ENGINE

Engine - V6 4.0L Petrol

ENGINE - V6 4.0L PETROL

SPECIFICATIONS

SEALERS

Item	Land Rover Part No.
Engine timing cover to cylinder block	STC 50550
Rear main bearing cap to cylinder block	8510302

LUBRICANT - UK, EUROPE AND ROW - NOT NAS/Japan

Item	Specification
(1) Recommended lubricant	The use of 5W/30 oil to Specification WSS - M2C929-A is preferred. Where oil to this specification is not available, then 5W/30 oil meeting specifications ACEA A1/A3 or API SJ or SL may be used.
(1) WSS is a Ford prefix to the oil specification	

LUBRICANT - NAS/Japan

Item	Specification
(1) Recommended lubricant	Use 5W/30 oil meeting Specification WSS-M2C929-A (GF4) and 'Certified for Gasoline Engines' by the American Petroleum Institute (API).
(1) WSS is a Ford prefix to the oil specification	

CAPACITY

Item	Capacity
Dry fill including filter	6.4 litres (11.2 pints) (6.7 US quarts)
Oil and filter change - Maximum	5.7 litres (10.0 pints) (6.0 US quarts)
Amount of oil required to bring the level from the lower to the upper holes on the dipstick	1.4 litres (2.4 pints) (1.5 US quarts)

GENERAL SPECIFICATION

Item	Specification
Type	4.0 litre, 60 degree 'V', petrol engine, single overhead camshaft per cylinder head, 2 valves per cylinder
Cylinder arrangement	V6, when looking towards the rear of the engine, cylinders 5 and 6 are at the rear.

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Cylinder numbering	Number 1, 3, 5 cylinder - right hand bank; Number 2, 4, 6 cylinder - left hand bank
Bore - nominal	100.4 mm (3.952 in)
Stroke	84.4 mm (3.322 in)
Capacity	4009 cm^3 (244.5 in^3)
Firing order	1 - 2 - 3 - 4 - 5 - 6
Compression ratio	9.75:1
Direction of rotation	Anti-clockwise viewed from rear of engine
Maximum power	156 Kw (209 bhp) @ 4750 rev/min
Maximum torque	346 Nm (255 lb-ft) @ 3500 rev/min
Dimensions:	
Length	669 mm (26.3 in)
Width	712 mm (28.0 in)
Height	747 mm (29.4 in)
Maximum permissable cylinder head warp	0.08 mm (0.003 in)
Engine oil pressure:	
At Idle	1.8 - 2.0 bars (180 - 200 kPa) (26.0 - 29.0 lb/in^2)
At 3500 rev/min	3.3 to 3.6 bars (330 - 360 kPa) (48.0 - 52.0 lb/in^2)

TORQUE SPECIFICATIONS

Description	Nm	lb-ft
Engine RH mounting bracket bolts	80	59
Engine RH mounting bracket nut	90	66
(1) Engine RH mounting to bracket bolts:		
Stage 1	45	33
Stage 2	Further 60°	Further 60°
(3) LH and RH Exhaust manifold nuts	25	18
Dipstick tube bolt	10	7
(1) Exhaust system to exhaust manifold bolts	40	30
(3) RH valve cover bolts/studs	10	7
(3) LH valve cover bolts/studs	10	7
CMP sensor bolt	6	4
(4) LH/RH camshaft cap bolts:		
Stage 1	6	4
Stage 2	16	12
(1)(3) (5) Cylinder head bolts:		
Stage 1 - M12 bolts	30	22

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Stage 2 - M12 Bolts	Further 80°	Further 80°
Stage 3 - M12 bolts	Further 80°	Further 80°
M8 bolts	35	26
Cylinder head coolant flange bolts	10	7
RH Cylinder head ground connector bolt	10	7
Generator mounting bracket bolts	45	33
(3) Generator bolts	45	33
Generator electrical connector nut	10	7
A/C compressor mounting bracket bolts	45	33
Knock sensor bracket bolt	10	7
Knock sensor retaining clip bolt	10	7
Electrical harness bridge bolt	45	33
EGR pipe nuts:		
Stage 1	Lightly tighten	Lightly tighten
Stage 2	40	30
Battery terminal clamp nut(s)	5	3.5
Wiring harness clamp bolt - RHD only	10	7
Oil pick-up pipe Torx screws	10	7
Oil strainer bolt	10	7
Oil pump Torx screws	20	15
Oil cooler lines nut and bolt	25	18
Oil cooler adapter	60	44
Transmission fluid lines bolt	10	7
Transmission fluid lines nut	10	7
Transmission support bracket nut	20	15
Transmission bolts	45	33
Engine front cover:		
M6 bolts	10	7
M8 bolts and studs	20	15
Coolant pump bolts	10	7
Ground cable nut	20	15
(3) **Cylinder block cradle:**		
Stage 1	Lightly tighten 2 rear bolts	Lightly tighten 2 rear bolts
Stage 2	Loosen 2 rear bolts	Loosen 2 rear bolts
Stage 3	Lightly tighten 2 rear bolts	Lightly tighten 2 rear bolts
Stage 4 - Outer bolts, nuts and Torx screws	10	7
Stage 5 - 2 rear bolts	43	32

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Stage 6 - Cylinder block cradle **set screws**	7	5
Stage 7 - Cylinder block cradle **bolts**	15	11
Stage 8 - Cylinder block cradle **bolts**	34	25
(1) **Crankshaft pulley bolt:**		
Stage 1	55	40
Stage 2	Further 85°	Further 85°
LH and RH camshaft sprocket bolts:		
Stage 1	20	15
Stage 2	Further 100°	Further 100°
Oil temperature sensor	20	15
Radiator access panel bolts	10	7
Oil pan bolts	10	7
Wiring harness to oil pan nuts	6	4
(2) Balance shaft Torx bolts	29	21
LH camshaft drive cassette chain guide bolt	25	18
RH camshaft drive cassette bolt	12	9
(1) **RH cassette jackshaft drive sprocket bolt (Rear):**		
Stage 1	40	35
Stage 2	Further 45°	Further 45°
(1) **Jackshaft sprocket Torx bolt (Front):**		
Stage 1	45	33
Stage 2	Further 70°	Further 70°
Crankshaft position sensor (CKP) bolt	8	6
	25	18
Jackshaft thrust plate Torx bolts	10	7
Oil pump drive gear bolt	20	15
LH and RH hydraulic timing chain tensioner	45	33
Primary timing chain tensioner bolt	10	7
Oil filter	18	13
Oil drain plug	37	27
(6) Starter motor cable nut	10	7
Starter motor bolts	45	33

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Fuel rail bolts	25	18
Valve cover fuel line clip bolt	10	7
(3) Intake manifold bolts	10	7
(1) RH catalytic converter to the exhaust manifold bolts	22	16
(1) LH catalytic converter to the exhaust manifold bolts	22	16
Flexplate to torque converter Torx bolts	45	33
Road wheel nuts	140	103

(1) New nuts/bolt(s) must be fitted

(2) New Torx bolts must be fitted

(3) Bolts/Torx bolts/studs must be tightened in sequence

(4) Bolts must be tightened in a diagonal sequence commencing with the 2 centre bearing caps

(5) Lubricate threads of bolts with engine oil prior to fitting

(6) Damage to internal components will result if this torque is exceeded

DESCRIPTION AND OPERATION

ENGINE

EXTERNAL VIEW

NOTE: Variant without oil cooler shown.

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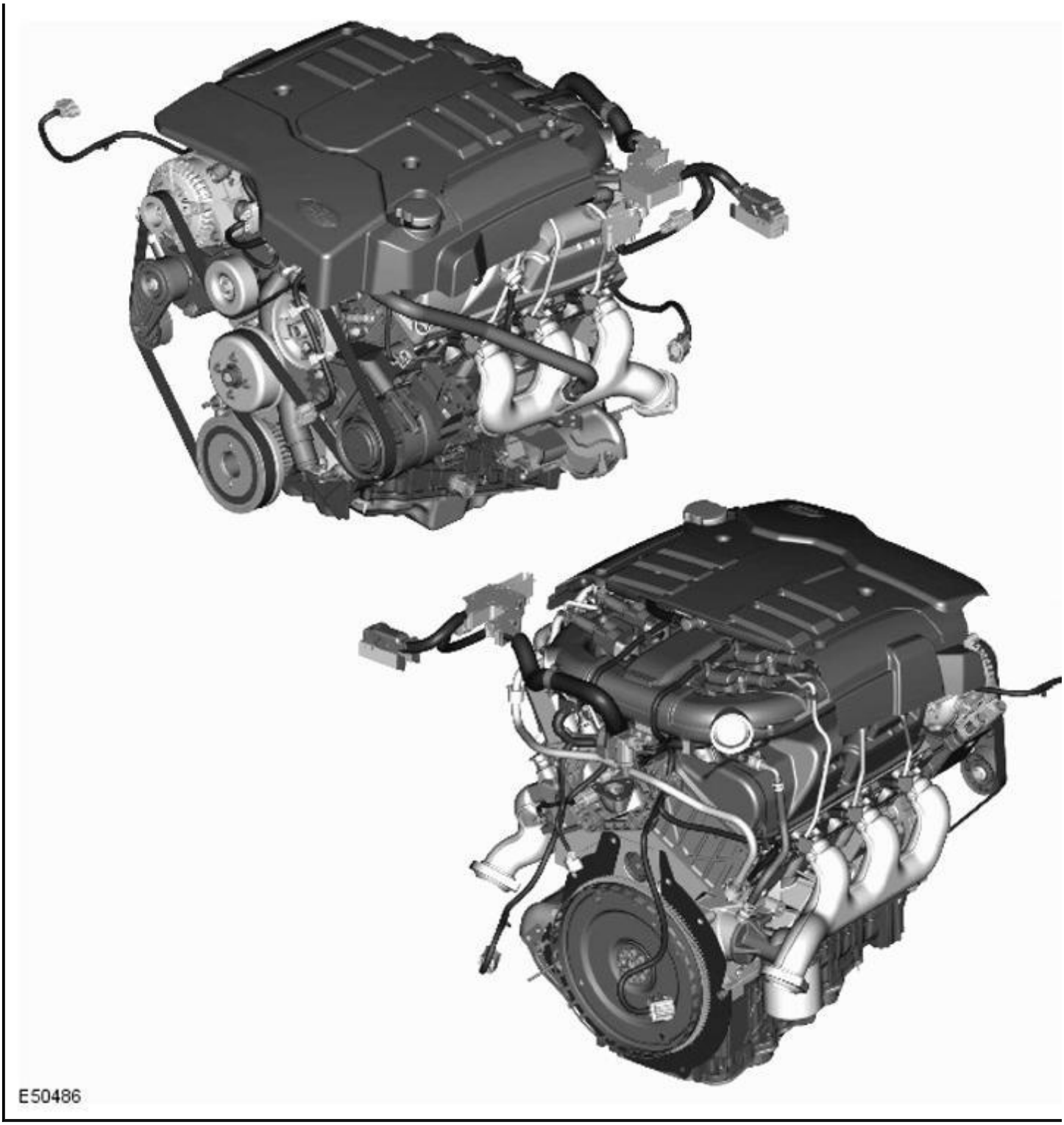

GENERAL

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

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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 aluminum ladder frame and balance shaft assembly bolted to the bottom of the block. The cylinder heads are cast aluminum with vinyl ester composite camshaft covers. The single-piece oil sump is formed from pressed steel. The intake manifold is manufactured from cast aluminum and incorporates a central chamber with six inlet port tracts

For additional information, refer to: **Intake Air Distribution and Filtering** .

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 aluminum cylinder heads, each incorporating a single hollow camshaft
- Rocker valve arms with hydraulic lash adjusters
- Engine front cover manufactured from aluminum 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 aluminum 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

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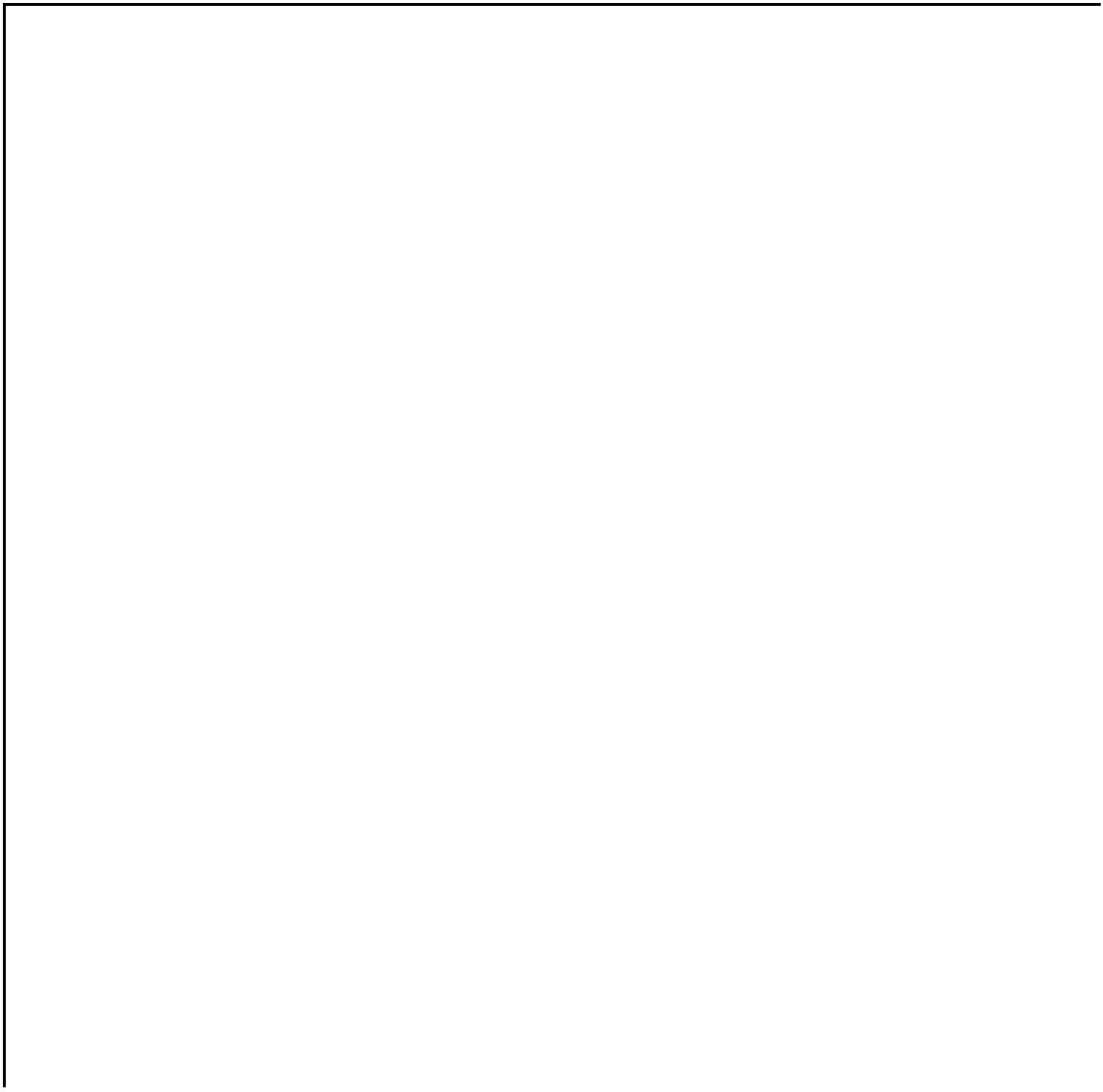
Compression	ratio 9.7:1
Firing	order 1 2 3 4 5 6
Oil	capacity 6.4 litres

CYLINDER NUMBERING

The cylinders are numbered as shown below, with cylinders 1 and 2 at the front of the engine.



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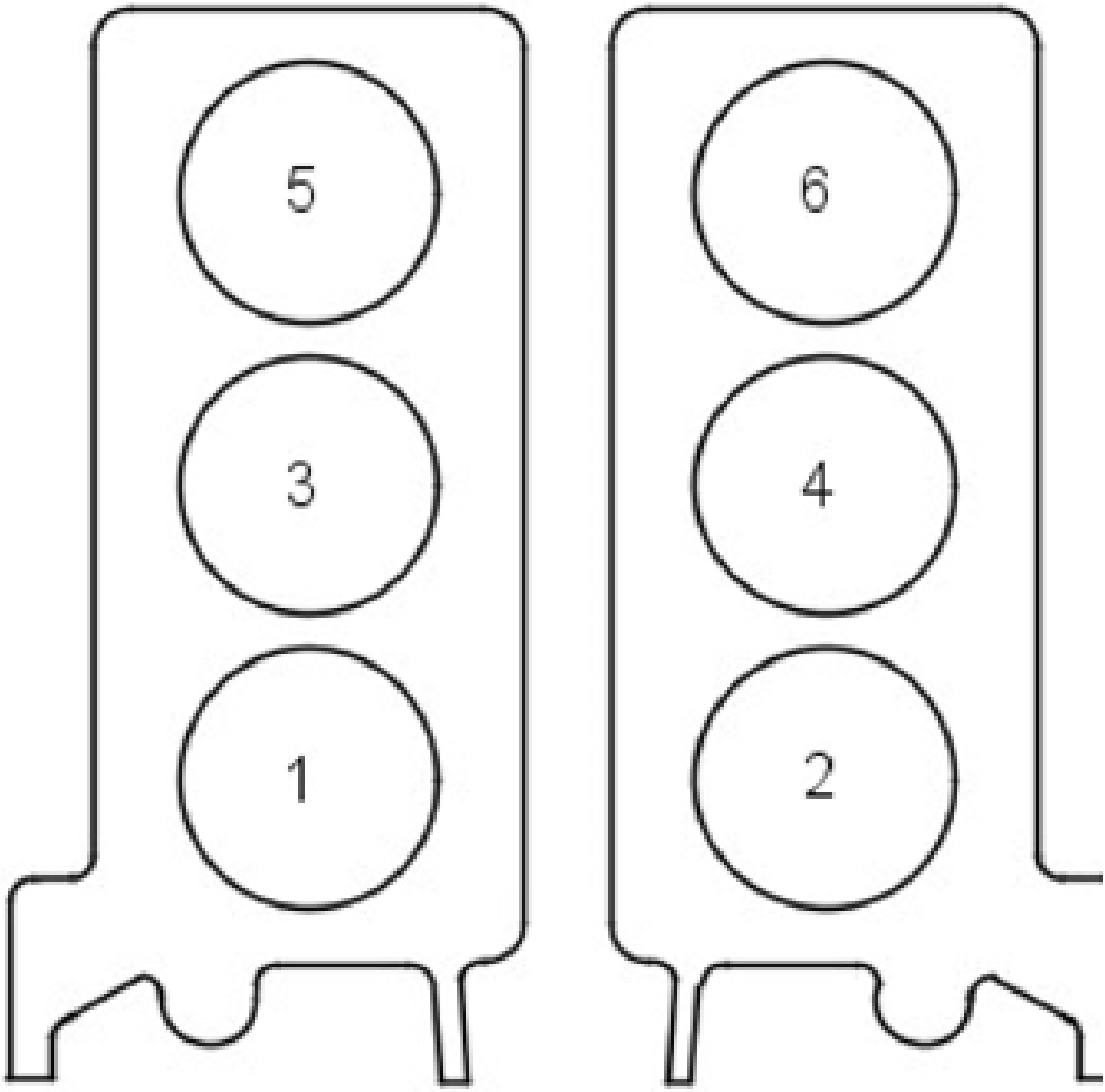

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CYLINDER BLOCK COMPONENTS

NOTE: Variant with oil cooler shown.

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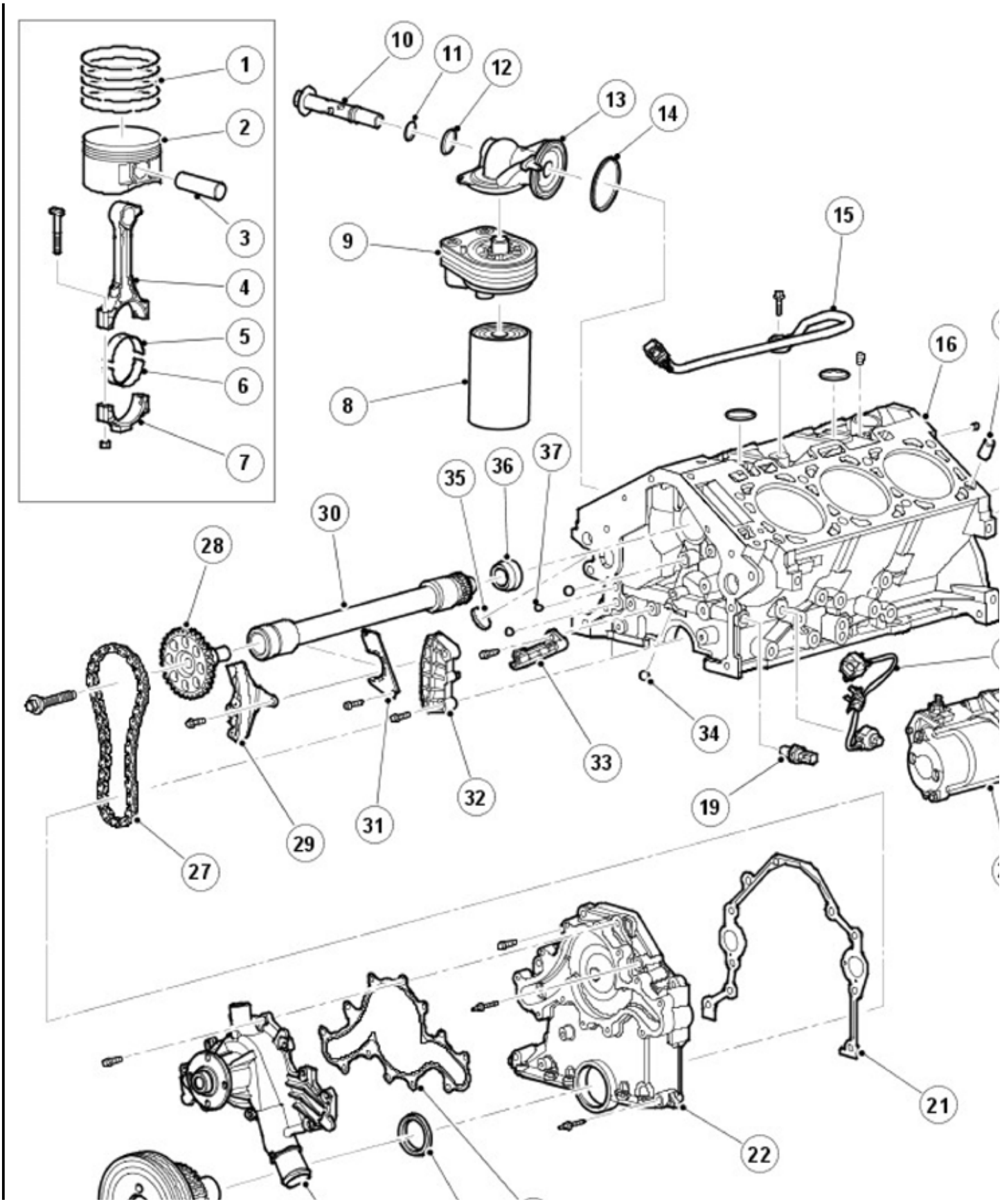

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Item	Part Number	Description
1	-	Piston Rings
2	-	Piston
3	-	Piston pin
4	-	Connecting rod
5	-	Connecting rod bearing - upper
6	-	Connecting rod bearing - lower
7	-	Connecting rod cap
8	-	Oil filter
9	-	Oil cooler (if fitted)
10	-	Oil filter adapter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

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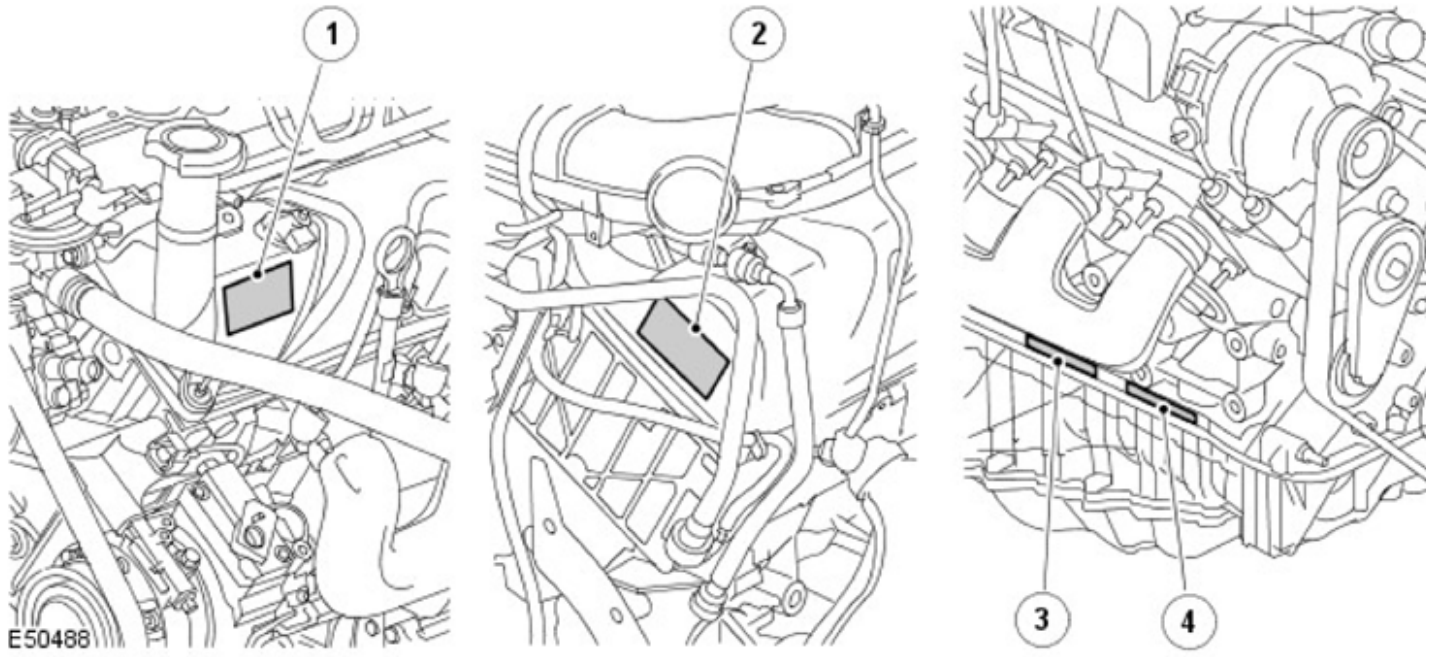
low volume coolant jacket improves warm-up times and piston noise levels; the longitudinal flow design of the jacket, with a single cylinder head coolant transfer port in each bank, improves rigidity and head gasket sealing.

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

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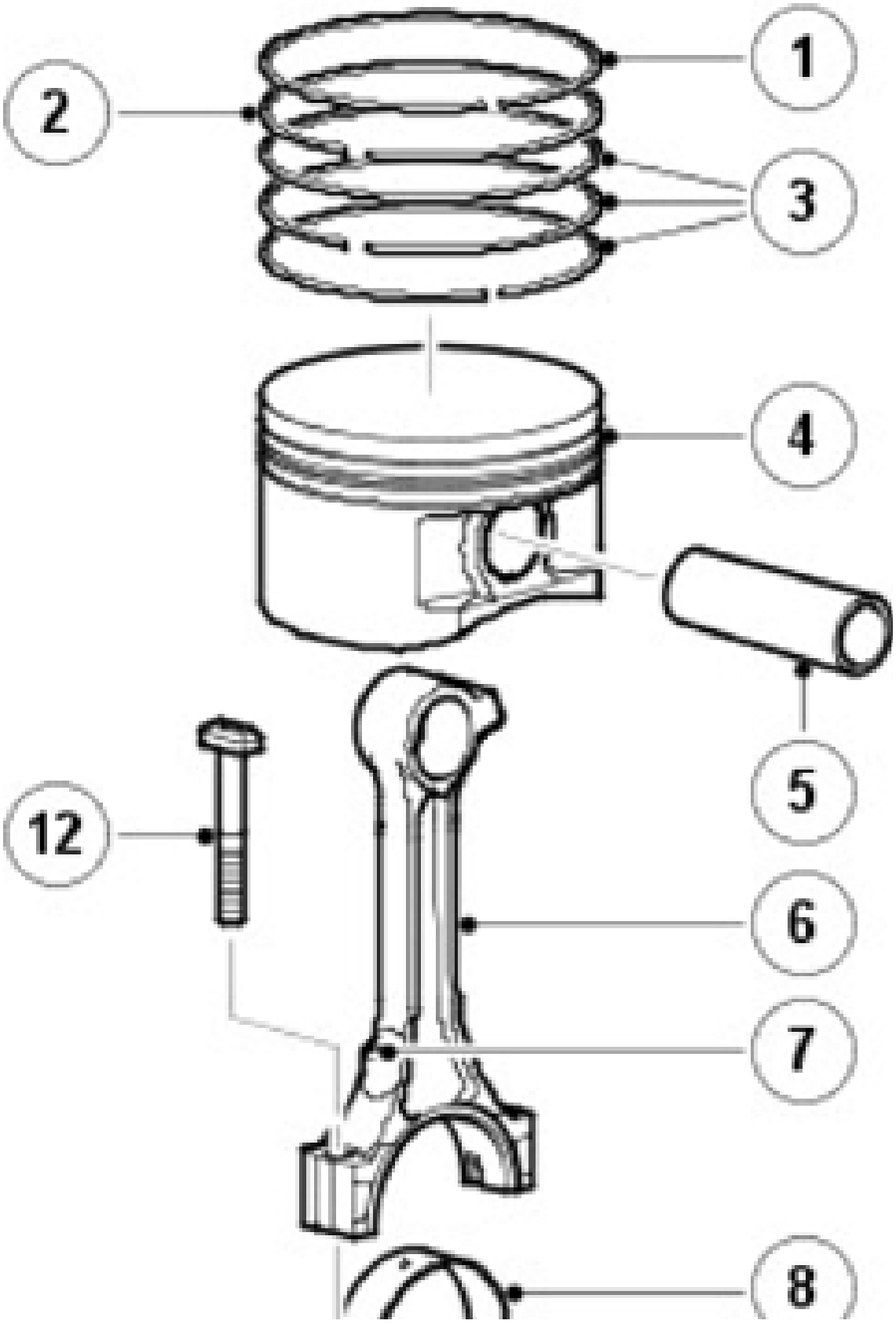

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Item	Part Number	Description
1	-	Piston ring, upper compression
2	-	Piston ring, lower compression
3	-	Piston rings, oil control
4	-	Piston
5	-	Piston pin
6	-	Connecting rod
7	-	Oil squirt hole
8	-	Connecting rod bearing, upper
9	-	Connecting rod bearing, lower
10	-	Connecting rod cap
11	-	Nut
12	-	Bolt

The aluminum 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 utilizes 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

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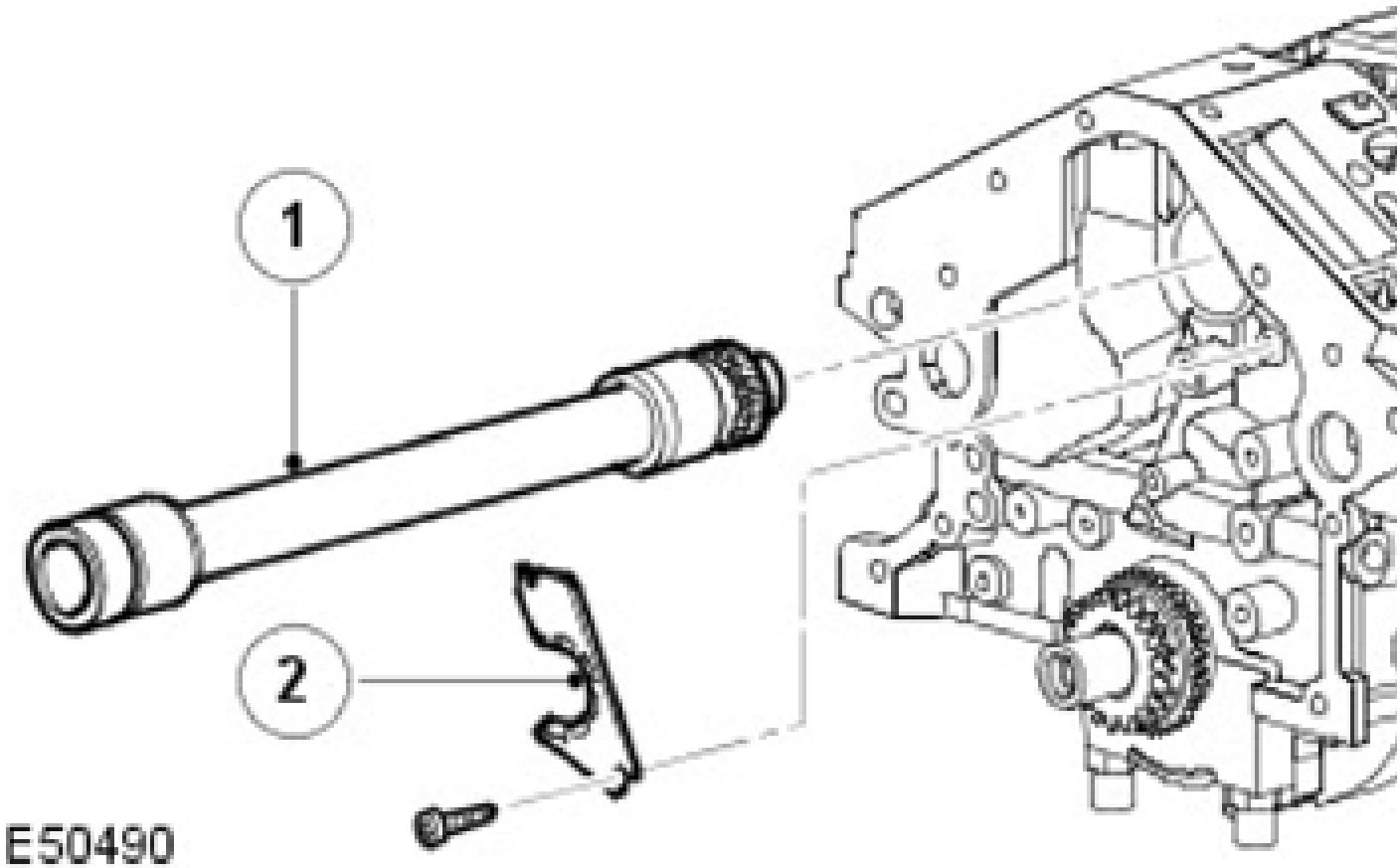

Item	Part Number	Description
1	-	Jackshaft
2	-	Thrust plate

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

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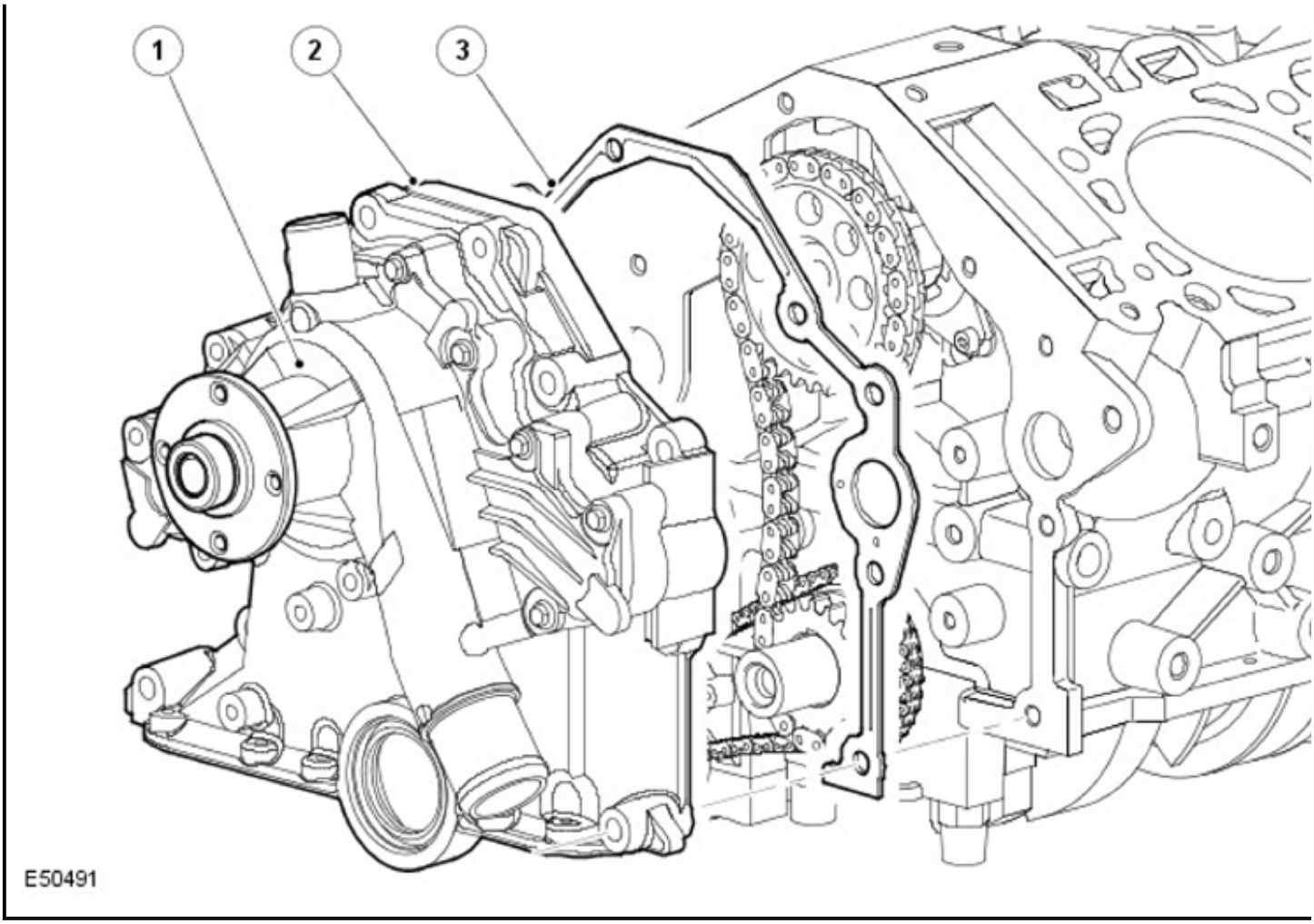

Item	Part Number	Description
1	-	Water pump assembly
2	-	Engine front cover
3	-	Gasket

The aluminum 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.

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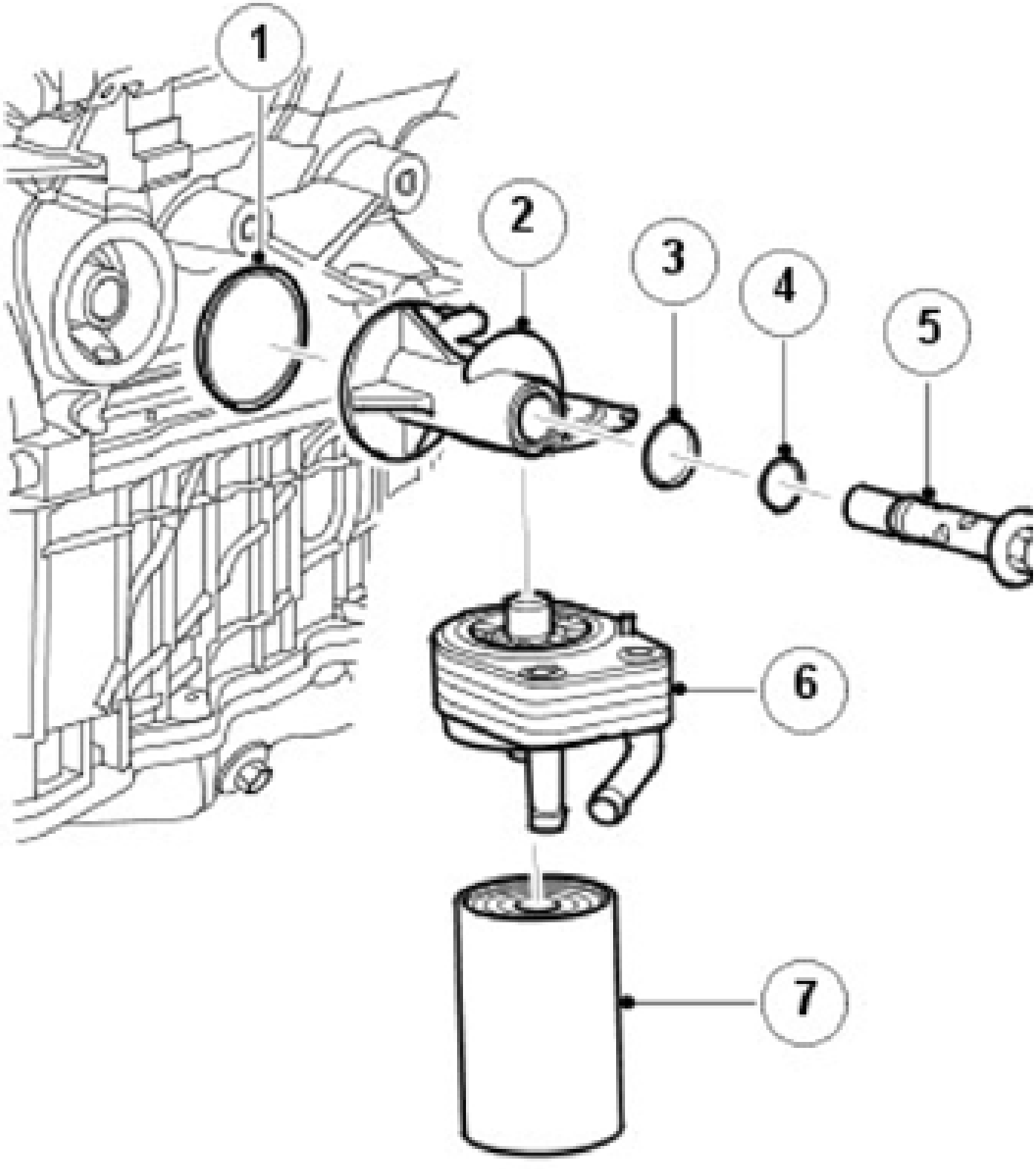

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Item	Part Number	Description
1	-	O ring
2	-	Adapter
3	-	O ring
4	-	O ring
5	-	Adapter mounting bolt
6	-	Cooler assembly (if fitted)
7	-	Oil filter

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

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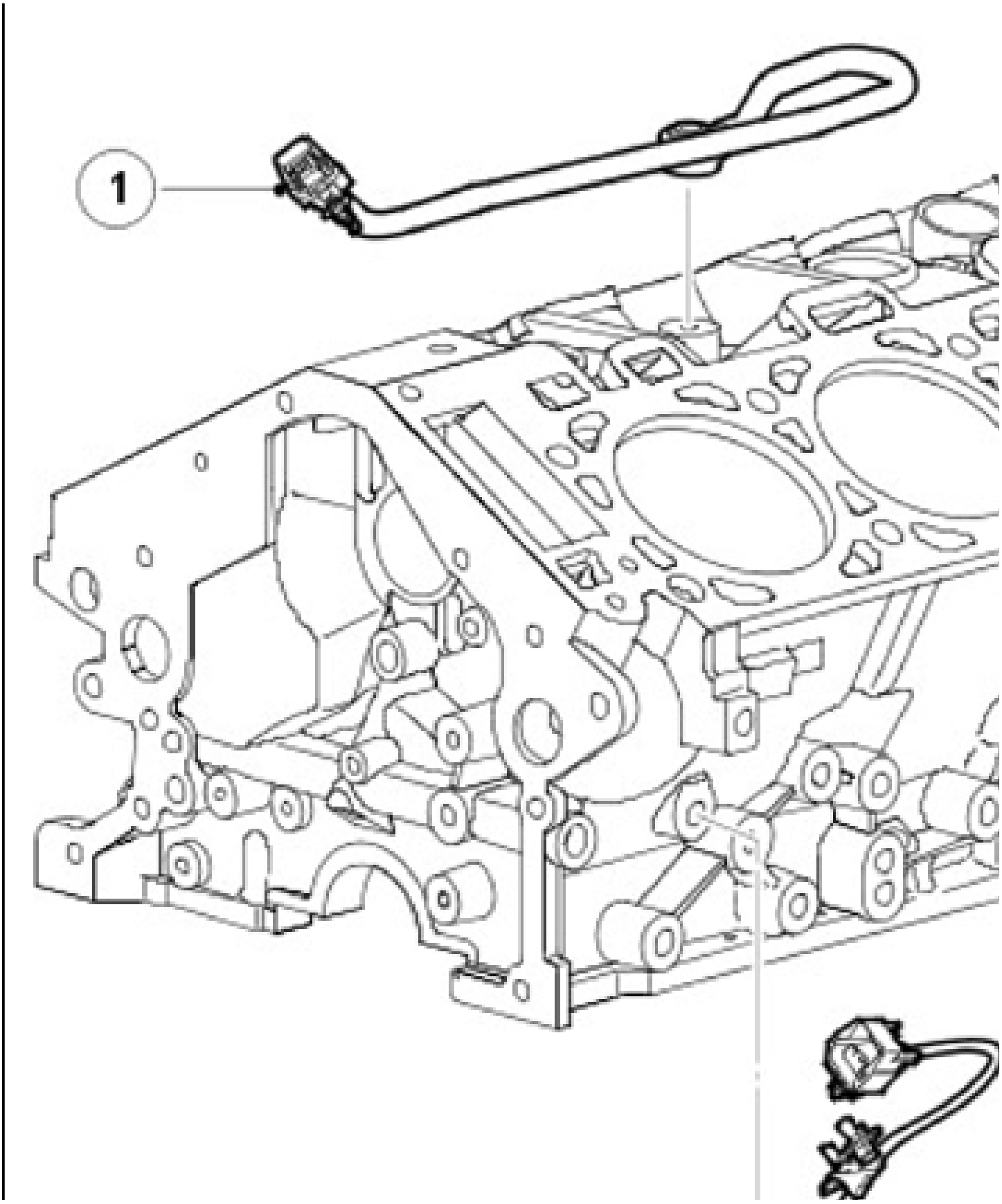

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Item	Part Number	Description
1	-	RH knock sensor
2	-	LH knock sensor

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** .

Oil Pressure Switch

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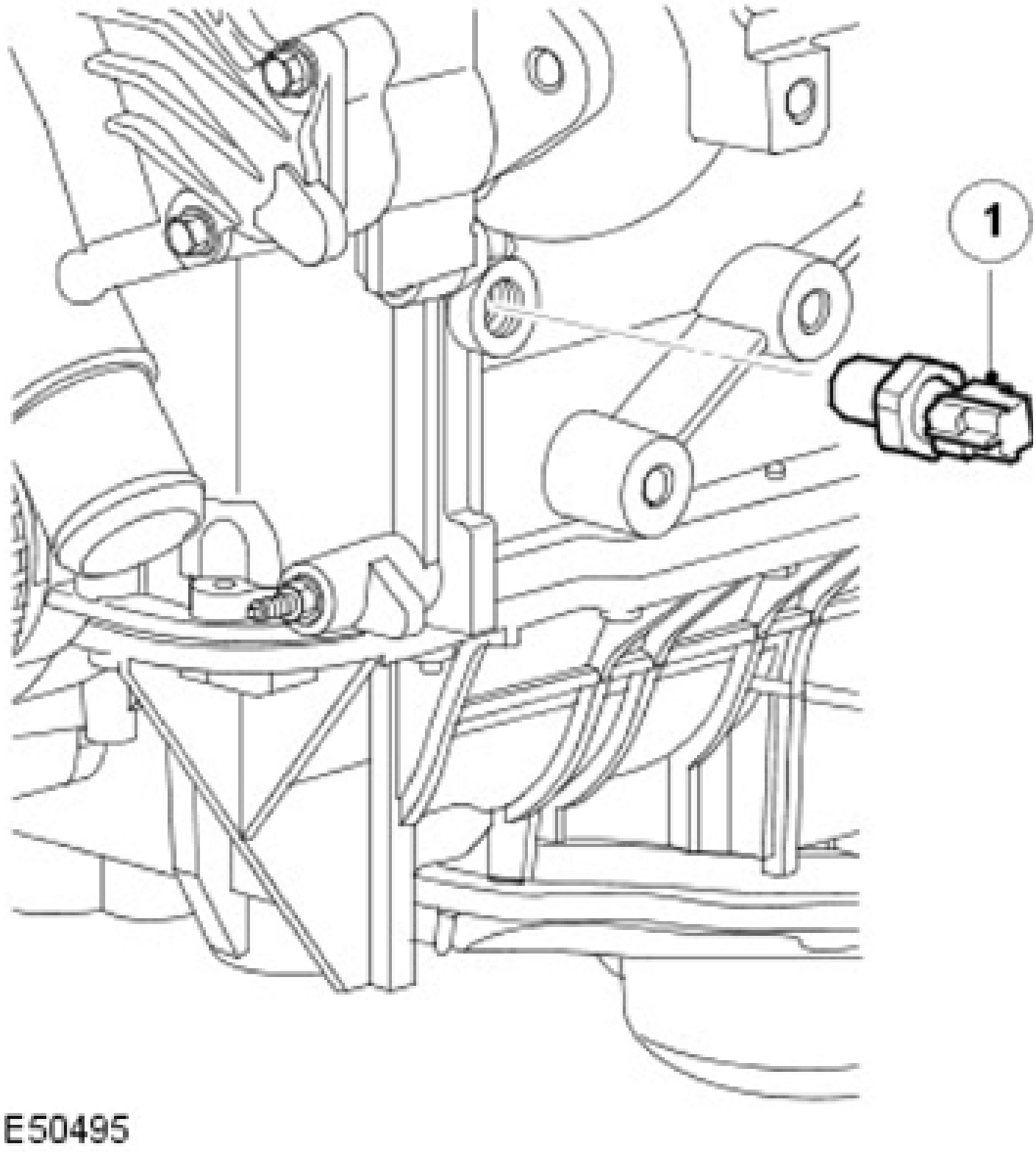

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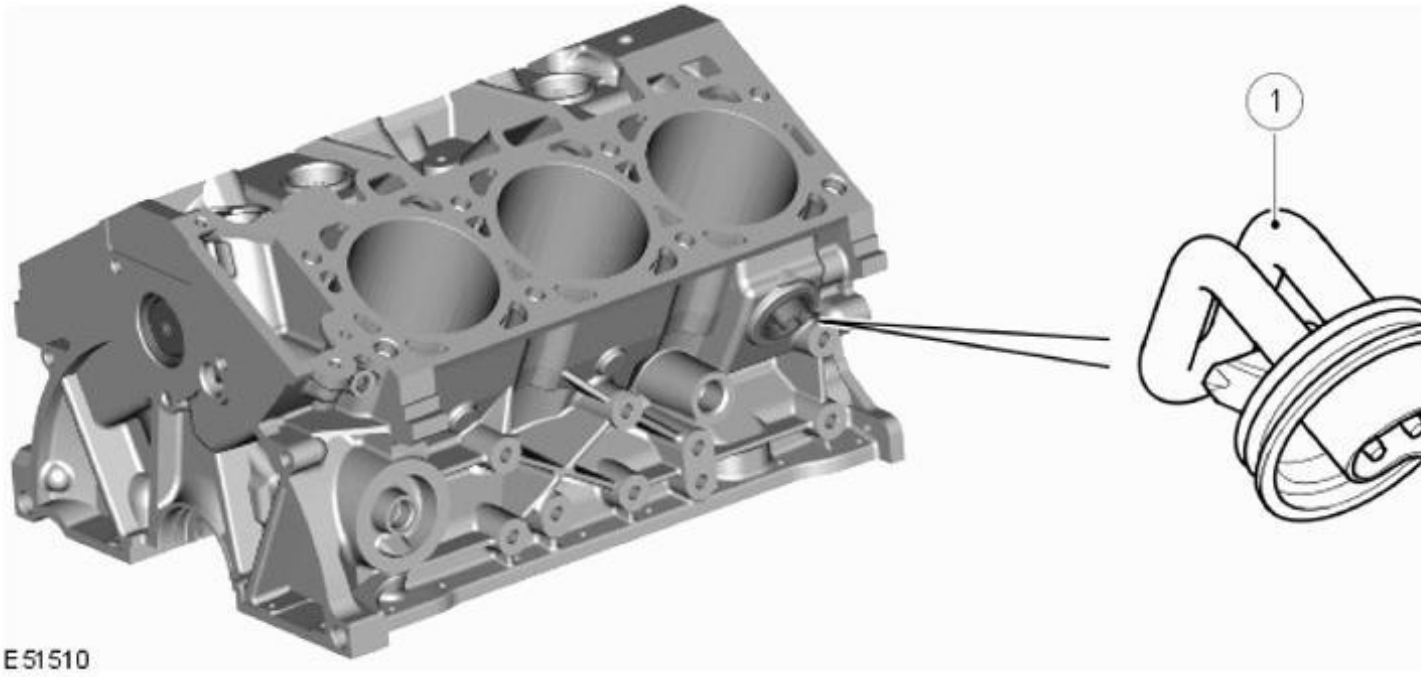
Item	Part Number	Description
1	-	Oil Pressure Switch

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



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

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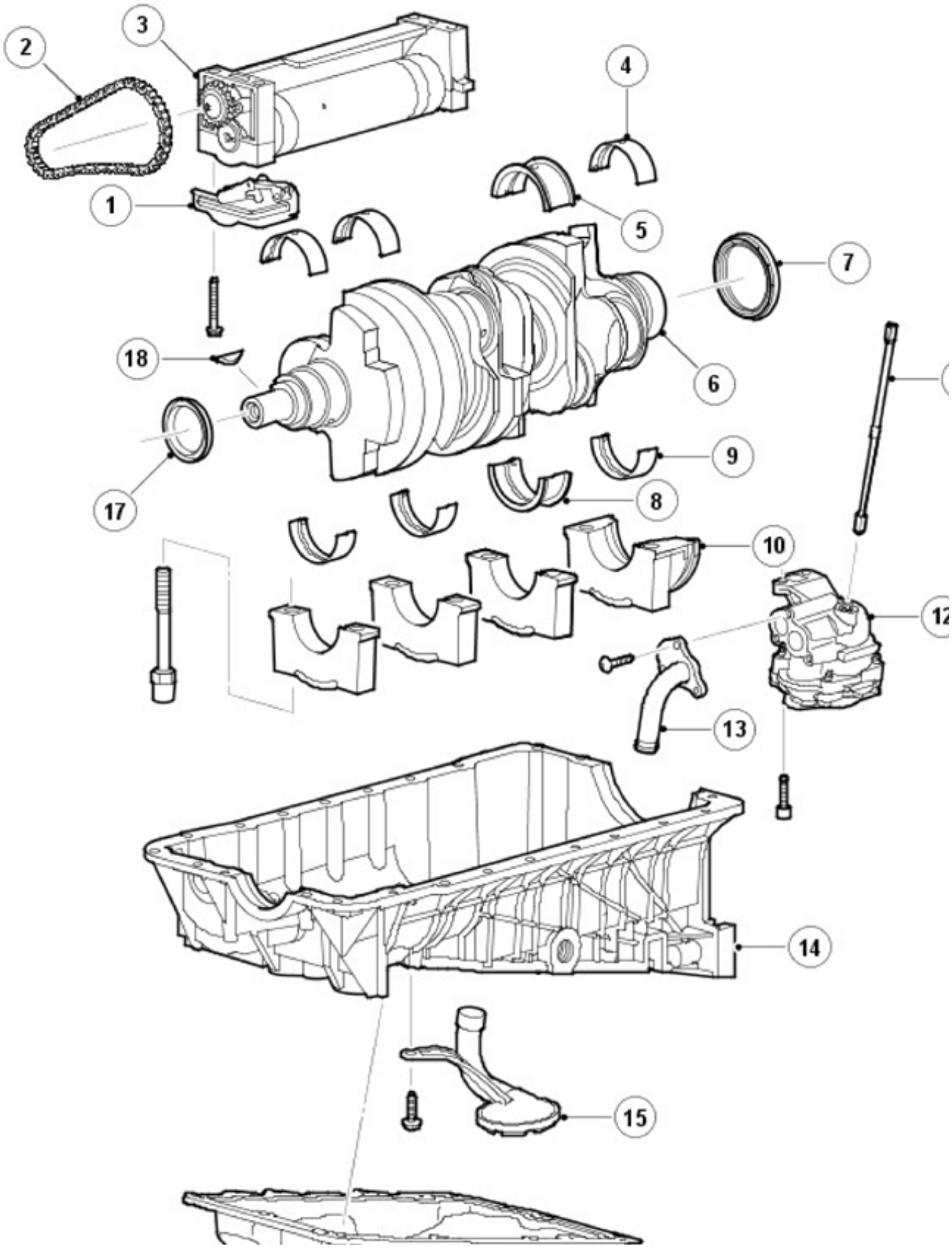

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Item	Part Number	Description
1	-	Tensioner
2	-	Chain
3	-	Balance shaft assembly
4	-	Main bearing, upper
5	-	Main thrust bearing, upper
6	-	Crankshaft
7	-	Crankshaft oil seal, rear
8	-	Main thrust bearing, lower
9	-	Main bearing, lower
10	-	Main bearing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

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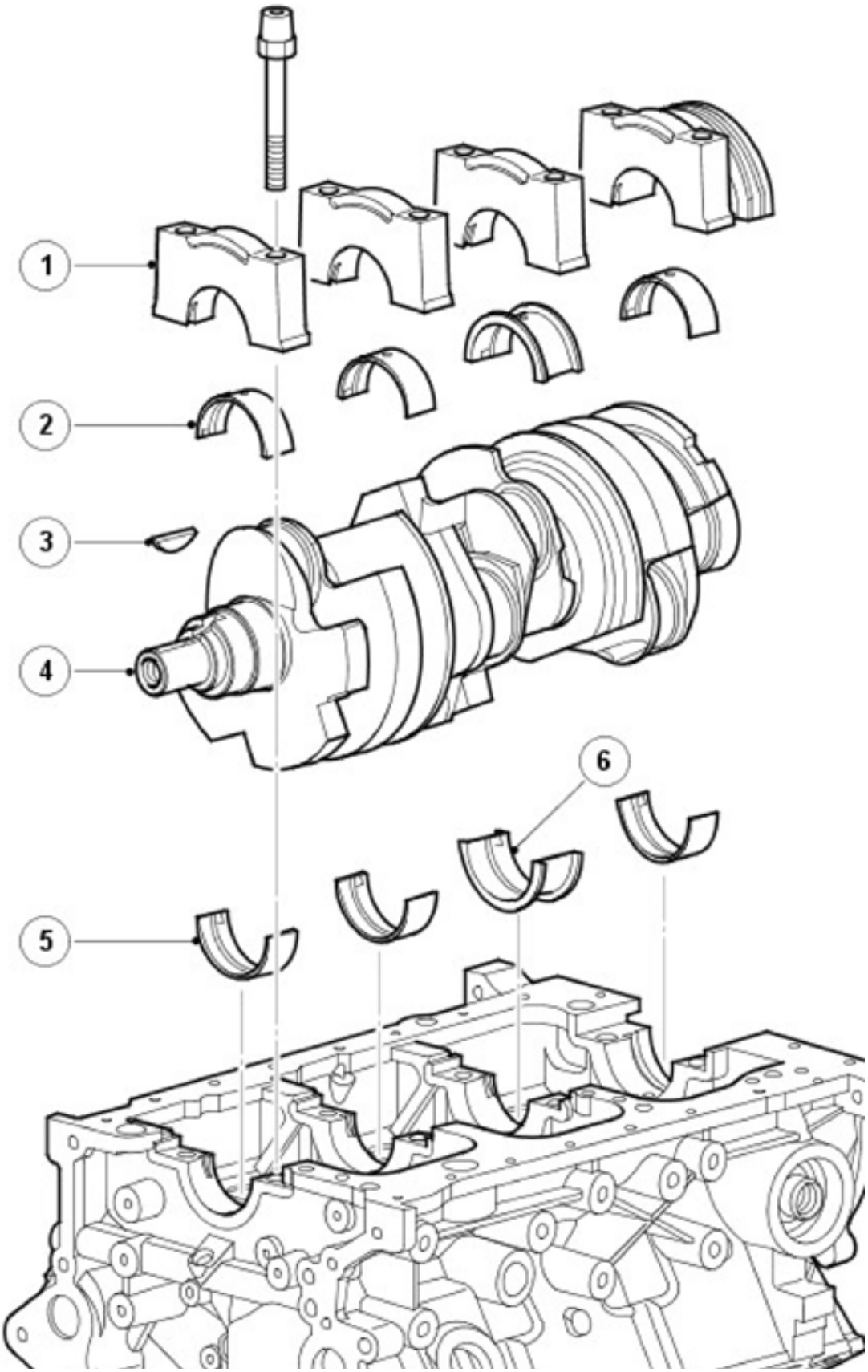

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Item	Part Number	Description
1	-	Main bearing cap
2	-	Main bearing, lower
3	-	Key
4	-	Crankshaft
5	-	Main bearing, upper
6	-	Main bearing, thrust

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

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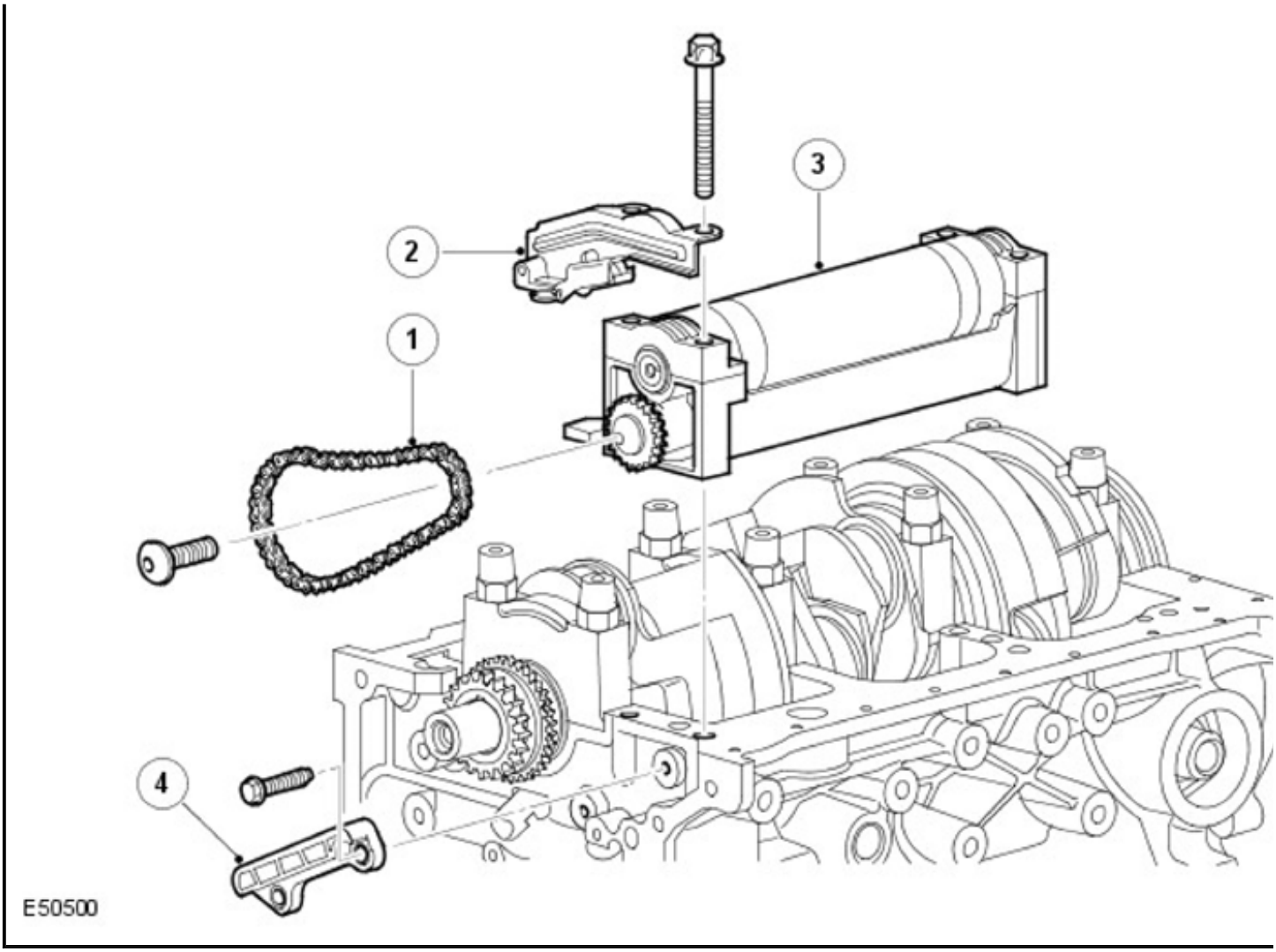

Item	Part Number	Description
1	-	Drive chain
2	-	Tensioner assembly
3	-	Balance assembly
4	-	Chain guide

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

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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

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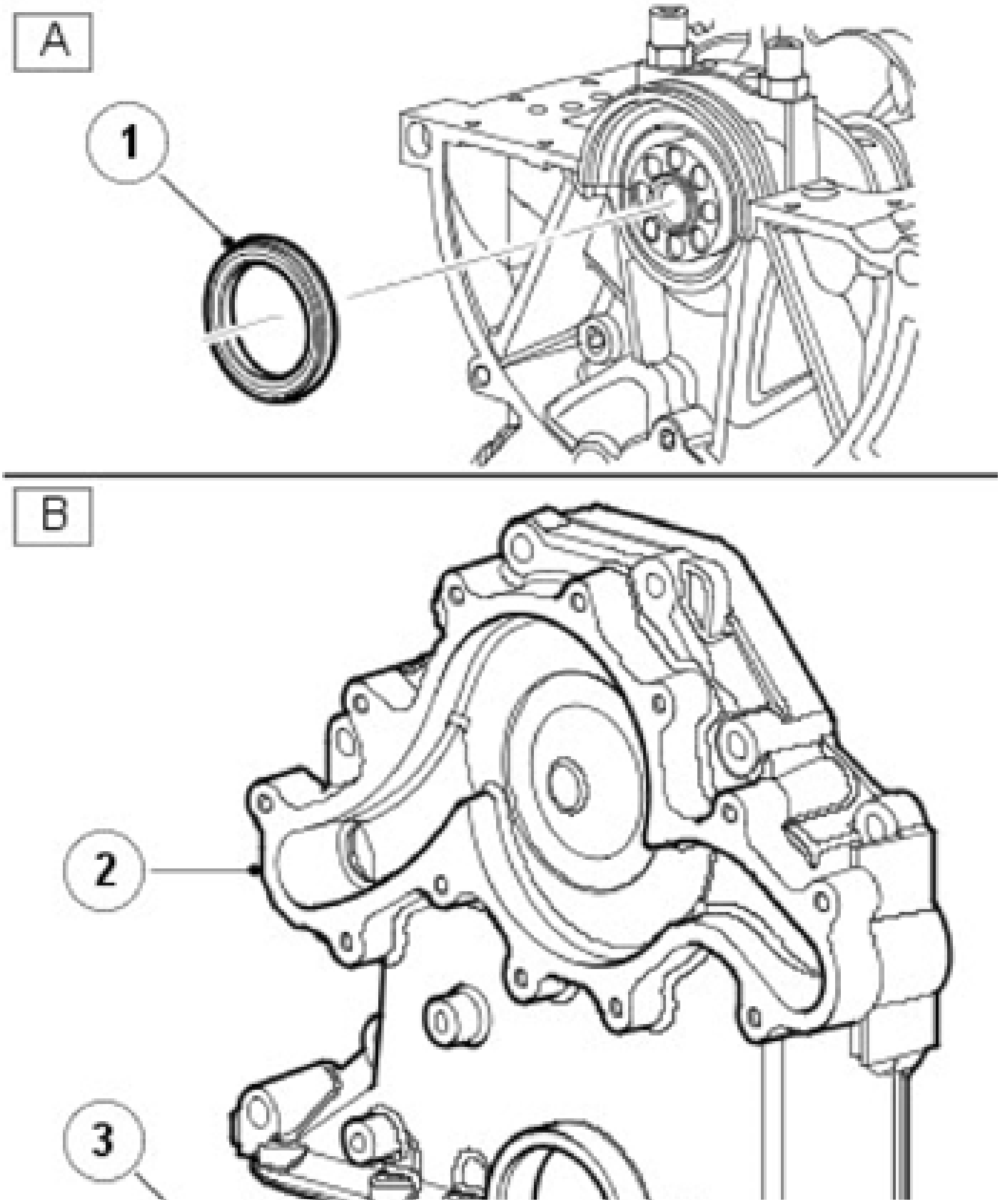

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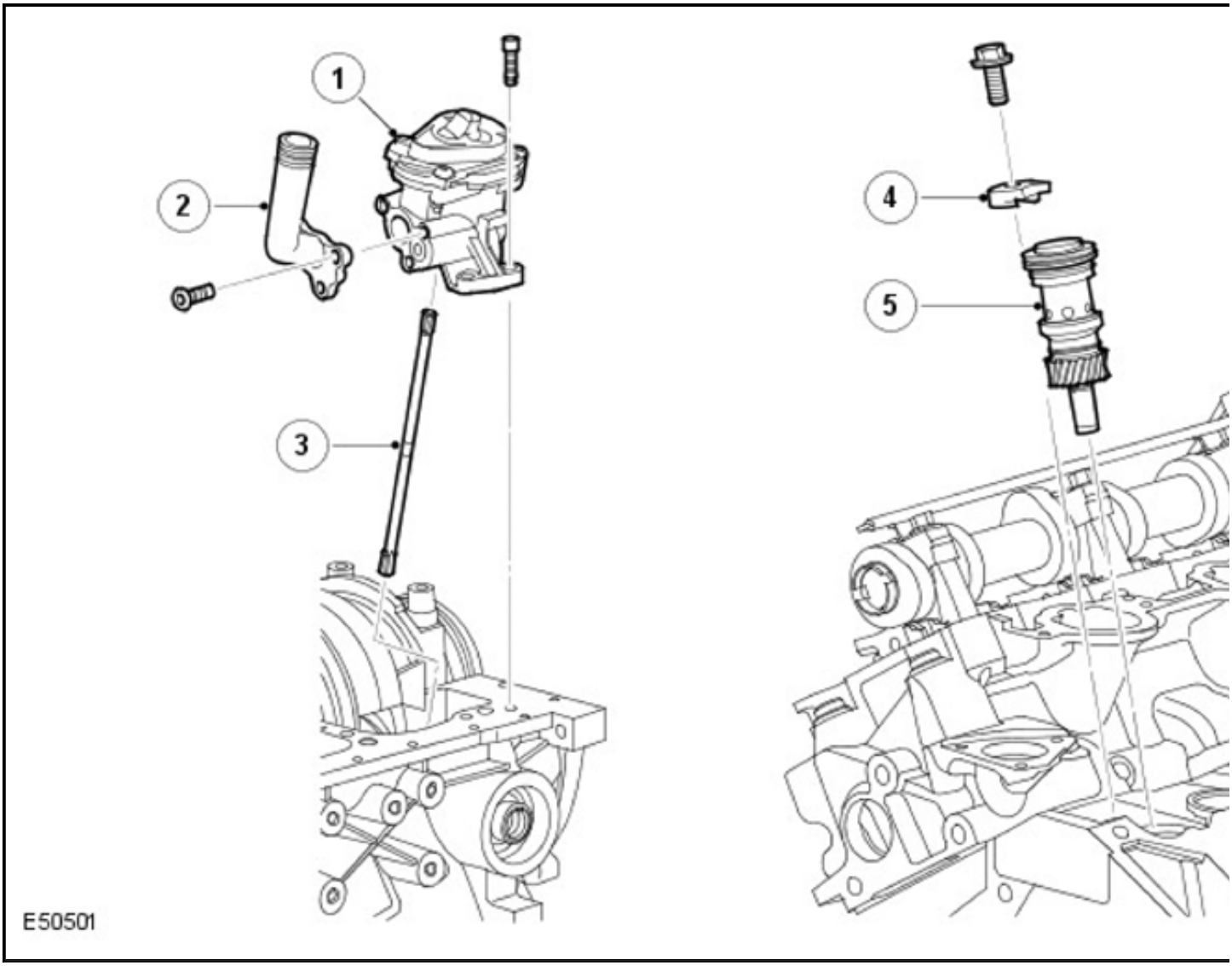
Item	Part Number	Description
A	-	Rear
B	-	Front
1	-	Rear seal
2	-	Front cover
3	-	Front seal

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



Item	Part Number	Description
1	-	Oil pump

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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

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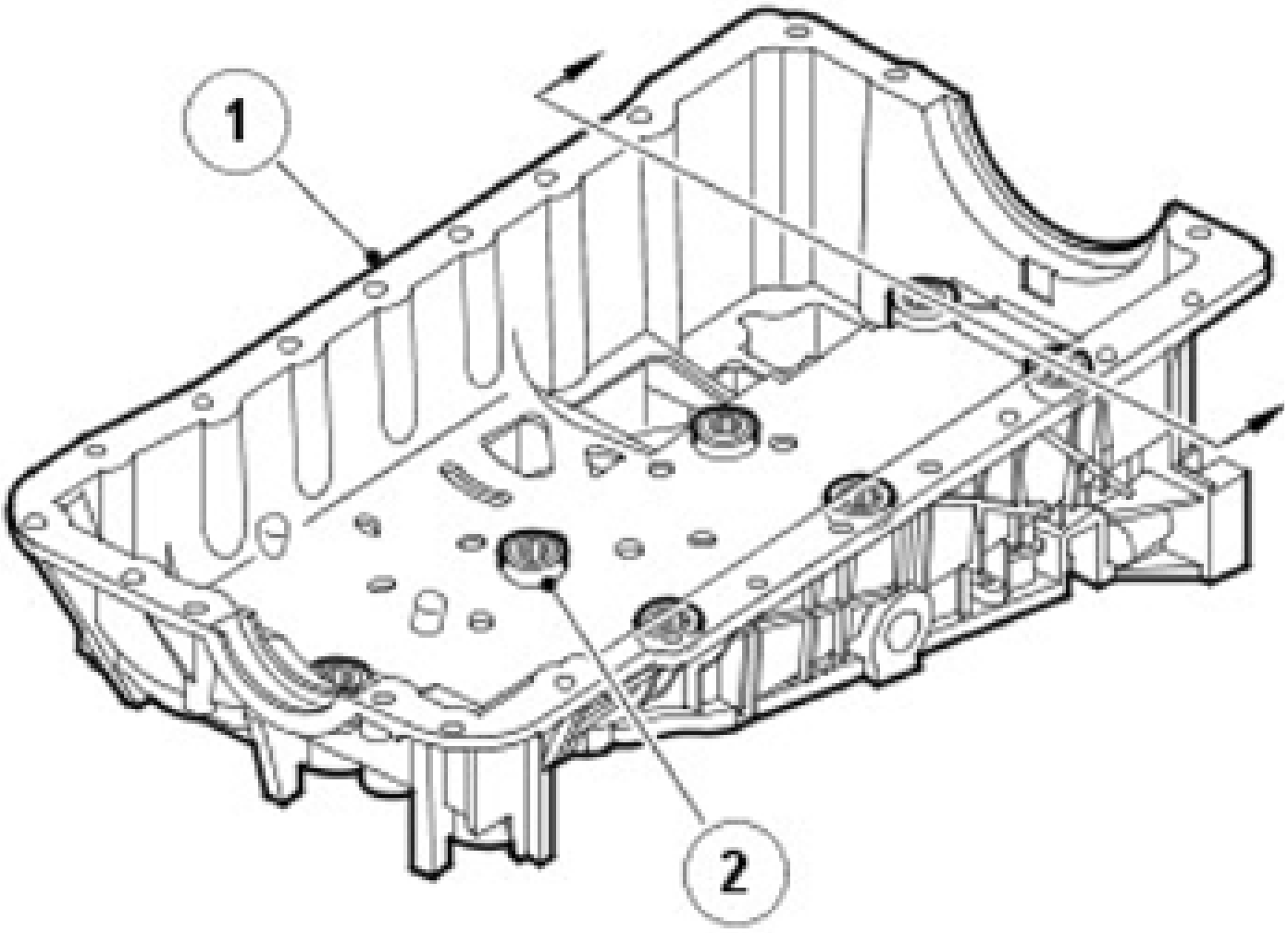

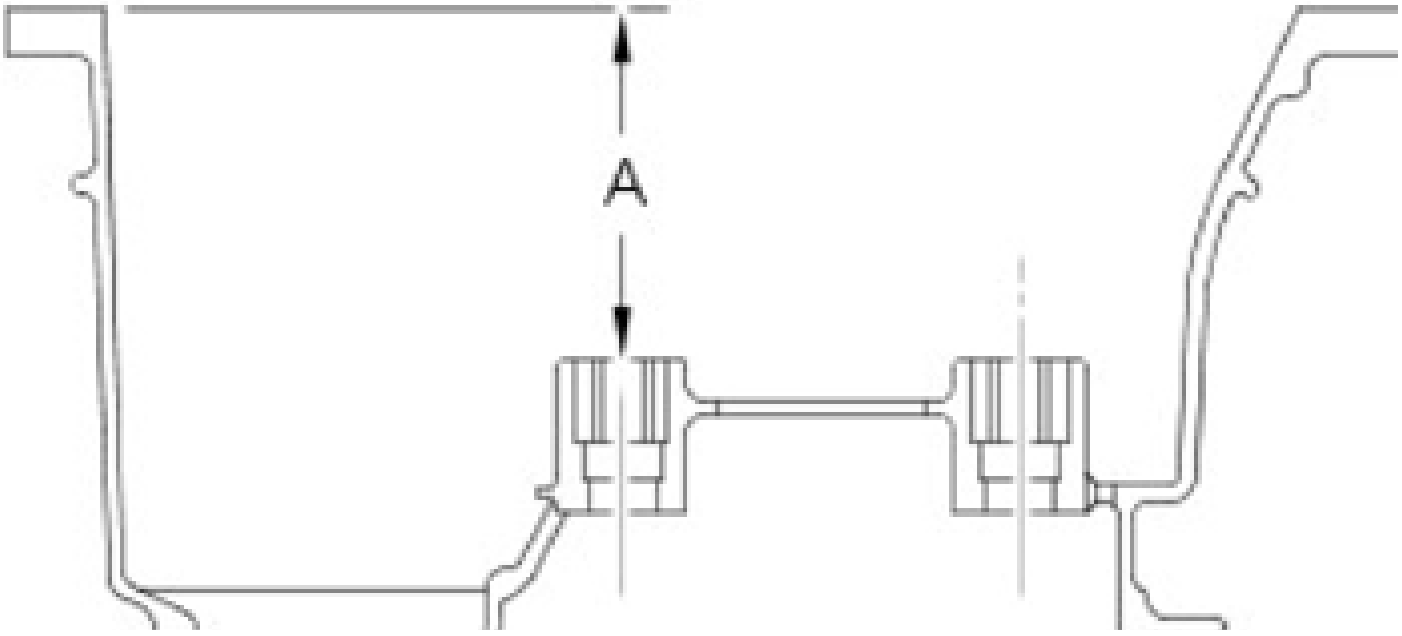

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Item	Part Number	Description
A	-	69.8 mm minimum
1	-	Engine bulkhead housing
2	-	Crankshaft main bearing cap adjustment screw

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 aluminum.

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

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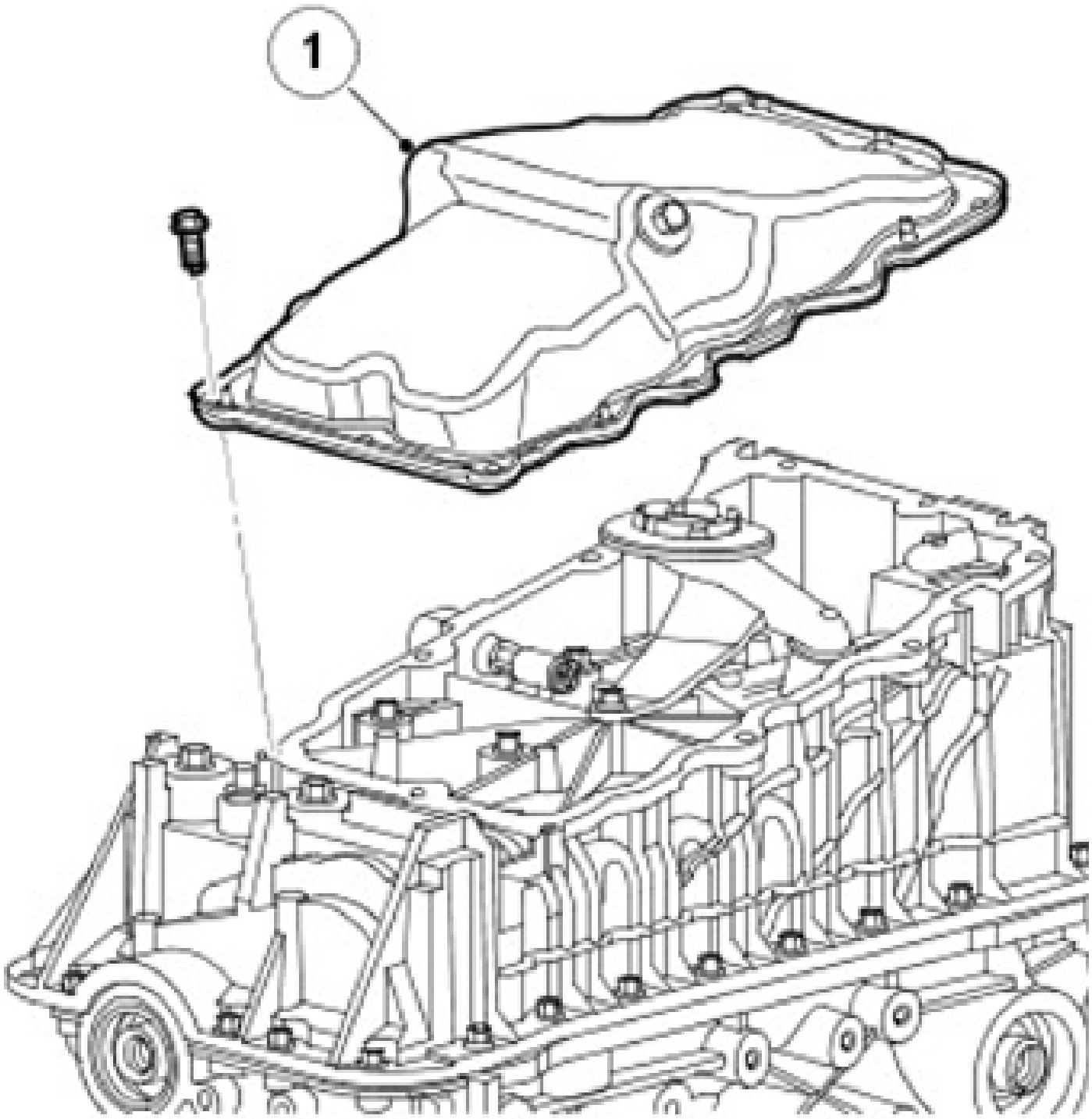

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Item	Part Number	Description
1	-	Sump

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

Oil Pick-up

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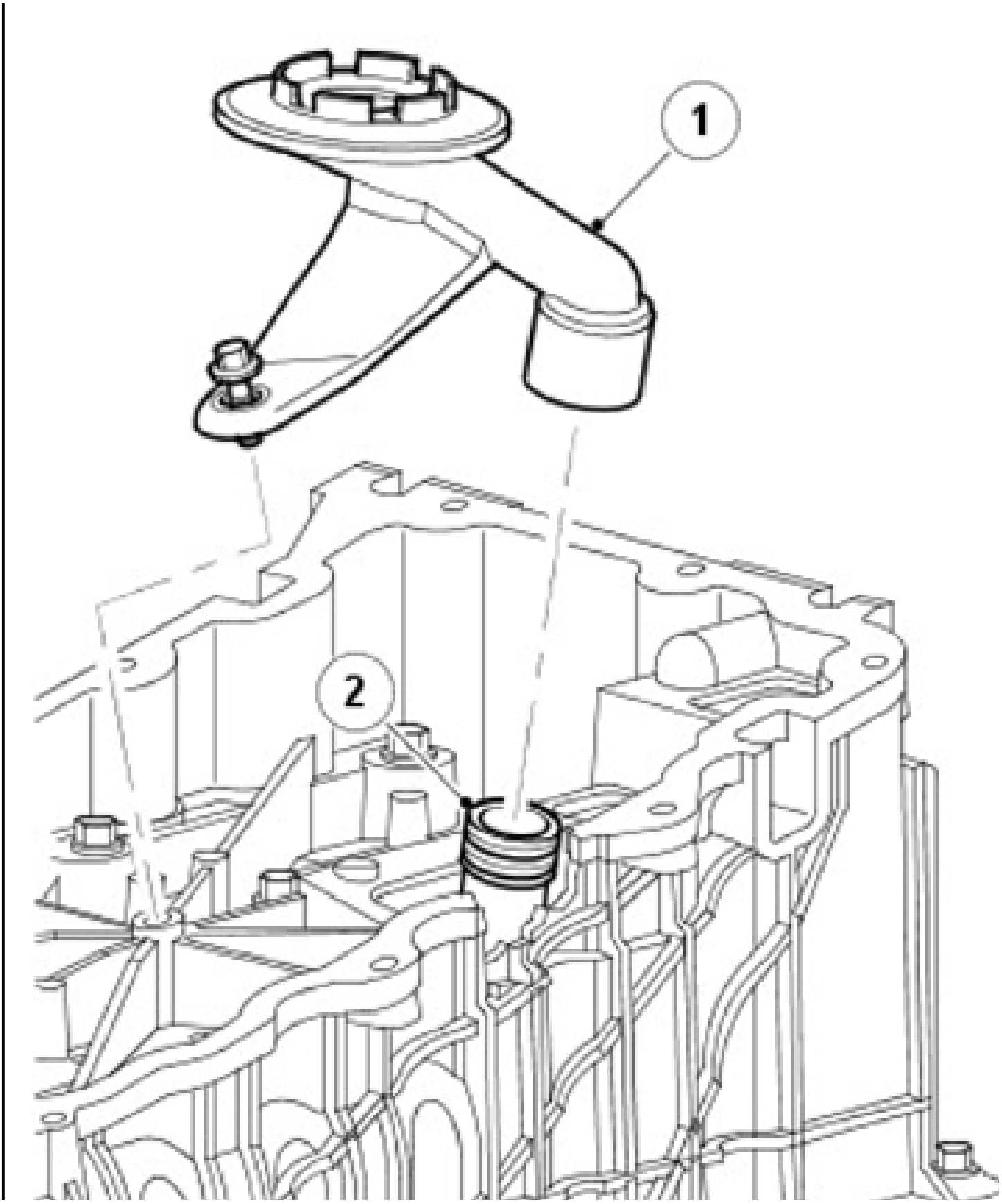

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Item	Part Number	Description
1	-	Item

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

CAMSHAFT TIMING COMPONENTS

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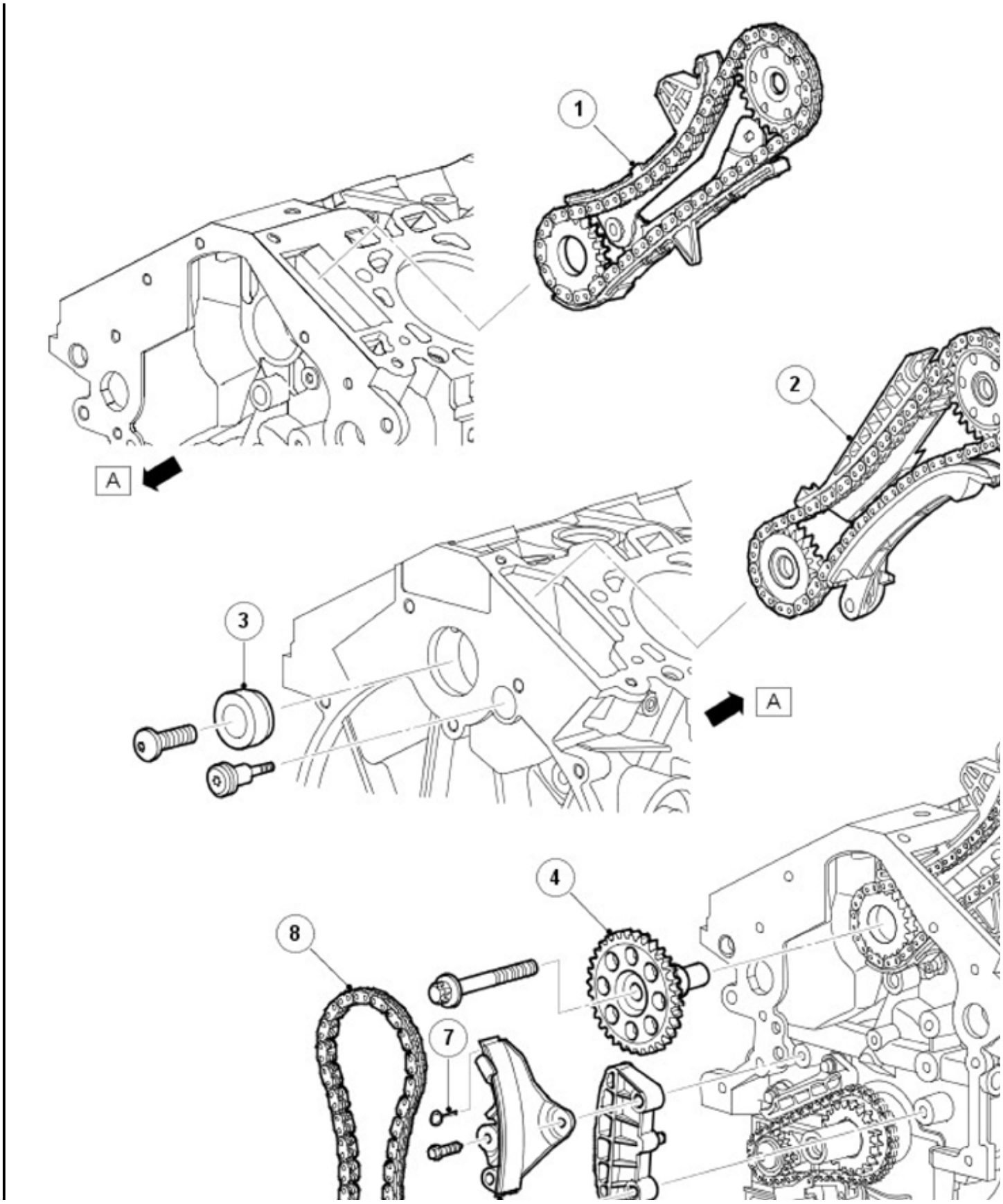

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Item	Part Number	Description
A	-	Front of engine
1	-	LH camshaft drive assembly
2	-	RH camshaft drive assembly
3	-	Spacer
4	-	Jackshaft sprocket
5	-	Chain guide
6	-	Jackshaft chain tensioner
7	-	Tensioner pin
8	-	Jackshaft chain

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

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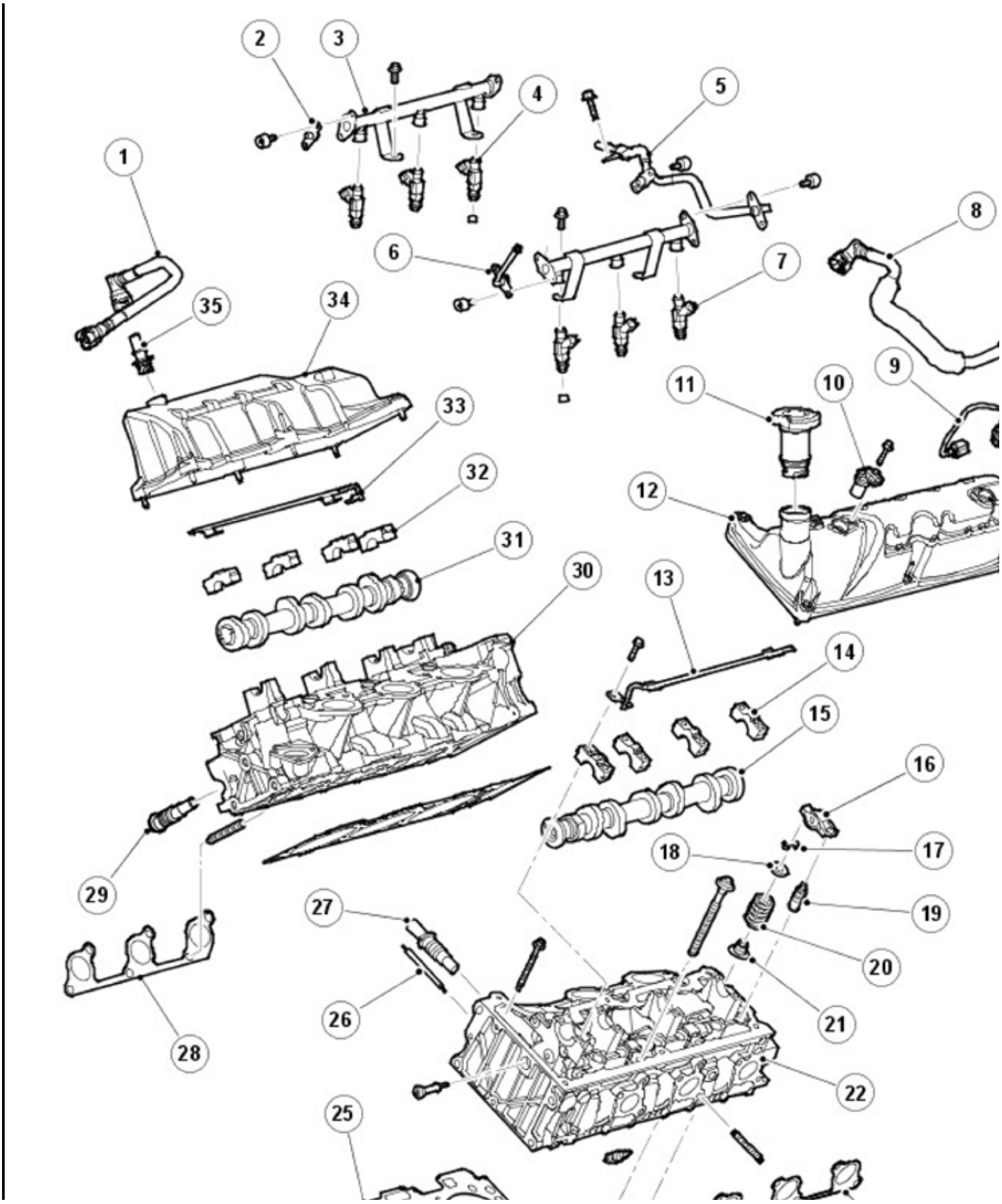

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Item	Part Number	Description
1	-	Hose, crankcase emissions, RH camshaft cover to intake manifold
2	-	End cover
3	-	RH Fuel rail
4	-	LH injectors (3 of)
5	-	Fuel supply line
6	-	Schrader valve
7	-	RH injectors (3 of)
8	-	Hose, crankcase emissions, LH 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

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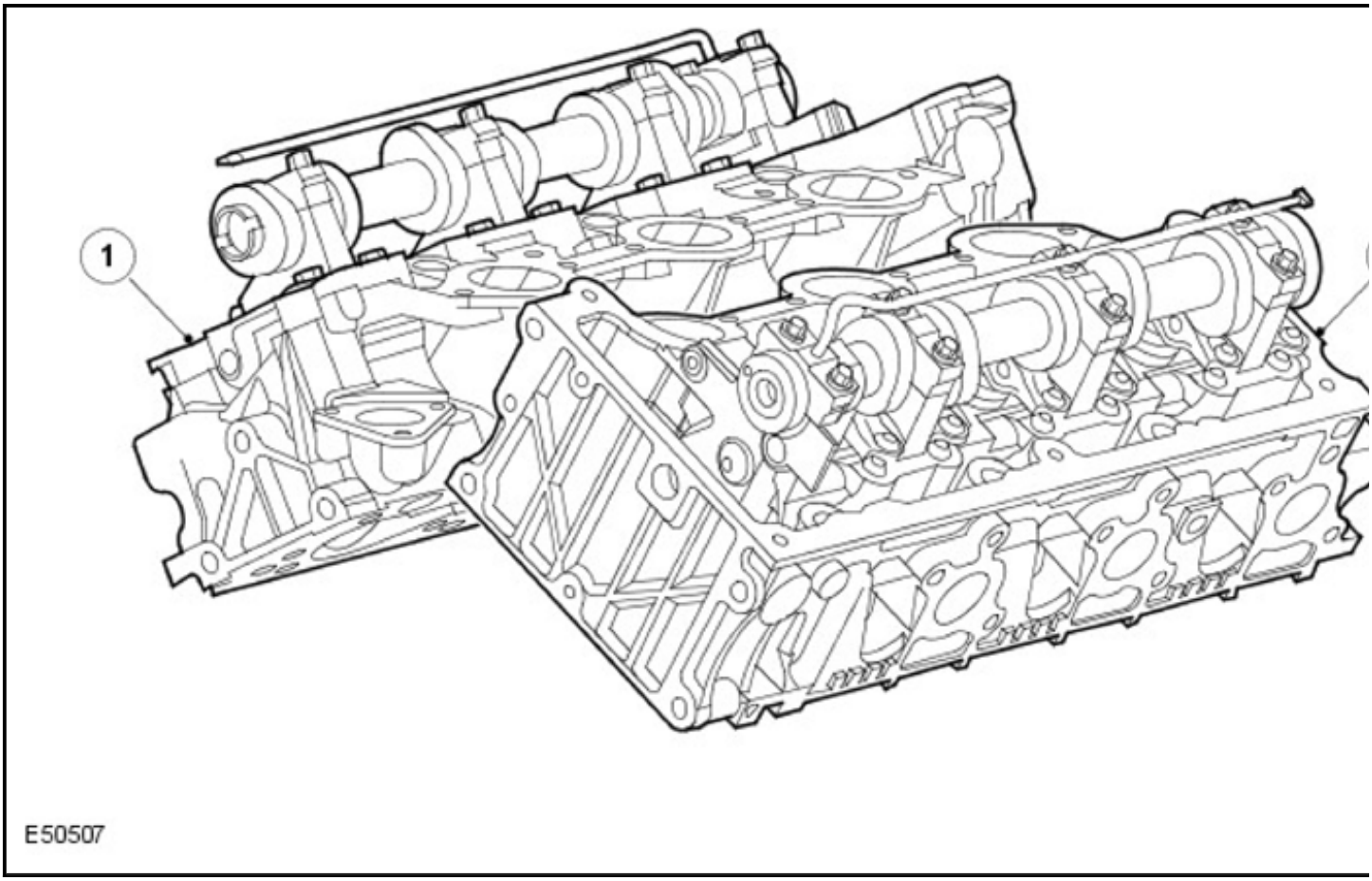
Cylinder Heads



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

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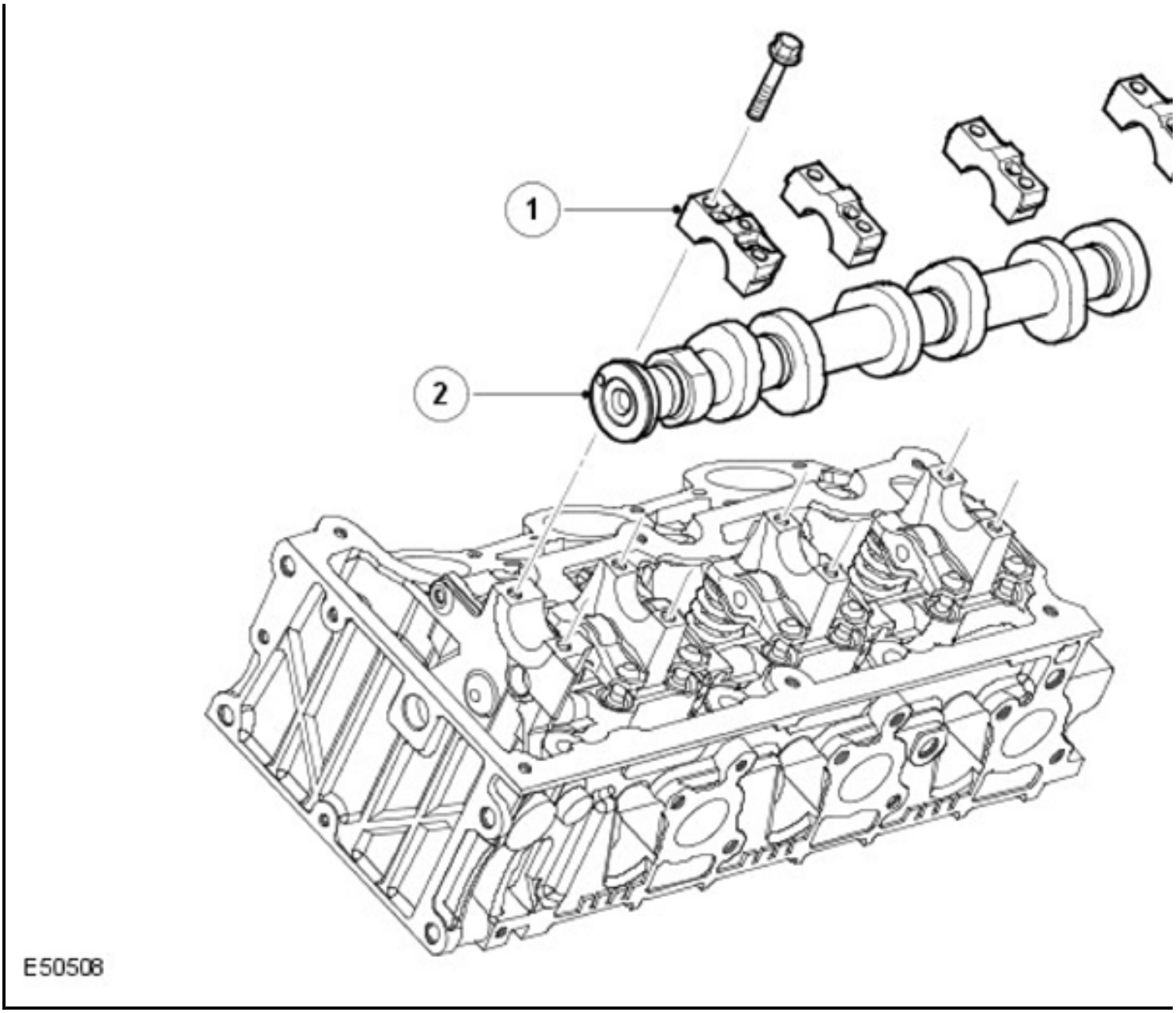

Item	Part Number	Description
1	-	Bearing cap
2	-	Camshaft

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

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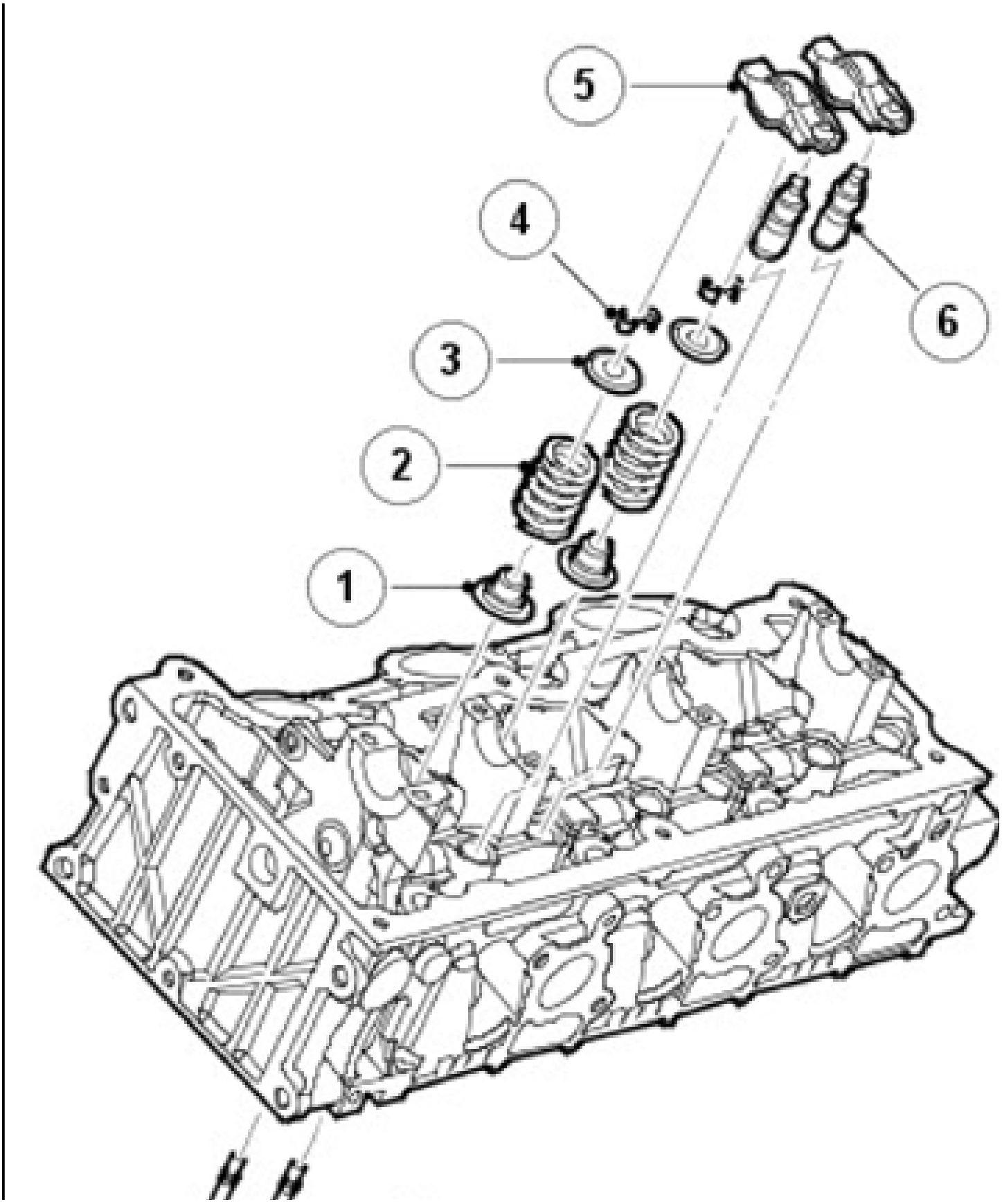

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Item	Part Number	Description
1	-	Valve stem seal
2	-	Valve spring
3	-	Valve spring retainer seat
4	-	Valve spring retainer key
5	-	Rocker arm
6	-	Hydraulic lash adjuster
7	-	Valve

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 pressurized oil. The pressurized 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 center 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

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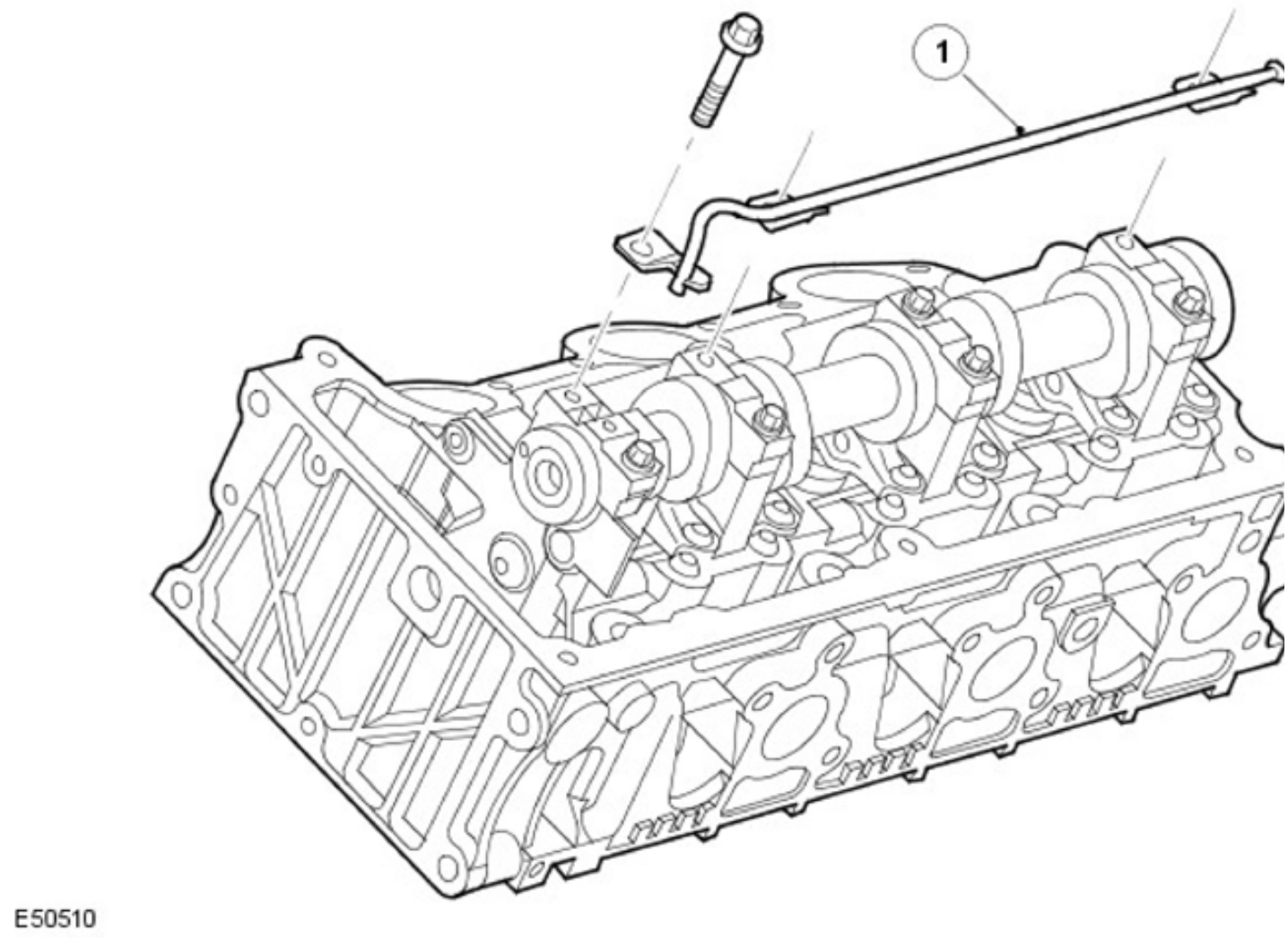

Item	Part Number	Description
1	-	Valve rocker arm oil supply tube

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

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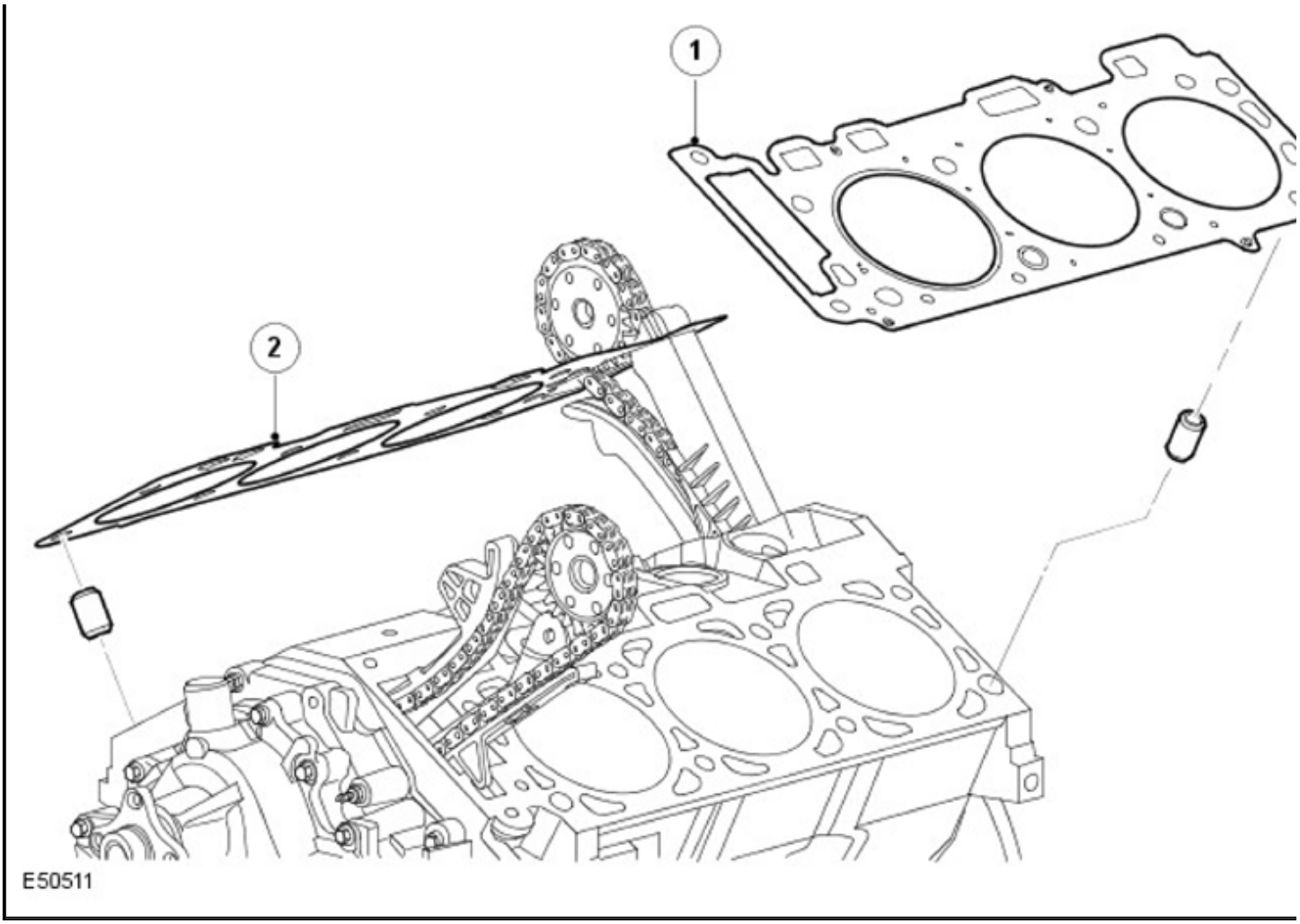

Item	Part Number	Description
1	-	LH cylinder head gasket
2	-	RH cylinder head gasket

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

Fuel Injectors

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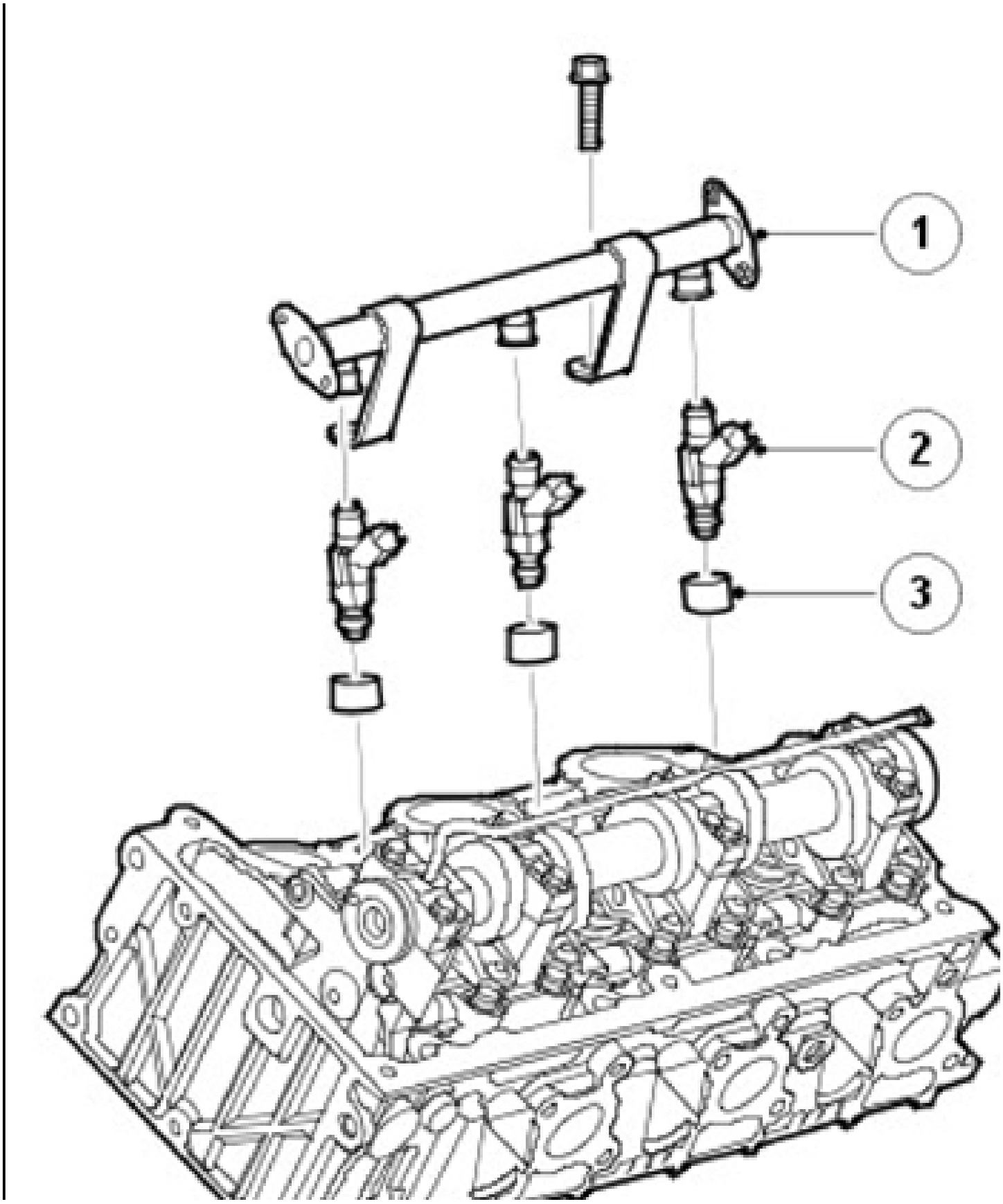

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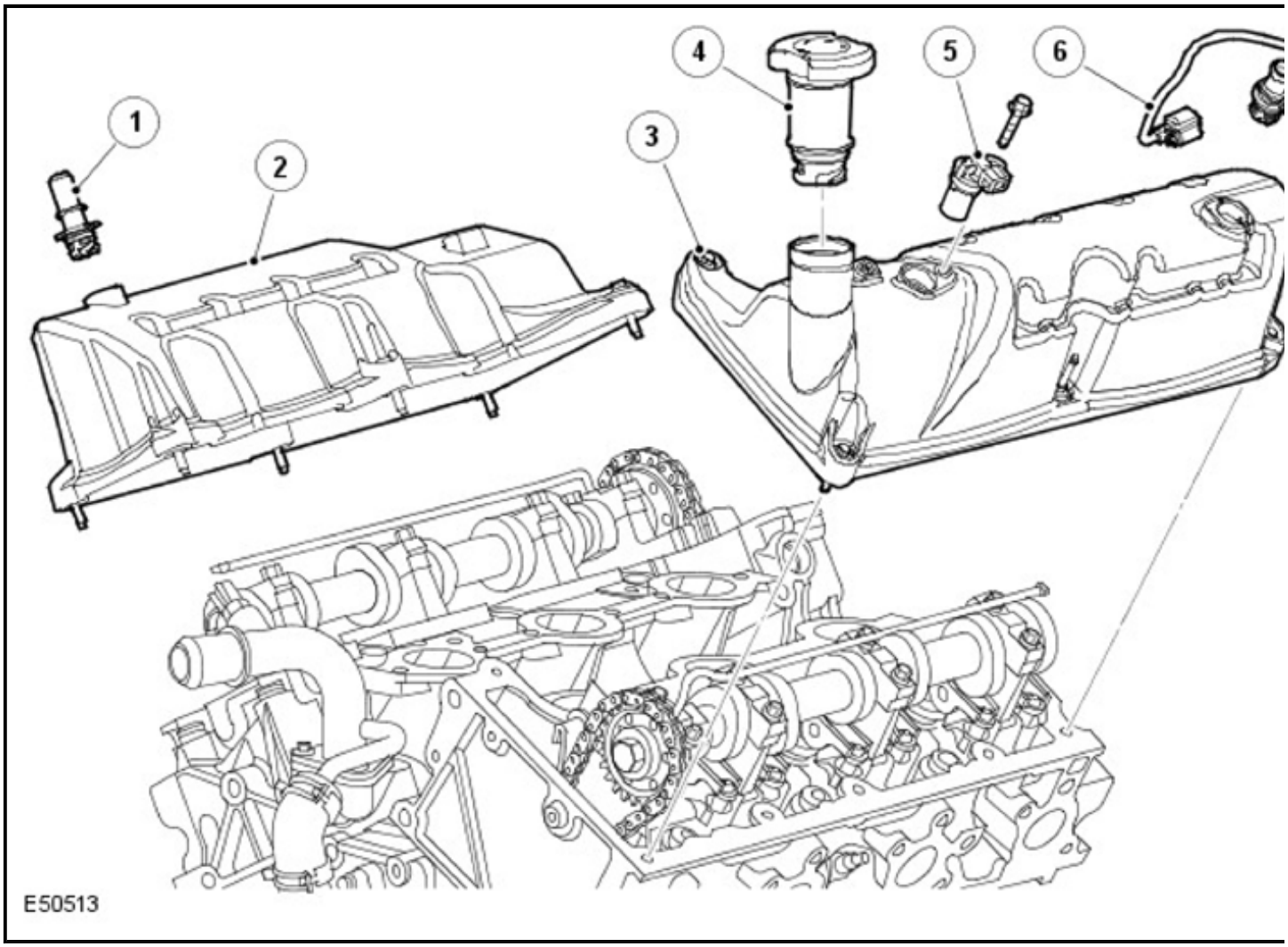
Item	Part Number	Description
1	-	Fuel rail
2	-	Injector
3	-	Adapter

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** .

Camshaft Cover



Item	Part Number	Description
1	-	Crankcase ventilation valve
2	-	RH camshaft cover
3	-	LH camshaft cover

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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

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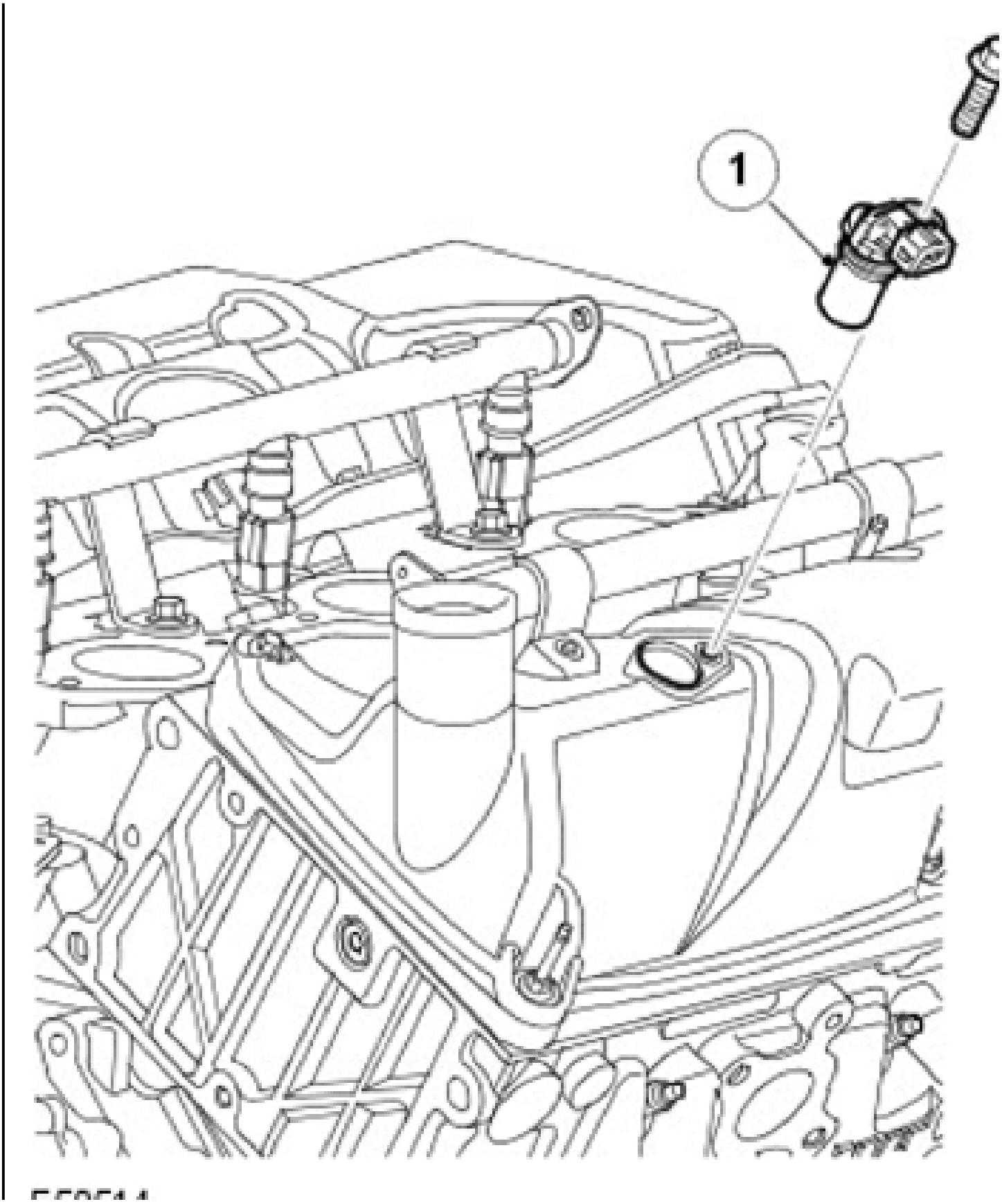

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Item	Part Number	Description
1	-	CMP sensor

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** .

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.

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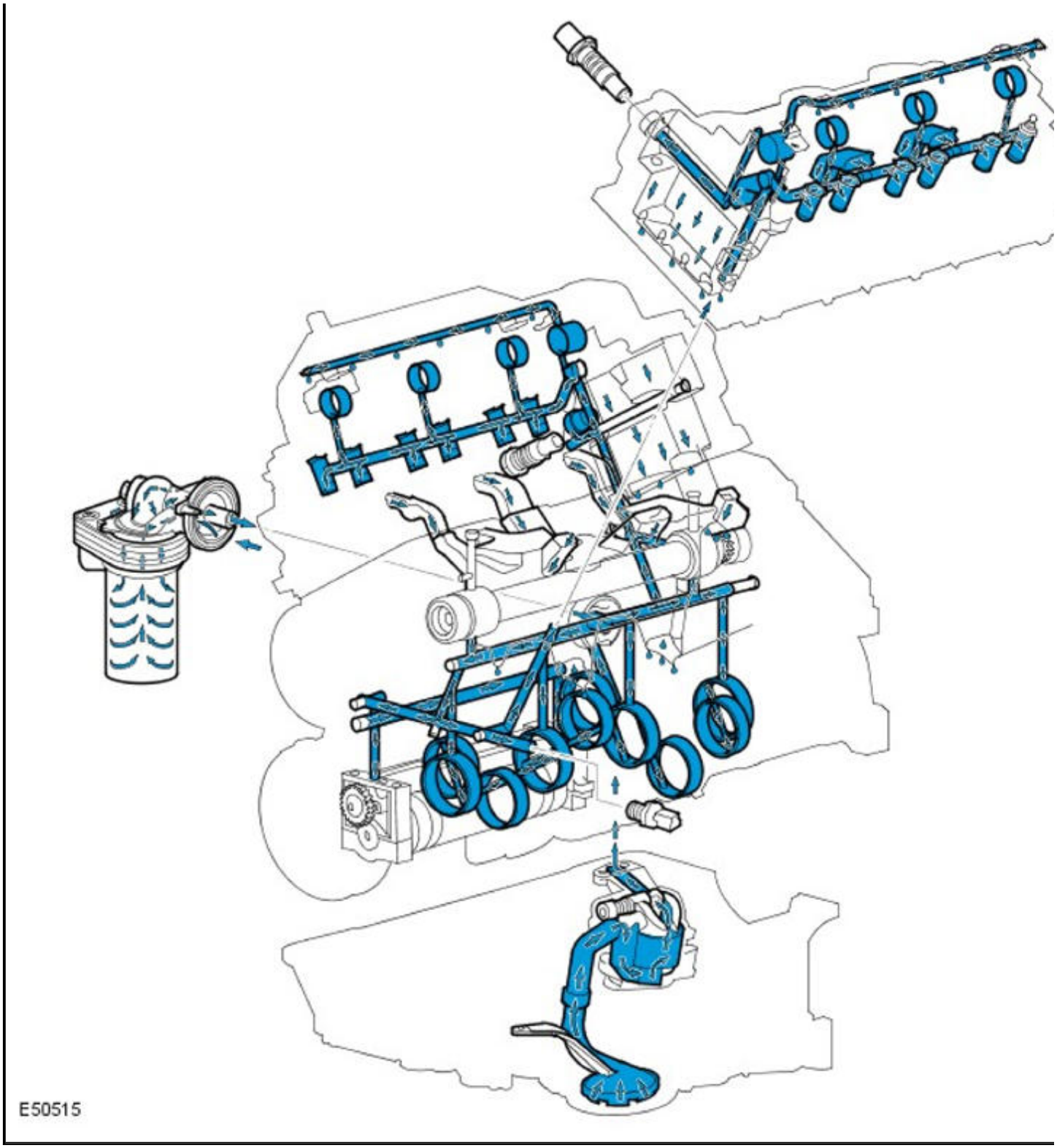

The lubrication system is of the full-flow filtration, force-fed type.

Oil is drawn, via a strainer and pick-up pipe in the sump into the jackshaft driven oil pump which has an

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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.

Pressurized 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

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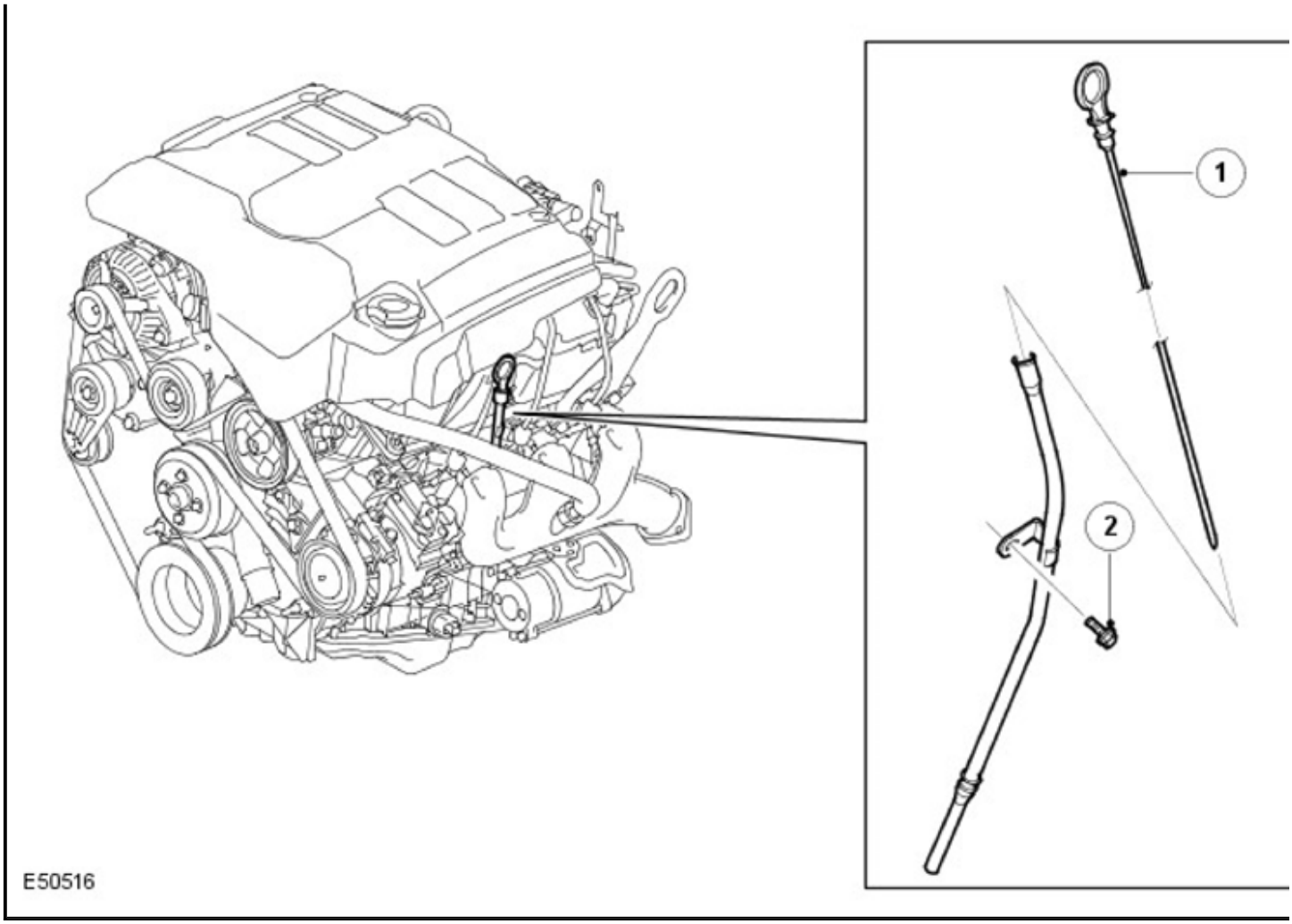

Item	Part Number	Description
1	-	Oil level gauge
2	-	Oil level gauge tube

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

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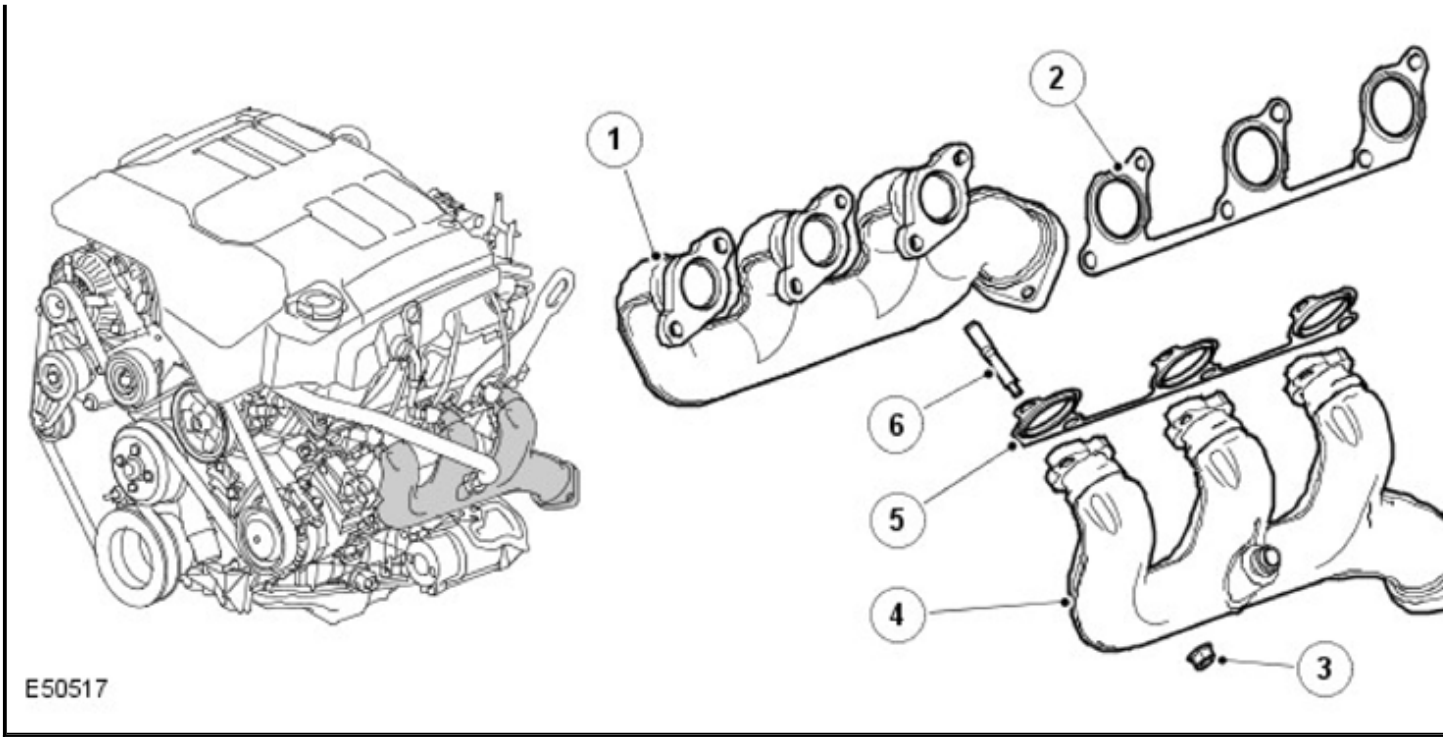

The dual wall stainless steel exhaust manifolds are unique for each cylinder bank.

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

GENERAL PROCEDURES

ENGINE OIL DRAINING AND FILLING

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the engine undershield.

   For additional information, refer to: **ENGINE UNDERSHIELD** .

4. Remove the oil pan drain plug.
   - Position a container to collect the fluid.
   - Discard the oil drain plug seal.
5. Remove the oil filter.

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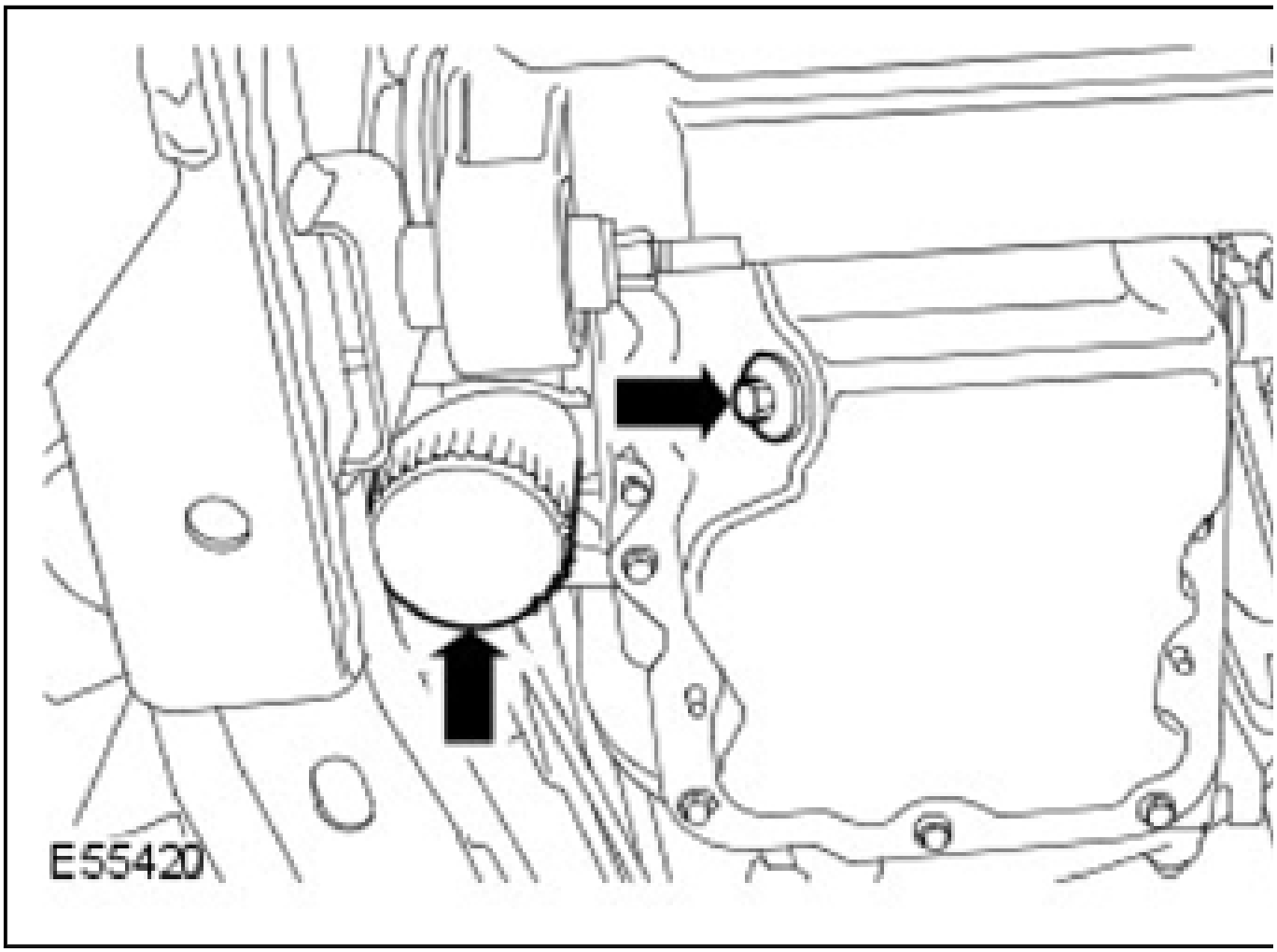
- Position a container to collect the fluid.
- Discard the oil filter.



6. To install, reverse the removal procedure.
   - Lubricate the oil filter seal with clean engine oil and tighten to 18 Nm.
   - Install a new seal.
   - Tighten the drain plug to 37 Nm.
7. Fill the engine with oil.
8. Check and top-up the engine oil.

CAMSHAFT TIMING

SPECIAL TOOL(S)

	Camshaft timing checking tool 303-1146

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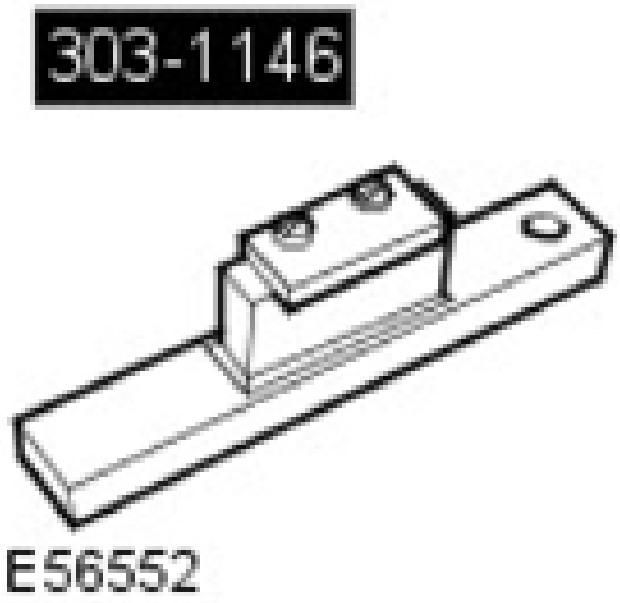	
	Crankshaft TDC timing/locking tool 303-573
	Camshaft Bolt Tool 303-575

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	Camshaft Bolt Socket 303-565
	Camshaft locking tool adaptor 303-576

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	Camshaft sprocket adjusting/locking tool 303-597-01
	Camshaft timing chain tensioning tool 303-571

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1. Check the camshaft timing.
2. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

3. Remove both valve covers.
4. Rotate the crankshaft clockwise, until number one cylinder is on TDC. Check the camshaft lobes are on the back of the cam.
5. Lock the crankshaft.
   - Install the special tool.
   - Tighten the screw.

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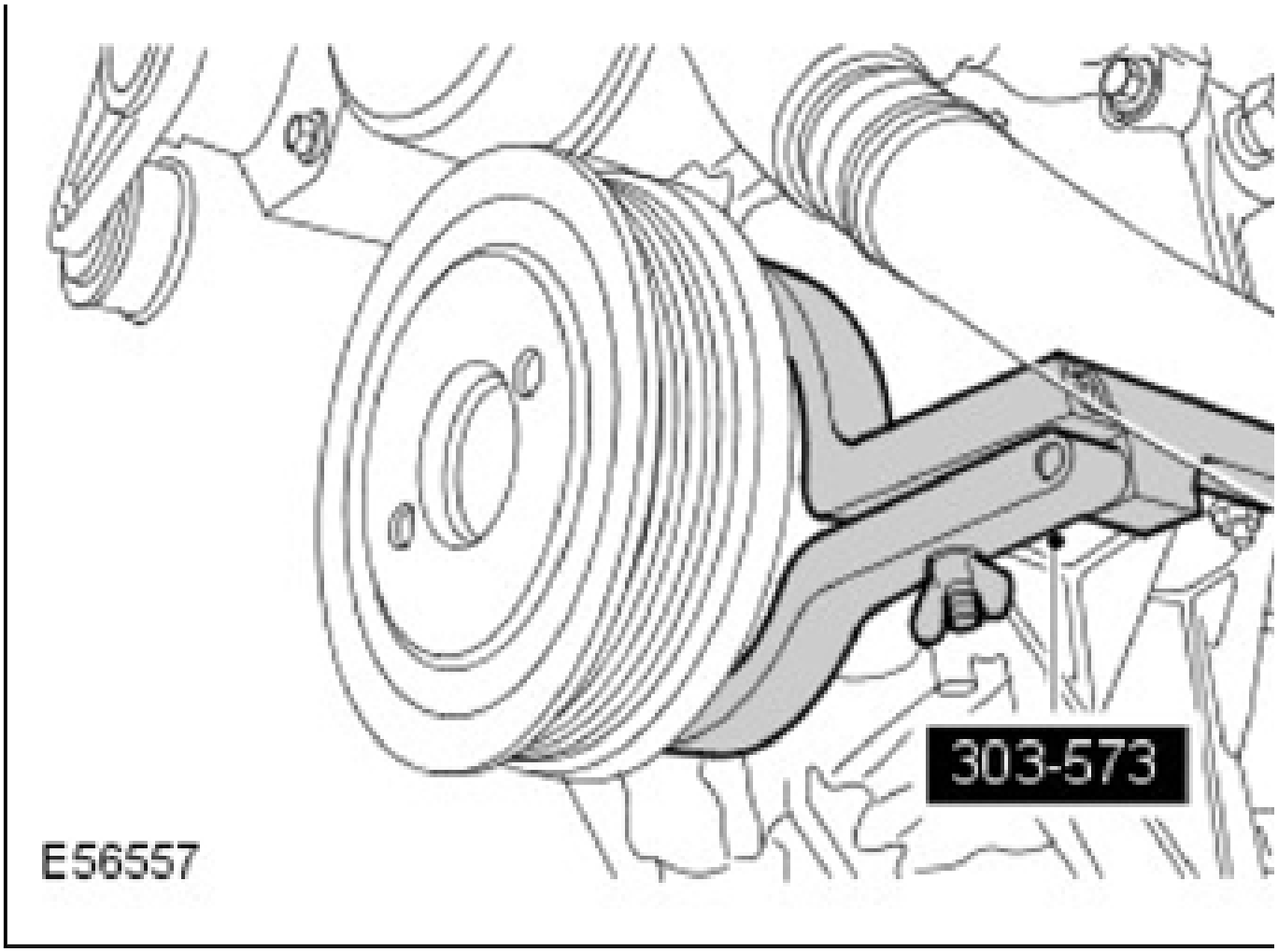

6. Install the special tool to the slot in the camshaft, the base of the special tool must remain in contact with the cylinder head. If the special tool can be passed from one side of the cylinder head to the other without resistance then the camshaft is correctly timed. Repeat the procedure on the other camshaft. If both camshafts are found to be correct, then no further action is required.

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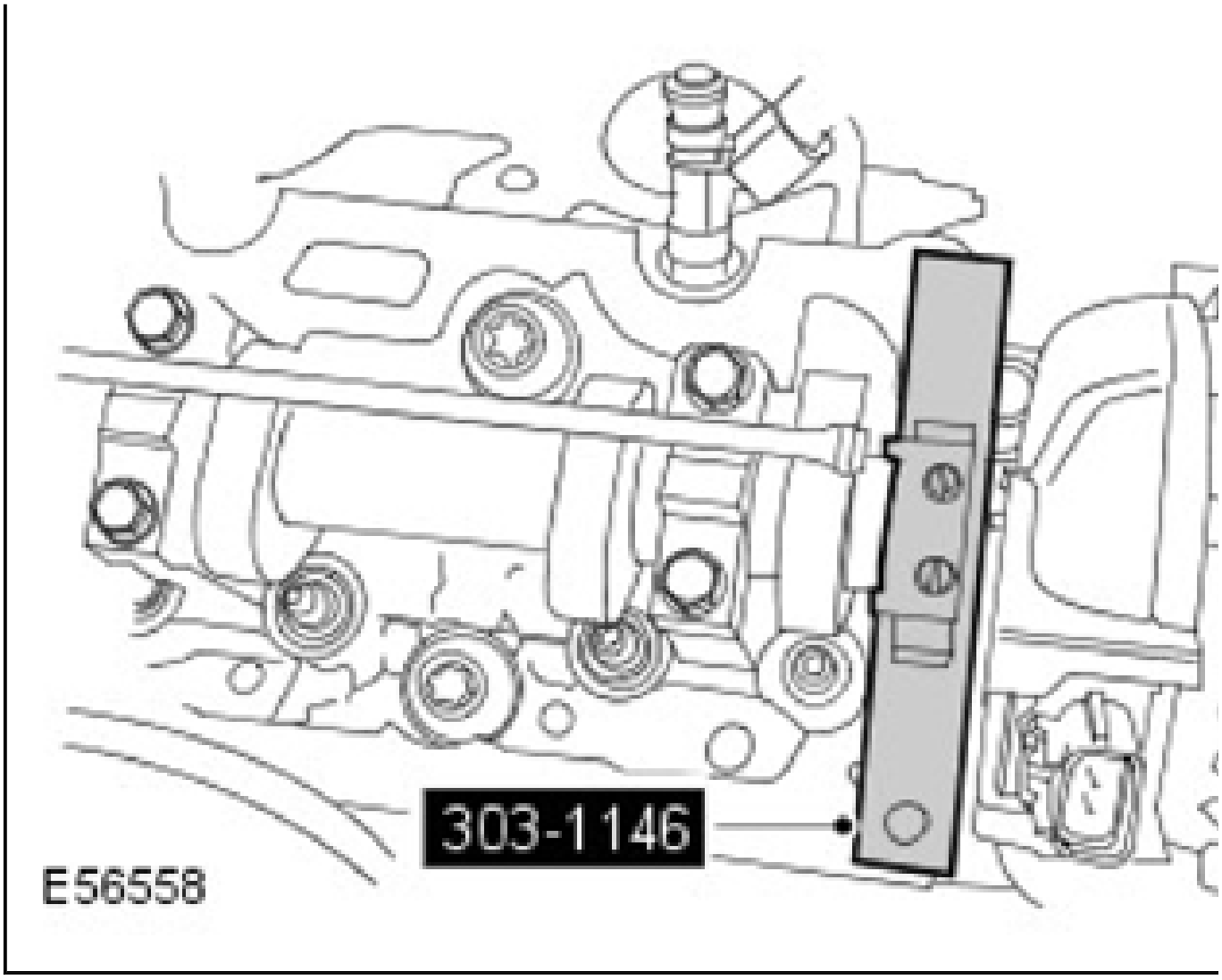

7. If the camshaft timing is found to be incorrect, proceed with the adjustment. Note both camshafts must be re-timed with the camshaft roller followers removed.
8. Remove the camshaft roller followers.

   For additional information, refer to: **CAMSHAFT ROLLER FOLLOWER** .

9. Position the generator aside for access.
   - Remove the 3 bolts.

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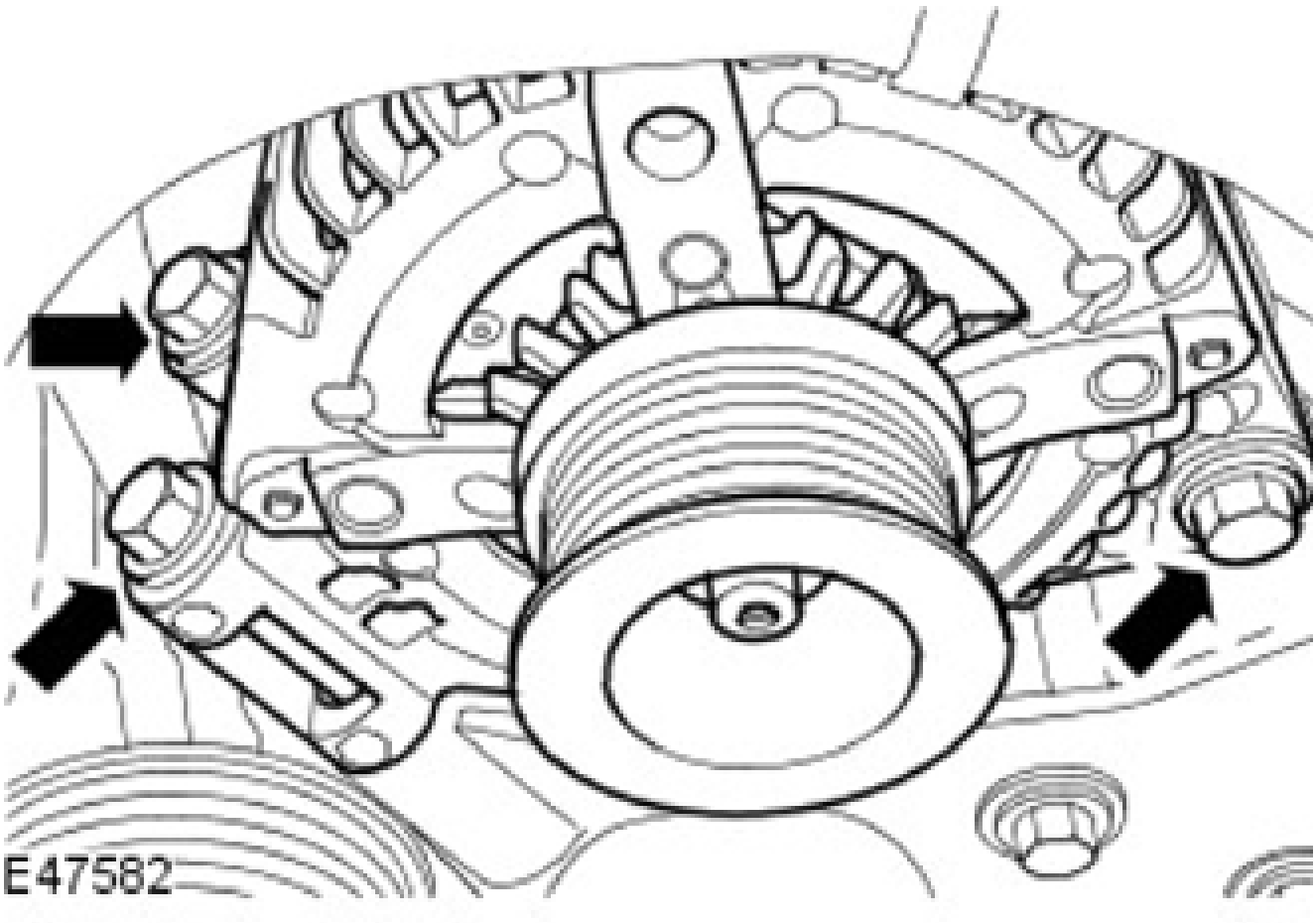

10. Remove the RH cylinder head harness carrier bolt.
    - Position the harness carrier aside for access.

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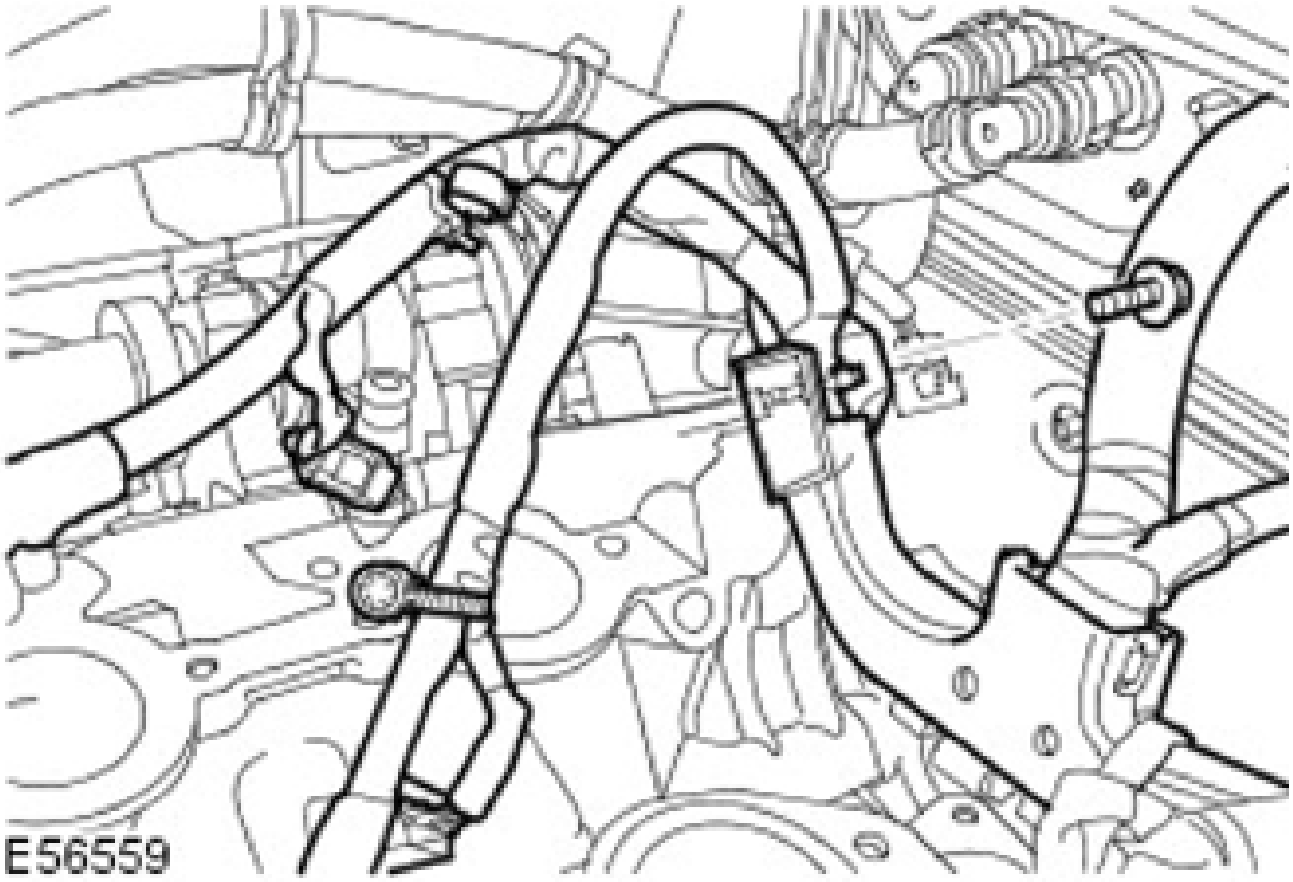

CAUTION: Damage to the camshaft will occur if the alignment tool is used to release the camshaft sprocket bolt.

NOTE: The camshaft timing slot is off center. Correctly timed the slot will be horizontal and below the center line.

11. Install the camshaft alignment special tool.
    - Clean the component mating faces.
    - Tighten the bolts to 10 Nm (7 lb.ft).
    - Lock the camshaft, tighten the special tool bolt to 45 Nm (33 lb.ft).

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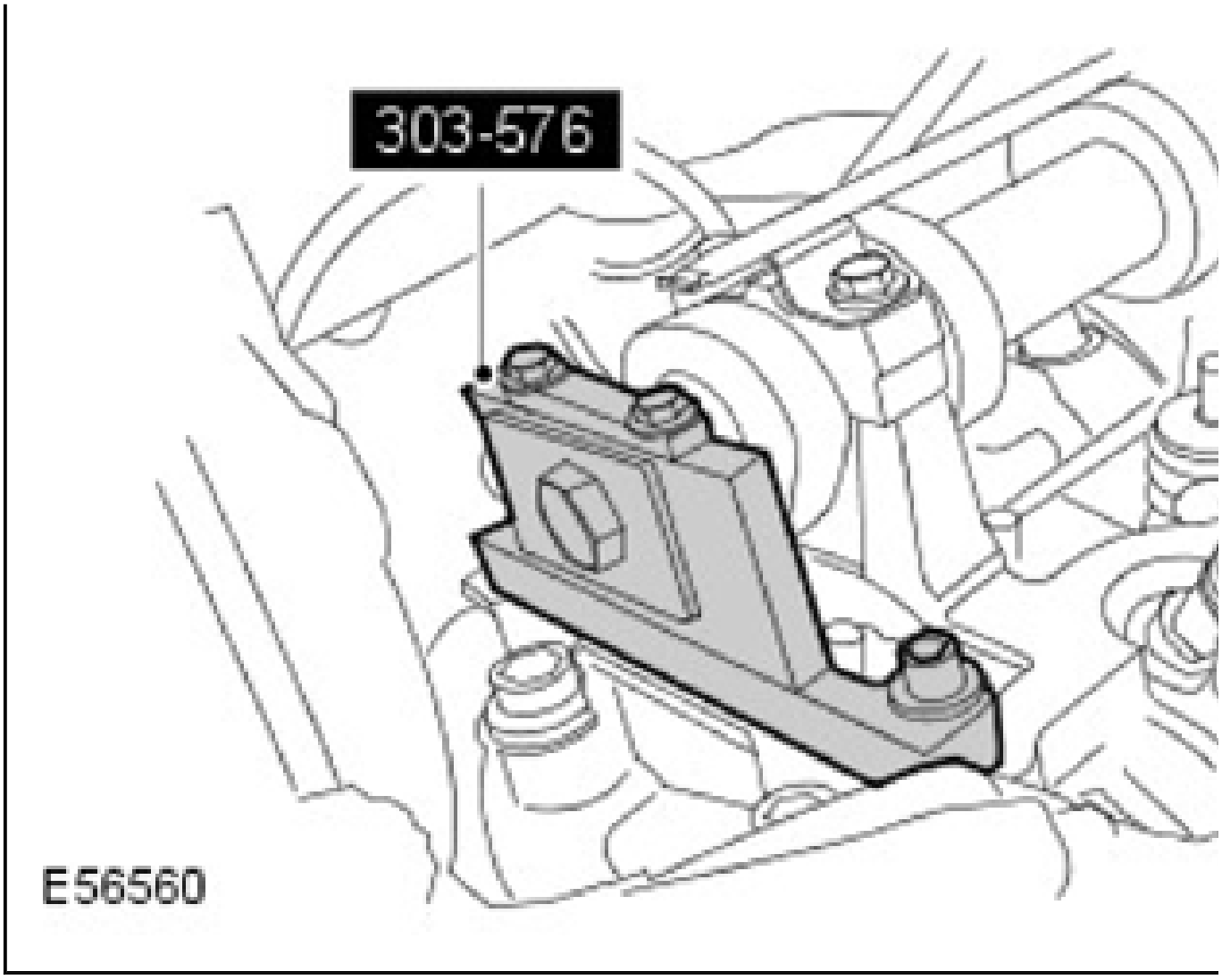

12. Install the special tool to the RH cylinder head.
    - Clean the component mating faces.
    - Tighten the bolts to 10 Nm (7 lb.ft).
    - Tighten the saddle clamp bolts to 10 Nm (7 lb.ft).

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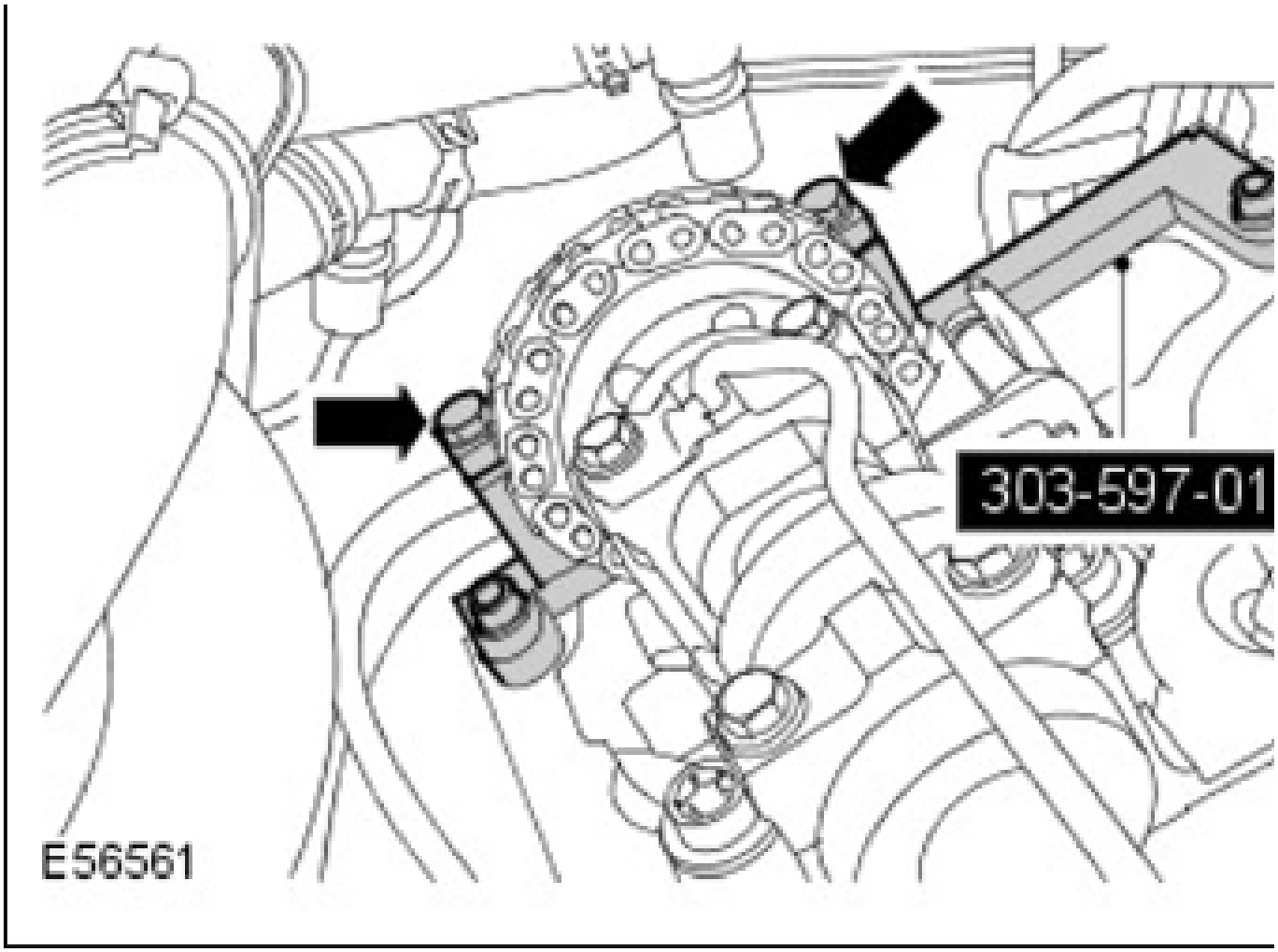

CAUTION: The RH camshaft sprocket bolt has a left hand thread.

13. Using the special tool, loosen the RH camshaft sprocket bolt.
    - Remove and discard the bolt.

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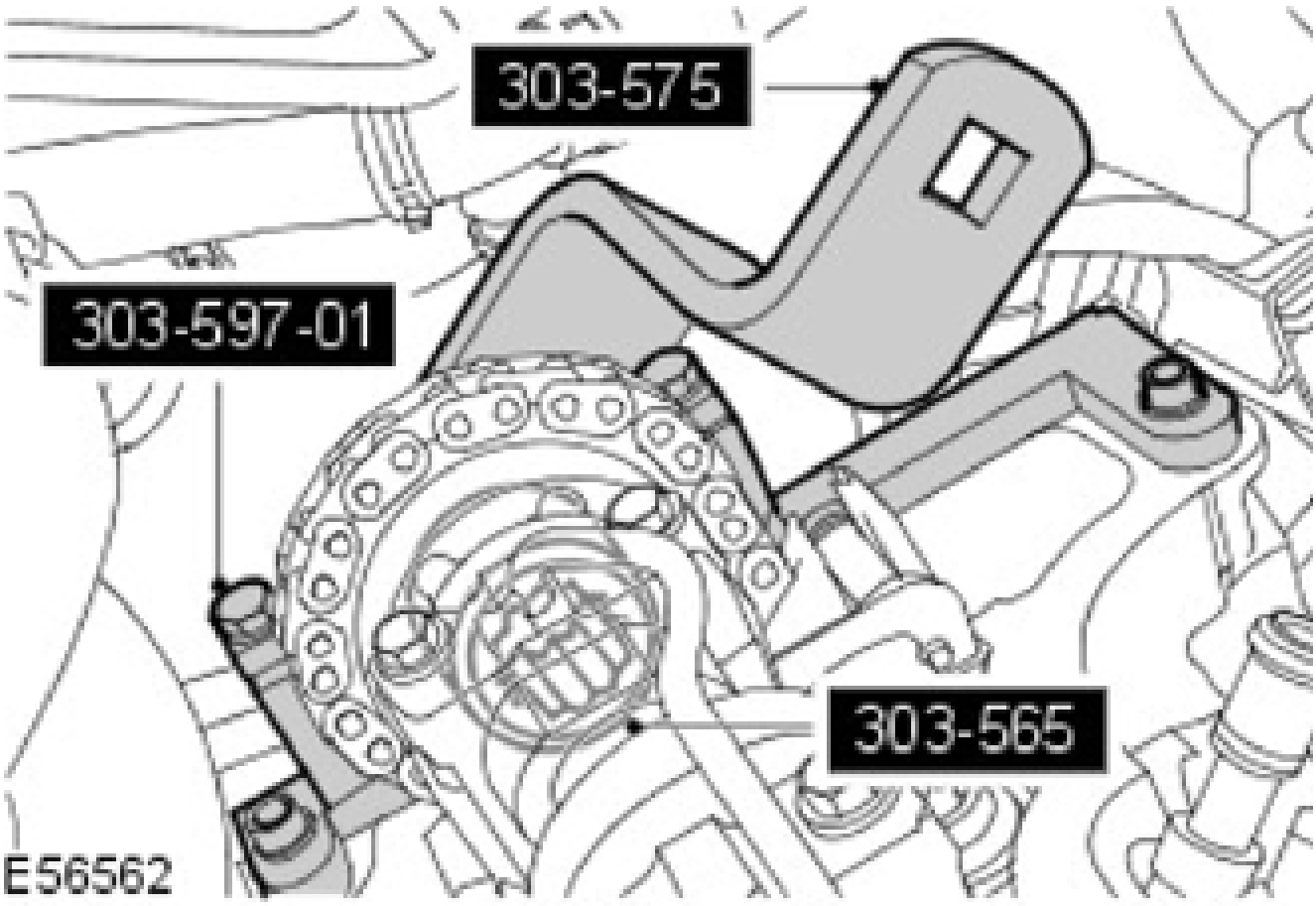

14. Loosen the special tool saddle clamp bolts.

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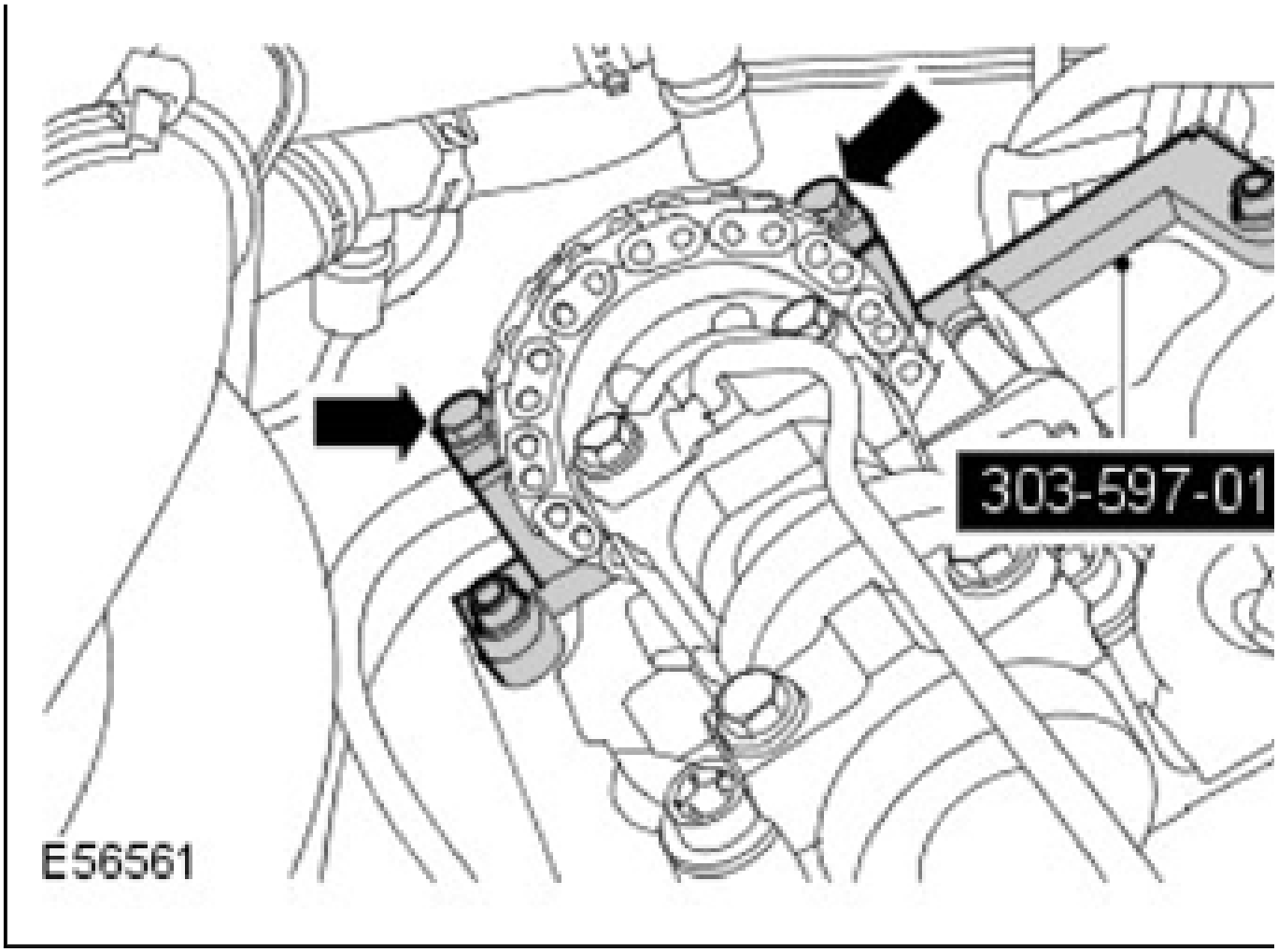

CAUTION: Before disconnecting or removing the components, ensure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

15. Remove the RH hydraulic timing chain tensioner.

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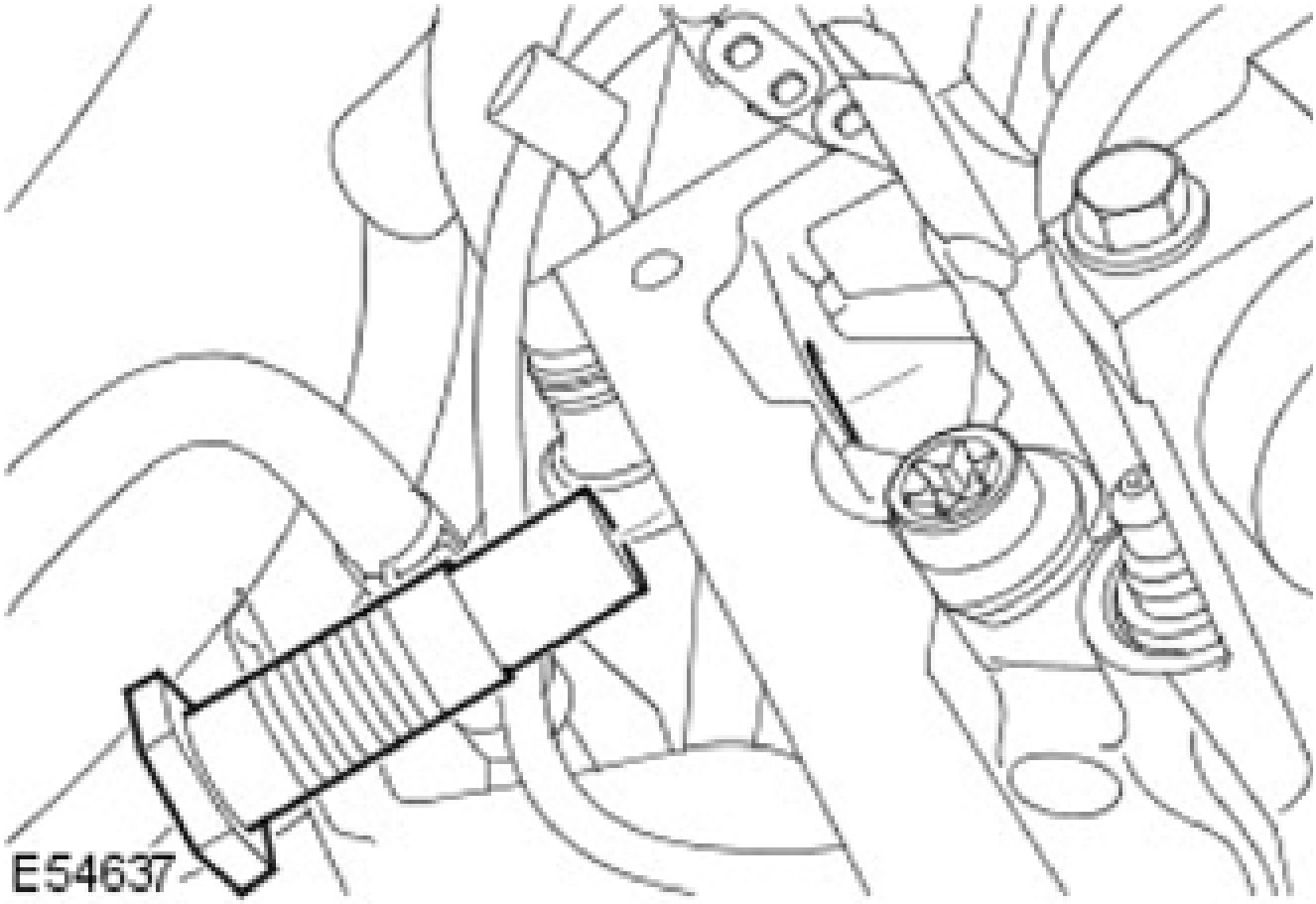

16. Install the special tool.
    - Clean the component mating faces.

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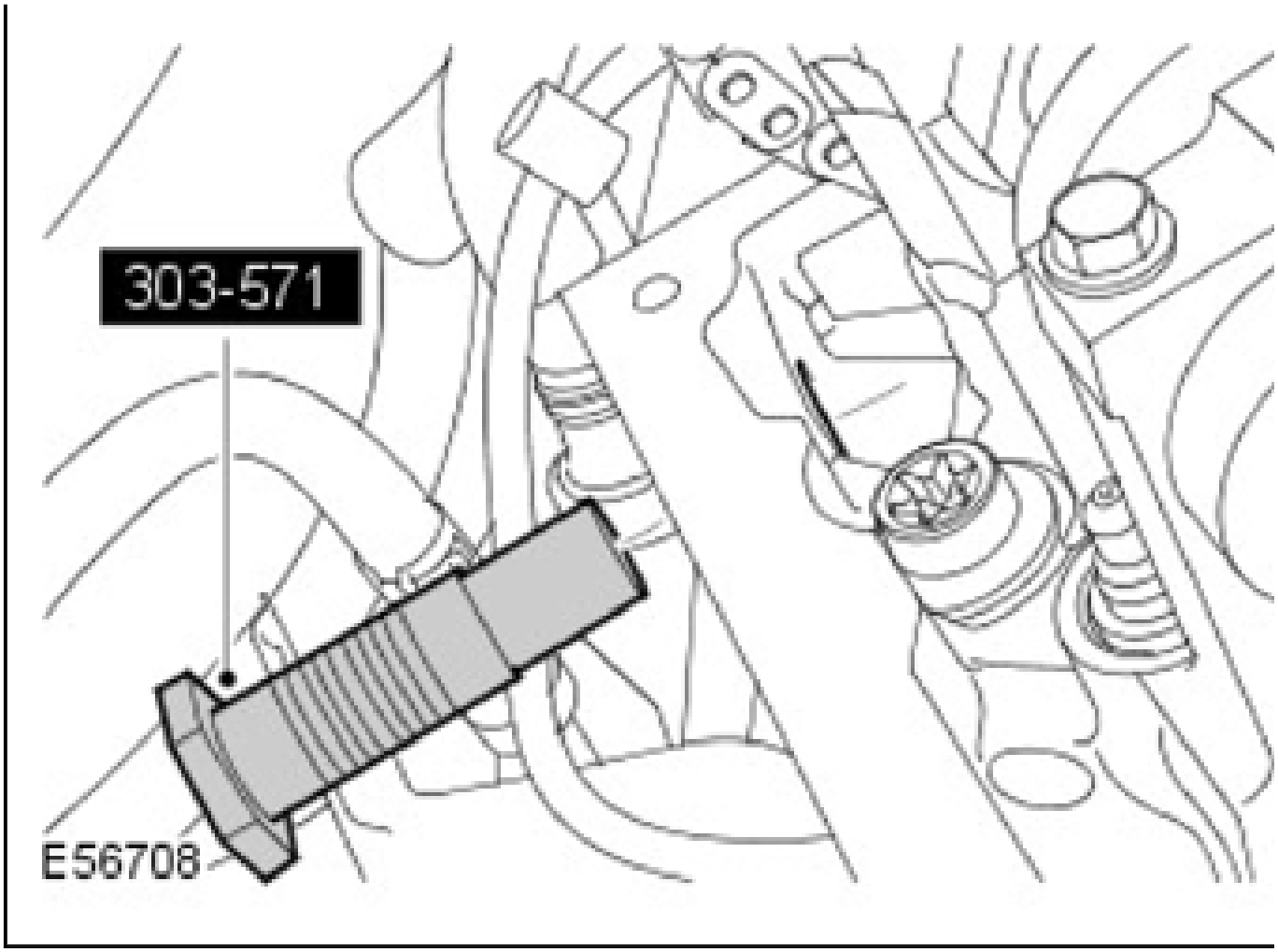

17. Tighten the saddle clamp bolts to 10 Nm (7 lb.ft).

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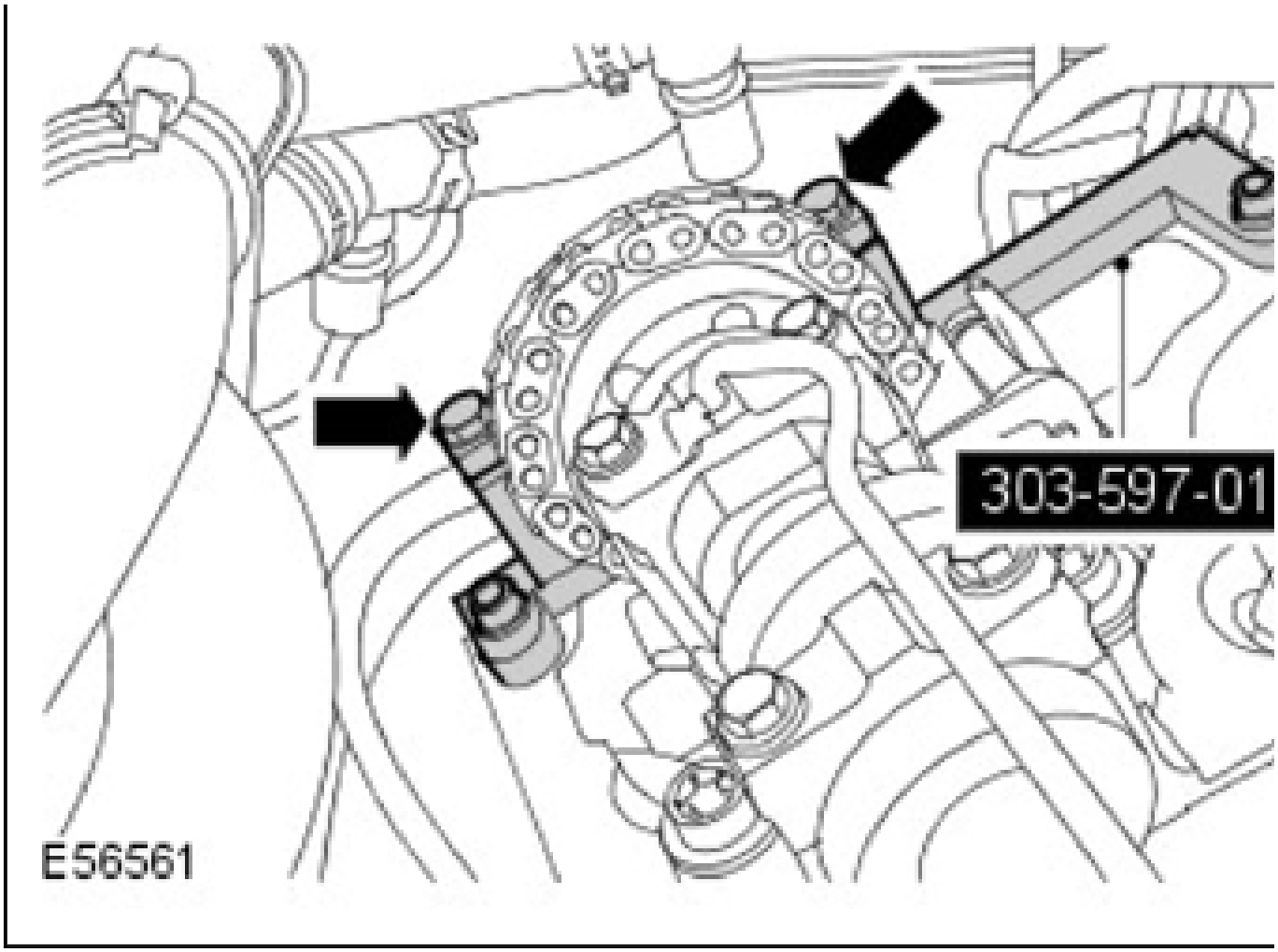

18. Using the special tool, tighten the camshaft sprocket bolt to 20 Nm (15 lb.ft), then a further 100 degrees.

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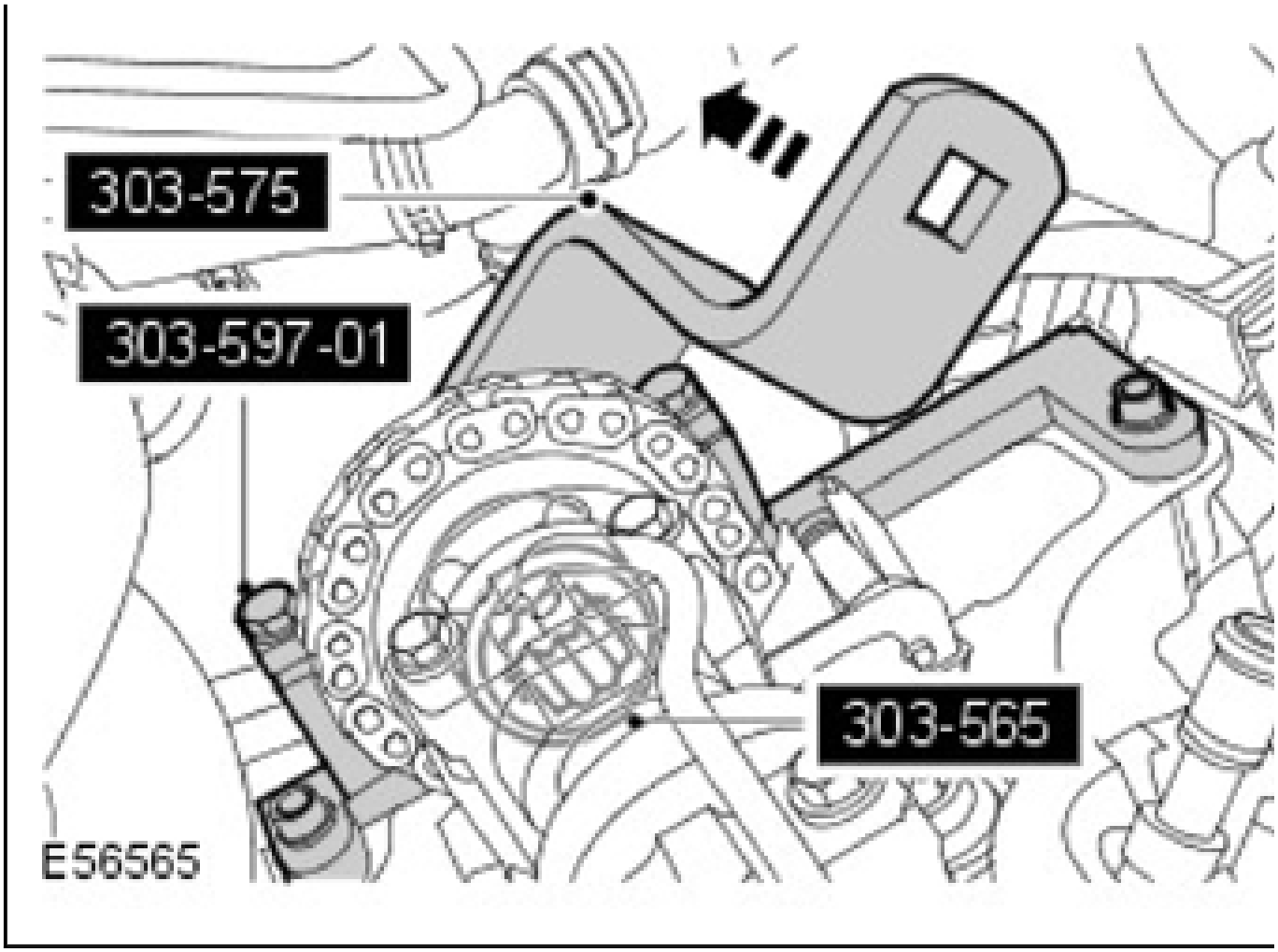

19. Remove the special tools.
20. Install the RH hydraulic timing chain tensioner.
    - Install a new seal.
    - Clean the component mating faces.
    - Tighten the tensioner to 44 Nm (32 lb.ft).

NOTE: If either camshaft is disturbed, both camshafts MUST be retimed. The LH camshaft sprocket bolt has a right hand thread.

21. Repeat the above procedure to adjust the LH camshaft timing.
22. Install the camshaft roller followers.

For additional information, refer to: **CAMSHAFT ROLLER FOLLOWER** .

CAUTION: Tighten the bolts in the sequence shown.

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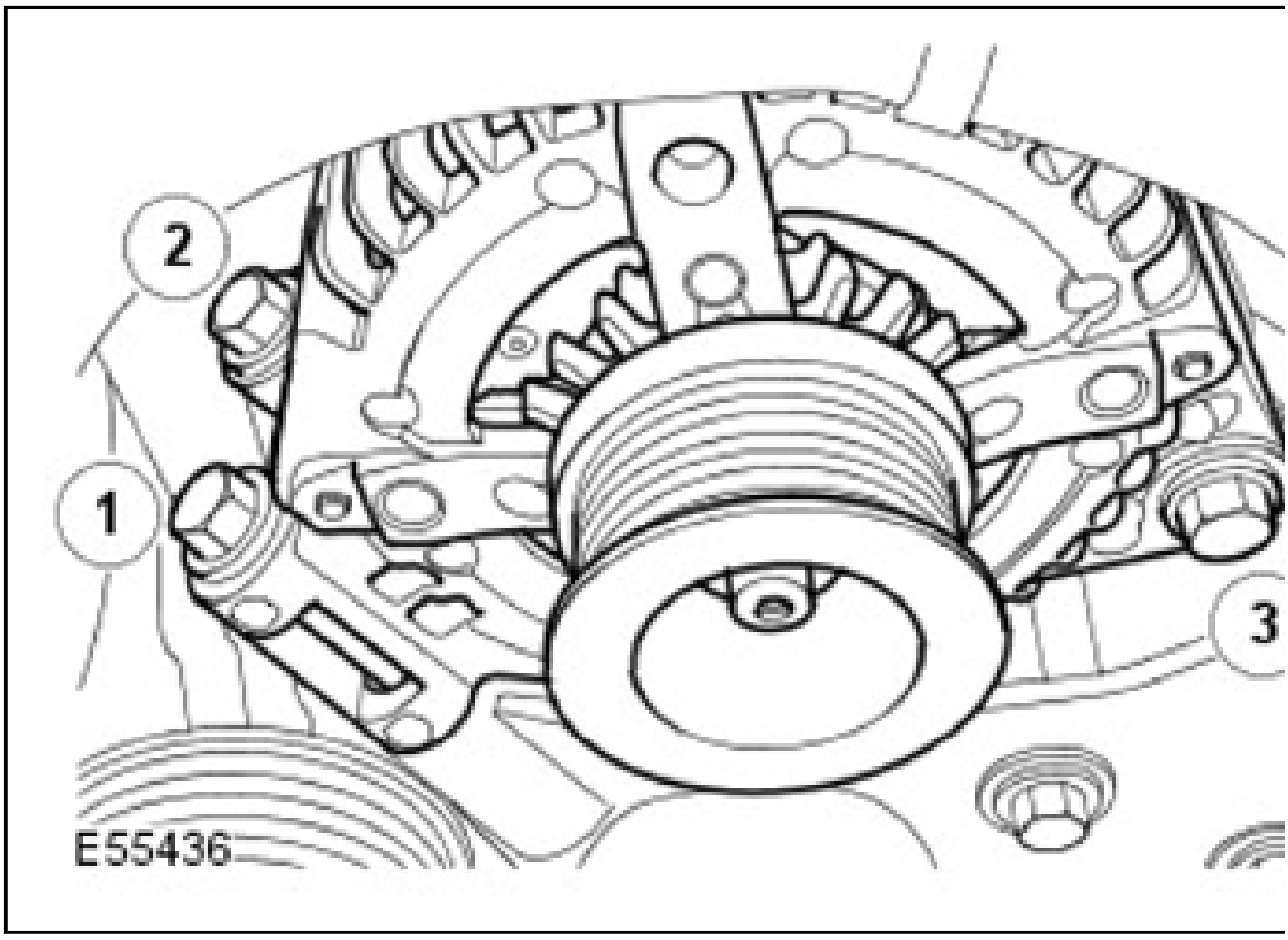
23. Install the generator.
    - Clean the component mating faces.
    - Tighten the bolts to 45 Nm (33 lb.ft).



24. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

IN-VEHICLE REPAIR

CAMSHAFT RH

REMOVAL

NOTE: Removal of the LH camshaft is similar to this procedure.

1. Disconnect the battery ground cable.

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For additional information, refer to: **SPECIFICATION** .

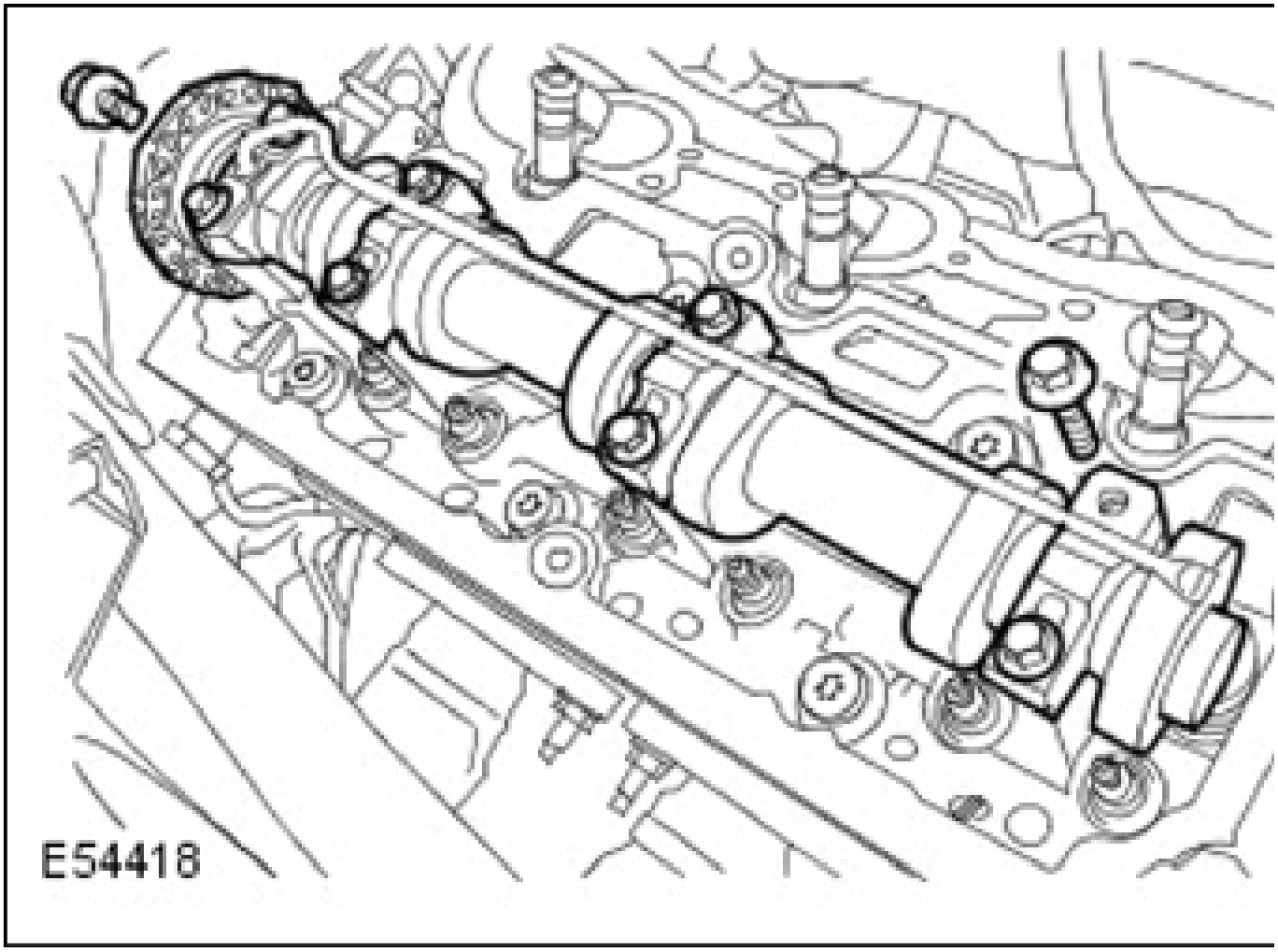
2. Refer to valve timing check and adjust.

   For additional information, refer to: **CAMSHAFT TIMING** .

3. Remove the camshaft sprocket bolt.
   - Position the sprocket and chain aside.

NOTE: Remove the camshaft bearing caps evenly and in stages. Note the fitted position.

4. Remove the camshaft bearing caps.
   - Remove the 8 bolts.
   - Collect the camshaft oil supply line.
5. Remove the camshaft.



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INSTALLATION

1. Install the camshaft.
   - Clean the component mating faces.
   - Lubricate the components with clean engine oil.

   NOTE: Note the fitted position.

2. Install the camshaft bearing caps.
   - Clean the component mating faces.
   - Lubricate the components with clean engine oil.

   NOTE: After installing the bolts check the camshaft is free to rotate.

3. Install the camshaft oil supply line.
   - Thoroughly clean and inspect the oil supply line.
   - Prime the oil supply line with clean engine oil.
   - Working in a diagonal sequence, evenly and progressively tighten the bolts in 2 stages.
   - Tighten the bolts to 6 Nm (4 lb.ft).
   - Tighten the bolts to 16 Nm (12 lb.ft).
4. Install the camshaft sprocket bolt.
   - Install the bolt, but do not tighten fully at this stage.
5. Adjust the valve timing.

   For additional information, refer to: **CAMSHAFT TIMING** .

6. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

CRANKSHAFT PULLEY

SPECIAL TOOL(S)

	Crankshaft TDC timing/locking tool 303-573

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	Remover crankshaft damper pulley 303-1149
	Remover oil seal front cover 303-107

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	Installer oil seal front cover 303-1148
	Installer - crankshaft damper pulley 303-102

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REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the accessory drive belt.

   For additional information, refer to: **Accessory Drive Belt** .

3. Using the special tool, retain the crankshaft front pulley.

   NOTE: The crankshaft pulley retaining bolt will be very tight.

4. Remove the crankshaft pulley retaining bolt.
   - Discard the bolt.

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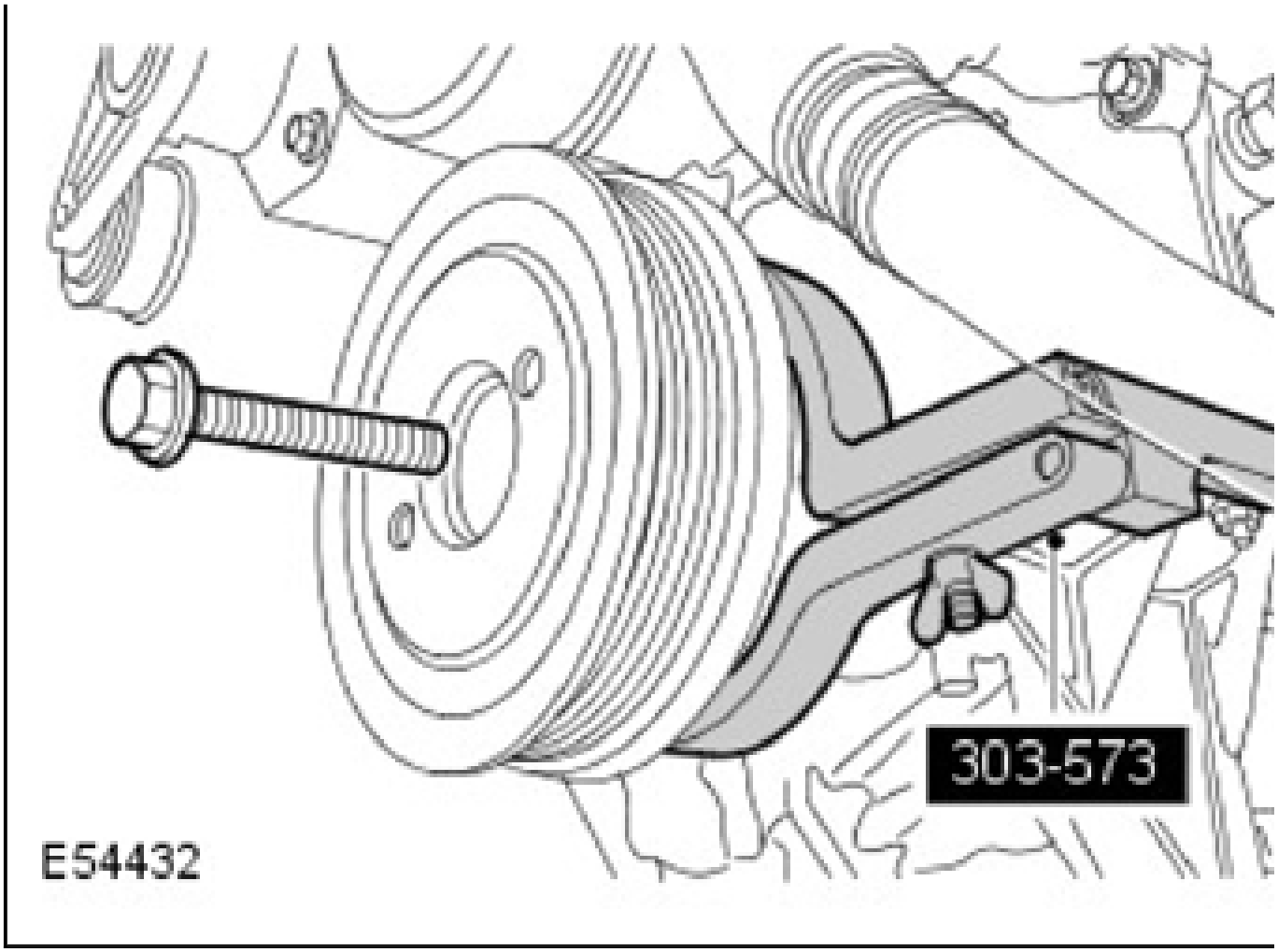

5. Using the special tools, remove the crankshaft pulley.
    - Collect the washer.
    - Remove the special tools.

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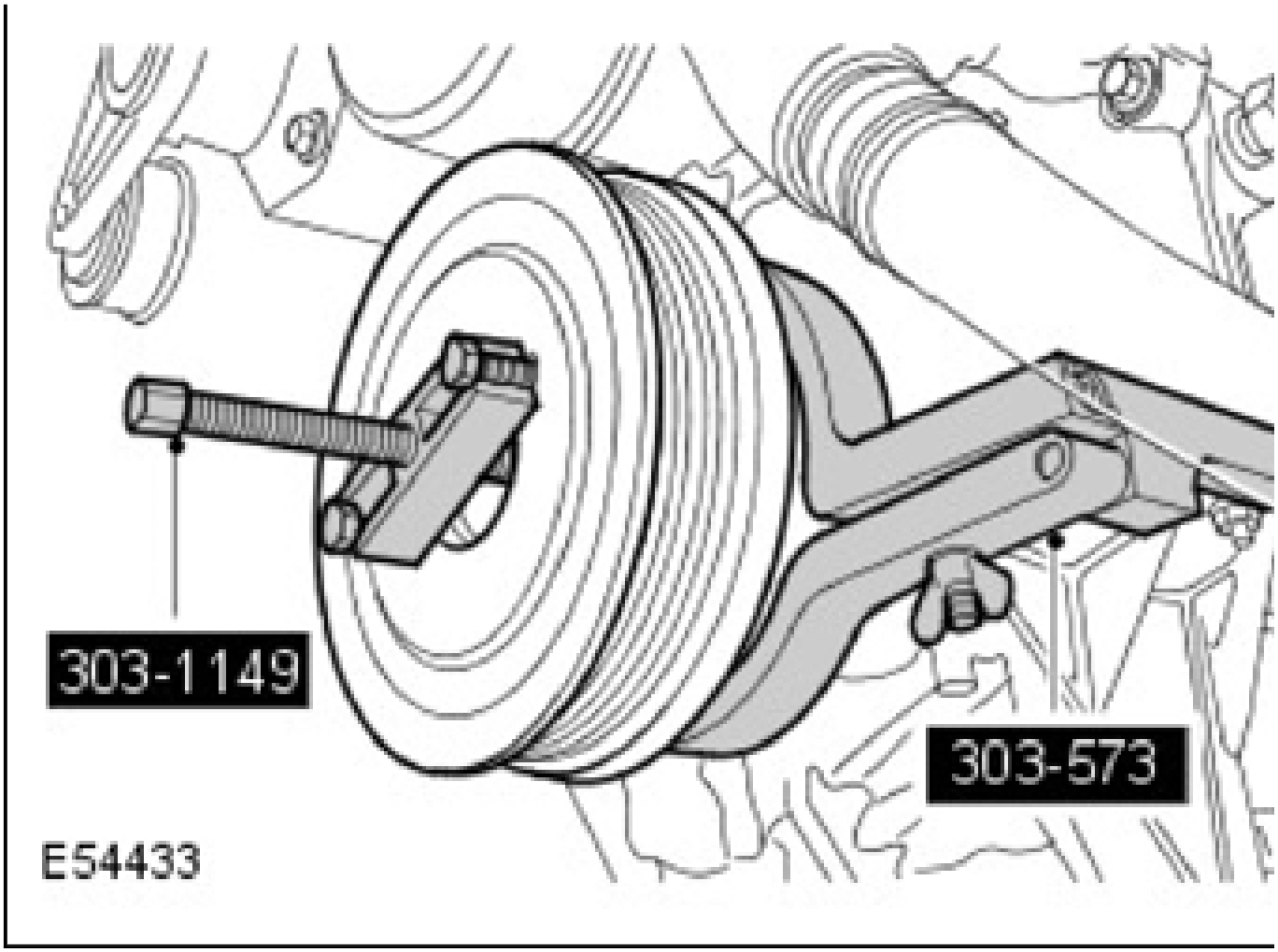

6. Using the special tool, remove the crankshaft front seal.

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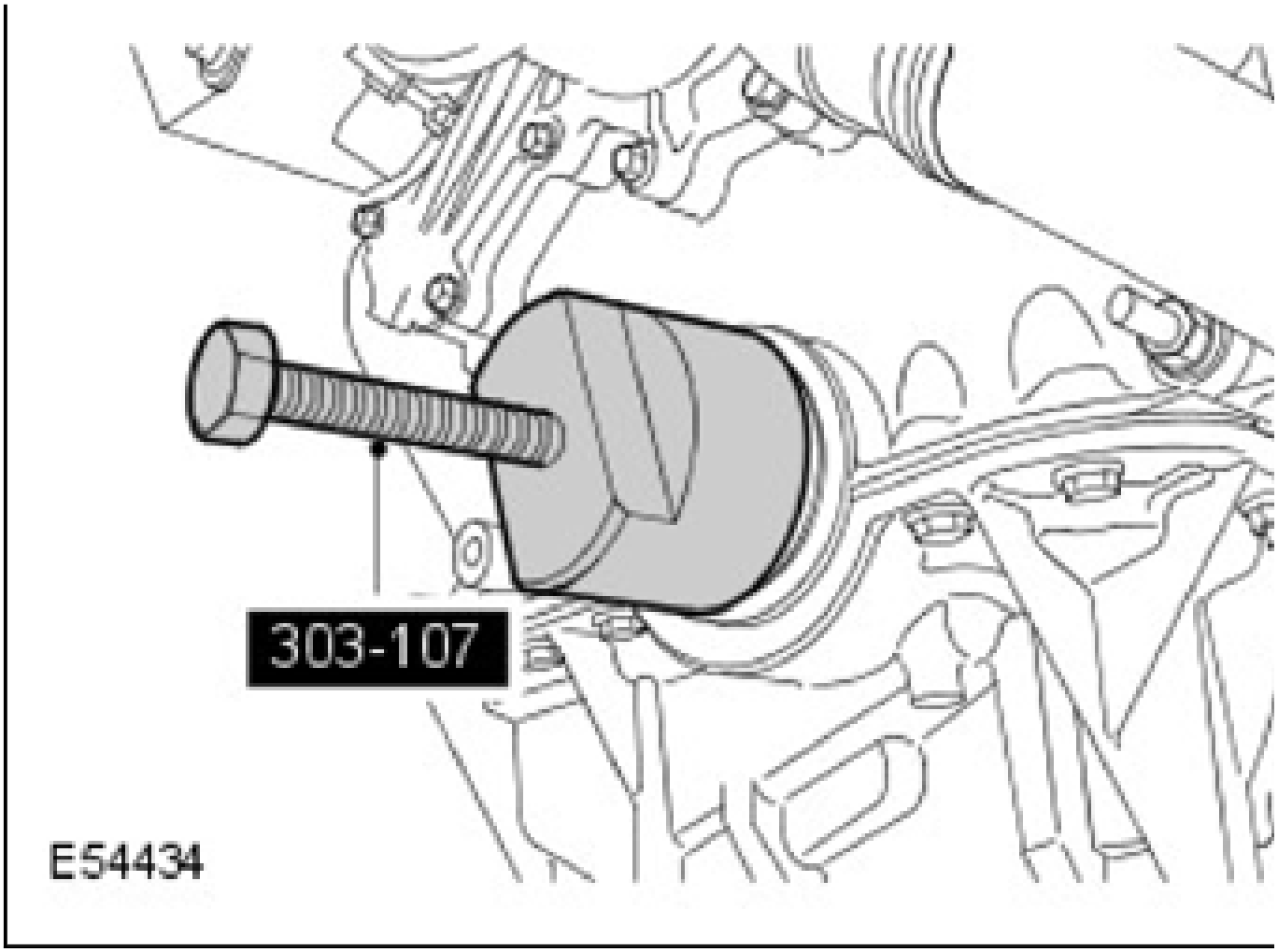

7. Check the crankshaft damper pulley and the washer for damage.

INSTALLATION

1. Clean all the crankshaft pulley mating faces.
2. Using the special tool, install the crankshaft front seal.
    - Lubricate the seal with clean engine oil.

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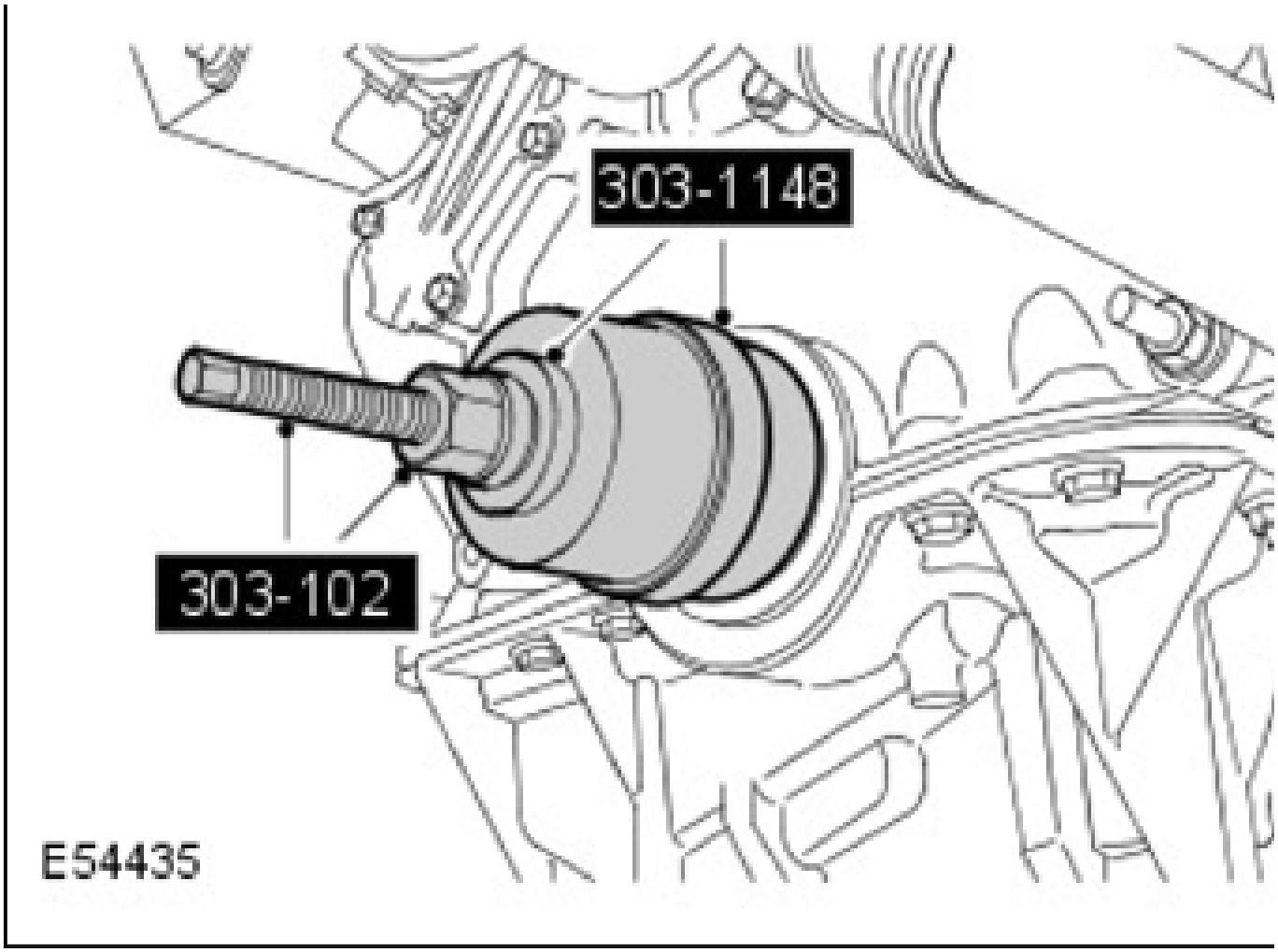

3. Using the special tool, install the crankshaft pulley.
    - Lubricate the seal with clean engine oil.
    - Remove the special tool.

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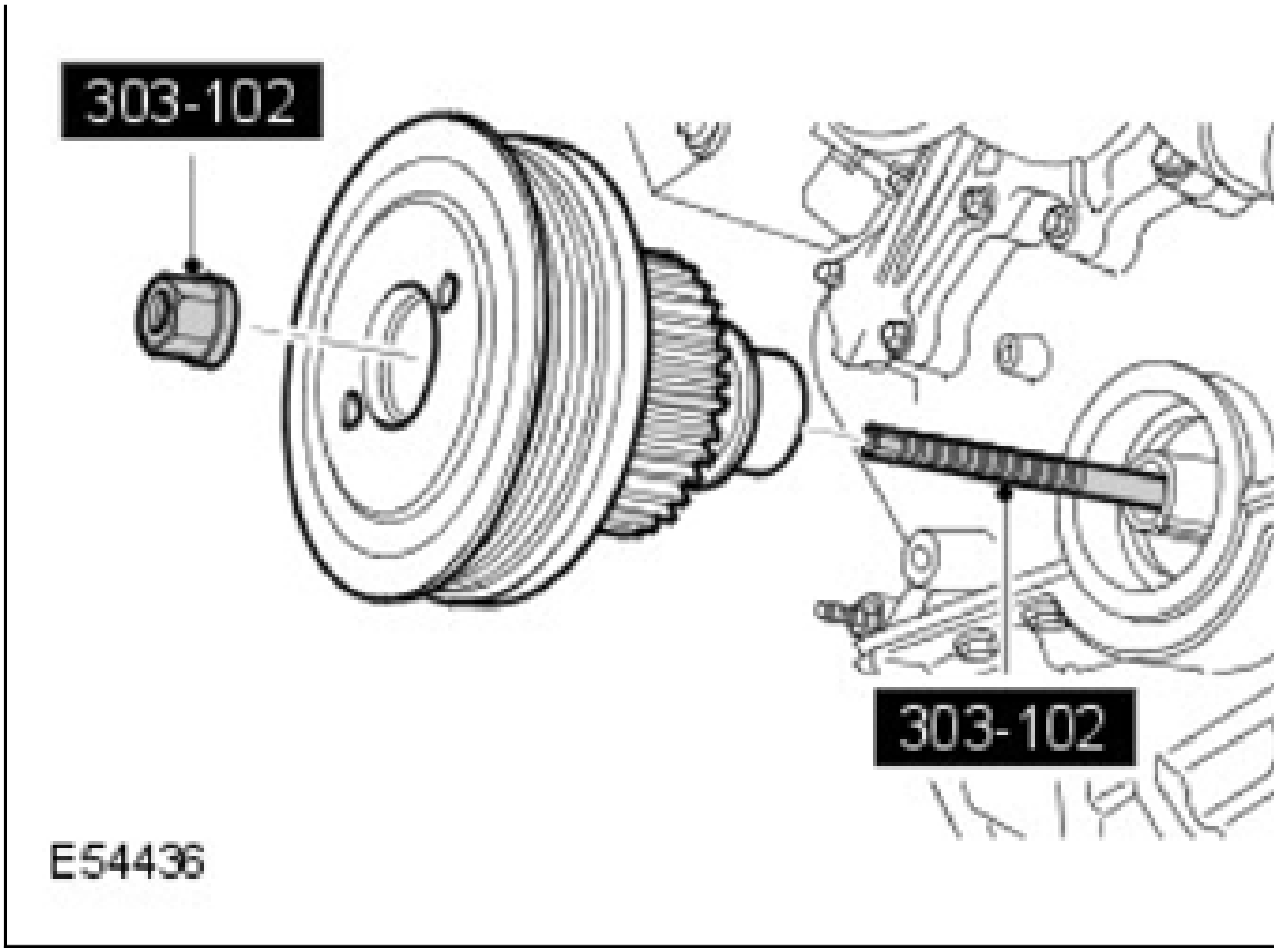

CAUTION: The screw thread in the crankshaft pulley must be cleaned out before installing a new crankshaft pulley bolt.

4. Install, but do not tighten, the new crankshaft pulley bolt.
5. Tighten the crankshaft pulley bolt.
    - Install the special tool.
    - Tighten the bolt to 55 Nm (40 lb.ft).
    - Tighten the bolt a further 85 degrees.
    - Remove the special tool.

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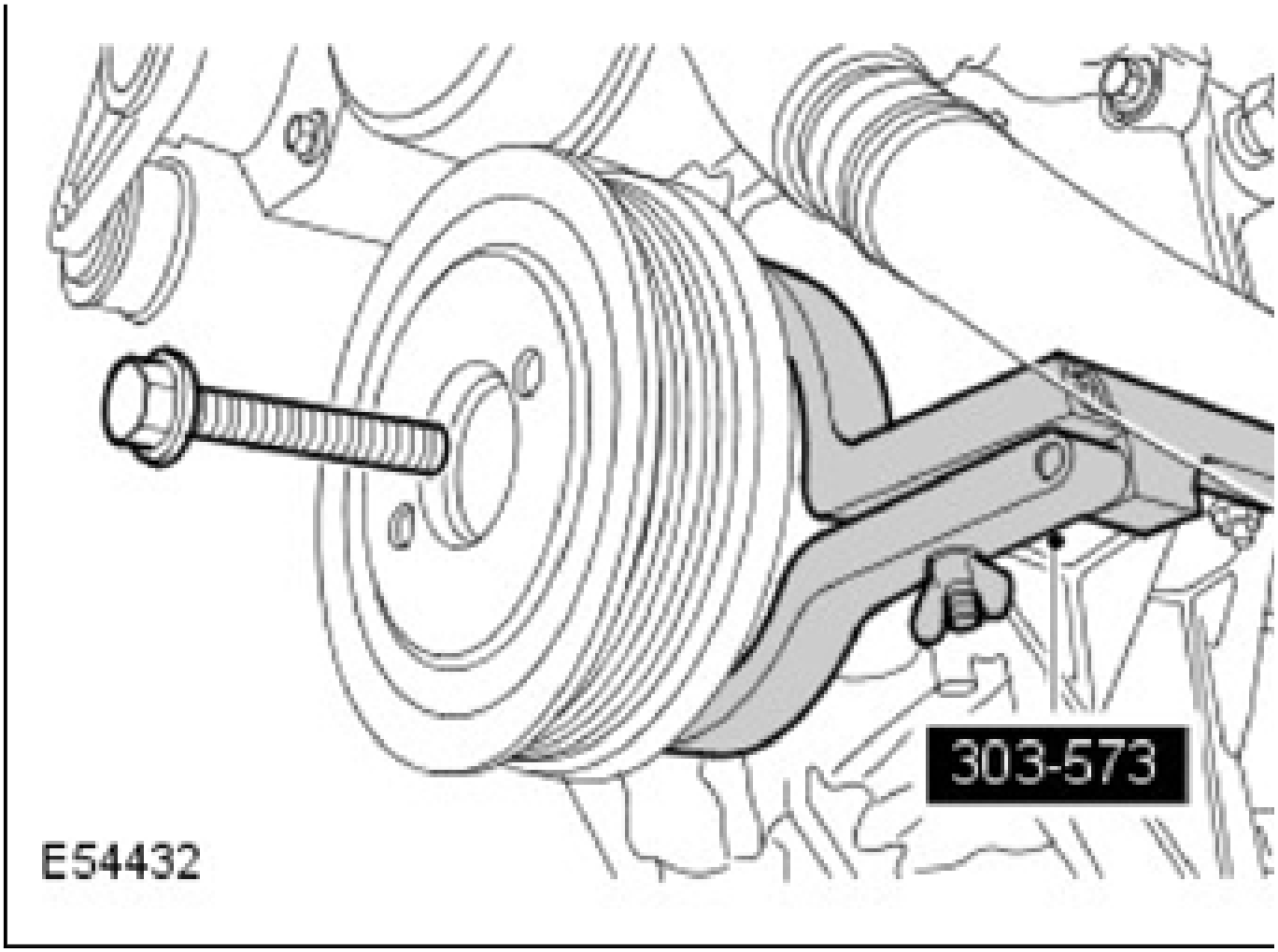

6. Install the accessory drive belt.

   For additional information, refer to: **Accessory Drive Belt** .

7. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

CRANKSHAFT FRONT SEAL

SPECIAL TOOL(S)

	Crankshaft TDC timing/locking tool 303-573

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	Remover crankshaft damper pulley 303-773
	Remover oil seal front cover 303-107

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	Installer oil seal front cover 303-1148
	Installer crankshaft damper pulley 303-102

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REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the accessory drive belt.

   For additional information, refer to: **Accessory Drive Belt** .

3. Using the special tool, retain the crankshaft front pulley.

   NOTE: The crankshaft pulley retaining bolt will be very tight.

4. Remove the crankshaft pulley retaining bolt.
   - Discard the bolt.

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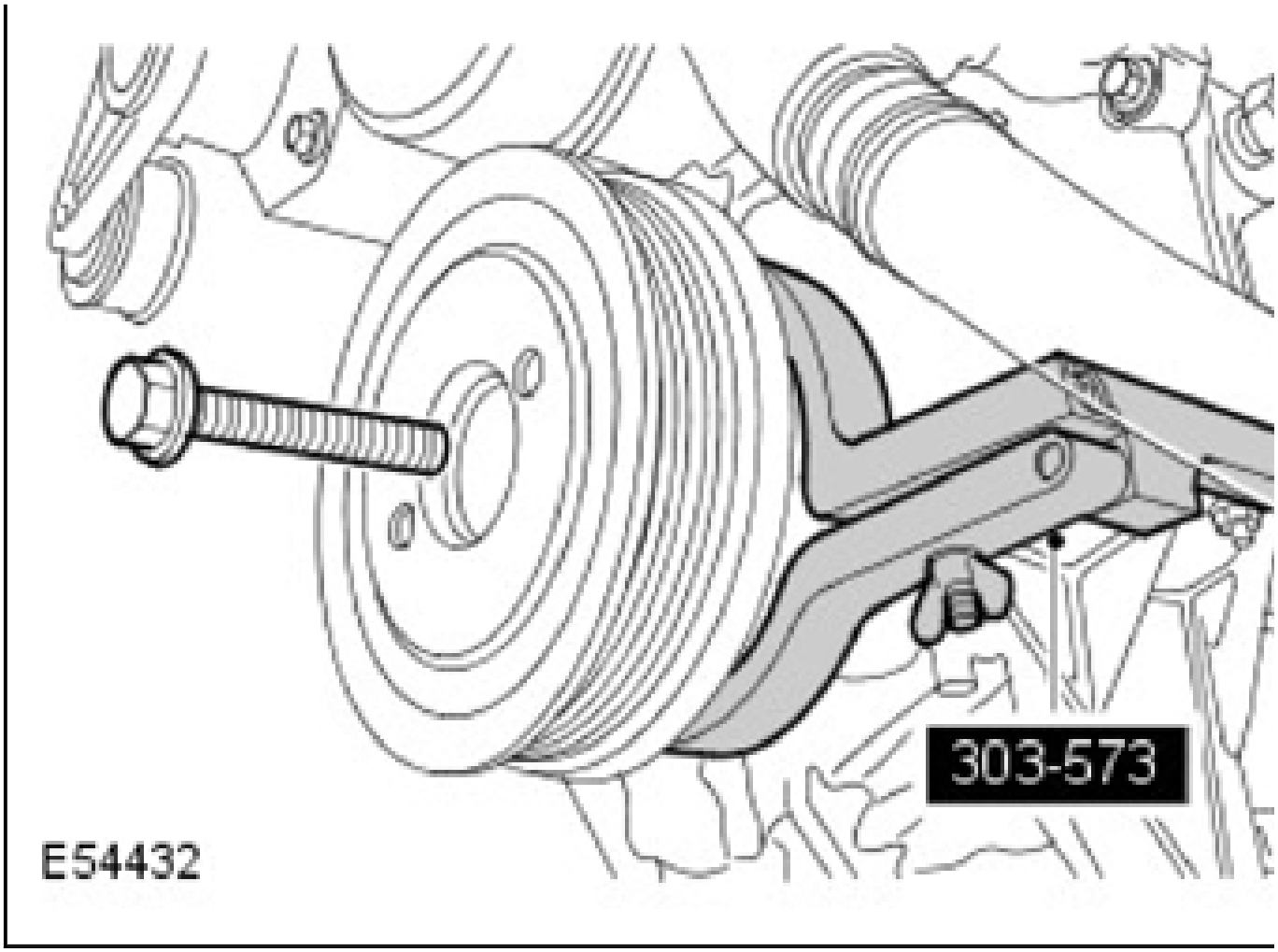

5. Using the special tools, remove the crankshaft pulley.
    - Collect the washer.

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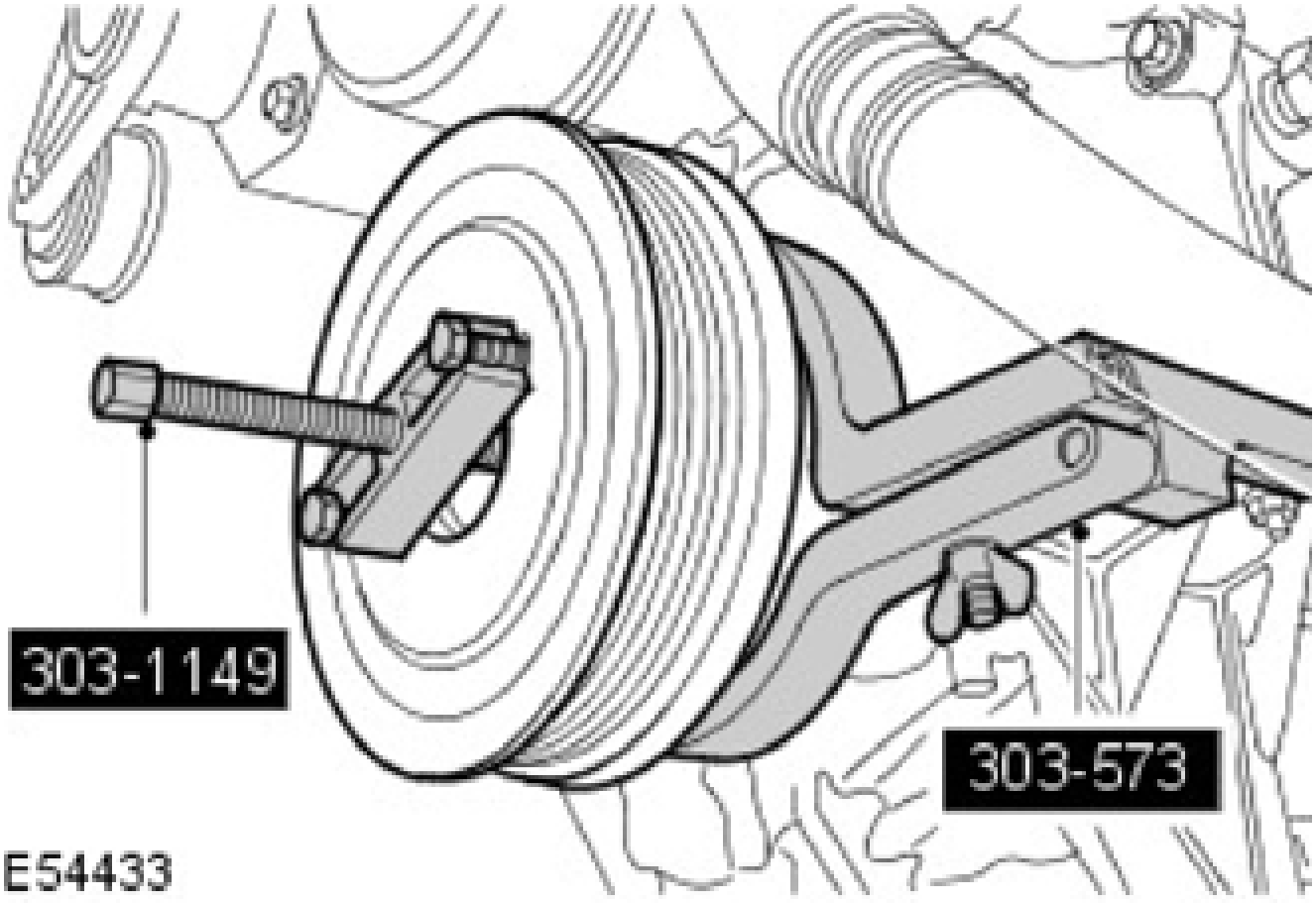

6. Remove the special tools from the crankshaft pulley.
7. Using the special tool, remove the crankshaft front seal.

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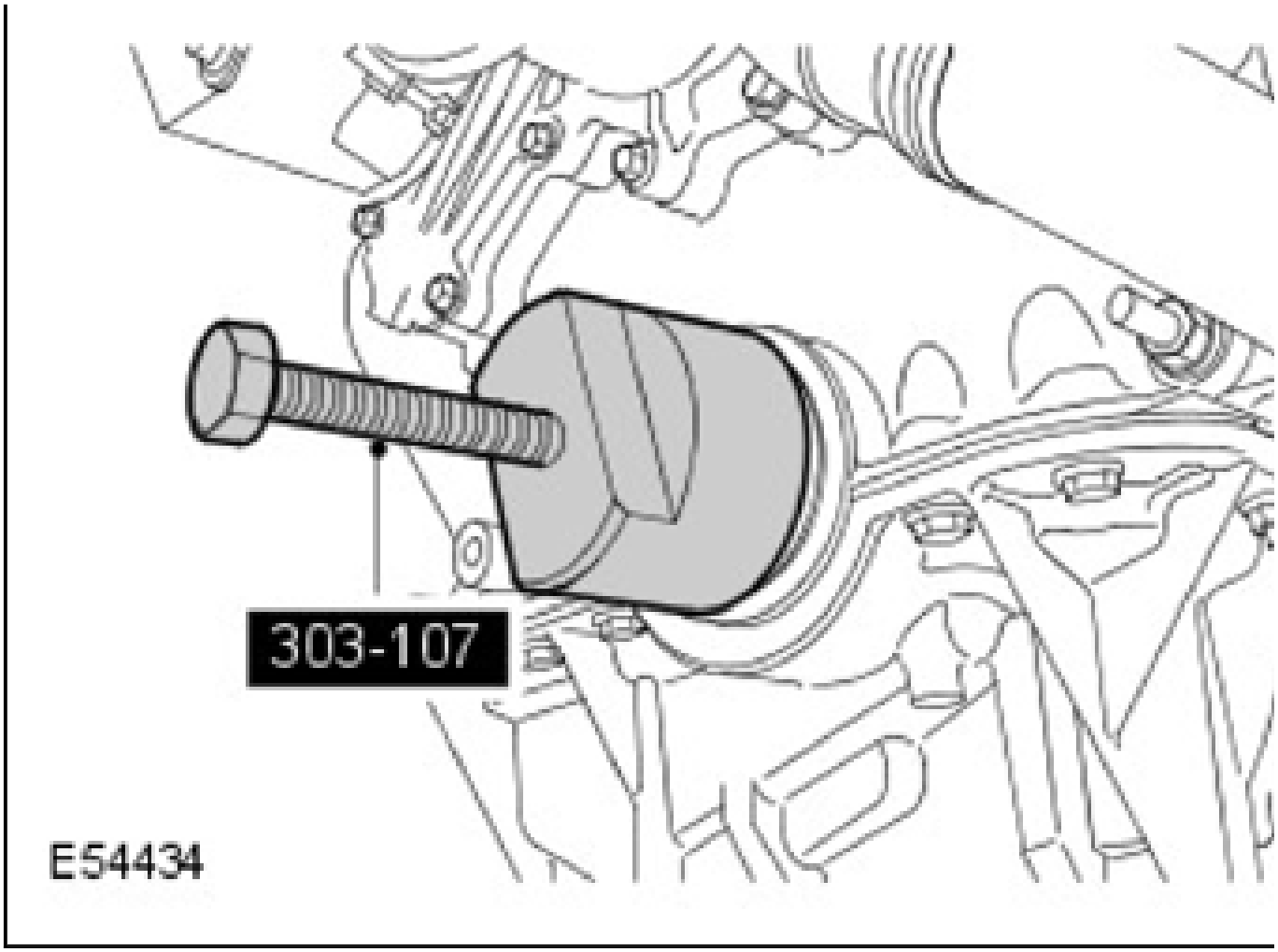

8. Check the crankshaft damper pulley and the washer for damage.

INSTALLATION

1. Clean all the crankshaft pulley mating faces.
2. Using the special tool, install the crankshaft front seal.
    - Lubricate the seal with clean engine oil.

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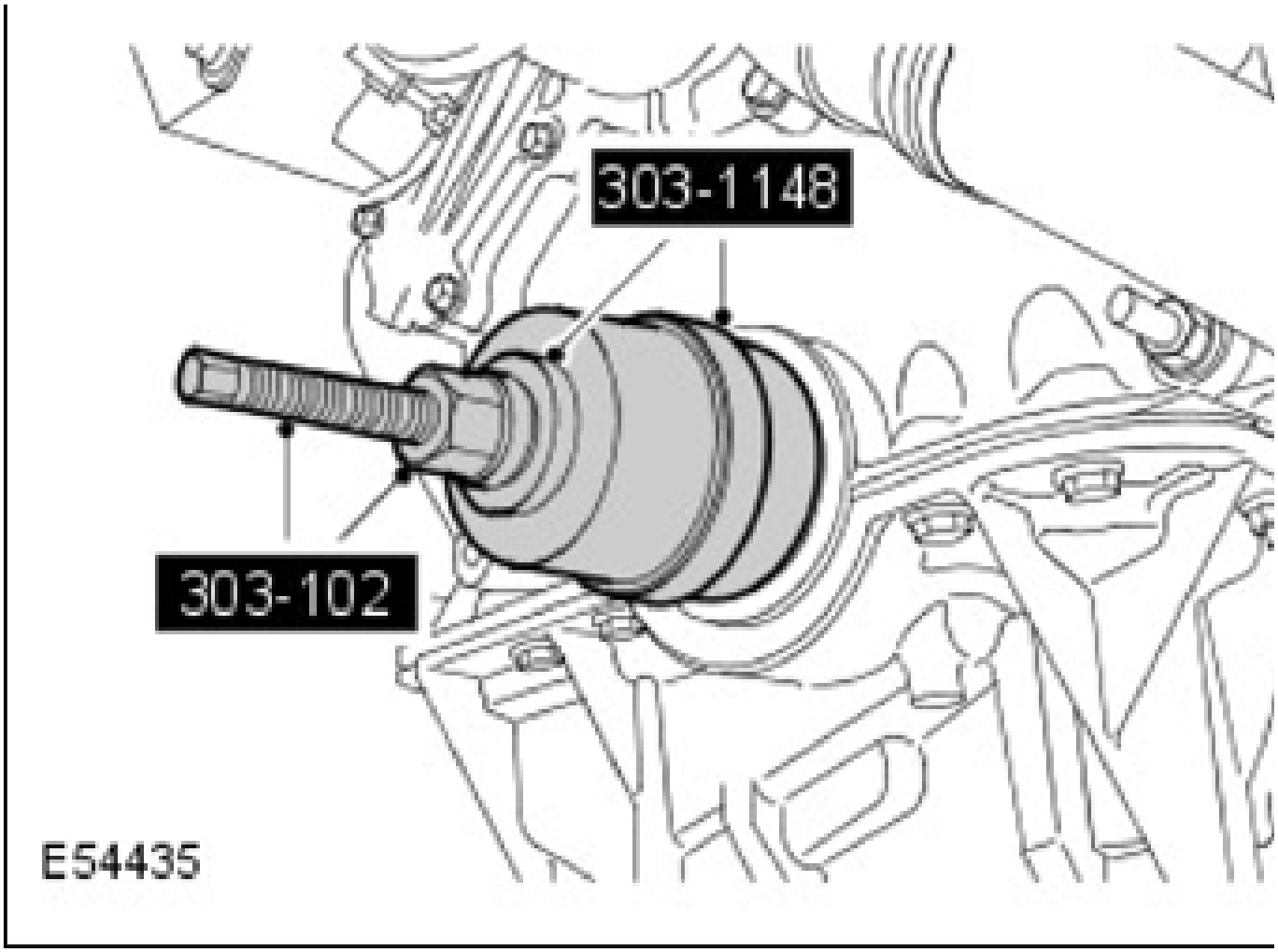

3. Using the special tool, install the crankshaft pulley.
    - Lubricate the seal with clean engine oil.
    - Remove the special tool.

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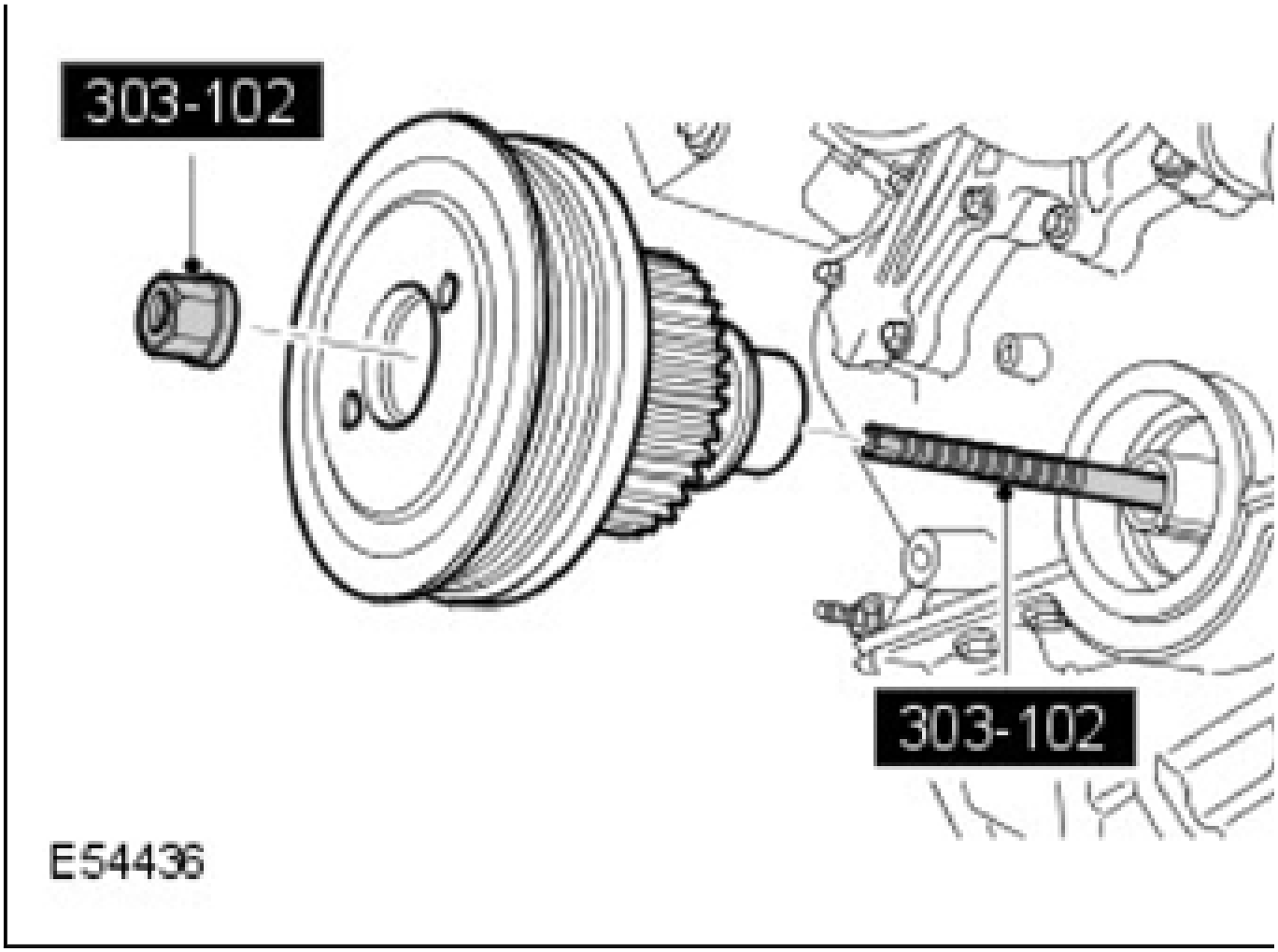

CAUTION: The screw thread in the crankshaft pulley must be cleaned out before installing a new crankshaft pulley bolt.

4. Install, but do not tighten, a new crankshaft pulley bolt.
5. Tighten the crankshaft pulley bolt.
    - Install the special tool.
    - Tighten the bolt to 45 Nm (33 lb.ft).
    - Tighten the bolt a further 85 degrees.
    - Remove the special tool.

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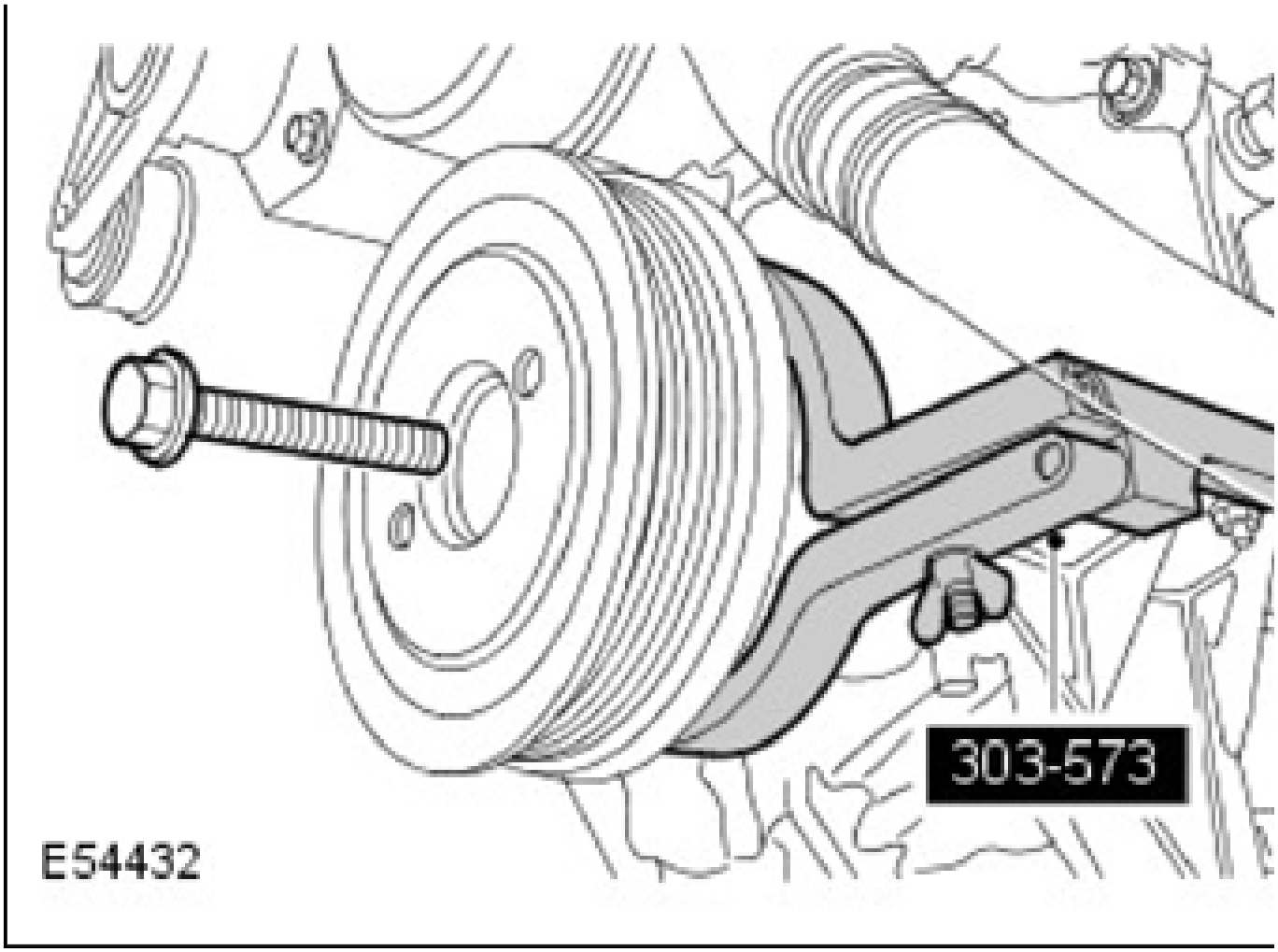

6. Install the accessory drive belt.

   For additional information, refer to: **Accessory Drive Belt** .

7. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

CRANKSHAFT REAR SEAL

SPECIAL TOOL(S)

	Oil seal remover 303-903 (LRT-12-092)

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	Crankshaft rear oil seal installer 303-527
	Crankshaft rear ol seal installer 303-525

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	Crankshaft rear oil seal installer 303-579

REMOVAL

NOTE: The seal installation tools are available individually or as a set 303-S524

1. Disconnect the battery ground cable.

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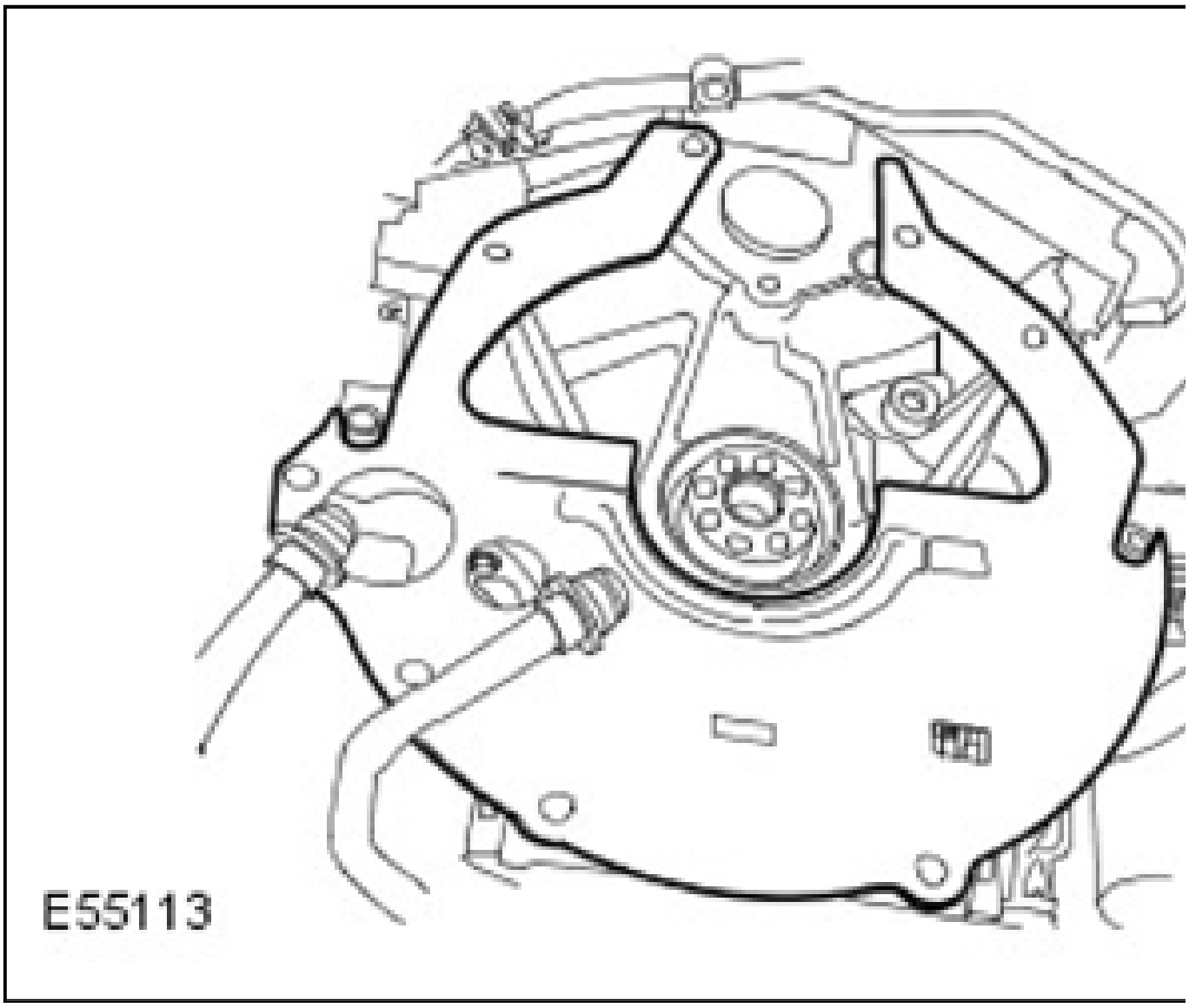
For additional information, refer to: **SPECIFICATION** .

WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the torque converter flexplate.

   For additional information, refer to: **FLEXPLATE** .

4. Remove the closing plate.



CAUTION: Care must be taken to avoid damage to the seal register and running

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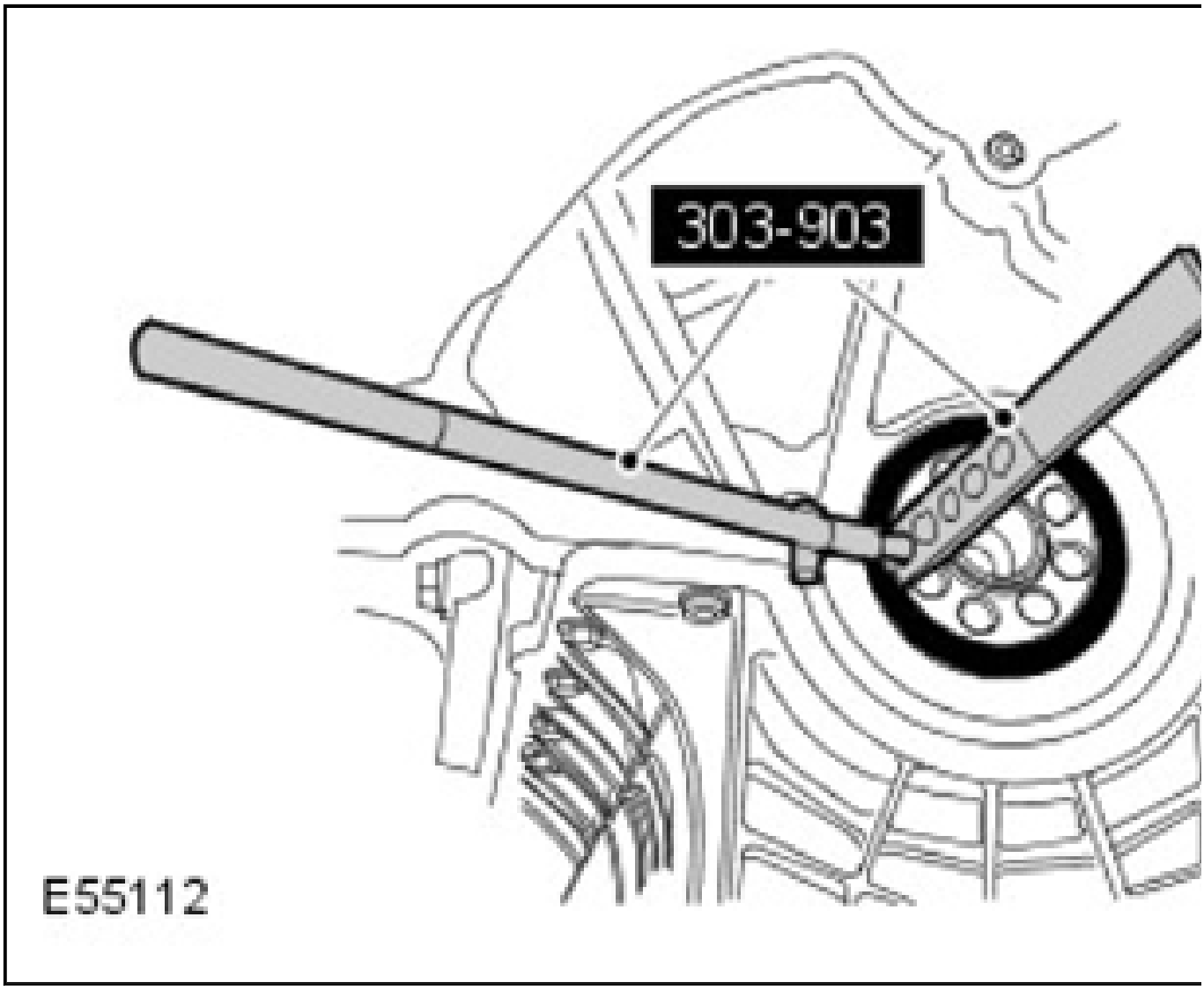
surface.

5. Using the special tools, remove and discard the crankshaft rear oil seal.



INSTALLATION

1. Install the special tool, 303-527.
   - Make sure the components are clean and dry.
   - Tighten the 2 Allen screws.

CAUTION: Make sure the seal is installed parallel

2. Using the special tool, install the crankshaft rear oil seal.

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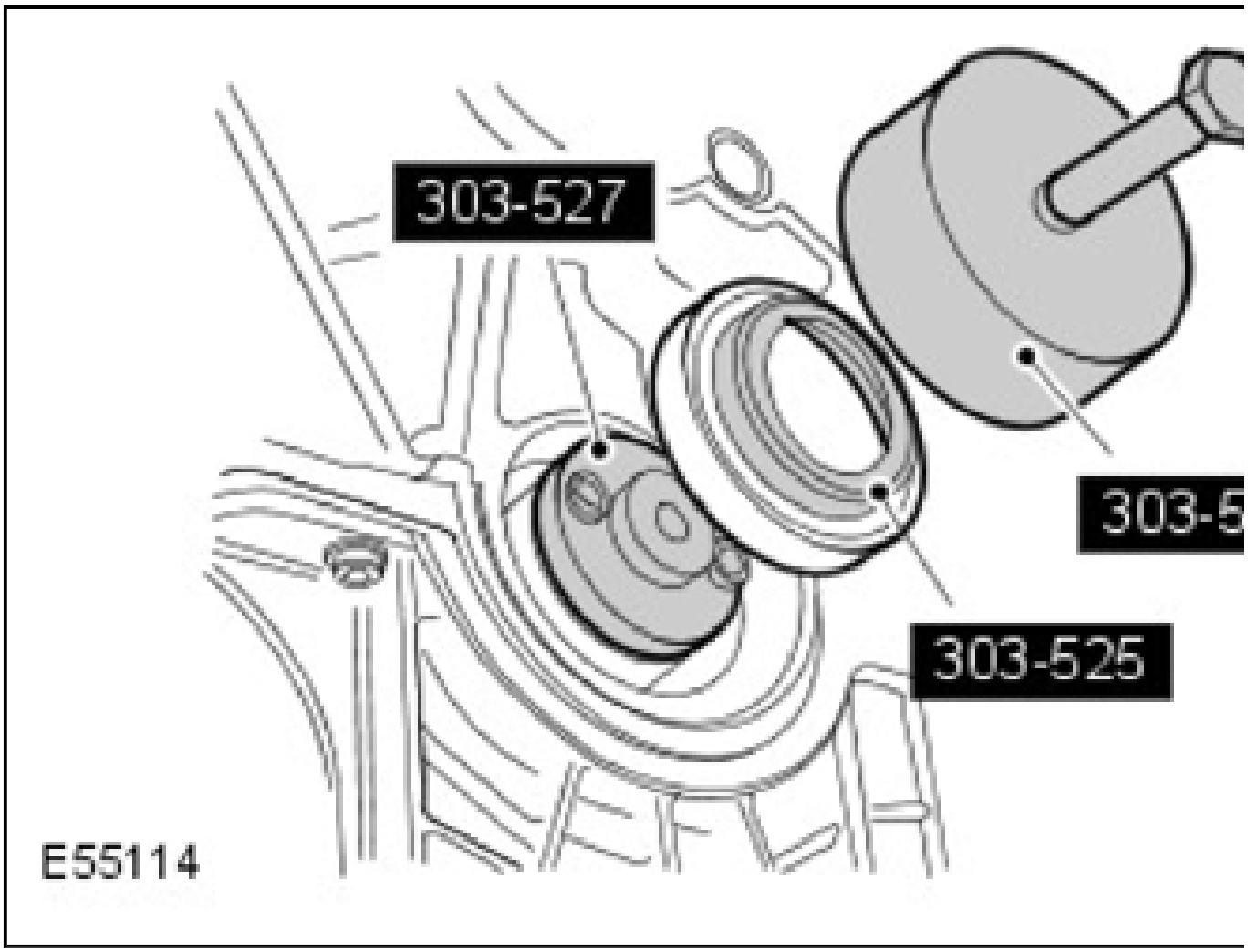
- Lubricate the seal with clean engine oil.
- Partially install the crankshaft rear oil seal.
- Tighten the bolt to fully install the seal.



3. Install the closing plate.
   - Clean the components.
4. Install the torque converter flexplate.

   For additional information, refer to: **FLEXPLATE** .

5. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

6. Check and top-up the engine oil.

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CYLINDER BLOCK CRADLE

SPECIAL TOOL(S)

	Cylinder block cradle insert adjustment tool 303-596

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the RH front wheel and tire.
4. Position the starter motor to one side.
   - Remove the 2 bolts.
   - Remove the terminal upper cover.
   - Remove the terminal lower cover.
   - Remove the nut.
   - Disconnect the 2 electrical connectors.

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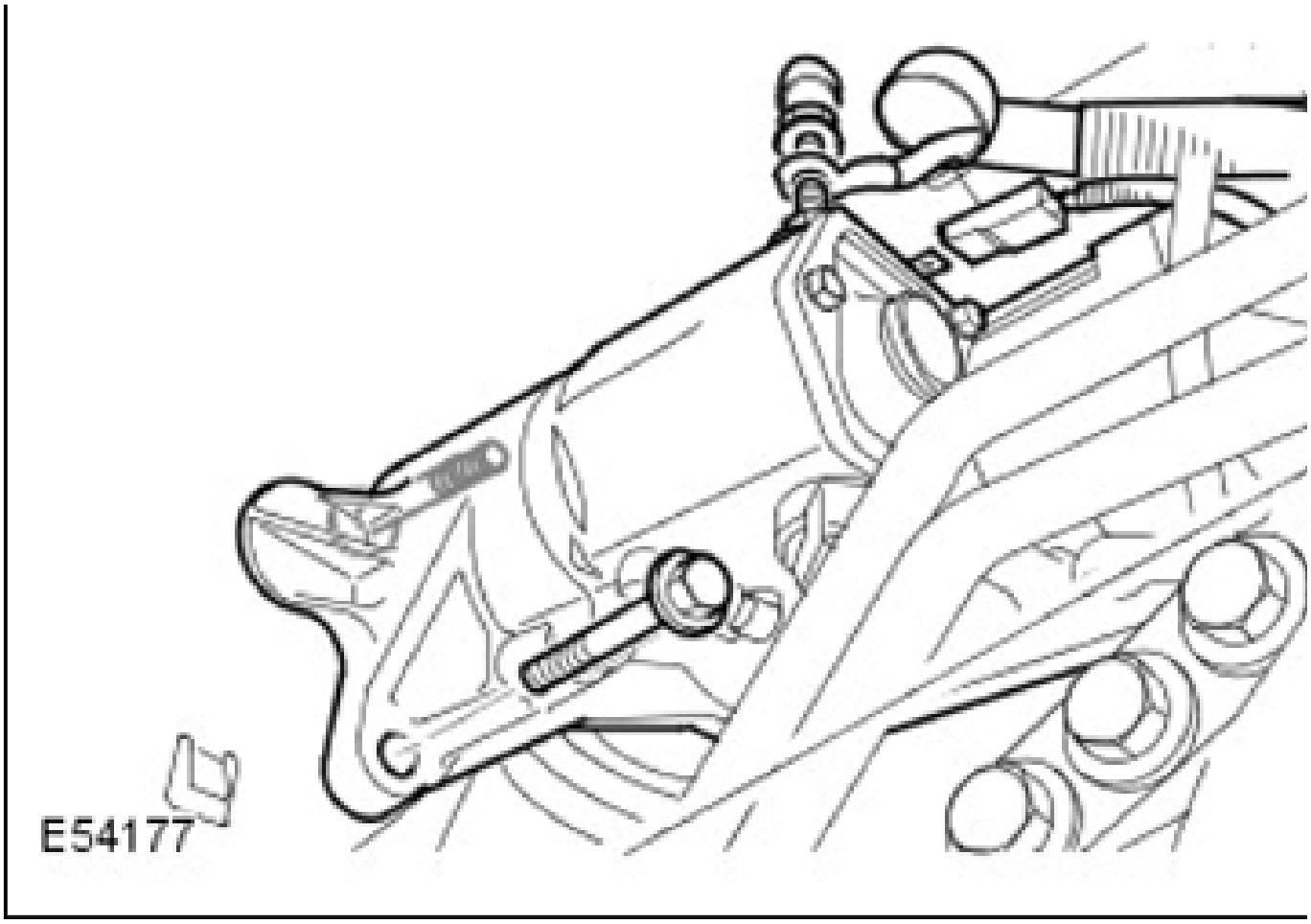

5. Remove the front axle tube.

   For additional information, refer to: **AXLE TUBE** .

6. Remove the oil pan.

   For additional information, refer to: **OIL PAN** .

7. Remove the front stabilizer bar.
8. Remove the radiator access panel.
   - Remove the 4 bolts.

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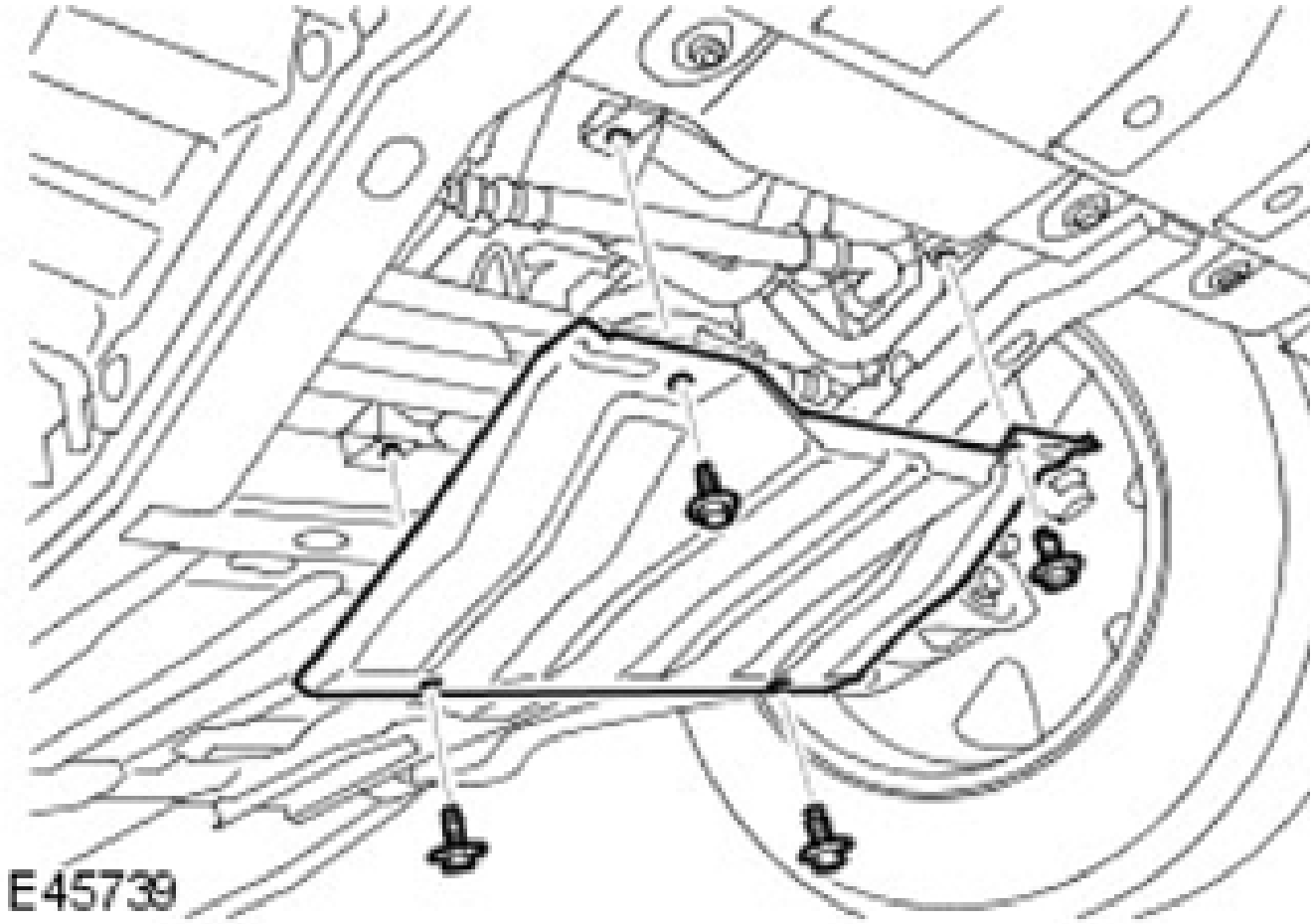

9. Release the engine oil cooler lines.
    - Remove the bolt.
    - Remove the nut.
    - Tie the lines aside.

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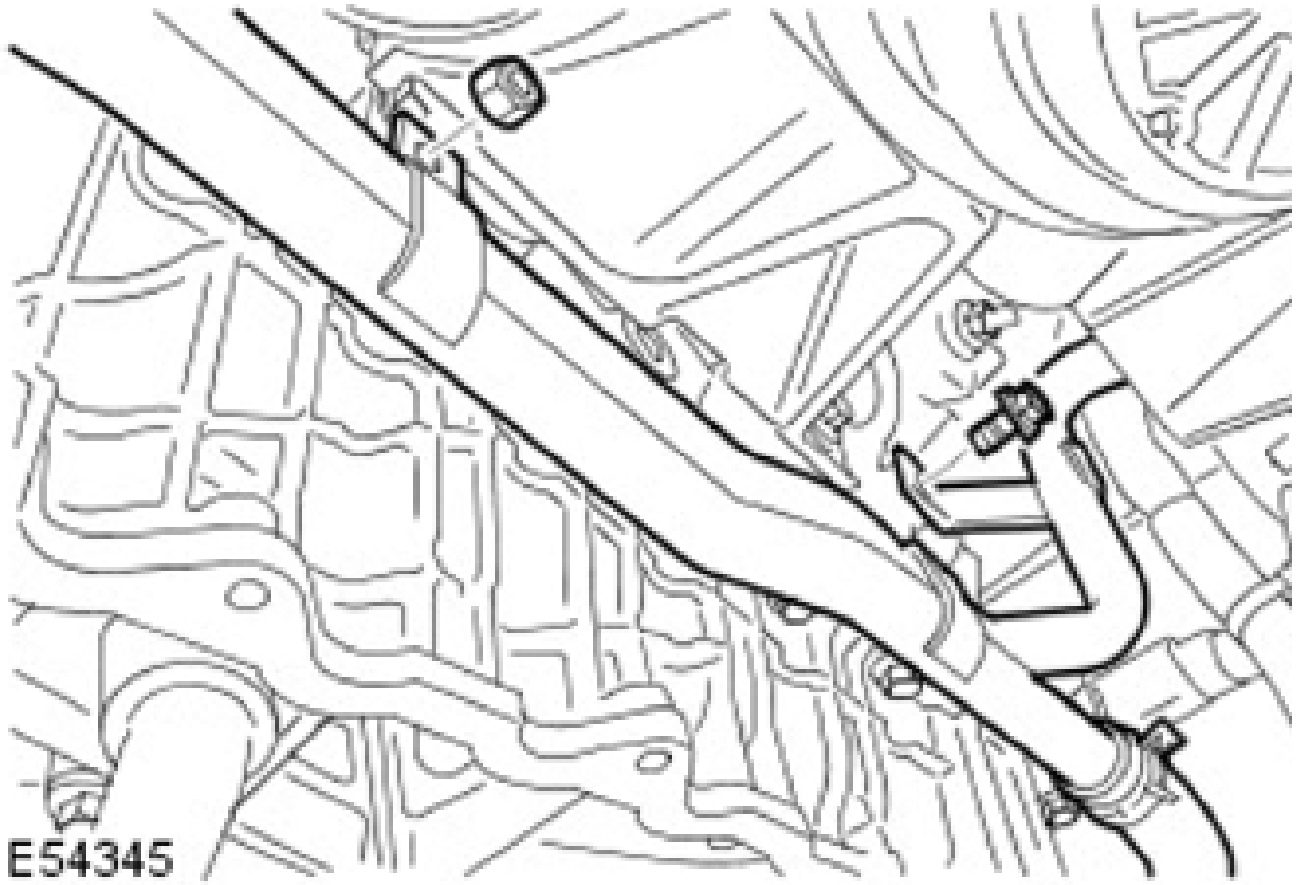

CAUTION: Before disconnecting or removing the components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

10. Remove the oil temperature sensor.
    - Disconnect the electrical connector.
    - Remove and discard the O-ring seal.

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11. Remove the oil strainer pick-up assembly.
    - Remove the bolt.

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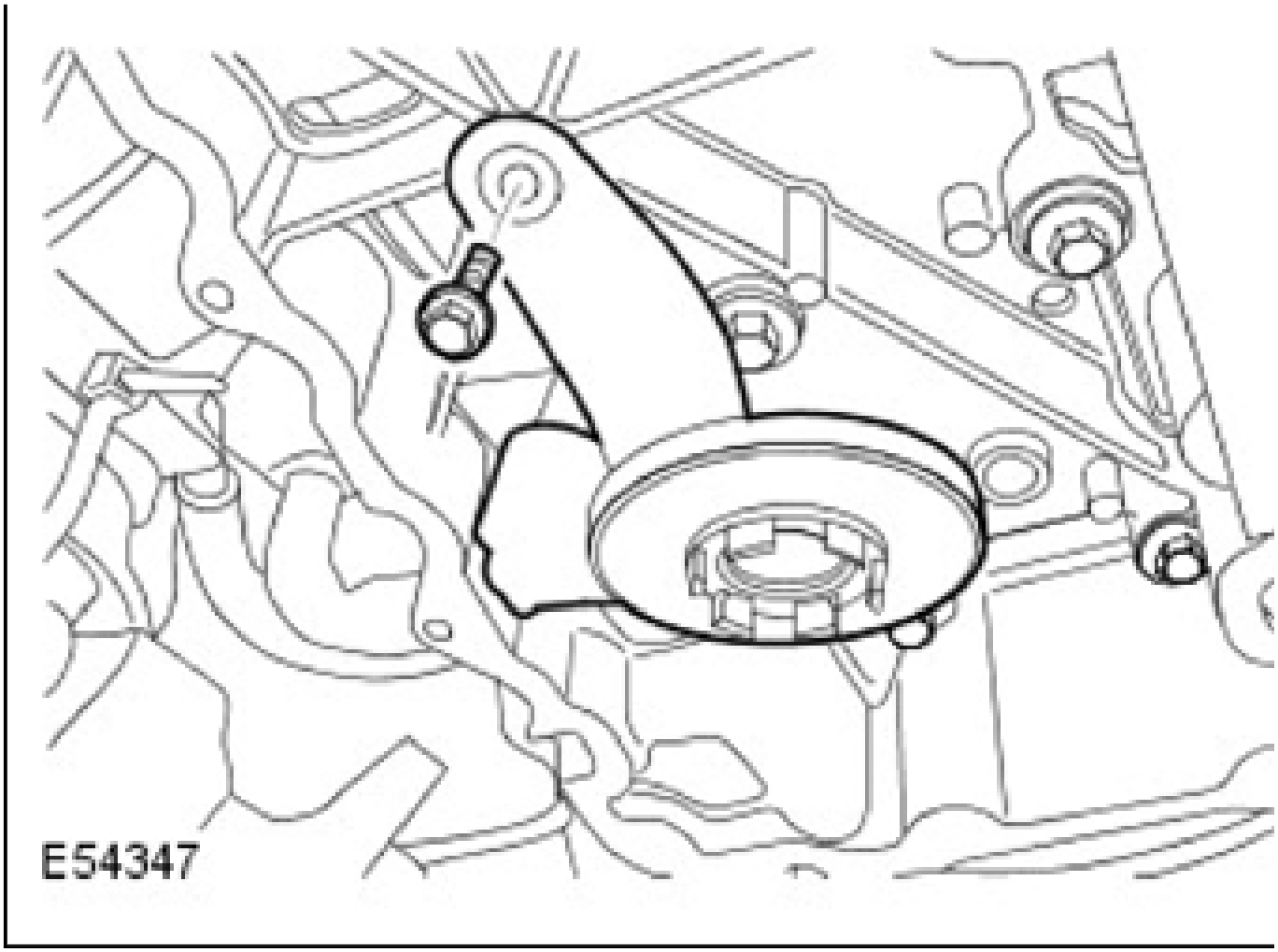

12. Remove the dipstick.
13. Using suitable ties, secure the transmission fluid lines and the wiring harness clear of the cylinder block cradle flange.

NOTE: Note the fitted position of the 2 sealing washers.

14. Remove the 8 cylinder block cradle bolts.
    - Remove and discard the 2 sealing washers.

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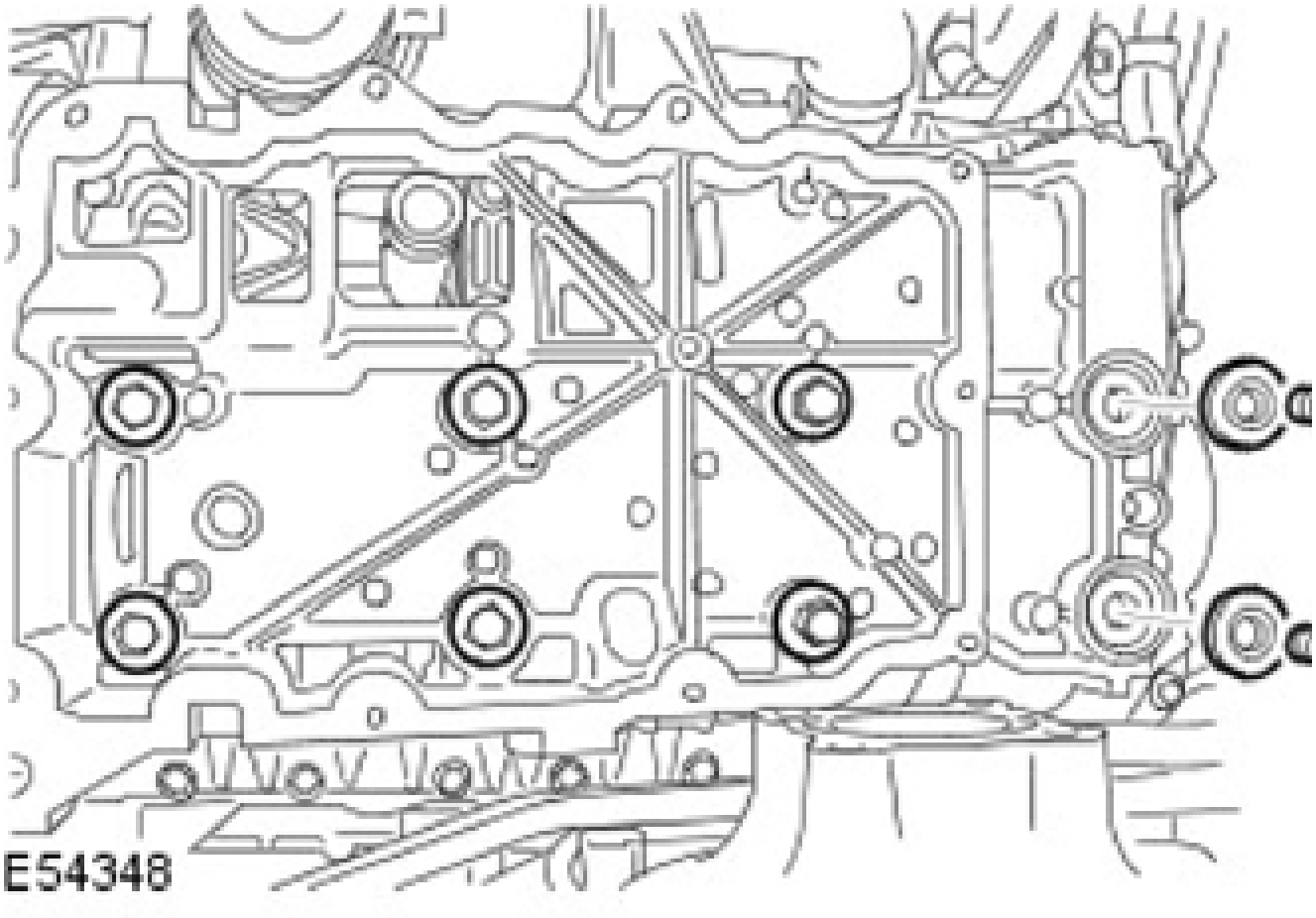

CAUTION: Failure to loosen the set screws may result in damage to the cylinder block cradle.

15. Using the special tool, loosen the 8 cylinder block cradle set screws.

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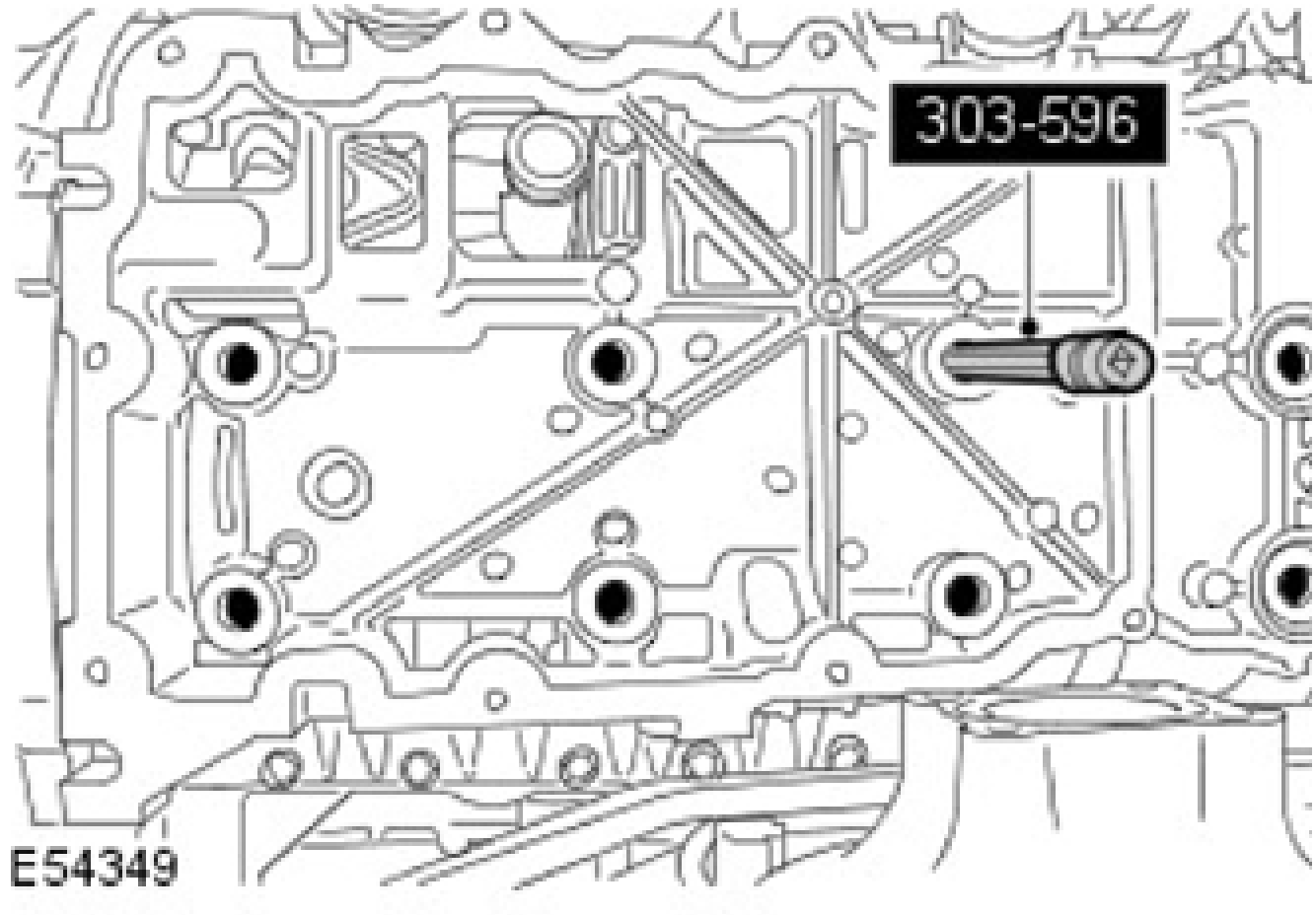

16. Remove the cylinder block cradle.
    - Remove the 2 rear bolts.
    - Remove the 2 Torx screws.
    - Remove the 2 nuts.
    - Remove the 20 bolts.
    - Remove and discard the gasket.

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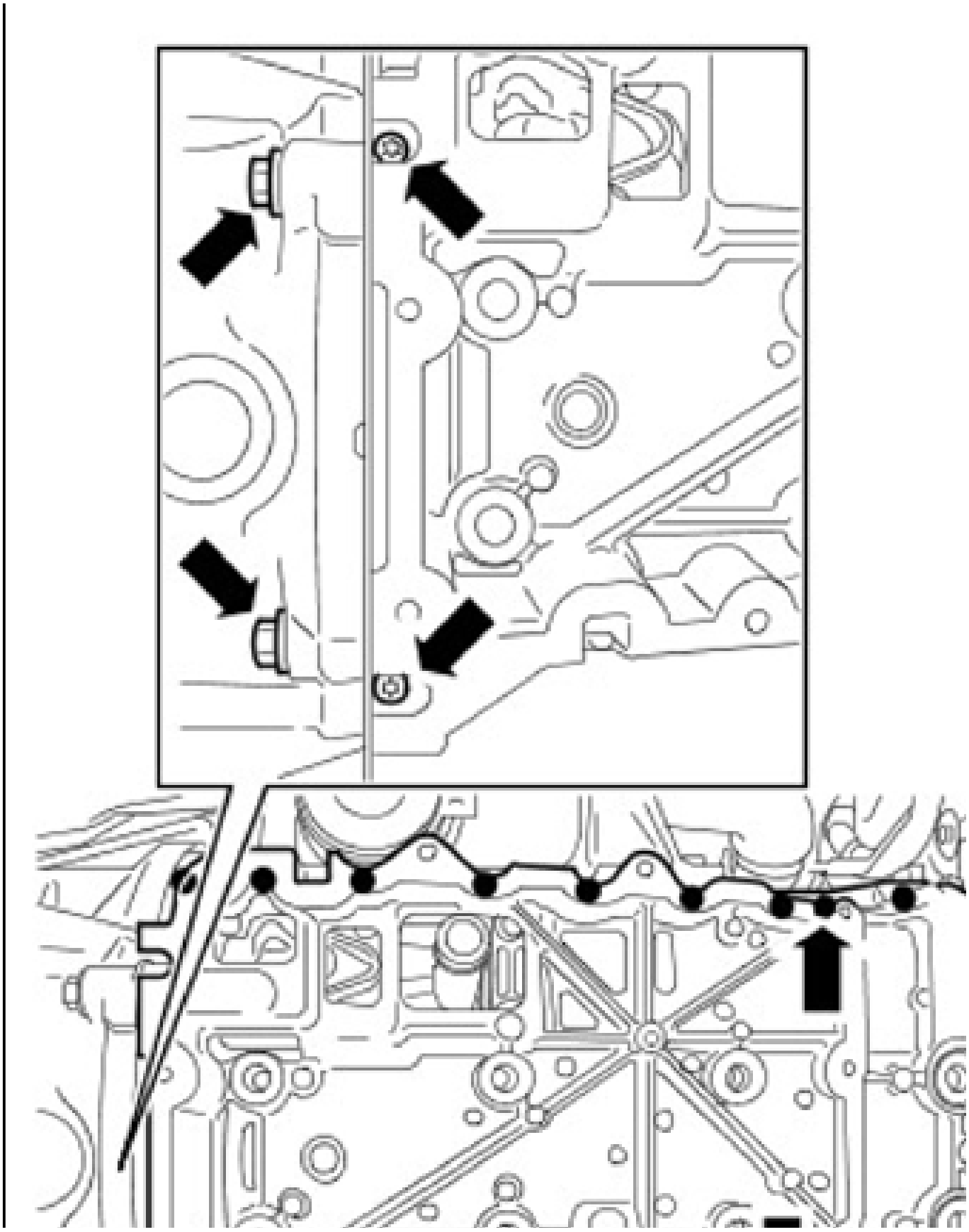

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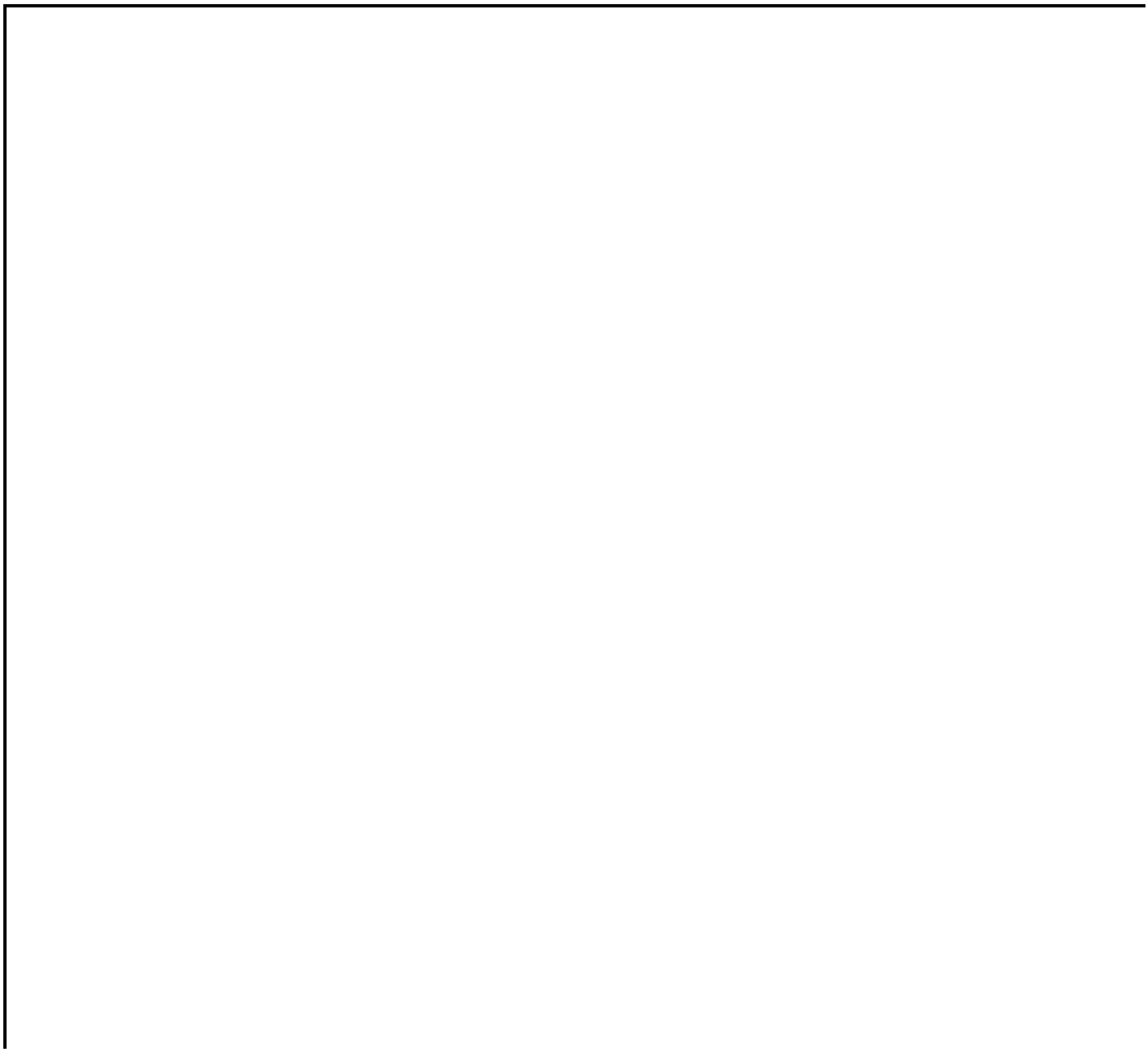
INSTALLATION

1. Clean the cylinder block cradle.
    - Clean the component mating faces.
    - Remove the sealant from the main bearing cap cavities.

CAUTION: Failure to loosen the set screws may result in damage to the cylinder block cradle.

2. Position the cylinder block cradle set screws.
    - Using the special tool, adjust the set screws until they are below the cylinder block cradle boss face.



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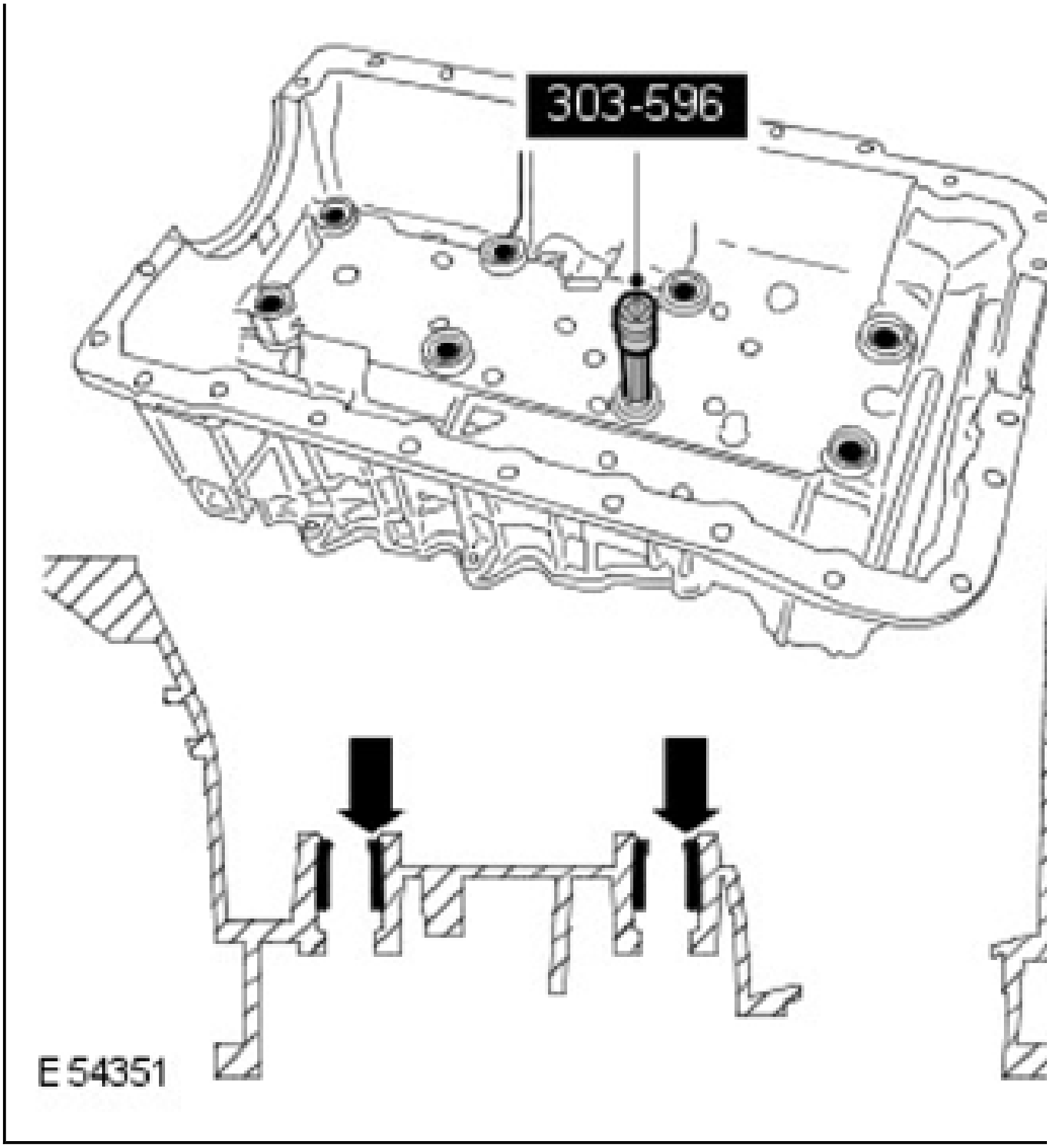

NOTE: The cradle must be installed within 20 minutes of the sealant application.

3. Apply sealant to the cylinder block cradle.
    - Apply sealant to the 6 places shown.

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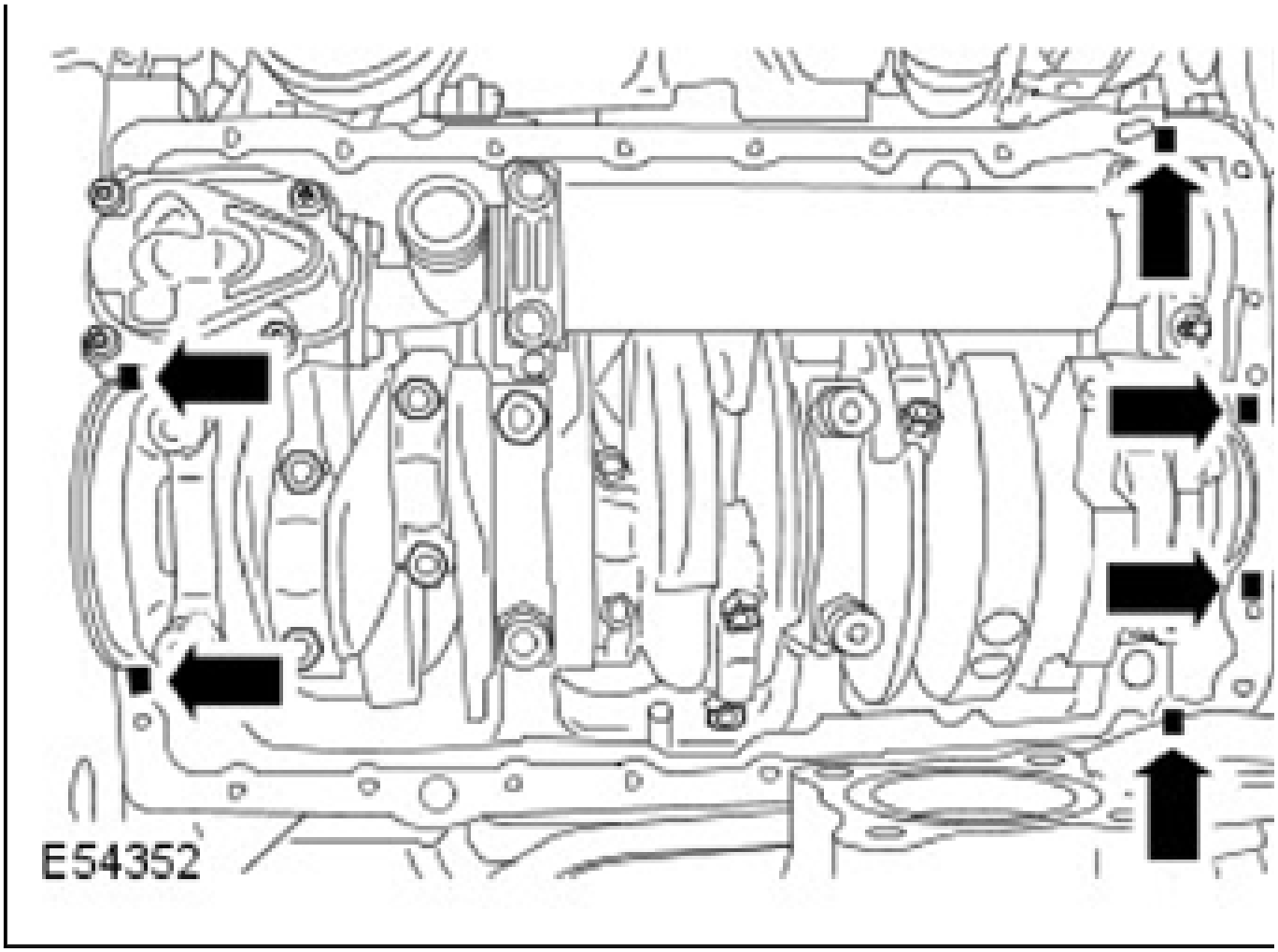

CAUTION: Make sure the gasket is installed correctly.

4. Install the cylinder block cradle.
    - Install a new gasket.
    - Install, then evenly and progressively lightly tighten the outer bolts, nuts and Torx screws.
5. Align the cylinder block cradle to the cylinder block rear face.
    - Install and tighten the 2 rear bolts.
    - Loosen the 2 rear bolts.
    - Lightly tighten the 2 rear bolts.
6. Evenly and progressively, tighten the outer bolts, nuts and Torx screws to 10 Nm (7 lb.ft).
7. Tighten the 2 rear bolts to 43 Nm (32 lb.ft).
8. Using the special tool, tighten the 8 cylinder block cradle set screws.
    - Tighten the set screws in the sequence shown to 7 Nm (5 lb.ft).

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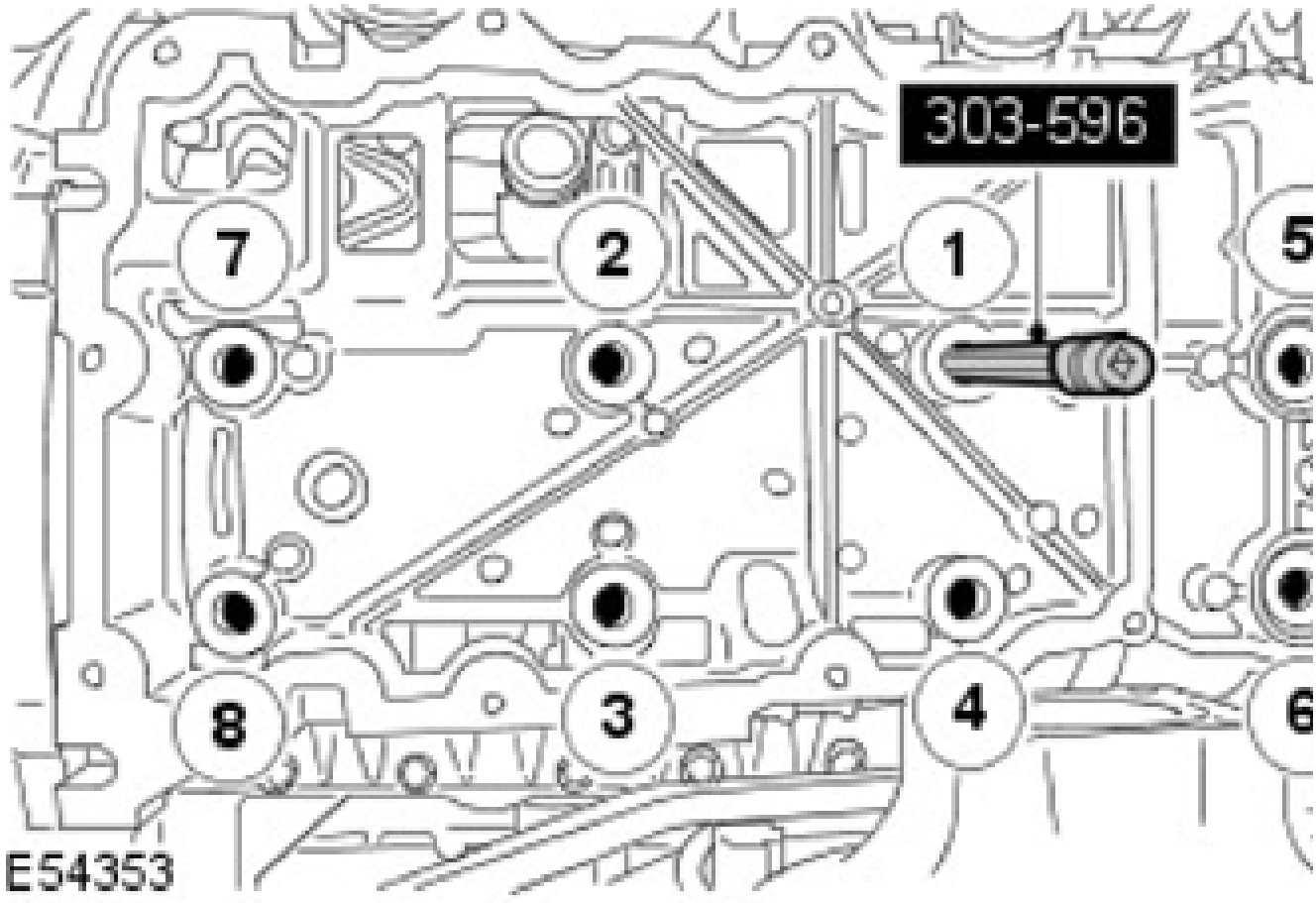

NOTE: The sealing washers are fitted to the silver coloured bolts. The silver coloured bolts are fitted in the 2 forward holes.

9. Install the 8 cylinder block cradle bolts and tighten in 2 stages.
    - Install 2 new sealing washers.
    - Tighten the bolts in sequence to 15 Nm (11 lb.ft).
    - Tighten the bolts in sequence to 34 Nm (25 lb.ft).

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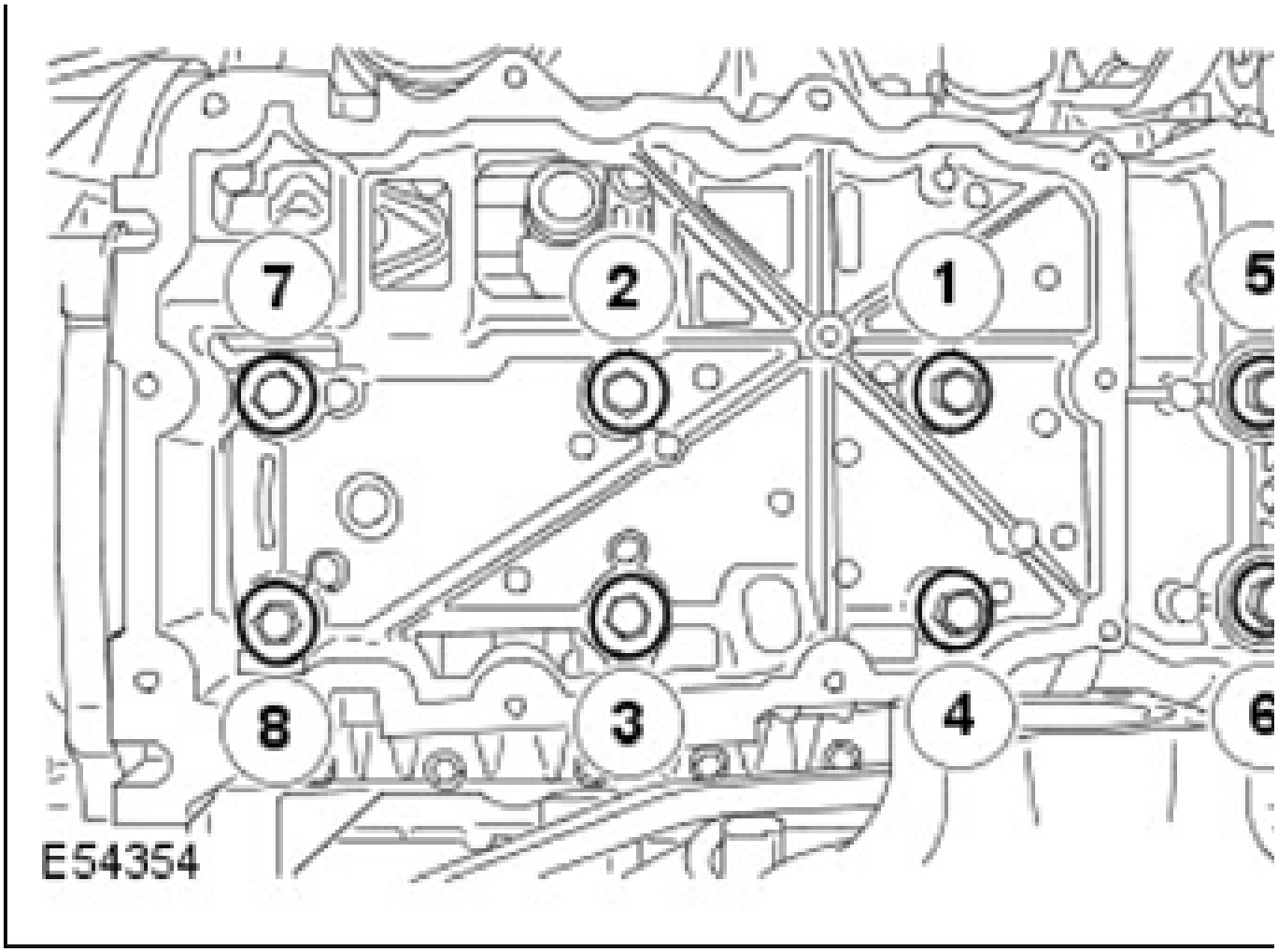

NOTE: Lubricate new seals with clean engine oil.

10. Install the oil strainer pick-up assembly.
    - Clean the components.
    - Tighten the bolt to 10 Nm (7 lb.ft).
11. Install the oil pan.

    For additional information, refer to: **OIL PAN** .

12. Install the dipstick.
    - Clean the component.

NOTE: Lubricate new seals with clean engine oil.

13. Install the oil temperature sensor.
    - Clean the component mating faces.

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- Install a new O-ring seal.
- Tighten the oil temperature sensor to 20 Nm (15 lb.ft).
- Connect the electrical connector.

14. Position the engine oil cooler lines.
    - Tighten the bolt and the nut to 25 Nm (18 lb.ft).
15. Install the radiator access panel.
    - Tighten the 4 bolts to 10 Nm (7 lb.ft).
16. Install the front stabilizer bar.
17. Install the front axle tube.

    For additional information, refer to: **AXLE TUBE** .

18. Install the starter motor.
    - Clean the component mating faces.
    - Connect the electrical connectors.
    - Tighten the nut to 10 Nm (7 lb.ft).
    - Install the terminal lower cover.
    - Install the terminal upper cover.
    - Tighten the bolts to 45 Nm (33 lb.ft).
19. Install the RH front wheel and tire.
20. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

CYLINDER HEAD LH

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Drain the coolant.

   For additional information, refer to: **AIR SUSPENSION AIR FILTER** .

3. Refer to camshaft timing. For additional information, refer to: **CAMSHAFT TIMING** .
4. Remove the exhaust manifold.

   For additional information, refer to: **EXHAUST MANIFOLD LH** .

5. Release the harness bridge for access.
   - Remove the bolt.

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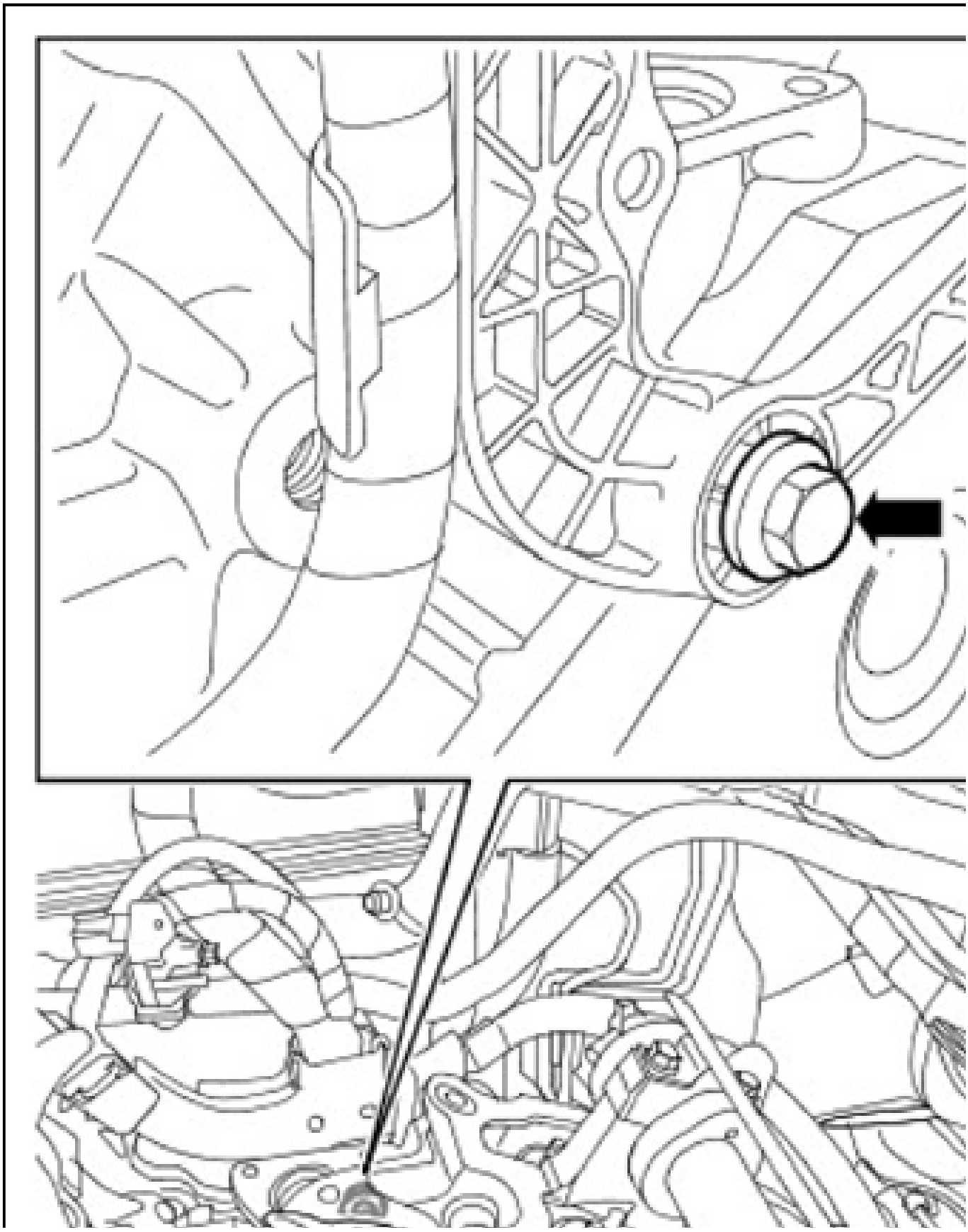

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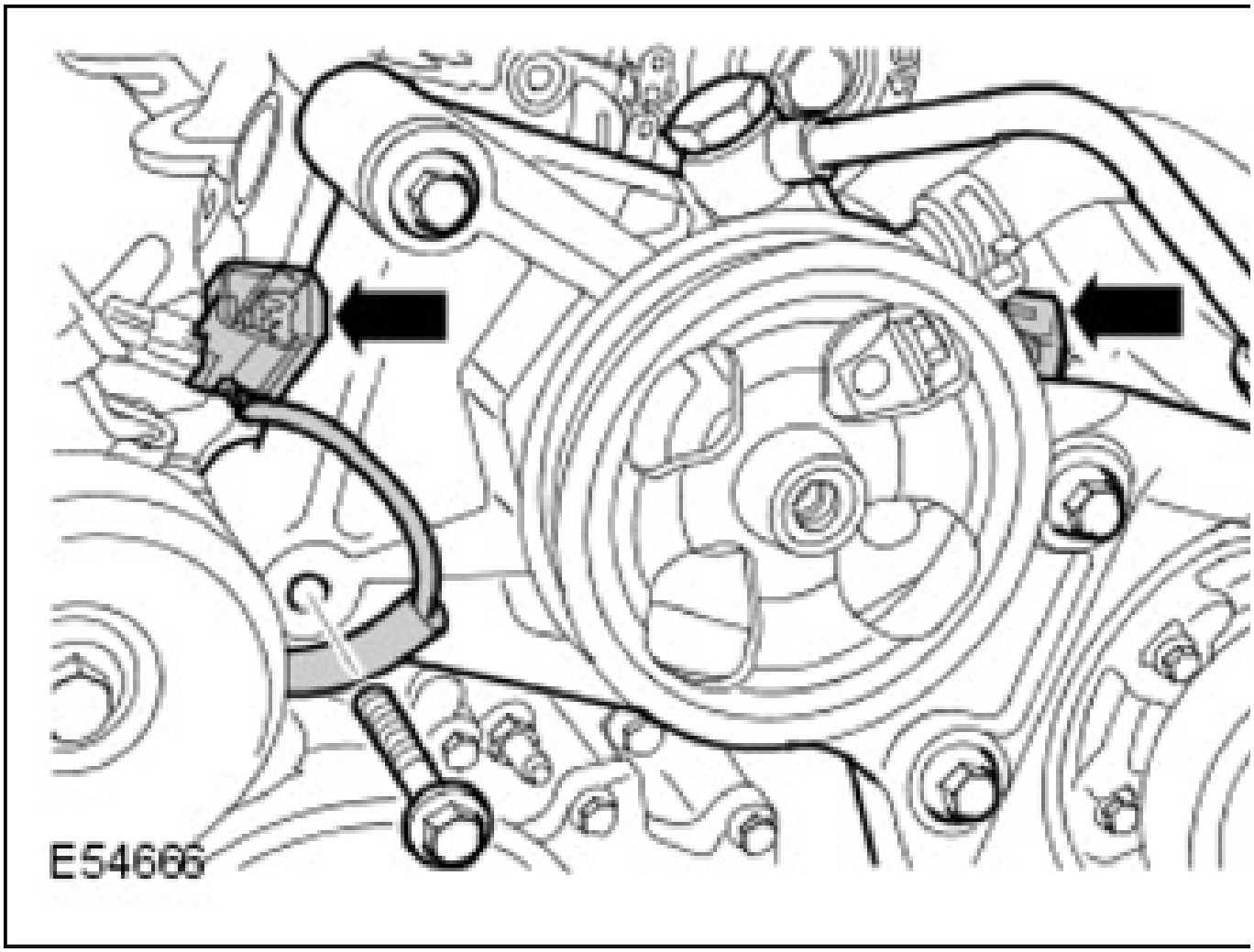
6. Position the A/C compressor mounting bracket assembly aside.
    - Remove the 4 bolts.
    - Release the knock sensor electrical connector retaining clips.
    - Tie the bracket aside.



7. Remove the LH hydraulic timing chain tensioner.
    - Clean the component mating faces.

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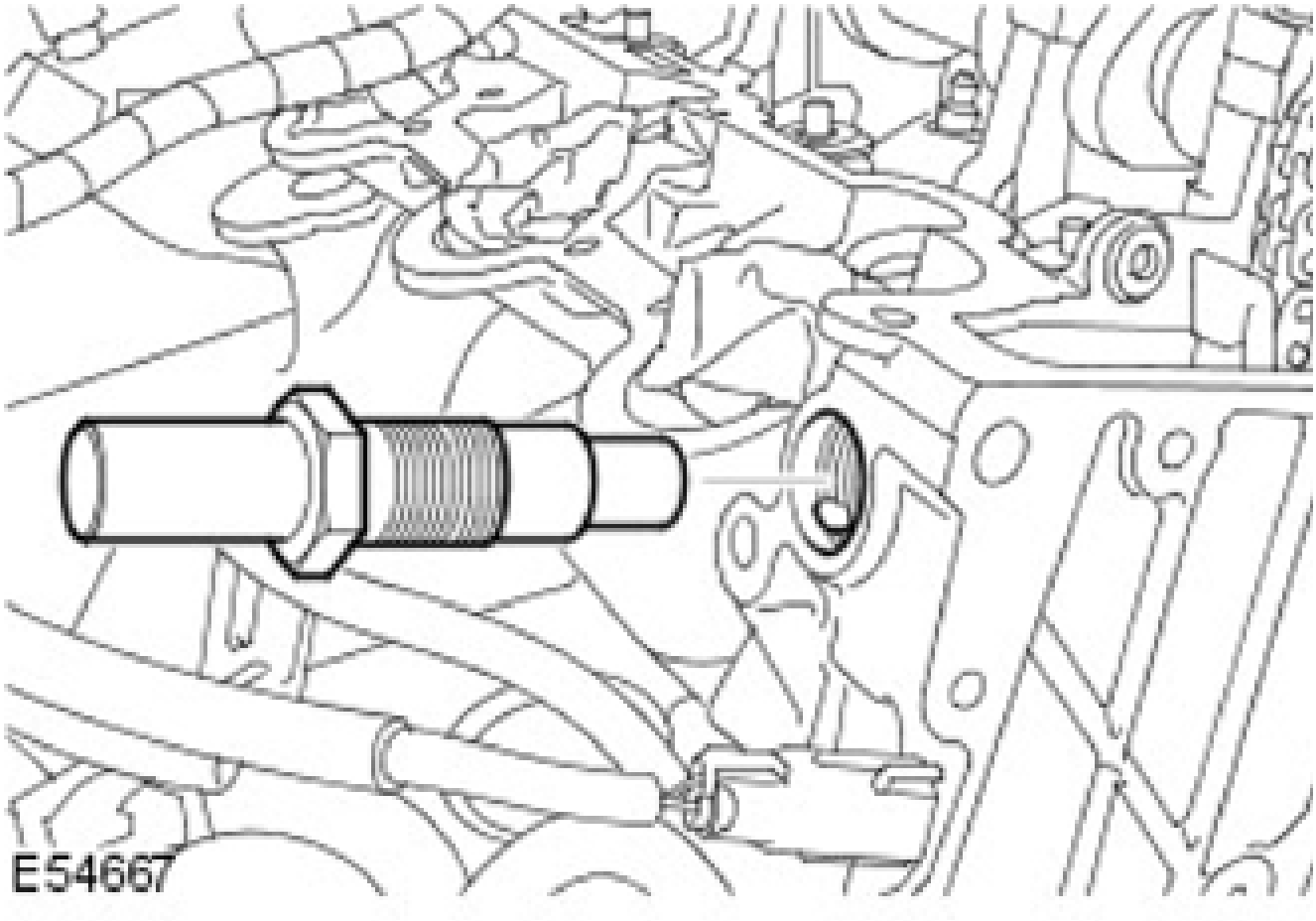

8. Remove the Torx bolt retaining the chain guide.
    - Remove and discard the O-ring seal.
9. Remove the camshaft sprocket bolt.
    - Remove the camshaft sprocket.
    - Secure the chain to the guide with a cable tie.

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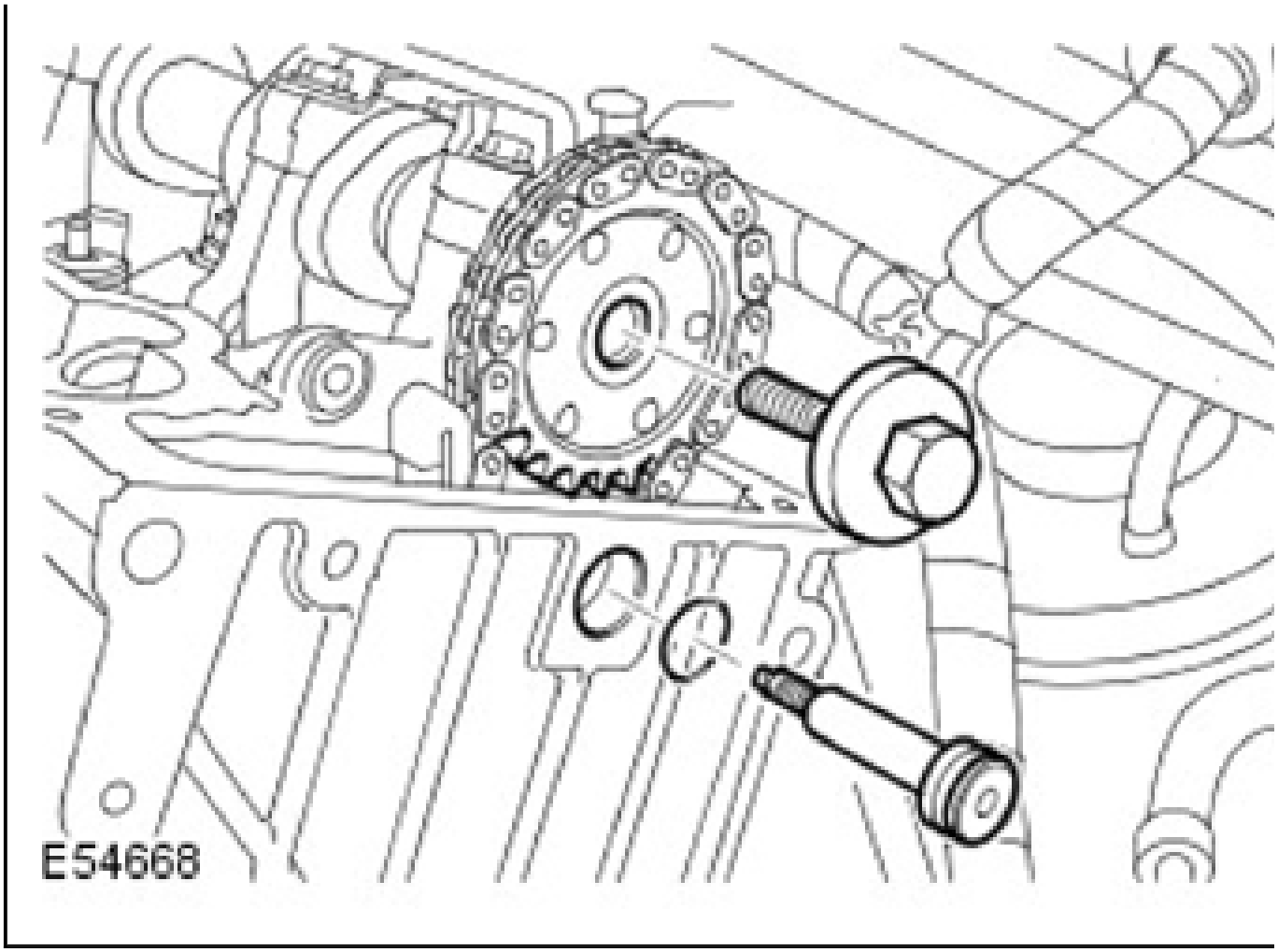

CAUTION: Working in a diagonal sequence, progressively loosen the bolts.

10. Remove the 10 cylinder head bolts.
    - Discard the bolts.

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11. Remove the cylinder head LH assembly.
    - Release the KS electrical harness clip.
    - Remove the bolt.

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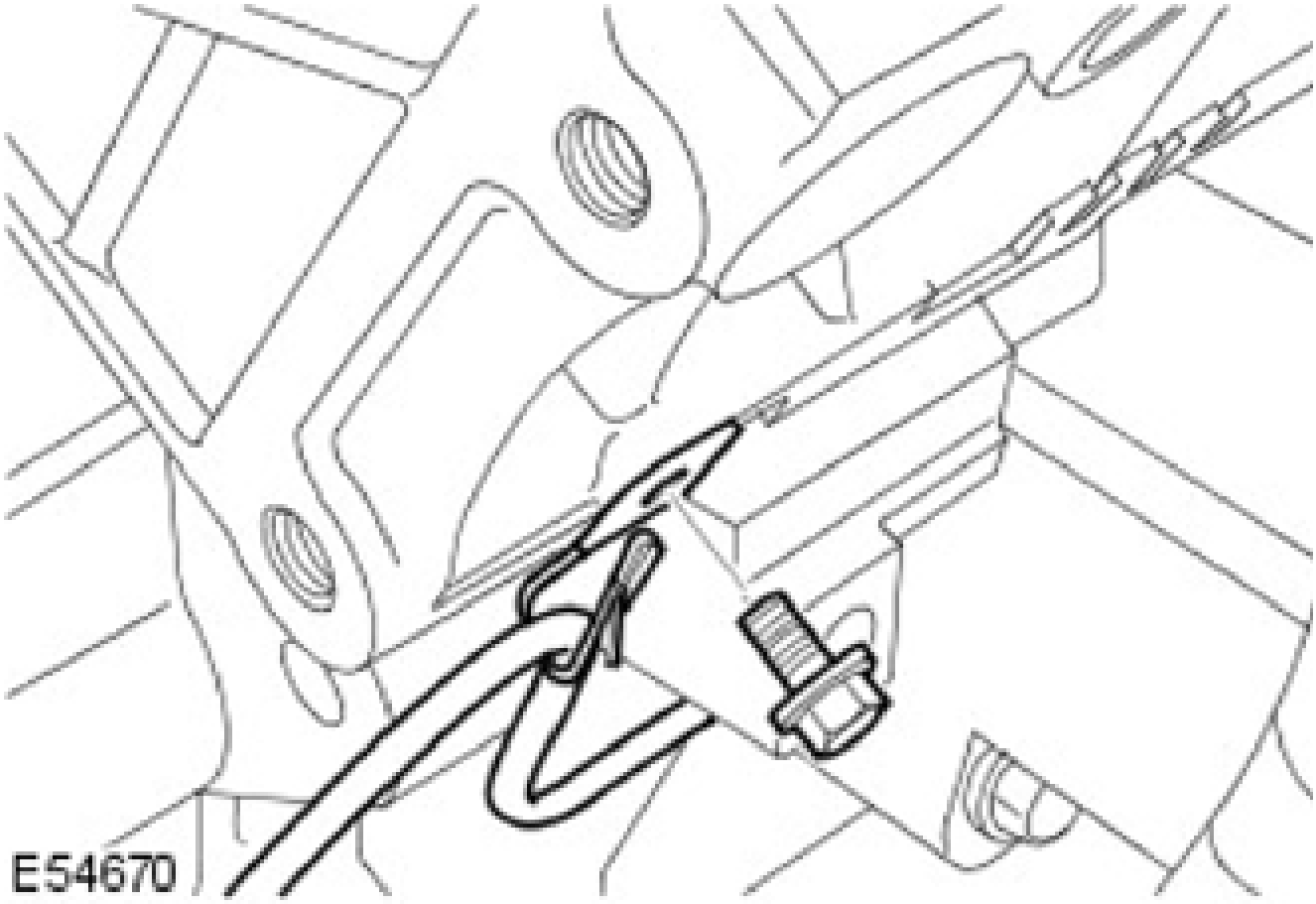

12. Remove and discard the cylinder head gasket.
    - Clean the cylinder head locating dowels.
    - Clean and inspect the cylinder head and cylinder block.

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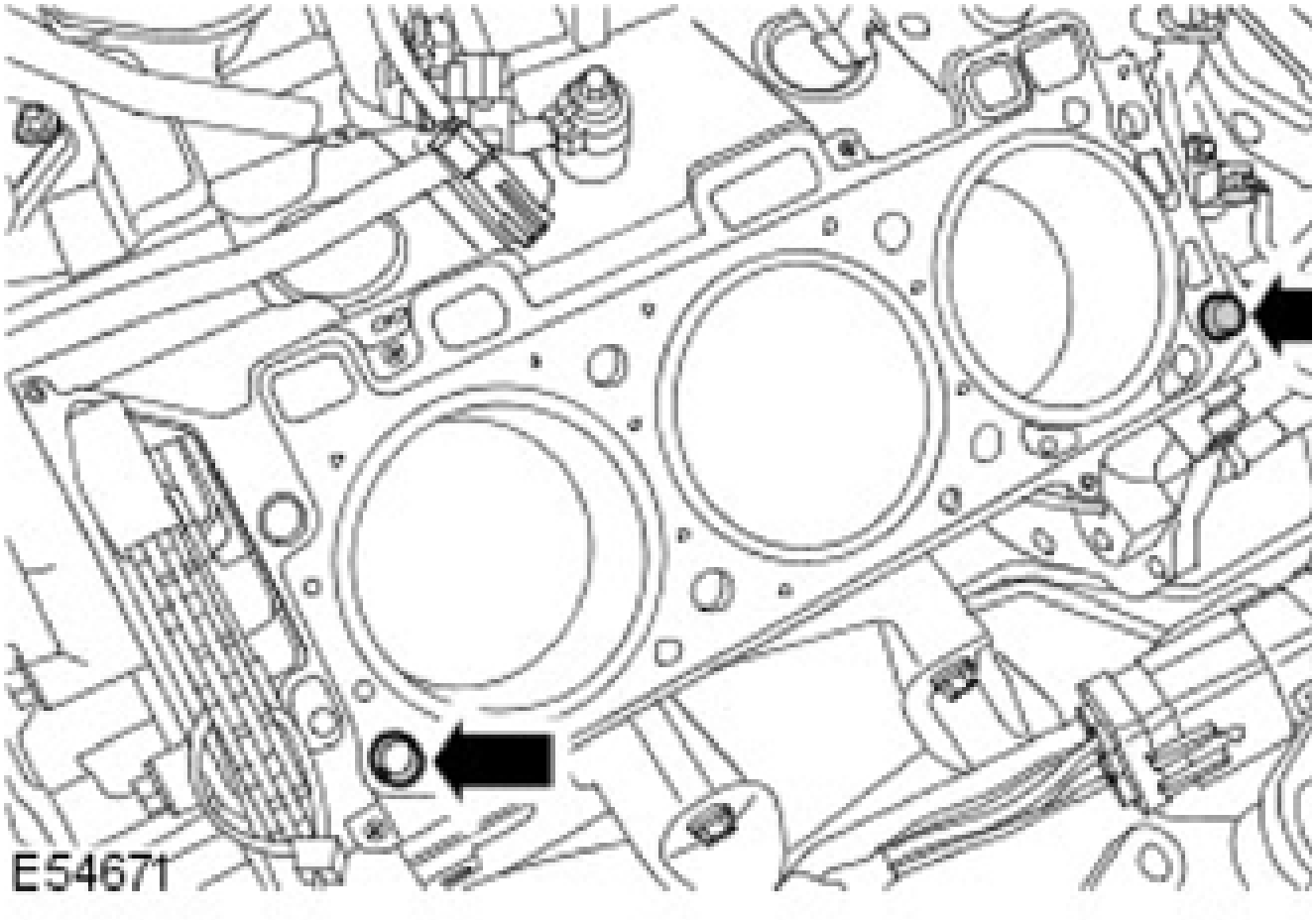

NOTE: Remove the camshaft bearing caps evenly and in stages.
Note the fitted position.
Do not disassemble further if the component is removed for access only.

13. Remove the camshaft bearing caps.
    - Remove the 8 bolts.
    - Collect the camshaft oil supply line.
14. Remove the camshaft.

INSTALLATION

1. Install the camshaft.
    - Clean the component mating faces.
    - Lubricate the components with clean engine oil.

NOTE: Note the fitted position.

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2. Install the camshaft bearing caps.
    - Clean the component mating faces.
    - Lubricate the components with clean engine oil.

NOTE: After installing the bolts check the camshaft is free to rotate.

3. Install the camshaft oil supply line.
    - Thoroughly clean and inspect the oil supply line.
    - Prime the oil supply line with clean engine oil.
    - Tighten the bolts evenly in 2 stages to the sequence shown.
    - Tighten the bolts to 6 Nm (4 lb.ft).
    - Tighten the bolts to 16 Nm (12 lb.ft).
4. Clean the component mating faces.
5. Check cylinder head face for distortion, across the center and from corner to corner.

For additional information, refer to: **SPECIFICATIONS** .

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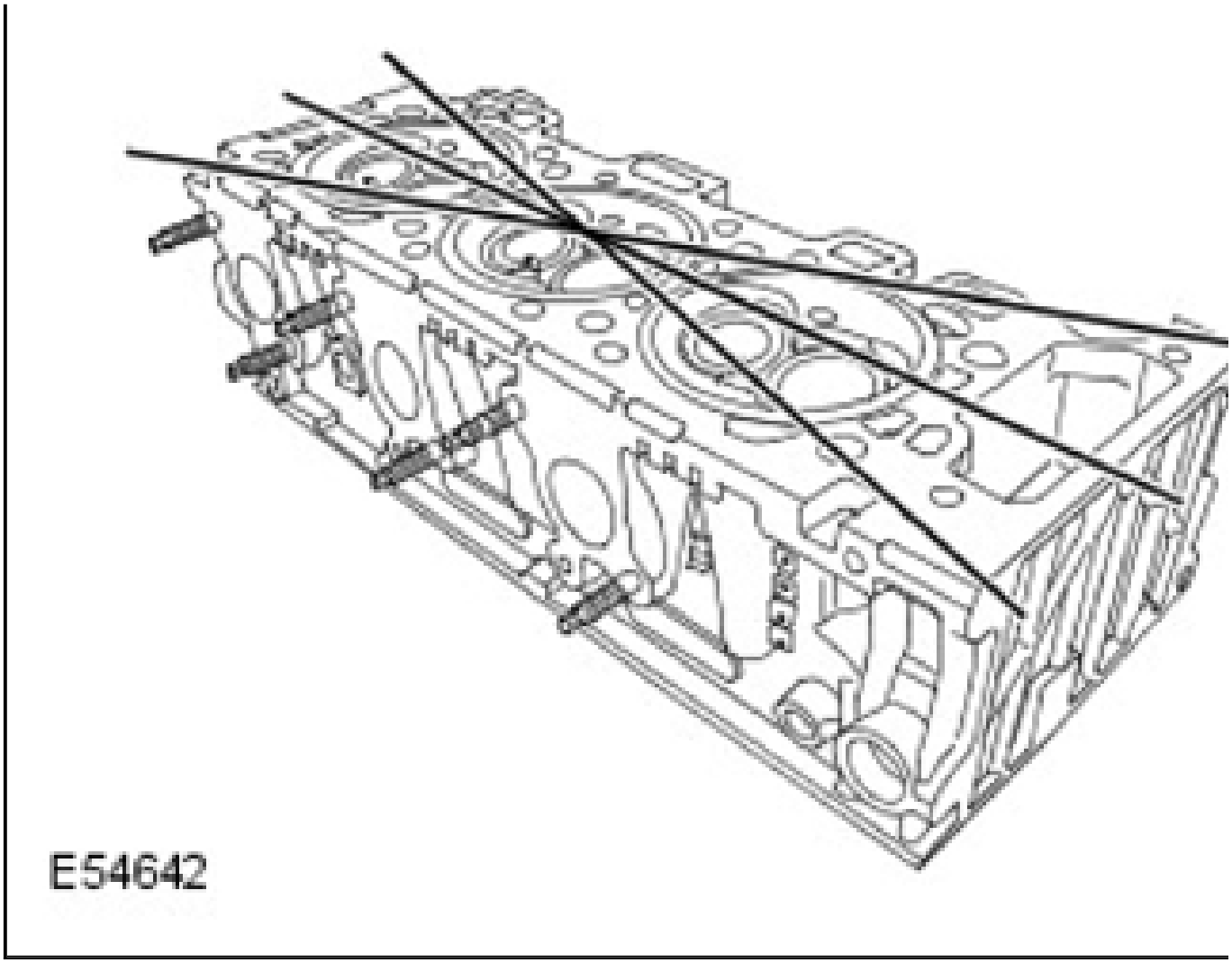

CAUTION: The head gasket must be installed over the cylinder block dowels.

6. Install a new cylinder head gasket.
7. Install the cylinder head LH assembly.
    - Install the knock sensor bracket.
    - Tighten the bolt to 10 Nm (7 lb.ft).

NOTE: Install the cylinder head bolts.
Tighten the bolts 1 to 8 in the sequence shown. The M12 bolts are tightened in 3 stages.

8.
    - Lubricate the new cylinder head bolt threads with clean engine oil.
    - Tighten the M12 bolts to 30 Nm (22 lb.ft), then a further 80 degrees.

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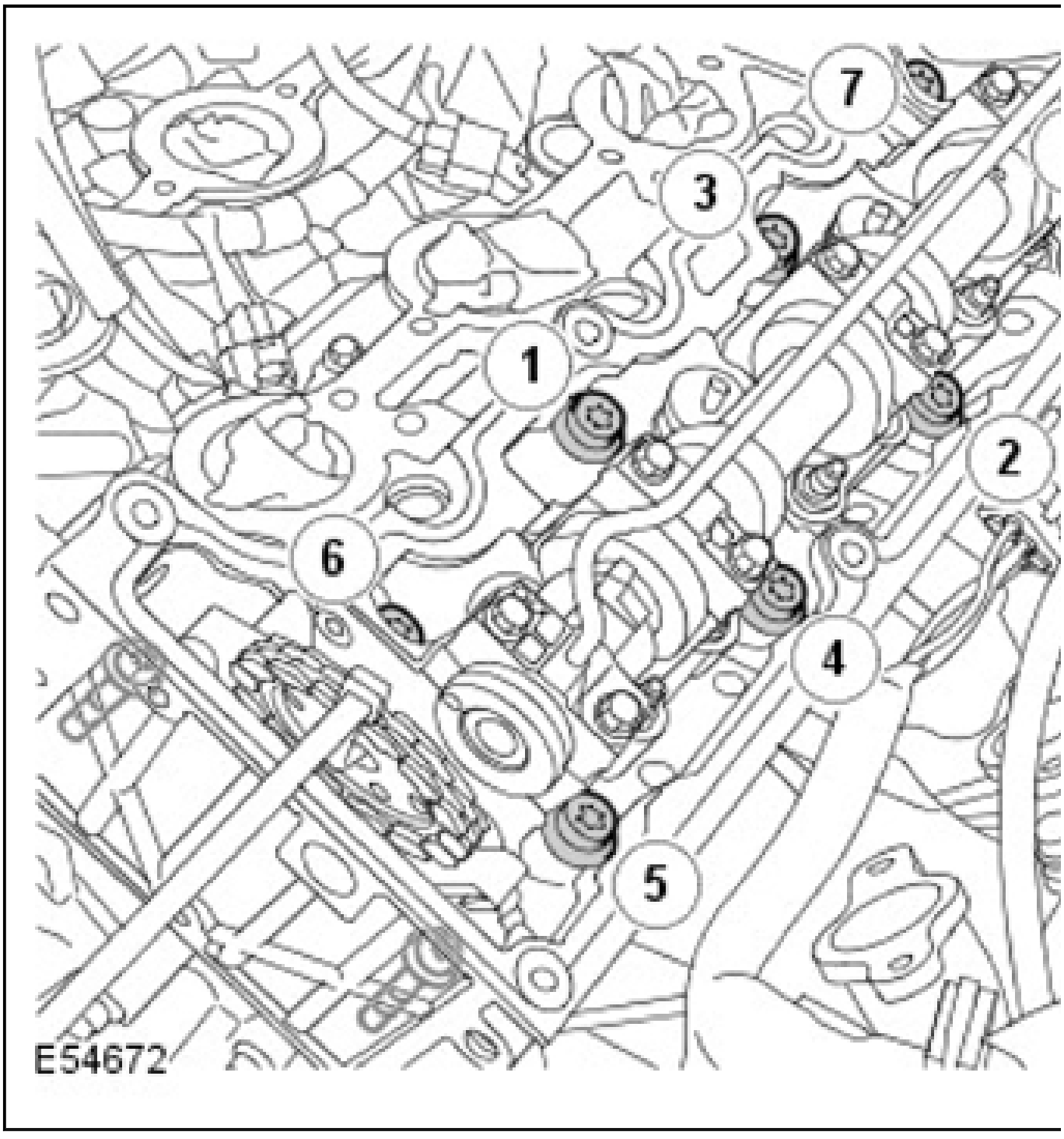
- Tighten the M12 bolts a further 80 degrees.
- Tighten the M8 bolts to 35 Nm (26 lb.ft).



9. Install the exhaust manifold.

   For additional information, refer to: **EXHAUST MANIFOLD LH** .

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10. Install the Torx bolt retaining the chain guide.
    - Install a new O-ring seal.
    - Tighten the bolt to 10 Nm (7 lb.ft).
    - Clean the component mating faces.
11. Install the A/C compressor mounting bracket assembly.
    - Clean the component mating faces.
    - Tighten the bolts to 45 Nm (33 lb.ft).
    - Secure the wiring harness.
    - Tighten the KS clip retaining bolt to 10 Nm (7 lb.ft).
12. Install the LH hydraulic timing chain tensioner.
13. Adjust the valve timing. For additional information, refer to: **CAMSHAFT TIMING** .
14. Install the electrical harness bridge.
    - Tighten the bolt to 45 Nm (33 lb.ft).
15. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

16. Refill and bleed the cooling system.

    For additional information, refer to: **AIR SUSPENSION AIR FILTER** .

CYLINDER HEAD RH

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Drain the coolant.

   For additional information, refer to: **AIR SUSPENSION AIR FILTER** .

3. Refer to camshaft timing. For additional information, refer to: **CAMSHAFT TIMING** .
4. Remove the exhaust manifold.

   For additional information, refer to: **EXHAUST MANIFOLD RH** .

5. Position the generator mounting bracket aside.
   - Remove the 3 bolts.
   - Release the wiring harness clip.
   - Disconnect the engine coolant temperature (ECT) sensor electrical connector.

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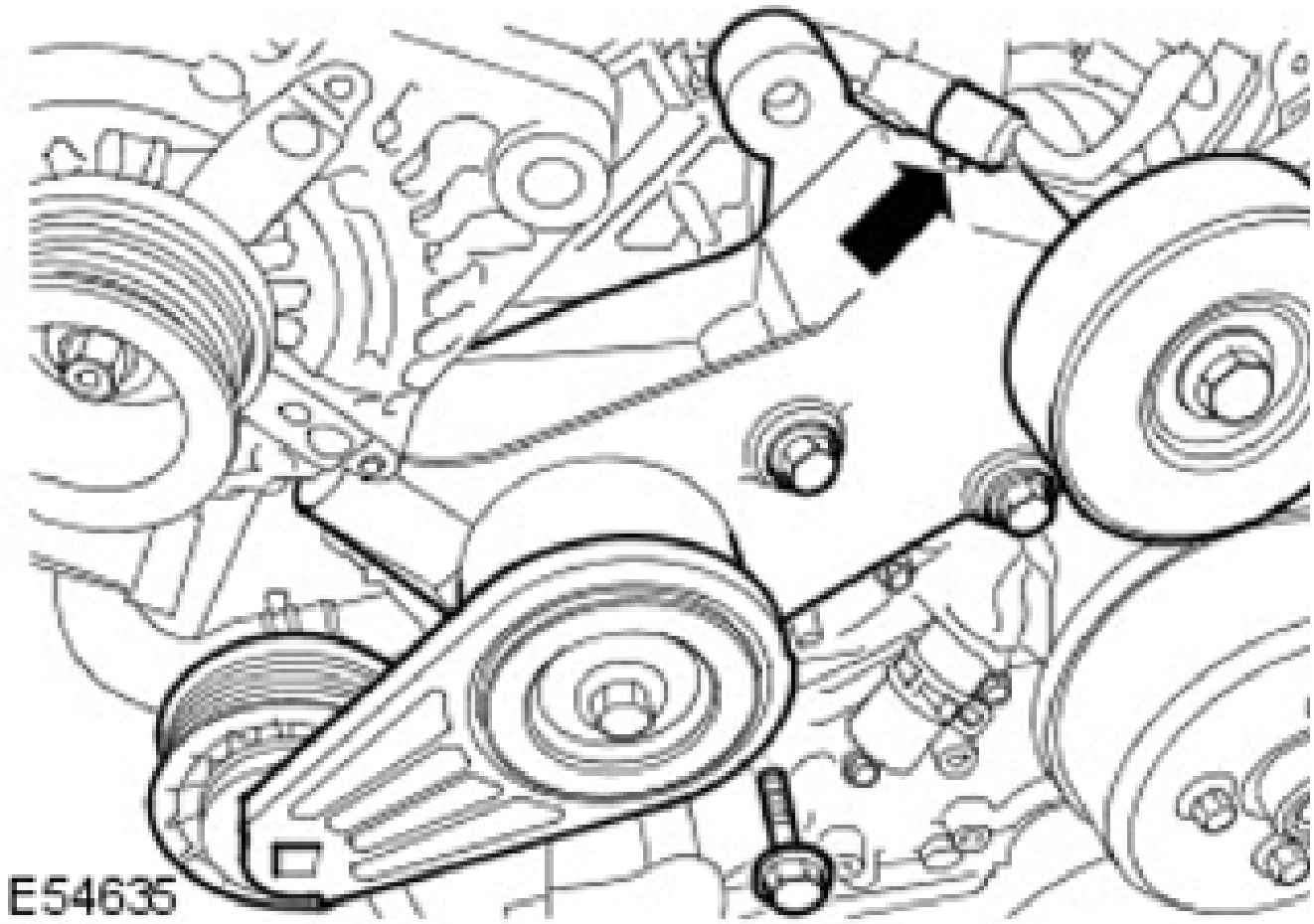

6. Remove the cylinder block coolant outlet elbow.
    - Disconnect the engine coolant temperature (ECT) sensor electrical connector.
    - Release the clip securing the coolant pump hose.
    - Remove the 3 bolts.

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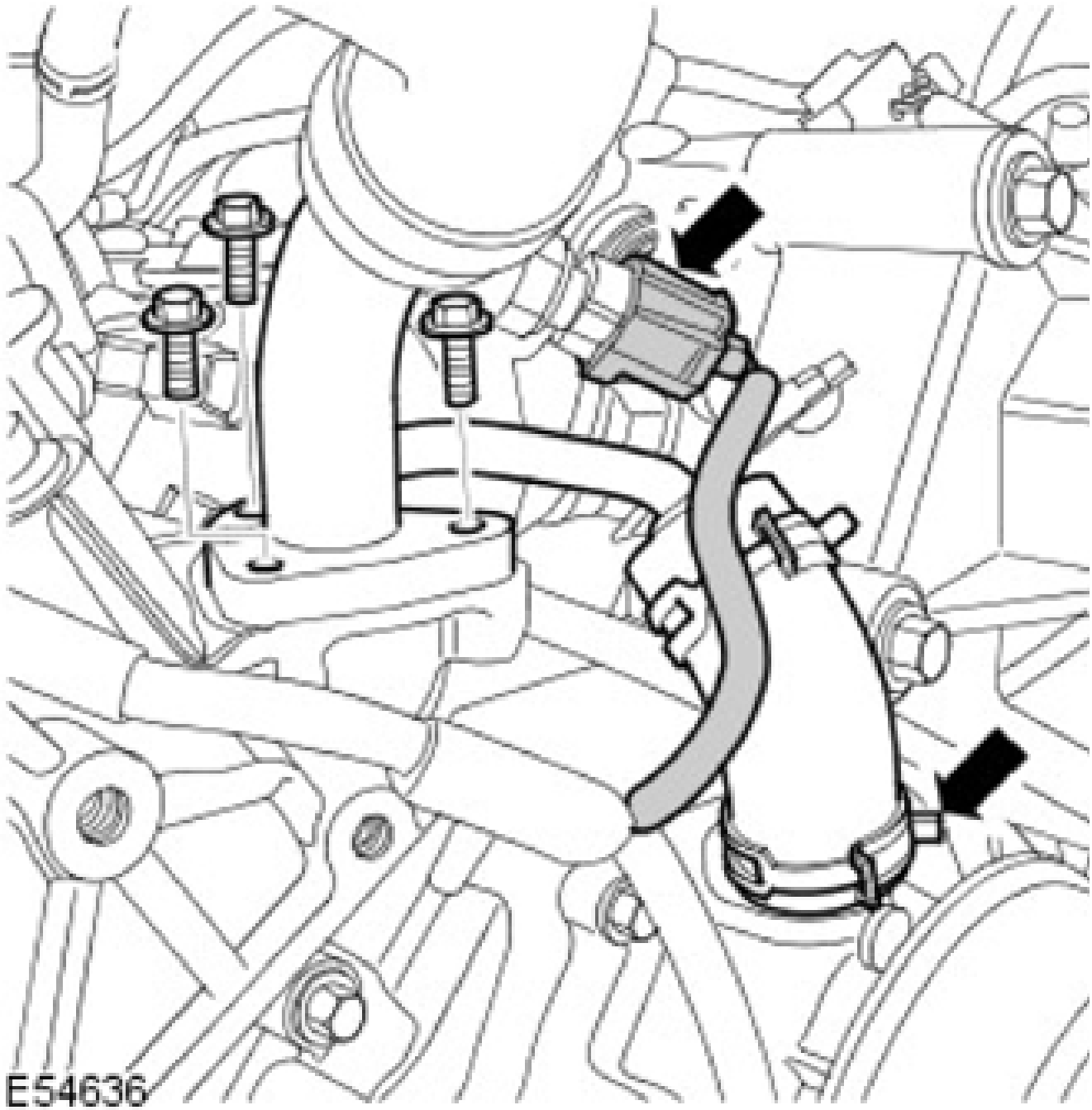

7. Remove the RH hydraulic timing chain tensioner.

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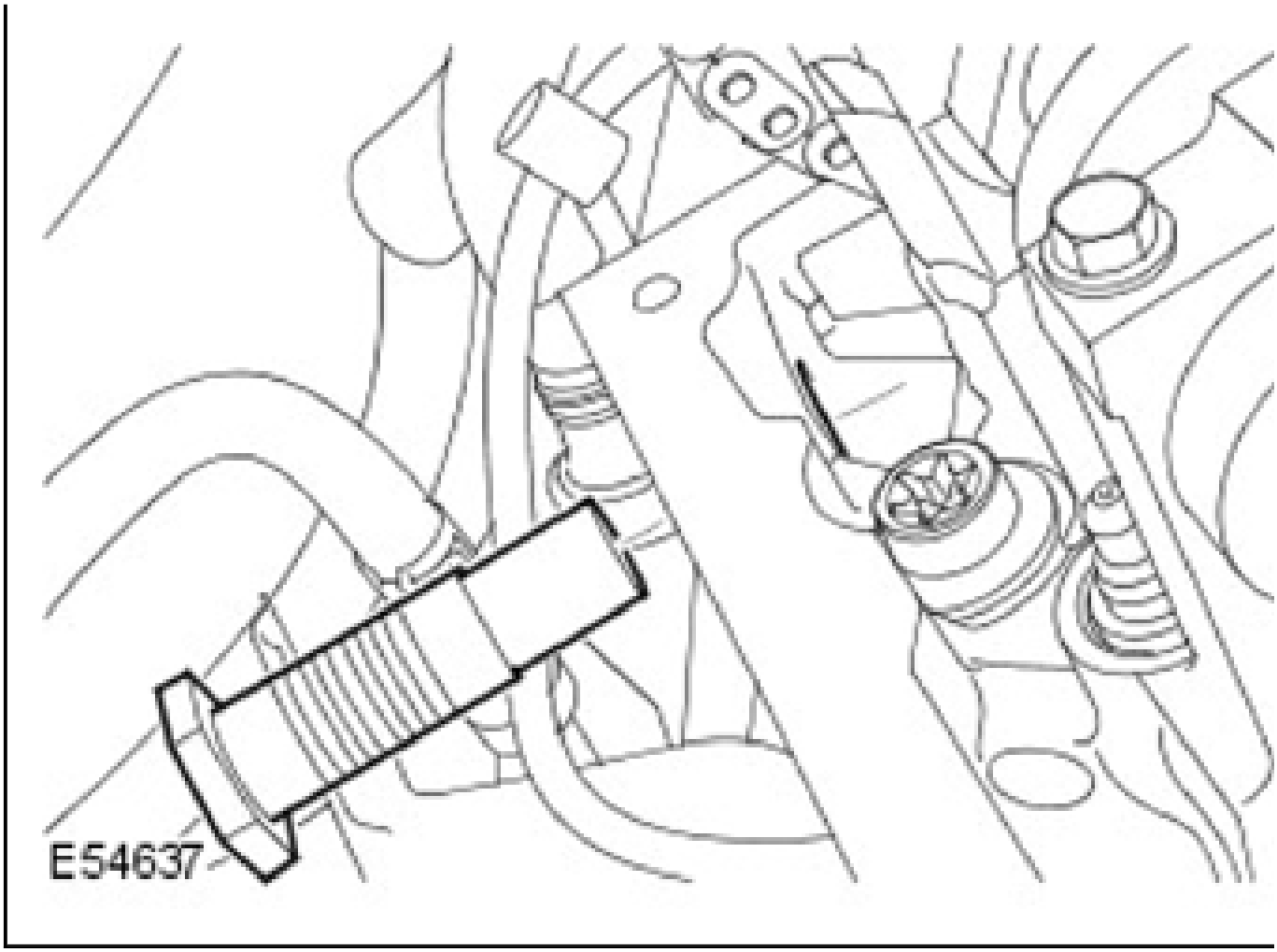

8. Remove the camshaft sprocket bolt.
    - Remove the camshaft sprocket.
    - Secure the chain to the guide with a cable tie.

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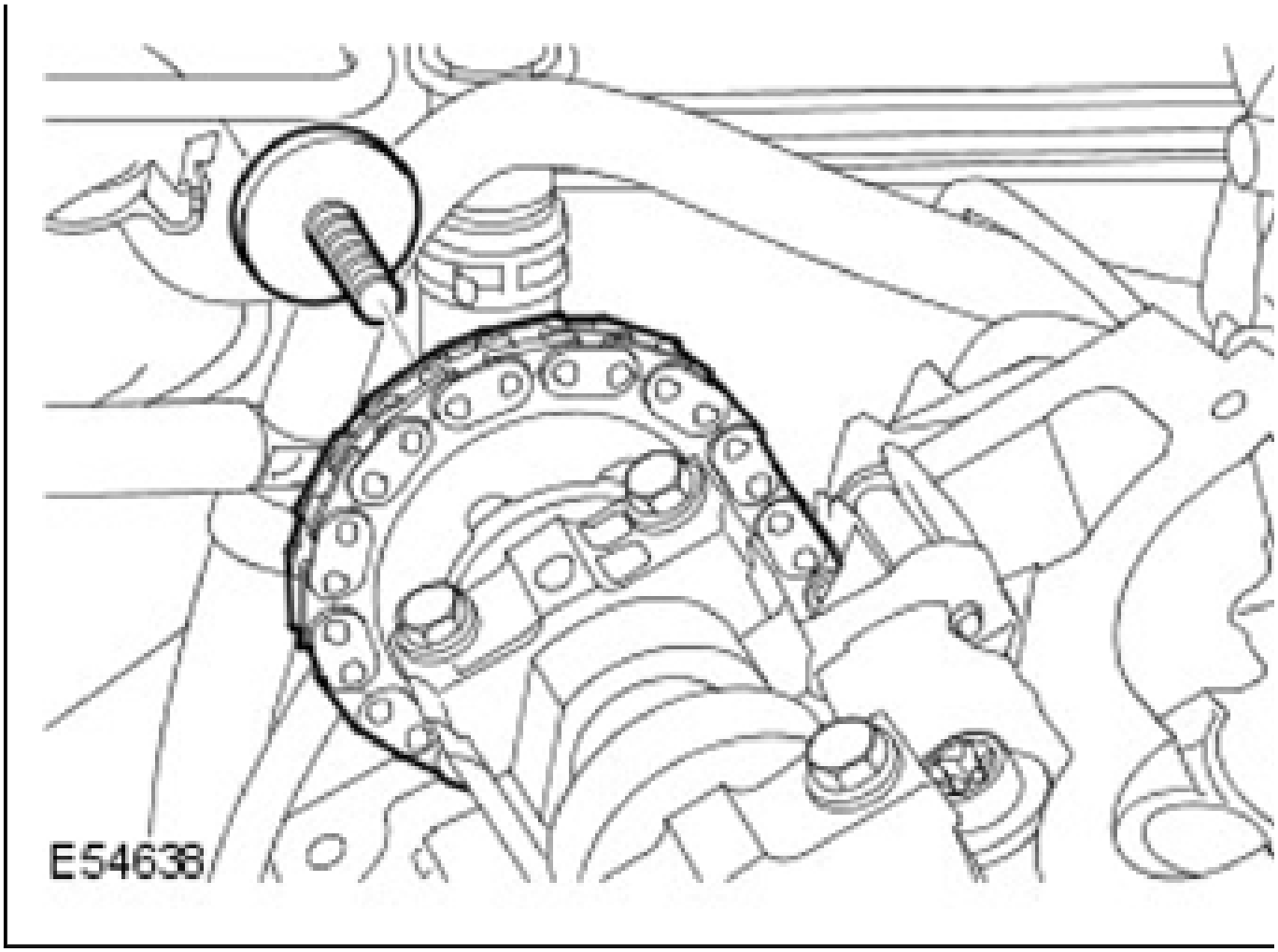

CAUTION: Working in a diagonal sequence, progressively loosen the bolts.

9. Remove the 10 cylinder head bolts.
    - Discard the bolts.

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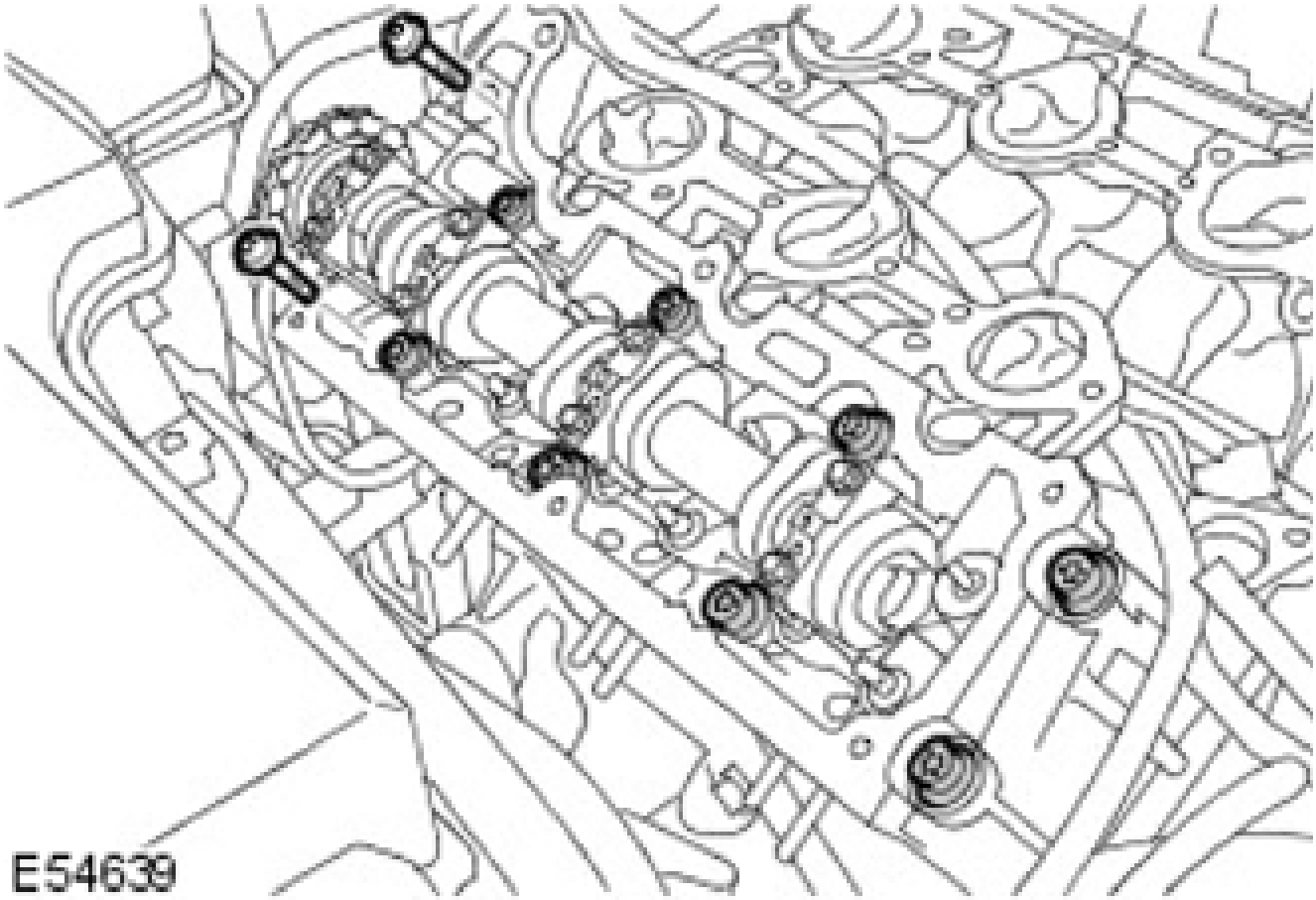

10. Remove the RH cylinder head assembly.
    - Disconnect the cylinder head earth connector.
    - Remove the bolt.

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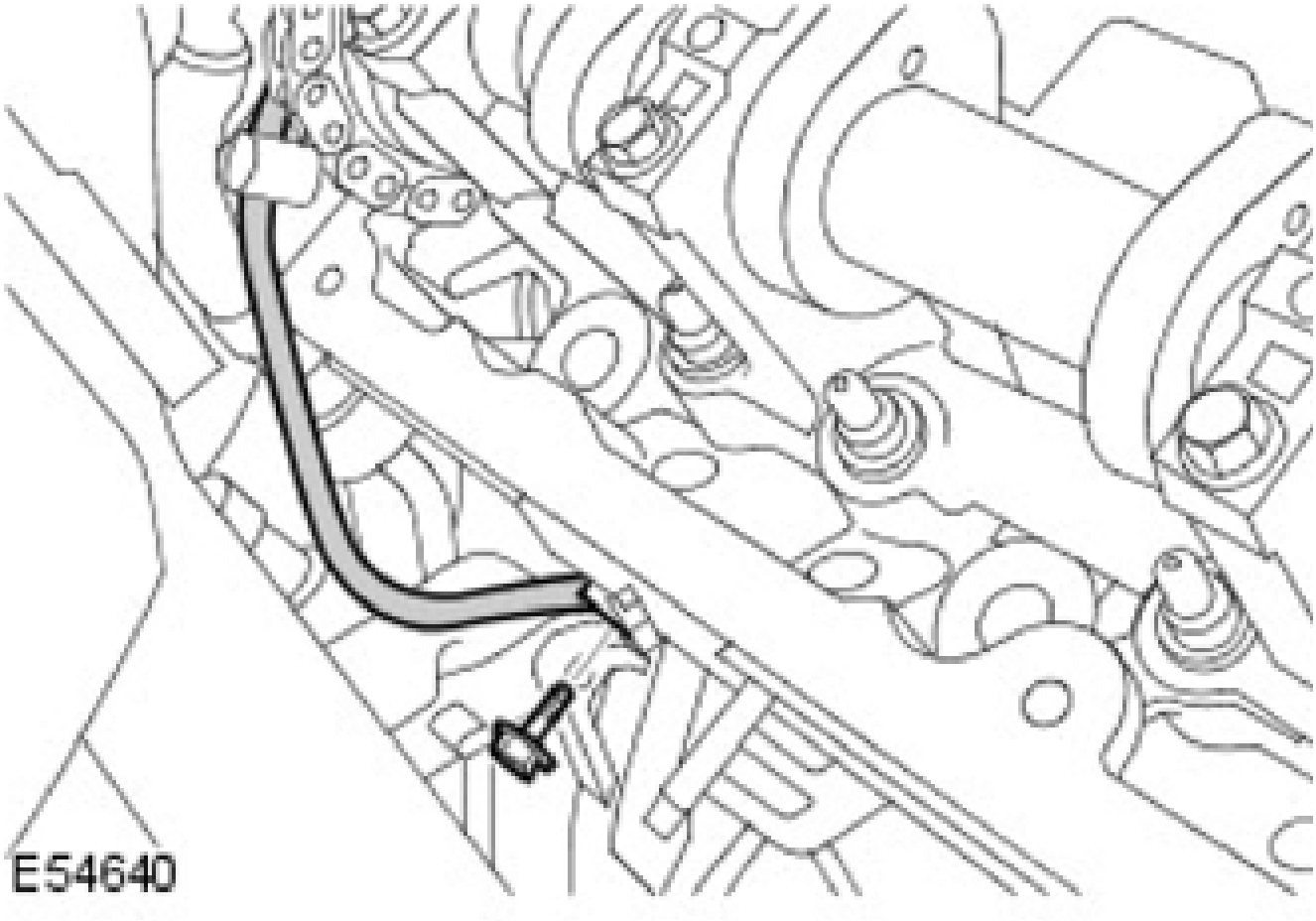

11. Remove and discard the cylinder head gasket.
    - Clean the cylinder head locating dowels.
    - Clean and inspect the cylinder head and cylinder block.

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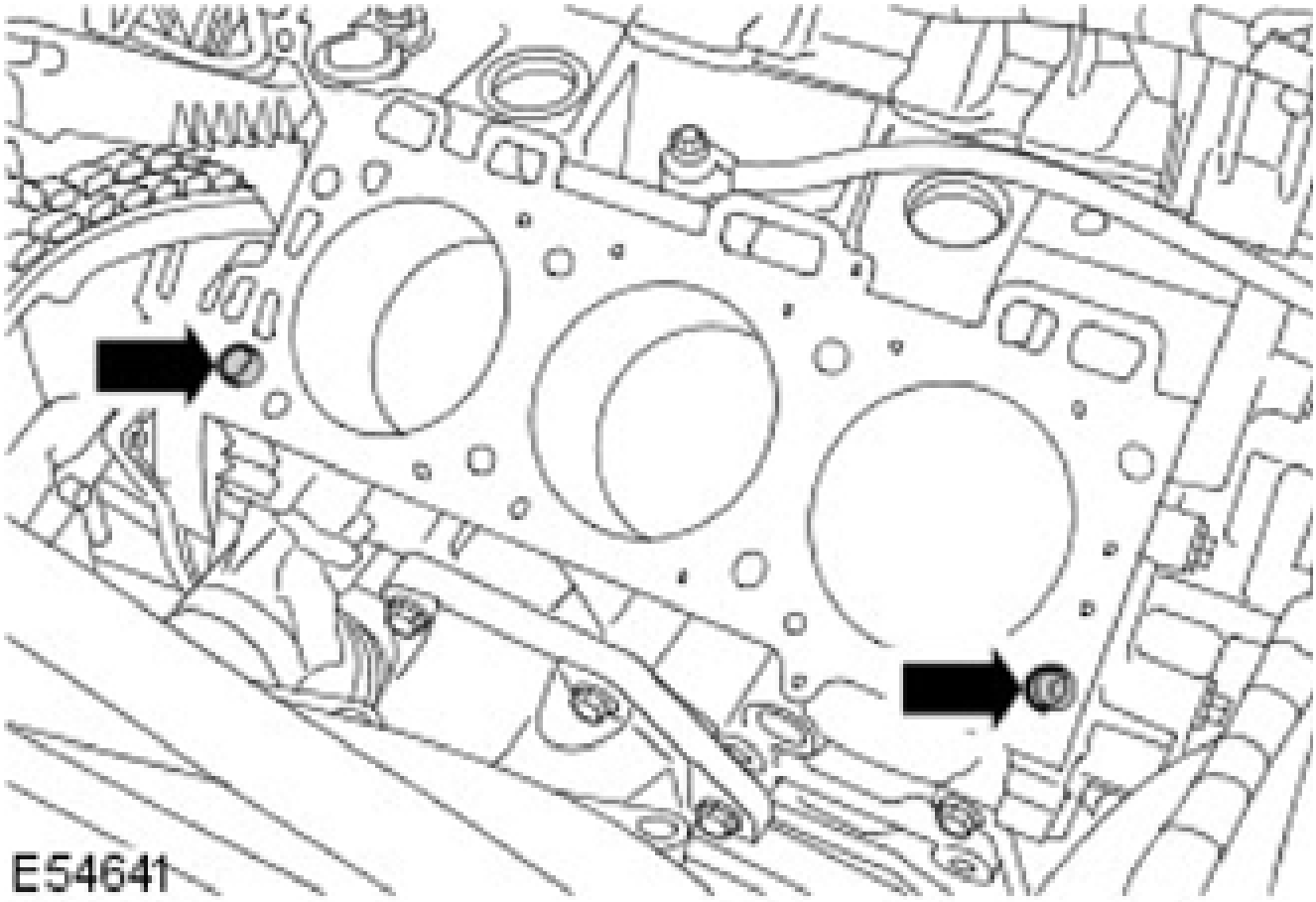

NOTE: Remove the camshaft bearing caps evenly and in stages.
Note the fitted position.
Do not disassemble further if the component is removed for access only.

12. Remove the camshaft bearing caps.
    - Remove the 8 bolts.
    - Collect the camshaft oil supply line.
13. Remove the camshaft.

INSTALLATION

1. Install the camshaft.
    - Clean the component mating faces.
    - Lubricate the components with clean engine oil.

NOTE: Note the fitted position.

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2. Install the camshaft bearing caps.
    - Clean the component mating faces.
    - Lubricate the components with clean engine oil.

NOTE: After installing the bolts check the camshaft is free to rotate.

3. Install the camshaft oil supply line.
    - Thoroughly clean and inspect the oil supply line.
    - Prime the oil supply line with clean engine oil.
    - Tighten the bolts evenly in 2 stages to the sequence shown.
    - Tighten the bolts to 6 Nm (4 lb.ft).
    - Tighten the bolts to 16 Nm (12 lb.ft).
4. Clean the component mating faces.
5. Check cylinder head face for distortion, across the center and from corner to corner.

For additional information, refer to: **SPECIFICATIONS** .

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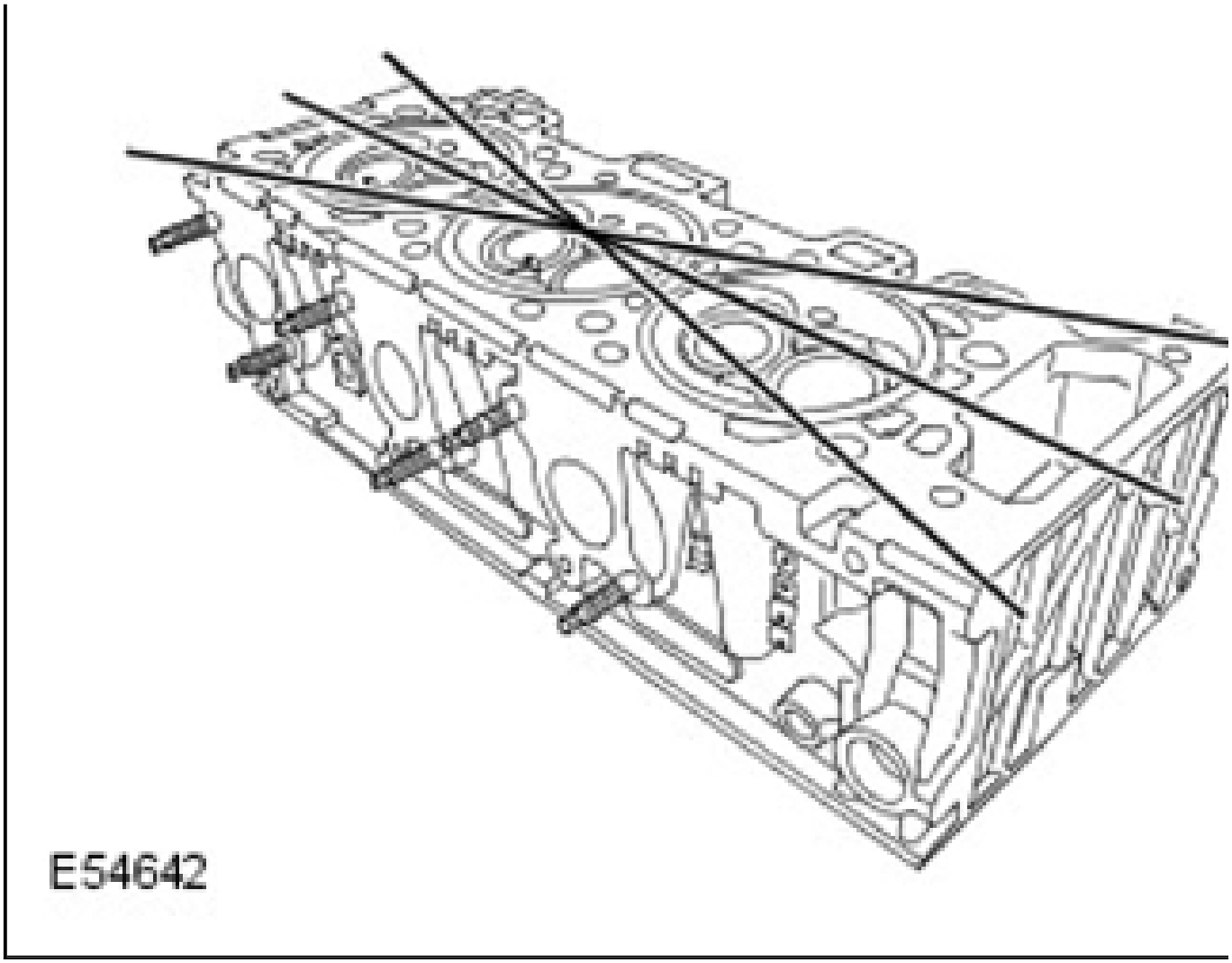

CAUTION: The head gasket must be installed over the cylinder block dowels.

6. Install a new cylinder head gasket.

NOTE: Care must be taken when installing the ground connections. The engine will fail to start on either or both banks if the ground is poor.

7. Install the cylinder head RH assembly.
   - Connect the cylinder head earth ground connector.
   - Tighten the bolt to 10 Nm (7 lb.ft).

NOTE: Tighten the bolts 1 to 8 in the sequence shown. The M12 bolts are tightened in 3 stages.

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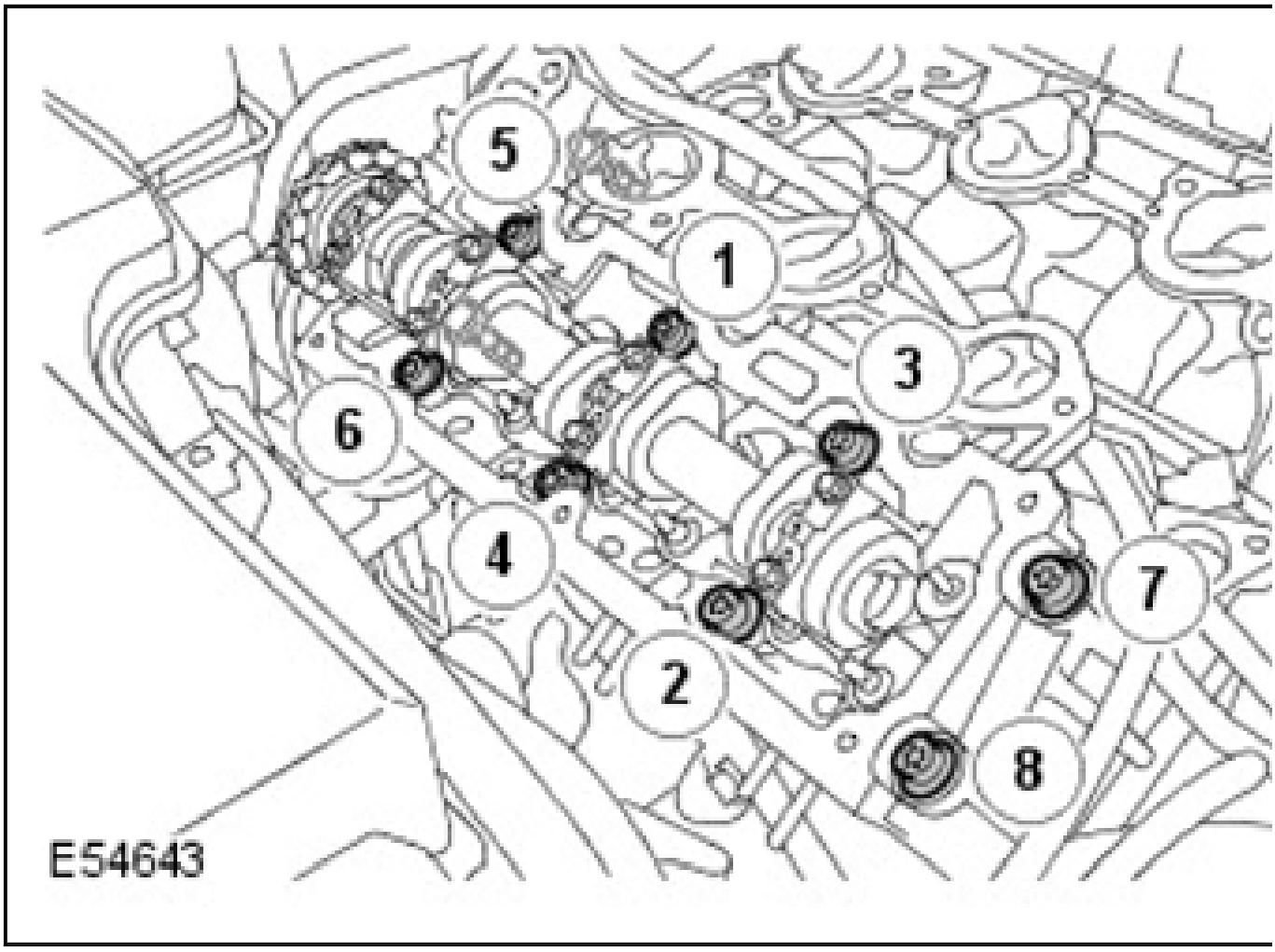
8. Install the cylinder head bolts.
    - Lubricate the new cylinder head bolt threads with clean engine oil.
    - Tighten the M12 bolts to 30 Nm (22 lb.ft), then a further 80 degrees.
    - Tighten the M12 bolts a further 80 degrees.
    - Tighten the M8 bolts to 35 Nm (26 lb.ft).



9. Install the exhaust manifold.

    For additional information, refer to: **EXHAUST MANIFOLD RH** .

    NOTE: The thread is left handed.

10. Install the camshaft sprocket bolt.
    - Remove and discard the cable tie.
    - Clean the component mating faces.
    - Install and lightly tighten the camshaft sprocket bolt.

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11. Install the RH hydraulic timing chain tensioner.
    - Tighten the tensioner to 45 Nm (33 lb.ft).
12. Install the cylinder head coolant flange.
    - Clean the component mating faces.
    - Tighten the bolts to 10 Nm (7 lb.ft).
    - Secure the hose with the clip.
    - Connect the ECT sensor electrical connector.
13. Install the generator mounting bracket.
    - Clean the component mating faces.
    - Tighten the bolts to 45 Nm (33 lb.ft).
    - Secure the wiring harness.
    - Connect the ECT sensor electrical connector.
14. Adjust the valve timing. For additional information, refer to: **CAMSHAFT TIMING** .
15. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

16. Refill and bleed the cooling system.

    For additional information, refer to: **AIR SUSPENSION AIR FILTER** .

VALVE COVER LH

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the fuel rail.

   For additional information, refer to: **Fuel Rail** .

3. Position the injector harness aside.
   - Release the 2 clips.
   - Disconnect the 3 fuel injector electrical connectors.

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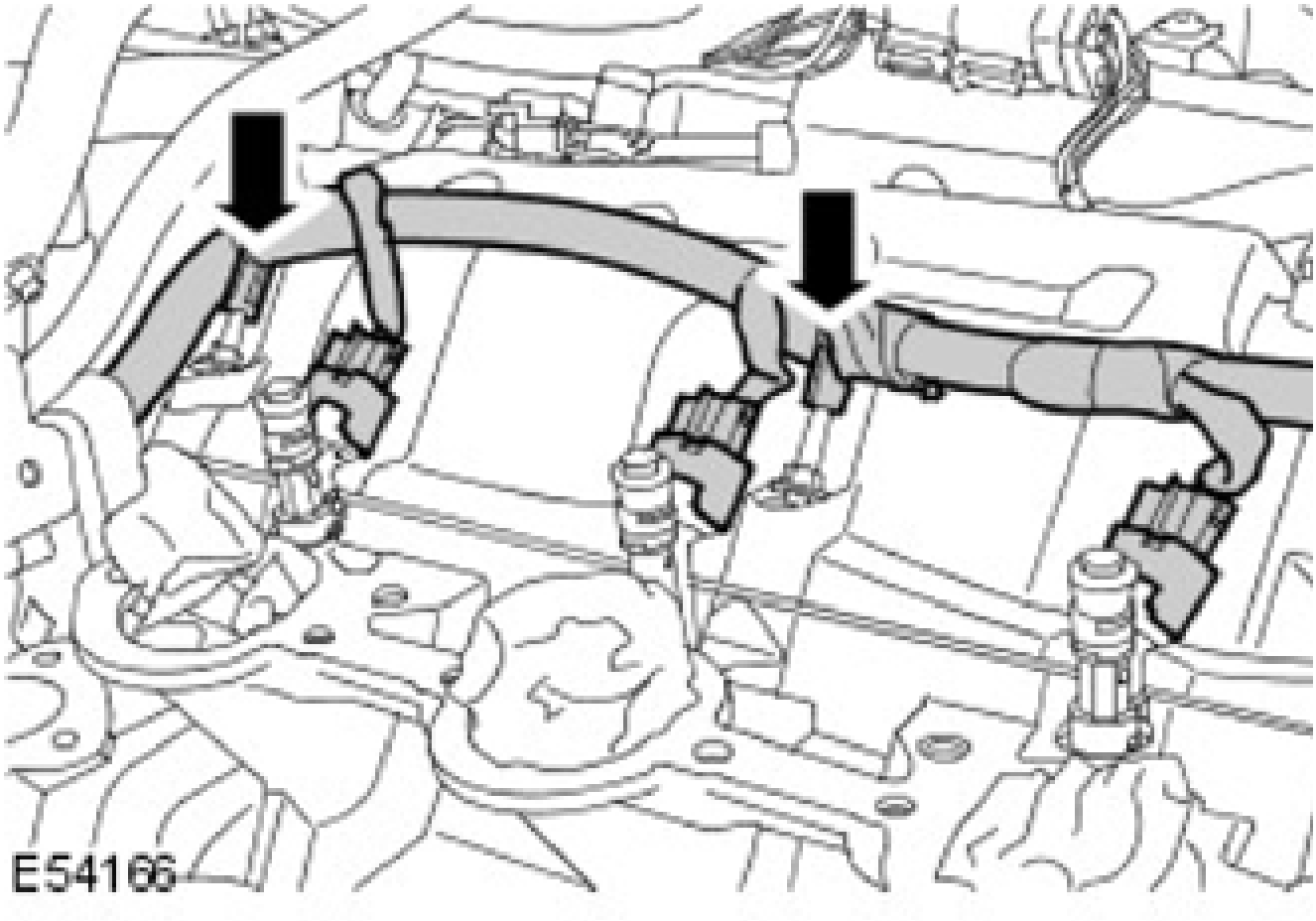

4. Disconnect the 3 electrical connectors.
   - Release the harness clip from the filler neck.
   - Noting the installed position of the Knock sensor electrical harness in relation to the oil filler tube, remove and discard the cable tie.

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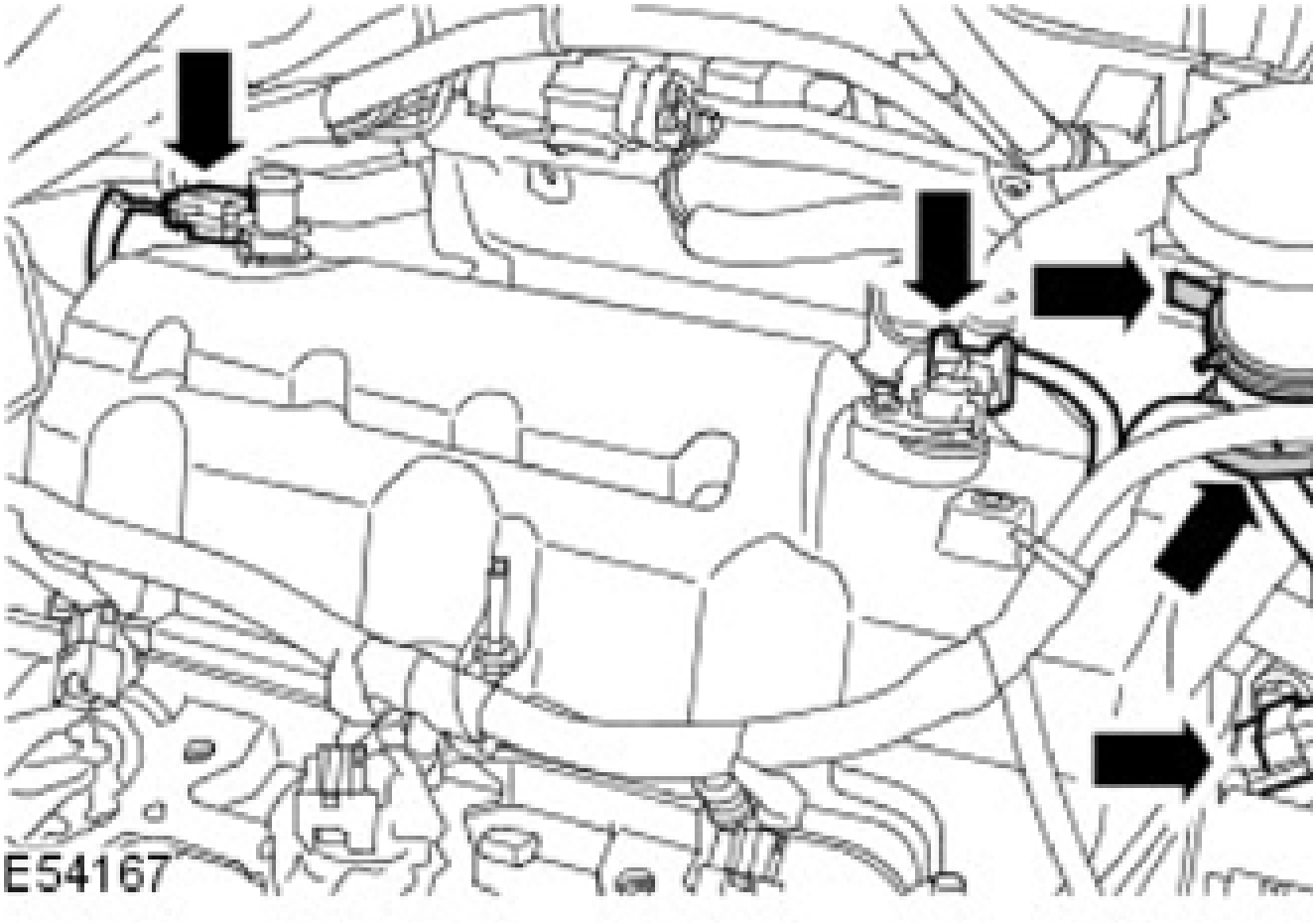

CAUTION: Before disconnecting or removing the components, ensure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

5. Remove the valve cover.
    - Remove the 3 bolts.
    - Remove the 3 studs.

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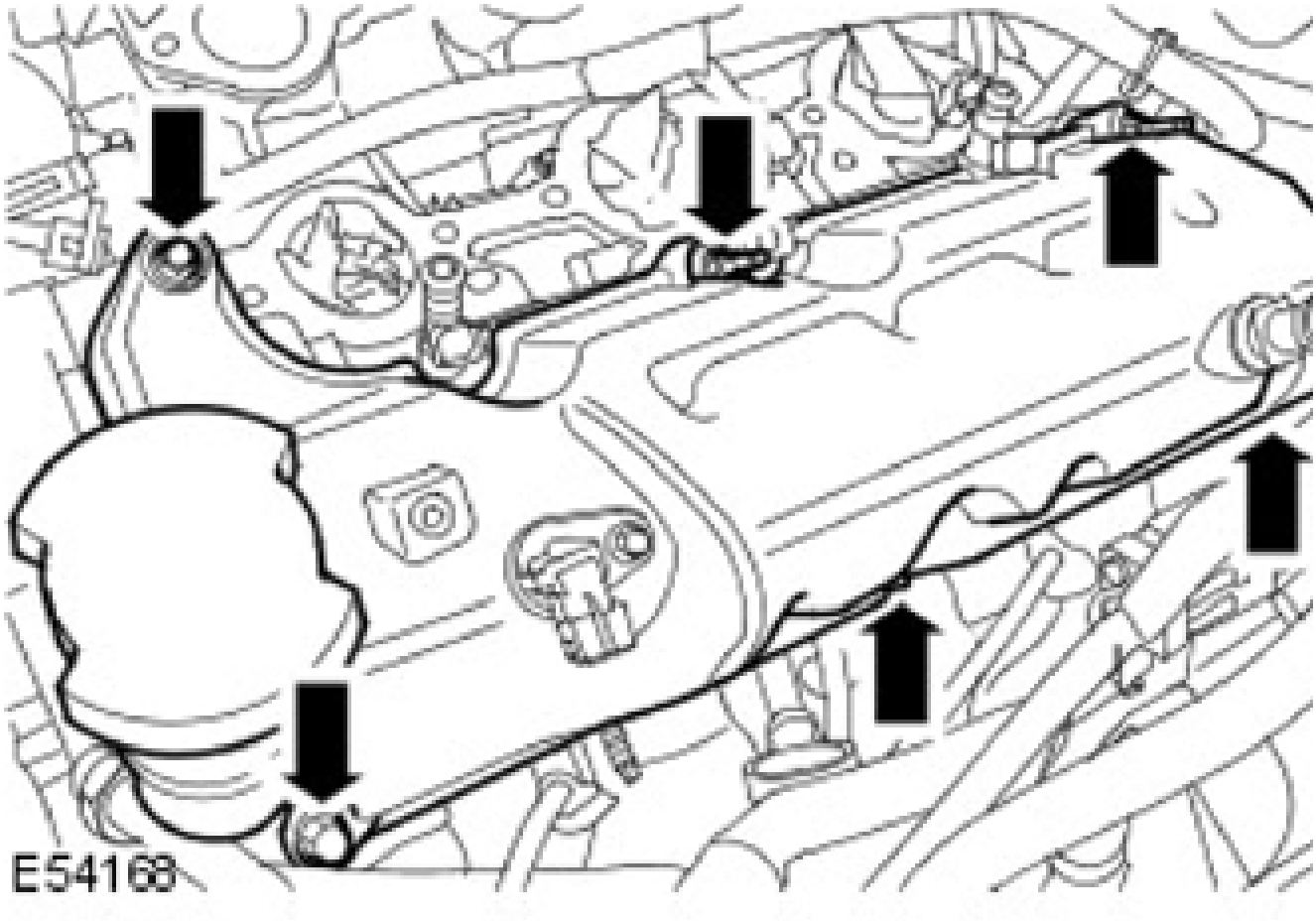

NOTE: Do not disassemble further if the component is removed for access only.

6. Remove and discard the gasket.

NOTE: Note the fitted position.

7. Remove the bolts and studs. Remove and discard the seals.

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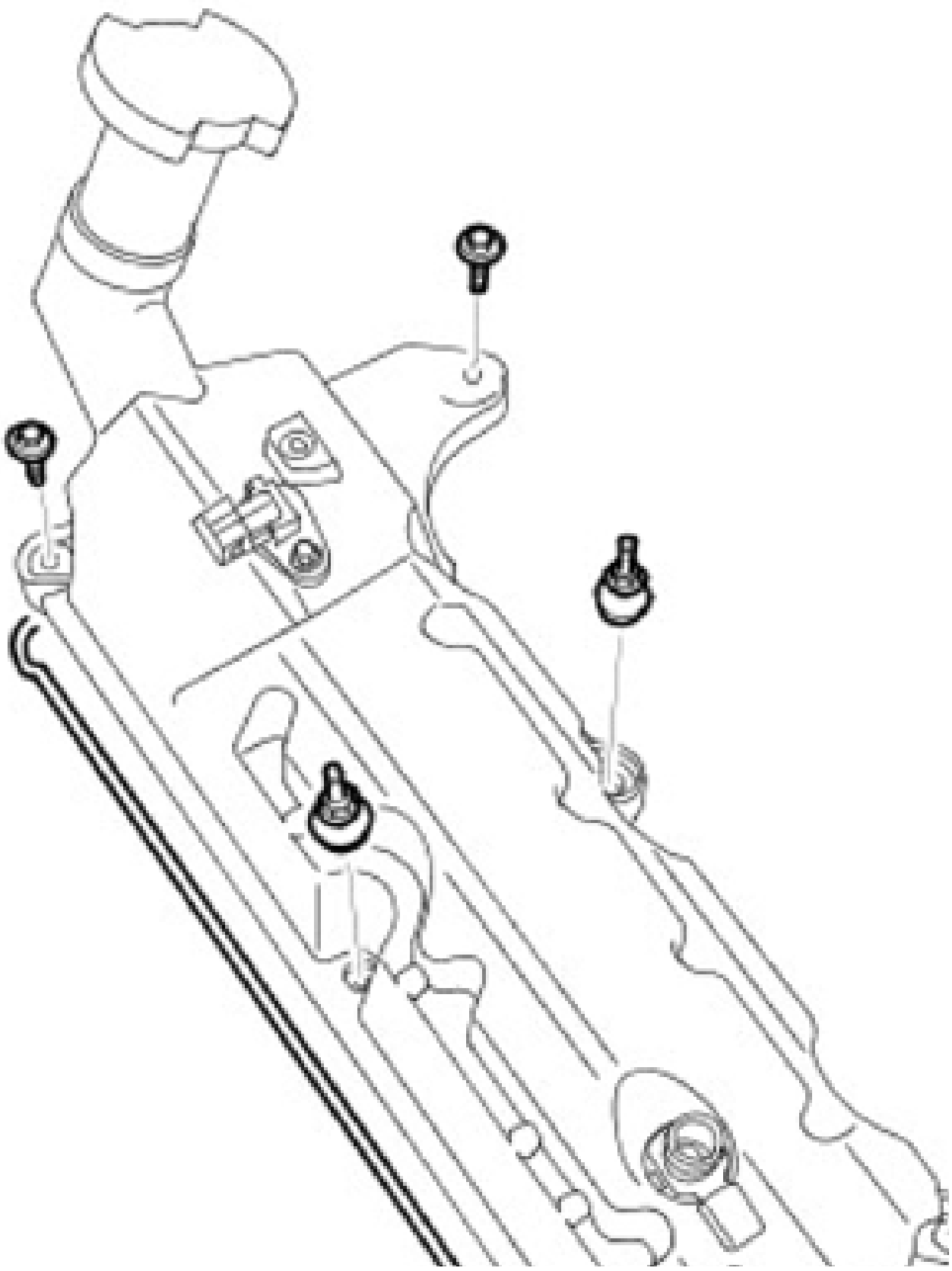

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8. Remove the camshaft position (CMP) sensor.
    - Remove the bolt.
    - Remove and discard the O-ring seal.
9. Remove the engine breather valve.
    - Remove and discard the O-ring seal.
10. Remove the oil filler cap.

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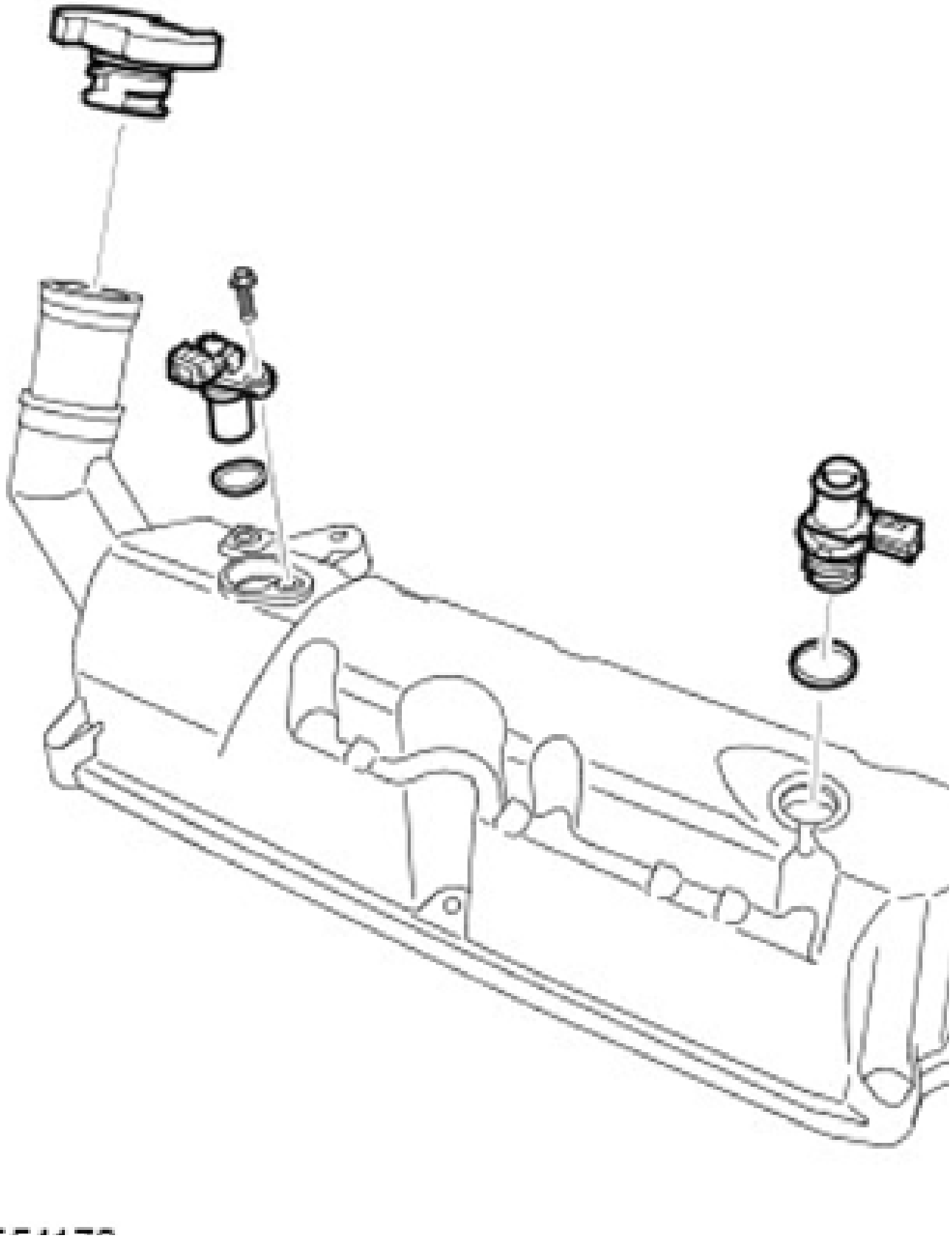

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INSTALLATION

1. Install the oil filler cap.
2. Install the engine breather valve.
   - Install a new O-ring seal.
3. Install the CMP sensor.
   - Install a new O-ring seal.
   - Tighten the bolt to 6 Nm (4 lb.ft).
4. Install the bolts and studs.
   - Install the new O-ring seals.
   - Install the new gasket.
5. Install the valve cover.
   - Clean the component mating faces.
   - Evenly and progressively tighten the bolts and studs, in the sequence shown, to 10 Nm (7 lb.ft).
   - Secure the electrical harness with the clip.

CAUTION: Make sure the knock sensor electrical harness is returned to the original fitted position.

6. Install the injector harness.
   - Secure with the clips.
   - Connect the fuel injector electrical connectors.
   - Connect the 3 electrical connectors.
   - Install a new cable tie.
7. Install the fuel rail.

   For additional information, refer to: **Fuel Rail** .

8. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

VALVE COVER RH

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the fuel rail.

   For additional information, refer to: **Fuel Rail** .

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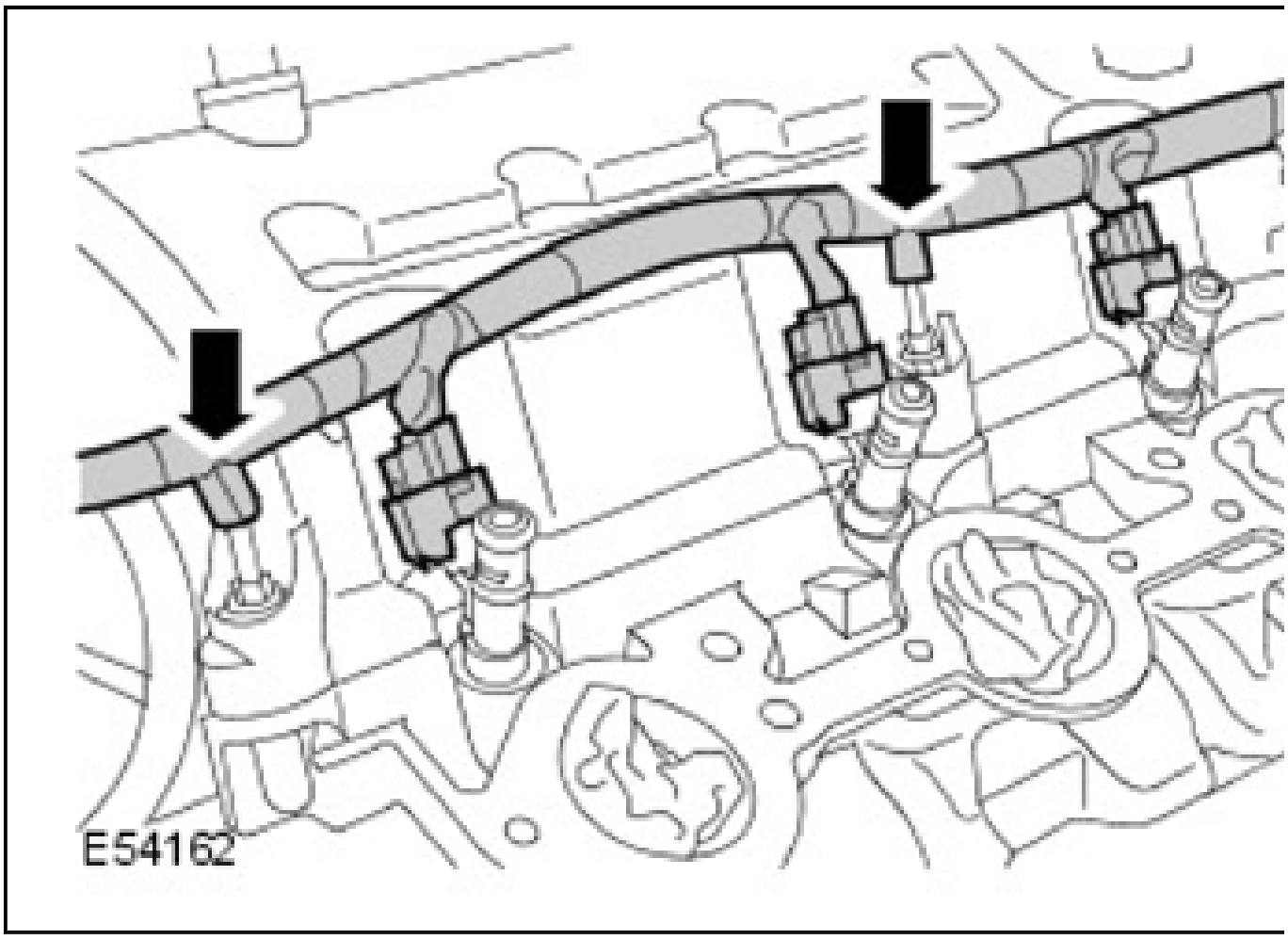
3. Position the injector harness aside.
    - Release the 2 clips.
    - Disconnect the 3 fuel injector electrical connectors.



CAUTION: Before disconnecting or removing the components, ensure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

4. Remove the valve cover.
    - Release the wiring harness retaining clip.
    - Remove the 2 bolts.
    - Remove the 4 studs.

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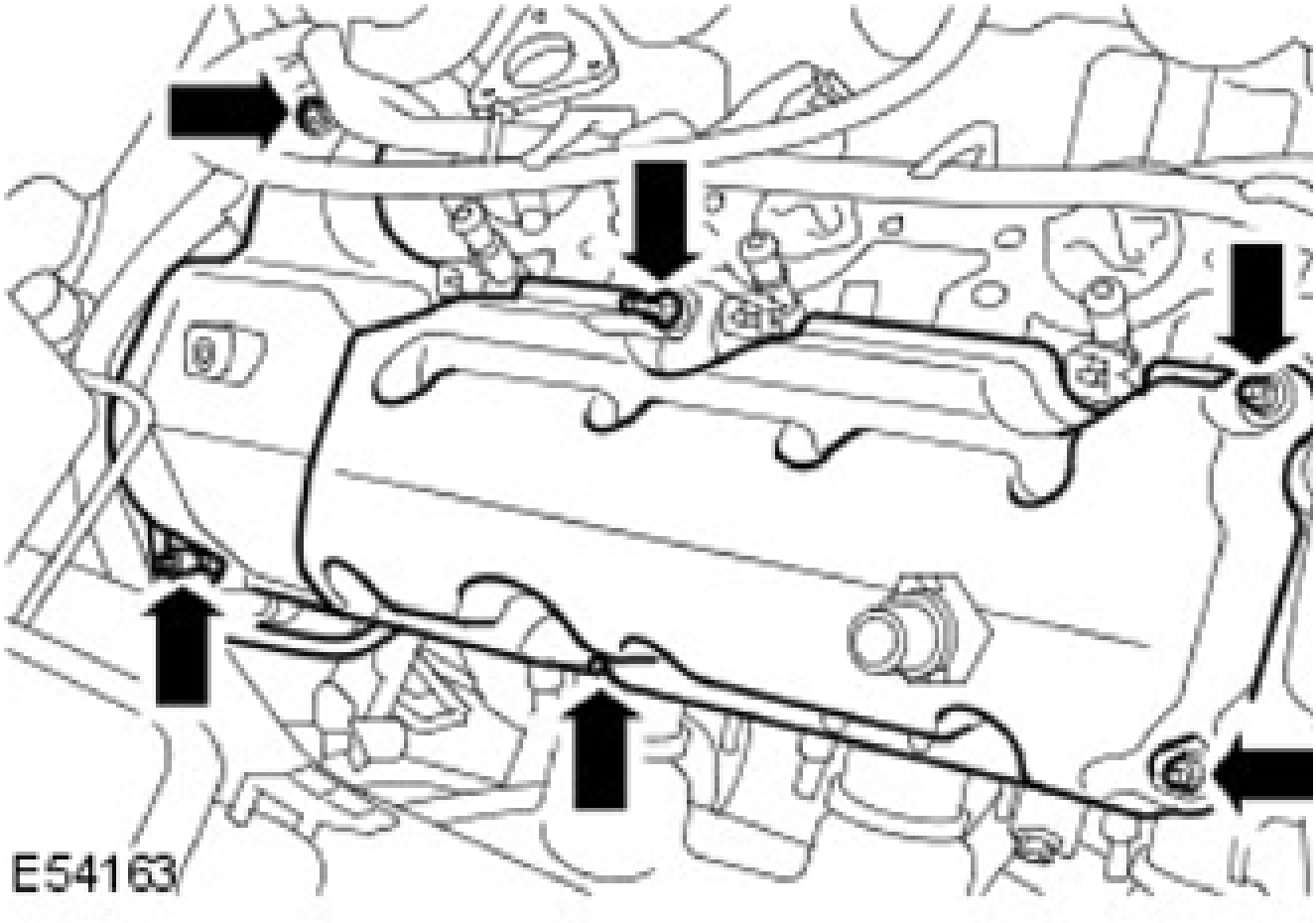

NOTE: Do not disassemble further if the component is removed for access only.

5. Remove and discard the gasket.

NOTE: Note the fitted position.

6. Remove the bolts and studs. Remove and discard the seals.

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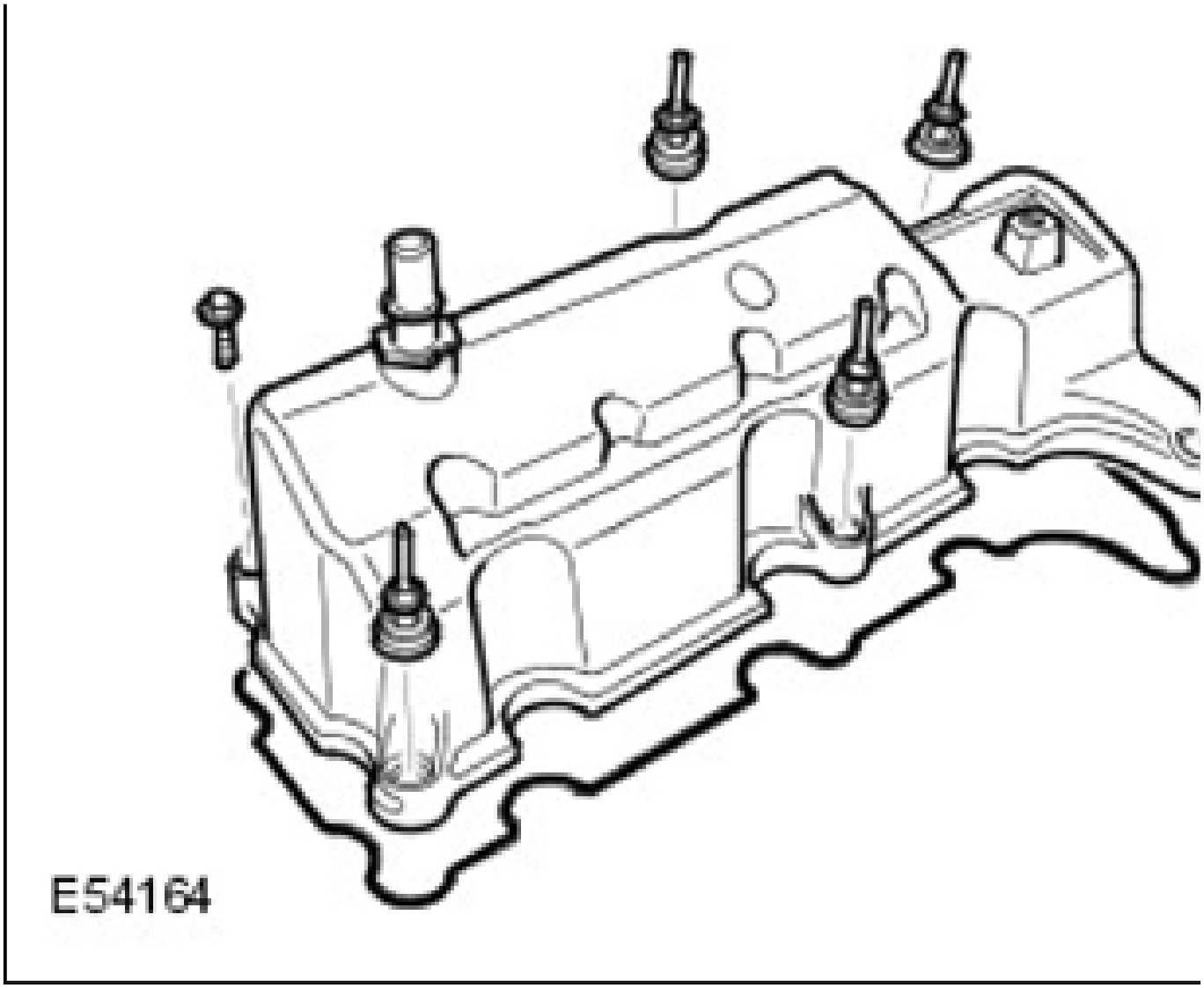

INSTALLATION

1. Install the bolts and studs.
    - Install the new O-ring seals.
    - Install the new gasket.
2. Install the valve cover.
    - Clean the component mating faces.
    - Evenly and progressively tighten the bolts and studs, in the sequence shown, to 10 Nm (7 lb.ft).
    - Secure the electrical harness with the clip.
3. Install the injector harness.
    - Secure with the clips.
    - Connect the fuel injector electrical connectors.
4. Install the fuel rail.

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For additional information, refer to: **Fuel Rail** .

5. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

CAMSHAFT ROLLER FOLLOWER

SPECIAL TOOL(S)

	Camshaft roller follower remover/replacer 303-581

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the LH valve cover.

   For additional information, refer to: **VALVE COVER LH** .

3. Remove the RH valve cover.

   For additional information, refer to: **VALVE COVER RH** .

4. Remove the viscous fan assembly.

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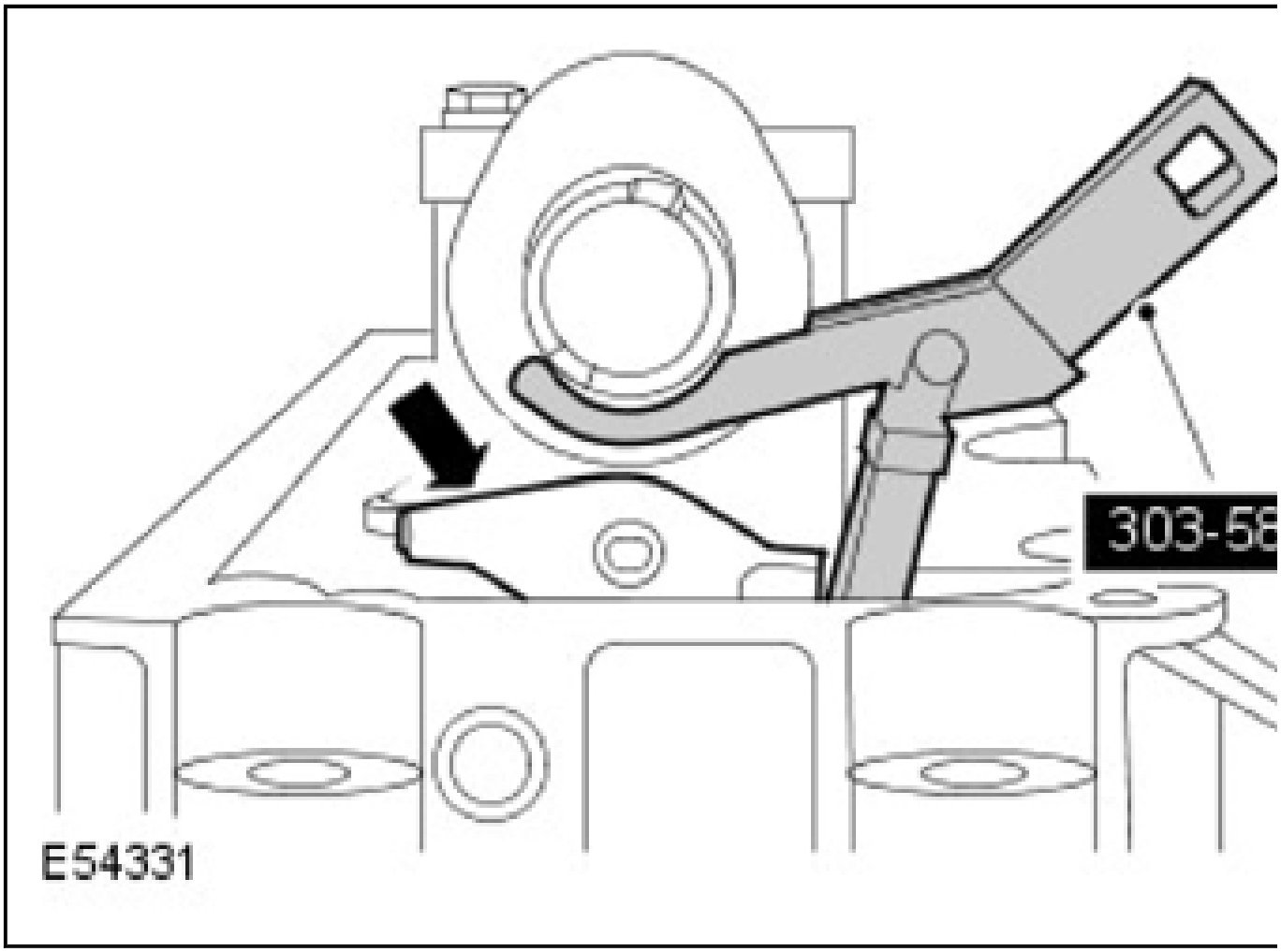
For additional information, refer to: **Cooling Fan** .

NOTE: **Make sure the camshaft lobe is opposite the camshaft roller follower, prior to removal.**
Mark each camshaft roller follower and lash adjuster. Make sure each component is returned to its original fitted position.

5. Using the special tool, remove the camshaft roller followers.
   - Depress the valve spring.



6. Rotate the engine as required to access the remaining camshaft roller followers.

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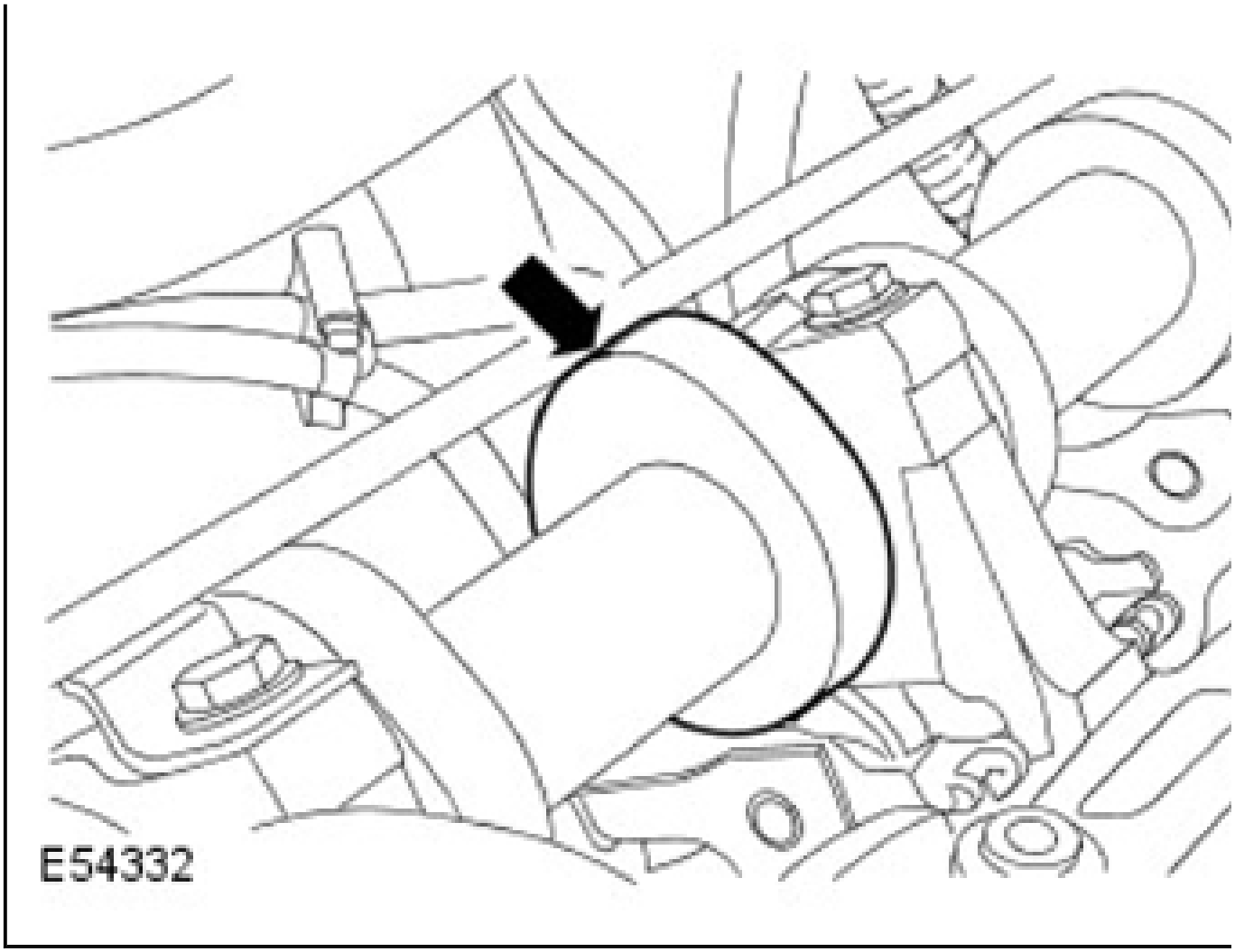

7. Remove the hydraulic lash adjusters.

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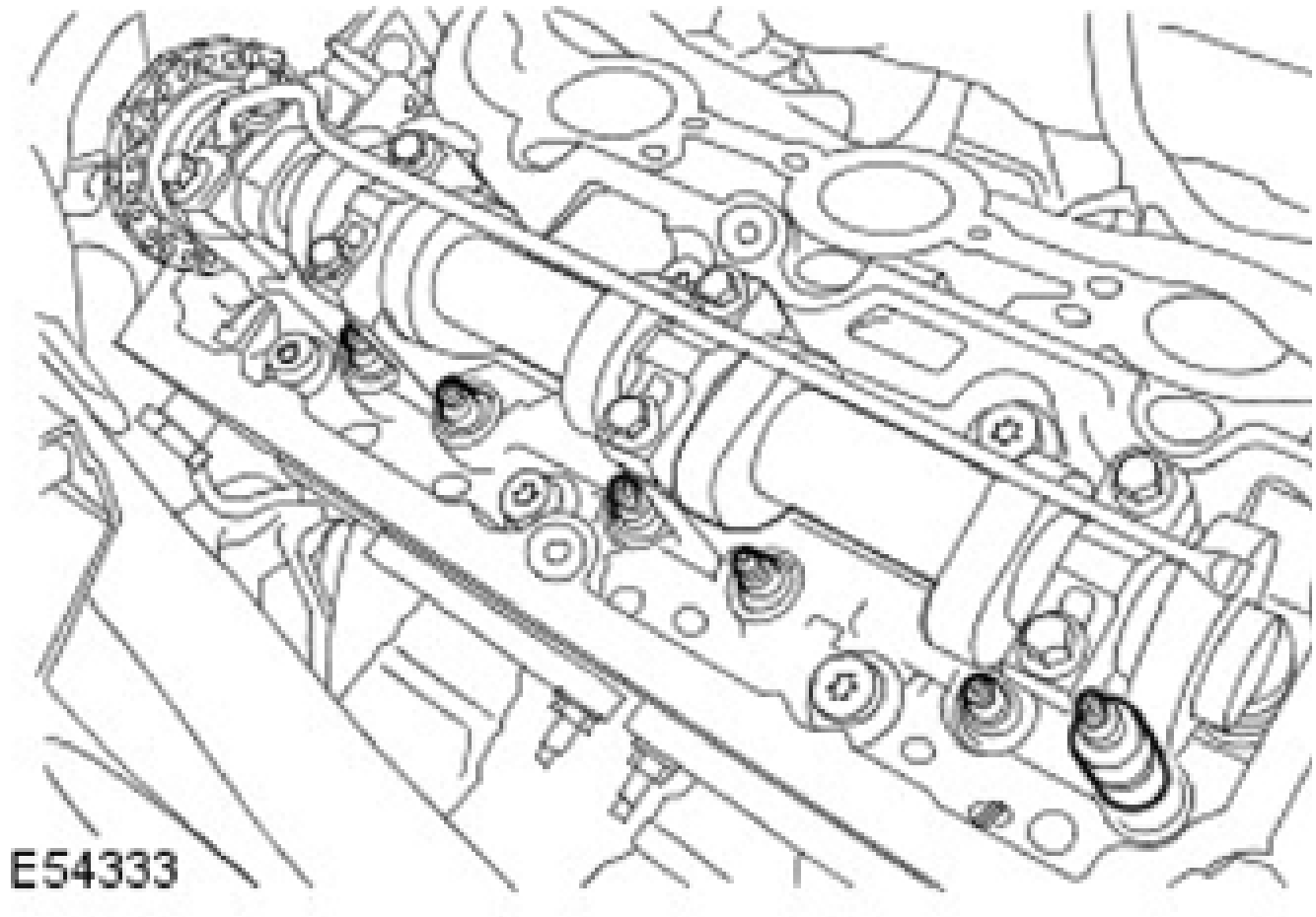

INSTALLATION

NOTE: Install the components to their original fitted positions.

1. Install the hydraulic lash adjusters.
   - Clean the component mating faces.
   - Lubricate the components with clean engine oil.

NOTE: Install the components to their original fitted positions.

2. Using the special tool, install the camshaft roller followers.
   - Clean the component mating faces.
   - Lubricate the components with clean engine oil.
   - To install, reverse the removal procedure.

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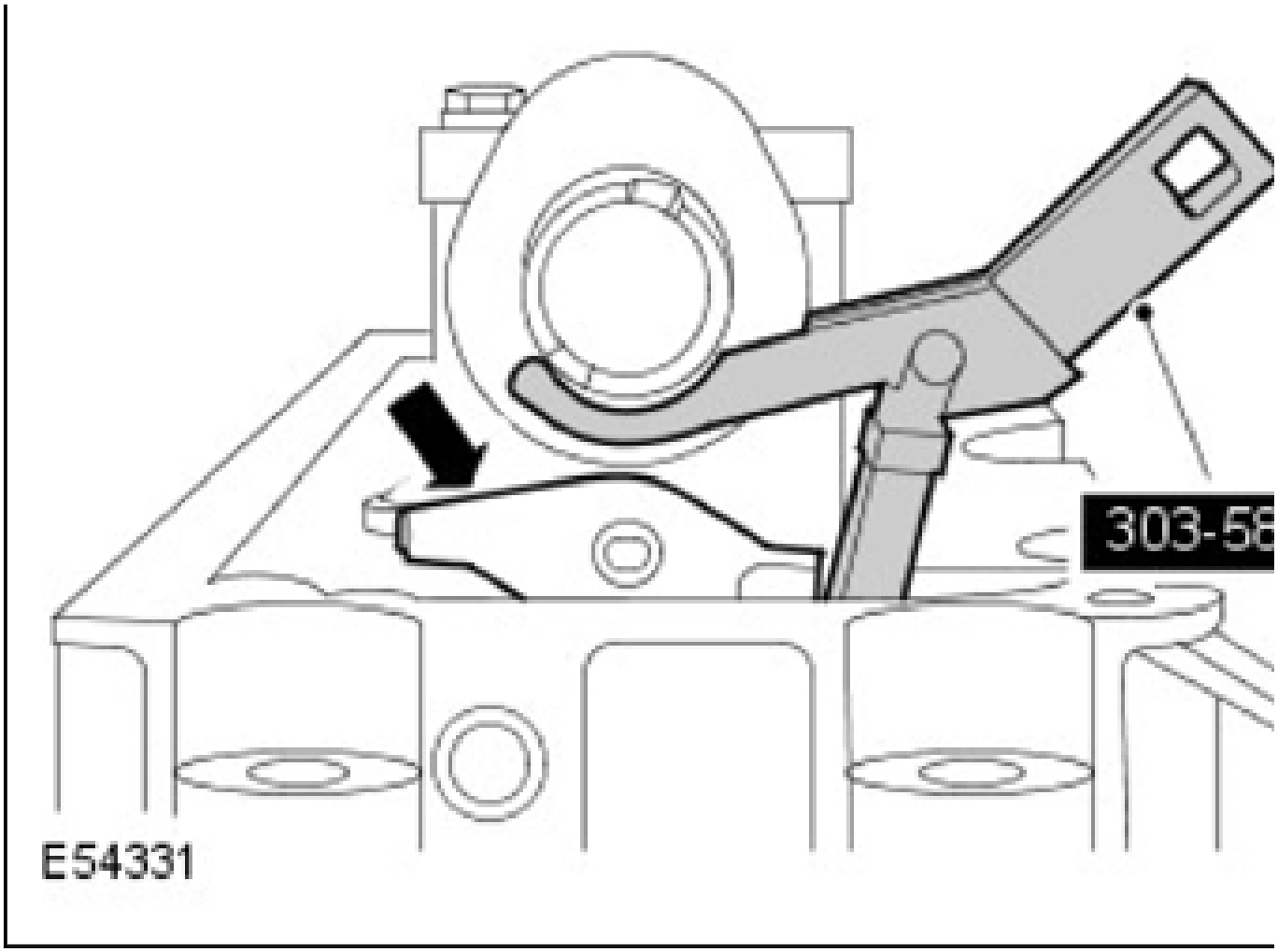

3. Rotate the engine as required to access the remaining camshaft roller followers.
4. Install the viscous fan assembly.

   For additional information, refer to: **Cooling Fan** .

5. Install the RH valve cover.

   For additional information, refer to: **VALVE COVER RH** .

6. Install the LH valve cover.

   For additional information, refer to: **VALVE COVER LH** .

7. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

ENGINE MOUNT LH

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REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the LH exhaust manifold.

   For additional information, refer to: **EXHAUST MANIFOLD LH** .

4. Release the starter motor cable.
   - Release the terminal cover.
   - Remove the terminal nut insulator.
   - Remove the nut.

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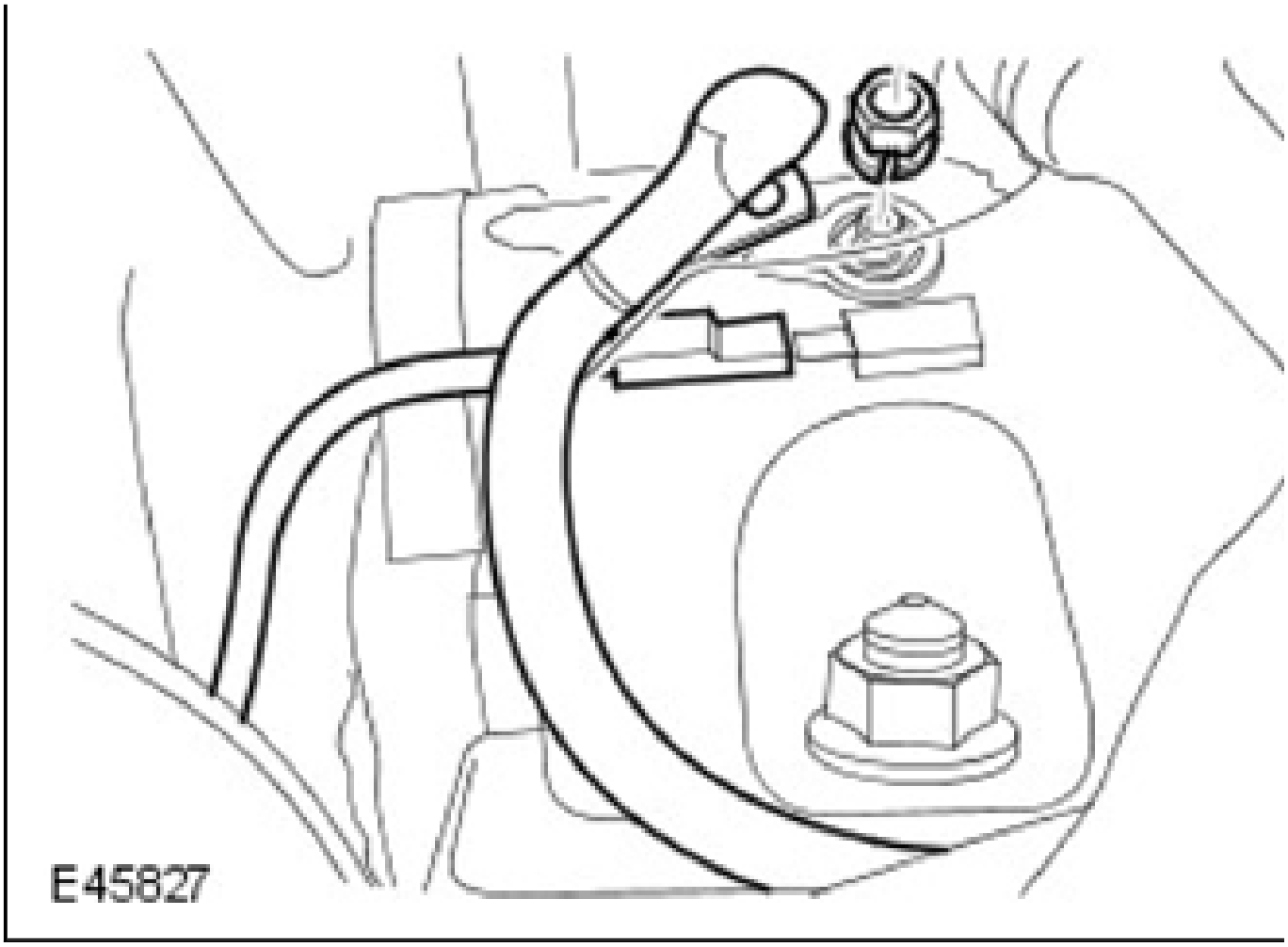

CAUTION: Protect the engine during this operation.

5. Remove the engine mount bracket.
    - Support the engine.
    - Remove the 4 bolts.
6. Remove the engine mount.
    - Remove and discard the 2 bolts.

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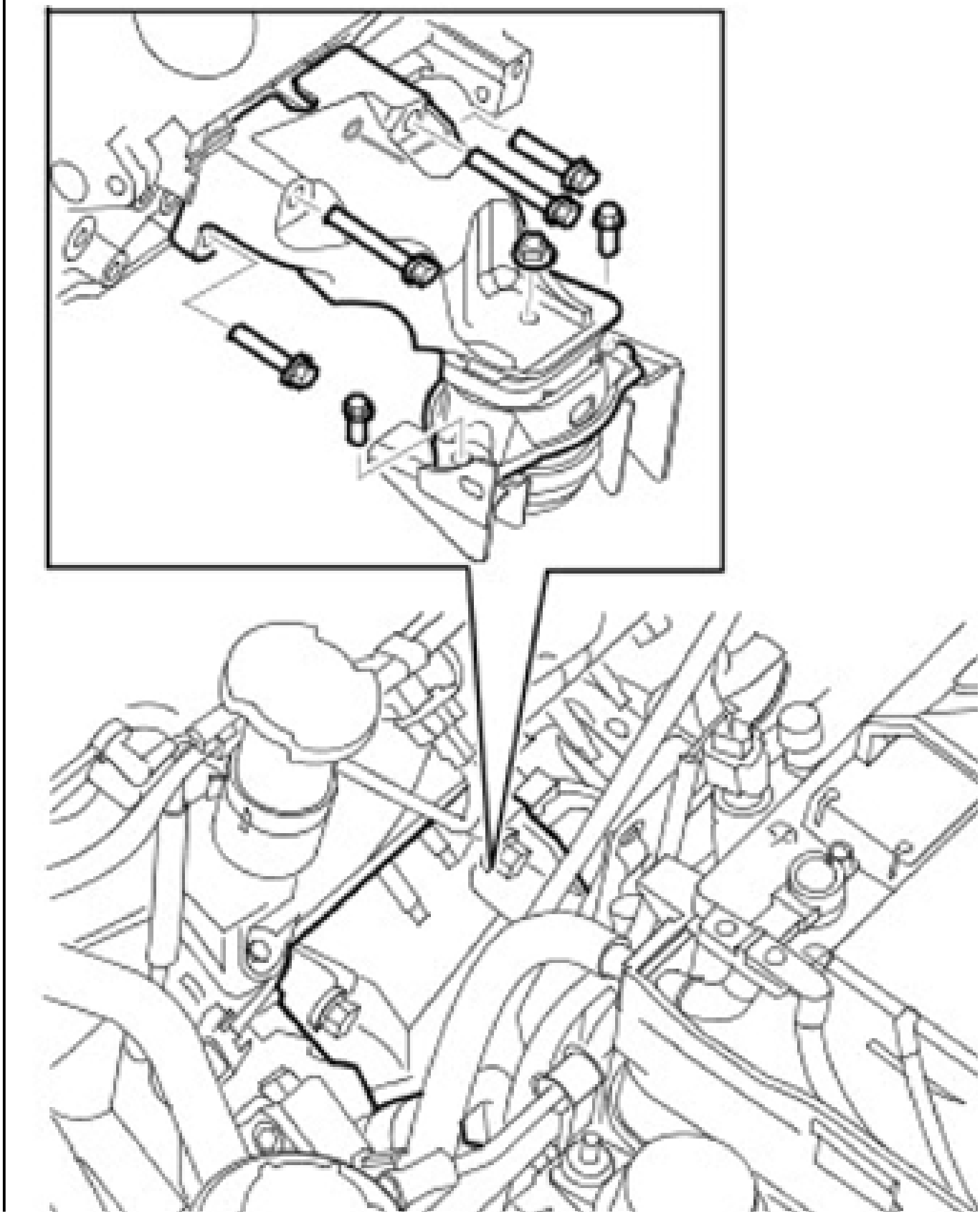

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INSTALLATION

1. Install the engine mount.
   - Clean the component mating faces.
   - Tighten the new bolts to 45 Nm (33 lb.ft), then a further 60 degrees.
2. Install the engine mount bracket.
   - Clean the component mating faces.
   - Tighten the bolts to 80 Nm (59 lb.ft).
   - Remove the engine support.
3. Connect the starter motor cable.
   - Tighten the nut to 10 Nm (7 lb.ft).
   - Install the terminal nut insulator.
   - Install the cover.
4. Install the exhaust manifold.

   For additional information, refer to: **EXHAUST MANIFOLD LH** .

5. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

ENGINE MOUNT RH

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the RH exhaust manifold.

   For additional information, refer to: **EXHAUST MANIFOLD RH** .

   CAUTION: Protect the engine during this operation.

4. Remove the engine mount bracket.
   - Support the engine.
   - Remove the nut.

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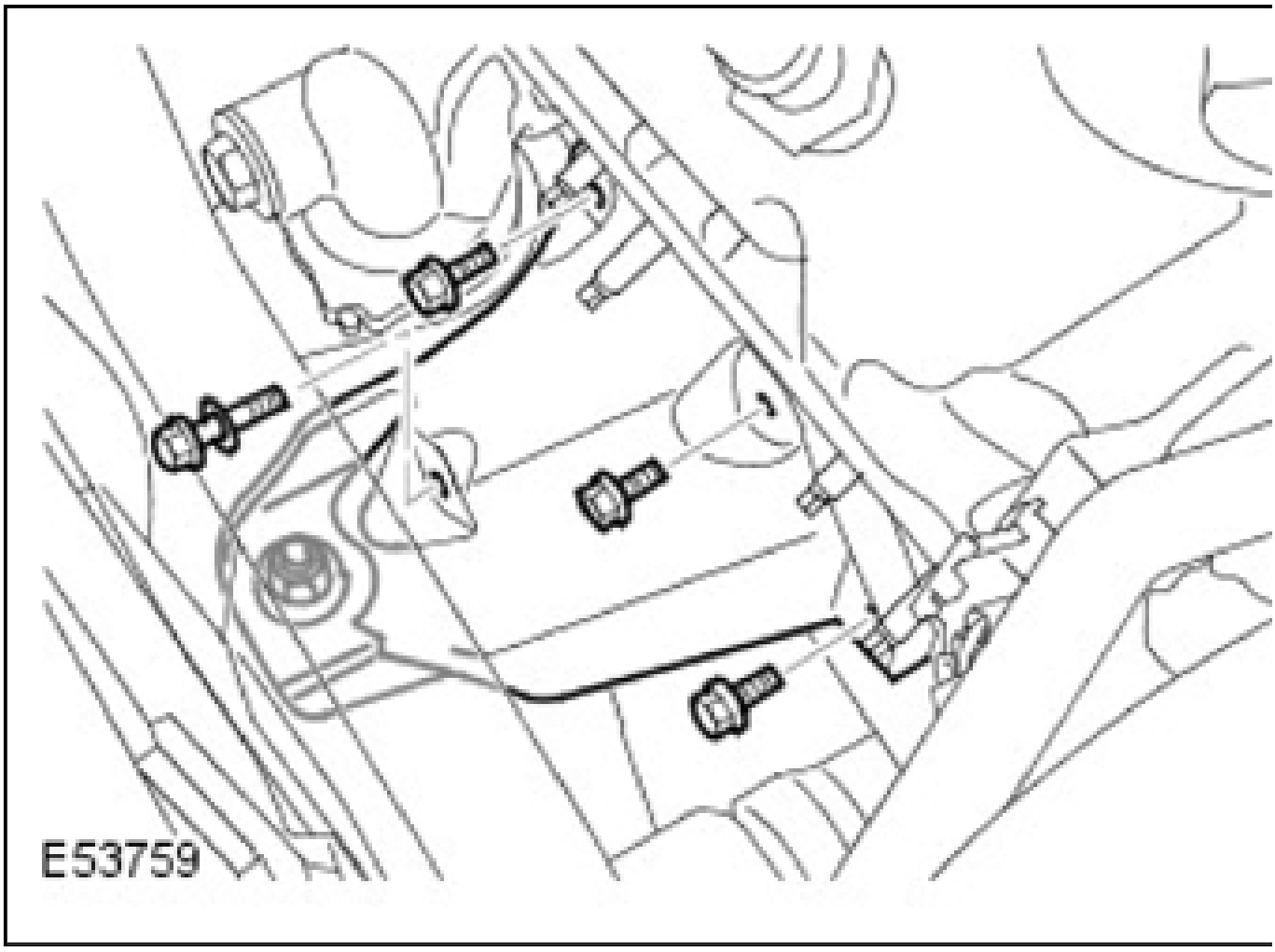
- Remove the 4 bolts.



5. Remove the engine mount.
    - Remove and discard the 2 bolts.

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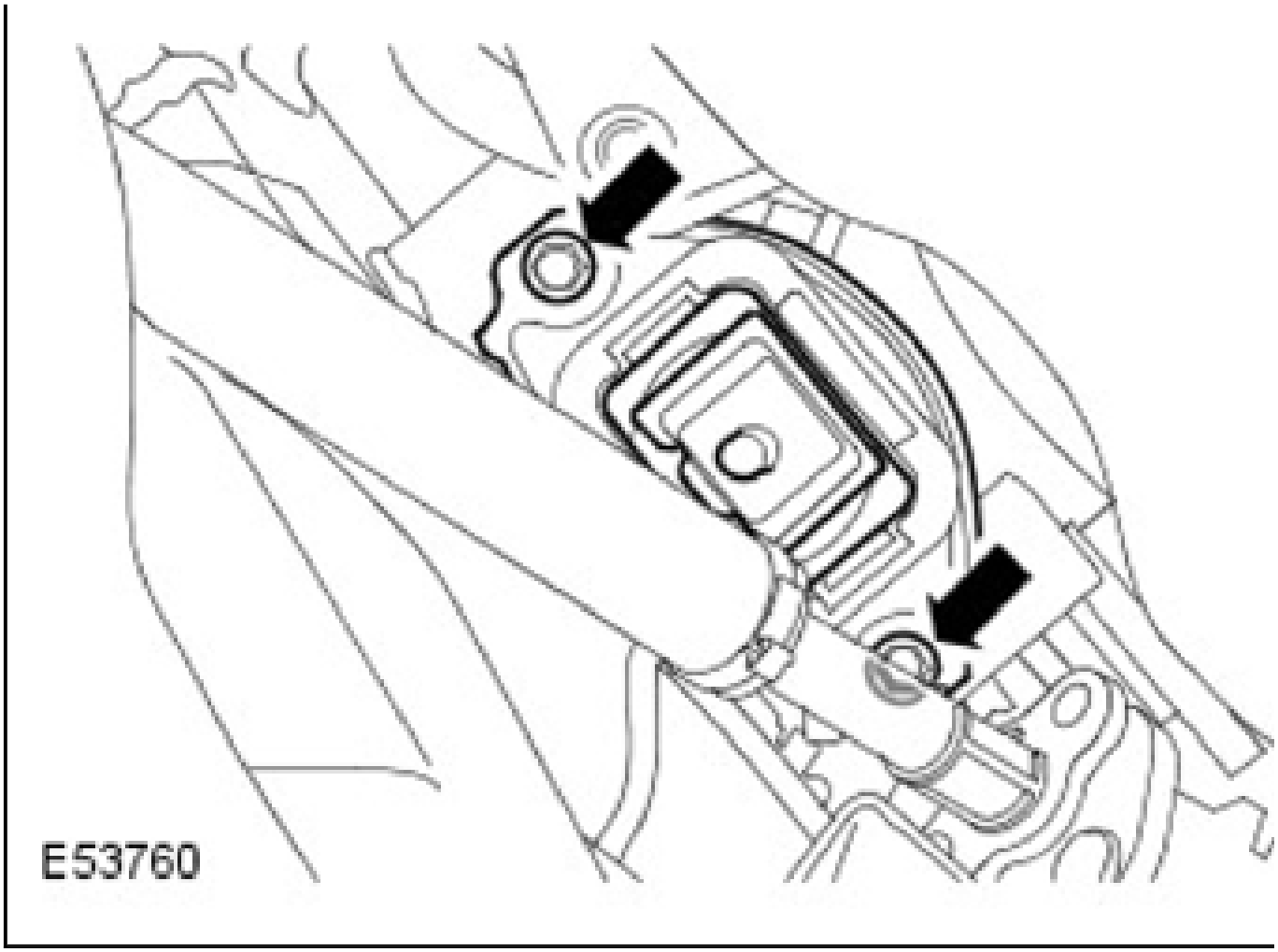

INSTALLATION

1. Install the engine mount.
   - Clean the component mating faces.
   - Tighten the new bolts to 45 Nm (33lb.ft), then a further 60 degrees.
2. Install the engine mount bracket.
   - Clean the component mating faces.
   - Tighten the bolts to 80 Nm (59 lb.ft).
   - Remove the engine support.
   - Tighten the nut to 90 Nm (66 lb.ft).
3. Install the exhaust manifold.

   For additional information, refer to: **EXHAUST MANIFOLD RH** .

4. Connect the battery ground cable.

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For additional information, refer to: **SPECIFICATION** .

FLEXPLATE

SPECIAL TOOL(S)

	Flex plate locking tool 303-947 (LRT-12-145)

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the transmission.

   For additional information, refer to: **TRANSMISSION** .

4. Flexplate alignment.
   - Rotate the crankshaft until number 1 cylinder is at TDC. The timing hole in the flexplate will be horizontal as shown.
   - Using the special tool, lock the flexplate.

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- Remove the Torx bolt shown to reveal the timing notch.
- Mark the position of the bolt hole with the notch in relation to the crankshaft.

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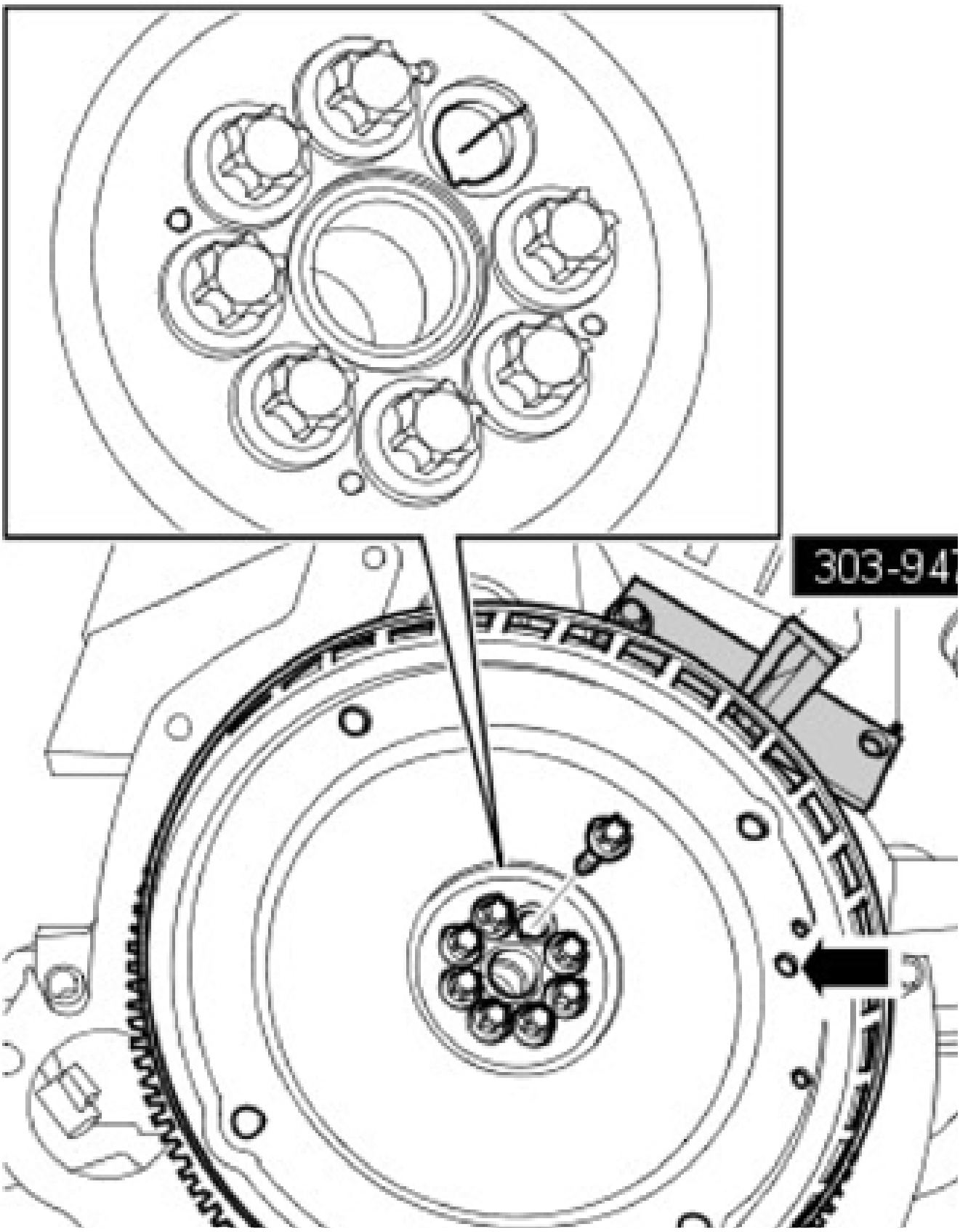

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5. Remove the torque converter flexplate.
    - Remove the 7 remaining Torx bolts.
    - Remove the spacer.

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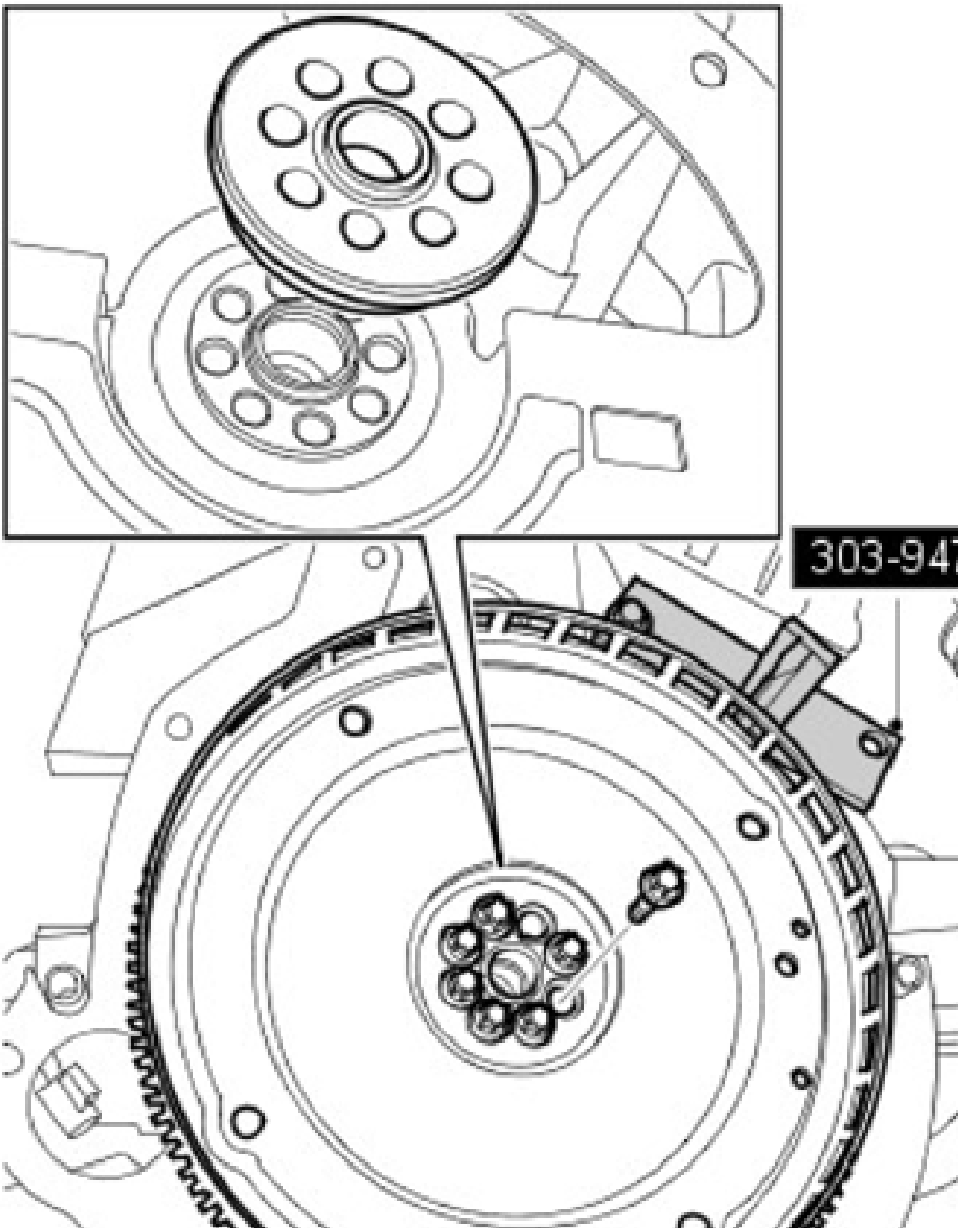

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INSTALLATION

1. Install the torque converter flexplate.
    - Clean the component mating faces.
    - Install the spacer.
    - Align the bolt hole with the alignment notch, to the mark previously made on the crankshaft.
    - Using the special tool, lock the flexplate.
    - Tighten the Torx bolts evenly in 2 stages, in the sequence shown.
    - Tighten the Torx bolts to 15 Nm (11 lb.ft).
    - Tighten the Torx bolts to 72 Nm (53 lb.ft)

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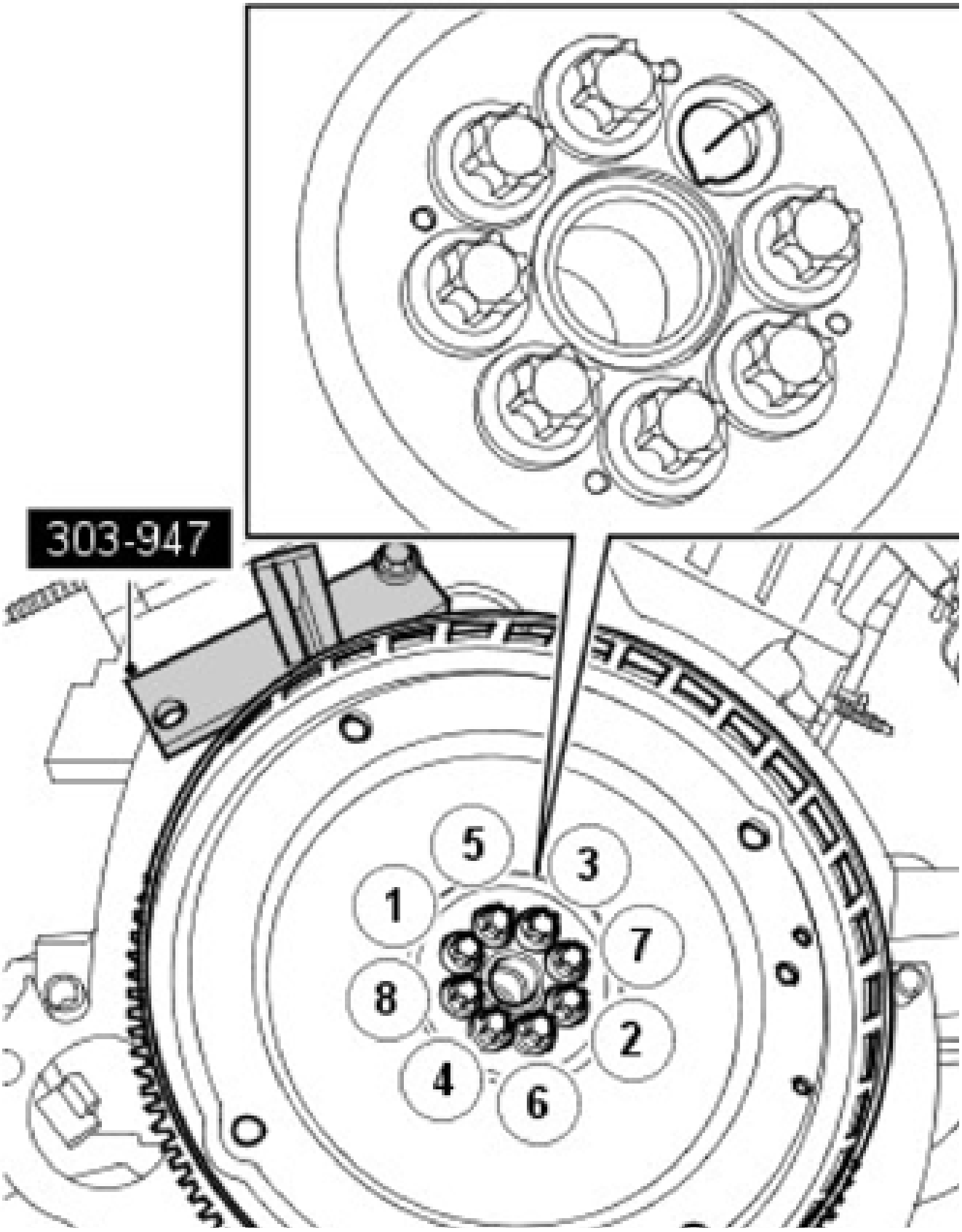

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2. Install the transmission.

   For additional information, refer to: **TRANSMISSION** .

3. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

OIL PUMP

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the front wheels and tires.
4. Remove the cylinder block cradle.

   For additional information, refer to: **CYLINDER BLOCK CRADLE** .

5. Remove the oil pump assembly.
   - Remove the 2 Torx screws.
   - Remove the driveshaft.

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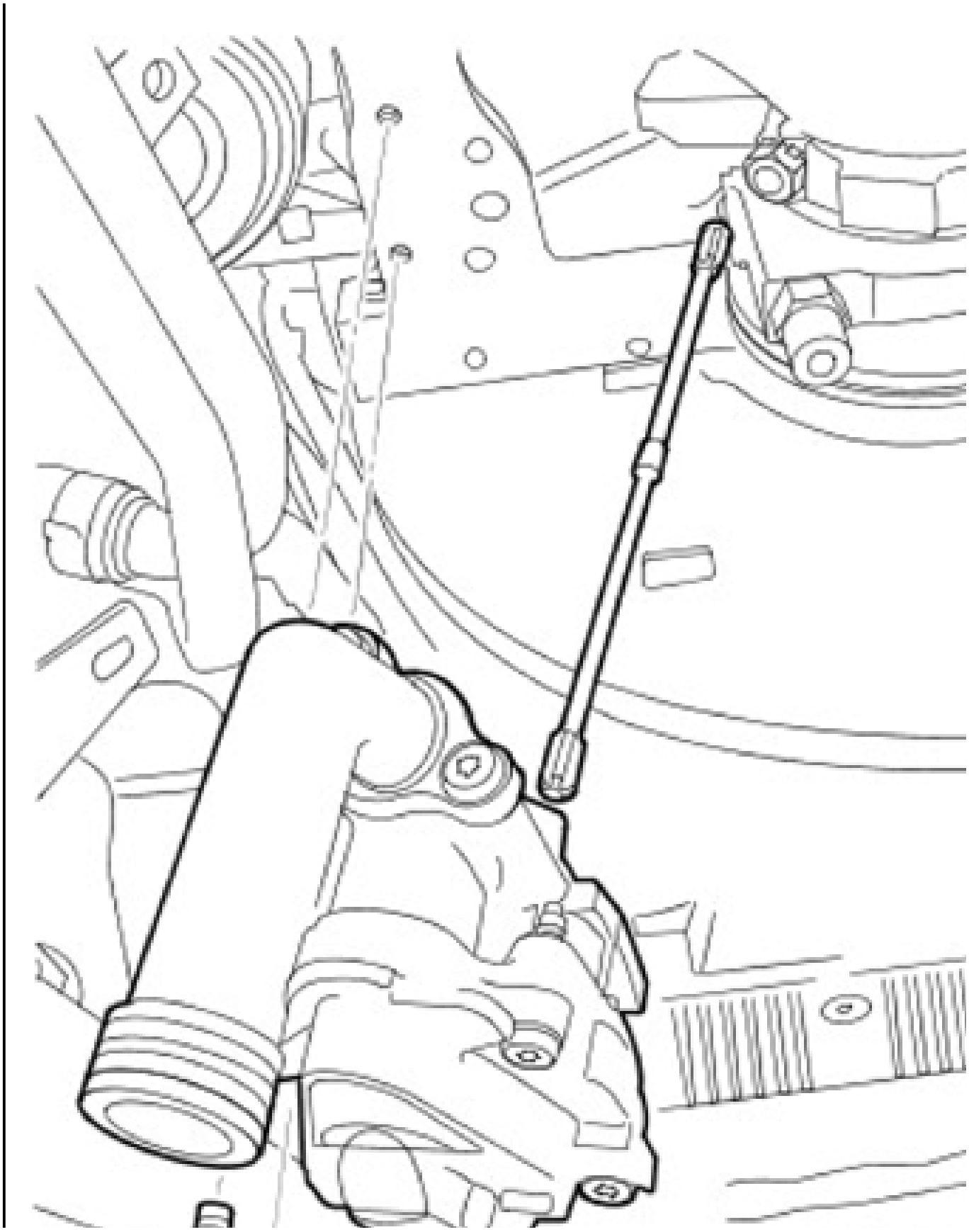

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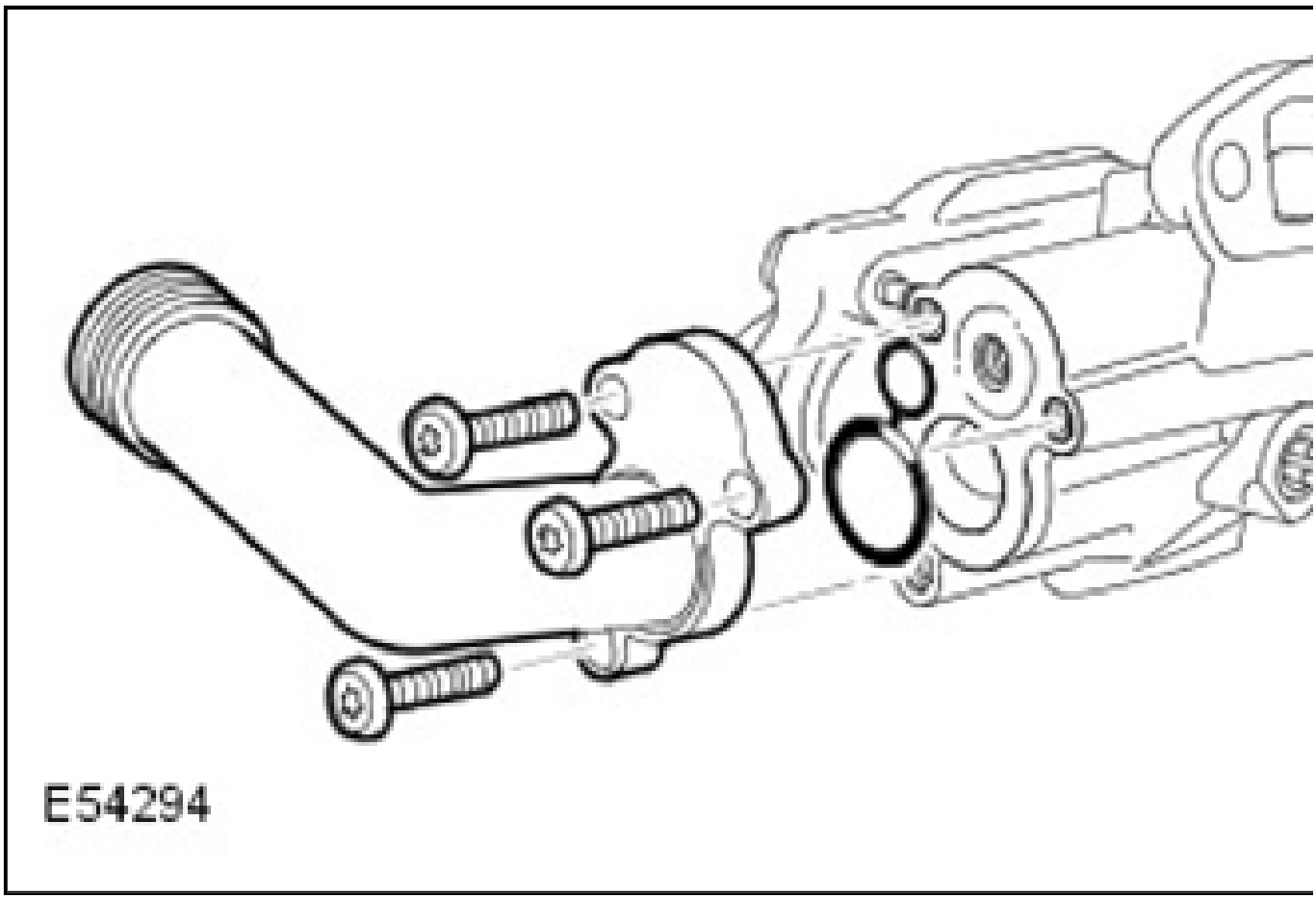
NOTE: Do not disassemble further if the component is removed for access only.

6. Remove the oil pickup pipe.
   - Remove the 3 Torx screws.
   - Remove and discard the seal.



INSTALLATION

1. Install the oil pickup pipe.
   - Clean the component mating faces.
   - Install a new seal.
   - Tighten the Torx screws to 10 Nm (7 lb.ft).

CAUTION: The oil pump driveshaft is not symmetrical. The longer end shown, is fitted into the oil pump.

2. Install the oil pump assembly.
   - Clean the component mating faces.

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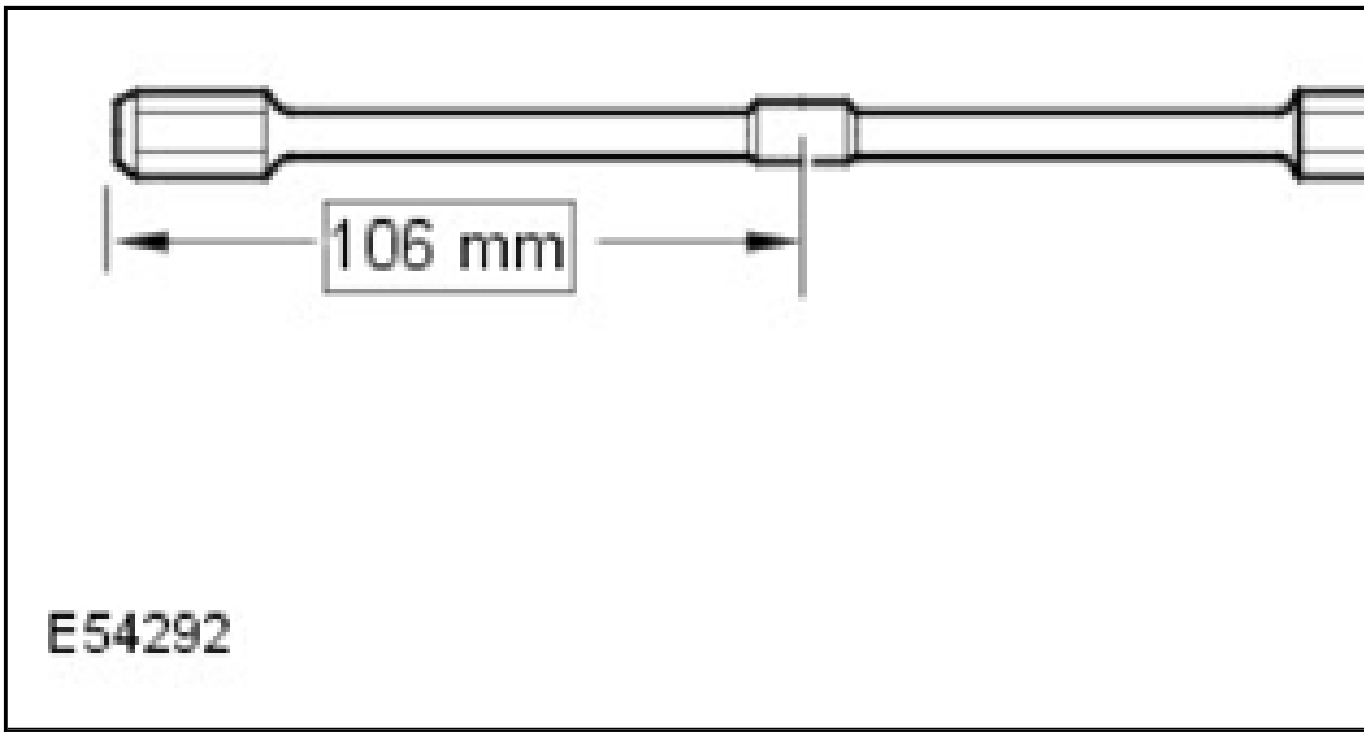
- Prime the oil pump.
- Install the driveshaft.
- Tighten Torx screws to 20 Nm (15 lb.ft).



3. Install the cylinder block cradle.

   For additional information, refer to: **CYLINDER BLOCK CRADLE** .

4. Install the front wheels and tires.
5. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

OIL PAN

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.

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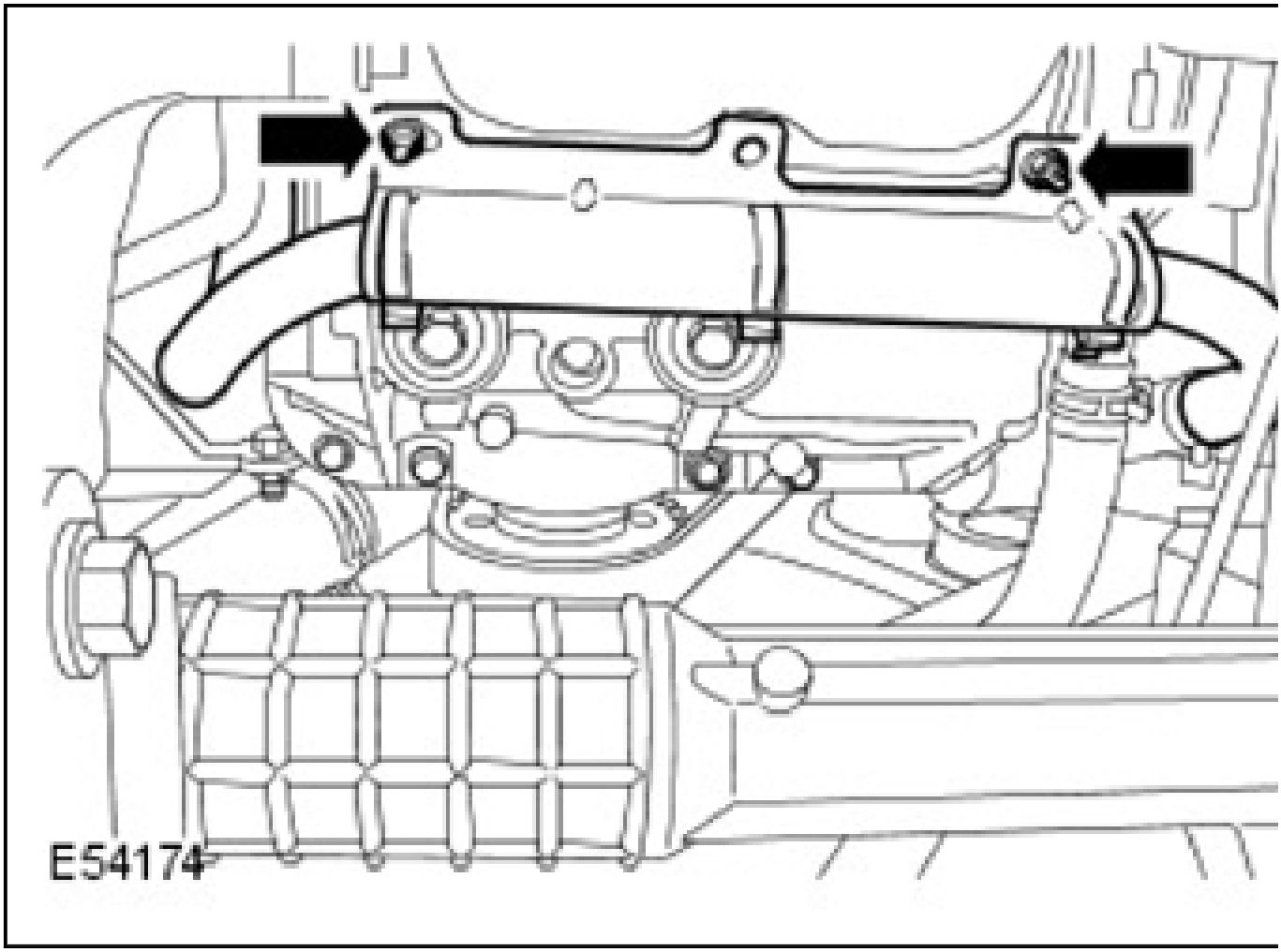
3. Drain the engine oil.

   For additional information, refer to: **ENGINE OIL DRAINING AND FILLING** .

4. Release the harness bracket.
   - Remove the 2 nuts.



5. Remove the oil pan.
   - Remove the 10 bolts.
   - Remove and discard the gasket.

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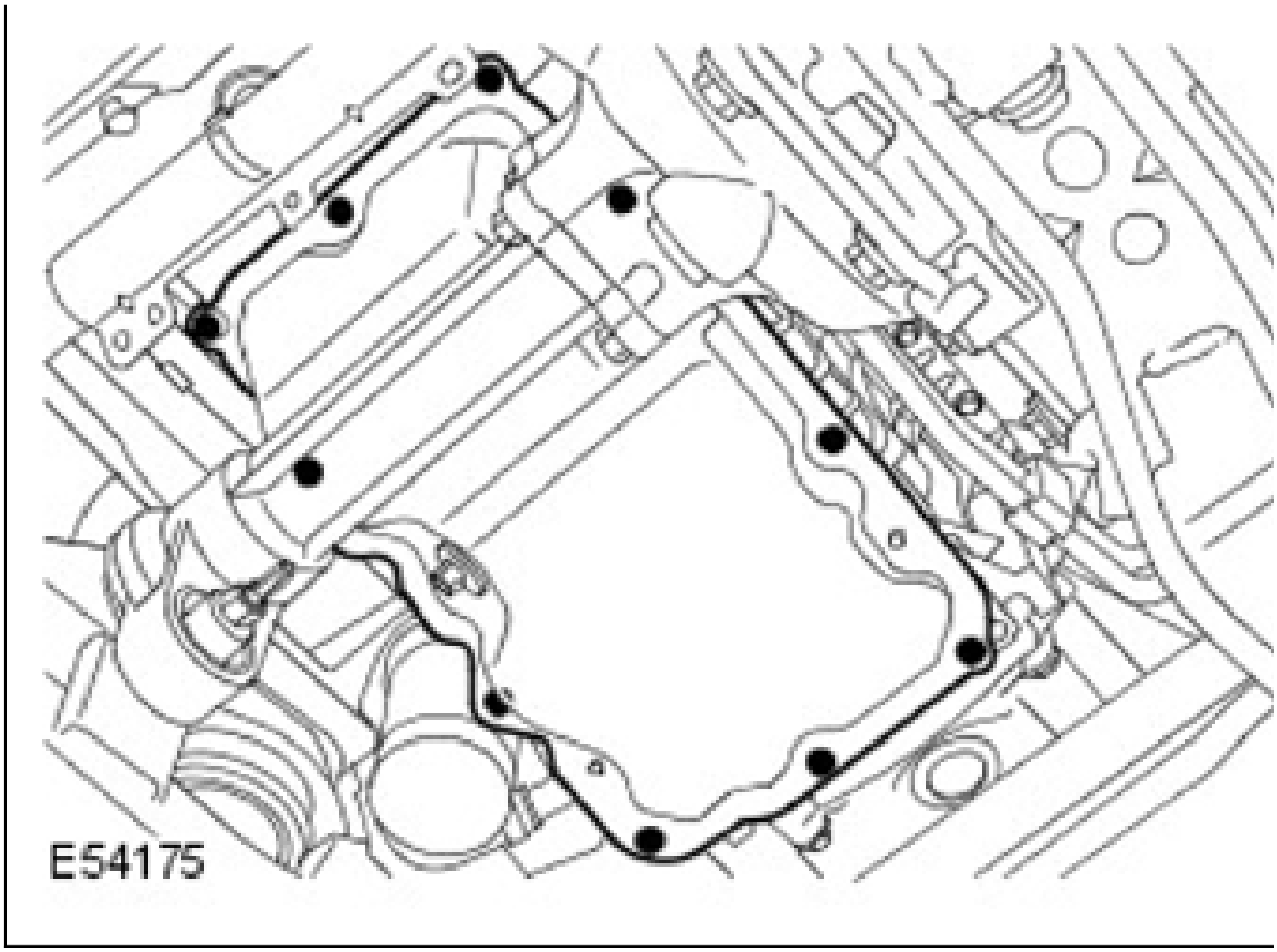

INSTALLATION

1. Install the oil pan.
   - Clean the component mating faces.
   - Install a new gasket.
   - Evenly and progressively tighten the bolts to 10 Nm (7 lb.ft).
2. Install the harness bracket.
   - Tighten the nuts to 6 Nm (4 lb.ft).
3. Fill the engine with oil.

   For additional information, refer to: **ENGINE OIL DRAINING AND FILLING** .

4. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

OIL COOLER

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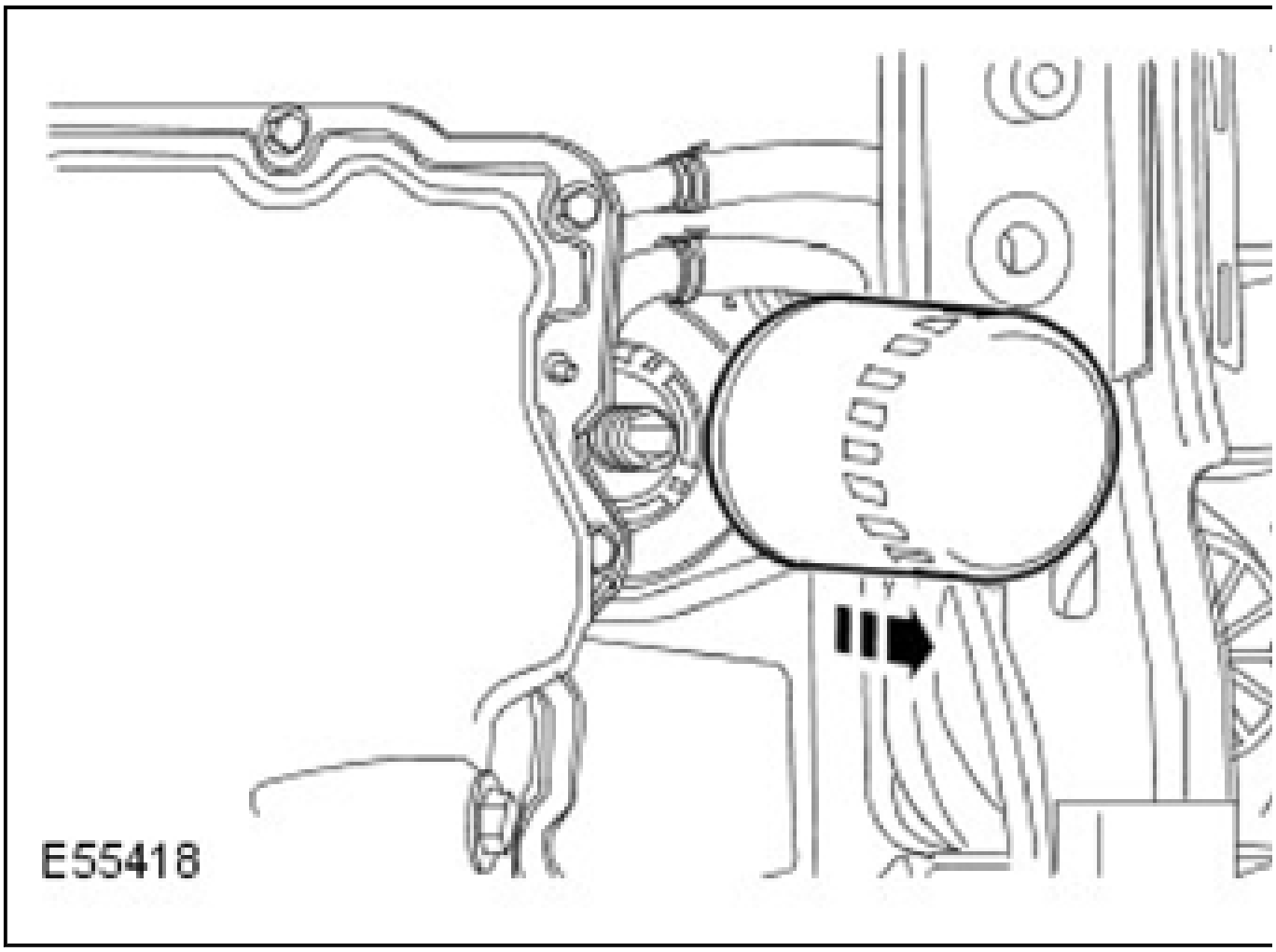
REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the oil filter.
   - Position a container to collect the fluid.



NOTE: Note the fitted position of the oil cooler assembly.

4. Remove the oil filter adapter.
   - Release the cooler from the oil filter head.

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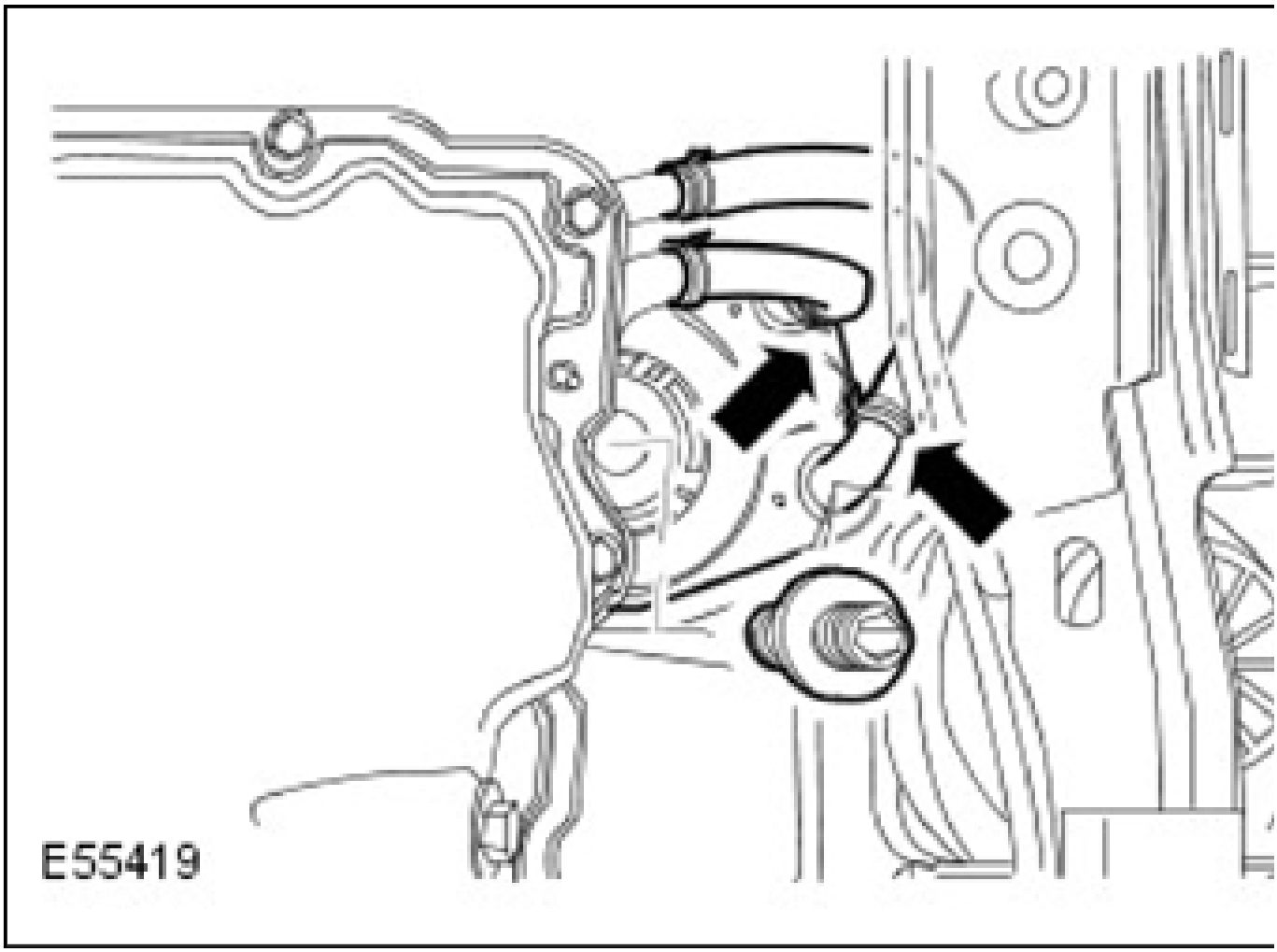
5. Clamp, then disconnect the coolant hoses from the oil cooler.



6. Remove the oil cooler.

INSTALLATION

NOTE: Fill the oil cooler with coolant to eliminate the air, prior to connecting the coolant hoses.

1. To install, reverse the removal procedure.
   - Tighten the adapter to 60 Nm (44 lb.ft)
   - Lubricate the oil filter seal with clean engine oil and tighten to 18 Nm (13 lb.ft).
2. Check and top-up the engine oil.
3. Top-up and bleed the coolant.

ENGINE FRONT COVER

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REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Drain the cooling system.

   For additional information, refer to: **AIR SUSPENSION AIR FILTER** .

3. Remove the intake manifold.

   For additional information, refer to: **INTAKE MANIFOLD** .

4. Remove the crankshaft pulley.

   For additional information, refer to: **CRANKSHAFT PULLEY** .

5. Remove the cooling fan lower shroud.
   - Release 2 clips from the cooling fan lower shroud.
   - Release and remove the cooling fan lower shroud from the cooling pack.

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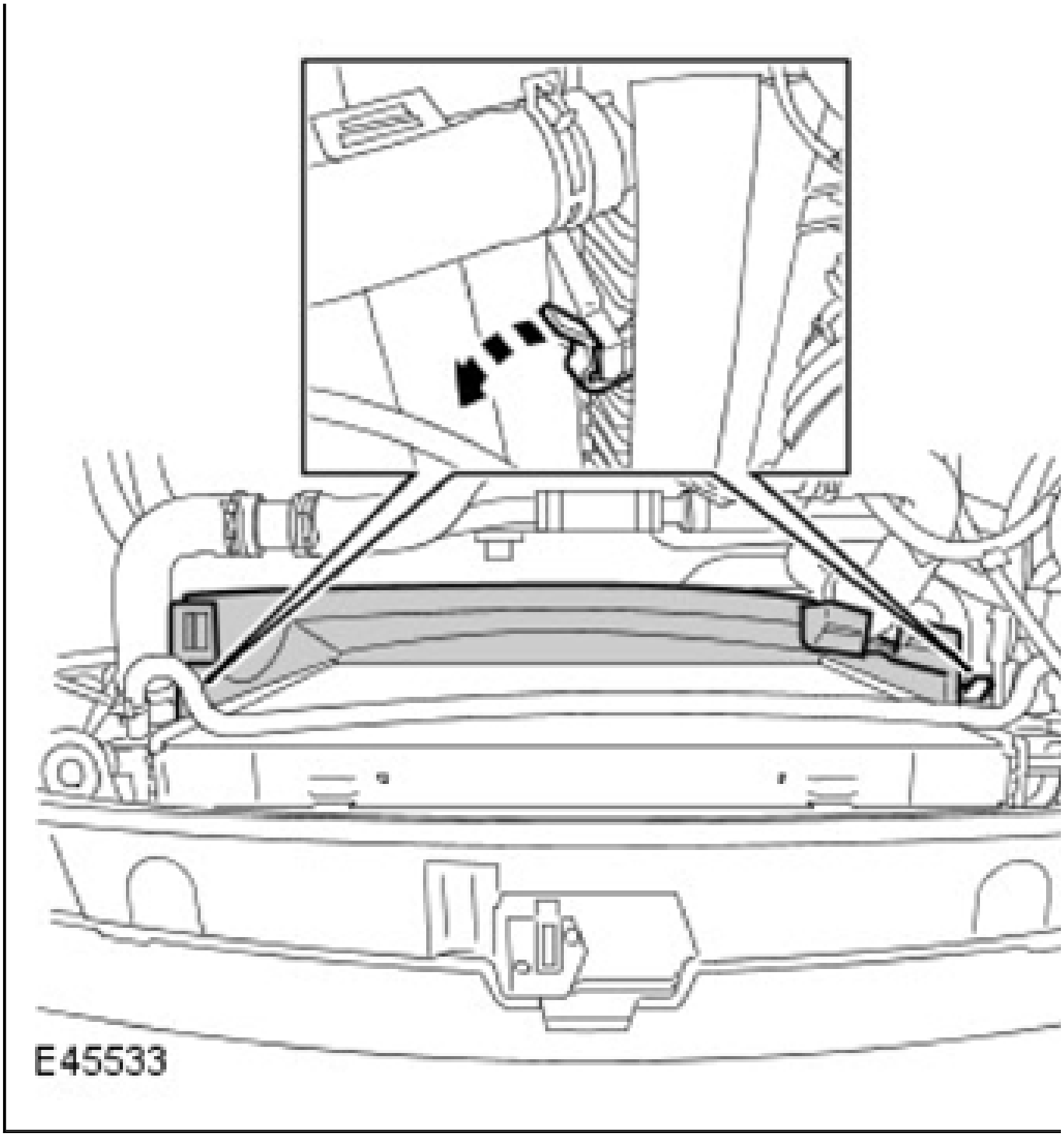

6. Position the A/C compressor mounting bracket assembly aside.
    - Remove the 4 bolts.
    - Tie aside.

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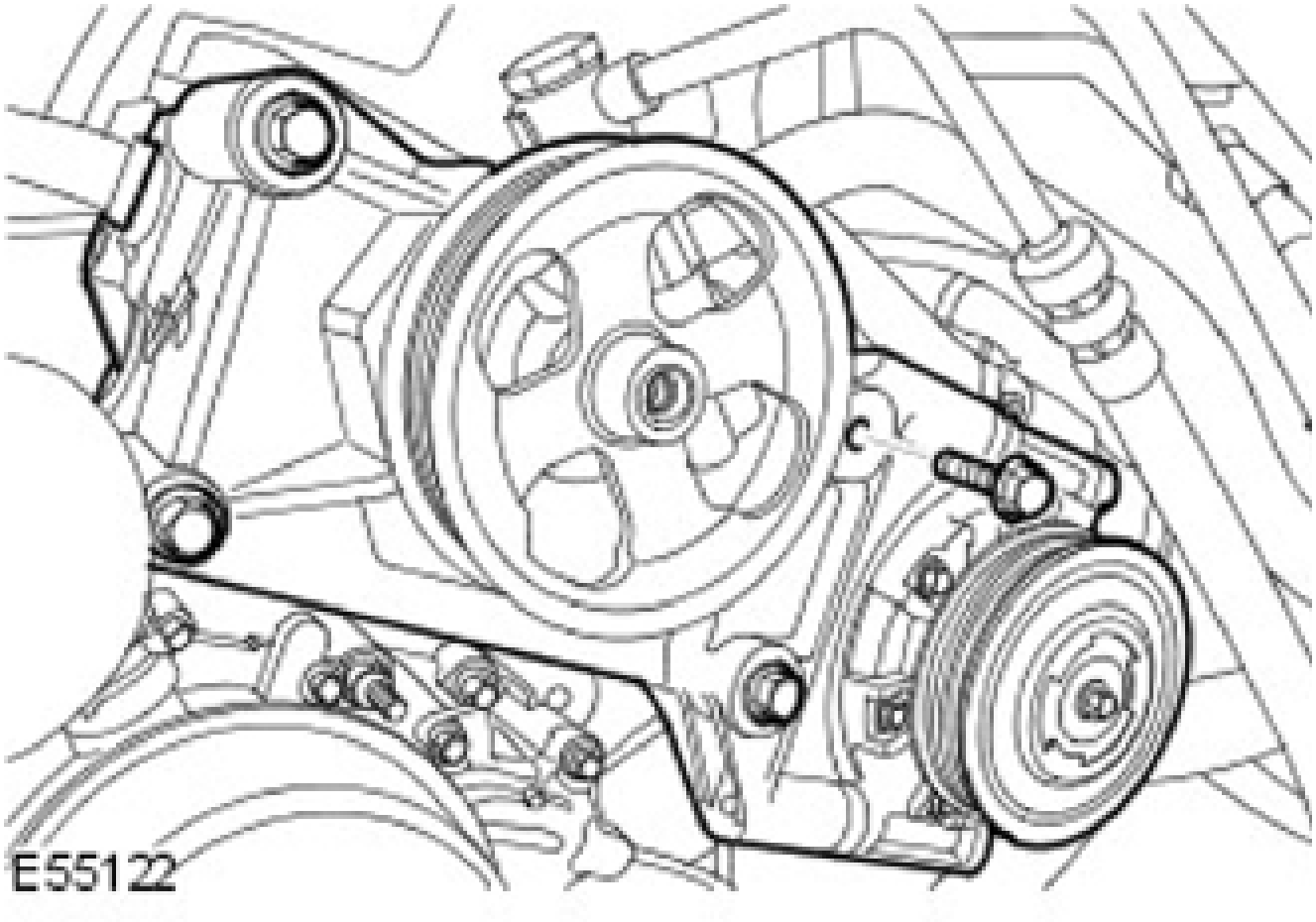

7. Disconnect the 2 hoses from the coolant pump.
    - Release the cylinder head coolant flange, to aid coolant hose removal.
    - Remove the 3 bolts.
    - Position the coolant hoses aside for access.

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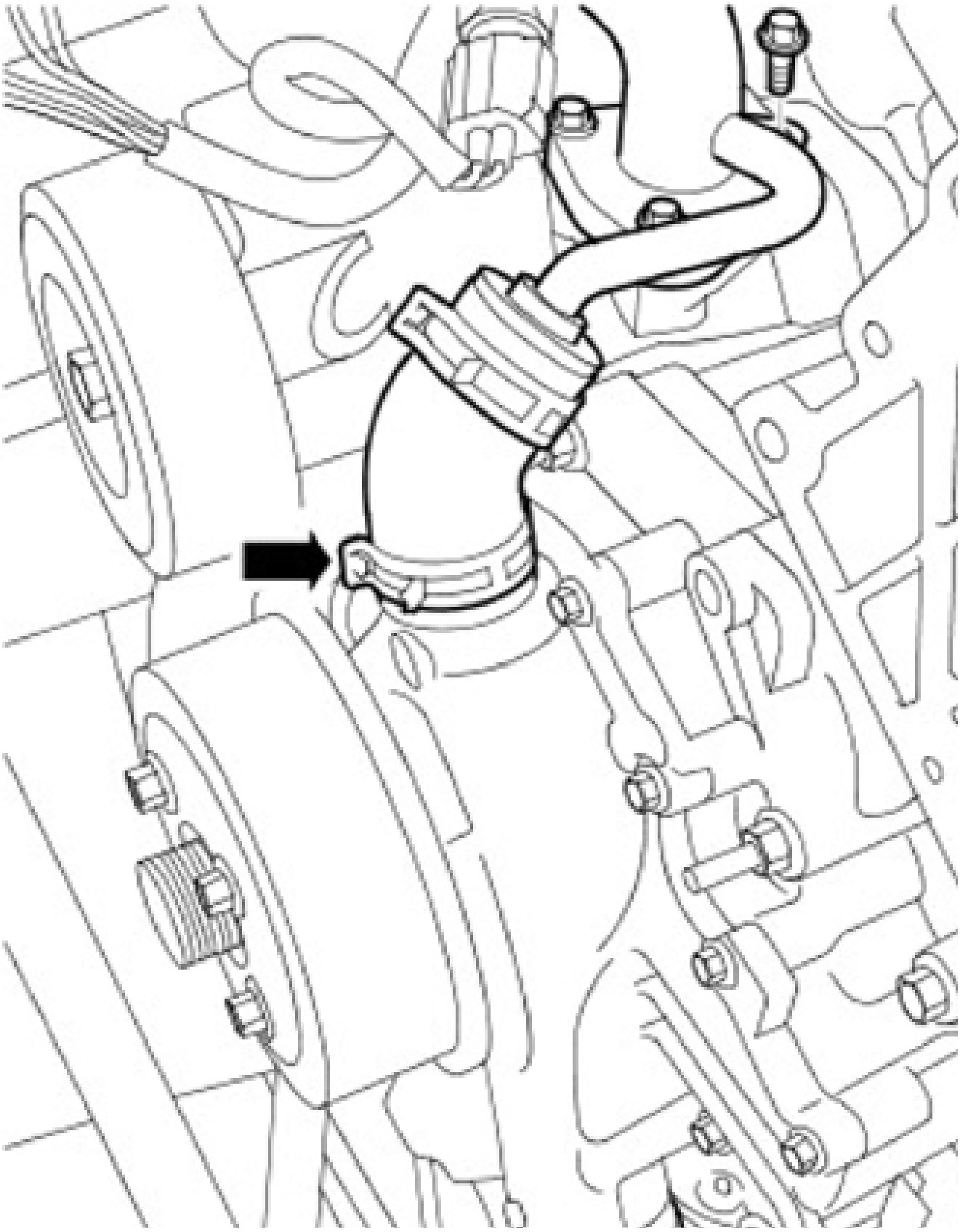

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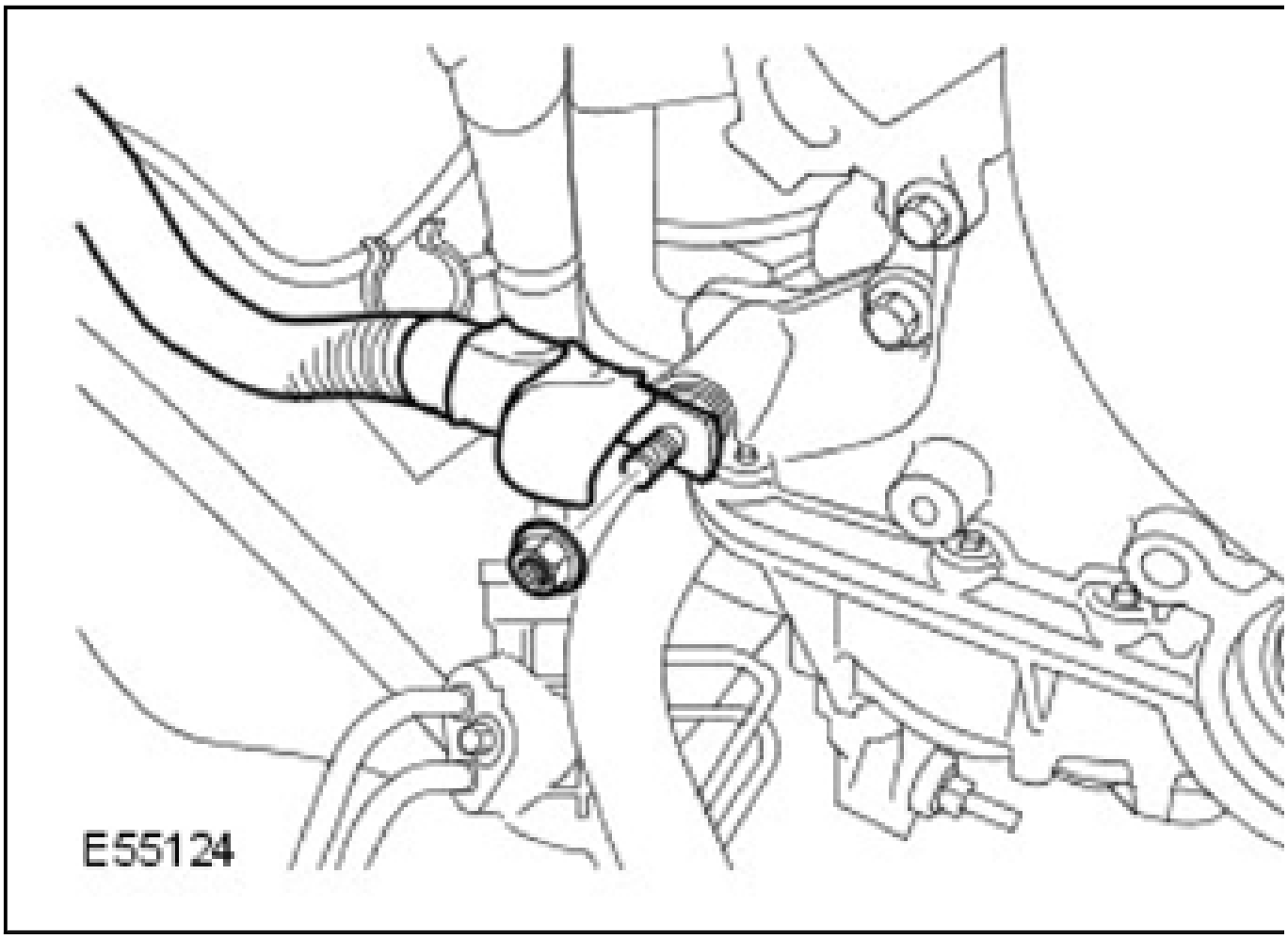
8. Disconnect the engine ground cable.
    - Remove the nut.



9. Release the transmission line support bracket.
    - Remove the nut.
    - Position aside.

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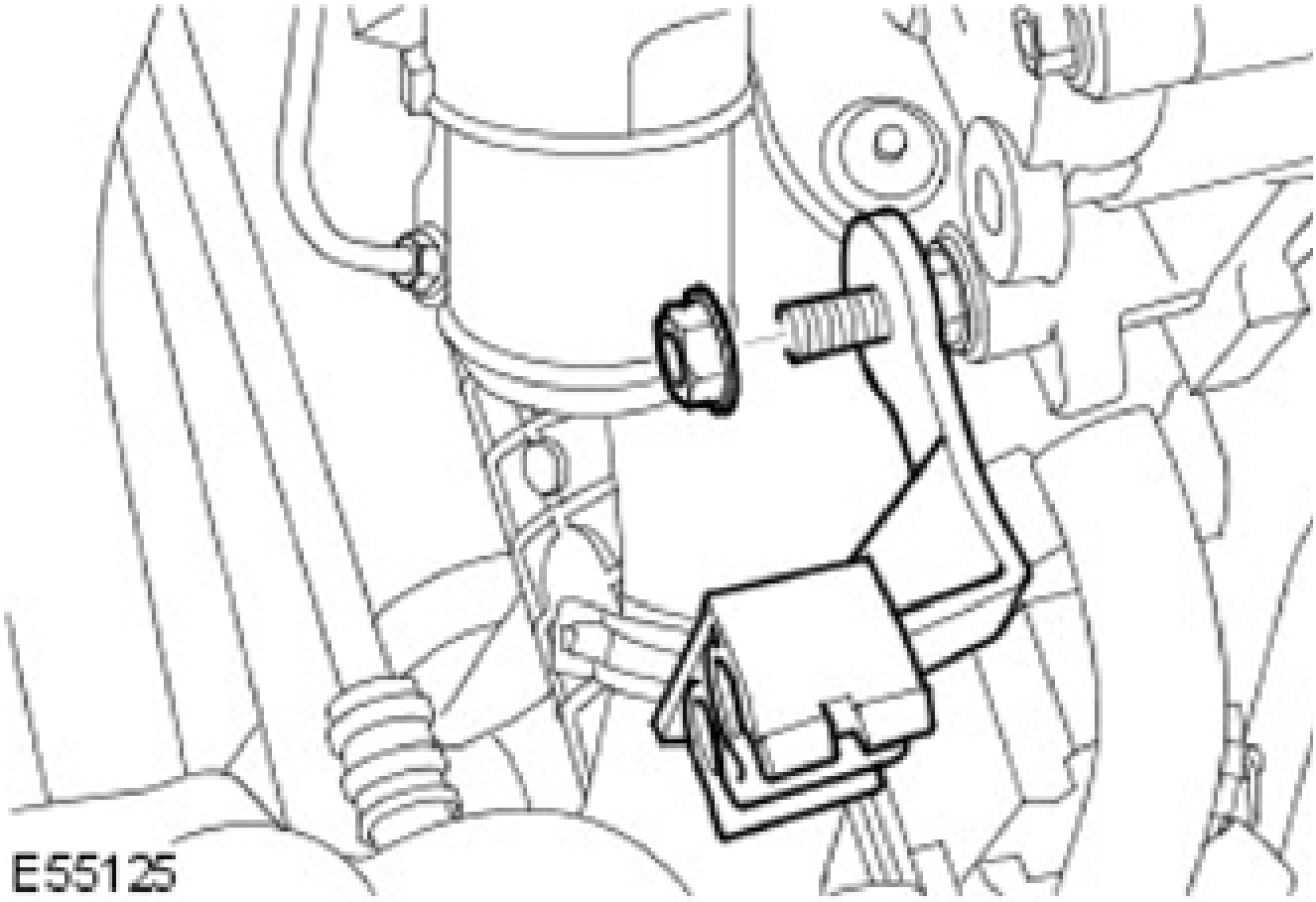

10. Remove the engine front cover.
    - Remove the 5 studs.
    - Remove the 4 bolts.
    - Remove the 5 cylinder cradle bolts.
    - Remove and discard the gasket.

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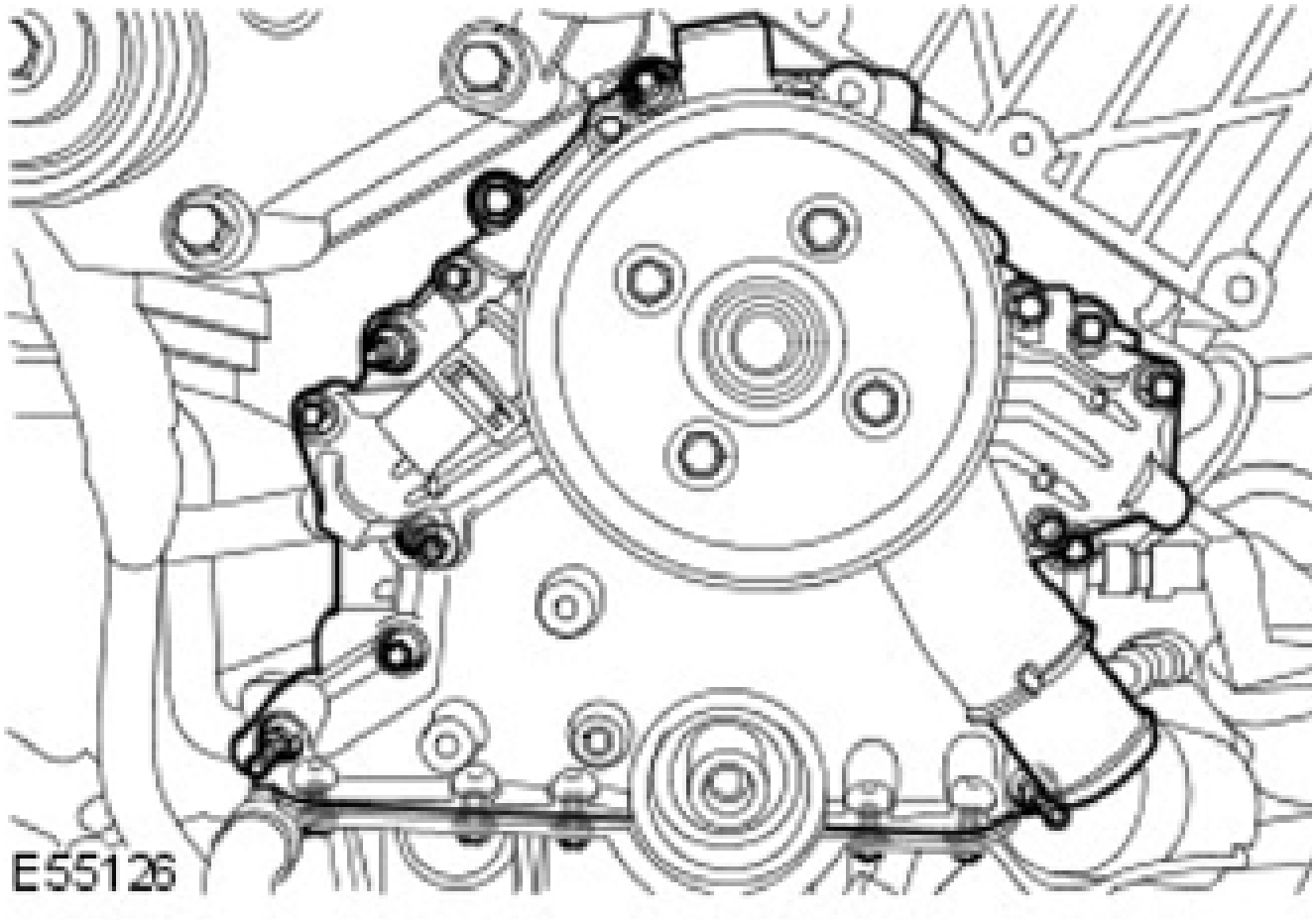

NOTE: Do not disassemble further if the component is removed for access only.

11. Remove the coolant pump.
    - Remove the 12 bolts.
    - Remove and discard the gasket.

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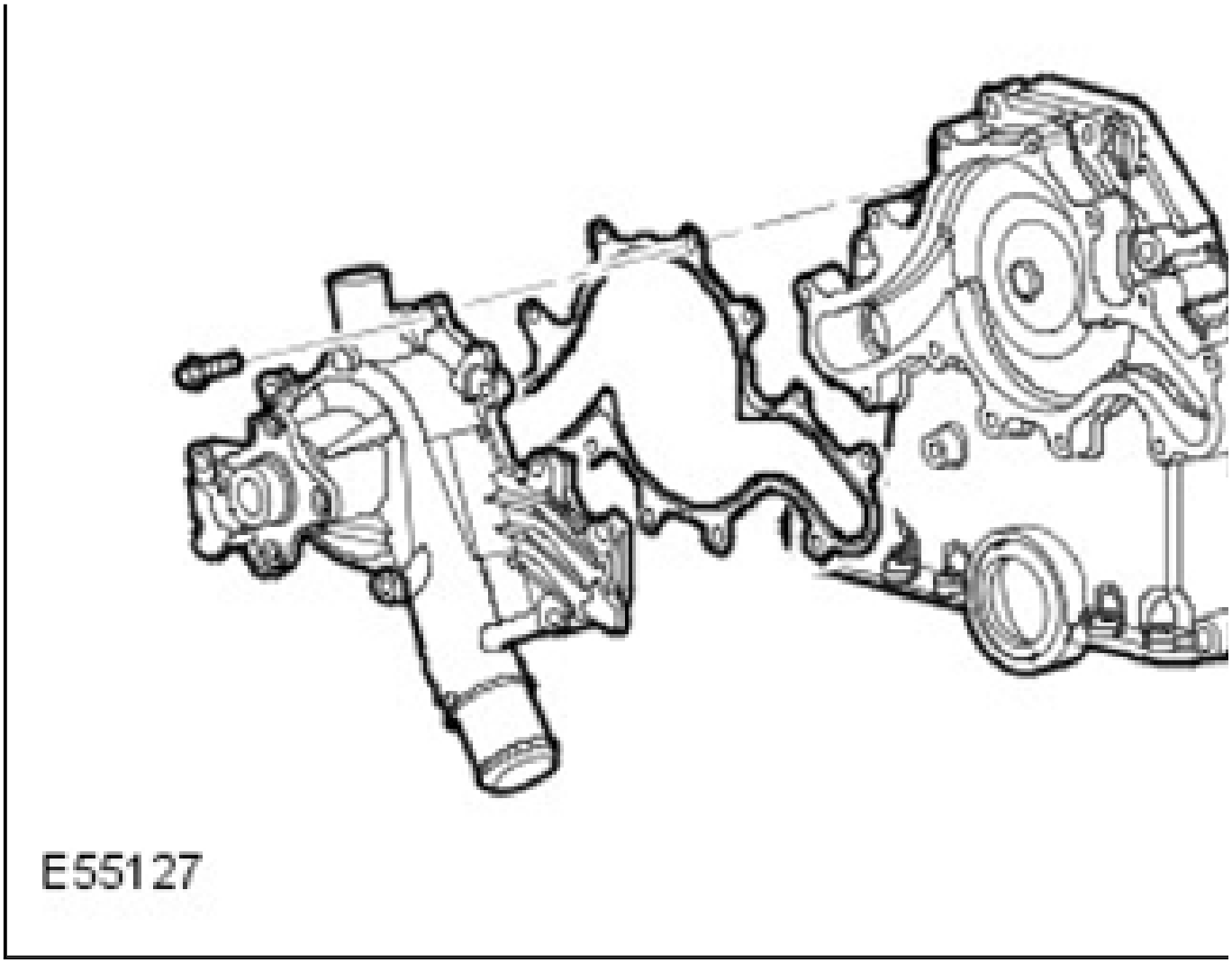

INSTALLATION

1. Install the coolant pump.
    - Clean the component mating faces.
    - Install the new gasket.
    - Tighten the bolts to 10 Nm (7 lb.ft).

CAUTION: Care must be taken when removing sealant from gasket faces, prevent damage to the mating faces.

NOTE: The component must be installed within 20 minutes of the sealant application.
Make sure the cylinder block cradle gasket is located correctly around the front oil seal.
Install the engine front cover.

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2.
   - Clean the component mating faces.
   - Spirit wipe the gasket mating faces.
   - Install a new gasket.
   - Apply sealant to the 4 places shown.

NOTE: Tighten the bolts in two stages.

3. Install the engine front cover bolts.
   - Evenly and progressively tighten the bolts and studs to 8 Nm (6 lb.ft).
   - Tighten the M6 bolts to 10 Nm (7 lb.ft).
   - Tighten the M8 bolts and studs to 20 Nm (15 lb.ft).
4. Install the transmission support bracket.
   - Tighten the nut to 20 Nm (15 lb.ft).

NOTE: Care must be taken when installing the ground connections. The engine will fail to start on either or both banks if the ground is poor.

5. Connect the engine ground cable, make sure the mating faces are clean.
   - Tighten the nut to 20 Nm (15 lb.ft).
6. Install the A/C compressor mounting bracket assembly.
   - Release the cable tie.
   - Tighten the bolts to 45 Nm (33 lb.ft).
7. Install the crankshaft pulley.

   For additional information, refer to: **CRANKSHAFT PULLEY** .

8. Install the cooling fan shroud.
9. Install the intake manifold.

   For additional information, refer to: **INTAKE MANIFOLD** .

10. Refill and bleed the cooling system.

    For additional information, refer to: **Cooling System Draining, Filling and Bleeding** .

11. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

TIMING DRIVE COMPONENTS

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SPECIAL TOOL(S)

	Crankshaft rotating tool 303-674

REMOVAL

NOTE: This procedure covers the removal and installation of the following components: Primary timing chain tensioner, timing chain guide, jackshaft sprocket, crankshaft sprocket and timing chain.

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the engine front cover.

   For additional information, refer to: **ENGINE FRONT COVER** .

3. Remove the primary timing chain tensioner.
   - Remove the 2 bolts.

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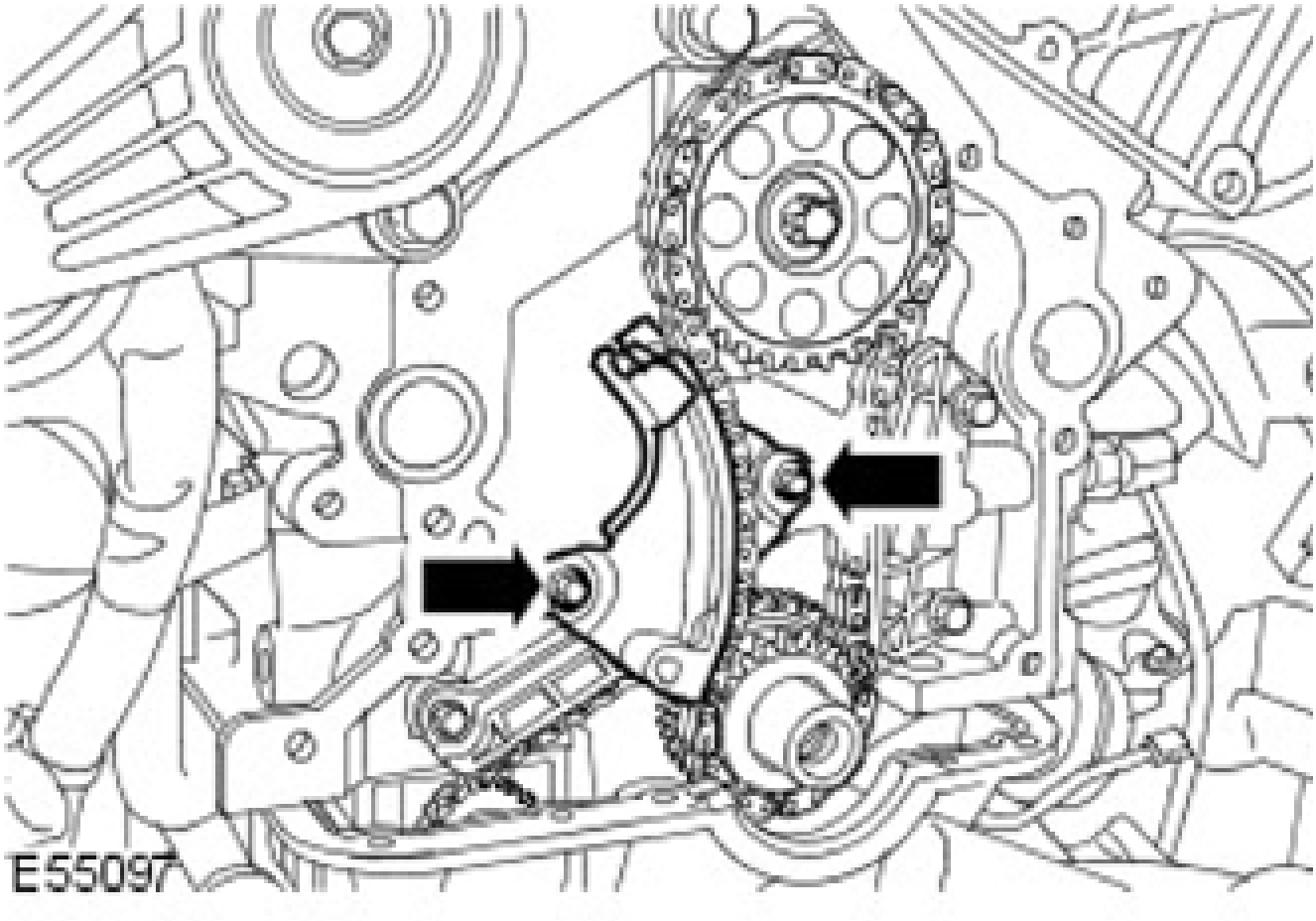

4. Remove the primary timing chain tensioner guide.
    - Remove the 2 bolts.

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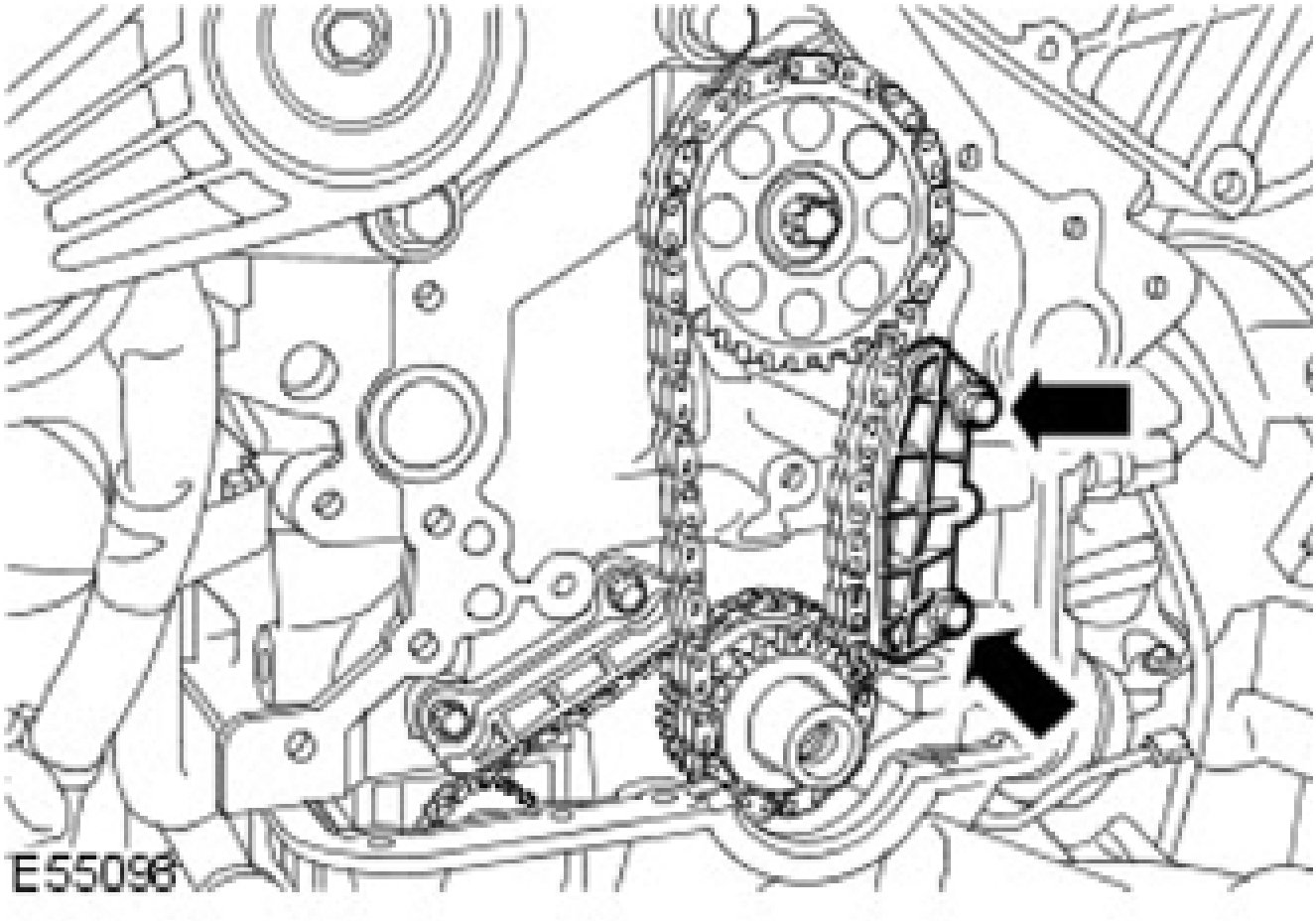

5. Install the special tool to the crankshaft.
6. Remove the jackshaft sprocket.
    - Using an additional wrench and the special tool, restrain the jackshaft sprocket.
    - Remove and discard the Torx bolt.

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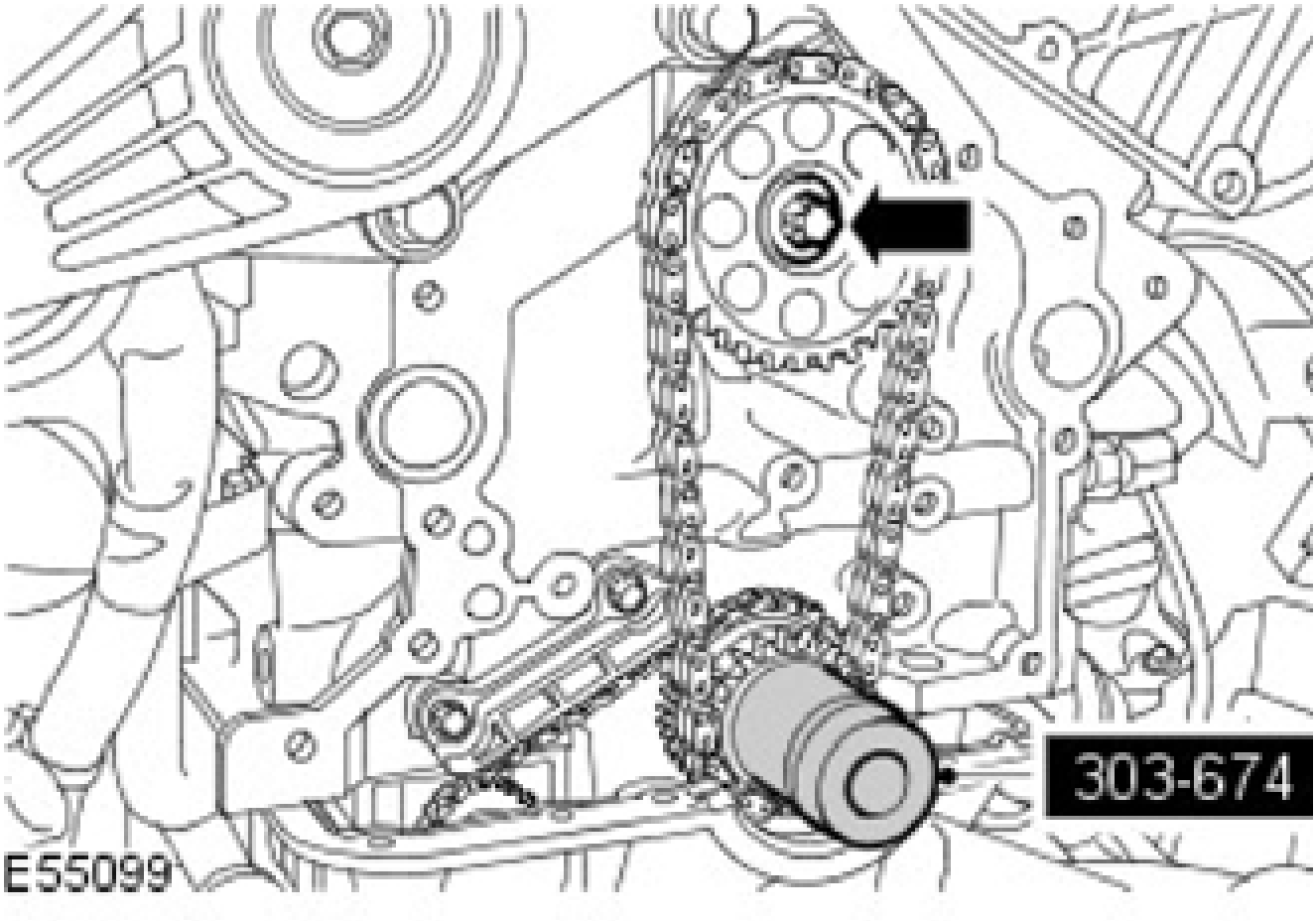

NOTE: Note the fitted position.

7. Remove the crankshaft sprocket.
    - Remove the primary timing chain.

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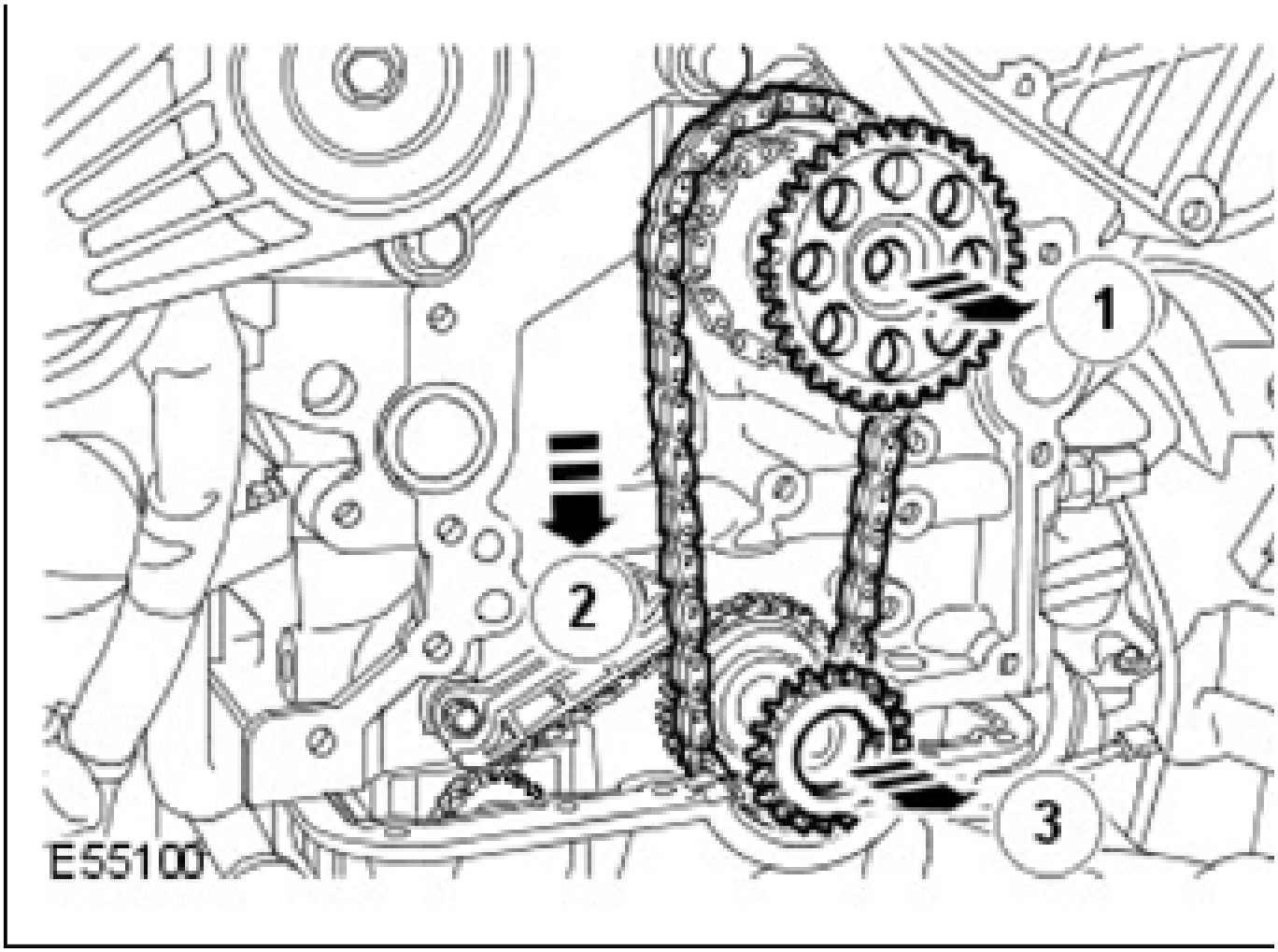

INSTALLATION

1. Install the primary timing chain.
    - Clean the component mating faces.
    - Install the crankshaft sprocket, the recessed face locates to the crankshaft side.
    - Install the special tool to the crankshaft.
2. Install the jackshaft sprocket.
    - Clean the component mating faces.
    - Locate the primary timing chain to the sprockets.
    - Install a new Torx bolt, lightly tighten at this stage.
3. Install the timing chain guide.
    - Clean the component mating faces.
    - Tighten the bolts to 20 Nm (15 lb.ft).
4. Install the timing chain tensioner.
    - Clean the component mating faces.

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- Tighten the bolts to 10 Nm (7 lb.ft).

5. Tighten the new Torx bolt to 45 Nm (33 lb.ft), then a further 70 degrees.
6. Install the engine front cover.

   For additional information, refer to: **ENGINE FRONT COVER** .

7. Adjust the valve timing.

   For additional information, refer to: **CAMSHAFT TIMING** .

8. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

CAMSHAFT DRIVE CASSETTE LH

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the cylinder head LH assembly.

   For additional information, refer to: **CYLINDER HEAD LH** .

3. Remove the timing drive components.

   For additional information, refer to: **TIMING DRIVE COMPONENTS** .

4. Remove the camshaft drive cassette assembly.
   - Remove the bolt retaining the chain guide.

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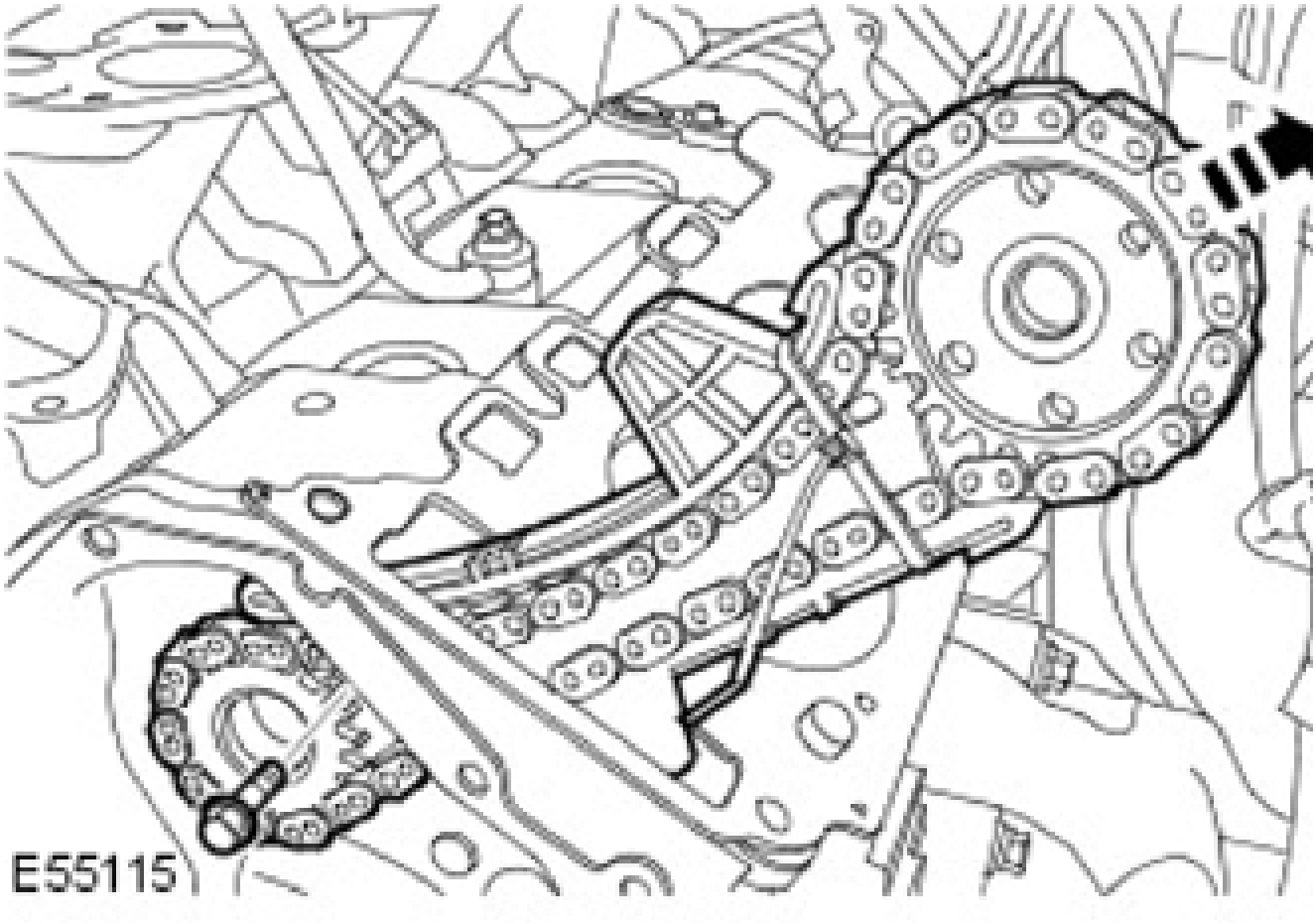

NOTE: Do not disassemble further if the component is removed for access only.

5. Disassemble the cassette assembly.
   - Release the cable tie.
   - Remove the sprockets and the chain.
   - Clean and inspect the components for deterioration.

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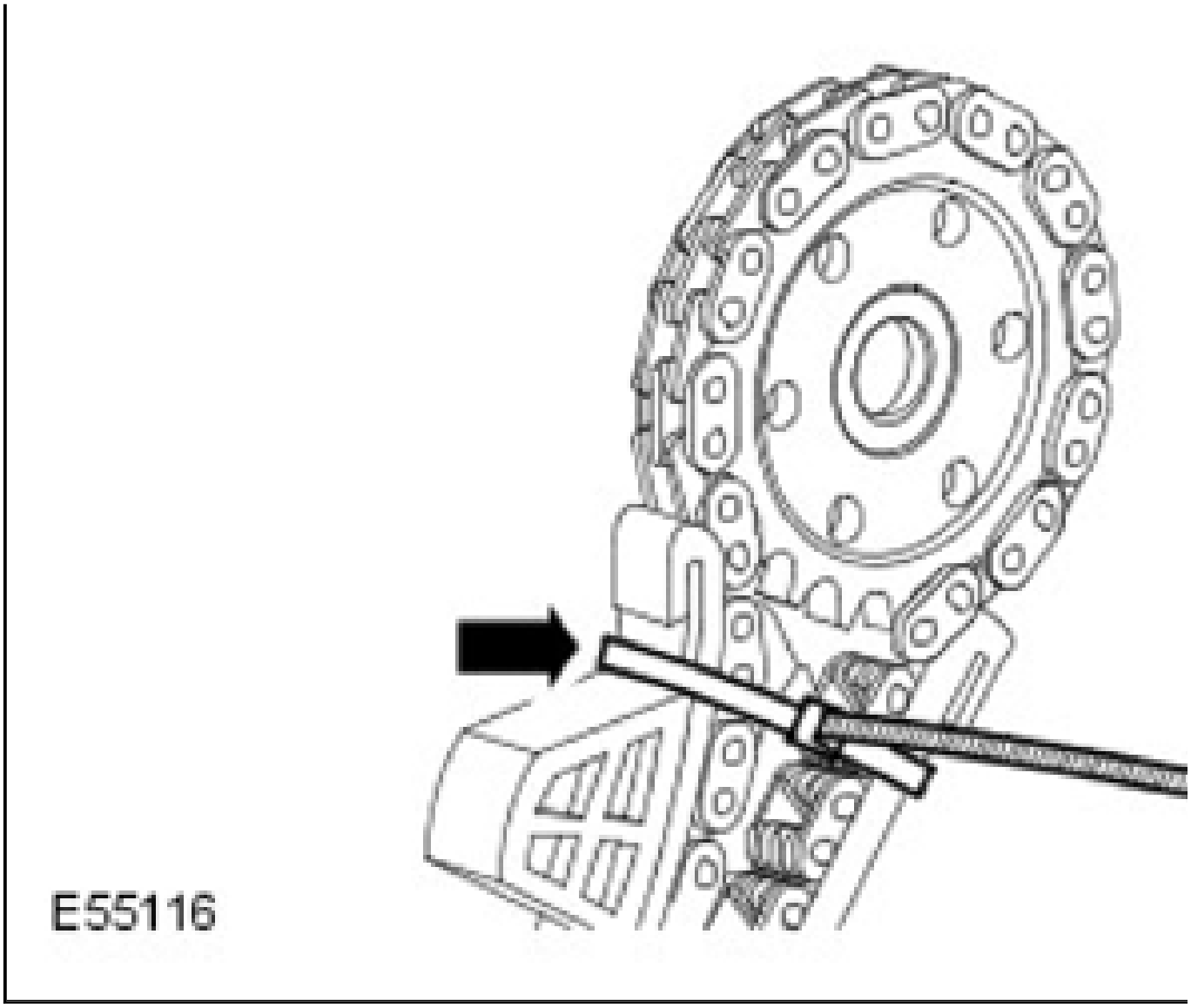

INSTALLATION

1. Assemble the cassette assembly.
    - Install the chain and the sprockets.
    - Secure with a cable tie.
2. Install the camshaft drive cassette assembly.
    - Tighten the bolt to 25 Nm (18 lb.ft).
3. Install the timing drive components.

    For additional information, refer to: **TIMING DRIVE COMPONENTS** .

4. Install the cylinder head LH assembly.

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For additional information, refer to: **CYLINDER HEAD LH** .

5. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

CAMSHAFT DRIVE CASSETTE RH

SPECIAL TOOL(S)

	Sprocket holding tool RH rear cassette 303-643

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the RH cylinder head assembly.

   For additional information, refer to: **CYLINDER HEAD RH** .

3. Remove the torque converter flexplate.

   For additional information, refer to: **FLEXPLATE** .

4. Remove the cylinder block jackshaft plug.
   - Drift to release.

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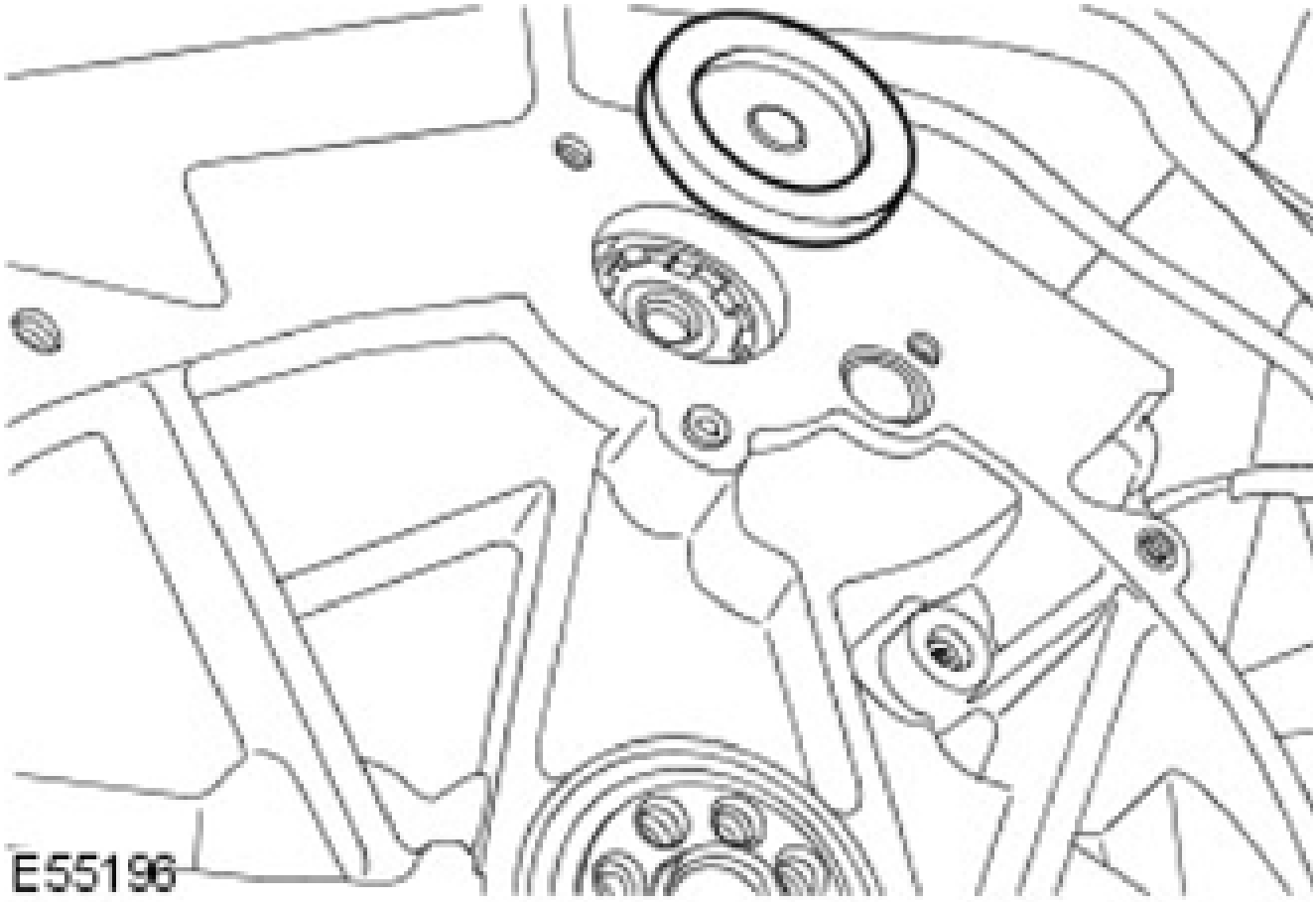

5. Using the special tool, remove the RH cassette jackshaft drive, sprocket bolt.
    - Remove and discard the Torx bolt.

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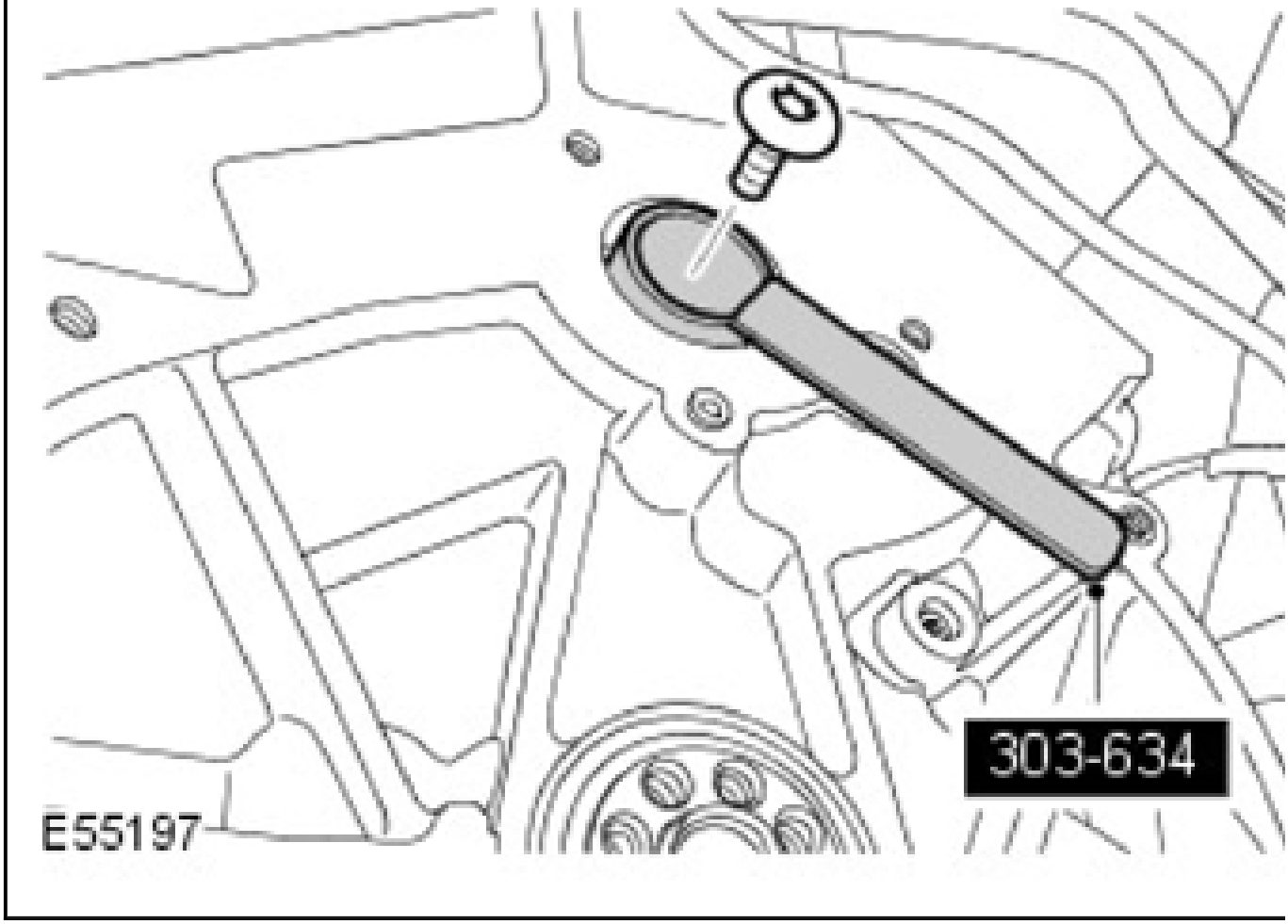

6. Remove the camshaft drive cassette assembly.
    - Remove the bolt retaining the chain guide.
    - Remove and discard the O-ring seal.

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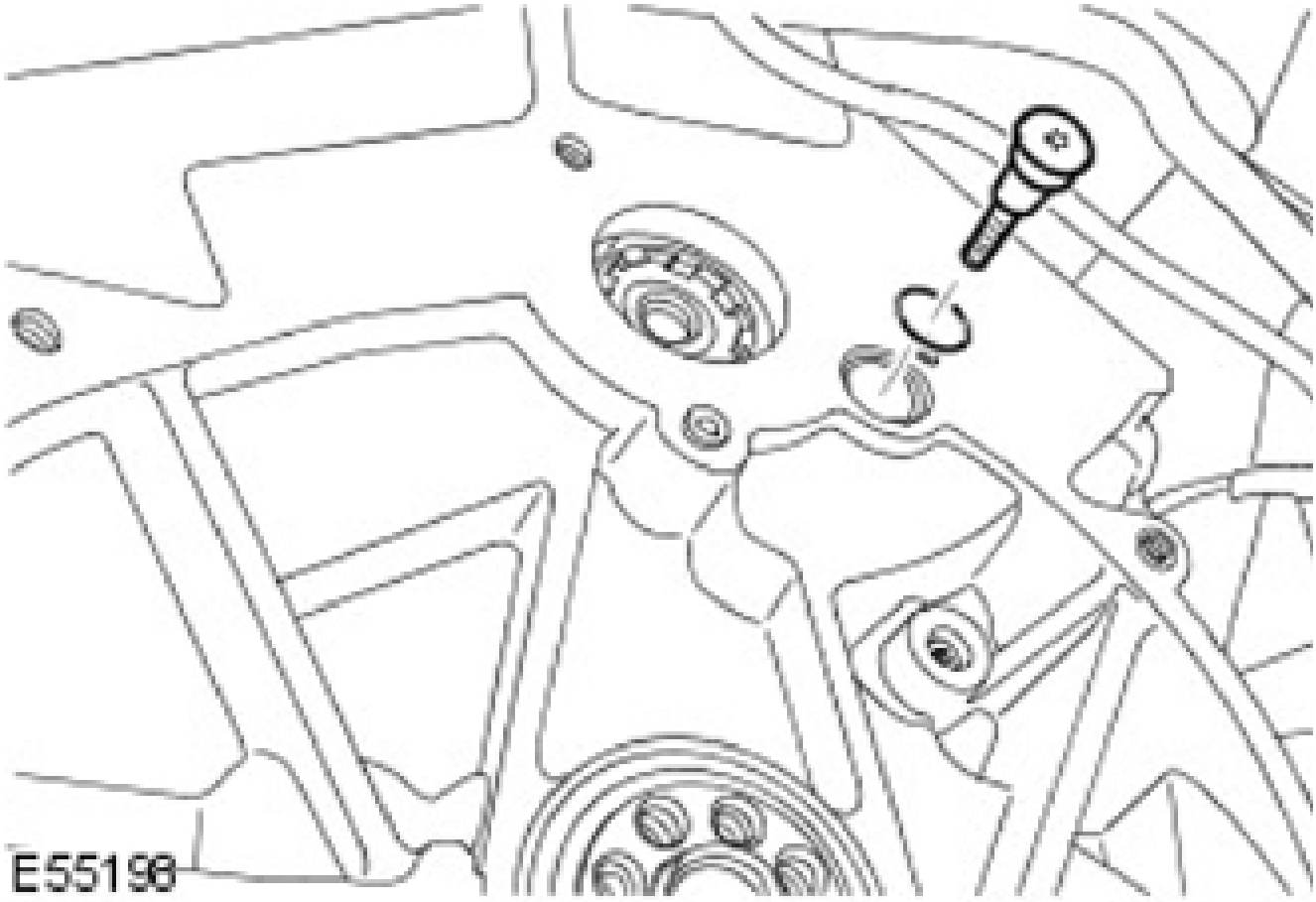

NOTE: Do not disassemble further if the component is removed for access only.

7. Disassemble the cassette assembly.
   - Release the cable tie.
   - Remove the sprockets and the chain.
   - Clean and inspect the components for deterioration.

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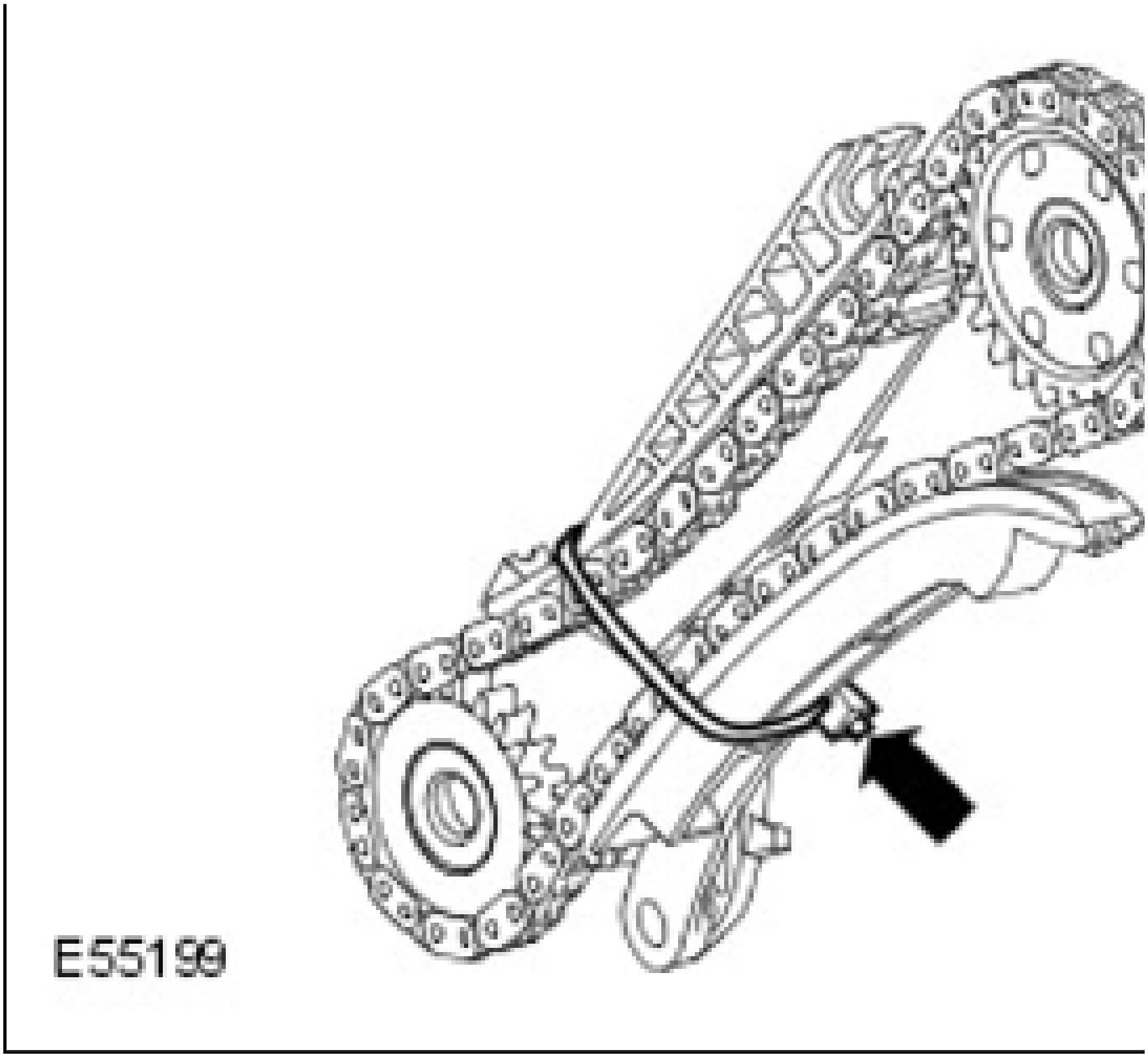

INSTALLATION

1. Assemble the cassette assembly.
    - Install the chain and the sprockets.
    - Secure with a cable tie.
2. Install the camshaft drive cassette assembly.
    - Install a new O-ring seal.
    - Tighten the bolt to 12 Nm (9 lb.ft).
3. Using the special tool, tighten the new jackshaft sprocket bolt to 40 Nm (30 lb.ft), then a further 45 degrees.

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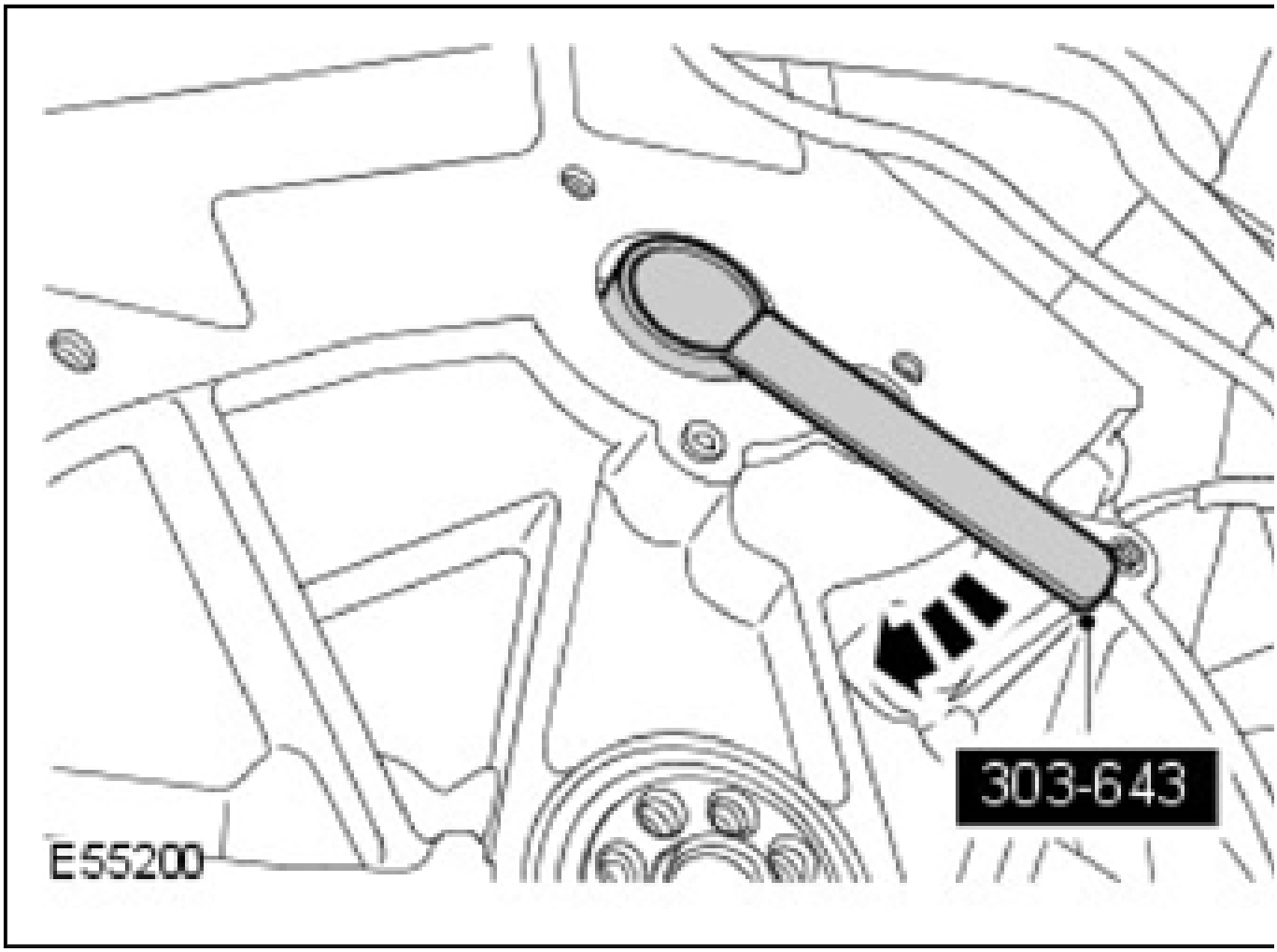

4. Install the cylinder block jackshaft plug.
   - Clean the component mating faces.
5. Install the torque converter flexplate.

   For additional information, refer to: **FLEXPLATE** .

6. Install the cylinder head RH assembly.

   For additional information, refer to: **CYLINDER HEAD RH** .

7. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

ENGINE DYNAMIC BALANCE SHAFT

SPECIAL TOOL(S)

	Crankshaft TDC timing/locking tool

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303-573

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

   WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the front wheels and tires.
4. Remove the cylinder block cradle.

   For additional information, refer to: **CYLINDER BLOCK CRADLE** .

5. Remove the balance shaft.
   - Remove the 4 Torx bolts.
   - Remove the drive chain tensioner.
   - Remove the tensioner blade.

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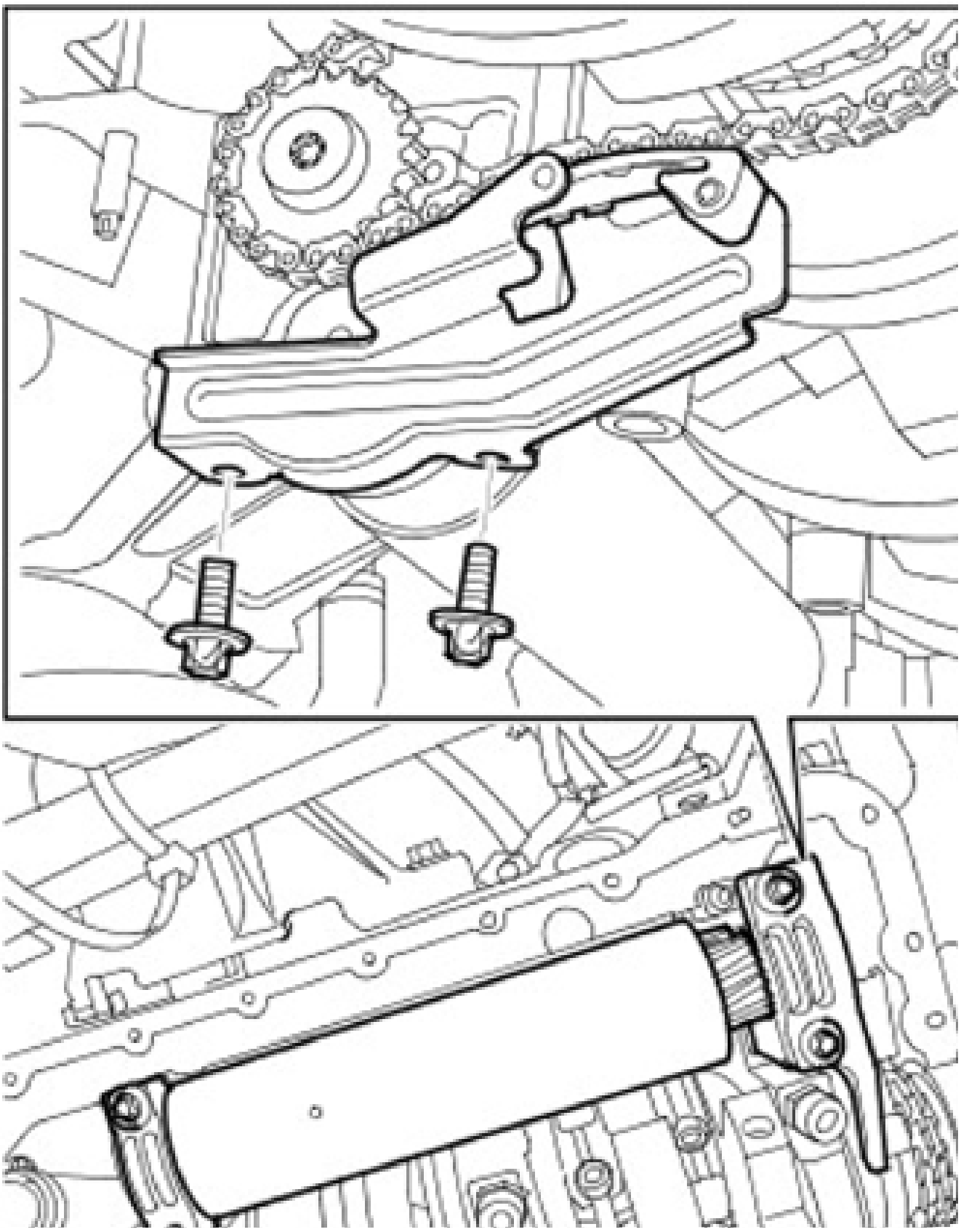

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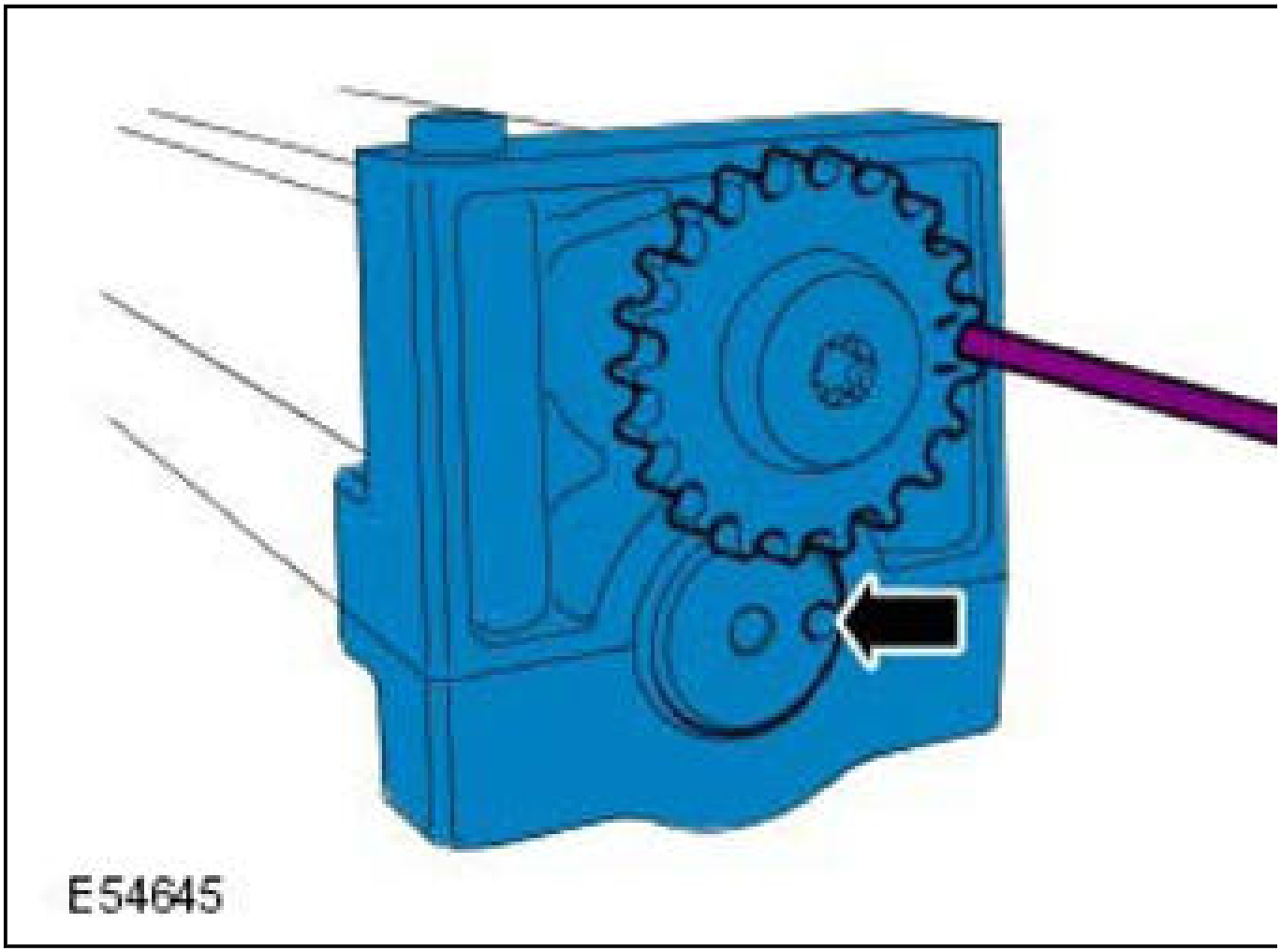
INSTALLATION

NOTE: Vehicles fitted with early type balance shaft.
Due to the gear ratio, it may be necessary to rotate the balance shaft up to 7 complete turns to find the correct position.

1. Align the balance shaft.
   - Clean the components.
   - Lubricate the components.
   - Install a 4 mm (0.16 in) pin to lock the shaft as shown.



NOTE: Vehicles fitted with later type balance shaft.
If a new balance shaft is being fitted make sure the timing pin is not removed prior to fitting.
Due to the gear ratio, it may be necessary to rotate the balance shaft up to 7 complete turns to find the correct position.

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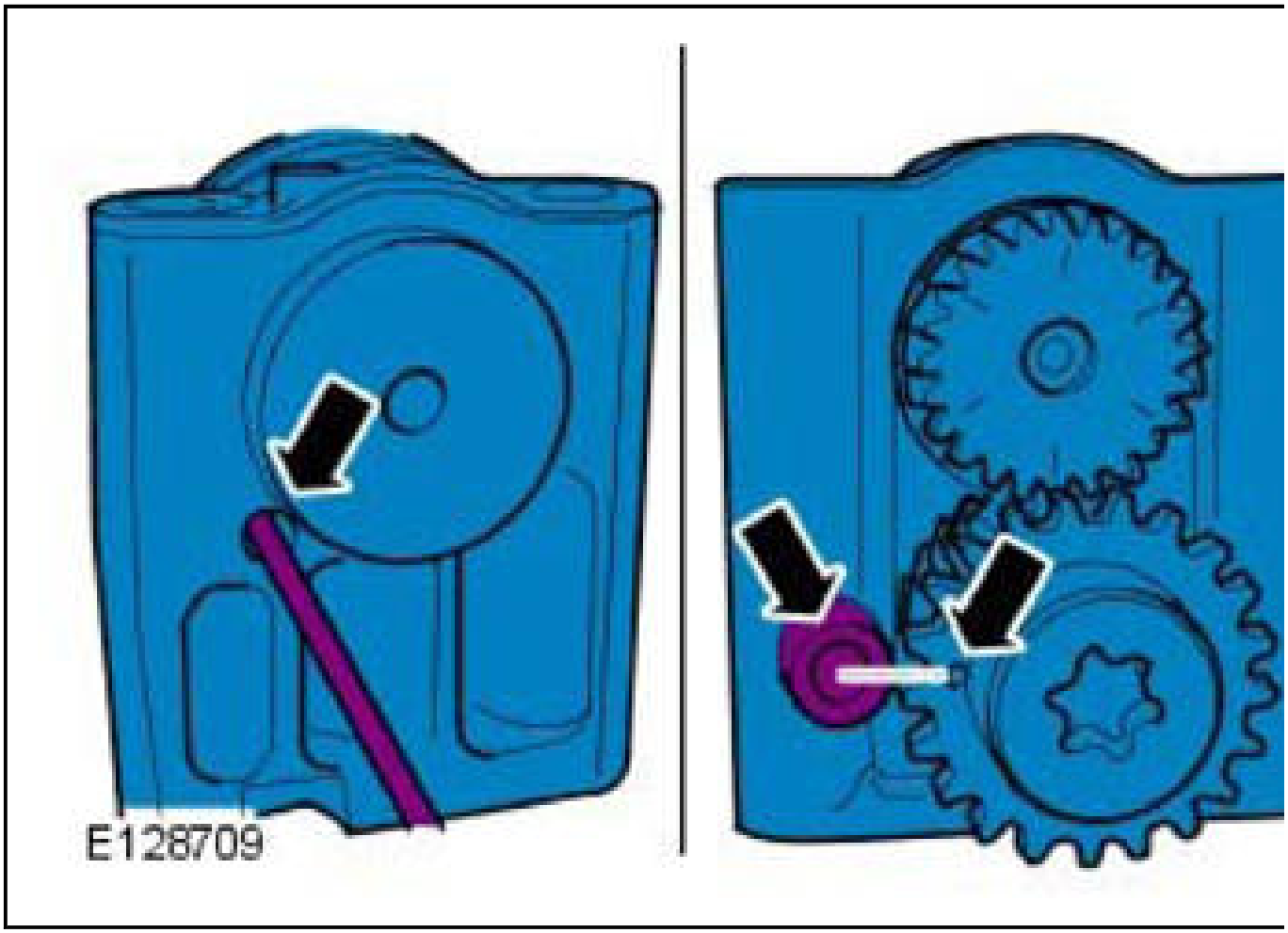
2. Align the balance shaft.
    - Clean the components.
    - Lubricate the components.
    - Install a 4 mm (0.16 in) pin to lock the shaft as shown and that the shaft can not rotate.
    - Make sure the drive gear timing marks are aligned as shown.



3. Rotate crankshaft clockwise until number one cylinder is at TDC and install the special tool.

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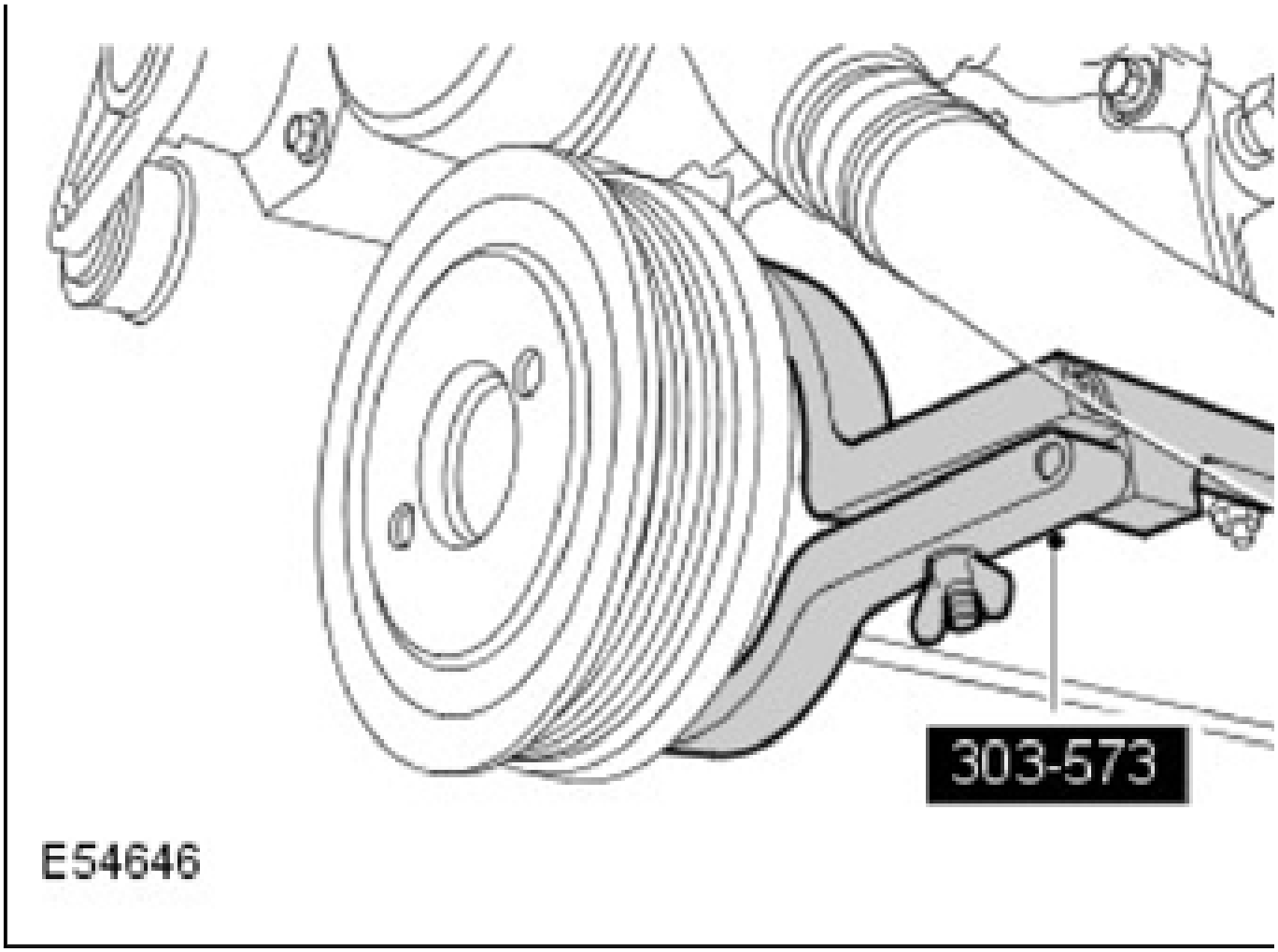

4. Install the balance shaft.
    - Clean the component mating faces.
    - Engage the drive chain.
    - Install the drive chain tensioner.
    - Tighten the Torx bolts to 15 Nm (11 lb.ft).
    - Tighten a further 90 degrees.
    - Remove the locking pin.
    - Remove the special tool.
5. Install the cylinder block cradle.

    For additional information, refer to: **CYLINDER BLOCK CRADLE** .

6. Install the front wheels and tires.
7. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

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JACKSHAFT

SPECIAL TOOL(S)

	Sprocket holding tool RH rear cassette 303-643

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the torque converter flexplate.

   For additional information, refer to: **FLEXPLATE** .

3. Remove the cylinder block jackshaft plug.
   - Drift to release.

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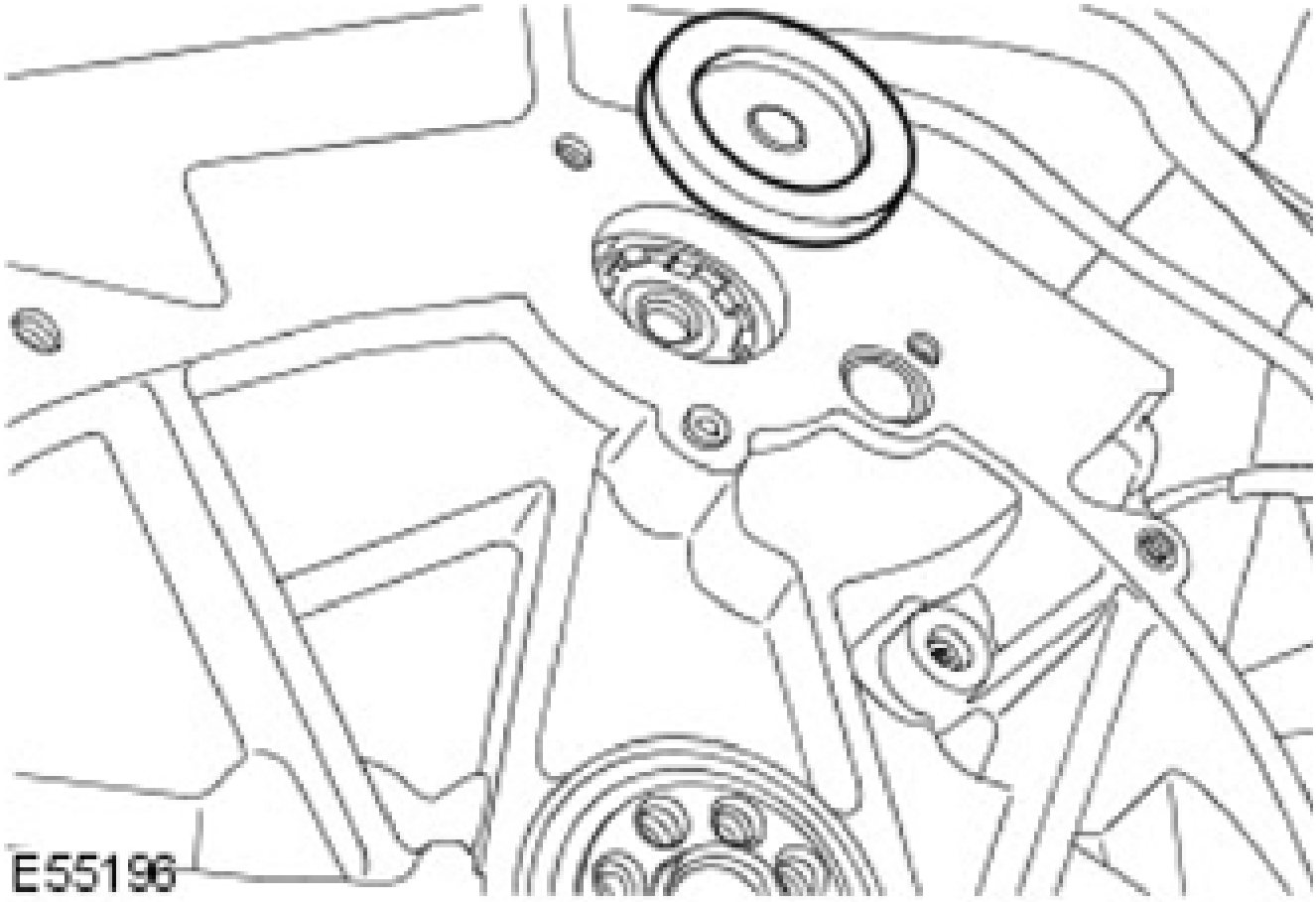

4. Using the special tool, remove the RH cassette jackshaft drive, sprocket bolt.
    - Remove and discard the Torx bolt.

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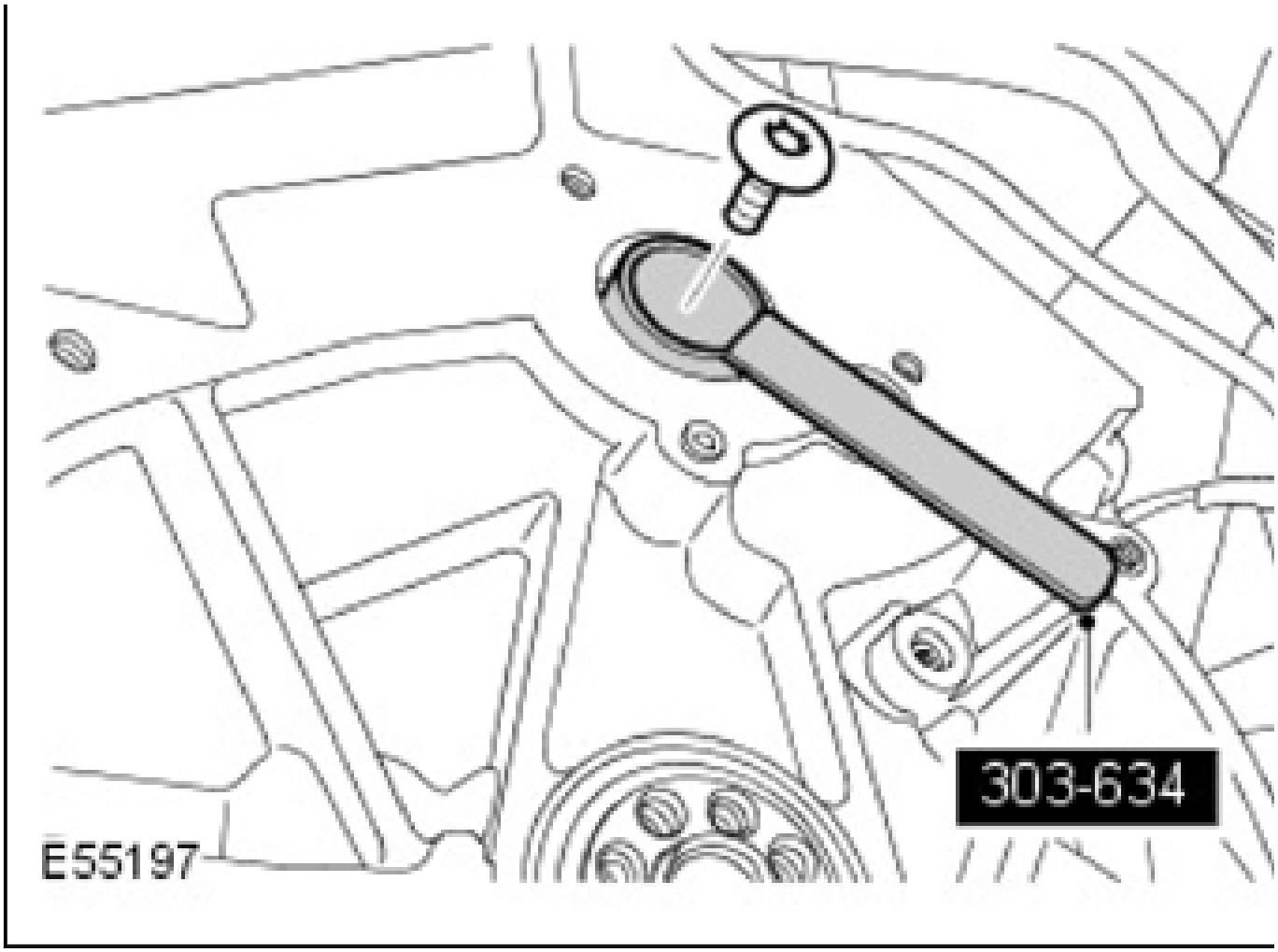

5. Remove the camshaft drive cassette LH assembly.

   For additional information, refer to: **CAMSHAFT DRIVE CASSETTE LH** .

6. Remove the oil pump drive gear.
   - Remove the bolt.
   - Remove the clamp.
   - Remove and discard the O-ring seal.

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7. Remove the jackshaft thrust plate.
    - Remove the 2 Torx bolts.

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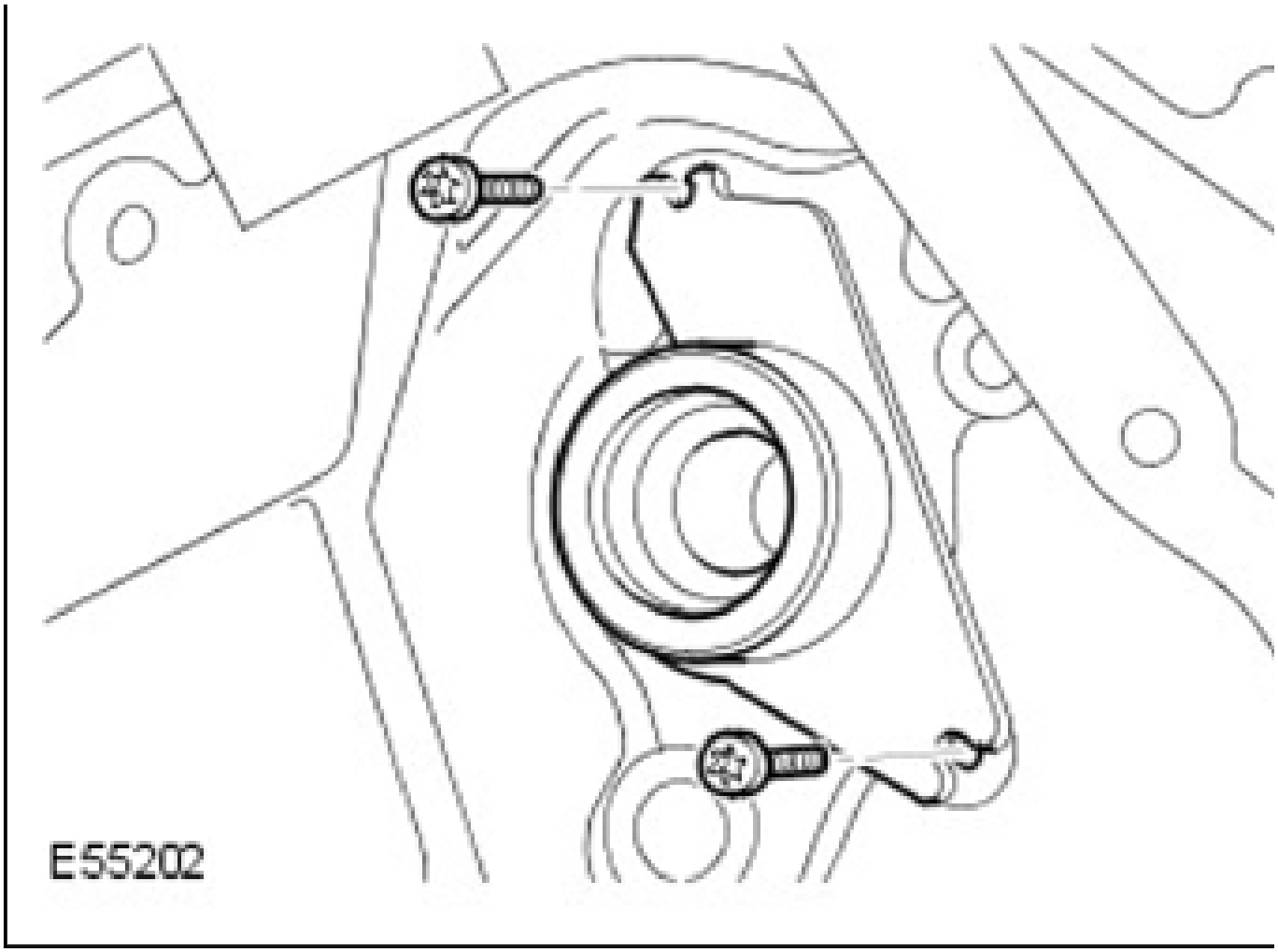

8. Remove the jackshaft.
    - Collect the spacer.

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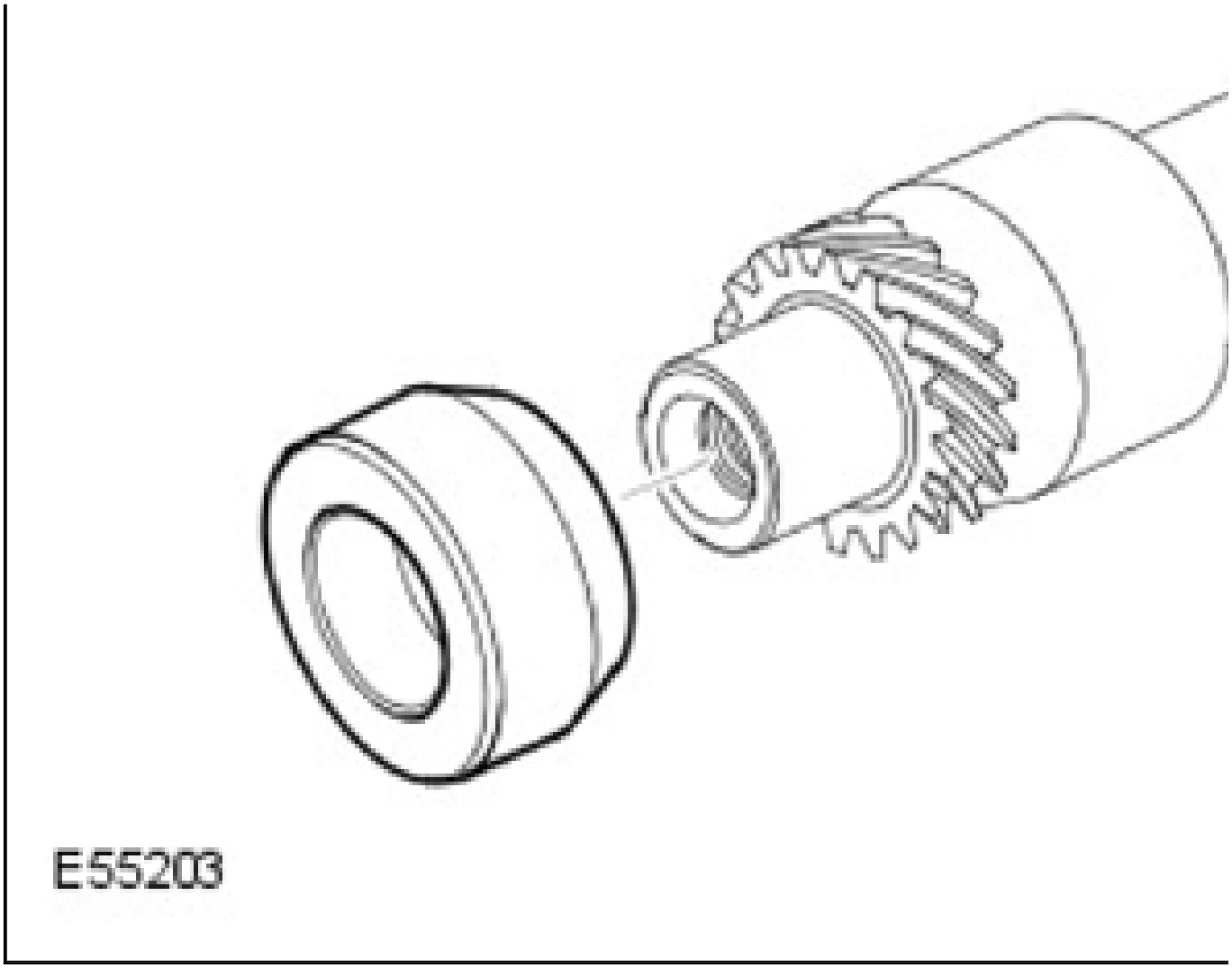

INSTALLATION

1. Install the jackshaft.
    - Clean the component mating faces.
    - Install the jackshaft spacer.
    - Lubricate the components with clean engine oil.

NOTE: The groove in the thrust plate must face the cylinder block.

2. Install the jackshaft thrust plate.
    - Clean the component mating faces.
    - Lubricate the components with clean engine oil.
    - Tighten the Torx bolts to 10 Nm (7 lb.ft).

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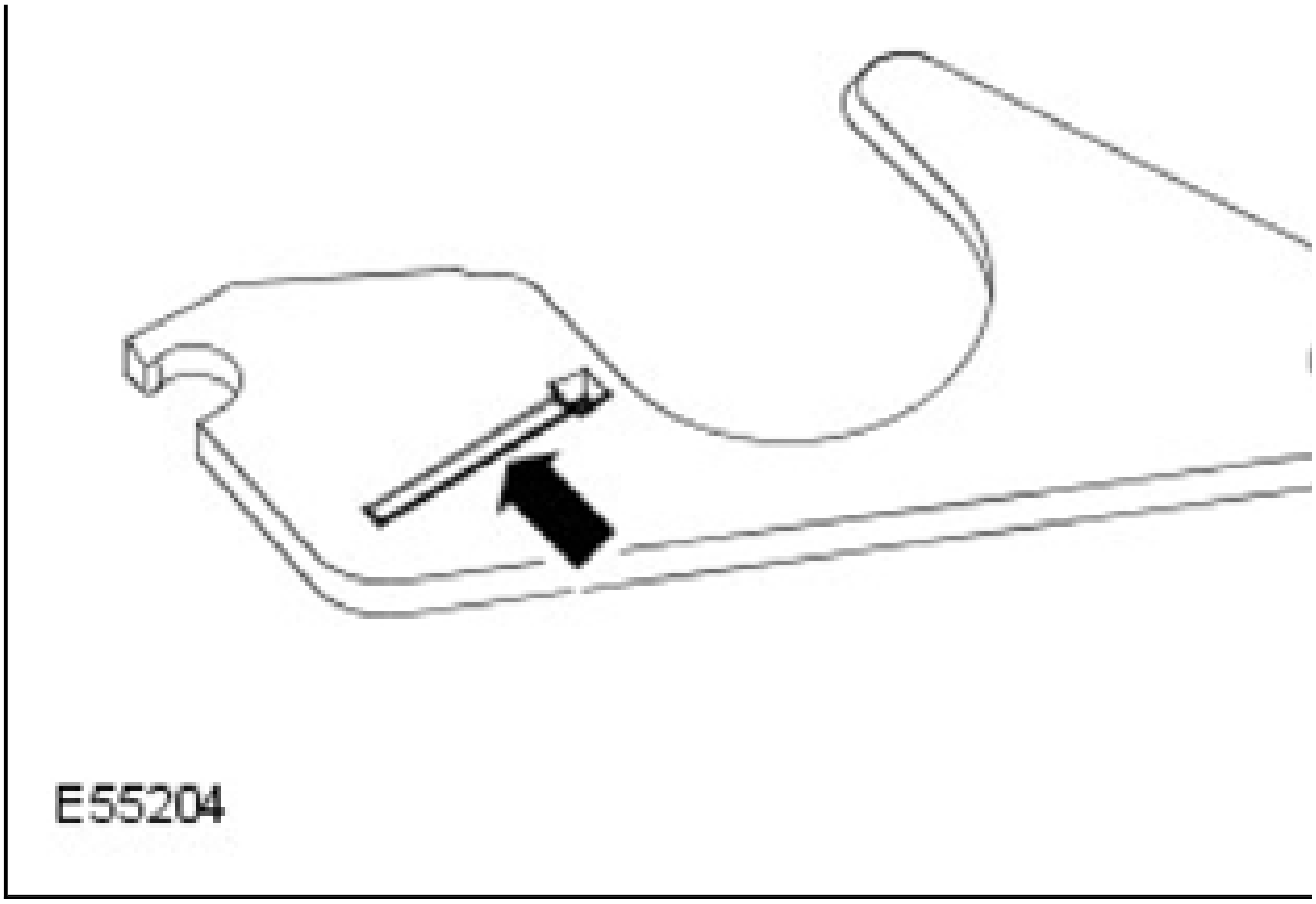

3. Install the oil pump drive gear.
   - Clean the components.
   - Lubricate the components with clean engine oil.
   - Install a new O-ring seal.
   - Install the clamp.
   - Tighten the bolt to 20 Nm (15 lb.ft).
4. Install the camshaft drive cassette LH assembly.

   For additional information, refer to: **CAMSHAFT DRIVE CASSETTE LH** .

5. Using the special tool, install the RH cassette jackshaft drive, sprocket bolt.
   - Clean the component mating faces.
   - Using the special tool, tighten the new jackshaft sprocket bolt to 40 Nm (30 lb.ft), then a further 45 degrees.

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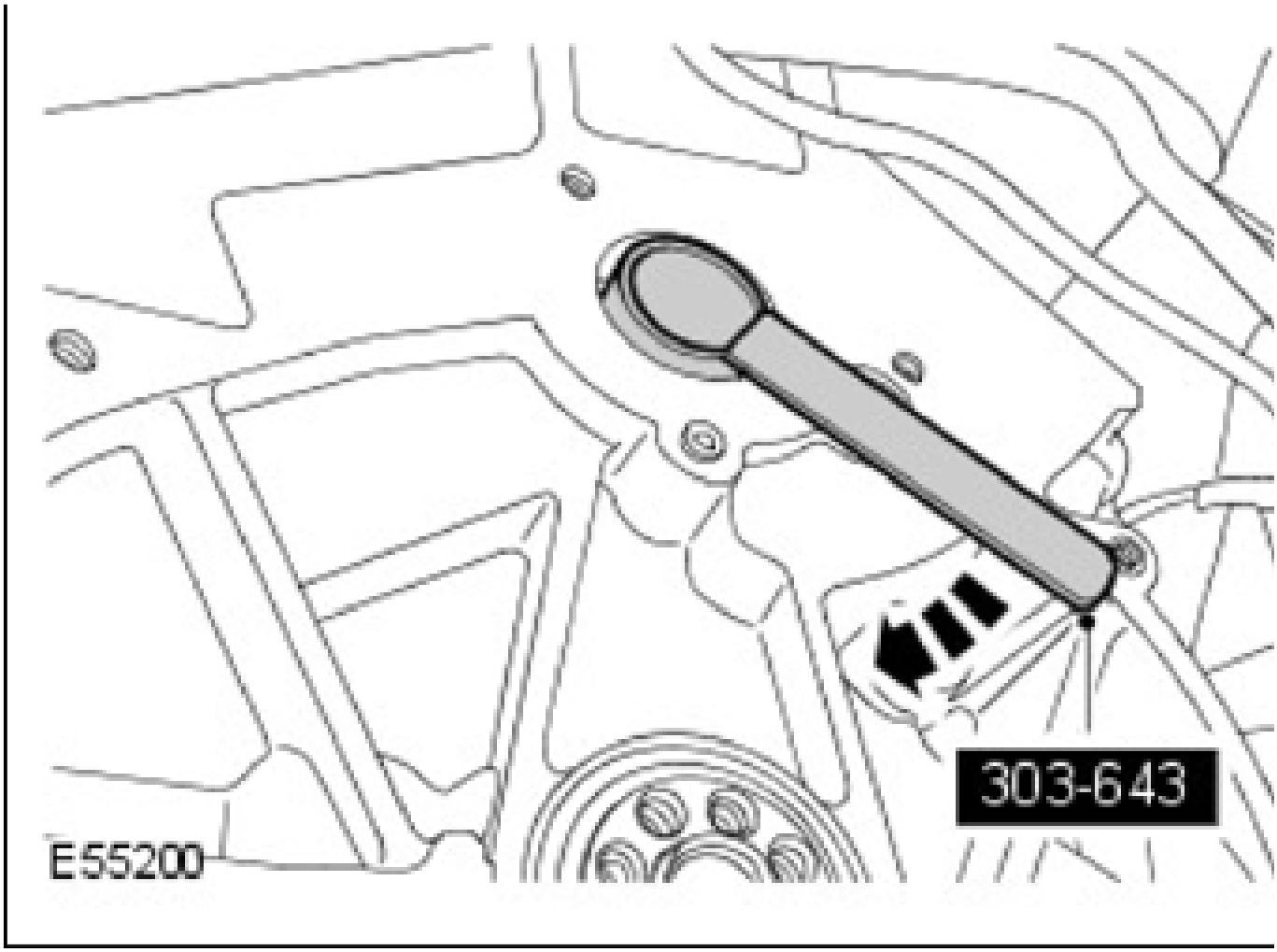

6. Install the cylinder block jackshaft plug.
    - Clean the component mating faces.
7. Install the torque converter flexplate.

    For additional information, refer to: **FLEXPLATE** .

8. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

HYDRAULIC TIMING CHAIN TENSIONER LH

REMOVAL

1. Disconnect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

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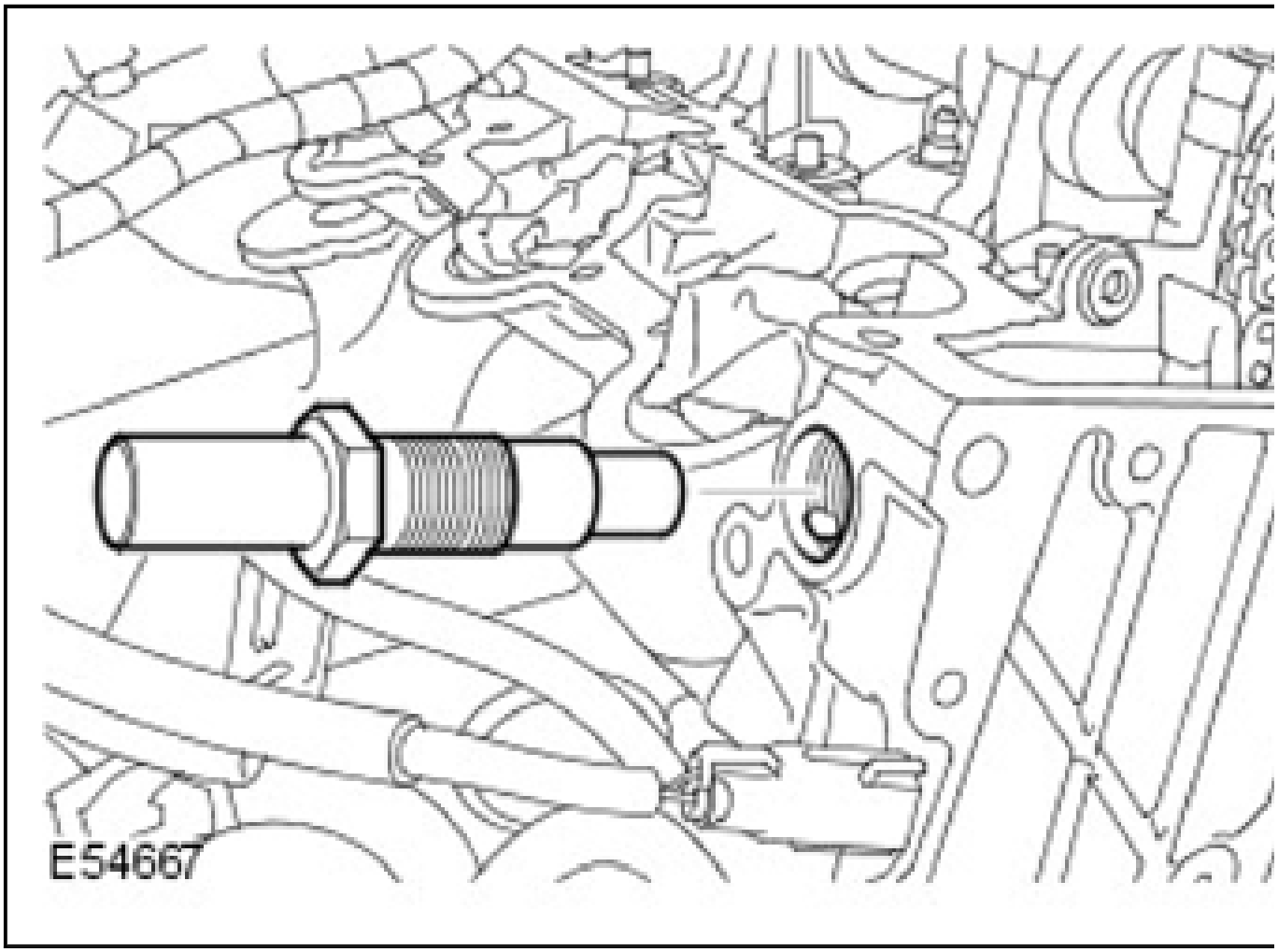
2. Remove the intake manifold.

   For additional information, refer to: **INTAKE MANIFOLD** .

   CAUTION: Before the disconnection or removal of any components, ensure the area around joint faces and connections are clean. Plug any open connections to prevent contamination.

3. Remove the LH hydraulic timing chain tensioner.



INSTALLATION

1. Install the LH hydraulic timing chain tensioner.
   - Clean the component mating faces.
   - Tighten the tensioner to 45 Nm (33 lb.ft).
2. Install the intake manifold.

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For additional information, refer to: **INTAKE MANIFOLD** .

3. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

HYDRAULIC TIMING CHAIN TENSIONER RH

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the engine cover.

   For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

CAUTION: Before the disconnection or removal of any components, ensure the area around joint faces and connections are clean. Plug any open connections to prevent contamination.

3. Remove the RH hydraulic timing chain tensioner.

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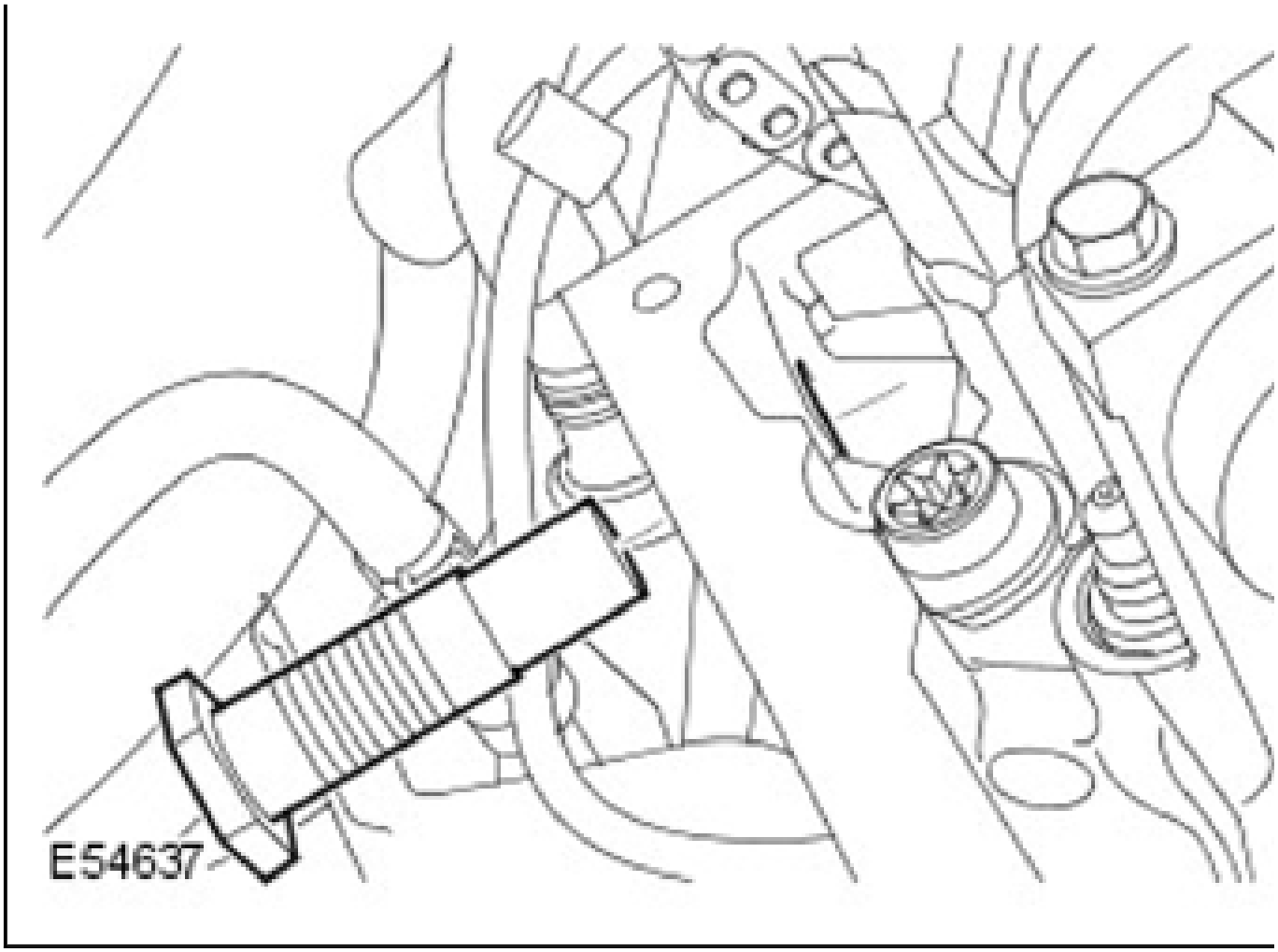

INSTALLATION

1. Install the RH hydraulic timing chain tensioner.
   - Clean the component mating faces.
   - Tighten the tensioner to 45 Nm (33 lb.ft).
2. Install the engine cover.

   For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

3. Connect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

INTAKE MANIFOLD

SPECIAL TOOL(S)

	Fuel spring lock decoupling tool 310-044

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REMOVAL

NOTE: Removal of the intake manifold on early vehicles will involve the partial dismantling of the fuel rail and the removal of the purge valve and mounting bracket. Once removed, it will also be necessary to remove some excess material from the intake manifold, see 'installation' steps 1 and 2.

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Secure the hood in the service position.
   - Release the support struts.
3. Remove the engine cover.

   For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

4. Remove the air intake resonator.

   For additional information, refer to: **Intake Air Resonator** .

5. Disconnect the throttle body electrical connector.

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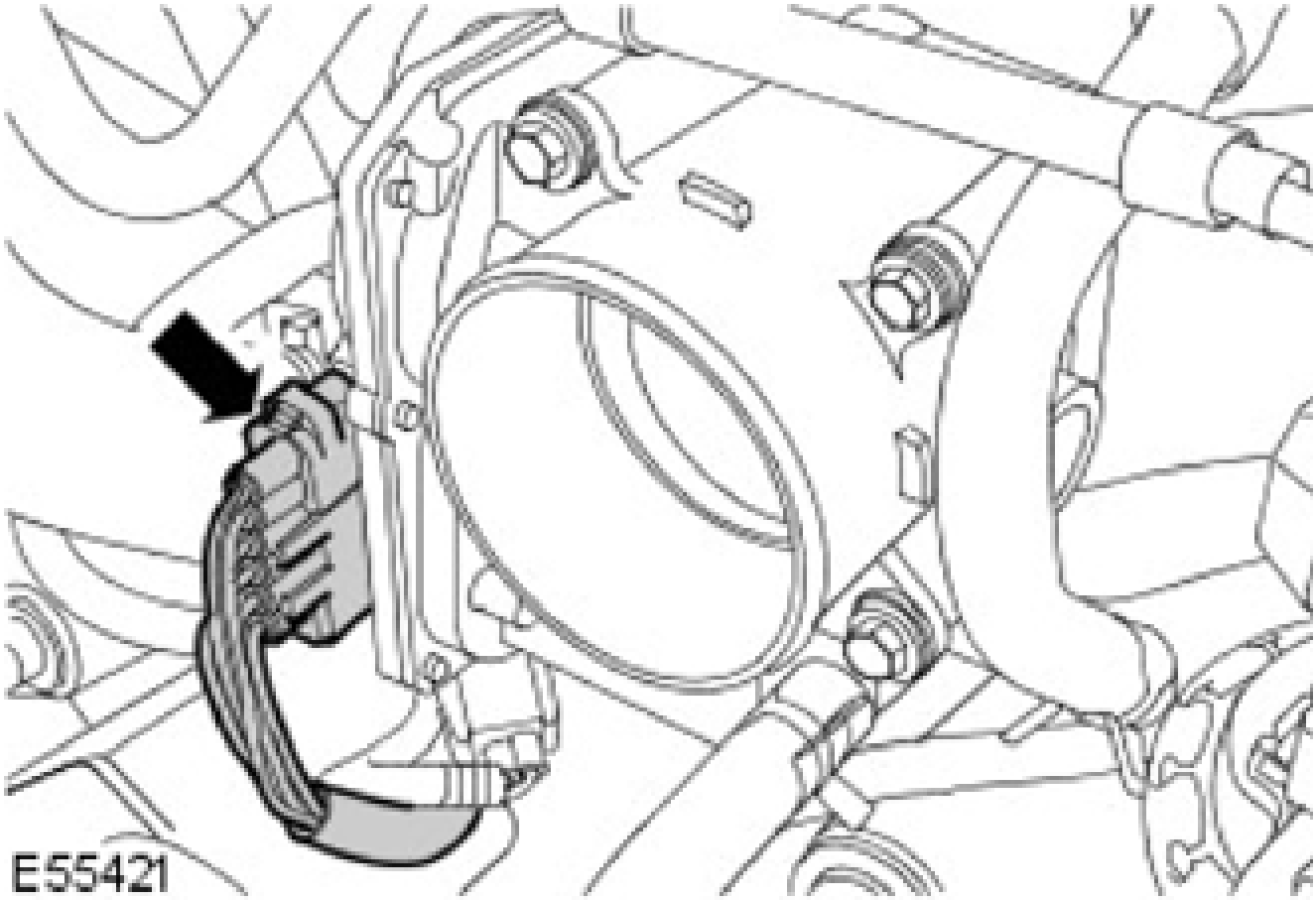

6. Disconnect the intake manifold coolant hose.
    - Clamp the relevant hose, to minimise coolant loss.
    - Release the clip.

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7. Disconnect the throttle body coolant hose.
    - Clamp the hose to minimise coolant loss.
    - Release the clip.

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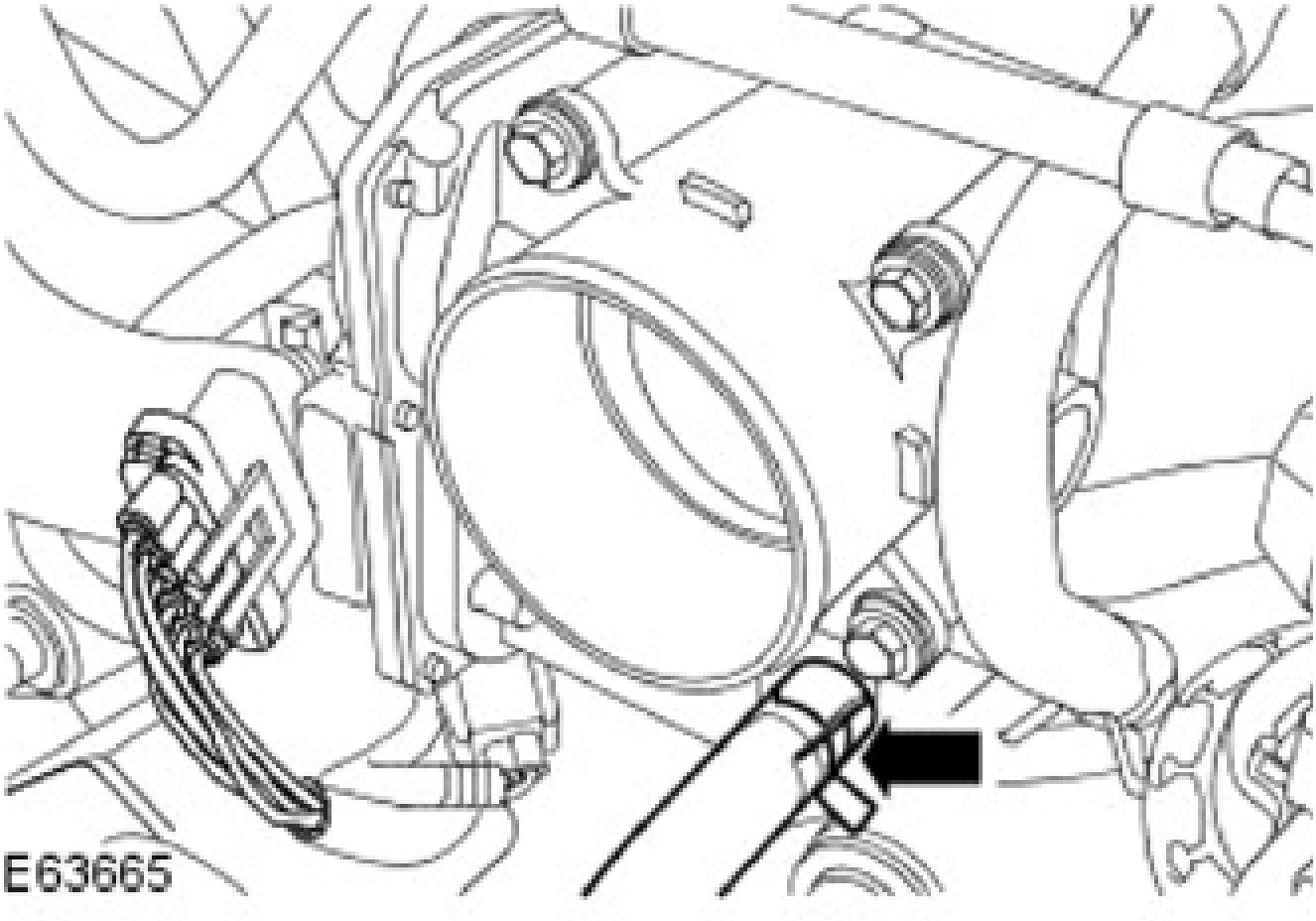

CAUTION: Before the disconnection or removal of any components, ensure the area around joint faces and connections are clean. Plug any open connections to prevent contamination.

8. Disconnect the crankcase vent hose.

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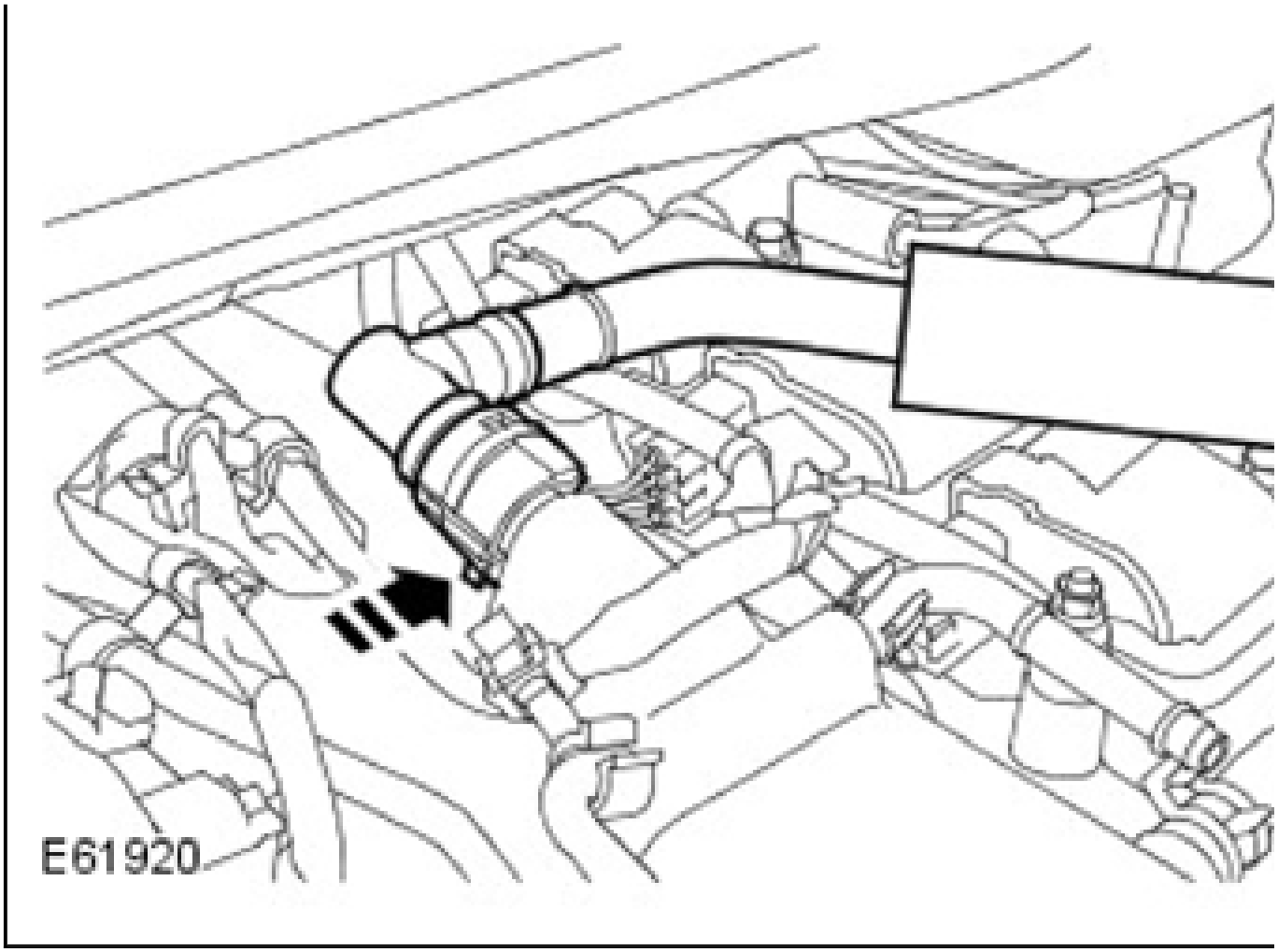

9. Remove the RH crankcase vent hose.

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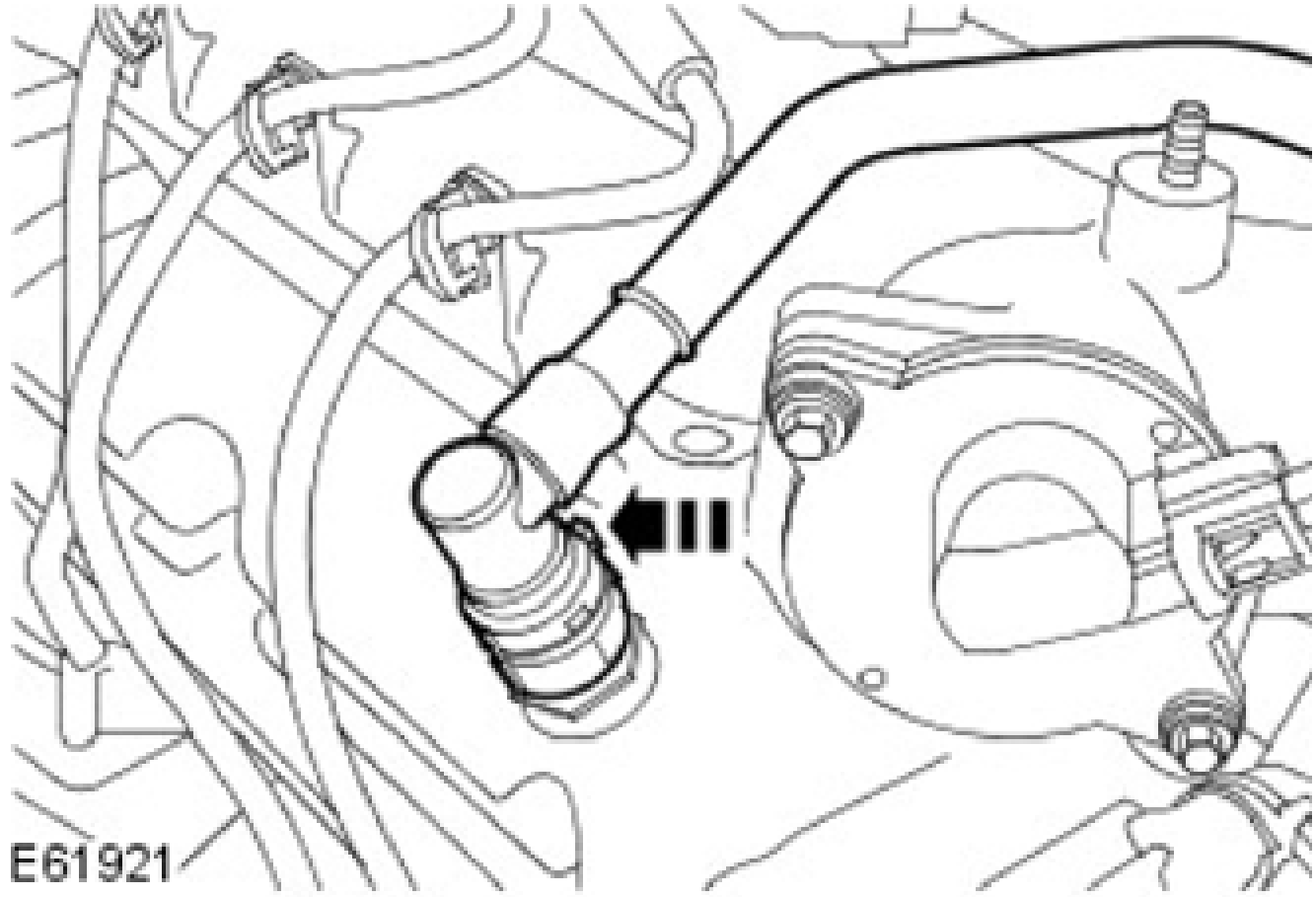

10. Disconnect the EGR valve electrical connector.

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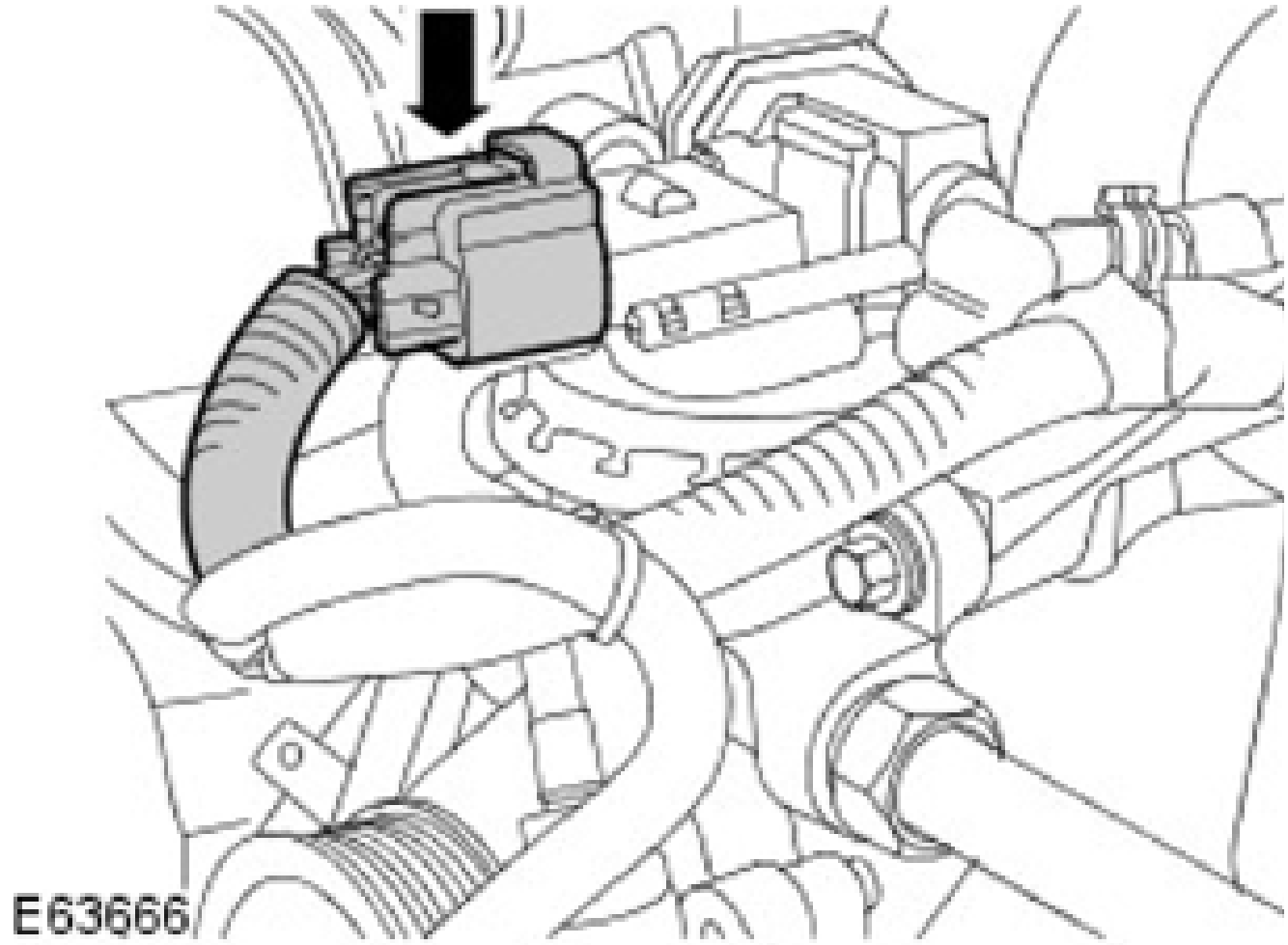

11. Disconnect the EGR valve feed pipe.
    - Loosen the EGR valve feed pipe union nut, at the exhaust manifold.
    - Disconnect the union nut, securing the EGR pipe to the valve.

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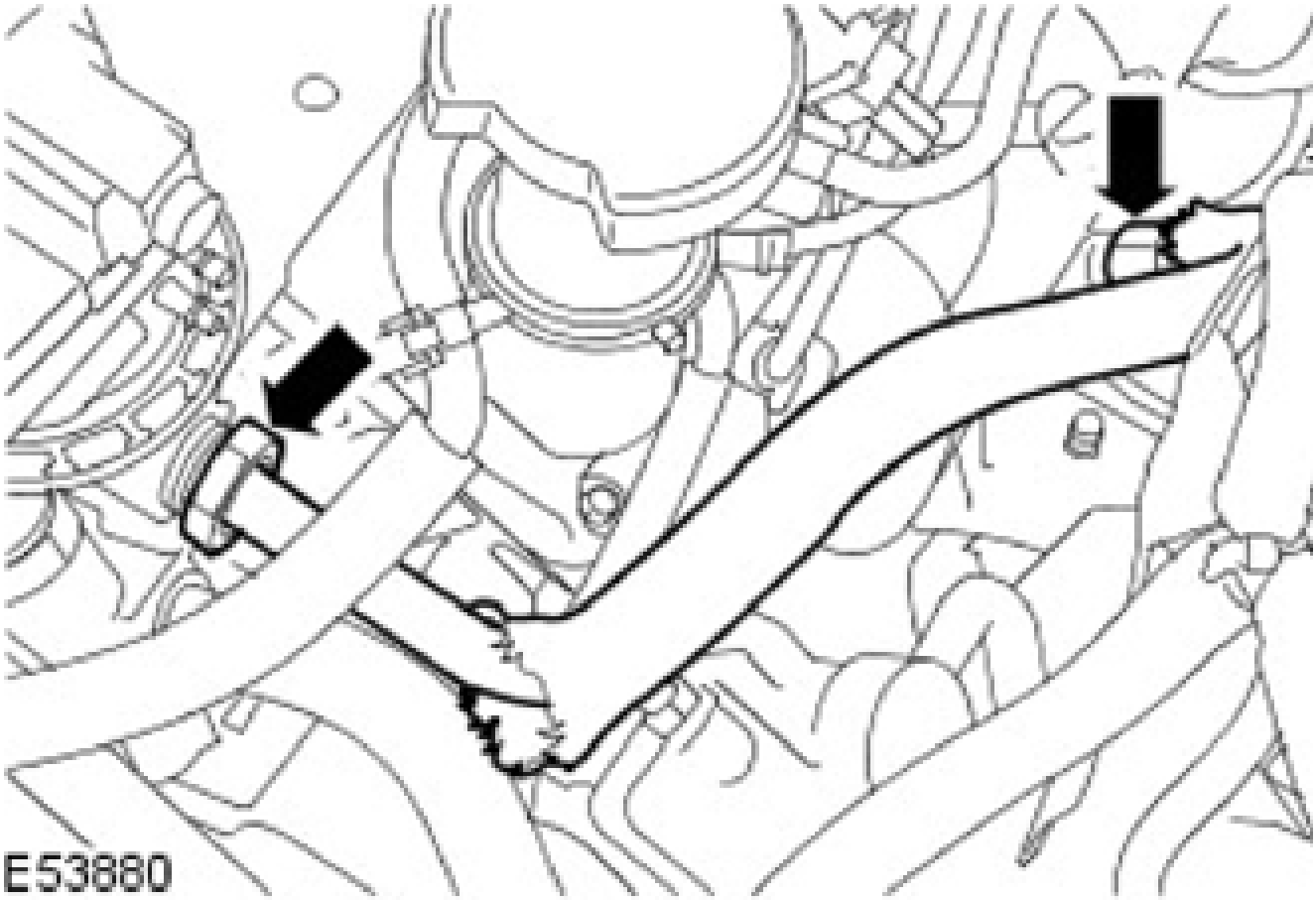

12. Disconnect the intake manifold vacuum pipe assembly.

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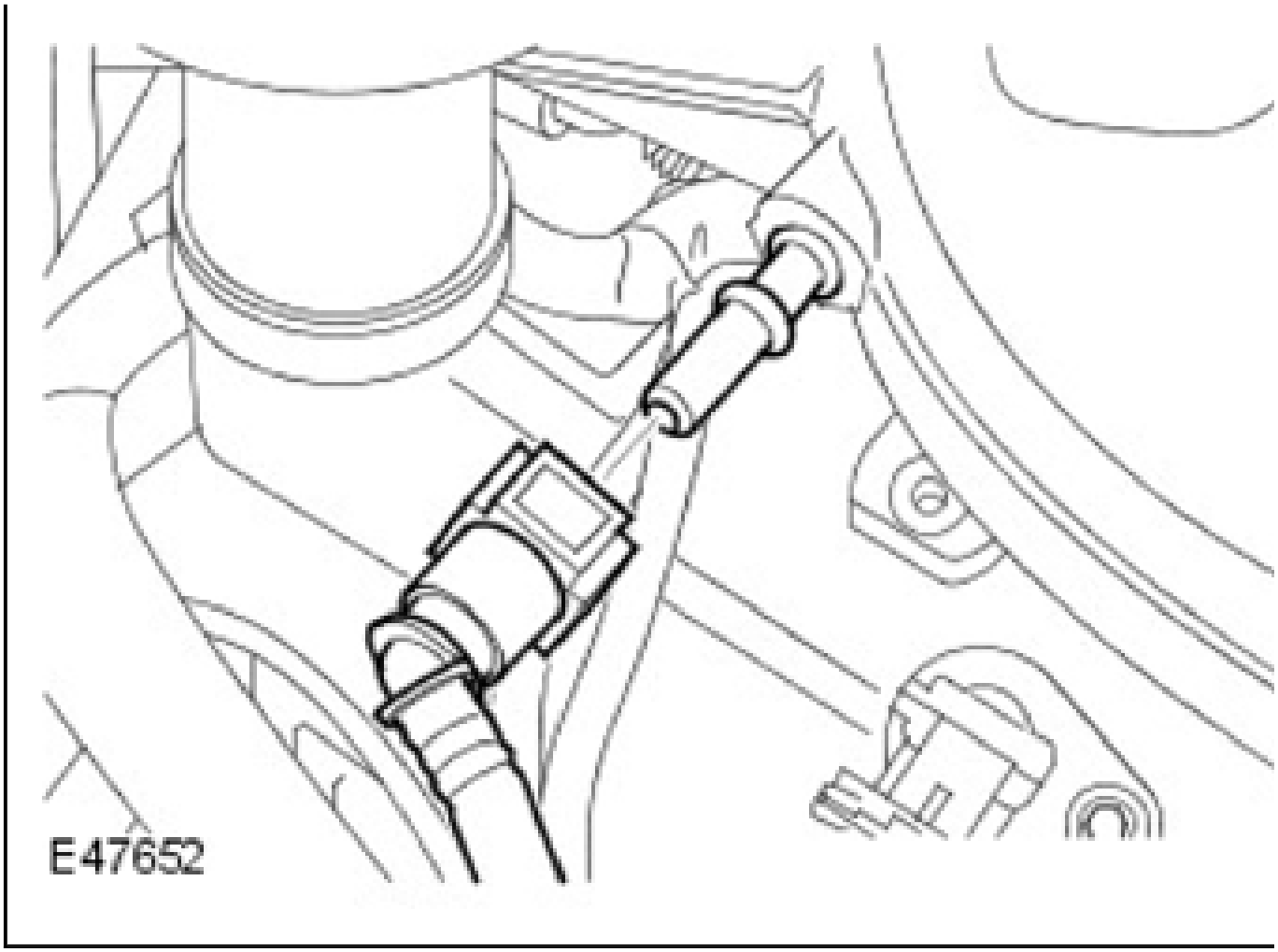

13. Disconnect the intake manifold tuning valve electrical connector.

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14. Release the purge line from the intake manifold.
    - Remove the clip retaining bolt.
    - Collect the spacer.

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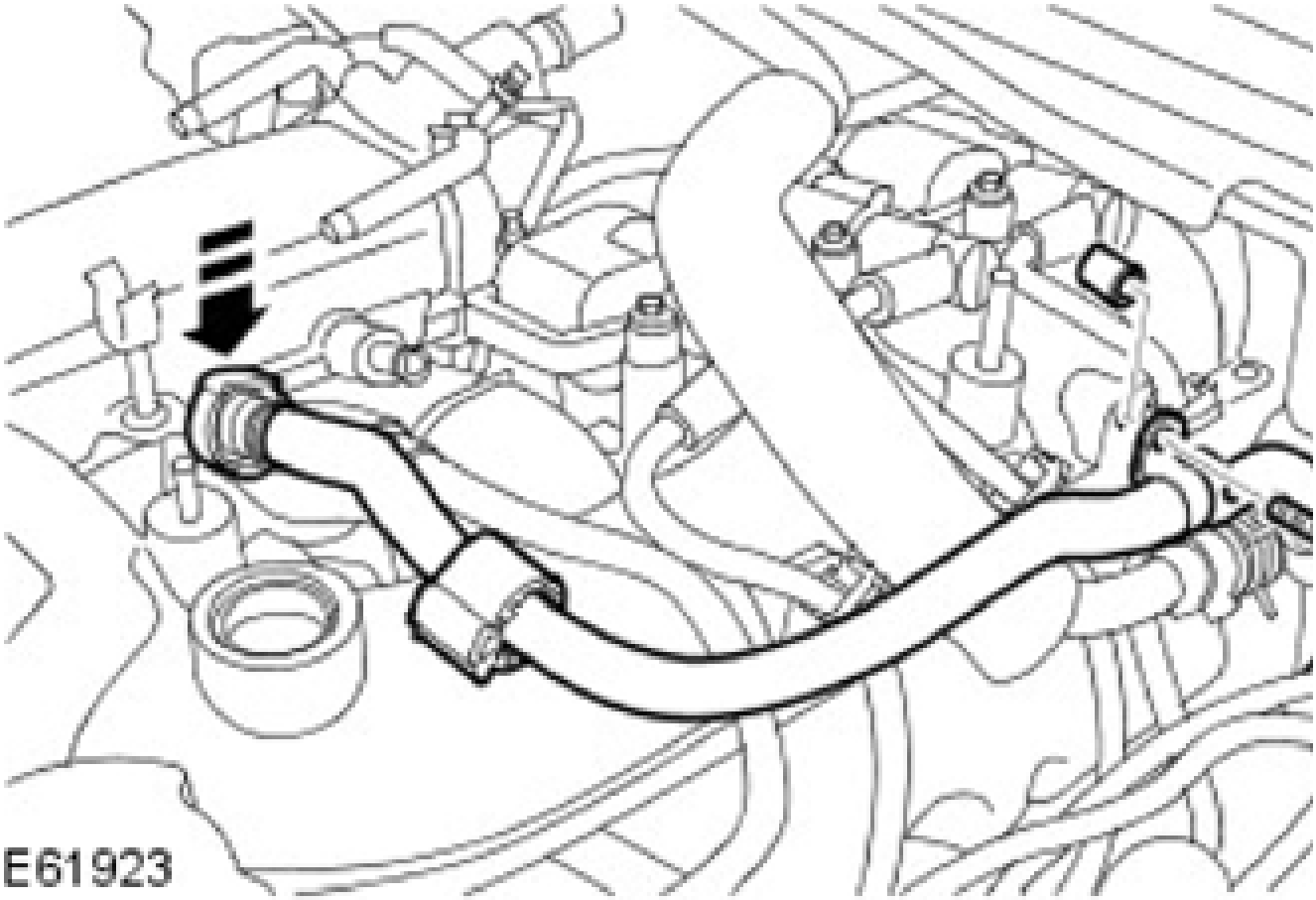

15. Release the coil wiring harness.
    - Release the 6 clips.
    - Remove the 2 coil harness ground nuts.

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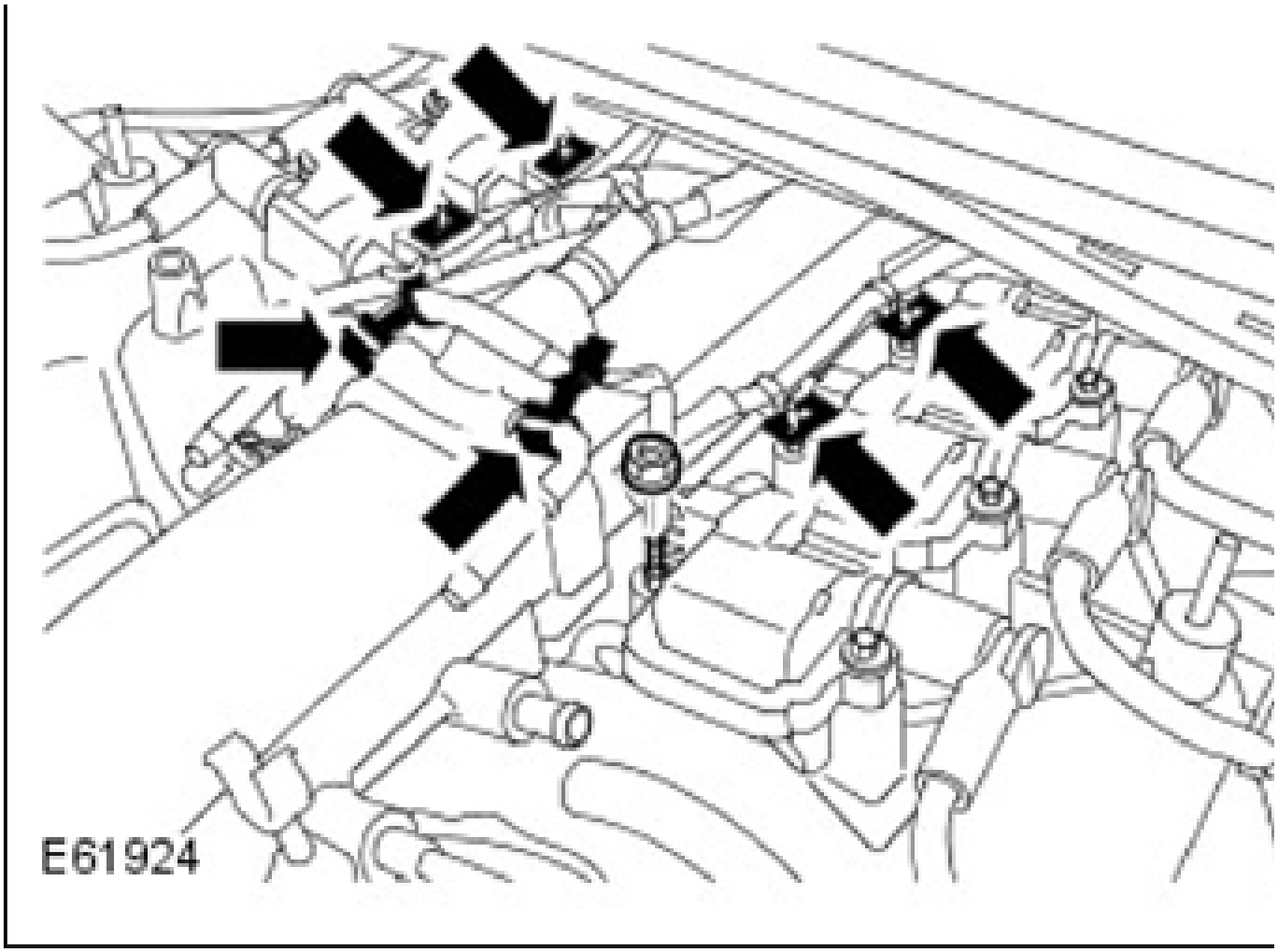

16. Disconnect the 6 coil electrical connectors.

NOTE: Note the fitted position of the fasteners.

17. Remove the 2 rear ignition coils.
    - Disconnect the sparking plug lead elbows at the coils.
    - Remove the 2 bolts and 2 studs.
    - Discard the fastener O-rings to aid installation.

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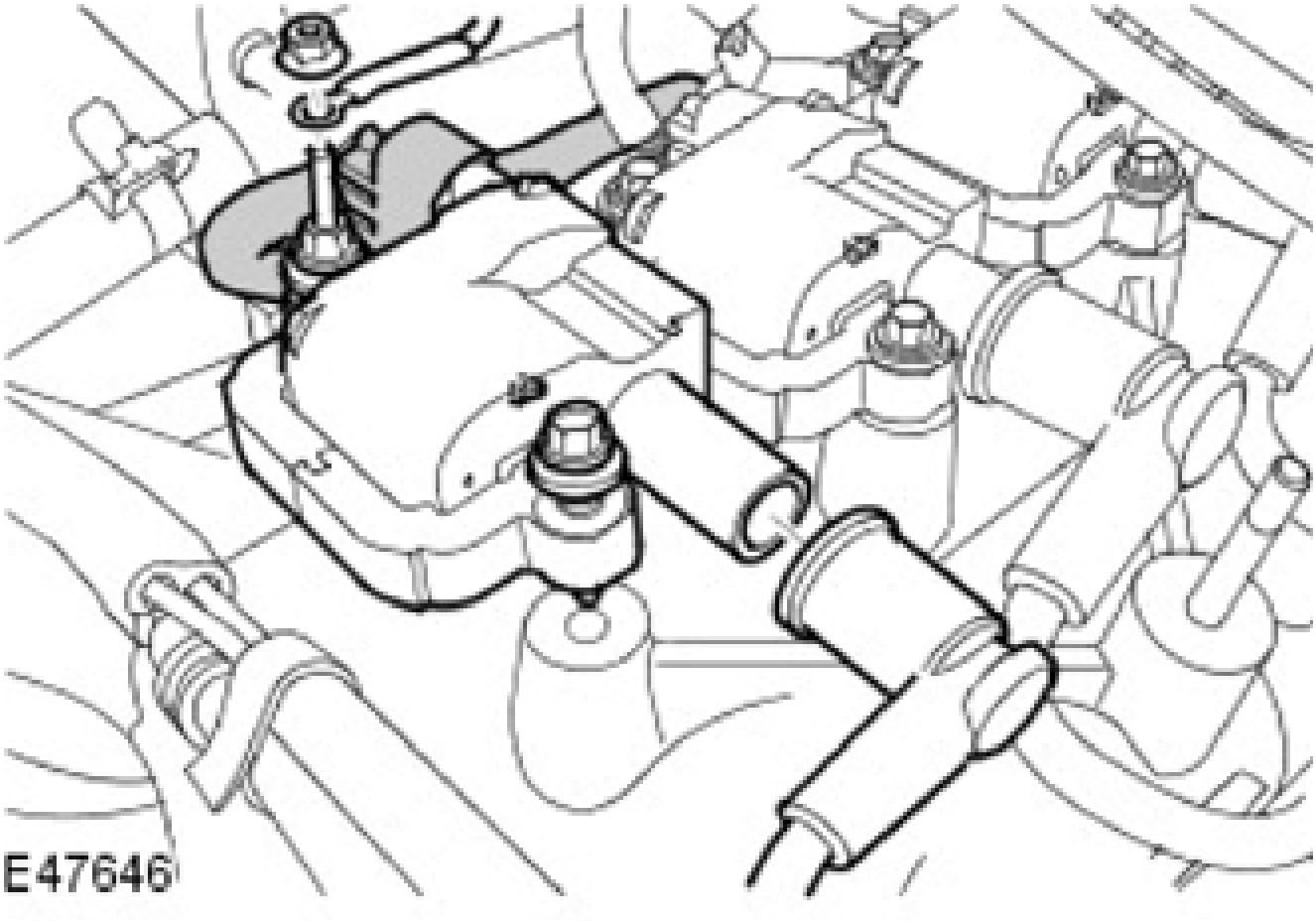

18. Disconnect the HT leads at the sparking plugs.
    - Position the leads aside.

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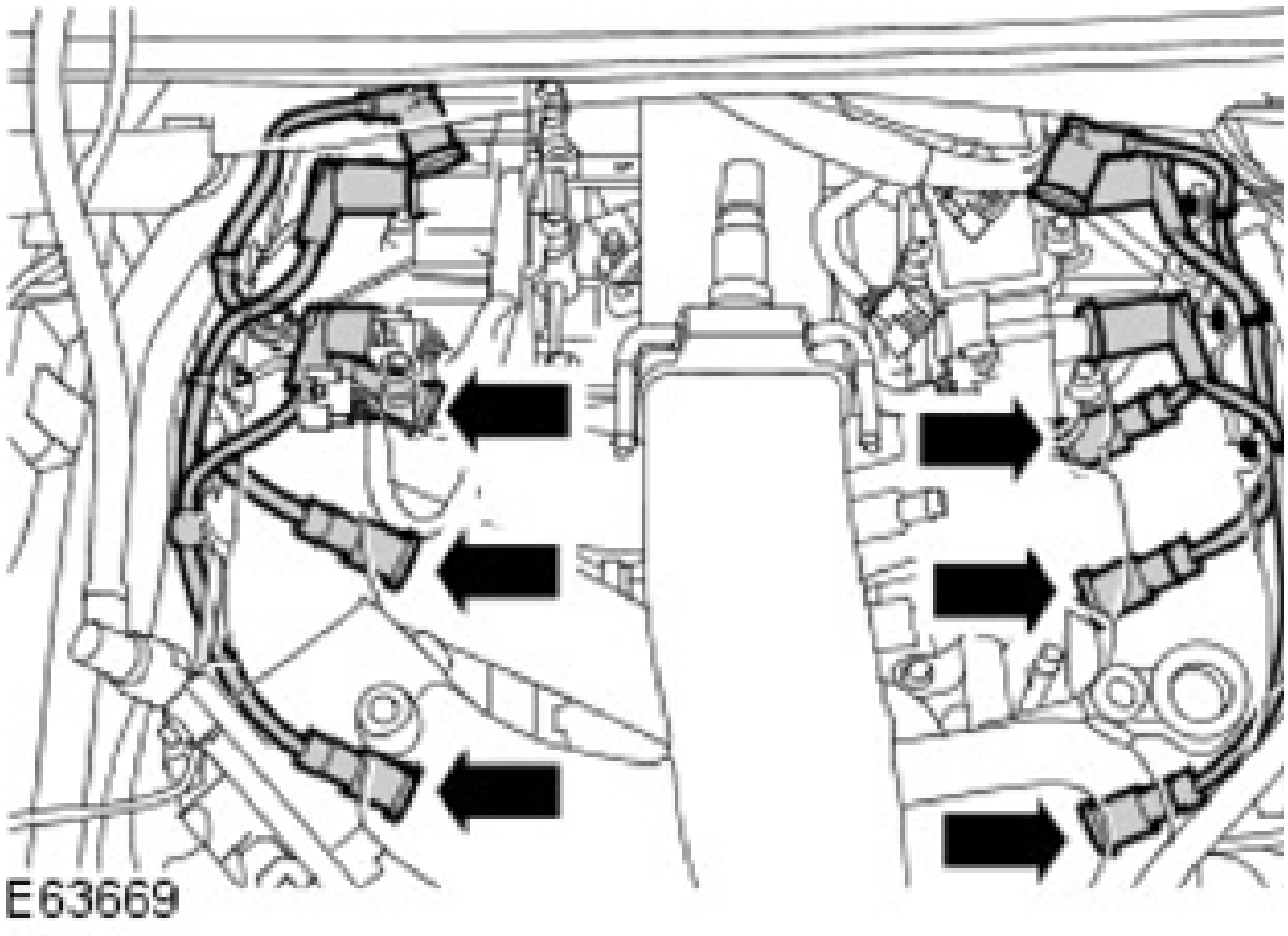

19. Position the engine wiring harness aside for access.

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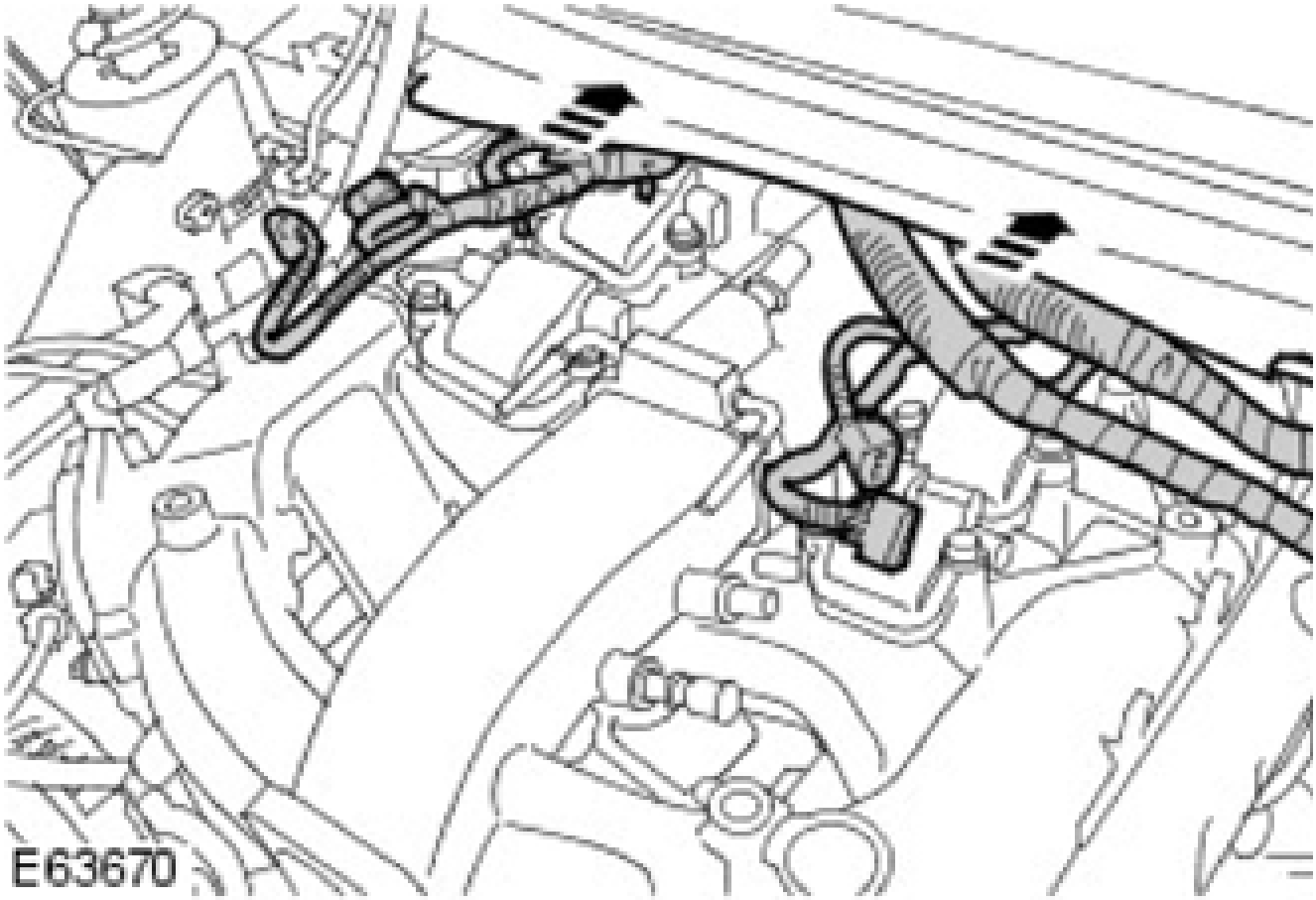

20. Remove the 8 intake manifold bolts.

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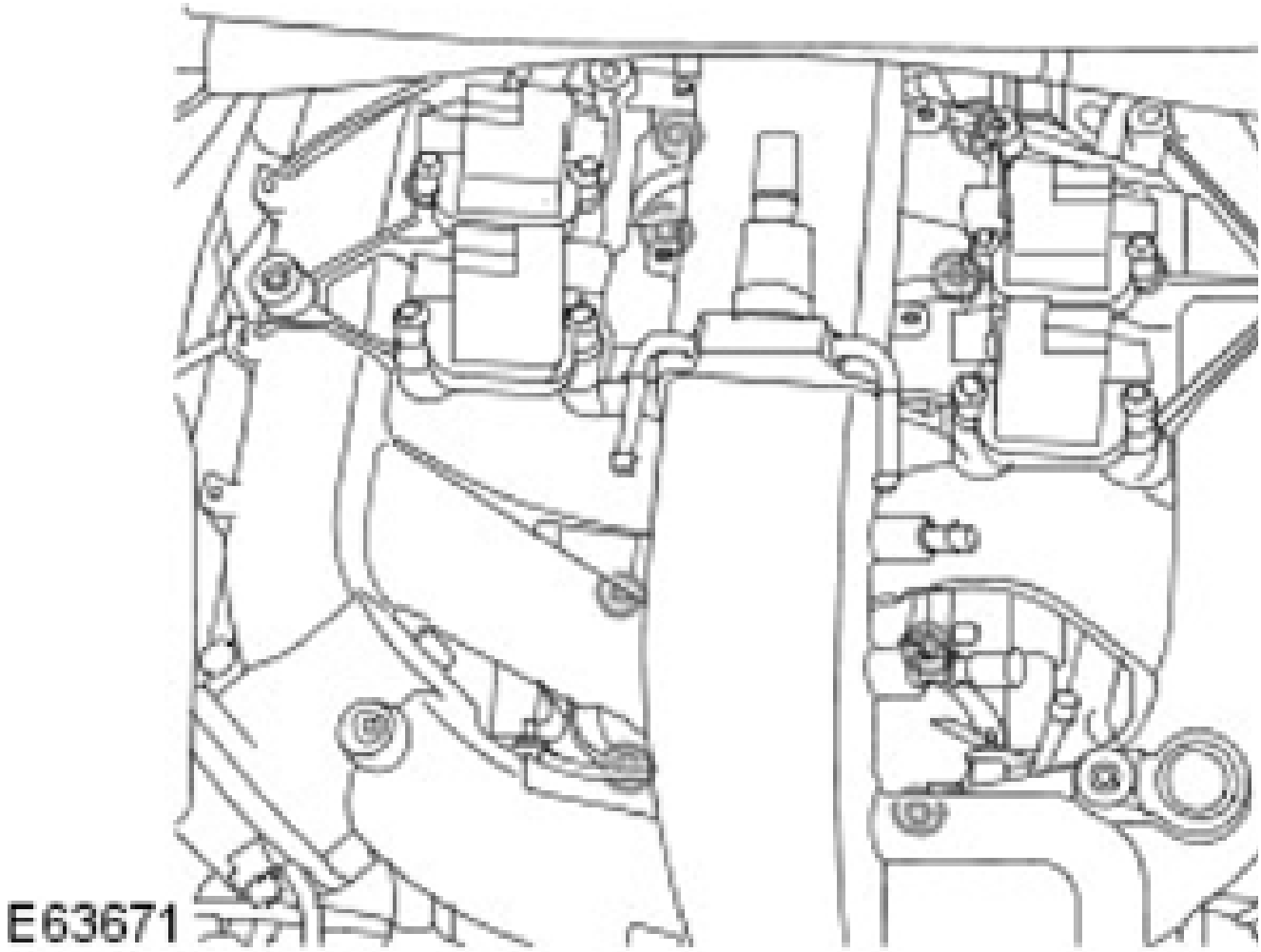

NOTE: The type of clip may vary depending on the hand of drive.

21. Release the intake manifold wiring harness clip.

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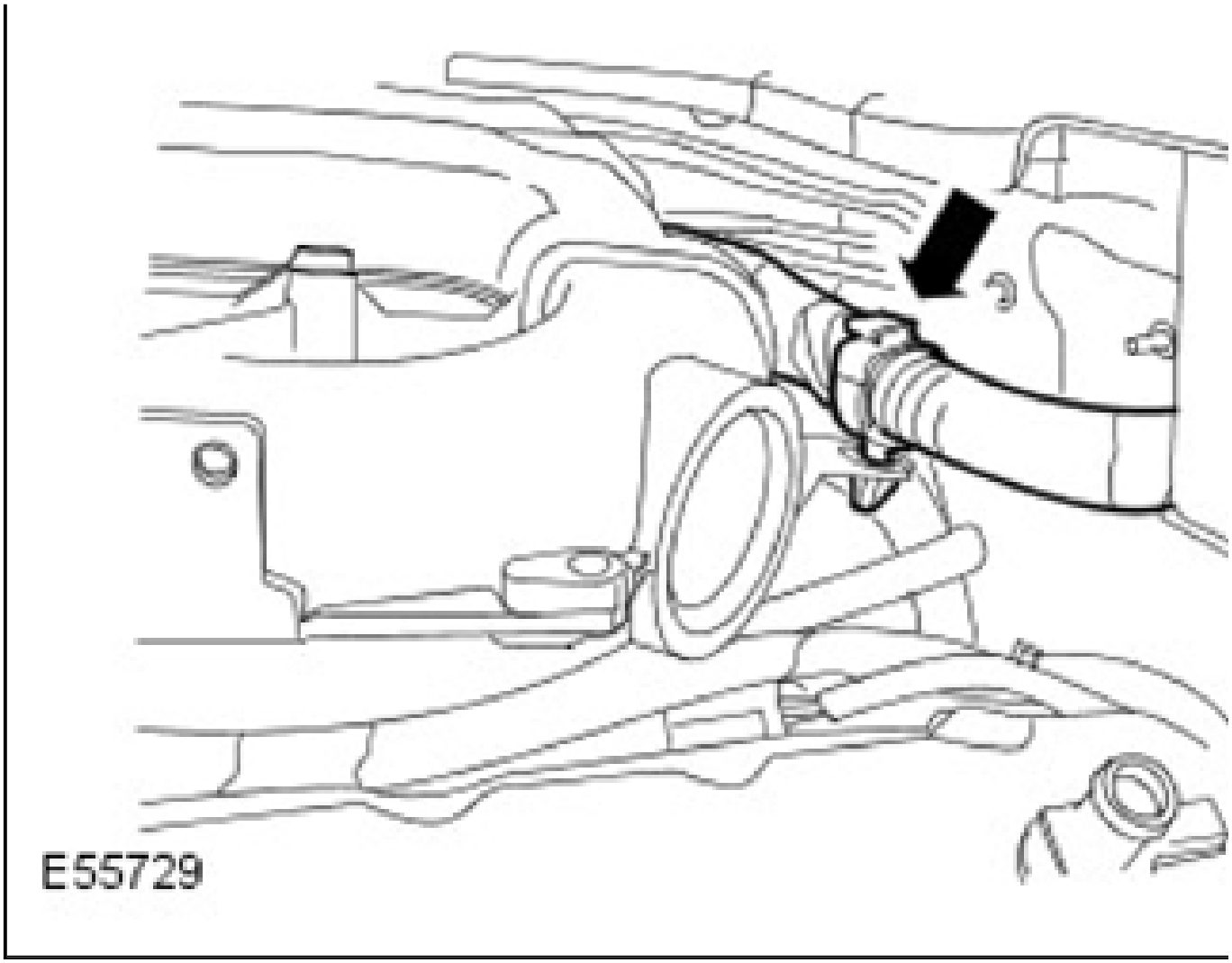

WARNING: Place the vehicle in a well ventilated, quarantined area and arrange ' No Smoking/Petrol Fumes' signs about the vehicle.
operation. Ensure that all necessary precautions are taken to prevent fire and explosion.
Wait at least 30 seconds after the engine stops before commencing any repair to the high-pressure fuel injection system. Failure to follow this instruction may result in personal injury.
If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

22. Using the special tool, disconnect the fuel line.
    - Remove the security clip.
    - Early vehicles only: Remove 4 bolts and release the fuel rail and injectors.
    - Early vehicles only: Disconnect the LH and RH cylinder head, rear fuel injector electrical connectors.
    - Early vehicles only: Remove the bolt and release the valve cover fuel line clip.

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- Early vehicles only: Cable tie the purge valve to the wiring harness.

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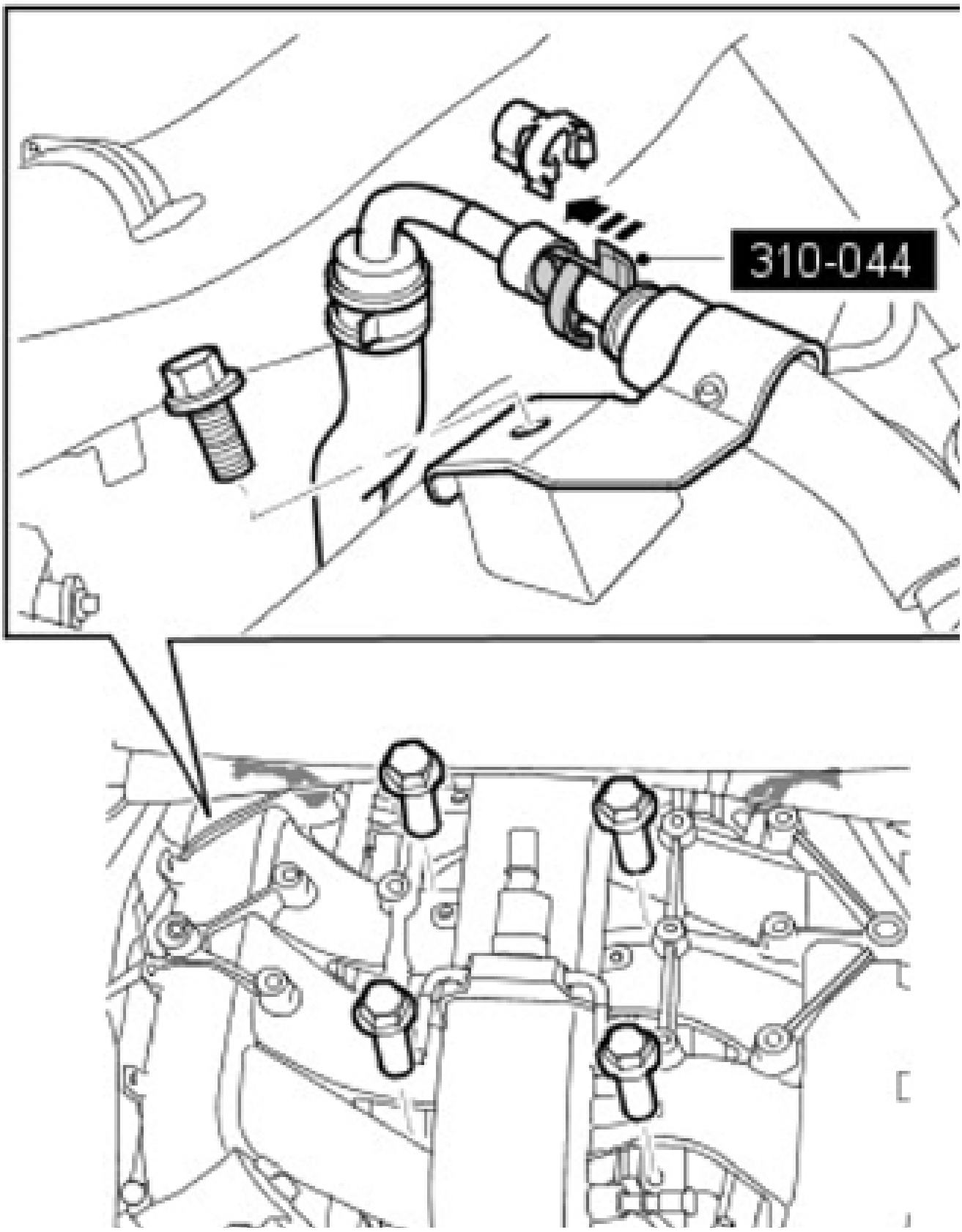

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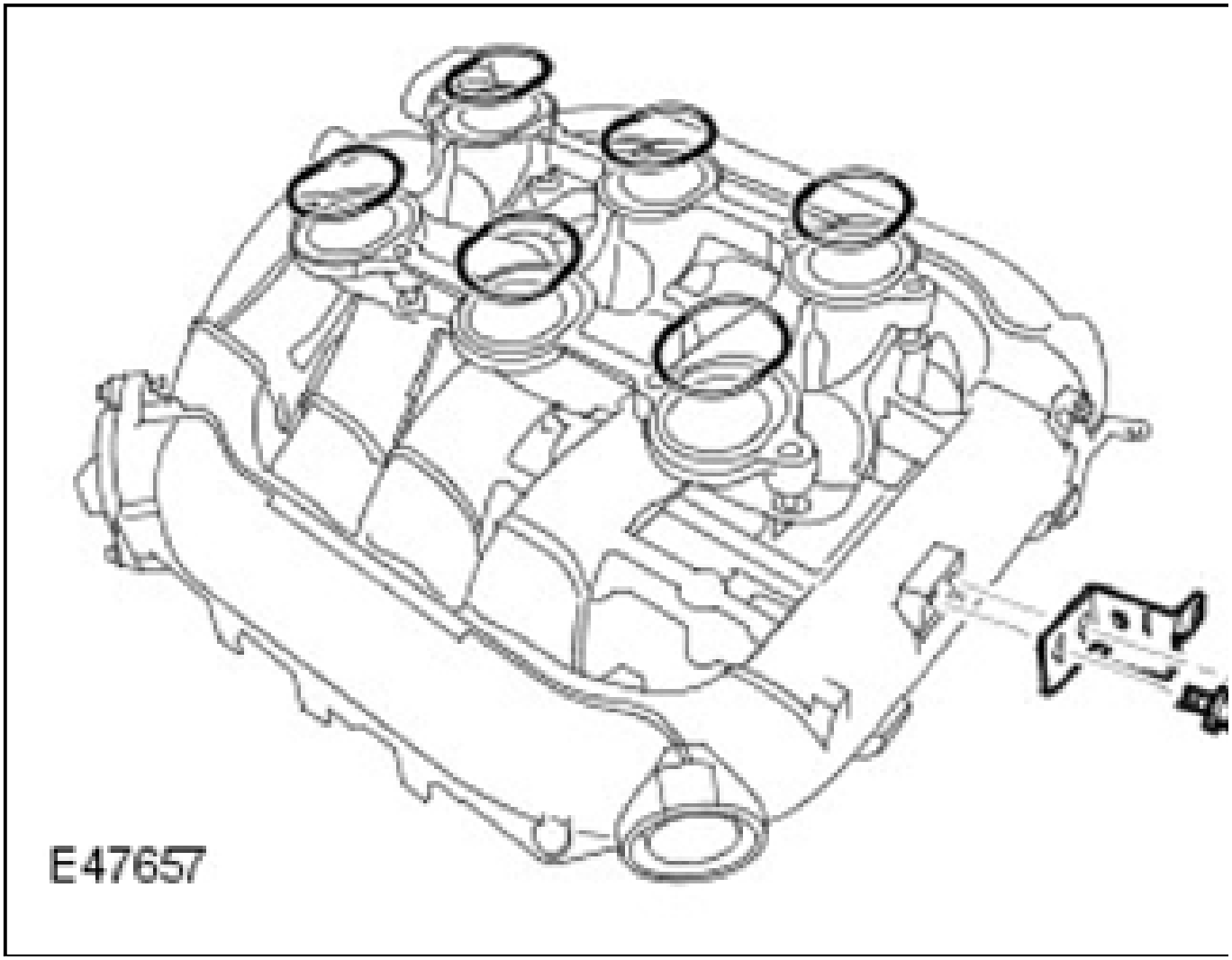
CAUTION: Early vehicles only: The purge valve and mounting bracket are bolted to the rear of the intake manifold and foul the fuel rail crossover link. Damage will occur if force is used when attempting to remove the intake manifold. If this occurs, remove the LH side, battery tray inner wall and base, for access to the purge valve bolt.
Care must be taken to avoid damaging the purge vale assembly during removal of the intake manifold.

NOTE: Due to the lack of access it may be necessary to break the engine and transmission wiring harness clips, care must be taken not to damage the wiring harnesses.

23. Release and then remove the intake manifold.
    - Discard the gaskets.
    - Install blanking caps to the exposed ports.



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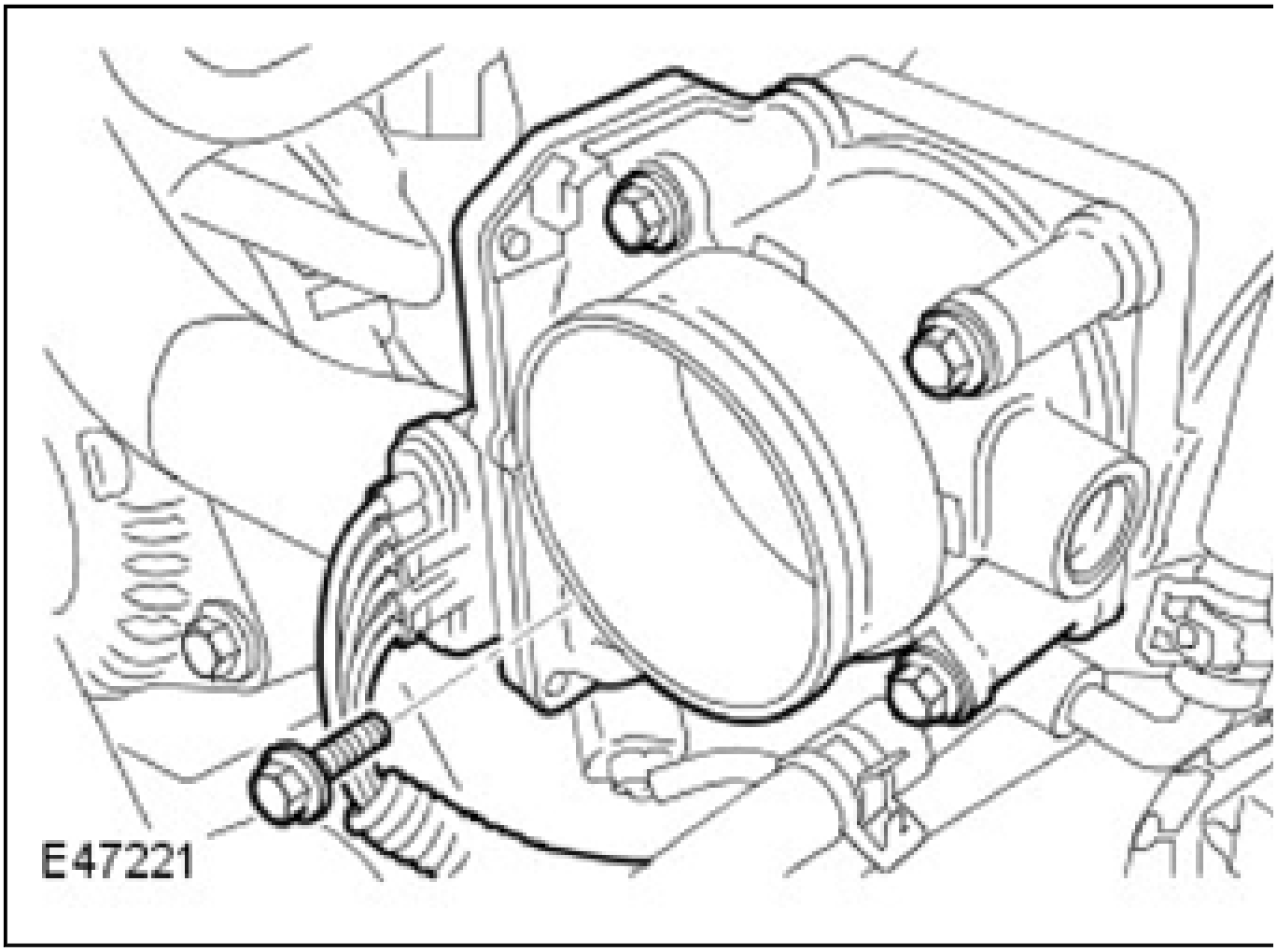
NOTE: Do not disassemble further if the component is removed for access only.

24. Remove the throttle body.
    - Remove the 4 bolts.
    - Remove and discard the throttle body gasket.
    - Disconnect the coolant hose.



25. Disconnect the EGR valve vacuum hose.
    - Disconnect and remove the vacuum hose at the intake manifold.

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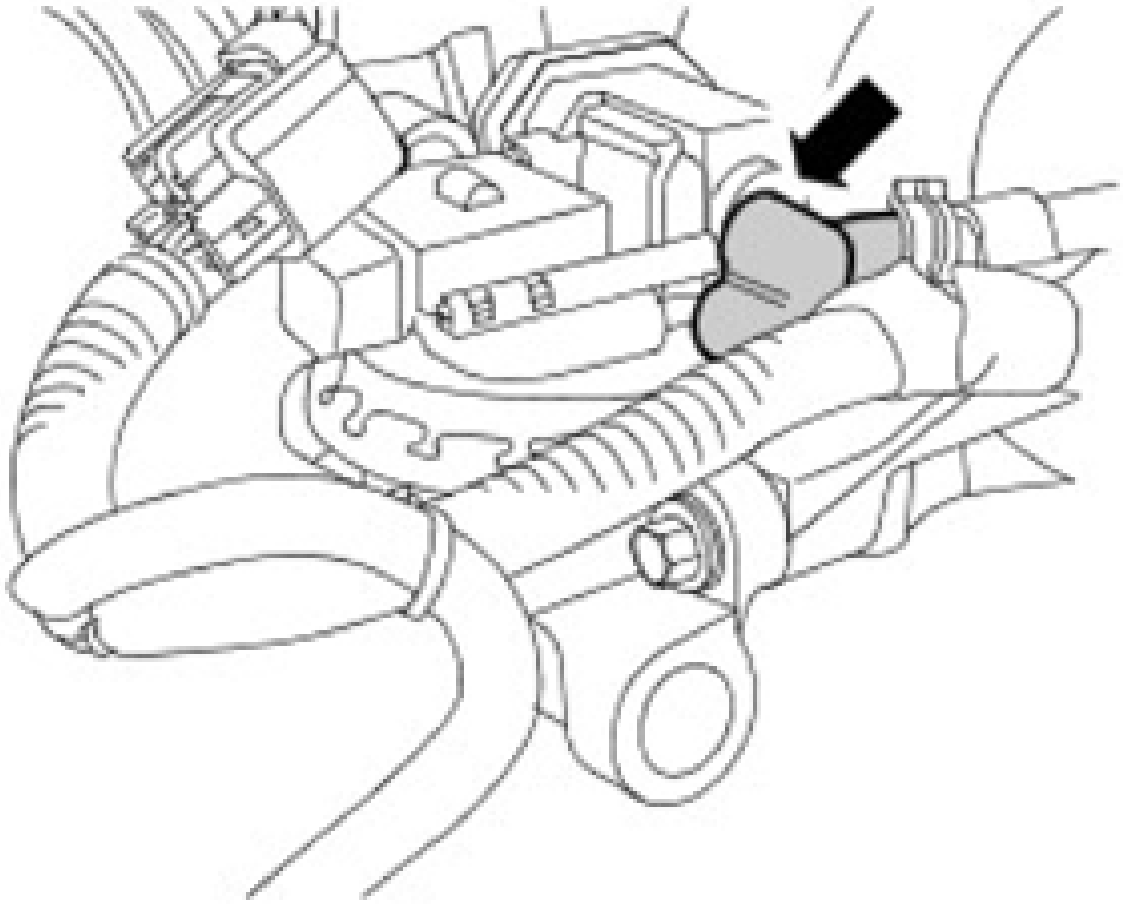

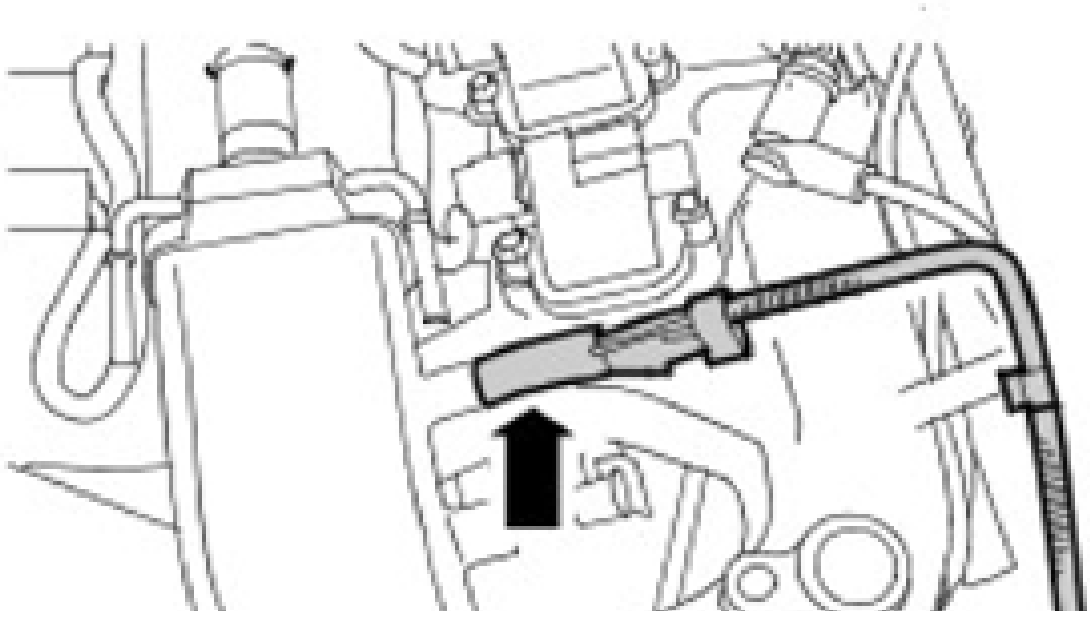

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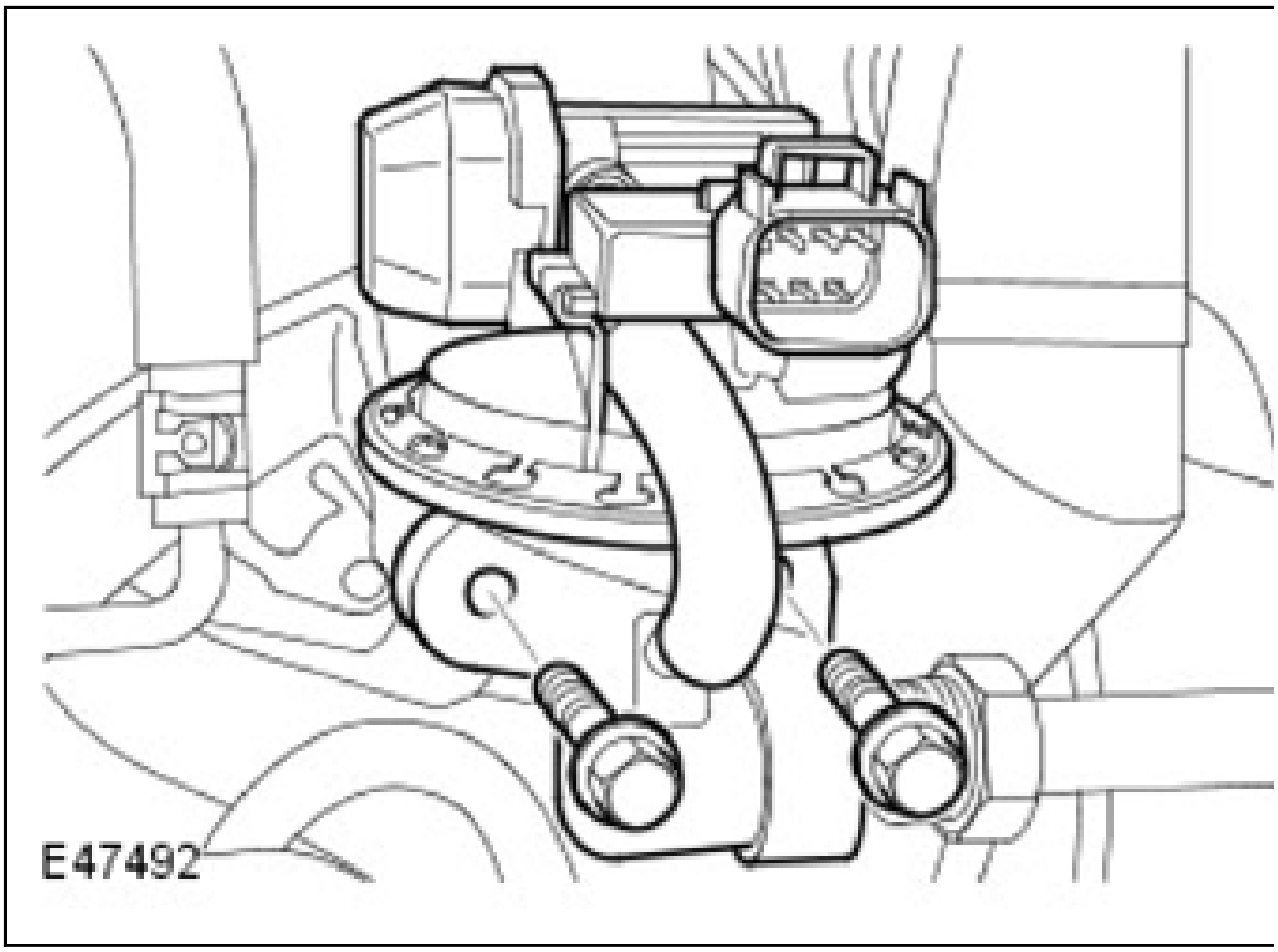
26. Remove the EGR valve.
    - Remove the 2 bolts.
    - Collect and discard the gasket.



27. Remove the remaining ignition coils.
    - Disconnect the sparking plug lead elbows at the coils.
    - Remove the bolts and studs. Remove and discard the seals.
28. Remove the HT leads.
    - Release the 6 plug lead clips.

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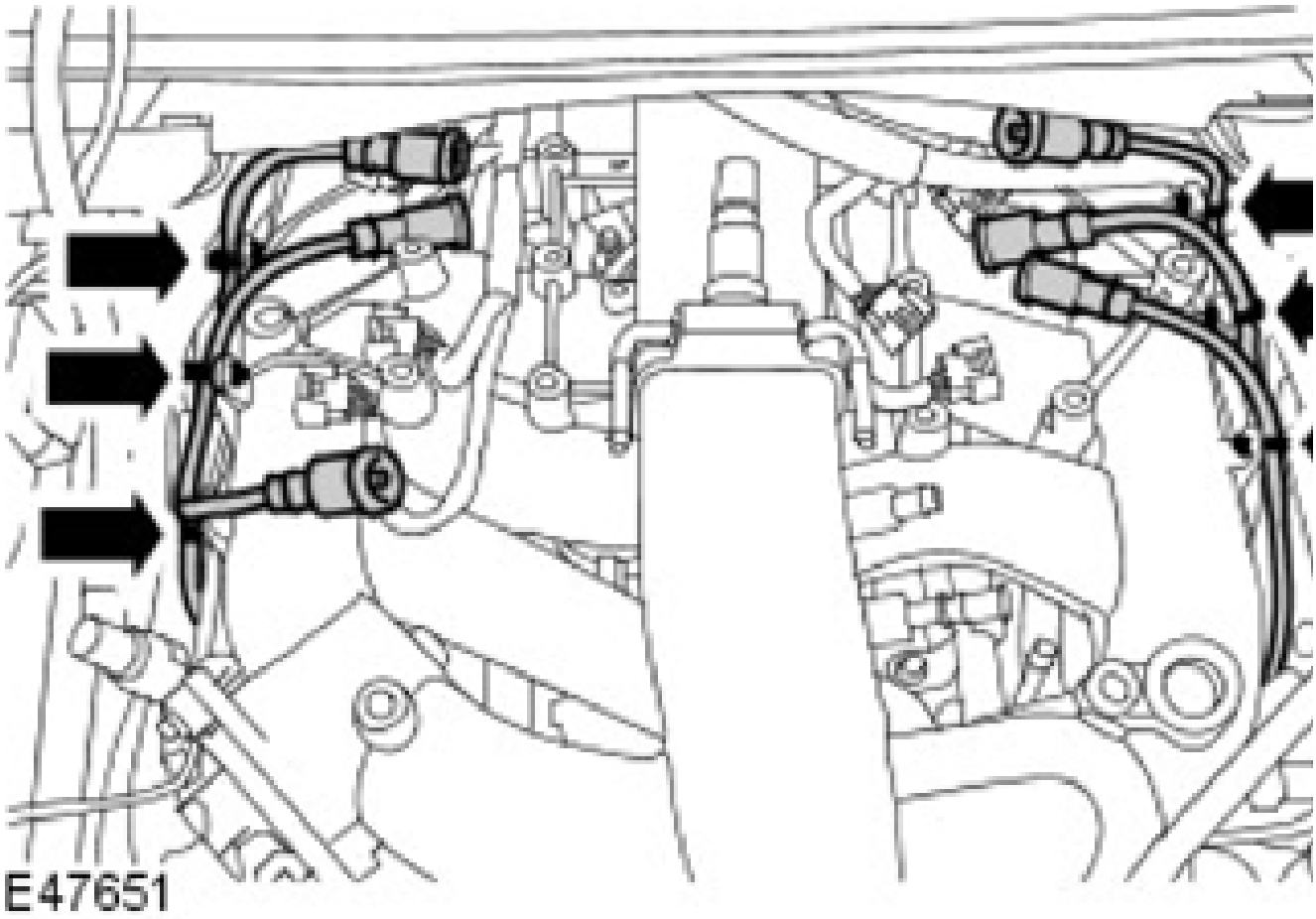

29. Remove the intake manifold tuning valve.
    - Remove the 2 bolts.
    - Discard the O-ring seal.

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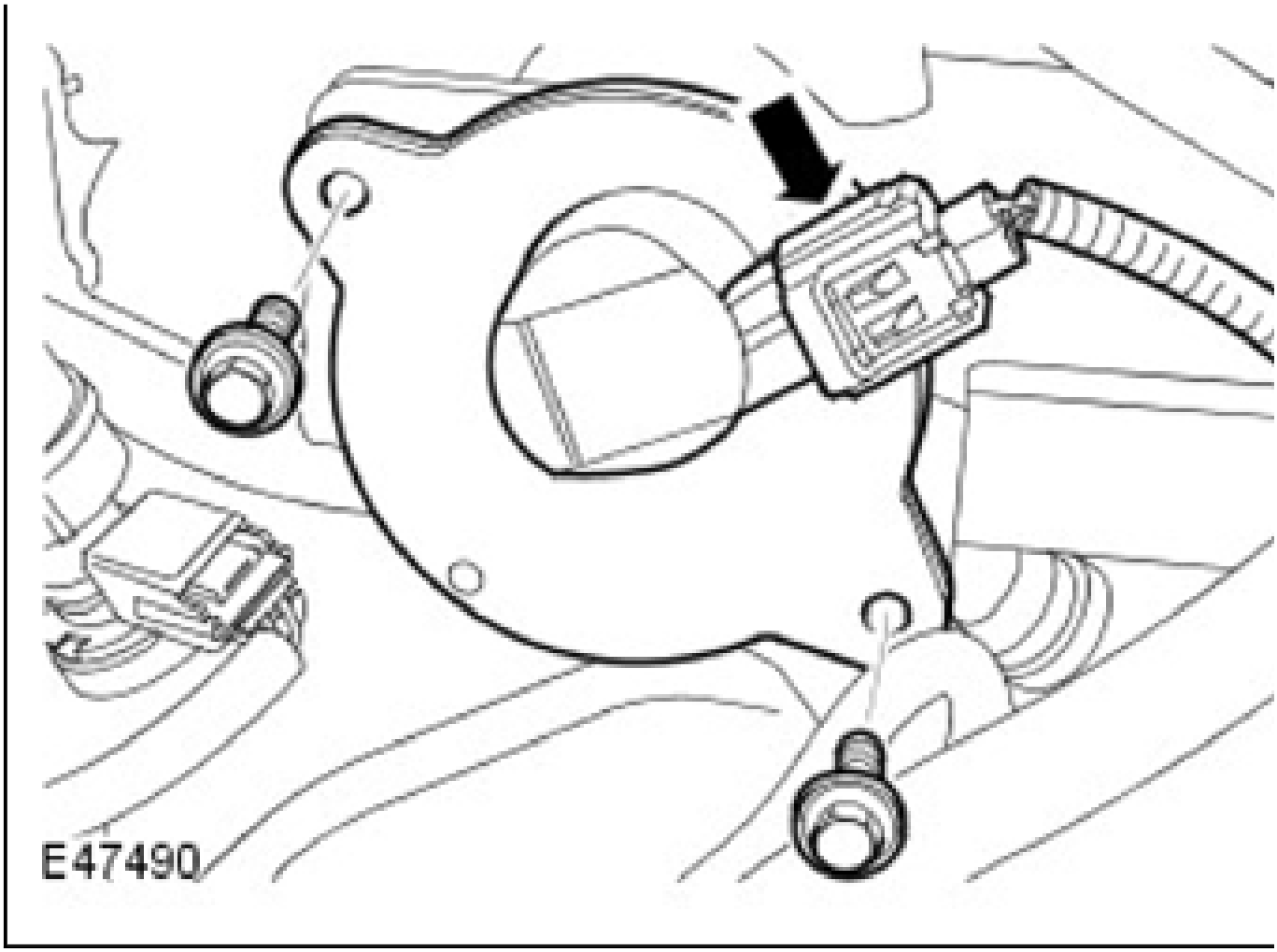

INSTALLATION

WARNING: Make sure there are no sharp edges after removing material.

1. Early vehicles only: Remove the center casting lug.

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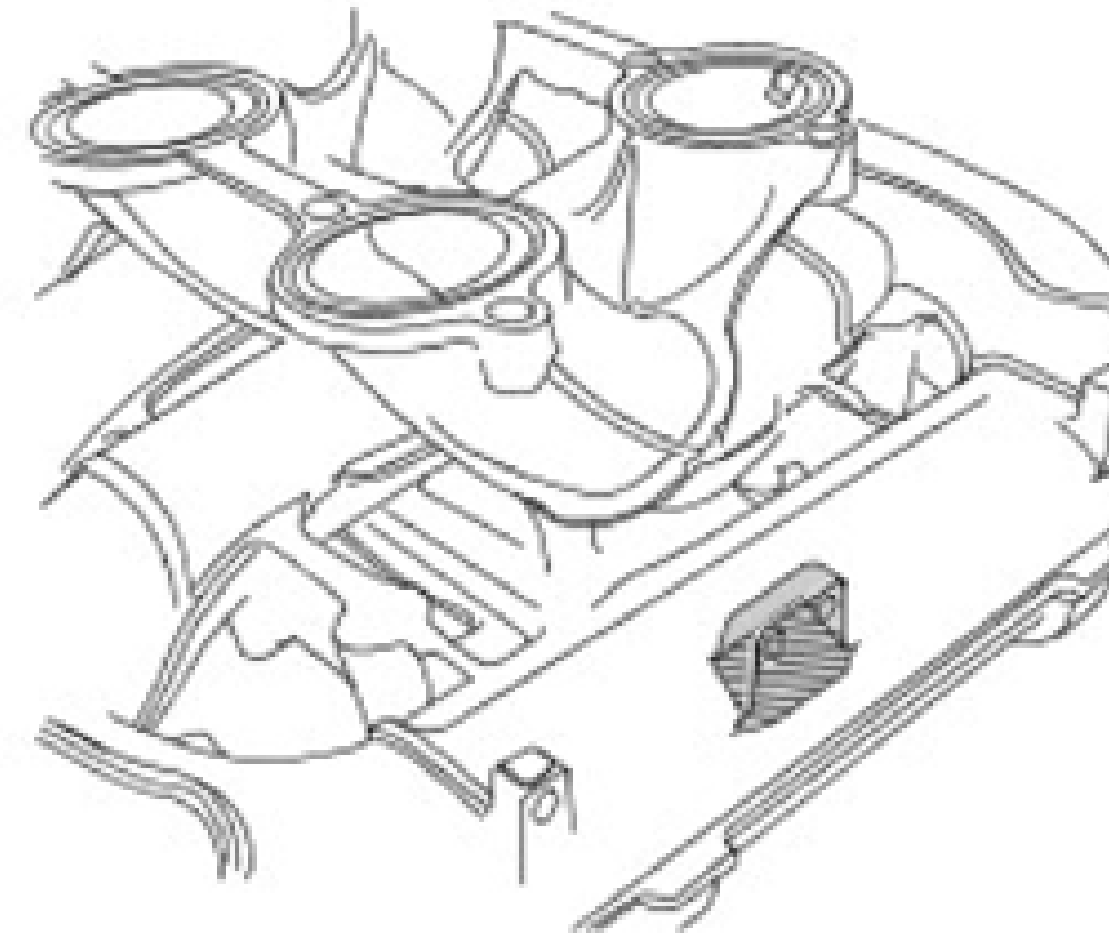

2. Early vehicles only: Remove excess material from the outside edges of the 6 intake manifold flange faces; file to within 2 mm of the gasket edge.

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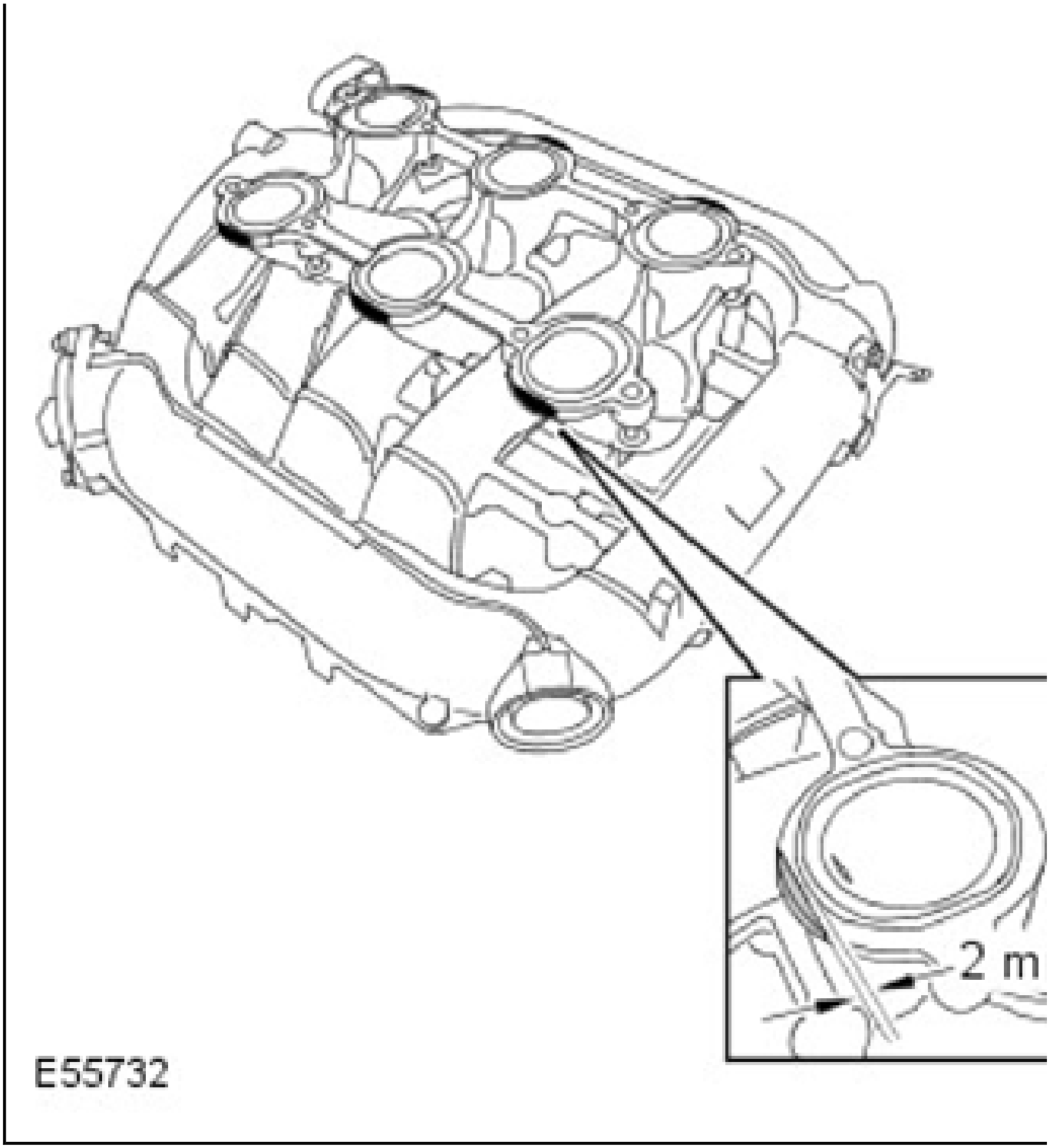

3. Early vehicles only: Install the fuel rail and injectors.
    - Clean the component mating faces.
    - Tighten the bolts to 25 Nm (18 lb.ft).
    - Connect the fuel injector electrical connectors.

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- Tighten the M6 bolt to 10 Nm (7 lb.ft).

4. Install the intake manifold tuning valve.
    - Clean the component mating faces.
    - Install a new O-ring seal.
    - Tighten the bolts to 10 Nm (7 lb.ft).
5. Secure the HT leads to the intake manifold with clips.

NOTE: Note the fitted position of the fasteners.

6. Install the 4 ignition coils.
    - Tighten the bolts to 6 Nm (4 lb.ft).
    - Tighten the studs to 6 Nm (4 lb.ft).
    - Connect the HT electrical connections.
7. Install the EGR valve.
    - Clean the component mating faces.
    - Install a new gasket.
    - Tighten the bolts to 25 Nm (18 lb.ft).
8. Connect the vacuum hose to the EGR valve.
9. Connect the EGR vacuum hose to the intake manifold.
    - Clean the component mating faces.
    - Connect the vacuum hose to the EGR valve.
10. Install the throttle body.
    - Clean the component mating faces.
    - Install a new gasket.
    - Tighten the 4 bolts to 10 Nm (7 lb.ft).
11. Install the throttle body coolant hose.
    - Secure the clip.
    - Remove the hose clamp.
12. Secure the wiring harness to the intake manifold.
    - Secure the wiring harness clip.

CAUTION: Care must be taken prior to tightening the intake manifold bolts. Make sure the electrical harness, vacuum and purge valve lines are not trapped.

NOTE: To aid installation: Position a Torx drive and extension, to the rear LH bank intake manifold Torx bolt, prior to installing the intake manifold. Retain with tape.
The ignition coils are removed from the illustration for clarity.

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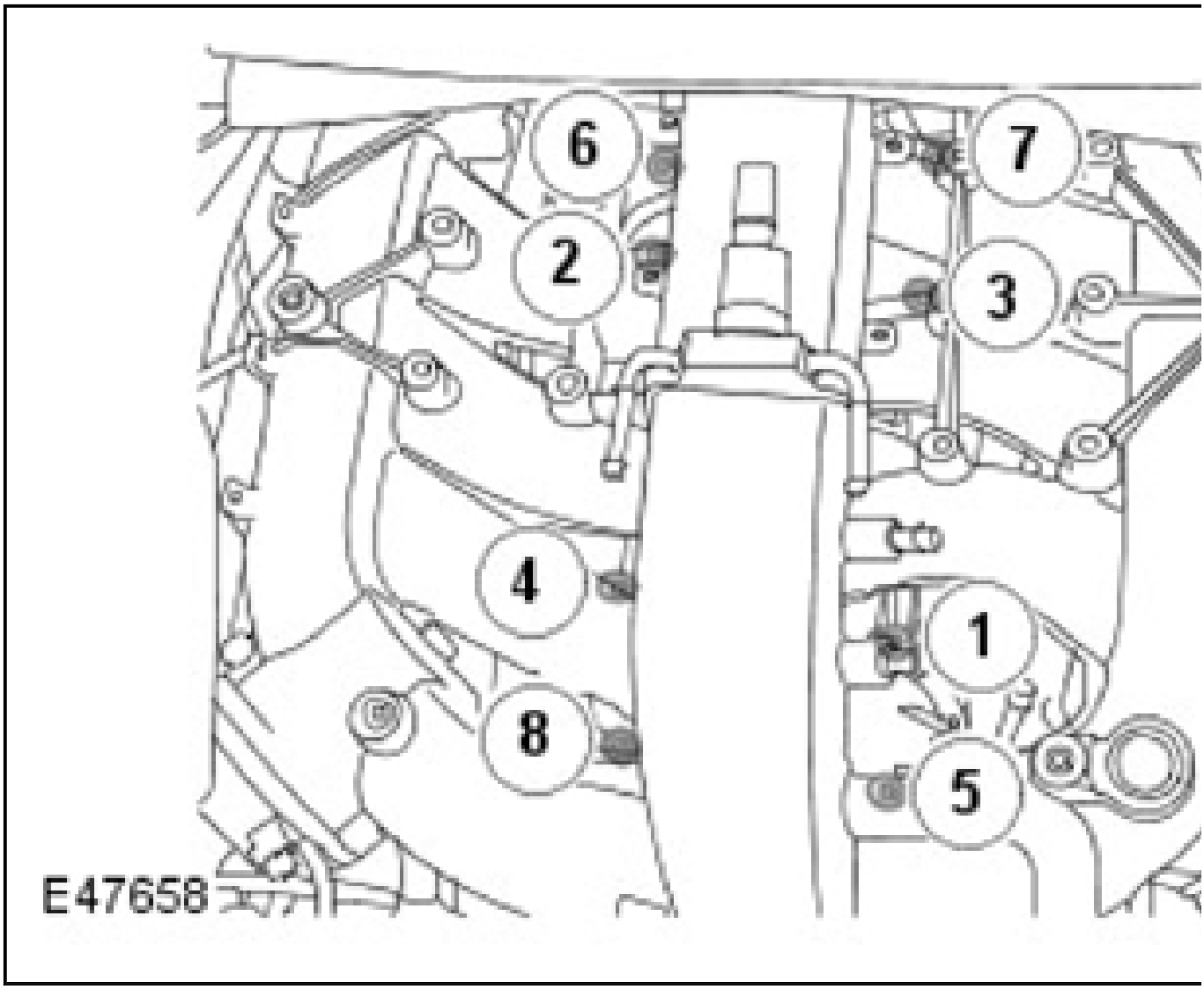
13. Install the intake manifold.
    - Clean the component mating faces.
    - Install the gaskets.
    - Evenly and progressively tighten the bolts in the sequence shown to 10 Nm (7 lb.ft).



14. Install the remaining ignition coils.
    - Tighten the bolts to 6 Nm (4 lb.ft).
    - Tighten the studs to 6 Nm (4 lb.ft).
    - Connect the HT electrical connections.
15. Connect the ignition coil electrical connectors.
16. Connect the fuel line to the fuel rail.
    - Clean the component mating faces.
    - Install the clip.

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17. Secure the coil wiring harness.
    - Connect the coil harness ground cables.
    - Tighten the nuts to 6 Nm (4 lb.ft).
    - Position and secure the clips.
18. Connect the intake manifold tuning valve electrical connector.
19. Connect the vacuum pipe to the inlet manifold.
20. Secure the purge line to the intake manifold.
    - Install the spacer.
    - Install the bolt.
    - Tighten the bolt to 6 Nm (4 lb.ft).
21. Connect the crankcase vent hose.
    - Clean the component mating faces.
22. Connect the intake manifold coolant hose.
    - Secure the clip.
    - Remove the hose clamp.
23. Install the air intake resonator.

    For additional information, refer to: **Intake Air Resonator** .

24. Install the engine cover.

    For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

25. Connect the hood support struts.
26. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

27. Check and top-up the coolant.

EXHAUST MANIFOLD LH

REMOVAL

All vehicles

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Remove the engine cover.

   For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

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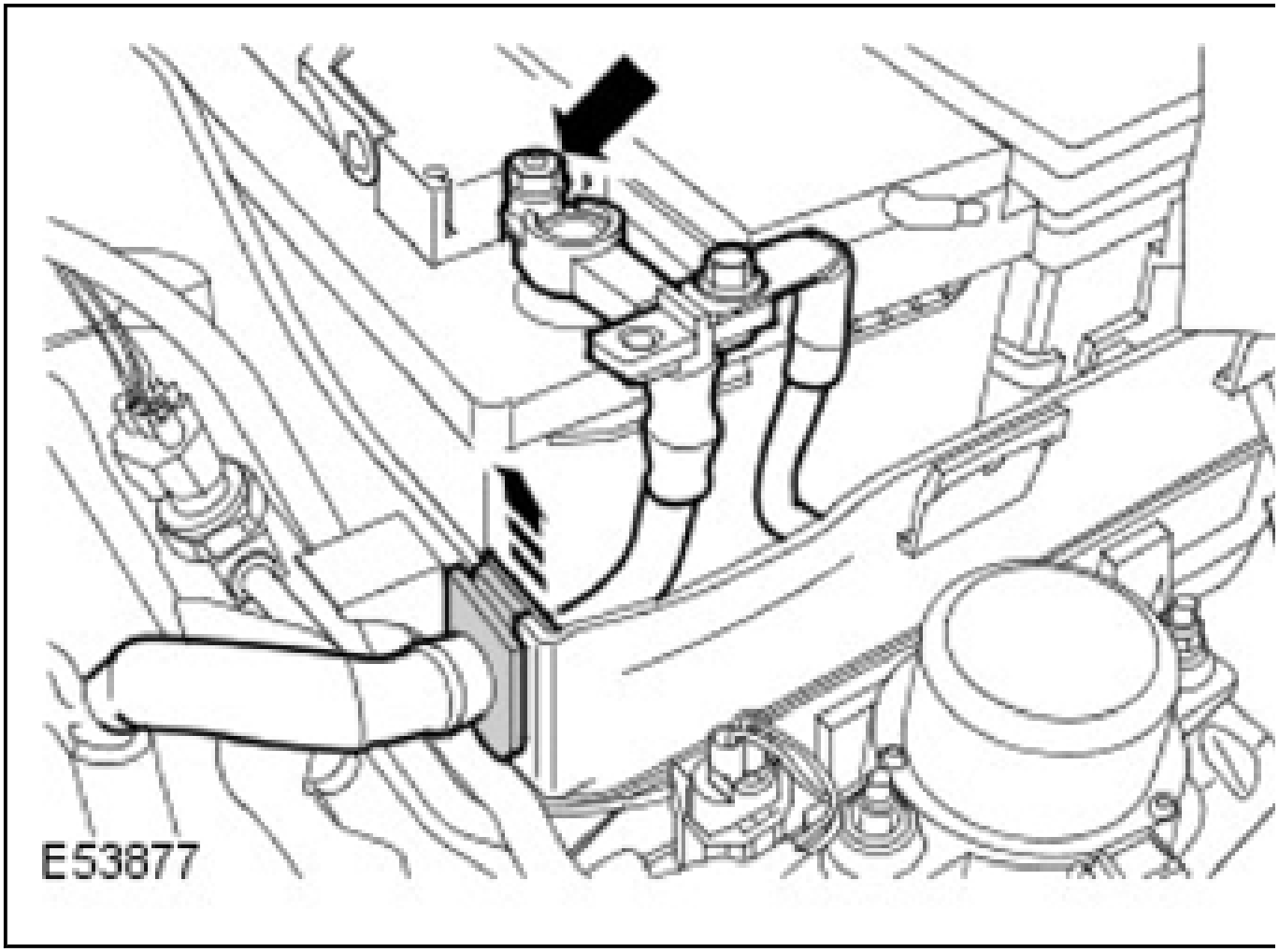
Right-hand drive vehicles

3. Release the battery positive cable.
    - Loosen the clamp.
    - Release the grommet.



Right-hand drive vehicles

4. Release the wiring harness clip.
    - Remove the bolt.

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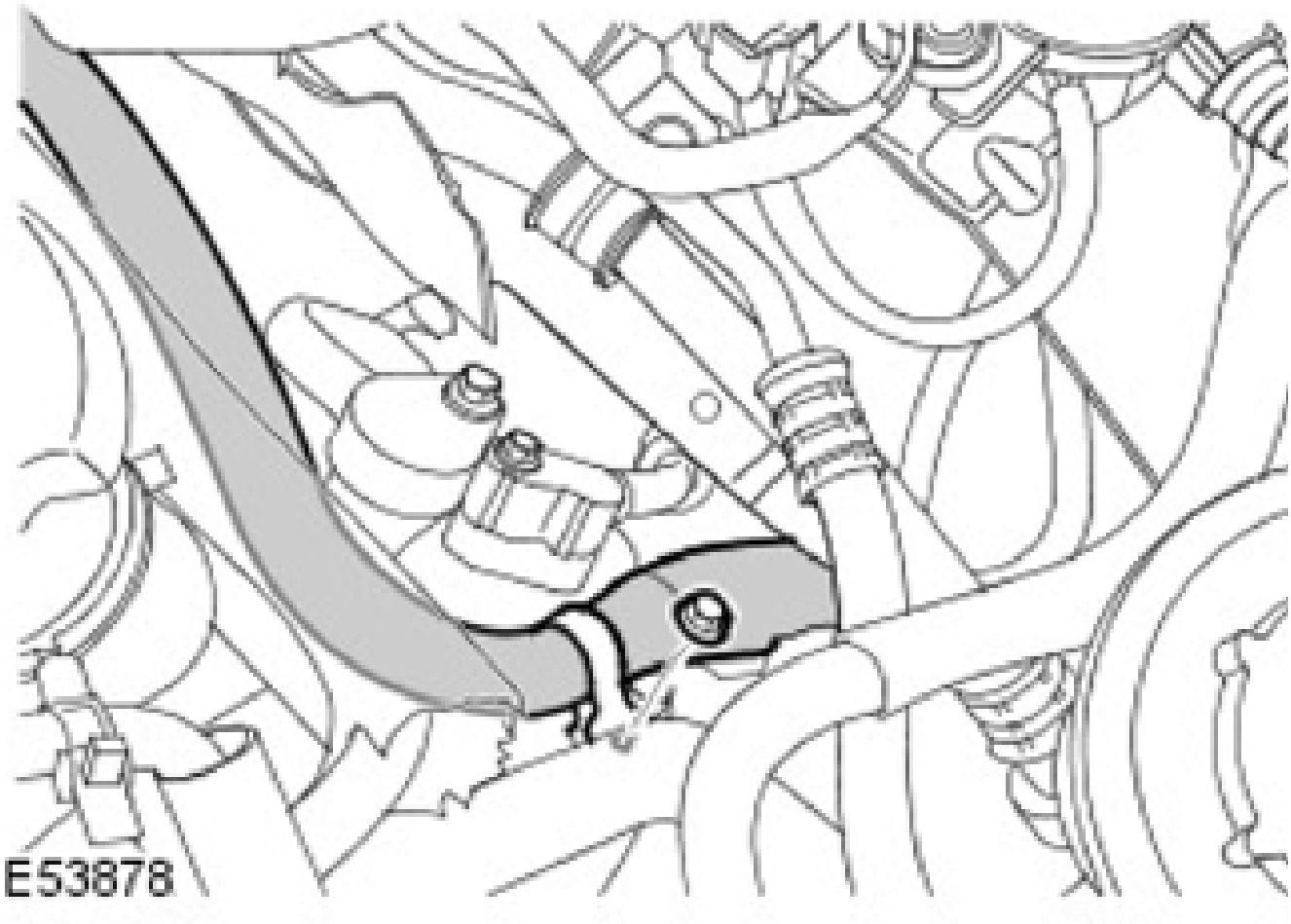

All vehicles

WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

5. **Raise and support the vehicle.**
6. Remove the engine undershield.

   For additional information, refer to: **ENGINE UNDERSHIELD** (501-02 Front End Body Panels, Removal and Installation).

7. Release the exhaust system from the exhaust manifold.
   - Remove and discard the 2 bolts.

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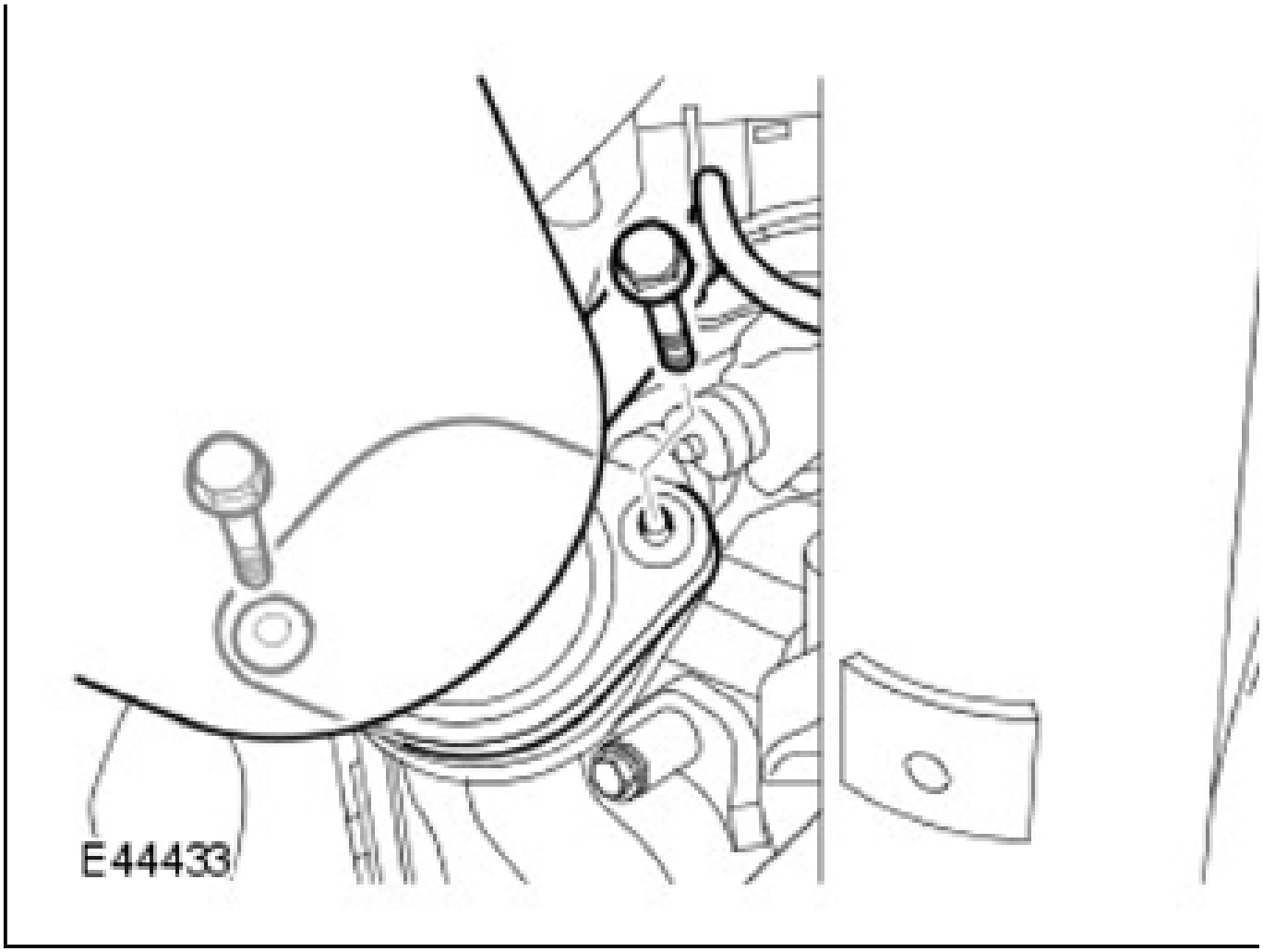

8. Lower the vehicle.

CAUTION: Protect the engine during this operation.

9. Raise the engine clear of its LH mount.
    - Remove the nut.

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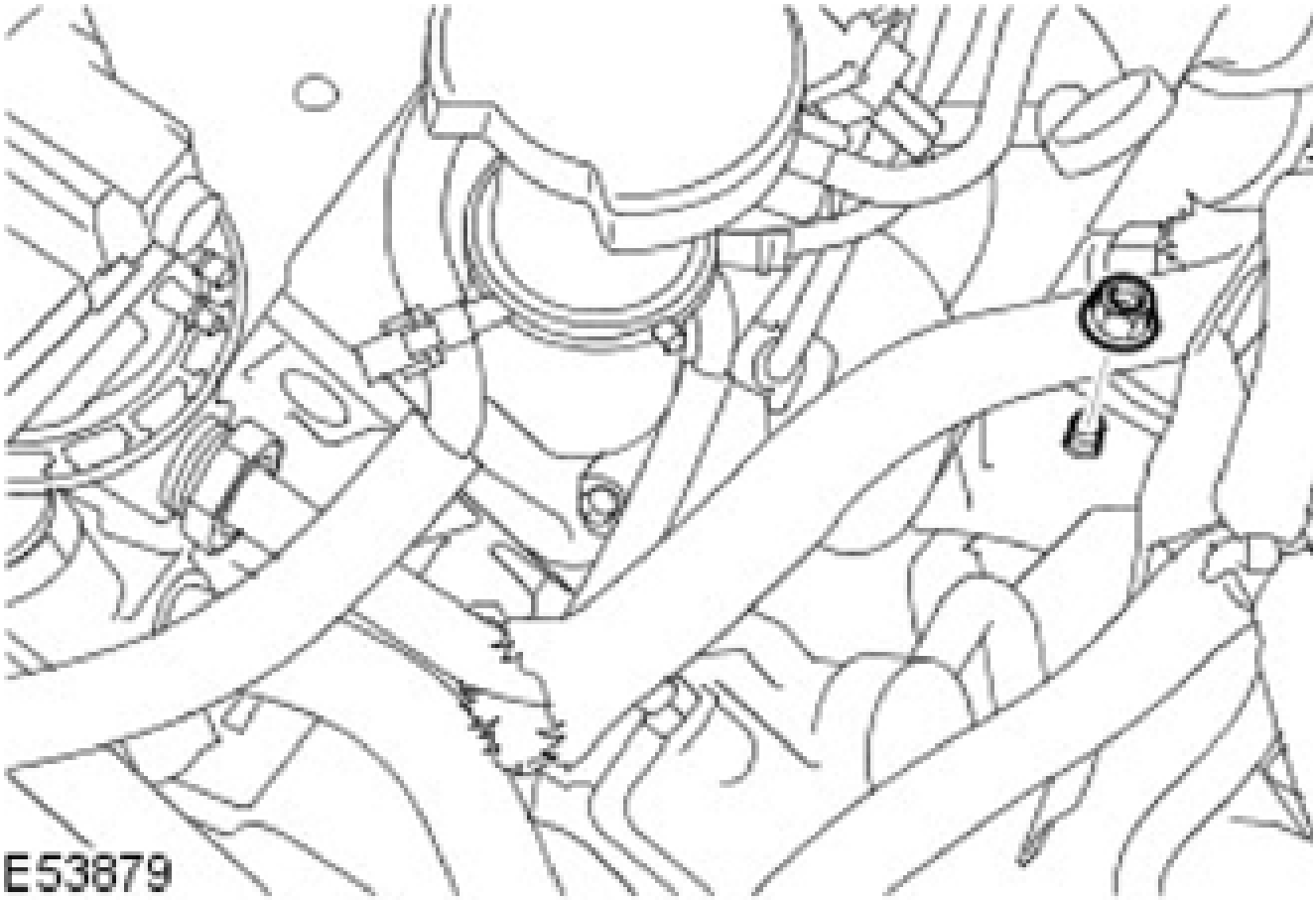

CAUTION: Before disconnecting or removing the components, ensure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

10. Remove the EGR pipe.
    - Release the 2 union nuts.

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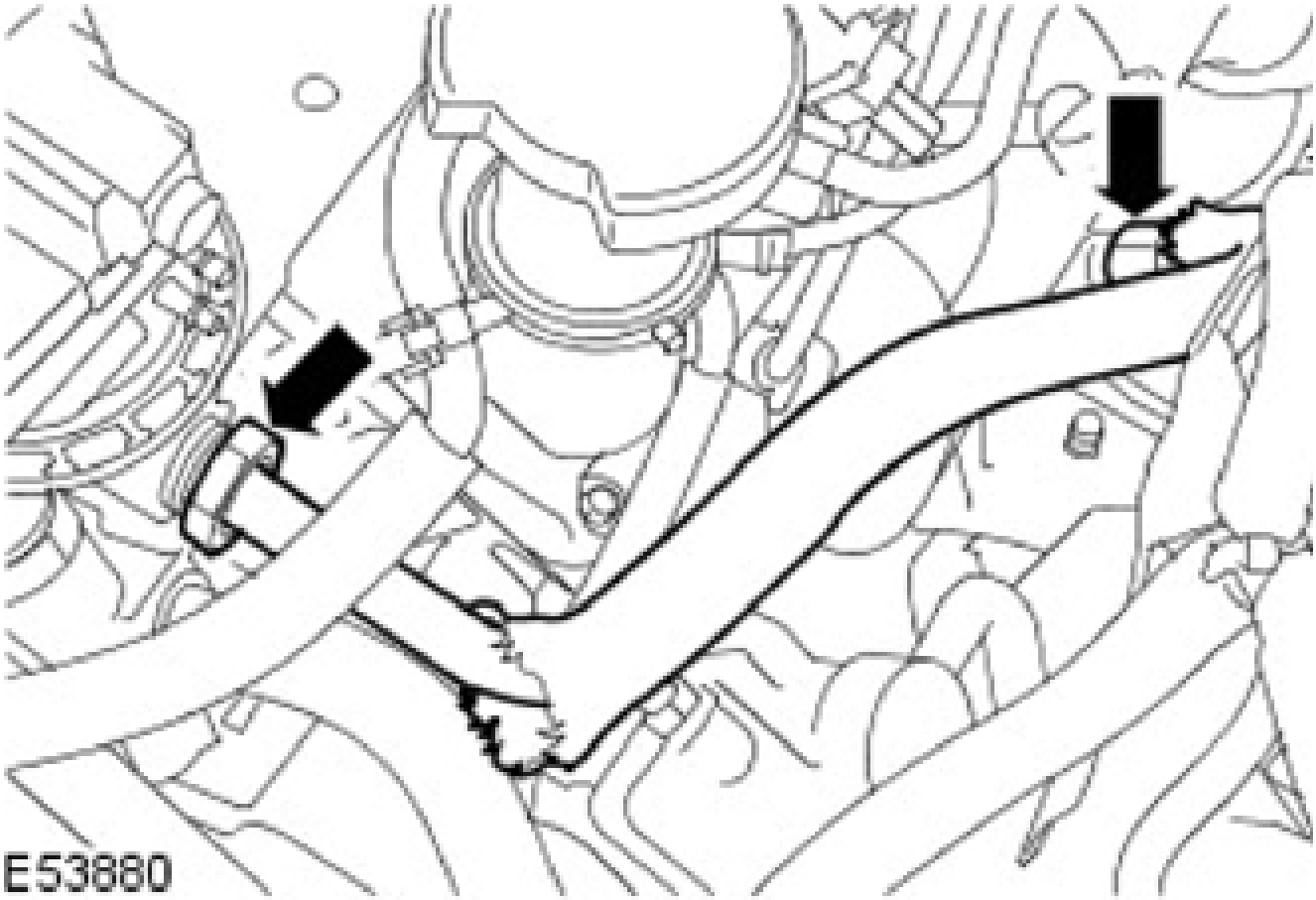

11. Disconnect the high tension (HT) electrical connectors.
    - Move the leads aside for access.

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CAUTION: Before disconnecting or removing the components, ensure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

12. Remove the dipstick tube.
    - Remove the dipstick.
    - Remove the bolt.
    - Discard the O-ring seal.

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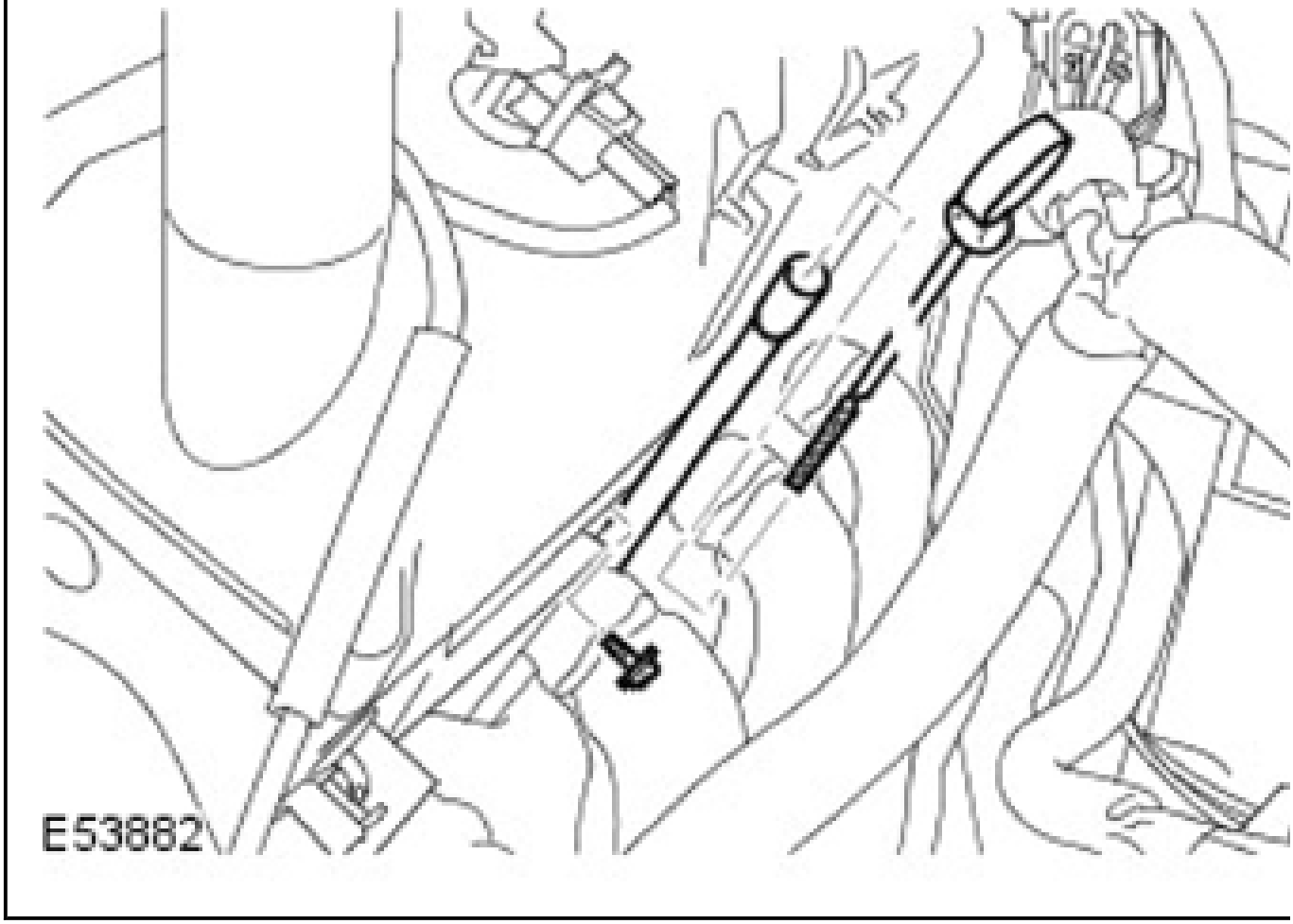

13. Remove the exhaust manifold.
    - Remove the 6 nuts.
    - Remove and discard the gasket.

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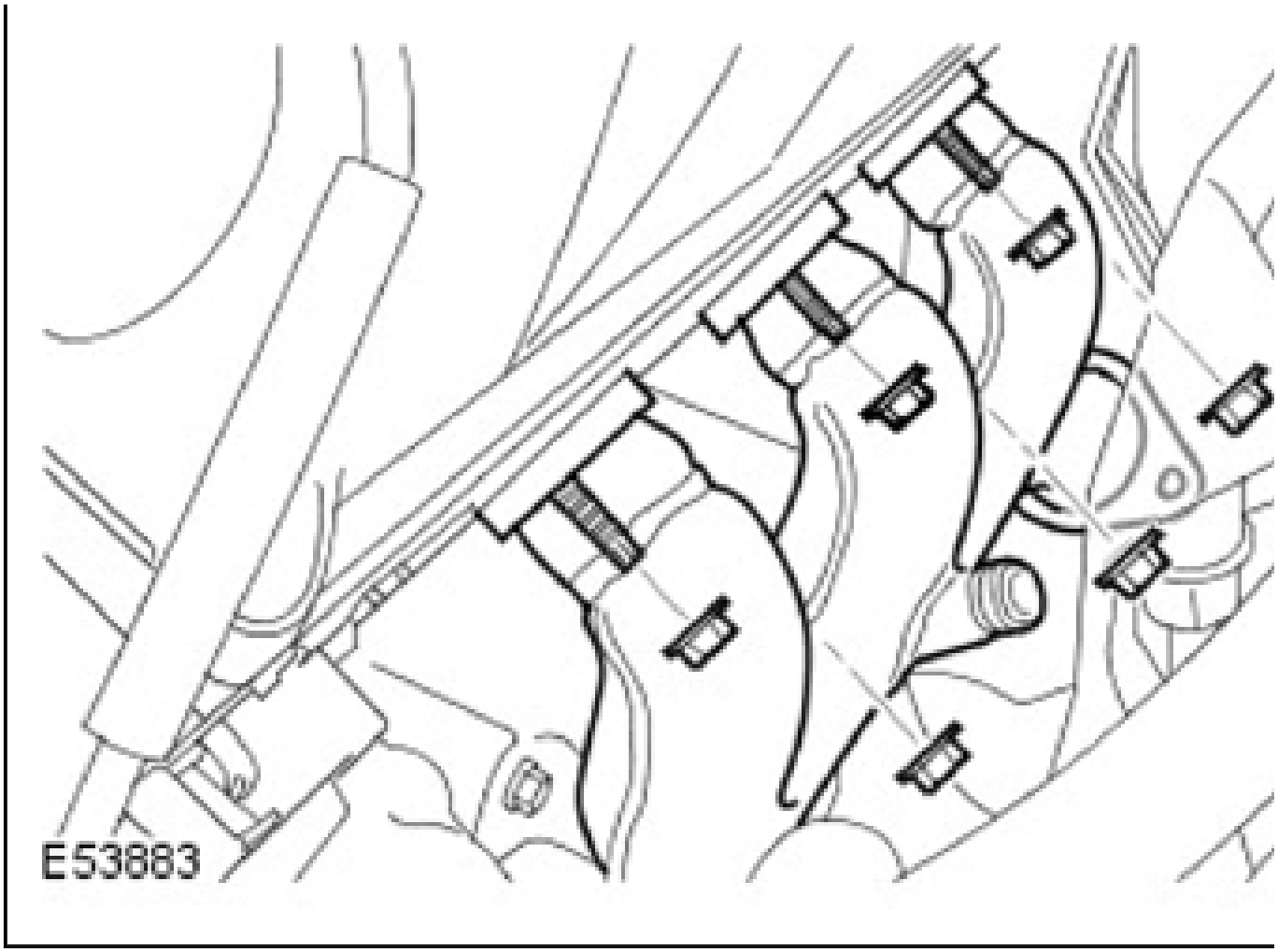

INSTALLATION

All vehicles

NOTE: The exhaust manifold gasket connecting links must be positioned to the lower edge of the manifold.

1. Install the exhaust manifold.
   - Install a new gasket.
   - Clean the component mating faces.
   - Tighten the nuts evenly in the sequence shown to 25 Nm (18 lb.ft).

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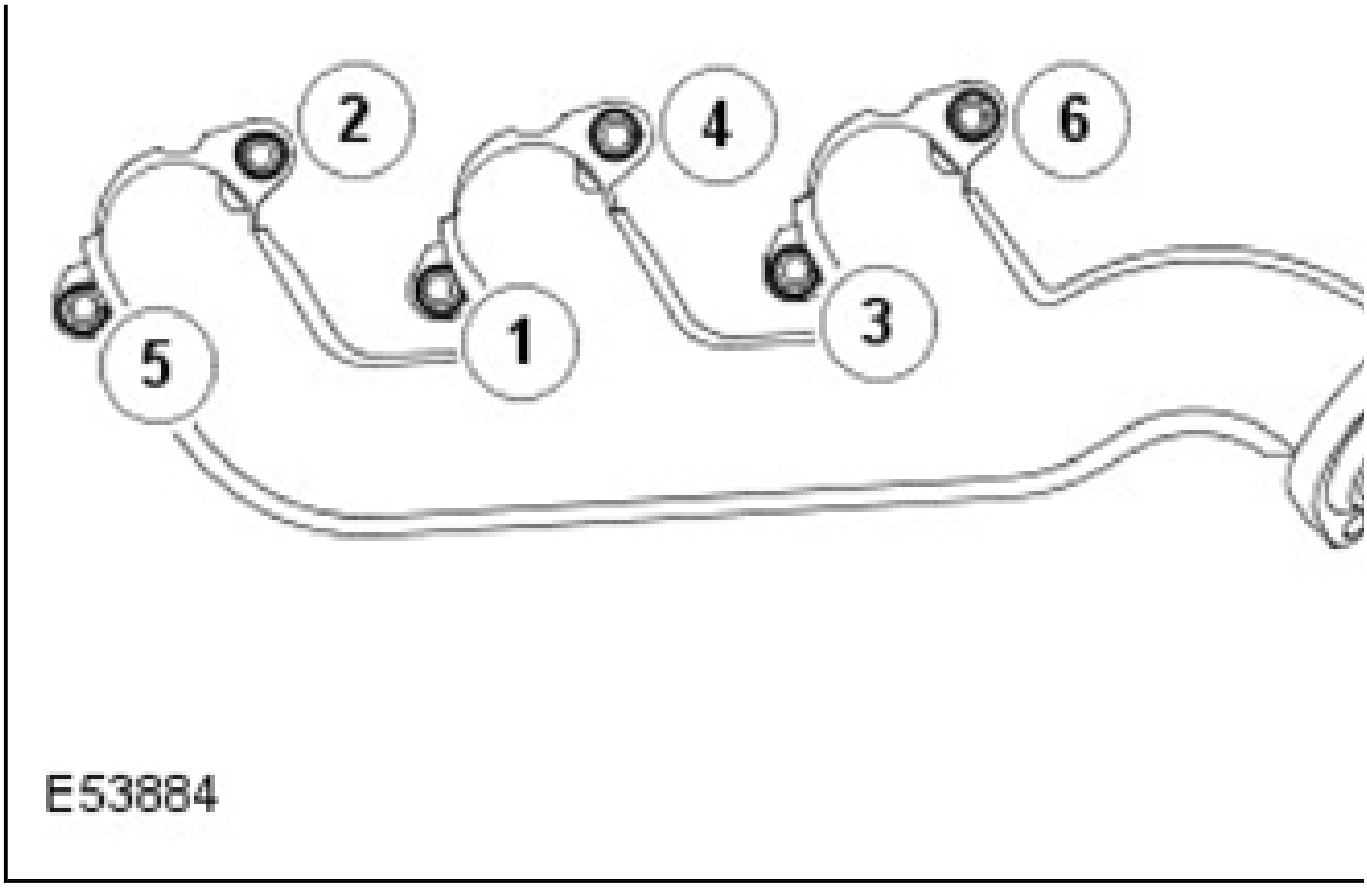

2. Install the dipstick tube.
    - Clean the component mating faces.
    - Install a new O-ring seal.
    - Lubricate the seal with clean engine oil.
    - Tighten the bolt to 10 Nm (7 lb.ft).
    - Install the dipstick.
3. Connect the HT electrical connectors.
4. Install the EGR pipe.
    - Clean the component mating faces.
    - Initially, finger tighten the nuts.
    - Finally, tighten the nuts to 40 Nm (30 lb.ft).
5. Lower the engine onto its mount.
    - Tighten the nut to 90 Nm (66 lb.ft).
6. Raise the vehicle.
7. Install the exhaust system.
    - Clean the component mating faces.
    - Install new bolts and tighten to 40 Nm (30 lb.ft).
8. Install the engine undershield.

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For additional information, refer to: **ENGINE UNDERSHIELD** .

9. Lower the vehicle.

Right-hand drive vehicles

NOTE: Apply petroleum jelly to the battery terminals.

10. Connect the battery positive cable.
    - Clean the component mating faces.
    - Install the grommet.
    - Tighten the clamp nut to 10 Nm (7 lb.ft).

Right-hand drive vehicles

11. Secure the wiring harness clip.
    - Tighten the bolt to 10 Nm (7 lb.ft).

All vehicles

12. Install the engine cover.

For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

13. Connect the battery ground cable.

For additional information, refer to: **SPECIFICATION** .

EXHAUST MANIFOLD RH

REMOVAL

1. Disconnect the battery ground cable.

For additional information, refer to: **SPECIFICATION** .

2. Remove the engine cover.

For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

3. Raise and support the vehicle.
4. Release the exhaust system from the exhaust manifold.

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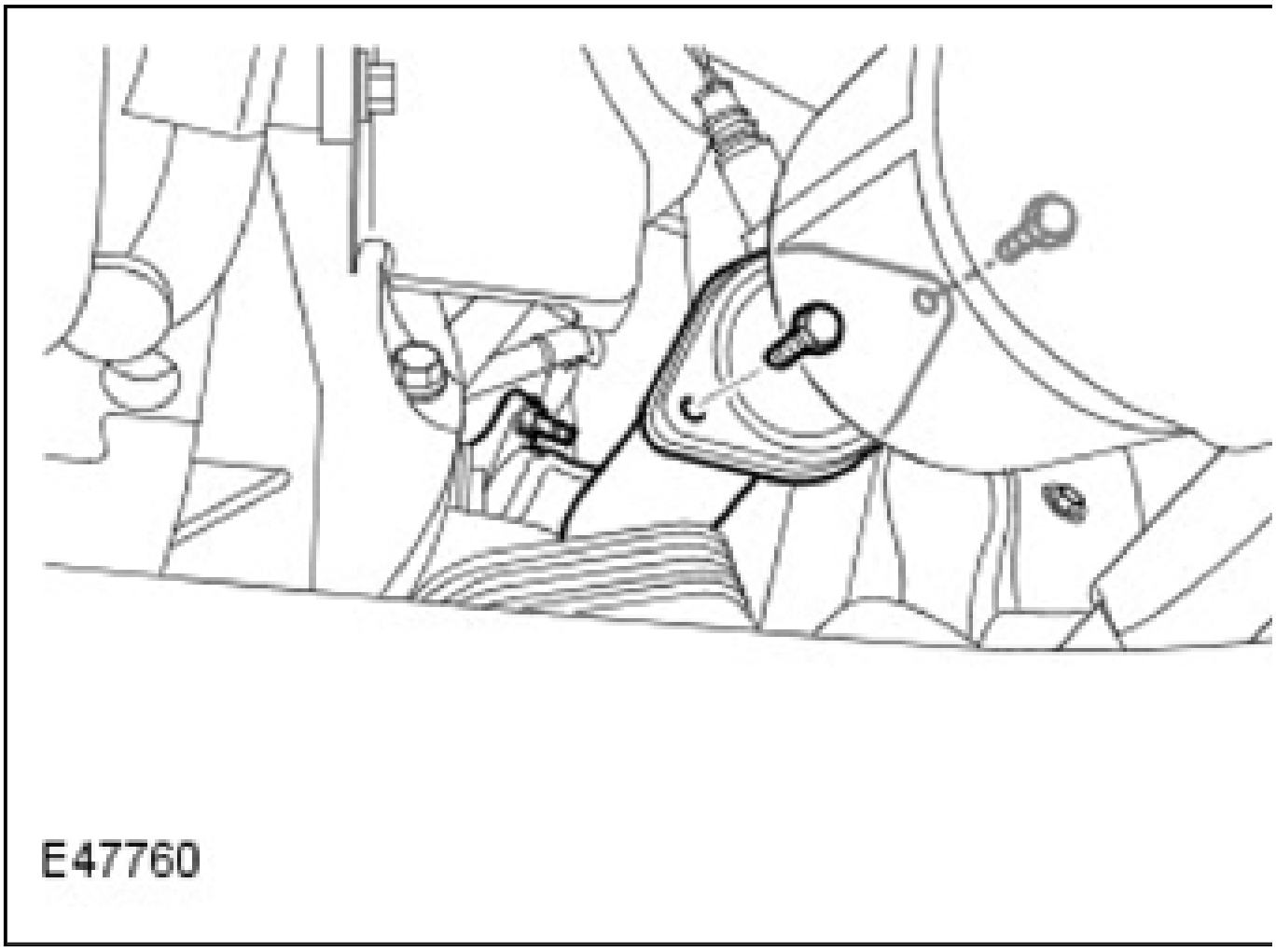
- Remove and discard the 2 bolts.



5. Lower the vehicle.
6. Disconnect the high tension (HT) electrical connectors.
    - Move the leads aside for access.

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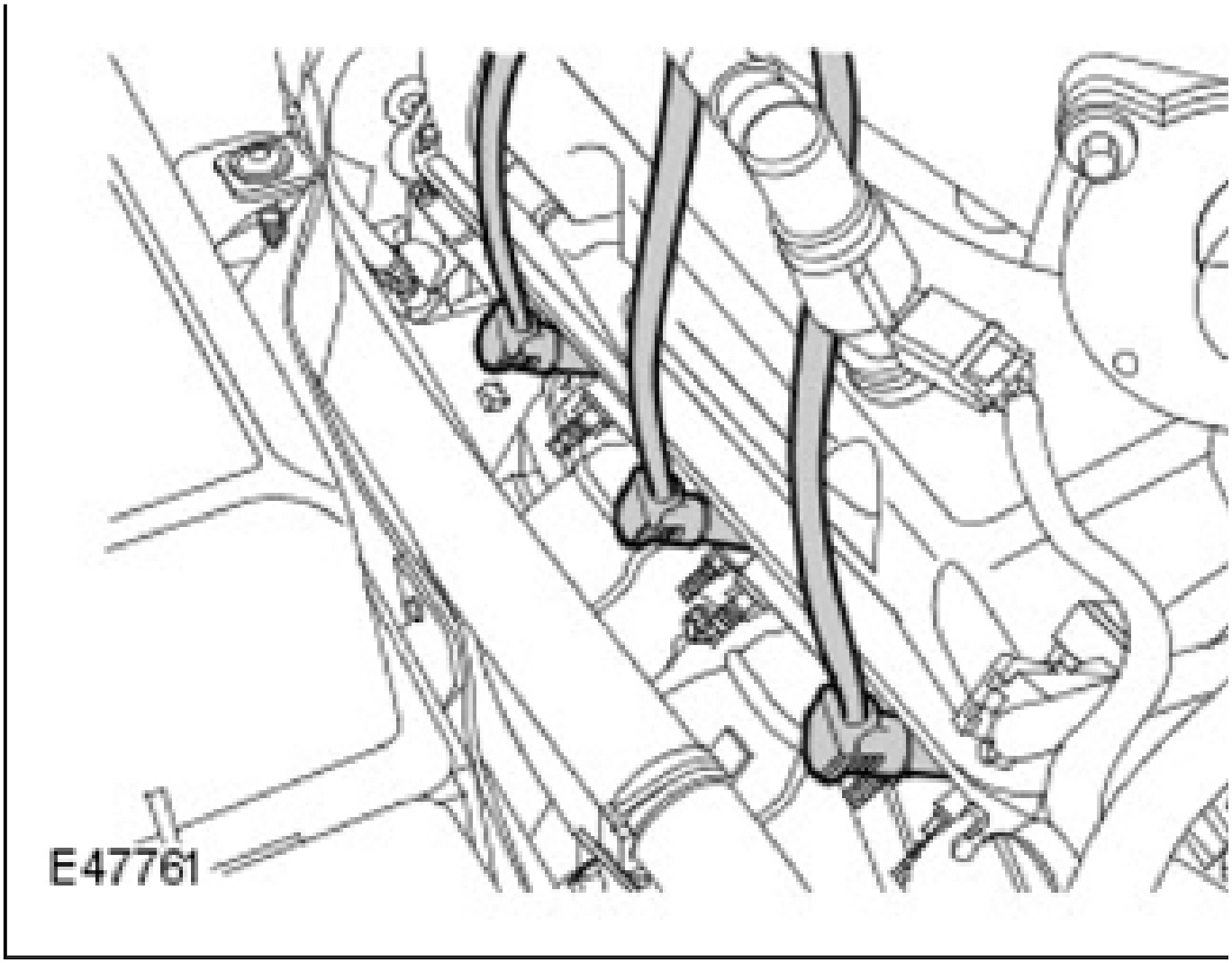

7. Remove the exhaust manifold.
    - Remove the 6 nuts.
    - Remove and discard the gasket.

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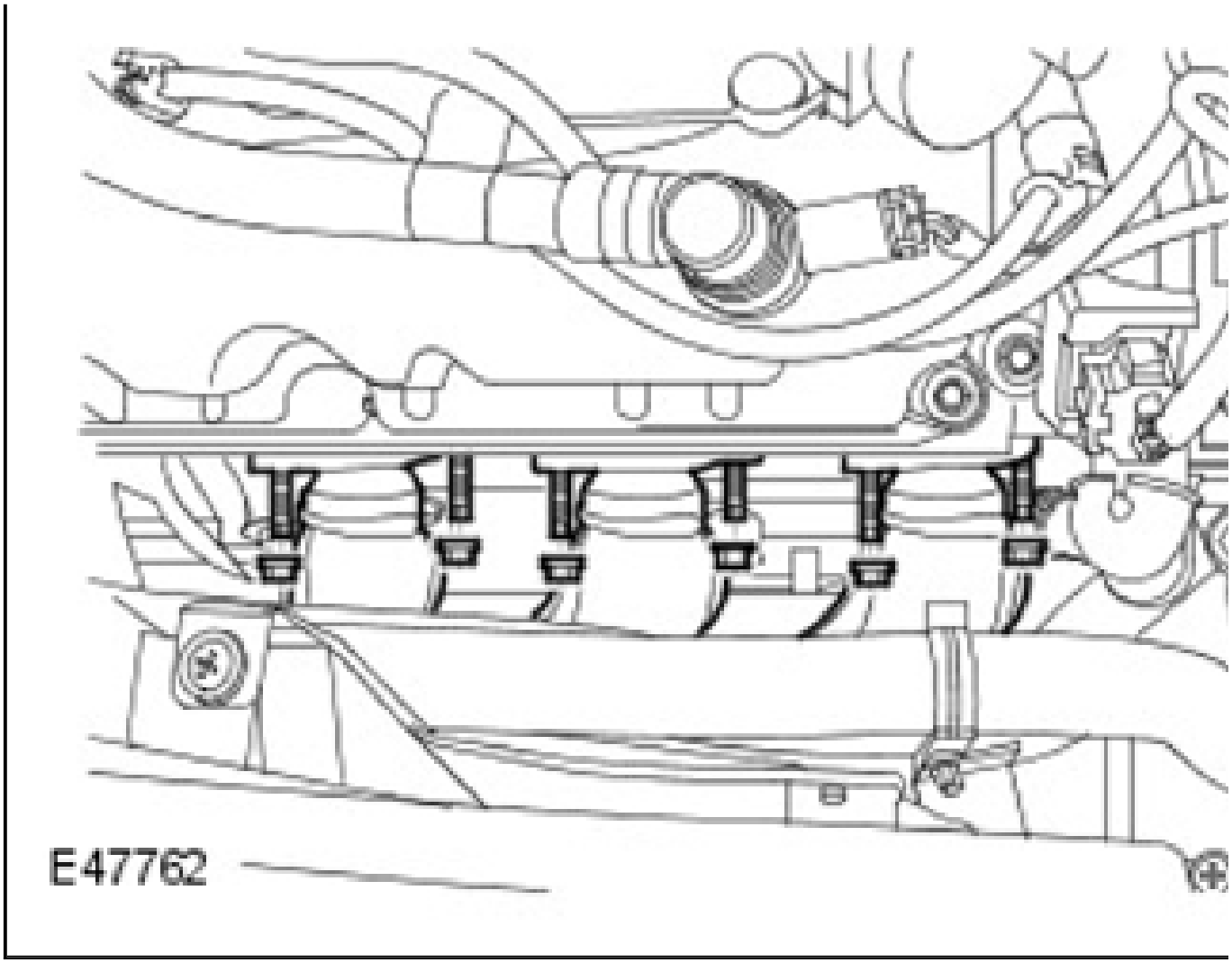

INSTALLATION

1. Install the exhaust manifold.
    - Clean the component mating faces.
    - Install a new gasket.
    - Evenly and progressively, tighten the nuts to 25 Nm (18 lb.ft).

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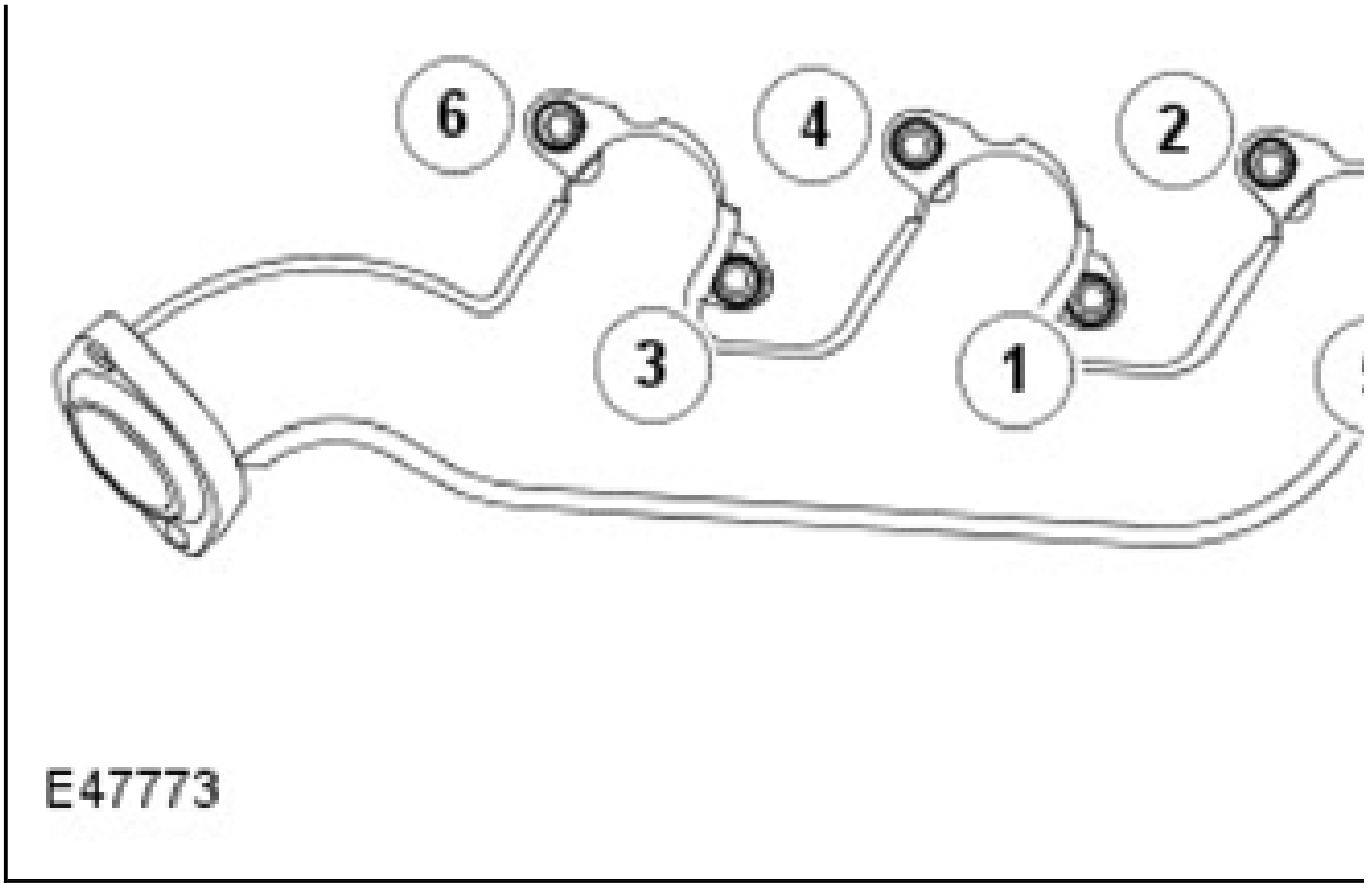

2. Connect the HT electrical connectors.
3. Raise the vehicle.
4. Install the exhaust system.
    - Clean the component mating faces.
    - Install new bolts and tighten to 40 Nm (30 lb.ft).
5. Lower the vehicle.
6. Install the engine cover.

    For additional information, refer to: **ENGINE COVER V6 4.0L PETROL** .

7. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

REMOVAL

ENGINE

SPECIAL TOOL(S)

	Engine lifting cradle - 4.0L

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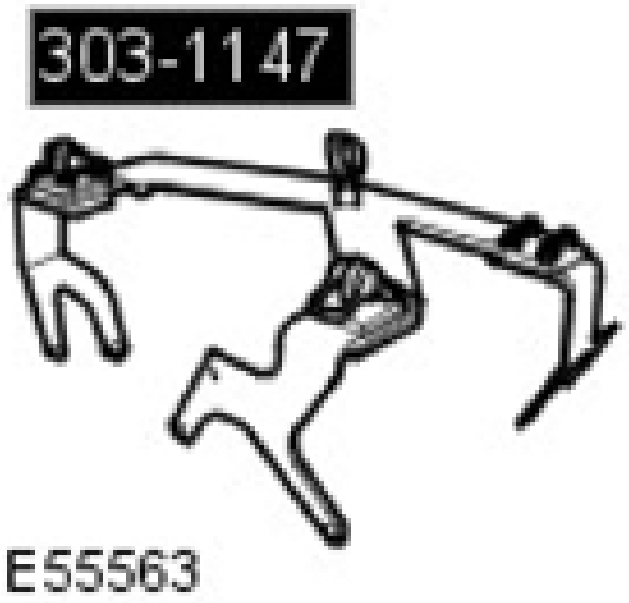
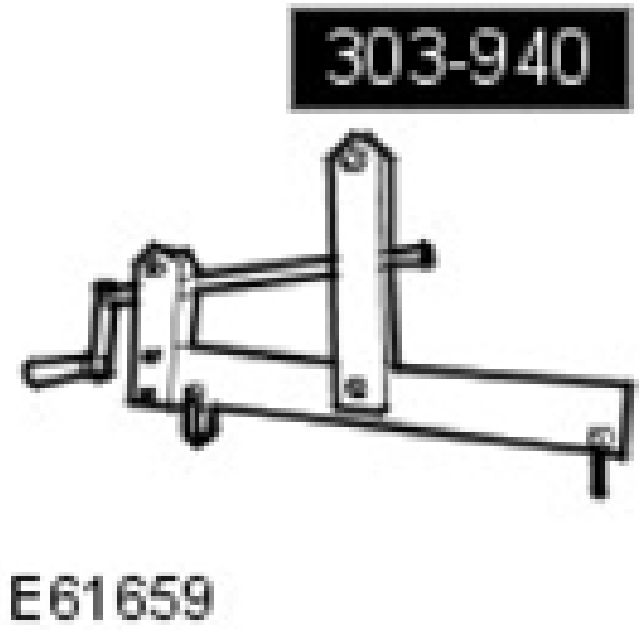
	303-1147
	Engine lifting bracket 303-940 (LRT-12-138)
	Lifting chains 303-940/1

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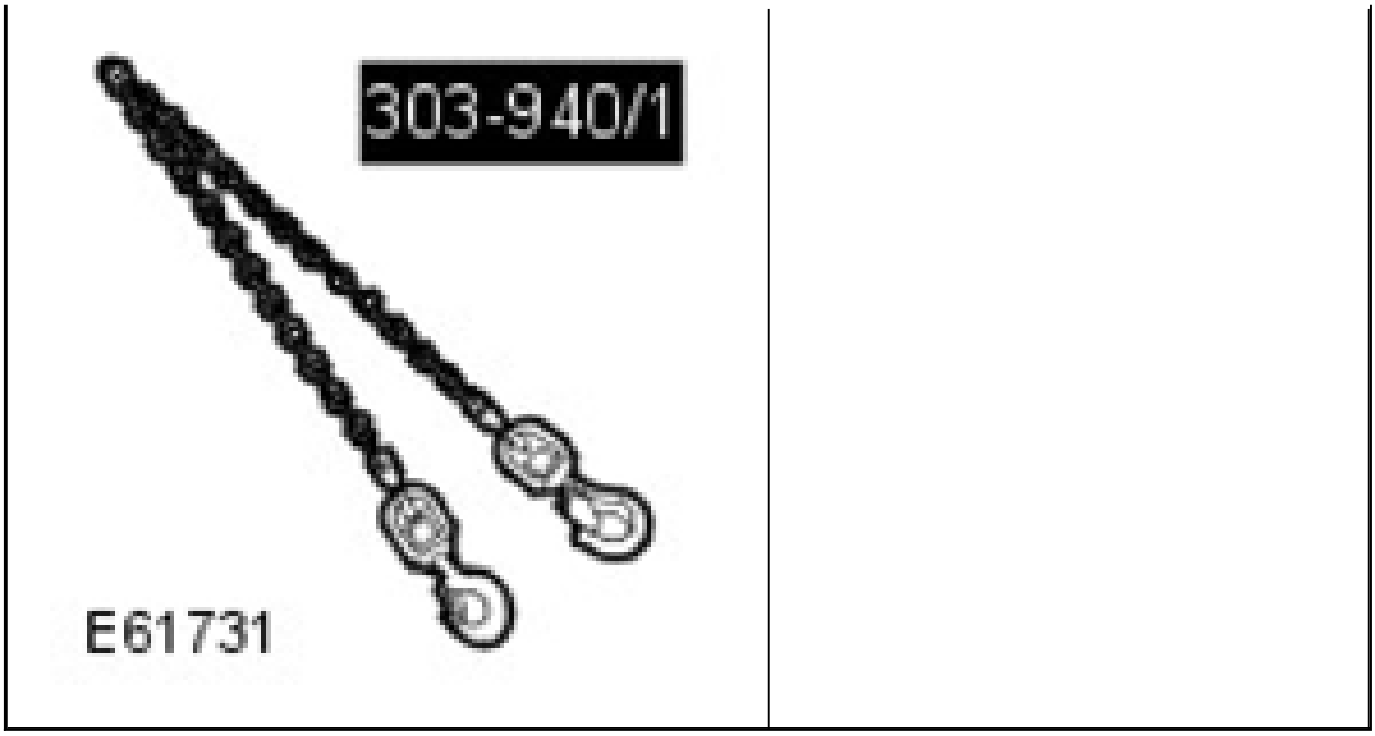

REMOVAL

1. Disconnect the battery ground cable.

   For additional information, refer to: **SPECIFICATION** .

2. Secure the hood in the service position.
3. Raise and support the vehicle.
4. Drain the cooling system.

   For additional information, refer to: **Cooling System Draining, Filling and Bleeding** .

5. Drain the engine oil.

   For additional information, refer to: **ENGINE OIL DRAINING AND FILLING** .

   NOTE: Early vehicles will require the partial release of the fuel rail, to allow the intake manifold to be removed.

6. Remove the intake manifold.

   For additional information, refer to: **INTAKE MANIFOLD** .

7. Remove the battery tray.

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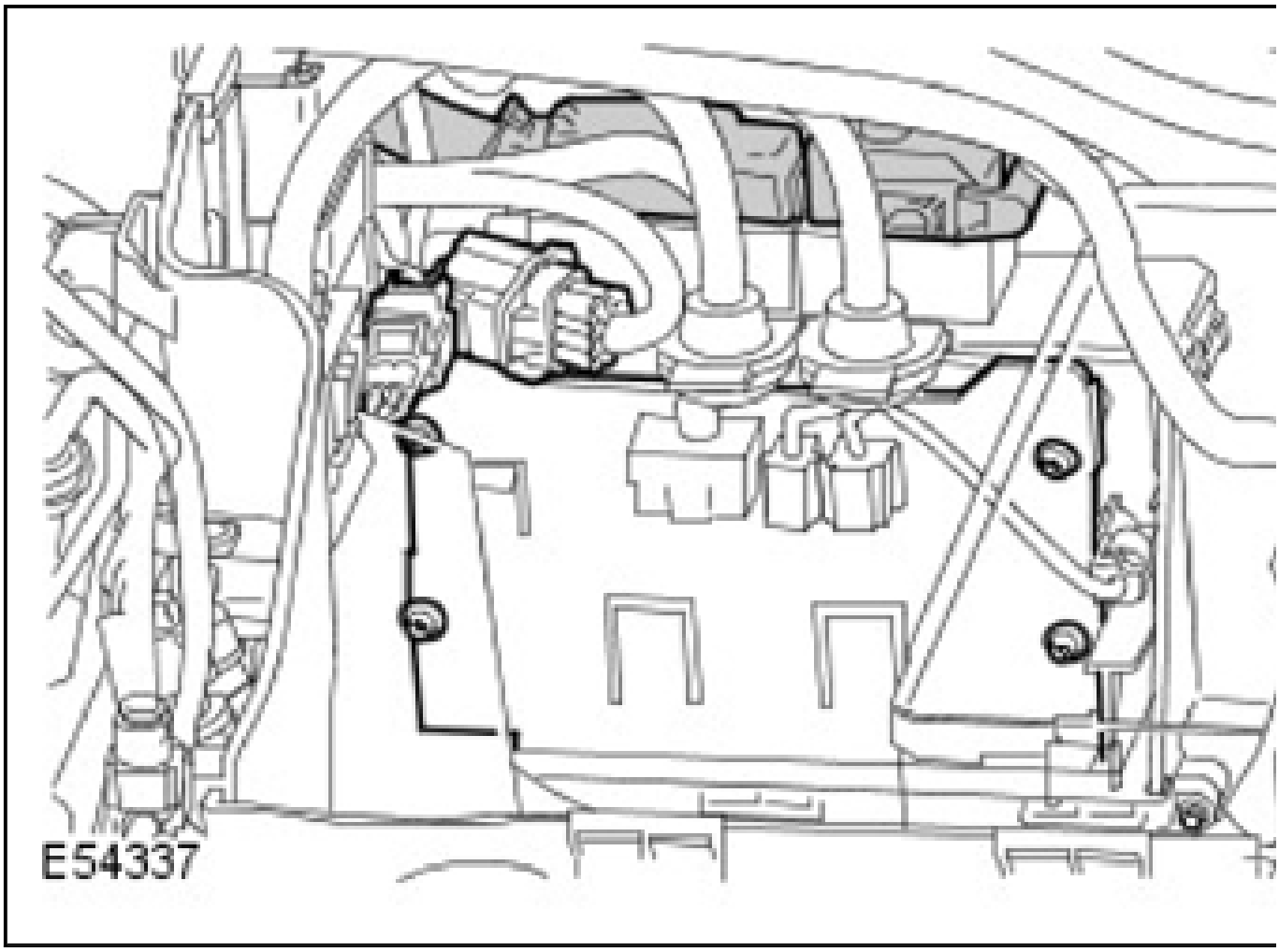
For additional information, refer to: **BATTERY TRAY** .

8. Disconnect the 2 ECM electrical connectors.



9. Release the wiring harness from the plenum.
   - Release the 2 clips.
   - Position the wiring harness aside.

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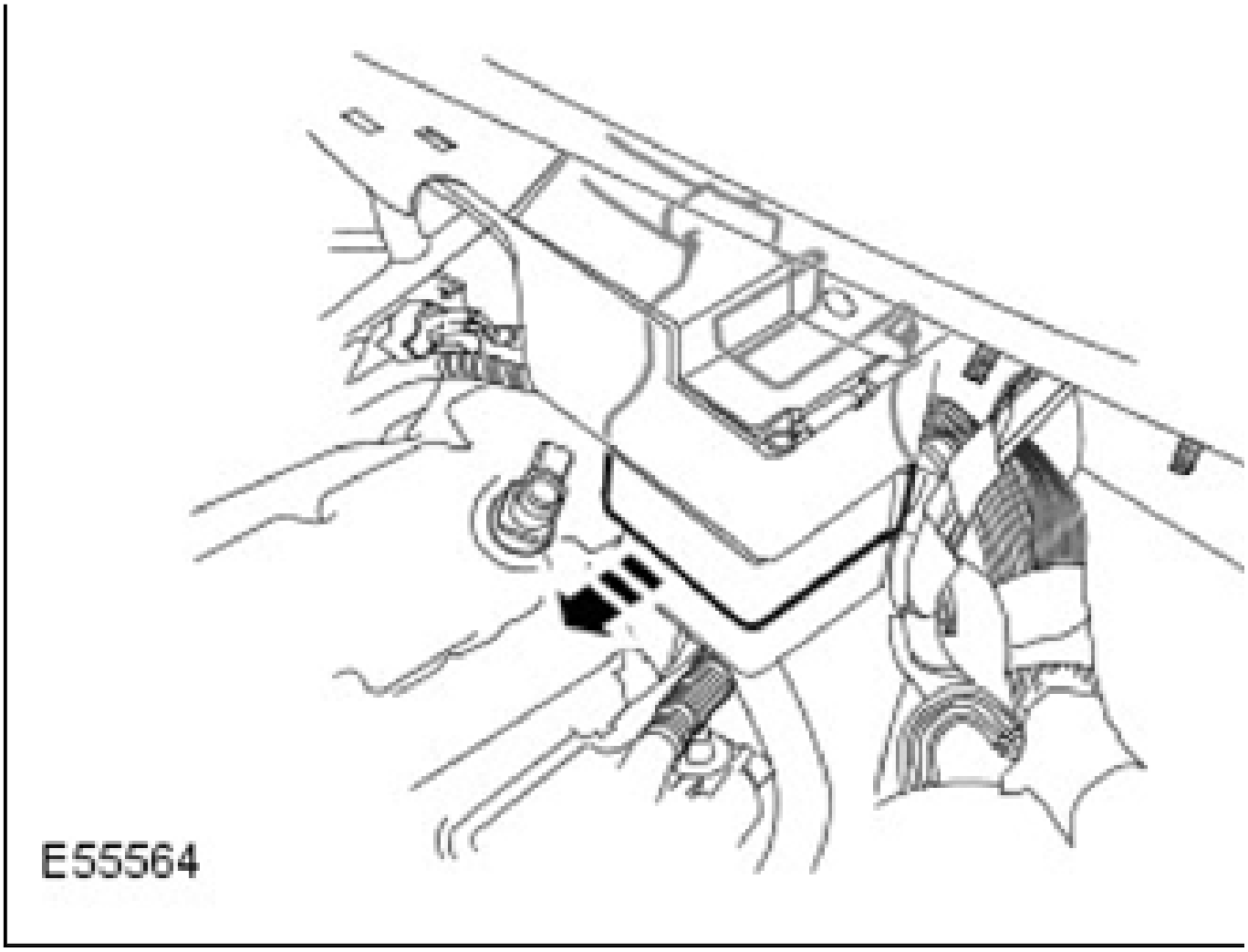

10. Remove the accessory drive belt.

    For additional information, refer to: **Accessory Drive Belt** .

11. Remove the lower fan shroud.
    - Release 2 clips from the cooling fan lower shroud.

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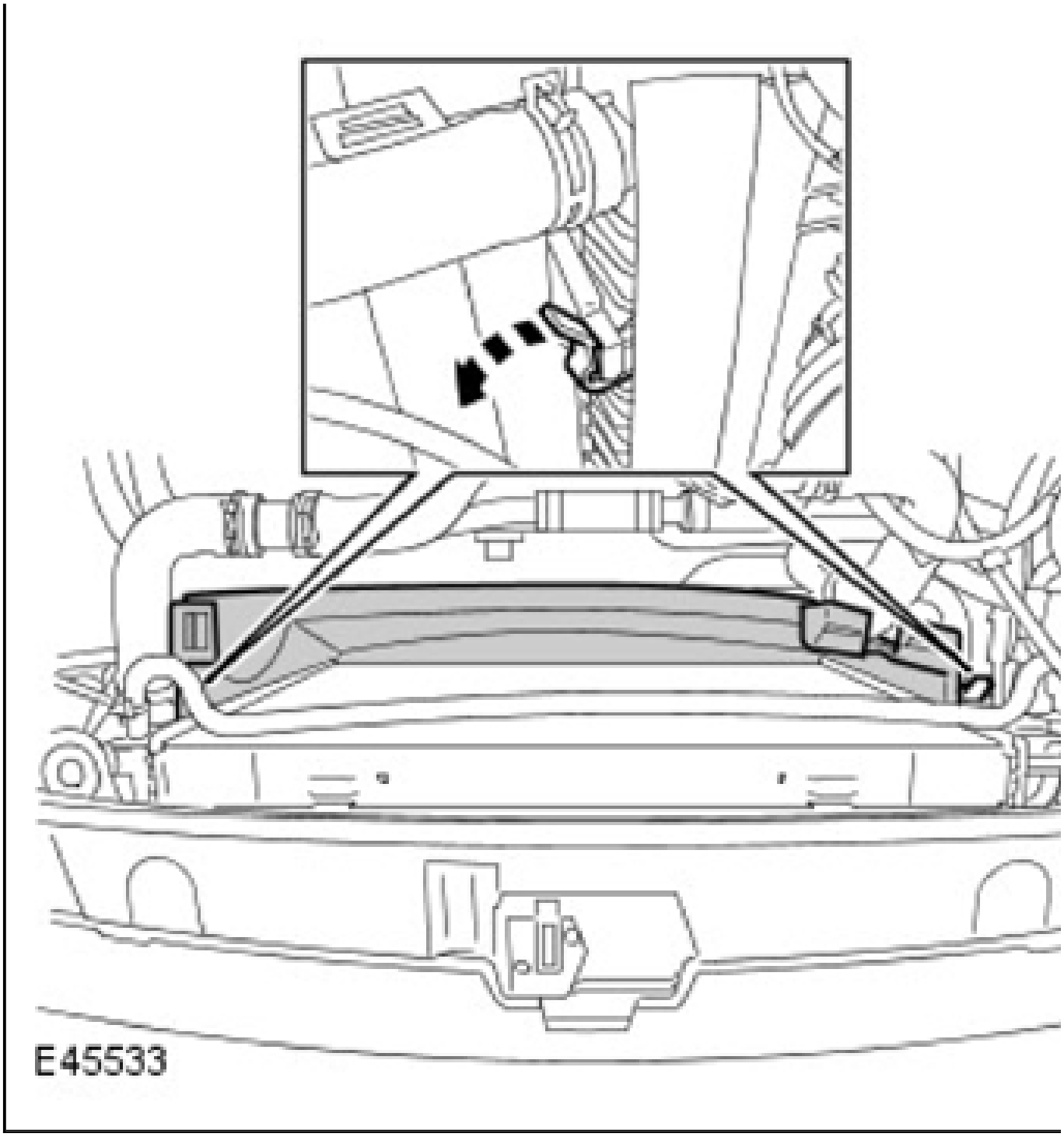

12. Install a shield to protect the radiator core from damage.
13. Disconnect the generator electrical connectors.
    - Disconnect the electrical connector.

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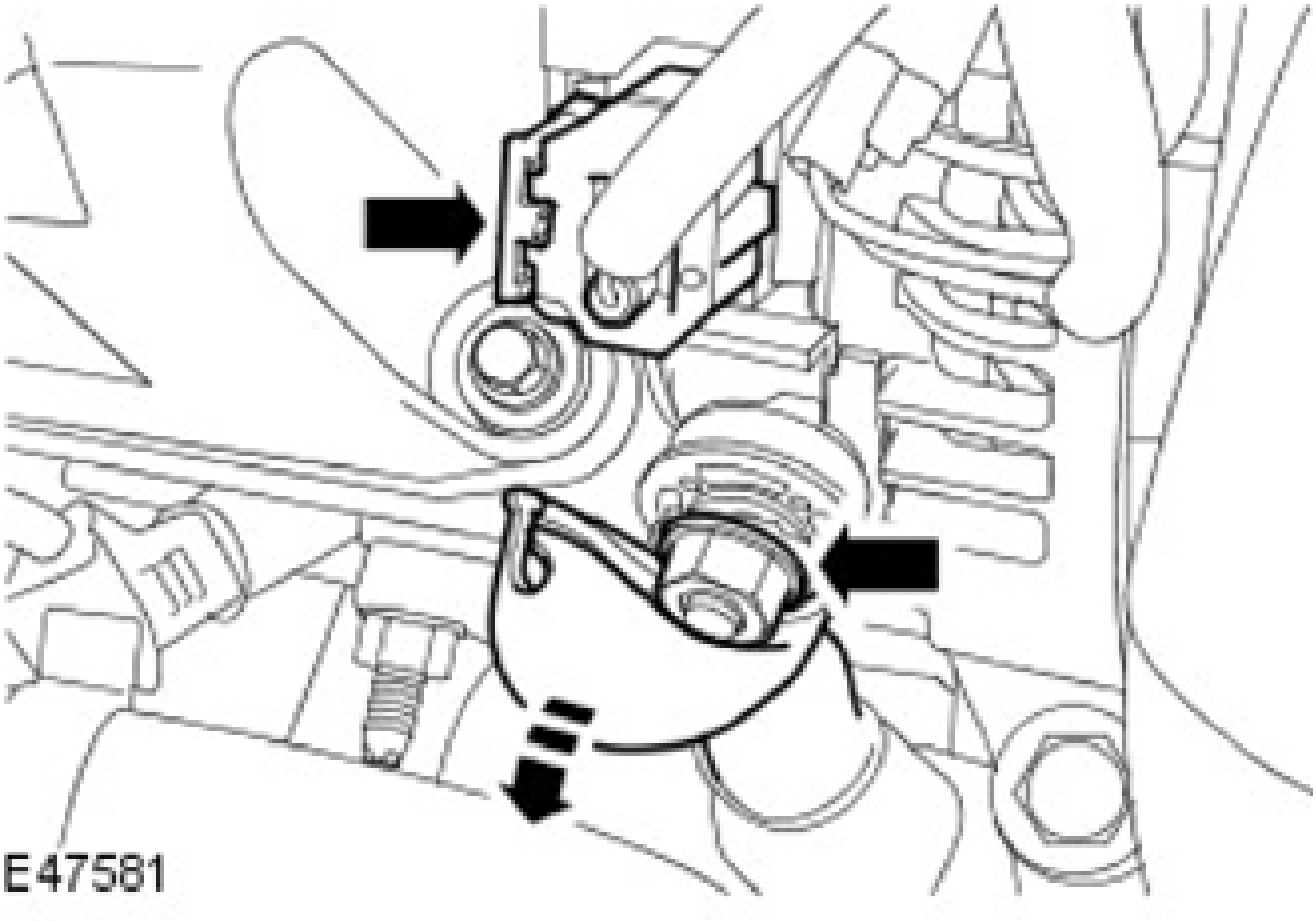

14. Position the generator mounting bracket aside.
    - Remove the 3 bolts.
    - Release the wiring harness clip.
    - Remove and discard the cable tie.

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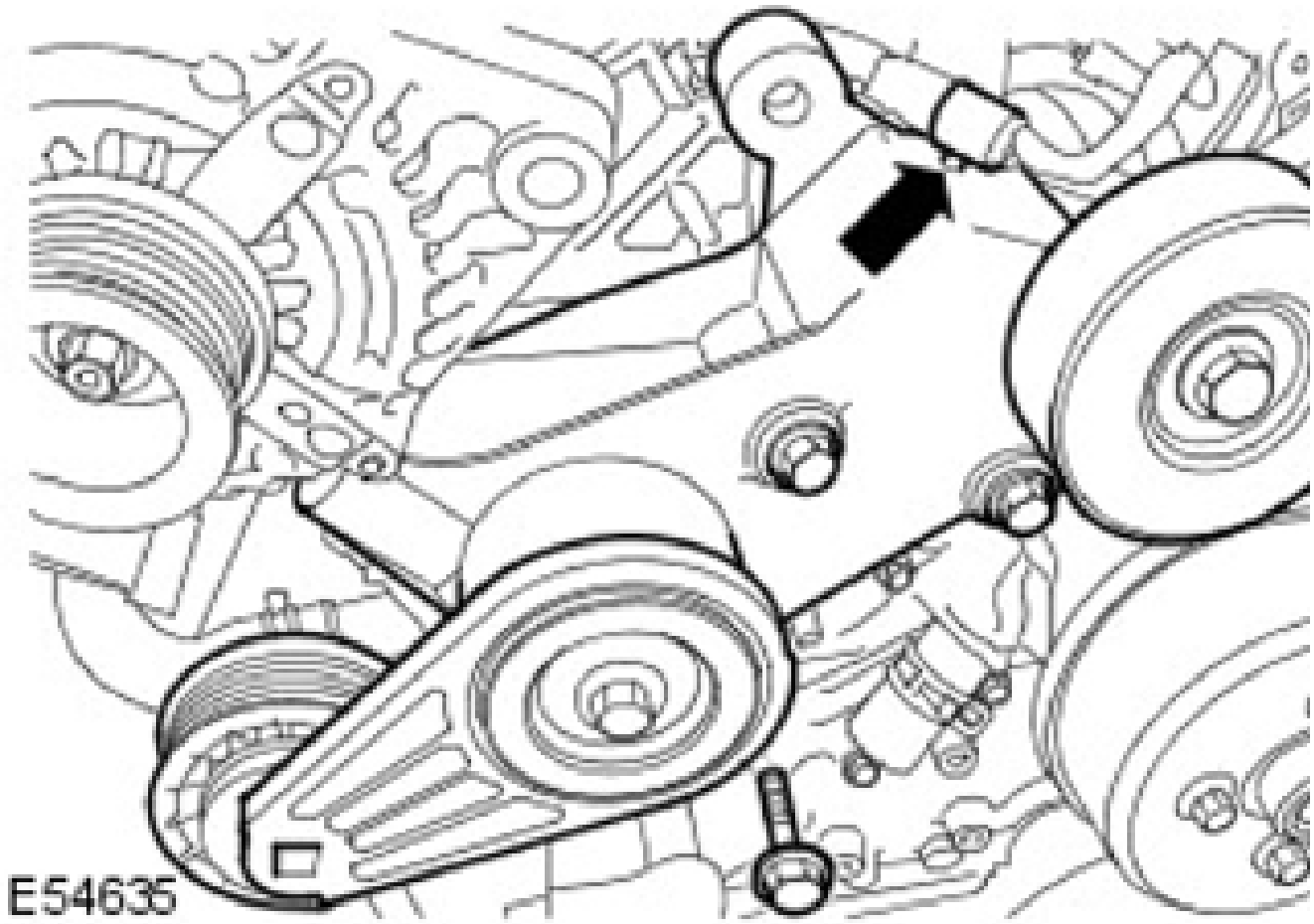

CAUTION: The A/C system will remain fully charged during this procedure, care must be taken when positioning the assembly aside.

15. Position the A/C compressor mounting bracket assembly aside.
    - Disconnect the A/C compressor electrical connector.
    - Release the LH KS electrical connector retaining clip.
    - Remove the 4 bolts.

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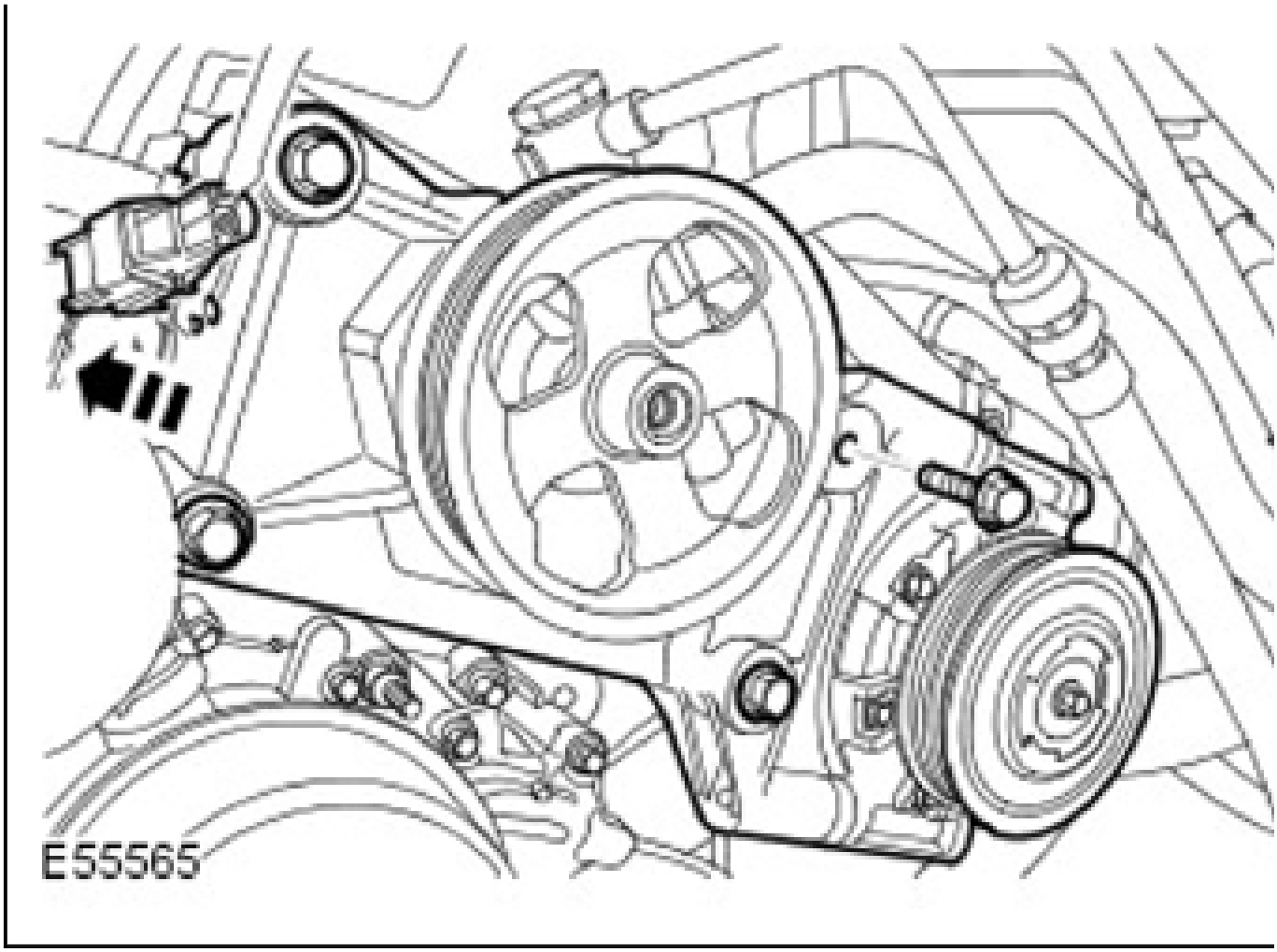

16. Disconnect the engine oil pressure (EOP) sensor electrical connector.

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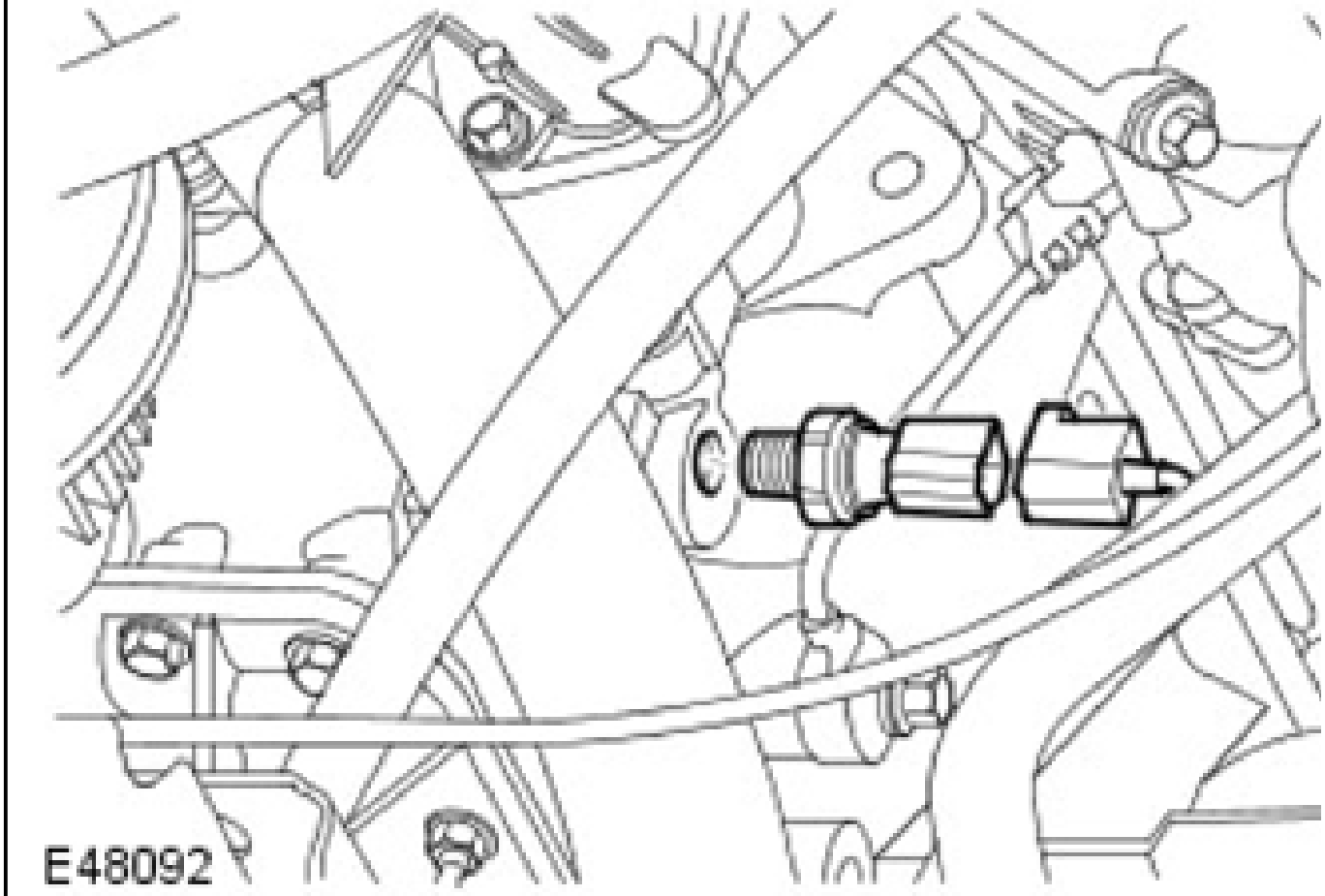

17. Disconnect the engine ground cable.
    - Remove the nut.

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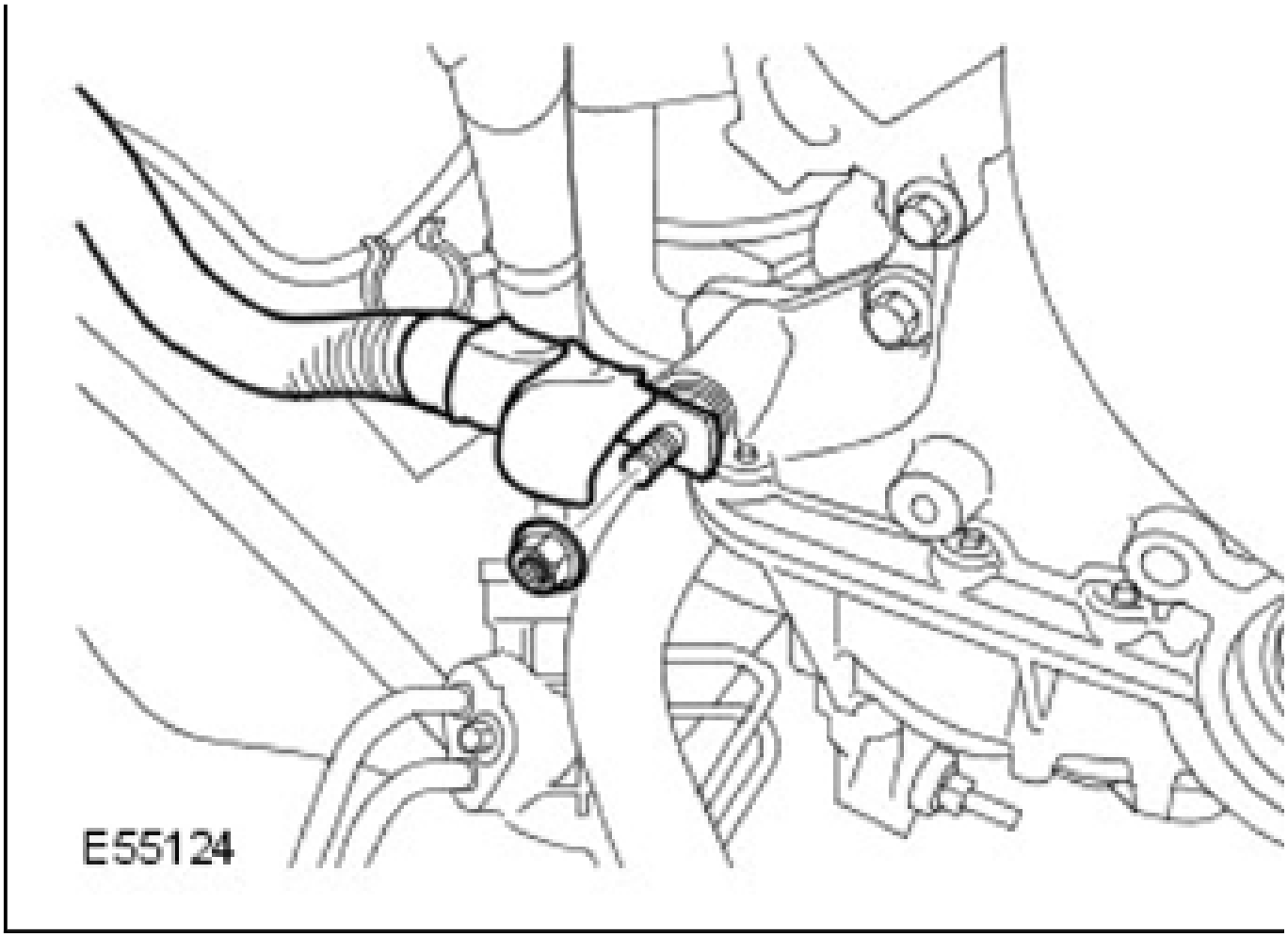

18. Release the transmission cooler pipes.
    - Remove the nut.
    - Position aside.

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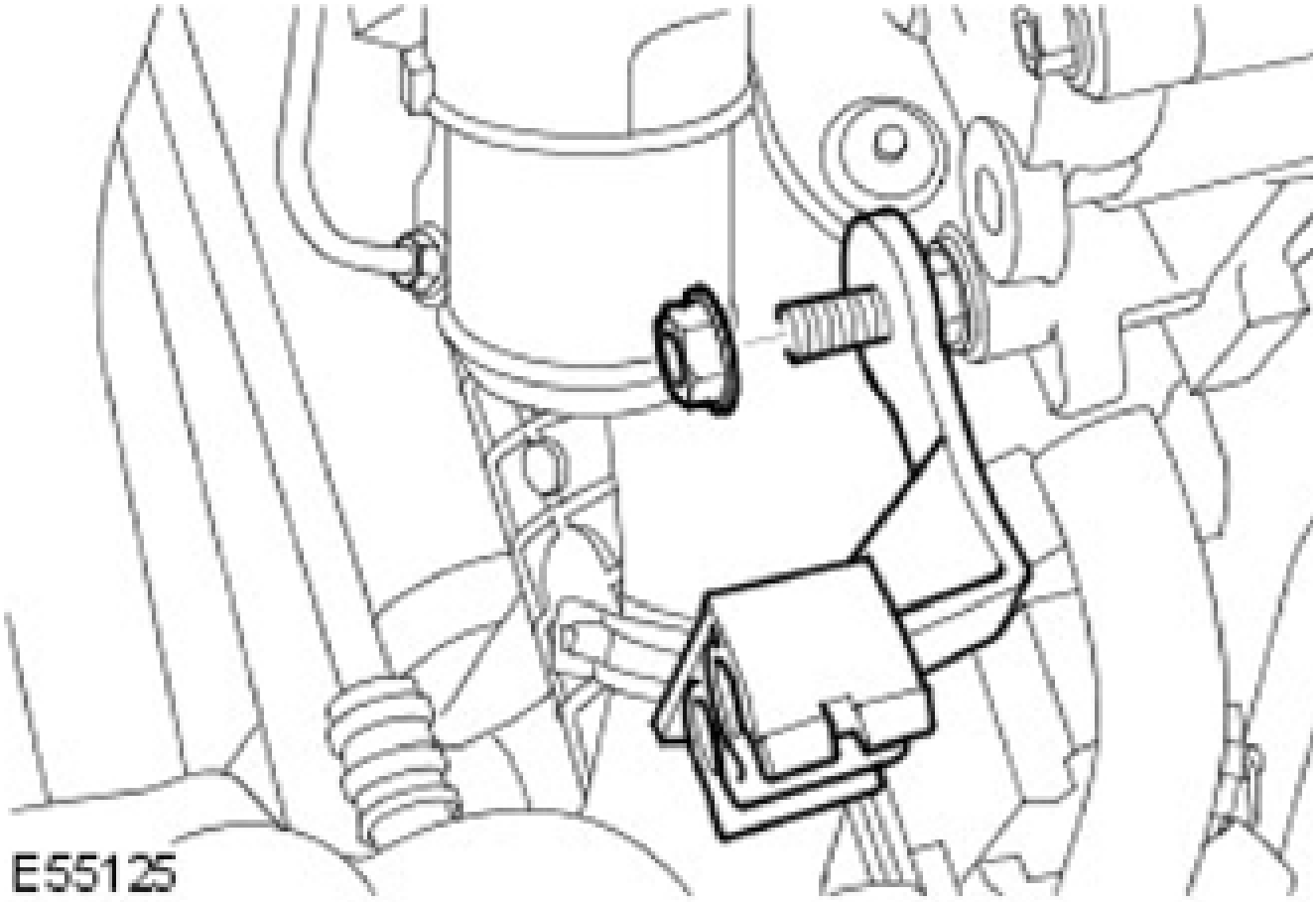

19. Remove the EGR pipe.
    - Loosen the EGR union nut and release the pipe.

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20. Check the road wheels are in the straight ahead position, then remove the upper clamp bolt.
    - Discard the retaining bolt.
21. Remove the steering gear universal joint clamp bolt.
    - Discard the retaining bolt.
22. Release the upper steering column shaft.
23. Release and remove the shaft and joint assembly.

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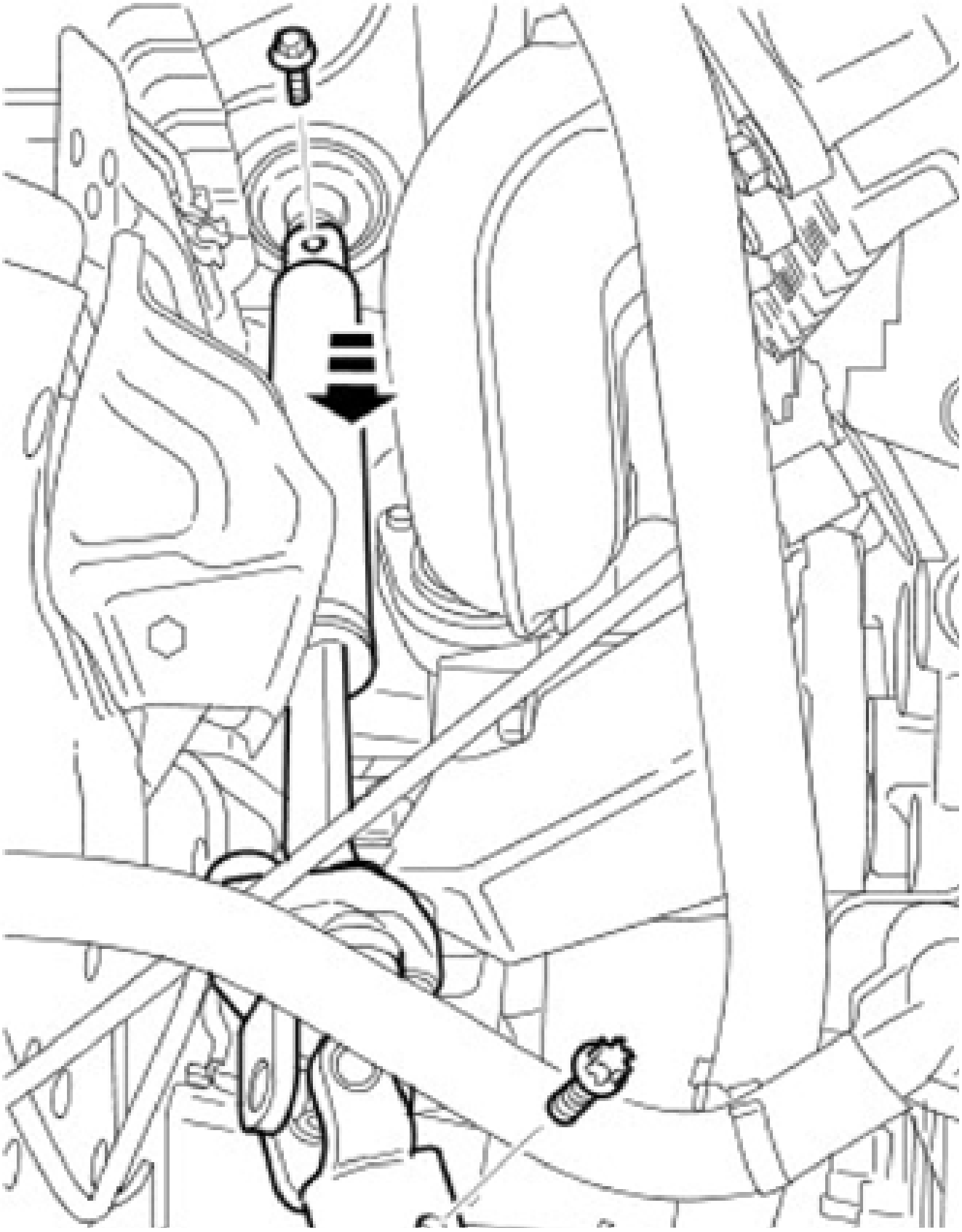

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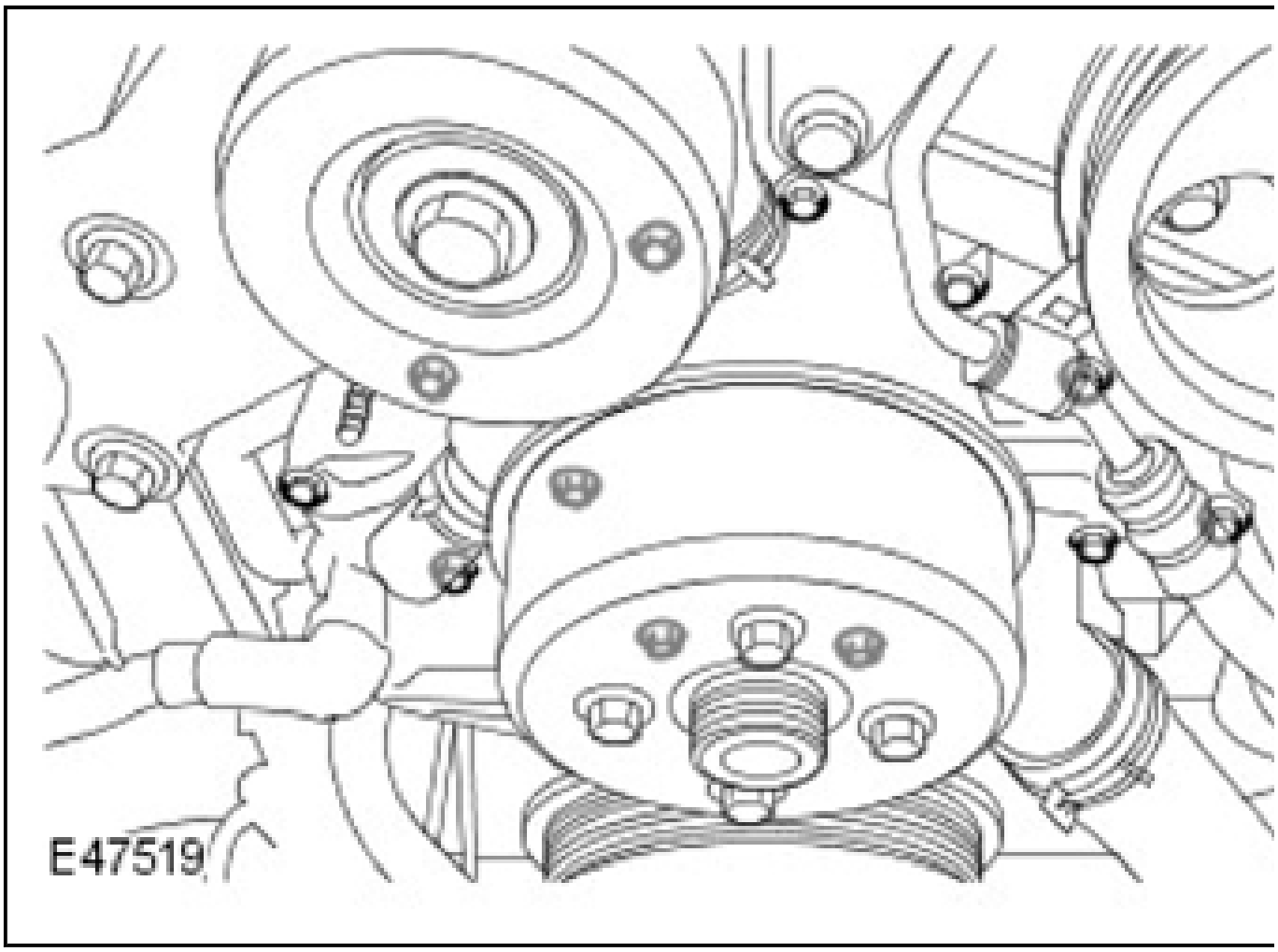
24. Release the coolant pump hose.
    - Position aside.
    - Release from the clip.



25. Disconnect the 2 engine oil cooler, coolant hoses.
    - Release the 2 clips.

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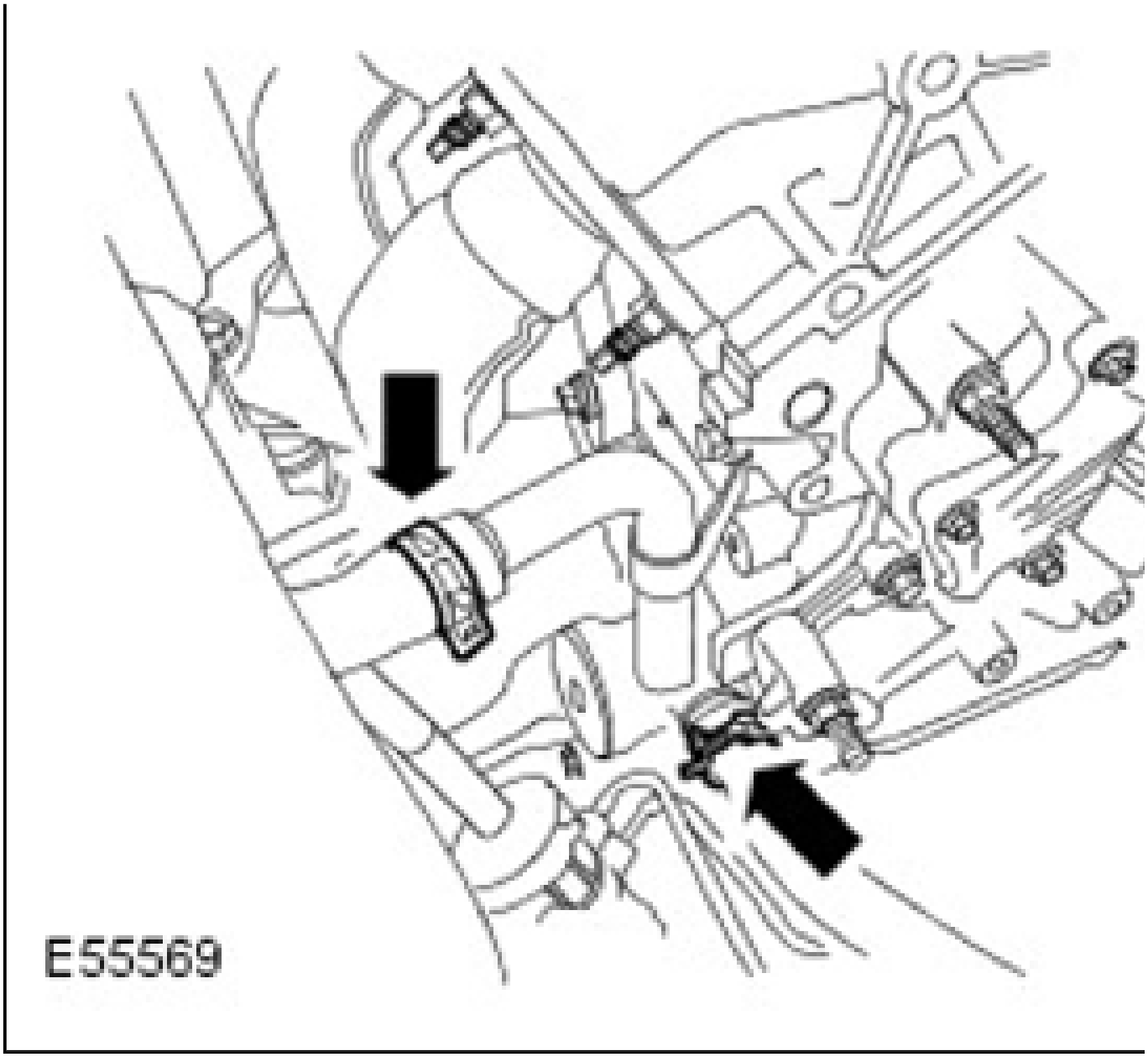

26. Remove the transmission heat shield.
    - Remove the 4 bolts.

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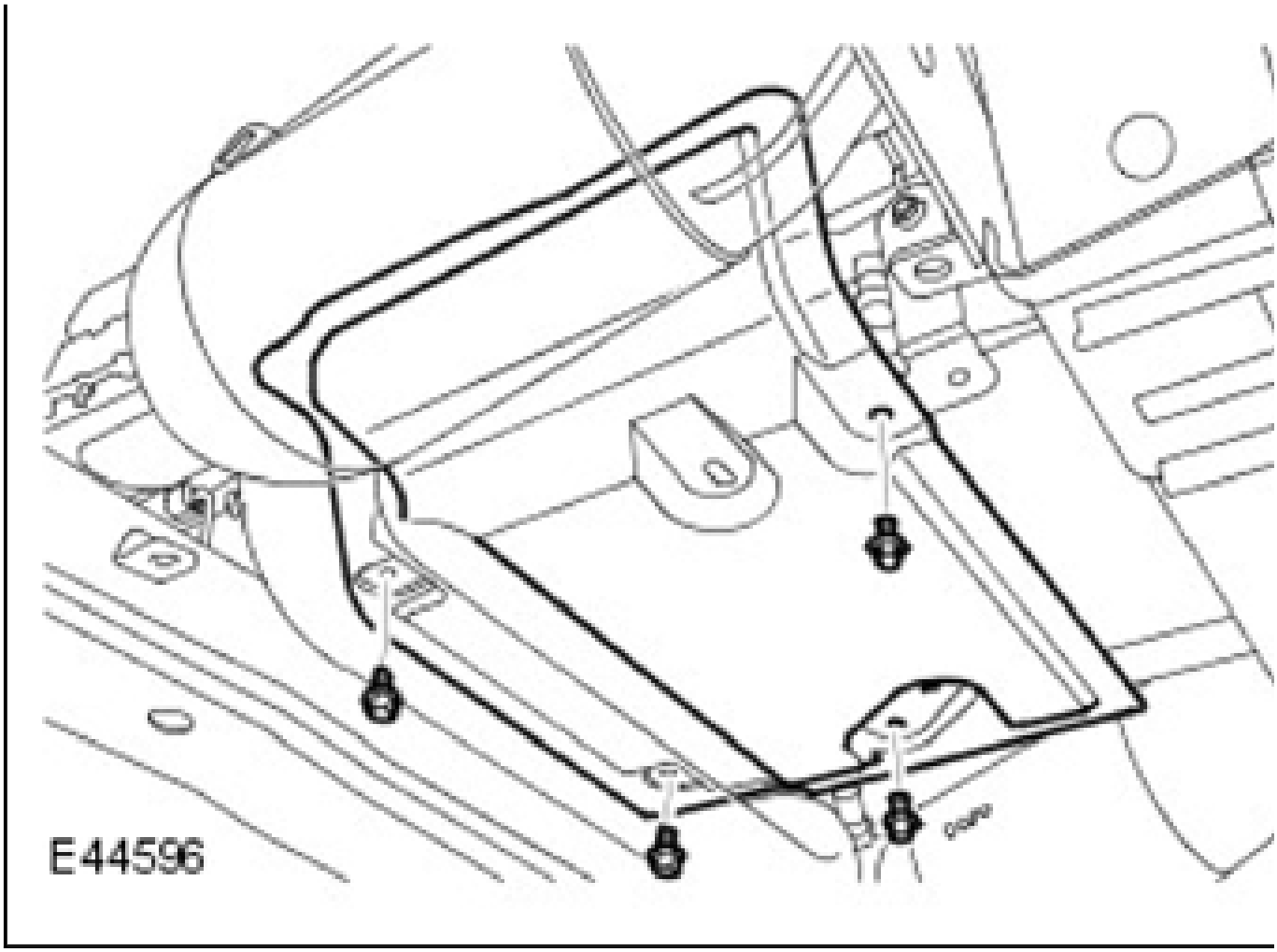

27. Disconnect the LH catalyst monitor sensor electrical connector.
    - Release HO2S harness from bracket.
28. Disconnect the LH catalytic converter from the exhaust manifold.
    - Remove the 2 bolts.

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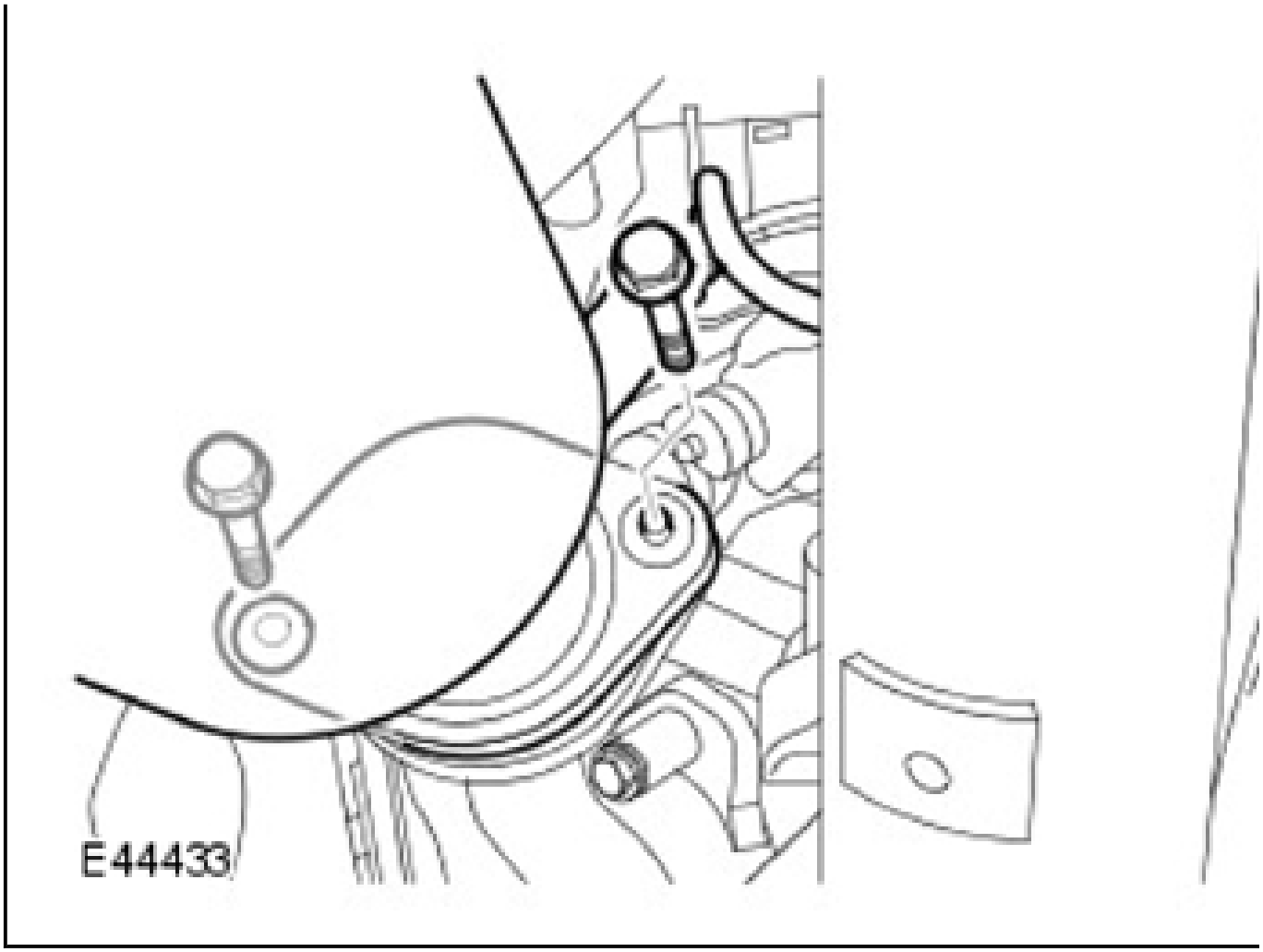

29. Disconnect the RH catalyst monitor sensor electrical connector.
    - Release HO2S harness from bracket.
30. Disconnect the RH catalytic converter from the exhaust manifold.
    - Remove the 2 bolts.

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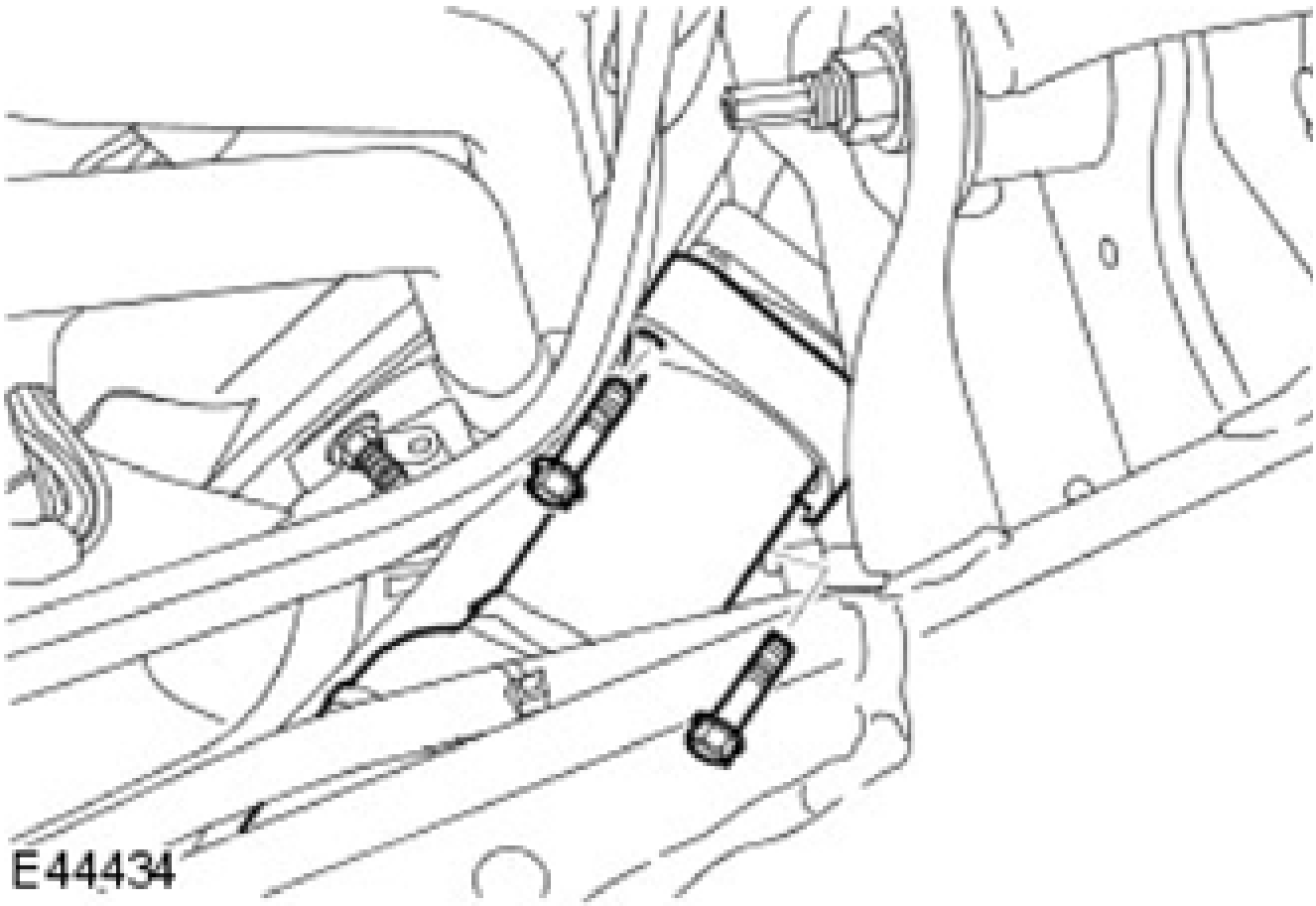

31. Disconnect the engine oil temperature sensor electrical connector.

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32. Release the starter motor.
    - Remove the 2 bolts.

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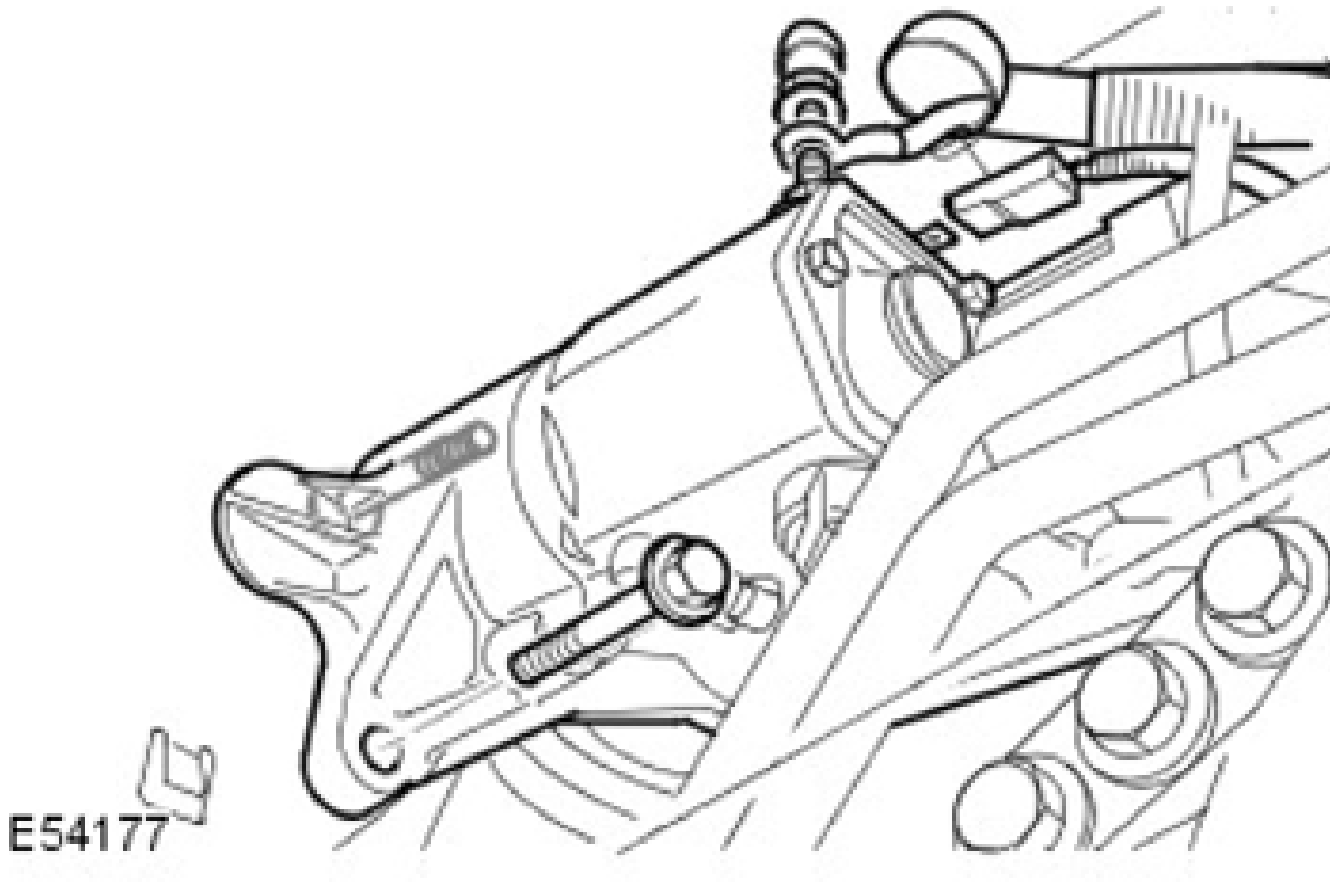

33. Release the harness bracket.
    - Remove the 2 nuts.

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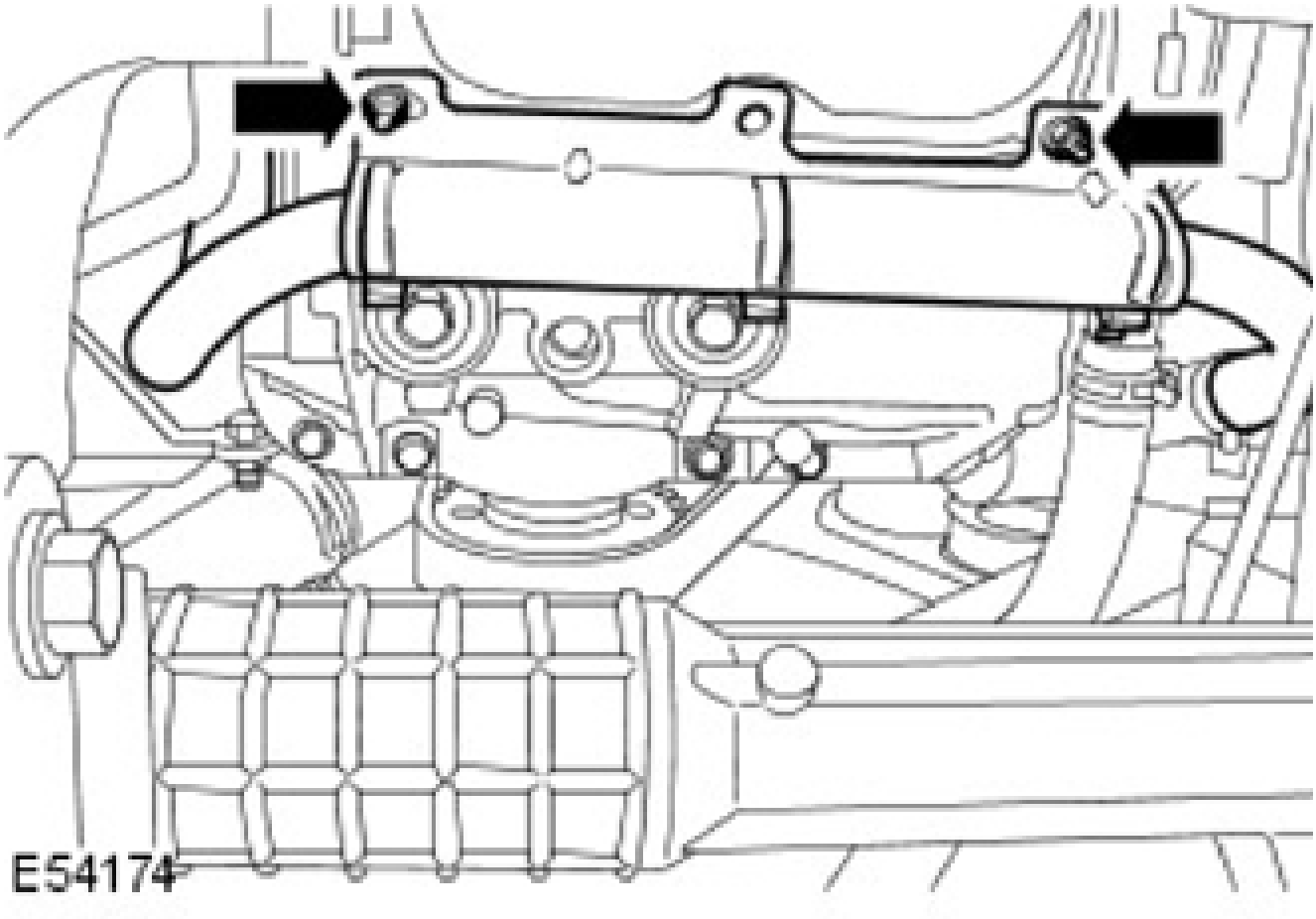

34. Disconnect the crankshaft position (CKP) sensor electrical connector.

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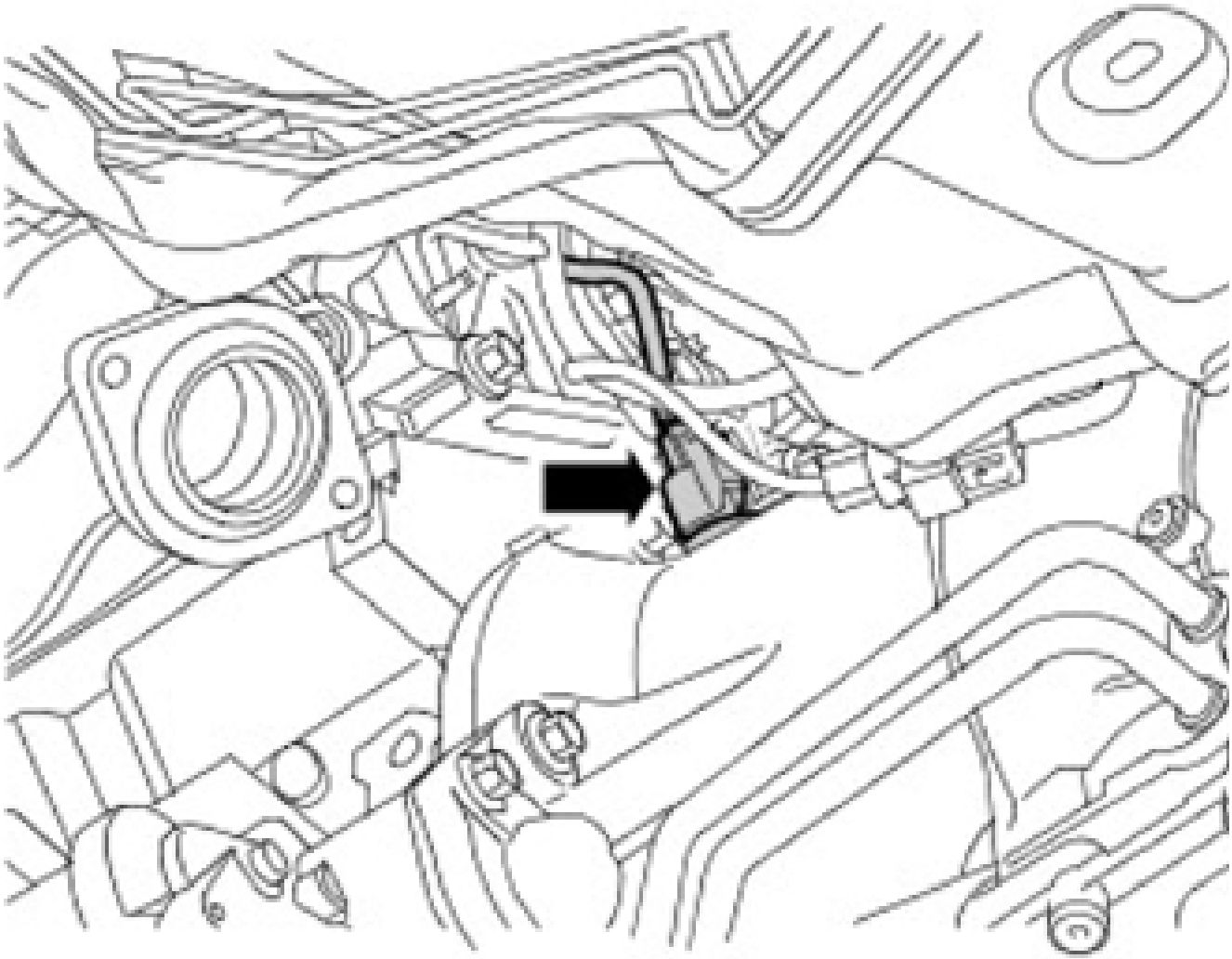

35. Install the engine lifting bracket.
    - Tighten the bolts to 45 Nm (33 lb.ft).
    - Evenly and progressively, tighten the nuts to 25 Nm (18 lb.ft).

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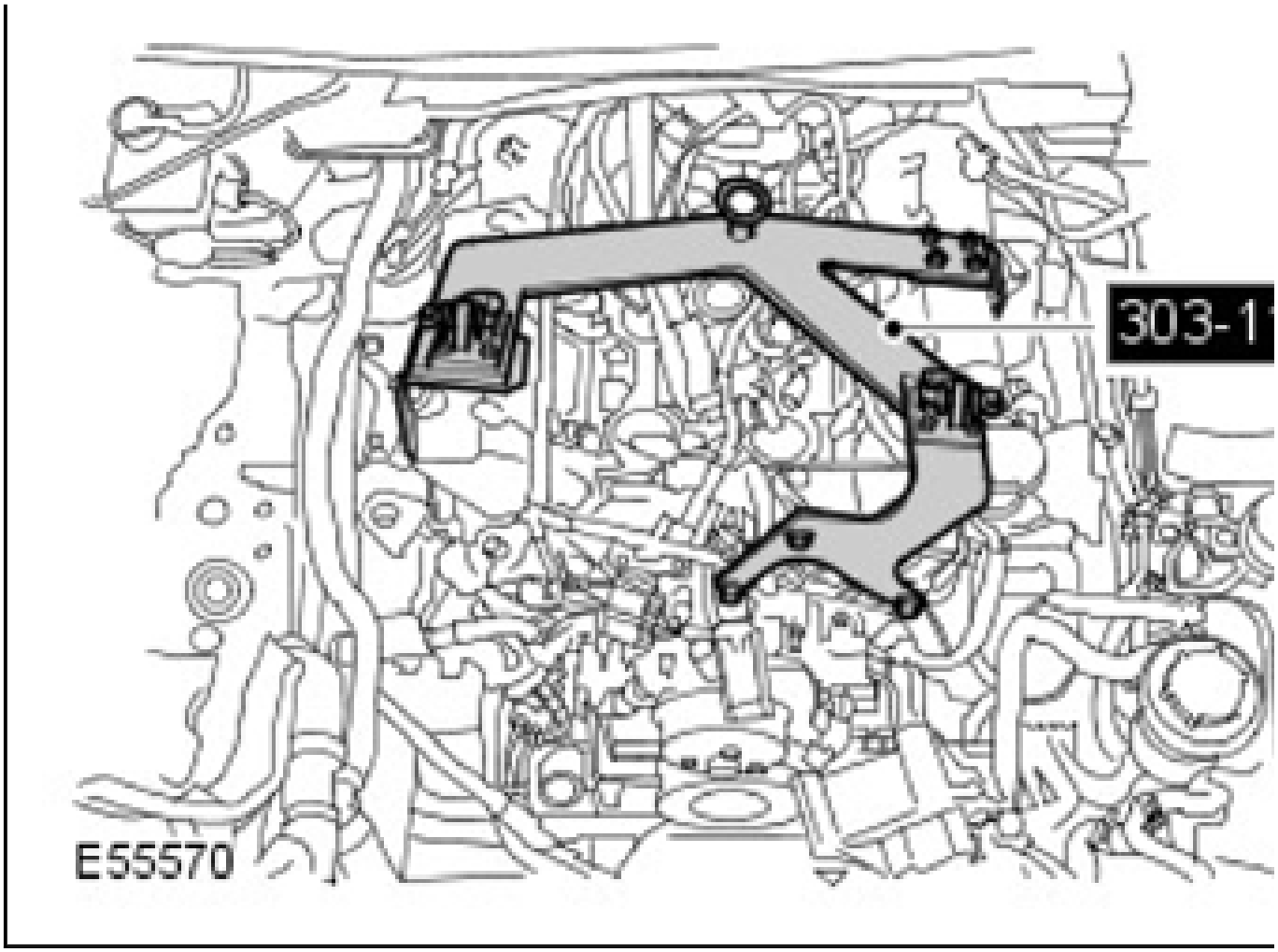

36. Release the flexplate.
    - Rotate the crankshaft to access the retaining bolts.
    - Remove the 4 bolts.

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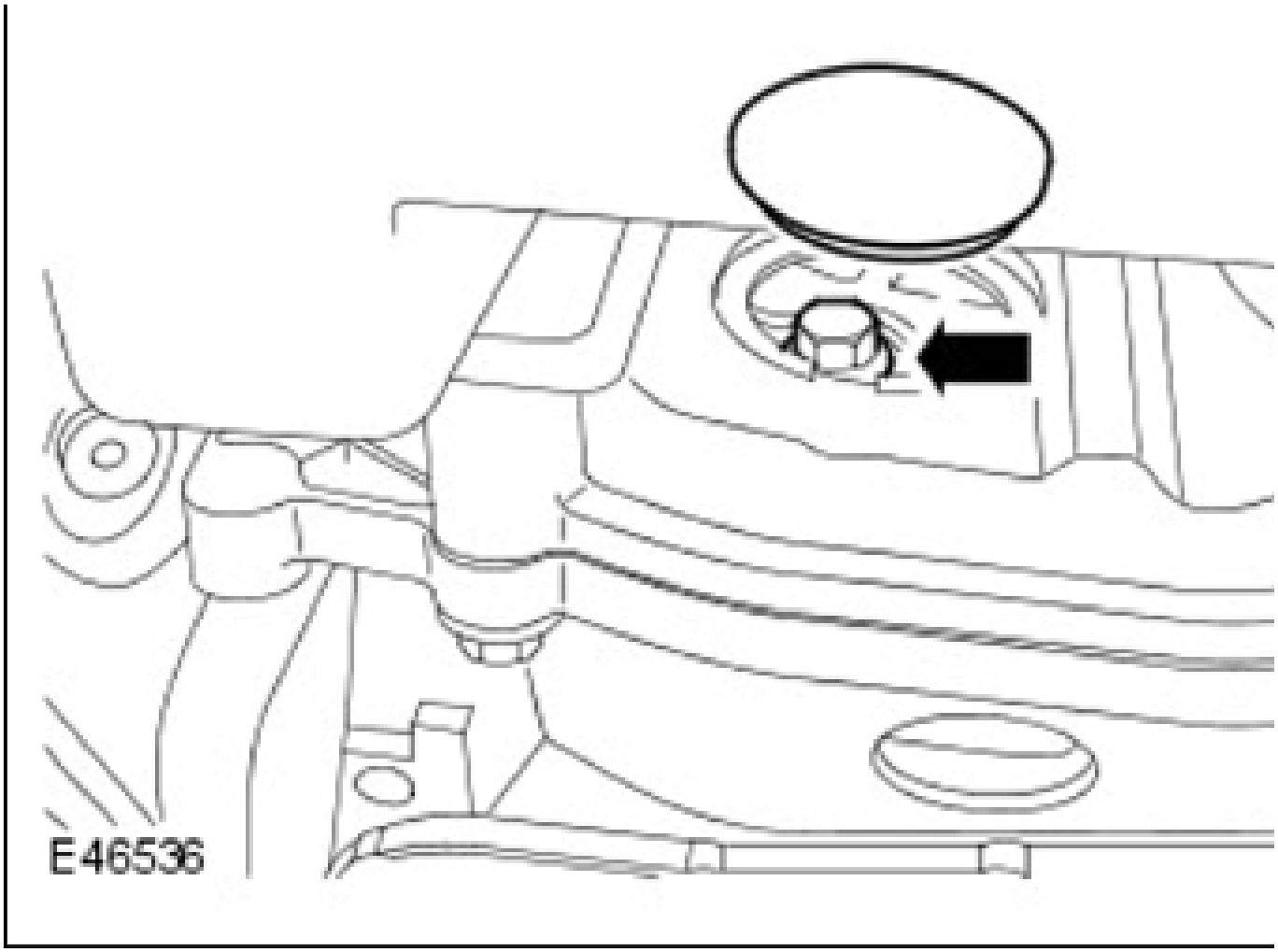

37. Release the fuel pipe and purge line heat shield.
    - Remove the 2 bolts.
    - Position the fuel line shield aside for access.

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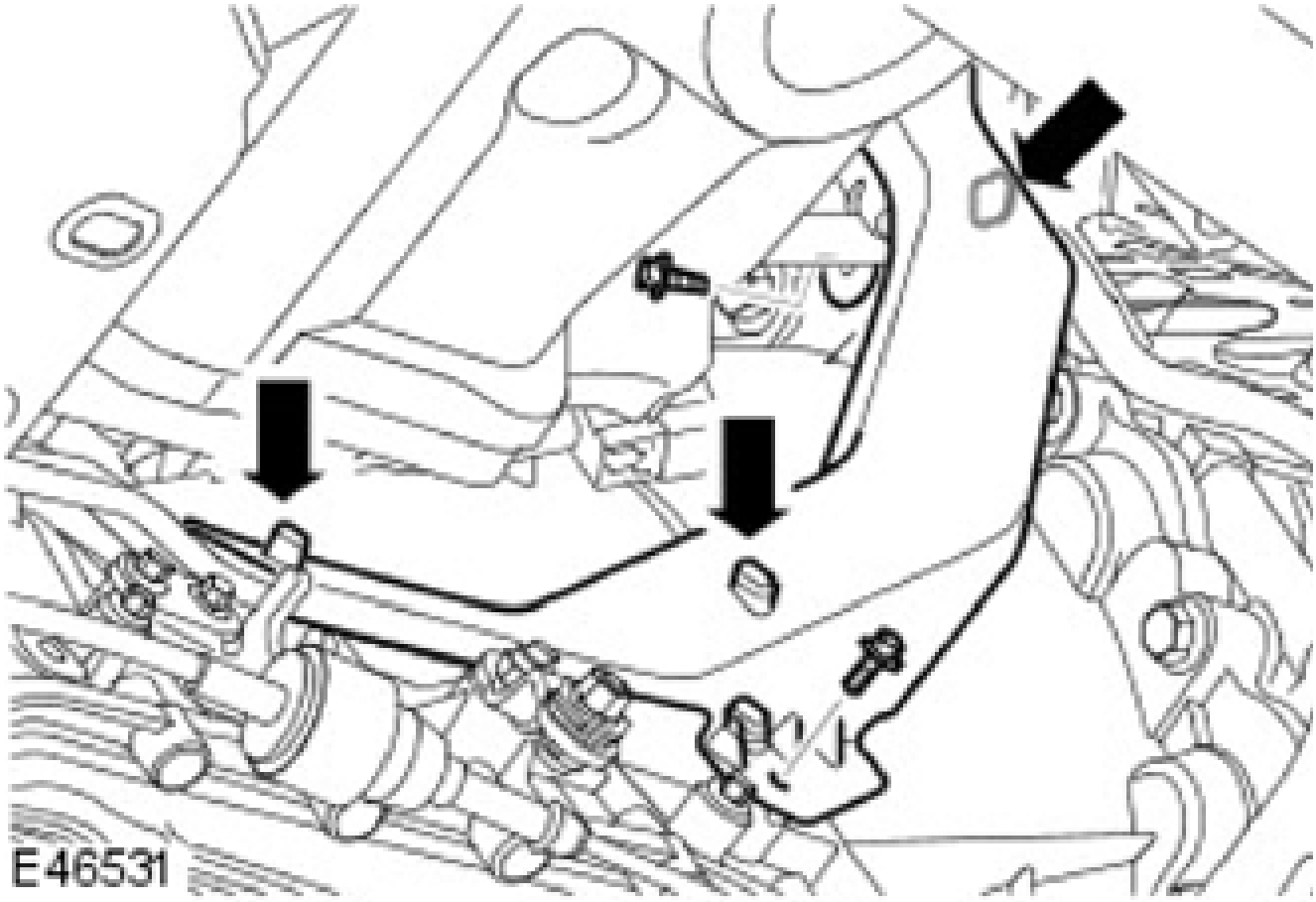

WARNING: Support the engine. The engine will fall forward when the transmission is removed.

38. Remove the transmission bolts.
    - Connect the lifting chains.
    - Support the transmission.
    - Remove the 8 bolts.

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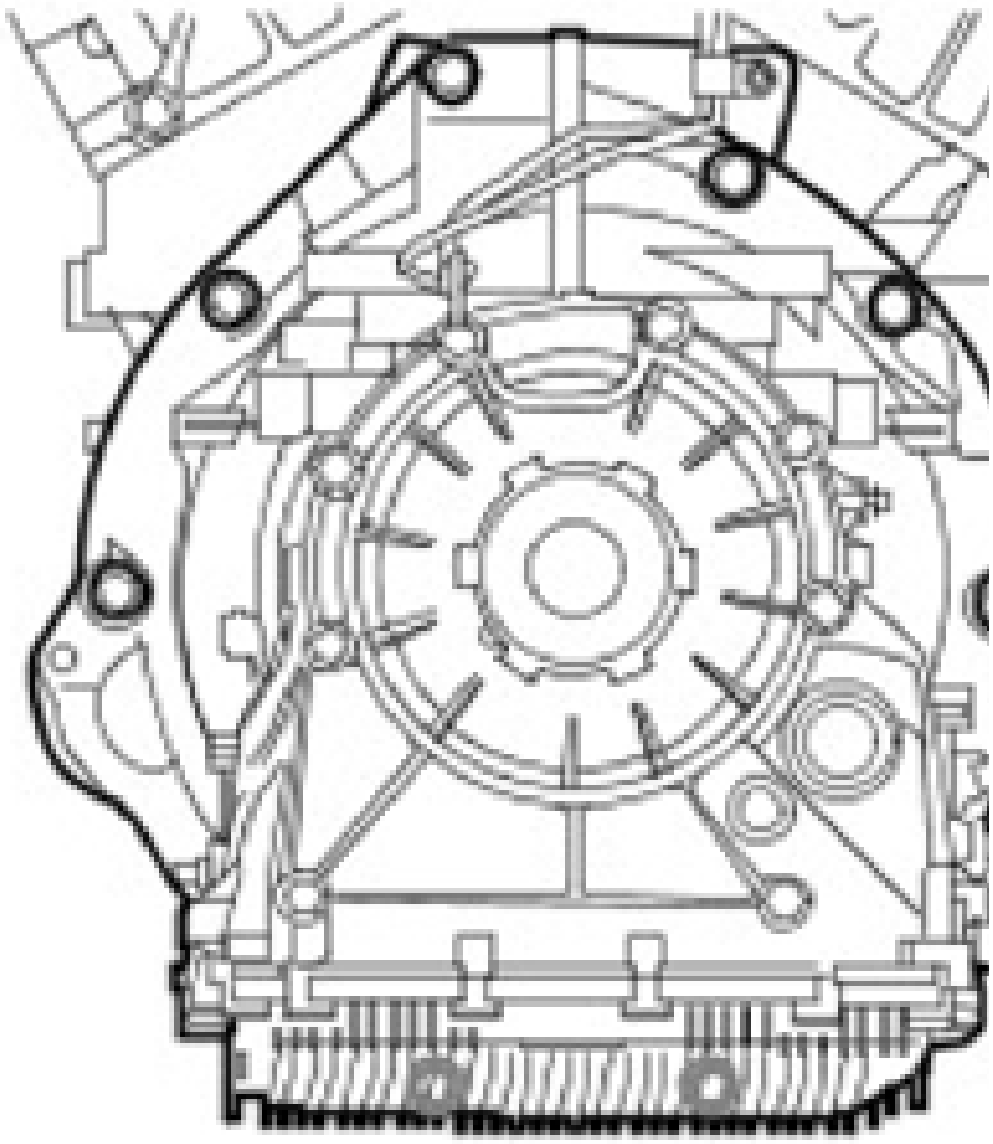

WARNING: **Make sure the torque converter remains with the transmission.**

39. Remove the engine.
    - Remove the 2 engine mount nuts.
    - Remove the engine RH mount.
    - Raise the engine.
    - With assistance, carefully remove the engine.

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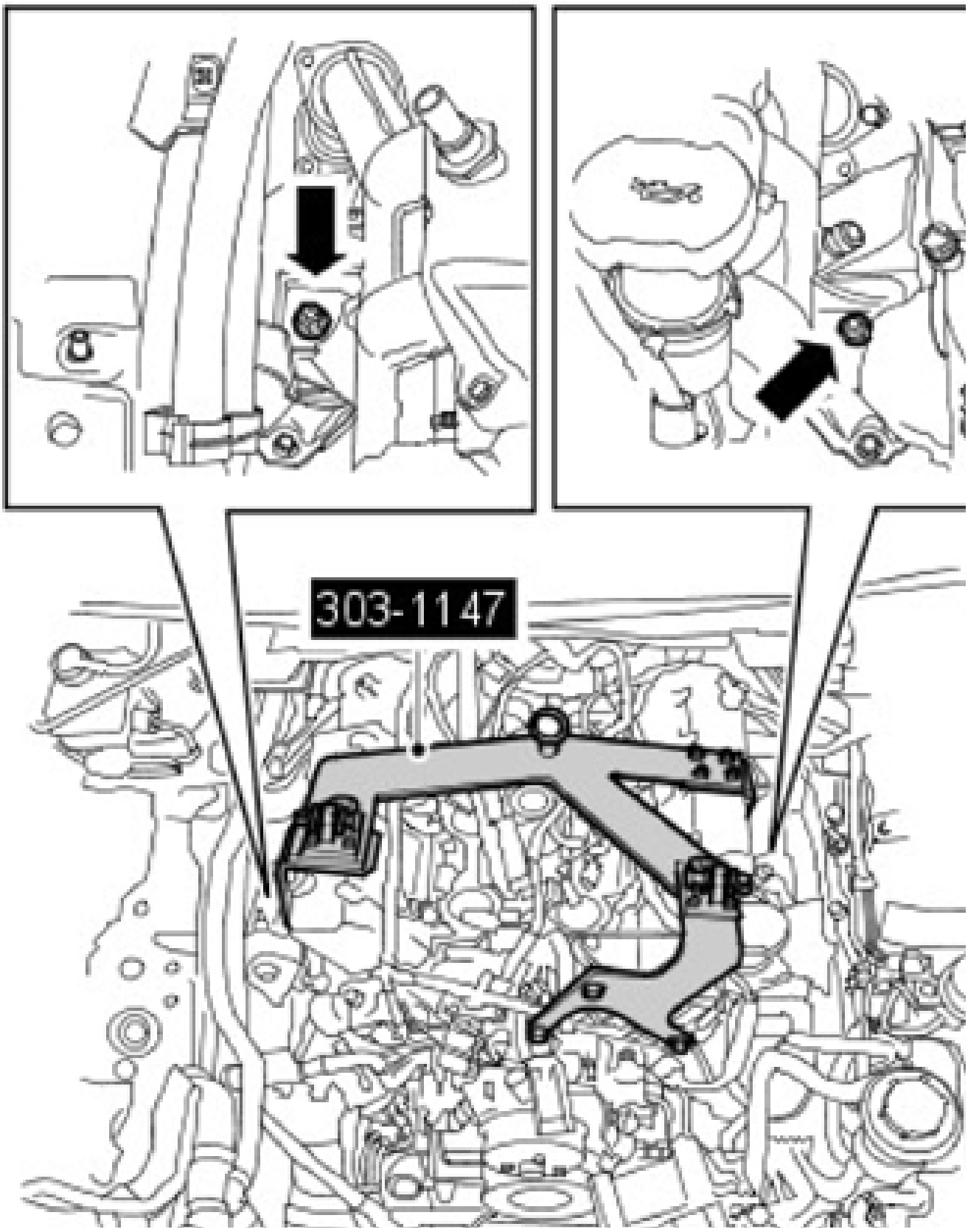

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40. Install the torque converter retainer.

INSTALLATION

ENGINE

INSTALLATION

1. Remove the torque converter retainer.
2. Install the engine.
    - Connect the lifting chains.
    - Carefully lower the engine until approximately 35mm above engine mounts.
    - With assistance align the engine to the transmission and engine mounts.
3. Install the RH engine mount.
4. Install the transmission retaining bolts.
    - Clean the component mating faces.
    - Remove the guide pins.
    - Tighten the bolts to 45 Nm (33 lb.ft).
5. Tighten the engine mount nuts to 90 Nm (66 lb.ft).
6. Remove the engine lifting bracket.
    - Disconnect the lifting chains.
    - Remove the 7 bolts.
    - Remove the 12 nuts.
7. Attach the flexplate to the torque converter.
    - Rotate the crankshaft to access the retaining bolts.
    - Tighten the bolts to 45 Nm (33 lb.ft).
    - Install the grommet.
8. Connect the CKP sensor electrical connector.
    - Clean the component mating faces.
9. Connect the HO2S electrical connectors.
10. Install the engine wiring harness support bracket.
11. Connect the engine oil temperature sensor electrical connector.
12. Install the starter motor.
    - Clean the component mating faces.
    - Tighten the bolts to 45 Nm (33 lb.ft).
13. Position the fuel pipe and purge line heat shield and secure with bolts.
14. Position the RH catalytic converter to the exhaust manifold.
    - Clean the components.
    - Tighten the new bolts to 22 Nm (16 lb.ft).

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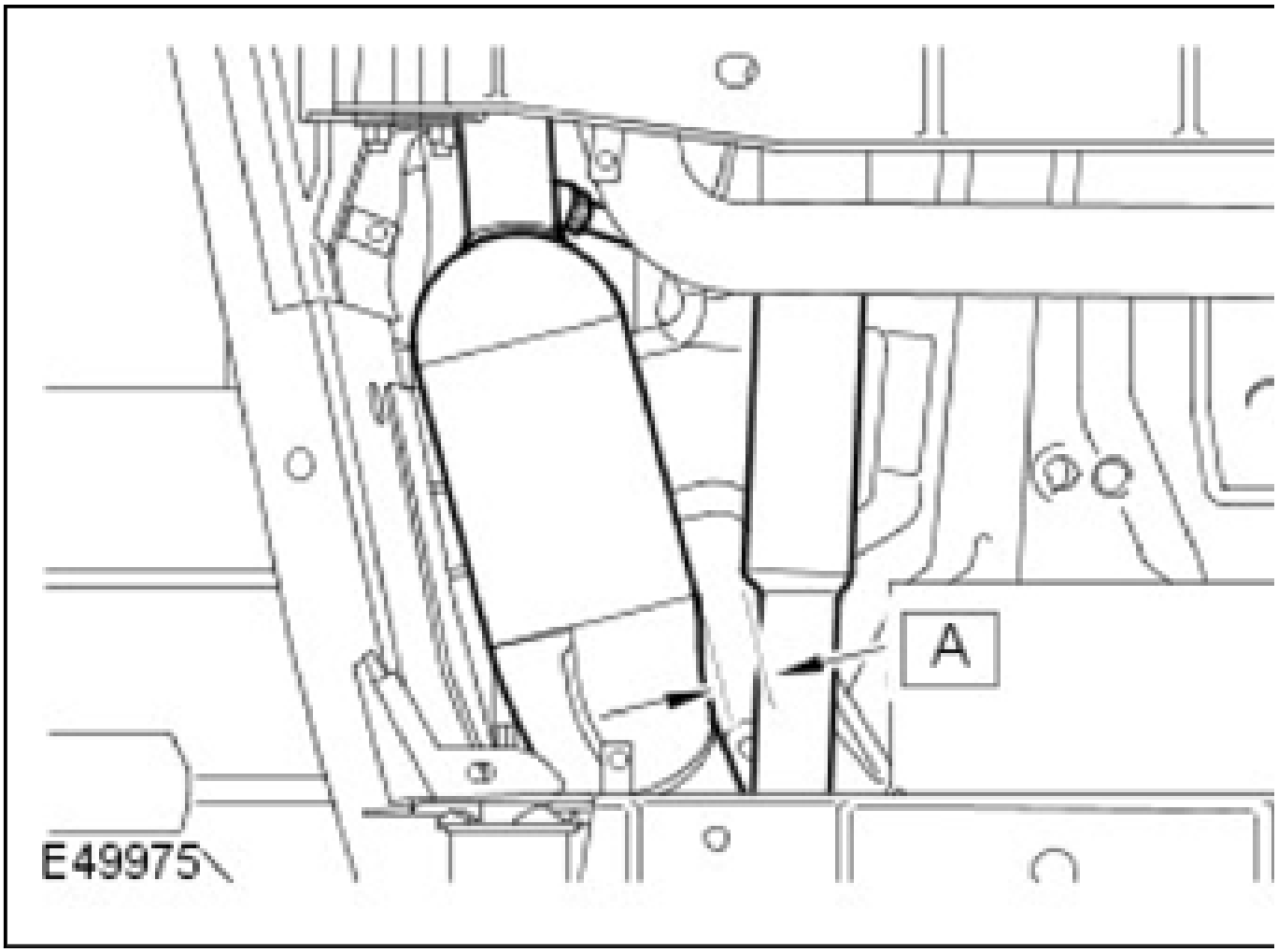
CAUTION: Make sure there is a clearance (A) of 25 mm to 30 mm between the closest points of the LH catalytic converter and the front driveshaft.

15. Position the LH catalytic converter to the exhaust manifold.
    - Clean the components.
    - Tighten the new bolts to 22 Nm (16 lb.ft).



16. Install the transmission heat shield.
17. Connect the engine oil cooler hoses.
    - Secure with the clips.
18. Connect the coolant pump hose.
    - Secure with the clip.
19. Install the steering column lower universal joint assembly.
    - Install new patchlock bolts and tighten to 25 Nm (18 lb.ft).
20. Connect the ECT sensor electrical connector.

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21. Install the EGR pipe.
    - Clean the component mating faces.
    - Install to the exhaust manifold, but do not fully tighten the union nut at this stage.
22. Install the transmission cooler pipes.
    - Install the support bracket.
    - Tighten the nut to 10 Nm (7 lb.ft).
23. Connect the engine ground cable, make sure the mating faces are clean.
    - Tighten the nut to 25 Nm (18 lb.ft).
    - Install the cover.
24. Install the A/C compressor mounting bracket assembly.
    - Clean the component mating faces.
    - Tighten the bolts to 45 Nm (33 lb.ft).
    - Install the KS electrical connector clip.
    - Connect the A/C compressor electrical connection.
25. Install the generator mounting bracket.
    - Clean the component mating faces.
    - Tighten the bolts to 45 Nm (33 lb.ft).
    - Secure the clip.
    - Install a new cable tie.
26. Connect the EOP sensor electrical connector.
27. Connect the generator electrical connectors.
28. Install the accessory drive belt.

    For additional information, refer to: **Accessory Drive Belt** .

29. Install the cooling fan lower shroud.
    - Remove the radiator protection.
    - Position and secure in the clips.
30. Install the wiring harness to the plenum.
    - Secure with the clips.
31. Connect the ECM electrical connectors.
32. Install the battery tray.

    For additional information, refer to: **BATTERY TRAY** .

33. Install the intake manifold.

    For additional information, refer to: **INTAKE MANIFOLD** .

34. Tighten the nuts securing the EGR pipe to the exhaust manifold and EGR valve to 25 Nm (18 lb.ft).

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35. Fill the engine with oil.

    For additional information, refer to: **ENGINE OIL DRAINING AND FILLING** .

36. Refill and bleed the cooling system.

    For additional information, refer to: **Cooling System Draining, Filling and Bleeding** .

37. Return the hood from the service position.
    - Release the 2 clips.
    - Connect the struts and secure with the clips.
38. Connect the battery ground cable.

    For additional information, refer to: **SPECIFICATION** .

39. Using the approved diagnostic equipment, clear the powertrain control module (PCM) adaptions.

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