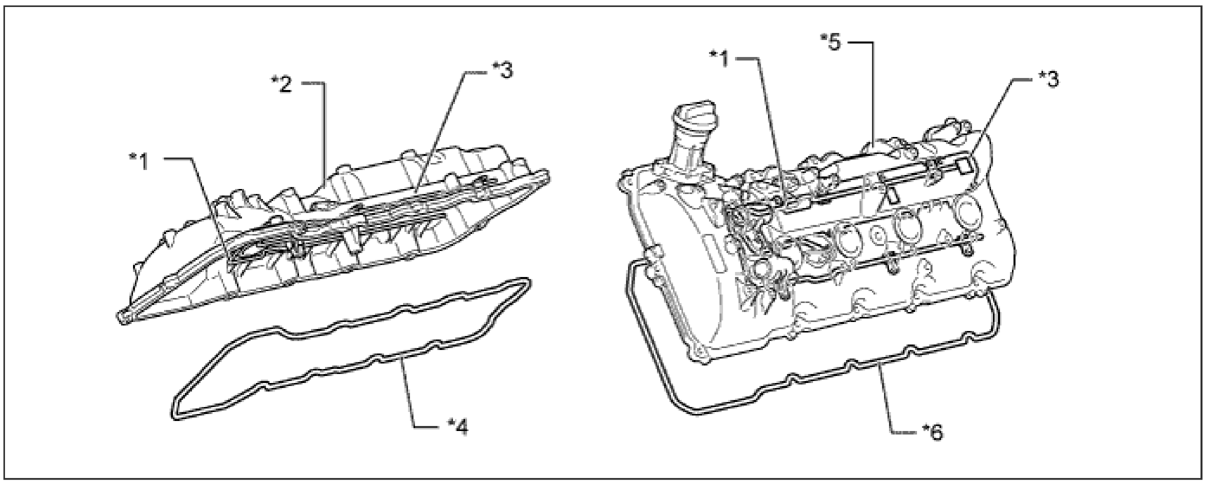
CONSTRUCTION

a. Cylinder Head Cover

i. A lightweight yet high-strength aluminum cylinder head cover is used.

ii. An oil delivery pipe is installed inside each cylinder head cover. This ensures lubrication to the sliding parts of the valve rocker arm sub-assemblies, thus improving reliability.

iii. Large baffle plates are built into the cylinder head covers. As a result, the speed of blowby gas flow is reduced, and the oil mist is removed from the blowby gas. Due to this, the amount of oil lost is reduced.



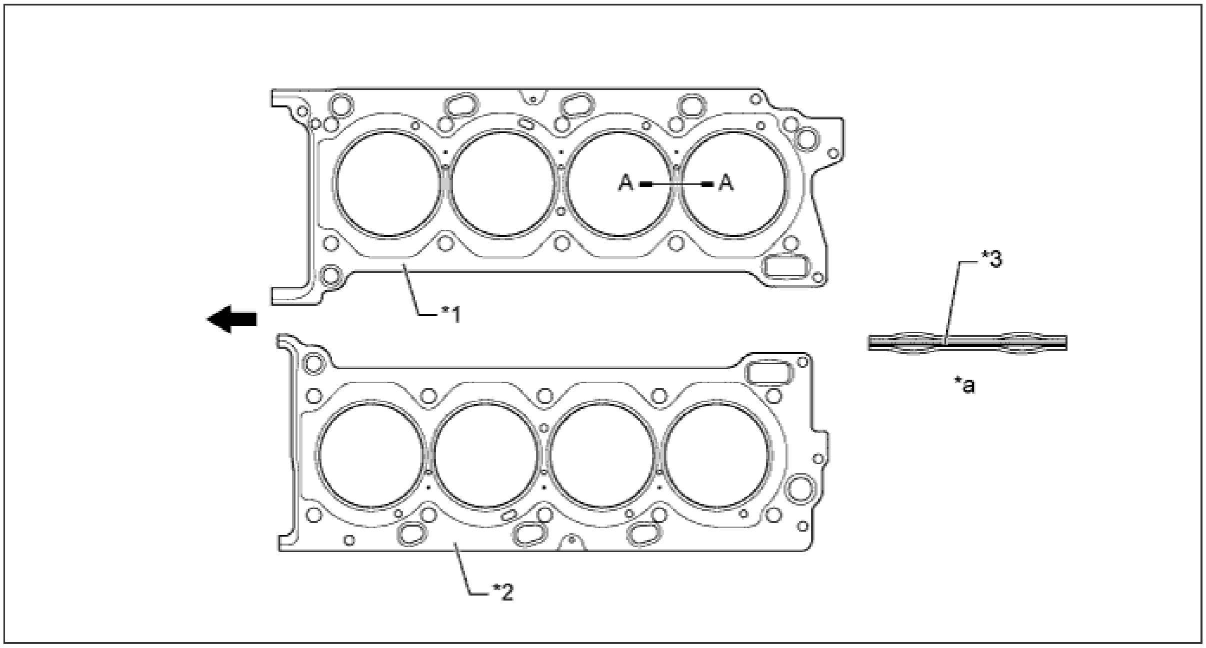
Text in Illustration

*1	Oil Delivery Pipe	*2	Cylinder Head Cover RH
*3	Baffle Plate	*4	Cylinder Head Cover Gasket RH
*5	Cylinder Head Cover LH	*6	Cylinder Head Cover Gasket LH

b. Cylinder Head Gasket

i. 3-layer steel-laminate type cylinder head gaskets are used. A shim is used around the cylinder bore of each gasket to help enhance sealing performance and durability. This results in improved fuel economy, reduced consumption rate of engine oil and reduced emission of exhaust gases.

ii. The surface is coated with highly heat-resistant fluoro rubber to support high power output.



Text in Illustration

*1	Cylinder Head Gasket RH	*2	Cylinder Head Gasket LH
*3	Shim	-	-
*a	A - A Cross Section	-	-
➡	Engine Front	-	-

c. Cylinder Head

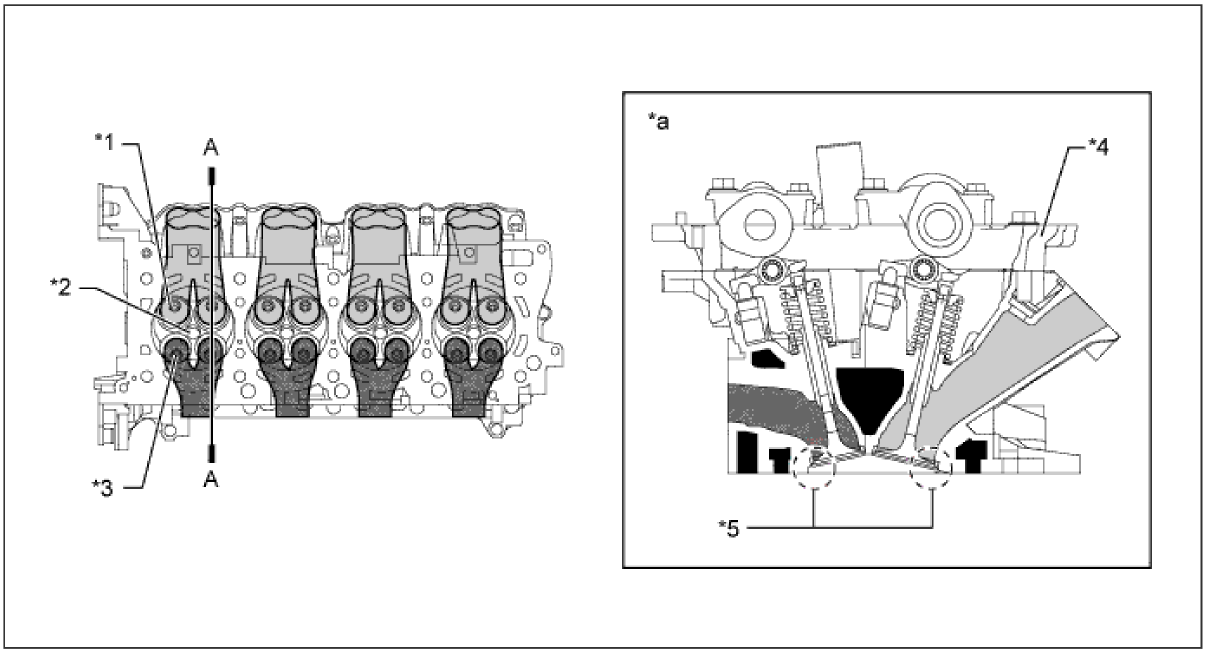
i. The cylinder head structure has been simplified by separating the cam journal portion (camshaft housing) from the cylinder head.

ii. The cylinder head, which is made of aluminum, 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.

iii. 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.

iv. 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.

v. A siamese type intake port is used. The port diameter gradually decreases toward the combustion chamber to optimize the airflow speed and intake pulsation.

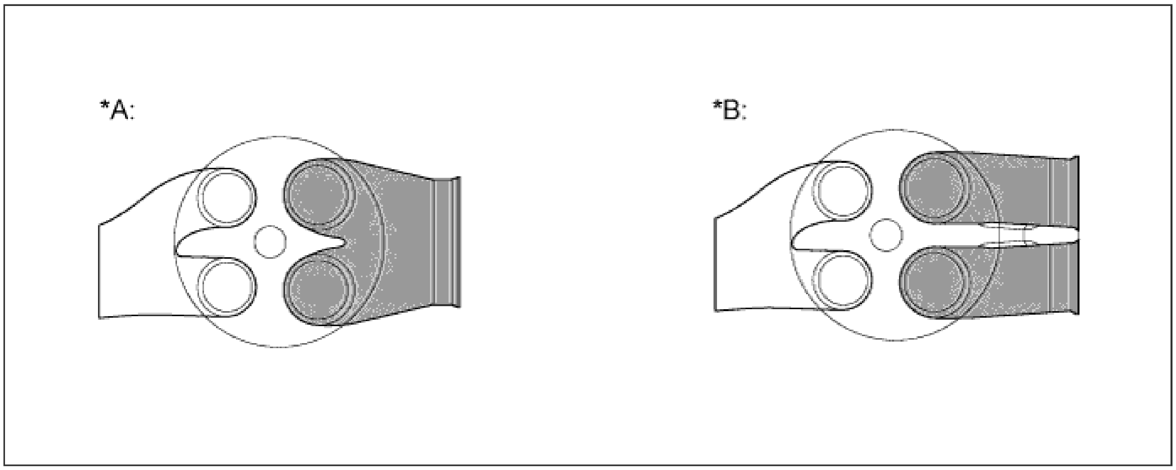


Text in Illustration

*1	Intake Valve	*2	Spark Plug Hole
*3	Exhaust Valve	*4	Camshaft Housing
*5	Taper Squish	-	-
*a	A - A Cross Section	-	-
	Intake Port		Exhaust Port

HINT:

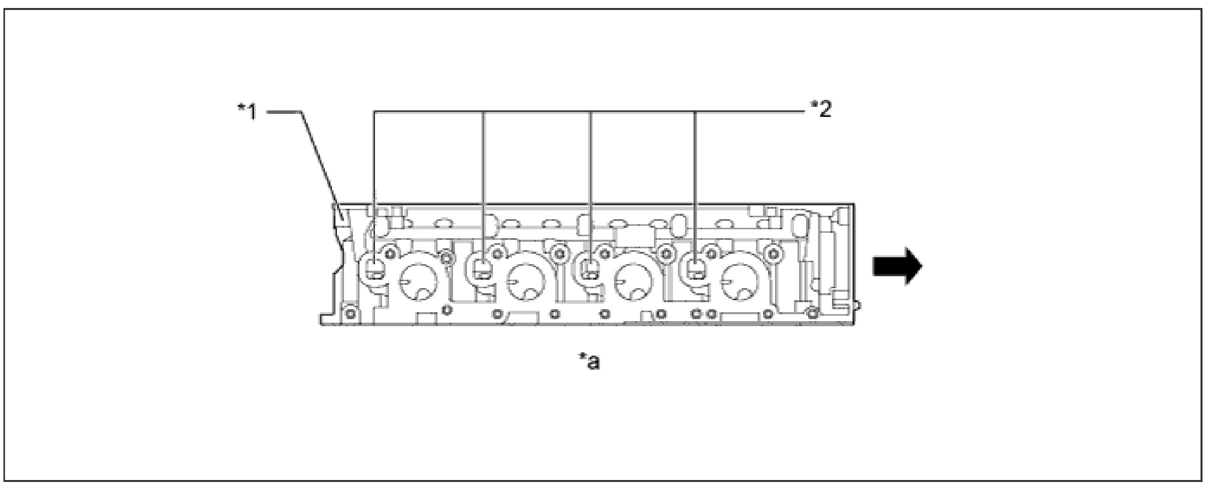
The difference between a siamese type intake port and an independent type one is shown in the following illustration:



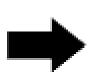
Text in Illustration

*A	Siamese Type	*B	Independent Type

vi. An air injection port is provided for the air injection system.



Text in Illustration

*1	Cylinder Head RH	*2	Air Injection Port
*a	Exhaust Side View	-	-
	Engine Front	-	-

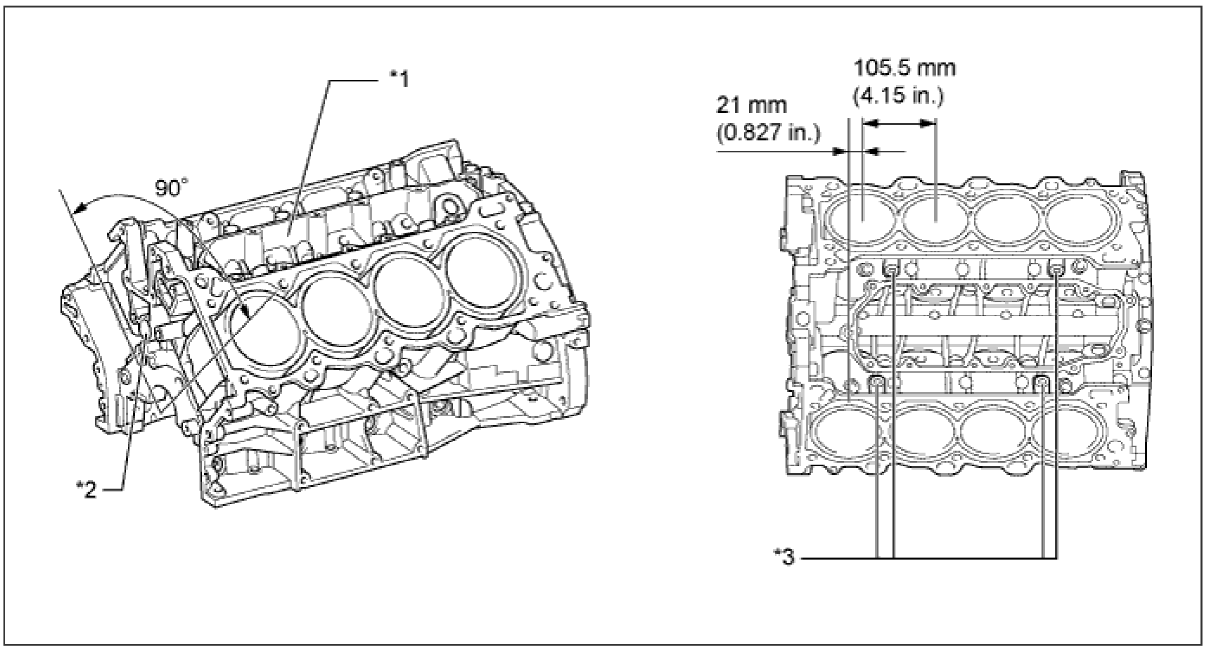
d. Cylinder Block

i. The cylinder block is made of aluminum alloy.

ii. 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 in its length and width considering its displacement.

iii. Installation bosses of the 4 knock control sensors are located on the inner side of the left and right banks to enhance the accuracy of the knock control sensors.

iv. 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 head and 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.

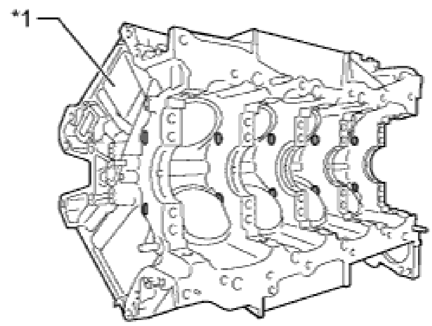


Text in Illustration

*1	Engine Coolant Distribution Pathway	*2	Main Oil Hole
*3	Knock Control Sensor Boss	-	-

v. Air passage holes are provided on the bulkheads 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 reciprocating movement) is reduced to improve the engine's output.

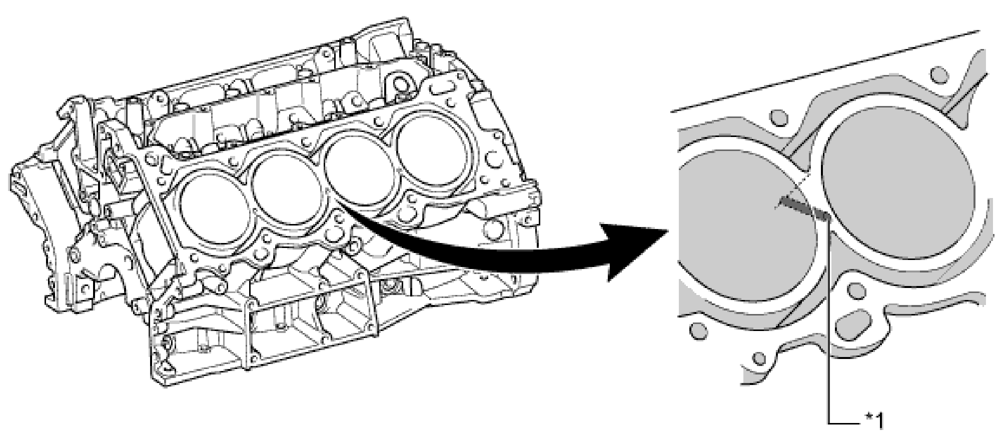
vi. An engine coolant distribution pathway is provided between the left and right banks. The engine coolant sent by the water pump passes through the engine coolant distribution pathway and flows to the cylinder head and water jackets of both banks. The engine coolant distribution pathway also cools the engine oil in the main oil hole located directly below the pathway.



Text in Illustration

*1	Cylinder Block	-	-
	Air Passage Hole	-	-

vii. A water passage is provided between the cylinder bores. By allowing the engine coolant to flow between the cylinder bores, this construction keeps the temperature of the cylinder walls uniform.



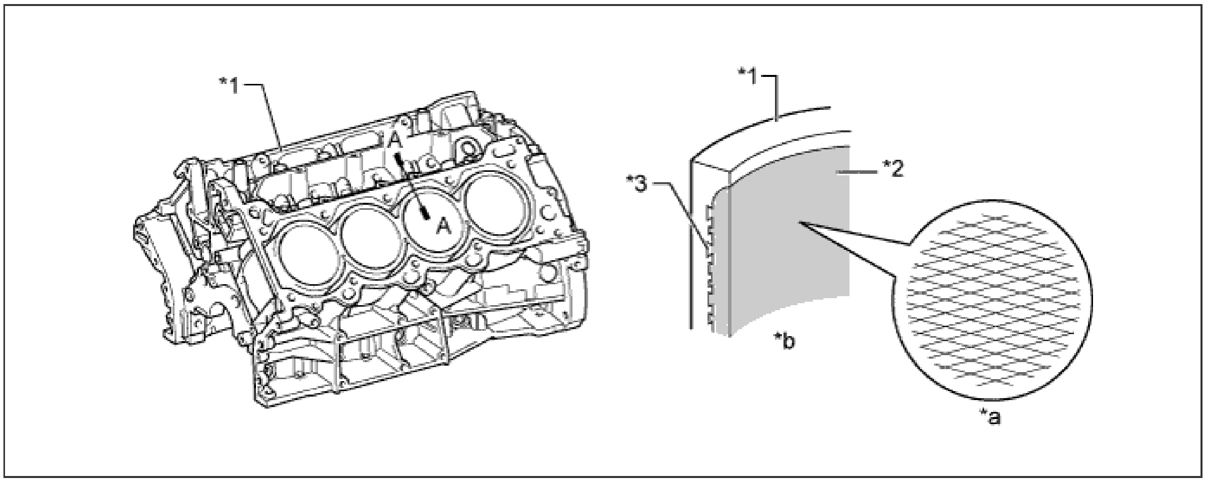
Text in Illustration

*1	Water Passage	-	-

viii. Spiny-type liners are used.

ix. 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.

x. The shape of the cross-hatching of the liner surface has been optimized to improve oil retention performance, resulting in reduced friction.

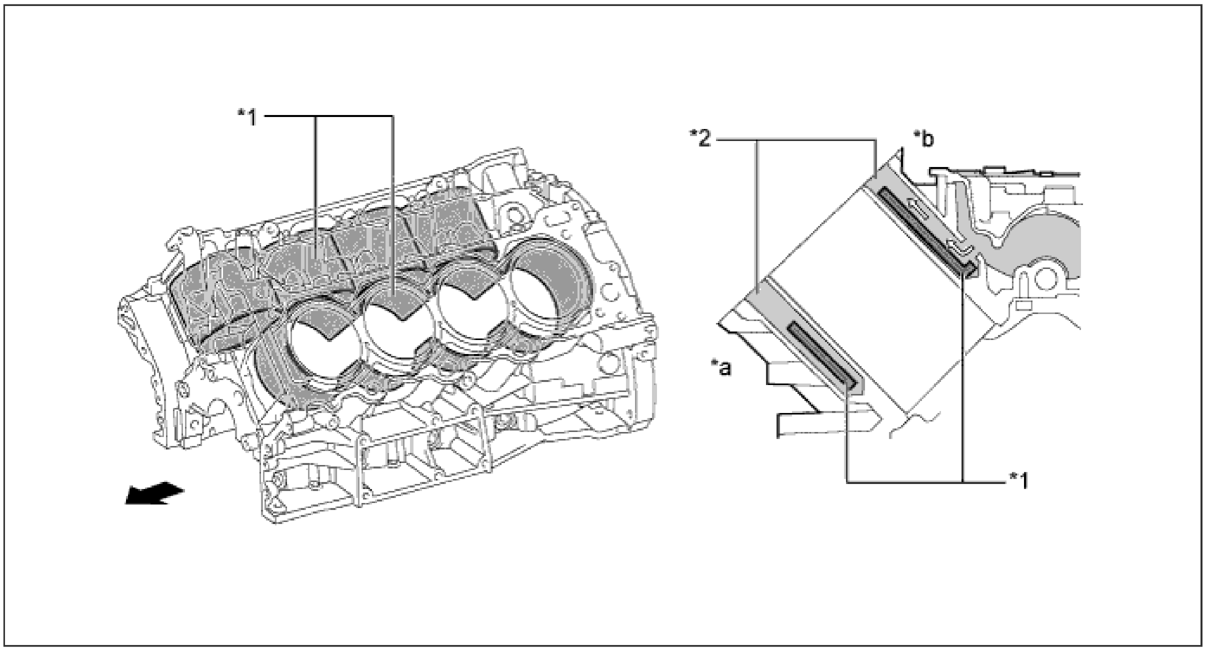


Text in Illustration

*1	Cylinder Block	*2	Liner
*3	Irregularly Shaped Outer Casting Surface of Liner	-	-
*a	Enlarged View of Cross-hatching	*b	A - A Cross Section

xi. 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.

xii. The temperature in the intake side of the 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 the 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.



Text in Illustration

*1	Cylinder Block Water Jacket Spacer	*2	Water Jacket
*a	Exhaust Side	*b	Intake Side
	Engine Front		Engine Coolant Flow
	Engine Coolant	-	-

e. Piston

i. The pistons are made of aluminum alloy.

ii. A compact combustion chamber is provided on top of the piston to achieve stable combustion. Together with the pentroof type combustion chamber of the cylinder head, this achieves a high compression ratio, resulting in both high performance and excellent fuel economy.

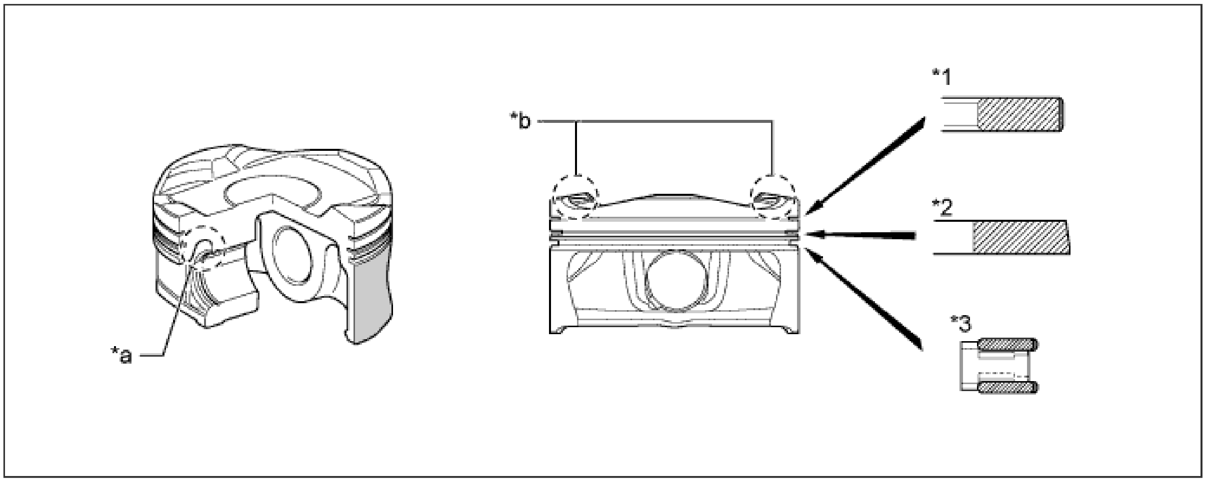
iii. A taper squish combustion chamber is used to improve anti-knocking performance and intake efficiency. In addition, engine performance and fuel economy are improved.

iv. In order to reduce weight, cast holes are provided on the bottom of the piston head near the pin bosses as shown in the illustration below.

v. The piston skirt is coated with resin to reduce friction losses.

vi. A Physical Vapor Deposition (PVD) coating has been applied to the surface of the No. 1 compression ring and oil ring, in order to improve its wear resistance.

vii. By increasing the machining precision of the cylinder bore diameter in the block, only one size of piston is required.



Text in Illustration

*1	No. 1 Compression Ring	*2	No. 2 Compression Ring
*3	Oil Ring	-	-
*a	Weight Reduction Area	*b	Taper Squish Shape
(light grey swatch)	Resin Coating	(dark grey swatch)	PVD Coating

HINT:

The same pistons are used for both right and left banks. When installing a piston, the front mark should face the front of the engine.

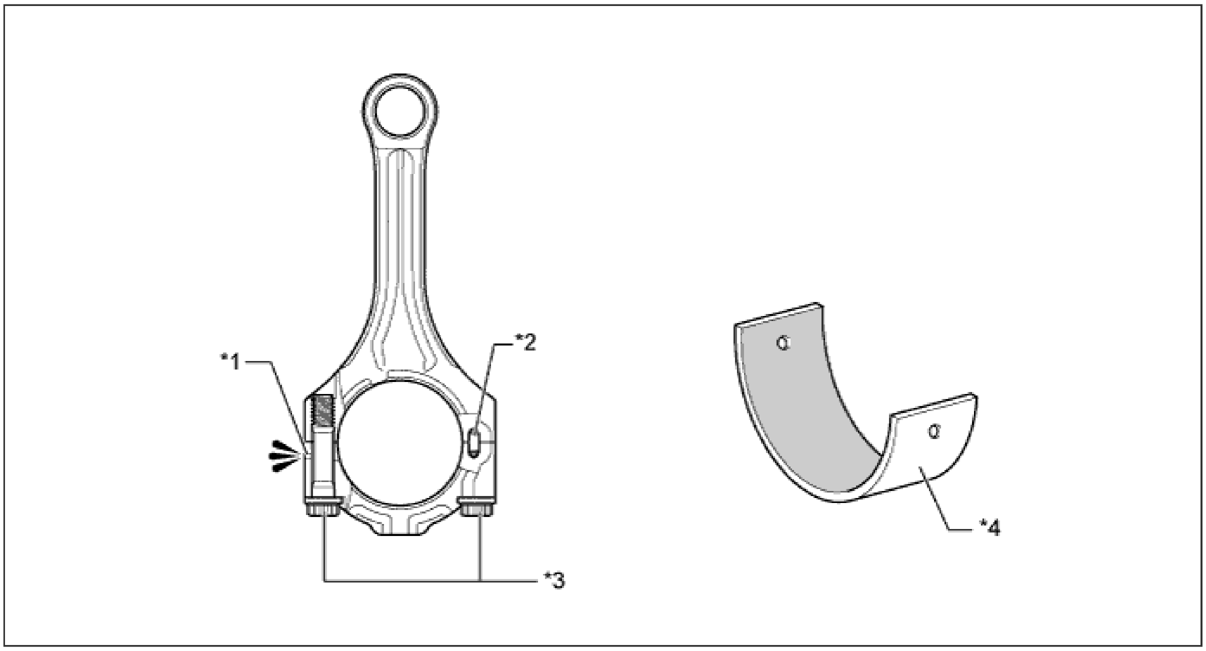
f. Connecting Rod and Connecting Rod Bearing

i. Connecting rods that have been forged for high strength are used for weight reduction.

ii. 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.

iii. Plastic region tightening bolts are used on the connecting rods.

iv. Resin-coated aluminum bearings are used for the connecting rod bearings. The connecting rod bearings are reduced in width to reduce friction.



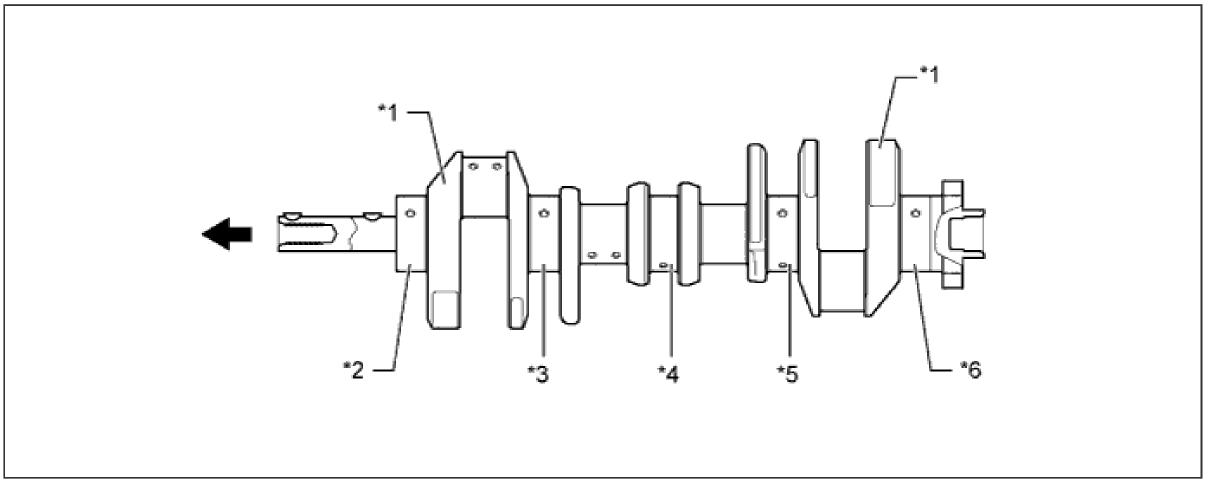
Text in Illustration

*1	Oil Jet	*2	Knock Pin
*3	Plastic Region Tightening Bolt	*4	Connecting Rod Bearing
	Resin Coating	-	-

g. Crankshaft

i. A crankshaft made of forged steel, which excels in rigidity and wear resistance, is used.

ii. The crankshaft has 5 main bearing journals and 6 balance weights.



Text in Illustration

*1	Balance Weight	*2	No. 1 Journal
*3	No. 2 Journal	*4	No. 3 Journal
*5	No. 4 Journal	*6	No. 5 Journal
➡	Engine Front	-	-

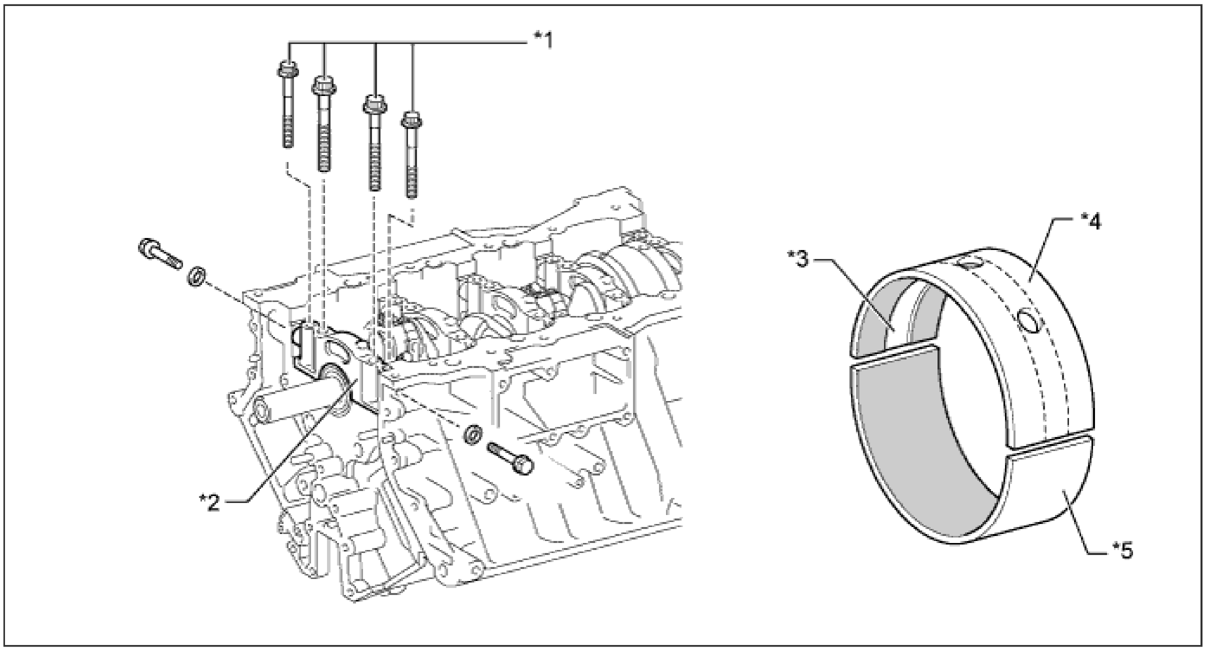
h. Crankshaft Bearing and Crankshaft Bearing Cap

i. The crankshaft bearings are made of aluminum alloy.

ii. The crankshaft bearings are reduced in width to reduce friction. The bearing lining surface is coated with resin to improve wear and seizure resistance.

iii. The upper crankshaft bearing has an oil groove around its inside circumference.

iv. The crankshaft bearing caps use 4 plastic region tightening bolts of different sizes in the inner and outer sides to secure the journals. This makes the crankshaft bearing caps more compact and lightweight. In addition, each cap has been tightened laterally to improve its reliability.

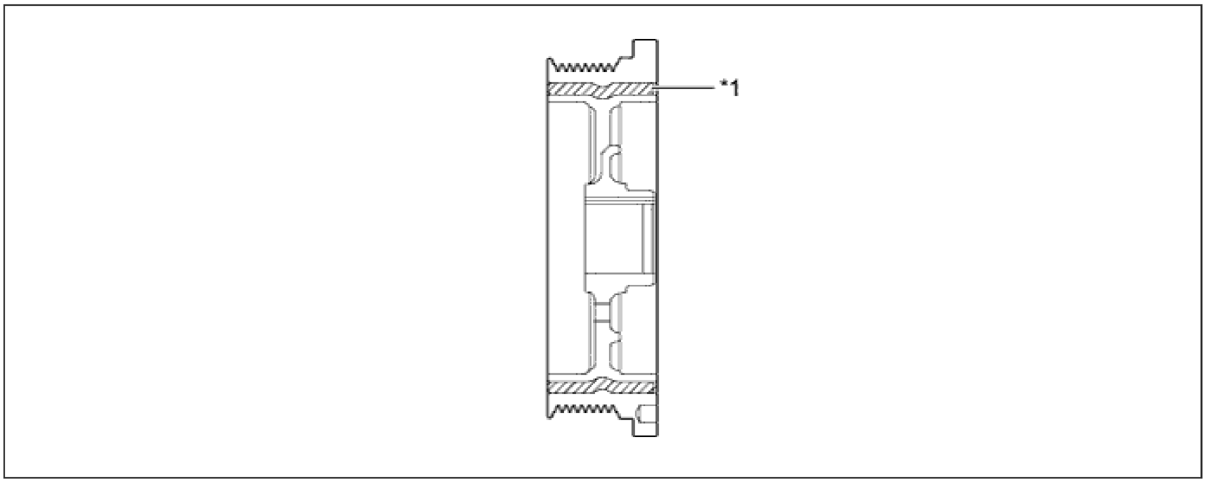


Text in Illustration

*1	Plastic Region Tightening Bolt	*2	Crankshaft Bearing Cap
*3	Oil Groove	*4	Upper Crankshaft Bearing
*5	Lower Crankshaft Bearing	-	-
(gray swatch)	Resin Coating	-	-

i. Crankshaft Pulley

i. The rigidity of the crankshaft pulley with its built-in torsional damper rubber reduces noise.



Text in Illustration

*1	Torsional Damper Rubber	-	-

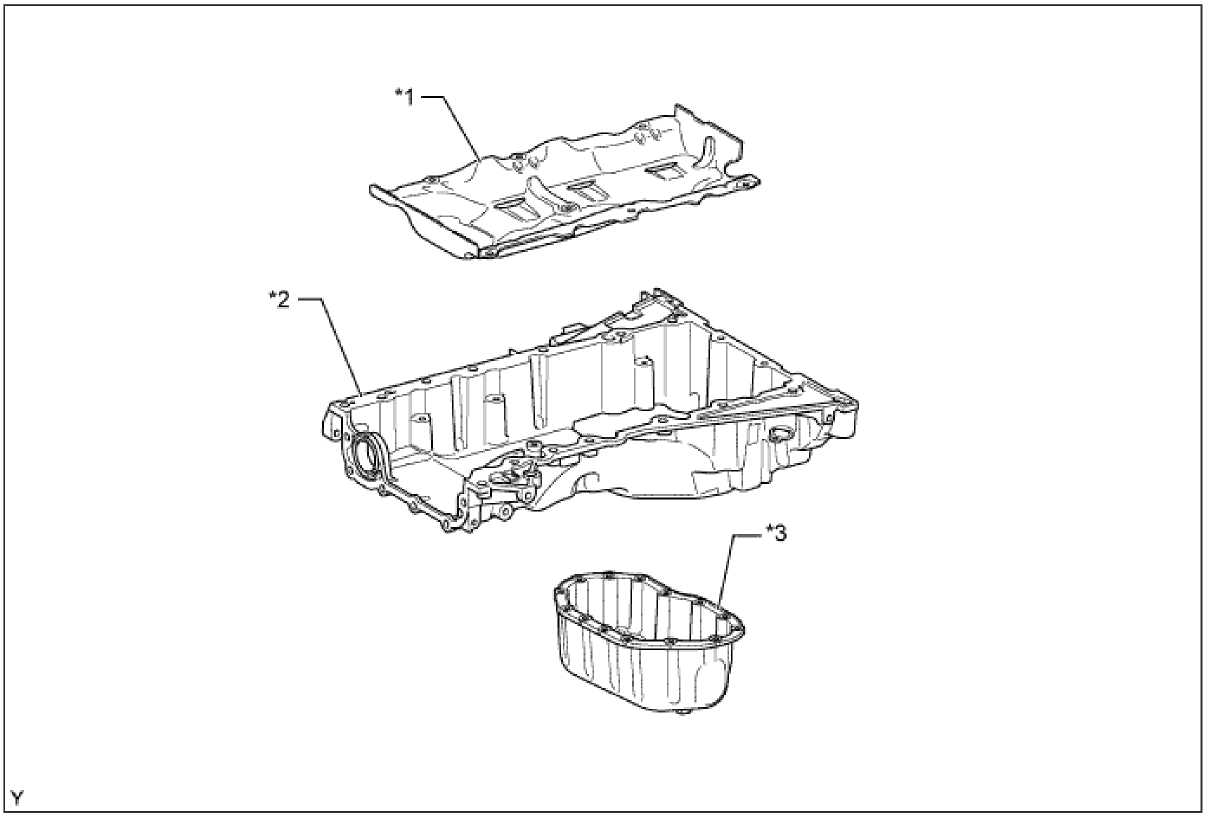
j. Oil Pan

i. No. 1 oil pan is made of aluminum alloy.

ii. No. 2 oil pan is made of steel.

iii. The No. 1 oil pan is secured to the cylinder block and the transmission housing to increase rigidity.

iv. The shape of the oil pan baffle plate has been optimized to ensure the proper space between the crankshaft and the engine oil surface. This enhances the separation of oil flow and ventilation gases, thus reducing friction and improving lubrication performance.

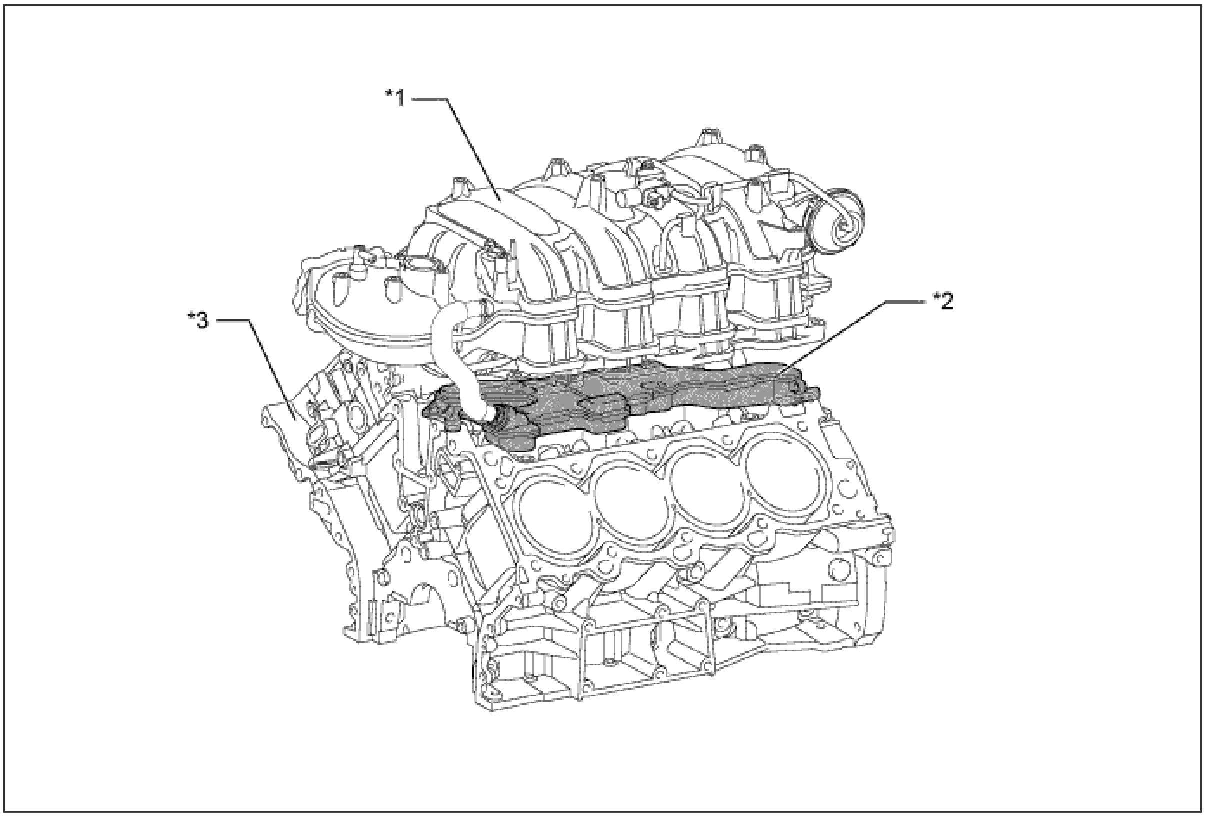


Text in Illustration

*1	Oil Pan Baffle Plate	*2	No. 1 Oil Pan
*3	No. 2 Oil Pan	-	-

k. Separator Case

i. A plastic separator case is provided between the cylinder block and the intake manifold in order to separate the engine oil included in the blowby gas.

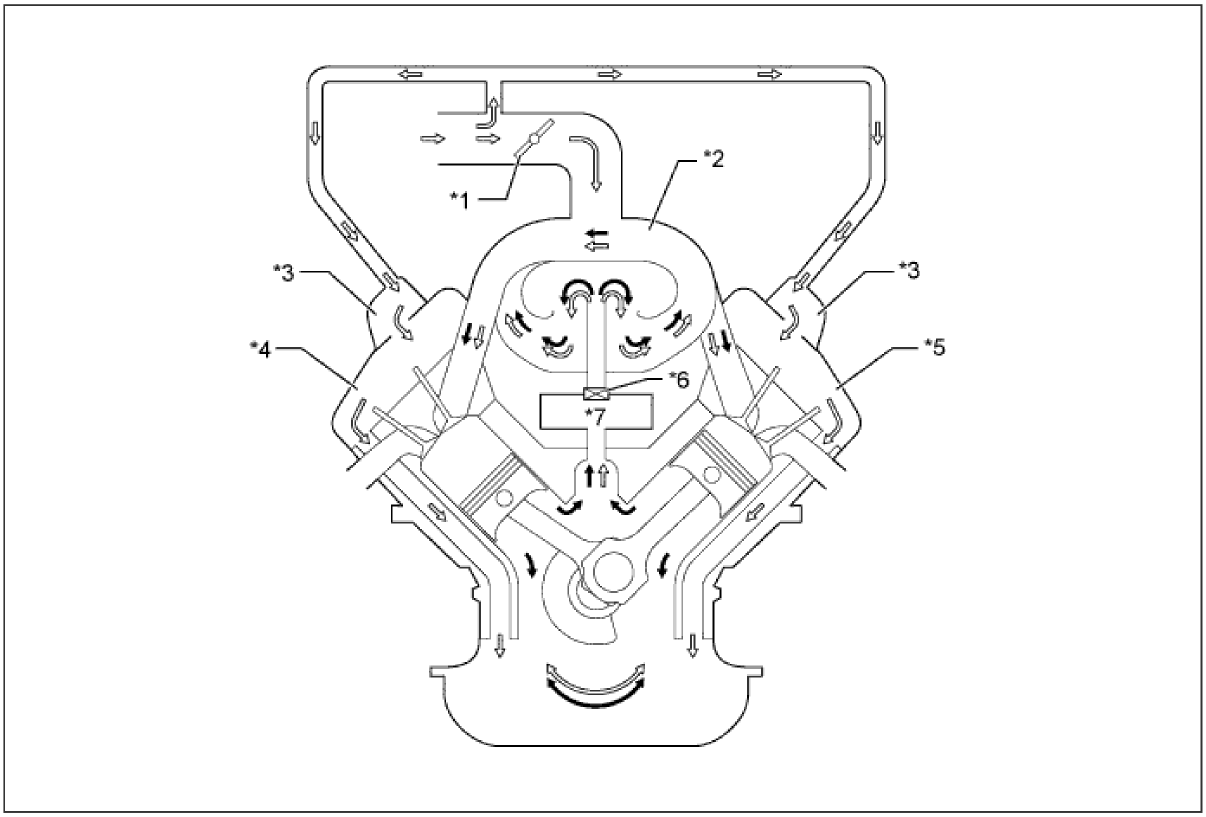


Text in Illustration

*1	Intake Manifold	*2	Separator Case
*3	Cylinder Block	-	-

ii. The oil separator portion of the cylinder head covers has been made compact through the use of an independent separator case. This contributes to making the entire engine compact.

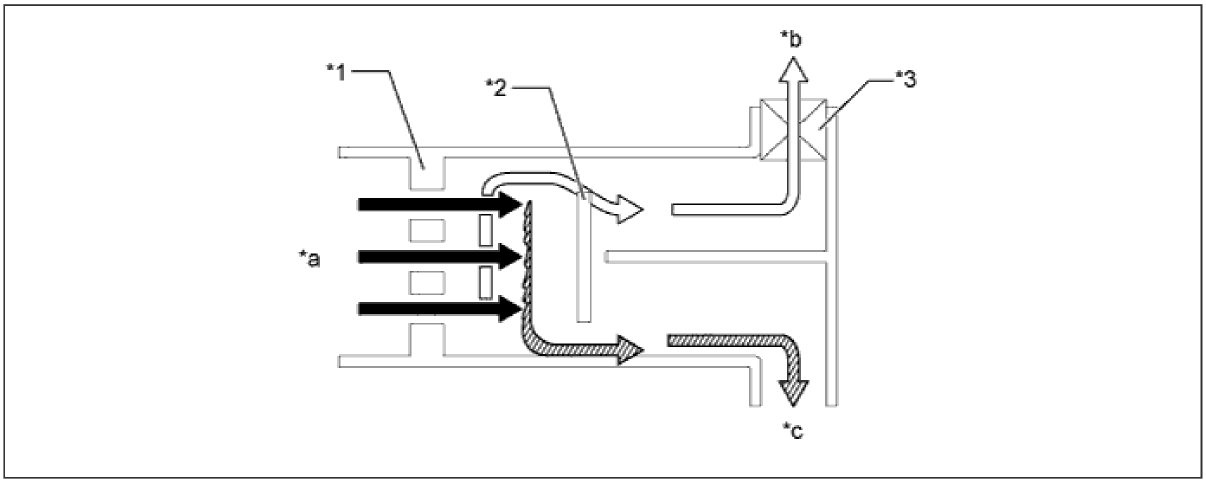
iii. Fresh air is drawn from the right and left bank cylinder head covers to improve the ventilation inside the engine and improve the deterioration resistance of the engine oil.



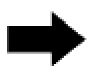
Text in Illustration

*1	Throttle Valve	*2	Intake Manifold
*3	Oil Separator Portion	*4	Cylinder Head Cover RH
*5	Cylinder Head Cover LH	*6	PCV Valve
*7	Separator Case	-	-
(black arrow)	Blowby Gas	(white arrow)	Fresh Air

iv. An inertial impaction system is used in the construction for separating the engine oil in the separator case. Blowby gas containing engine oil hits the plate, thus causing the engine oil to adhere and accumulate on the plate. Then, the oil drips down by way of gravity. Thus, this system efficiently separates the engine oil from the blowby gas. This improves the rate of the collection of the engine oil and reduces the amount of engine oil consumption.



Text in Illustration

*1	Separator Case	*2	Intake Manifold
*3	PCV Valve	-	-
*a	From Cylinder Block	*b	To Intake Manifold
*c	To Oil Pan	-	-
	Blowby Gas Containing Engine Oil		Blowby Gas
	Engine Oil	-	-

l. Valve Mechanism

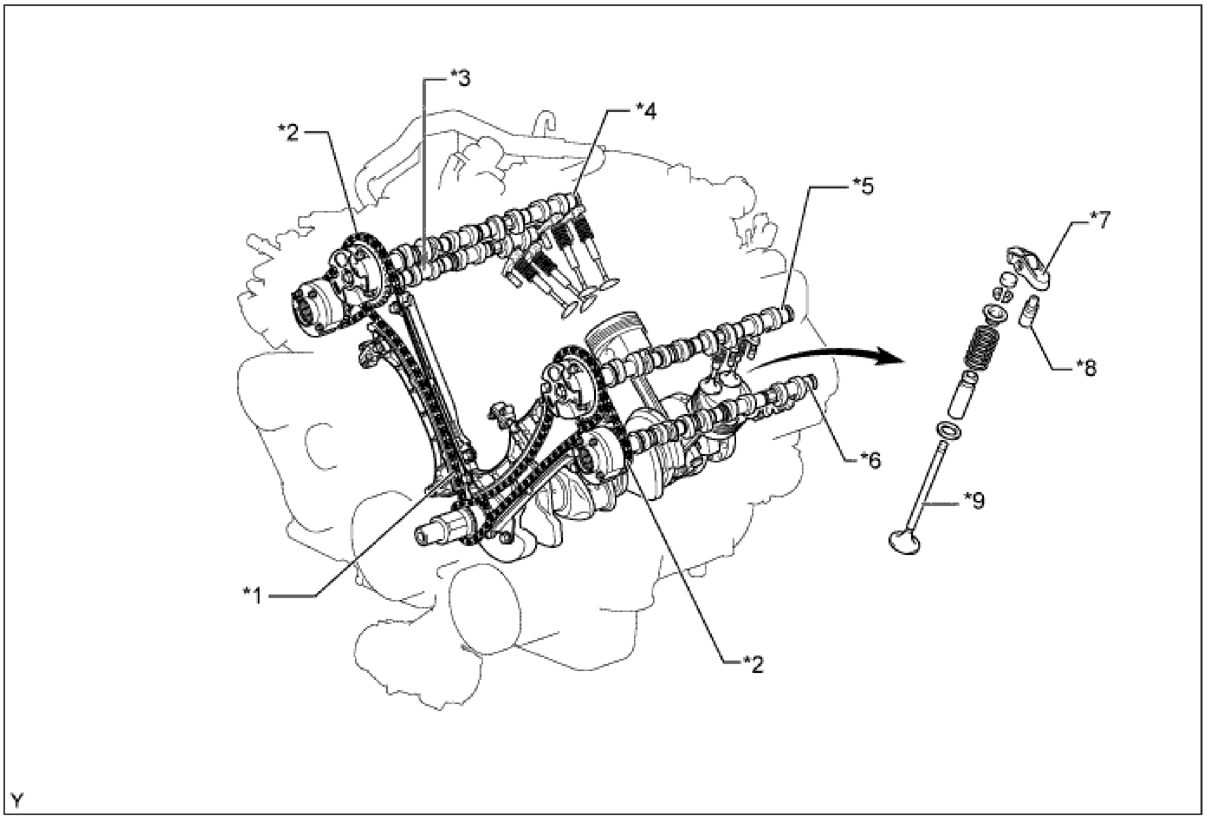
i. Each cylinder of this engine has 2 intake valves and 2 exhaust valves. Intake and exhaust efficiency is increased due to the larger total port areas.

ii. This engine uses valve rocker arm sub-assemblies with built-in needle bearings. This reduces the friction that occurs between the cams and the valve rocker arm sub-assemblies when the valves are pushed down, thus improving fuel economy.

iii. A valve lash adjuster assembly, which maintains a constant zero valve clearance through the use of oil pressure and spring force, is used.

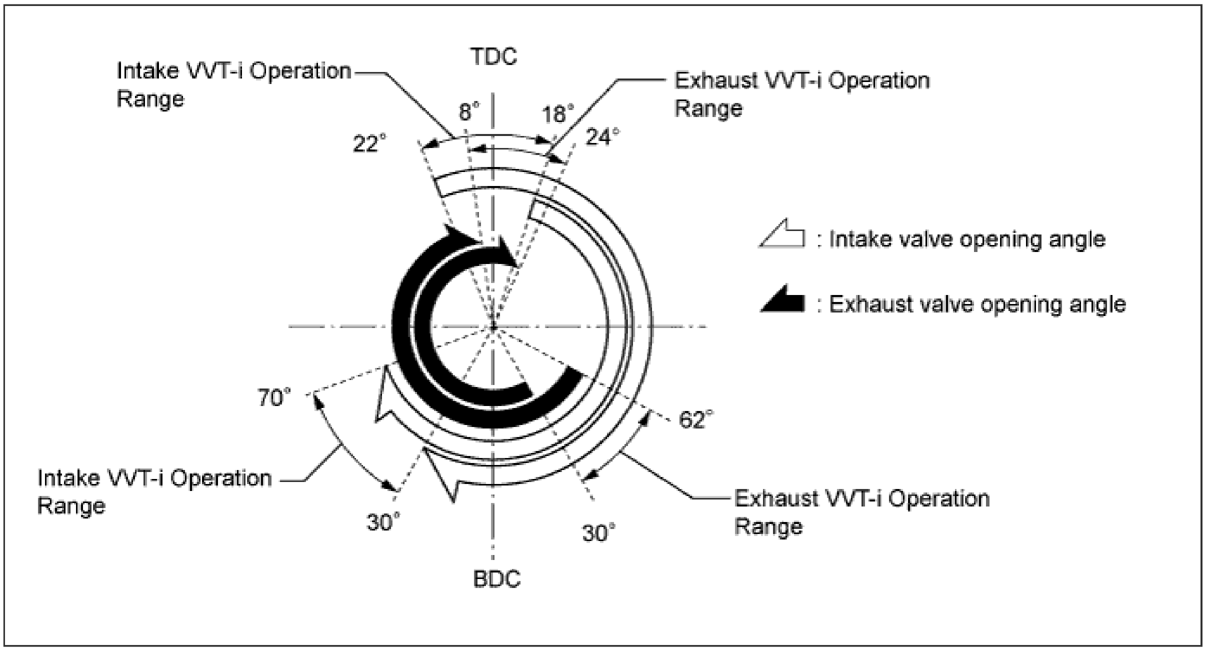
iv. The intake camshafts are driven by the crankshaft via the primary timing chain. The exhaust camshafts are each driven by the intake camshaft of their respective bank via a secondary chain.

v. This engine uses the Dual Variable Valve Timing-intelligent (Dual VVT-i) system which controls the intake camshafts and exhaust camshafts to provide optimal valve timing in accordance with driving conditions. As a result, lower fuel consumption, higher engine performance, and fewer exhaust emissions have been achieved.



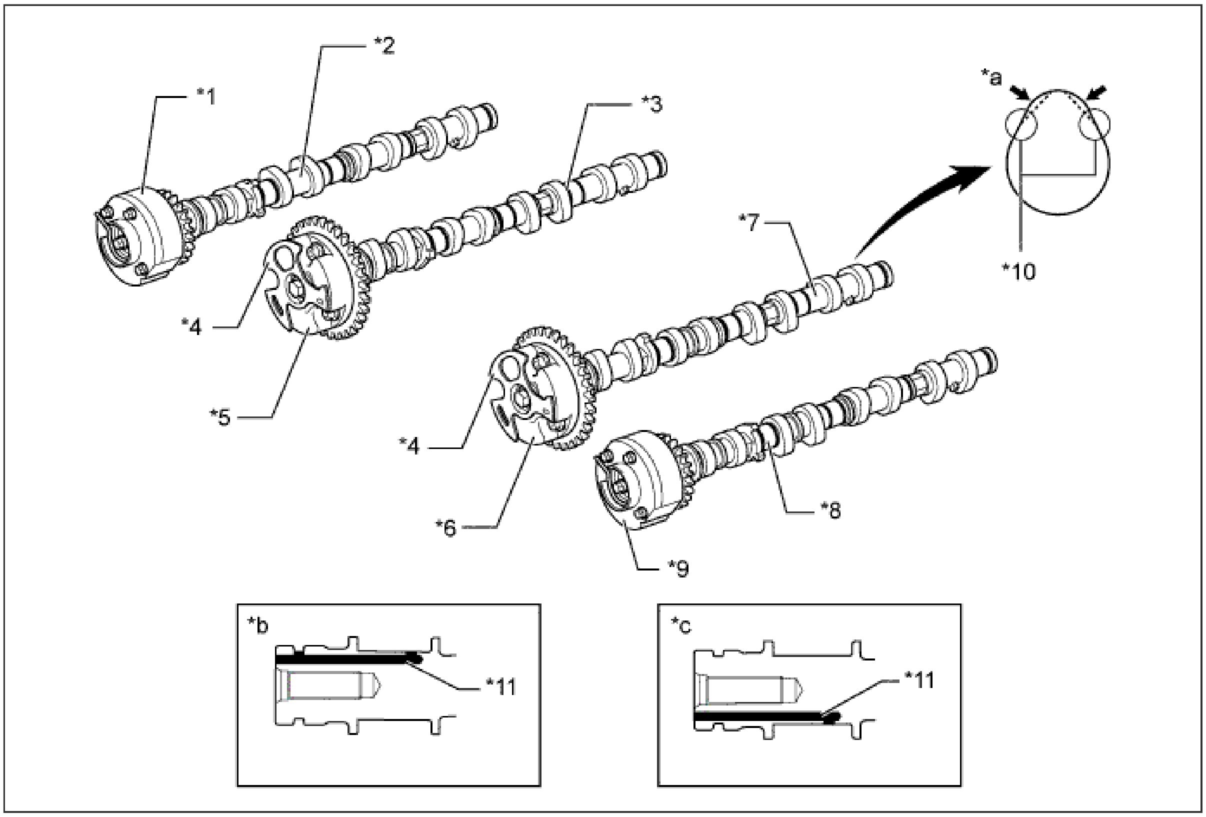
Text in Illustration

*1	Primary Timing Chain	*2	Secondary Timing Chain
*3	No. 2 Camshaft (Exhaust)	*4	No. 1 Camshaft (Intake)
*5	No. 3 Camshaft (Intake)	*6	No. 4 Camshaft (Exhaust)
*7	Valve Rocker Arm Sub-assembly	*8	Valve Lash Adjuster Assembly
*9	Valve	-	-



m. Camshaft

- **i.** The camshafts are made of cast iron alloy.
- **ii.** Oil passages are provided on the intake and exhaust camshafts in order to supply engine oil to the VVT-i system.
- **iii.** VVT-i controllers are installed on the front of the intake and exhaust camshafts to vary the timing of the intake and exhaust valves.
- **iv.** Together with the use of the valve rocker arm sub-assemblies, the cam profile has been optimized. This results in increased valve lift when the valve begins to open and when it finishes closing, thus helping to achieve enhanced output performance.



Text in Illustration

*1	VVT-i Controller (Exhaust RH)	*2	No. 2 Camshaft (Exhaust)
*3	No. 1 Camshaft (Intake)	*4	Timing Rotor
*5	VVT-i Controller (Intake RH)	*6	VVT-i Controller (Intake LH)
*7	No. 3 Camshaft (Intake)	*8	No. 4 Camshaft (Exhaust)
*9	VVT-i Controller (Exhaust LH)	*10	Modified profile of Camshaft Lobe
*11	Oil Passage	-	-
*a	Increased Valve Lift	*b	Cross Section of End of Intake Camshaft
*c	Cross Section of End of Exhaust Camshaft	-	-

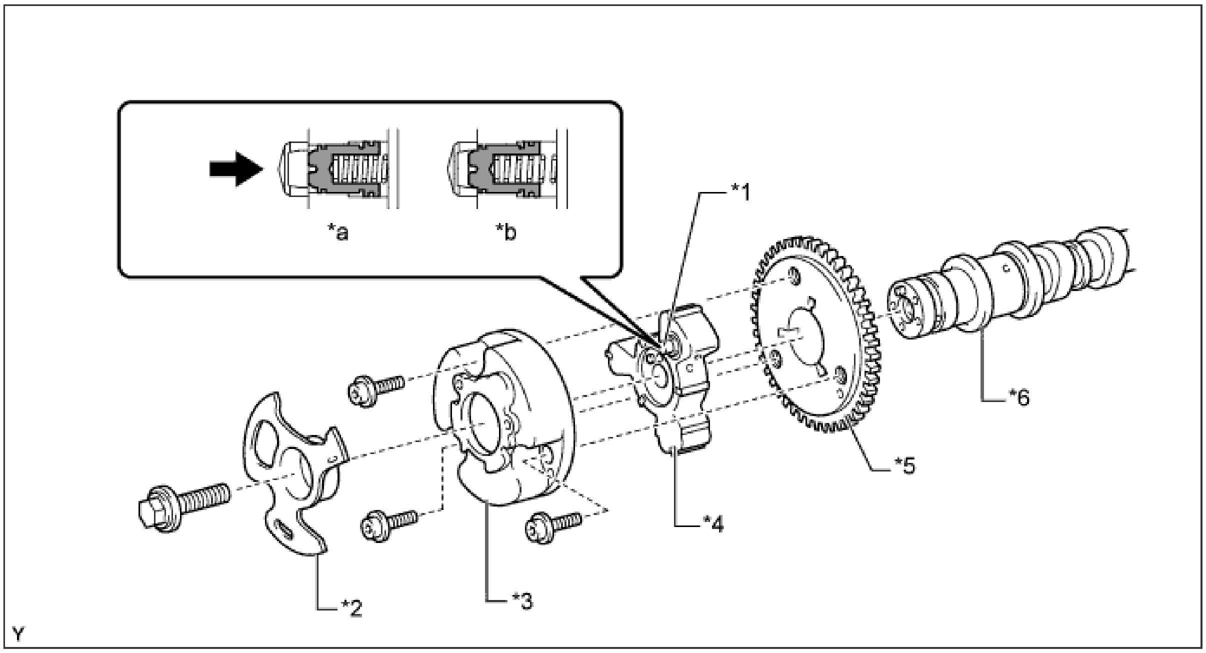
n. VVT-i Controller (Intake)

i. This controller consists of an outer housing driven by the timing chain sprocket, and a vane coupled to each camshaft.

ii. The intake side uses a VVT-i controller with 3 vanes.

iii. When the engine stops, each intake side VVT-i controller is locked at the most retarded angle by its lock pin. This ensures excellent engine startability.

iv. The oil pressure sent from the advance or retard side passages of the intake camshafts causes rotation of the vane relative to the timing chain sprocket, to vary the valve timing continuously.



Text in Illustration

*1	Lock Pin	*2	Timing Rotor
*3	Outer Housing	*4	Vane (Coupled to Intake Camshaft)
*5	Timing Chain Sprocket	*6	Intake Camshaft
*a	Engine Operating	*b	Engine Stopped
	Oil Pressure	-	-

o. VVT-i Controller (Exhaust)

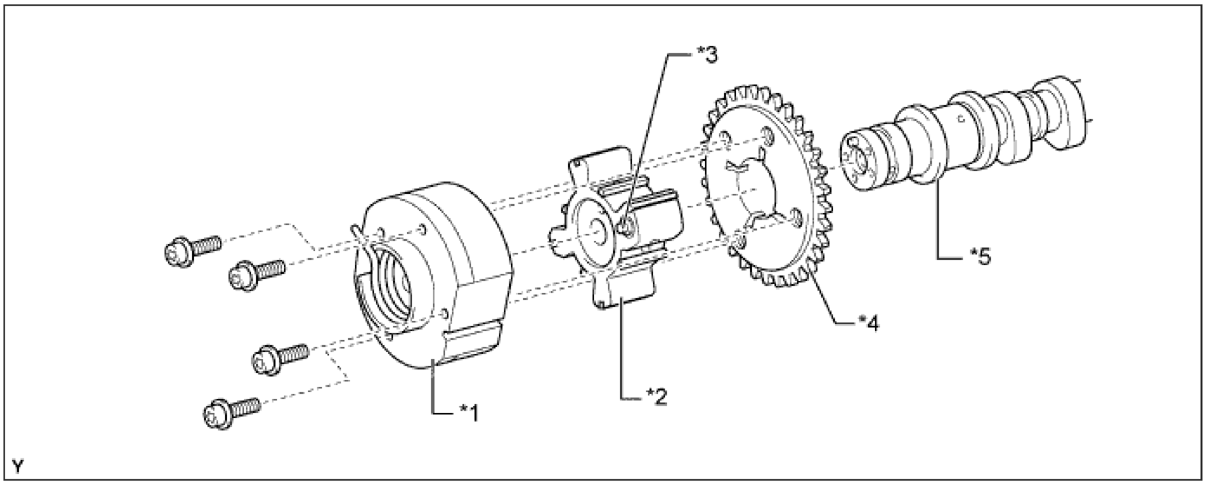
i. This controller consists of an outer housing that is driven by the timing chain sprocket, and a vane that is coupled to each camshaft.

ii. The exhaust side uses a VVT-i controller with 4 vanes.

iii. When the engine stops, the exhaust side VVT-i controller is locked at the most advanced angle. This ensures excellent engine startability.

iv. The oil pressure sent from the advance or retard side passages of the exhaust camshafts causes rotation of the vane relative to the timing chain sprocket, to vary the valve timing continuously.

v. An advance assist spring is provided on the exhaust side VVT-i controller. This helps to apply torque in the advance angle direction so that the vane lock pin securely engages with the housing when the engine stops.



Text in Illustration

*1	Outer Housing	*2	Vane (Coupled to Exhaust Camshaft)
*3	Lock Pin	*4	Timing Chain Sprocket
*5	Exhaust Camshaft	-	-

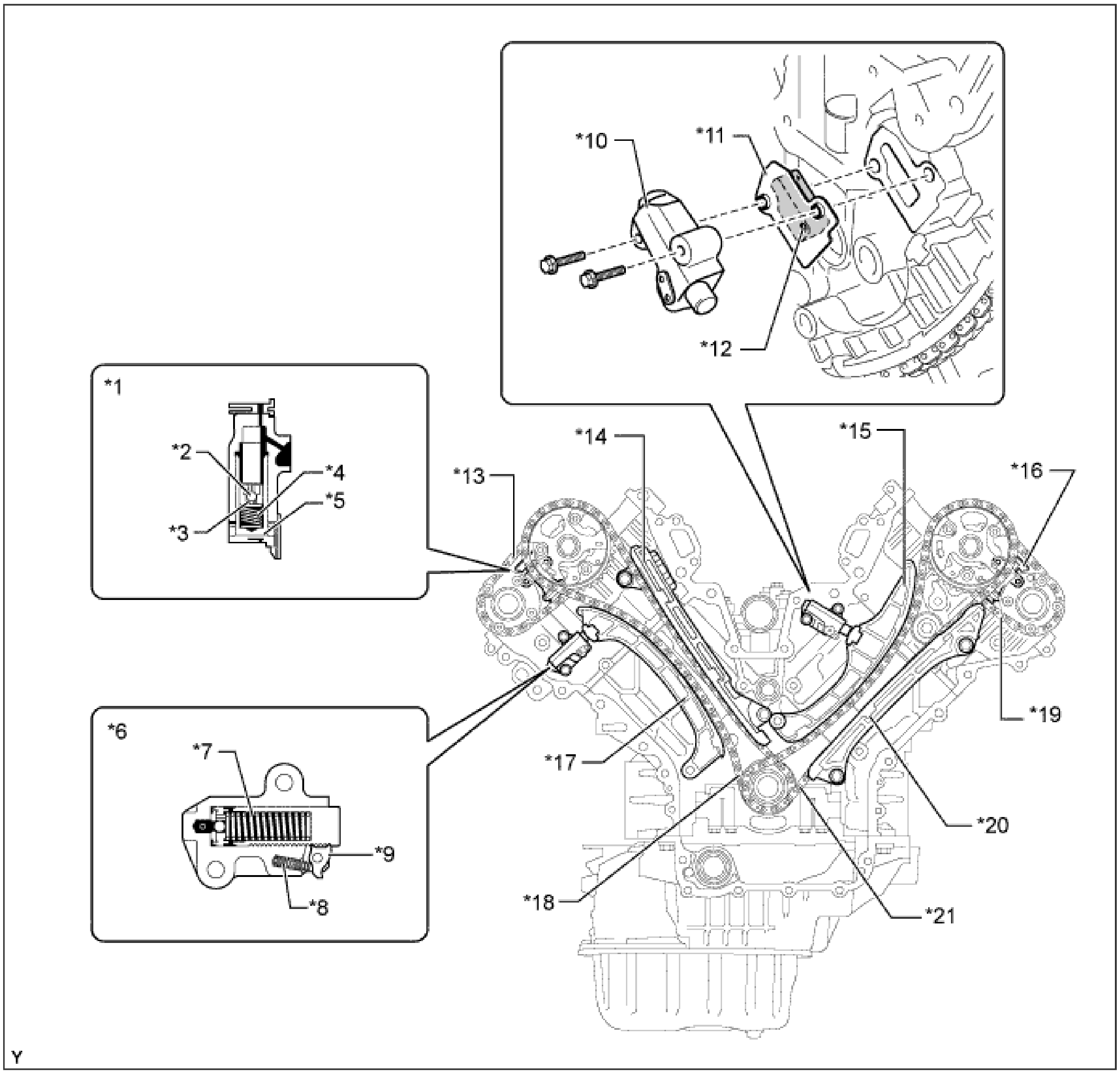
p. Timing Chain and Chain Tensioner

i. Both the primary and secondary timing chains use roller chains with a pitch of 9.525 mm (0.375 in.).

ii. A chain tensioner is provided for each primary timing chain and secondary timing chain in each bank.

iii. Both types of chain tensioner use a spring and oil pressure to maintain proper chain tension at all times. They suppress noise generated by the chains.

iv. The chain tensioner for the primary timing chain is a ratchet type with a non-return mechanism. Furthermore, an oil pocket creates oil pressure when the engine is started, and simultaneously applies oil pressure to the chain tensioner. This prevents the timing chain from flapping and reduces noise.



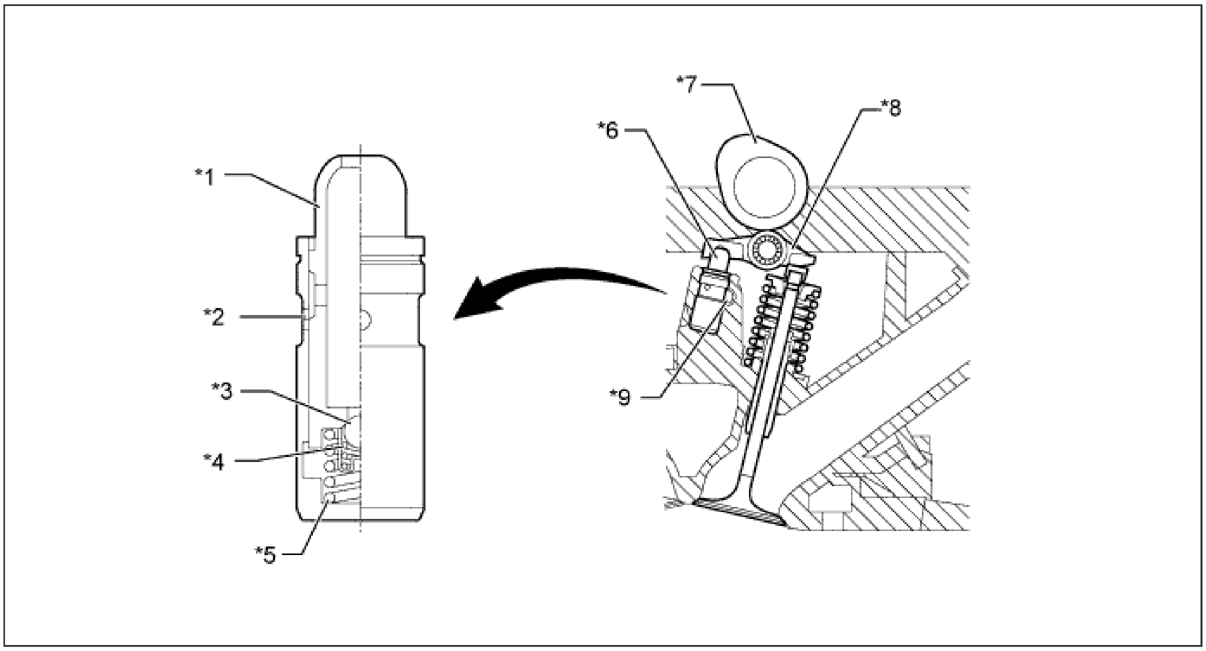
Text in Illustration

*1	Chain Tensioner (Secondary) RH	*2	Ball
*3	Ball Spring	*4	Main Spring
*5	Plunger	*6	Chain Tensioner (Primary) RH
*7	Spring	*8	Cam Spring
*9	Cam	*10	Chain Tensioner (Primary) LH
*11	Gasket	*12	Oil Pocket
*13	Secondary Timing Chain RH	*14	Chain Damper RH
*15	Chain Slipper LH	*16	Chain Tensioner (Secondary) LH
*17	Chain Slipper RH	*18	Primary Timing Chain RH
*19	Secondary Timing Chain LH	*20	Chain Damper LH
*21	Primary Timing Chain LH	-	-

q. Valve Lash Adjuster Assembly

i. The valve lash adjuster assembly, which is located at the fulcrum (pivot point) of the valve rocker arm sub-assemblies, consists primarily of a plunger, a plunger spring, a check ball, and a check ball spring.

ii. The engine oil is supplied from the cylinder head and the built-in spring actuates the valve lash adjuster assembly. The oil pressure and the spring force, that act on the plunger, push the valve rocker arm sub-assembly against the cam, in order to adjust the clearance between the valve stem and rocker arm. This prevents the generation of noise during the opening and closing of the valves. As a result, engine noise has been reduced.



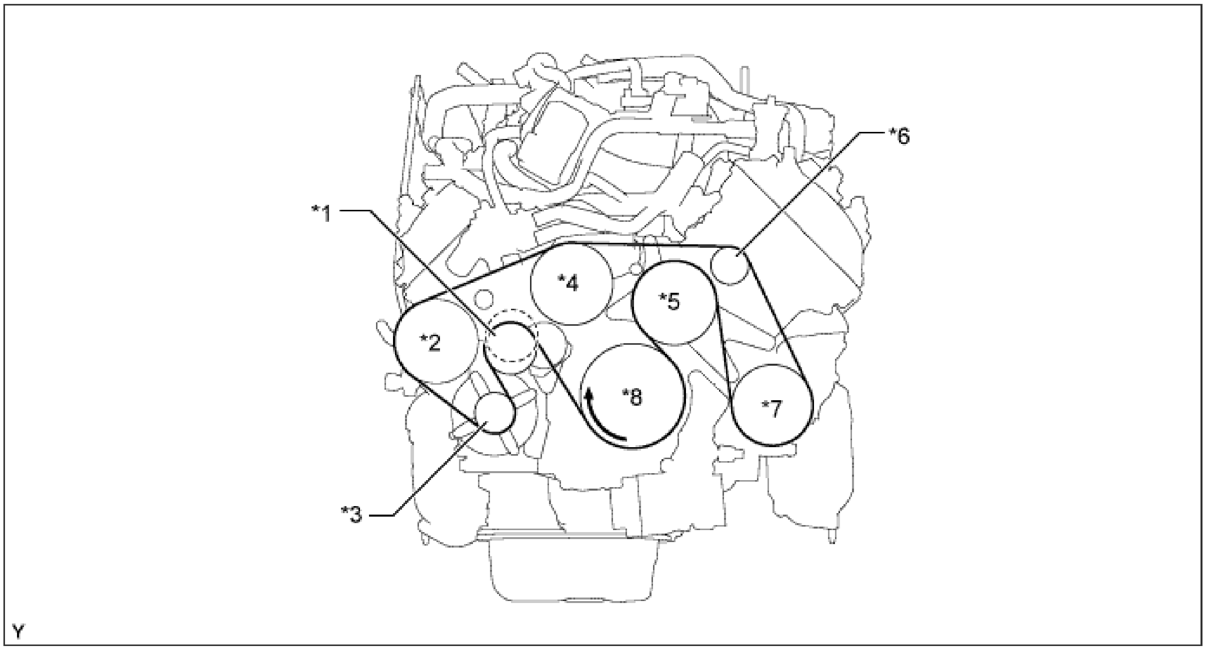
Text in Illustration

*1	Plunger	*2	Oil Passage
*3	Check Ball	*4	Check Ball Spring
*5	Plunger Spring	*6	Valve Lash Adjuster Assembly
*7	Cam	*8	Valve Rocker Arm Sub-assembly
*9	Oil Passage	-	-

r. V-ribbed Belt

i. Accessory components are driven by a serpentine belt consisting of a single V-ribbed belt. It reduces the overall engine length, weight and number of engine parts.

ii. An automatic tensioner eliminates the need for tension adjustment.



Text in Illustration

*1	V-ribbed Belt Tensioner (Automatic Tensioner)	*2	Power Steering Pump Pulley
*3	Generator Pulley	*4	Water Pump Pulley
*5	Fan Pulley	*6	Idler Pulley
*7	Air Conditioning Compressor Pulley	*8	Crankshaft Pulley