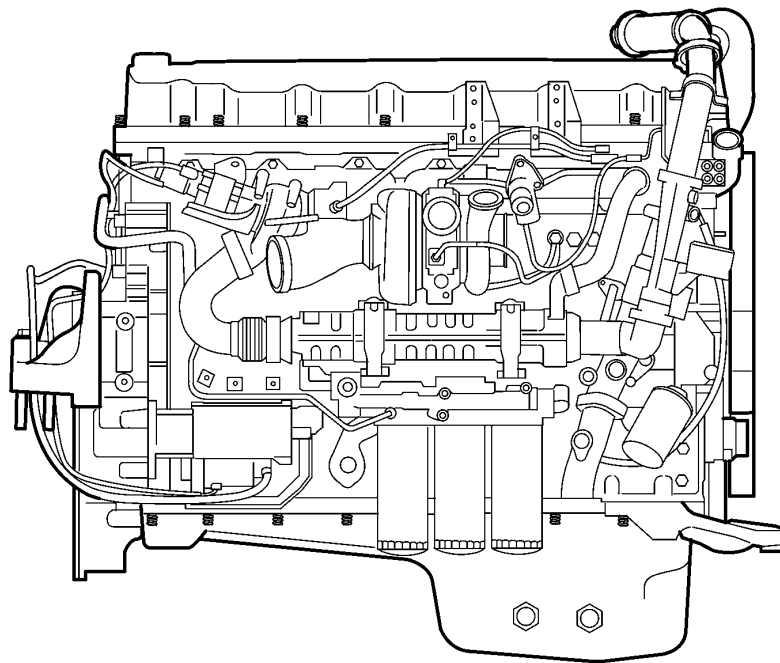


Engine Brake
Design and Function
D13F

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 D13F engine.

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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

The engine (compression) brake operates by opening the exhaust valves during the inlet stroke and just before bottom dead center (BDC) on the compression stroke, which utilizes the braking force of the compression stroke. This is achieved mechanically with the aid of a camshaft with an extra braking cam with two lobes, a brake rocker arm and a control valve that regulates the lubricating oil pressure to the rocker shaft. The control valve is located on the cylinder head between cylinders three and four. The inlet of the control valve is connected to a lubricating oil channel in the engine block, and the outlet of the valve is connected to the rocker arm shaft through a tube. If the engine is equipped with an engine brake, this is shown on the front engine identification label, on the left side of the rocker cover.

Compared with the earlier VEB system, the mechanical loads are now shared by two rocker arms, which means that the braking power can be increased without increasing mechanical stress. Using the engine brake increases the gas flow through the cylinder which reduces the thermal stress on the injector spray nozzles. The increased gas flow cools the nozzles.

System Components

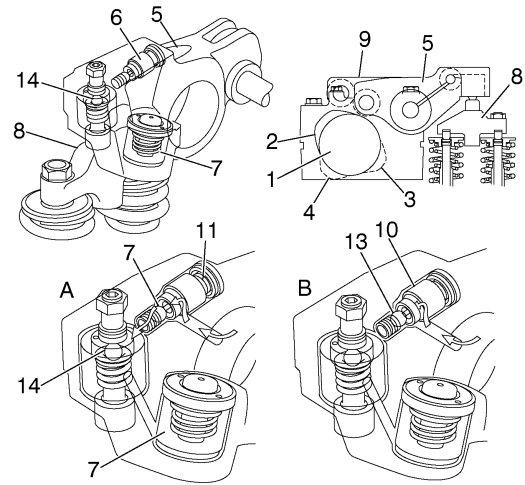
Camshaft

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 lobes on the brake cam are very low compared to that of normal exhaust cam lobes.

As mentioned, the camshaft (1) on an engine with a compression brake has four cams for each cylinder; the inlet cam, injection cam, exhaust cam and braking cam.

The brake cam has two lobes, the charging lobe (3) and the decompression lobe (4) which lifts the exhaust valves at the appropriate time to eliminate the power stroke driving power and fully utilize the braking power.

Inside the exhaust valve rocker arm (5) are two pistons, the pump piston (7) and the power piston (14), along with a non-return valve (6), another piston (10) and a spring (13). The power piston is located directly above the exhaust valve bridge and it is the power piston that presses down on the bridge to open the exhaust valves. The pump piston is located directly underneath the engine brake rocker arm (9) and is what the brake rocker arm pushes against. The exhaust rocker arm (5) is shaped so that the brake rocker arm is positioned above the exhaust rocker arm. When the lubricating oil pressure is sufficient, the clearance between the rocker arms is taken up by the pump piston. Both pistons in the exhaust rocker arm are linked by an oil channel. When the pump piston is pressed down, the oil underneath the piston is pumped to the power piston. At the same time, the non-return valve closes and the higher oil pressure causes the power piston to be pressed down to open the exhaust valves.

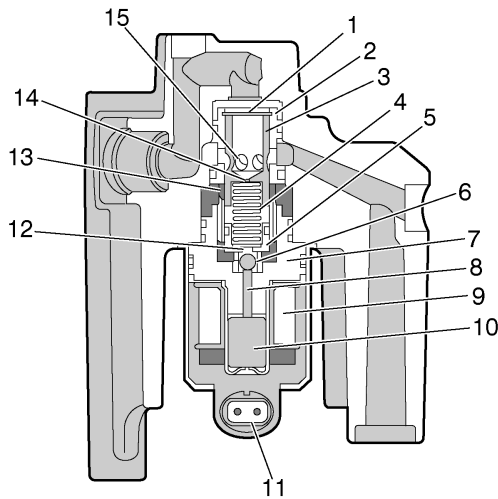


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Control Valve

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. The control valve regulates the oil pressure to the rocker arm shaft assembly and is controlled by the Engine Electronic Control Unit (EECU).

1. Locking Ring
2. Sleeve
3. Valve Slider
4. Balance Spring
5. Spring Seat with Ball Holder
6. Valve Ball
7. Cylinder
8. Rod
9. Solenoid Coil
10. Piston
11. Electrical Connection
12. Pressure Regulation Hole for Flow Control
13. Return Hole
14. Calibration Hole
15. Hole for Oil Flow to Rocker Arm



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Neutral

The VEB valve is shown in its neutral position, which means that the engine is stationary. The solenoid coil (9) is not energized and the valve slider (3) is up against the locking ring (1).

Normal Driving

During normal engine running, the solenoid coil (9) is not energized. The solenoid valve is in regulation mode and forces oil through the hole (15) to the rocker arms while allowing oil to flow through the calibration hole (14) and onwards to the return hole (13). This reduces the oil pressure to 100 kPa (14.5 psi), which is enough to lubricate the camshaft bearings and valve rocker arms.

Engine Brake Activated

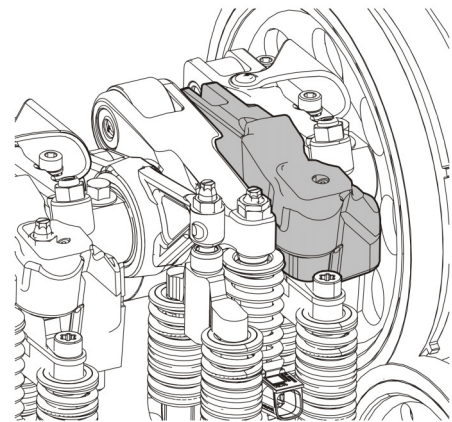
When the engine is running and the engine brake is activated, the solenoid coil (9) is energized and the valve slider (3) is forced to its end position which is fully open. The trapped oil acts as a hydraulic lock. Full oil pressure is now delivered to the rocker arm shaft and the compression brake comes into action.

Engine Brake Deactivated

When the engine is running and the engine brake is released, the solenoid coil (9) is de-energized. The high pressure oil inside the rocker arm shaft causes the valve slider (3) to quickly move and open the oil return connection (13) so that the oil can drain out. When the oil pressure has fallen to approximately 100 kPa (14.5 psi), the valve slider returns to its regulation position.

Exhaust Rocker Arms

The exhaust rocker arms on an engine with a compression brake are larger than those of a conventional engine. The rocker arm is equipped with a non-return valve and a piston with a pressure-limiting valve. Its purpose is to regulate oil flow during compression braking.



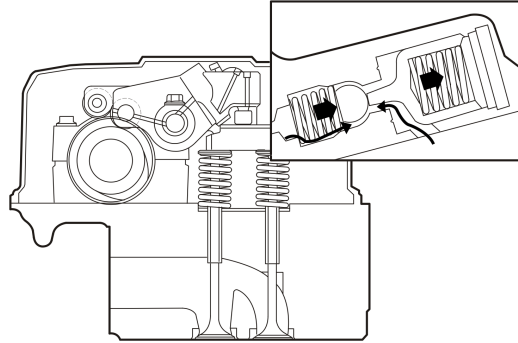
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Non-Return Valve

The non-return valve, consisting of a piston, spring and ball is located in the exhaust 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 begins 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.

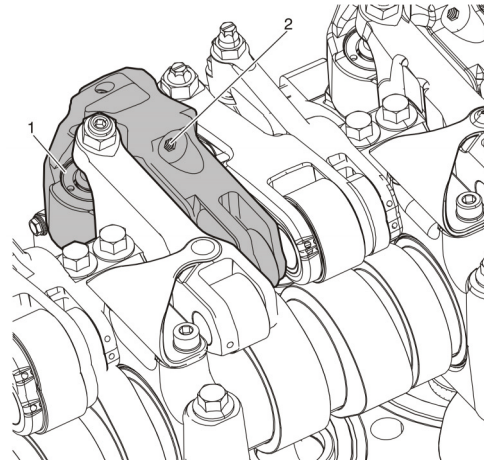


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Rocker Arm Piston

The rocker arm (pump) 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 arm and the engine brake rocker arm.

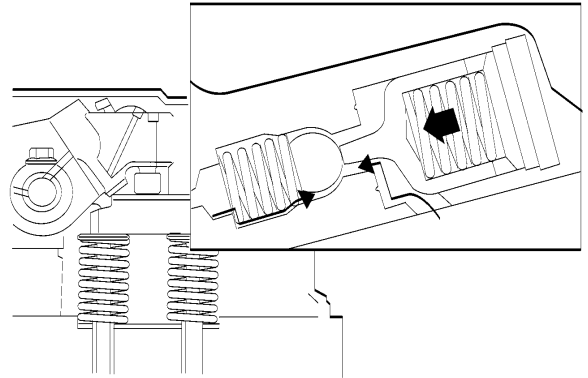
1. Rocker Arm (Pump) Piston
2. Non-Return Valve Location



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Normal Engine Operation — No Compression Braking

While the engine is running, the control valve reduces the oil pressure in the rocker arm shaft to approximately 100 kPa (14.5 psi). The non-return valve is kept open by the piston being pushed forward. The oil channels fill, but the low pressure is not able to push the pump piston to its upper position. The brake rocker arm does not contact the exhaust valve rocker arm (5). In this situation, the exhaust valves are not affected by the cam lobes on the engine brake cam.

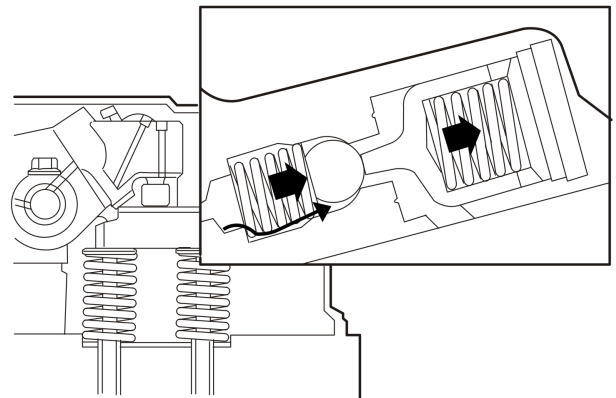


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Compression Braking

During compression braking, the control valve raises the oil pressure to system oil pressure in the rocker arm shaft. The piston is moved back, but the non-return valve is held open by the oil flow. The higher pressure is able to push the pump piston to its upper position. When the pump piston is pushed to its upper position, the clearance between the engine brake rocker arm and the exhaust valve rocker arm is taken up.

Oil pressure pushes the pump piston to its upper position and fills the volume beneath the piston. Once the oil has filled the system and no longer flows, the non-return valve closes. When the brake rocker arm travels over one of the two lobes, the pump piston is pushed down and the oil volume beneath the piston applies pressure to the power piston. The piston is pushed down and the exhaust valves open. The non-return valve is kept closed by the high oil pressure while the exhaust valves are open.



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After the exhaust valves close and the brake rocker arm is no longer exerting pressure on the pump piston, the oil that was pushing the power piston down runs back to the pump piston. The system then refills because the non-return valve opens to allow the amount of oil that leaked out during the previous cycle to come through.

Deactivation takes place when the oil pressure in the rocker shaft falls to approximately 100 kPa (14.5 psi). The non-return valve piston opens the non-return valve so that oil can flow back to the rocker arm shaft. The pump piston spring forces the pump piston back to its lower position and the brake rocker arm cannot come into contact with the pump piston.

Control System

The engine brake is associated with accelerator pedal movement 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.

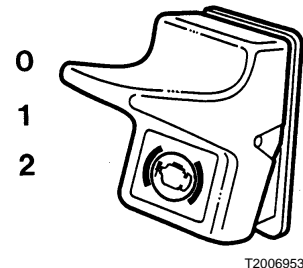
Note: The engine brake functions as long as the engine control system has received signals from engine sensors indicating that the required preconditions for engine braking have been met. For example, the engine speed must be greater than 1100 rpm, the vehicle speed must be greater than 12 km/h (7.5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

Switch

The compression brake is controlled by a switch located on the dash.

A typical switch can have the following selections:

- 0 Compression brake not engaged
- 1 LO — Half compression braking power
- 2 HI — Full compression braking power



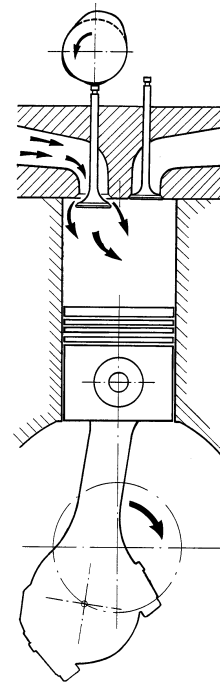
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VEB Induction (Charging) Phase

The induction phase begins at the end of the intake stroke and continues just before BDC on the compression stroke.

The piston travels downward toward bottom dead center and the VEB cam charging lobe opens the exhaust valves long enough to fill the cylinder with exhaust backpressure caused by the turbocharger.

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



VEB Decompression Phase

At the end of the compression stroke, as the piston approaches top dead center, the engine brake cam decompression lobe opens the exhaust valves and releases the built-up pressure from the cylinder. Shortly before bottom dead center, the ordinary exhaust lobe opens the exhaust valves.

