

2007 Land Rover LR3 HSE

ENGINE Engine - V8 4.4L Petrol

ENGINE**Engine - V8 4.4L Petrol****ENGINE - V8 4.4L PETROL****SPECIFICATIONS****SEALERS**

Item	Land Rover Part No.
Valve cover gasket	8510303
Sump pan	8510303
Oil strainer pick-up pipe bolts	STC 50553
Cylinder block core plugs	STC 50554
Timing cover seal apertures	8510303
Cylinder block coolant outlet elbow stub pipe	STC 50554
Bedplate to cylinder block	8510303

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

Item	Specification
(1) Recommended Lubricant	5W/30 Preferred: WSS-M2C913-B Alternative: ACEA A3/B3
(1) WSS is a Ford prefix to the oil specification	

LUBRICANT NAS/Japan

Item	Specification
(1) Recommended Lubricant	5W/30 - ILSAC GF4 and API SM
(1) WSS is a Ford prefix to the oil specification	

CAPACITY

Item	Capacity
Dry fill including filter	8 litres (14 pints) (8.5 US quarts)
Oil and filter change	7.7 litres (13.6 pints) (8.1 US quarts)
Amount of oil required to bring the level from the lower to the upper holes on the dipstick	1.5 litres (2.6 pints) (1.5 US quarts)

GENERAL SPECIFICATION

Item	Specification
Type	4.4 litre 90° 'V', petrol engine, twin overhead camshafts per cylinder head, 4 valves per cylinder
Bore - nominal	88.0 mm (3.465 in)
Stroke	90.3 mm (3.55 in)

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Capacity	4396 cm ³ (268.3 in ³)
Firing order	Refer to DESCRIPTION AND OPERATION section
Compression ratio	10.5:1
Direction of rotation	Anti-clockwise - viewed from rear of engine
Maximum power:	
UK/Europe and ROW - Not NAS/Japan	220 kW (295 bhp) @ 5500 rev/min
NAS/Japan	300 bhp (224 kW) @ 5500 rev/min
Maximum torque:	
UK/Europe and ROW - Not NAS/Japan	425 Nm (313 lb-ft) @ 4000 rev/min
NAS/Japan	315 lb-ft (427 Nm) @ 4000 rev/min
Dimensions:	
Length	720 mm (28.3 in)
Width	720 mm (28.3 in)
Height	785 mm (30.9 in)
(1) Engine oil pressure:	
At idle	1.0 bars (100 kPa) (15.0 lb/in ²)
At 3500 rev/min	3.0 bars (300 kPa) (44.0 lb/in ²)
(2) Valve clearances:	
Inlet	0.18 to 0.22 mm (0.007 to 0.008 in)
Exhaust	0.23 to 0.27 mm (0.009 to 0.010 in)
Cylinder Head	
Maximum permitted warp	0.125 mm (0.005 in)
(1) Note: prior to checking the engine oil pressure, a road test of 6 miles (10 kilometres) must be carried out. Do not attempt to attain engine normal operating temperature by allowing the engine to idle	
(2) Note: that there are 50 different thicknesses of graded tappet available ranging from 2.950 to 3.685 mm (0.116 to 0.145 in) rising in increments of 0.015 mm (0.0005 in)	

TORQUE SPECIFICATIONS

Description	Nm	lb-ft
Exhaust manifold heat shield bolt	25	18
(1) Exhaust manifold to cylinder head bolts	20	15
Battery clamp nut	10	7
(4) Cylinder head bolts:		
Stage 1 - Tighten bolts 1 to 10	20	15
Stage 2 - Tighten bolts 1 to 10	35	26
Stage 3 - Tighten bolts 1 to 10	Further 90°	Further 90°
Stage 4 - Tighten bolts 1 to 10	Further 90°	Further 90°
Stage 5 - Tighten the M8 bolts 11	25	18

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and 12		
Connecting rod bolts		
Stage 1	10	7
Stage 2	56	41
EGR pipe to exhaust manifold flange nuts	25	18
CMP sensor Torx screw	7	5
Oil filter adapter	60	44
(5) Oil filter	18	13
Oil drain plug	25	18
Oil cooler bolts	10	7
Oil cooler Allen bolt	60	44
Primary timing chain tensioner guide bolts	12	9
Primary timing chain tensioner bolts	12	9
Secondary timing chain tensioner bolts	12	9
Primary timing chain tensioner guide stud	12	9
(2) VCT oil control unit bolts	22	16
LH VCT oil control unit nut	10	7
(1) Camshaft bearing cap bolts	10	7
(2) Intake camshaft sprocket retaining bolt		
Stage 1	20	15
Stage 2	Further 90°	Further 90°
(2) Exhaust camshaft sprocket retaining bolt		
Stage 1	20	15
Stage 2	Further 90°	Further 90°
Engine front mount bolts:		
Stage 1	45	33
Stage 2	Further 60°	Further 60°
Engine to front mount nut	90	66
Engine ground cable bolt	25	18
Starter motor bolts	45	33
(6) Starter motor cable nut	10	7
(4) Steering column lower universal joint bolts	25	18
Brake hose to upper arm bolt	23	17

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(2) Upper arm/wheel knuckle nut	70	52
Stabilizer bar link nuts	175	129
(4) Crankshaft pulley bolt	380	280
PCV valve bolts	6	4
(1) RH valve cover bolts	12	9
(1) LH valve cover bolts	12	9
Oil level indicator tube nut	6	4
(1) Sump pan bolts	20	15
Transmission retaining bolts	45	33
Transmission cooler pipes clamp bolt	25	18
A/C compressor bolts	25	18
Power steering pump bolts	25	18
Differential extension bolts	45	33
HO2S mounting bracket bolts	10	7
Oil pump to cylinder block bolts	10	7
(3) Oil strainer pick-up pipe bolts - M5	6	4
Oil strainer pick-up pipe bolt - M6	10	7
Coolant pump pulley bolts	10	7
Coolant crossover tube bolts	6	4
Accessory drive belt idler pulley bolt	25	18
Accessory drive belt tensioner bolt	40	30
Viscous fan drive belt tensioner pulley bolt	25	18
Viscous fan drive belt tensioner bolt	40	30
Radiator access panel bolts	10	7
Engine oil pressure sensor	12	9
Exhaust manifold EGR pipe to flange nuts and bolts	25	18
EGR valve to EGR pipe bolts	25	18
Upper suspension arm and brake line heat shield nuts and bolts	10	7
Battery positive cable to battery junction box (BJB) bolt	10	7
Flexplate to torque converter bolts:		
Stage 1	15	11
Stage 2	110	81

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Hood bolts	25	18
Road wheel nuts	140	103
Engine oil temperature sensor	20	15
Engine front cover bolts	12	9
Generator mounting bracket bolts	45	33
Generator mounting bolts	48	35

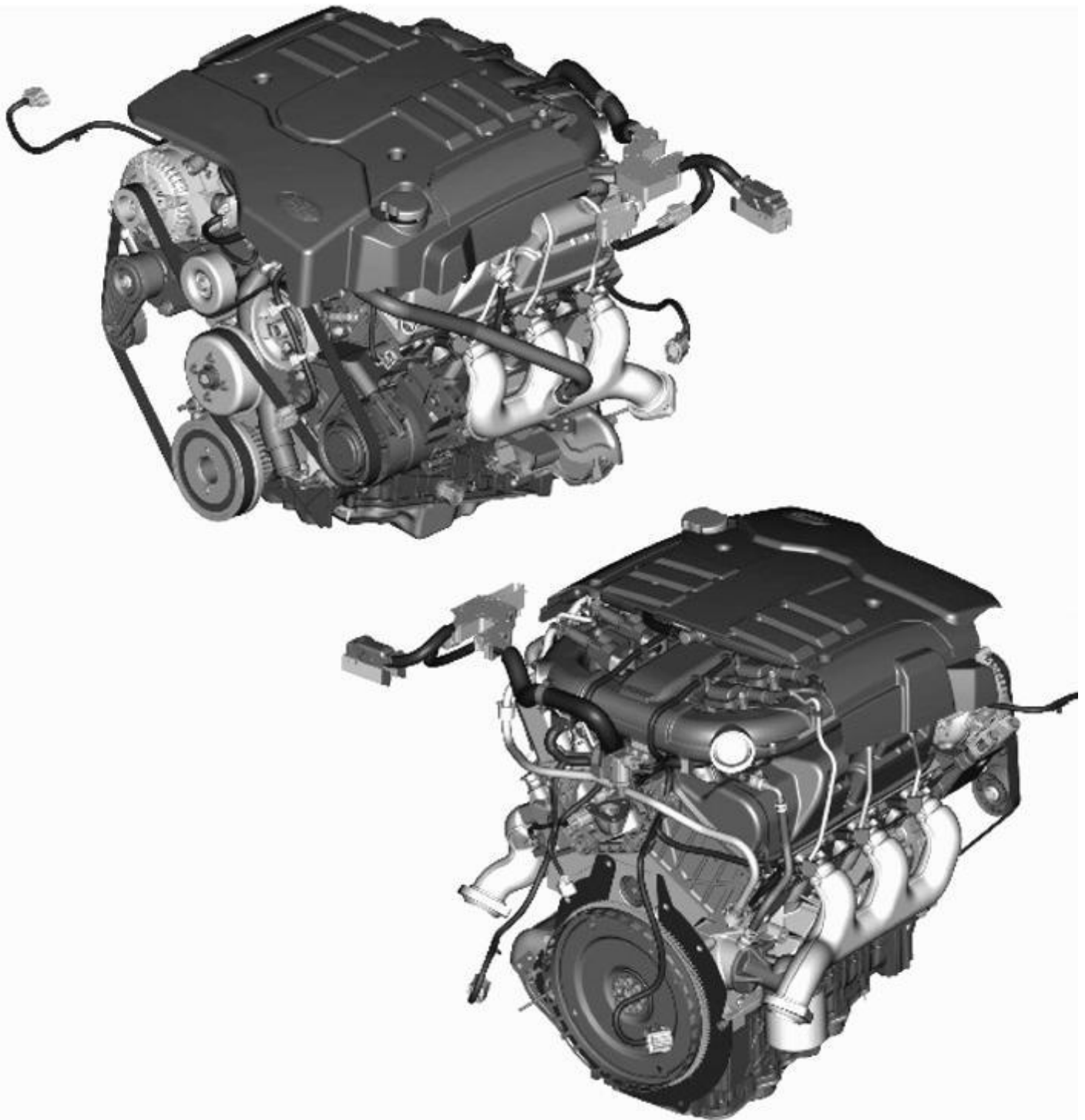
(1) Bolts must be tightened in sequence
(2) New nuts/bolts must be installed
(3) Apply sealant to threads
(4) New Patchlok bolt(s) must be installed

+ Lightly oil bolt threads
(5) Apply engine oil to seal
(6) Damage to internal connections will result if this torque is exceeded

DESCRIPTION AND OPERATION

ENGINE

EXTERNAL VIEW



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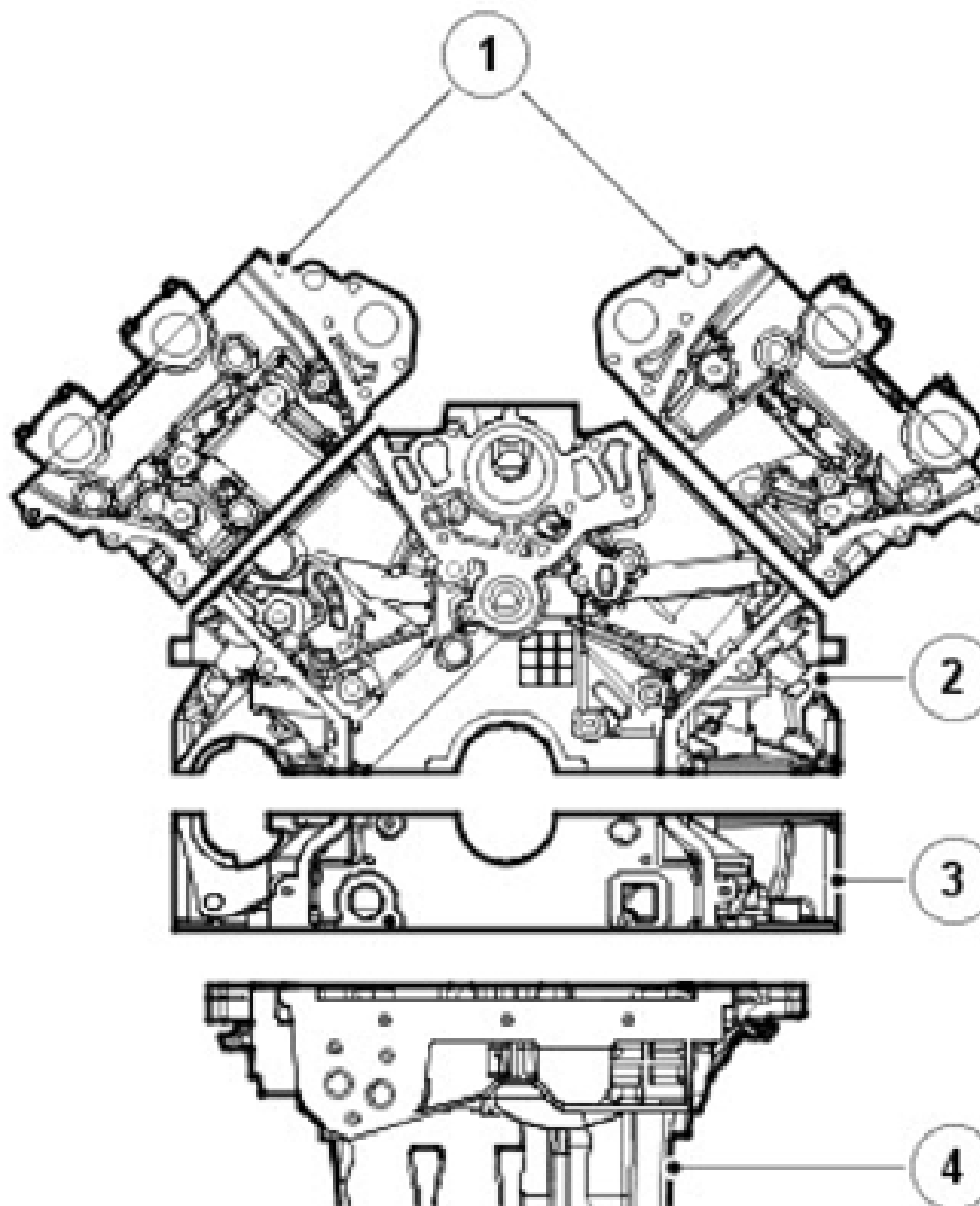
GENERAL

The V8 petrol engine is a 4.4 litre, 8 cylinder, 90 degrees 'Enclosed' V unit, with 4 valves per cylinder, operated by two overhead camshafts. The engine emissions comply with ECD3 (European Commission Directive) and

US Federal Tier2 Bin 8 legislative requirements and employs catalytic converters, electronic engine management control, positive crankcase ventilation and exhaust gas re-circulation to limit the emission of pollutants. The cooling system is a low volume, high velocity system. The Engine Control Module (ECM) controls the fuel injection system.

The cylinder block is of aluminium alloy construction with cast iron liners and a cast aluminium bedplate bolted to the bottom of the block to improve lower structure rigidity. The cylinder heads are cast aluminium with thermo-plastic camshaft covers. The single-piece oil sump is also cast aluminium. The fabricated stainless steel twin skin 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.

ENGINE STRUCTURE



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Item	Part Number	Description
1	-	Cylinder heads
2	-	Cylinder block
3	-	Bed plate
4	-	Structural sump

TECHNICAL FEATURES

The technical features include:

- An eight cylinder 90 degree 'Enclosed V' configuration liquid cooled aluminium cylinder block with cast iron liners
- Pistons are of open-ended skirt design, with two compression rings and a three piece oil control ring
- Two aluminium cylinder heads, each incorporating two hollow camshafts manufactured in chilled cast iron
- Four valves per cylinder
- Aluminium graded valve lifters (shimless)
- Variable Valve Timing (VVT) (inlet only)
- Top fed, 12-jet fuel injectors
- Engine front cover manufactured from aluminium which accommodates the crankshaft front oil seal
- Primary and secondary chains drive the camshafts
- An aluminium bed plate
- A cast iron crankshaft
- Fracture-split connecting rods in sintered-forged steel
- A twin multi-vee belt, which drives the front end accessories
- Fabricated stainless steel twin skin exhaust manifolds
- Electronic Exhaust Gas Recirculation (EGR) valve
- An advanced engine management system incorporating electronic throttle control
- Meets with the fault handling requirements, as detailed in the European On-Board Diagnostic (EOBD) III, US Federal OBD and California OBDII legislation.

ENGINE DATA

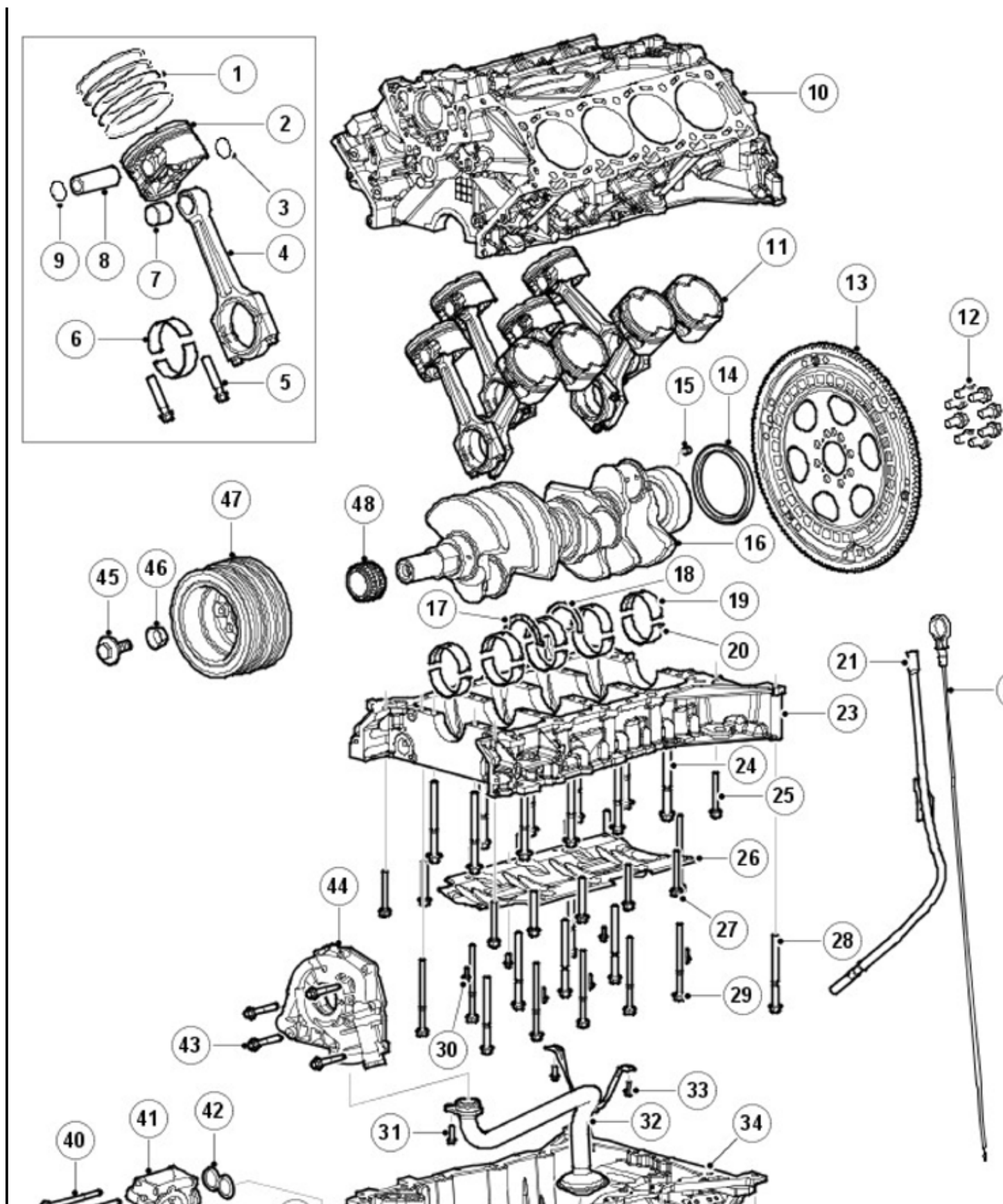
DESCRIPTION	TYPE
Configuration	90 degree V8
Maximum power	220 kW at 6000 rpm
Maximum torque	425 Nm at 4000 rpm
Displacement	4.396 litres
Stroke/bore	90.3/88.0 mm
Compression ratio	10.50: 1
Firing order (pre 2005)	1 5 4 2 6 3 7 8

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Firing order (2005 onwards)	1 2 7 3 4 5 6 8
Engine weight	208 kg (approx.)
Oil volume	7.5 litres (wet)

CYLINDER BLOCK COMPONENTS



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Item	Part Number	Description
1	-	Piston rings
2	-	Piston
3	-	Circlip
4	-	Connecting rod
5	-	Bolts
6	-	Connecting rod bearing shells
7	-	Bearing
8	-	Gudgeon pin
9	-	Circlip
10	-	Cylinder block
11	-	Pistons
12	-	Bolts
13	-	Flywheel
14	-	Seal
15	-	Dowel
16	-	Crankshaft
17	-	Thrust washer
18	-	Thrust washer
19	-	Bearing shells - upper
20	-	Bearing shells - lower
21	-	Oil level gauge tube
22	-	Oil level gauge
23	-	Bedplate
24	-	Bolts
25	-	Bolts
26	-	Windage tray
27	-	Bolts
28	-	Bolts
29	-	Bolts
30	-	Bolt
31	-	Bolt
32	-	Oil pick-up pipe
33	-	Bolts
34	-	Sump
35	-	Bolts
36	-	Bolts
37	-	Bolts
38	-	Oil filter
39	-	Oil cooler assembly
40	-	Bolts
41		

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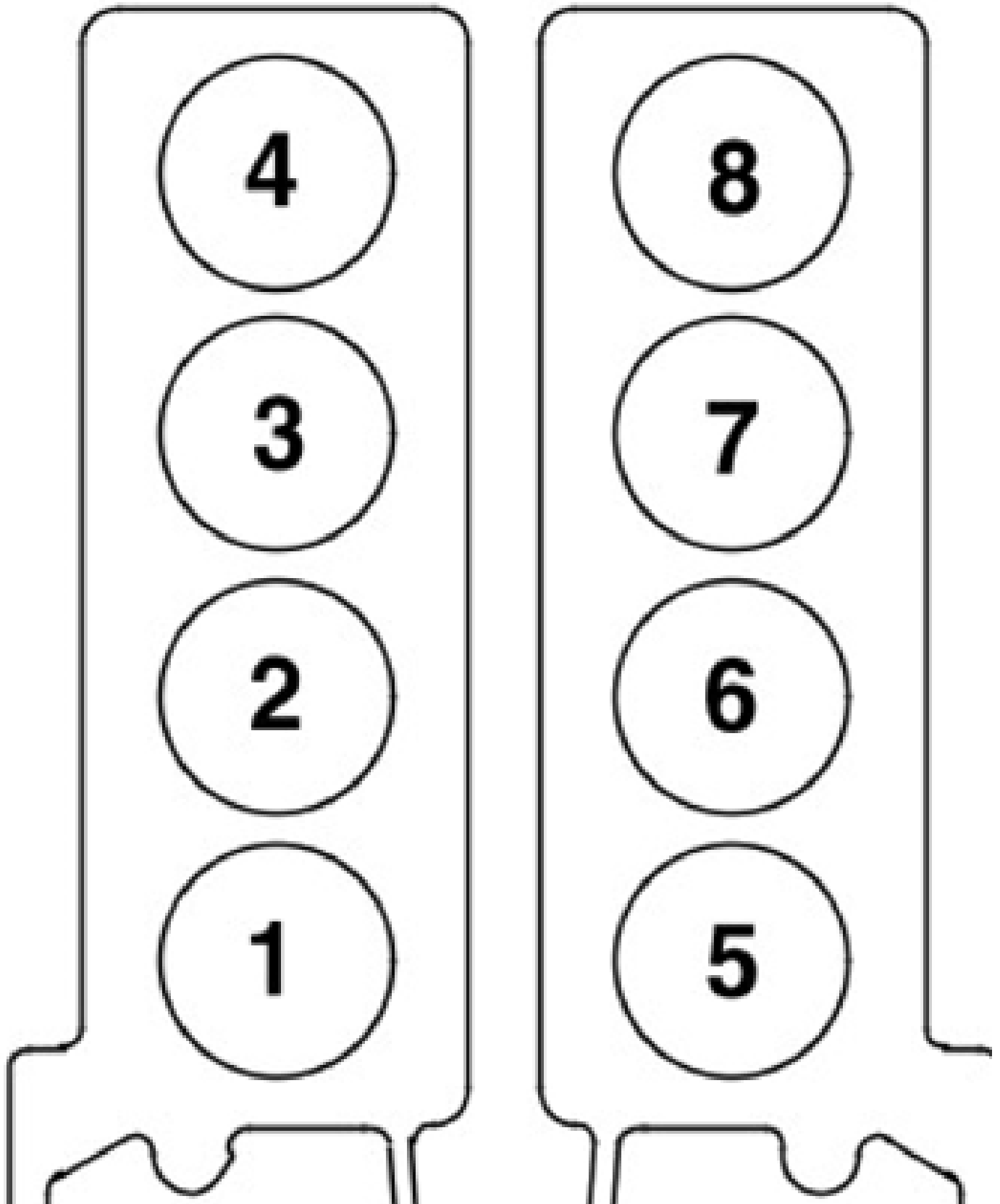
	-	Oil filter head assembly
42	-	Seals
43	-	Bolts
44	-	Oil pump
45	-	Crankshaft bolt
46	-	Taper collet
47	-	Crankshaft pulley
48	-	Crankshaft sprocket

Cylinder Block

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

Cylinder Numbering Convention

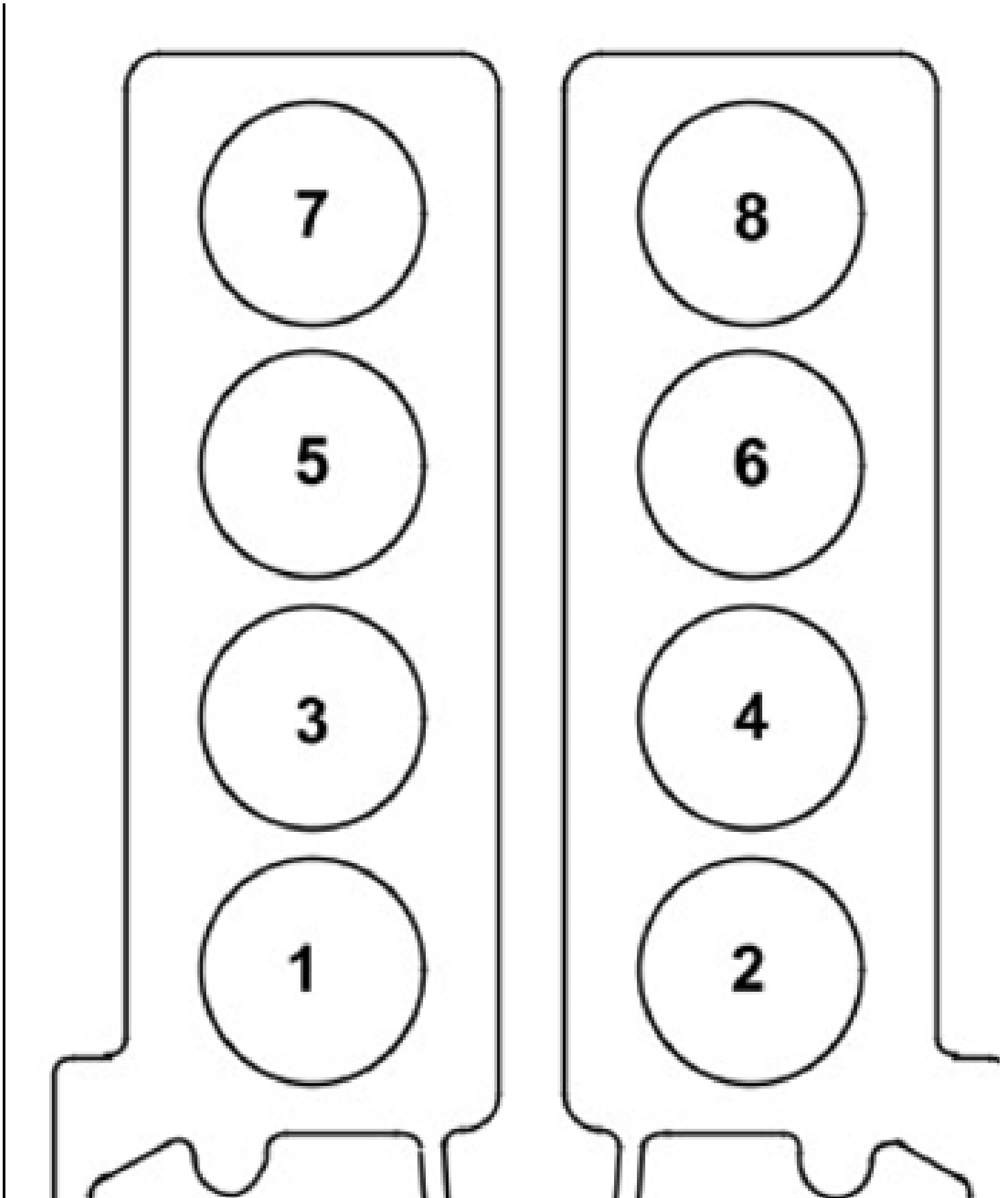
Pre 2005



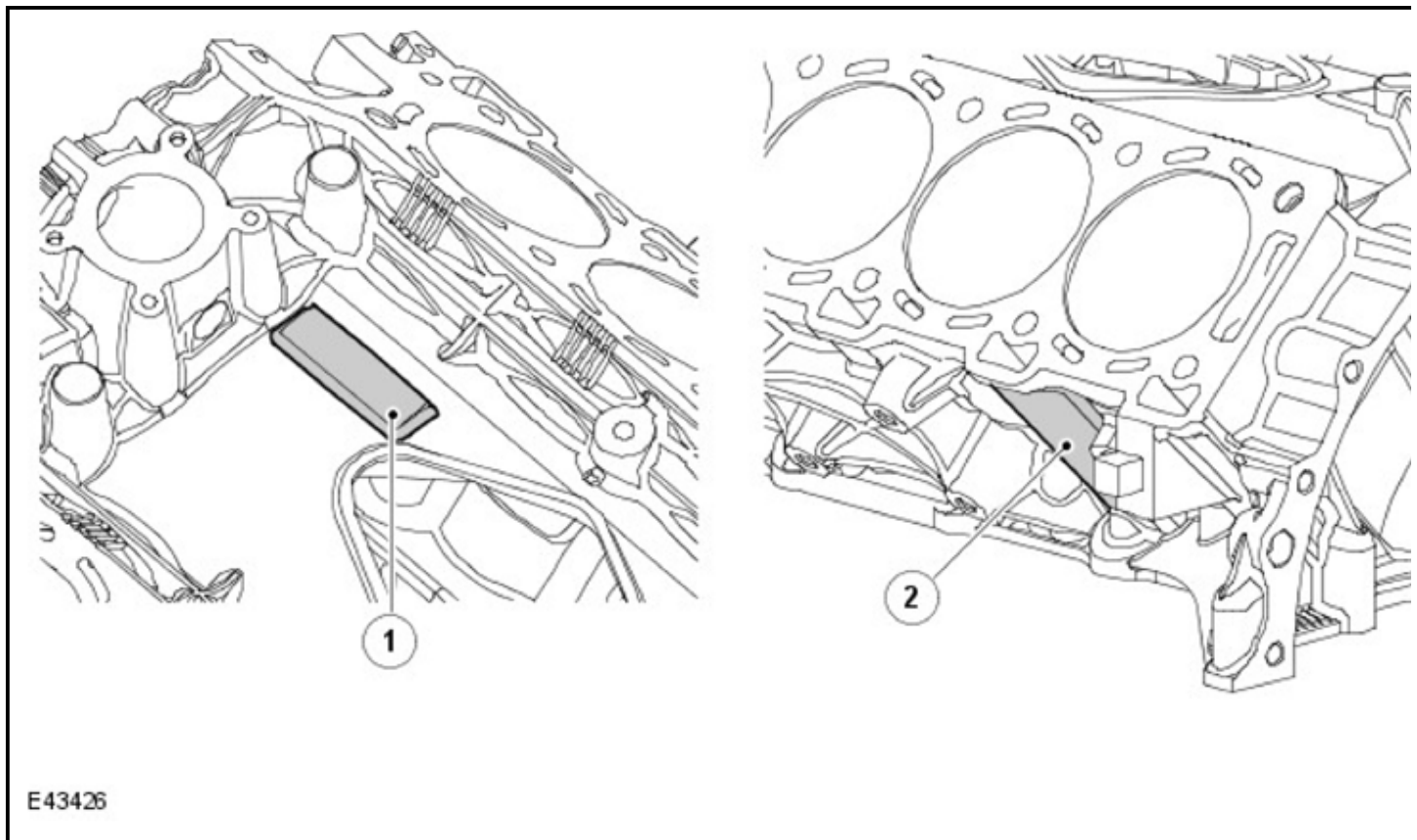
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2005 onwards



Engine Data Locations

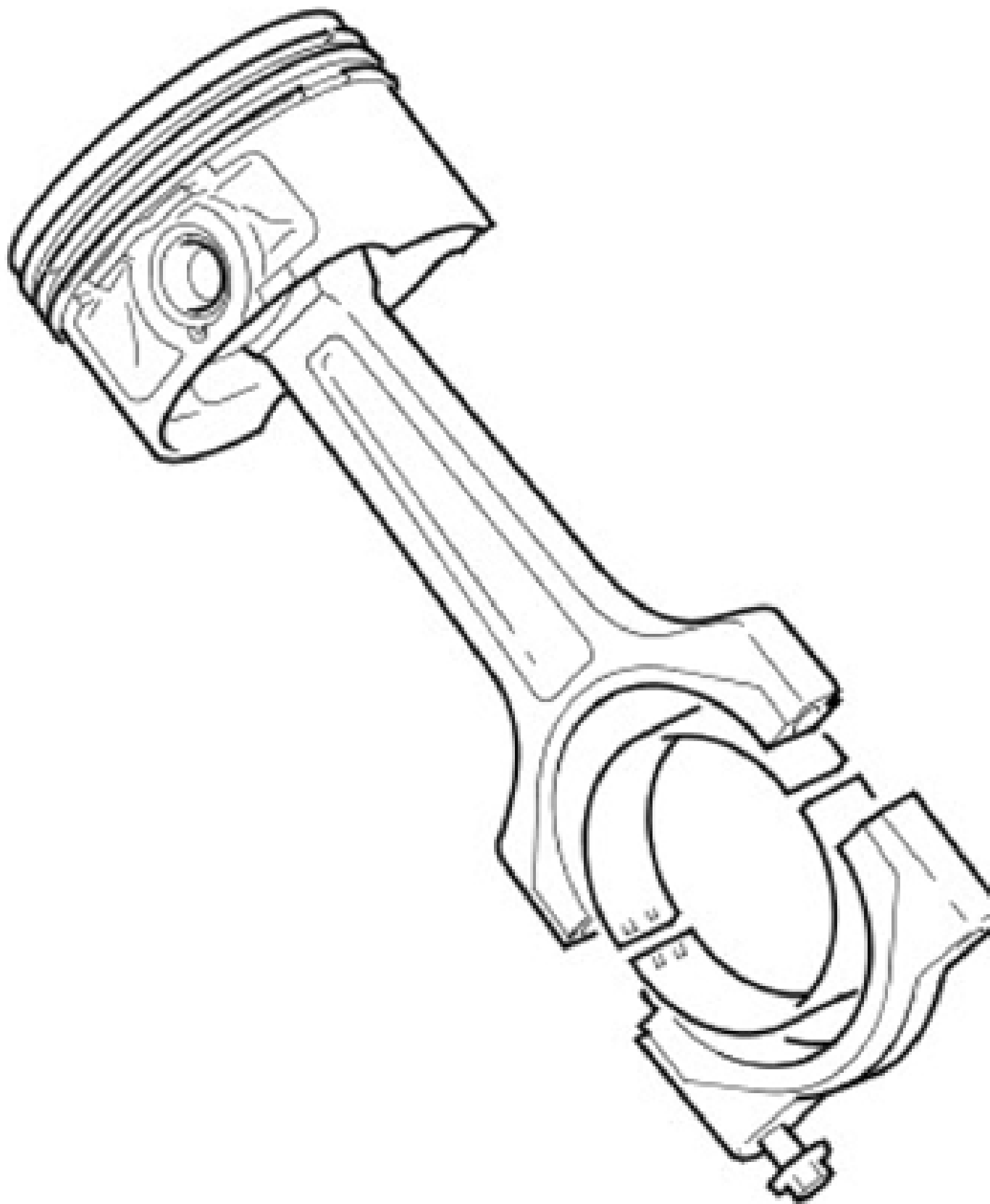


Item	Part Number	Description
1	-	Engine part number
2	-	Engine data (main bearing diameters, cylinder bore diameters, etc), emissions code and engine number

Engine data is marked at three locations, two on the cylinder block (shown) and one on the engine front cover, which consists a label displaying the engine number. Component diameters are represented by alphabetical and numerical codes; keys to the codes are in the Service Repair Procedures (SRP) information.

Connecting Rods and Pistons

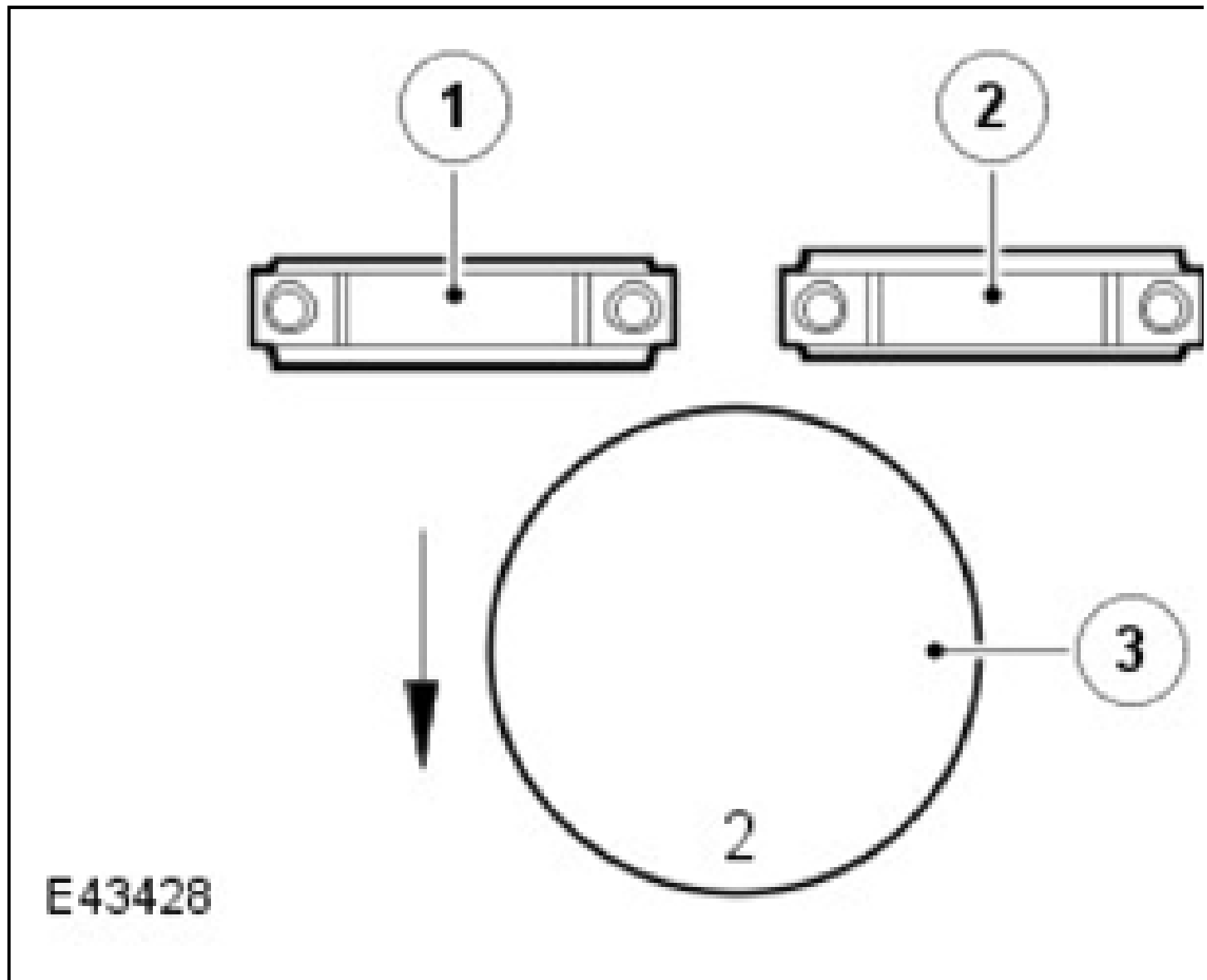




The connecting rods are manufactured from sinter-forged steel and have fracture-split bearing caps. The bearing caps are produced by fracturing the opposing sides of the connecting rod at the bearing horizontal centre line. As well as being easier to manufacture, when reassembled the fractured surfaces interlock to form a strong seamless joint. The cylinder position is marked on adjoining sides of the joint to identify matching connecting rods and bearing caps. The connecting rod bearings are aluminium/tin split plain bearings.

The pistons are of the open-ended skirt design. Three piston rings, two compression and one oil control, are installed on each piston. Each piston is installed on a gudgeon pin located in a aluminium/tin bushing in the connecting rod.

Connecting Rod and Piston Installation



Item	Part Number	Description

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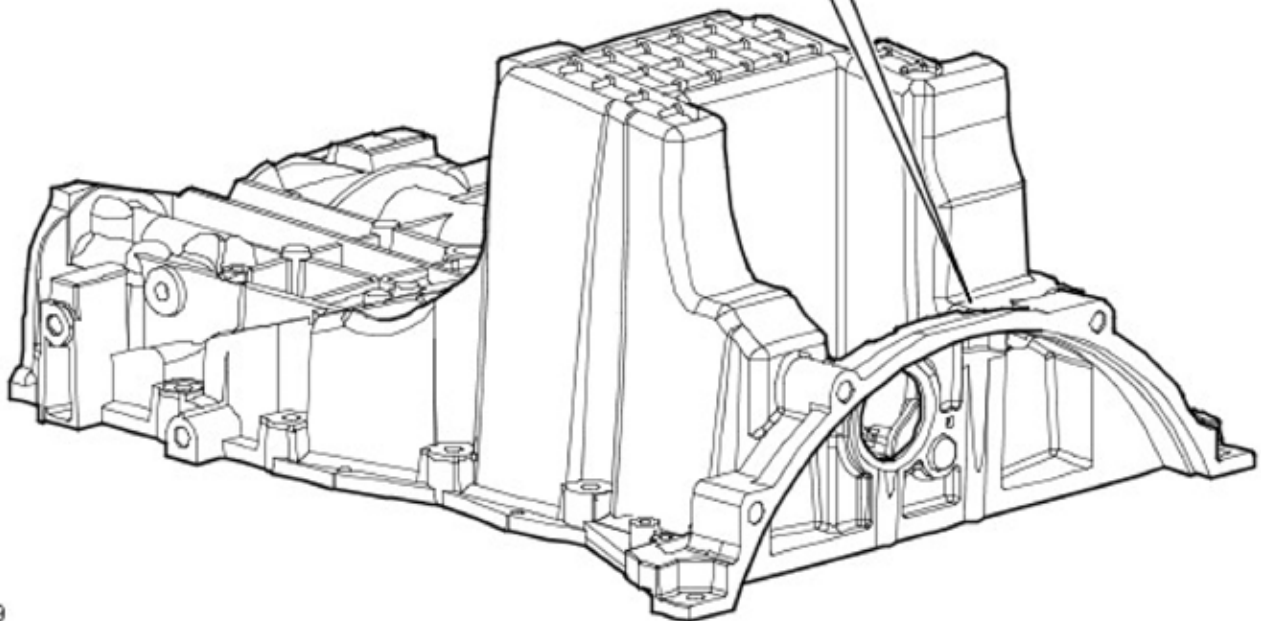
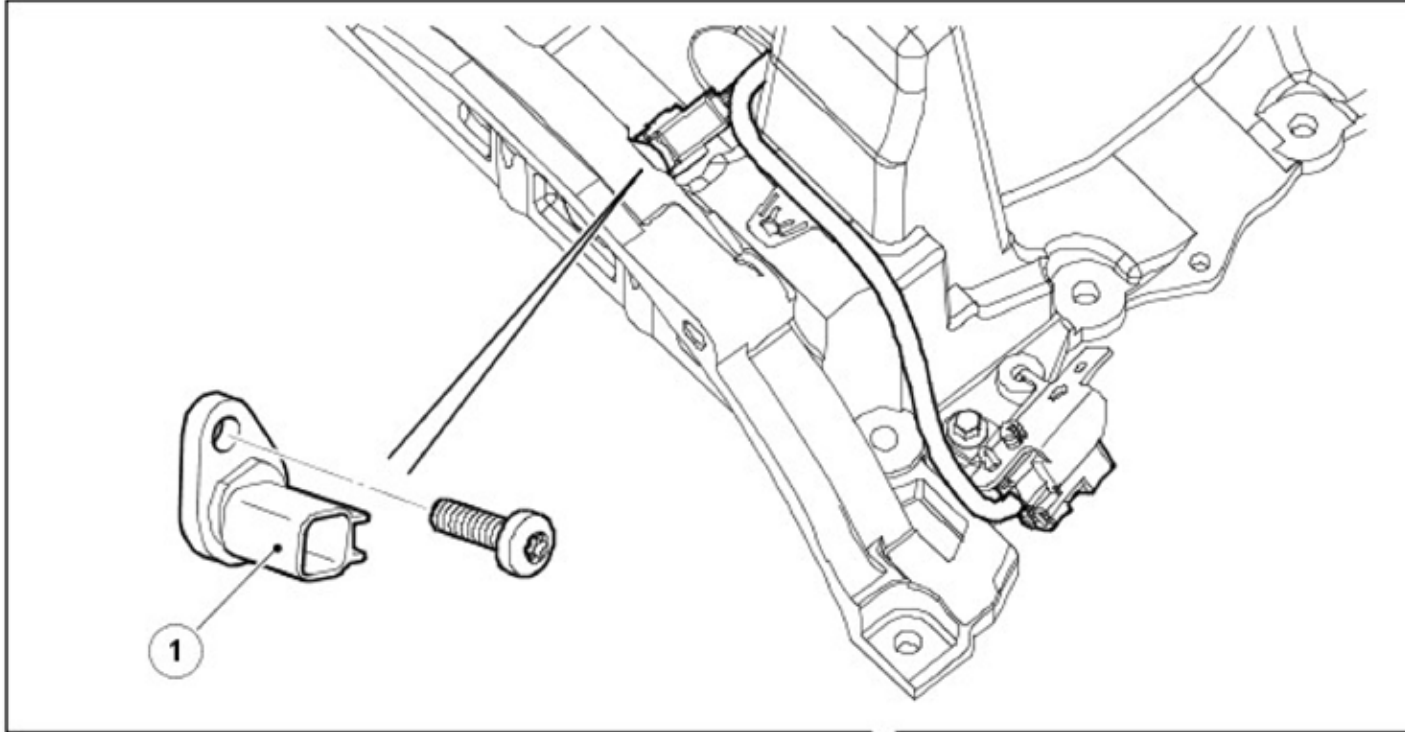
1	-	Bank A (RHS)
2	-	Bank B (LHS)
3	-	Piston

The piston grade number is stamped on the crown of the piston and must coincide with that for each cylinder bore.

The piston must be assembled in the correct orientation for the designated cylinder bore:

- Bank 'A' - piston grade number and the thick flange of the connecting rod must face the front of the engine
- Bank 'B' - piston grade number and the thin flange of the connecting rod must face the front of the engine

Crankshaft Position Sensor



E43429

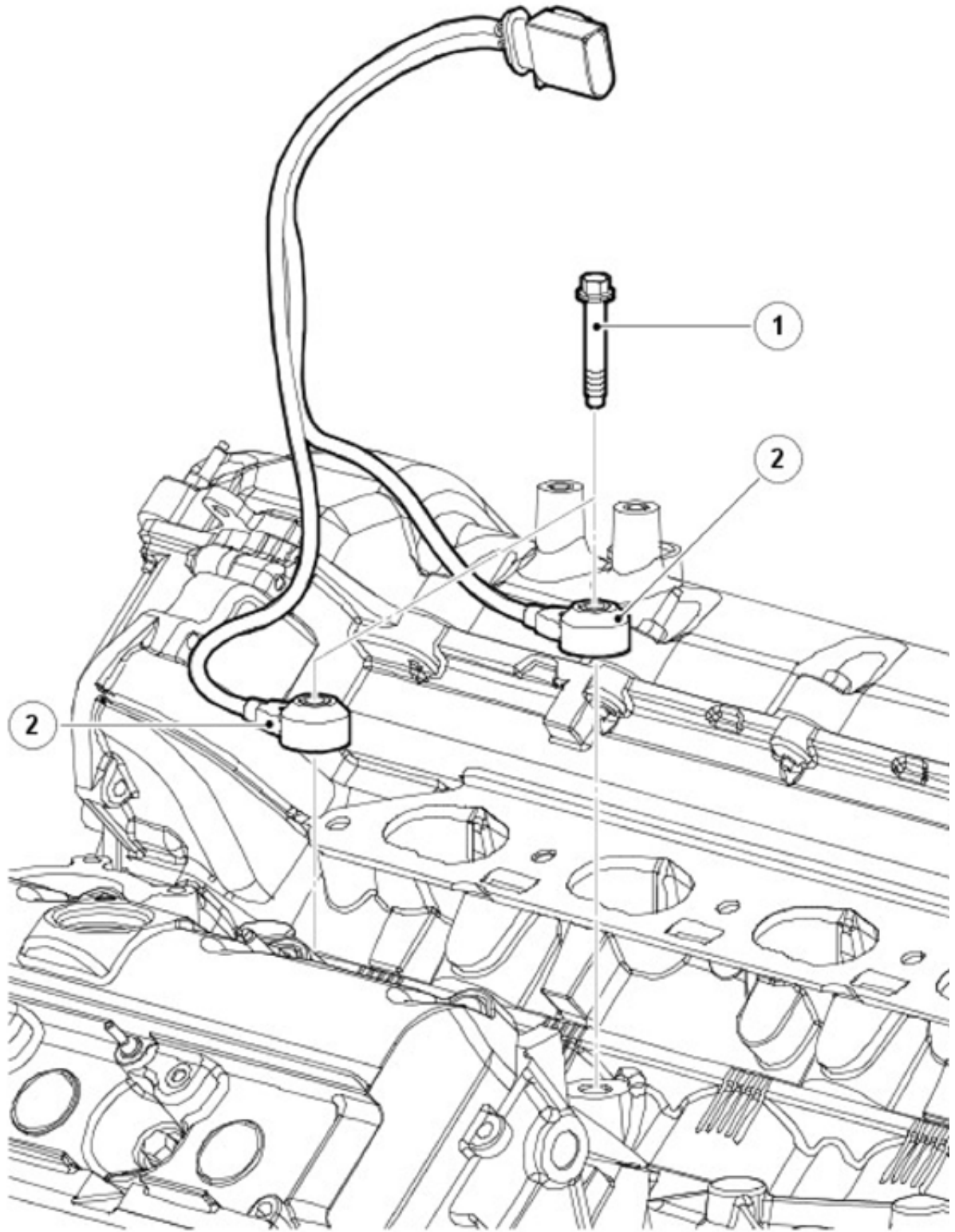
Item	Part Number	Description
1	-	Crankshaft position sensor (CKP)

The CKP sensor is installed at the rear of the sump. It is a variable reluctance sensor that provides an input of

engine crankshaft speed and position.

For additional information, refer to: **Electronic Engine Controls** .

Knock Sensors



E43430

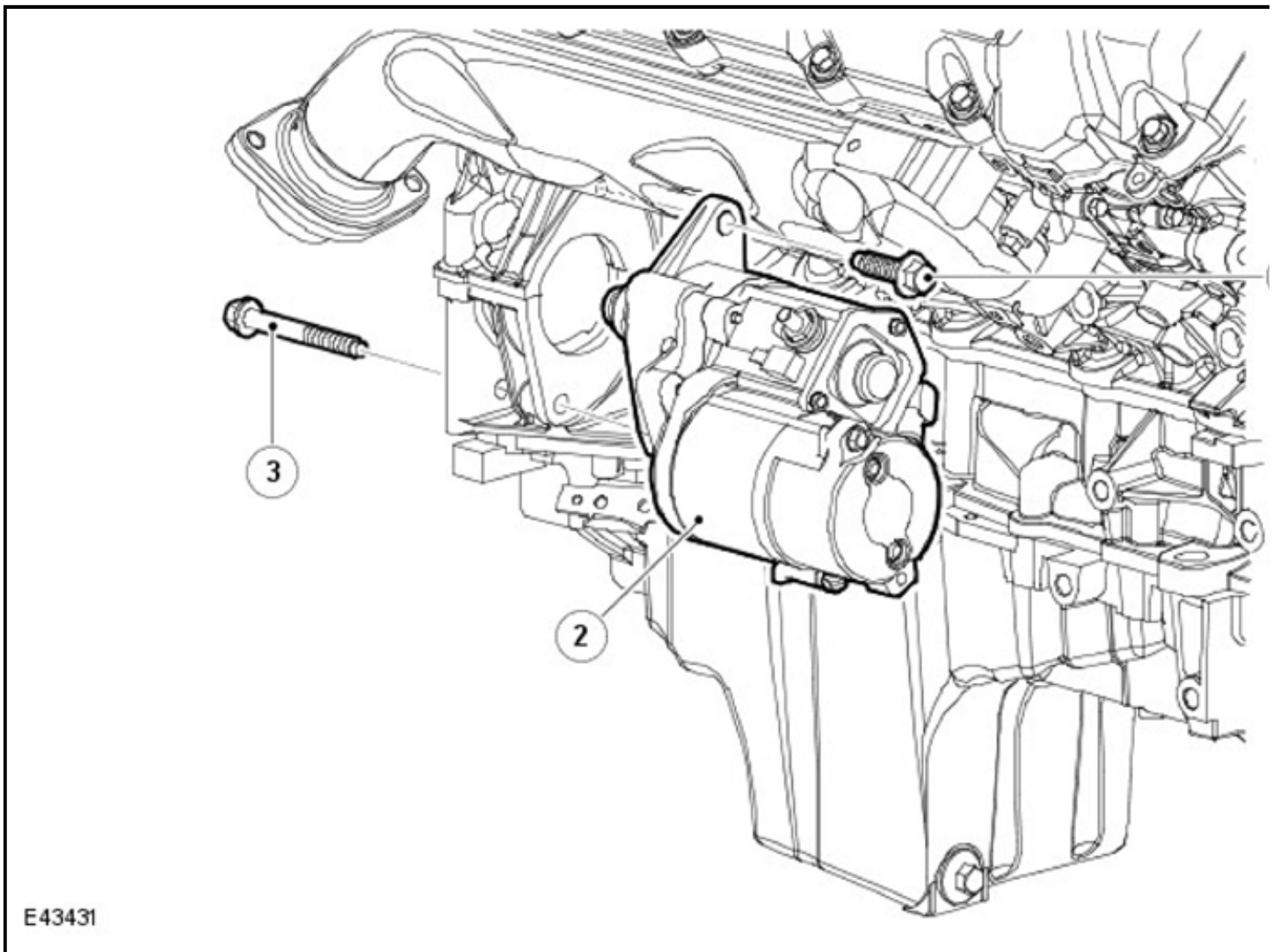
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Item	Part Number	Description
1	-	Bolt
2	-	Knock sensor

The knock sensors are installed in the cylinder block on the inboard side of each cylinder bank. They are piezo-electric sensors that provide inputs to detect and locate detonation during combustion.

For additional information, refer to: **Electronic Engine Controls** .

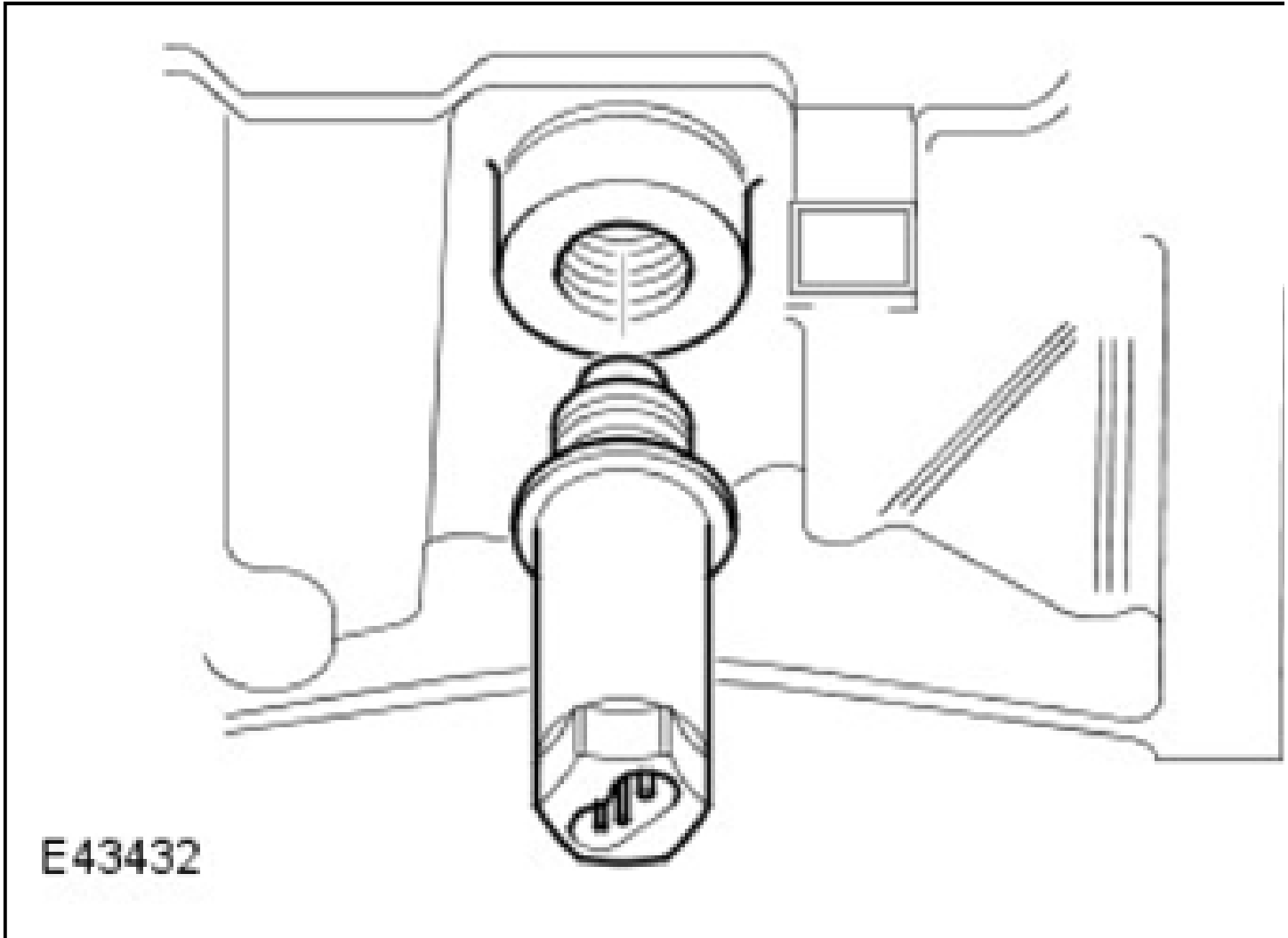
Starter

Item	Part Number	Description
1	-	Bolt
2	-	Starter motor
3	-	Bolt

The engine starter motor is installed at the rear right side of the engine, at the cylinder block to bedplate split line.

For additional information, refer to: **Starting System** .

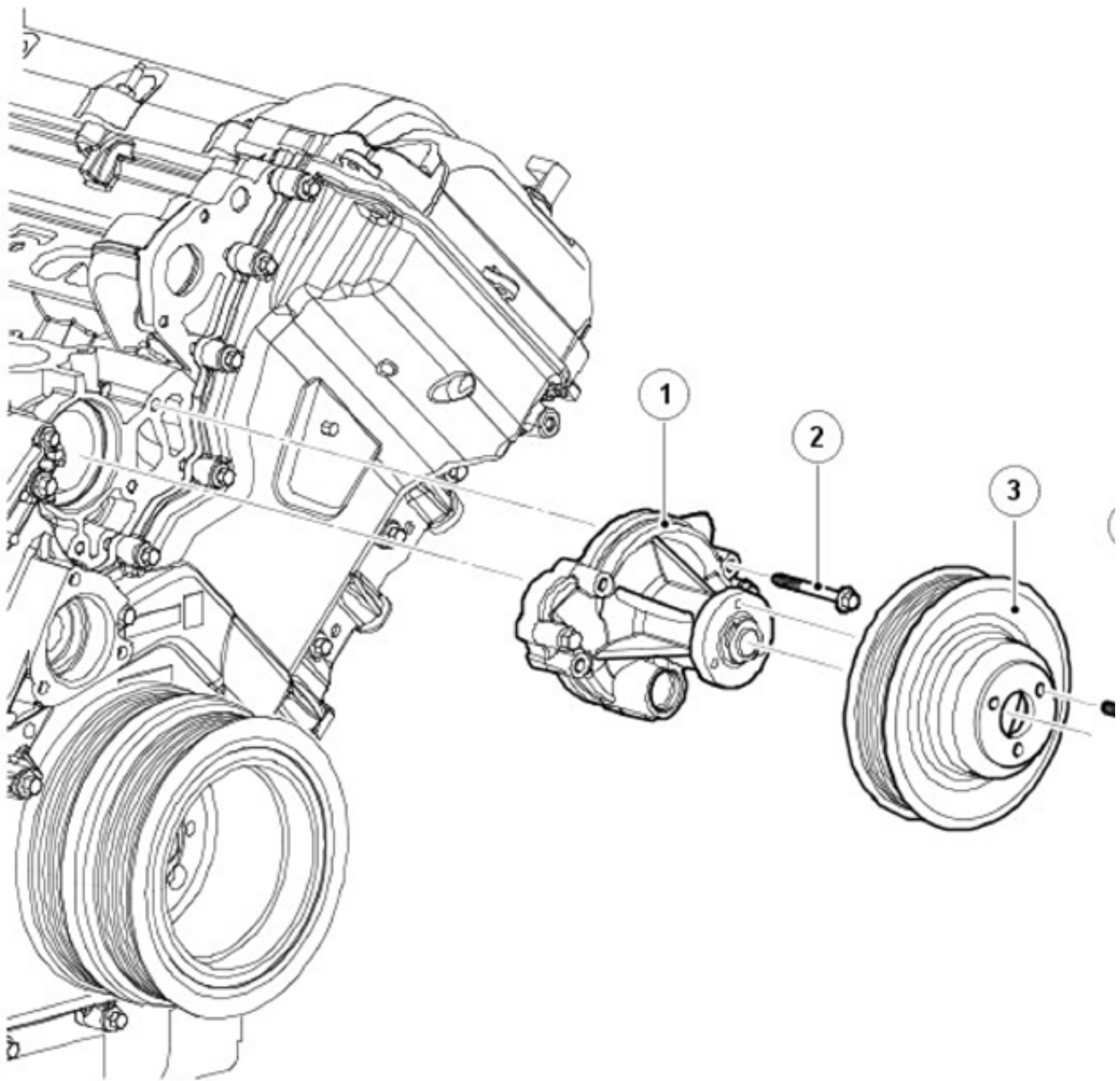
Coolant Drain Plug/Heater



A coolant drain plug is installed on the rear left side of the cylinder block. On vehicles with the cold climate package, the cylinder block heater replaces the drain plug.

On vehicles destined for Canada, the coolant heater is installed during engine manufacture, but for Scandinavian vehicles the heater is supplied in kit form to be installed at the dealership.

Coolant Pump



E43433

Item	Part Number	Description
1	-	Coolant pump

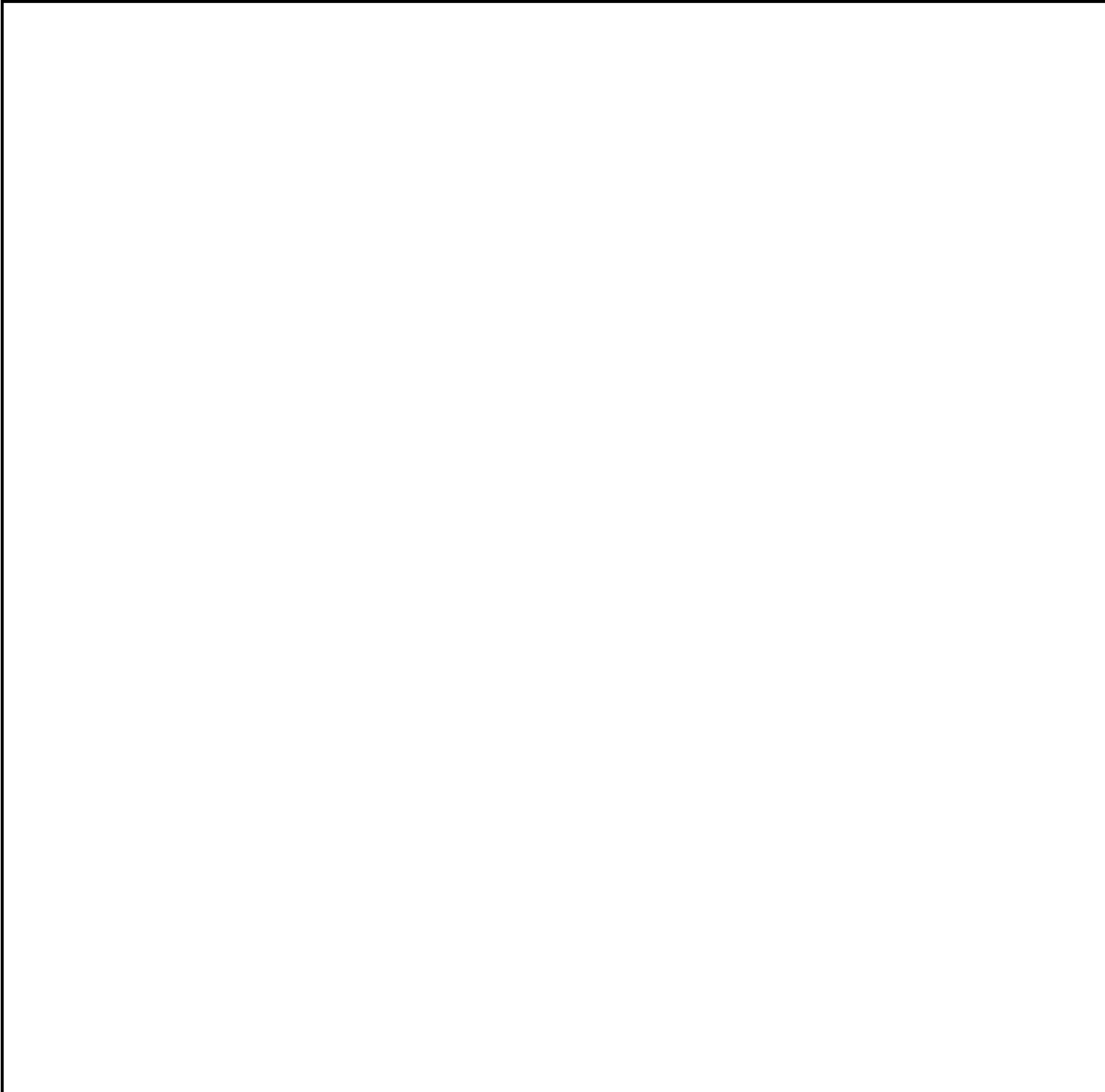
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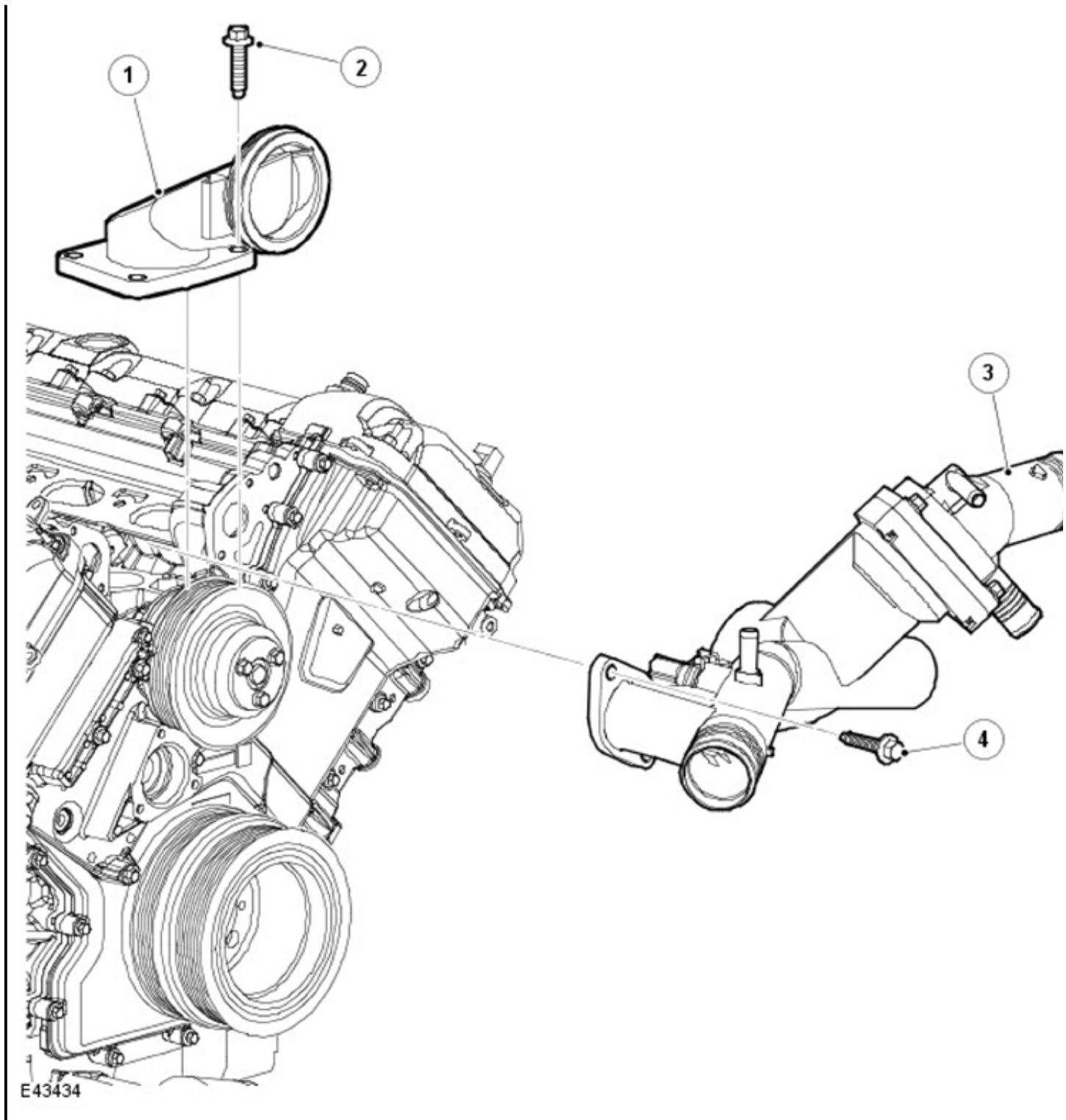
ENGINE Engine - V8 4.4L Petrol

2	-	Bolt
3	-	Pulley
4	-	Bolt

The coolant pump is installed between the two cylinder banks, on the front face of the cylinder block.

Thermostat Housing





Item	Part Number	Description
1	-	Coolant outlet elbow
2	-	Bolt

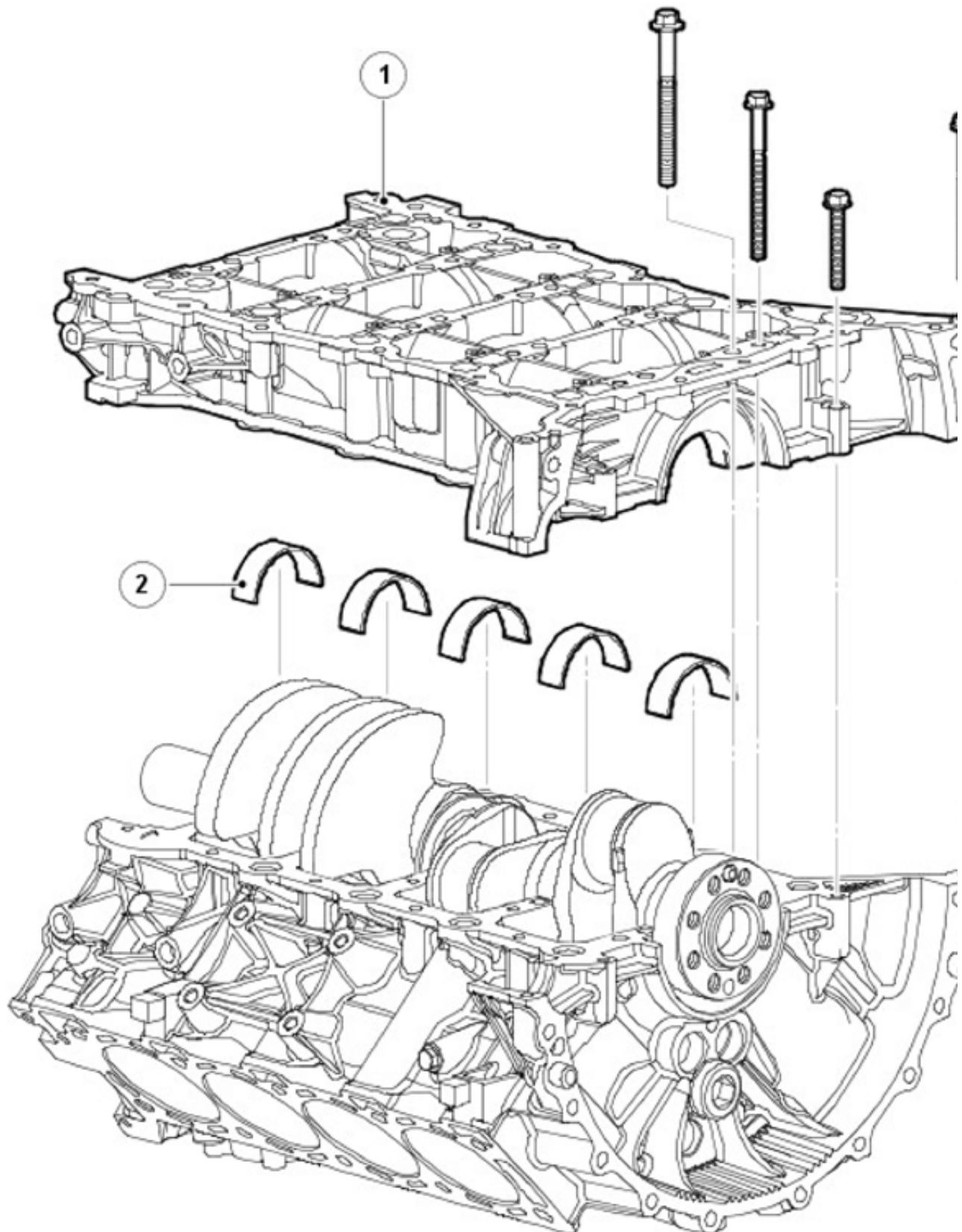
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3	-	Thermostat housing
4	-	Bolt

The composite thermostat housing is installed between the two cylinder banks, immediately above the coolant pump. The thermostat controls the flow of coolant through the radiator.

CRANKSHAFT AND SUMP COMPONENTS



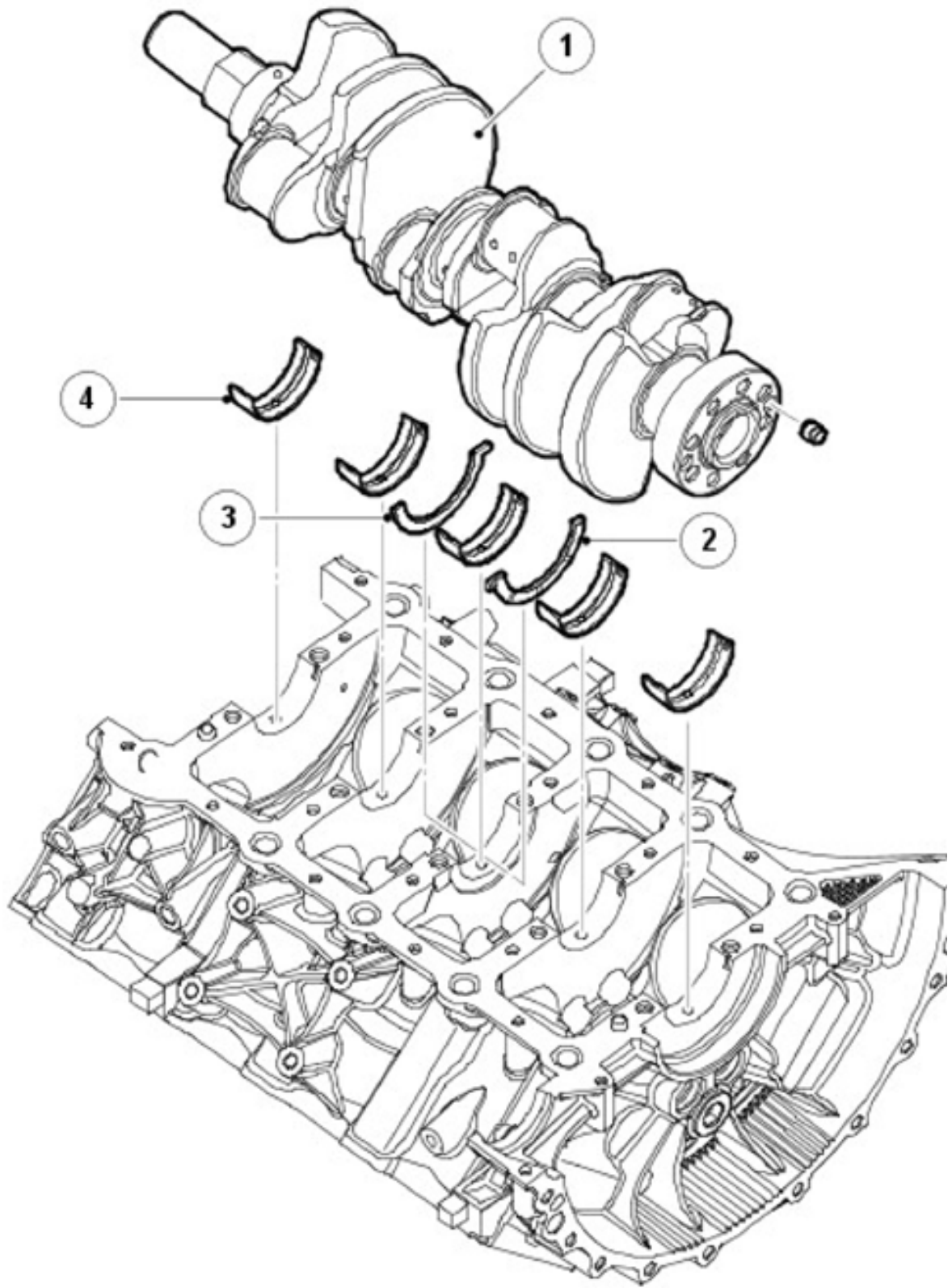
E43435

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Item	Part Number	Description
1	-	Bedplate
2	-	Main bearings - lower

Crankshaft and Main Bearings



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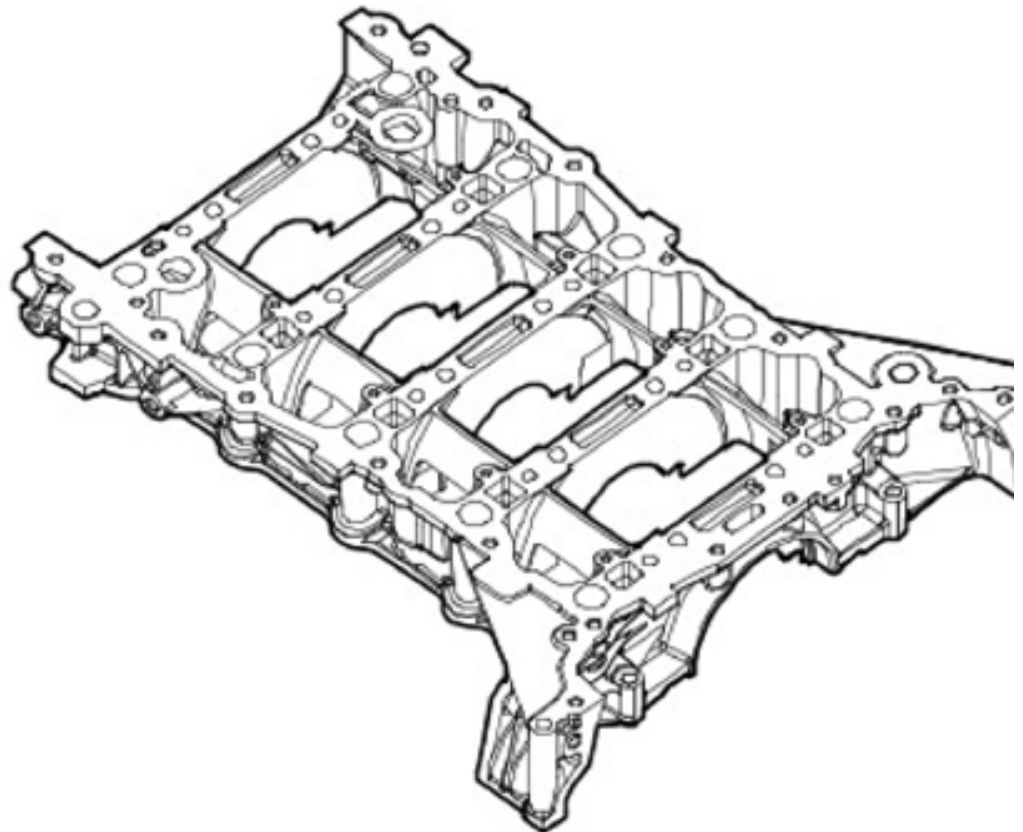
Item	Part Number	Description
1	-	Crankshaft
2	-	Thrust washer
3	-	Thrust washer
4	-	Main bearings - upper

Six counter-balance weights ensure good vibration levels from the four throw, five bearing crankshaft. Manufactured in cast iron, the crankshaft also has undercut and rolled fillets for improved strength.

The crankshaft rear oil seal is a press fit in the bedplate to cylinder block interface.

The main bearings are aluminium/tin split plain bearings. An oil groove in the upper half of each bearing transfers the oil into the crankshaft for lubrication of the connecting rod bearings. A aluminium/tin thrust washer is installed each side of the top half of the centre main bearing.

Bedplate



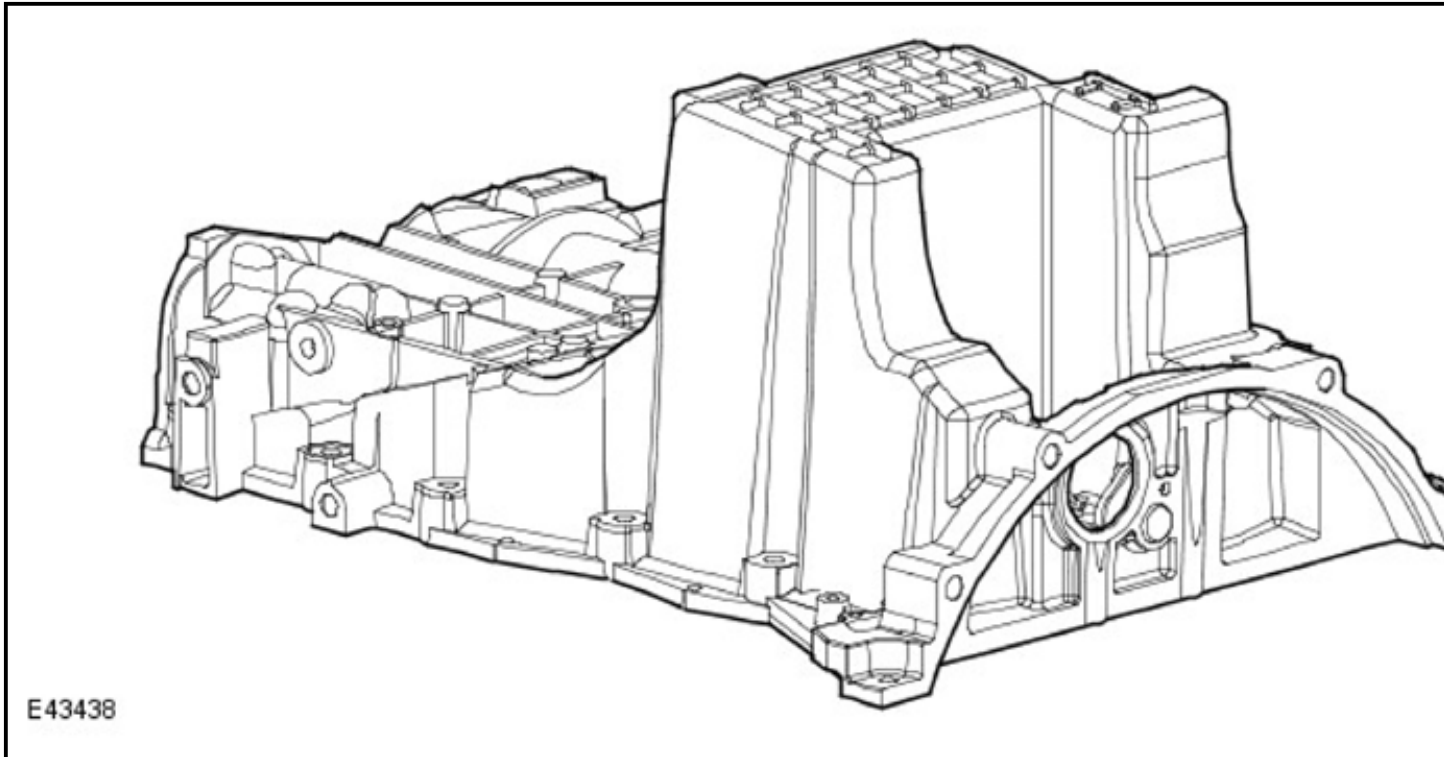
E43437

The bedplate is a structural casting bolted to the bottom of the cylinder block to retain the crankshaft. The use of a bedplate further improves rigidity. Iron inserts, cast into the main bearing supports of the bedplate, minimise main bearing clearance changes due to heat expansion.

Two hollow dowels align the bedplate with the cylinder block.

Beads of sealant seal the joint between the bedplate and the cylinder block.

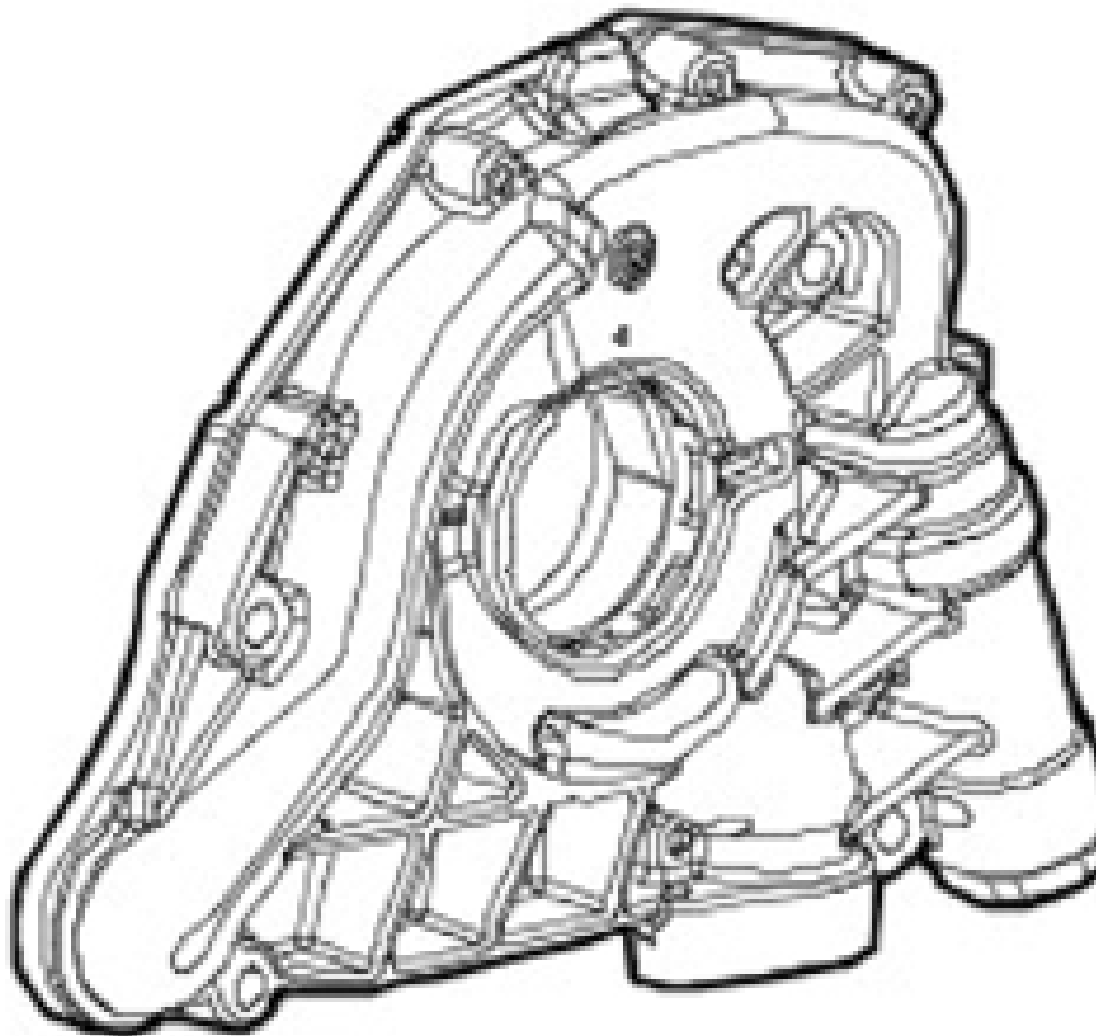
Sump



The aluminium alloy structural sump is bolted to the bedplate. A windage tray attached to the underside of the bedplate isolates the oil pan from the disturbed air produced by the rotation of the crankshaft, to prevent oil aeration and improve oil drainage. A rubber plug at the rear of the structural sump seals the port that provides access to the torque converter securing bolts. The engine oil drain plug is located at the front right corner of the oil pan.

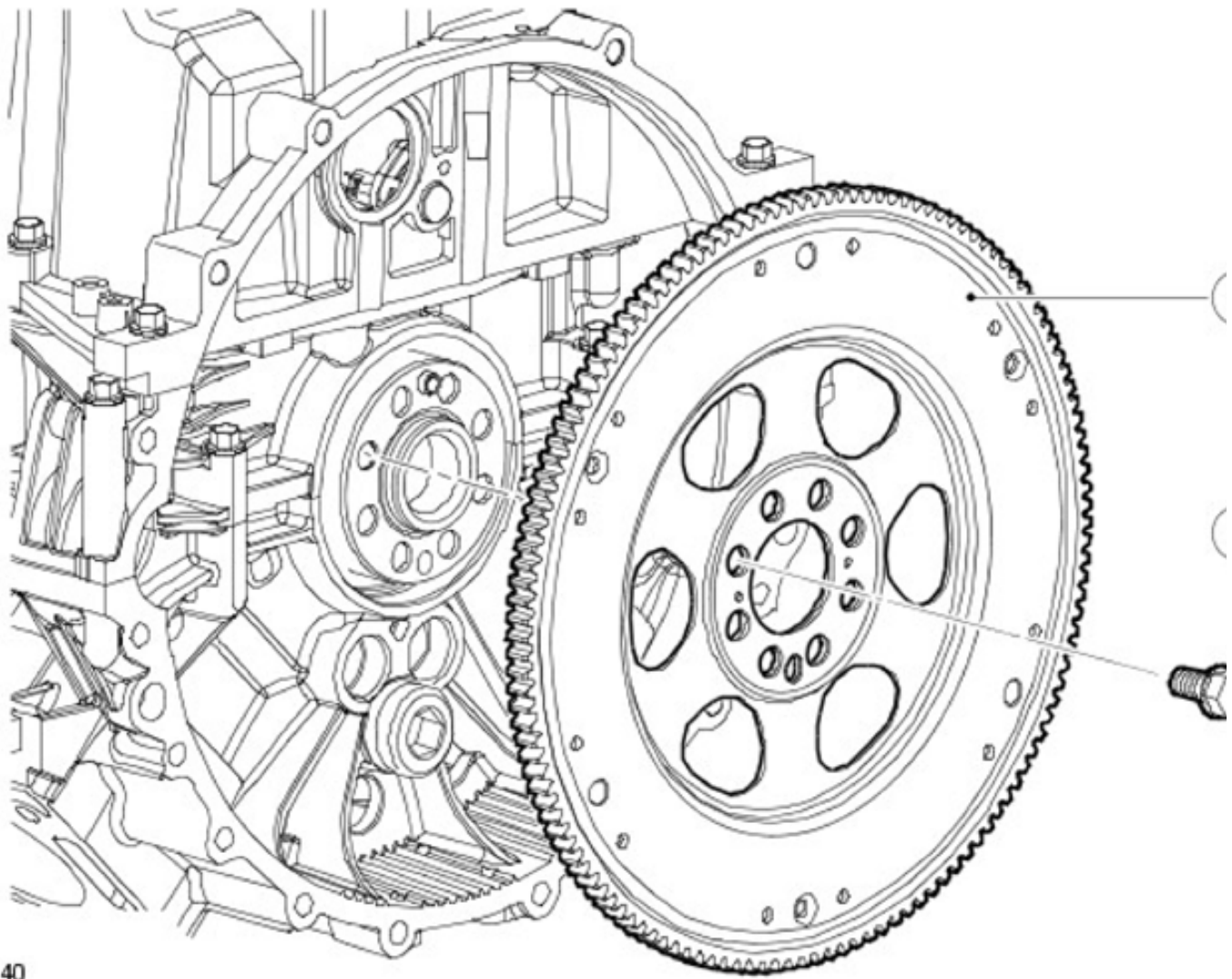
A bead of sealant seals the joint between the structural sump and the bedplate.

Oil Pump

**E43439**

The oil pump is installed on the crankshaft at the front of the engine. The pump inlet and outlet ports align with oil passages in the bedplate.

Starter Drive Plate



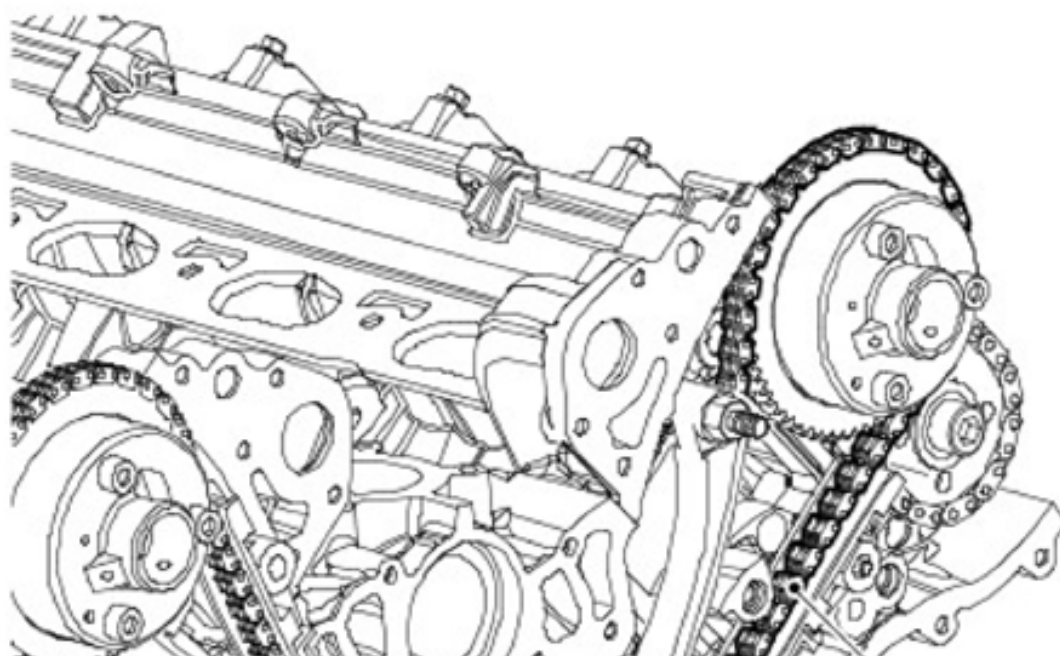
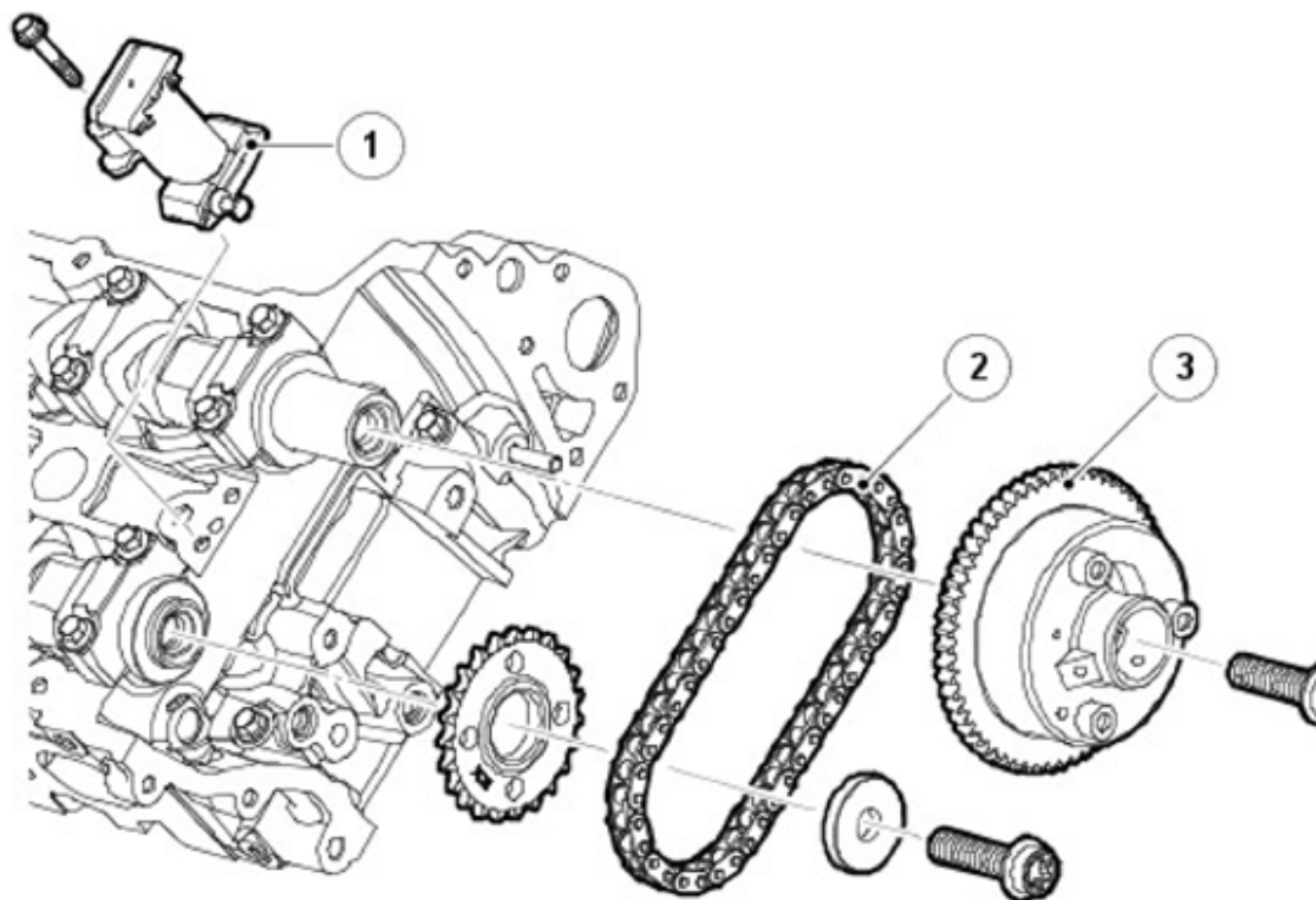
Item	Part Number	Description
1	-	Starter drive plate
2	-	Bolt

The starter drive plate is attached to the rear of the crankshaft. A timing disc, for the engine speed sensor, is spot welded to the front face of the drive plate.

Timing Disc



CAMSHAFT TIMING COMPONENTS



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Item	Part Number	Description
1	-	Secondary chain tensioner
2	-	Secondary chain
3	-	Variable valve timing unit
4	-	Primary chain
5	-	Primary chain tensioner

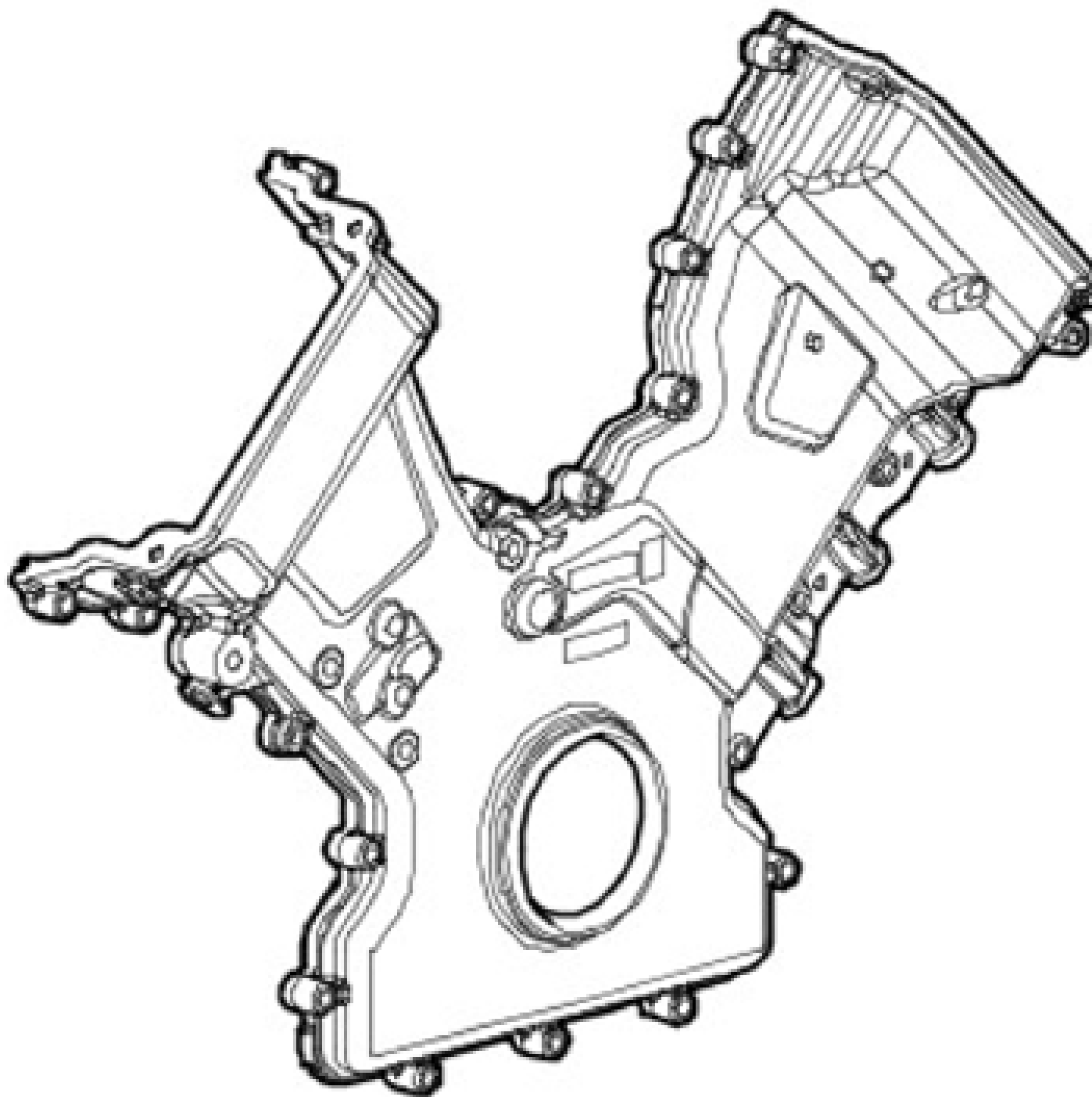
Timing Gear

Multiple link primary and single row secondary chains drive the camshafts of each cylinder bank. The primary chains transmit the drive from two sprockets on the crankshaft to variable valve timing units on the intake camshafts. The secondary chains transmit the drive from the variable valve-timing units to sprockets on the exhaust camshafts.

A key locates the two drive sprockets on the crankshaft. The crankshaft's torsional vibration damper retains the sprockets in position. The variable valve timing units and the exhaust camshaft sprockets are non-interference, non-keyed fits on their respective camshafts; the drive being transmitted by the face to face friction load produced by the valve timing unit/sprocket securing bolt.

Each chain has a hydraulic tensioner operated by engine oil. The primary chains are lubricated via oil squirt tubes located at the front of the engine block, near the crankshaft drive sprockets. A jet of oil from the end of each secondary chain tensioner lubricates the secondary chains. The primary chain tensioners act on pivoting flexible tensioner blades. The secondary chain tensioners act directly on the chains. Guide rails are installed on the drive side of the primary chains.

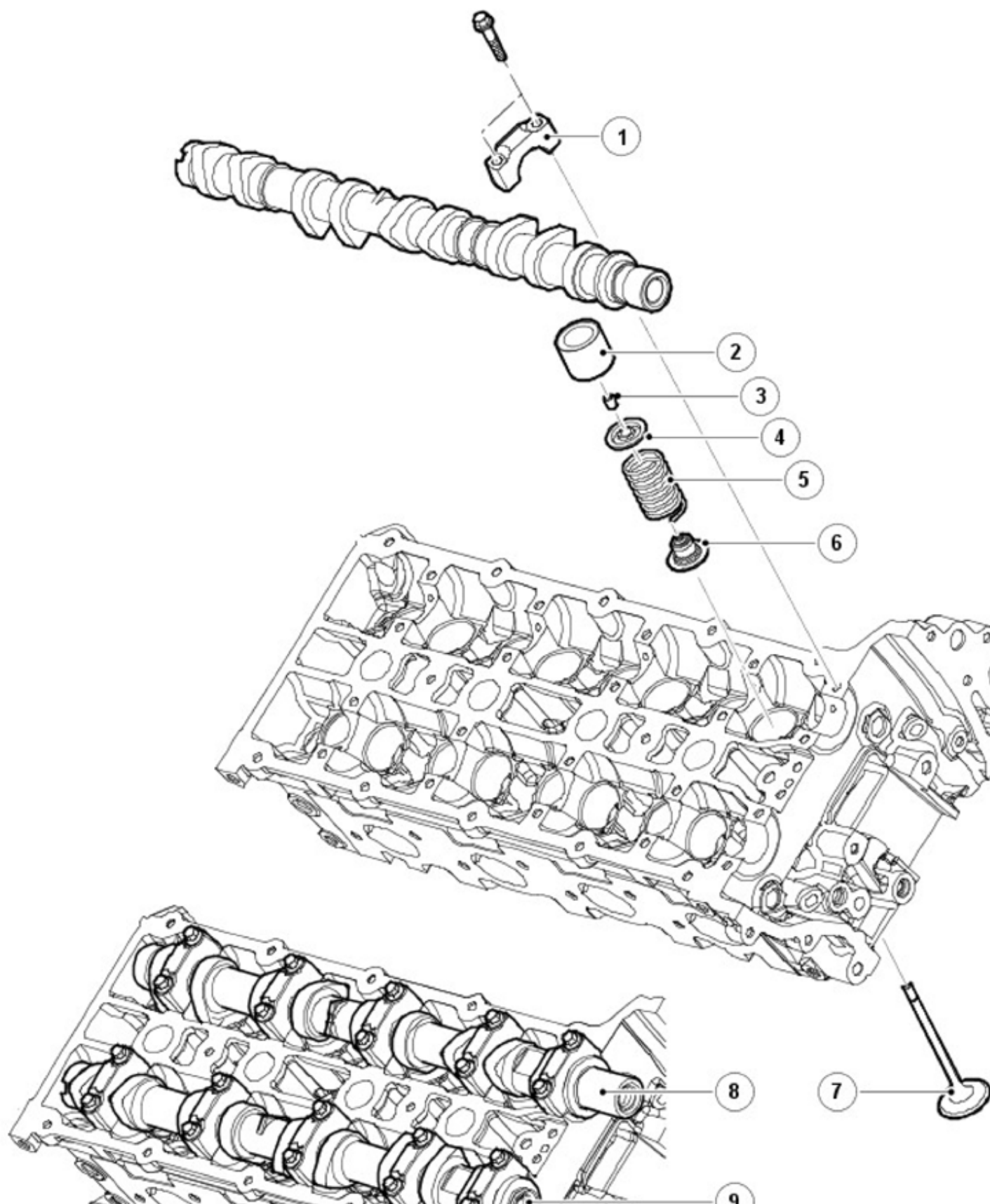
Timing Cover



E43443

The aluminium alloy timing cover accommodates the crankshaft front oil seal (a PTFE lip seal). Silicon rubber in-groove gaskets seal the joint between the timing cover and the front face of the engine.

CYLINDER HEAD COMPONENTS



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Item	Part Number	Description
1	-	Camshaft bearing cap
2	-	Tappet (shimless)
3	-	Collet
4	-	Valve spring cap
5	-	Valve spring
6	-	Valve stem oil seal
7	-	Valve
8	-	Inlet camshaft
9	-	Exhaust camshaft

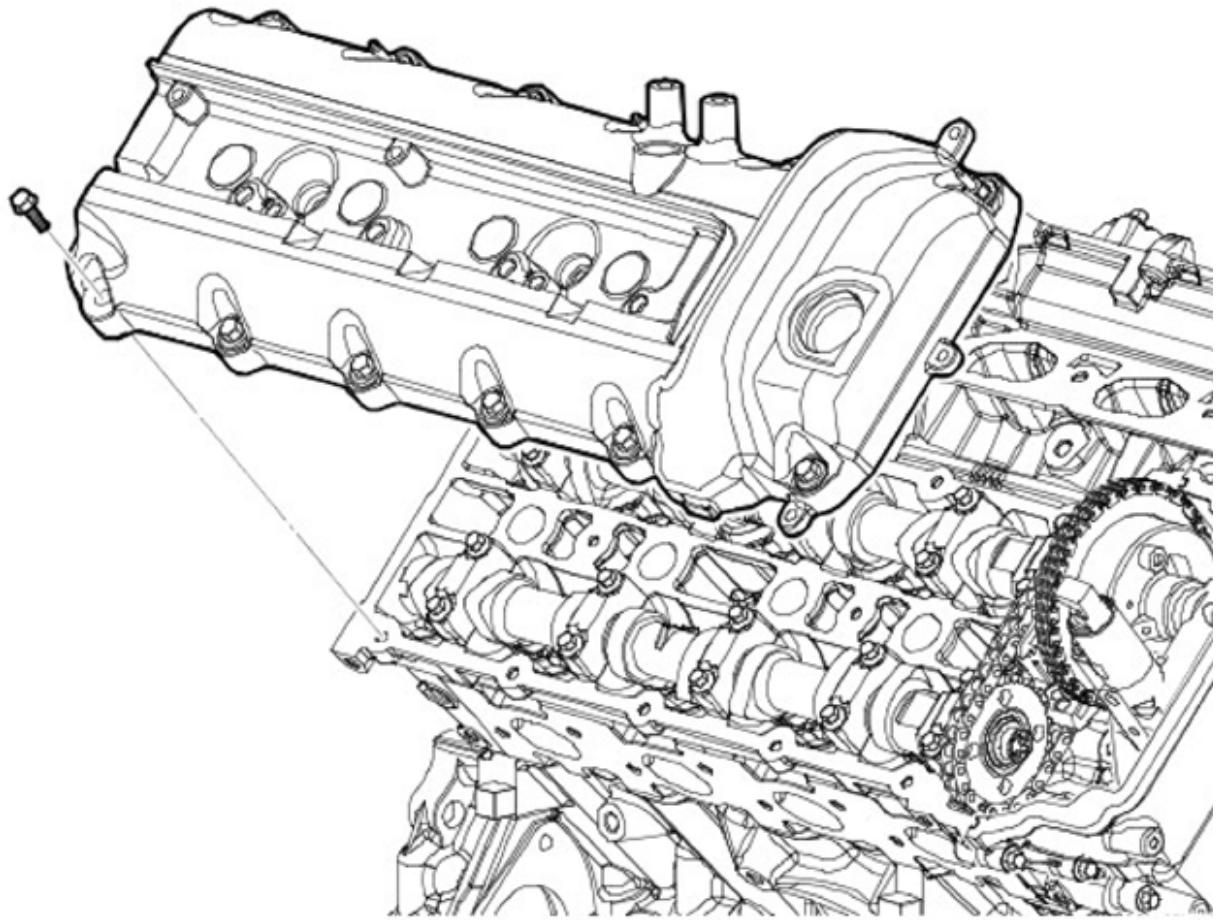
Cylinder Heads

The cylinder heads are unique to each cylinder bank. Deep-seated bolts, to reduce distortion, secure the cylinder heads to the cylinder block. Two hollow dowels align each cylinder head with the cylinder block.

The 14 mm spark plugs, one per cylinder, locate in recesses down the centre line of each cylinder head.

The engine-lifting eyes are bolted to the cylinder heads; two on the rear (one per head) and one at the front.

Camshaft Covers



The camshaft covers are manufactured from thermo-plastic. The A bank camshaft cover incorporates an outlet for the part load engine breather. The bank B camshaft cover incorporates an outlet for the full load engine breather and the engine oil filler cap. Identical oil separators are incorporated below the breather outlet in each cover.

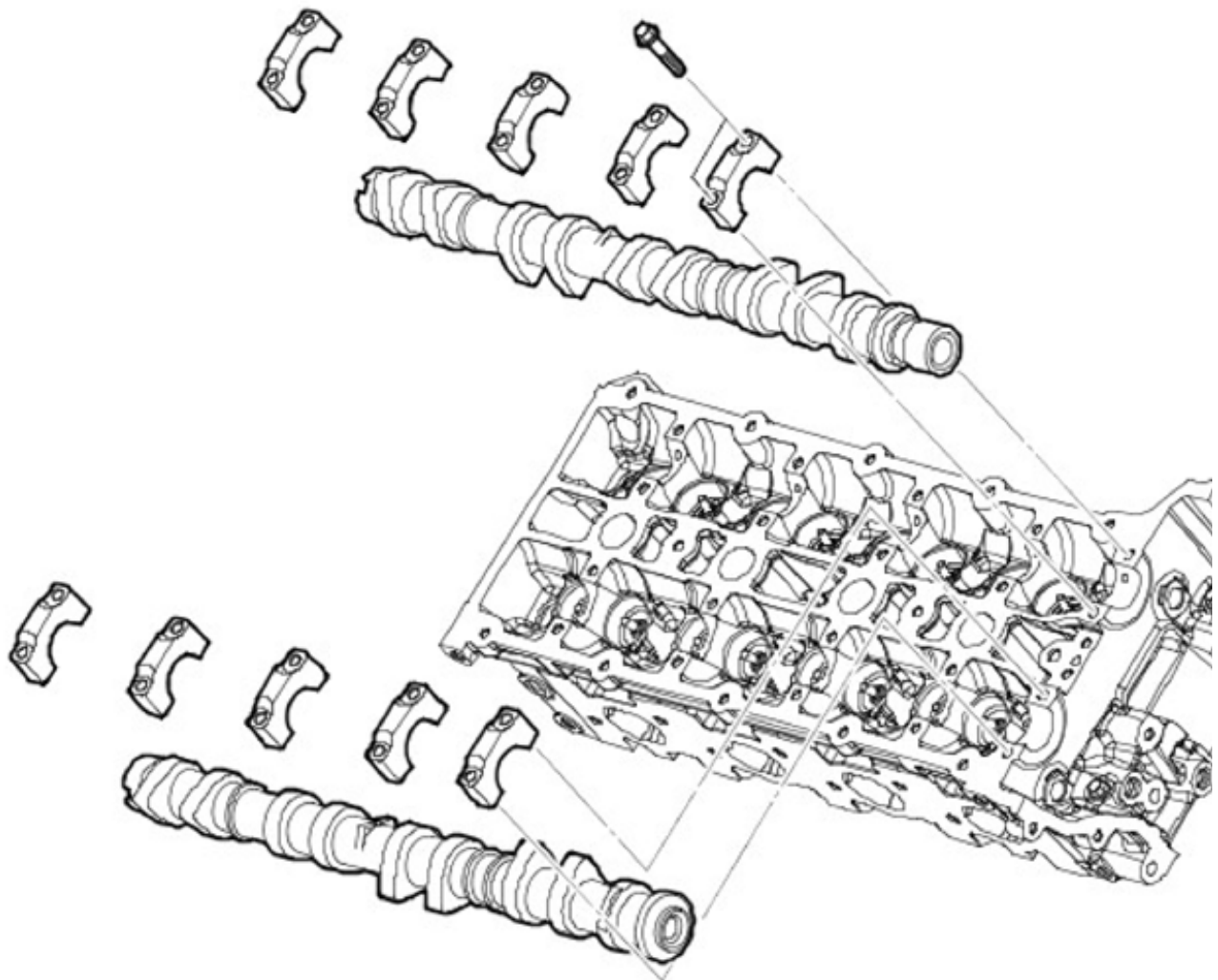
For additional information, refer to: **Electronic Engine Controls** .

Silicon rubber in-groove gaskets seal the joints between the camshaft covers and the cylinder heads. Together with spacers and seals on the camshaft cover fasteners, they also isolate the covers from direct contact with the cylinder heads, to reduce noise.

Cylinder Head Gasket

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

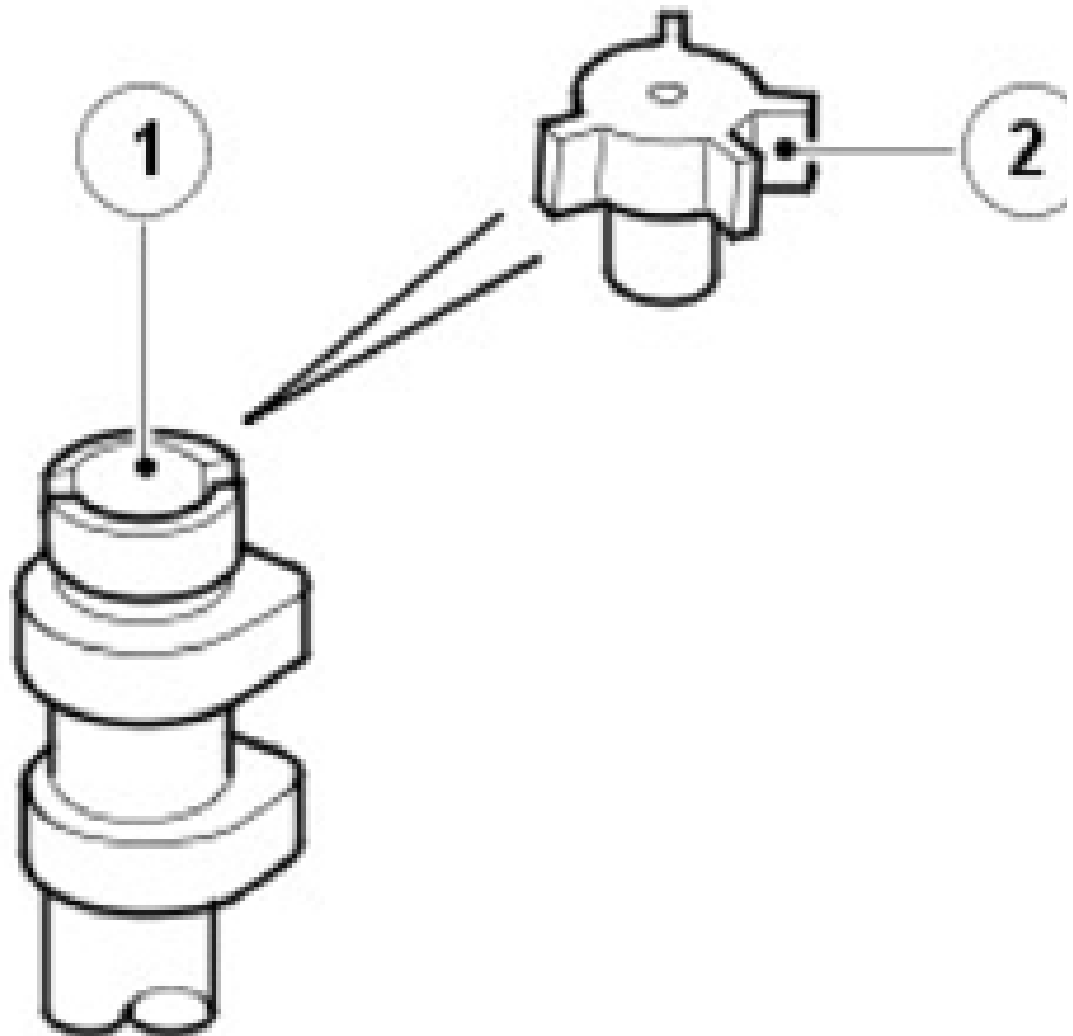
Camshafts



E43446

The camshafts are manufactured in chilled cast iron. Five aluminium alloy caps retain each camshaft. Location numbers, 0 to 4 for the intake camshaft and 5 to 9 for the exhaust camshaft, are marked on the outer faces of the caps.

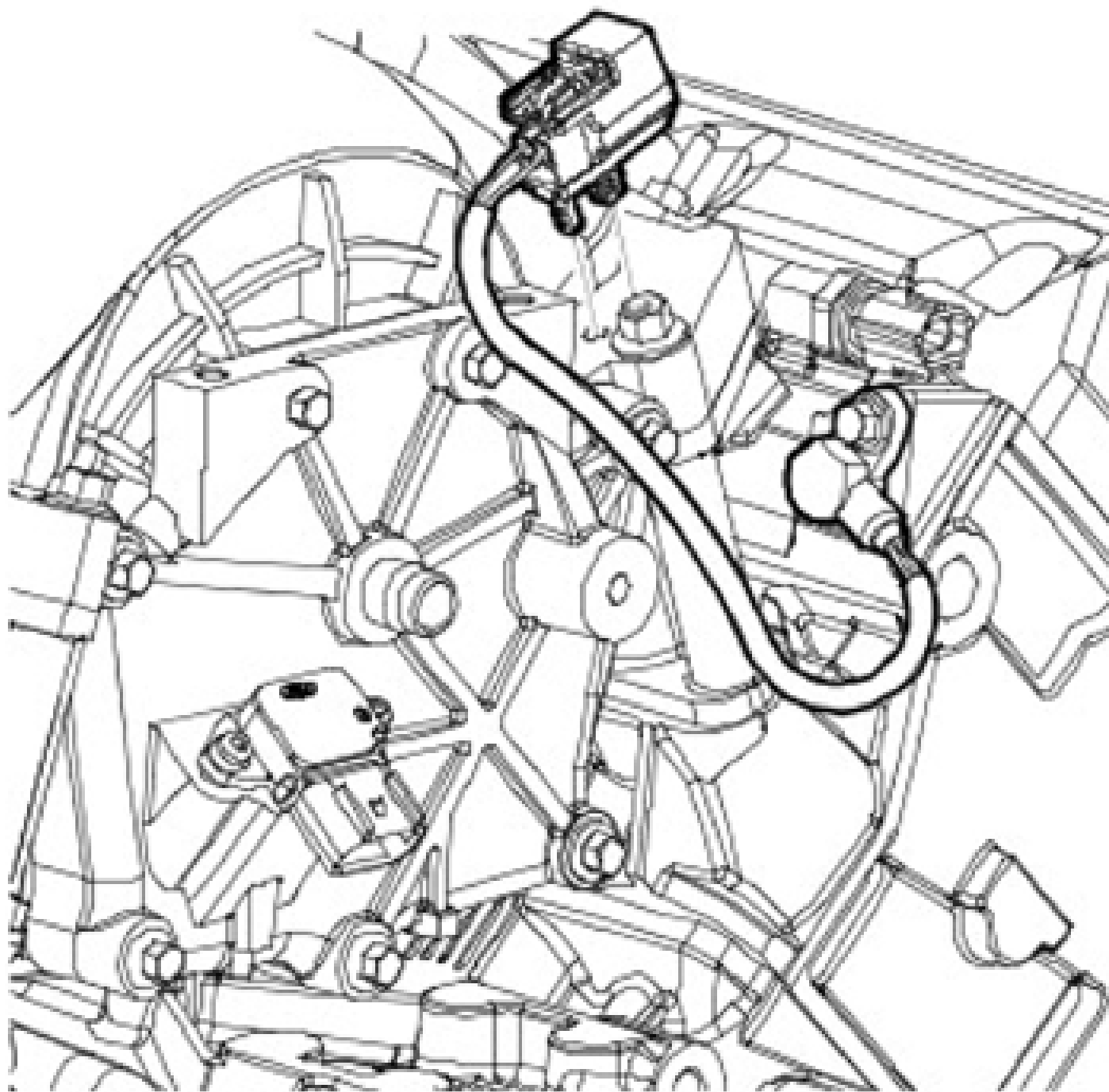
Sensor Ring

**E43447**

Item	Part Number	Description
1	-	Inlet camshaft
2	-	Sensor ring

Timing rings for each camshaft position sensor are located at the rear of both intake camshafts. A flat, machined near the front of each camshaft, enables the camshafts to be locked during the valve timing procedure.

Camshaft Position Sensor



E43448

The camshaft position sensors are installed in each cylinder head at the rear of the intake camshaft. 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** .

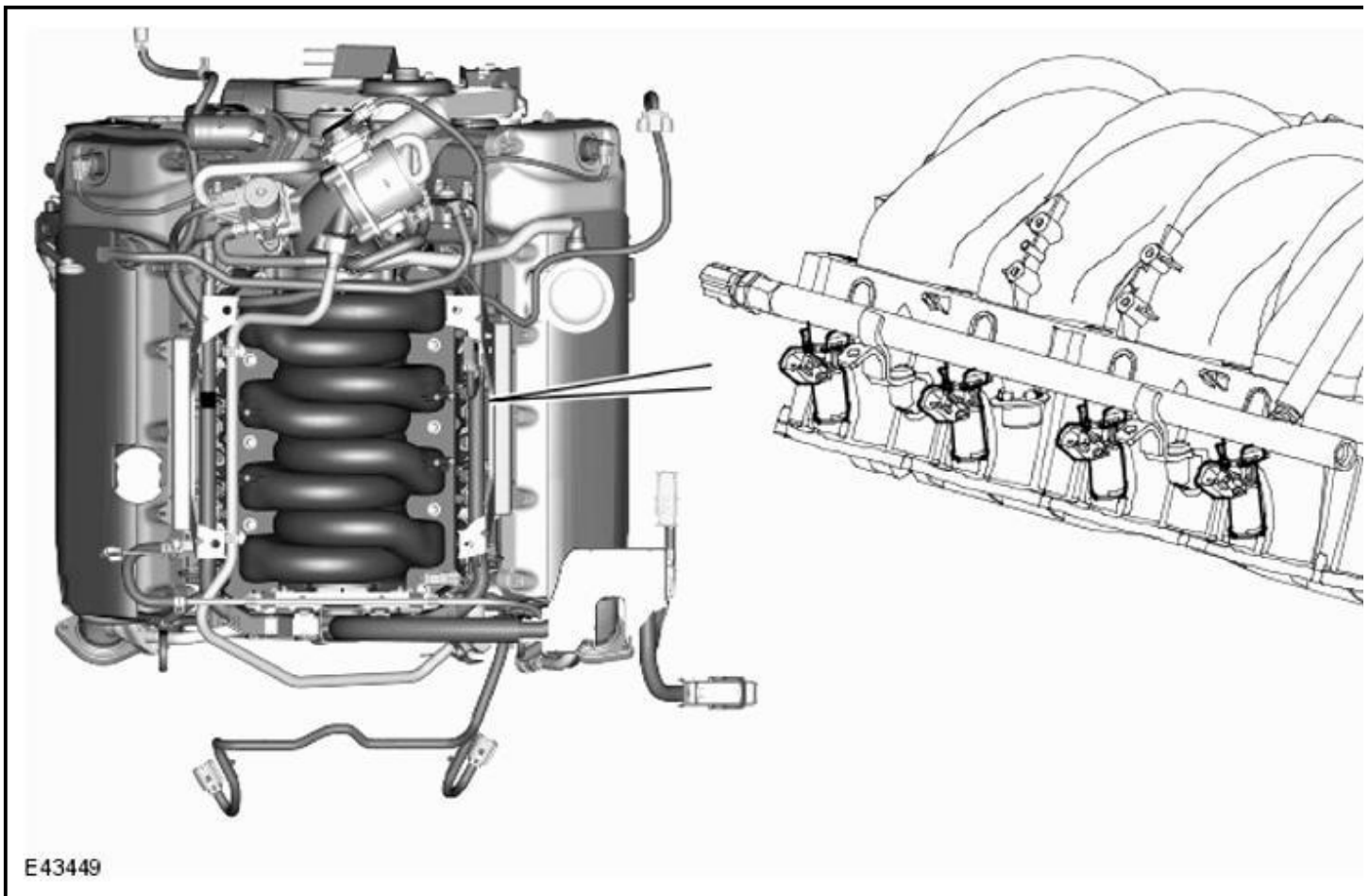
Inlet and Exhaust Valves

Each cylinder head incorporates dual overhead camshafts operating four valves per cylinder via solid shimless aluminium alloy valve lifters.

The lightweight valve gear provides good economy and noise levels. Valve head diameters are 31mm (1.220 in) for the exhaust and 35mm (1.378 in) for the intake. All valves have 5mm (0.197 in) diameter stems supported in sintered metal seats and guide inserts. Collets, valve collars and spring seats locate single valve springs on both intake and exhaust valves. Valve stem seals are integrated into the spring seats.

CAUTION: Due to slight variations in length, the valves are not interchangeable between marques (Land Rover, Jaguar and Aston Martin).

Fuel Injectors



Eight, top fed, 12-jet, fuel injectors are installed in the fuel rails. The injectors are electromagnetic solenoid valves controlled by the ECM. Two O-rings seal each injector to manifold interface. The fuel jets from the injectors are directed onto the back of the intake valves.

For additional information, refer to: **Electronic Engine Controls** .

VARIABLE VALVE TIMING (VVT)

The continuously VVT unit turns the intake camshaft in relation to the primary chain to advance and retard the timing.

The system improves low and high-speed engine performance, engine idle quality and exhaust emission.

The VVT system changes the phasing of the intake valves, relative to the fixed timing of the exhaust valves, to alter:

- The mass of air flow into the engine's cylinders and the engine's torque response and emissions.

The VVT unit uses a vane device to control the camshaft angle (refer to VVT operation). The system operates over a range of 48° and is advanced or retarded to the optimum angle within this range.

The ECM controls the VVT, using engine speed and load, and engine oil temperature signals to calculate the appropriate camshaft position.

For additional information, refer to: **Electronic Engine Controls** .

The continuous VVT system provides the following advantages:

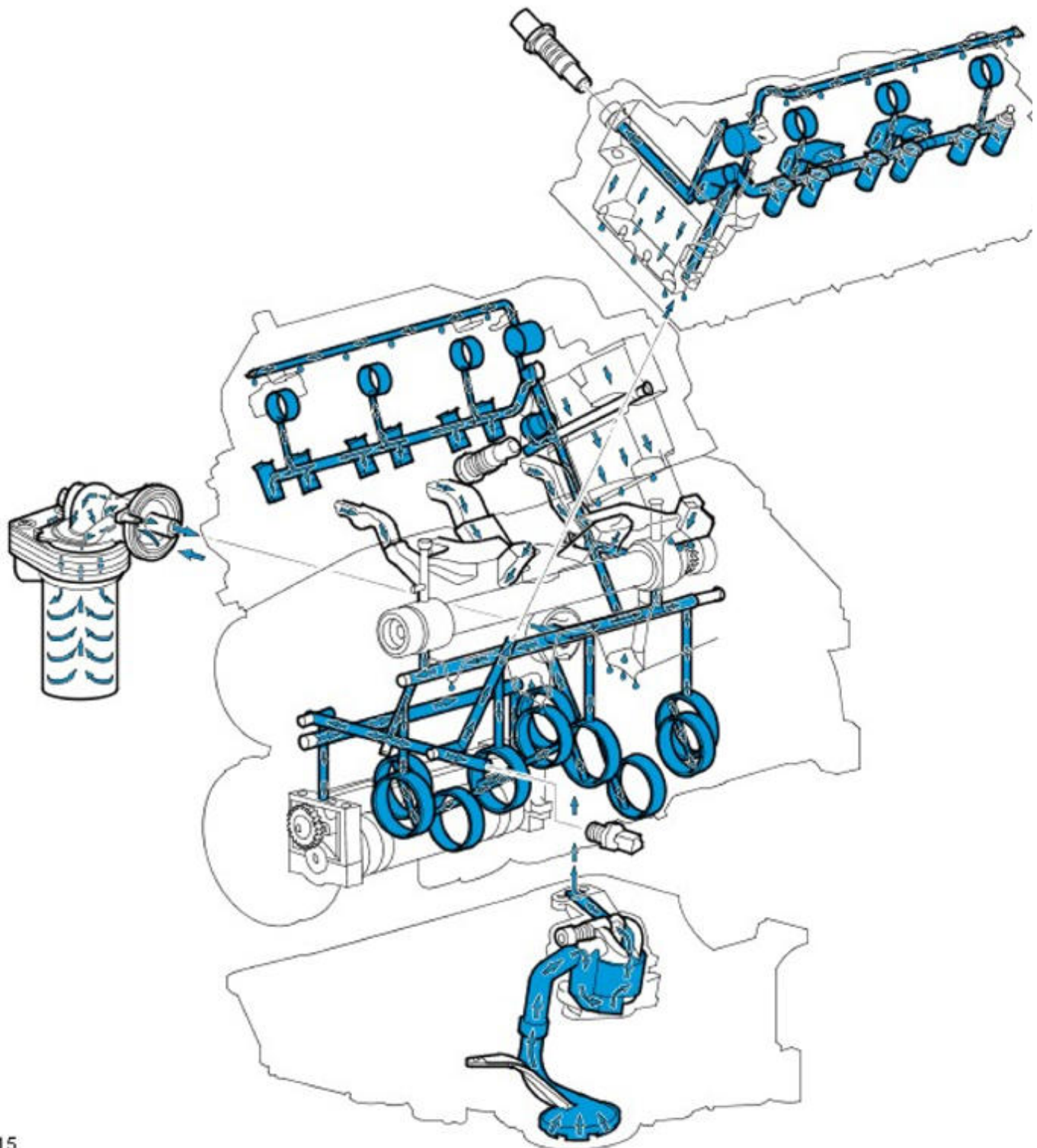
- Reduces engine emissions and fuel consumption by further optimising the camshaft timing, this improves the engine's internal exhaust gas re-circulation (EGR) effect over a wider operating range
- Improves full-load torque characteristics as the camshaft timing is optimised at all engine speeds for superior volumetric efficiency
- Improves fuel economy by optimising torque over the engine's speed range.

This system also has the added benefits of operating at a lower oil-pressure and faster response time when compared to a non-VVT system.

Variable Valve Timing Operation

2007 Land Rover LR3 HSE

ENGINE Engine - V8 4.4L Petrol



E50515

Item	Part Number	Description
A	-	Retarded

2007 Land Rover LR3 HSE

ENGINE Engine - V8 4.4L Petrol

B	-	Advanced
1	-	Engine oil pressure

The VVT unit is a hydraulic actuator mounted on the end of the intake camshaft, which advances or retards the intake camshaft timing and thereby alters the camshaft to crankshaft phasing. The oil control solenoid, controlled by the ECM, routes oil pressure to either the advance or retard chambers located either side of the three vanes interspersed within the machined housing of the unit.

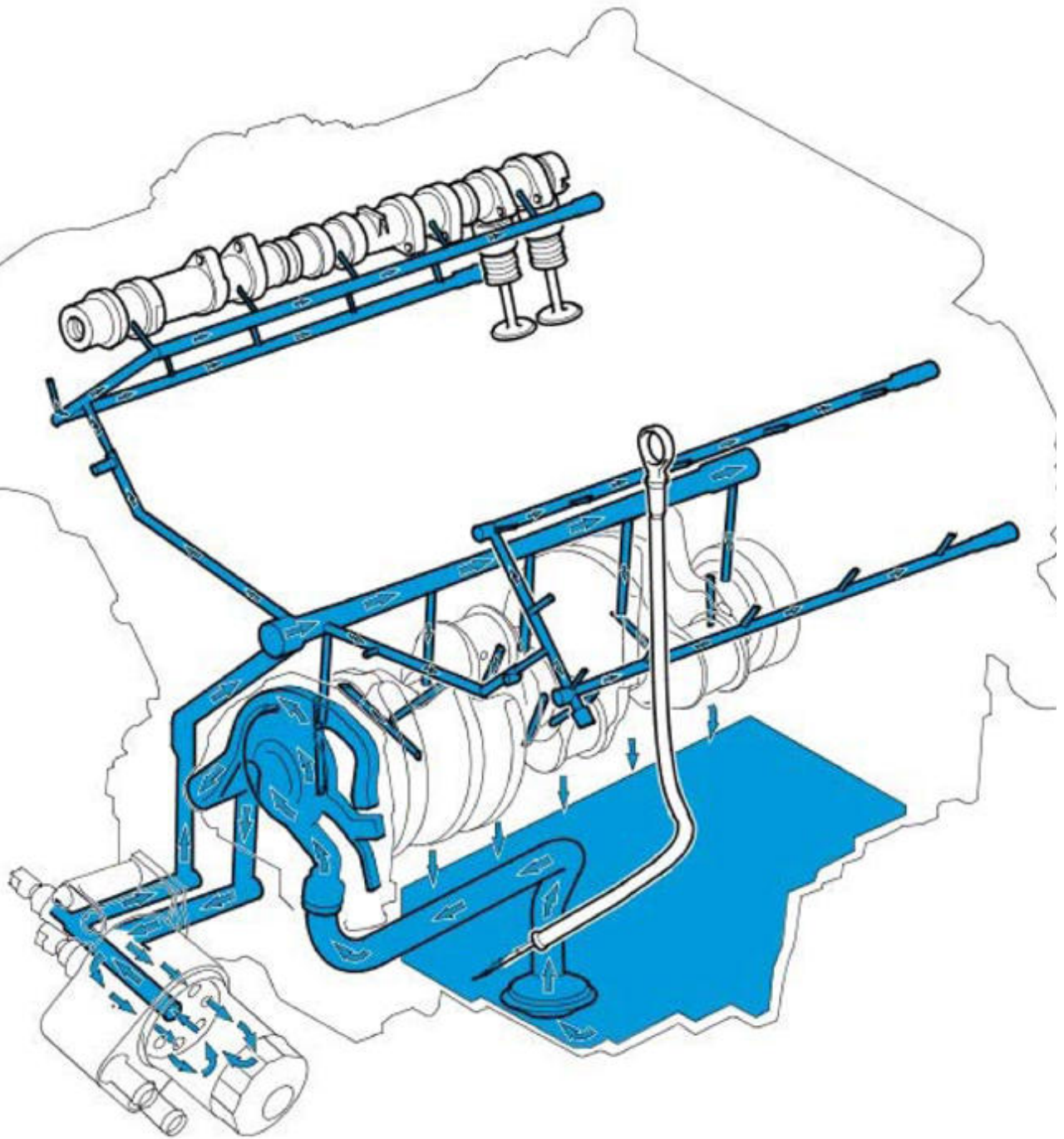
The VVT unit is driven by the primary chain and rotates relative to the exhaust camshaft sprocket. When the ECM requests the camshaft timing to advance, the oil control solenoid is energized moving the shuttle valve to the relevant position to allow engine oil pressure, via a filter, into the VVT unit's advance chambers. When the camshaft timing is requested to retard, the shuttle valve moves position to allow oil pressure to exit the advance chambers, while simultaneously routing the oil pressure into the retard chambers.

When directed by the ECM, the VVT unit will be set to the optimum position between full advance and retard for a particular engine speed and load. This is achieved when the ECM sends the energising signal to the oil control solenoid until the target position is met. At this point, the energizing signal is reduced to hold the solenoid position, and as a result the position of the shuttle valve. This function is under closed-loop control, where the ECM will assess any decrease in shuttle-valve oil-pressure, via signals from the camshaft position sensor. The ECM will increase the energizing signal, when required, to maintain the shuttle-valve hold position.

Engine oil properties and temperature can affect the ability of the VVT mechanism to follow demand changes to the cam phase angle. At very low oil-temperatures, movement of the VVT mechanism is sluggish due to increased viscosity, and at high oil-temperatures the reduced viscosity may impair operation if the oil pressure is too low. To maintain satisfactory VVT performance, an increased capacity oil pump is installed, plus an engine oil temperature sensor to enable monitoring by the ECM. The VVT system is normally under closed-loop control except in extreme temperature conditions, such as cold starts below 0°C. At extremely high oil-temperatures, the ECM may limit the amount of VVT advance to prevent the engine from stalling when returning to idle speed.

The VVT does not operate when engine oil-pressure is below 1.25 bar, as there is insufficient pressure to release the VVT unit's internal stopper pin. This usually occurs when the engine is shutting-down and the VVT has returned to the retarded position. The stopper pin locks the camshaft to the VVT unit to ensure camshaft stability during the next engine start-up.

LUBRICATION SYSTEM



E43454

General

Oil is drawn from the reservoir in the oil pan and pressurised by the oil pump. The output from the oil pump is then filtered, cooled and distributed through internal oil passages.

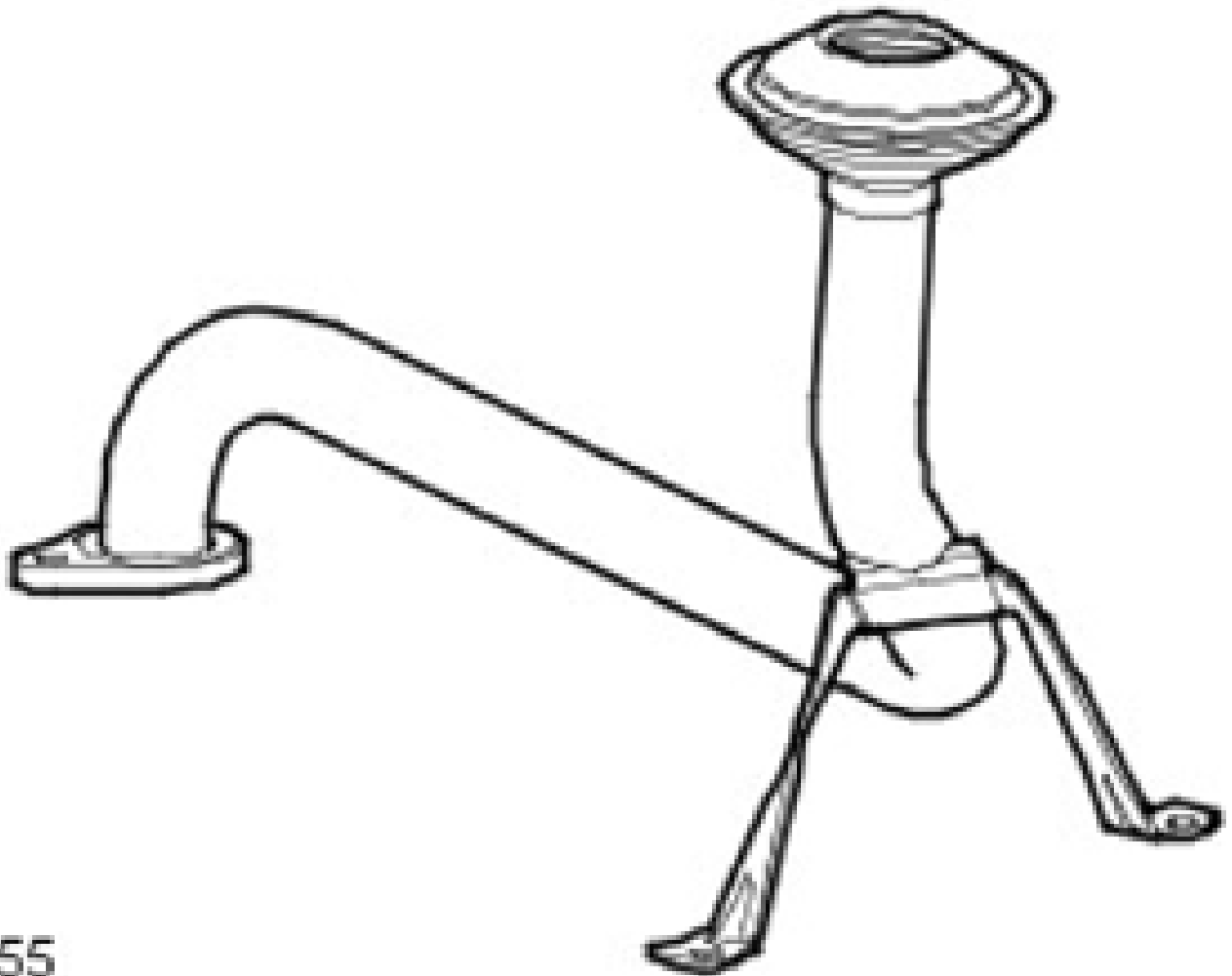
All moving parts are lubricated by pressure or splash oil. Pressurised oil is also provided for operation of the variable valve timing units and the timing gear chain tensioners.

The oil returns to the oil pan under gravity. Large drain holes through the cylinder heads and cylinder block ensure the quick return of the oil, reducing the volume of oil required and enabling an accurate check of the contents soon after the engine stops.

System replenishment is through the oil filler cap on the bank 'B' camshaft cover.

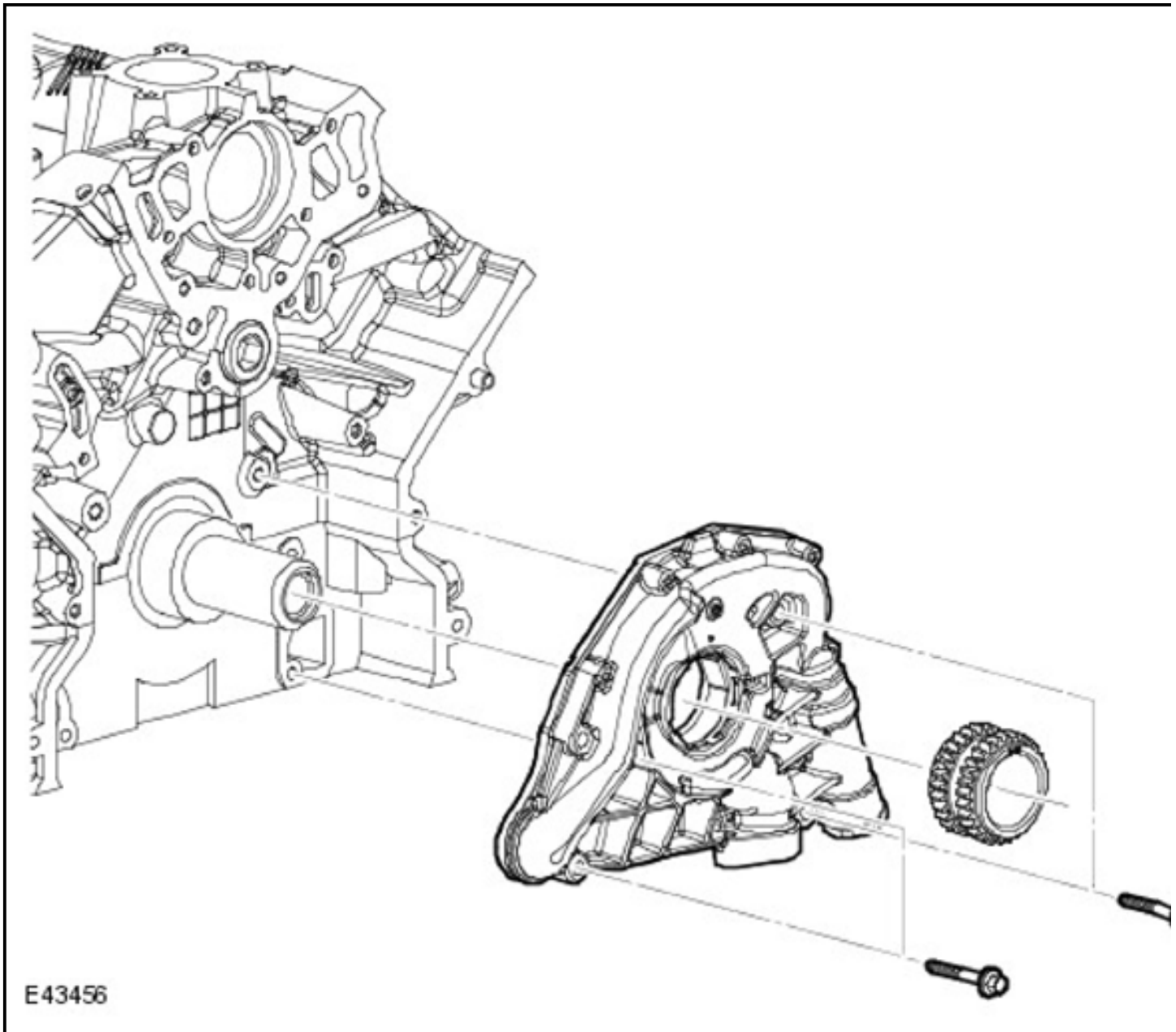
With the exception of the pump, all oil system components are installed on the structural sump.

Oil Pick-up



The fabricated steel oil pick-up is immersed in the oil reservoir to provide a supply to the oil pump during all normal vehicle attitudes. A mesh screen in the inlet prevents debris from entering the oil system.

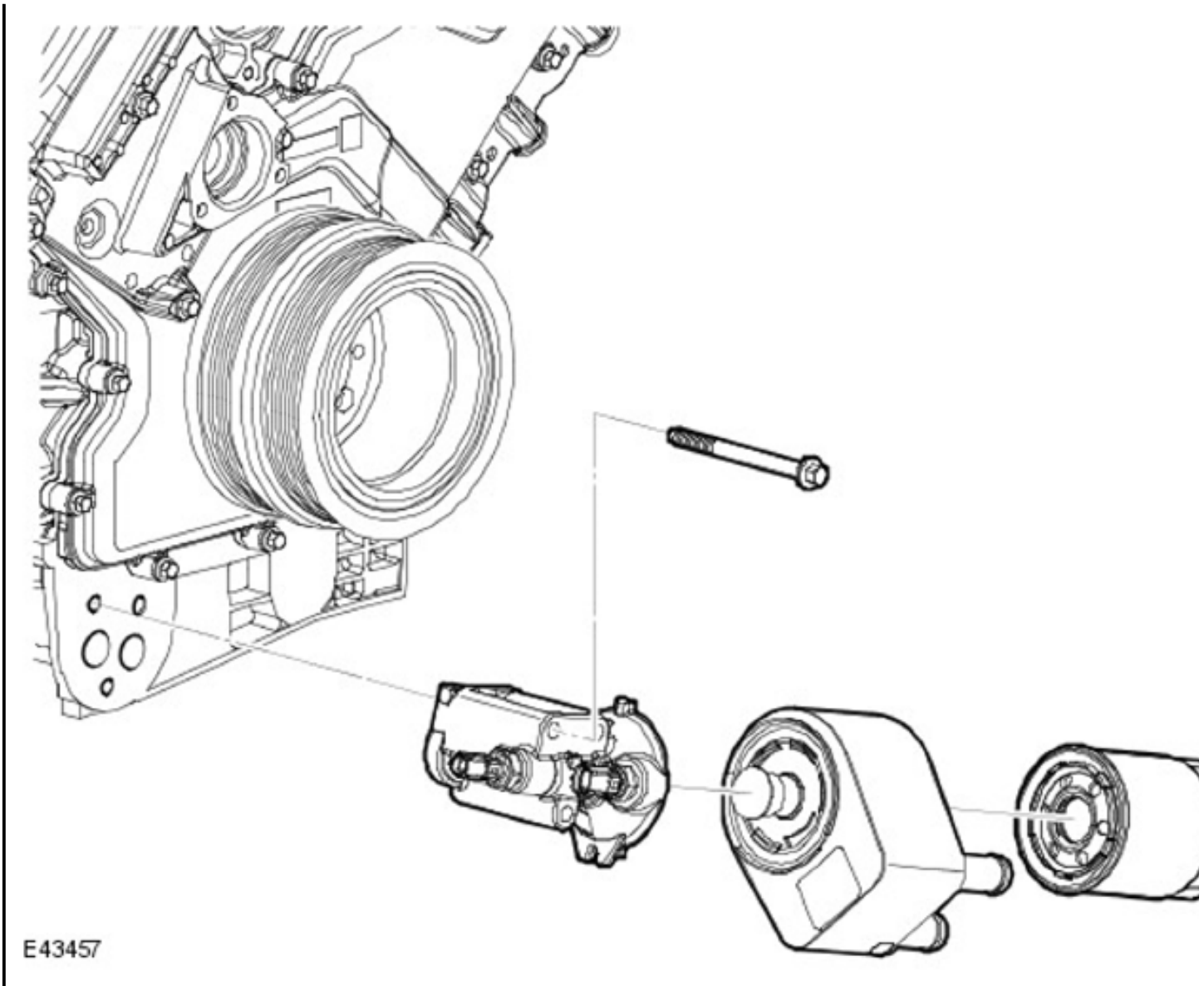
Oil Pump



The oil pump is installed on the crankshaft at the front of the engine. The pump inlet and outlet ports align with oil passages in the bedplate.

The pumping element is an eccentric rotor, which is directly driven by flats on the crankshaft. An integral pressure relief valve regulates pump outlet pressure at 4.5 bar (65.25 psi).

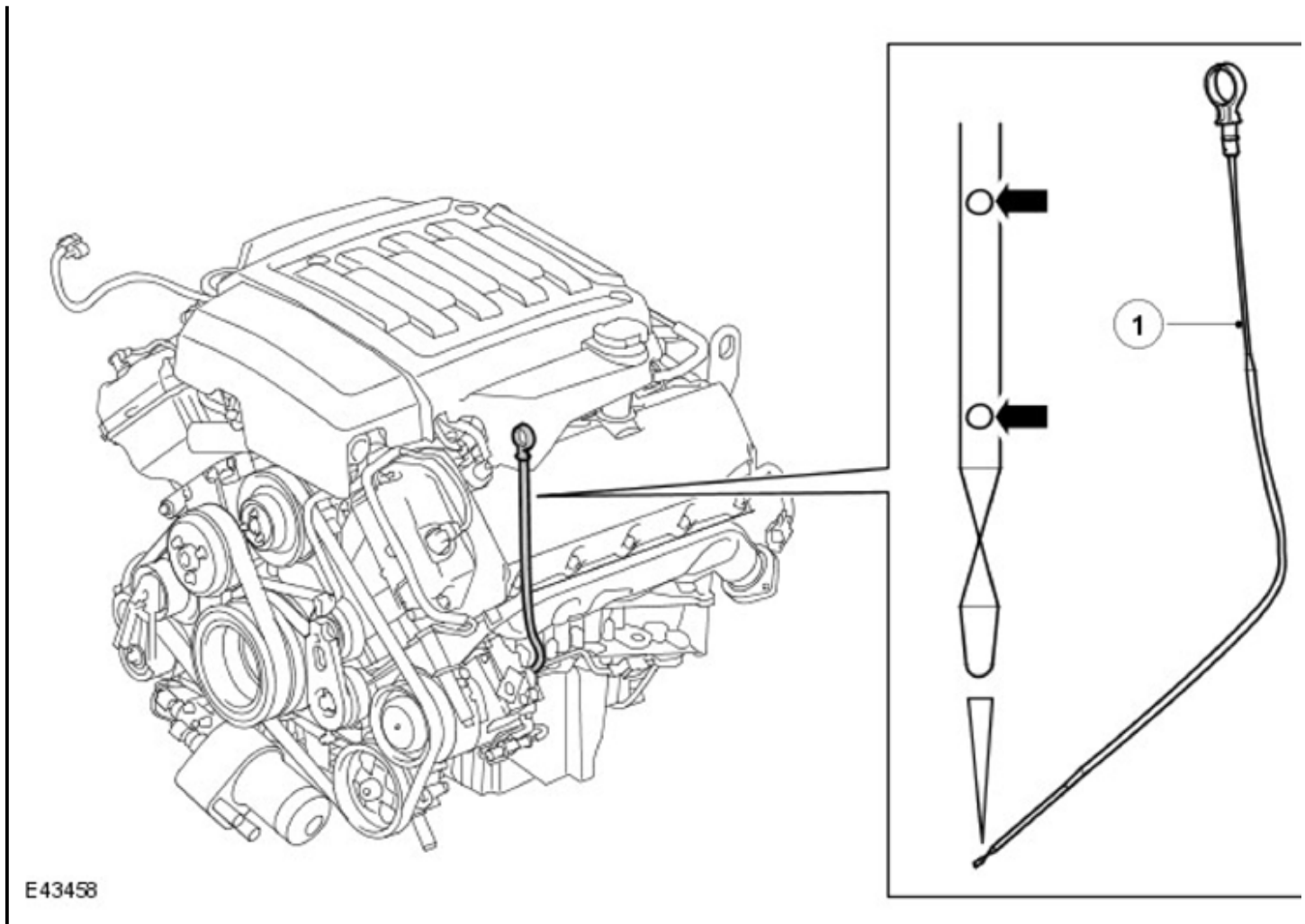
Oil Filter and Oil Pressure Switch



The oil filter is a replaceable cartridge installed on an adapter. An internal bypass facility permits full flow bypass if the filter is blocked.

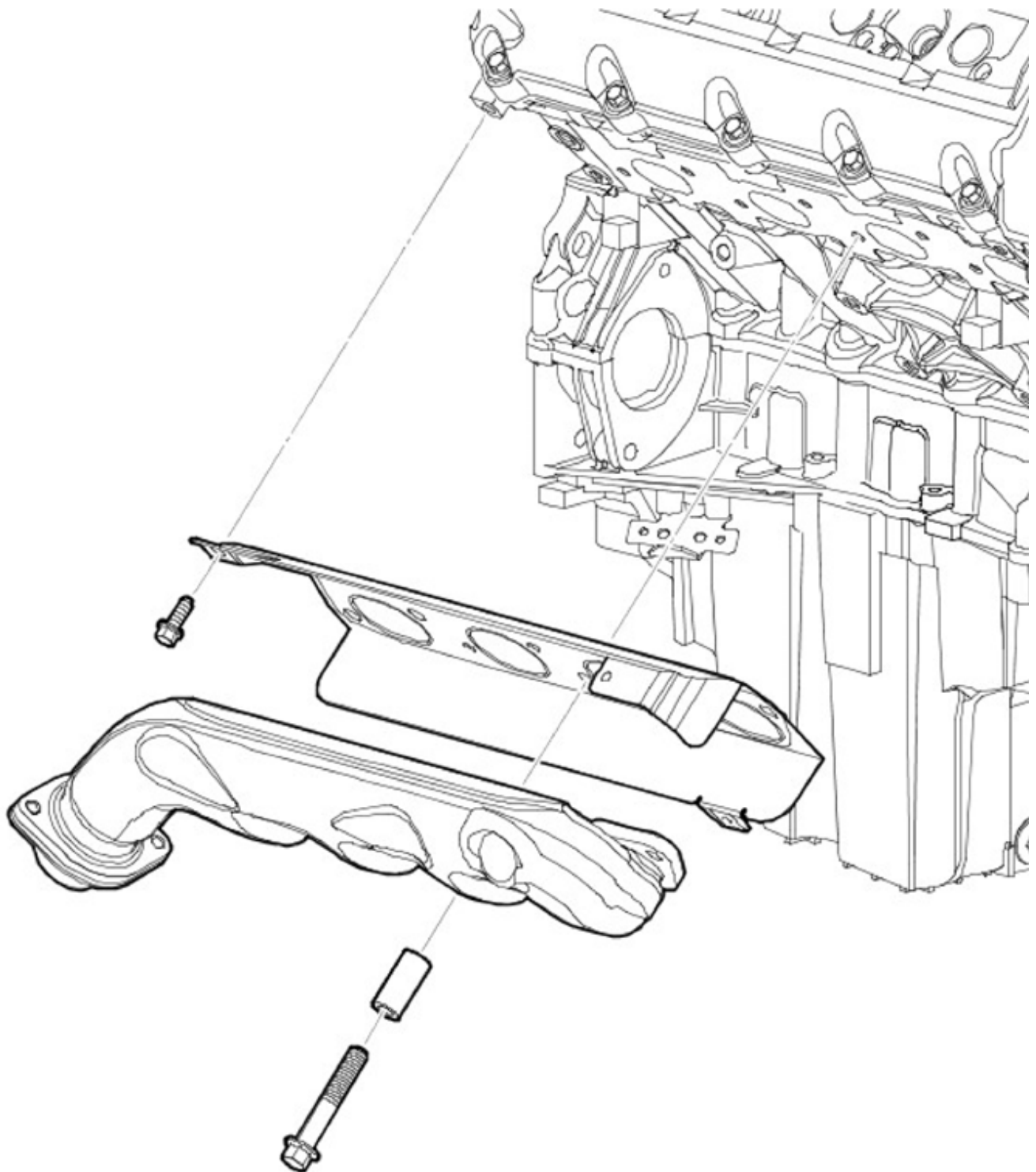
The oil pressure switch connects a ground input to the instrument cluster when oil pressure is present. The switch operates at a pressure of 0.15 to 0.41 bar (2.2 to 5.9 psi).

Oil Level Gauge



The oil level gauge locates along the left side of the oil pan, 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



E43459

The fabricated stainless steel twin skin exhaust manifolds are unique for each cylinder bank. The bank B manifold has a connection for the EGR transfer pipe.

Spacers on the securing bolts allow the manifolds to expand and retract with changes of temperature while

maintaining the clamping loads.

Heat shields are integrated into the exhaust manifold gaskets.

GENERAL PROCEDURES

VALVE CLEARANCE CHECK

1. Disconnect the battery ground cable.

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

2. Remove the cooling fan.

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

3. Remove the LH valve cover.

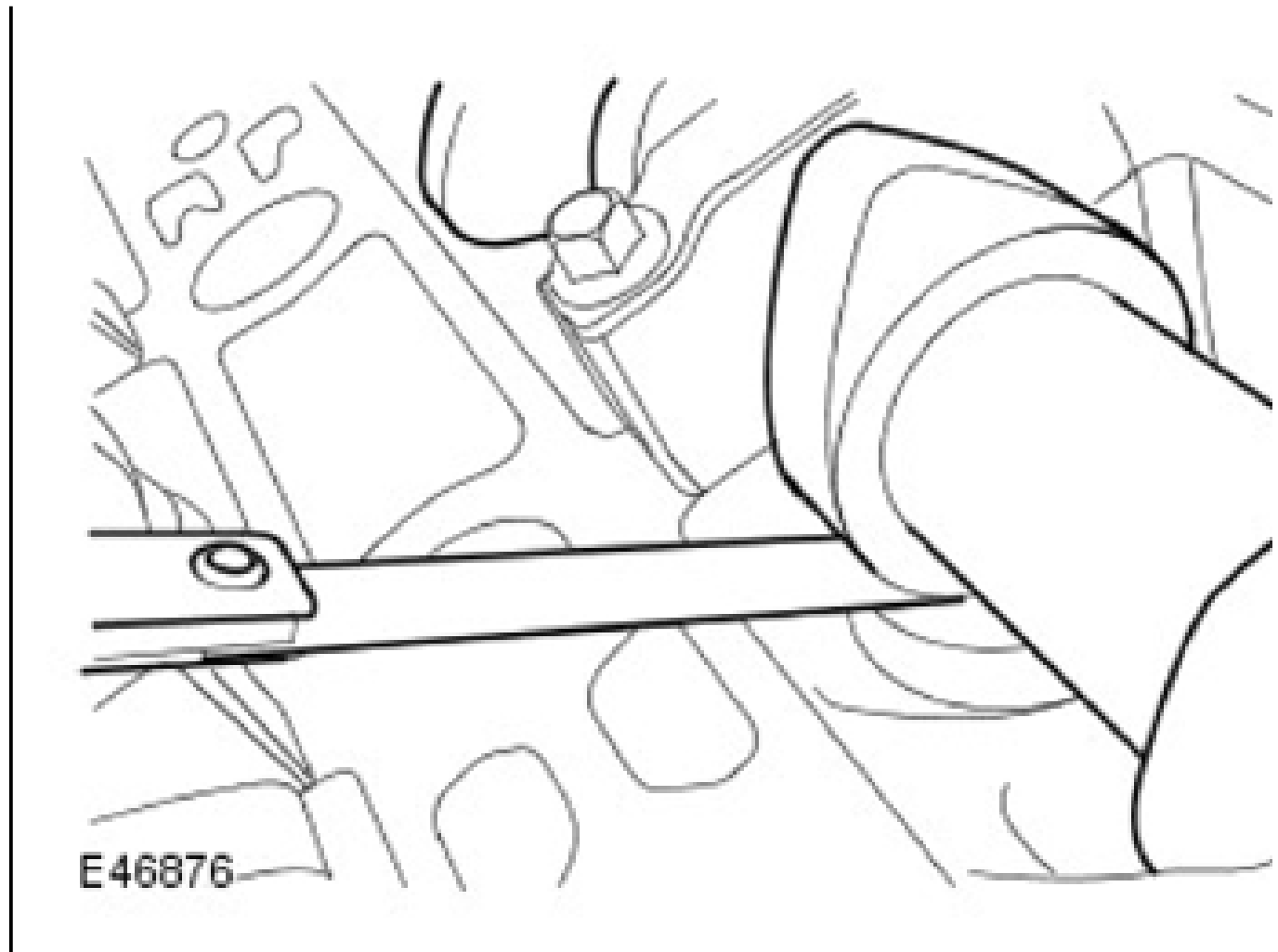
For additional information, refer to: **VALVE COVER LH** .

4. Remove the RH valve cover.

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

CAUTION: Camshaft lobes must be 180 degrees away from each valve tappet or valve clearance will be incorrect.

5. Rotate the engine clockwise to position the camshaft lobe away from the valve tappet
6. Using the feeler gauge set, measure the clearance between the camshaft and the valve tappet.



7. Repeat the above procedure for the remaining 31 tappets.
8. Adjust the clearance as necessary.
9. For cylinder head data, refer to **SPECIFICATIONS**.
10. Install the RH valve cover.

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

11. Install the LH valve cover.

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

12. Install the cooling fan.

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

13. Connect the battery ground cable.

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

VALVE CLEARANCE ADJUSTMENT

NOTE: **The valve clearances adjustment procedure is part of the the camshafts removal and installation procedure.**

1. Remove the camshafts.

For additional information, refer to: **CAMSHAFTS RH** .

2. Install the camshafts.

For additional information, refer to: **CAMSHAFTS RH** .

ENGINE OIL DRAINING AND FILLING

1. Disconnect the battery ground cable.

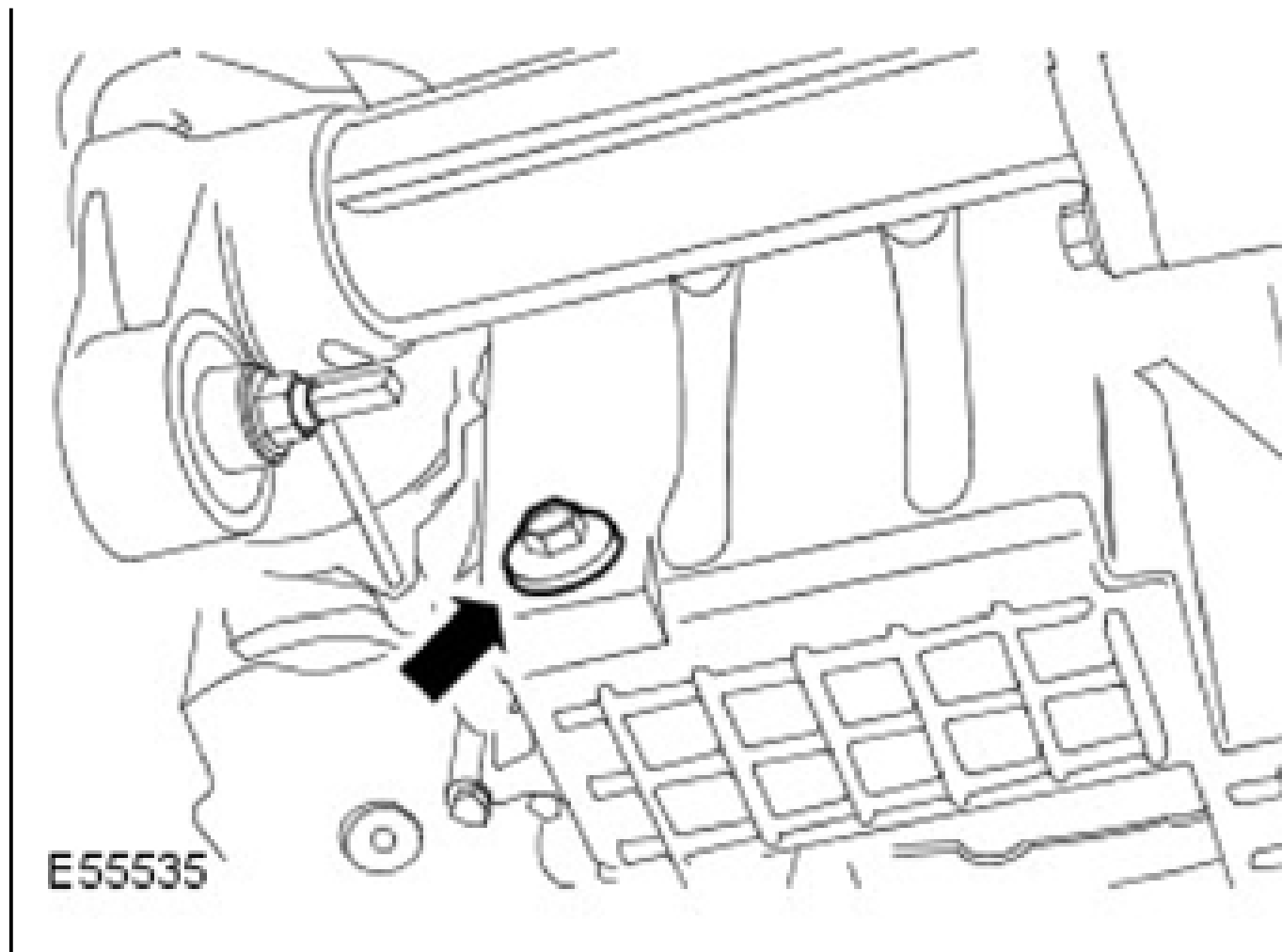
For additional information, refer to: **SPECIFICATION** .

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

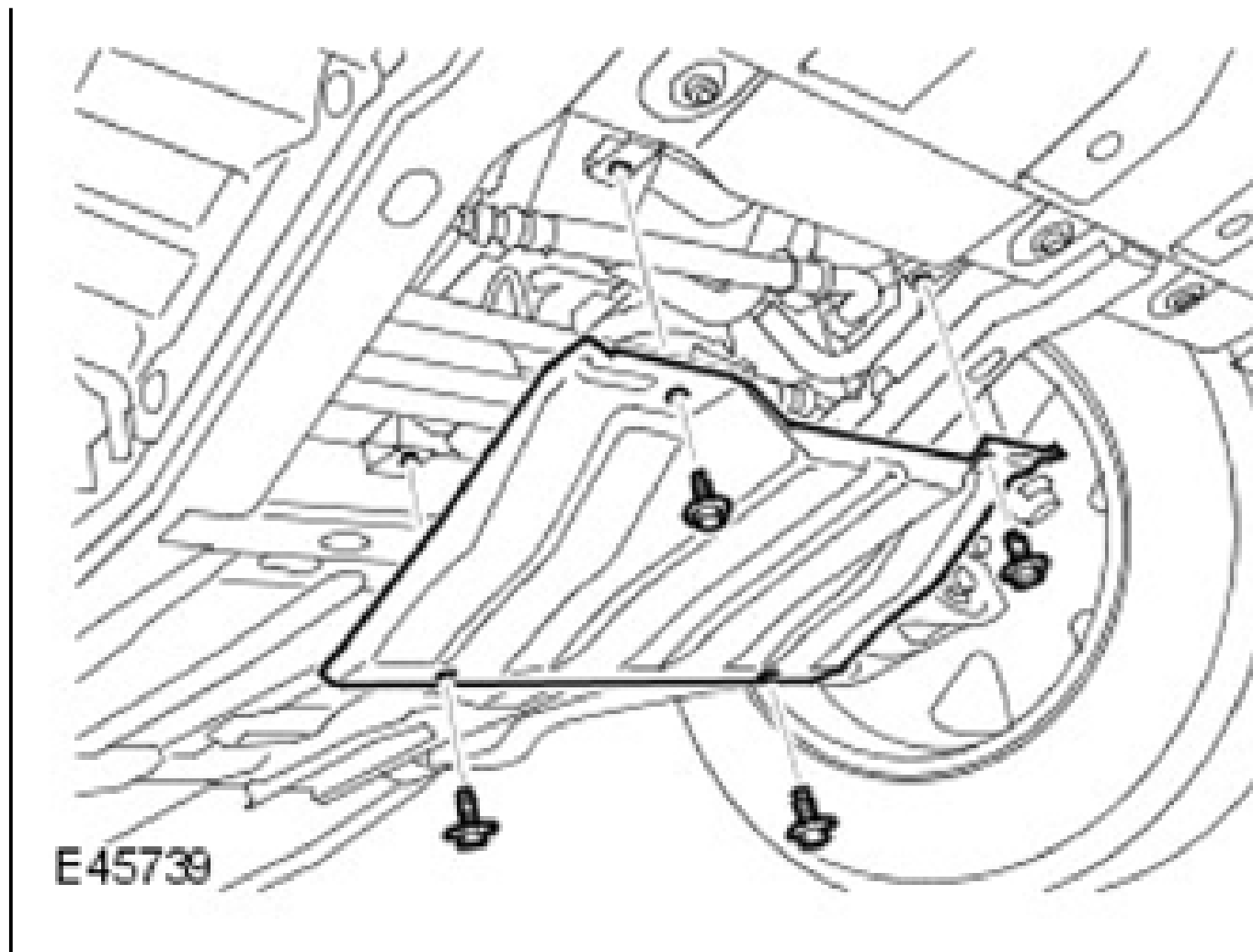
2. Raise and support the vehicle.
3. Remove the engine undershield.

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

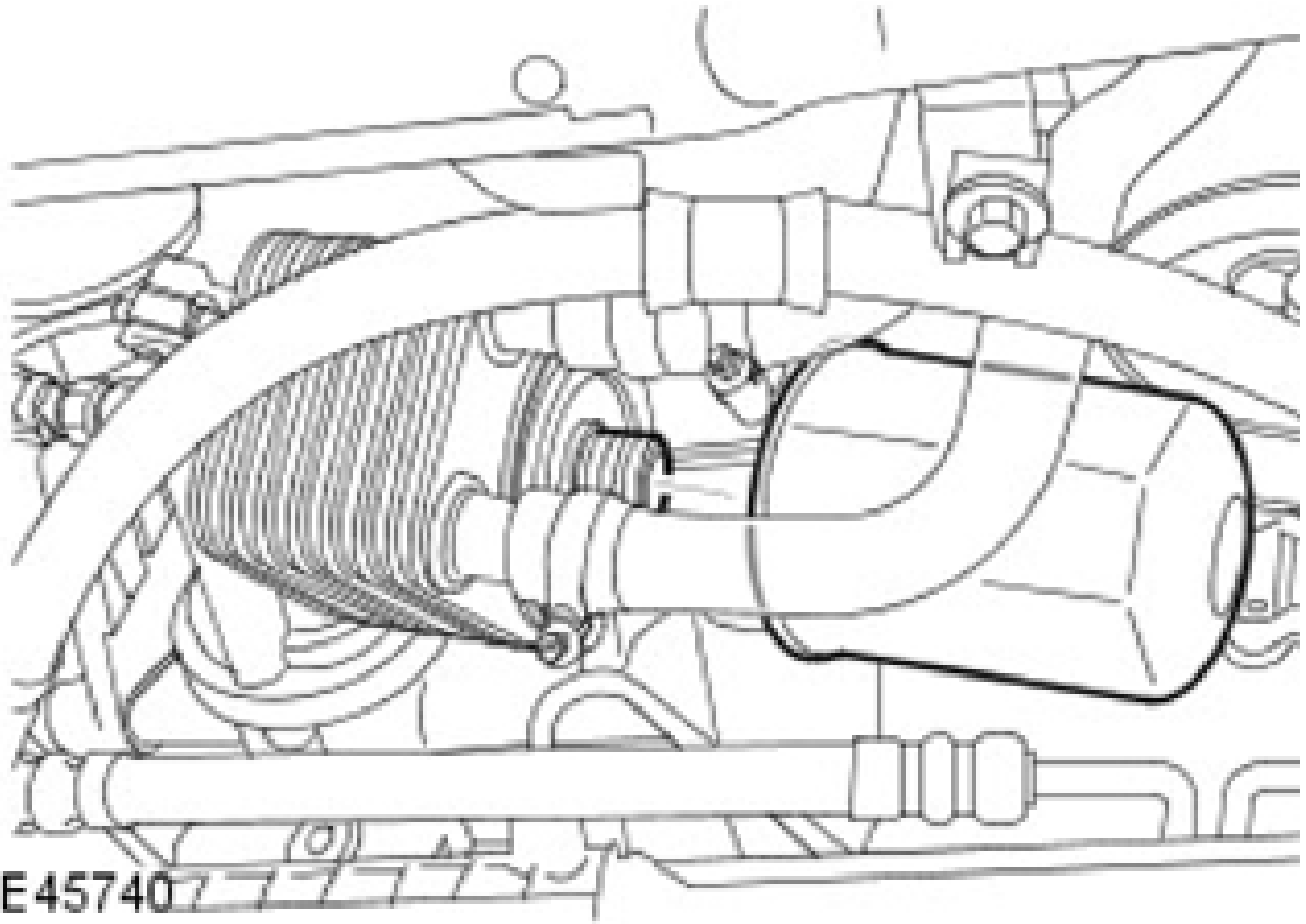
4. Remove the oil pan drain plug.
 - Position a container to collect the fluid.
 - Discard the oil drain plug seal.



5. Remove the radiator access panel.
 - Remove the 4 bolts.



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



7. Install the engine oil filter.
 - Lubricate the oil filter seal with clean engine oil and tighten to 18 Nm (13 lb.ft).
 - Install a new seal.
 - Tighten the drain plug to 25 Nm (18 lb.ft).
8. Tighten the drain plug to 25 Nm (18 lb.ft).
 - Install a new seal.
9. Install the engine undershield.

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

10. Fill the engine with oil.
11. Check and top-up the engine oil.
12. Connect the battery ground cable.

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

IN-VEHICLE REPAIR

CAMSHAFTS RH

SPECIAL TOOL(S)

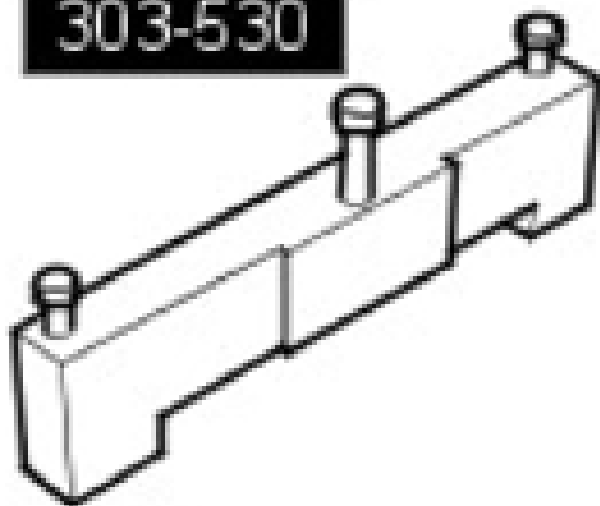
303-645



E46881

Timing Setting tool
303-645

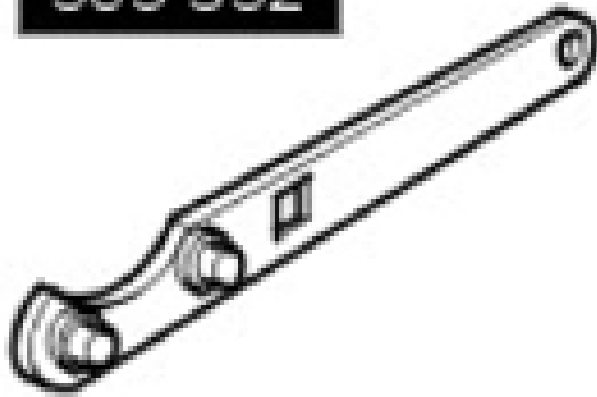
303-530



E46879

Camshaft setting/locking tool
303-530

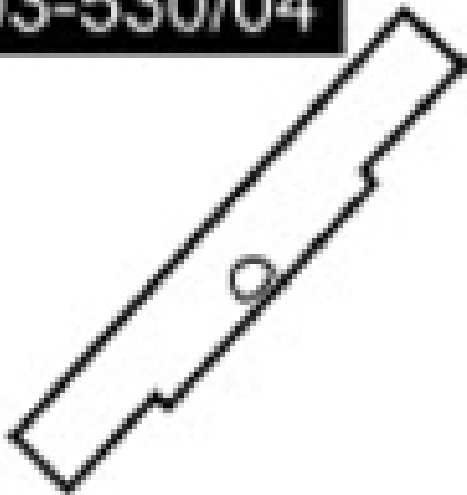
303-532



E46880

Timing chain tensioning tool
303-532

303-530/04



E115082

Timing shim tool
303-530/04

REMOVAL

1. Disconnect the battery ground cable.

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

2. Remove the battery tray.

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

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. Remove the engine front cover.

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

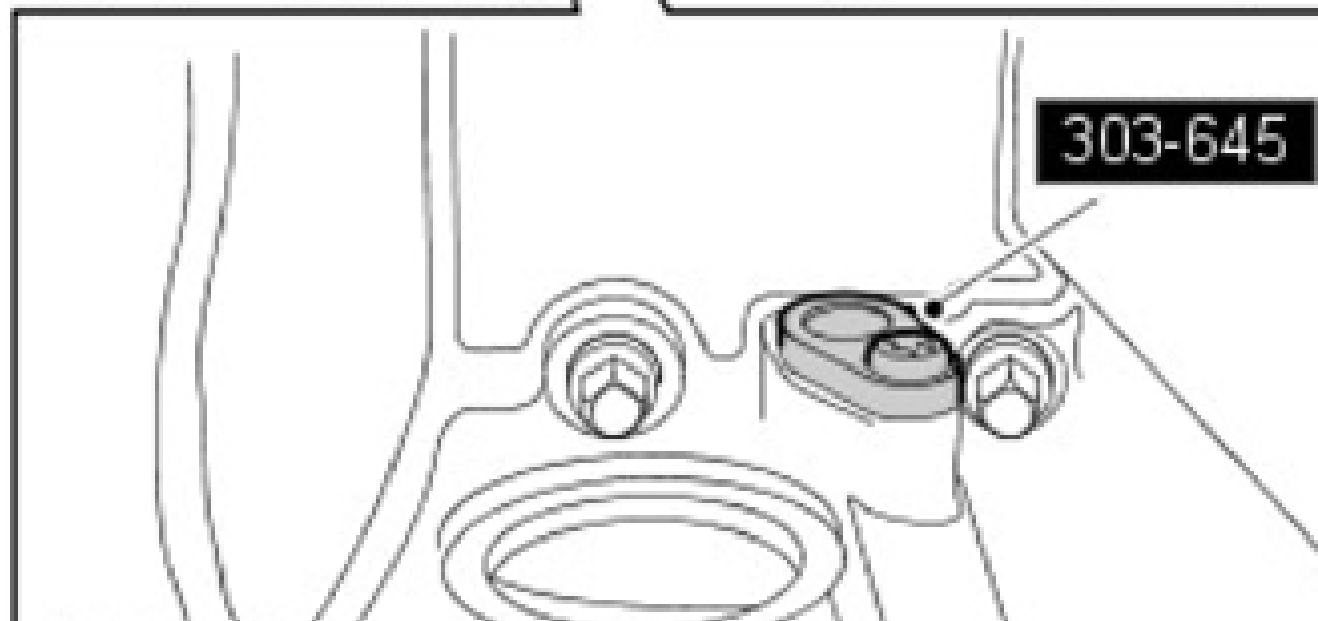
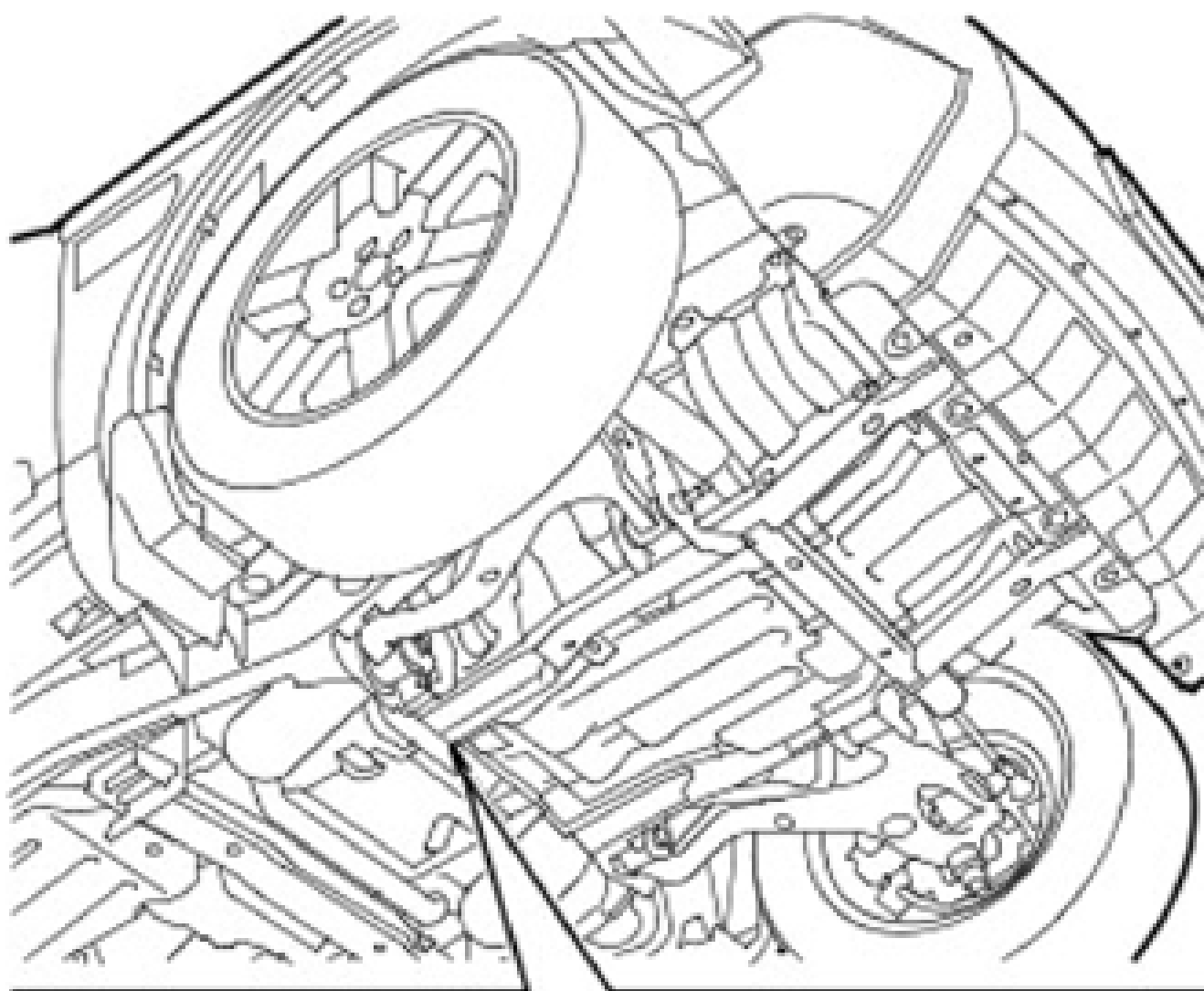
5. Remove the crankshaft position (CKP) sensor.

For additional information, refer to: **CRANKSHAFT POSITION (CKP) SENSOR** .

6. Rotate the crankshaft until the flats on the camshafts are parallel with the cylinder head joint faces.

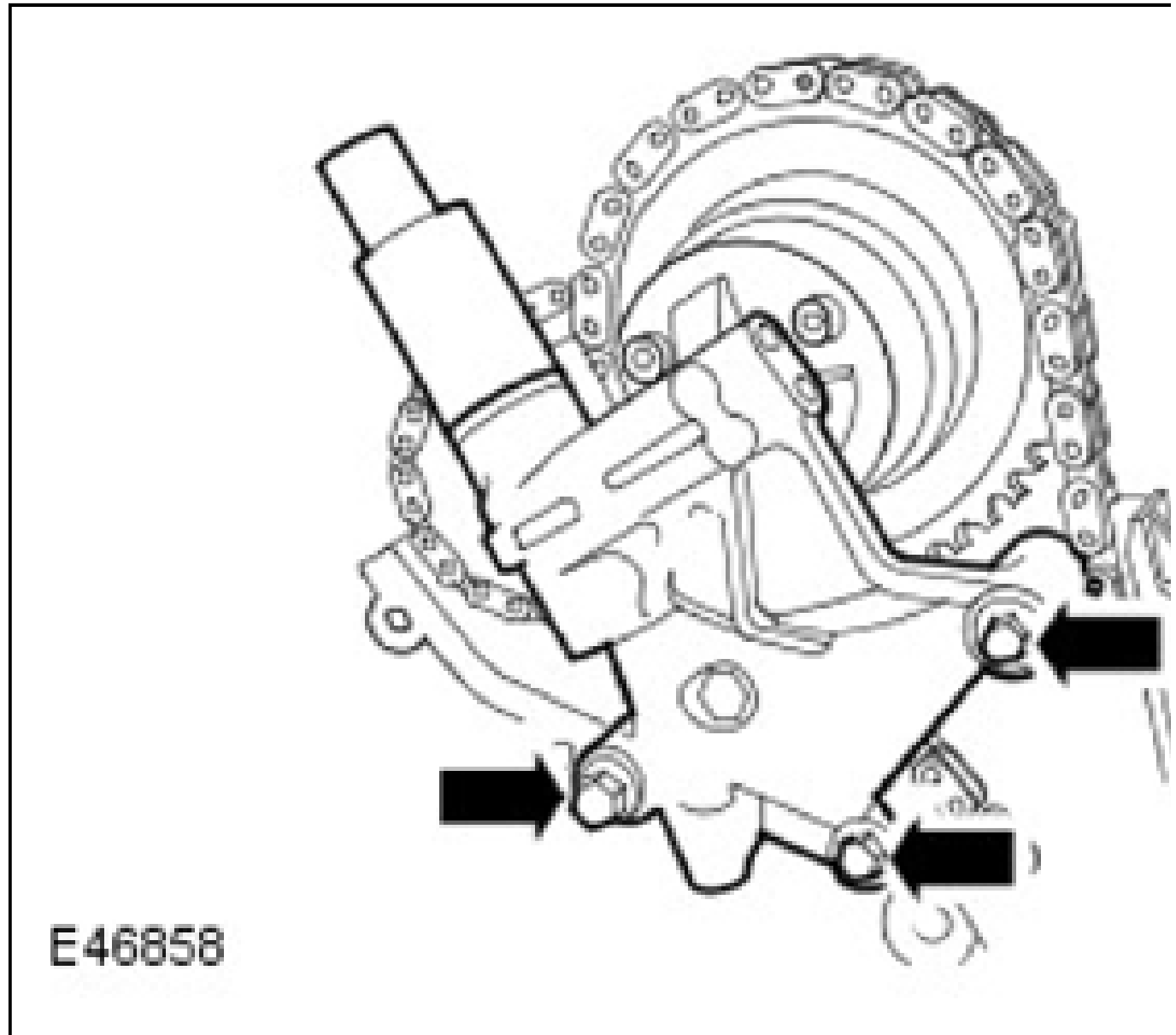
NOTE: **The engine is now in the SAFE position.**

7. Lock the crankshaft.
 - Install the special tool.
 - Install the screw.



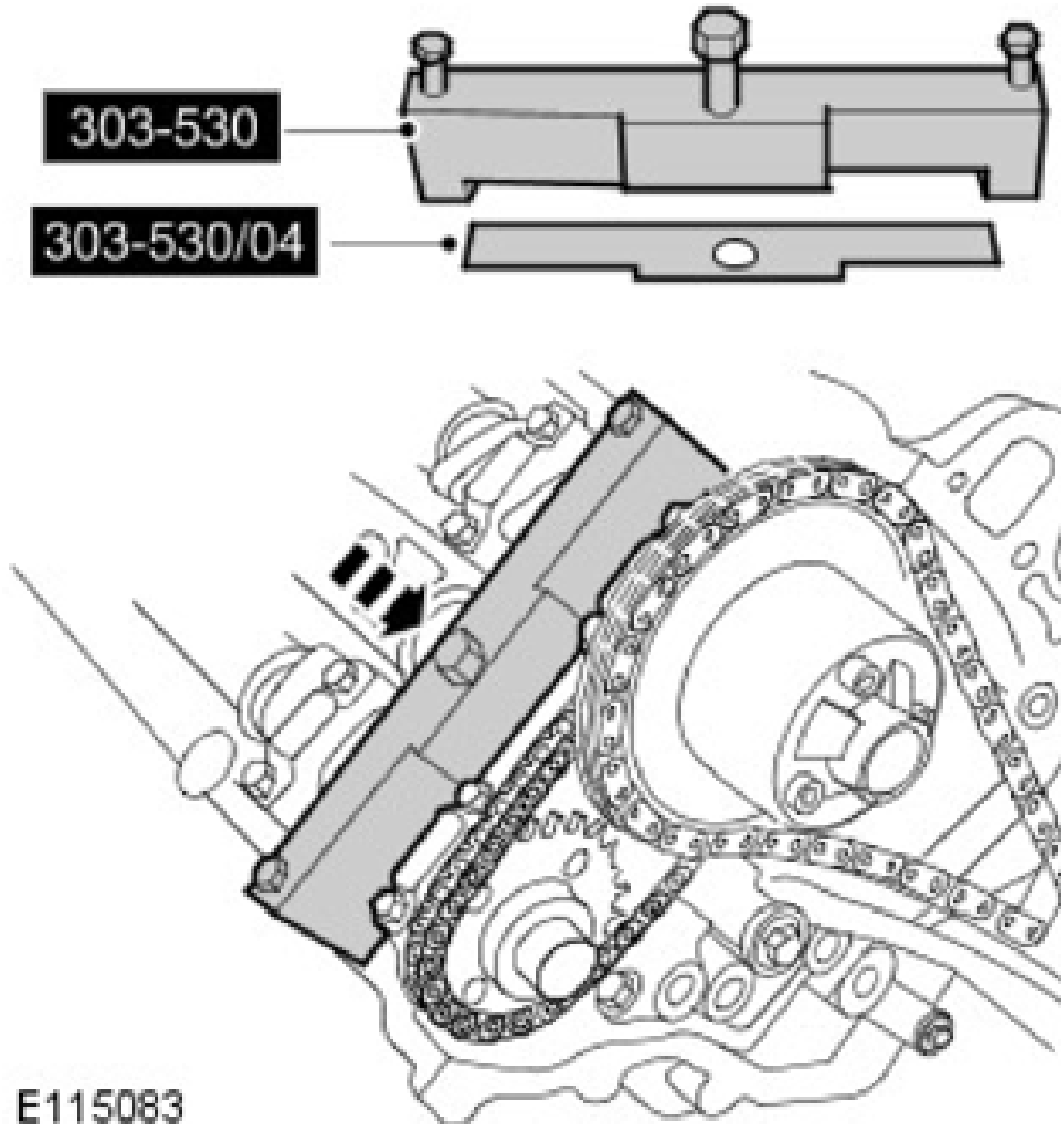
8. Remove the RH variable camshaft timing (VCT) control unit.

- Remove the 3 bolts.
- Remove and discard the O-ring seals.



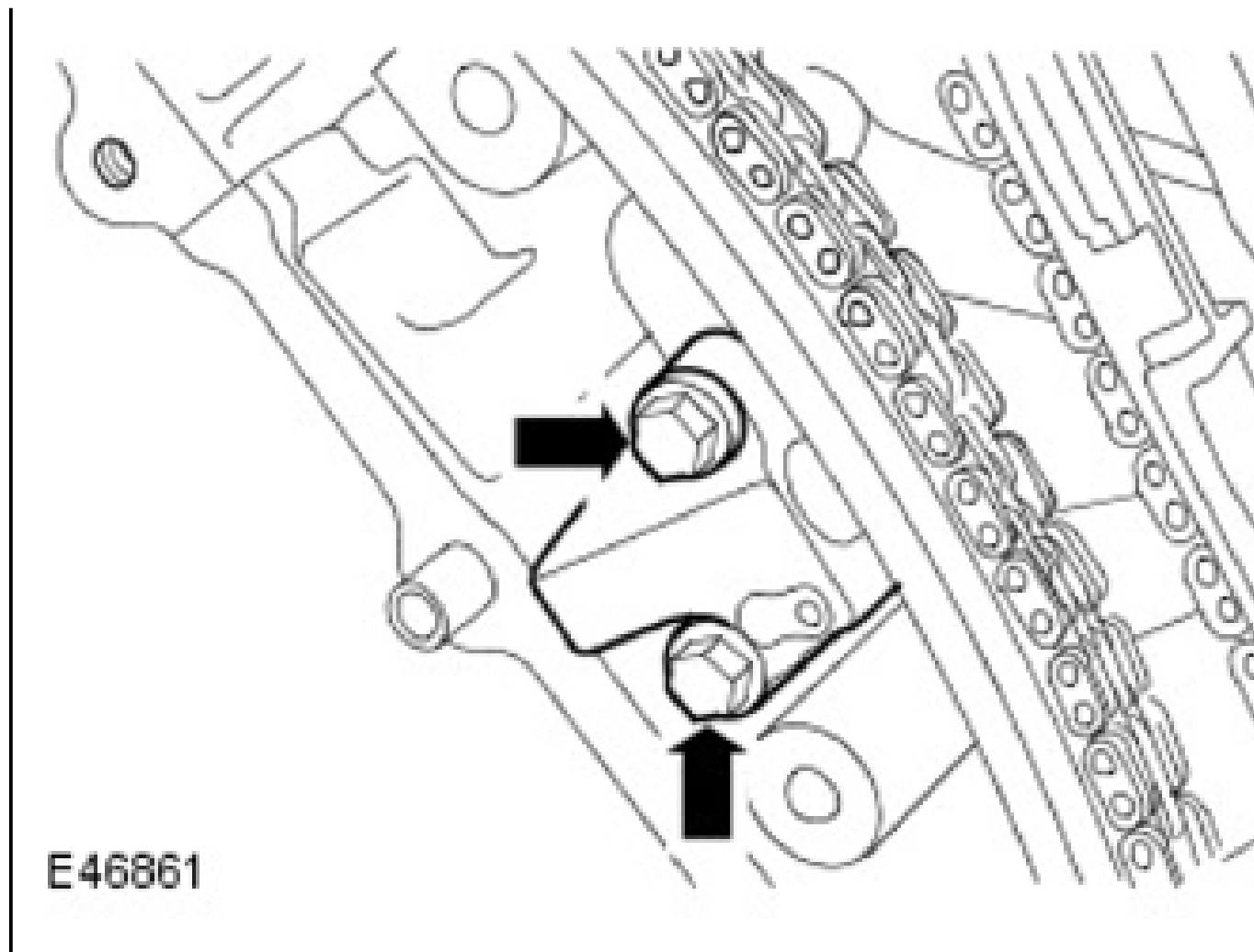
9. Install the special tools to the RH cylinder head.

- Install the 3 bolts.

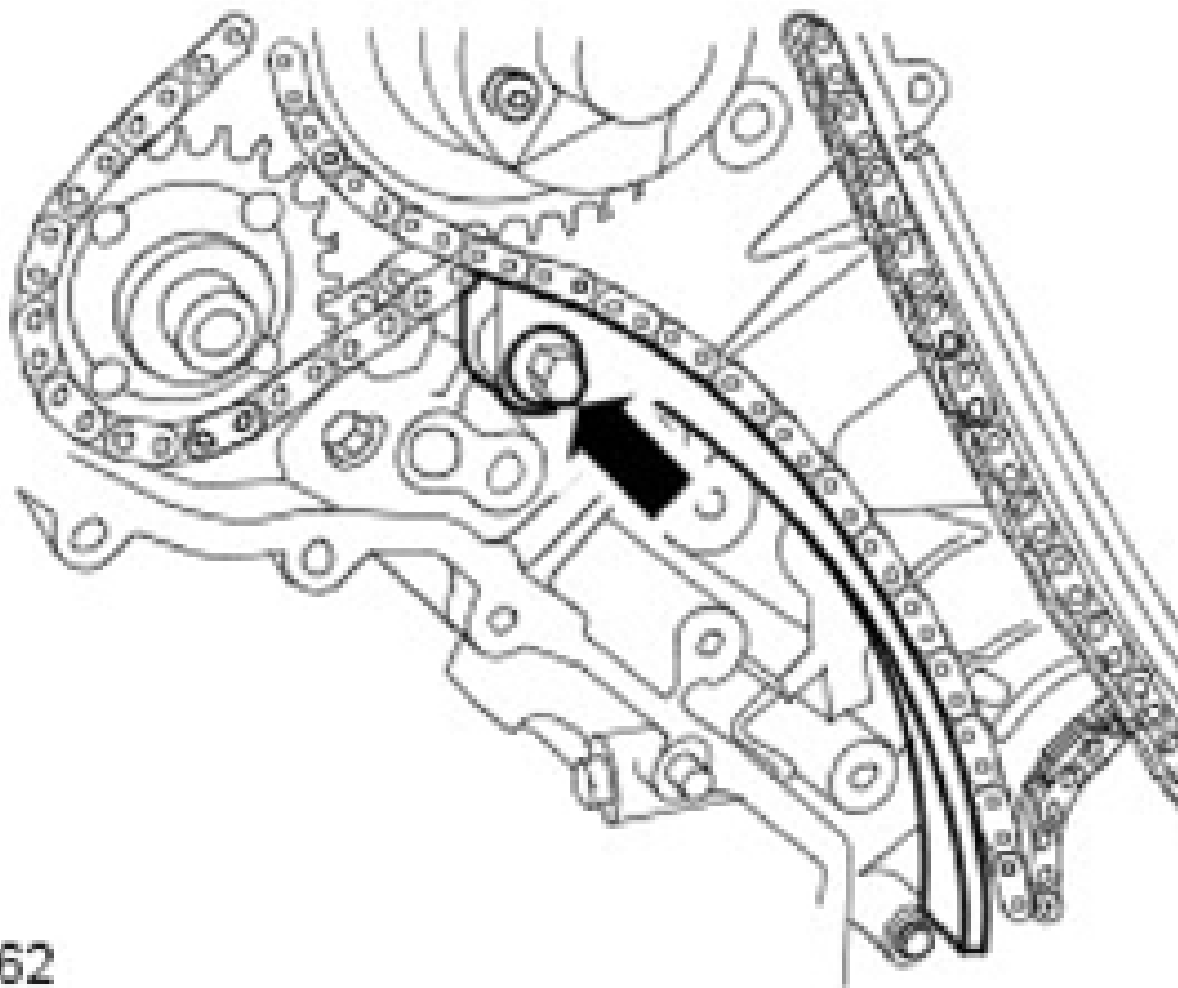


10. Remove the primary timing chain tensioner.

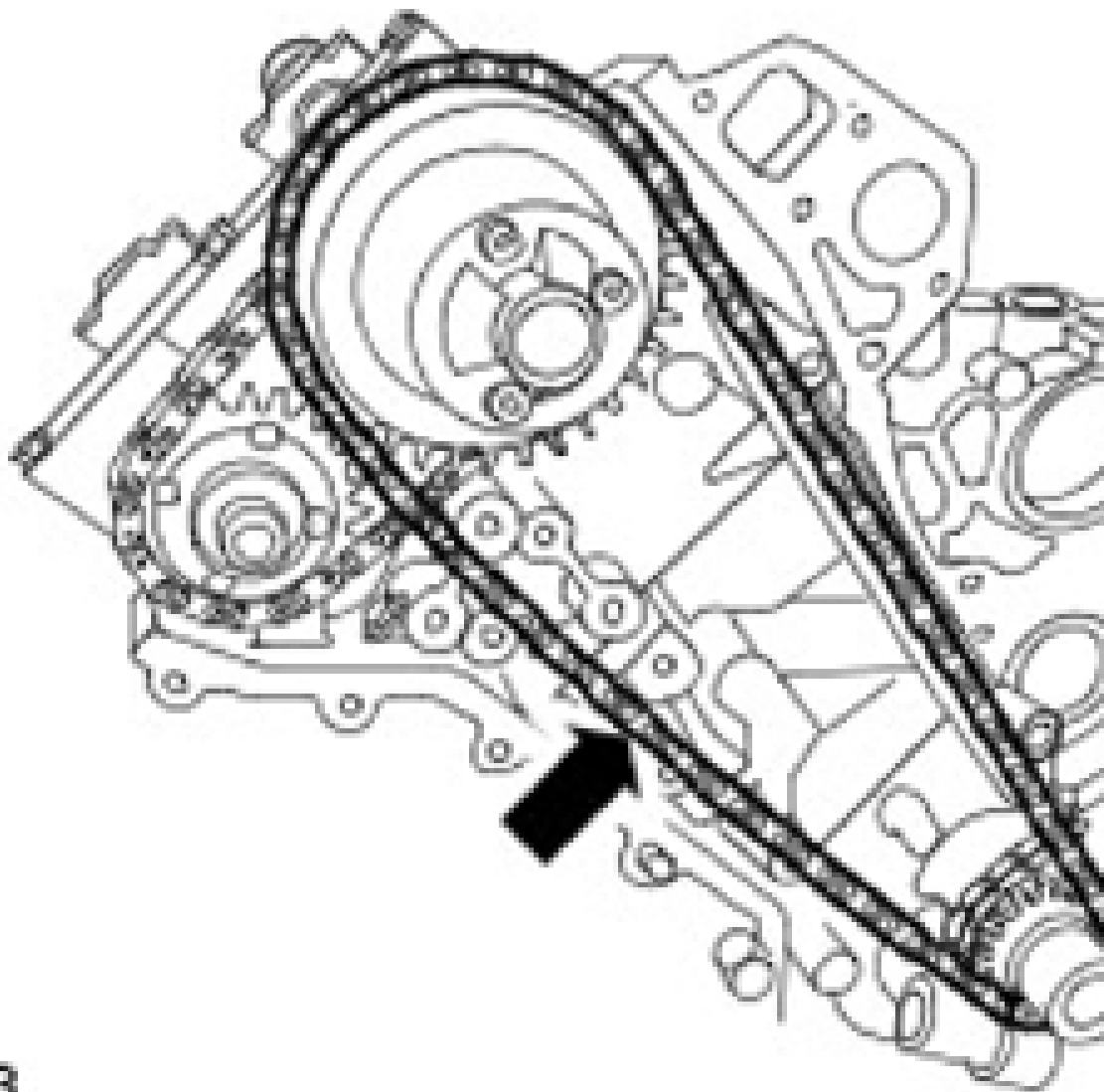
- Remove the 2 bolts.



11. Remove the primary timing chain tensioner guide.
 - Remove the bolt.

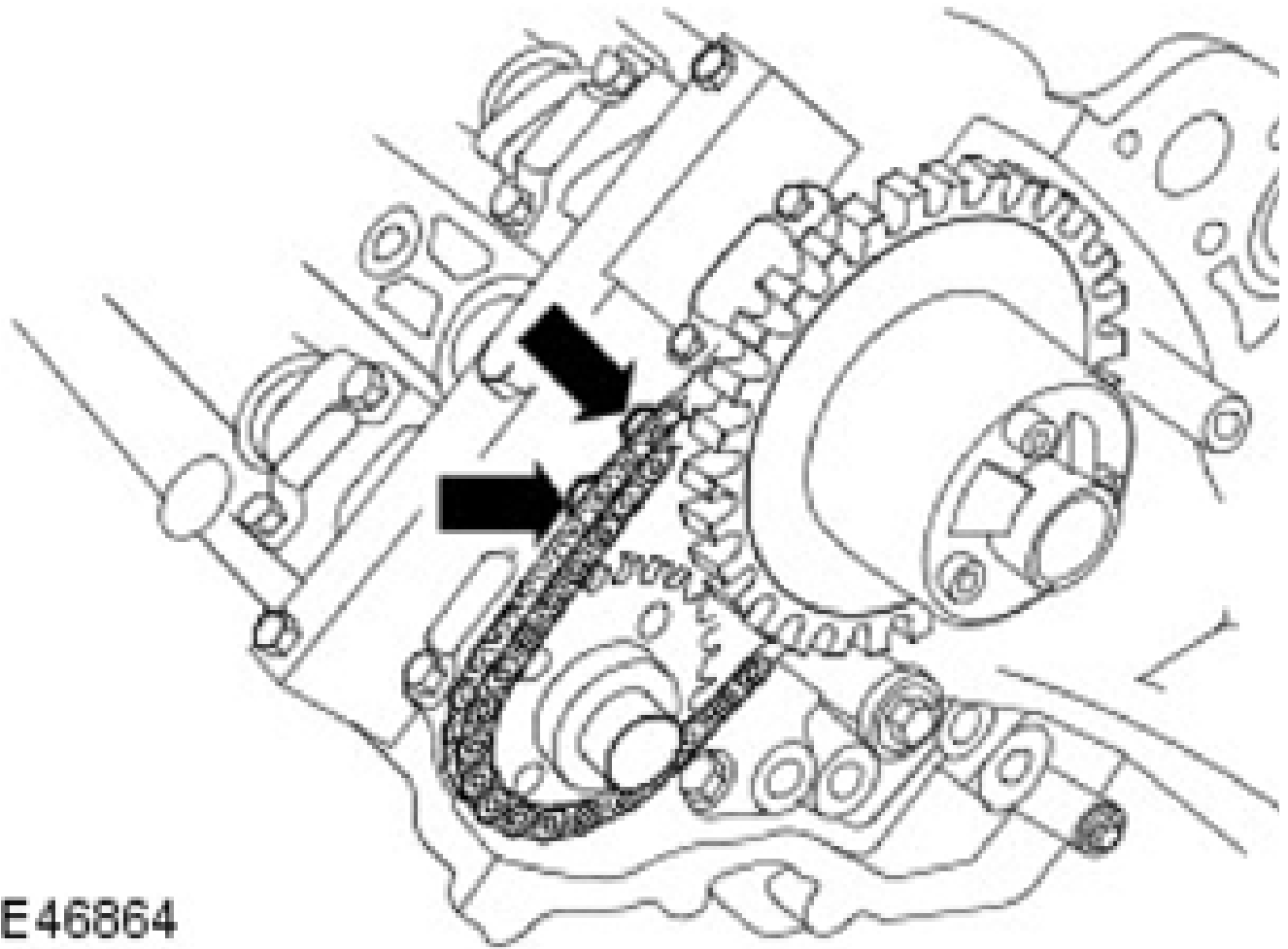


12. Remove the primary timing chain.



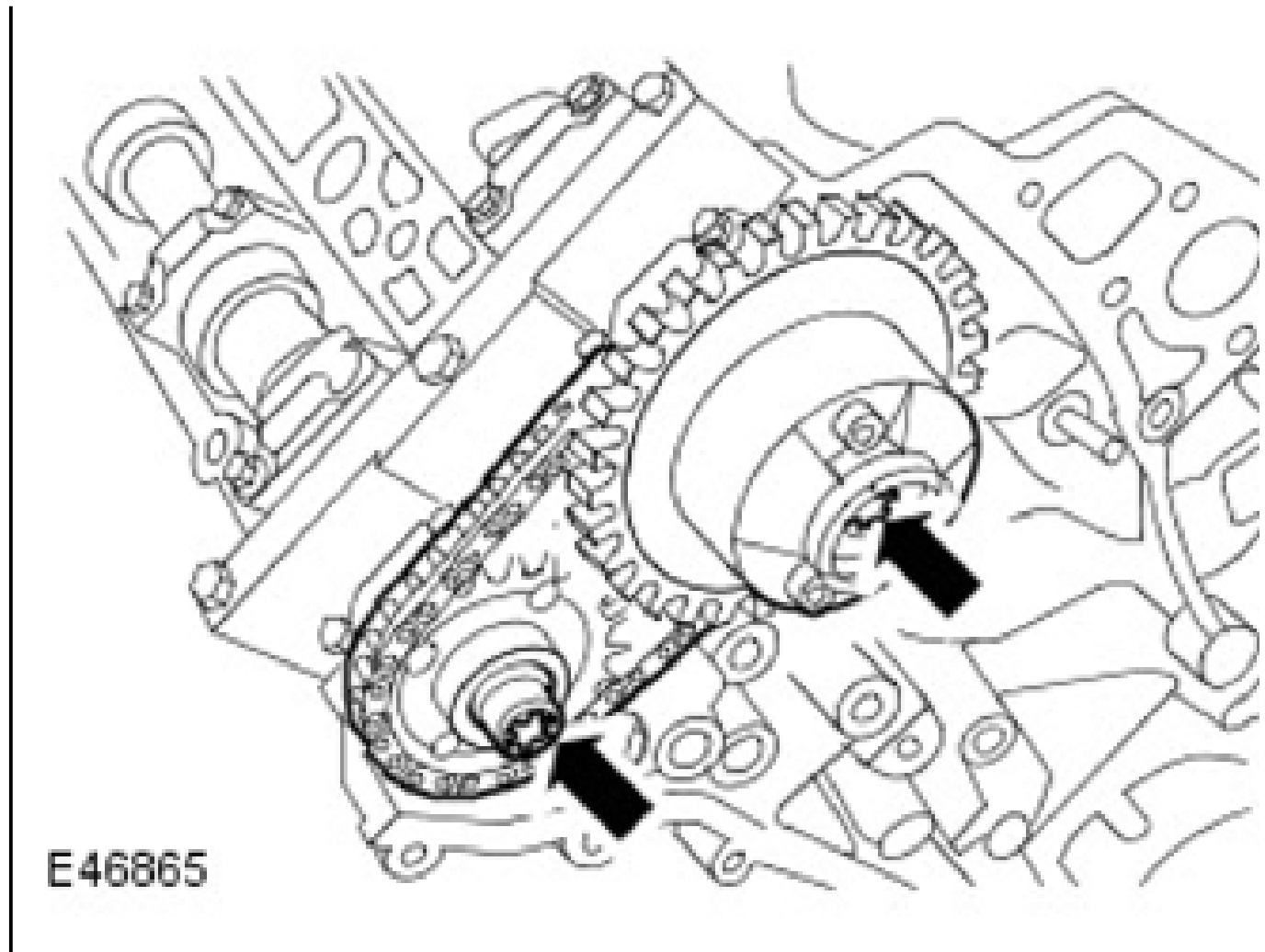
E46863

13. Remove the secondary timing chain tensioner and the secondary timing chain.
 - Remove the 2 retaining bolts.



CAUTION: Discard the bolts.

14. Remove the camshaft sprockets.
 - Remove the 2 bolts.

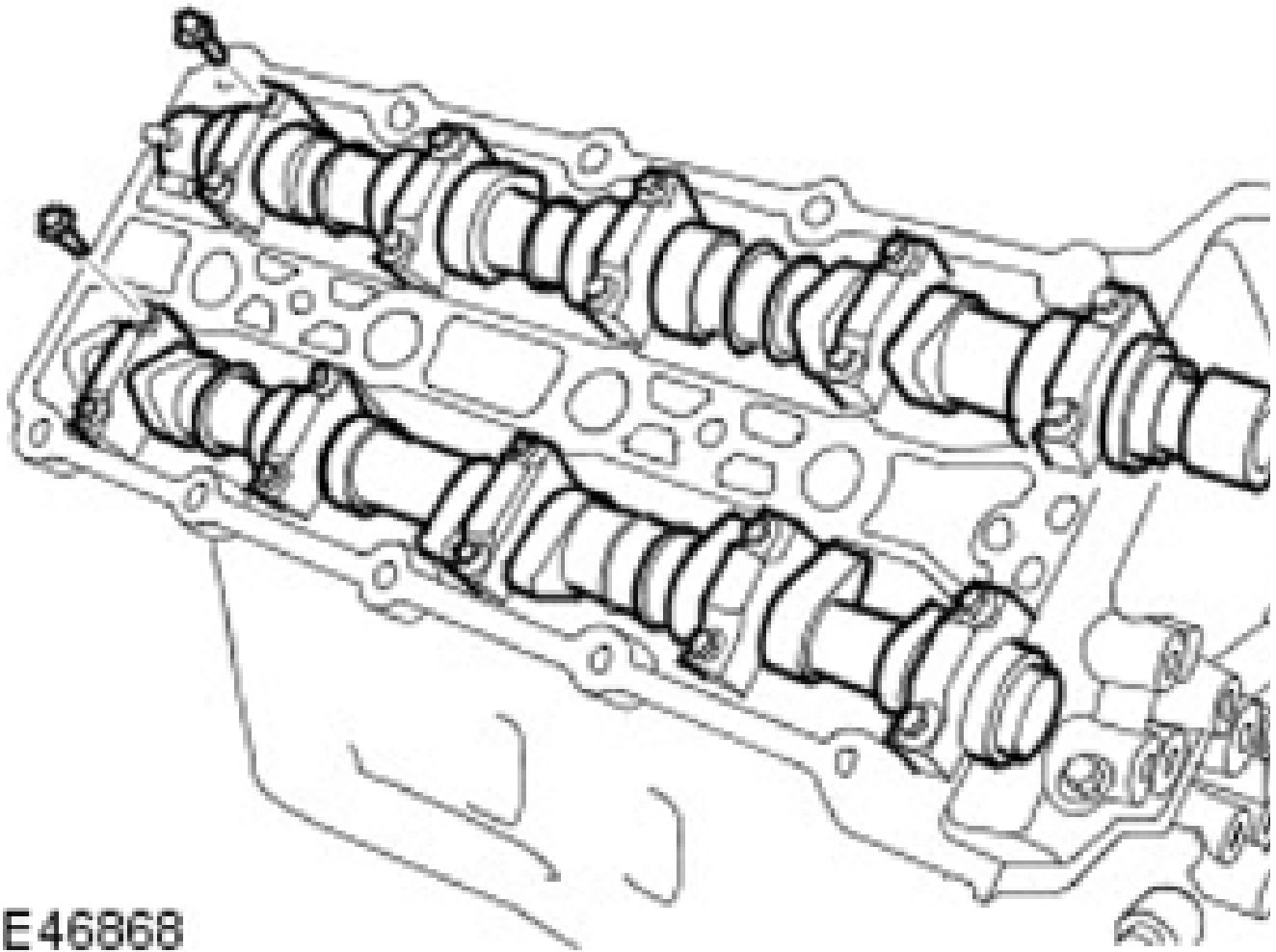


15. Remove the special tools from the RH cylinder head.
 - Remove the 3 bolts.

CAUTION: Evenly and progressively, release the camshaft bearing caps.

NOTE: Remove the camshaft bearing caps. Note: their position, orientation and markings. Each is marked with its position (number) and an orientation (arrow).

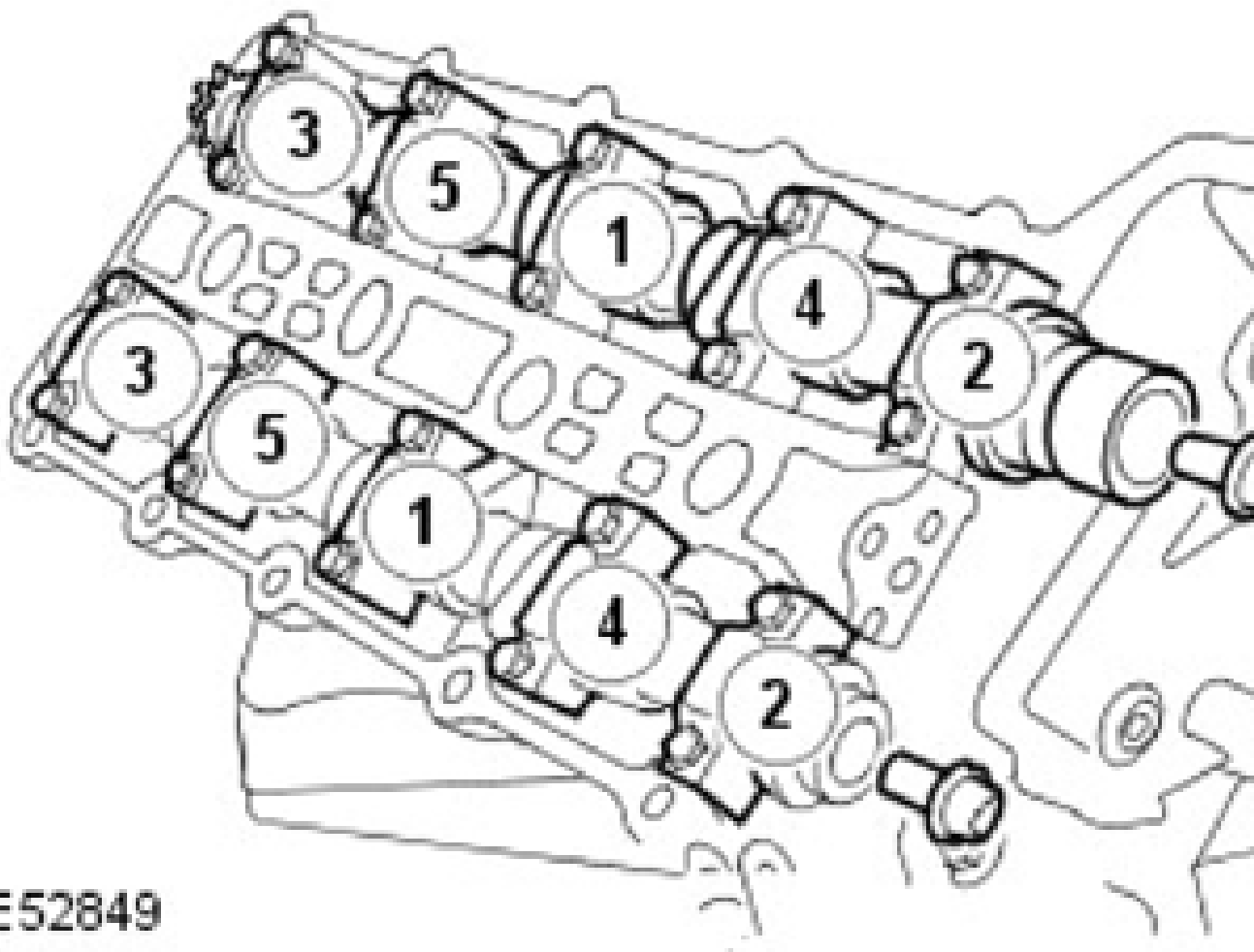
16. Remove the camshaft bearing caps.
 - Remove the 20 bolts.



17. Remove the camshafts.

INSTALLATION

1. Check and adjust the valve tappet clearances.
2. Replace the valve shims, with the smallest shim available.
 - Apply a light coat of clean engine oil to the replacement valve shims.
3. Install the camshafts.
 - Clean the component mating faces.
 - Lubricate the journals and camshaft lobes.
4. Install the camshaft bearing caps.
 - Evenly and progressively tighten the bolts in the sequence shown to 10 Nm.

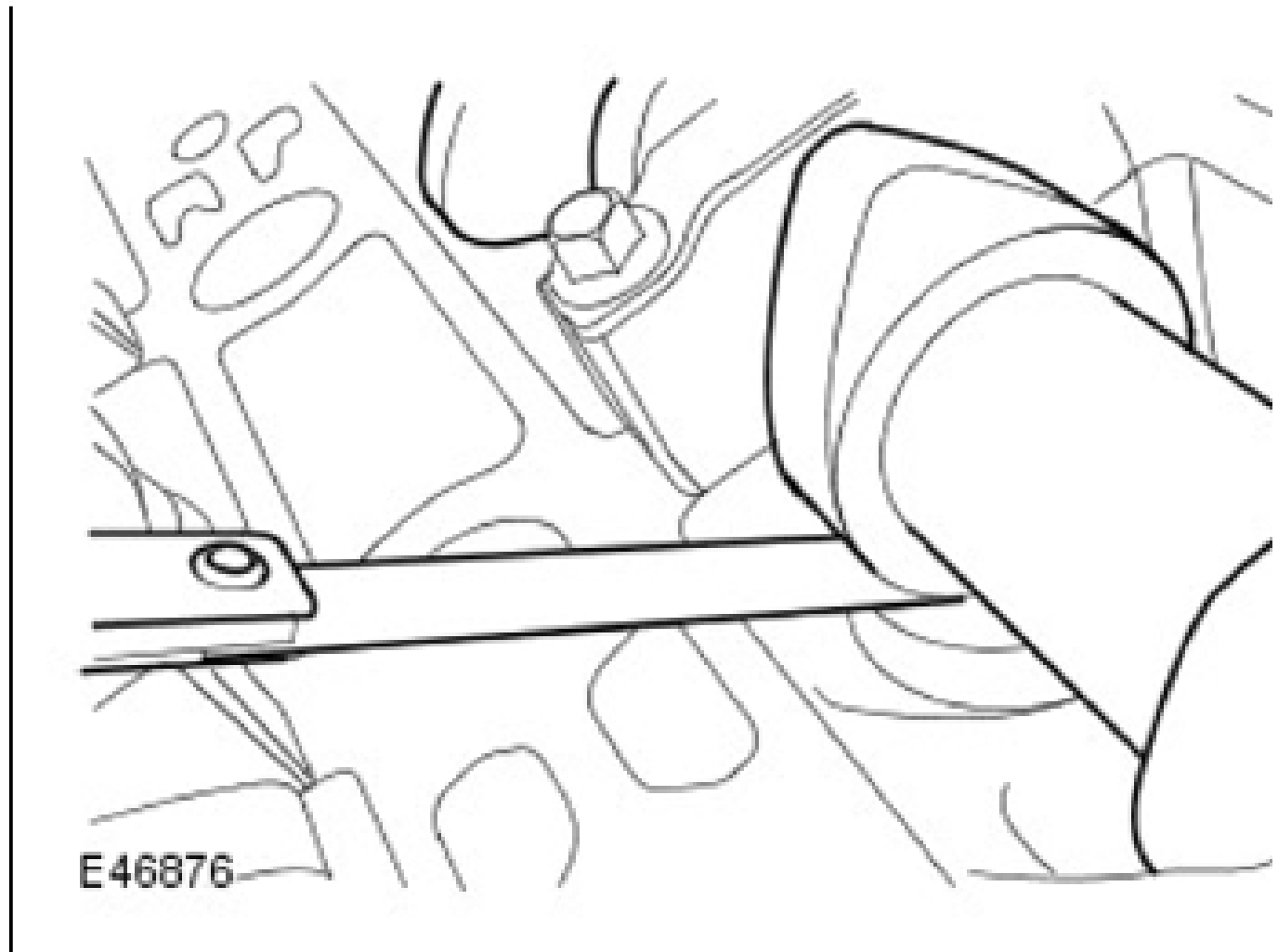


CAUTION: Make sure that new bolts are installed.

5. Install the sprocket retaining Torx bolts to the camshafts.

CAUTION: Camshaft lobes must be 180 degrees away from each valve tappet or valve clearance will be incorrect.

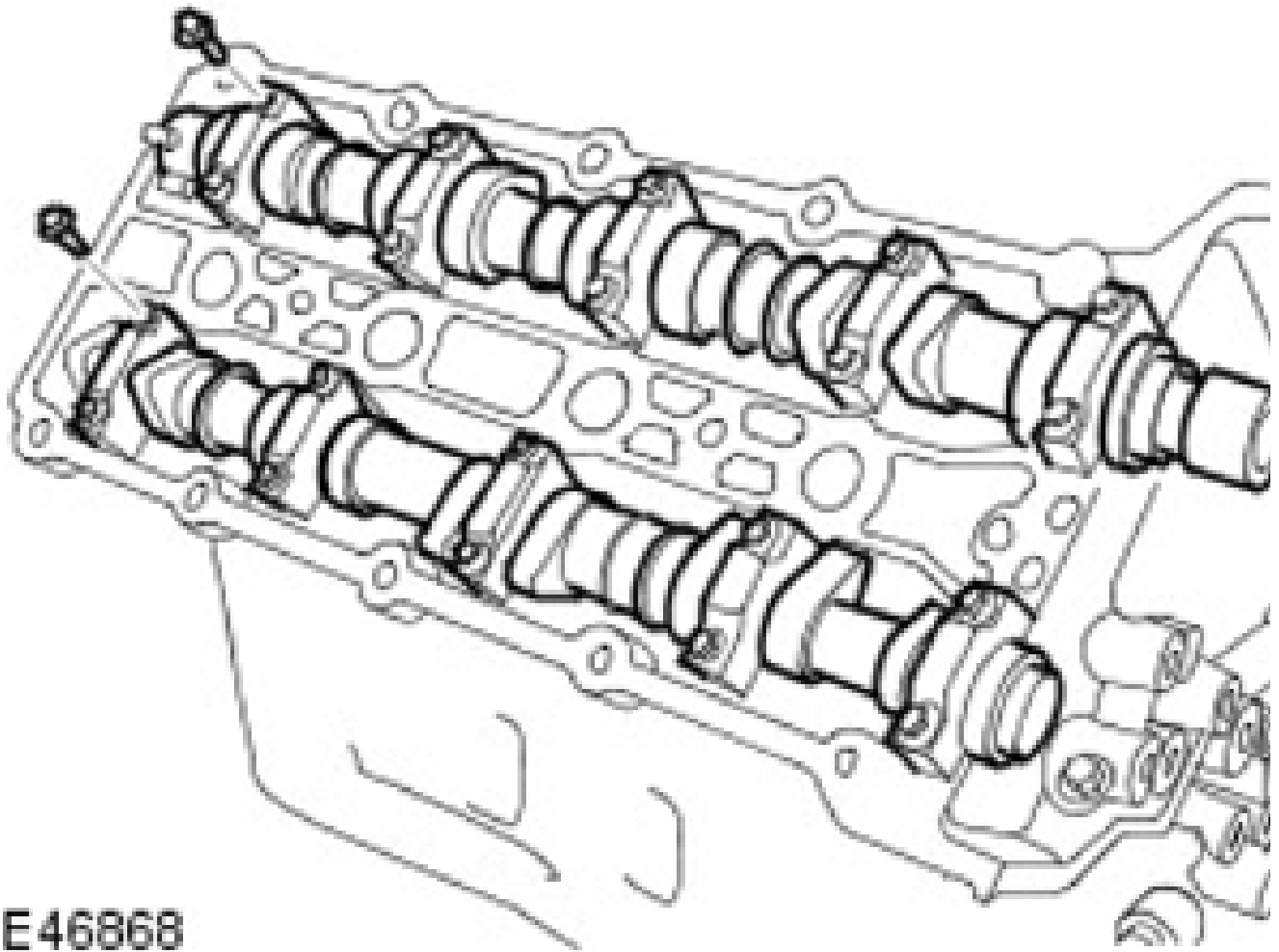
6. Measure and record the tappet clearances.
 - Rotate the camshafts using the Torx bolts.



CAUTION: Evenly and progressively, release the camshaft bearing caps.

NOTE: Remove the camshaft bearing caps. Note: their position, orientation and markings. Each is marked with its position (number) and an orientation (arrow).

7. Remove the camshaft bearing caps.
 - Remove the 20 bolts.

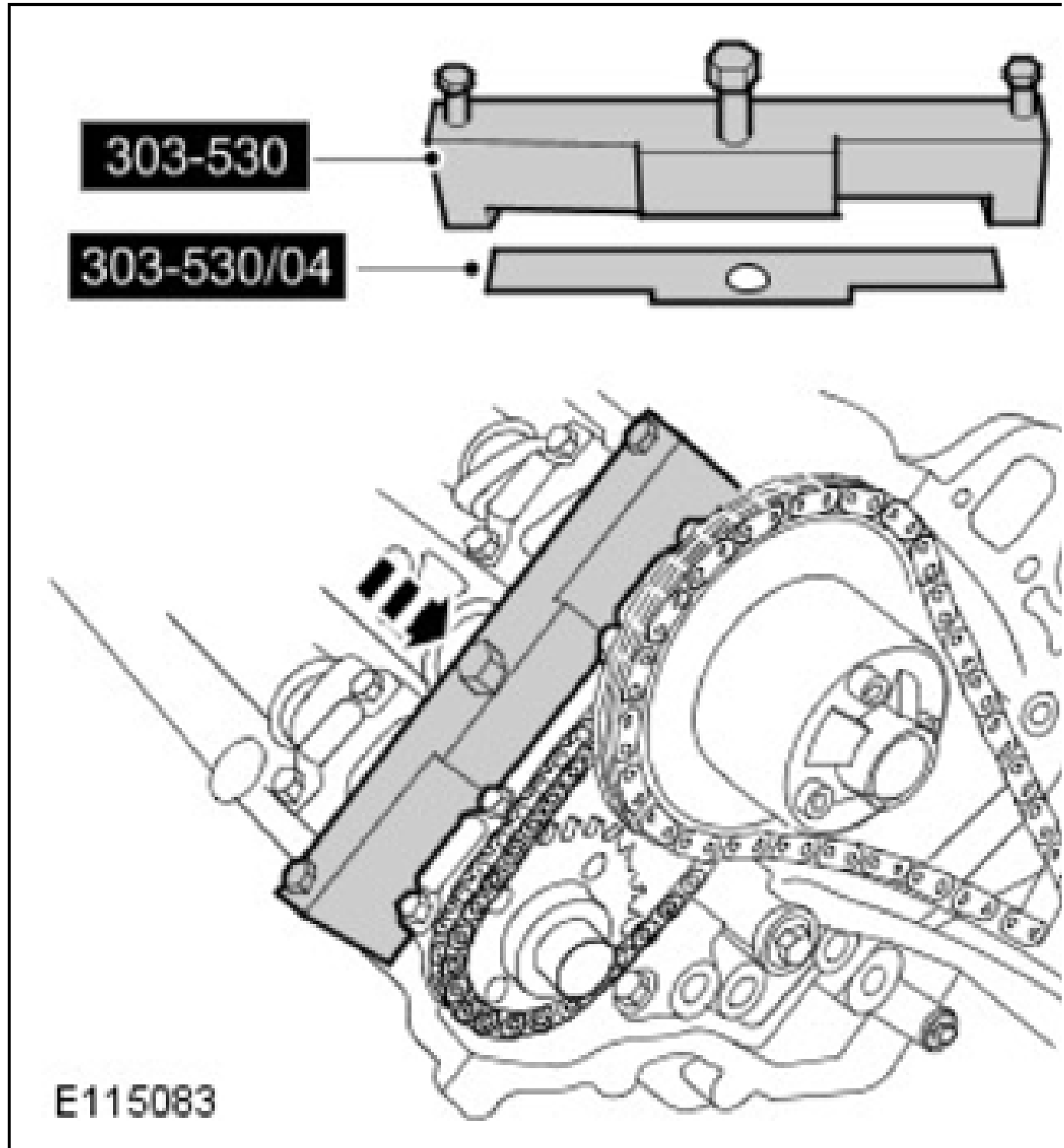


8. Remove the camshafts.
9. Remove the valve tappets, replace with selected tappets.
10. Install the camshafts.
 - Lubricate the journals and camshaft lobes.
 - Clean the component mating faces.
11. Install the camshaft bearing caps.
 - Evenly and progressively tighten the bolts in the sequence shown to 10 Nm.

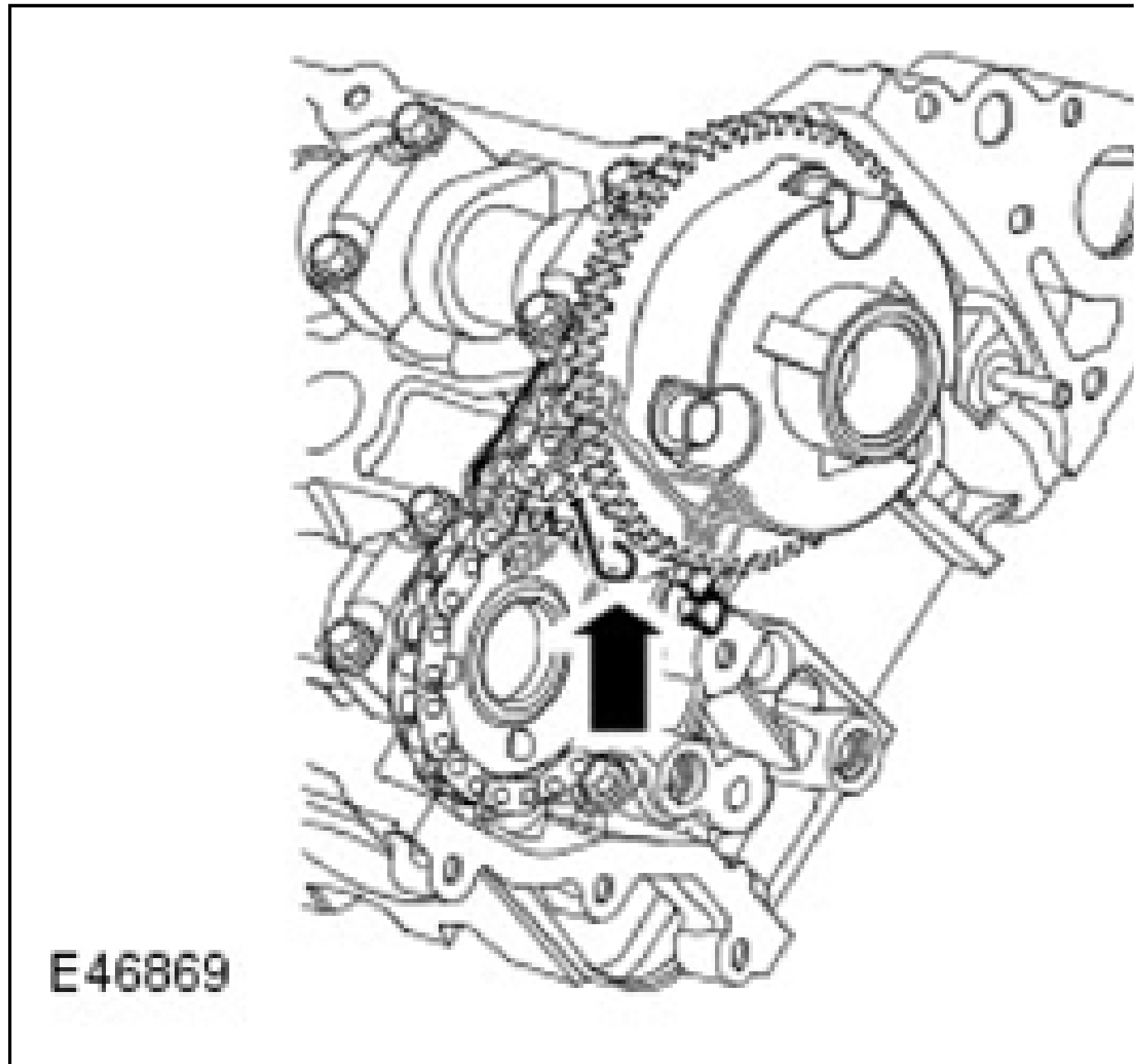
CAUTION: Camshaft lobes must be 180 degrees away from each valve tappet or valve clearance will be incorrect.

12. Check valve tappet clearances are correct.
 - Rotate the camshafts using the Torx bolts.

- Remove the camshaft Torx bolts after the check is complete.
13. Install the special tools to the RH cylinder head.
- Install the 3 bolts.



14. Retain the RH secondary timing chain tensioner piston.
- Using 1 mm diameter metal rod, retain the chain tensioner piston.



15. Install the secondary timing chain tensioner and chain to the camshaft sprockets.

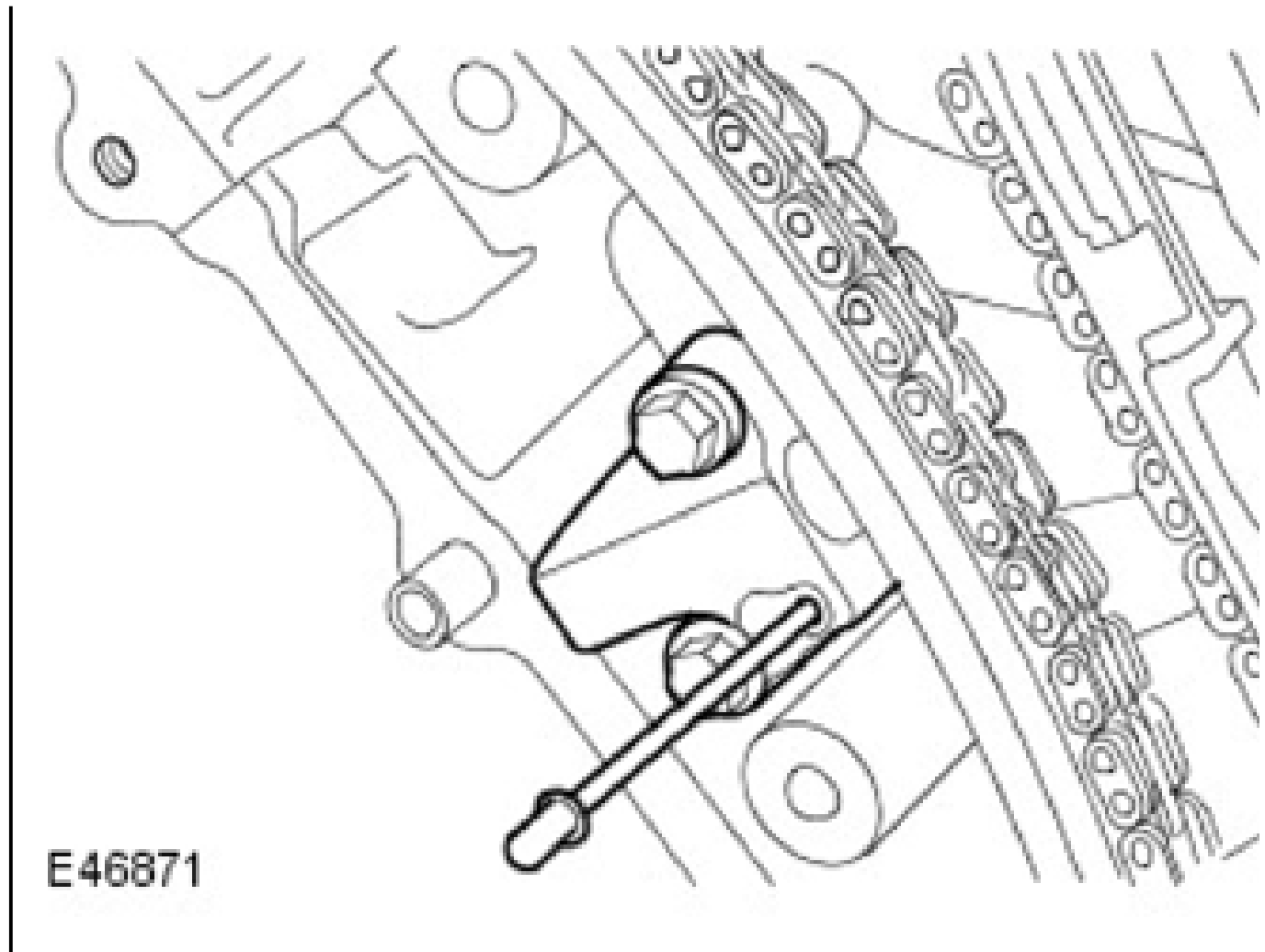
NOTE: Lightly tighten the camshaft sprocket Torx bolts, the sprockets **MUST** be free to move.

16. Install the secondary timing chain and sprockets to the camshafts.
- Install the sprocket retaining Torx bolts to the camshafts.

17. Install the secondary timing chain tensioner retaining bolts.
 - Tighten the bolts to 12 Nm.
18. Tension the secondary timing chain.
 - Remove the retaining rod.
19. Install the primary timing chain.
 - Make sure the timing chain slack is on the tensioner side of the timing chain.
20. Install the primary tensioner guide.
 - Tighten the bolts to 12 Nm.

CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

21. Install the primary chain tensioner.
 - Using 3 mm diameter metal rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm.
 - Remove the retaining rod.

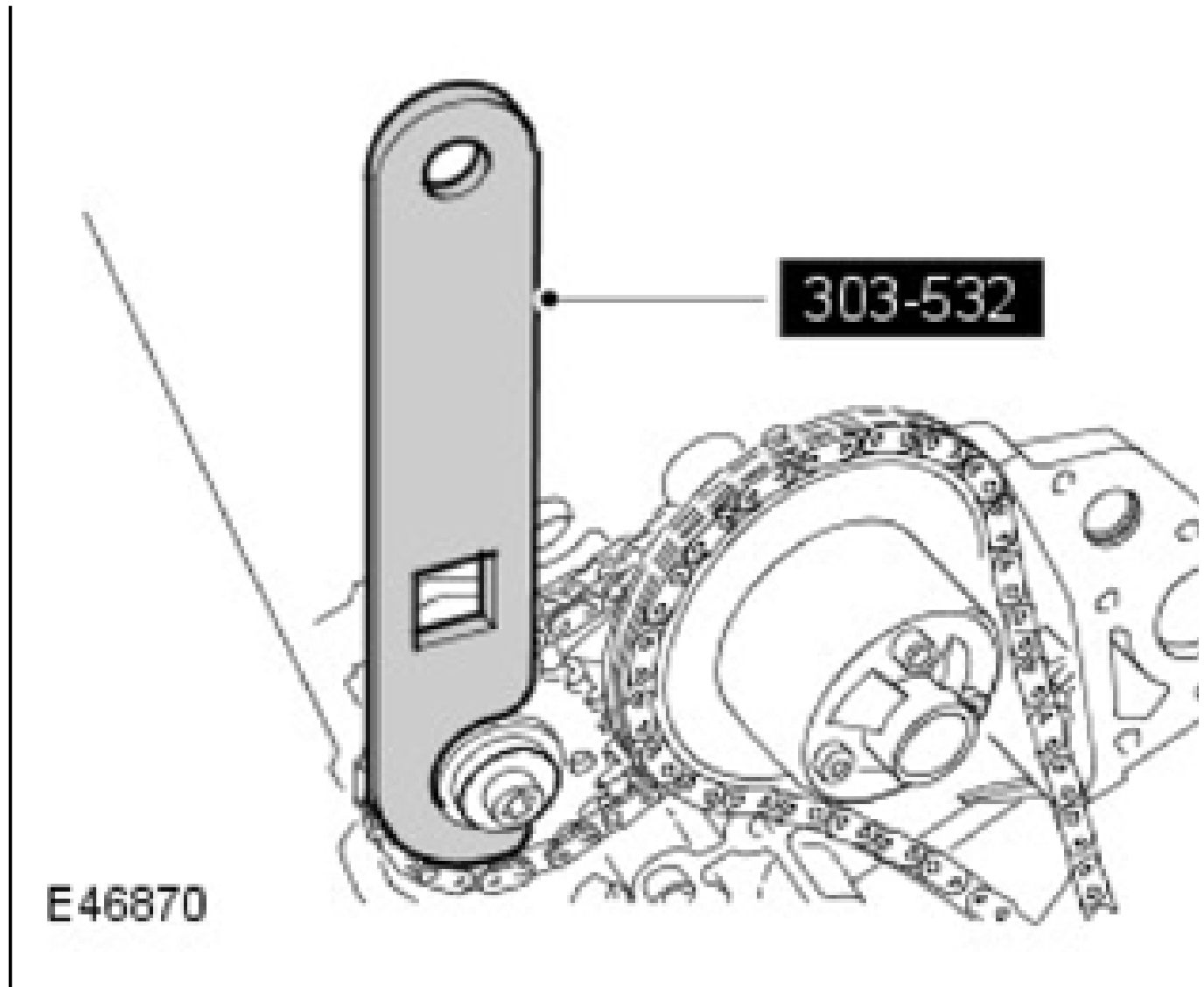


CAUTION: The intake camshaft sprocket retaining bolt **MUST** be tightened before the exhaust camshaft sprocket retaining bolt. Engine damage will occur if this procedure is not followed.

Using the special tool, apply force to the tool in a counter-clockwise direction, to tension the primary timing chain on its drive side.

22. Install the special tool to the exhaust camshaft sprocket.

- Tighten the intake camshaft sprocket retaining bolt to 20 Nm + 90 deg.
- Tighten the exhaust camshaft sprocket retaining bolt to 20 Nm + 90 deg.



23. Remove the special tools from the RH cylinder head.
24. Install the RH VCT oil control unit.
 - Install the new O-ring seals.
 - Tighten the new bolts to 22 Nm.
25. Remove the crankshaft locking tool.
 - Remove the screw.
26. Install the CKP sensor.

For additional information, refer to: **CRANKSHAFT POSITION (CKP) SENSOR** .

NOTE: Before installing the valve covers, check the valve clearances.

27. Install the engine front cover.

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

28. Install the battery tray.

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

CAMSHAFTS LH

SPECIAL TOOL(S)

303-645

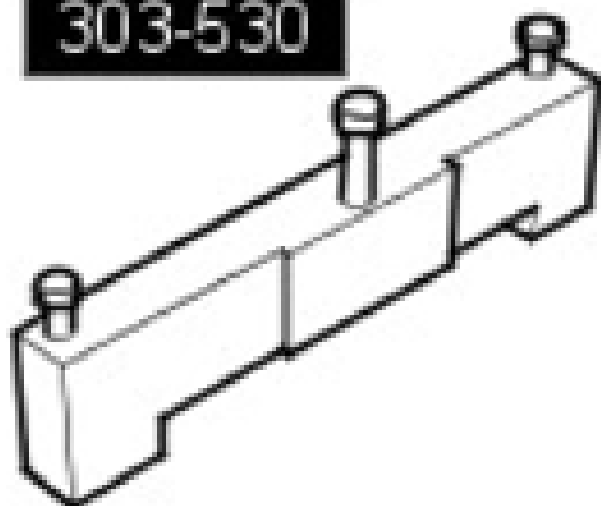


E 46881

Timing Setting tool
303-645

Camshaft setting/locking tool
303-530

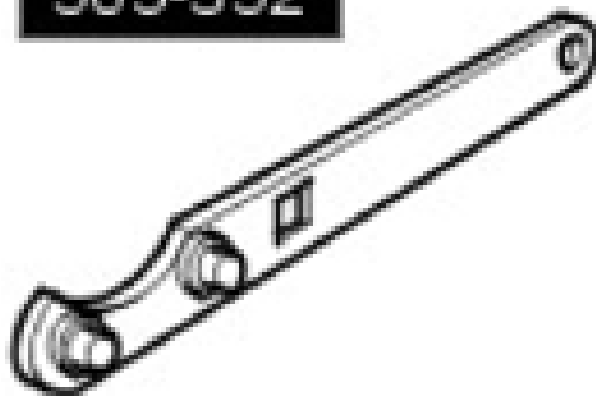
303-530



E46879

Timing chain tensioning tool
303-532

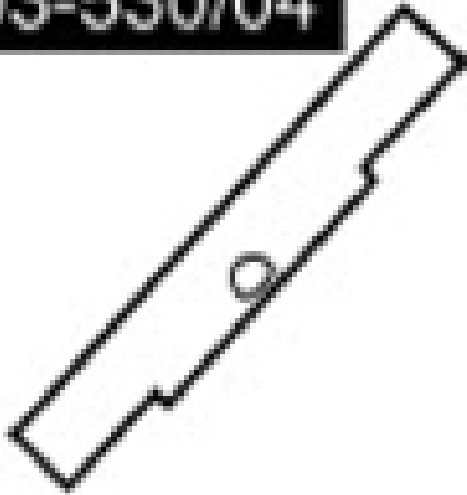
303-532



E46880

Timing shim tool
303-530/04

303-530/04



E115082

REMOVAL

1. Disconnect the battery ground cable.

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

2. Remove the battery tray.

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

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. Remove the engine front cover.

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

5. Remove the crankshaft position (CKP) sensor.

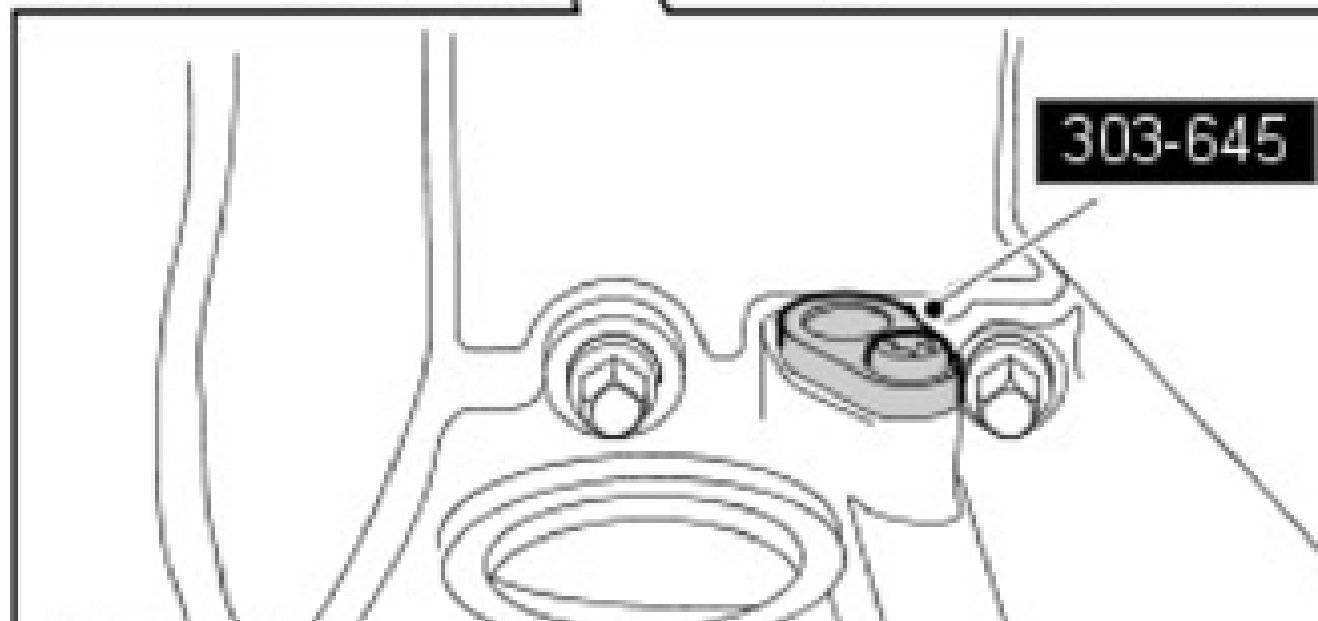
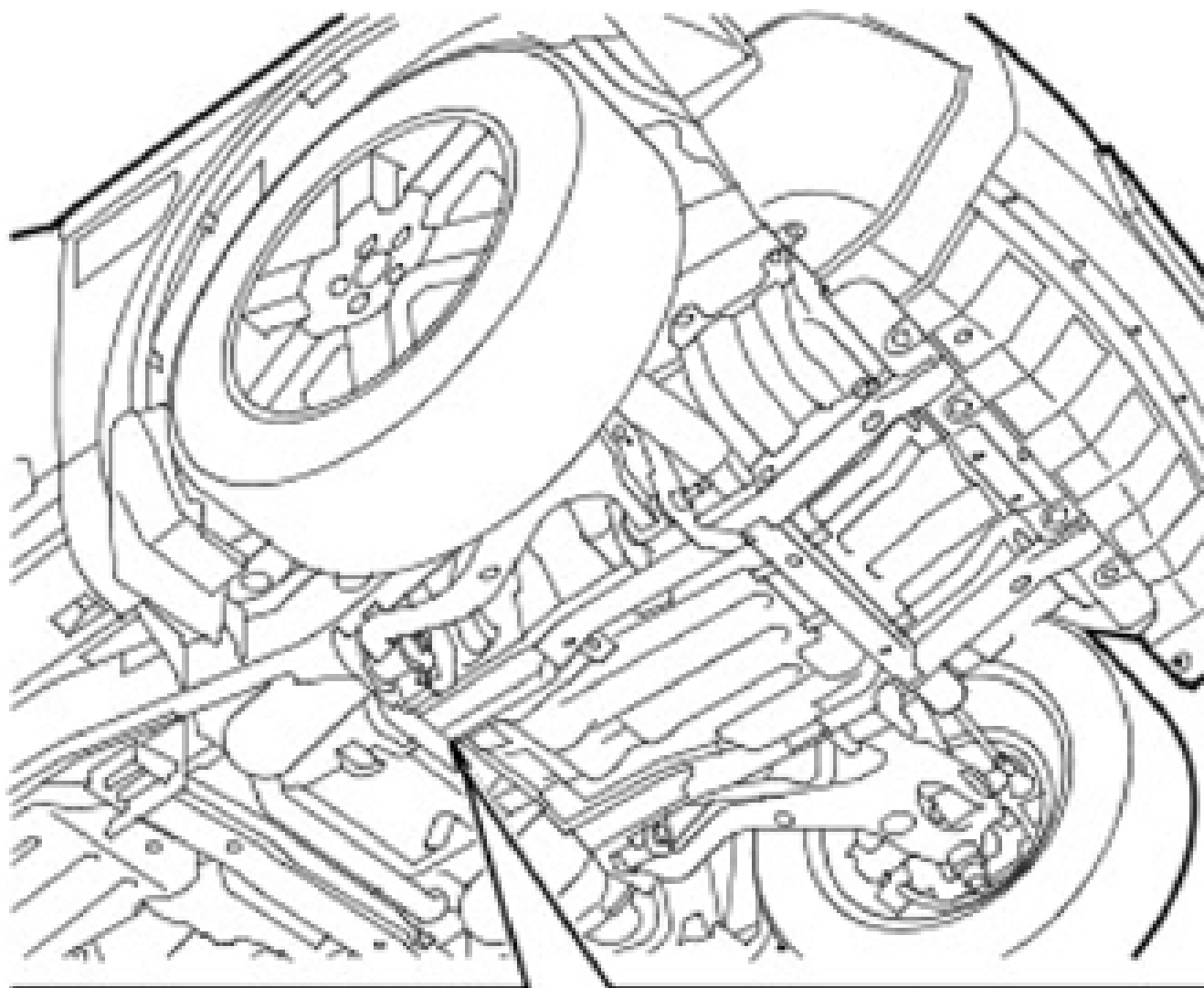
For additional information, refer to: **CRANKSHAFT POSITION (CKP) SENSOR** .

6. Rotate the crankshaft until the flats on the camshafts are parallel with the cylinder head joint faces.

NOTE: **The engine is now in the SAFE position.**

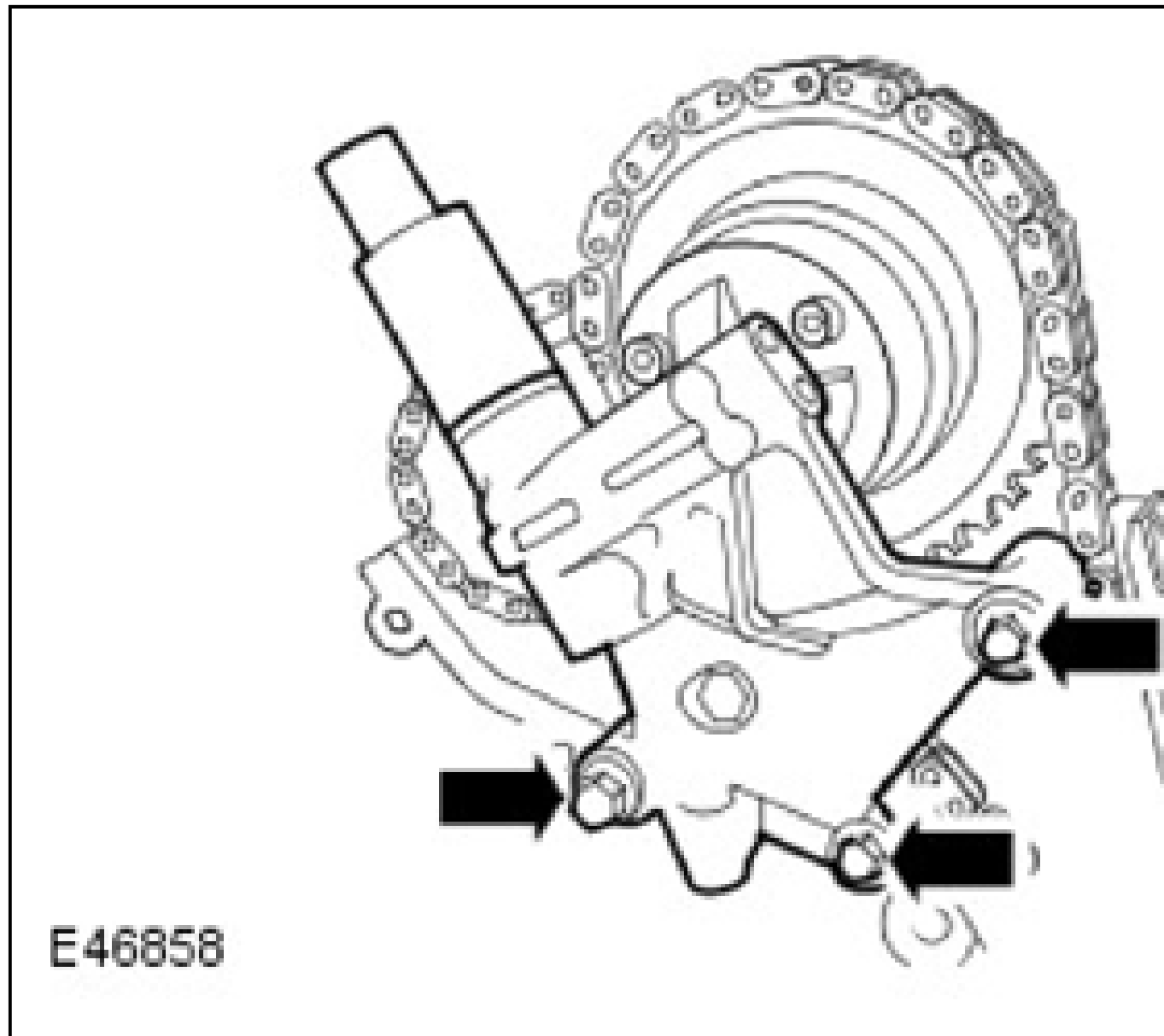
7. Lock the crankshaft.

- Install the special tool.
- Install the screw.



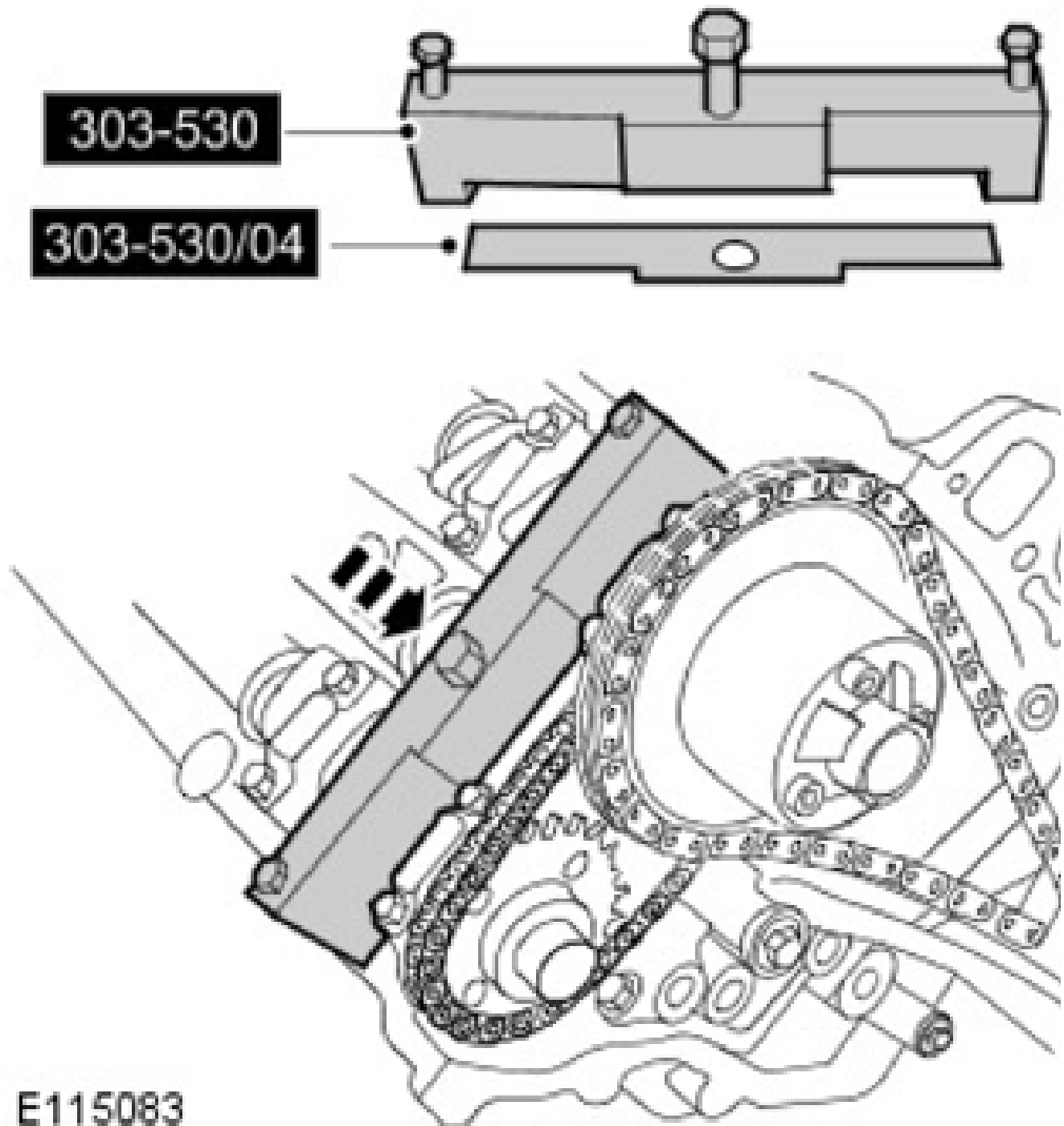
8. Remove the RH variable camshaft timing (VCT) control unit.

- Remove the 3 bolts.
- Remove and discard the O-ring seals.

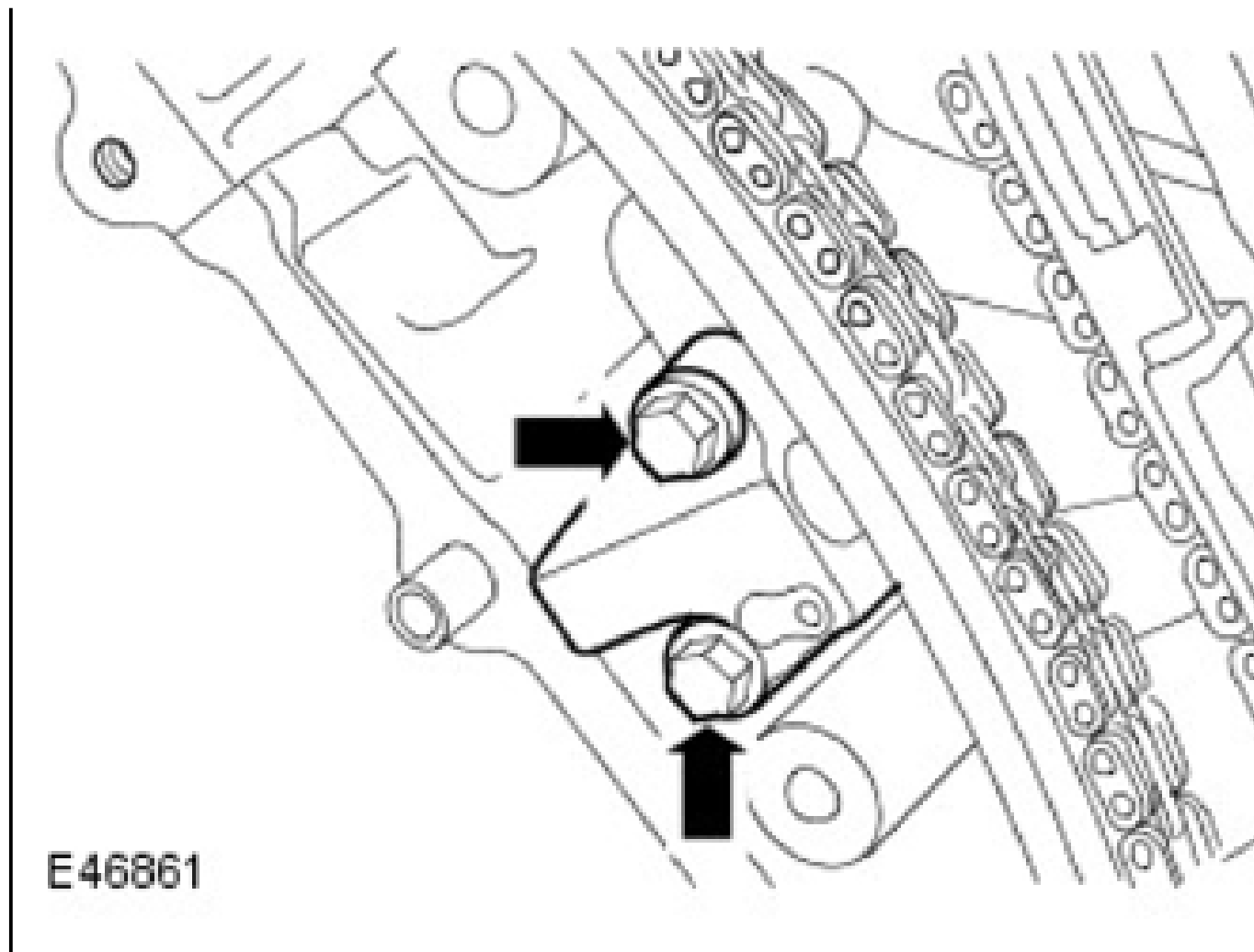


9. Install the special tools to the RH cylinder head.

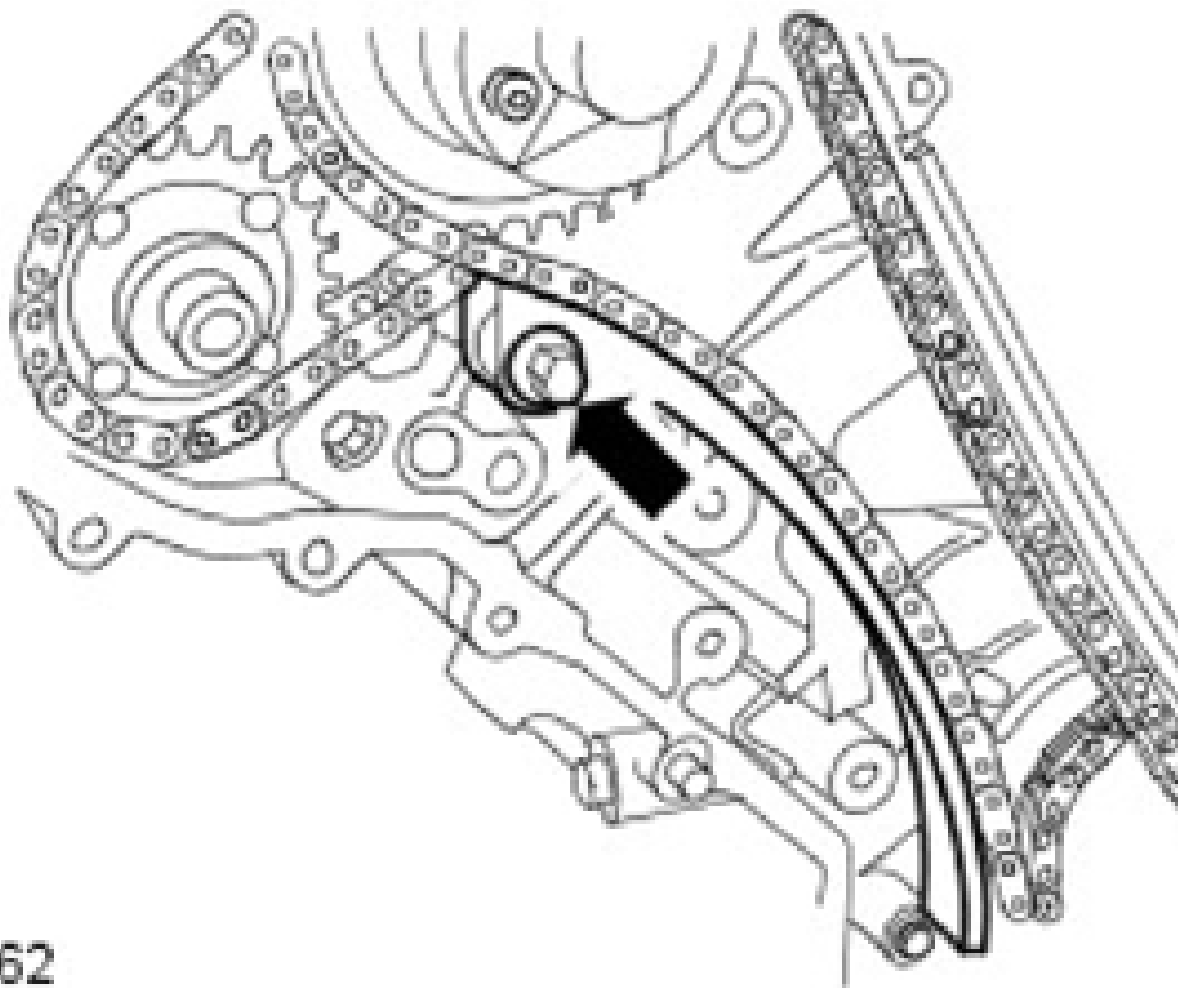
- Install the 3 bolts.



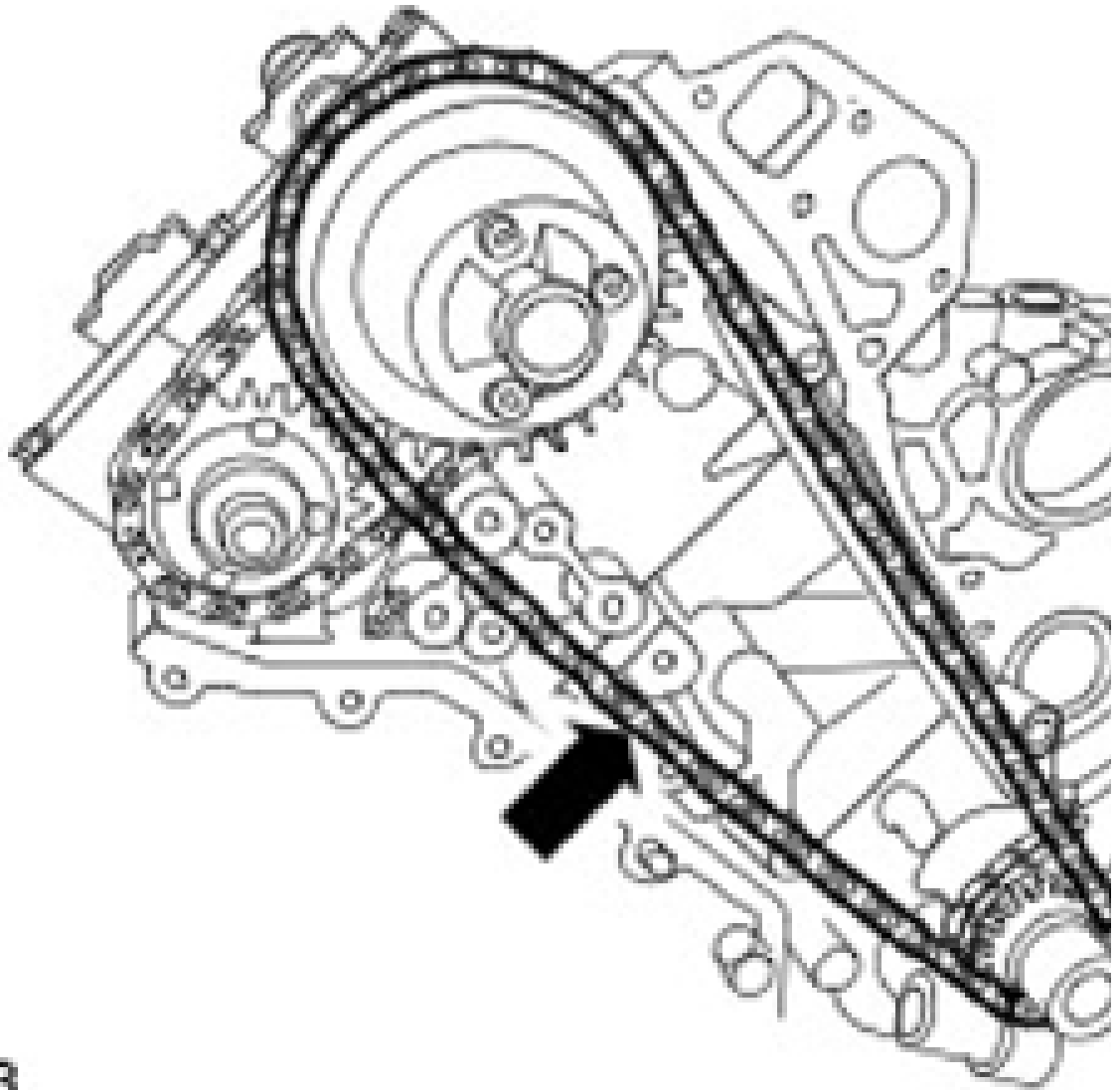
10. Remove the RH primary timing chain tensioner assembly.
 - Remove the 2 bolts.



11. Remove the RH primary timing chain tensioner guide.
 - Remove the bolt.

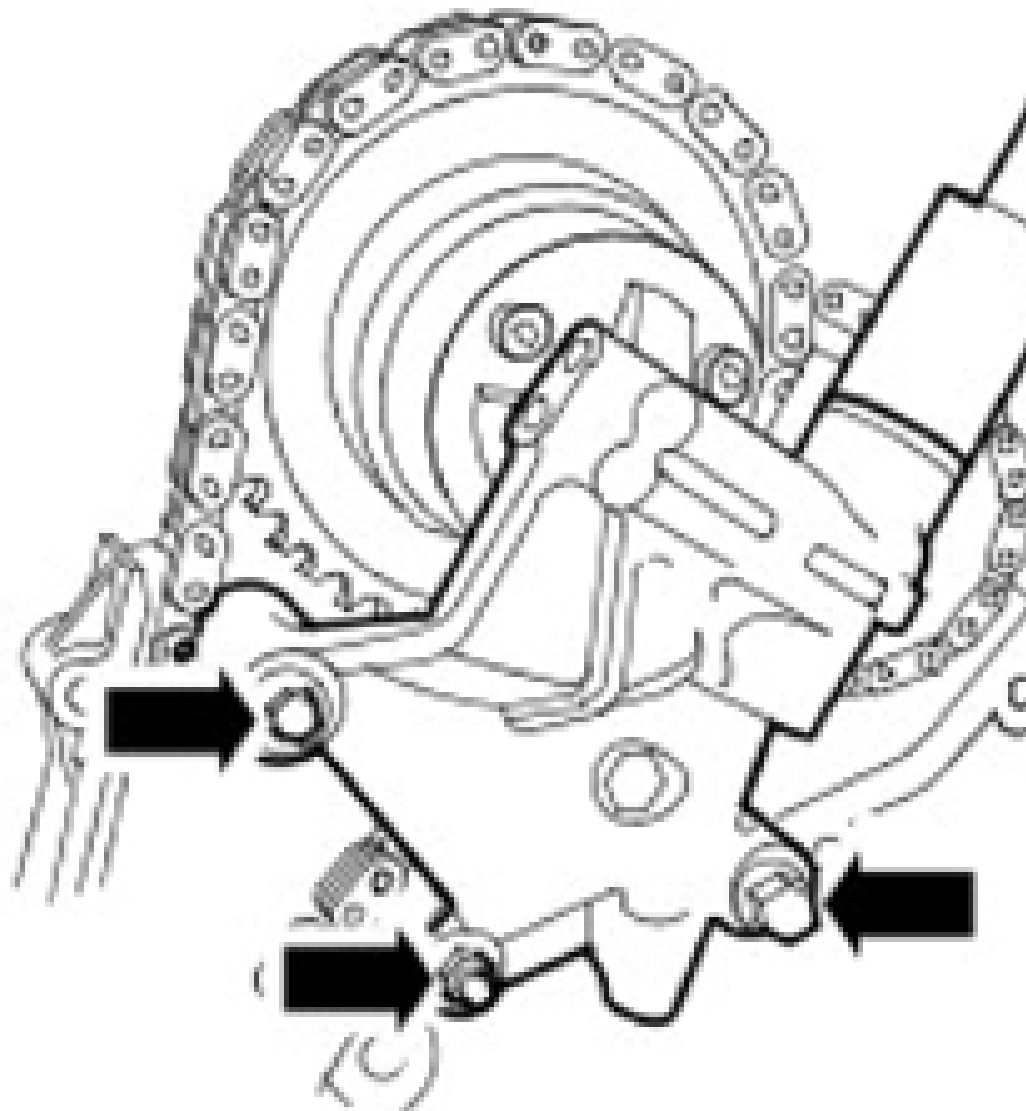


12. Remove the RH primary timing chain.



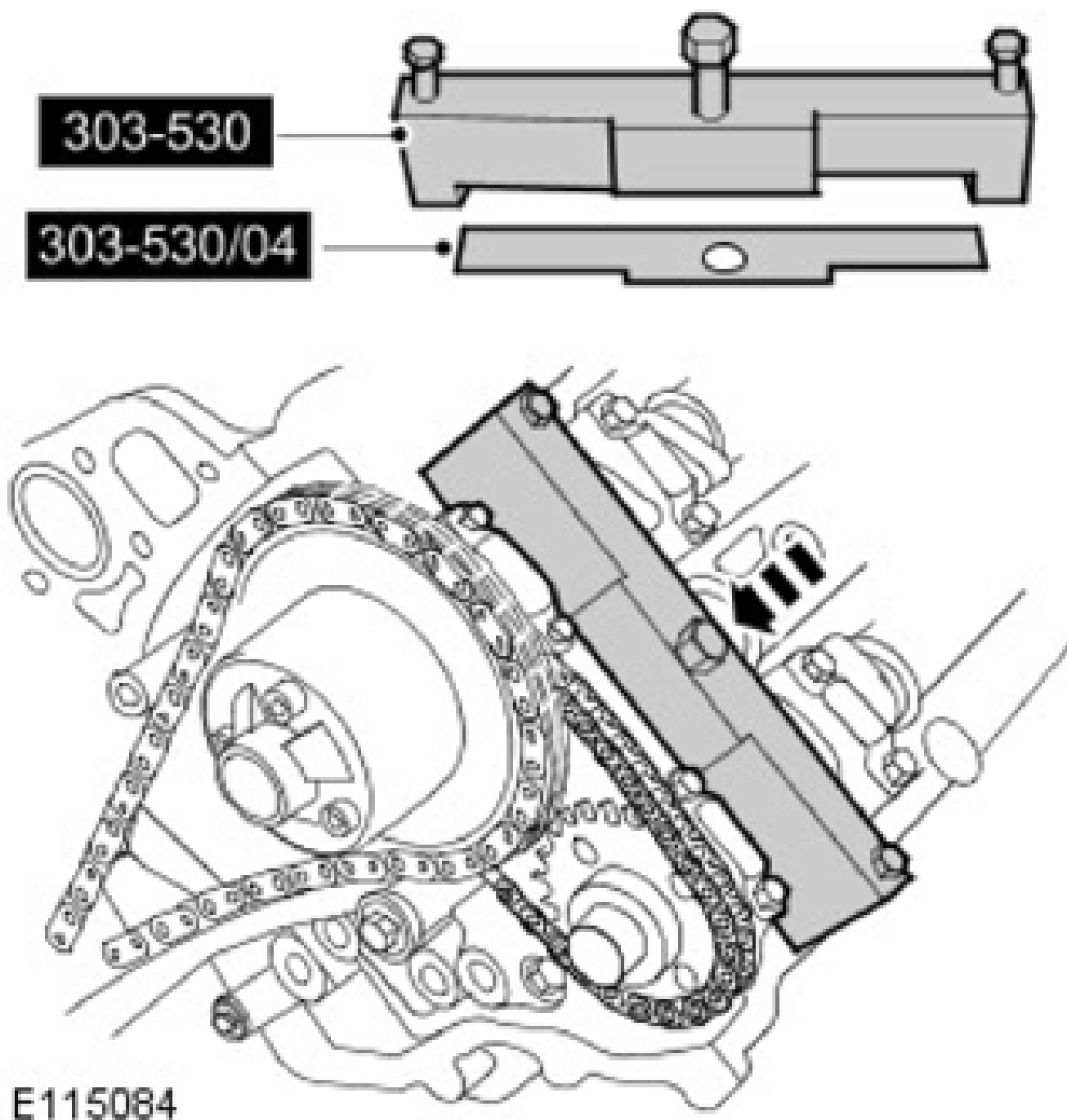
E46863

13. Remove the special tools from the RH cylinder head.
 - Remove the 3 bolts.
14. Remove the LH variable camshaft timing (VCT) control unit.
 - Remove the 2 bolts.
 - Remove the nut.
 - Remove and discard the O-ring seals.

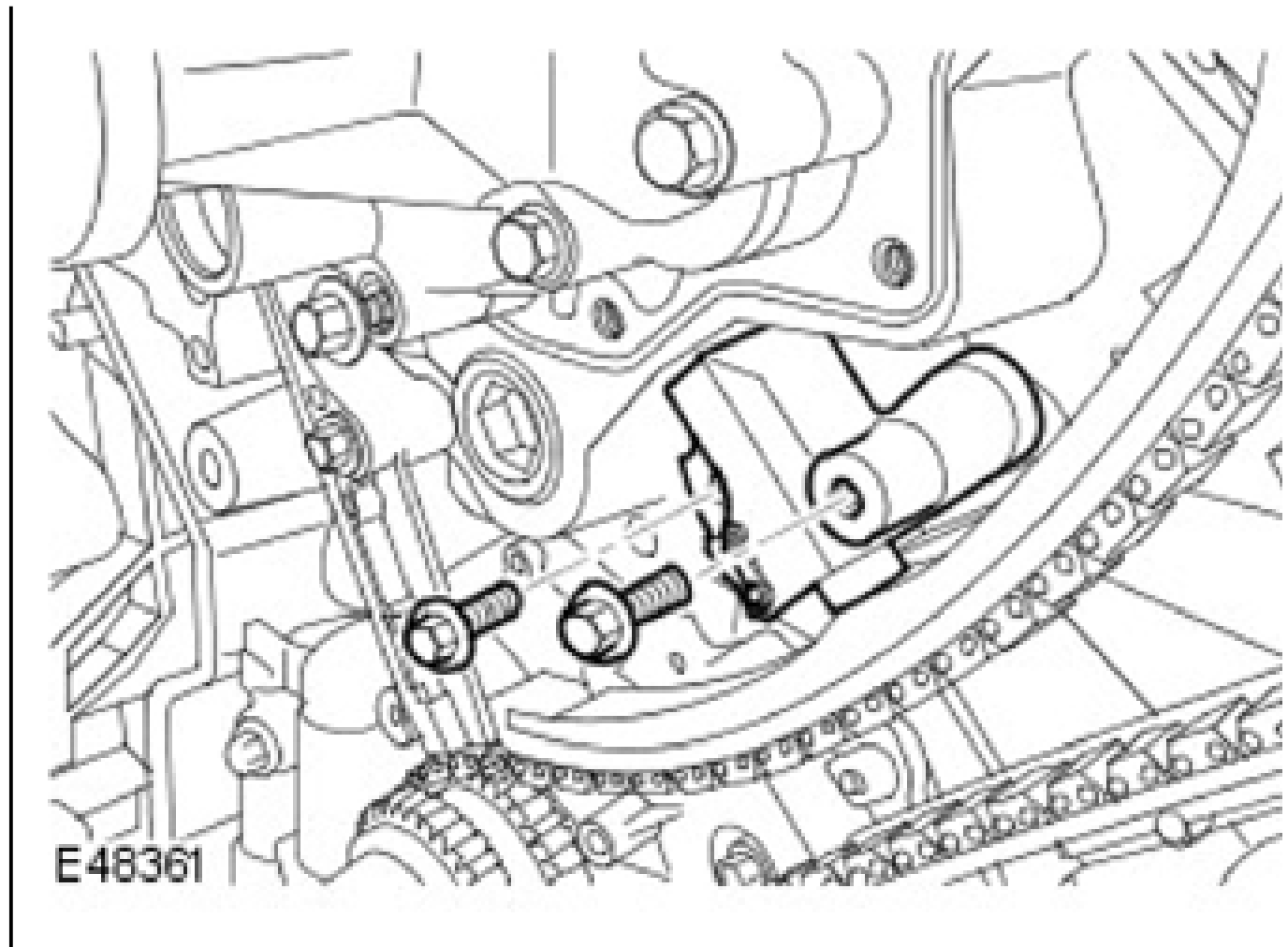


E48360

15. Install the special tools to the LH cylinder head.
 - Install the 3 bolts.

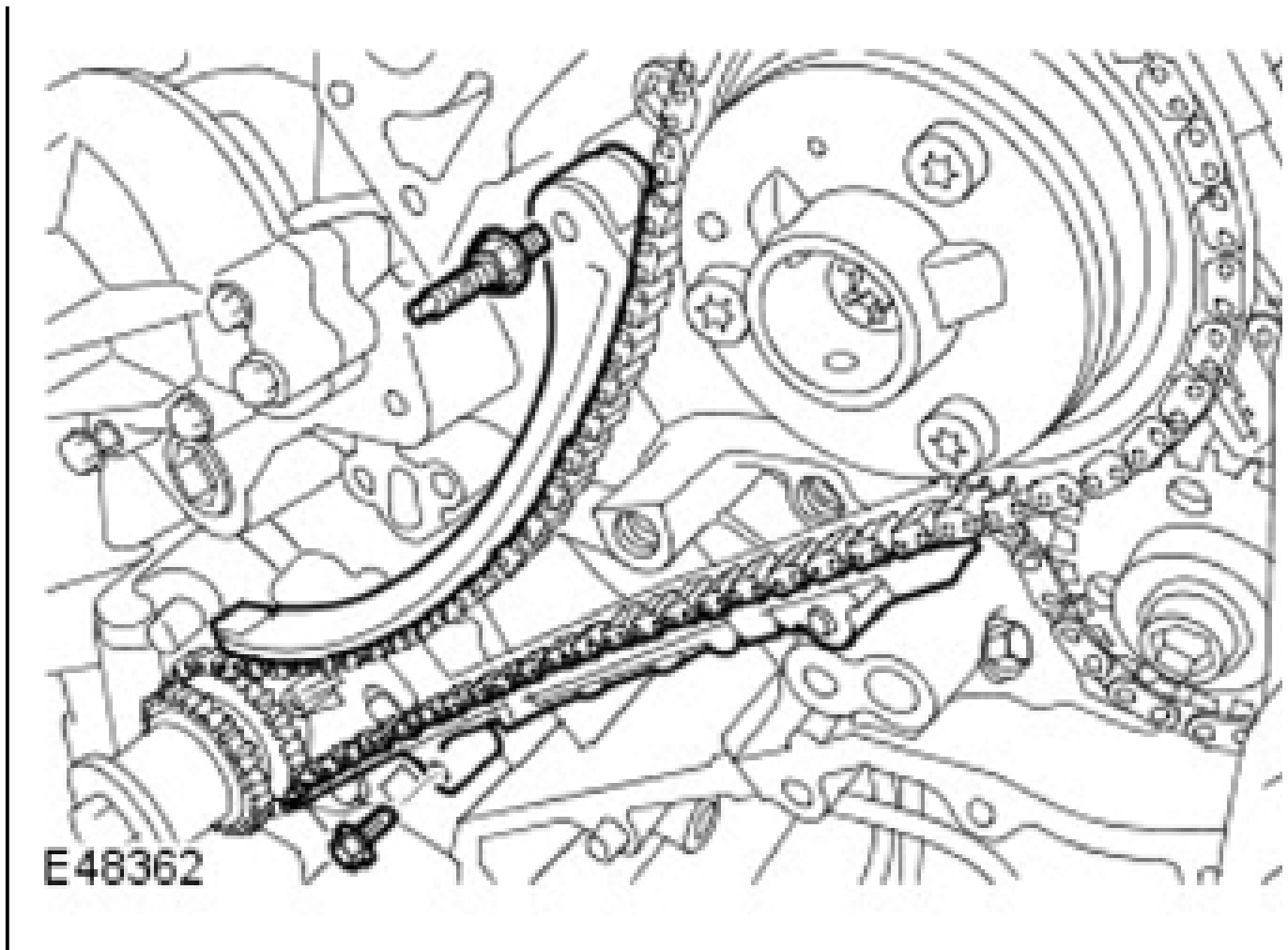


16. Remove the LH primary timing chain tensioner.
 - Remove the 2 bolts.



17. Remove the LH upper and lower primary timing chain tensioner guides.

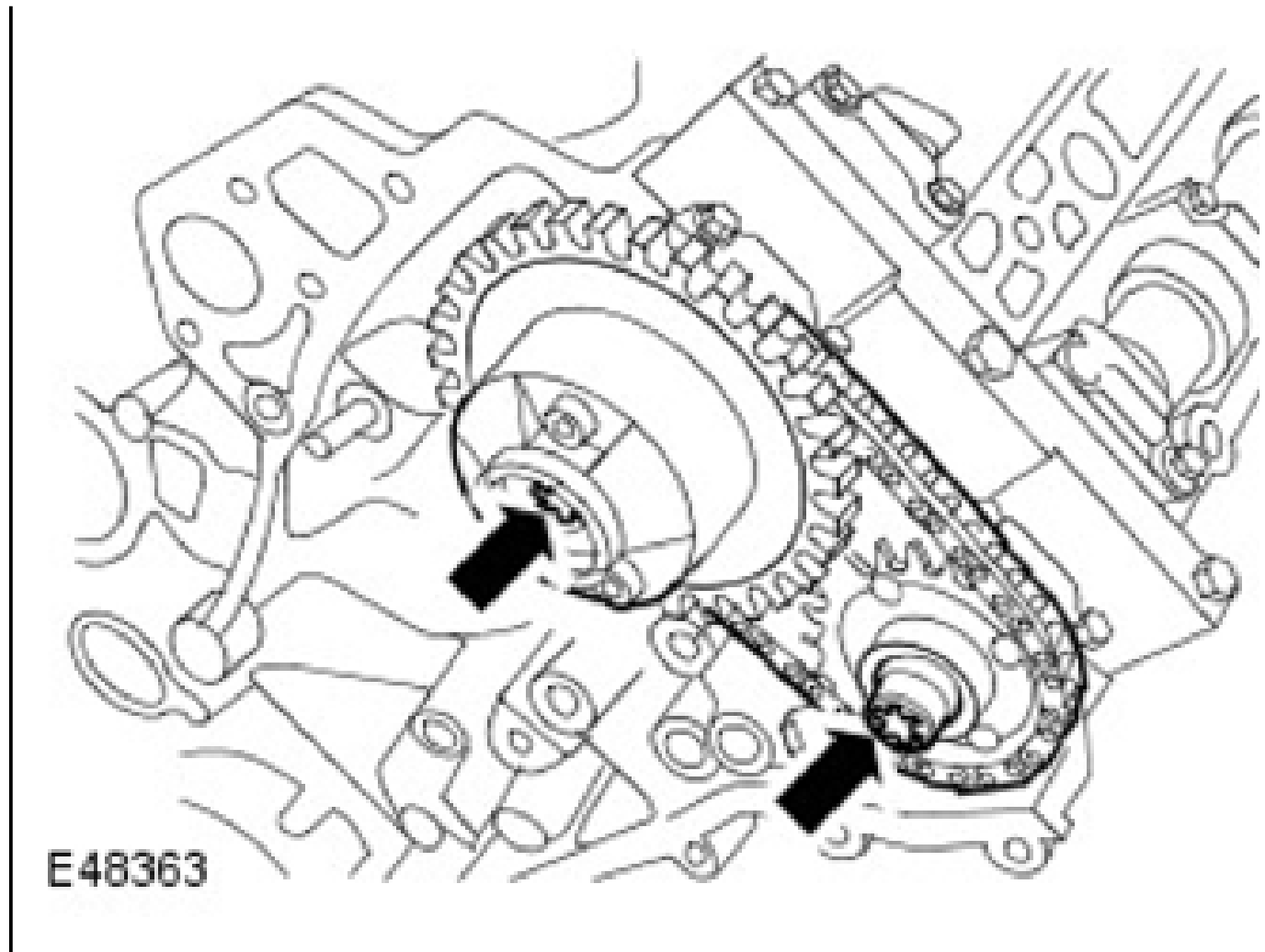
- Remove the stud.
- Remove the bolt.



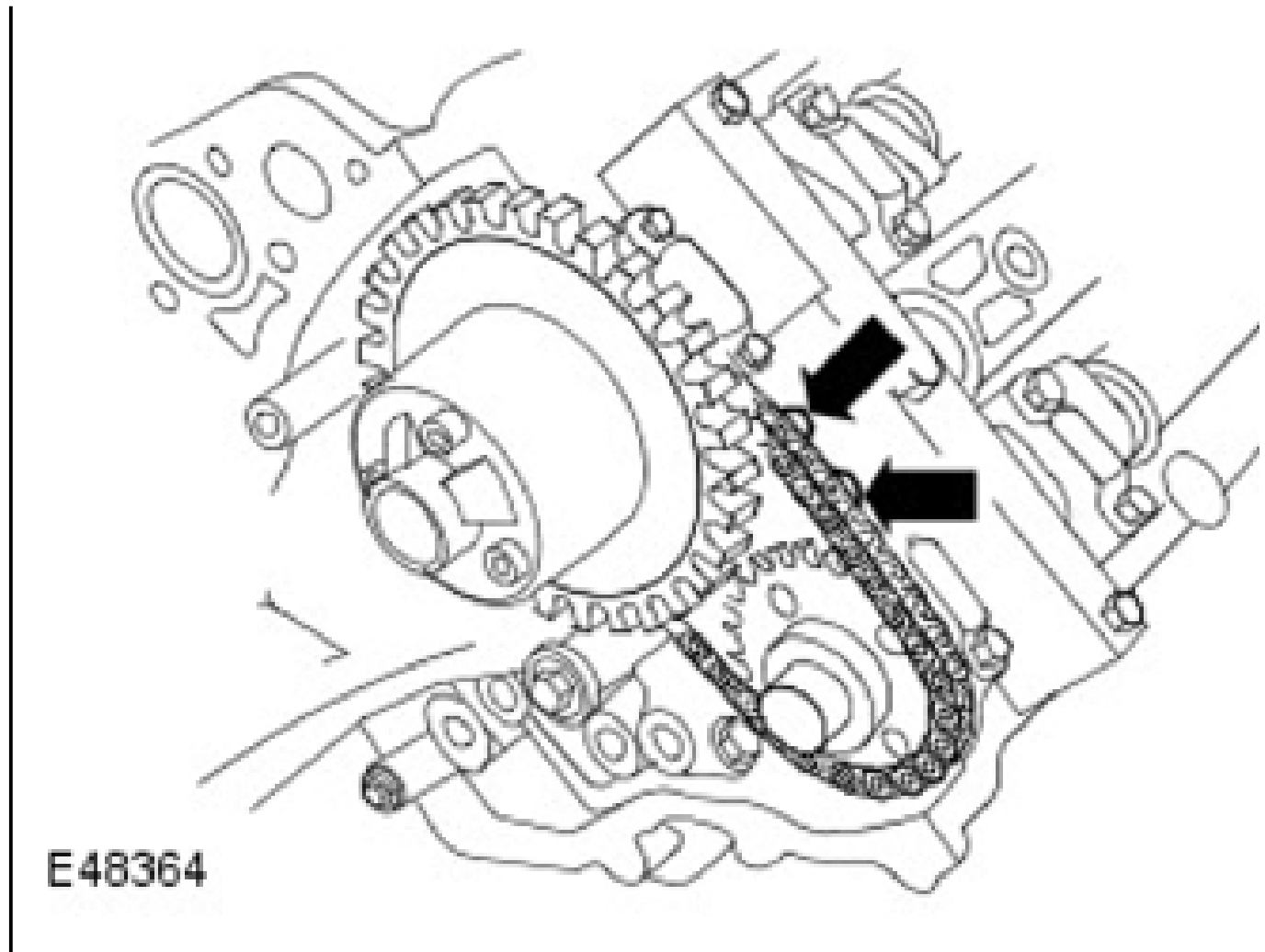
18. Remove the LH primary timing chain.

CAUTION: Discard the bolts.

19. Remove the camshaft sprockets.
- Remove the 2 bolts.



20. Remove the secondary timing chain tensioner and the secondary timing chain.
- Remove the 2 bolts.



21. Remove the special tools from the LH cylinder head.

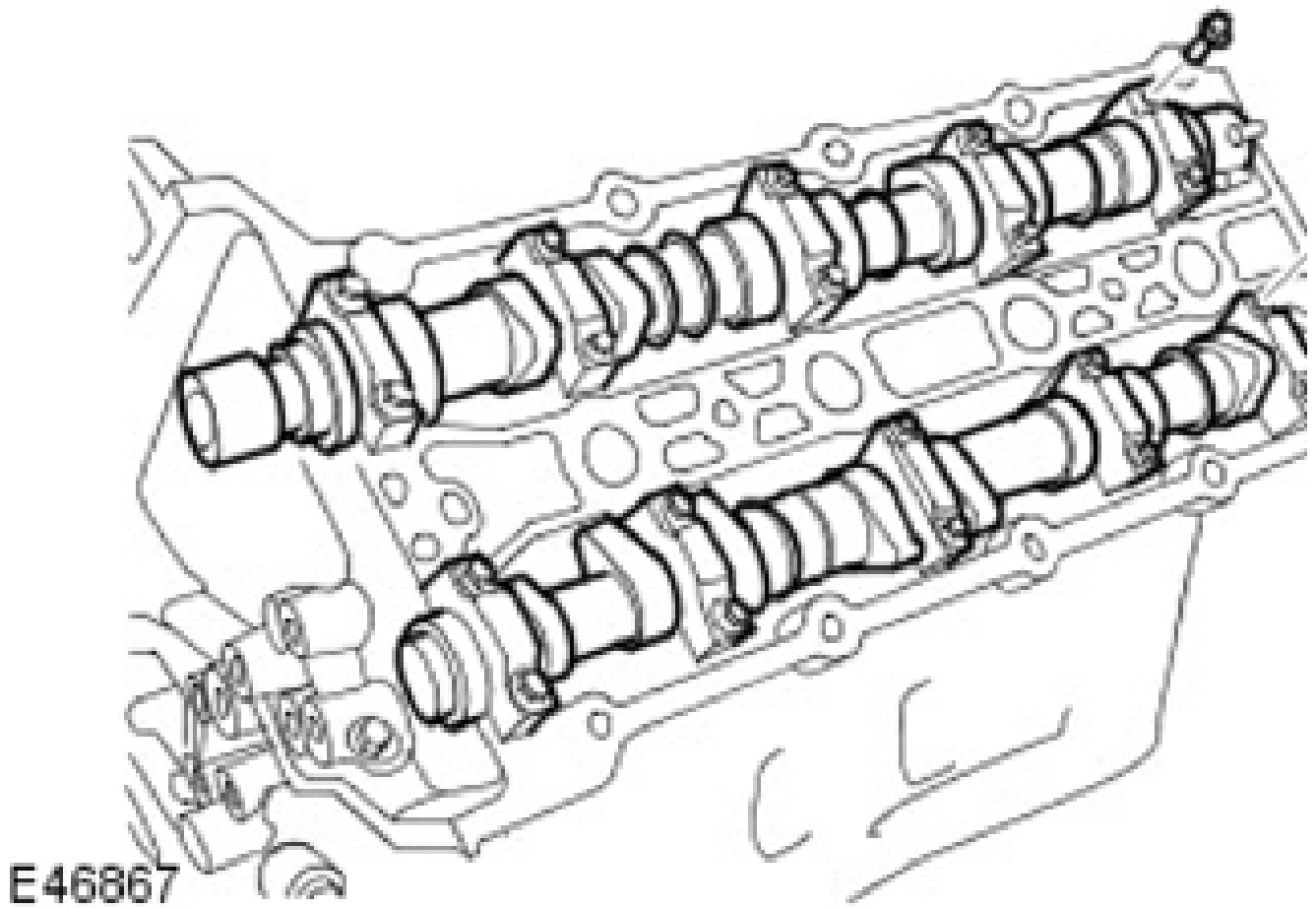
- Remove the 3 bolts.

CAUTION: Evenly and progressively, release the camshaft bearing caps.

NOTE: Remove the camshaft bearing caps. Note: their position, orientation and markings. Each is marked with its position (number) and an orientation (arrow).

22. Remove the camshaft bearing caps.

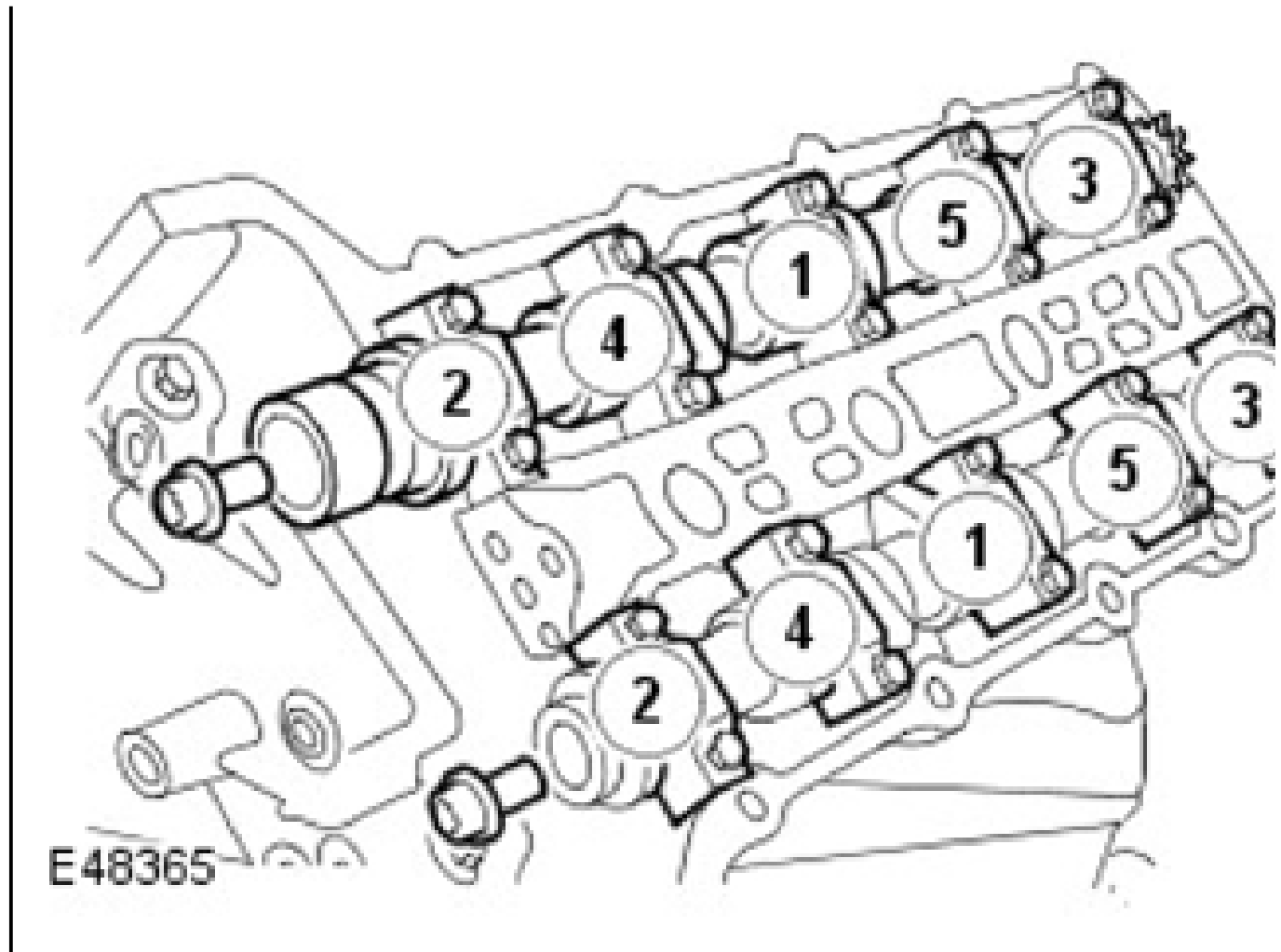
- Remove the 20 bolts.



23. Remove the camshafts.

INSTALLATION

1. Check and adjust the valve tappet clearances.
2. Replace the valve shims, with the smallest shim available.
 - Apply a light coat of clean engine oil to the replacement valve shims.
3. Install the camshafts.
 - Clean the component mating faces.
 - Lubricate the journals and camshaft lobes.
4. Install the camshaft bearing caps.
 - Evenly and progressively tighten the bolts in the sequence shown to 10 Nm.

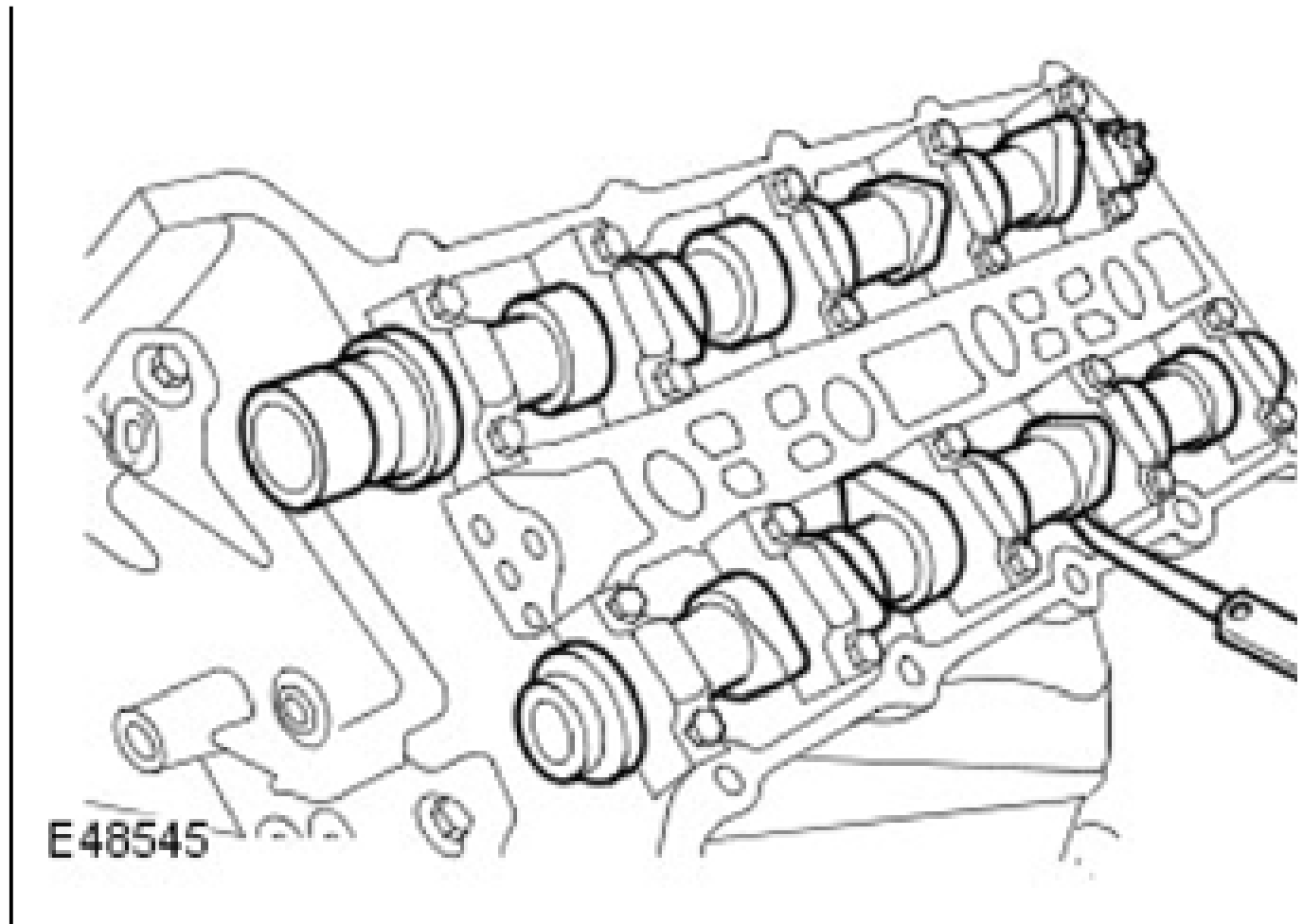


CAUTION: Make sure that new bolts are installed.

5. Install the sprocket retaining Torx bolts to the camshafts.

CAUTION: Camshaft lobes must be 180 degrees away from each valve tappet or valve clearance will be incorrect.

6. Measure and record the tappet clearances.
 - Rotate the camshafts using the Torx bolts.

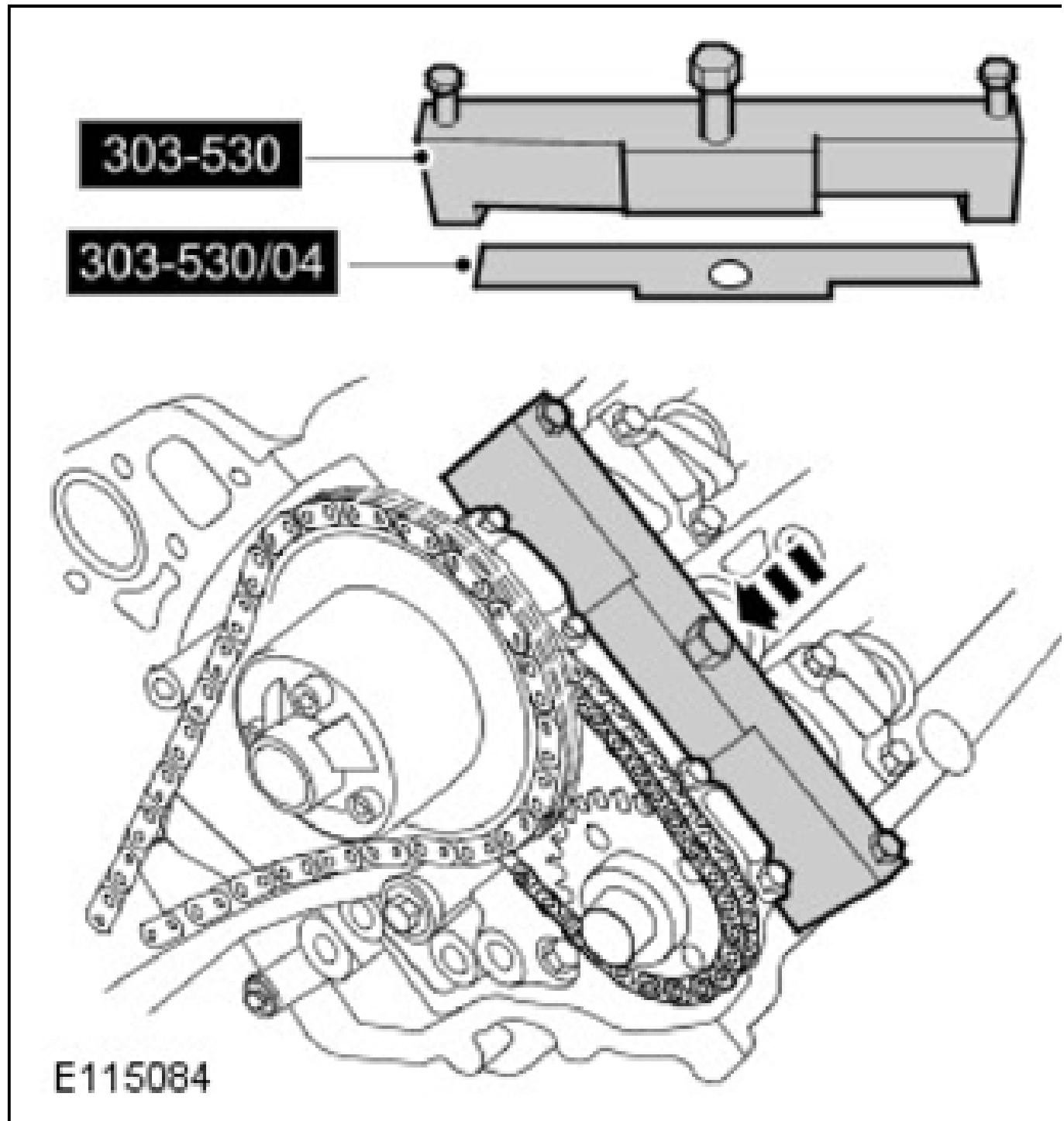


NOTE: Remove the camshaft bearing caps evenly and in stages. Remove the camshaft bearing caps. Note: their position, orientation and markings. Each is marked with its position (number) and an orientation (arrow).

7. Remove the camshafts.
 - Remove the 20 bolts.
8. Remove the valve tappets, replace with selected tappets.
9. Install the camshafts.
 - Lubricate the journals and camshaft lobes.
 - Clean the component mating faces.
10. Install the camshaft bearing caps.
 - Evenly and progressively tighten the bolts in the sequence shown to 10 Nm.

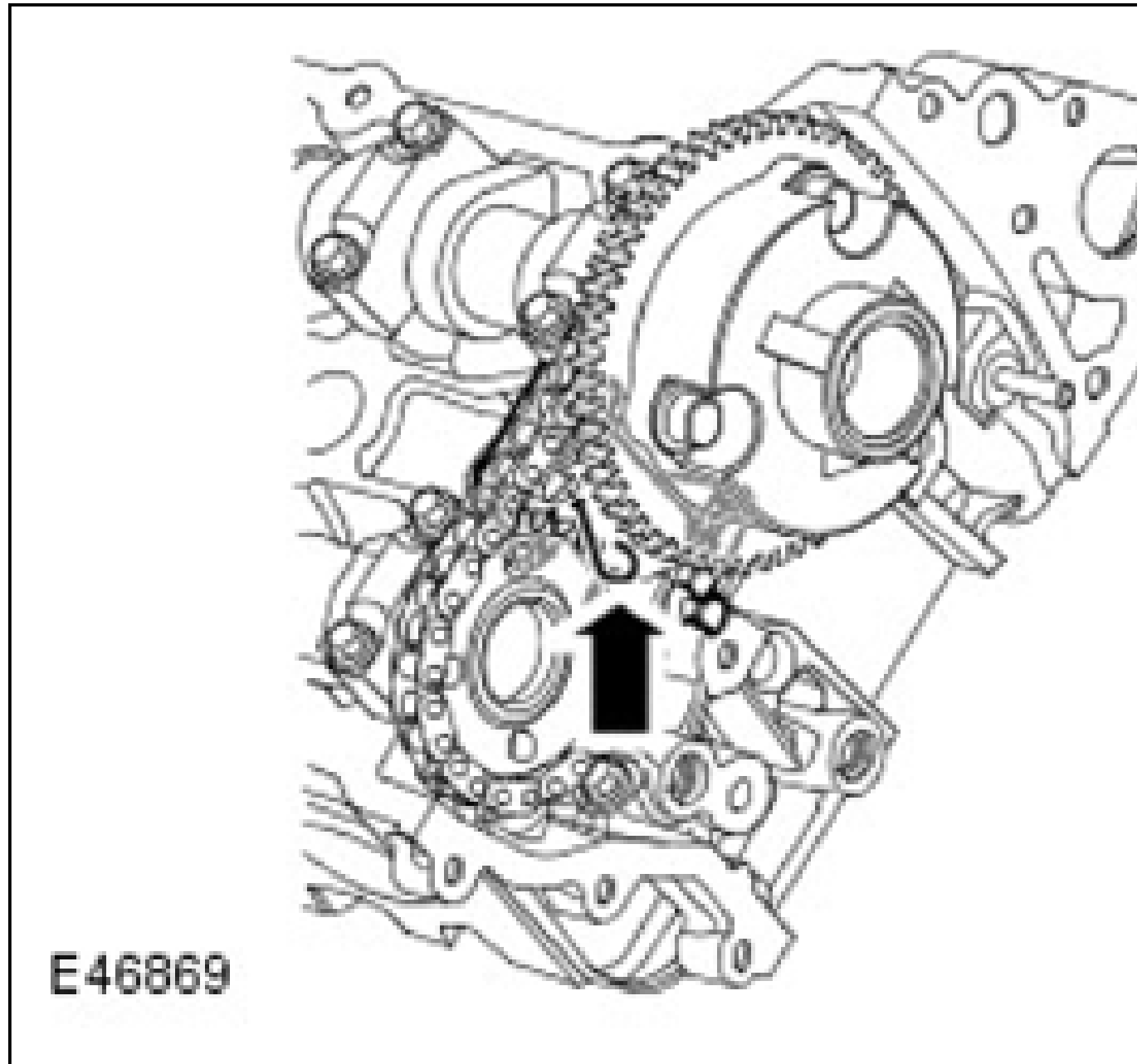
CAUTION: Camshaft lobes must be 180 degrees away from each valve tappet or valve clearance will be incorrect.

11. Check valve tappet clearances are correct.
 - Rotate the camshafts using the Torx bolts.
 - Remove the camshaft Torx bolts after the check is complete.
12. Install the special tools to the LH cylinder head.
 - Install the 3 bolts.



NOTE: RH illustration shown, LH is similar.

13. Depress the LH secondary timing chain tensioner piston.
 - Using 1 mm diameter metal rod, retain the chain tensioner piston.



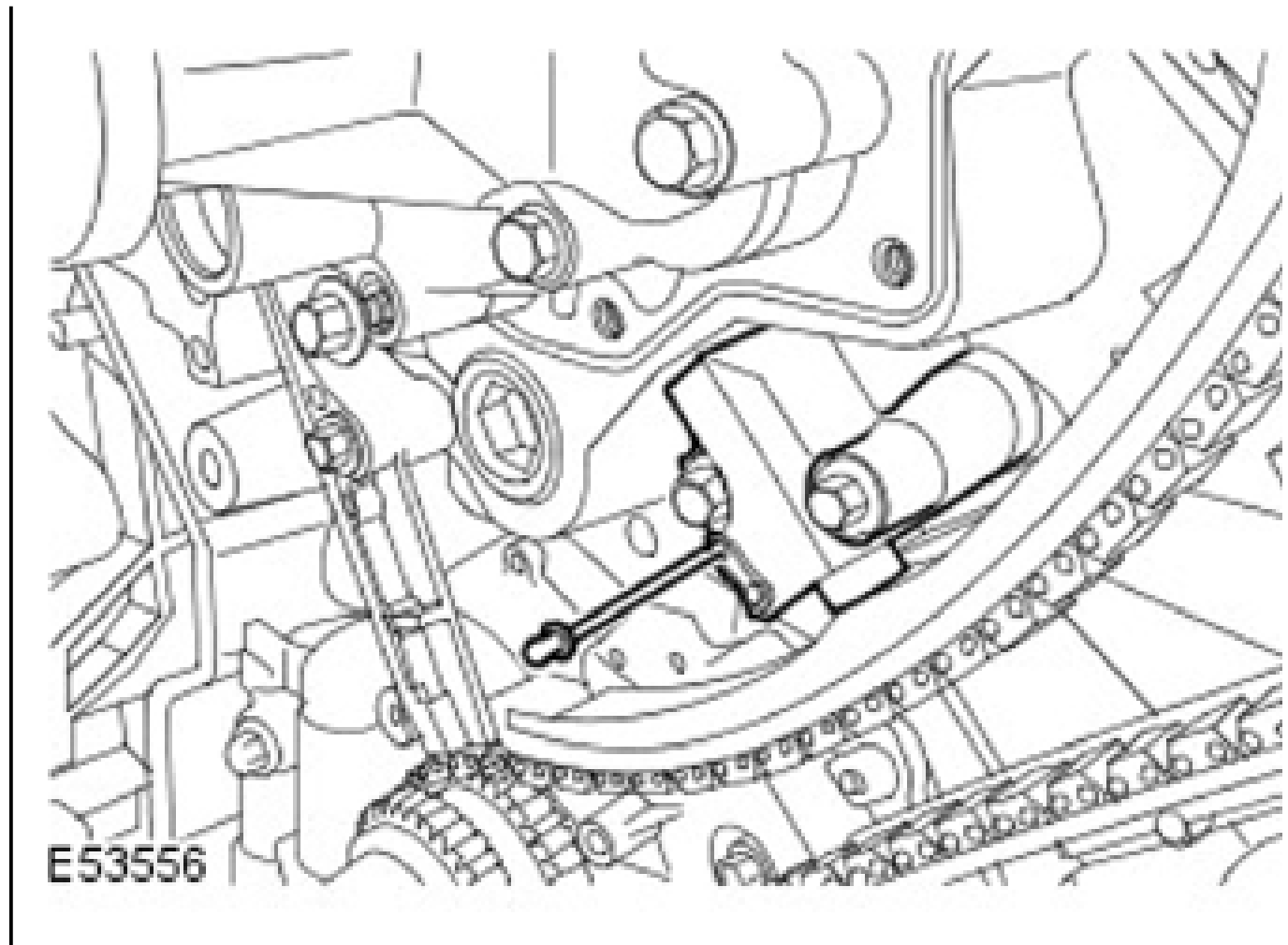
14. Install the LH secondary timing chain tensioner and chain to the camshaft sprockets.
15. Install the LH secondary timing chain tensioner retaining bolts.
 - Tighten the bolts to 12 Nm.

NOTE: **Lightly tighten the camshaft sprocket Torx bolts, the sprockets MUST be free to move.**

16. Install the LH secondary timing chain and sprockets to the camshafts.
 - Install the sprocket retaining Torx bolts to the camshafts.
17. Tension the secondary timing chain.
 - Remove the retaining rod.
18. Install the LH primary timing chain.
 - Make sure the timing chain slack is on the tensioner side of the timing chain.
19. Install the LH primary chain tensioner guide.
 - Tighten the stud to 12 Nm.

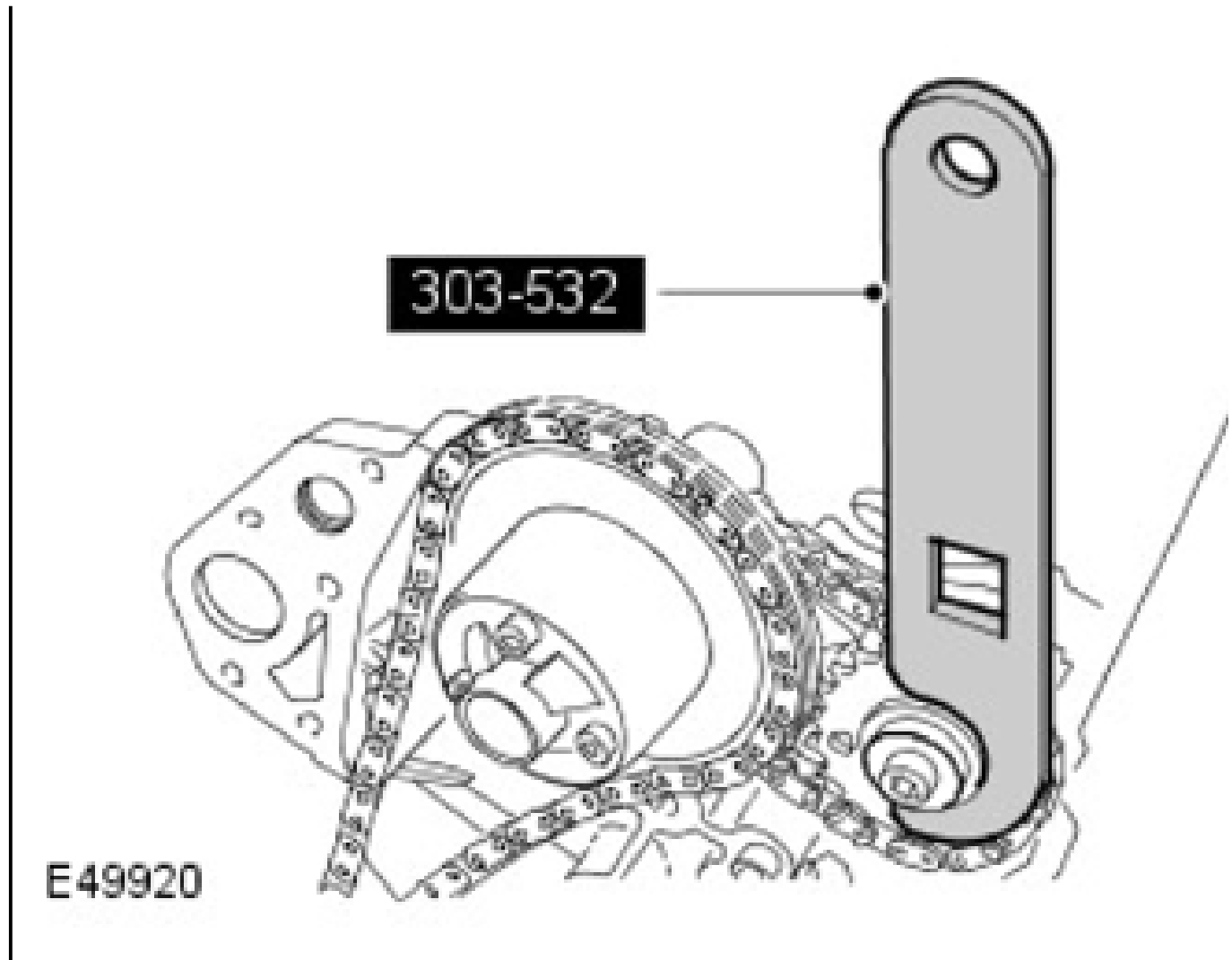
CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

20. Install the LH primary timing chain tensioner.
 - Using 3 mm diameter metal rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm.
 - Remove the retaining rod.

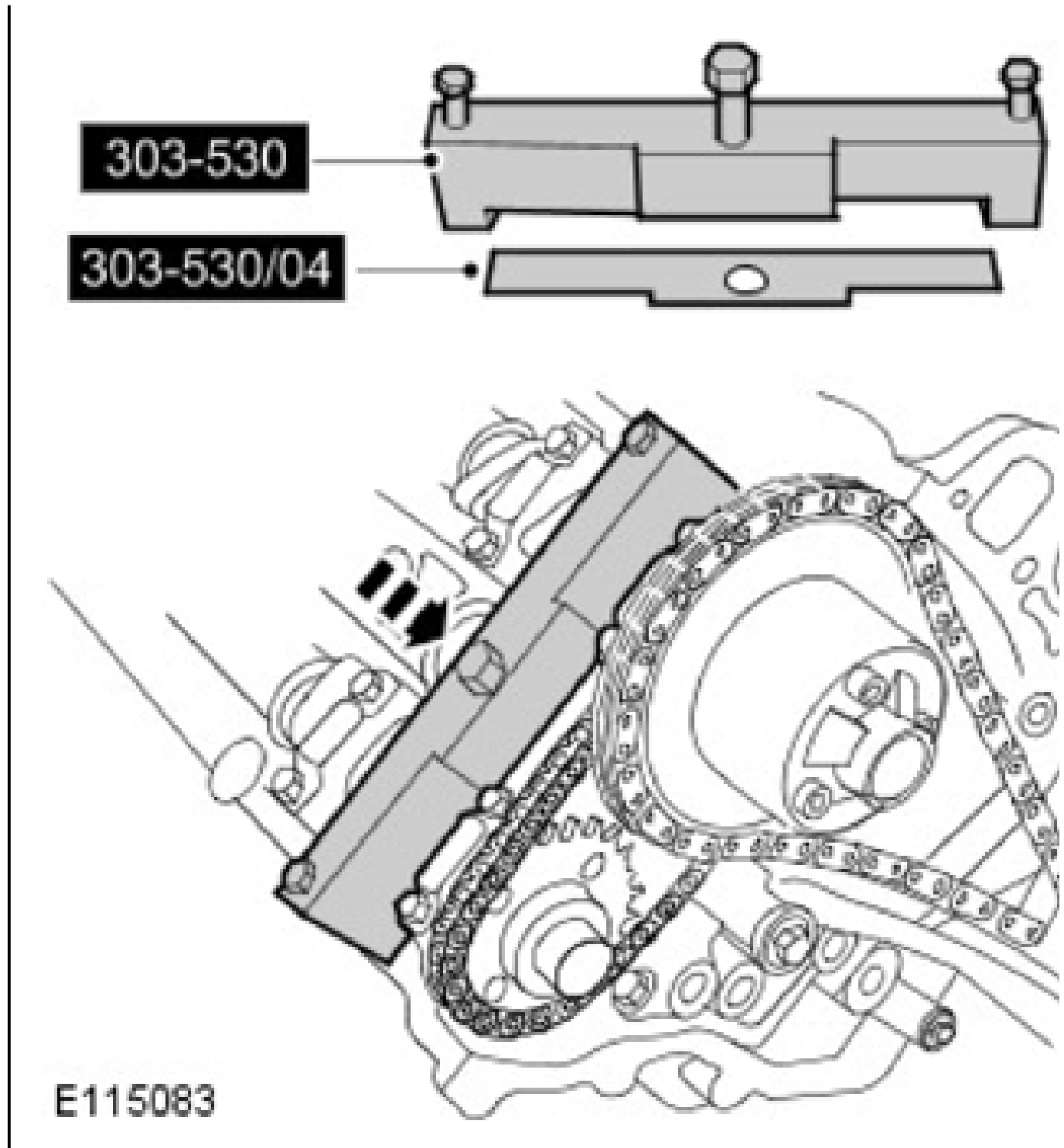


CAUTION: Using the special tool, apply force to the tool in a counter-clockwise direction, to tension the primary timing chain on its drive side. The intake camshaft sprocket retaining bolt **MUST** be tightened before the exhaust camshaft sprocket retaining bolt. Engine damage will occur if this procedure is not followed. Make sure that new bolts are installed.

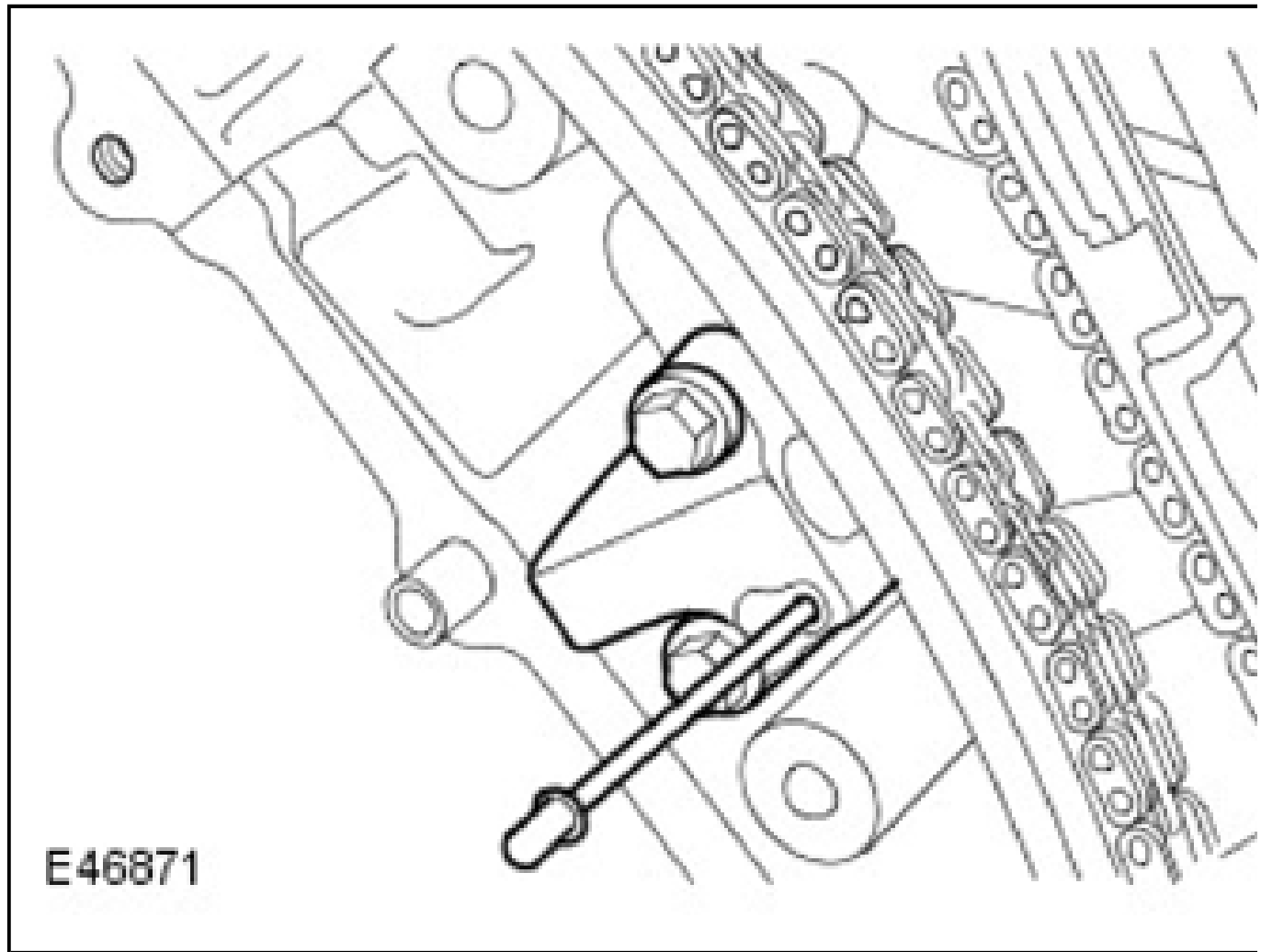
21. Install the special tool to the exhaust camshaft sprocket.
 - Tighten the intake camshaft sprocket retaining bolt to 20 Nm + 90 deg.
 - Tighten the exhaust camshaft sprocket retaining bolt to 20 Nm + 90 deg.



22. Install the LH VCT oil control unit.
 - Install the new O-ring seals.
 - Tighten the new bolts to 22 Nm.
 - Tighten the nut to 10 Nm.
23. Remove the special tools from the LH cylinder head.
 - Remove the 3 bolts.
24. Install the special tools to the RH cylinder head.
 - Install the 3 bolts.



25. Install the RH primary timing chain.
 - Make sure the timing chain slack is on the tensioner side of the timing chain.
26. Install the RH primary timing chain tensioner guide.
 - Tighten the bolts to 12 Nm.



CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

27. Install the RH primary timing chain tensioner.

- Using 3 mm diameter metal rod, retain the chain tensioner piston.
- Tighten the bolts to 12 Nm.
- Remove the retaining rod.

CAUTION: Using the special tool, apply force to the tool in a counterclockwise direction, to tension the primary timing chain on its drive side. The intake camshaft sprocket retaining bolt **MUST** be tightened before the exhaust camshaft sprocket retaining bolt. Engine damage will occur if this procedure is not followed. Make sure that new bolts are installed.

28. Install the special tool to the exhaust camshaft sprocket.
 - Tighten the intake camshaft sprocket retaining bolt to 20 Nm + 90 deg.
 - Tighten the exhaust camshaft sprocket retaining bolt to 20 Nm + 90 deg.
29. Install the RH VCT oil control unit.
 - Install the new O-ring seals.
 - Tighten the new bolts to 22 Nm.
30. Remove the special tools from the RH cylinder head.
 - Remove the 3 bolts.
31. Remove the crankshaft locking tool.
 - Remove the screw.
32. Install the CKP sensor.

For additional information, refer to: **CRANKSHAFT POSITION (CKP) SENSOR** .

NOTE: **Before installing the valve covers, check the valve clearances.**

33. Install the engine front cover.

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

34. Install the battery tray.

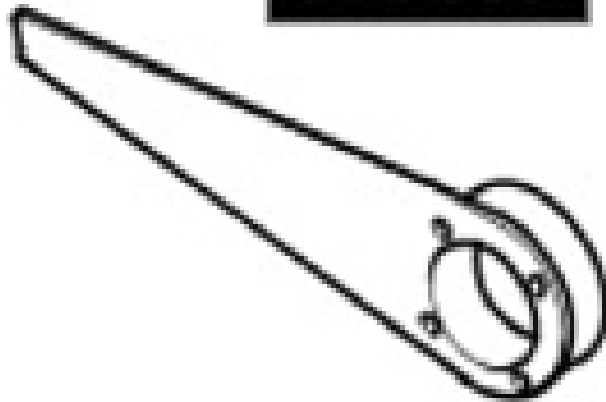
For additional information, refer to: **BATTERY TRAY** .

CRANKSHAFT PULLEY

SPECIAL TOOL(S)

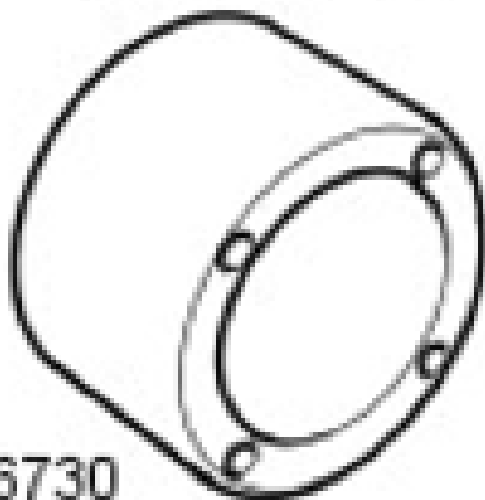
	Holding Tool Crankshaft Pulley 303-893(LRT-12-080)
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303-893



E46728

303-191-03

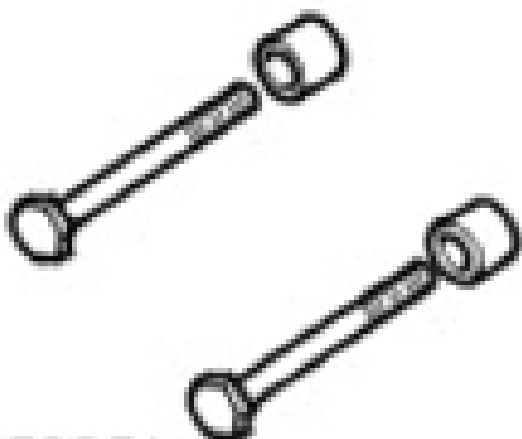


E46730

Adapter
303-191-03

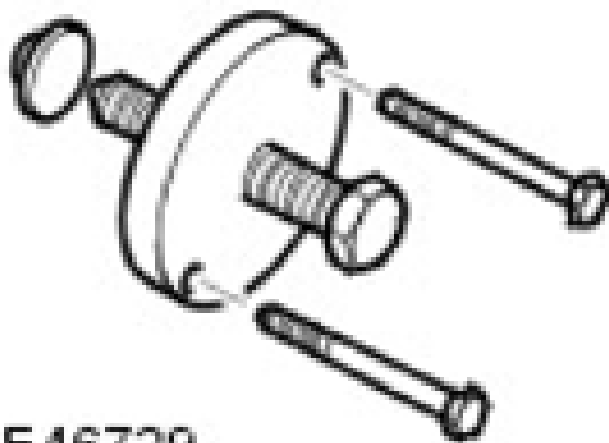
Bolts and spacers
303-191-04

303-191-04



E59251

303-588



E46729

Remover, crankshaft pulley
303-588

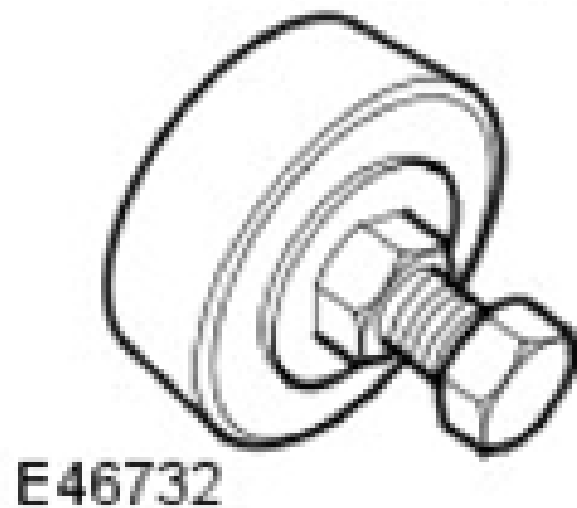
Remover, crankshaft seal
303-D121

303-D121



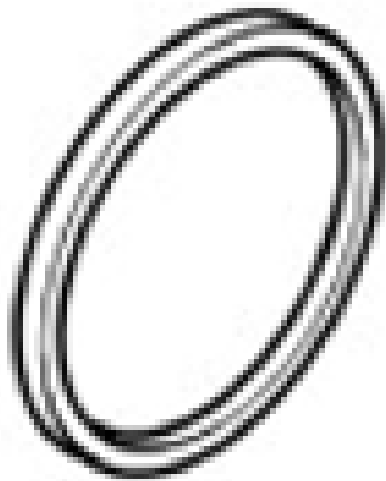
Installer, crankshaft seal
303-1100

303-1100



Adapter - Crankshaft seal installer
303-1100-01

303-1100-01



E67144

REMOVAL

1. Disconnect the battery ground cable.

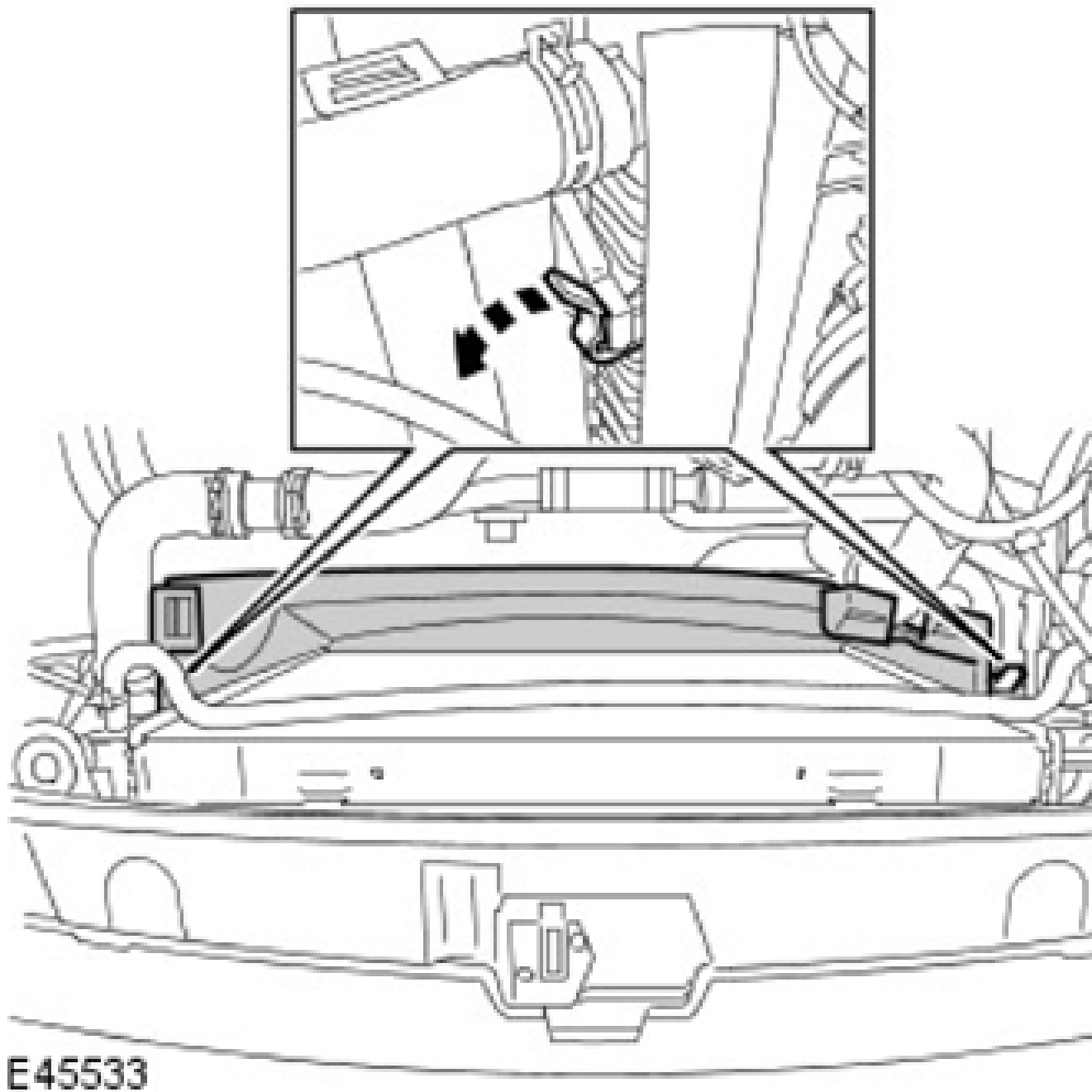
For additional information, refer to: **SPECIFICATION** .

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

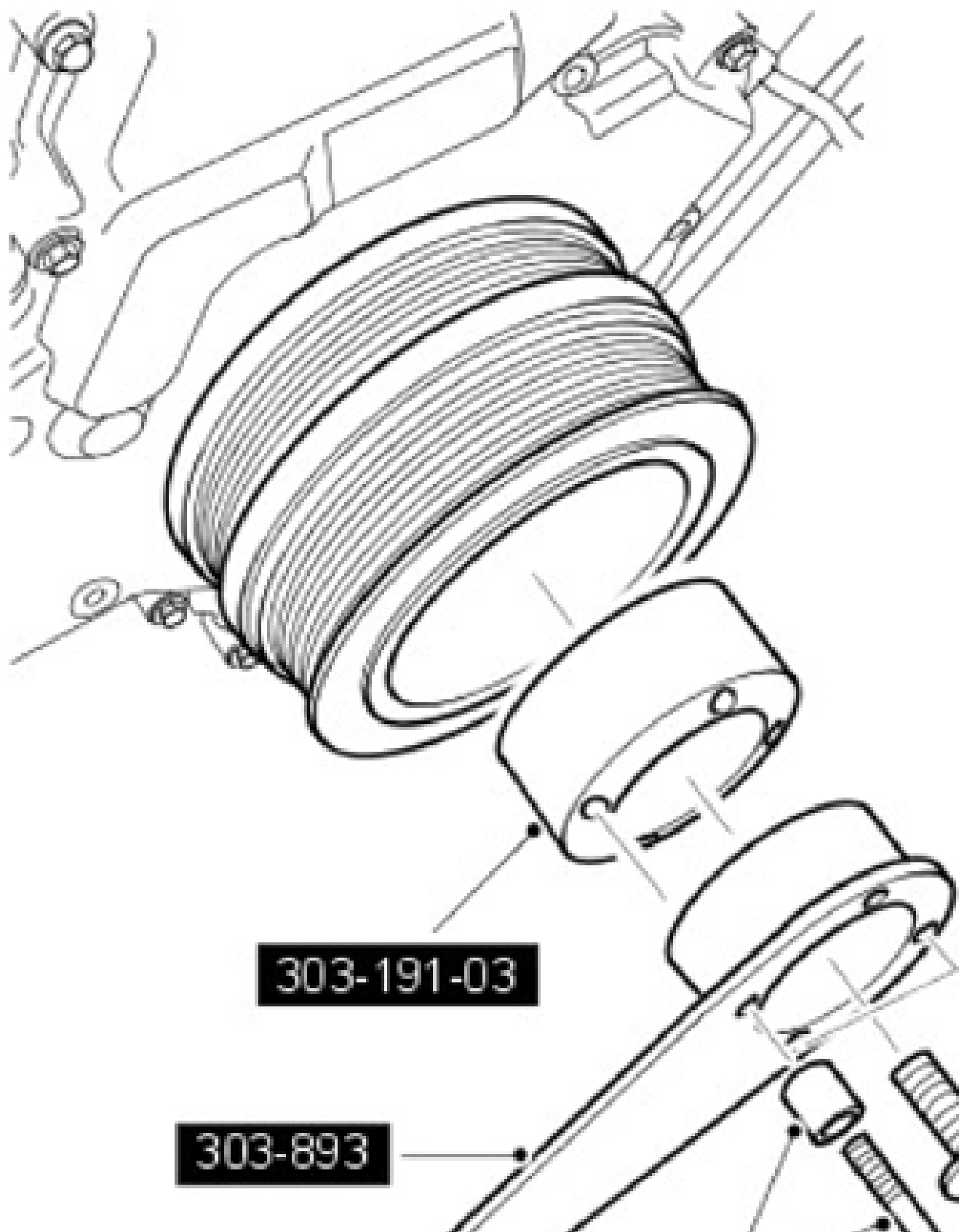
2. Raise and support the vehicle.
3. Remove the accessory drive belt.

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

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



5. Using the special tools, retain the crankshaft pulley.



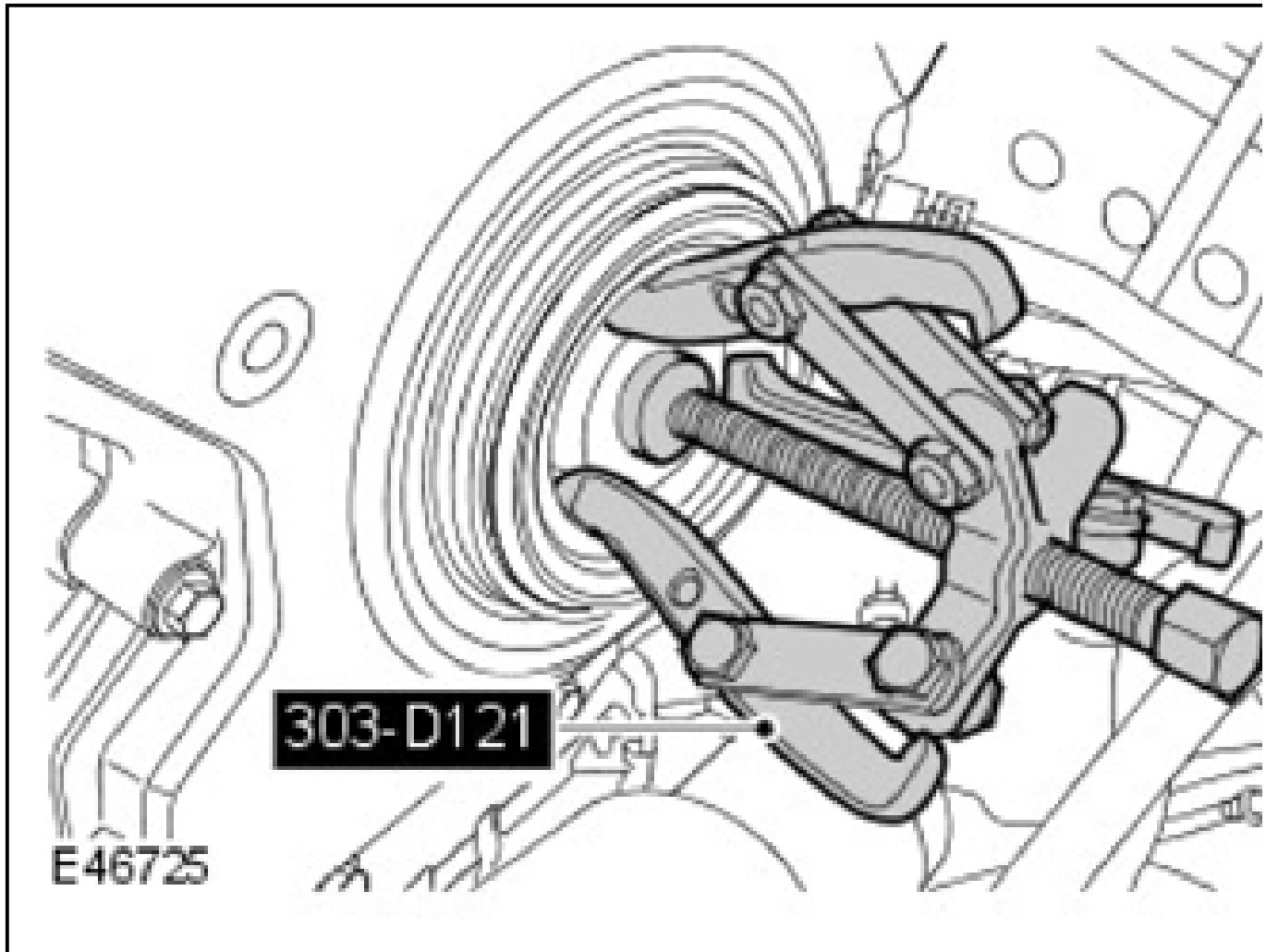
CAUTION: Under no circumstances should the crankshaft setting peg, 303-645, be used in the following operations, to restrain the crankshaft.

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

6. Remove the crankshaft pulley retaining bolt.
 - Discard the bolt.
7. Remove the special tools.
8. Using the special tools, remove the crankshaft pulley.
 - Collect the locking ring.



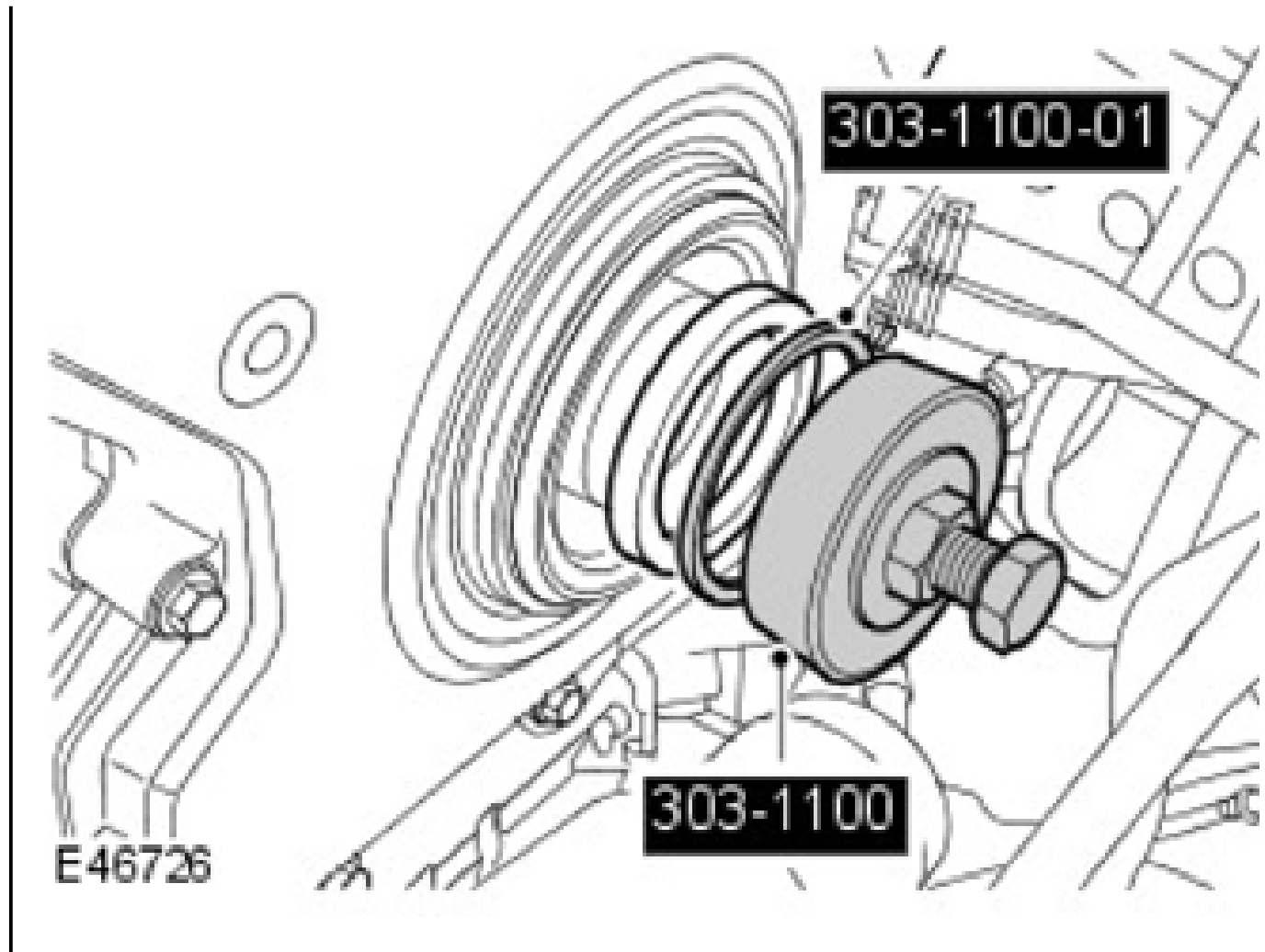
9. Remove the special tools from the crankshaft pulley.
10. Using the special tool, remove the crankshaft front seal.
 - Remove the outer section of the seal.
 - Repeat the process to remove the inner section of seal.



11. Check the crankshaft damper pulley and locking ring for damage.

INSTALLATION

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



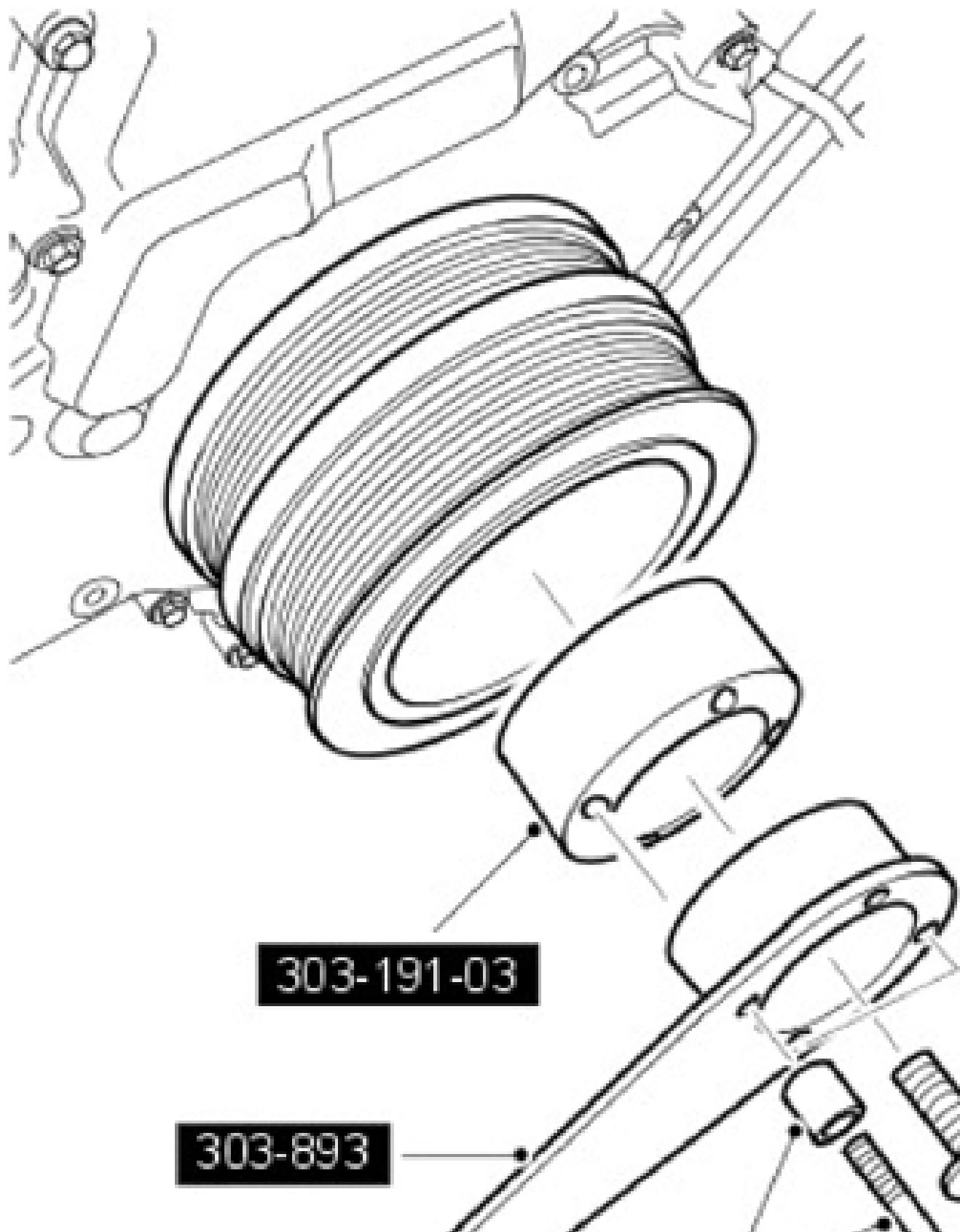
3. Install the crankshaft pulley.
 - Lubricate the seal with clean engine oil.
4. Install the crankshaft pulley locking ring.

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

5. Install, but do not tighten, the new crankshaft pulley bolt.

CAUTION: Under no circumstances should the crankshaft setting peg, 303-645, be used in the following operations, to restrain the crankshaft.

6. Using the special tools, retain the crankshaft pulley.
 - Tighten the crankshaft pulley bolt to 380 Nm (280 lb.ft).



7. Remove the special tools.
8. Install the cooling fan lower shroud.
9. Install the accessory drive belt.

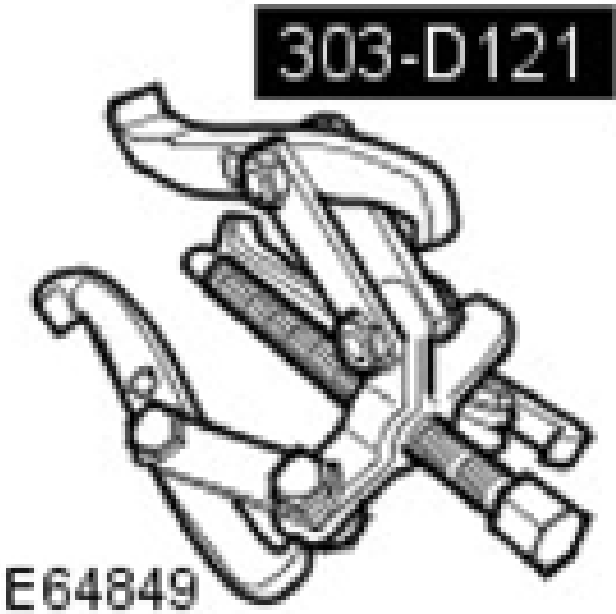
For additional information, refer to: **Accessory Drive Belt** .

10. Connect the battery ground cable.

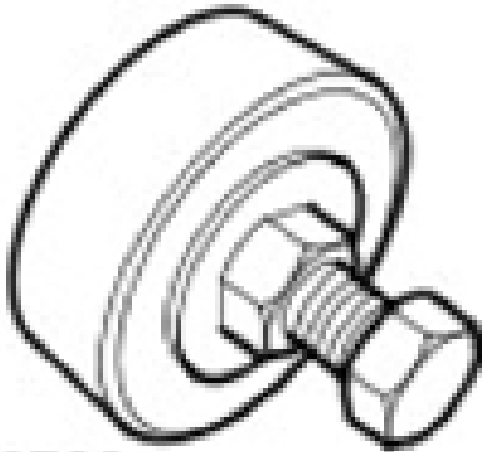
For additional information, refer to: **SPECIFICATION** .

CRANKSHAFT FRONT SEAL

SPECIAL TOOL(S)

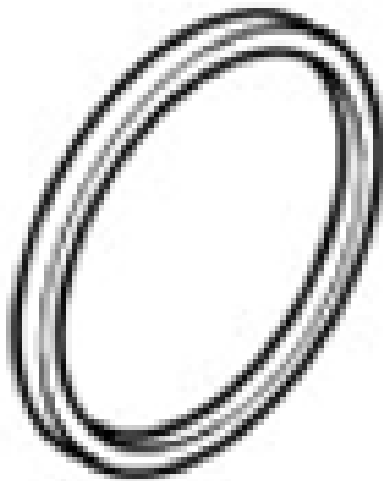
 303-D121 E64849	Remover, crankshaft seal 303-D121
	Installer, crankshaft seal 303-1100

303-1100



E46732

303-1100-01



E67144

Adapter - Crankshaft seal installer
303-1100-01

REMOVAL

1. Disconnect the battery ground cable.

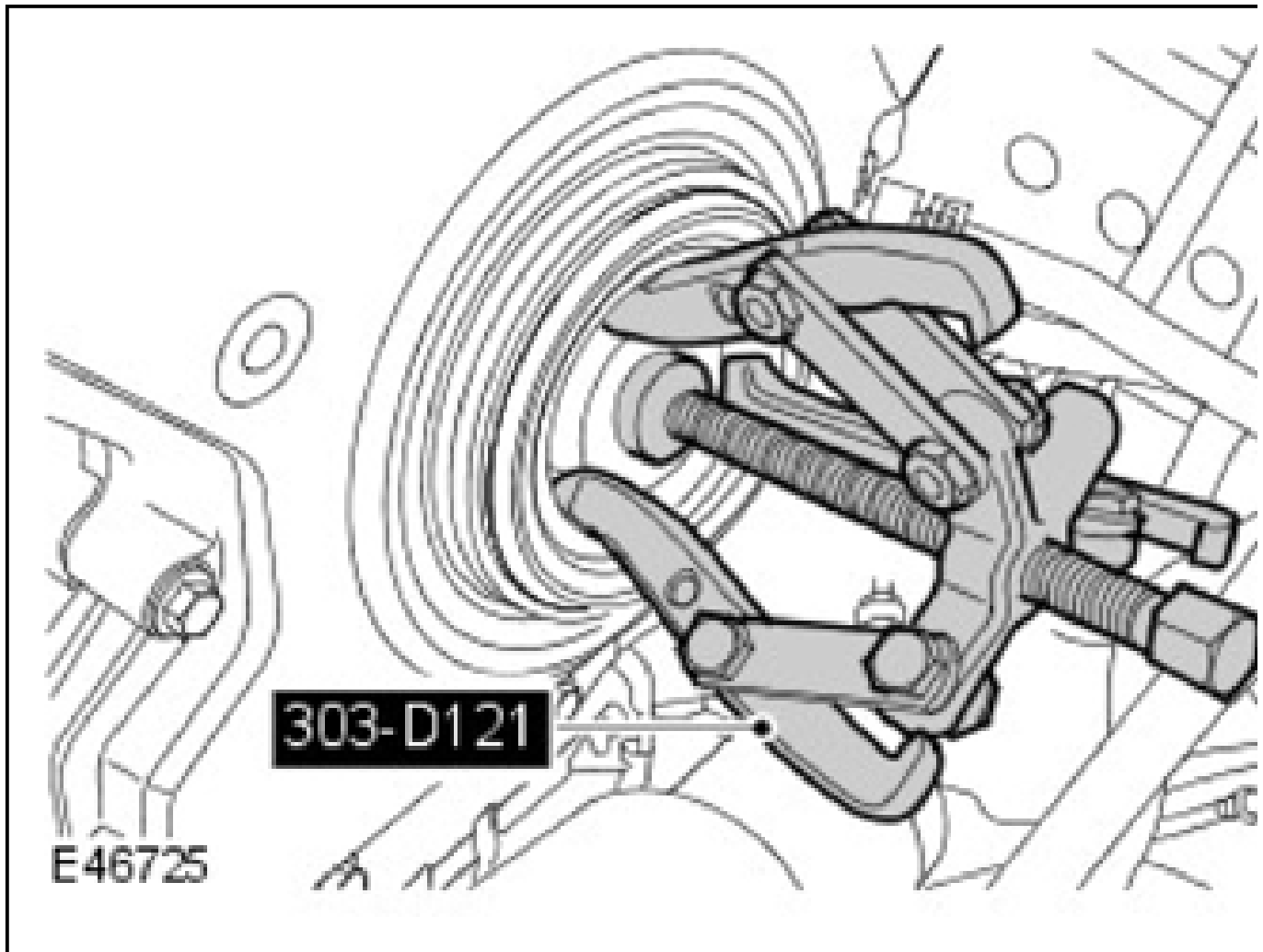
For additional information, refer to: SPECIFICATION .

2. Remove the crankshaft pulley.

For additional information, refer to: CRANKSHAFT PULLEY .

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.

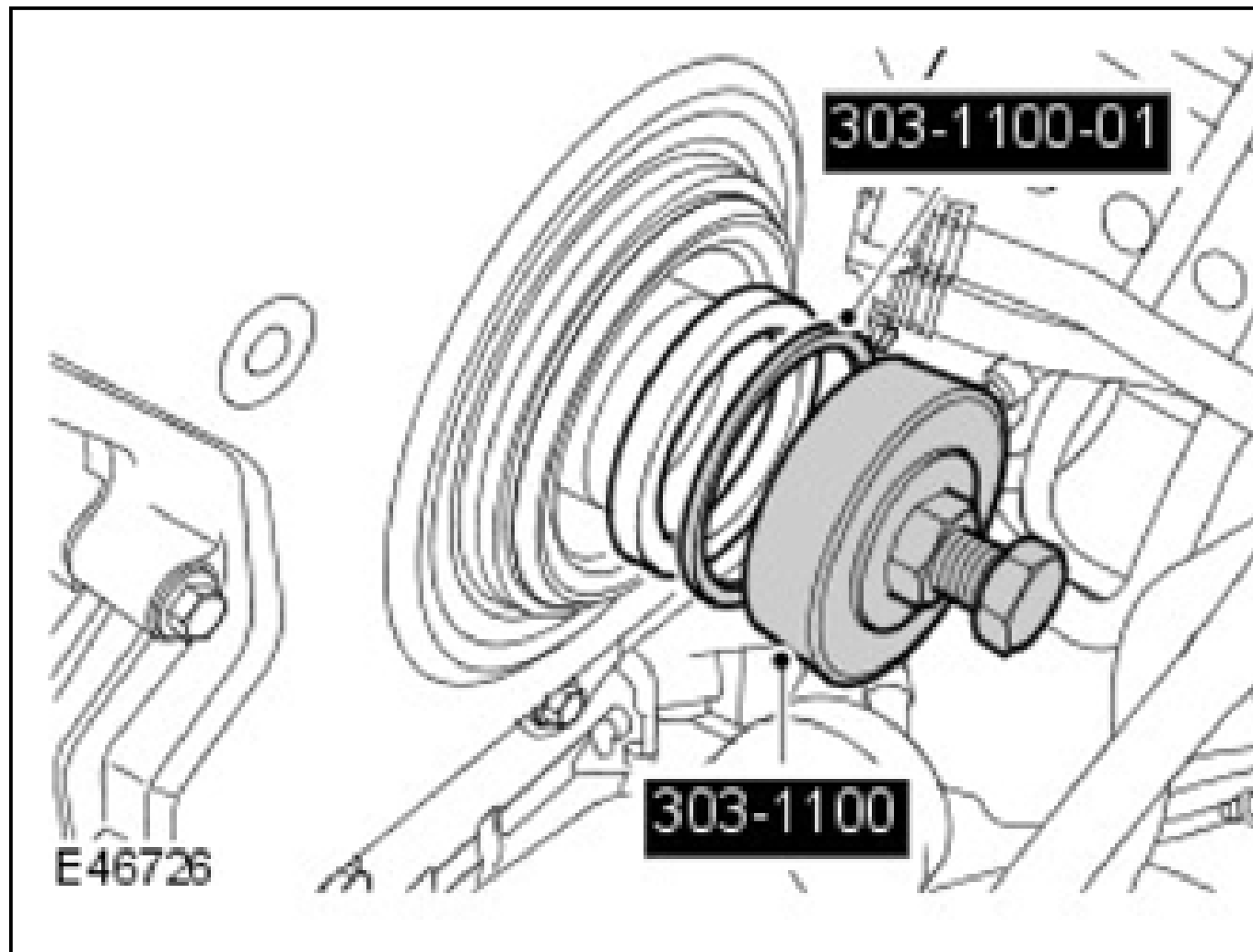
3. Using the special tool, remove the crankshaft front seal.



INSTALLATION

1. Using the special tools, install the crankshaft front seal.

- Clean the component mating faces.



2. Install the crankshaft pulley.

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

CRANKSHAFT REAR SEAL

SPECIAL TOOL(S)

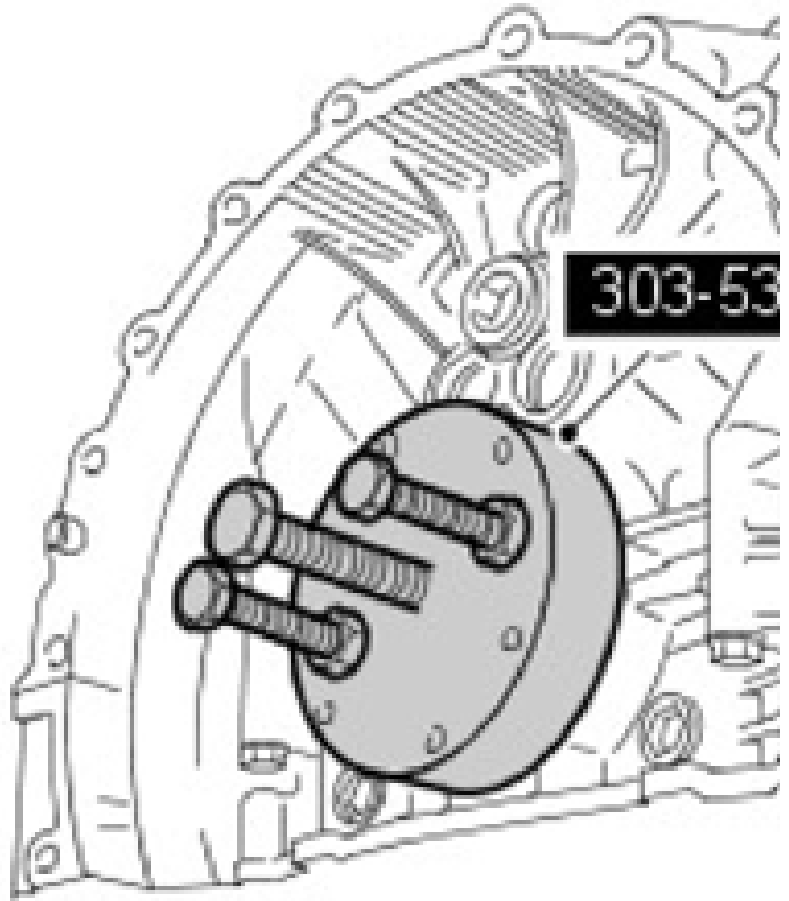
	Crankshaft rear oil seal remover/installer 303-538
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**REMOVAL**

1. Disconnect the battery ground cable.

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

E46613



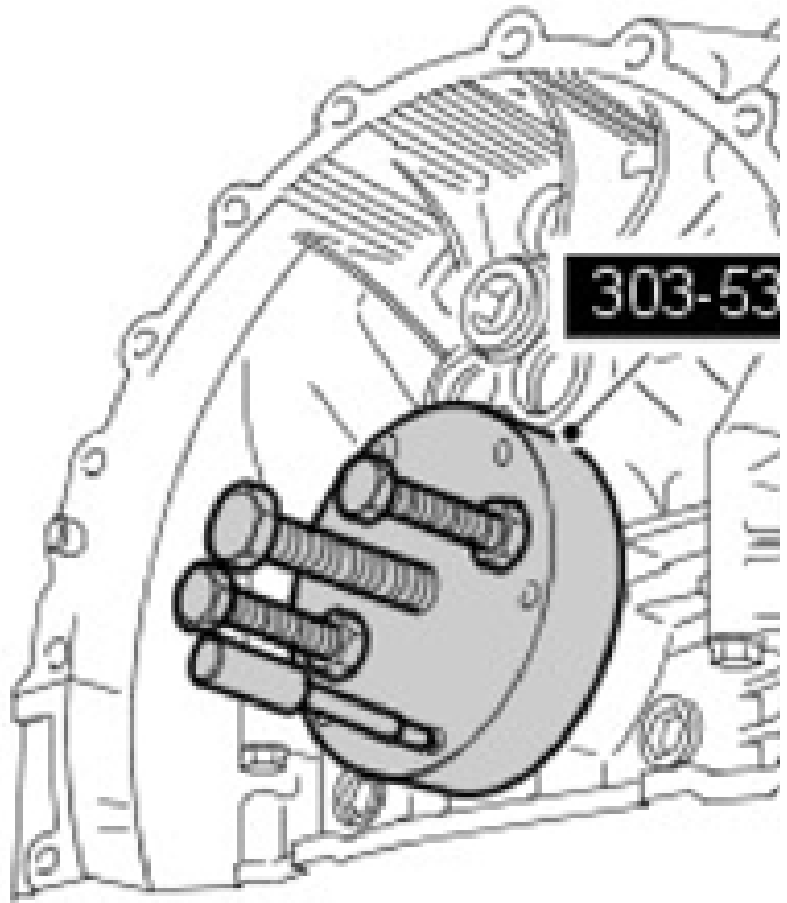
WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

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

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

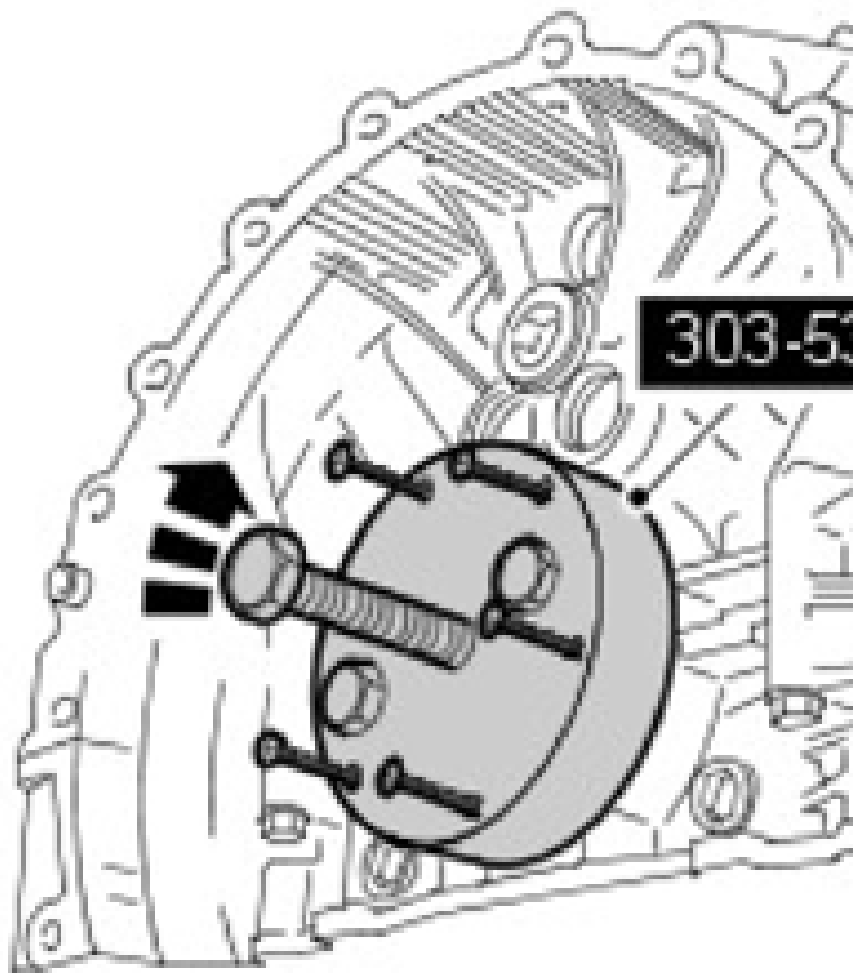
4. Install the special tools.
 - Install the 2 bolts.
 - Tighten the 2 nuts to retain the special tool.
5. Using the special tool, pierce the seal to create holes for the 6 self-tapping screws.

E46614



6. Using the special tools, remove and discard the crankshaft rear oil seal.
 - Install the 6 self-tapping screws.
 - Adjust the 2 nuts.
 - Tighten the center bolt.

E46615



INSTALLATION

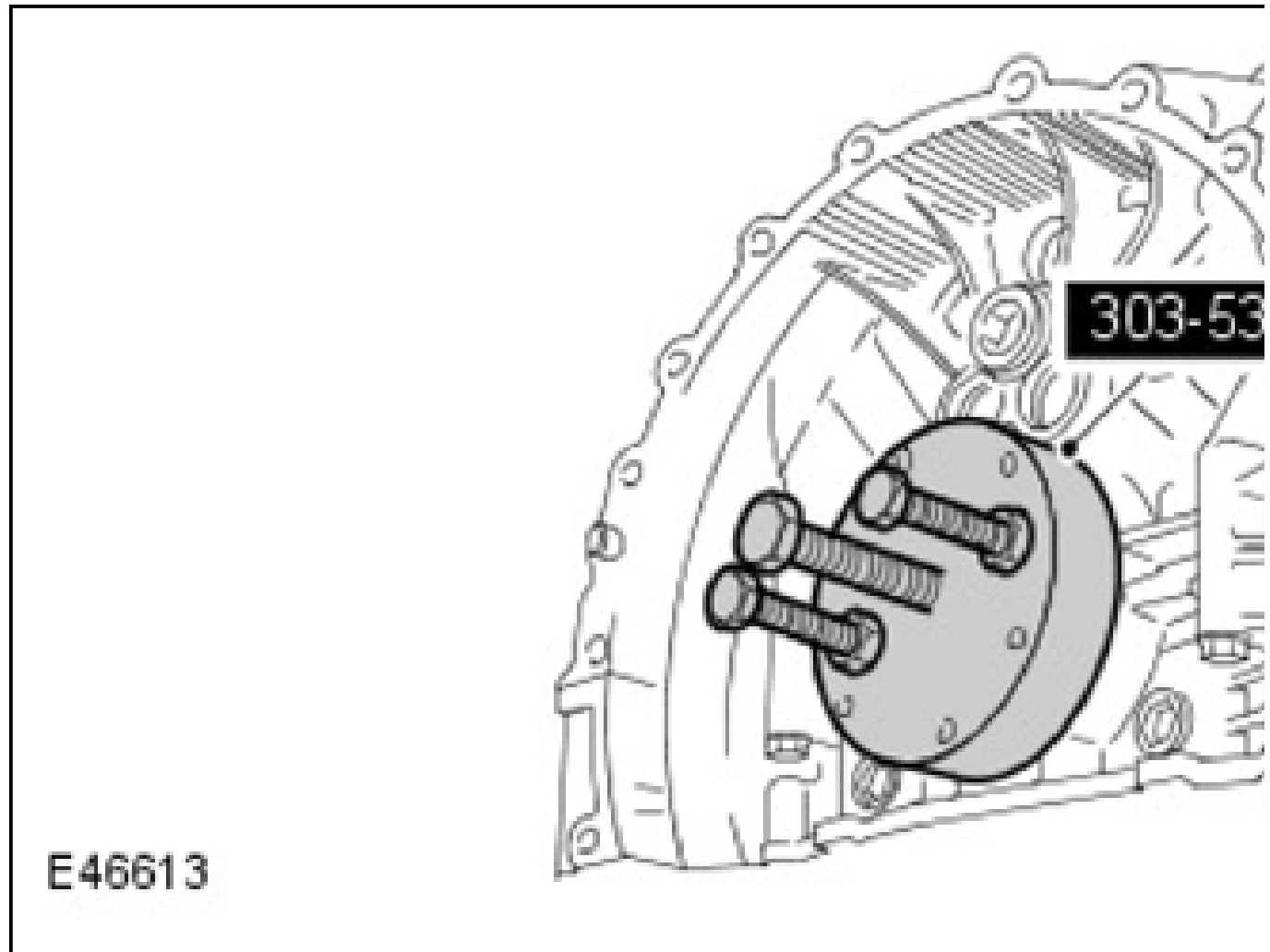
CAUTION: Do not lubricate the components.

1. Partially install the crankshaft rear oil seal.
 - Make sure the components are clean and dry.
 - Carefully remove the transit sleeve, leaving the seal on the crankshaft.

CAUTION: Make sure the seal is installed parallel

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

- Tighten the special tool nuts evenly and progressively to fully install the seal.



3. Install the torque converter flexplate.

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

CYLINDER HEAD LH

REMOVAL

1. Disconnect the battery ground cable.

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

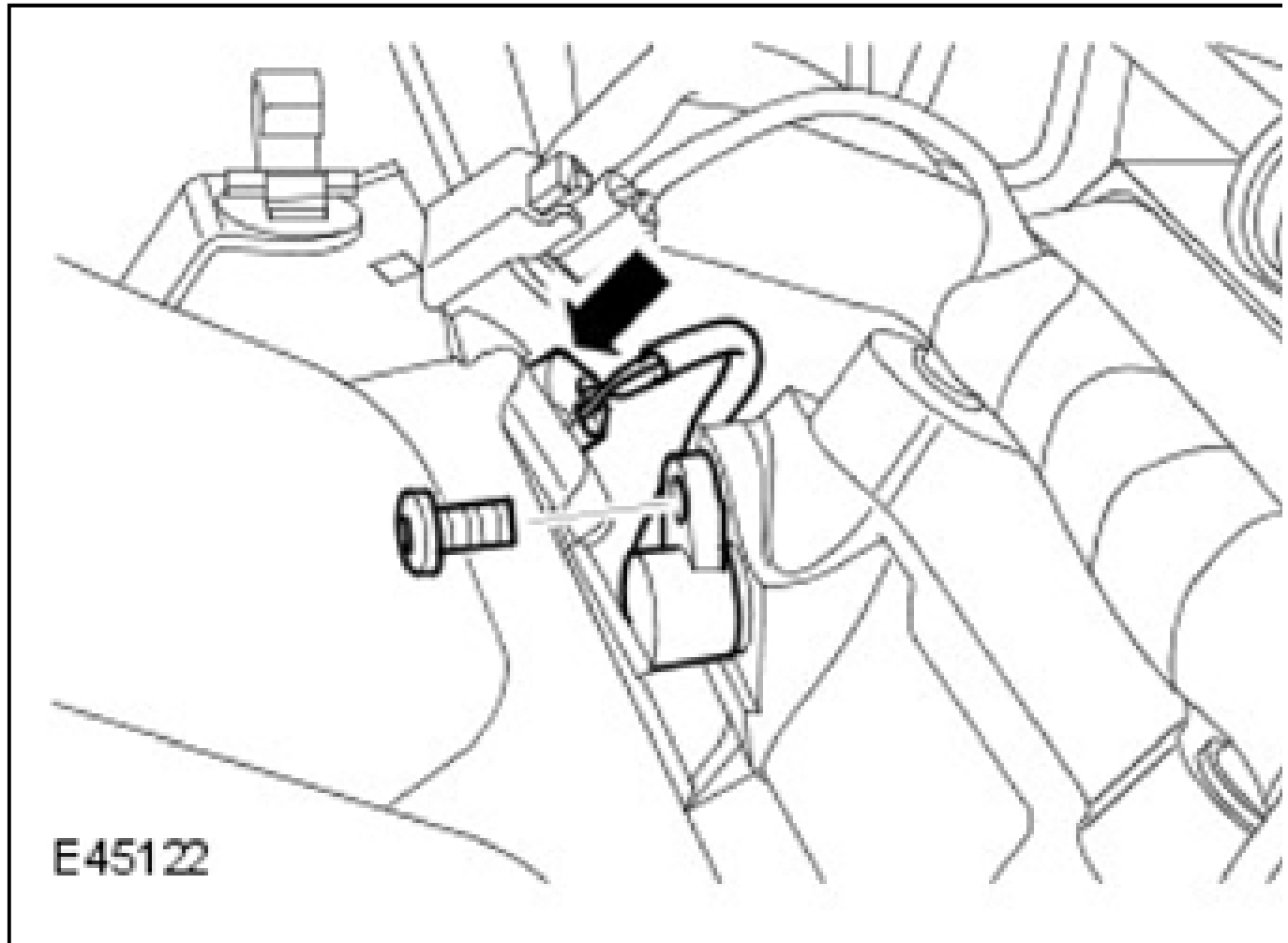
2. Remove the intake manifold.

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

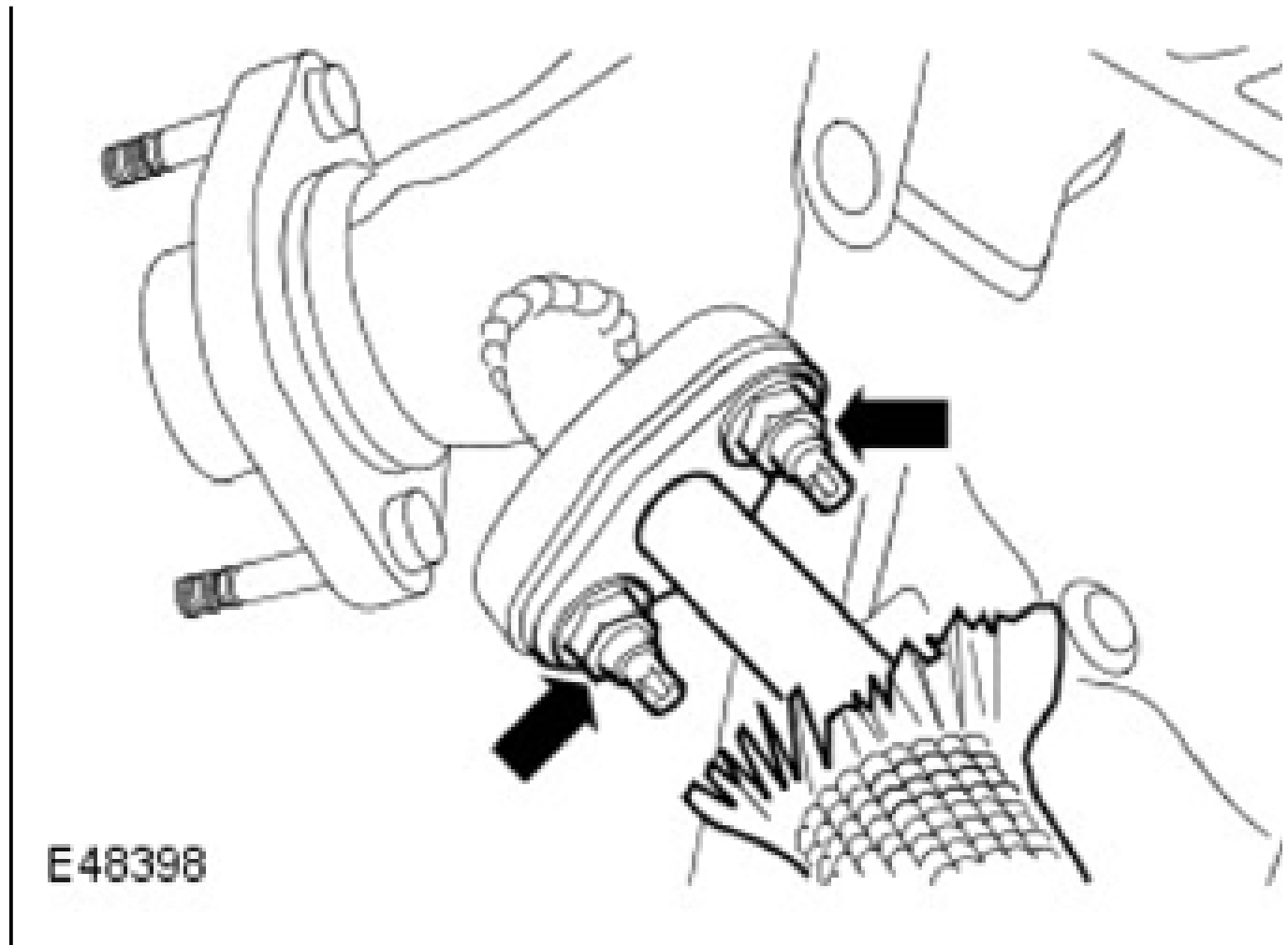
3. Remove the LH bank camshafts.

For additional information, refer to: **CAMSHAFTS LH** .

4. Remove the camshaft position (CMP) sensor.
 - Remove the Torx screw.
 - Disconnect the electrical connector.



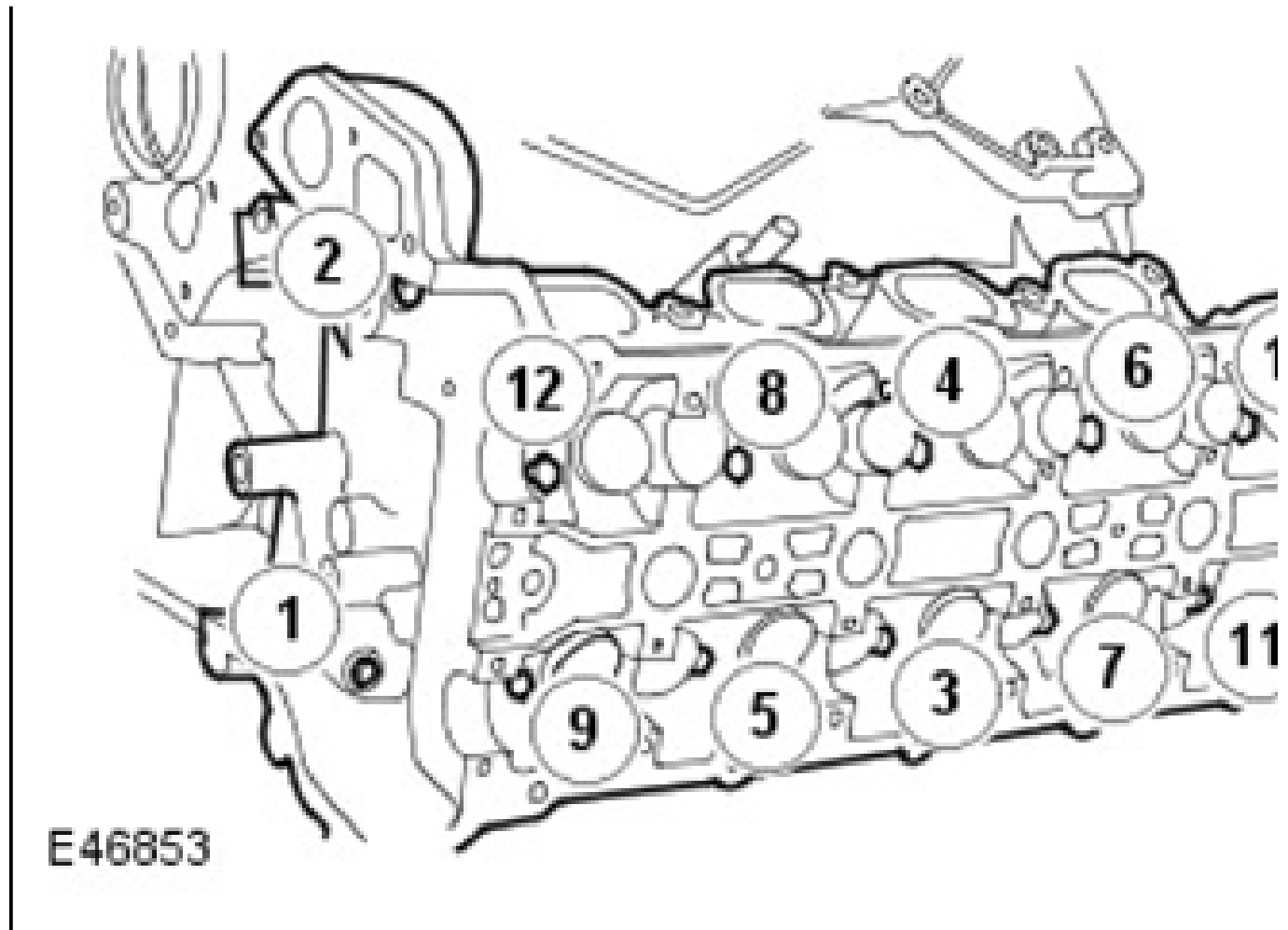
5. Disconnect the exhaust manifold EGR pipe flange.
 - Remove the 2 nuts.



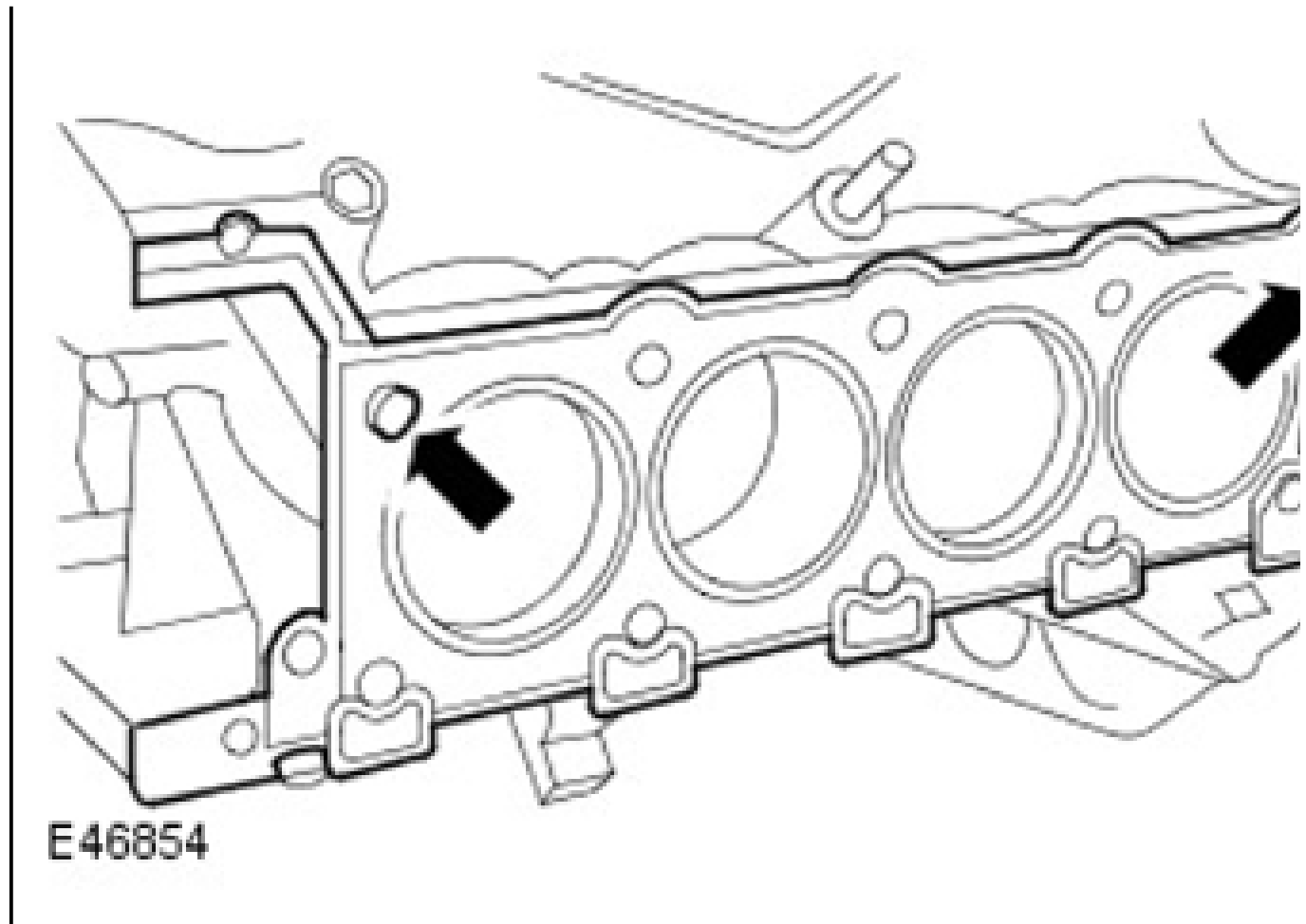
CAUTION: The bolts can only be used twice, mark the bolts with a center punch. If two punch marks are visible, discard the bolts. Vehicles fitted with Polydrive cylinder head bolts, the cylinder head bolts must be removed using a 10 mm Polydrive socket or a 10 mm Allen key. Failure to follow this instruction may result in damage to the component.

NOTE: Remove the bolts in the indicated sequence.

6. Remove the 12 cylinder head bolts.

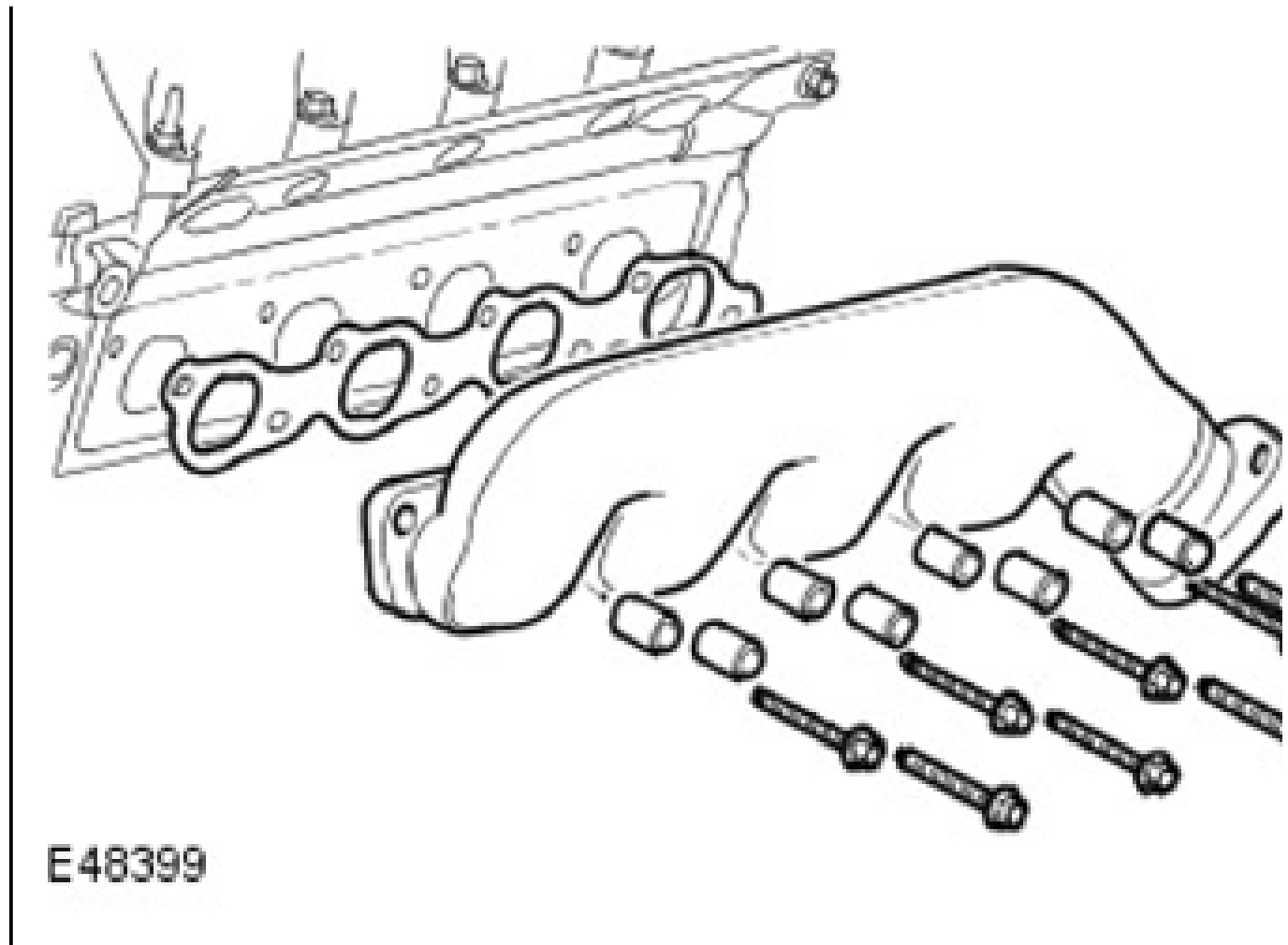


7. Remove the LH cylinder head assembly.
 - With assistance remove the cylinder head.
8. Remove and discard the cylinder head gasket.
 - Clean the cylinder head locating dowels.



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

9. Remove the exhaust manifold.
 - Remove the 8 bolts.
 - Discard the gasket and the bolts.

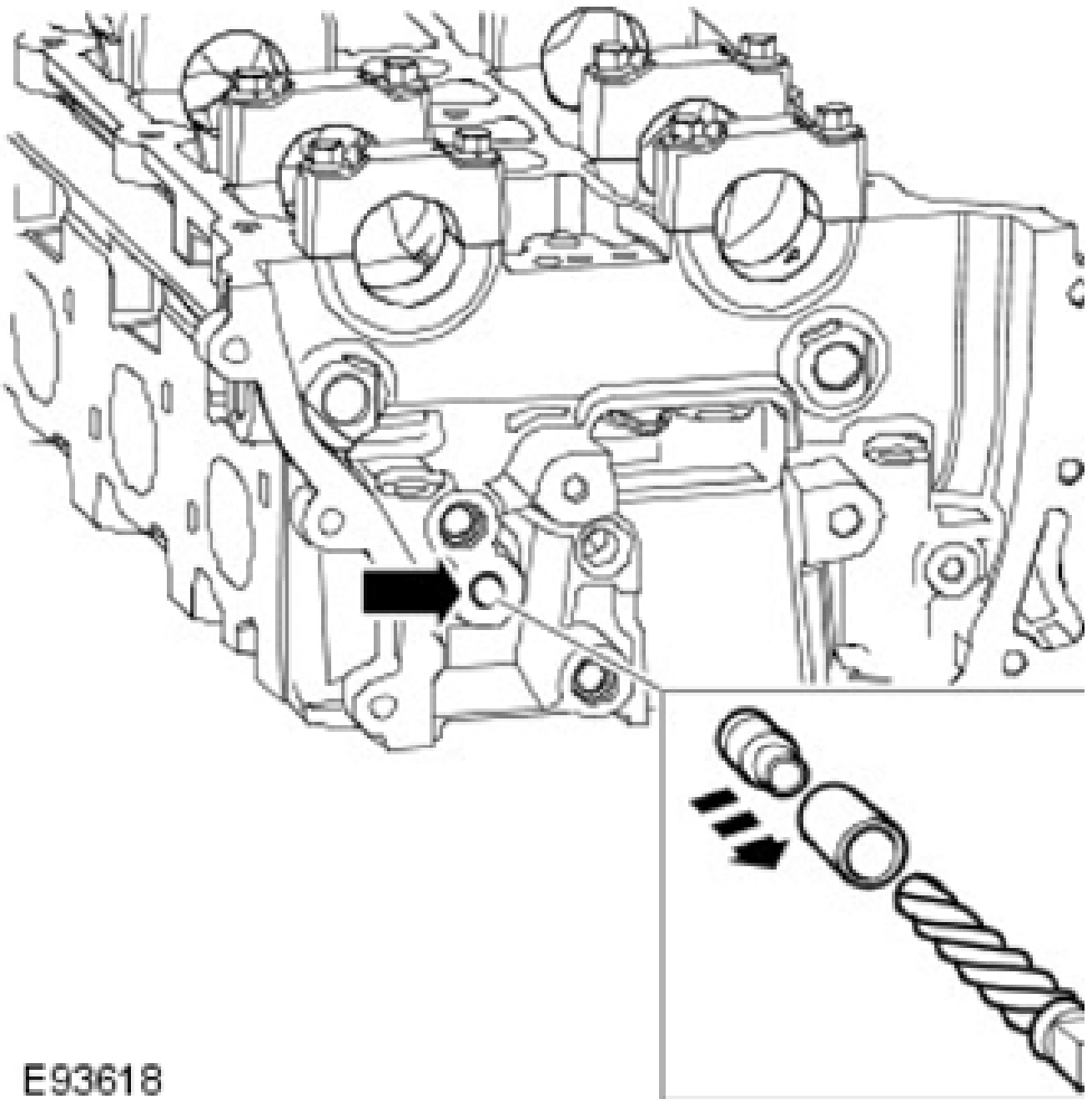
**INSTALLATION**

CAUTION: If a new cylinder head is to be installed to a vehicle with variable valve timing (VVT), the cylinder head must have the oil gallery blind rivet removed before installation.

Make sure that all debris and foreign material is removed from the cylinder head and cylinder head oil gallery.

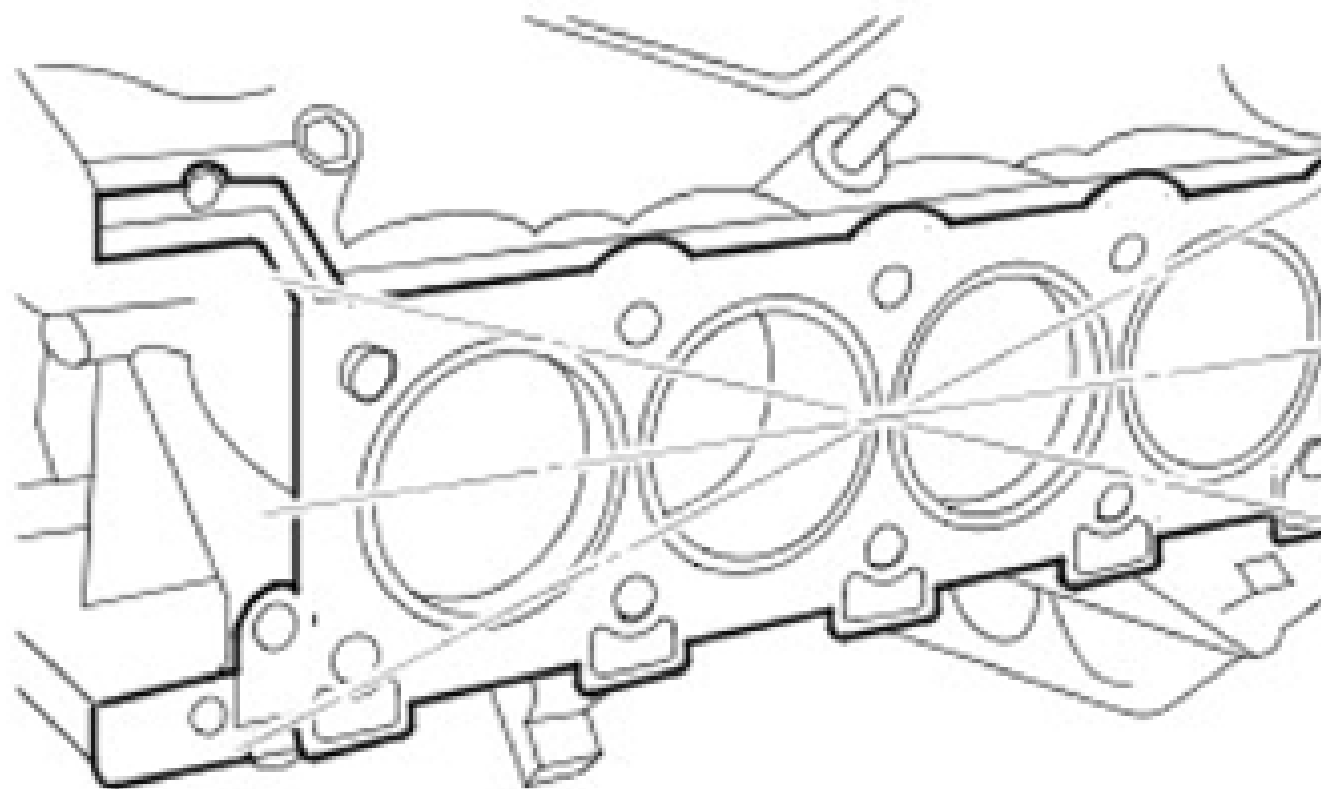
NOTE: The centre bore of the blind rivet is 6 mm (0.24 inch) diameter.

1. Vehicles fitted with VVT: remove the blind rivet from the VVT oil gallery.
 - Identify the VVT oil supply gallery and the 8 mm (0.31 inch) blind rivet.
 - Using a suitable 3 mm (0.12 inch) punch release the centre of the blind rivet until it is released from the outer part of the blind rivet.
 - Using a suitable extraction tool, remove the remaining part of the blind rivet.



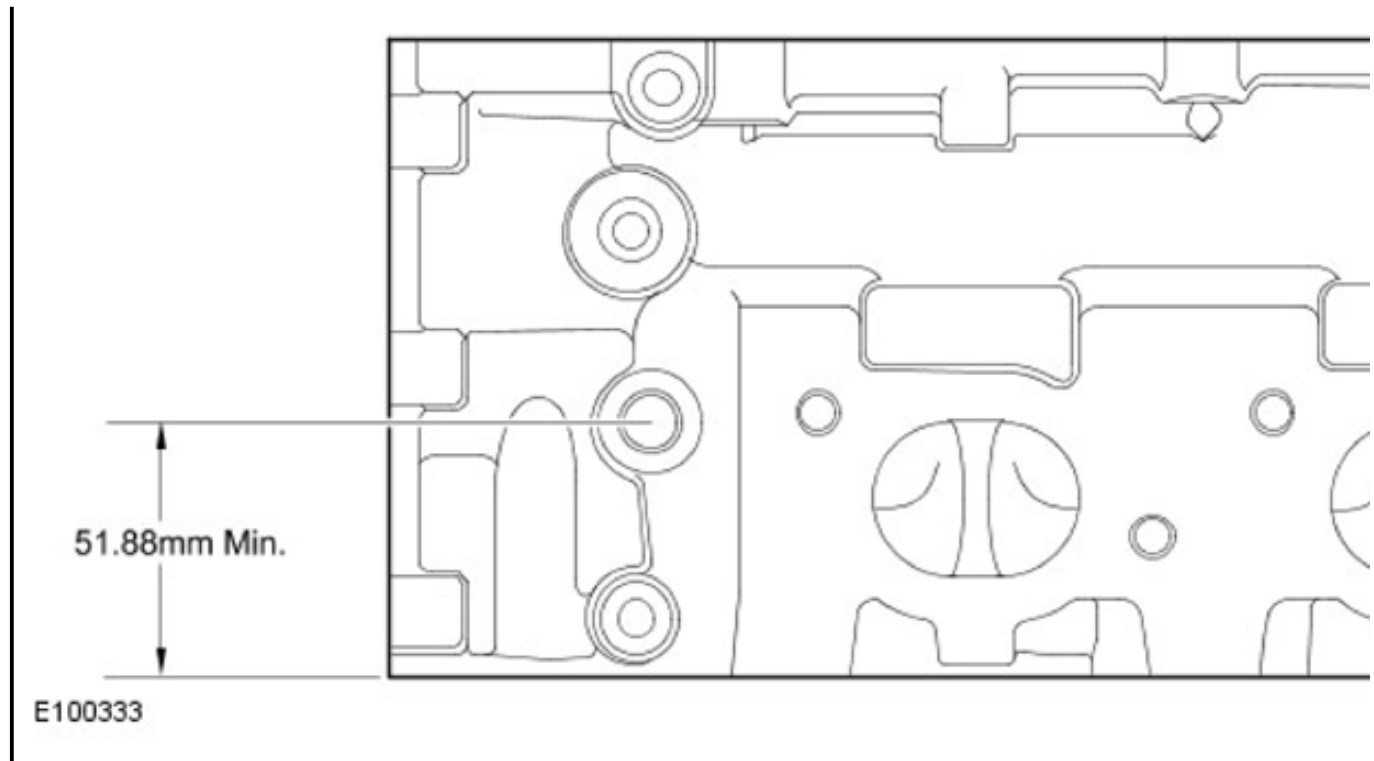
E93618

2. Clean the component mating faces.
3. Check cylinder head face for distortion, across the center and from corner to corner.



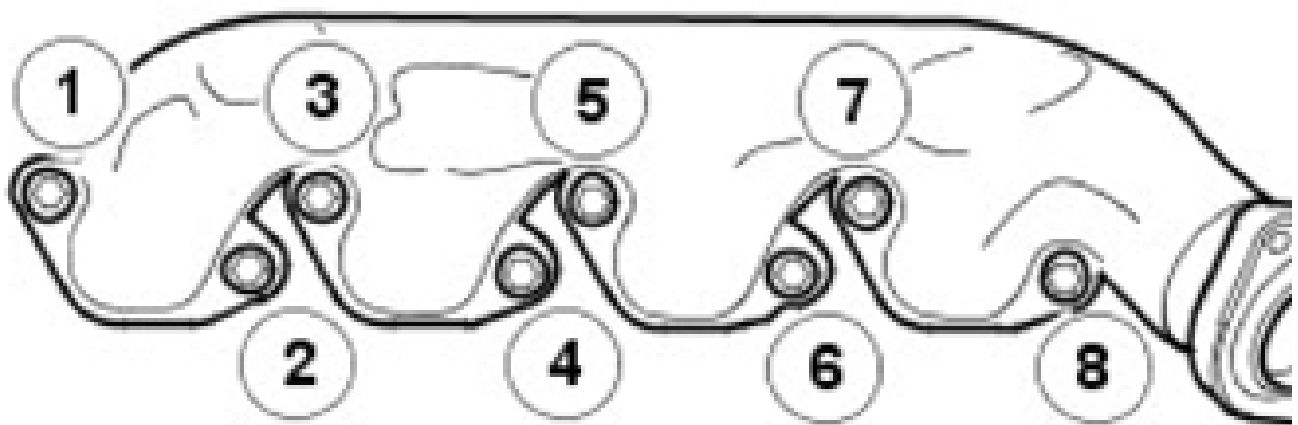
E46855

4. For cylinder head face distortion data, refer to **SPECIFICATIONS**.



NOTE: For cylinder head with distortion above the maximum allowance, the cylinder head material must be measured.

5. Measure the cylinder head material.
 - Check measurement from the centre of the exhaust dowel to the cylinder head face as shown.
 - If the measurement is less than 51.88 mm the cylinder head requires replacement.
6. Install the exhaust manifold.
 - Clean the component mating faces.
 - Install the gasket/heat shield.
 - Tighten the heat shield bolt to 25 Nm (18 lb.ft).
 - Evenly and progressively, tighten the bolts in the sequence shown to 20 Nm (15 lb.ft).

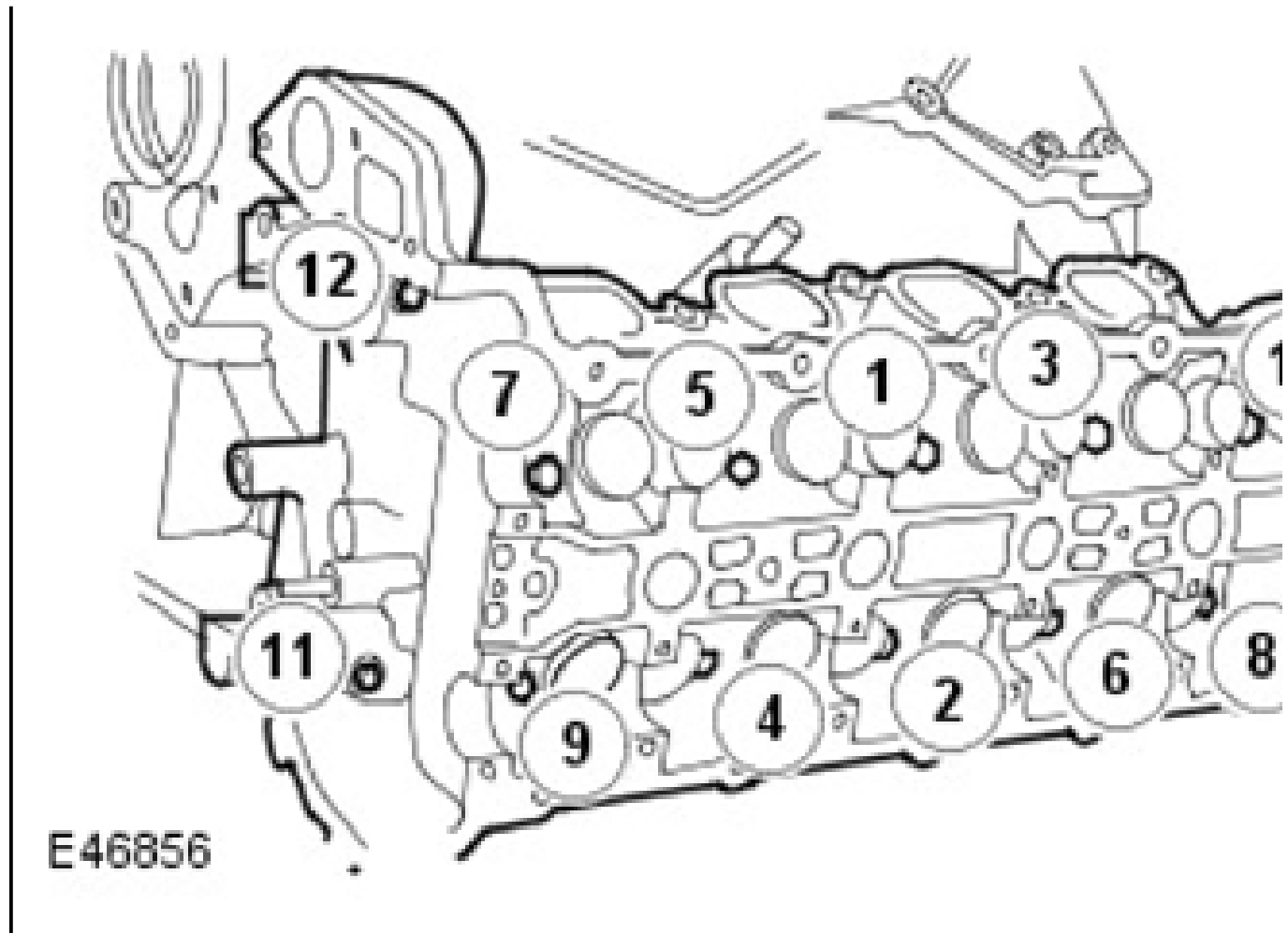
**E47144**

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

7. Install a new cylinder head gasket.
8. With assistance install the cylinder head.

NOTE: Tighten the bolts 1 to 10 in the sequence shown.

9. Install the cylinder head bolts.
 - Lubricate the new cylinder head bolt threads with clean engine oil.
 - Tighten the bolts to 20 Nm (15 lb.ft).
 - Tighten the bolts to 35 Nm (26 lb.ft).
 - Tighten the bolts 1 to 10, a further 90 degrees.
 - Tighten the bolts 1 to 10, a further 90 degrees.
 - Tighten the M8 bolts 11 and 12, to 25 Nm (18 lb.ft).



10. Connect the EGR pipe and exhaust manifold flanges.

- Tighten the nuts to 25 Nm (18 lb.ft).

11. Install the CMP sensor.

- Tighten the Torx screw to 7 Nm (5 lb.ft).
- Connect the electrical connector.

12. Install the LH bank camshafts.

For additional information, refer to: **CAMSHAFTS LH** .

13. 13. Install the intake manifold.

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

14. 14. Connect the battery ground cable.

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

VALVE COVER LH**REMOVAL**

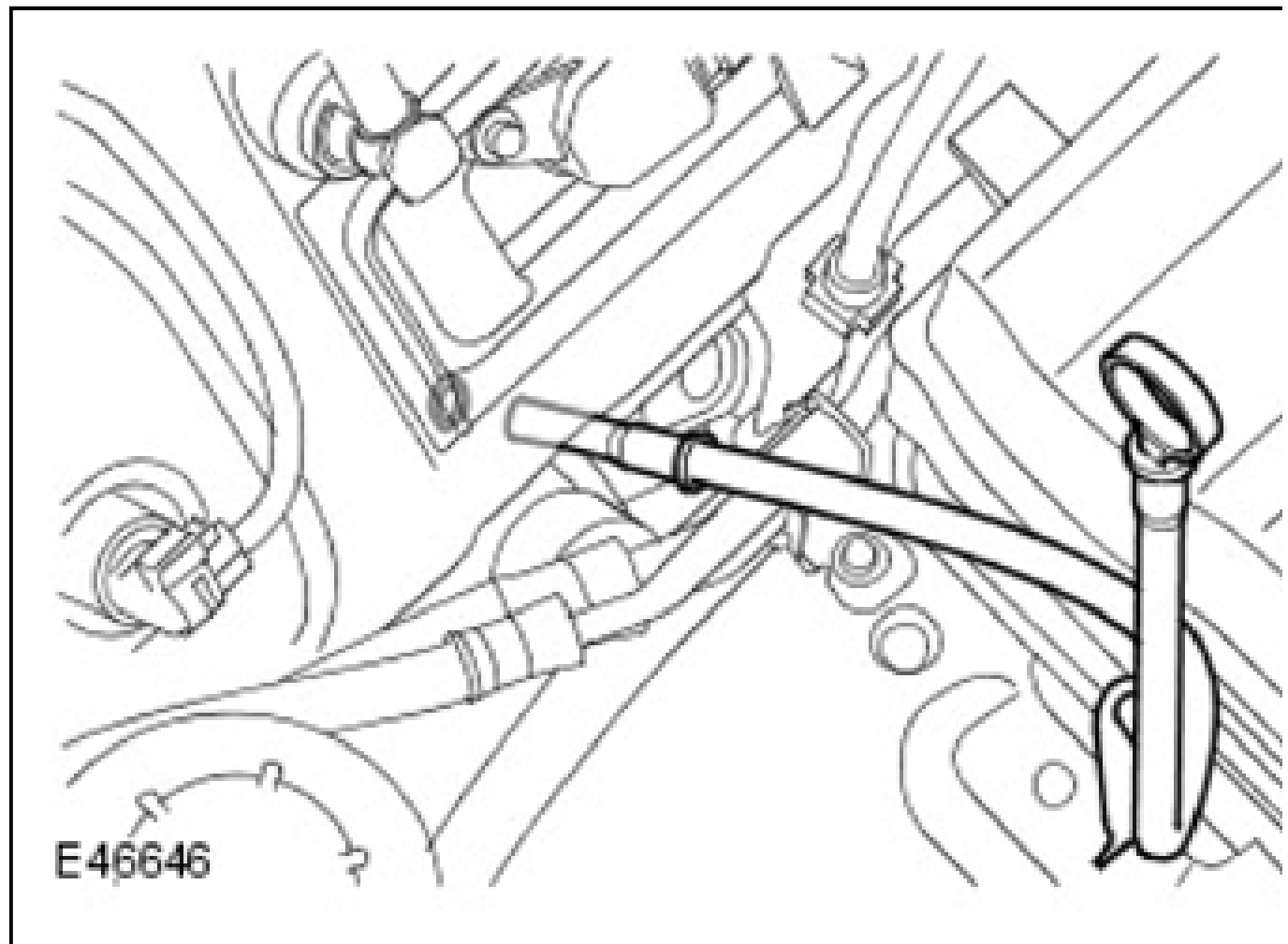
1. Disconnect the battery ground cable.

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

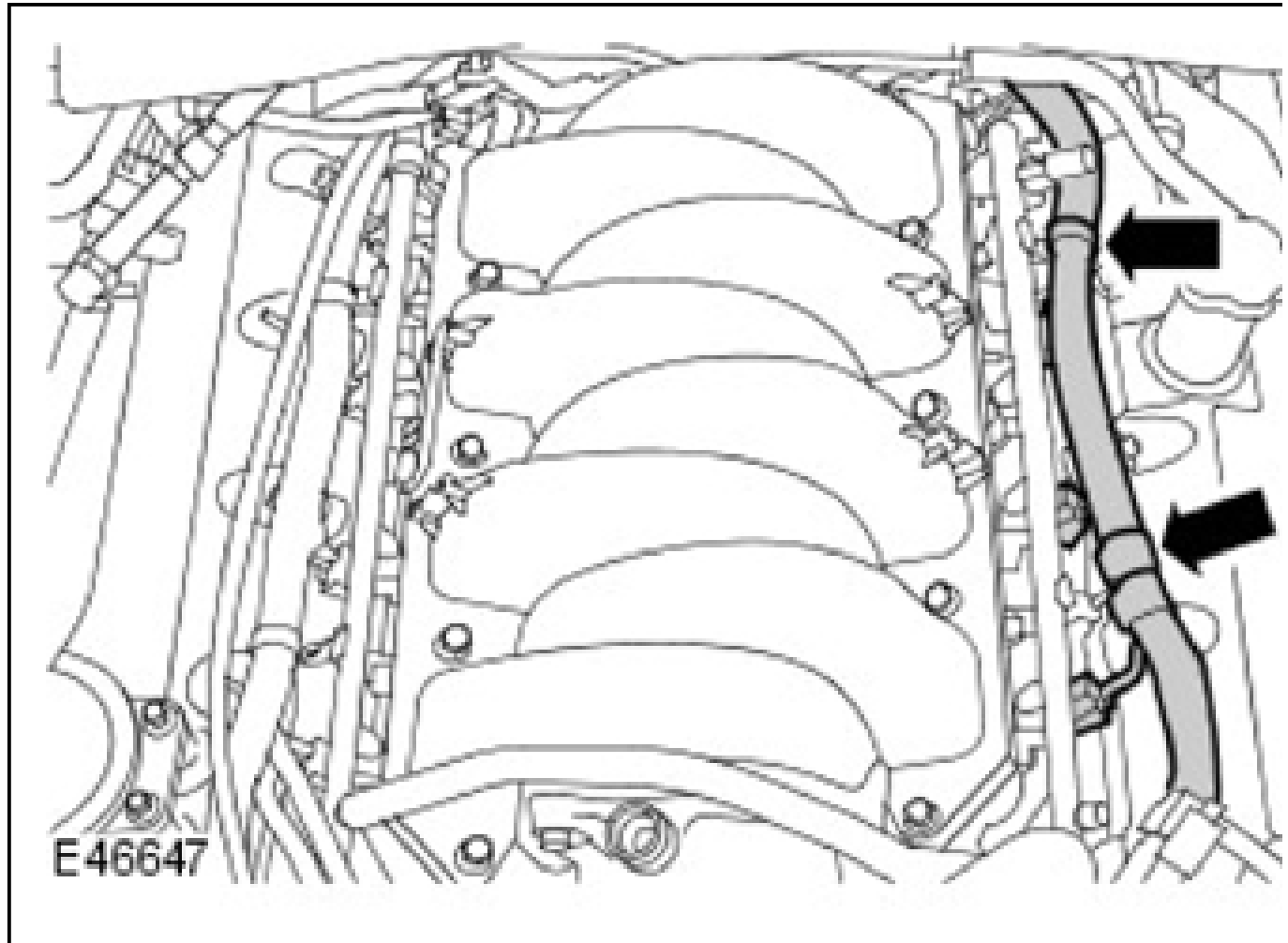
2. Remove the ignition coil-on-plug.

For additional information, refer to: **IGNITION COIL-ON-PLUG** .

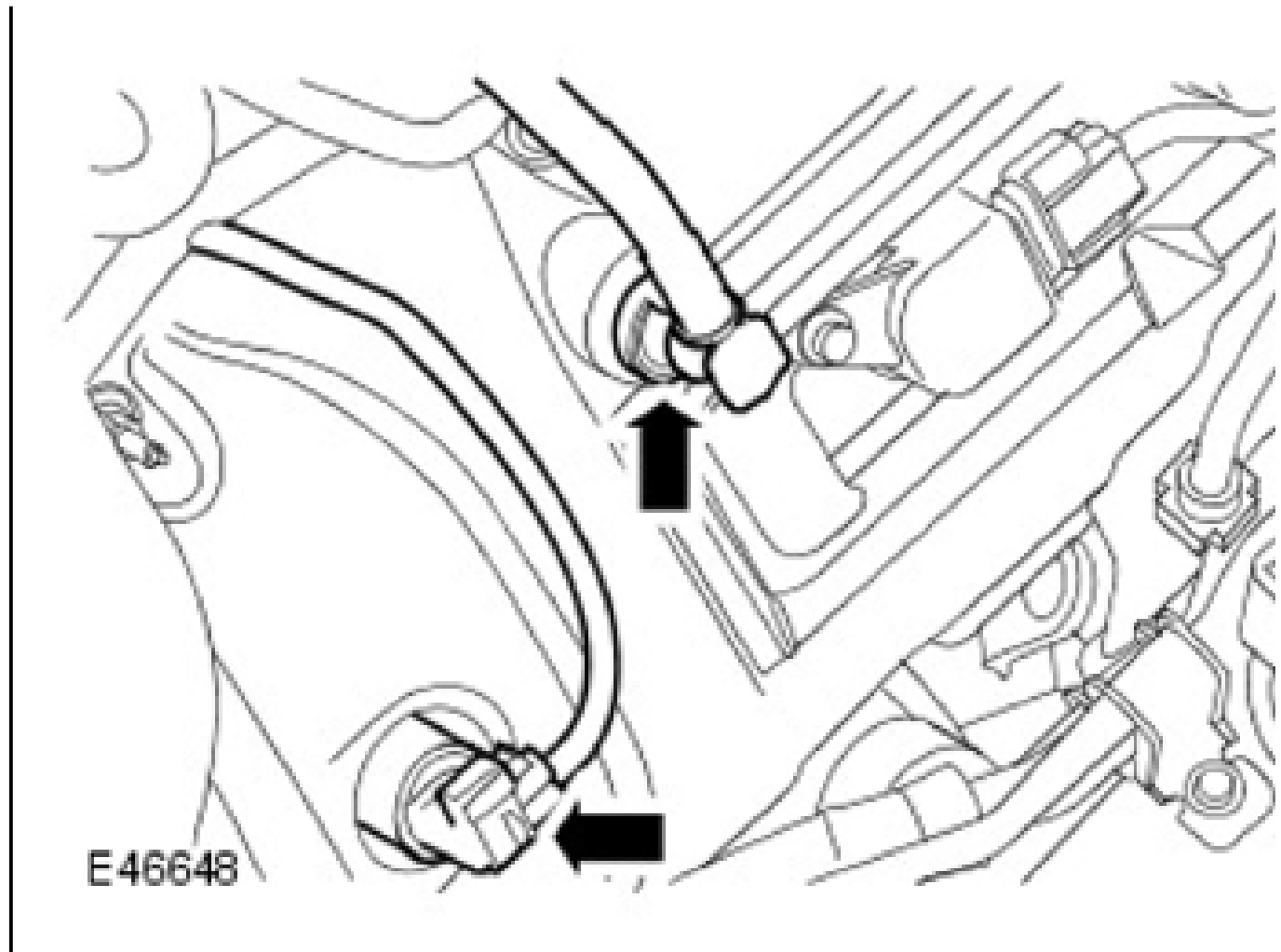
3. Remove the remaining ignition coil-on-plugs.
4. Remove the oil level indicator and tube.
 - Remove the dipstick.
 - Remove the nut.
 - Discard the O-ring seal.



5. Release the engine wiring harness from the retaining bracket.

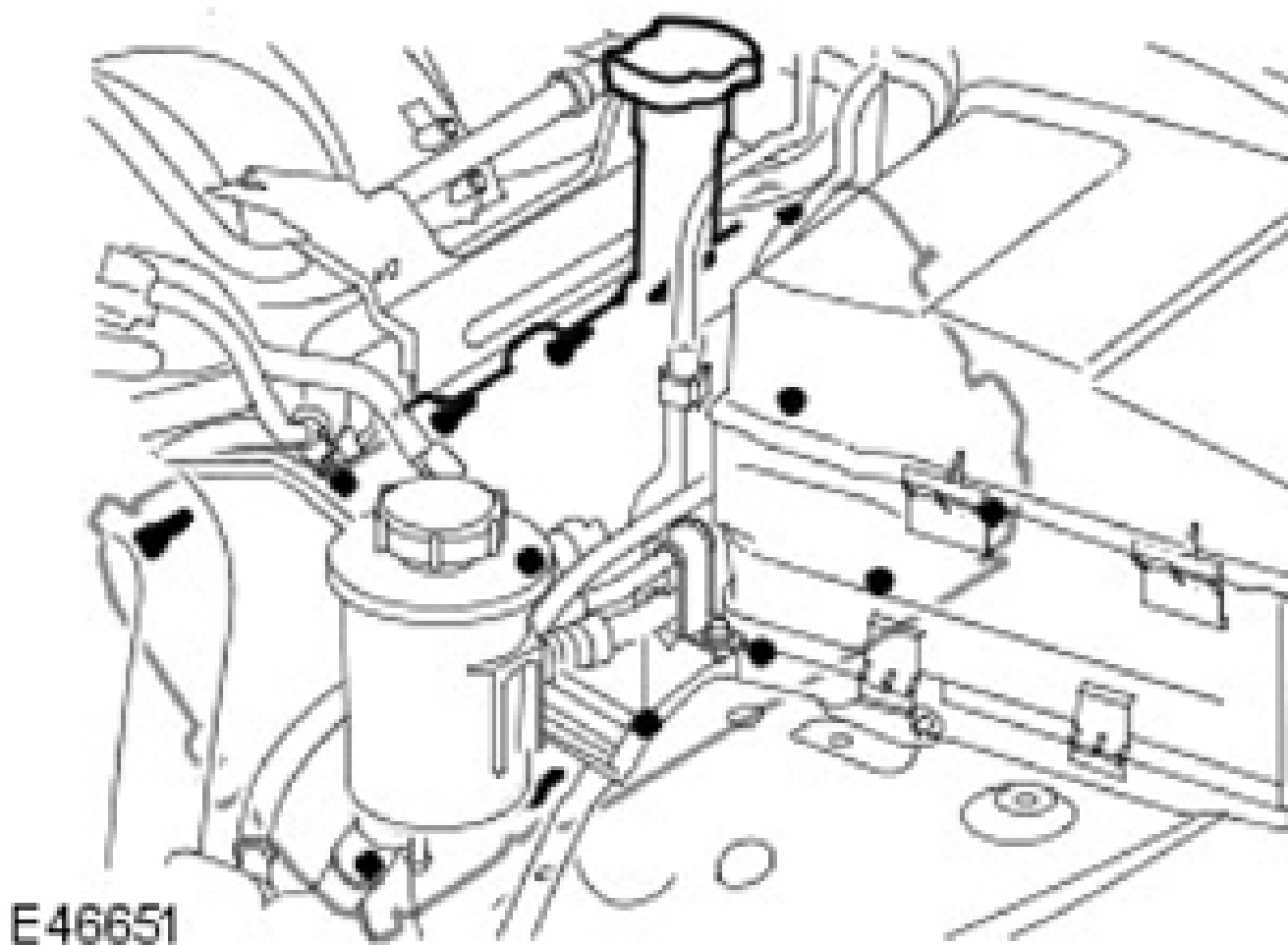


6. Disconnect the variable camshaft timing (VCT) oil solenoid electrical connector.
7. Disconnect the valve cover breather hose.

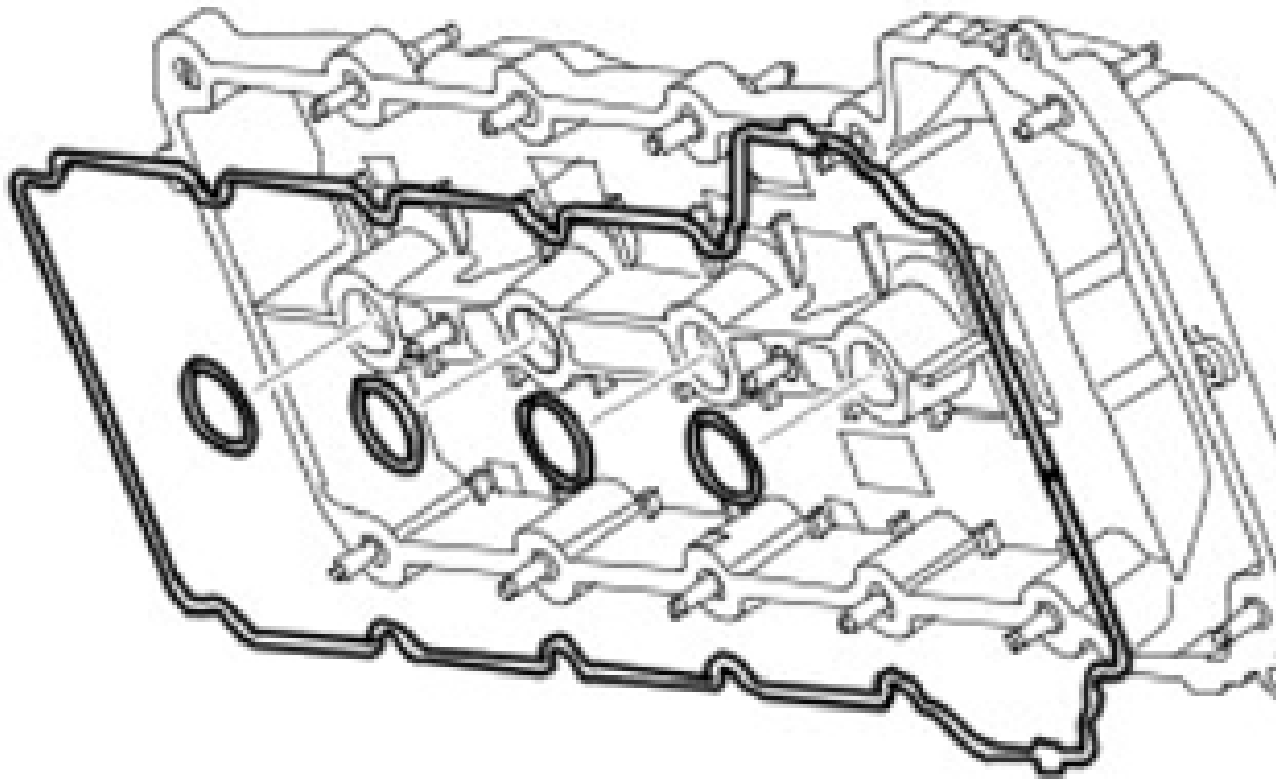


NOTE: Note the fitted position of the retaining bolts prior to removal.

8. Remove the valve cover assembly.
 - Remove the 14 valve cover retaining bolts.



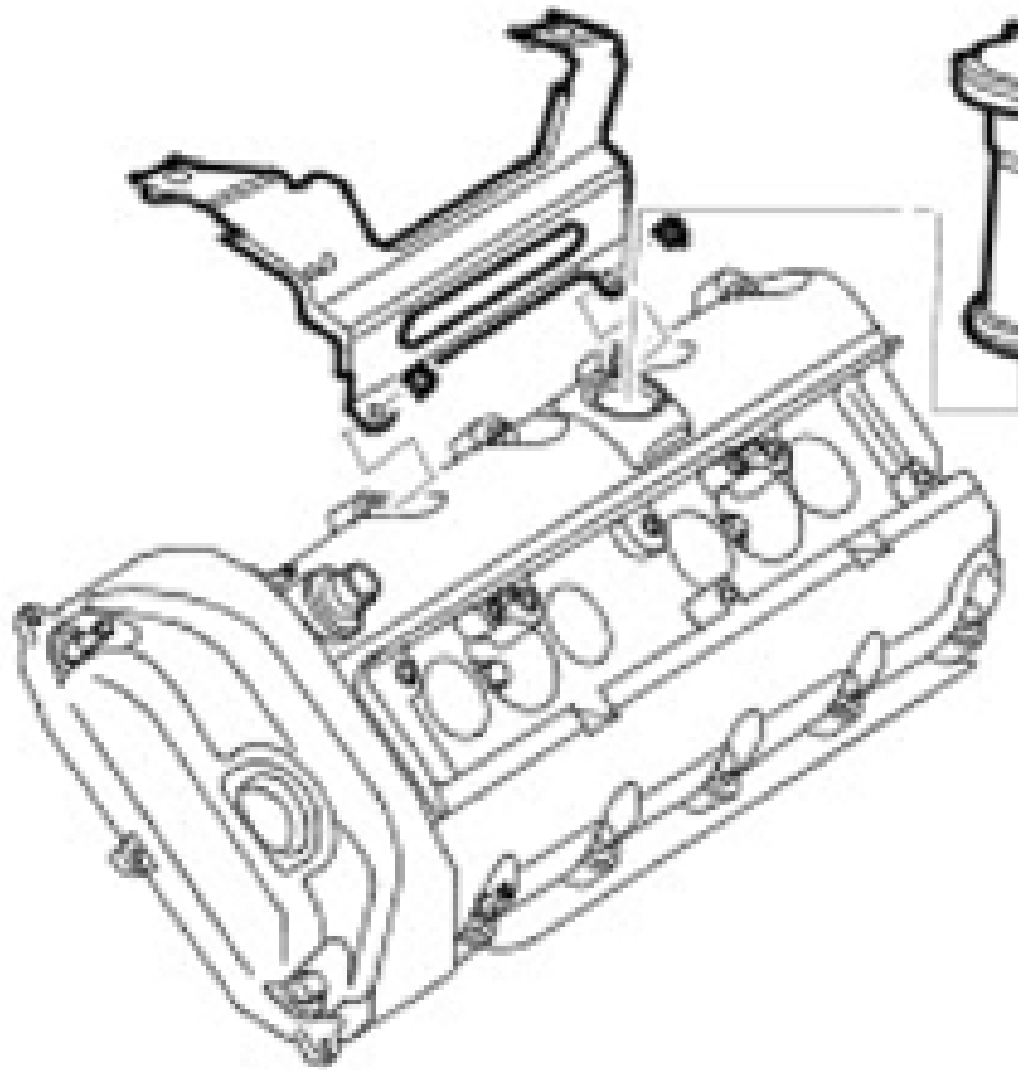
9. Remove and discard the valve cover gaskets.



E46652

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

10. Remove the oil filler tube.
 - Remove and discard the O-ring seal.

**INSTALLATION**

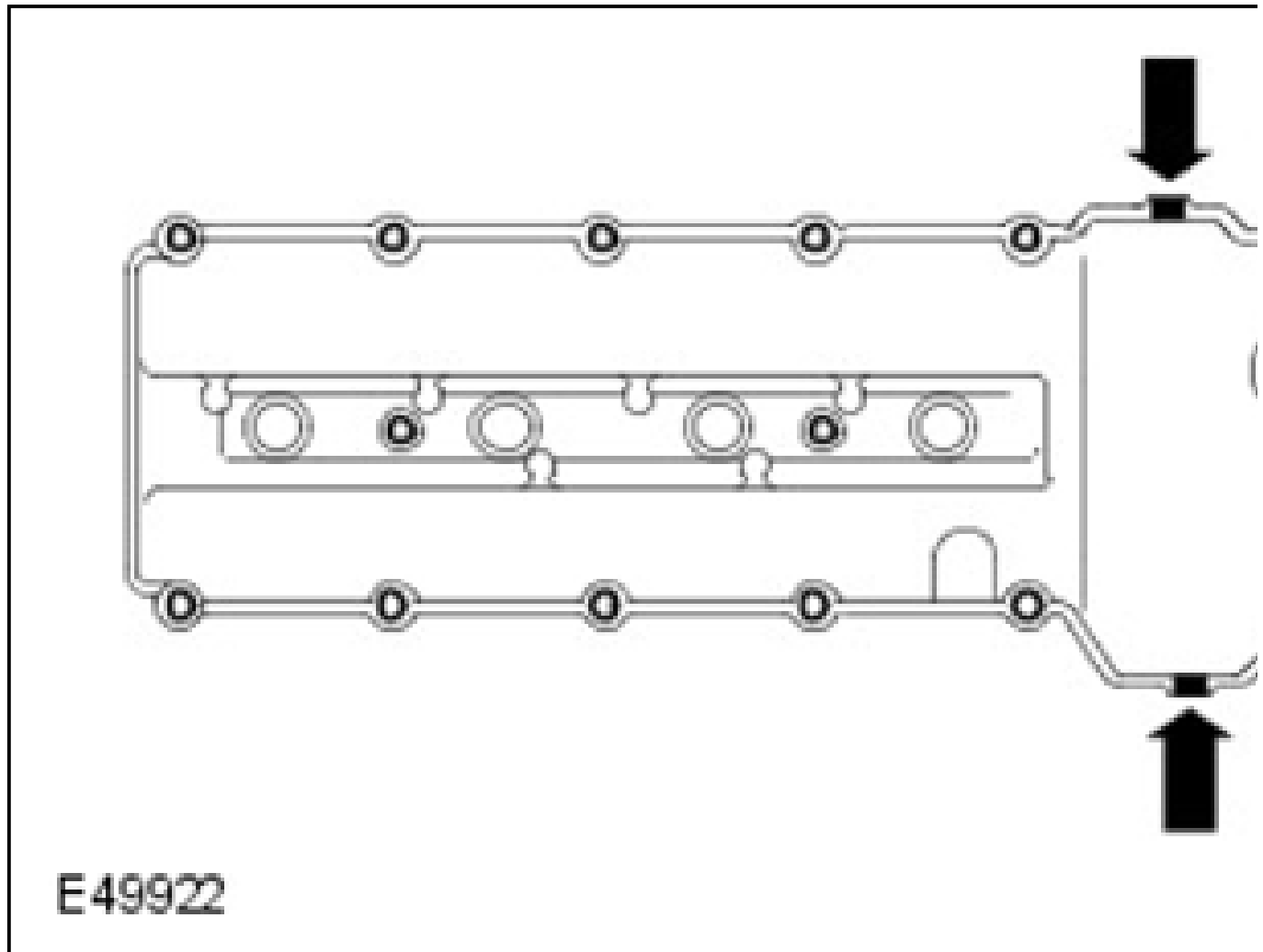
1. Install the oil filler tube.
 - Install a new O-ring seal.
2. Install new valve cover plug aperture seals
3. Install a new valve cover gasket.

NOTE: Apply two beads of silicone gasket sealant as shown on the illustration. The application of the sealant must be 3mm diameter 12mm long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

4.

Install the valve cover.

- Clean the component mating faces.



5. Install the valve cover retaining bolts.
 - Install valve cover retaining bolts to their position previously noted.
 - Complete the tightening sequence as illustrated.
 - Tighten the bolts to 12 Nm (9 lb.ft).



- Clean the component mating faces.
- Install a new O-ring seal.
- Lubricate the seal with clean engine oil.
- Tighten the nut to 6 Nm (4 lb.ft).

For additional information, refer to: **IGNITION COIL-ON-PLUG**.

10. Install the remaining ignition coil-on-plugs.

VALVE COVER RH

REMOVAL

1. Disconnect the battery ground cable.

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

2. Remove the air intake resonator.

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

3. Remove the air cleaner assembly.

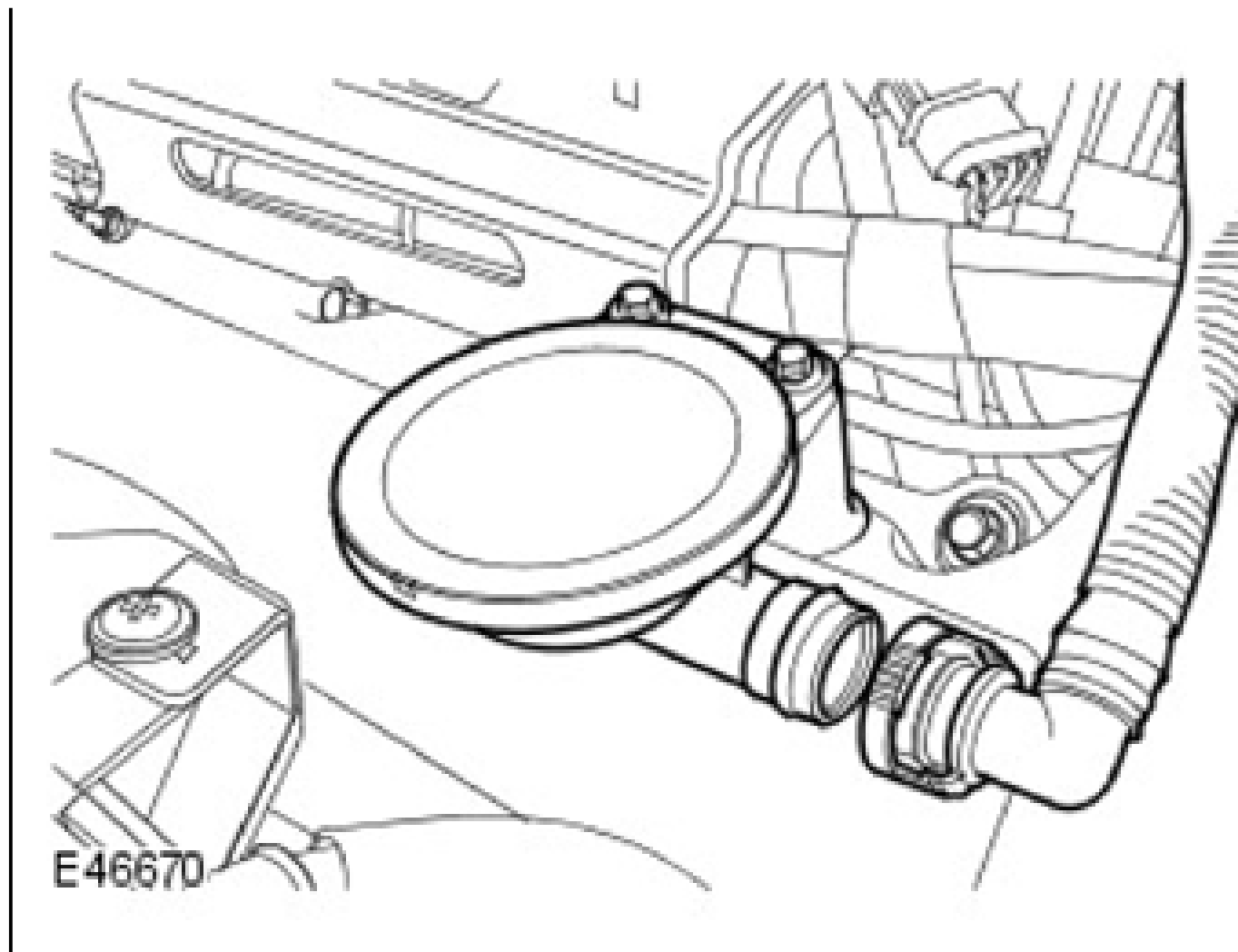
For additional information, refer to: **Intake Air Resonator** .

4. Remove the ignition coil-on-plug.

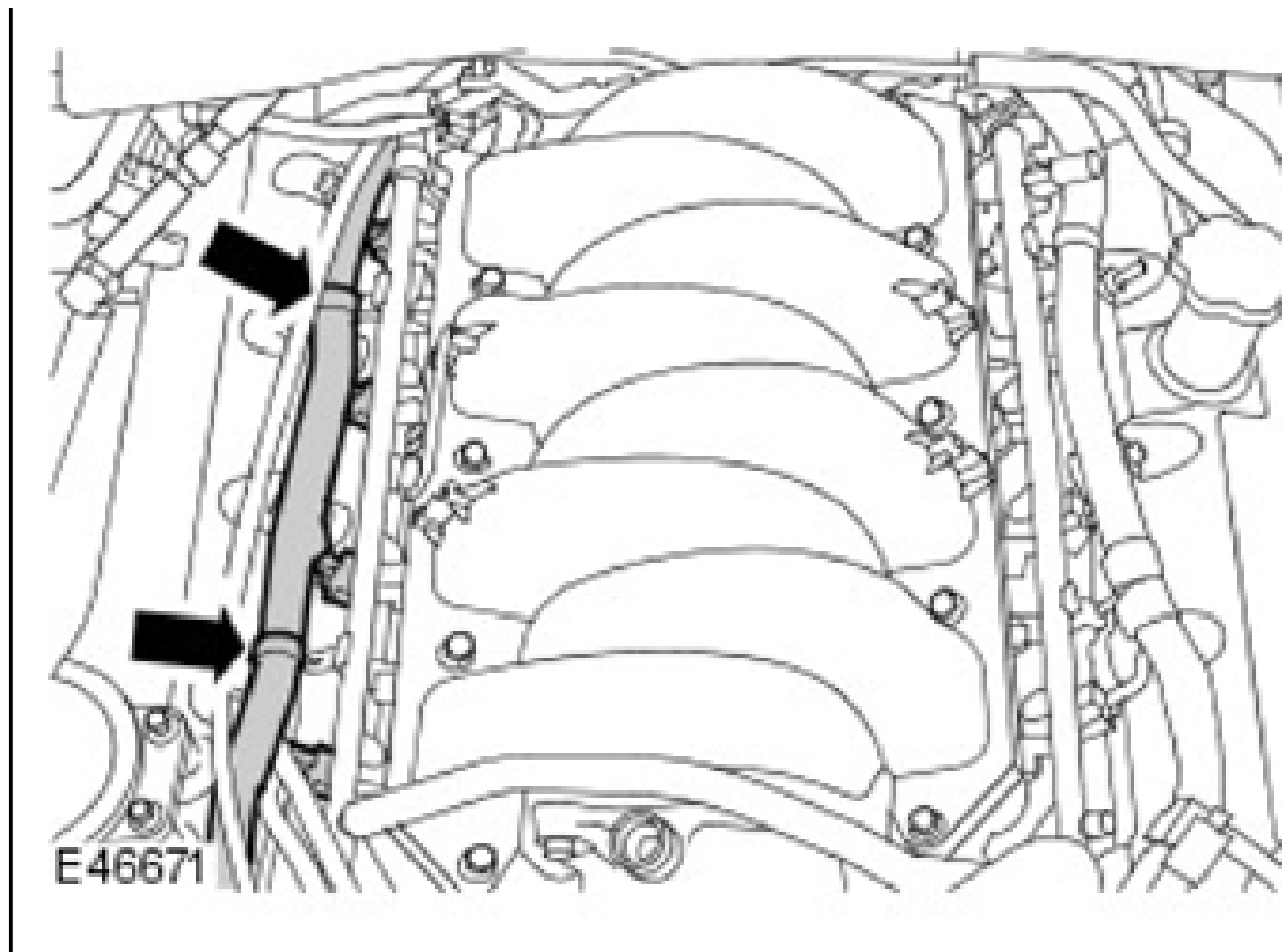
For additional information, refer to: **IGNITION COIL-ON-PLUG** .

5. Remove the remaining ignition coil-on-plugs.

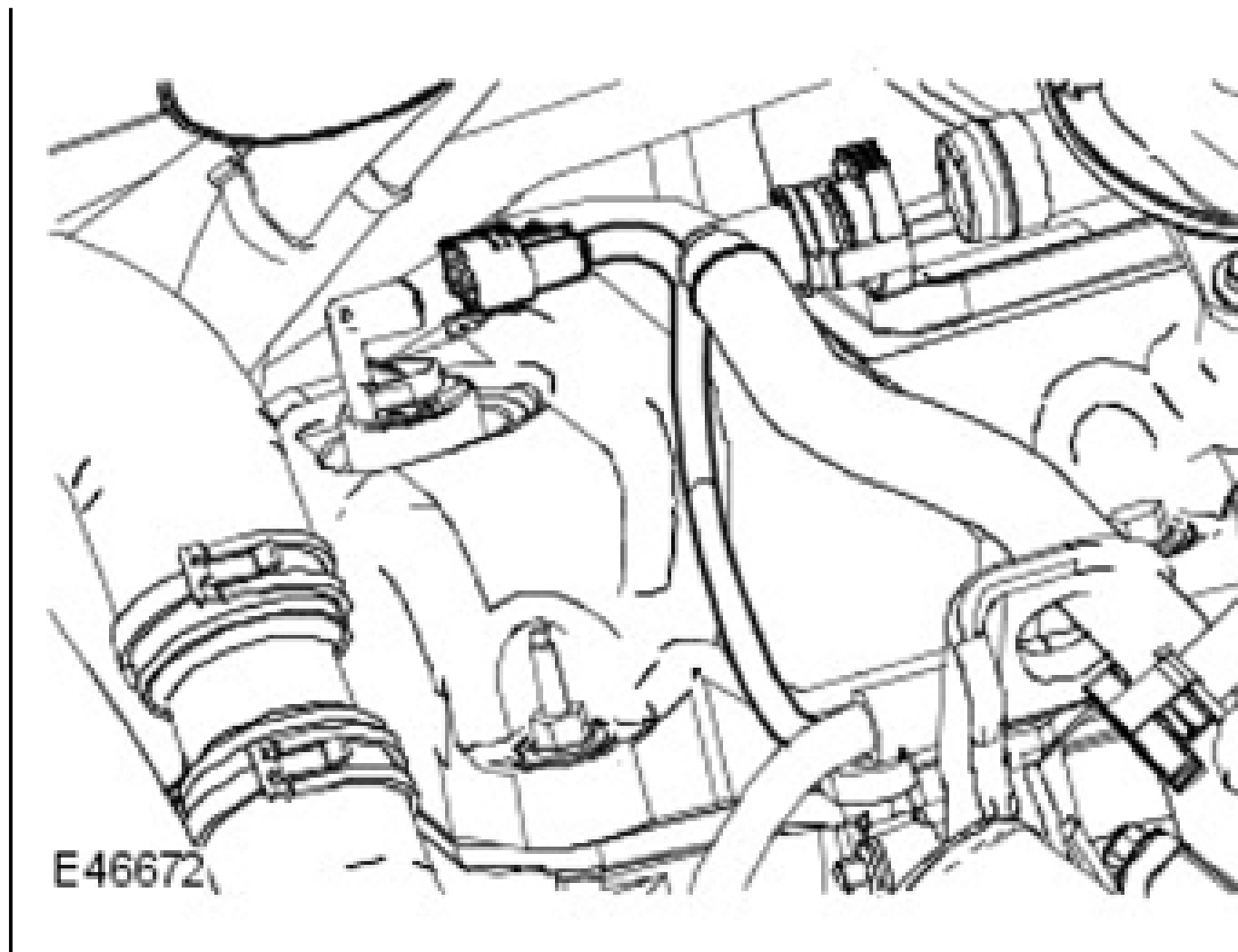
6. Disconnect the positive crankcase ventilation (PCV) line.



7. Release the engine wiring harness from the retaining bracket.

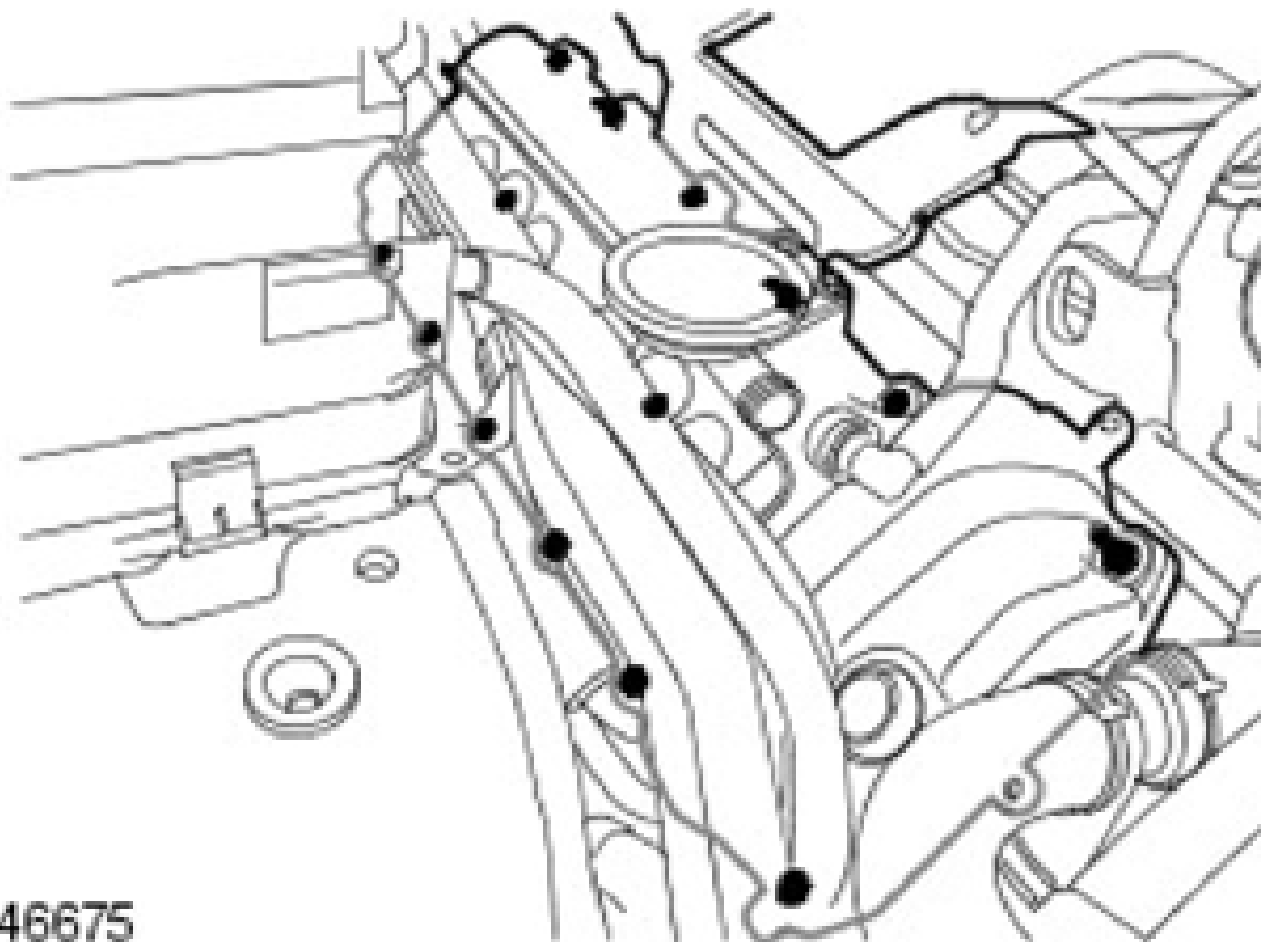


8. Disconnect the variable camshaft timing (VCT) oil solenoid electrical connector.



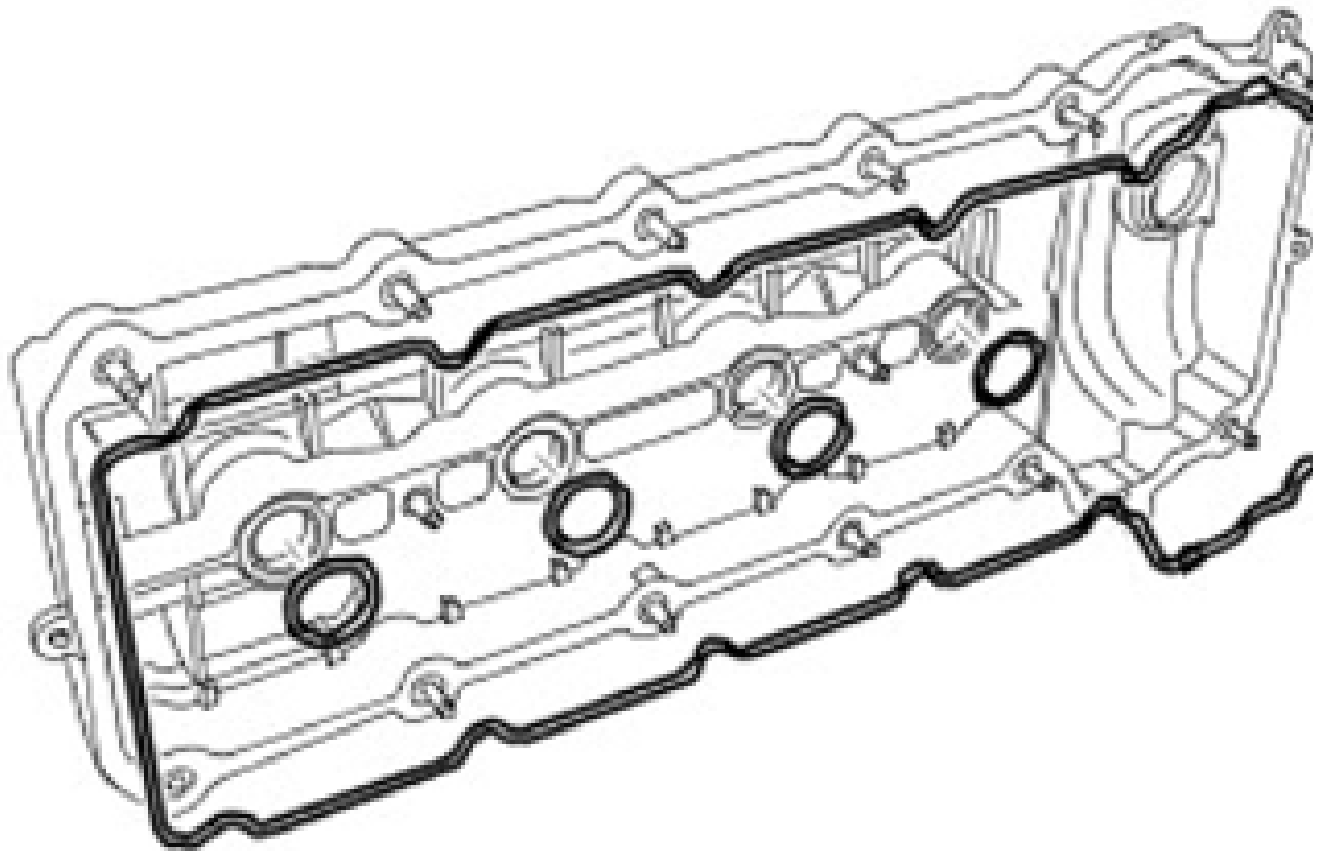
NOTE: Note the fitted position of the retaining bolts prior to removal.

9. Remove the valve cover assembly.
 - Remove the 14 valve cover retaining bolts.
 - Remove the engine cover bracket.



E46675

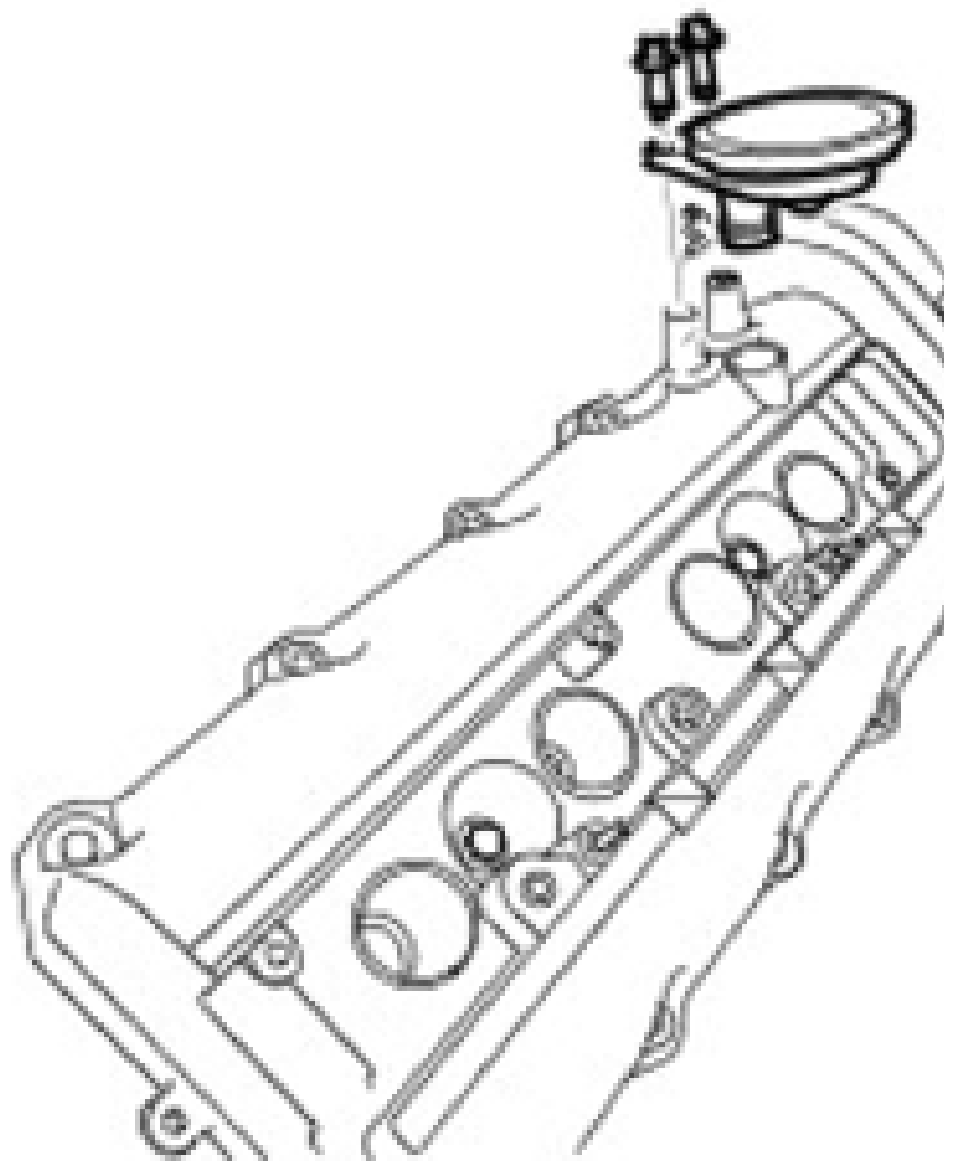
10. Remove and discard the valve cover gasket.
11. Remove the valve cover plug aperture seals.



E46677

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

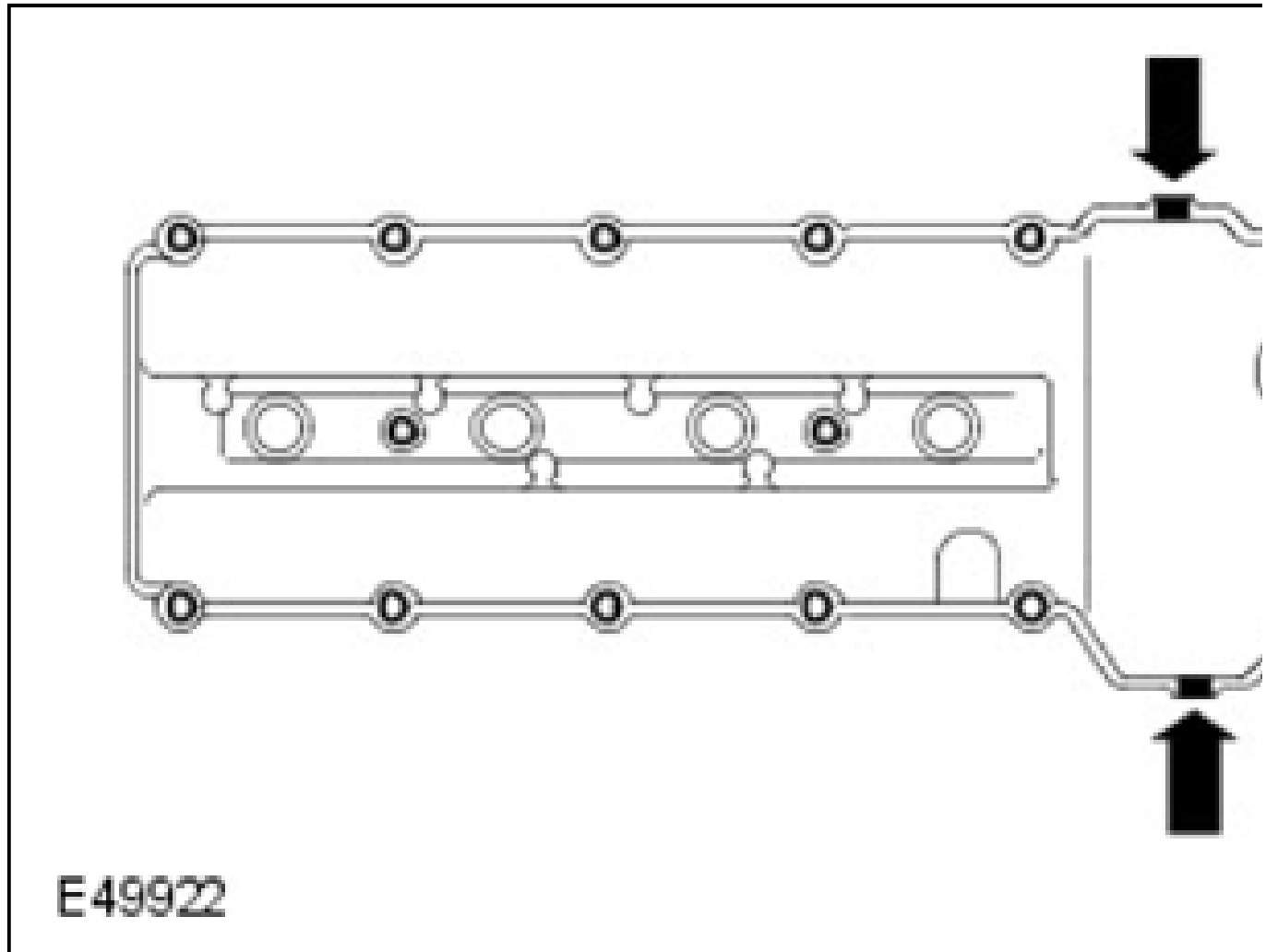
12. Remove the PCV valve.
 - Remove the 2 bolts.
 - Remove and discard the O-ring seal.

**E46678****INSTALLATION**

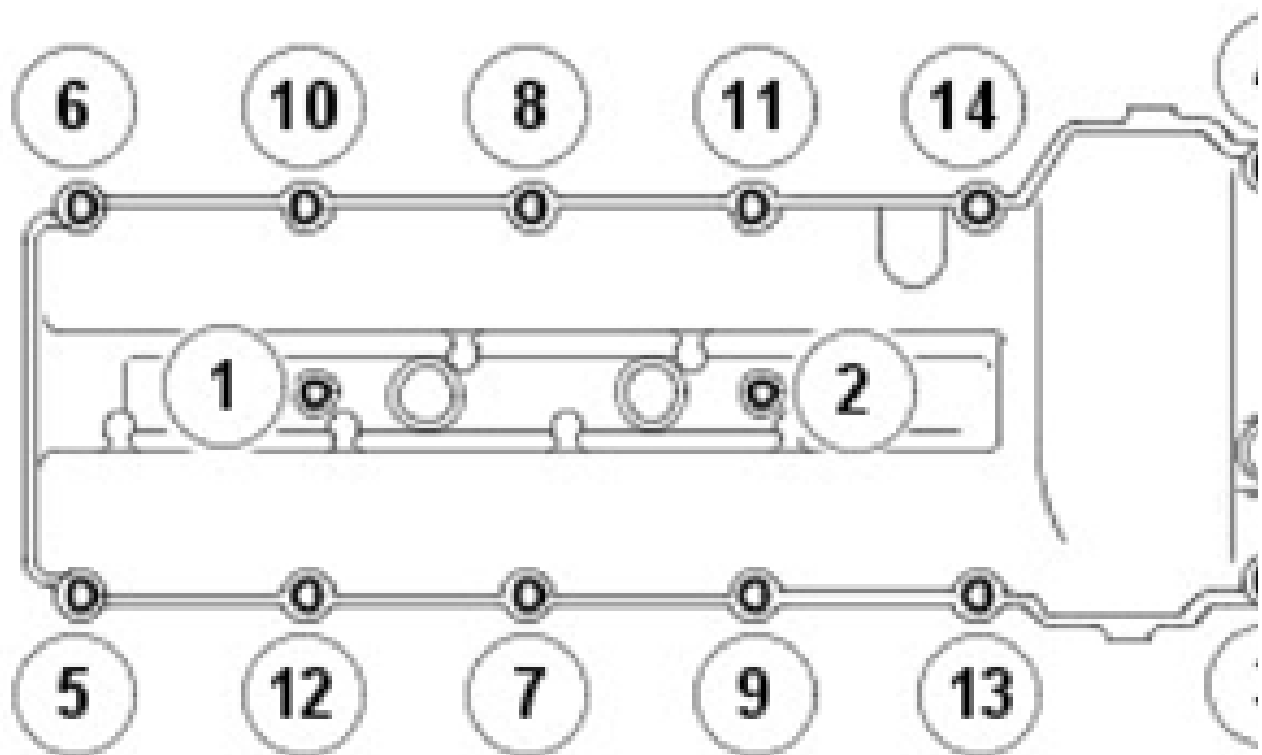
1. Install the PCV valve.
 - Clean the component mating faces.
 - Install a new O-ring seal.
 - Tighten the bolts to 6 Nm (4 lb.ft).
2. Install new valve cover plug aperture seals
3. Install a new valve cover gasket.

NOTE: Apply two beads of silicone gasket sealant as shown on the illustration. The application of the sealant must be 3mm diameter 12mm long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

4. Install the valve cover.
 - Clean the component mating faces.



5. Install the valve cover retaining bolts.
 - Install valve cover retaining bolts to their position previously noted.
 - Tighten the bolts to 12 Nm (9 lb.ft).
 - Complete the tightening sequence as illustrated.



E46679

6. Connect the VCT oil solenoid electrical connector.
7. Install the ignition coil-on-plugs.

For additional information, refer to: **IGNITION COIL-ON-PLUG** .

8. Install the remaining ignition coil-on-plugs.
9. Attach the engine wiring harness to the retaining bracket.
10. Connect the PCV line.
11. Install the air cleaner assembly.

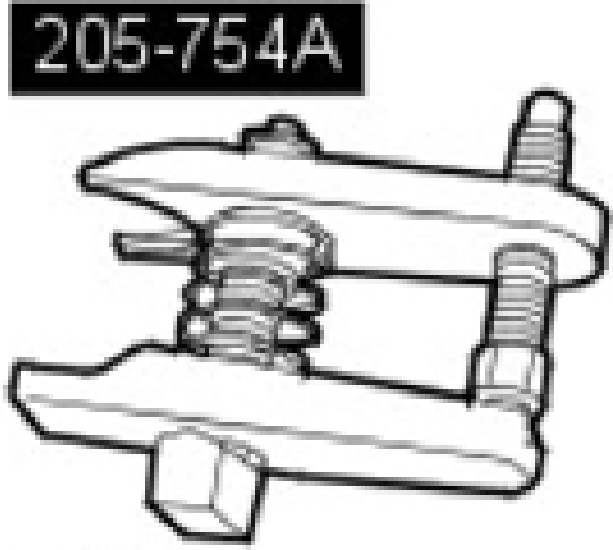
For additional information, refer to: **Air Cleaner** .

12. Install the air intake resonator.

For additional information, refer to: **Air Cleaner** .

ENGINE MOUNT LH

SPECIAL TOOL(S)

 205-754A E45276	Ball joint separator 205-754 (LRT-54-027)
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REMOVAL

1. Disconnect the battery ground cable.

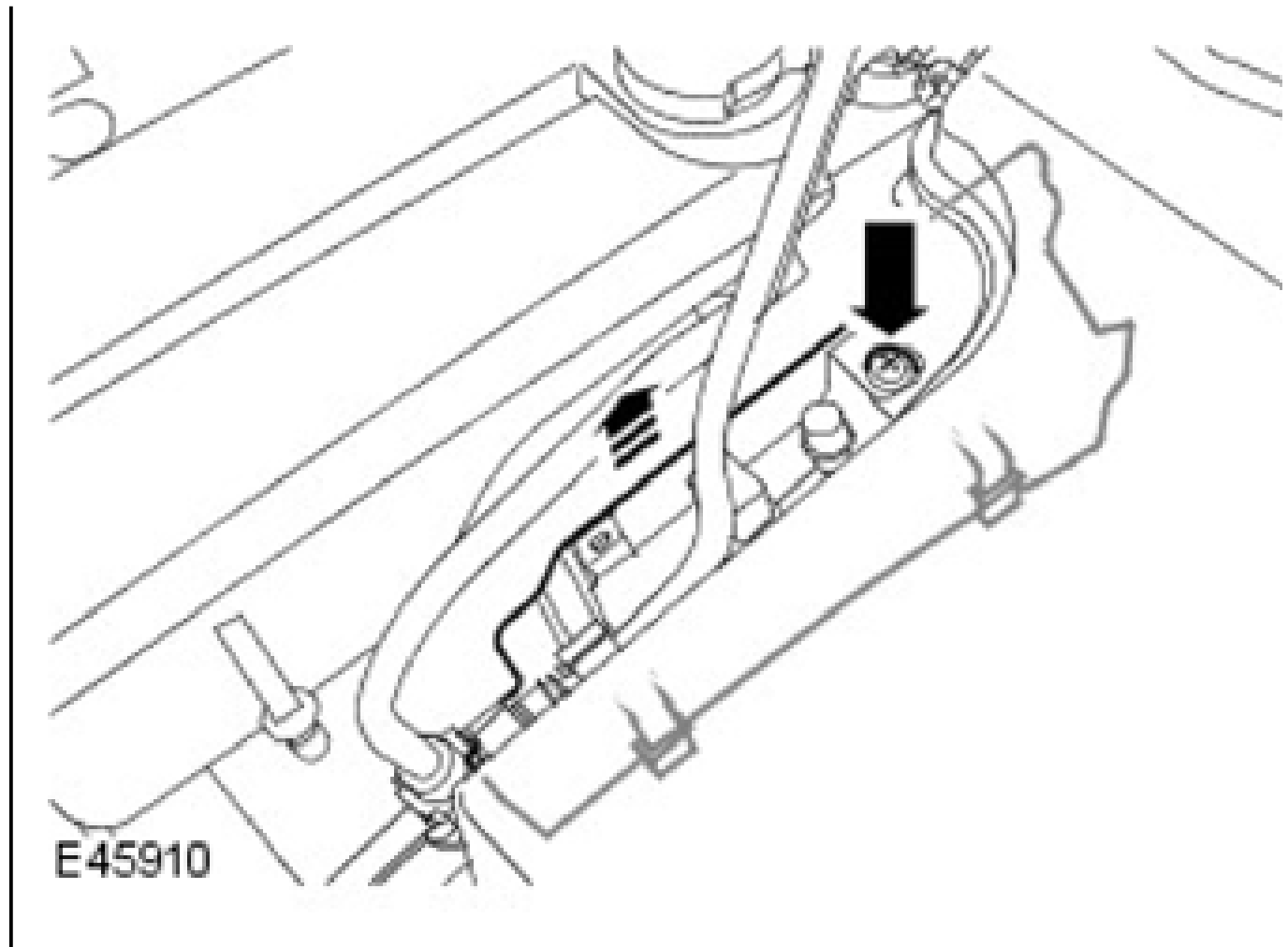
For additional information, refer to: **SPECIFICATION** .

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 front wheel.
4. Remove the engine undershield.

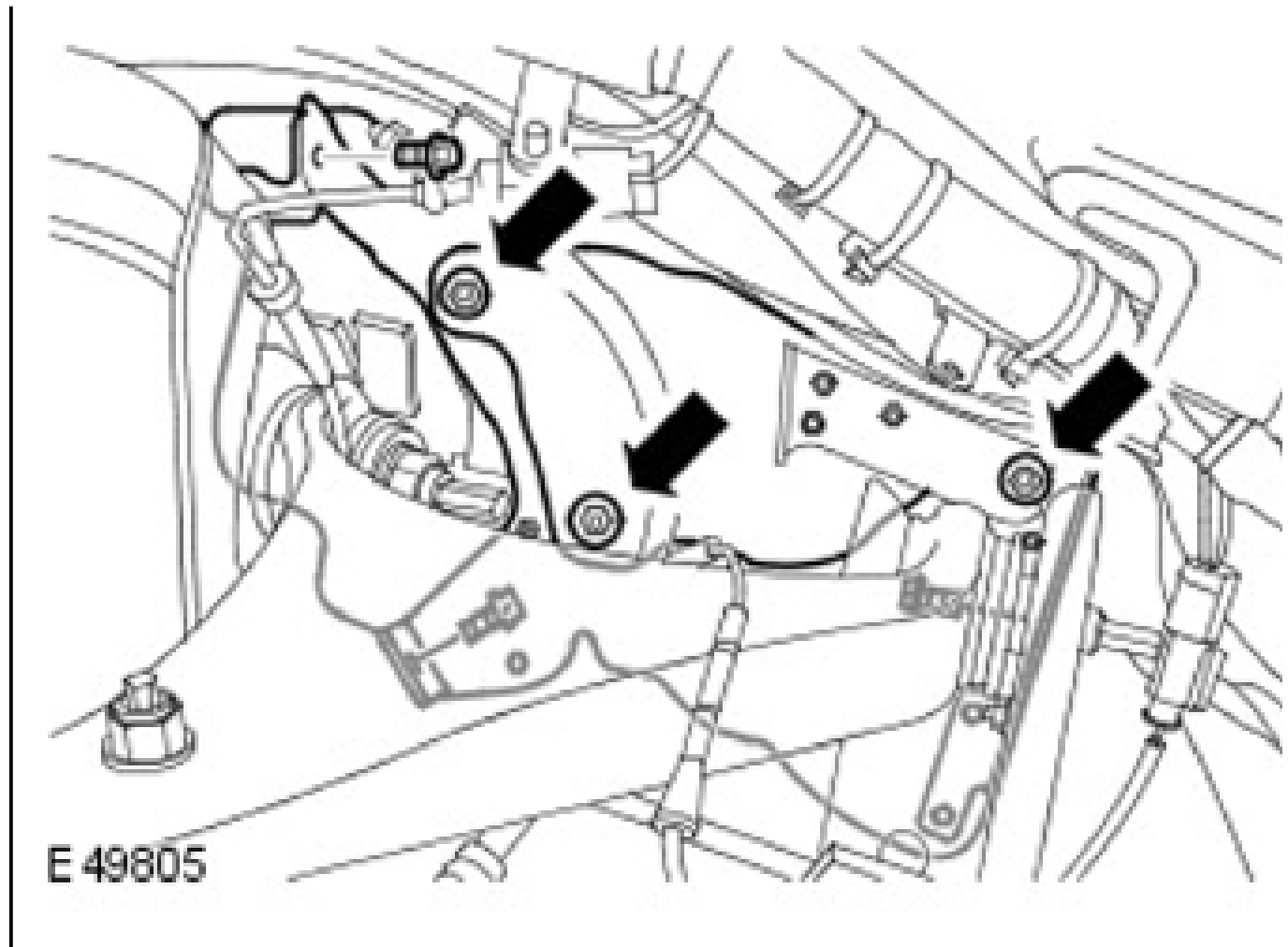
For additional information, refer to: **ENGINE UNDERSHIELD** (501-02 Front End Body Panels, Removal and Installation).

5. Remove the engine compartment LH upper heat shield.
 - Remove the screw.



NOTE: The heatshield consists of 3 parts.

6. Remove the upper suspension arm and brake line heat shields for access.
 - Remove the 3 nuts.
 - Remove the 3 bolts.



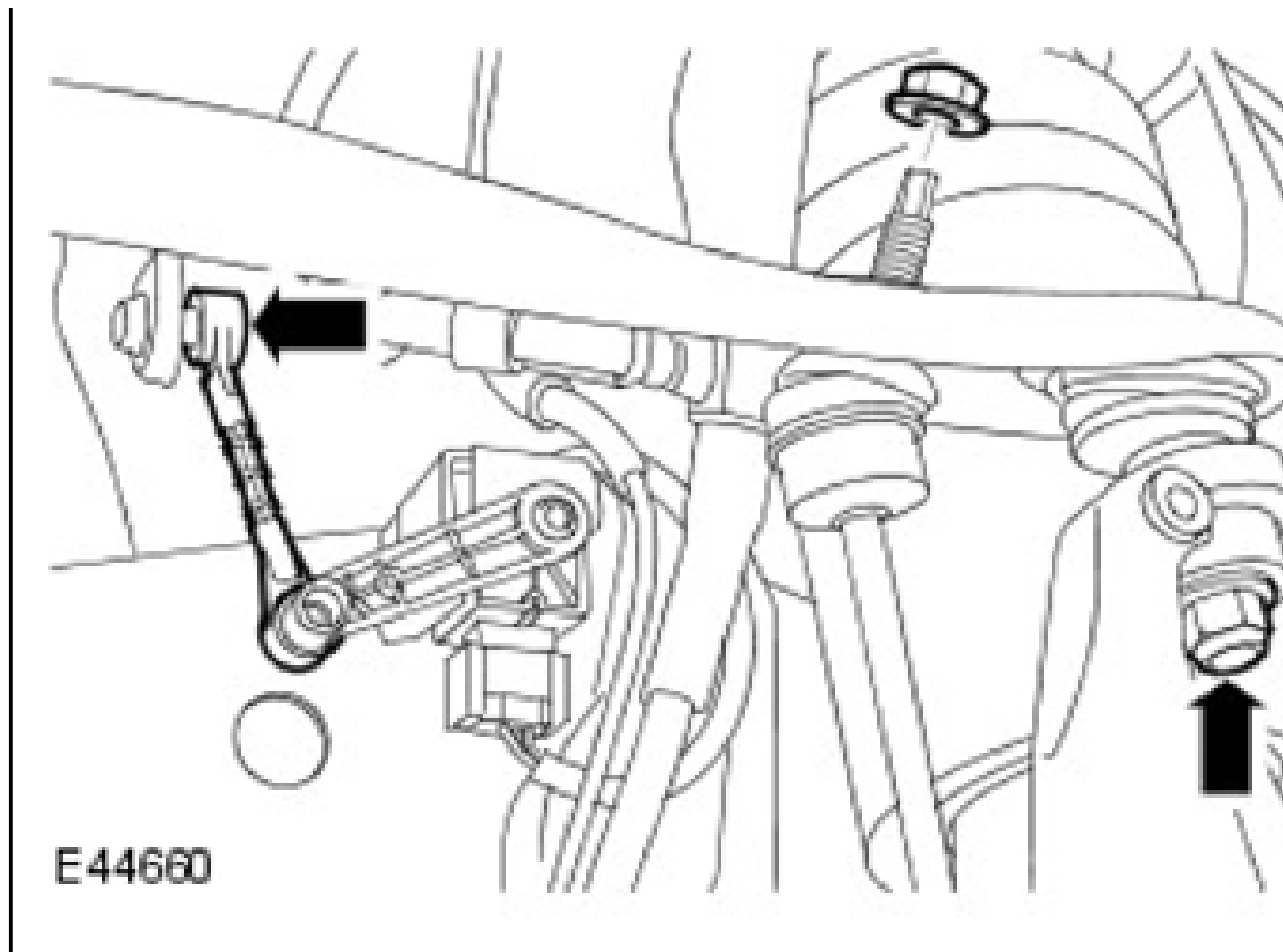
7. Disconnect the height sensor link arm.

CAUTION: Use a wrench on the hexagon provided to prevent the ball joint rotating.

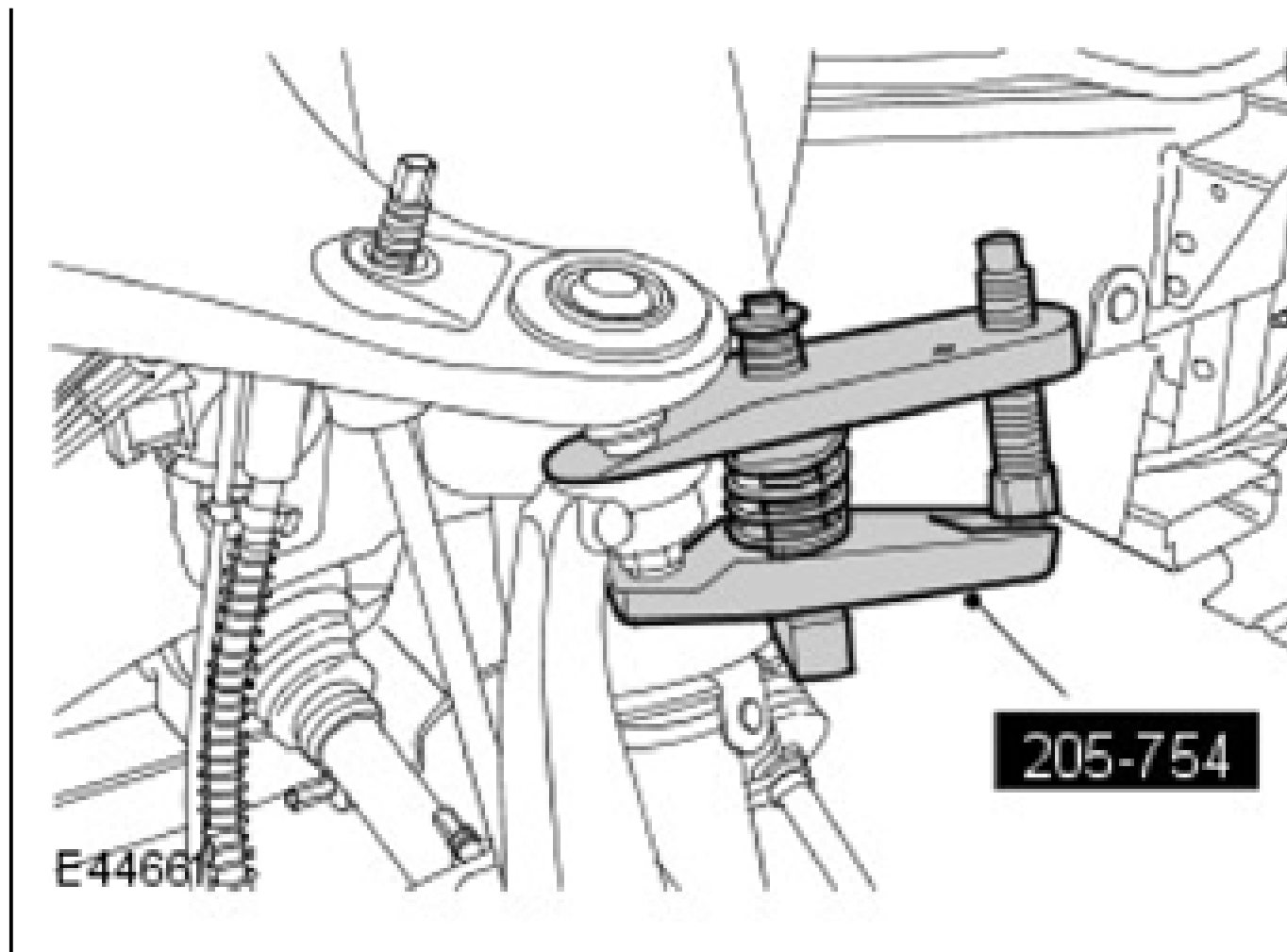
8. Remove the stabilizer bar link nut.

CAUTION: To prevent the wheel knuckle falling outwards and disconnection of the halfshaft inner joint, support the wheel knuckle.

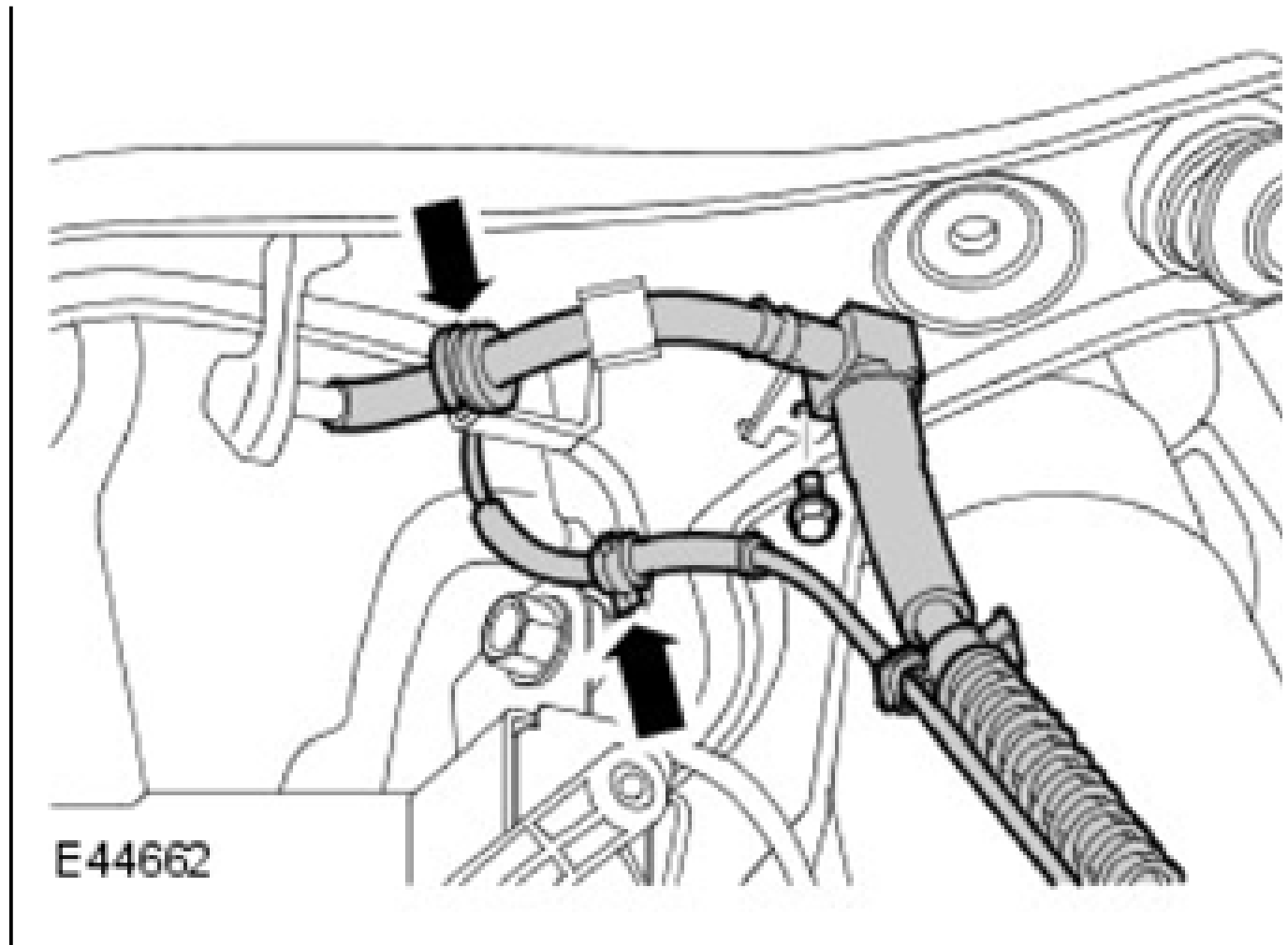
9. Loosen the upper arm retaining nut.



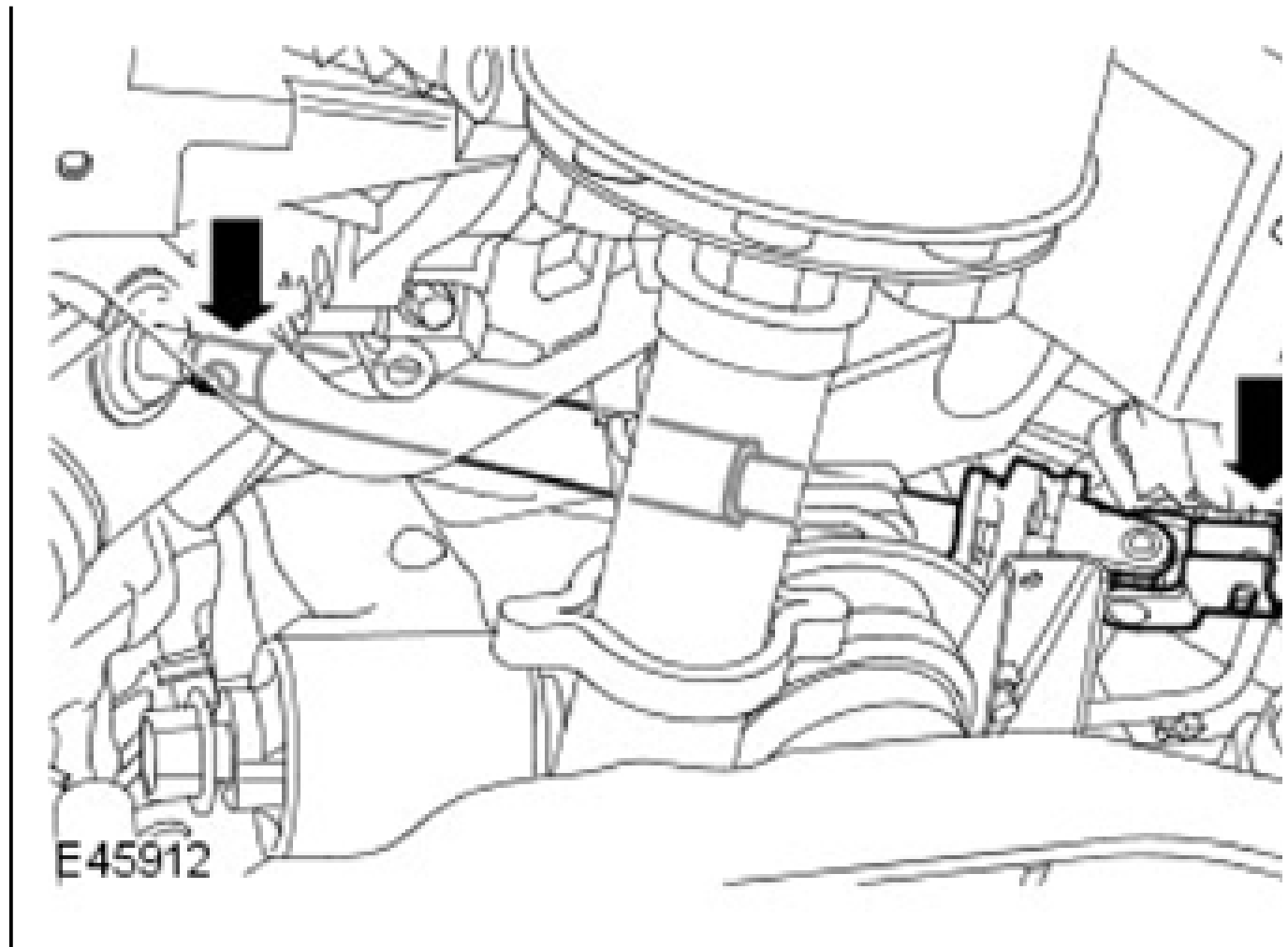
10. Using the special tool, release the upper arm ball joint.
 - Remove and discard the retaining nut.



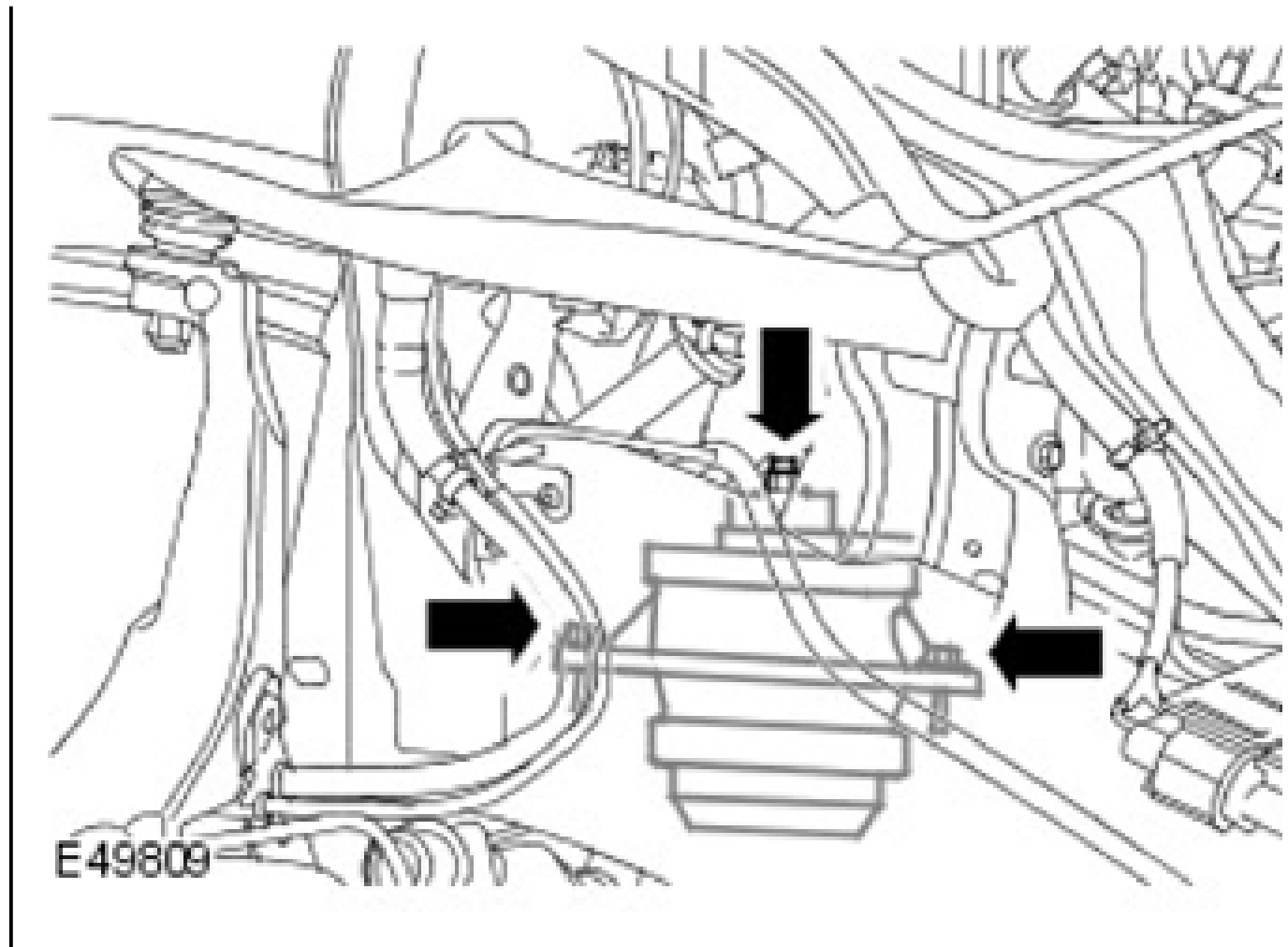
11. Release the brake hose from the upper arm.



12. Tie the upper suspension arm aside for access.
13. Remove the steering column lower universal joint assembly for access.
 - Remove and discard the bolts.



14. Support the engine.
15. Raise the engine.
 - Remove the nut.
16. Remove the engine front mount.
 - Remove and discard the 2 bolts.



INSTALLATION

1. Clean the component mating faces.
2. Install the engine front mount.
 - Tighten the bolts to 45 Nm (33 lb.ft), then a further 60 degrees.
3. Lower the engine onto the mount.
 - Tighten the nut to 90 Nm (66 lb.ft).
4. Remove the engine support.
5. Install the steering column lower universal joint assembly.
 - Install new patchlock bolts and tighten to 25 Nm (18 lb.ft).
6. Secure the brake hose to the upper arm.
 - Tighten the bolt to 23 Nm (17 lb.ft).
7. Connect the upper arm and wheel knuckle.
 - Remove the cable tie securing the upper arm.
 - Install a new nut and tighten to 70 Nm (52 lb.ft).

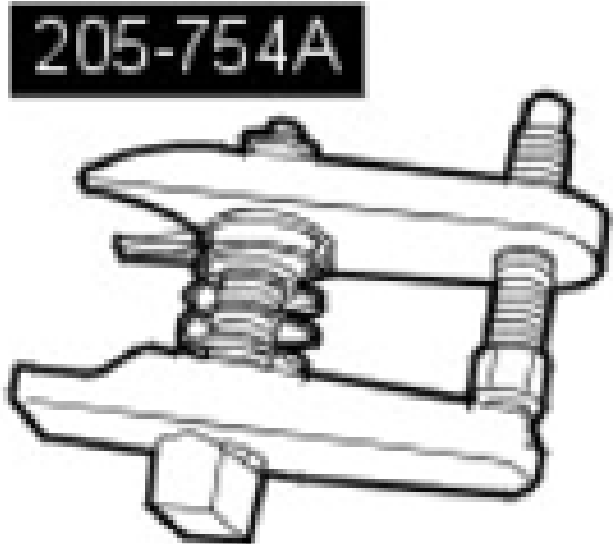
8. Secure the stabilizer bar link.
 - Tighten the nut to 115 Nm (85 lb.ft).
9. Connect the height sensor link arm.
10. Install the upper suspension arm and brake line heat shields.
 - Install the bolts.
 - Install the nuts.
11. Install the engine compartment upper LH heat shield.
 - Install the screw.
12. Install the engine undershield.

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

13. Install the front wheel.
 - Tighten the wheel nuts to 140 Nm (103 lb.ft).

ENGINE MOUNT RH

SPECIAL TOOL(S)

 205-754A E45276	Ball joint separator 205-754 (LRT-54-027)
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REMOVAL

1. Disconnect the battery ground cable.

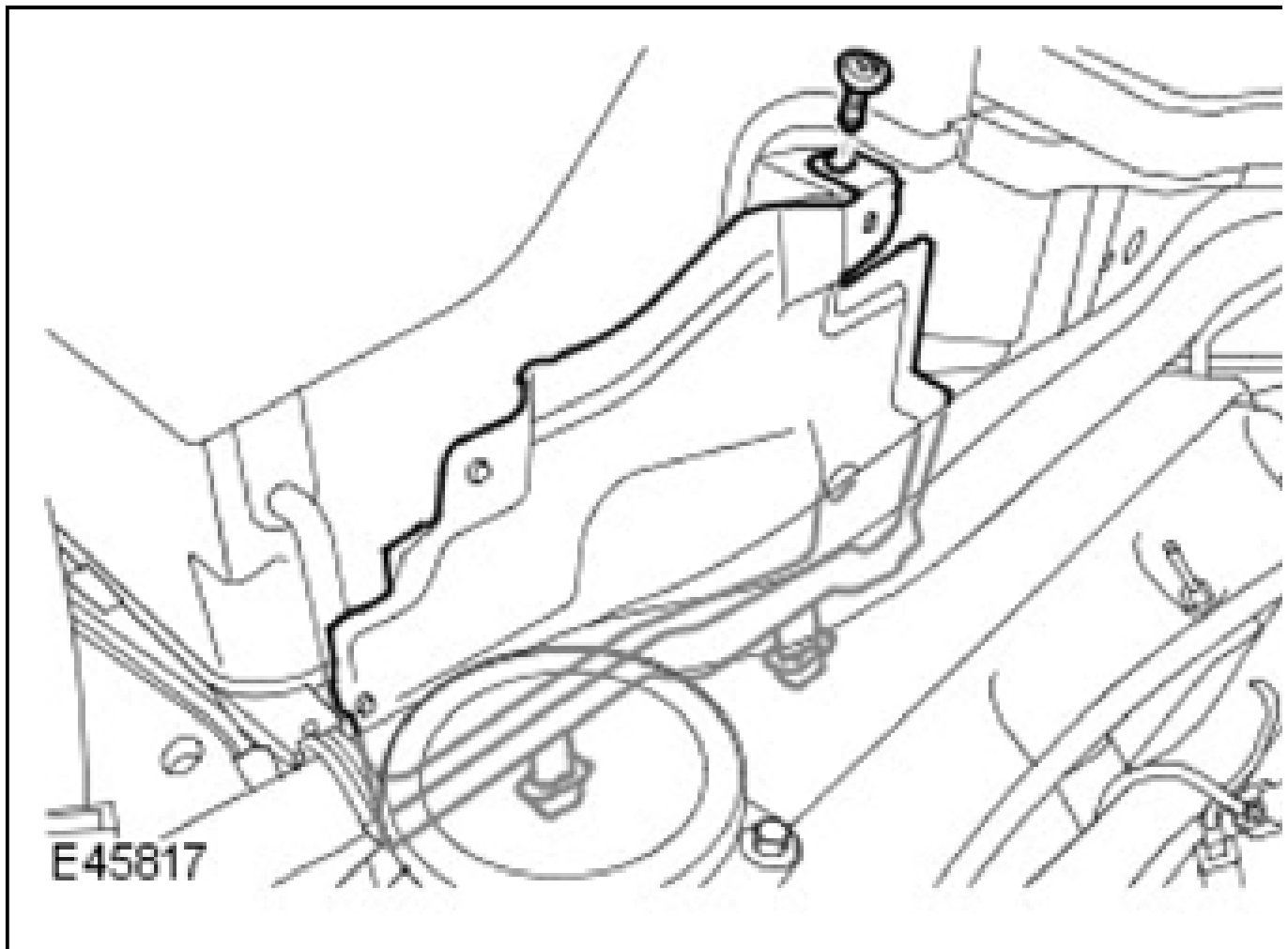
For additional information, refer to: **SPECIFICATION** .

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 RH front wheel.
4. Remove the engine undershield.

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

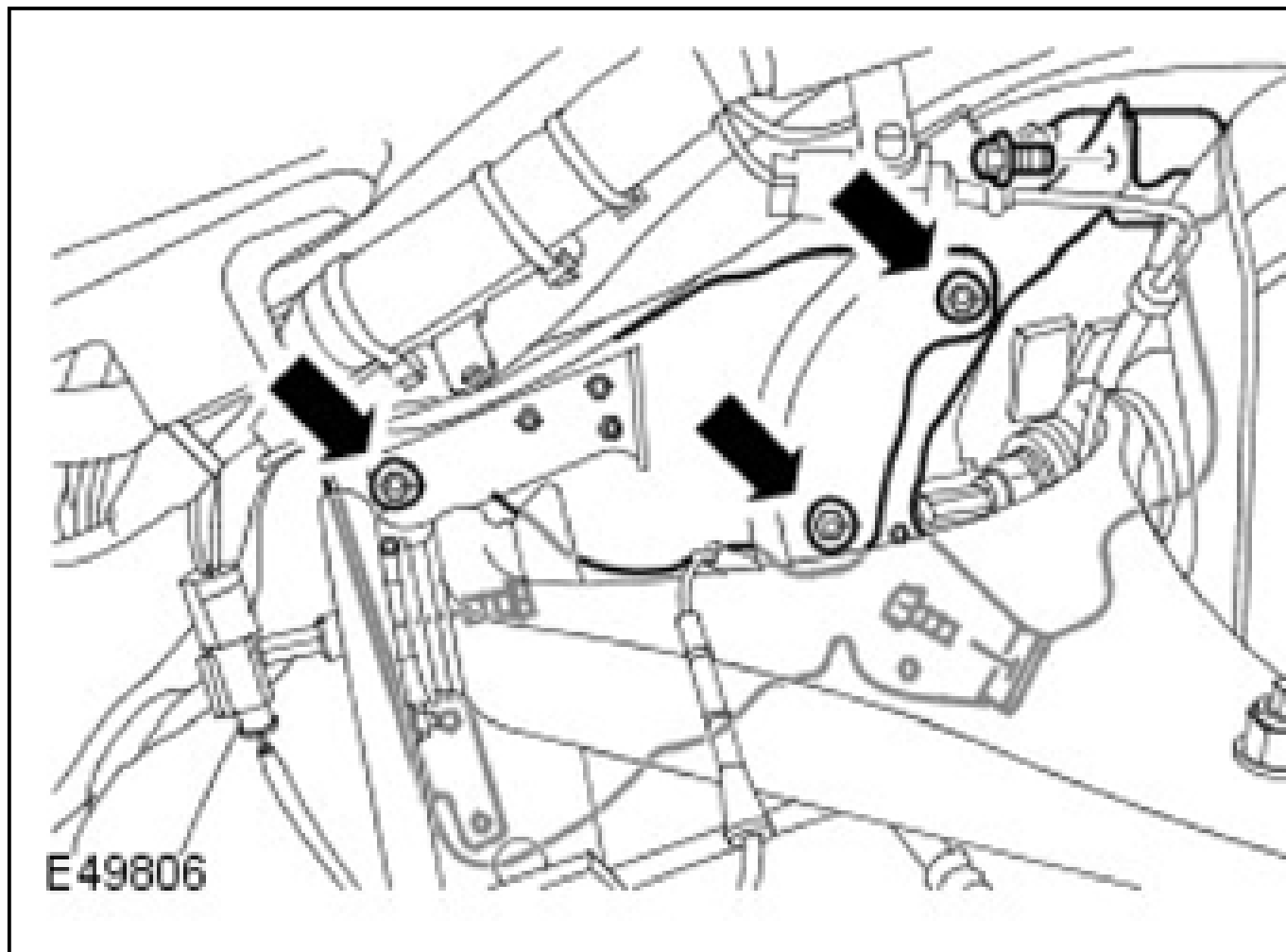
5. Remove the engine compartment upper RH heat shield.
 - Remove the screw.



NOTE: The heatshield consists of 3 parts.

6. Remove the upper suspension arm and brake line heat shields for access.
 - Remove the 3 nuts.

- Remove the 3 bolts.



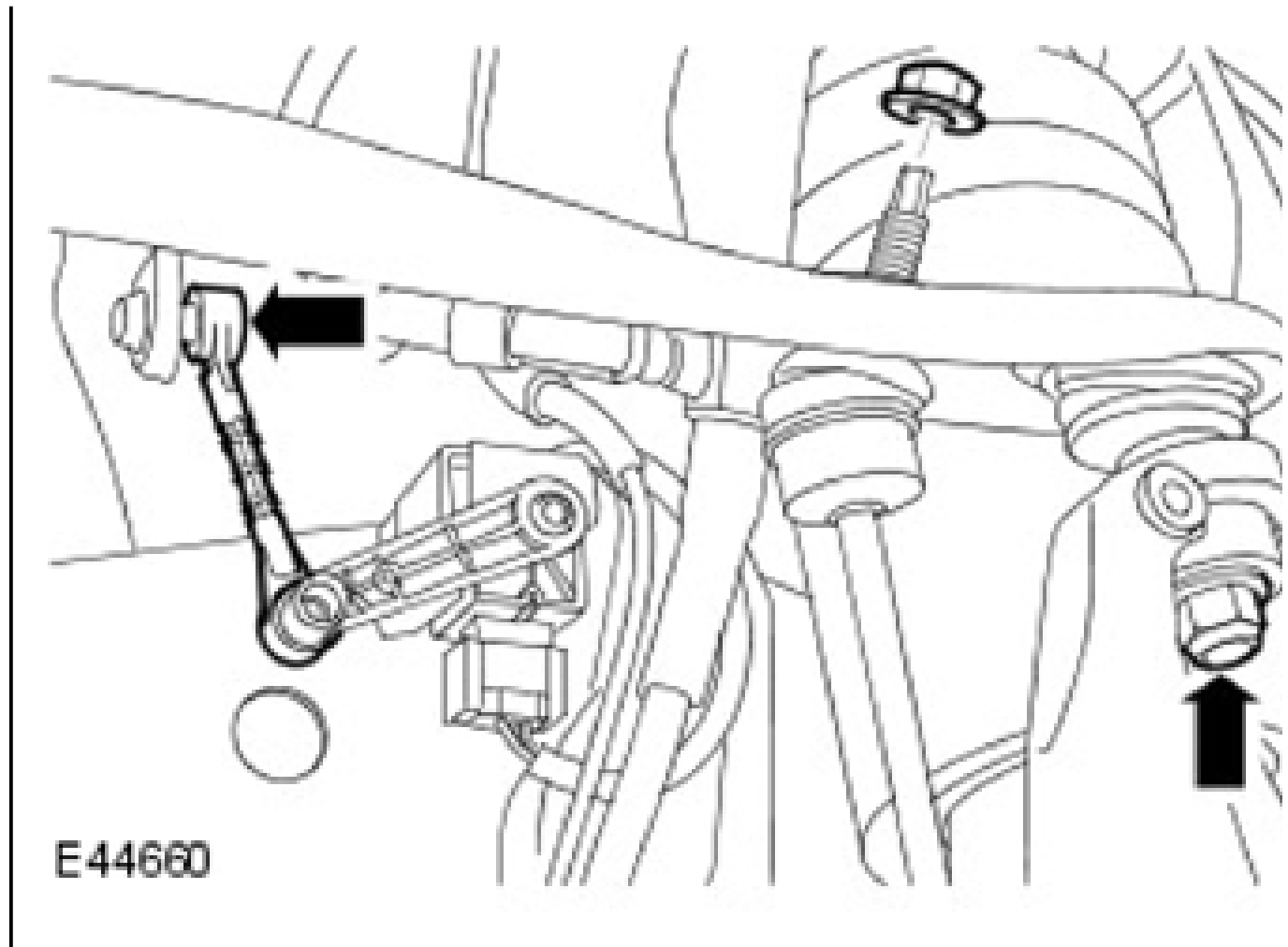
7. Disconnect the height sensor link arm.

CAUTION: Use a wrench on the hexagon provided to prevent the ball joint rotating.

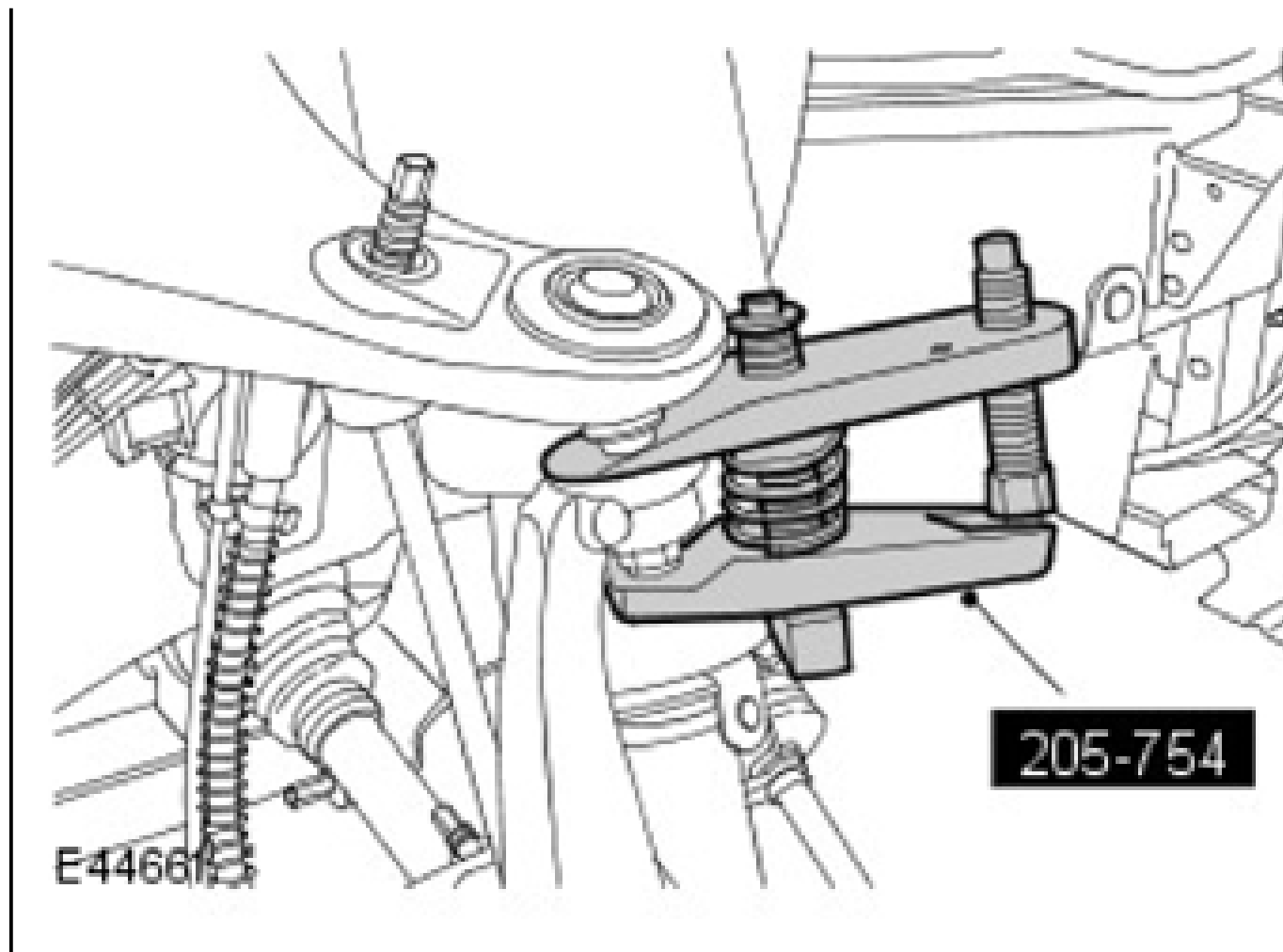
8. Remove the stabilizer bar link nut.

CAUTION: To prevent the wheel knuckle falling outwards and disconnection of the halfshaft inner joint, support the wheel knuckle.

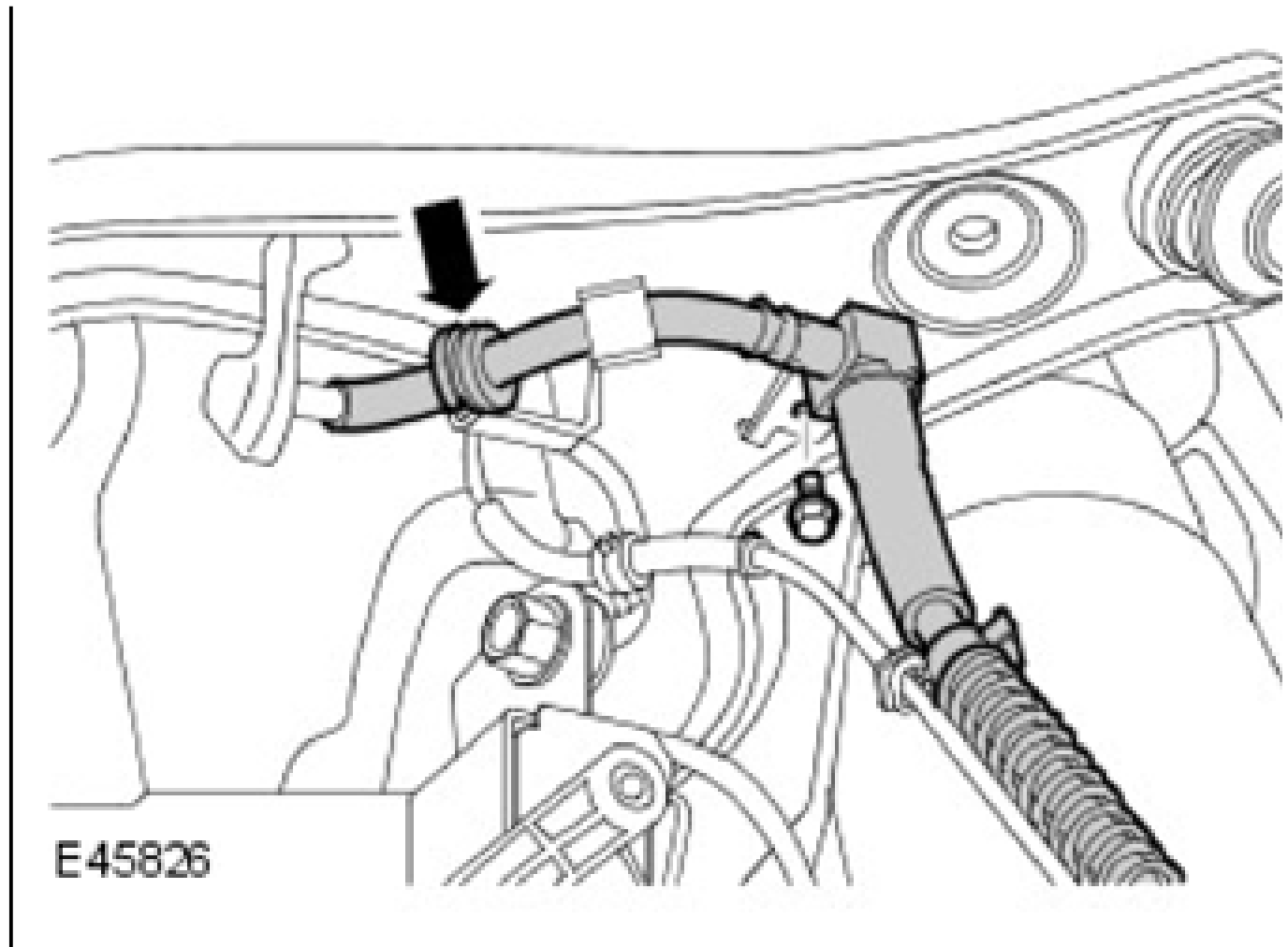
9. Loosen the upper arm retaining nut.



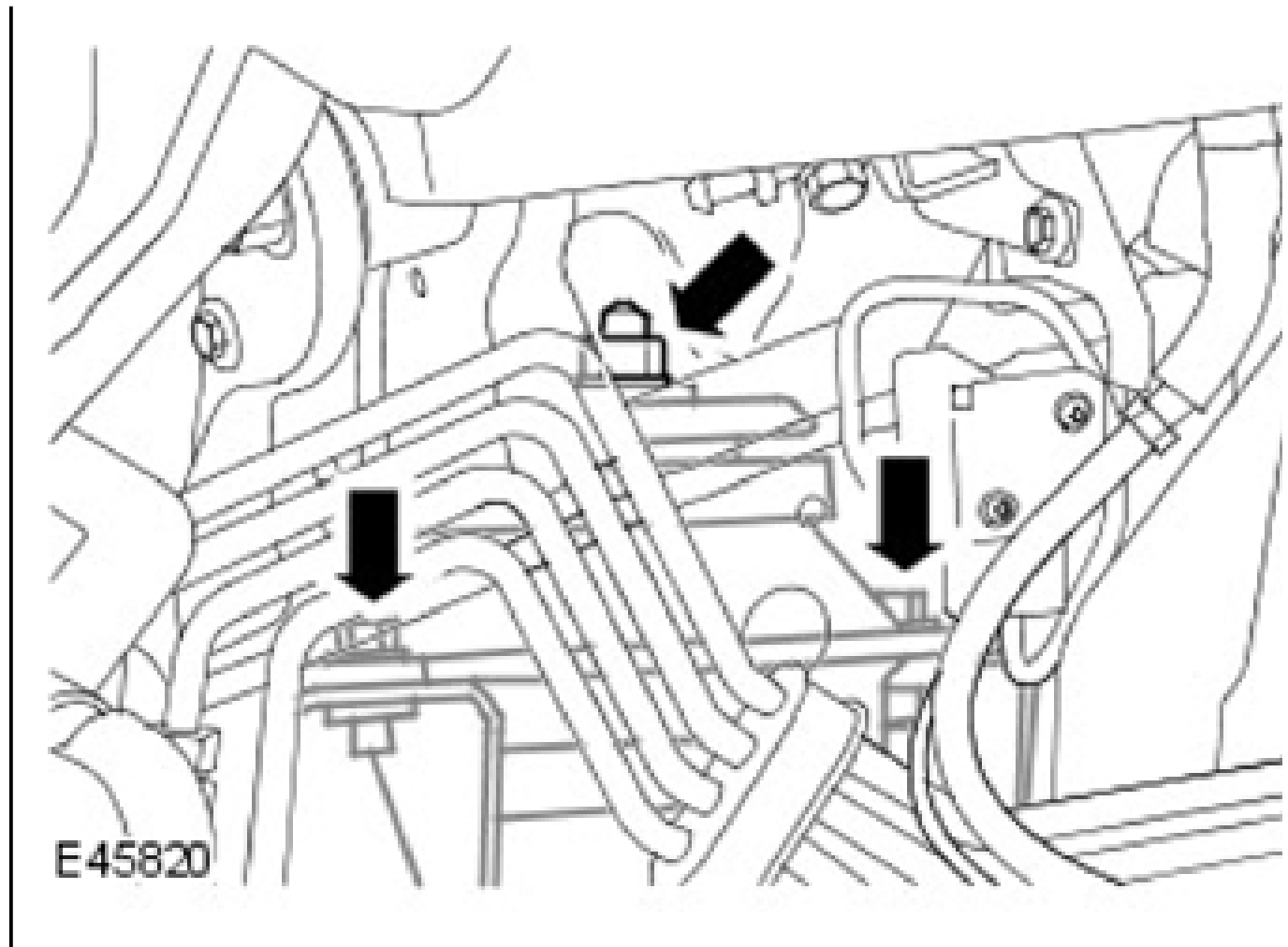
10. Using the special tool, release the upper arm ball joint.
 - Remove and discard the retaining nut.



11. Release the brake hose from the upper arm.



12. Tie the upper suspension arm aside for access.
13. Support the engine.
14. Raise the engine.
 - Remove the nut.
15. Remove the engine front mount.
 - Remove and discard the 2 bolts.



INSTALLATION

1. Clean the component mating faces.
2. Install the engine front mount.
 - Tighten the bolts to 45 Nm (33 lb.ft), then a further 60 degrees.
3. Lower the engine onto the mount.
 - Tighten the nut to 90 Nm (66 lb.ft).
4. Remove the engine support.
5. Secure the brake hose to the upper arm.
 - Tighten the bolt to 23 Nm (17 lb.ft).
6. Connect the upper arm and wheel knuckle.
 - Remove the cable tie securing the upper arm.
 - Install a new nut and tighten to 70 Nm (52 lb.ft).
7. Secure the stabilizer bar link.
 - Tighten the nut to 115 Nm (85 lb.ft).

8. Connect the height sensor link arm.

NOTE: **The heatshield consists of 3 parts.**

9. Install the upper suspension arm and brake line heat shields.
 - Install the bolts.
 - Install the nuts.
10. Install the engine compartment upper RH heat shield.
 - Install the screw.
11. Install the engine undershield.

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

12. Install the front wheel.
 - Tighten the wheel nuts to 140 Nm (103 lb.ft).

FLEXPLATE

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** .

CAUTION: The bolts can only be used 3 times, mark the bolts with a center punch. If 2 punch marks are visible, discard the bolts.

NOTE: **Prevent the flexplate from rotating.**

4. Remove the torque converter flexplate.
 - Remove the 8 bolts.



INSTALLATION

NOTE: Prevent the flexplate from rotating.

1. Install the torque converter flexplate.
 - Clean the component mating faces.
 - Tighten the bolts evenly and progressively in 2 stages.
 - Tighten the bolts to 15 Nm (11 lb ft).
 - Tighten the bolts to 110 Nm (81 lb.ft).
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** .

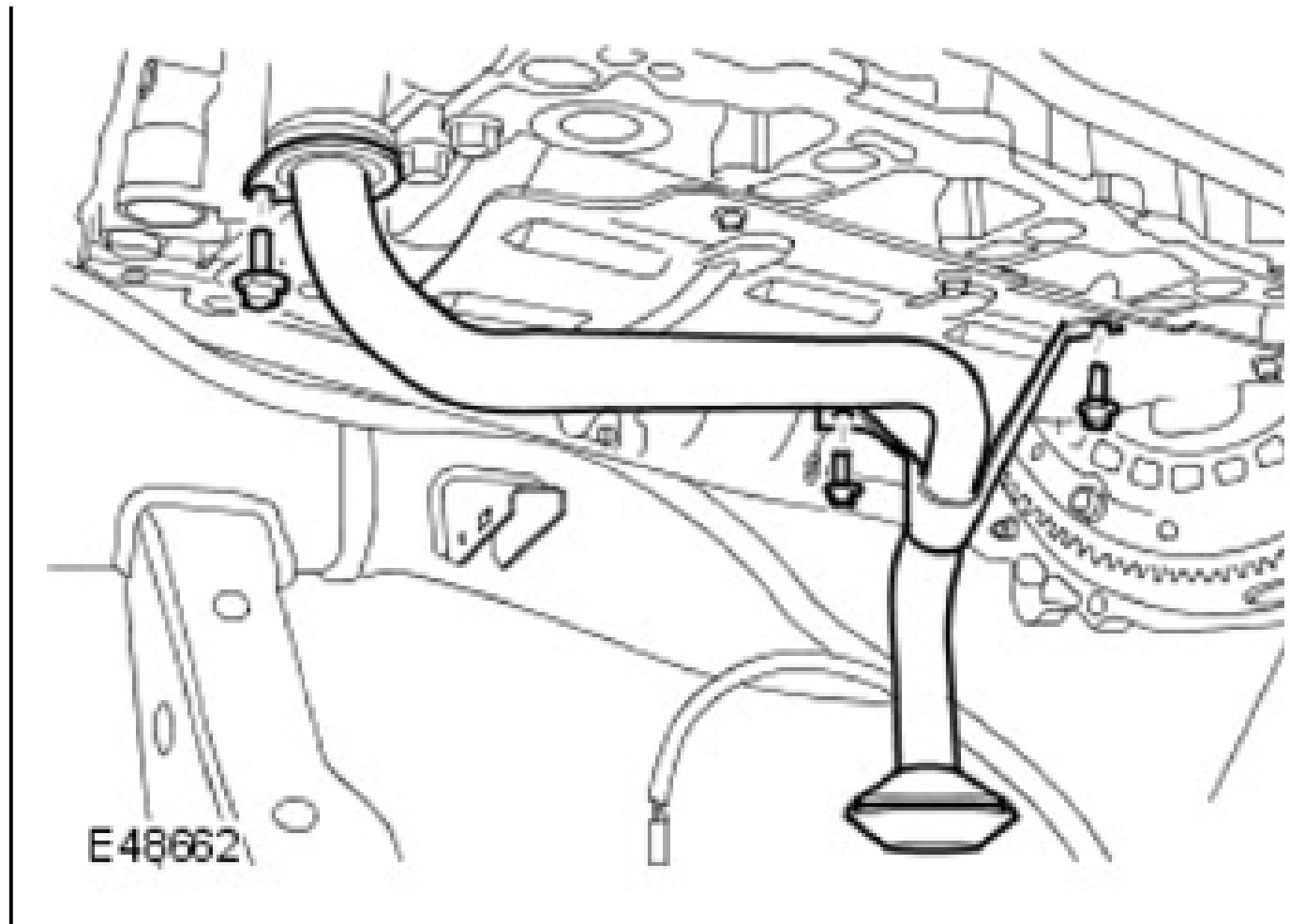
2. Remove the timing drive components.

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

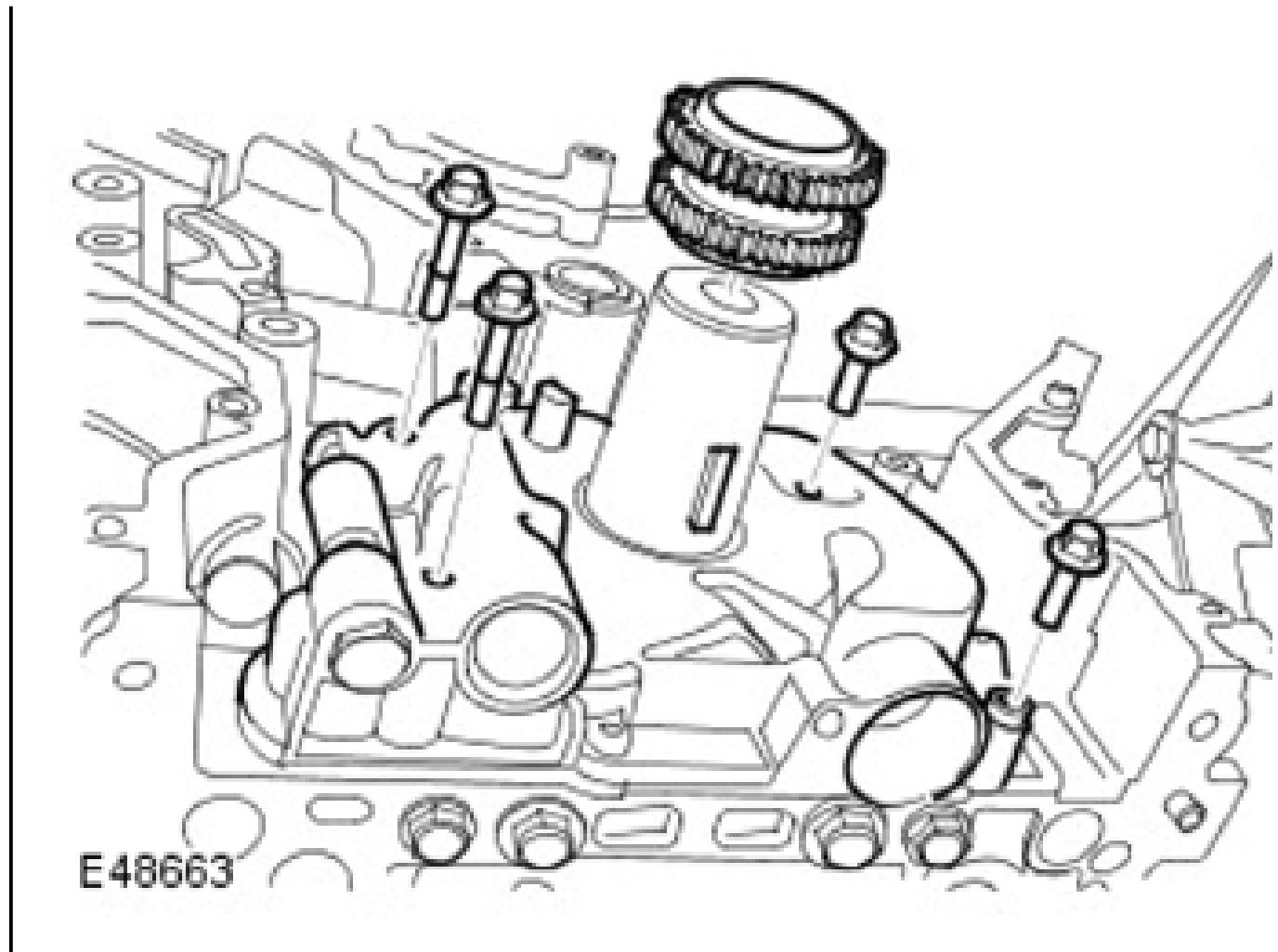
3. Remove the sump pan.

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

4. Remove the oil strainer pick up assembly.
 - Remove the 3 bolts.
 - Remove and discard the O-ring seal.



5. Remove the oil pump assembly.
 - Remove the 4 bolts.
 - Remove and discard the gasket.
 - Clean the component mating faces.



INSTALLATION

1. Install the oil pump assembly.
 - Install the new gasket.
 - Tighten the bolts to 10 Nm (7 lb.ft).
2. Install the oil strainer pick up assembly.
 - Install the O-ring seal.
 - Tighten the bolt to 6 Nm (4.4 lb.ft).
 - Tighten the bolts to 10 Nm (7 lb.ft).
3. Install the sump pan.

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

4. Install the timing drive components.

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

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.
3. Drain the engine oil.
4. Remove the oil cooler assembly.

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

5. Remove the engine front cover.

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

6. Remove the front differential.

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

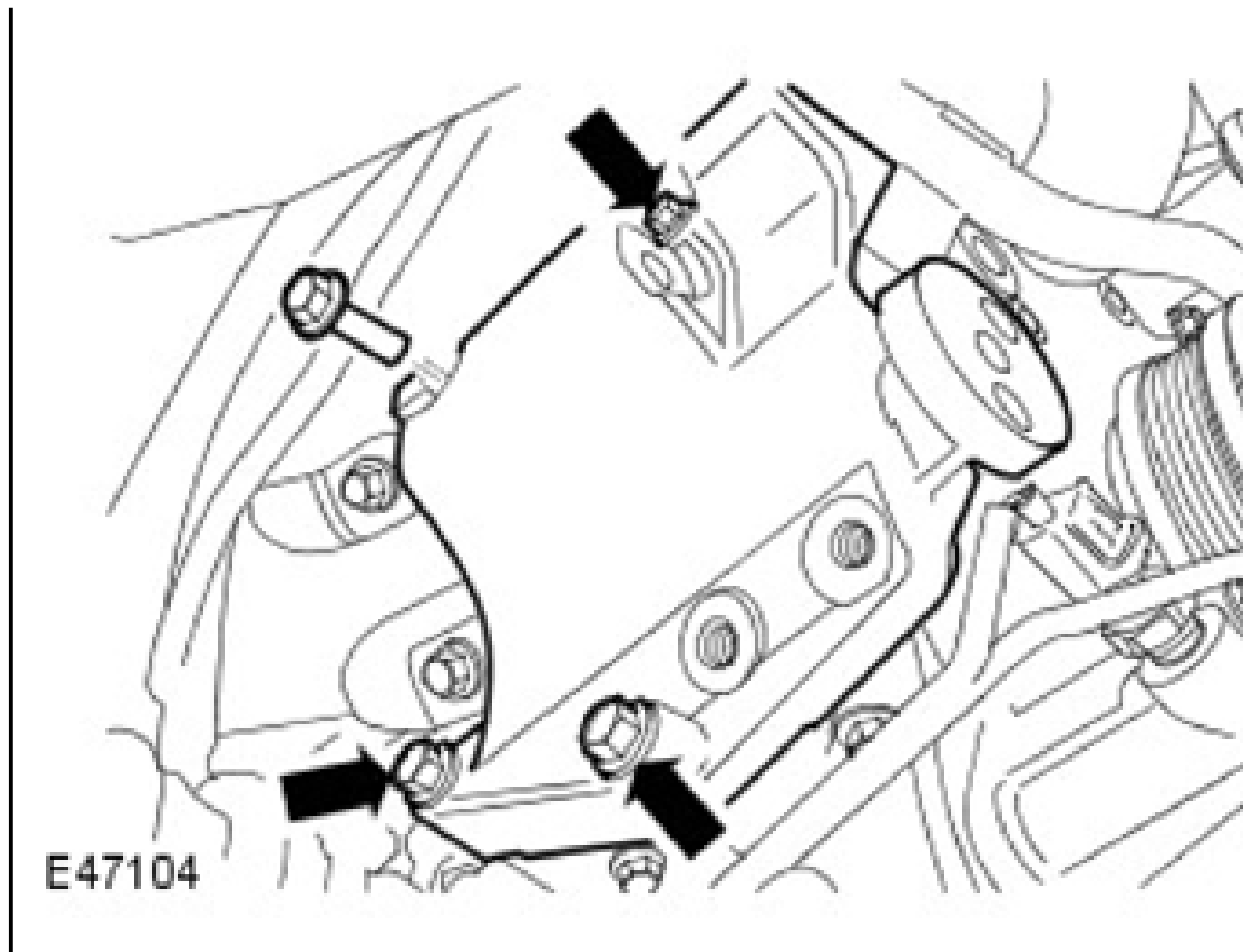
7. Remove the steering gear.

For additional information, refer to: **STEERING GEAR V8 4.4L PETROL** .

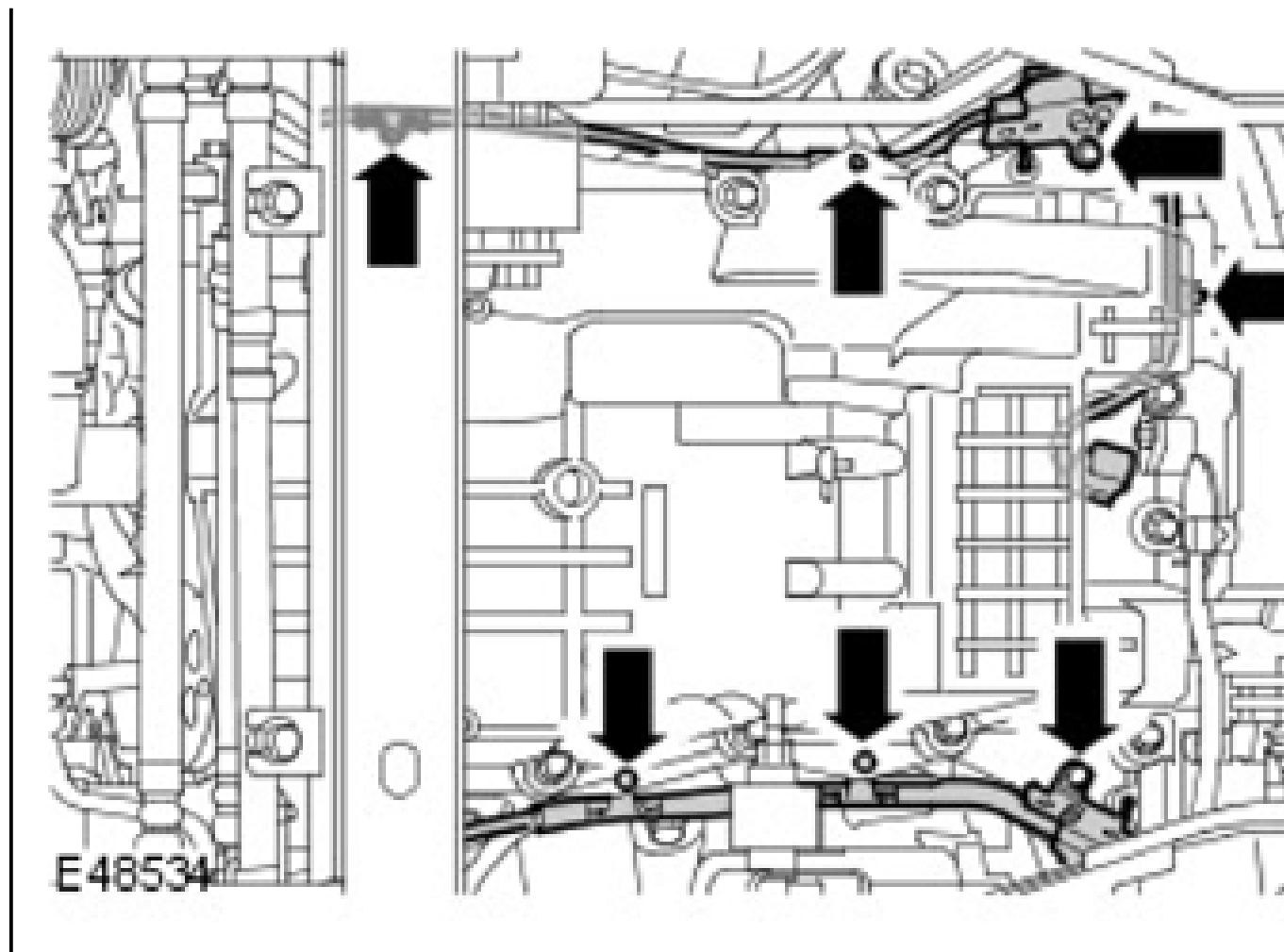
8. Remove the generator.

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

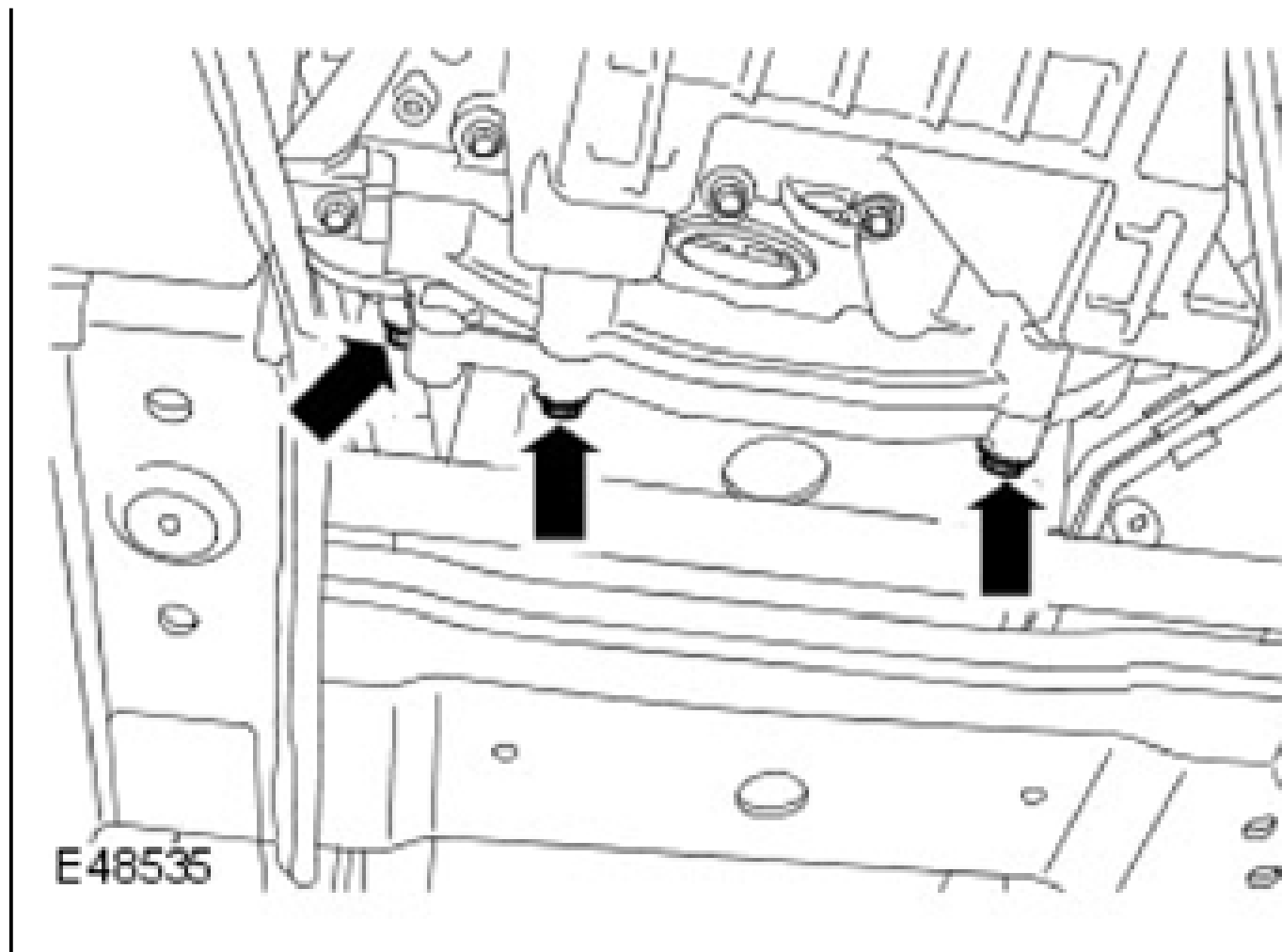
9. Remove the generator mounting bracket.
 - Remove the 4 bolts.



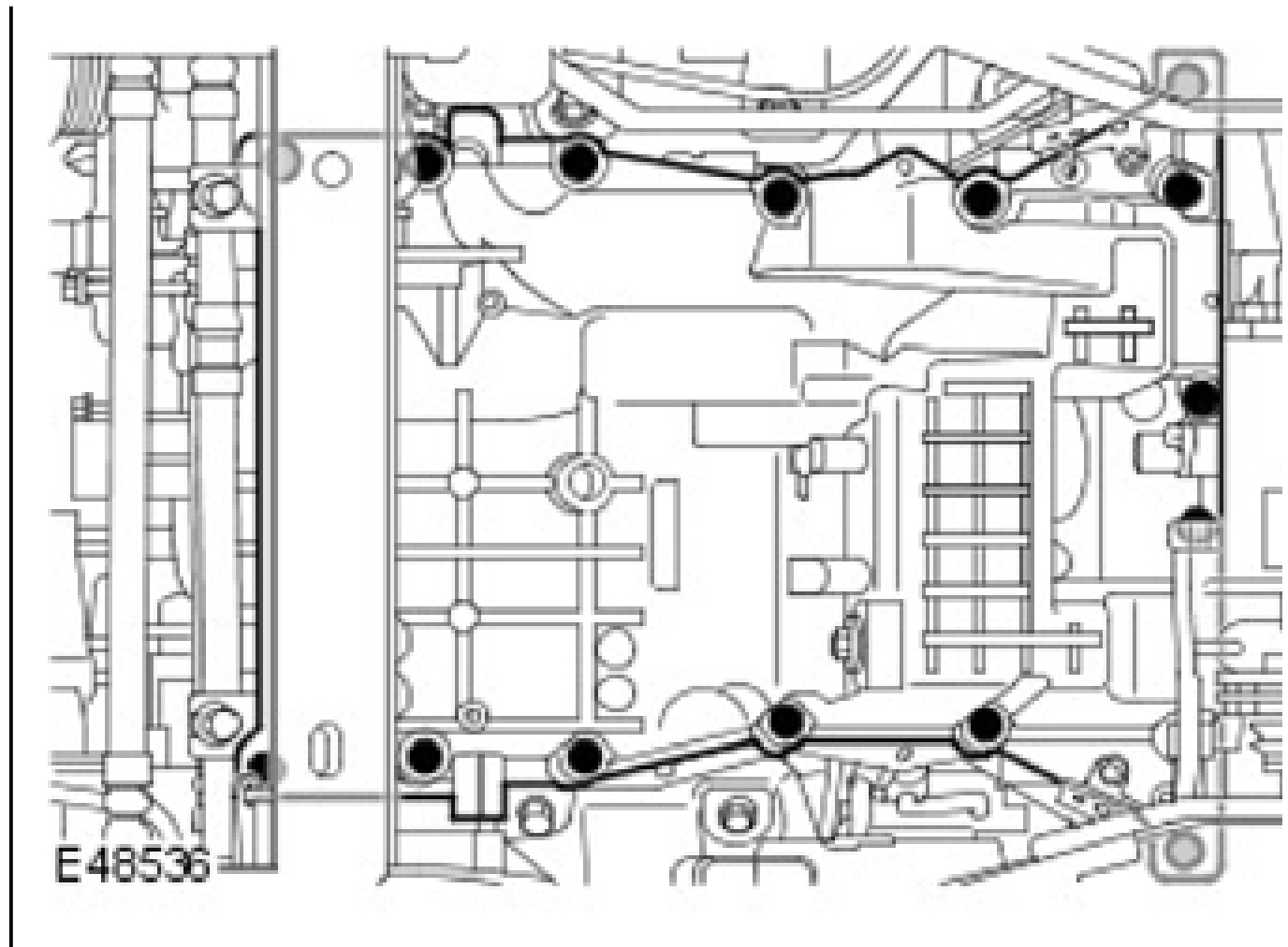
10. Disconnect the heated oxygen sensor (HO2S) electrical connectors.
 - Release the 8 wiring harness securing clips.



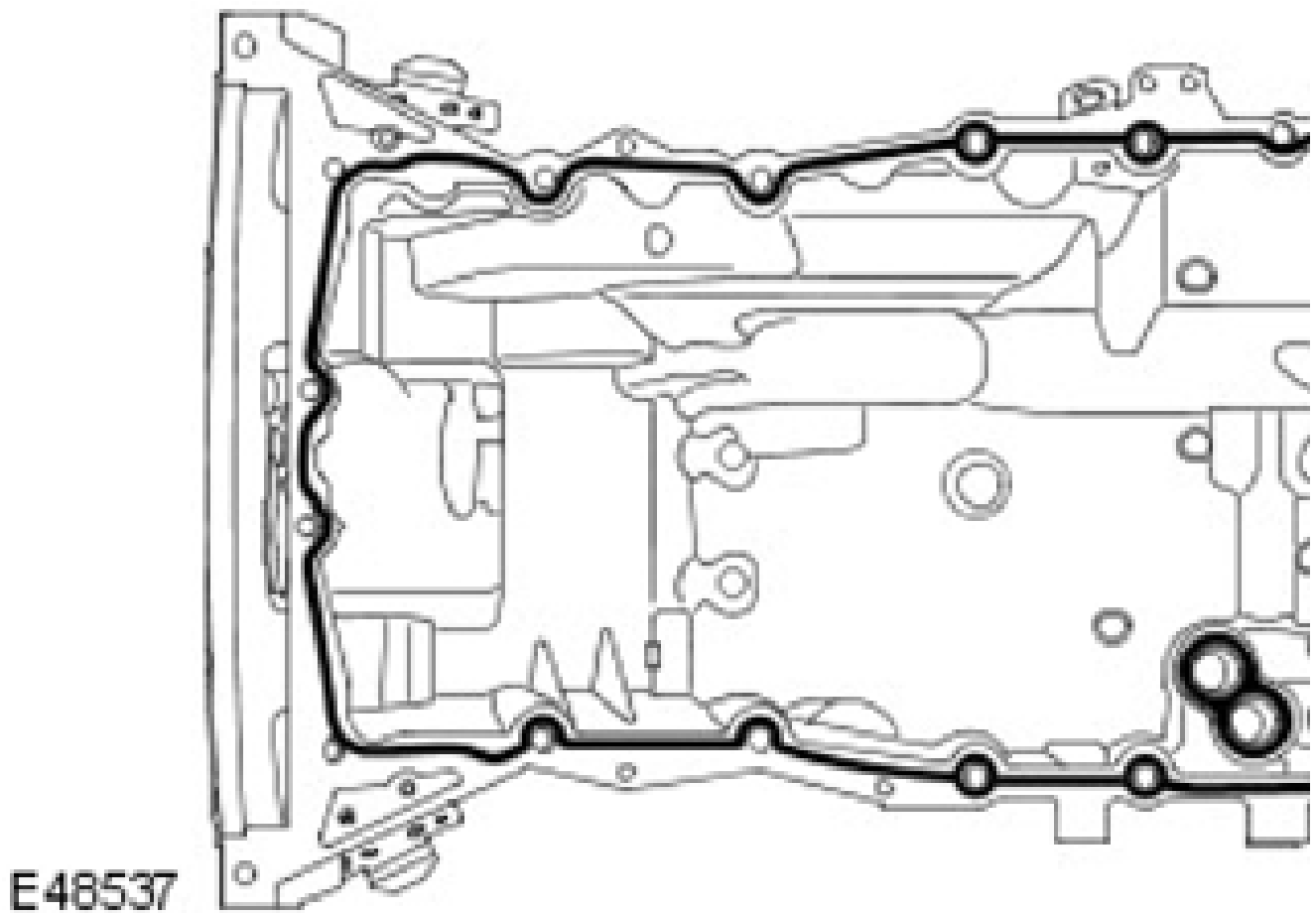
11. Release the HO2S mounting bracket.
 - Remove the 2 bolts.
12. Release the HO2S wiring harness from the oil pan.
 - Release the 3 clips.
13. Remove the transmission retaining bolts.
 - Remove the 3 bolts.



14. Remove the sump pan.
 - Remove the 16 bolts.

**INSTALLATION**

1. Install the sump pan.
 - Clean the component mating faces.
 - Apply a bead of sealant, 3 mm diameter by 130 cm long, to the areas indicated.
 - Tighten the bolts to 20 Nm (15 lb.ft).



2. Install the transmission retaining bolts.
 - Tighten the bolts to 45 Nm (33 lb.ft).
3. Install the HO2S mounting bracket.
 - Tighten the 2 bolts to 10 Nm (7 lb.ft).
4. Connect the HO2S electrical connectors.
 - Install the wiring harness clips.
5. Install the HO2S wiring harness.
 - Secure the clips.
6. Install the generator mounting bracket.
 - Clean the component mating faces.
7. Install the generator.

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

8. Install the steering gear.

For additional information, refer to: **STEERING GEAR V8 4.4L PETROL** .

9. Install the front differential.

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

10. Install the oil cooler assembly.

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

11. Install the engine front cover.

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

12. Fill the engine with oil.
13. Connect the battery ground cable.

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

OIL COOLER

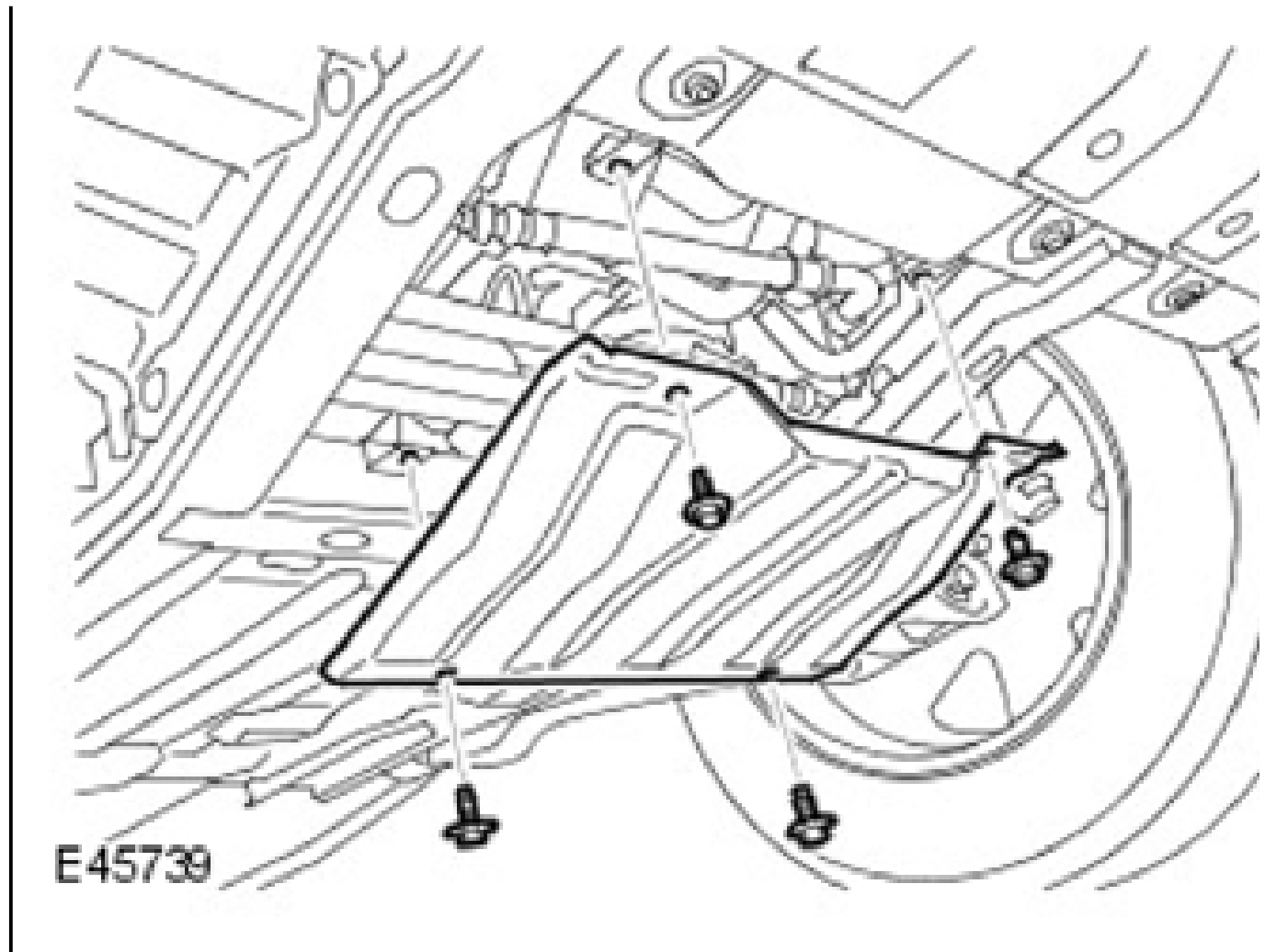
REMOVAL

1. Disconnect the battery ground cable.

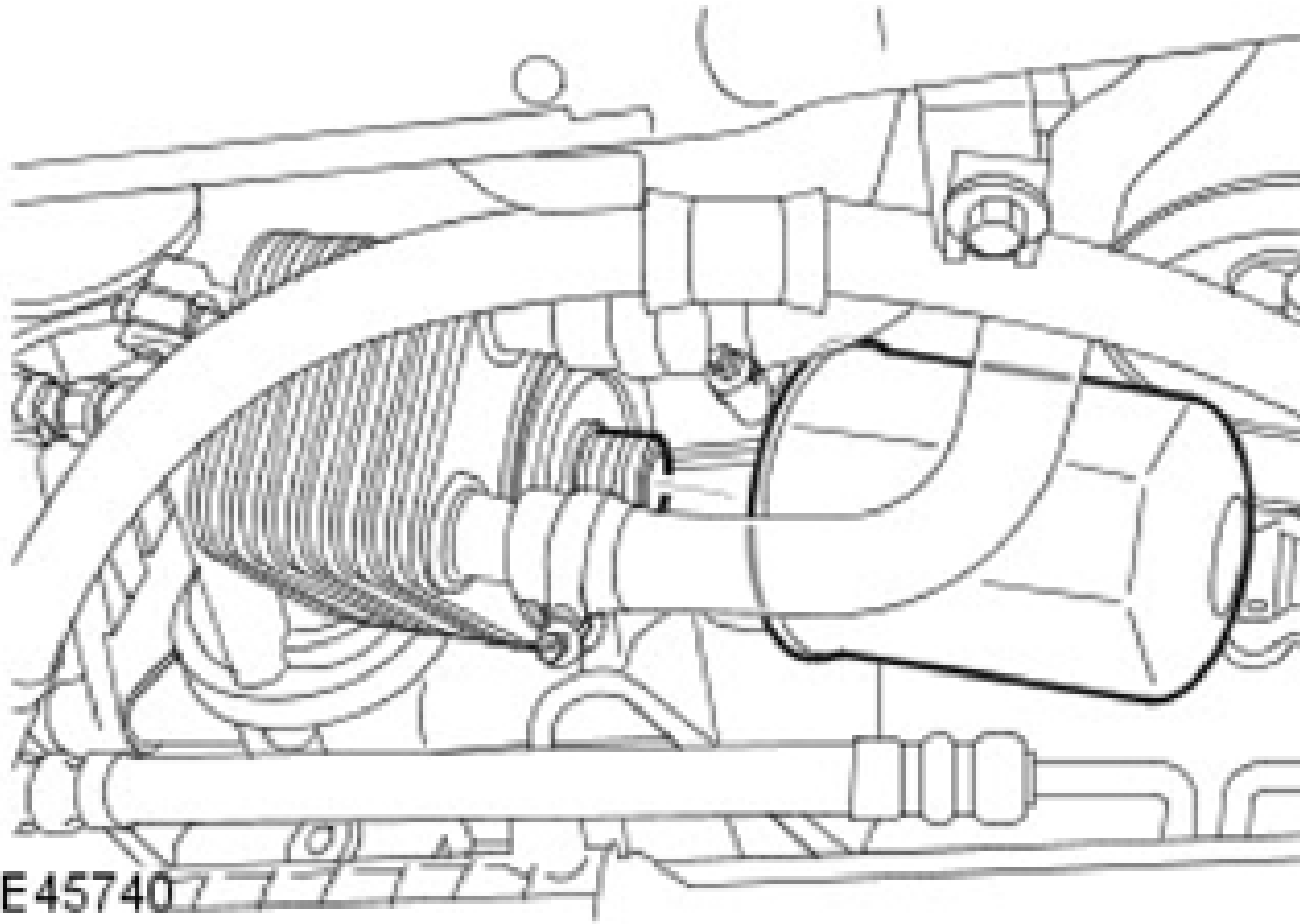
For additional information, refer to: **SPECIFICATION** .

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 radiator access panel.
 - Remove the 4 bolts.

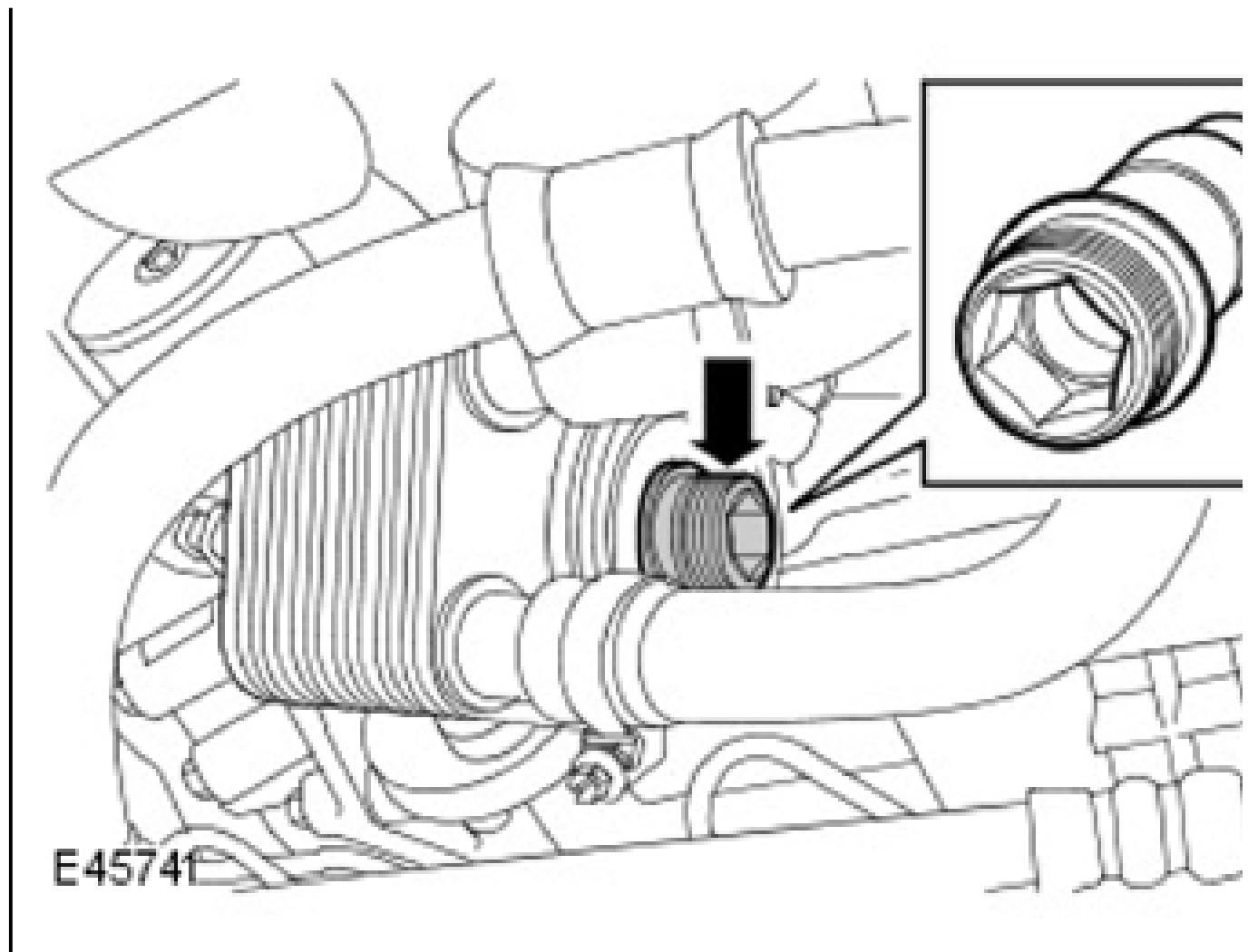


4. Remove the oil filter.
 - Position a container to collect the fluid.

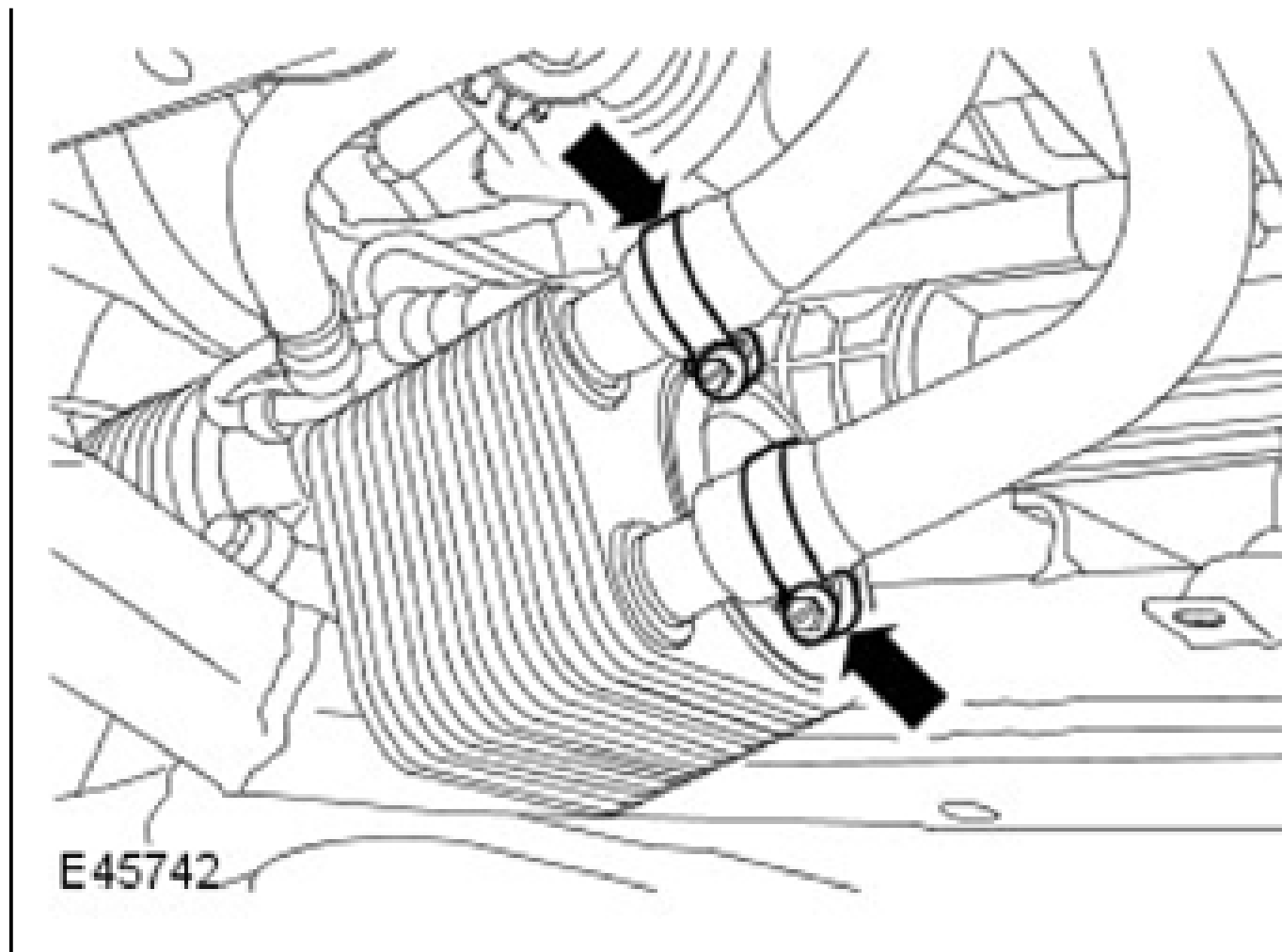


NOTE: Note the fitted position of the oil cooler assembly.

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



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



7. Remove the oil cooler.

INSTALLATION

NOTE: Fill the 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).
 - Tighten the bolts to 10 Nm (7 lb.ft).
2. Check and top up the engine oil.
3. Top up and bleed the coolant.

ENGINE FRONT COVER

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. Drain the cooling system.

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

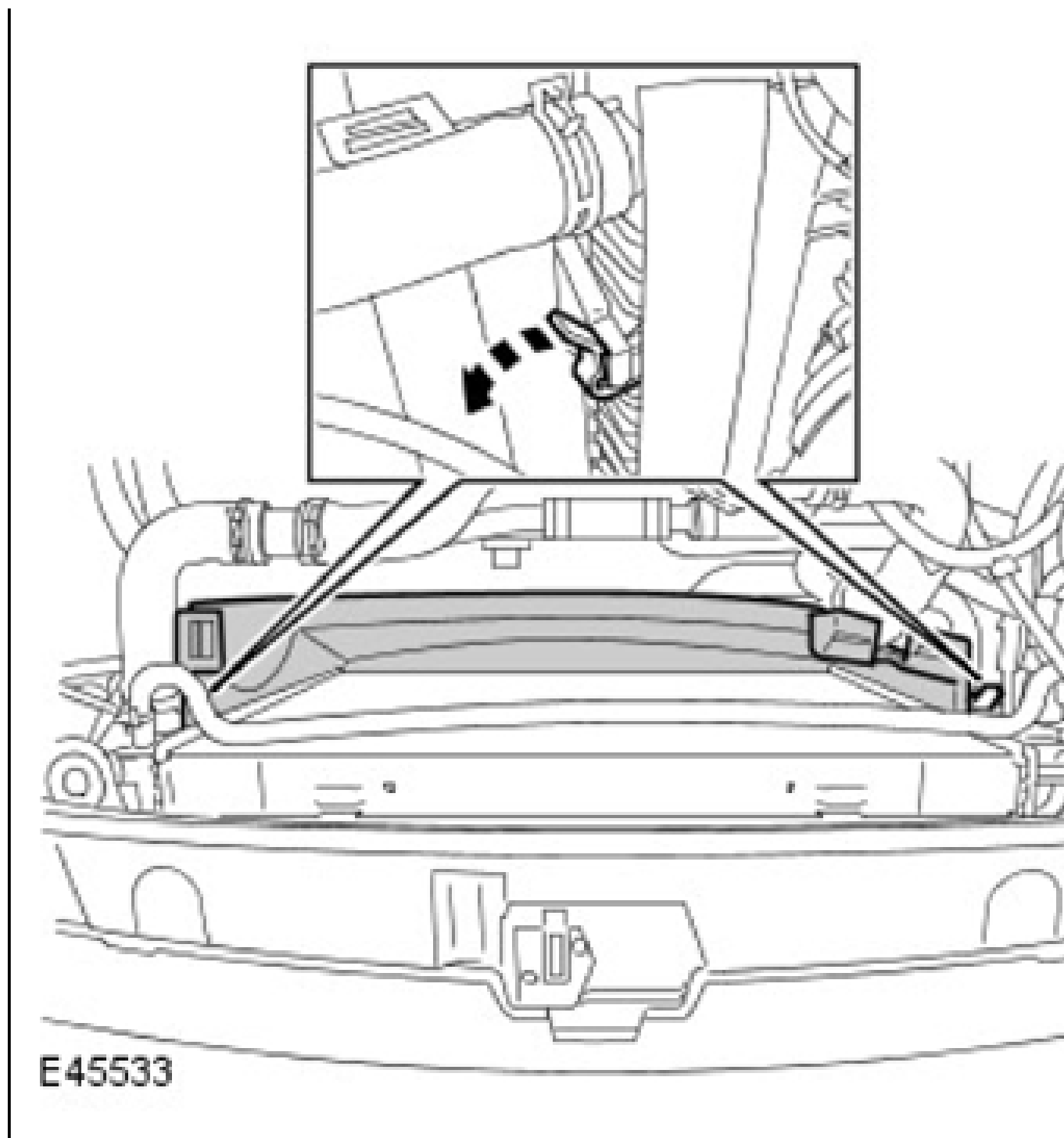
4. Remove the throttle body gasket.

For additional information, refer to: **Throttle Body Gasket** .

5. Remove the crankshaft front oil seal.

For additional information, refer to: **CRANKSHAFT FRONT SEAL** .

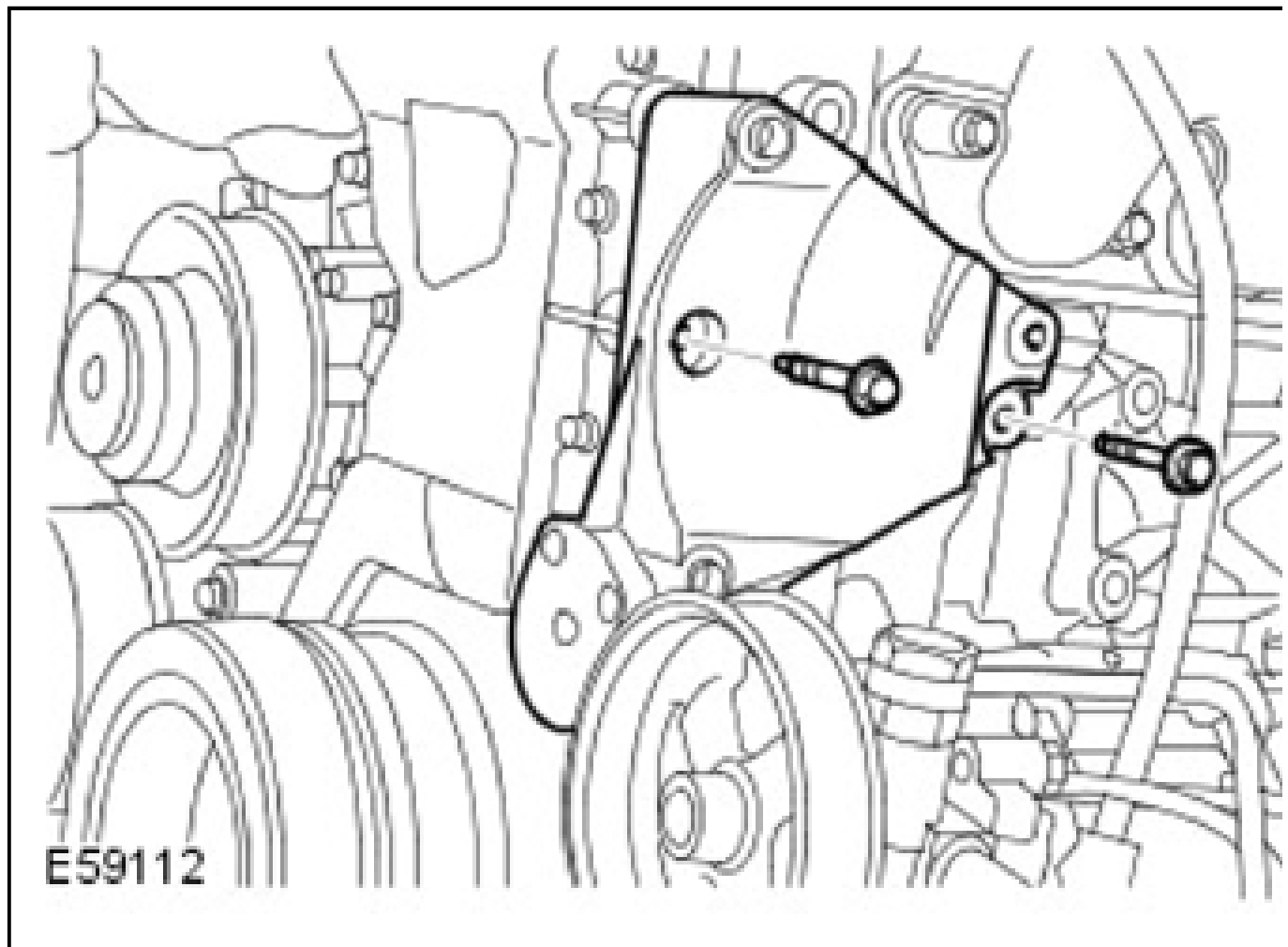
6. Remove the cooling fan lower shroud.
 - Release 2 clips from the cooling fan lower shroud.
 - Release and remove the cooling fan lower shroud from the cooling pack.



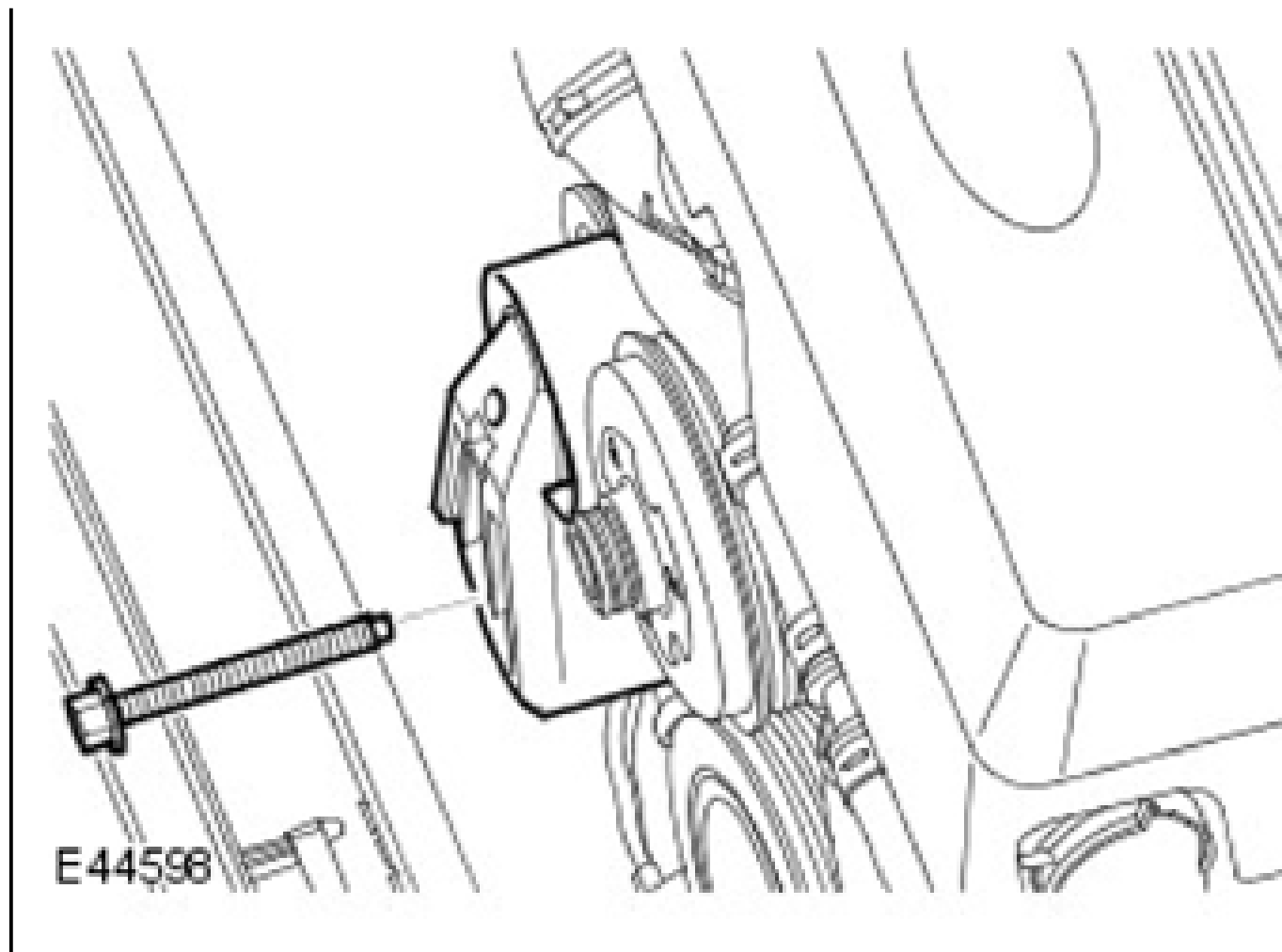
7. Remove the air conditioning (A/C) compressor.

For additional information, refer to: **AIR CONDITIONING (A/C) COMPRESSOR** .

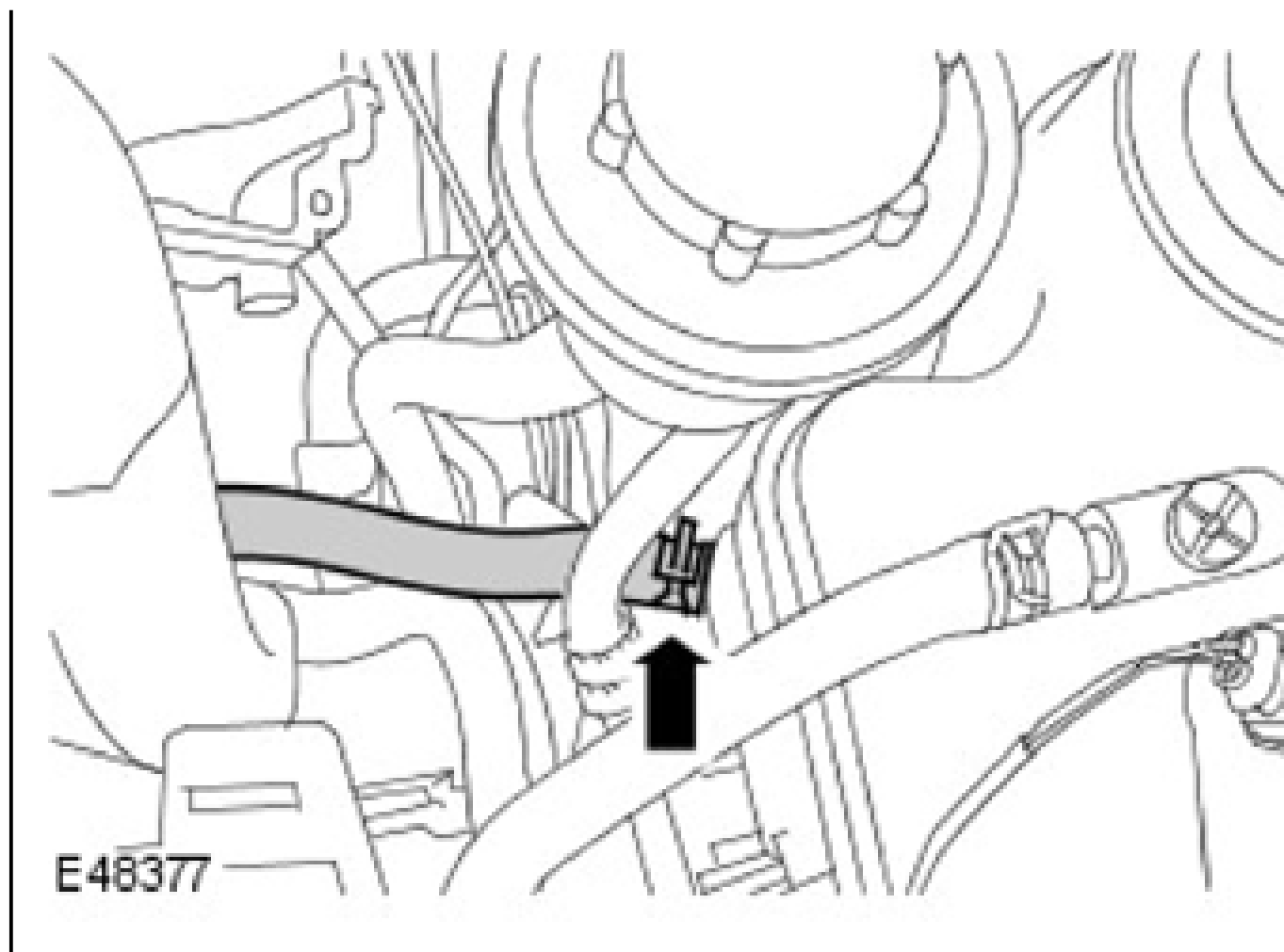
8. Remove the A/C compressor mounting bracket.
 - Remove the 2 bolts.



9. Remove the cooling fan drive belt tensioner.
 - Remove the bolt.

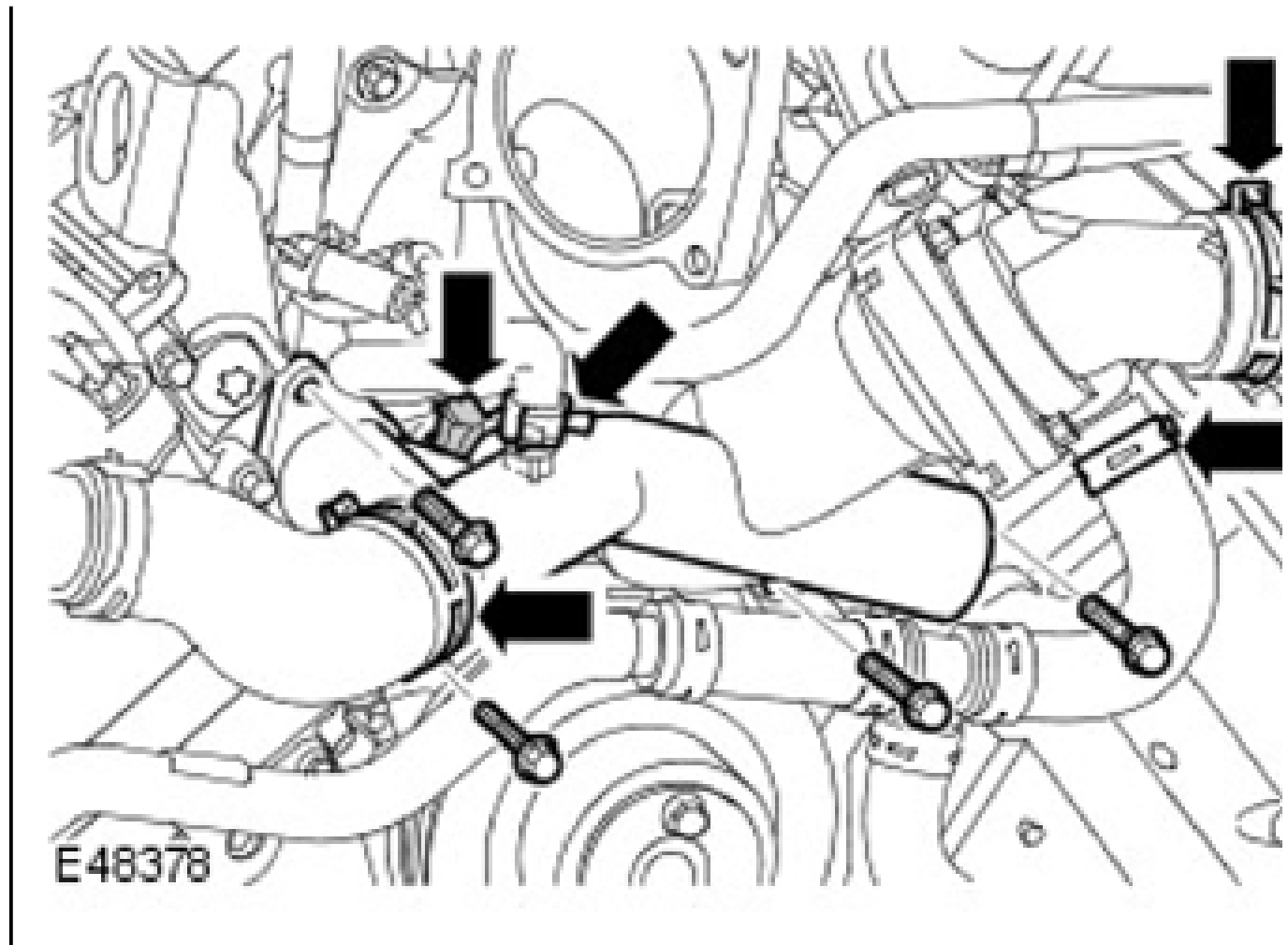


10. Disconnect the coolant expansion tank hose.
 - Release the clip.

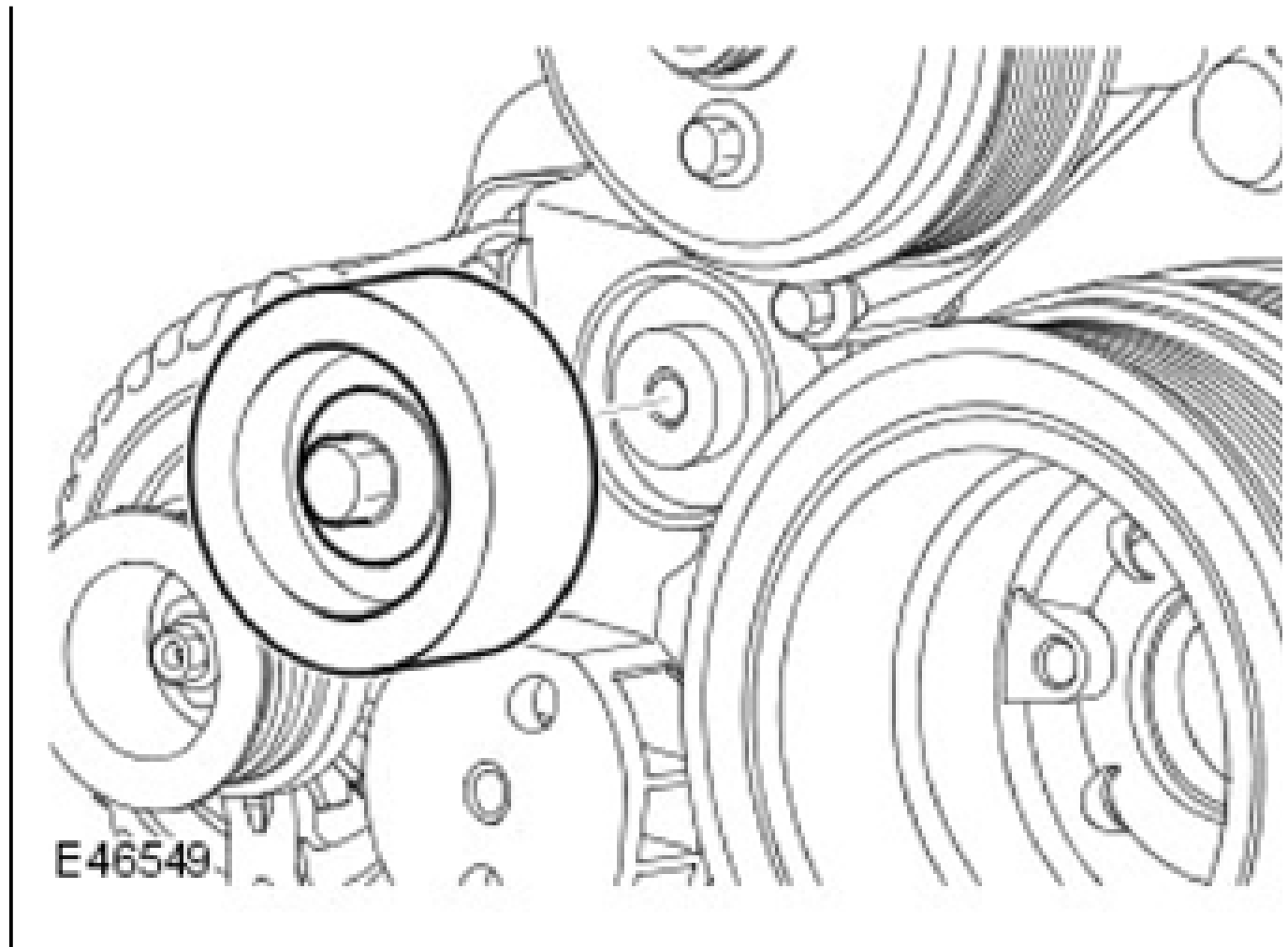


11. Remove the coolant manifold.

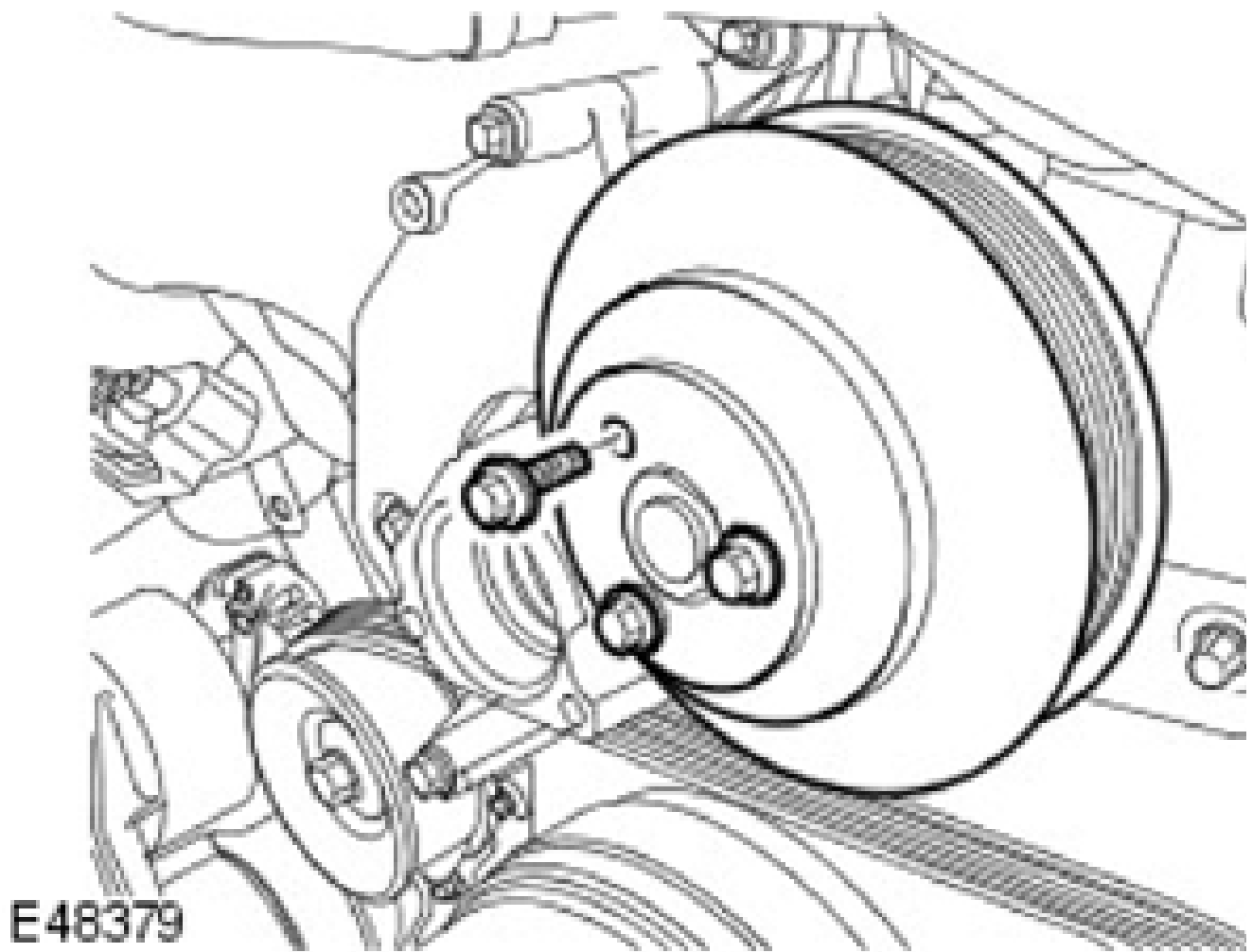
- Release the clips and disconnect the 4 coolant hoses.
- Remove the 4 bolts.
- Disconnect the electrical connector.
- Position the coolant hoses aside for access.



12. Release the engine wiring harness clips.
13. Remove the accessory drive belt idler pulley.
 - Remove the bolt.



14. Remove the coolant pump pulley.
 - Remove the 3 bolts.



15. Remove the RH exhaust manifold heat shield.

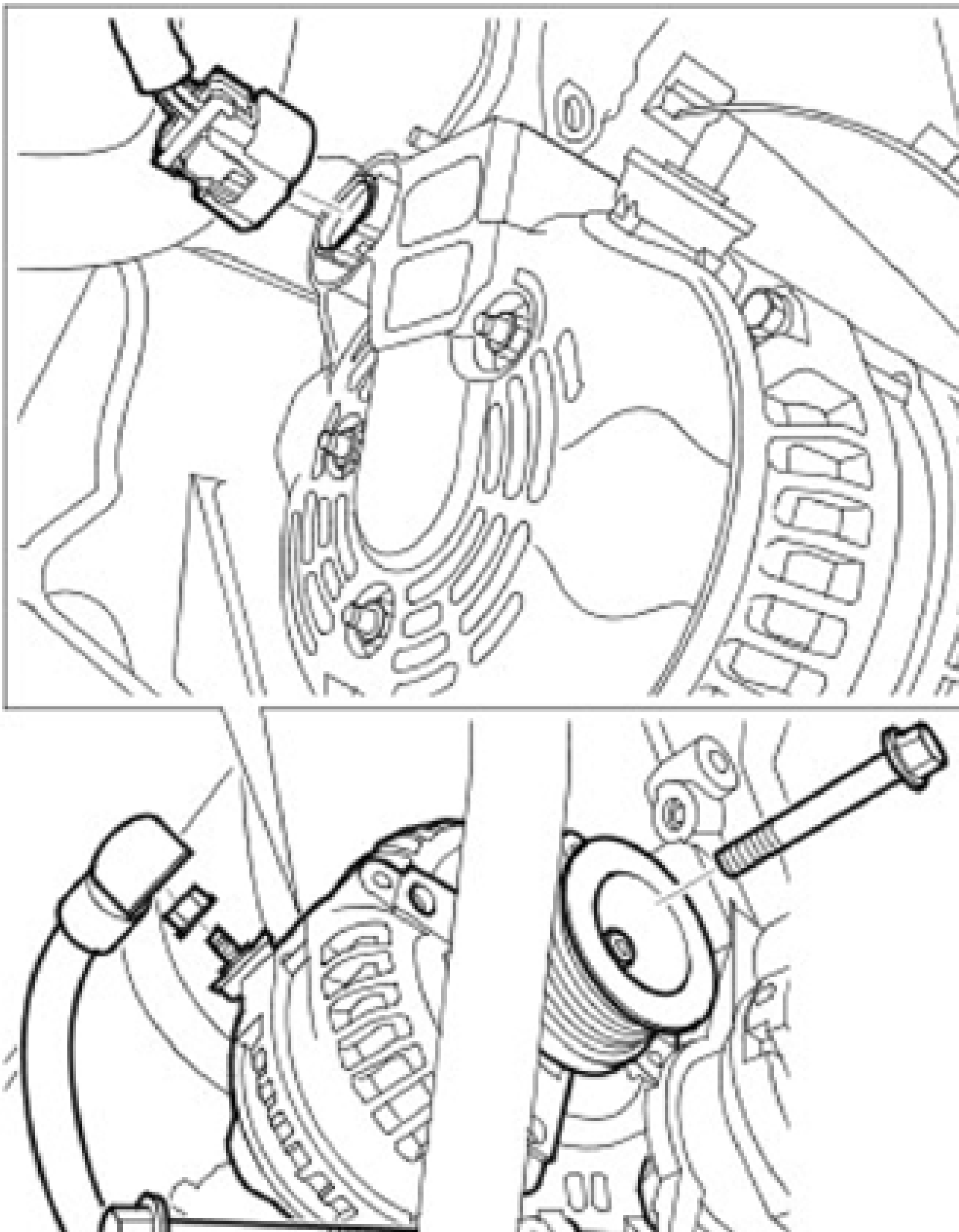
- Remove the 2 screws.



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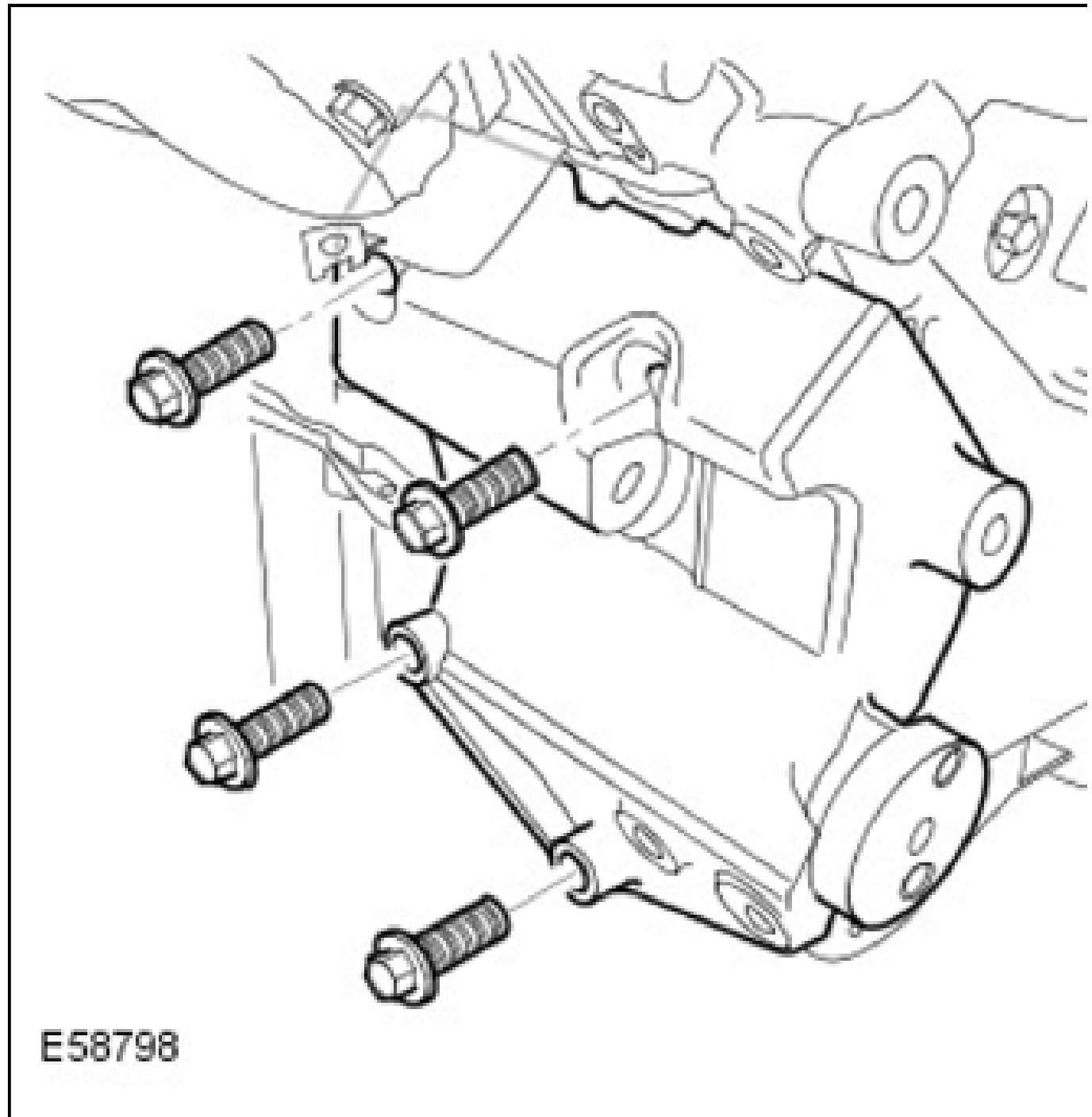
16. Disconnect the battery positive cable.
 - Release the cover.
 - Remove the nut.
 - Disconnect the electrical connector.
17. Remove the generator.

- Remove the 3 bolts.



18. Remove the generator mounting bracket.

- Remove the 4 bolts.



19. Remove the RH valve cover.

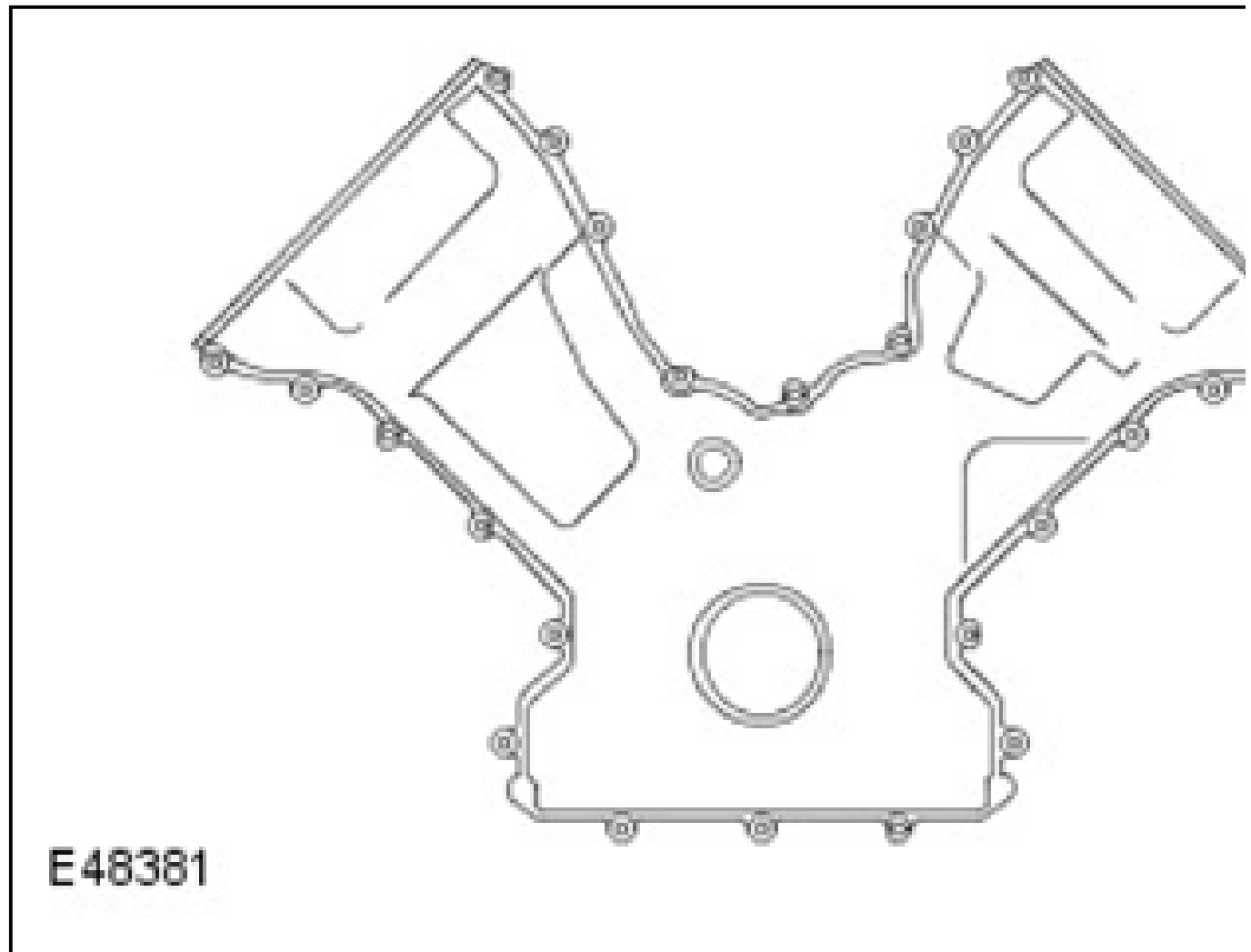
For additional information, refer to: **VALVE COVER RH** .

20. Remove the LH valve cover.

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

21. Remove the engine front cover.

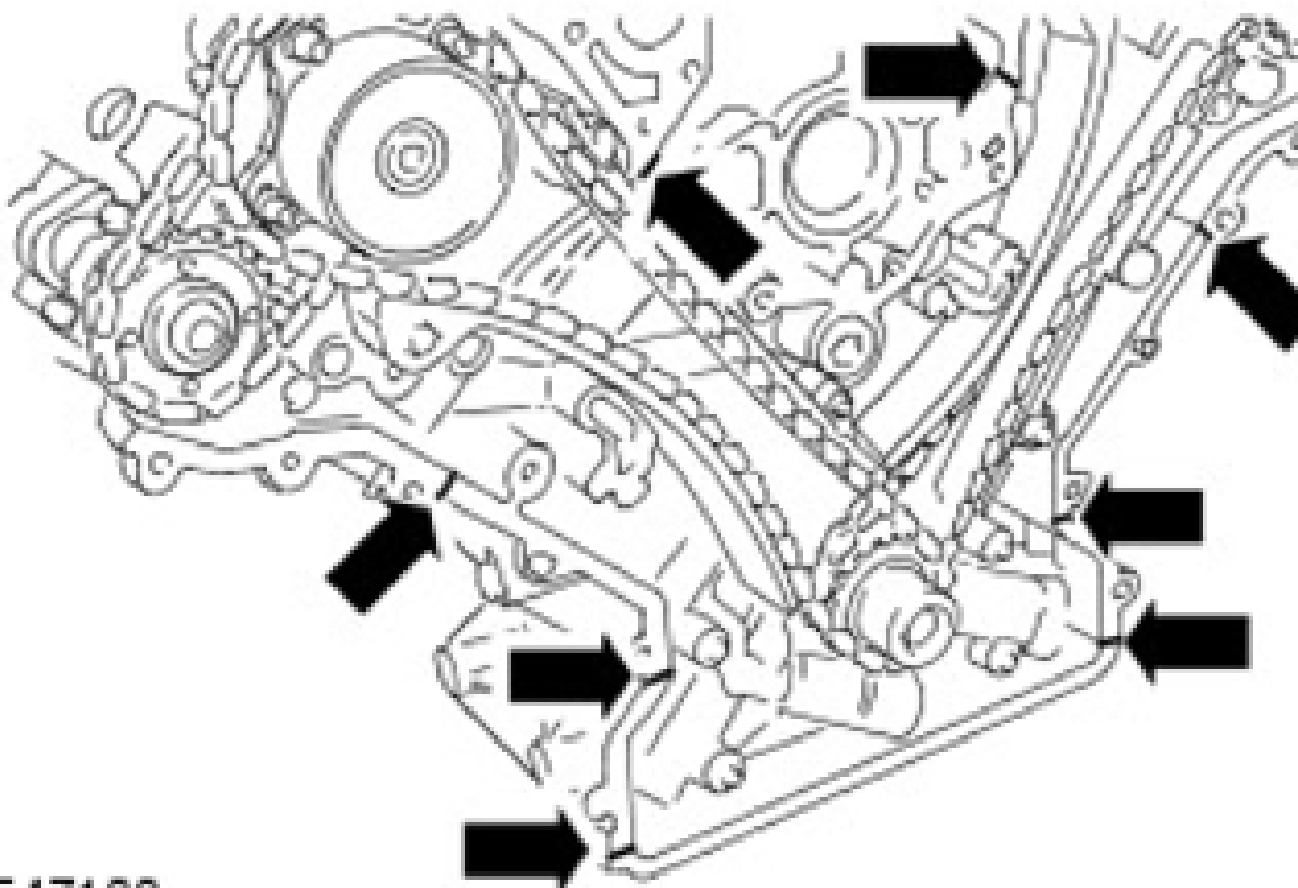
- Release the engine wiring harness clips.
- Remove the 24 bolts.
- Remove and discard the gasket.



INSTALLATION

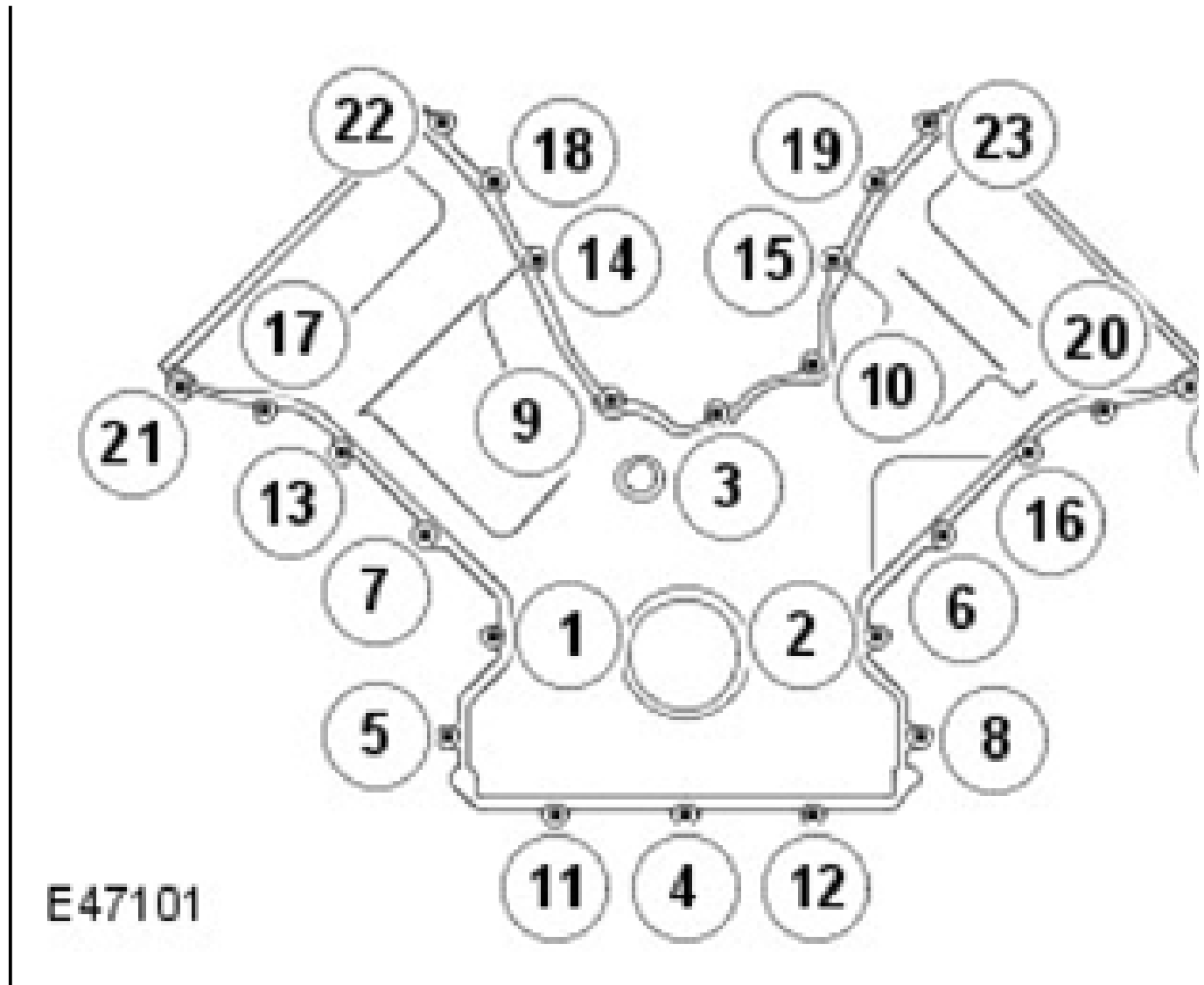
1. Install the engine front cover.

- Clean the component mating faces.
- Apply a bead of sealant 3 mm diameter, by 12 mm long, to the 8 places indicated.



E47100

2. Evenly and progressively tighten the bolts in the sequence shown to 12 Nm (9 lb.ft).



3. Install the crankshaft front oil seal.

For additional information, refer to: **CRANKSHAFT FRONT SEAL** .

4. Install the LH valve cover.

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

5. Install the RH valve cover.

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

6. Install the generator mounting bracket.
 - Clean the locating dowels.
 - Clean the component mating faces.

- Tighten the bolts to 45 Nm (33 lb.ft).
- 7. Install the generator.
 - Clean the component mating faces.
 - Tighten the bolts to 48 Nm (35 lb.ft).
- 8. Connect the battery positive cable.
 - Tighten the nut to 10 Nm (7 lb.ft).
 - Secure the cover.
- 9. Install the RH exhaust manifold heat shield.
 - Tighten the screws.
- 10. Install the coolant manifold.
 - Tighten the bolts to 6 Nm (4 lb.ft).
 - Install the coolant hoses.
 - Secure with the clips.
- 11. Install the coolant expansion tank hose.
 - Connect the clip.
- 12. Install the coolant pump pulley.
 - Tighten the bolts to 10 Nm (7 lb.ft).
- 13. Install the accessory drive belt idler pulley.
 - Tighten the bolt to 25 Nm (18 lb.ft).

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

- 14. Secure the engine wiring harness clips.
- 15. Install the cooling fan drive belt tensioner.
 - Tighten the pulley bolt to 25 Nm (18 lb.ft).
 - Tighten the tensioner bolt to 40 Nm (30 lb.ft).
- 16. Install the A/C mounting bracket.
- 17. Install the A/C compressor.

For additional information, refer to: **AIR CONDITIONING (A/C) COMPRESSOR** .

- 18. Install the cooling fan shroud.
- 19. Install the throttle body gasket.

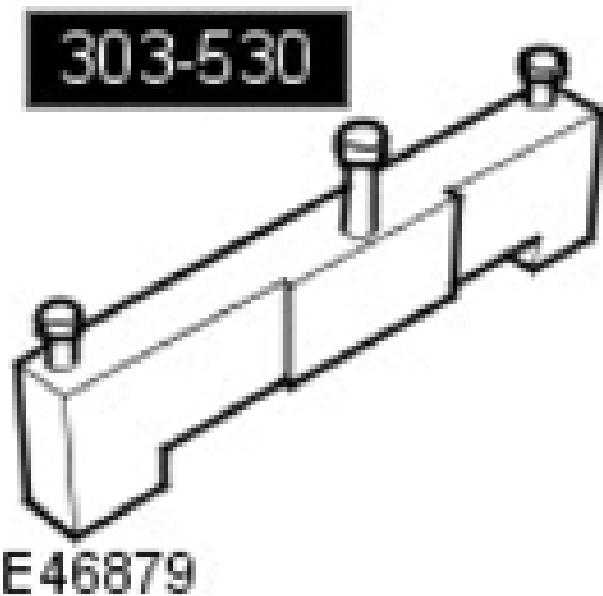
For additional information, refer to: **Throttle Body Gasket** .

- 20. Refill and bleed the cooling system.

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

TIMING DRIVE COMPONENTS

SPECIAL TOOL(S)



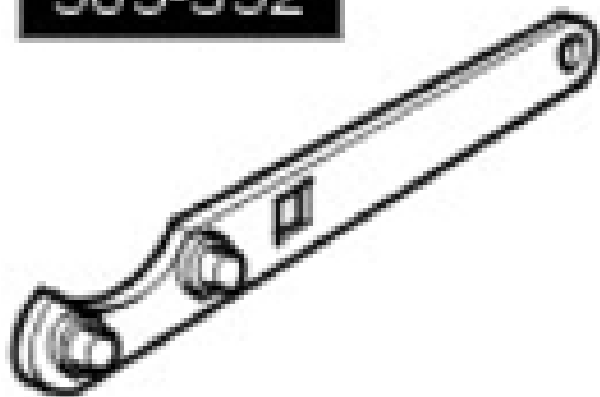
Camshaft setting/locking tool
303-530



Timing Setting tool
303-645

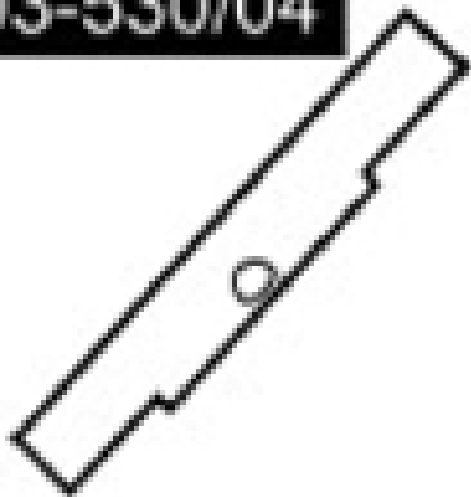
Timing chain tensioning tool
303-532

303-532



E46880

303-530/04



E115082

Timing shim tool
303-530/04**REMOVAL**

NOTE: This procedure covers the removal and installation of the following components: timing chains, chain guides, tensioners and sprockets.

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.

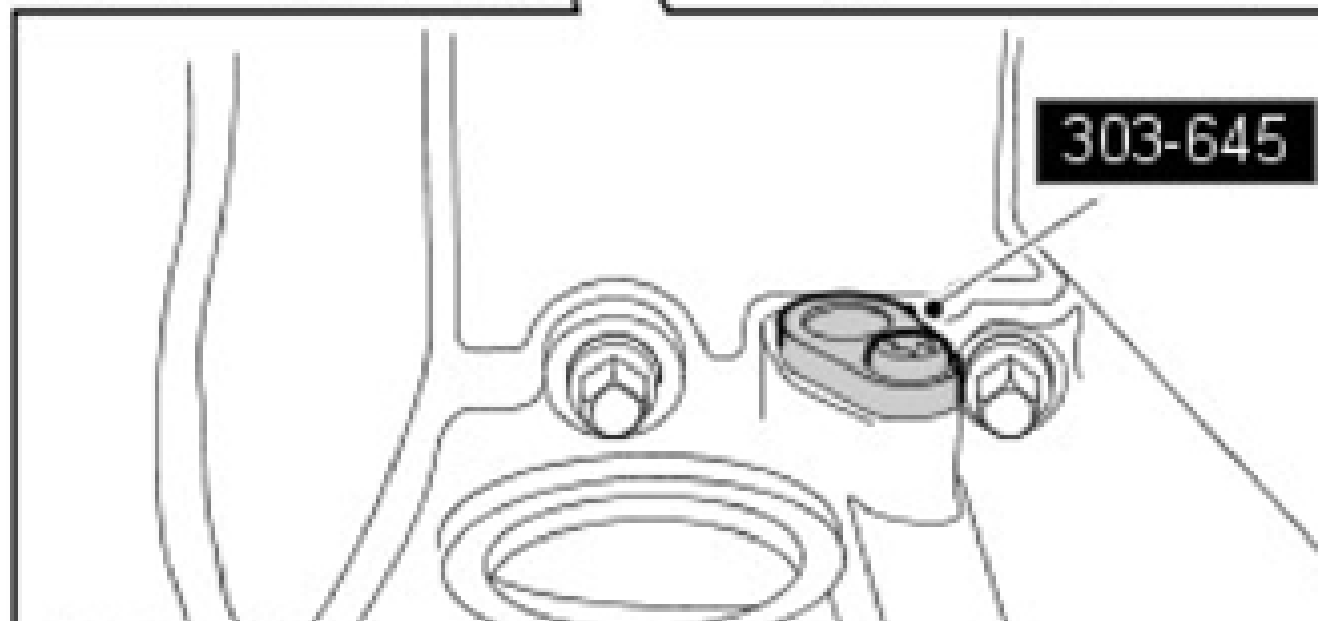
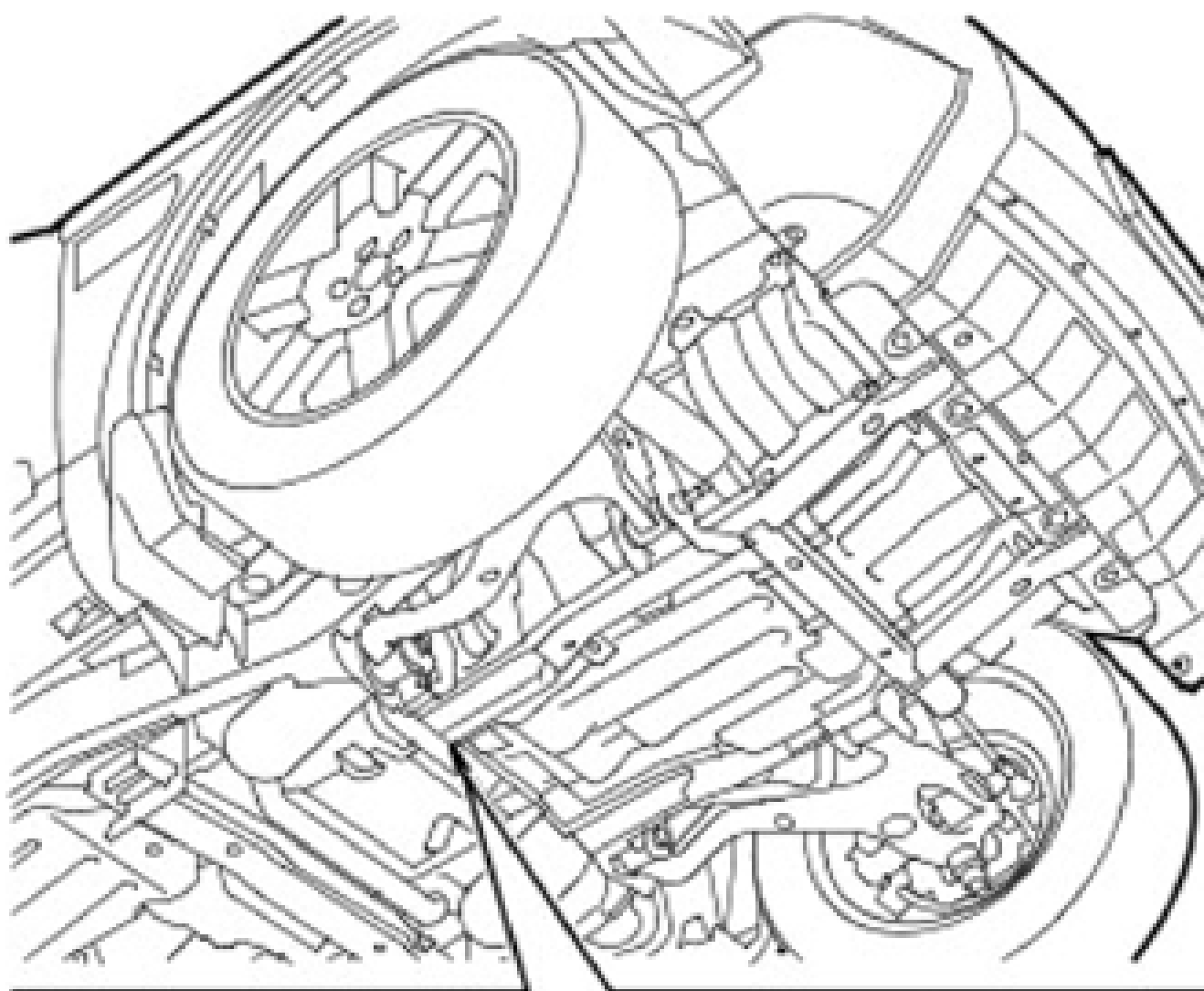
2. Raise and support the vehicle.
3. Remove the engine front cover.

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

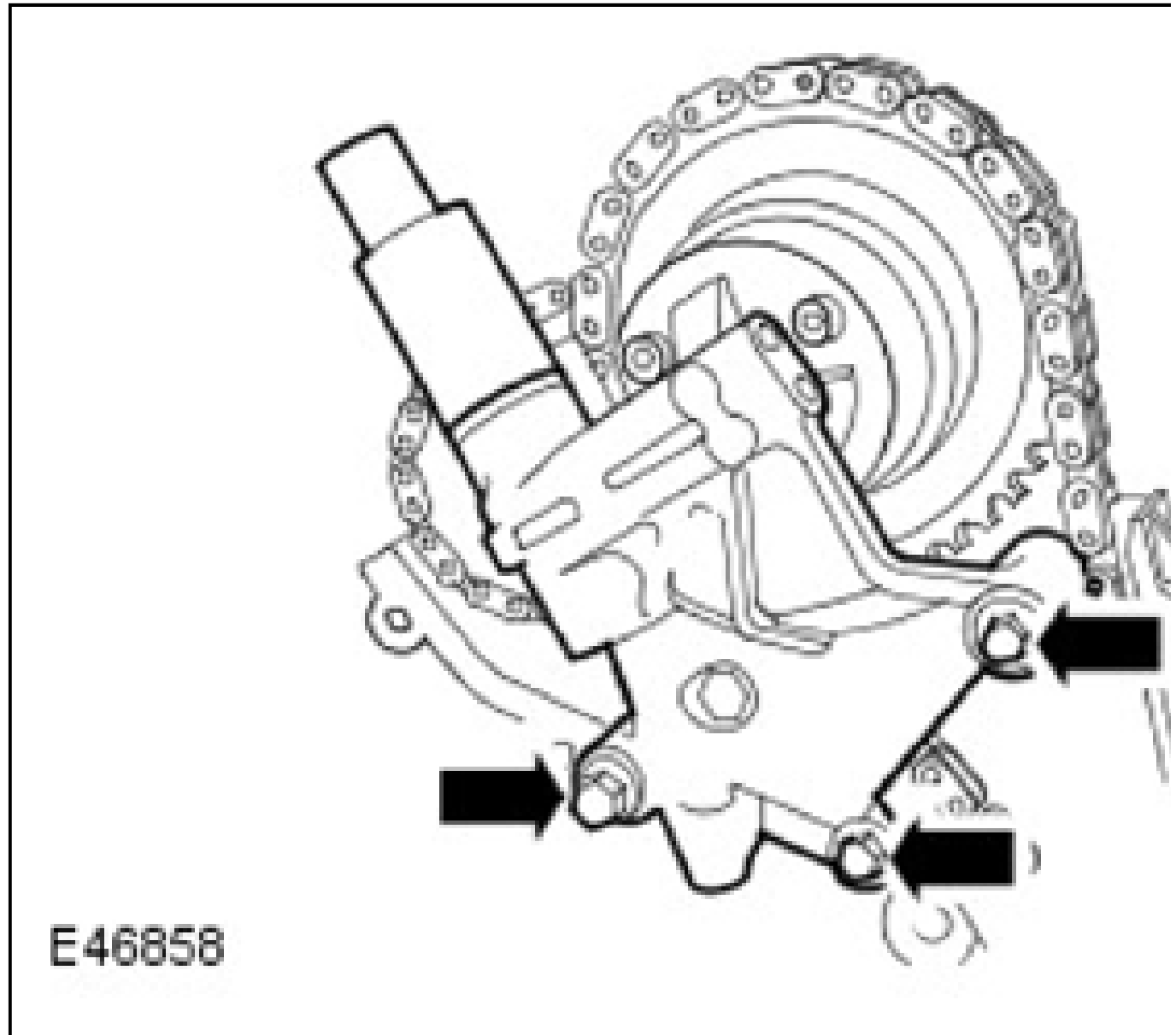
4. Remove the crankshaft position (CKP) sensor.

For additional information, refer to: **CRANKSHAFT POSITION (CKP) SENSOR** .

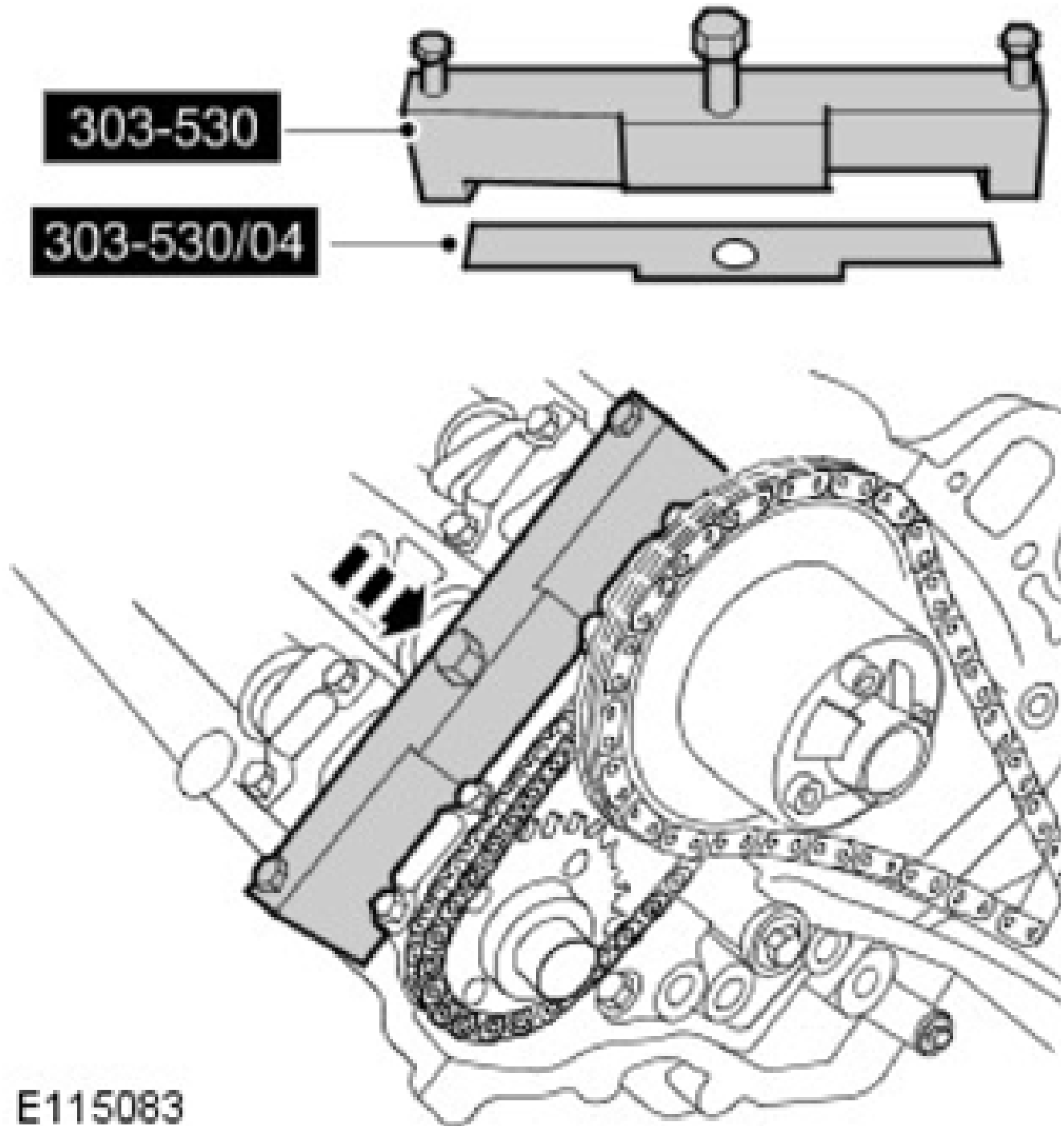
5. Lock the crankshaft.
 - Install the special tool.
 - Install the screw.



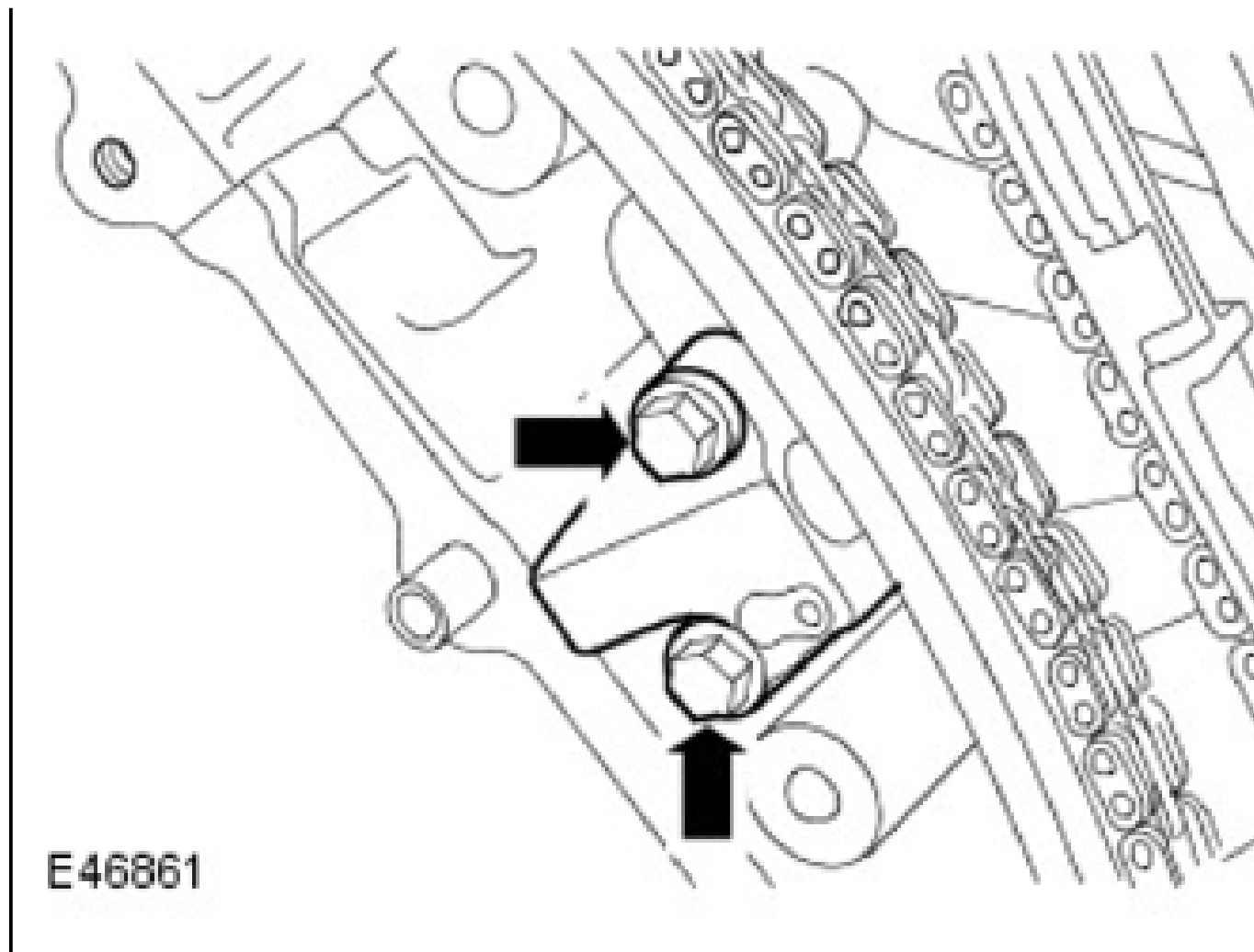
6. Remove the RH variable camshaft timing (VCT) control solenoid housing.
 - Remove the 3 bolts.
 - Remove and discard the O-ring seals.



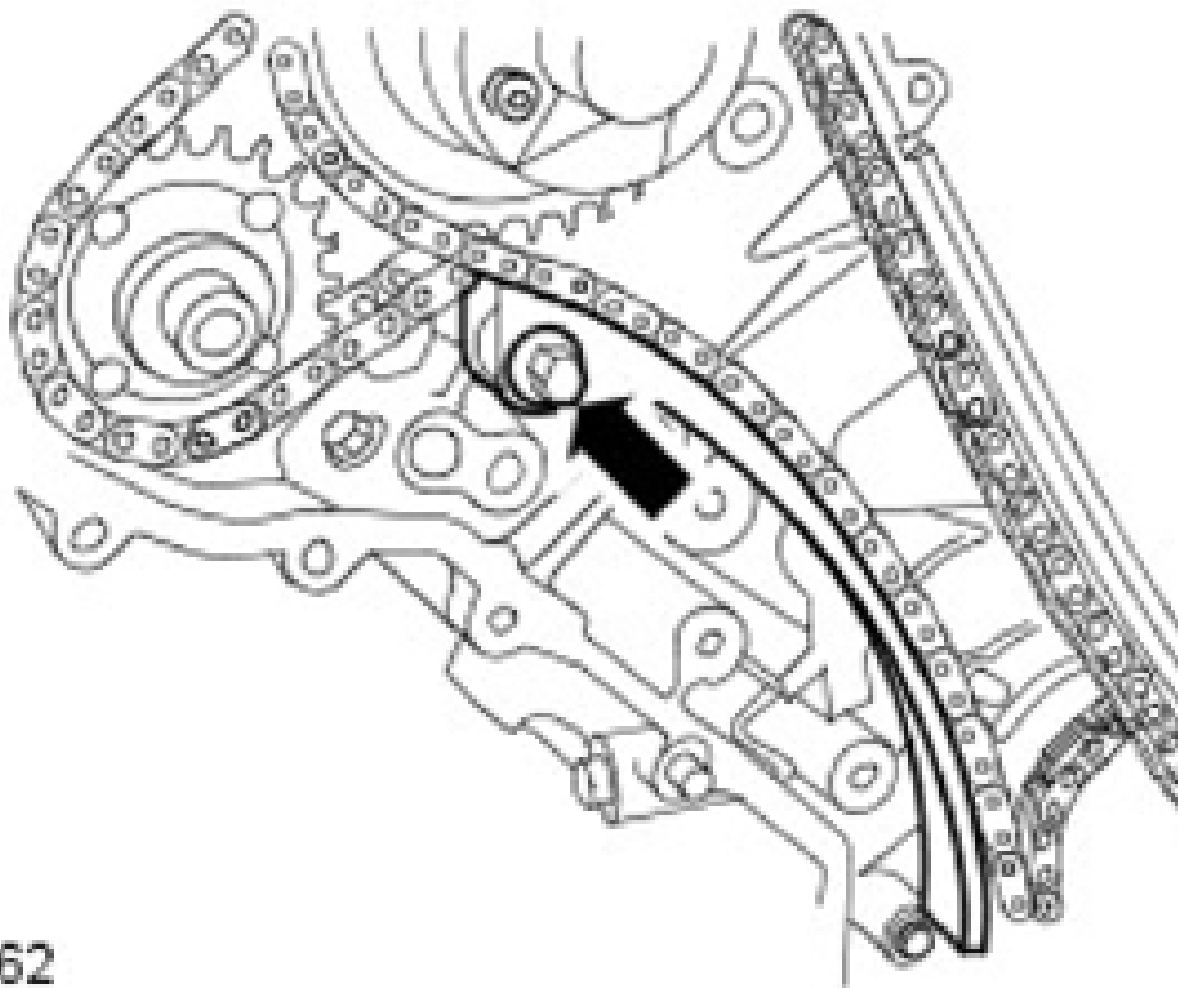
7. Install the special tools to the RH cylinder head.
 - Install the 3 bolts.



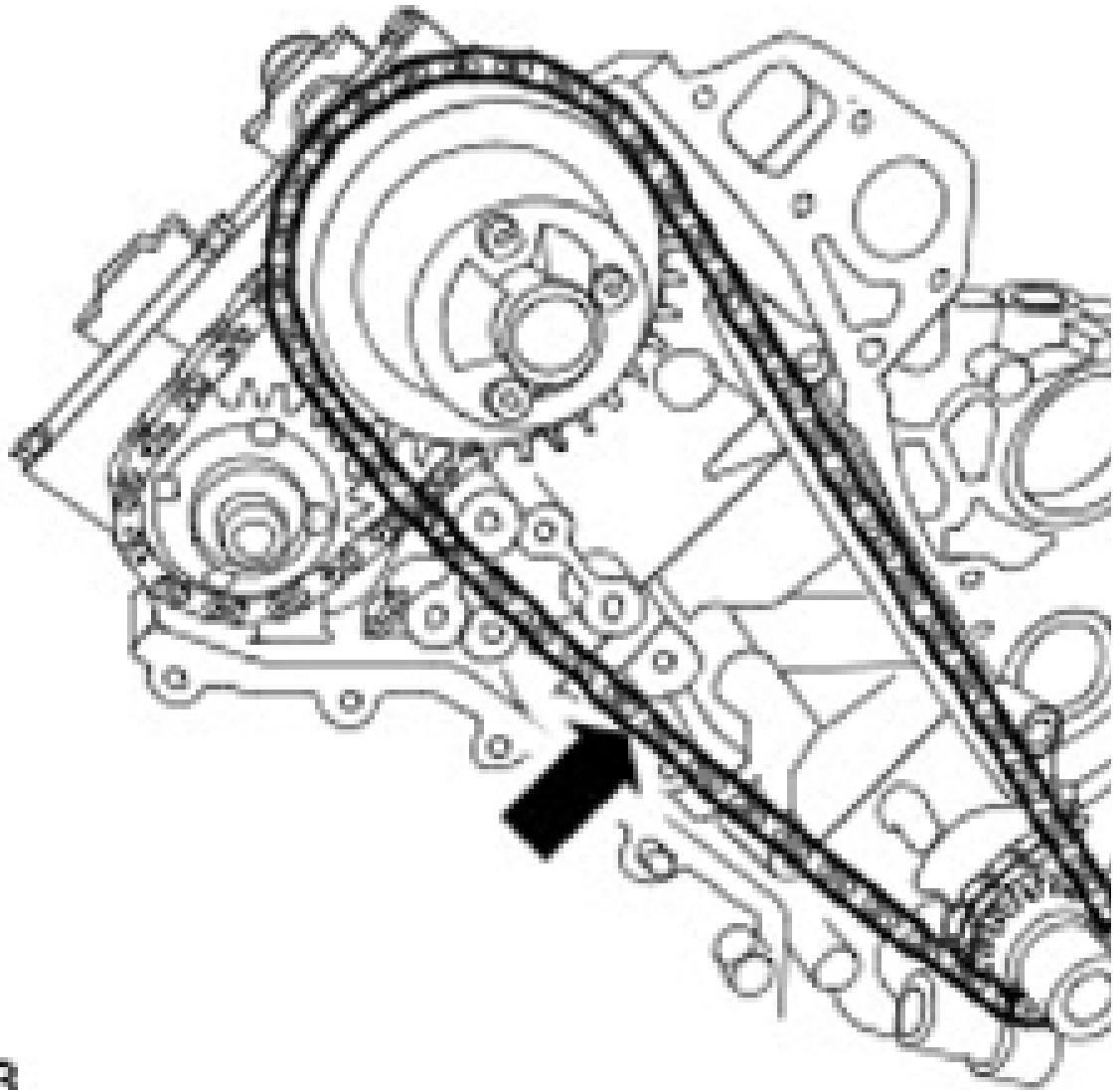
8. Remove the RH primary timing chain tensioner assembly.
 - Remove the 2 bolts.



9. Remove the RH primary timing chain tensioner guide.
 - Remove the bolt.

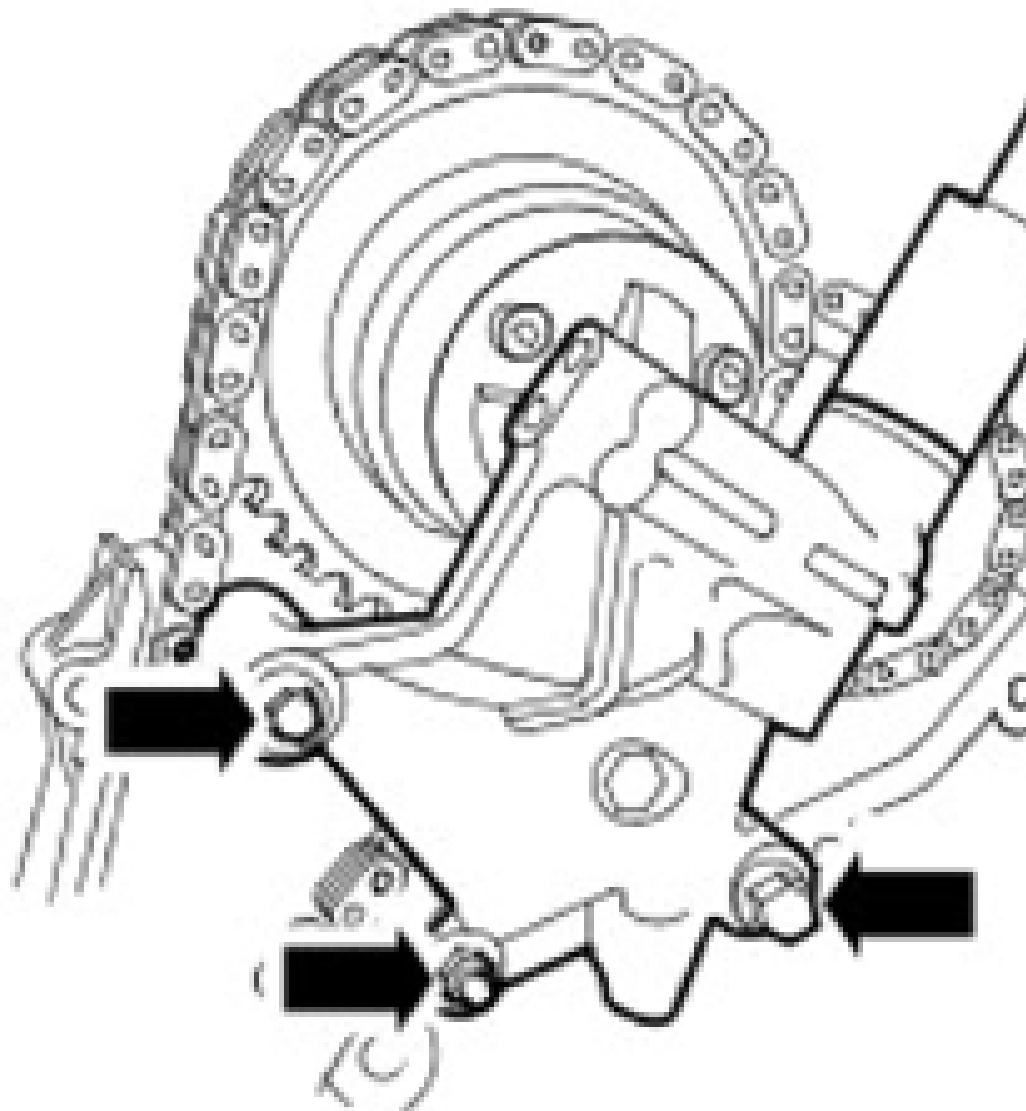


10. Remove the RH primary timing chain.
 - Remove the bolt retaining the chain guide.



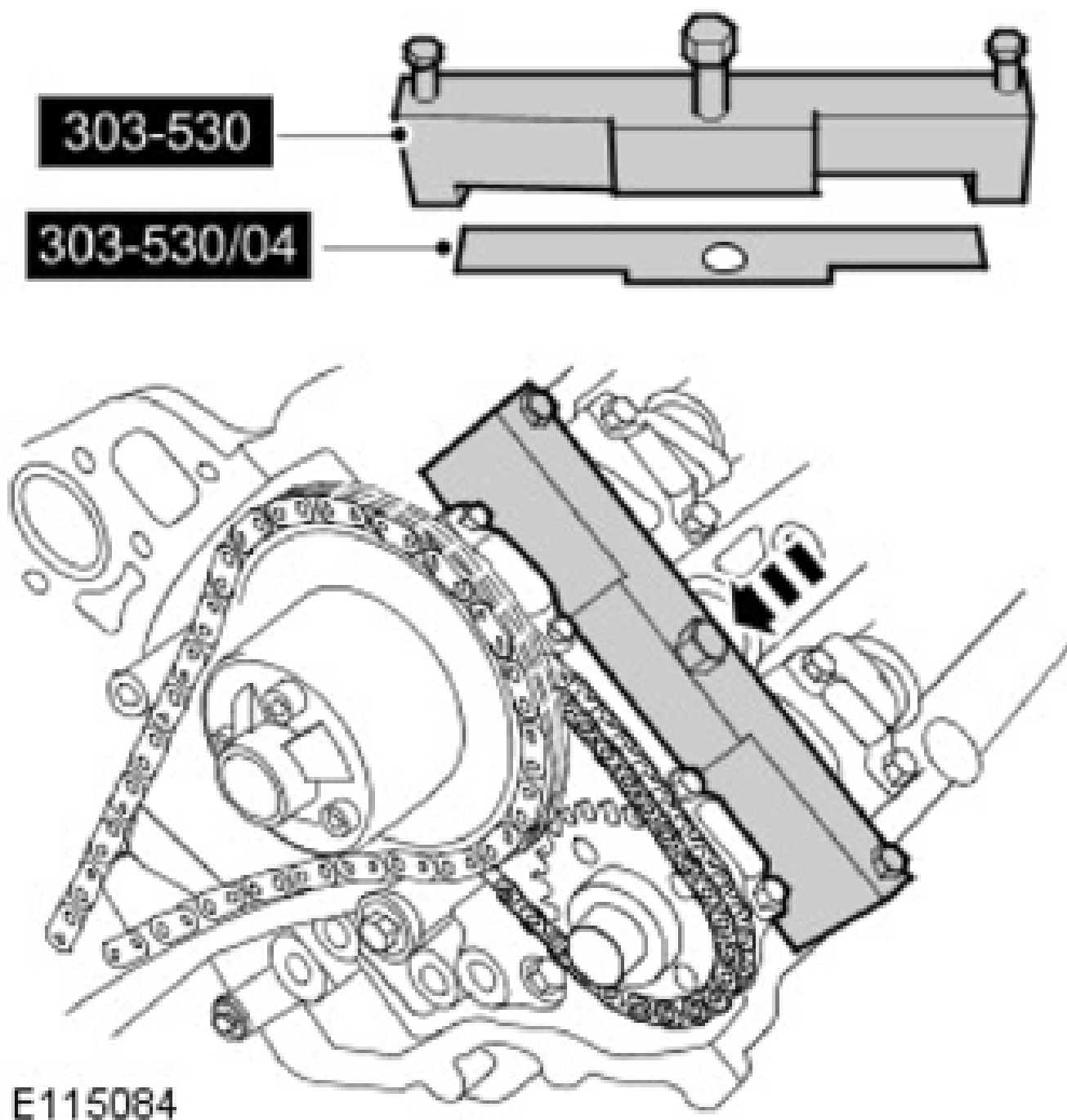
E46863

11. Remove the special tools from the RH cylinder head.
 - Remove the 3 bolts.
12. Remove the LH variable camshaft timing (VCT) control solenoid housing.
 - Remove the 2 bolts.
 - Remove the nut.
 - Remove and discard the O-ring seals.

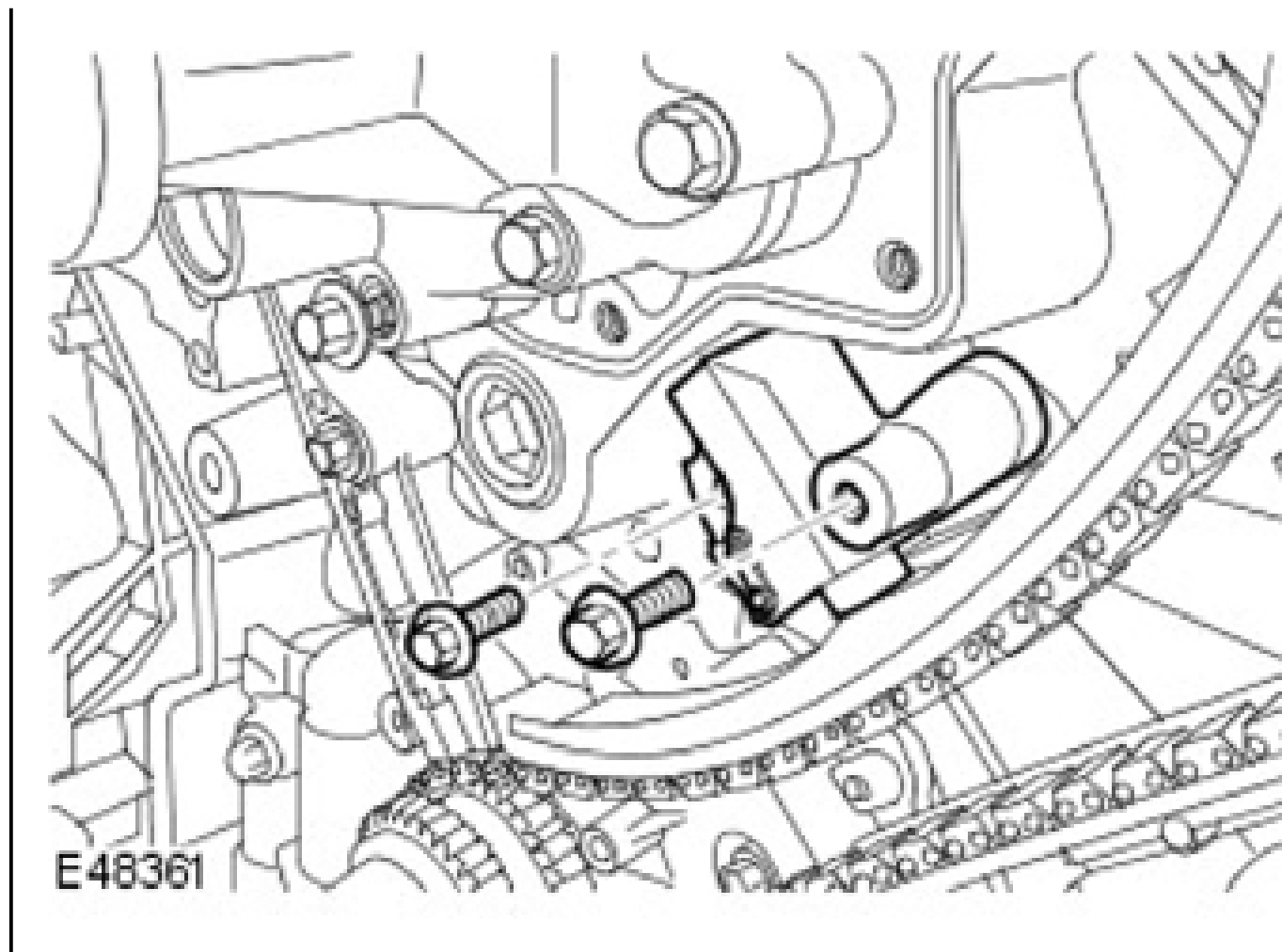


E48360

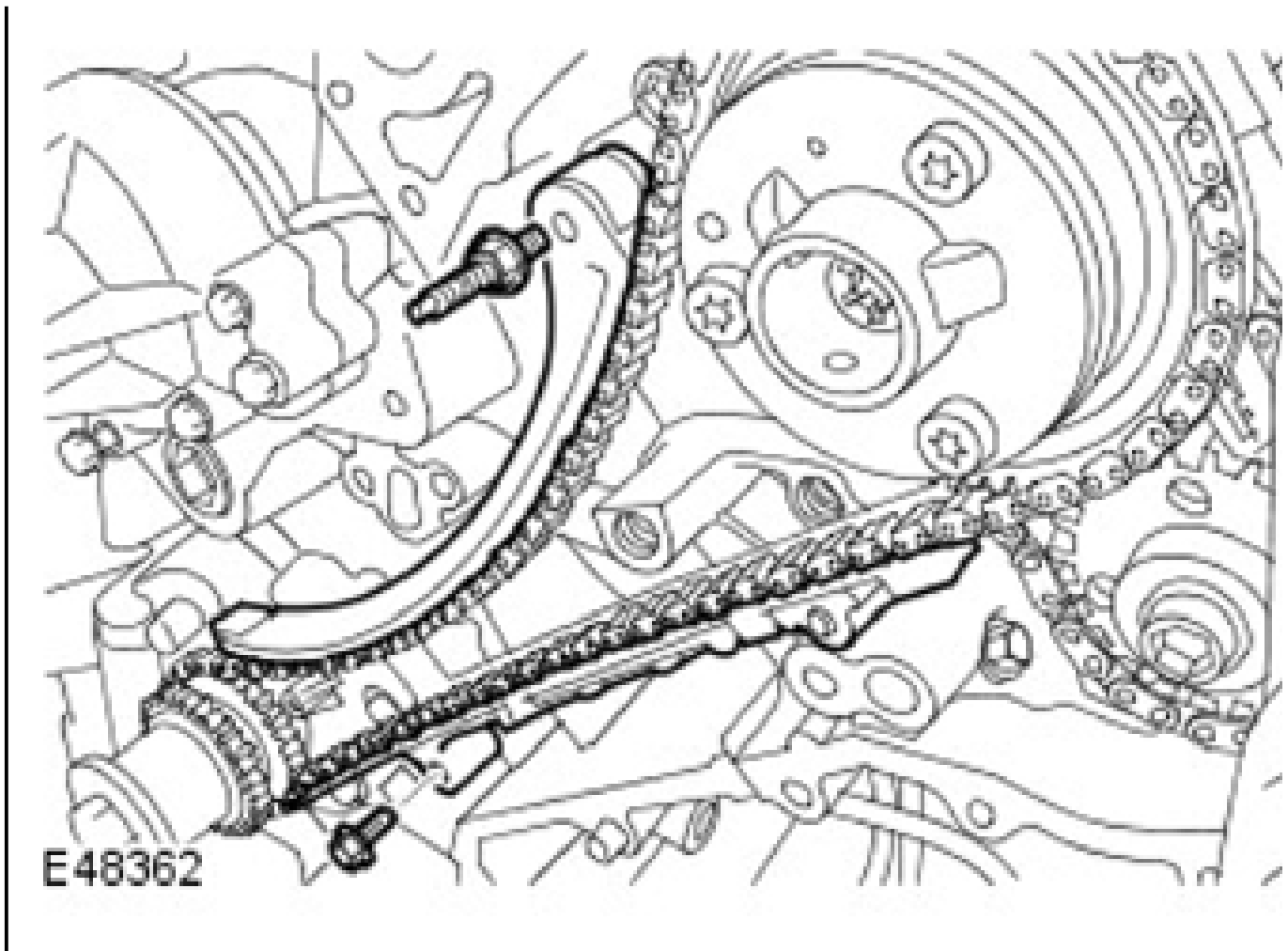
13. Install the special tools to the LH cylinder head.
 - Install the 3 bolts.



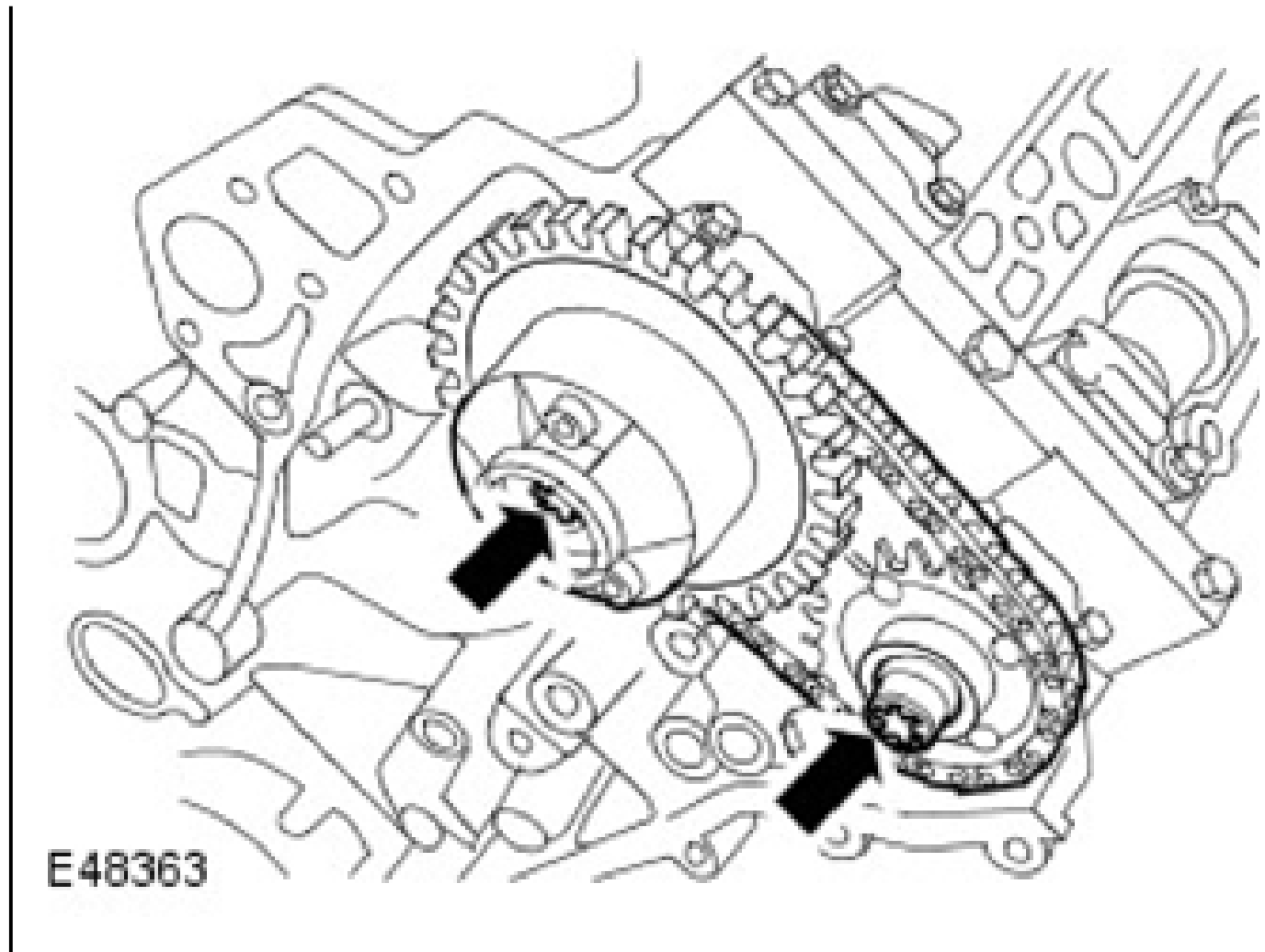
14. Remove the LH primary timing chain tensioner.
 - Remove the 2 bolts.



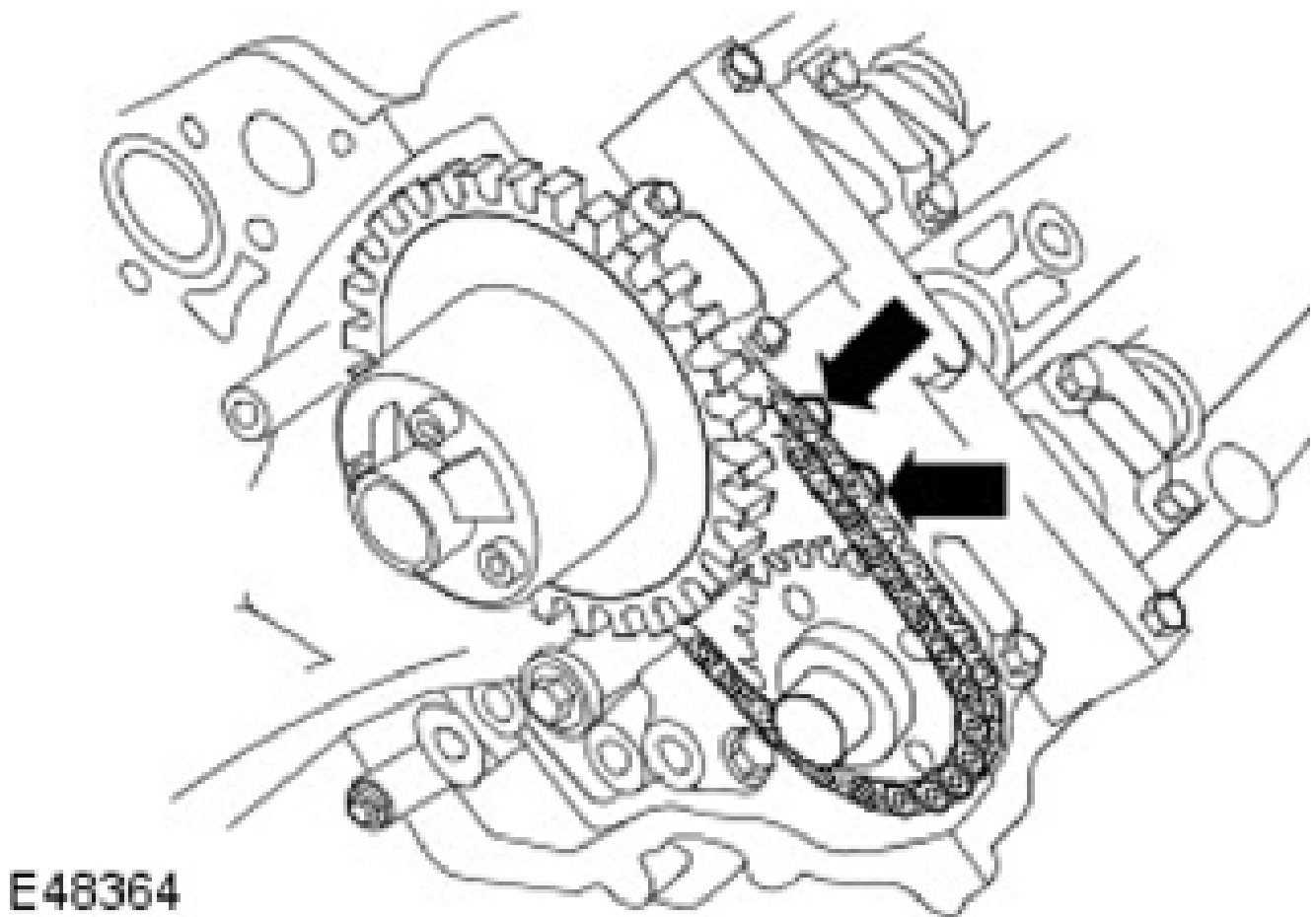
15. Remove the LH upper and lower primary timing chain tensioner guides.
 - Remove the 2 bolts.
16. Remove the LH primary timing chain.



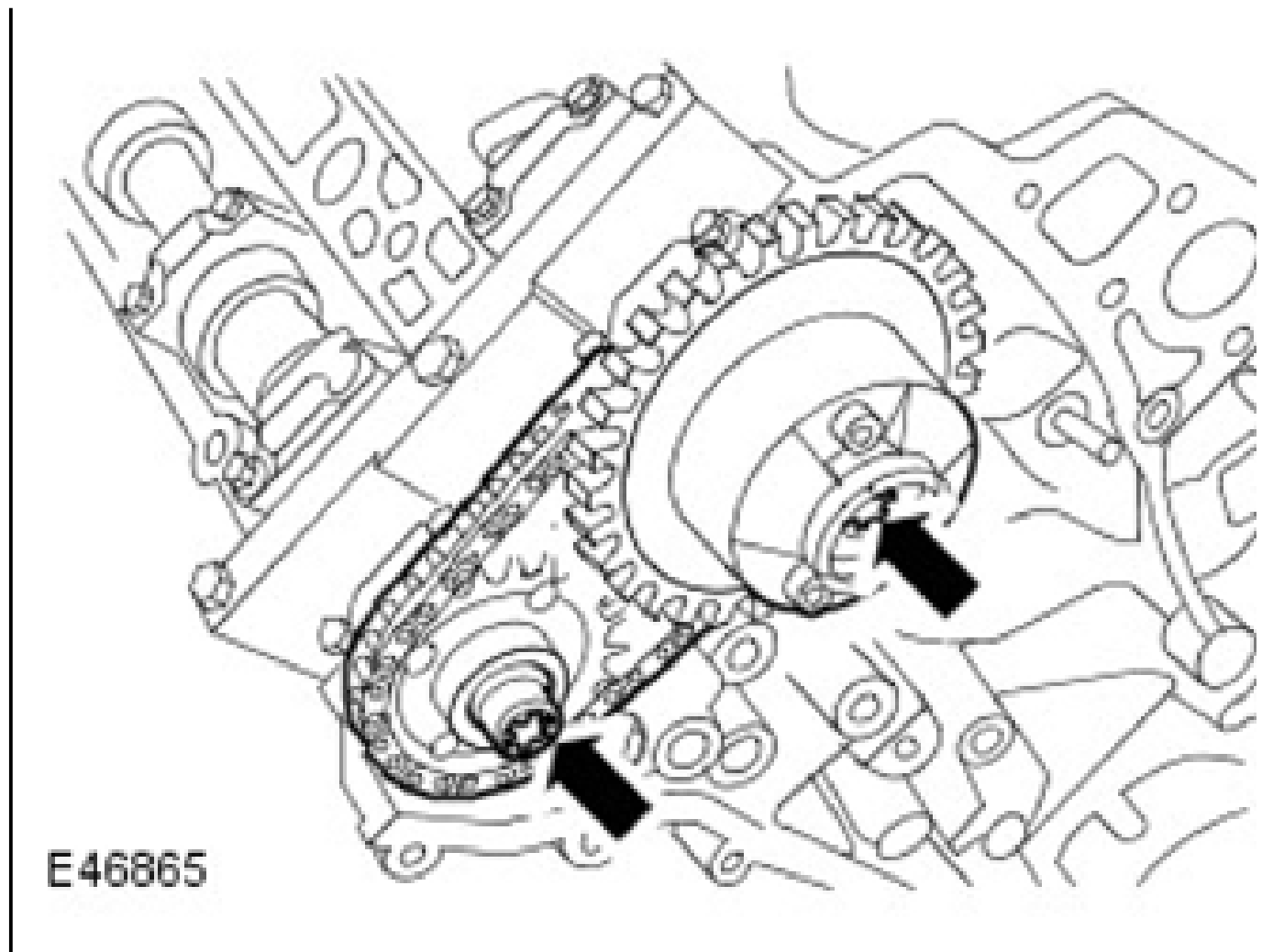
17. Remove the LH camshaft sprocket assembly.
- Remove the 2 Torx bolts.



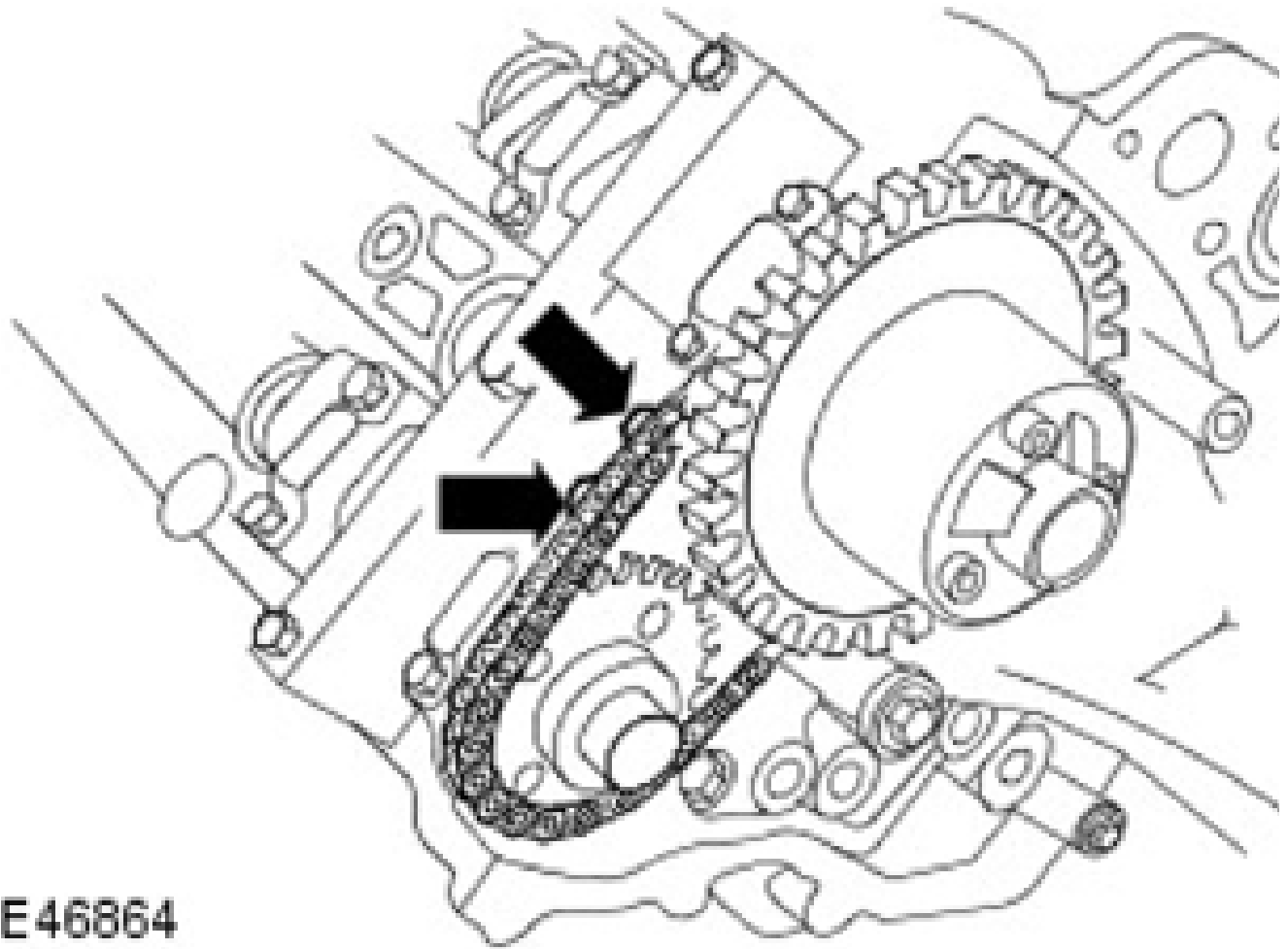
18. Remove the LH secondary timing chain tensioner and the secondary timing chain.
 - Remove the 2 bolts.



19. Remove the RH camshaft sprocket assembly.
 - Remove the 2 Torx bolts.

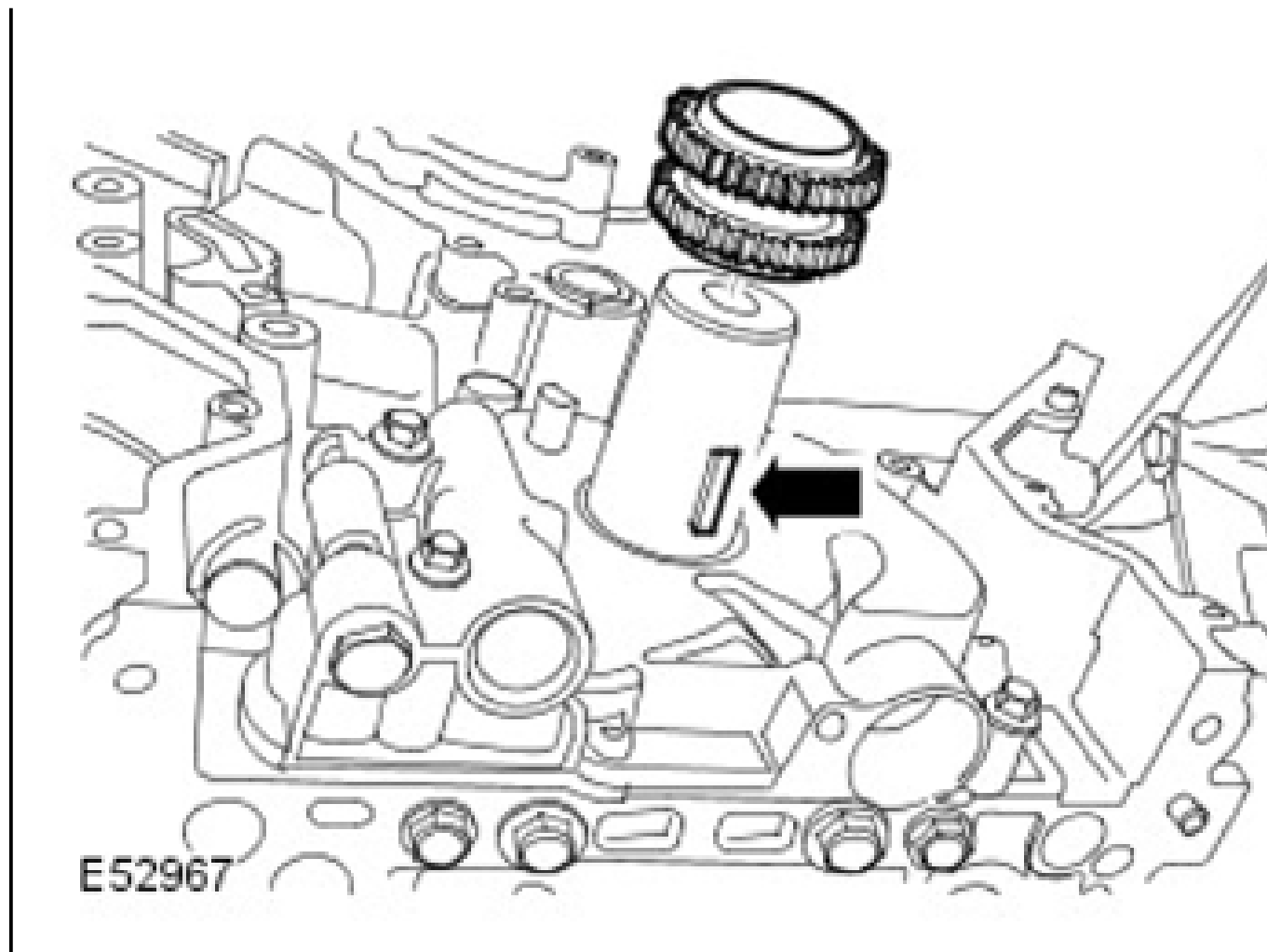


20. Remove the RH secondary timing chain tensioner and the secondary timing chain.
- Remove the 2 retaining bolts.



NOTE: Note the orientation of the crankshaft sprocket.

21. Remove the crankshaft sprocket.
 - Remove the crankshaft sprocket key.

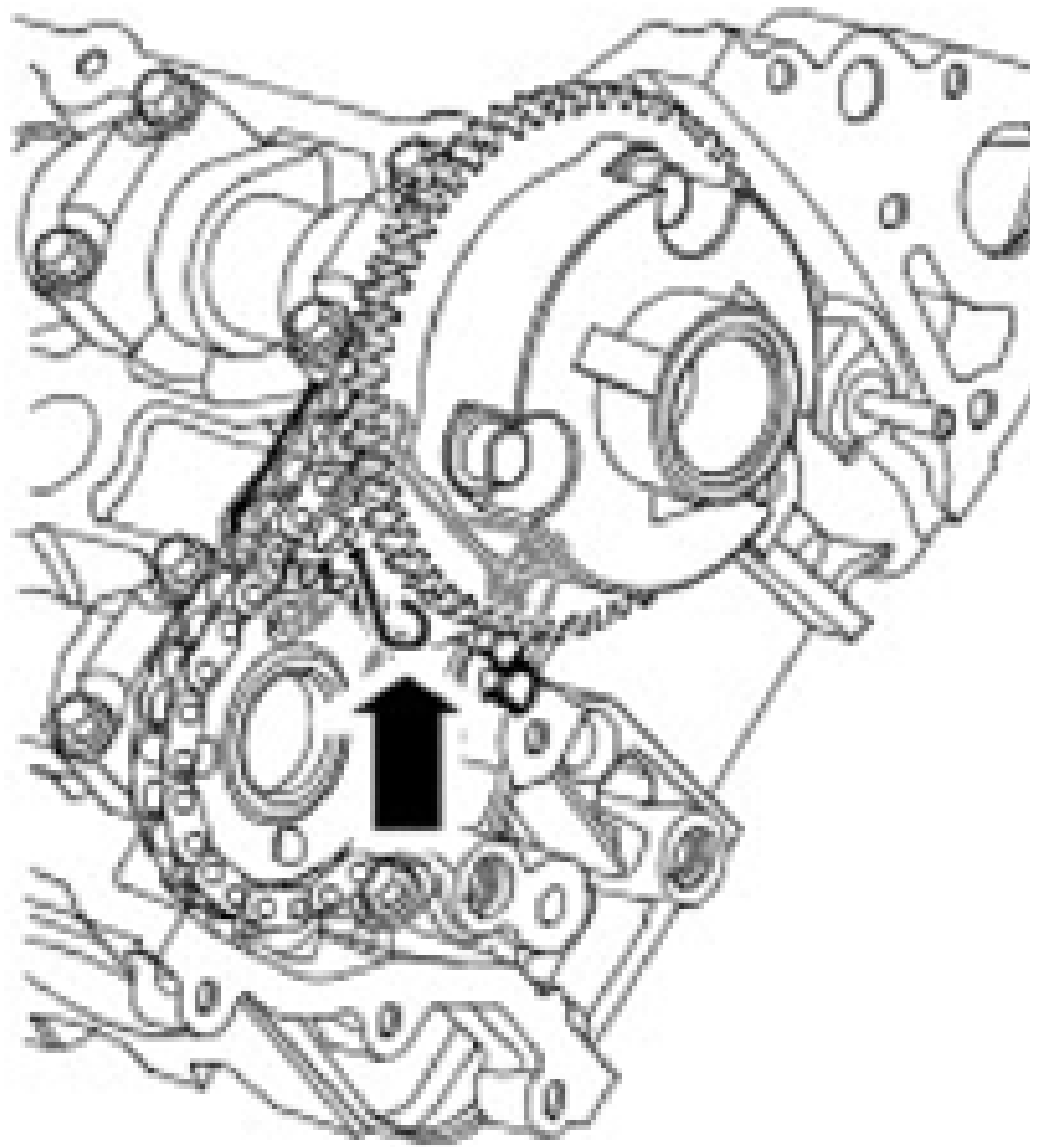


INSTALLATION

1. Install the crankshaft sprocket key.
 - Clean the component mating faces.
2. Install the crankshaft sprocket.
3. Depress the LH secondary timing chain tensioner piston.
 - Using 1 mm diameter metal rod, retain the chain tensioner piston.

NOTE: RH illustration shown, LH is similar.

4. Install the LH secondary timing chain tensioner and chain to the camshaft sprockets.



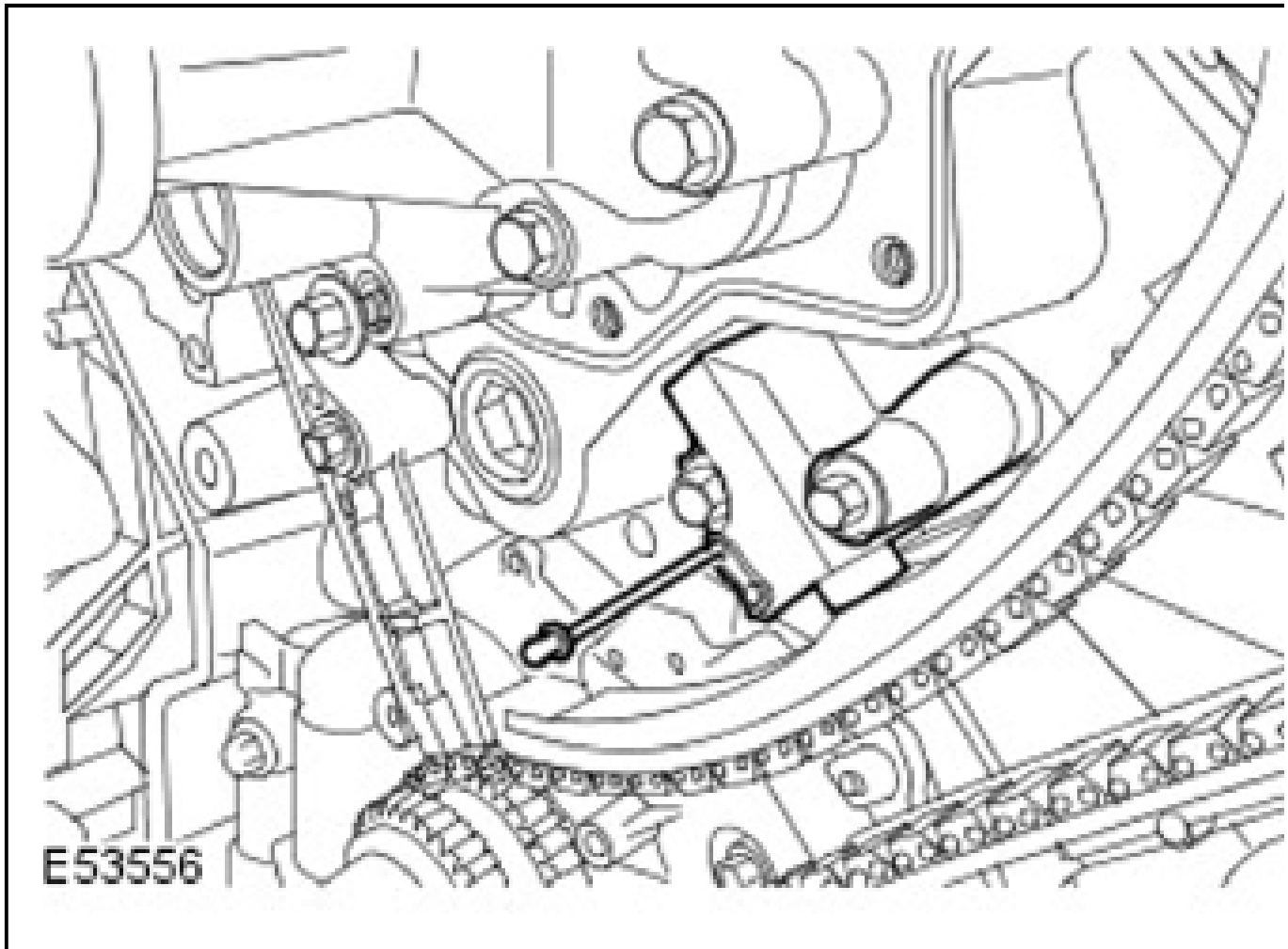
E46869

5. Install the LH secondary timing chain tensioner retaining bolts.
 - Tighten the bolts to 12 Nm.
6. Install the LH primary timing chain.
 - Make sure the timing chain slack is on the tensioner side of the timing chain.
7. Install the LH primary timing chain tensioner guides.
 - Tighten the bolts to 12 Nm.

CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed

in its bore or damage to the ratchet stem will result.

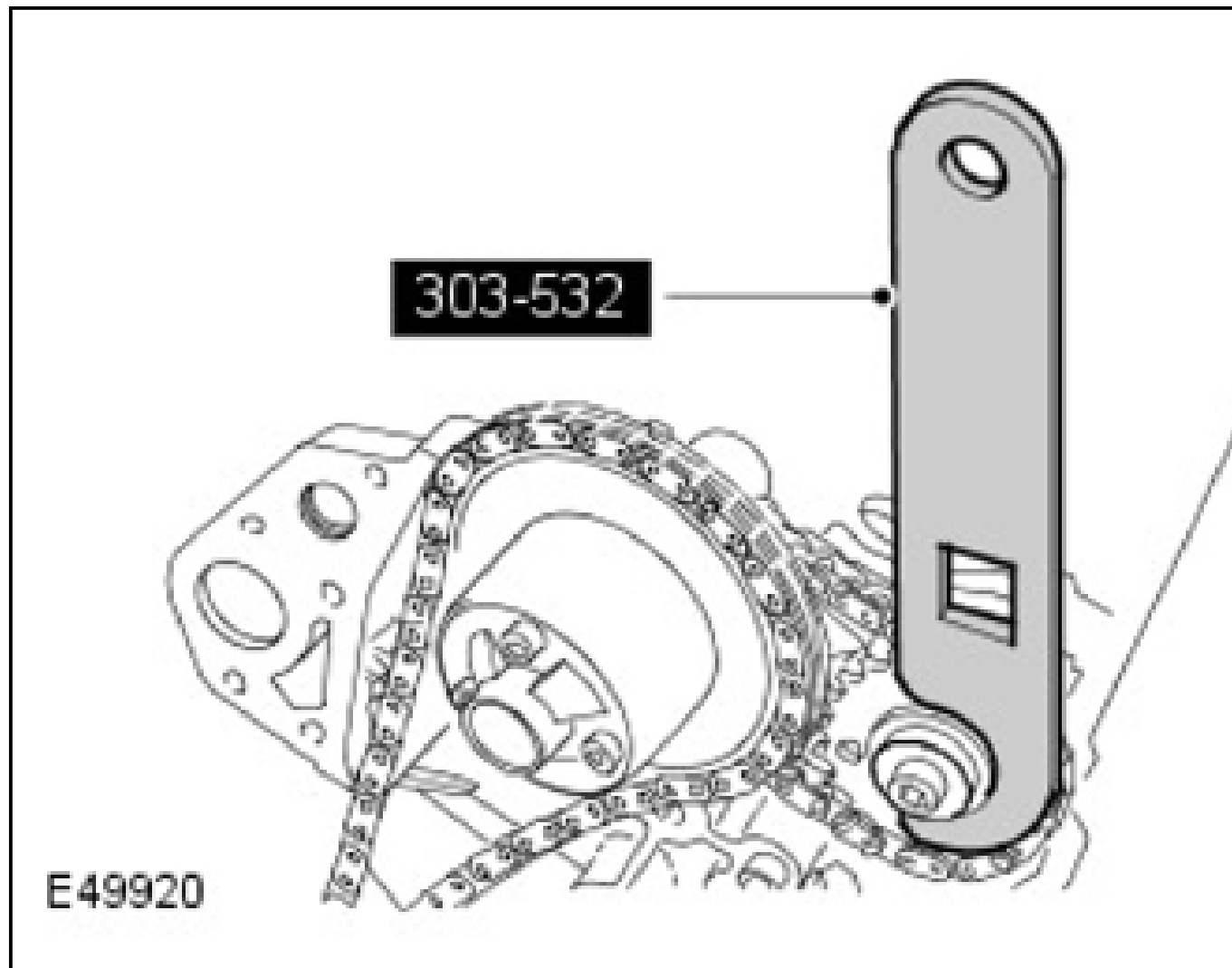
8. Install the LH primary timing chain tensioner.
 - Using 3 mm diameter metal rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm.
 - Remove the retaining rod.



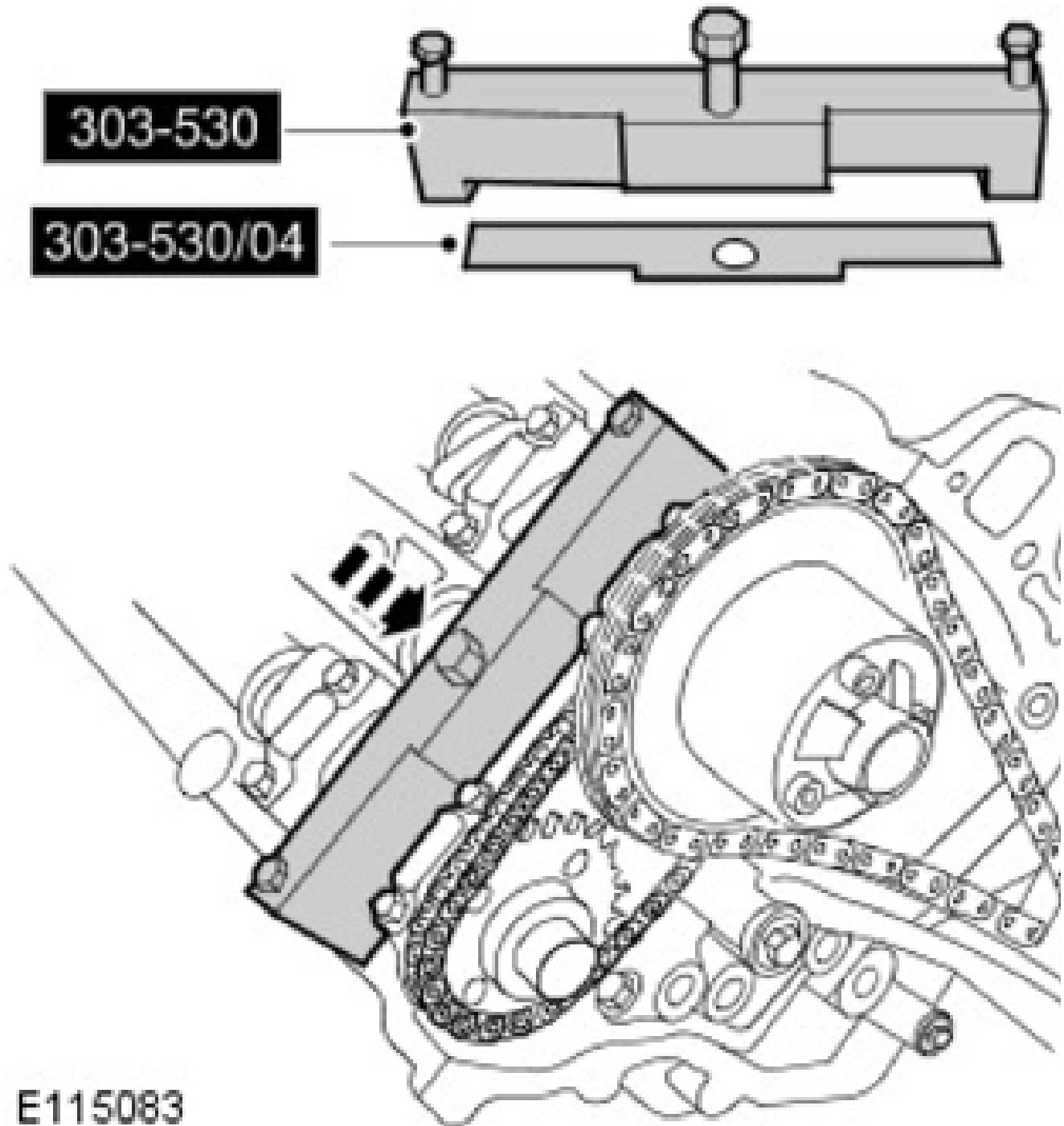
CAUTION: Using the special tool, apply force to the tool in a counter-clockwise direction, to tension the primary timing chain on its drive side. The intake camshaft sprocket retaining bolt **MUST** be tightened before the exhaust camshaft sprocket retaining bolt. Engine damage will occur if this procedure is not followed. Make sure that new bolts are installed.

9. Install the special tool to the LH exhaust camshaft sprocket.
 - Tighten the intake camshaft sprocket retaining bolt to 20 Nm + 90 deg.

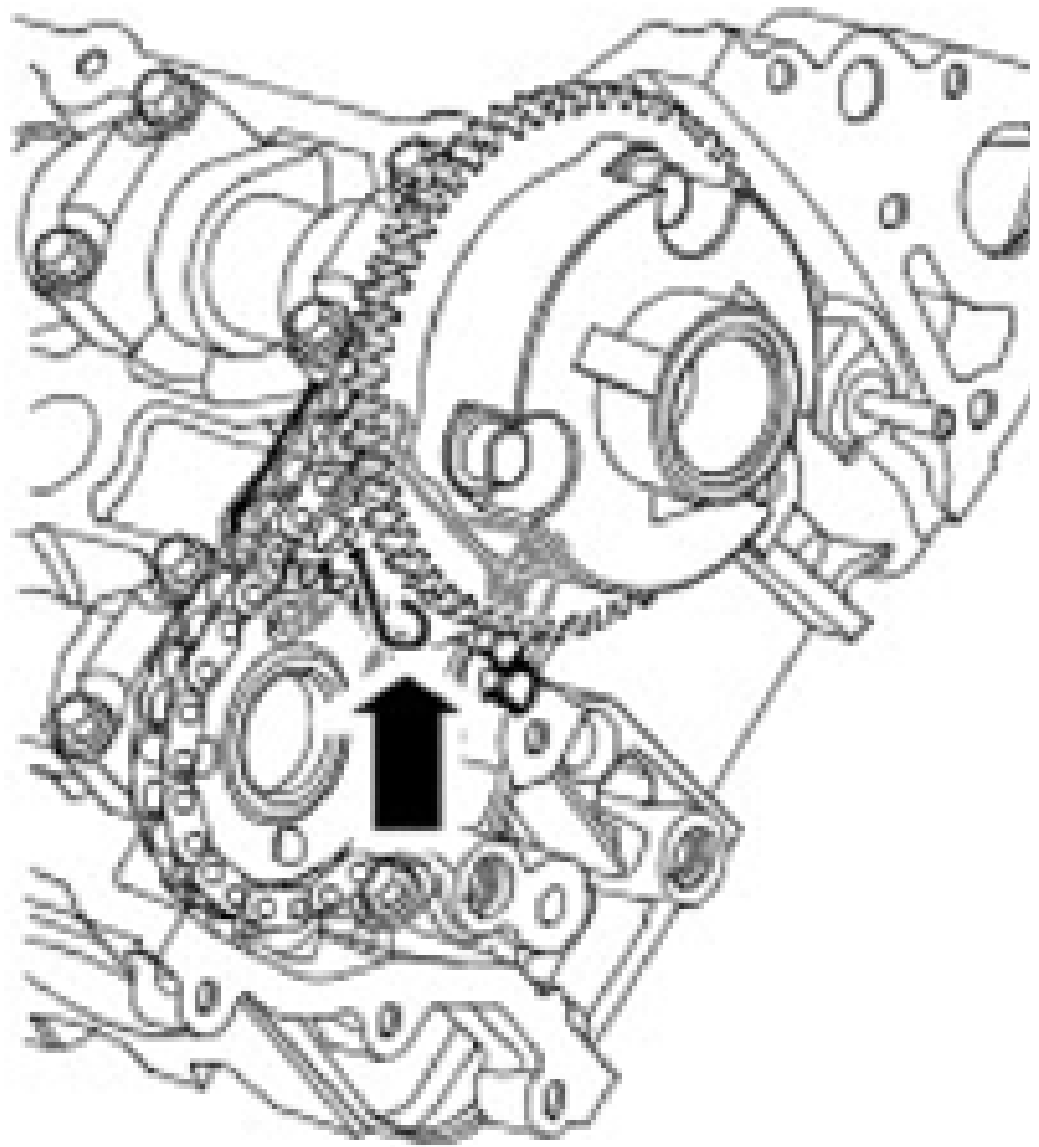
- Tighten the exhaust camshaft sprocket retaining bolt to 20 Nm + 90 deg.



10. Install the LH VCT control solenoid housing.
 - Install the new O-ring seals.
 - Tighten the new bolts to 22 Nm.
 - Tighten the nut to 10 Nm.
11. Remove the special tools from the LH cylinder head.
 - Remove the 3 bolts.
12. Install the special tools to the RH cylinder head.
 - Install the 3 bolts.



13. Retain the RH secondary timing chain tensioner piston.
 - Using 1 mm diameter metal rod, retain the chain tensioner piston.



E46869

14. Install the RH secondary timing chain tensioner and the secondary timing chain to the camshaft sprockets.

NOTE: **Lightly tighten the camshaft sprocket Torx bolts, the sprockets MUST be free to move.**

15. Install the RH secondary timing chain and sprockets to the camshafts.
 - Install the sprocket retaining Torx bolts to the camshafts.
16. Install the RH secondary timing chain tensioner retaining bolts.
 - Tighten the bolts to 12 Nm.

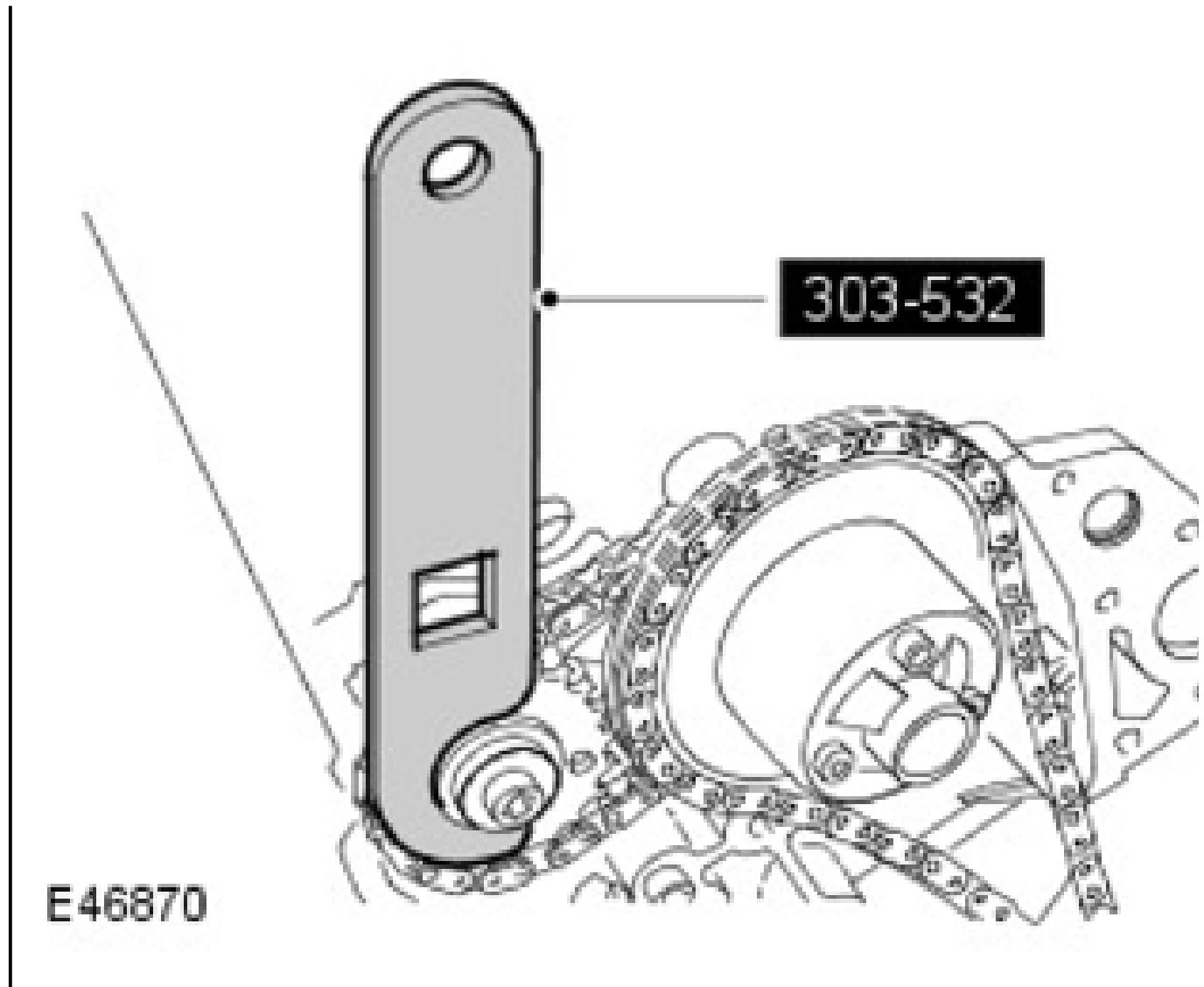
17. Tension the secondary timing chain.
 - Remove the retaining rod.
18. Install the RH primary timing chain.
 - Make sure the timing chain slack is on the tensioner side of the timing chain.
19. Install the RH primary timing chain tensioner guide.
 - Tighten the bolts to 12 Nm.

CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

20. Install the RH primary timing chain tensioner.
 - Using 3 mm diameter metal rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm.
 - Remove the retaining rod.

CAUTION: The intake camshaft sprocket retaining bolt MUST be tightened before the exhaust camshaft sprocket retaining bolt. Engine damage will occur if this procedure is not followed. Using the special tool, apply force to the tool in a counter-clockwise direction, to tension the primary timing chain on its drive side. Make sure that new bolts are installed.

21. Install the special tool to the RH exhaust camshaft sprocket.
 - Tighten the intake camshaft sprocket retaining bolt to 20 Nm + 90 deg.
 - Tighten the exhaust camshaft sprocket retaining bolt to 20 Nm + 90 deg.



22. Install the RH VCT control solenoid housing.
 - Install the new O-ring seals.
 - Tighten the new bolts to 22 Nm.
23. Remove the special tool from the RH cylinder head.
24. Install the engine front cover.

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

25. Remove the crankshaft locking tool.
 - Remove the screw.
26. Install the CKP sensor.

For additional information, refer to: **CRANKSHAFT POSITION (CKP) SENSOR** .

27. Connect the battery ground cable.

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

EXHAUST MANIFOLD LH

REMOVAL

All vehicles

1. Disconnect the battery ground cable.

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

2. Remove the exhaust system.

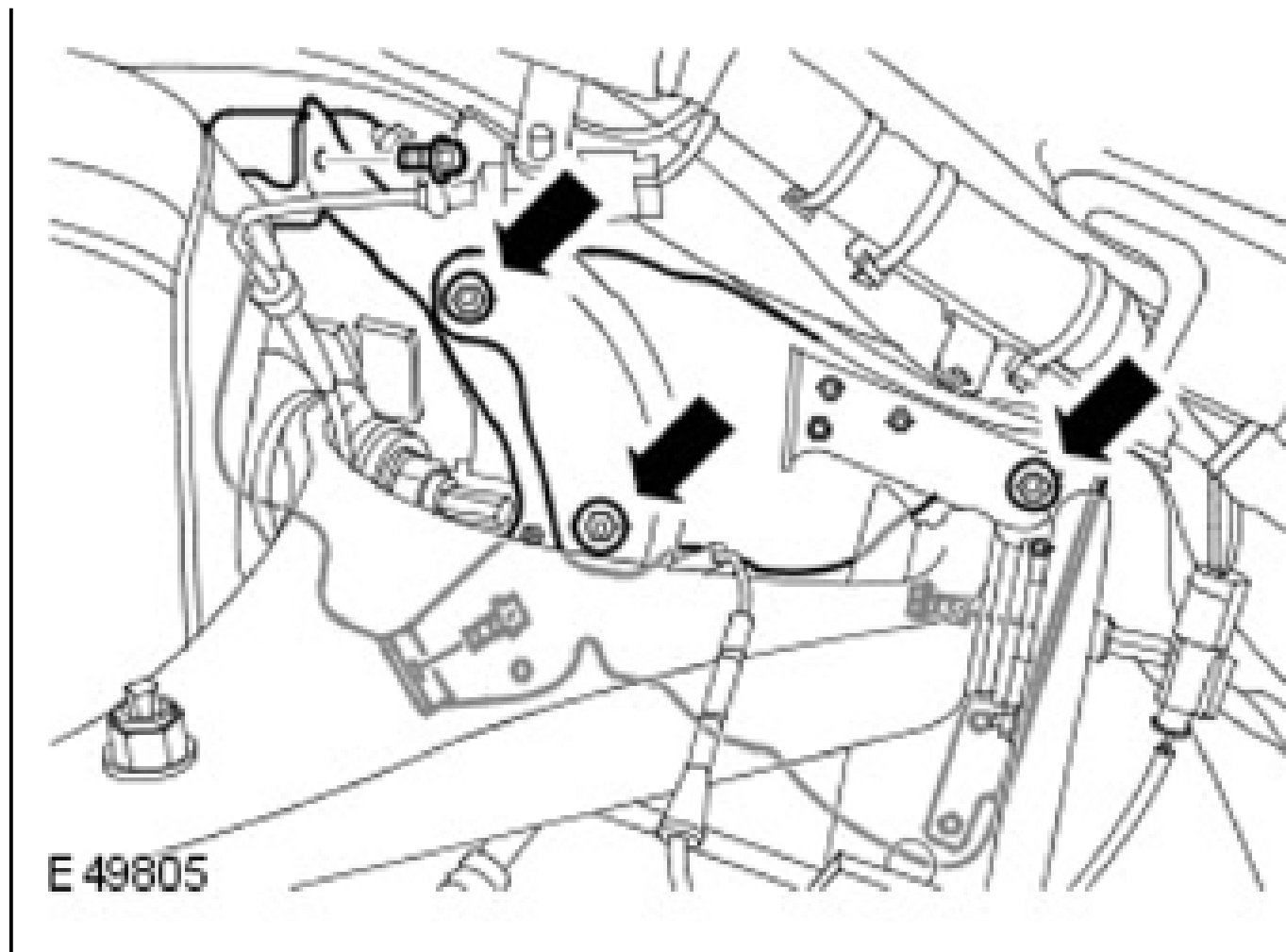
For additional information, refer to: **EXHAUST SYSTEM** .

3. Remove the fender splash shield.

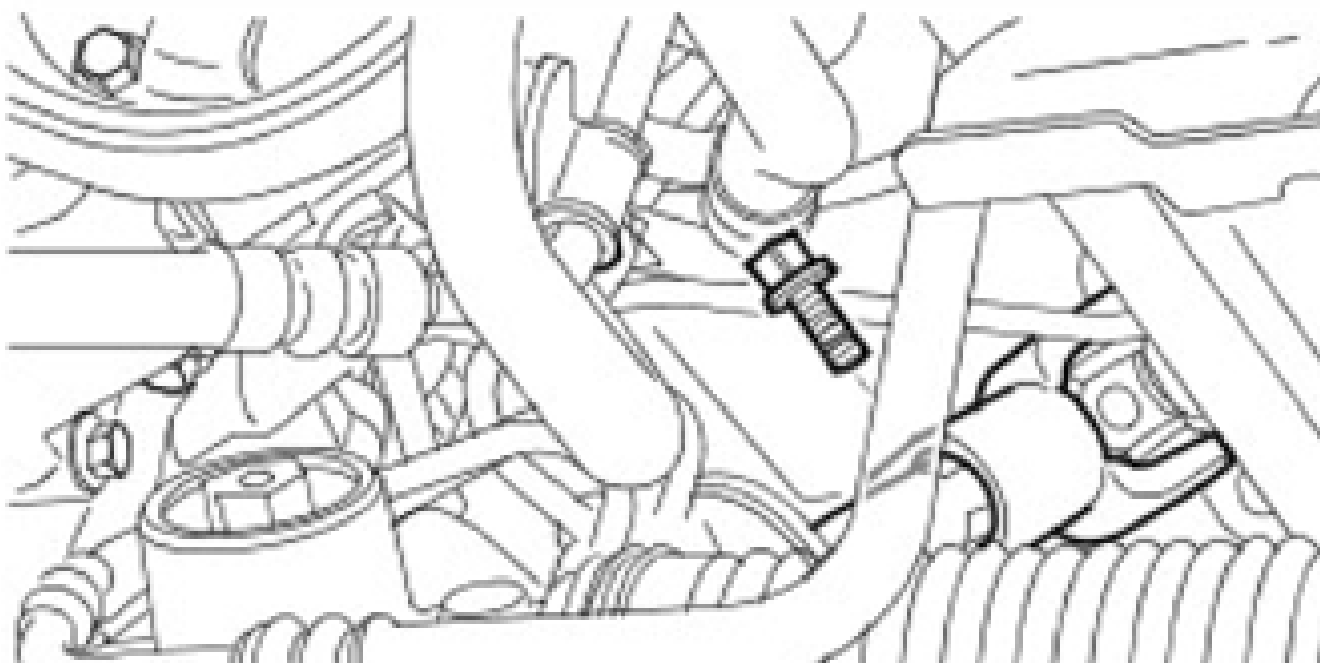
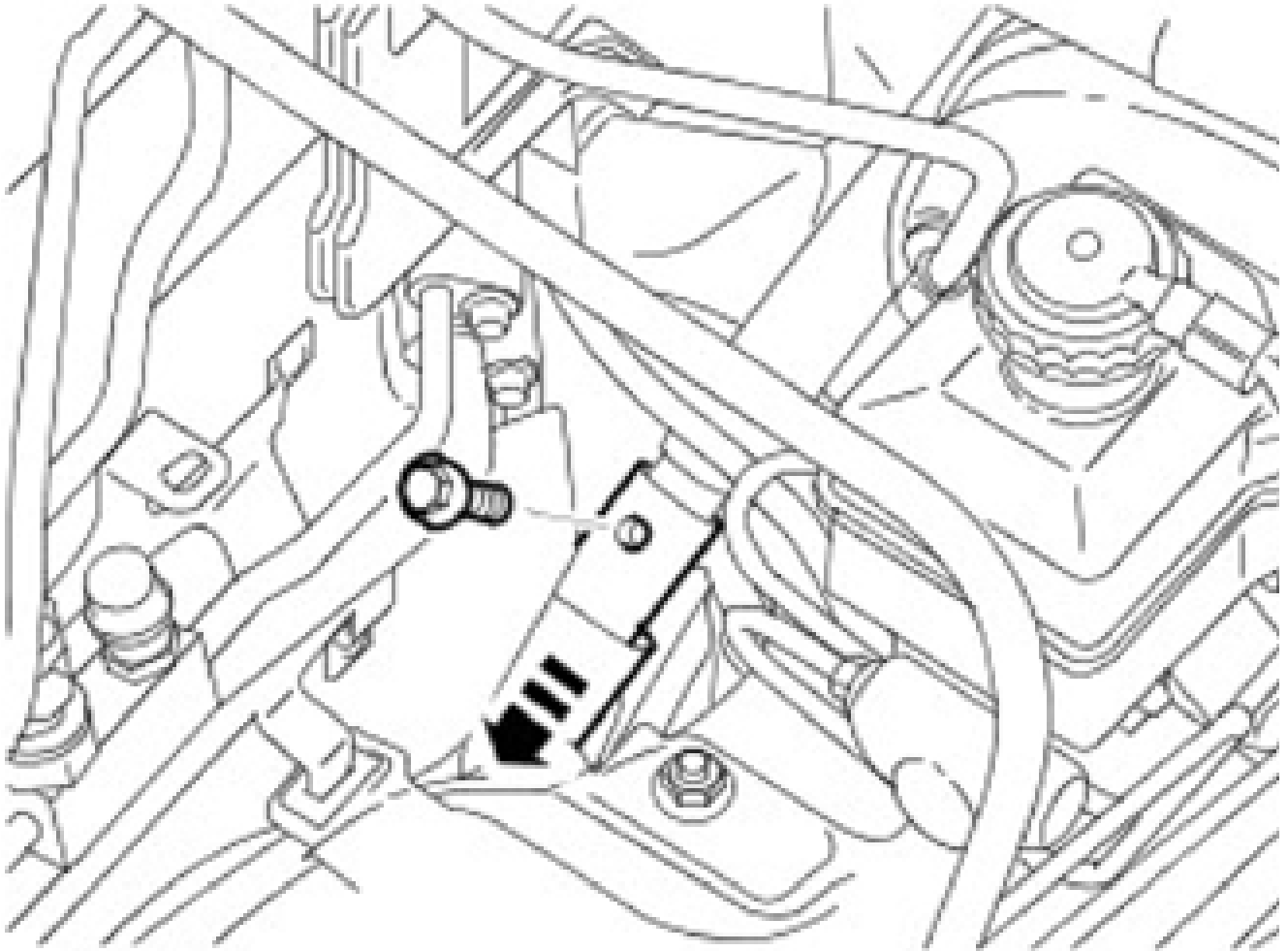
For additional information, refer to: **FENDER SPLASH SHIELD** .

NOTE: **The heatshield consists of 3 parts.**

4. Remove the upper suspension arm and brake line heat shields for access.
 - Remove the 3 nuts.
 - Remove the 3 bolts.

**Left-hand drive vehicles**

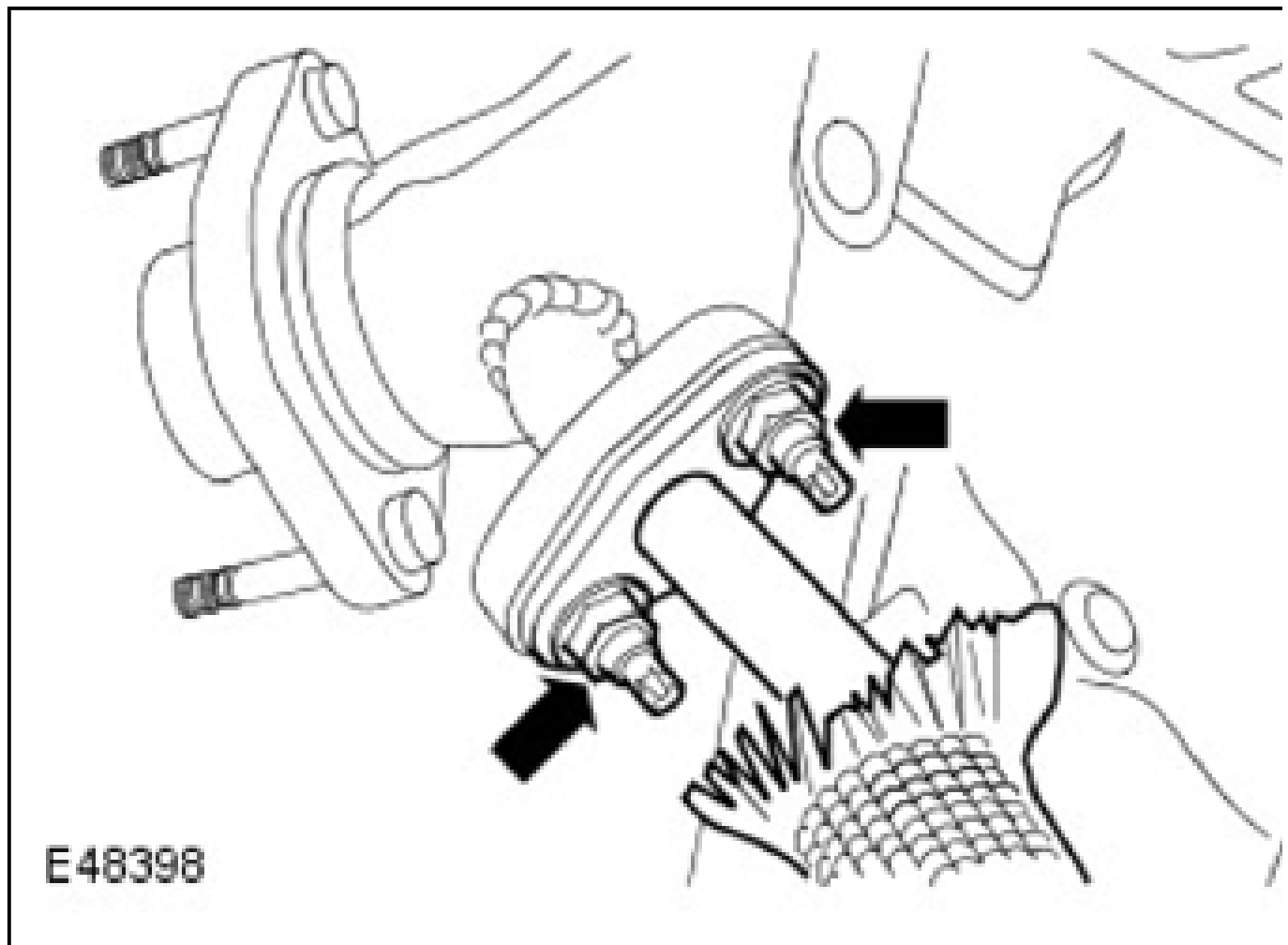
5. Check the road wheels are in the straight ahead position, then remove the steering column universal joint upper clamp bolt.
 - Discard the retaining bolt.
6. Release the upper steering column shaft.
7. Remove the steering rack universal joint clamp bolt.
 - Discard the retaining bolt.
8. Release and remove the shaft and joint assembly.



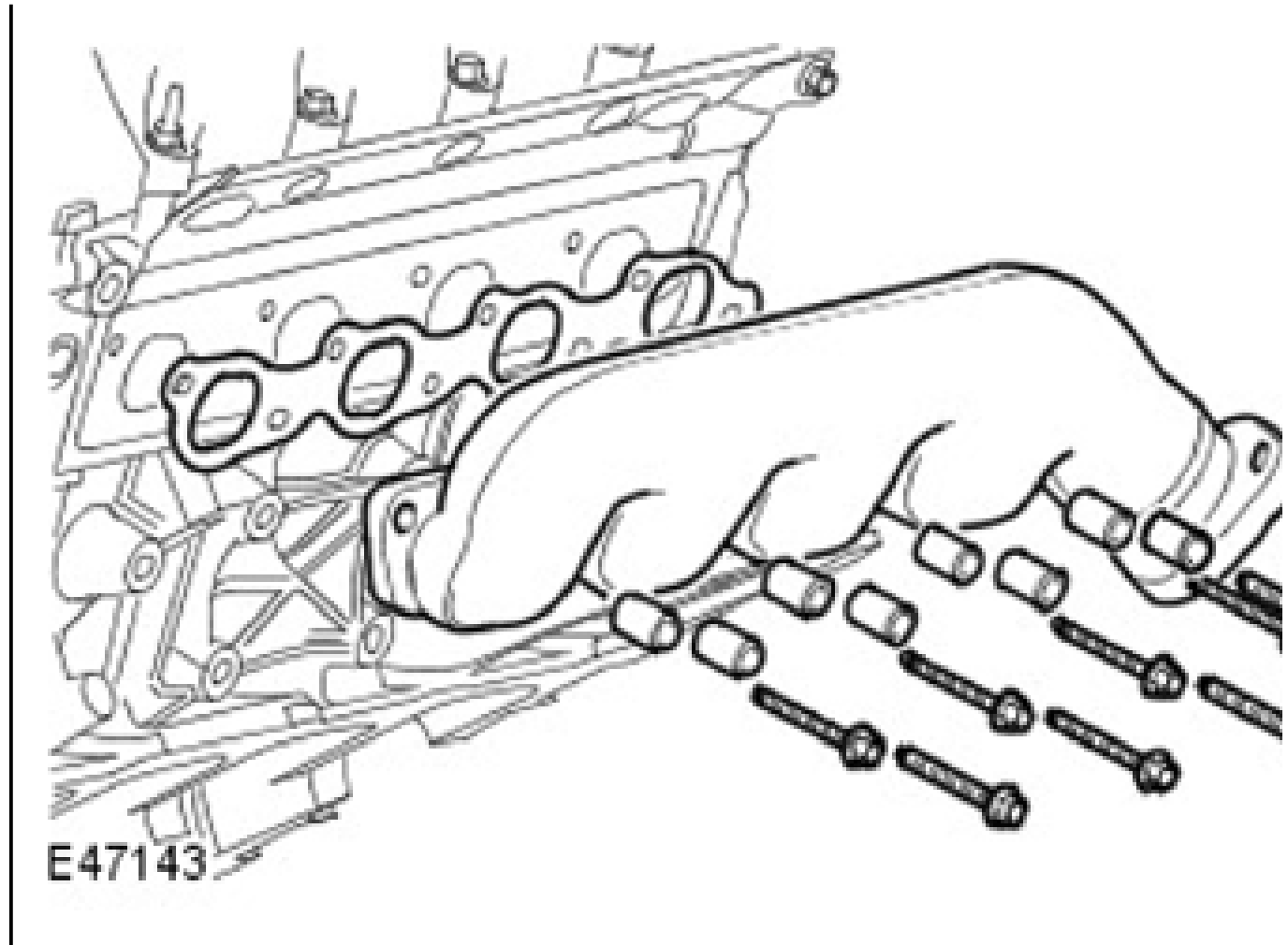
All vehicles

CAUTION: Failure to follow this procedure can lead to the EGR pipe stress cracking.

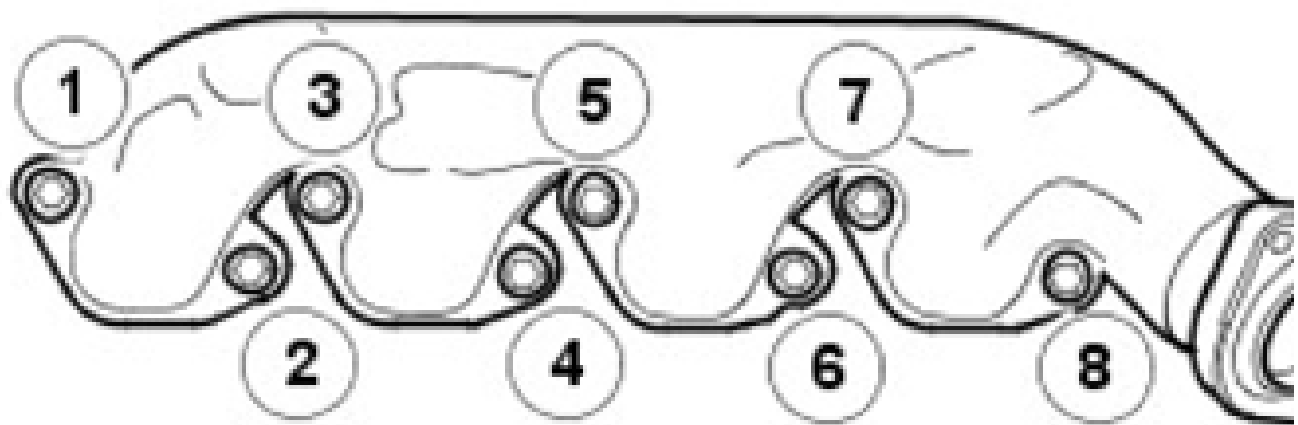
9. Disconnect the exhaust manifold EGR pipe flange.
 - Remove the 2 nuts.
 - Discard the gasket.
 - Loosen, but do not remove 2 bolts, securing the EGR pipe to the EGR valve.



10. Remove the exhaust manifold.
 - Remove the 8 bolts.
 - Collect the spacers and discard the bolts.
 - Remove the gasket/heat shield retaining bolt.
 - Discard the gasket/heat shield.

**INSTALLATION****All vehicles**

1. Clean the component mating faces.
2. Install the exhaust manifold.
 - Install the gasket/heat shield.
 - Tighten the heat shield bolt to 25 Nm (18 lb.ft).
 - Install, and lightly tighten the bolts.
 - Evenly and progressively, tighten the bolts in the sequence shown to 20 Nm (15 lb.ft).

**E47144**

3. Connect the EGR pipe and exhaust manifold flanges.

- Install a new gasket.
- Tighten the nuts to 25 Nm (18 lb.ft).
- Tighten the bolts to 25 Nm (18 lb.ft).

Left-hand drive vehicles

4. Install the steering column lower universal joint assembly.

- Clean the component mating faces.
- Install new patchlock bolts and tighten to 25 Nm (18 lb.ft).

All vehicles

NOTE: The heatshield consists of 3 parts.

5. Install the upper suspension arm and brake line heat shields.

- Install the bolts.
- Install the nuts.

6. Install the fender splash shield.

For additional information, refer to: **FENDER SPLASH SHIELD** .

7. Install the exhaust system.

For additional information, refer to: **EXHAUST SYSTEM** .

8. Connect the battery ground cable.

EXHAUST MANIFOLD RH

REMOVAL

1. Disconnect the battery ground cable.

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

2. Remove the exhaust system.

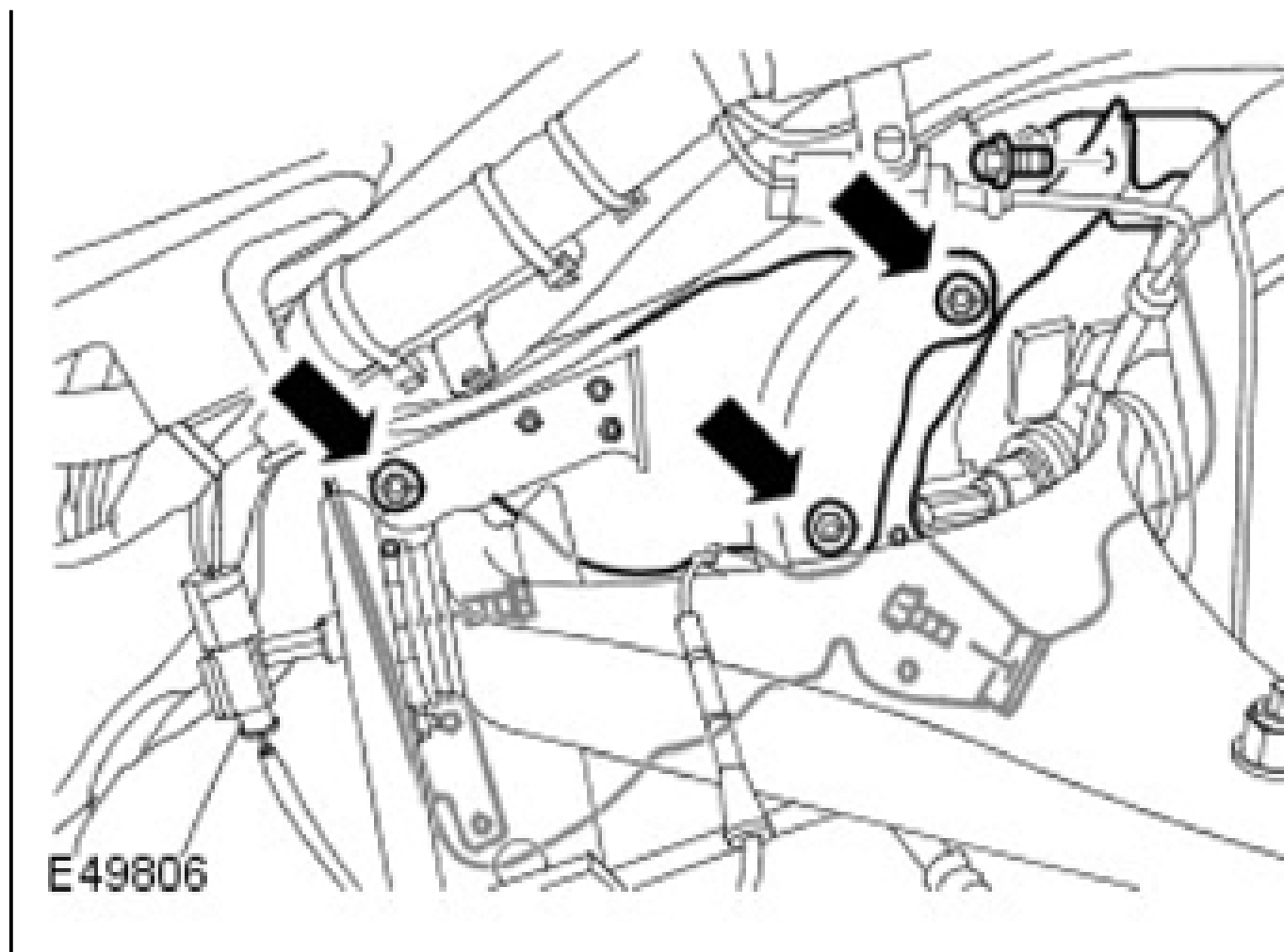
For additional information, refer to: **EXHAUST SYSTEM** .

3. Remove the fender splash shield.

For additional information, refer to: **FENDER SPLASH SHIELD** .

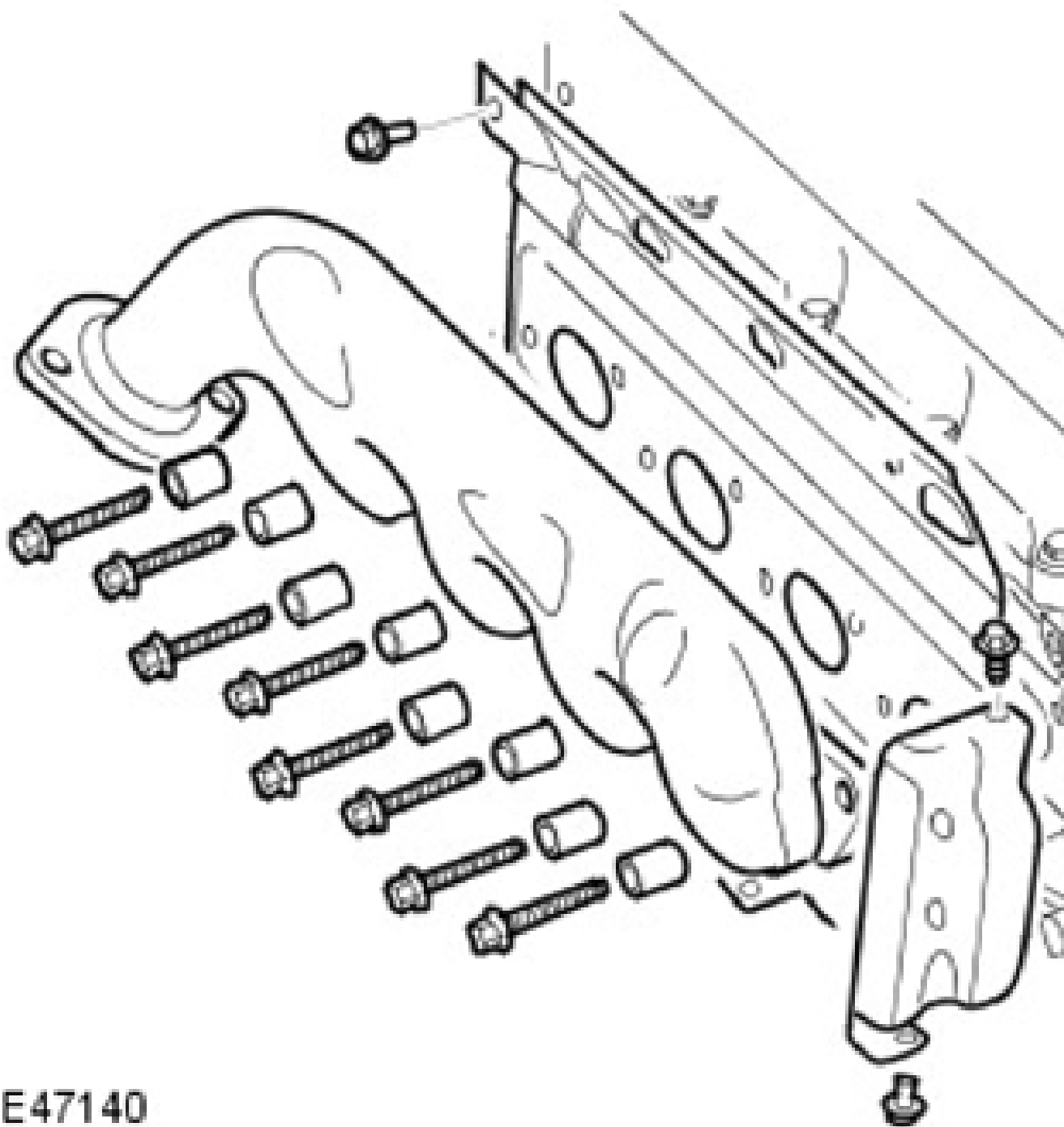
NOTE: **The heatshield consists of 3 parts.**

4. Remove the upper suspension arm and brake line heat shields for access.
 - Remove the 3 nuts.
 - Remove the 3 bolts.



5. Remove the exhaust manifold.

- Remove the 8 bolts.
- Collect the spacers and discard the bolts.
- Remove the gasket/heat shield retaining bolt.
- Discard the gasket/heat shield.

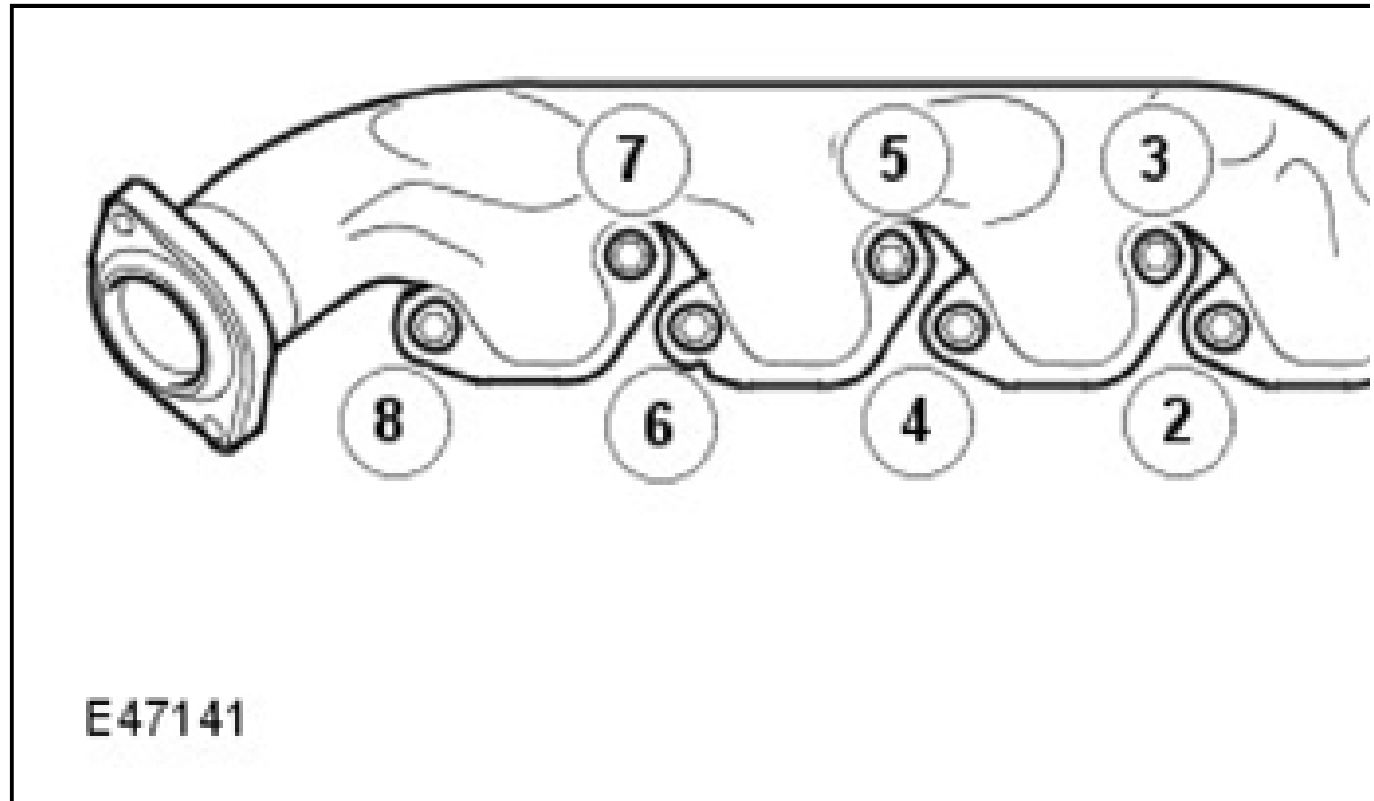


E47140

INSTALLATION

1. Clean the component mating faces.
2. Install the exhaust manifold.

- Install the gasket/heat shield.
- Tighten the heat shield bolt to 25 Nm (18 lb.ft).
- Evenly and progressively, tighten the bolts in the sequence shown to 20 Nm (15 lb.ft).



NOTE: The heatshield consists of 3 parts.

3. Install the upper suspension arm and brake line heat shields.
 - Install the bolts.
 - Install the nuts.

4. Install the fender splash shield.

For additional information, refer to: **FENDER SPLASH SHIELD** .

5. Install the exhaust system.

For additional information, refer to: **EXHAUST SYSTEM** .

6. Connect the battery ground cable.

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

VARIABLE CAMSHAFT TIMING (VCT) UNIT

REMOVAL

NOTE: The removal and installation of the RH VCT unit is similar to the LH and is covered within the timing drive component procedure.

1. Disconnect the battery ground cable.

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

2. Remove the timing drive components.

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

INSTALLATION

1. Install the timing drive components.

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

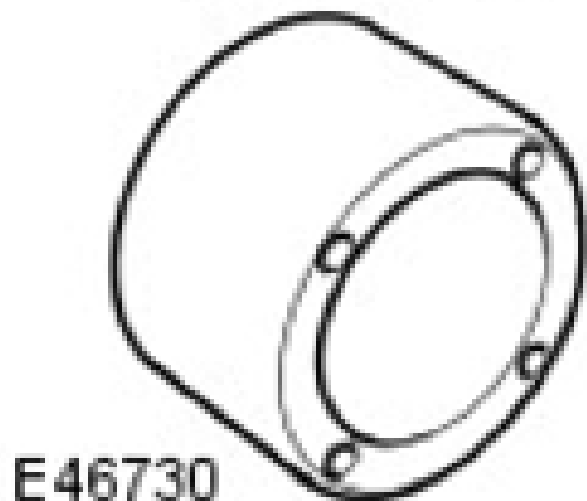
2. Connect the battery ground cable.

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

REMOVAL AND INSTALLATION**CRANKSHAFT MAIN BEARING CARRIER****SPECIAL TOOL(S)**

	Adapter 303-191-03
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303-191-03



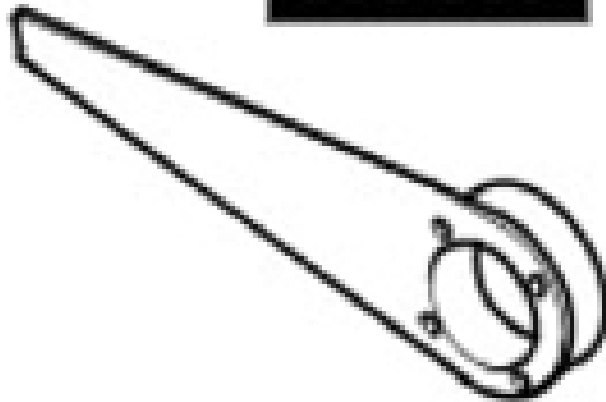
303-191-04



Bolts and spacers
303-191-04

Holding Tool Crankshaft Pulley
303-893(LRT-12-080)

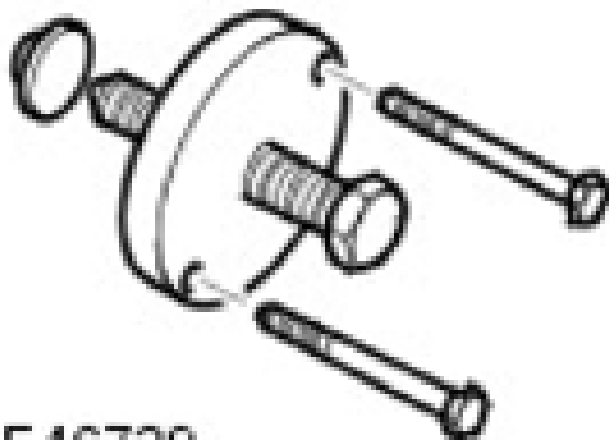
303-893



E46728

Remover, crankshaft pulley
303-588

303-588



E46729

Remover, crankshaft seal
303-D121

303-D121



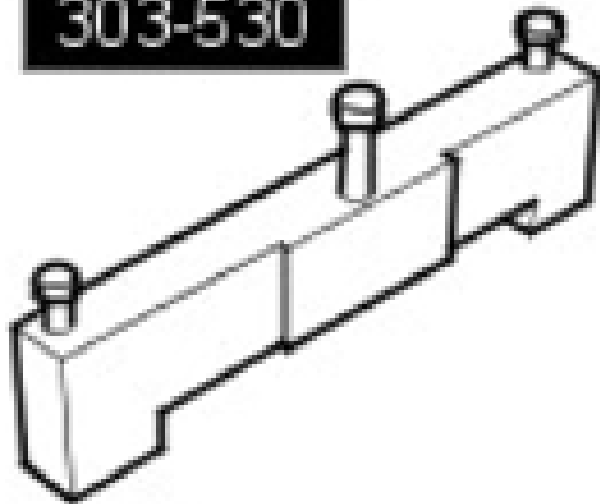
303-645



Timing Setting tool
303-645

Camshaft setting/locking tool
303-530

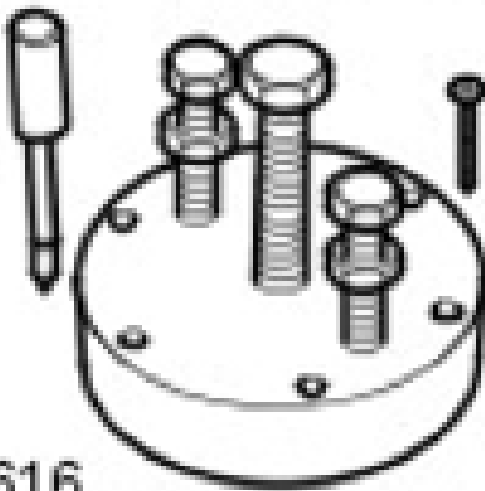
303-530



E46879

Crankshaft rear oil seal remover/installer
303-538

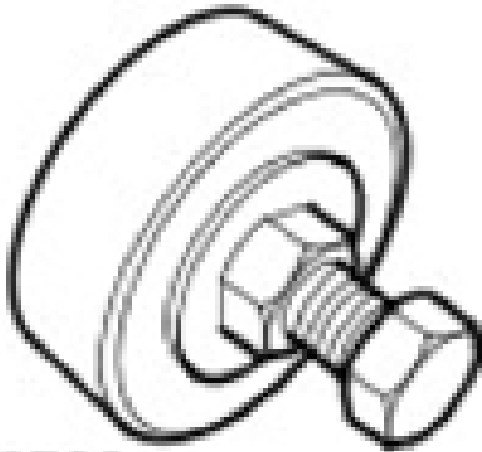
303-538



E46616

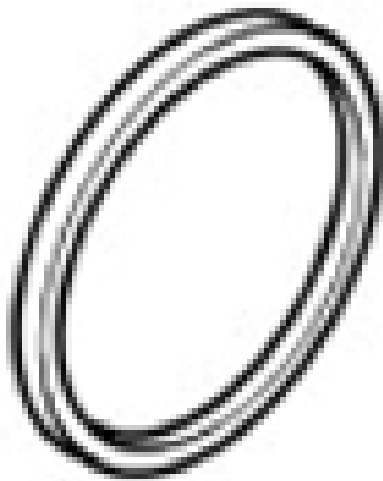
Installer, crankshaft seal
303-1100

303-1100



E46732

303-1100-01



E67144

Adapter - Crankshaft seal installer
303-1100-01

REMOVAL

1. Disconnect the battery ground cable.

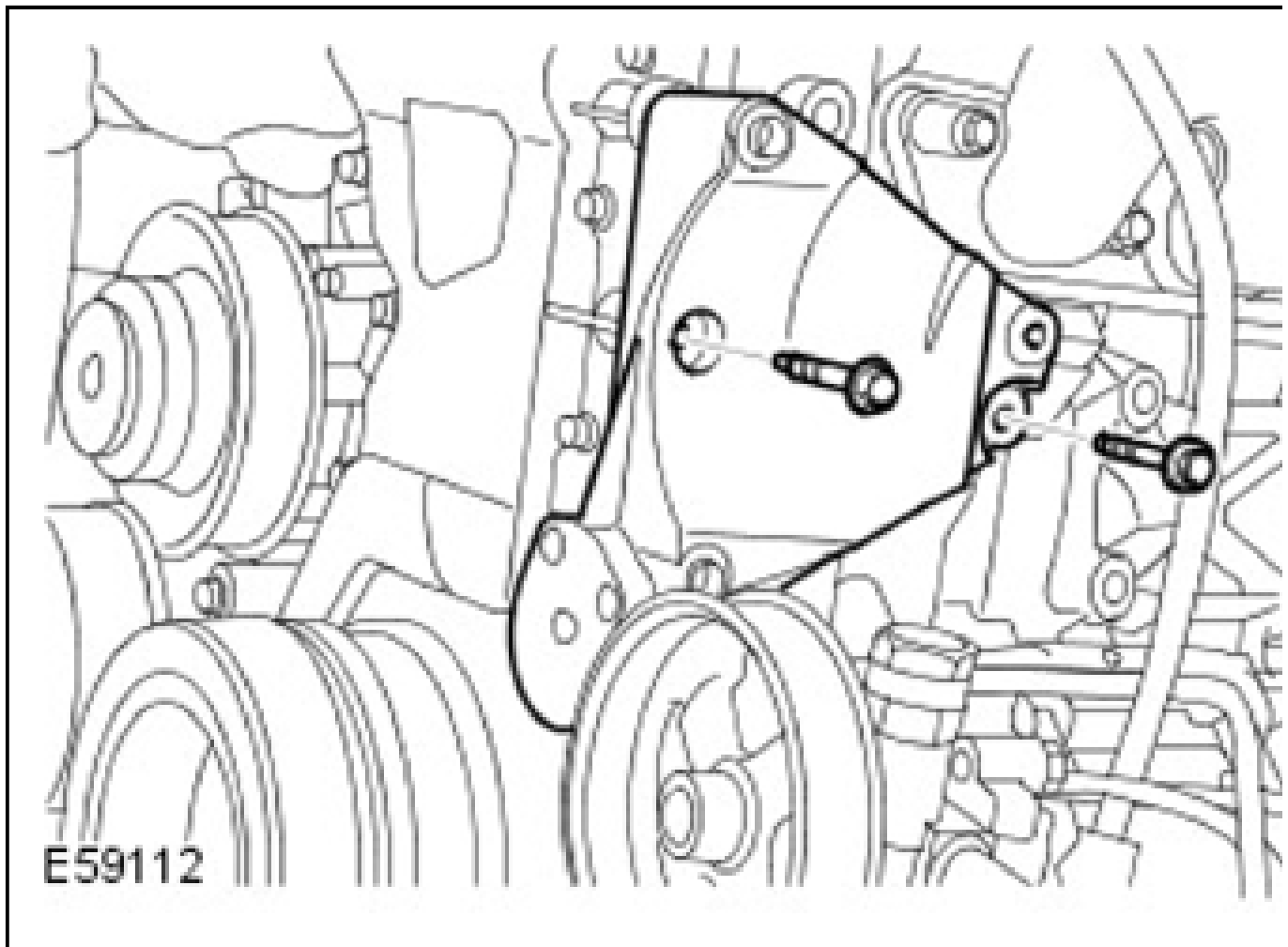
For additional information, refer to: **SPECIFICATION** .

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 engine.

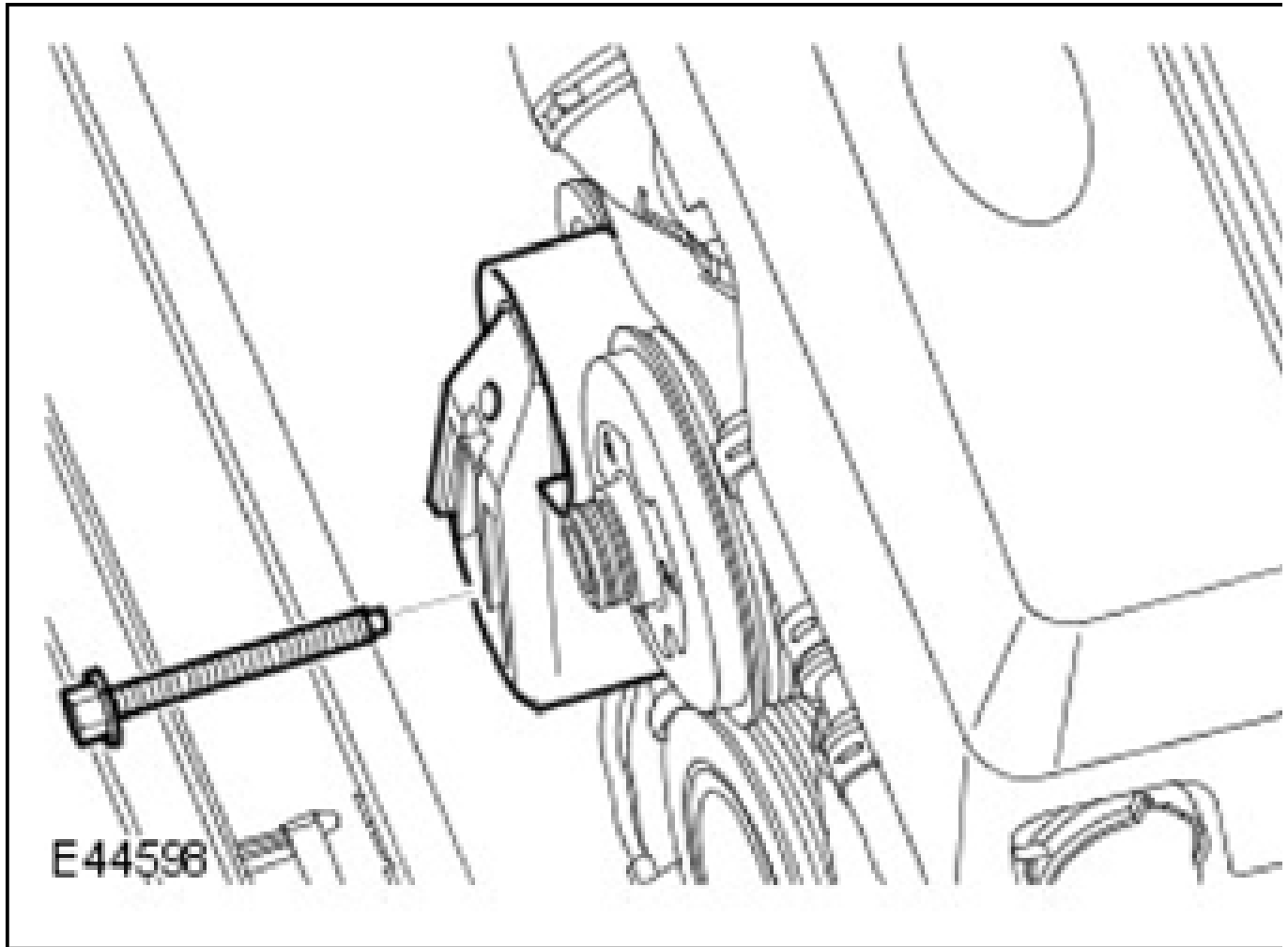
For additional information, refer to: **ENGINE** .

4. Mount the engine to an engine stand.
5. Remove the air conditioning compressor (A/C) support bracket.
 - Remove the 2 bolts.



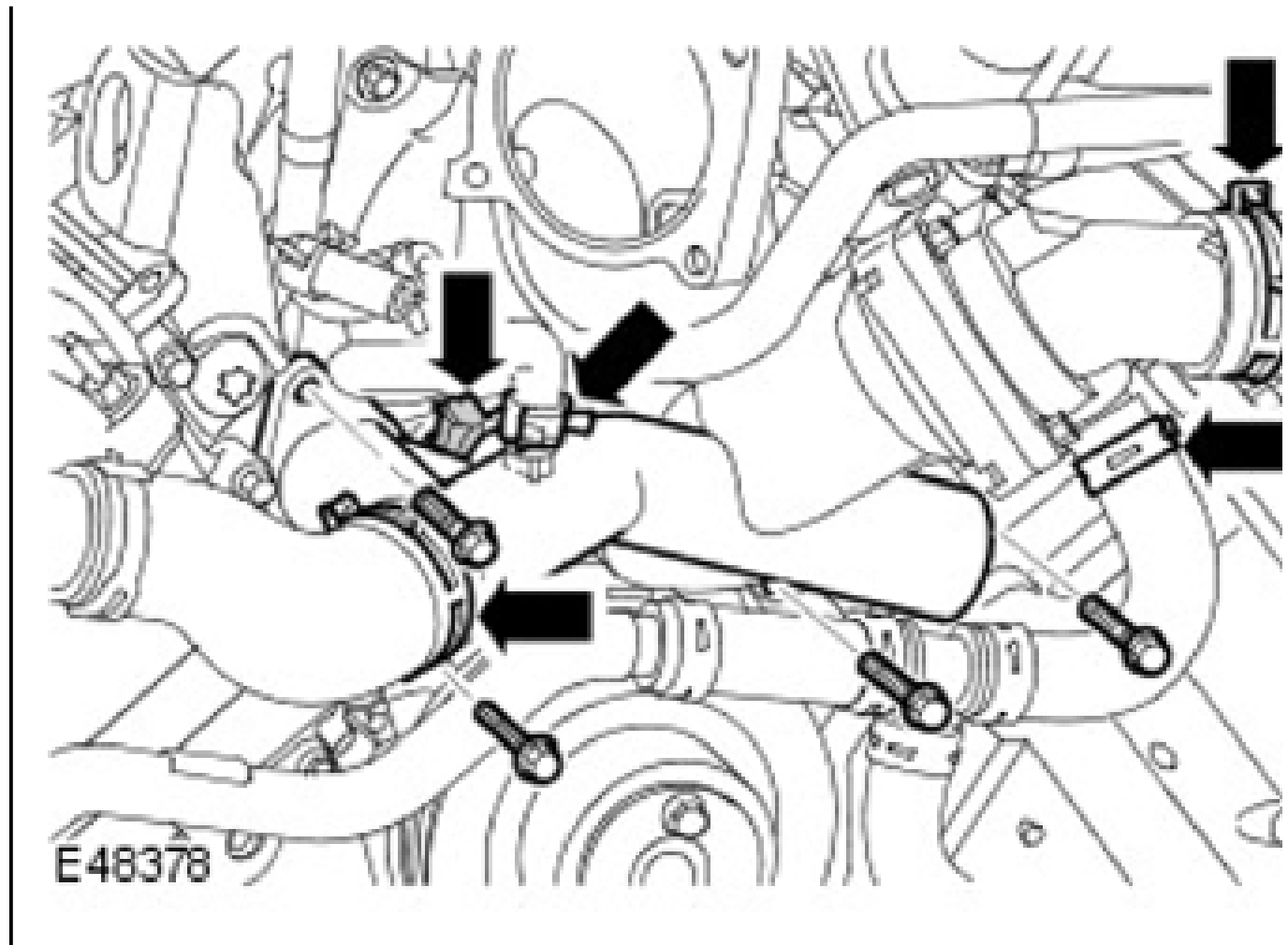
6. Remove the cooling fan drive belt tensioner.

- Remove the bolt.

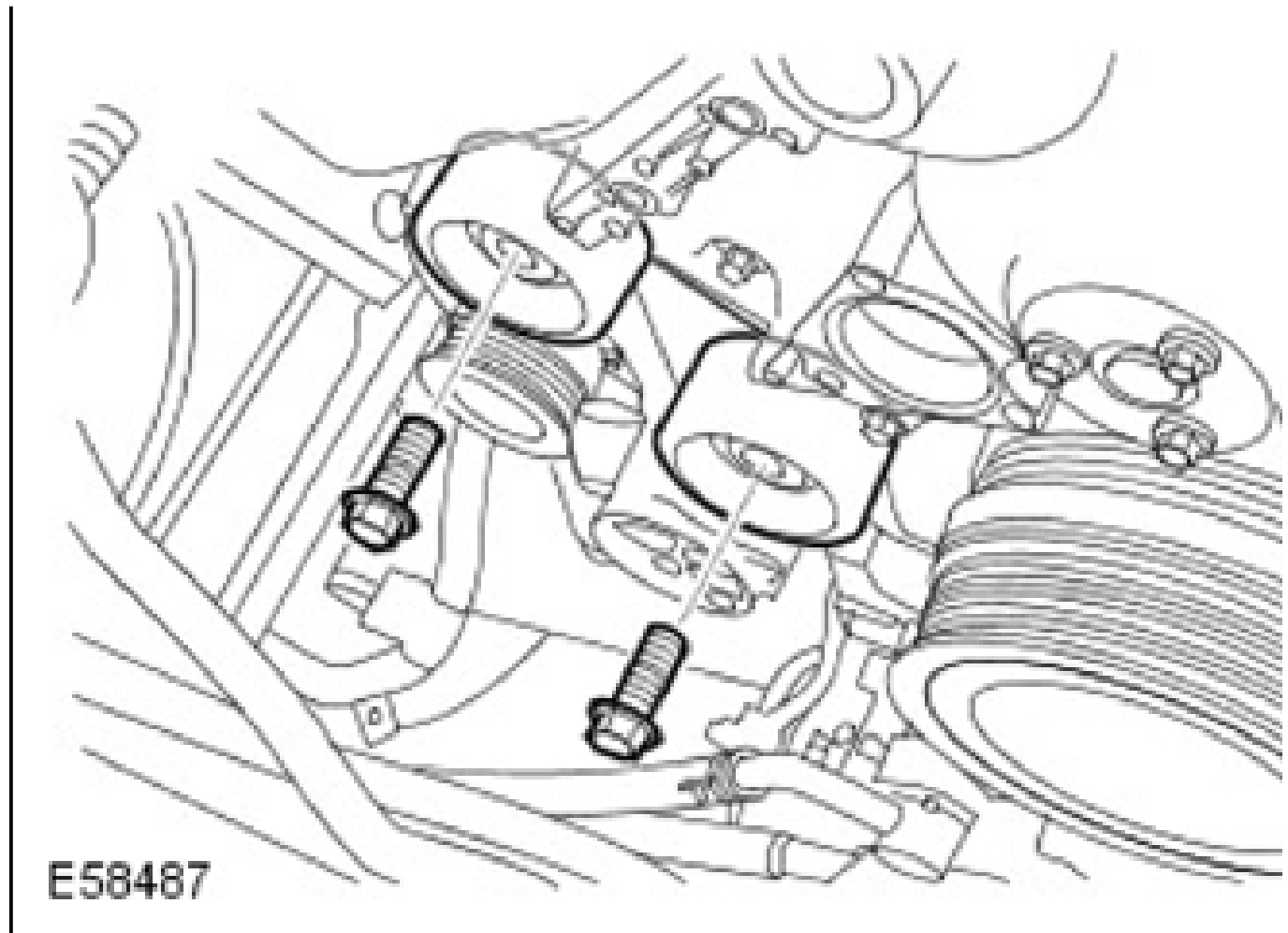


7. Remove the coolant manifold.

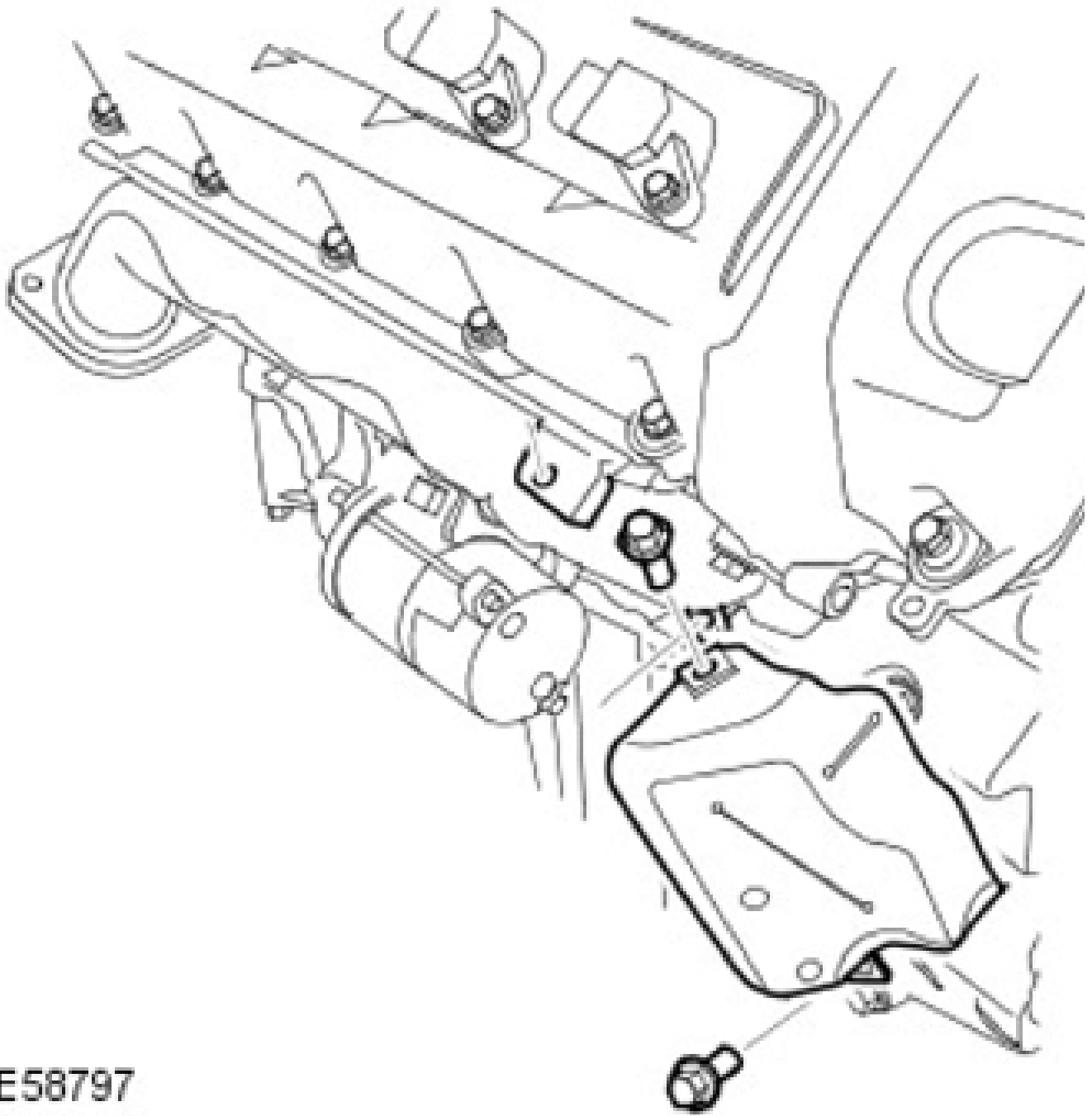
- Release the clips and disconnect the 4 coolant hoses.
- Remove the 4 bolts.
- Disconnect the engine coolant temperature (ECT) sensor electrical connector.



8. Remove the coolant pump and accessory drive belt idler pulleys.
 - Remove the bolts.



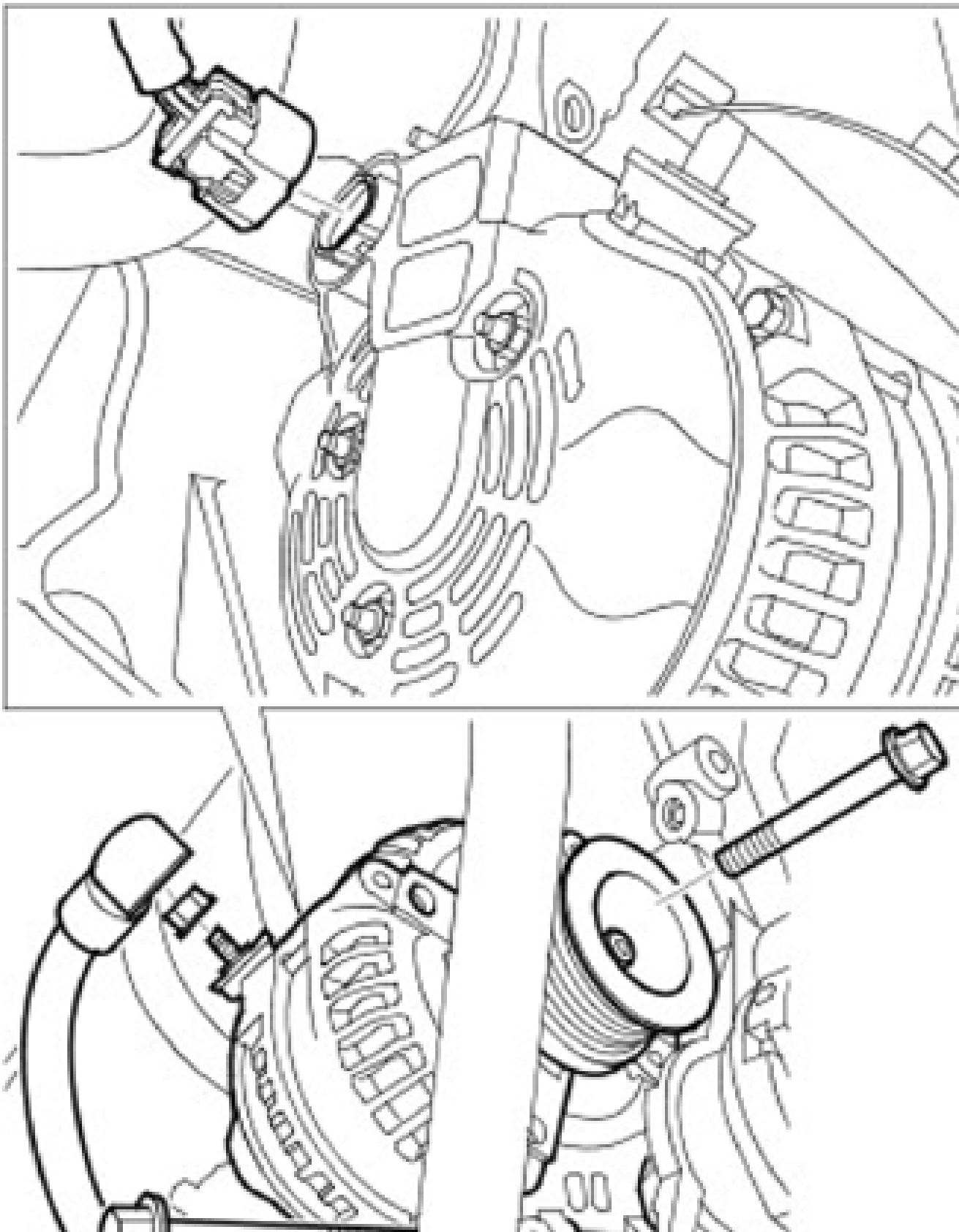
9. Remove the exhaust manifold heat shield.
 - Remove the 2 bolts.



E58797

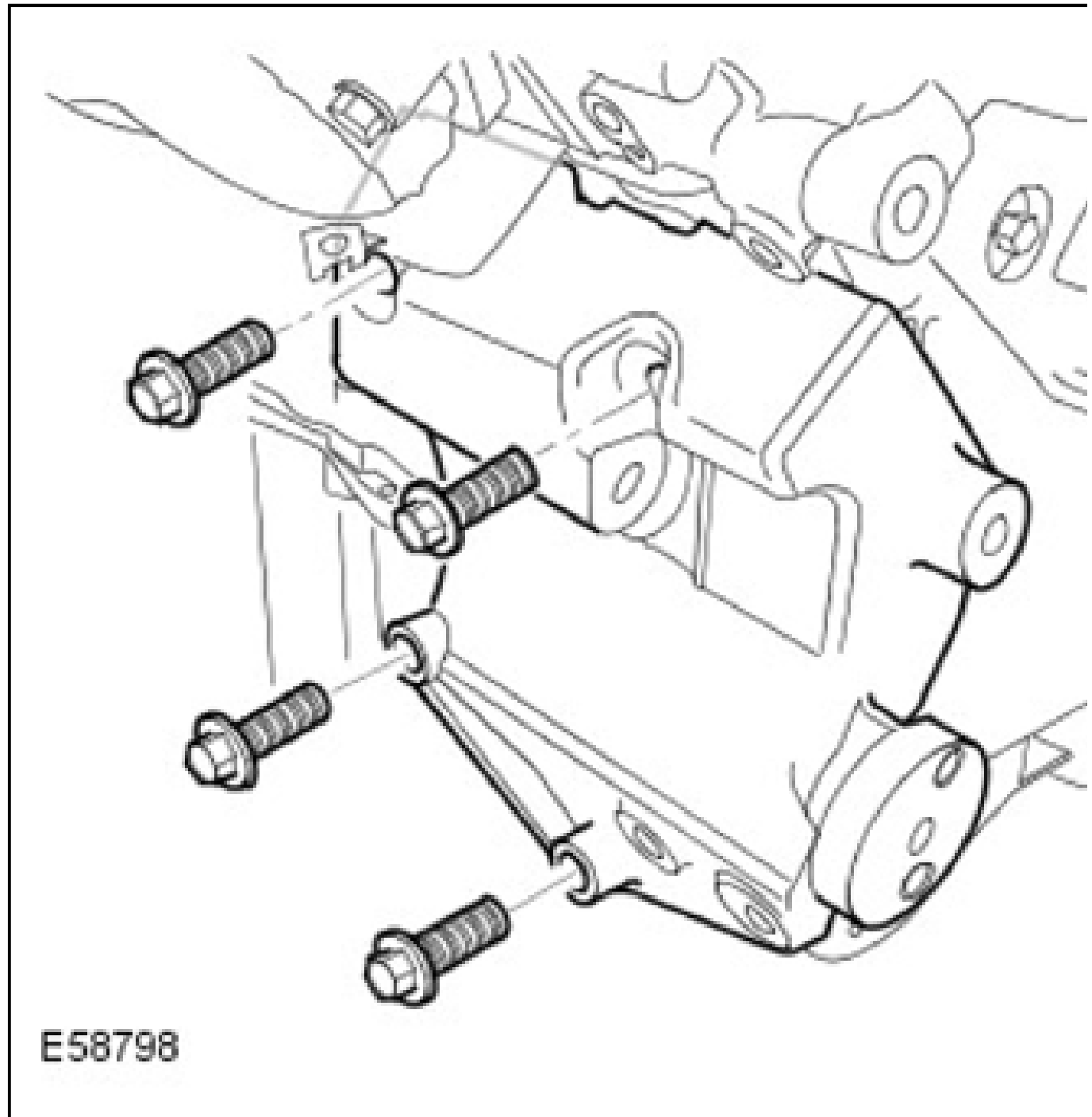
10. Disconnect the battery positive cable.
 - Remove the battery positive cable cover.
 - Remove the nut.
11. Remove the generator.
 - Disconnect the electrical connector.

- Remove the 3 bolts.

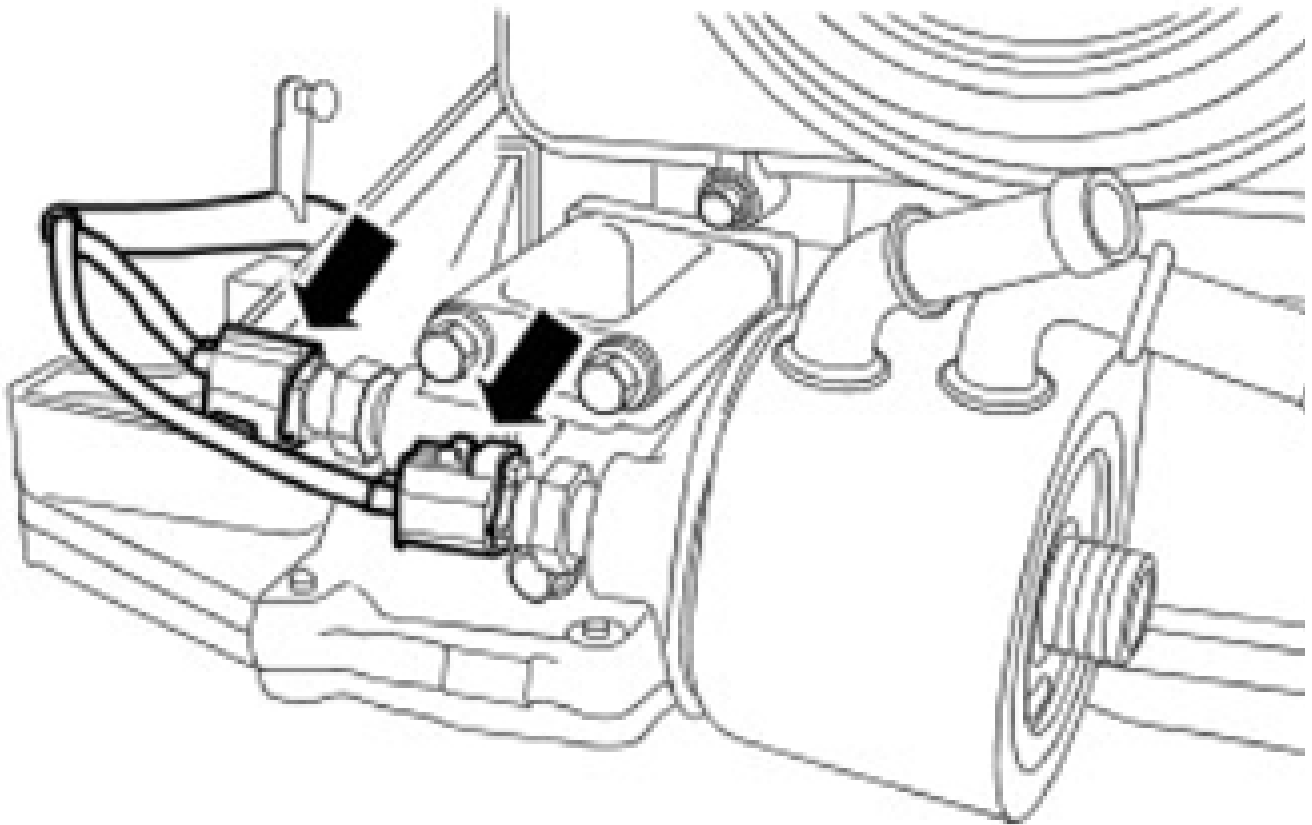


12. Remove the generator mounting bracket.

- Remove the 4 bolts.



13. Disconnect the engine oil temperature sensor electrical connector.

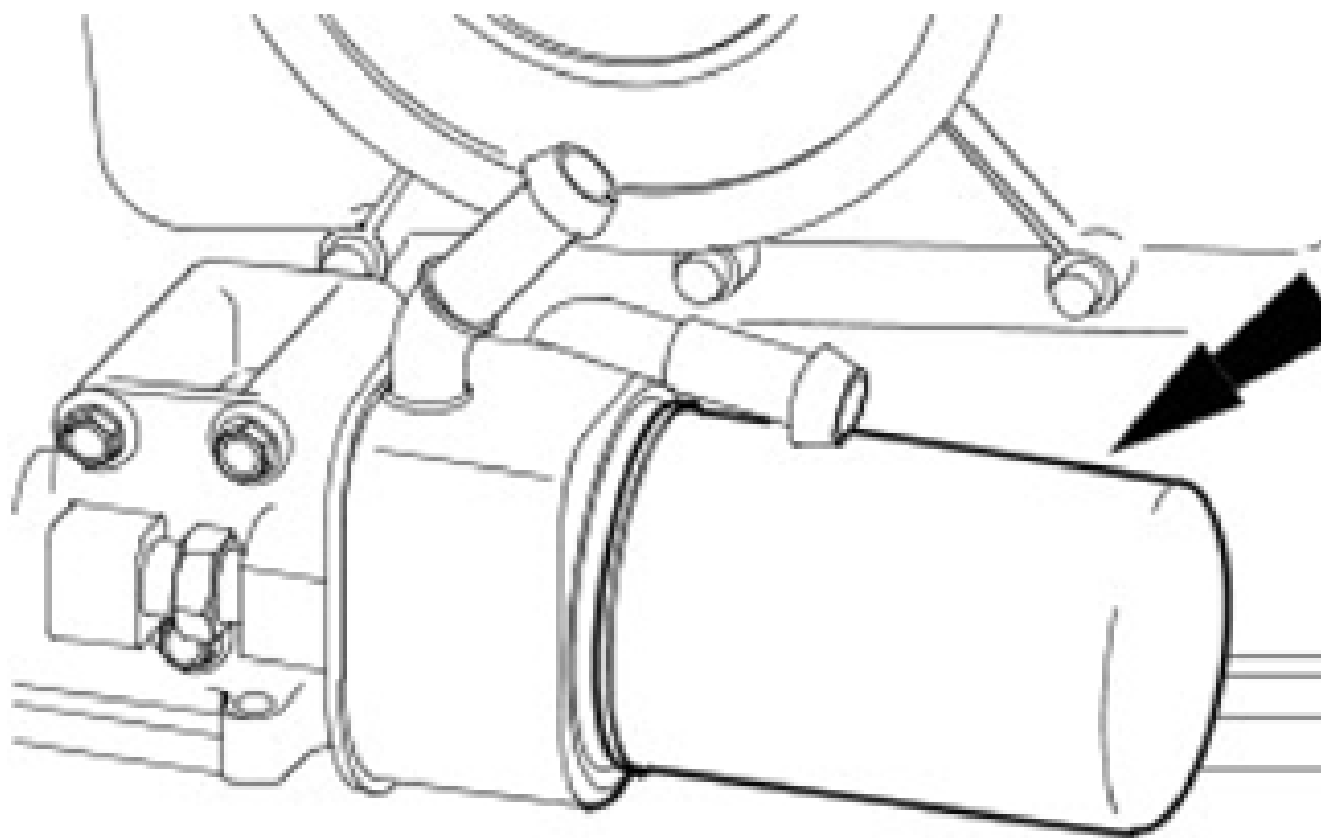


E82652

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

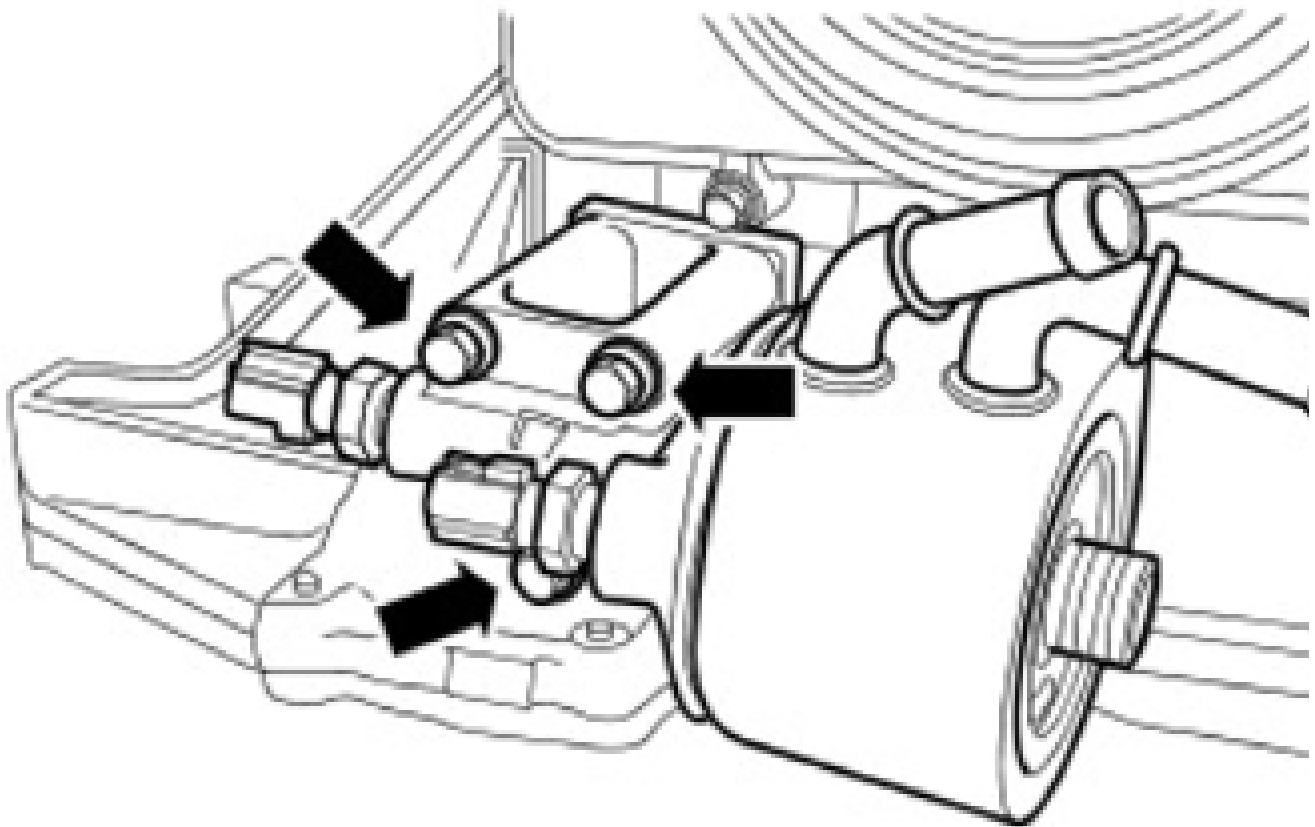
NOTE: **Some oil spillage is inevitable during this operation.**
 Clean the components general area prior to dismantling.

15. Remove the oil filter.



VUJ0001576

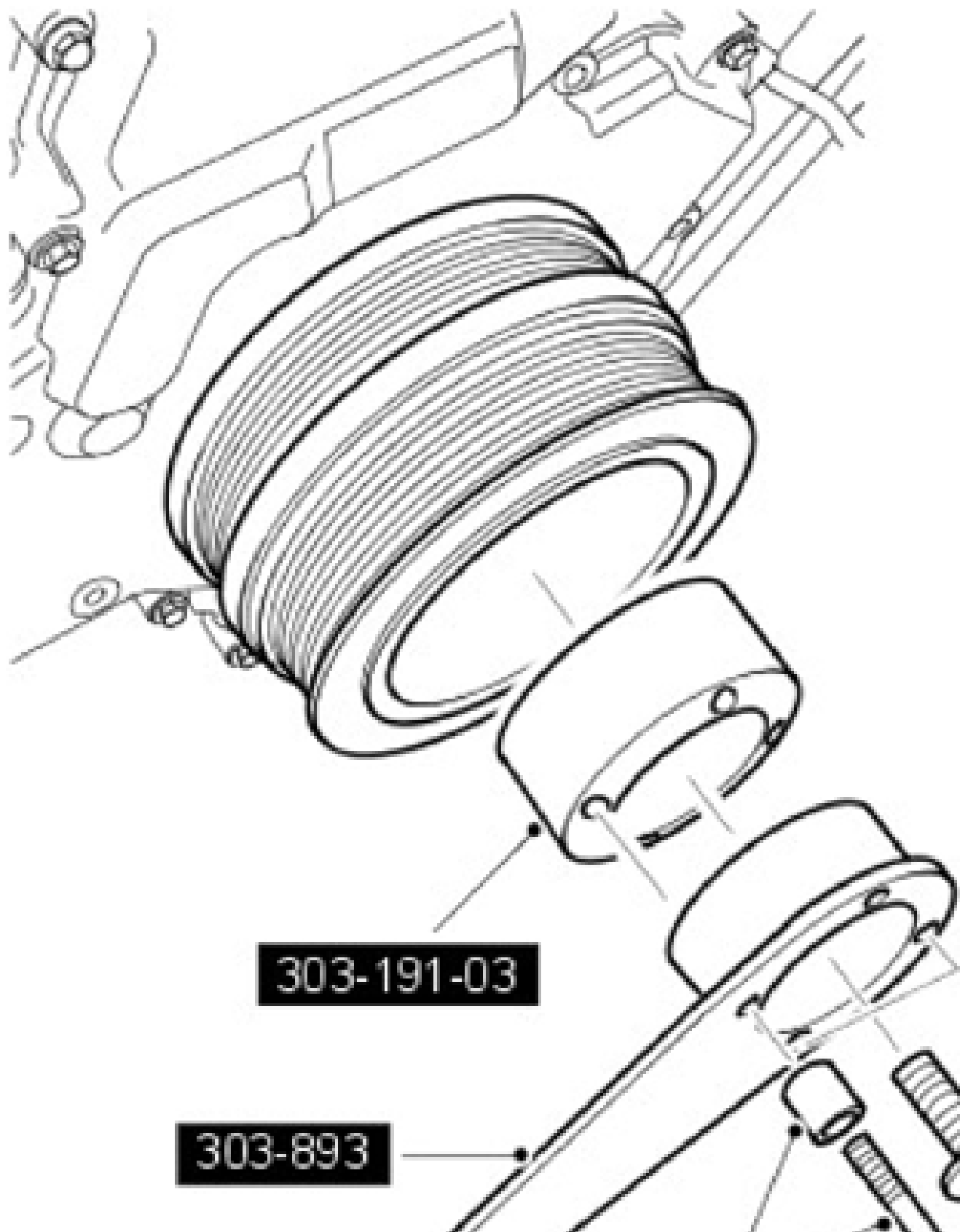
16. Remove the oil filter housing.
 - Remove the 3 bolts.
 - Remove and discard the O-ring seal.



E82653

CAUTION: Under no circumstances should the crankshaft setting peg, 303-645, be used in the following operations, to restrain the crankshaft.

17. Using the special tools, retain the crankshaft pulley.



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

18. Using the special tools, remove the crankshaft pulley bolt.

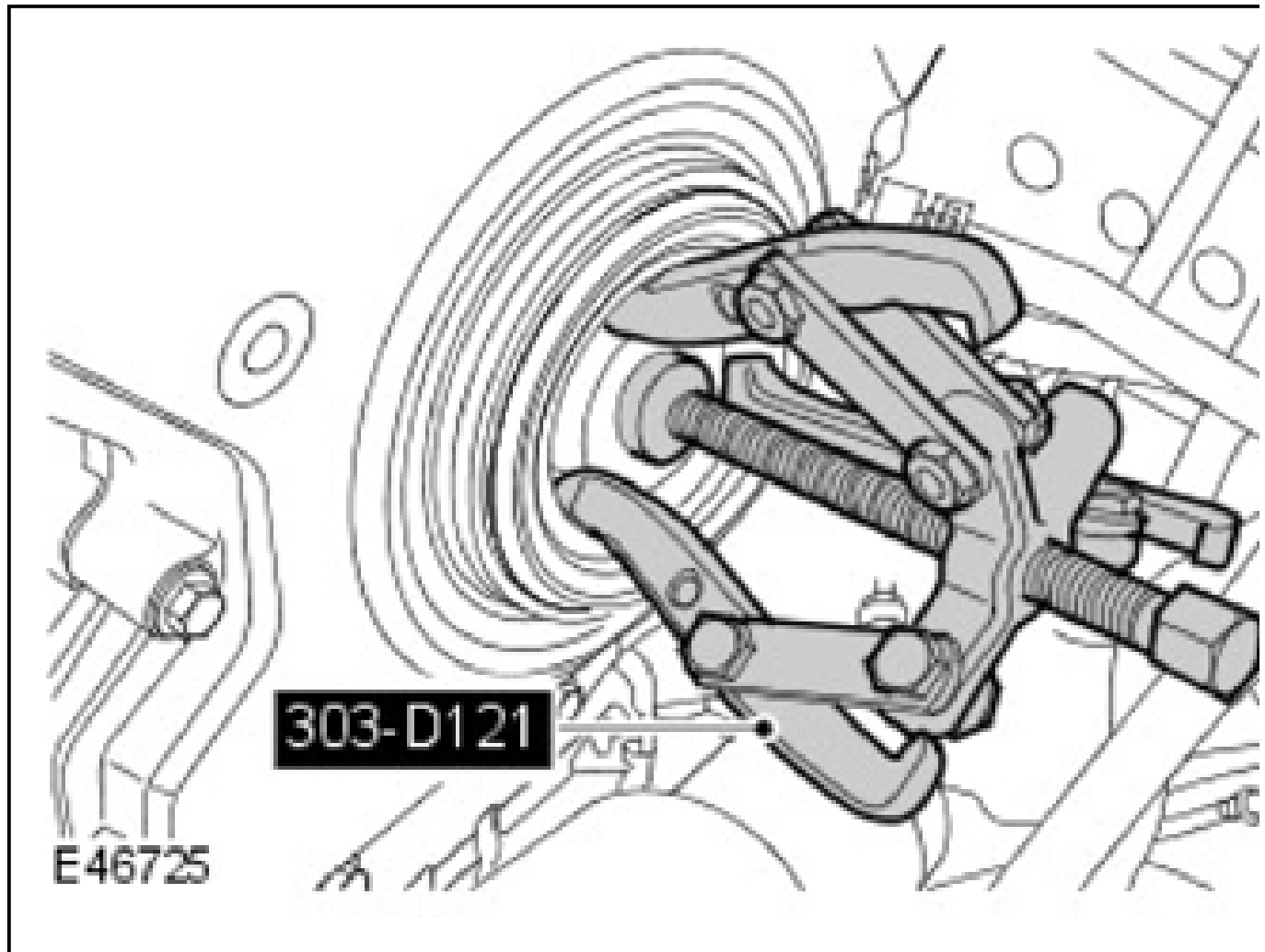
- Discard the bolt.
- Remove the special tools.

NOTE: The crankshaft pulley will be very tight.

19. Using the special tools, remove the crankshaft pulley.

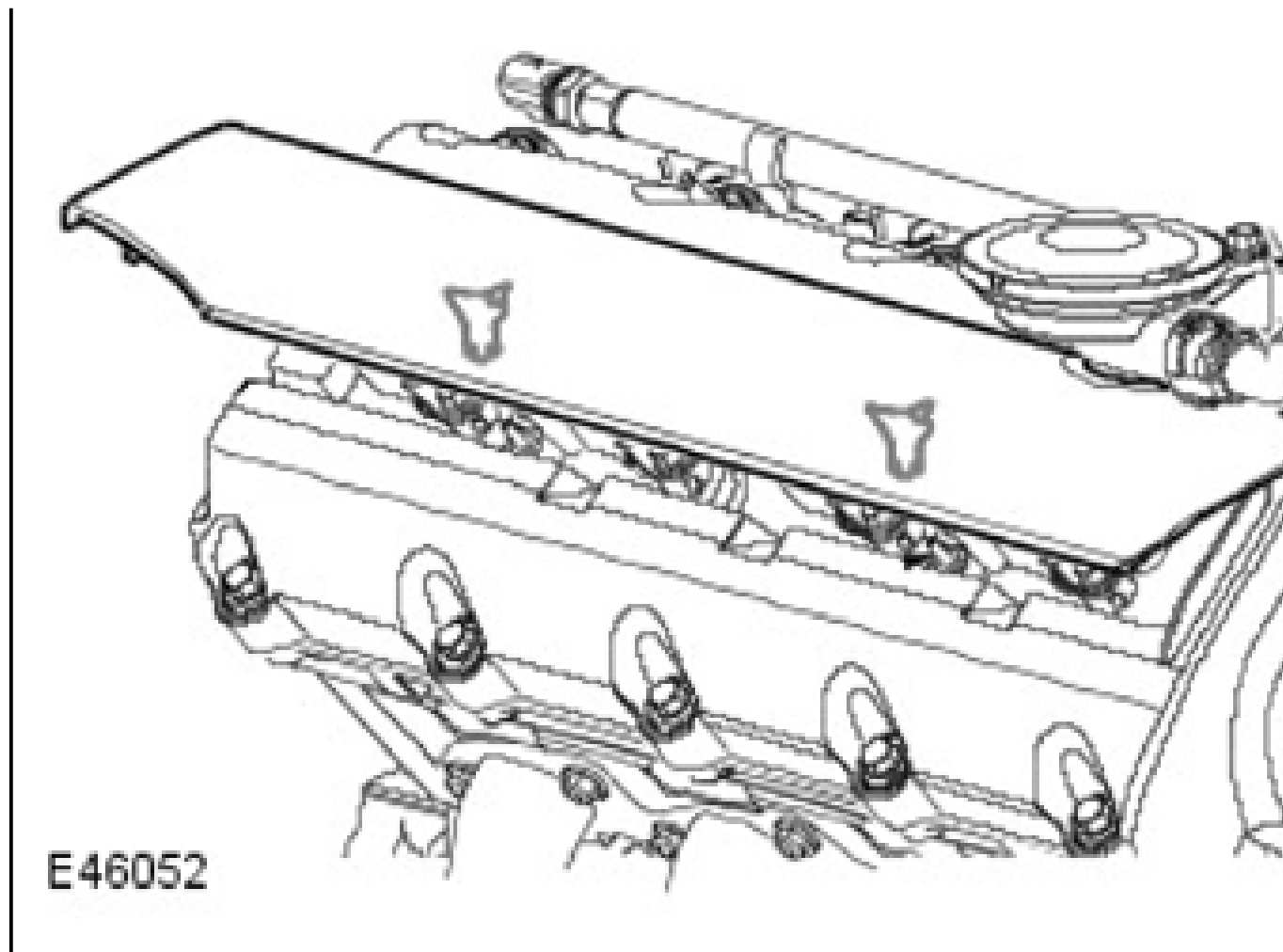
- Collect the locking ring.
- Remove the special tools.

20. Using the special tool, remove and discard the crankshaft front seal.

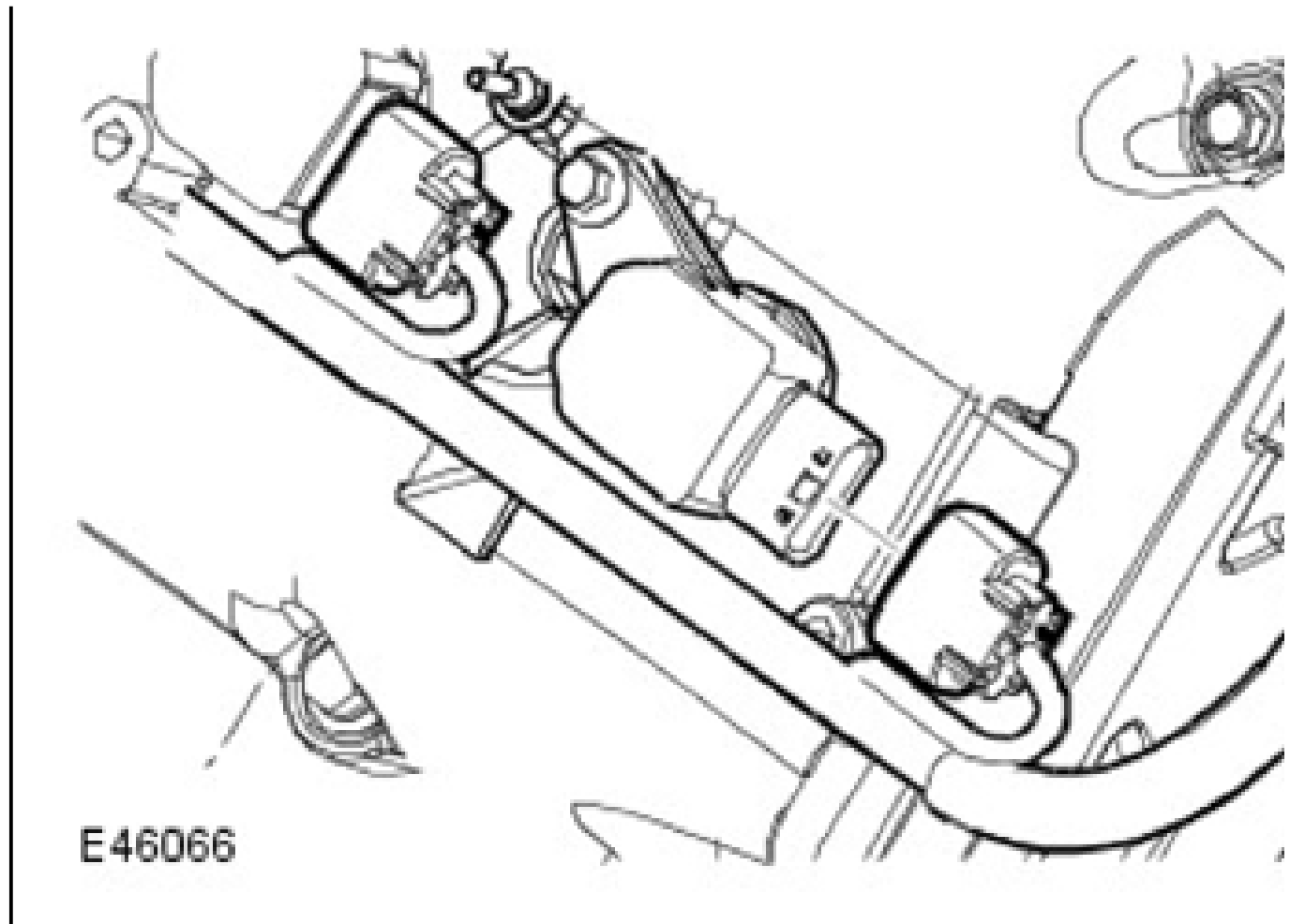


21. Remove the RH ignition coil-on-plug cover.

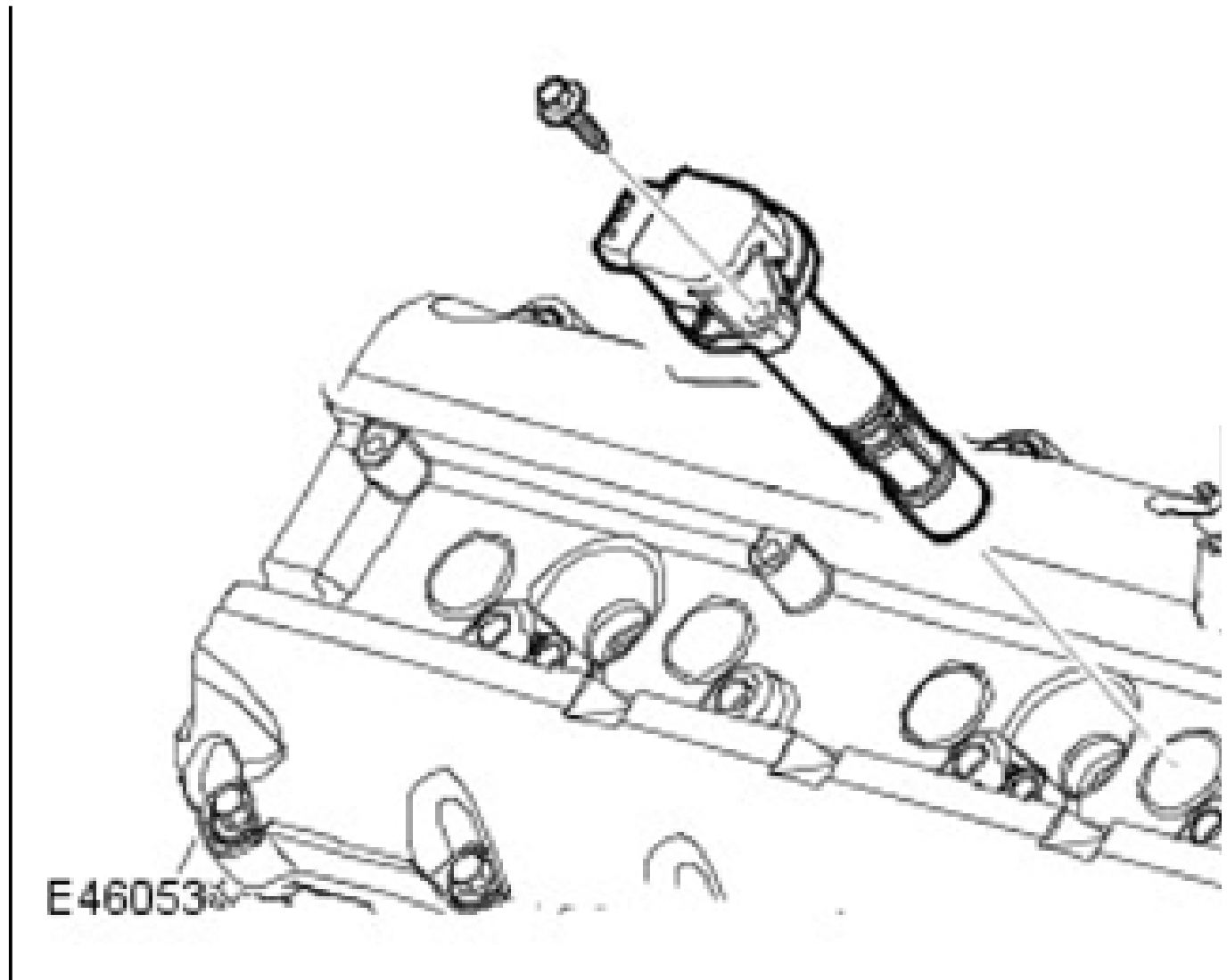
- Release from the 2 clips.



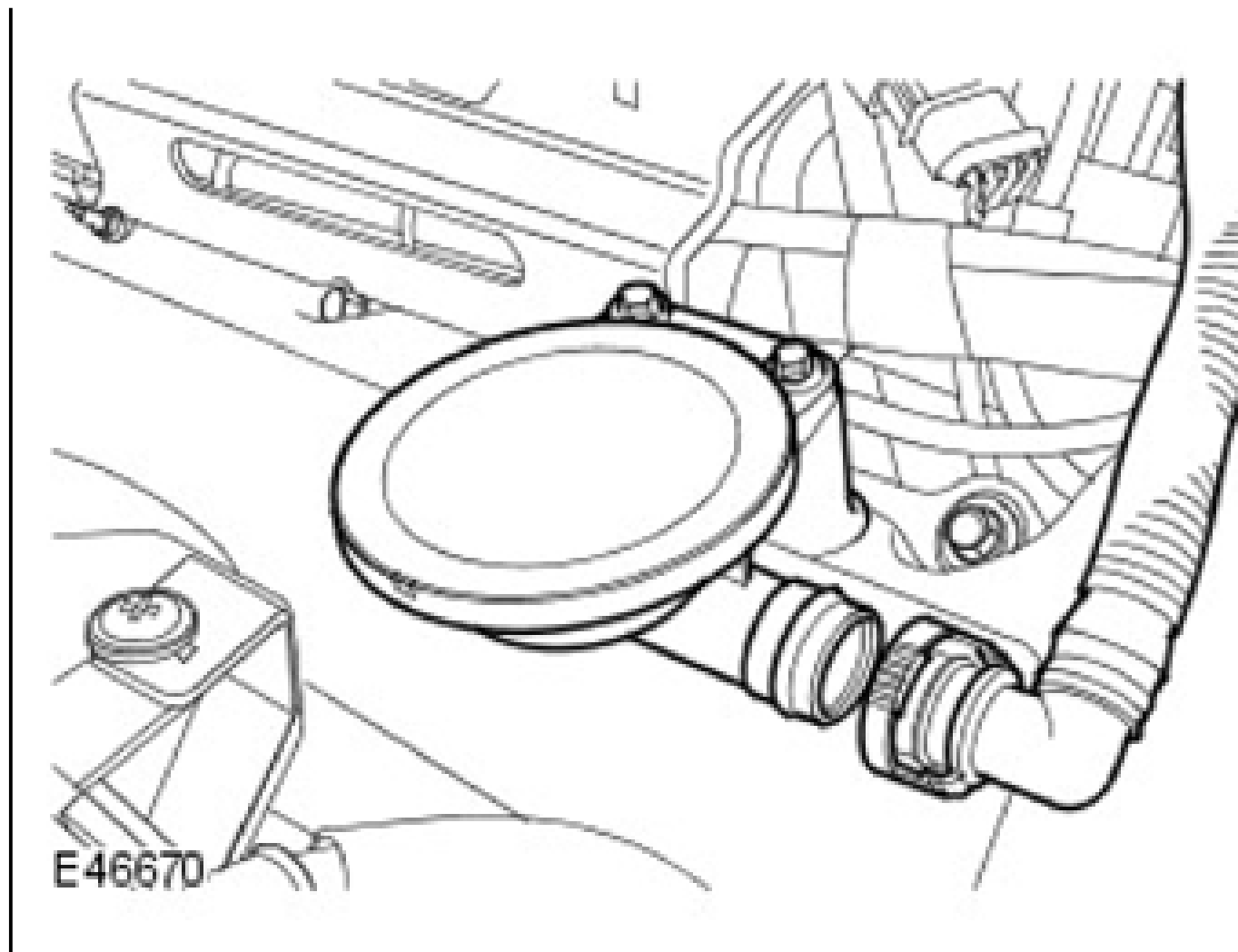
22. Disconnect the RH ignition coil-on-plug electrical connector.



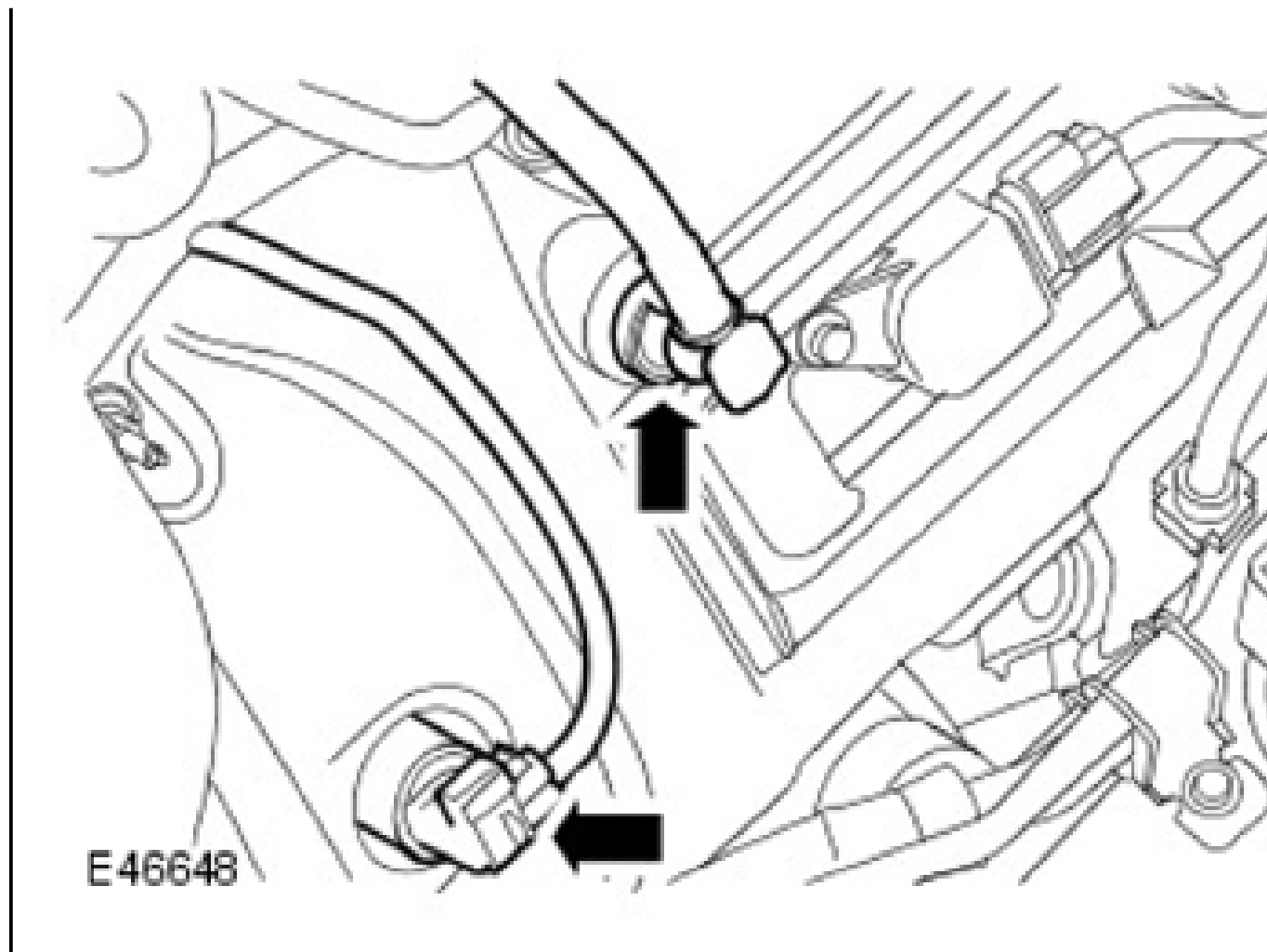
23. Remove the RH ignition coil-on-plug.
- Remove the bolt.
 - Remove and discard the seal.



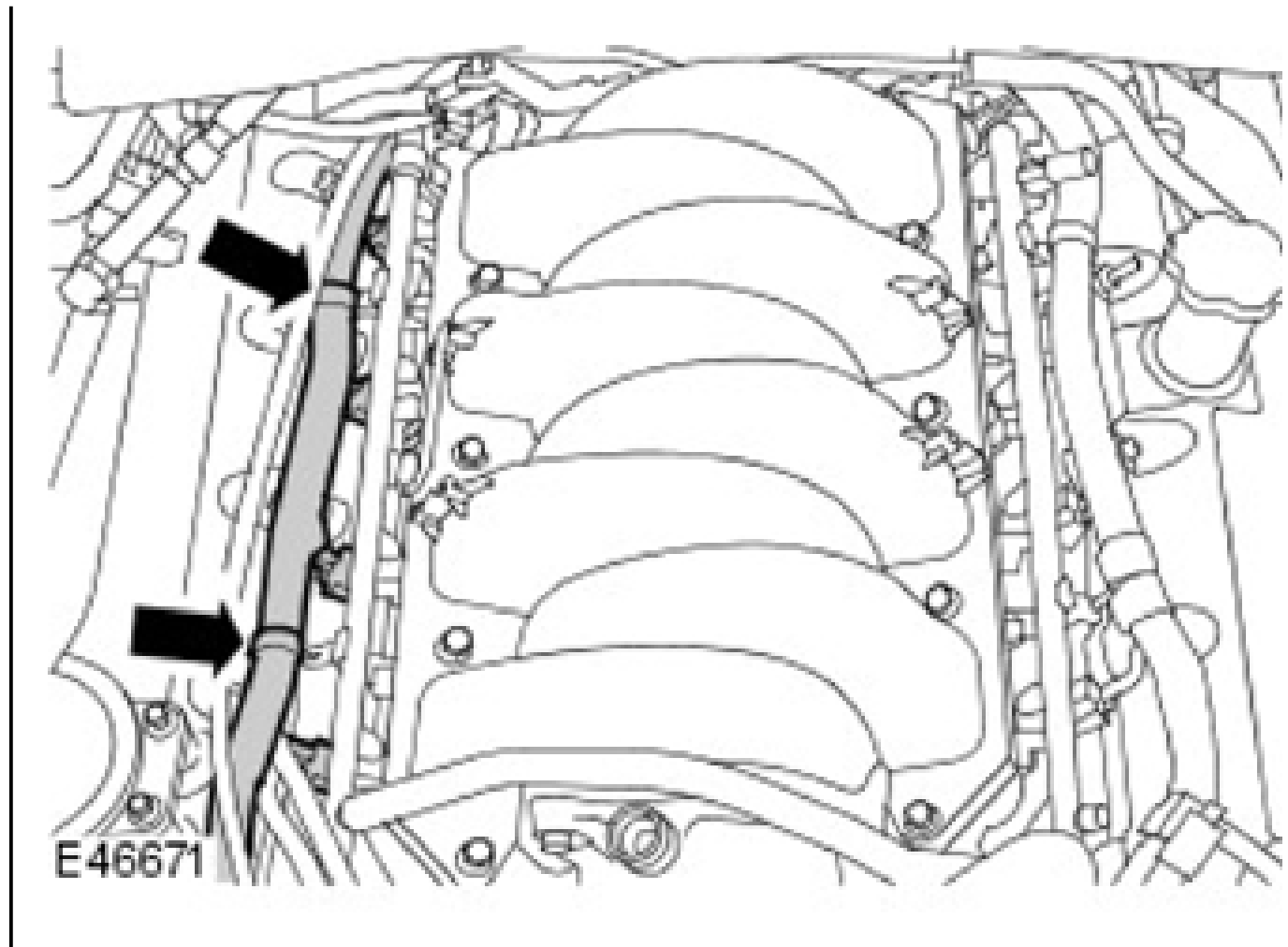
24. Remove the remaining ignition coil-on-plugs.
25. Disconnect the positive crankcase ventilation (PCV) line.



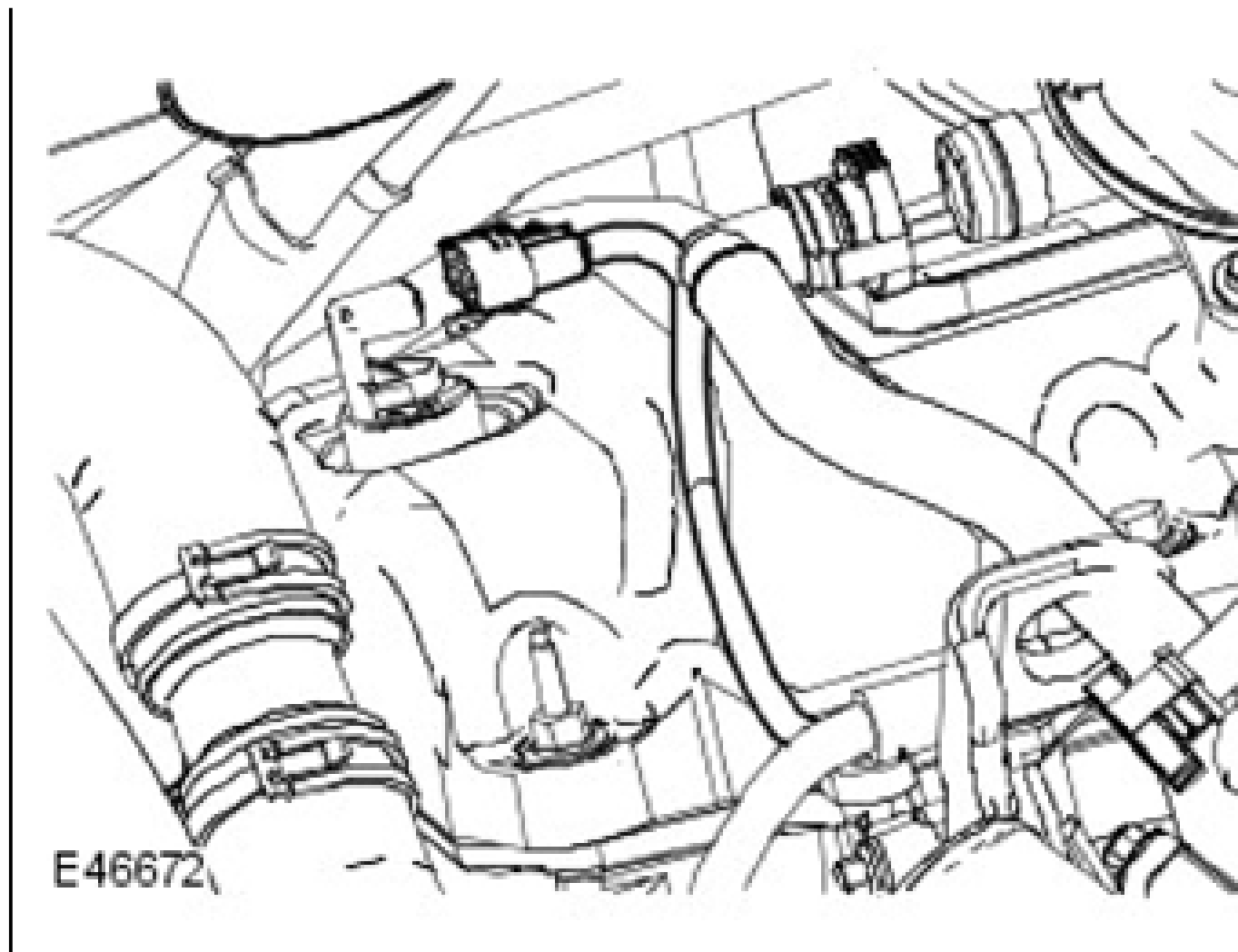
26. Disconnect the LH variable camshaft timing (VCT) oil solenoid electrical connector.
27. Disconnect the valve cover breather hose.



28. Release the engine wiring harness from the retaining bracket.

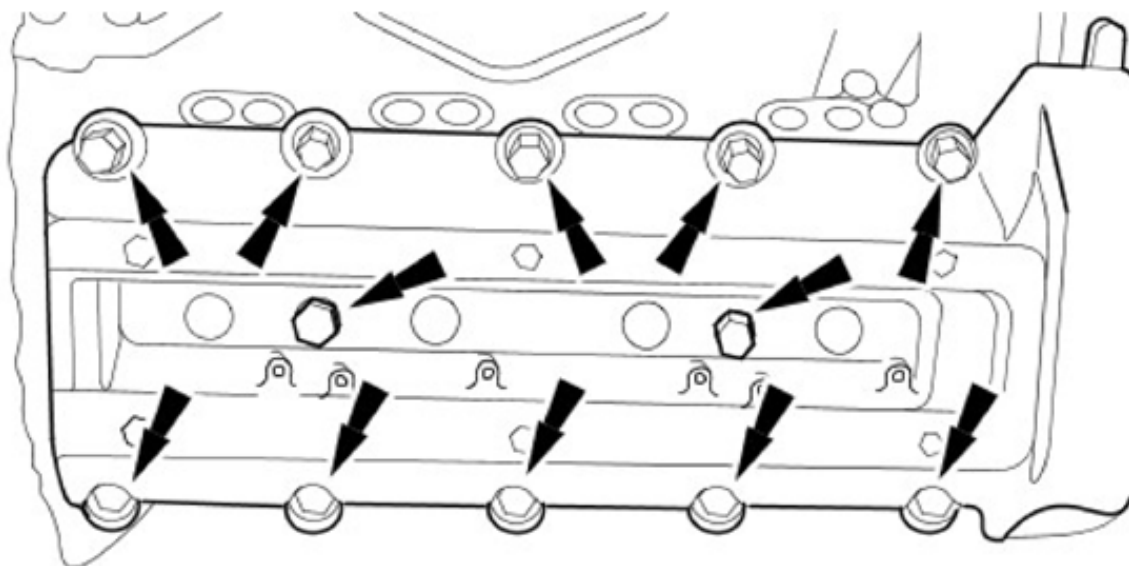


29. Disconnect the RH variable camshaft timing (VCT) oil solenoid electrical connector.



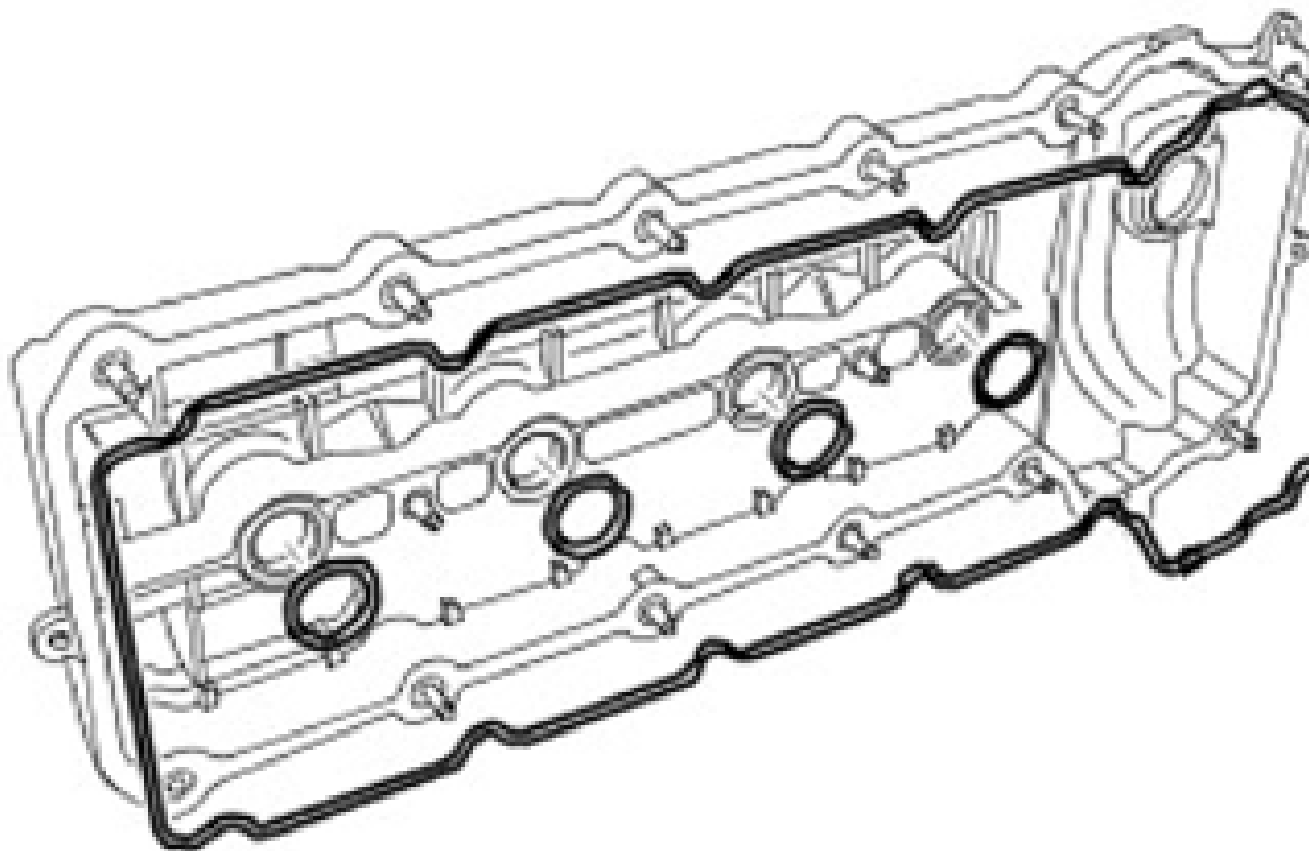
NOTE: **Note the fitted position of the retaining bolts prior to removal.**

30. Remove the RH valve cover.
- Remove the 14 valve cover retaining bolts.
 - Remove the engine cover bracket.



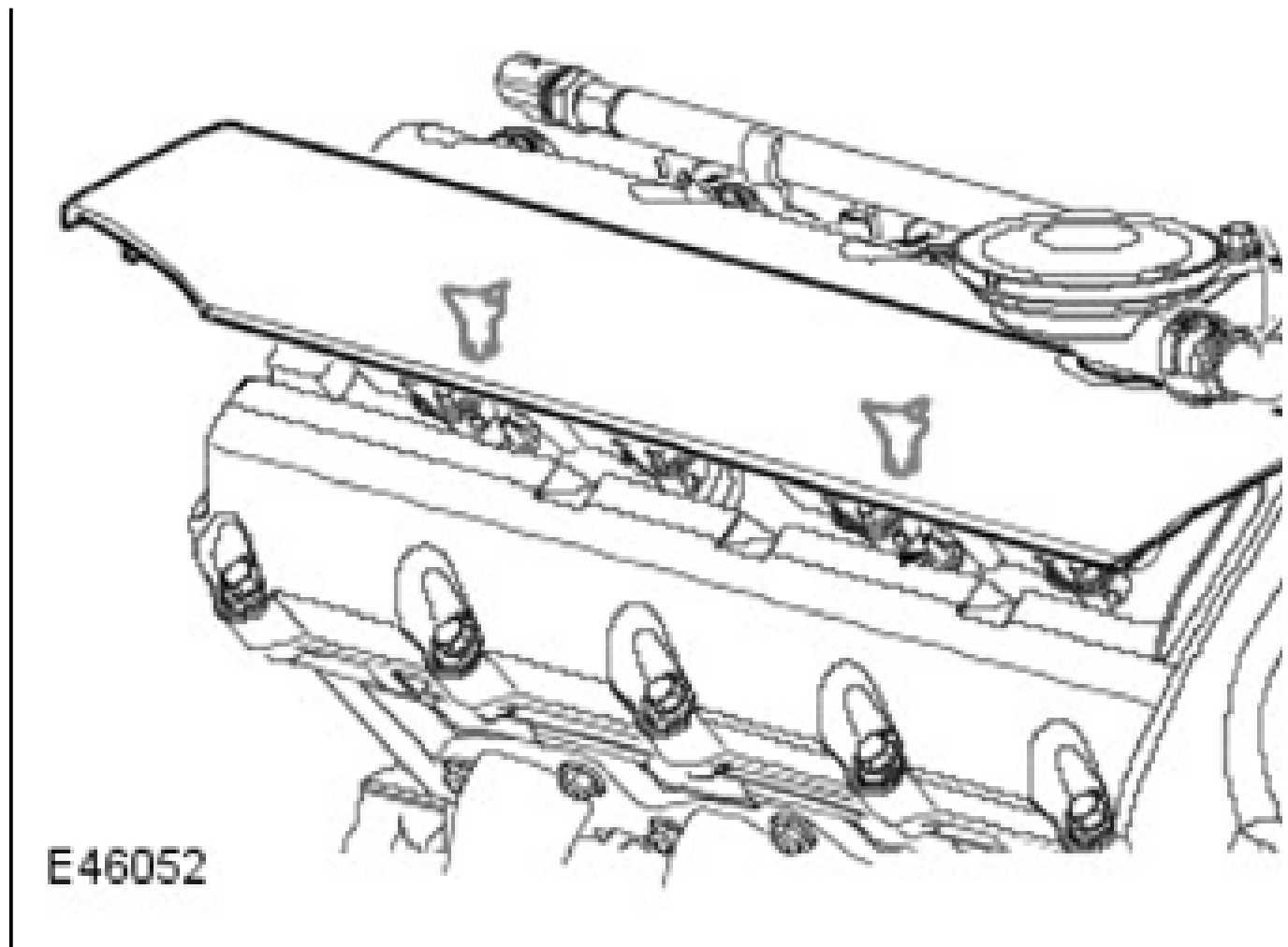
E30696

31. Remove and discard the RH valve cover gaskets.
- Remove and discard the seals.

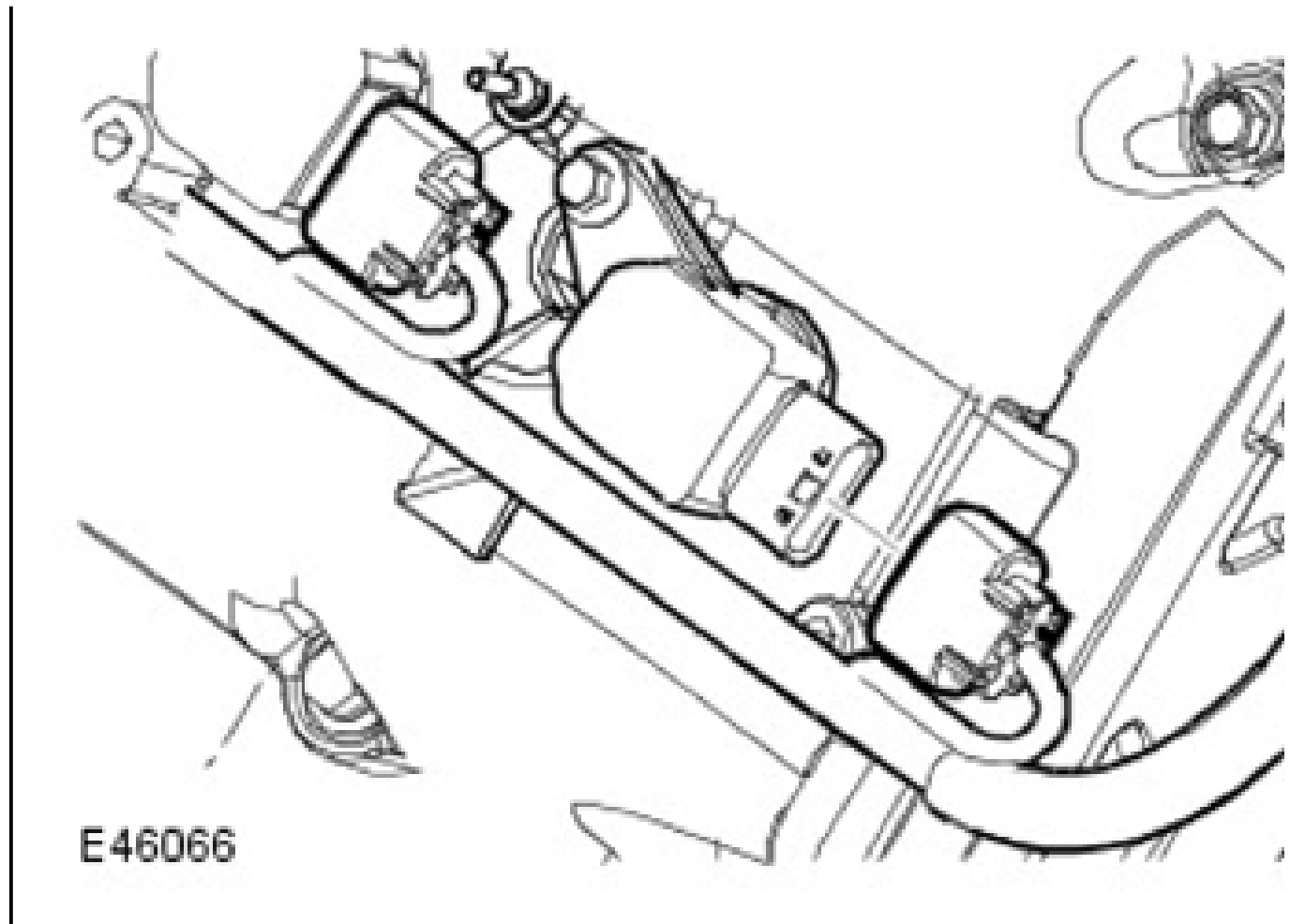


E46677

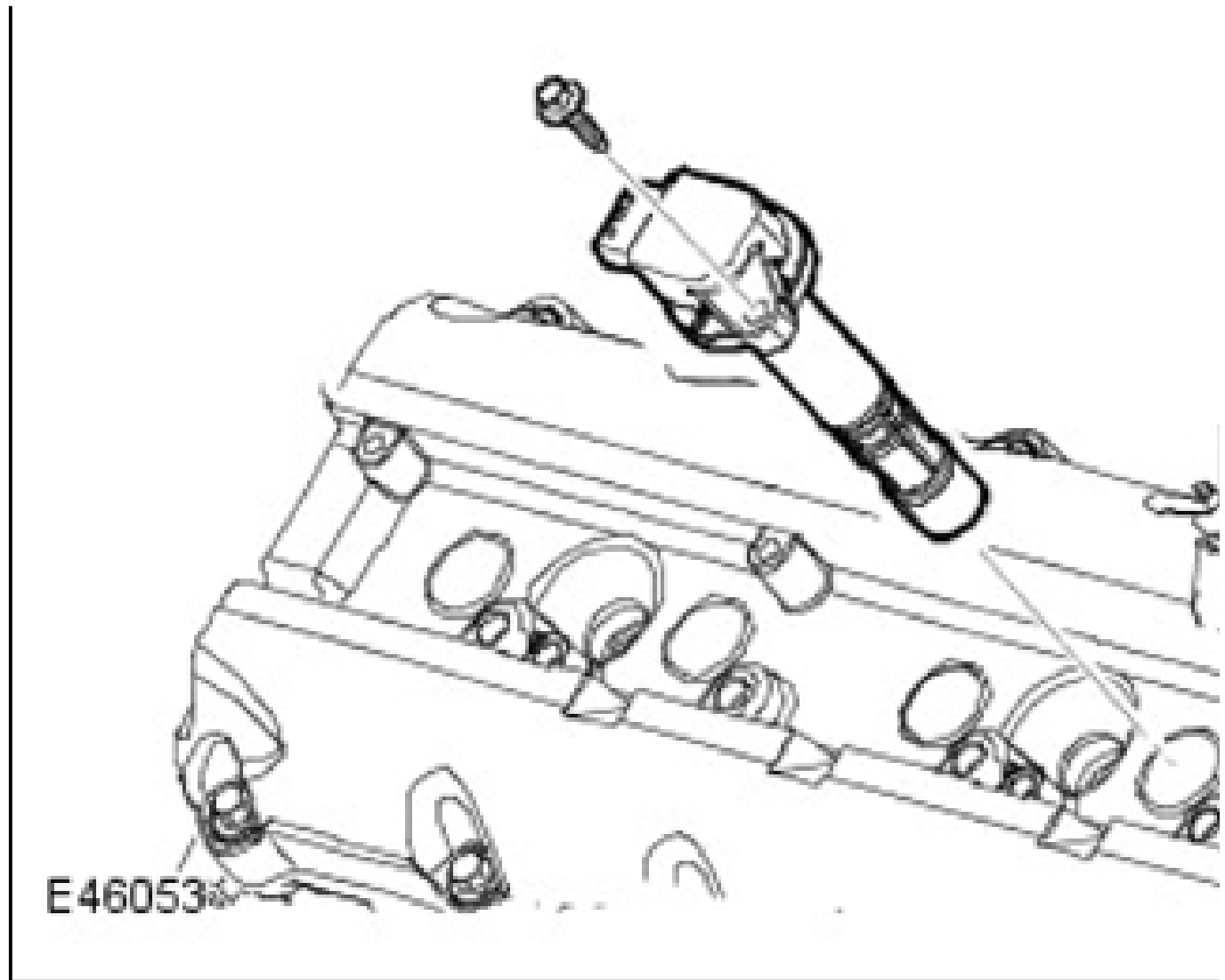
32. Remove the LH ignition coil-on-plug cover.
- Release from the 2 clips.



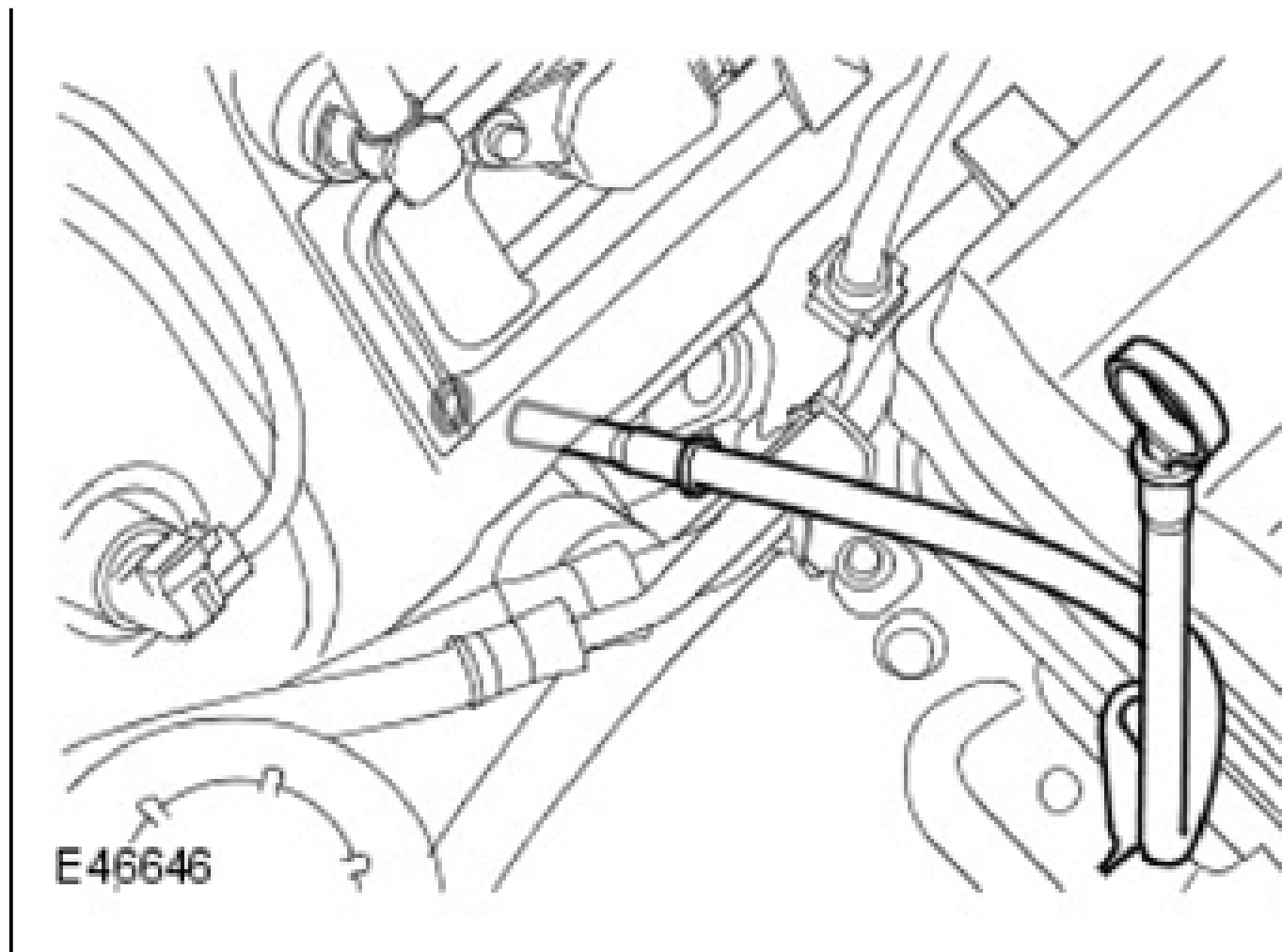
33. Disconnect the LH ignition coil-on-plug electrical connector.



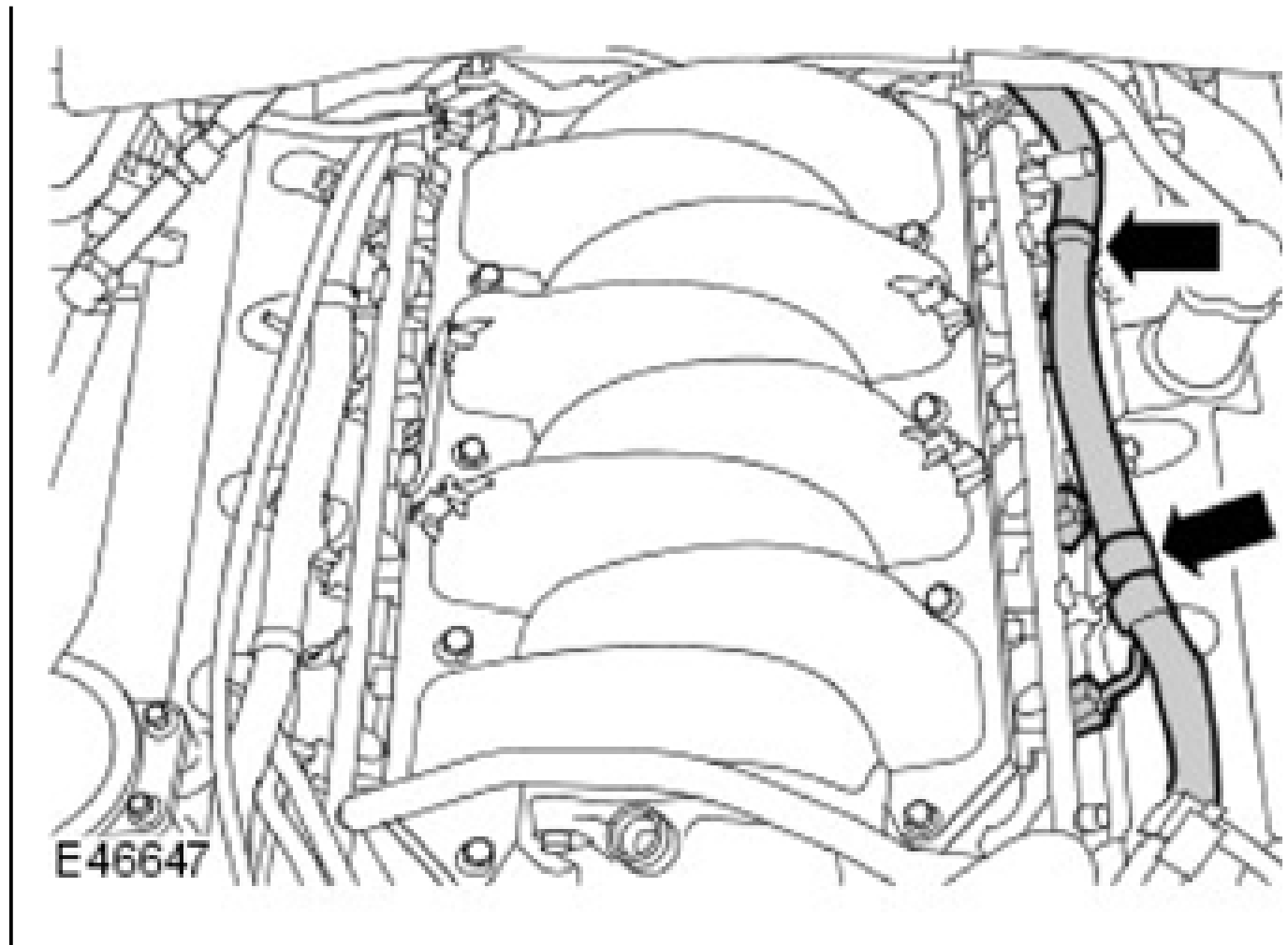
34. Remove the LH ignition coil-on-plug.
- Remove the bolt.
 - Remove and discard the seal.



35. Remove the remaining LH ignition coil-on-plugs.
36. Remove the oil level indicator and tube.
 - Remove the oil level indicator.
 - Remove the nut.
 - Remove the tube.
 - Remove and discard the O-ring seal.

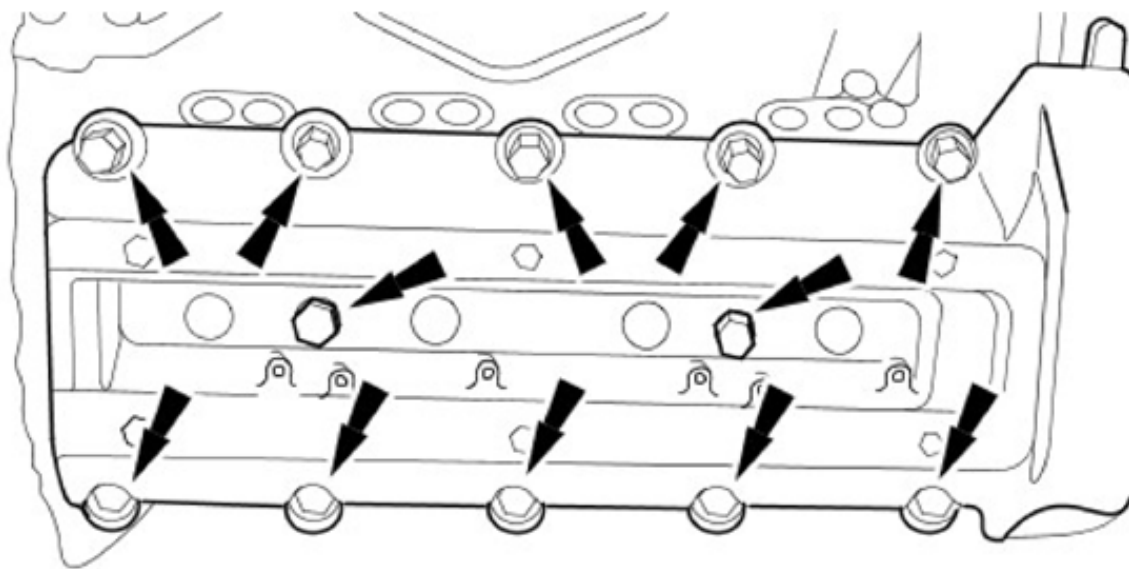


37. Release the engine wiring harness from the retaining bracket.



NOTE: Note the fitted position of the retaining bolts prior to removal.

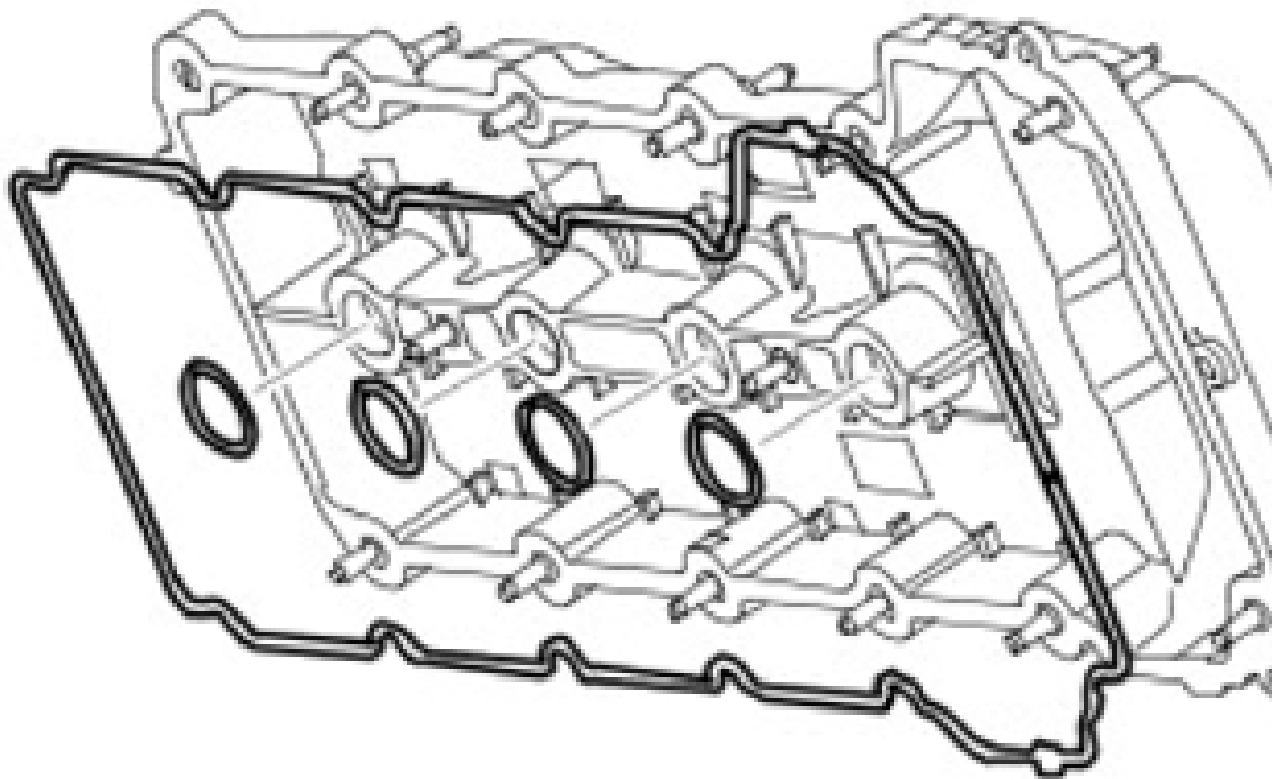
38. Remove the LH valve cover.
 - Remove the 14 valve cover retaining bolts.



E30696

39. Remove and discard the LH valve cover gaskets.

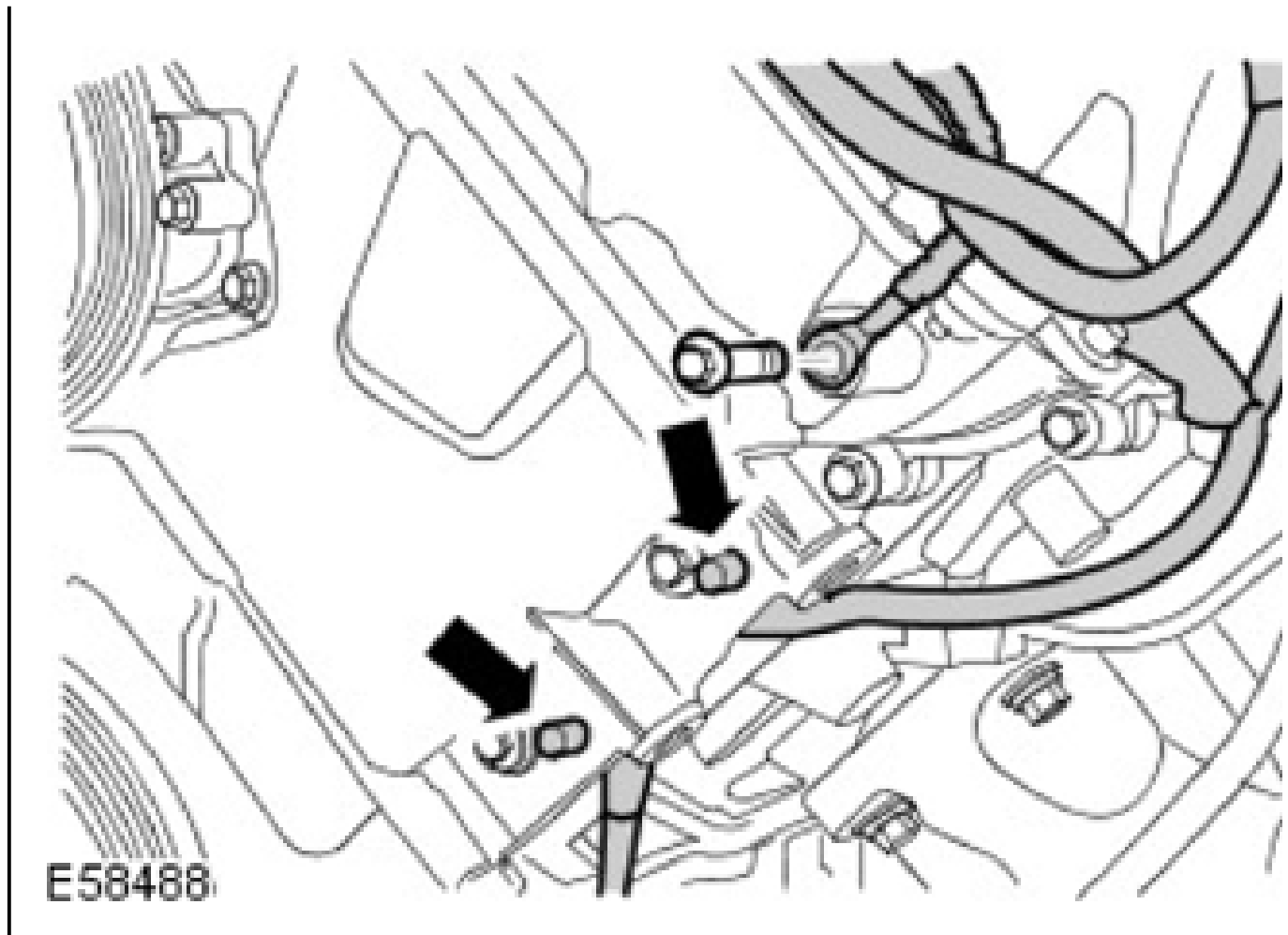
- Remove and discard the seals.



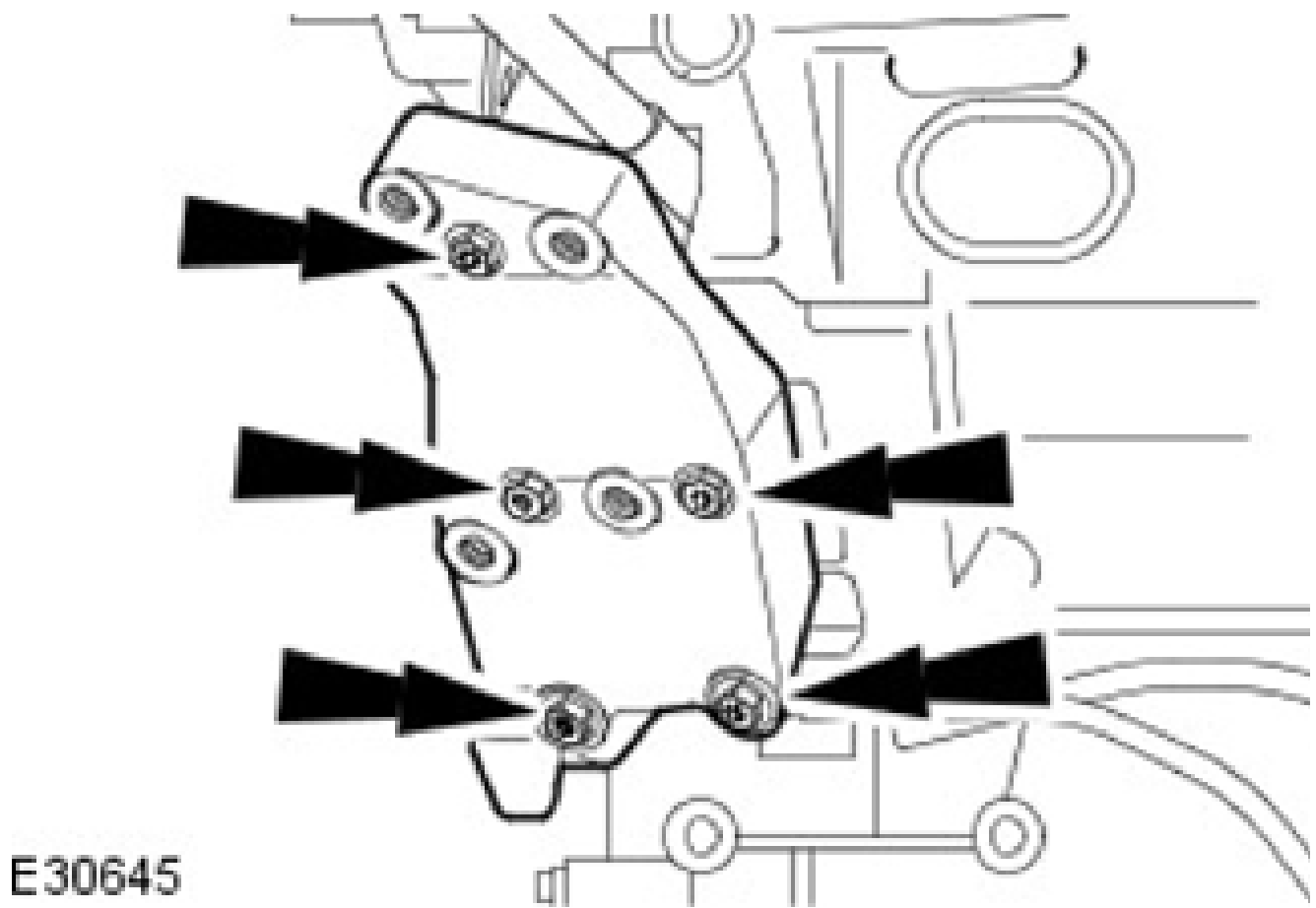
E46652

40. Release the engine wiring harness.

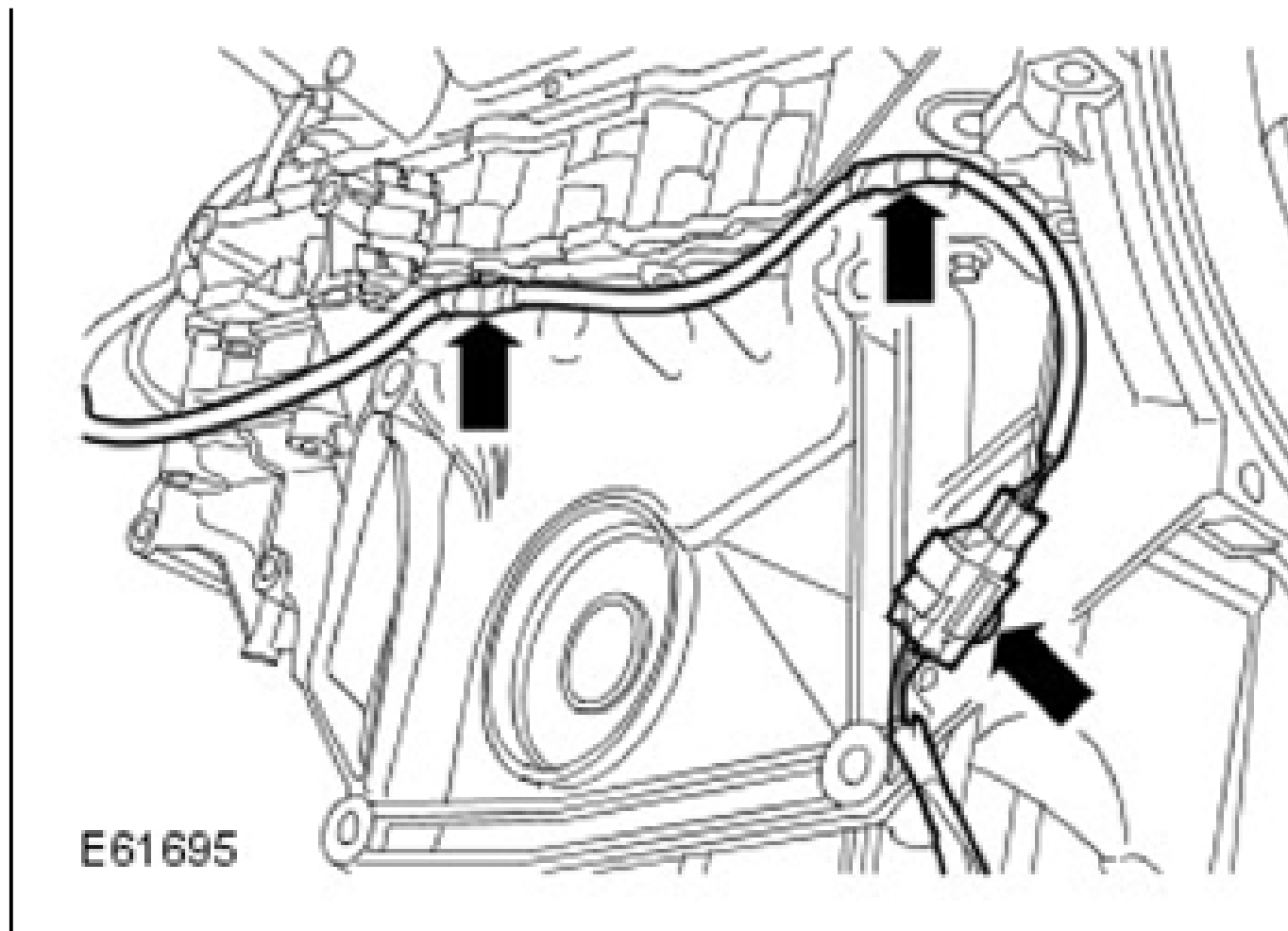
- Release the 2 clips.
- Remove the bolt.



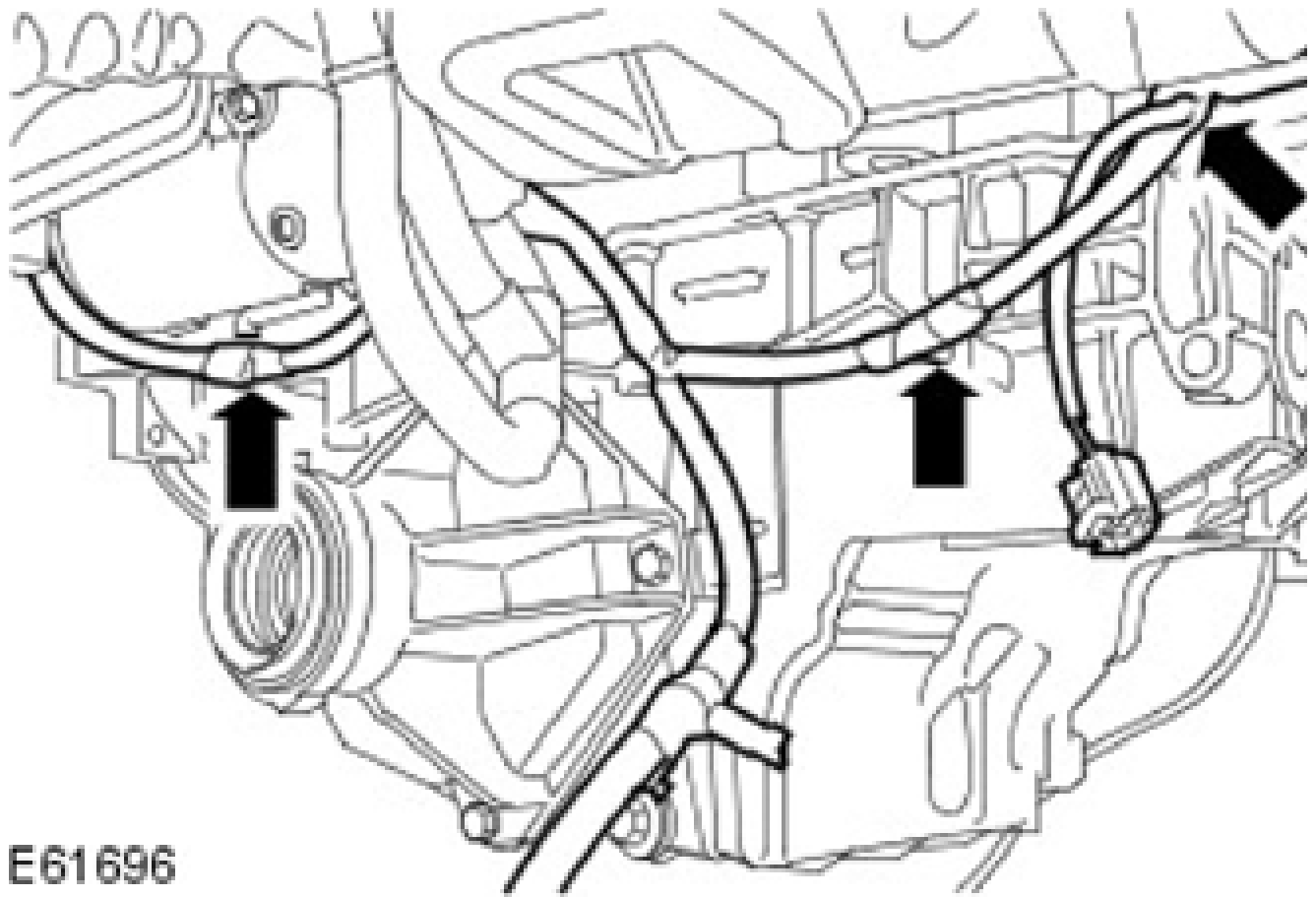
41. Remove the power steering pump mounting bracket.
- Remove the 5 bolts.



42. Release the wiring harness from the LH side of the engine.
- Release the 3 clips.

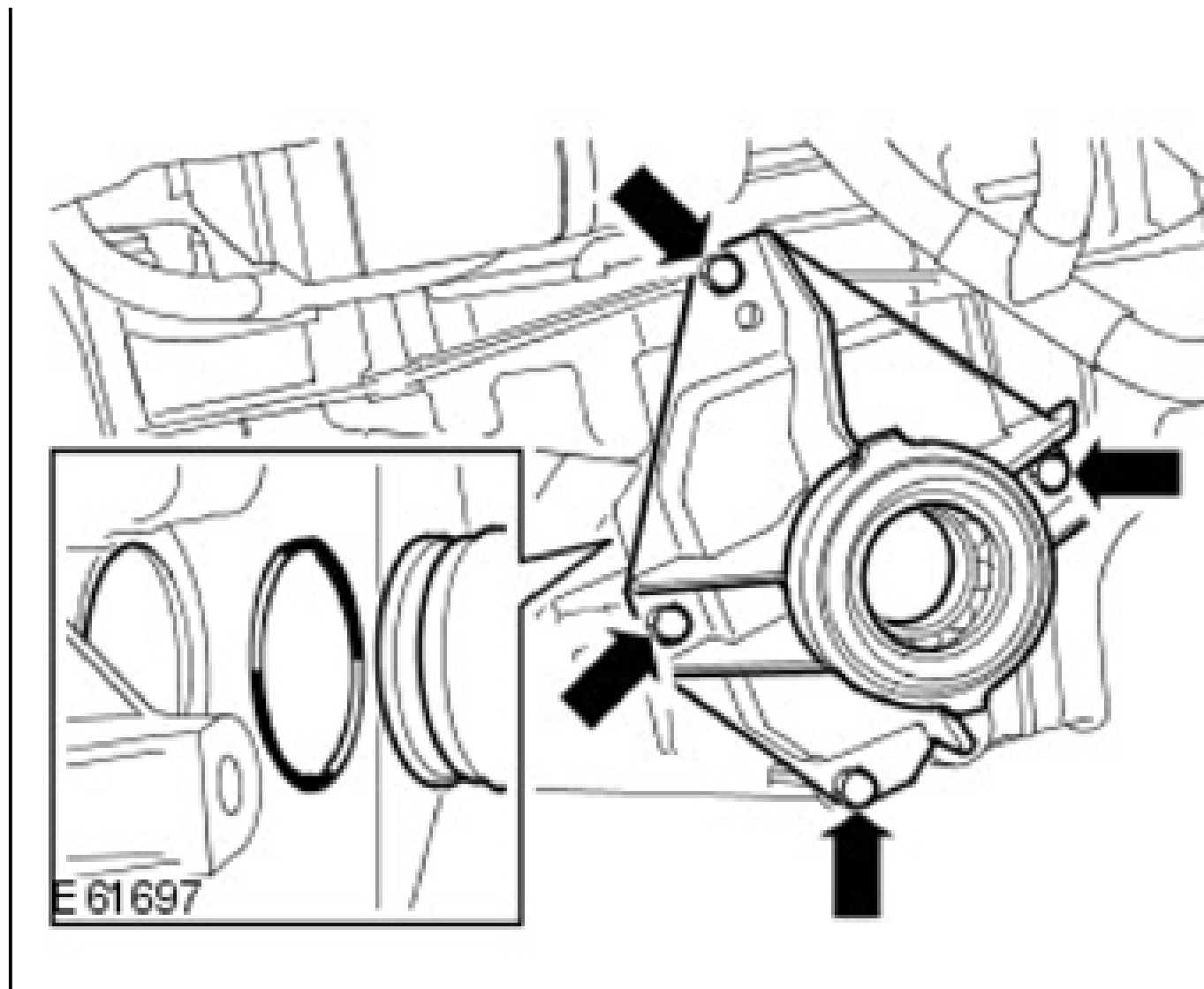


43. Release the wiring harness from the RH side of the engine.
- Release the 3 clips.

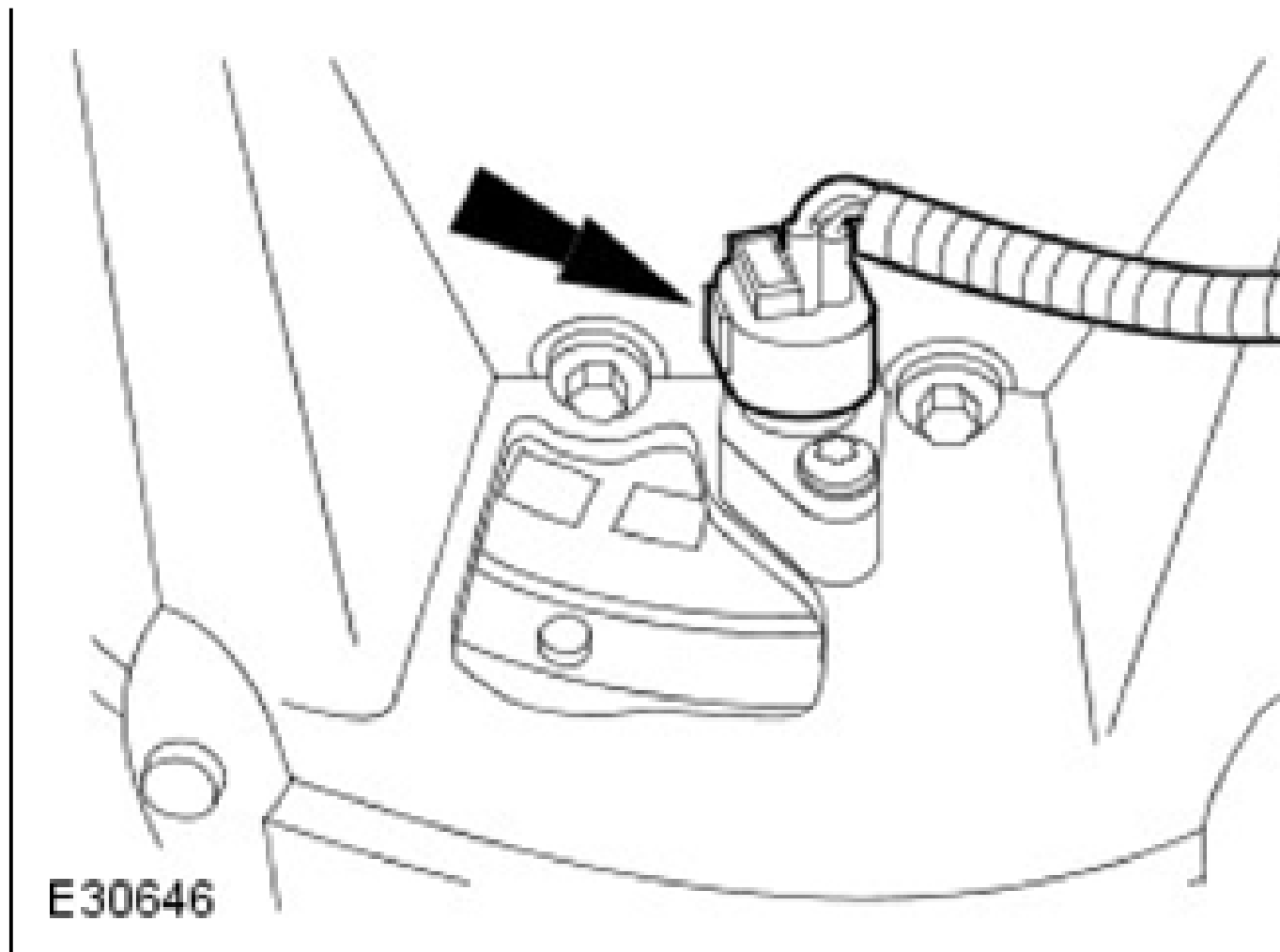


44. Remove the halfshaft support bearing housing.

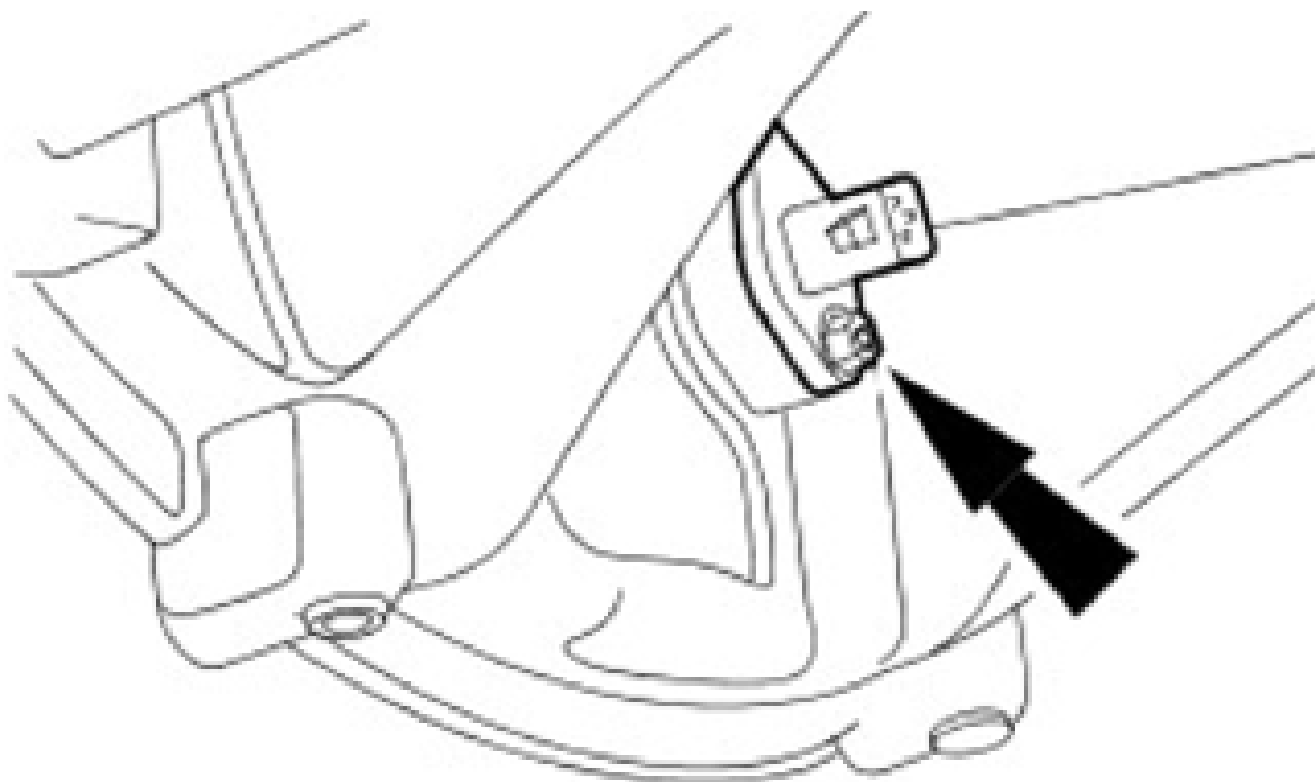
- Remove the 4 bolts.
- Remove and discard the O-ring seal.



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



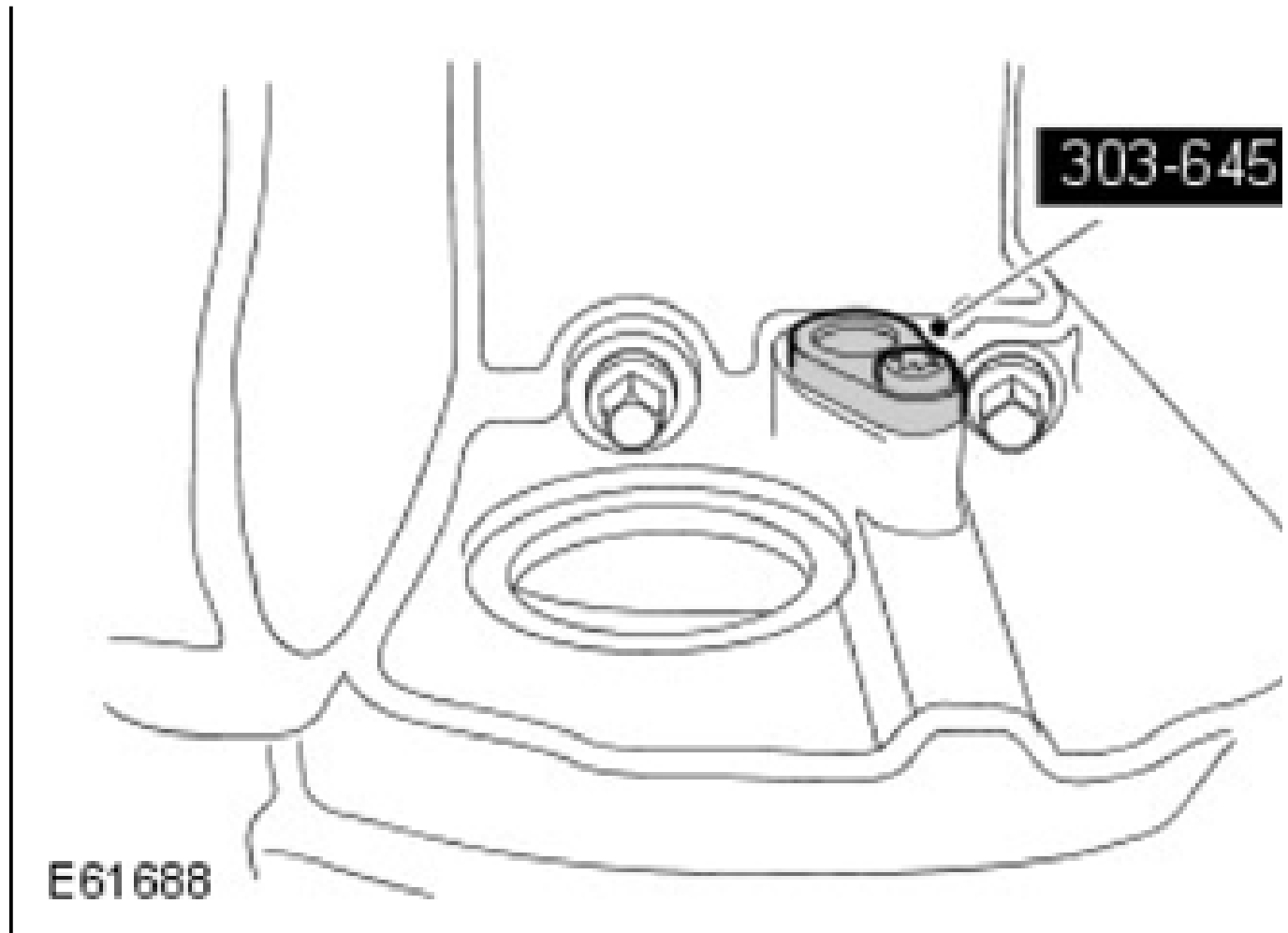
46. Remove the CKP sensor.
- Remove the bolt.



E30694

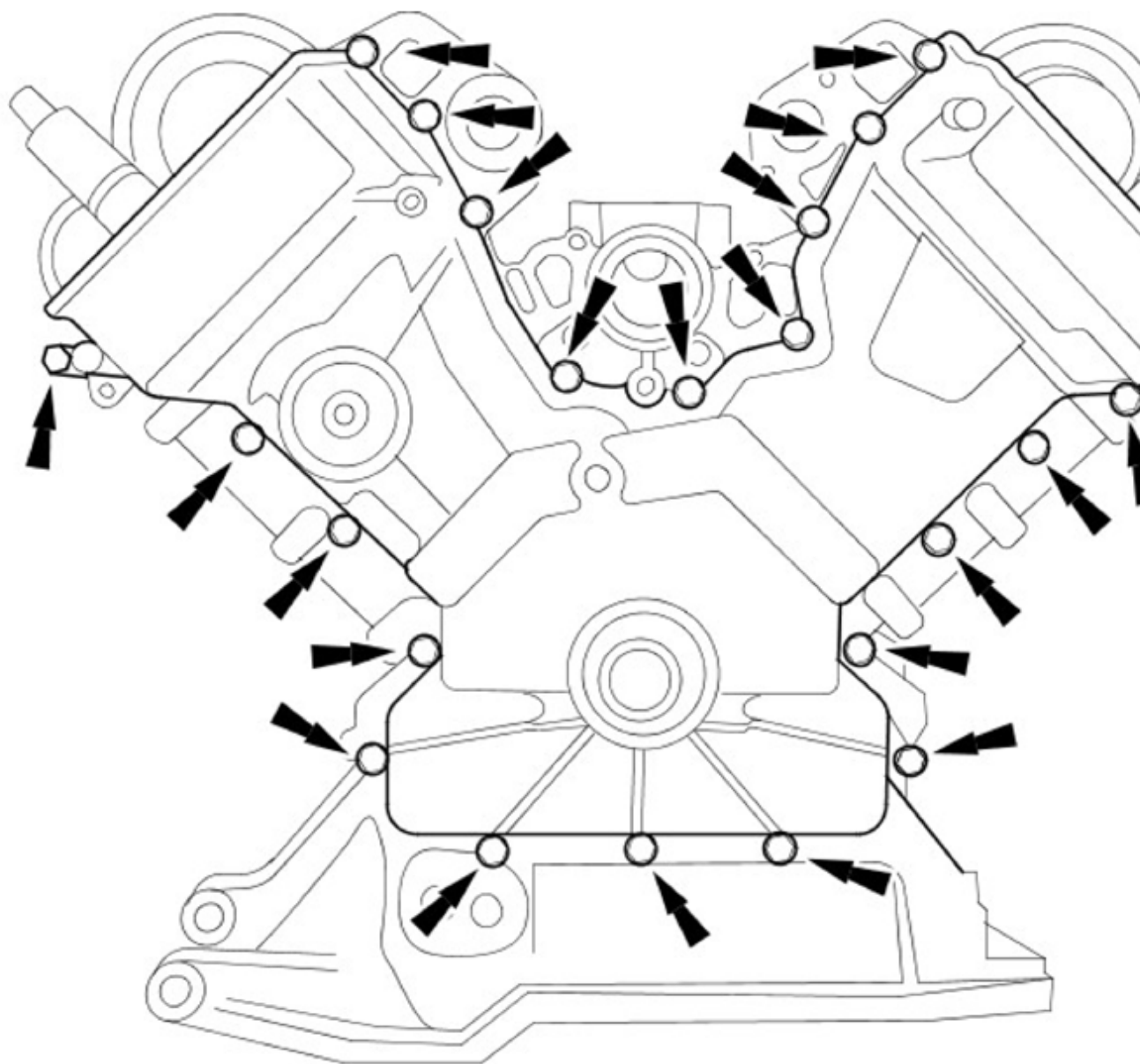
NOTE: Install the special tool to the crankshaft sensor aperture.

47. Lock the crankshaft.
 - Install the special tool.
 - Install the screw.



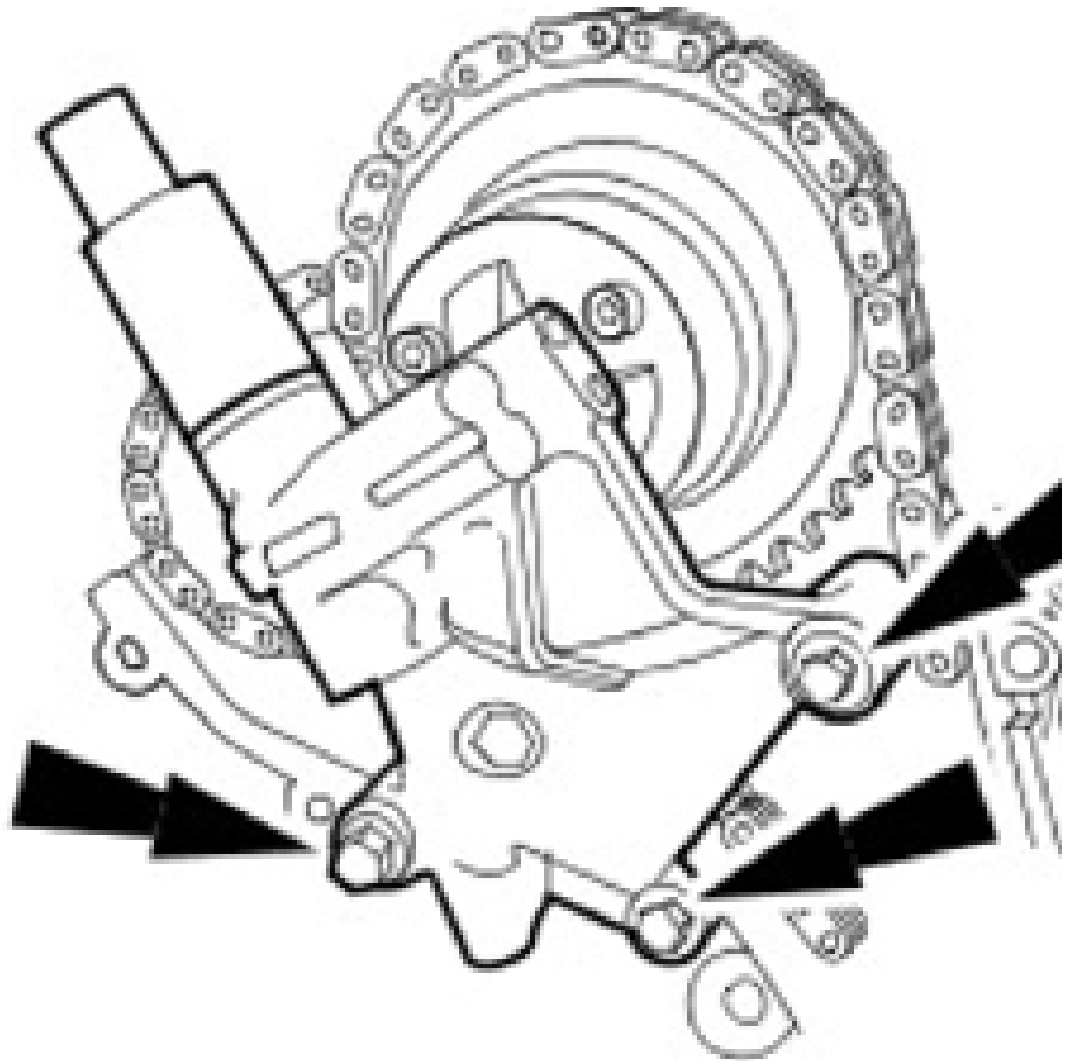
48. Remove the engine front cover.

- Remove the 24 bolts.
- Remove and discard the gasket.
- Remove and discard the 3 O-ring seals.



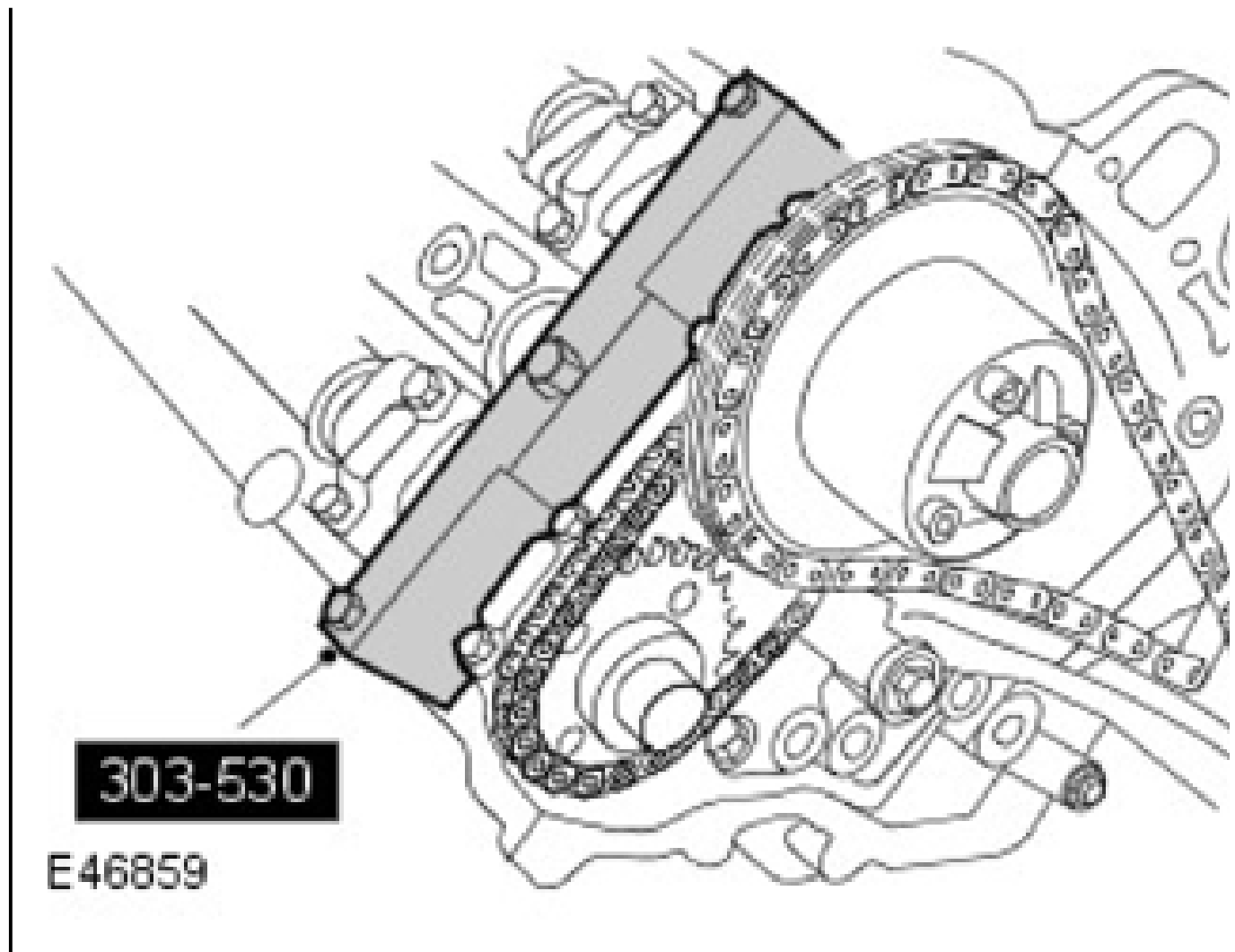
VUJ0002398

49. Remove the RH VCT housing.
 - Remove the 3 bolts.
 - Remove and discard the O-ring seals.

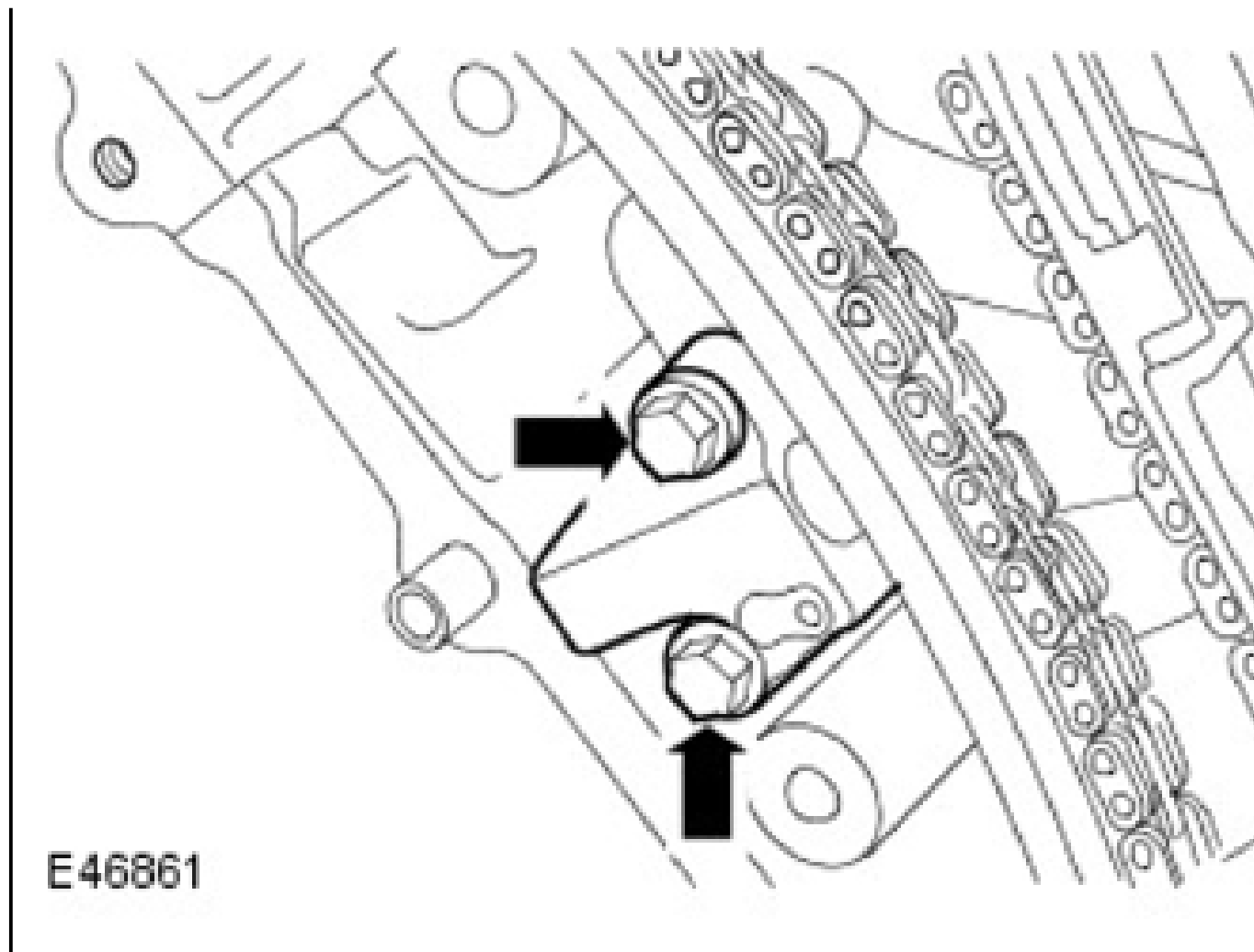


E30699

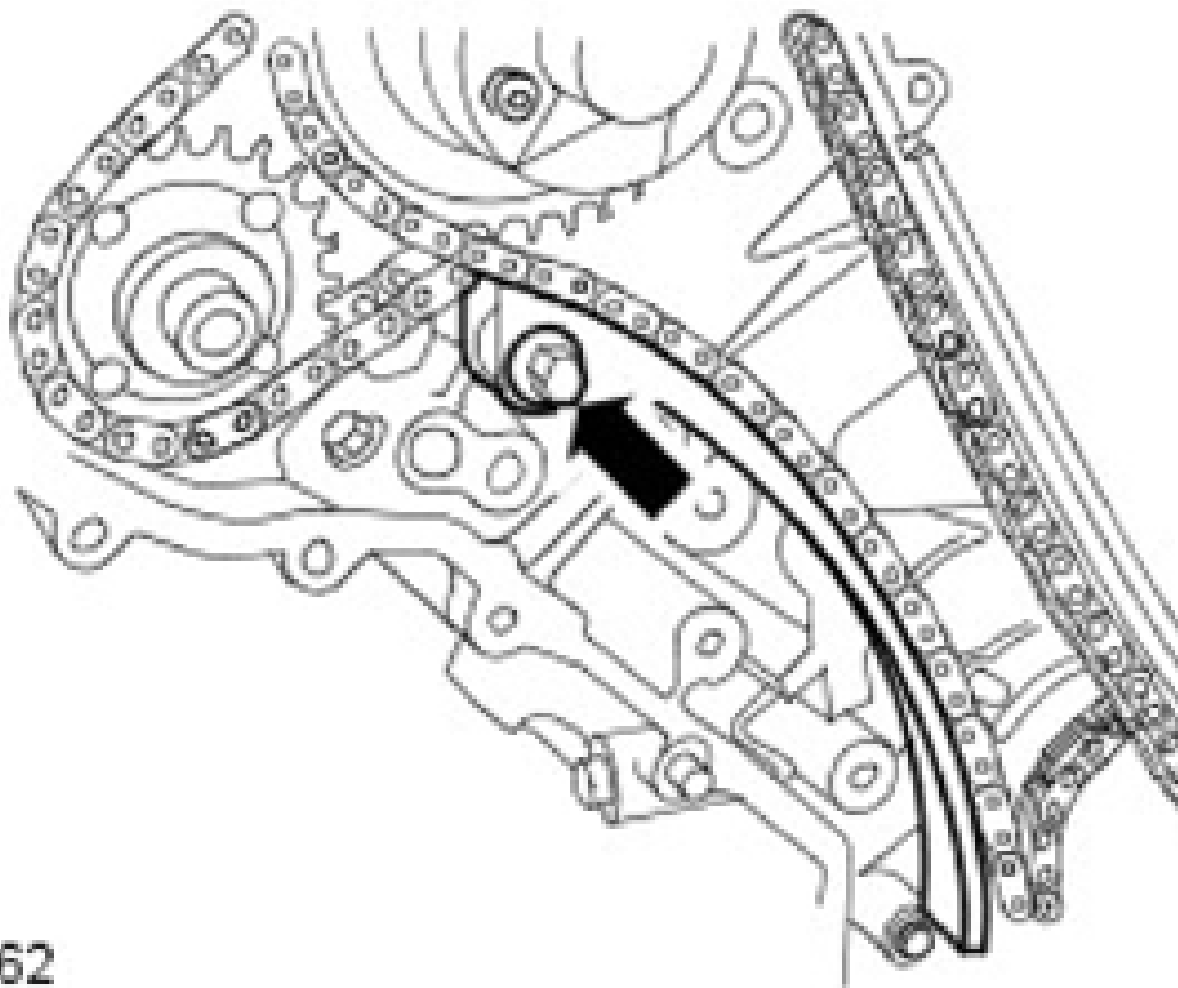
50. Install the special tool to the RH cylinder head.
- Install the 3 bolts.



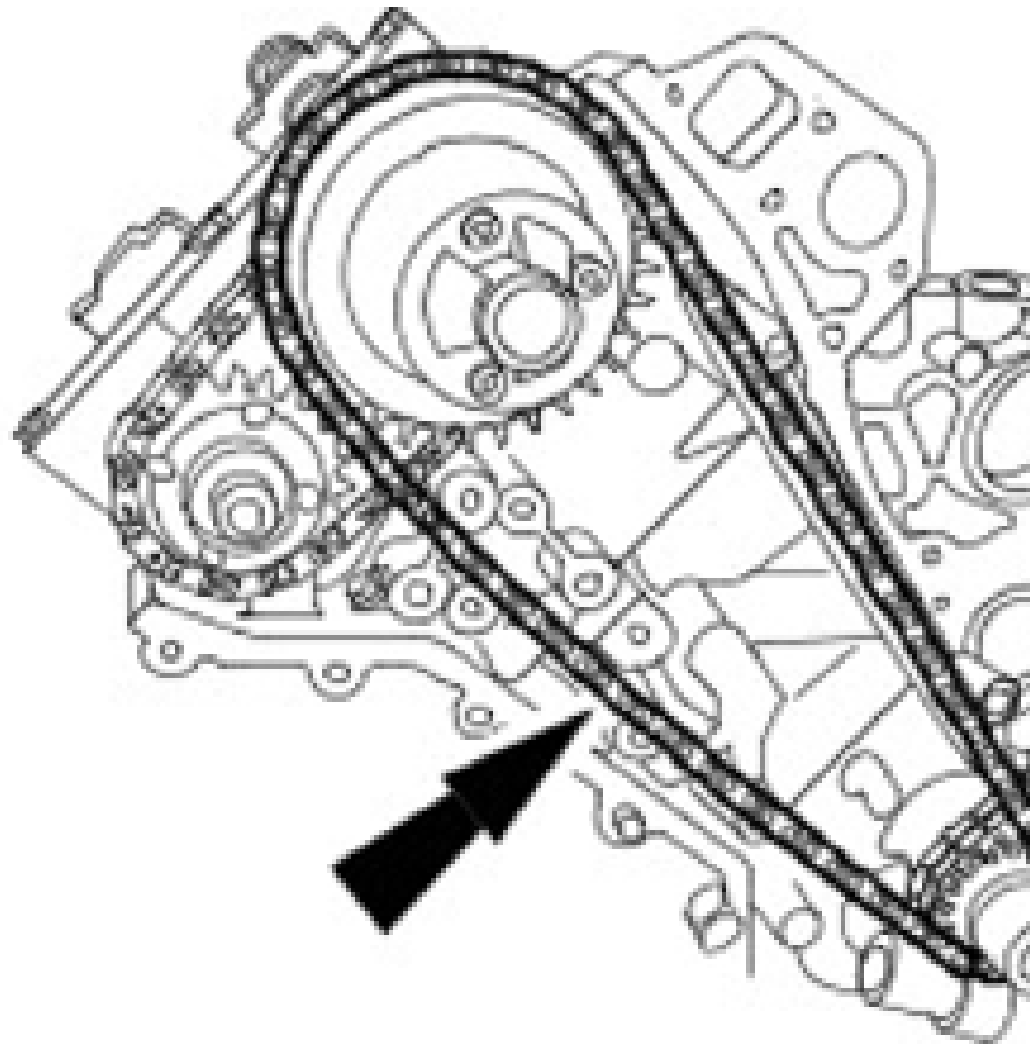
51. Remove the RH primary timing chain tensioner assembly.
- Remove the 2 bolts.



52. Remove the RH primary timing chain tensioner guide.
- Remove the bolt.

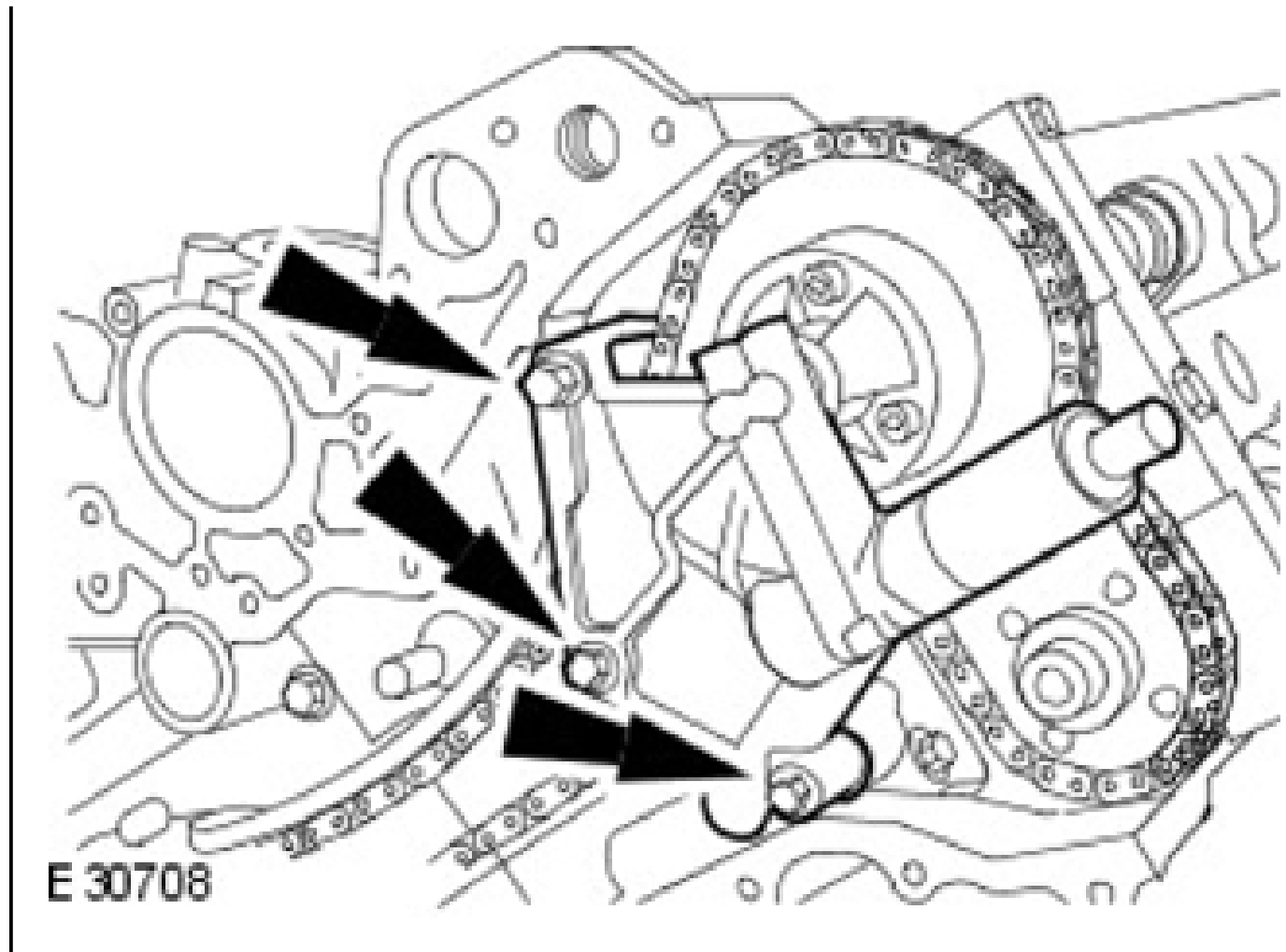


53. Remove the RH primary timing chain.

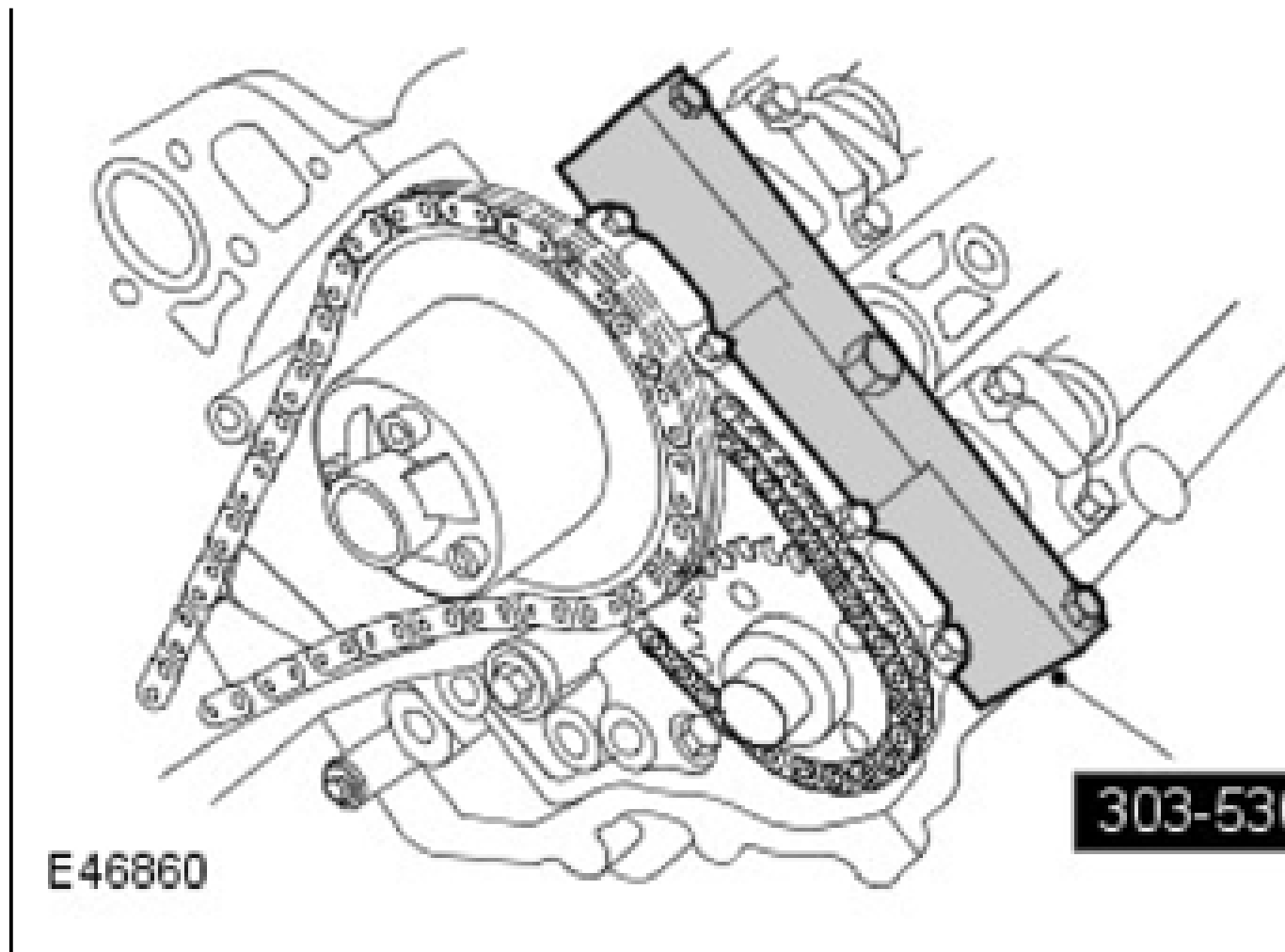


E30703

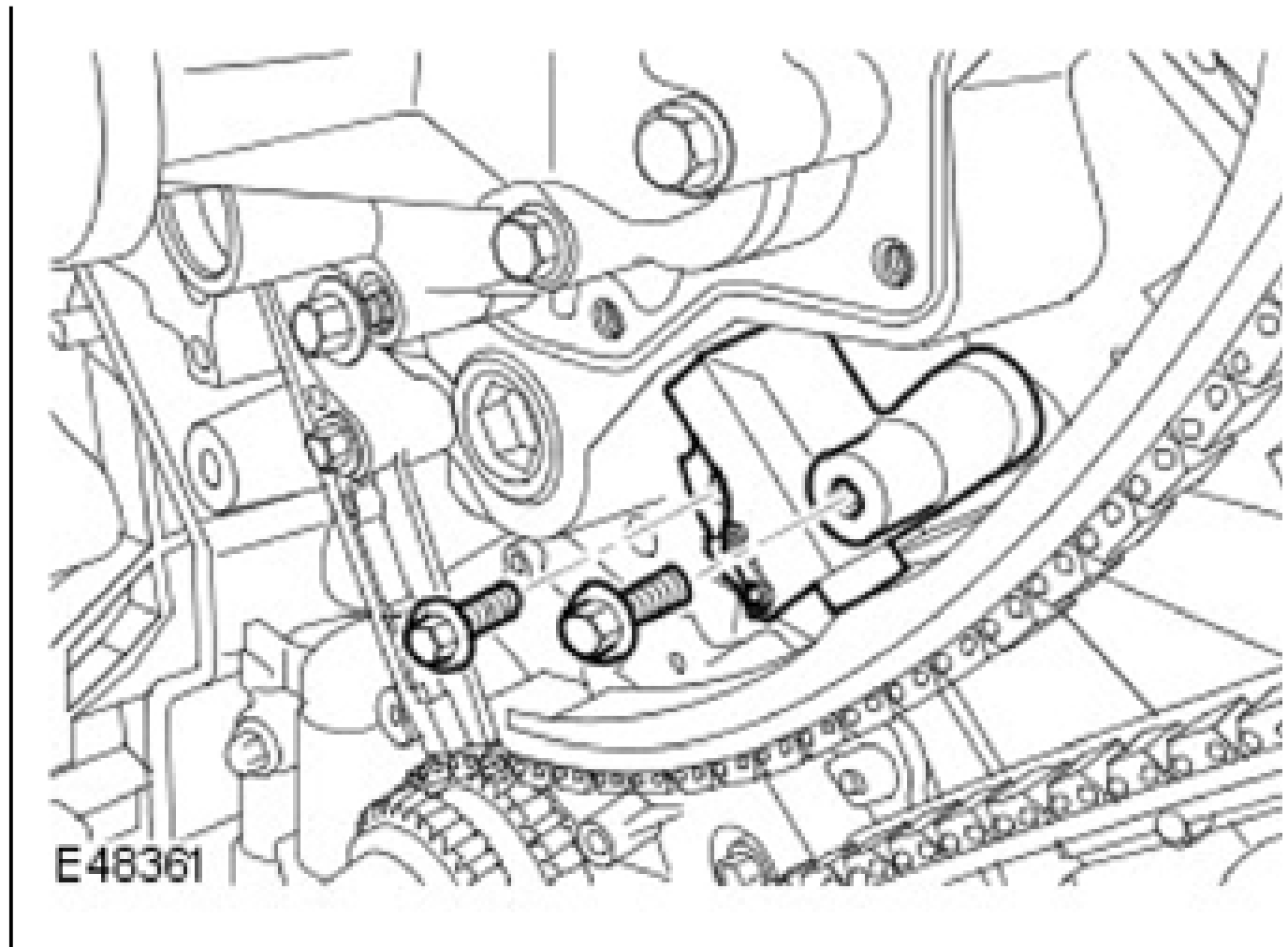
54. Remove the LH VCT housing.
- Remove the 3 bolts.
 - Remove and discard the O-ring seals.



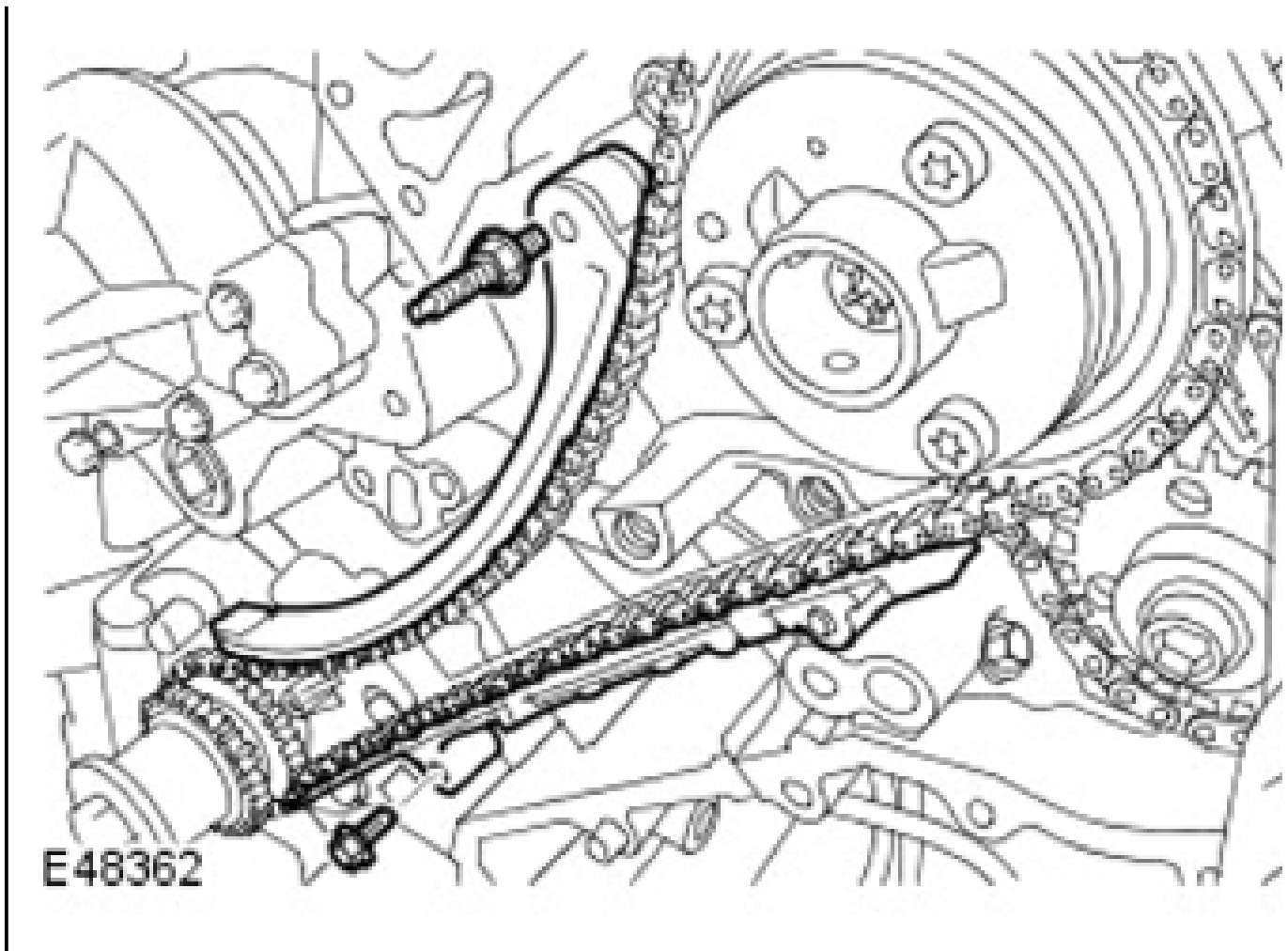
55. Install the special tool to the LH cylinder head.
- Install the 3 bolts.



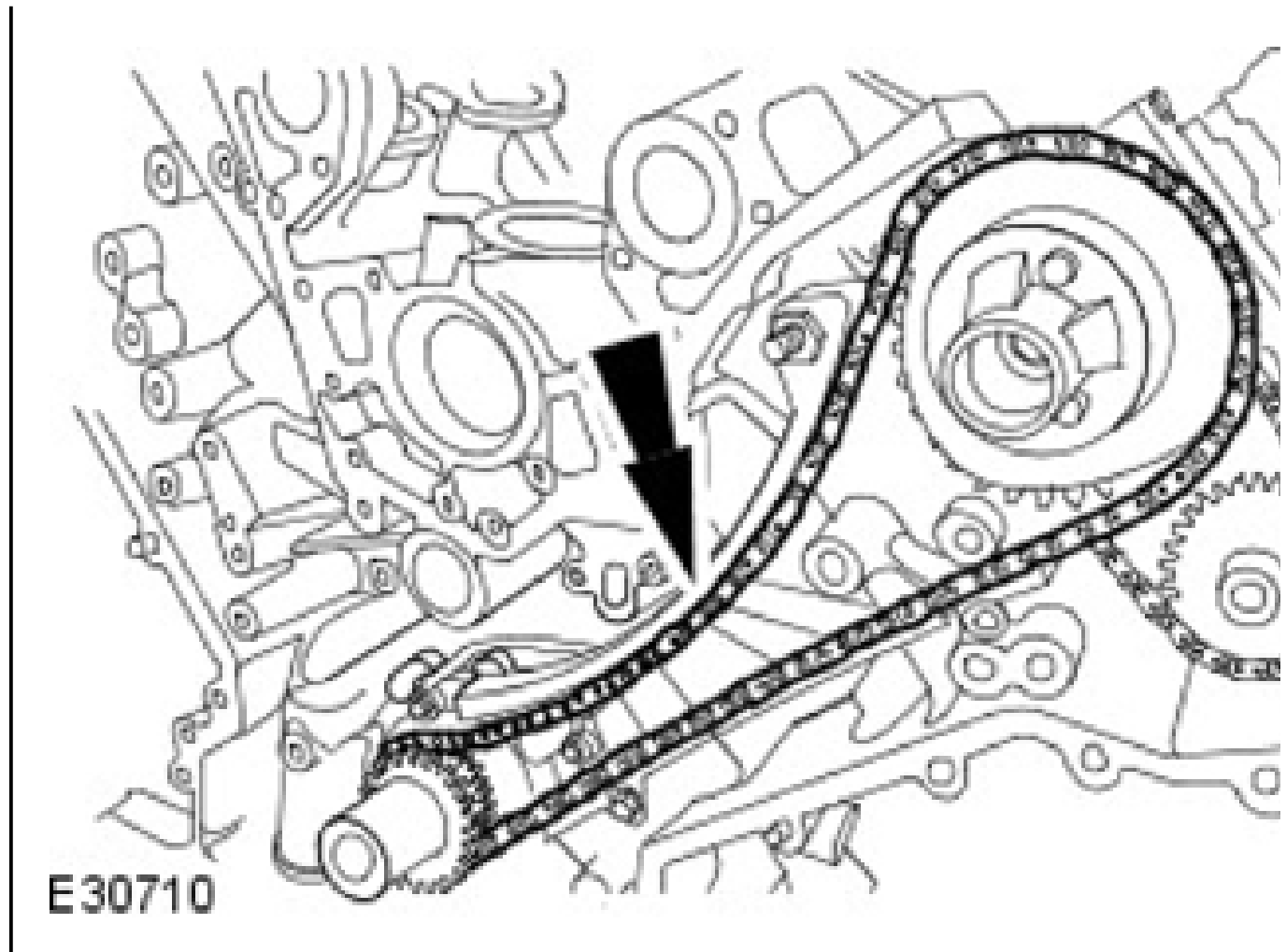
56. Remove the LH primary timing chain tensioner.
- Remove the 2 bolts.



57. Remove the LH upper and lower primary timing chain tensioner guides.
- Remove the 2 bolts.

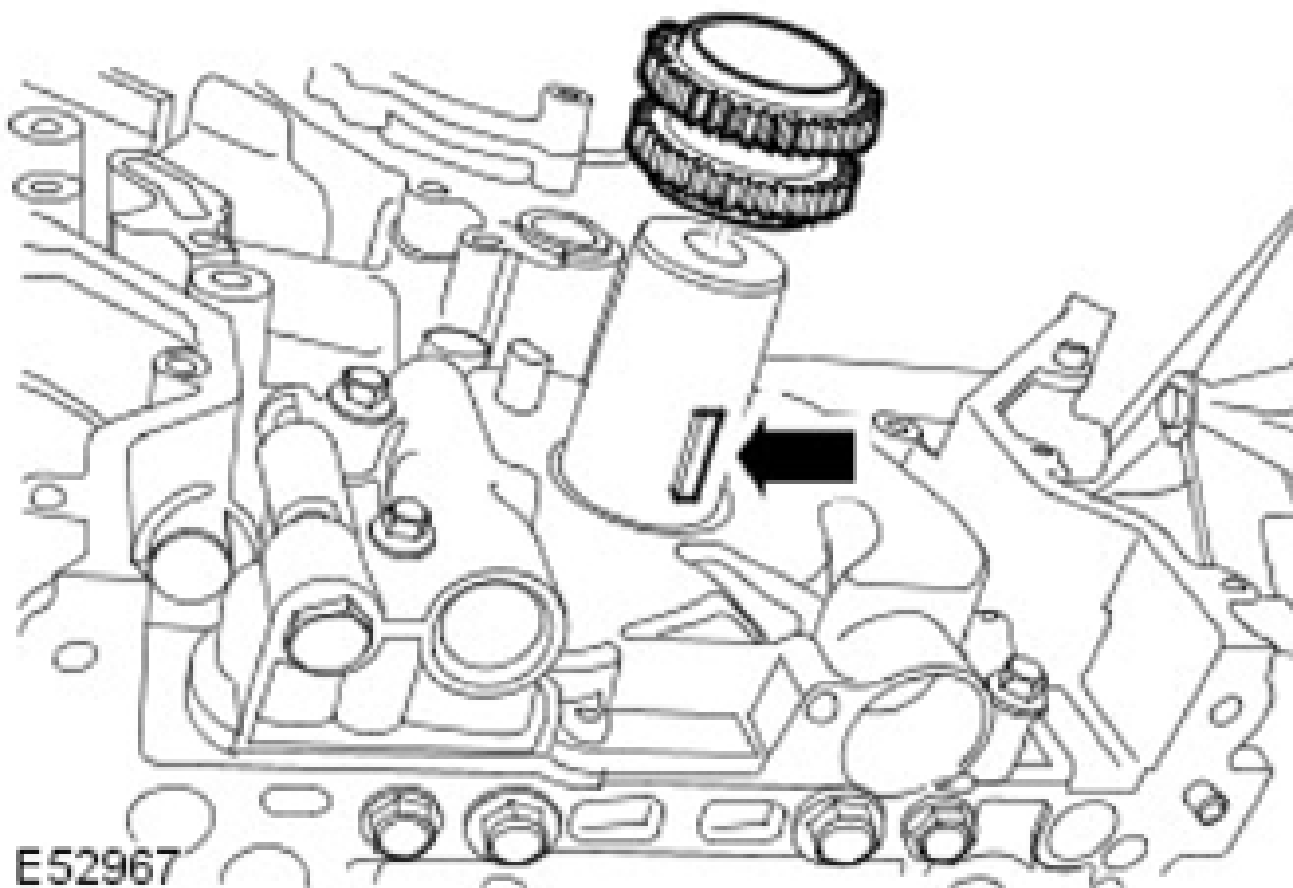


58. Remove the LH primary timing chain.

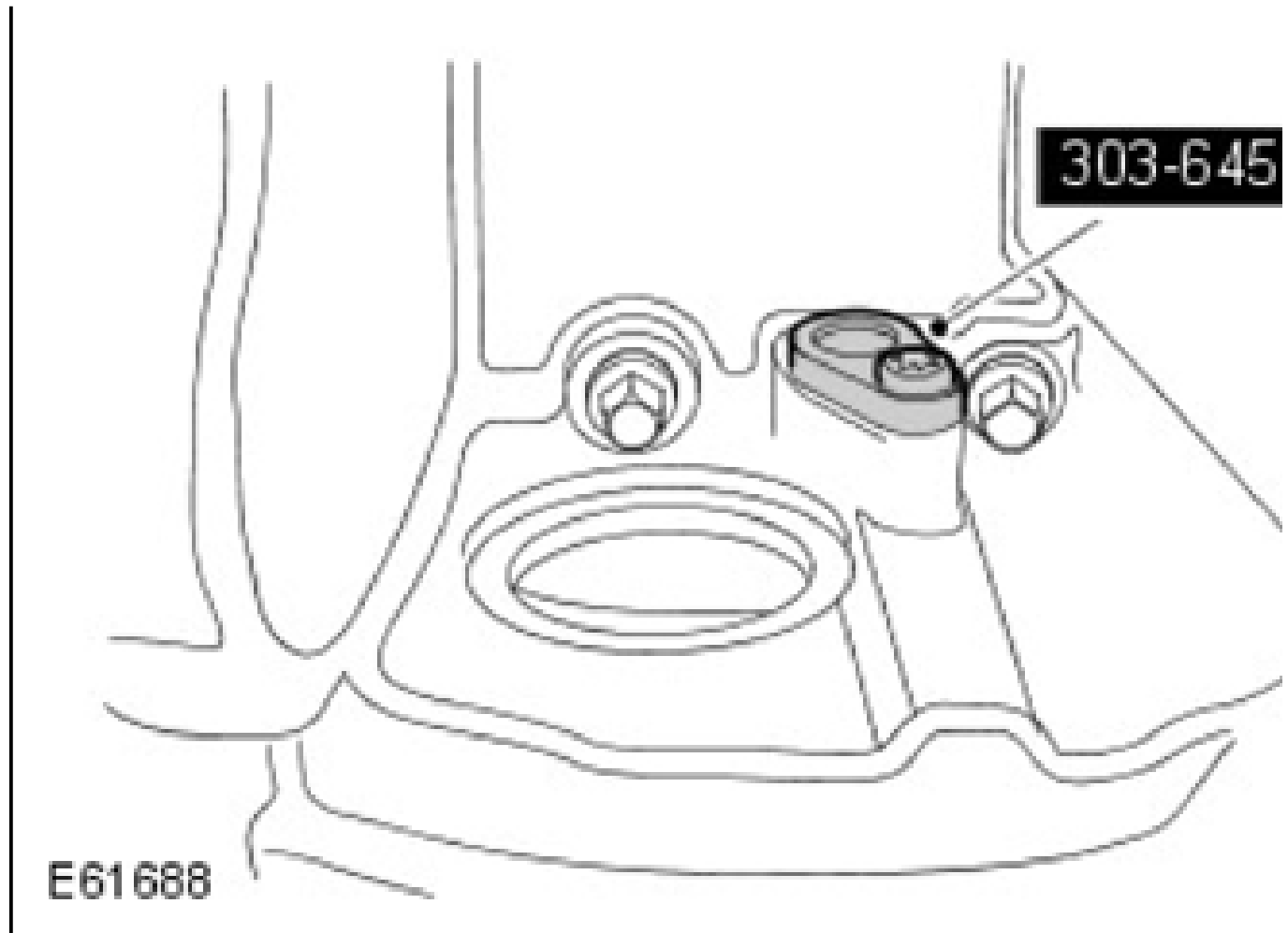


NOTE: **Note the orientation of the crankshaft sprocket.**

59. Remove the crankshaft sprocket.
 - Remove the crankshaft sprocket key.



60. Remove the special tool.



CAUTION: The bolts can only be used 3 times, mark the bolts with a center punch. If 2 punch marks are visible, discard the bolts.

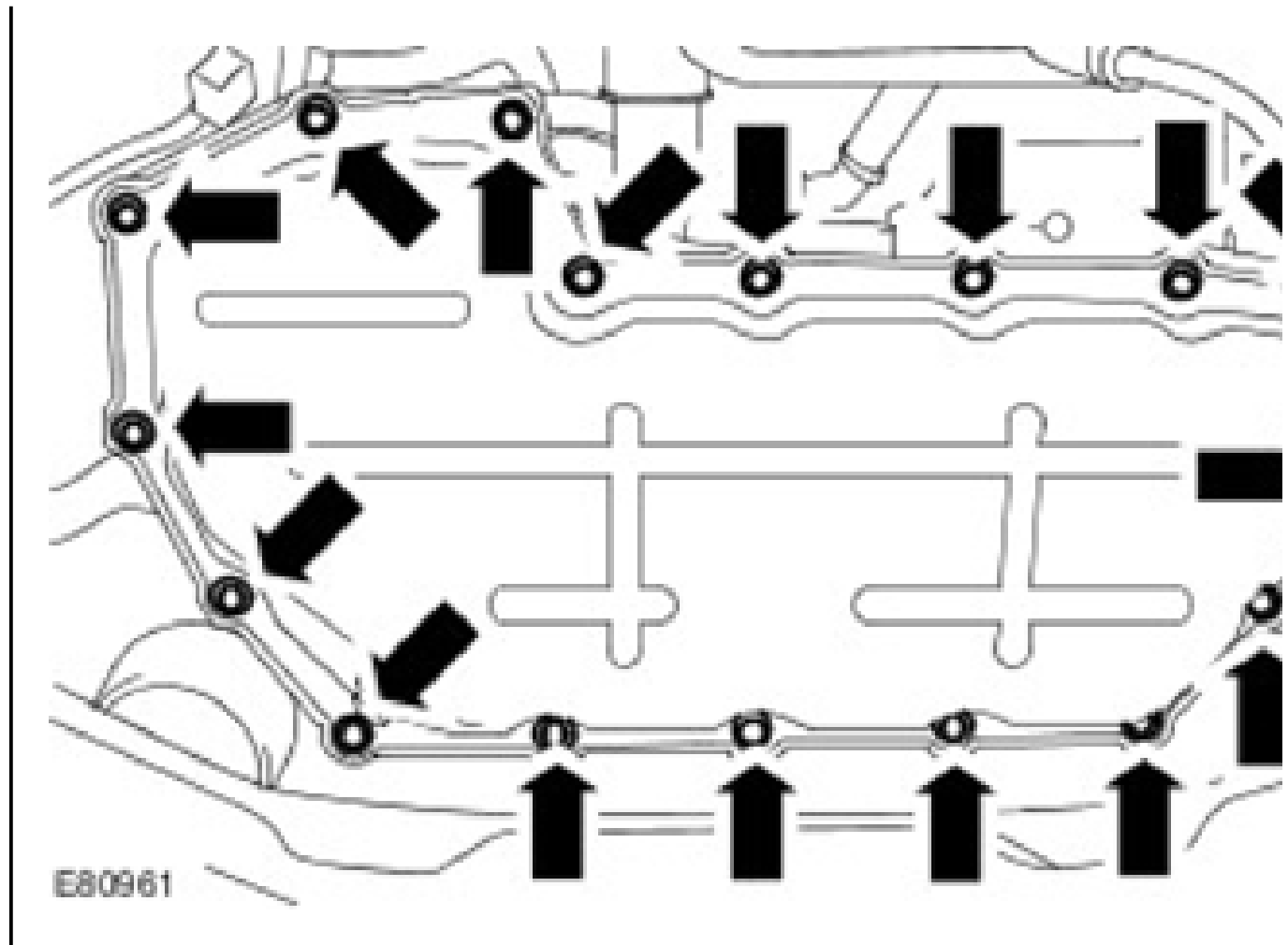
61. Remove the torque converter flexplate.
 - Remove the 8 bolts.



CAUTION: Note the position of the bolts, prior to removal.

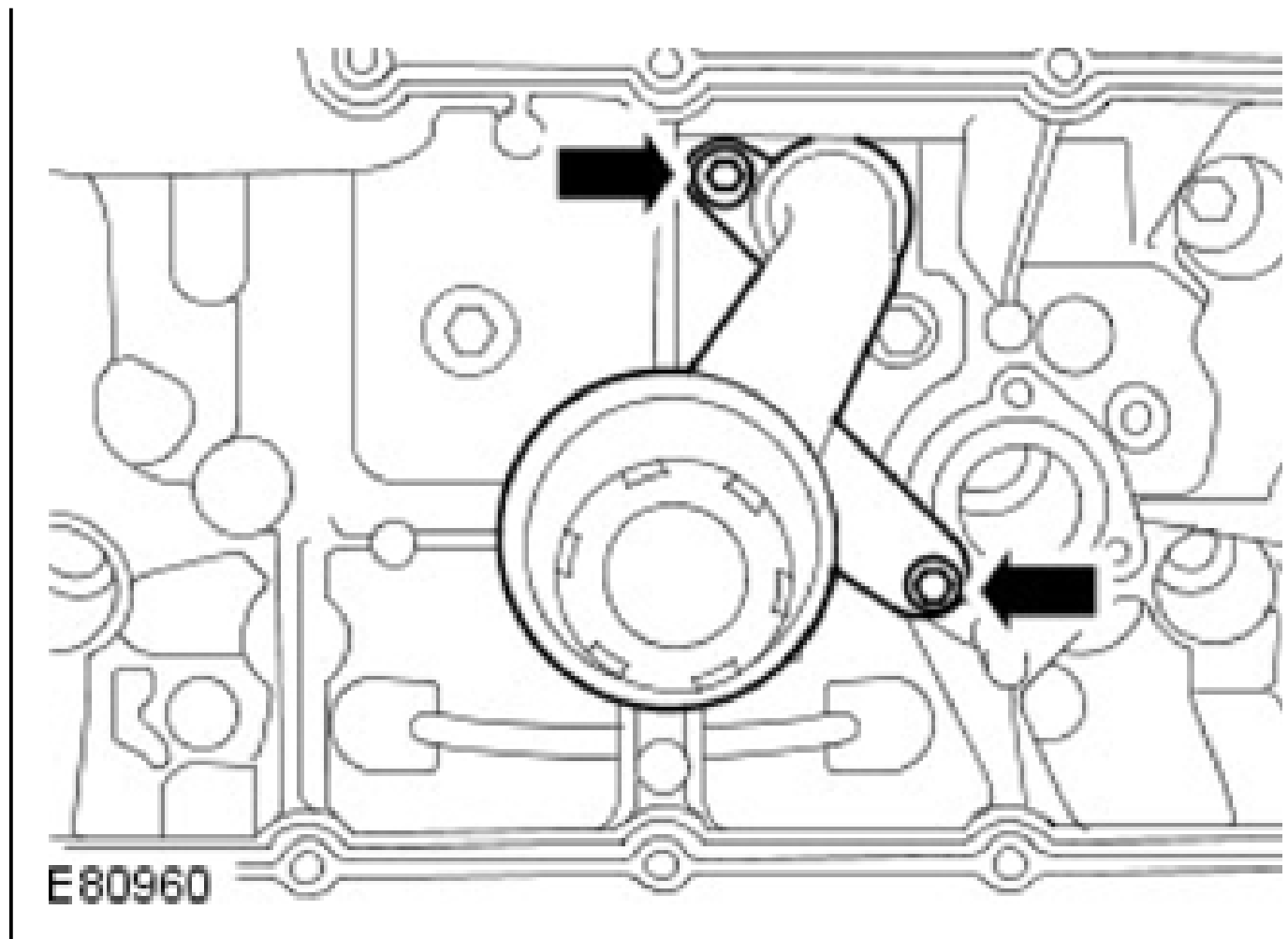
62. Remove the oil pan.

- Remove the 17 bolts.
- Remove and discard the gasket.

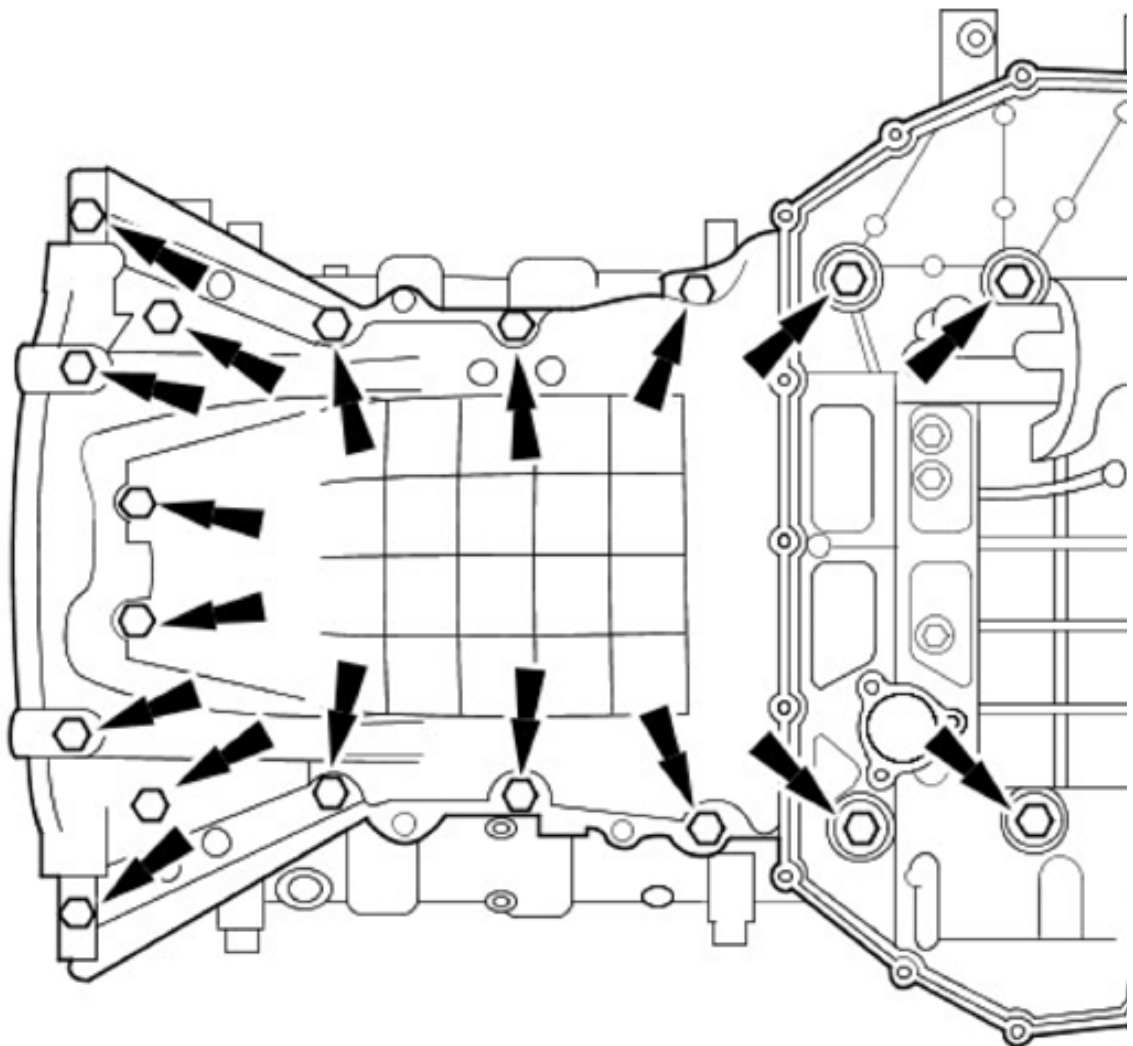


63. Remove the oil strainer pick-up assembly.

- Remove the 2 bolts.
- Remove and discard the O-ring seal.

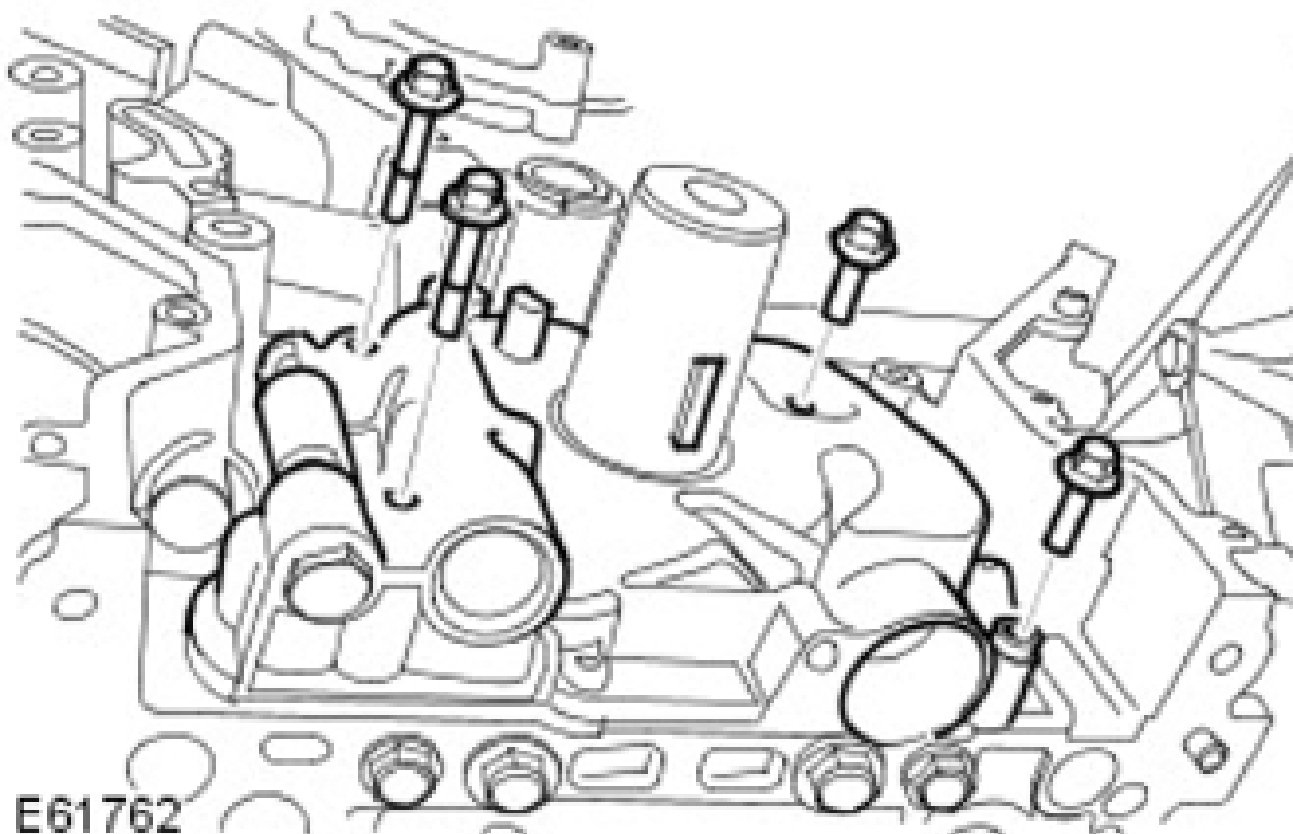


64. Remove the oil pan extension.
- Remove the 18 bolts.

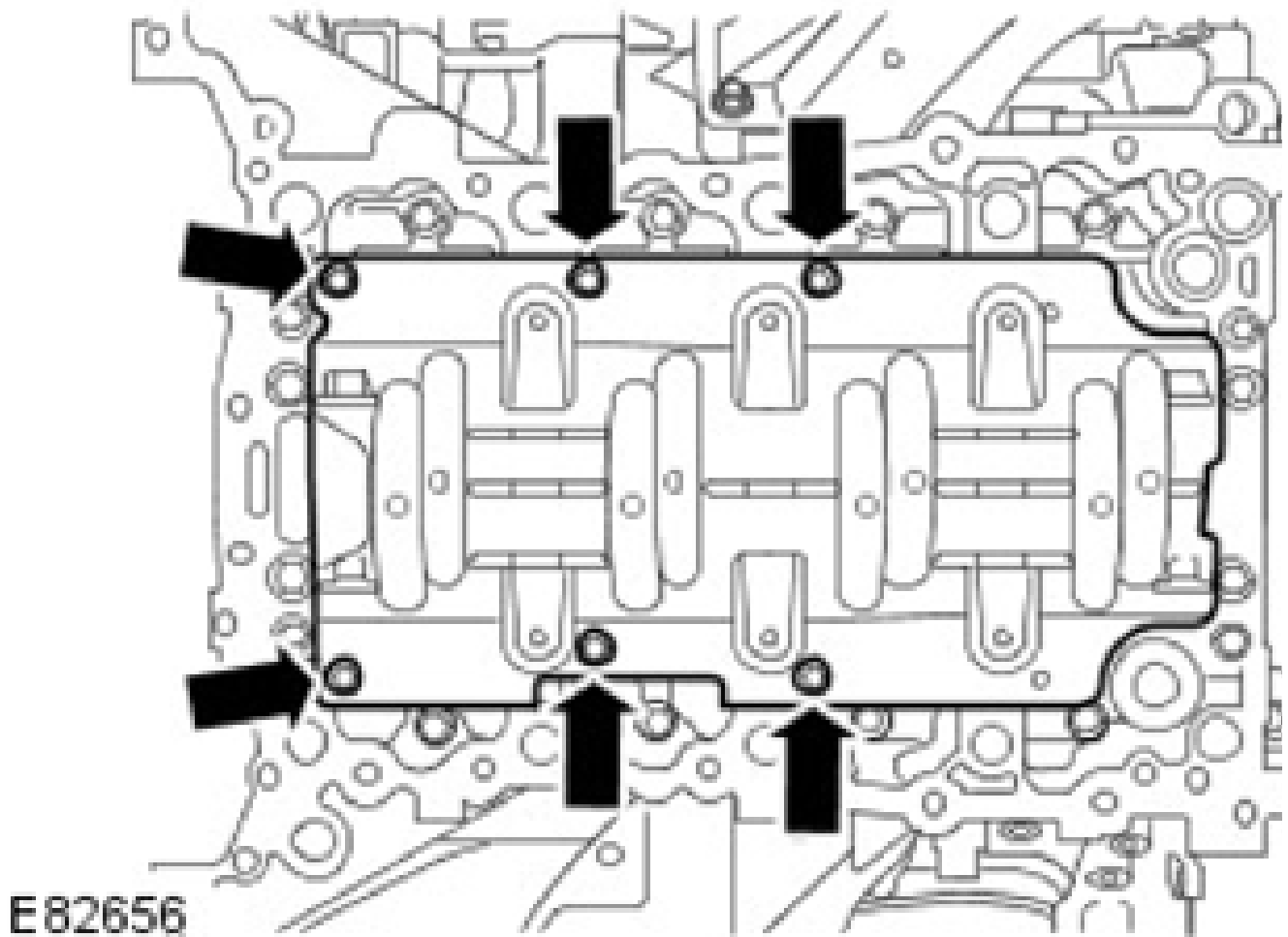


65. Remove the oil pump assembly.

- Remove the 4 bolts.
- Remove and discard the gasket.
- Clean the component mating faces.



66. Remove the baffle plate.
- Remove the 6 bolts.

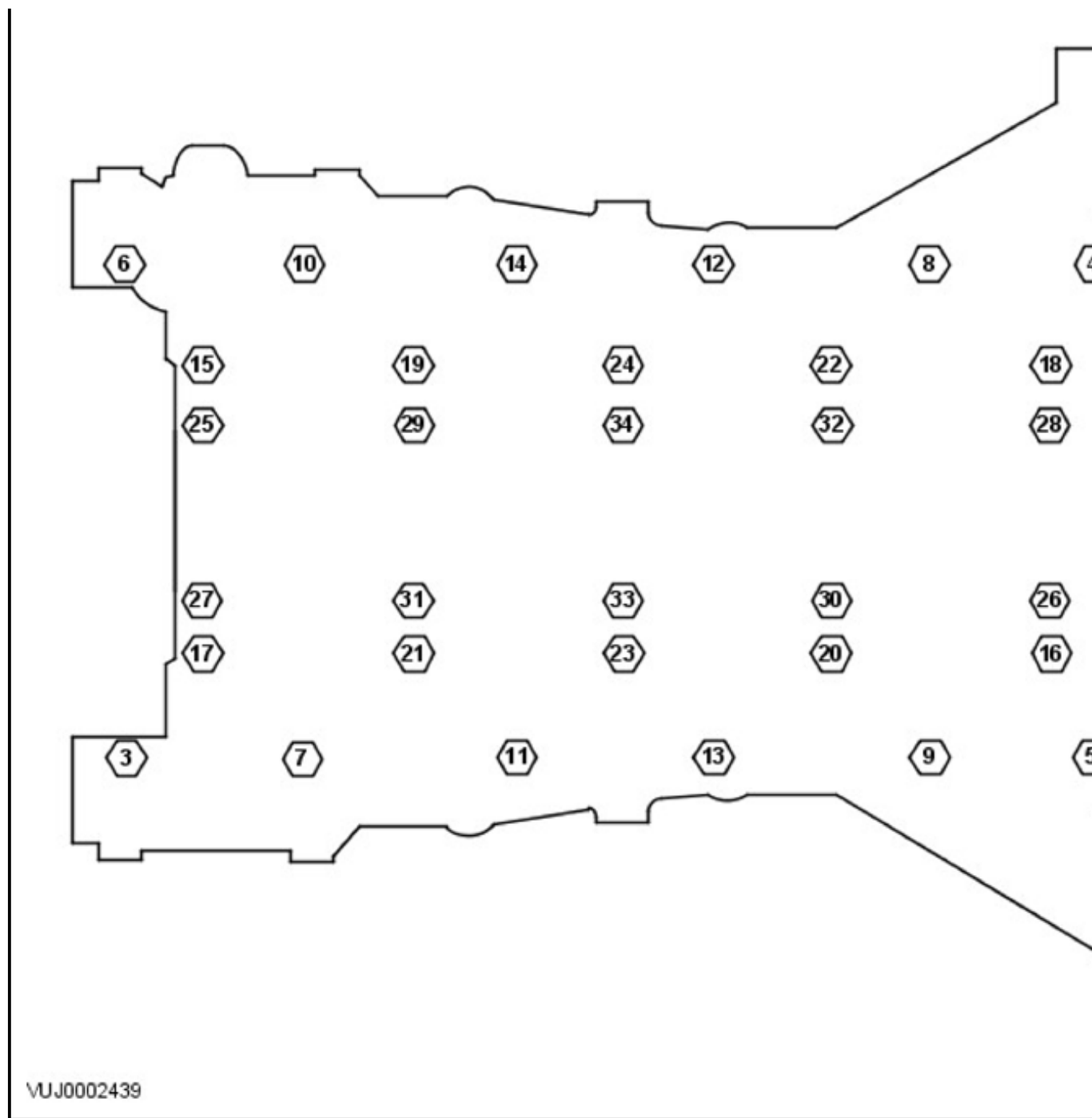


CAUTION: To make sure damage does not occur to the crankshaft and piston components, the engine must be inverted on the engine stand.
Failure to follow this instruction may result in damage to the engine.

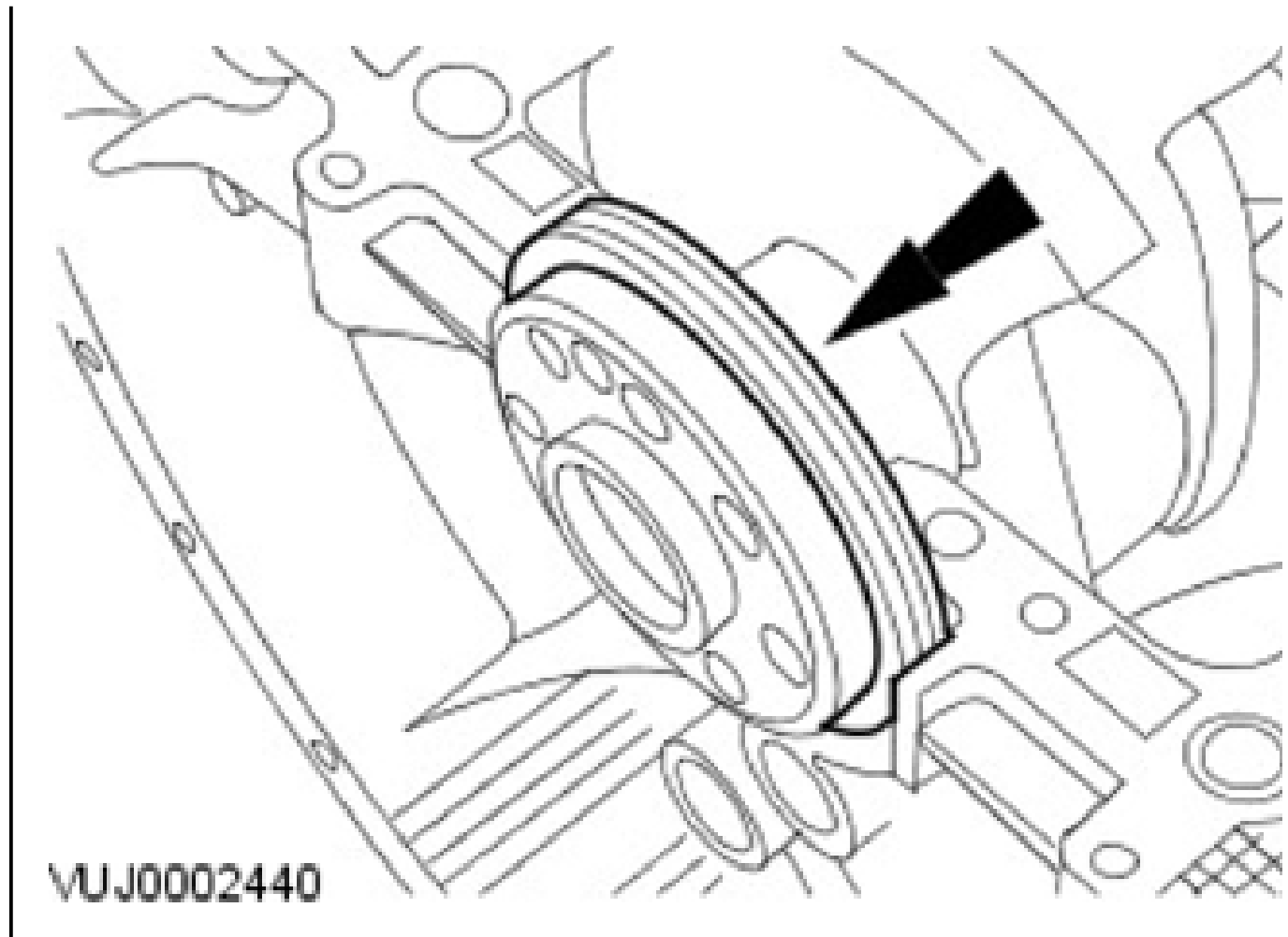
NOTE: If the crankshaft main bearing carrier retaining bolts have been marked with a center punch dot, they must be discarded and new bolts installed.

67. Remove the crankshaft main bearing carrier.

- Remove the crankshaft main bearing carrier retaining bolts in the indicated sequence.



68. Remove and discard the rear crankshaft oil seal.



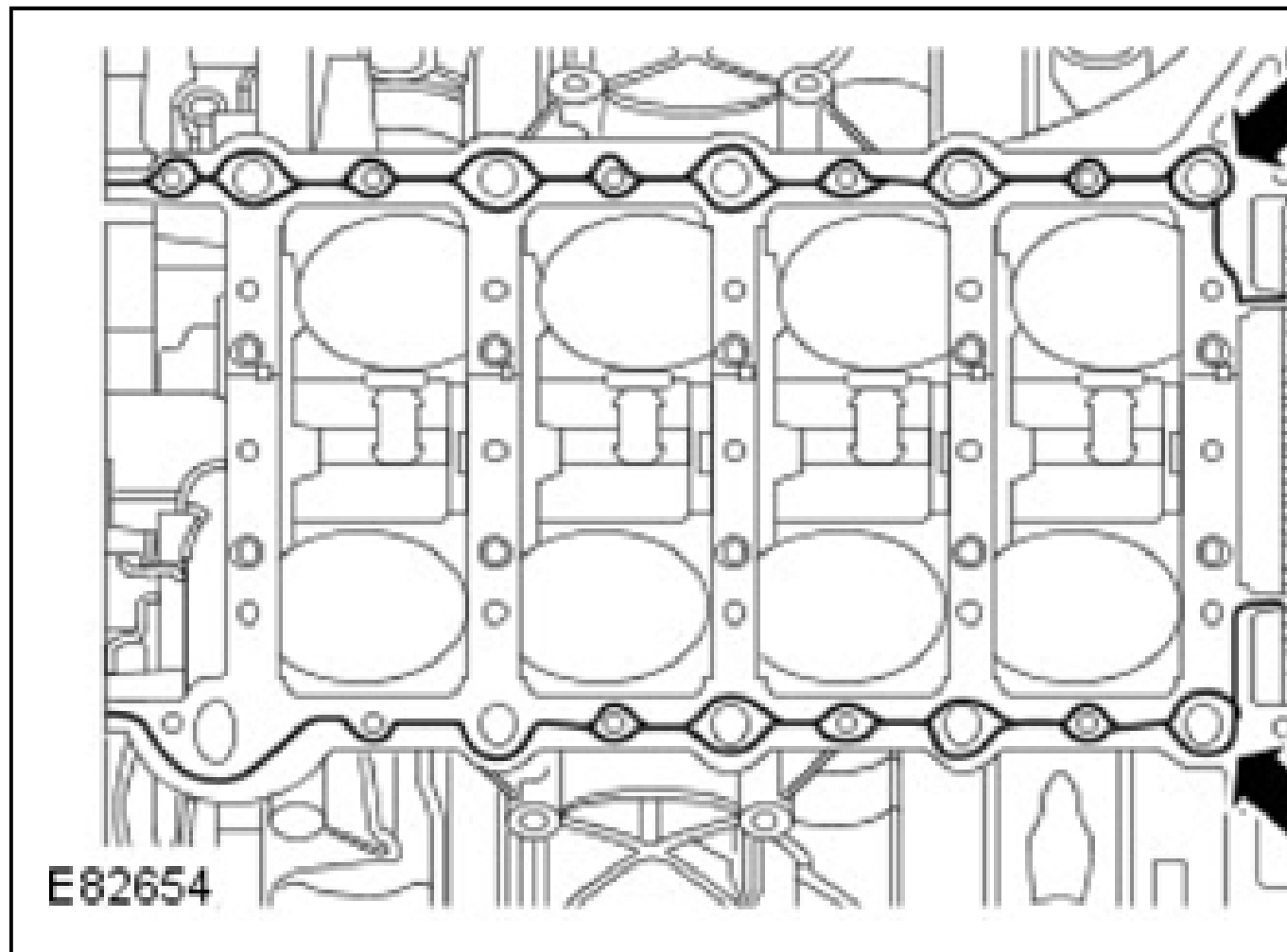
INSTALLATION

CAUTION: Use only a plastic scraper when removing the sealing material. If any new bolts are to be installed to retain the crankshaft main bearing carrier, pre-stress the retaining bolts by installing the crankshaft main bearing carrier without any sealant and tightening the new retaining bolts to the specified torque. Remove the crankshaft main bearing carrier once the bolts have been pre-stressed. Failure to follow this instruction may result in damage to the vehicle.

1. Clean all the mating faces and reusable parts thoroughly and check for damage.

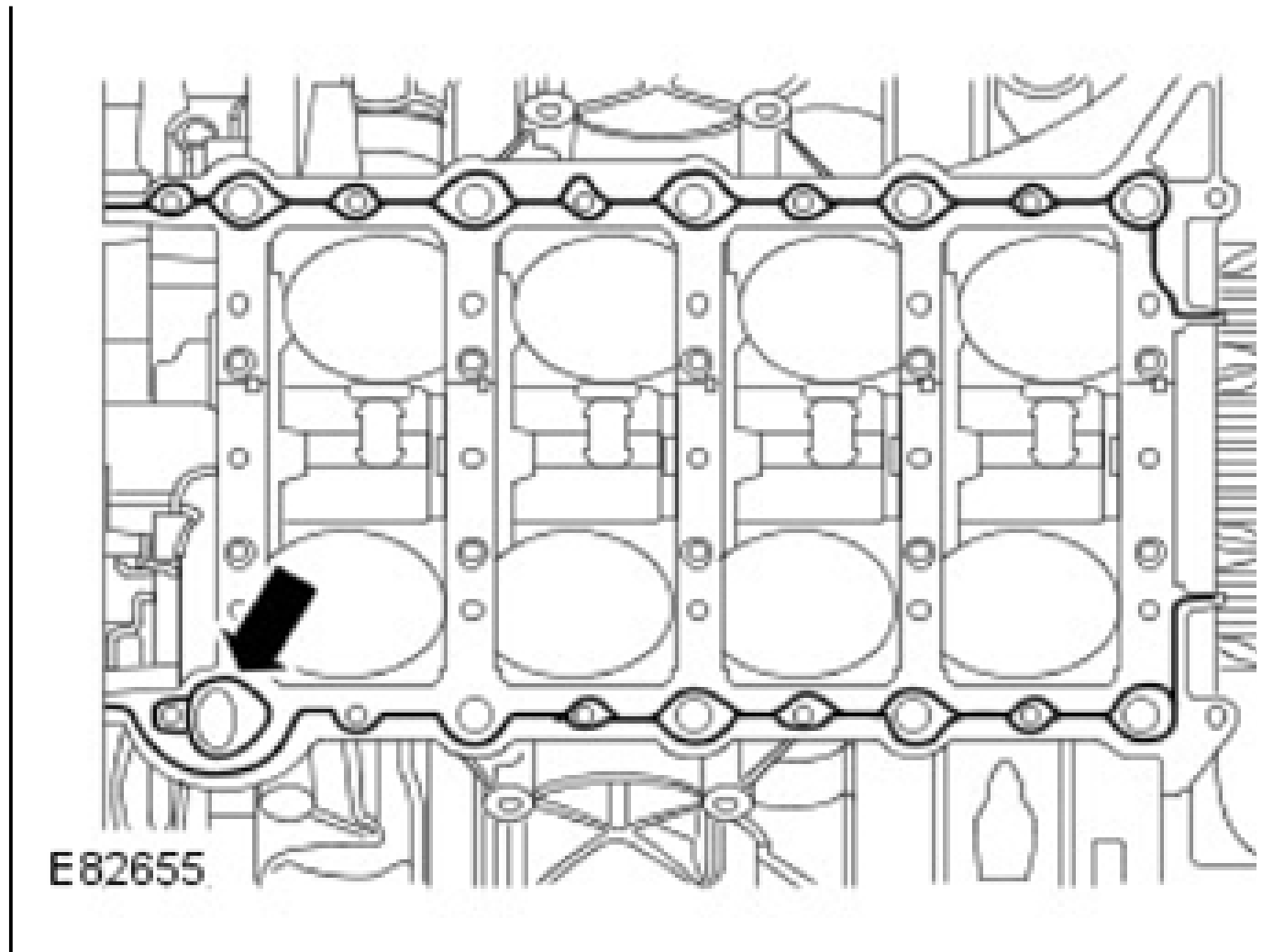
NOTE: Install the crankshaft main bearing carrier and tighten bolts to specification within twenty minutes of applying the sealant.

2. Apply a 2 mm (0.08in) bead of sealant to the cylinder block in the area shown.
 - Use WSS-M4G323-A4-RTV sealant.



NOTE: Install the crankshaft main bearing carrier and tighten bolts to specification within twenty minutes of applying the sealant.

3. Apply a 1 mm (0.039in) bead of sealant to the cylinder block in the area shown.
 - Use WSS-M4G323-A4-RTV sealant.

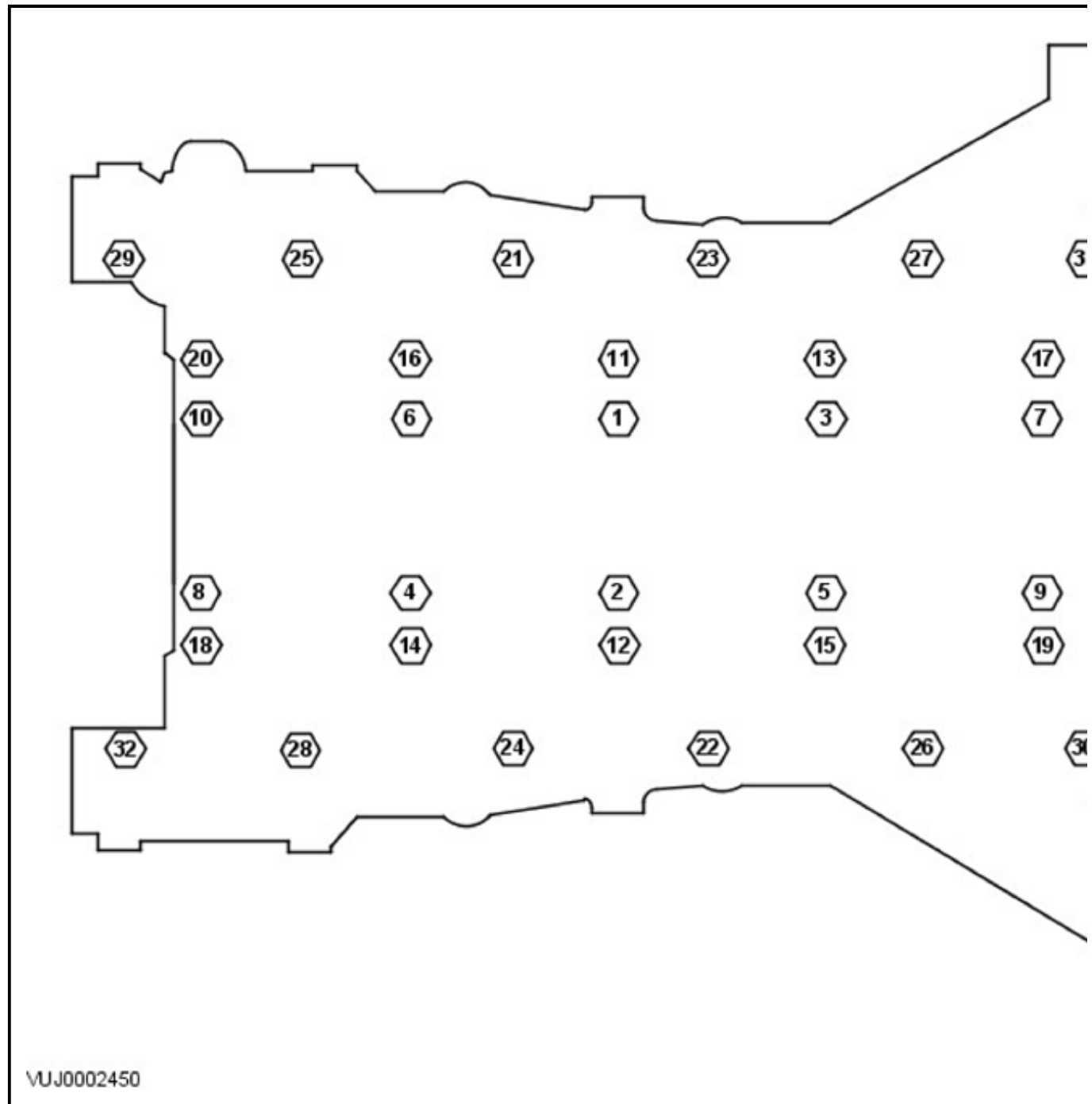


CAUTION: Make sure all dowels are fully seated into the crankshaft main bearing carrier prior to tightening the bolts.

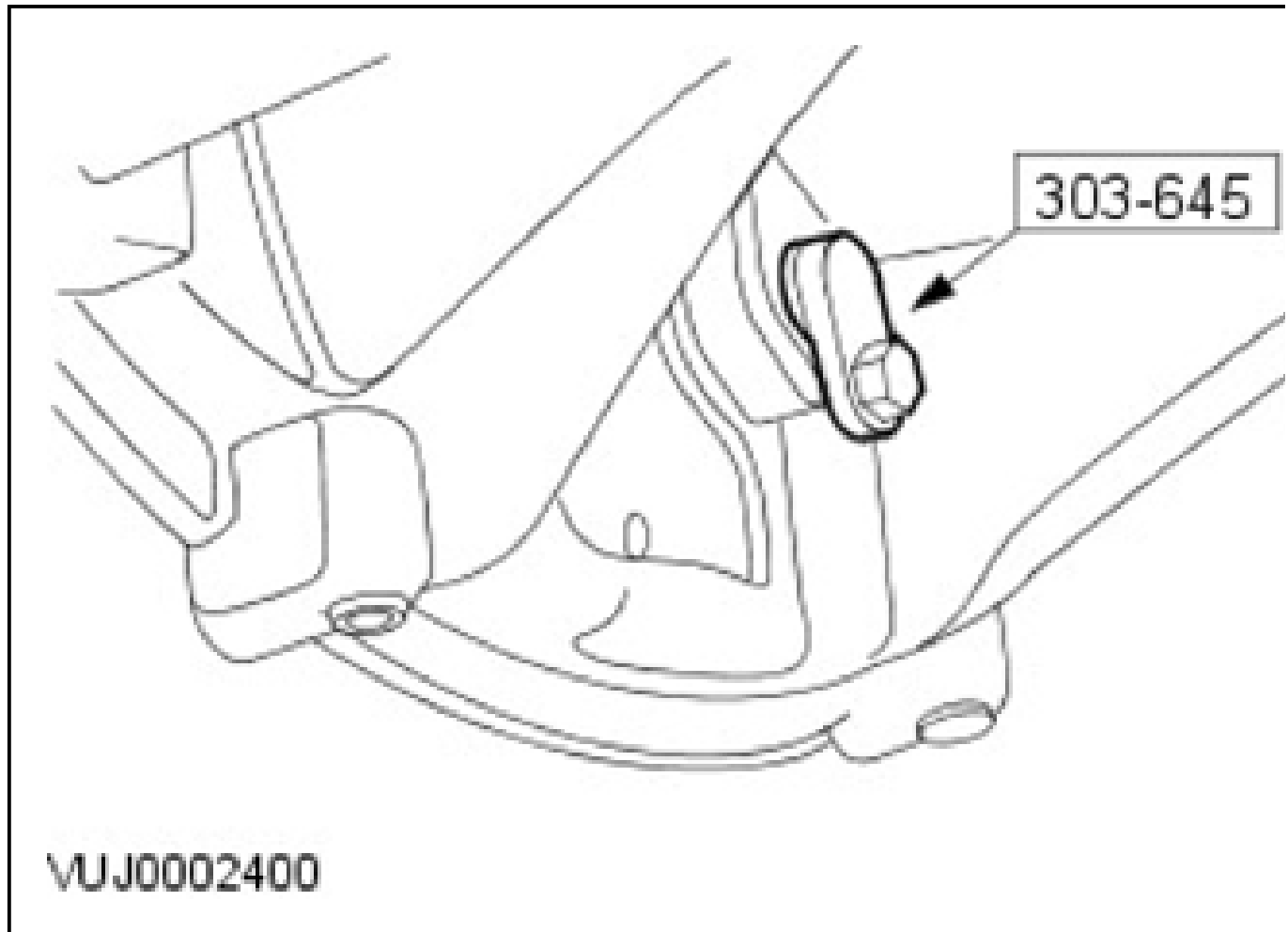
NOTE: Do not lubricate the crankshaft main bearing carrier retaining bolts. Do not rotate the crankshaft until all the retaining bolts are tightened to specification. The retaining bolts must be tightened within twenty minutes of applying the sealant. Tighten the retaining bolts in the sequence shown.

4. Install the crankshaft main bearing carrier to the cylinder block.
 1. Stage 1: Bolts 21 to 32, tighten to 15 Nm (11 lb.ft).
 2. Stage 2: Bolts 33 to 34, tighten to 15 Nm (11 lb.ft).
 3. Stage 3: Bolts 1 to 10, tighten to 25 Nm (18 lb.ft).
 4. Stage 4: Bolts 11 to 20, tighten to 15 Nm (11 lb.ft).

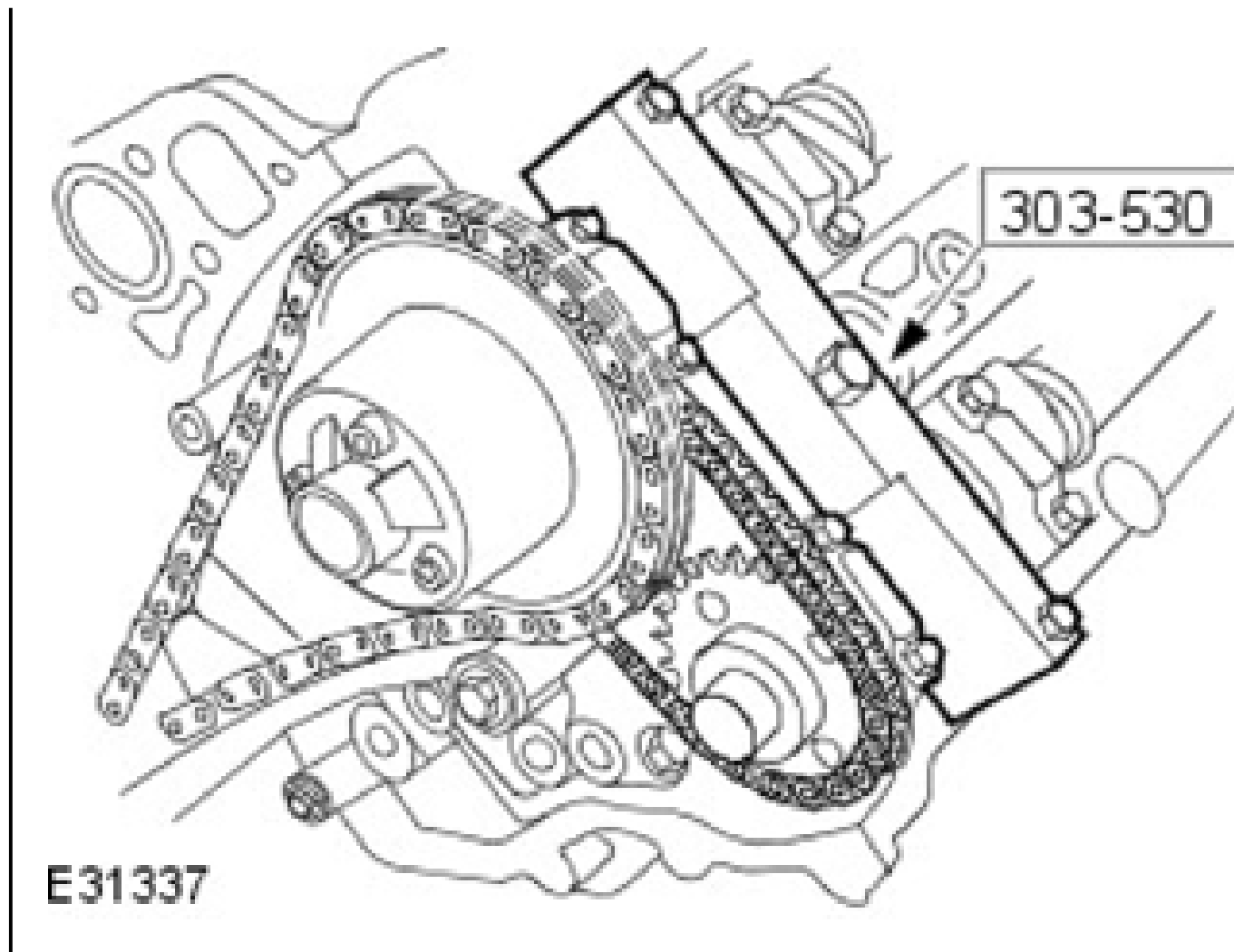
5. Stage 5: Bolts 1 to 10, tighten to 35 Nm (26 lb.ft), then a further 135 degrees.
6. Stage 6: Bolts 11 to 20, tighten to 20 Nm (15 lb.ft), then a further 150 degrees.
7. Stage 7: Bolts 21 to 32, tighten to 20 Nm (15 lb.ft), then a further 90 degrees.
8. Stage 8: Bolts 33 to 34, tighten to 20 Nm (15 lb.ft), then a further 150 degrees.
9. Stage 9: Center punch each of the bolt heads to indicate it has been reused.



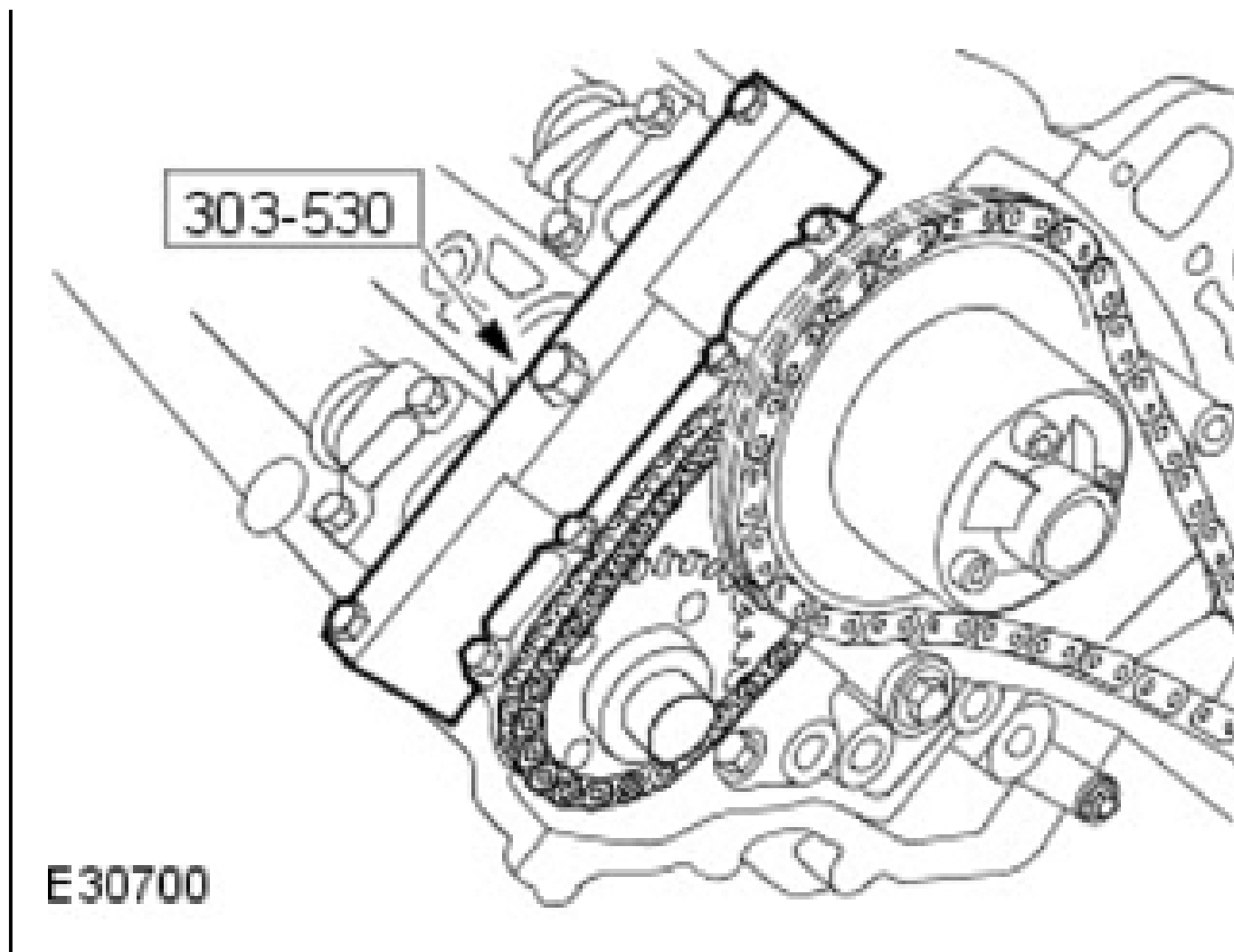
5. Remove the special tool.



6. Remove the special tool from the left-hand cylinder head.

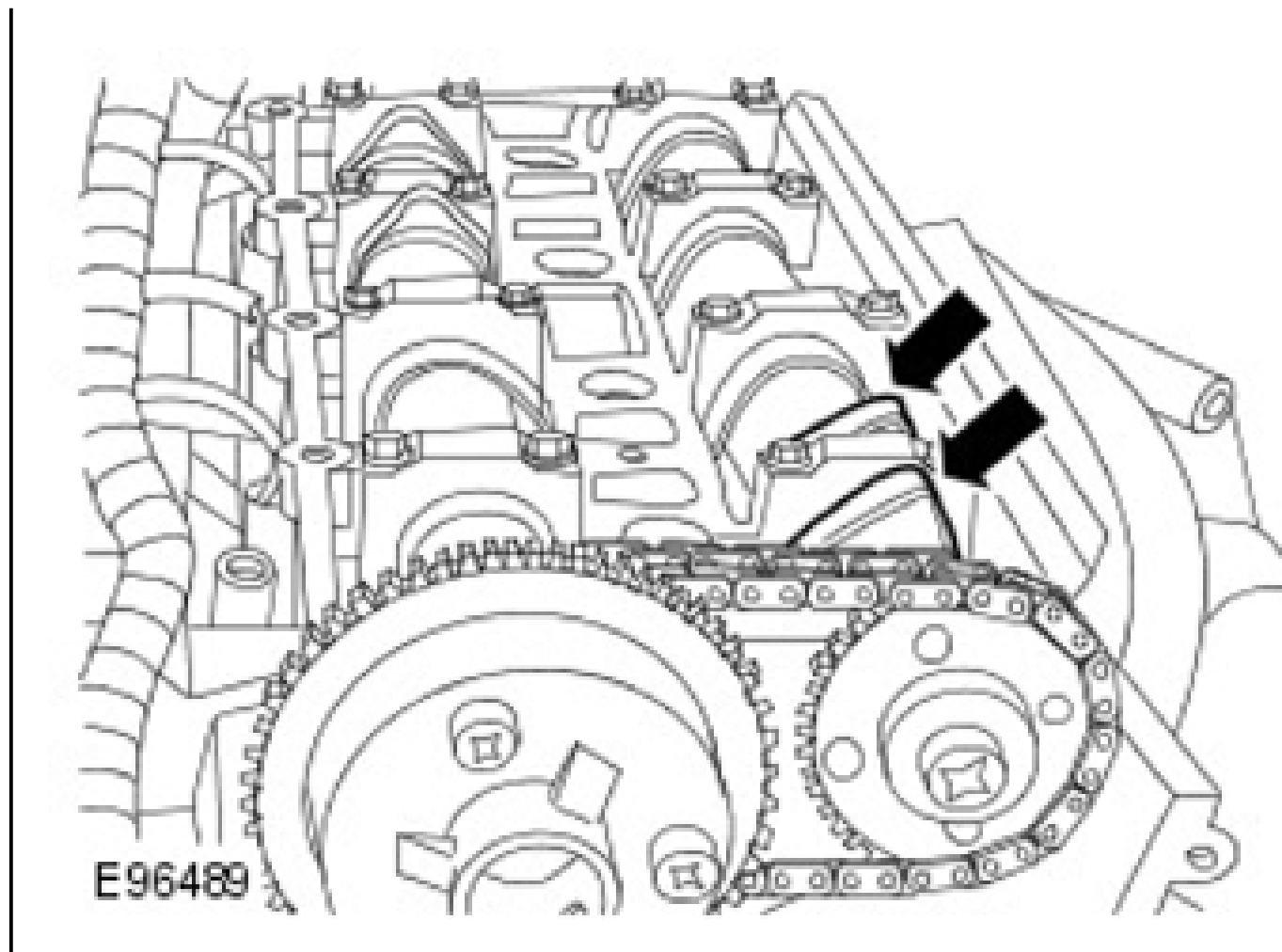


7. Remove the special tool from the right-hand cylinder head.



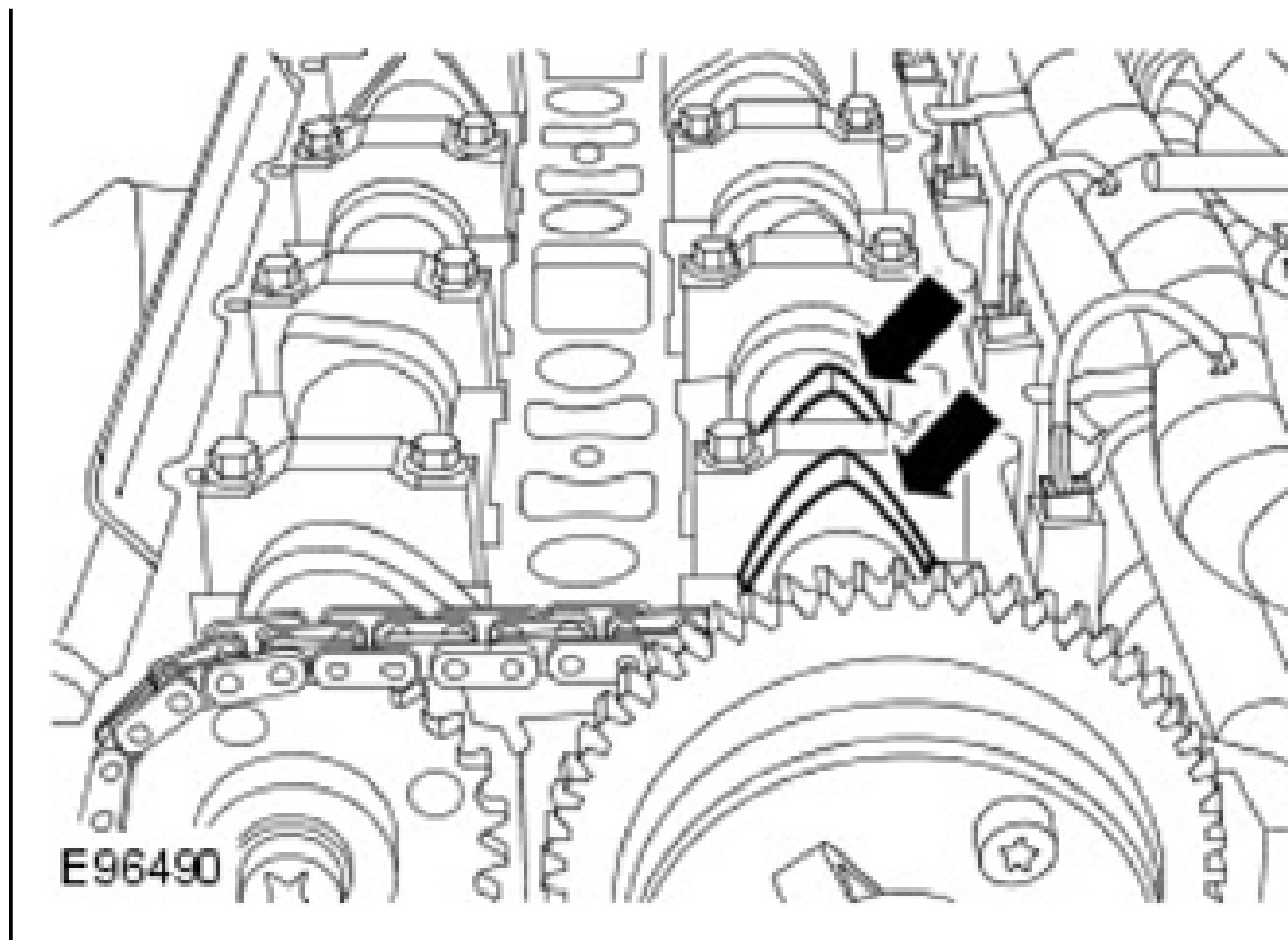
CAUTION: Make sure that number 1 cylinder intake camshaft lobes are vertical to the cylinder head face.

8. Position the right-hand camshafts to the neutral position.



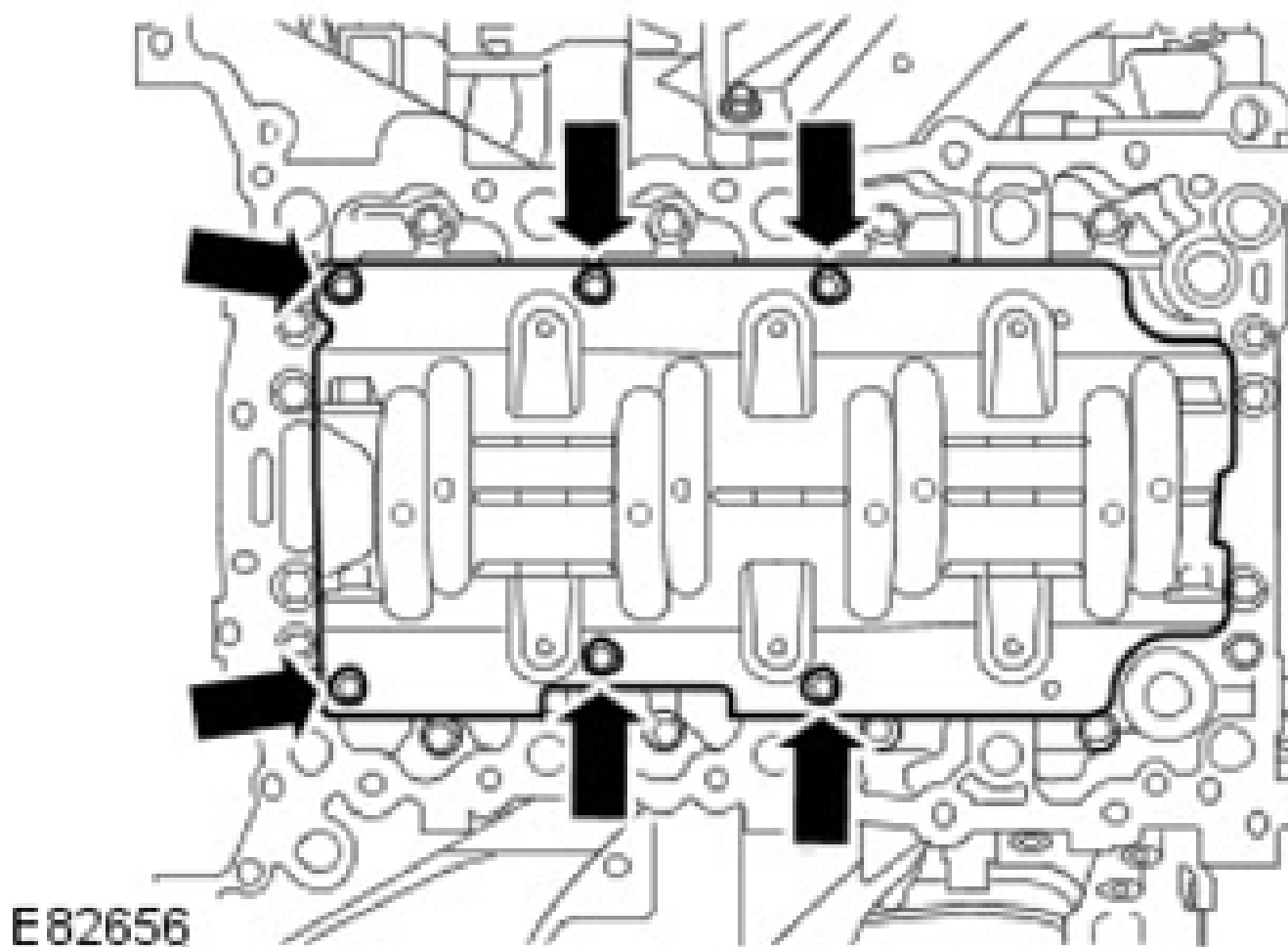
CAUTION: Make sure that number 2 cylinder exhaust camshaft lobes are vertical to the cylinder head face.

9. Position the left-hand camshafts to the neutral position.



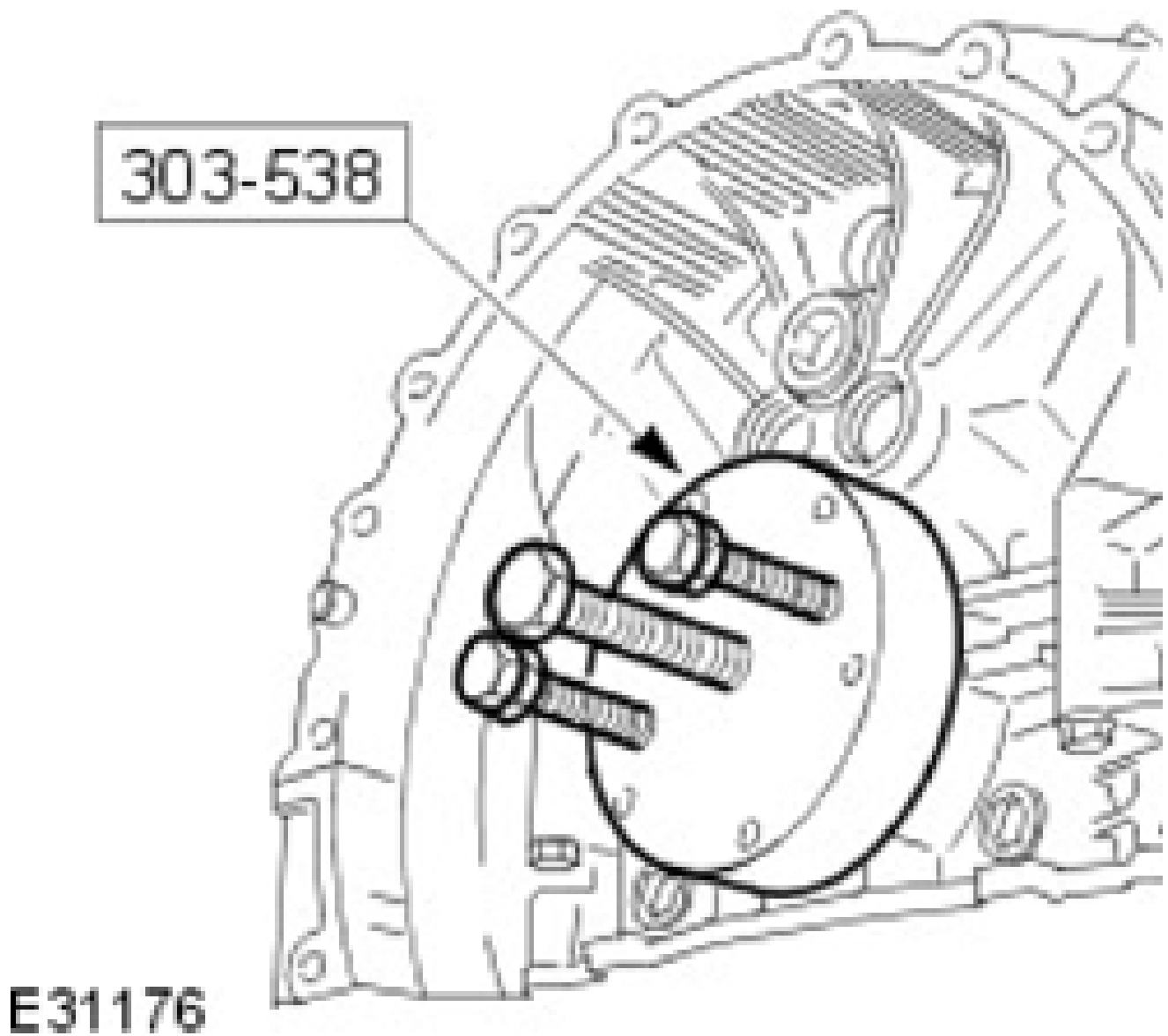
CAUTION: Make sure no binding of the crankshaft occurs.
Make sure the spark plugs are removed to enable the engine to rotate freely.

10. Carefully rotate the crankshaft two complete turns to check for correct operation.
11. Install the baffle plate.
 - Tighten the 6 bolts to 6 Nm (4 lb.ft).



NOTE: Carefully remove the transit sleeve, leaving the seal in place. Make sure that the transit sleeve is correctly positioned and install the new seal over the crankshaft. Do not use any lubricant on the seal, the transit sleeve or the crankshaft.

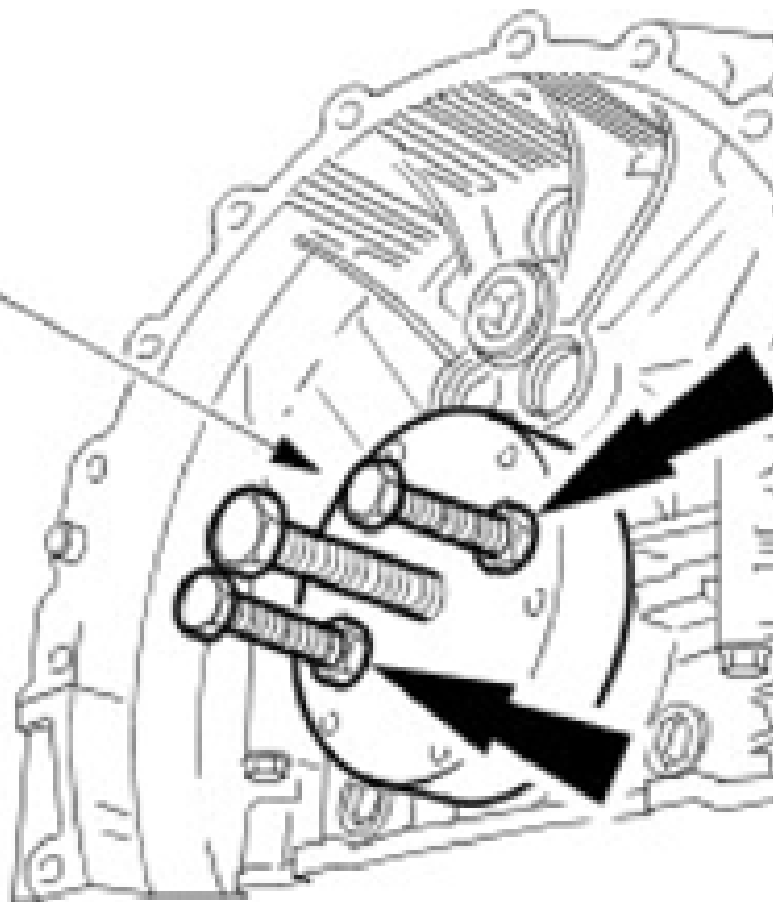
12. Using the special tool, position the crankshaft rear oil seal.
 - Install the special tool to the crankshaft.



CAUTION: Alternate the nut tightening to correctly seat the crankshaft rear oil seal.

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

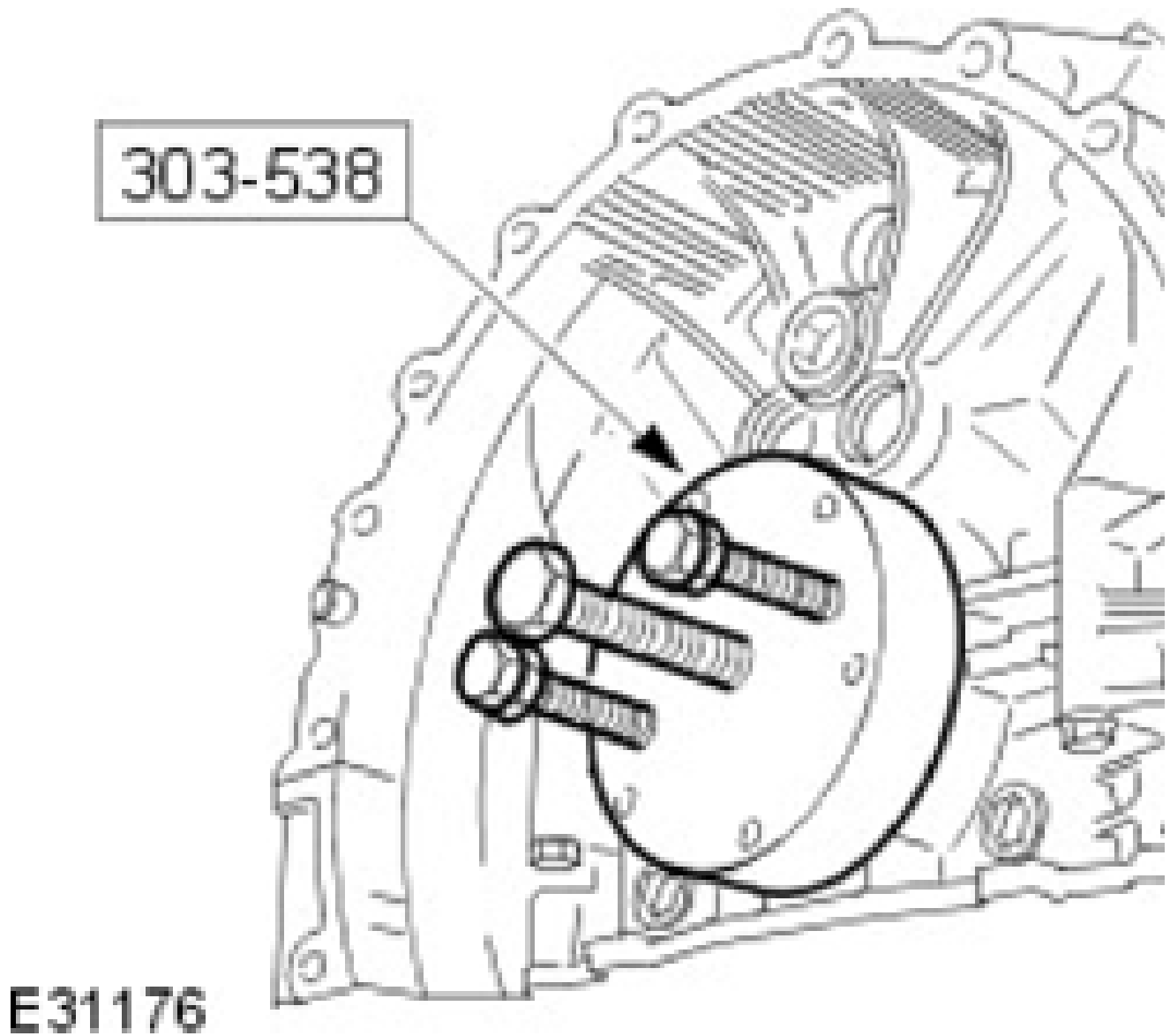
303-538



E31177

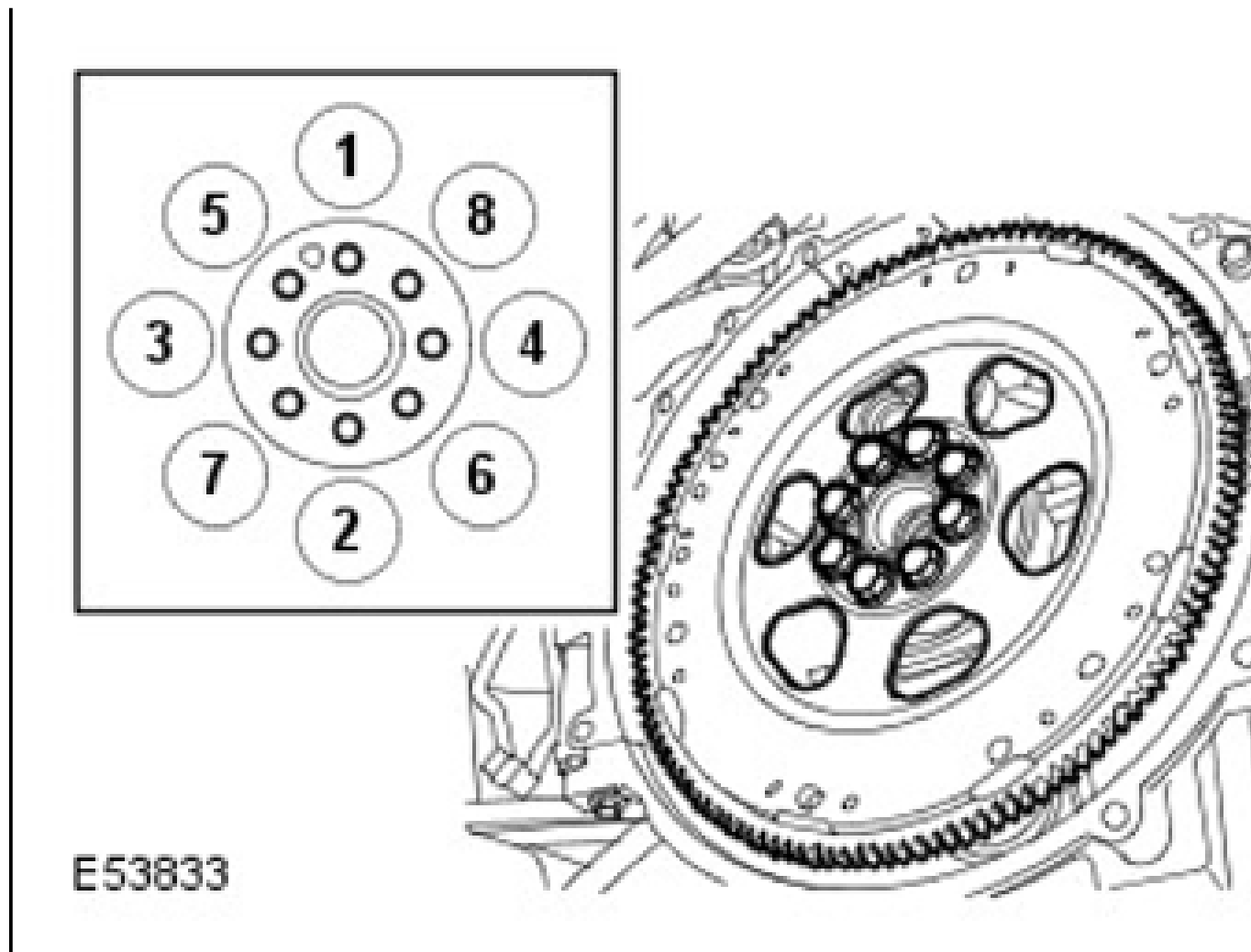
CAUTION: Make sure that the crankshaft rear oil seal is correctly located.

14. Remove the special tool.



NOTE: Prevent the flexplate from rotating.

15. Install the torque converter flexplate.
 - Clean the component mating faces.
 - Tighten the bolts evenly in 2 stages to the sequence shown.
 - Tighten the bolts to 15 Nm (11 lb ft).
 - Tighten the bolts to 110 Nm (81 lb.ft).

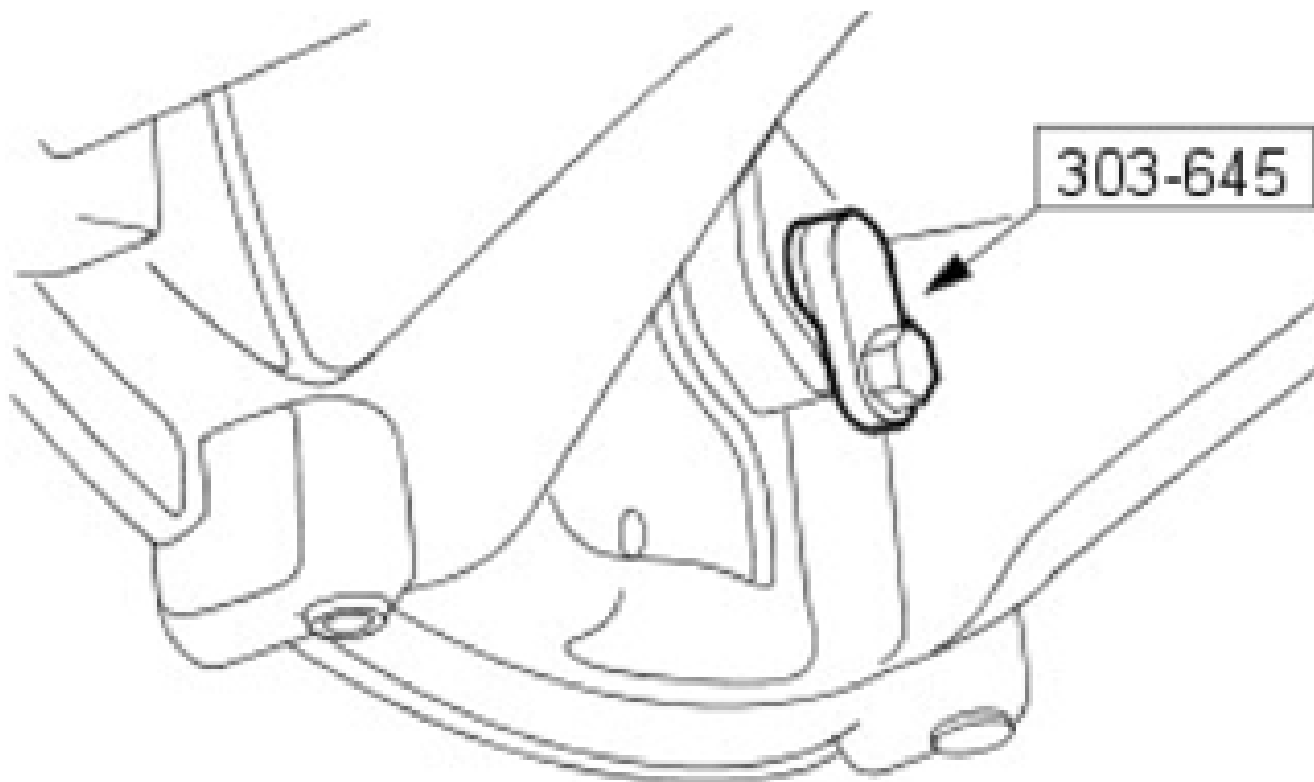


CAUTION: Make sure the spark plugs are removed to enable the engine to rotate freely.

Do not rotate the crankshaft counterclockwise.

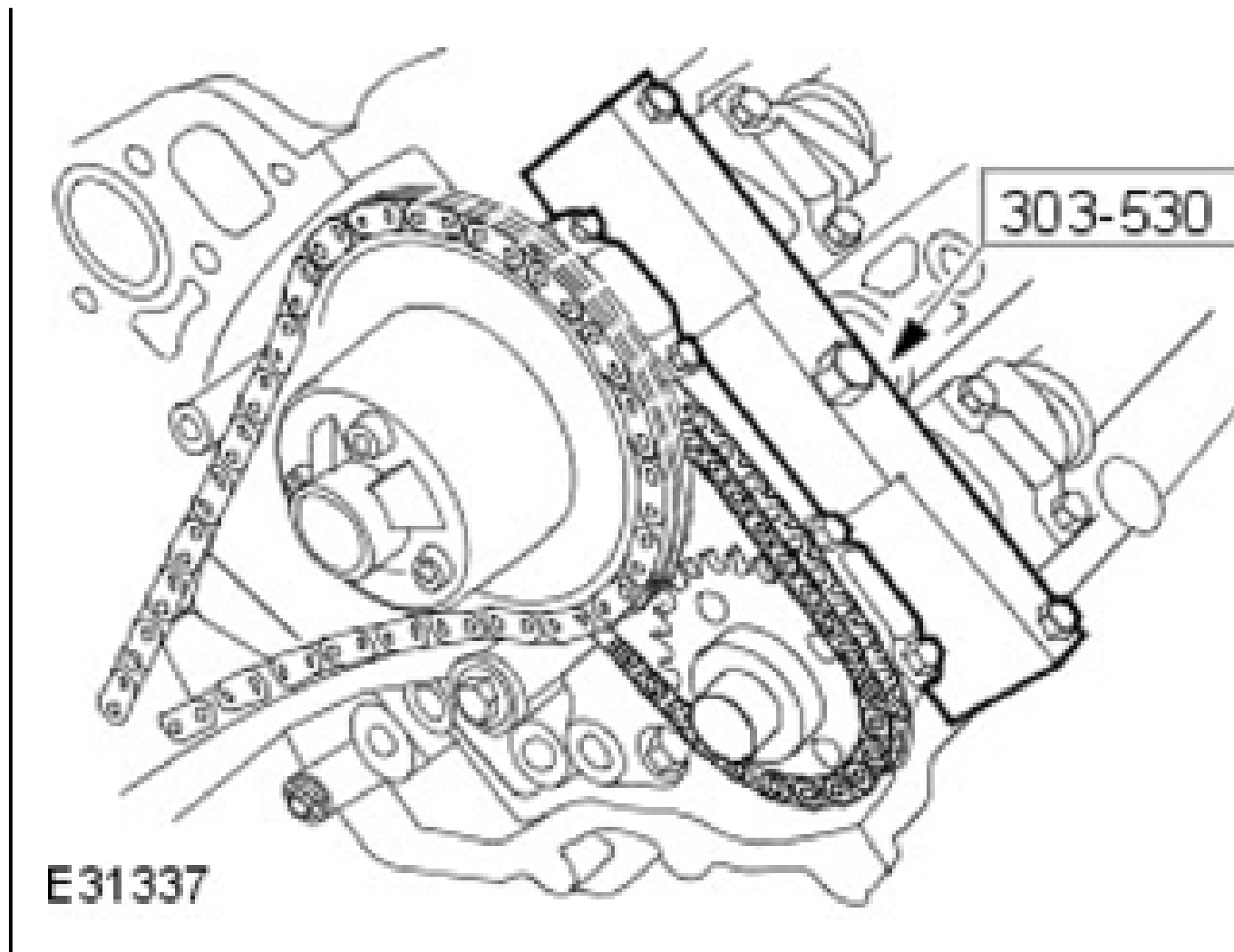
Rotate the crankshaft clockwise to position the engine to top dead center (TDC) No. 1 cylinder

16. Install the special tool.

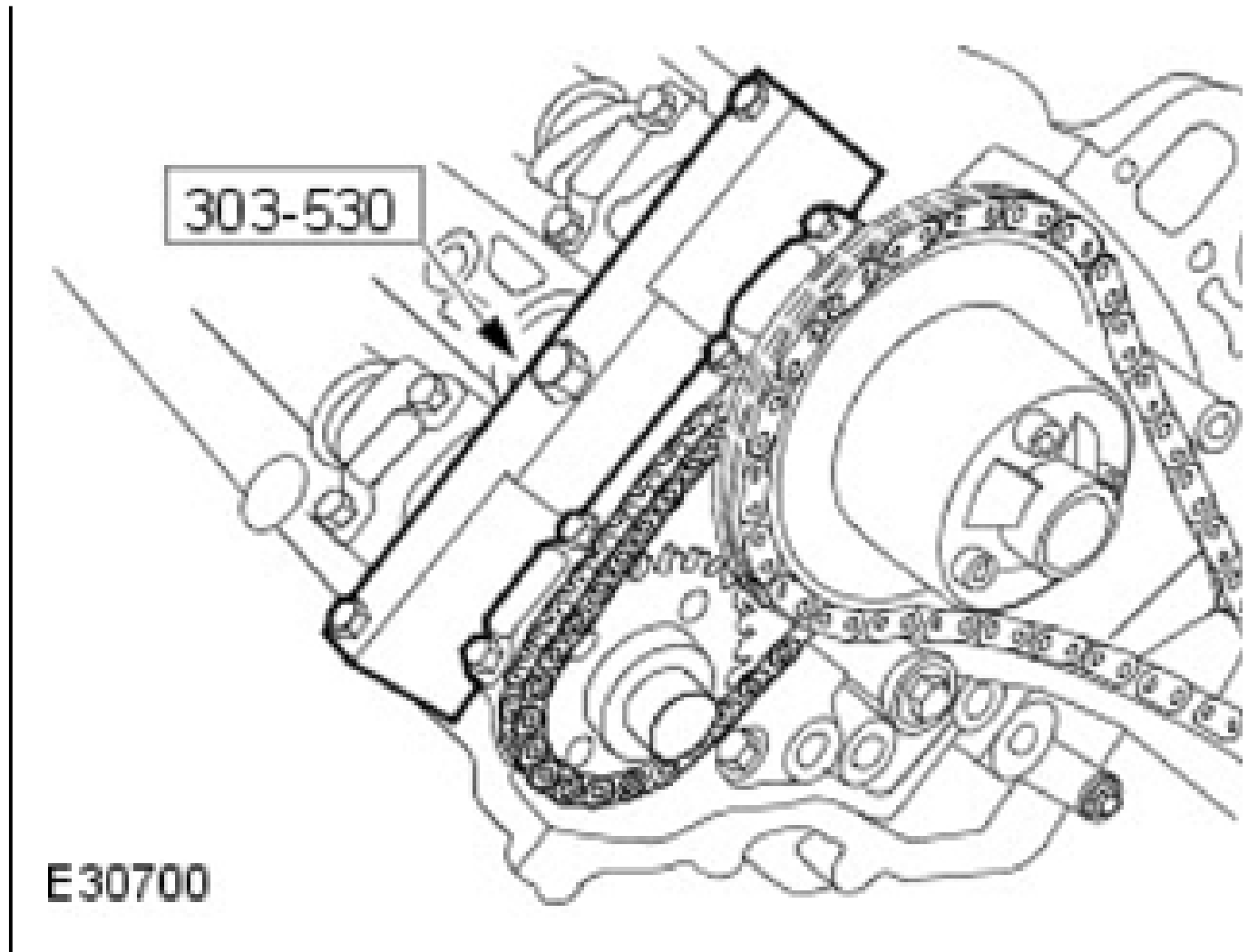


VJJ0002400

17. Install the special tool to the left-hand cylinder head.



18. Install the special tool to the right-hand cylinder head.



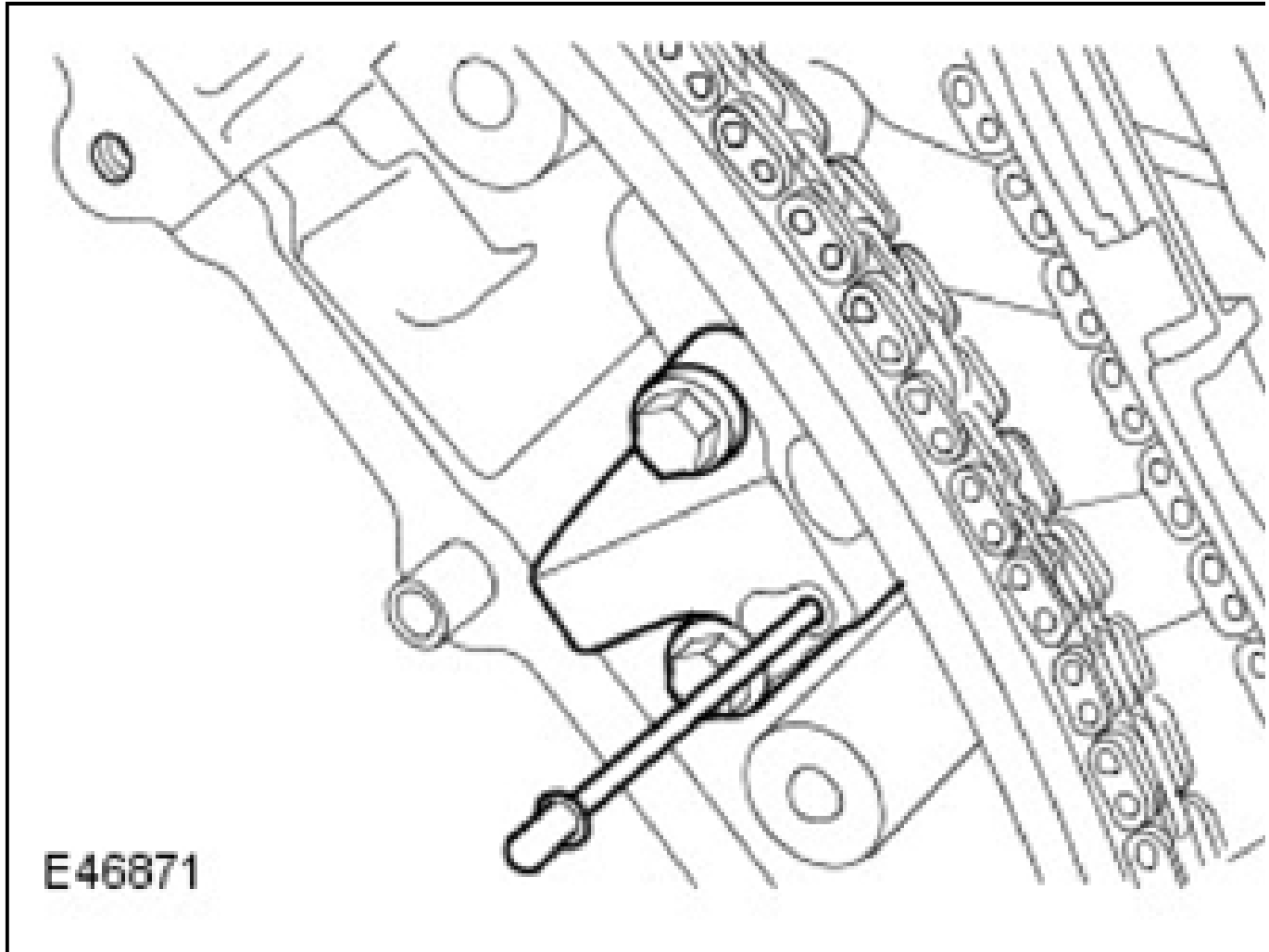
NOTE: Install a new gasket.

19. Install the oil pump assembly.
 - Clean the component mating faces.
 - Install the gasket.
 - Tighten the bolts to 10 Nm (7 lb.ft).

NOTE: Install a new O-ring seal.

20. Install the oil strainer pick-up assembly.
 - Install the O-ring seal.
 - Tighten the M6 bolt to 10 Nm (7 lb.ft).
 - Apply sealant to the M5 bolts.
 - Tighten the M5 bolts to 6 Nm (4 lb.ft).
21. Install the crankshaft sprocket.

- Clean the component mating faces.
 - Install the crankshaft sprocket key.
22. Install the LH primary timing chain.
- Make sure the timing chain slack is on the tensioner side of the timing chain.
23. Install the LH primary timing chain tensioner guides.
- Tighten the bolts to 12 Nm (9 lb.ft).



CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

24. Install the LH primary timing chain tensioner.
- Using a 3 mm (0.118 in) diameter rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm (9 lb.ft).
 - Remove the retaining rod.

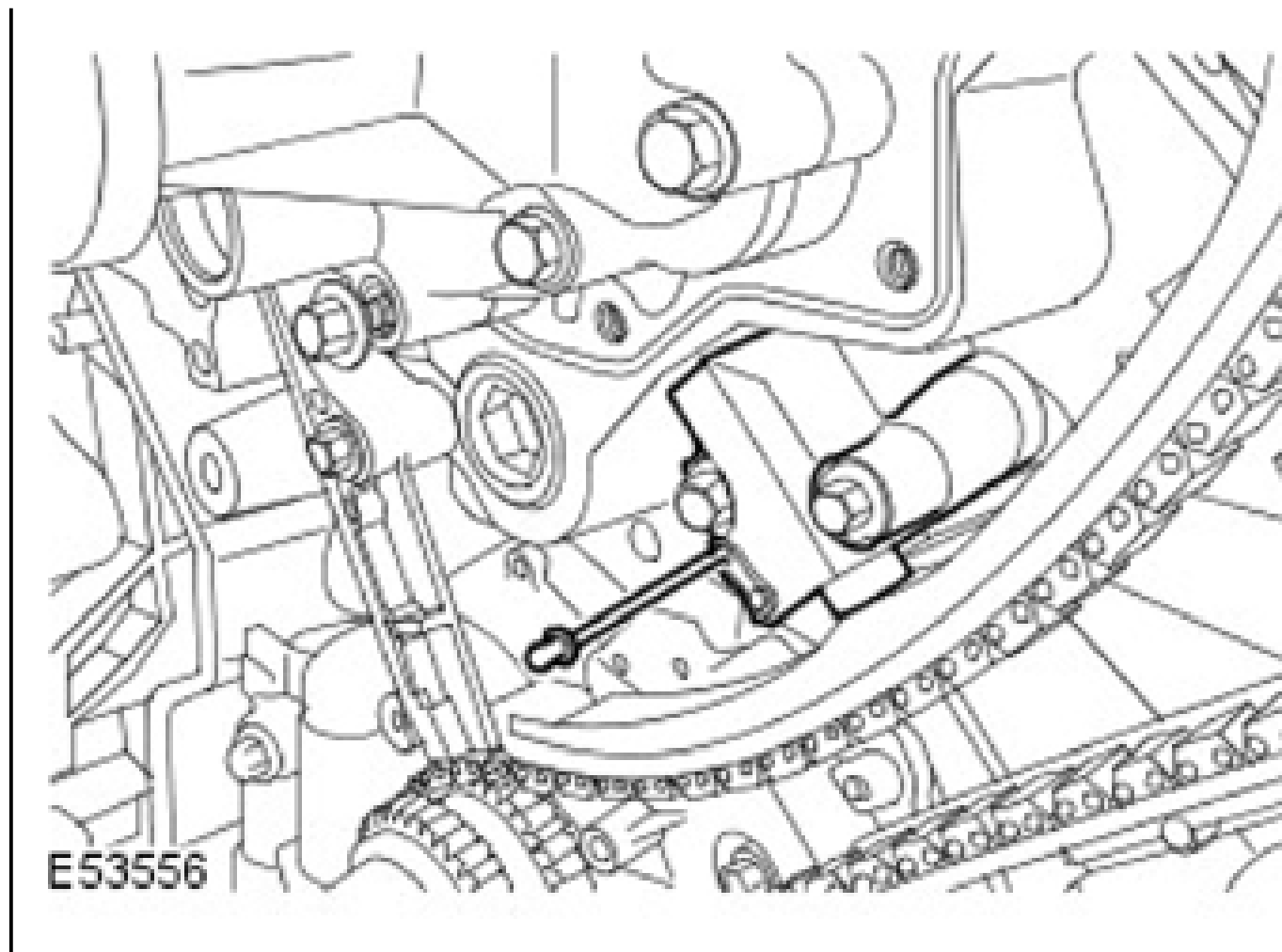
CAUTION: Make sure that new bolts are installed.

NOTE: Install new O-ring seals.

25. Install the LH VCT control solenoid housing.
 - Install the O-ring seals.
 - Tighten the bolts to 22 Nm (16 lb.ft).
 - Tighten the nut to 10 Nm (7 lb.ft).
26. Install the RH primary timing chain.
 - Make sure the timing chain slack is on the tensioner side of the timing chain.
27. Install the RH primary timing chain tensioner guide.
 - Tighten the bolts to 12 Nm (9 lb.ft).

CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

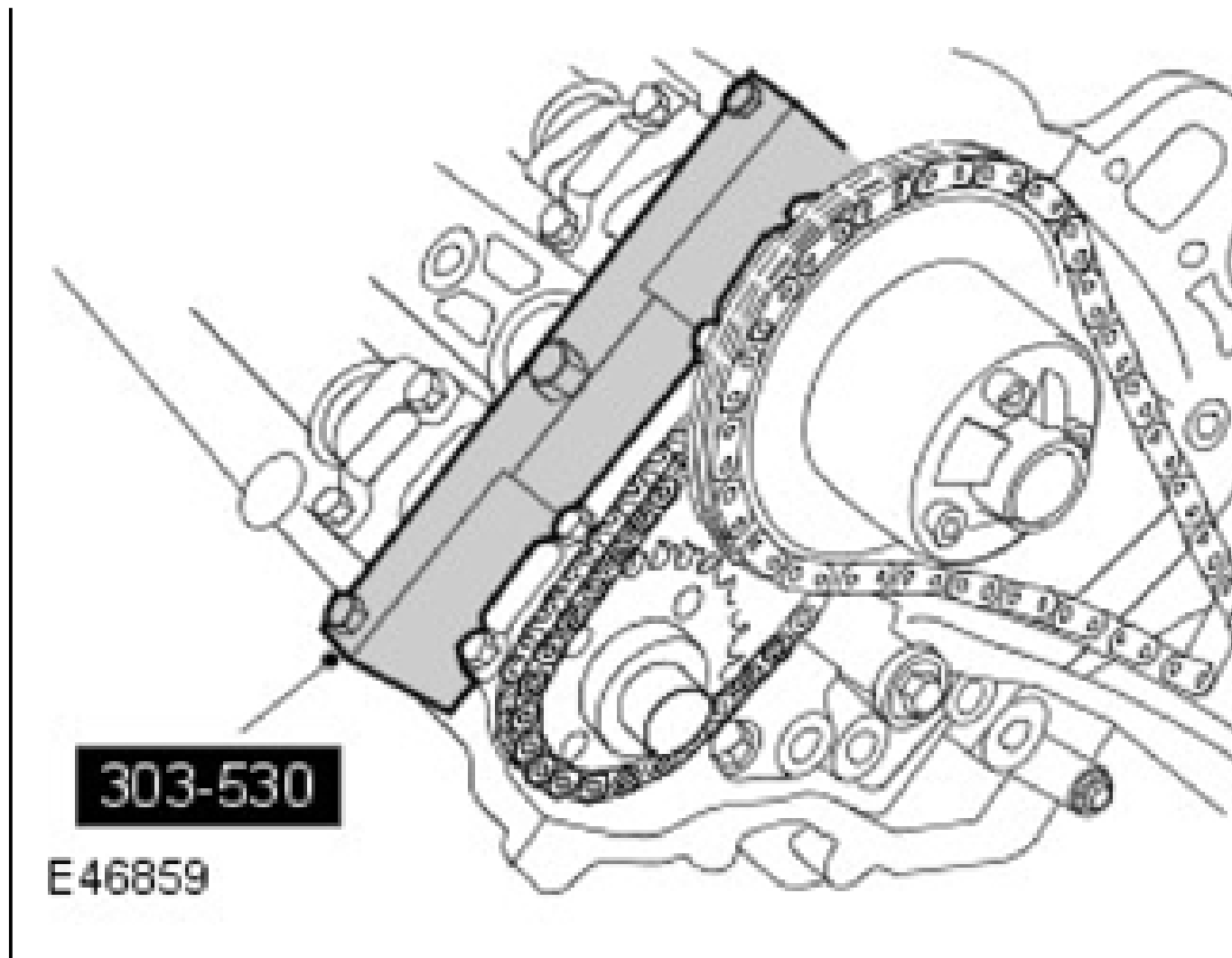
28. Install the RH primary timing chain tensioner.
 - Using a 3 mm (0.118 in) diameter rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm (9 lb.ft).
 - Remove the retaining rod.



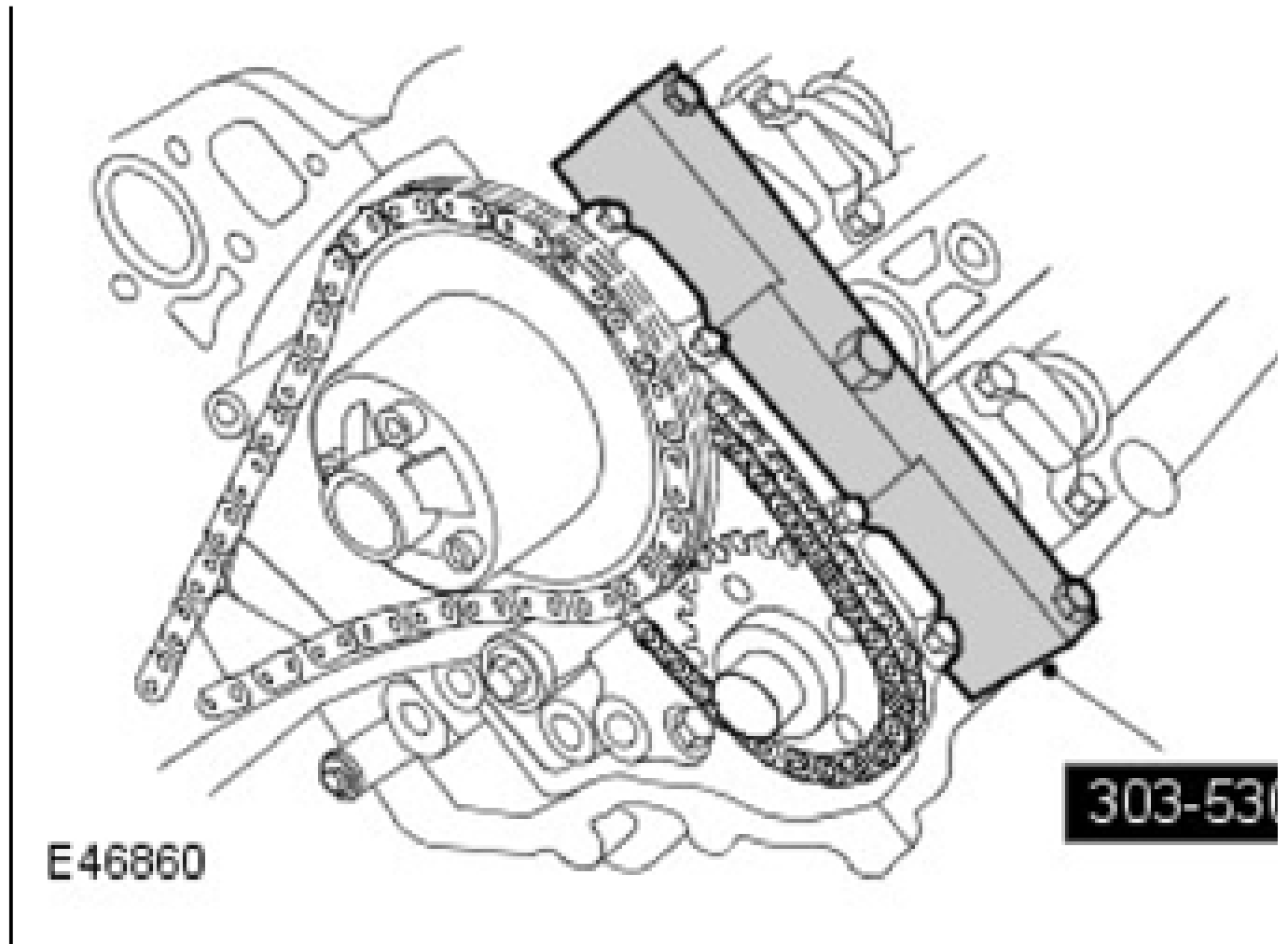
CAUTION: Make sure that new bolts are installed.

NOTE: Install new O-ring seals.

29. Install the RH VCT control solenoid housing.
 - Install the O-ring seals.
 - Tighten the bolts to 22 Nm (16 lb.ft).
 - Tighten the nut to 10 Nm (7 lb.ft).
30. Remove the special tool from the RH cylinder head.

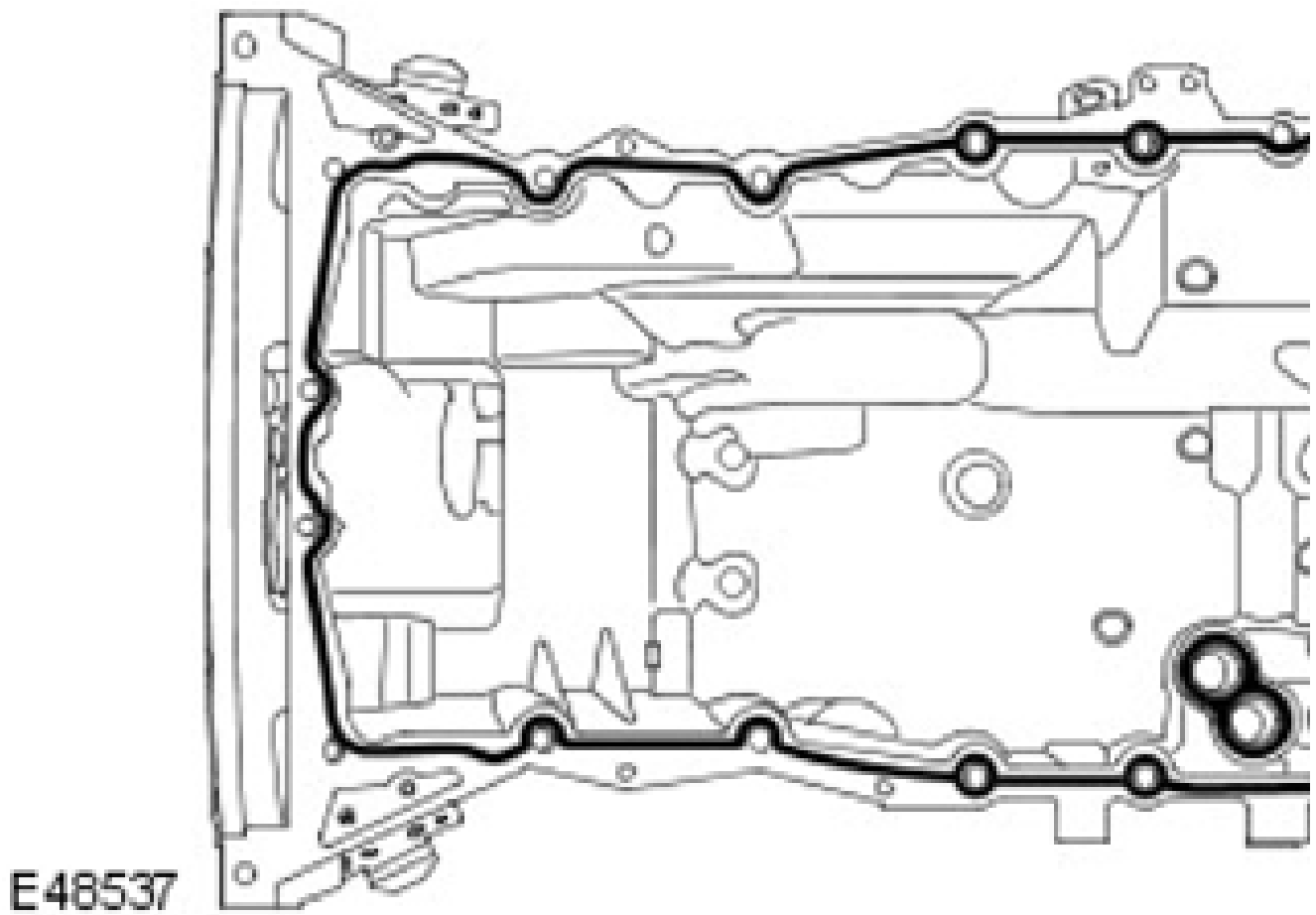


31. Remove the special tool from the LH cylinder head.

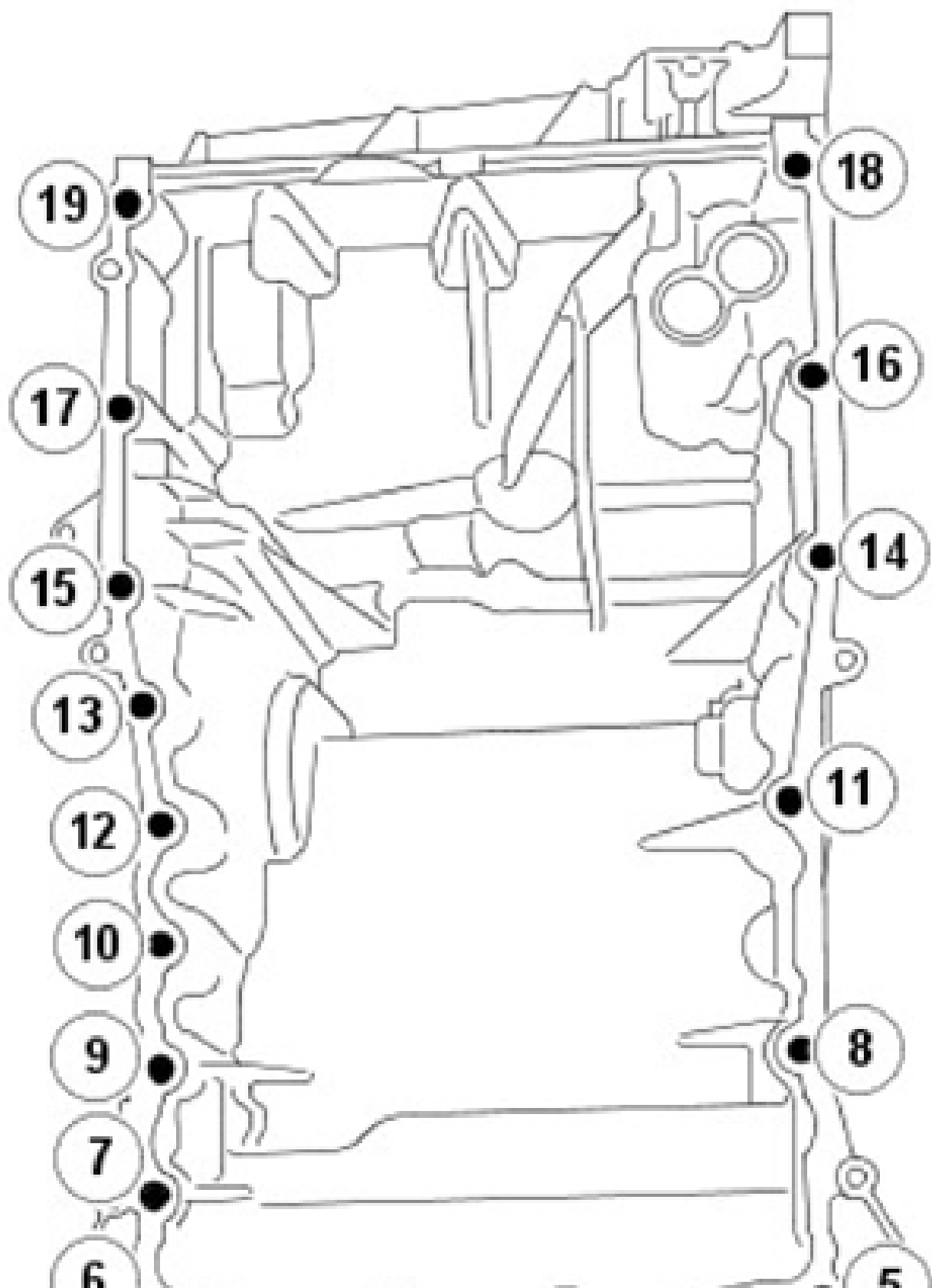


32. Install the oil pan extension.

- Clean the component mating faces.
- Apply a 3 mm (0.118 in) diameter bead of sealant, to the area indicated.
- Install the bolts, but do not tighten fully at this stage.

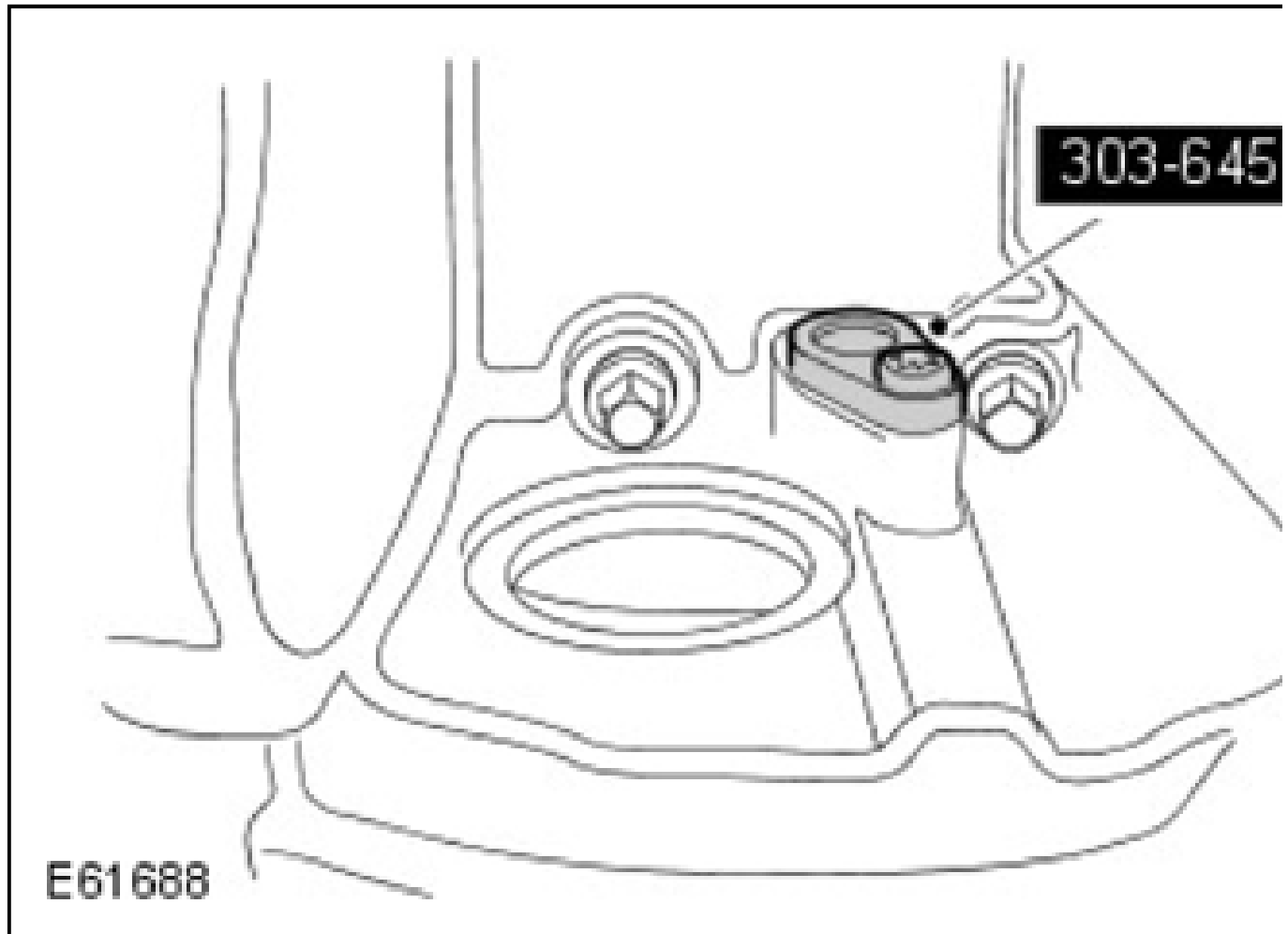


33. Tighten the oil pan bolts in the sequence shown to 20 Nm (15 lb.ft).



34. Remove the special tool.

- Remove the bolt.

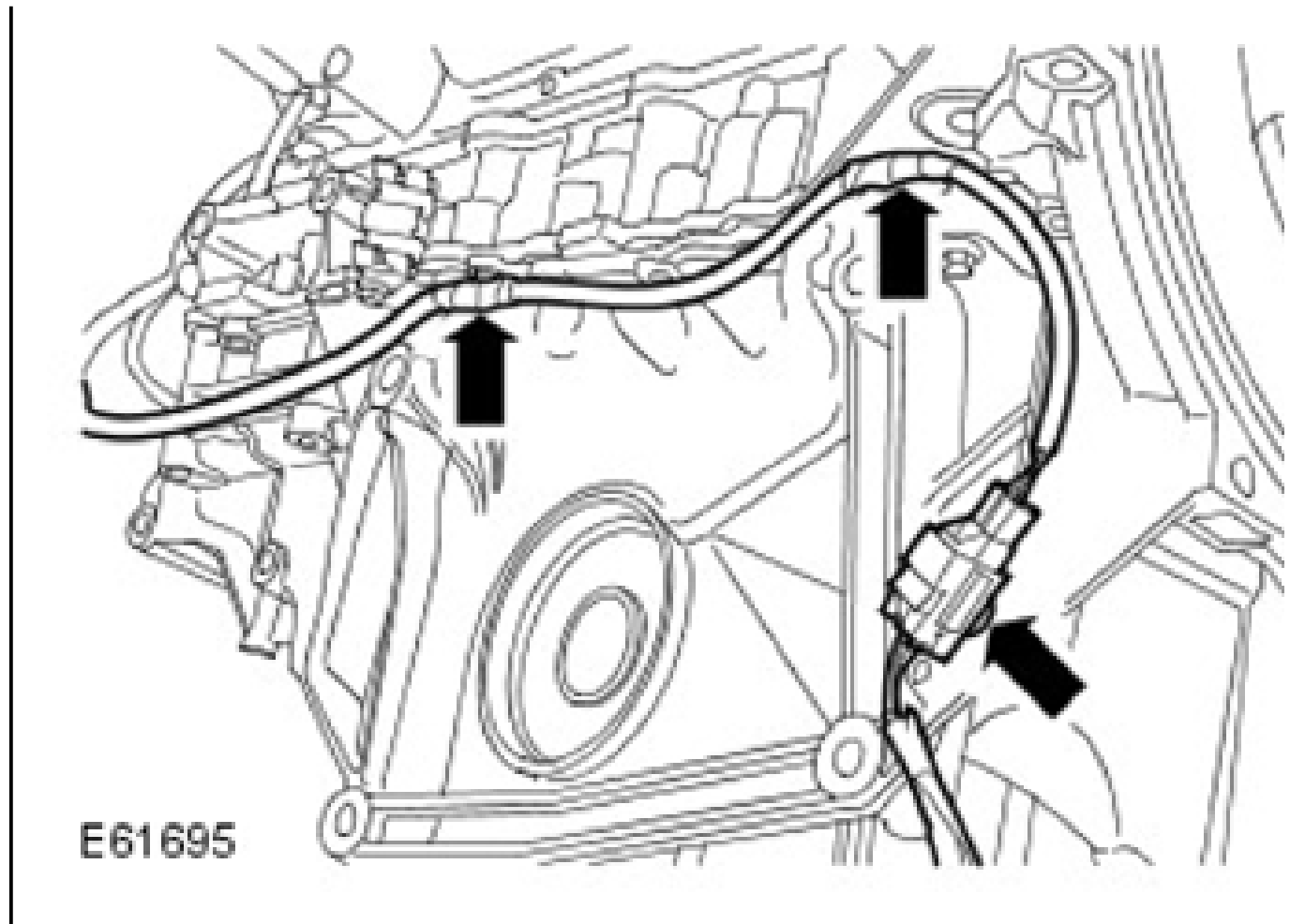


35. Install the CKP sensor.

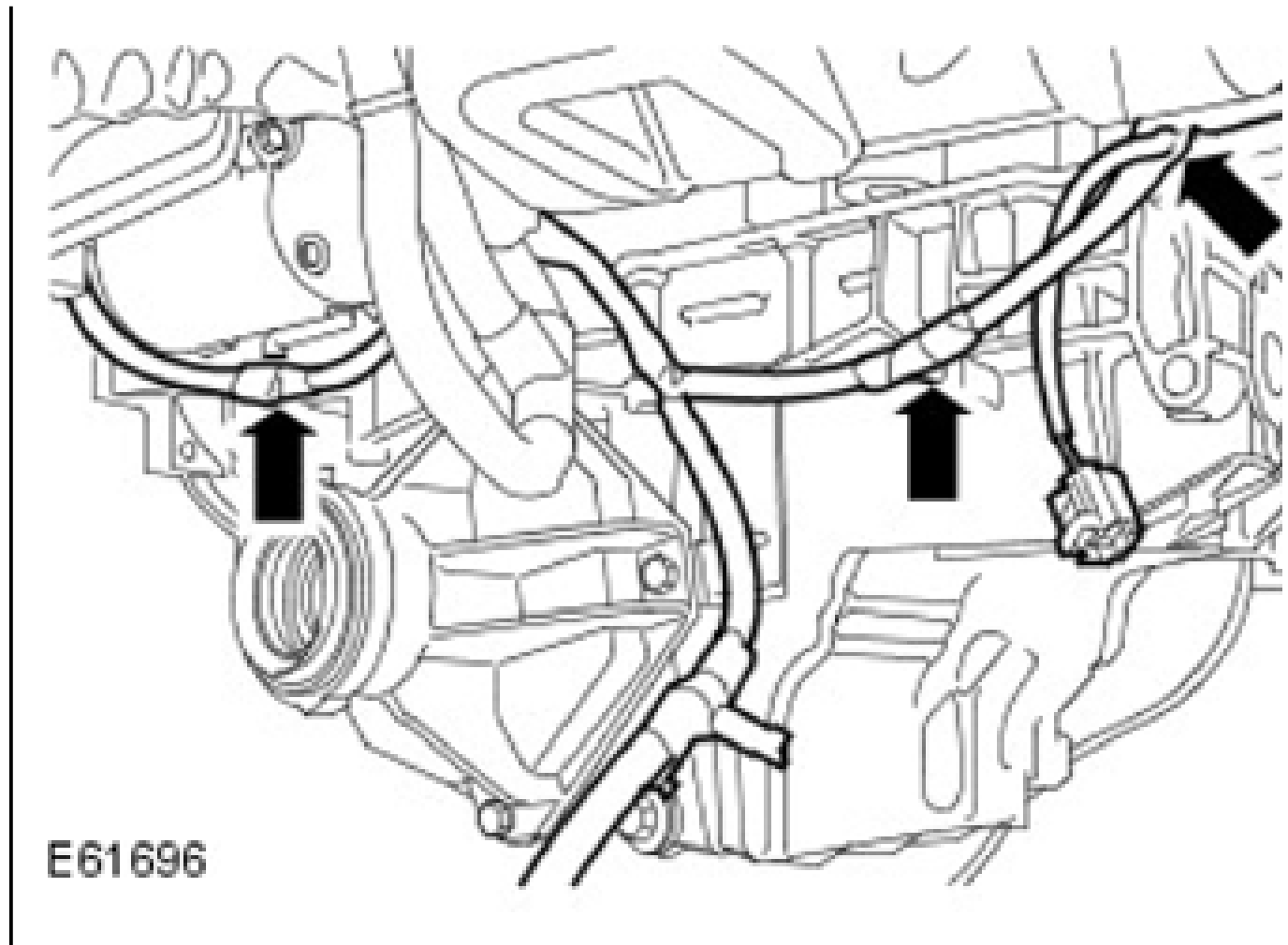
- Tighten the bolt to 8 Nm (6 lb.ft)

36. Attach the wiring harness to the LH side of the engine

- Secure the clips.



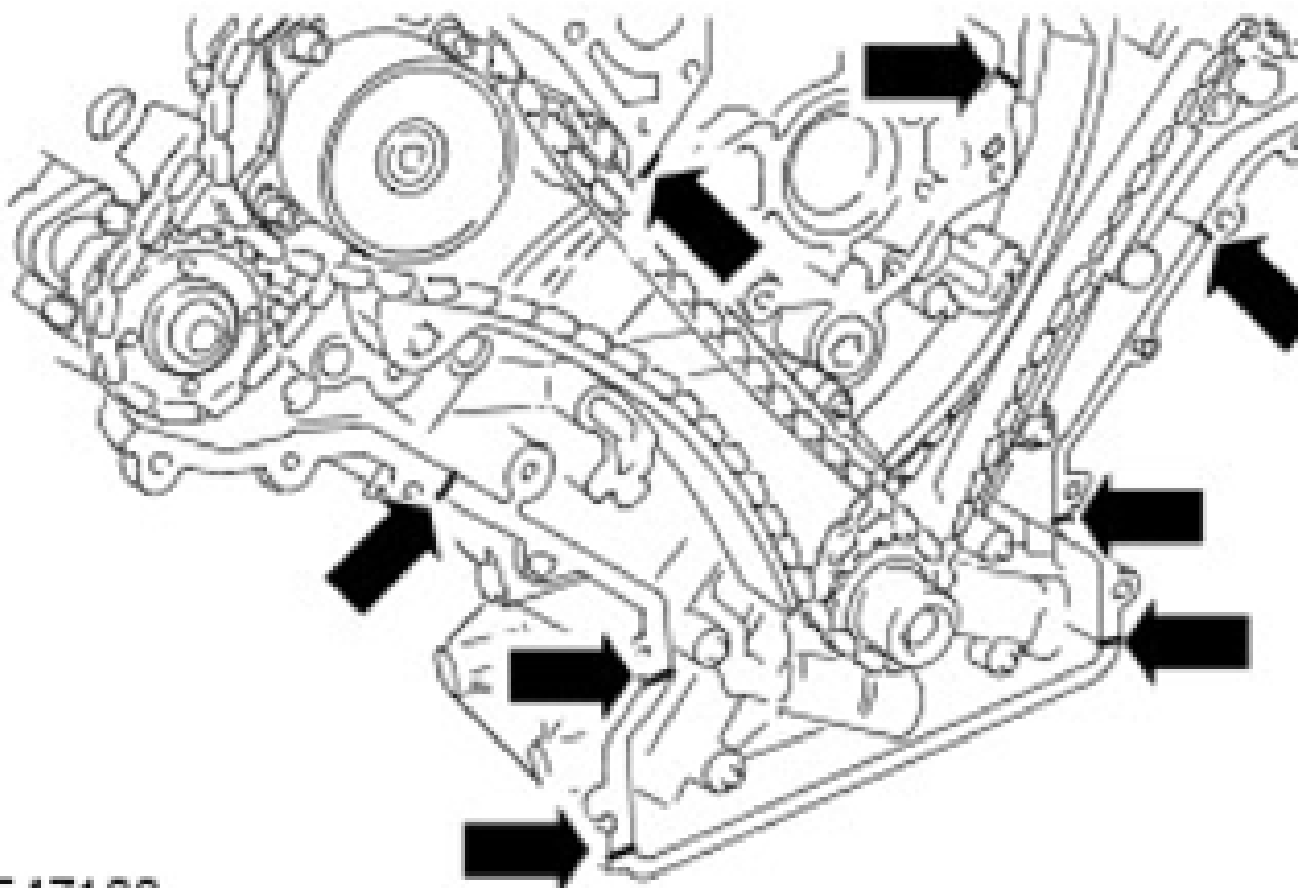
37. Attach the wiring harness to the RH side of the engine.
- Secure the clips.



38. Install the power steering pump mounting bracket.
- Tighten the bolts to 25 Nm (18 lb.ft).

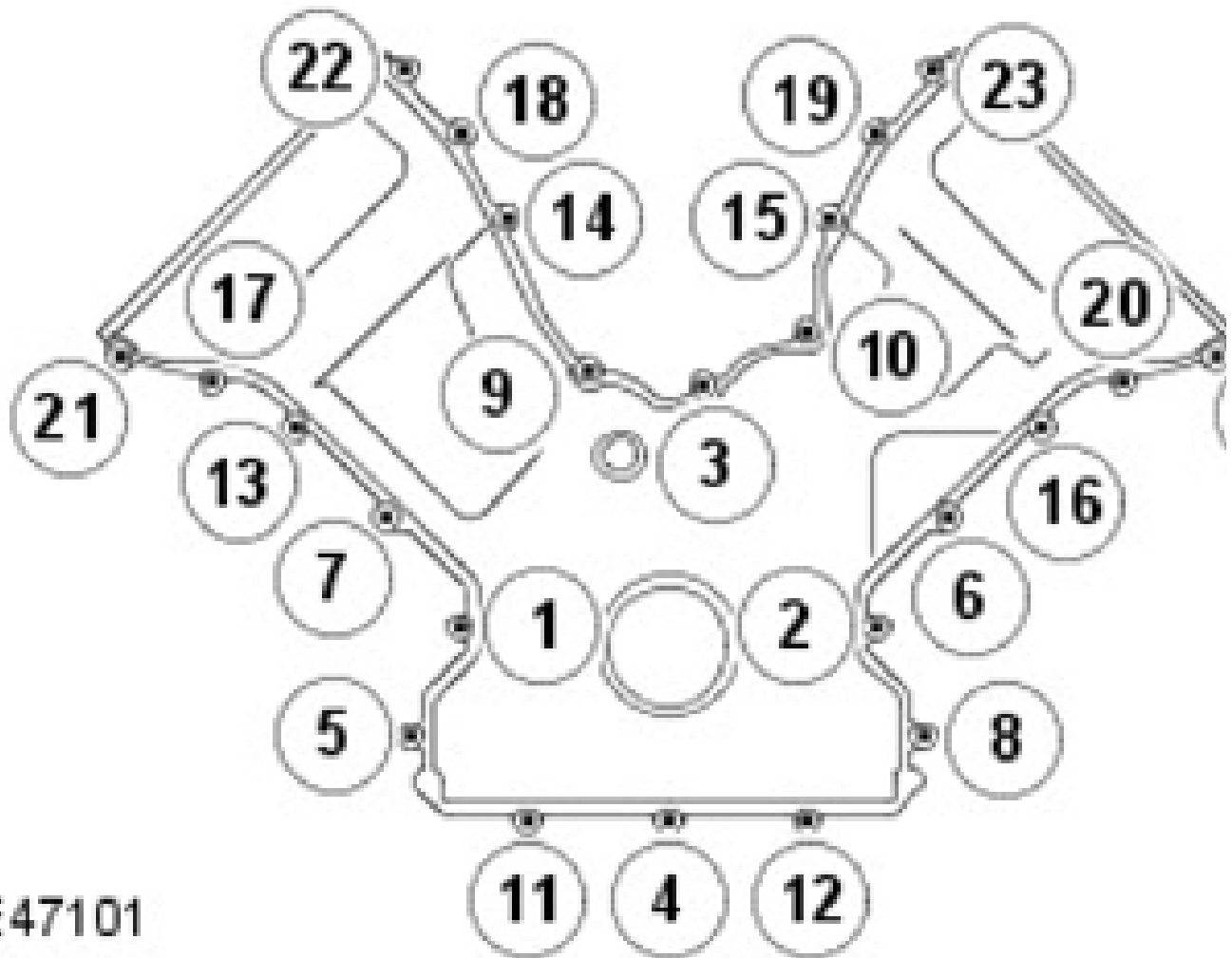
NOTE: **Install a new gasket.**
 Install a new O-ring seal.

39. Install the engine front cover.
- Clean the component mating faces.
 - Apply a 3 mm (0.118 in) diameter bead of sealant 12mm (0.47 in) long, to the 8 places indicated.
 - Install the gasket.
 - Install the O-ring seal.



E47100

40. Evenly and progressively tighten the bolts in the sequence shown to 12 Nm (9 lb.ft).



E47101

41. Attach the engine wiring harness.
- Secure the clips.
 - Tighten the bolt to 10 Nm (7 lb.ft).

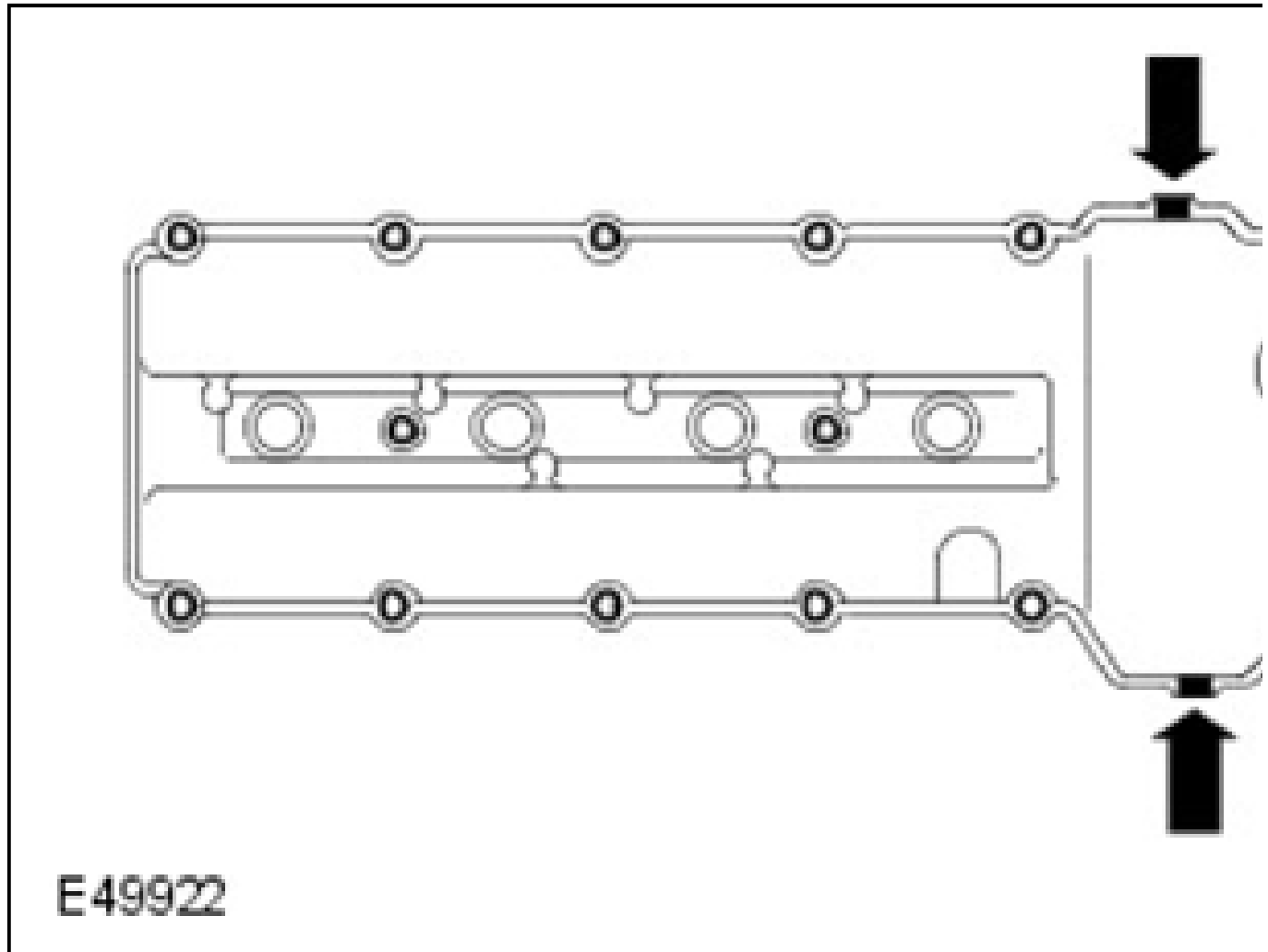
NOTE: Install new seals.

42. Install the LH valve cover plug aperture seals.

NOTE: Install a new gasket.
 Apply two beads of silicone gasket sealant as shown on the illustration. The application of the sealant must be 3 mm (0.118 in) diameter 12 mm (0.47 in) long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

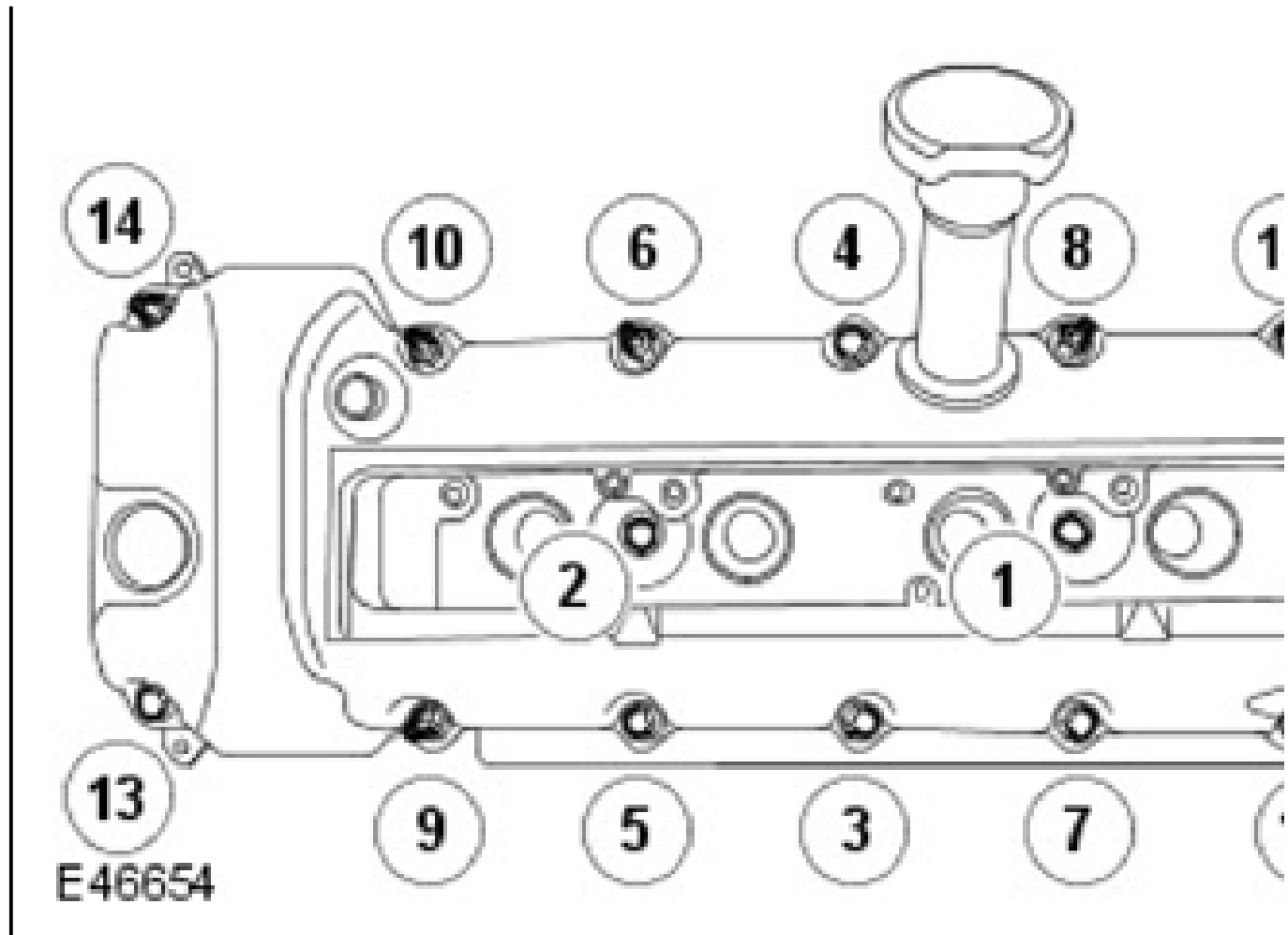
43. Install the LH valve cover.

- Clean the component mating faces.
- Install the valve cover gasket.



44. Install the LH valve cover bolts.

- Install the LH valve cover bolts to the positions previously noted.
- Tighten the bolts in the sequence shown to 12 Nm (9 lb.ft).



45. Connect the LH VCT oil solenoid electrical connector.
46. Attach the engine wiring harness to the retaining bracket.

NOTE: Install a new O-ring seal.

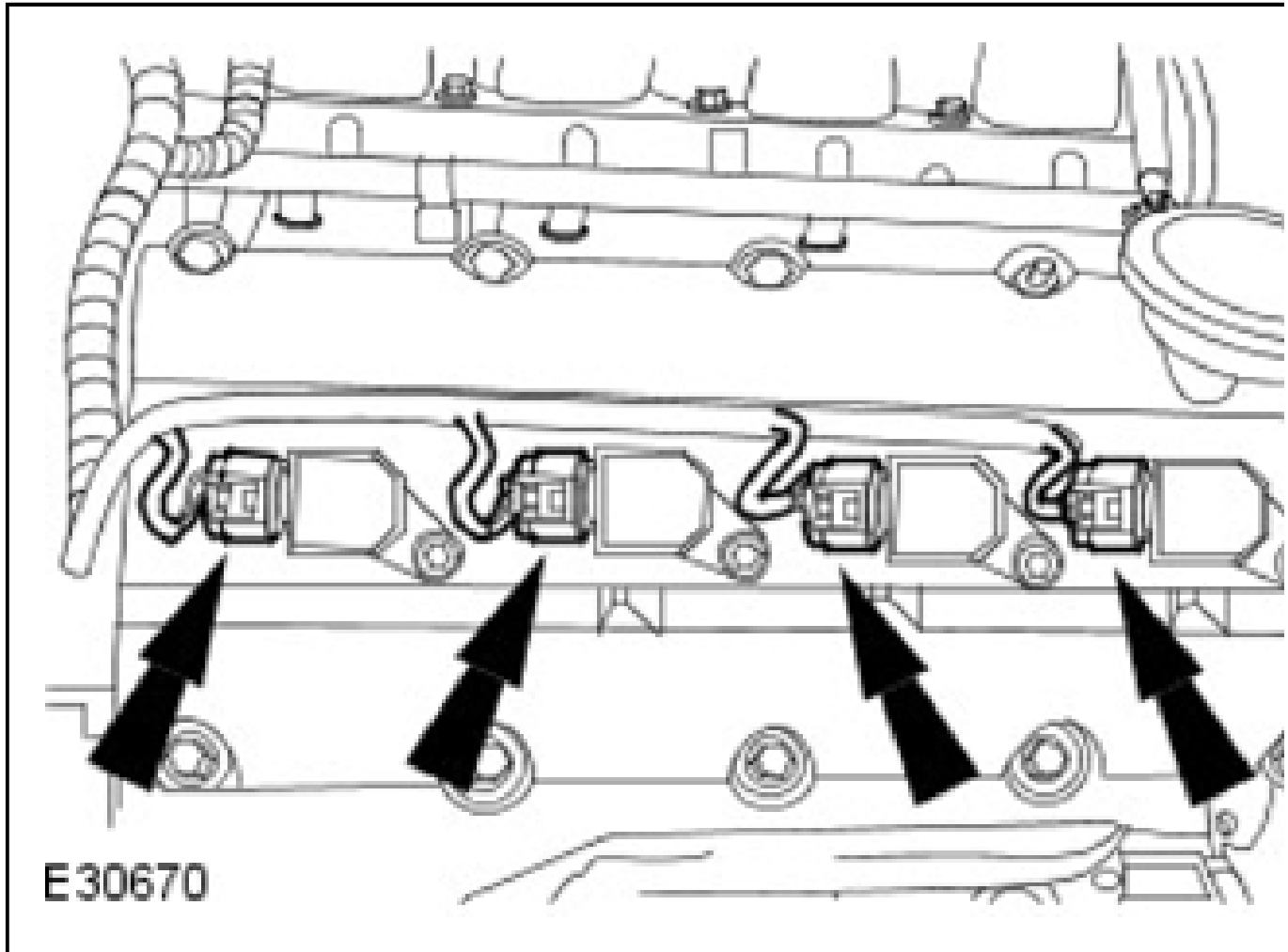
47. With assistance, install the oil level indicator and tube.
 - Clean the component mating faces.
 - Install the O-ring seal.
 - Lubricate the O-ring seal with clean engine oil.
 - Tighten the nut to 6 Nm (4 lb.ft).

NOTE: Install new O-ring seals.

48. Install the 4 LH ignition coil-on-plugs.
 - Install the O-ring seals.
 - Install the 4 ignition coil-on-plugs.

- Tighten the bolts to 6 Nm (4 lb.ft).

49. Connect the 4 electrical connectors.



50. Install the LH ignition coil-on-plug cover.

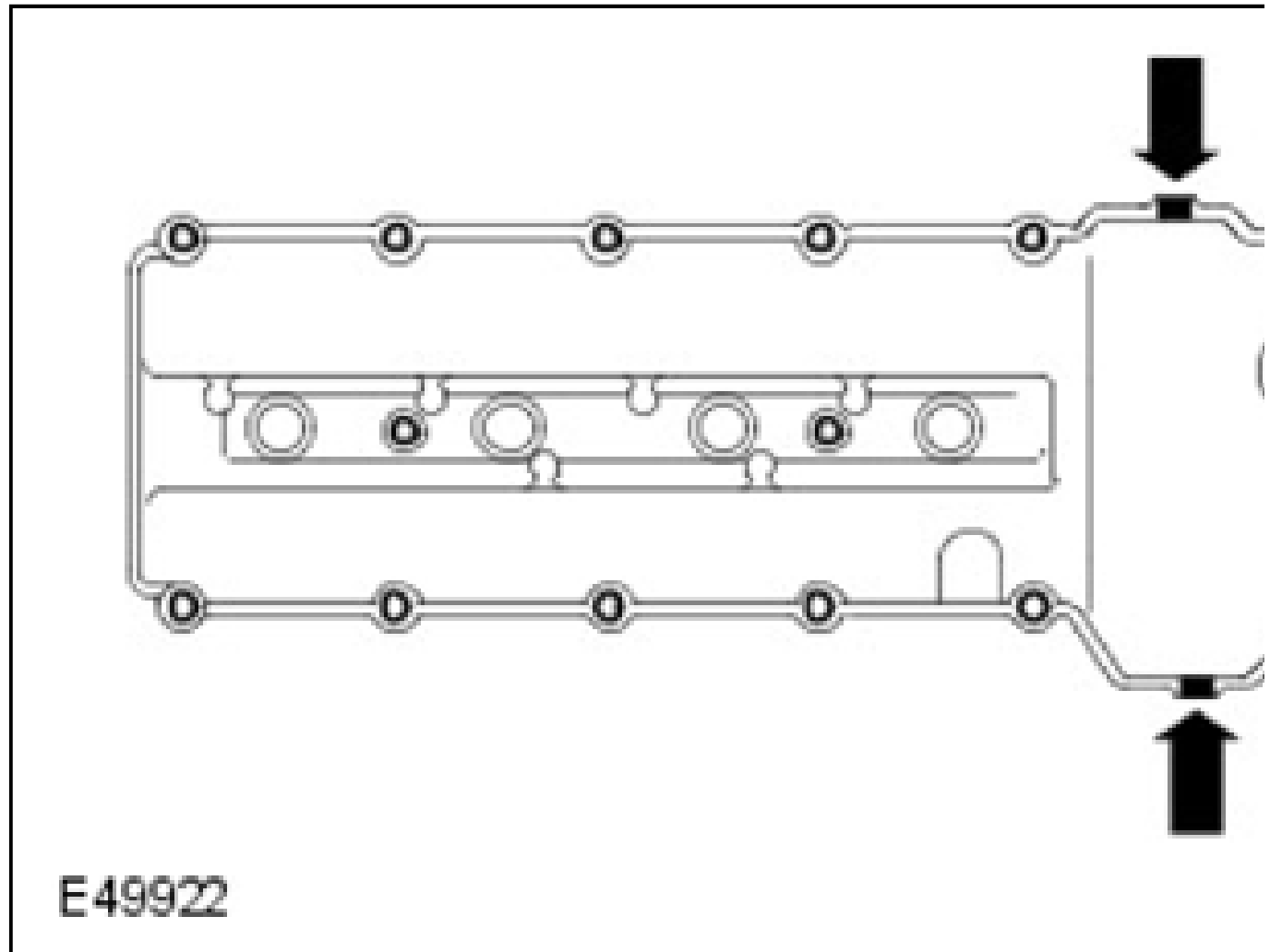
NOTE: Install new seals.

51. Install new RH valve cover plug aperture seals.

NOTE: Install a new gasket.
Apply two beads of silicone gasket sealant as shown on the illustration. The application of the sealant must be 3 mm (0.118 in) diameter 12 mm (0.47 in) long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

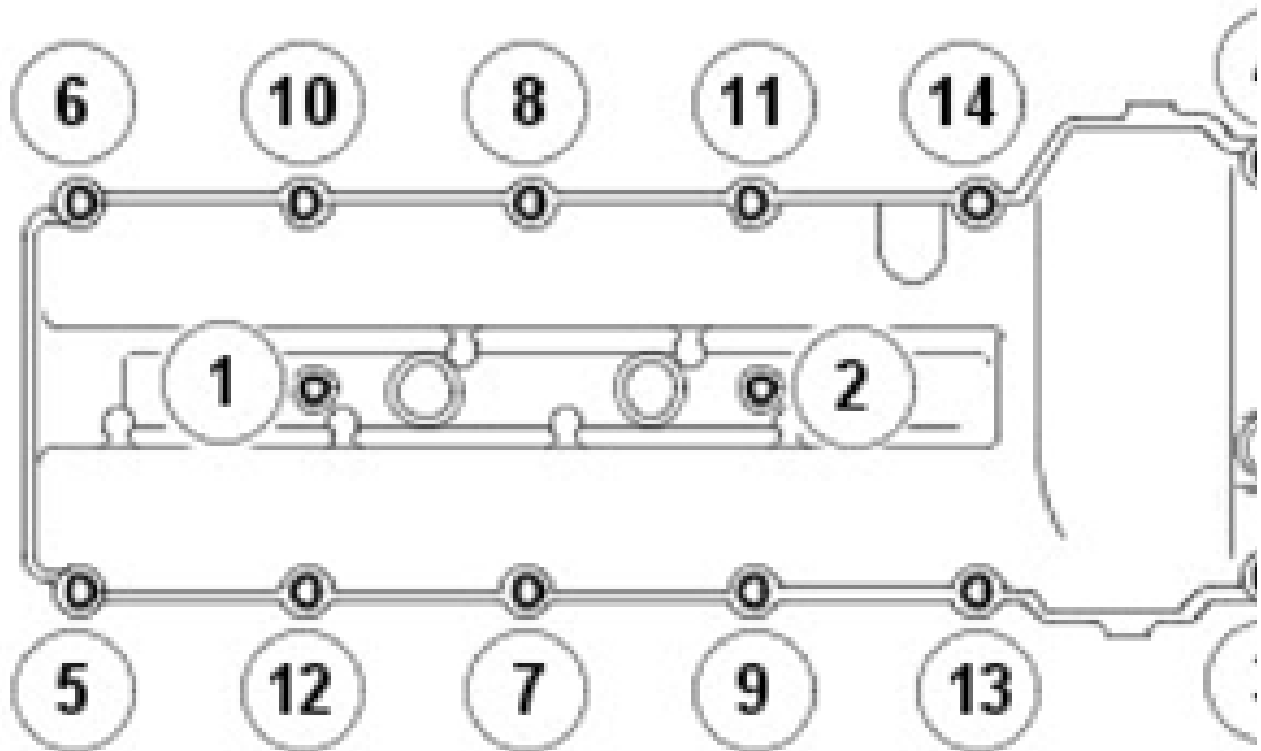
52. Install the RH valve cover.

- Clean the component mating faces.
- Install the gasket.



53. Install the RH valve cover bolts.

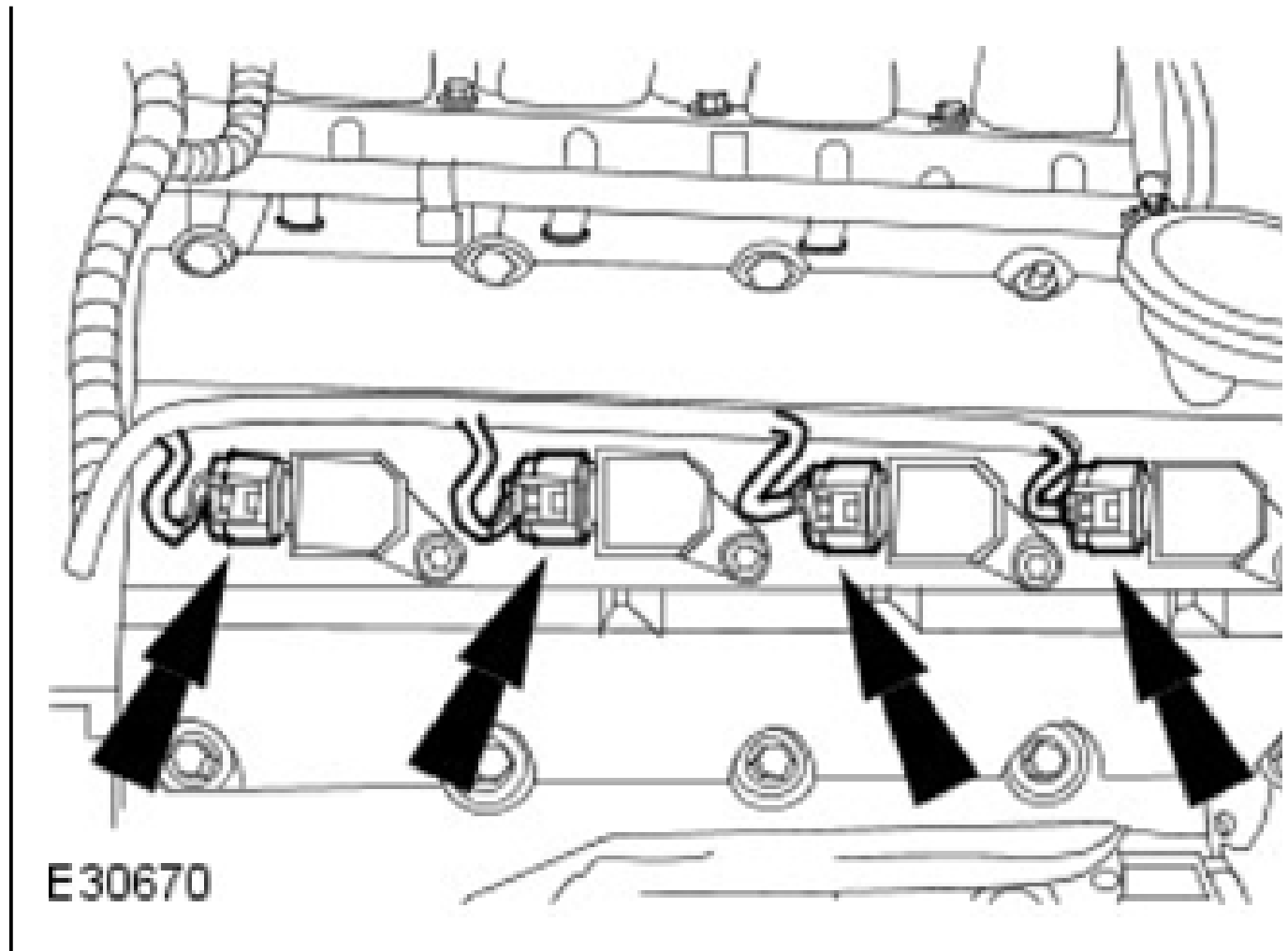
- Install the RH valve cover bolts to the positions previously noted.
- Tighten the bolts in the sequence shown to 12 Nm (9 lb.ft).



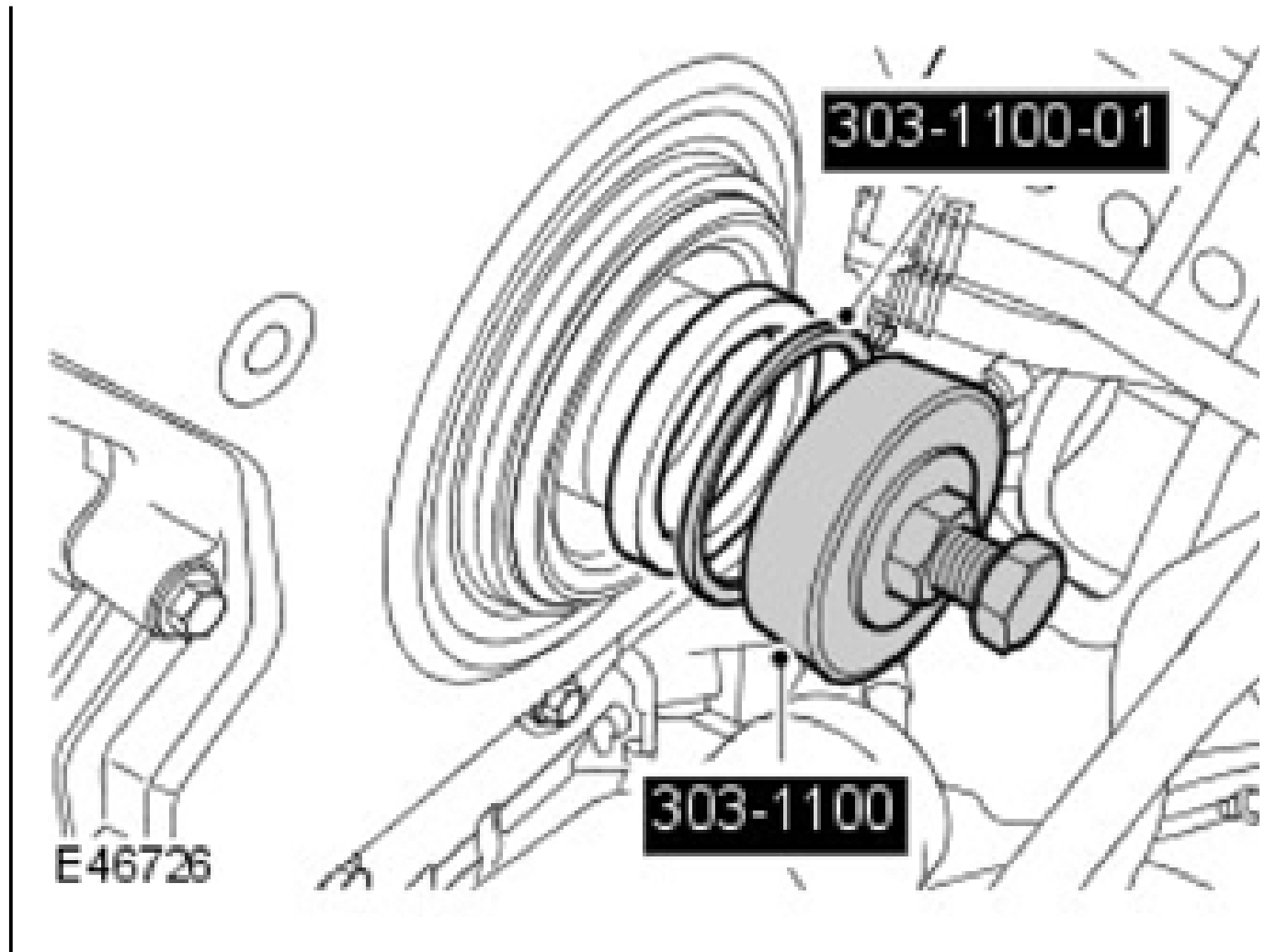
E46679

NOTE: Install new O-ring seals.

54. Install the 4 RH ignition coil-on-plugs.
 - Install the O-ring seals.
 - Install the 4 ignition coil-on-plugs.
 - Tighten the bolts to 6 Nm (4 lb.ft).
55. Connect the 4 electrical connectors.



56. Connect the RH VCT oil solenoid electrical connector.
57. Attach the engine wiring harness to the retaining bracket.
58. Connect the PCV line to the RH valve cover.
59. Clean the crankshaft pulley mating faces.
60. Using the special tool, install the crankshaft front seal.
 - Lubricate the seal with clean engine oil.
 - Use the discarded crankshaft bolt with the special tool.
 - Remove the special tools.



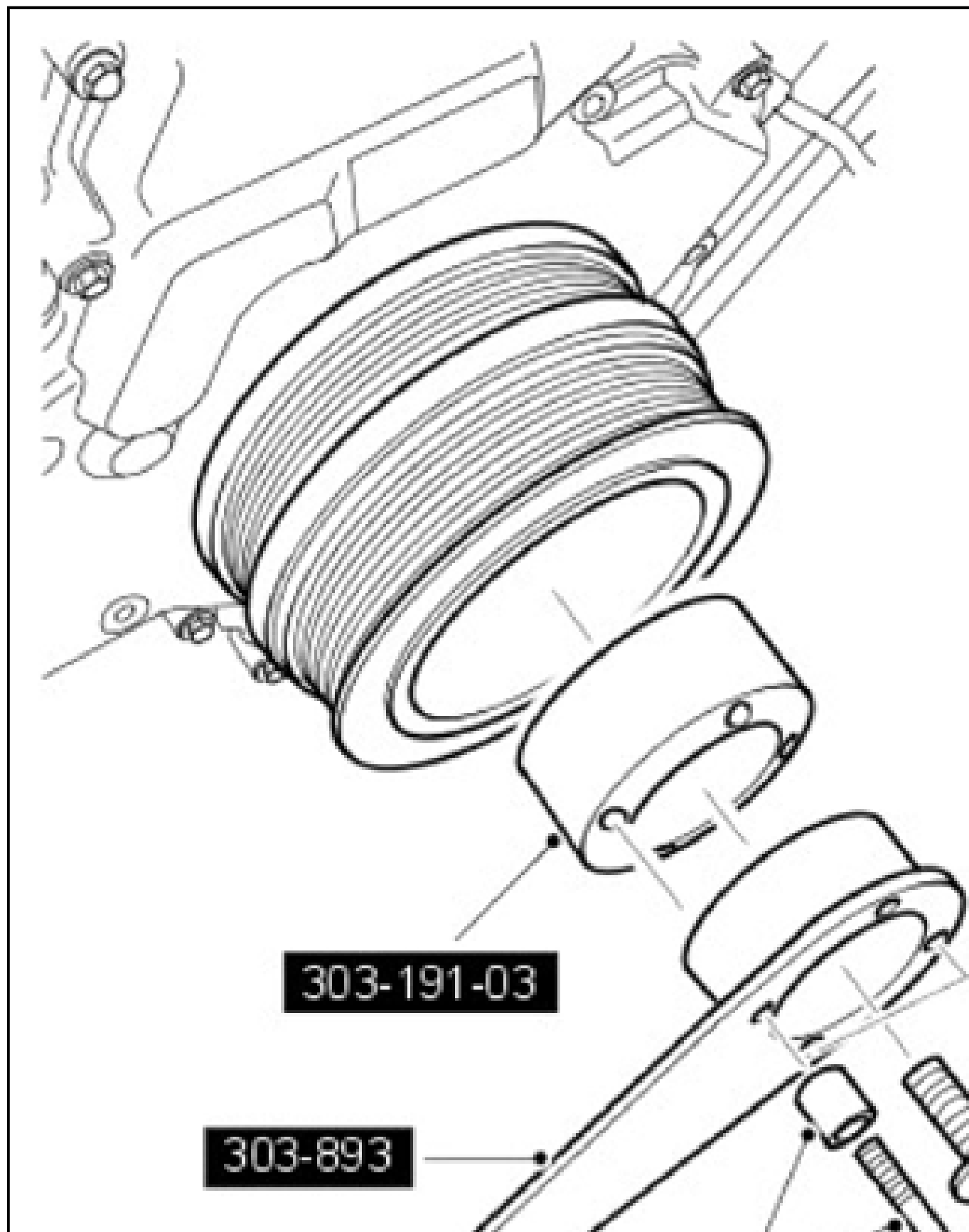
61. Install the crankshaft pulley.
 - Lubricate the seal with clean engine oil.
62. Install the crankshaft pulley locking ring.

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

63. Install, but do not tighten, the new crankshaft pulley bolt.

CAUTION: Under no circumstances should the crankshaft setting peg, 303-645, be used in the following operations, to restrain the crankshaft.

64. Using the special tools, tighten the crankshaft pulley bolt.
 - Tighten the crankshaft pulley bolt to 380 Nm (280 lb.ft).
 - Remove the special tools.



65. Install the oil filter housing.
 - Clean the component mating faces.
 - Install a new O-ring seal.
 - Tighten the bolts to 20 Nm (15 lb.ft).
66. Install the engine oil filter.
 - Lubricate the oil filter seal with clean engine oil and tighten to 18 Nm (13 lb.ft).
67. Connect the EOP sensor electrical connector.
68. Connect the engine oil temperature sensor electrical connector.
69. Install the generator mounting bracket.
 - Tighten the 4 bolts to 45 Nm (33 lb.ft).
70. Install the generator.
 - Tighten the 3 bolts to 48 Nm (35 lb.ft).
 - Connect the electrical connector.
71. Connect the battery positive cable.
 - Tighten the nut to 10 Nm (7 lb.ft).
 - Install the battery positive cable cover.
72. Install the exhaust manifold heat shield.
 - Tighten the 2 bolts.
73. Install the accessory drive belt idler pulleys.
 - Tighten the bolts to 25 Nm (18 lb.ft).
74. Install the coolant pump pulley.
 - Tighten the bolts to 10 Nm (7 lb.ft).

NOTE: Install new O-ring seals.

75. Install the coolant manifold.
 - Clean the components.
 - Install the O-ring seals.
 - Connect the 4 coolant hoses and install the clips.
 - Attach the wiring harness bracket.
 - Tighten the Torx screws to 10 Nm (7 lb.ft).
76. Connect the ECT sensor electrical connector.
77. Install the cooling fan drive belt tensioner.
 - Tighten the bolt to 40 Nm (30 lb.ft).
78. Install the A/C compressor mounting bracket.
 - Tighten the bolts to 25 Nm (18 lb.ft).
79. Remove the engine from the engine stand.
80. Install the engine.

For additional information, refer to: ENGINE .

81. Connect the battery ground cable.

For additional information, refer to: SPECIFICATION .

REMOVAL

ENGINE

SPECIAL TOOL(S)



Engine lifting cradle
303-1144

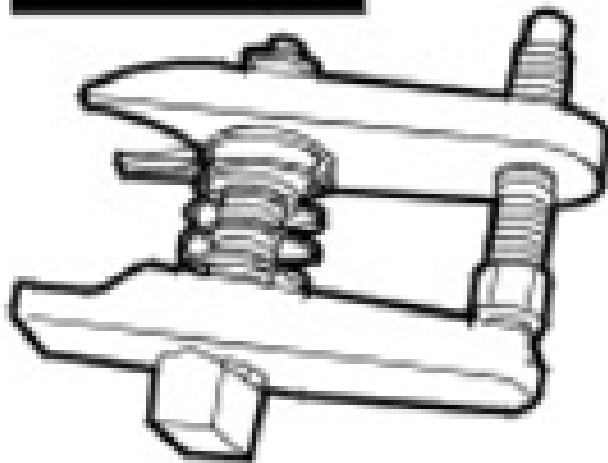
Fuel spring lock decoupling tool
310-D005

310-D005



E45289

205-754A



E45276

Ball joint separator
205-754(LRT-54-027)

REMOVAL

1. Position the vehicle on a lift.
2. Disconnect the battery ground cable.

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

3. Secure the hood in the service position.
4. Remove the battery tray.

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

5. Remove the auxiliary battery tray.

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

6. Remove the air cleaner assembly.

For additional information, refer to: **AIR CLEANER** .

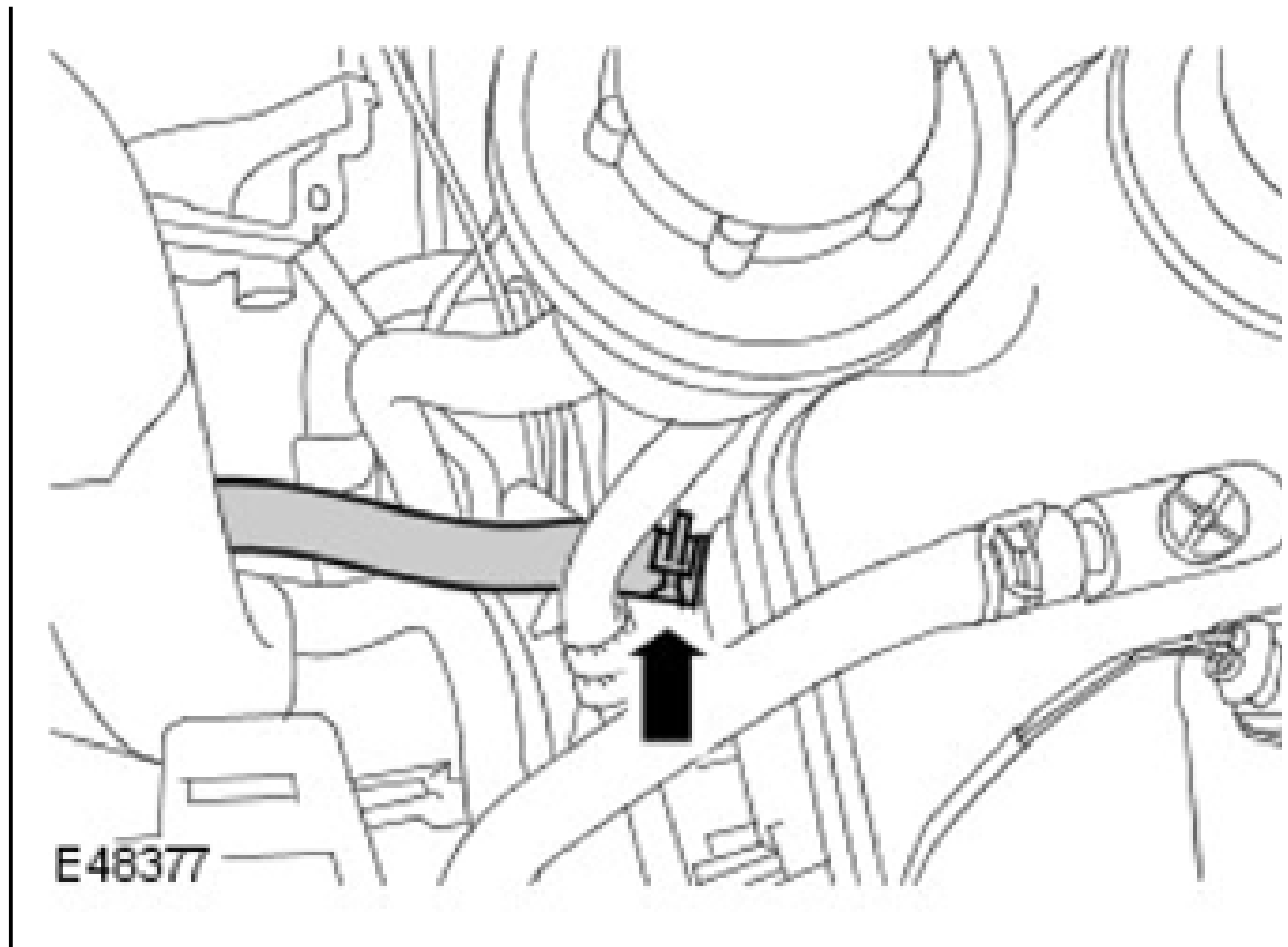
7. Remove the accessory drive belt.

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

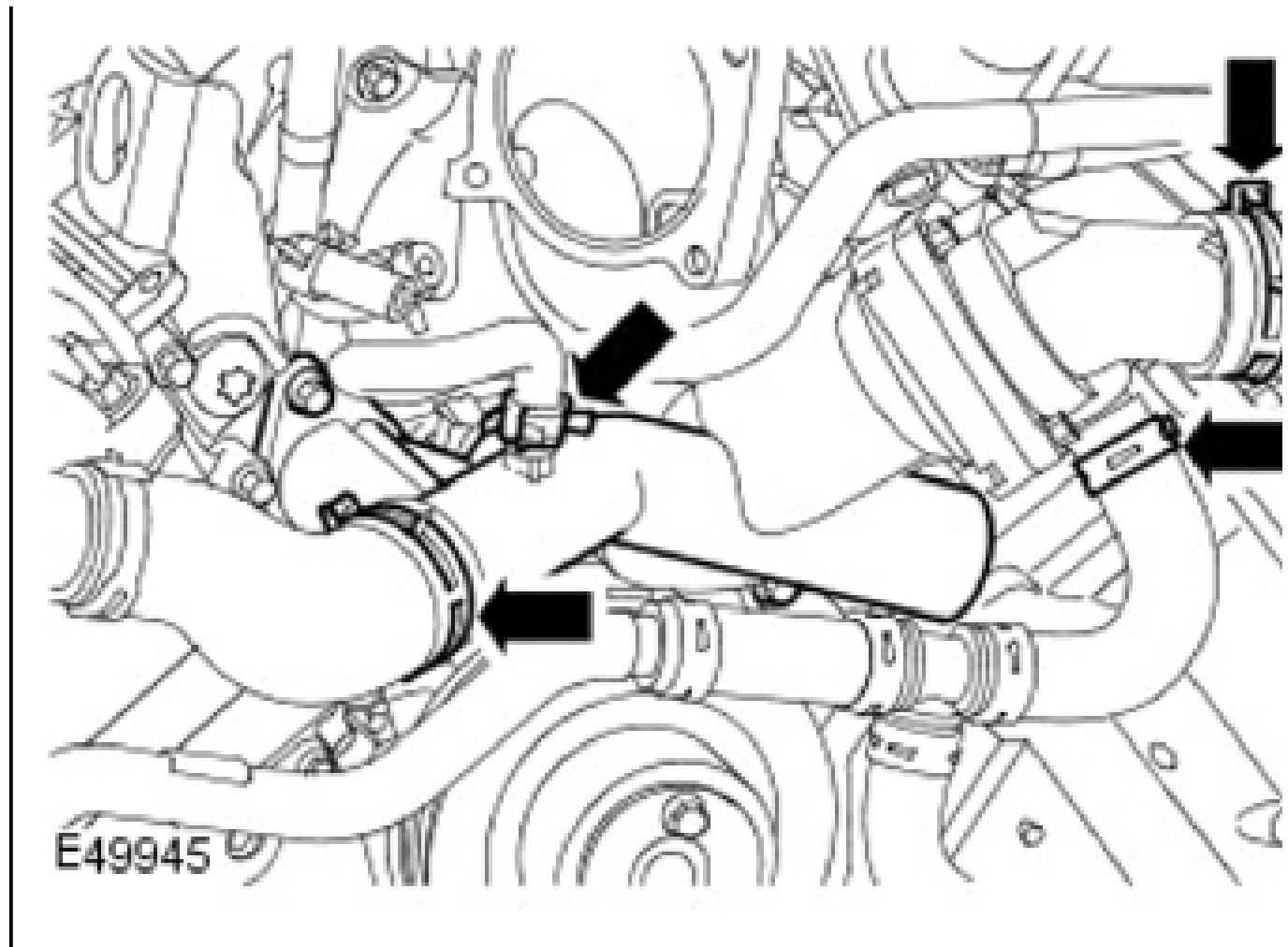
8. Drain the coolant.

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

9. Disconnect the coolant expansion tank lower hose.
 - Release the clip.

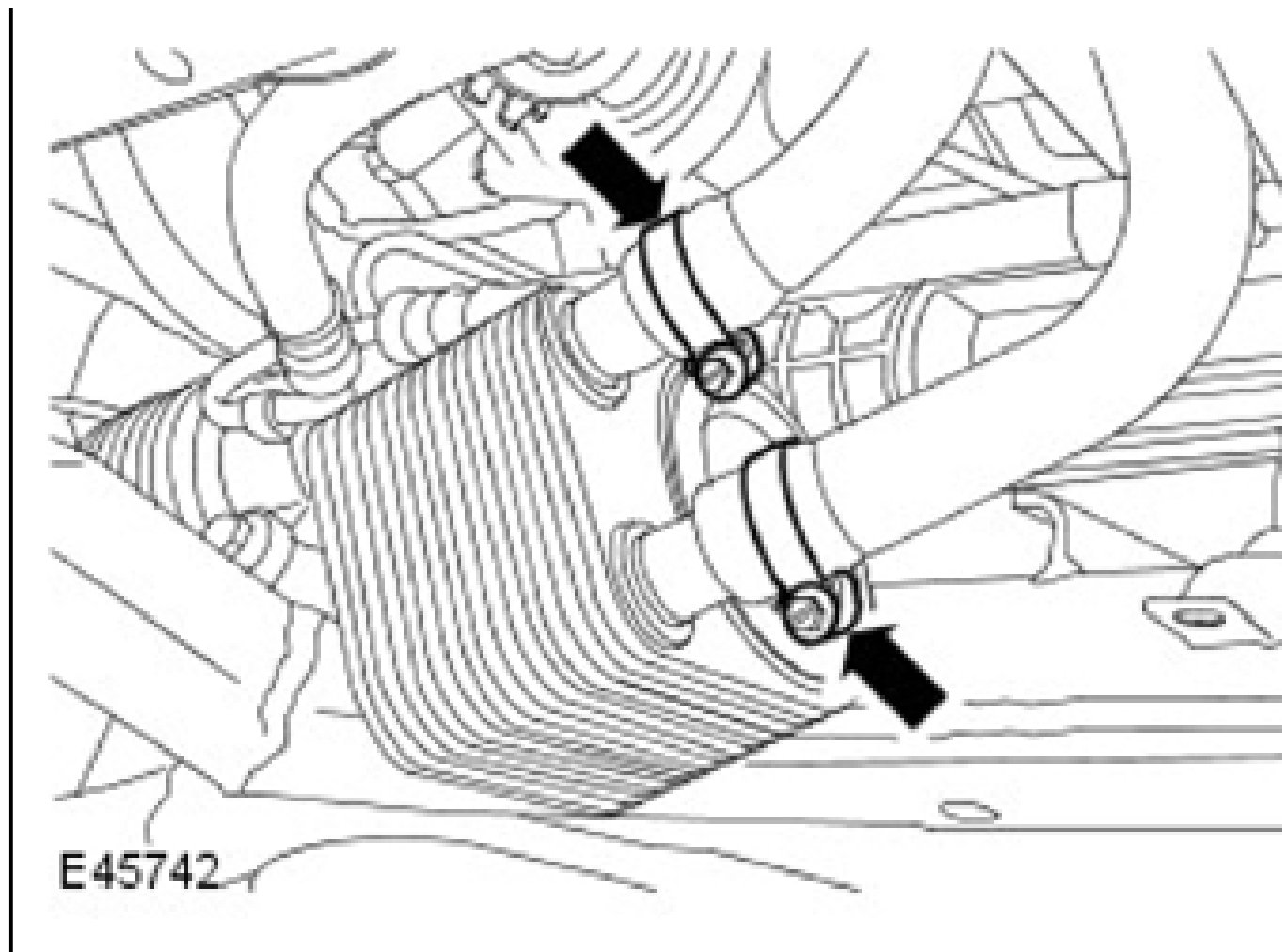


10. Disconnect the thermostat housing coolant hoses.
 - Release the 2 clips.
11. Disconnect the upper coolant hose assembly.
 - Release the 2 clips.

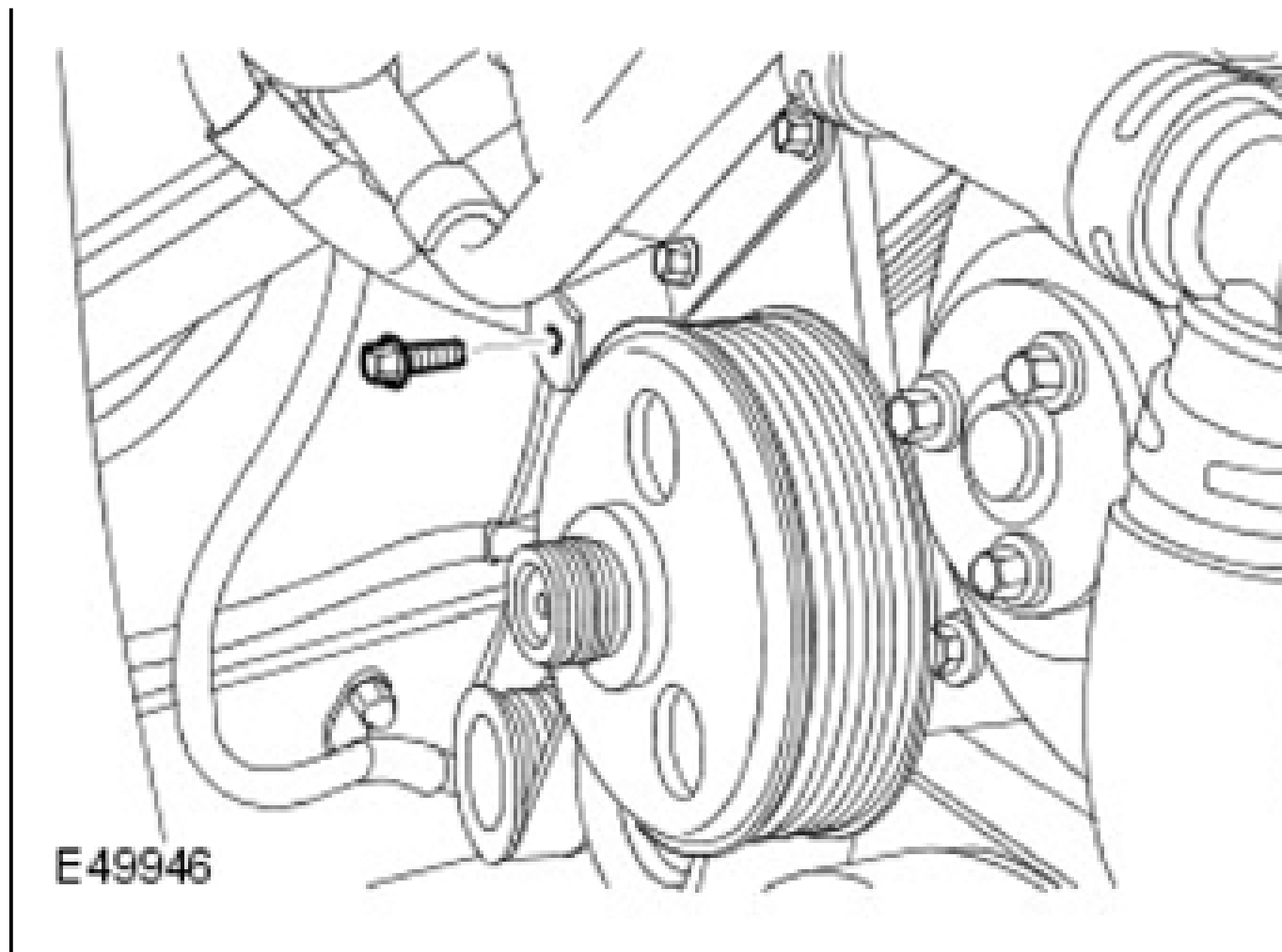


12. Disconnect the engine oil cooler coolant hoses.

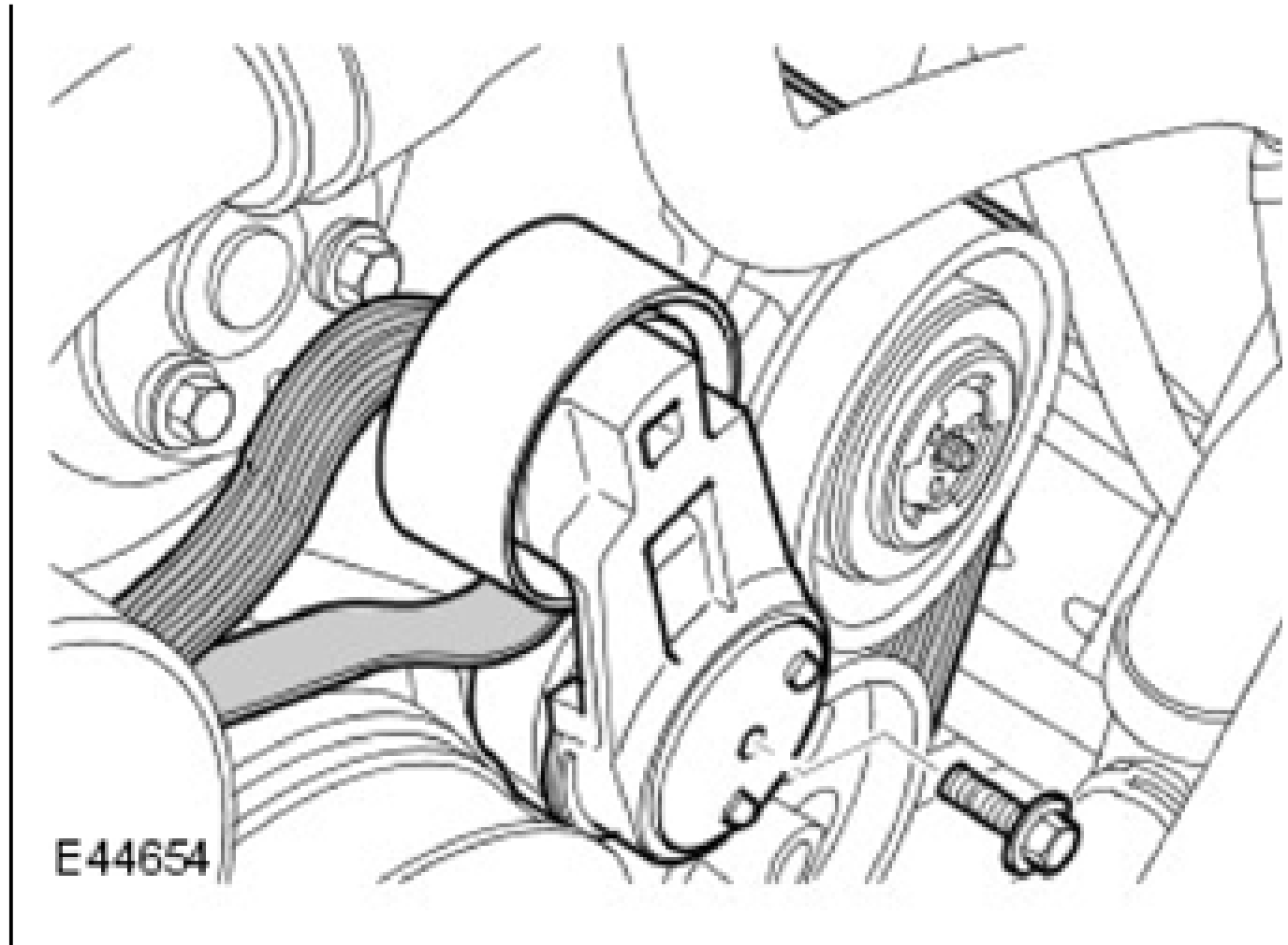
- Release the 2 clips.
- Remove the hose assembly.



13. Tie the hose assembly aside for access.
 - Remove the bolt.



14. Remove the accessory drive belt tensioner.
 - Remove the bolt.



15. Remove the fender splash shields.

For additional information, refer to: **FENDER SPLASH SHIELD** .

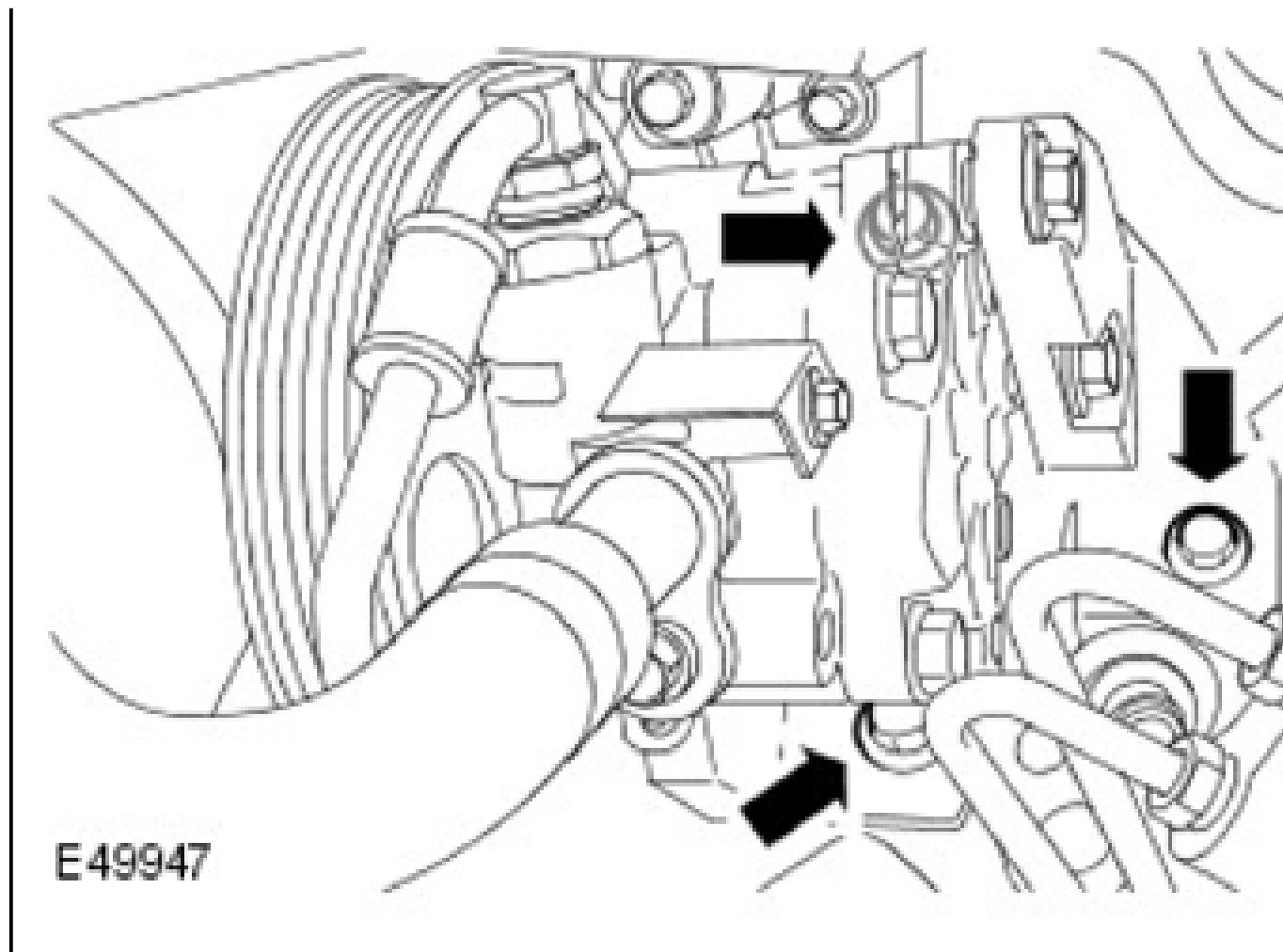
16. Remove the exhaust system.

For additional information, refer to: **EXHAUST SYSTEM** .

17. Drain the engine oil.

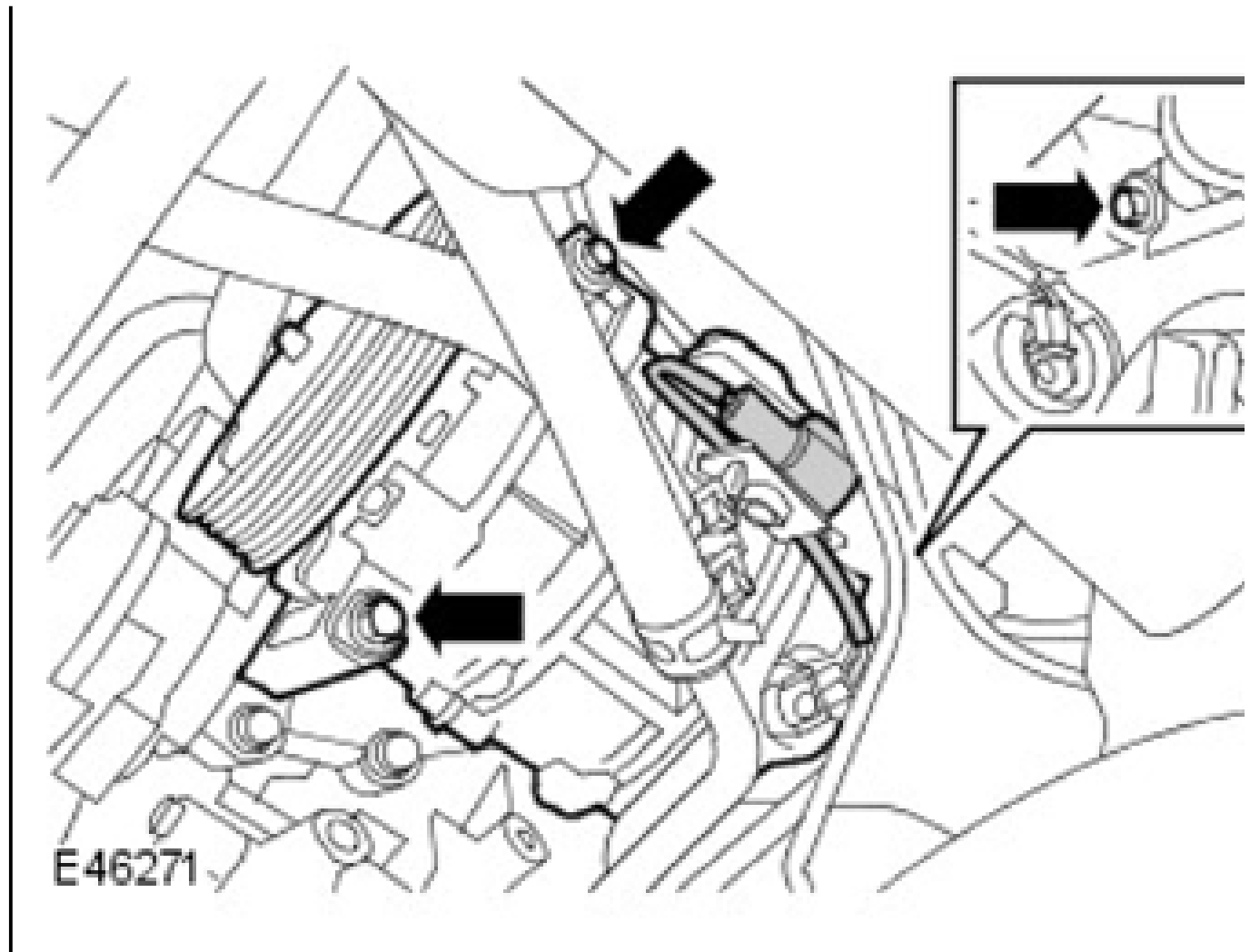
For additional information, refer to: **ENGINE OIL DRAINING AND FILLING** .

18. Release the power steering pump and tie aside
- Remove the 3 bolts.



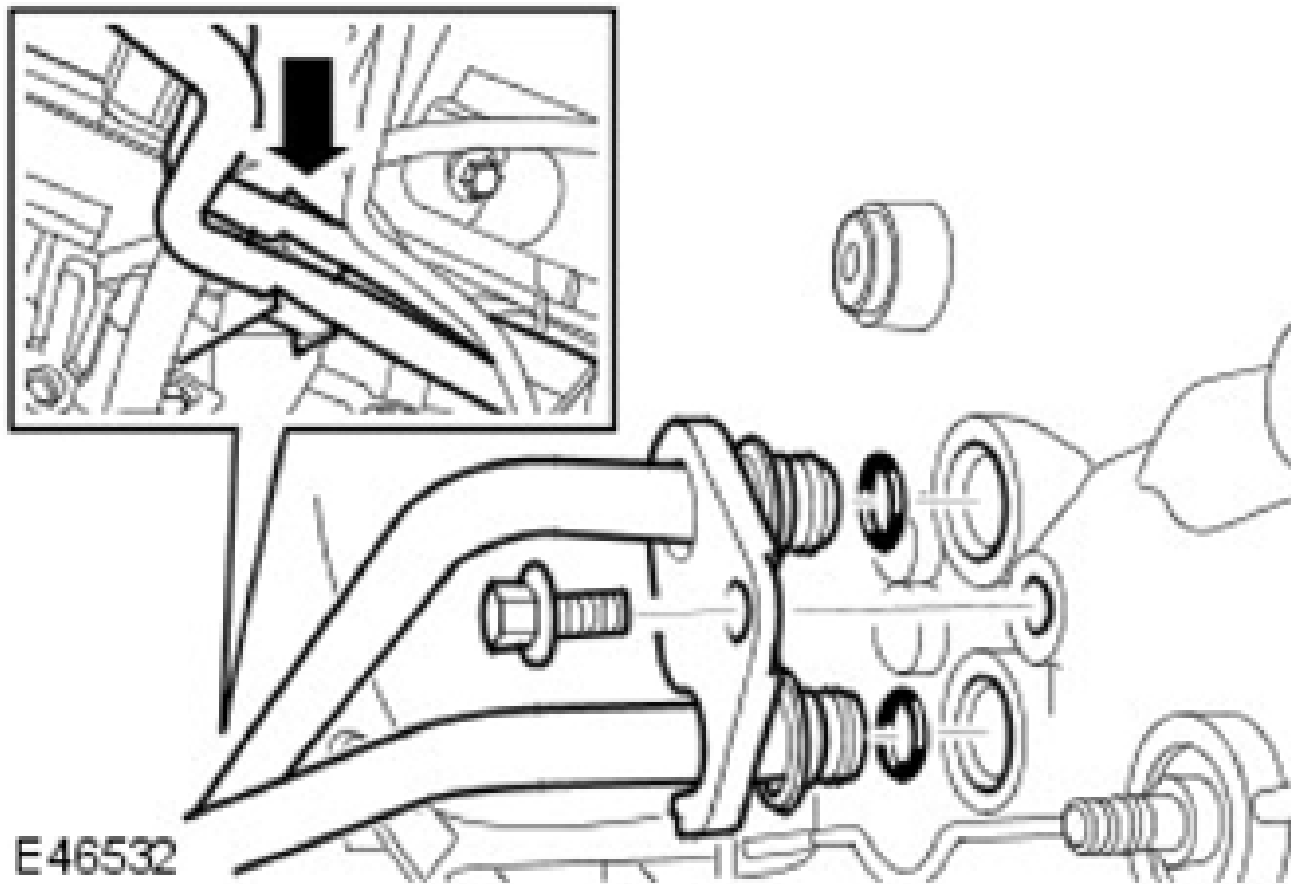
19. Release the A/C compressor and tie aside.

- Remove the 3 bolts.



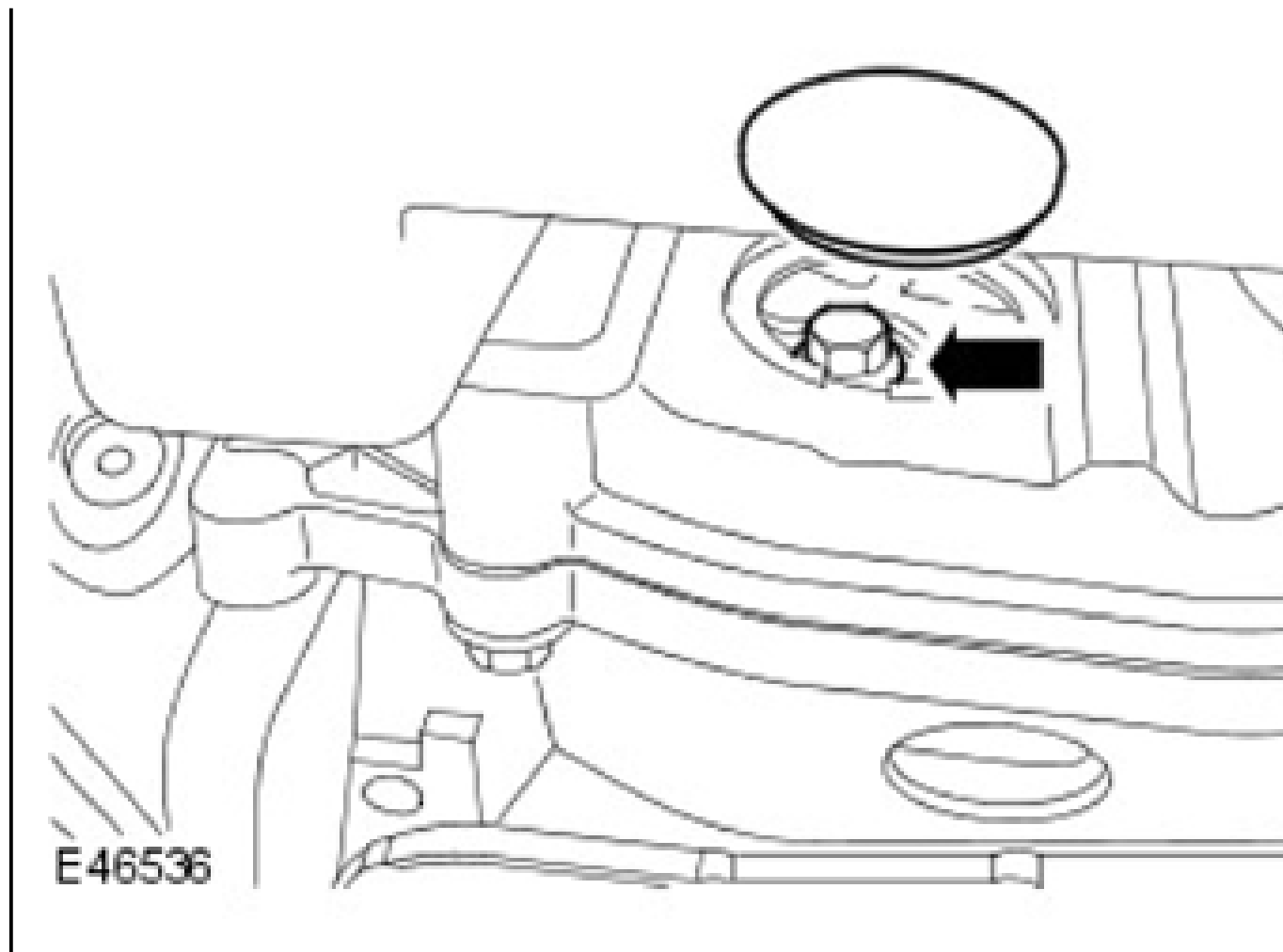
20. Release the transmission cooler pipes.

- Position a container to collect the fluid.
- Remove the bolt.
- Release the 2 clips.
- Move the transmission pipes aside.



21. Release the flexplate.

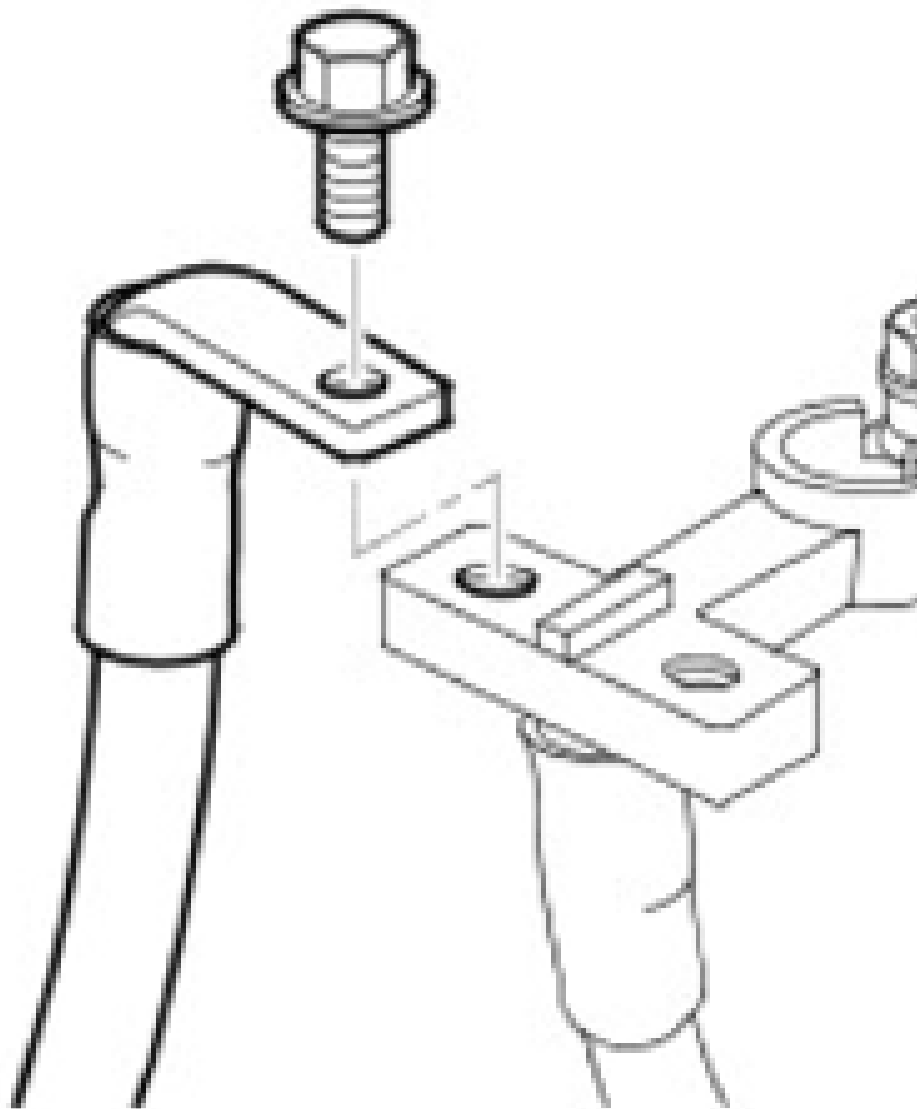
- Remove the grommet.
- Rotate the crankshaft to access the retaining bolts.
- Remove the 3 bolts.



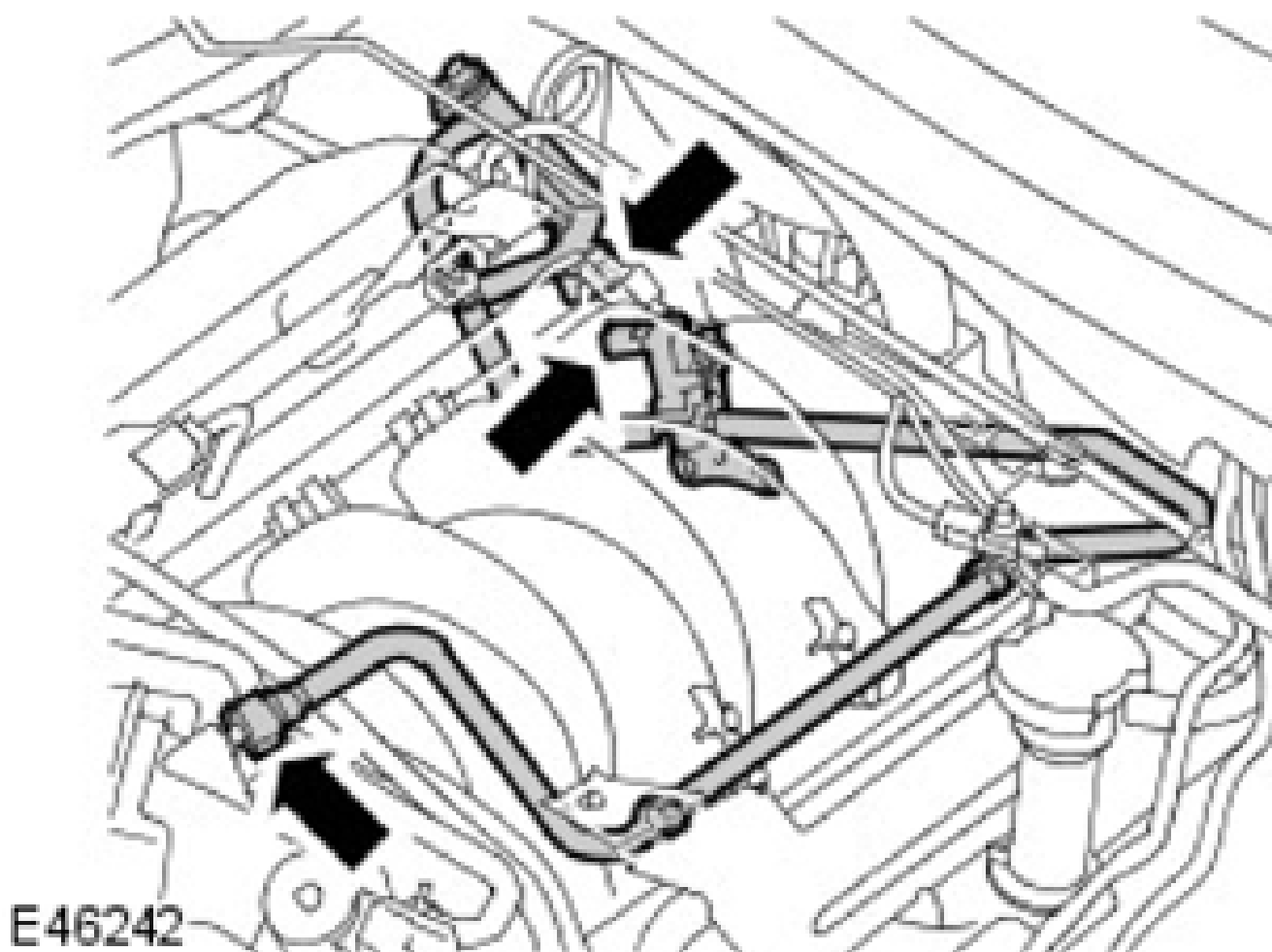
22. Disconnect the battery positive cable from the BJB.

- Remove the bolt.
- Position the positive cable aside.

E49948

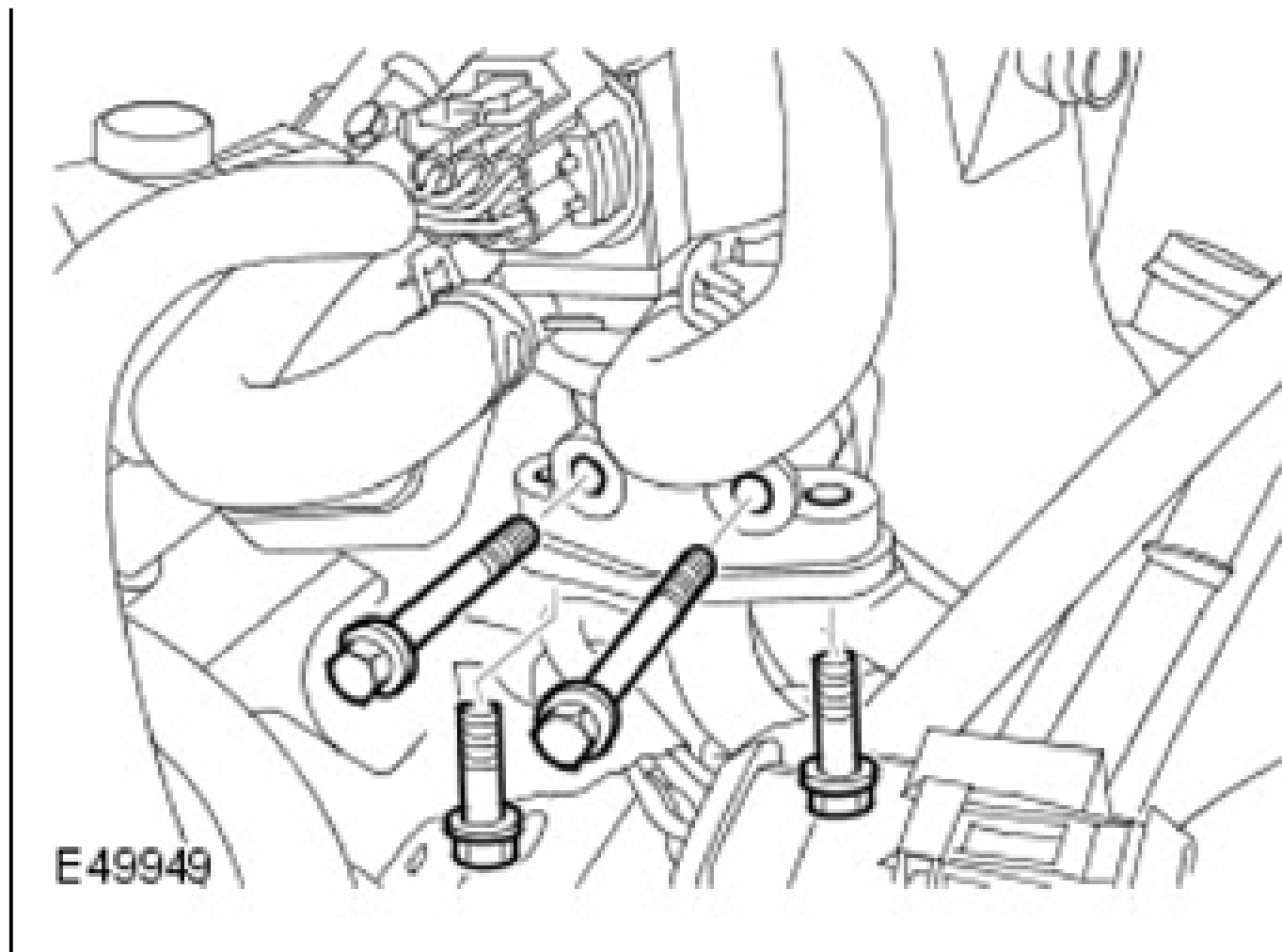


23. Disconnect the evaporative emission hose from the intake manifold assembly.
- Position the hose aside for access.

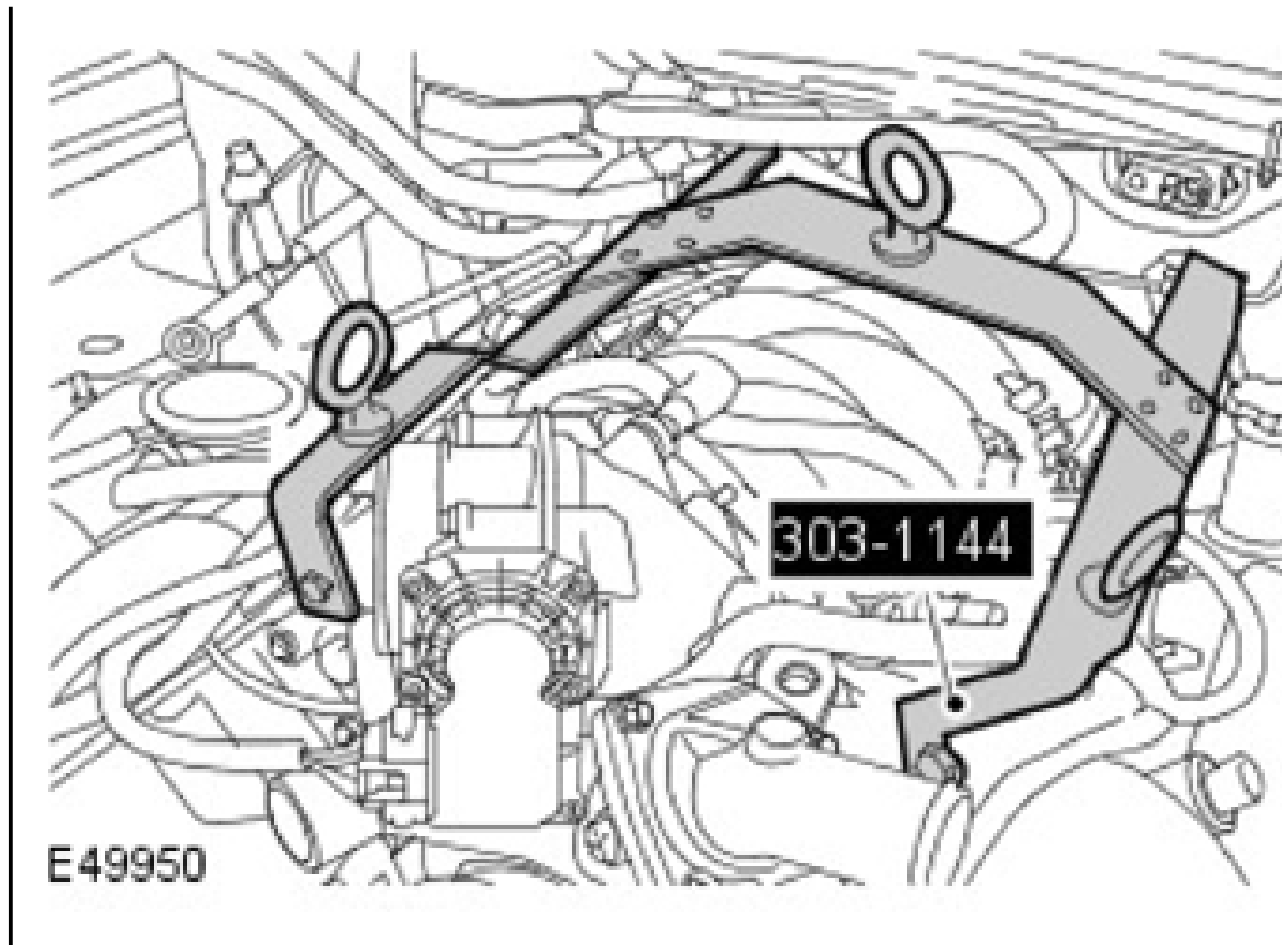


CAUTION: Before the disconnection or removal of any components, ensure the area around joint faces and connections are clean. Plug any open connections to prevent contamination.

24. Position the EGR valve aside.
- Remove the 4 bolts.
 - Remove and discard the gasket.

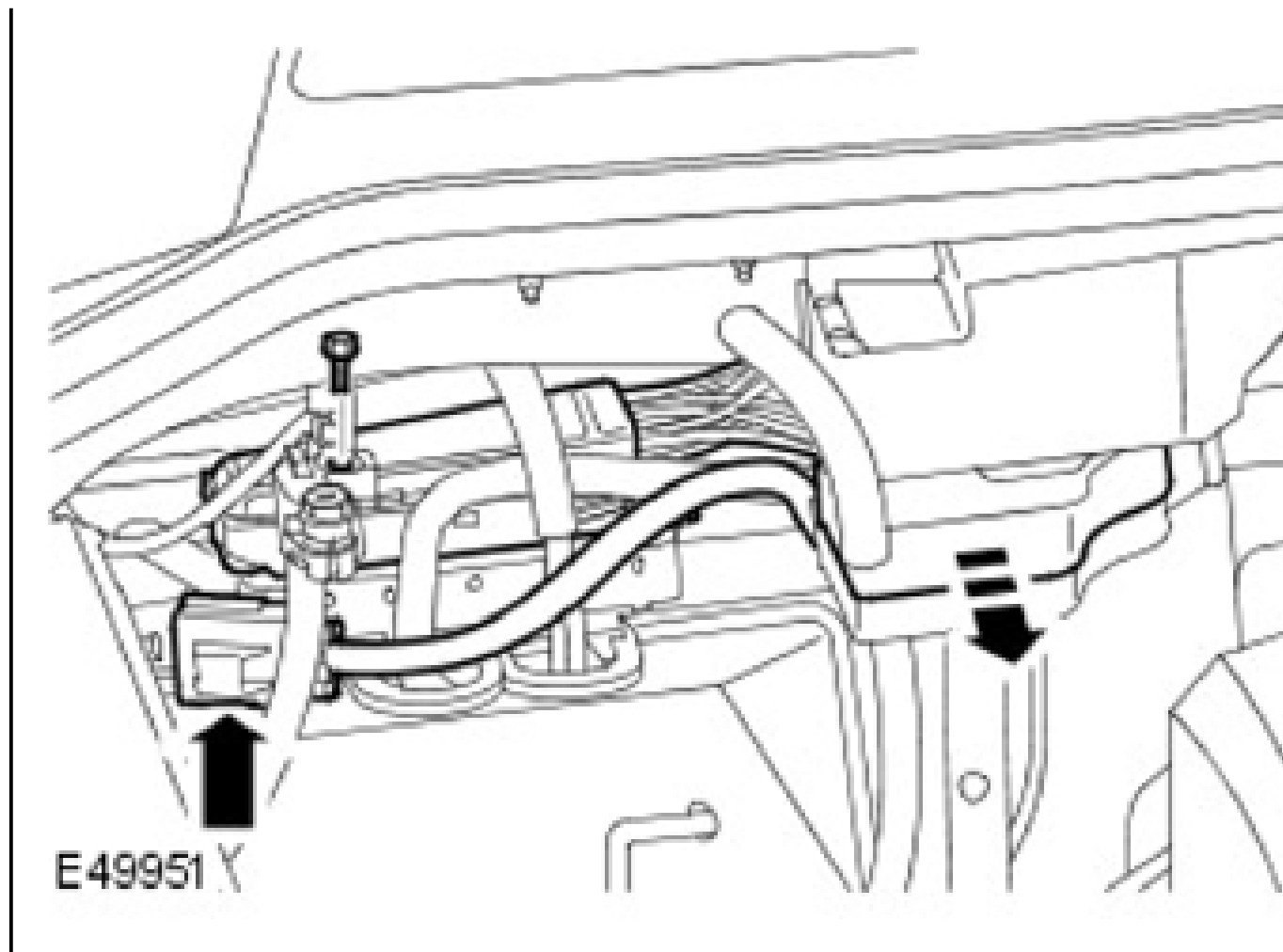


25. Install the special tool.

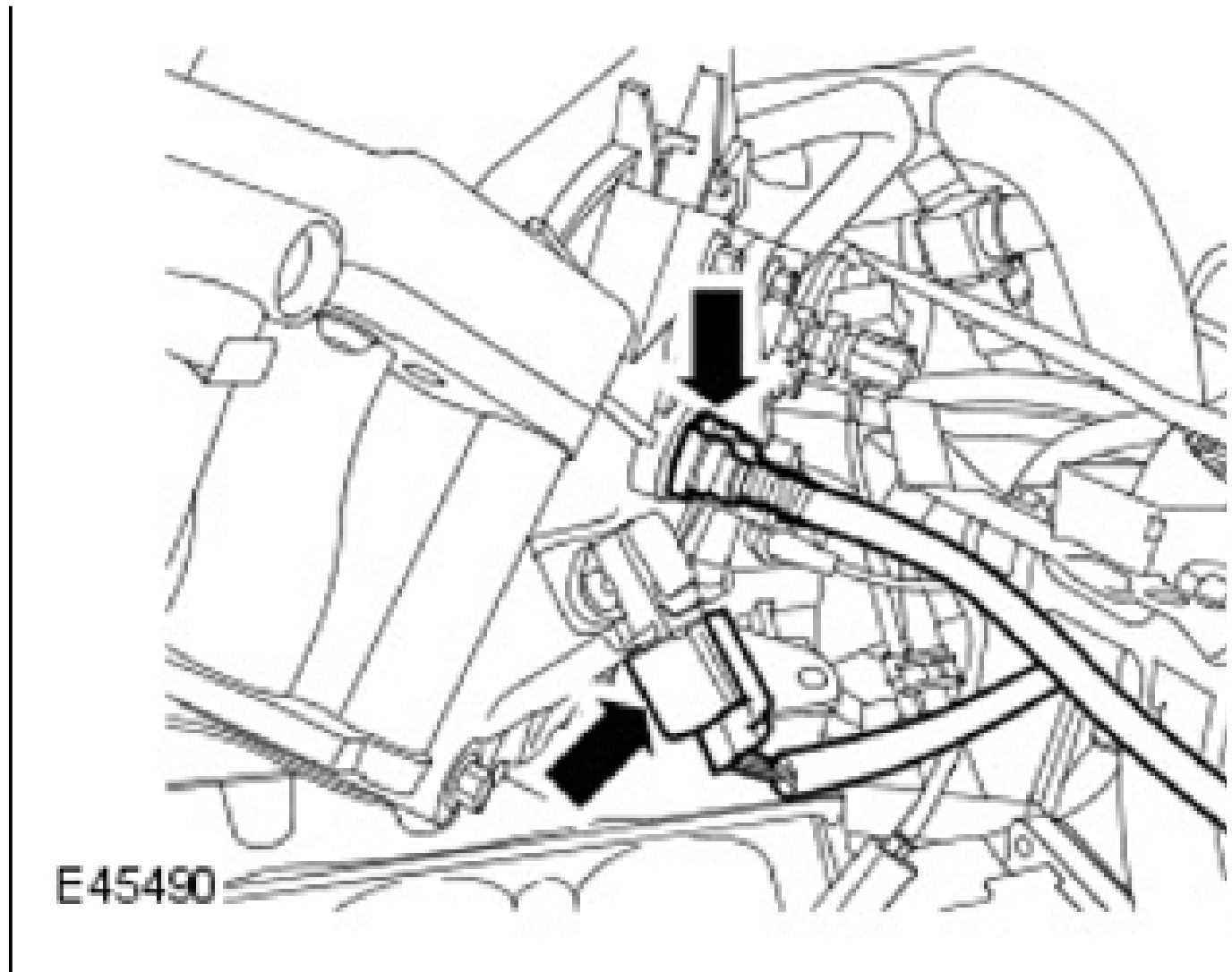


26. Disconnect the engine wiring harness.

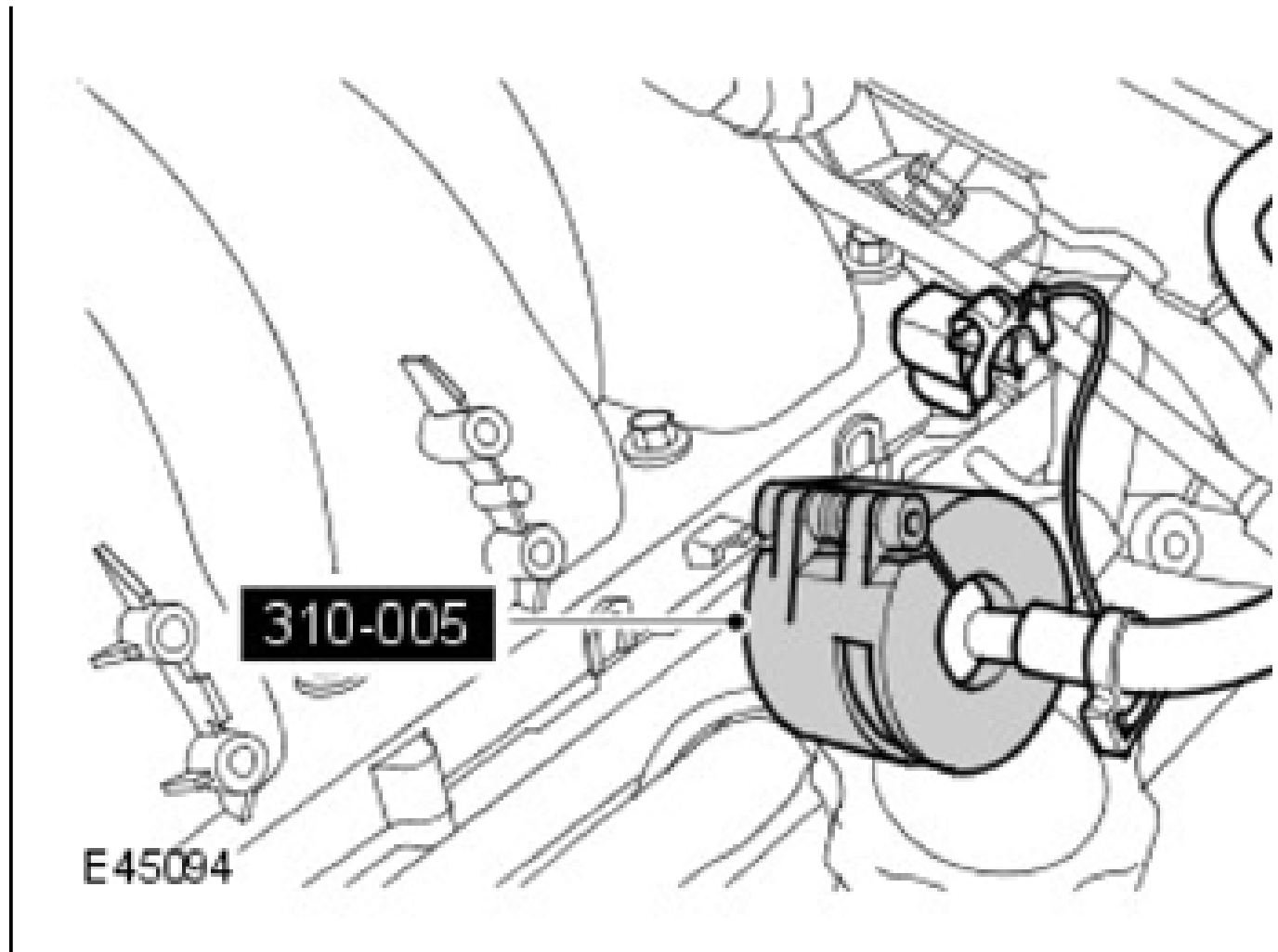
- Release the cassette.
- Release and disconnect the 2 electrical connectors.
- Remove the ground cable bolt.



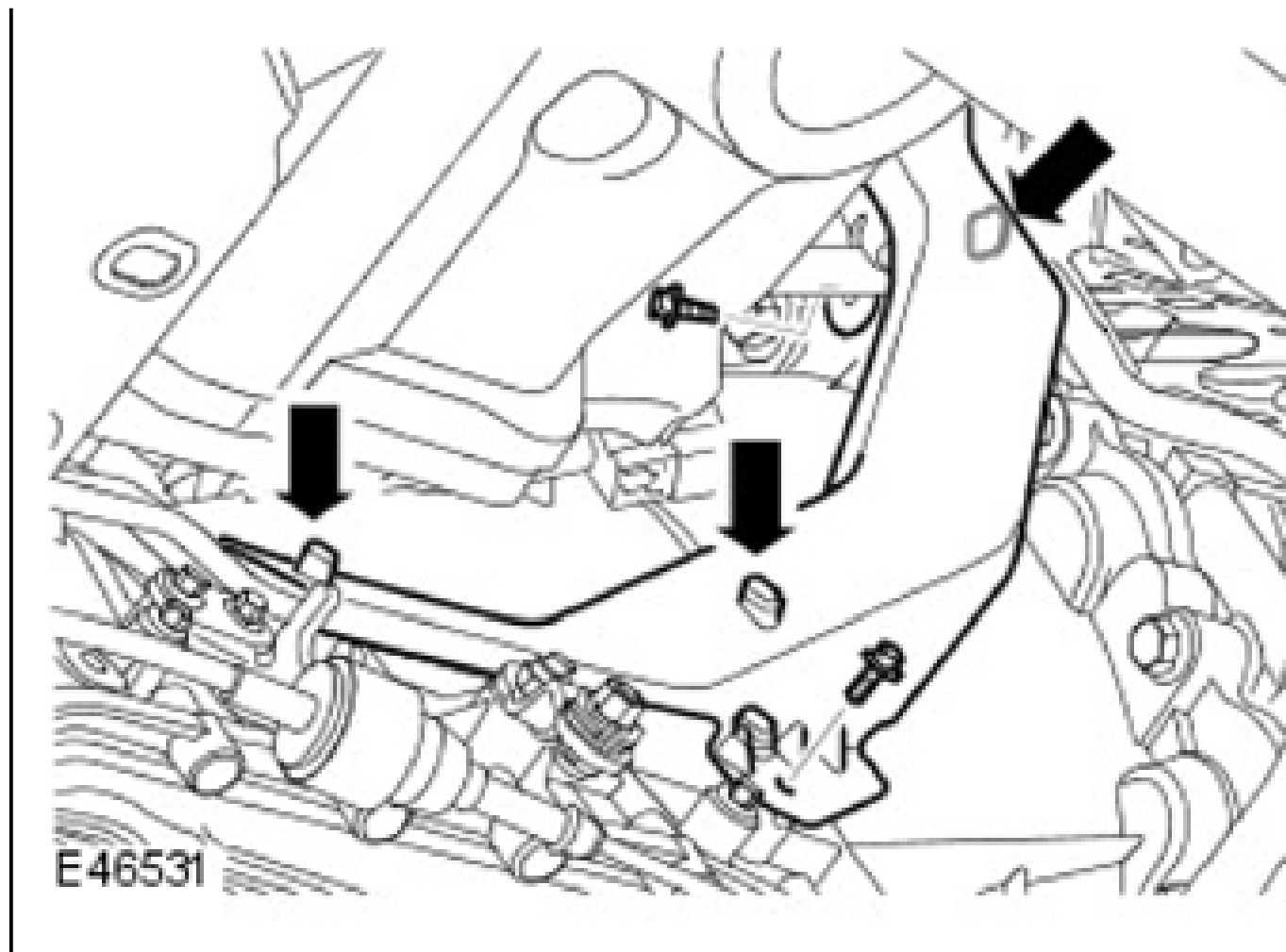
27. Disconnect the brake booster vacuum hose from the intake manifold.



28. Depressurize the fuel rail.
 - Position an absorbent cloth to collect fluid spillage.
29. Using the special tool, disconnect the fuel line.
 - Position the supply line aside.

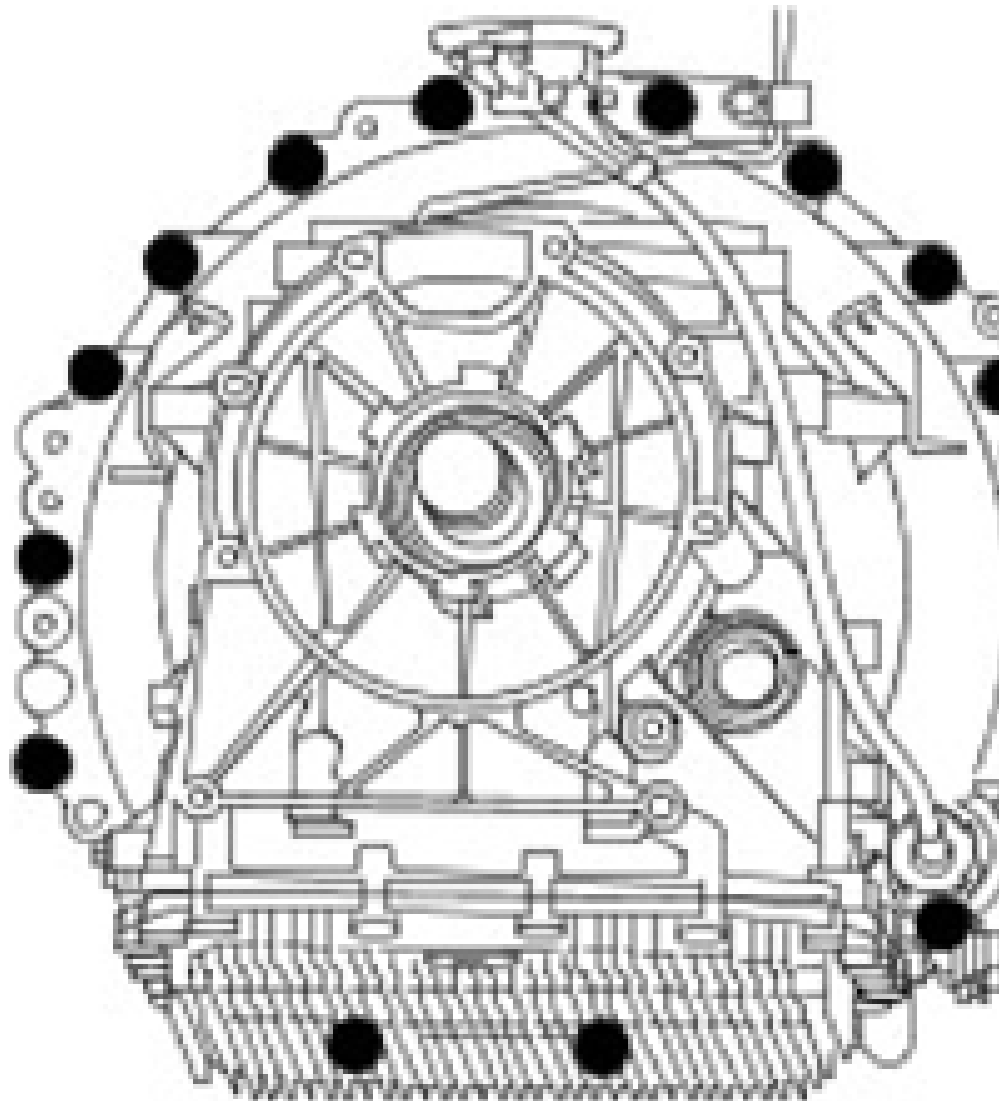


30. Release the heat shield for access to the transmission bolts.
- Remove the 2 bolts.
 - Move the shield aside.



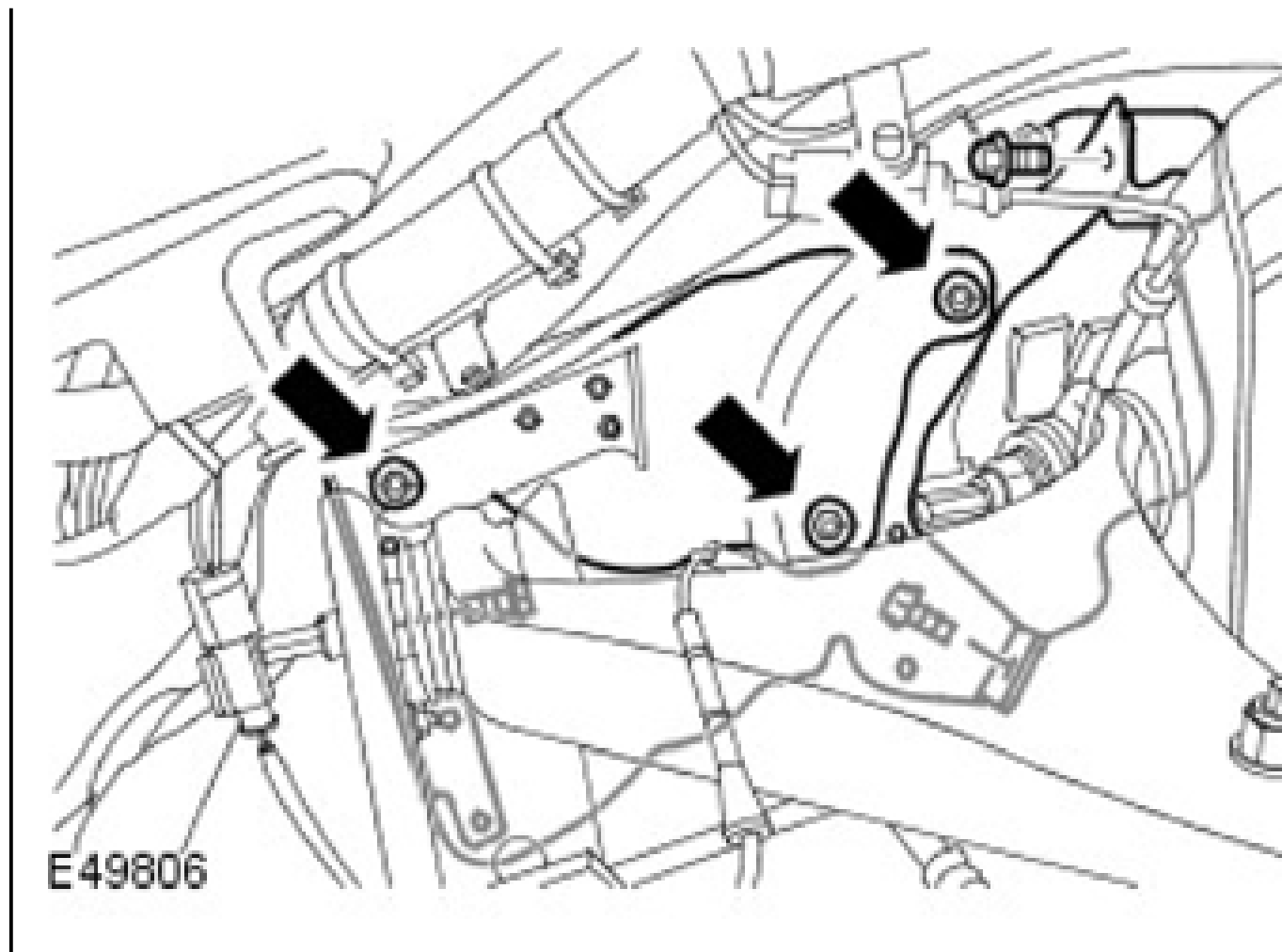
31. Remove the transmission bolts.

- Support the transmission.
- Remove the 16 bolts.

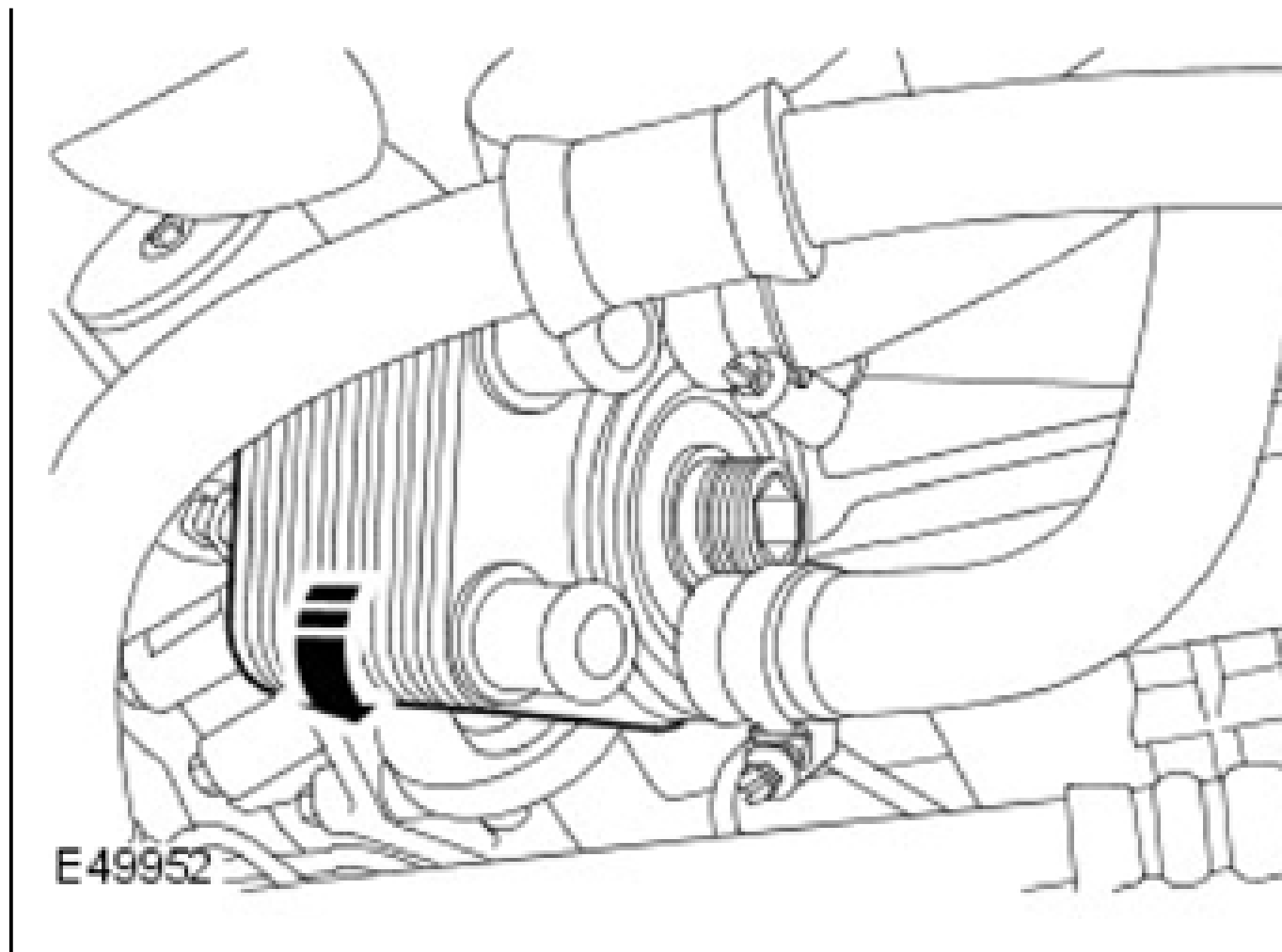


E46537

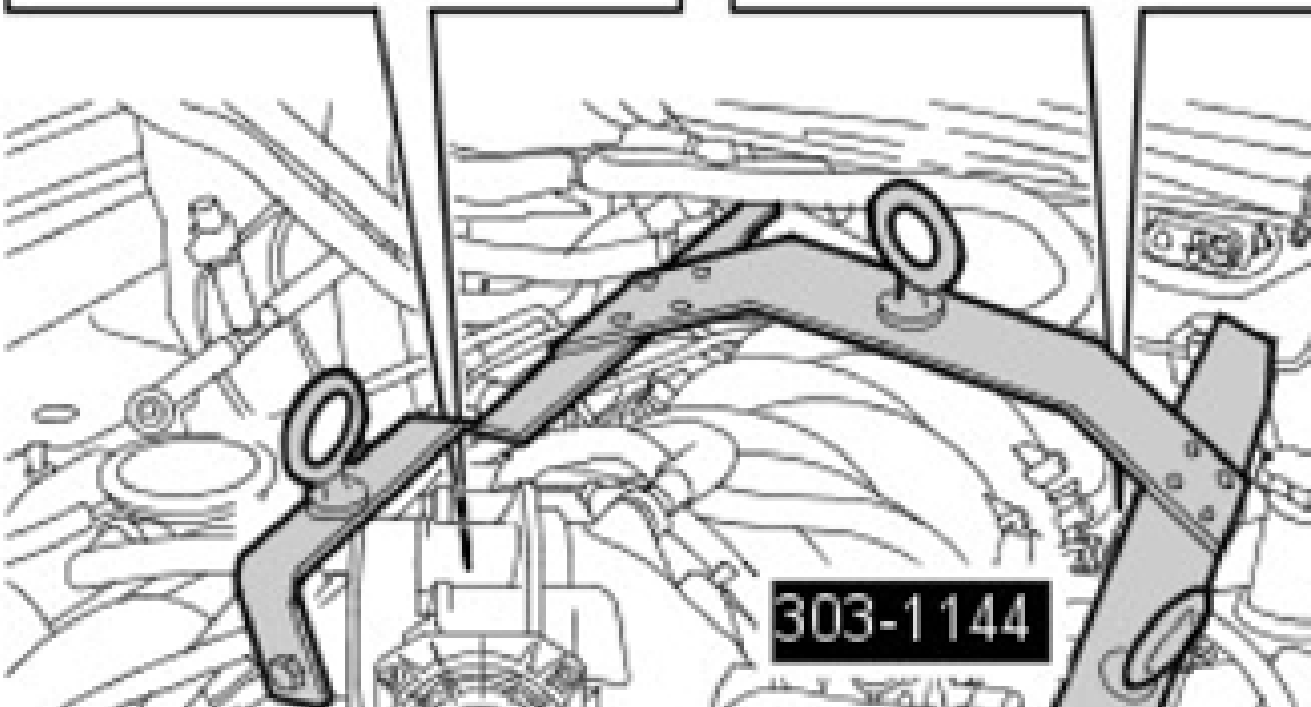
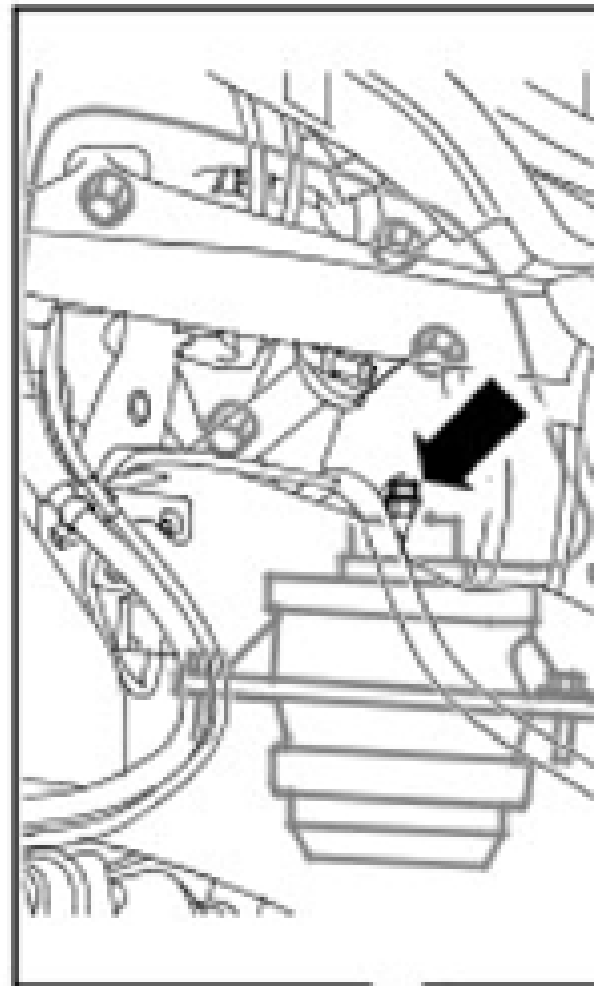
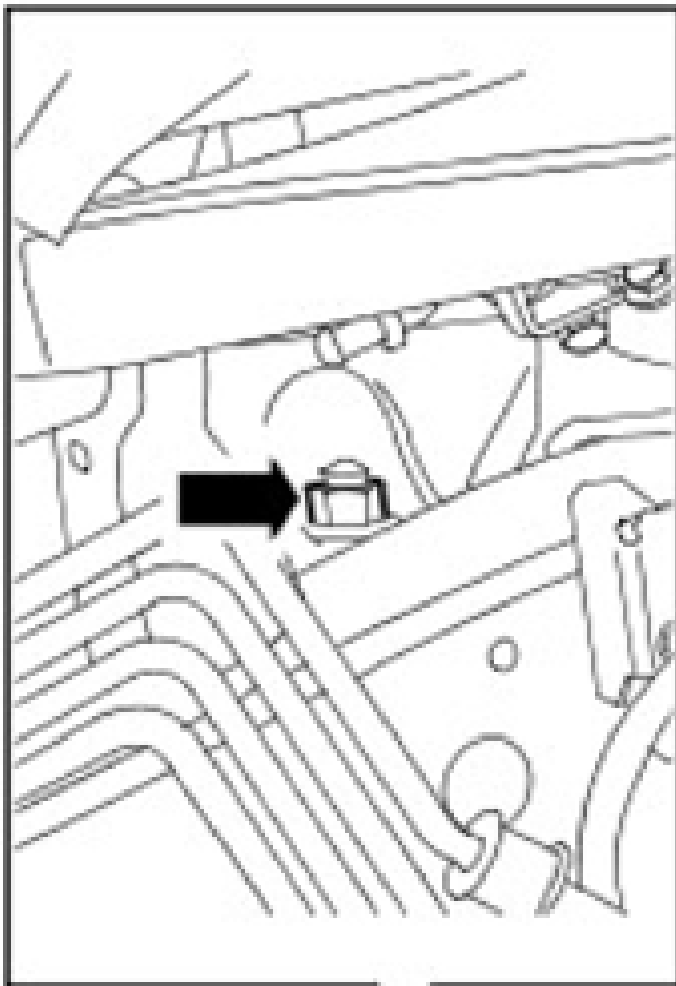
32. Remove the upper suspension arm and brake line heat shields for access.
- Remove the 3 bolts.
 - Remove the 3 nuts.



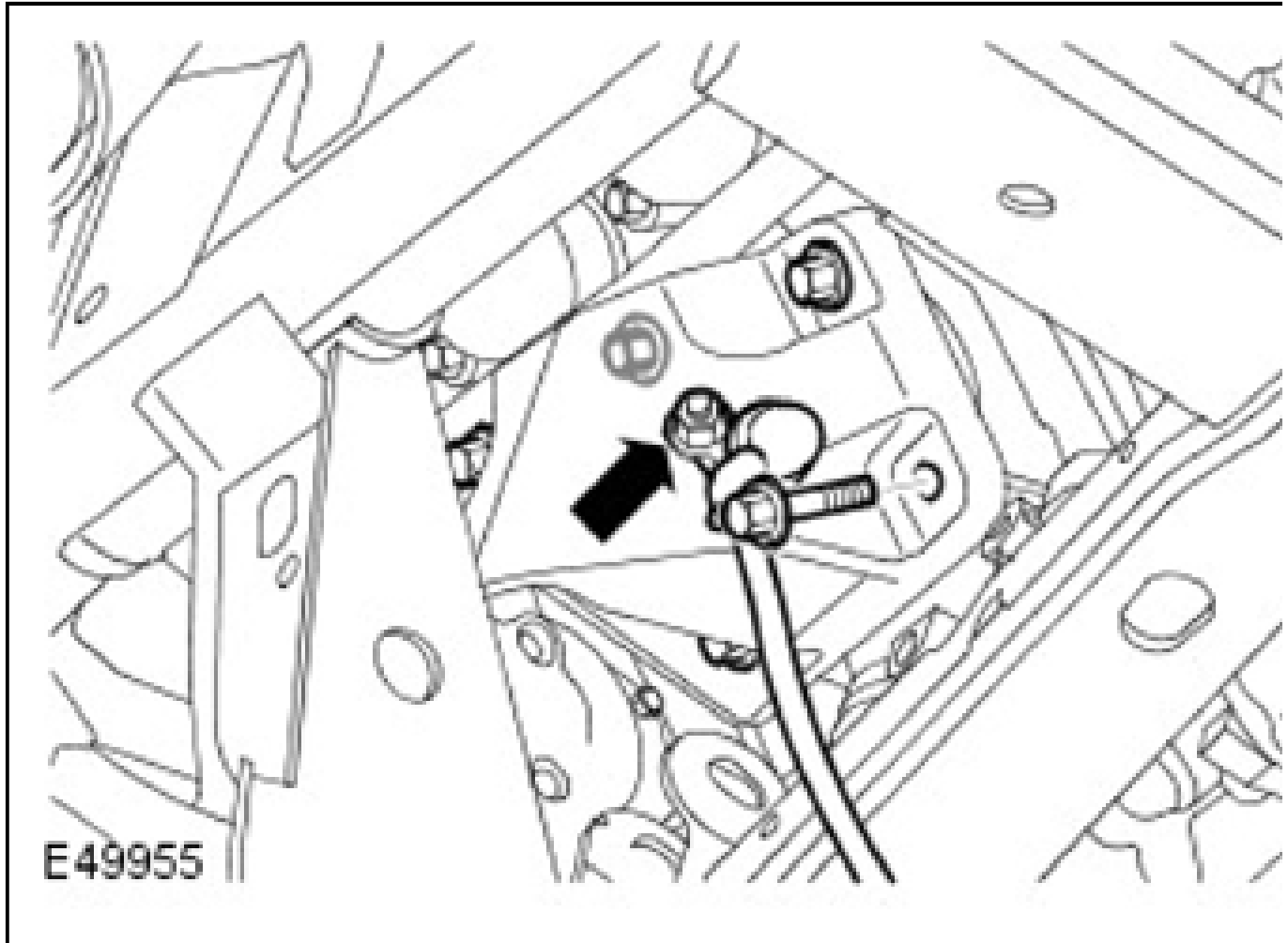
33. Loosen the Allen bolt and rotate the engine oil cooler aside for access.



34. Remove the 2 engine mount nuts.



35. Release the engine from mounts and the transmission.
 - Install the lifting chains.
 - Raise the RH side of the engine by approximately 35 mm.
36. Remove the engine RH mount bracket.
 - Remove 4 bolts securing the engine mount bracket to the cylinder block.
 - Disconnect the engine ground cable from the RH mounting bracket.



CAUTION: Make sure the torque converter remains connected to the transmission.
Care must be taken to avoid damaging the steering rack and differential.

37. Carefully and progressively raise and remove the engine.
38. Disconnect the lifting chains.

DISASSEMBLY

ENGINE

SPECIAL TOOL(S)

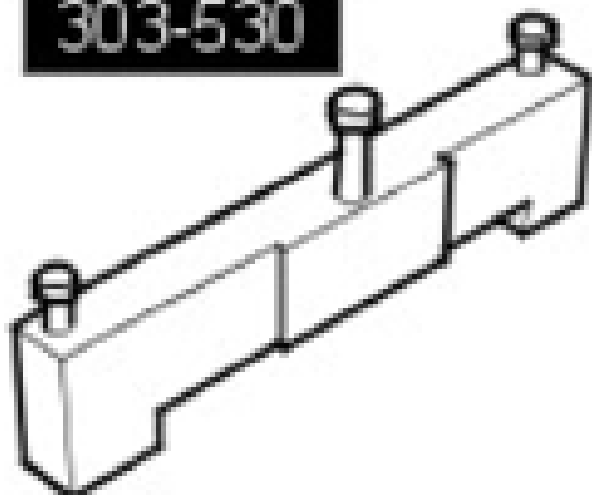
303-645



E 46881

Timing Setting tool
303-645

303-530



E 46879

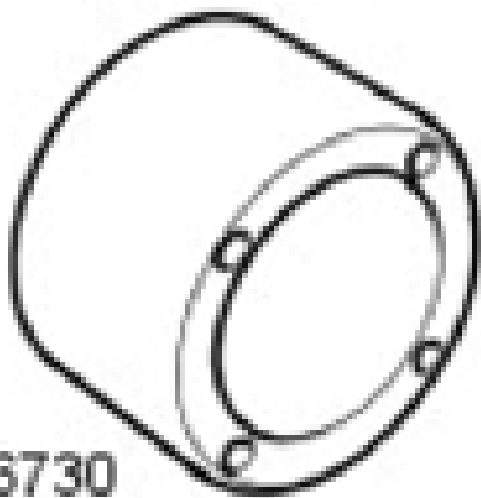
Camshaft setting/locking tool
303-530Adapter - Crankshaft seal installer
303-1100-01

303-1100-01



E67144

303-191-03



E46730

Adapter
303-191-03

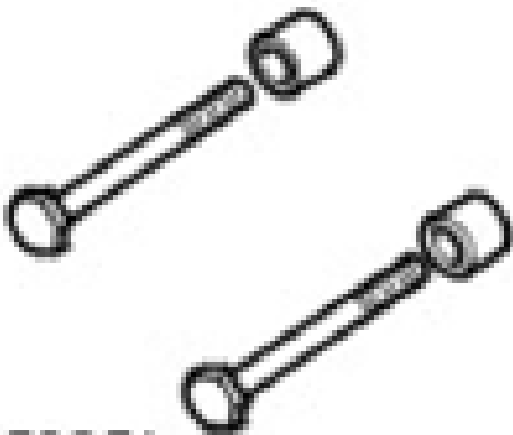
Holding Tool Crankshaft Pulley
303-893(LRT-12-080)

303-893



E 46728

303-191-04

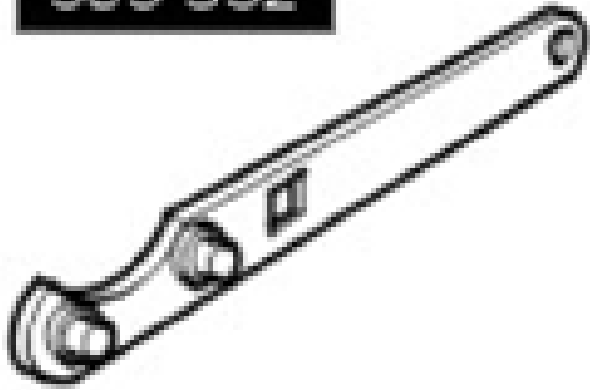


E 59251

Bolts and spacers
303-191-04

Timing chain tensioning tool
303-532

303-532



E 46880

DISASSEMBLY

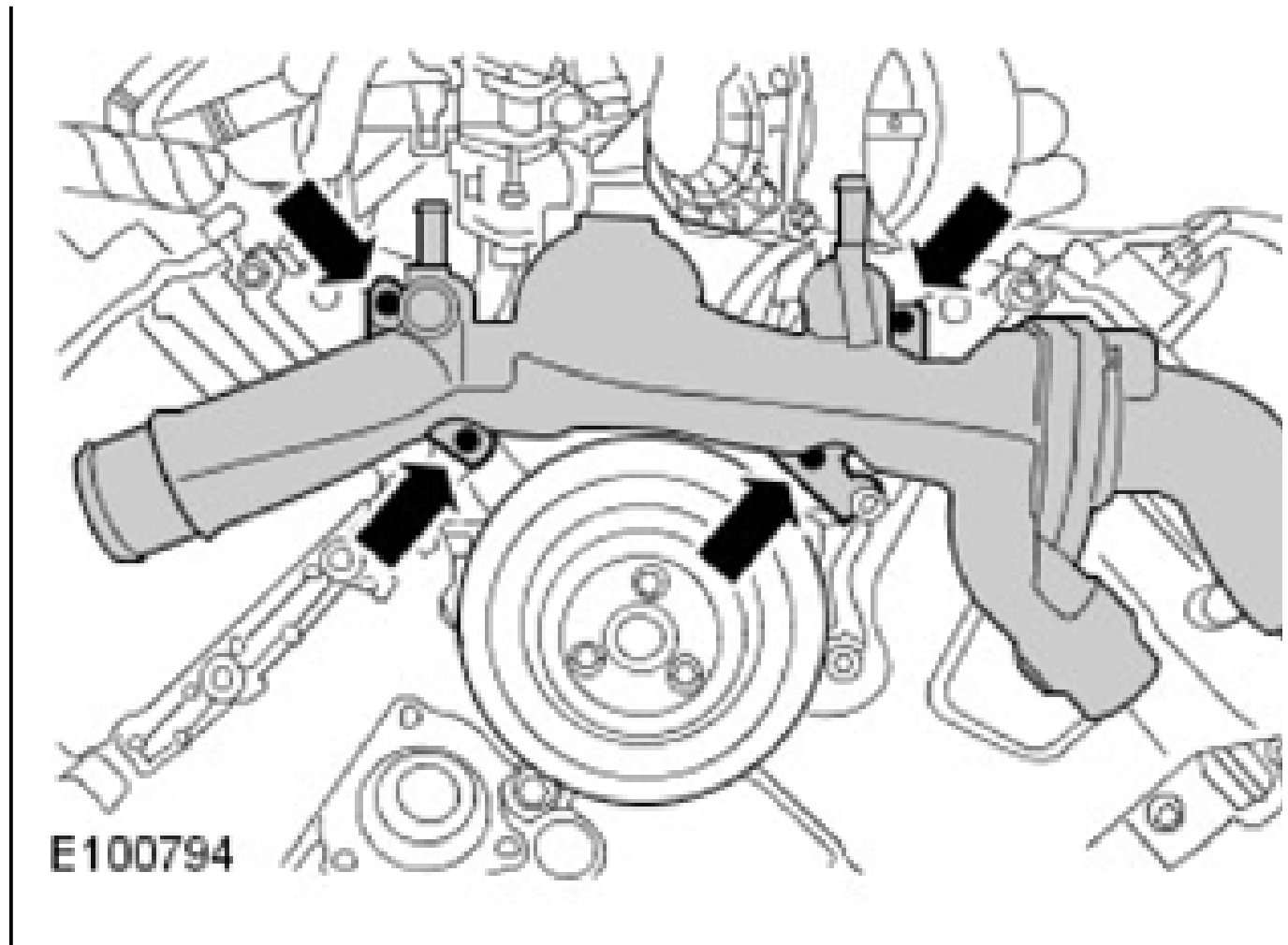
1. Remove the engine assembly.

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

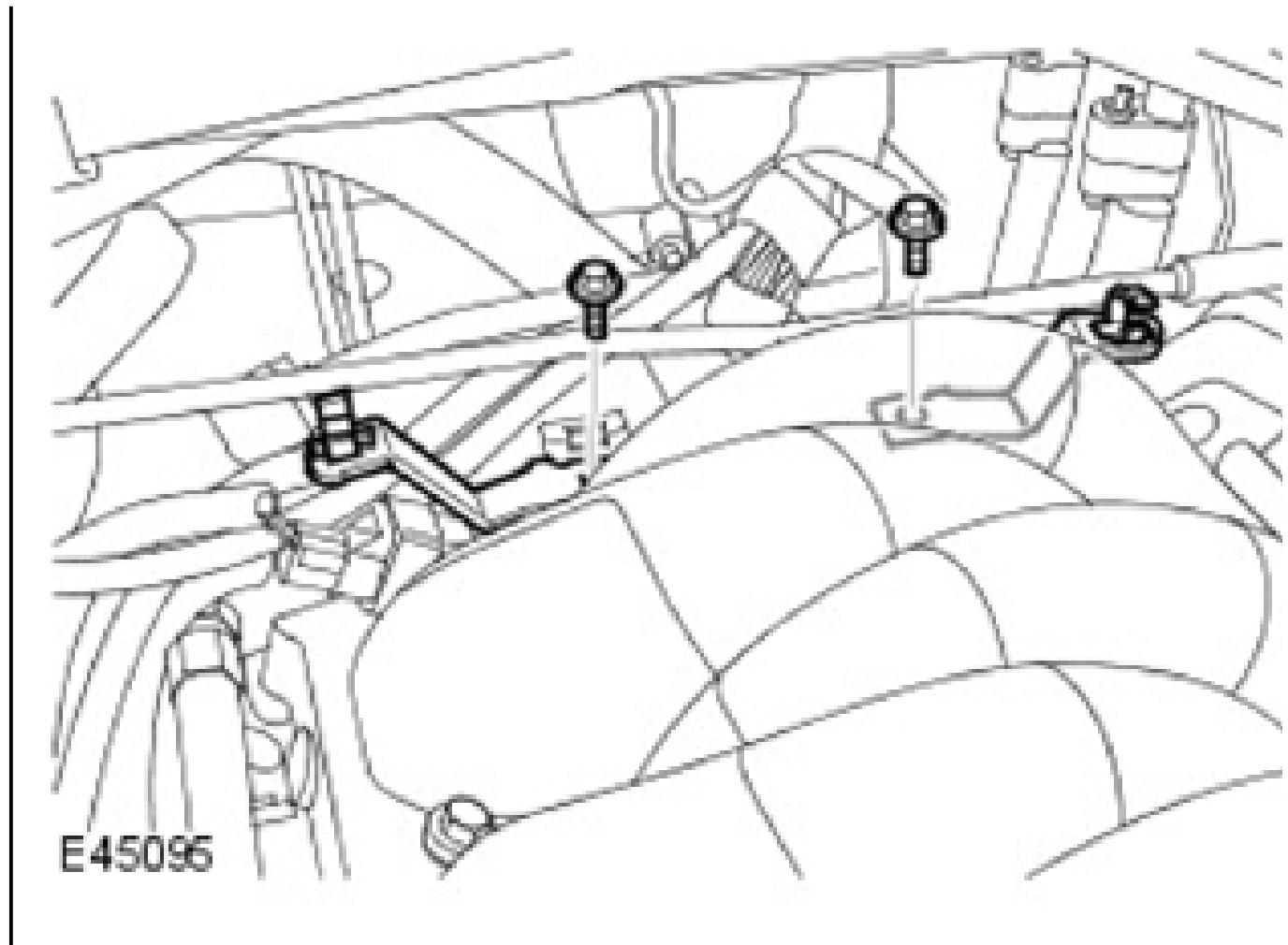
2. Secure the engine to the engine stand.
 - Align the engine to the engine stand.
 - Adjust the engine stand legs into position.
 - Mount the engine to an engine stand.
 - Fully tighten the engine stand leg nuts.
3. Release the camshaft position (CMP) sensor connector block from the intake manifold assembly.



4. Remove the coolant manifold.
 - Remove the 4 bolts.
 - Disconnect the electrical connector.

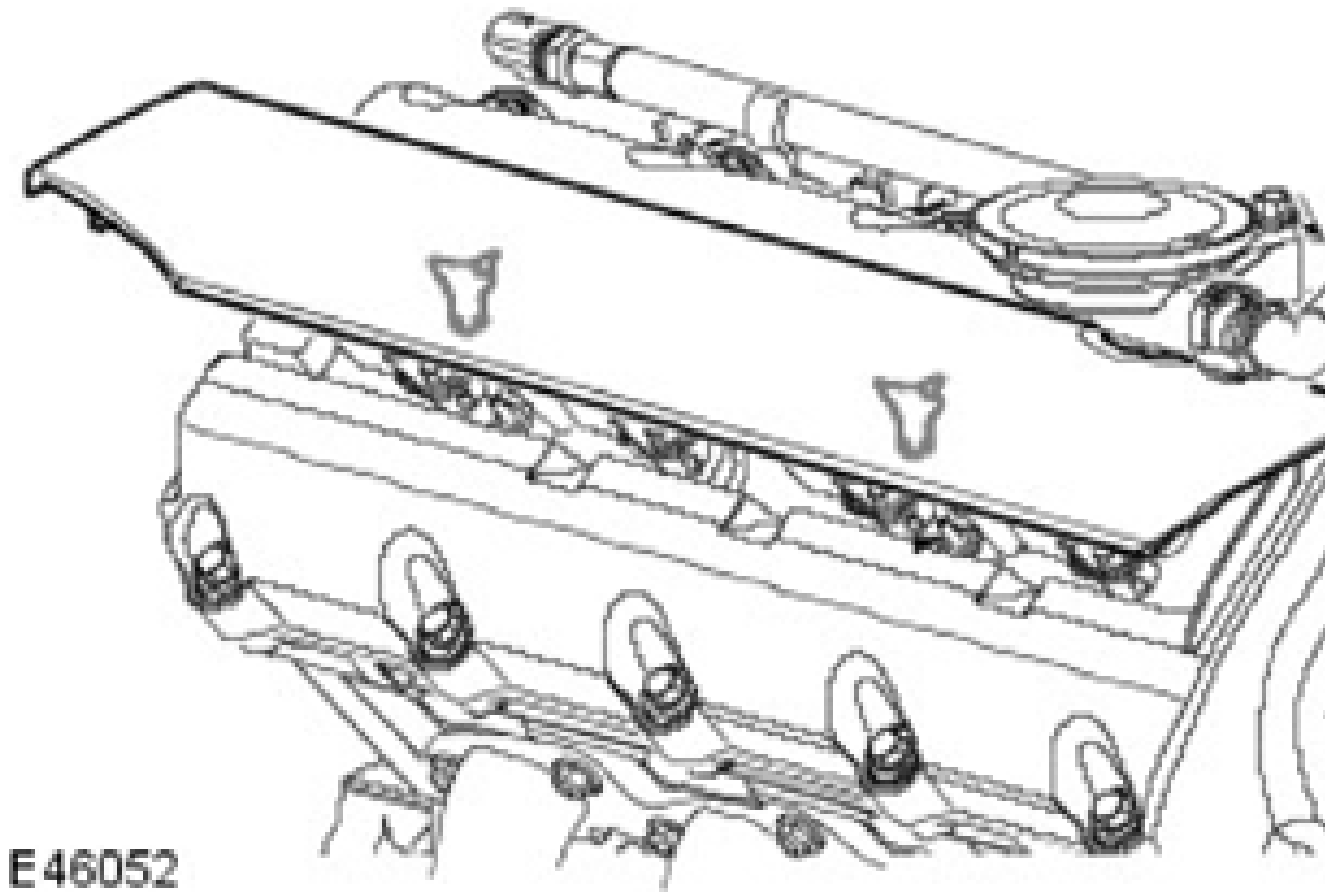


5. Position the wiring harness support bracket aside for access.
 - Remove the 2 bolts.



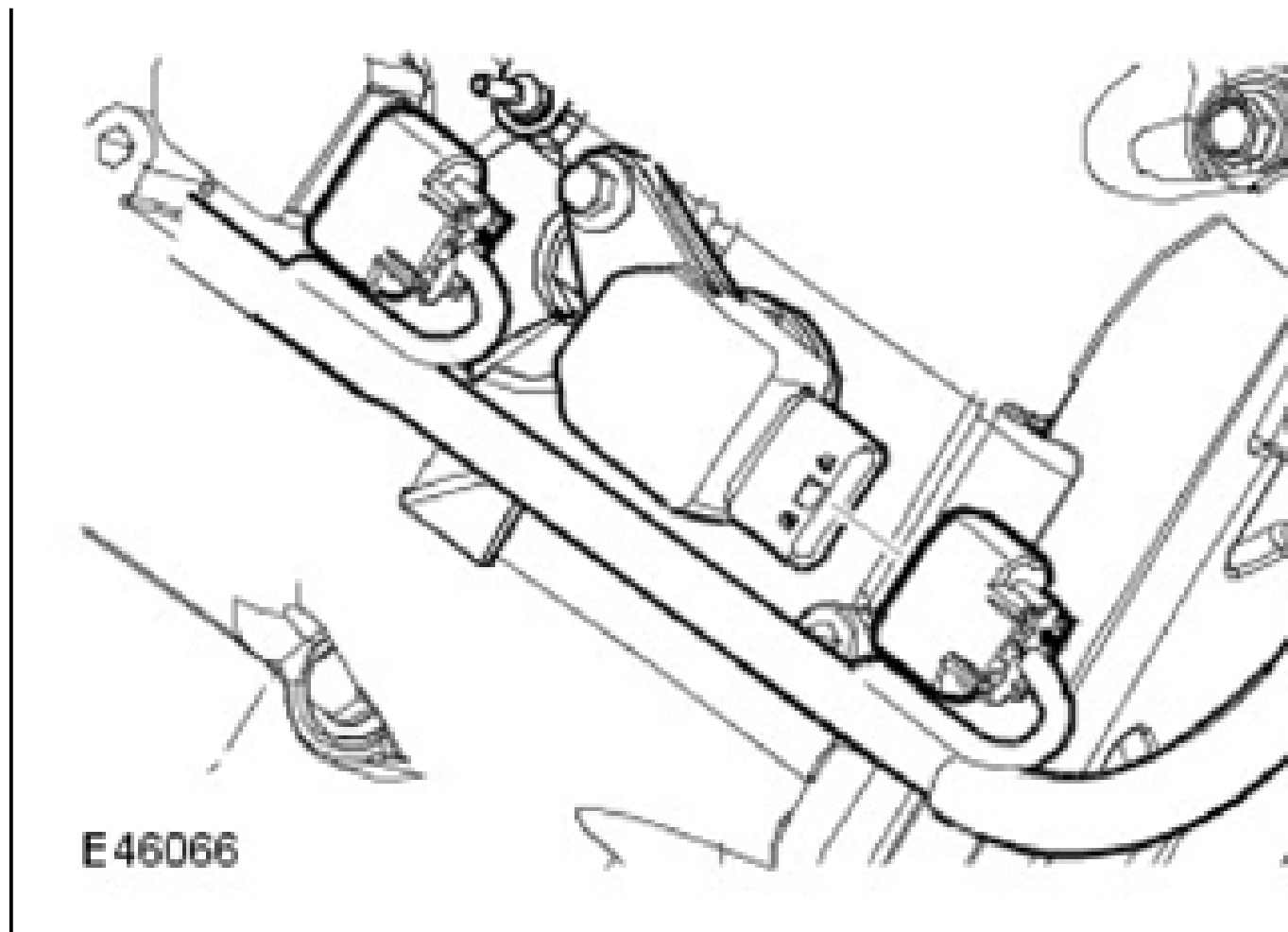
NOTE: RH illustration shown, LH is similar.

6. Remove both the ignition coil-on-plug covers.
 - Release from the 2 clips.

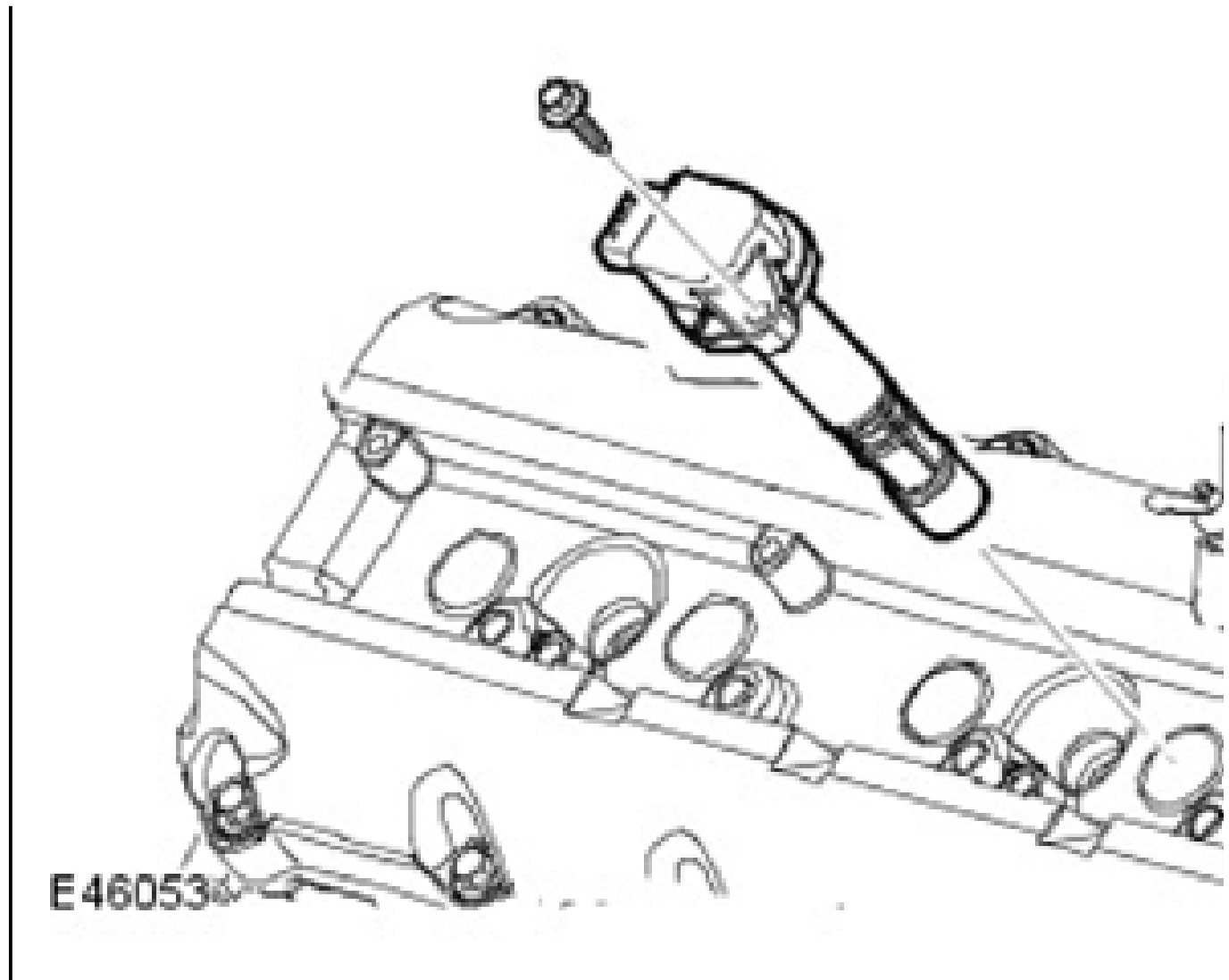


NOTE: RH illustration shown, LH is similar.

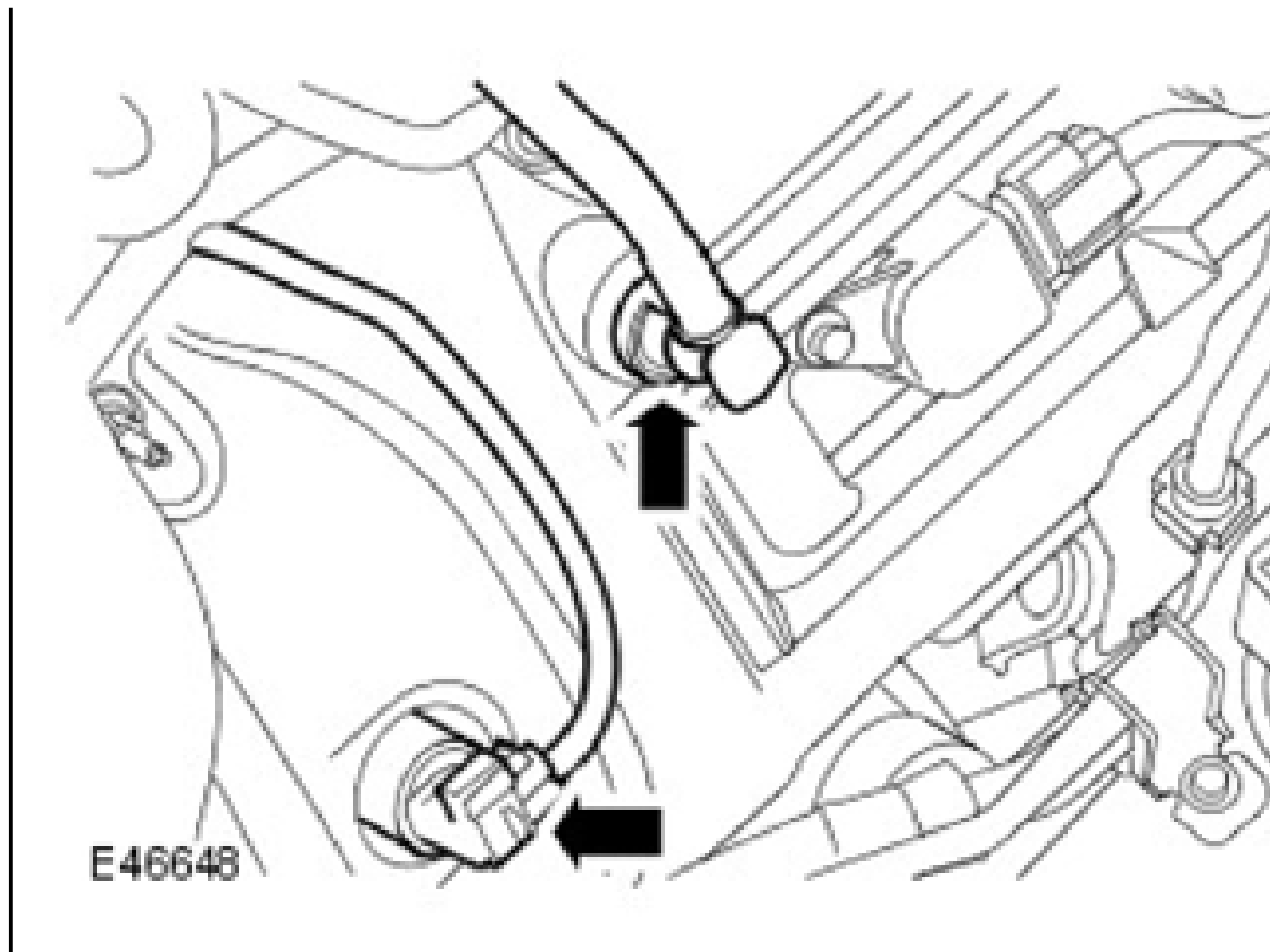
7. Disconnect the 8 ignition coil-on-plug electrical connectors.



8. Remove the 8 ignition coil-on-plugs.
 - Remove the 8 bolts.



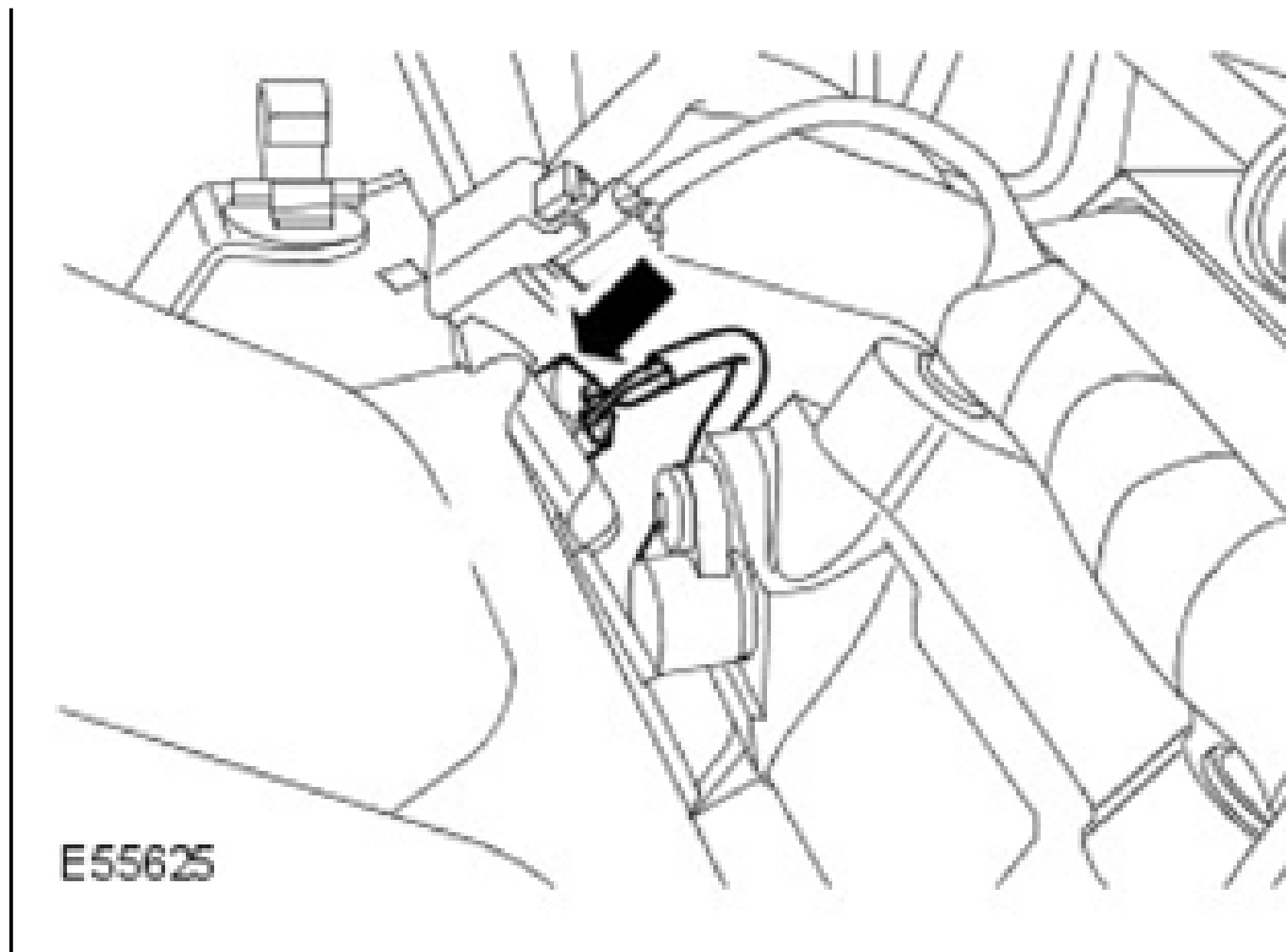
9. Disconnect the valve cover breather hose.
- Disconnect the variable camshaft timing (VCT) oil control solenoid electrical connector.
 - Repeat the operation for the other side.



10. Disconnect the engine coolant temperature (ECT) sensor electrical connector.

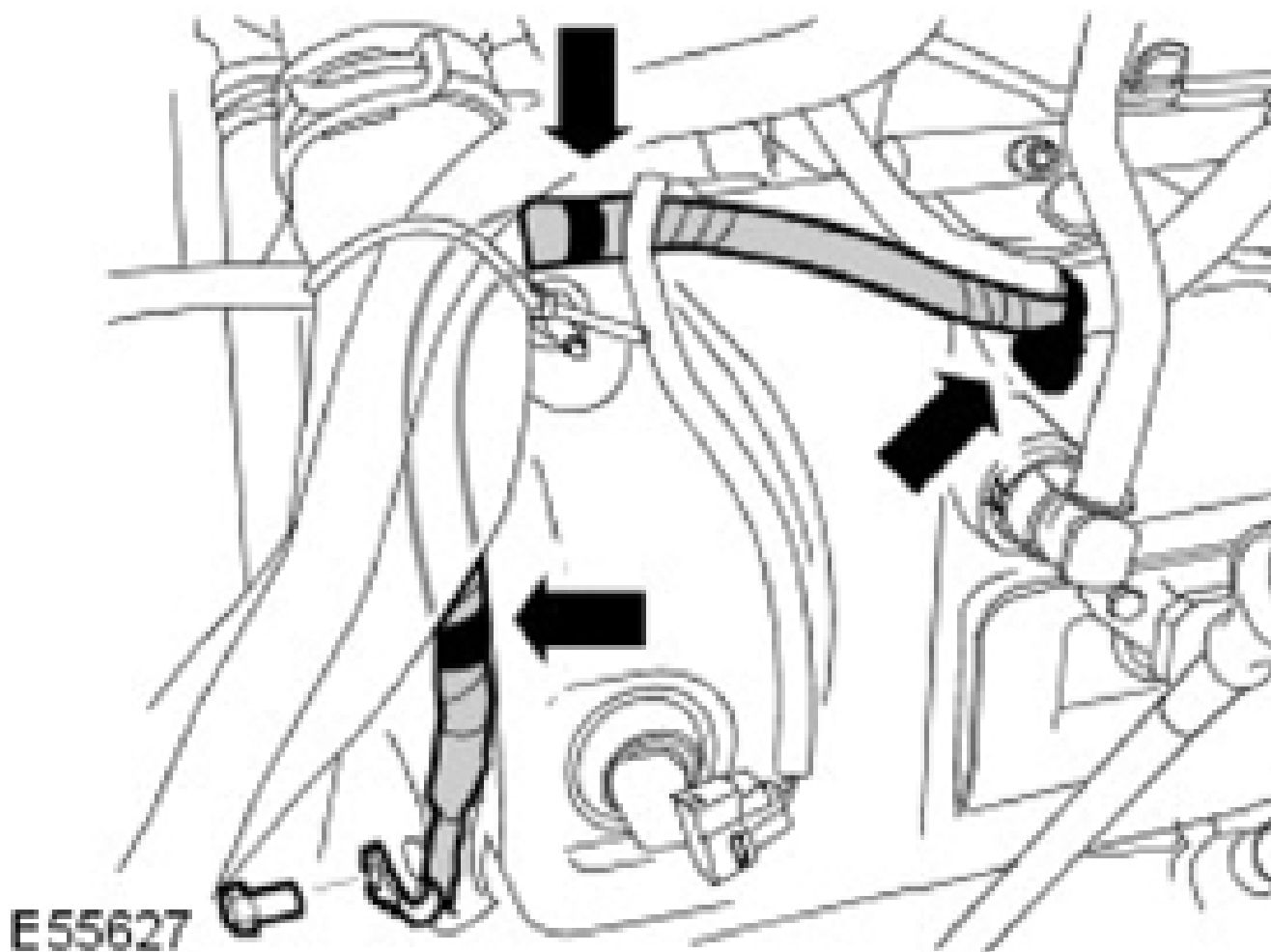


11. Disconnect the CMP sensor electrical connector.
 - Repeat the above procedure for the RH side.

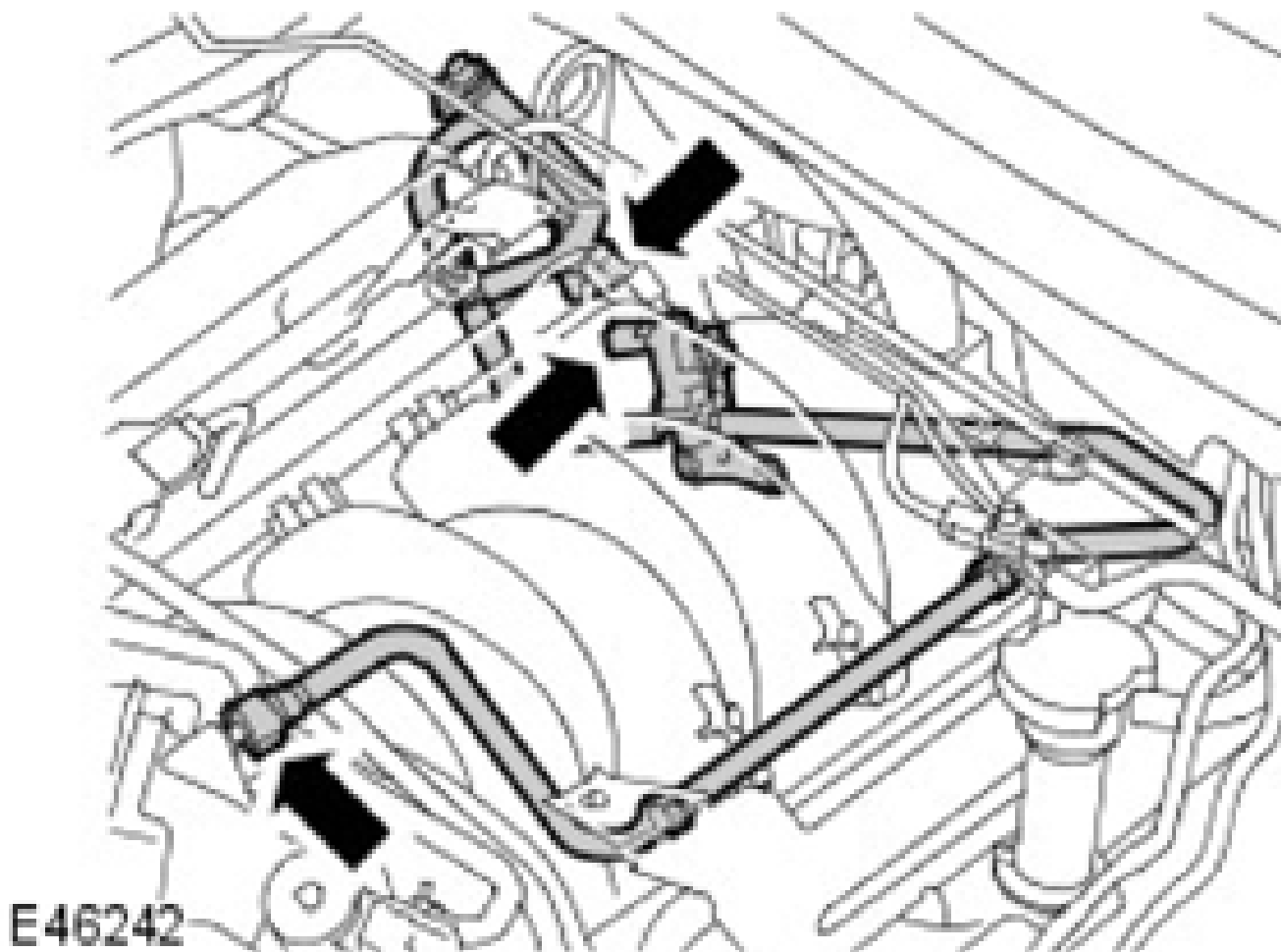


12. Disconnect the cylinder head earth connector.

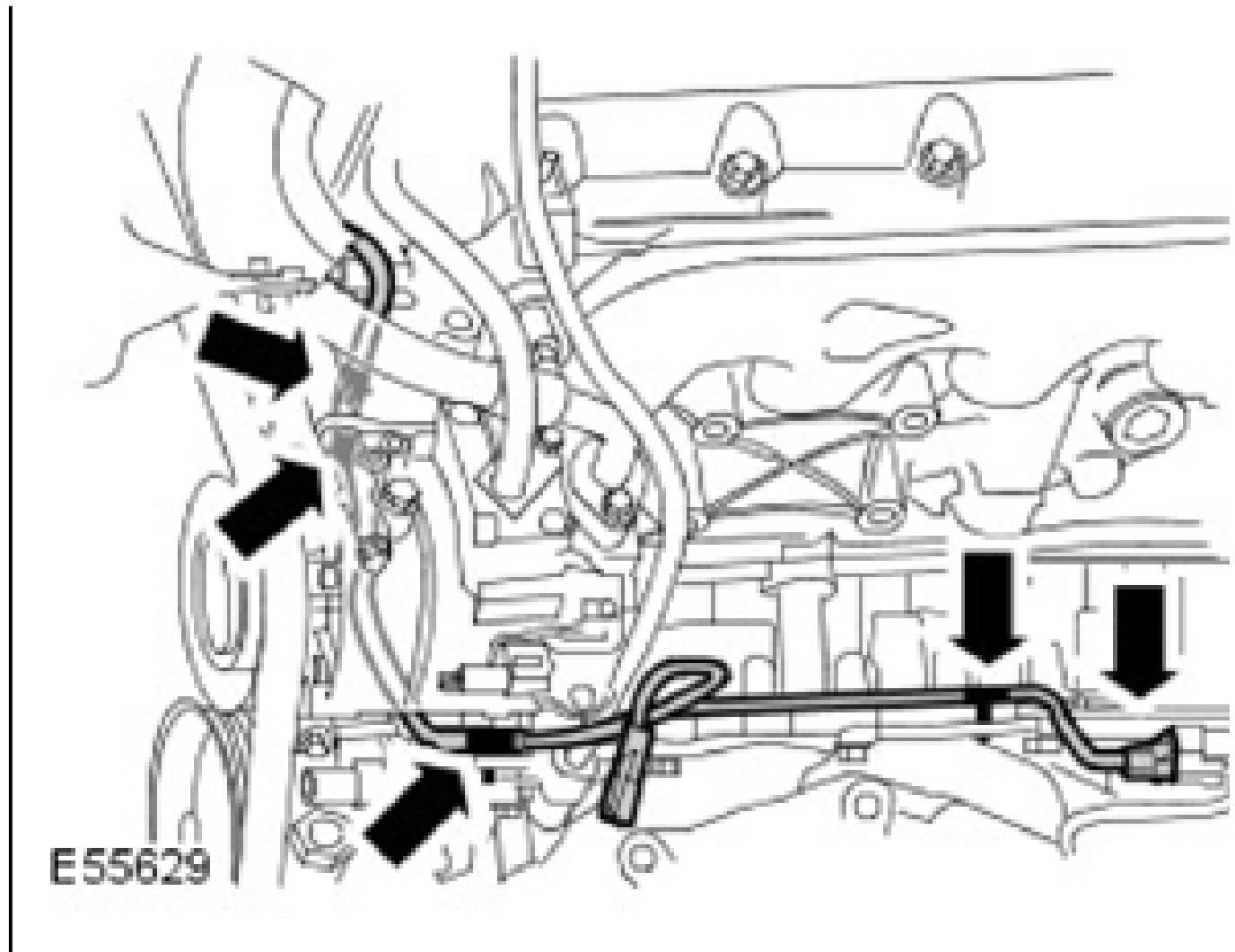
- Remove the bolt.
- Release the 3 clips.



13. Disconnect the knock sensors (KS) electrical connector.
14. Release the purge valve from the mounting bracket.
 - Disconnect the quick release connector.
 - Disconnect the electrical connector.
 - Remove the bolt.

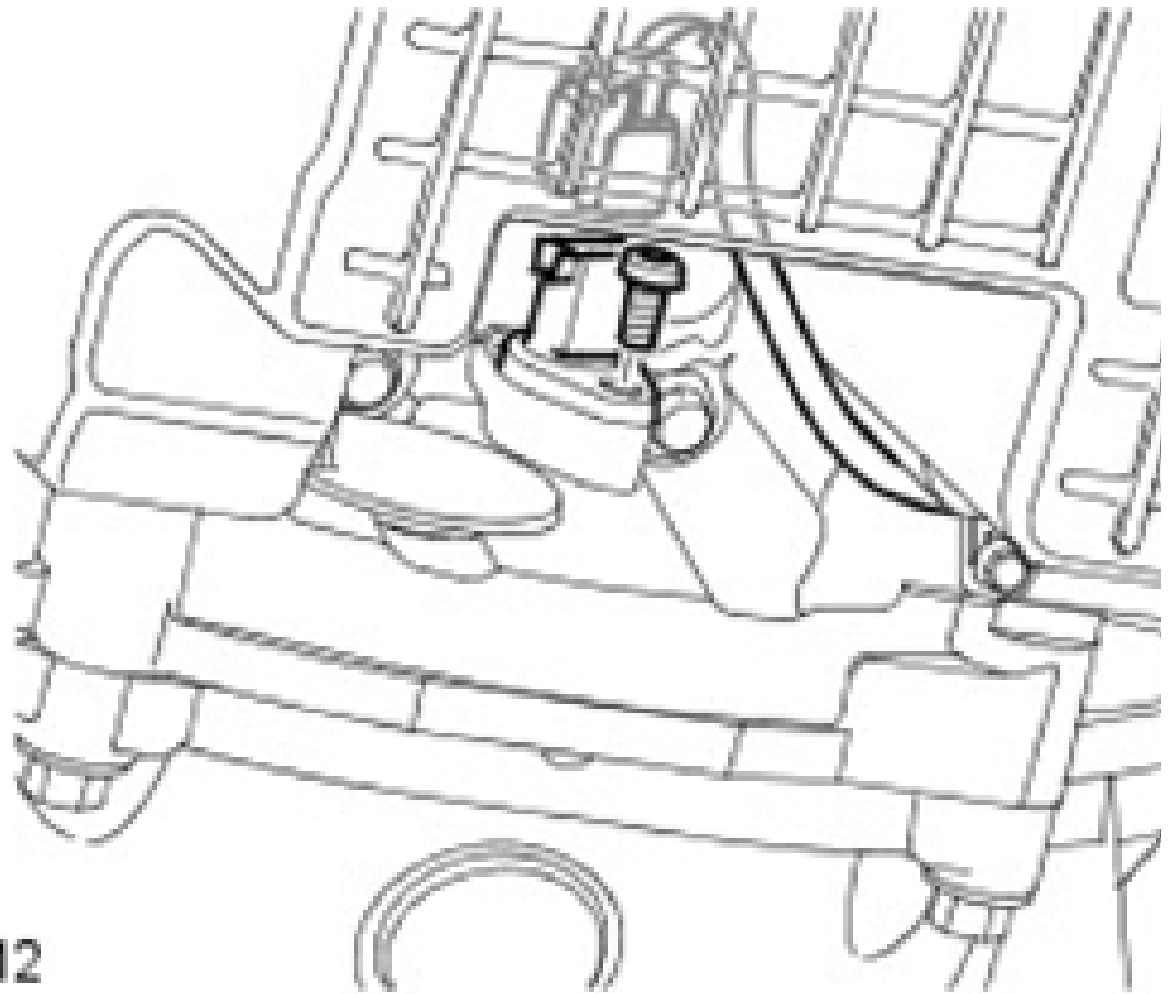


15. Release the 5 air conditioning (A/C) harness retaining clips.



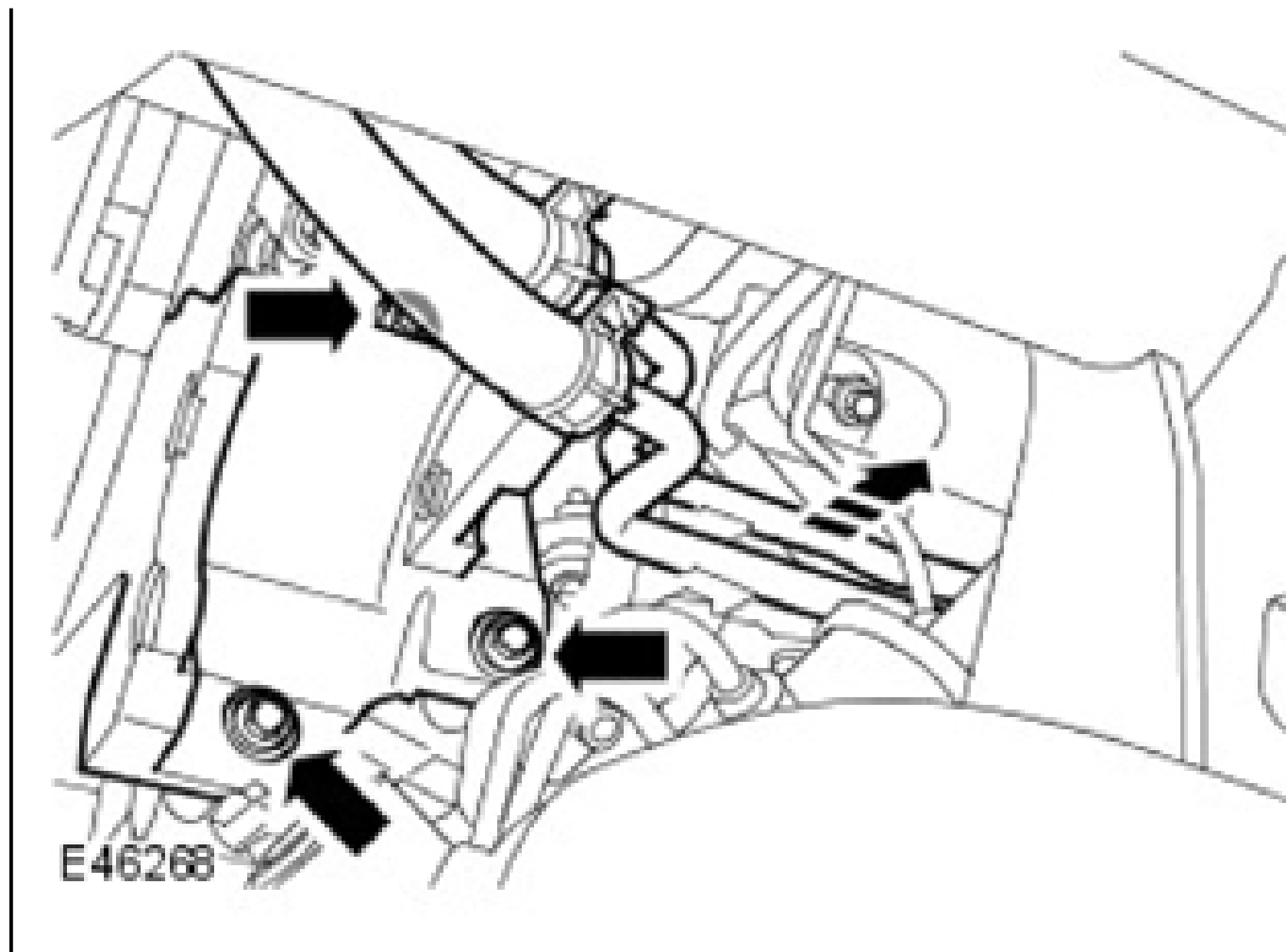
16. Remove the crankshaft position (CKP) sensor.

- Disconnect the electrical connector.
- Remove the Torx screw.

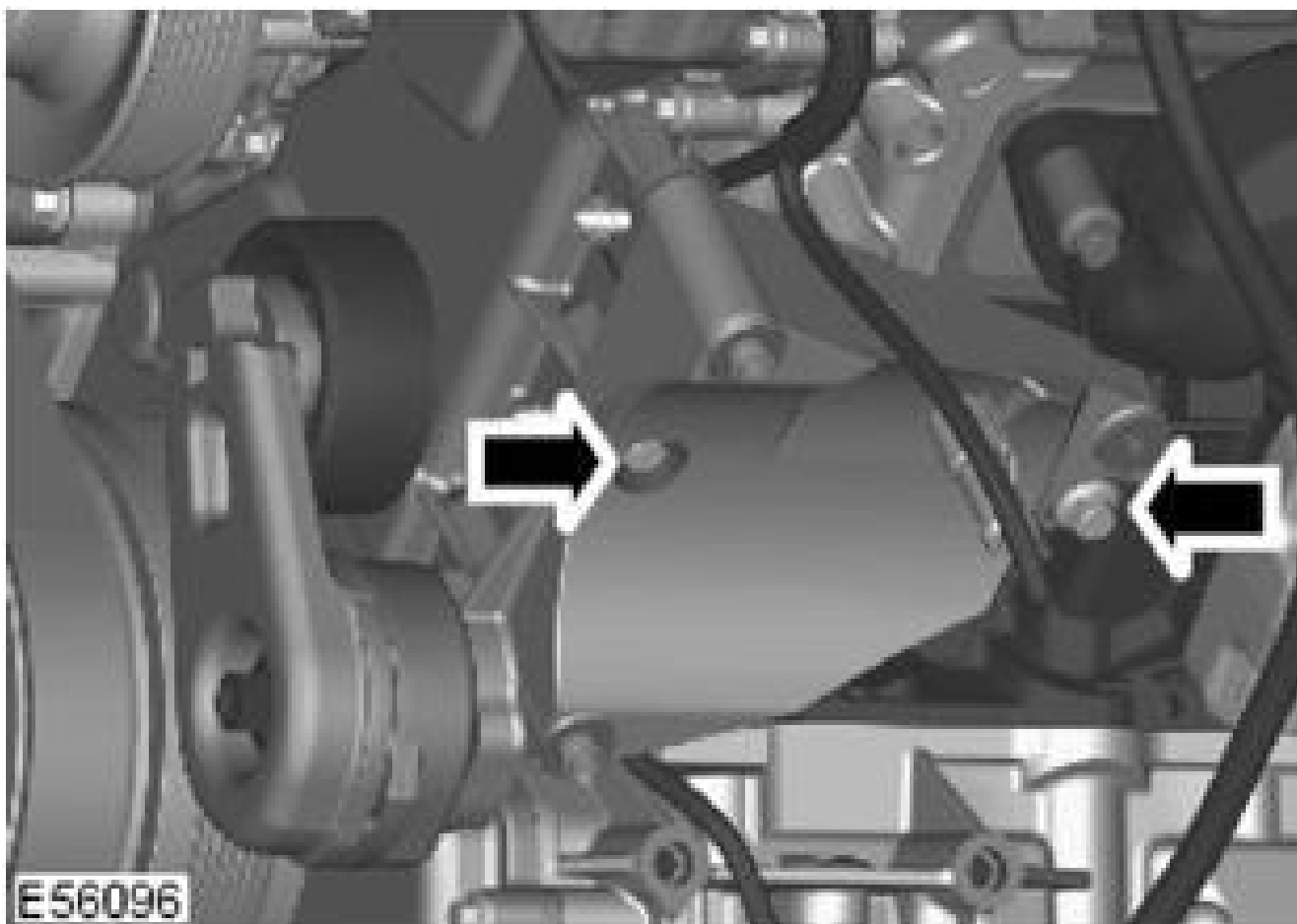


17. Remove the power steering pump mounting bracket.

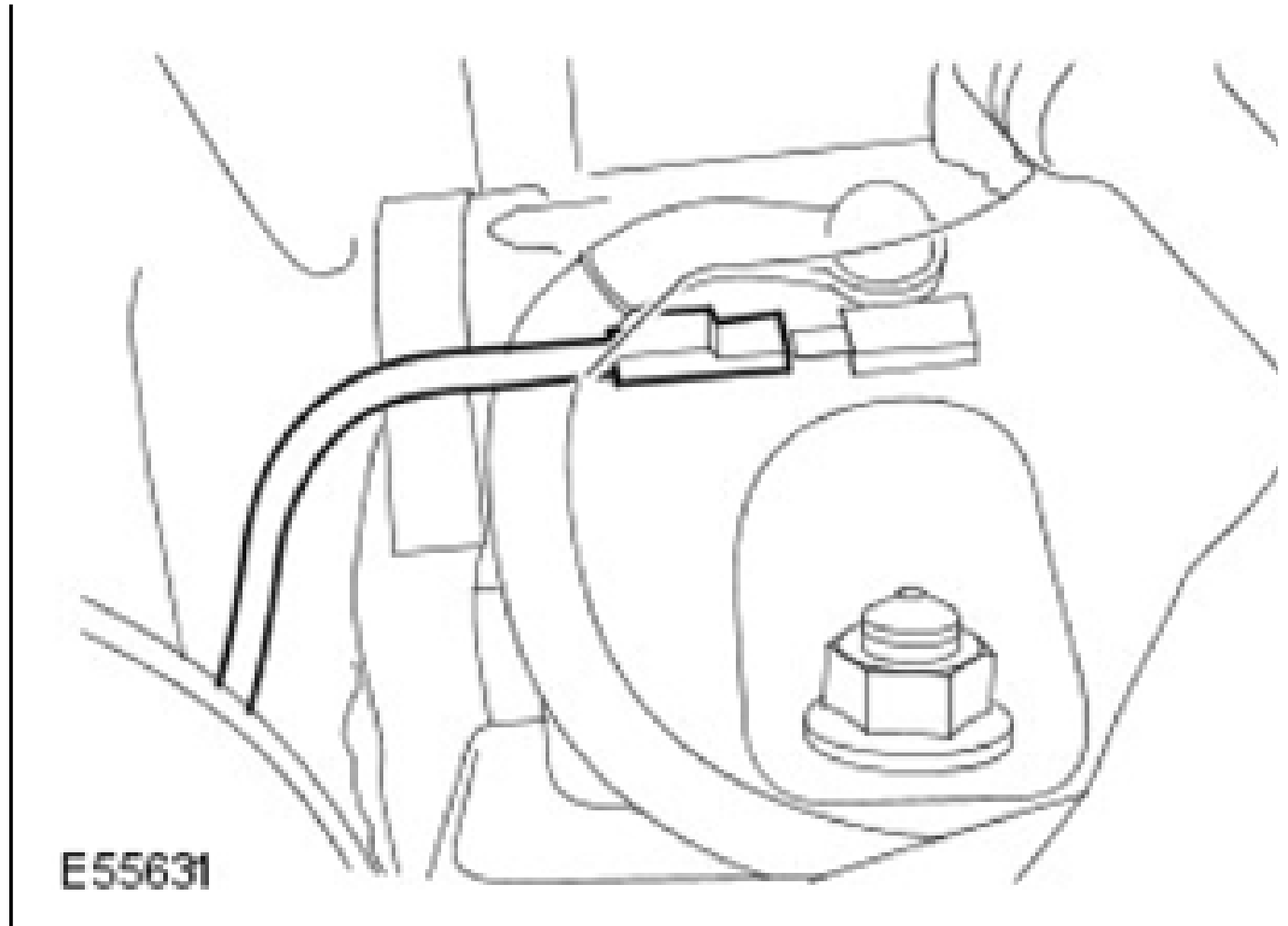
- Remove the 3 bolts.
- Release the transmission cooler pipe clips.



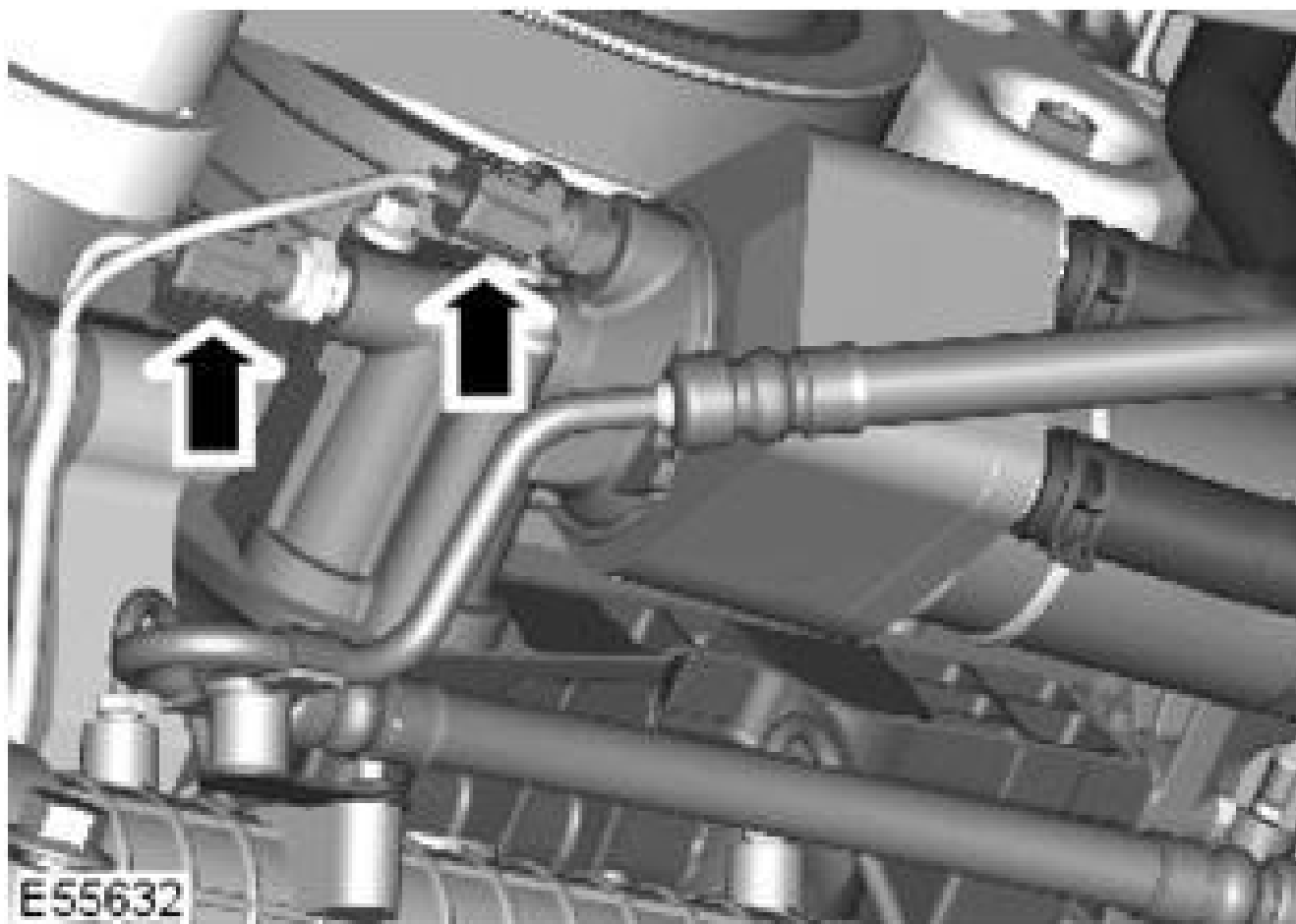
18. Remove the A/C compressor mounting bracket.
- Remove the 2 bolts.



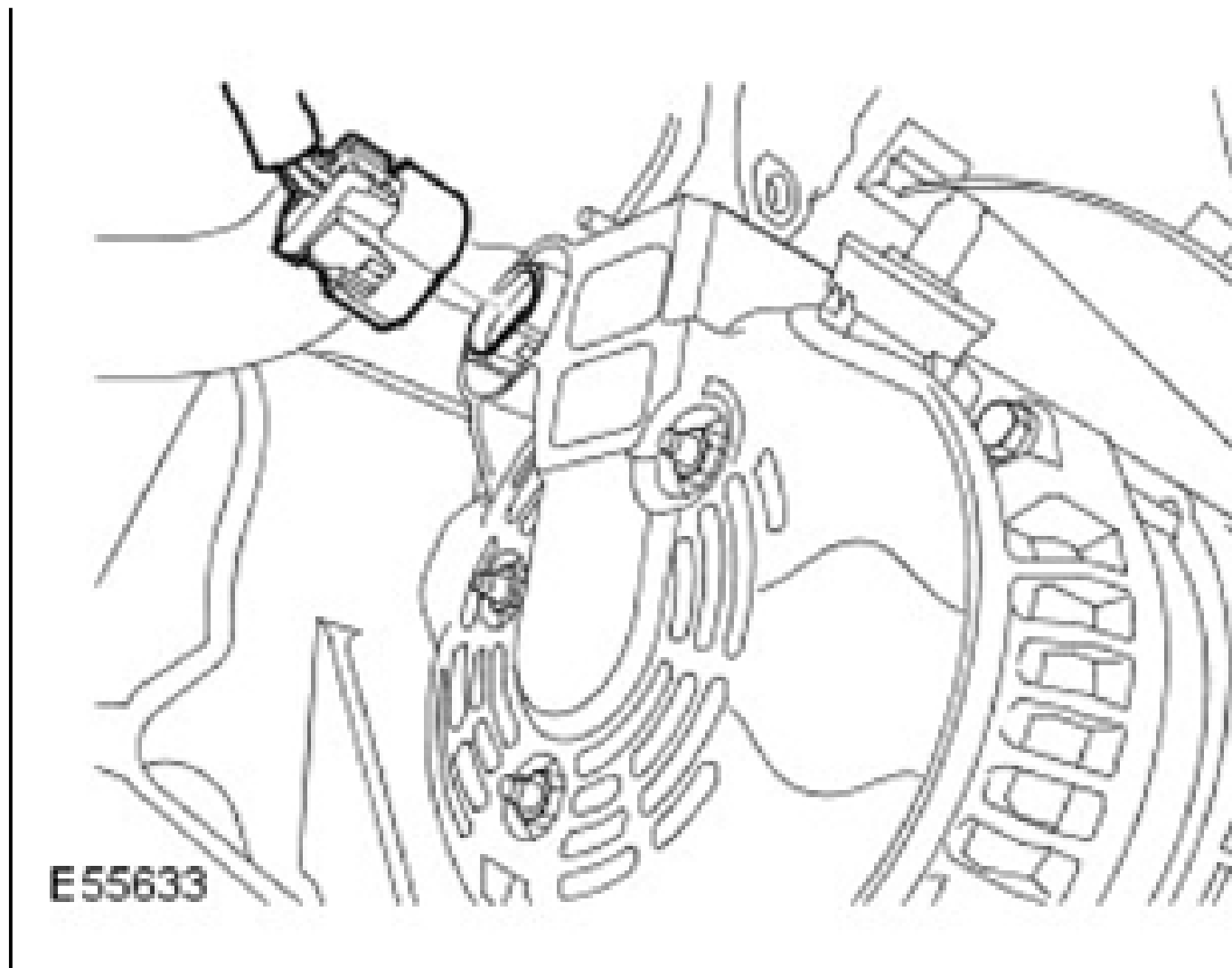
19. Disconnect the starter motor connector.



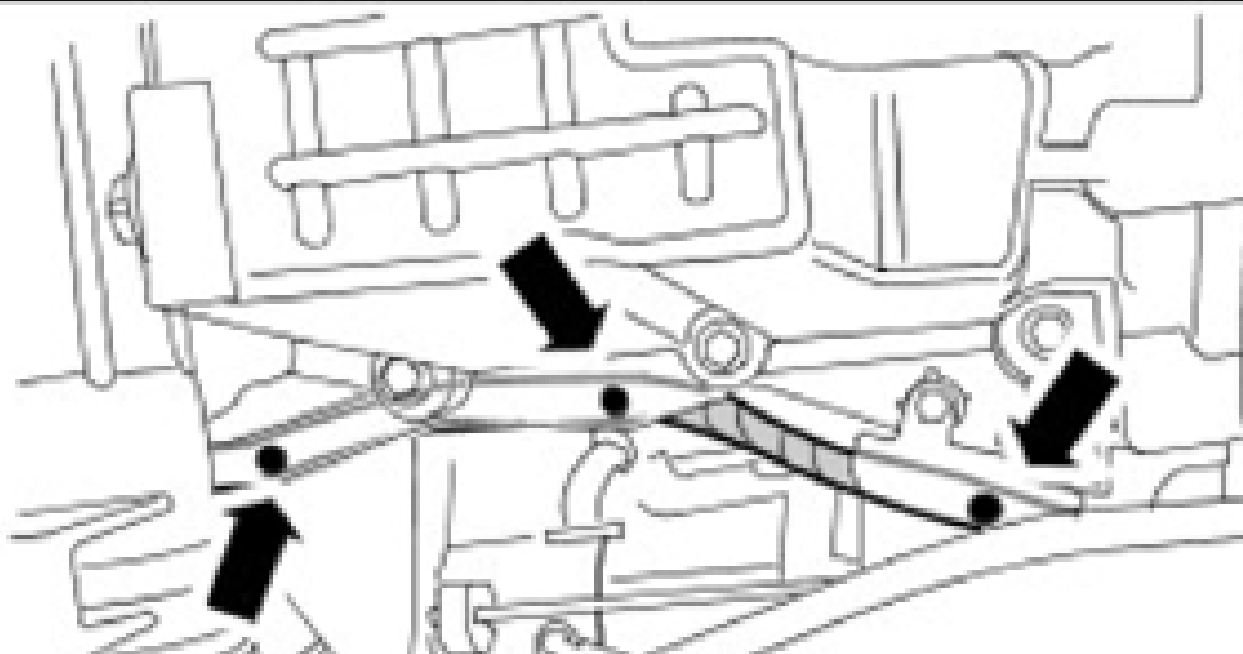
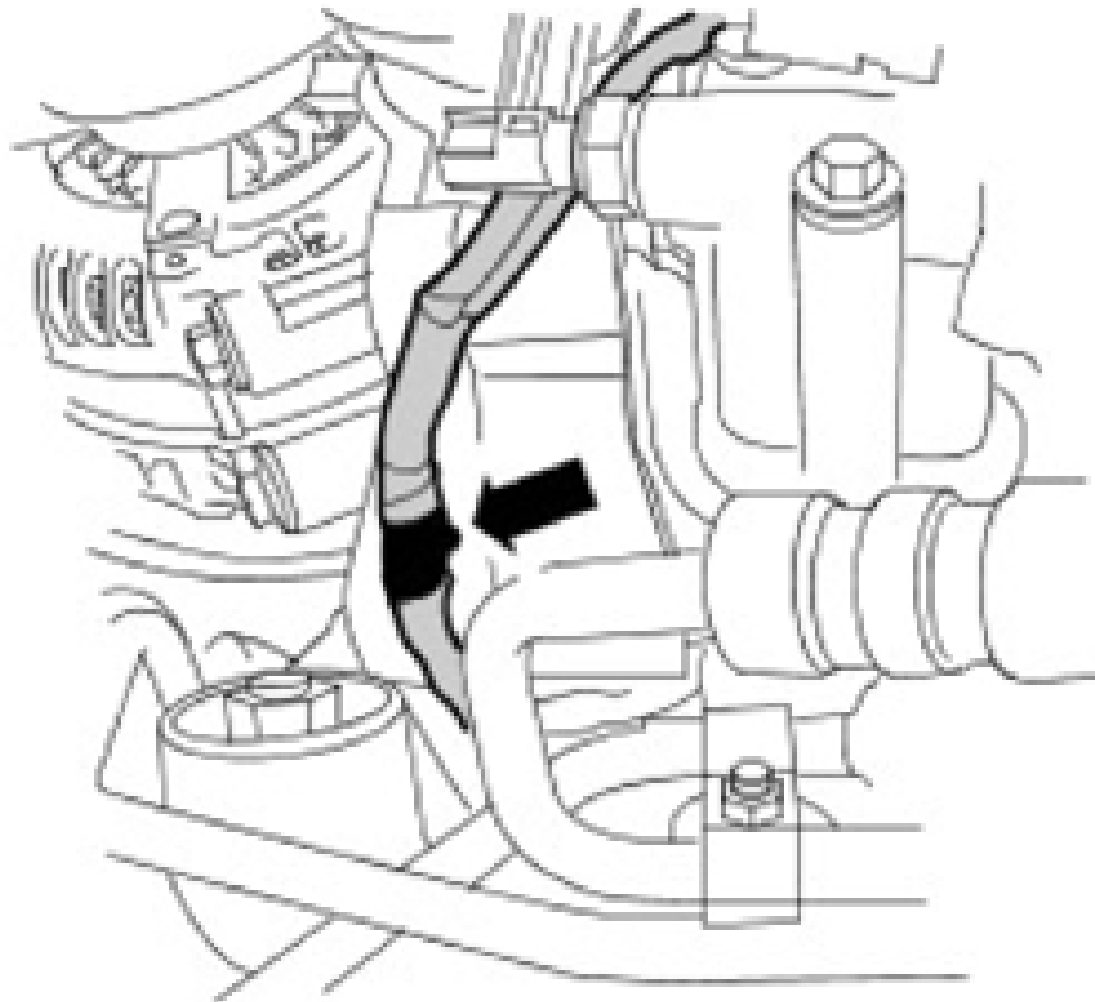
20. Disconnect the oil temperature and oil pressure sensors.



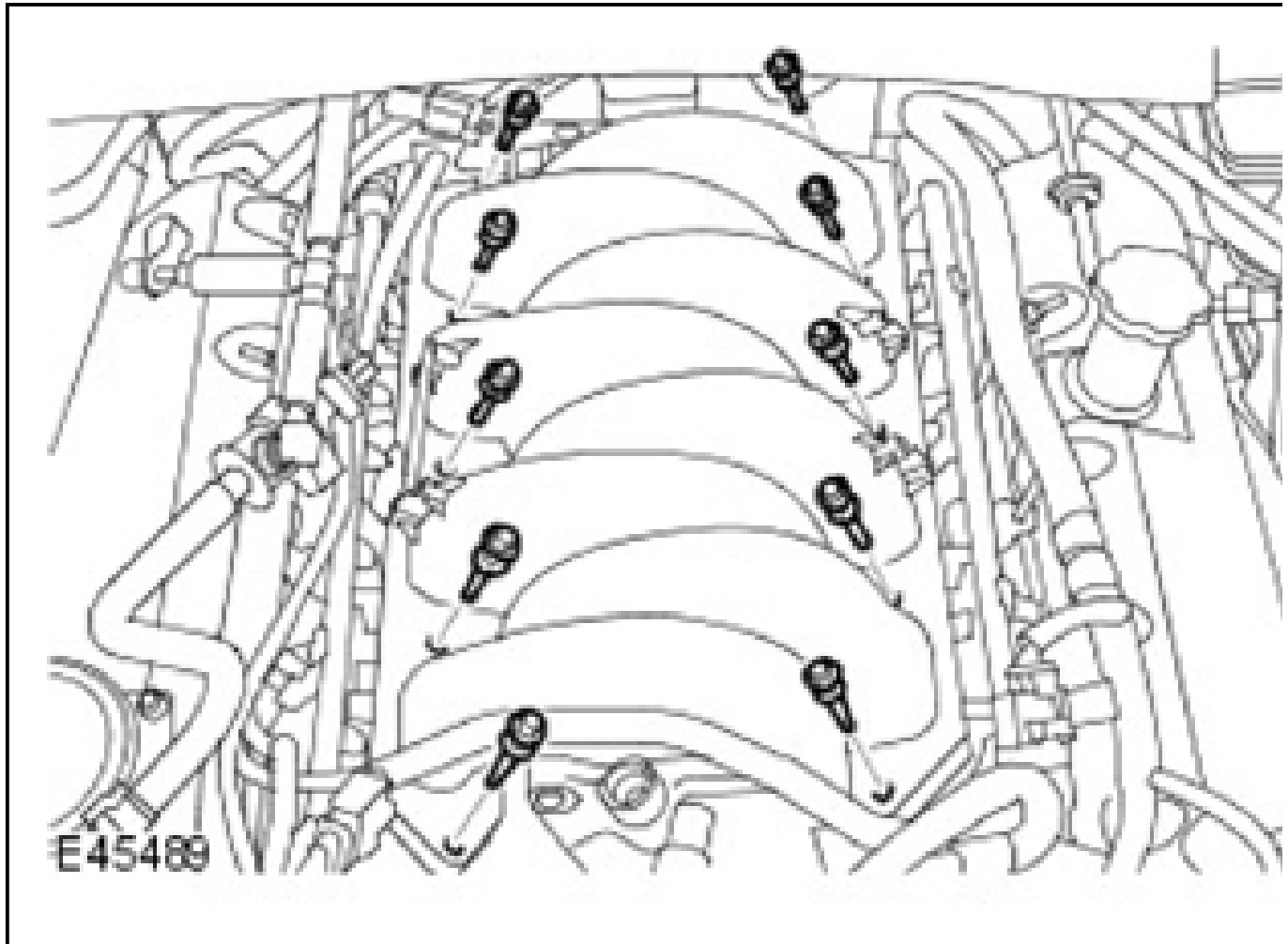
21. Disconnect the generator connector.



22. Release the 4 clips securing the generator harness.



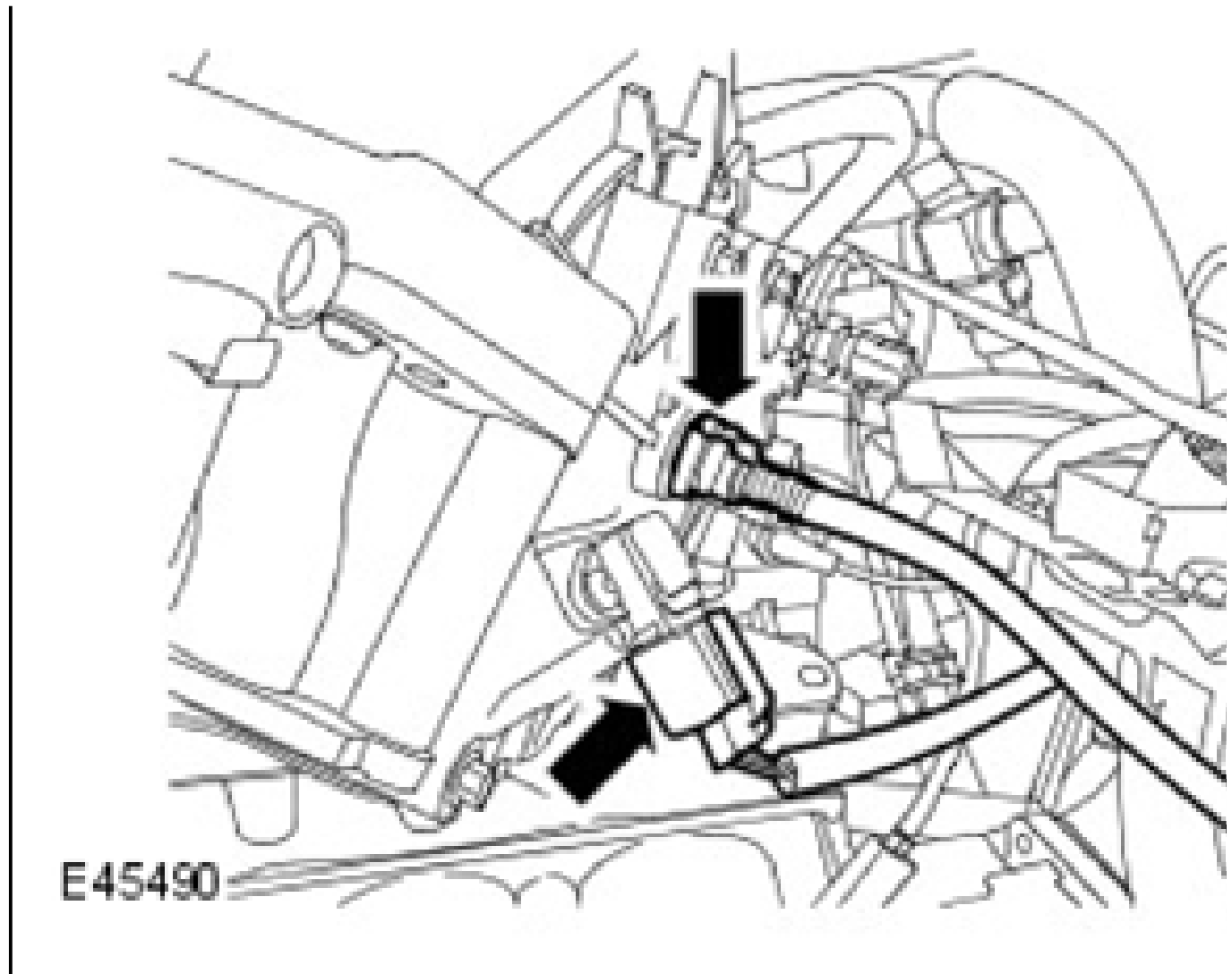
23. Remove the 10 intake manifold bolts.



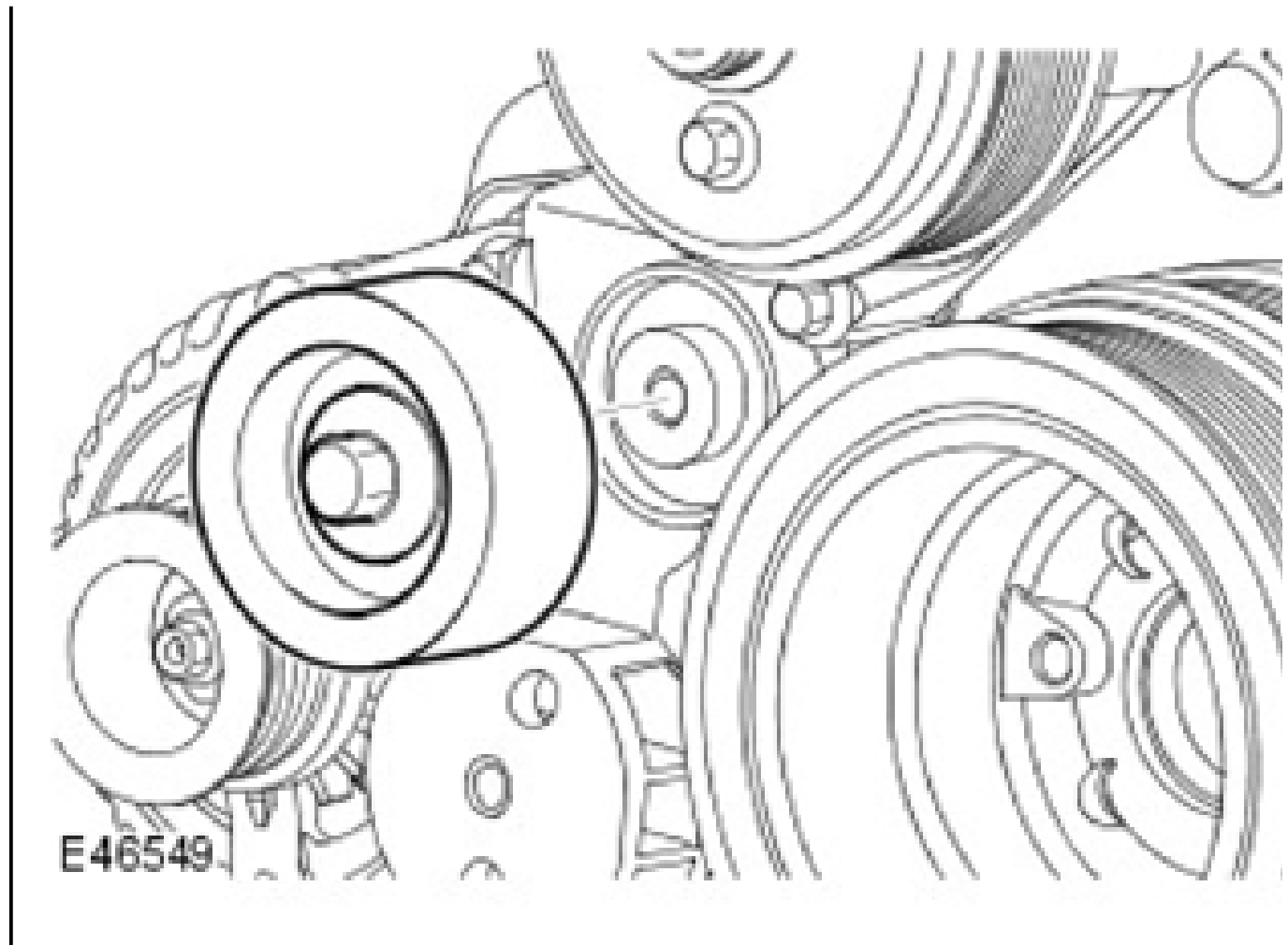
CAUTION: Before the disconnection or removal of any components, ensure the area around joint faces and connections are clean. Plug any open connections to prevent contamination.

24. Remove the intake manifold.

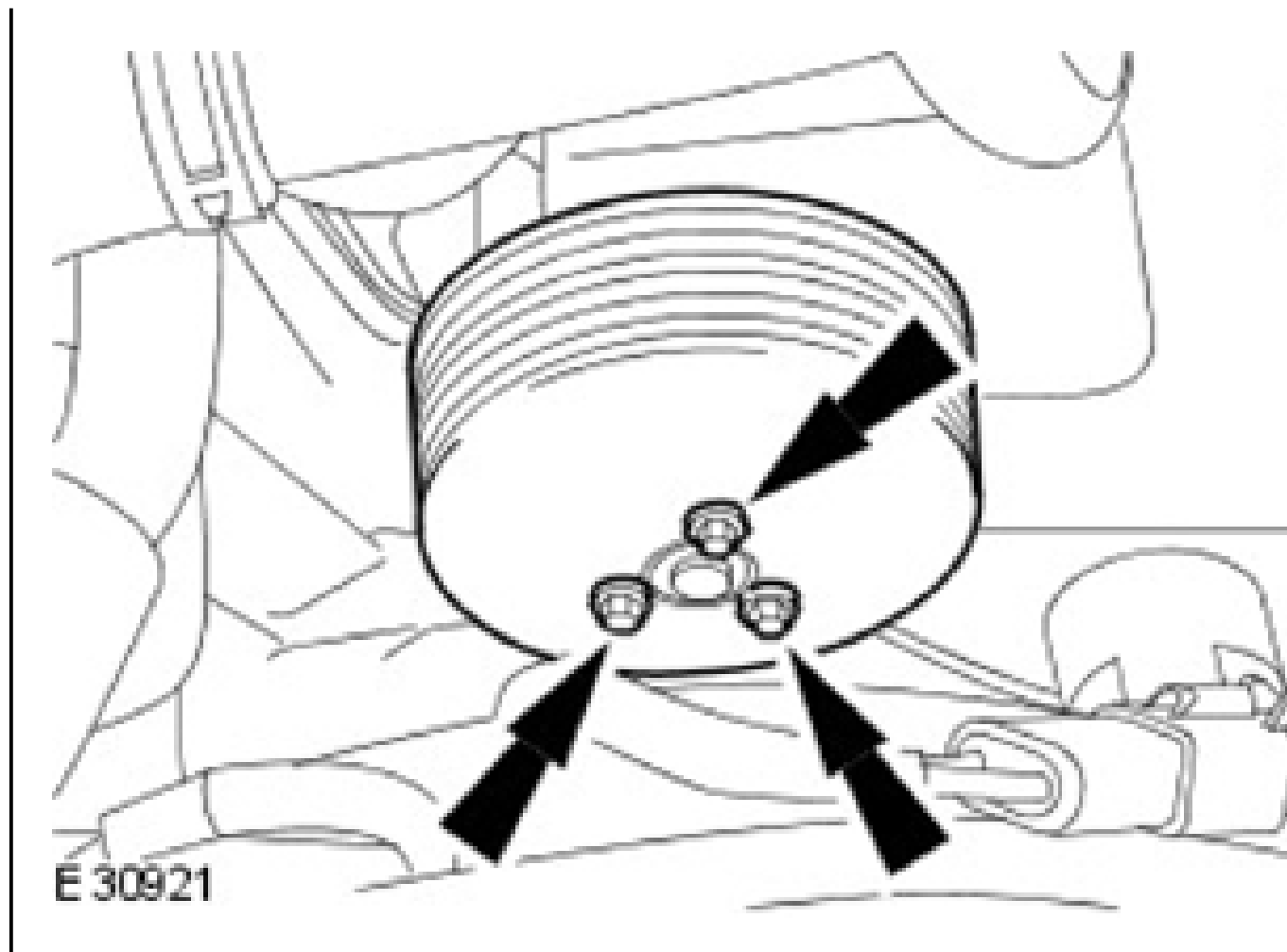
- Disconnect the brake booster vacuum hose from the intake manifold.
- Discard the gaskets.
- Disconnect the manifold absolute pressure (MAP) sensor electrical connector.



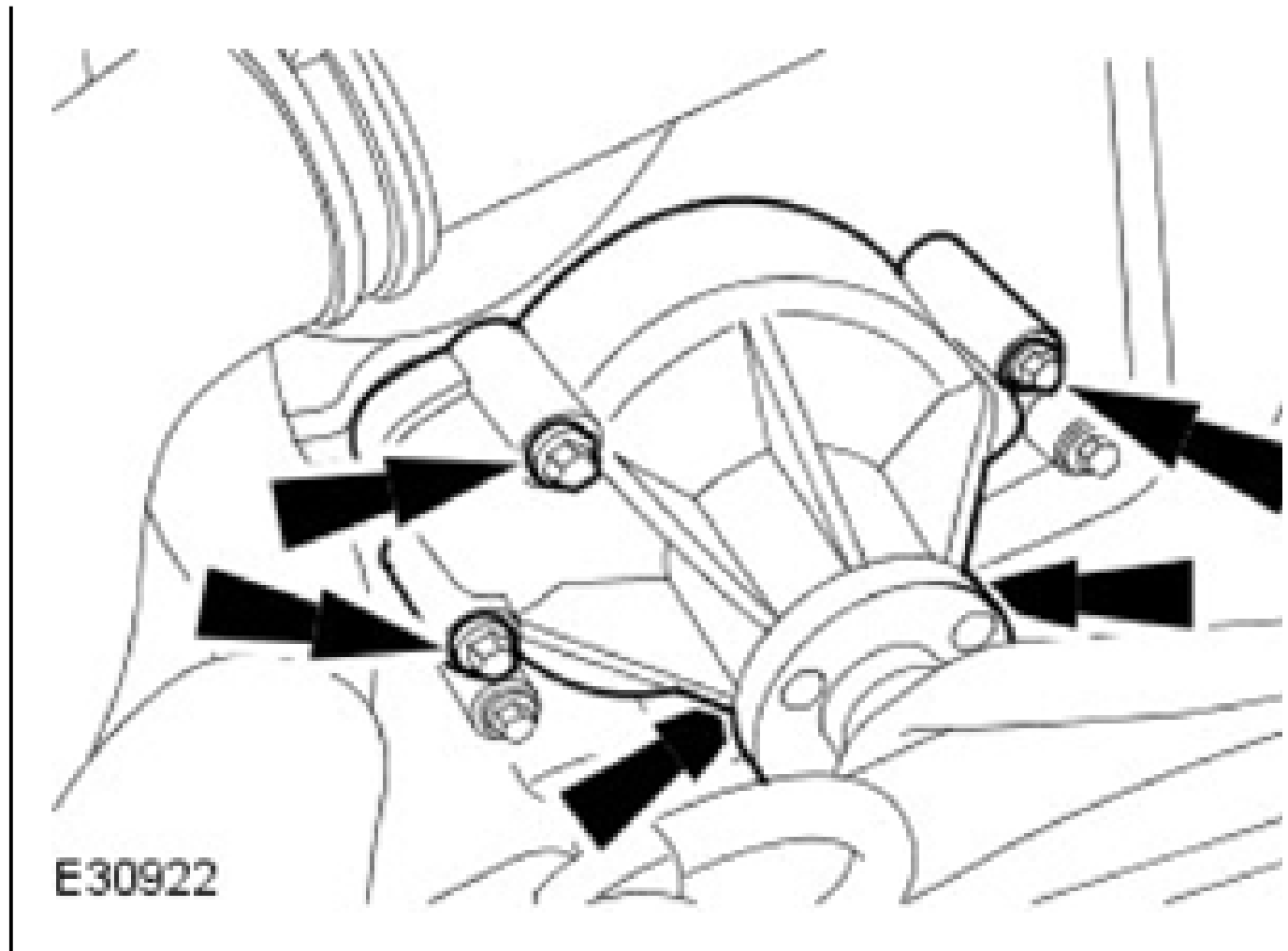
25. Remove the accessory drive belt idler pulley.
- Remove the bolt.



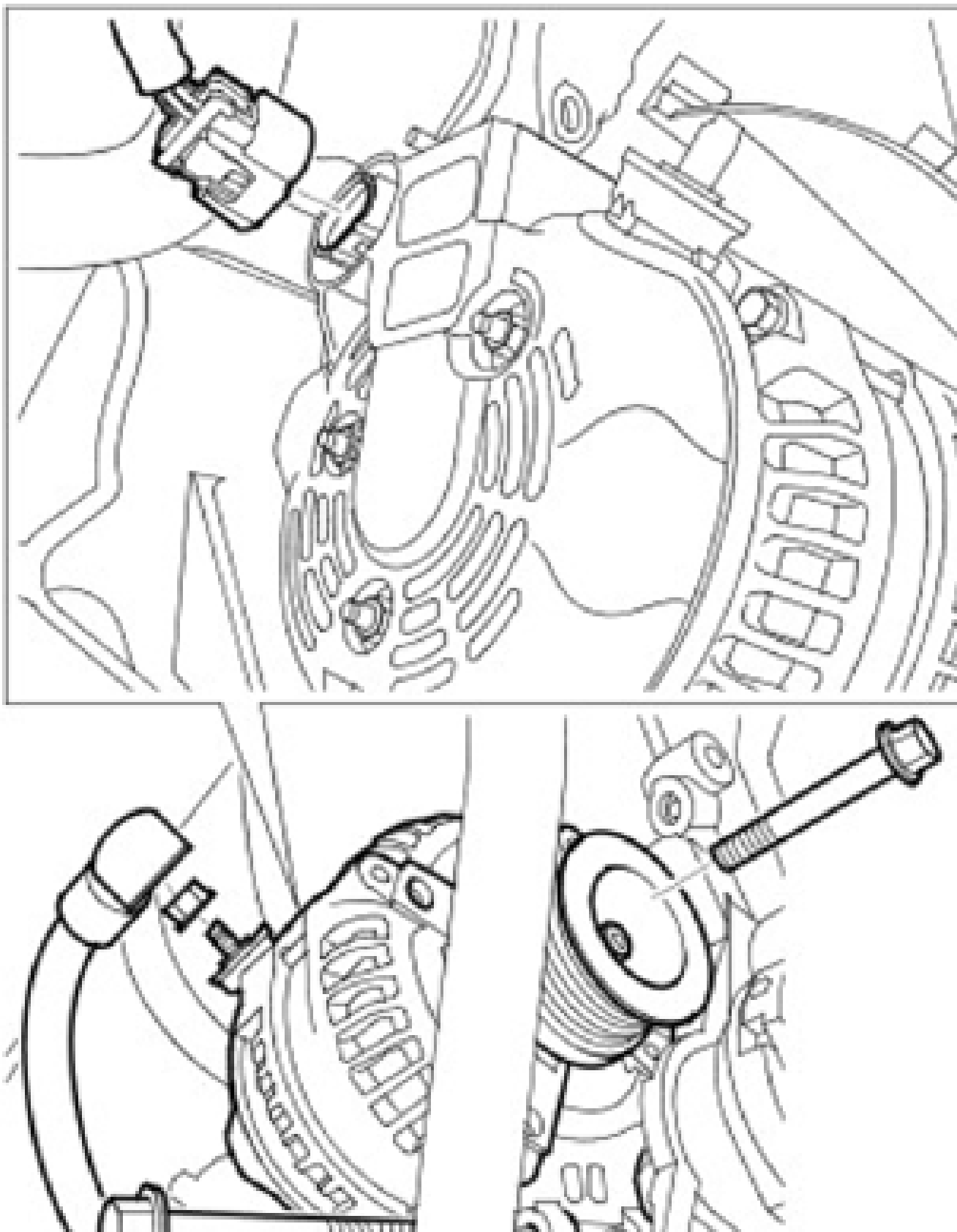
26. Remove the coolant pump pulley.
- Remove the 3 bolts.



27. Remove the coolant pump.

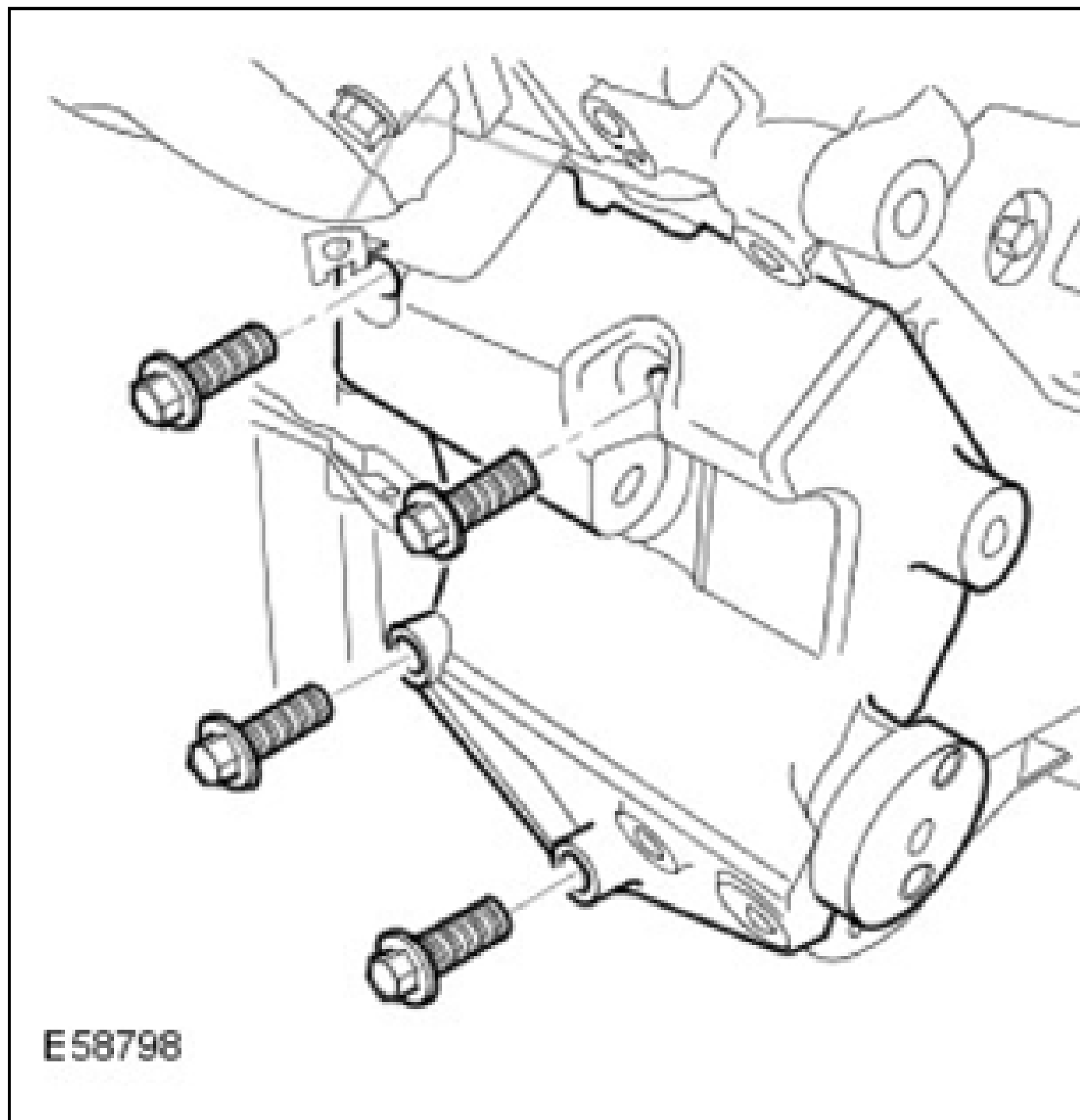


28. Remove the generator.
- Disconnect the electrical connector.
 - Remove the 3 bolts.



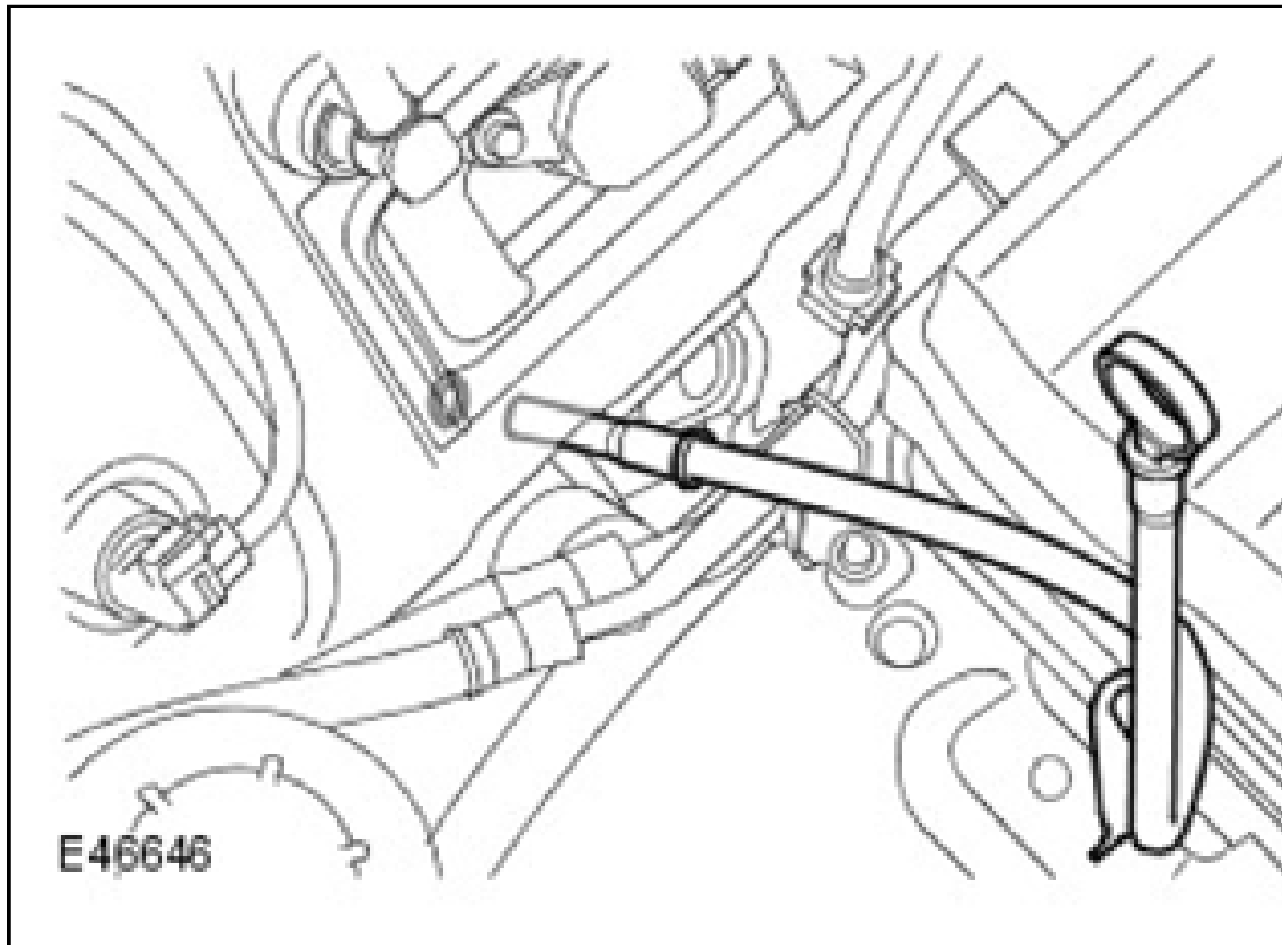
29. Remove the generator mounting bracket.

- Remove the 4 bolts.



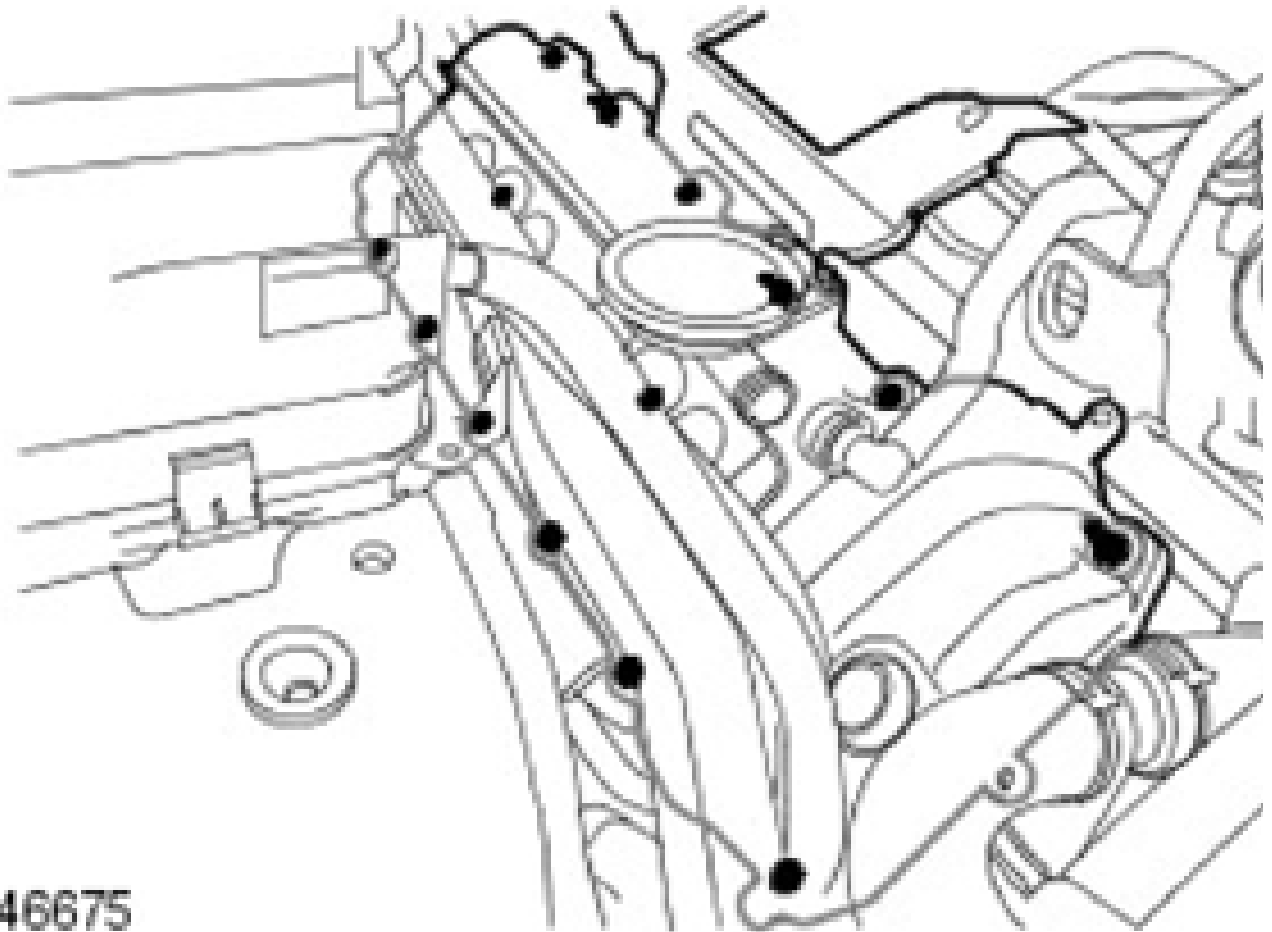
30. Remove the oil level indicator and tube.

- Remove the nut.
- Discard the O-ring seal.



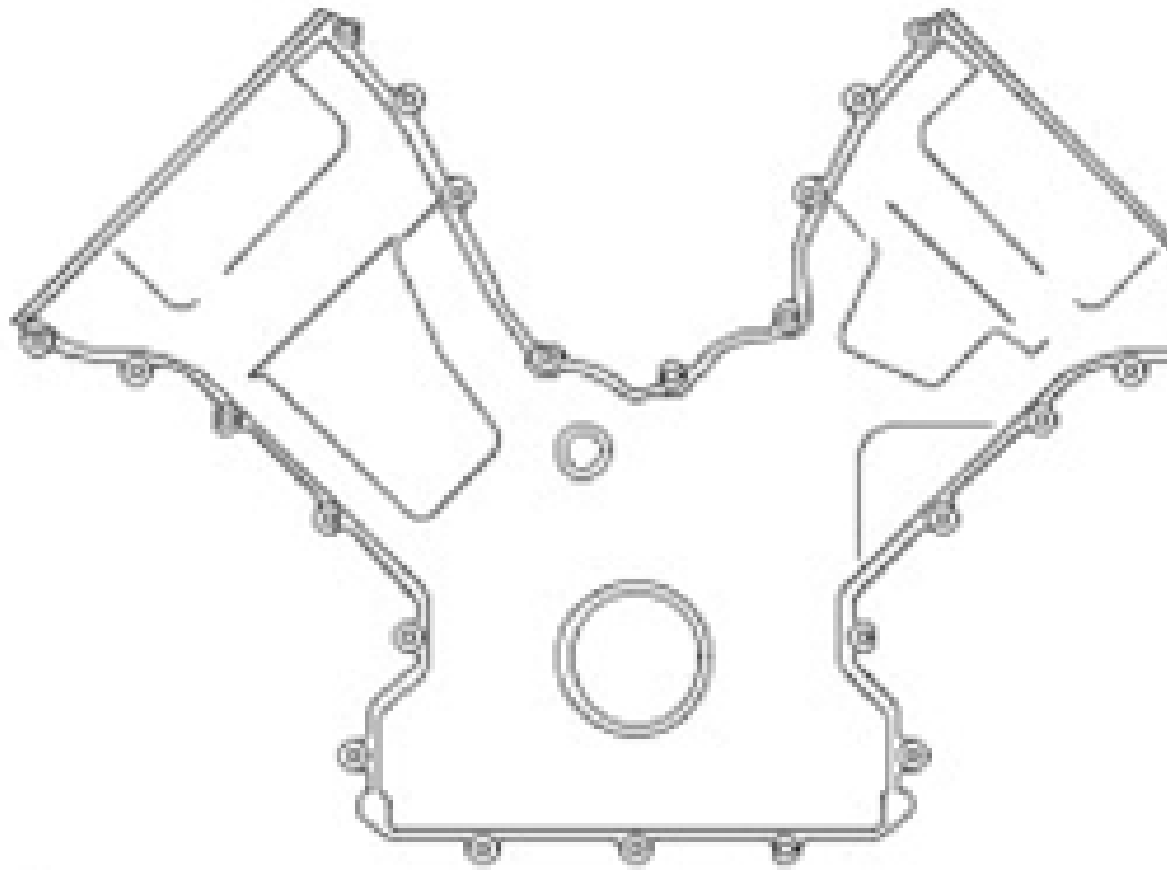
31. Remove the RH valve cover.

- Remove the 14 valve cover retaining bolts.
- Remove and discard the valve cover gasket.
- Remove and discard the valve cover plug aperture seals.
- Repeat the operation for the LH side.



E46675

32. Remove the engine front cover.
- Release the engine wiring harness clips.
 - Remove the 24 bolts.
 - Remove and discard the gasket.

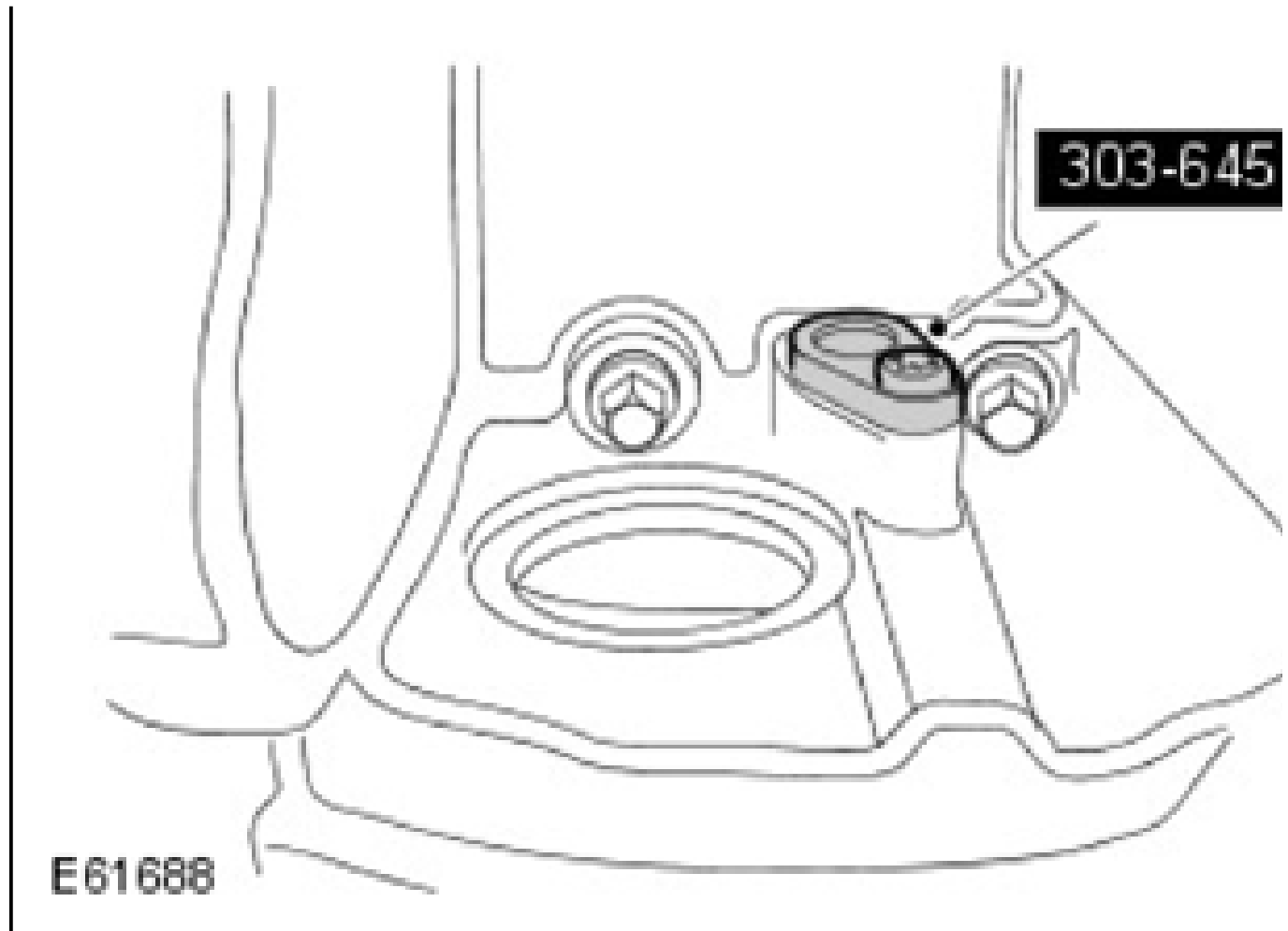


E 48381

33. Rotate the crankshaft until the flats on the camshafts are parallel with the cylinder head joint faces.

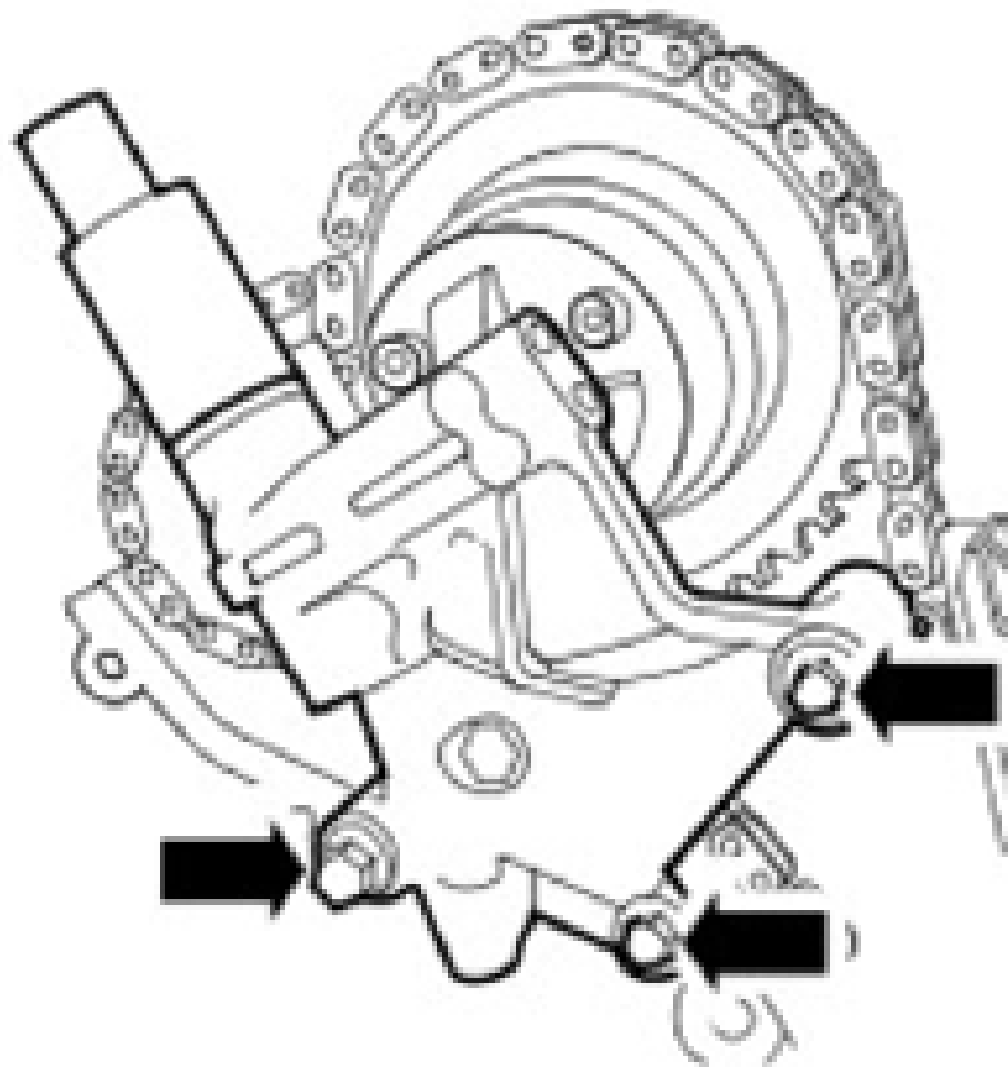
NOTE: **The engine is now in the SAFE position.**

34. Lock the crankshaft.
- Install the special tool.
 - Install the screw.



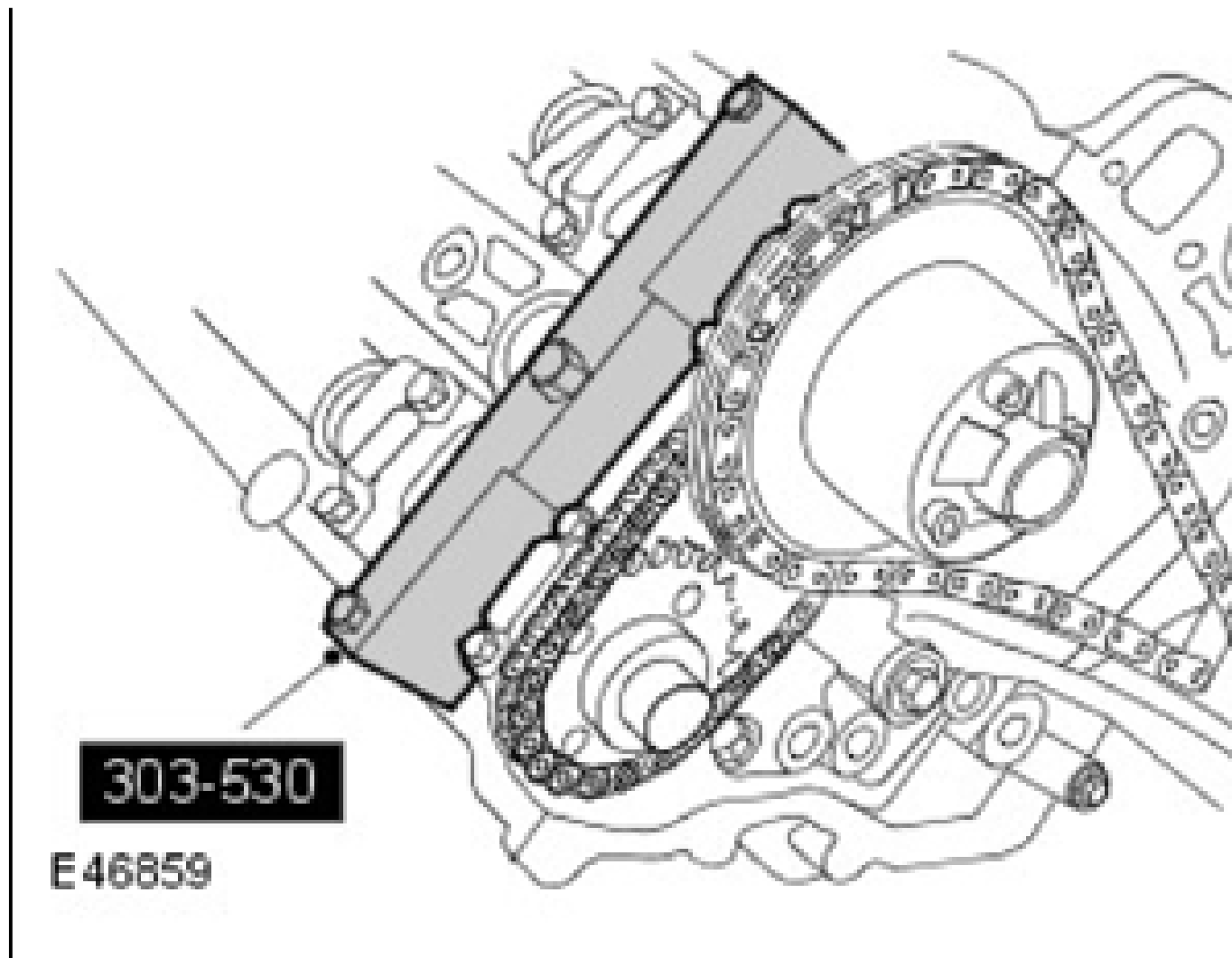
35. Remove the RH VCT control unit.

- Remove the 3 bolts.
- Remove and discard the O-ring seals.

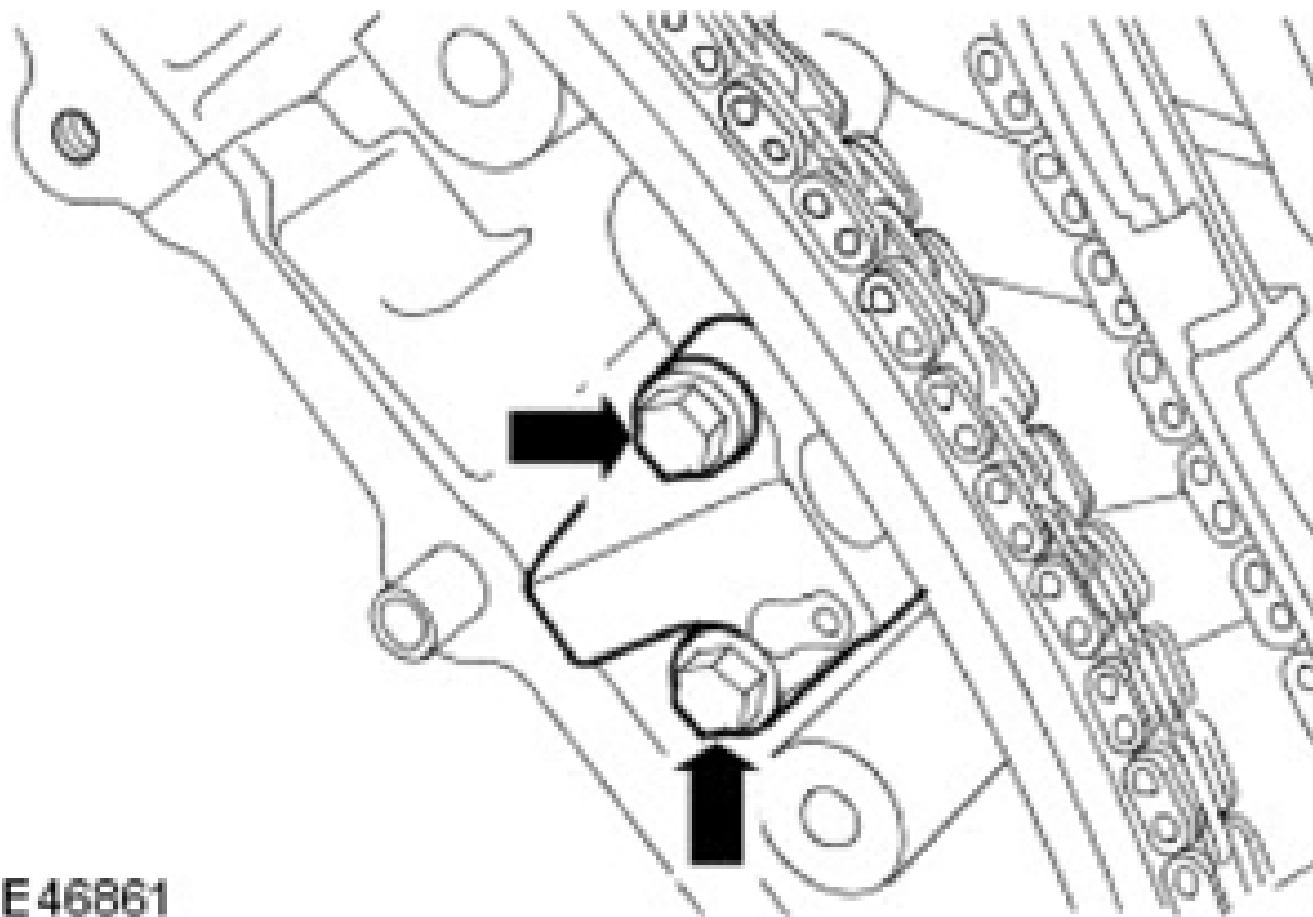


E 46858

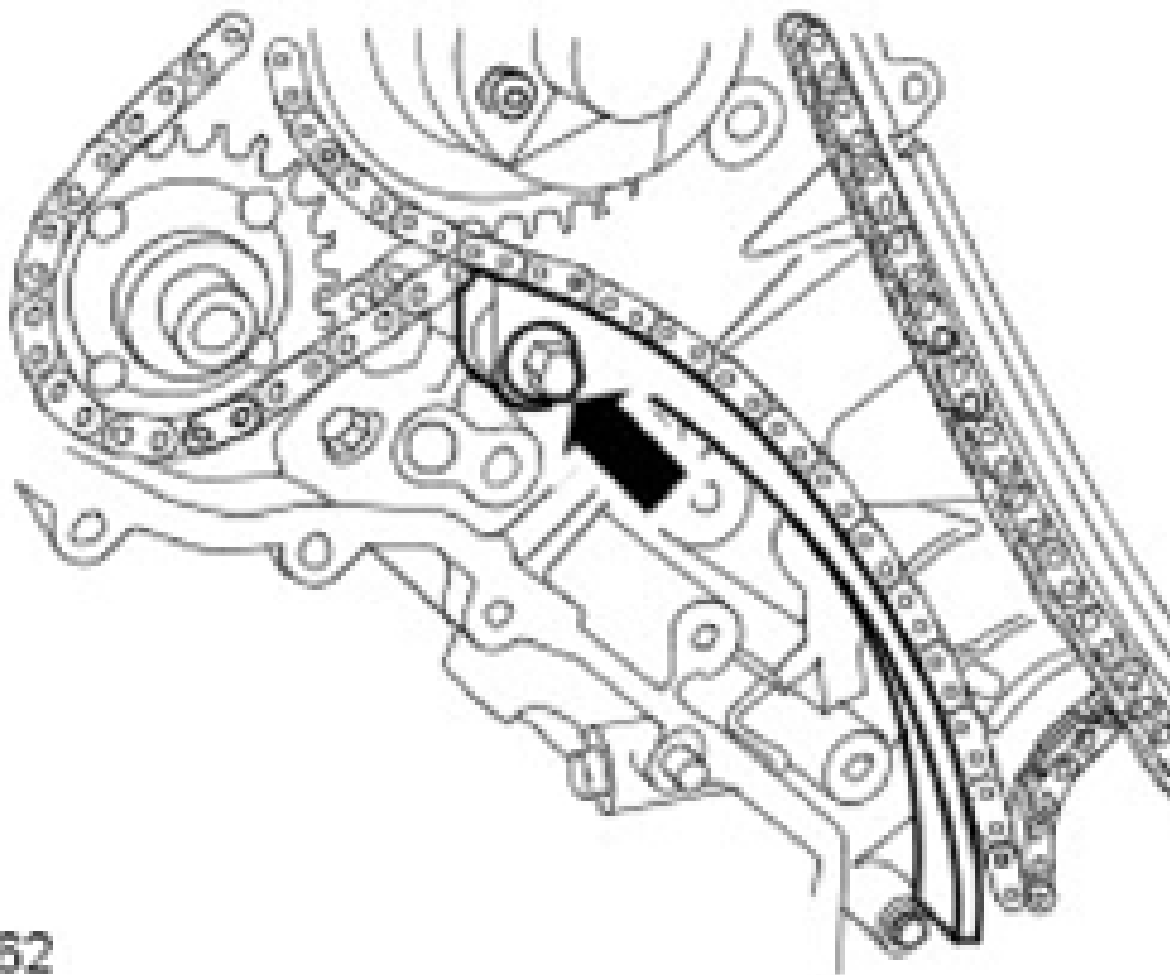
36. Install the special tool to the RH cylinder head.
- Install the 3 bolts.



37. Remove the RH primary timing chain tensioner assembly.
- Remove the 2 bolts.

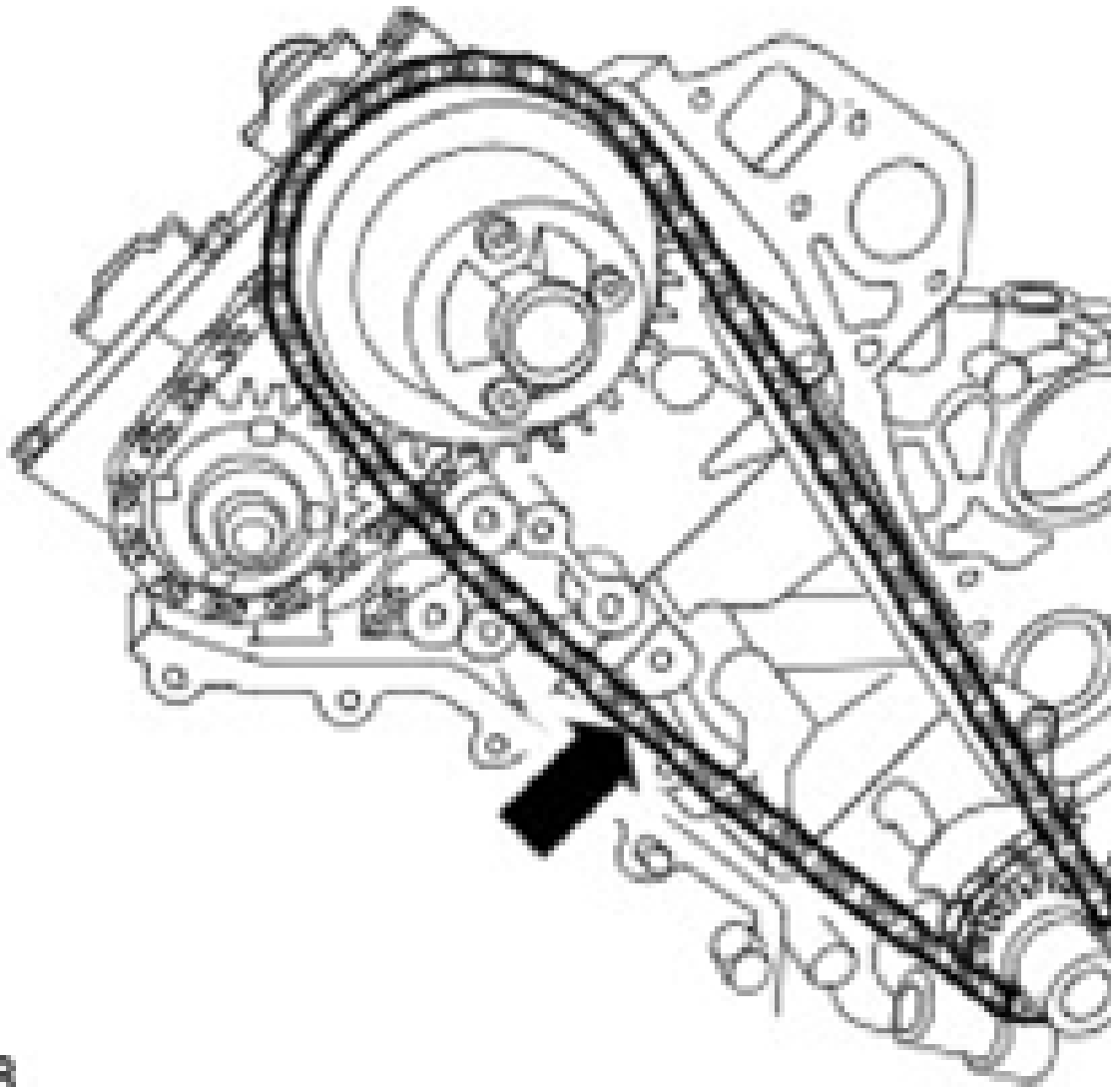


38. Remove the RH primary timing chain tensioner guide.
- Remove the bolt.



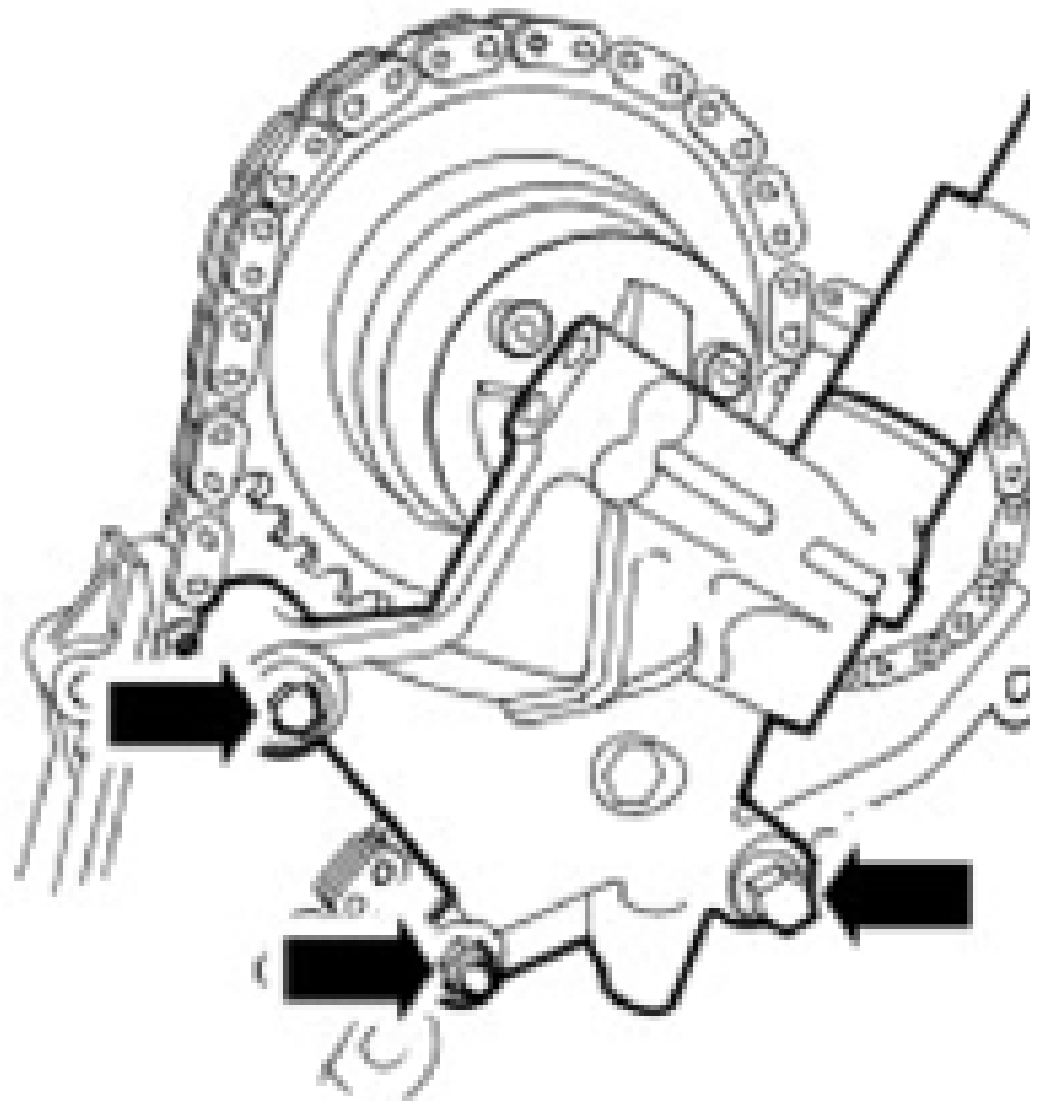
E 46862

39. Remove the RH primary timing chain.

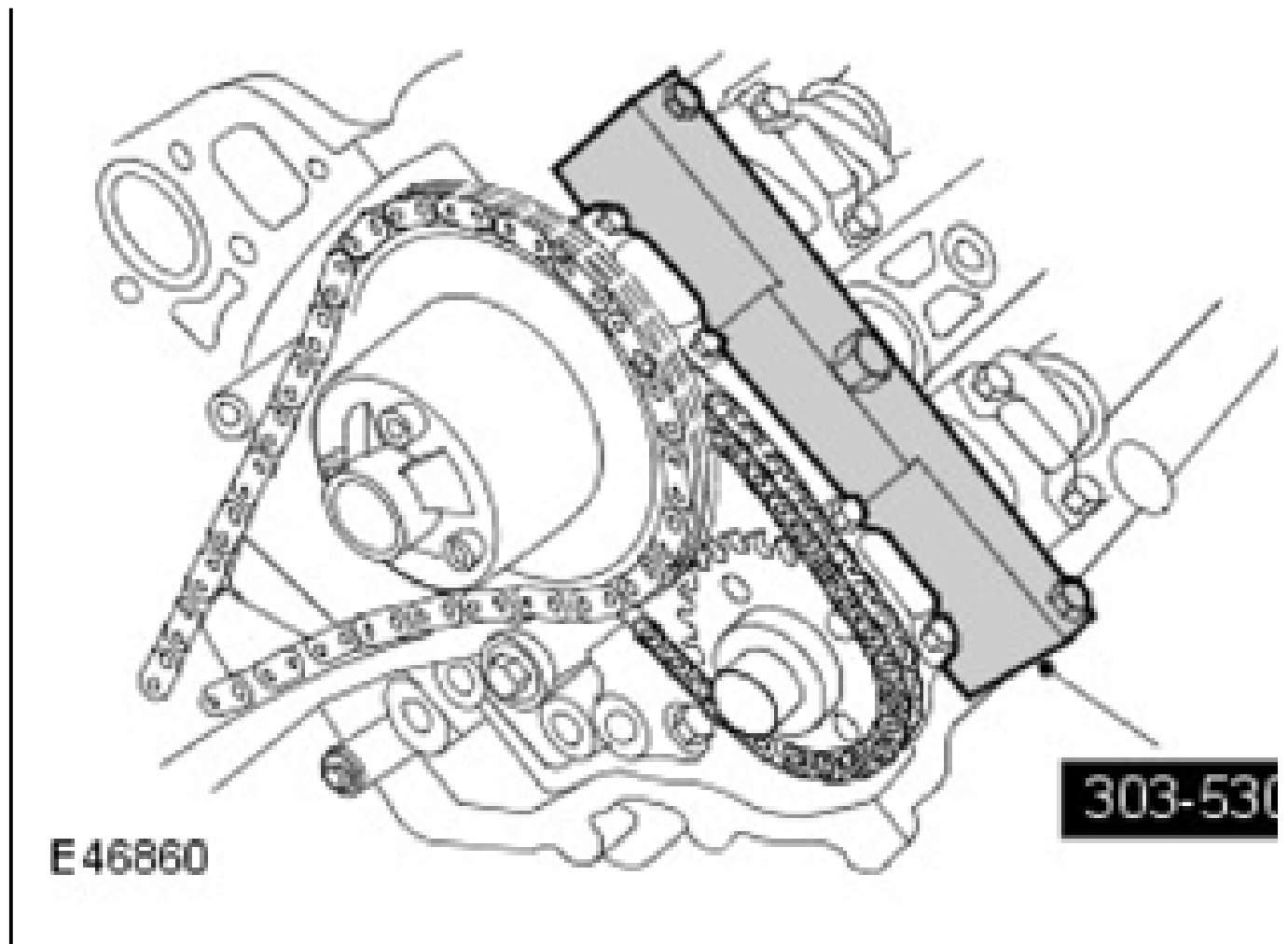


E 46863

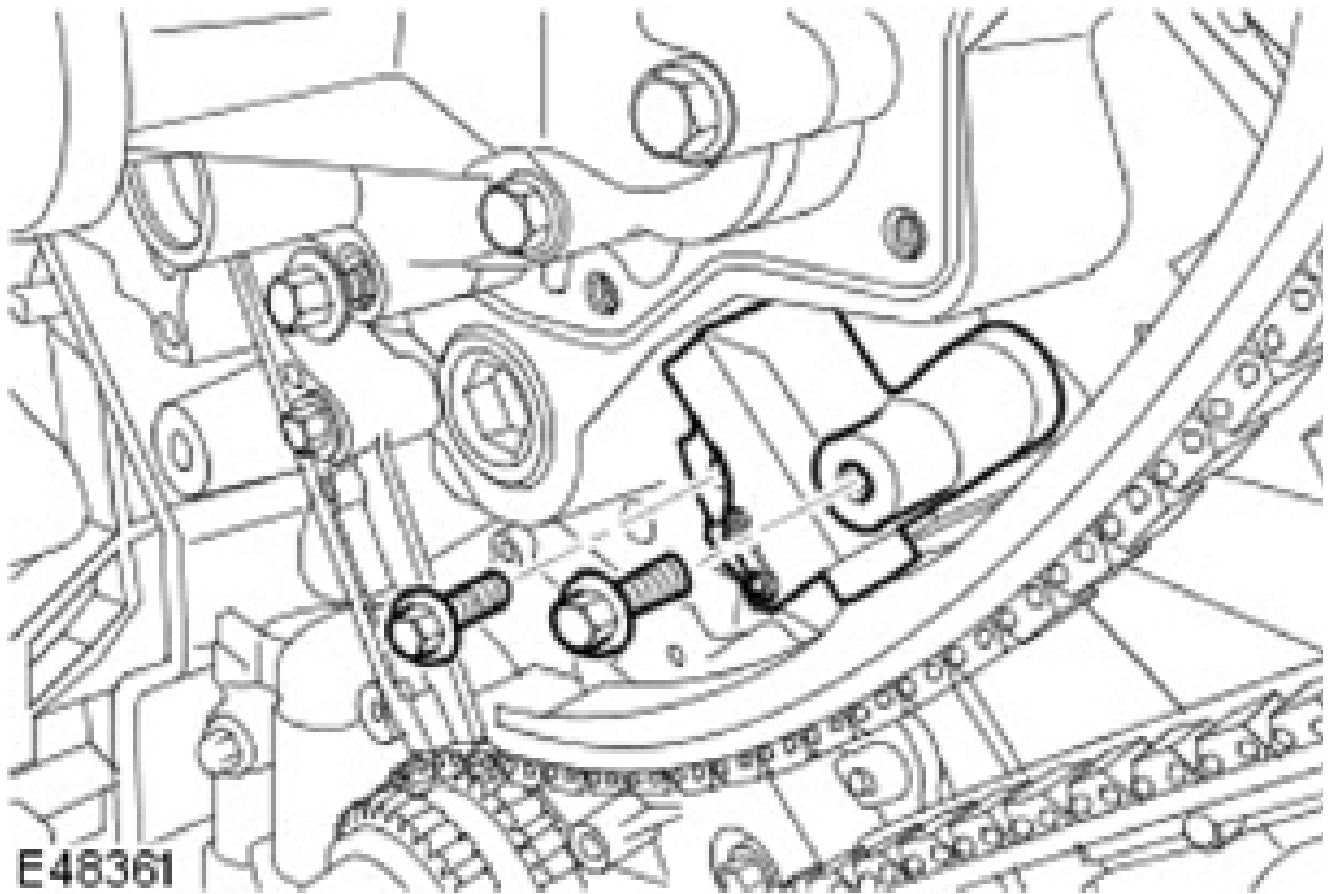
40. Remove the LH VCT control unit.
- Remove the 2 bolts.
 - Remove the nut.
 - Remove and discard the O-ring seals.



41. Install the special tool to the LH cylinder head.
- Install the 3 bolts.

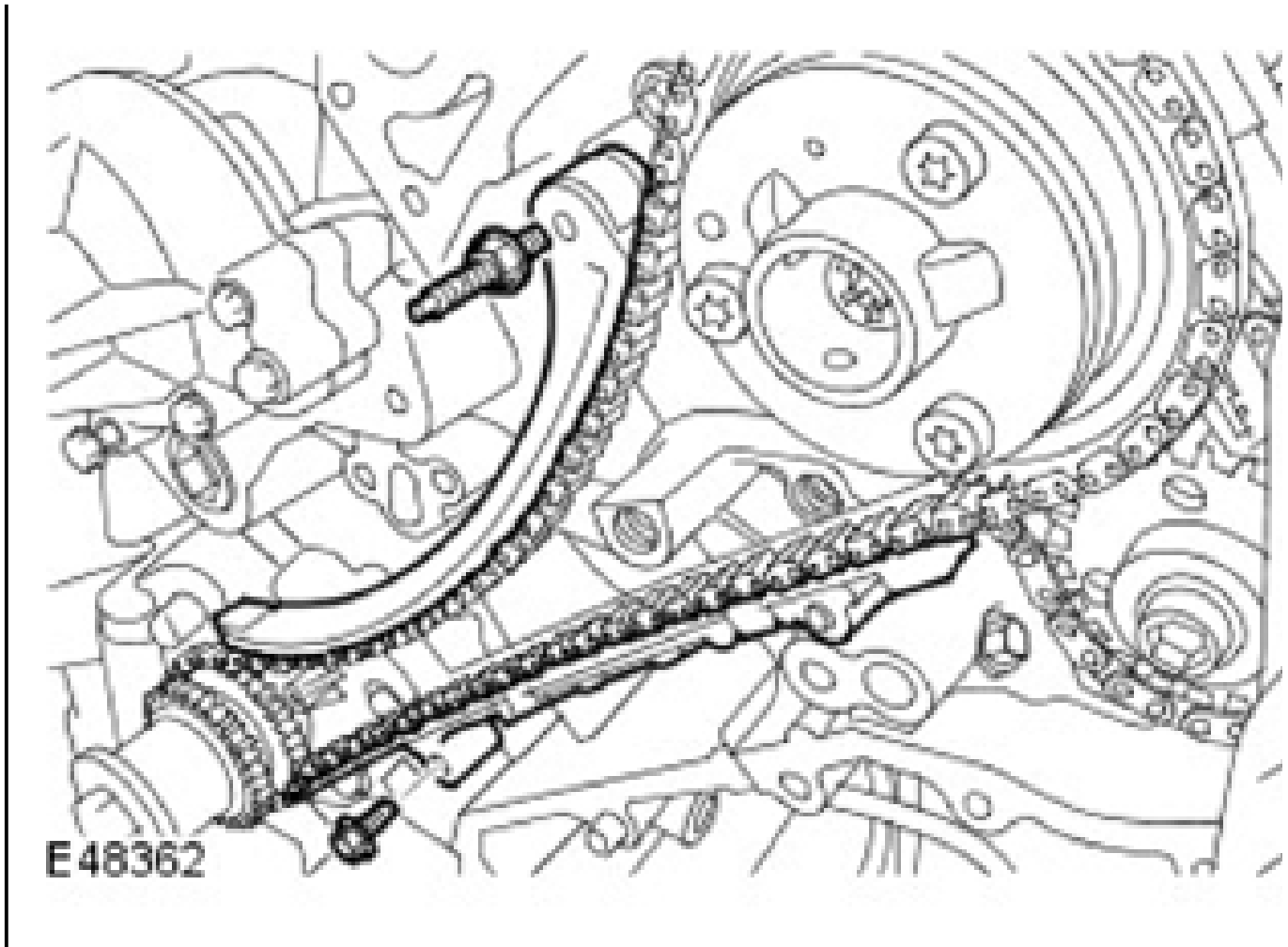


42. Remove the LH primary timing chain tensioner.
- Remove the 2 bolts.



43. Remove the LH upper and lower primary timing chain tensioner guides.

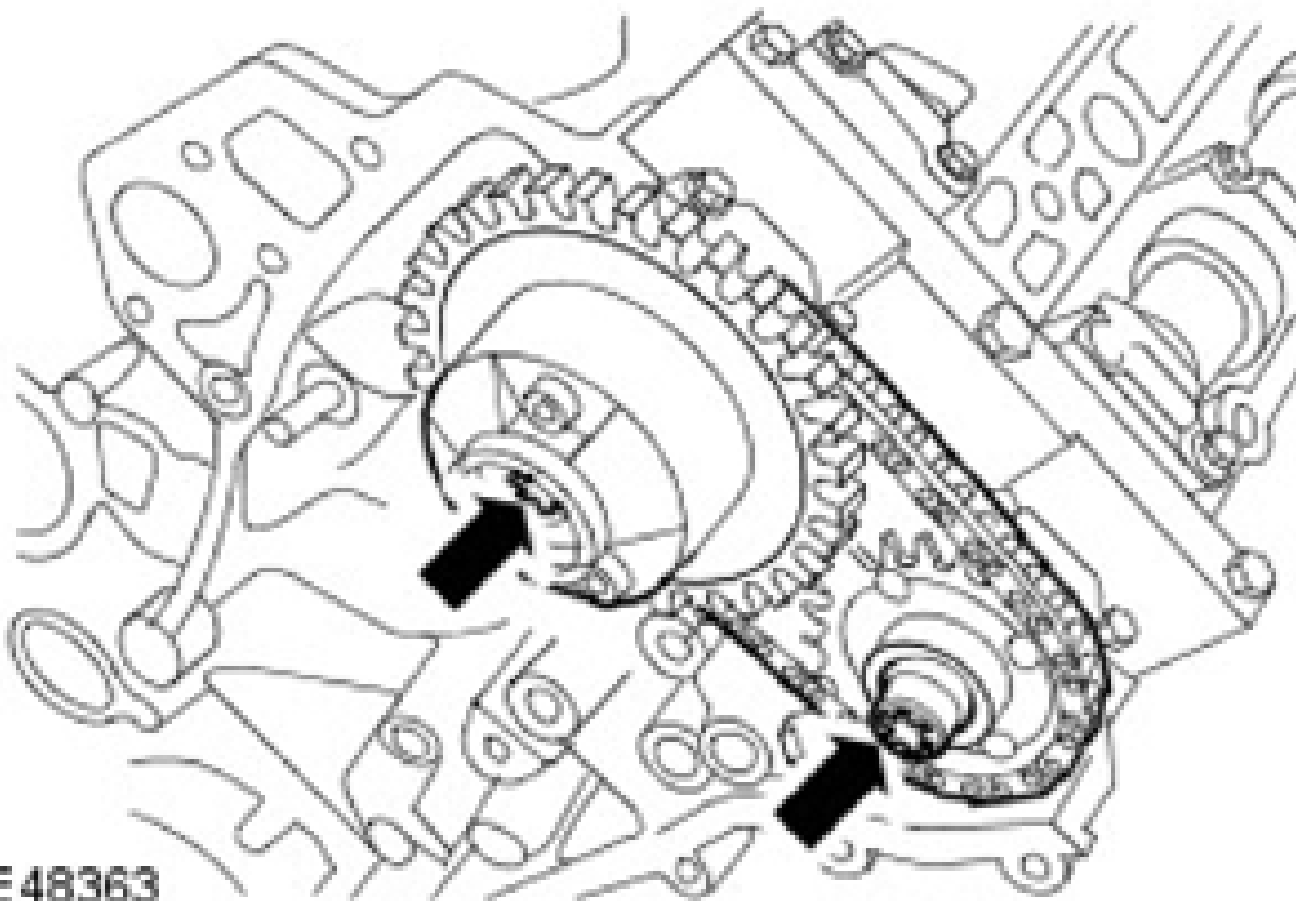
- Remove the stud.
- Remove the bolt.



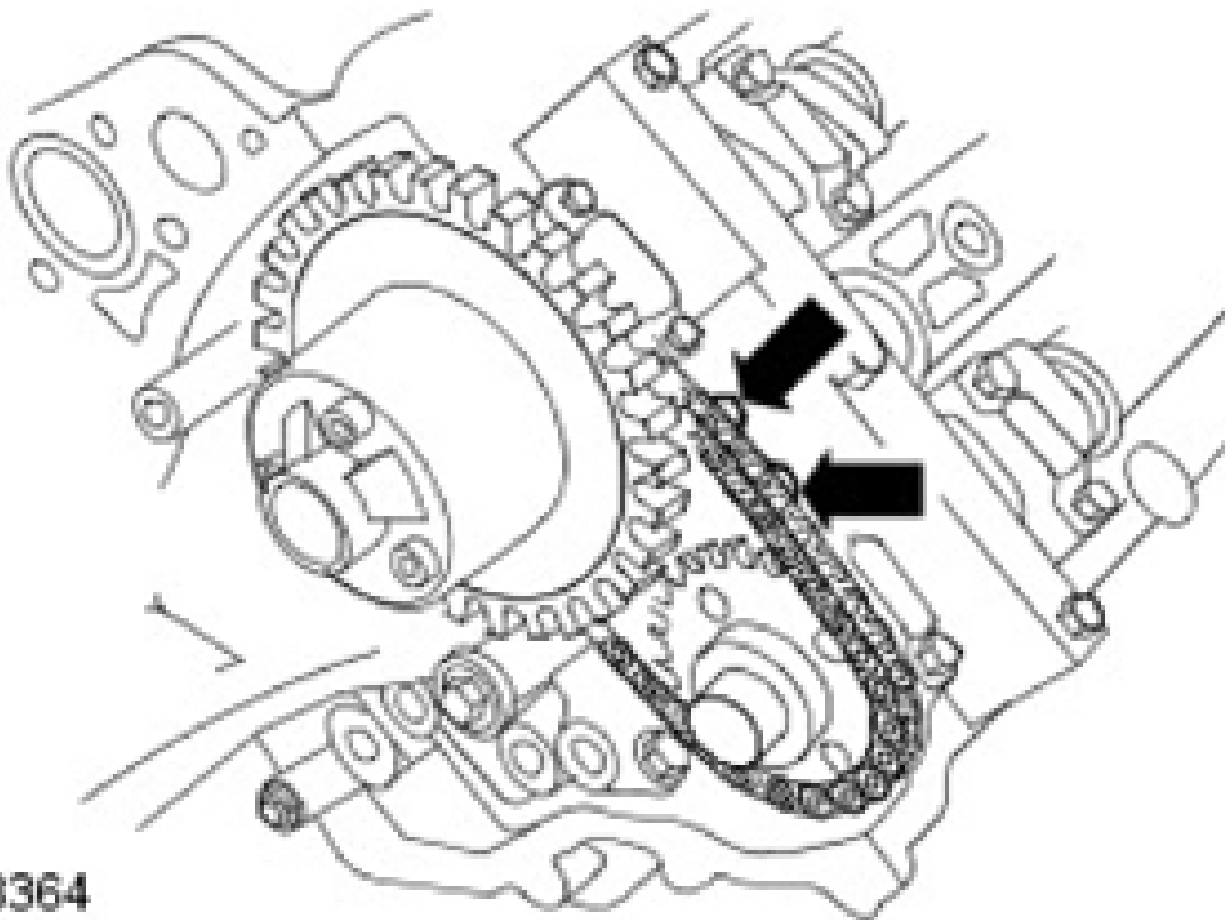
44. Remove the LH primary timing chain.

CAUTION: Discard the bolts.

45. Remove the camshaft sprockets.
- Remove the 2 bolts.

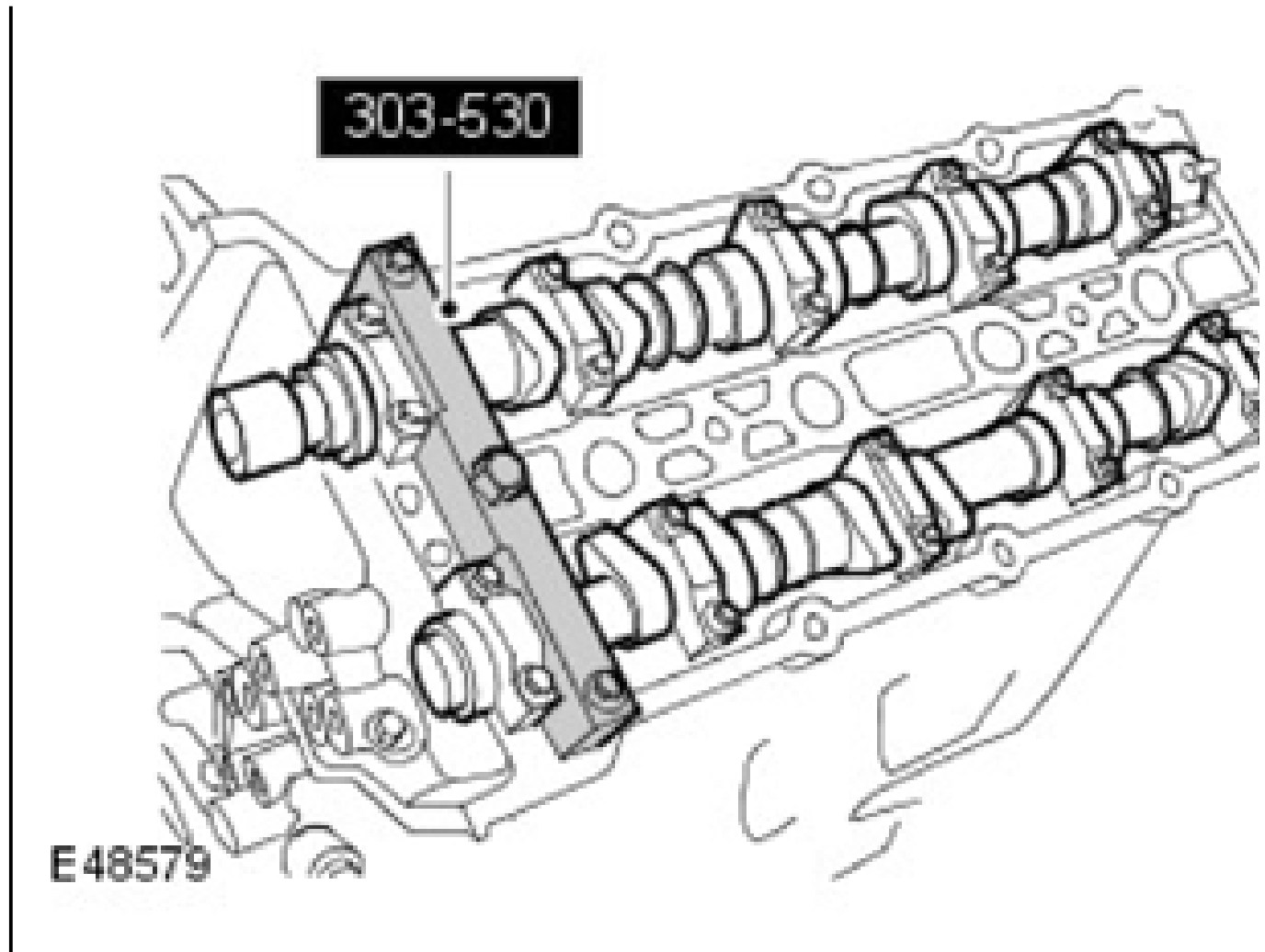


46. Remove the secondary timing chain tensioner and the secondary timing chain.
- Remove the 2 bolts.



E48364

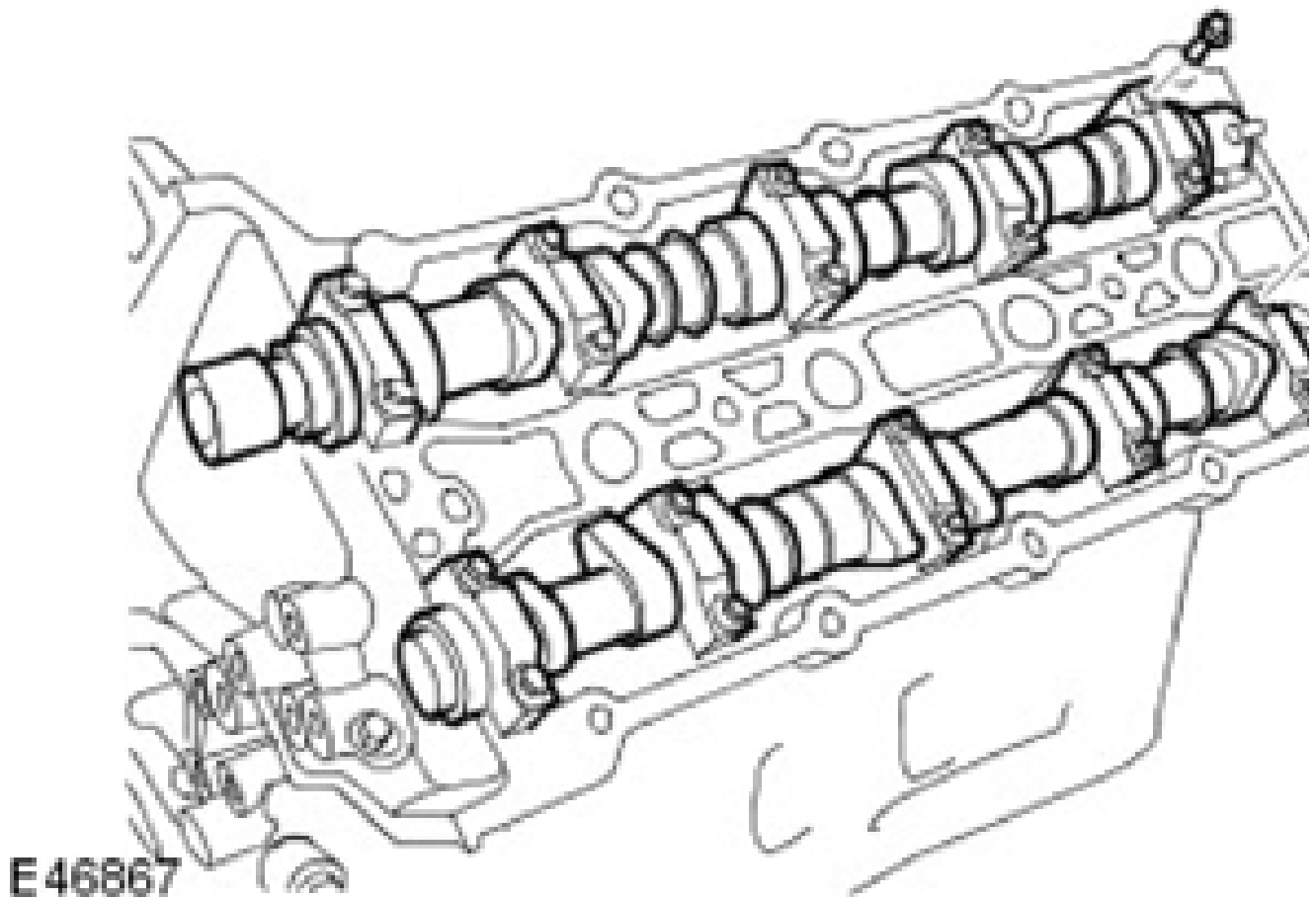
47. Remove the special tool from the LH cylinder head.
- Remove the 3 bolts.



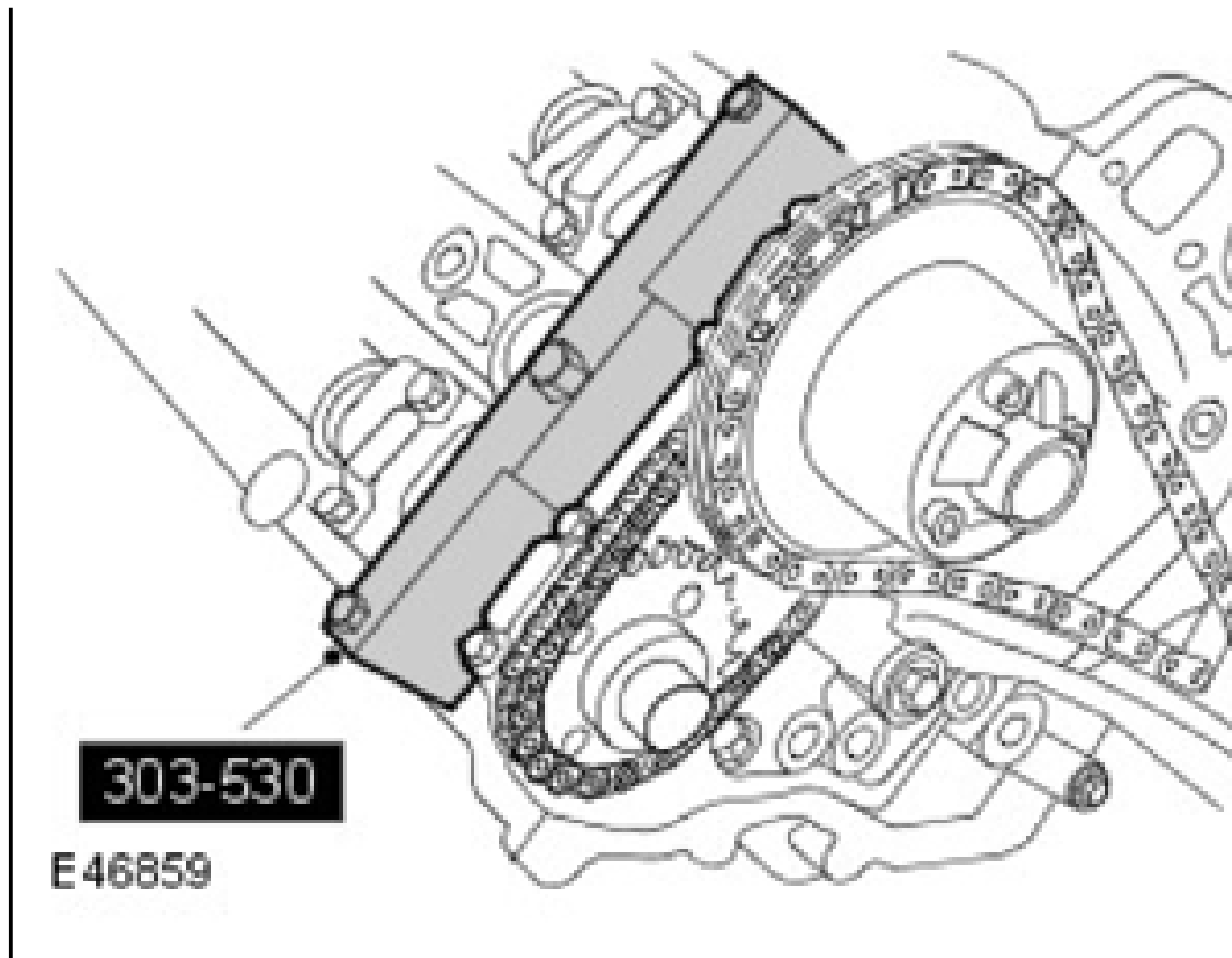
CAUTION: Evenly and progressively, release the camshaft bearing caps.

NOTE: Remove the camshaft bearing caps. Note: their position, orientation and markings. Each is marked with its position (number) and an orientation (arrow).

48. Remove the camshaft bearing caps.
 - Remove the 20 bolts.



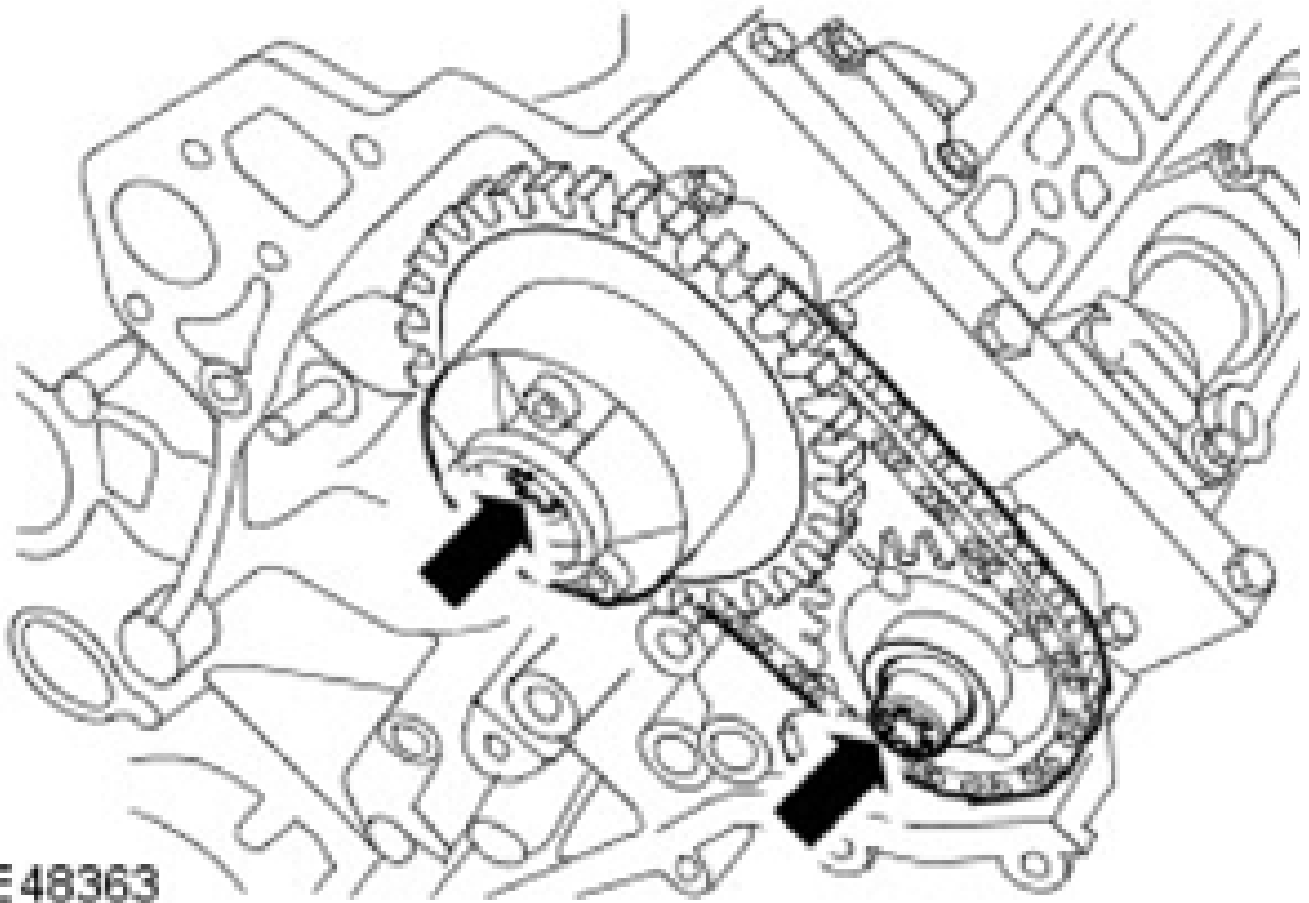
49. Remove the camshafts.
50. Install the special tool to the RH cylinder head.
 - Install the 3 bolts.



CAUTION: Discard the bolts.

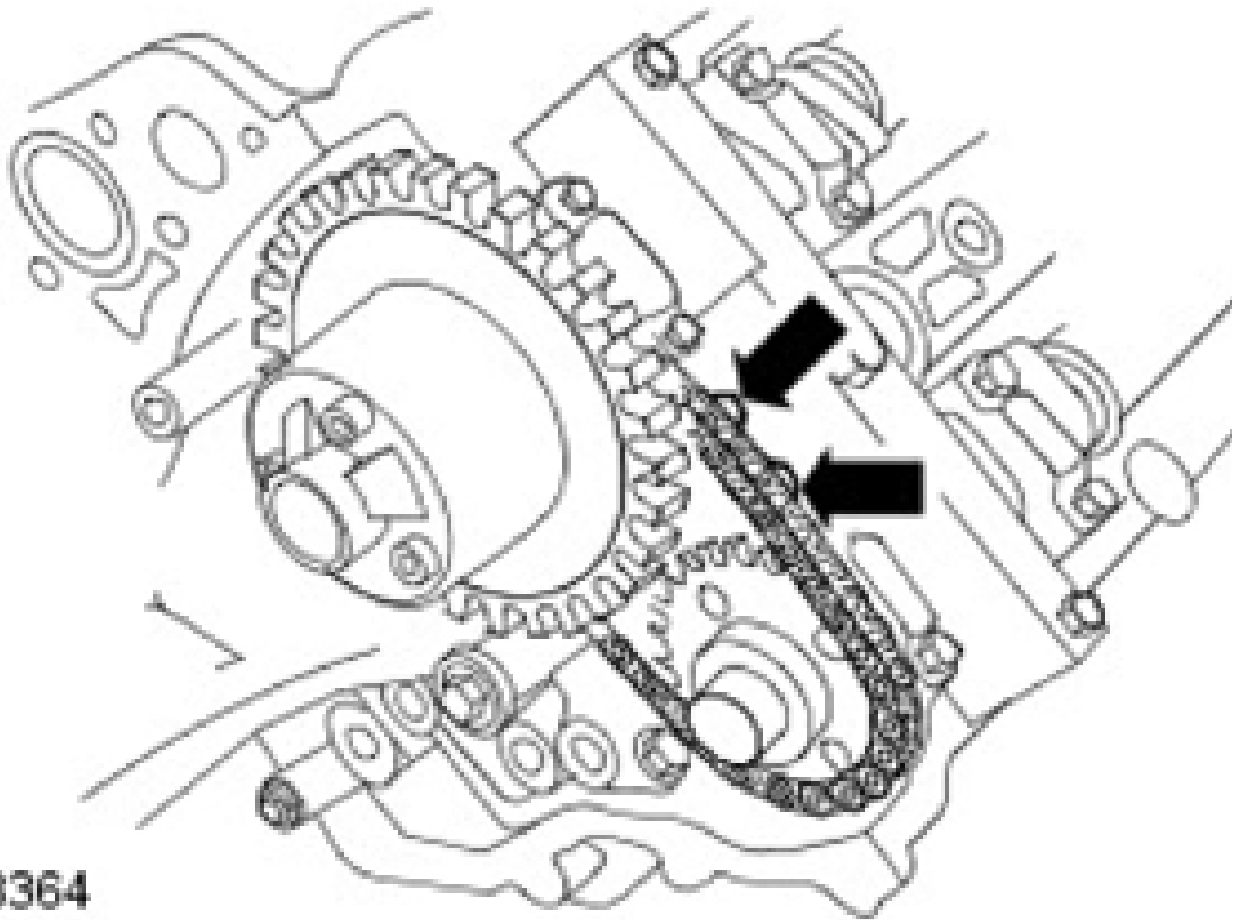
NOTE: LH illustration shown, RH is similar.

51. Remove the camshaft sprockets.
 - Remove the 2 bolts.



NOTE: LH illustration shown, RH is similar.

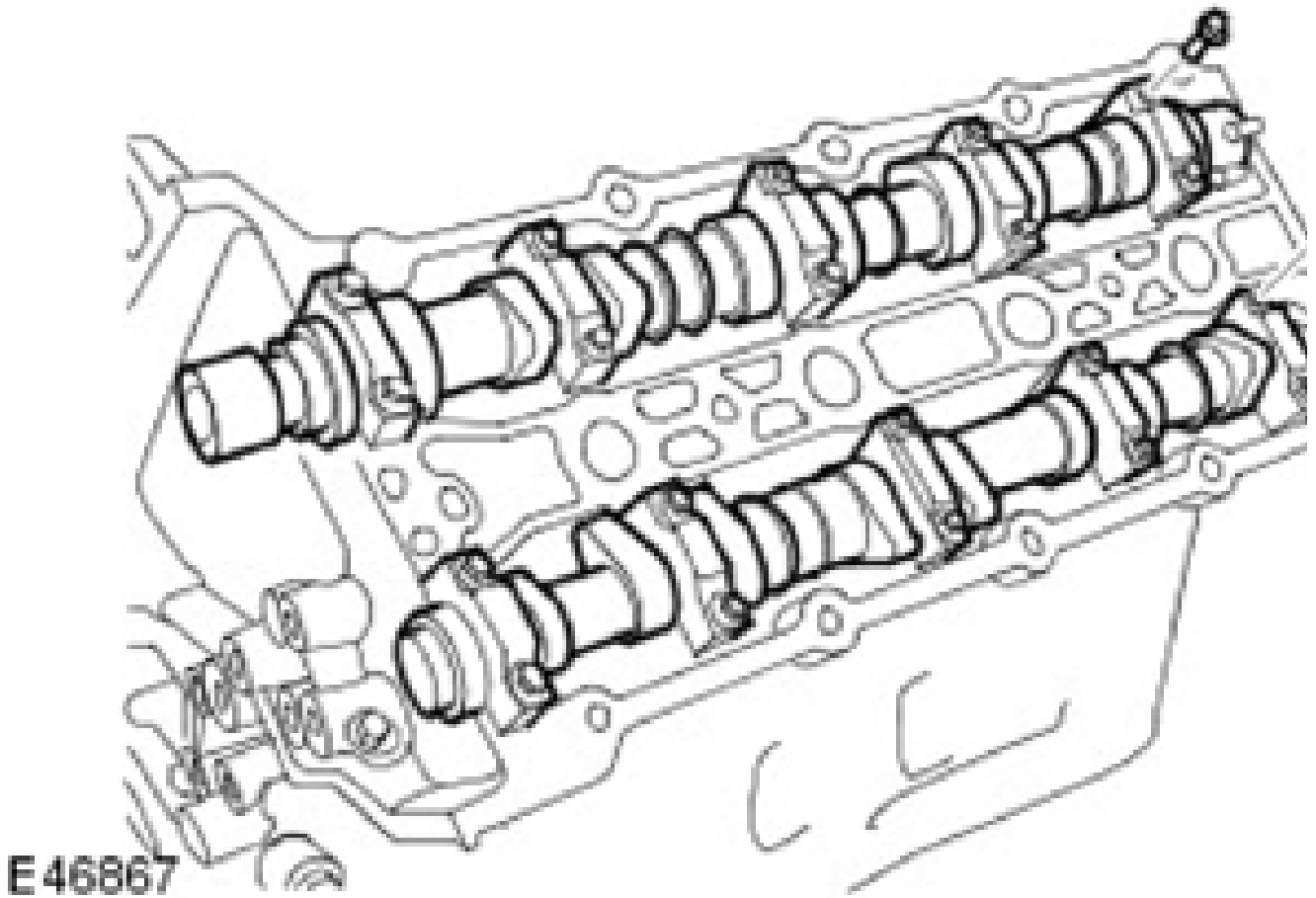
52. Remove the secondary timing chain tensioner and the secondary timing chain.
 - Remove the 2 bolts.



CAUTION: Evenly and progressively, release the camshaft bearing caps.

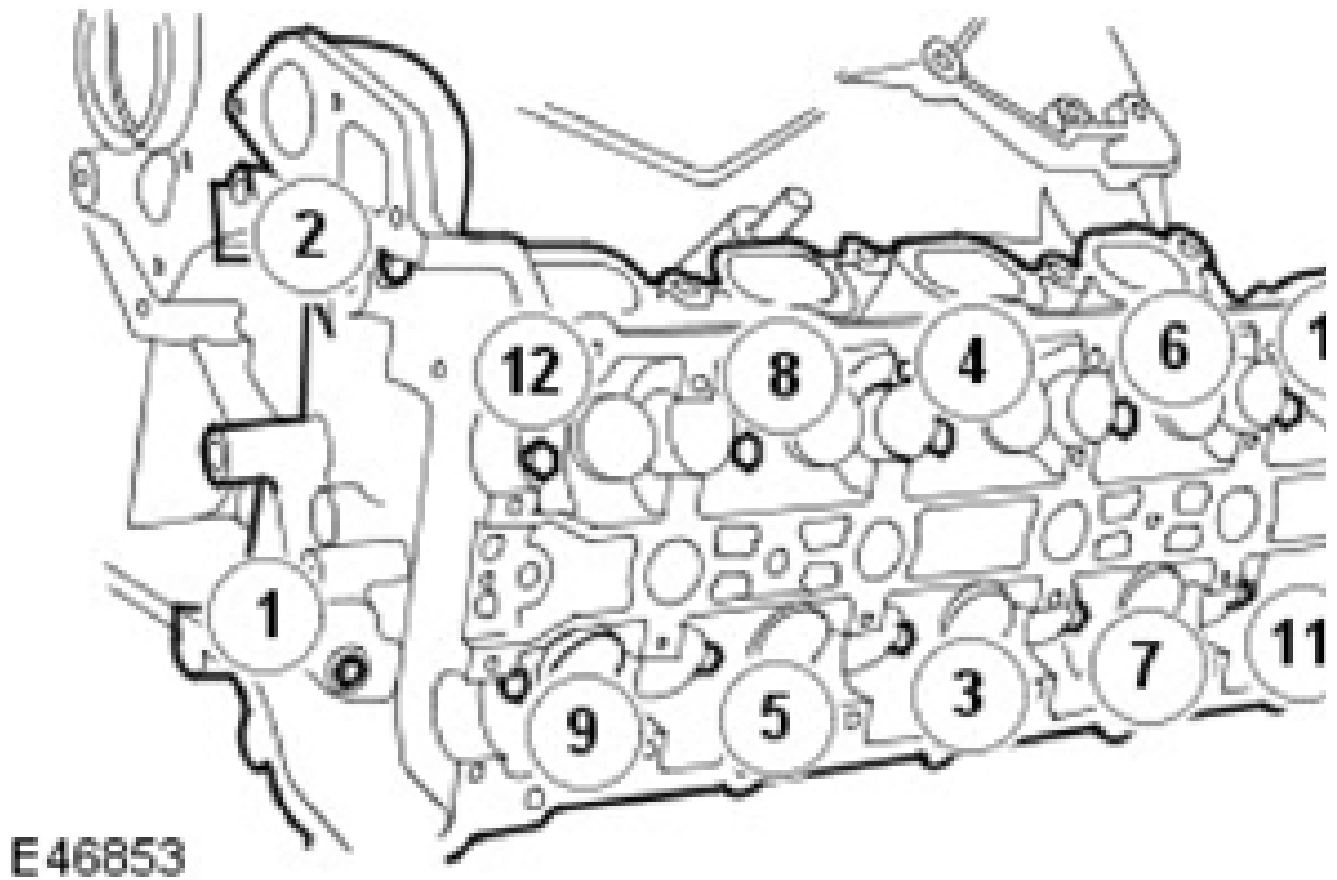
NOTE: Remove the camshaft bearing caps. Note: their position, orientation and markings. Each is marked with its position (number) and an orientation (arrow).
LH illustration shown, RH is similar.

53. Remove the camshaft bearing caps.
- Remove the 20 bolts.

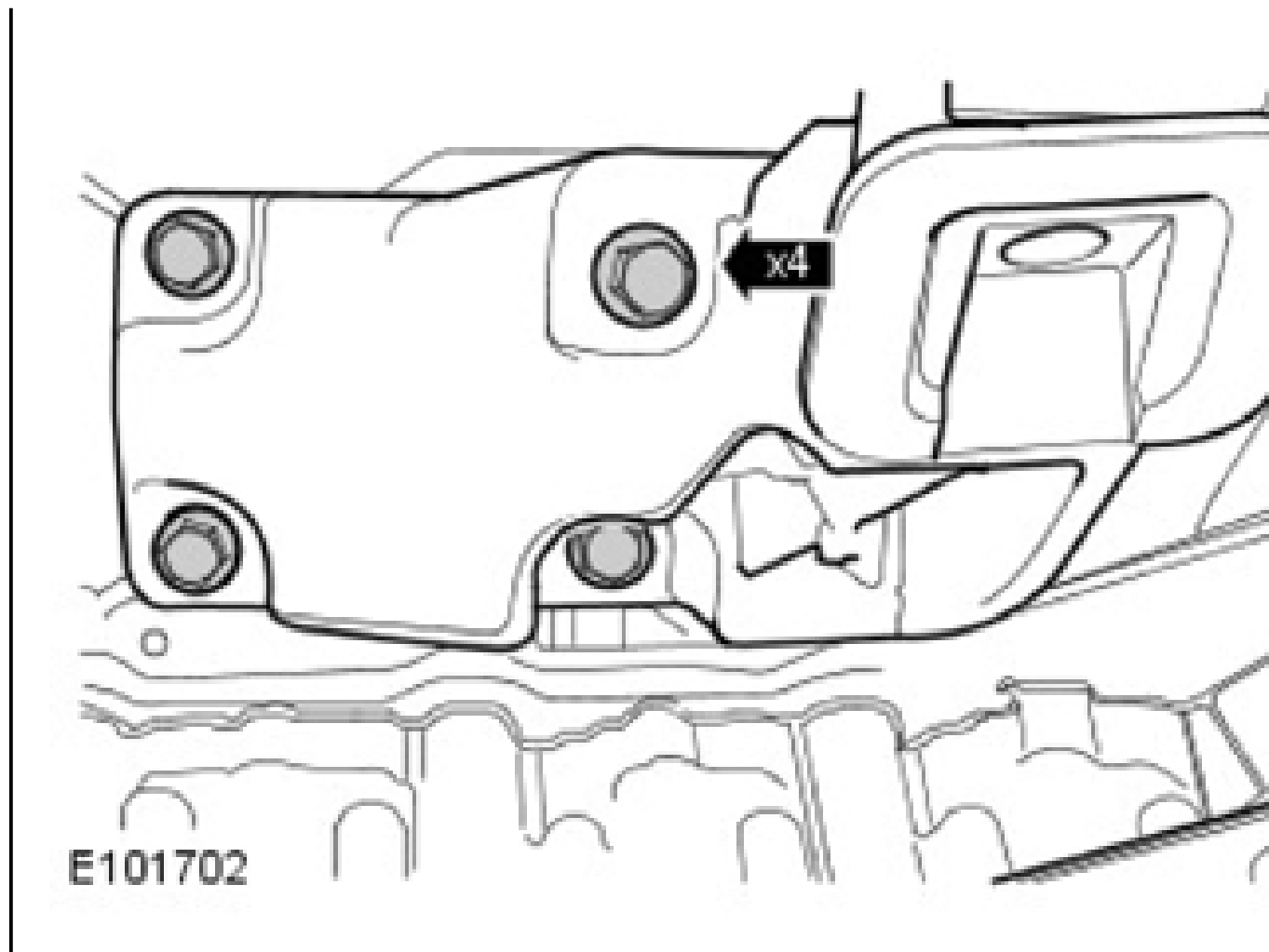


CAUTION: The bolts can only be used twice, mark the bolts with a center punch. If two punch marks are visible, discard the bolts. Vehicles fitted with Polydrive cylinder head bolts, the cylinder head bolts must be removed using a 10 mm Polydrive socket or a 10 mm Allen key. Failure to follow this instruction may result in damage to the component.

54. Remove the LH cylinder head assembly.
- Remove the 12 cylinder head bolts.
 - With assistance remove the cylinder head.
 - Remove and discard the cylinder head gasket.
 - Clean the cylinder head locating dowels.
 - Clean the component mating faces.
 - Repeat the operation for the RH side.

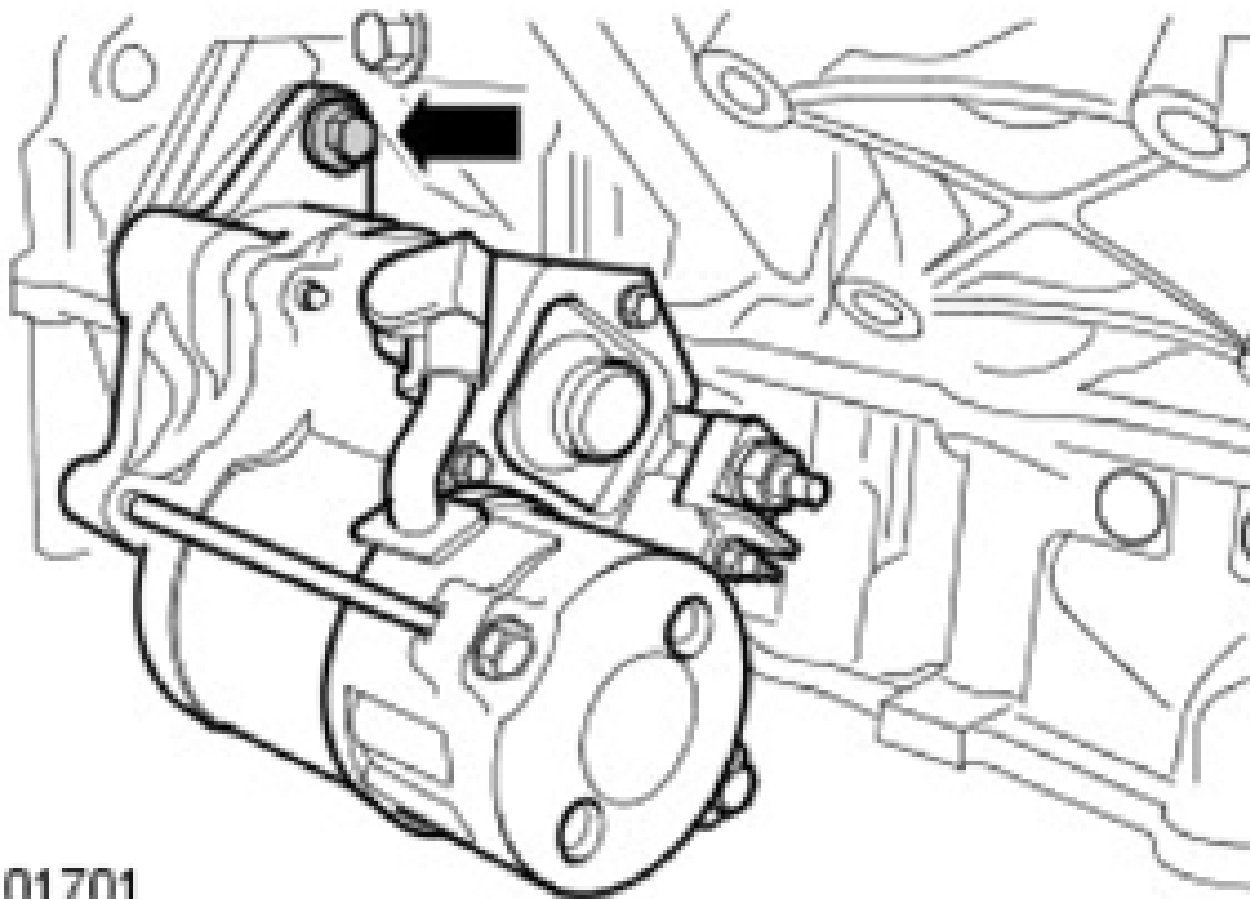


55. Remove 4 bolts securing the engine mount bracket to the cylinder block.



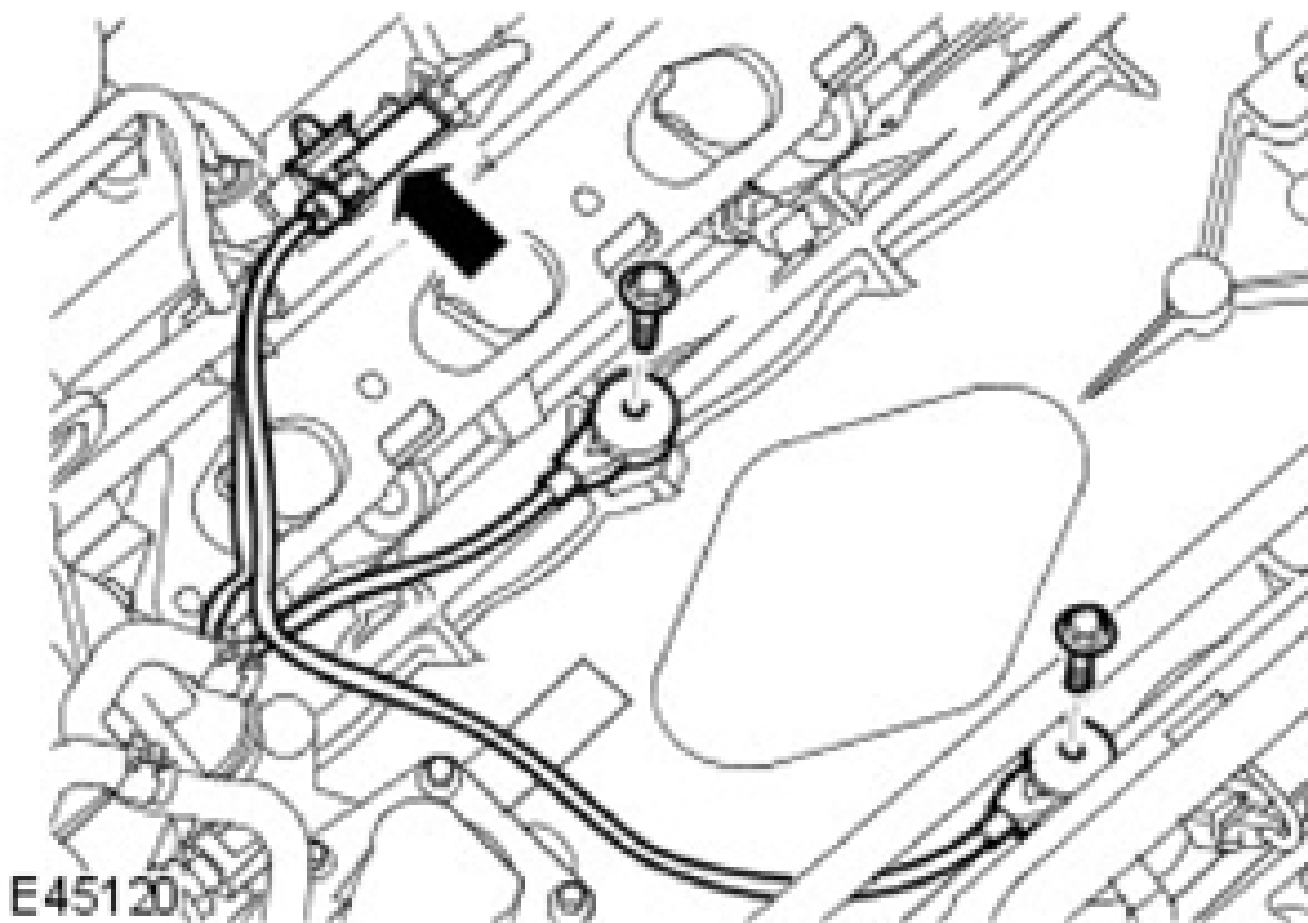
CAUTION: Note the position of the bolt.

56. Remove the starter motor.
- Remove the remaining starter motor bolt.

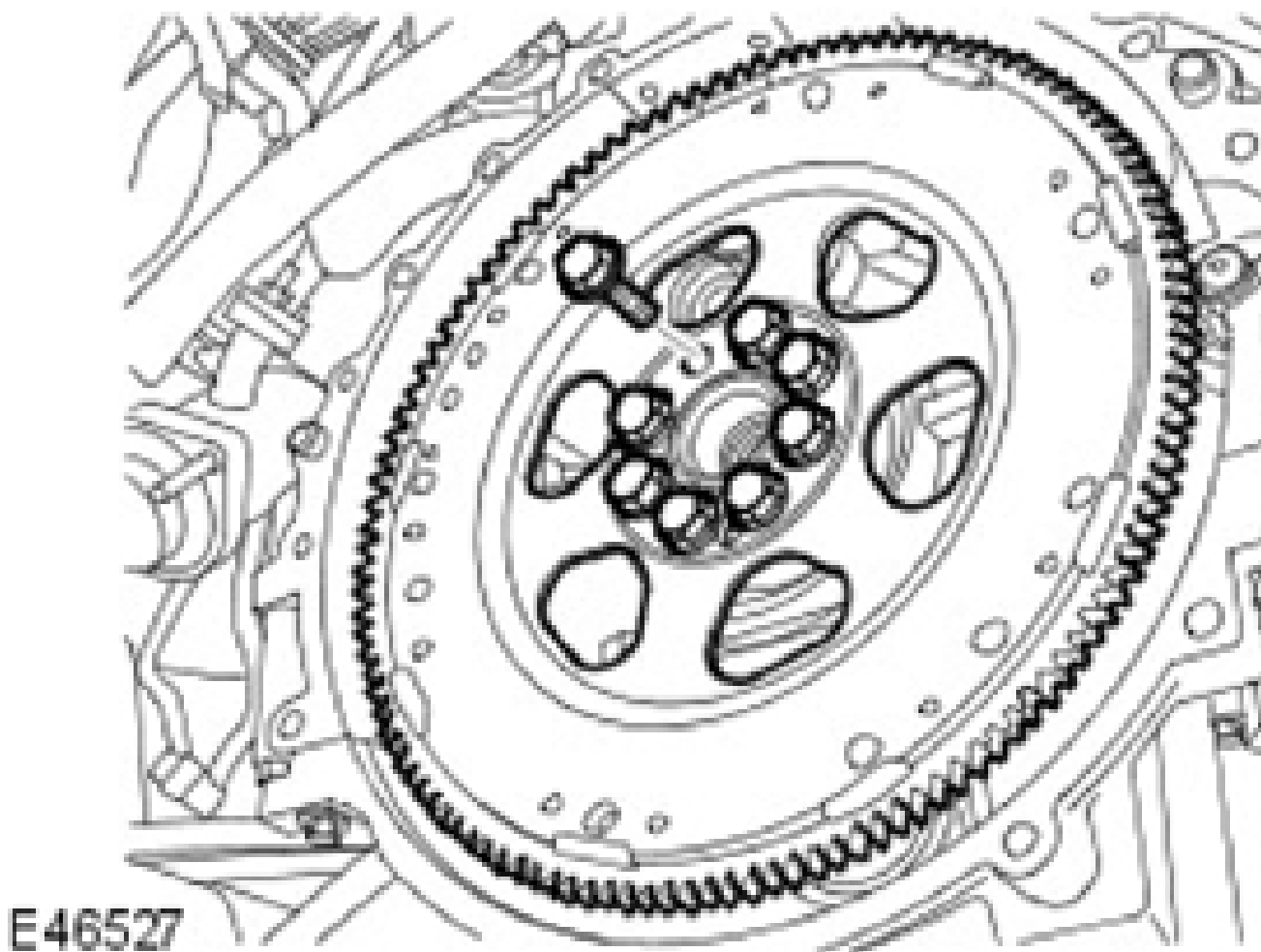


E101701

57. Remove the KS.



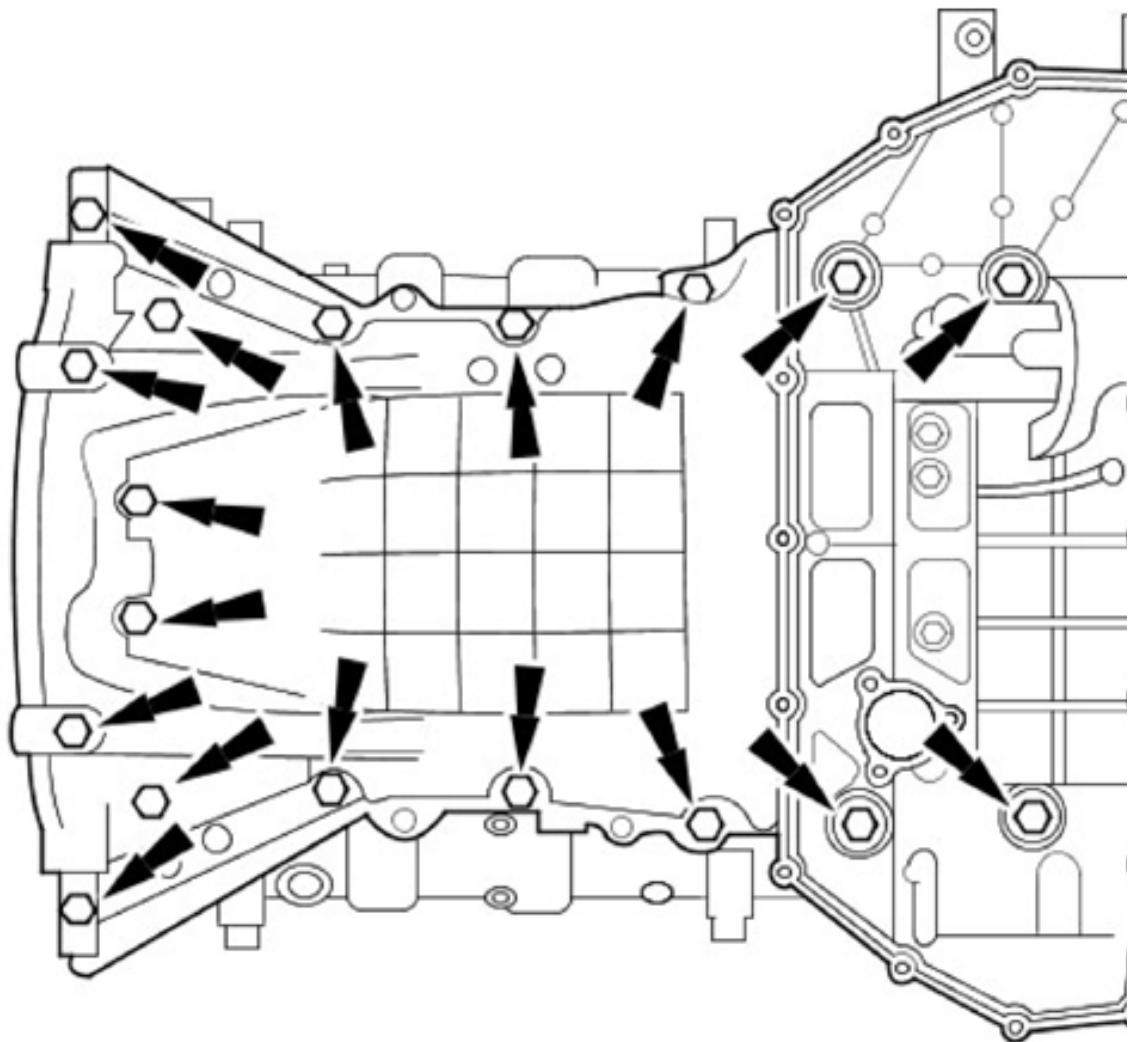
58. Remove the flexplate.
- Remove and discard the 8 bolts.



NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

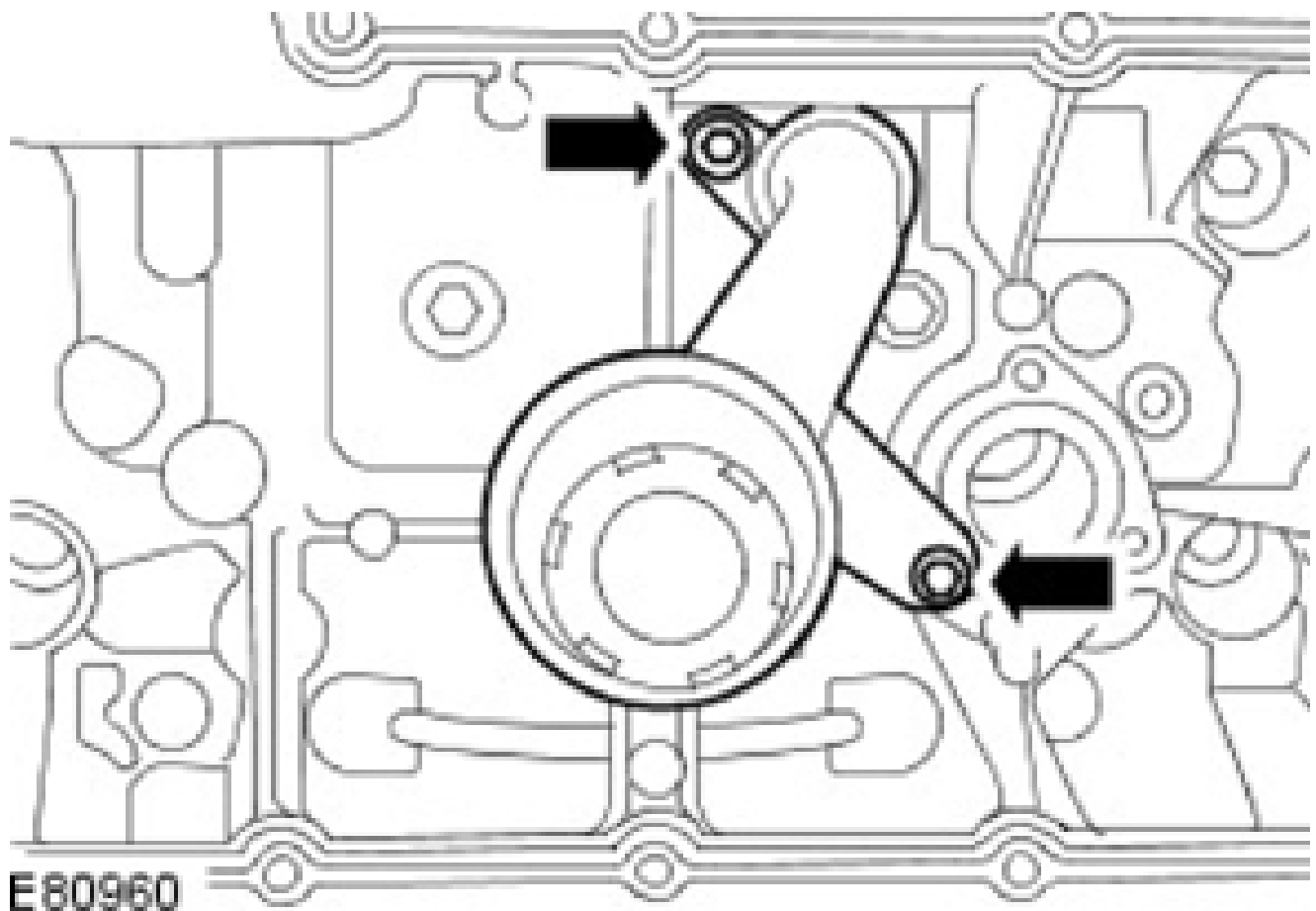
59. Remove the oil pan.

- Remove the 18 bolts.
- Clean all the mating faces and reusable parts thoroughly and check for damage.

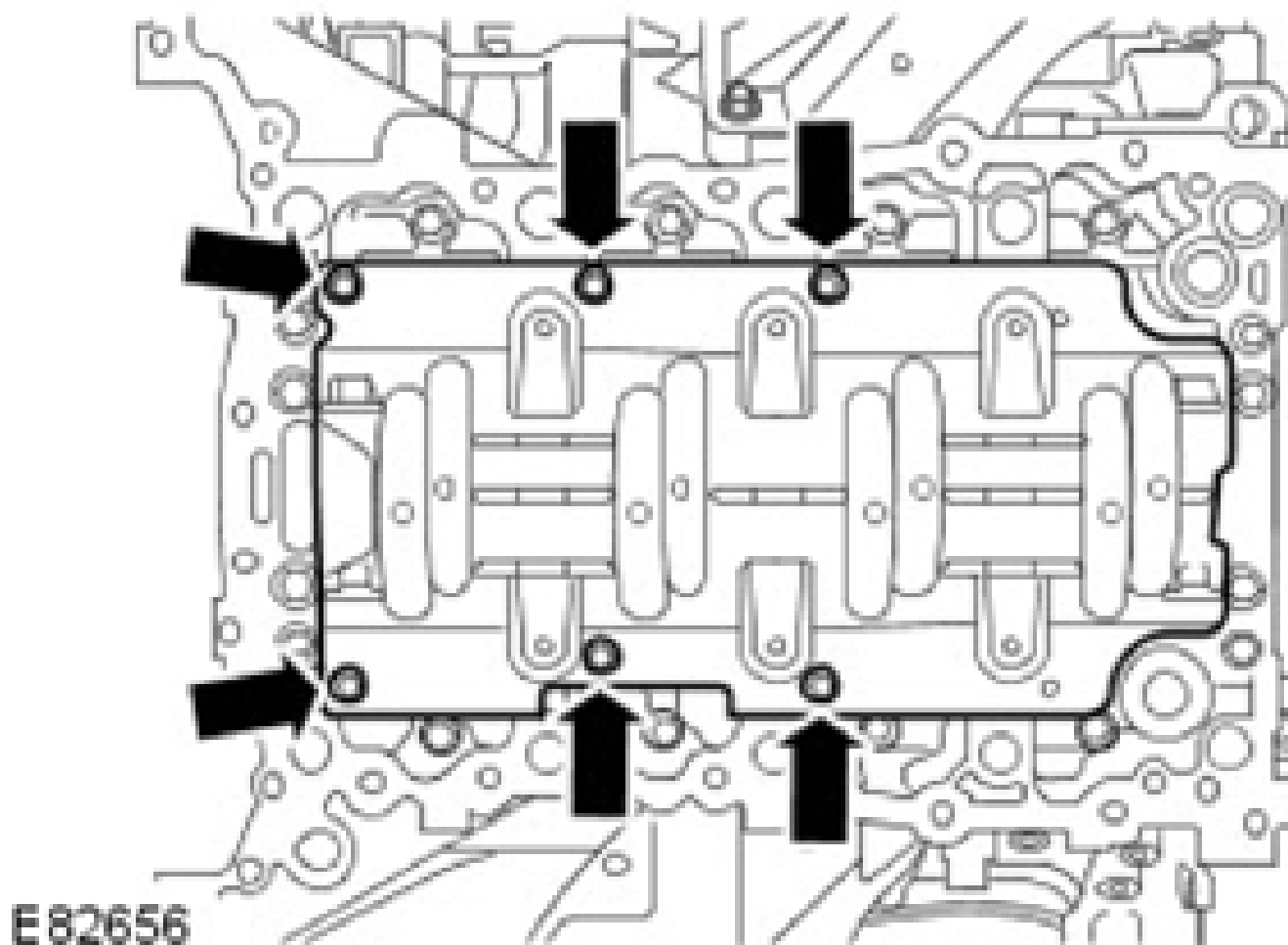


VUJ0002435

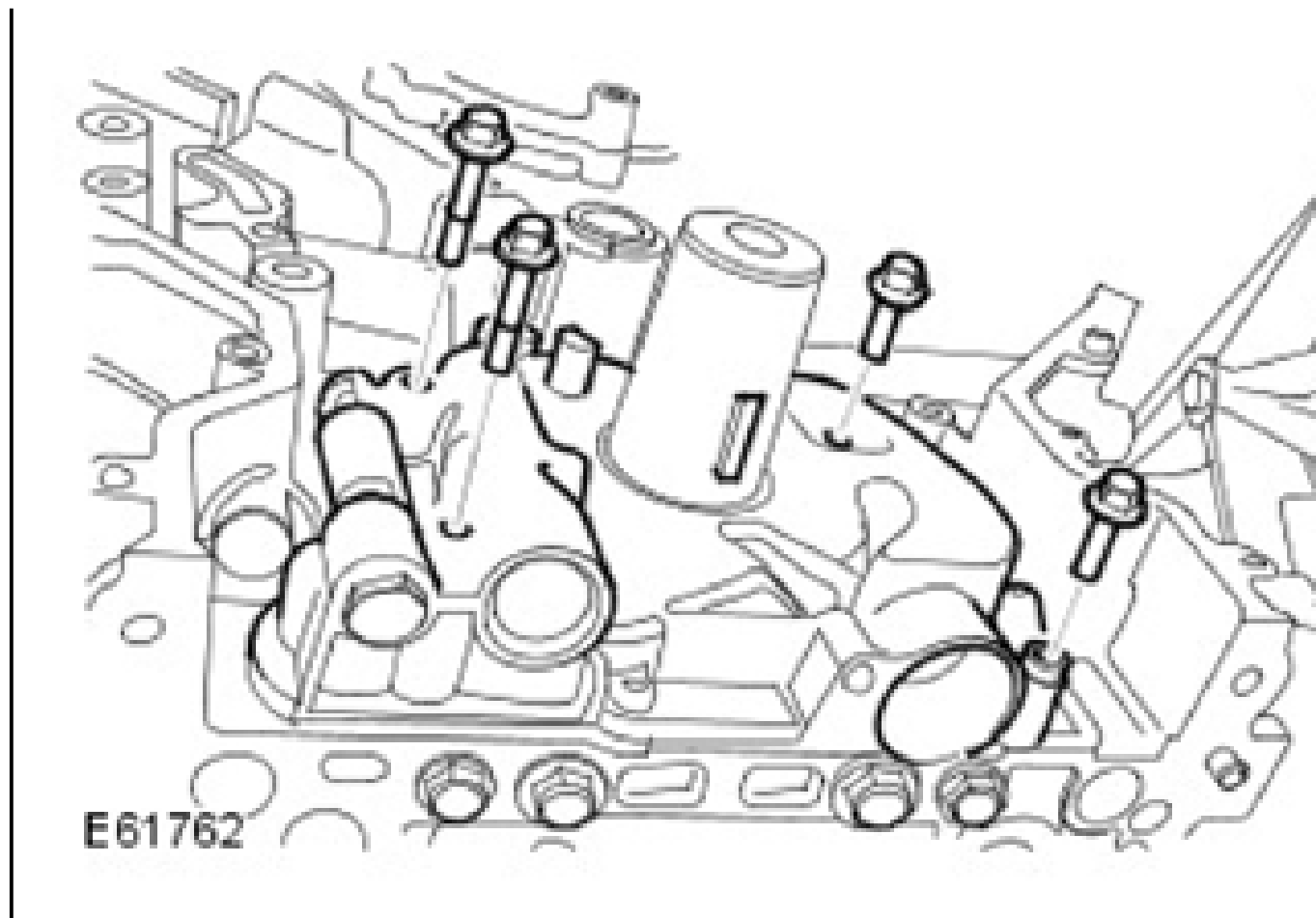
60. Remove the oil strainer pick-up assembly.
 - Remove the 2 bolts.
 - Remove and discard the O-ring seal.



61. Remove the baffle plate.
- Remove the 6 bolts.



62. Remove the oil pump assembly.
- Remove the 4 bolts.
 - Remove and discard the gasket.
 - Clean the component mating faces.



63. Remove the engine from the engine stand.

- With assistance, remove the engine block from the stand.

ASSEMBLY

ENGINE

SPECIAL TOOL(S)

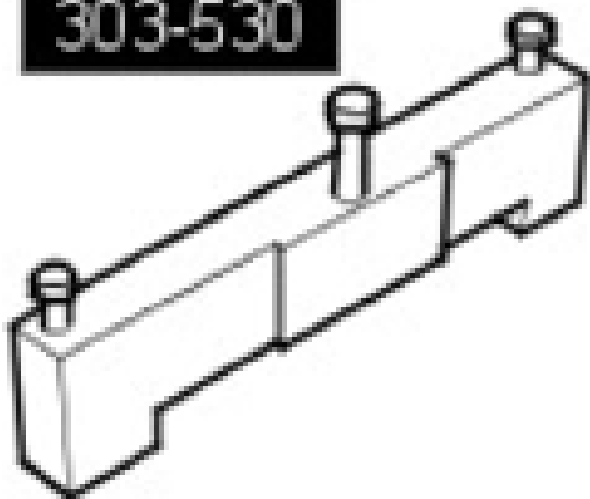
Timing Setting tool
303-645

303-645



E 46881

303-530



E 46879

Camshaft setting/locking tool
303-530

Adapter - Crankshaft seal installer
303-1100-01

303-1100-01



E67144

303-191-03

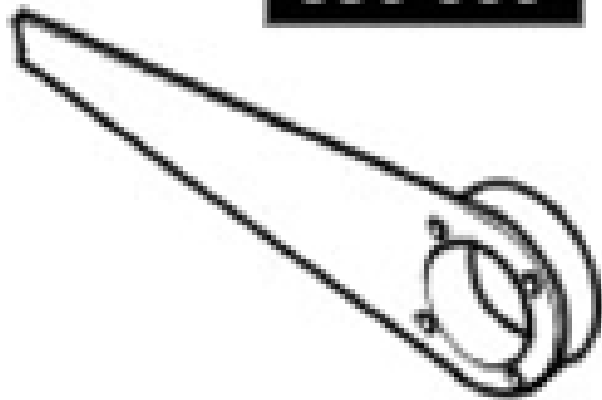


E46730

Adapter
303-191-03

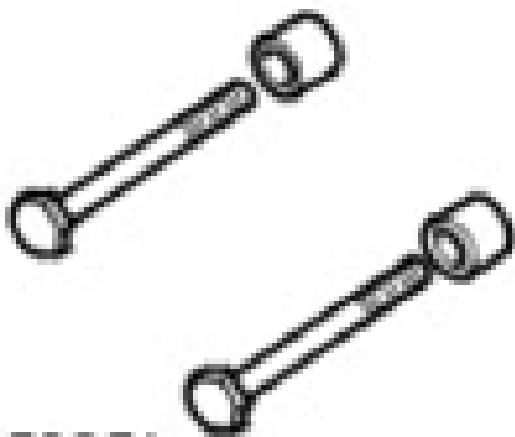
Holding Tool Crankshaft Pulley
303-893(LRT-12-080)

303-893



E 46728

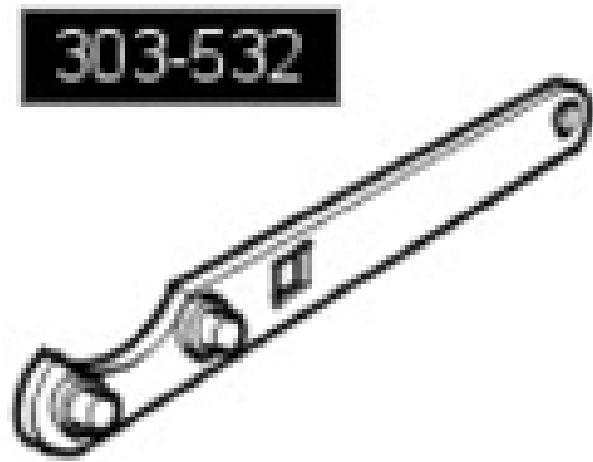
303-191-04



E 59251

Bolts and spacers
303-191-04

Timing chain tensioning tool
303-532



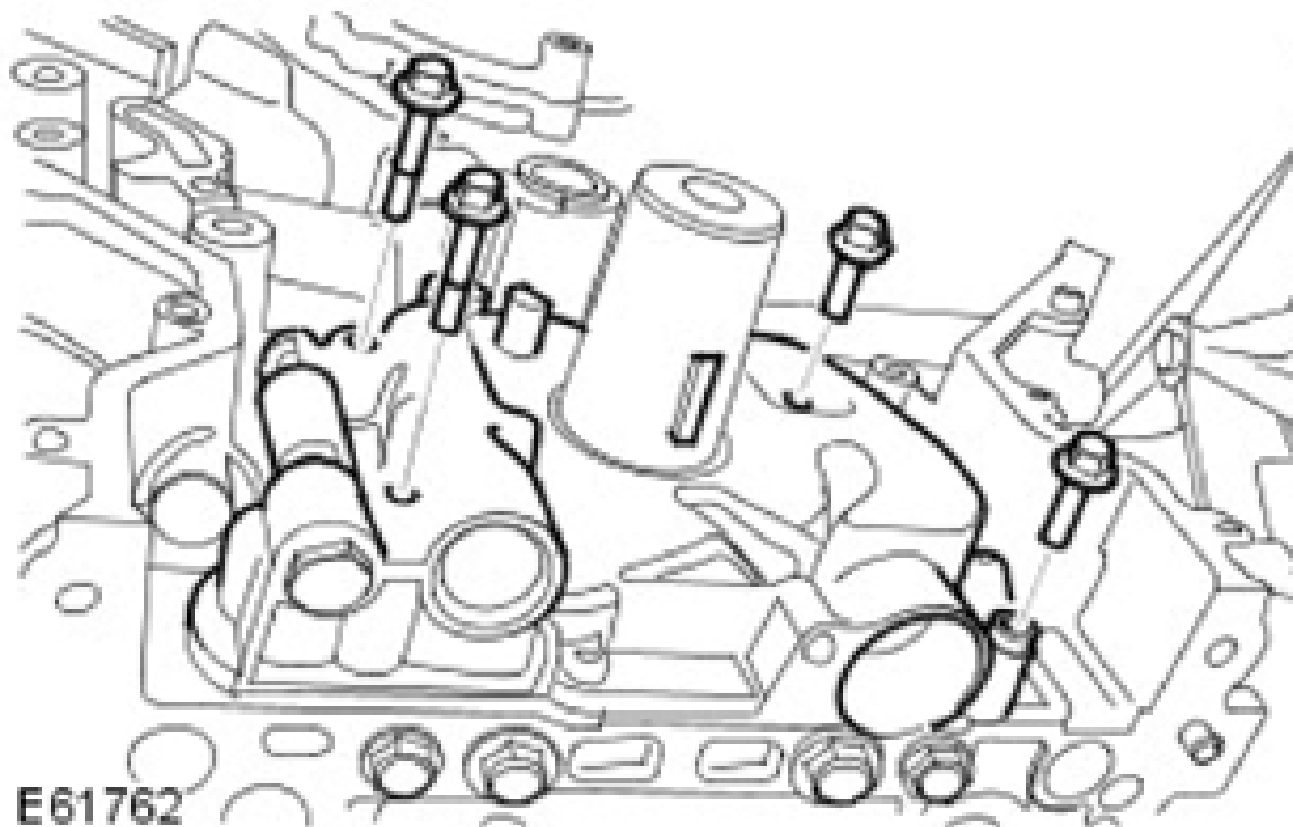
E 46880

ASSEMBLY

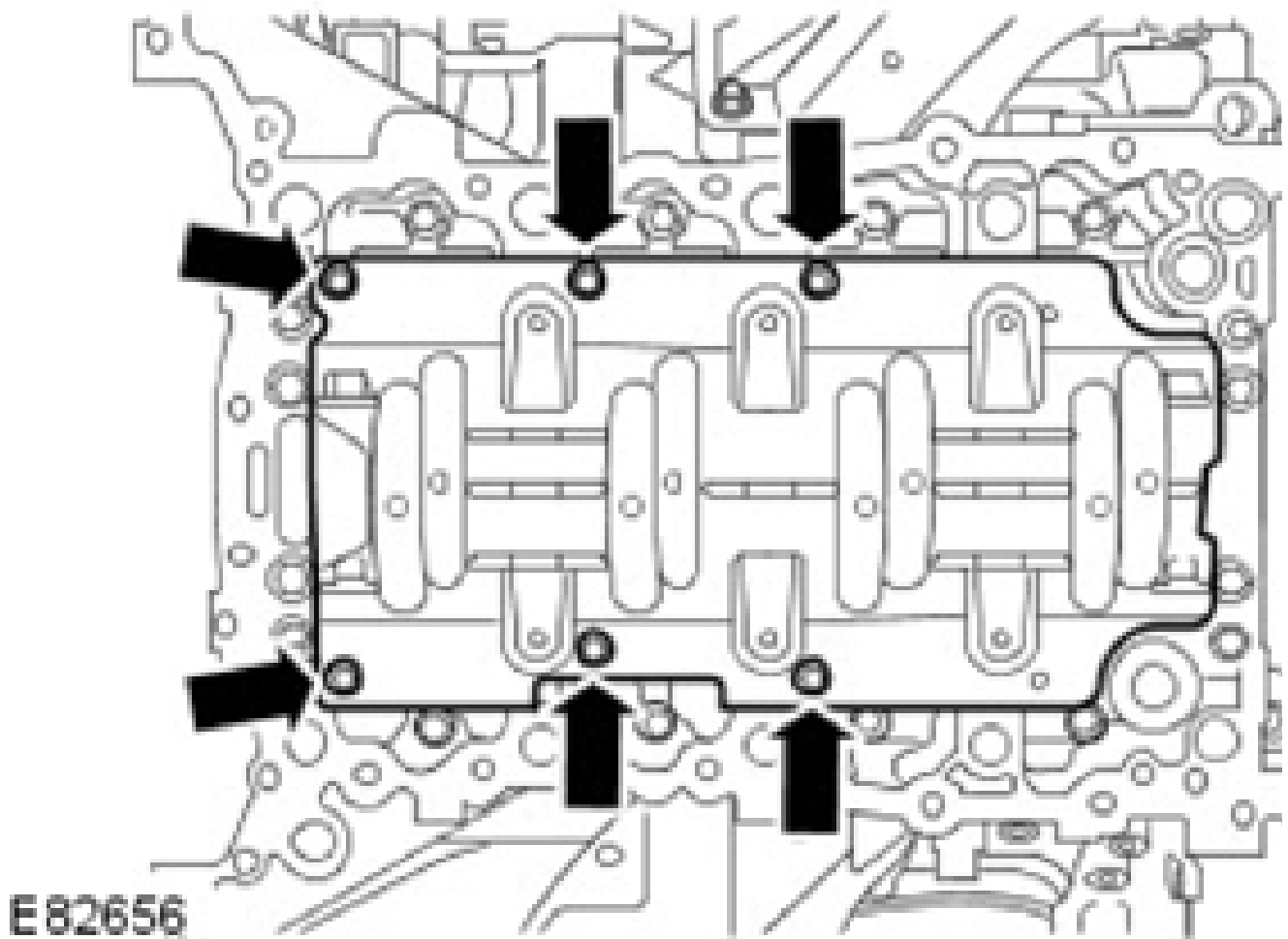
1. Secure the engine to the engine stand.
 - Align the engine to the engine stand.
 - Adjust the engine stand legs into position.
 - Mount the engine to an engine stand.
 - Fully tighten the engine stand leg nuts.

NOTE: **Install a new gasket.**

2. Install the oil pump assembly.
 - Clean the component mating faces.
 - Install the gasket.
 - Tighten the bolts to 10 Nm.

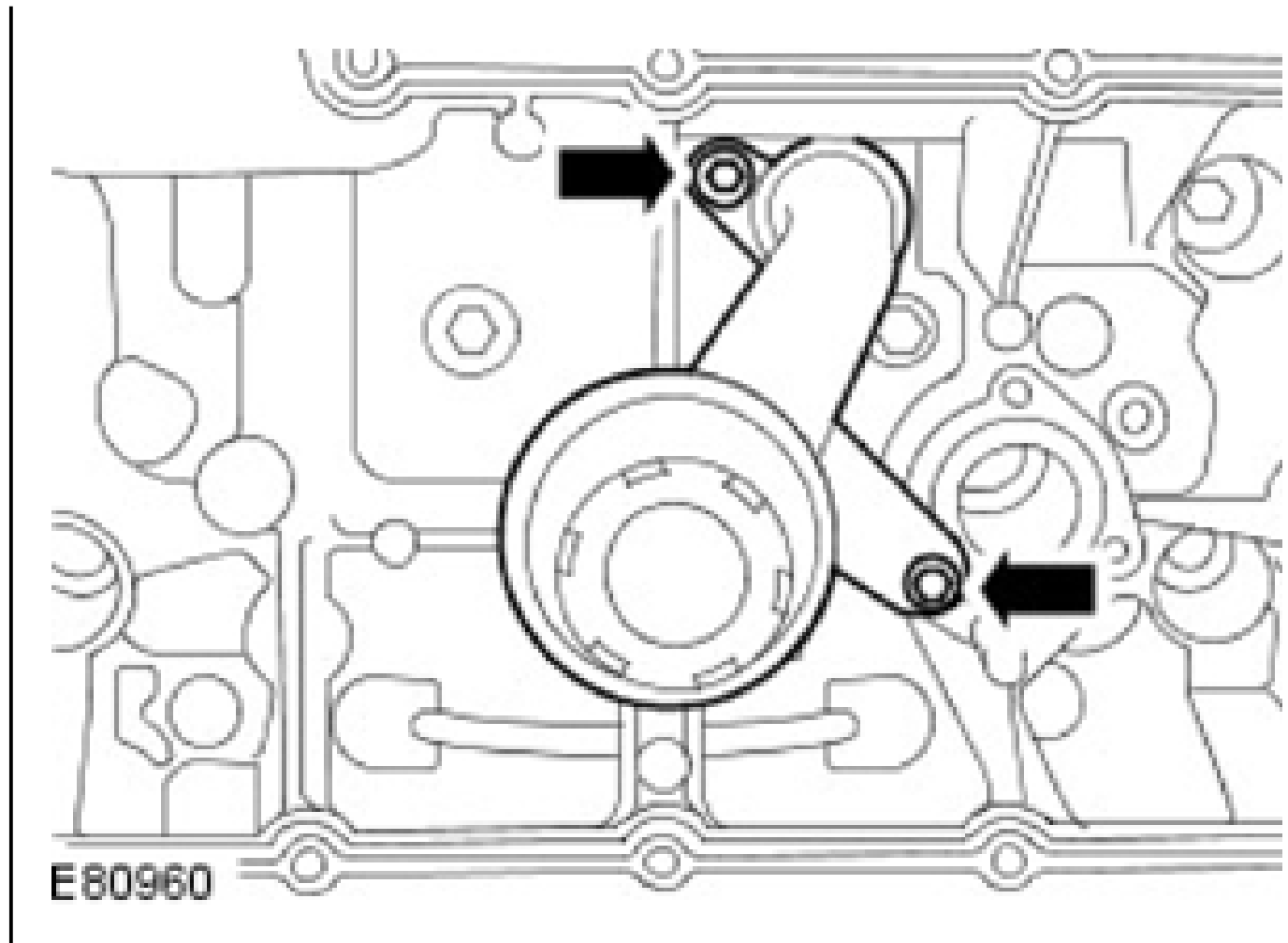


3. Install the baffle plate.
 - Tighten the 6 bolts to 6 Nm.



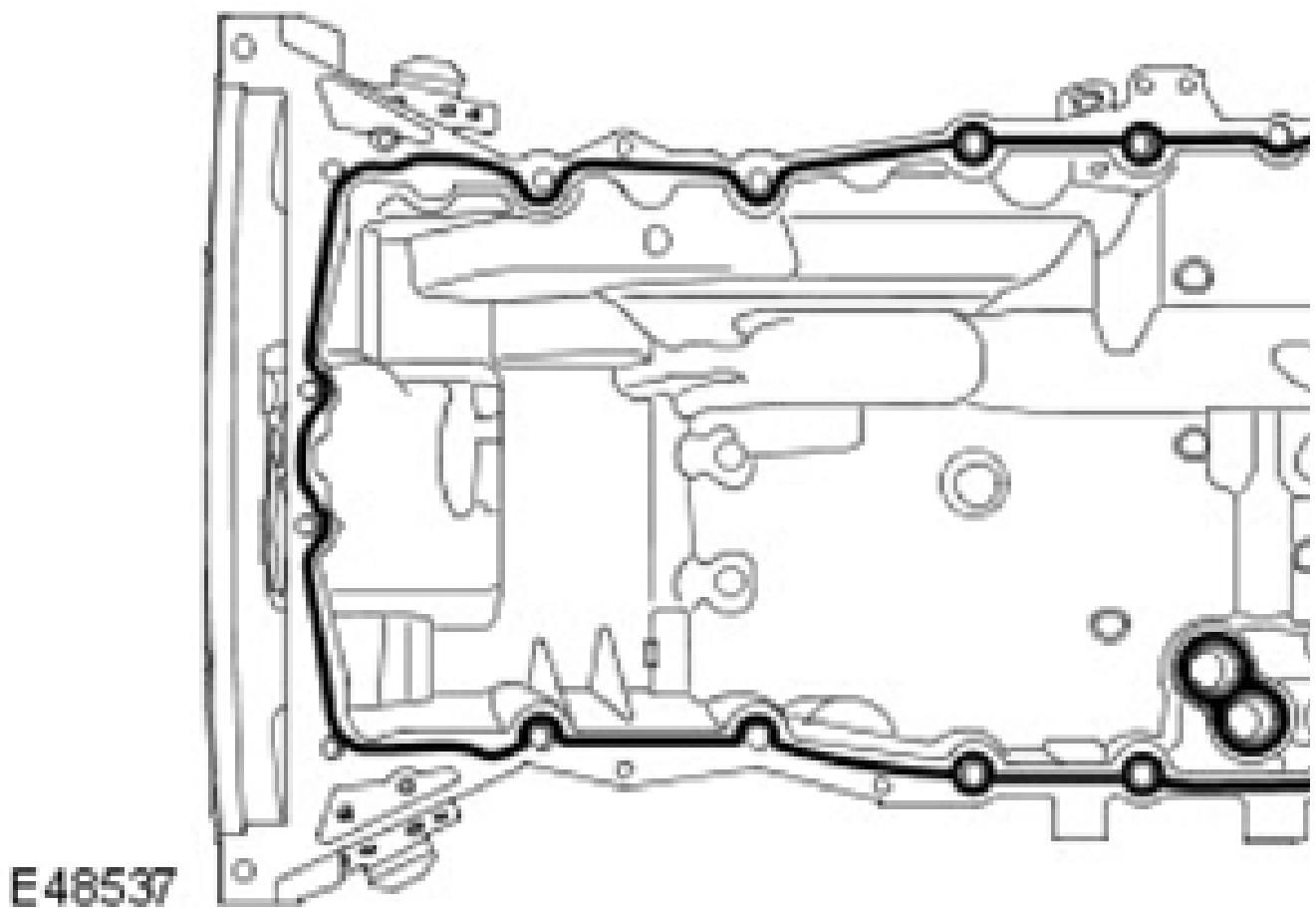
NOTE: Install a new O-ring seal.

4. Install the oil strainer pick-up assembly.
 - Install the O-ring seal.
 - Tighten the M6 bolt to 10 Nm.
 - Apply sealant to the M5 bolts.
 - Tighten the M5 bolts to 6 Nm.

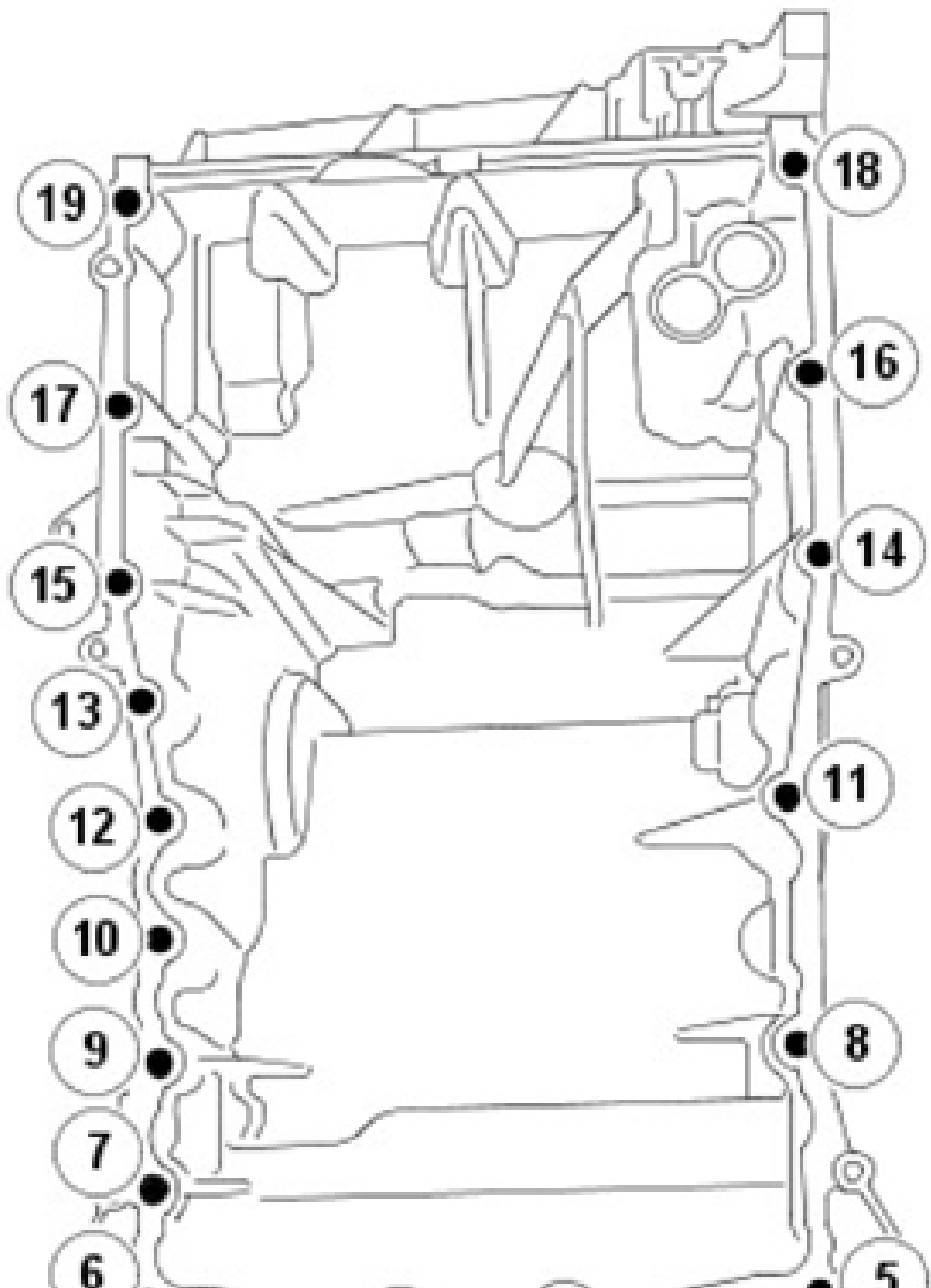


5. Install the oil pan.

- Clean the component mating faces.
- Apply a 3 mm diameter bead of sealant, to the area indicated.
- Install the bolts, but do not tighten fully at this stage.



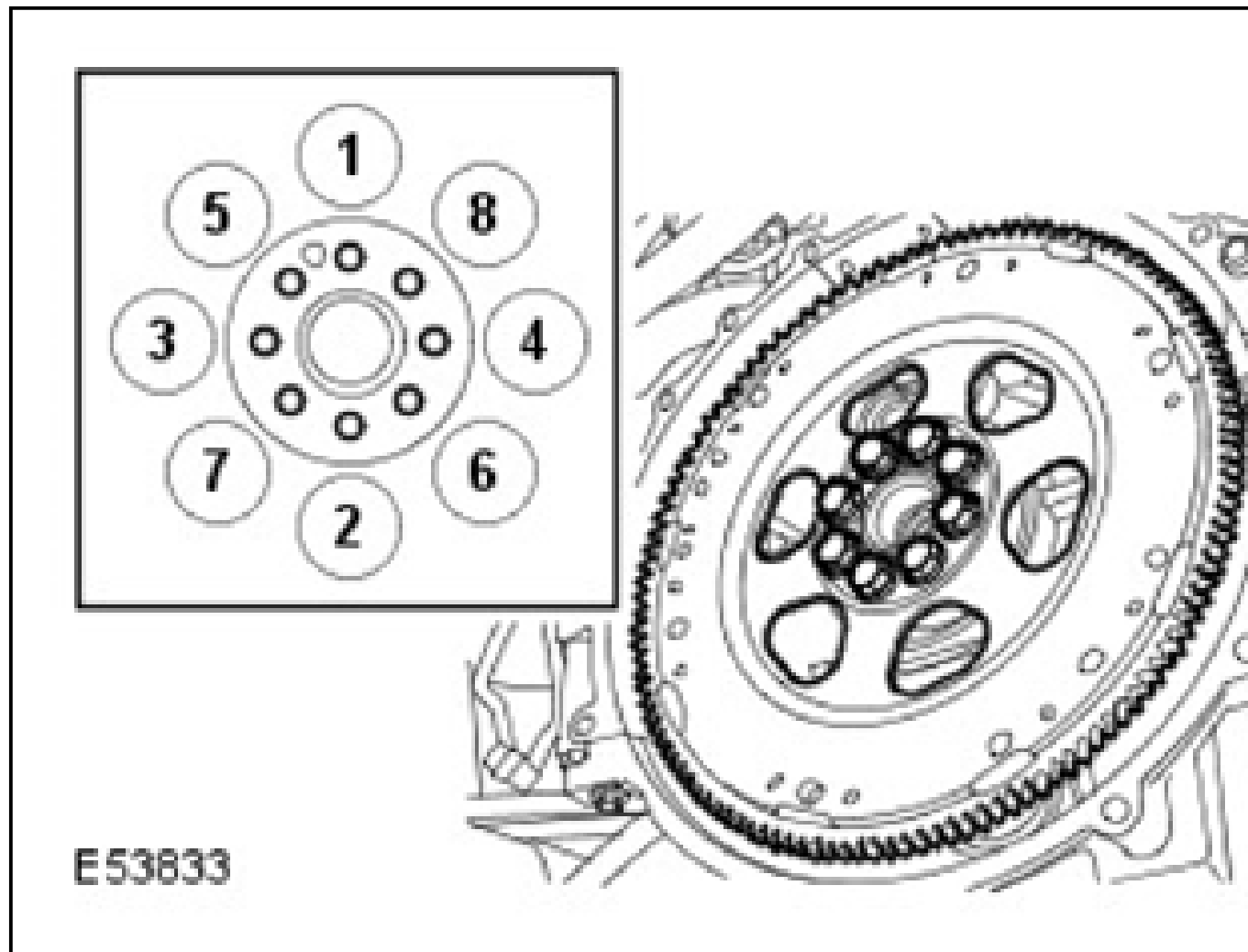
6. Tighten the oil pan bolts in the sequence shown to 20 Nm.



NOTE: Prevent the flexplate from rotating.

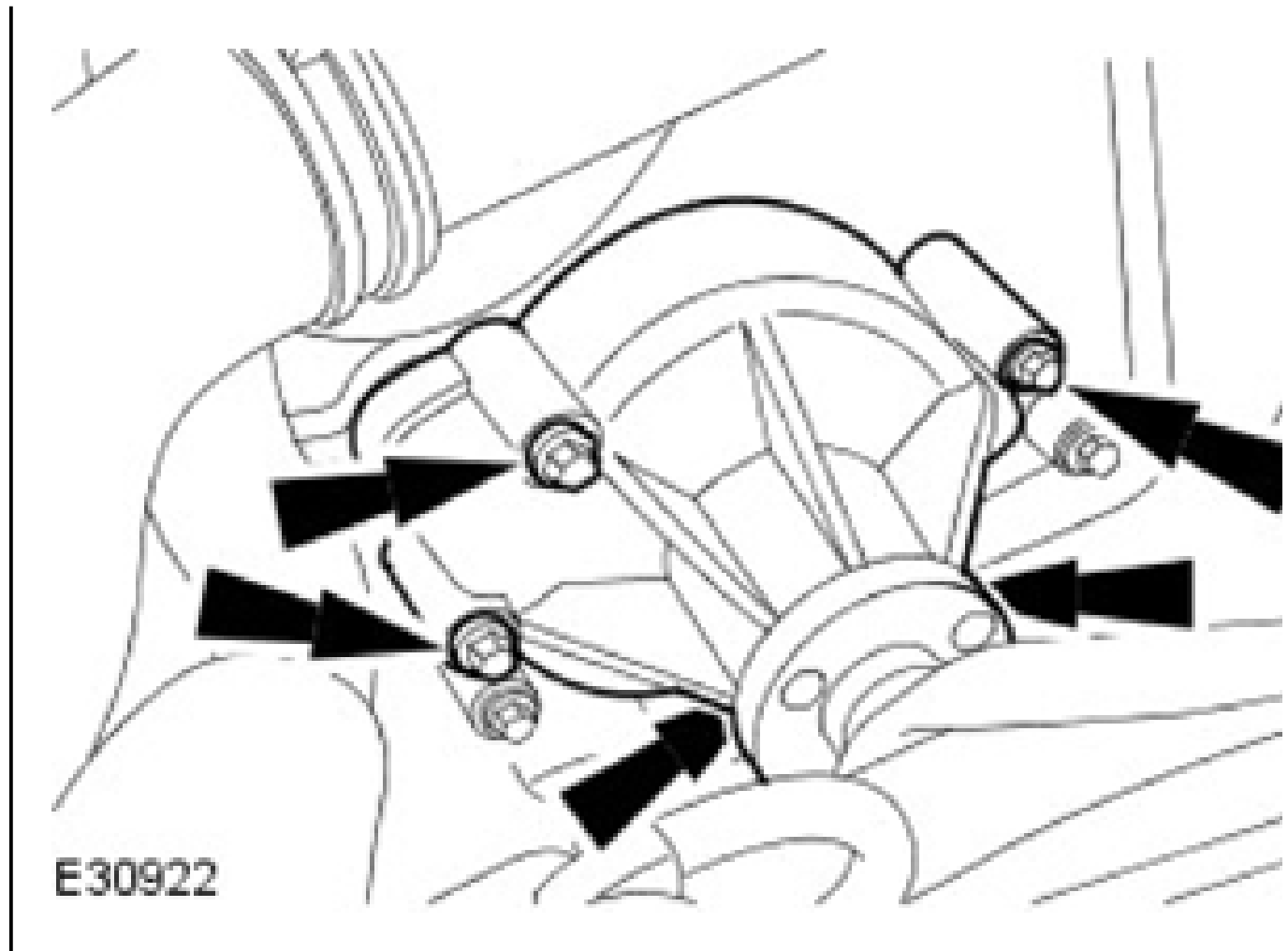
7. Install the flexplate.

- Clean the component mating faces.
- Tighten the bolts evenly in 2 stages to the sequence shown.
- Tighten the bolts to 15 Nm.
- Tighten the bolts to 110 Nm.



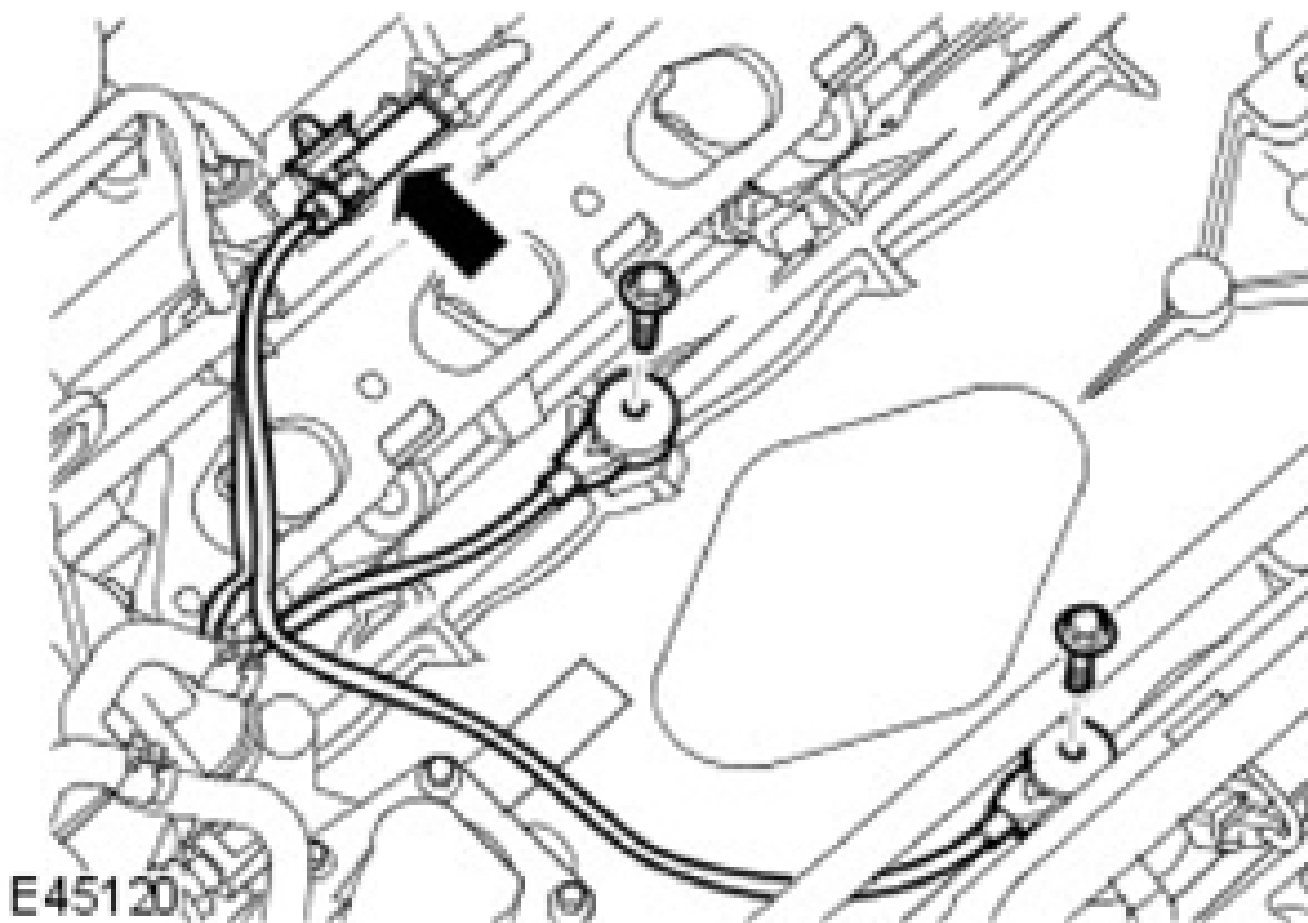
8. Install the coolant pump.

- Tighten the 5 bolts to 10 Nm.

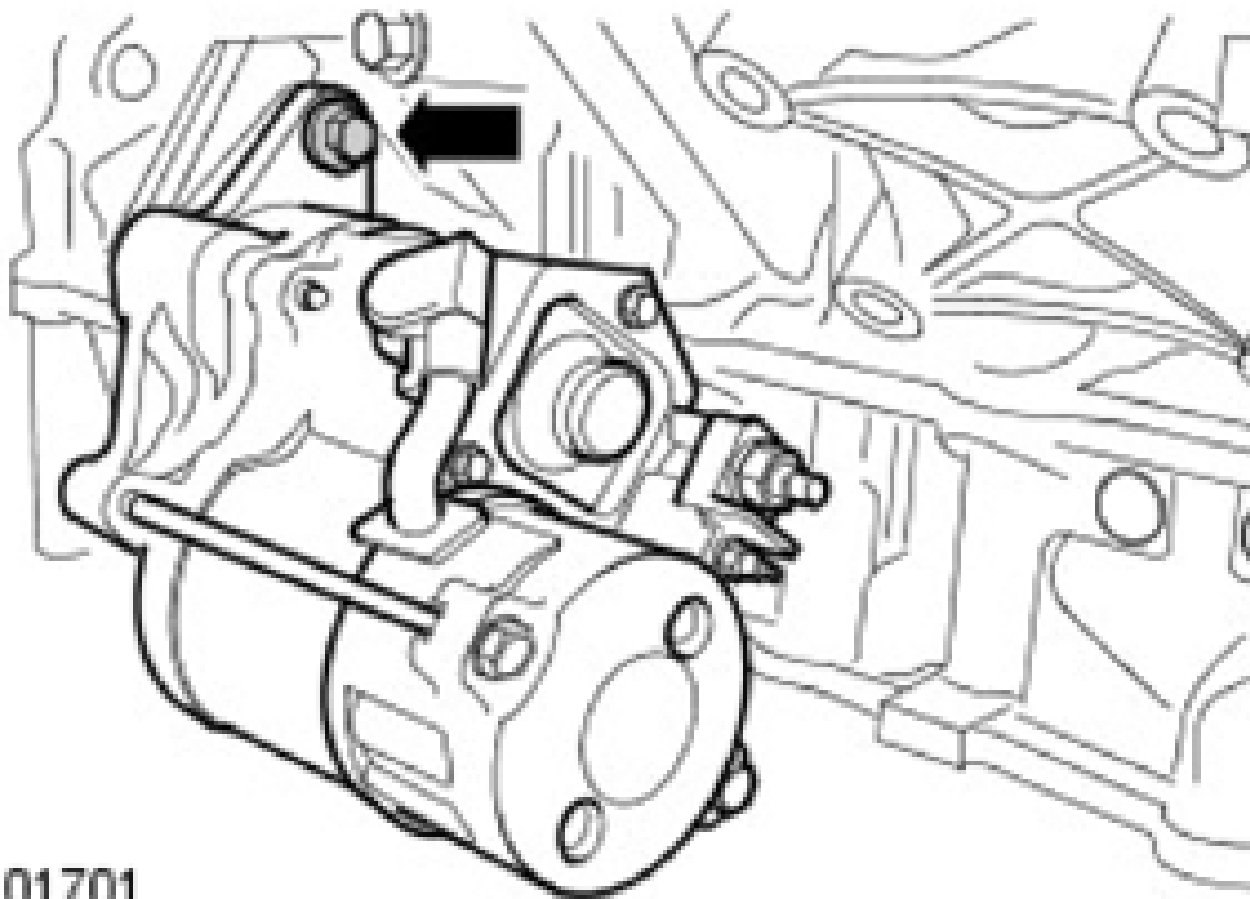


NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

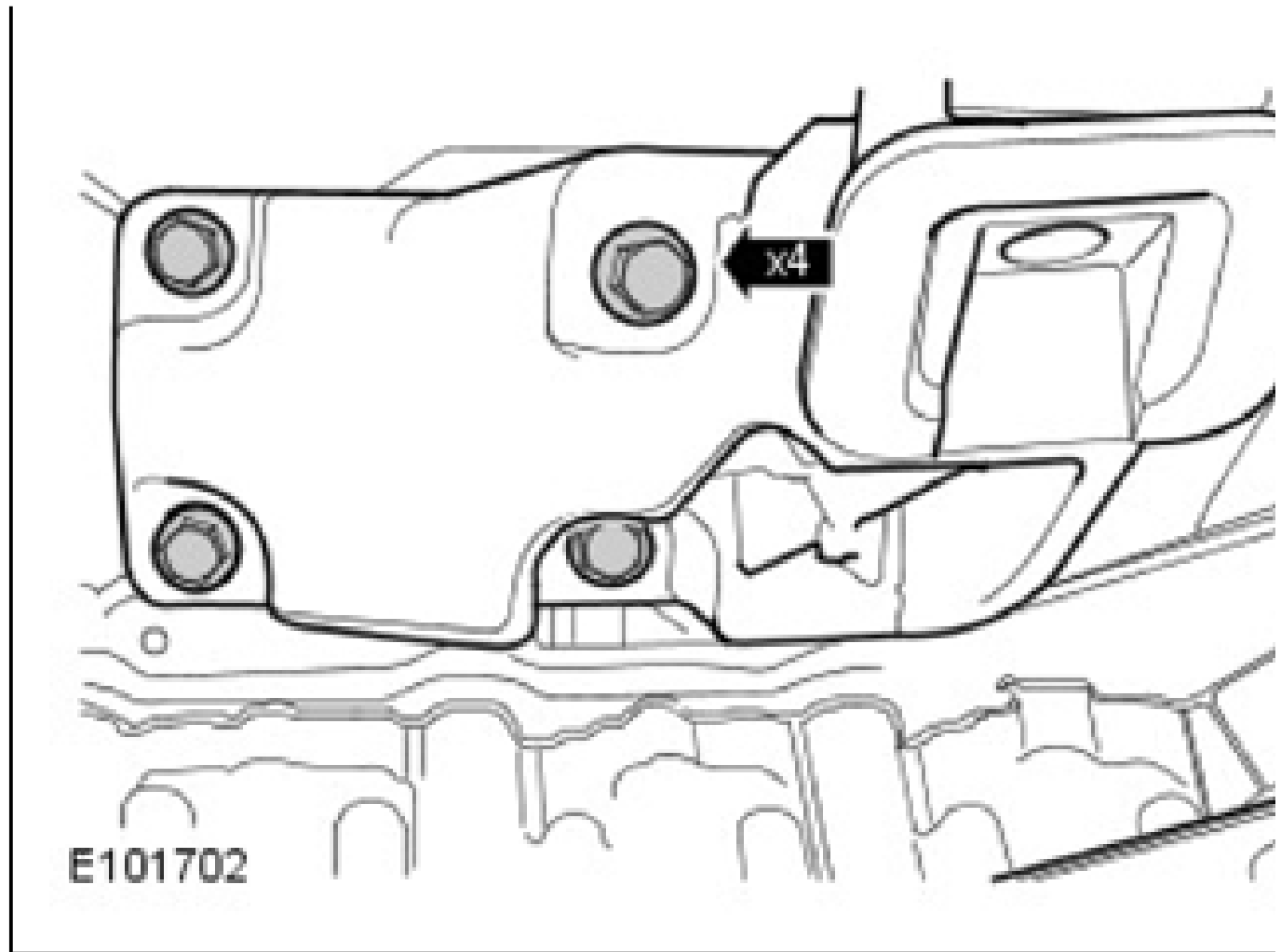
9. Install the knock sensors (KS).
 - Tighten the bolts to 20 Nm.



10. Install the starter motor.
 - Tighten the bolt to 45 Nm



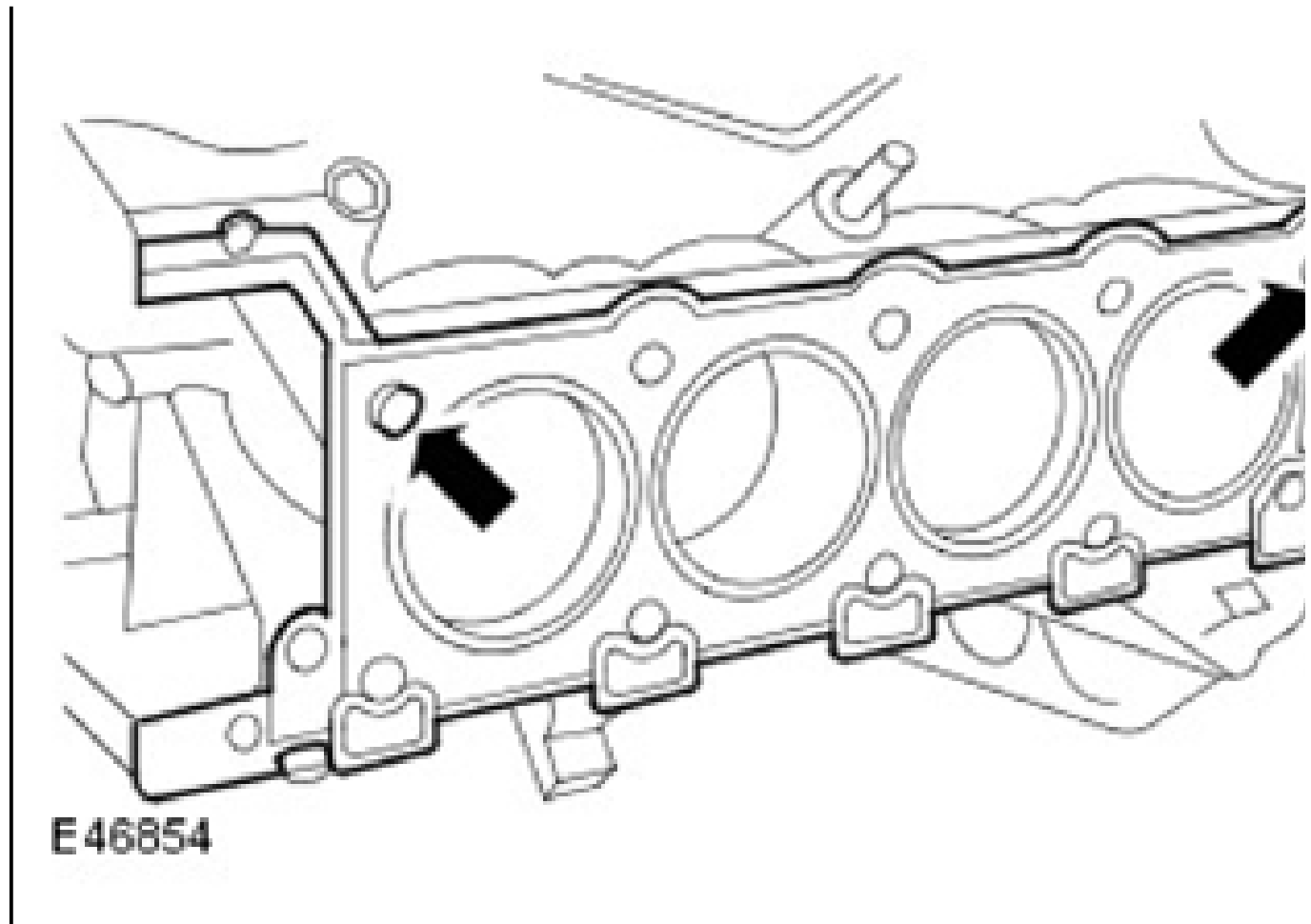
11. Attach the engine mounting bracket.



NOTE: The cylinder head gaskets must be installed over the cylinder head to block dowels.

12. Install the RH cylinder head.

- Clean the component mating faces.
- Clean the cylinder head locating dowels.
- Install a new cylinder head gasket.
- With assistance install the cylinder head.
- Repeat the operation for the LH side.

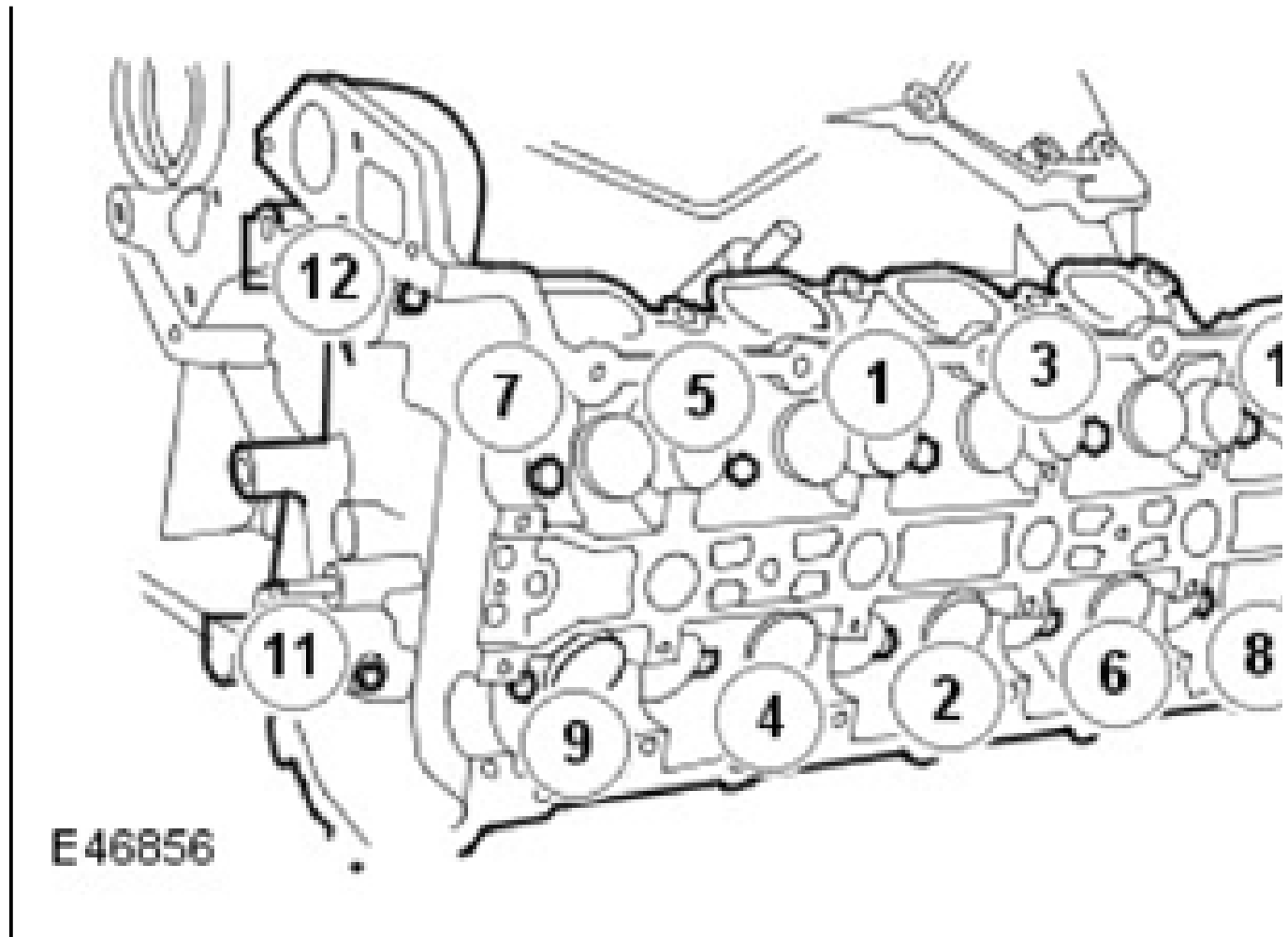


CAUTION: Vehicles fitted with Polydrive cylinder head bolts, the cylinder head bolts must be installed using a 10 mm Polydrive socket or a 10 mm Allen key. Failure to follow this instruction may result in damage to the component.

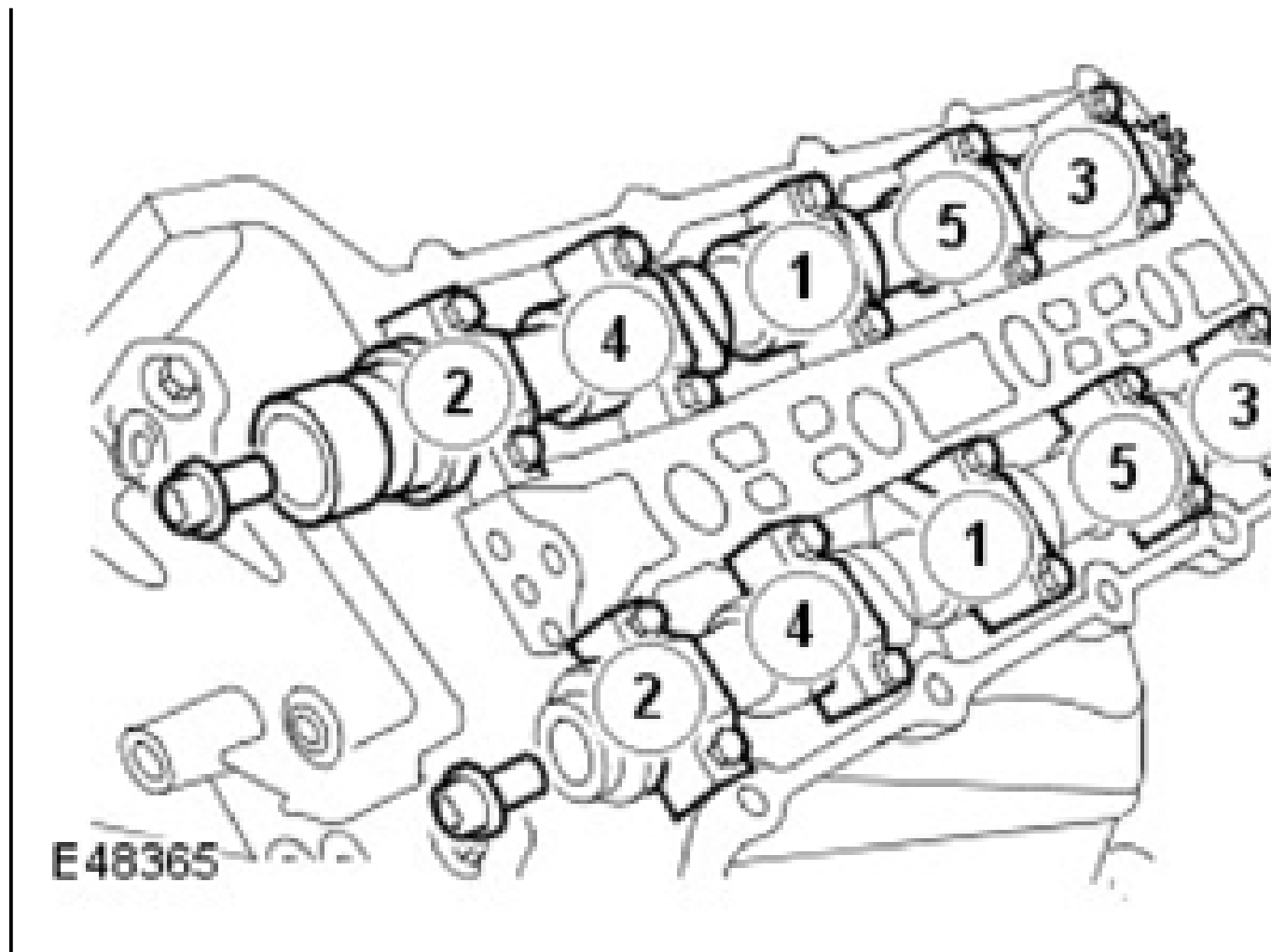
NOTE: Tighten the bolts 1 to 10 in the sequence shown.
LH illustration shown, RH is similar.

13. Install the cylinder head bolts.

- Tighten the bolts to 20 Nm.
- Tighten the bolts to 35 Nm.
- Tighten the bolts 1 to 10, a further 90 degrees.
- Tighten the bolts 1 to 10, a further 90 degrees.
- Tighten the M8 bolts 11 and 12, to 25 Nm.
- Repeat the operation for the LH side.



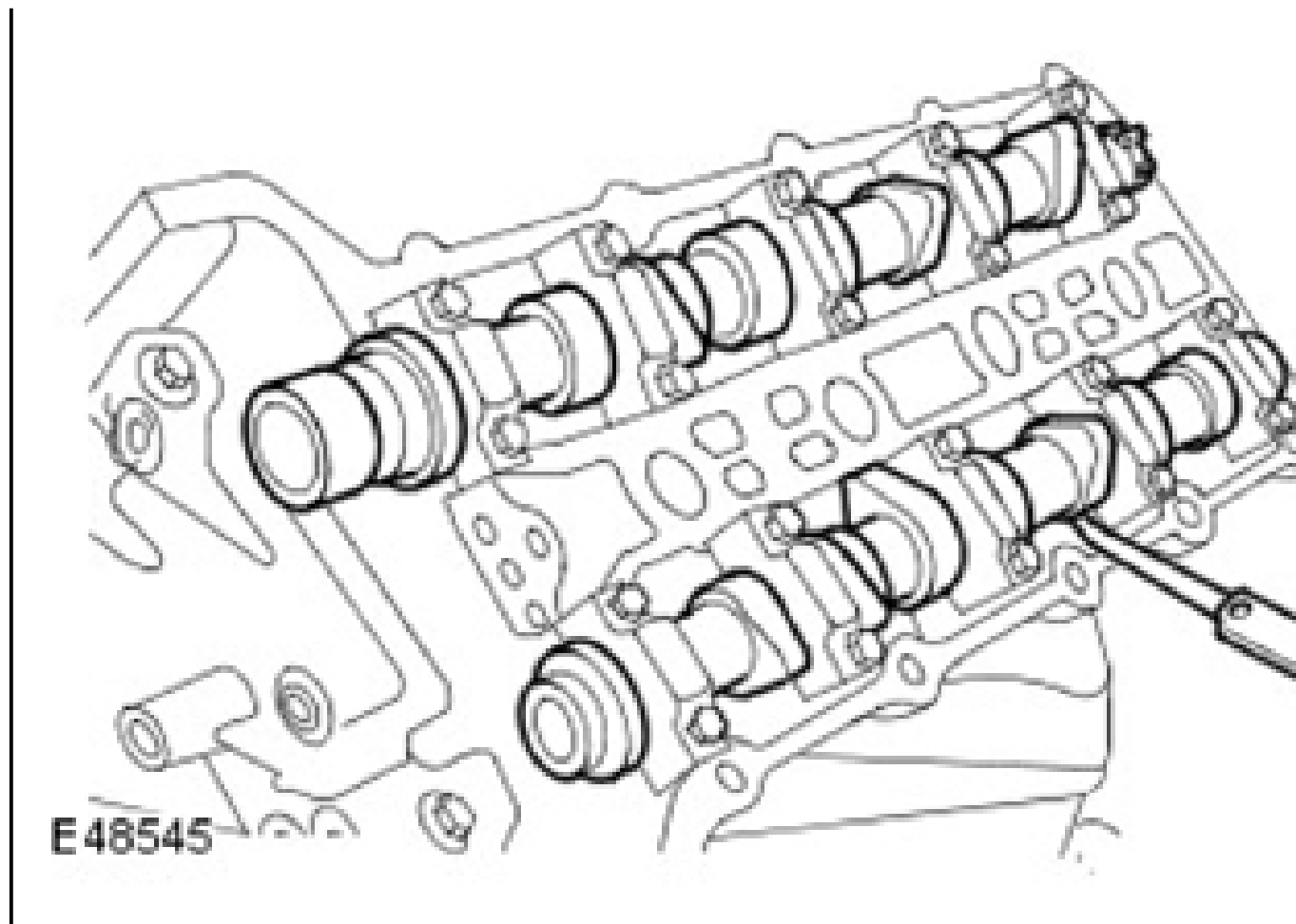
14. Install the LH camshafts.
 - Clean the component mating faces.
 - Lubricate the journals and camshaft lobes.
15. Install the camshaft bearing caps.
 - Evenly and progressively tighten the bolts in the sequence shown to 10 Nm (7 lb.ft).



16. Install the sprocket retaining Torx bolts to the camshafts.

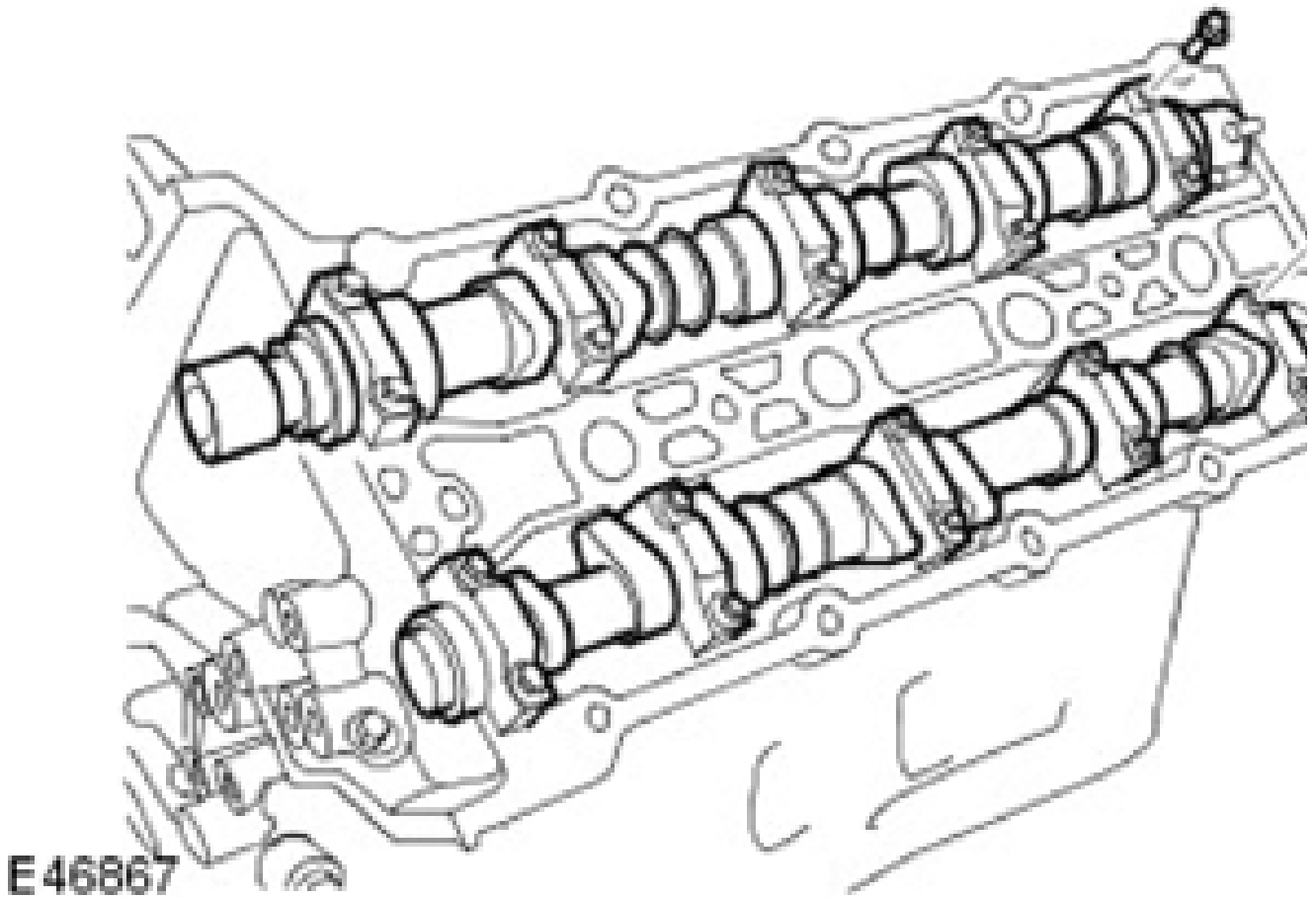
CAUTION: Camshaft lobes must be 180 degrees away from each valve tappet or valve clearance will be incorrect.

17. Measure and record the tappet clearances.
- Rotate the camshafts using the Torx bolts.

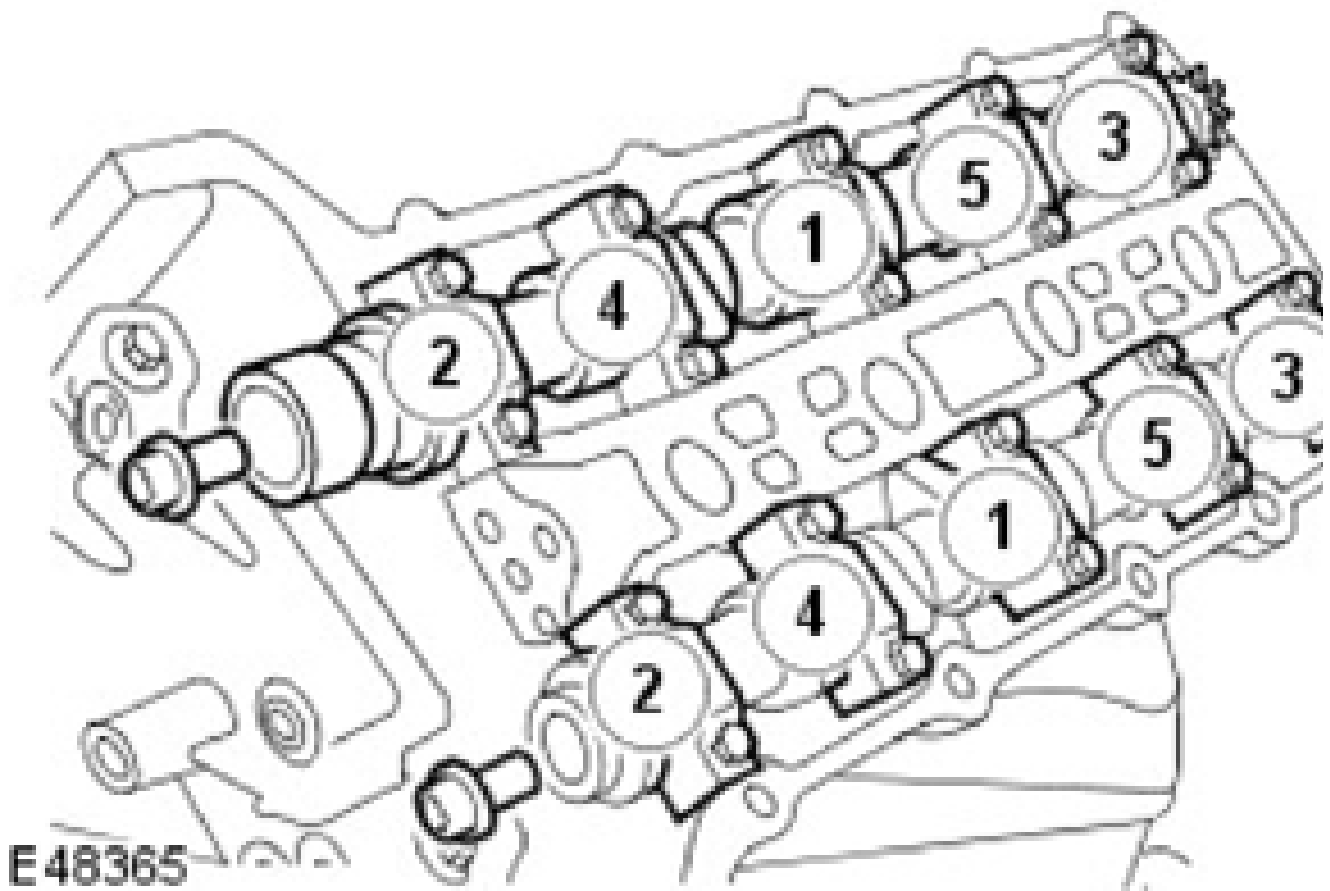


NOTE: Remove the camshaft bearing caps evenly and in stages. Remove the camshaft bearing caps. Note: their position, orientation and markings. Each is marked with its position (number) and an orientation (arrow).

18. Remove the camshafts.
 - Remove the 20 bolts.



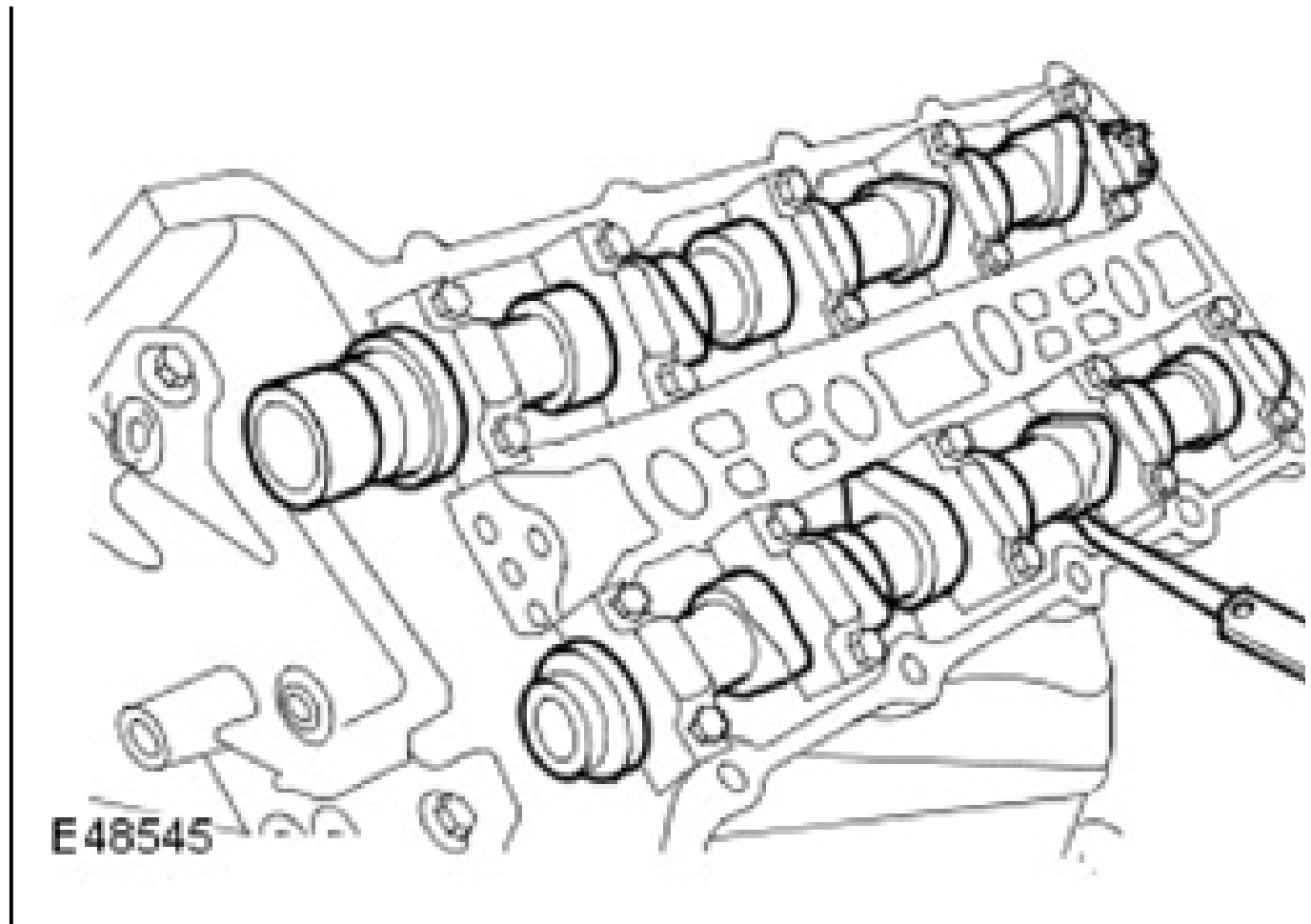
19. Remove the valve tappets, replace with selected tappets.
20. Install the camshafts.
 - Lubricate the journals and camshaft lobes.
 - Clean the component mating faces.
21. Install the camshaft bearing caps.
 - Evenly and progressively tighten the bolts in the sequence shown to 10 Nm (7 lb.ft).



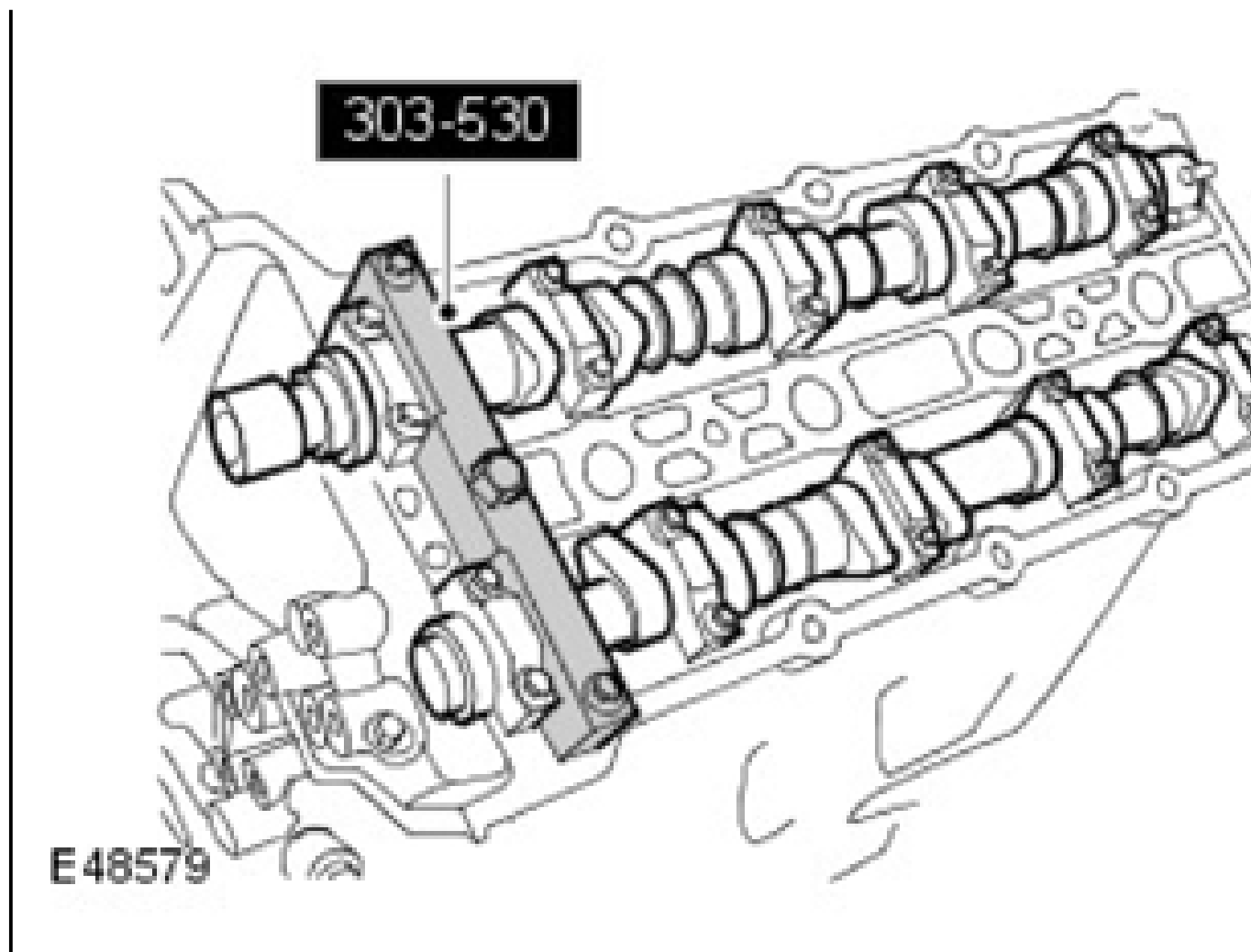
CAUTION: Camshaft lobes must be 180 degrees away from each valve tappet or valve clearance will be incorrect.

22. Check valve tappet clearances are correct.

- Rotate the camshafts using the Torx bolts.
- Remove the camshaft Torx bolts after the check is complete.

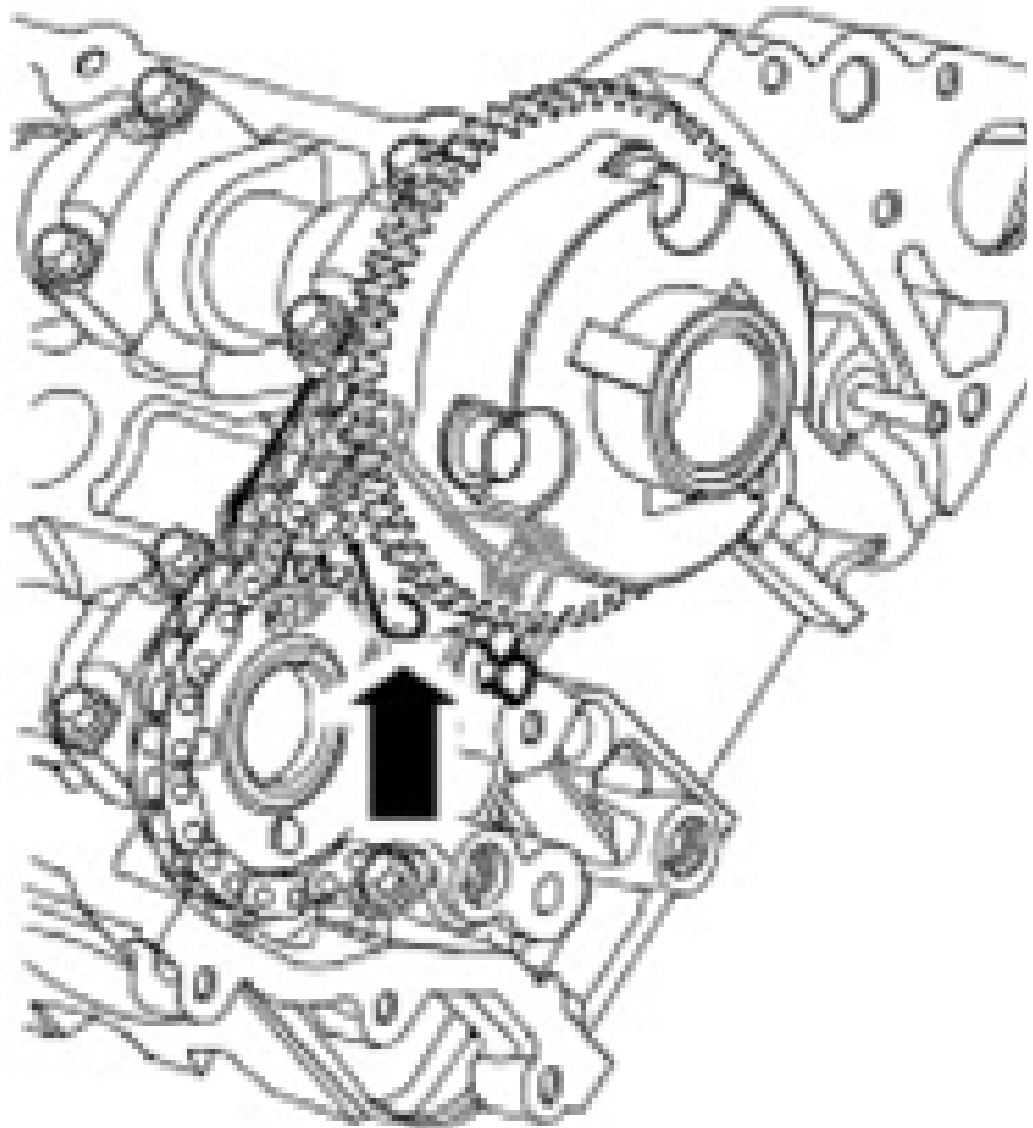


23. Repeat the operation for the RH camshafts.
24. Install the special tool to the LH cylinder head.



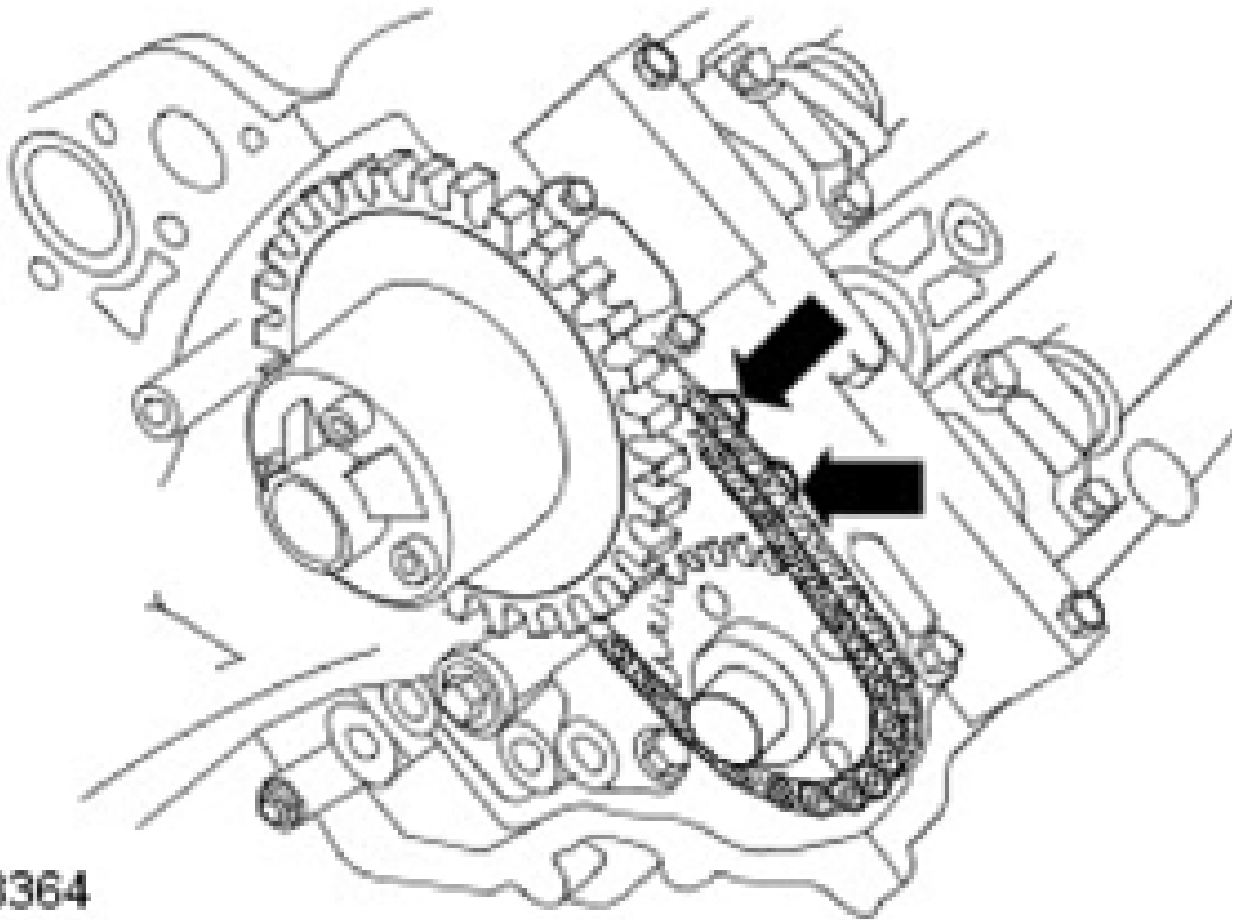
NOTE: RH illustration shown, LH is similar.

25. Depress the LH secondary timing chain tensioner piston.
 - Using 1 mm diameter metal rod, retain the chain tensioner piston.



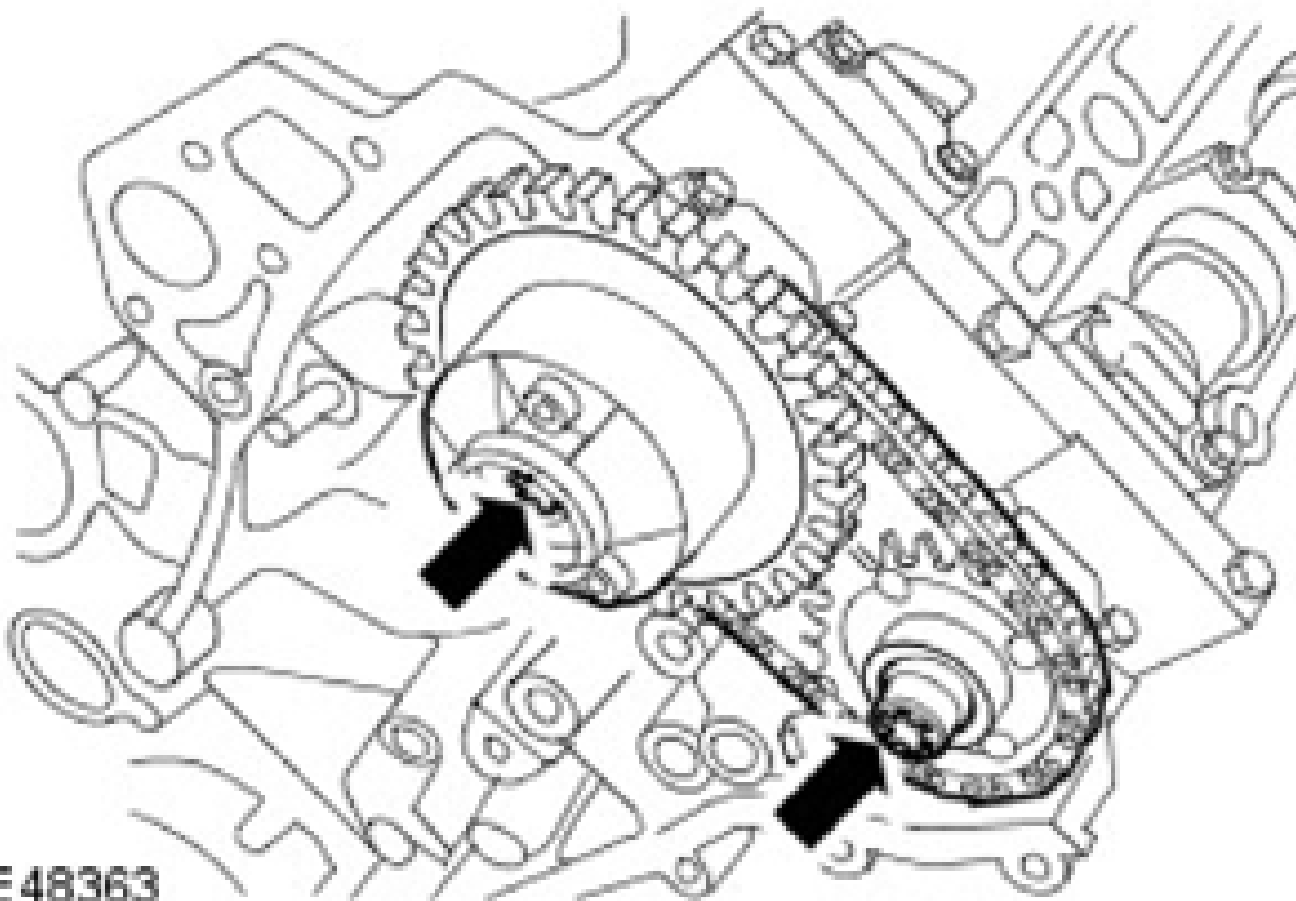
E 46869

26. Install the LH secondary timing chain tensioner retaining bolts.
- Tighten the bolts to 12 Nm.

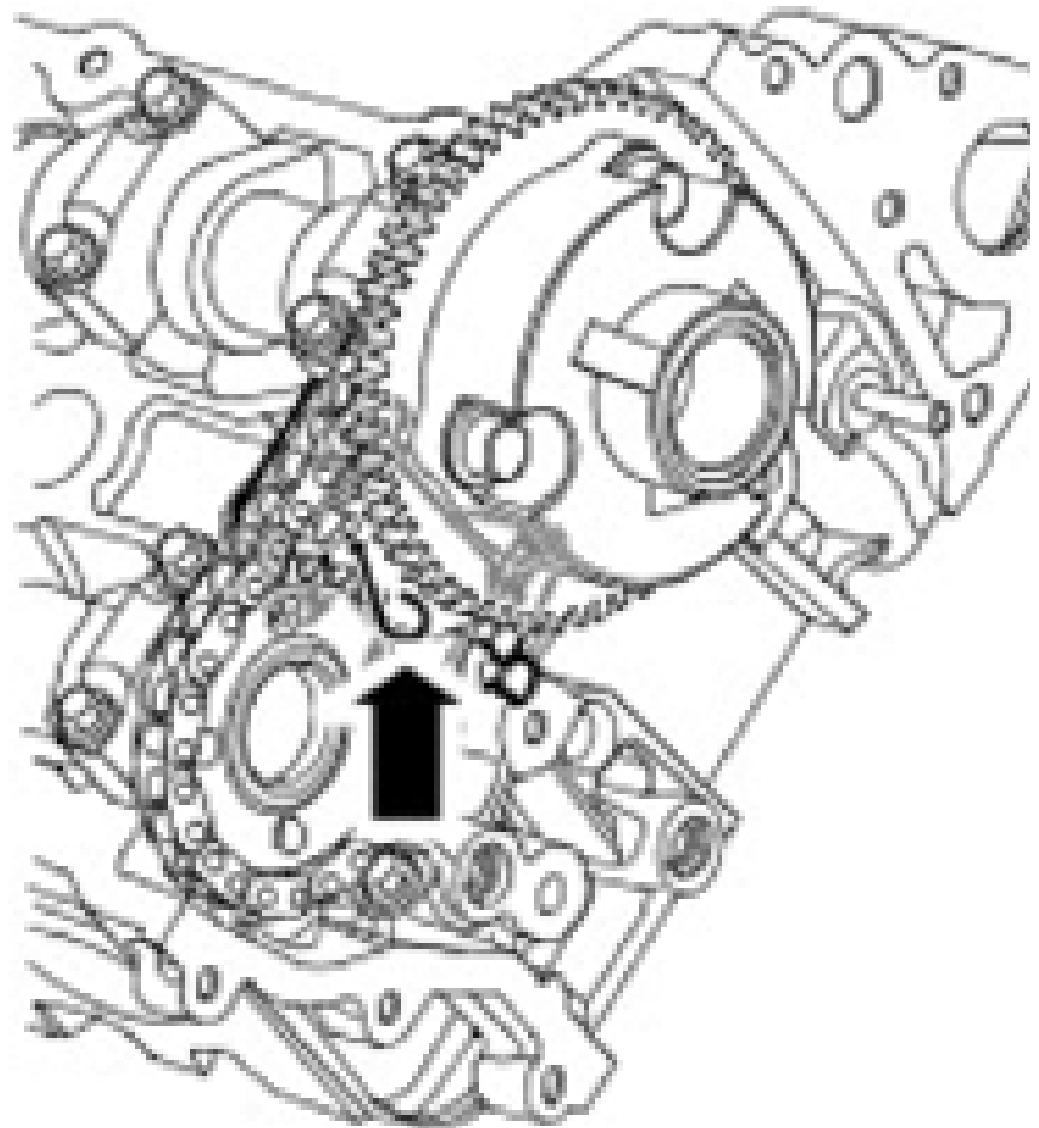


NOTE: Lightly tighten the camshaft sprocket Torx bolts, the sprockets **MUST** be free to move.

27. Install the LH secondary timing chain and sprockets to the camshafts.
 - Install the sprocket retaining Torx bolts to the camshafts.



28. Tension the secondary timing chain.
- Remove the retaining rod.



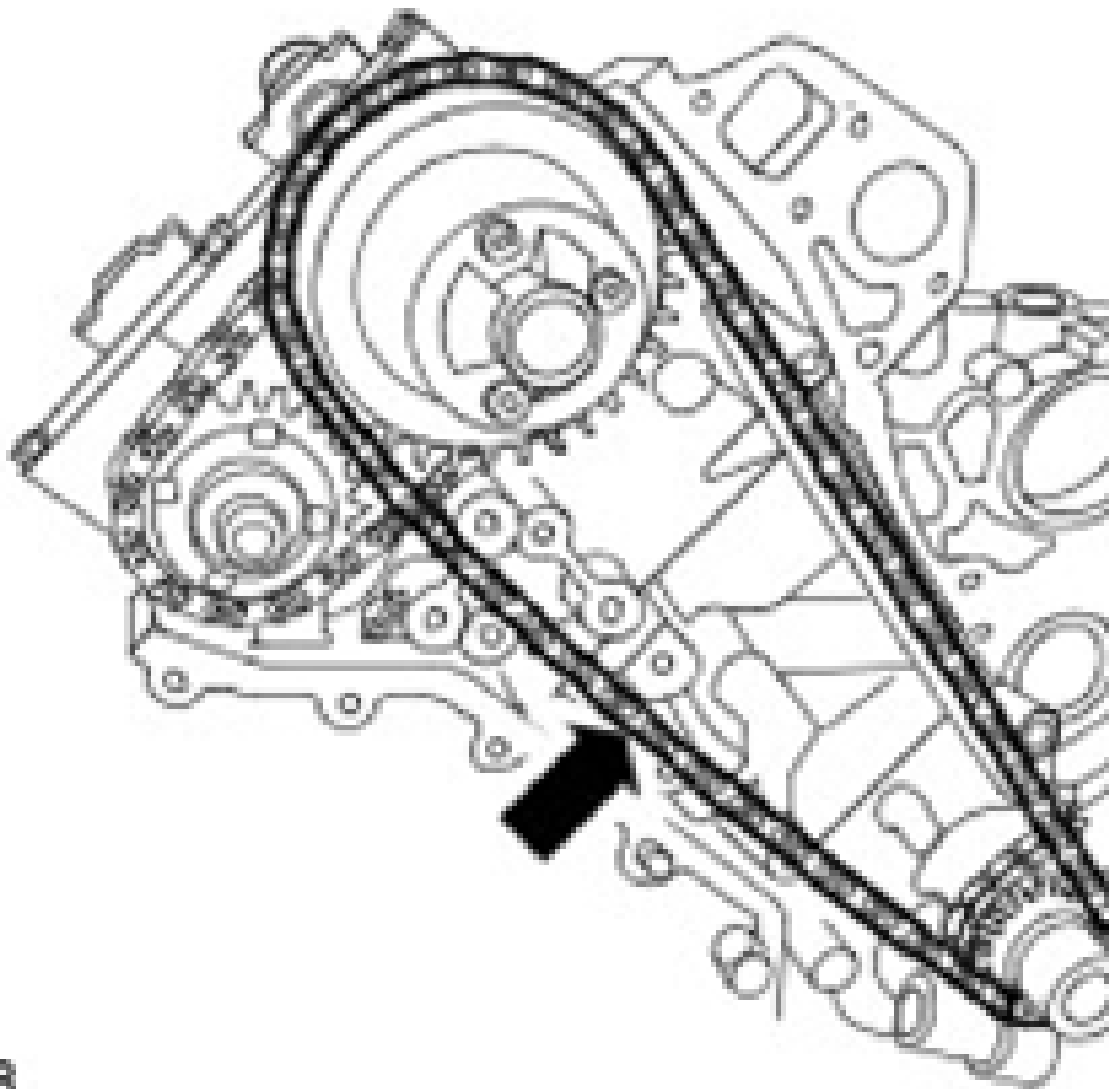
E 46869

29. Repeat the operation for the RH camshafts.

NOTE: RH illustration shown, LH is similar.

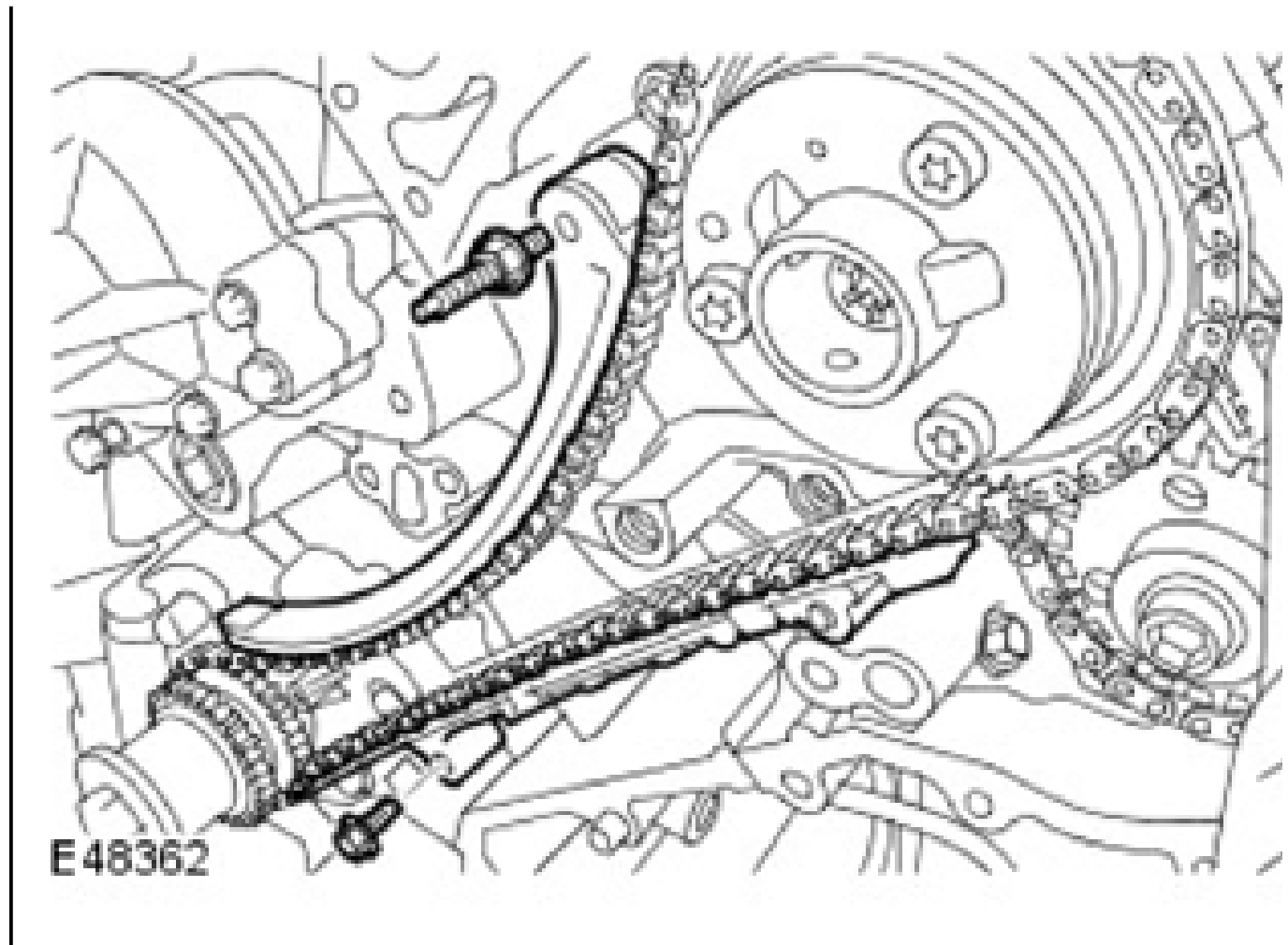
30. Install the LH primary timing chain.

- Make sure the timing chain slack is on the tensioner side of the timing chain.



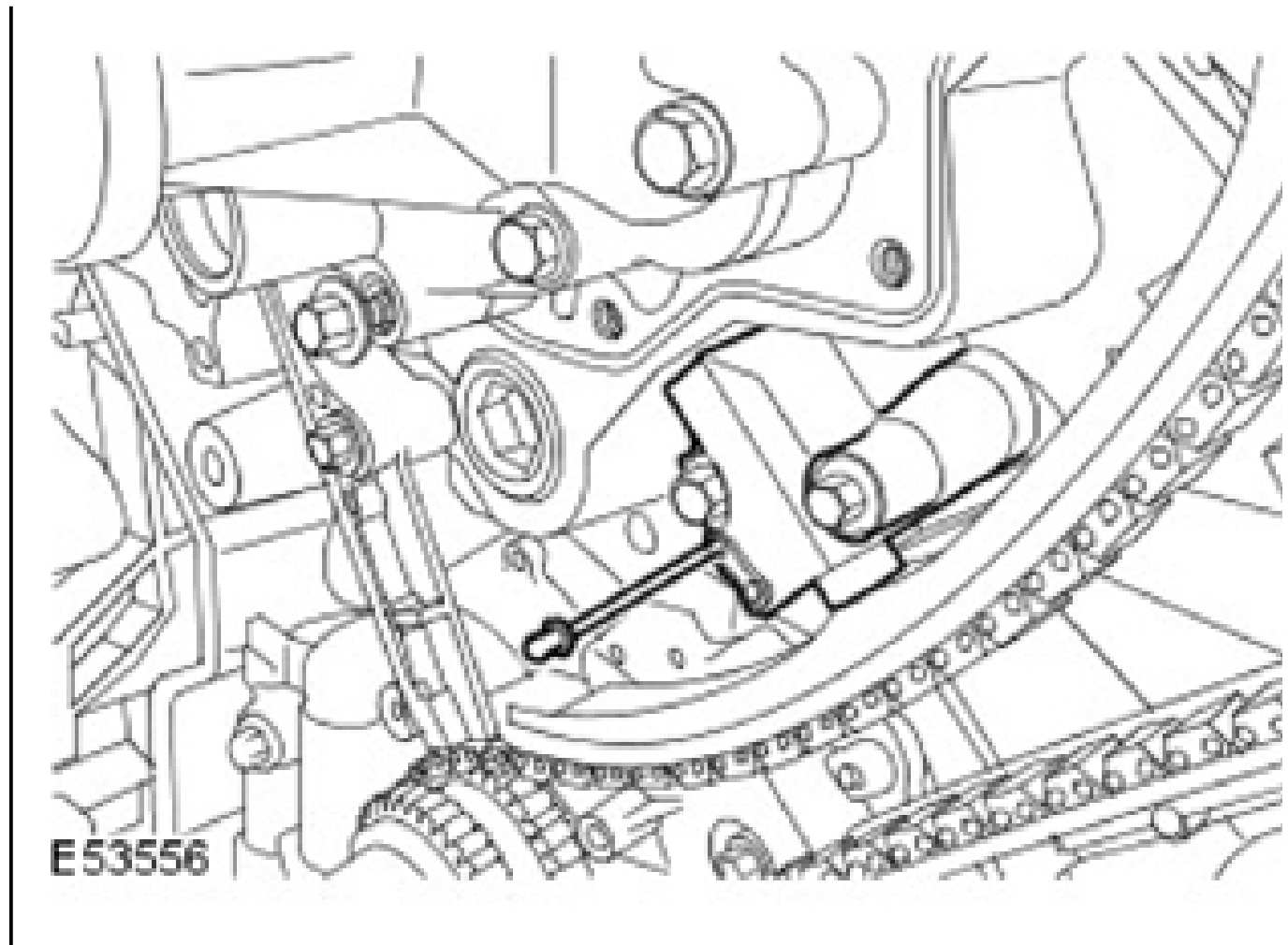
E 46863

31. Install the LH primary chain tensioner guide.
- Tighten the stud to 12 Nm.



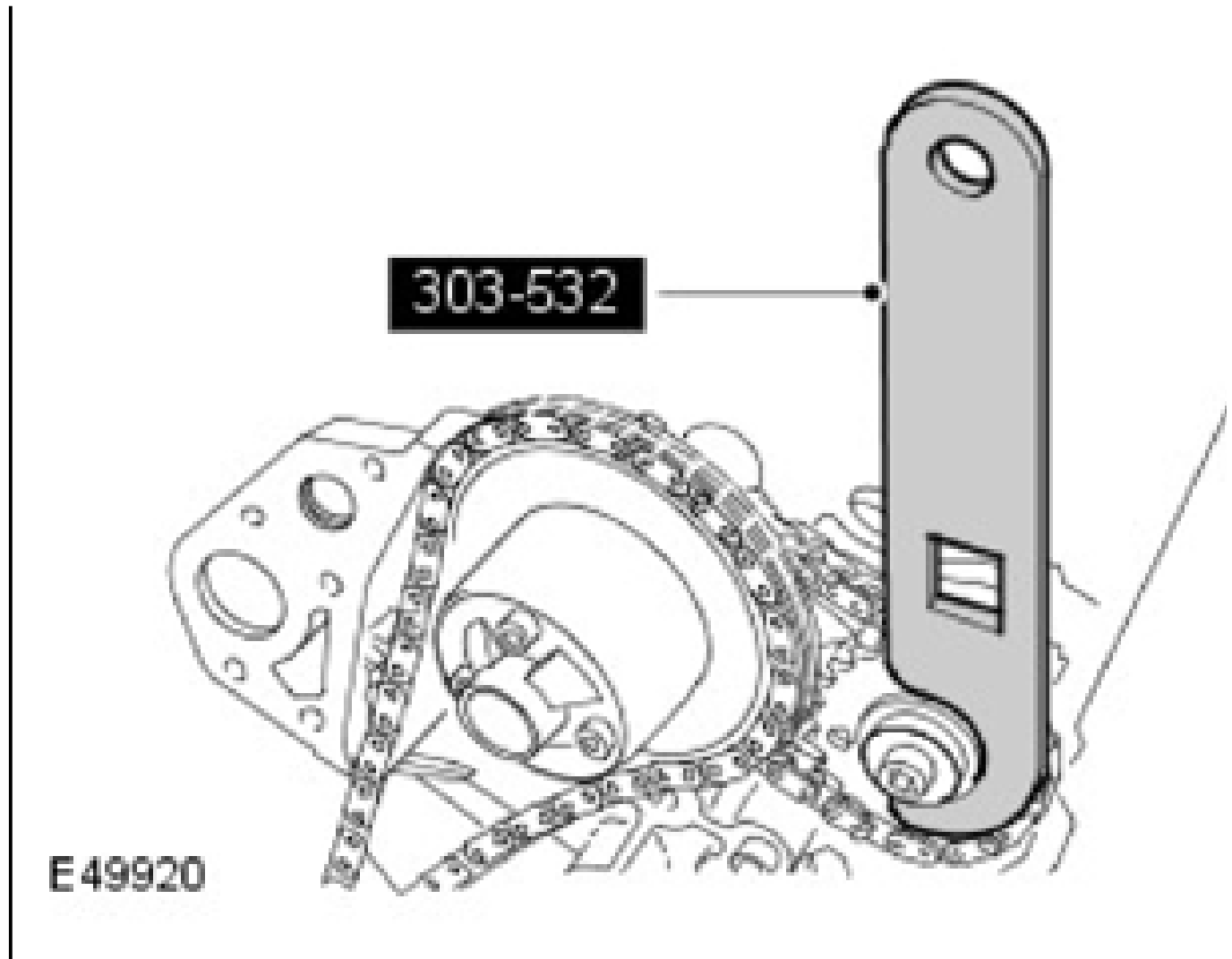
CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

32. Install the LH primary timing chain tensioner.
- Using 3 mm diameter metal rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm.
 - Remove the retaining rod.



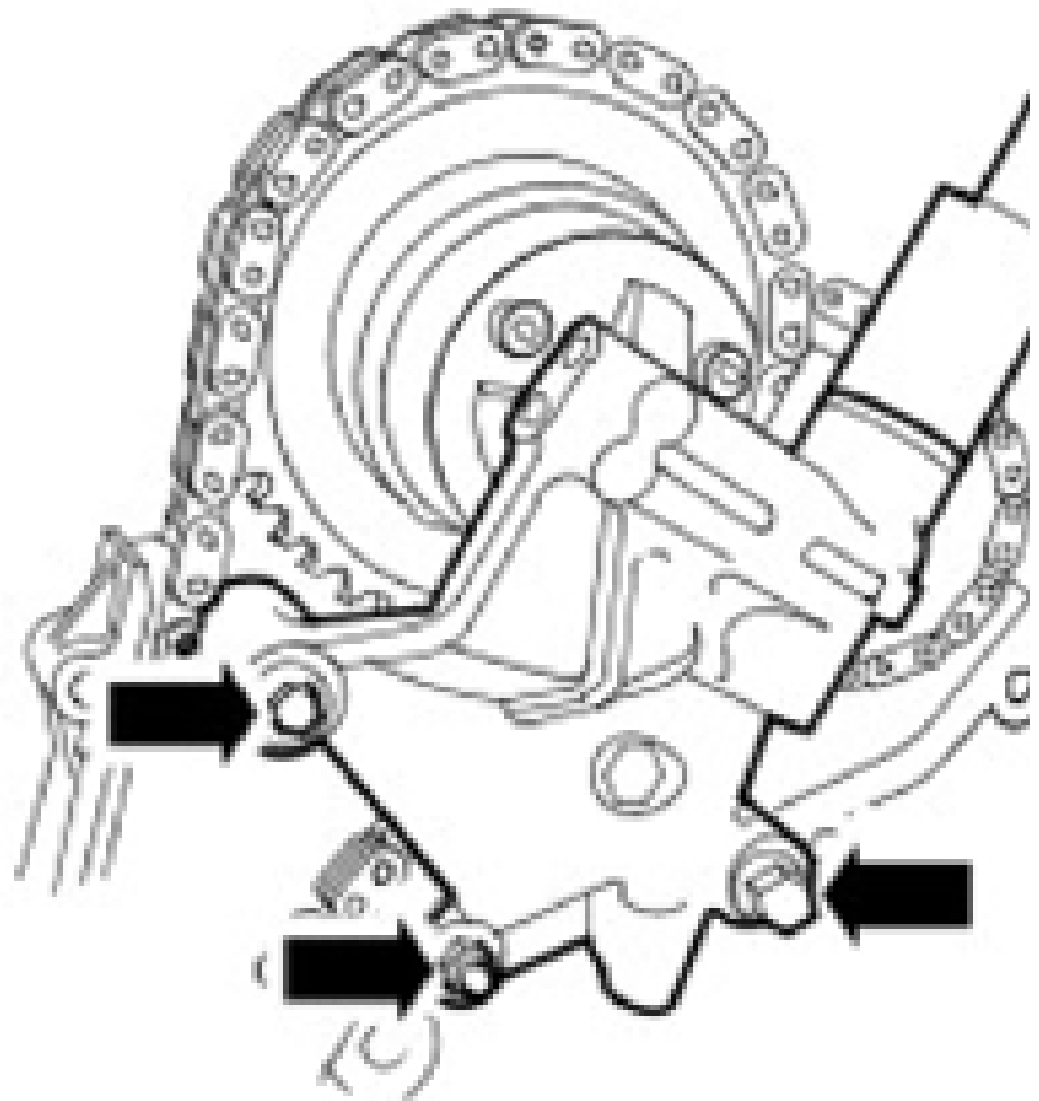
CAUTION: Using the special tool, apply force to the tool in a counterclockwise direction, to tension the primary timing chain on its drive side. The intake camshaft sprocket retaining bolt **MUST** be tightened before the exhaust camshaft sprocket retaining bolt. Engine damage will occur if this procedure is not followed. Make sure that new bolts are installed.

33. Install the special tool to the exhaust camshaft sprocket.
- Tighten the intake camshaft sprocket bolt to 20 Nm then a further 90 degrees.
 - Tighten the exhaust camshaft sprocket bolt to 20 Nm then a further 90 degrees.

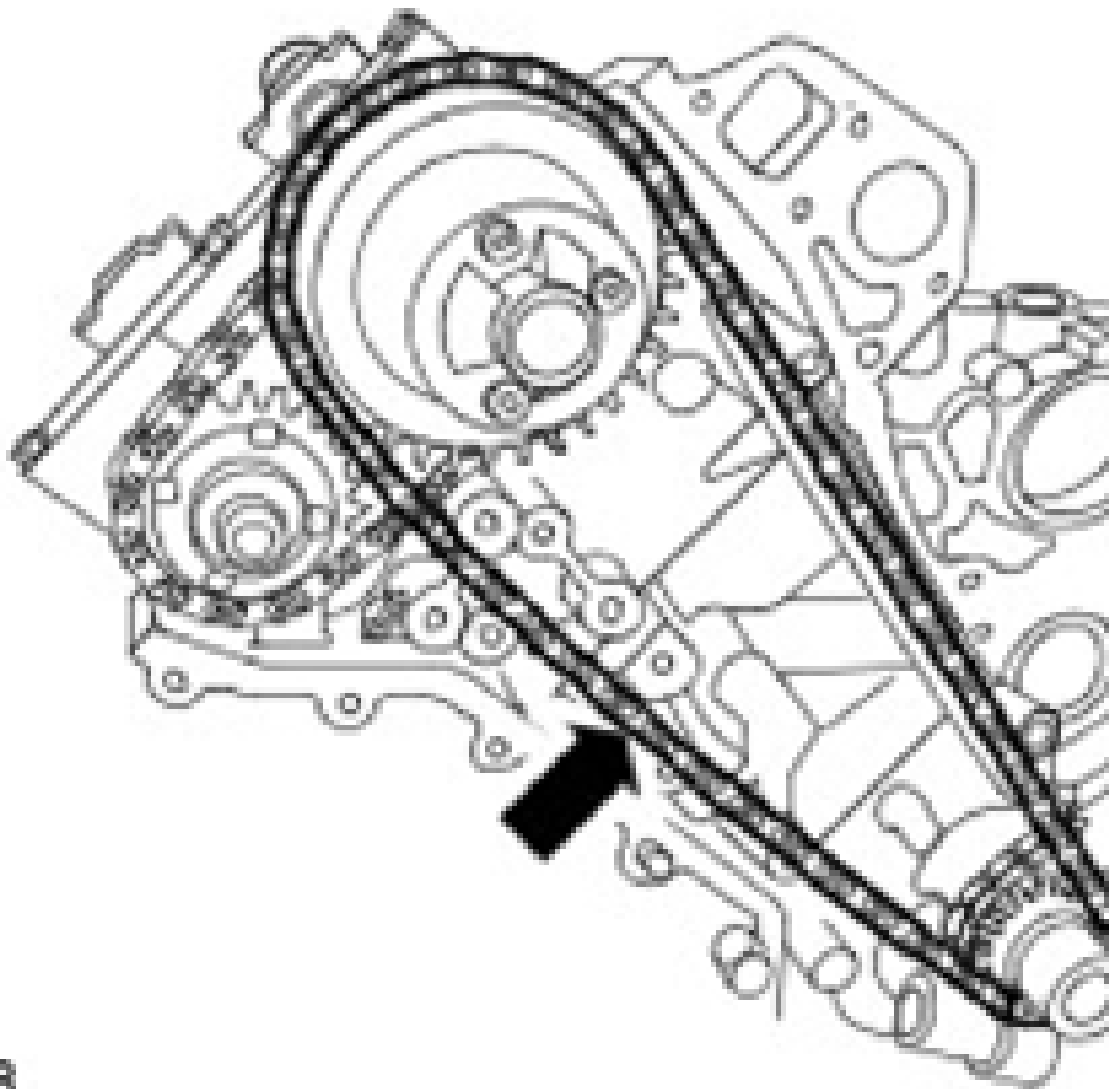


34. Install the LH variable camshaft timing (VCT) oil control unit.

- Install the new O-ring seals.
- Tighten the new bolts to 22 Nm.
- Tighten the nut to 10 Nm.

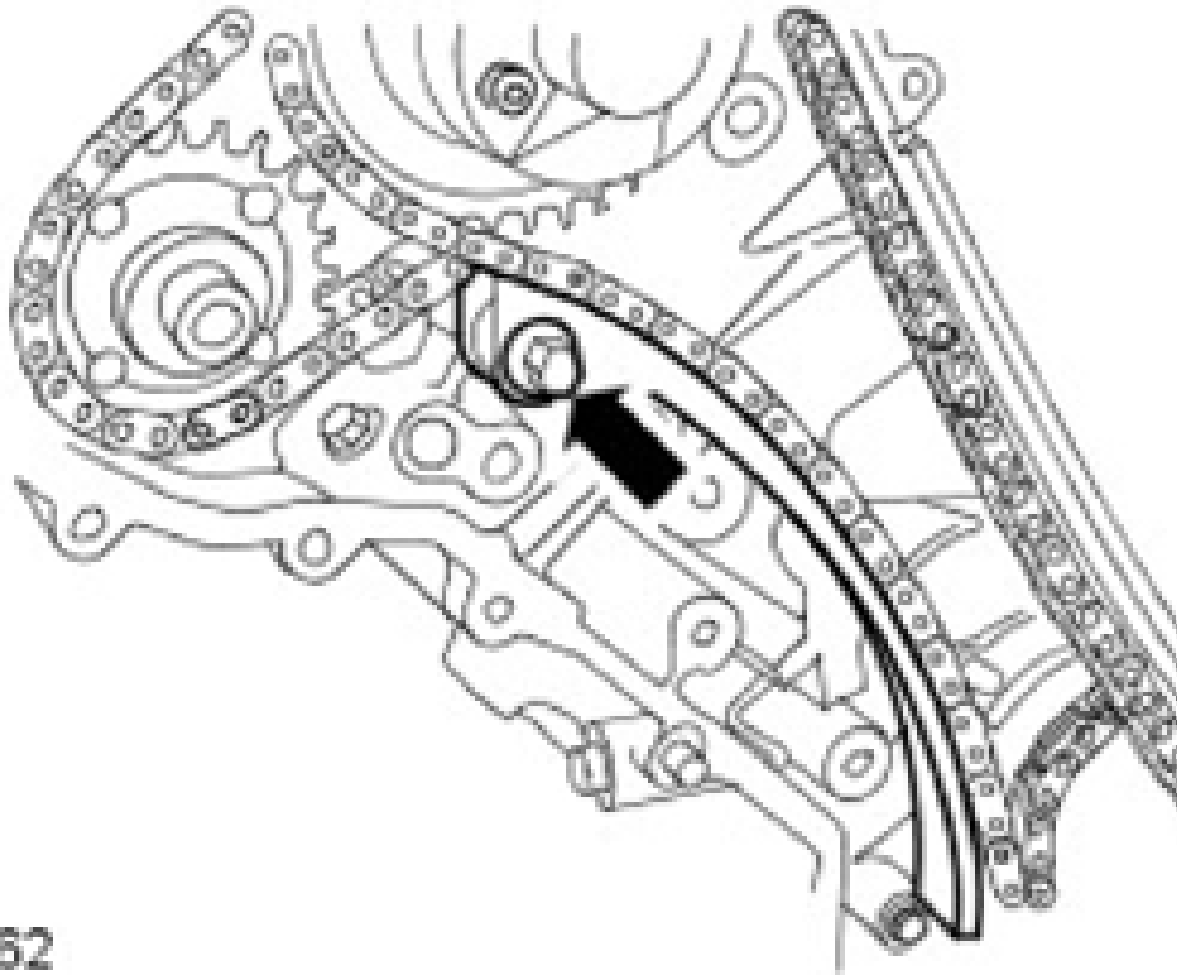


35. Install the RH primary timing chain.
- Make sure the timing chain slack is on the tensioner side of the timing chain.



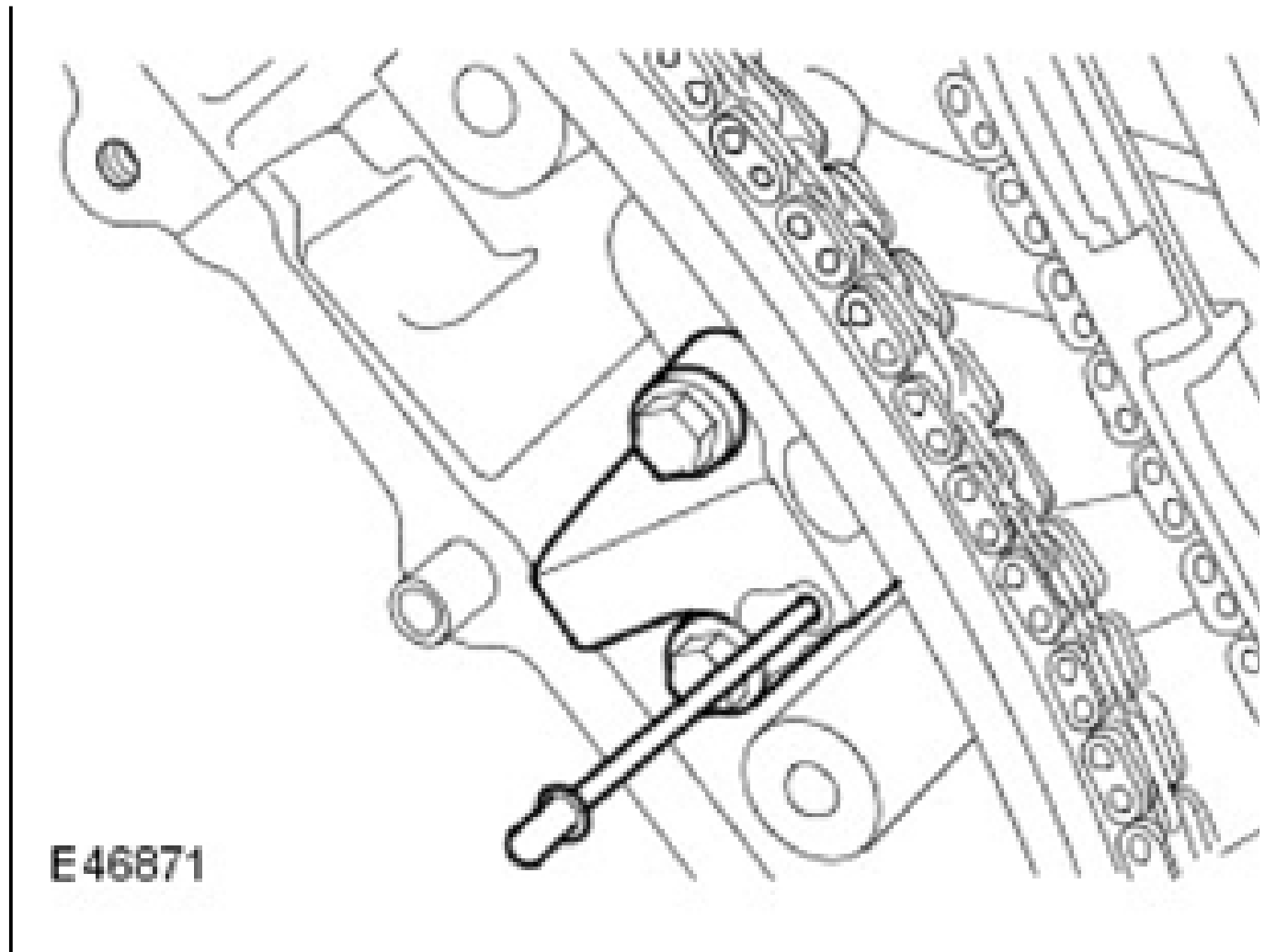
E46863

36. Install the RH primary timing chain tensioner guide.
- Tighten the bolts to 12 Nm.



CAUTION: During timing chain tensioner compression, do not release the ratchet stem until the timing chain tensioner piston is fully bottomed in its bore or damage to the ratchet stem will result.

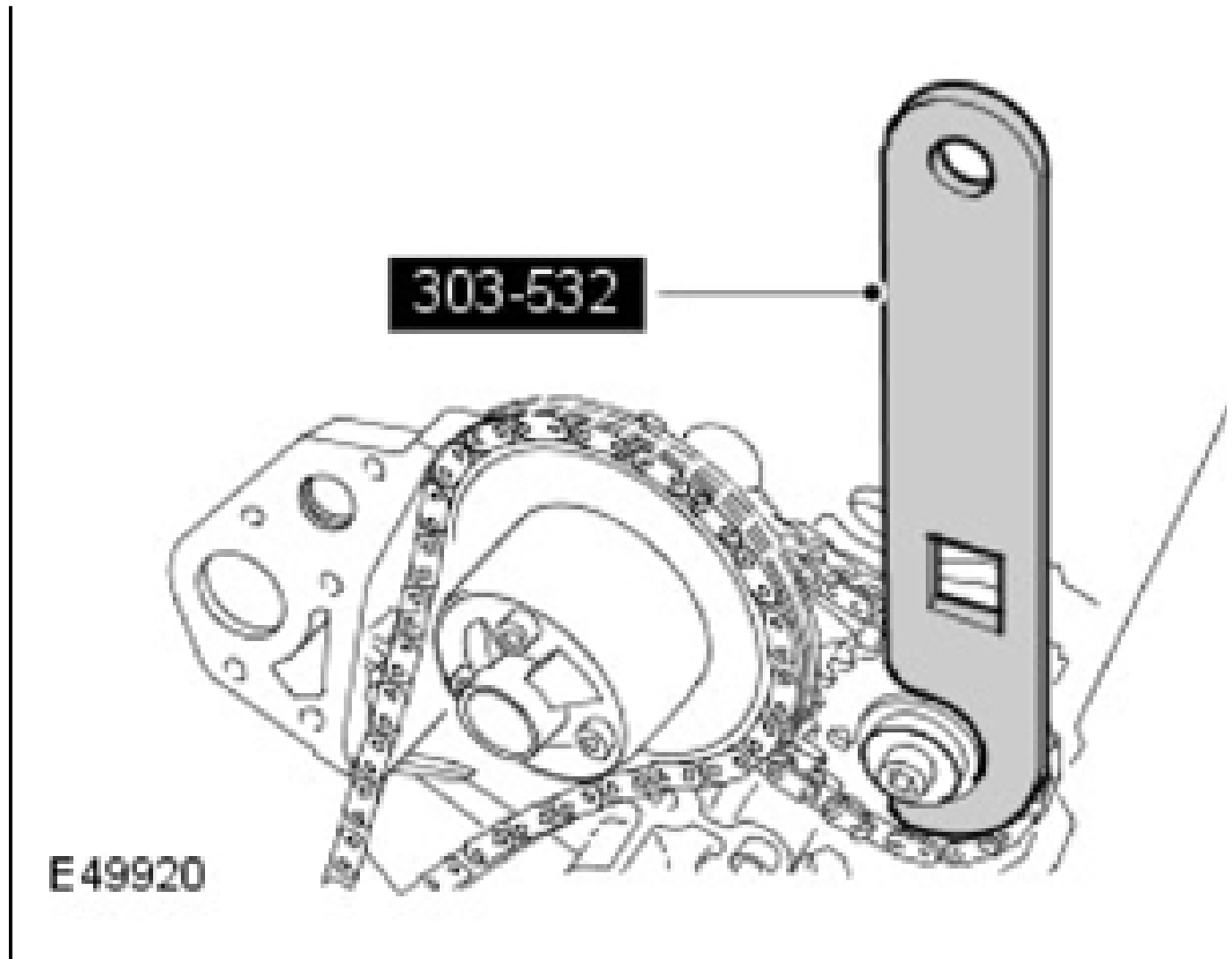
37. Install the RH primary timing chain tensioner.
- Using 3 mm diameter metal rod, retain the chain tensioner piston.
 - Tighten the bolts to 12 Nm.
 - Remove the retaining rod.



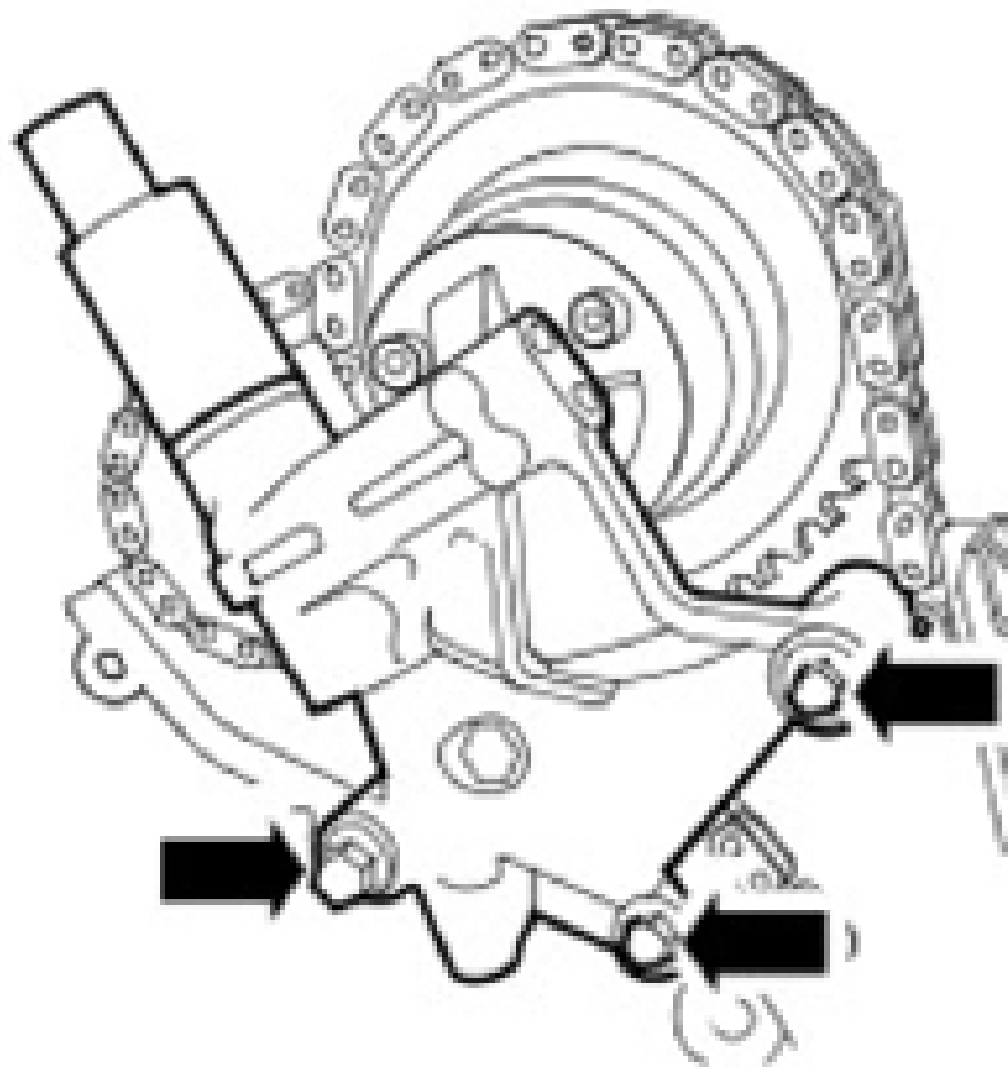
CAUTION: Using the special tool, apply force to the tool in a counterclockwise direction, to tension the primary timing chain on its drive side. The intake camshaft sprocket retaining bolt **MUST** be tightened before the exhaust camshaft sprocket retaining bolt. Engine damage will occur if this procedure is not followed. Make sure that new bolts are installed.

38. Install the special tool to the exhaust camshaft sprocket.

- Tighten the intake camshaft sprocket bolt to 20 Nm then a further 90 degrees.
- Tighten the exhaust camshaft sprocket bolt to 20 Nm then a further 90 degrees.

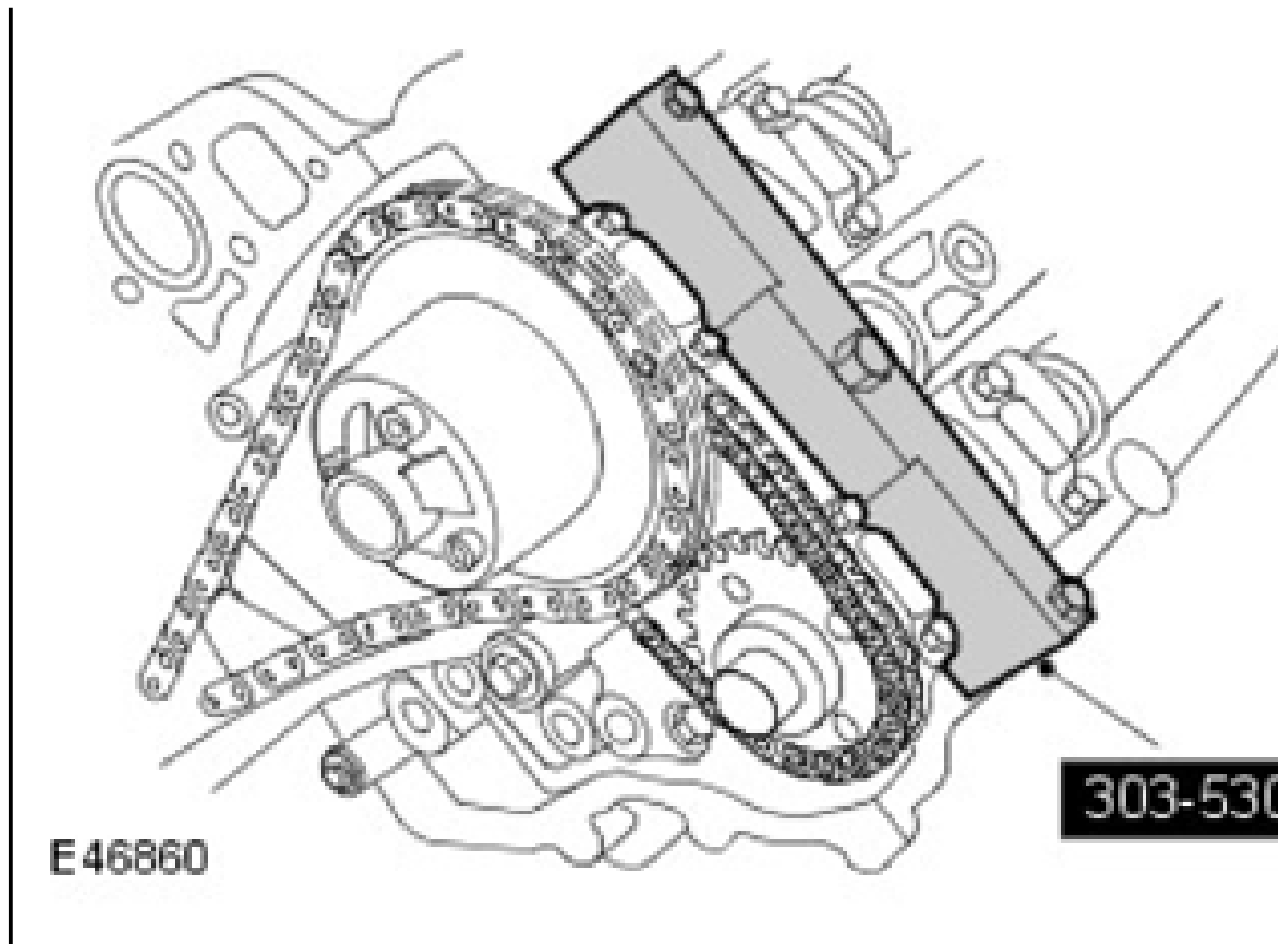


39. Install the RH VCT oil control unit.
- Install the new O-ring seals.
 - Tighten the new bolts to 22 Nm.

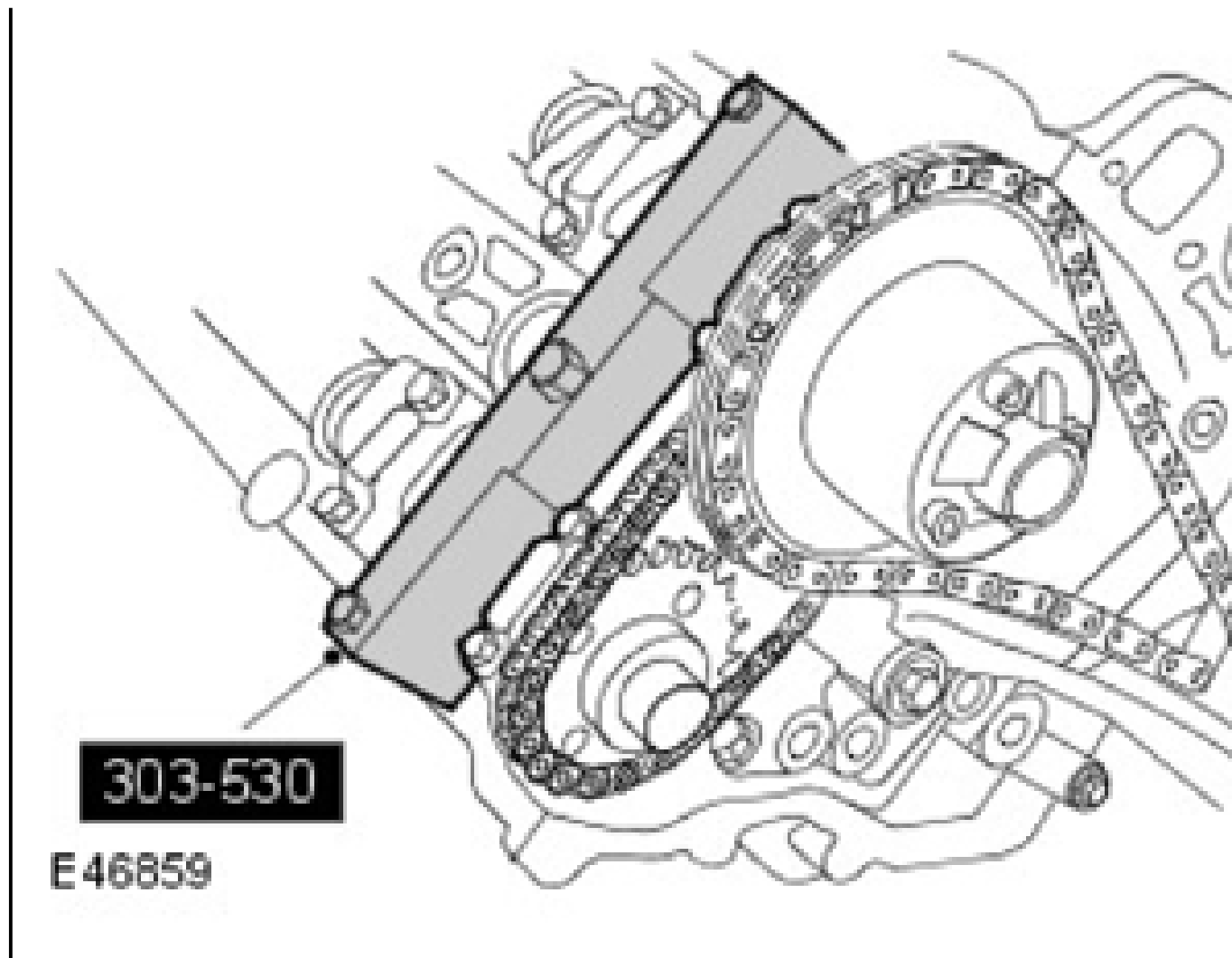


E 46858

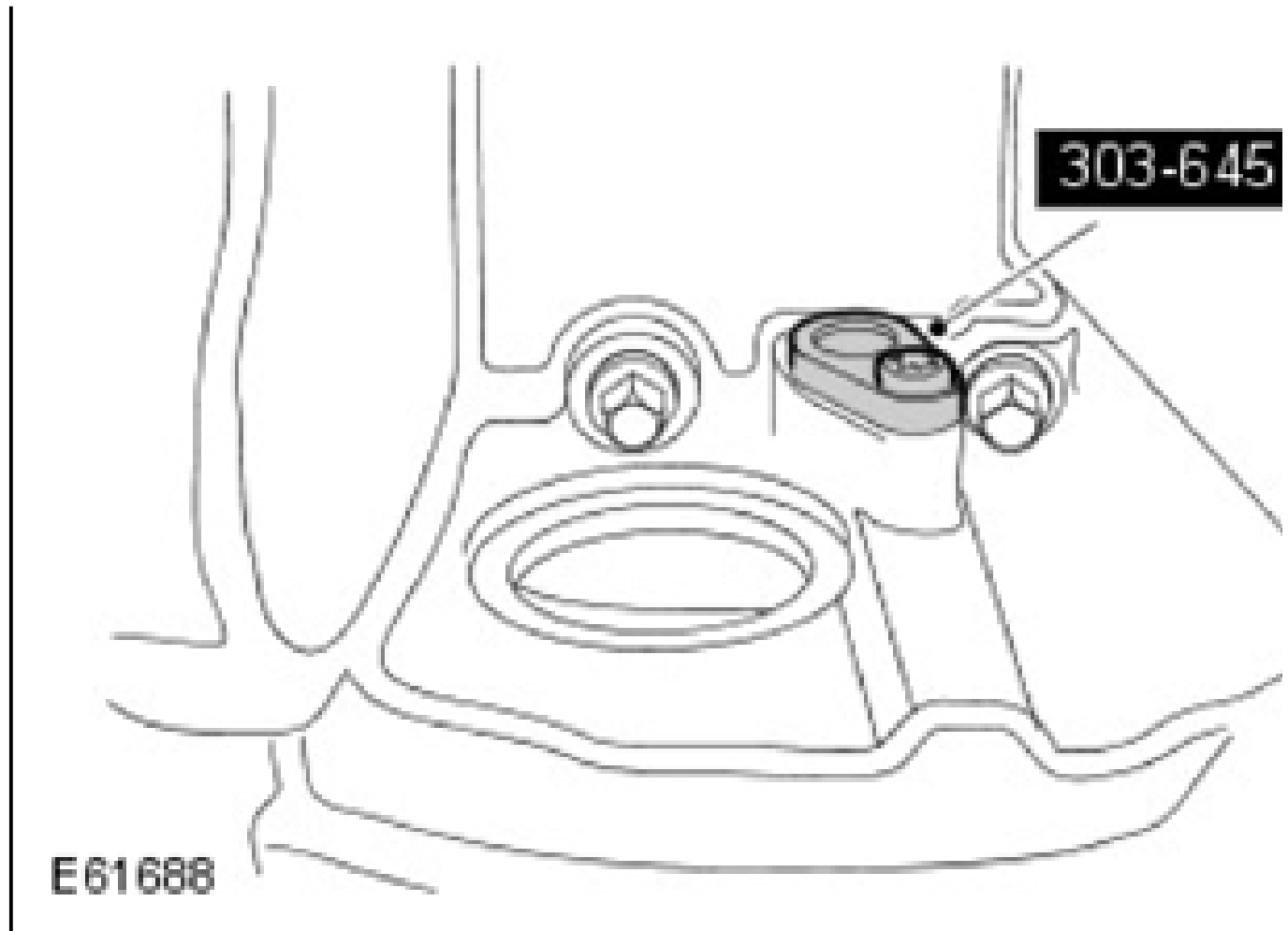
40. Remove the special tool from the LH cylinder head.



41. Remove the special tool from the RH cylinder head.

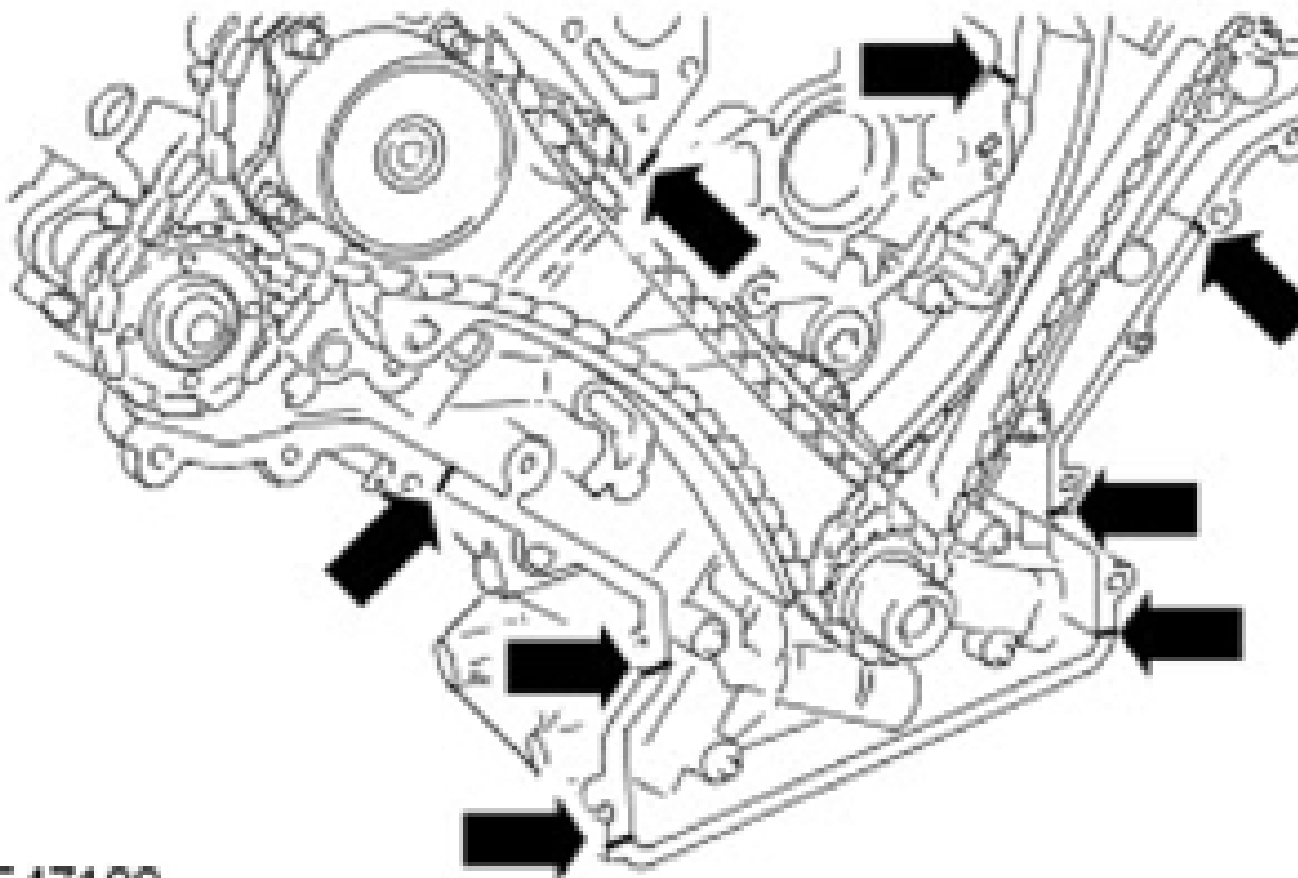


42. Remove the crankshaft locking tool.
- Remove the screw.



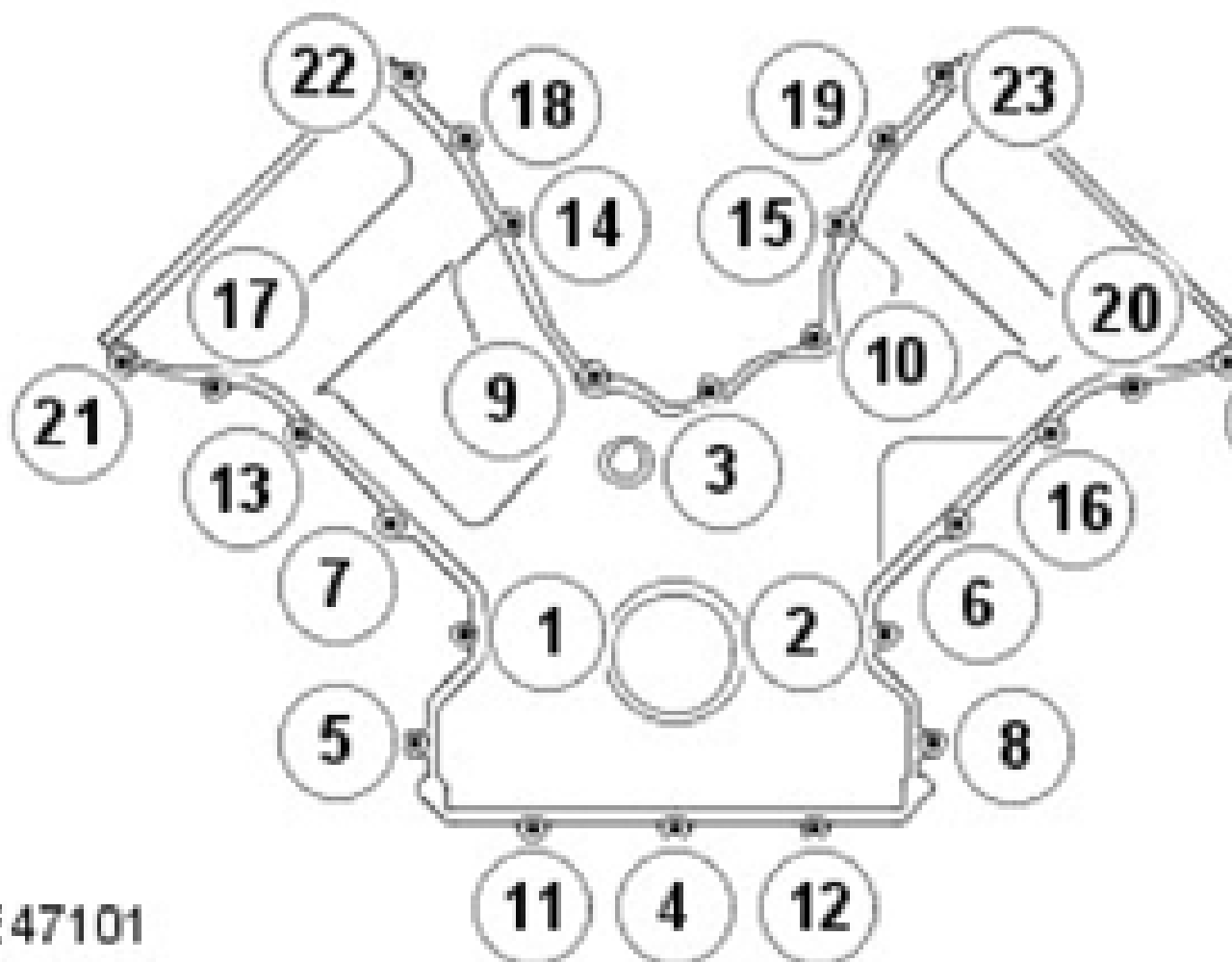
43. Install the engine front cover.

- Clean the component mating faces.
- Apply a bead of sealant 3 mm diameter, by 12 mm long, to the 8 places indicated.



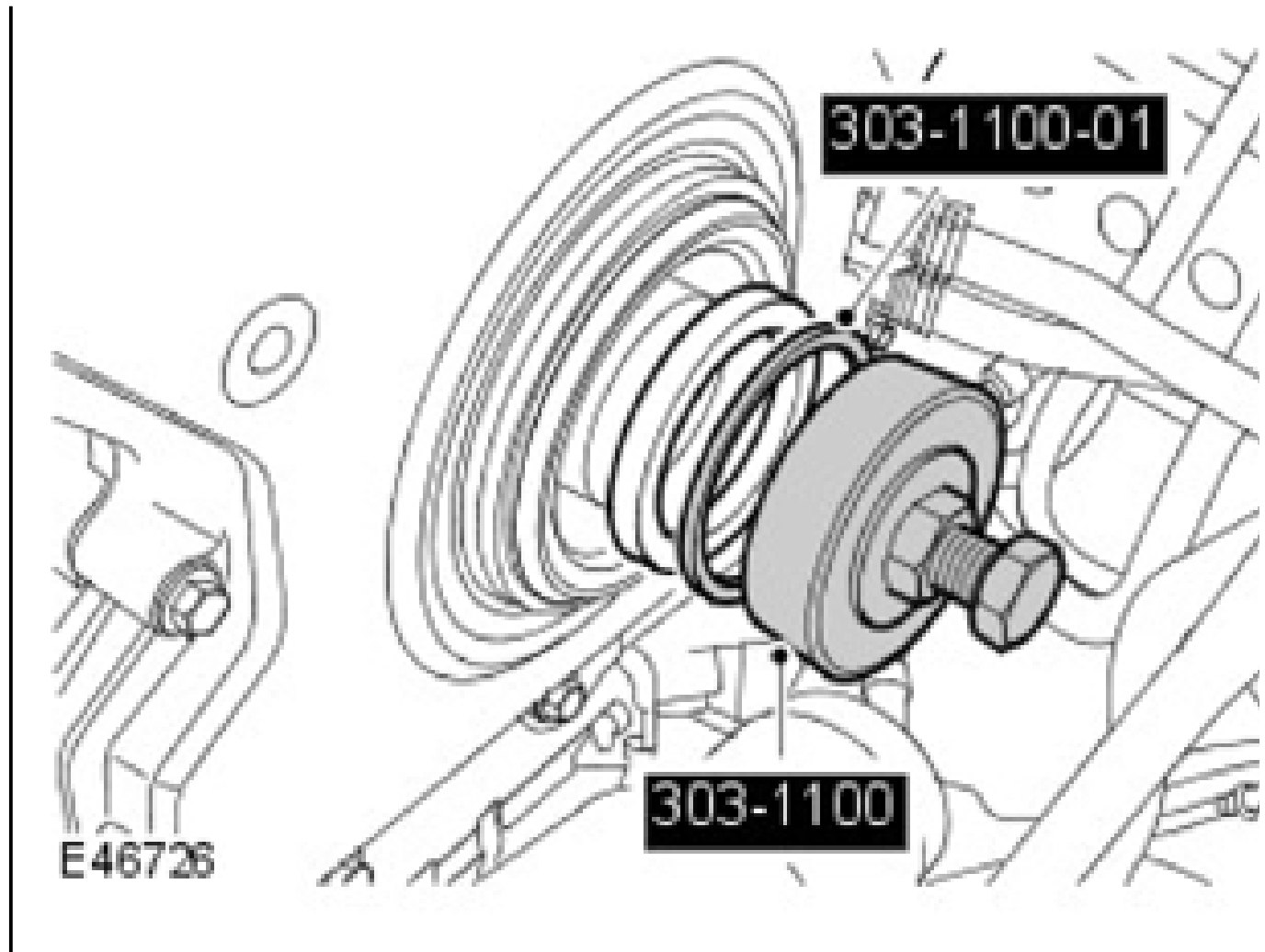
E47100

44. Evenly and progressively tighten the bolts in the sequence shown to 12 Nm.

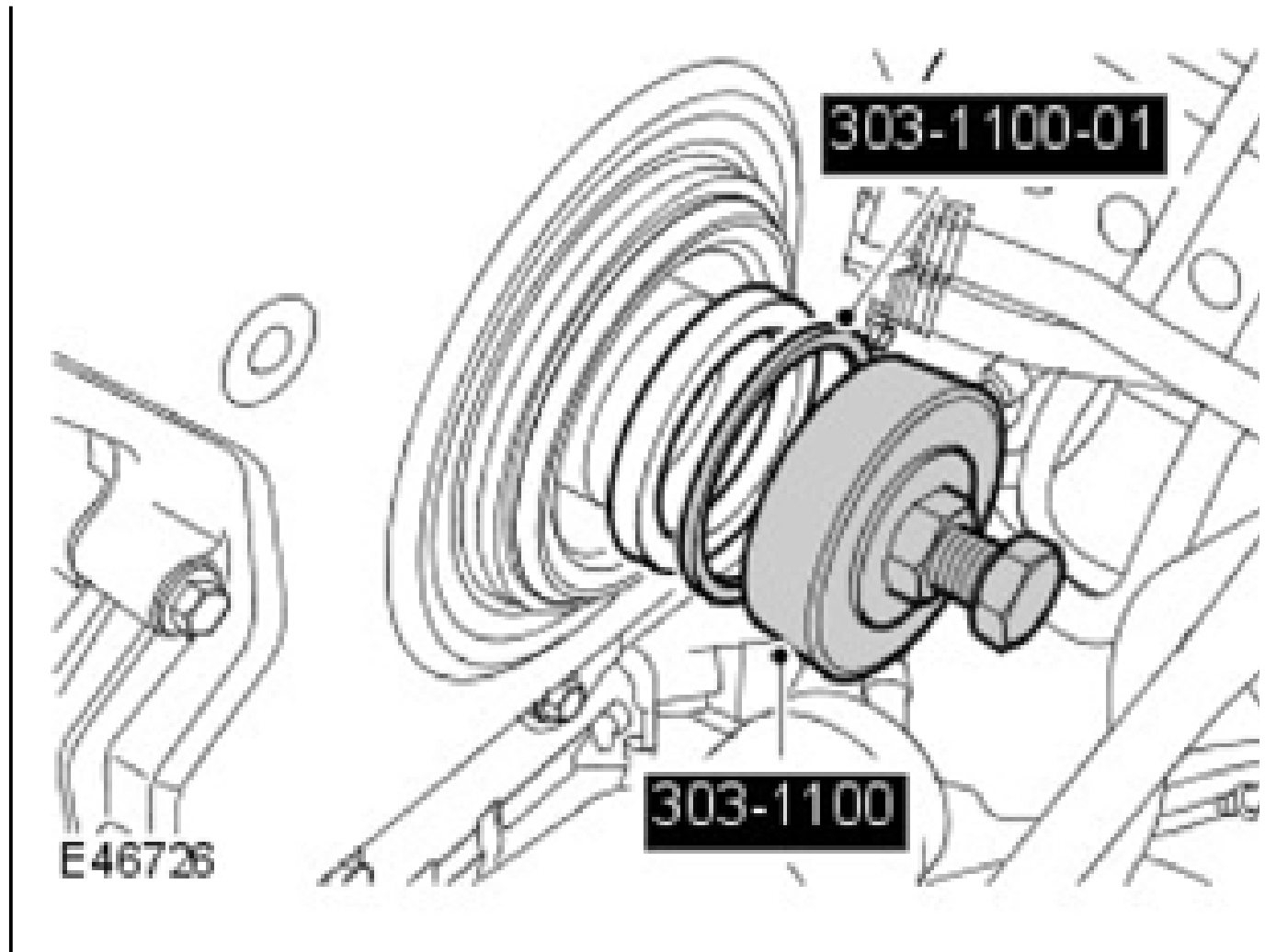


45. Using the special tools, install the crankshaft front seal.

- Clean the component mating faces.
- Lubricate the seal with clean engine oil.
- Use the discarded crankshaft bolt with the service tool.



46. Using the special tools, install the crankshaft front seal.
- Clean the component mating faces.



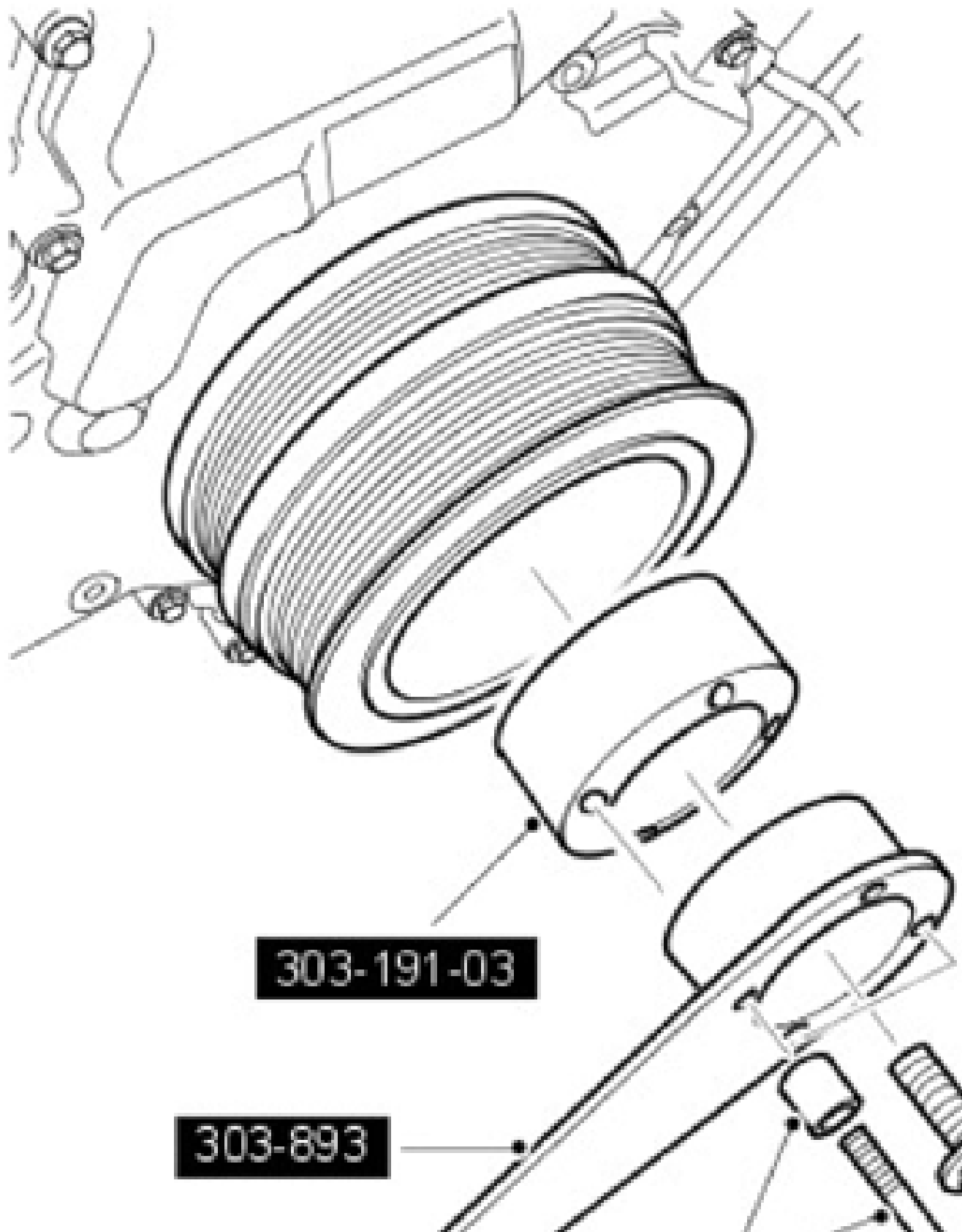
47. Install the crankshaft pulley.
 - Lubricate the seal with clean engine oil.
48. Install the crankshaft pulley locking ring.

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

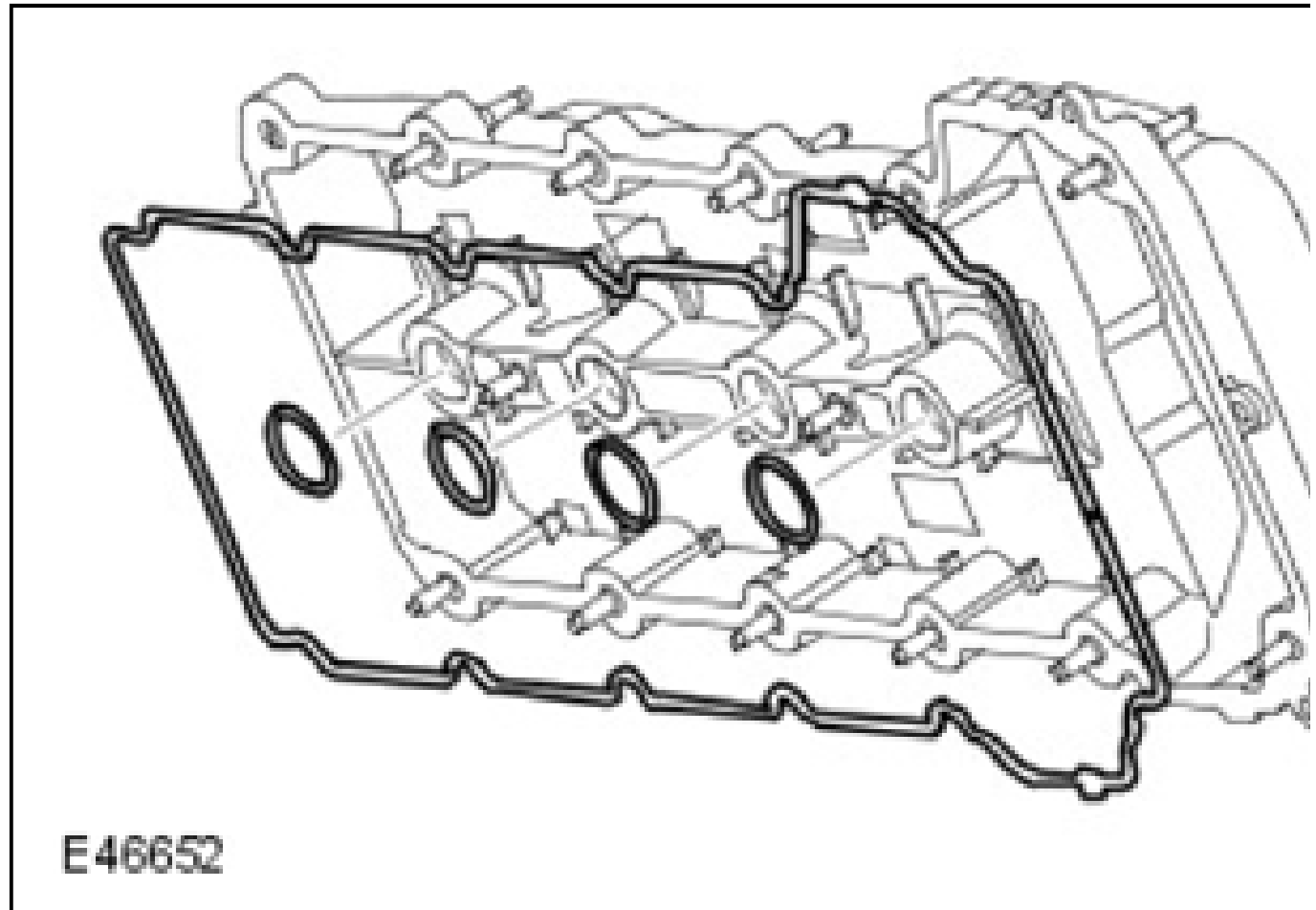
49. Install, but do not tighten, the new crankshaft pulley bolt.

CAUTION: Under no circumstances should the crankshaft setting peg, 303-645, be used in the following operations, to restrain the crankshaft.

50. Using the special tools, retain the crankshaft pulley.
 - Tighten the crankshaft pulley bolt to 380 Nm.

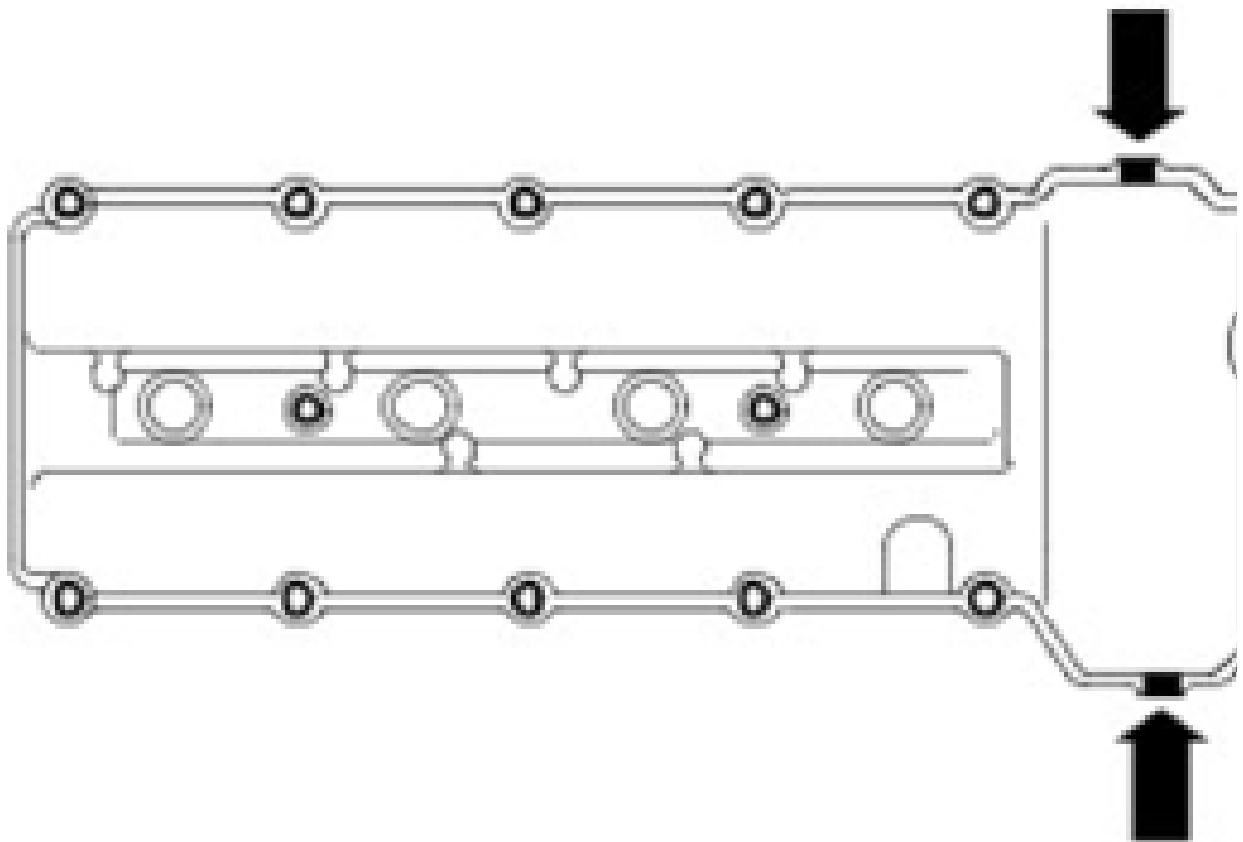


51. Remove the special tools.
52. Install new valve cover plug aperture gaskets.
 - Install a new valve cover gasket.



NOTE: Apply two beads of silicone gasket sealant as shown on the illustration. The application of the sealant must be 3mm diameter 12mm long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

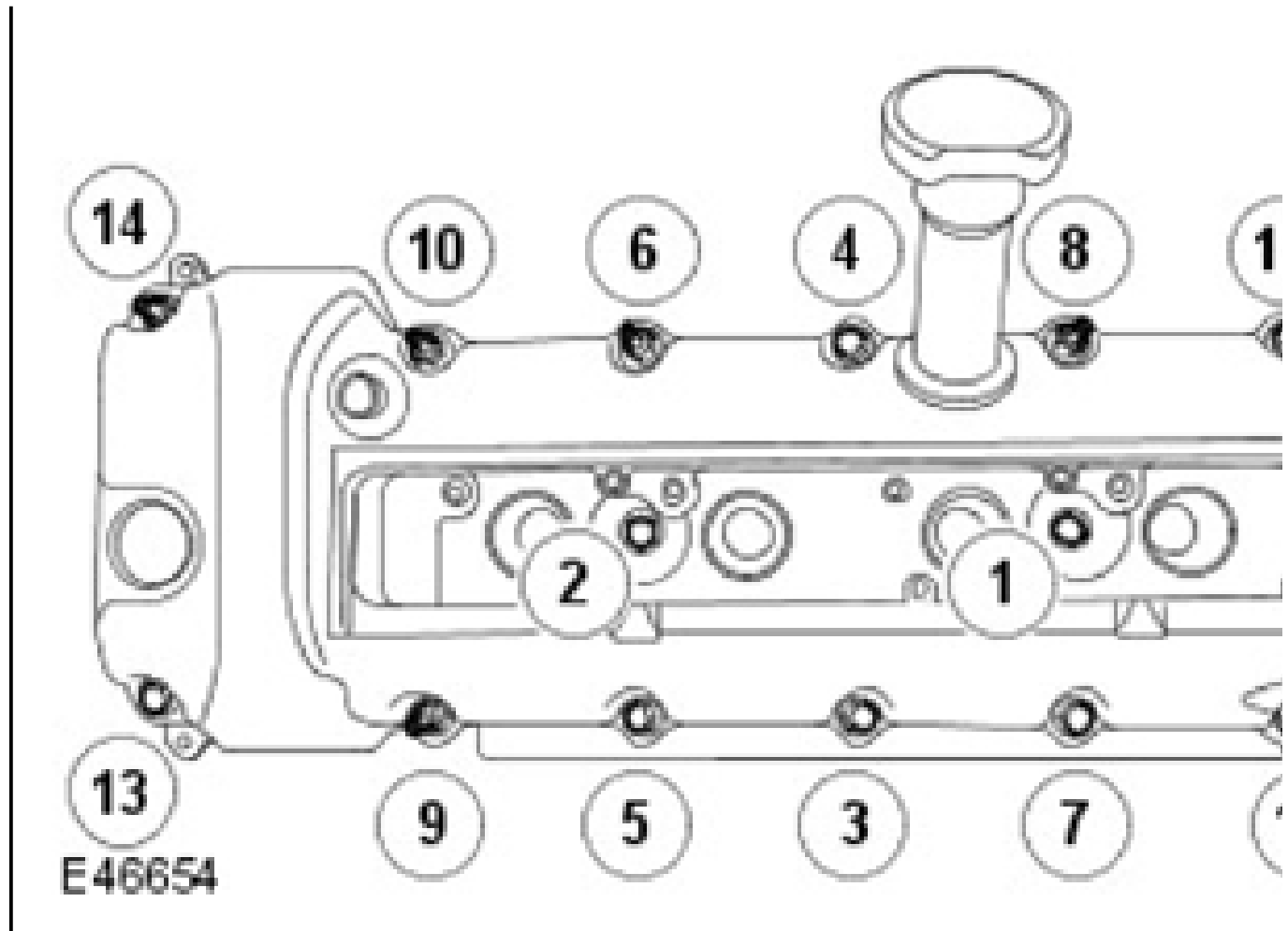
53. Install the valve cover.
 - Clean the component mating faces.



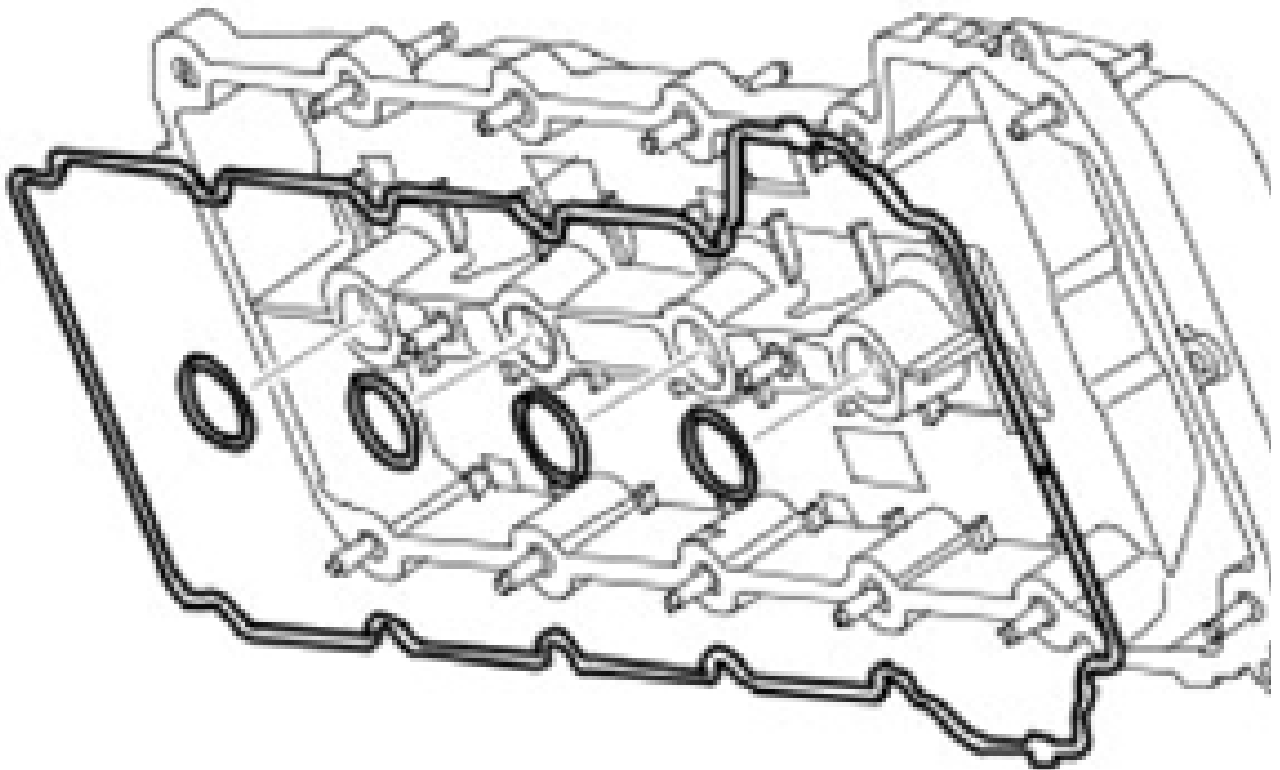
E49922

54. Install the valve cover retaining bolts.

- Install valve cover retaining bolts to their position previously noted.
- Complete the tightening sequence as illustrated.
- Tighten the bolts to 12 Nm.



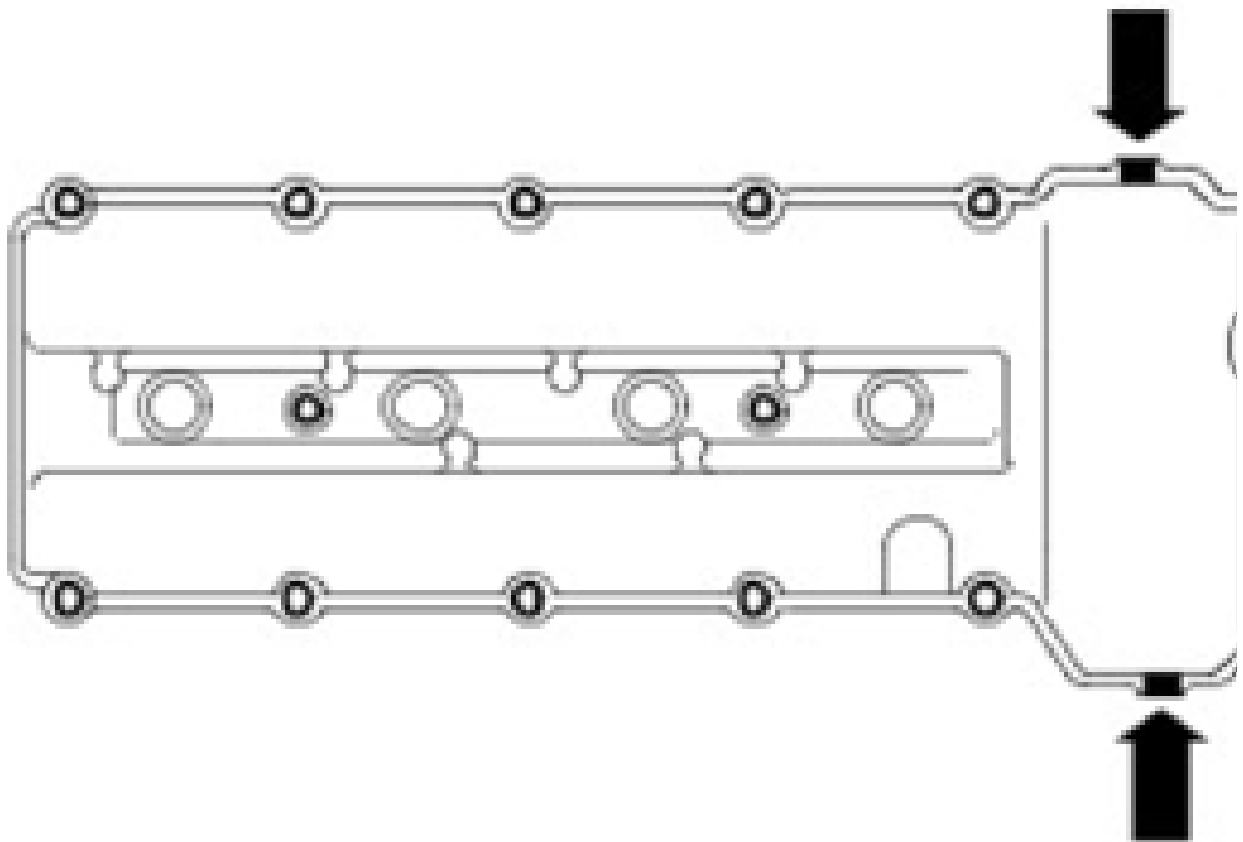
55. Install new valve cover plug aperture gaskets.
- Install a new valve cover gasket.



E46652

NOTE: Apply two beads of silicone gasket sealant as shown on the illustration. The application of the sealant must be 3mm diameter 12mm long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

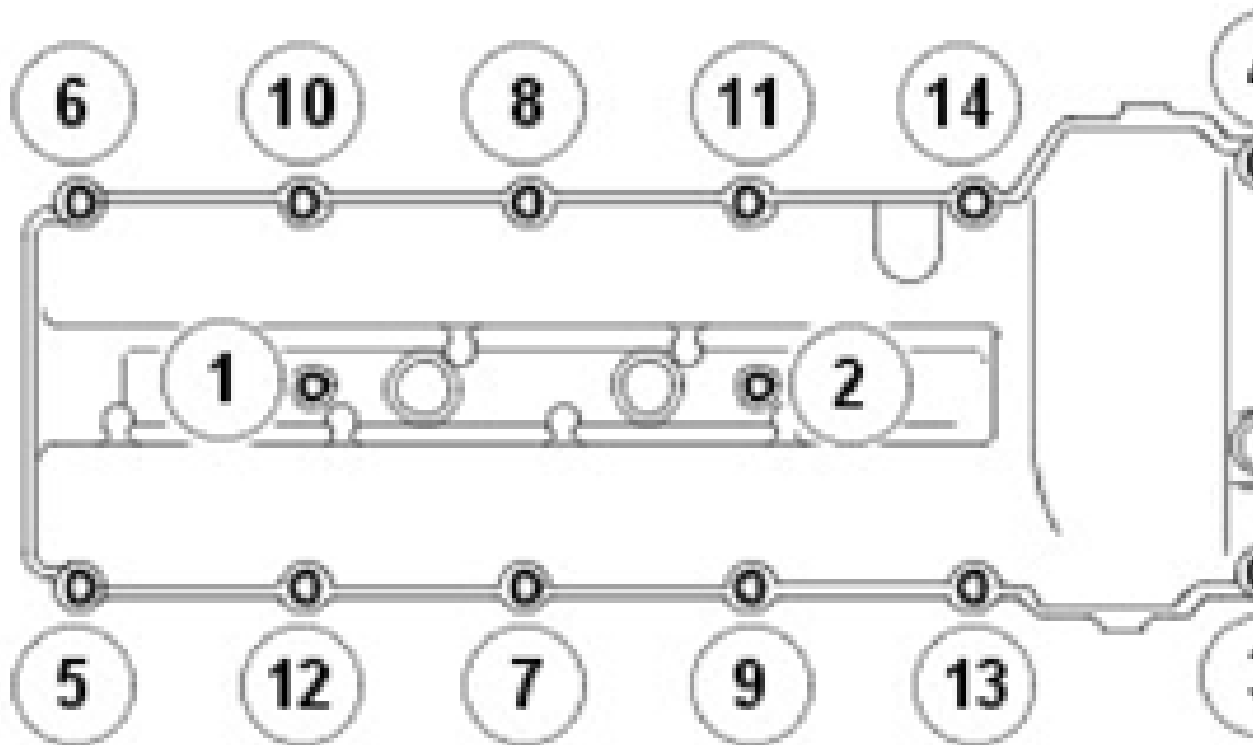
56. Install the valve cover.
- Clean the component mating faces.



E49922

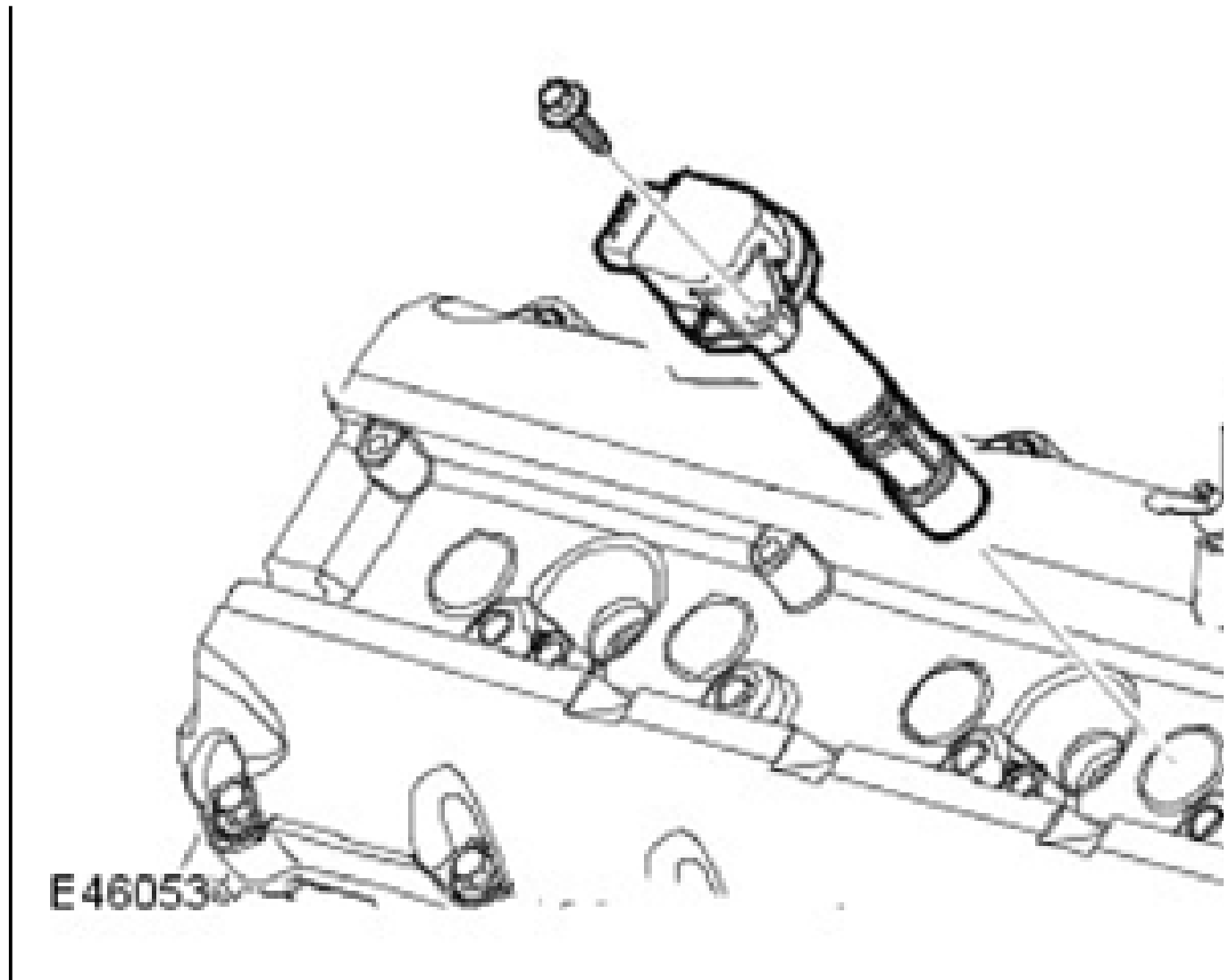
57. Install the valve cover retaining bolts.

- Install valve cover retaining bolts to their position previously noted.
- Tighten the bolts to 12 Nm.
- Complete the tightening sequence as illustrated.

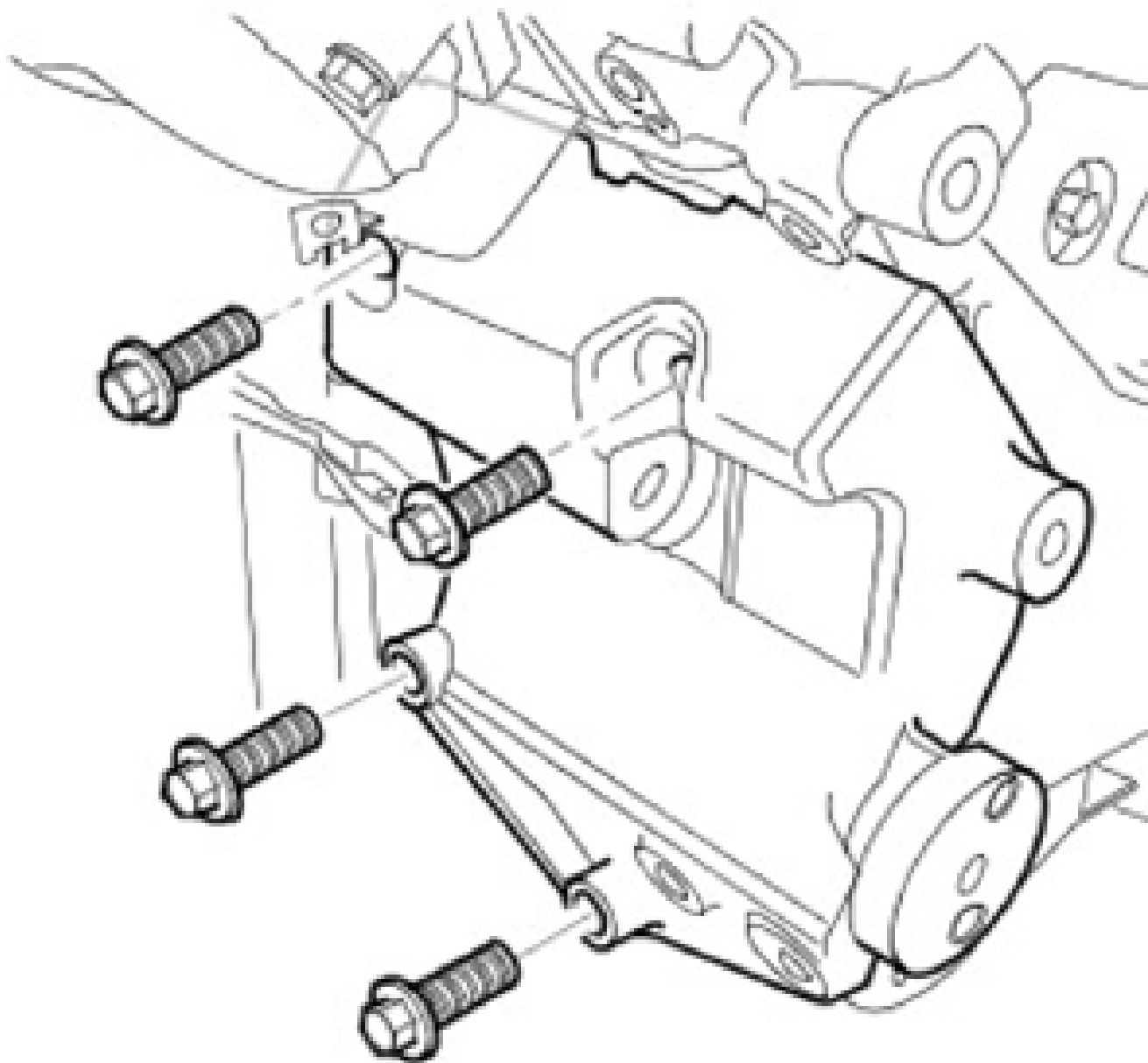
**E46679**

58. Install the 8 ignition coil-on-plugs.

- Install the 8 bolts.
- Tighten the bolts to 6 Nm.

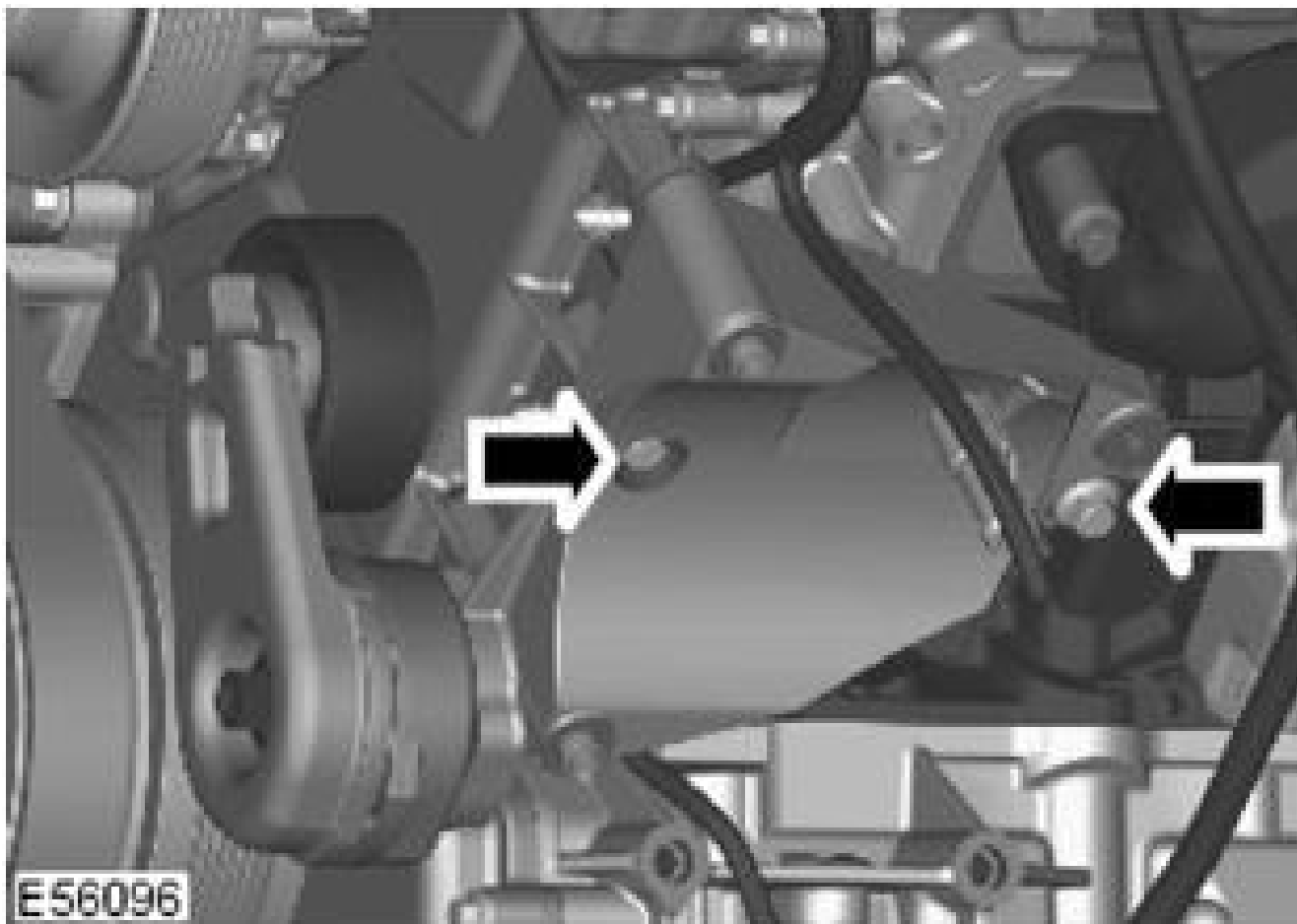


59. Install the generator mounting bracket.
- Clean the locating dowels.
 - Clean the component mating faces.
 - Tighten the bolts to 45 Nm.

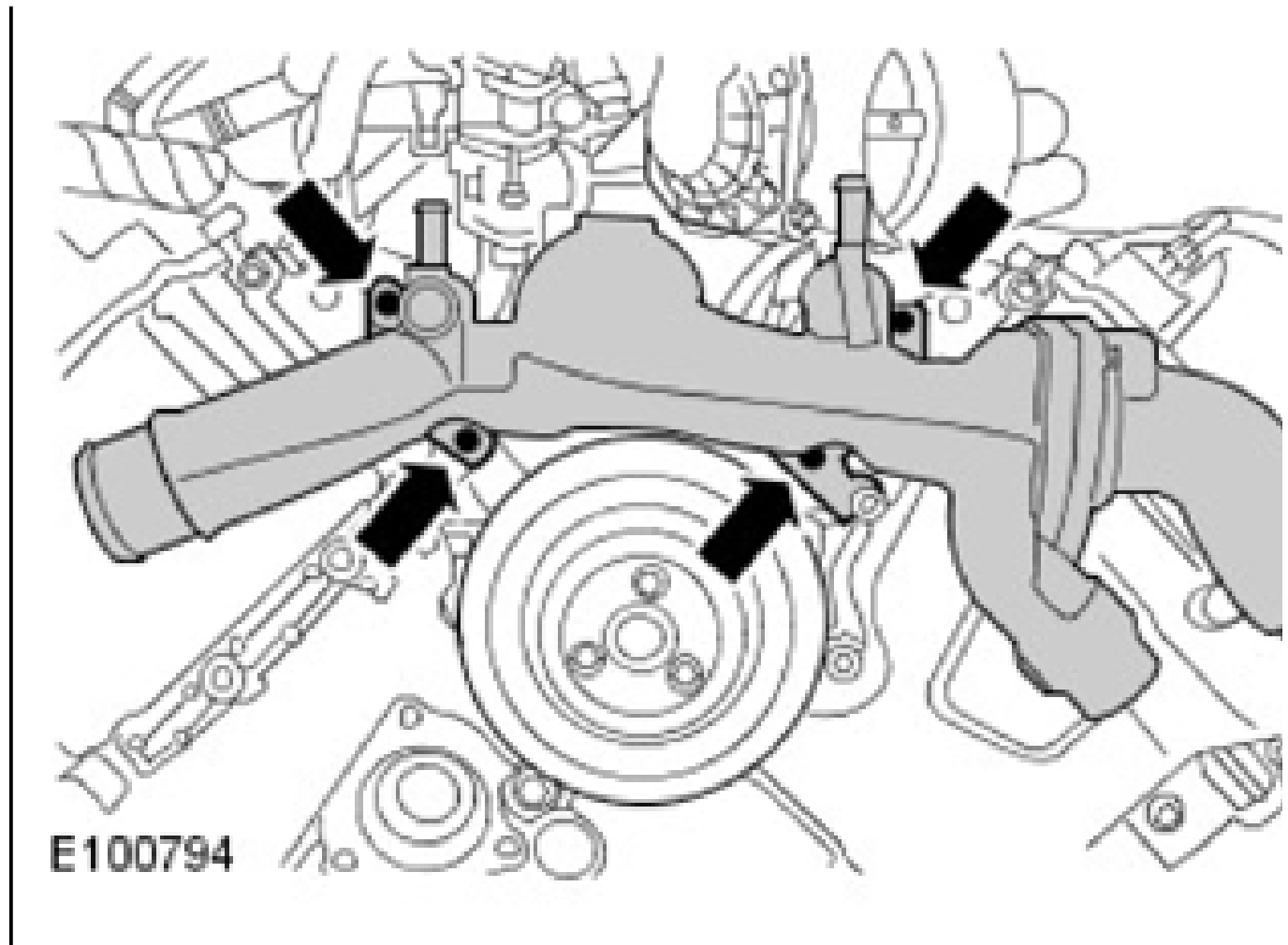


E58798

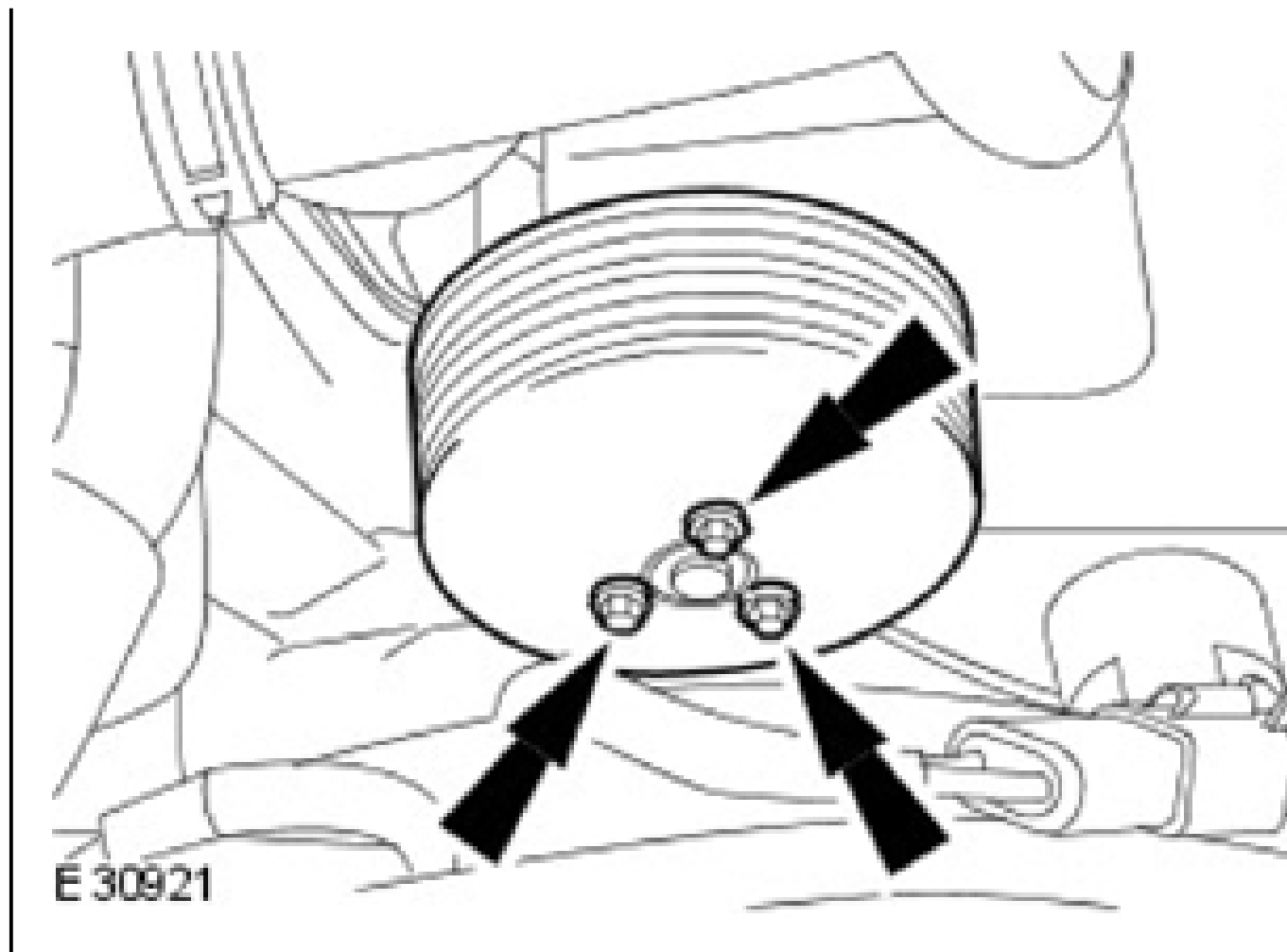
60. Install the A/C mounting bracket.



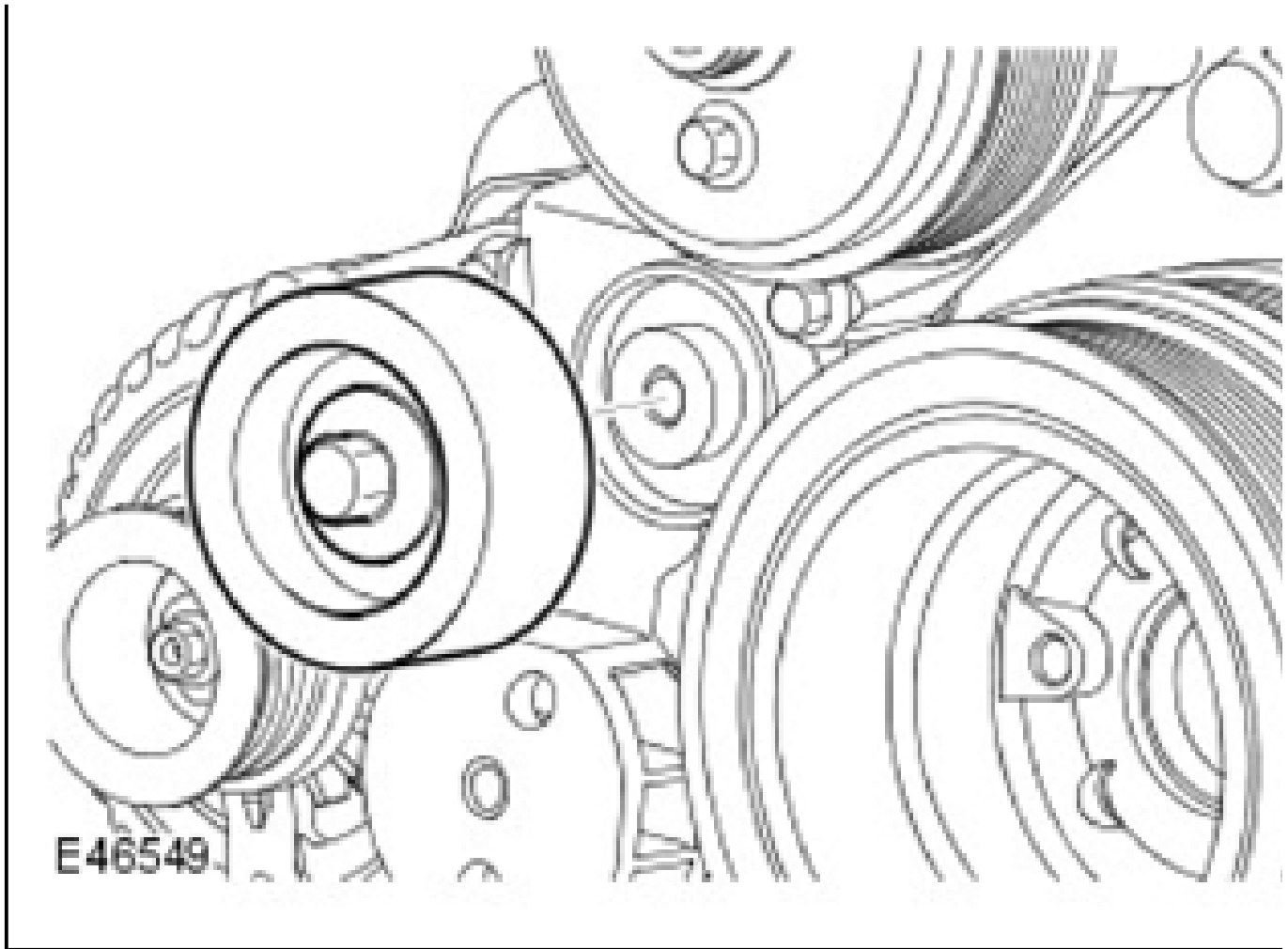
61. Install the coolant manifold.
- Tighten the bolts to 6 Nm.



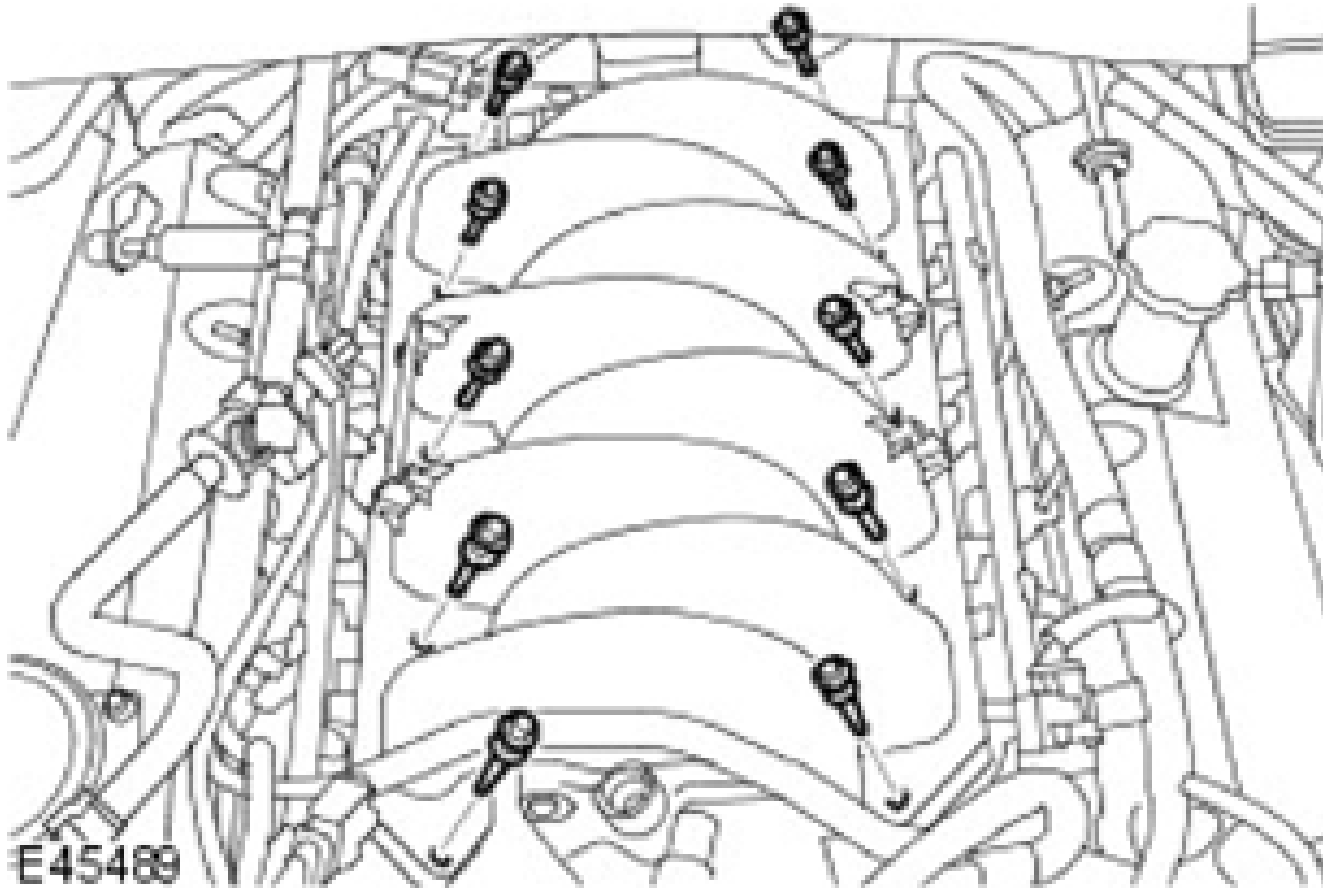
62. Install the coolant pump pulley.
- Tighten the bolts to 10 Nm.



63. Install the accessory drive belt idler pulley.
- Tighten the bolt to 25 Nm.

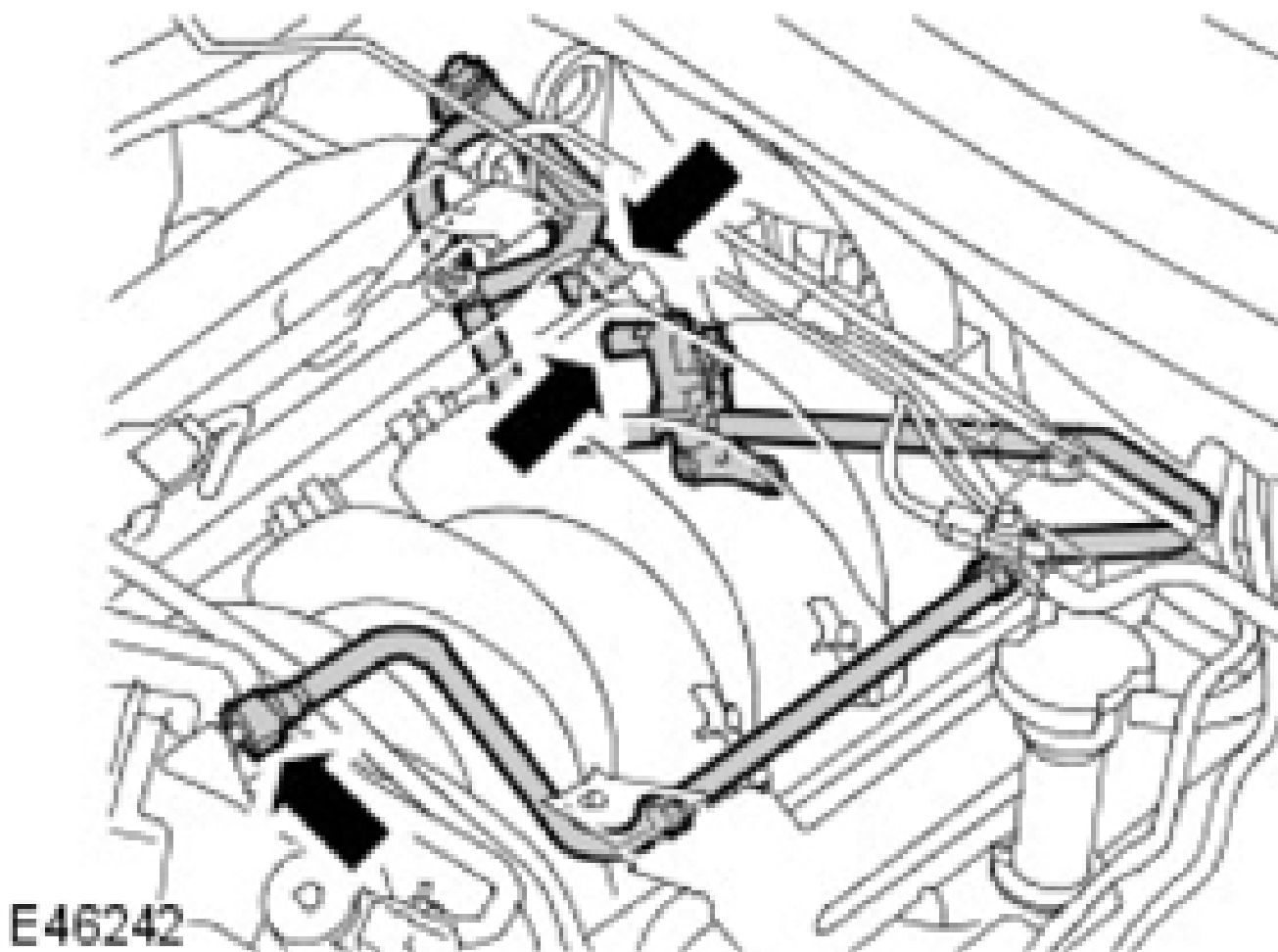


64. With assistance, install the intake manifold.
- Install the gaskets.
 - Evenly and progressively tighten the bolts to 20 Nm.

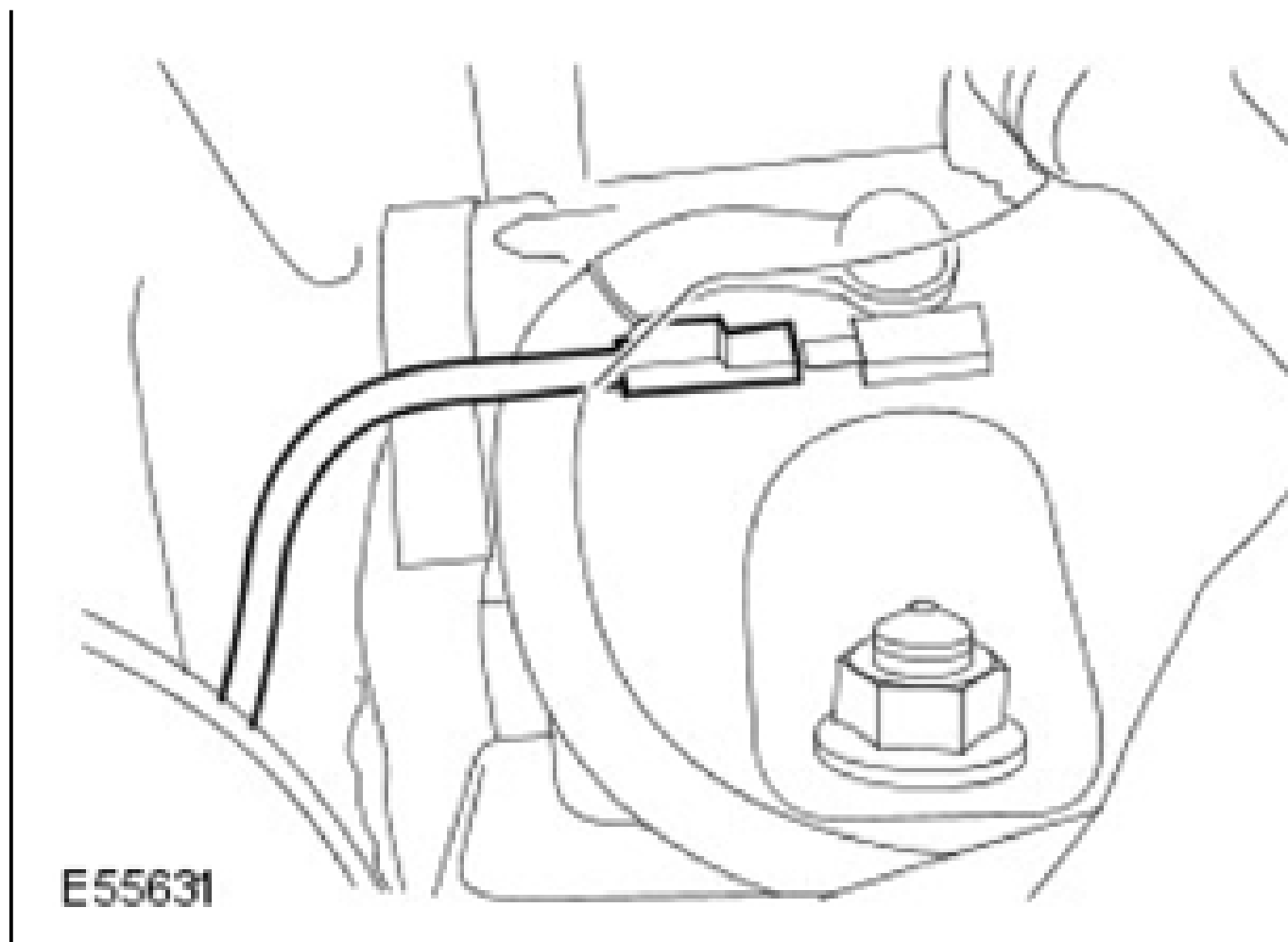


65. Install the purge valve.

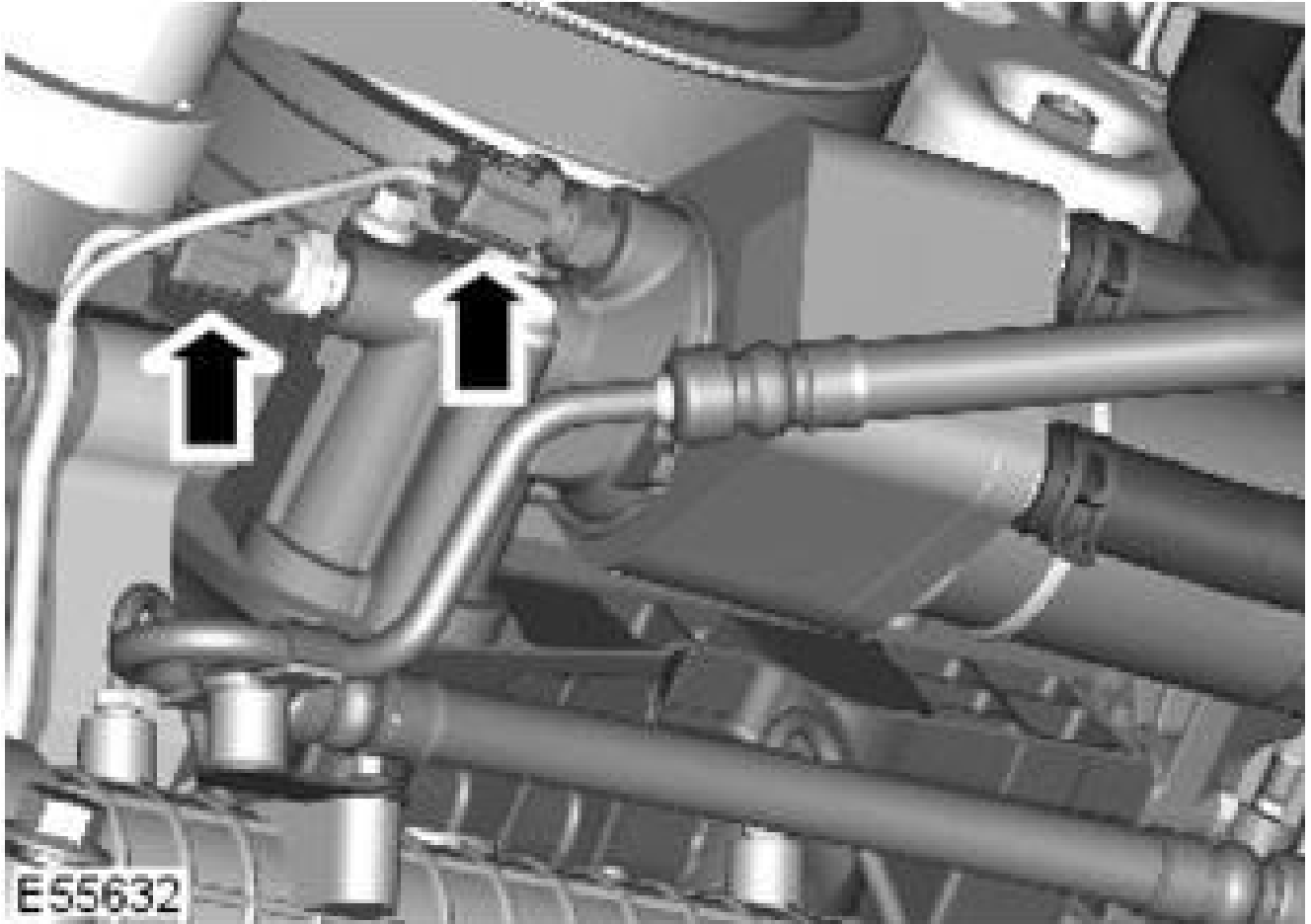
- Secure the electrical harness with the clip.
- Tighten the bolt to 6 Nm.
- Connect and secure the electrical connector.



66. Connect the starter motor positive cable.
- Secure the cover.

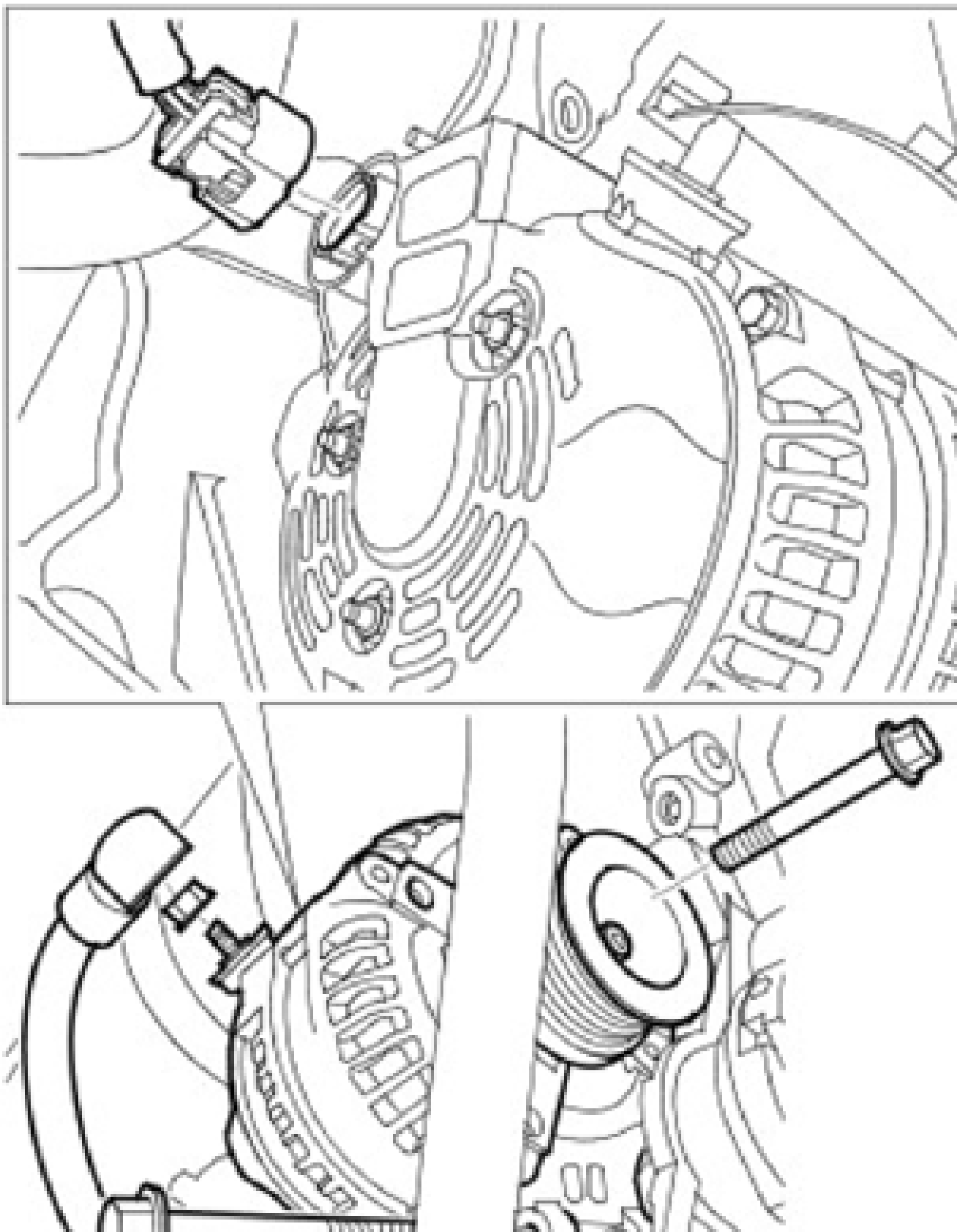


67. Connect the oil temperature and oil pressure sensors.



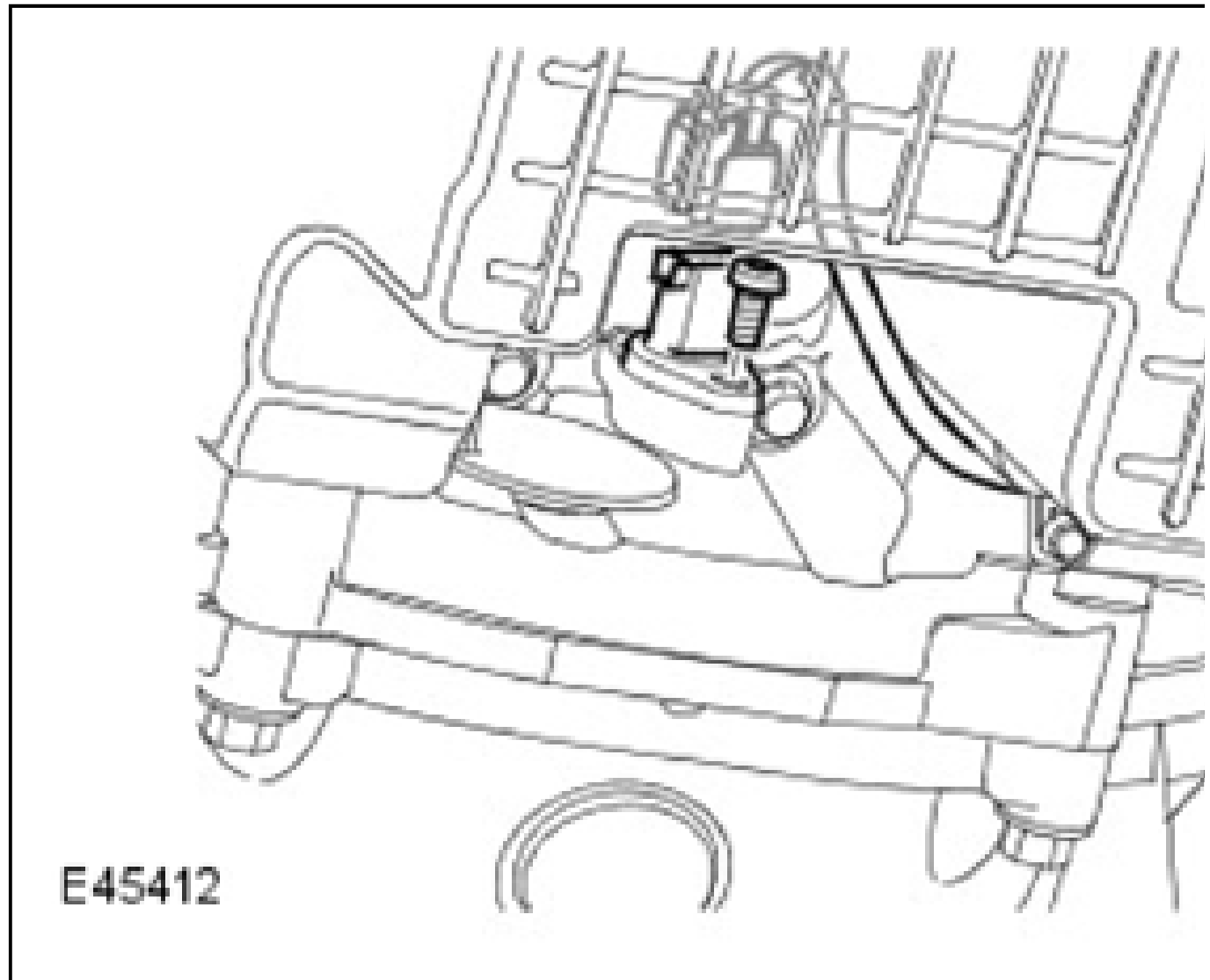
68. Install the generator.

- Clean the component mating faces.
- Tighten the bolts to 48 Nm.
- Connect the generator electrical connector.
- Secure the clips.



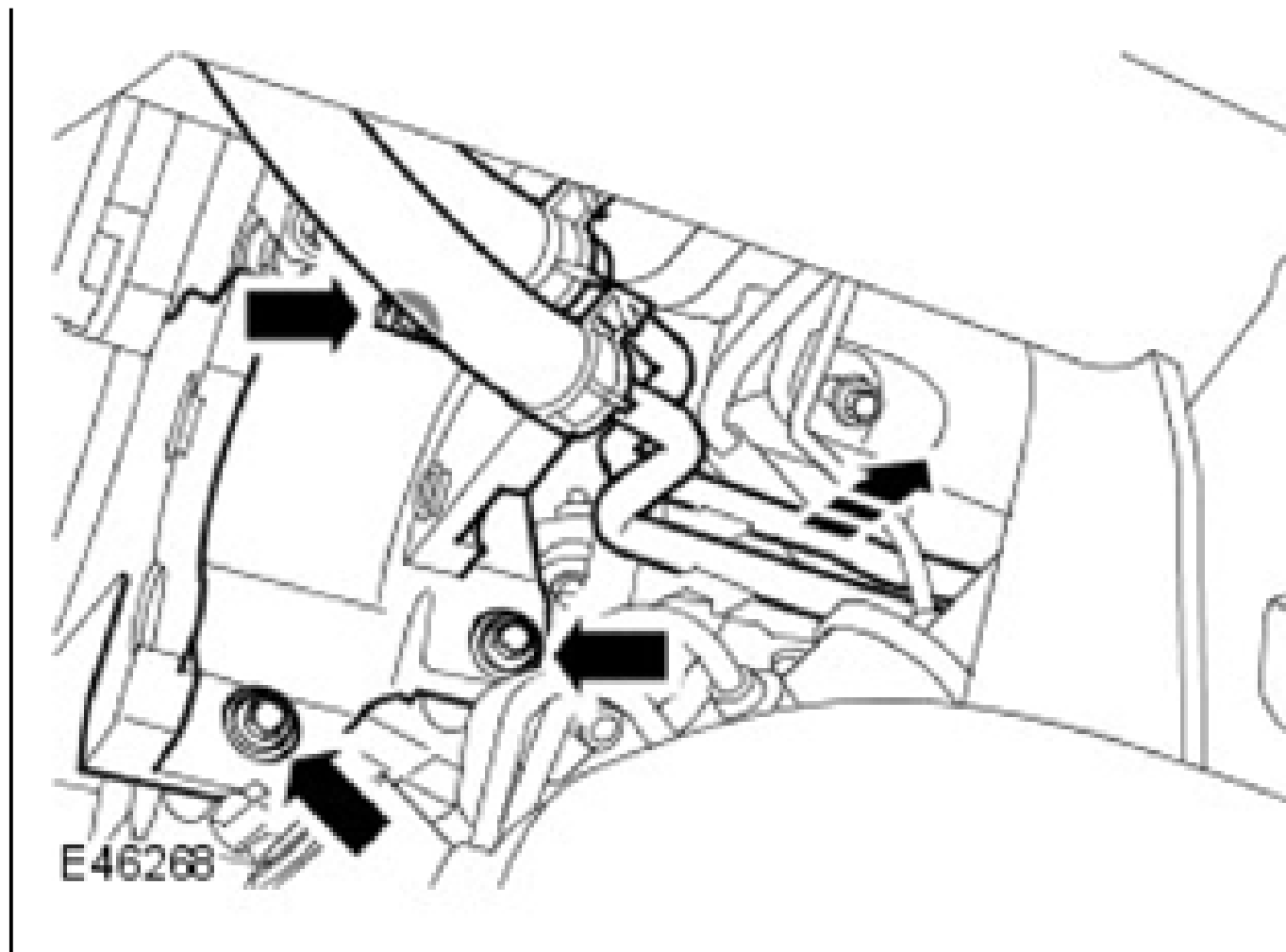
69. Install the crankshaft position (CKP) sensor electrical connector.

- Connect the CKP sensor electrical connector.



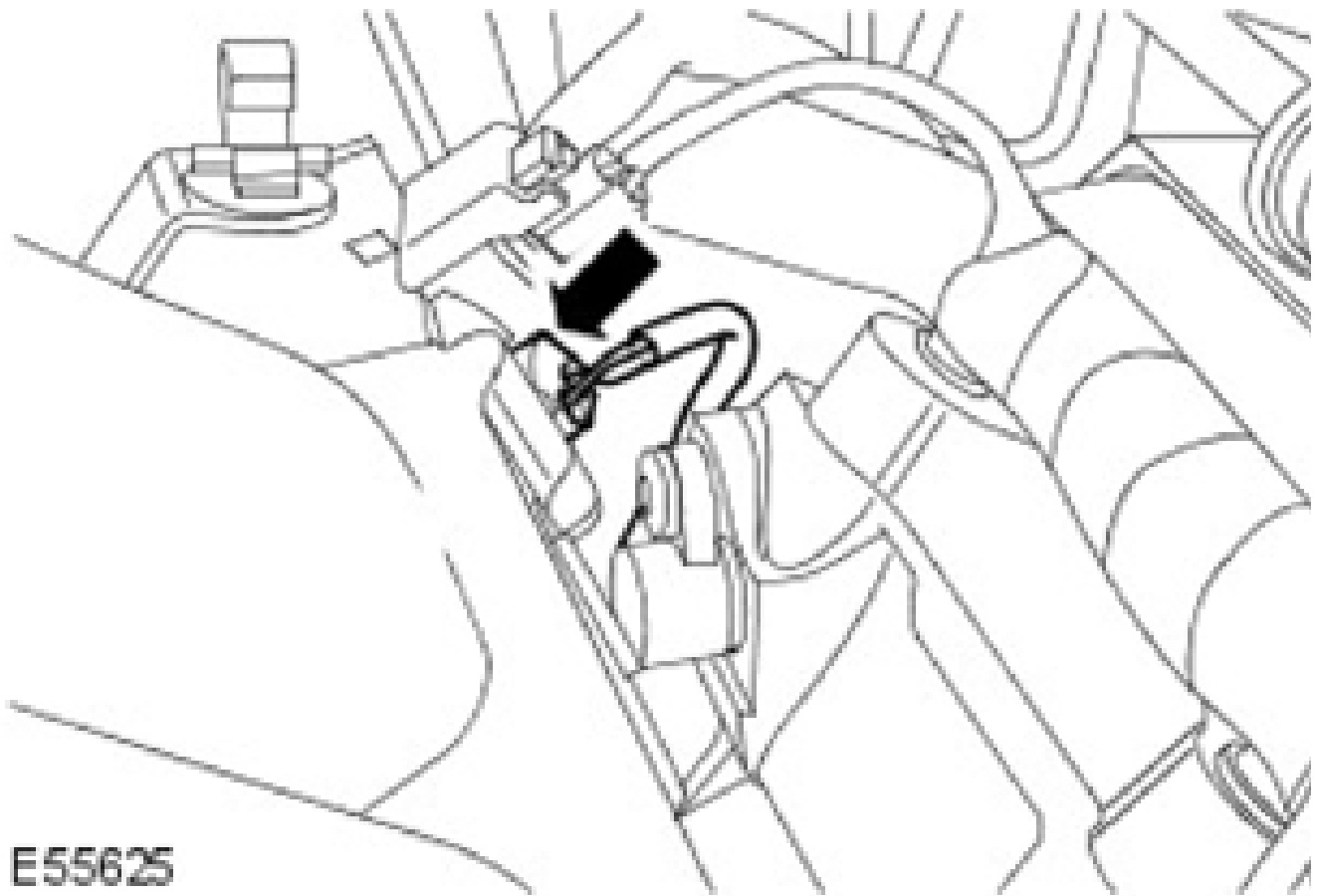
70. Install the power steering pump mounting bracket.

- Clean the component mating faces.
- Tighten the bolts to 25 Nm.
- Secure the transmission cooler pipes into clips.



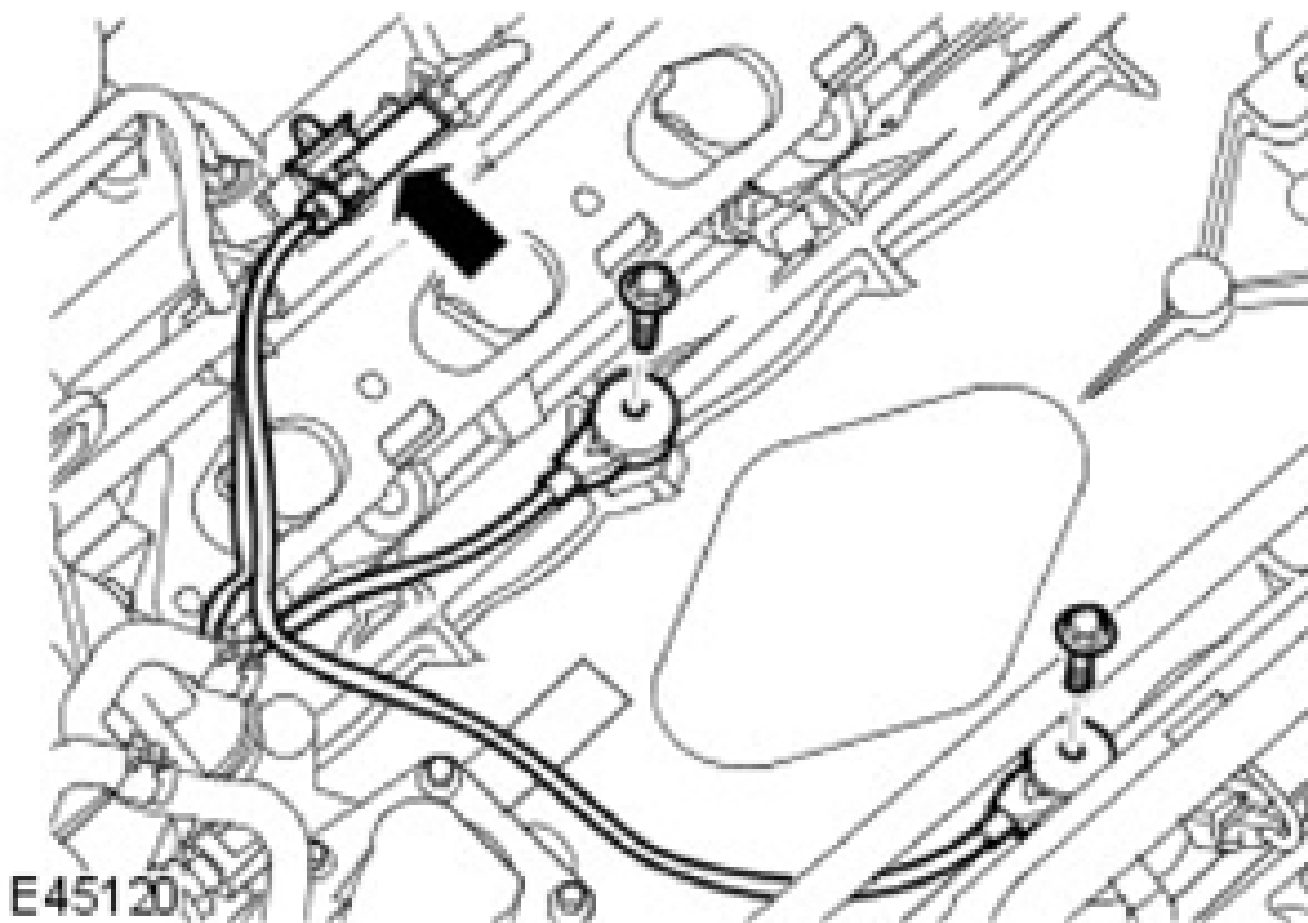
71. Connect and secure the CMP sensor electrical connectors.

- Repeat the operation for the RH side.



NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

72. Connect the KS electrical connector.

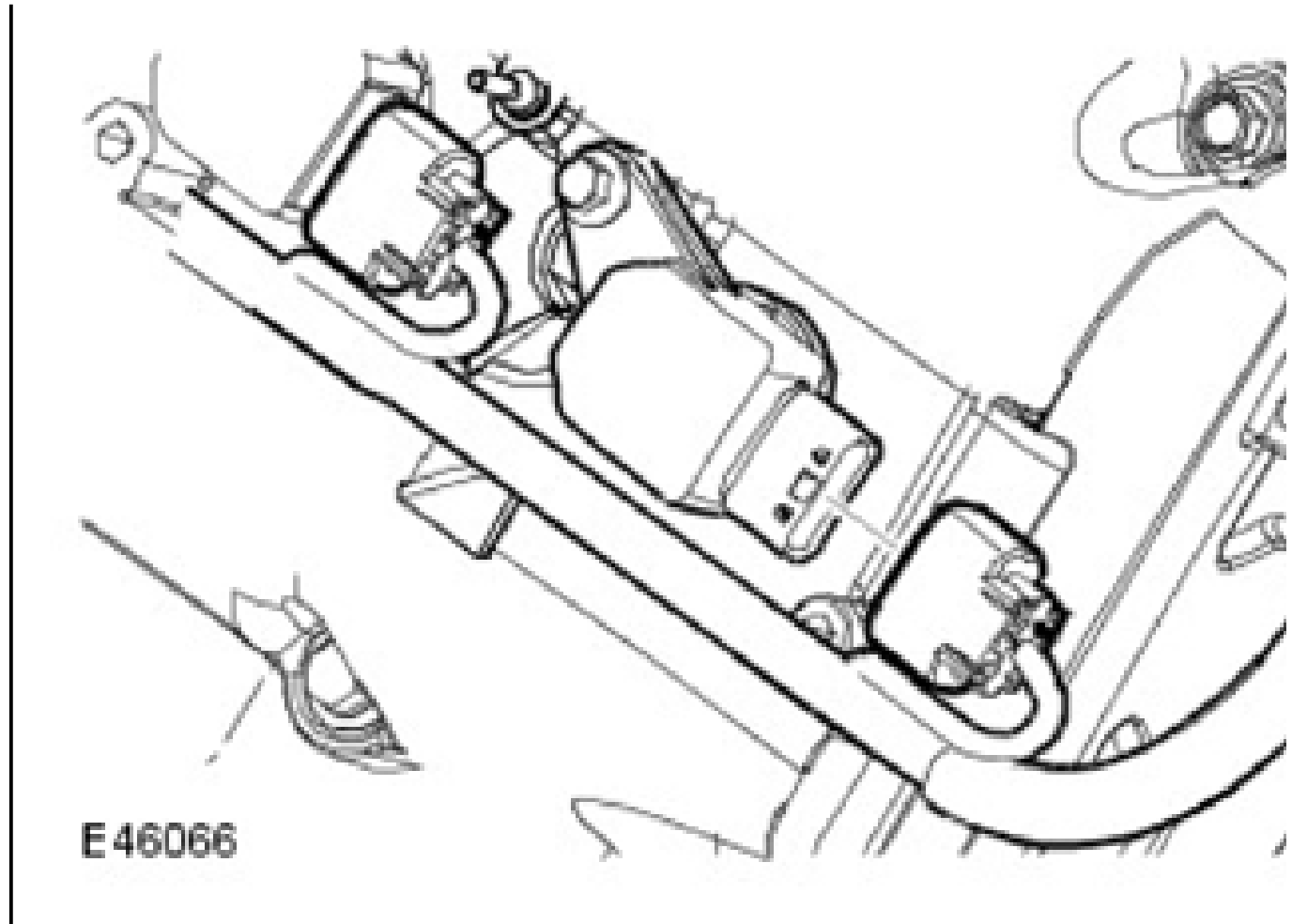


73. Connect the engine coolant temperature (ECT) sensor electrical connector.

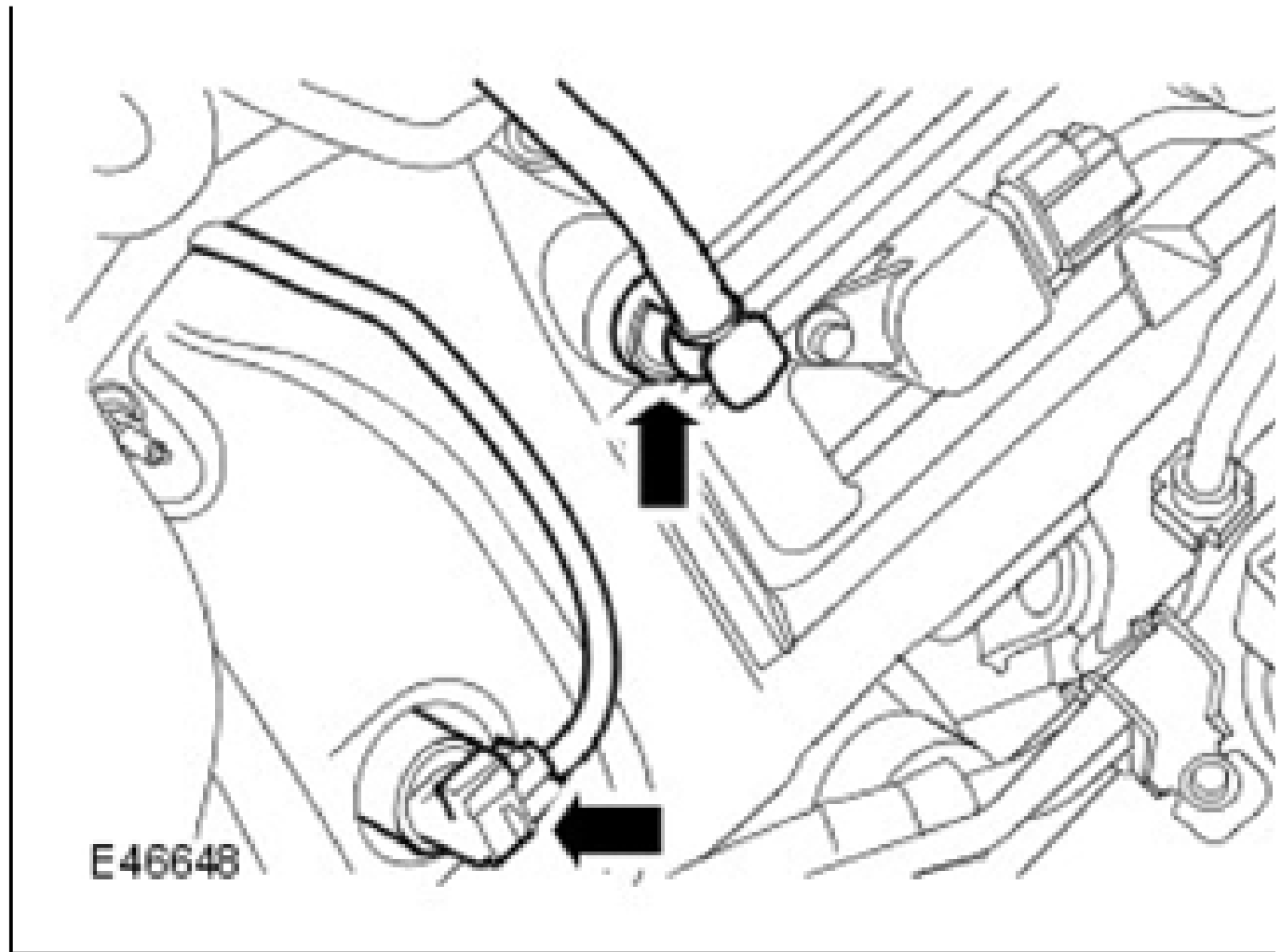


74. Connect the ignition coil-on-plug electrical connections.

- Install the clips.
- Repeat the above procedure for the other side.

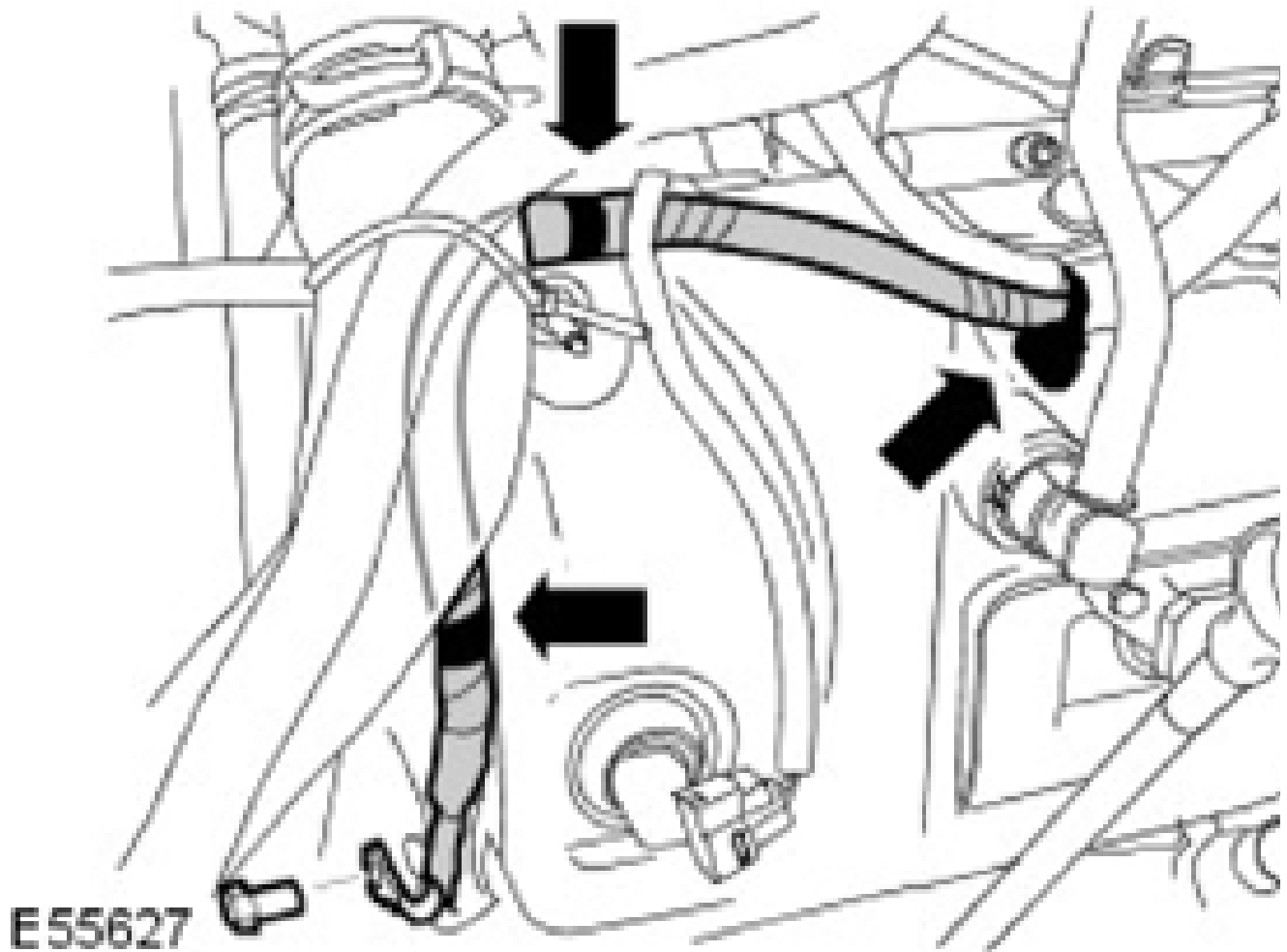


75. Connect the VCT oil solenoid electrical connector.
- Repeat the above procedure for the other side.
 - Connect the valve cover breather hose.



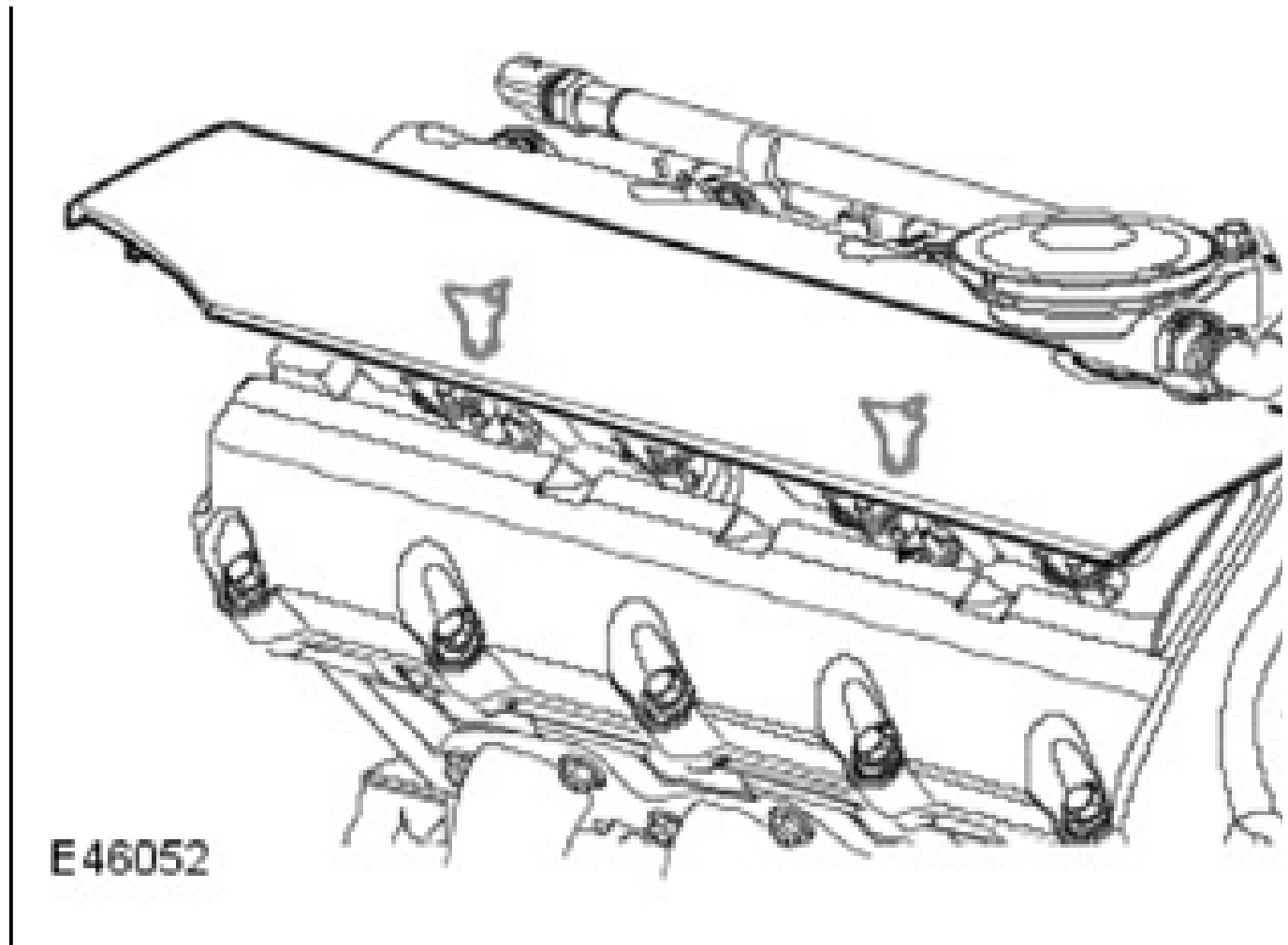
76. Connect the cylinder head earth ground connector.

- Install the bolt.
- Secure the 3 clips.



77. Install the ignition coil-on-plug cover.

- Secure the clips.
- Repeat the above procedure for the other side.



78. Remove the engine from the engine stand.

79. Install the engine assembly.

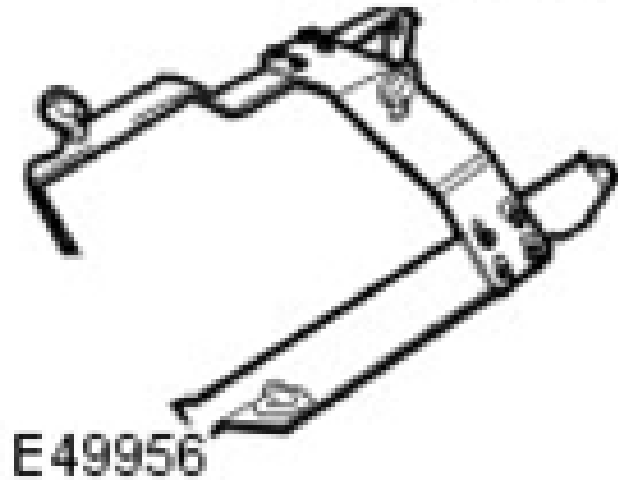
INSTALLATION

ENGINE

SPECIAL TOOL(S)

Engine lifting cradle
303-1144

303-1144

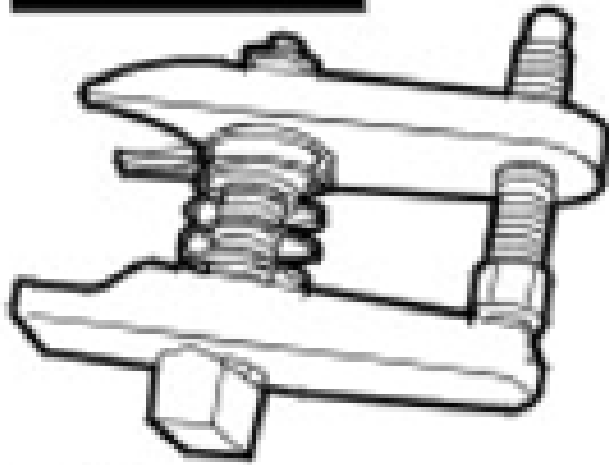


Fuel spring lock decoupling tool
310-D005

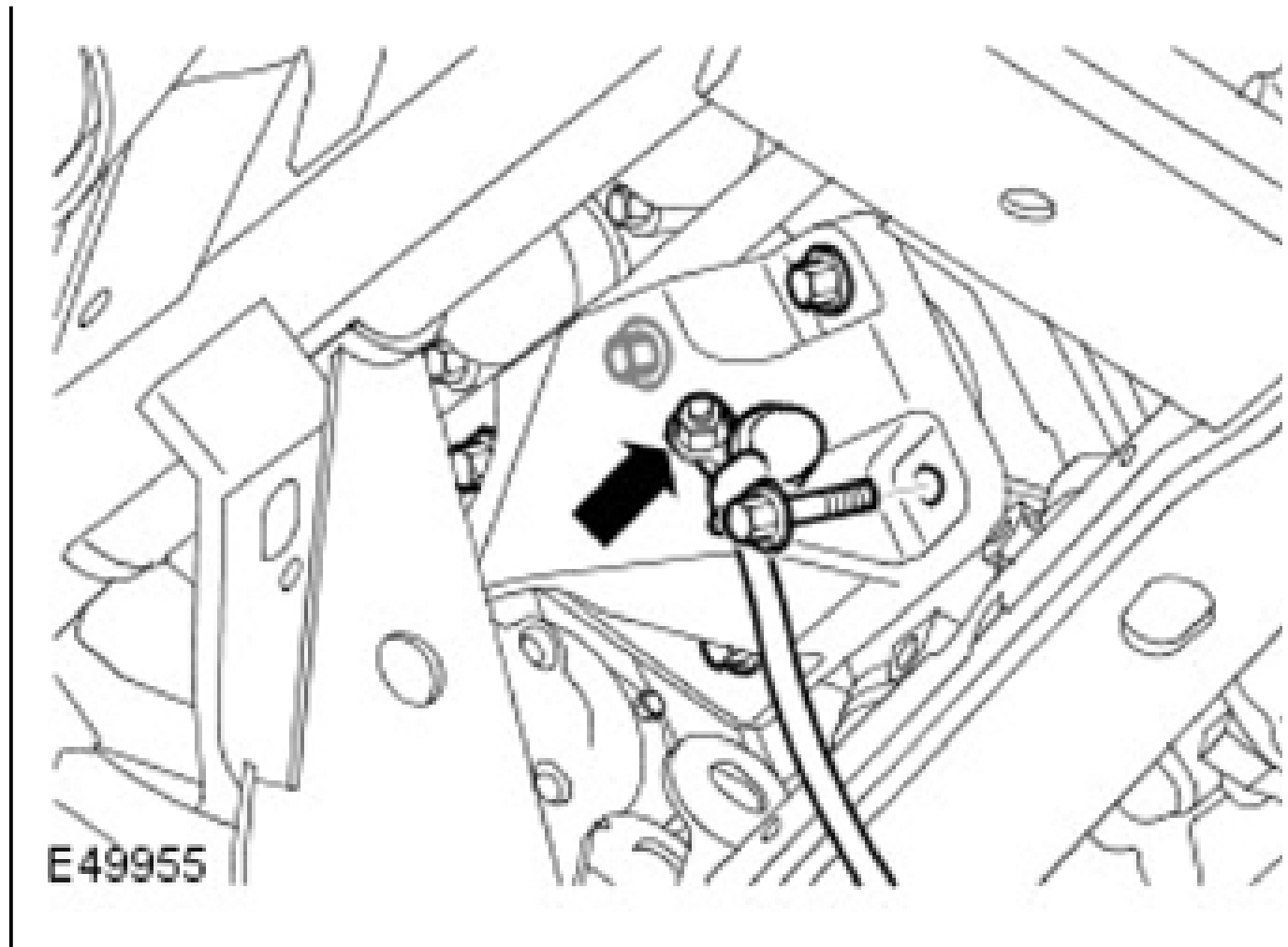
310-D005



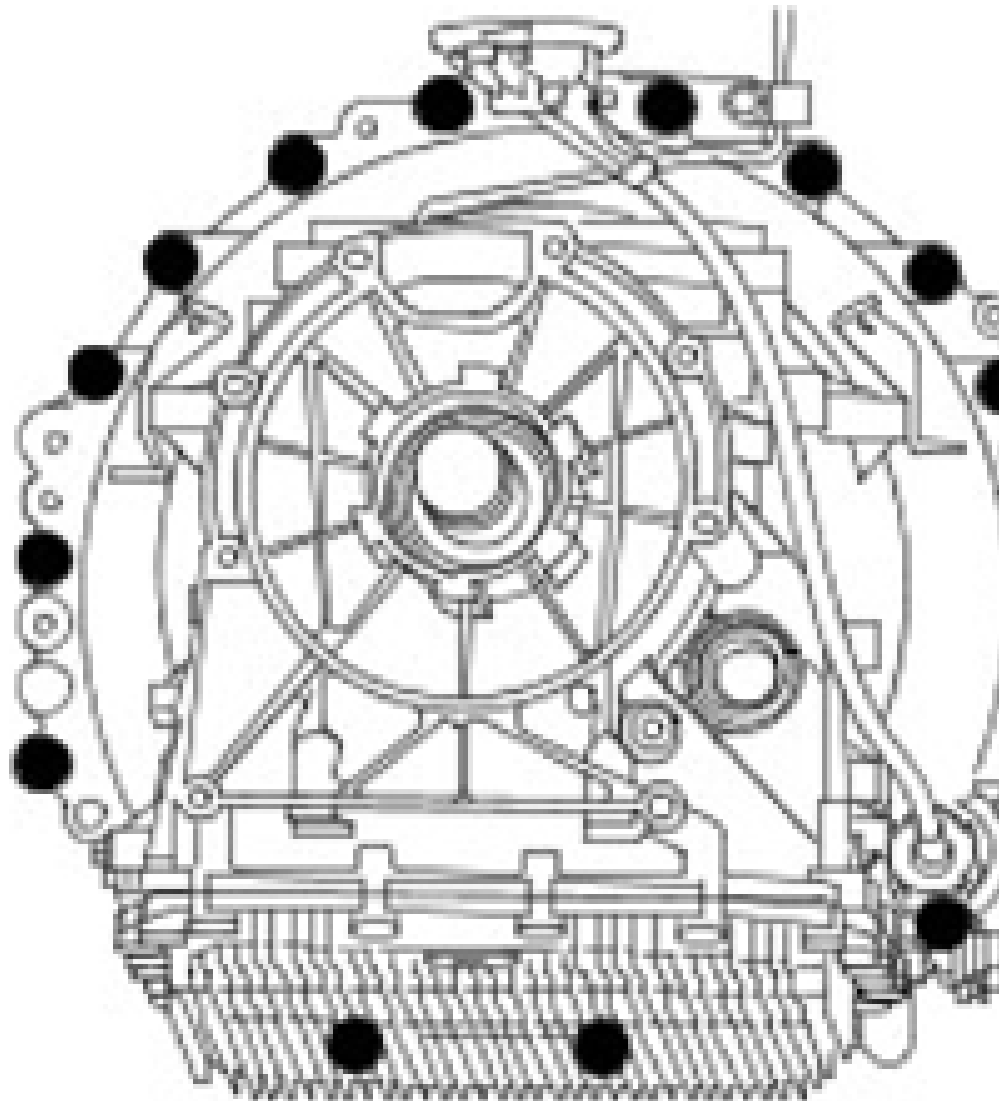
Ball joint separator
205-754(LRT-54-027)

205-754A**E45276****INSTALLATION**

1. Install the engine.
 - Install the lifting chains.
 - Raise the engine.
 - Clean the component mating faces.
 - Clean the locating dowels.
2. Carefully lower the engine until approximately 35mm above engine mounts.
3. Install the engine front mount bracket.
 - Tighten the new bolts to 45 Nm (33 lb.ft), then a further 60 degrees.
 - Connect the engine ground cable and tighten the bolt to 25 Nm (18 lb.ft).

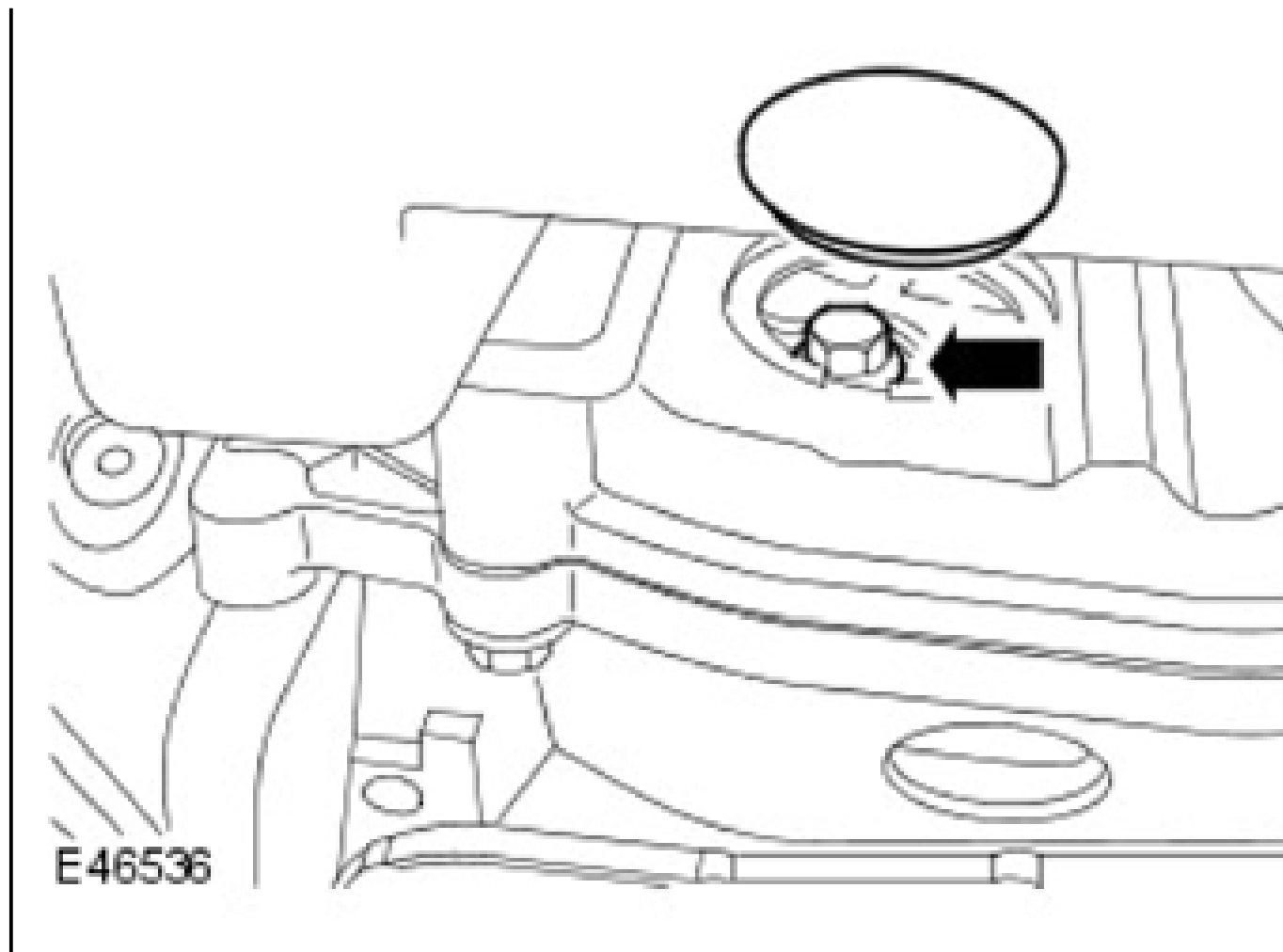


4. Clean the component mating faces.
5. With assistance align the engine to the transmission and engine mounts.
 - Install the transmission retaining bolts.
 - Tighten the bolts to 45 Nm (33 lb.ft).
 - Tighten the engine mount nuts to 90 Nm (66 lb.ft).

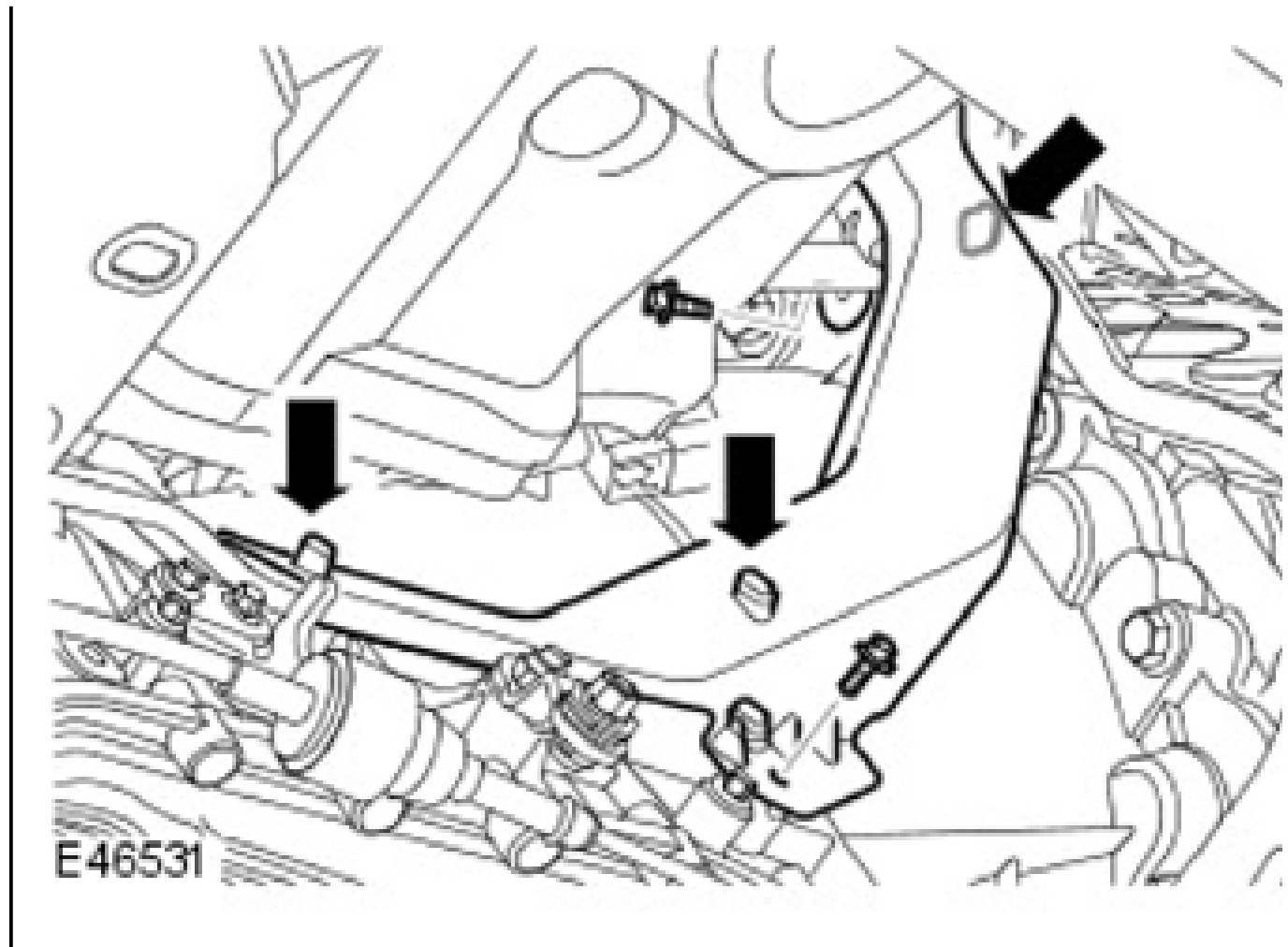


E46537

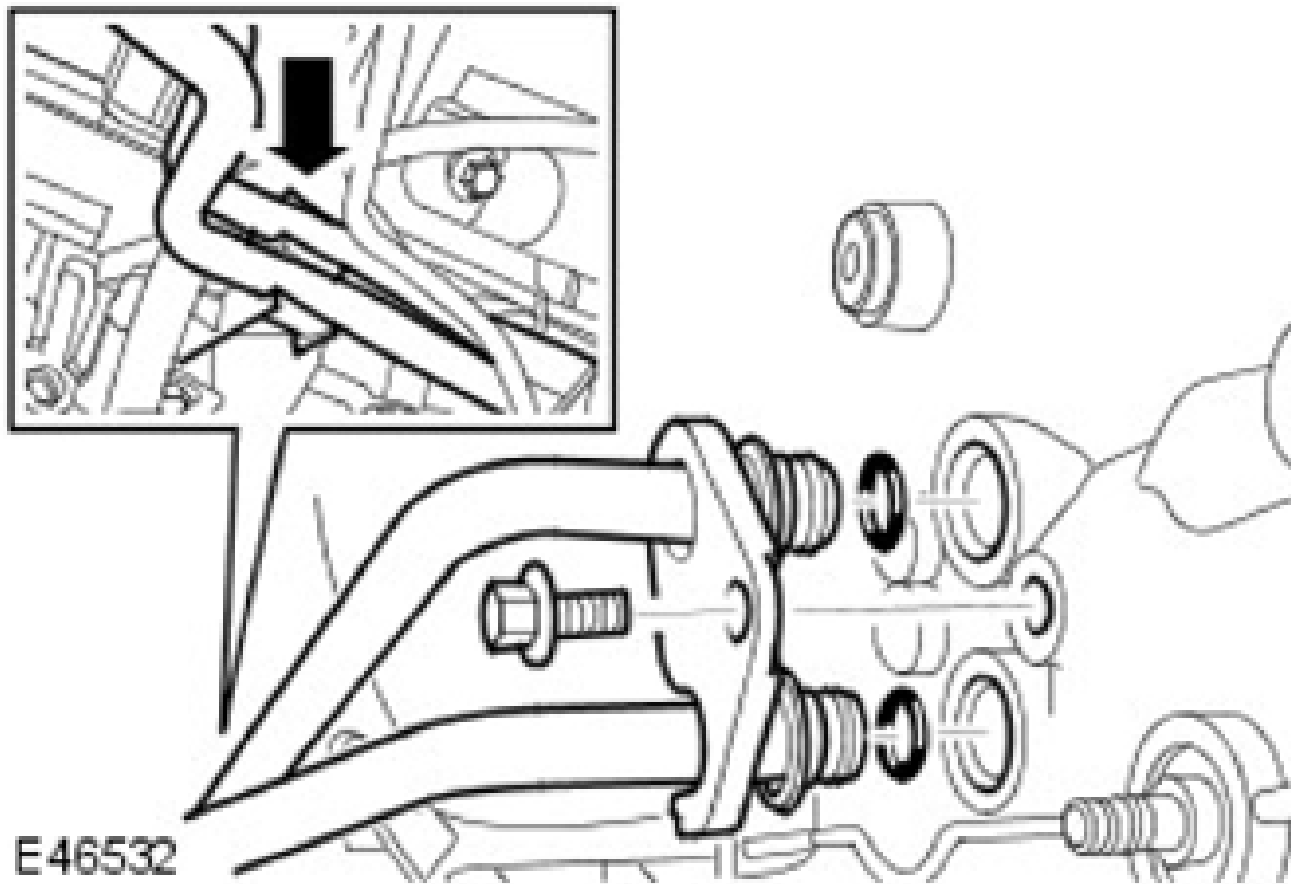
6. Attach the flexplate to the torque converter.
 - Rotate the crankshaft to access the retaining bolts.
 - Tighten the bolts evenly and progressively in 2 stages.
 - Tighten the bolts to 15 Nm (11 lb ft).
 - Tighten the bolts to 110 Nm (81 lb.ft).
 - Install the grommet.



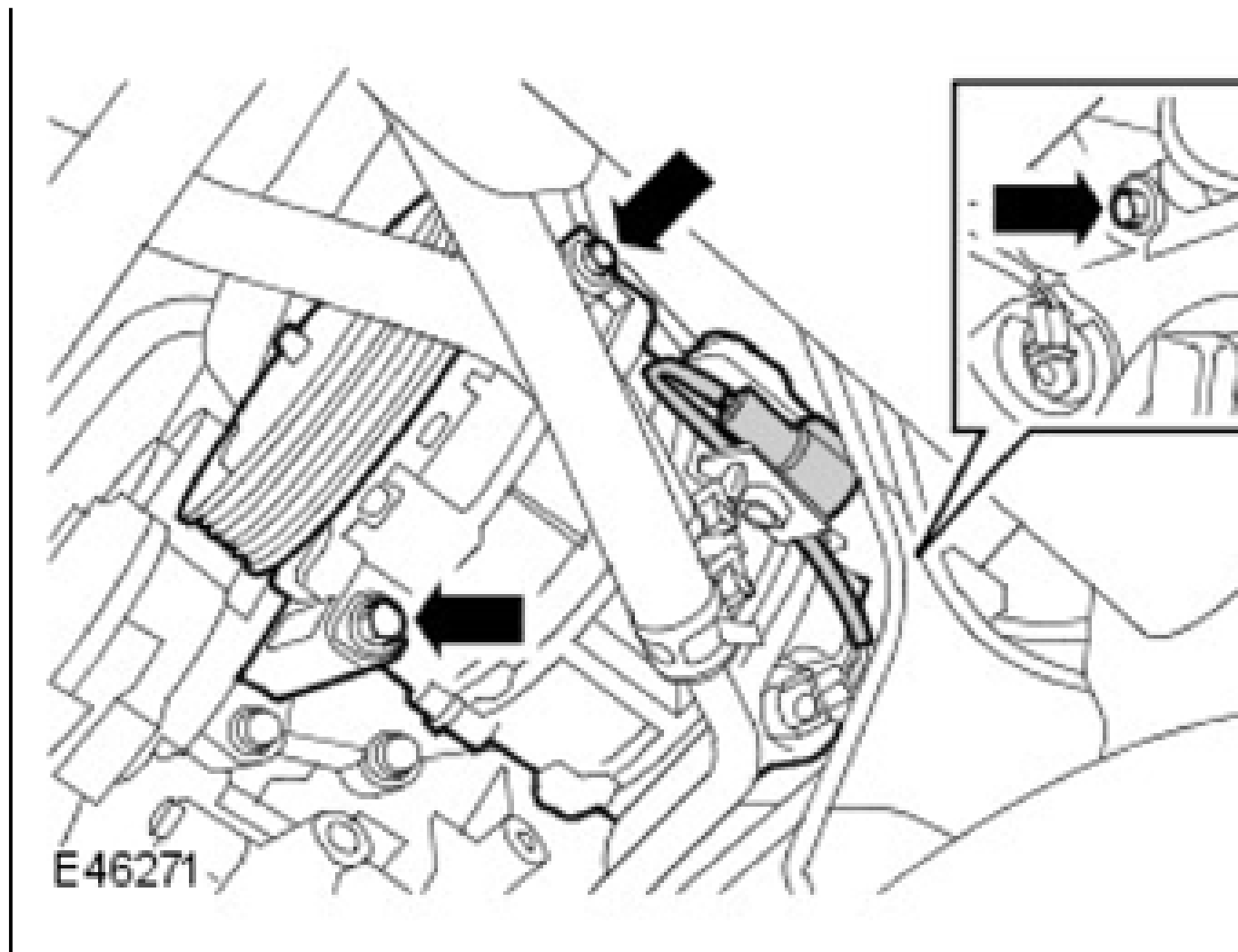
7. Install the transmission heat shield.



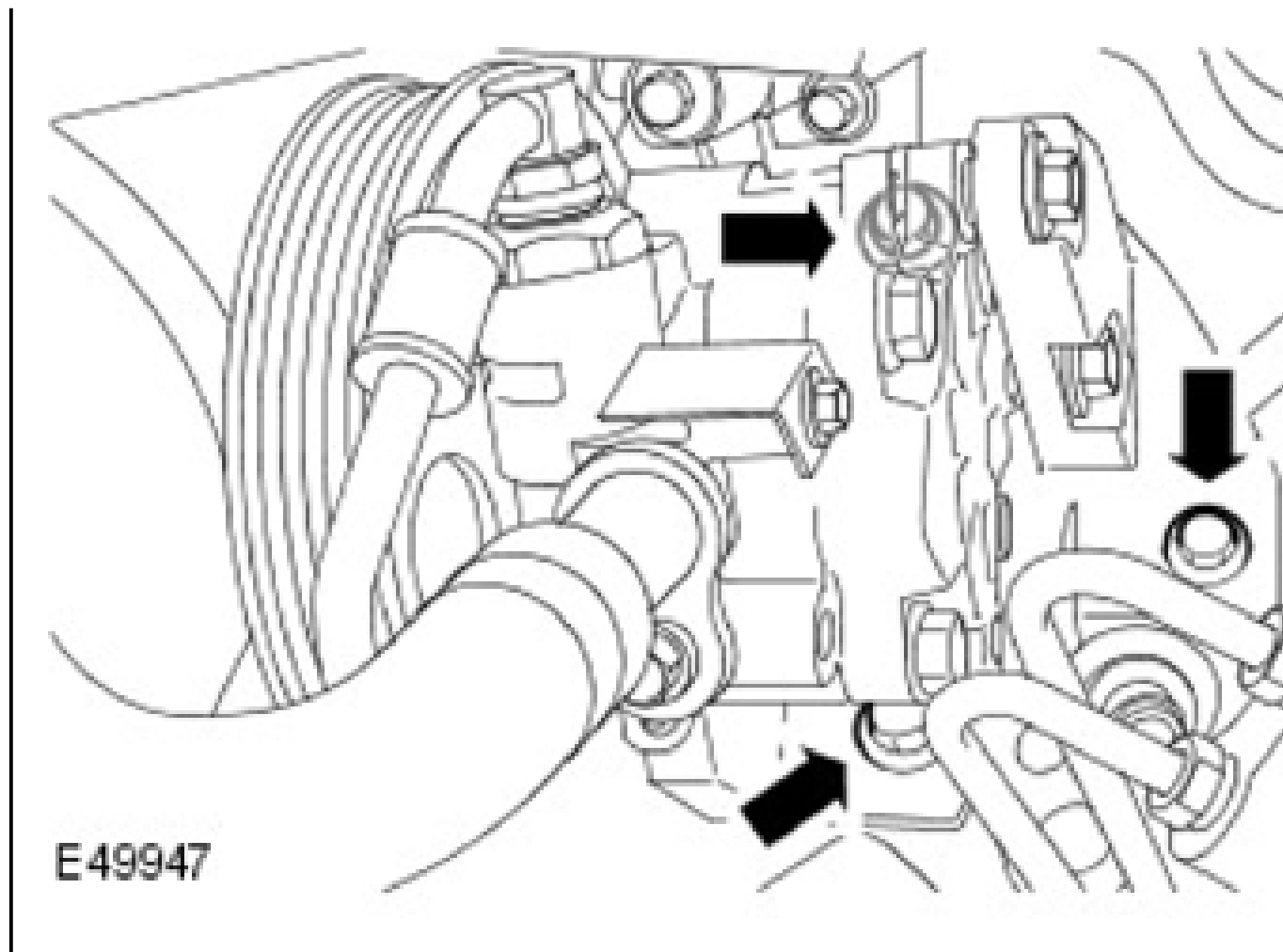
8. Install the transmission cooler pipes.
 - Clean the component mating faces.
 - Install new O-ring seals.
 - Install the clamp.
 - Tighten the bolt to 25 Nm (18 lb.ft).



9. Install the A/C compressor assembly.
 - Tighten the bolts to 25 Nm (18 lb.ft).



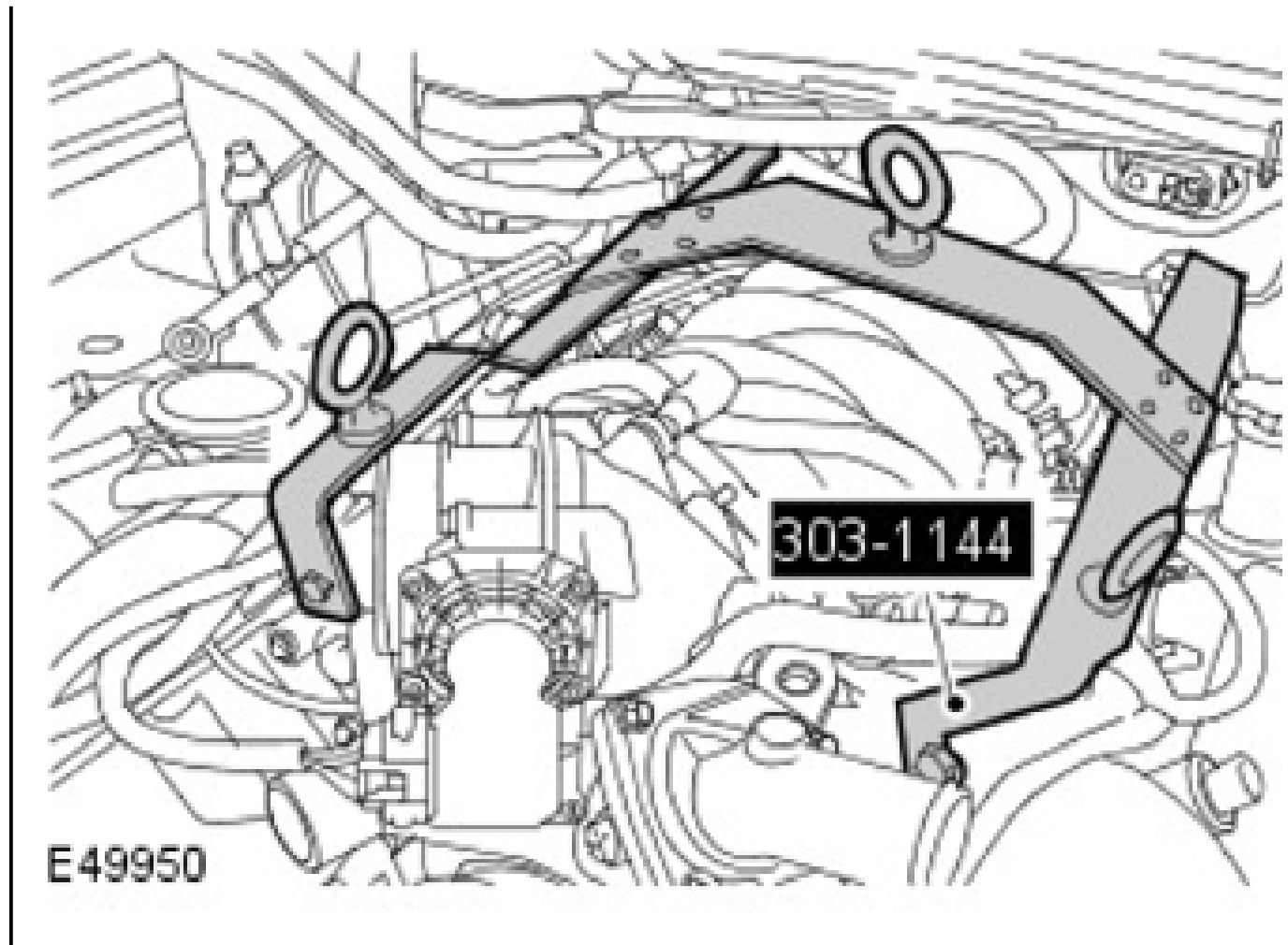
10. Install the power steering pump.
 - Tighten the bolts to 25 Nm (18 lb.ft).



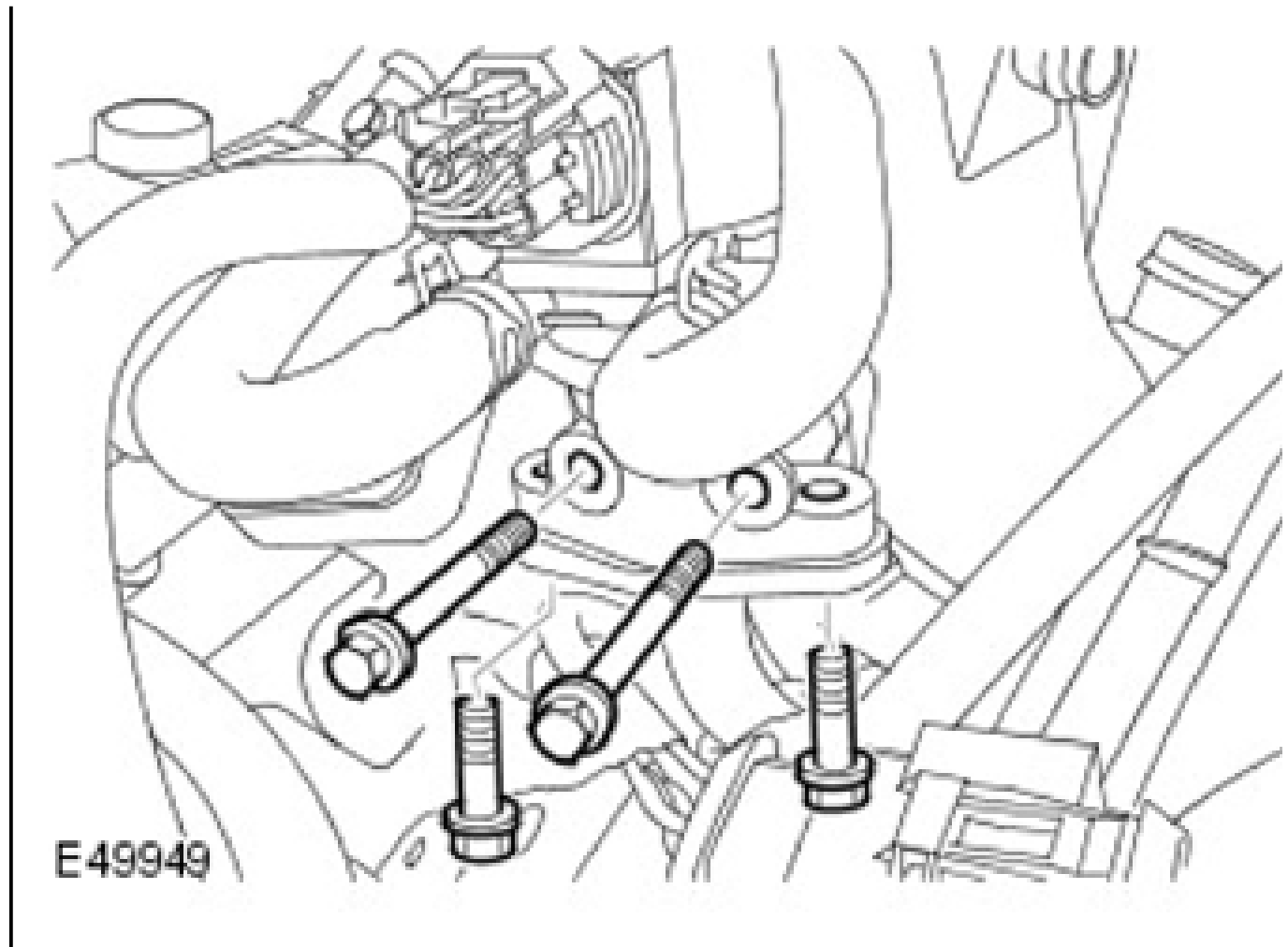
11. Install the exhaust system.

For additional information, refer to: **EXHAUST SYSTEM**.

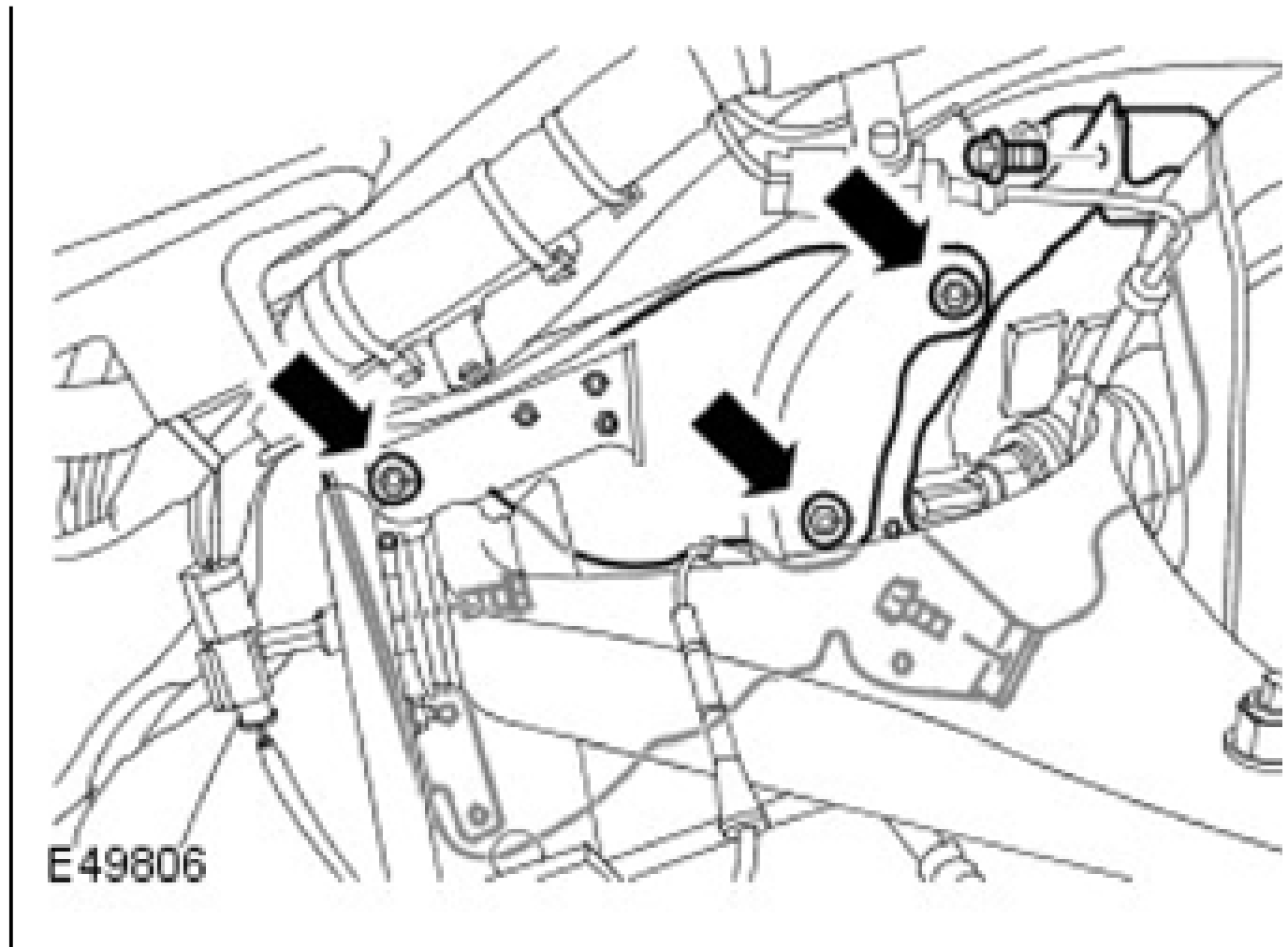
12. Align the engine oil cooler to the fitted position.
 - Tighten the Allen bolt to 60 Nm (44 lb.ft).
13. Disconnect the lifting chains.
14. Remove the special tools.
 - Remove the lifting brackets.



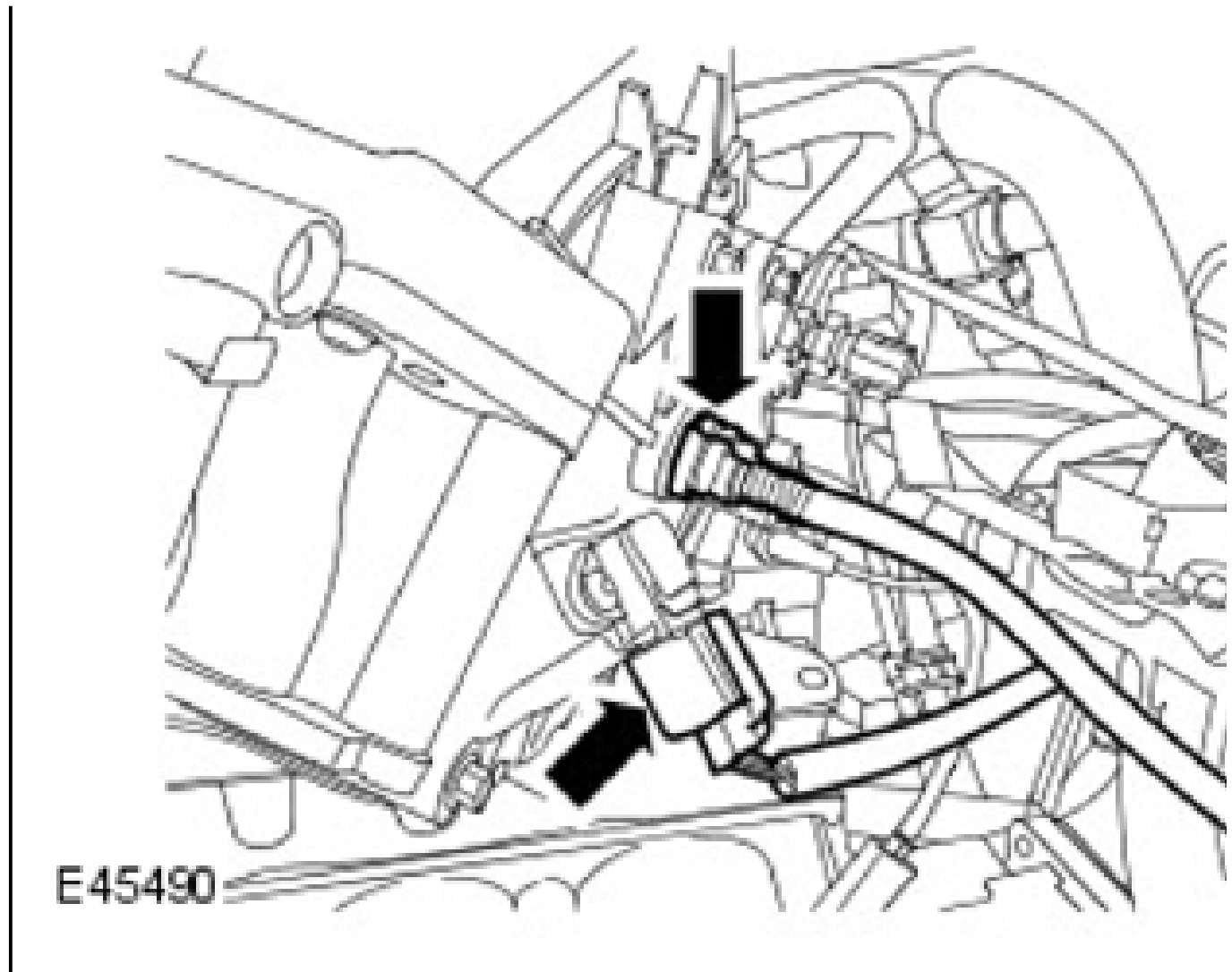
15. Position the EGR valve to the EGR pipe, fit the bolts and tighten to 25 Nm (18 lb.ft).
 - Install and align new gasket.



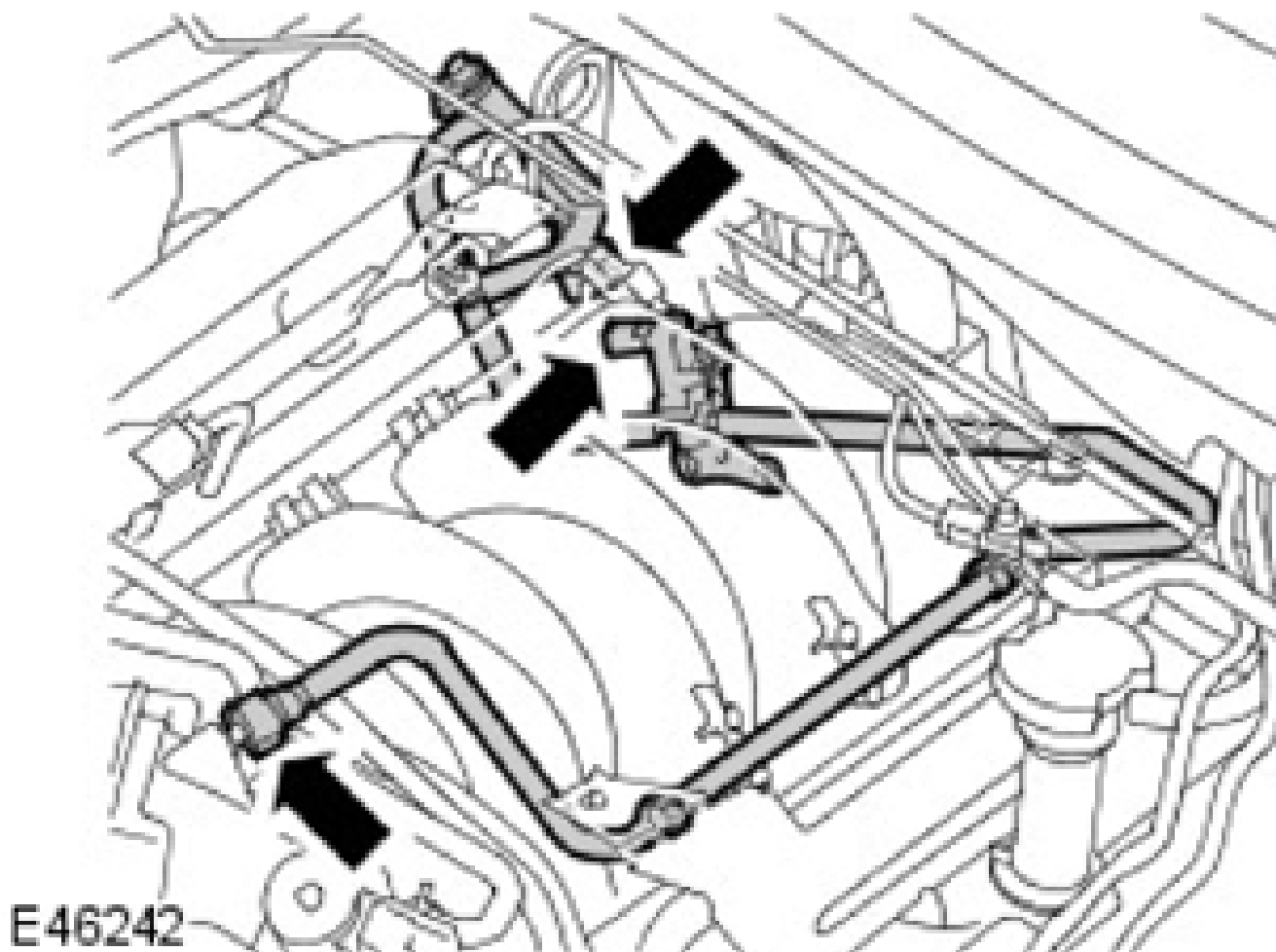
16. Install the upper suspension arm and brake line heat shields.
- Install the bolts and tighten to 10 Nm (7 lb.ft).
 - Tighten the nuts to 10 Nm (7 lb.ft).



17. Connect the fuel line to the fuel rail.
 - Clean the component mating faces.
 - Secure with the clips.
18. Connect the brake booster vacuum hose to the intake manifold.

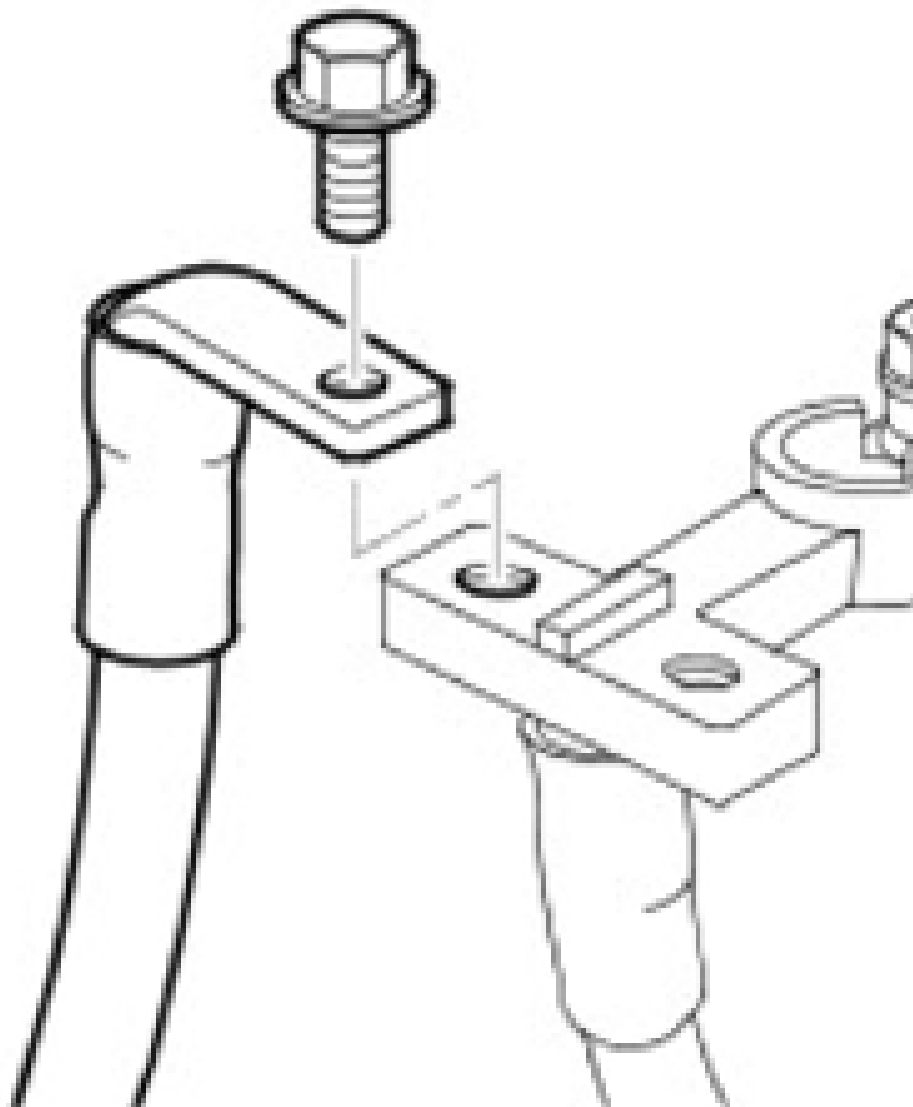


19. Connect the engine wiring harness.
 - Connect the ground cable.
 - Connect the electrical connectors.
 - Install the cassette.
20. Connect the evaporative emission hose to the intake manifold.

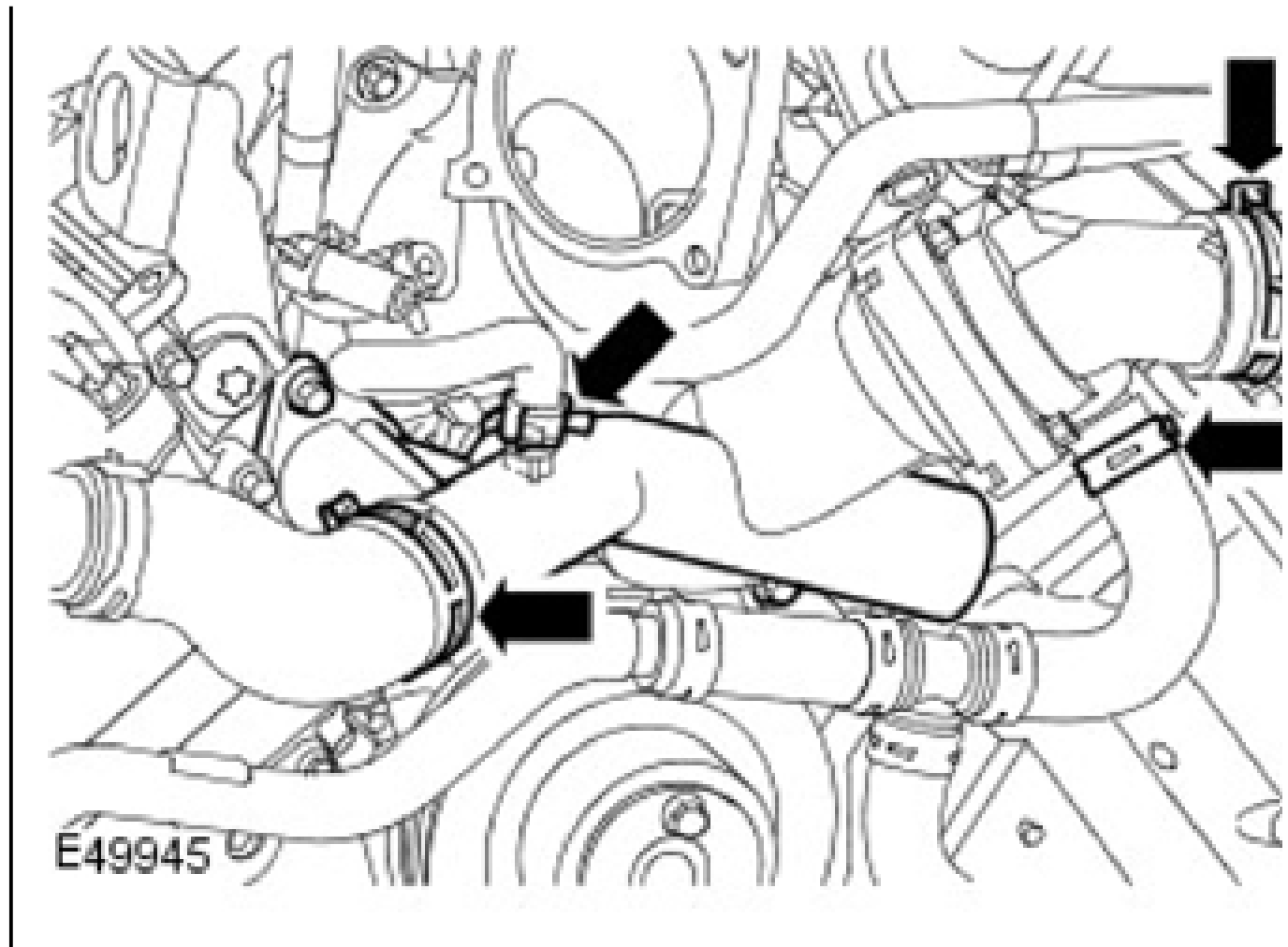


21. Connect the battery positive cable to the BJB.
- Tighten the bolt to 10 Nm (7 lb.ft).

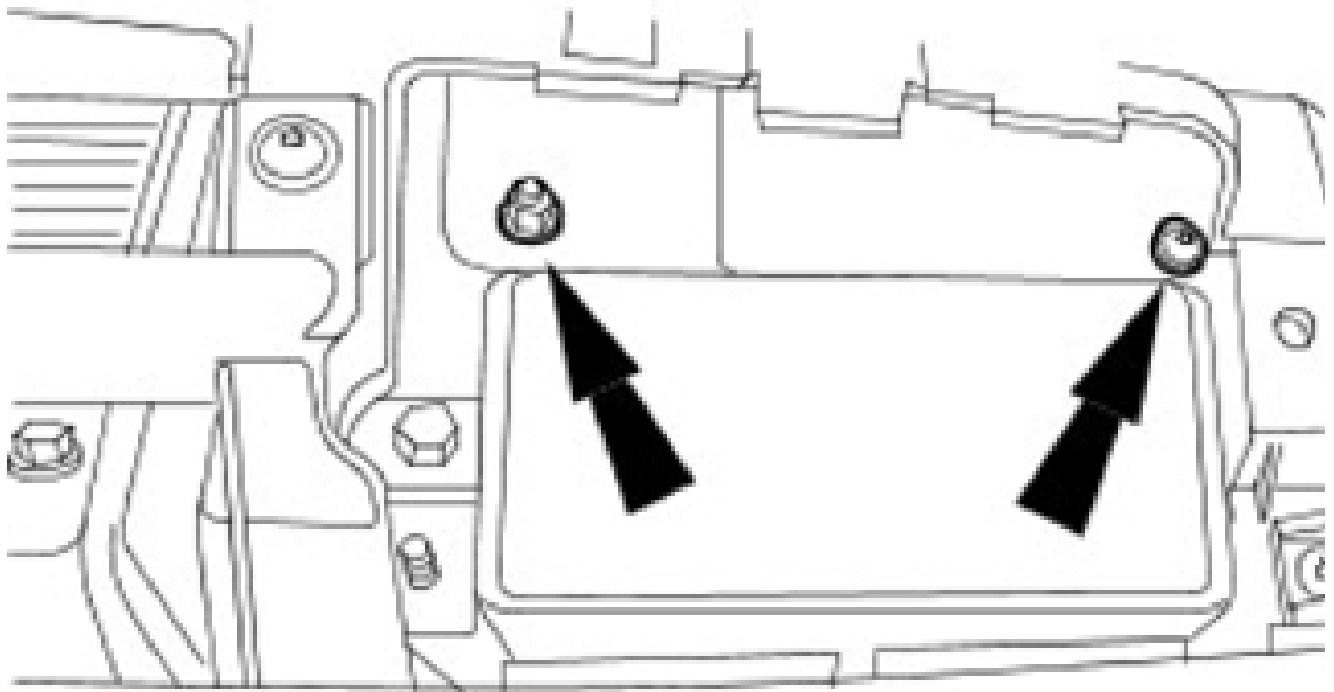
E49948



22. Connect and secure the coolant hoses.



23. Install the accessory drive belt tensioner.
- Tighten the bolt to 45 Nm (33 lb.ft).

**E44645**

24. Install the accessory drive belt.

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

25. Install the RH air cleaner assembly.

For additional information, refer to: **AIR CLEANER** .

26. Install the auxiliary battery tray.

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

27. Install the battery tray.

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

28. Fill the engine with oil.

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

29. Connect the battery ground cable.

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

30. Refill the cooling system.

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

31. Return the hood from the service position.

- Release the 2 clips.
- Connect the struts and secure with the clips.

32. Using the approved diagnostic equipment, clear the powertrain control module (PCM) adaptations.