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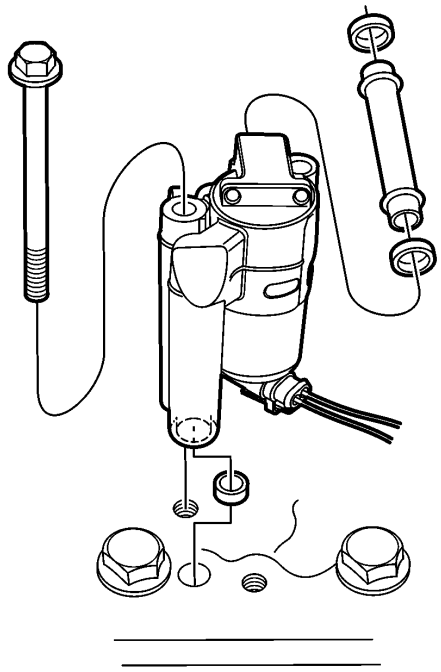
Engine Brake
Design and Function
D16F

Engine Brake, Design and Function



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This information covers the design and function of the Volvo Engine Brake (VEB) on the Volvo D16F engine.

Contents

Note: Information is subject to change without notice.
Illustrations are used for reference only and can differ slightly from the actual vehicle being serviced. However, key components addressed in this information are represented as accurately as possible.

Design and Function

Engine Brake

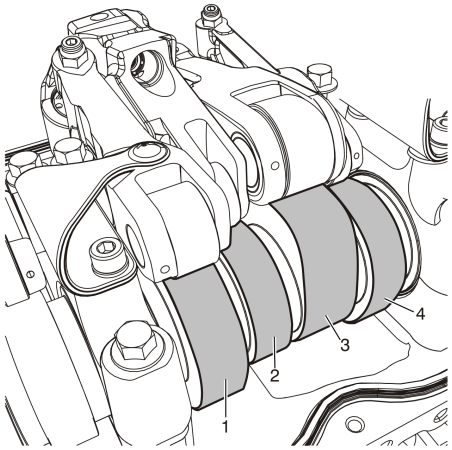
During the engine compression stroke and combustion (operating) stroke, the controlled opening of the exhaust valves creates an overpressure in the combustion chamber. This in turn, produces a braking effect on the crankshaft.

To better accomplish this task, the Volvo Engine Brake (VEB) is designed with an additional cam and rocker arm at each cylinder for operation of the VEB. To make sure the VEB cams open the exhaust valves, the VEB and exhaust rocker arms are arranged and valved in a manner that reduces valve clearance during the braking sequence.

System Components

Camshaft

On engines with a compression brake, the camshaft is designed with an additional cam at each cylinder for operation of the VEB. There are now four distinct cams, operating the intake valves, the unit injectors, the exhaust valves and the VEB, respectively. The lift height of the VEB cam lobes is very low compared to that of normal exhaust cam lobes.



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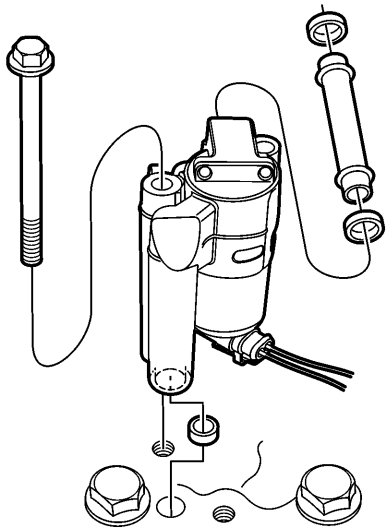
1 VEB Cam
2 Exhaust Cam
3 Unit Injector Cam
4 Intake Cam

Control Valve

The control valve is mounted on the cylinder head under the valve cover and is connected to the oil system ahead of the rocker arm shaft. Its purpose is to reduce oil pressure to the rocker arms while the engine is operating. There is always full system oil pressure to the control valve inlet. A seal connects the inlet to the lube oil gallery in the cylinder head. Oil pressure to the rocker arm shaft can be increased by the solenoid valve which is a part of the control valve, from about 100 kPa (14.5 psi) while the engine is operating to over 200 kPa (29 psi) during compression braking.



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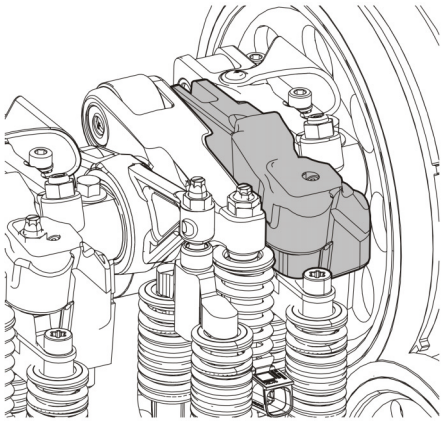
Exhaust and Engine Brake Rocker Arms

The exhaust rocker arms on an engine with a compression brake are larger than that of a conventional engine.

The engine brake rocker arms are equipped with a non-return valve and a piston with a pressure-limiting valve. The purpose of the non-return valve and pressure-limiting valve is to regulate oil flow during compression braking.

Spring-tab pressure holds the rocker arm at the rest position against the exhaust valve bridge.



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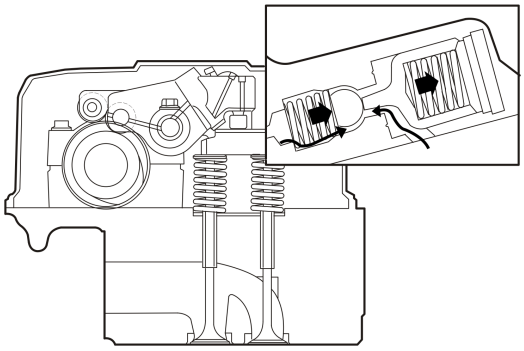
Non-Return Valve

The non-return valve, consisting of a piston, spring and ball is located in the VEB rocker arm. When oil from the rocker arm shaft is forced into the valve, the spring force and the oil pressure determine movement of the piston.

When the oil pressure is low, about 100 kPa (14.5 psi), the control valve is in its engine operating position. During this time, the piston will not move out of its rest position because the oil pressure cannot overcome the spring force. The piston pin prevents the ball from seating and the oil can flow freely through the valve in both directions.

When the control valve takes up the position for compression braking, oil pressure to the non-return valve increases. The spring force in the non-return valve is such that when the oil pressure exceeds about 200 kPa (29 psi), it overcomes the spring force and moves the piston to where it no longer controls the ball. The spring forces the ball against its seat and the oil contained above the piston cannot flow past the ball. As a result, high oil pressure is formed above the piston.



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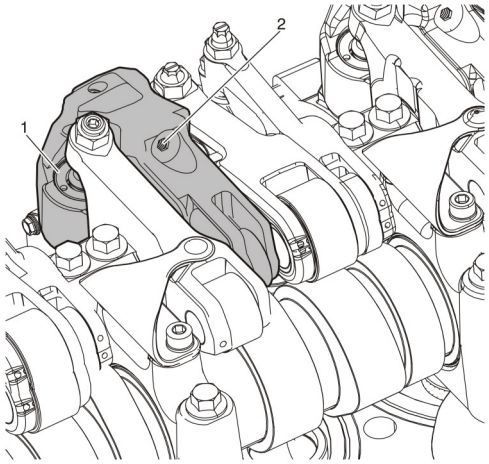
Rocker Arm Piston

The rocker arm piston is located in the arm offset, facing upward and aligned with the VEB rocker arm adjustment screw. The purpose of the piston is to eliminate all valve clearance during compression braking which it does by closing the gap between the exhaust rocker and VEB rocker arms.



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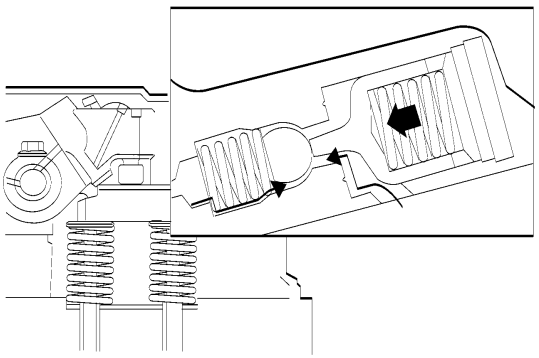
1 Rocker Arm Piston
2 Non-Return Valve

Normal Engine Operation — No Compression Braking

When the engine is operating under normal conditions, there is reduced oil pressure — approximately 100 kPa (14.5 psi) — through the control valve to the rocker arm shaft. Under this condition, the exhaust rocker arm non-return valve is open and there is no compression braking. Oil flows freely through the non-return valve in both directions. As a result, oil pressure does not build up to move the piston and close the valve. Clearance between the contact surfaces of the exhaust rocker and VEB rocker arms remains open with only the exhaust rocker arm operating the valves.

The valve mechanism operates the same as on an engine without a compression brake; in other words, only the exhaust cam opens the exhaust valves.



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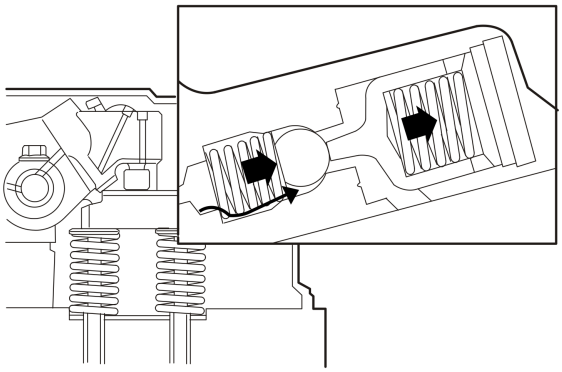
Compression Braking

During compression braking, the control valve does not reduce the oil pressure, so an oil pressure of at least 200 kPa (29 psi) is delivered to the rocker arm shaft.

The increased oil pressure overcomes piston spring pressure, moving the piston back out of its rest position. This allows the opposing spring to seat the ball, trapping oil above the brake piston and eliminating the normal clearance between the exhaust rocker and VEB rocker arms. The VEB rocker arm, through contact with the exhaust rocker, now controls the momentary opening the exhaust valves at the end of each intake stroke and the beginning of each compression stroke.

The exhaust rocker arm piston is fitted with a pressure limiting valve. When the oil pressure within the piston cylinder becomes too great, the pressure limiting valve opens and oil can exit through the hole in the piston. The opening pressure of the pressure limiting valve is governed by the force of the valve spring.



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Control System

The engine brake is associated with the accelerator pedal and is activated when the pedal is completely released, based on the selection made with the engine brake switch on the instrument panel.

The selection made with this switch also regulates engine braking activated by the cruise control.

Note: The engine brake functions as long as the engine control system has received signals from engine sensors indicating that the required preconditions for engine braking have been met. For example, the engine speed must be greater than 1100 rpm, the vehicle speed must be greater than 12 km/h (7.5 mph) and the engine coolant temperature must be above 70°C (160°F).

Switch

The engine brake can be controlled by a three-position switch located on the dash. Four position or five position switches are available.

A typical three-position switch has the following selections:

1 No engine brake engaged
2 Engine brake engaged 50%
3 Engine brake engaged 100%

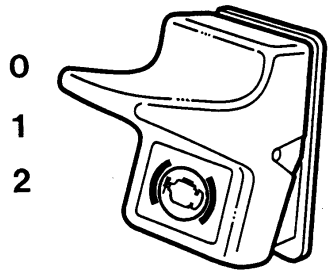

Fig. 1: Typical Three-Position Switch for Engine Brake

VEB Induction Phase

The induction phase begins at the end of the intake stroke and continues slightly into the compression stroke.

The piston travels downward toward bottom dead center and the camshaft induction lobe opens the exhaust valves long enough to fill the cylinder with the backpressure.

When the induction lobe closes the exhaust valves, the cylinder has a backpressure at the start of the compression stroke. This backpressure increases cylinder compression during the compression stroke which creates the braking effect as the piston moves upward in the cylinder.

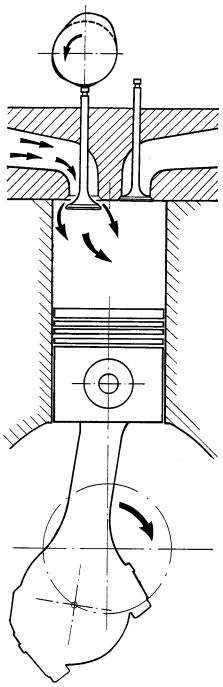

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Fig. 2: Induction Phase

VEB Decompression Phase

At the end of the compression stroke, as the piston approaches top dead center, the camshaft decompression lobe opens the exhaust valves and releases the pressure from the cylinder. Shortly before bottom dead center, the normal exhaust lobe of the camshaft opens the exhaust valves. During the exhaust stroke, a backpressure is created in the exhaust manifold.

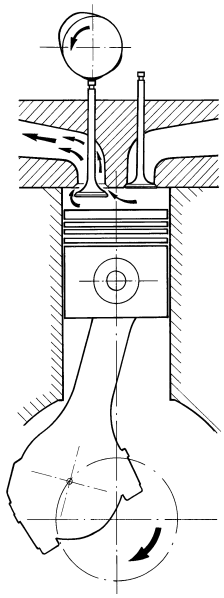

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Fig. 3: Decompression Phase