

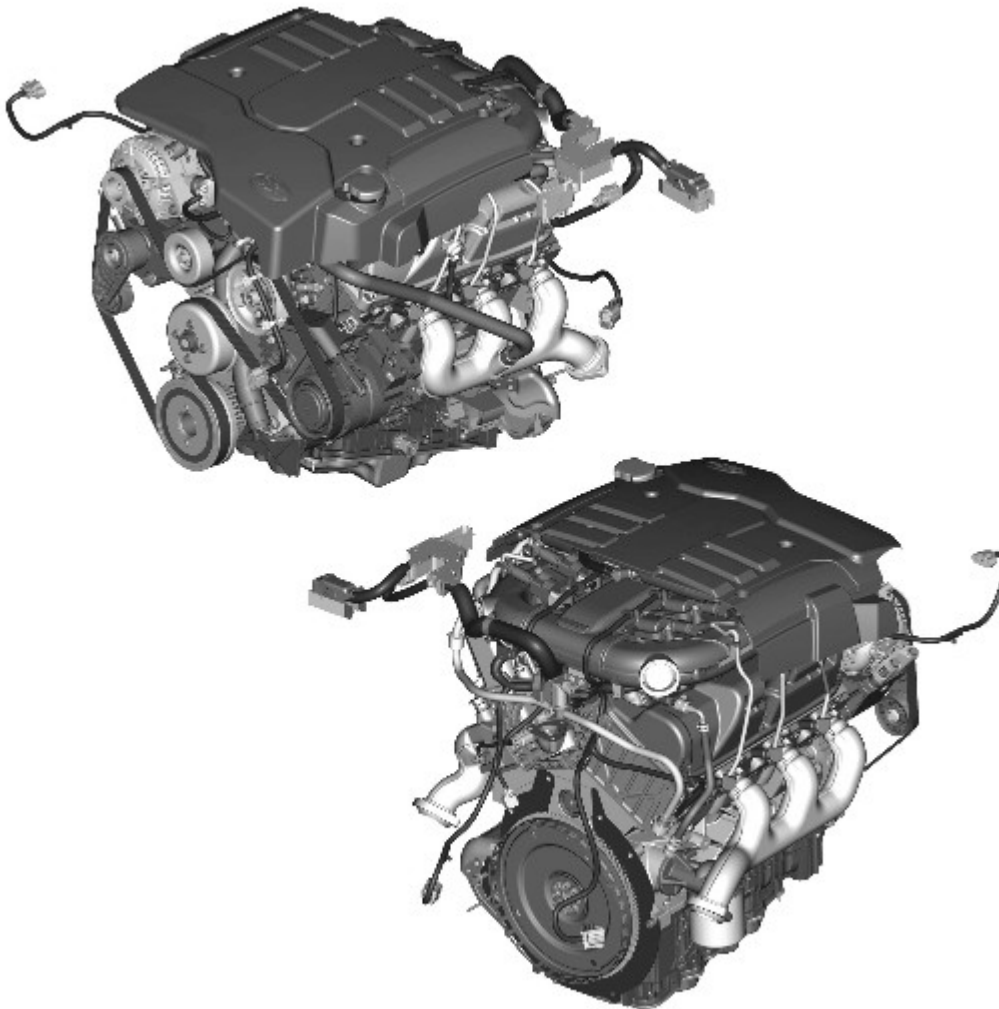
Published : Oct 22, 2004

Engine

External View

NOTE :

Variant without oil cooler shown.



E50486

GENERAL

The V6 petrol engine is a 4.0 litre, 6 cylinder, 60 degrees 'V' unit, with 2 valves per cylinder, operated by a single overhead camshaft. The engine emissions comply with ECD4 (European Commission Directive) and USA Tier 2 Bin 8 legislative requirements and employs catalytic converters, electronic engine management control, positive crankcase ventilation and exhaust gas recirculation to limit the emission of pollutants. The cooling system is a low volume, high velocity system. The fuel injection system is controlled by the Engine Control Module (ECM).

The cylinder block is of cast iron construction with a cast aluminium ladder frame and balance shaft assembly bolted to the bottom of the block. The cylinder heads are cast aluminium with vinyl ester composite camshaft covers. The single-piece oil sump is formed from pressed steel. The intake manifold is manufactured from cast aluminium and incorporates a central chamber with six inlet port tracts. For additional information, refer to [Intake Air Distribution and Filtering](#) (303-12A Intake Air Distribution and Filtering - 4.0L)

. The dual wall stainless steel exhaust manifolds are unique for each cylinder bank and a moulded plastic acoustic cover

is fitted over the upper engine to reduce engine-generated noise.

Technical Features

The technical features include:

- A six cylinder, 60 degree 'V' configuration liquid cooled cast iron cylinder block
- Pistons comprise two compression rings and a three piece oil control ring
- Two aluminium cylinder heads, each incorporating a single hollow camshaft
- Rocker valve arms with hydraulic lash adjusters
- Engine front cover manufactured from aluminium which accommodates the coolant pump assembly
- Each camshaft is driven by a separate single row chain
- Electronically controlled vacuum operated Exhaust Gas Recirculation (EGR) valve
- Exhaust re-treatment by means of catalytic converters
- Cast aluminium engine ladder frame assembly
- A fully counter balanced cast iron crankshaft
- An advanced engine management system incorporating electronic throttle control
- Electronic Intake Manifold Tuning Valve (IMTV) with ECM control
- Emissions comply with ECD4 (European Commission Directive) and USA Tier 2 Bin 8 legislative requirements.

Engine Data

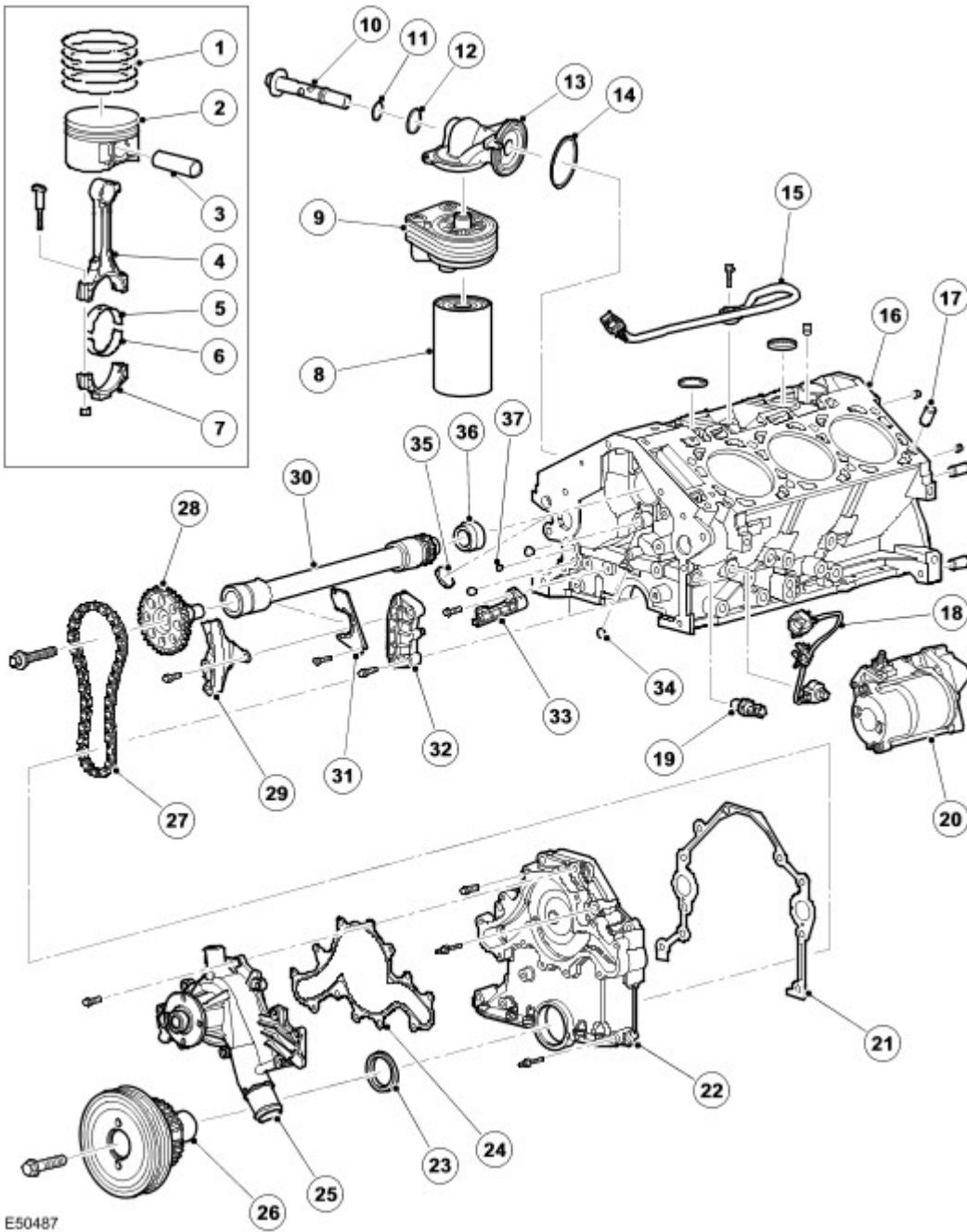
The technical data is detailed below.

DESCRIPTION	TYPE
Configuration	60 degree V6
Maximum power	156 kW at 4750 rpm
Maximum torque	346 Nm at 3000 rpm
Displacement	4009cc
Stroke/bore	84.4mm/100.4mm
Compression ratio	9.7:1
Firing order	1 4 2 5 3 6
Oil capacity	6.4 litres

CYLINDER BLOCK COMPONENTS

NOTE :

Variant with oil cooler shown.



E50487

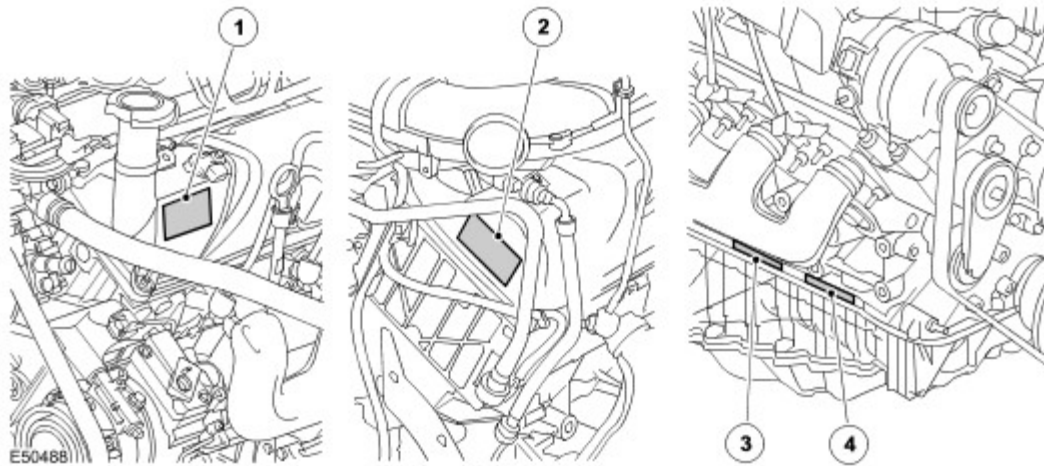
Item	Part Number	Description
1	-	Piston Rings
2	-	Piston
3	-	Piston pin
4	-	Connecting rod
5	-	Connecting rod bearing - upper
6	-	Connecting rod bearing - lower
7	-	Connecting rod cap
8	-	Oil filter
9	-	Oil cooler (if fitted)
10	-	Oil filter adapter mounting bolt

11	-	O ring
12	-	O ring
13	-	Oil filter adapter
14	-	O ring
15	-	Knock sensor
16	-	Cylinder block
17	-	Locating dowel
18	-	Knock sensor
19	-	Oil pressure switch
20	-	Starter motor
21	-	Gasket
22	-	Front cover
23	-	Seal
24	-	Gasket
25	-	Water pump
26	-	Crankshaft pulley
27	-	Jackshaft shaft chain
28	-	Jackshaft shaft sprocket
29	-	Chain tensioner
30	-	Jackshaft shaft
31	-	Jackshaft thrust plate
32	-	Chain guide
33	-	Chain guide
34	-	Oil gallery plug
35	-	Plug
36	-	Spacer
37	-	Oil gallery plug

Cylinder Block

The cylinder block is a 'V' design, which provides an inherently rigid structure with good vibration levels. A low volume coolant jacket improves warm-up times and piston noise levels; the longitudinal flow design of the jacket, with a single cylinder head coolant transfer port in each bank, improves rigidity and head gasket sealing.

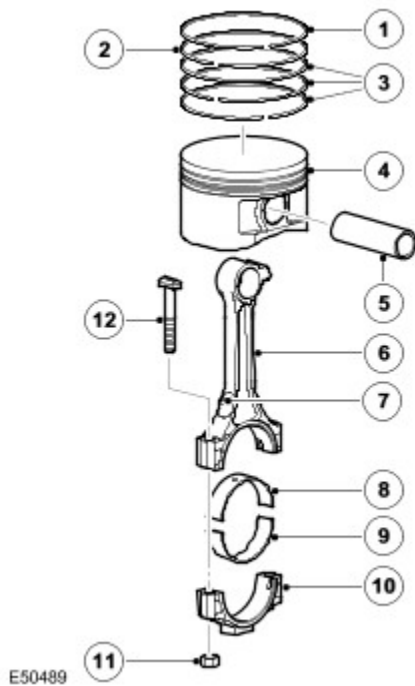
Engine Data Locations



Item	Part Number	Description
1	-	Engine data
2	-	Engine data
3	-	Vehicle Identification Number (primary location)
4	-	Vehicle Identification Number(secondary location)

Engine data is marked at three locations.

Pistons and Connecting Rod Assembly



Item	Part Number	Description
1	-	Piston ring, upper compression
2	-	Piston ring, lower compression
3	-	Piston rings, oil control
4	-	Piston

5	-	Piston pin
6	-	Connecting rod
7	-	Oil squirt hole
8	-	Connecting rod bearing, upper
9	-	Connecting rod bearing, lower
10	-	Connecting rod cap
11	-	Nut
12	-	Bolt

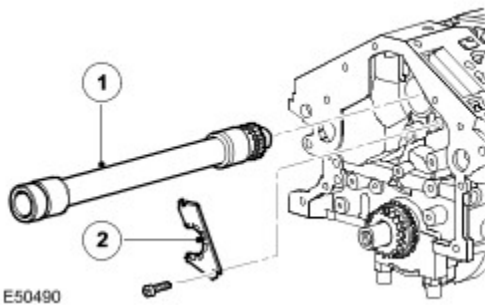
The aluminium alloy, thermal expansion, lightweight pistons, with semi-floating piston pins, are offset to the thrust side and are carried on forged steel connecting rods. Pistons are supplied in four grades, 1, 2, 3 and 4. The pistons are marked to ensure they are correctly oriented in the cylinder bore; the 'arrow' mark should be toward the front of the engine.

The V6 petrol engine utilises forged steel H-sectioned connecting rods, with the piston pin being an interference fit in the small end of the connecting rod. The big ends are horizontally split.

Selective bearing shells with two grades of thickness; standard and 0.25 mm undersize, control big end bearing diametric clearance. The big-end upper and lower bearing shells are plain with locating tags.

Each piston is fitted with two compression rings and an oil control ring. The top compression ring has a nitrided surface, a process that involves the diffusion of nitrogen into the surface layers of a low carbon steel. The formation of nitrides provides an increased hardness. The 2nd compression ring is chrome-plated. The oil control rings have stainless steel top and bottom rails and integral expander rings.

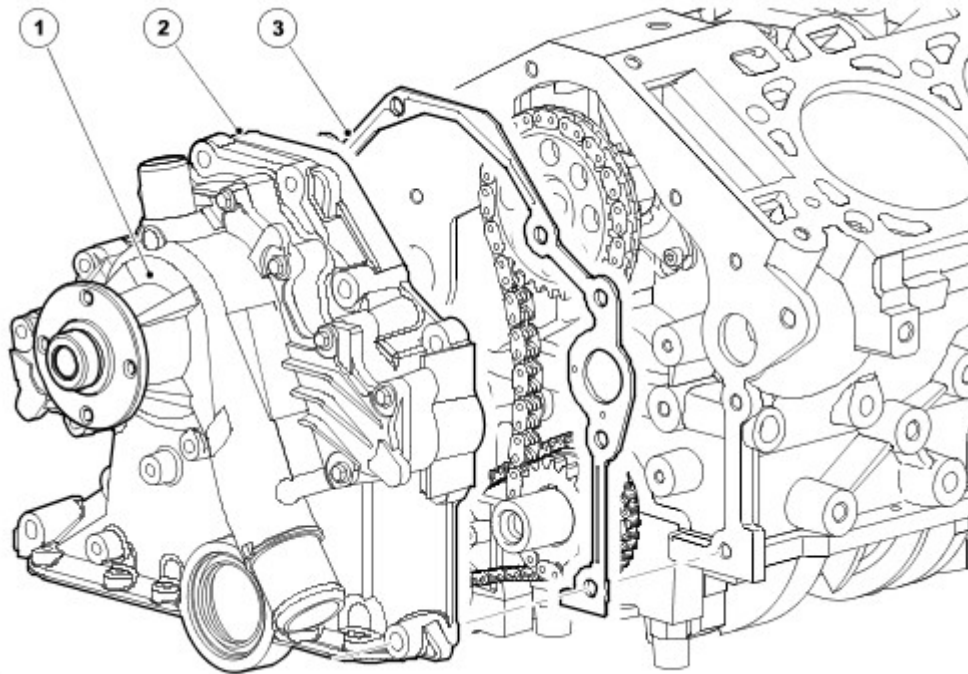
Jackshaft Assembly



Item	Part Number	Description
1	-	Jackshaft
2	-	Thrust plate

The jackshaft assembly is located centrally in the upper part of the cylinder block. The assembly is used to supply drive to each camshaft, via a chain. The LH camshaft is driven from the front of the jackshaft and the RH camshaft is driven from the rear. The Jackshaft assembly is driven, via a chain, by the crankshaft gear at the front of the engine. The assembly is held in position by a thrust plate.

Front Cover and Water Pump Assembly



E50491

Item	Part Number	Description
1	-	Water pump assembly
2	-	Engine front cover
3	-	Gasket

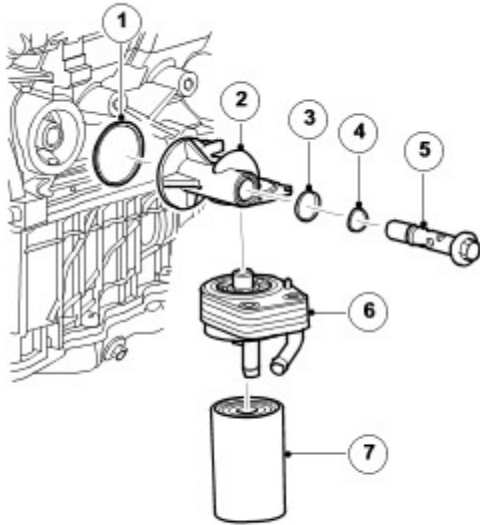
The aluminium front cover assembly is secured to the engine block by five bolts and five studs and is sealed via a gasket. The front cover also houses the crankshaft front seal.

The water pump is attached to the engine front cover assembly and is secured and sealed, to the front cover, by twelve bolts and a gasket. A poly-vee belt drives the water pump via the crankshaft.

Oil Cooler (If Fitted) and Filter Assembly

NOTE :

Variant with oil cooler shown.



E50492

Item	Part Number	Description
1	-	O ring
2	-	Adapter
3	-	O ring
4	-	O ring
5	-	Adapter mounting bolt
6	-	Cooler assembly (if fitted)
7	-	Oil filter

A full-flow, disposable canister-type oil filter is attached to the oil cooler assembly (if fitted).

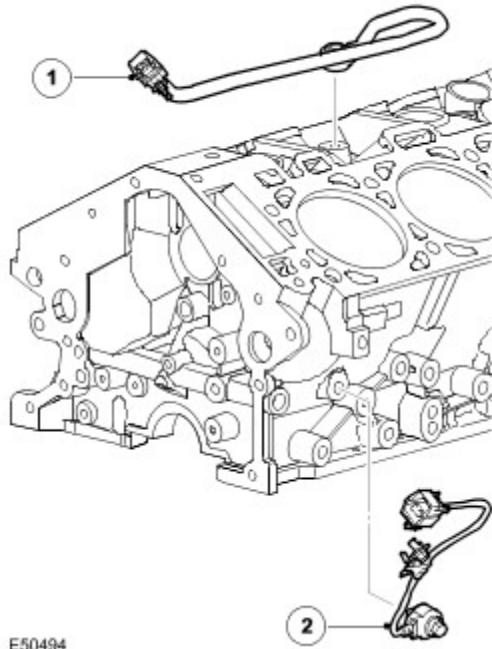
The oil filter and cooler assembly (if fitted) is attached the rear RH side of the cylinder block and consists a full-flow, disposable canister-type filter, cooler (if fitted) and an adapter.

The filter adapter-mounting bolt locates in the cylinder block oil gallery and is sealed by an 'O' ring. The filter adapter houses the adapter bolt and is also sealed to the cylinder block by an 'O' ring.

The oil cooler (if fitted) keeps the engine lubrication oil cool, under heavy loads and high ambient temperatures and is cooled by the engine cooling system.

Oil is delivered to and from the oil cooler (if fitted) through galleries in the cylinder block. Hoses from the engine cooling system are connected to two pipes on the oil cooler for the supply and return of coolant.

Knock Sensors

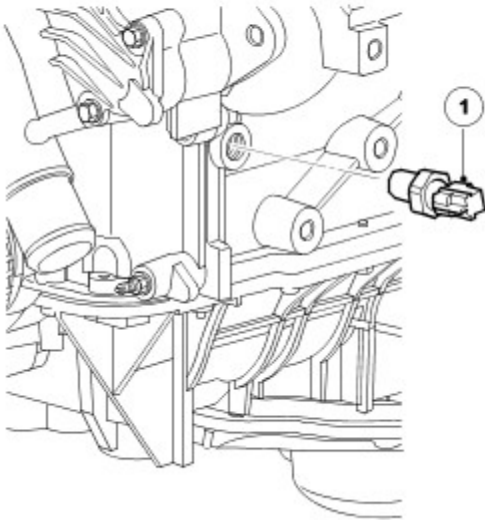


E50494

Item	Part Number	Description
1	-	RH knock sensor
2		LH knock sensor

The knock sensors are installed in the cylinder block in two different locations. One is located on the inboard of the RH cylinder bank and one is located at the front of the LH side of the cylinder block, next to the oil pressure switch. They are piezo-electric sensors that provide inputs to detect and locate detonation during combustion. For additional information, refer to [Electronic Engine Controls](#) (303-14A Electronic Engine Controls - 4.0L)

Oil Pressure Switch

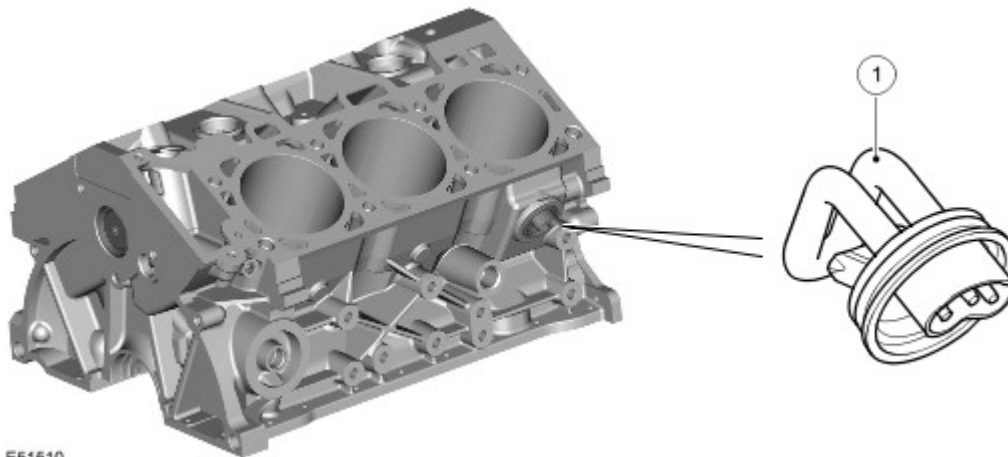


E50495

Item	Part Number	Description
1	-	Oil Pressure Switch

The oil pressure switch is located in a port at the front LH side of the cylinder block. It detects when a safe operating pressure has been reached during engine starting and initiates the illumination of a warning light in the instrument cluster if the oil pressure drops below a given value. The switch operates at a pressure of 0.15 to 0.41 bar (2.2 to 5.9 psi).

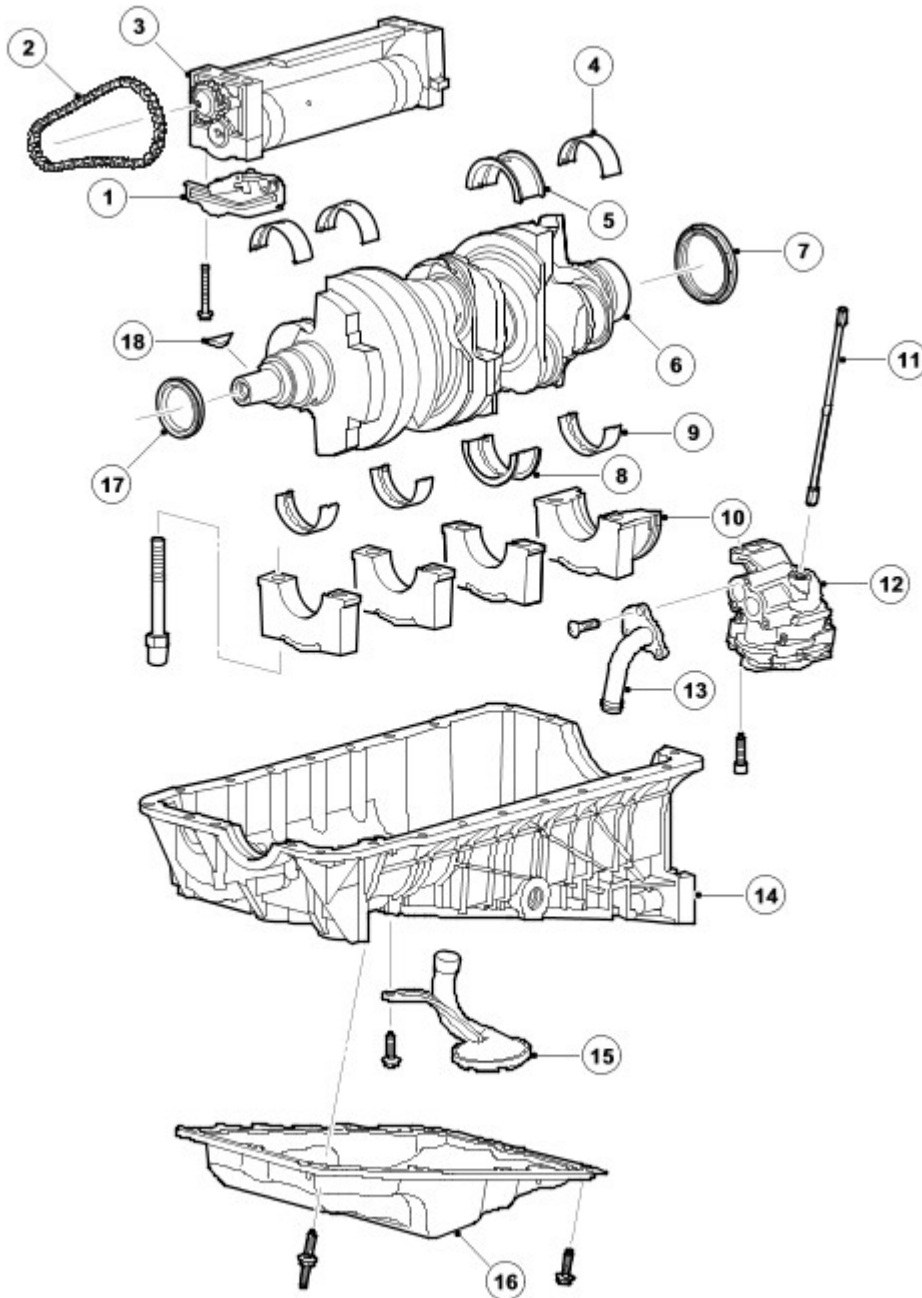
Engine Block Heater



E51510

For cold climate markets an engine block heater is fitted, which is located at the front of the LH side of the cylinder block.

CRANKSHAFT, SUMP AND OIL PUMP COMPONENTS

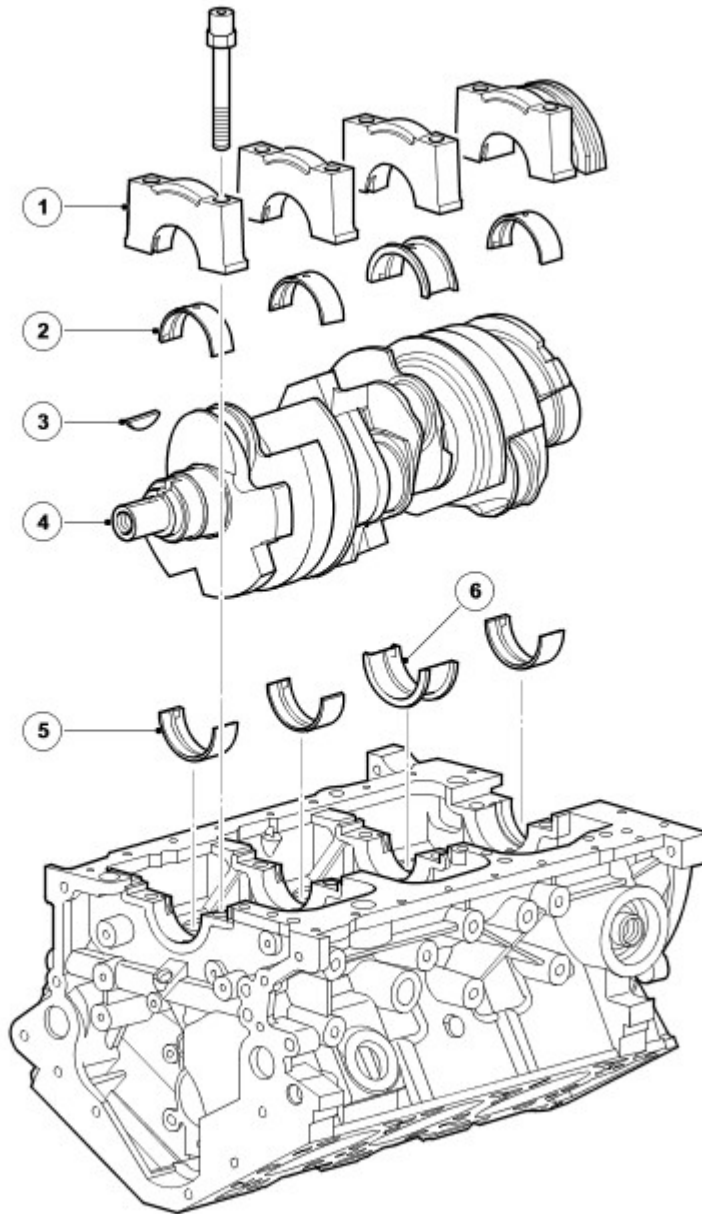


E50497

Item	Part Number	Description
1	-	Tensioner
2	-	Chain
3	-	Balance shaft assembly
4	-	Main bearing, upper
5	-	Main thrust bearing, upper
6	-	Crankshaft
7	-	Crankshaft oil seal, rear
8	-	Main thrust bearing, lower
9	-	Main bearing, lower
10	-	Main bearing cap, rear

11	-	Intermediate shaft
12	-	Oil pump
13	-	Pick-up pipe adapter
14	-	Ladder frame
15	-	Oil pick-up pipe
16	-	Sump
17	-	Crankshaft oil seal, front
18	-	Key

Crankshaft and Main Bearings



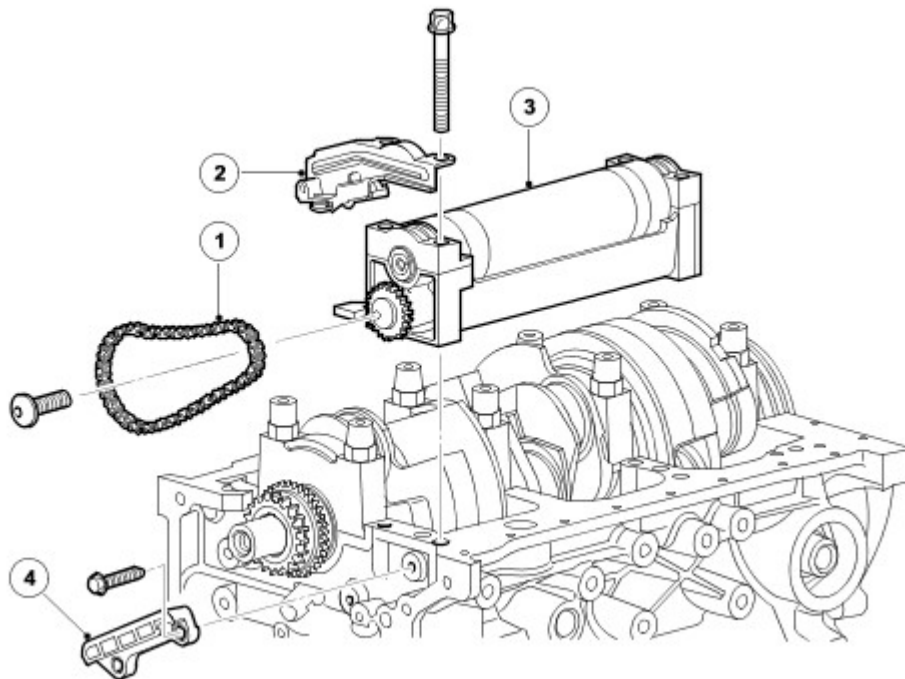
E50498

Item	Part Number	Description
1	-	Main bearing cap
2	-	Main bearing, lower
3	-	Key
4	-	Crankshaft
5	-	Main bearing, upper
6	-	Main bearing, thrust

The crankshaft is supported on four main bearings, with each pair of crankpins mutually offset by 30 degrees to give equal firing intervals. Cast in Spheroidal Graphite (SG) iron, the crankshaft has cold rolled fillets on all journals, except the outer mains, for toughness and failure resistance. The nine crankshaft counterweights increase smoothness and reduce bearing wear by splitting the loads evenly across the bearings. Thrust washer halves at the top and bottom of number three main bearing control end-float.

Oil grooves are provided in the upper and lower halves of all the main bearing shells to supply oil, via drillings in the crankshaft, to the connecting rod big-end bearings.

Balance Shaft Assembly



Item	Part Number	Description
1	-	Drive chain
2	-	Tensioner assembly
3	-	Balance assembly
4	-	Chain guide

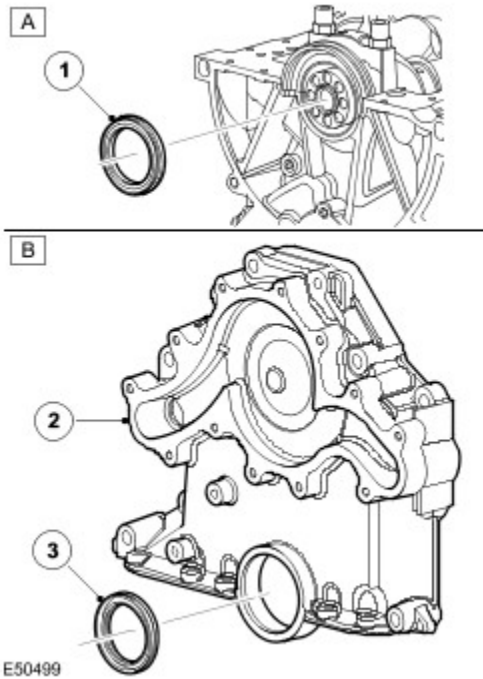
A 60 degree V6 is often thought of inherently balanced, because its first-order forces can be compensated by crankshaft counter-weighting. However, the V6 4.0L engine generates a second-order unbalanced at twice the crank speed.

To achieve the desired smoothness, the V6 4.0L engine includes a unique counter-rotating balance shaft, which is chain driven by the crankshaft and runs at twice engine speed. The shaft produces an opposite second-order force, which cancels the inherent unbalance.

Since the balance shaft is positioned on the bottom the cylinder block, on the RH side and is secured by 4 bolts. Because

the unit is near the engine oil level, it is encased in a steel tube to avoid aerating the oil. The balance shaft attaches to the engine as an assembled unit, including an integrated gear and lubrication system. The gear is needed to rotate the shaft in the same direction as the unbalanced force.

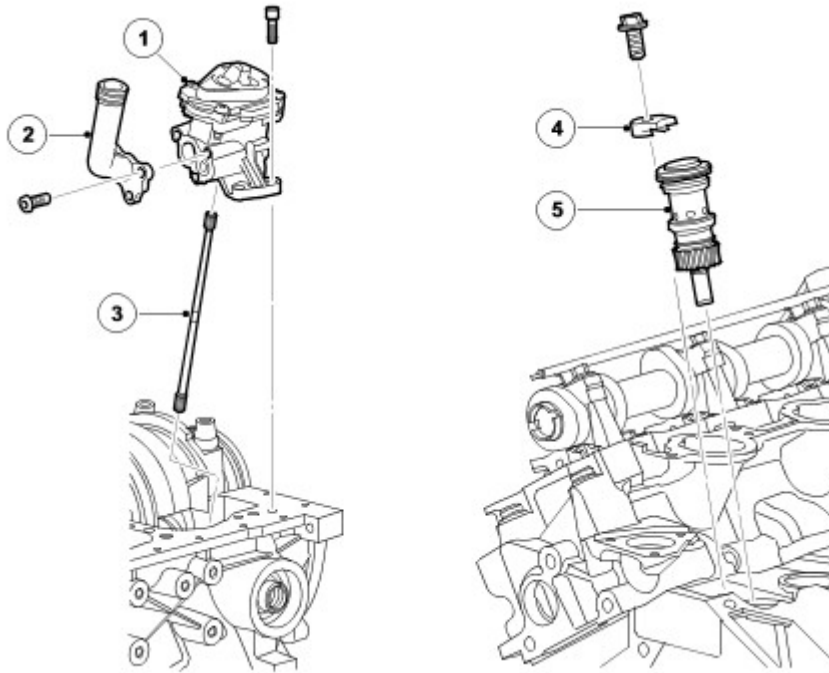
Crankshaft Oil Seals



Item	Part Number	Description
A	-	Rear
B	-	Front
1	-	Rear seal
2	-	Front cover
3	-	Front seal

The rear crankshaft oil seal is a press fit in the rear of the cylinder block. The front crankshaft oil seal is located in the engine front cover assembly, just below the water pump.

Oil Pump

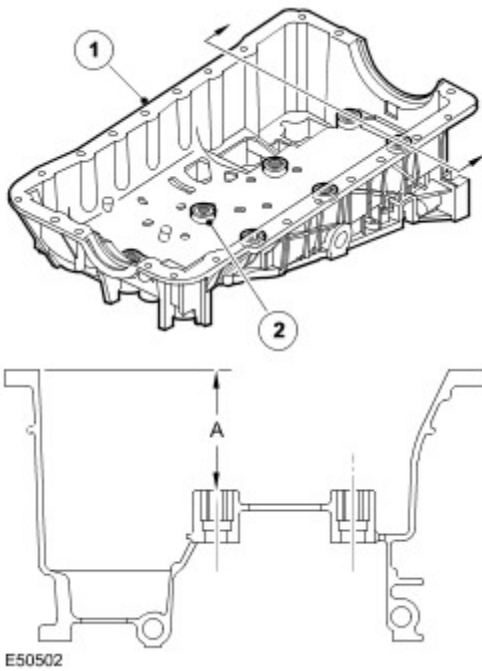


E50501

Item	Part Number	Description
1	-	Oil pump
2	-	Pick-up pipe adapter assembly
3	-	Intermediate shaft
4	-	Clamp
5	-	Drive assembly

The oil pump is located on the RH rear underside of the cylinder block, contained within the ladder frame assembly, and is secured by two bolts. The unit is driven by the jackshaft, via an intermediate shaft, and receives its oil feed from the main gallery via drillings in the cylinder block. The intermediate shaft locates through the cylinder block and is connected to the drive assembly, which is situated in the 'V' at the rear of the engine and held in place via a clamp. The oil pump housing includes the oil pressure relief valve.

Engine Ladder Frame Assembly



Item	Part Number	Description
A	-	69.8 mm minimum
1	-	Engine bulkhead housing
2	-	Crankshaft main bearing cap adjustment screw

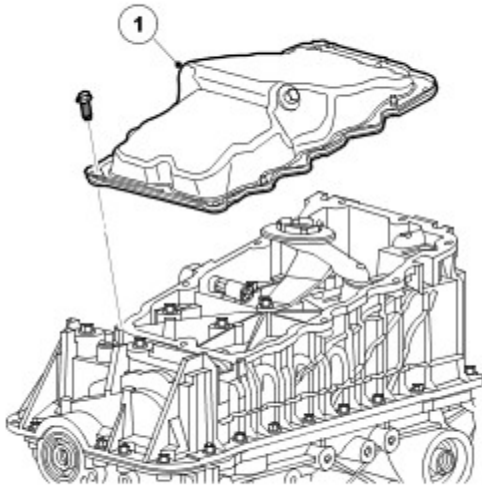
The ladder frame is fitted to the lower cylinder block, via 20 bolts and 2 studs and nuts, to stiffen the base structure thus helping to reduce Noise, Vibration and Harshness (NVH). The frame is made of high-pressure die cast aluminium.

Located in the bulkhead housing are eight crankshaft main bearing cap adjustment screws.

A gasket seals the joint between the bulkhead housing and the cylinder block.

A port for the oil level gauge tube is included in the casting on the LH side of the cylinder block.

Sump

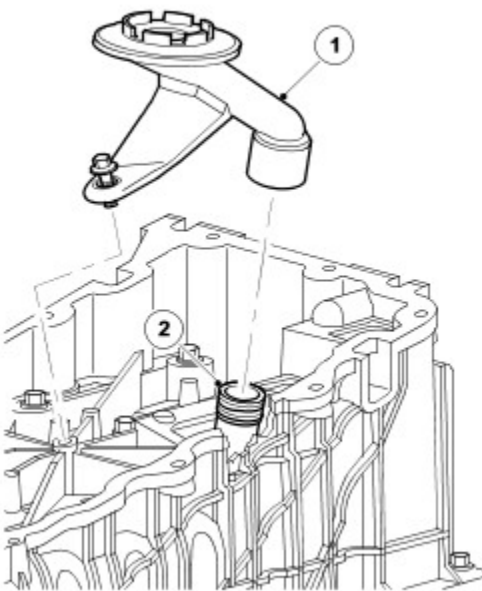


E50503

Item	Part Number	Description
1	-	Sump

The pressed steel sump is a wet-type, sealed to the ladder frame using a gasket and 10 bolts.

Oil Pick-up

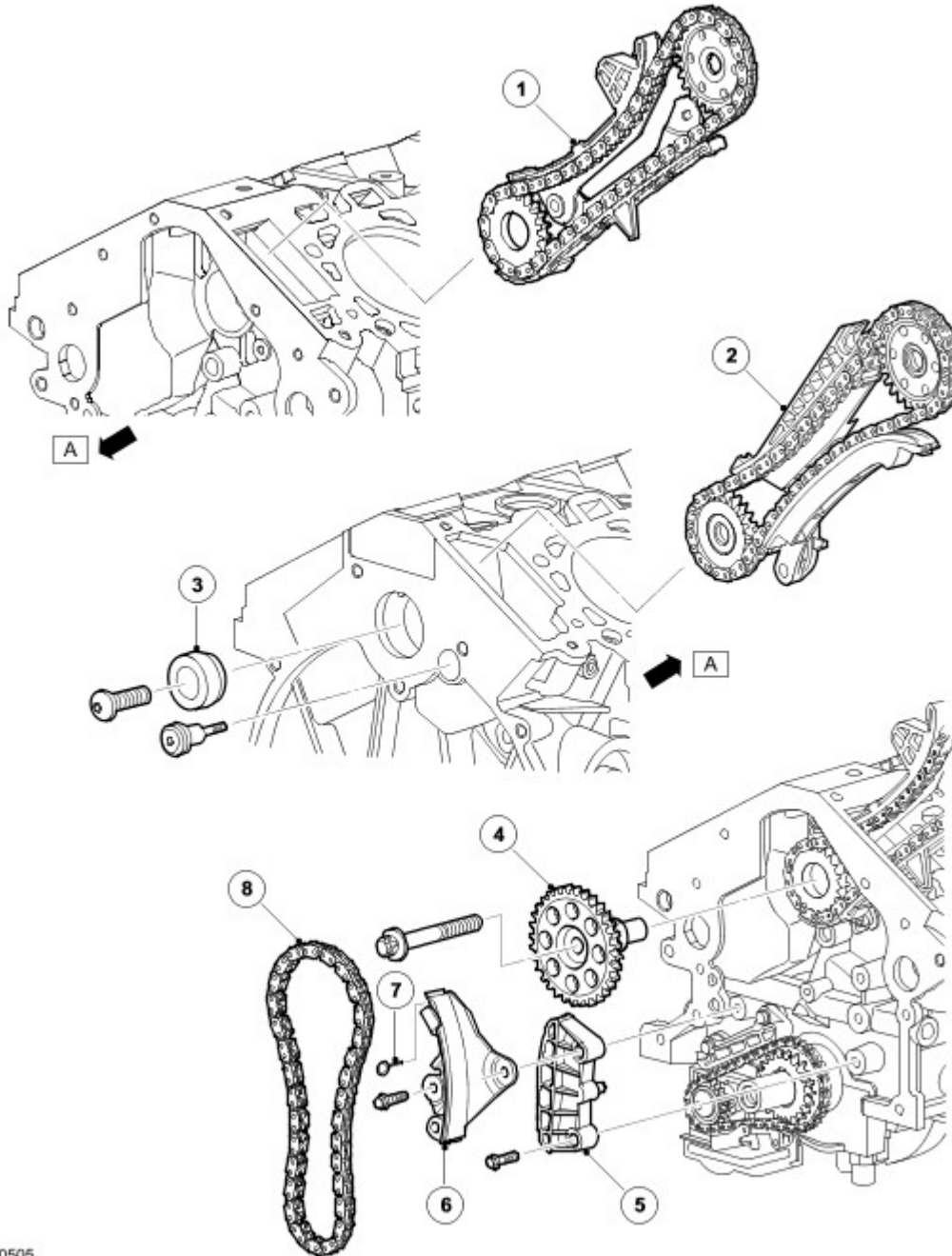


E50504

Item	Part Number	Description
1	-	Oil pick-up

The oil pick-up is a two-piece unit with strainer located in the centre of the sump oil well, as a source for the supply of engine lubrication oil to the oil pump. Oil is drawn through the end of the pick-up and strained to prevent solid matter from entering the oil pump.

CAMSHAFT TIMING COMPONENTS



E50505

Item	Part Number	Description
A	-	Front of engine
1	-	LH camshaft drive assembly
2	-	RH camshaft drive assembly
3	-	Spacer
4	-	Jackshaft sprocket

5	-	Chain guide
6	-	Jackshaft chain tensioner
7	-	Tensioner pin
8	-	Jackshaft chain

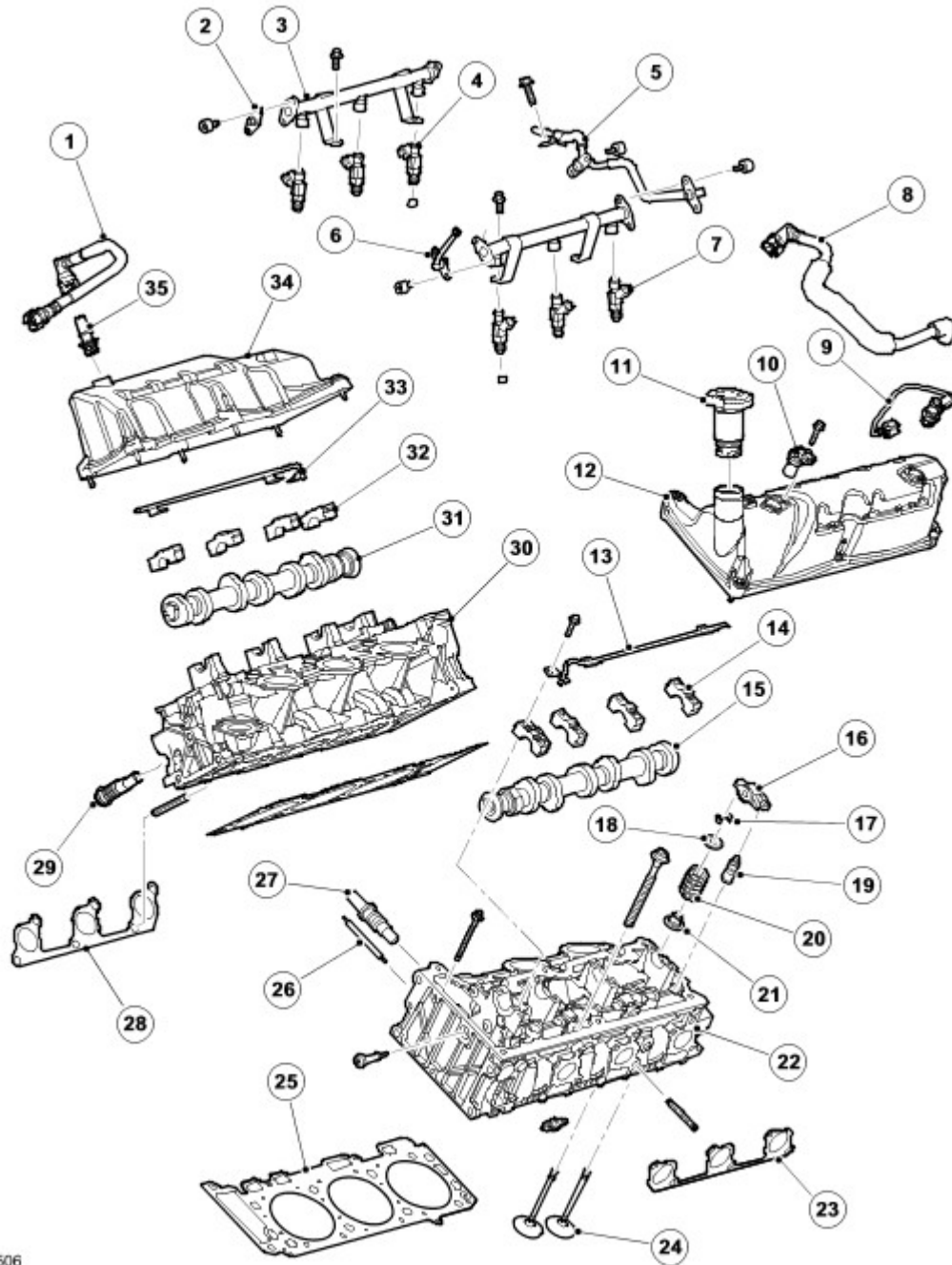
Camshaft Drive Assembly

Each camshaft drive assembly comprises:

- A jackshaft gear
- A camshaft gear
- A drive chain
- A chain guide

The LH drive assembly is driven from the front of the jackshaft and the RH assembly from the rear.

CYLINDER HEAD COMPONENTS

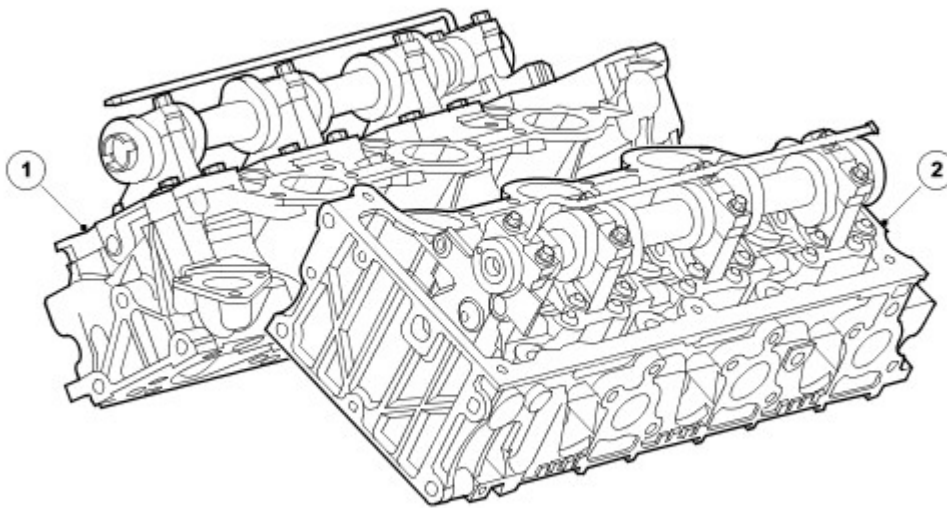


E50506

Item	Part Number	Description
1	-	Hose, crankcase emissions, RH camshaft cover to intake manifold
2	-	Fuel injector pulse damper
3	-	RH Fuel rail
4	-	LH injectors (3 of)
5	-	Fuel supply line
6	-	Schrader valve
7	-	RH injectors (3 of)
8	-	Hose, crankcase emissions, LH camshaft cover to intake manifold
9	-	Electrically heated positive crankcase ventilation valve
10	-	Camshaft position (CMP) sensor

11	-	Oil filler cap
12	-	LH camshaft cover
13	-	LH valve rocker arm oil supply tube
14	-	LH camshaft bearing caps
15	-	LH camshaft
16	-	Valve rocker arm
17	-	Collet
18	-	Valve spring retainer seat
19	-	Hydraulic lash adjuster
20	-	Valve spring
21	-	Valve stem seal
22	-	LH cylinder head
23	-	LH exhaust manifold gasket
24	-	Valves
25	-	Cylinder head gasket
26	-	Volume reduction plug/valves
27	-	Timing chain tensioner
28	-	RH exhaust manifold gasket
29	-	Timing chain tensioner
30	-	RH cylinder head
31	-	RH camshaft
32	-	RH camshaft bearing caps
33	-	RH valve rocker arm oil supply tube
34	-	RH camshaft cover
35	-	Crankcase ventilation valve

Cylinder Heads



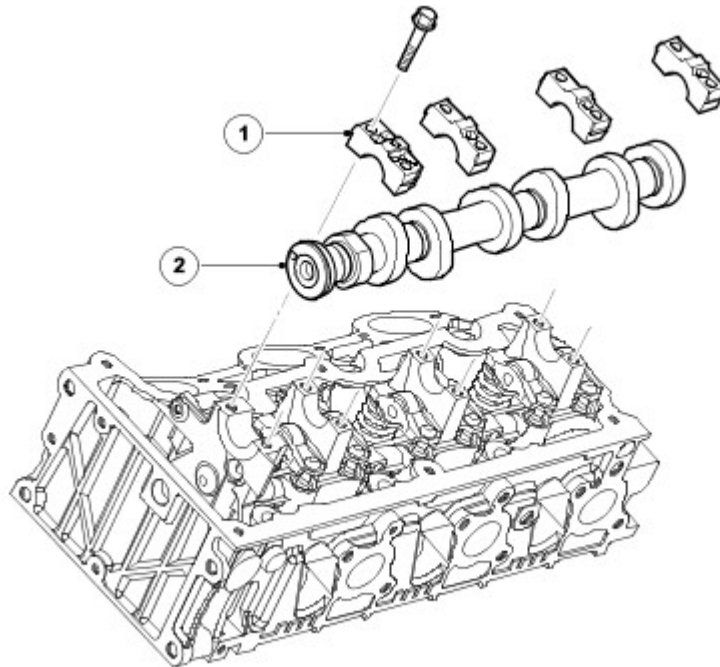
E50507

Item	Part Number	Description
1	-	RH cylinder head
2	-	LH cylinder head

The cross-flow cylinder heads are based on a twin valve, central spark plug combustion chamber, with the inlet ports designed to induce swirl and control the speed of the induction charge. This serves to improve combustion and hence fuel economy, performance and exhaust emissions.

LH and RH cylinder heads are identical castings.

Camshafts



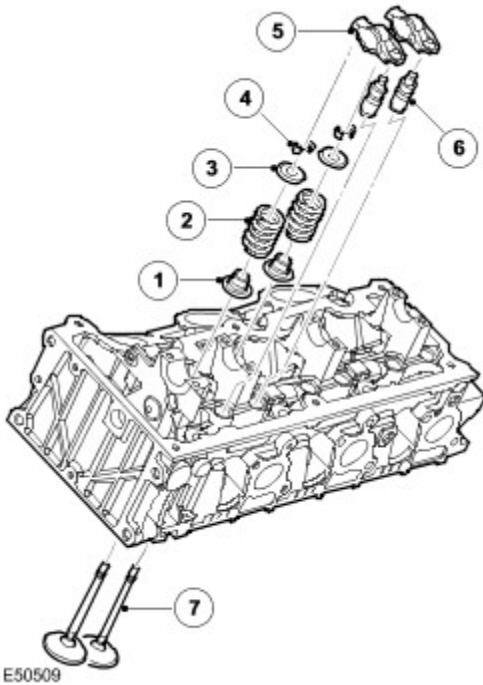
E50508

Item	Part Number	Description
1	-	Bearing cap
2	-	Camshaft

A single camshaft on each cylinder bank is retained by a camshaft carrier, line bored with the cylinder head. The camshafts are located by a flange, which also controls end-float.

The LH camshaft incorporates a reluctor, which is used in conjunction with the Camshaft Position (CMP) sensor to measure engine position.

Valves and Hydraulic Lash Adjusters



Item	Part Number	Description
1	-	Valve stem seal
2	-	Valve spring
3	-	Valve spring retainer seat
4	-	Valve spring retainer key
5	-	Rocker arm
6	-	Hydraulic lash adjuster
7	-	Valve

The valve springs are made from spring steel and are of the parallel single-coil type. The bottom end of each spring rests on the flange of a spring retainer, which has an integral valve stem seal. The top end of the spring is held in place by a spring retainer, which is held in position at the top end of the valve stem by split taper collets. The taper collets have grooves on the internal bore that locate to grooves ground into the upper stems of the valves.

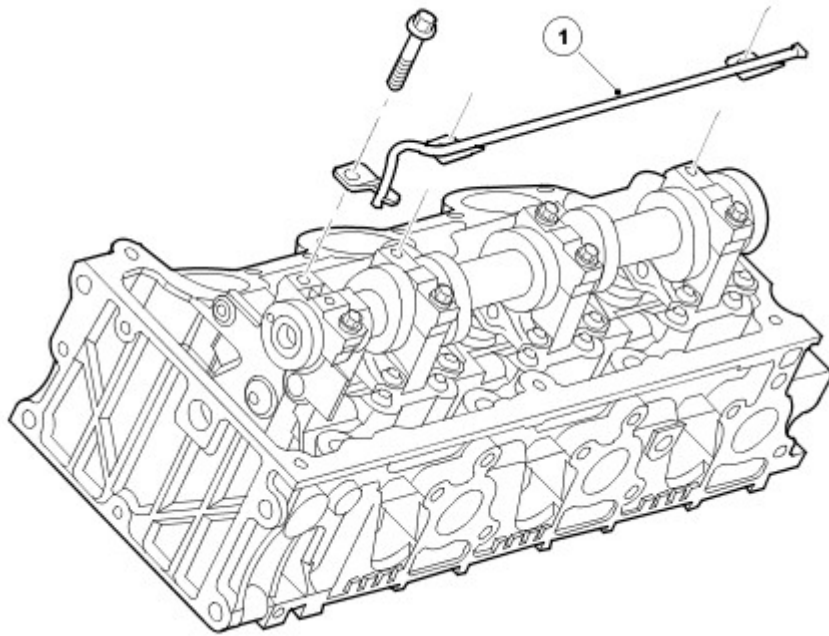
Valve seats and valve guides are an interference fit in the cylinder head.

The valves are operated through roller-type finger rockers and hydraulic lash adjusters, actuated by the camshaft lobes. When the camshaft lobe presses down on the top of a finger rocker, roller mechanism, the respective valve is forced down, opening the affected inlet or exhaust valve. The use of this type of actuation method helps reduce friction in the valve timing mechanism.

The body of the hydraulic lash adjusters contains a plunger and two chambers for oil feed and pressurised oil. The pressurised oil is supplied to the lash adjusters via the main oil galleries in the cylinder head and through a hole in the side of the lash adjuster body. The oil passes into a feed chamber in the lash adjuster and then through to a separate pressure chamber via a one way ball valve.

Oil flow from the pressure chamber is determined by the amount of clearance between the lash adjuster outer body and the centre plunger. Oil escapes up the side of the plunger every time the lash adjuster is operated, the downward pressure on the plunger forcing a corresponding amount of oil in the lash adjuster body to be displaced. When the downward pressure from the camshaft and finger rocker is removed (i.e. after the trailing flank of the camshaft lobe has passed), oil pressure forces the lash adjuster's plunger up again. This pressure is not sufficient to effect the valve operation, but eliminates the clearance between the finger rocker and top of the valve stem.

Valve Rocker Arm Oil Supply Tube

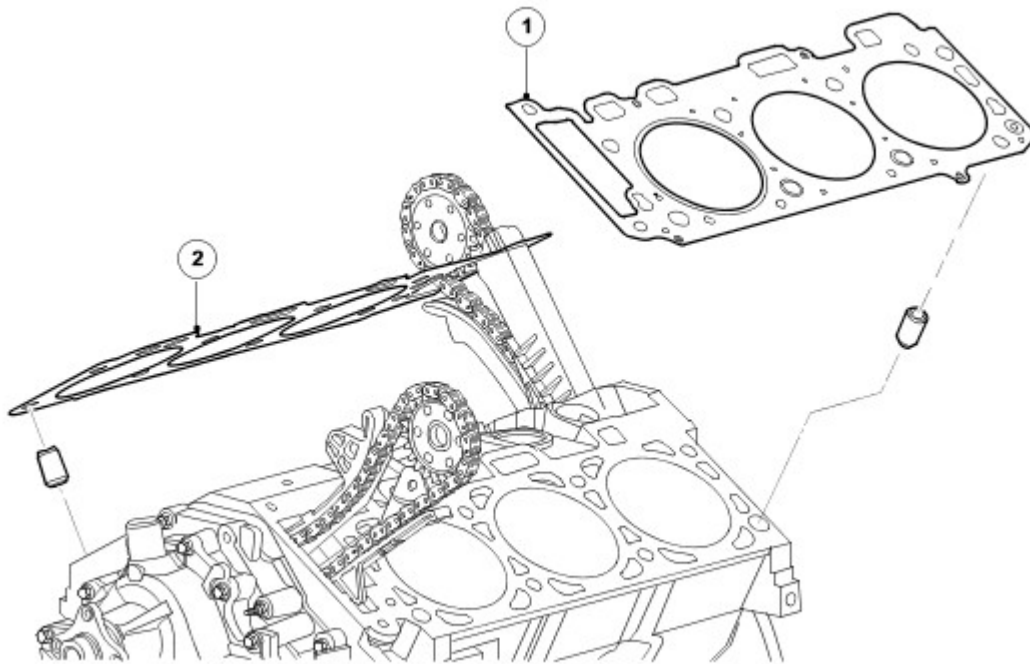


E50510

Item	Part Number	Description
1	-	Valve rocker arm oil supply tube

The valve rocker arm oil supply tube locates on top of each camshaft and is secured by two bolts to the front and rear camshaft bearing caps. Oil is supplied to the tube via a gallery in the cylinder head and is distributed to each rocker arm through adjacent spray holes in the tube.

Cylinder Head Gasket



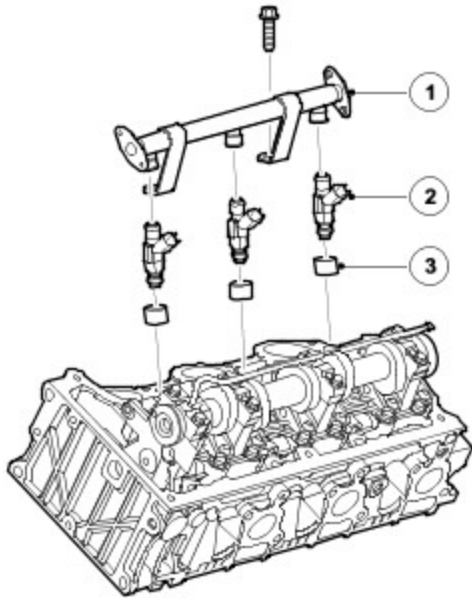
E50511

Item	Part Number	Description
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1	-	LH cylinder head gasket
2	-	RH cylinder head gasket

The multi-layered steel cylinder head gasket has cylinder specific water flow cross-sections for uniform coolant flow.

Fuel Injectors

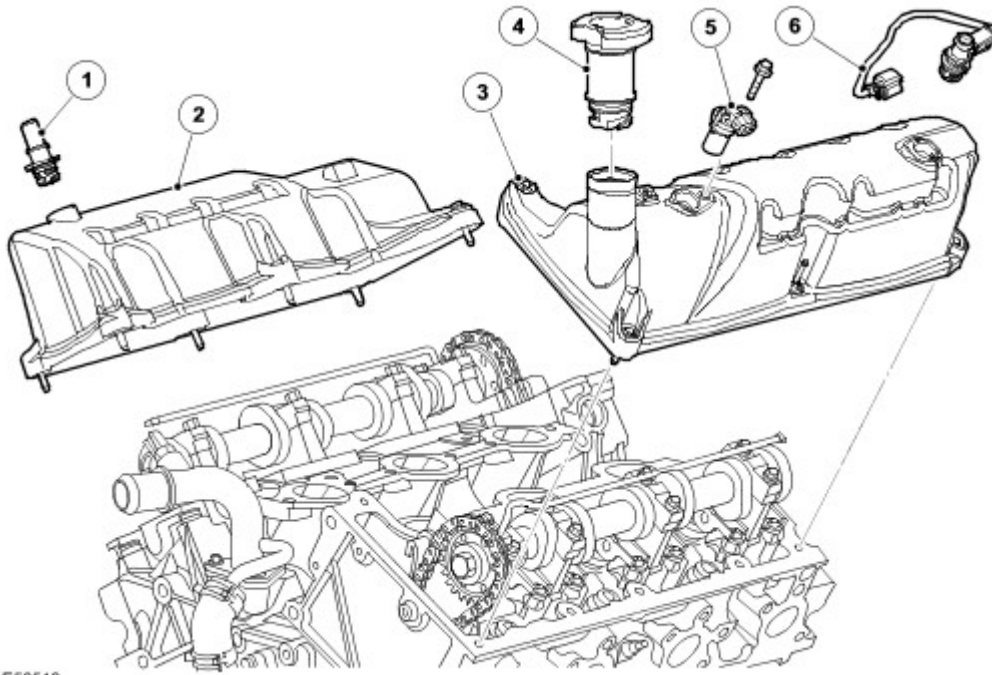


E50512

Item	Part Number	Description
1	-	Fuel rail
2	-	Injector
3	-	Adapter

The fuel injectors are installed in each of the two fuel rails, one per cylinder head. The injectors are electromagnetic solenoid valves controlled by the ECM. Each injector nozzle locates in the cylinder head via an injector insert adapter. An 'O' ring seals each injector to the fuel rail. The fuel jets from the injectors are directed onto the back of the intake valves. For additional information, refer to [Electronic Engine Controls](#) (303-14A Electronic Engine Controls - 4.0L)

Camshaft Cover

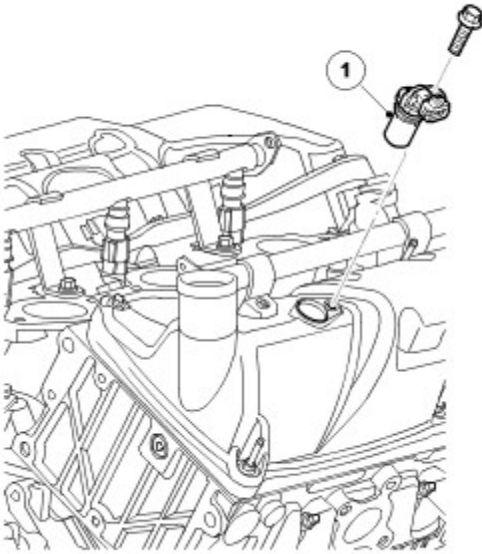


E50513

Item	Part Number	Description
1	-	Crankcase ventilation valve
2	-	RH camshaft cover
3	-	LH camshaft cover
4	-	Oil filler cap and extension
5	-	Camshaft Position (CMP) sensor
6	-	Electrically heated positive crankcase ventilation valve

The camshaft covers are manufactured from thermo-plastic. The LH cover incorporates a hole, located directly above the camshaft reluctor, for the camshaft position sensor. The LH cover also incorporates the engine oil filler aperture.

Camshaft Position (CMP) Sensor



E50514

Item	Part Number	Description
1	-	CMP sensor

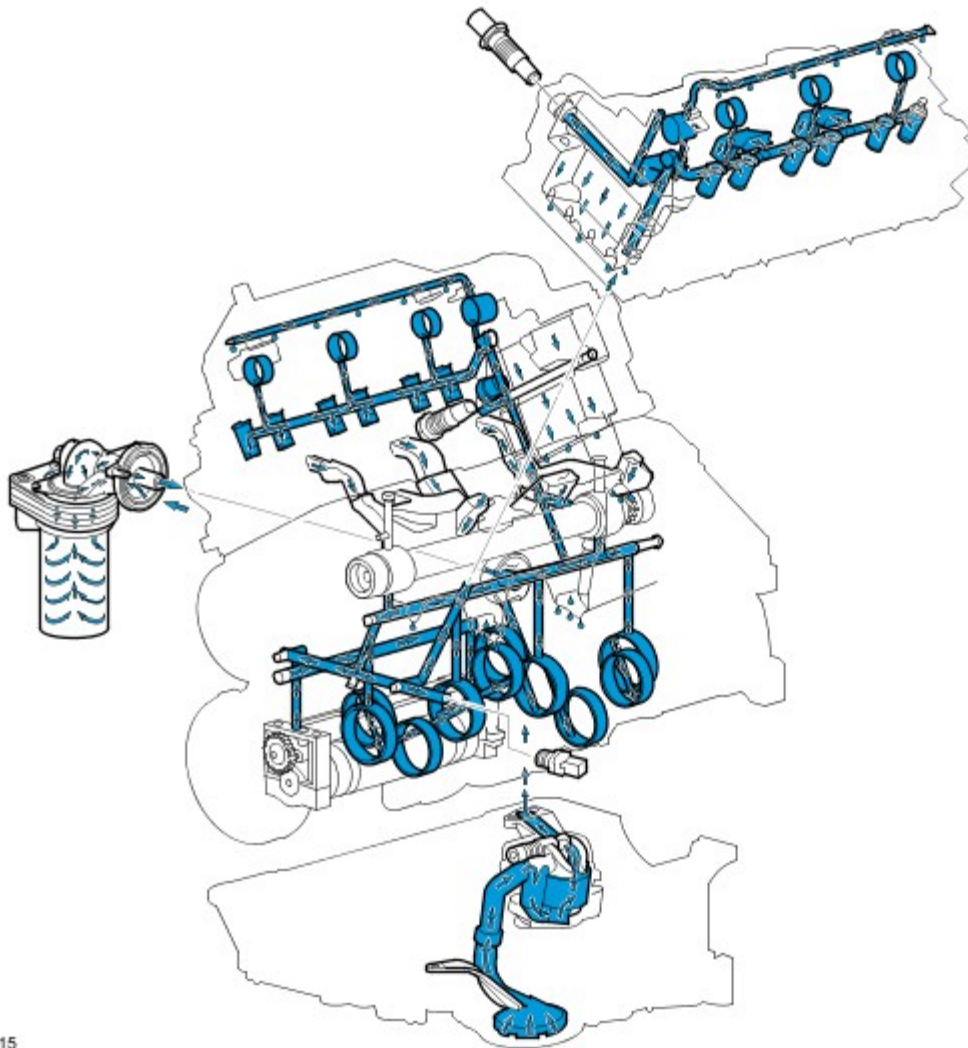
The CMP sensor is installed at the front of the LH camshaft cover. It is a variable reluctance sensor that provides an input to the ECM regarding the position of the camshaft. For additional information, refer to [Electronic Engine Controls](#) (303-14A Electronic Engine Controls - 4.0L)

The reluctor for the camshaft position sensor is located at the front of the LH camshaft. A flat, machined surface near the front of each camshaft, enables the camshafts to be locked during the valve timing procedure.

LUBRICATION SYSTEM

NOTE :

Variant with oil cooler shown.



E50515

The lubrication system is of the full-flow filtration, force-fed type.

Oil is drawn, via a strainer and pick-up pipe in the sump into the jackshaft driven oil pump which has an integral pressure relief valve. The strainer in the pick-up pipe prevents any ingress of foreign particles from passing through to the inlet side of the oil pump and damaging the oil pump and restricting oil drillings. The oil pressure relief valve in the oil pump opens if the oil pressure becomes excessive and diverts oil back around the pump.

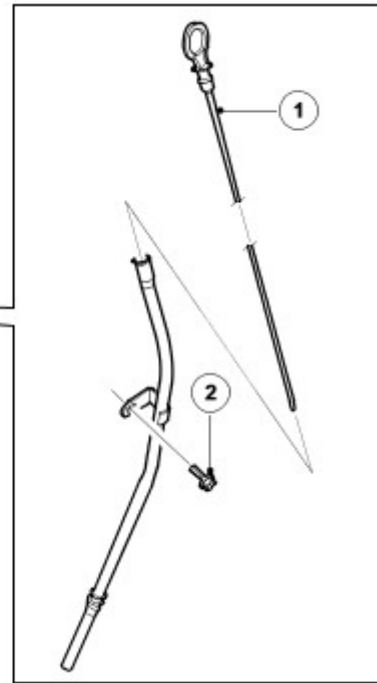
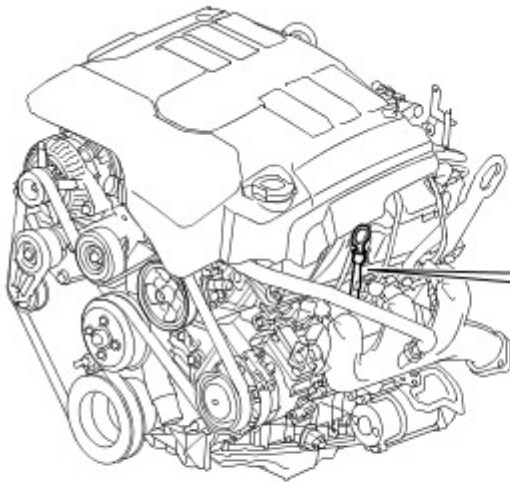
Pressurised oil is pumped through the oil filter, mounted on the oil pump housing. The lubrication system is designed so that a higher proportion of oil flow is directed to the cylinder block main oil gallery while a lower proportion of oil flow, (controlled by a restrictor in the oil filter housing), is directed to the engine oil cooler (if fitted). The remainder of the oil flow from the outlet side of the oil filter is combined with the return flow from the oil cooler (if fitted) before being passed into the cylinder block main oil gallery.

The main oil gallery has drillings that direct the oil to each cylinder head and the main bearings. Cross drillings in the crankshaft main bearings carry the oil to the connecting rod big-end bearings. Oil galleries in the cylinder head carry the oil to the camshafts and the hydraulic lash adjusters.

The oil pressure switch is located in the cylinder block to sense the oil pressure level before the oil flow enters the main gallery in the cylinder block. A warning lamp in the instrument cluster is illuminated if low oil pressure is detected.

Oil at reduced pressure is directed to each cylinder bank via two restrictors in the cylinder block/cylinder head locating dowels, one at the front on the LH bank and the other at the rear on the RH bank. Oil then passes through a drilling in the cylinder head to the camshaft carrier, where it is directed via separate galleries to the camshaft bearings and hydraulic tappet housings. Return oil from the cylinder head drains into the sump via the cylinder head bolt passages.

Oil Level Gauge

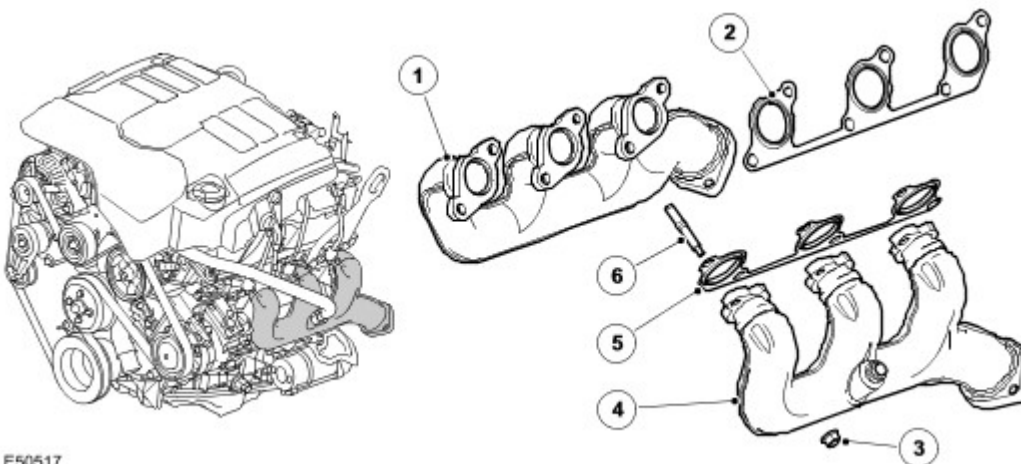


E50516

Item	Part Number	Description
1	-	Oil level gauge
2	-	Oil level gauge tube

The oil level gauge locates along the LH side of the cylinder block, supported in a tube installed in the sump. Two holes in the end of the gauge indicate the minimum and maximum oil levels. There is a difference of approximately 1.5 litres (1.58 US quart) between the two levels.

EXHAUST MANIFOLD



E50517

The dual wall stainless steel exhaust manifolds are unique for each cylinder bank.

The exhaust manifolds are sealed to the cylinder heads via metal gaskets.