

# **MECHANICAL (H4SO)**

# GENERAL

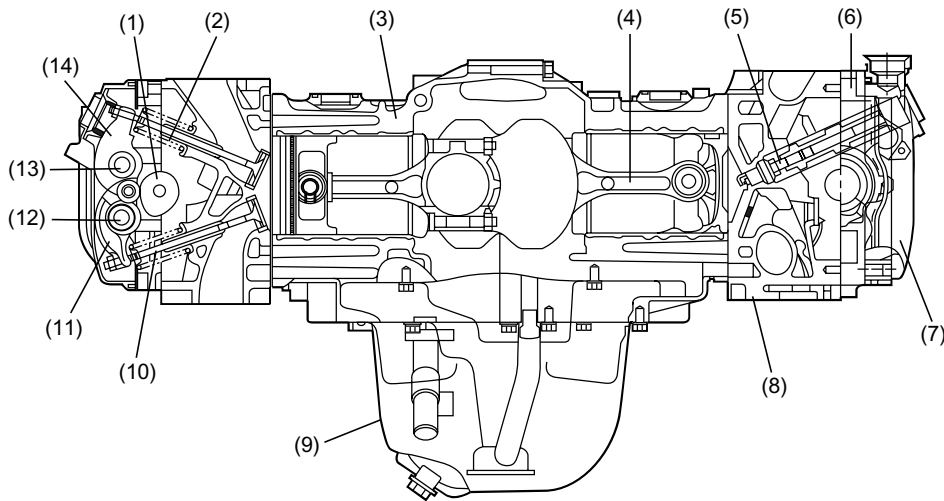
## MECHANICAL

### 1. General

The engine used in this vehicle is of a horizontally opposed, four-cylinder design. This four-stroke-cycle, water-cooled, SOHC 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.
- There are a screw and nut at the valve end of each rocker arm. They are used for adjusting the valve clearance.
- A single timing belt drives two camshafts on the left and right banks and the water pump on the left bank. A belt tension adjuster automatically adjusts the belt tension and eliminates the need for manual adjustments.
- The crankshaft is supported at five journals with high rigidity and strength.
- The cylinder block is made of aluminum die-casting, and cast iron cylinder liners are cast in.

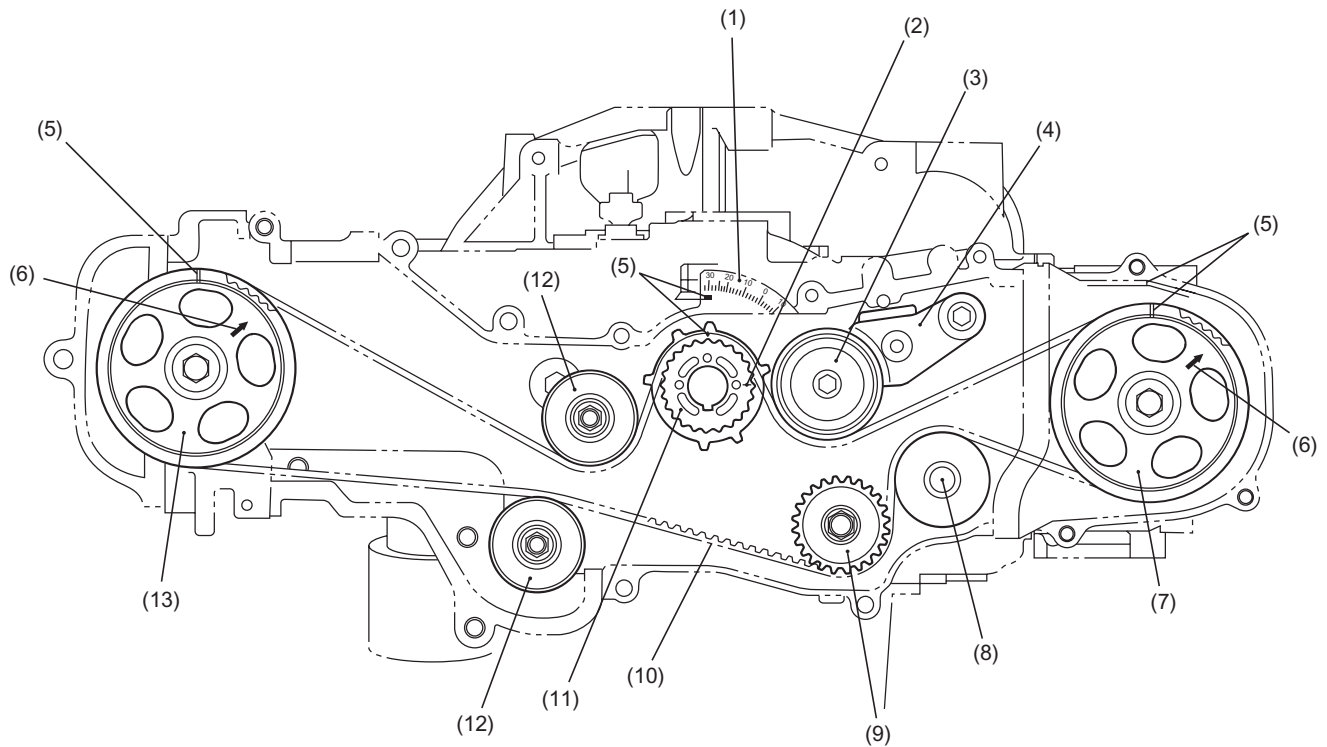


ME-00312

- |                    |                        |                           |
|--------------------|------------------------|---------------------------|
| (1) Camshaft       | (6) Camshaft cap       | (11) Exhaust rocker arm   |
| (2) Intake valve   | (7) Valve rocker cover | (12) Exhaust rocker shaft |
| (3) Cylinder block | (8) Cylinder head      | (13) Intake rocker shaft  |
| (4) Connecting rod | (9) Oil pan            | (14) Intake rocker arm    |
| (5) Spark plug     | (10) Exhaust valve     |                           |

## 2. Timing Belt

- A single timing belt drives two camshafts (one in the left bank and one in the right 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-00431

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

### NOTE:

\*: The #1 piston is at TDC when the piston position mark on the crankshaft sprocket is aligned with the timing mark on the cylinder block.

\*\* : The #1 piston is at TDC on the compression stroke when the piston position mark on the camshaft sprocket is aligned with the timing mark on the belt cover.

# AUTOMATIC BELT TENSION ADJUSTER

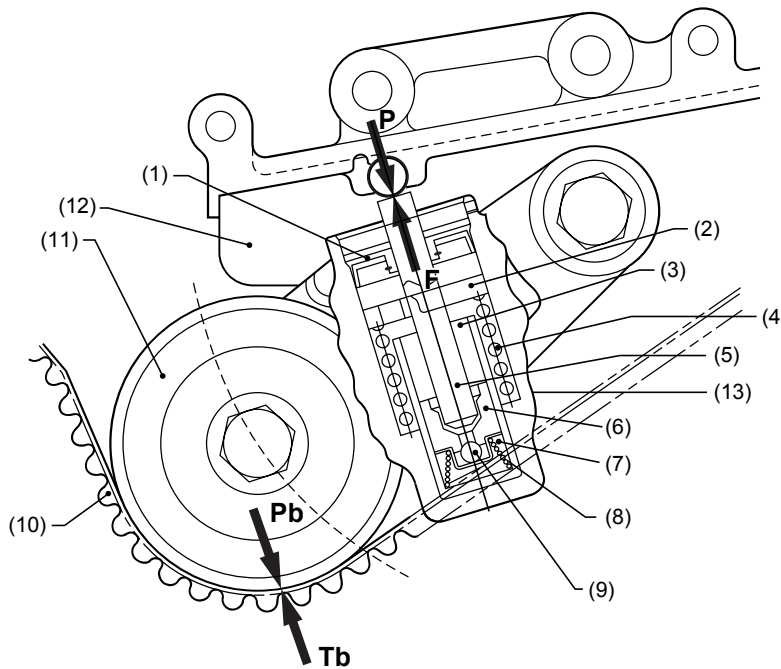
MECHANICAL

## 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

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- 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

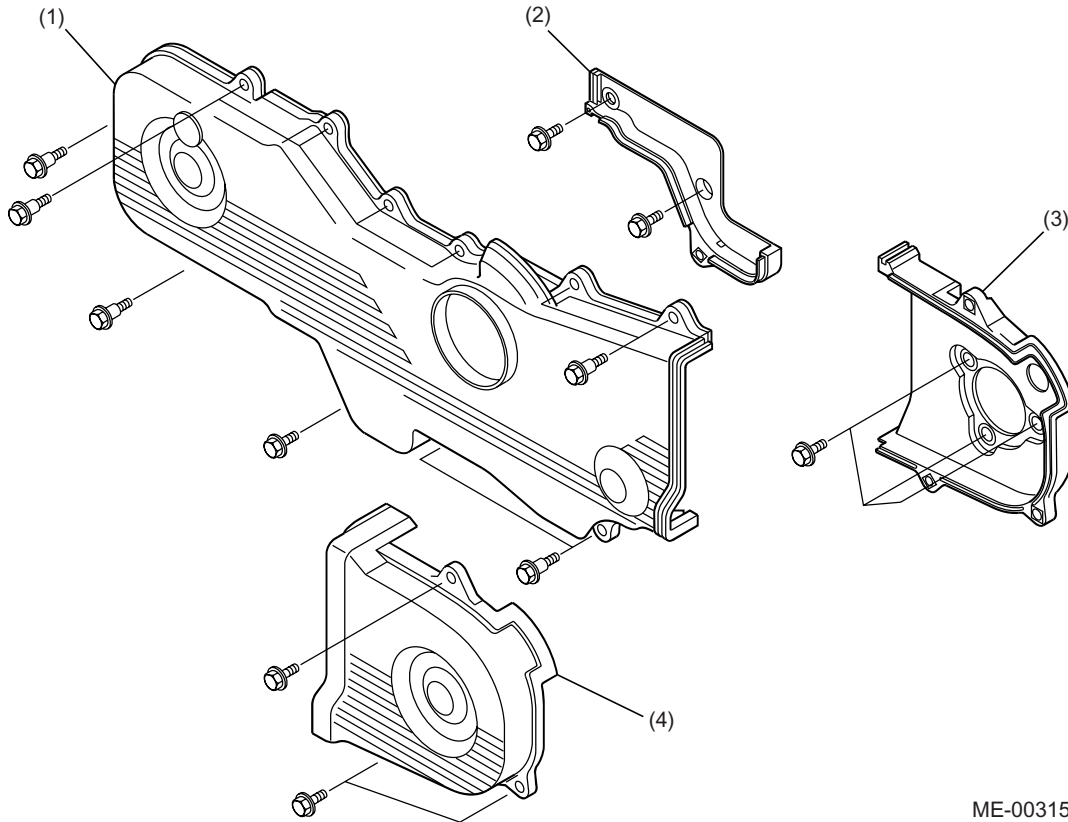
If the tension of the timing belt increases excessively, the force  $P$  becomes larger than the thrust force  $F$  and silicone oil is returned from the oil pressure chamber to the reservoir chamber little by little until the force  $P$  balances again with the thrust force  $F$ . Thus the timing belt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

# BELT COVER

MECHANICAL

## 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.

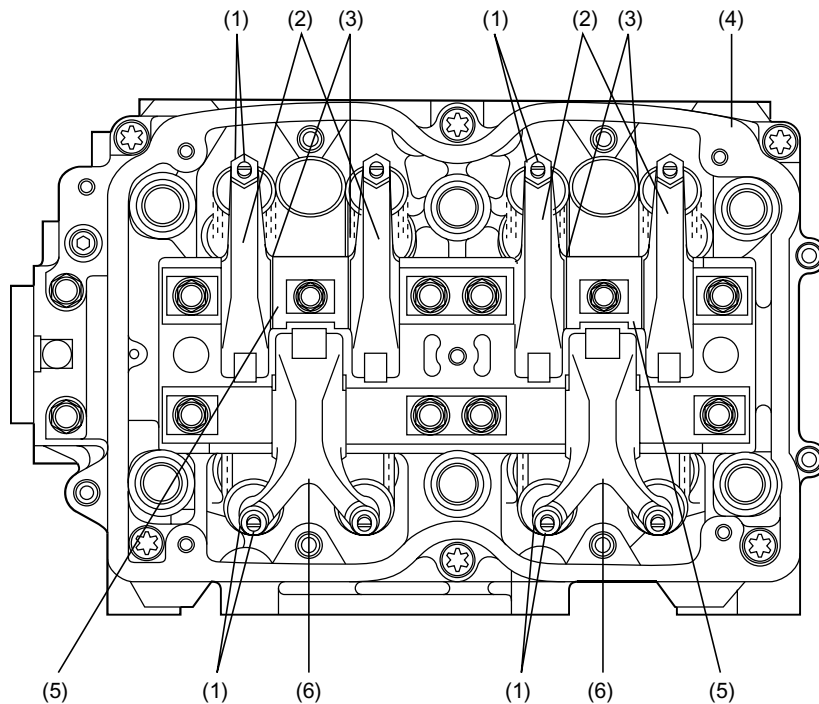


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- (1) Front belt cover
- (2) Belt cover No. 2 (RH)
- (3) Belt cover No. 2 (LH)
- (4) Belt cover (LH)

## 5. Valve Rocker Assembly (Until '05MY)

- The intake valve rocker arms and the exhaust valve rocker arms are installed on their own rocker shafts both of which are retained by the camshaft caps.
- The valve end of each rocker arm is provided with valve rocker adjusting screw and nut. Turning of this screw adjusts the valve clearance.
- The exhaust valve rocker arms are Y-shaped, and each arm operates two exhaust valves simultaneously.
- Each rocker shaft has an oil passage in it.



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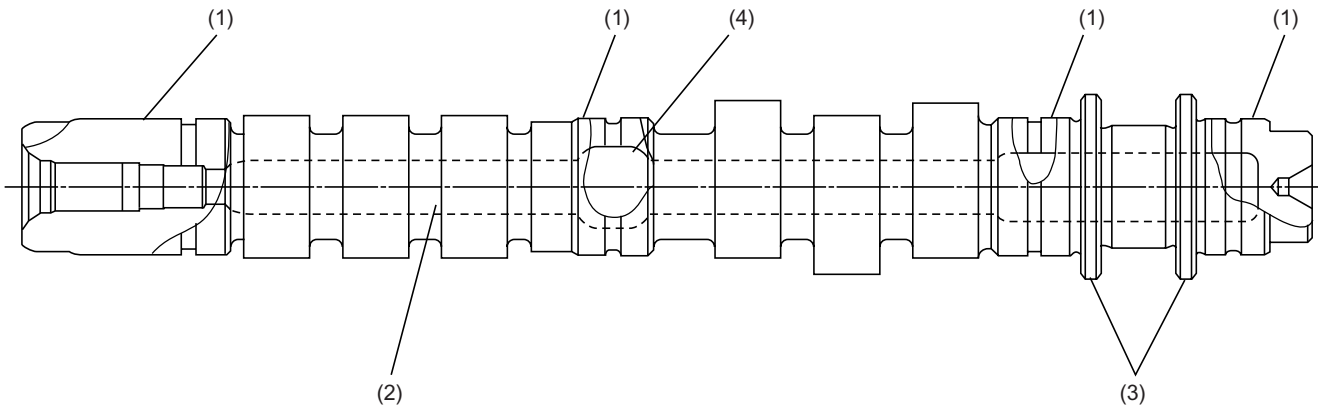
- |  |                              |
|--|------------------------------|
| (1) Valve rocker adjusting screw and nut | (4) Camshaft cap             |
| (2) Intake valve rocker arm              | (5) Supporter                |
| (3) Wave washer                          | (6) Exhaust valve rocker arm |

# CAMSHAFT (UNTIL '05MY)

MECHANICAL

## 6. Camshaft (Until '05MY)

- The camshaft is supported inside the cylinder head at four journals.
- The two flanges on each camshaft supports thrust forces to limit the end play of the camshaft within the tolerance.
- Each camshaft has an oil passage in it. The oil passage is formed by casting (hollowed in varying inner diameter) to reduce the weight.



ME-02102

- (1) Journal
- (2) Oil passage
- (3) Shaft flange
- (4) Hollowed in varying inner diameter



## 7. Variable Valve Lift System (From '06MY)

### A: GENERAL

Variable valve lift system of SOHC engine is the system that aims at the improvement of fuel efficiency, the improvement of engine output, and the decrease of toxic substances in exhaust gas, etc.

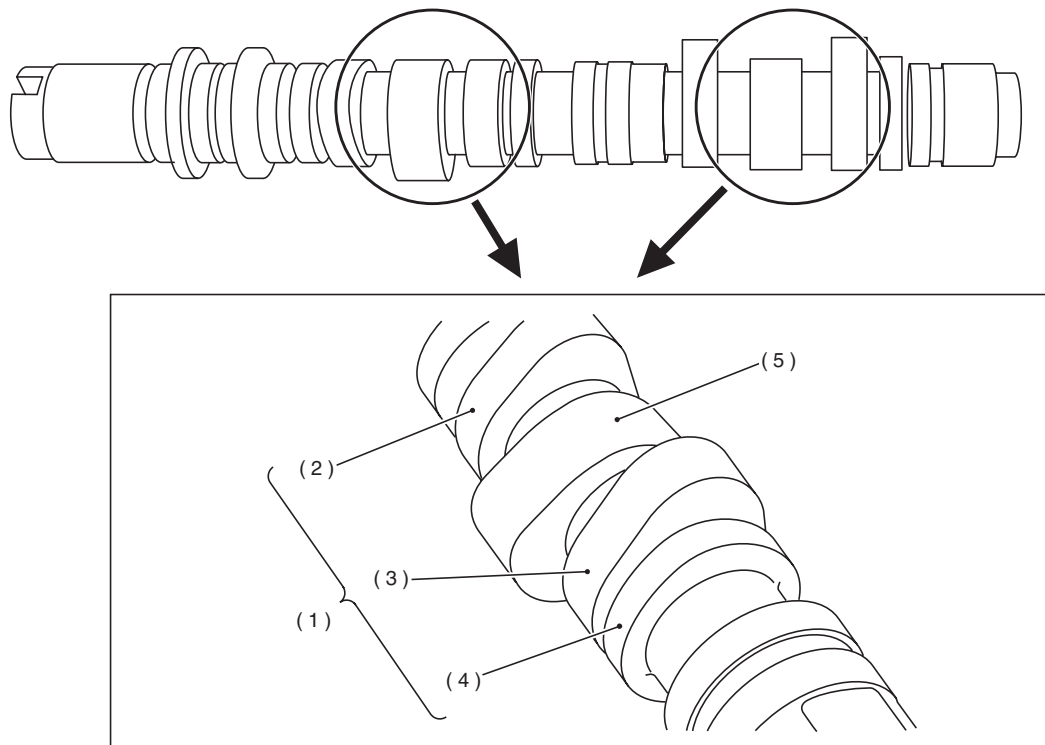
It changes the lift amount of intake valve to low-lift or high-lift according to the engine driving status. Then, the combustion status of air-fuel mixture has been improved in the medium-low speed area. In the high-speed area, the intake air efficiency has been improved. As a result, the engine output improves, and at the same time the fuel efficiency improves.

### B: STRUCTURE

The variable valve lift mechanism that is provided to intake valve rocker assembly changes the lift amount of one side intake valves to high-lift or low-lift according to the engine speed and engine load. The variable valve lift mechanism is operated by the engine oil pressure that is controlled by the oil switching valve (OSV).

#### 1. CAMSHAFT

3 cams are provided to each cylinder: the fixed lift cam, the variable high lift cam, and the variable low lift cam.



- (1) Intake cams
- (2) Normal lift cam
- (3) Variable high lift cam

- (4) Variable low lift cam
- (5) Exhaust cam

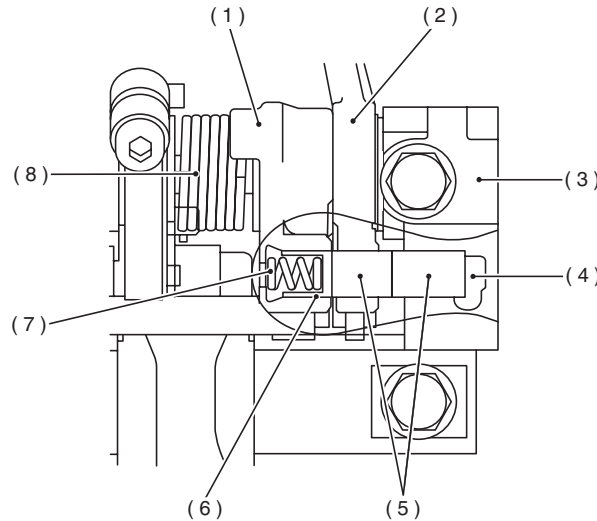
ME-02786

# VARIABLE VALVE LIFT SYSTEM (FROM '06MY)

MECHANICAL

## 2. VARIABLE VALVE LIFT MECHANISM

The variable valve lift mechanism consists of a low lift arm, high lift arm, torsion spring, and a small cylinder that includes 2 locking pins and a spring. The engine oil pressure is led from OSV to the oil chamber of support.



ME-02787

- |                   |                    |
|-------------------|--------------------|
| (1) High lift arm | (5) Locking pin    |
| (2) Low lift arm  | (6) Small cylinder |
| (3) Support       | (7) Spring         |
| (4) Oil chamber   | (8) Torsion spring |

## C: OPERATION

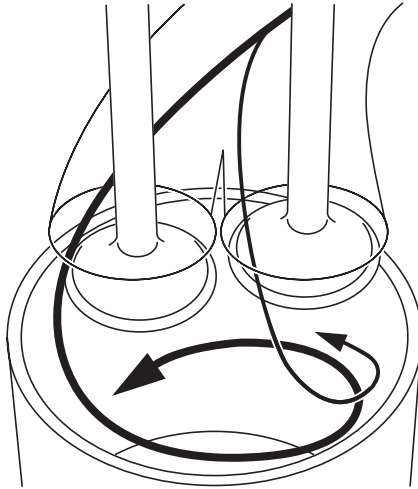
### 1. LOW LIFT

When the low lift arm and the high lift arm are pushed up by the camshaft rotation, the locking pin is in the unlock position. Therefore, the high lift arm is separated from the low lift rocker arm and can operate freely. The valve lift may be small in this condition because the valve is opened or closed being linked with the low lift cam via the low lift arm.

At this time, the high lift arm is pushed against the high lift cam with the torsion spring.

In the cylinder at intake air process, the swirl occurs because the flow velocity is sped up by the air-fuel mixture sucked from one side valve. The flow velocity of air-fuel mixture in the combustion chamber is further sped up around TDC on its compression stroke because of the piston head and the squish area of the combustion chamber.

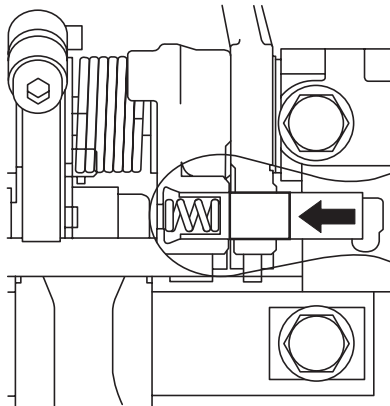
Then, the rich A/F area is made around the ignition area of spark plug and the combustion of the air-fuel mixture is improved. As a result, the generated torque improves, and at the same time it is possible to drive with the lean A/F, and toxic substances in exhaust gas are decreased.



ME-02788

- Operation change from low lift to high lift

When the oil pressure provided from OSV to the oil chamber increases, the locking pin is pushed against the high lift arm side. Then, the return spring of small cylinder is compressed, and then the locking pin of low lift arm is pressed into the locking hole of high lift arm. By a series of these operations, the low lift arm is integrated to the high lift arm.



ME-02789

# VARIABLE VALVE LIFT SYSTEM (FROM '06MY)

MECHANICAL

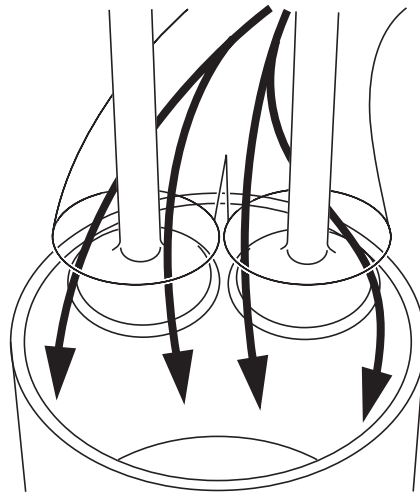
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## 2. HIGH LIFT

As the valve is pushed up to the high lift cam by the high lift arm and low lift arm that were integrated, the valve lift becomes larger.

When the low lift arm operates upward or downward, the connecting position between the locking pin of low lift arm and the locking pin of support may change. But the low lift arm keeps integrating with the high lift arm because the locking pin of the low lift arm keeps being pushed.

By opening the 2 intake valves, the air flow resistance of valves is decreased and the valve overlap in TDC on its exhaust stroke is increased (because the valve opening angle of high lift cam is wider than the fixed lift cam). Then, in the high-speed area that the throttle valve opens greatly, the intake and exhaust inertia effect can be used. As a result, a lot of air is sucked in the cylinder and the engine output may be improved.



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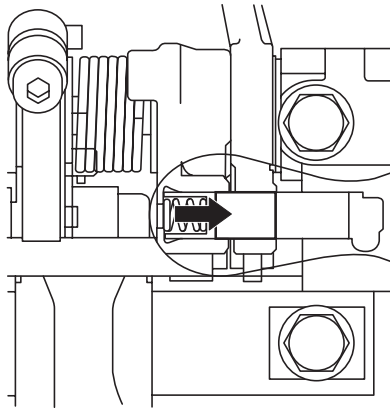
## VARIABLE VALVE LIFT SYSTEM (FROM '06MY)

MECHANICAL

- Operation change from high lift to low lift

When the oil pressure from OSV to oil chamber is decreased, the return spring of small cylinder pushes back the locking pin of low lift arm and the locking pin of rocker shaft holder to the unlock position.

As a result, the low lift arm separates from the high lift arm, and then the variable valve lift mechanism becomes the low lift operation.

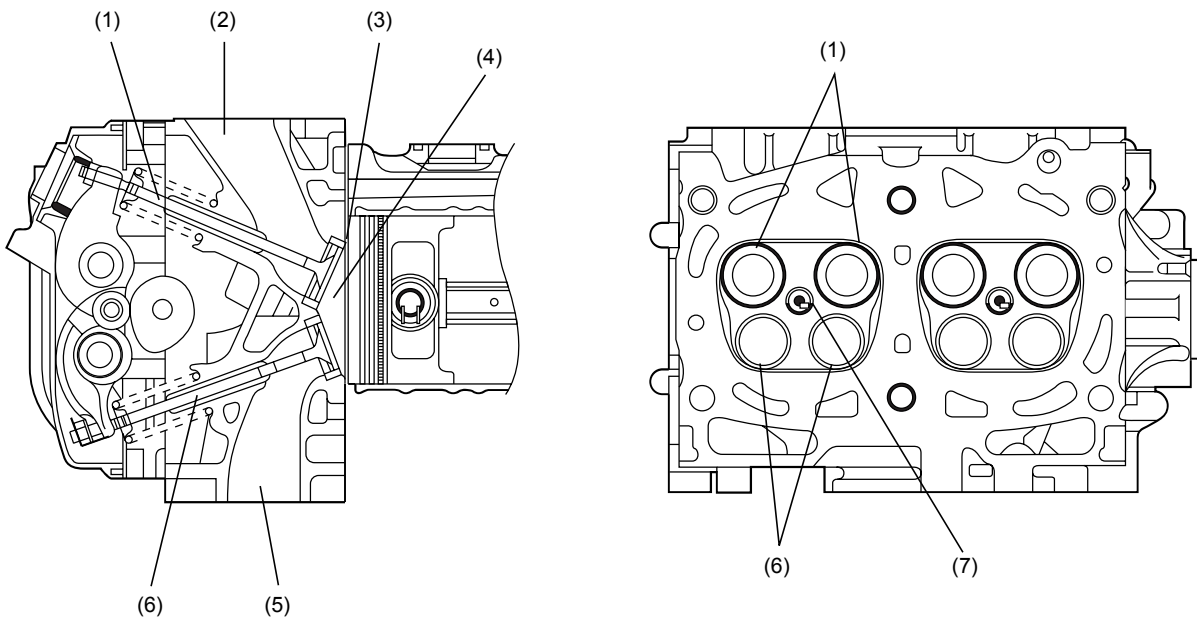


ME-02791

# CYLINDER HEAD

## 8. 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.
- As a design feature, the exhaust port of adjacent cylinders are joined to a single port, aiming at decreasing heat dissipation and accelerate activation of the catalytic converter.
- The cylinder head gasket is a metallic gasket. The gasket is highly resistant to heat and maintains high level of sealing performance for a long period.



ME-00318

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

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

## 9. Cylinder Block

- The cylinder block is made of aluminum die casting. Its open-deck design provides it with such advantageous features as relatively small weight, high rigidity and excellent cooling efficiency.
- 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.

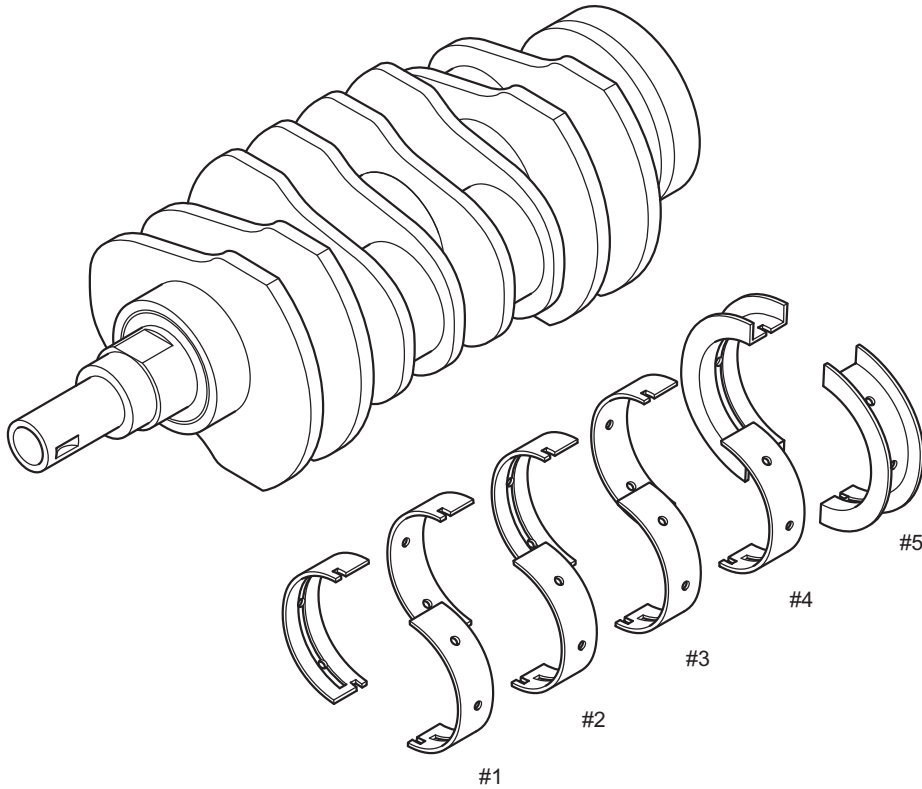
# CRANKSHAFT

MECHANICAL

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## 10.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.

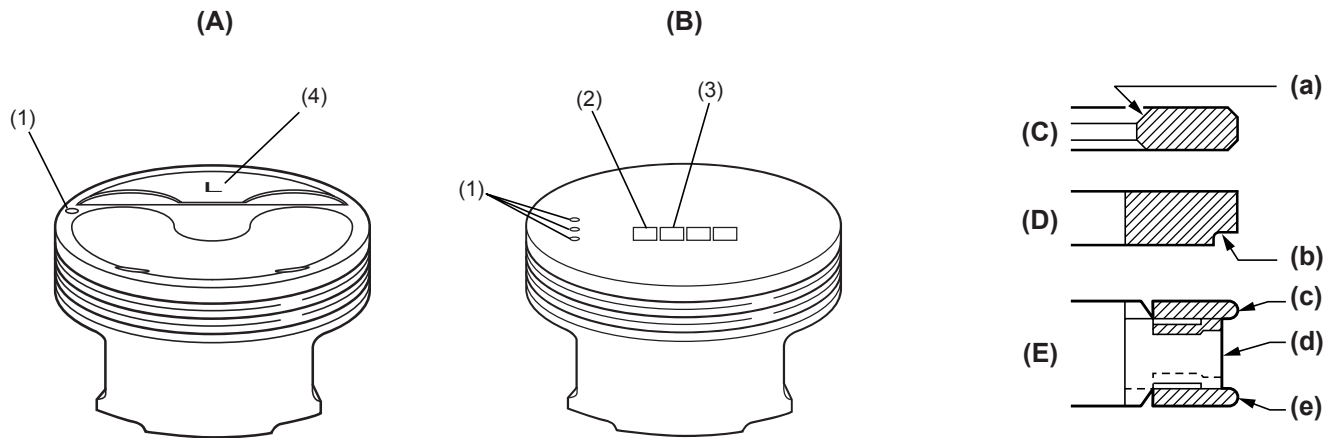


ME-00319



## 11. 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 pistons downwards, No. 2 and No. 4 pistons 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. On type I models, the piston heads are concaved at the entire exhaust side to gather the tumble flow around the spark plug and improve combustion. Only on the type I models the pistons are distinguished left or right.
- 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 an interrupt (cut) on the bottom outside to reduce oil consumption.



ME-02393

- (1) Location mark (engine front side)
- (2) Identification mark (piston size)
- (3) Engine displacement
- (4) Identification mark (left or right)

- (A)** Type I models
- (B)** Type II models
- (C)** Top ring
- (D)** Second ring
- (E)** Oil ring

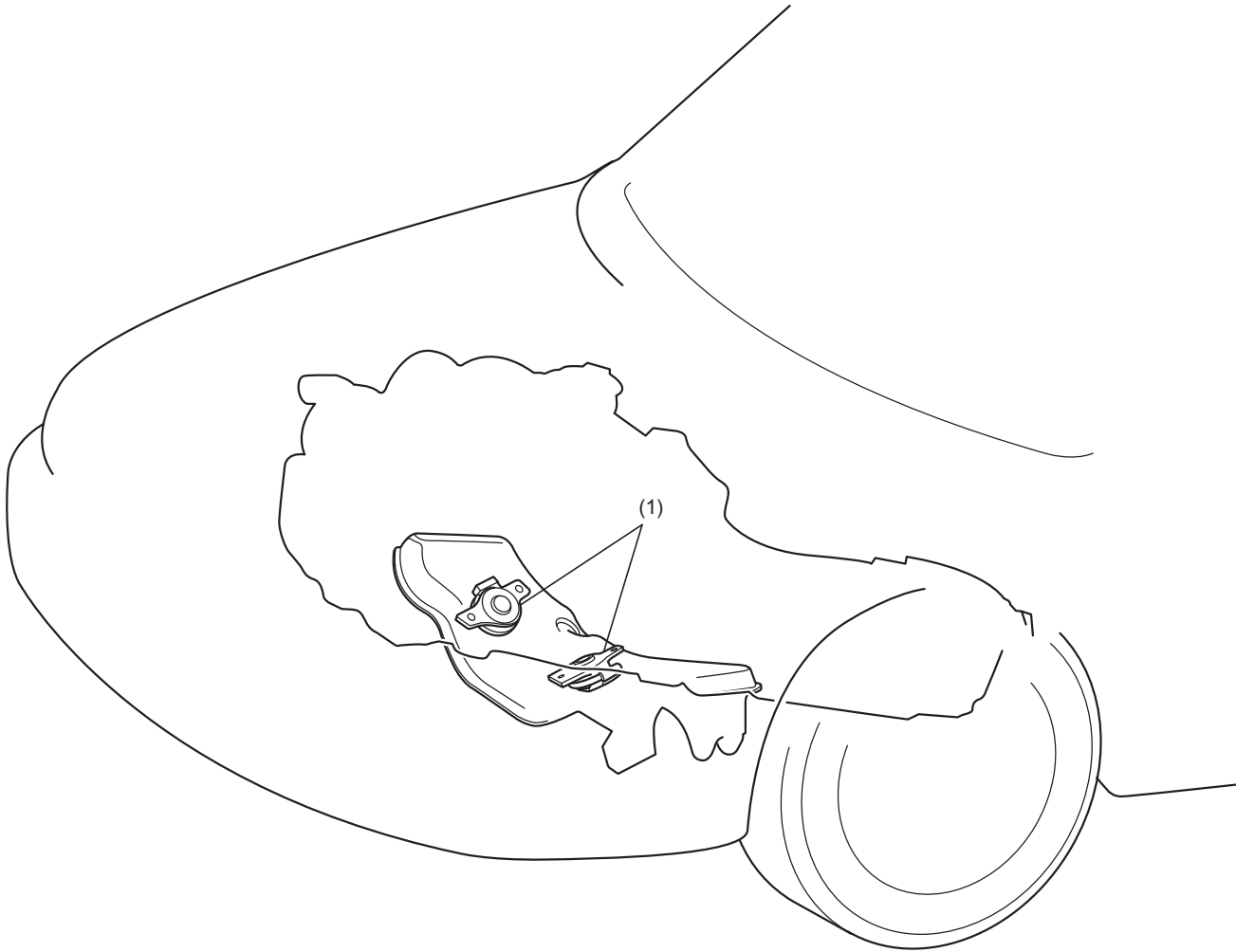
- (a)** Inner-bevel
- (b)** Cut
- (c)** Upper rail
- (d)** Expander
- (e)** Lower rail

# ENGINE MOUNTING

MECHANICAL

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## 12.Engine Mounting



ME-00434

(1) Cushion rubber