

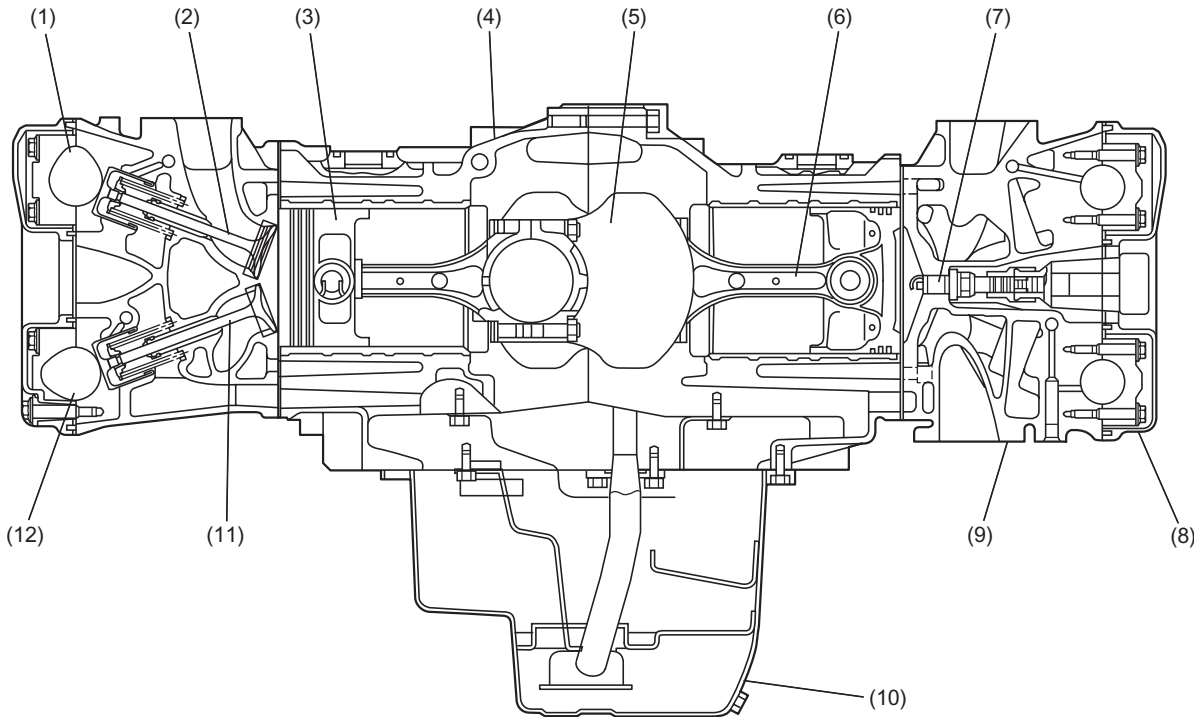
# **MECHANICAL (H4DOTC)**

### 1. General

The engine used in this vehicle is of a horizontally opposed, four-cylinder design. This four-stroke-cycle, water-cooled, DOHC turbocharged engine uses a total of 16 valves and its main components are made of aluminum alloy. It is fueled by a multiple fuel injection system.

The engine's major structural and functional features are as follows:

- The cylinder head forms pent roof combustion chambers, each having a spark plug located at its center and two each of intake and exhaust valves (four valves per cylinder). The intake and exhaust ports are located in a cross-flow arrangement.
- A single timing belt drives four camshafts on the left and right banks and the water pump on the left bank. Belt tension is automatically adjusted by a belt tension adjuster, eliminating need for manual adjustment.
- The crankshaft is supported at five journals with high rigidity and strength.
- The cylinder block is made of cast aluminum, and cast iron cylinder liners are cast in.

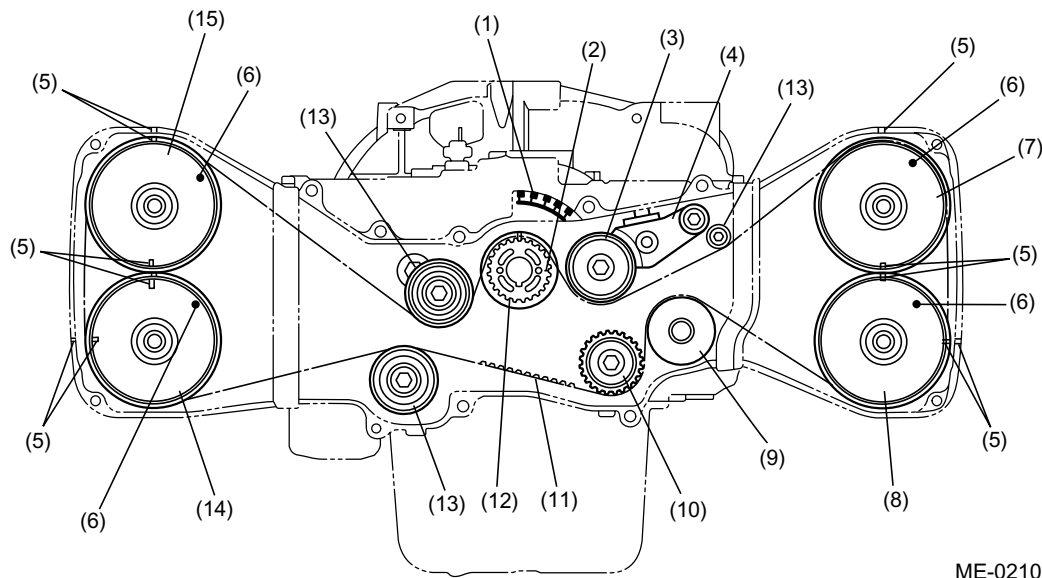


ME-00828

- |                     |                        |                       |
|---------------------|------------------------|-----------------------|
| (1) Intake camshaft | (5) Crankshaft         | (9) Cylinder head     |
| (2) Intake valve    | (6) Connecting rod     | (10) Oil pan          |
| (3) Piston          | (7) Spark plug         | (11) Exhaust valve    |
| (4) Cylinder block  | (8) Valve rocker cover | (12) Exhaust camshaft |

## 2. Timing Belt

- A single timing belt drives four camshafts (intake and exhaust camshafts on each bank). The belt also drives the water pump by its non-toothed side.
- The timing belt teeth have a specially designed round profile which contributes to quiet operation. The timing belt is made of strong and inflexible core cords, wear-resistant canvas and heat-resistant rubber material.
- A hydraulic automatic belt tension adjuster always keeps the belt taut to the specified tension. Any manual belt tension adjustment is unnecessary.



ME-02106

- |   |                                   |
|---|-----------------------------------|
| (1) Timing indicator (for timing mark of crankshaft pulley) | (9) Water pump pulley             |
| (2) *Piston position mark                                   | (10) Idler No. 2                  |
| (3) Belt tension pulley                                     | (11) Timing belt                  |
| (4) Automatic belt tension adjuster assembly                | (12) Crankshaft sprocket          |
| (5) Alignment mark  | (13) Idler                        |
| (6) **Piston position mark                                  | (14) Exhaust camshaft sprocket RH |
| (7) Intake camshaft sprocket LH                             | (15) Intake camshaft sprocket RH  |
| (8) Exhaust camshaft sprocket LH                            |                                   |

### NOTE:

\*: The #1 piston is set at the top dead center (TDC) when the piston-position mark on the crankshaft sprocket is aligned with the mark on cylinder block.

\*\* : The #1 piston is set at TDC on the compression stroke when the piston-position mark on the camshaft sprocket is facing directly upward.

# AUTOMATIC BELT TENSION ADJUSTER

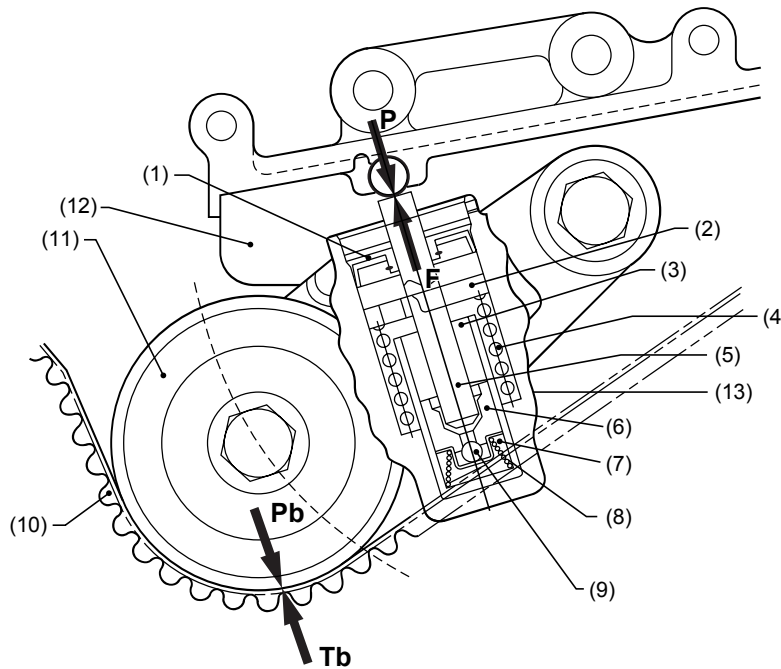
MECHANICAL

## 3. Automatic Belt Tension Adjuster

The automatic belt tension adjuster consists of a tensioner unit and a bracket. It maintains the timing belt tension automatically at a specified level to enable the belt to transmit power correctly, reduce operating noise and increase the life of the belt.

The cylinder of the tensioner unit incorporates an adjuster rod, wear ring, plunger spring, return spring, check ball and silicone oil.

The automatic belt tension adjuster gives tension to the belt by a levering action which is produced by the push force of the tensioner unit's adjuster rod. It operates in the process detailed below.



ME-00314

- |                           |                          |
|---------------------------|--------------------------|
| (1) Oil seal              | (8) Plunger spring       |
| (2) Wear ring             | (9) Check ball           |
| (3) Oil reservoir chamber | (10) Timing belt         |
| (4) Return spring         | (11) Belt tension pulley |
| (5) Adjuster rod          | (12) Tensioner bracket   |
| (6) Plunger               | (13) Cylinder            |
| (7) Oil pressure chamber  |                          |

## AUTOMATIC BELT TENSION ADJUSTER

MECHANICAL

- Timing belt tensioning action

When the belt becomes slack, the adjuster rod is pushed upward by the return spring. The oil in the reservoir chamber, which is pressurized by the plunger spring to a certain level, pushes open the check ball and flows into the oil pressure chamber to keep the pressure constant.

The thrust force  $F$  resulting from extension of the adjuster rod applies a counterclockwise torque to the tensioner bracket, which causes the belt tension pulley at its end to turn in the same direction. This applies tensioning pressure  $P_b$  to the timing belt.

- Timing belt tension balancing action

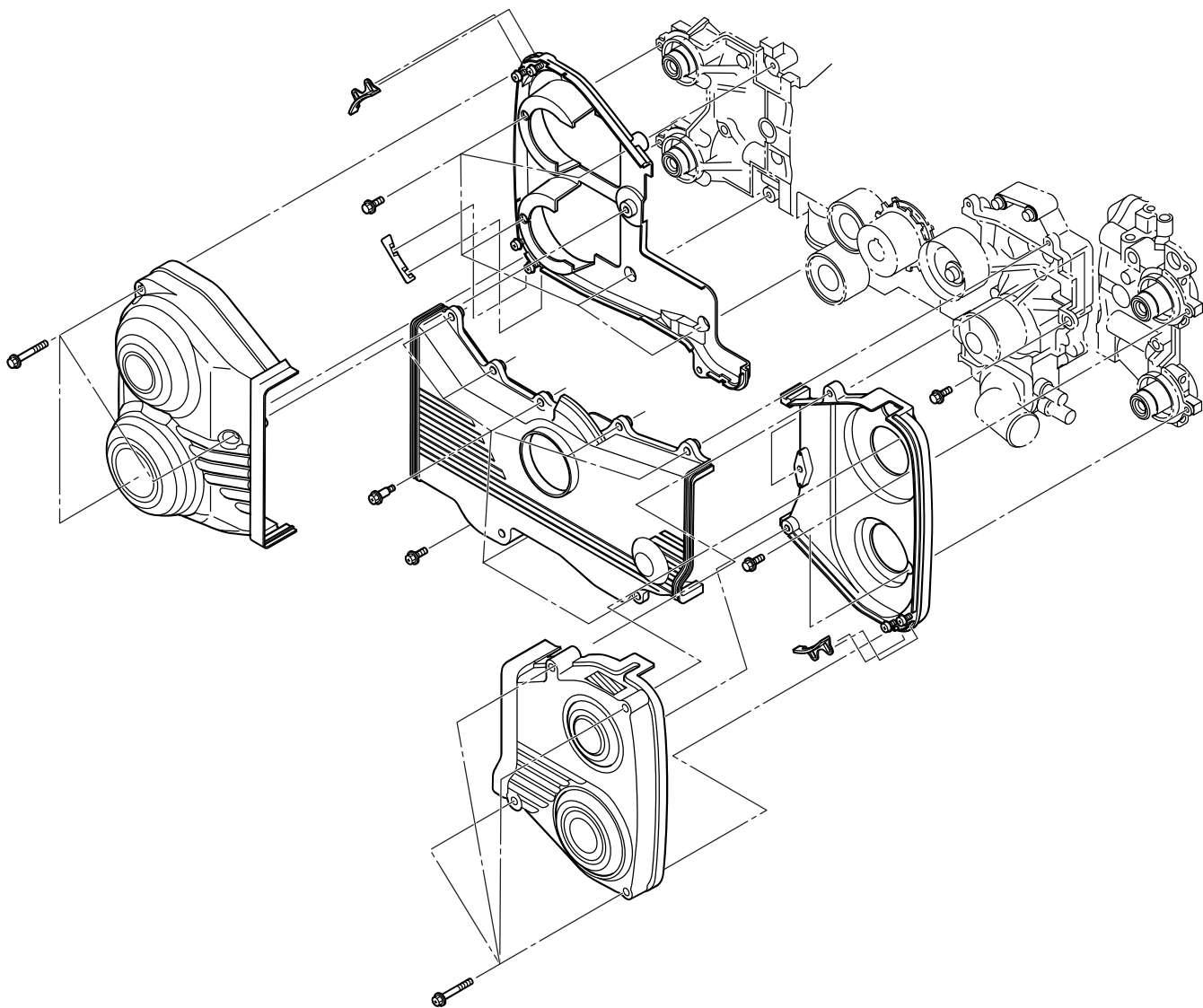
When the belt tension pulley is pushed against the timing belt with pressure  $P_b$ , reaction force  $T_b$  of the timing belt generates the reaction force  $P$  at the point on which the adjuster rod force is acting. This force  $P$  pushes the adjuster rod until it balances with the sum of the thrust force  $F$  and the pressure of the oil in the oil pressure chamber. Therefore, the timing belt tension is kept constant.

- Over-tension correction action

If the tension of the timing belt increases excessively, the force  $P$  becomes larger than the thrust force  $F$  and silicone oil is returned from the oil pressure chamber to the reservoir chamber little by little until the force  $P$  balances again with the thrust force  $F$ . Thus the timing belt tension is maintained at the specified level at all times.

## 4. Belt Cover

- The belt cover is made of lightweight, heat resistant synthetic resin molding. It constitutes a totally enclosed housing with its cylinder block mating edges sealed with rubber gaskets. This effectively protects the inside components from dust and liquid.
- Rubber seals used between the cylinder block and the belt cover effectively reduces transmission of noise and vibration.
- The front belt cover has a line mark for ignition-timing checking.



ME-00823

## **5. Camshaft**

The DOHC engine uses four camshafts in all; intake and exhaust camshafts on each of the right and left banks.

The camshafts are of a composite material type using sintered steel for cam lobes and carbon steel for pipe part.

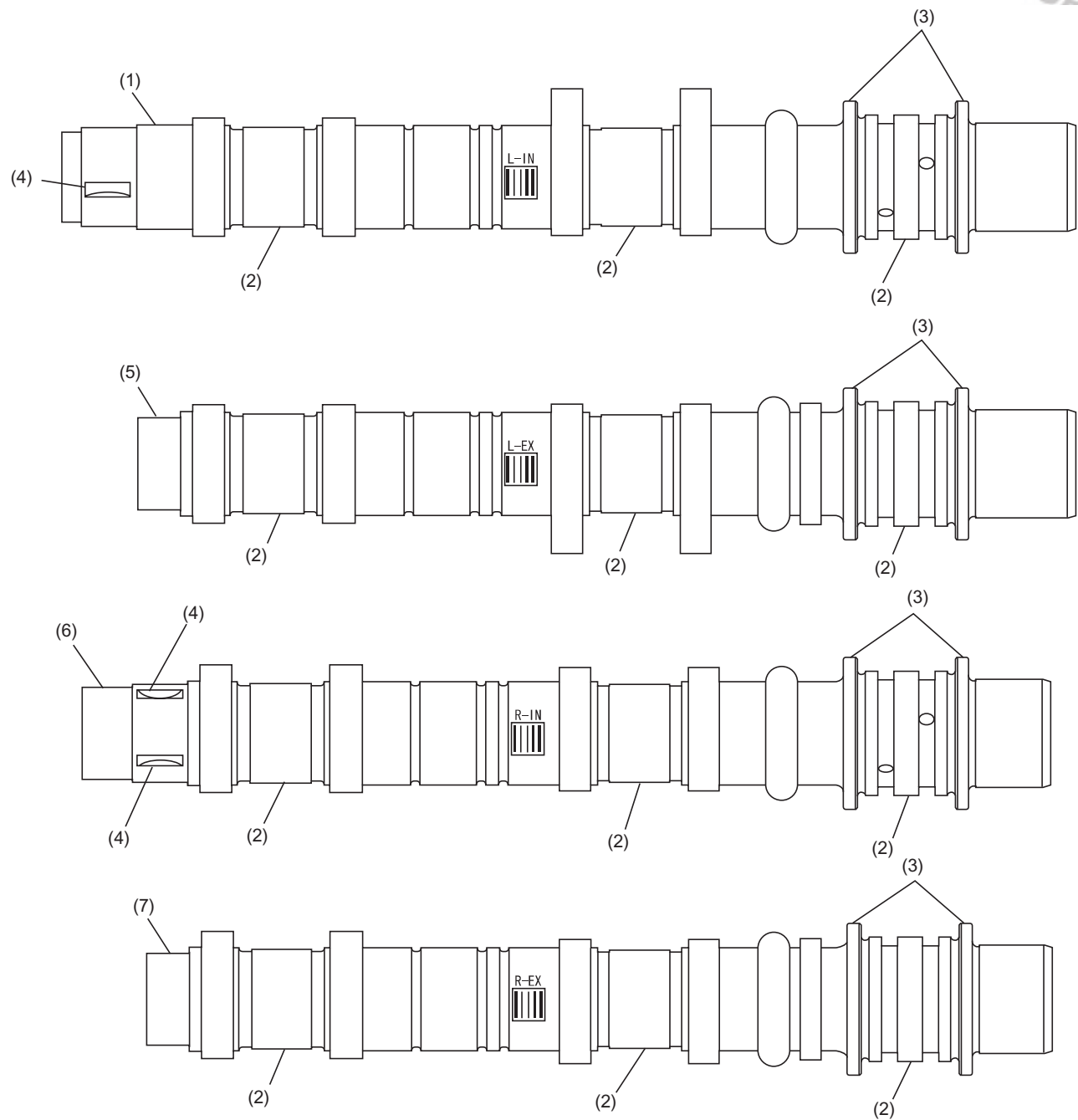
The sintered steel cams are very high in the resistance to wear, which enables the cam lift to be increased. In addition, use of a hollow pipe material contributes to reduction in weight.

Each camshaft is supported at its three journals and held in position by three camshaft caps. The two flanges on each camshaft supports thrust forces to limit the end play of the camshaft within the tolerance.

For DOHC turbo model engines, slots (notches) for variable valve timing position sensors are provided at the intake side.

# CAMSHAFT

MECHANICAL



ME-00790

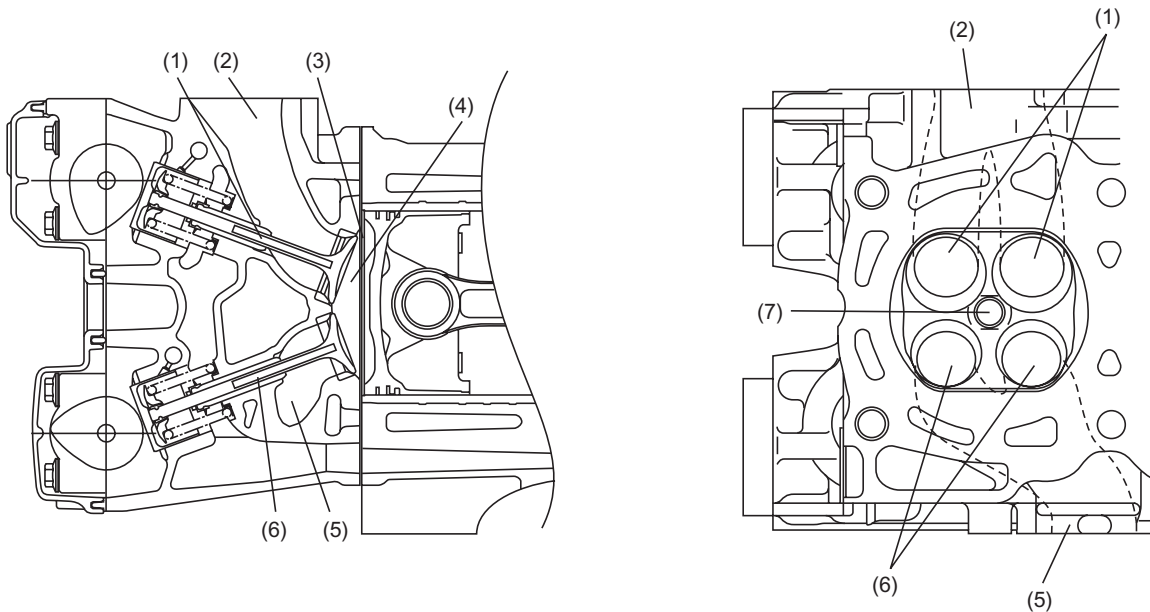
- |  |                         |
|--|-------------------------|
| (1) Intake camshaft LH                               | (5) Exhaust camshaft LH |
| (2) Journal  | (6) Intake camshaft RH  |
| (3) Flange   | (7) Exhaust camshaft RH |
| (4) Slot (notch) for variable timing position sensor |                         |

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## 6. Cylinder Head

- The cylinder head is made of low pressure cast aluminum.
- Each combustion chamber in the cylinder head is a compact, pent roof design. The spark plug is located at the center of the combustion chamber, which contributes to creation of a wide “squish area” for increased combustion efficiency.
- The two intake and two exhaust valves are arranged on opposite sides for a cross-flow feature.
- The cylinder head gasket is a metallic gasket consisting of three layers of the stainless steel sheets. The gasket is highly resistant to heat and maintains high level of sealing performance for a long period.



ME-00793

- (1) Intake valve
- (2) Intake port
- (3) Squish area
- (4) Combustion chamber

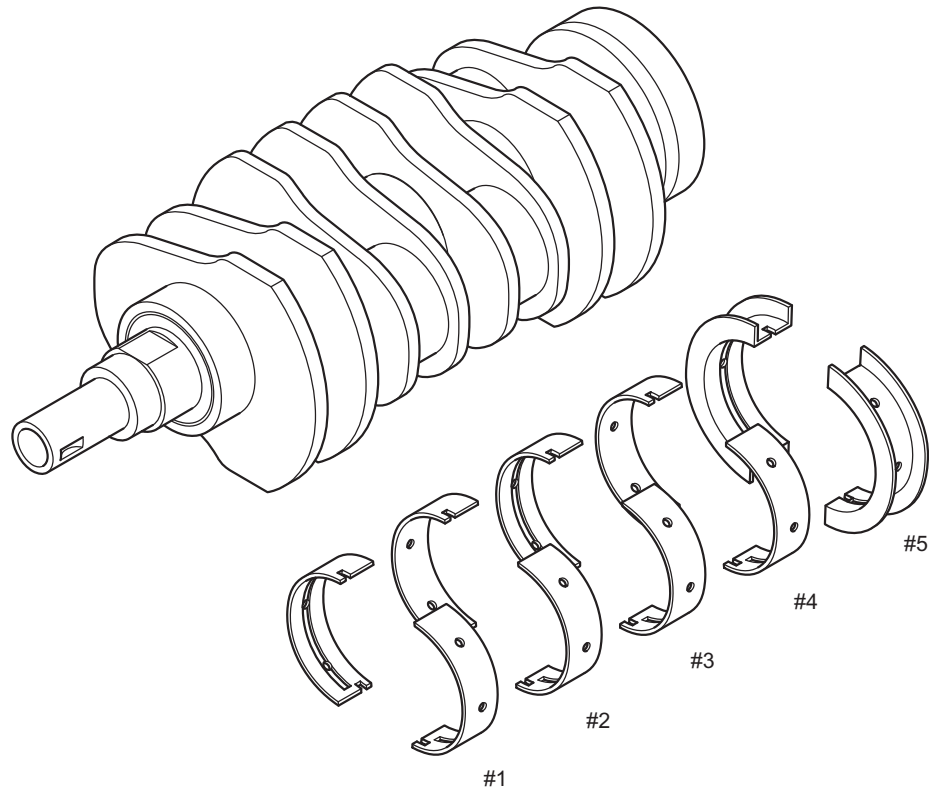
- (5) Exhaust port
- (6) Exhaust valve
- (7) Spark plug

### 7. Cylinder Block

- The cylinder block is made of aluminum die casting. A semi-closed deck structure is used to obtain a higher rigidity to hold the cylinder liners.
- The cylinder liners are made of cast iron. As they are of a dry type, their outer surfaces are entirely in contact with the cylinder block.
- The cylinder block supports the crankshaft at its five journals. The journal supporting portions are designed such that sufficient stiffness and quiet operation are ensured.
- Sintered material is fit in the casting at the #5 journal to achieve further quietness.
- The oil pump is located in the front center of the cylinder block and the water pump is located at the front of the left-cylinder bank. At the rear of the right-cylinder bank is an oil separator which removes oil mist contained in blow-by gas.

## 8. Crankshaft

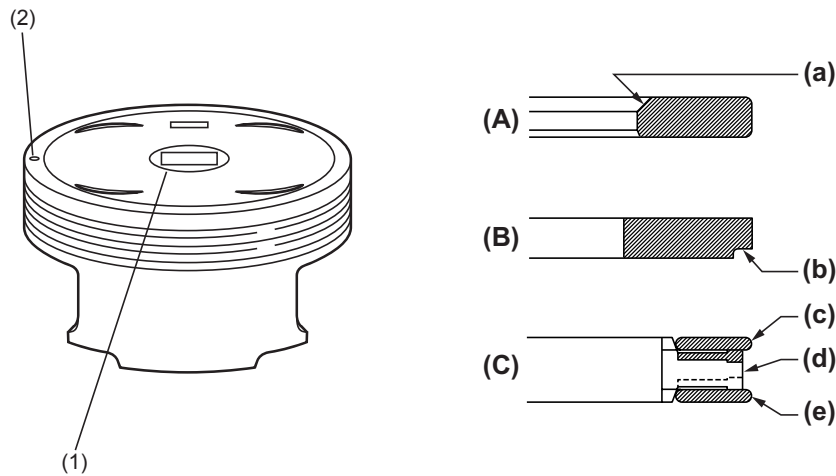
The crankshaft is supported in the cylinder block at five journals. Each corner formed by a journal or pin and a web is finished by fillet-rolling method, which increases strength of that area. The five crankshaft bearings are made of aluminum alloy and the No. 5 bearing is provided with a flanged metal to support thrust forces.



ME-00319

## 9. Piston

- The pistons are of a slipper skirt design for reduced weight and friction. The piston is also a thermal flow type whose oil control ring groove is provided with round oil drain holes.
- The piston pin is offset toward the thrust side (No. 1 and No. 3 downwards, No. 2 and No. 4 upwards) to reduce piston slap noises.
- The piston head has recesses to prevent interference with the intake and exhaust valves. It also has engraved marks to identify the piston size and the direction of installation. All the pistons are common in their design.
- Three piston rings are used for each piston; two compression rings and one oil control ring. The top piston ring has inner bevels and the second piston ring has a cut on the bottom outside to reduce oil consumption.



ME-00791

- (1) Identification mark  
(2) Location mark (engine front side)

- (A) Top ring  
(B) Second ring  
(C) Oil ring

- (a) Inner-bevel  
(b) Cut  
(c) Upper rail  
(d) Spacer  
(e) Lower rail

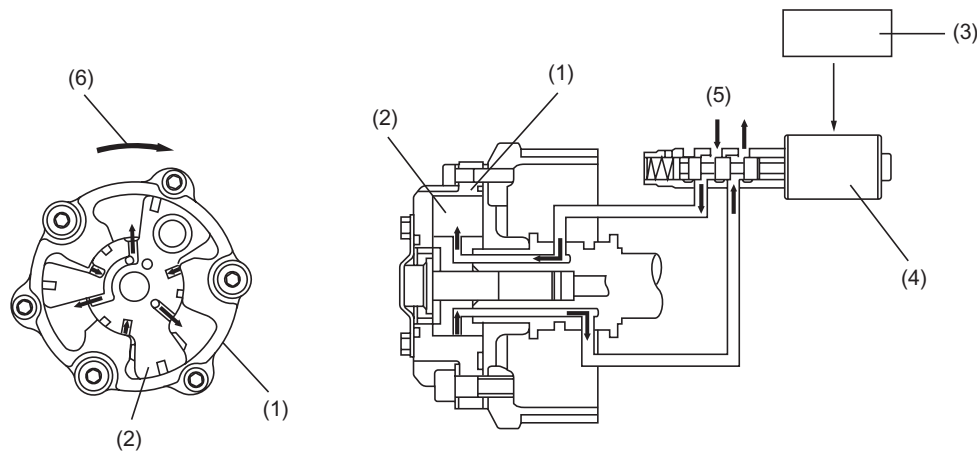
## 10. Variable Valve Timing System

This engine has a variable valve timing system, which adjusts the opening and closing timings of the valves optimally by continuously changing the phase angle of the camshaft sprocket relative to the camshaft.

- The ECM determines the optimal cam angle relative to the crank angle by making reference to the engine speed, vehicle speed, throttle opening and other relevant parameters.
- Under the control of the ECM, the oil flow control solenoid valve moves its spool to switch the hydraulic passage to/from the advance and retard chambers that are formed in the camshaft sprocket to change continuously the phase angle between the camshaft sprocket and camshaft.

### A: PHASE ANGLE ADVANCES

In response to an advance signal from the ECM, the oil flow control solenoid valve moves its spool such that hydraulic pressure is applied to the advance chamber in the camshaft sprocket. The sprocket is then turned in the direction in which its phase angle advances relative to the camshaft.



ME-00825

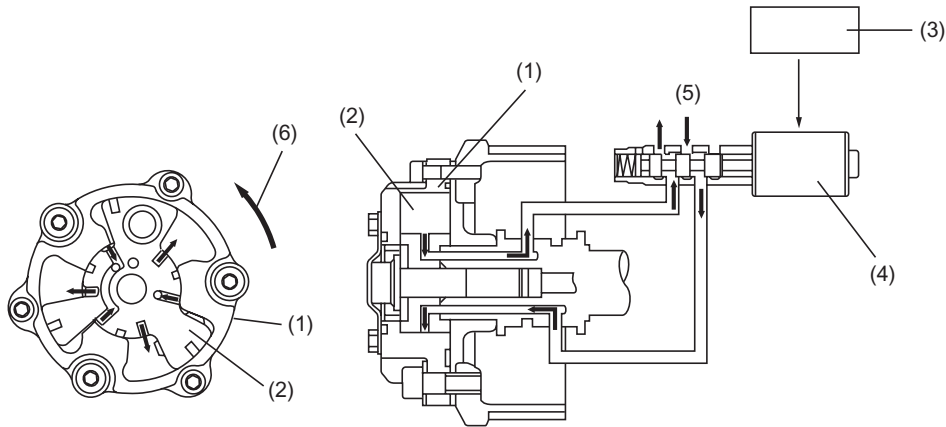
- (1) Variable valve timing controller (attached to camshaft sprocket)
- (2) Vane (attached to camshaft)
- (3) ECM
- (4) Oil flow control solenoid valve
- (5) Oil pressure
- (6) Turns in advance direction

# VARIABLE VALVE TIMING SYSTEM

MECHANICAL

## B: PHASE ANGLE RETARDS

In response to a retard signal from the ECM, the oil flow control solenoid valve moves its spool such that hydraulic pressure is applied to the retard chamber in the camshaft sprocket. The sprocket is then turned in the direction in which its phase angle retards relative to the camshaft.

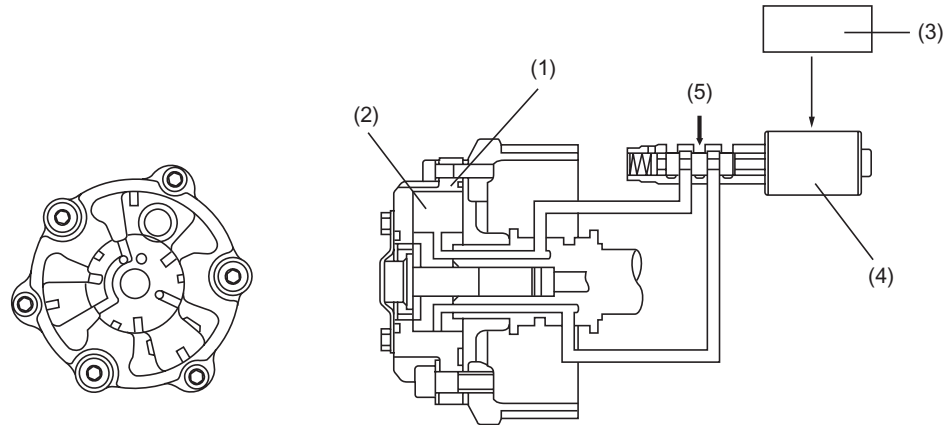


ME-00826

- (1) Variable valve timing controller (attached to camshaft sprocket)
- (2) Vane (attached to camshaft)
- (3) ECM
- (4) Oil flow control solenoid valve
- (5) Oil pressure
- (6) Turns in retard direction

## C: A CERTAIN PHASE ANGLE IS RETAINED

When the ECM issues a signal to keep the phase angle unchanged, the oil flow control solenoid valve moves its spool to the position at which the hydraulic pressures to/from both the chambers are blocked. The pressures in the chambers are thus maintained, so the phase angle does not change and the intake valves' opening and closing timings also remain unchanged.

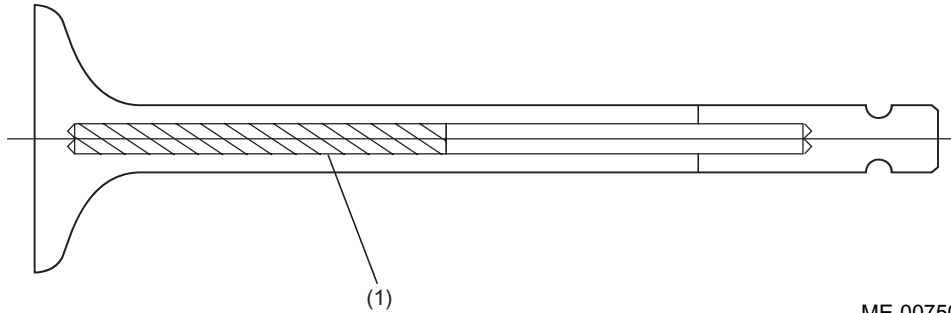


ME-00827

- (1) Variable valve timing controller (attached to camshaft sprocket)
- (2) Vane (attached to camshaft)
- (3) ECM
- (4) Oil flow control solenoid valve
- (5) Oil pressure

## 11.Sodium-filled Exhaust Valves

Each exhaust valve contains pure sodium in its hollow stem. Sodium has high thermal conductivity. The entrapped sodium will liquefy at high temperatures and move inside the stem as the valve is operated. Thus the sodium will effectively transfer heat from the valve head to the valve stem, contributing to cooling down the valve head faster.

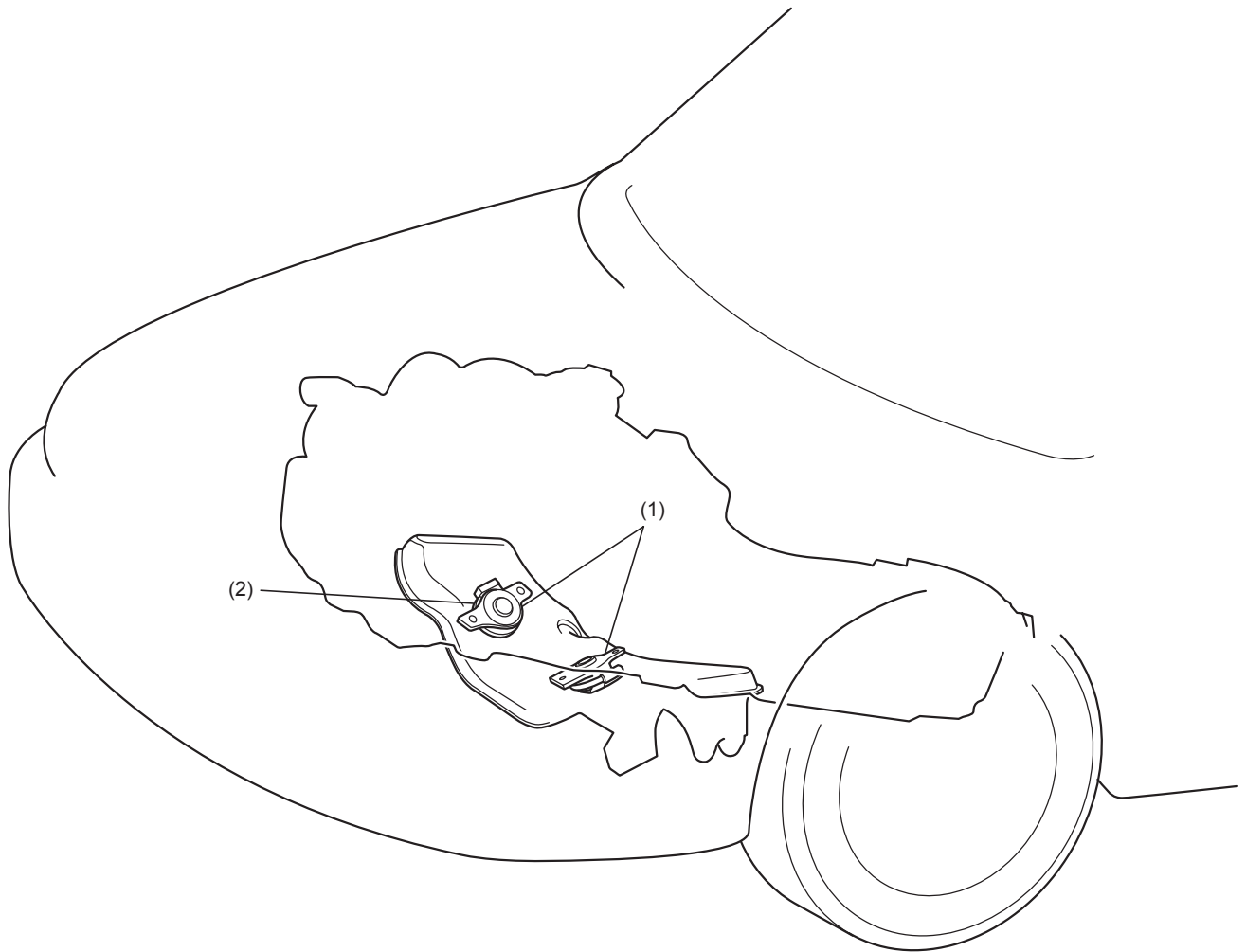


ME-00750

(1) Pure sodium



## 12.Engine Mounting



ME-02441

- (1) Cushion rubber
- (2) Engine mounting cover