bottom of the piston generated by the piston's reciprocal movement) is reduced to improve the engine's output.
- The oil filter and the air conditioner compressor brackets are integrated into the crankcase. Also, the water pump swirl chamber and thermostat housing are integrated into the cylinder block.

▶ Air Flow During Engine Revolution ◀

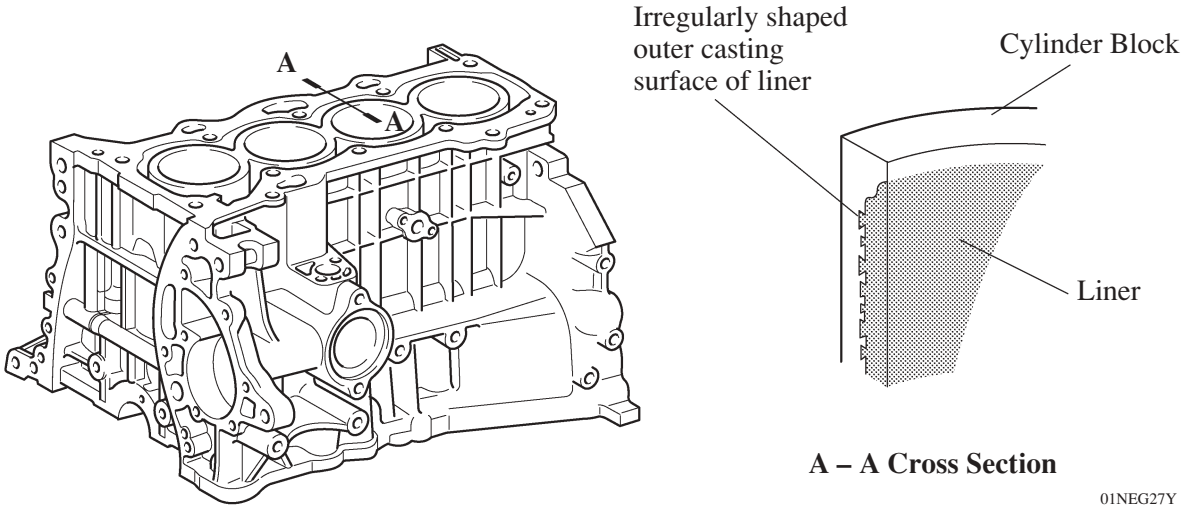


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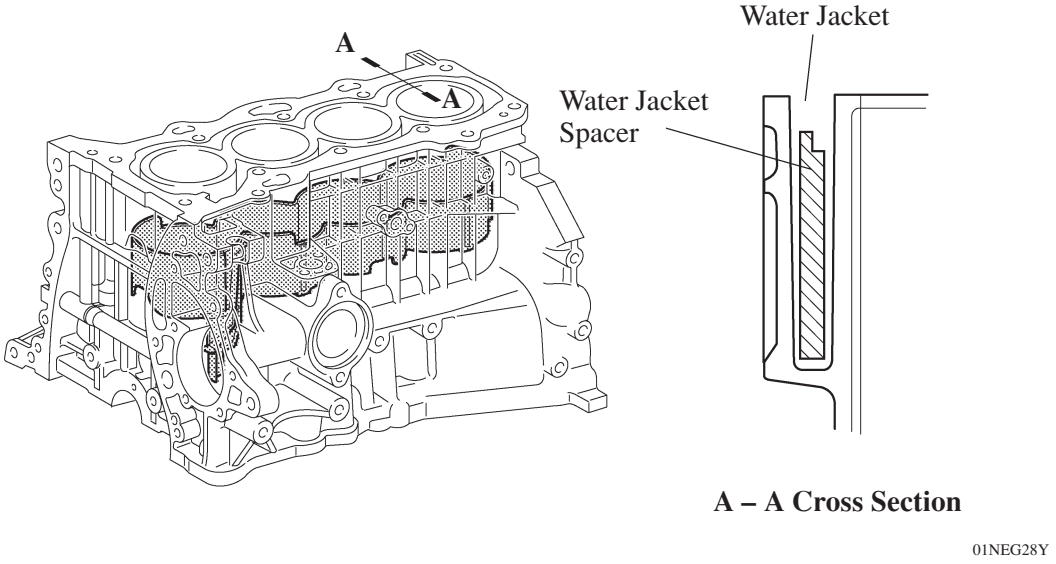
NOTICE

Never attempt to machine the cylinder because it has a thin liner thickness.

- In the 2AZ-FE engine, 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.



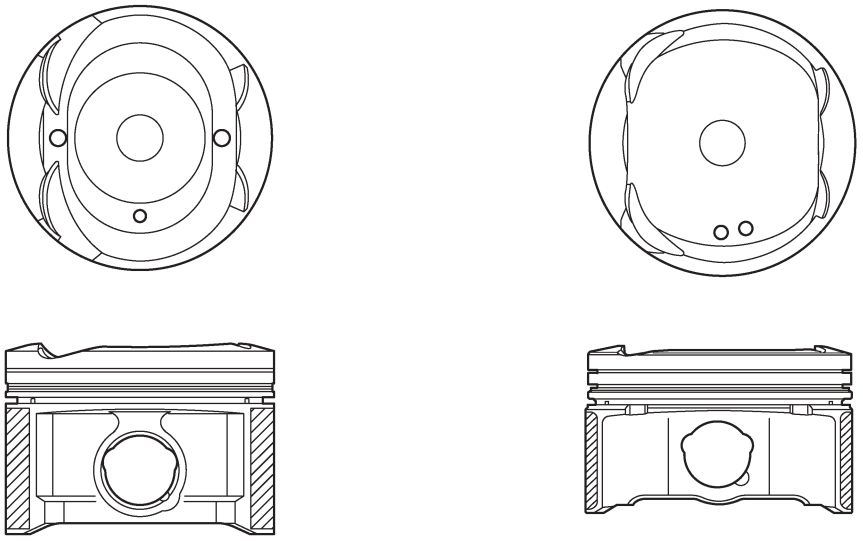
- On the 2AZ-FE engine, water jacket spacers are provided in the water jacket of the cylinder block.
- They suppress the water flow in the center of the water jackets, guide the coolant above and below the cylinder bores, and ensure uniform temperature distribution. As a result, the viscosity of the engine oil that acts as a lubricant between the bore walls and the pistons can be lowered, thus reducing friction.



5. Piston

- The piston is made of aluminum alloy and skirt area is made compact and lightweight.
- The piston head portion uses a taper squish shape to improve the fuel combustion efficiency.
- The piston skirt has been coated with resin to reduce the friction loss.

▨ : Resin Coating

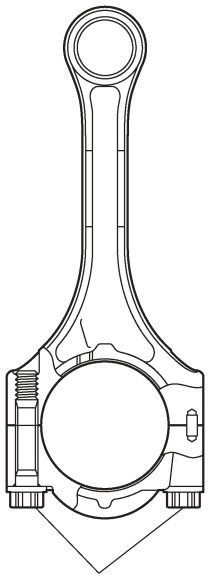


1AZ-FE Engine **2AZ-FE Engine**

01NEG29Y

6. Connecting Rod

- The connecting rods and caps are made of high-strength steel for weight reduction.
- Nut-less type plastic region tightening bolts are used on the connecting rod for a lighter design.
- The connecting rod bearings are reduced in width to reduce friction.

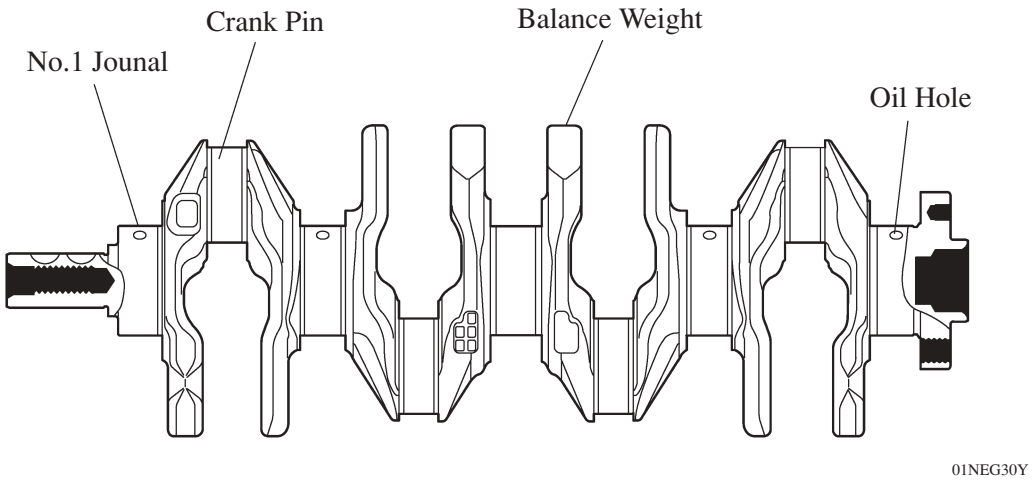


Plastic Region Tightening Bolts

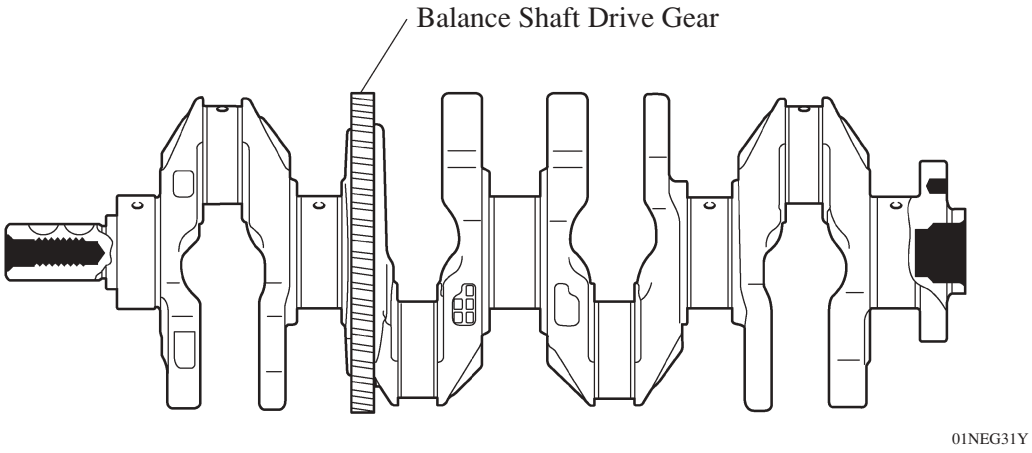
240EG45

7. Crankshaft

- The forged crankshaft has 5 journals and 8 balance weights.
- The crankshaft is made of forged steel.
- Pin and journal fillets are roll-finished to maintain adequate strength.
- A balance shaft drive gear is provided on the crankshaft of the 2AZ-FE engine.



1AZ-FE Engine

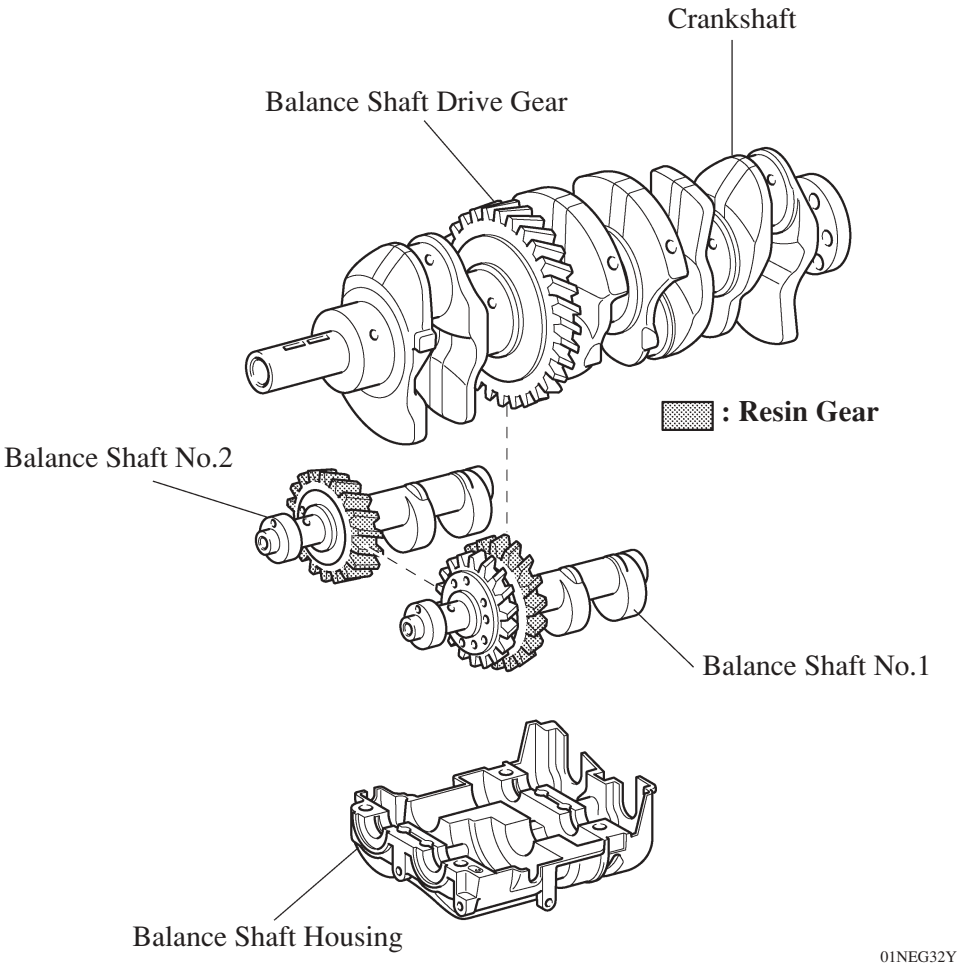


2AZ-FE Engine

8. Balance Shaft (For 2AZ-FE Engine)

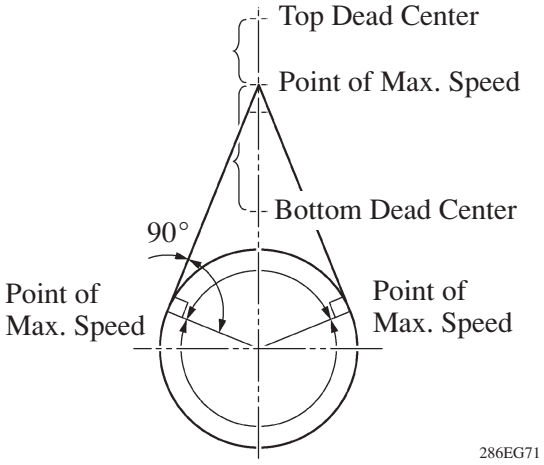
General

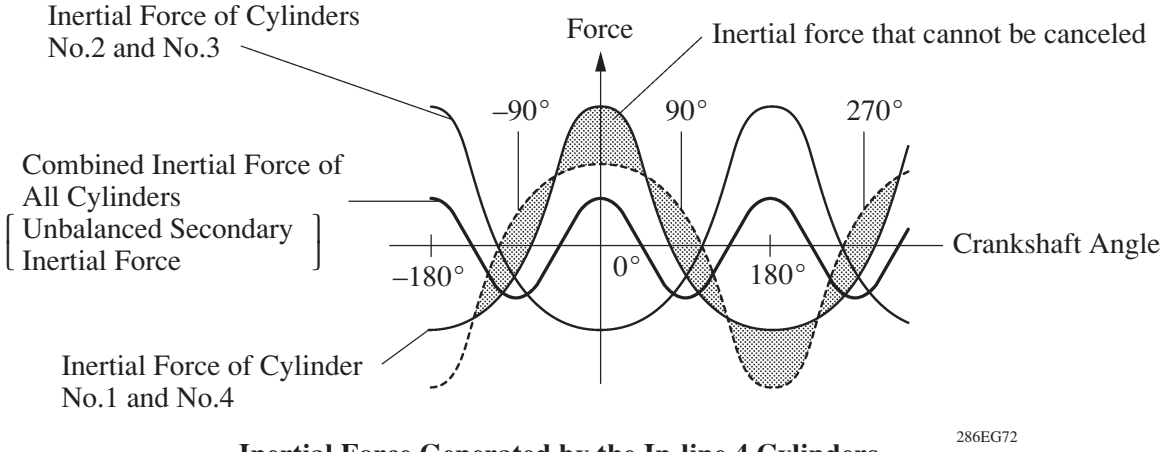
- A balance shaft is used to reduce vibrations.
- The crankshaft directly drives the No. 1 balance shaft.
- In addition, a resin gear is used on the driven side to suppress noise and offer lightweight design.



Operation

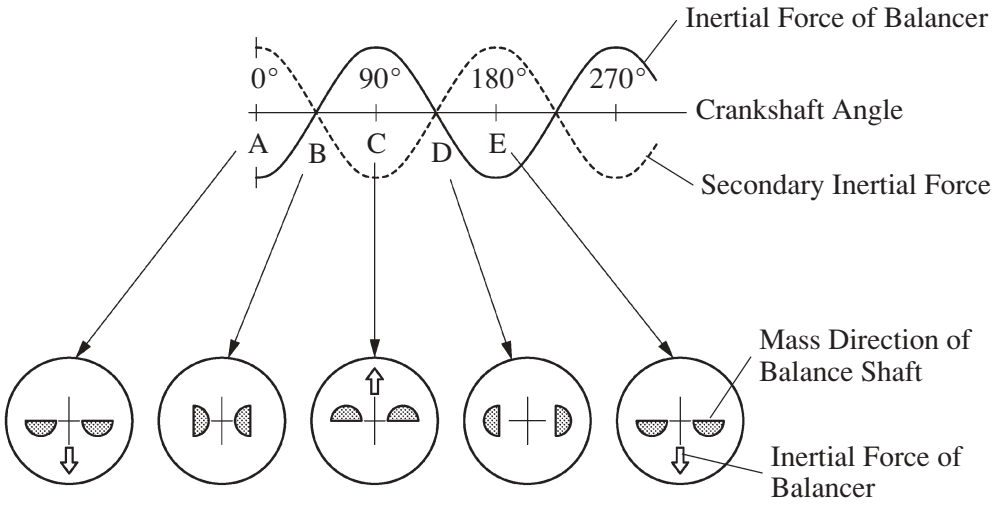
In the in-line 4-cylinder engine, the crankshaft angle for cylinders No.1 and No.4 are exactly at the opposite (180°) position of cylinders No.2 and No.3. Therefore, the inertial force of the pistons and the connecting rods of the former 2 cylinders and of the latter 2 cylinders almost cancel each other. 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.





Inertial Force Generated by the 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.



Mass Direction of Balance Shaft at Crankshaft Angle