

**ENGINE****Engine Mechanical****ENGINE (I6 3.2L PETROL)****SPECIFICATIONS****LUBRICANTS, FLUIDS, SEALERS AND ADHESIVES**

| Description                                           | Land Rover Part No.                         |
|-------------------------------------------------------|---------------------------------------------|
| Cam cover to cylinder head joint                      | LR006801 (Loctite 510)                      |
| Bedplate to oil sump                                  | STC50550                                    |
| Block to bedplate                                     | STC50550                                    |
| Engine oil - NAS, Middle East and North Africa Models | 5W/30 - ACEA A1 + ILSAC GF-3 or ILSAC GF-3* |
| Engine oil - ROW Models                               | 0W/30 - ACEA A5/B5                          |

The recommended oil change interval for ILSAC GF-3 is 5000 miles.

**CAPACITIES**

| Item                                                                                       | Capacity (liters/pints/US quarts) |
|--------------------------------------------------------------------------------------------|-----------------------------------|
| Dry fill including filter                                                                  | 9.3/16.4/9.8                      |
| Service fill - includes filter                                                             | 7.7/13.6/8.1                      |
| Amount of oil required to bring the level from the lower to the upper mark on the dipstick | 0.8/1.4/0.9                       |

**GENERAL SPECIFICATION**

| Item                         | Specification                                                                                         |
|------------------------------|-------------------------------------------------------------------------------------------------------|
| Type                         | 3.2 liter, inline 6 naturally aspirated petrol engine, twin overhead camshafts, 4 valves per cylinder |
| Cylinder arrangement         | Inline 6                                                                                              |
| Cylinder numbering           | 1-6 from front of engine                                                                              |
| Bore - nominal               | 84.0 mm (3.307 in)                                                                                    |
| Stroke                       | 96.0 mm (3.779 in)                                                                                    |
| Capacity                     | 3192 cm <sup>3</sup> (195.8 in <sup>3</sup> )                                                         |
| Firing order                 | 1 - 5 - 3 - 6 - 2 - 4                                                                                 |
| Compression ratio            | 10.8:1                                                                                                |
| Direction of rotation        | Clockwise from front of engine                                                                        |
| Maximum power                | 171 kW (230 hp) @ 6300rpm                                                                             |
| Maximum torque               | 317 Nm (234 lb-ft) @ 3200rpm                                                                          |
| <b>Engine oil pressure*:</b> |                                                                                                       |
| At 800 rev/min               | 1.03 bar/103 kPa/15 lb/in <sup>2</sup>                                                                |

# 2009 Land Rover LR2 HSE

## ENGINE Engine Mechanical

|                                                          |                                                             |
|----------------------------------------------------------|-------------------------------------------------------------|
| At 4000 rev/min                                          | 3.45 bar/345 kPa/50 lb/in <sup>2</sup>                      |
| <b>Oil pump</b>                                          |                                                             |
| Oil pump to crankshaft clearance                         | 0.087mm ±0.022 mm (0.00343 in ± 0.000866 in)                |
| <b>Maximum permissible cylinder head warp:</b>           |                                                             |
| Over head length                                         | 0.05 mm (0.00196 in)                                        |
| Over head width                                          | 0.03 mm (0.00118 in)                                        |
| Cylinder head height                                     | 149.4 mm ± 0.15 mm (5.882 in ± 0.0059 in)                   |
| Maximum permissible amount to be removed during skimming | 0.3 mm (0.0118 in)                                          |
| <b>Main bearing journals:</b>                            |                                                             |
| Number                                                   | 7                                                           |
| Diameter standard                                        | 65 mm + 0.004 - 0.015 mm (2.55 in + 0.000157 - 0.000590 in) |
| Maximum diameter variation                               | 0.006 mm (0.000236 in)                                      |
| <b>Big end journals:</b>                                 |                                                             |
| Diameter standard                                        | 50 mm + 0.004 - 0.015 mm (1.96 in + 0.000157 - 0.000590 in) |
| Maximum diameter variation                               | 0.01 mm (0.000393 in)                                       |
| <b>Camshaft:</b>                                         |                                                             |
| Number of bearings                                       | 7 per camshaft                                              |
| <b>Tappets+:</b>                                         |                                                             |
| Inlet                                                    | Hydraulic                                                   |
| Exhaust+                                                 | Graded                                                      |
| <b>Valves:</b>                                           |                                                             |
| Valve clearance - Exhaust                                | 0.45mm ±0.05 mm (0.0177 in ± 0.00196 in)                    |
| Length - inlet valve                                     | 106.19 mm ± 0.07 mm (4.18 in ± 0.0275 in)                   |
| Length - exhaust valve                                   | 129.96 mm ± 0.07 mm (5.12 in ± 0.0275 in)                   |
| Seat angle                                               | 45° ± 0.01°                                                 |
| Head diameter - inlet valve                              | 33 mm ± 0.15 mm (1.29 in ± 0.0590 in)                       |
| Head diameter - exhaust valve                            | 28 mm ± 0.15 mm (1.10 in ± 0.0590 in)                       |
| Stem diameter - inlet valve                              | 5.97 mm + 0 - .015 mm (0.235 in + 0 - 0.000590 in)          |
| Stem diameter - exhaust valve                            | 5.962 mm +0 -0.007 mm (0.234 in +0 -0.000275 in)            |
| Stem to guide clearance - inlet valve                    | 50-70 µ'm                                                   |
| Stem to guide clearance - exhaust valve                  | 50-70 µ'm                                                   |
| <b>Valve springs:</b>                                    |                                                             |
| Type                                                     | Conical                                                     |
| Length (free)                                            | 45 mm (1.77 in)                                             |

\* Prior to checking the engine oil pressure, a road test of 6 miles (10 kilometres) must be carried out. Do not attempt to attain normal engine operating temperature by allowing the engine to idle.

+ There are 50 different thicknesses of graded tappet available ranging from 2.950mm to 3.685 mm

(0.116 in to 0.145 in) rising in increments of 0.015 mm (0.0005 in).

### TORQUE SPECIFICATIONS

| Description                                     | Nm       | lb-ft    |
|-------------------------------------------------|----------|----------|
| Camshaft bearing housing to cylinder head bolts | A        | A        |
| <b>Camshaft drive sprocket bolts</b>            |          |          |
| Exhaust                                         | 75 + 90° | 55 + 90° |
| Inlet                                           | 110      | 81       |
| Cylinder head bolts                             | A        | A        |
| Cylinder head wiring harness mounting bolts     | 6        | 5        |
| Dipstick tube bolt                              | 10       | 7        |
| Engine insulator lower bolts                    | 110      | 81       |
| Engine insulator lower heatshield Torx screw    | 10       | 7        |
| Engine insulator upper bolts                    | 110      | 81       |
| <b>Engine mount bracket LH:</b>                 |          |          |
| M8*                                             | 25       | 18       |
| M12*                                            | 80       | 59       |
| <b>Engine mount LH bolts</b>                    | 175      | 129      |
| <b>Engine mount RH bolts</b>                    | 80       | 59       |
| <b>Engine mount bracket RH bolt:</b>            |          |          |
| M10*                                            | 45       | 33       |
| M12*                                            | 80       | 59       |
| Flywheel flexplate bolts                        | 45 + 50° | 33 + 50° |
| Exhaust manifold bolts                          | A        | A        |
| Intake manifold bolts                           | 16       | 12       |
| Lifting bracket bolts                           | 48       | 35       |
| Lower inlet manifold bolts                      | 10       | 7        |
| Lubricant drain plug                            | 38       | 28       |
| Oil cooler assembly to block retaining bolts    | 10       | 7        |
| Oil cooler hose bolts                           | 10       | 7        |
| Oil filter                                      | 25       | 18       |
| Oil level sensor bolt                           | 8        | 6        |
| <b>Oil pan bolts:</b>                           |          |          |
| M7                                              | 17       | 13       |
| M10                                             | 45       | 33       |
| Oil pump adjuster bolt                          | 17       | 13       |
| Oil pump lock adjuster sleeve bolt              | 8        | 6        |
| Oil strainer pick-up assembly bolt              | 17       | 13       |

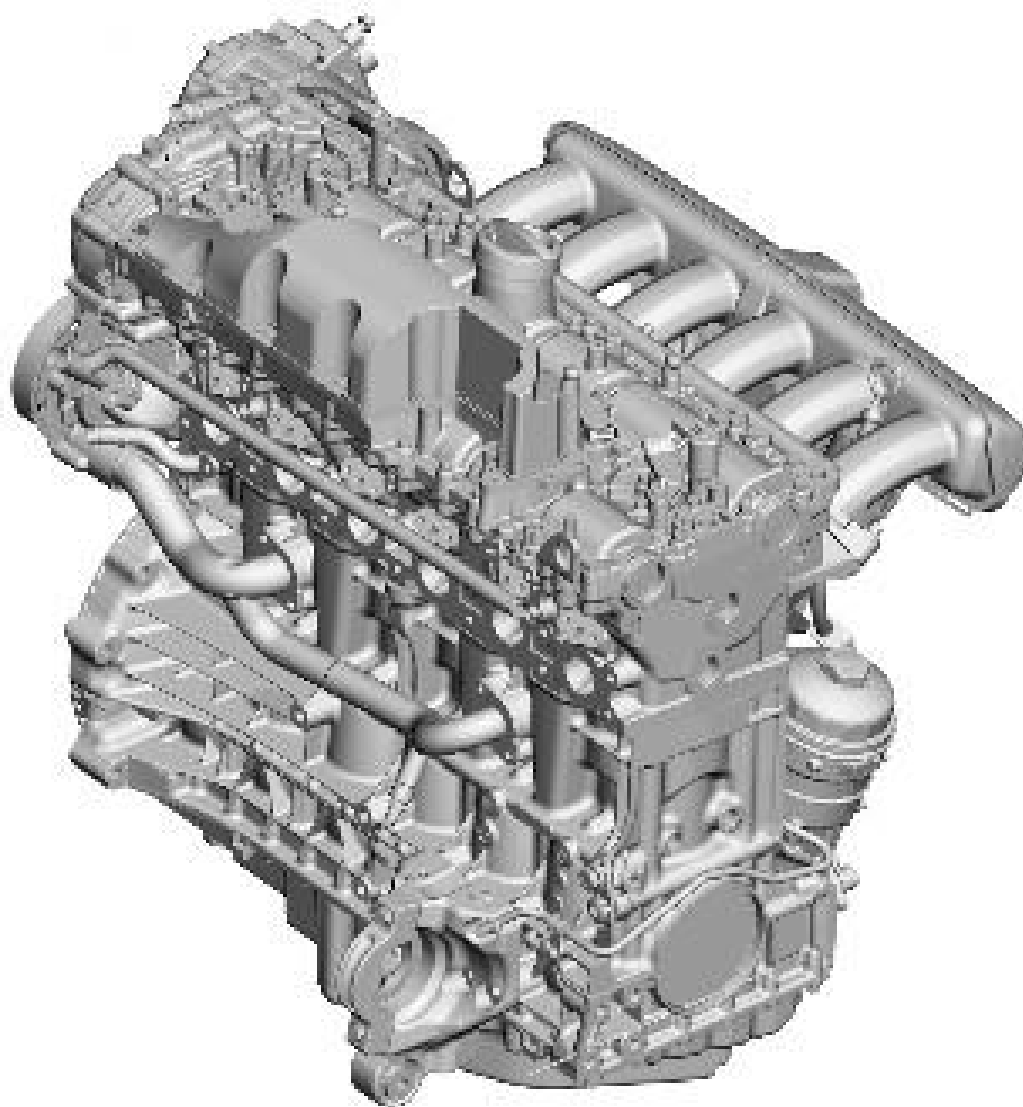
**2009 Land Rover LR2 HSE****ENGINE Engine Mechanical**

|                                     |    |   |
|-------------------------------------|----|---|
| Oil squirt jet                      | 6  | 5 |
| Throttle body to block support bolt | 10 | 7 |
| Throttle body screws*               | 8  | 6 |
| Timing chain tensioner bolt         | 10 | 7 |
| Timing cover bolts                  | A  | A |
| VVT solenoid                        | 10 | 7 |
| VVT unit retaining bolt             | A  | A |

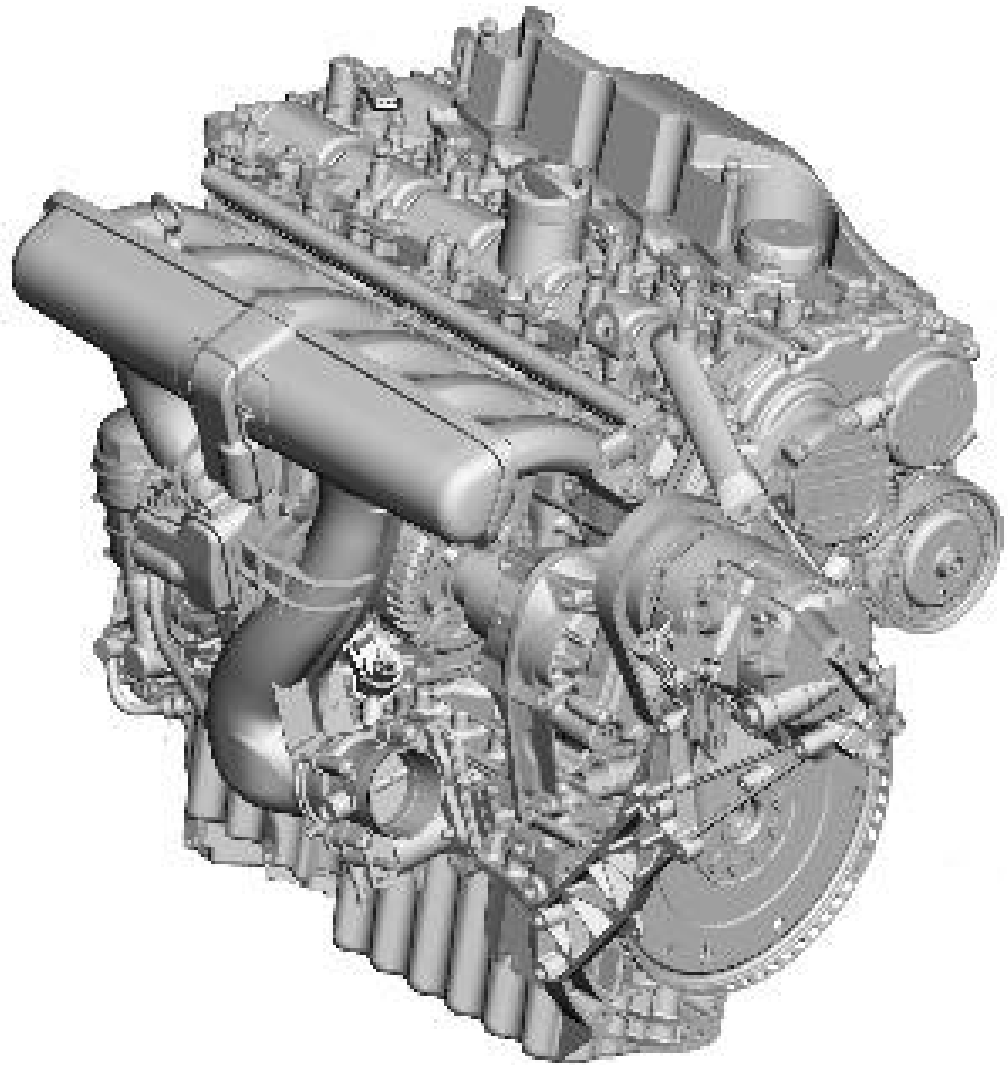
**\* New nuts/bolts must be fitted**

**A = refer to procedure for correct torque sequence**

**DESCRIPTION & OPERATION****EXTERNAL VIEW**



E79455



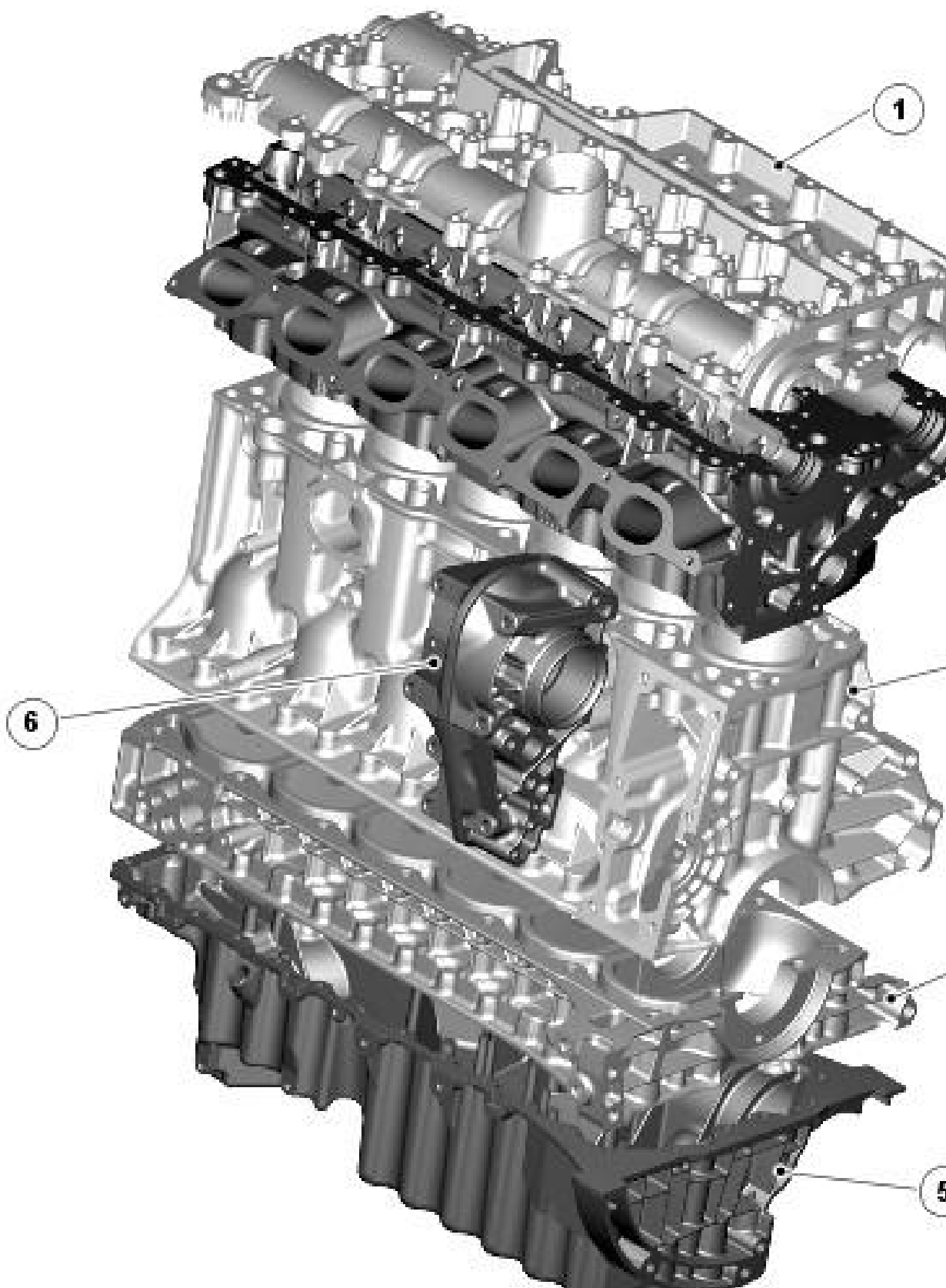
E79456

## OVERVIEW

The Si6 petrol engine is a 3.2 liter, inline 6-cylinder, naturally aspirated unit, with 4 valves per cylinder, operated by 2 overhead camshafts. The engine emissions comply with EURO 5 (European Union emission regulations) and Ultra Low Emissions Vehicle (ULEV) II legislative requirements and employs catalytic converters, electronic engine management control and pressure controlled crankcase ventilation 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 and the ignition system.

The cylinder block is of aluminum alloy construction with cast iron liners and a pressed aluminum bedplate section bolted to the bottom of the block to improve lower structure rigidity. The single-piece oil sump is also of a pressed aluminum construction. The cylinder head and the camshaft bearing housing are manufactured from cast aluminum. The exhaust manifolds are of a fabricated stainless steel twin skin design incorporating catalytic converters and a molded plastic acoustic cover is fitted over the upper engine to reduce engine-generated noise.

**ENGINE STRUCTURE**



**2009 Land Rover LR2 HSE****ENGINE Engine Mechanical**

| <b>Item Number</b> | <b>Description</b>       |
|--------------------|--------------------------|
| 1                  | Camshaft bearing housing |
| 2                  | Cylinder head            |
| 3                  | Cylinder block           |
| 4                  | Bedplate section         |
| 5                  | Oil pan                  |
| 6                  | Gear housing             |

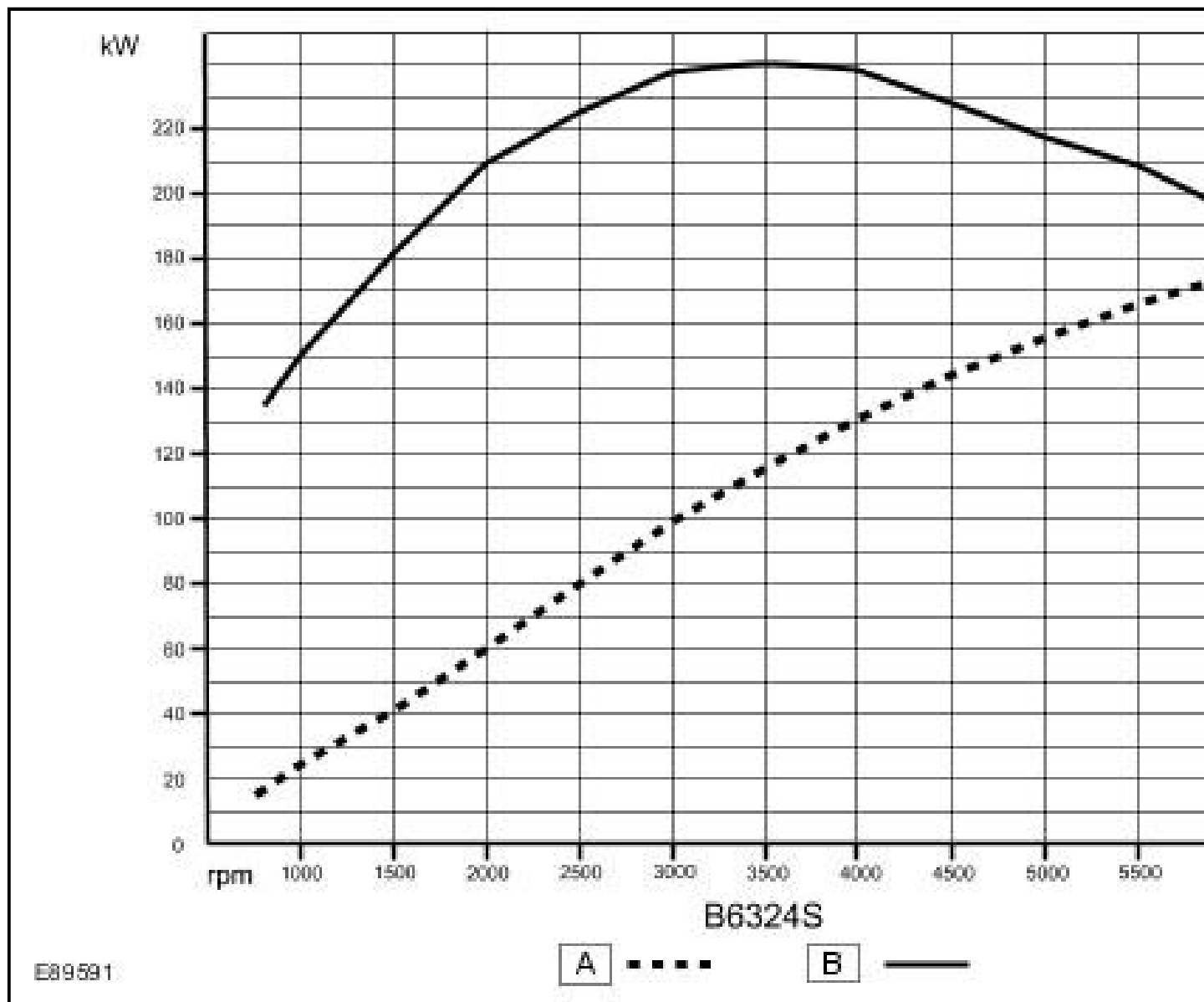
**TECHNICAL FEATURES**

The engines technical features include:

- A 6-cylinder, inline configuration, liquid cooled, aluminum cylinder block with cast iron liners
- Pistons are cast from a light alloy metal, with 2 compression rings and a 3-piece oil control ring
- Aluminum cylinder head, incorporating 2 camshafts
- Four valves per cylinder
- Variable lift height hydraulic valve tappets (intake only)
- Variable Camshaft Timing (VCT) (intake only)
- Crankshaft vibration damper to give the crankshaft a smoother operation
- A single gear driven camshaft timing chain drives both camshafts
- An aluminum bedplate section between the oil pan and cylinder block
- A forged steel crankshaft with induction hardened bearing surfaces
- Forged steel connecting rods
- A Rear End Ancillary Drive (READ) system
- Two fabricated stainless steel twin skin exhaust manifolds
- A 3-position Variable Intake System (VIS)
- An advanced Engine Management System (EMS) incorporating electronic throttle control
- Four catalytic converters

**TECHNICAL DATA**

| <b>DESCRIPTION</b>        | <b>TYPE</b>                                                          |
|---------------------------|----------------------------------------------------------------------|
| <b>Configuration</b>      | Inline 6-cylinder                                                    |
| <b>Output</b>             | 171 kW at 6200 rpm                                                   |
| <b>Torque</b>             | 320 Nm at 3200 rpm                                                   |
| <b>Displacement</b>       | 3192 cm <sup>3</sup>                                                 |
| <b>Stroke/bore</b>        | 96.0 mm/84.0 mm                                                      |
| <b>Compression ratio</b>  | 10.8:1                                                               |
| <b>Firing order</b>       | 1-5-3-6-2-4                                                          |
| <b>Approximate weight</b> | 180 kg (including intake pipe, exhaust manifold, alternator and oil) |



| Item Number | Description |
|-------------|-------------|
| A           | Power (kW)  |
| B           | Torque (Nm) |

### CYLINDER BLOCK COMPONENTS

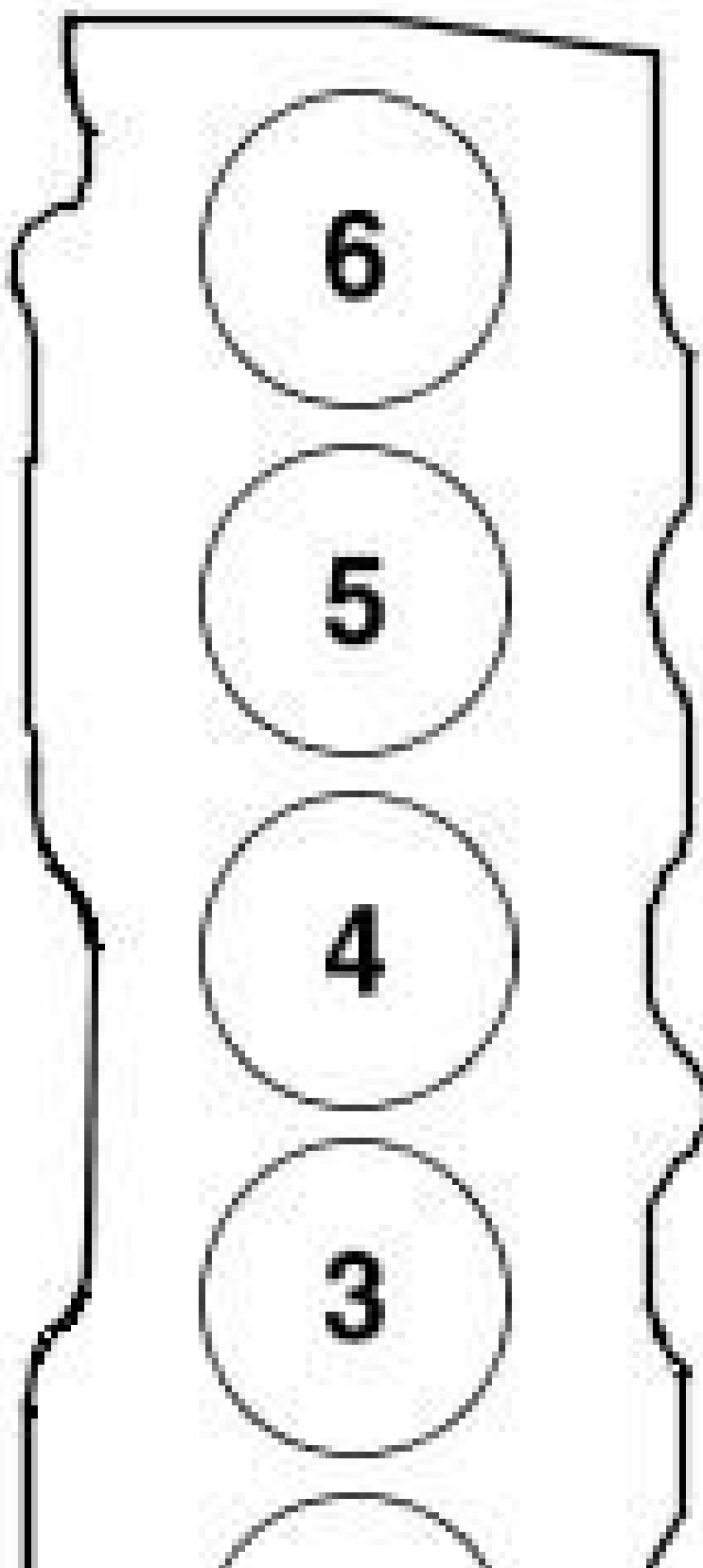
The main cylinder block components are:

- Cylinder block
- Connecting rods and pistons
- Piston cooling jets
- Generator

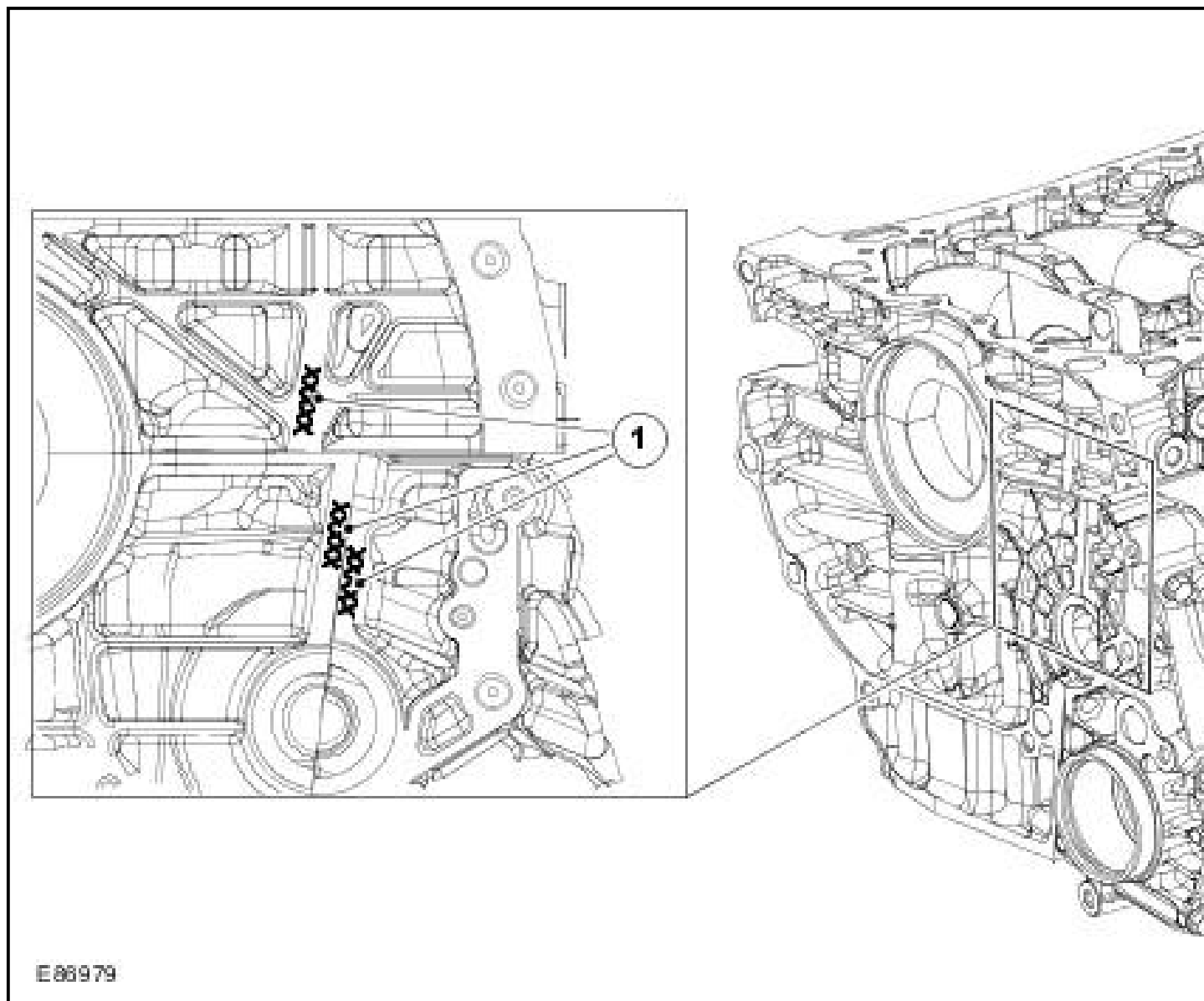
- Gear housing
- Thermostat housing
- Crankshaft Position (CKP) sensor
- Knock sensors
- Coolant pump
- Coolant inlet pipe

**CYLINDER NUMBERING**

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



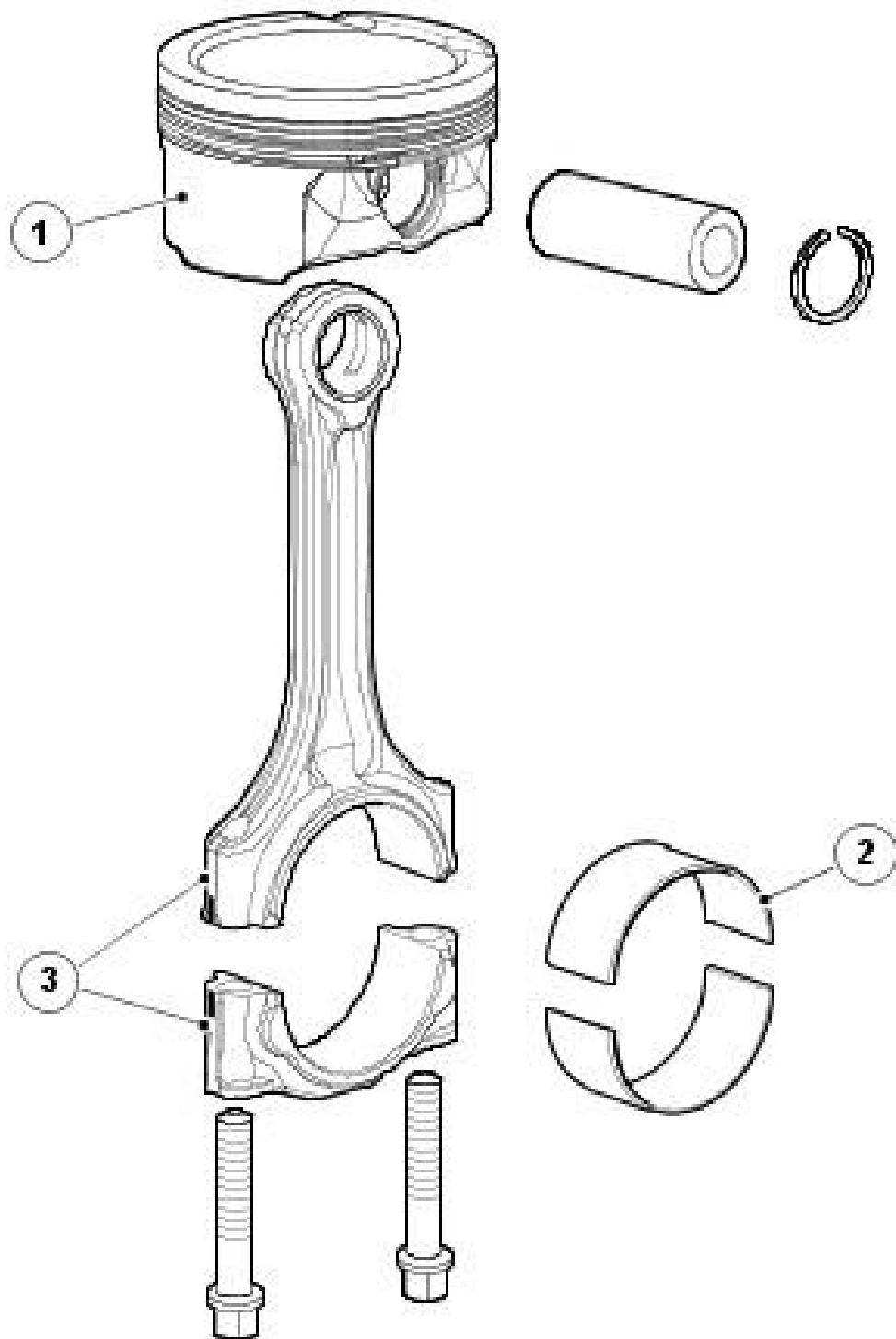
## CYLINDER BLOCK



| Item Number | Description             |
|-------------|-------------------------|
| 1           | Identification markings |

The cylinders and crankcase are contained in the cylinder block, which is of a cast aluminum construction. The cylinder sleeves are made of cast iron and cast in bores. The cylinder block is of a pen coolant mantle design, which allows coolant to flow freely around the upper section of the cylinders.

## CONNECTING RODS AND PISTONS



E80986

| Item Number | Description             |
|-------------|-------------------------|
| 1           | Piston                  |
| 2           | Connecting rod bearings |

3

Connecting rod and cap assembly

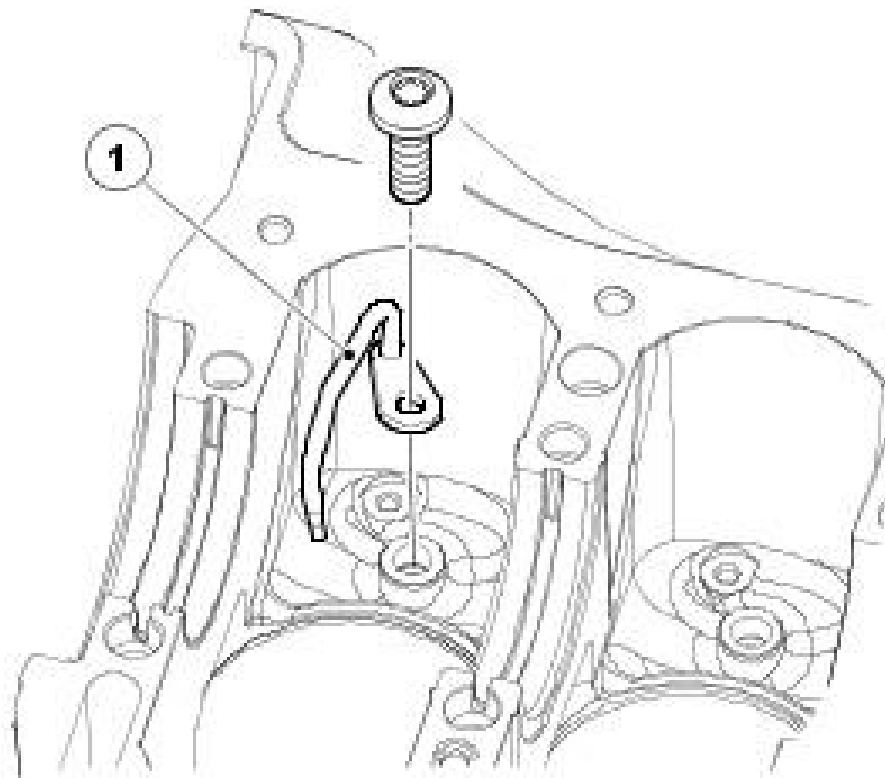
The connecting rods are 'L' profile forged with a trapezium shaped (a shape with 4 sides with 2 of its sides parallel) small end. The big end has a fracture split bearing cap, which gives a stable joint because the bearing cap and connecting rod are secured in the actual fracture surface. Aluminum bearings are used for both the lower and upper bearing half.

The pistons are cast from a light-alloy metal consisting of aluminum and silicon. The piston skirt is graphite coated at the front and rear to ensure low friction between the piston and cylinder, particularly during cold starting and during short periods of extreme load. The piston is 'weight optimized', which means, for example, that the piston pin is comparatively short and that the piston is missing material from the sides.

Each piston has 3 piston rings:

- An upper compression ring of nitrated steel
- A second ring of alloyed cast iron, which functions as both a compression ring and an oil scraper ring
- A 3-part oil ring made of nitrated steel

#### PISTON COOLING JETS

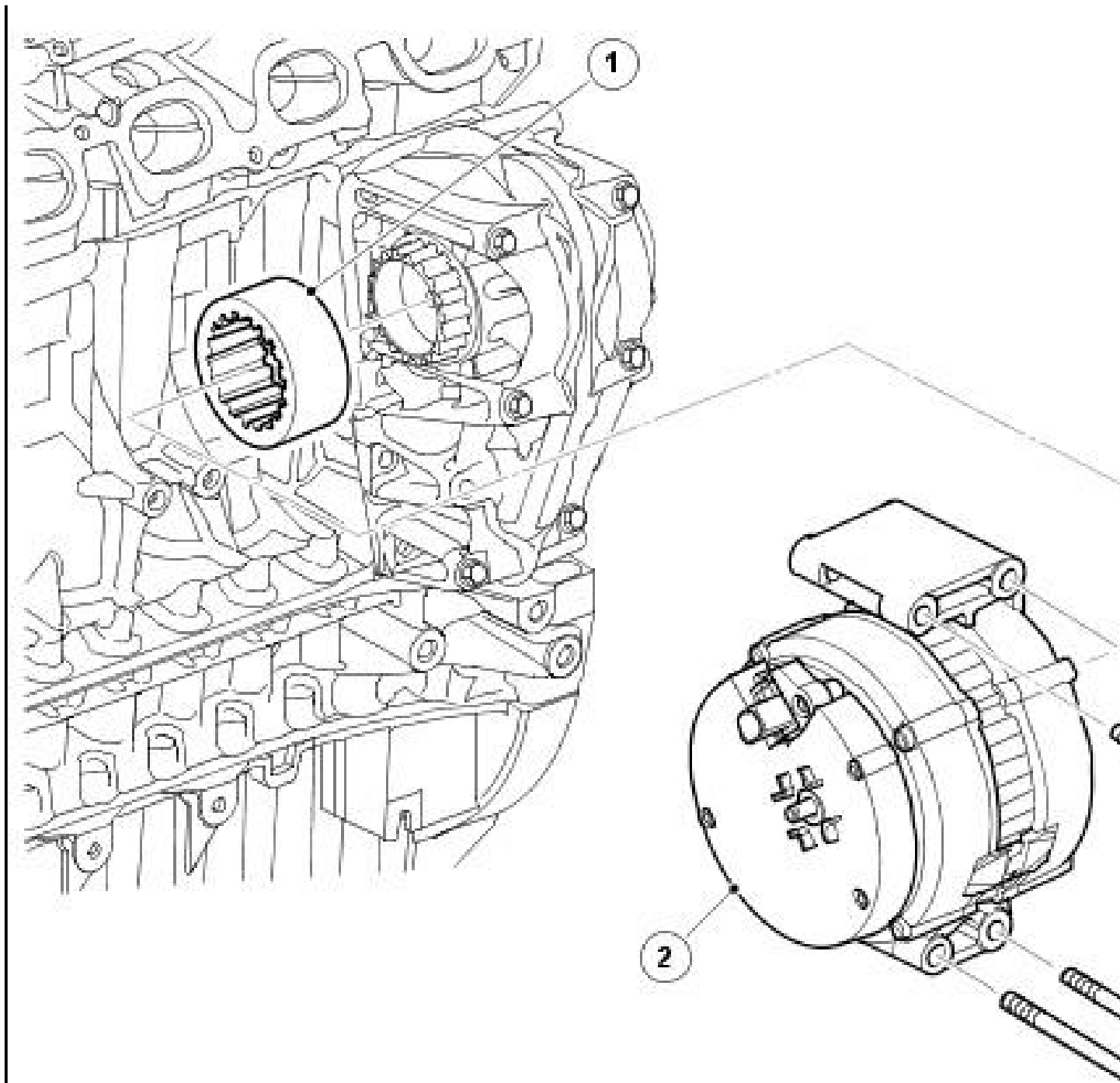


E86987

| Item Number | Description                |
|-------------|----------------------------|
| 1           | Piston cooling jet (6 off) |

Jets located in the cylinder block spray oil on to the inside of the piston to provide piston and piston pin lubrication and cooling. The oil is distributed through the cylinder block, via the main oil gallery and channels bored in the block.

**GENERATOR**

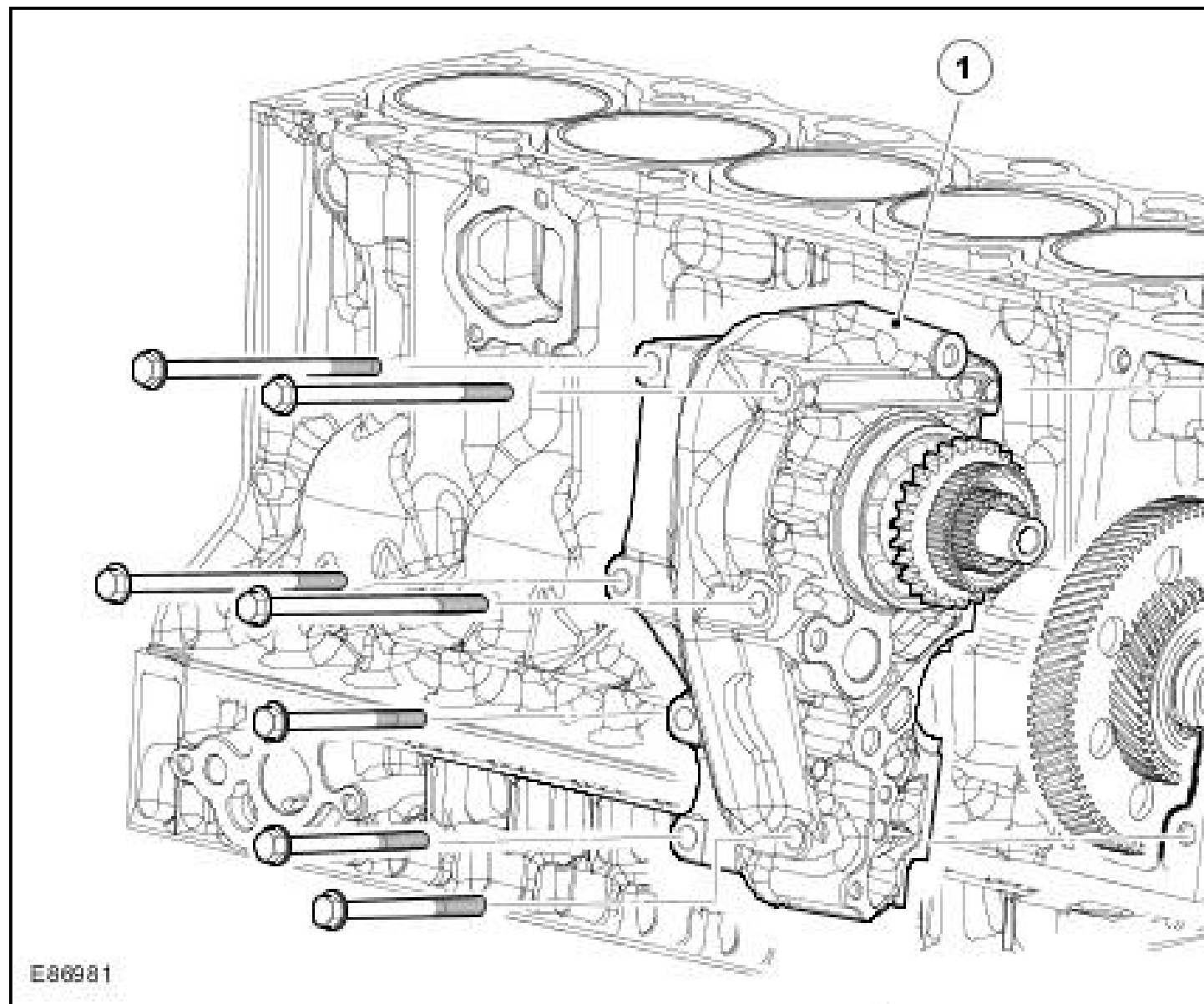


E87044

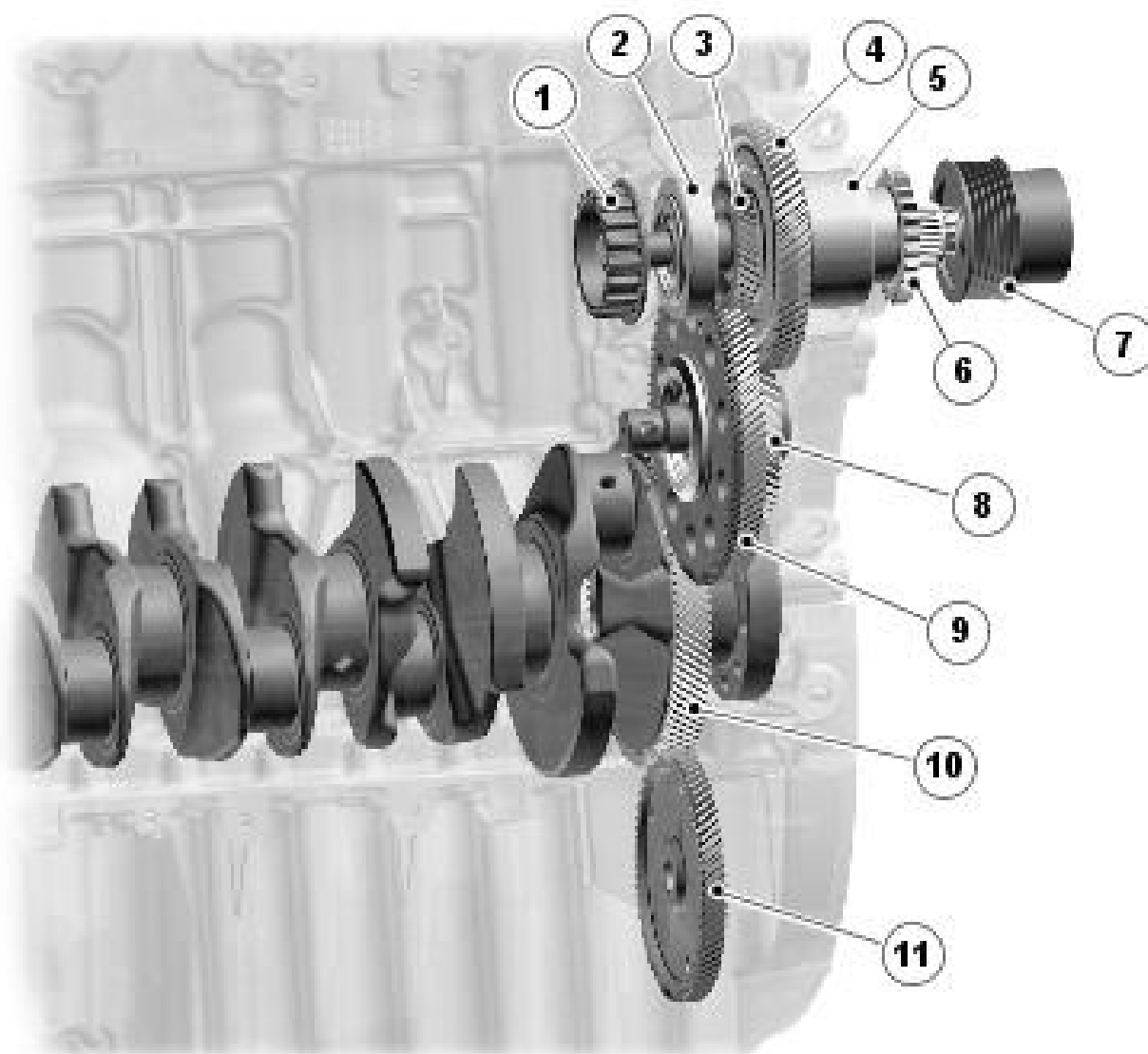
| Item Number | Description   |
|-------------|---------------|
| 1           | Rubber sleeve |
| 2           | Generator     |

The generator is located at the rear of the intake side of the cylinder block. The generator is driven by the crankshaft gearwheel via the auxiliary unit shaft gearwheel and the auxiliary unit inner shaft gear wheel (see gear housing section for more information).

#### GEAR HOUSING COMPONENTS



| Item Number | Description           |
|-------------|-----------------------|
| 1           | Gear housing assembly |



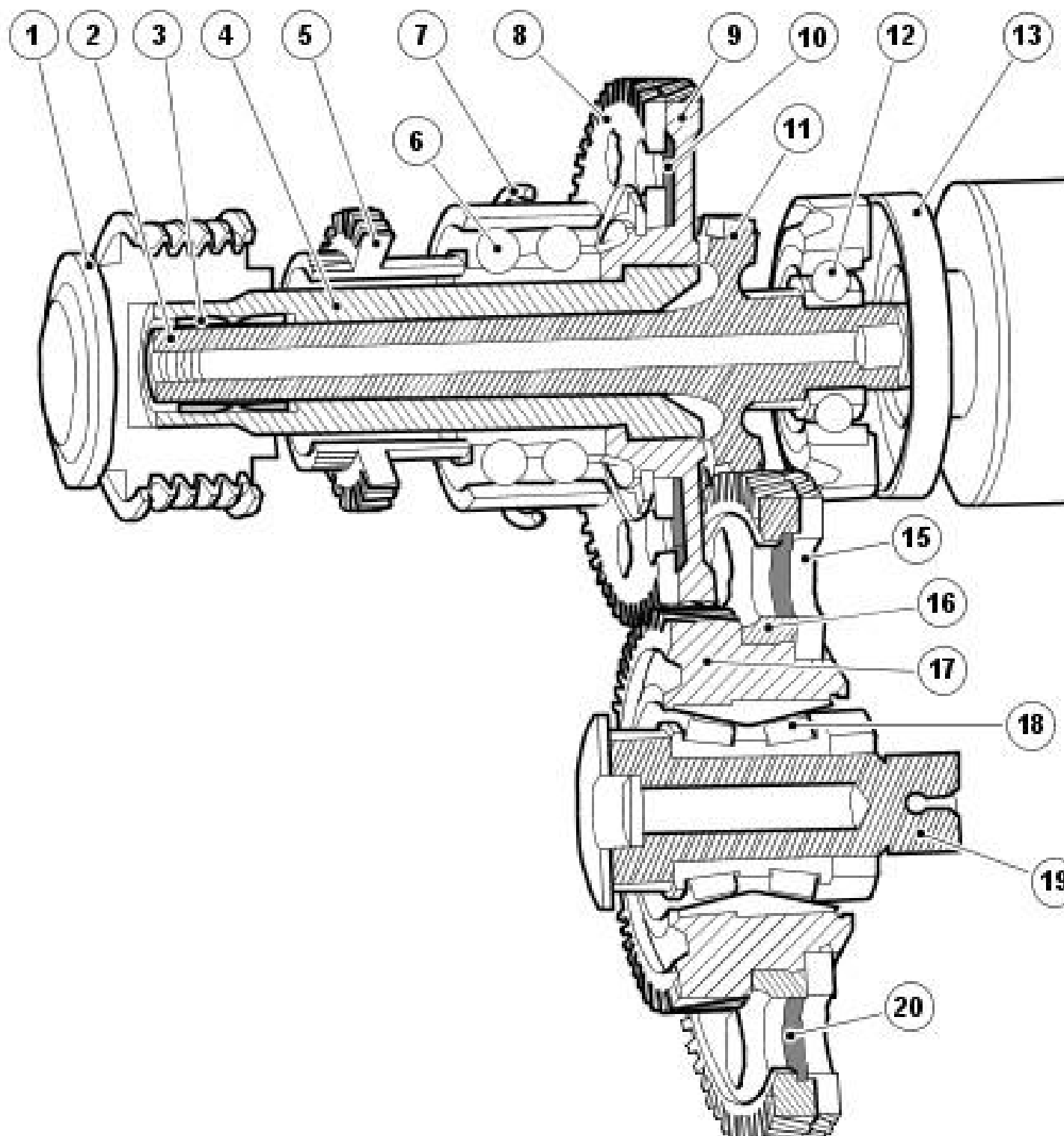
E89597

| Item Number | Description                           |
|-------------|---------------------------------------|
| 1           | Generator connection sleeve           |
| 2           | Front bearing                         |
| 3           | Auxiliary unit inner shaft gear wheel |
| 4           | Camshaft drive outer shaft gear wheel |
| 5           | Rear bearing                          |
| 6           | Camshaft chain gear wheel             |
| 7           | Pulley                                |
| 8           | Camshaft drive shaft gear wheel       |
| 9           | Auxiliary unit shaft drive gear wheel |
| 10          | Crankshaft gear wheel                 |

## 2009 Land Rover LR2 HSE

### ENGINE Engine Mechanical

|    |                     |
|----|---------------------|
| 11 | Oil pump gear wheel |
| 12 | Intermediate shaft  |



| Item Number | Description                                                                            |
|-------------|----------------------------------------------------------------------------------------|
| 1           | Pulley                                                                                 |
| 2           | Auxiliary unit shaft                                                                   |
| 3           | Needle bearing                                                                         |
| 4           | Cam driving shaft                                                                      |
| 5           | Gear, camshaft chain                                                                   |
| 6           | Seal                                                                                   |
| 7           | Double row bearing                                                                     |
| 8           | "Narrow" gear wheel (Scissor gear) intermediate shaft                                  |
| 9           | "Wide" gear wheel, cam driving shaft                                                   |
| 10          | Spring © spring)                                                                       |
| 11          | Gear wheel, auxiliary unit shaft                                                       |
| 12          | Single row bearing with bearing housing                                                |
| 13          | Seal                                                                                   |
| 14          | Sleeve connection, alternator                                                          |
| 15          | "Narrow" gear wheel (Scissor gear) intermediate shaft, drives the auxiliary unit shaft |
| 16          | "Wide" gear wheel intermediate shaft, drives the auxiliary unit shaft                  |
| 17          | Small gear wheel intermediate shaft, drives the cam driving shaft                      |
| 18          | Double row conical bearing                                                             |
| 19          | Intermediate shaft                                                                     |
| 20          | Spring © spring)                                                                       |

The gear housing functions as an external cover for the following sub-sections:

- Intermediate shaft
- Camshaft drive outer shaft
- Auxiliary unit inner shaft

### Intermediate Shaft

The intermediate shaft is used to locate the camshaft drive shaft gear wheel in the cylinder block. The shaft is journaled with a double conical roller bearing. The auxiliary unit shaft drive gear wheel is in 2 pieces, with the narrow half being spring tensioned in the opposite direction to the wide half. This feature reduces noise because gear play is eliminated. Only the wide half drives the auxiliary unit's gear wheel. The camshaft chain gear wheel is of the conventional design.

The shaft is sealed against the exhaust side (i.e. the rear side of the cylinder block) by a sealing washer. To remove or install the washer, the flywheel/flexplate must be removed.

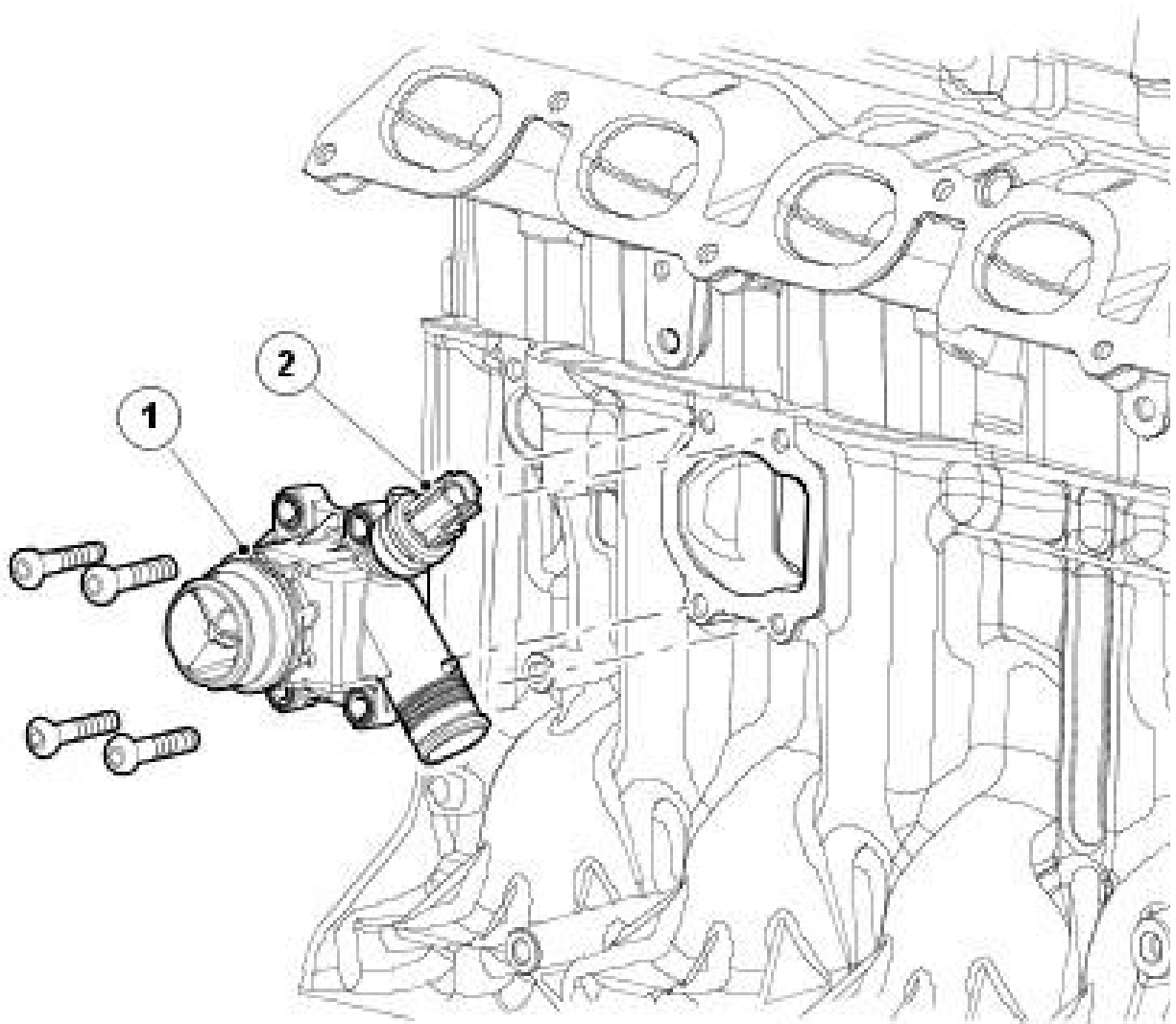
### Camshaft Drive Outer Shaft

The camshaft drive outer shaft is journaled at the front end of the shaft with a double row bearing in the gear housing. Needle bearings are used at the rear end (pulley side) against the auxiliary unit shaft. The camshaft drive outer shaft gear wheel is in 2 pieces, a wide and a narrow half to reduce noise. The camshaft chain gear wheel is also located on the shaft and is used to drive the camshafts chain.

### Auxiliary Unit Inner Shaft

The auxiliary unit inner shaft is journaled at the front end of the shaft (generator side) in the gear housing with a single row bearing. Needle bearings are used at the rear end (pulley side) against the camshaft drive shaft. There is a pulley at the rear end of the shaft that drives the Air Conditioning (AC) compressor and the power steering pump, via a polyvee belt. The shaft also drives the generator at the front end, via a sleeve connector.

### THERMOSTAT HOUSING



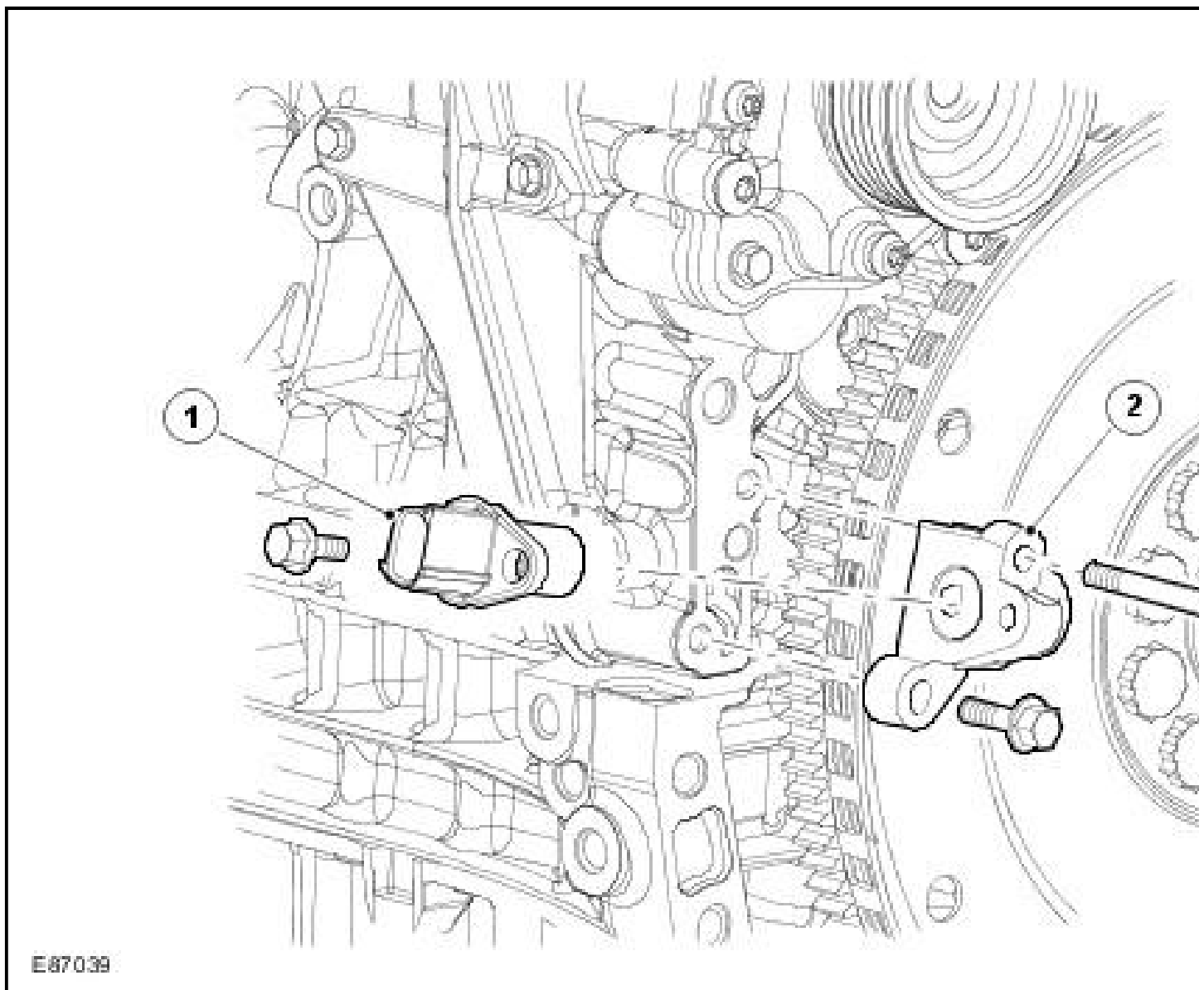
E87015

| Item Number | Description                |
|-------------|----------------------------|
| 1           | Thermostat housing         |
| 2           | Coolant temperature sensor |

The thermostat housing is located towards the front of the intake side of the engine cylinder block. The housing contains a wax type thermostat and a coolant temperature sensor.

Coolant flows in at the coolant pump and passes through a number of channels before it collects and then flows out to the thermostat housing. If the thermostat housing is closed, the coolant passes via the by-pass channel directly to the coolant pump to then circulate through the cylinder block again Refer to **Engine Cooling** . .

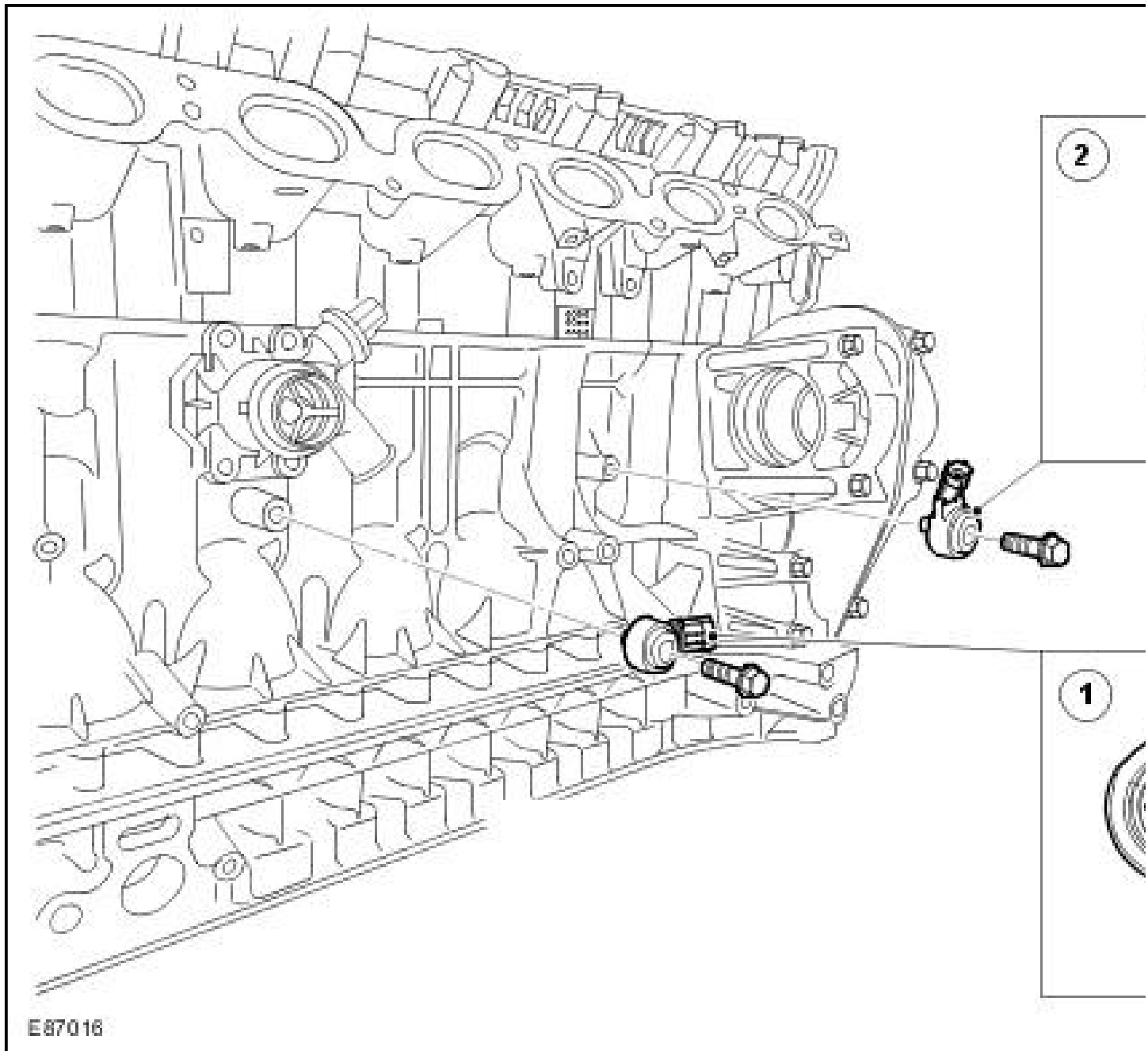
#### CRANKSHAFT POSITION SENSOR



| Item Number | Description    |
|-------------|----------------|
| 1           | CKP sensor     |
| 2           | Sensor bracket |

The Crankshaft Position (CKP) sensor is located at the rear of the intake side of the cylinder block. The sensor provides an input of engine crankshaft speed and position. The sensor works on the principle of the Hall effect and scans a trigger wheel (magnetic disc) on the flywheel. Refer to **Electronic Engine Controls** . .

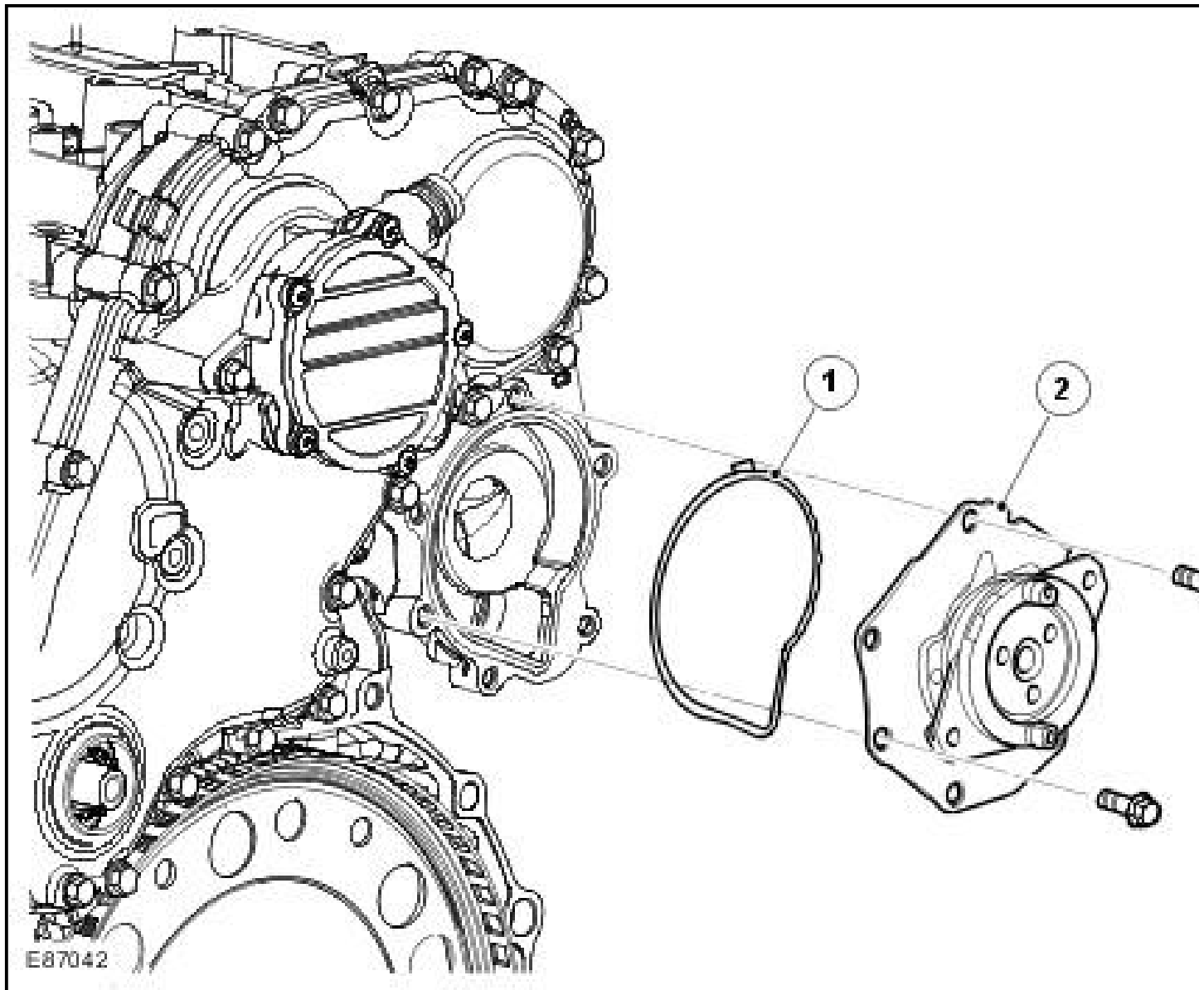
#### KNOCK SENSORS



| Item Number | Description        |
|-------------|--------------------|
| 1           | Front knock sensor |
| 2           | Rear knock sensor  |

The knock sensors are located at the front and rear intake side of the cylinder block. They are piezo-electric sensors that provide inputs to detect and locate detonation during combustion Refer to **Electronic Engine Controls** . .

#### COOLANT PUMP

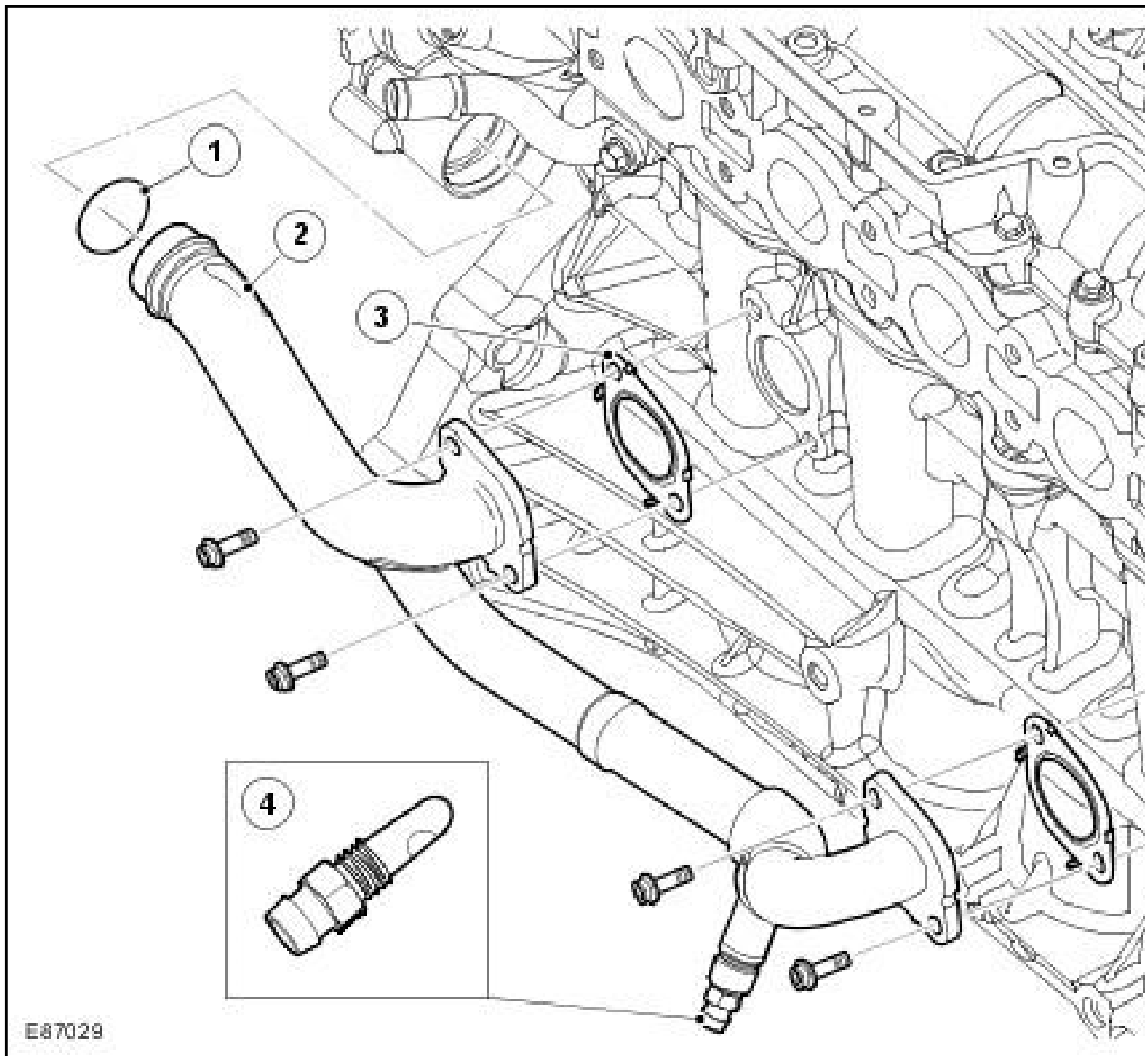


| Item Number | Description |
|-------------|-------------|
| 1           | Seal        |

2

Coolant pump

The coolant pump is installed on the RH side of the cylinder block rear face and is secured and sealed via 6 bolts and an 'O' ring. The coolant pump and power steering pump are both driven by a single pulley via a poly-vee belt. A keyed shaft at the front of the pulley drives the power steering pump, while a driver mechanism attached to the rear of the pulley drives the coolant pump.

**COOLANT INLET PIPE**

| Item Number | Description        |
|-------------|--------------------|
| 1           | O ring             |
| 2           | Coolant inlet pipe |
| 3           | Gasket (2 off)     |
| 4           | Drain nipple       |

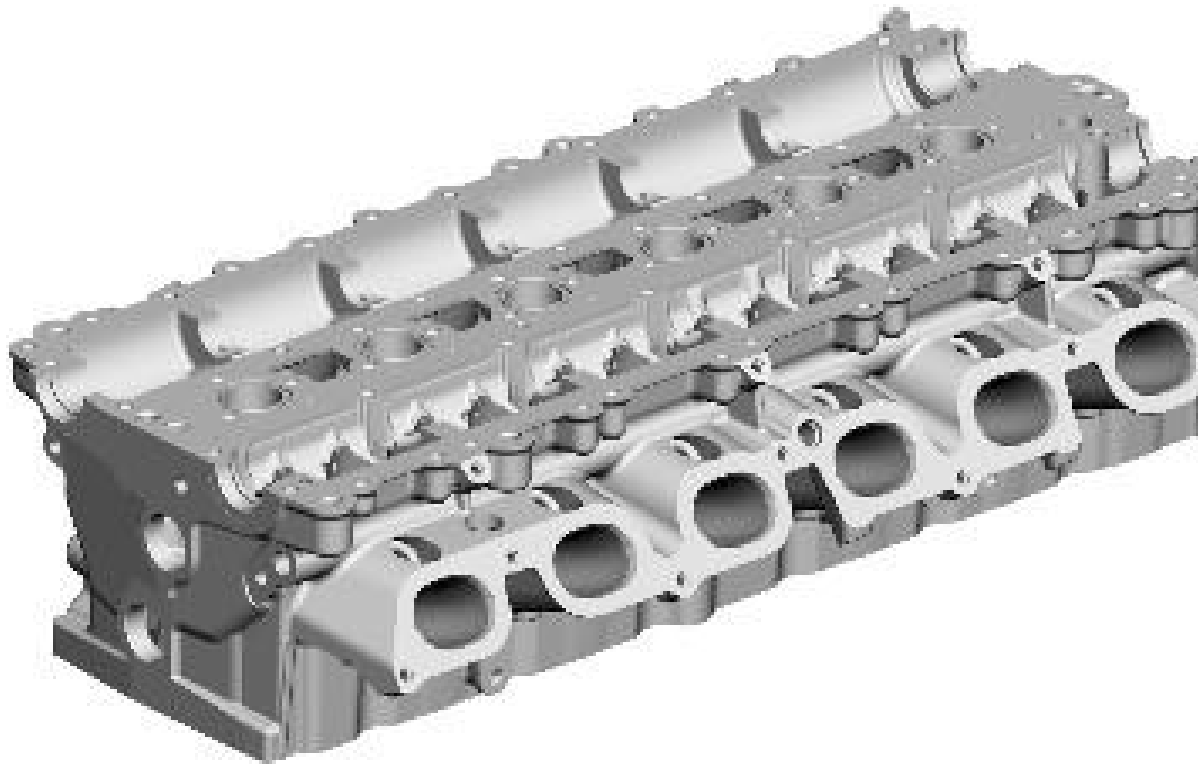
The coolant inlet pipe is located on the exhaust side of the engine. The coolant is routed from the coolant pump into 2 connections on the engine block via the coolant inlet pipe and leaves the engine block at the rear end, via the thermostat housing.

### CYLINDER HEAD COMPONENTS

The main cylinder head components are:

- Cylinder head
- Cylinder head gasket
- Oil separator
- Camshaft housing
- Camshafts
- Intake and exhaust valve assemblies
- Variable Camshaft Timing (VCT) solenoid and Camshaft Position (CMP) sensors
- Spark plugs
- Coils
- Fuel rail and injectors
- Vacuum pump
- Intake manifold
- Exhaust manifold

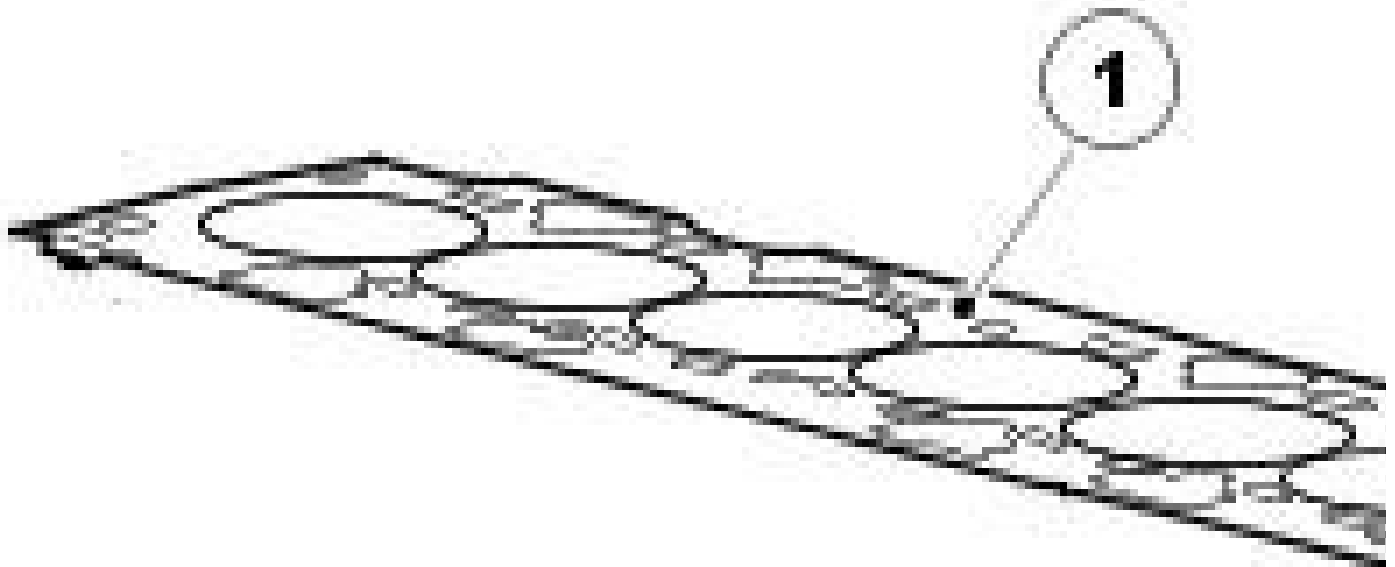
### CYLINDER HEAD



E90912

The chill cast cylinder head is of the cross-flow type, manufactured from a light-alloy metal. Deep-seated bolts, to reduce distortion, secure the cylinder head to the cylinder block. Two hollow locating dowels align the cylinder head with the cylinder block. The 2 camshafts are supported by 7 bearing caps each, directly in the cylinder head and camshaft cover.

#### CYLINDER HEAD GASKET

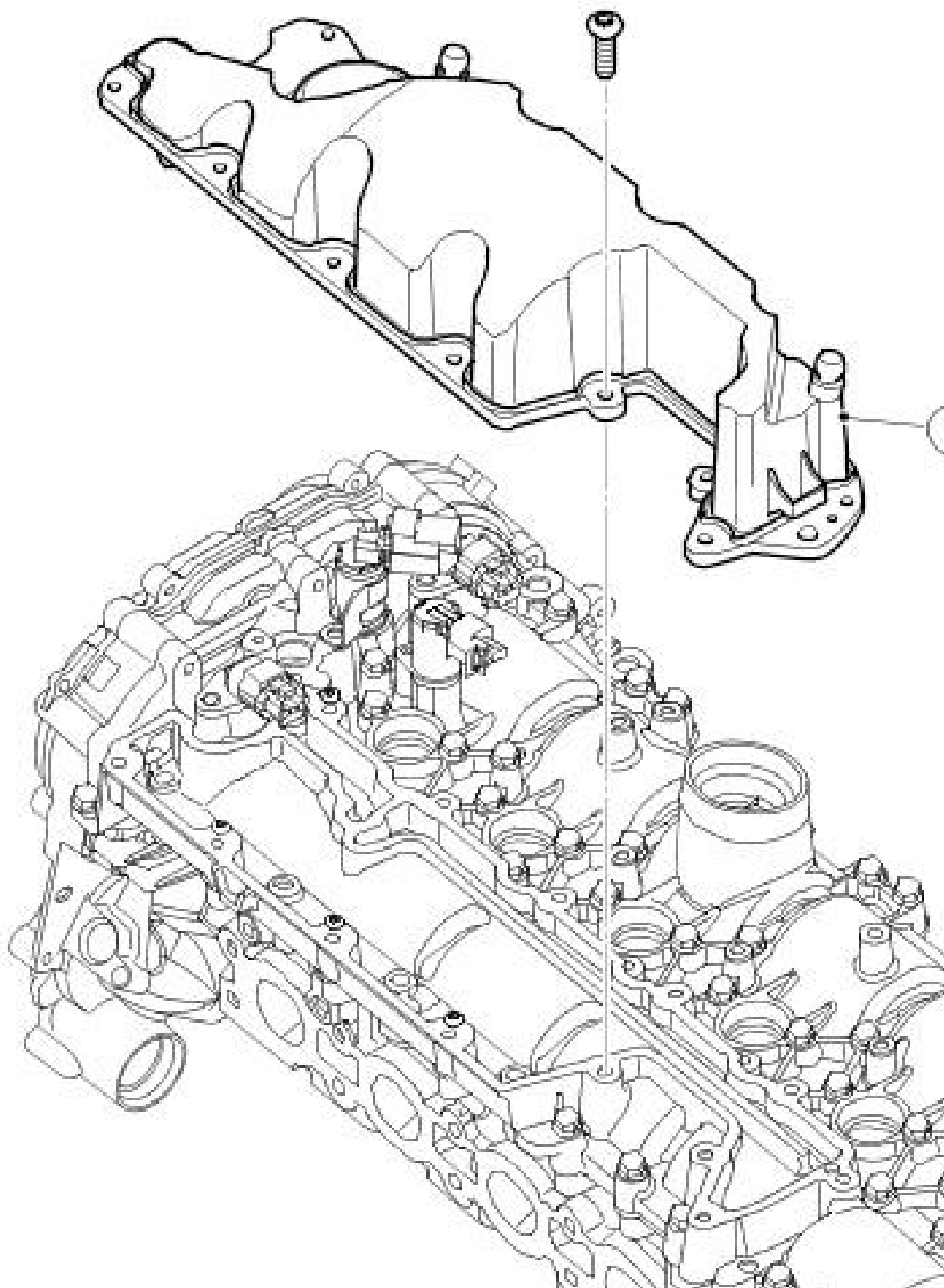


E89572

| Item Number | Description          |
|-------------|----------------------|
| 1           | Cylinder head gasket |

The seal between the cylinder head and cylinder block is a conventional cylinder head gasket. The head gasket is made of steel and has multiple layers. For service, there is only 1 size of gasket available.

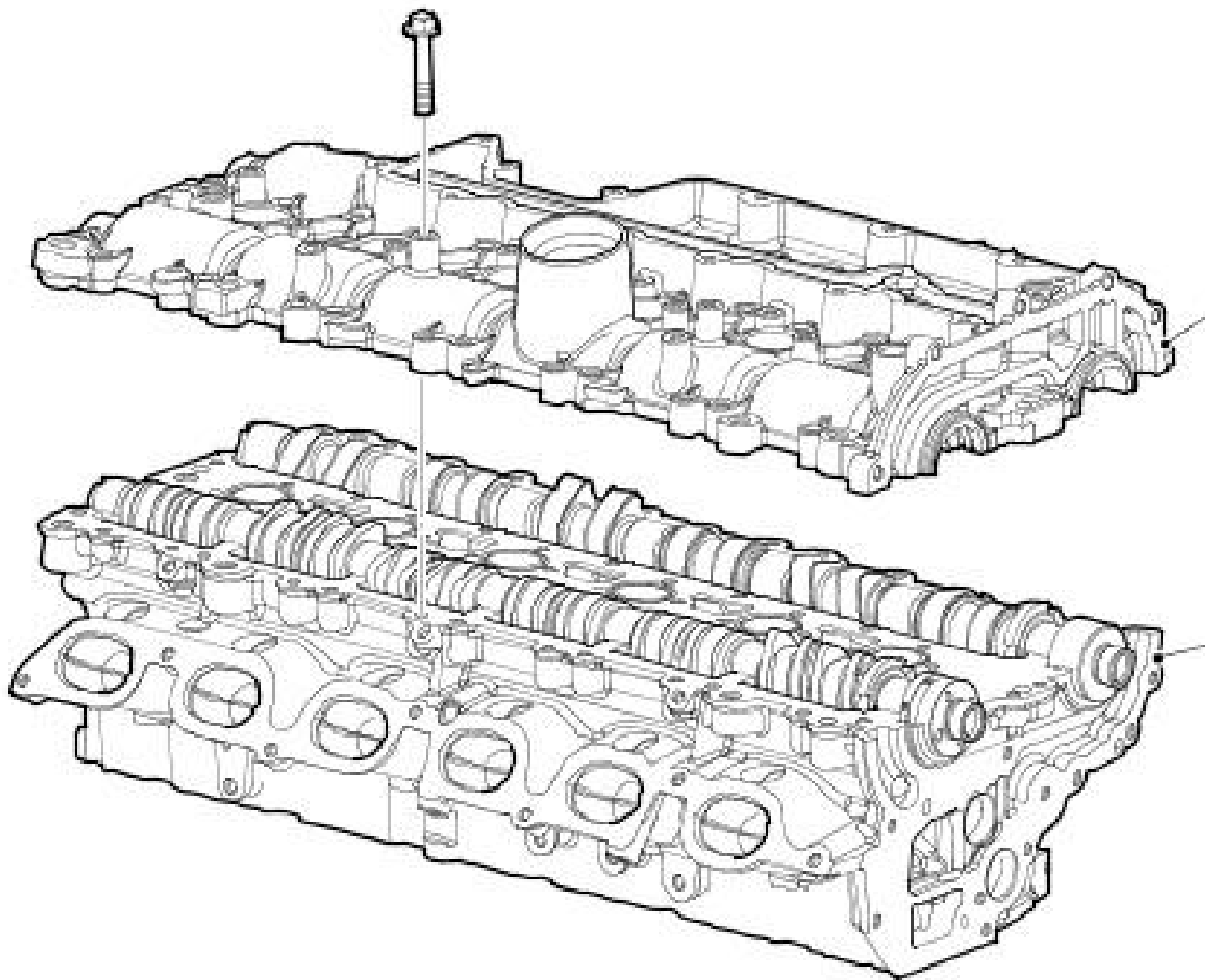
#### OIL SEPARATION HOUSING



| Item Number | Description            |
|-------------|------------------------|
| 1           | Oil separation housing |

Crankcase gases are routed from the crankcase, engine block and cylinder head to the oil separation housing located on the camshaft cover. From the oil separation housing, the crankcase gases are routed via a pressure regulator, located at the rear edge of the housing, to the cylinder head and the intake ports for the intake valves. Refer to **Evaporative Emissions** .

#### CAMSHAFT HOUSING



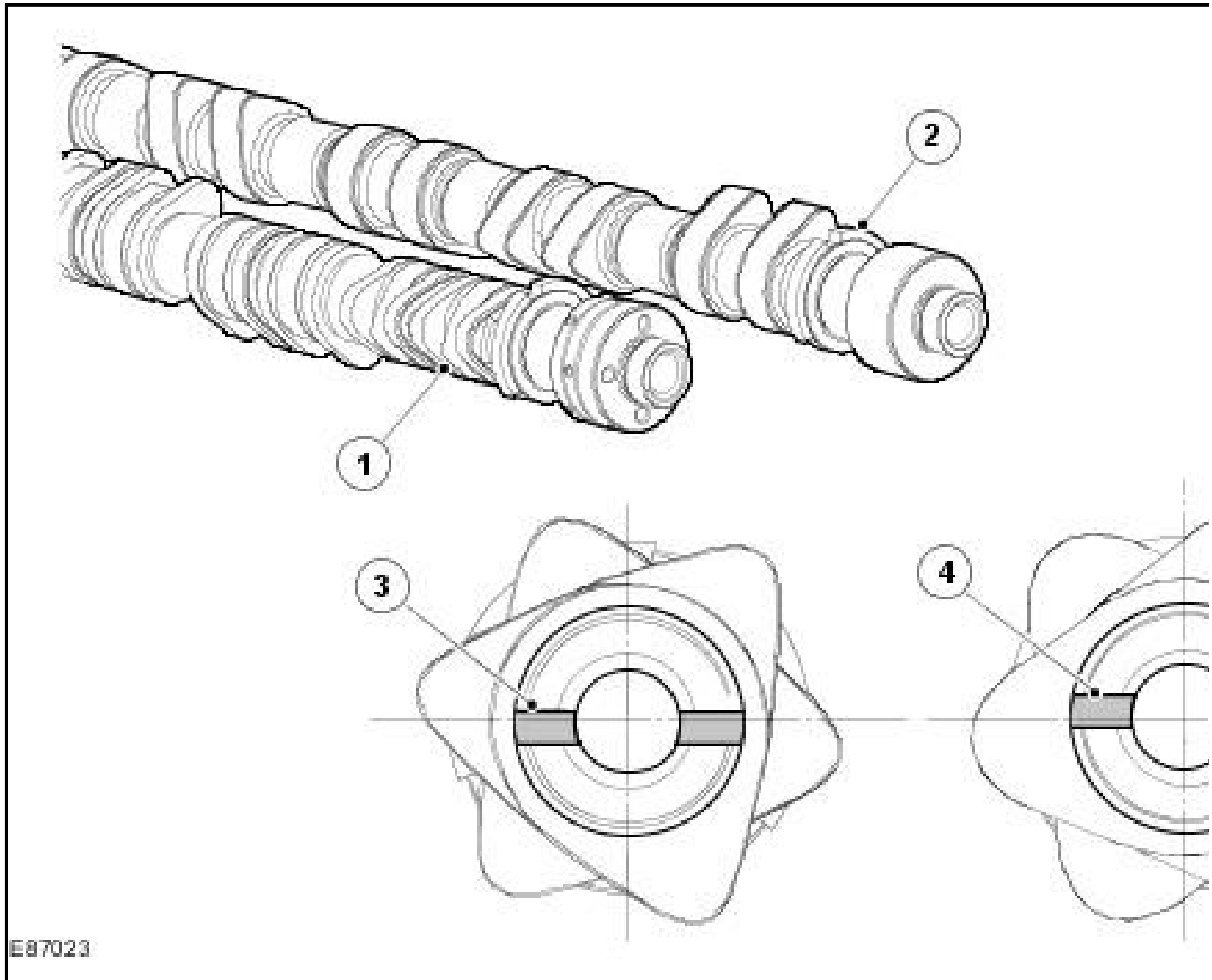
E87026

| Item Number | Description      |
|-------------|------------------|
| 1           | Camshaft housing |
| 2           | Cylinder head    |

The chill cast camshaft housing is manufactured from a light-alloy metal and acts as a combined valve cover

and camshaft bearing cap. The housing has cast oil ducts on it's underside, which ensure good oil supply to the camshafts and the valve lifters. The oil separation housing is located on the camshaft cover Engine Emission Control - 3.2L. Refer to **ENGINE EMISSION CONTROL - 3.2L** . .

### CAMSHAFTS



| Item Number | Description                             |
|-------------|-----------------------------------------|
| 1           | Intake camshaft                         |
| 2           | Exhaust camshaft                        |
| 3           | Exhaust camshaft slot below center line |
| 4           | Inlet camshaft slot above center line   |

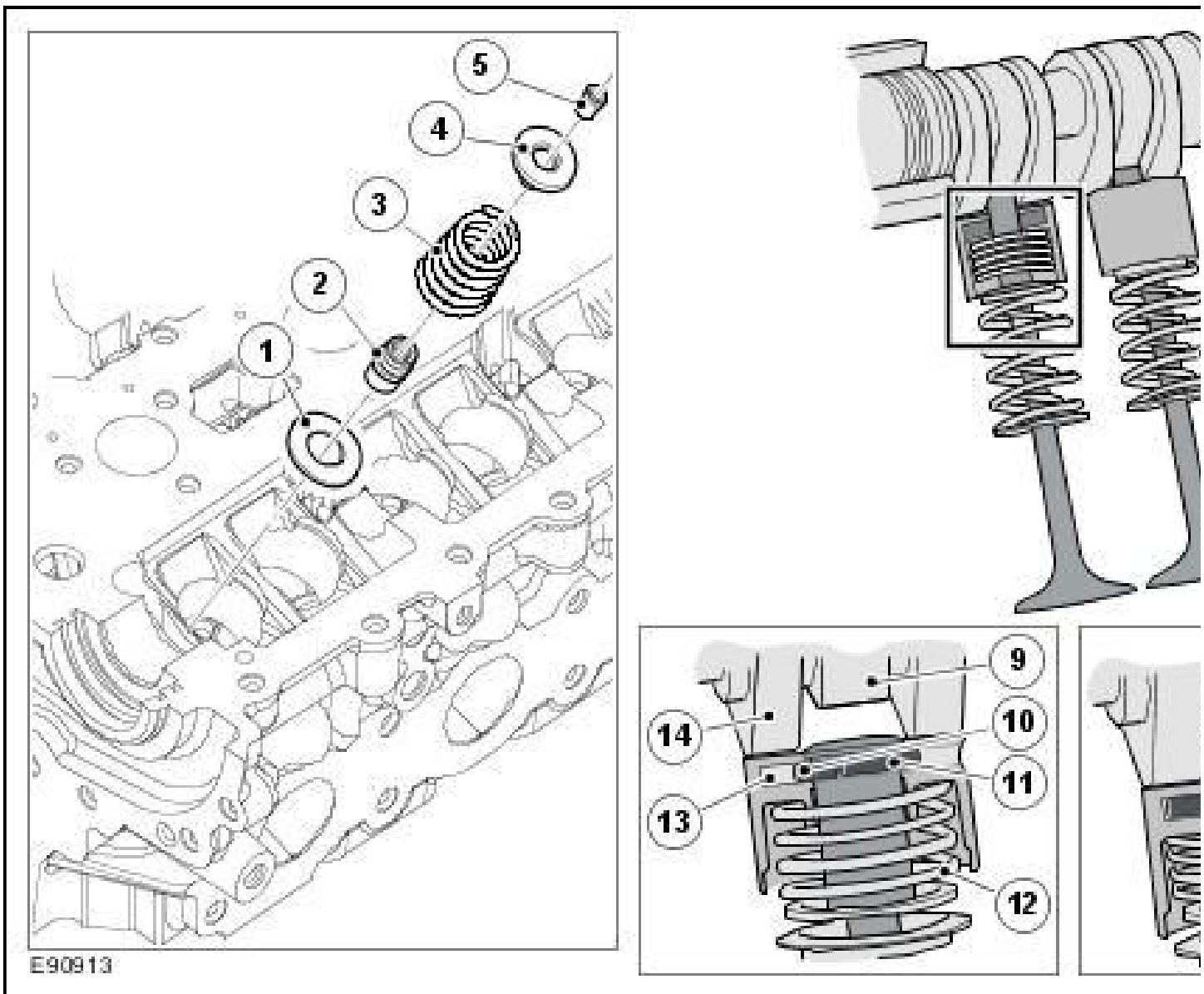
The camshafts are of a hollow steel tube construction, drilled to save weight. Each camshaft is retained in the

cylinder head by the camshaft housing. The intake camshaft is equipped with a VCT unit and also drives the vacuum pump.

The intake camshaft has cam lobes with different profiles. One for a small lifting height of 3.6 mm, and 1 for larger lifting height of 10.0 mm. The transition between the lifting heights is controlled via the Camshaft Profile Switching (CPS) function.

The exhaust camshaft is conventional, i.e. only has a lifting height of 10.0 mm.

#### INTAKE AND EXHAUST VALVE ASSEMBLIES



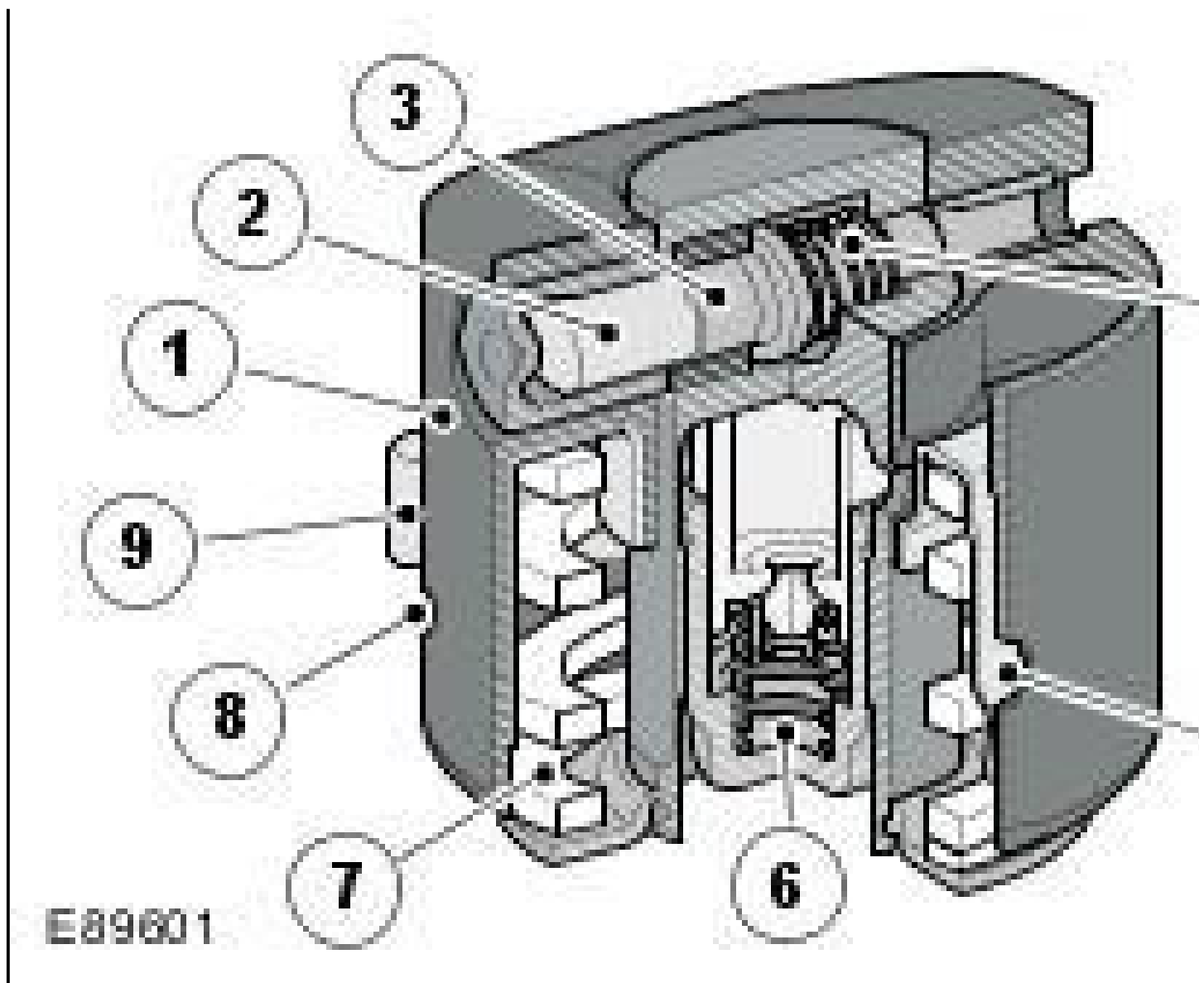
| Item Number | Description                |
|-------------|----------------------------|
| 1           | Valve spring seat (24 off) |

|    |                                              |
|----|----------------------------------------------|
| 2  | Valve stem seal (24 off)                     |
| 3  | Valve spring (12 off intake, 12 off exhaust) |
| 4  | Valve spring retainer (24 off)               |
| 5  | Valve spring collets (48 off)                |
| 6  | Intake camshaft                              |
| 7  | Hydraulic tappet, inner                      |
| 8  | Tappet, outer                                |
| 9  | Cam lobe, central (smaller lifting height)   |
| 10 | Locking pin, outer                           |
| 11 | Locking pin, inner                           |
| 12 | Return spring, outer tappet                  |
| 13 | Oil inlet                                    |
| 14 | Cam lobes, outer (greater lifting height)    |

The cylinder head incorporates 2 overhead camshafts operating 4 valves per cylinder via hydraulic tappets for the intake camshaft and mechanical tappets for the exhaust camshaft.

### Camshaft Profile Switching

CPS is a system where the intake valves, at engine speeds up to approximately 3000 rpm, have a small lifting height of 3.6 mm, and at speeds above approximately 3000 rpm, have a greater lifting height of 10.0 mm. CPS, in combination with the VCT function makes it possible to control the cylinders' incoming air quantity in such a way that the Electronic Throttle Actuator (ETA) can be fully open. A fully open ETA, during operation, reduces the pump losses considerably compared with when the amount of intake air is controlled by the ETA itself. Reduced pump losses, in turn, cause a reduction in fuel consumption.



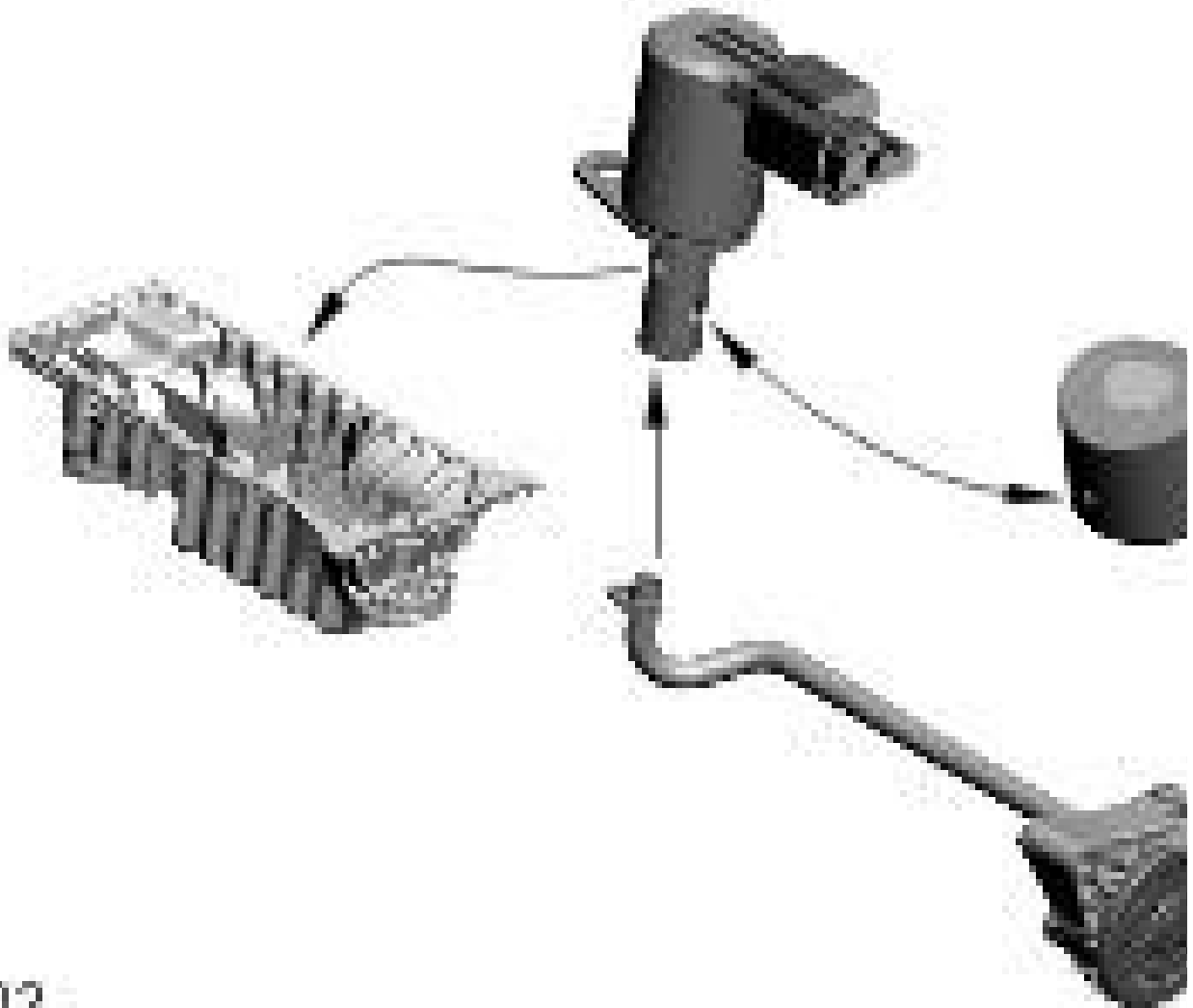
| Item Number | Description                           |
|-------------|---------------------------------------|
| 1           | Outer tappet                          |
| 2           | Locking pin, outer                    |
| 3           | Inner tappet                          |
| 4           | Locking pin with spring, inner        |
| 5           | Oil inlet, hydraulic valve adjustment |
| 6           | Hydraulic valve adjustment unit       |
| 7           | Return spring, outer tappet           |
| 8           | Lug                                   |
| 9           | Oil inlet, CPS function               |

The electrical hydraulic valves are seat valves.

The valves have 3 inputs/outputs:

- Inlet, oil supply
- To/from tappet
- To return, i.e. oil pan

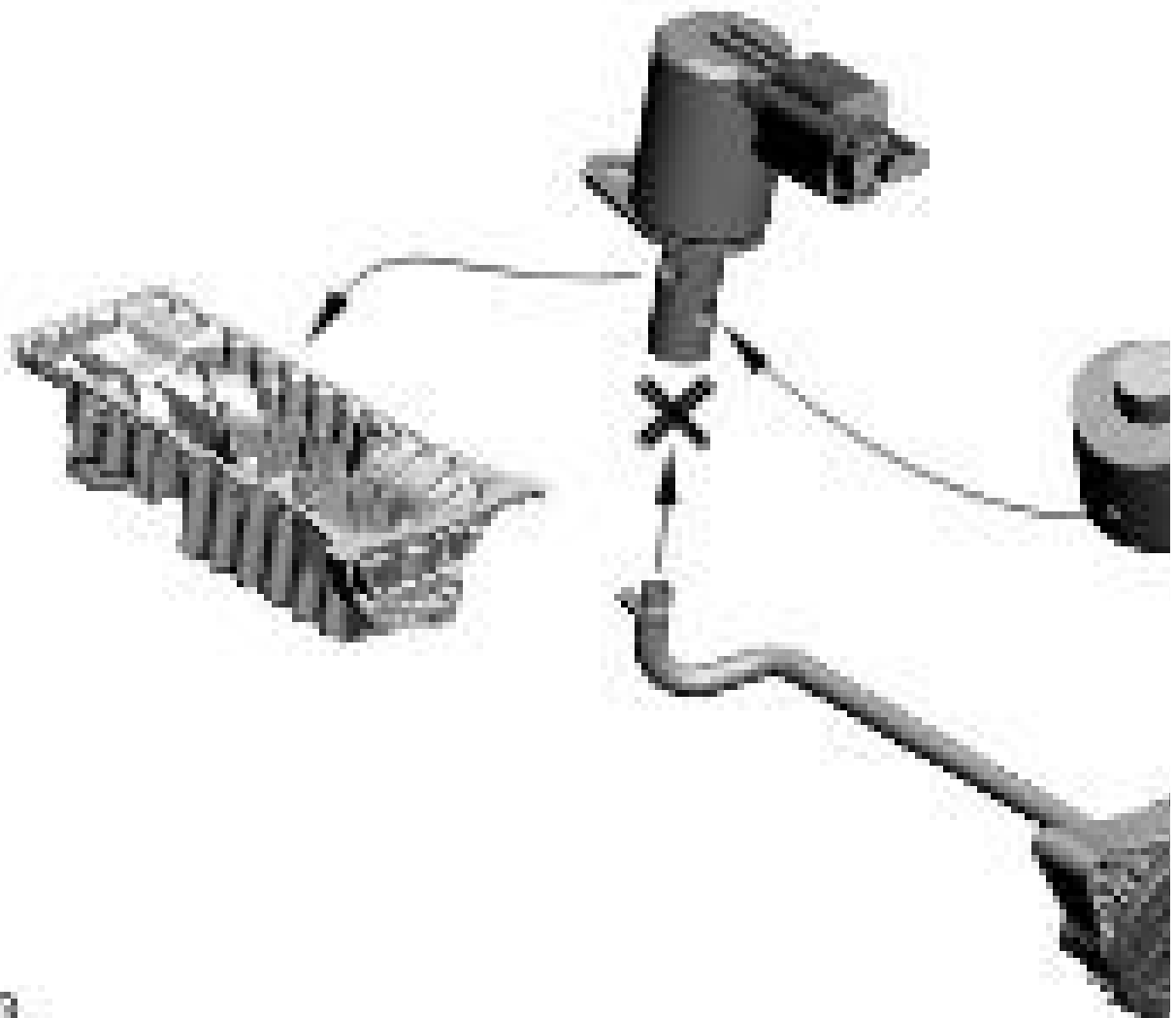
A solenoid is affected via an electro-magnet, which affects a valve that can assume 2 positions.



**E89602**

When the solenoid is not activated, the valve is only affected by the oil pressure on the intake side. The valve closes for intake but opens between the tappet and return.

The oil pressure is low at the tappet's outer locking pin and the valves lift a small amount.

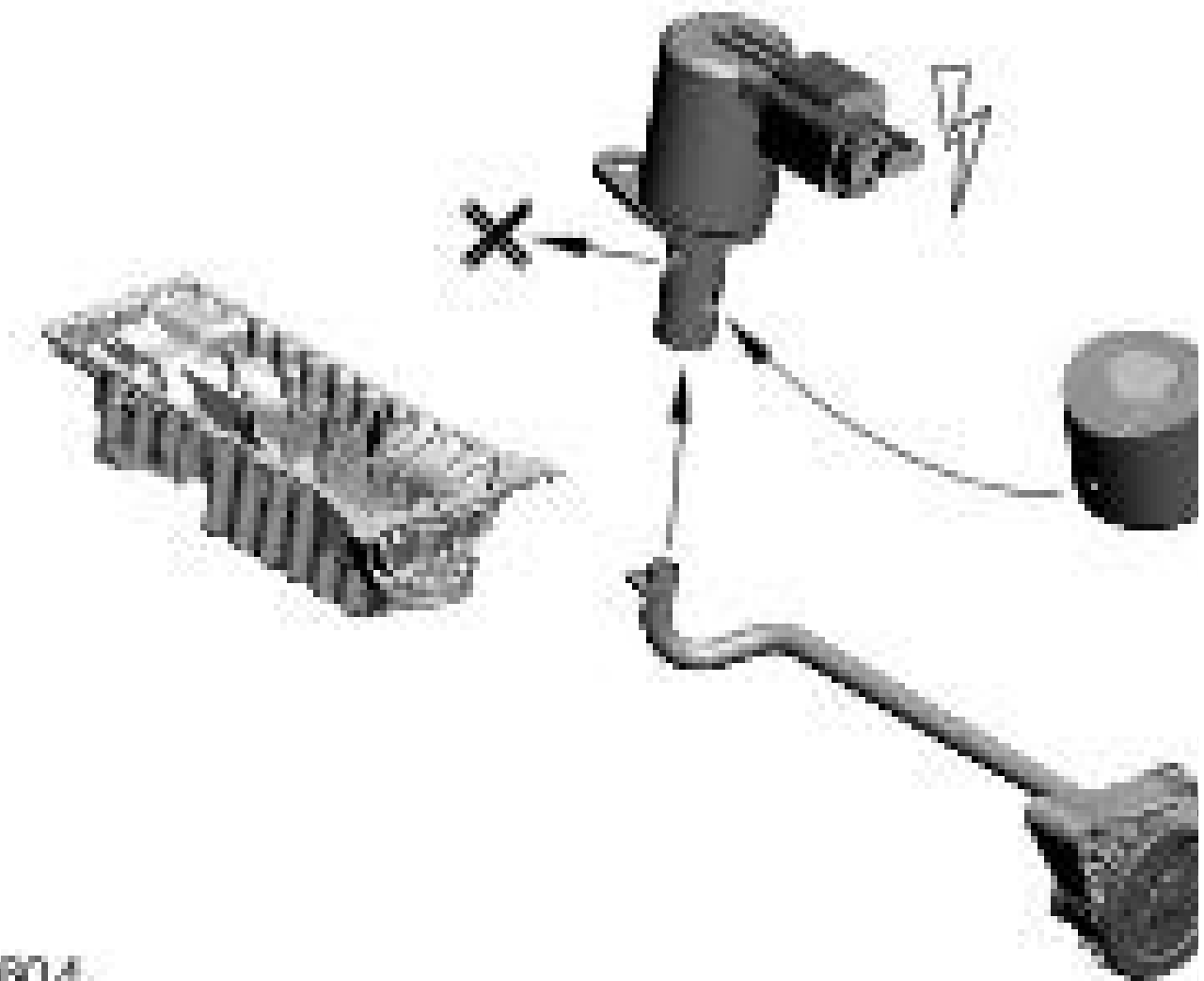


E89003

When the solenoid is activated, the valve is affected from above by an electro-magnet that overpowers the force of the oil pressure.

The valve shifts position and closes between the tappet and return but opens the connections between intake and tappet.

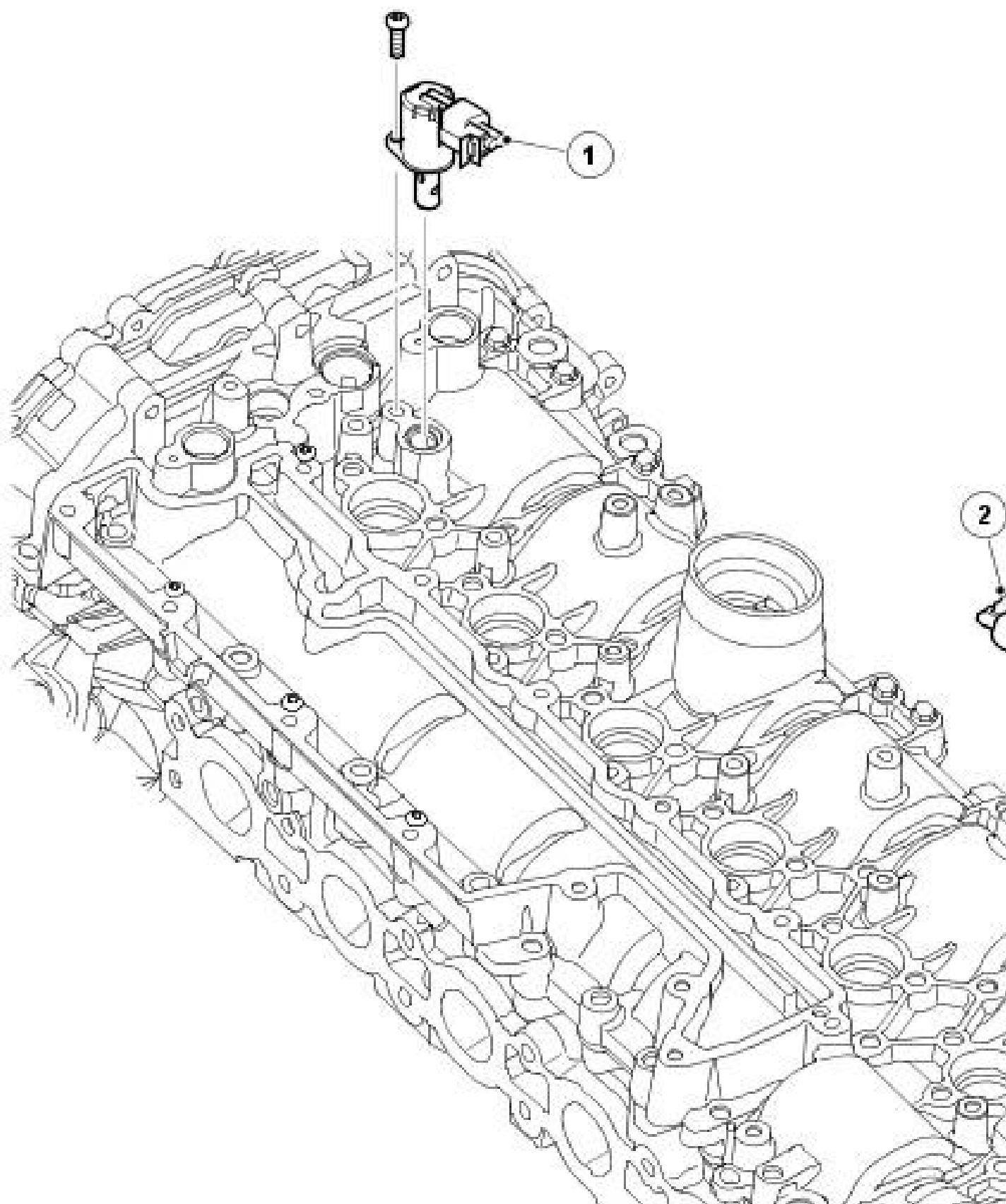
The oil pressure is high at the tappet's outer locking pin that is lifted and affects the inner locking pin. Outer and inner tappet connect and the valves lift a greater amount.



The intake camshaft is equipped with 3 lobes for each valve. One centrally located with a small lifting height of 3.6 mm, and 2 outer lobes with greater (same) lifting heights of 10.0 mm.

At small lifting heights, only the centrally located lobe works on the valve, which occurs via the inner tappet. The outer lobes work on the outer tappet that follows the movement of the lobes. The return spring is compressed and ensures that the tappet is always in contact with the camshaft. When the centrally located tappet and the outer tappet are not joined, the outer tappet moves without affecting the valve. Thus the lifting height is small. At high lifting height, the inner tappet and the outer tappet are joined via the 2 lock pins.

The position of the lock pins is controlled hydraulically by 2 electro-hydraulic CPS solenoid valves. These valves are located in the camshaft housing.



| Item Number | Description                               |
|-------------|-------------------------------------------|
| 1           | CPS solenoid valve - cylinders 3, 5 and 6 |
| 2           | CPS solenoid valve - cylinders 1, 2 and 4 |

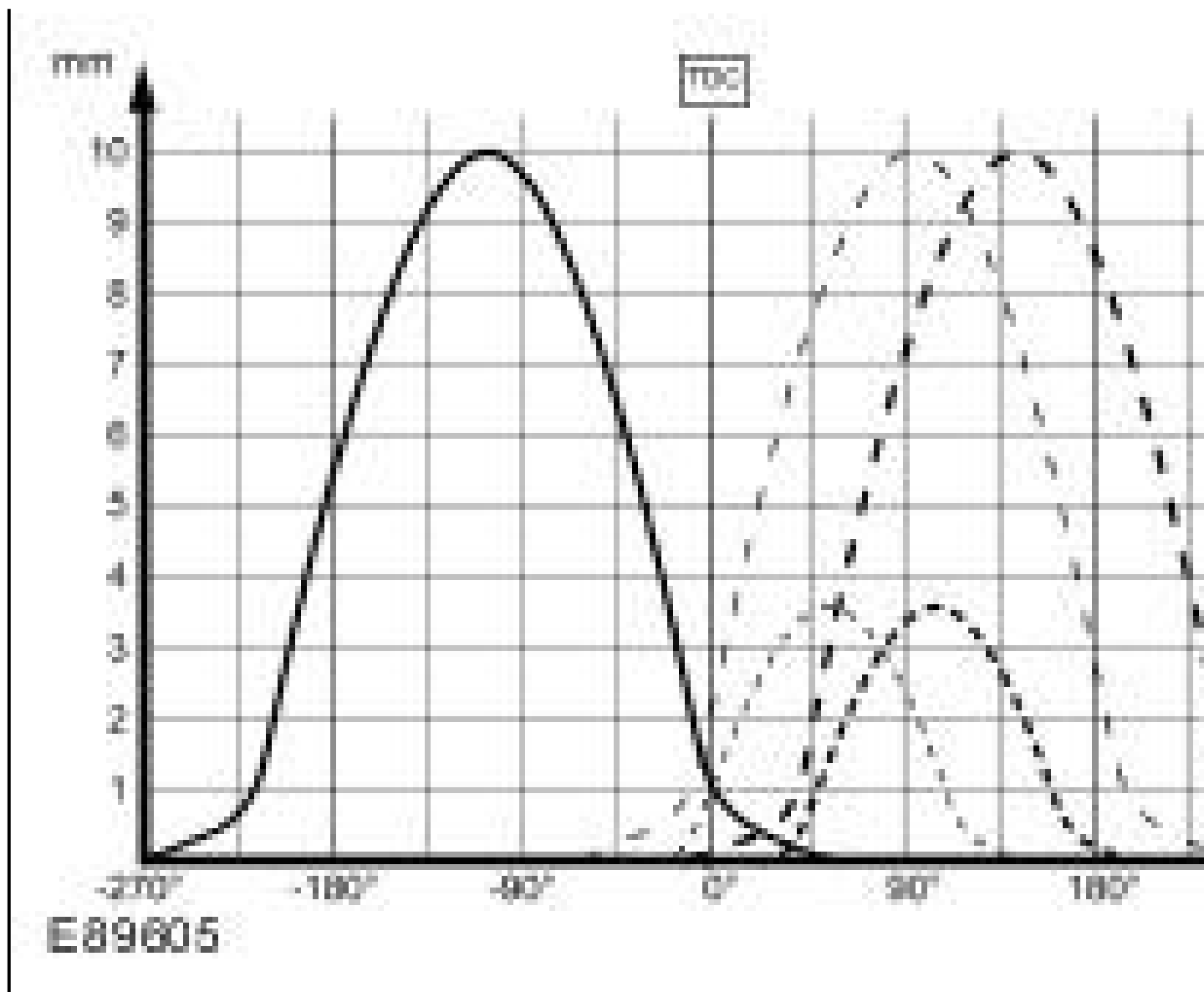
One solenoid controls the valves for cylinders 1, 2 and 4 whilst the other controls the valves for cylinders 3, 5 and 6. The solenoids therefore control 6 valves each (when the engine has 2 intake valves and 2 exhaust valves per cylinder).

The position of the solenoids valves, on or off, are controlled by the ECM Refer to **Electronic Engine Controls** . .

The inner tappet works like a hydraulic tappet, which compensates for any wear. The valve clearance is therefore '0'.

The exhaust camshaft is conventional and has a lifting height of 10.0 mm. The tappets are mechanical (i.e. have valve clearance).

#### Camshaft Data



### Intake

- Opening angle, 3.6, mm lifting height:

Crankshaft degrees - 152°

Crankshaft degrees - 76°

- Opening angle, 10.0 mm lifting height:

Crankshaft degrees - 240°

Crankshaft degrees - 120°

**Exhaust**

- Opening angle, 10.0 mm lifting height:

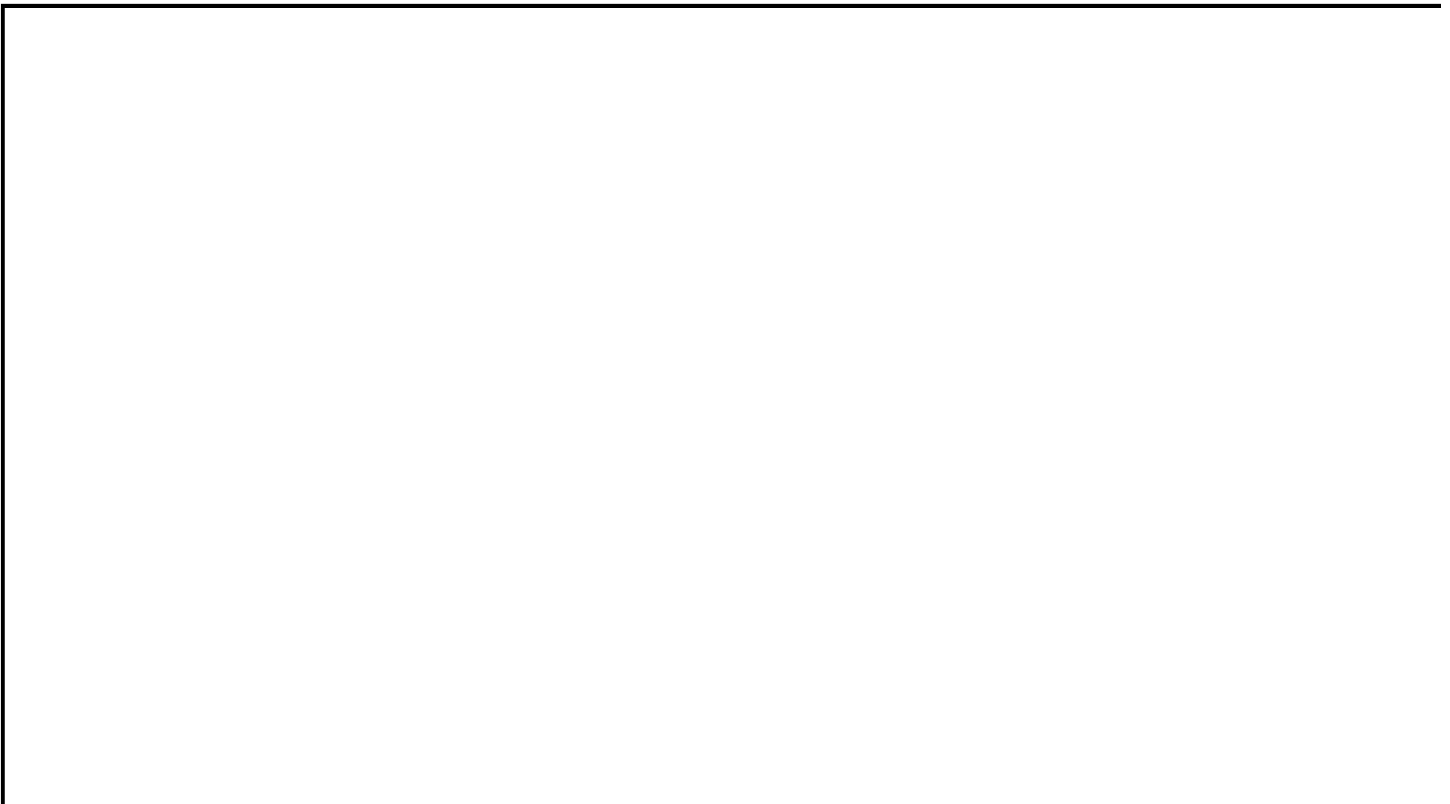
Crankshaft degrees - 240°

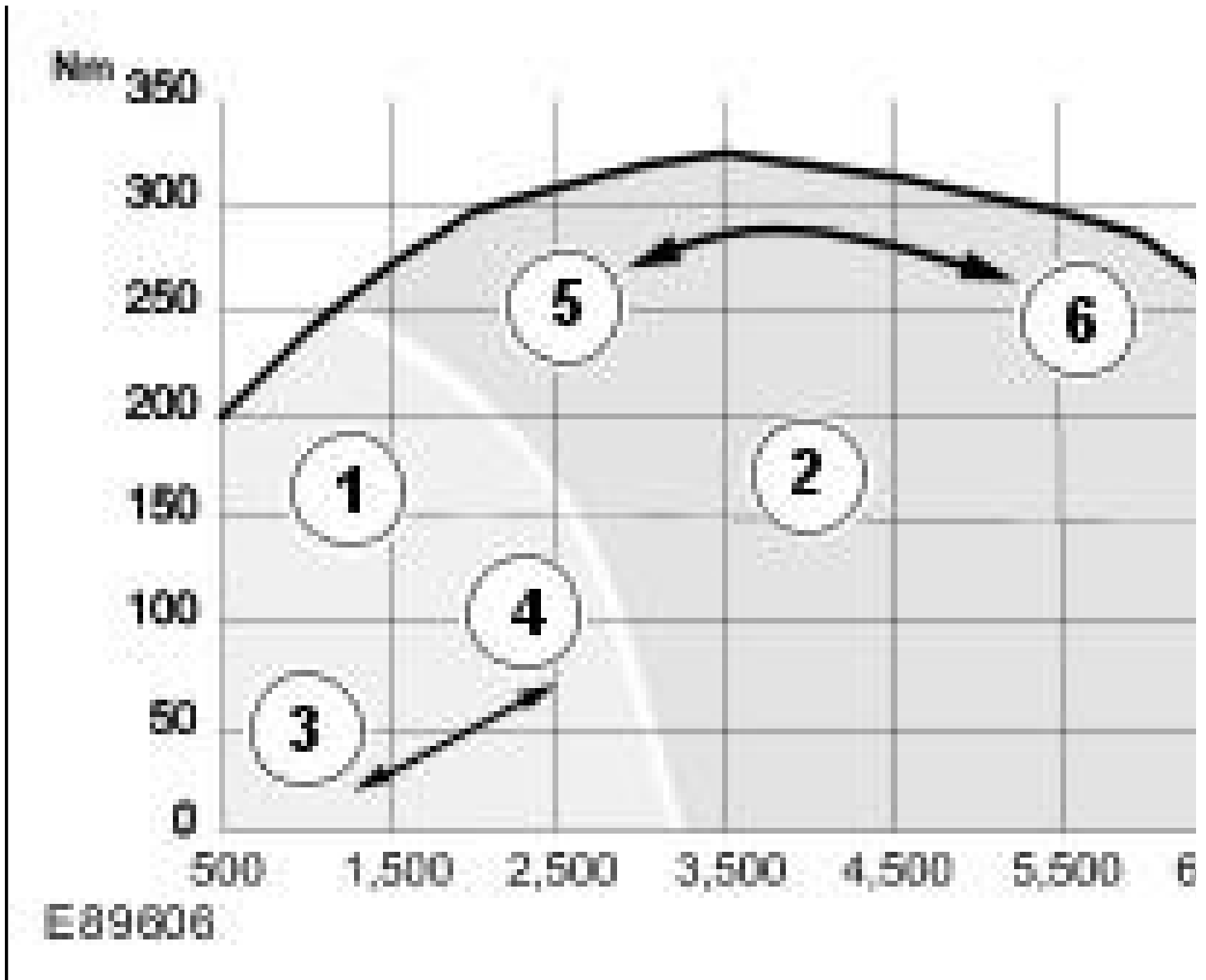
Crankshaft degrees - 120°

The intake camshaft has a VCT unit.

| Lifting height          | Opens                 | Closes                                       |
|-------------------------|-----------------------|----------------------------------------------|
| <b>Intake 3.6 mm</b>    | 32 BTDC to 28 ATDC    | 120 ATDC to 180 ATDC (or 60 BBDC to 0 BBDC)  |
| <b>Intake 10.0 mm</b>   | 37 BTDC to 23 ATDC    | 203 ATDC to 263 ATDC (or 23 ABDC to 83 ABDC) |
| <b>Exhaust, 10.0 mm</b> | 228 BTDC (or 48 BBDC) | 12 ATDC                                      |

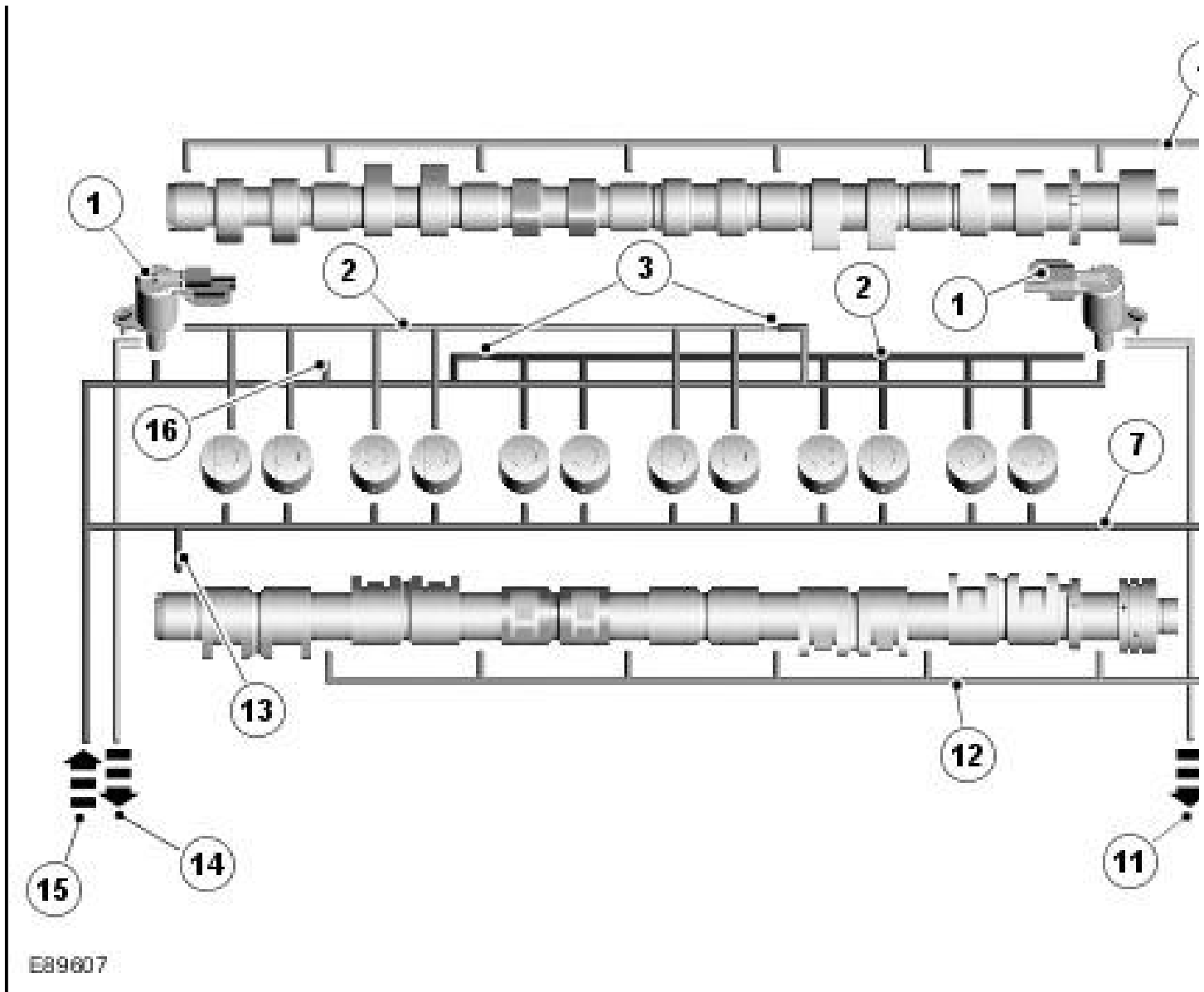
- BTDC = Before Top Dead Centre
- ABDC = After Bottom Dead Centre
- BBDC = Before Bottom Dead Centre
- ATDC = After Top Dead Centre

**Camshaft Position in Relation to Load and RPM**



| Item Number | Description                            |
|-------------|----------------------------------------|
| 1           | Range for lifting height 3.6 mm        |
| 2           | Range for lifting height 10.0 mm       |
| 3           | Small lifting height, 'early' camshaft |
| 4           | Small lifting height, 'late' camshaft  |
| 5           | Large lifting height, 'early' camshaft |
| 6           | Large lifting height, 'late' camshaft  |

By closing the intake valves early at low load and low engine speed, reduced fuel consumption is achieved.



E89607

| Item Number | Description                                      |
|-------------|--------------------------------------------------|
| 1           | CPS solenoid valve (x 2)                         |
| 2           | Oil circuit, tappet CPS function                 |
| 3           | Calibrated passage (choke)                       |
| 4           | To bearing, exhaust camshaft                     |
| 5           | Tensioner, camshaft chain                        |
| 6           | Nozzle, camshaft chain lubrication               |
| 7           | Oil circuit, hydraulic adjusting valve clearance |
| 8           | Vacuum pump                                      |
| 9           | VCT unit                                         |
| 10          | Oil inlet, rear                                  |

|    |                                   |
|----|-----------------------------------|
| 11 | Return                            |
| 12 | To bearing, intake camshaft       |
| 13 | To front bearing, intake camshaft |
| 14 | Return                            |
| 15 | Oil inlet, front                  |
| 16 | Bleeding                          |

The oil inlet, located on the front edge of the cylinder, supplies oil to the following:

- The hydraulic tappets
- The vacuum pump
- The nozzle for cam chain lubrication
- The intake camshaft's front bearing
- The electro-hydraulic CPS solenoid valves, front and rear
- The tappets with CPS function

There is a bleed valve (16) in the duct for the rear electro-hydraulic solenoid valves.

The duct is also equipped with 2 calibrated passages (3) to each tappet circuit (2) (i.e. the circuits after the CPS solenoid valves). A continuous flow through the circuit ensures the necessary stable pressure differences that are necessary for a stable transfer between the small and large tappet (or vice versa).

**NOTE:** In the event of a small lifting height, the tappet circuit, in principle, has no pressure when the CPS valves are open, which produces a return flow to the oil pan.

A filter is located in each passage.

The oil inlet, located on the rear edge of the cylinder, supplies oil to the following:

- The camshaft chain's hydraulic tensioner
- The intake camshaft VCT unit
- The intake camshaft's bearings
- The exhaust camshaft's bearings

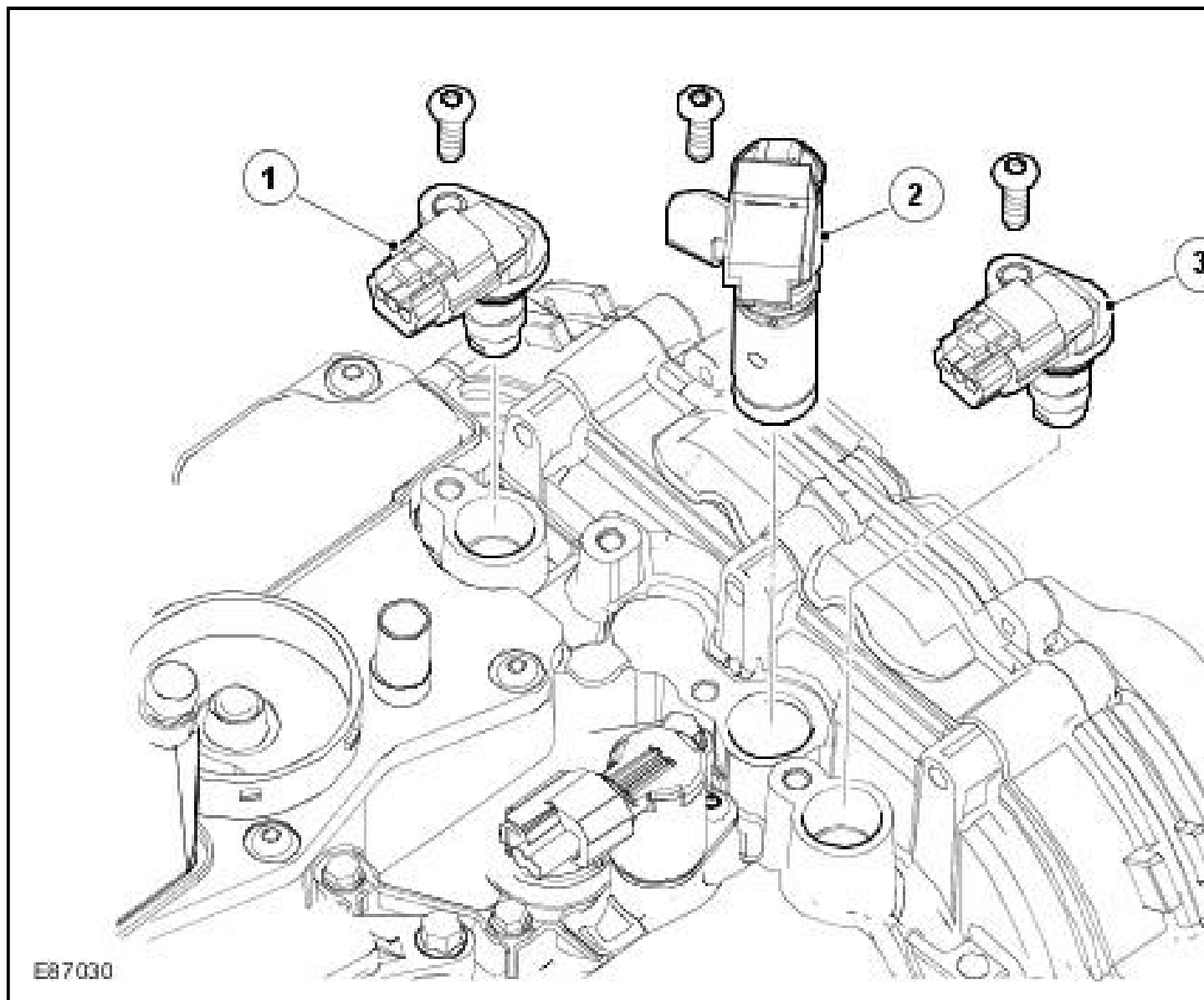
To switch from low lift to high lift and vice versa as smoothly as possible, the transfer is only permitted when certain conditions are completed. These are:

- That the oil temperature is above +40°C (104°F). Calculated internally in the ECM, from, amongst other things, the coolant temperature
- Occasionally the volumetric efficiency is the same for low and high lift, which means that the air requirement is within a range where it can be managed initially by VCT control. This is to achieve as soft a transfer as possible.

- It is possible to adjust ignition timing to prevent torque peaks during CPS control

Refer to **Electronic Engine Controls** .

#### VARIABLE CAMSHAFT TIMING SOLENOID AND CAMSHAFT POSITION SENSORS



| Item Number | Description                   |
|-------------|-------------------------------|
| 1           | CMP Sensor - exhaust camshaft |
| 2           | VCT solenoid                  |
| 3           | CMP Sensor - intake camshaft  |

The profile, or position and shape of the camshaft lobes are optimized for a certain engine rpm, but this

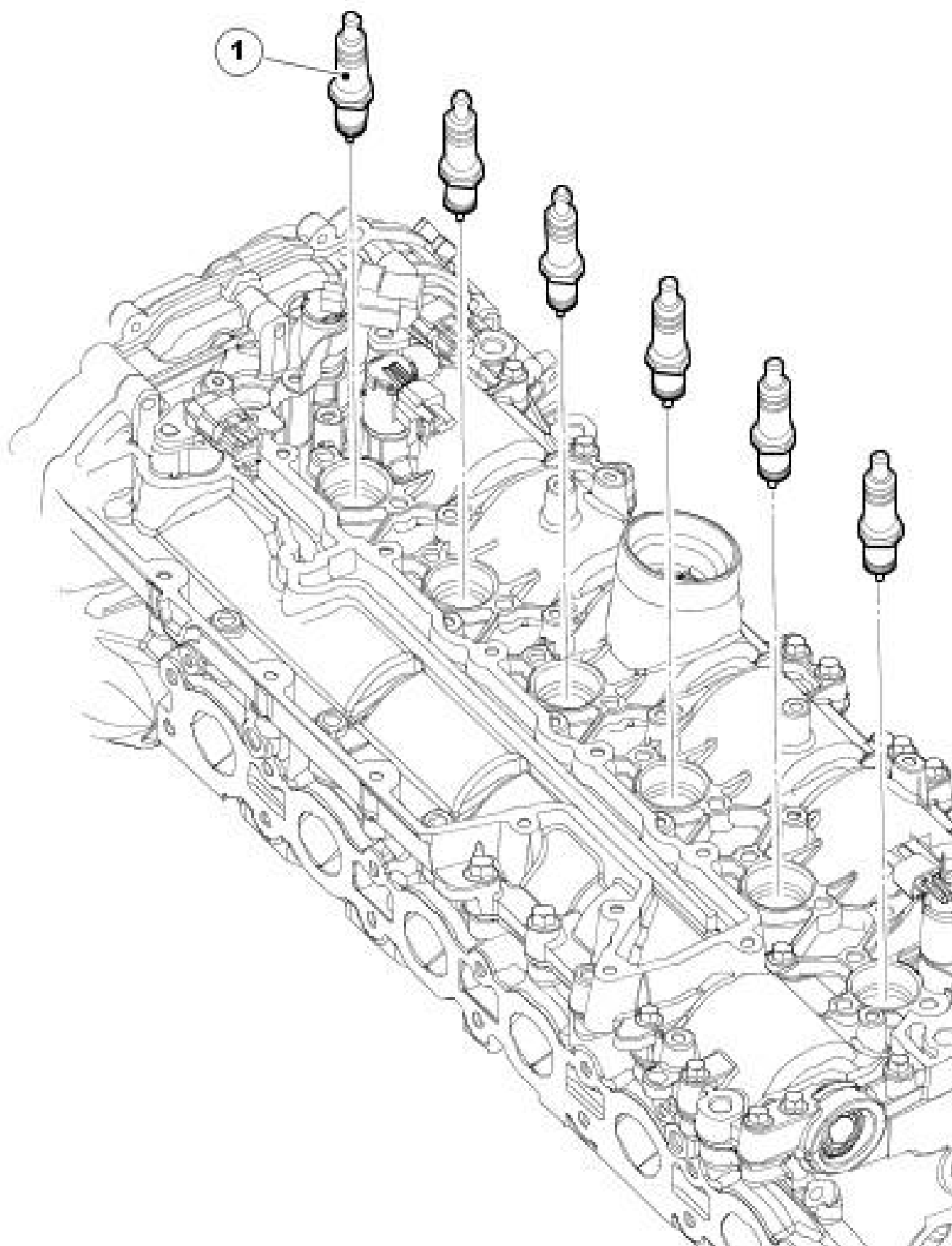
normally limits low-end torque or high-end power. At high engine speeds, an engine requires large amounts of air. However, the intake valves may close before all the air has been given a chance to flow in. On the other hand, if the camshaft keeps the valves open for longer periods of time, problems start to occur at the lower engine speeds. This will cause unburnt fuel to exit the engine since the valves are still open.

To overcome this, VCT changes the valve timing by either advancing or retarding the camshafts to allow for optimum engine performance, reduced emissions, and increased fuel efficiency. This is achieved via an electronically controlled hydraulic solenoid valve located in the camshaft housing at the rear of the engine, behind the rear CPS solenoid. The ECM transmits a signal to the solenoid, which directs engine oil into the VCT unit. A valve spool in the VCT unit regulates the flow of oil. Refer to **Electronic Engine Controls** . .

There are 2 CMP sensors located in the camshaft housing. The CMP sensors monitor the position of the camshafts to establish ignition timing order, fuel injection triggering and for accurate VCT camshaft advance-retard timing feedback.

The CMP sensor is a Hall-effect sensor, which switches a battery fed supply on and off. The supply is switched when the teeth of the reluctor pass by the tip of the sensor. The 4 teeth are of differing shapes, so the ECM can determine the exact position of the camshaft at any time. Refer to **Electronic Engine Controls** .

#### SPARK PLUGS



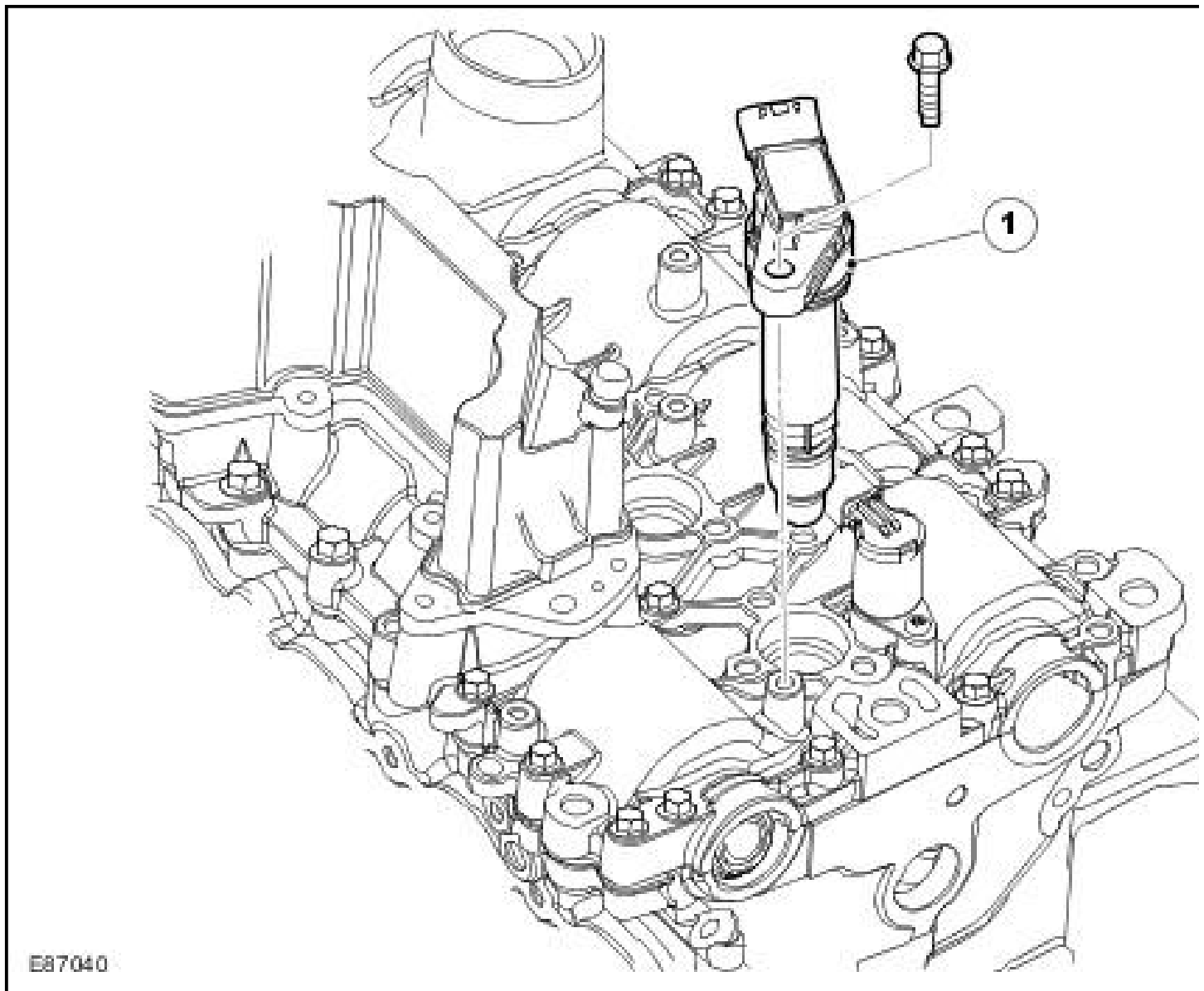
## 2009 Land Rover LR2 HSE

### ENGINE Engine Mechanical

| Item Number | Description       |
|-------------|-------------------|
| 1           | Spark plug (6 of) |

The spark plugs screw into the cylinder head through the camshaft housing and are controlled by the ECM via individual coils.

#### IGNITION COILS



| Item Number | Description          |
|-------------|----------------------|
| 1           | Ignition coil (6 of) |

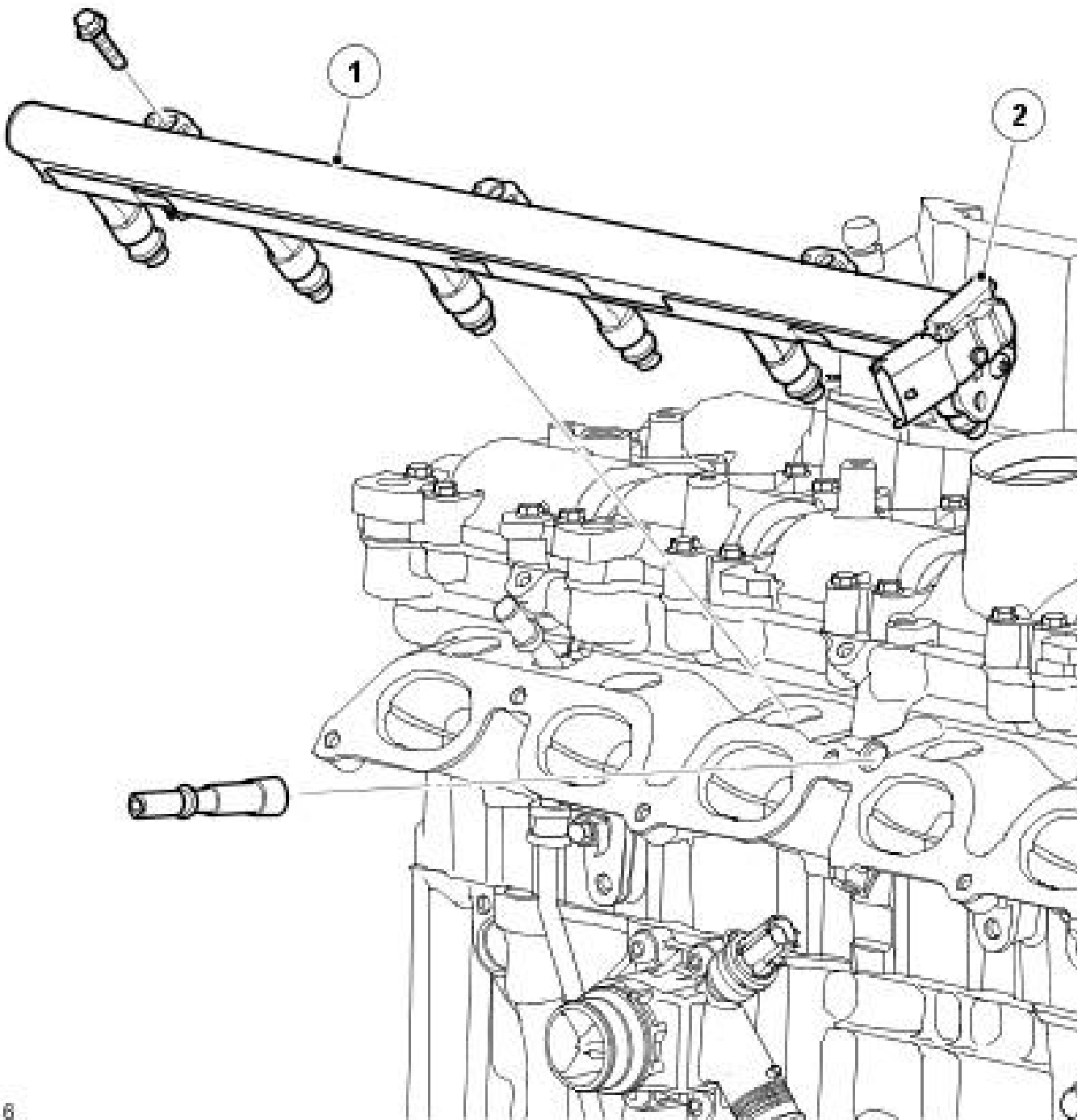
The ECM uses a separate ignition coil for each spark plug. The ignition coils are of the plug top design, which

attach to the top of the spark plug. The coils are secured to the camshaft housing with a bolt.

The coil has a rubber seal, which seals the coil in the spark plug hole in the cylinder head, preventing the ingress of moisture and debris around the spark plug. These coils eliminate the requirement for HT leads, which in turn improves the ignition system reliability.

Each coil has a 3-pin female connector, which provide for a battery voltage ignition feed, an earth for the secondary winding and a primary winding negative (switch) terminal. The switch terminal of each coil is connected to a separate pin on the ECM to allow independent switching. Refer to **Electronic Engine Controls** .

#### **FUEL RAIL AND INJECTORS**



E87036

| Item Number | Description                               |
|-------------|-------------------------------------------|
| 1           | Fuel rail                                 |
| 2           | Fuel rail pressure and temperature sensor |

3

Fuel pressure pipe

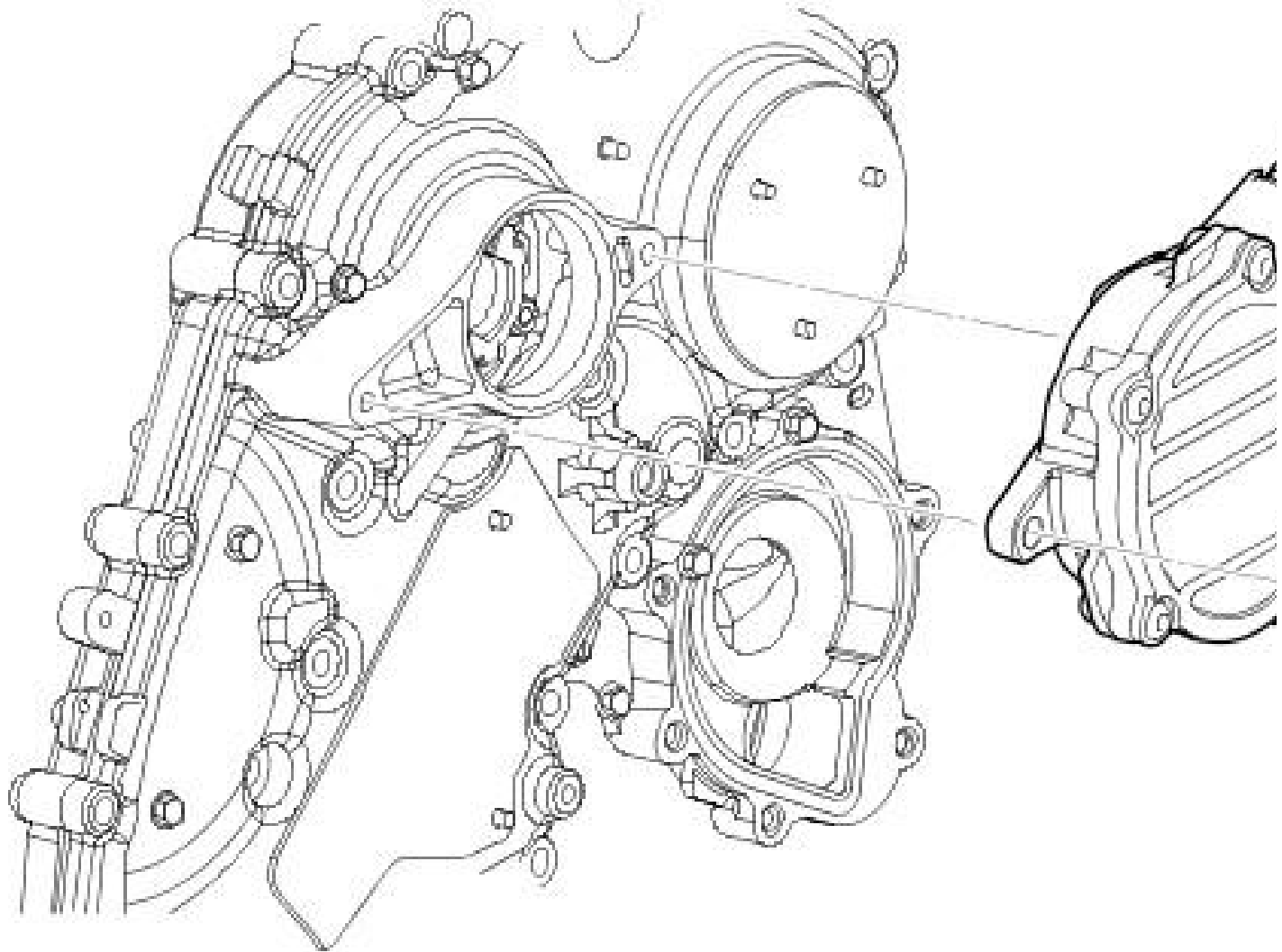
The fuel rail maintains a fuel pressure of 3.8 bar (55 psi) above manifold depression under normal operating conditions, though this is programmed to rise to 4.2 bar (61 psi) in response to either:

- Cold start conditions, to improve fuel vaporization
- Cold fuel conditions, as the colder the fuel the higher viscosity

The fuel rail is attached to the intake side of the cylinder head with 3 bolts. Six fuel injectors are installed in the cylinder head and connected to the fuel rail. 'O' ring seals are used to seal the injectors in both the fuel rail and cylinder head. A connection for the fuel pressure pipe is located between injectors 1 and 2.

There is a fuel rail pressure and temperature sensor located at the end of the fuel rail, next to injector number 6. The pressure sensor continuously monitors the fuel pressure in the fuel rail, this value is used by the ECM to calculate the injector pulse-width required to deliver the correct mass of fuel per injection. The temperature sensor measures the temperature of the fuel in the fuel rail. This input is then used to deliver the correct quantity of fuel to the engine. Refer to **Electronic Engine Controls** .

#### VACUUM PUMP



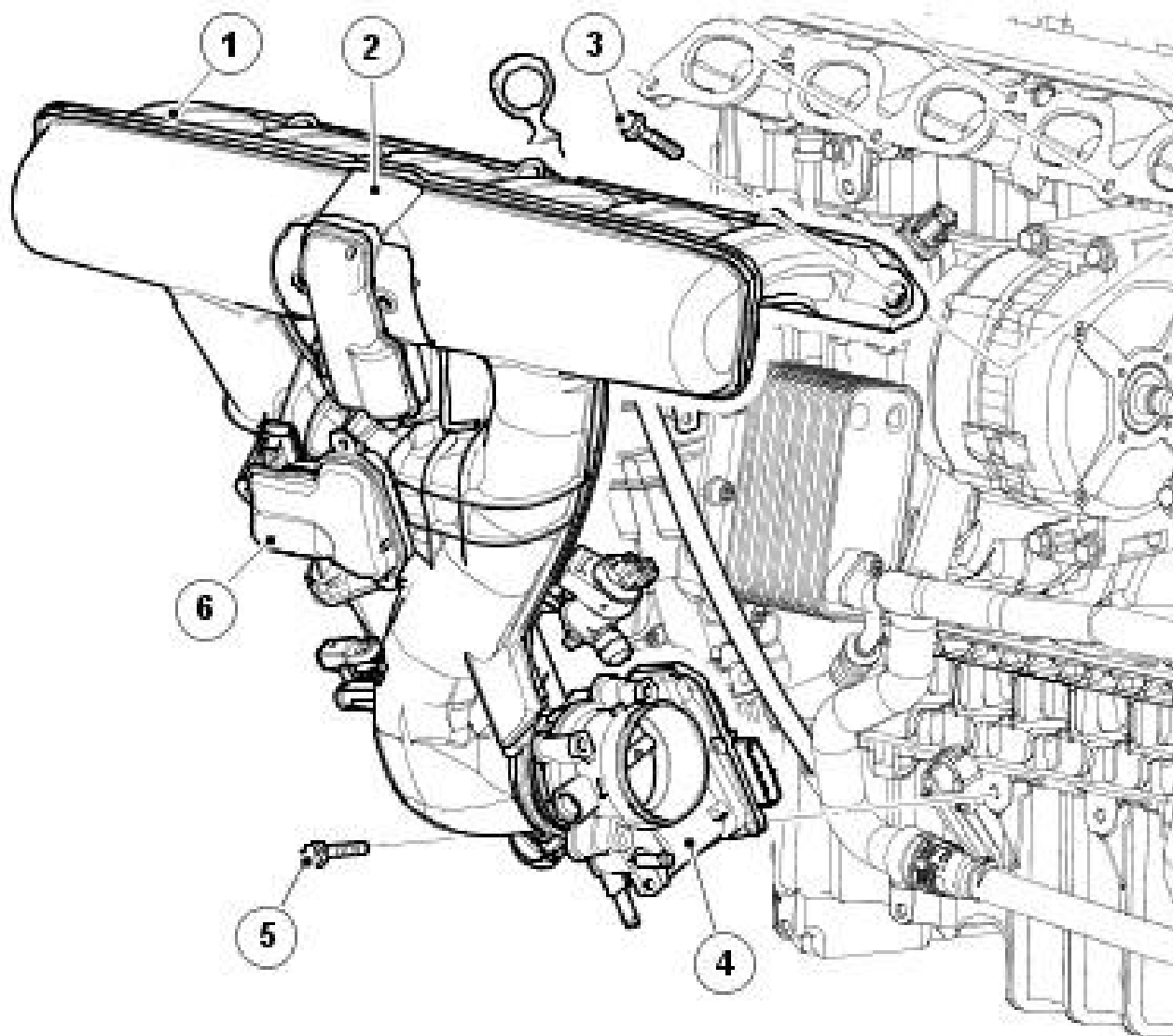
E87033

| Item Number | Description |
|-------------|-------------|
| 1           | Vacuum pump |

The intake camshaft is equipped with the VCT unit. The intake camshaft also drives the vacuum pump.

**NOTE:** When installing the vacuum pump make sure the slot in the VCT unit and the vacuum pump coupling are in the vertical position to aid installation. The vertical position is marked on the vacuum pump housing by 2 raised lines.

#### INTAKE MANIFOLD



E90915

| Item Number | Description              |
|-------------|--------------------------|
| 1           | Intake manifold          |
| 2           | Variable plenum valve    |
| 3           | Bolt (7 of)              |
| 4           | Throttle body and module |
| 5           | Bolt (2 of)              |
| 6           | Variable tract valve     |

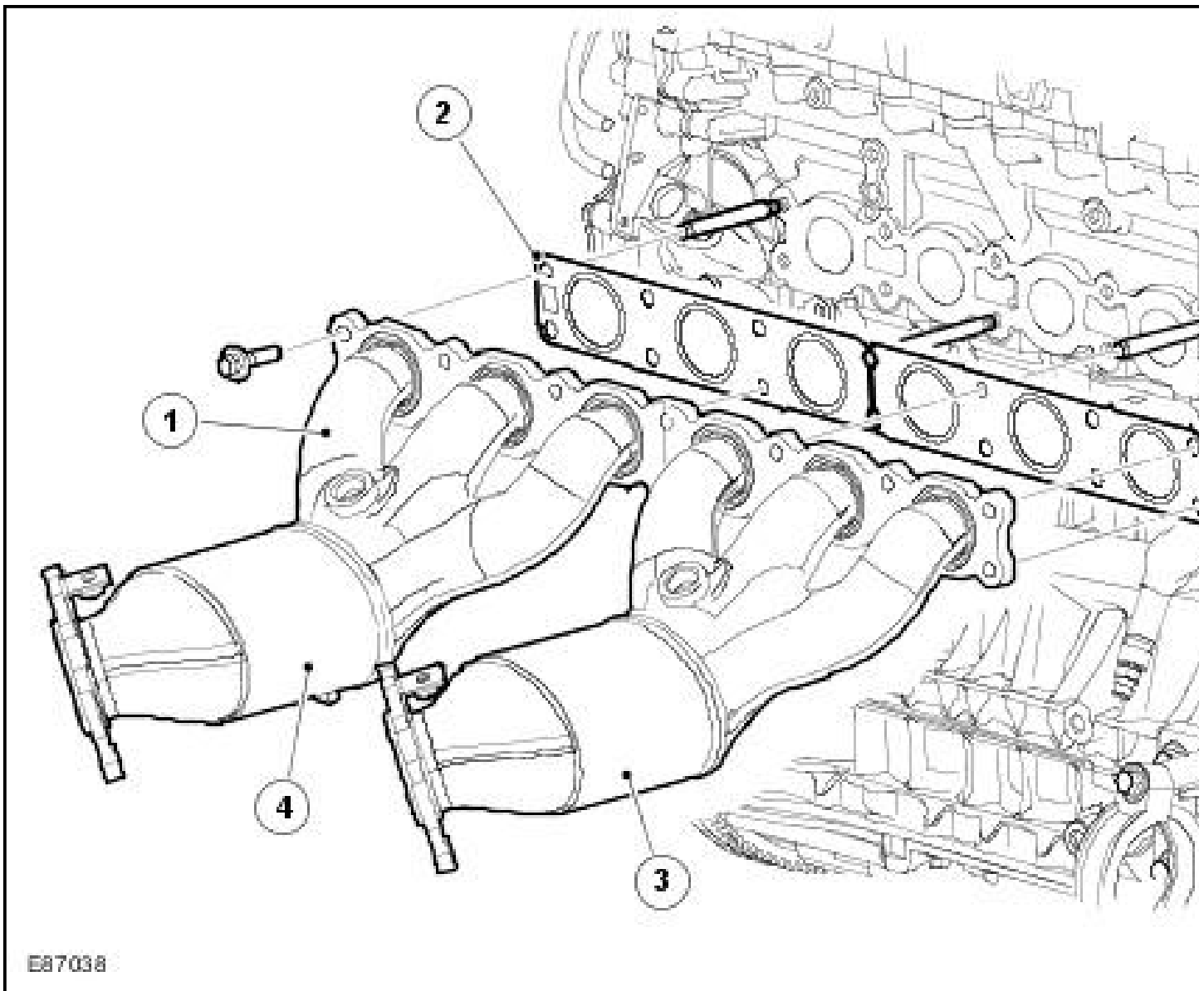
The intake manifold attaches to the cylinder head with 6 bolts and the oil pan with 2 bolts.

The manifold is capable of varying both intake tract length and plenum volume by means of 2 separate valves.

At low engine speeds, long intake tracts are utilized to provide optimum engine torque. Shorter tracts are used at medium speeds, again, to optimize engine torque for the existing engine speed range.

At higher engine speeds the benefits of optimizing the tract lengths are outweighed by the necessity of maintaining an appropriate supply of air to meet the engines requirements. Therefore, the plenum valve is opened to create a single, large plenum volume to provide the maximum quantity of air to charge the engines cylinders. Refer to **Intake Air Distribution and Filtering** .

#### EXHAUST MANIFOLD



| Item Number | Description               |
|-------------|---------------------------|
| 1           | Exhaust manifold assembly |
| 2           | Gasket                    |

|   |                                     |
|---|-------------------------------------|
| 3 | Exhaust manifold - cylinders 1 to 3 |
| 4 | Exhaust manifold - cylinders 4 to 6 |

The exhaust manifold comprises 2 separate manifold assemblies. One manifold is used for cylinders 1 to 3 and the second manifold is used for cylinders 4 to 6. The manifolds are sealed to the cylinder head with a gasket and secured with 14 bolts.

Each manifold comprises 3 fabricated branches, which merge into an integral catalytic converter. A threaded boss is positioned where the 3 branches merge and provides for the fitment of a pre-catalyst Heated Oxygen Sensor (HO2S). The catalytic converter outlets have offset flanges which mate with corresponding flanges on the front section exhaust system.

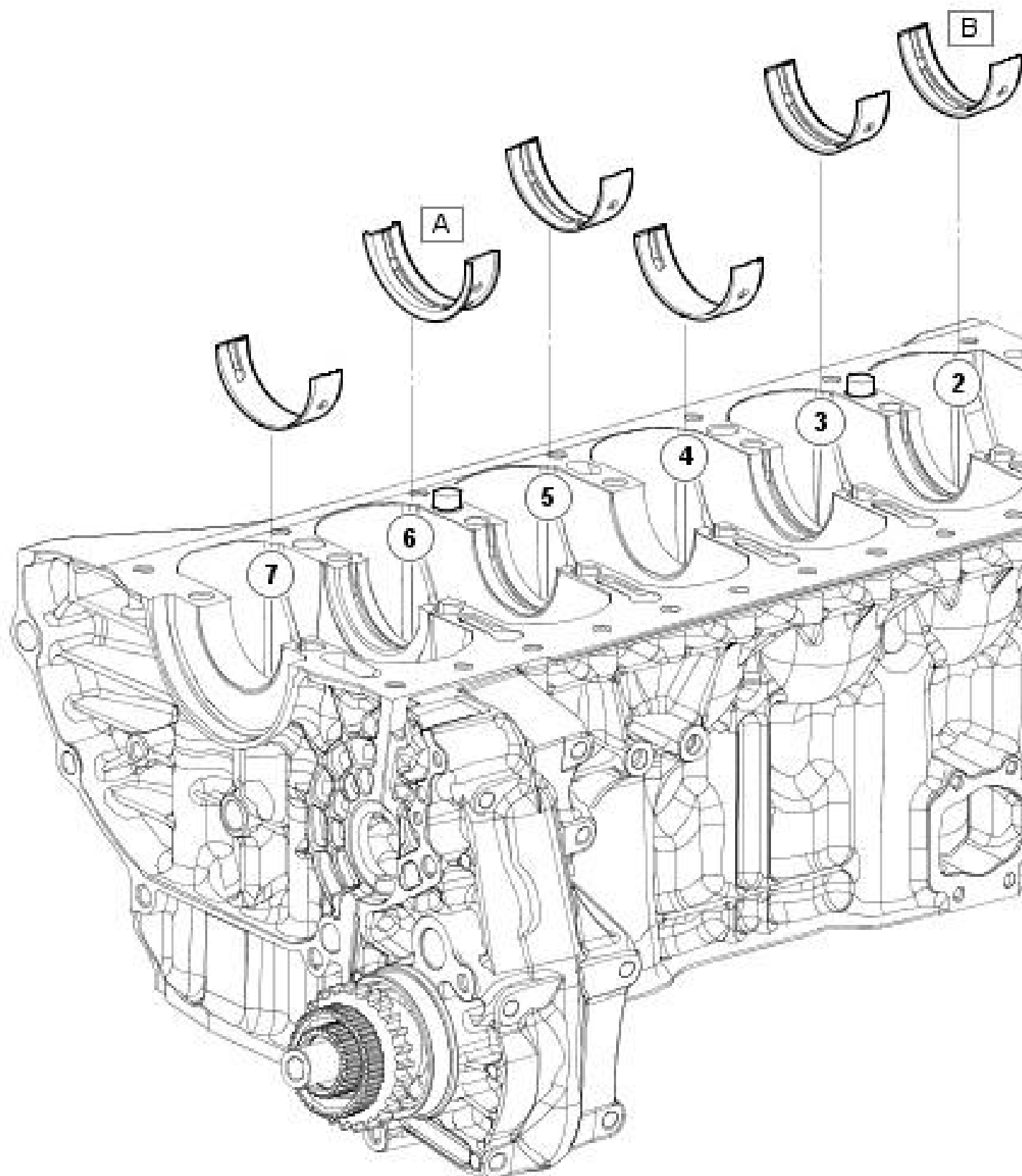
A bracket on each outlet flange allows for the attachment of an exhaust manifold heat shield.

#### **CRANKSHAFT, BEDPLATE AND OIL PAN COMPONENTS**

The crankshaft and oil pan components are:

- Crankshaft and main bearings
- Crankshaft vibration damper and cooling valve
- Bedplate
- Oil filter and cooler assembly
- Oil pump assembly
- Oil pick-up
- Oil pan
- Oil level gage
- Starter motor

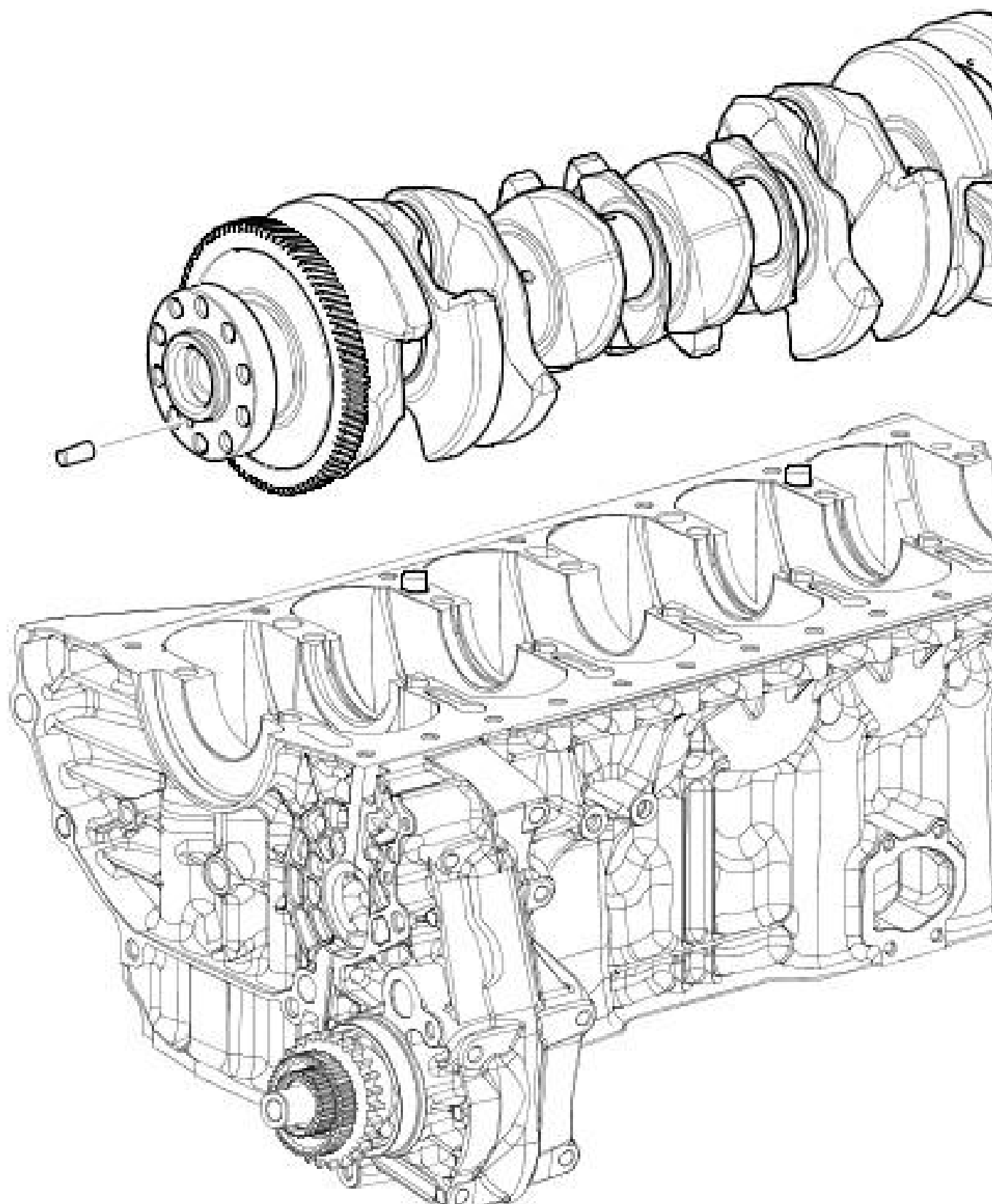
#### **CRANKSHAFT AND MAIN BEARINGS**



**2009 Land Rover LR2 HSE**

ENGINE Engine Mechanical

| Item Number | Description                                 |
|-------------|---------------------------------------------|
| A           | Thrust bearing - position 6                 |
| B           | Grooved main bearing - positions 2, 3 and 5 |
| C           | Main bearing - positions 1, 4 and 7         |



The crankshaft is made of forged steel and has induction hardened bearing surfaces. There are 2 types of aluminum main bearing:

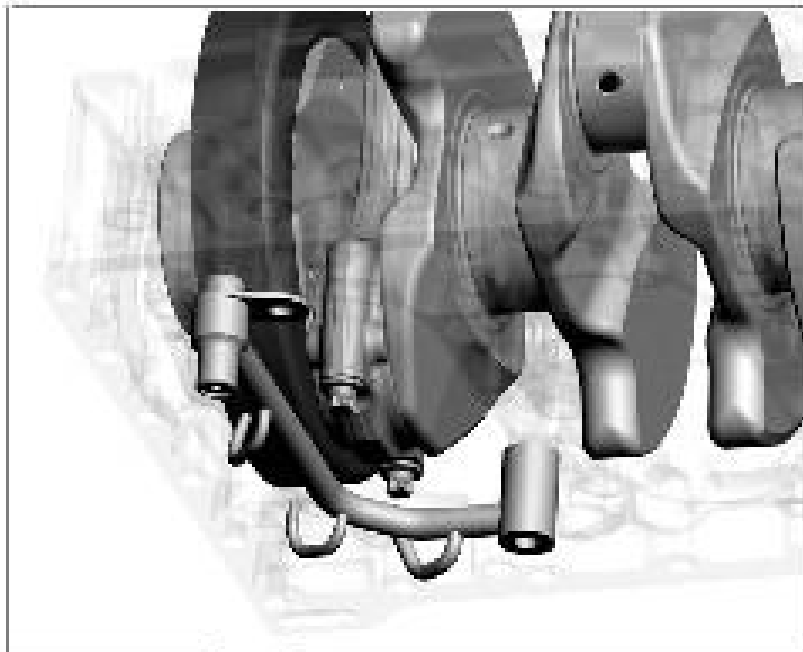
- With complete oil ducts for upper main bearings 2, 3, 5 and 6
- With short oil ducts for all lower and 1, 4 and 7 upper main bearings

Due to missing counter-weights for cylinders 1 and 6 and selected counter-balancing of the entire crankshaft, main bearings 1, 4 and 7 are exposed to greater loads than the others. To reduce the load on the bearings, bearing shells with short oil ducts are used. In addition, these main bearings have their own oil circuit where the oil is not distributed on to the connecting rod bearings. The 6th main bearing also works as a thrust bearing.

A gear wheel is crimped to the rear edge of the crankshaft. The gear wheel drives the oil pump and the Rear End Ancillary Drive (READ) timing gear.

The crankshaft has a viscous vibration damper located directly in front of the connecting rod pin for cylinder 1, i.e. located in the actual cylinder block.

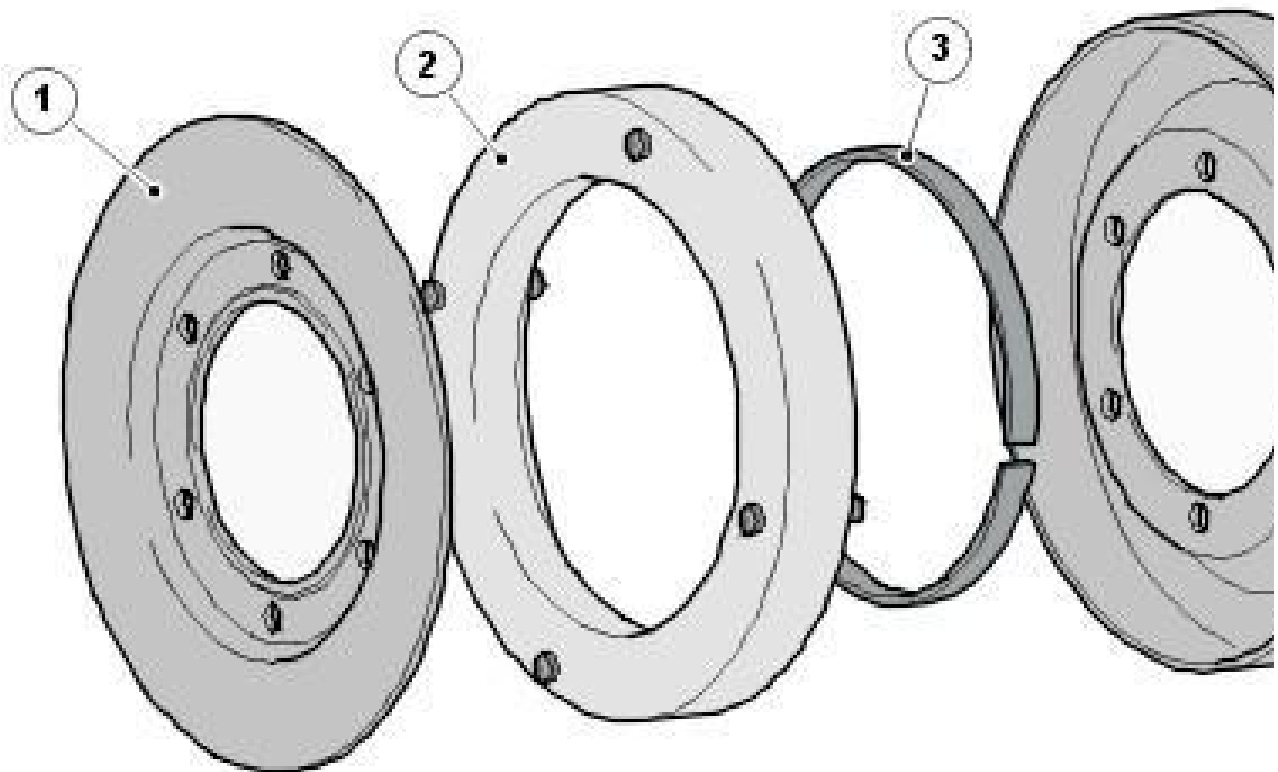
#### CRANKSHAFT VIBRATION DAMPER AND COOLING VALVE



E89594

| Item Number | Description                               |
|-------------|-------------------------------------------|
| 1           | Crankshaft vibration damper               |
| 2           | Crankshaft vibration damper cooling valve |

One of the remedies for obtaining a compact engine unit is to place the crankshaft vibration damper inside the engine block. The damper has been positioned at the front of the crankshaft between the end and the connecting rod pin for the crankshaft for cylinder 1.



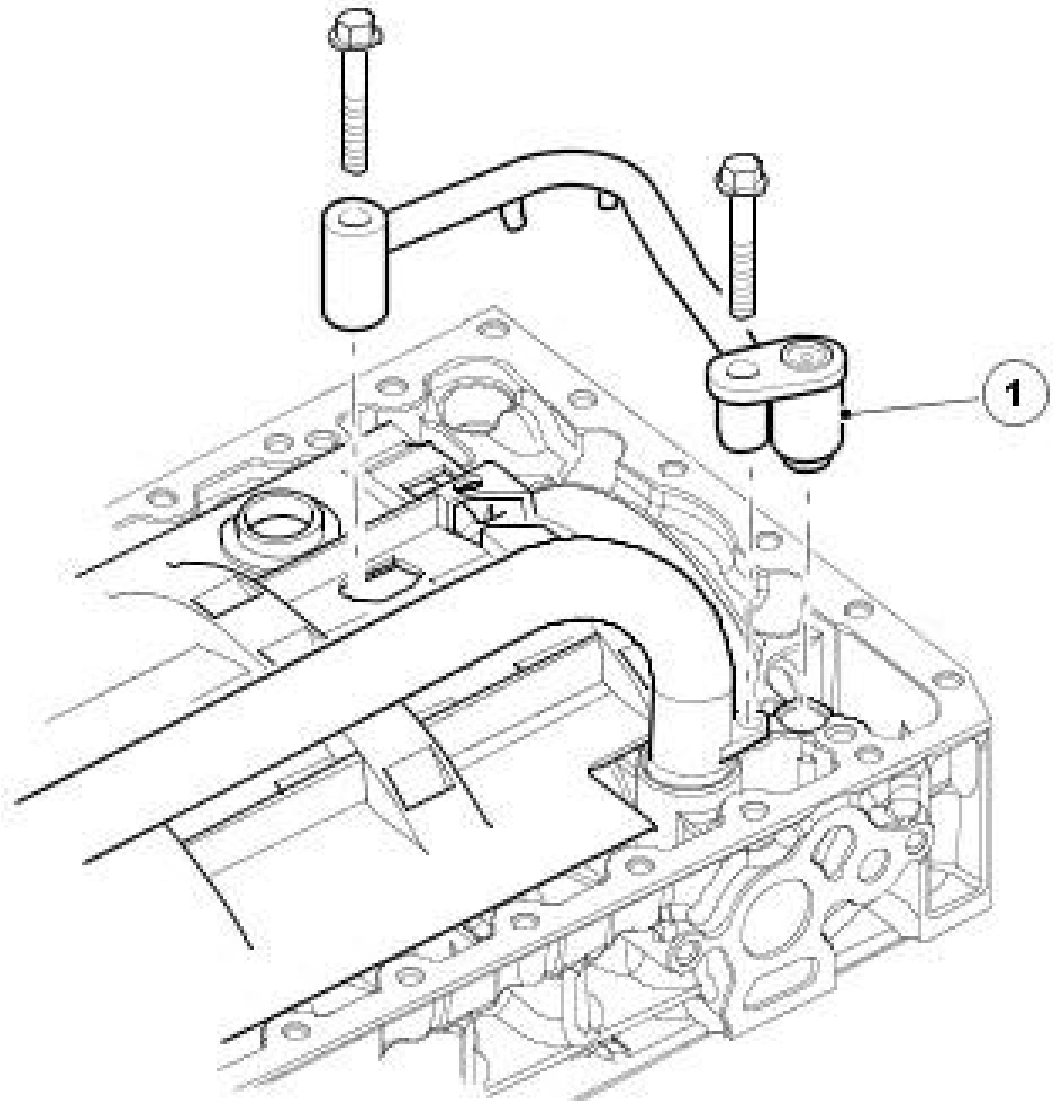
E89595

| Item Number | Description      |
|-------------|------------------|
| 1           | Front housing    |
| 2           | Solid steel ring |
| 3           | Plastic bearing  |
| 4           | Rear housing     |

The damper consists of a solid steel ring, placed in an enclosed housing filled with silicon fluid. The ring is radially journaled through a plastic bearing. There are buttons on the front and rear side surfaces, 4 on each side. These buttons are axially journaled.

The task of the damper is to even out fast unwanted increases and reductions in speed (i.e. crankshaft oscillations) and to give the crankshaft a smoother operation.

When the rotation speed of the crankshaft increases or reduces quickly, the change in speed of the steel ring is delayed due to the high viscosity of the silicon fluid. The function of the damper is based on the braking effect of the silicon fluid and the steel ring's own inertia. When the ring moves in the silicon fluid in the damper housing, a large amount of heat is generated that must be routed away.



E87018

| Item Number | Description |
|-------------|-------------|
| 1           | Valve       |

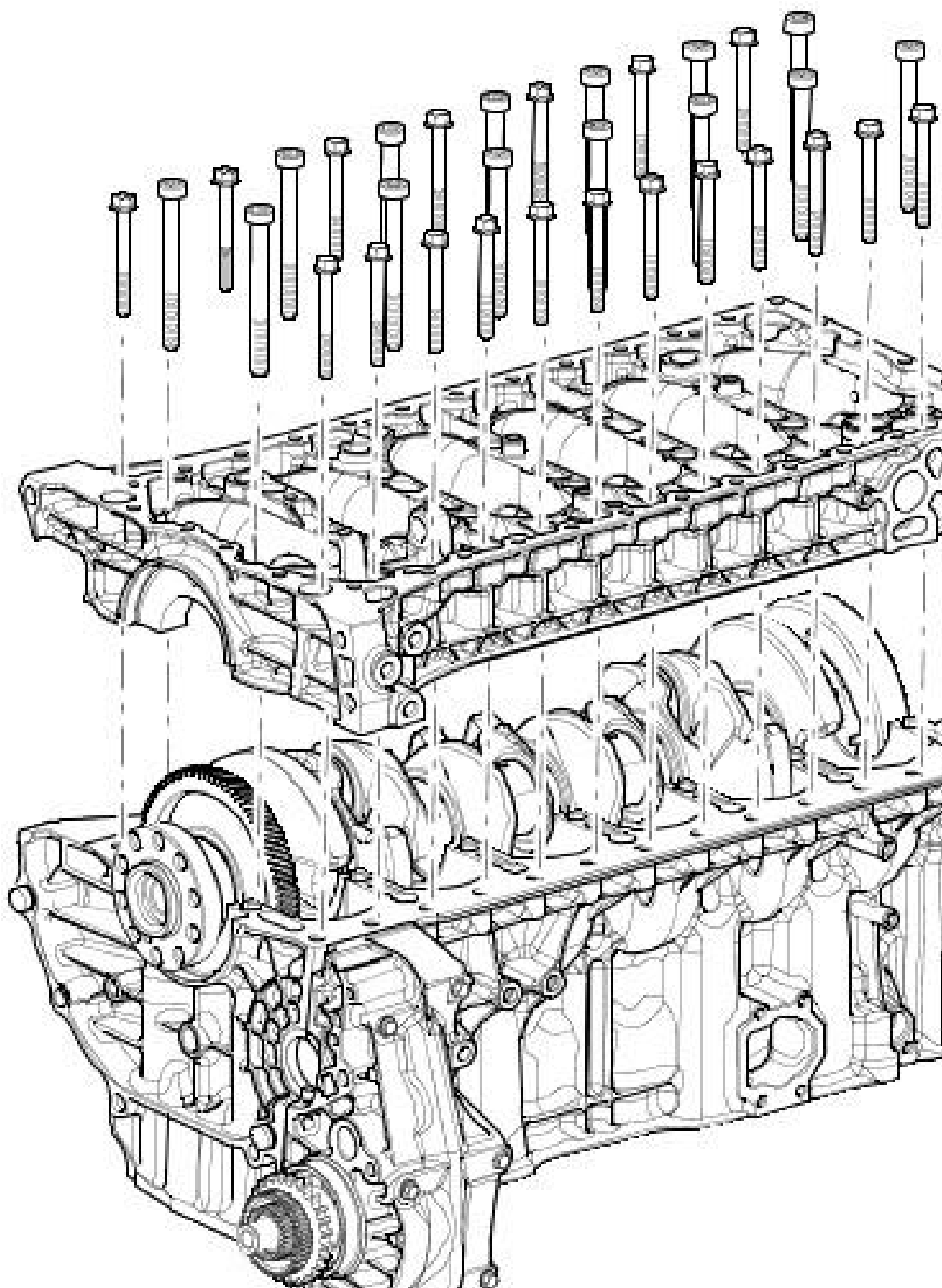
Because the damper is located in an environment where the normal operating temperature can reach approximately 140°C (284°F), coupled with the fact that the damper also generates its own heat, it is necessary for it to be oil cooled. A separate oil circuit routes oil from the engine's oil cooler to a valve in the engine block, which opens at approximately 2 bar. The oil then flows to 3 jets, located on the crankshaft vibration damper cooling pipe, which then directs the oil to the lower section of the damper.

The oil flows through the jets at approximately 12 liters per minute.

At high temperatures, oil cooling reduces the damper temperature by approximately 7°C (45°F).

**BEDPLATE**

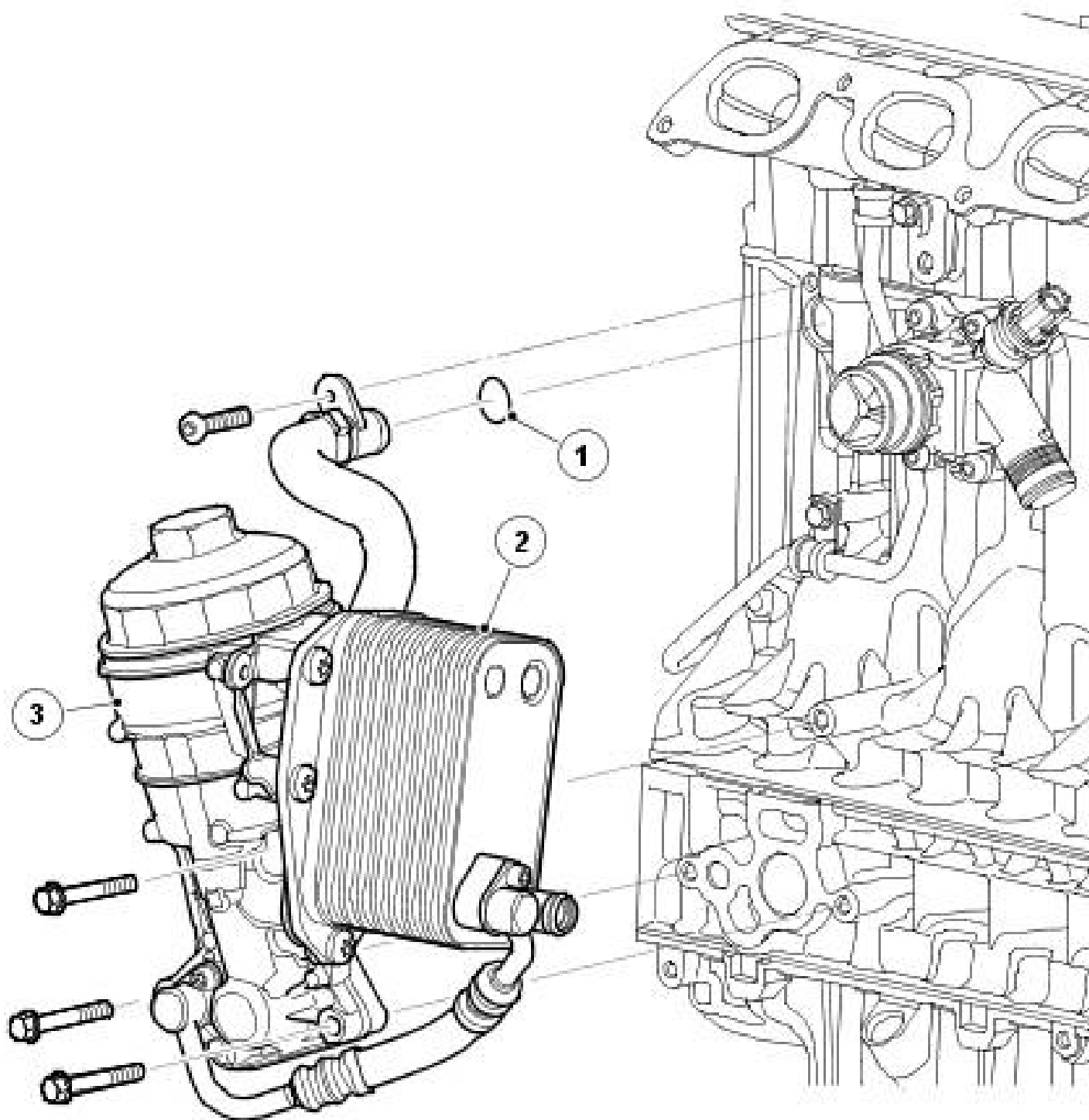
---



The bedplate is of an aluminum alloy structure bolted to the bottom of the cylinder block to further improve rigidity and to retain the crankshaft. The 7 cast iron crankshaft bearing caps are cast in the boreholes.

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.

**OIL FILTER AND COOLER ASSEMBLY**



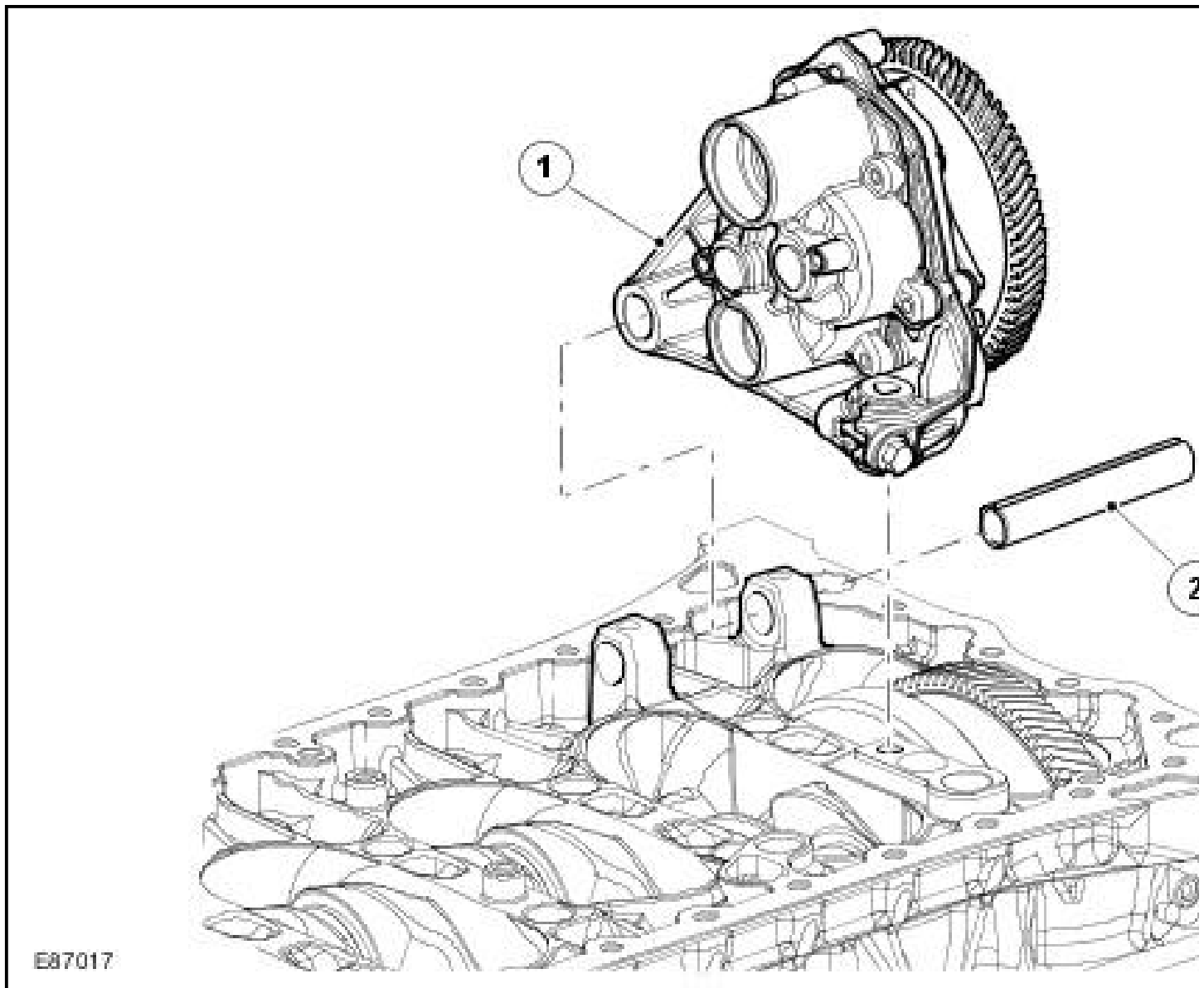
E87034

| Item Number | Description |
|-------------|-------------|
| 1           | O-ring      |
| 2           | Oil cooler  |

3

Oil filter housing

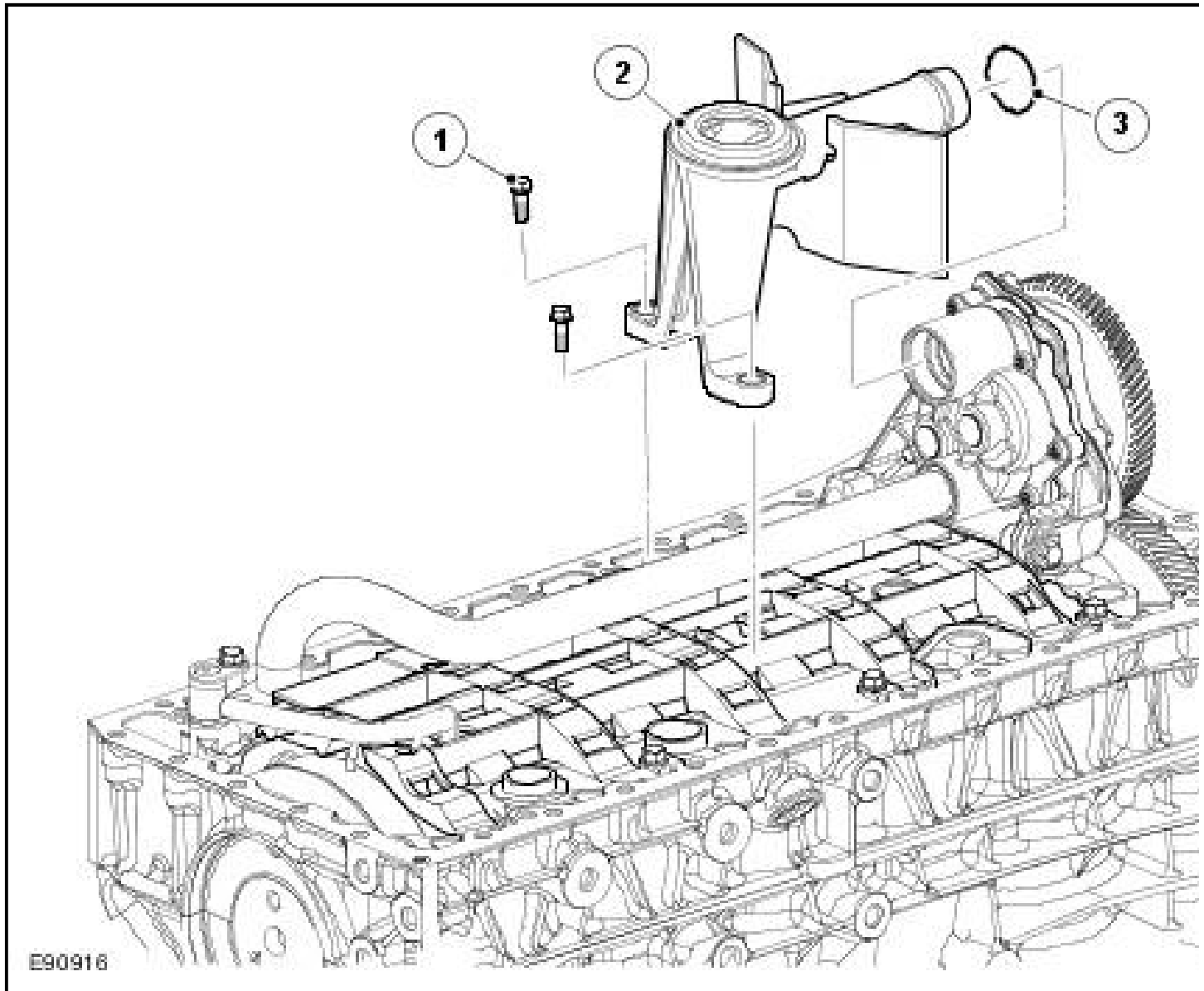
The oil filter and cooler assembly is located at the front of the LH side of the cylinder block. The oil filter housing contains a separate single oil filter element. The oil filter supplies clean oil to the oil cooler, which is connected to the coolant system, and is further distributed to the various engine systems (For more information refer to the lubrication section).

**OIL PUMP ASSEMBLY**

| Item Number | Description       |
|-------------|-------------------|
| 1           | Oil pump assembly |
| 2           | Pivot pin         |

The oil pump is attached to bottom of the bedplate via a pivot pin and a bolt. The pump is an external gear wheel pump with integrated pressure control valve (for more information refer to the lubrication section).

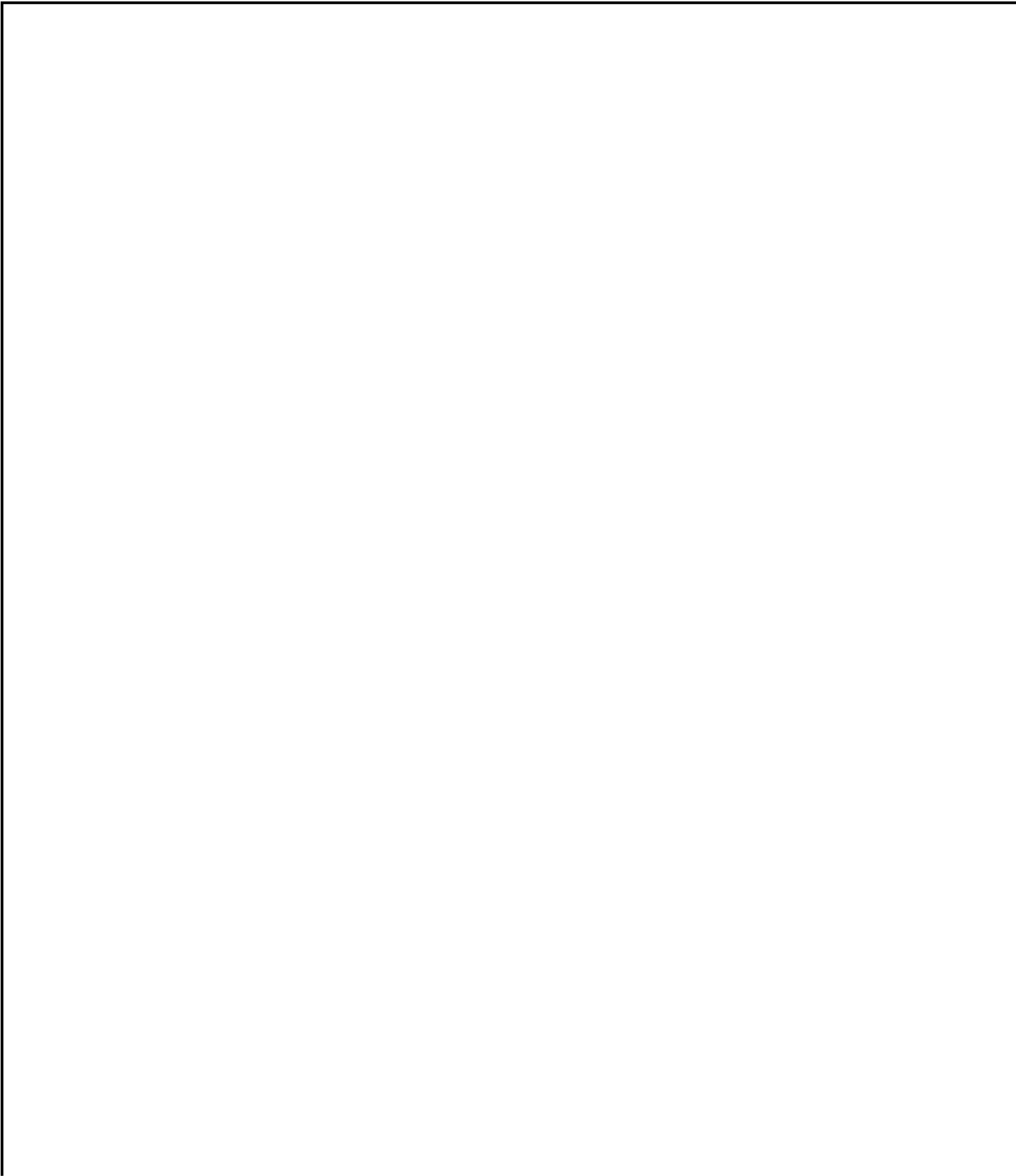
#### OIL PICK-UP

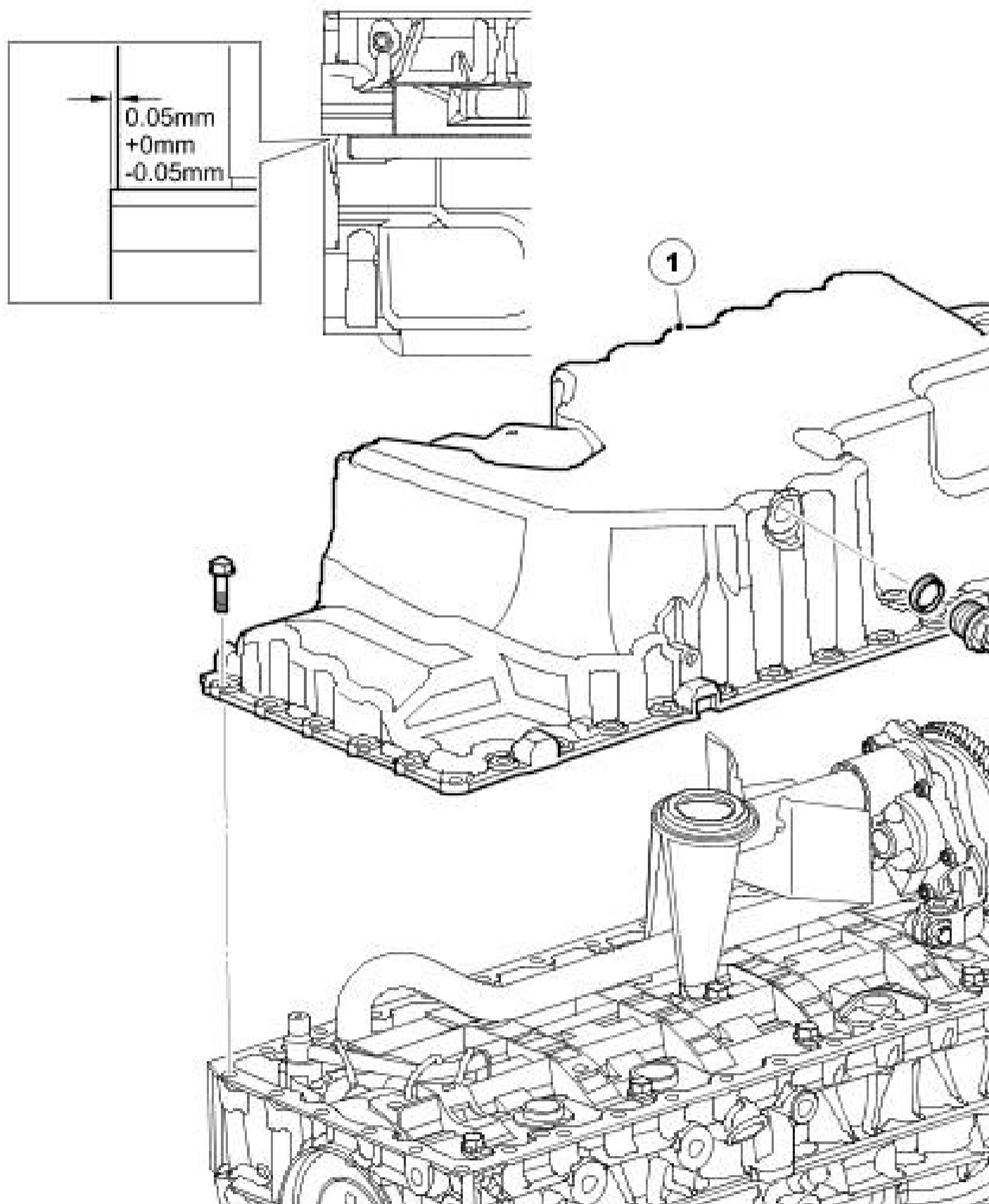


| Item Number | Description |
|-------------|-------------|
| 1           | Bolt (2 of) |
| 2           | Oil pick-up |
| 3           | O-ring seal |

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 intake prevents debris from entering the oil system.

**OIL PAN**



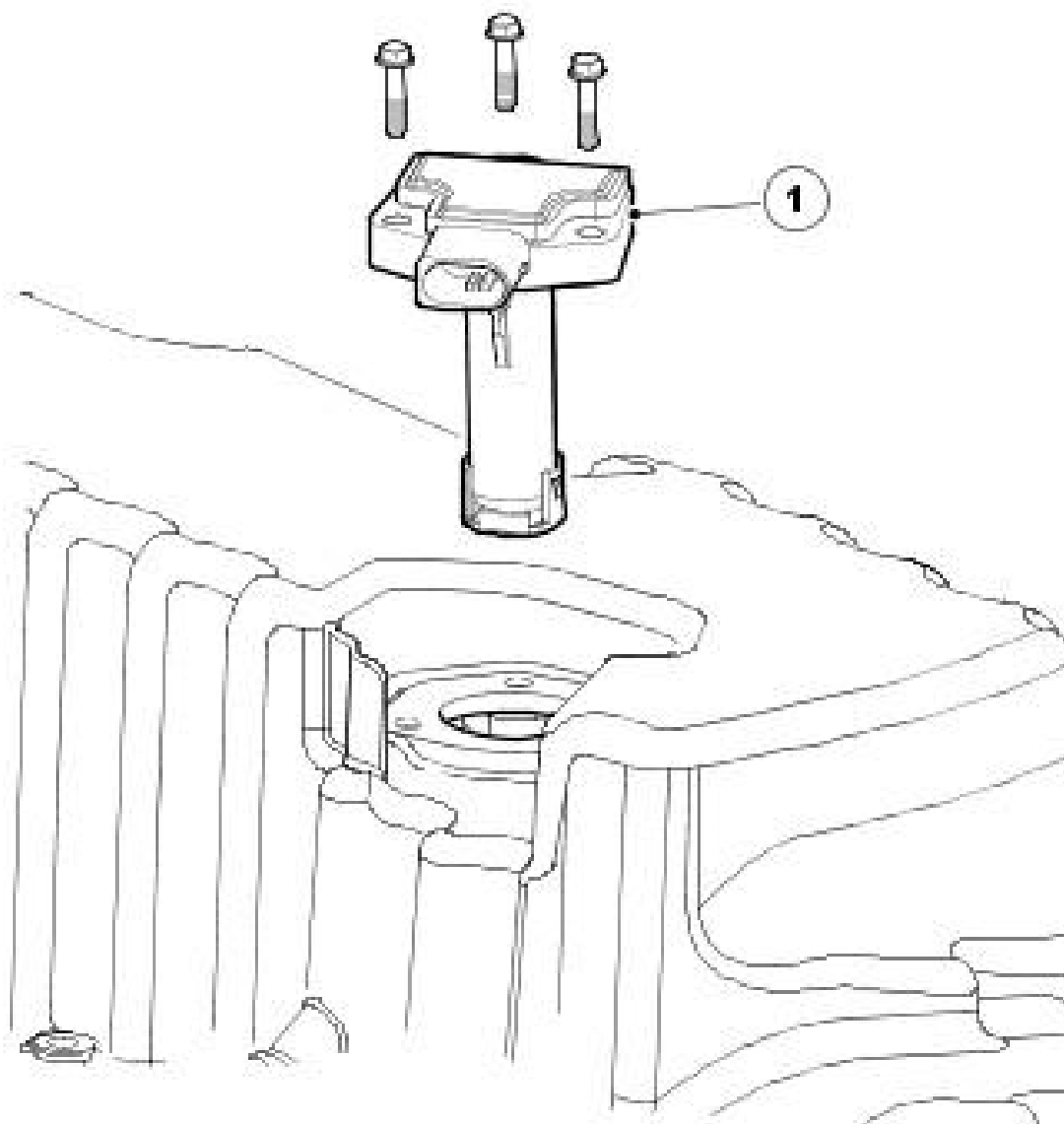


| Item Number | Description    |
|-------------|----------------|
| 1           | Oil pan        |
| 2           | Oil drain plug |

The aluminum alloy structural oil pan is bolted to the bedplate.

**NOTE:** The oil pan should always be fitted proud of the bedplate by 0.05mm (+0mm - 0.05mm).

A combined oil level/temperature sensor is attached to the underside of the oil pan via 3 bolts. The tip of the sensor locates through an aperture and is sealed with an O-ring.



E87019

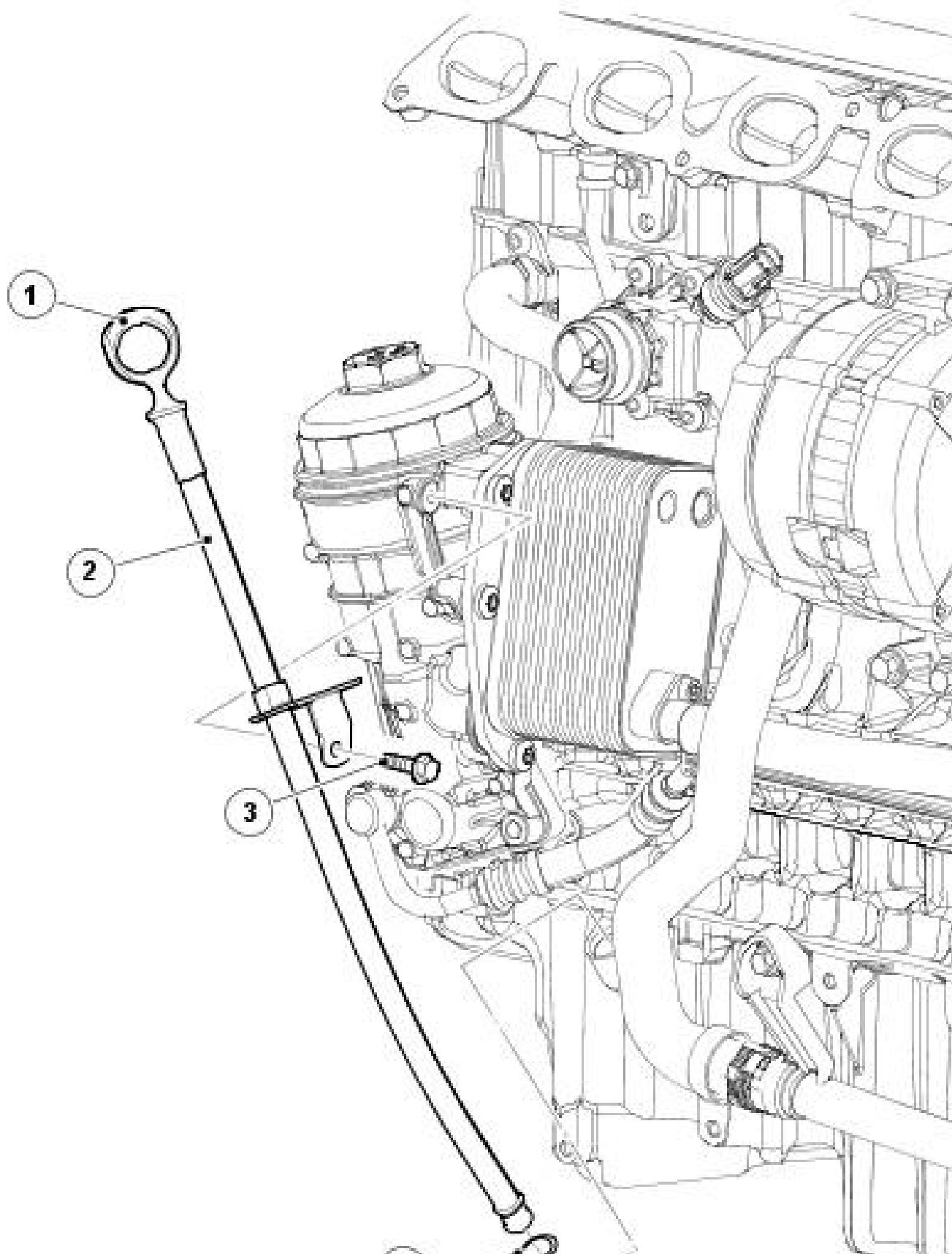
**2009 Land Rover LR2 HSE**

ENGINE Engine Mechanical

| Item Number | Description                  |
|-------------|------------------------------|
| 1           | Oil level/temperature sensor |

The engine oil drain plug is located on the exhaust side of the engine, towards the bottom of the oil pan.

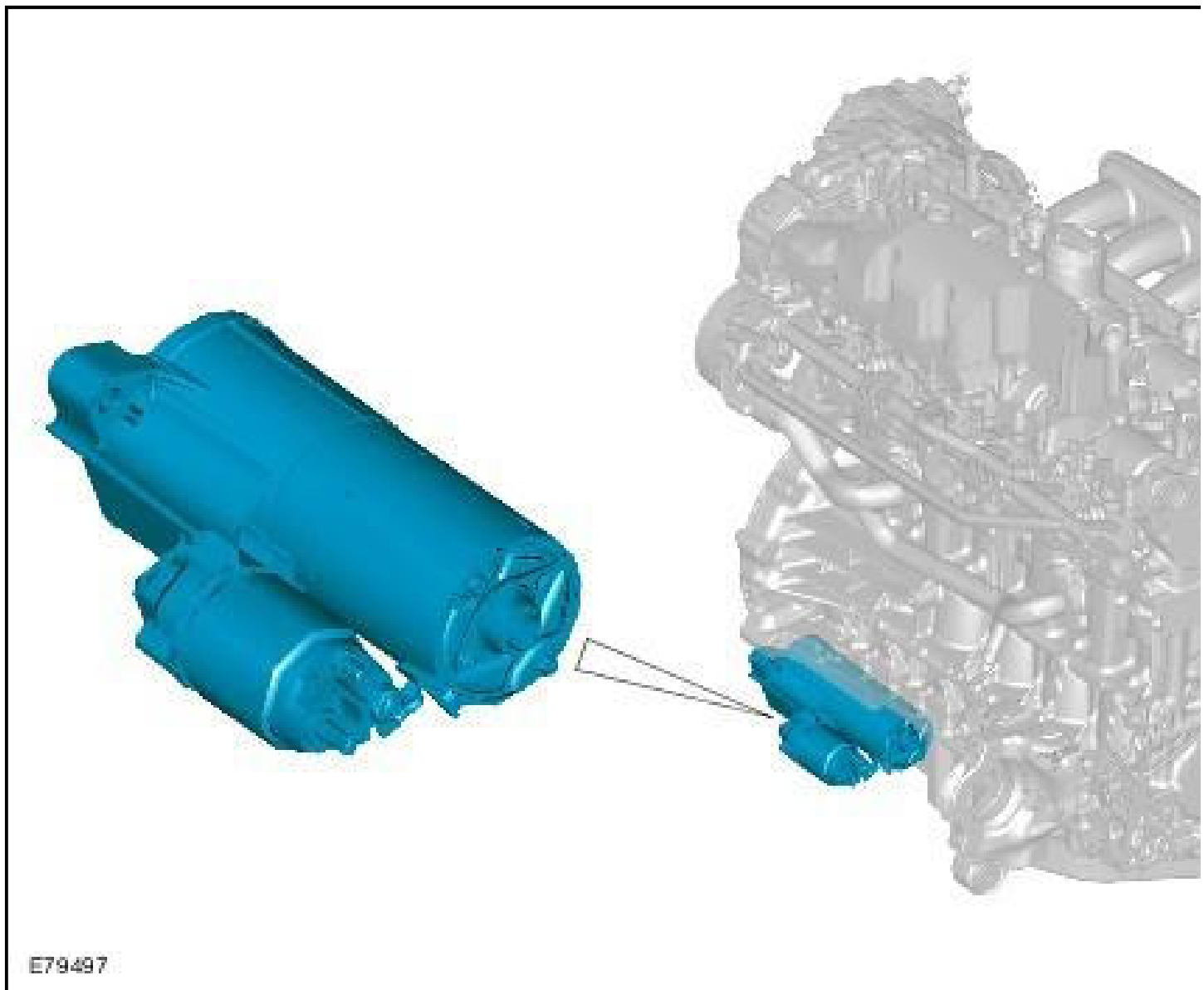
**OIL LEVEL GAGE**



| Item Number | Description         |
|-------------|---------------------|
| 1           | Oil level gage      |
| 2           | Oil level gage tube |
| 3           | Bolt                |
| 4           | O-ring seal         |

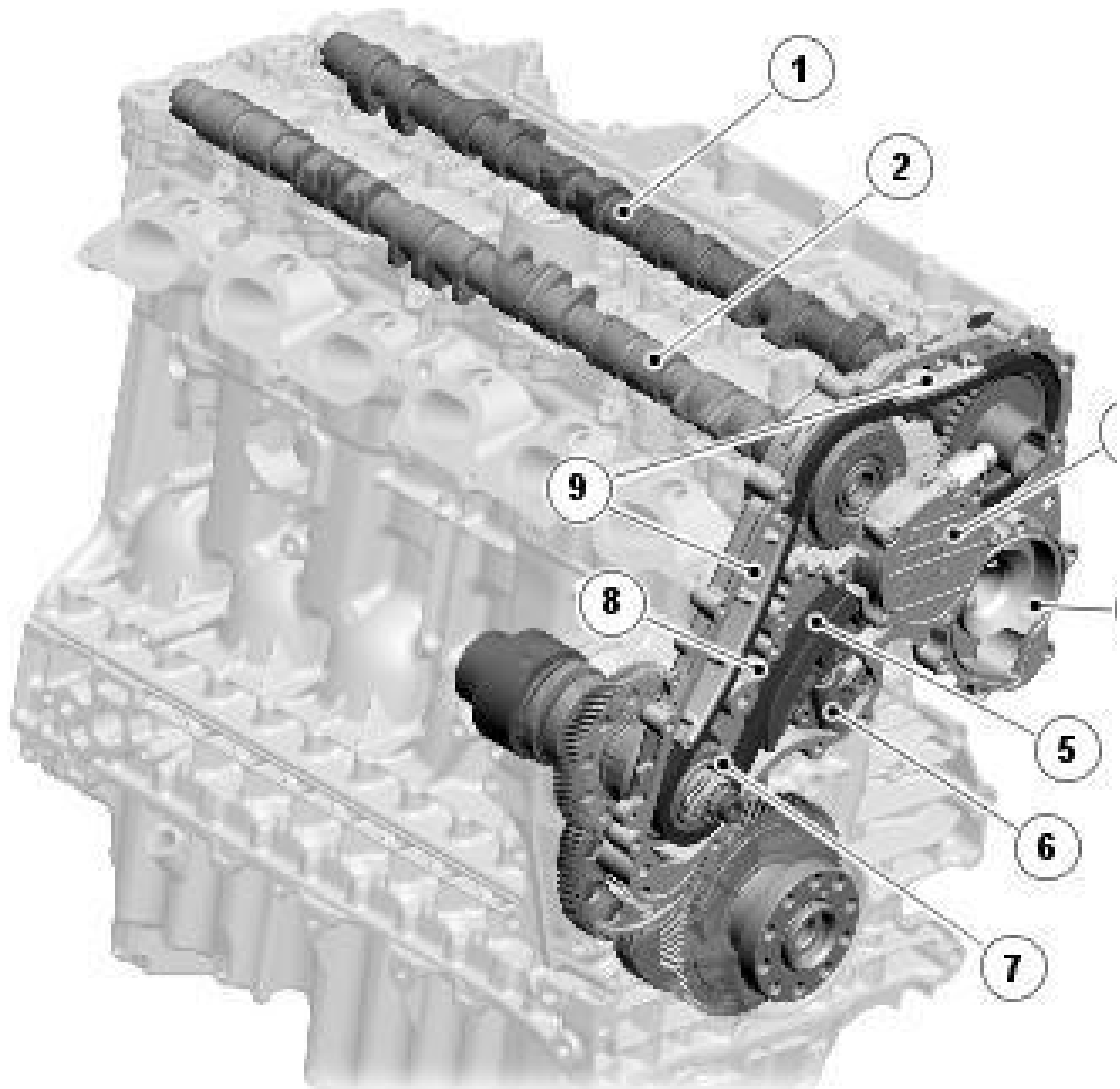
The oil level gauge locates along the intake side of the engine and is supported in a tube installed in the oil pan. A bolt securely attaches the tube to the engine oil cooler via a bracket. Two holes in the end of the gauge indicate the minimum and maximum oil levels. The difference between the dipstick markings, minimum and maximum, corresponds to 0.8 liters.

#### STARTER MOTOR



The starter motor is located in a recess at the rear of the exhaust side of the oil pan. The motor, rated at 1.4 kW, uses permanent magnets instead of field windings to provide a low-weight starter motor; with the use of planetary gears to deliver a good torque to weight ratio Refer to **Starting System** . .

### CAMSHAFT TIMING COMPONENTS



E89599

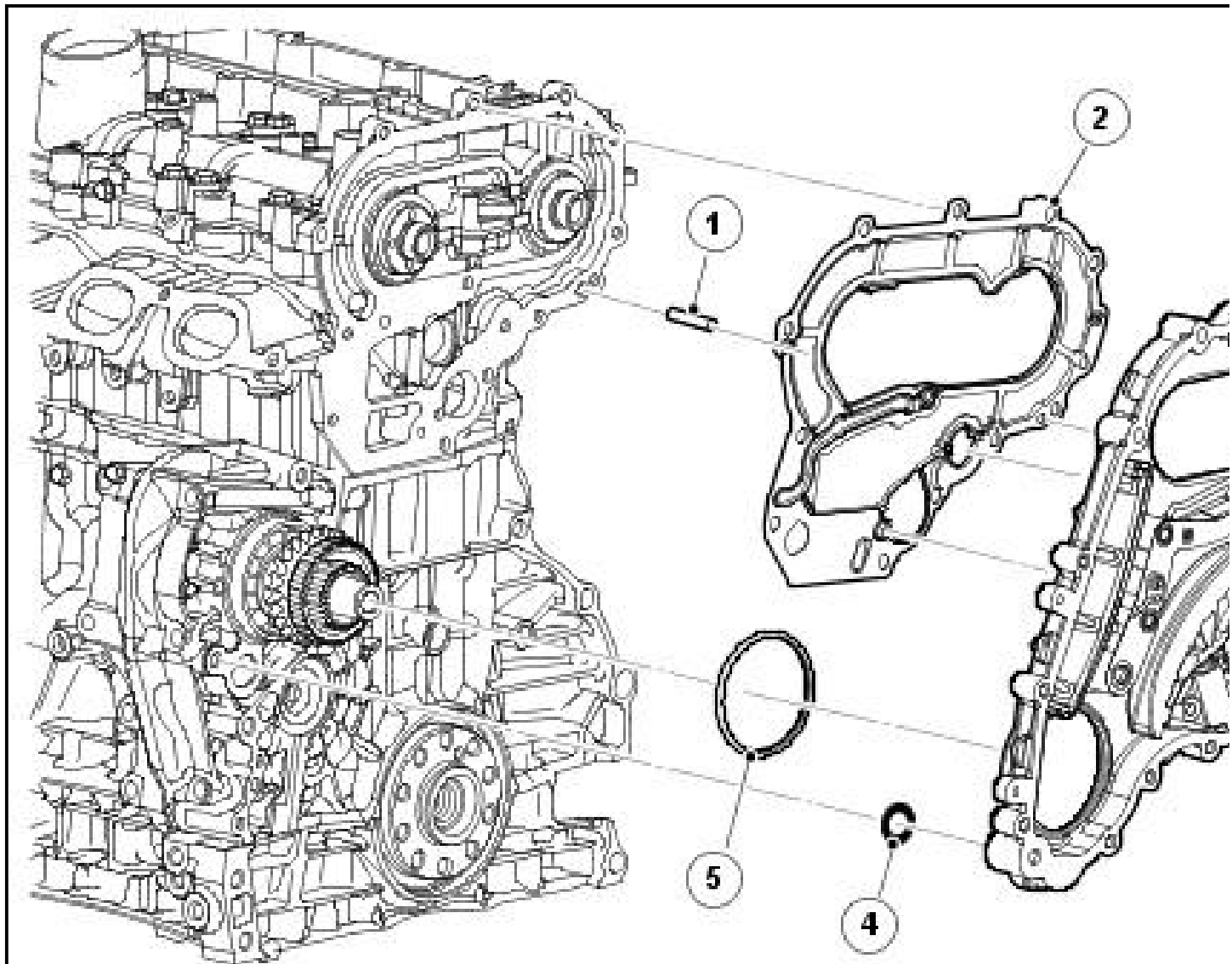
| Item Number | Description          |
|-------------|----------------------|
| 1           | Exhaust camshaft     |
| 2           | Intake camshaft      |
| 3           | Vacuum pump          |
| 4           | Cooling pump housing |
| 5           | Chain guide          |

## 2009 Land Rover LR2 HSE

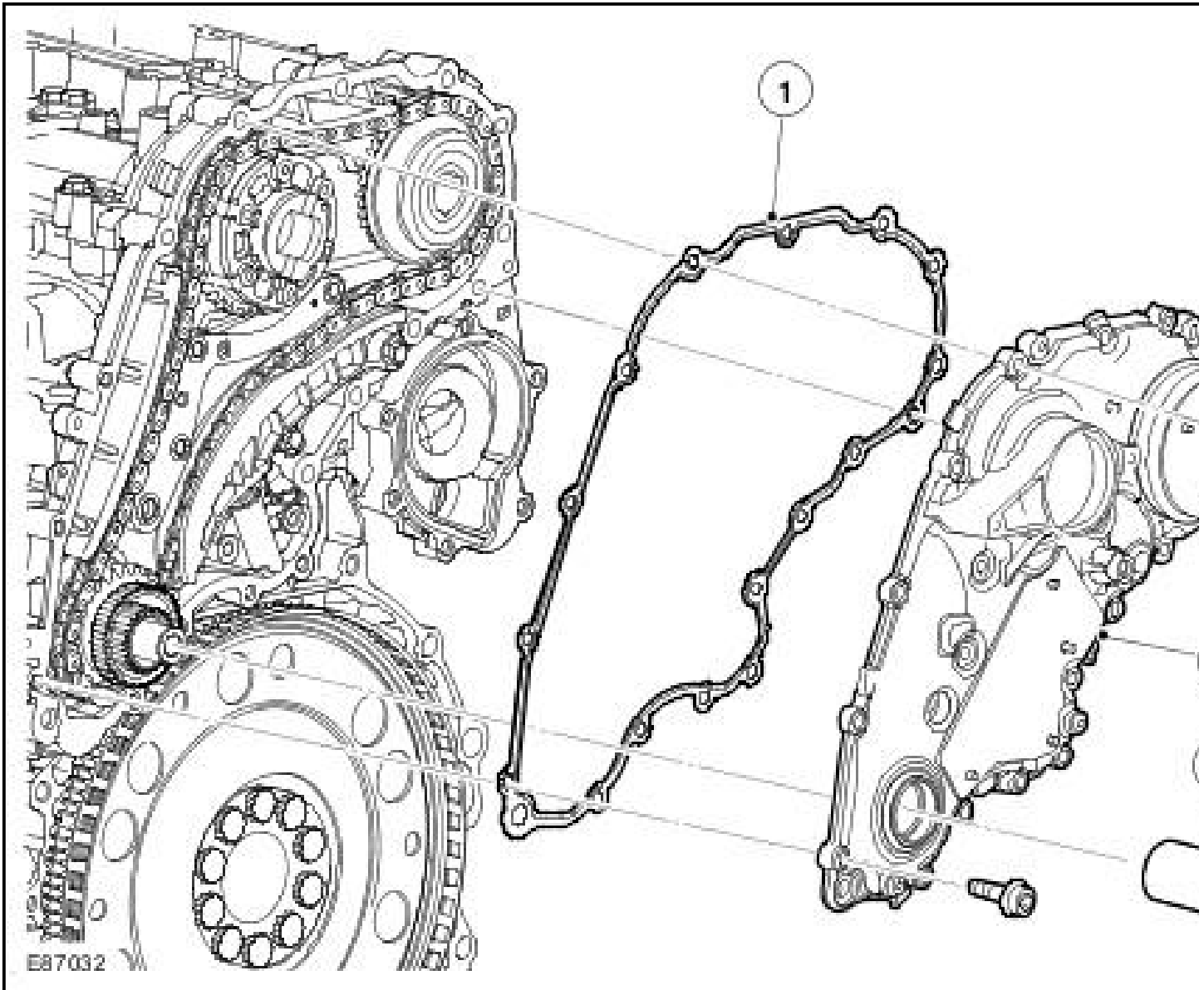
### ENGINE Engine Mechanical

|   |                                   |
|---|-----------------------------------|
| 6 | Hydraulic chain tensioner         |
| 7 | Camshaft chain gear               |
| 8 | Camshaft chain lubrication nozzle |
| 9 | Chain guide                       |

The timing chain for the camshafts is located in a housing at the rear of the engine.



| Item Number | Description                                  |
|-------------|----------------------------------------------|
| 1           | Dowel (used to align gasket and timing case) |
| 2           | Gasket                                       |
| 3           | Front timing case                            |
| 4           | Seal                                         |



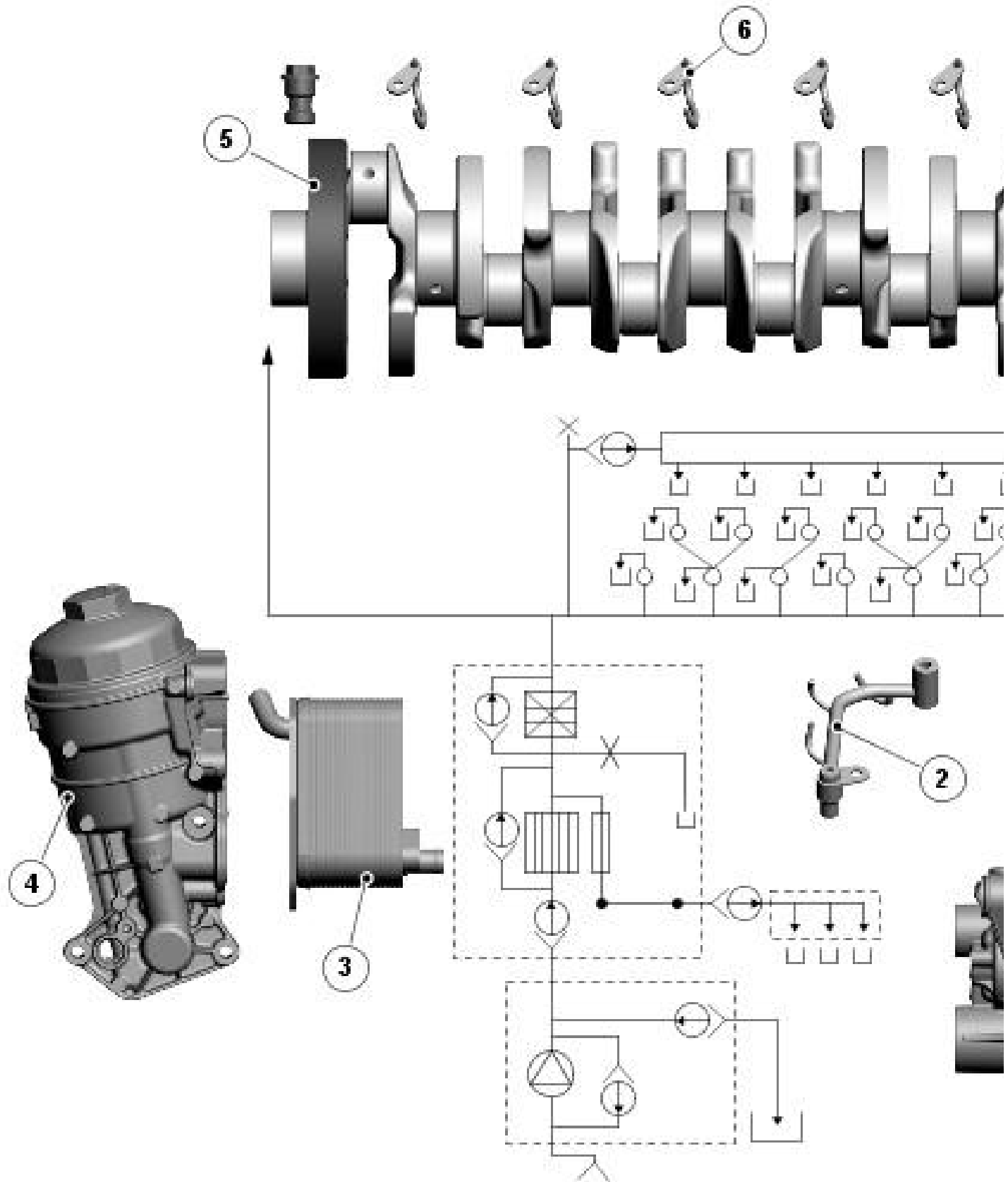
| Item Number | Description      |
|-------------|------------------|
| 1           | Gasket           |
| 2           | Oil scraper      |
| 3           | Rear timing case |
| 4           | Centering tool   |

The timing chain is driven by the camshaft chain gear via the crankshaft. The chain drives both the intake and exhaust camshafts. The chain is continually tensioned by a hydraulic chain tensioner and is lubricated by oil via a separate nozzle. The tensioner has an inhibitor that prevents the chain from slackening in the event of reversed loading.

The intake camshaft is equipped with a VCT unit and also drives the vacuum pump.

The return oil from the camshafts housing is routed to the gear housing and lubricates the timing gear's bearings and gear wheel.

## **LUBRICATION SYSTEM**



The lubrication system components and functions are:

- Oil pick-up
- Oil pump
- Oil filter and cooler assembly
- Intake valve (piston cooling)
- Cylinder head oil supply
- Gear housing

#### **OIL PICK-UP**

The oil pick-up contains a strainer, which separates large contaminants and prevents them from reaching the oil pump.

#### **OIL PUMP**

The oil pump is an external gear wheel pump with integrated pressure control valve. The valve opens at approximately 4.5 bar and controls the system pressure.

The pump is driven by the crankshaft and is 1.3 times faster than the crankshaft.

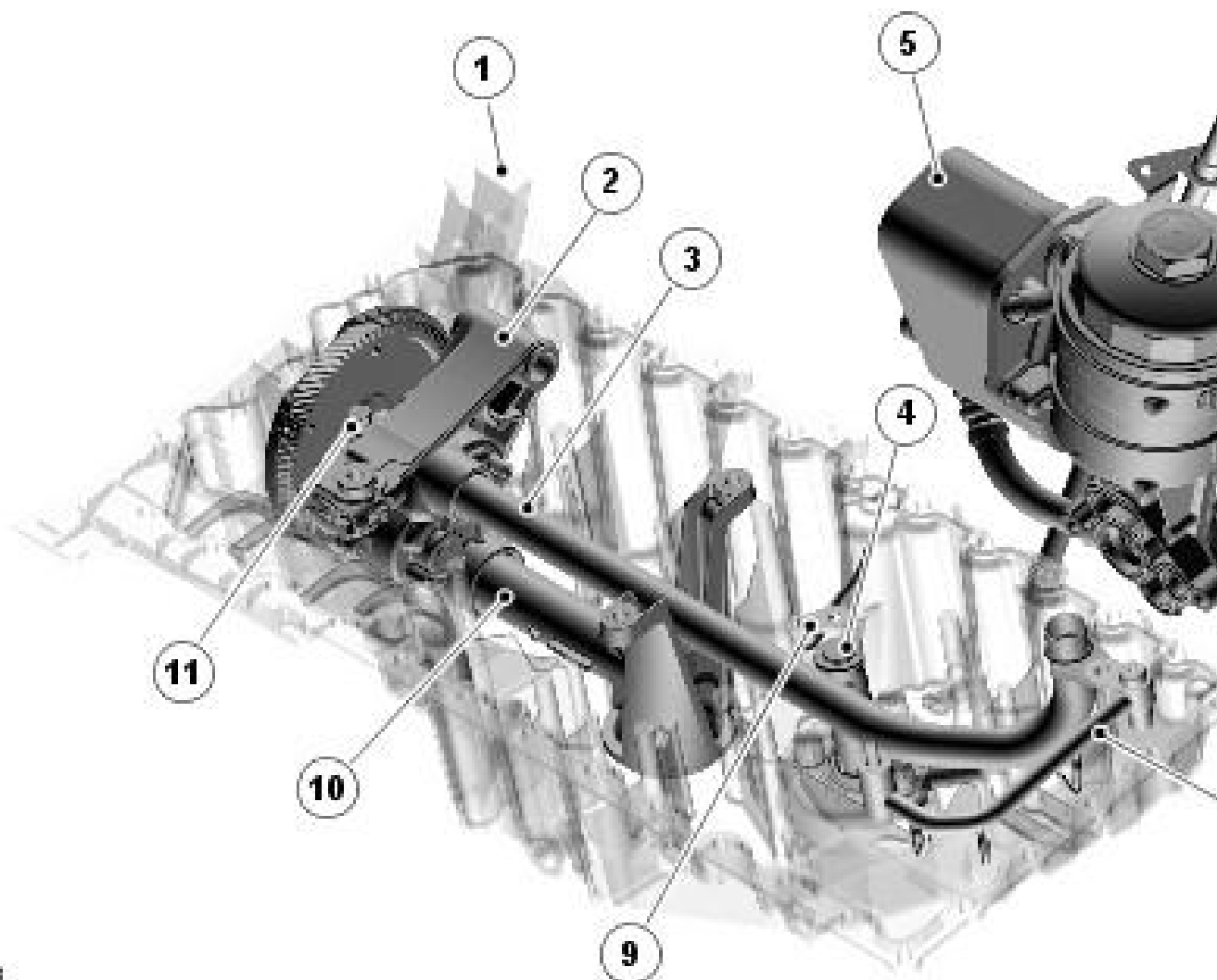
To ensure that the air is released from the oil system, a valve is located in the oil pump on the pressure side. During the build-up of pressure, air is routed out into the crankcase. This continues until the valve closes at approximately 0.2 bar.

#### **OIL FILTER AND COOLER ASSEMBLY**

The majority of oil is routed to the oil filter, which is a separate single filter element located in the housing. The over-flow valve for the blocked filter is in the cover. The valve opens at approximately 2 bar.

There is a valve at the bottom of the housing. The task of the valve is to drain the housing of oil when the oil filter is removed. When the oil filter is installed, the valve is closed. A spring loaded ring at the bottom of the filter housing is affected by the actual filter. The ring is, in turn, mechanically connected to the valve.

When the filter is removed, the spring lifts the ring, which, in turn, opens the valve and allows the oil to drain into the oil pan.



E89648

| Item Number | Description                     |
|-------------|---------------------------------|
| 1           | Oil pan                         |
| 2           | Oil pump                        |
| 3           | Oil pressure pipe               |
| 4           | Oil level/temperature sensor    |
| 5           | Oil cooler                      |
| 6           | Oil level gage                  |
| 7           | Oil filter cover                |
| 8           | Vibration damper pipe with jets |
| 9           | Piston cooling jet (6 off)      |
| 10          | Supply line with strainer       |

The oil passes a non-return valve before it reaches the oil cooler/filter housing. The non-return valve ensures that the oil filter housing is not drained of oil when the engine is switched off. The valve opens at approximately 0.2 bar.

The oil first passes the oil cooler, a plate oil cooler. The chamber for oil and coolant is split alternately between the plates. There are 20 plates used in total. The first 16 plates are used for oil, which is routed through the engine's normal lubrication circuit, i.e. the oil is routed to the oil filter.

The 4 last plates are used to provide a proportion of the oil with extra cooling before it is routed onwards to cool the vibration damper. The circuit is calibrated to achieve correct flow.

There is a by-pass valve parallel to the oil cooler. The valve ensures an oil flow to the oil filter even if the oil cooler is blocked. The valve opens at approximately 2 bar.

#### **INTAKE VALVE (PISTON COOLING)**

The oil is also routed to the duct for oil cooling, which is parallel to the ducts for main bearings and connecting rod bearings.

The oil first passes a valve that opens/closes at approximately 2.0 bar. Thereafter, the oil is routed to the jets for piston cooling:

- If the valve has too high an opening pressure, this means that the oil flow to the pistons reduces, which can cause engine damage
- If the valve has too low an opening pressure, this produces an increased flow to piston cooling. It can, in certain situations (before the relief valve is opened) result in the engine's oil pressure being too low causing engine damage

The jets direct the oil towards the underneath of the pistons. Each cylinder has its own jet.

#### **CYLINDER HEAD OIL SUPPLY**

Oil is routed from the cylinder block through a front and rear duct to the cylinder head. The duct at the front edge supplies 2 circuits in the cylinder head with oil:

##### **1. Circuit for the hydraulic tappets, vacuum pump and cam chain lubrication**

A longitudinal duct on the intake side supplies the following components with oil:

- The hydraulic tappets
- The vacuum pump
- The nozzle for cam chain lubrication

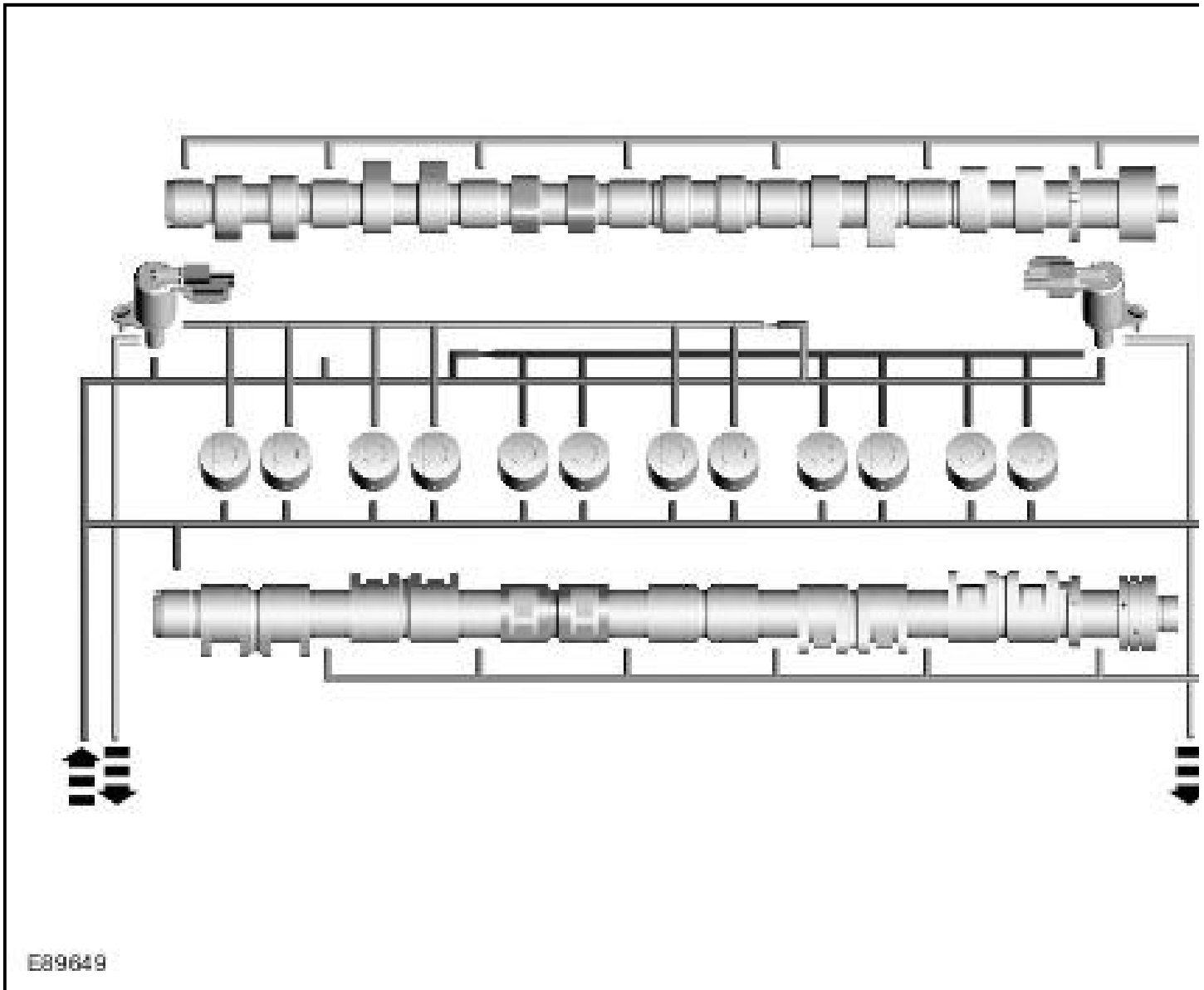
##### **2. Circuit for the intake camshaft's front bearing, the CPS valves and the tappets with CPS function**

A duct supplies the intake camshaft's front bearing and both the CPS valves.

The front CPS valve controls the oil flow to the tappets for cylinders 1, 2 and 4 and the rear CPS valve controls the oil flow to the tappets for cylinders 3, 5 and 6.

When the CPS valve solenoids are activated, the valves open (i.e. shift from low to high valve lifting height) and the tappets are supplied with oil under pressure.

The longitudinal duct that supplies the rear CPS valve is equipped with a bleed hole. This is to ensure that no air reaches the CPS valves or the tappets.



The duct is also equipped with 2 calibrated passages to each tappet circuit (i.e. the circuits after the CPS valves). A continuous flow through the circuit ensures the necessary stable pressure differences required for a stable

transfer between the small and large tappet (or vice versa).

**NOTE:** In the event of a small lifting height, the tappet circuit, in principle, has no pressure when the CPS valves are open, which produces a return flow to the oil pan.

A filter is located in each passage.

The duct at the rear edge supplies the following components/functions with oil:

- The camshaft chain's hydraulic tensioner
- The VCT valve and the VCT unit for the intake camshaft
- The camshaft bearings for the intake camshaft (6, i.e. all except the front)
- The camshaft bearings for the exhaust camshaft (all 7)

#### GEAR HOUSING

The drained oil from the camshaft chain housing is supplied to bearings and meshings, i.e. the oil is not pressurized. The oil is routed through the bottom of the gear housing via the rear bearing, onwards into the housing where the meshings and front bearing are spray lubricated.

The internal needle bearings between the shafts are also supplied by the oil on its way out from the camshaft chain housing. The oil reaches the bearings through the opening between the shafts.

Even the intermediate shaft bearings are lubricated by the oil that is sprayed around the housing.

#### DIAGNOSTIC PROCEDURES

##### PRINCIPLES OF OPERATION

For a detailed description of the engine system, refer to the relevant Description and Operation section in the workshop manual. Engine - 3.2L Refer to the relevant Description and Operation section in the workshop manual. REFER to: **Description & Operation**.

##### INSPECTION AND VERIFICATION

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

##### VISUAL INSPECTION

| Mechanical                                                                                                                                                          | Electrical                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Coolant leaks</li> <li>• Oil leaks</li> <li>• Leaks in the fuel system</li> <li>• Visibly damaged or worn parts</li> </ul> | <ul style="list-style-type: none"> <li>• Fuses</li> <li>• Loose or corroded electrical connectors</li> <li>• Harnesses</li> <li>• Sensors</li> </ul> |

- Loose or missing fixings

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

## SYMPTOM CHART

**NOTE:** If an engine is suspect, when the vehicle remains under the Manufacturers warranty refer to the Warranty Policy and Procedure manual (section B1.2), or determine if any prior approval program is in operation, prior to the installation of a new engine.

**NOTE:** Due to the possibility of loose carbon, that has become trapped between the valve face and seat, effecting the pressure readings, when carrying out a compression test and some cylinders are found to have low pressures, install the spark plugs, road test the vehicle and re-test the suspect cylinders. If the correct pressures are restored, no further action is required.

| Symptom                         | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| All engine related issues       | <ul style="list-style-type: none"> <li>• Check ECM for Diagnostic Trouble Codes (DTCs) and refer to DTC Index. Refer to <b><u>Electronic Engine Controls - 3.2L</u></b> article.</li> </ul>                                                                                                                                                                                                                                                                                                                                                    |
| Difficult to start hot and cold | <ul style="list-style-type: none"> <li>• Carry out general engine checks:<br/><br/>Compression test. Refer to component tests in this section.<br/><br/>Valve clearances. See <b><u>Valve Clearance Check</u></b>.<br/><br/>Spark plug condition and color</li> </ul>                                                                                                                                                                                                                                                                          |
| Poor idle                       | <ul style="list-style-type: none"> <li>• Ensure the air intake system is free from leaks</li> <li>• Carry out general engine checks:<br/><br/>Compression test. Refer to component tests in this section.<br/><br/>Valve clearances. See <b><u>Valve Clearance Check</u></b>.<br/><br/>Spark plug condition and color</li> <li>• Check for collapsed catalytic converter/blocked exhaust system</li> <li>• Check long and short term fuel trim datalogger signals</li> </ul> <p>Readings up to 10%: may be considered as acceptable if the</p> |

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | <p>readings are equal bank to bank</p> <p>Positive readings of between 10-20%: check for air leaks in air intake system</p> <p>Negative readings of between 10-20%: check for over fuelling e.g. leaking injectors, high fuel pressure</p> <p>Readings above 20%: check for DTCs and refer to DTC Index. Refer to <b><u>Electronic Engine Controls - 3.2L</u></b> article.</p> <ul style="list-style-type: none"> <li>• Carry out a vacuum gauge check. Refer to component tests in this section.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Insufficient power/Insufficient compression | <ul style="list-style-type: none"> <li>• Ensure the air intake system is free from leaks</li> <li>• Carry out general engine checks:</li> </ul> <p>Compression test. Refer to component tests in this section.</p> <p>Valve clearances. See <b><u>Valve Clearance Check</u></b>.</p> <p>Spark plug condition and color</p> <ul style="list-style-type: none"> <li>• Check for collapsed catalytic converter/blocked exhaust system</li> <li>• Check long and short term fuel trim datalogger signals</li> </ul> <p>Readings up to 10%: may be considered as acceptable if the readings are equal bank to bank</p> <p>Positive readings of between 10-20%: check for air leaks in air intake system</p> <p>Negative readings of between 10-20%: check for over fuelling e.g. leaking injectors, high fuel pressure</p> <p>Readings above 20%: check for DTCs and refer to DTC Index. Refer to <b><u>Electronic Engine Controls - 3.2L</u></b> article.</p> <ul style="list-style-type: none"> <li>• Carry out a vacuum gauge check. Refer to component tests in this section.</li> </ul> |
| Oil consumption                             | <ul style="list-style-type: none"> <li>• Carry out oil leak check followed by an oil consumption test. Refer to the component tests in this section</li> <li>• If oil consumption is excessive:</li> <li>• Check the integrity of the engine breather system</li> <li>• Carry out general engine checks:</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

|       |                                                                                                                                                                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | <p>Compression test. Refer to component tests in this section.</p> <p>Valve clearances. See <b><u>Valve Clearance Check</u></b>.</p> <p>Spark plug condition and color</p>                                                                                         |
| Noise | <ul style="list-style-type: none"> <li>Refer to the Special Service Messages on the Electronic Product Quality Report (EPQR) system for sound files. If the symptom does NOT compare to any of the sound files, contact Dealer Technical Support (DTS).</li> </ul> |

## COMPONENT TESTS

### ENGINE OIL LEAKS

**NOTE:** Before installing new gaskets or oil seals, make sure that the fault is clearly established.

If the oil leak cannot be identified clearly by a visual inspection, carry out an Ultraviolet test:

### FLUORESCENT OIL ADDITIVE METHOD

1. Clean the engine with a suitable cleaning fluid (brake cleaner).
2. Drain the engine oil and refill with recommended oil, premixed with Diesel Engine Oil Dye or equivalent. Use a minimum 14.8 ml (0.5 ounce) to a maximum 29.6 ml (1 ounce) of fluorescent additive to all engines. If oil is not premixed, fluorescent additive must first be added to the crankcase.
3. Run engine for 15 minutes. Stop the engine and inspect all seal and gasket areas for leaks using a 12 Volt Master UV Diagnostic Inspection Kit or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.
4. As necessary, pressurize the main oil gallery system to locate leaks due to incorrectly sealed, loose or cocked plugs. If the flywheel bolts leak oil, look for sealer on the threads.
5. Repair all leaks as necessary.

## COMPRESSION TEST

### GENERAL REMARKS

**NOTE:** Removing fuses and disconnecting electrical components may cause the Engine Control Module (ECM) to log Diagnostic Trouble Codes (DTCs). After the measurements have been carried out, DTCs should be cleared from memory by connecting to the Manufacturer Approved Diagnostic System.

**NOTE:** Only check the compression pressure with the valves set to the prescribed clearance (if this can be adjusted).

The compression pressure should be checked with the engine at operating temperature.

## CHECK THE COMPRESSION PRESSURE

**WARNING:** Move gear selector lever to 'P' position. Failure to follow this instruction may result in personal injury.

1. Remove the fuel pump relay.
2. Start the engine - the engine will start, run for a few seconds then stop.
3. Remove the spark plugs.
4. Install the compression tester.
5. Install an auxiliary starter switch in the starting circuit. With the ignition switch OFF, using the auxiliary starter switch, crank the engine a minimum of five compression strokes and record the highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
6. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes.
7. Install the removed components in reverse order, observing the specified tightening torques.
8. Clear all DTCs from the ECM.

## INTERPRETATION OF THE RESULTS

**NOTE:** Due to the possibility of loose carbon that has become trapped between the valve face and seat effecting the pressure readings, when carrying out a compression test and cylinders are found to have low pressures, install the spark plugs, road test the vehicle and re-test the suspect cylinders. If the correct pressures are restored, no further action is required.

The indicated compression pressures are considered within specification if the lowest reading cylinder is within 75% of the highest reading.

If the cylinder pressures are found to be low, carry out a leakdown test to determine the location of the fault (if any leakback can be heard through the engine breather system suspect the piston rings, if any leakback can be heard through the inlet system suspect the inlet valve or seat, if any leakback can be heard through the exhaust manifold suspect the exhaust valve or seat. If the measurements for two cylinders next to each other are both too low then it is very likely that the cylinder head gasket between them is burnt through. This can also be recognized by traces of engine oil in the coolant and/or coolant in the engine oil).

## OIL CONSUMPTION TEST

The amount of oil an engine uses will vary with the way the vehicle is driven in addition to normal engine-to-engine variation. This is especially true during the first 16, 100 km (10, 000 miles) when a new engine is being broken in or until certain internal components become conditioned. Vehicles used in heavy-duty operation may use more oil. The following are examples of heavy-duty operation:

- Trailer towing applications
- Severe loading applications
- Sustained high speed operation

Engines need oil to lubricate the following internal components:

- Cylinder block cylinder walls
- Pistons and piston rings
- Intake and exhaust valve stems
- Intake and exhaust valve guides
- All internal engine components

When the pistons move downward, a thin film of oil is left on the cylinder walls. As the vehicle is operated, some oil is also drawn into the combustion chambers past the intake and exhaust valve stem seals and burned.

The following are examples of conditions that can affect oil consumption rates:

- Engine size
- Operator driving habits
- Ambient temperatures
- Quality and viscosity of oil
- Engine is being run in an overfilled condition (check the oil level at least five minutes after a hot shutdown with the vehicle parked on a level surface. The oil level should not be above the top of the cross-hatched area and the letter "F" in FULL).

Operation under varying conditions can frequently be misleading. A vehicle that has been run for several thousand miles on short trips or in below-freezing ambient temperatures may have consumed a "normal" amount of oil. However, when checking the engine oil level, it may measure up to the full mark on the oil level indicator due to dilution (condensation and fuel) in the engine crankcase. The vehicle then might be driven at high speeds on the highway where the condensation and fuel boil off. The next time the engine oil is checked it may appear that a liter of oil was used in about 160 km (100 miles). Oil consumption rate is about one liter per 2, 400 km (1, 500 miles).

Make sure the selected engine oil meets manufacturer specification and the recommended API performance category "SG" and SAE viscosity grade as shown in the vehicle Owner's Guide. It is also important that the engine oil is changed at the intervals specified for the typical operating conditions.

The following diagnostic procedure is used to determine the source of excessive oil consumption.

**NOTE: Oil use is normally greater during the first 16, 100 km (10, 000 miles) of service. As mileage increases, oil use decreases. High speed driving, towing, high ambient temperature and other factors may result in greater oil use.**

1. Define excessive consumption, such as the number of miles driven per liter of oil used. Also determine customers driving habits, such as sustained high speed operation, towing, extended idle and other considerations.
2. Verify that the engine has no external oil leaks as described under Engine Oil Leaks in this section.
3. Carry out an oil consumption test:

- Run the engine to normal operating temperature. Switch engine OFF and allow oil to drain back for at least five minutes.
- With vehicle parked on level surface, check the engine oil level.
- If required, add engine oil to set level exactly to the FULL mark.
- Record the vehicle mileage.
- Instruct the customer to return for a level check after driving the vehicle as usual for 1,610 km (1000 miles).
- Check the oil level under the same conditions and at the same location as the initial check.

**NOTE: If the oil consumption rate is unacceptable go to Step 4.**

4. Check the Positive Crankcase Ventilation (PCV) system. Make sure the system is not plugged.
5. Check for plugged oil drain-back holes in the cylinder head and cylinder block.
6. Carry out a cylinder compression test. Refer to the Compression Test procedure in this section. This can help determine the source of oil consumption such as valves, piston rings or other areas.
7. Check valve guides for excessive guide clearance. Install new valve stem seals after verifying valve guide clearance.
8. Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on the tips of the spark plugs can be a clue to internal oil consumption.

#### INTAKE MANIFOLD VACUUM TEST

Bring the engine to normal operating temperature. Connect a vacuum gauge or equivalent to the intake manifold. Run the engine at the specified idle speed.

The vacuum gauge should read between 51-74 kPa (15-22 in-Hg) depending upon the engine condition and the altitude at which the test is performed. Subtract 4.0193 kPa (1 in-Hg) from the specified reading for every 304.8 m (1,000 feet) of elevation above sea level.

The reading should be steady. As necessary, adjust the gauge damper control (where used) if the needle is fluttering rapidly. Adjust damper until needle moves easily without excessive flutter.

#### INTERPRETING VACUUM GAUGE READINGS

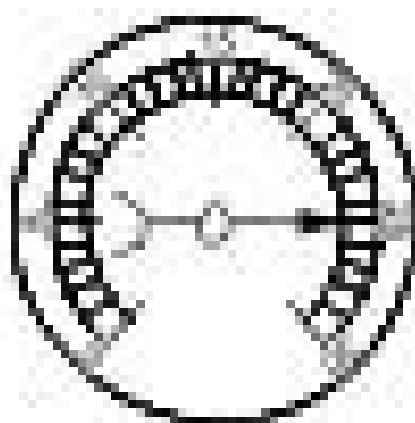
A careful study of the vacuum gauge reading while the engine is idling will help pinpoint trouble areas. Always conduct other appropriate tests before arriving at a final diagnostic decision. Vacuum gauge readings, although helpful, must be interpreted carefully.

Most vacuum gauges have a normal band indicated on the gauge face.

The following are potential gauge readings. Some are normal; others should be investigated further.



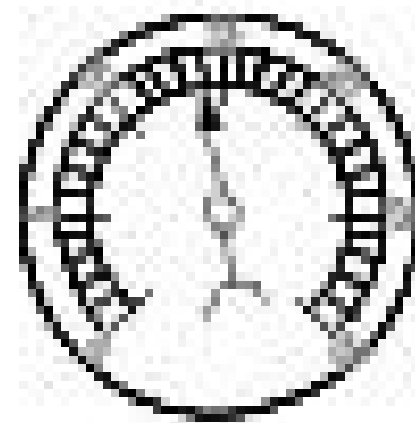
1



2



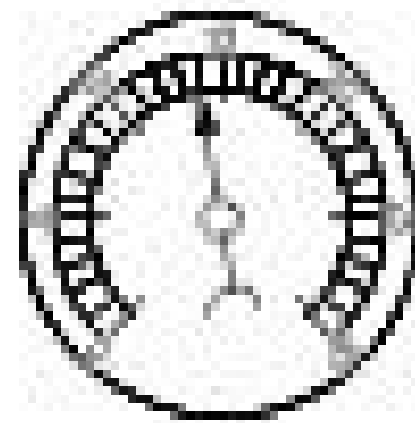
4



5



7



8



1. **NORMAL READING:** Needle between 51-74 kPa (15-22 in-Hg) and holding steady.
2. **NORMAL READING DURING RAPID ACCELERATION:** When the engine is rapidly accelerated, the needle will drop to a low (not to zero) reading. When the throttle is suddenly released, the needle will snap back up to a higher than normal figure.
3. **NORMAL FOR HIGH-LIFT CAMSHAFT WITH LARGE OVERLAP:** The needle will register as low as 51 kPa (15 in-Hg) but will be relatively steady. Some oscillation is normal.
4. **WORN RINGS OR DILUTED OIL:** When the engine is accelerated, the needle drops to 0 kPa (0 in-Hg). Upon deceleration, the needle runs slightly above 74 kPa (22 in-Hg).
5. **STICKING VALVES:** When the needle remains steady at a normal vacuum but occasionally flicks (sharp, fast movement) down and back about 13 kPa (4 in-Hg), one or more valves may be sticking.
6. **BURNED OR BENT VALVES:** A regular, evenly-spaced, downscale flicking of the needle indicates one or more burned or damaged valves. Insufficient hydraulic valve tappet or hydraulic lash adjuster clearance will also cause this reaction.
7. **POOR VALVE SEATING:** A small but regular downscale flicking can mean one or more valves are not seating correctly.
8. **WORN VALVE GUIDES:** When the needle oscillates over about a 13 kPa (4 in-Hg) range at idle speed, the valve guides could be worn. As engine speed increases, the needle will become steady if guides are responsible.
9. **WEAK VALVE SPRINGS:** When the needle oscillation becomes more violent as engine RPM is increased, weak valve springs are indicated. The reading at idle could be relatively steady.
10. **LATE VALVE TIMING:** A steady but low reading could be caused by late valve timing.
11. **IGNITION TIMING RETARDED:** Retarded ignition timing will produce a steady but somewhat low reading.
12. **INSUFFICIENT SPARK PLUG GAP:** When spark plugs are gapped too close, a regular, small pulsation of the needle can occur.
13. **INTAKE LEAK:** A low, steady reading can be caused by an intake manifold or throttle body gasket leak.
14. **BLOWN HEAD GASKET:** A regular drop of fair magnitude can be caused by a blown head gasket or warped cylinder head to cylinder block surface.
15. **RESTRICTED EXHAUST SYSTEM:** When the engine is first started and is idled, the reading may be normal, but as the engine RPM is increased, the back pressure caused by a clogged muffler, kinked tail pipe or other concerns will cause the needle to slowly drop to 0 kPa (0 in-Hg). The needle then may slowly rise. Excessive exhaust clogging will cause the needle to drop to a low point even if the engine is only idling.

When vacuum leaks are indicated, search out and correct the cause. Excess air leaking into the system will upset the fuel mixture and cause concerns such as rough idle, missing on acceleration or burned valves. If the leak exists in an accessory such as the power brake booster, the unit will not function correctly. Always repair vacuum leaks.

## GENERAL PROCEDURES

### ENGINE OIL DRAINING AND FILLING

**NOTE:** Removal steps in this procedure may contain installation details.

**WARNING: Make sure to support the vehicle with axle stands.**

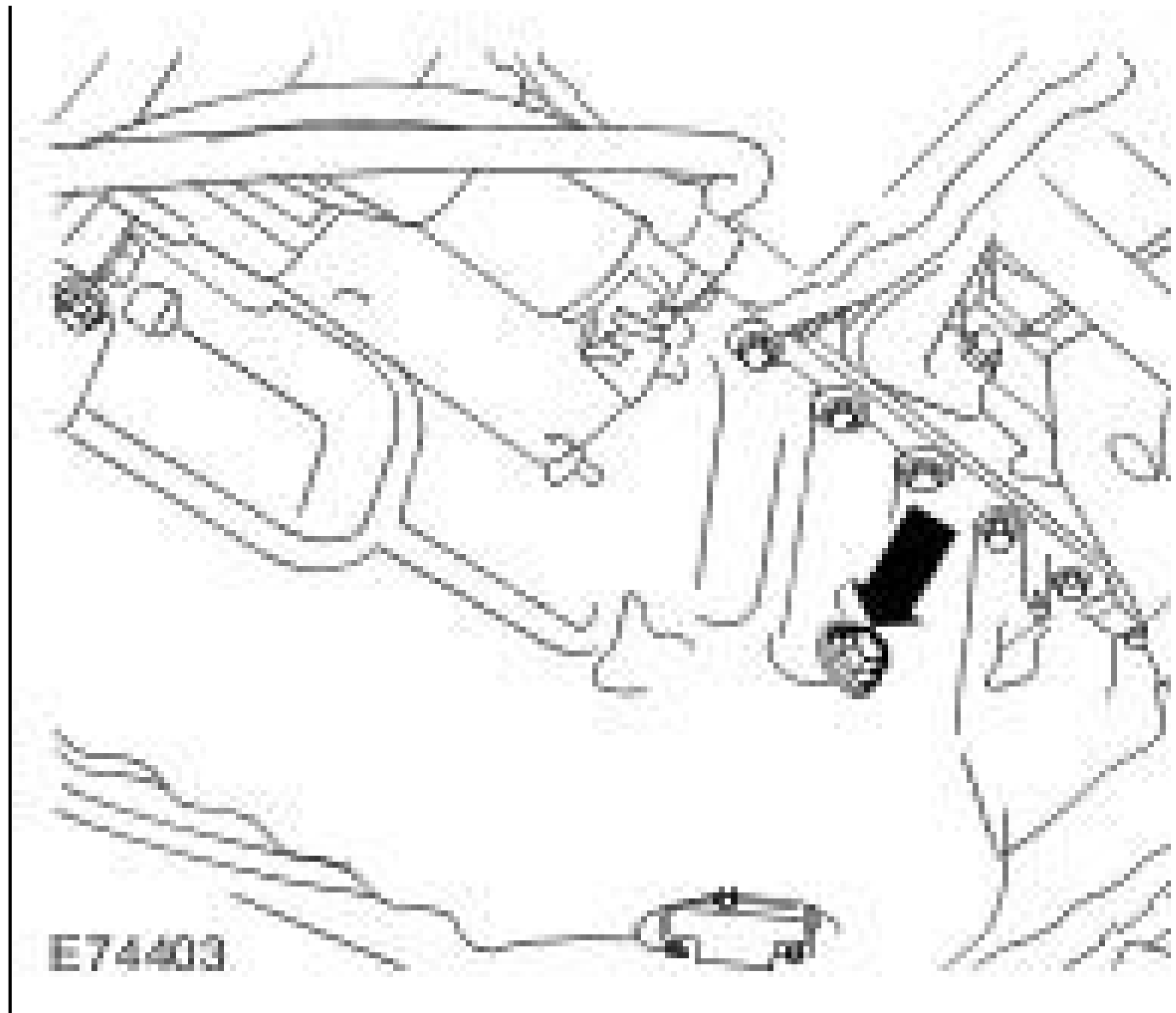
1. Raise and support the vehicle.
2. Remove the oil filter. See **Oil Filter Element**.
3. Remove the engine undershield. Refer to **Engine Undershield** .

**WARNING: Avoid skin contact with the specified material.**

**CAUTION: Hot fluid.**

**CAUTION: Be prepared to collect escaping fluids.**

4.
  - Torque: 38
  - Remove and discard the sealing washer.



**CAUTION:** Make sure that the component is clean, free of foreign material and lubricant.

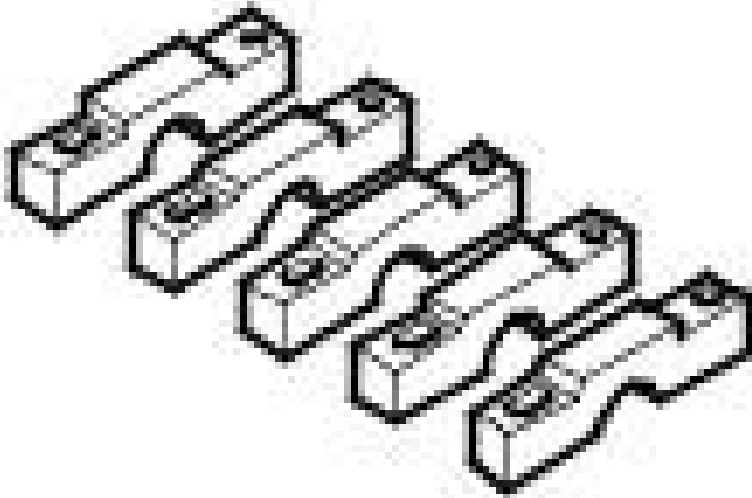
**CAUTION:** Make sure that new sealing washers are installed.

5. To install, reverse the removal procedure.
6. Check and top-up the engine oil.

#### VALVE CLEARANCE ADJUSTMENT

303-1235 Holder, Camshaft

303-1235

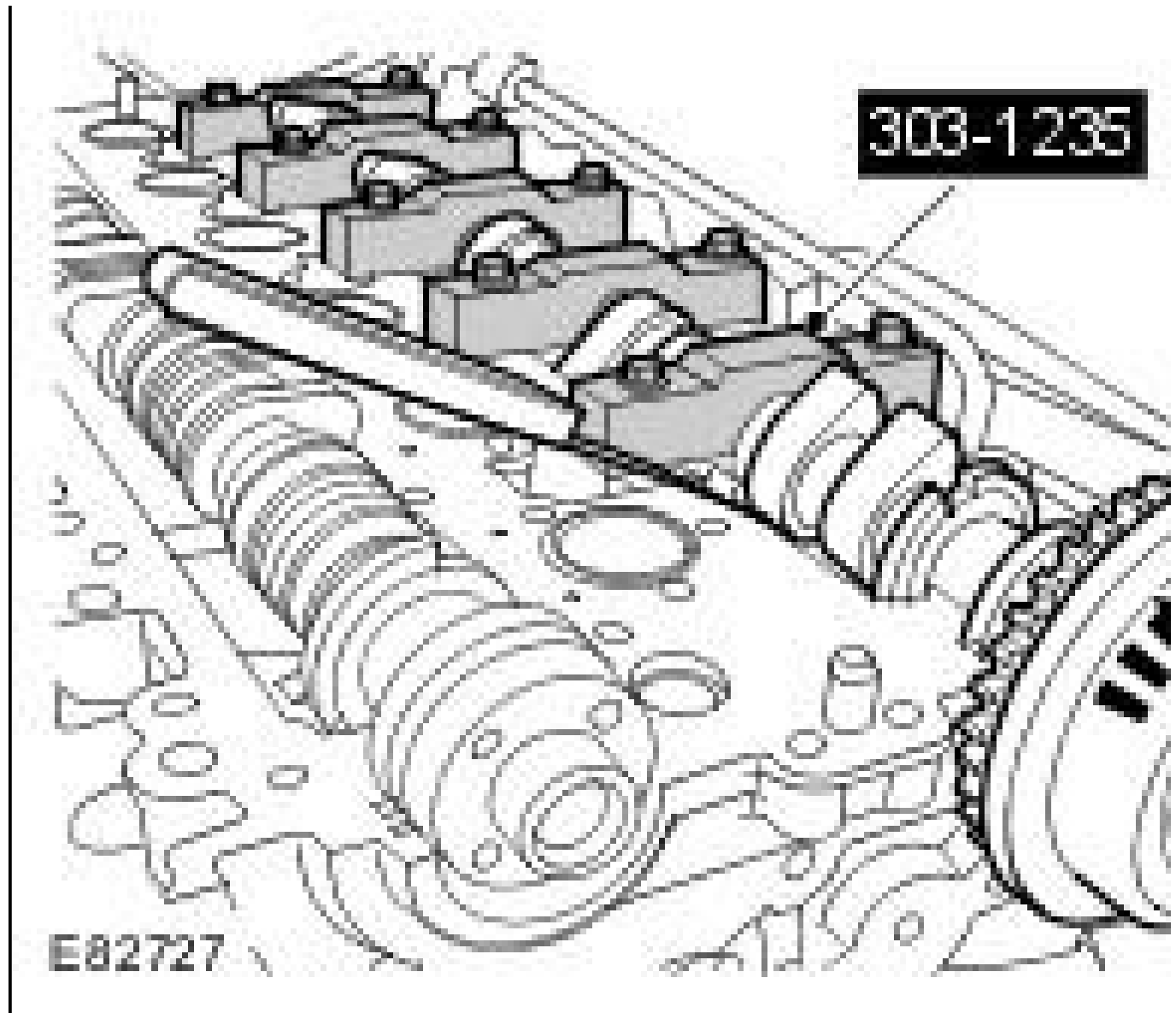


E82725

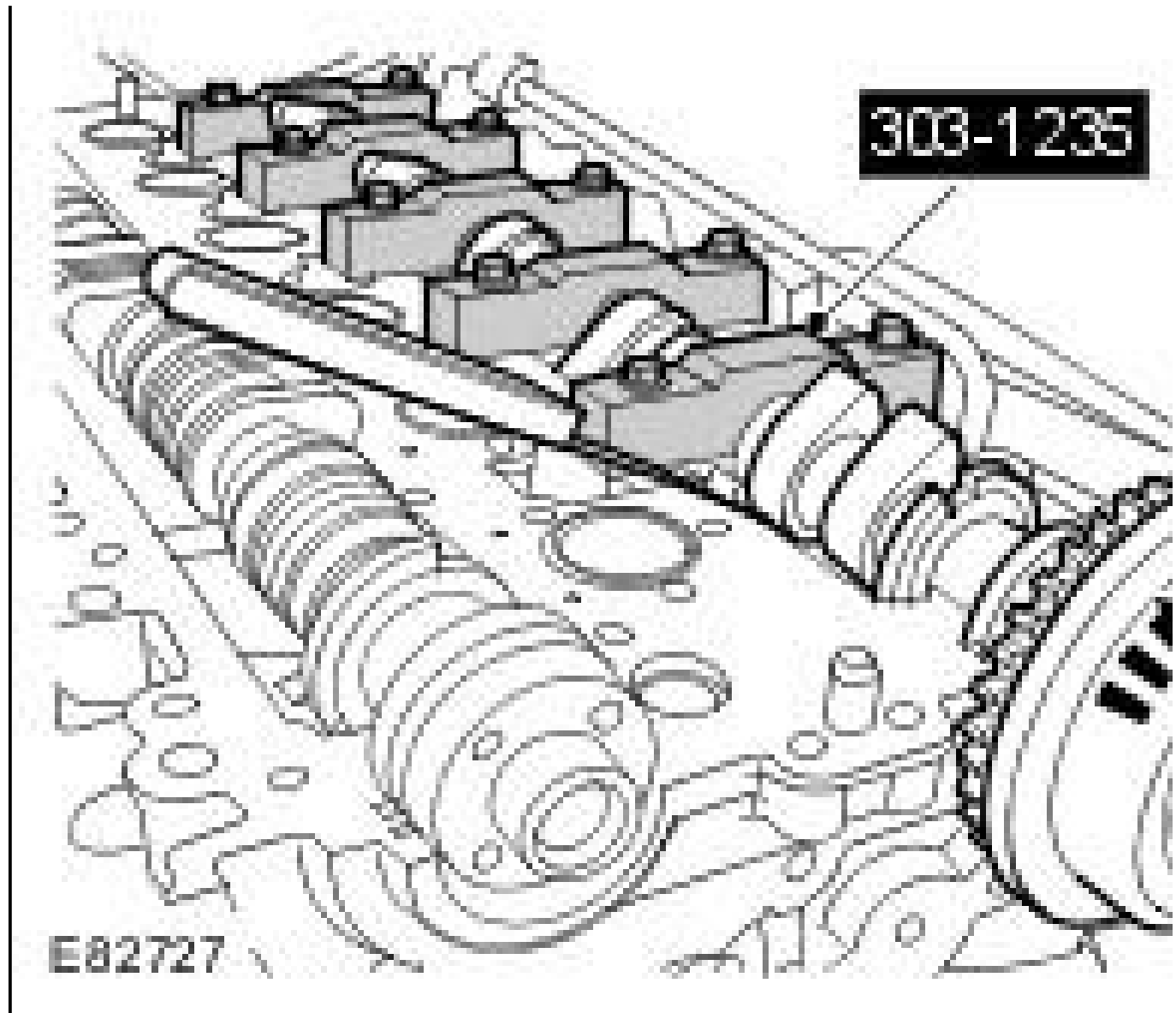
**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable. Refer to **Specifications** .
3. Remove the camshafts. See **Camshafts**.
4. Replace the valve shims, with the smallest shim available.
5. Using the special tools, position and secure the exhaust camshaft.

Holder, Camshaft (303-1235)



6. Using the original bolt, install the camshaft sprocket and lightley tighten.
7. Using a feeler gauge, measure the clearance between the camshaft and the valve shim.



8. Measure and record the tappet clearances.
9. Remove the camshaft sprocket.
10. Remove the special tool.
11. Remove the exhaust camshaft.
12. Remove the valve tappets, replace with selected tappets.
13. Install the camshafts. See **Camshafts**.
14. Connect the battery ground cable and install the cover. Refer to **Specifications**.

#### VALVE CLEARANCE CHECK

#### Special Tool(s)

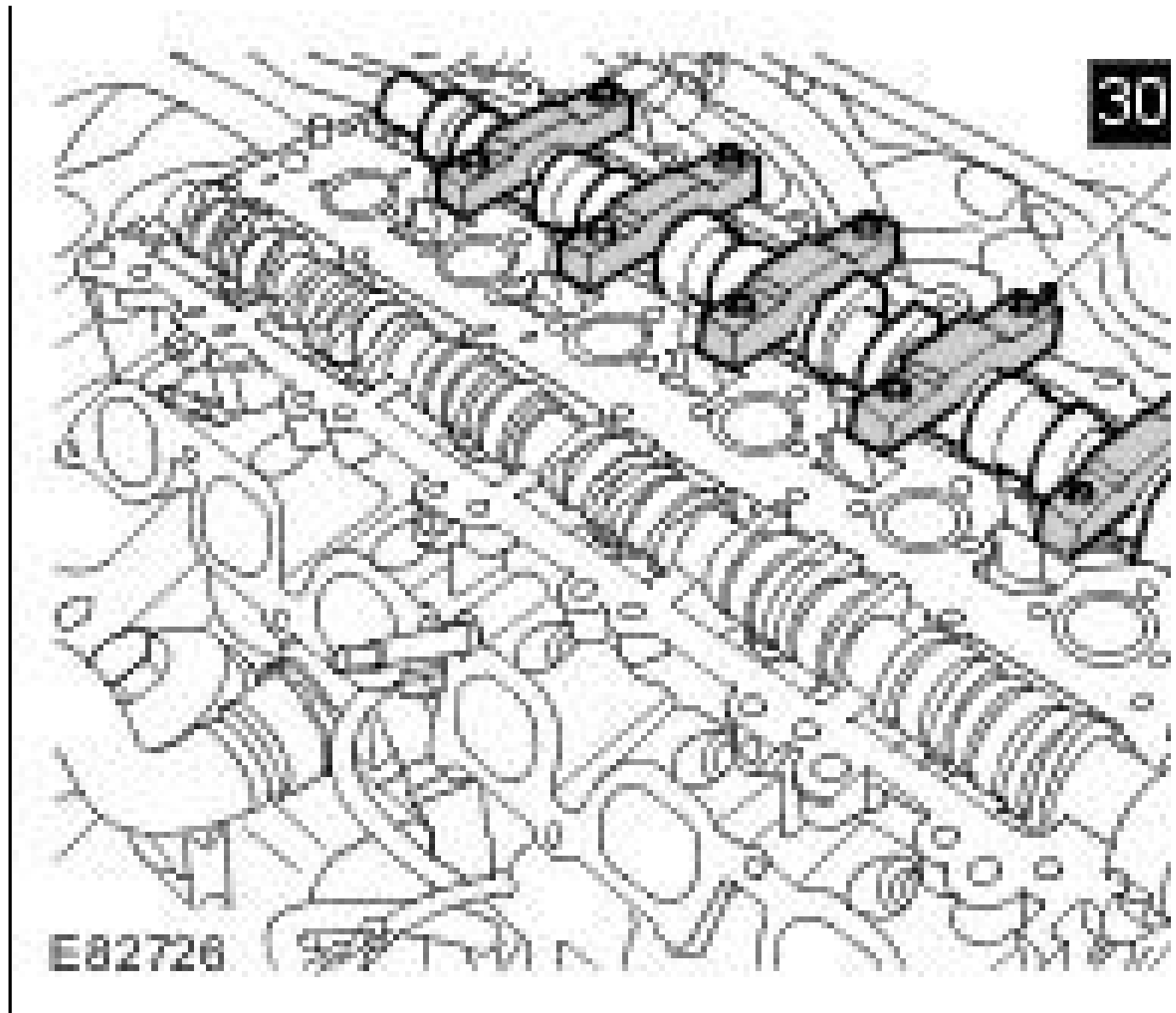
## 303-1235 Holder, Camshaft

**NOTE:** Only the exhaust cam shaft has adjustable tappets.

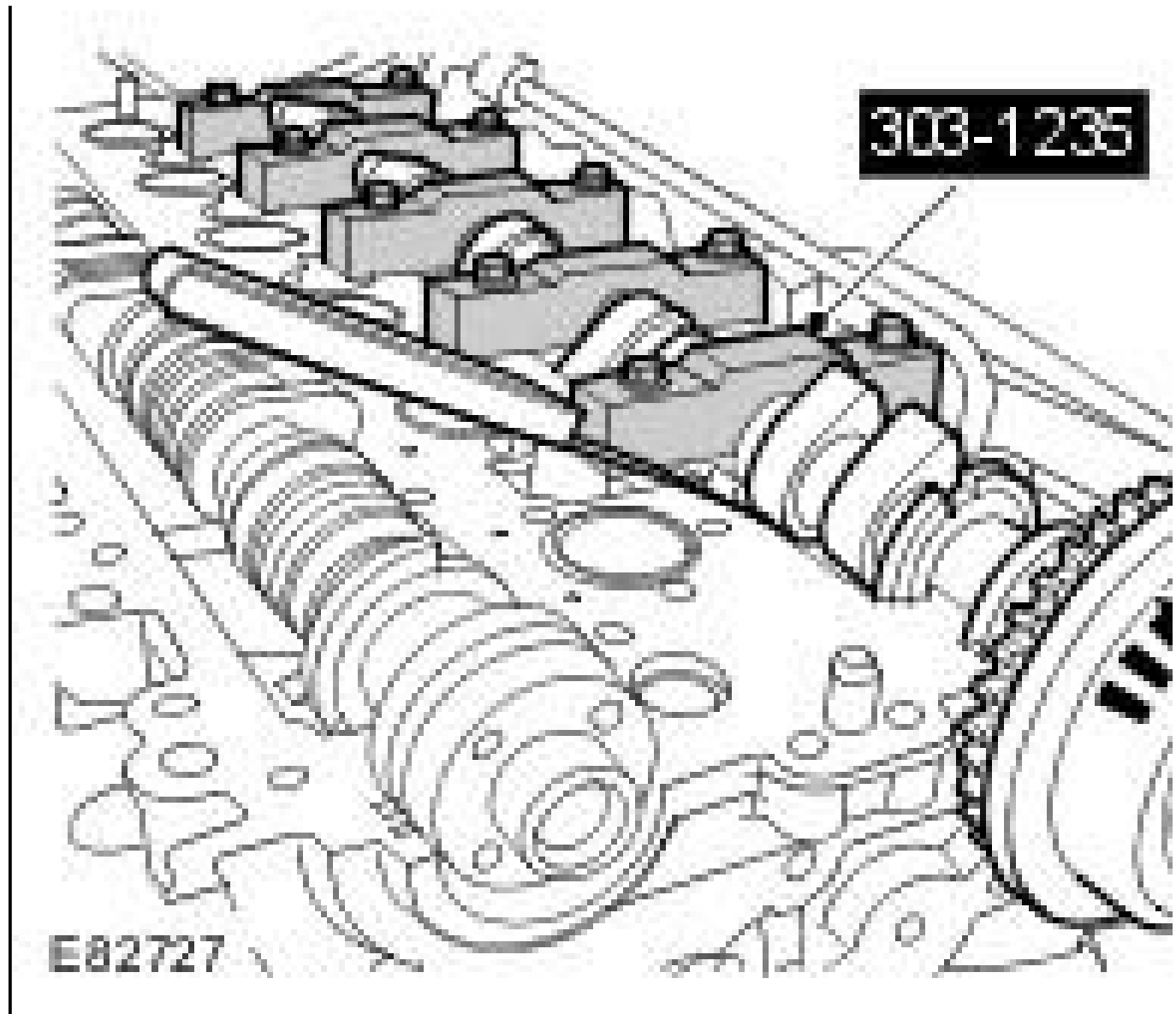
**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable. Refer to **Specifications** .
3. Remove the camshaft bearing housing. See **Valve Cover**.
4. Using the special tools, position and secure the exhaust camshaft.

Holder, Camshaft (303-1235)



5. Using the original bolt, install the camshaft sprocket and lightley tighten.
6. For valve clearance data, refer to specifications. See **Specifications**.
7. Using a feeler gauge, measure the clearance between the camshaft and the valve shim.



8. Remove the camshaft sprocket.
9. Remove the special tools.
10. Install the camshaft bearing housing. See **Valve Cover**.
11. Connect the battery ground cable and install the cover. Refer to **Specifications**.

#### HYDRAULIC LASH ADJUSTER PRIMING

**NOTE:** Hydraulic lash adjusters are fitted to the intake camshaft only.

1. Check the engine oil level.
2. If lash adjuster noise occurs when the engine is started, allow the engine to warm at idle for 1 minute (at -20 degrees celsius allow the engine to warm for 5 minutes).

3. Run the engine at 3500 RPM for 1 minute.
4. Allow the engine to idle for 30 seconds.
5. If the valve train noise is still present, repeat the above up to a maximum of 6 times.

## REMOVAL AND INSTALLATION

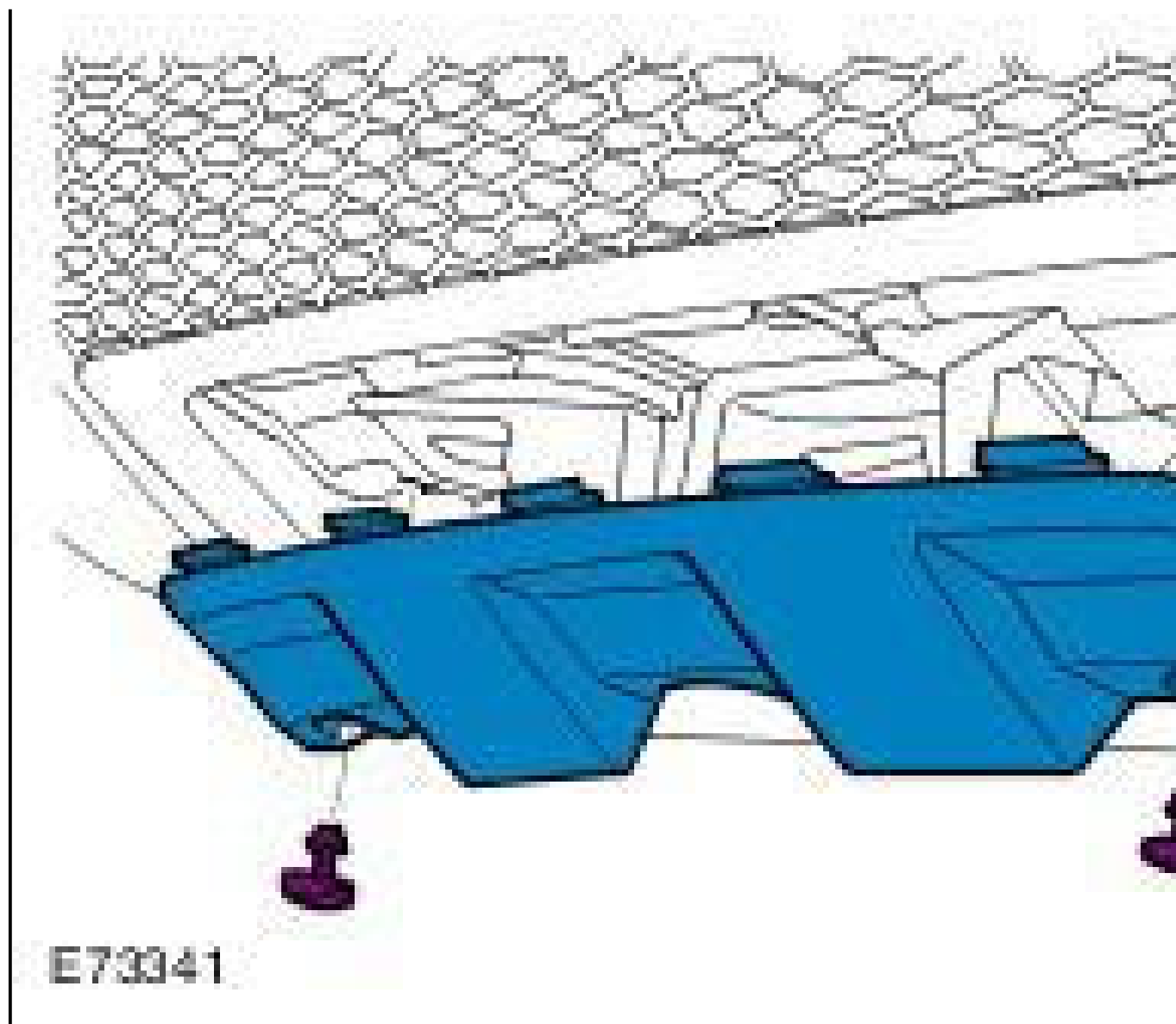
### INTAKE MANIFOLD

#### REMOVAL

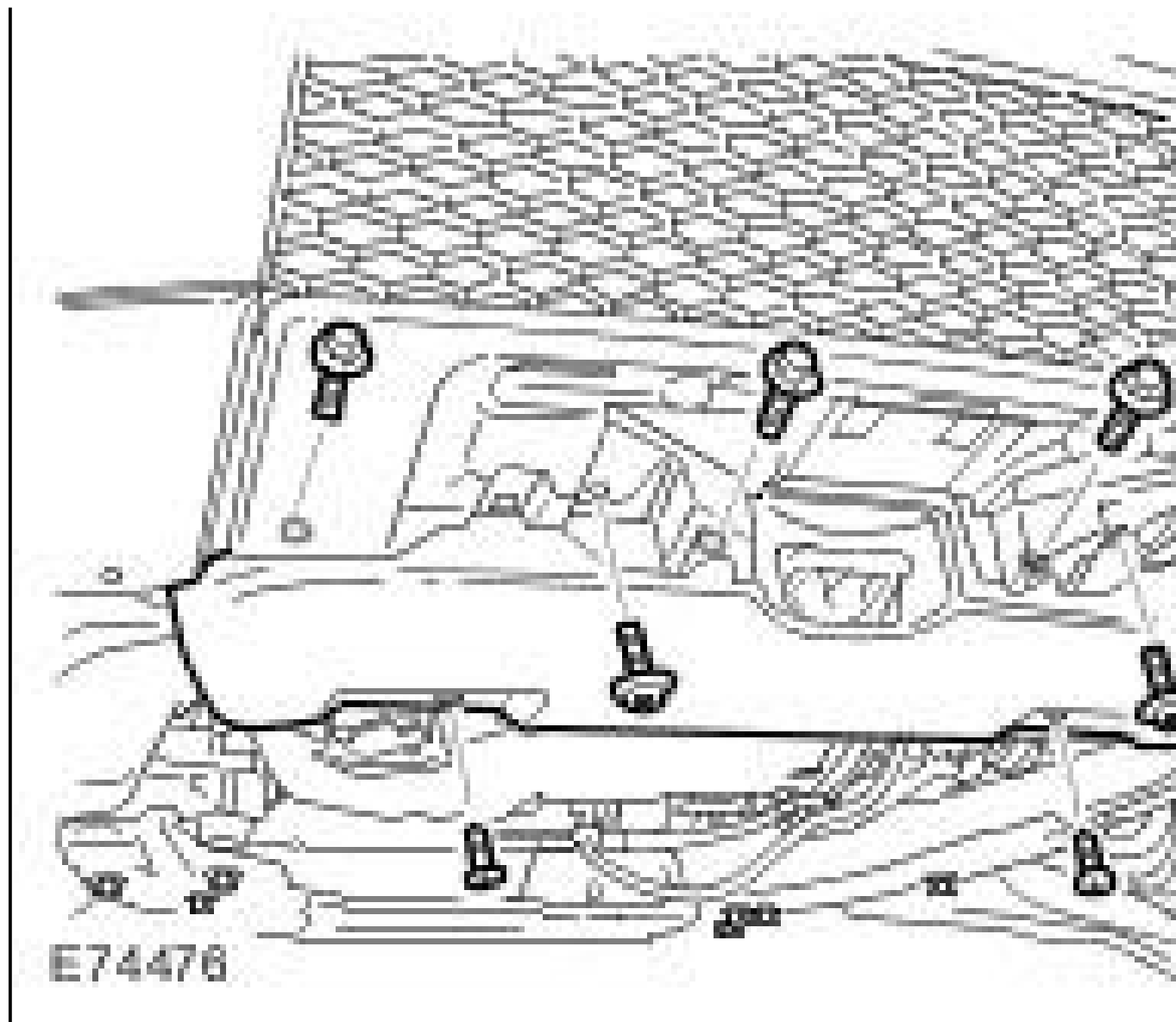
1. Disconnect the battery ground cable. Refer to Specifications .
2. Remove the engine cover. Refer to Engine Cover - 3.2L .
3. Remove the air cleaner assembly. Refer to Air Cleaner .

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

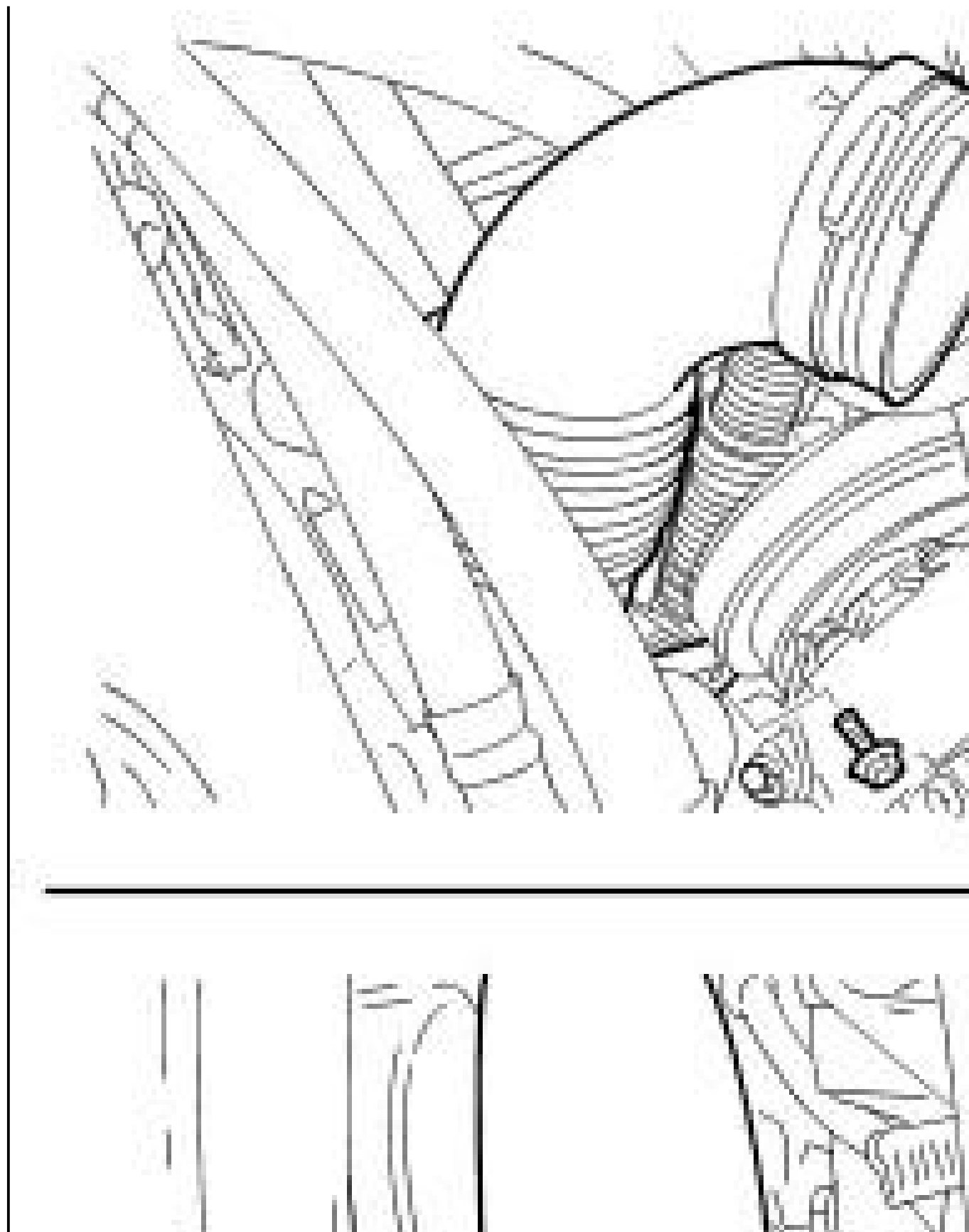
4. Raise and support the vehicle.
5. Remove the engine undershield. Refer to Engine Undershield .
6. See figure.



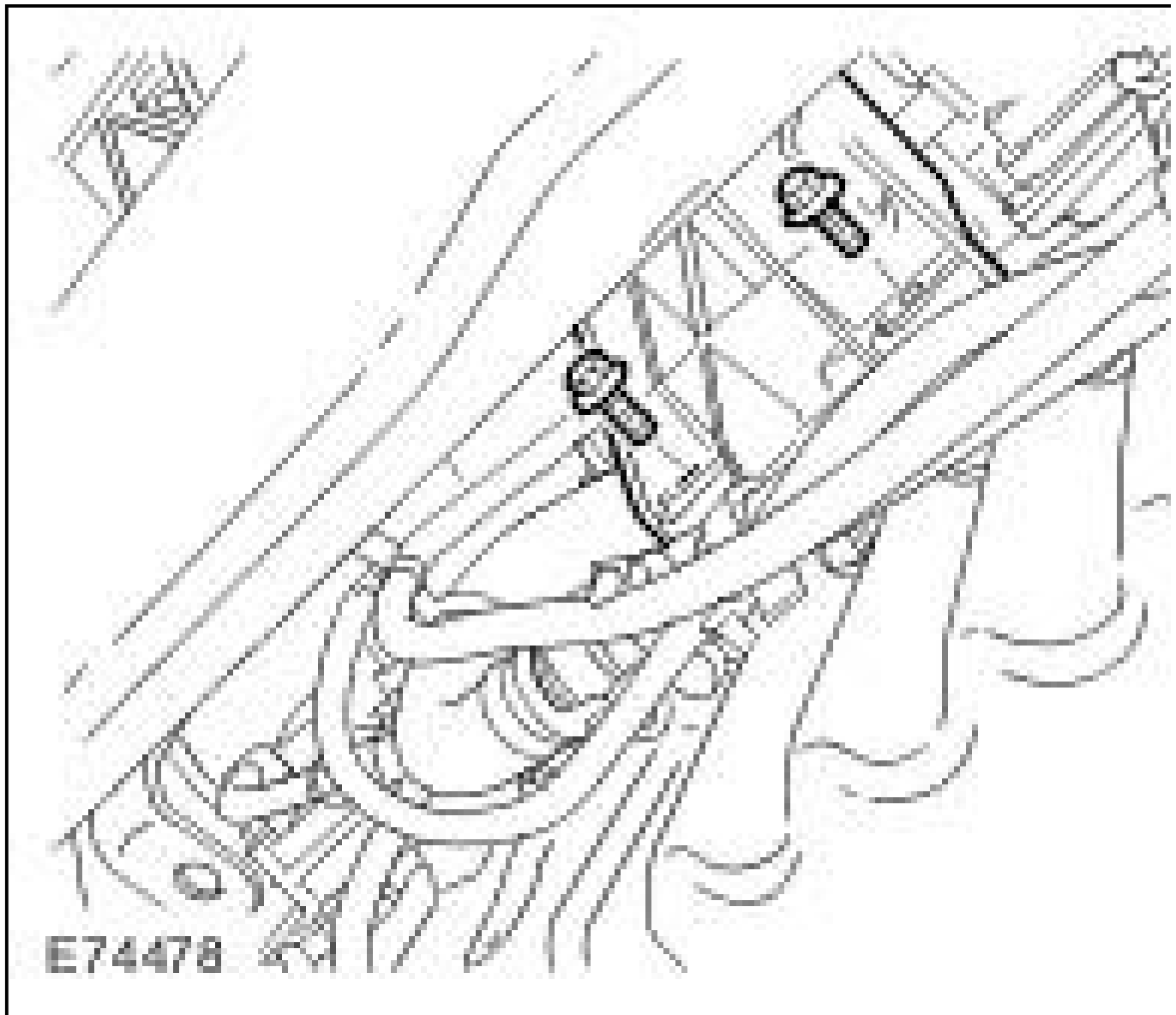
7. See figure.



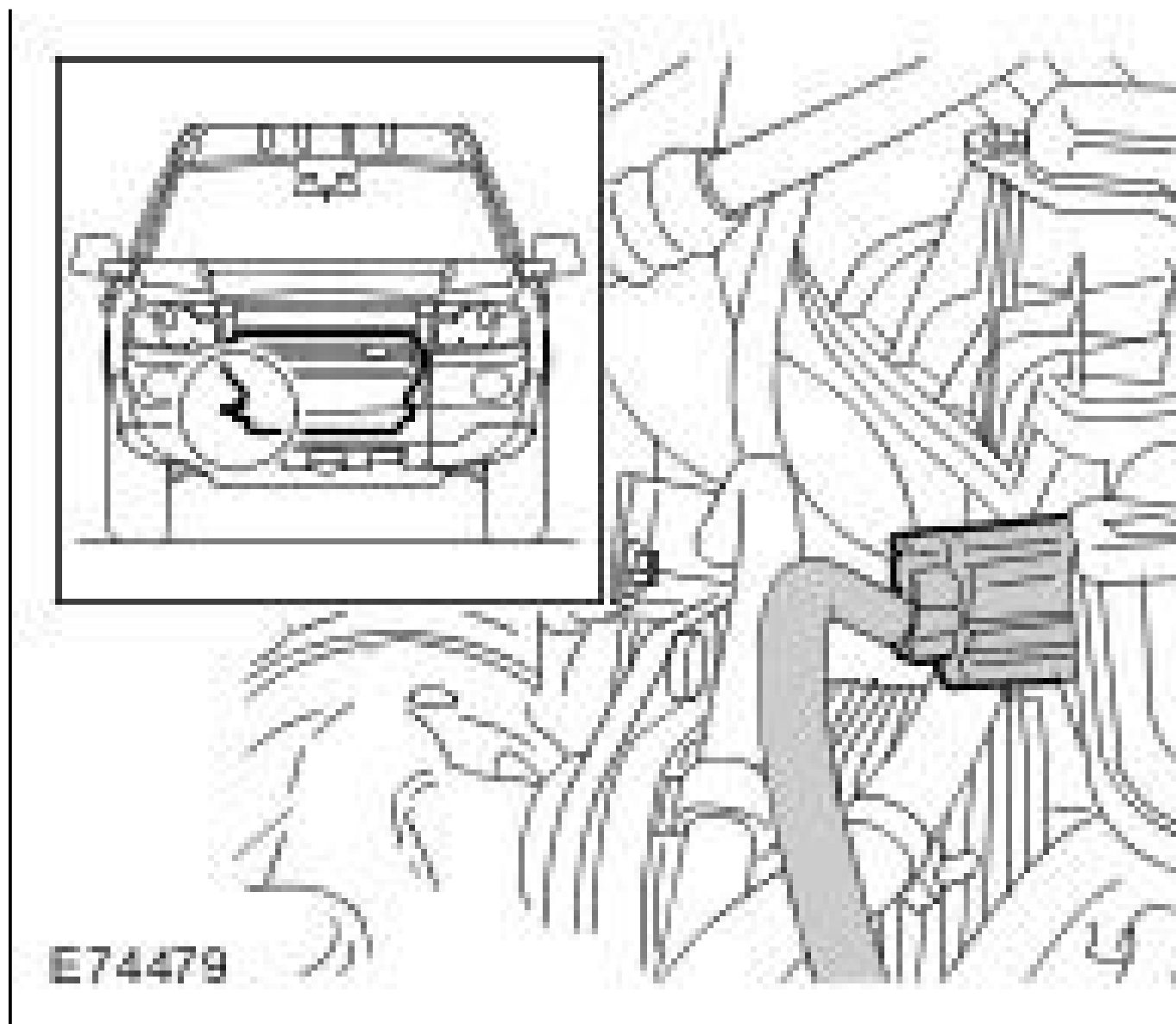
8. Remove the air cleaner outlet pipe.



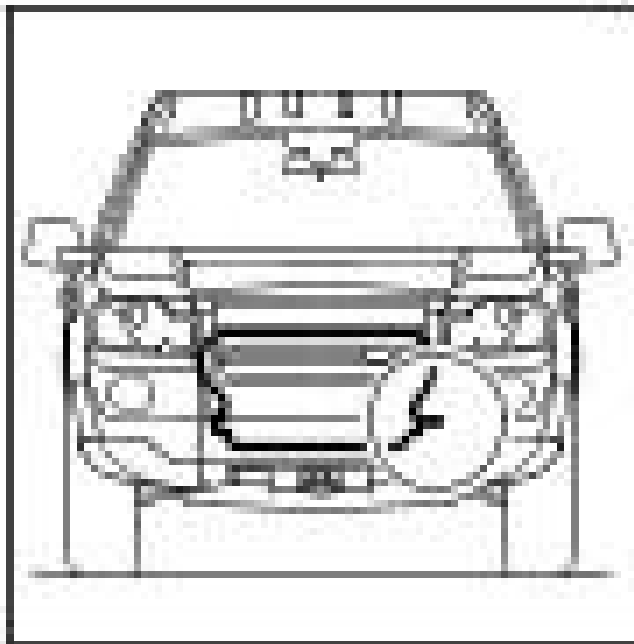
9. Remove the 2 lower intake manifold bolts.



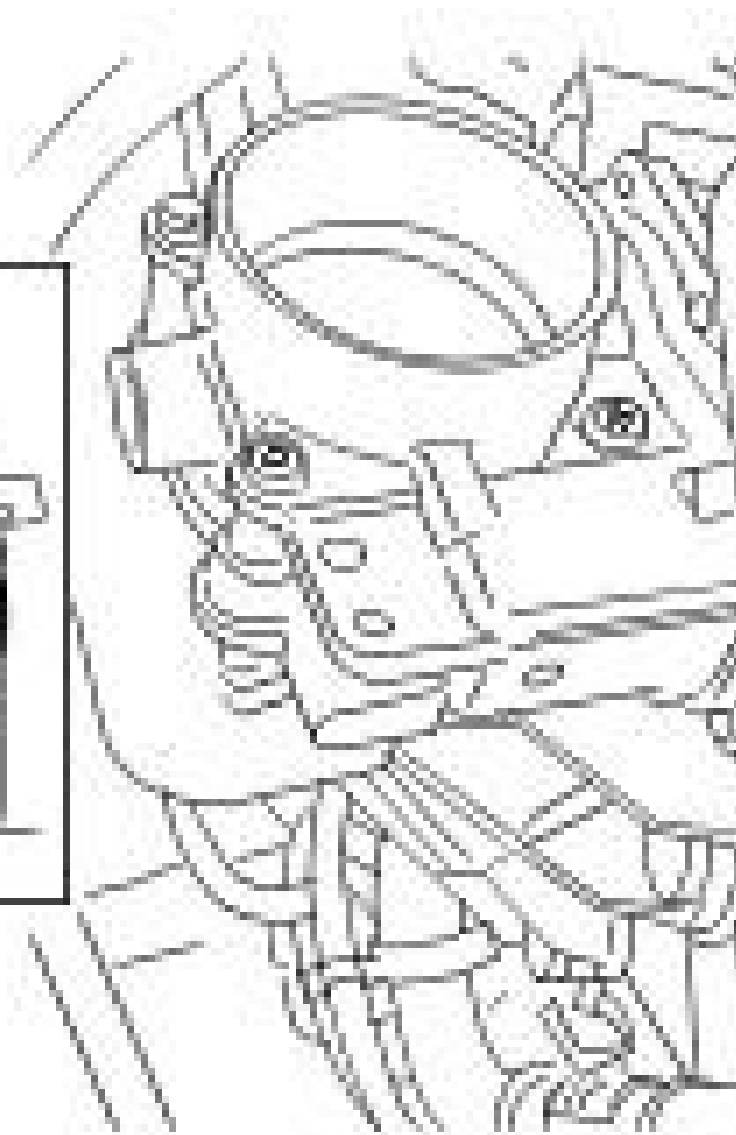
10. Disconnect the MAP sensor electrical connector.



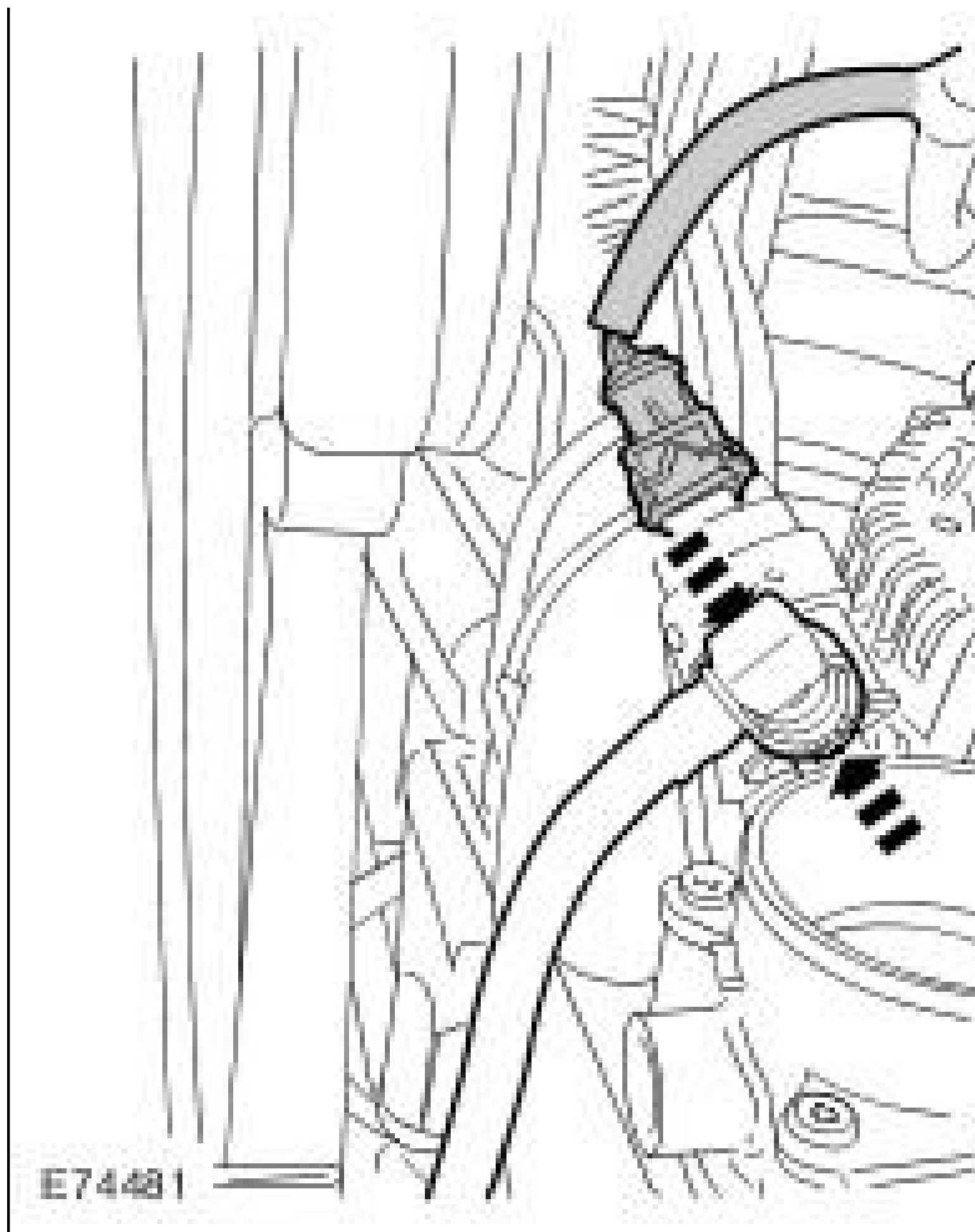
11. Disconnect the throttle body electrical connector.



E74480



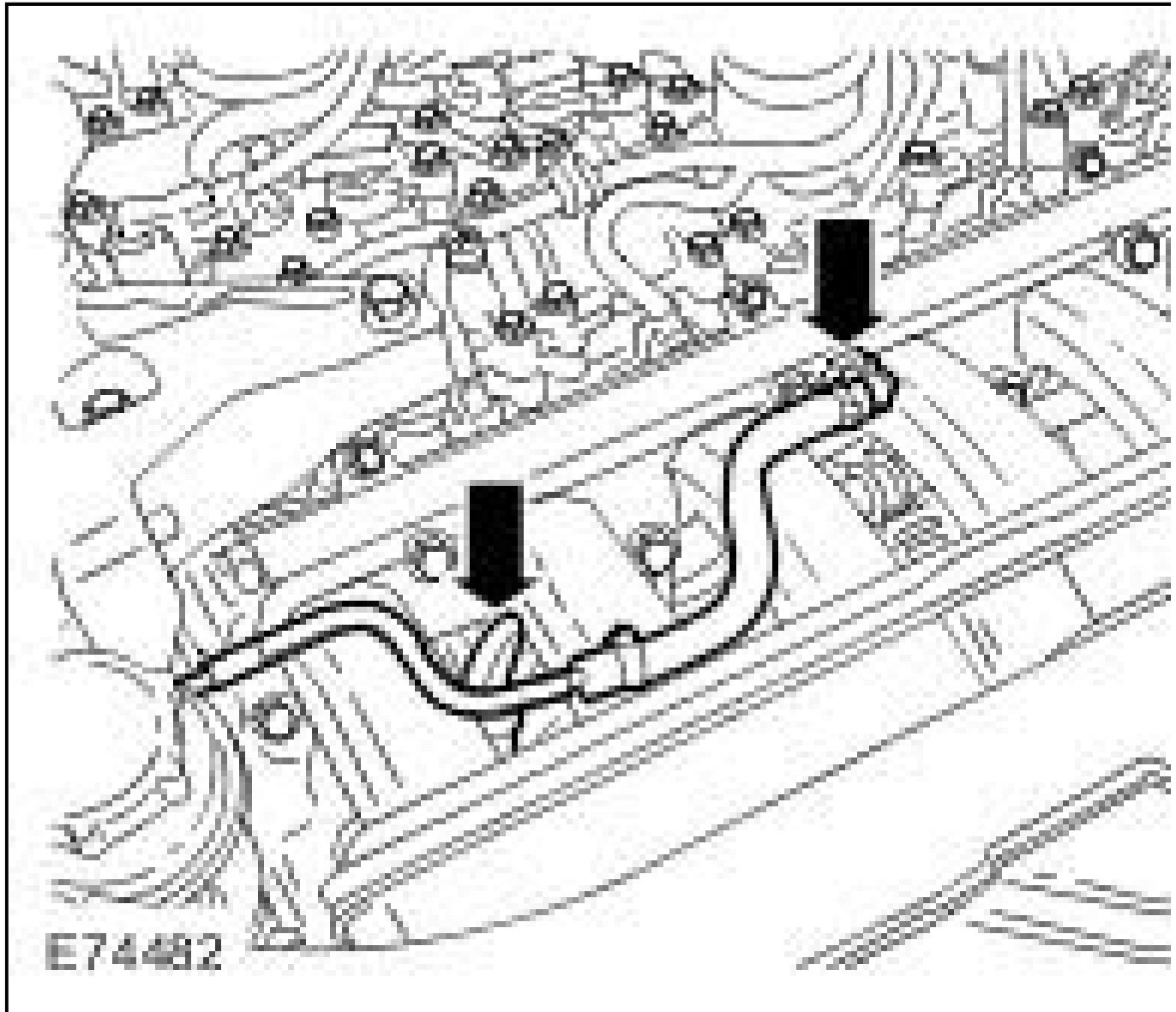
12. Disconnect the fuel purge line.
13. Disconnect the purge control valve (PCV) electrical connector.



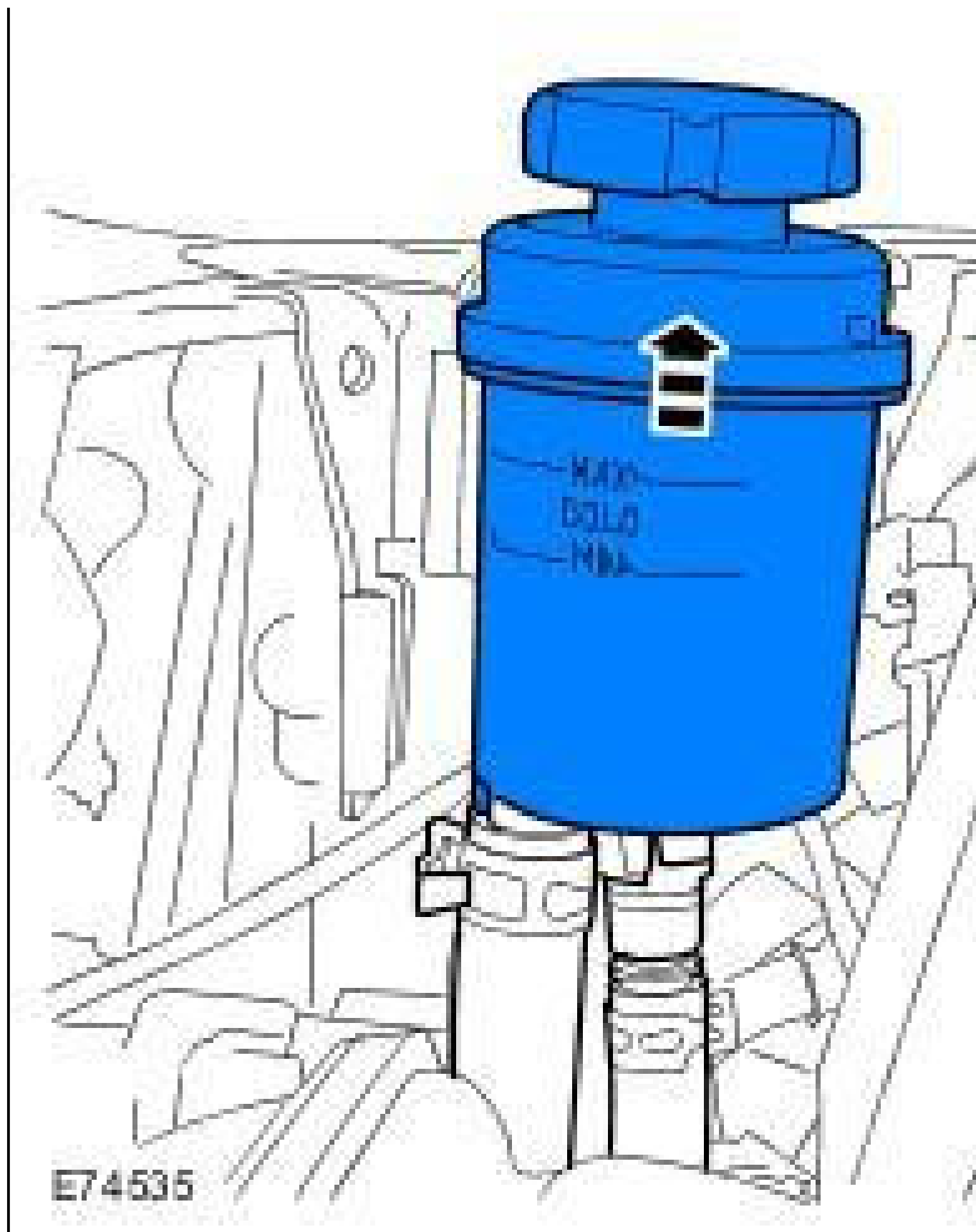
14. Disconnect the fuel rail pressure (FRP) sensor electrical connector.
15. Remove the dipstick.

**CAUTION: Be prepared to collect escaping fluids.**

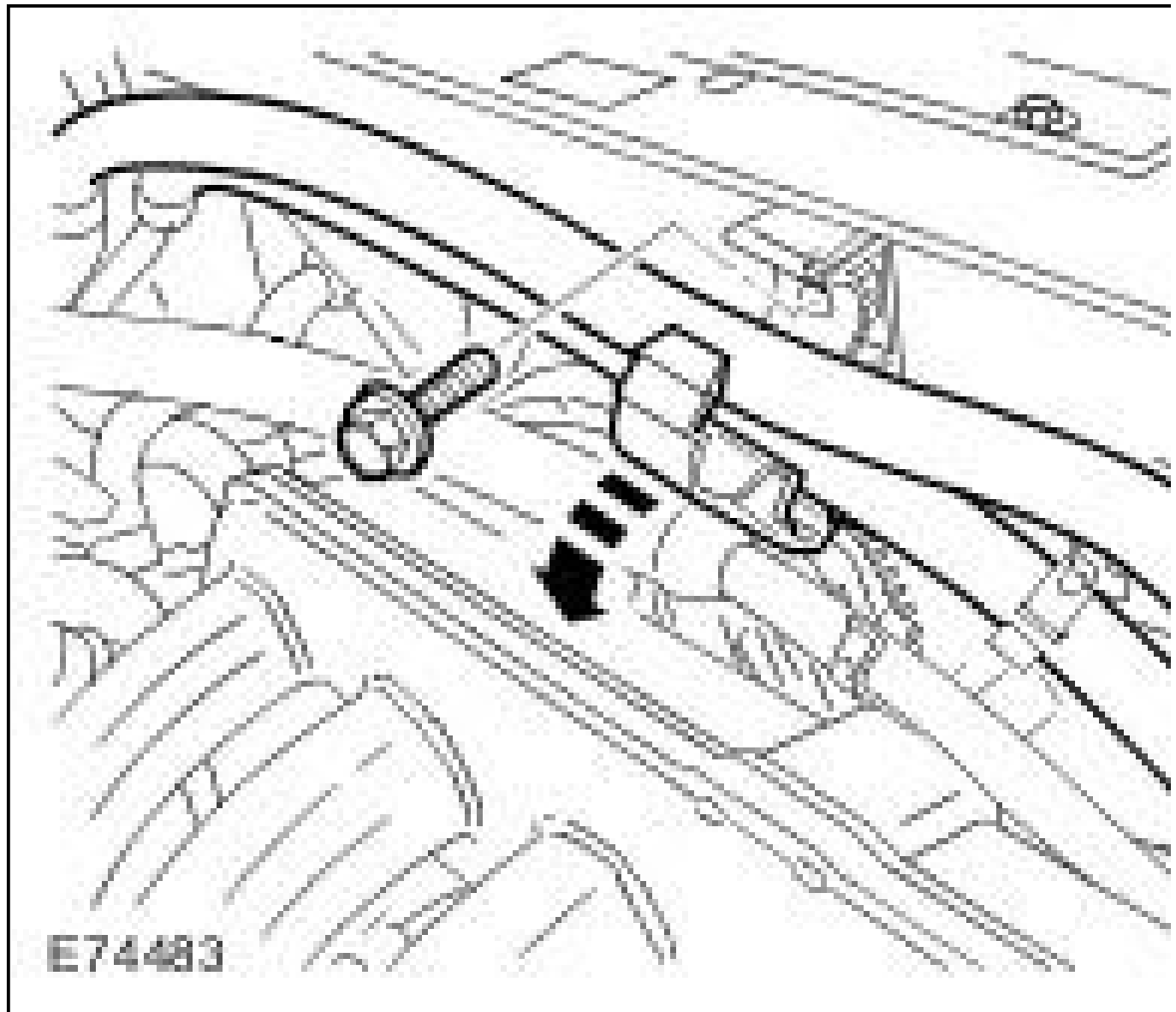
16. Disconnect the coolant bleed hose.



17. Release the PAS fluid reservoir from the bracket and tie aside.

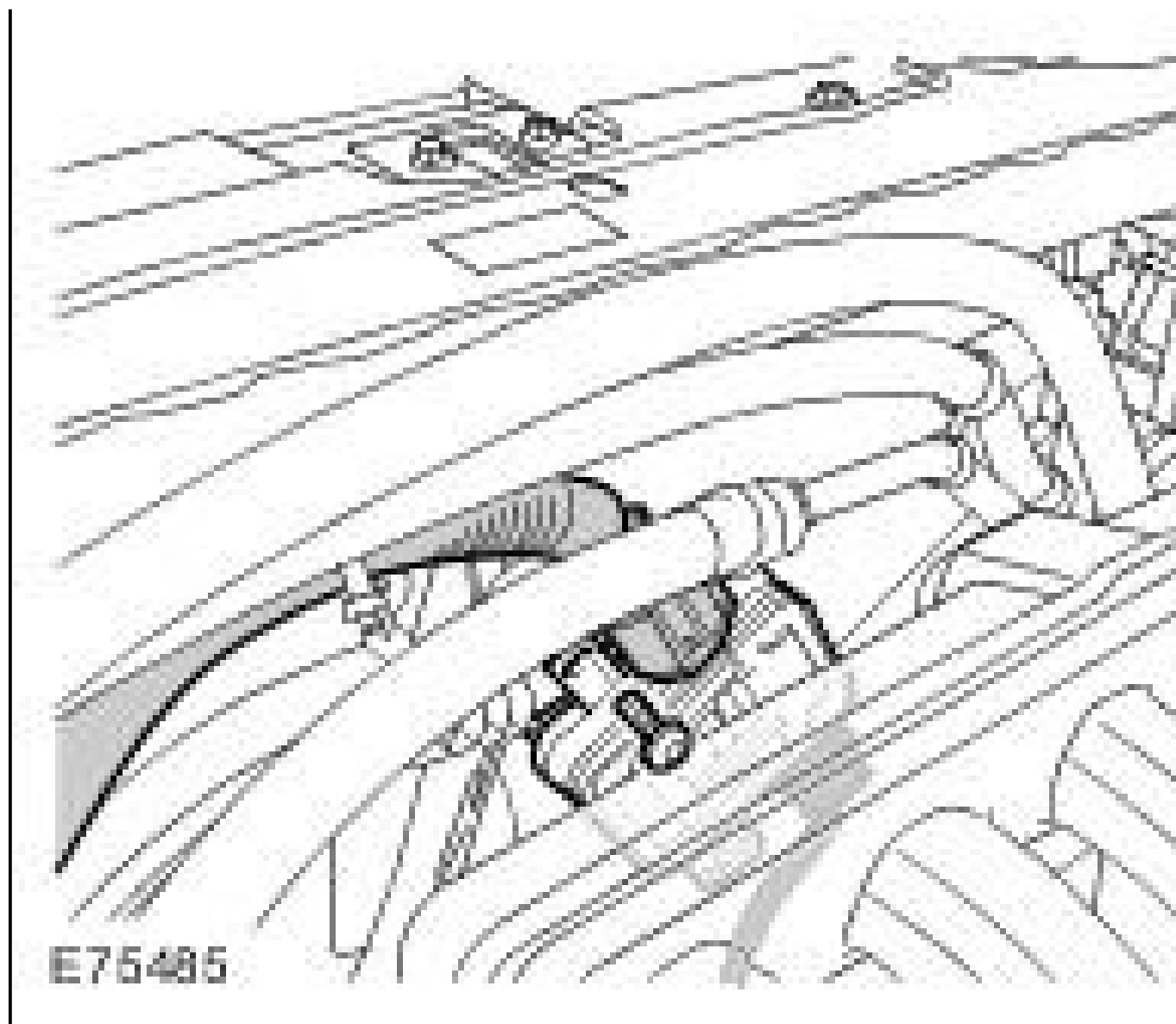


18. Remove the A/C line support bracket.

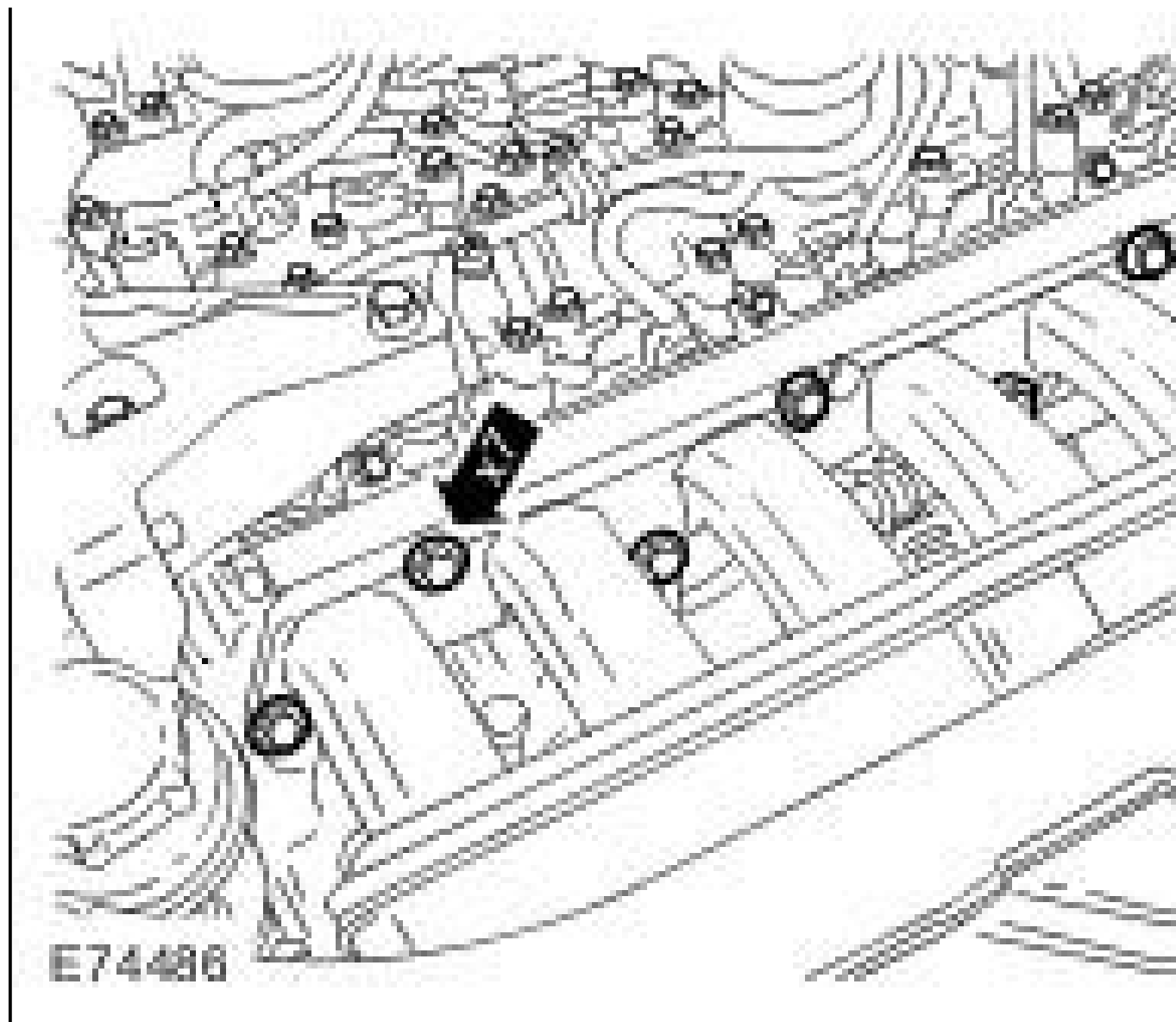


19. Remove the cooling fan module.

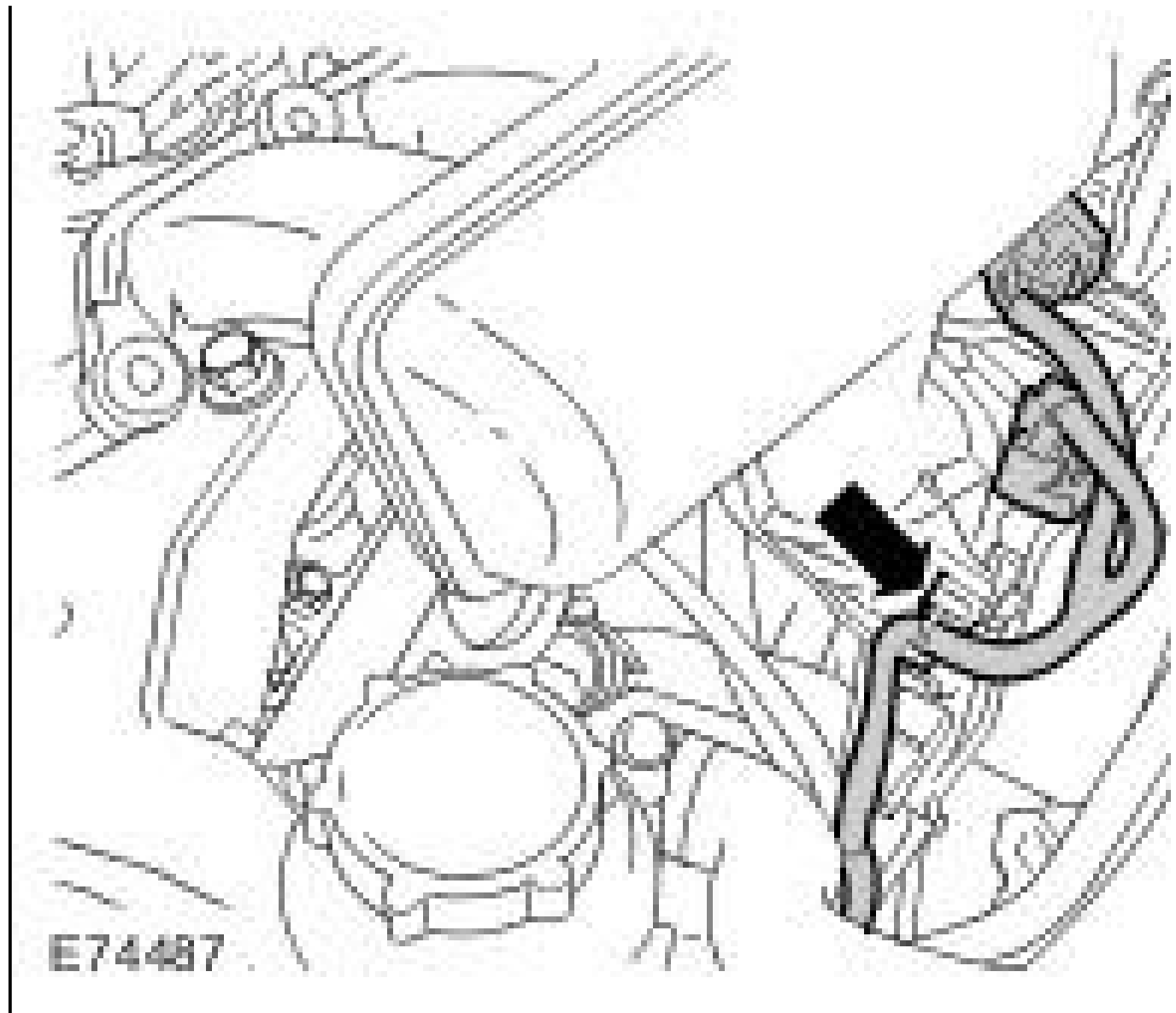




20. Remove the intake manifold.

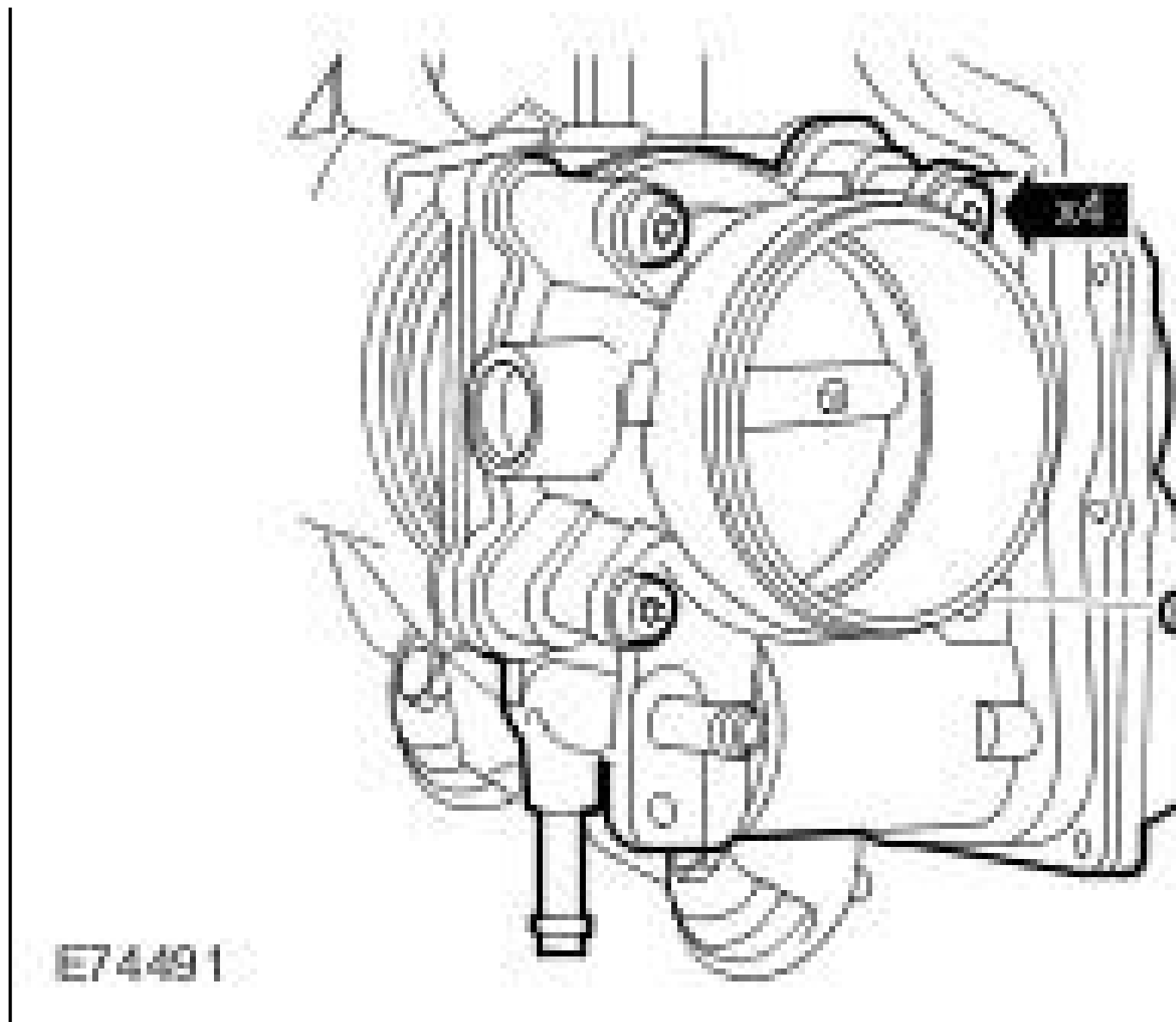


21. Disconnect the 2 intake manifold module connectors.

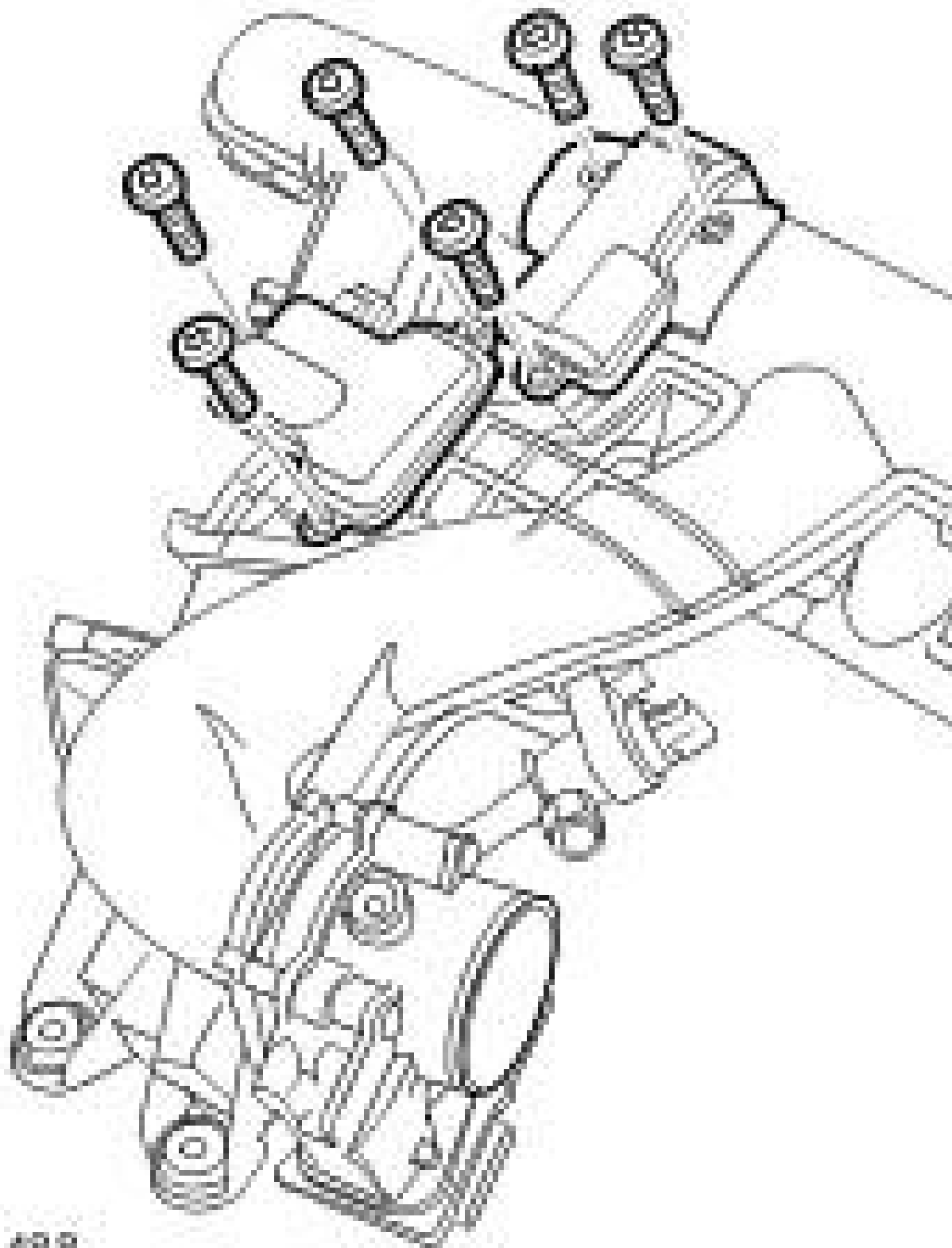


**NOTE:** Do not disassemble further if the component is removed for access only.

22. Remove the throttle body.

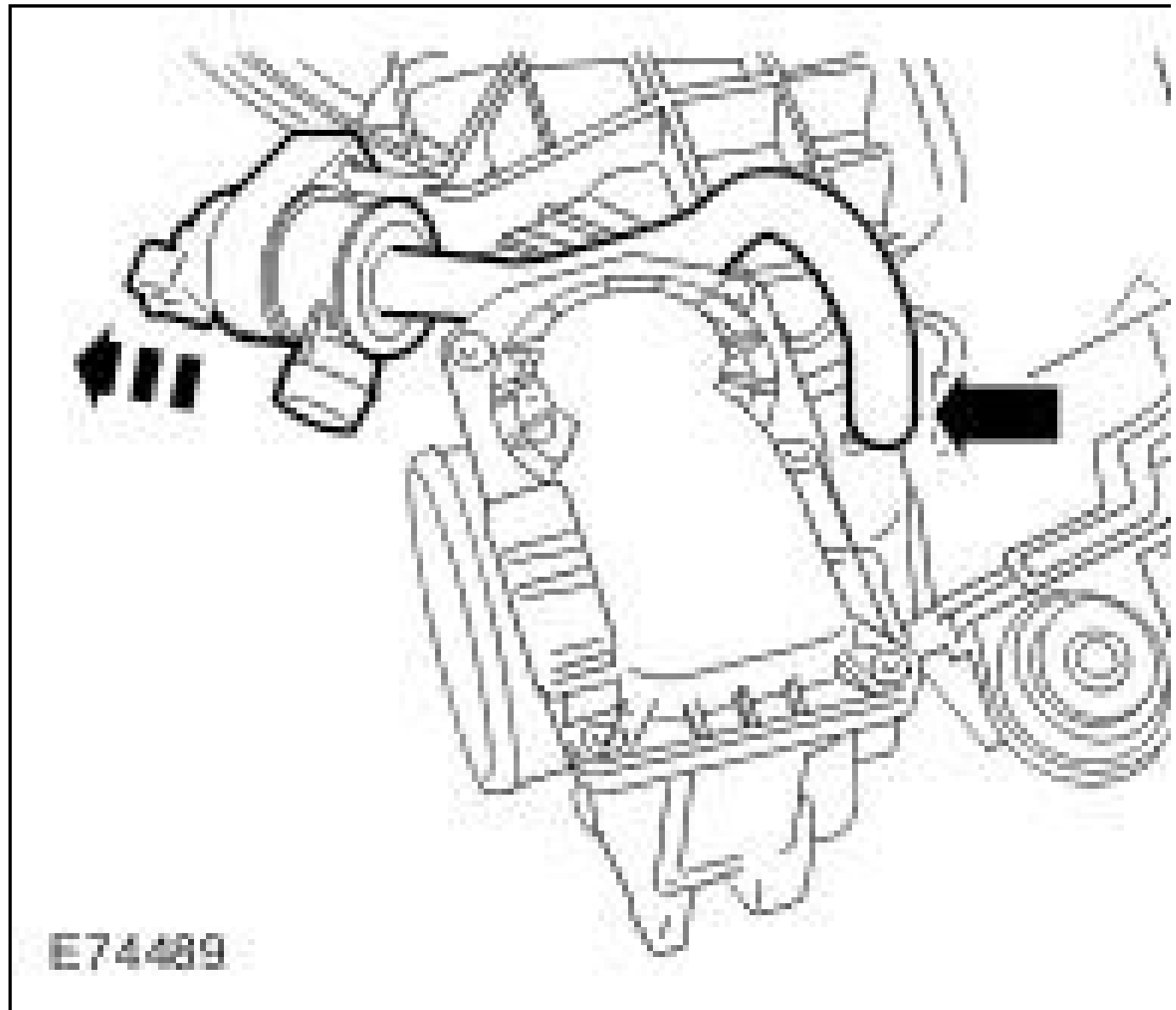


23. Remove the 2 intake manifold modules.



E74488

24. Remove the purge valve assembly.



25. Remove the manifold absolute pressure (MAP) sensor.

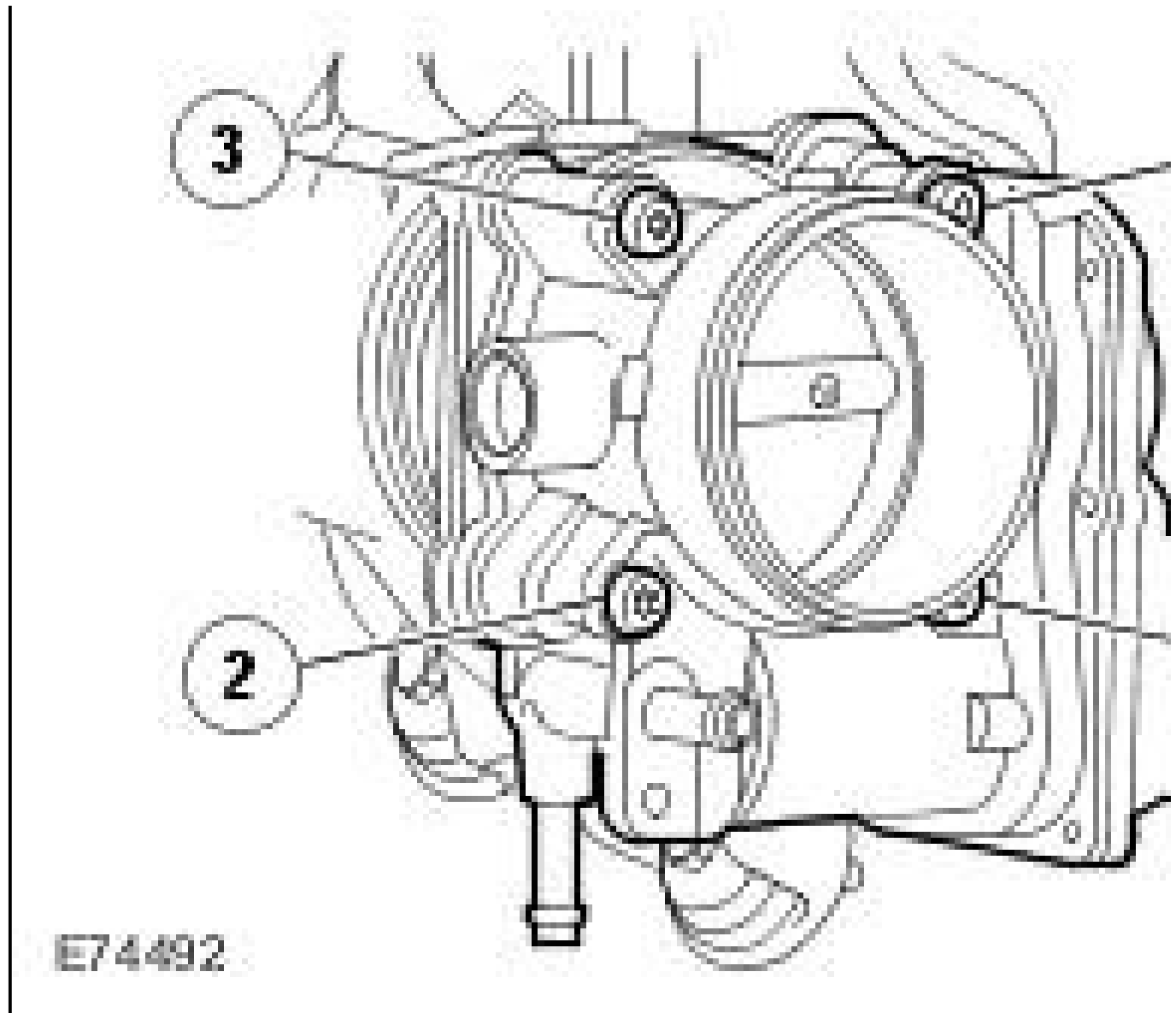


26. Remove and discard the intake manifold gaskets.

**E75392****INSTALLATION**

1. Clean the component mating faces.
2. Install the gaskets.
3. Install the intake manifold modules.
4. Install the MAP sensor.
5. Install the purge valve assembly.
6. Install the throttle body and tighten the screws in the sequence shown.

Torque: 8



7. Install the inlet manifold and tighten the bolts.

Torque: 16

8. Install the cooling fan module.
9. Connect the coolant bleed hose.
10. Install the PAS fluid reservoir in the bracket.
11. Install the dipstick.
12. Connect and secure the electrical connectors.
13. Install the A/C line support bracket and tighten the bolt.

Torque: 10

14. Connect the purge line.
15. Install the lower intake manifold bolts.

Torque: 10

16. Install the air cleaner outlet pipe.
17. Install the engine undershield. Refer to Engine Undershield .
18. Install the front undershield.
19. Install the front towing eye cover.
20. Install the air cleaner assembly. Refer to Air Cleaner .
21. Install the engine cover. Refer to Engine Cover - 3.2L .
22. Connect the battery ground cable. Refer to Specifications .
23. Check and top-up the coolant.

#### VARIABLE VALVE TIMING (VVT) UNIT

##### REMOVAL

**CAUTION:** Extreme cleanliness must be exercised when handling these components.

**NOTE:** This procedure is the same as the timing chain and gears procedure.

1. Remove the cover and disconnect the battery ground cable. Refer to Specifications .
2. Remove the variable valve timing (VVT) unit. See Timing Chain.

##### INSTALLATION

1. Install the VVT unit. See Timing Chain.
2. Connect the battery ground cable and install the cover. Refer to Specifications .

##### VALVE COVER

##### Special Tool(s)

|  |                          |
|--|--------------------------|
|  | 303-1285 Roller, Sealant |
|--|--------------------------|

303-1285



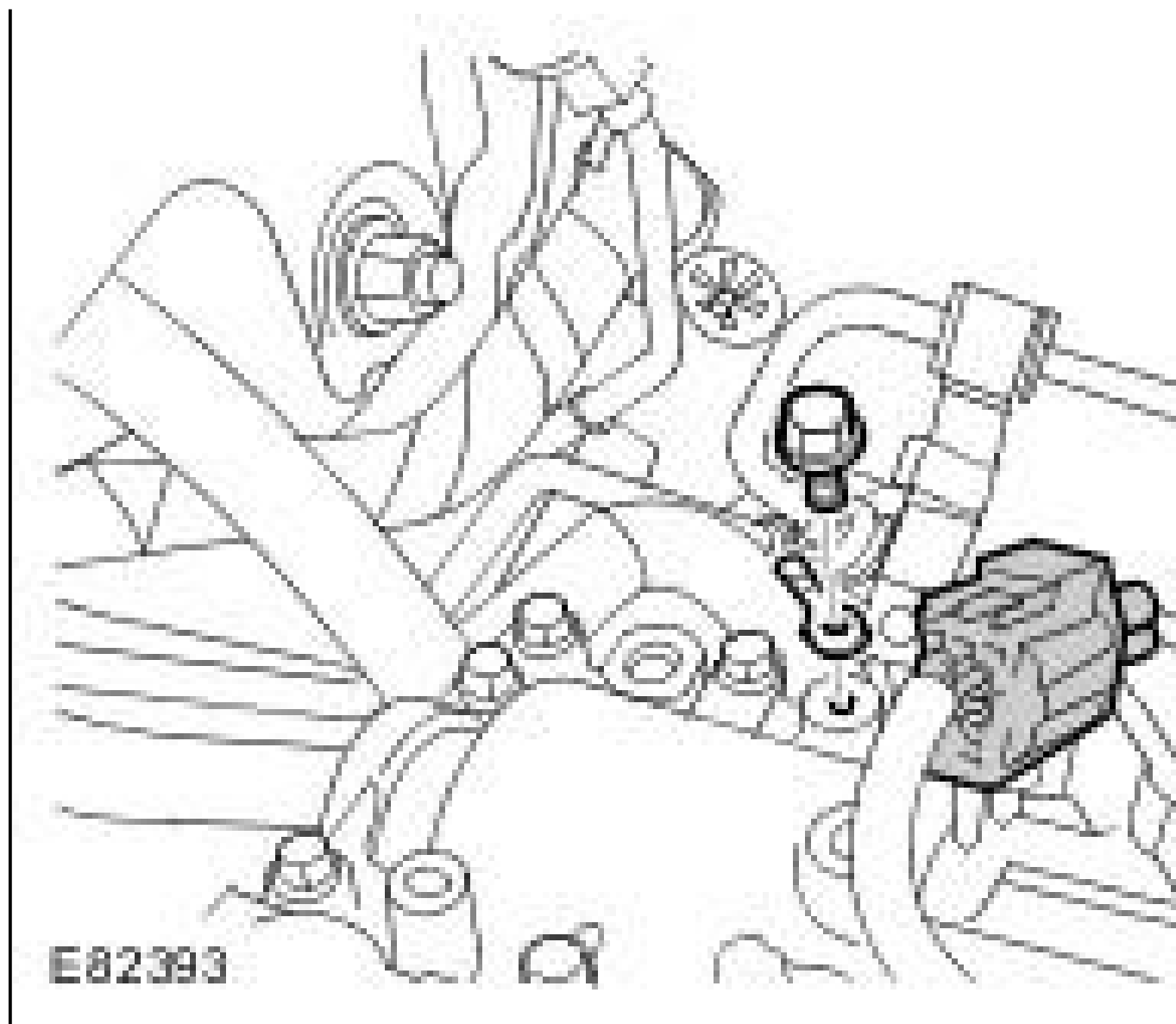
E82840

**REMOVAL**

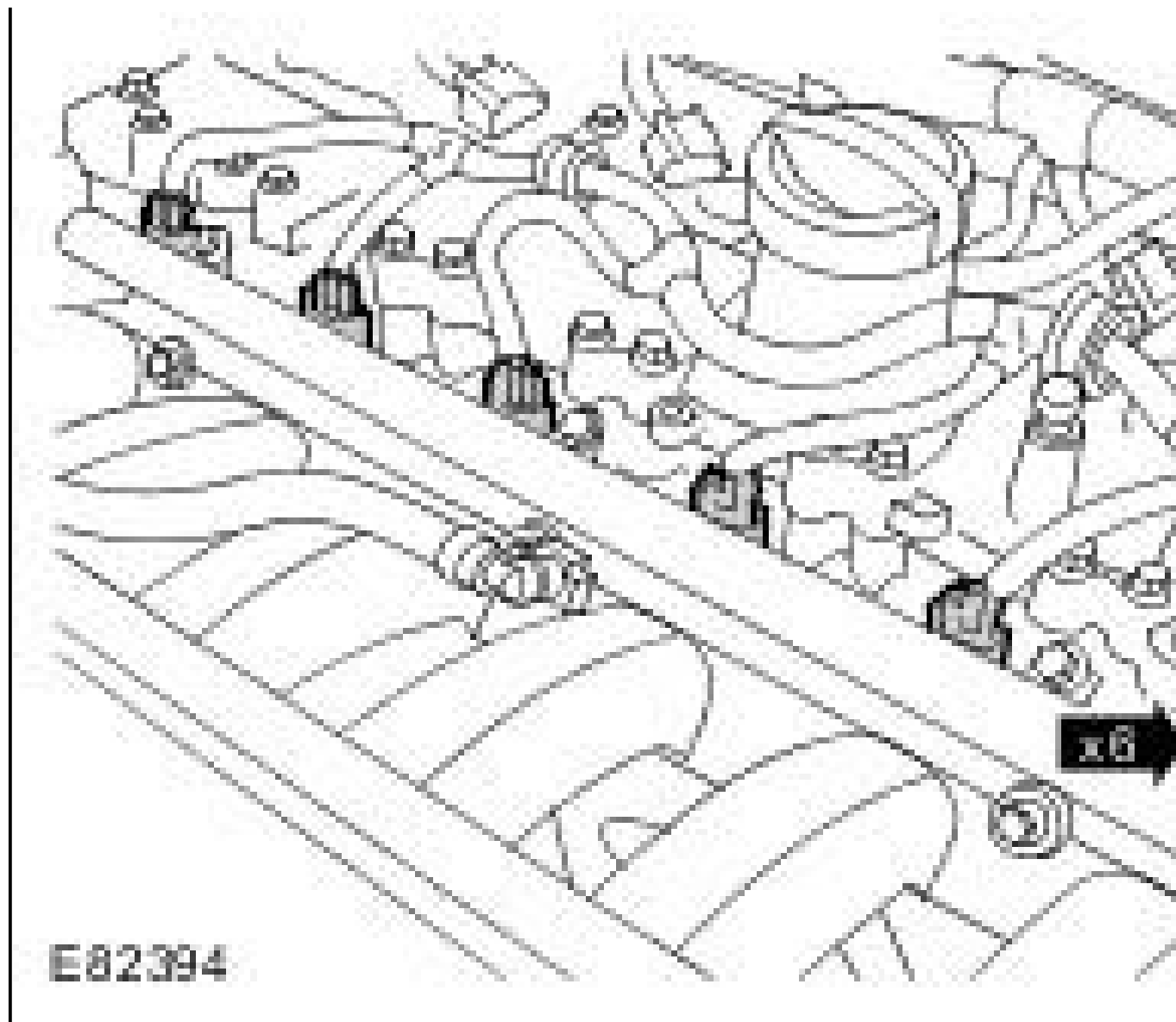
**NOTE:** The cylinder head and valve cover are machined as a pair, and cannot be serviced separately.

**WARNING:** Make sure to support the vehicle with axle stands.

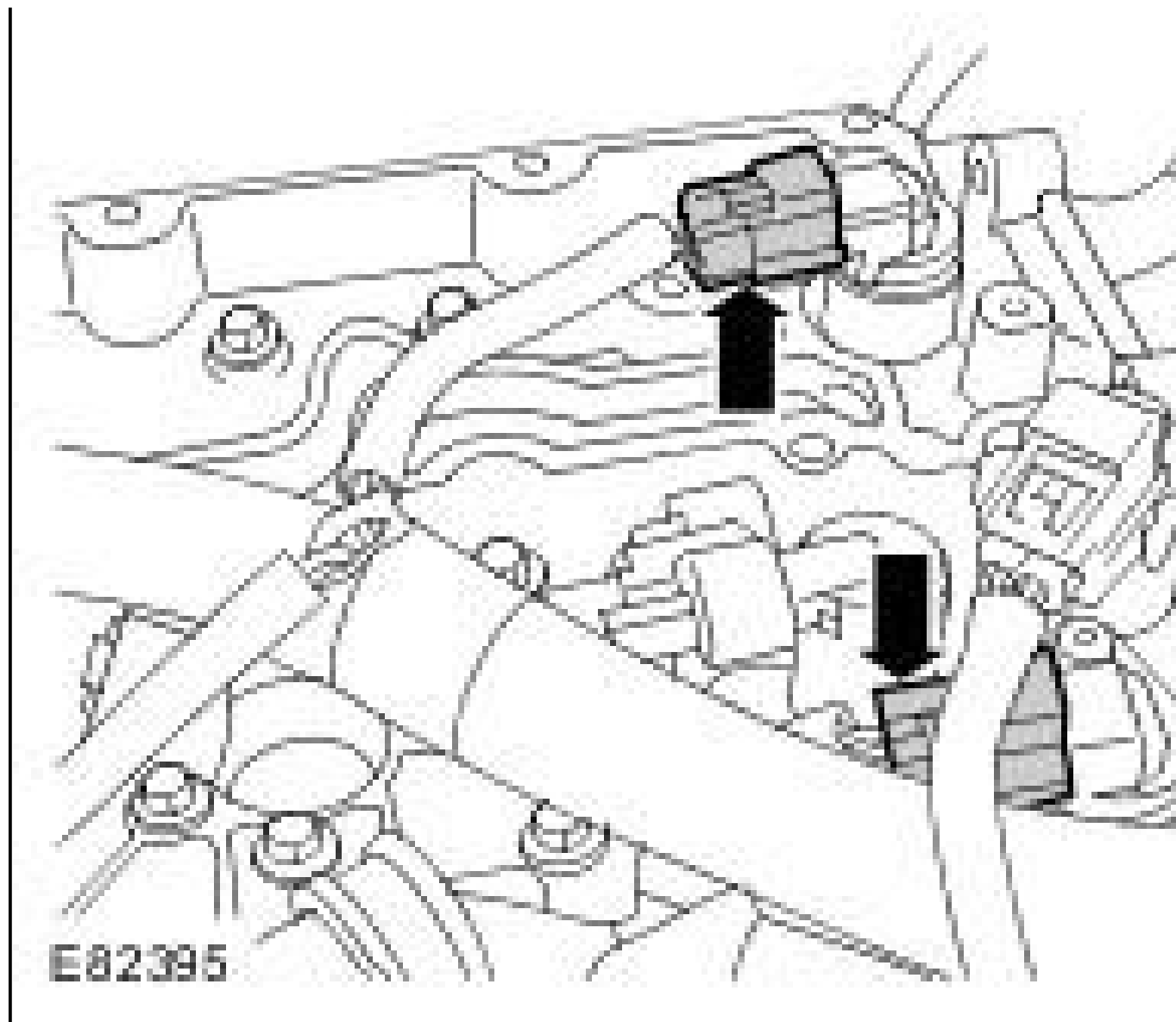
1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable. Refer to **Specifications** .
3. Remove the timing component housing. See **Timing Components Housing**.
4. Remove the crankcase vent oil separator. Refer to **Crankcase Vent Oil Separator** .
5. Remove the engine RH mount. See **Engine Mount RH**.
6. Remove the 6 ignition coil-on-plugs. Refer to **Ignition Coil-On-Plug** .
7. Disconnect the engine ground cable.
8. Disconnect the RH front HO2S electrical connector.



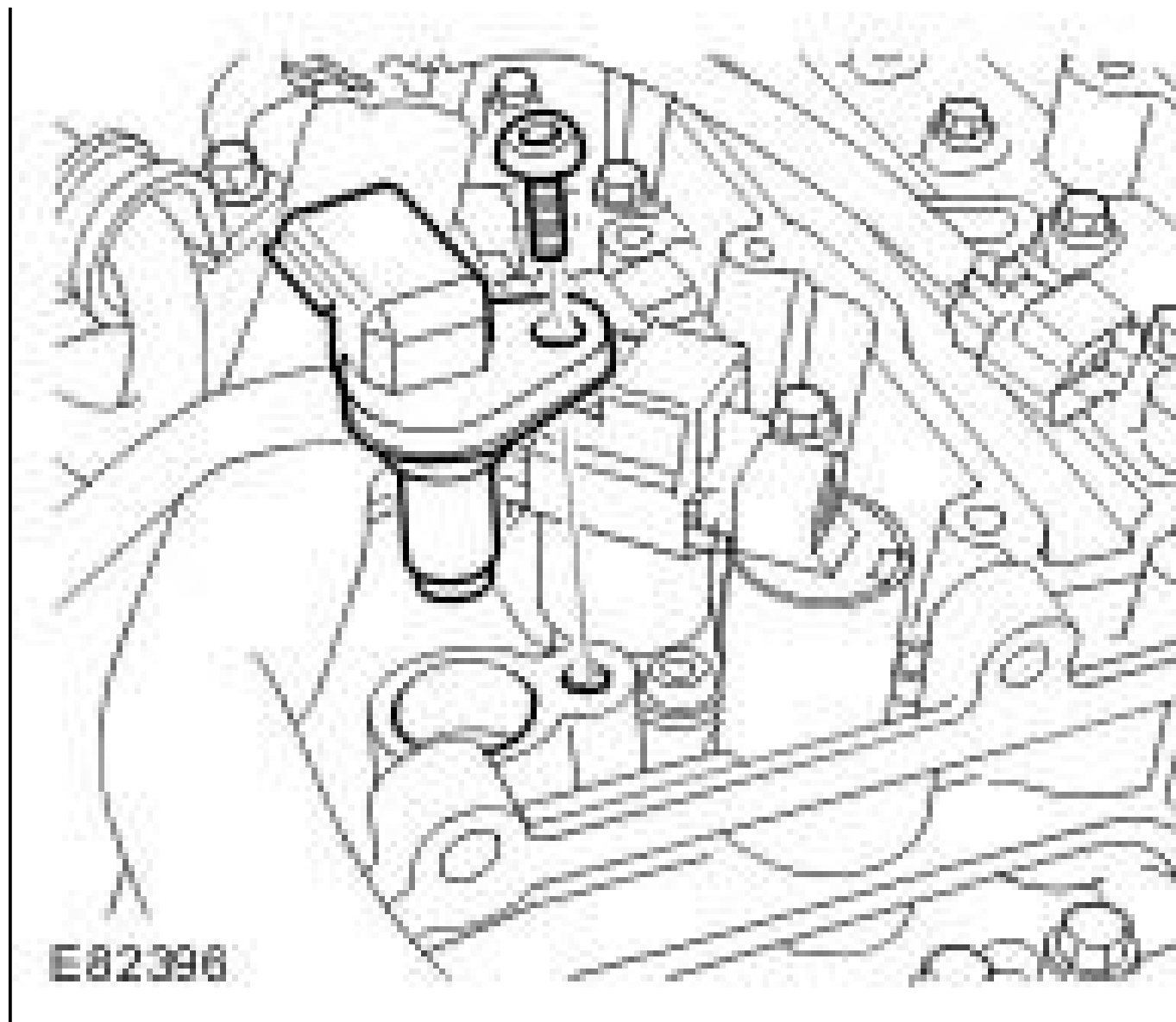
9. Disconnect the 6 fuel injector electrical connectors.



10. Disconnect the 2 camshaft position (CMP) sensor electrical connectors.



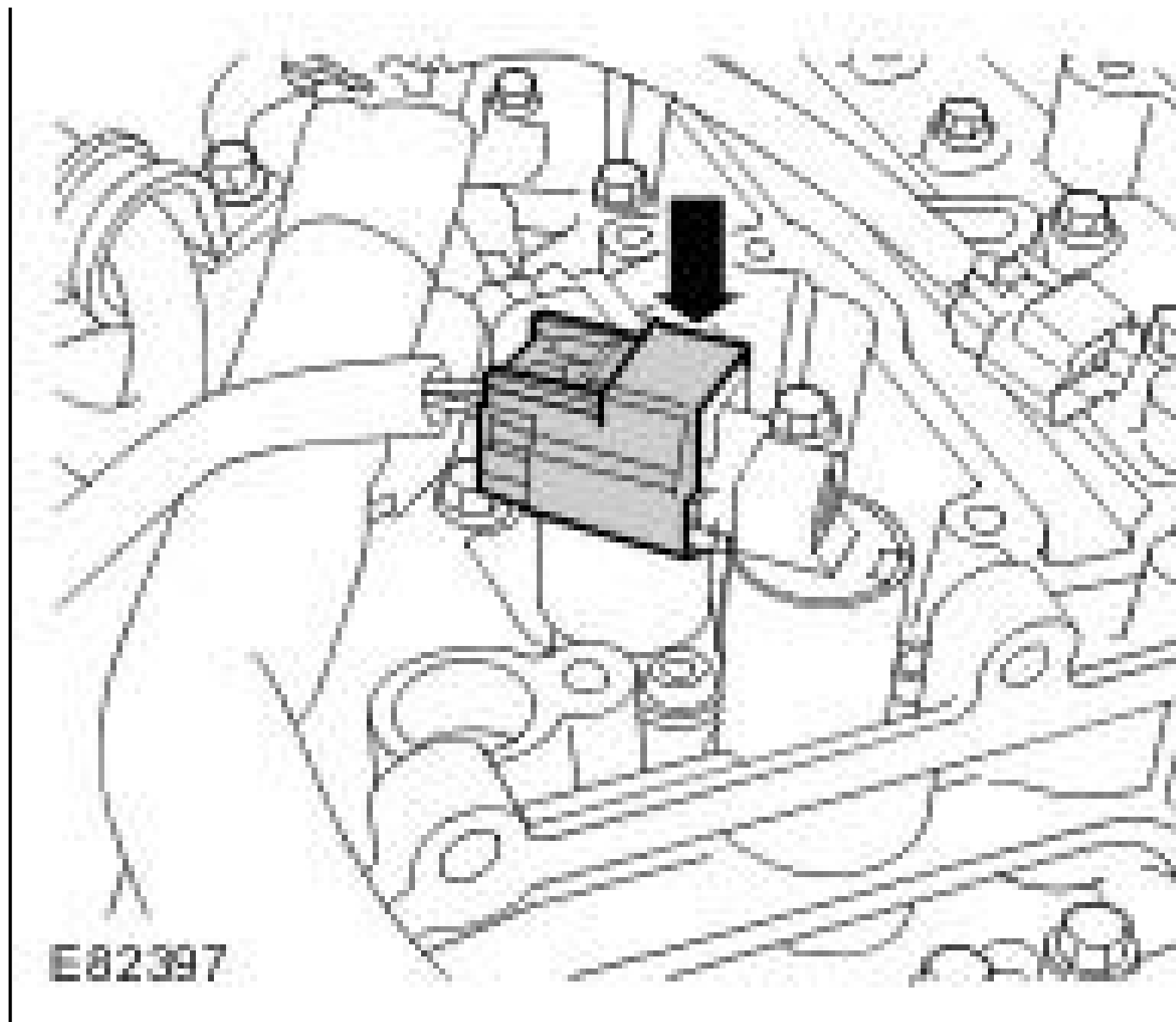
11. Remove the 2 CMP sensors.



12. Disconnect the variable valve timing (VVT) solenoid.

**CAUTION: Extreme cleanliness must be exercised when handling this component.**

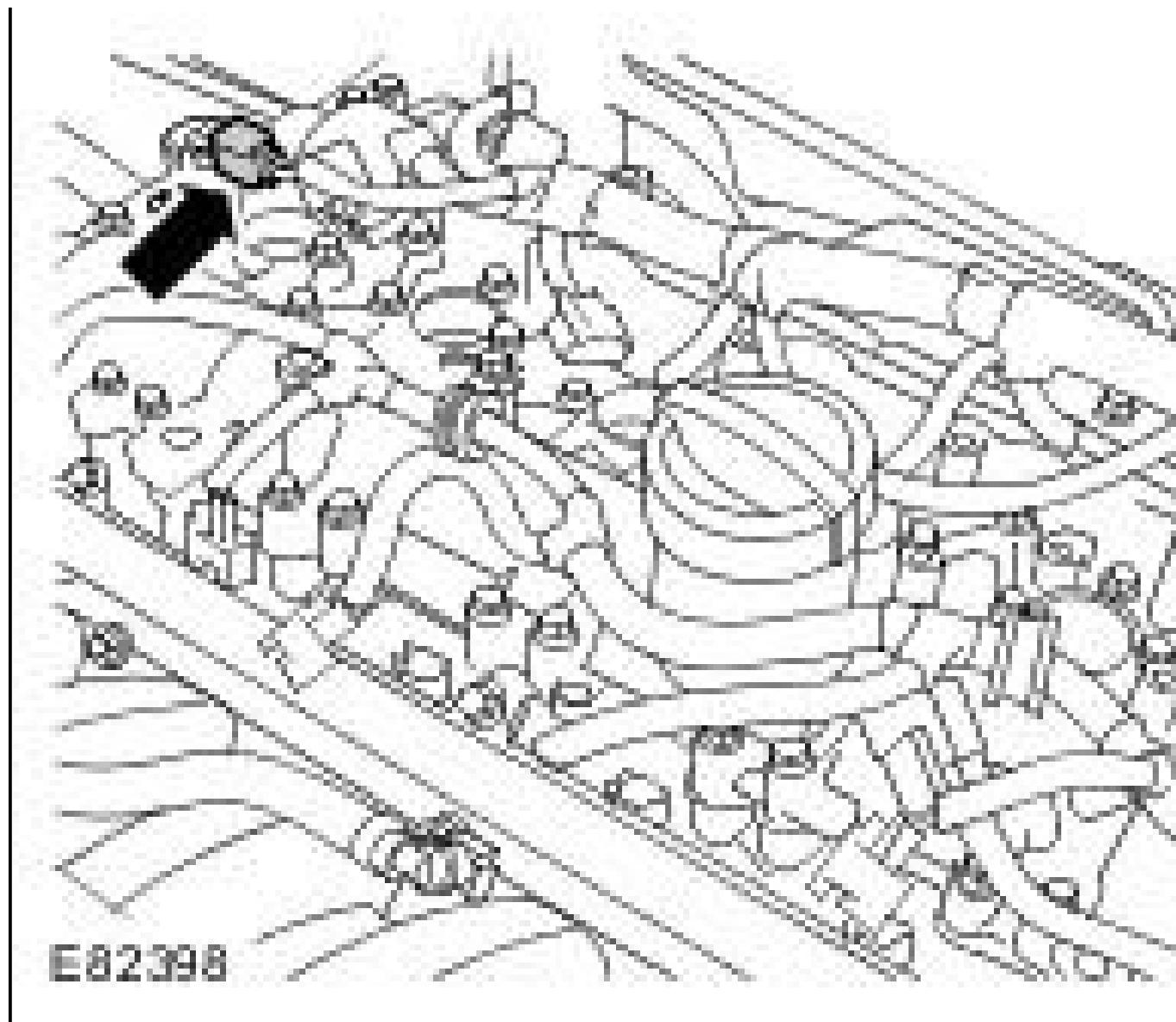
13. Remove the VVT solenoid.



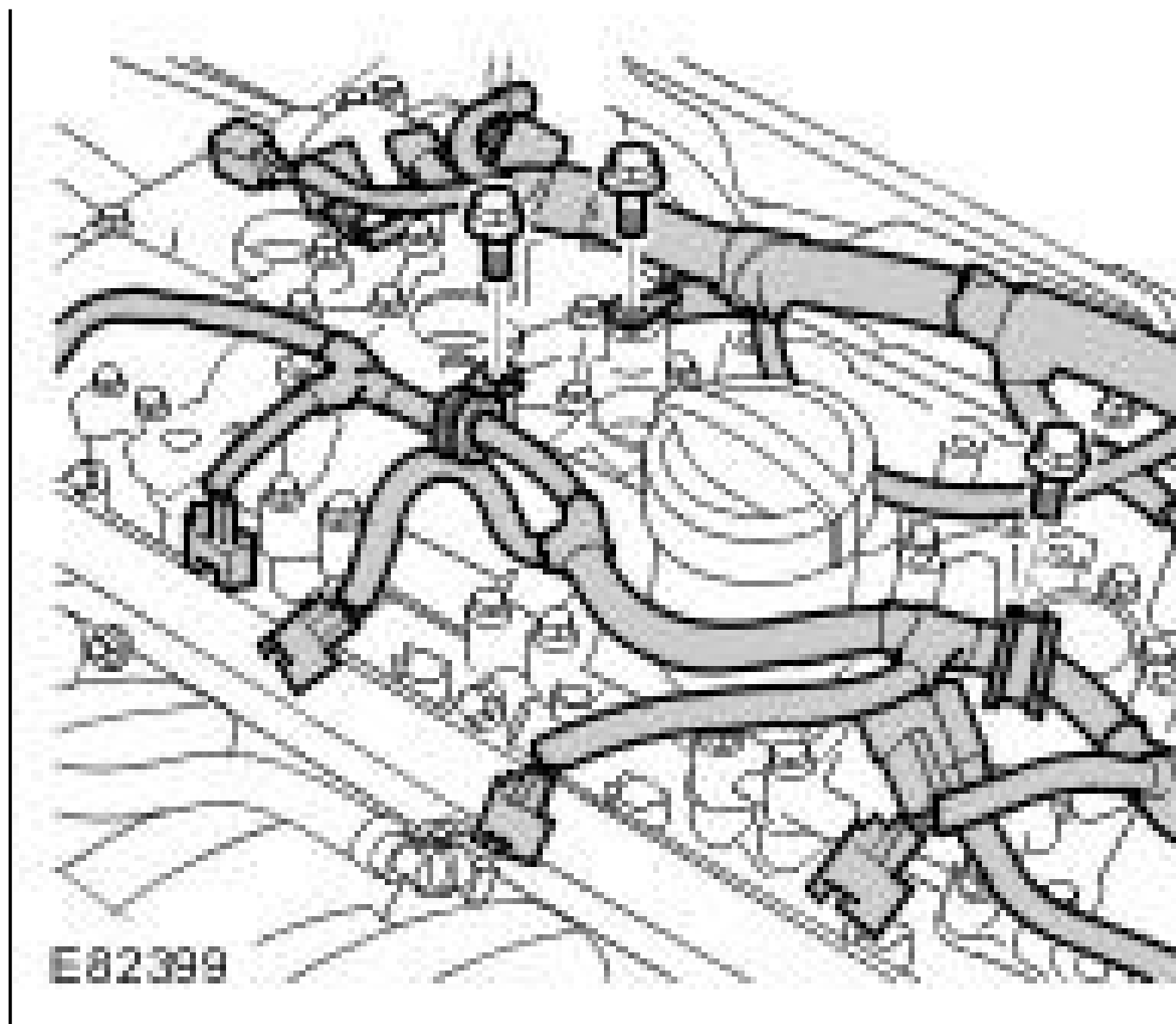
14. Disconnect the camshaft profile switching (CPS) solenoids.

**CAUTION: Extreme cleanliness must be exercised when handling this component.**

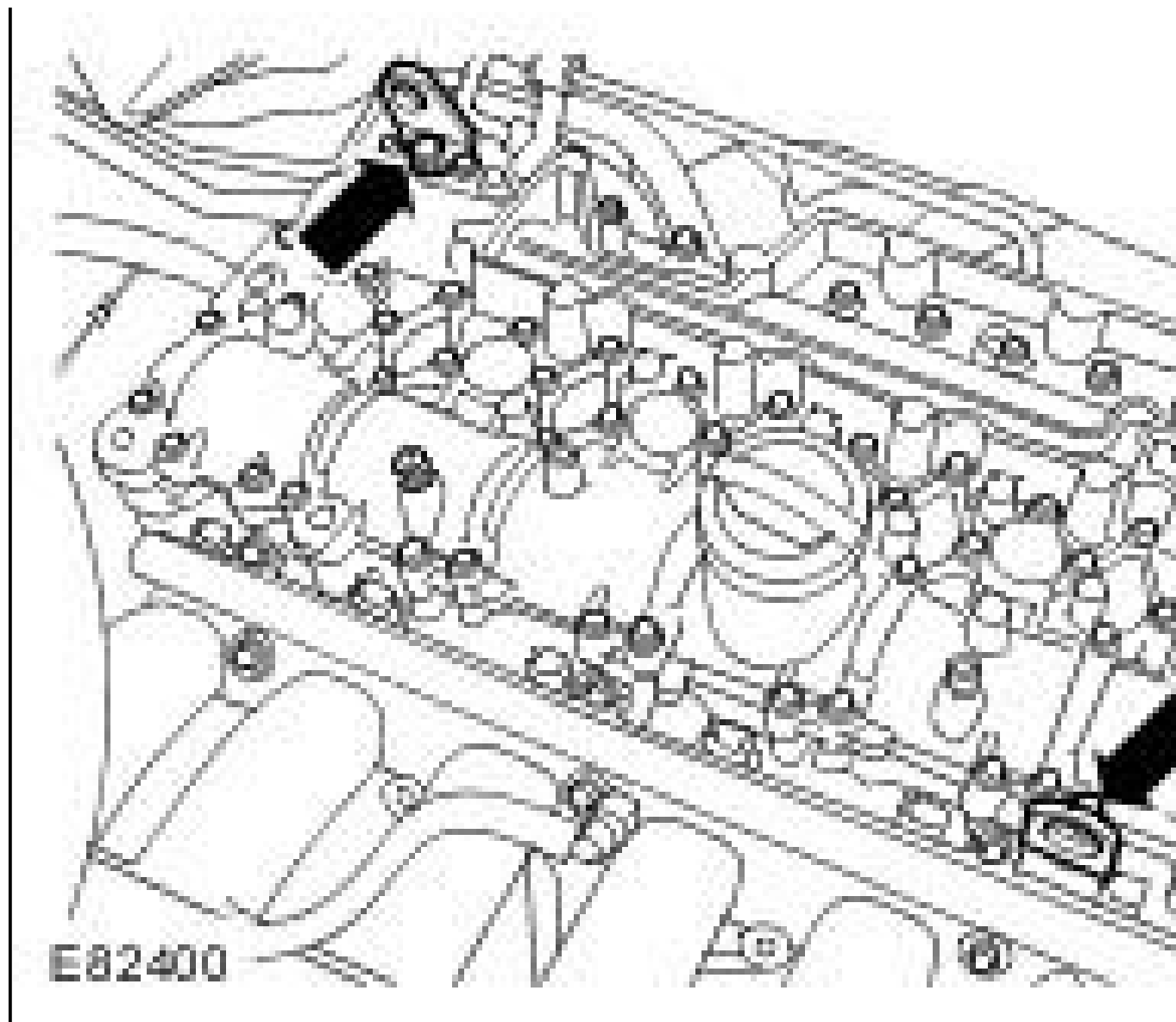
15. Remove the CPS solenoids.



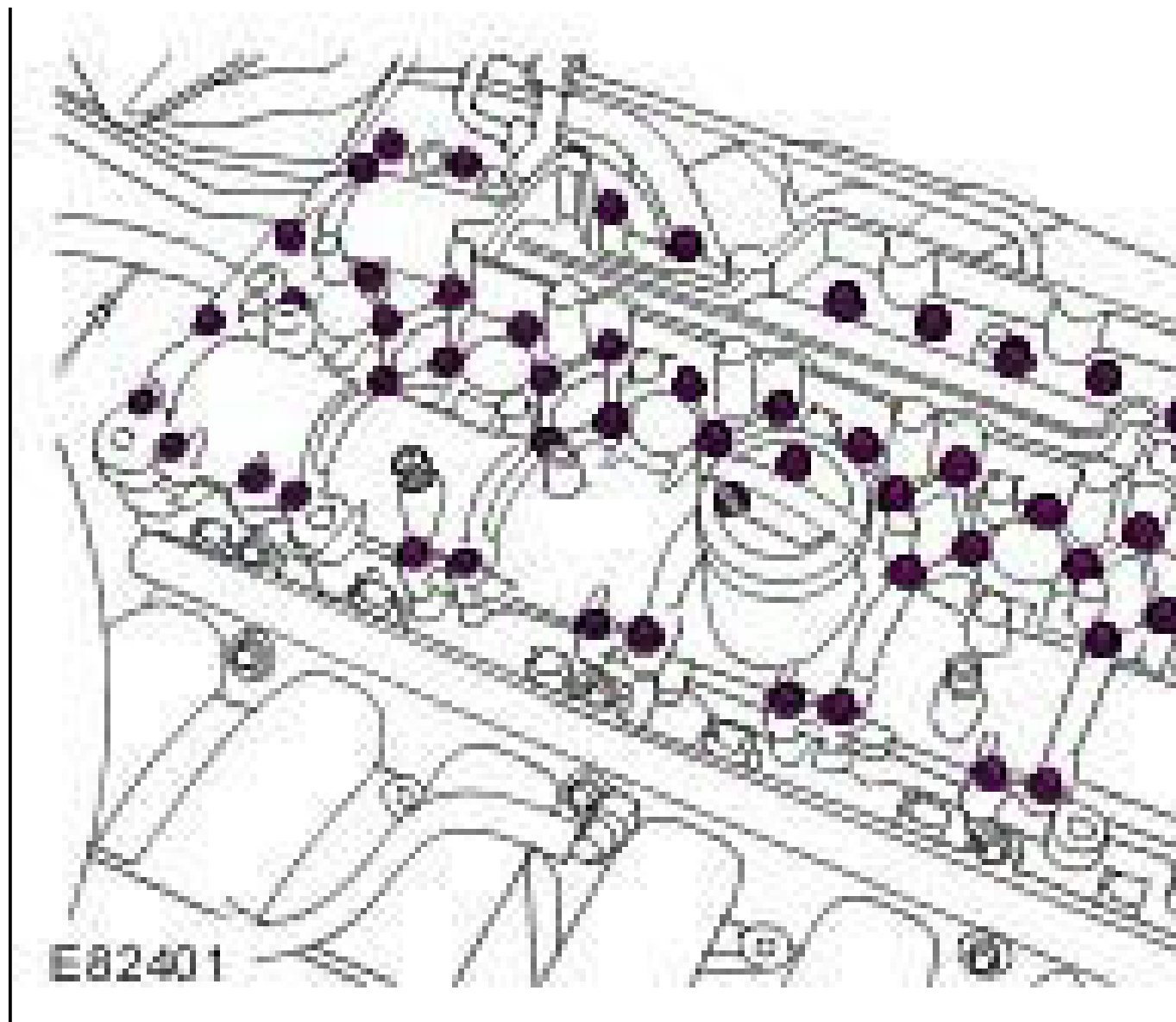
16. Release the cylinder head wiring harness.



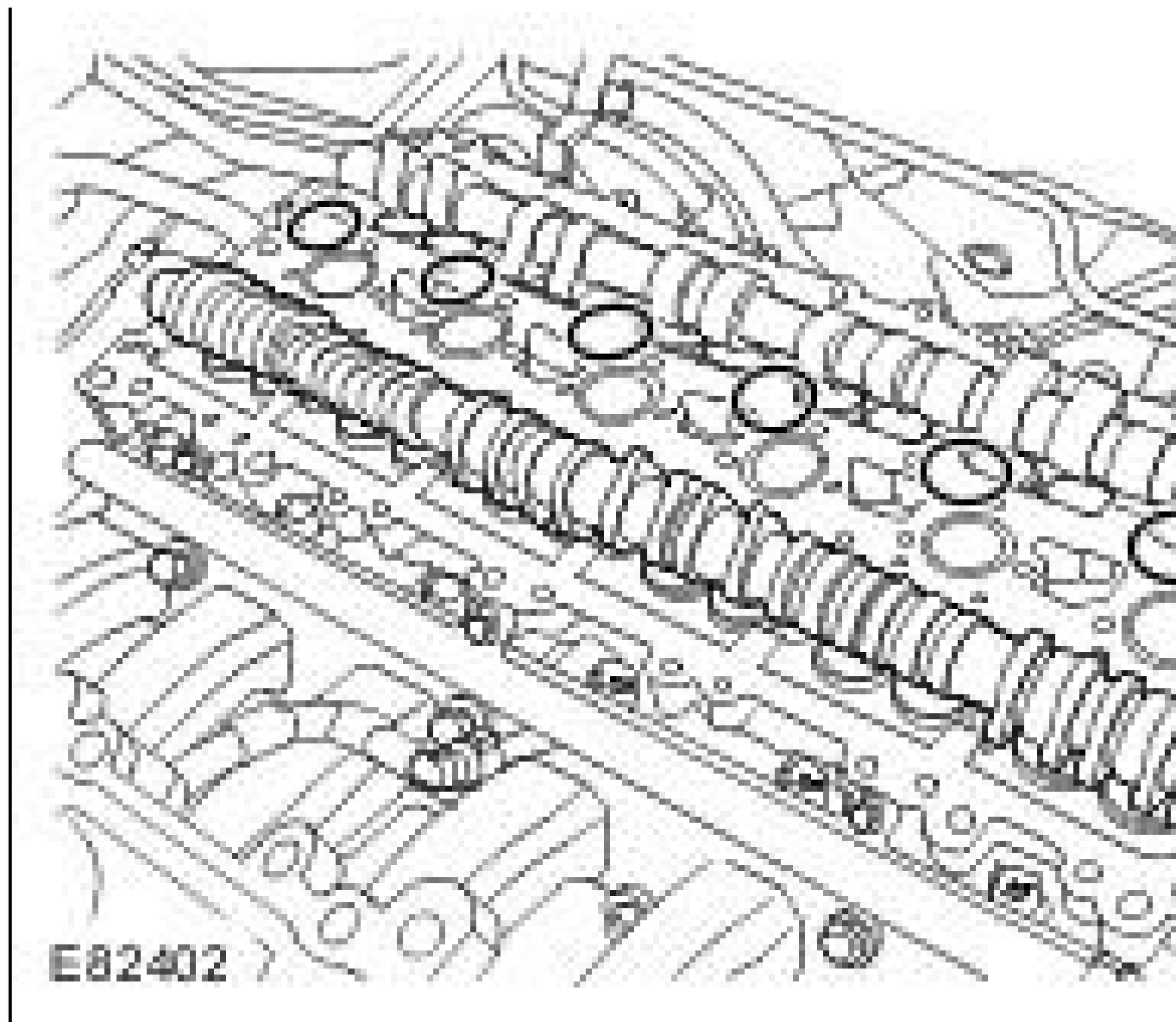
17. Remove the 2 lifting brackets.



18. Remove the valve cover.

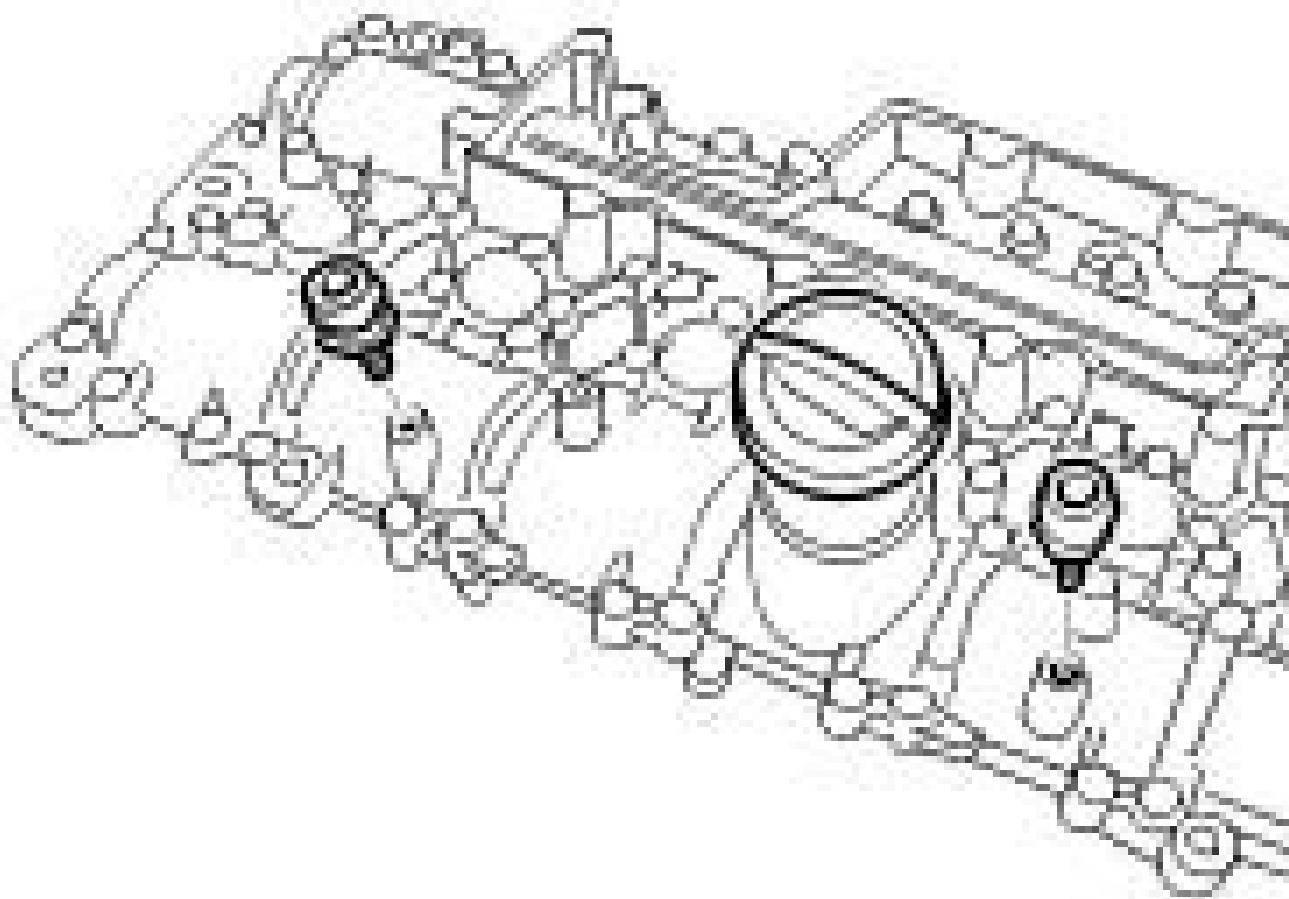


19. Remove and discard the 6 O-ring seals.



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

20. Remove the oil filler cap.
21. Remove the 2 clips.



E82403

#### INSTALLATION

1. Install the clips.
2. Install the oil filler cap.

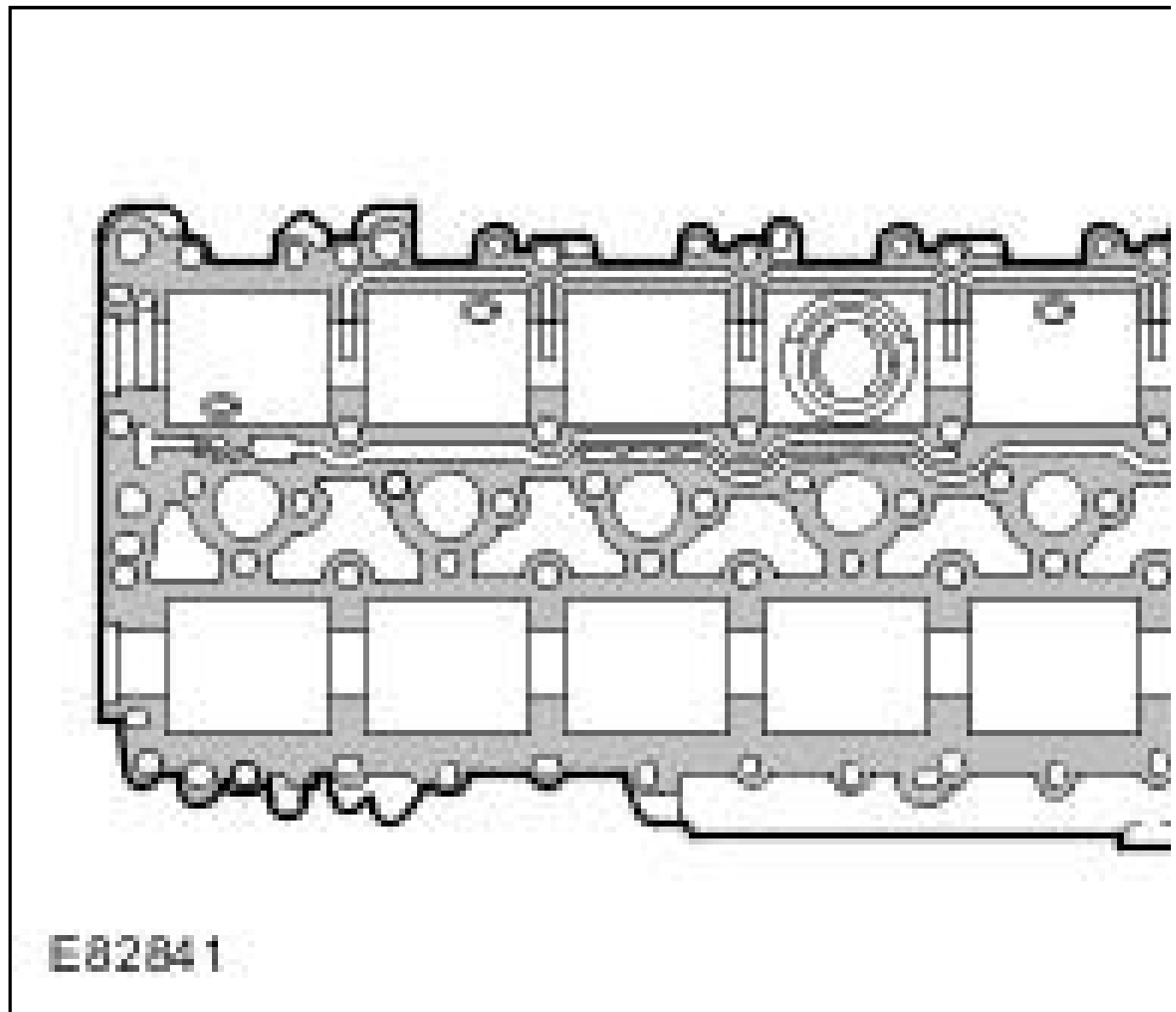
**CAUTION:** Extreme cleanliness must be exercised when handling these components.

**CAUTION:** Make sure that the mating faces are clean and free of corrosion and foreign material.

3. Clean the component mating faces.

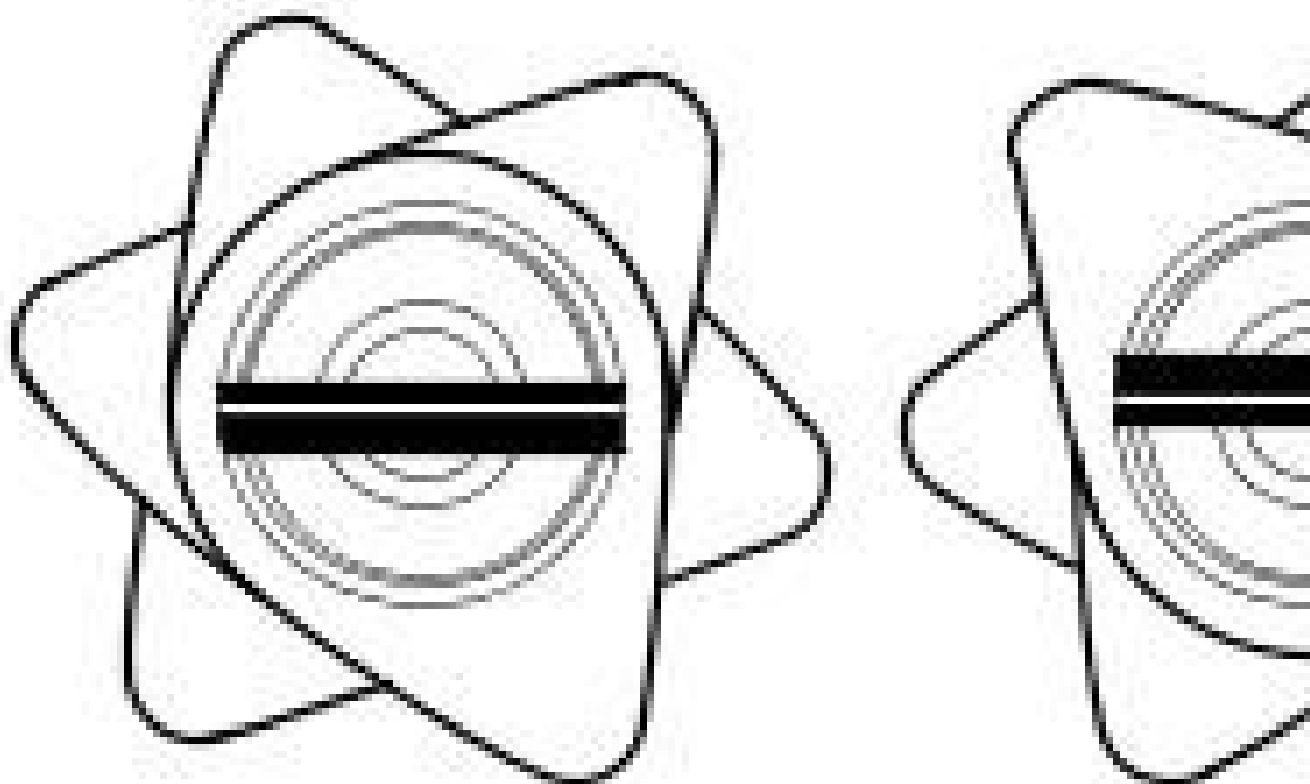
4. Install new O-ring seals.
5. For sealant information, refer to the engine specification section. See **Specifications**.
6. Apply the sealant as shown.

Roller, Sealant (303-1285)



**CAUTION: Extreme cleanliness must be exercised when handling these components.**

7. Position the camshafts, if required.

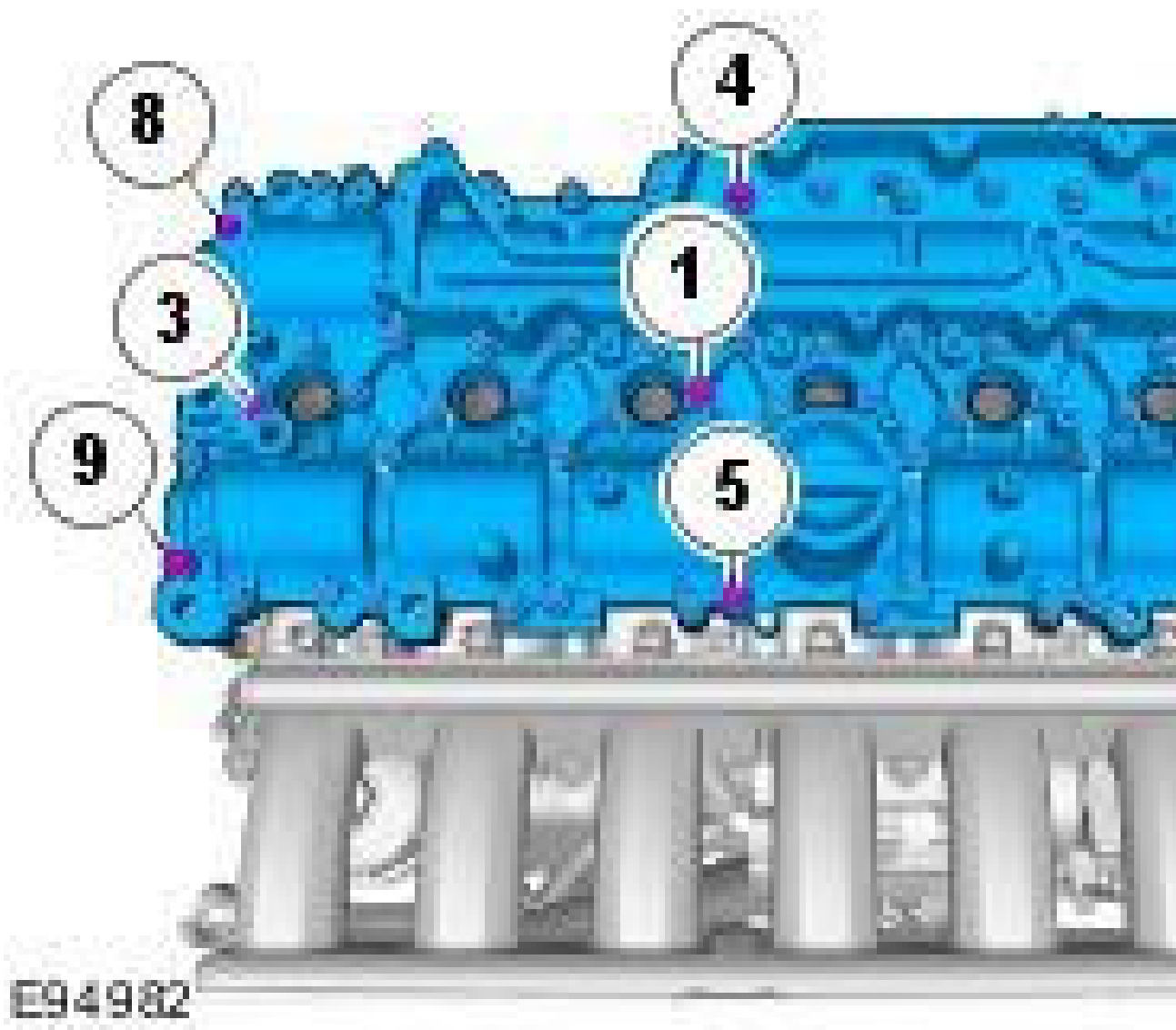


E94981

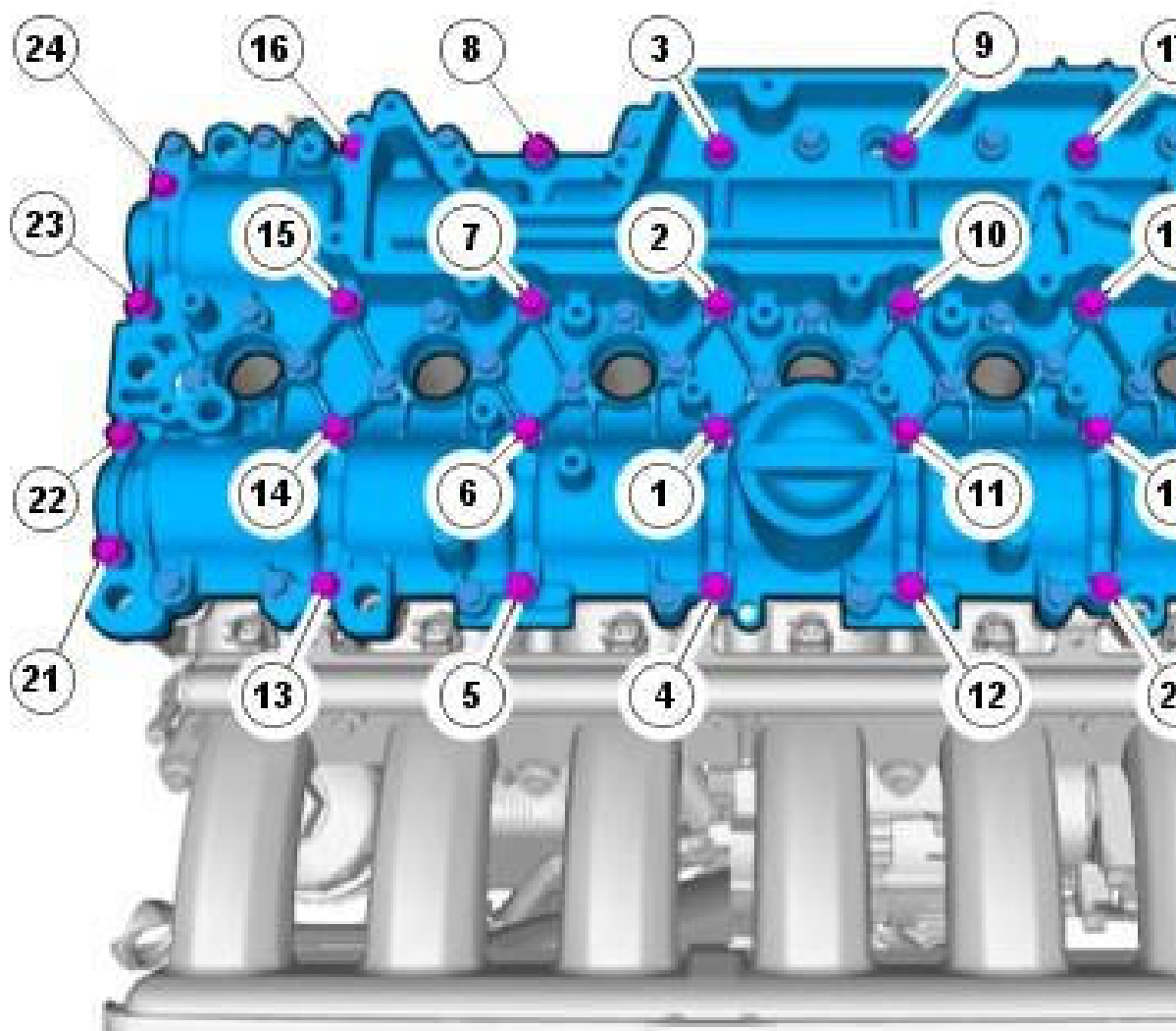
**NOTE:** The component must be installed within 20 minutes of the sealant application.

**NOTE:** Do not tighten at this stage.

8. Using the sequence illustrated, tighten the valve cover to cylinder head bolts evenly and progressively a few turns at a time, until there is full contact.

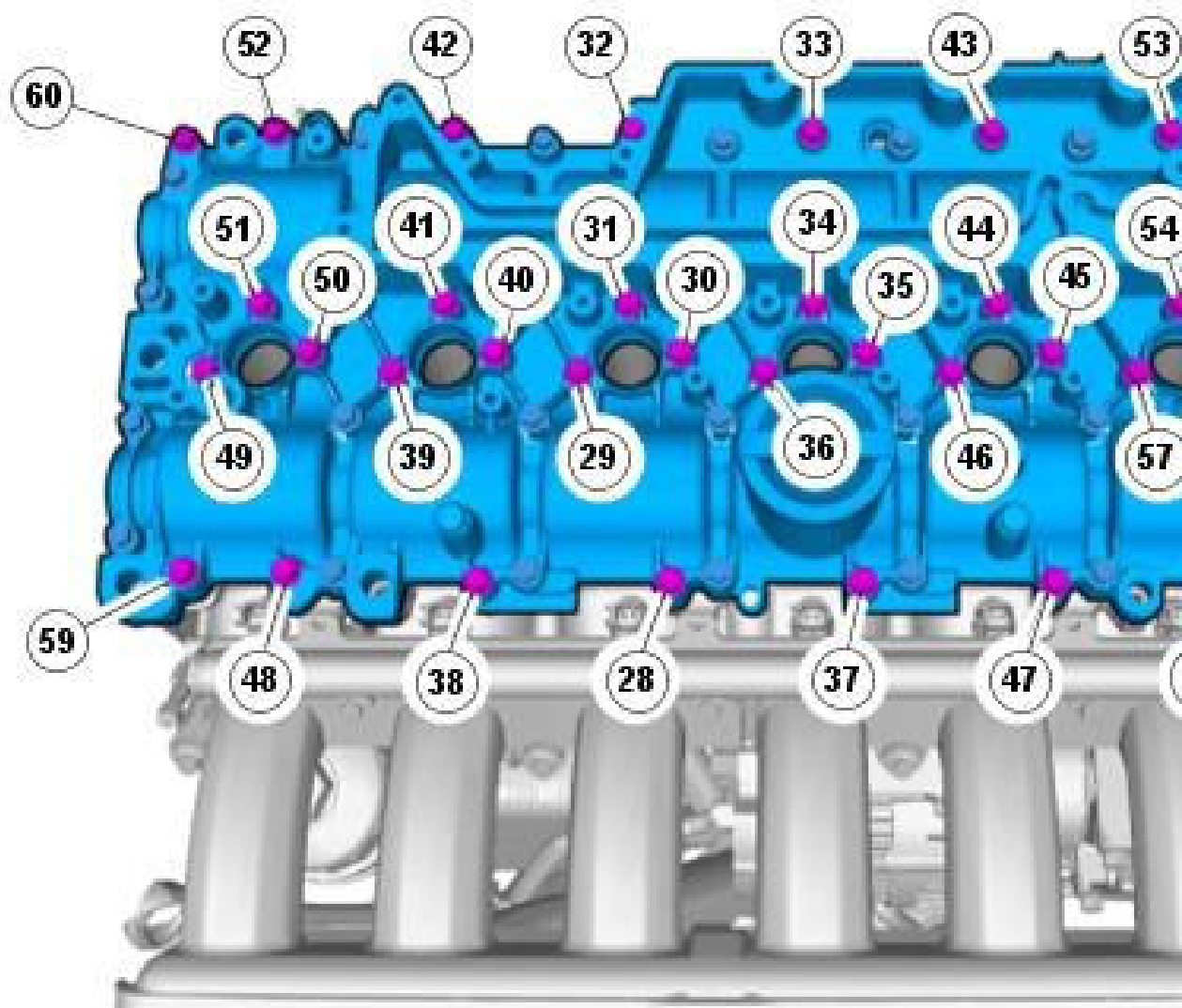


9. Torque: 16 Nm.



E94983

10. Torque: 16 Nm



E94984

11. Install the lifting brackets.

Torque: 48 Nm.

12. Secure the cylinder head wiring harness.

Torque: 6 Nm.

**CAUTION: Extreme cleanliness must be exercised when handling this**

component.

**CAUTION: A new O-ring seal is to be installed.**

13. Install the CPS solenoids.

Torque: 10 Nm.

14. Connect the CPS solenoids.

**CAUTION: Apply clean engine oil to the VVT solenoid shaft.**

**CAUTION: Extreme cleanliness must be exercised when handling this component.**

**CAUTION: A new O-ring seal is to be installed.**

15. Install the VVT solenoid.

Torque: 10 Nm.

16. Connect the VVT solenoid.

17. Install the CMP sensors.

Torque: 10 Nm.

18. Connect and secure the CMP sensor electrical connectors.

19. Connect the fuel injector electrical connectors.

20. Connect the ground cable.

Torque: 6 Nm.

21. Install the engine mount. See **Engine Mount RH**.

22. Install the ignition coil-on-plugs. Refer to **Ignition Coil-On-Plug** .

23. Install the crankcase vent oil separator. Refer to **Crankcase Vent Oil Separator** .

24. Install the timing component housing. See **Timing Components Housing**.

25. Connect the battery ground cable and install the cover. Refer to **Specifications** .

## CAMSHAFTS

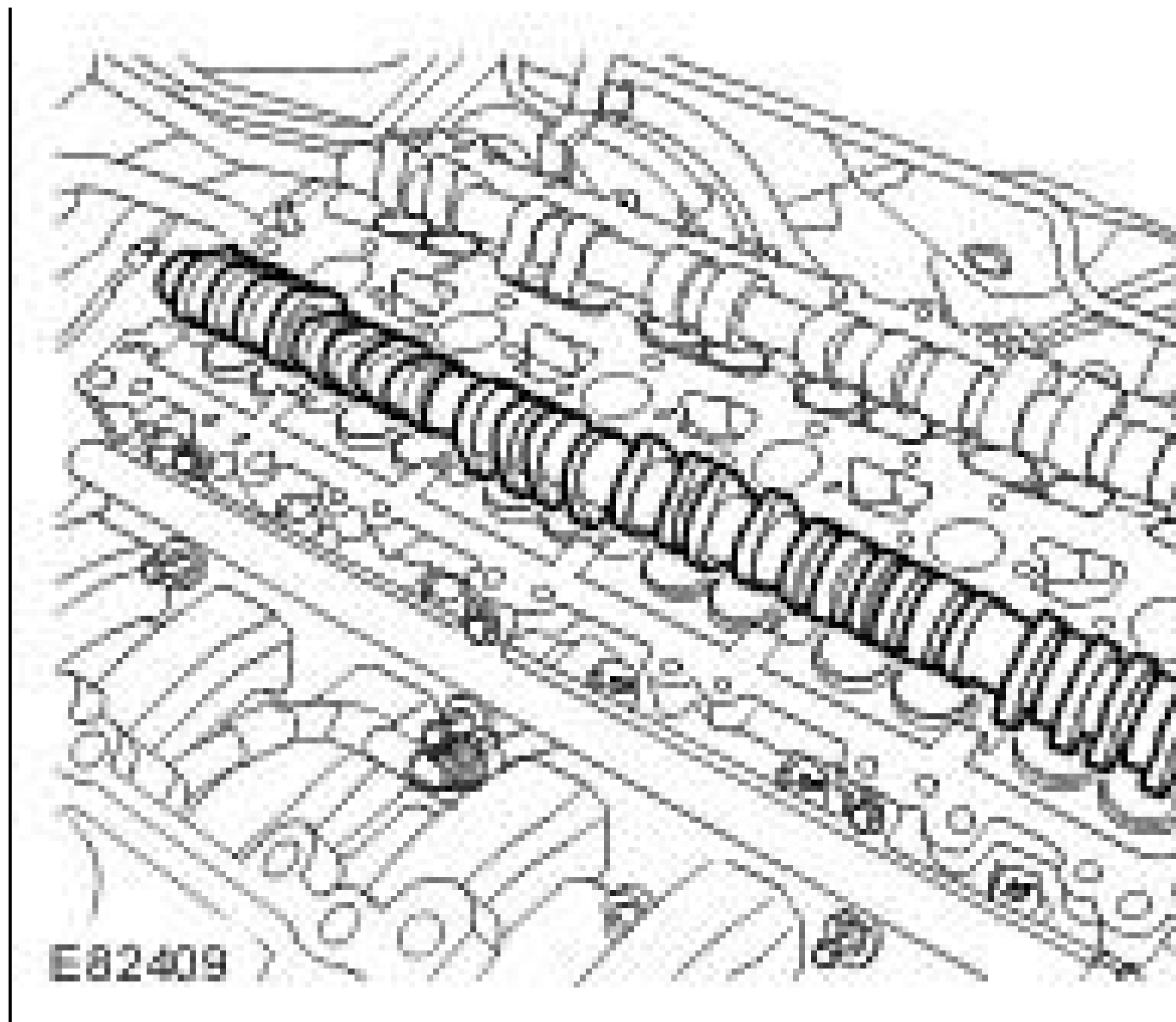
## REMOVAL

**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable. Refer to Specifications .
3. Remove the camshaft bearing housing. See Valve Cover.

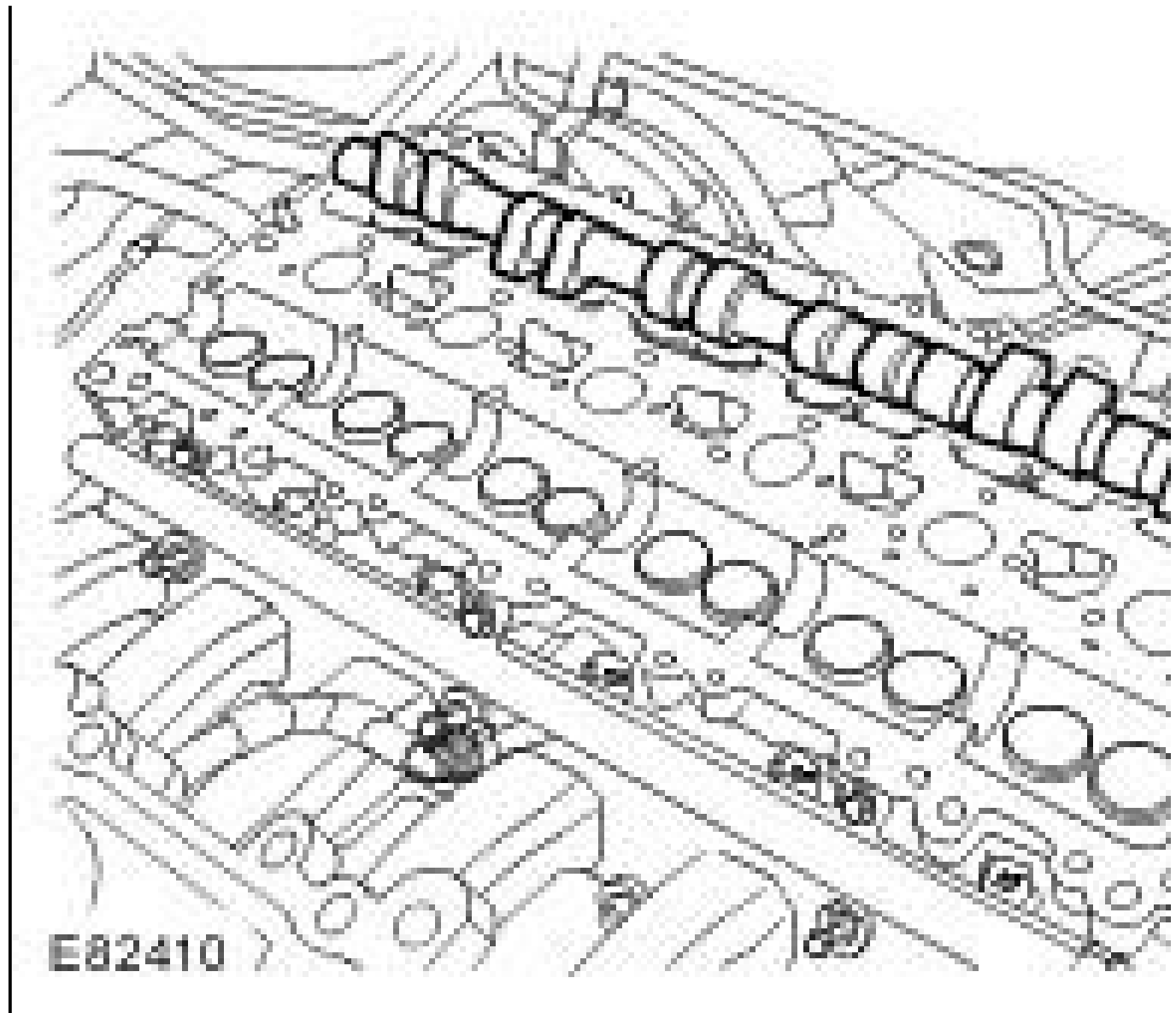
**CAUTION:** Extreme cleanliness must be exercised when handling this component.

4. Remove the intake camshaft.



**CAUTION:** Extreme cleanliness must be exercised when handling this component.

5. Remove the exhaust camshaft.



## INSTALLATION

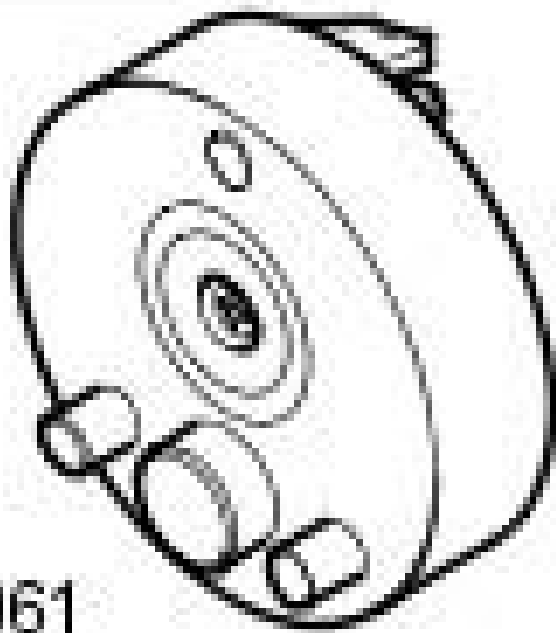
**CAUTION:** Extreme cleanliness must be exercised when handling these components.

1. Install the camshafts.
2. Check the valve clearances. See Valve Clearance Check.
3. Install the camshaft bearing housing. See Timing Components Housing.
4. Connect the battery ground cable and install the cover. Refer to Specifications.

## TIMING CHAIN

## Special Tool(s)

303-1219

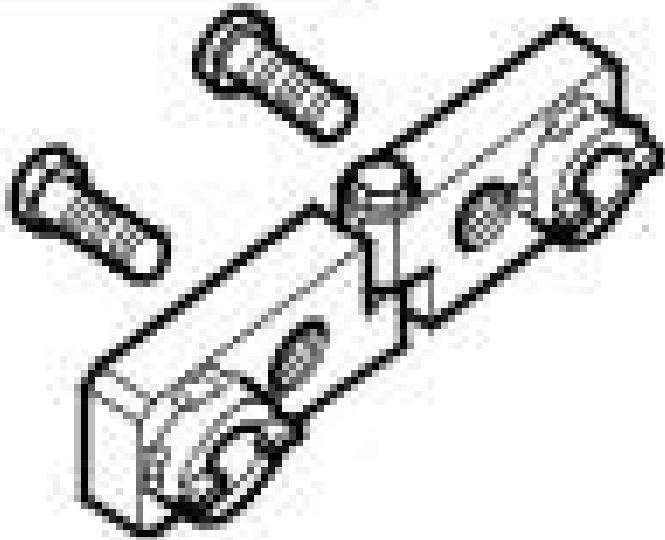


E 82061

303-1219 Locking Tool,  
Crankshaft

303-1223 Locking Tool, Camshaft

303-1223



E82062

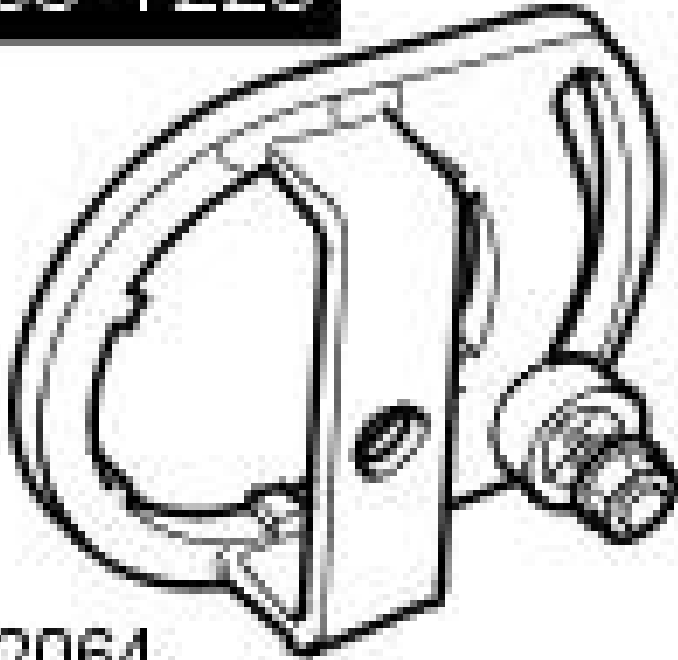
303-1225



E82062

303-1225 Locking Tool, Camshaft  
Tool

303-1226



E82064

303-1226 Locking Tool, Camshaft Tool

**REMOVAL**

**CAUTION:** Extreme cleanliness must be exercised when handling these components.

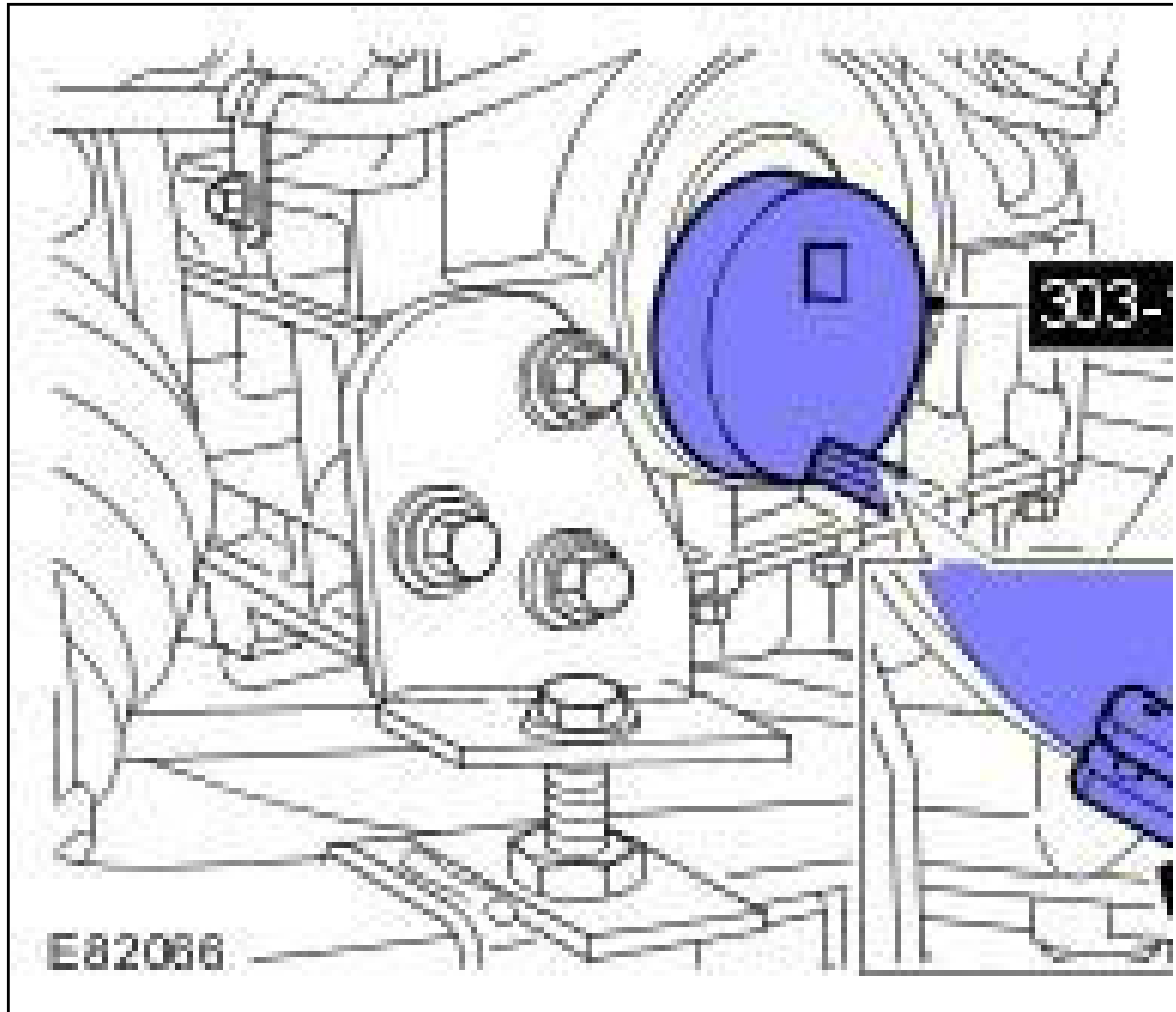
**NOTE:** Make sure the timing chain free length is on the tensioner run of the chain before releasing the tensioner locking device.

**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable. Refer to **Specifications** .
3. Remove the crankshaft front oil seal. See **Engine Front Seal**.
4. Remove the RH engine mount. See **Engine Mount RH**.
5. Remove the timing cover. See **Timing Cover**.

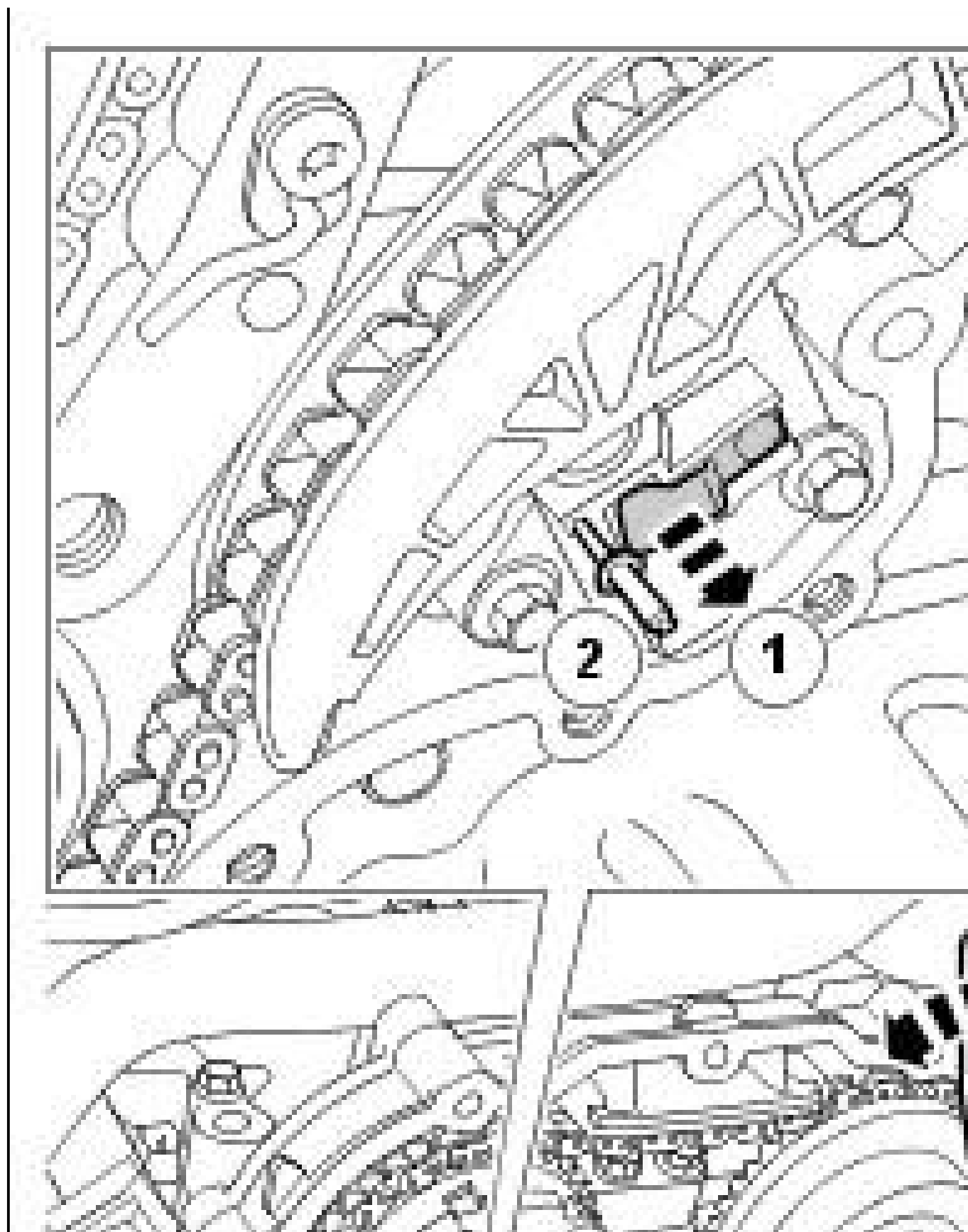
## 6. Position and lock the crankshaft.

Locking Tool, Crankshaft (303-1219)



## 7.

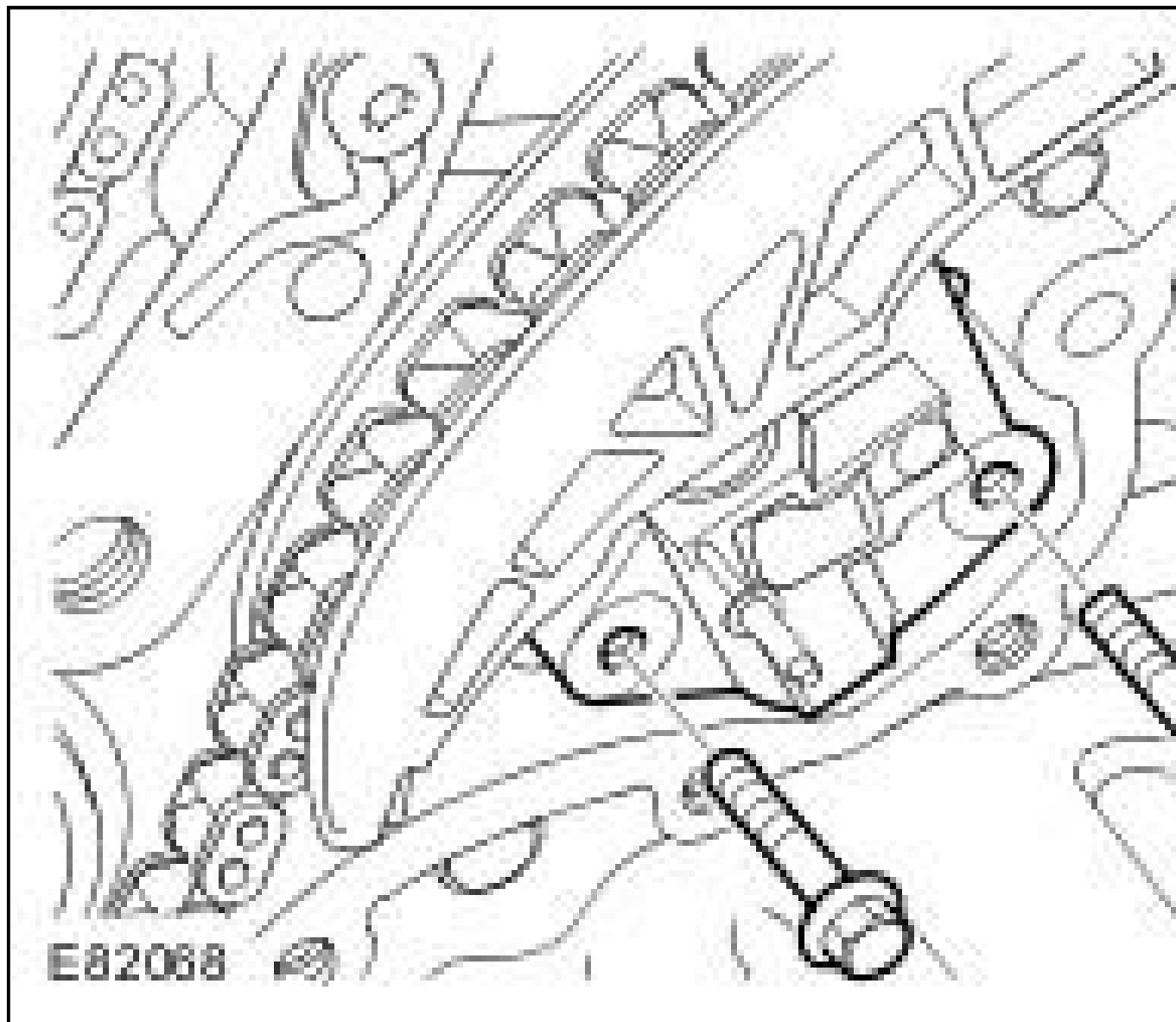
- To depress the chain tensioner piston and lock it in position with a 2mm, or less, diameter pin.
- Apply an even pressure in a counter clockwise direction.
- Lift the piston ratchet clip.
- Install a pin with 2mm, or less, diameter.



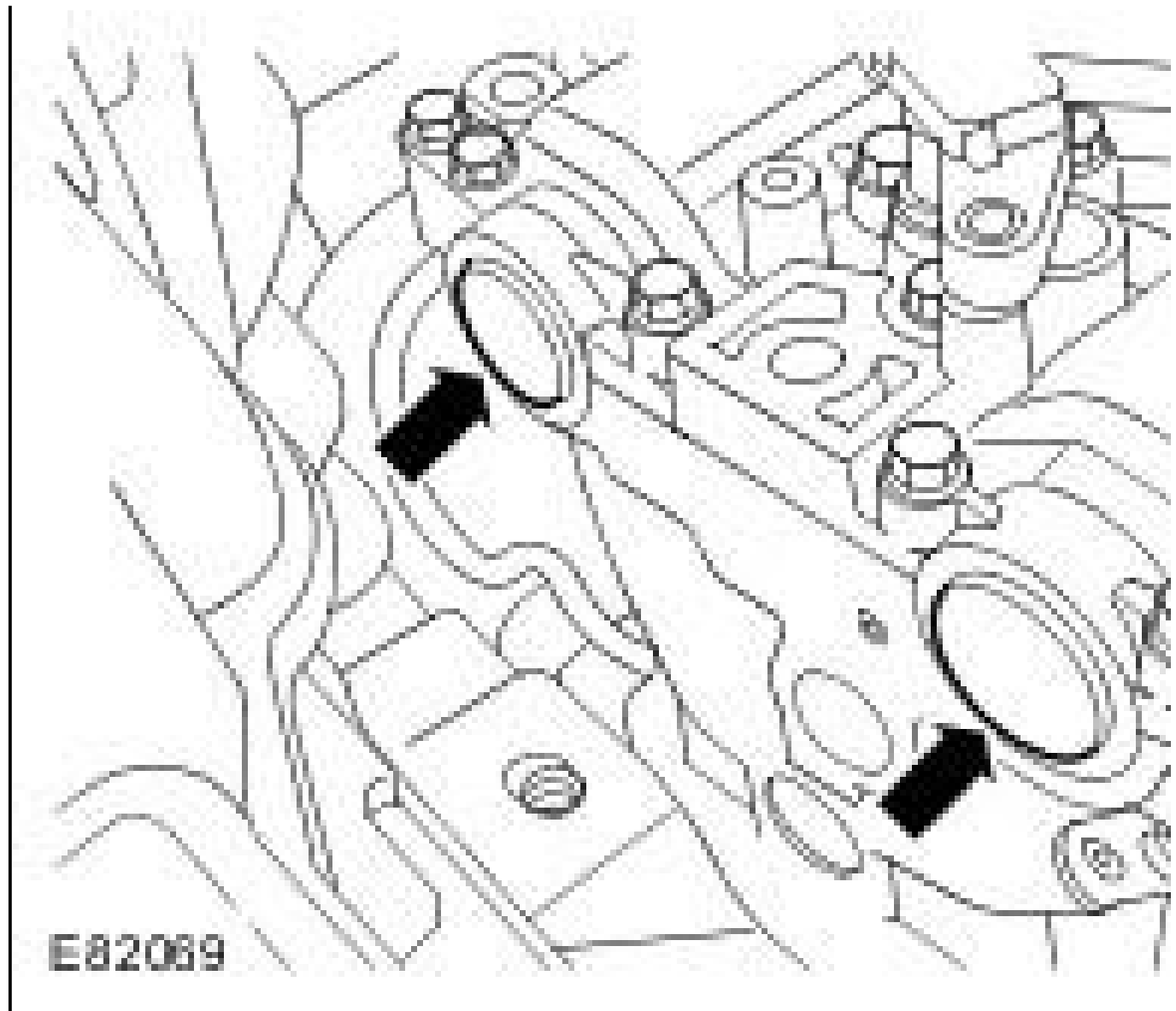
**CAUTION:** Mark the components to aid installation.

**CAUTION:** Extreme cleanliness must be exercised when handling this component.

8. Remove the timing chain tensioner.

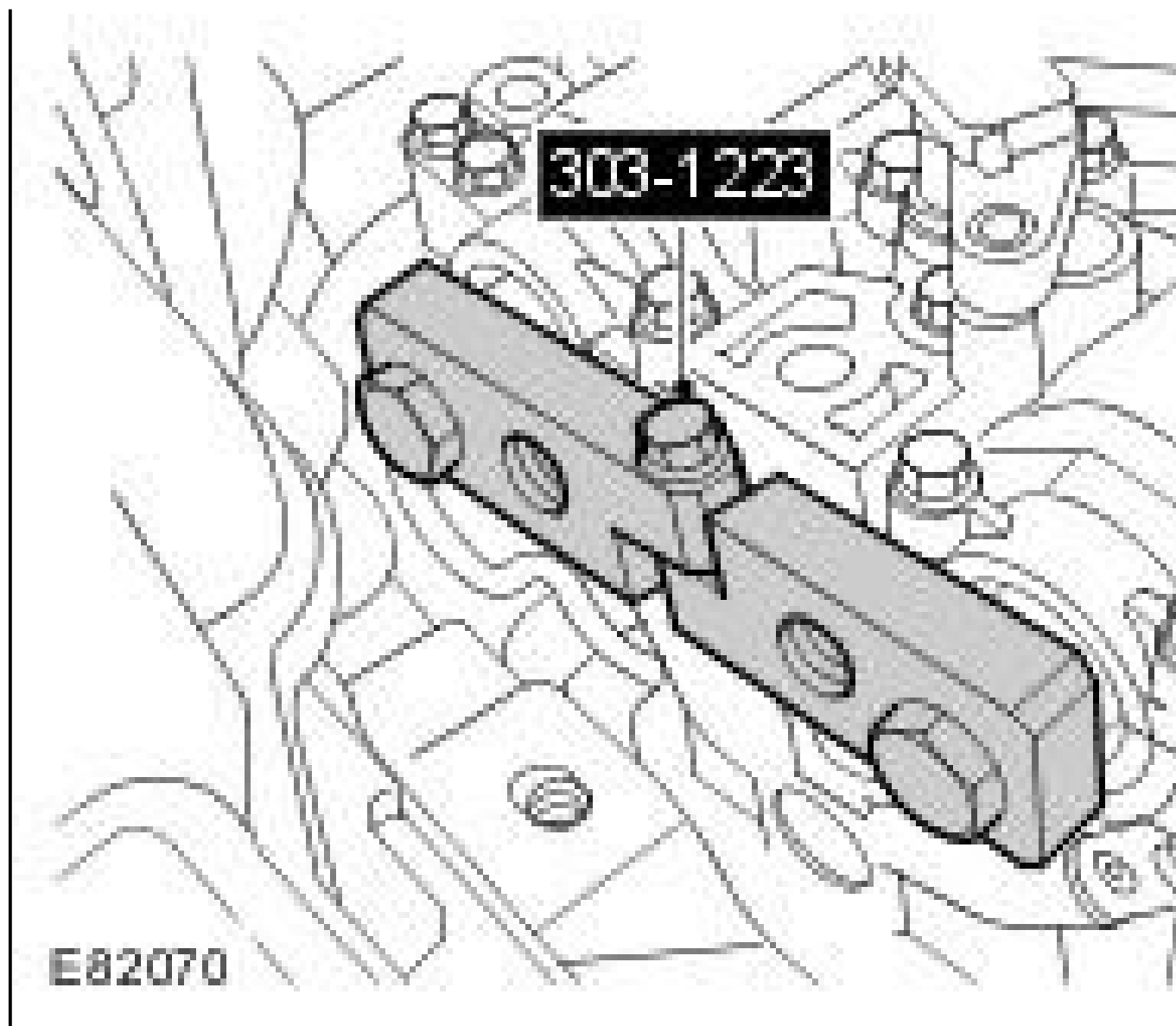


9. Remove and discard the camshaft bore plugs.



10. Install the camshaft alignment special tool.

Locking Tool, Camshaft (303-1223)

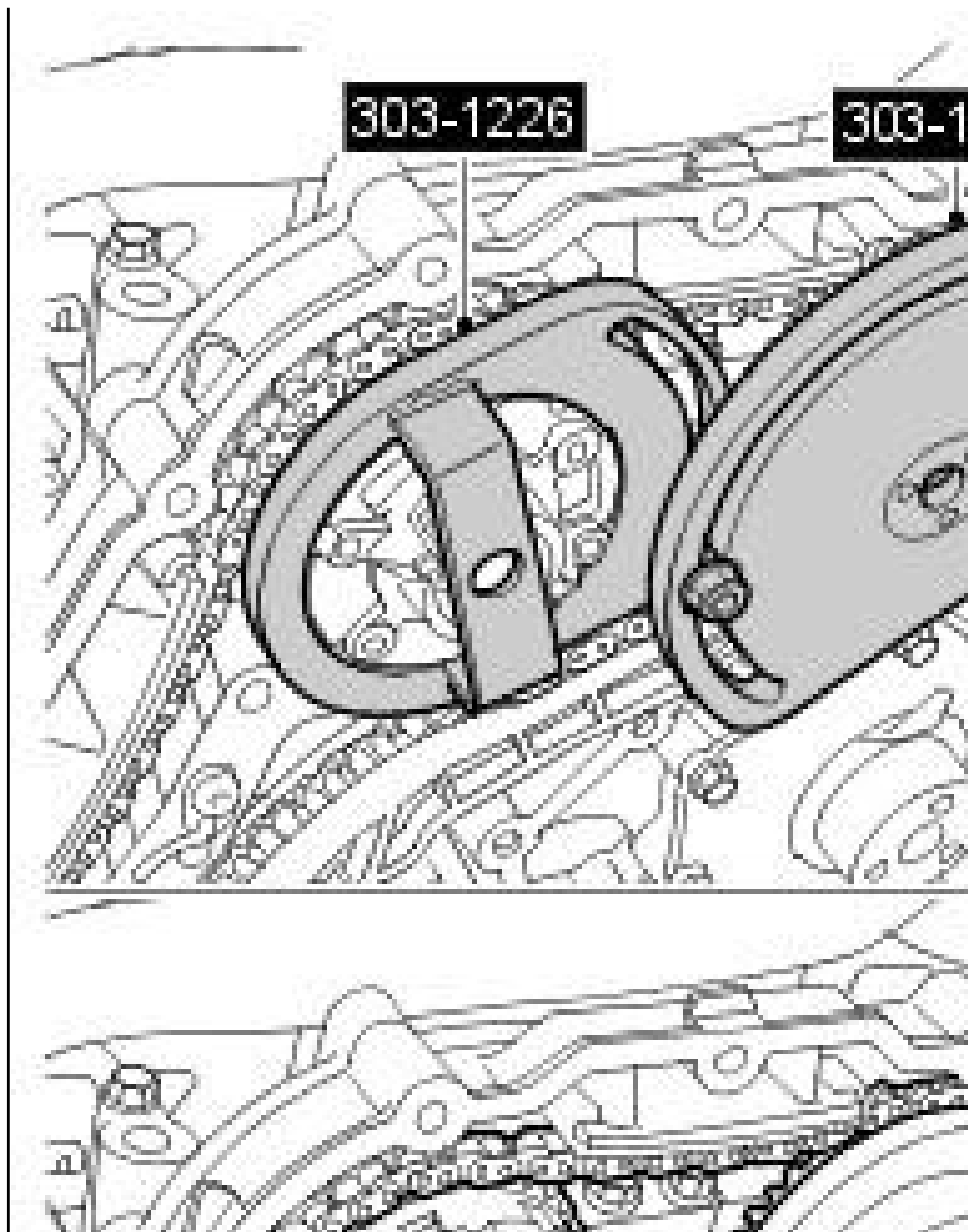


11. Using the special tool, lock the camshaft drive sprockets.

Locking Tool, Camshaft Tool (303-1225)

Locking Tool, Camshaft Tool (303-1226)

12. Remove and discard the 2 camshaft sprockets bolts
13. Remove the sprockets and the chain.



**INSTALLATION**

1. Install the chain and the sprockets.

**CAUTION: Do not tighten the camshaft sprocket bolts at this stage.**

**CAUTION: Make sure that new bolts are installed.**

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

**CAUTION: Make sure that the area around the component is clean and free of foreign material.**

**CAUTION: Extreme cleanliness must be exercised when handling these components.**

3. Install the timing chain tensioner.

Torque: 10 Nm.

4. Release the chain tensioner
5. Using the special tool, lock the camshaft drive sprockets.

Locking Tool, Camshaft Tool (303-1225)

Locking Tool, Camshaft Tool (303-1226)

6. Tighten the exhaust camshaft drive sprocket.7590
7. Tighten the inlet camshaft drive sprocket.

Torque: 110

8. Remove the camshaft alignment special tool.

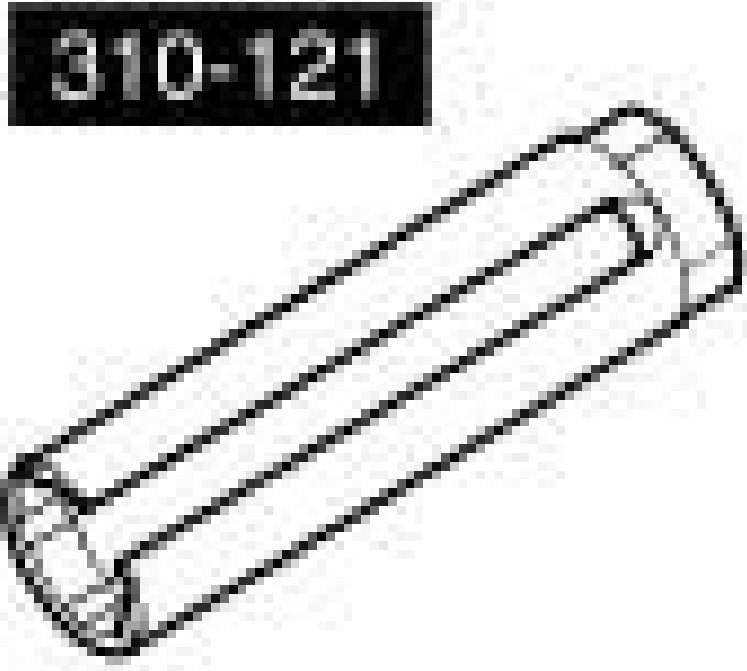
**CAUTION: Make sure that the area around the component is clean and free of foreign material.**

**CAUTION: The plugs must be installed dry.**

9. Install new camshaft bore plugs.
10. Remove the crankshaft locking tool.
11. Install the crankshaft front oil seal. See Engine Front Seal.
12. Install the timing cover. See Timing Cover.
13. Install the RH engine mount. See Engine Mount RH.
14. Connect the battery ground cable and install the cover. Refer to Specifications.

## EXHAUST MANIFOLD

### Special Tool(s)

|                                                                                    |                      |
|------------------------------------------------------------------------------------|----------------------|
|  | 310-121 Wrench, H02S |
|------------------------------------------------------------------------------------|----------------------|

## REMOVAL

**WARNING:** Observe due care when working near a hot exhaust system.

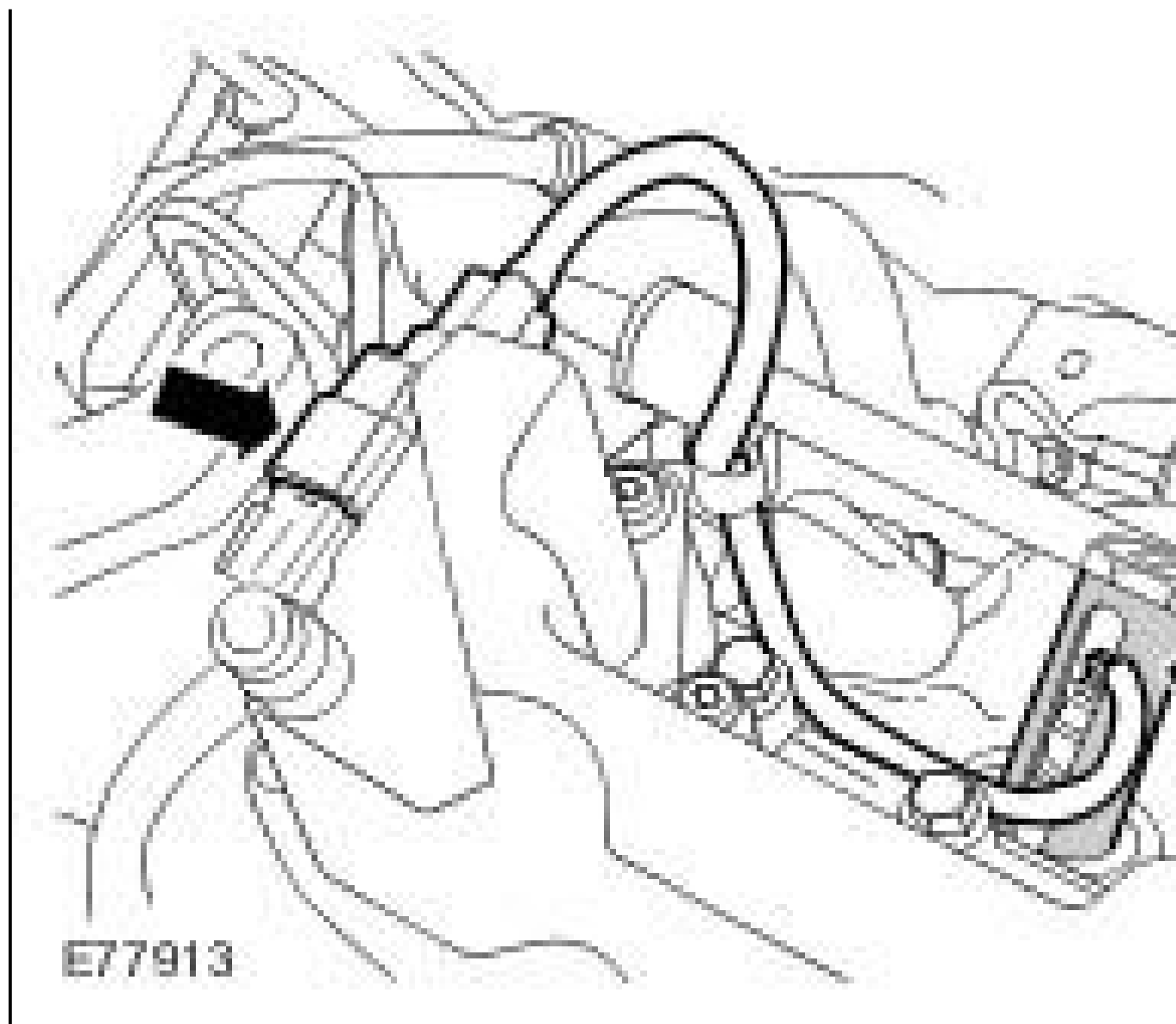
**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the engine cover. Refer to **Engine Cover** .
3. Remove the catalytic converters. Refer to **Catalytic Converter** .
4. Remove the RH fender splash shield. Refer to **Fender Splash Shield** .
5. Disconnect the heated oxygen sensors (HO2S) electrical connectors.

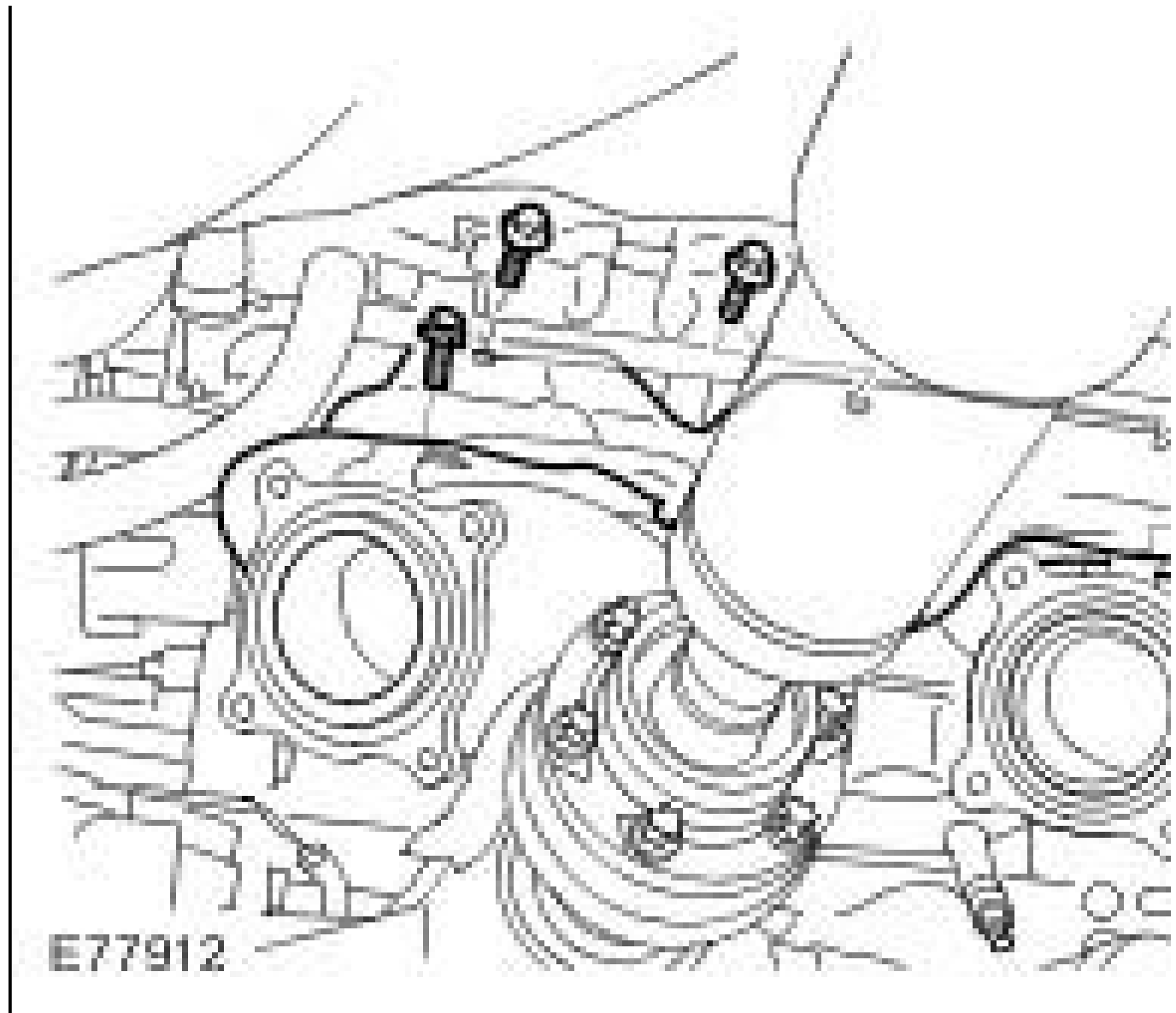
**WARNING:** Do not twist the HO2S wiring harness on removal. Failure to follow this instruction may result in damage to the component.

6. Remove the 2 HO2S.

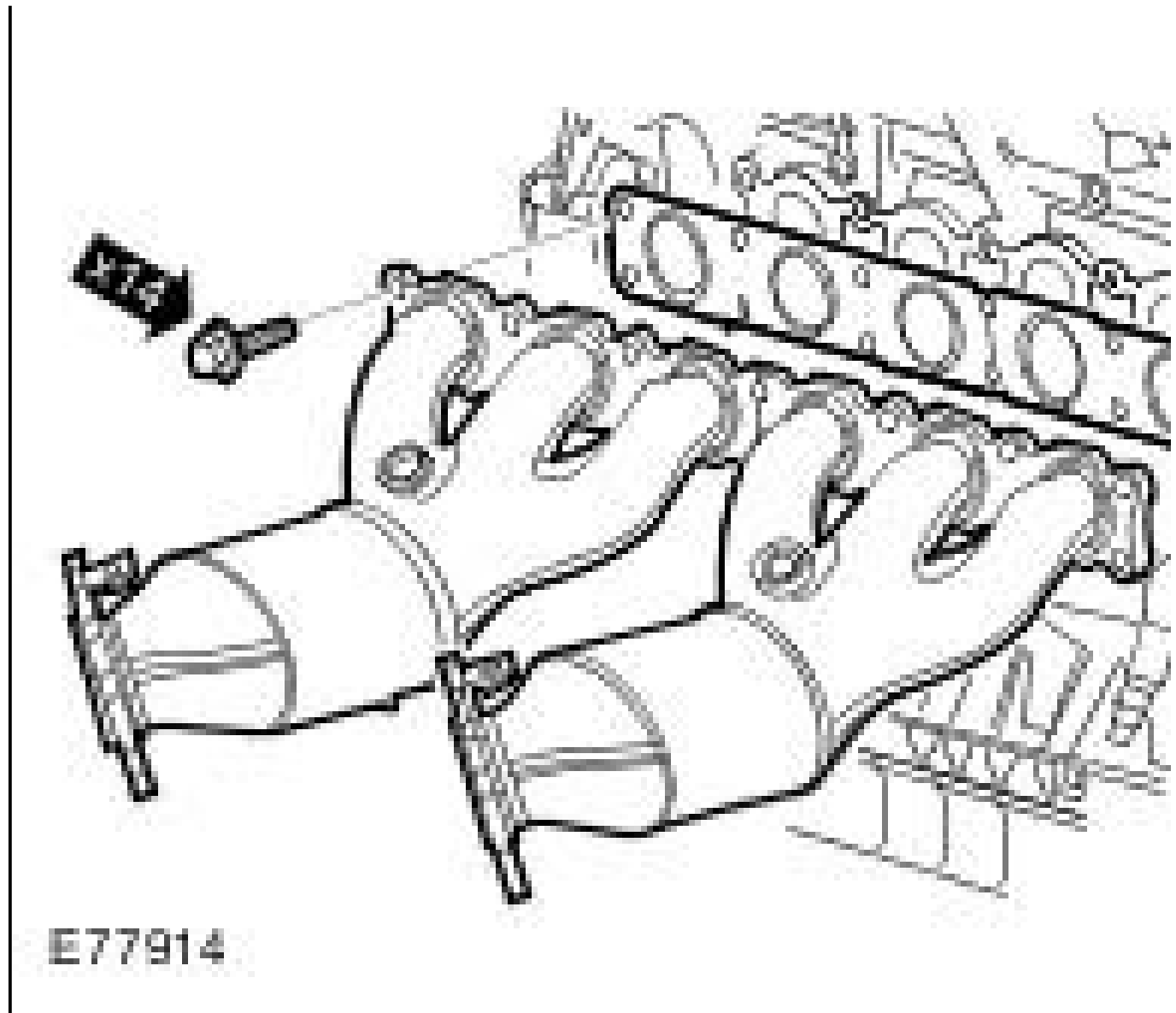
Wrench, H02S (310-121)



7. Remove the exhaust manifold heat shield.



8. Remove the 2 exhaust manifolds.
9. Remove and discard the 2 gaskets.

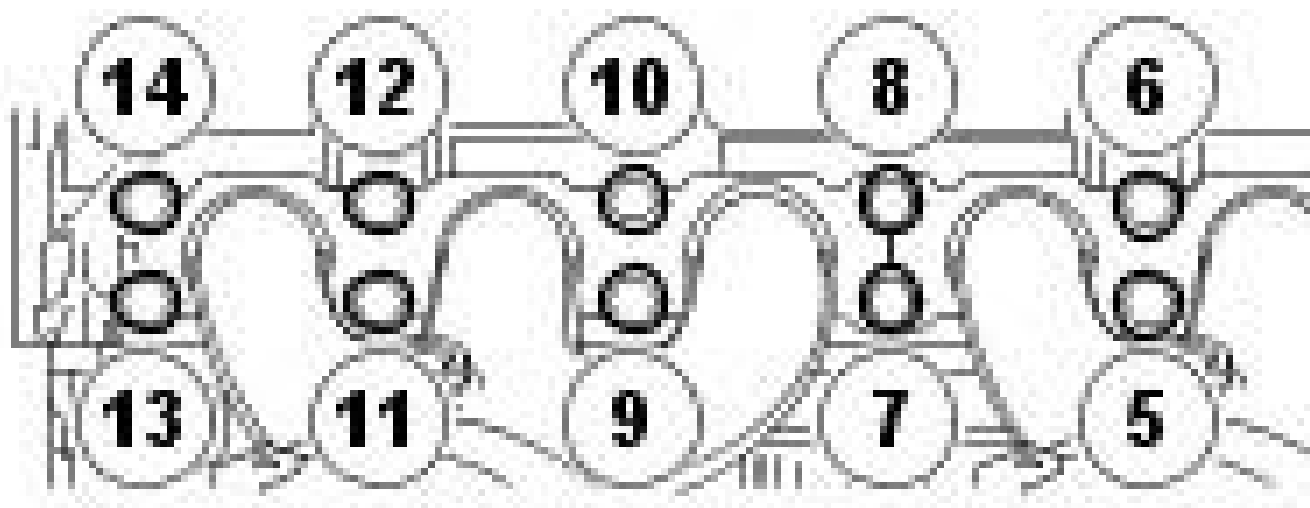
**INSTALLATION**

1. Install new gaskets.

**CAUTION:** Make sure that the area around the component is clean and free of foreign material.

2. Evenly and progressively, tighten the bolts in the sequence shown.

Torque: 24 Nm.



E77915

3. Install the exhaust manifold heat shield.

Torque: 10 Nm.

**CAUTION:** Make sure the anti-seize compound does not contact the HO2S tip.

4. Install the HO2S.

Wrench, H02S (310-121)

Torque: 45 Nm.

5. Connect the HO2S electrical connectors.
6. Install the fender splash shield. Refer to **Fender Splash Shield** .
7. Remove the catalytic converters. Refer to **Catalytic Converter** .
8. Install the engine cover. Refer to **Engine Cover** .

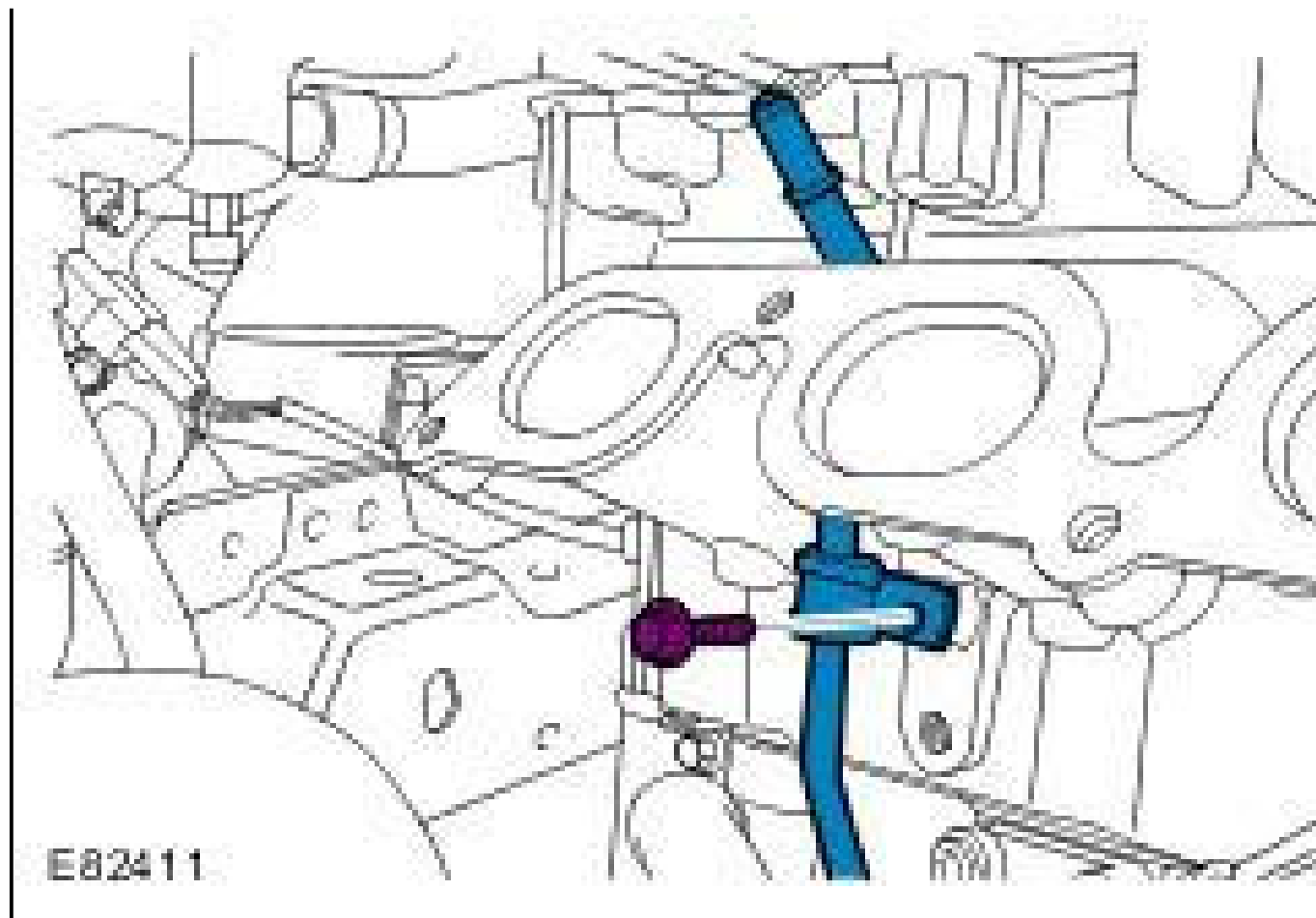
## CYLINDER HEAD

### REMOVAL

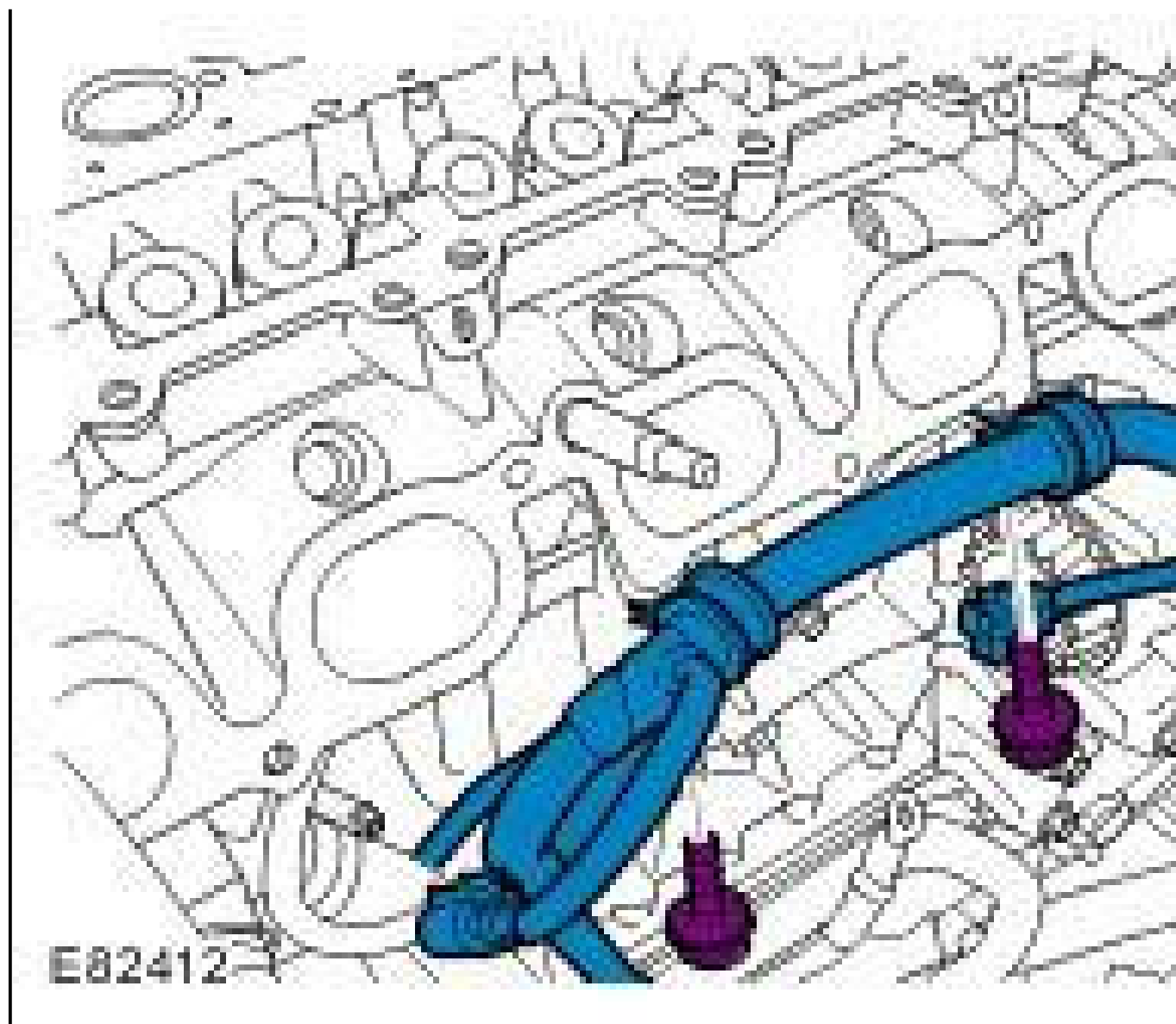
1. Remove the cover and disconnect the battery ground cable. Refer to **Specifications** .

**WARNING: Make sure to support the vehicle with axle stands.**

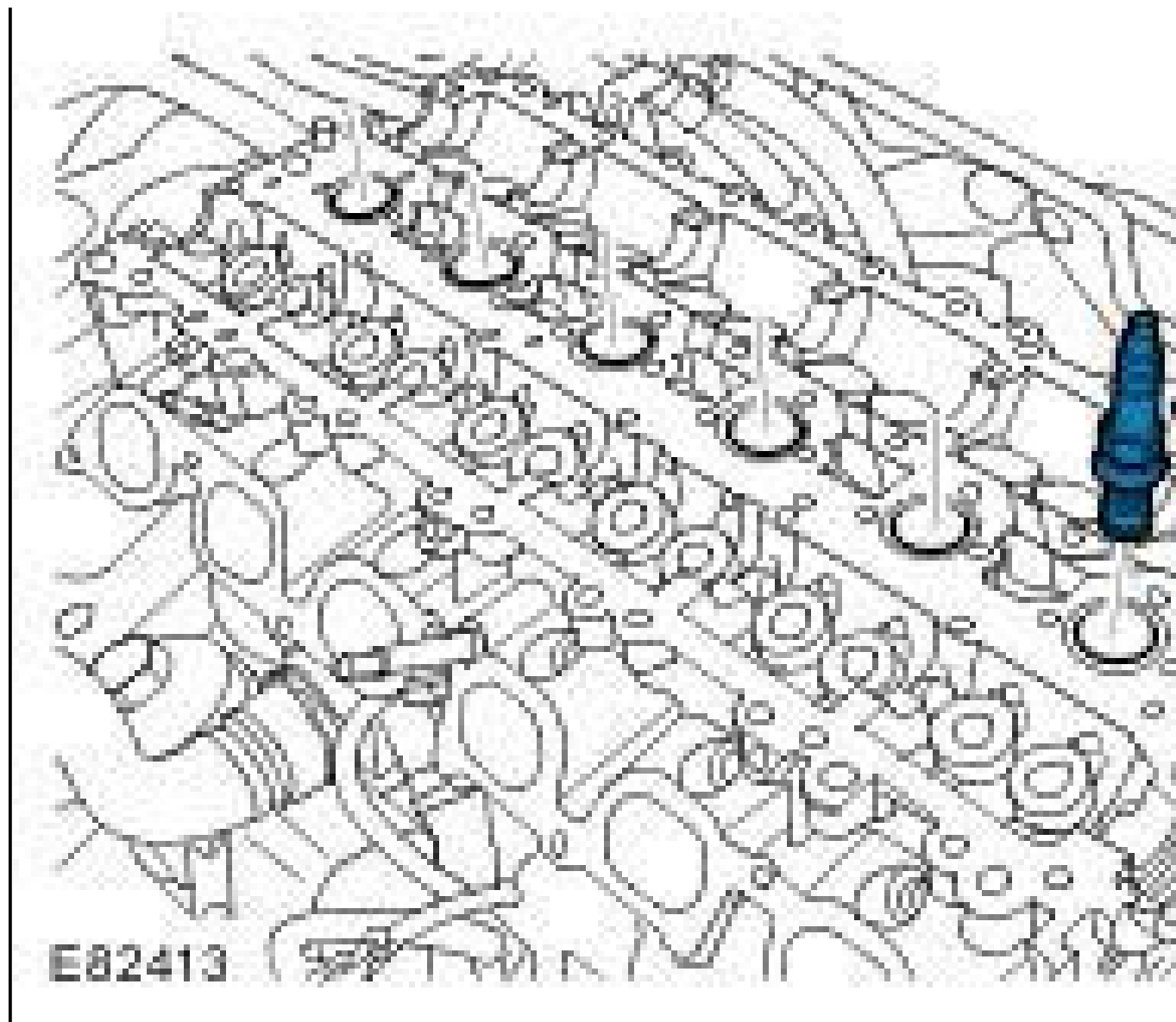
2. Raise and support the vehicle.
3. Remove the fuel rail. Refer to **Fuel Rail** .
4. Remove the generator. Refer to **Generator - 3.2L** .
5. Remove both exhaust manifolds. See **Exhaust Manifold**.
6. Remove the camshafts. See **Camshafts**.
7. Release the fuel pipe.



8. Release the engine wiring harness clips.



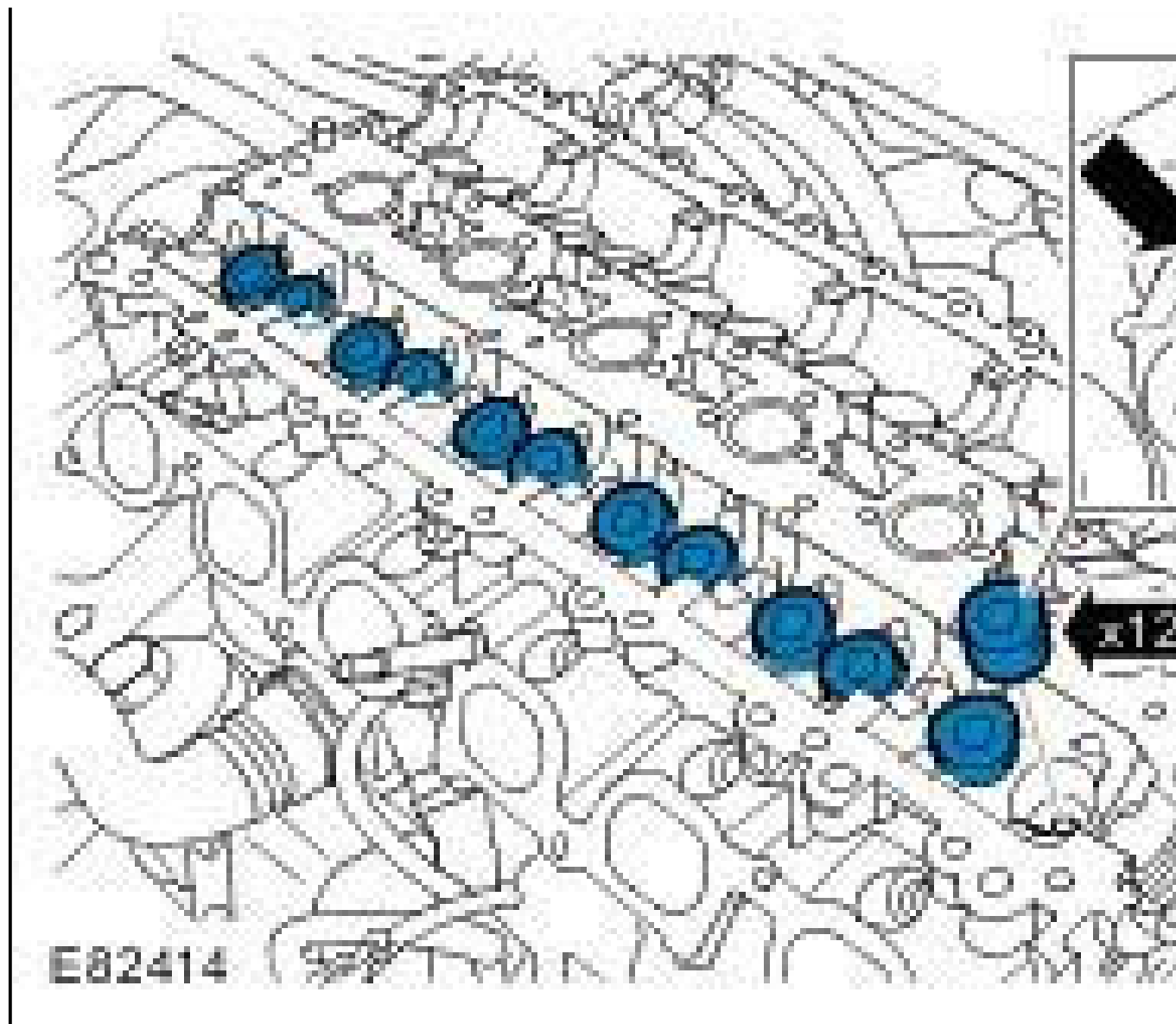
9. Remove the spark plugs.



**CAUTION:** Mark the components to aid installation.

**CAUTION:** Extreme cleanliness must be exercised when handling these components.

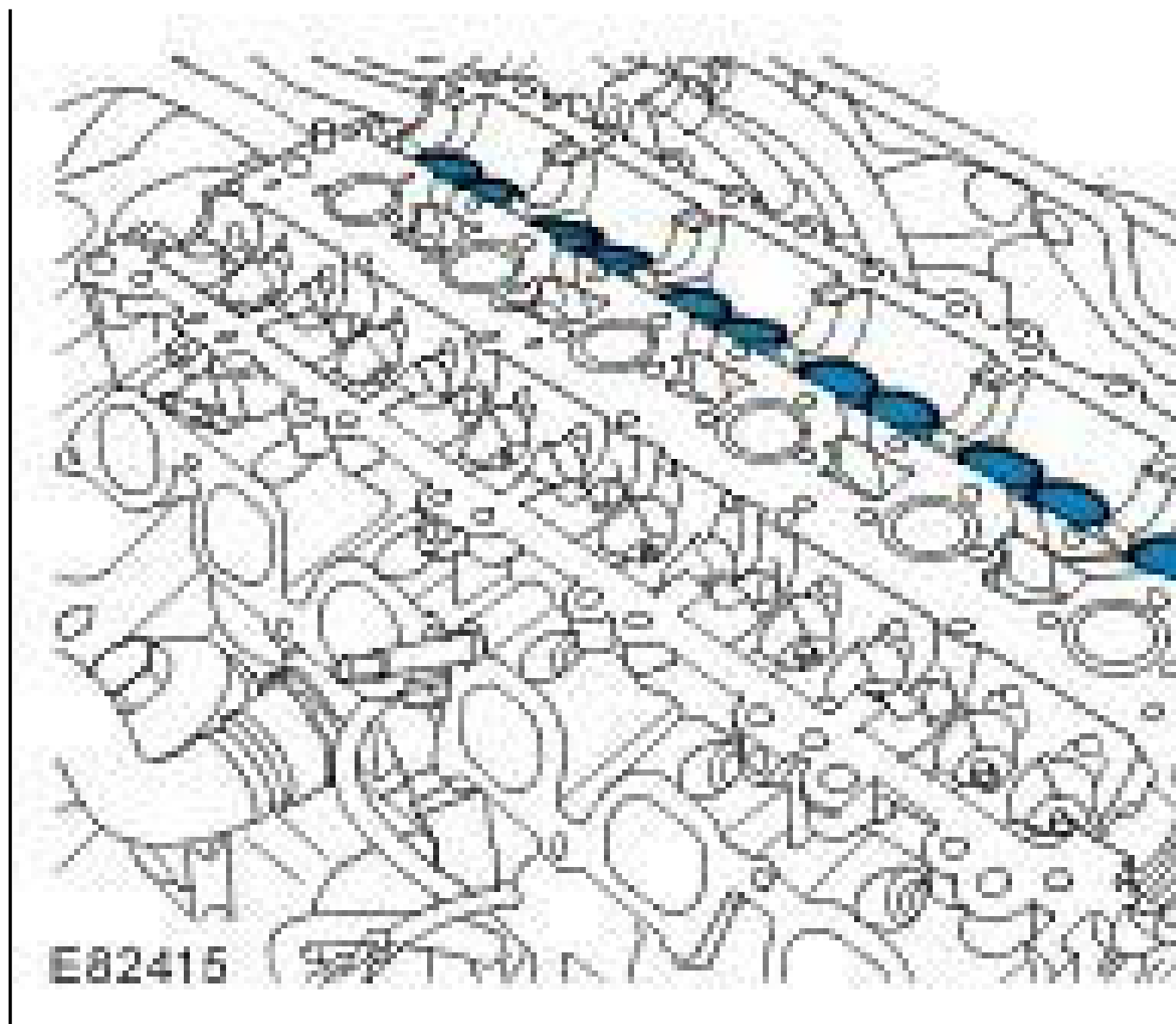
10. Remove the 12 two-stage hydraulic lash adjusters.



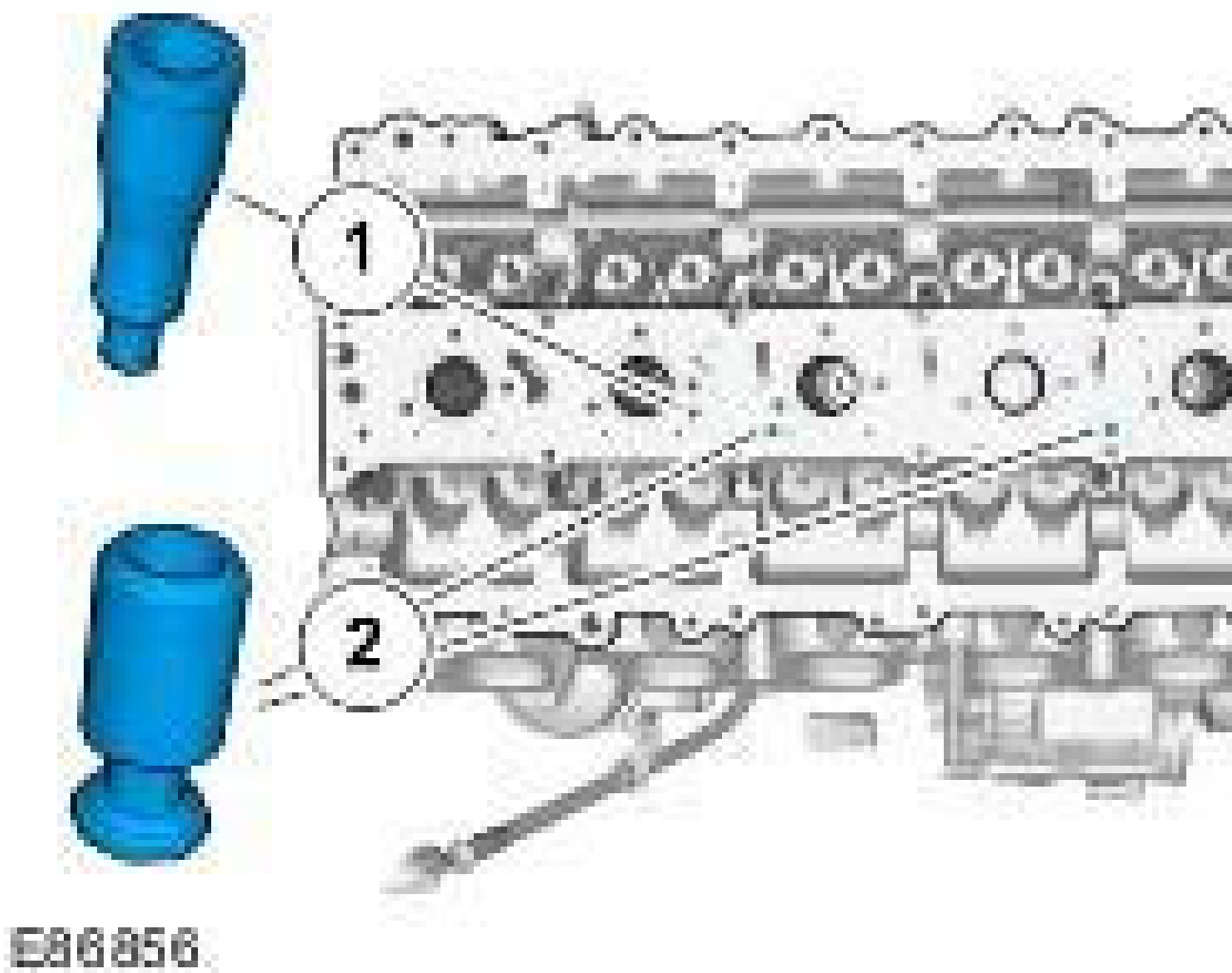
**CAUTION:** Mark the components to aid installation.

**CAUTION:** Extreme cleanliness must be exercised when handling these components.

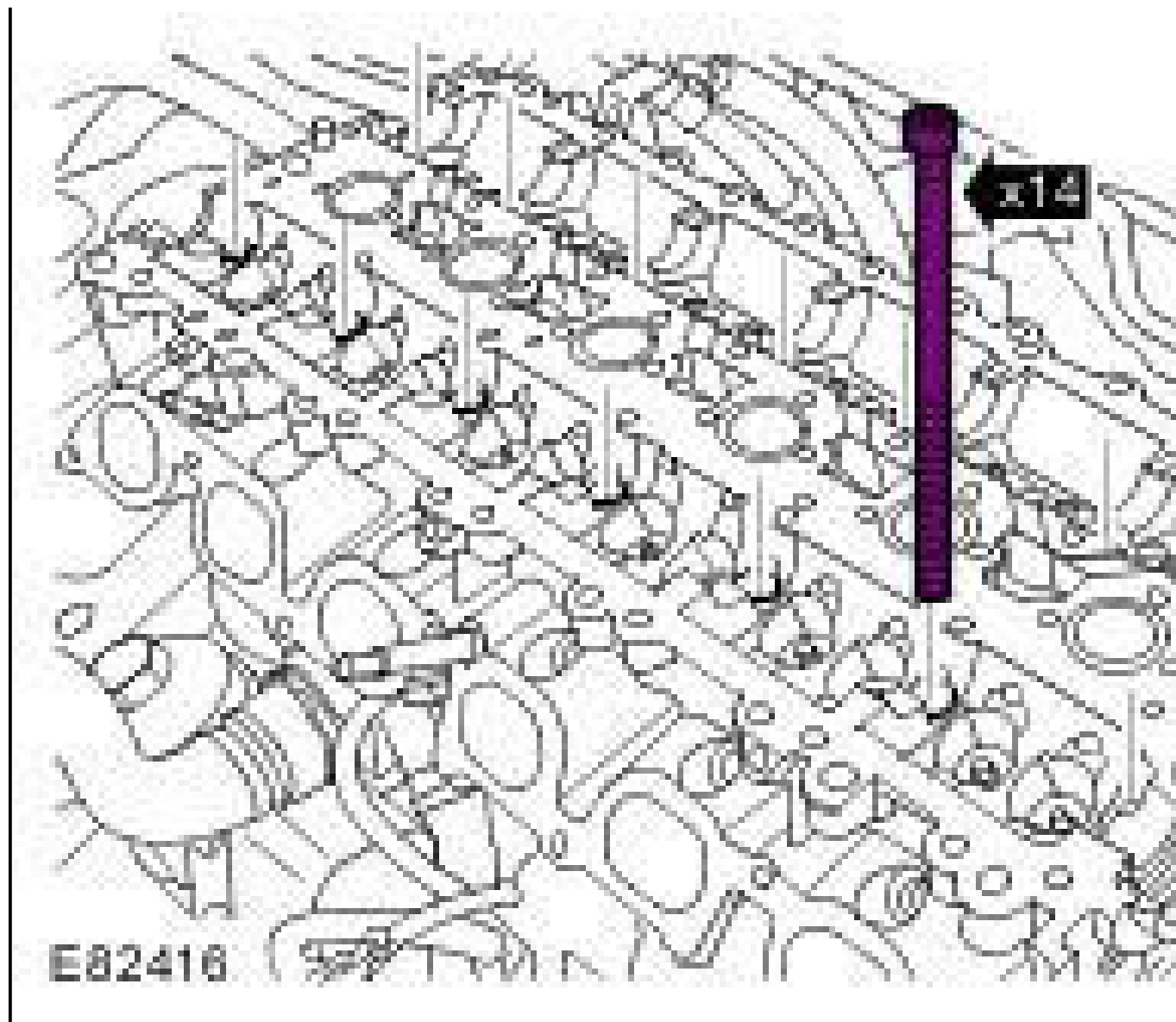
11. Remove the 12 tappets.



12. See figure.

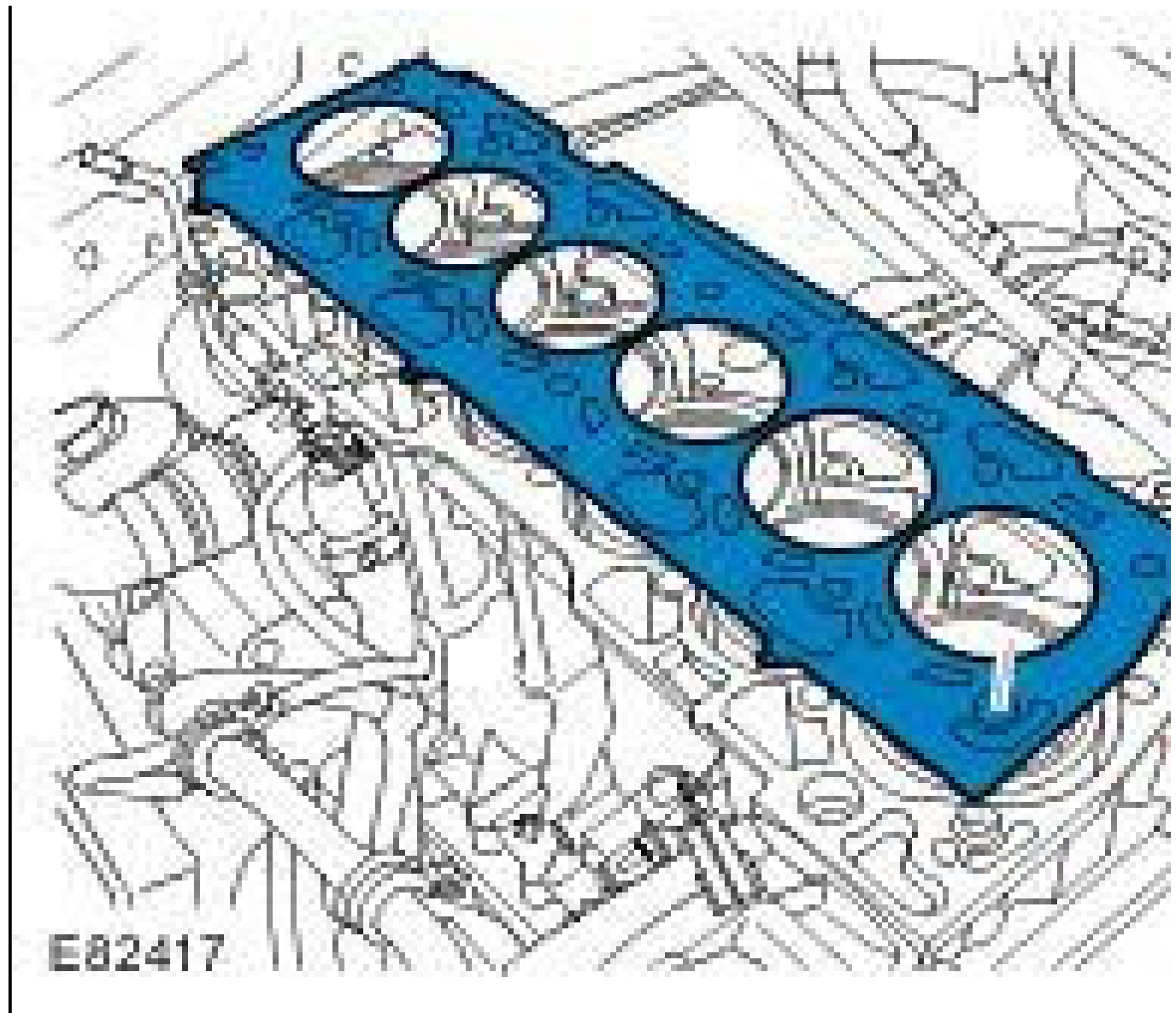


13. Remove and discard the 14 cylinder head bolts.



**NOTE:** This step requires the aid of another technician.

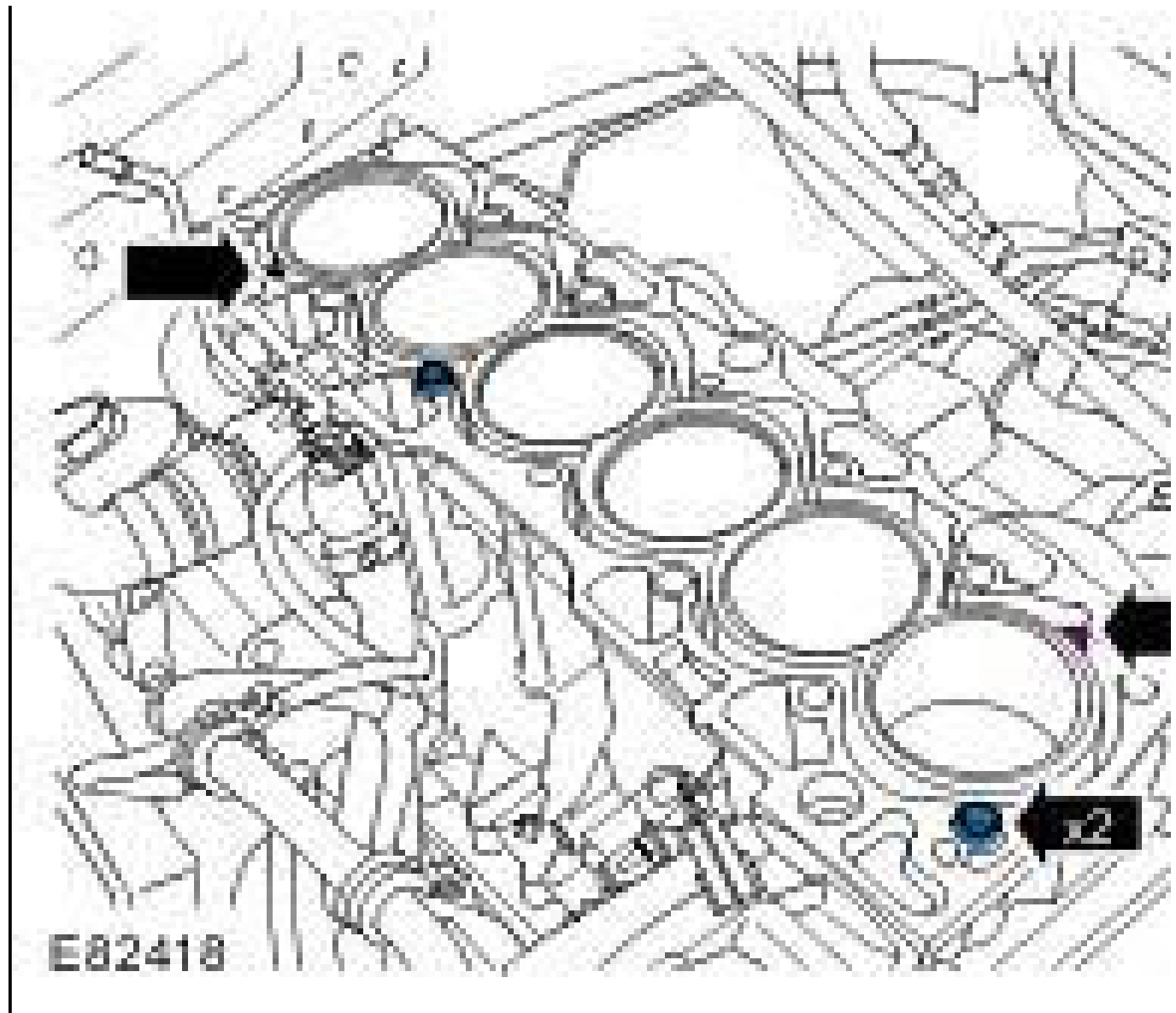
14. Remove the cylinder head.
15. Remove and discard the cylinder head gasket.



**NOTE:** Make sure that these components are installed to the noted removal position.

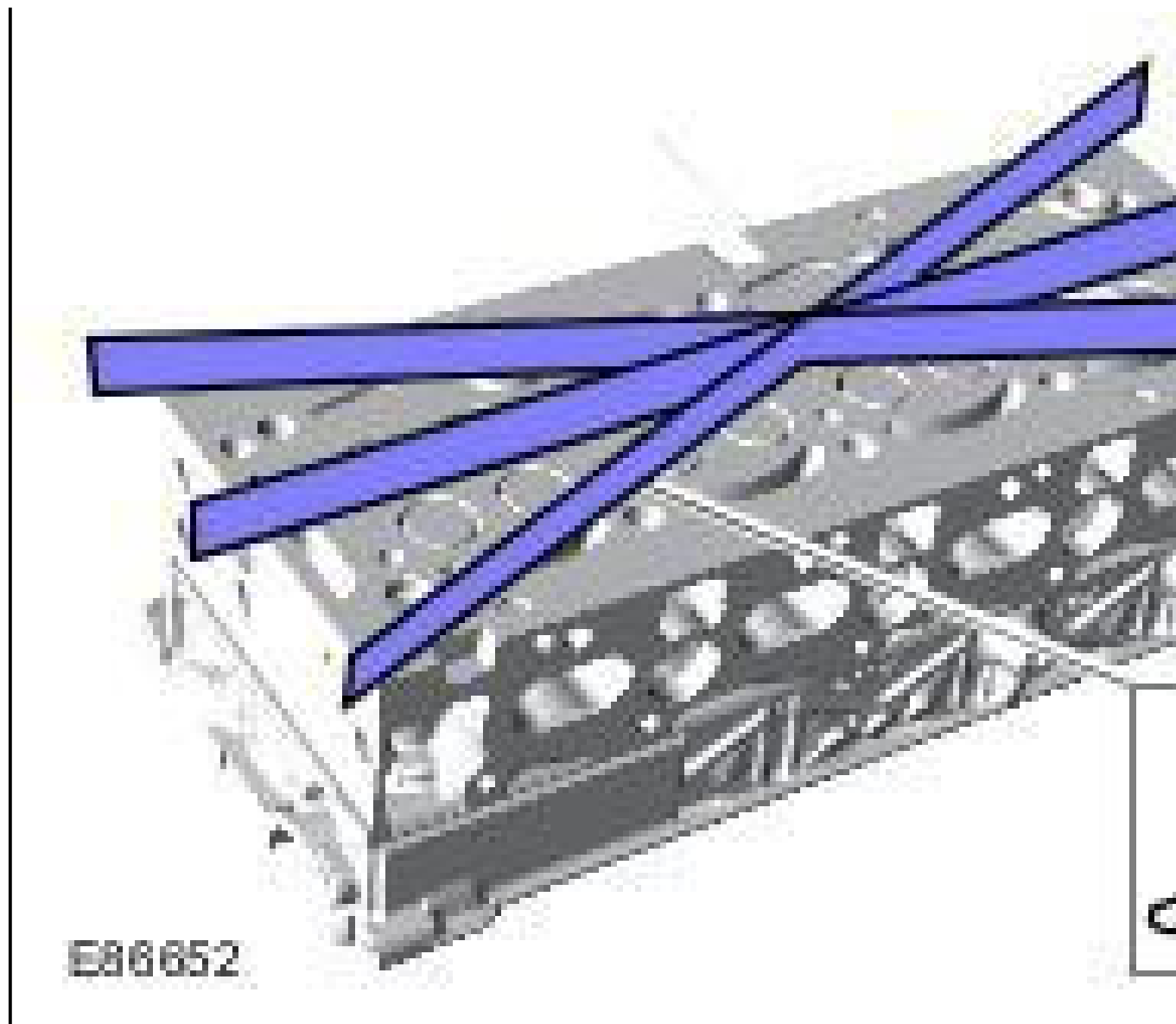
16.

1. Remove the dowels.
2. Check that the cylinder block water jacket restrictors are installed.



#### INSTALLATION

1. Install the dowels.
2. Clean and inspect the cylinder head and cylinder block.
3. Check cylinder head face for distortion, across the center and from corner to corner. See **Specifications**.



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

4. Install a new cylinder head gasket.

**CAUTION:** Make sure that the component is correctly located on the locating dowels.

**NOTE:** This step requires the aid of another technician.

5. Install the cylinder head.
- 6.

**CAUTION:** Make sure that new cylinder head bolts are installed.

6.

**CAUTION:** Take extra care not to damage the mating faces.

**NOTE:** The cylinder head tightening process is carried out once to 45 Nm, then the bolts are loosened and the final torque and angle applied.

**NOTE:** The cylinder head tightening process is carried out once to 45 Nm, then the bolts are loosened and the final torque and angle applied.

1. Tighten the cylinder head bolts in the sequence shown.

Torque: 45

2. Check the cylinder head bolt torque in the sequence shown.

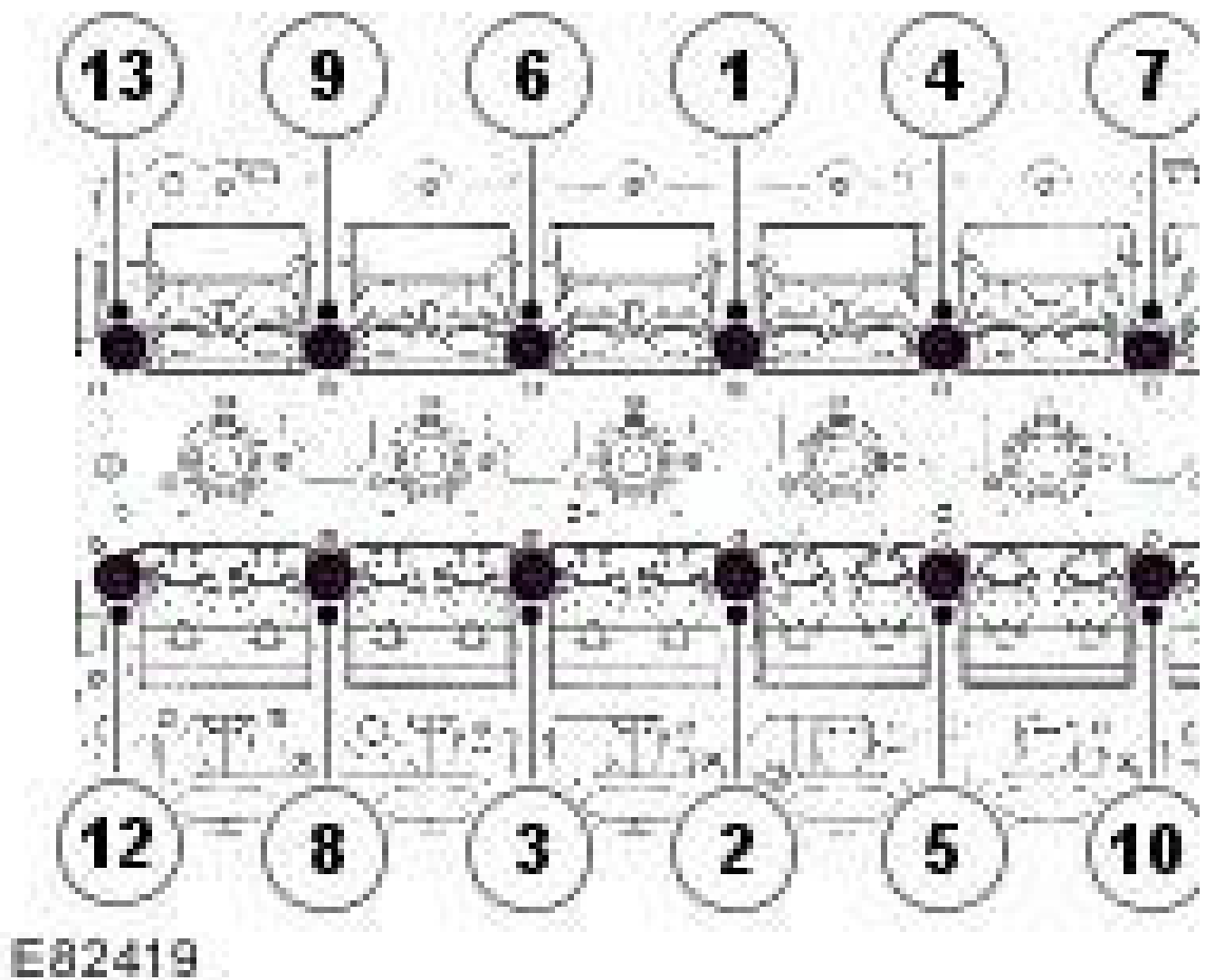
Torque: 45

3. Tighten the cylinder head bolts in the sequence shown.

Torque: 90

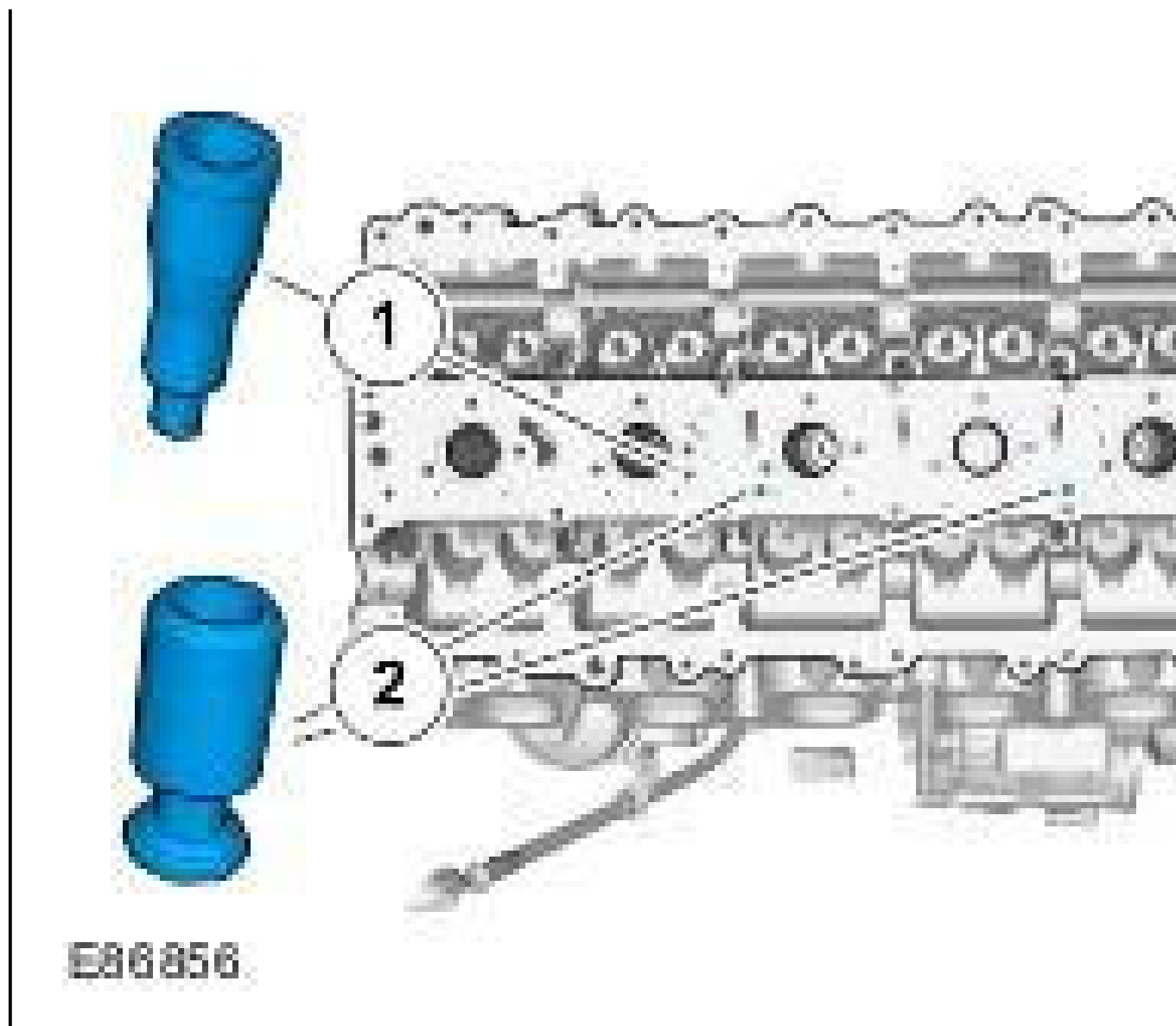
4. Tighten the cylinder head bolts in the sequence shown.

Torque: 180



**CAUTION:** Make sure that the choke valves (1), (2) are in place.

7. See figure



**CAUTION:** Extreme cleanliness must be exercised when handling these components.

**CAUTION:** Make sure that these components are installed to the noted removal position.

8. Install the tappets.

**CAUTION:** Extreme cleanliness must be exercised when handling these components.

**CAUTION:** Make sure that these components are installed to the noted removal position.

9. Install the lash adjusters.
10. Install the engine wiring harness clips.

Torque: 6

11. Install the spark plugs.

Torque: 28

12. Secure the fuel line.

Torque: 10

13. Install the camshafts. See Camshafts.
14. Install the generator. Refer to Generator - 3.2L.
15. Install the fuel rail. Refer to Fuel Rail.
16. Install both exhaust manifolds. See Exhaust Manifold.
17. Connect the battery ground cable and install the cover. Refer to Specifications.

## OIL PAN

### REMOVAL

1. Remove the cover and disconnect the battery ground cable. Refer to Specifications.

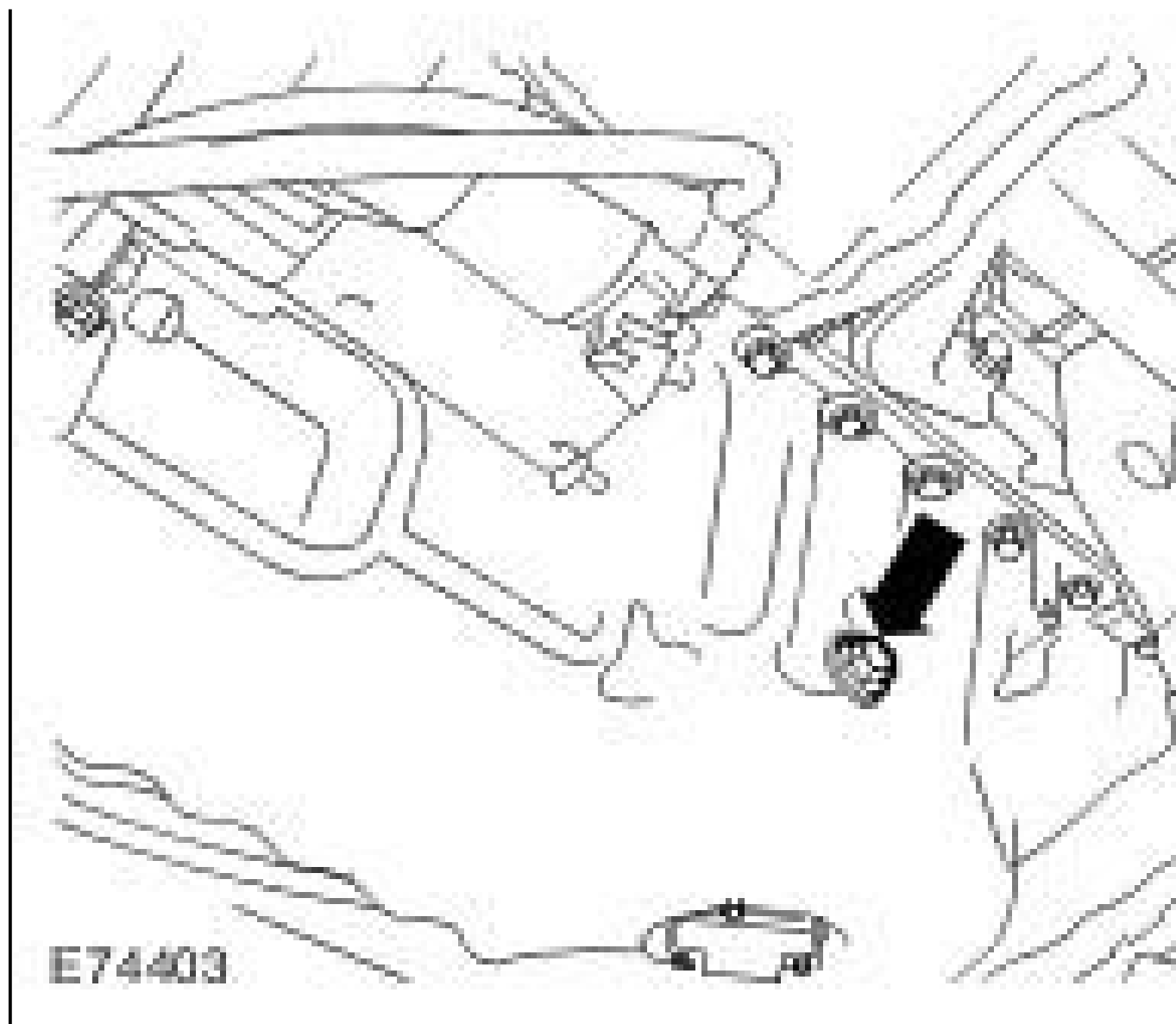
**WARNING:** Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

2. Raise and support the vehicle.
3. Remove the starter motor. Refer to Starter Motor - Petrol.

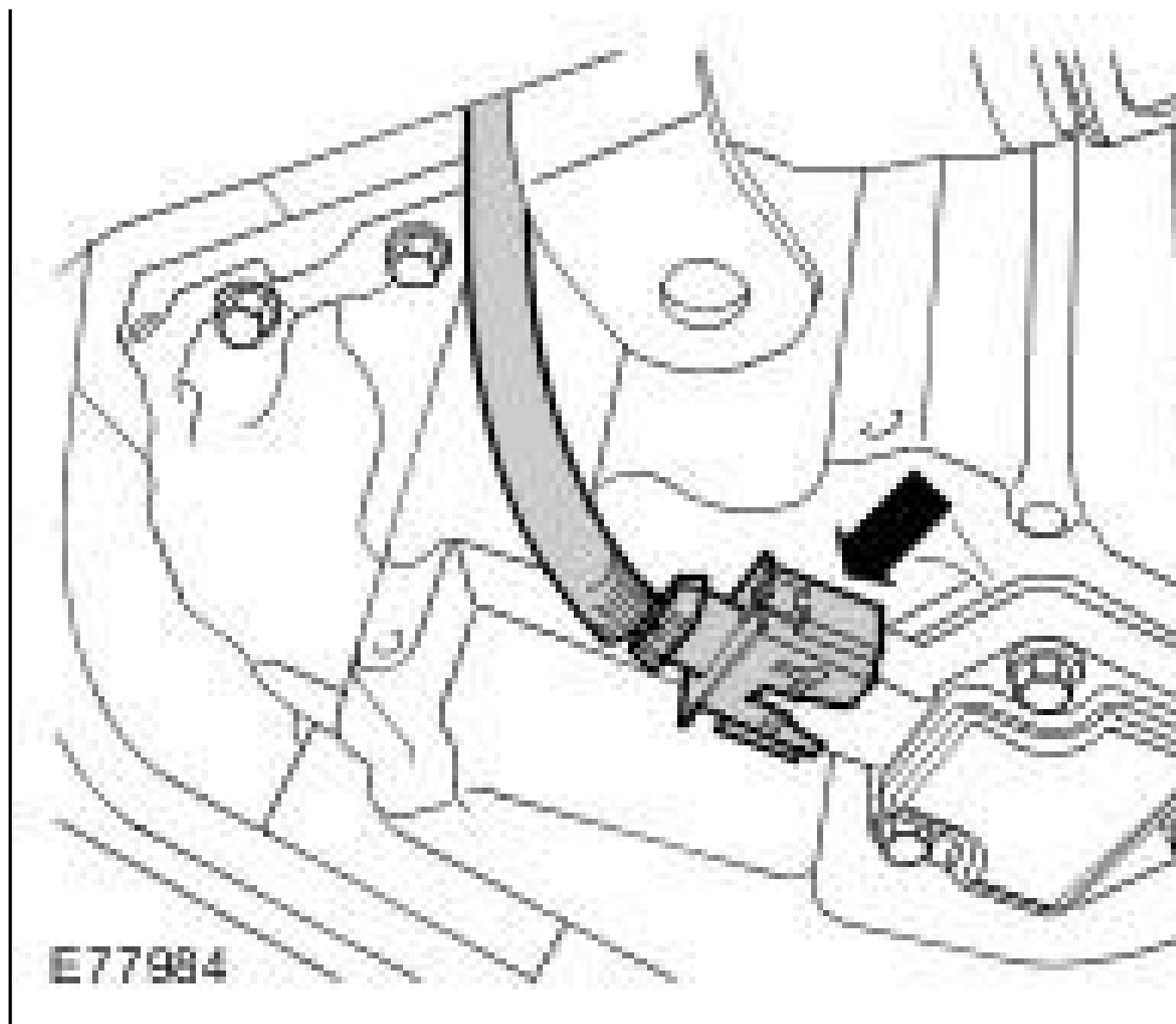
**WARNING:** Be prepared to collect escaping oil.

**CAUTION:** Discard the seal.

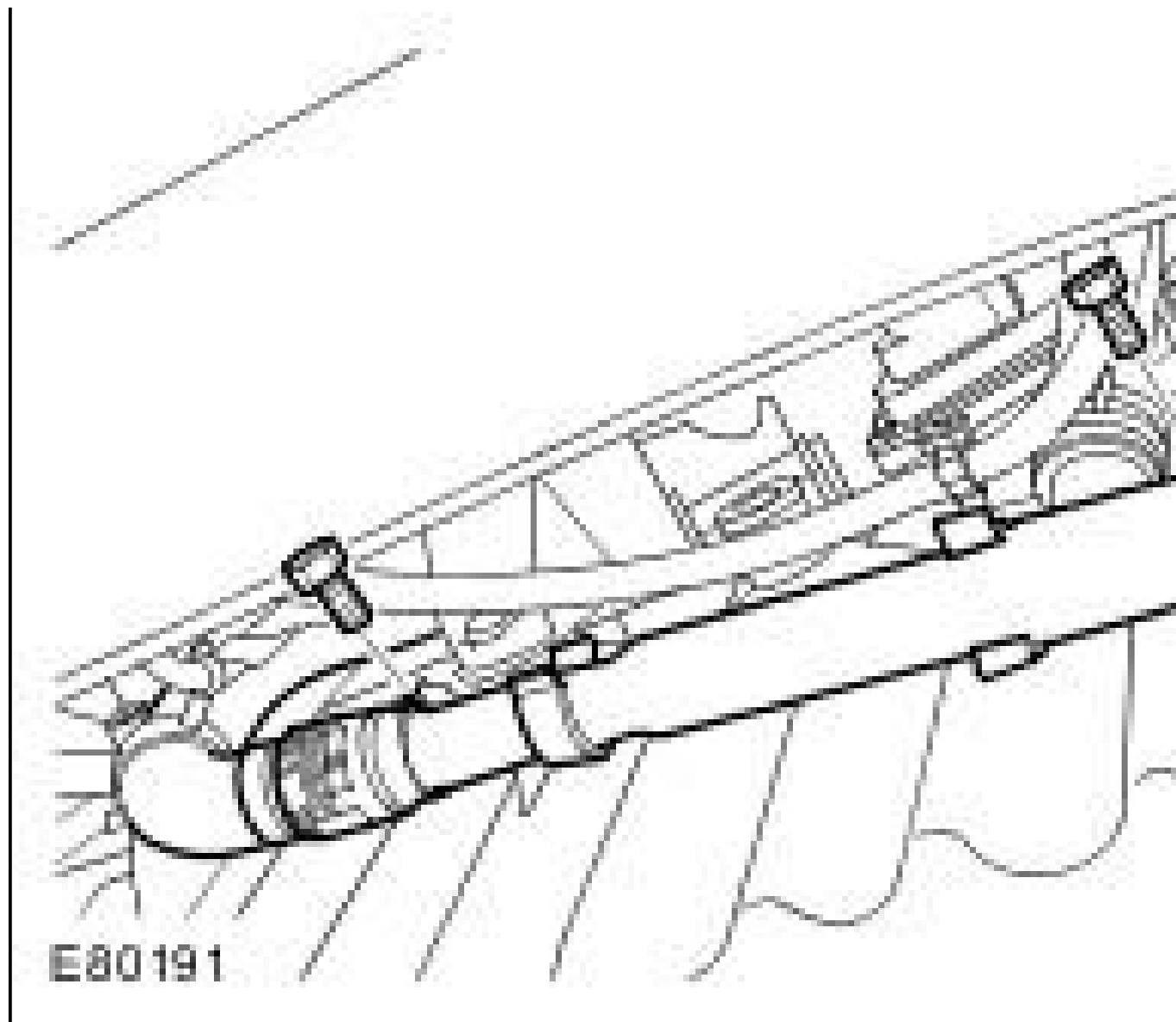
4. Remove the lubricant drain plug.



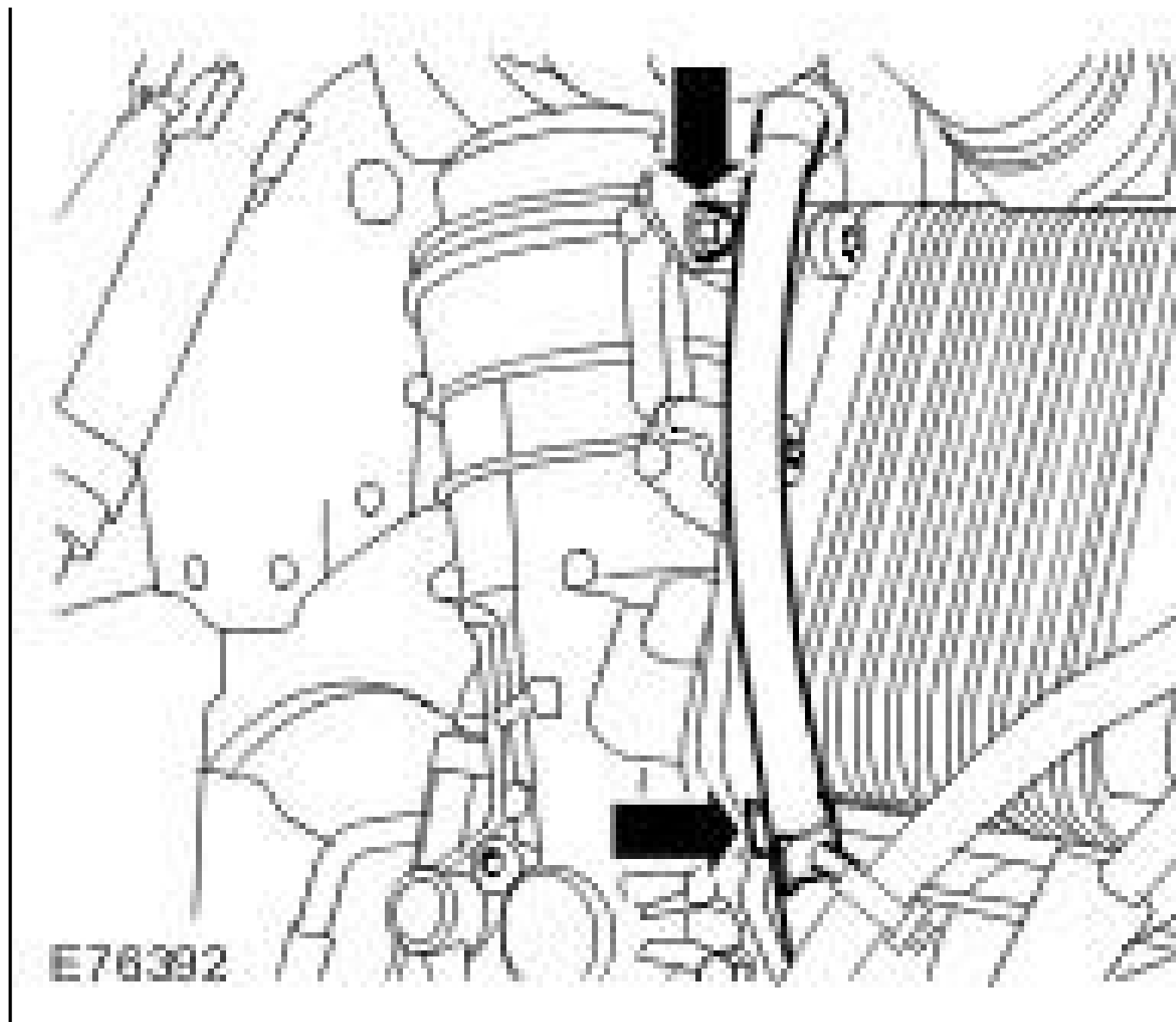
5. Disconnect the oil level sensor electrical connector.



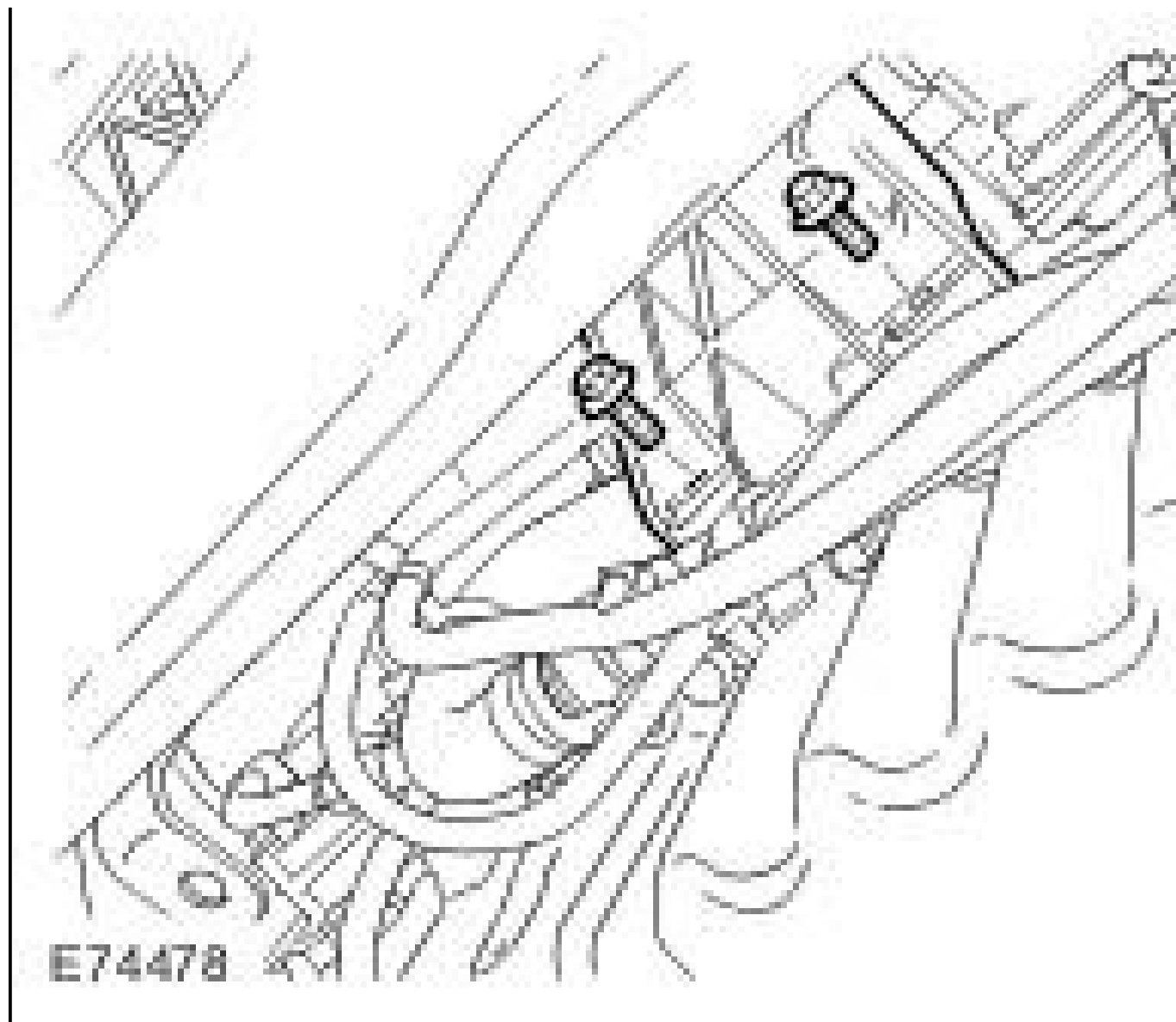
6. Release the coolant rail.



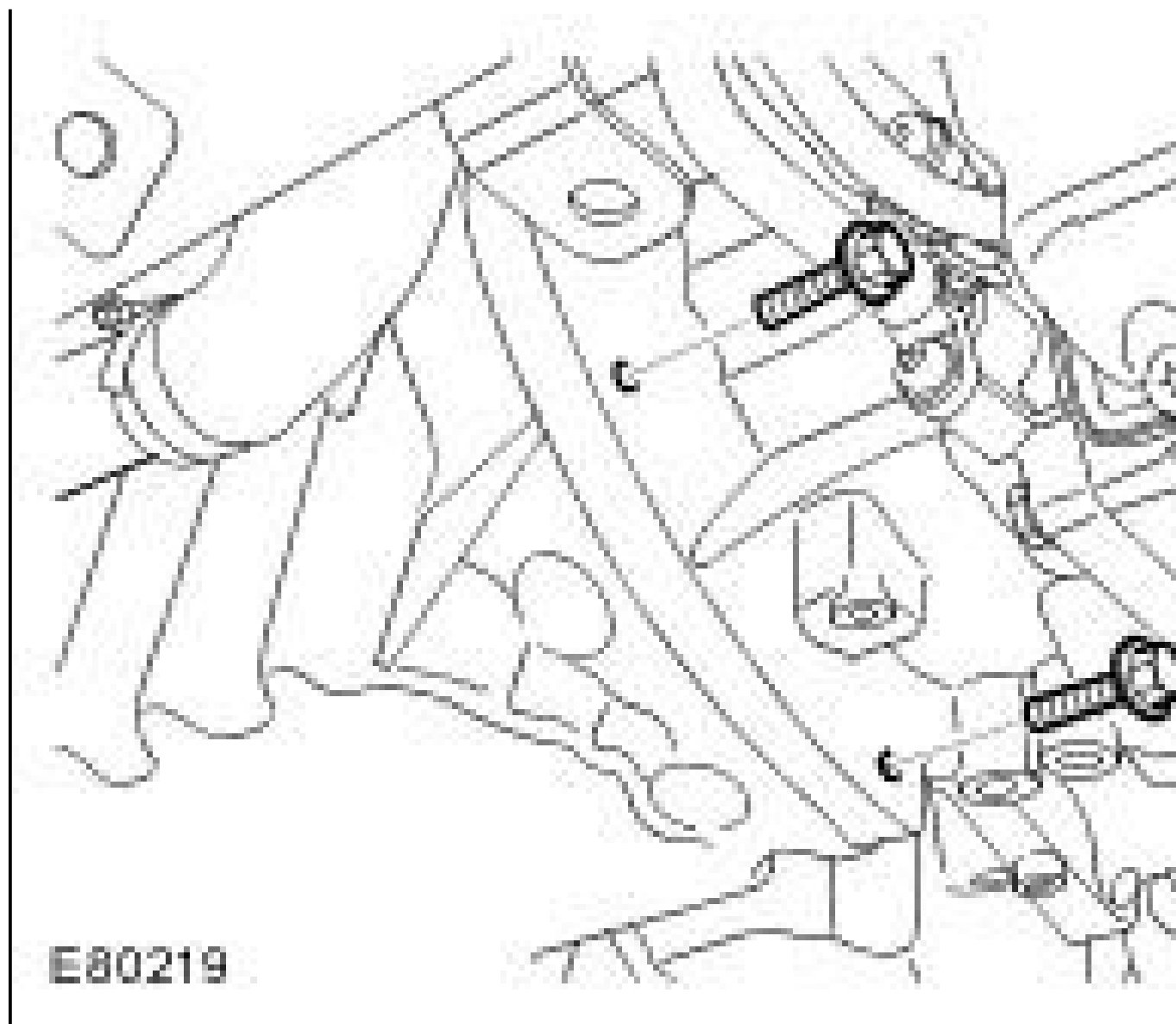
7. Remove the dipstick tube.



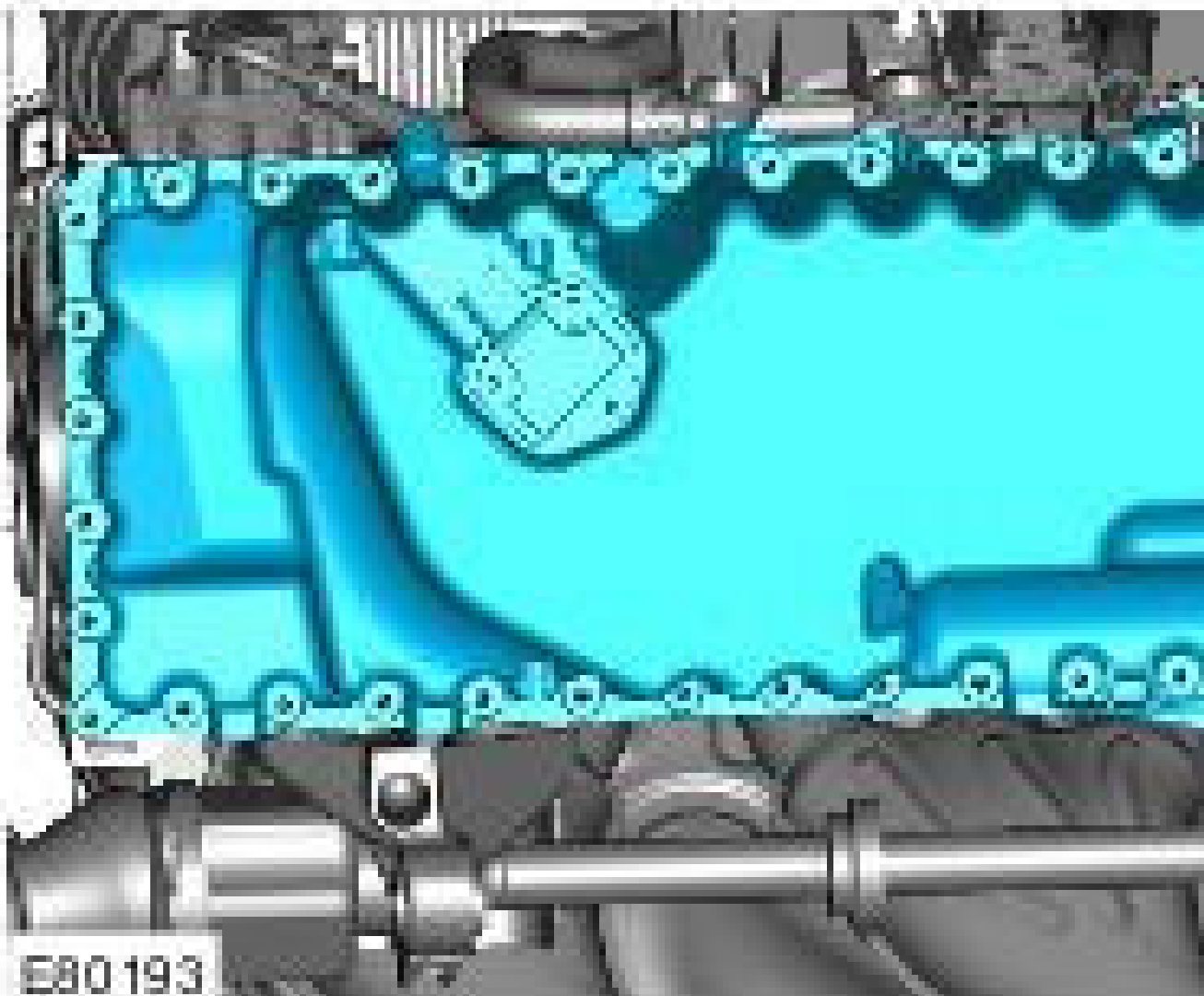
8. Remove the intake manifold lower bolts.



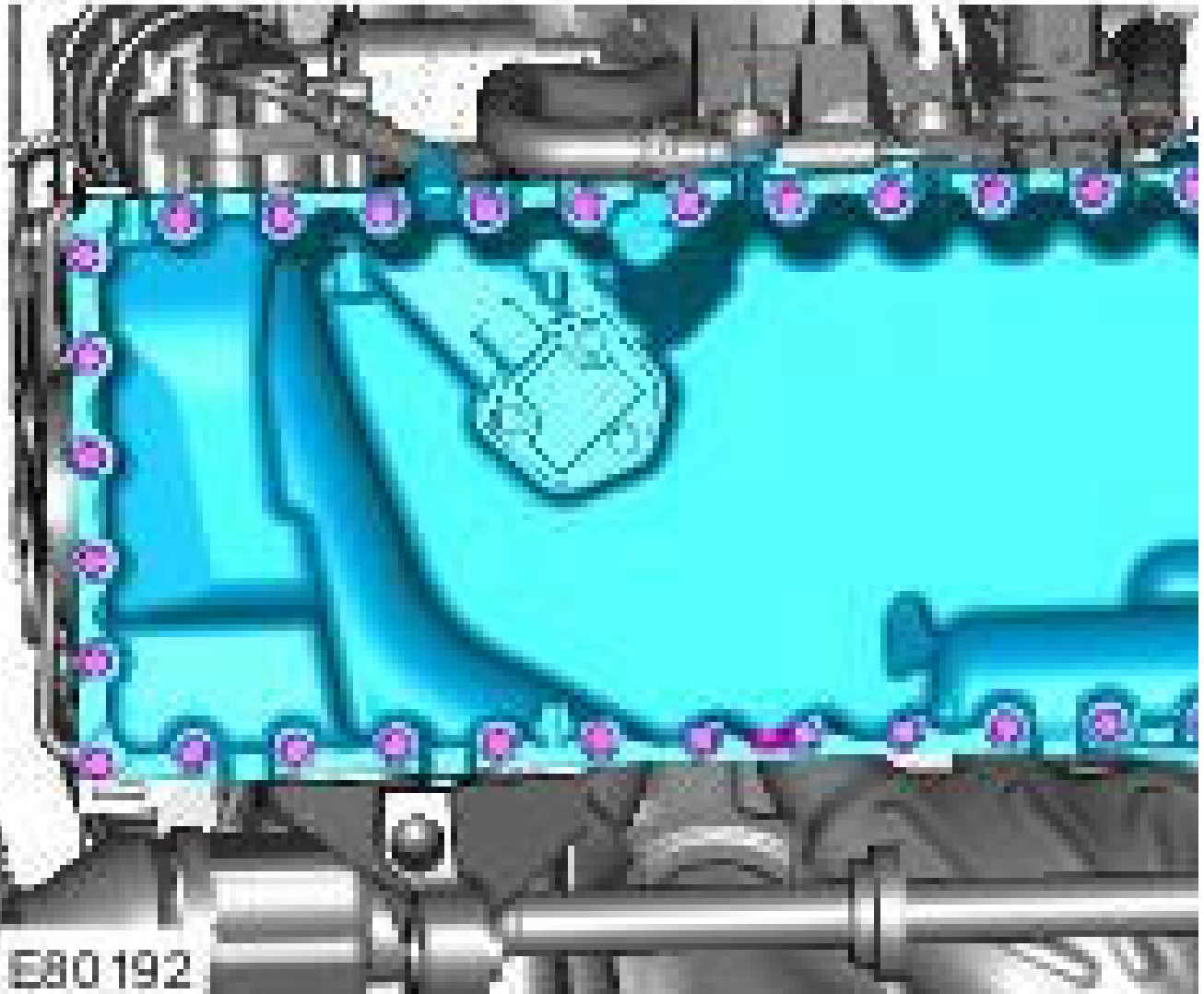
9. Remove the 2 sump to gearbox bolts.



10. Remove the 3 oil pan bolts.



11. Remove the 31 oil pan bolts



12. Remove the oil pan gasket.

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

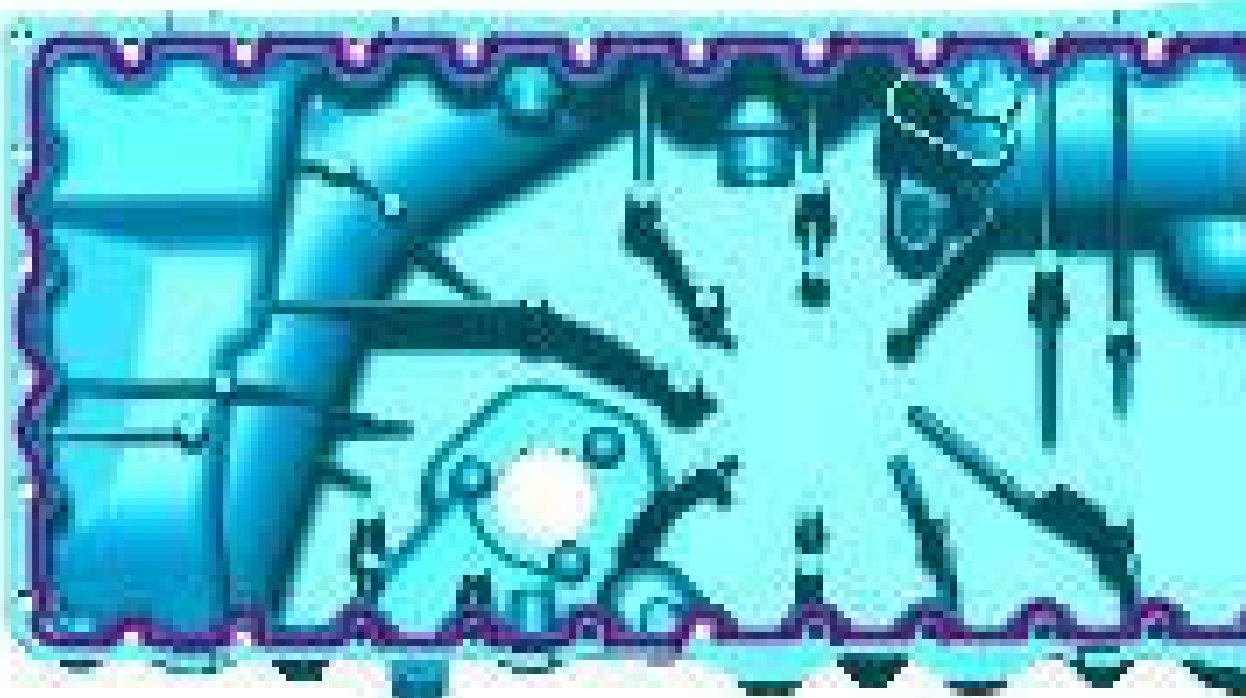
13. Remove the oil level sensor.

**Installation**

1. Install the oil level sensor.

Torque: 8 Nm.

2. For sealant information, refer to the engine specification section. See **Specifications**.
3. Apply a bead of sealant, 2.5 mm diameter, to the area indicated.



E80195

4. Install the oil pan.

Torque: - 17 Nm.

Torque: - 45 Nm.

5. Secure the coolant rail.

Torque: 10 Nm.

6. Install the intake manifold.

Torque: 10 Nm.

**CAUTION:** Make sure that new sealing washers are installed.

7. Install the lubricant drain plug.

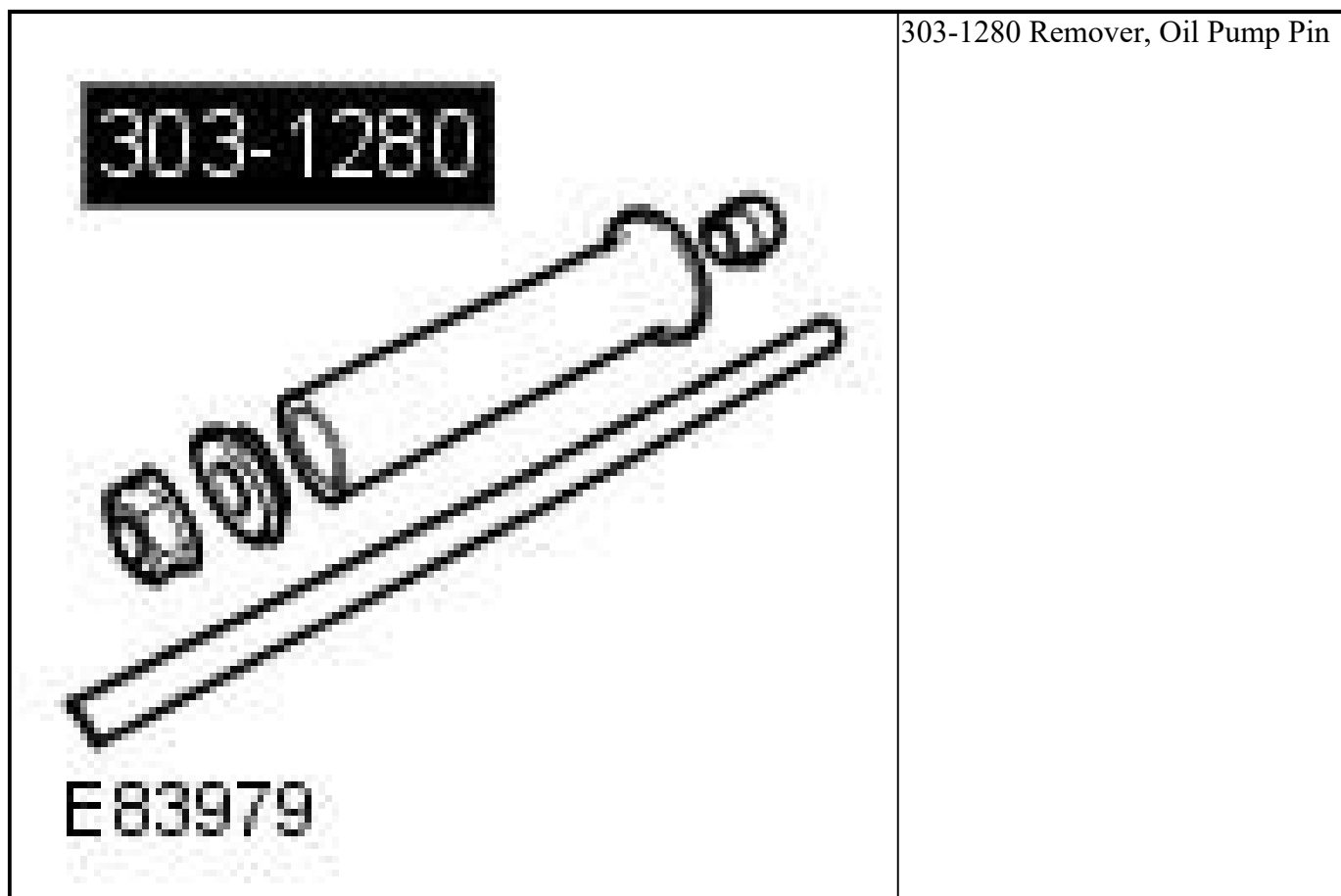
Torque: 38 Nm.

8. Fill the engine with oil.  
9. Install the starter motor. Refer to **Starter Motor - Petrol** .  
10. Check and top-up the engine oil.  
11. Connect the battery ground cable and install the cover. Refer to **Specifications** .  
12. Install the dipstick tube.

Torque: 10 Nm.

## OIL PUMP

### Special Tool(s)



## REMOVAL

**CAUTION:** Extreme cleanliness must be exercised when handling these components.

**NOTE:** Always fit a new oil pump, as the pump gear is sprayed with a 'spacecoat' that allows accurate setting of the backlash..

1. Remove the cover and disconnect the battery ground cable. Refer to Specifications .

**WARNING:** Make sure to support the vehicle with axle stands.

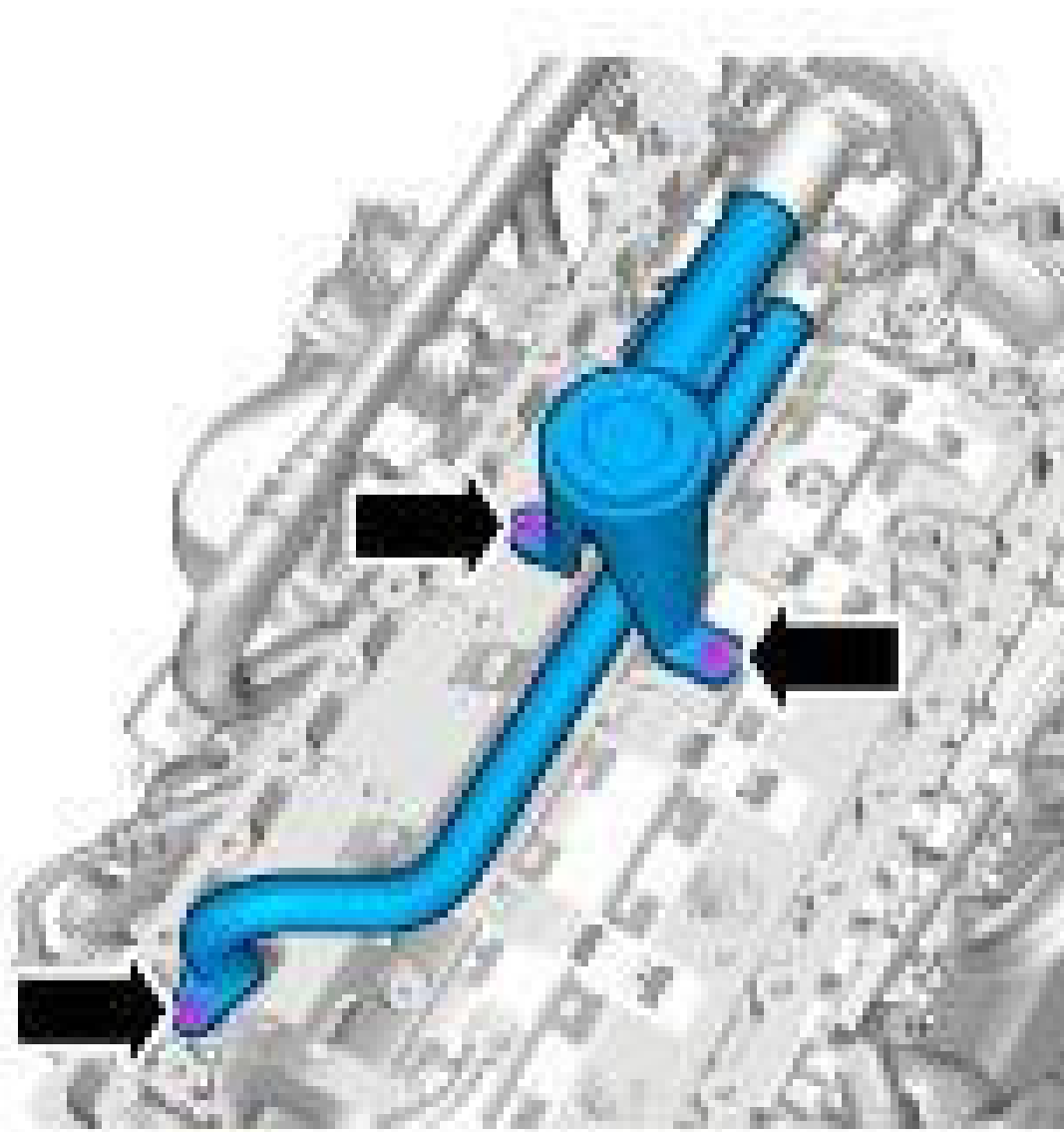
2. Raise and support the vehicle.
3. Remove the oil pan. See Oil Pan.

**CAUTION:** Discard the seal.

4. Remove the oil strainer pick-up assembly.

**CAUTION:** Discard the seals.

5. Remove the oil pressure pipe.

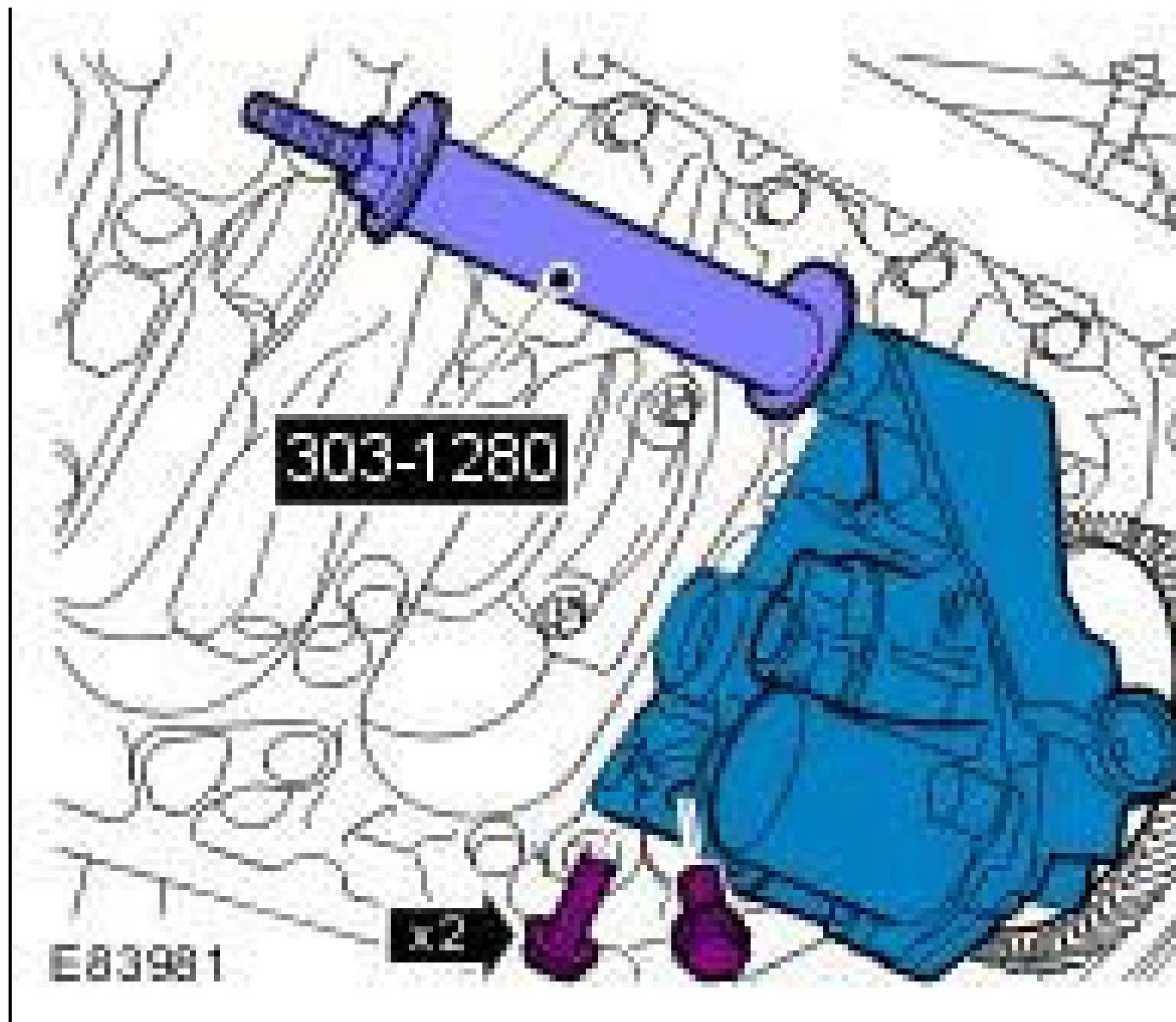


E83980

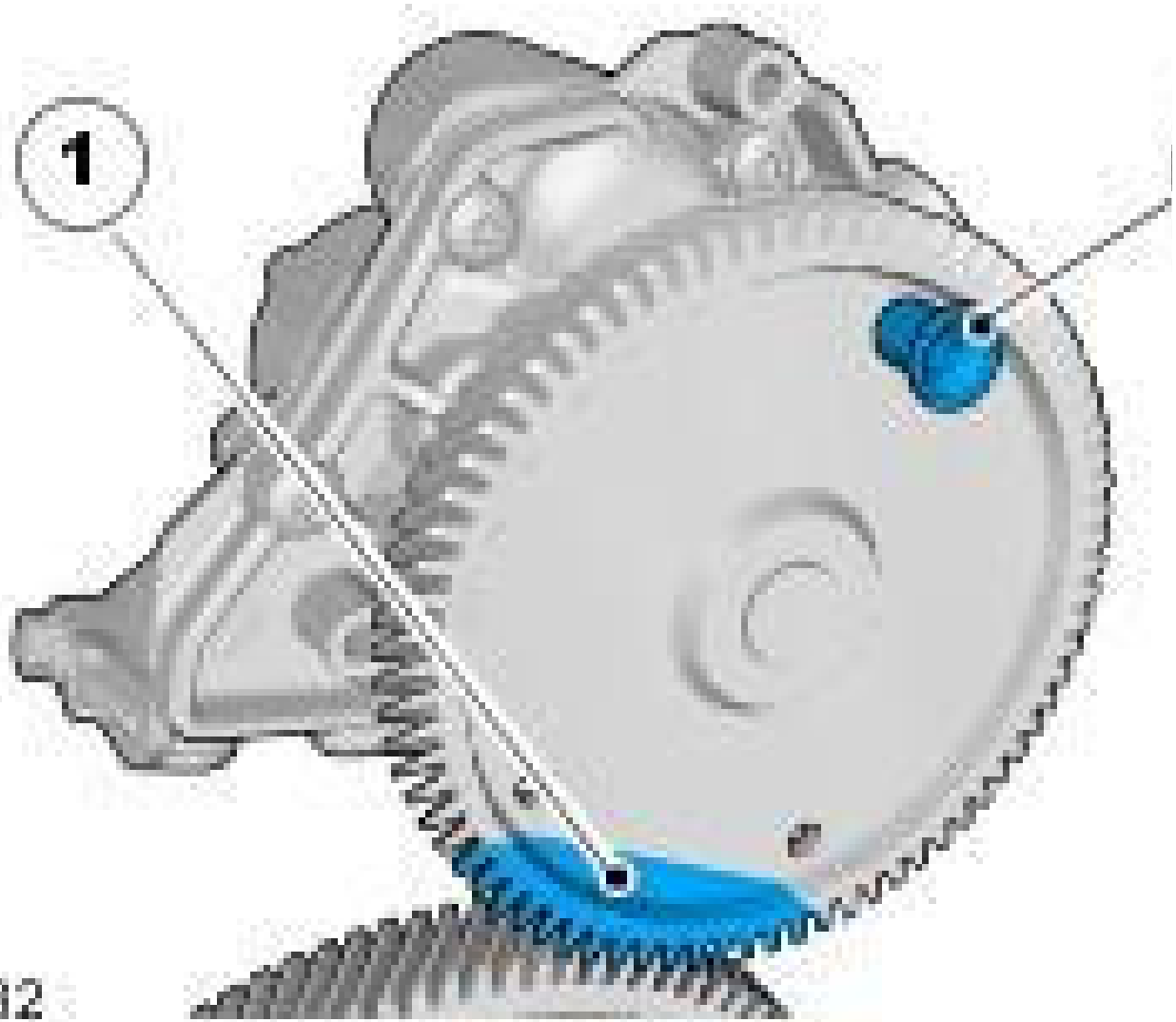
6. Remove the oil pump pivot pin.

Remover, Oil Pump Pin (303-1280)

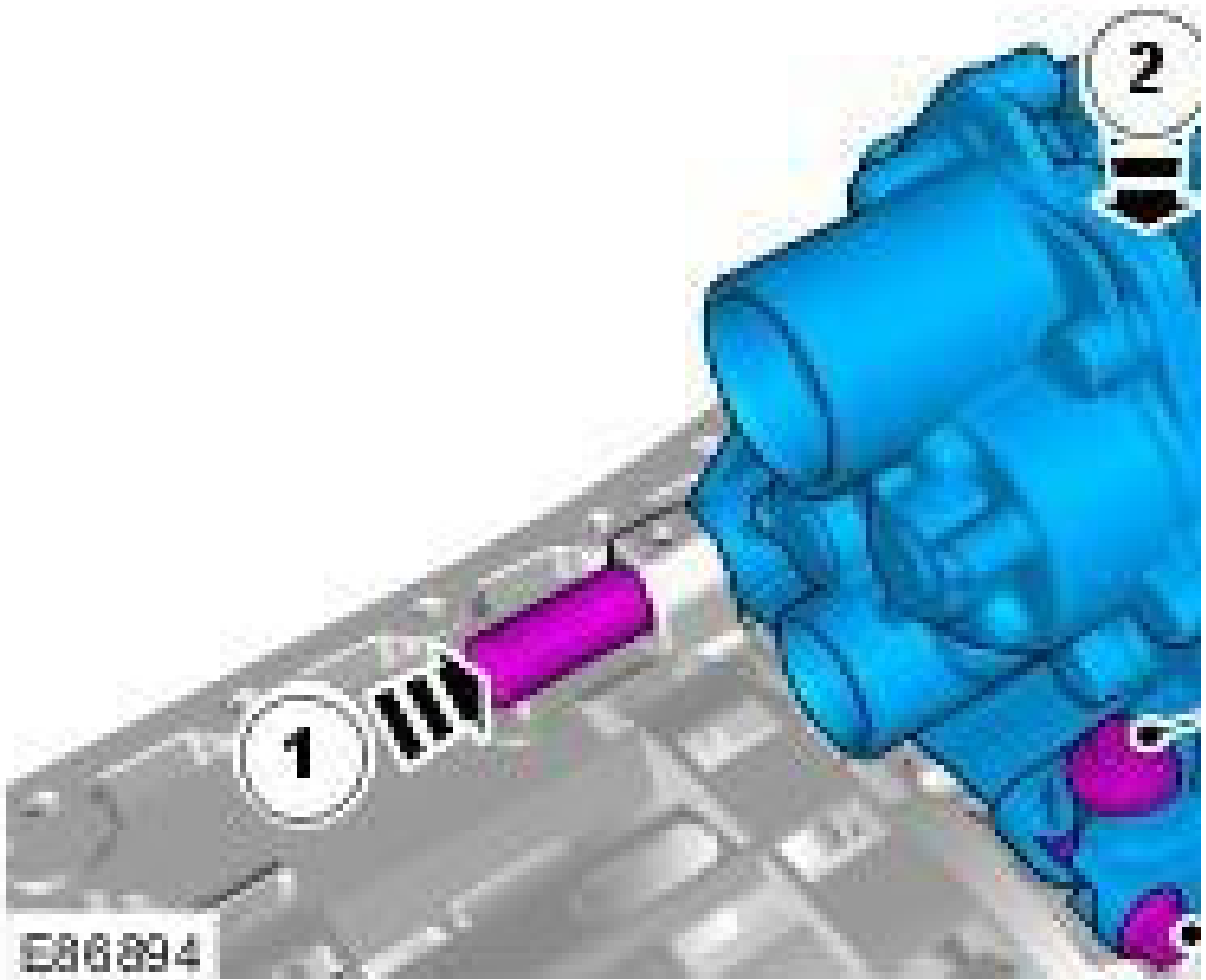
7. Remove the oil pump.



## INSTALLATION



1.
  - The oil pump drive has a coating in one place to set the gear clearance.
  - Plastic pin is used to position the gear for installation. Do Not remove this pin until the oil pump is correctly installed.



2.

- Install the pin.
- Apply light pressure to the pump body.
- Torque: 17 Nm.
- Torque: 10 Nm.

**CAUTION: "Make sure that a new component is installed. "**

3. Remove the oil pump locking pin.

**NOTE:** Install new O-ring seals.

**NOTE:** Lubricate new seals with clean engine oil.

4. Install the oil pressure pipe.

Torque: 17 Nm.

**CAUTION:** A new O-ring seal is to be installed.

**NOTE:** Lubricate new seals with clean engine oil.

5. Install the oil strainer pick-up assembly.

Torque: 17 Nm.

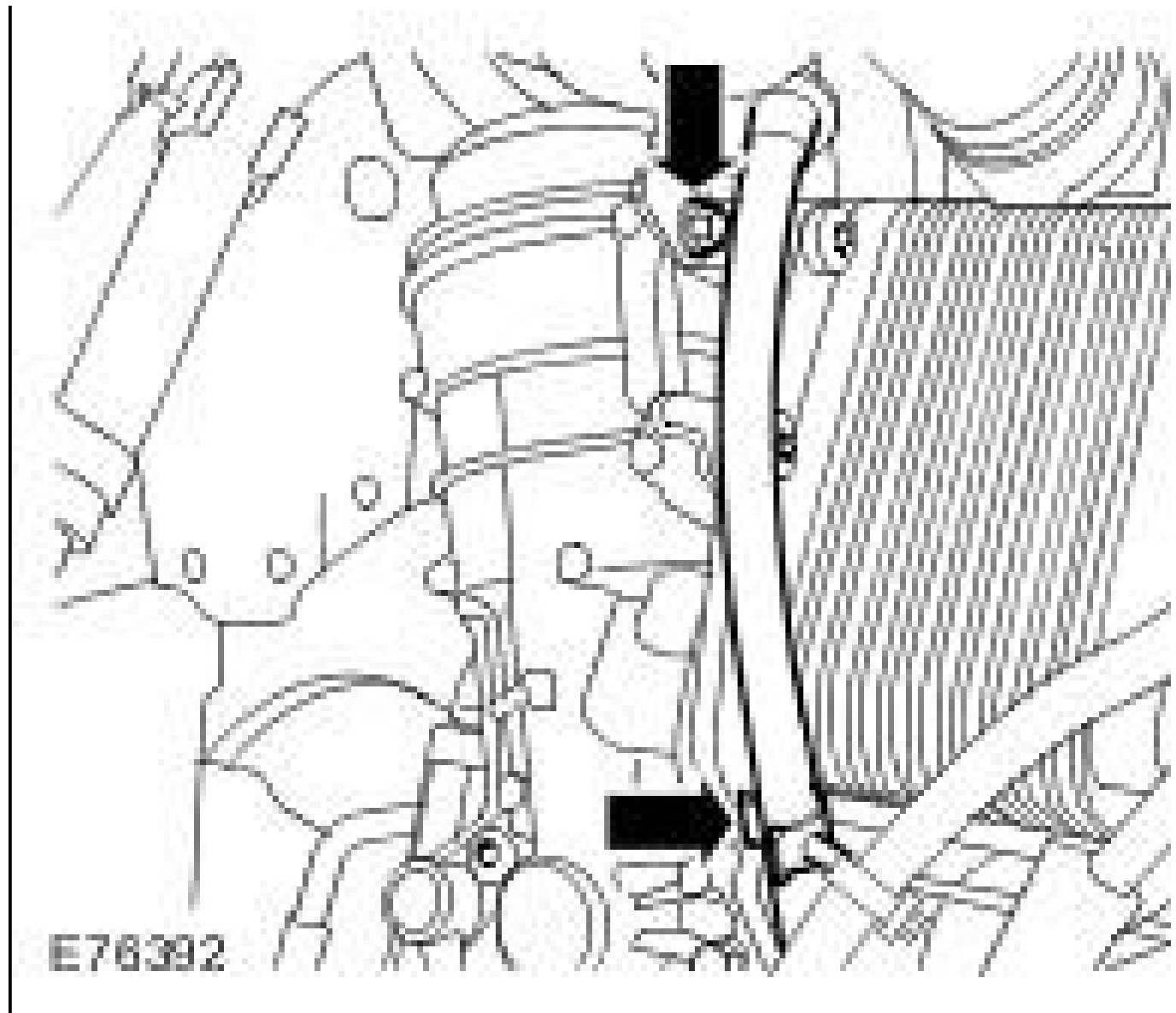
6. Install the oil pan. See **Oil Pan**.
7. Connect the battery ground cable and install the cover. Refer to **Specifications** .

## OIL COOLER

### REMOVAL

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

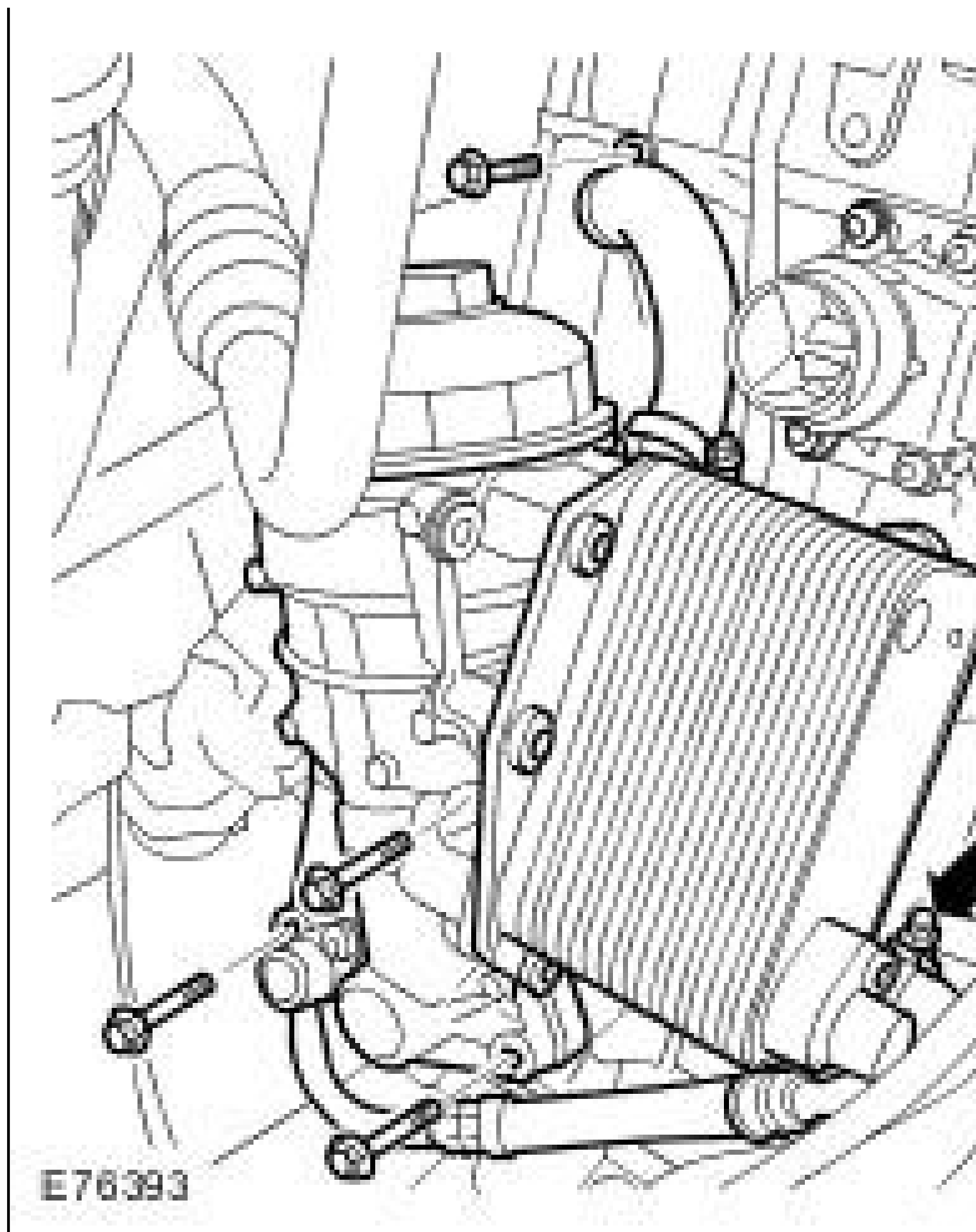
1. Raise and support the vehicle.
2. Drain the cooling system. Refer to **Cooling System Draining, Filling and Bleeding** .
3. Remove the intake manifold assembly. See **Intake Manifold**.
4. Remove the dipstick tube.



5. Loosen the element cover 4 complete turns to allow engine oil to drain from the filter cover.

**CAUTION: Be prepared to collect escaping oil.**

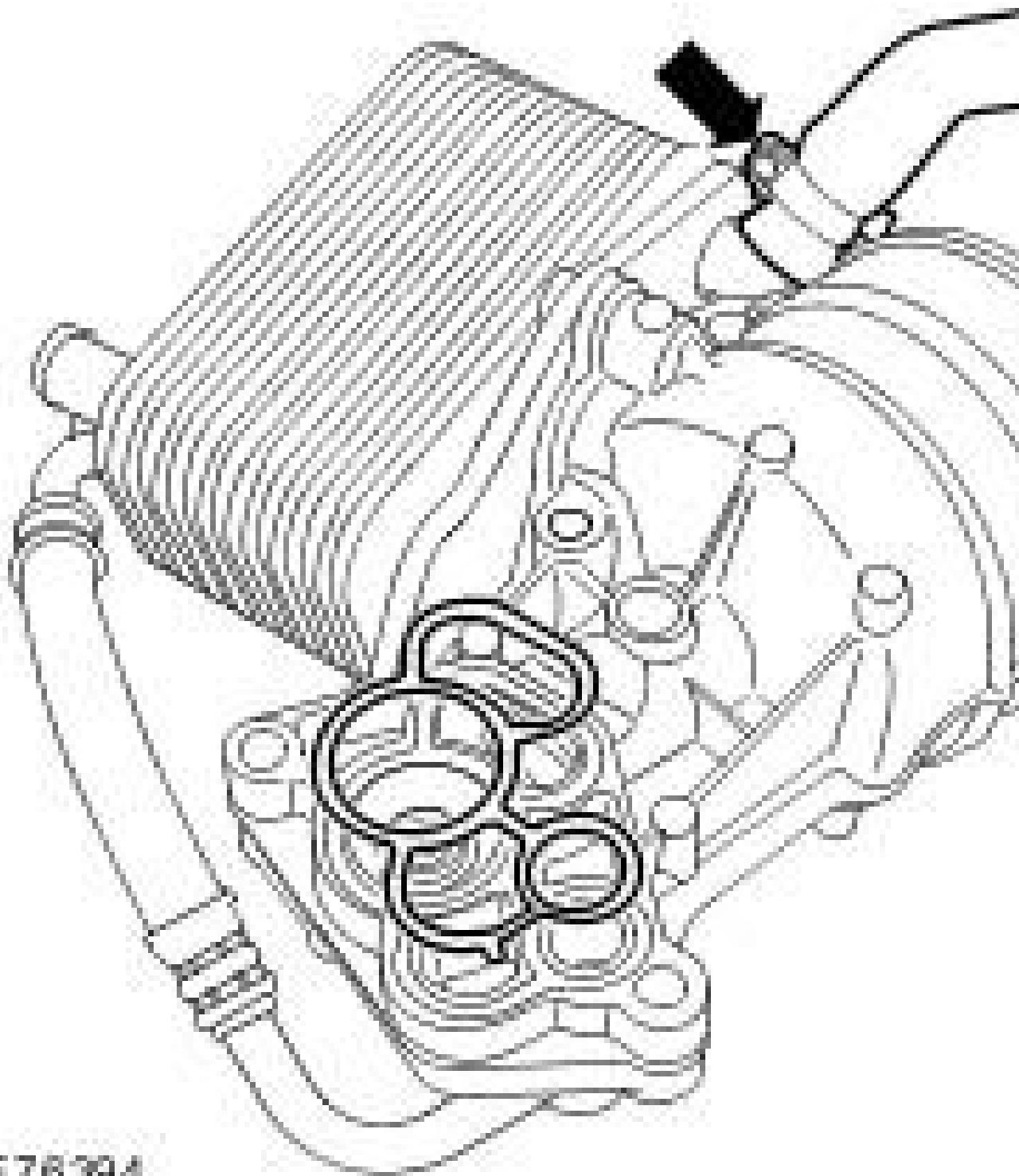
6. Remove the oil filter assembly.



7. Remove and discard the gasket.

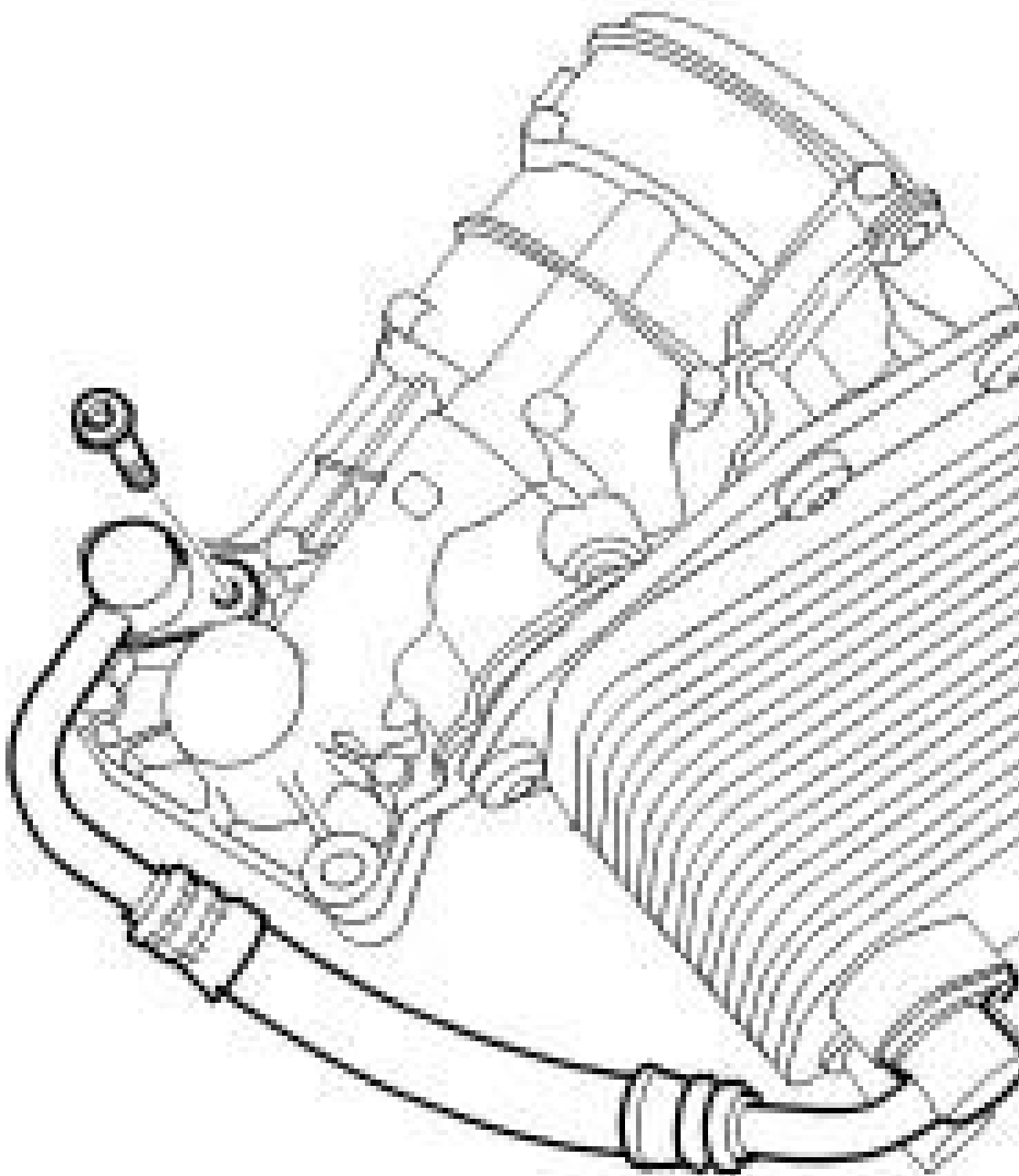
**NOTE:** Do not disassemble further if the component is removed for access only.

8. Remove the coolant hose.



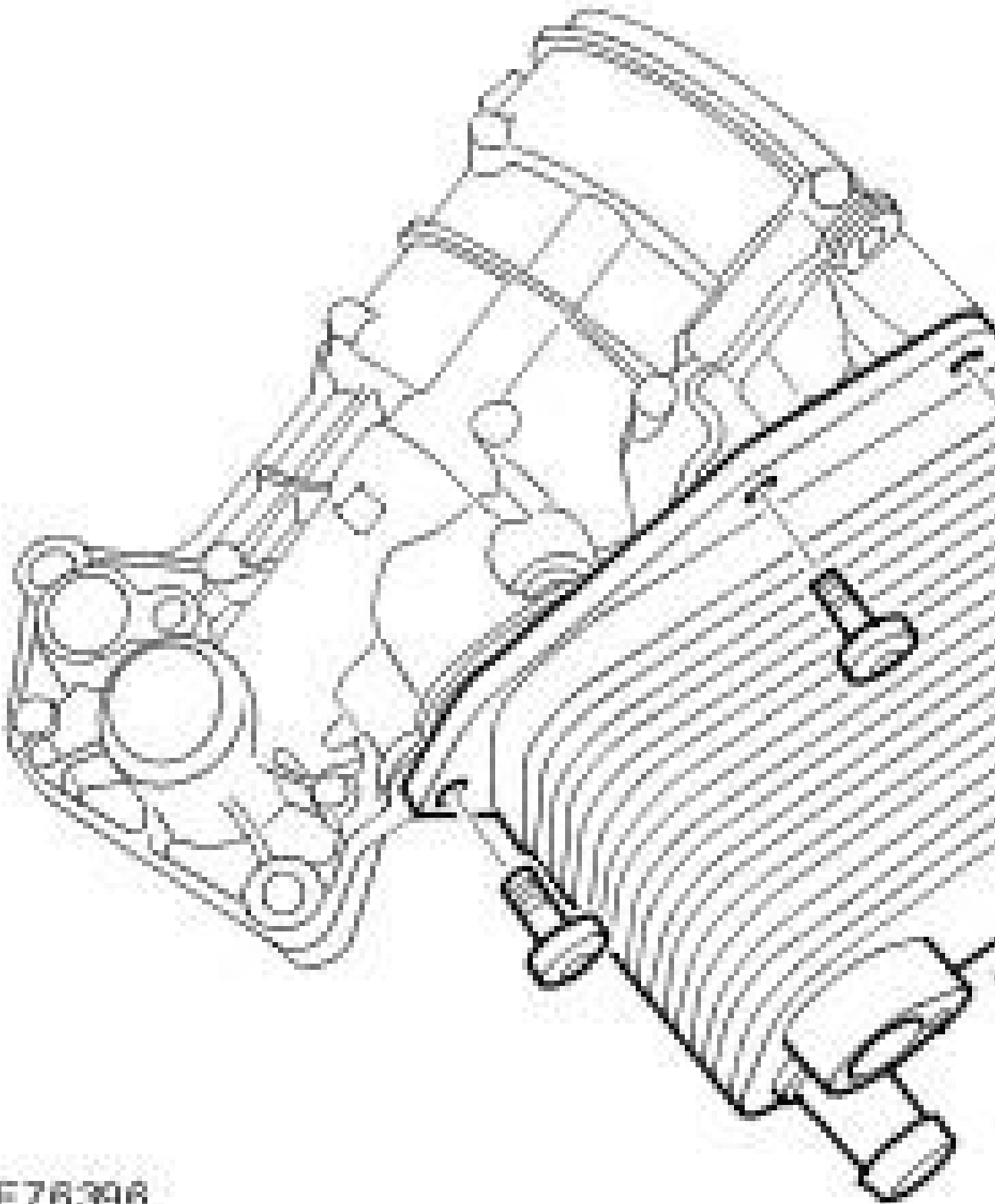
E76394

9. Remove the hose and discard the seals.



E76395

10. Remove the oil cooler.



E76396

11. Remove and discard the 2 gaskets.

## INSTALLATION

1. Install new gaskets.
2. Install the engine oil cooler.

Torque: 10

3. Install the hose.

Torque: 10 Nm.

4. Install and tighten the engine oil filter.

Torque: 5 Nm.

5. Install the coolant hose.
6. Install the new gasket.
7. Install the dipstick tube.

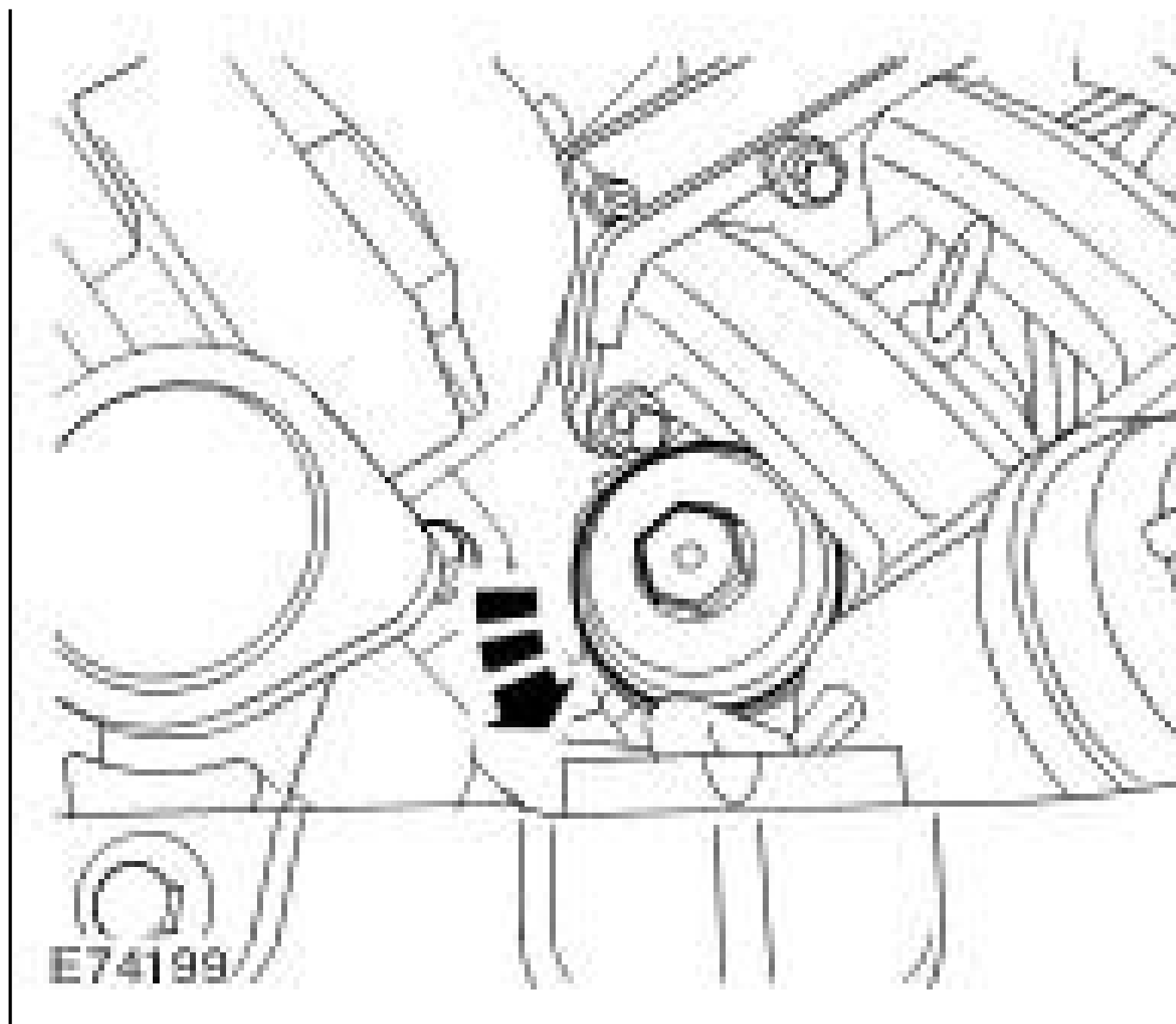
Torque: 10 Nm.

8. Install the intake manifold assembly. See **Intake Manifold**.
9. Fill and bleed the cooling system. Refer to **Cooling System Draining, Filling and Bleeding**.
10. Check and top-up the engine oil if required.

## OIL FILTER ELEMENT

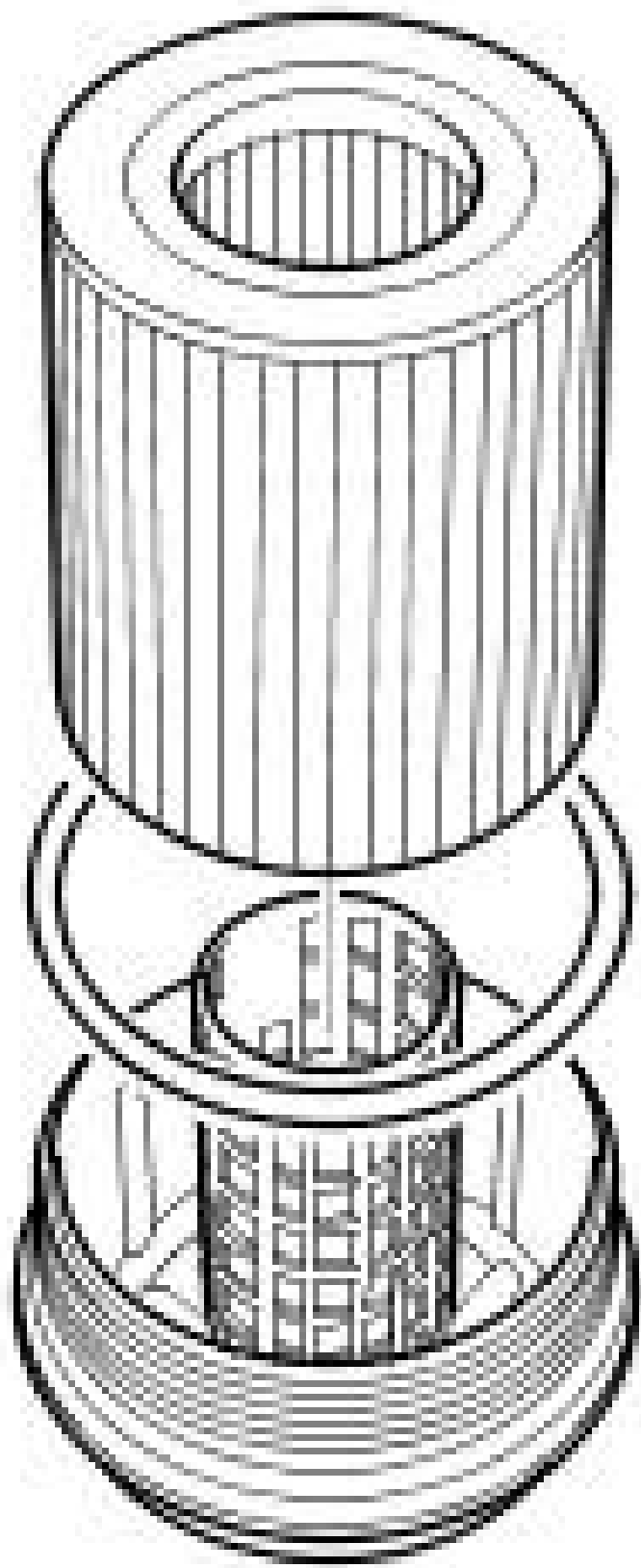
### REMOVAL

1. Release the PAS fluid reservoir from the bracket and tie aside.
2. Loosen the element cover 4 complete turns to allow engine oil to drain from the filter cover.



3. See figure.





E74200

**INSTALLATION**

1. Install the oil filter element.
2. Install the engine oil filter.

Torque: 25

3. Secure the reservoir.
4. Check and top-up the engine oil.

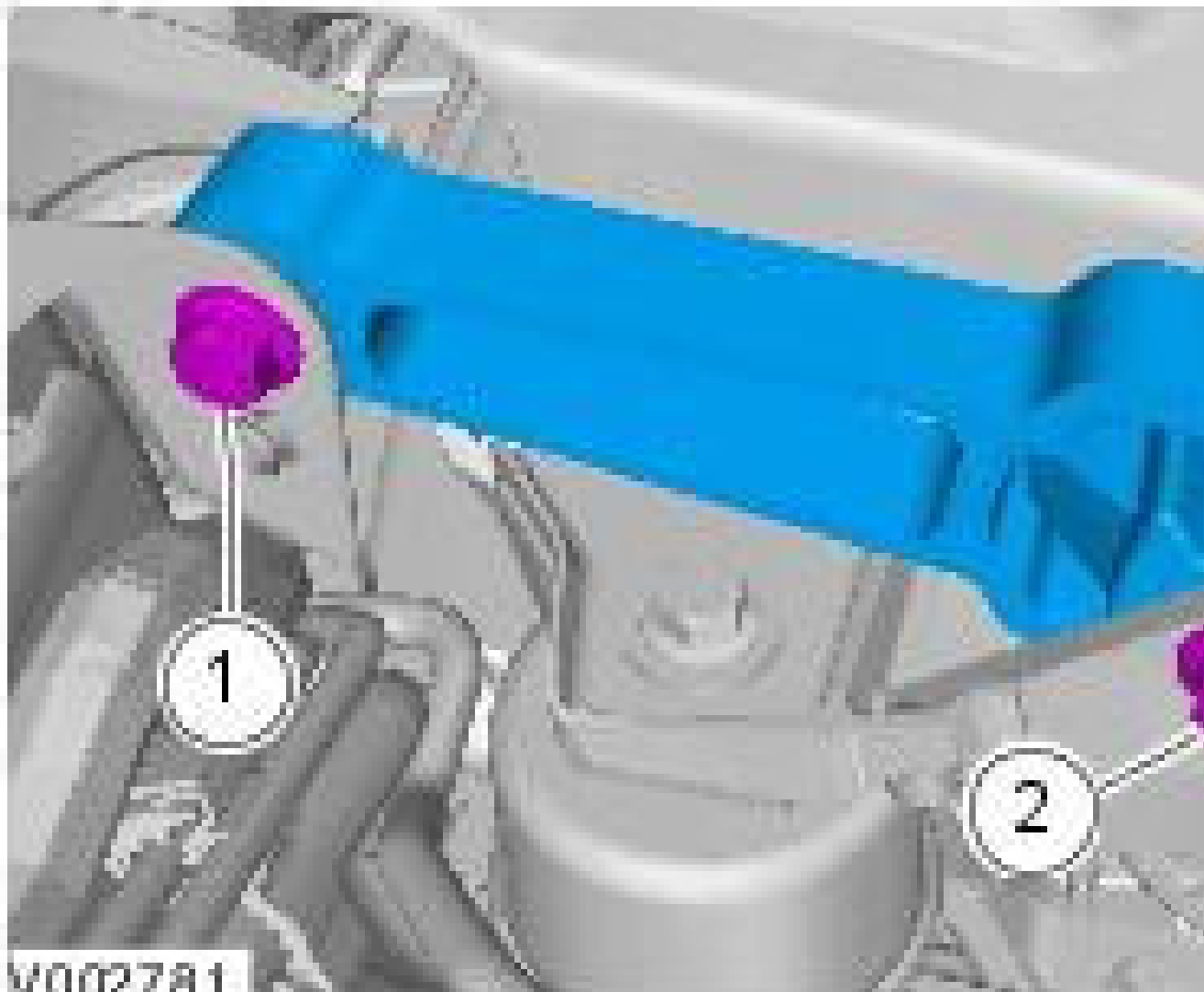
**ENGINE UPPER SUPPORT INSULATOR****REMOVAL**

**NOTE:** Removal steps in this procedure may contain installation details.

1. Torque: 10 Nm.



2. Torque: 110 Nm.



#### INSTALLATION

1. To install, reverse the removal procedure.

#### ENGINE LOWER SUPPORT INSULATOR

#### REMOVAL

**NOTE:** Removal steps in this procedure may contain installation details.

All vehicles

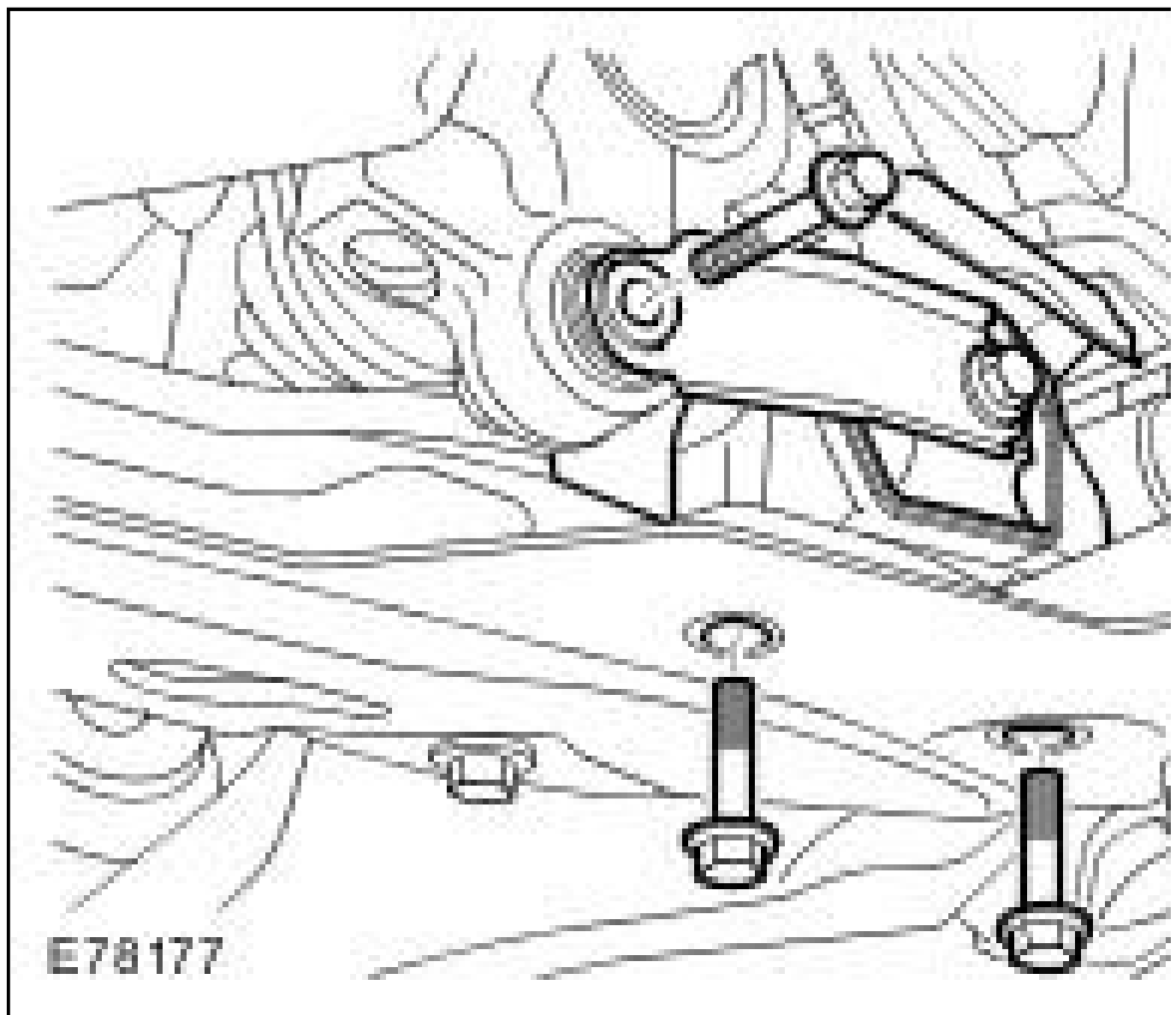
**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the engine undershield. Refer to Engine Undershield .

**CAUTION:** Make sure that these components are installed to the noted removal position.

3. Remove the lower support insulator.

Torque: 110 Nm.

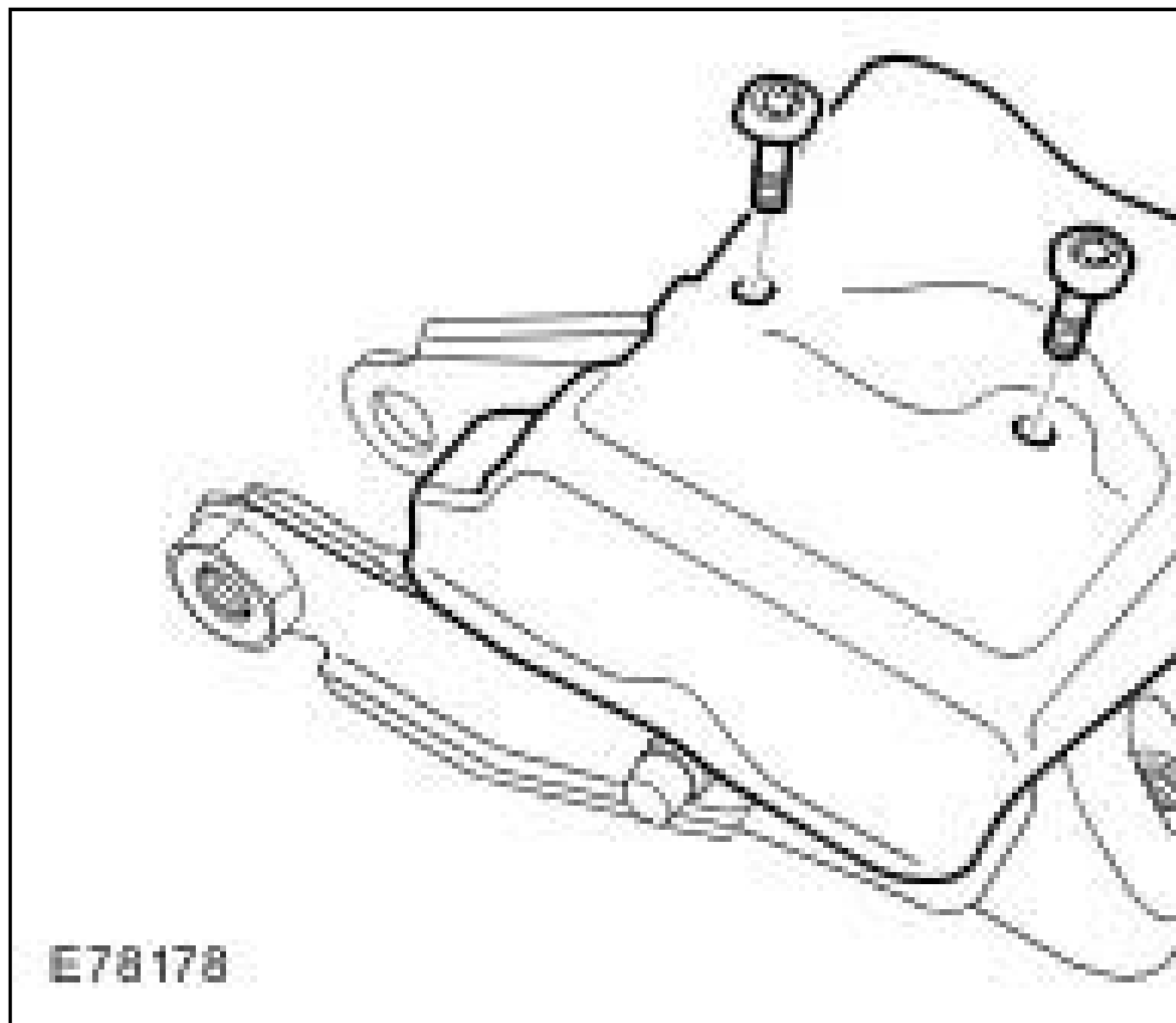


**Vehicles with petrol engine**

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

1. Remove the heat shield.

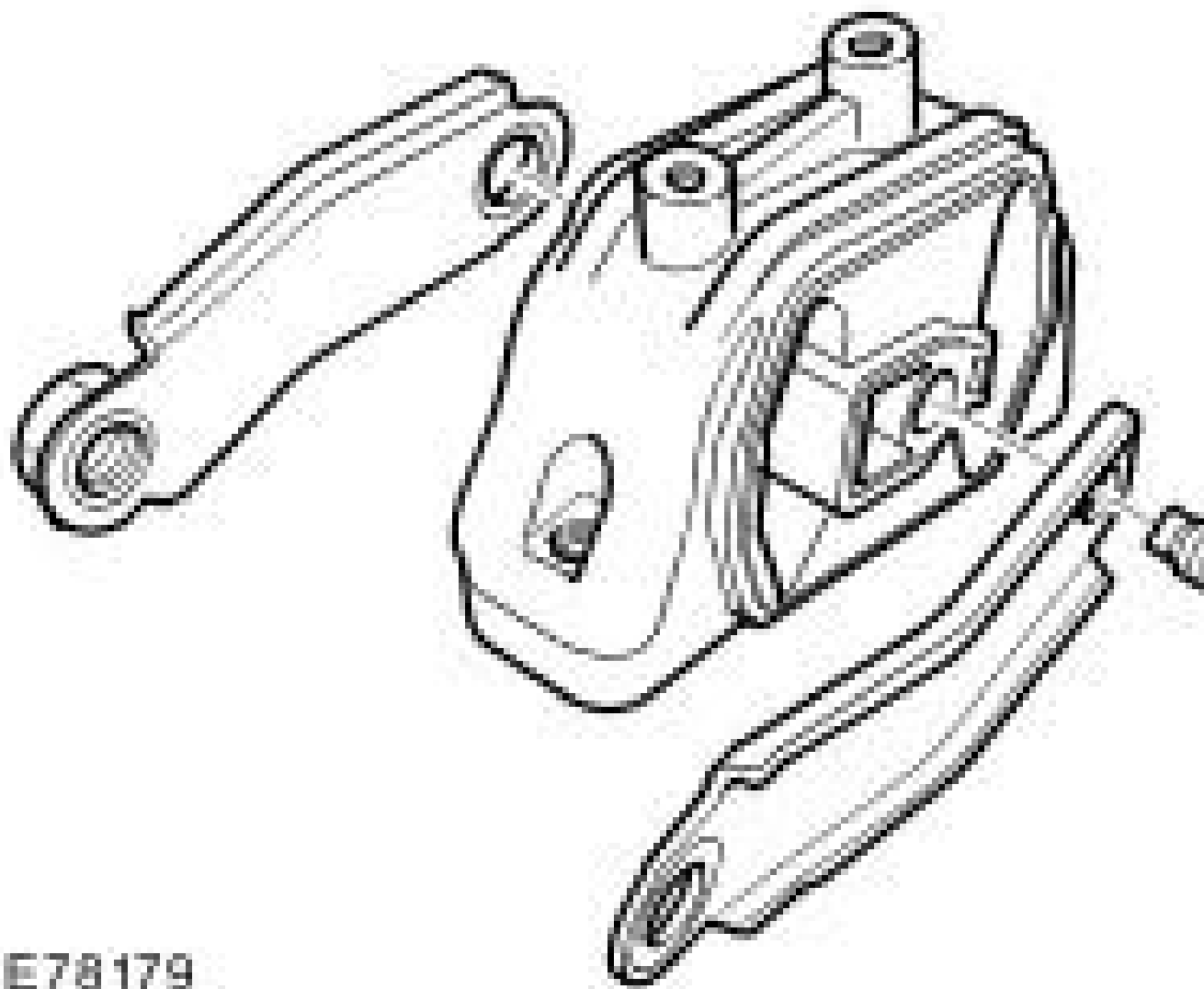
Torque: 10 Nm.



#### All vehicles

1. Remove the engine mount link brackets.

Torque: 110 Nm.



#### INSTALLATION

1. To install, reverse the removal procedure.

#### ENGINE MOUNT LH

#### REMOVAL

**NOTE:** Removal steps in this procedure may contain installation details.

**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the engine undershield. Refer to **Engine Undershield** .
3. Support the transmission.
4. Remove the air cleaner assembly. Refer to **Air Cleaner** .
5. Remove the battery tray. Refer to **Battery Tray** .

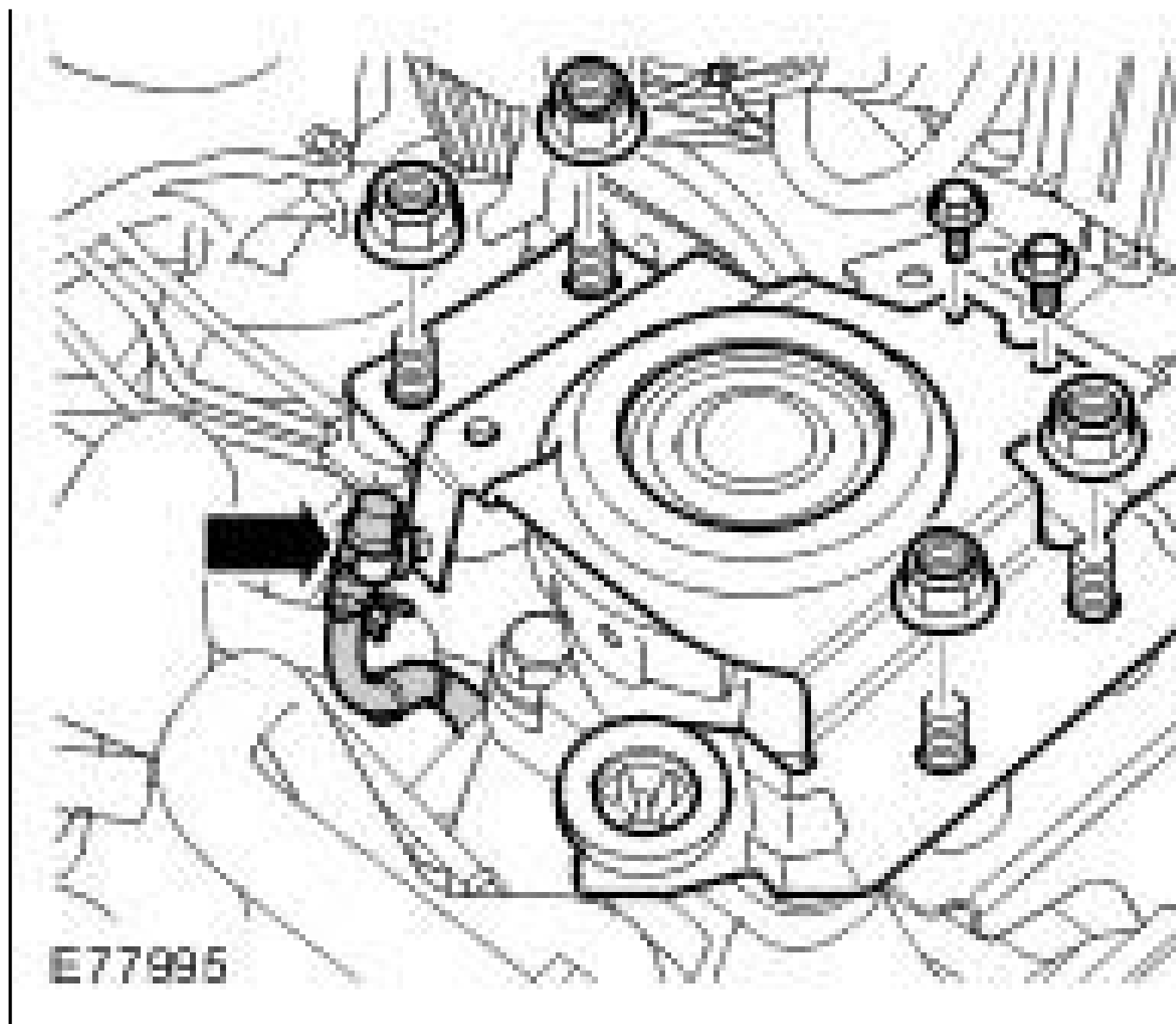
**WARNING: Make sure that new nuts are installed.**

**NOTE: Vehicles with automatic transmission have a breather pipe attached to the mounting.**

6. Remove the bracket.

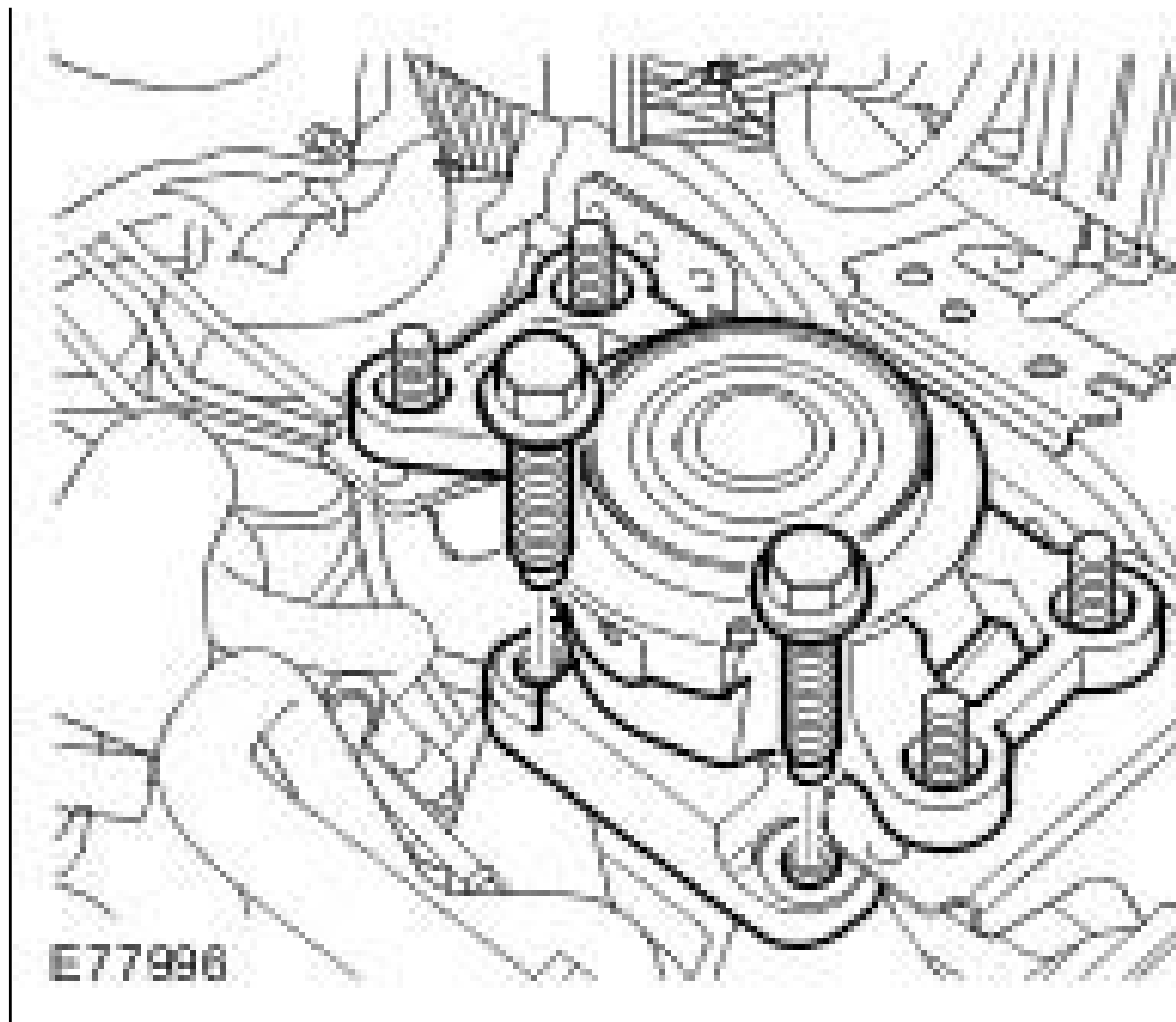
M12 Torque: - 80 Nm.

M8 Torque: - 25 Nm.



7. Remove the engine mount LH.

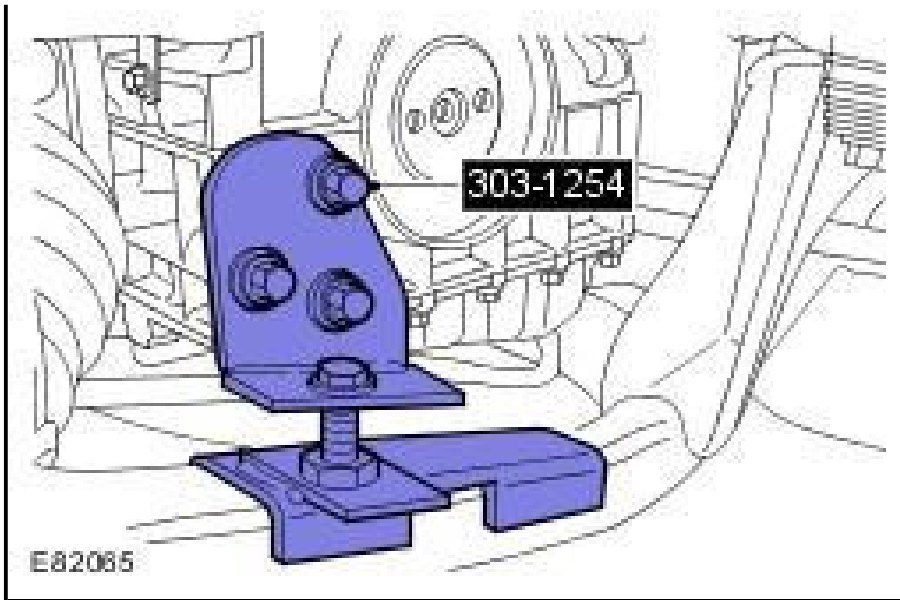
Torque: 175 Nm.

**INSTALLATION**

1. To install, reverse the removal procedure.

**ENGINE MOUNT RH****Special Tool(s)**

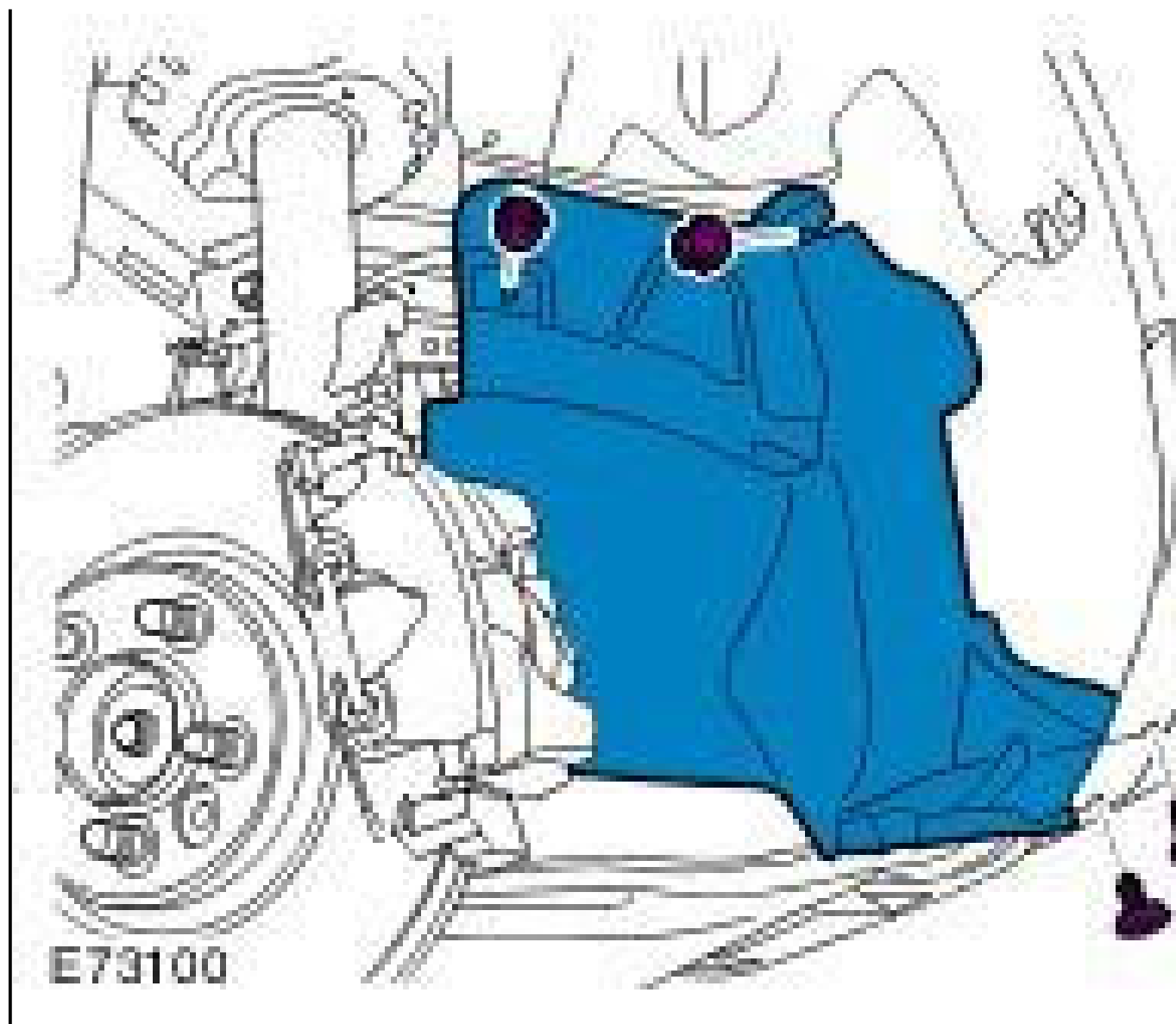
|  |                          |
|--|--------------------------|
|  | 303-1254 Support, Engine |
|--|--------------------------|

**REMOVAL**

**NOTE:** Removal steps in this procedure may contain installation details.

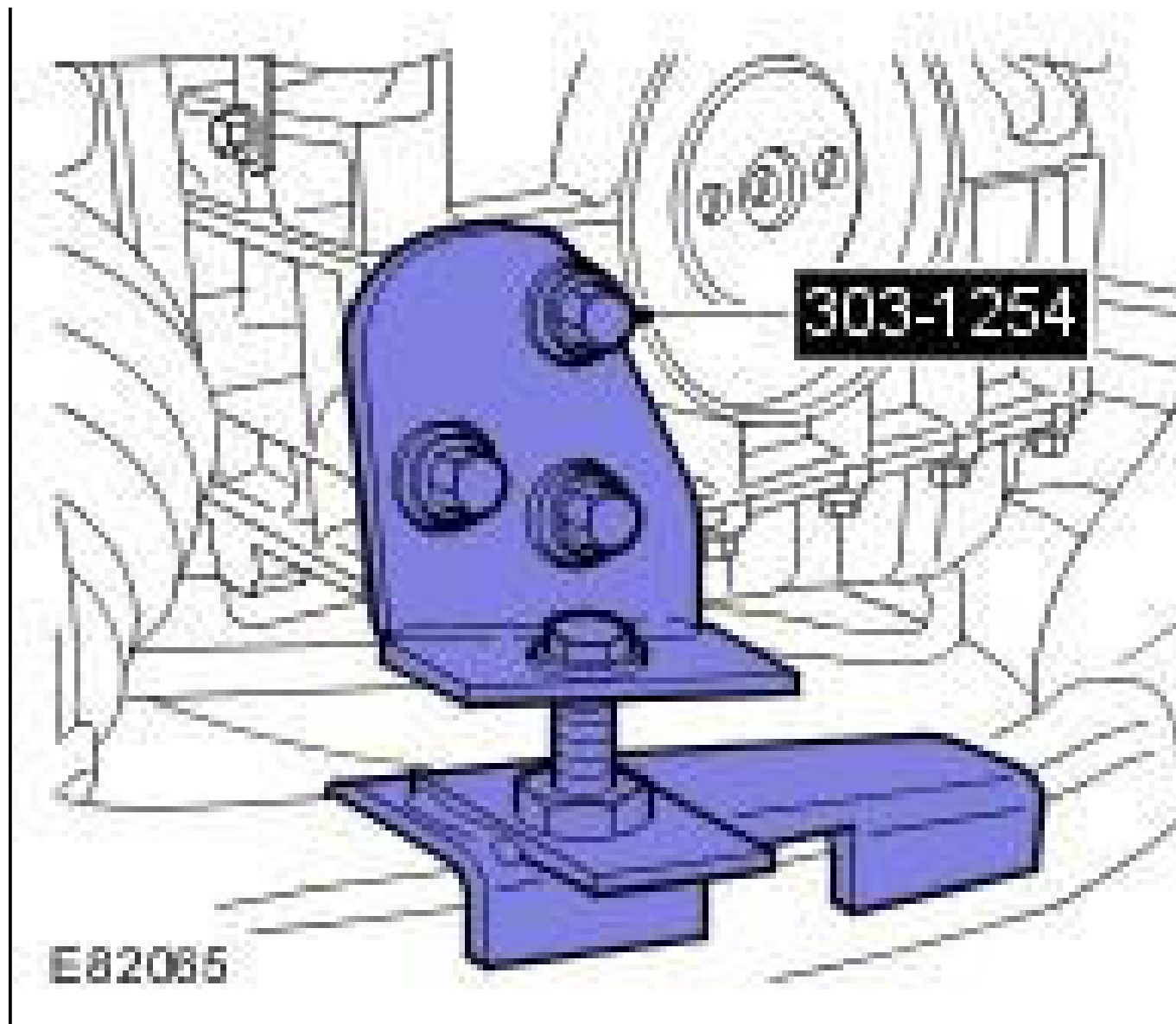
**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the engine undershield. Refer to **Engine Undershield** .
3. Remove the RH front wheel and tire. Refer to **Wheel and Tire** .
4. Remove the fender splash shield extension panel.



5. Support the engine.

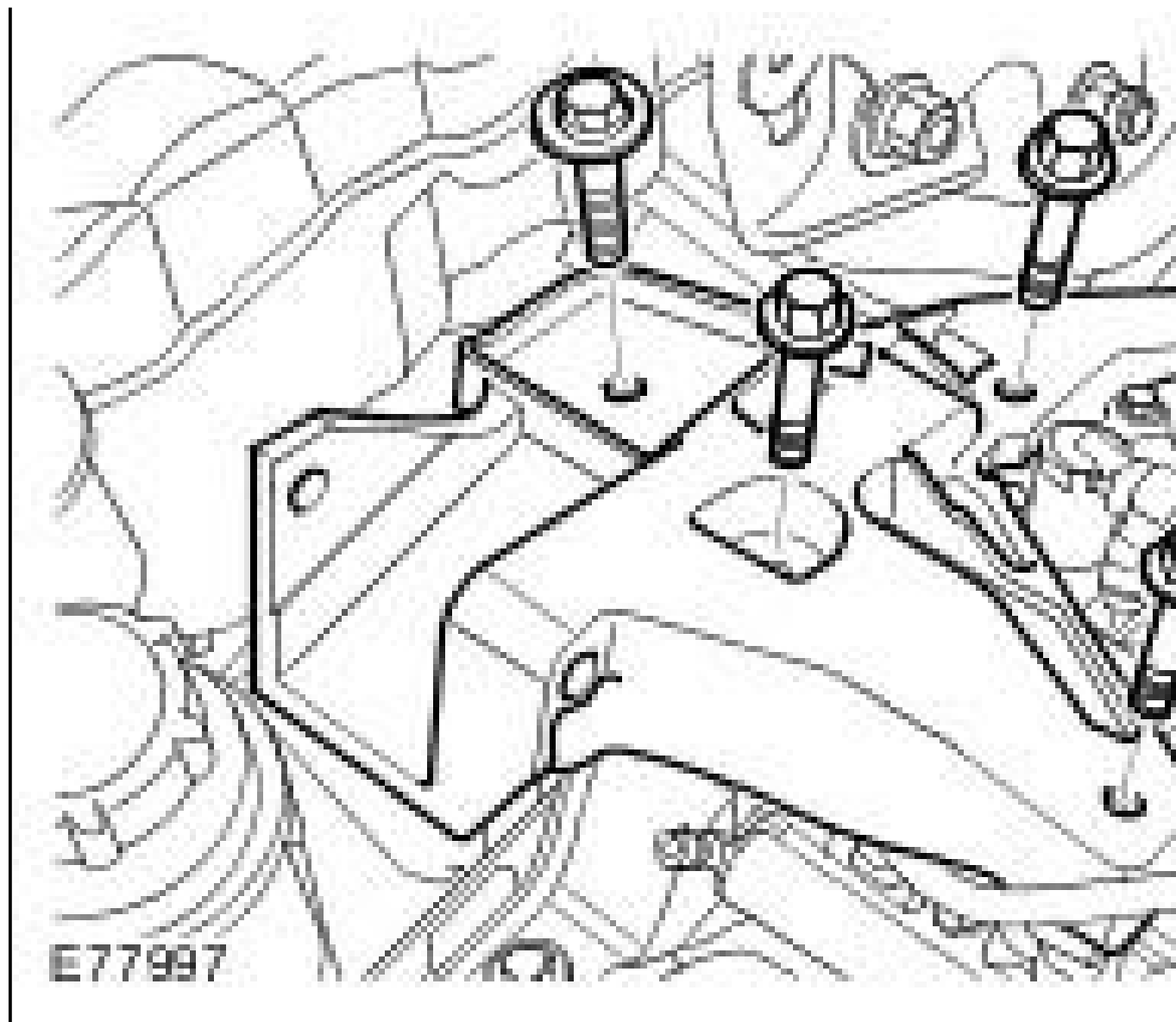
Support, Engine (303-1254)



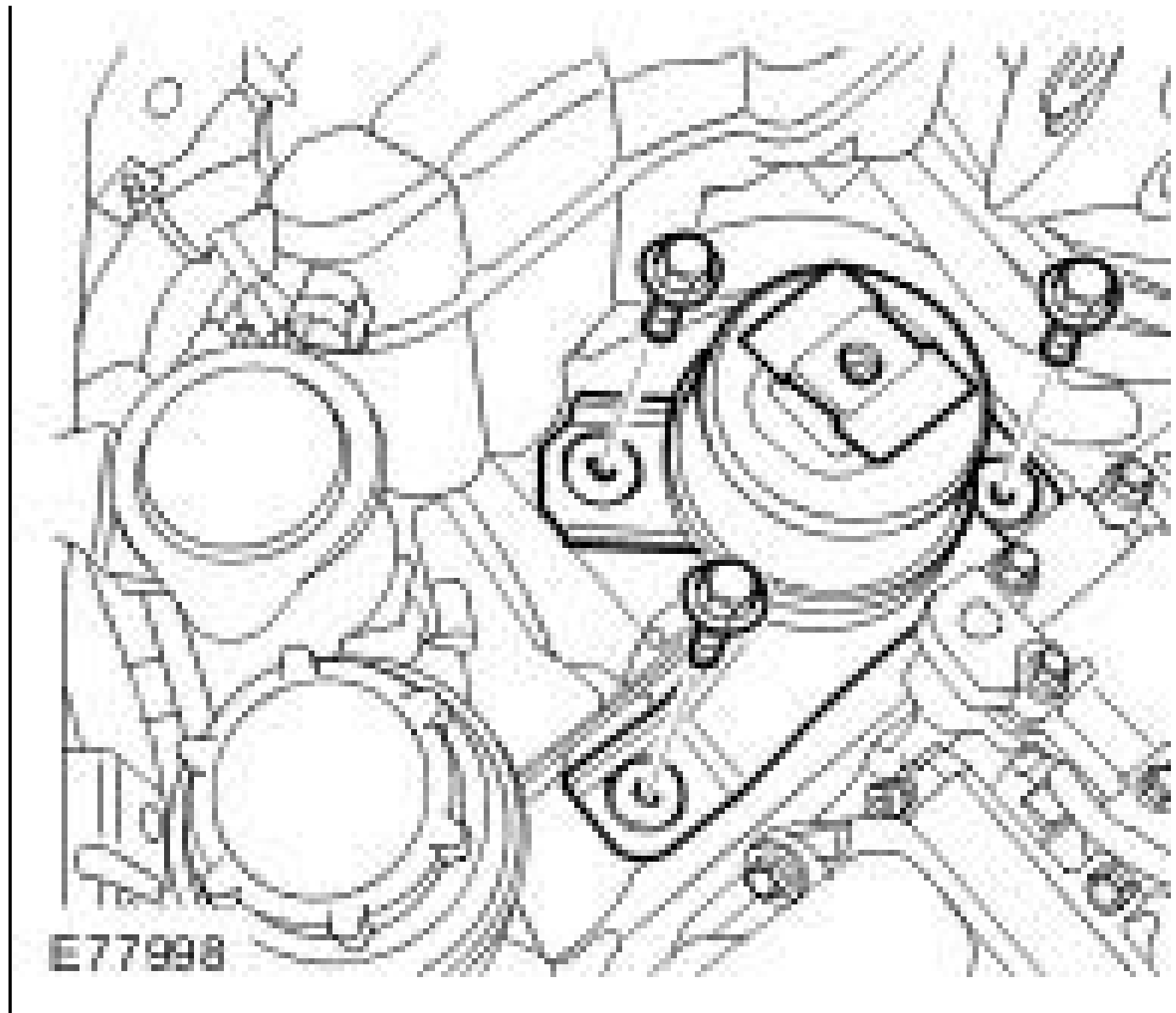
6. Remove the engine cover. Refer to **Engine Cover - 3.2L**.
7. Remove the stabilizer bar. See **Engine Upper Support Insulator**.
8. Torque:

M10: - 45 Nm.

M12: - 80 Nm.



9. Torque: 80 Nm.

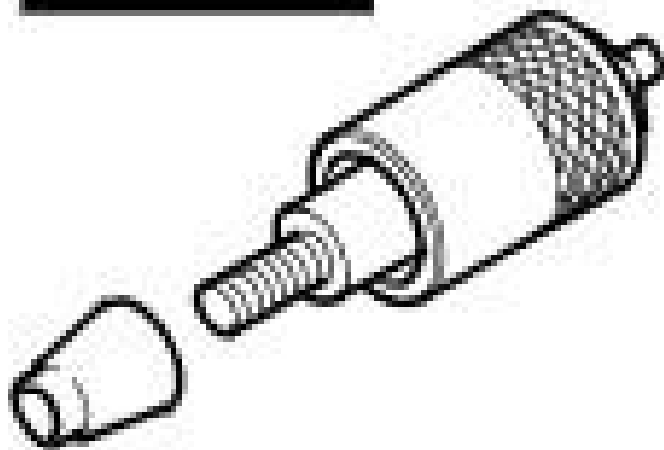
**INSTALLATION**

1. To install, reverse the removal procedure.

**Timing Cover****Special Tool(s)**

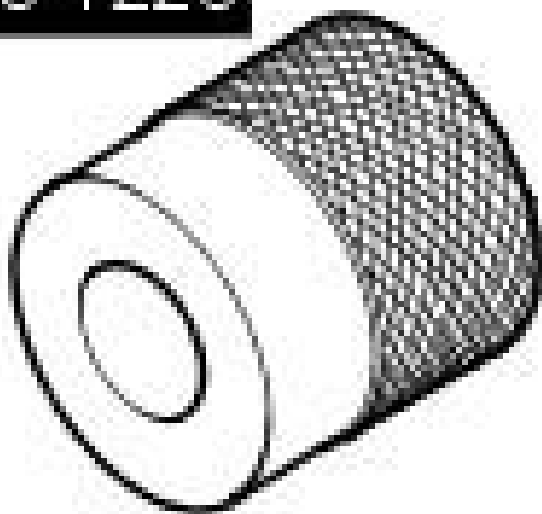
|  |                                          |
|--|------------------------------------------|
|  | 303-1227 Installer, Accessory Drive Seal |
|--|------------------------------------------|

303-1227



E82074

303-1228



E82073

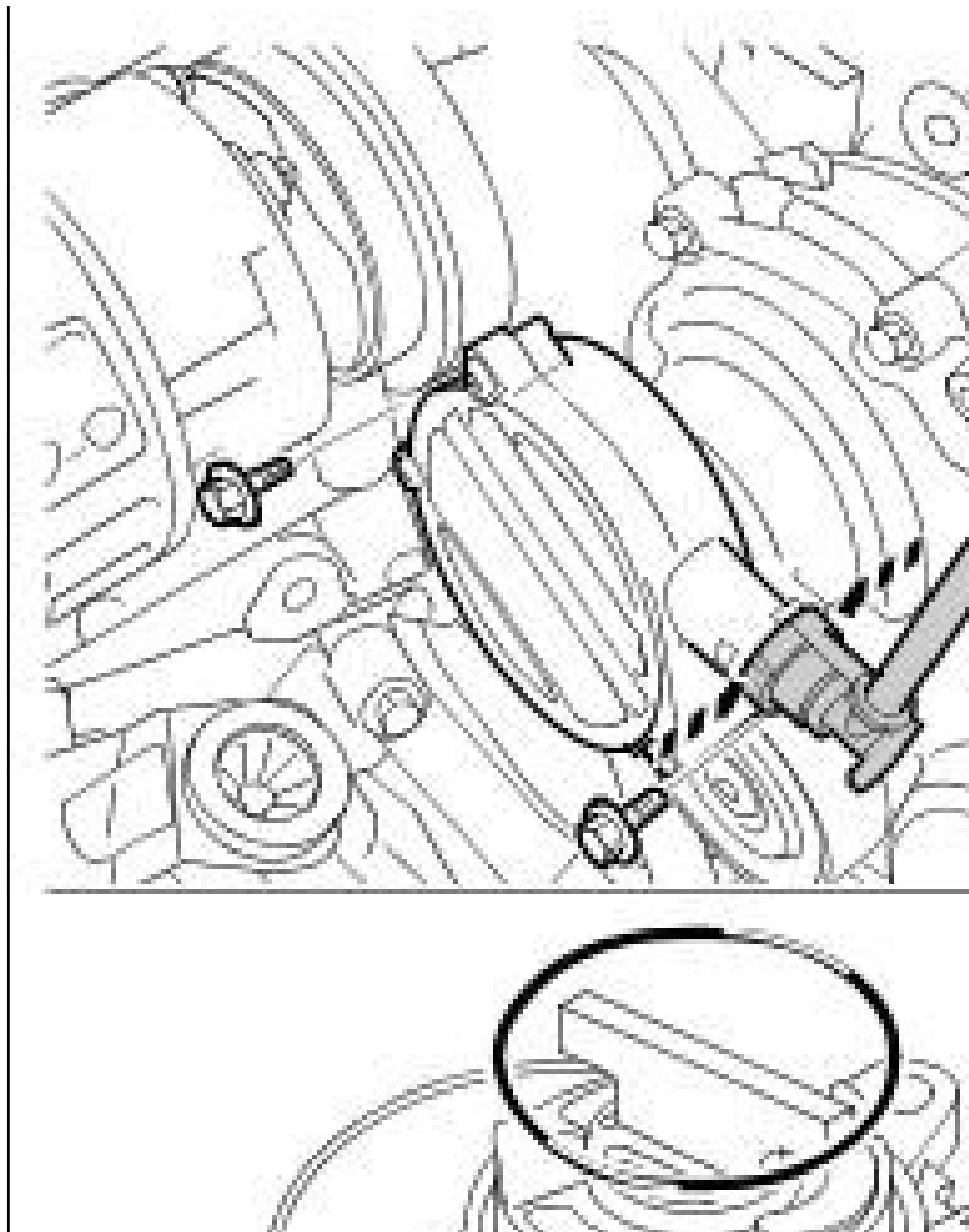
303-1228 Holder, Generator Pulley

**Removal****WARNING:** Make sure to support the vehicle with axle stands.

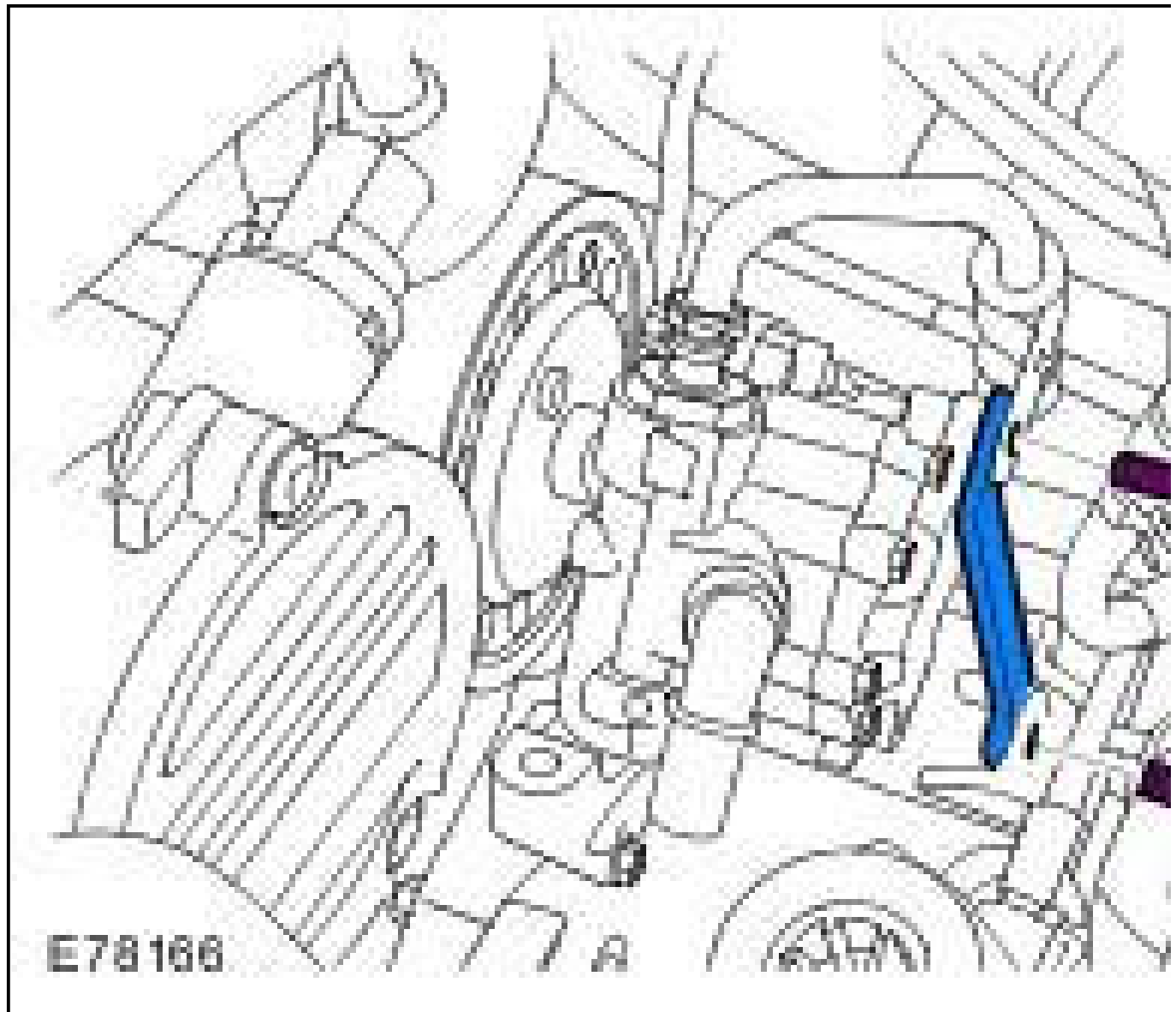
1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable. Refer to **Specifications** .
3. Drain the coolant. Refer to **Cooling System Draining, Filling and Bleeding** .
4. Remove the accessory drive pulley. Refer to **Accessory Drive Pulley** .

**CAUTION: The O-ring seal is to be reused unless damaged.**

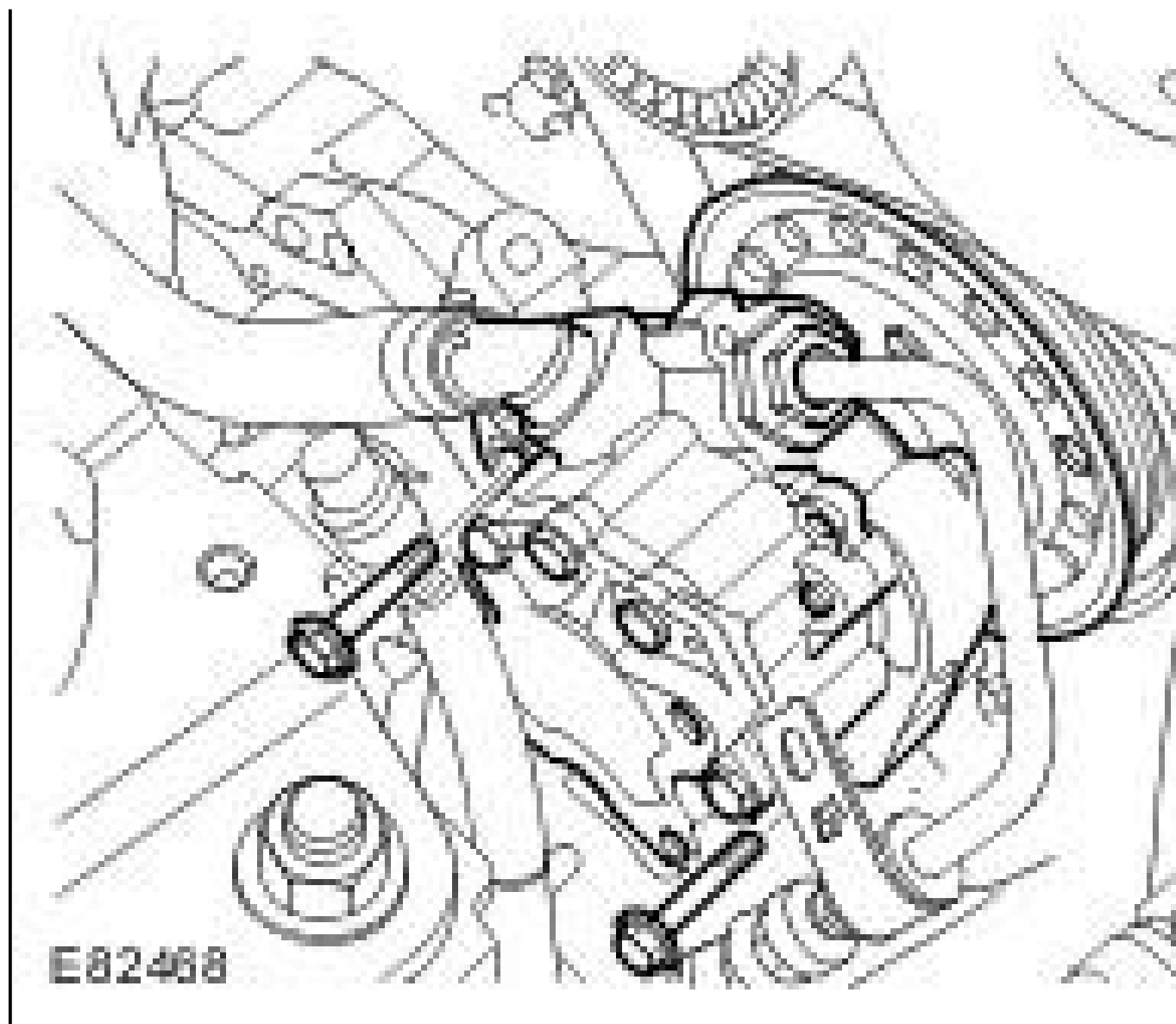
5. Remove the brake vacuum pump.



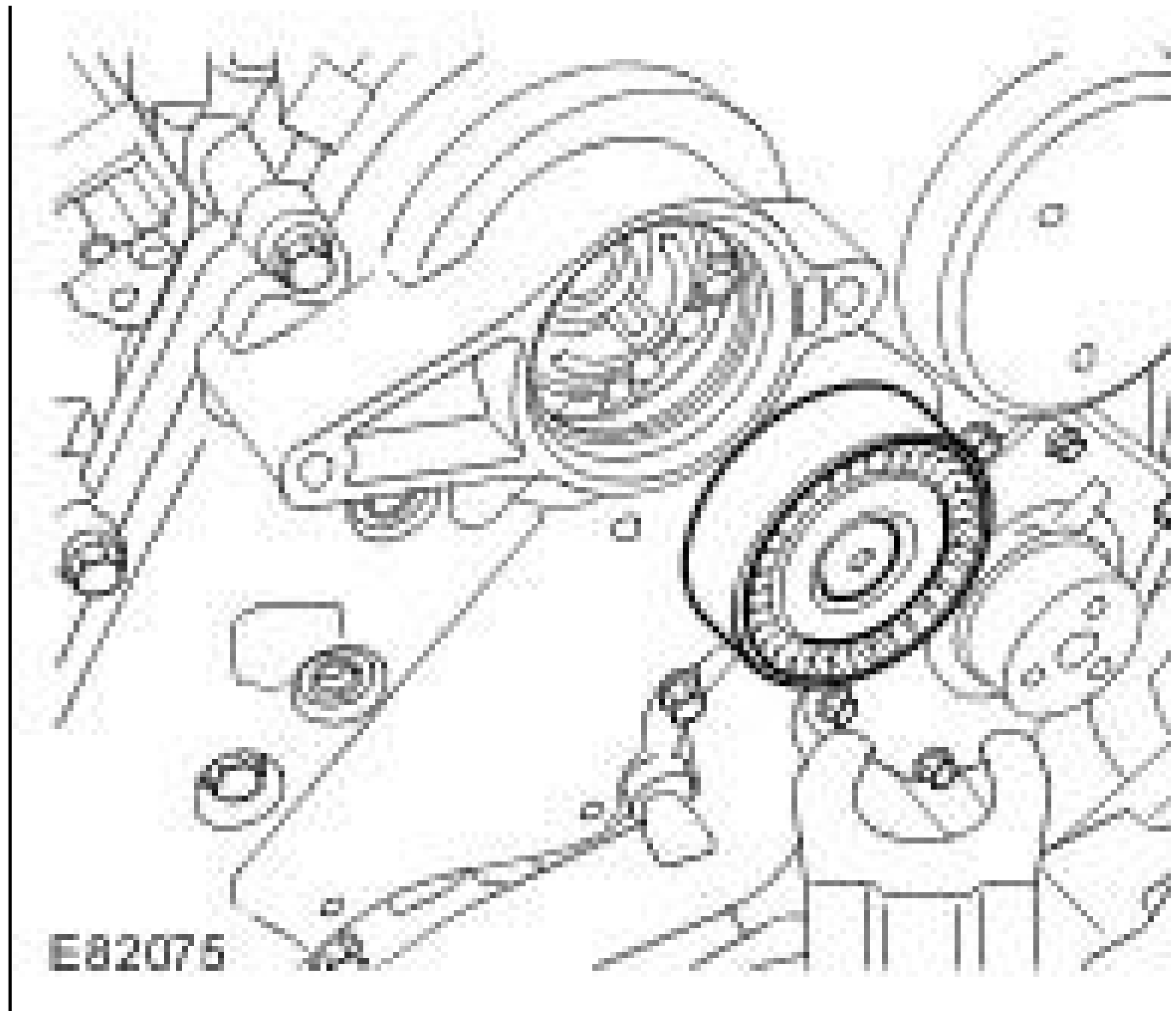
6. Remove the power steering pump support bracket.



7. Release the power steering pump and tie aside

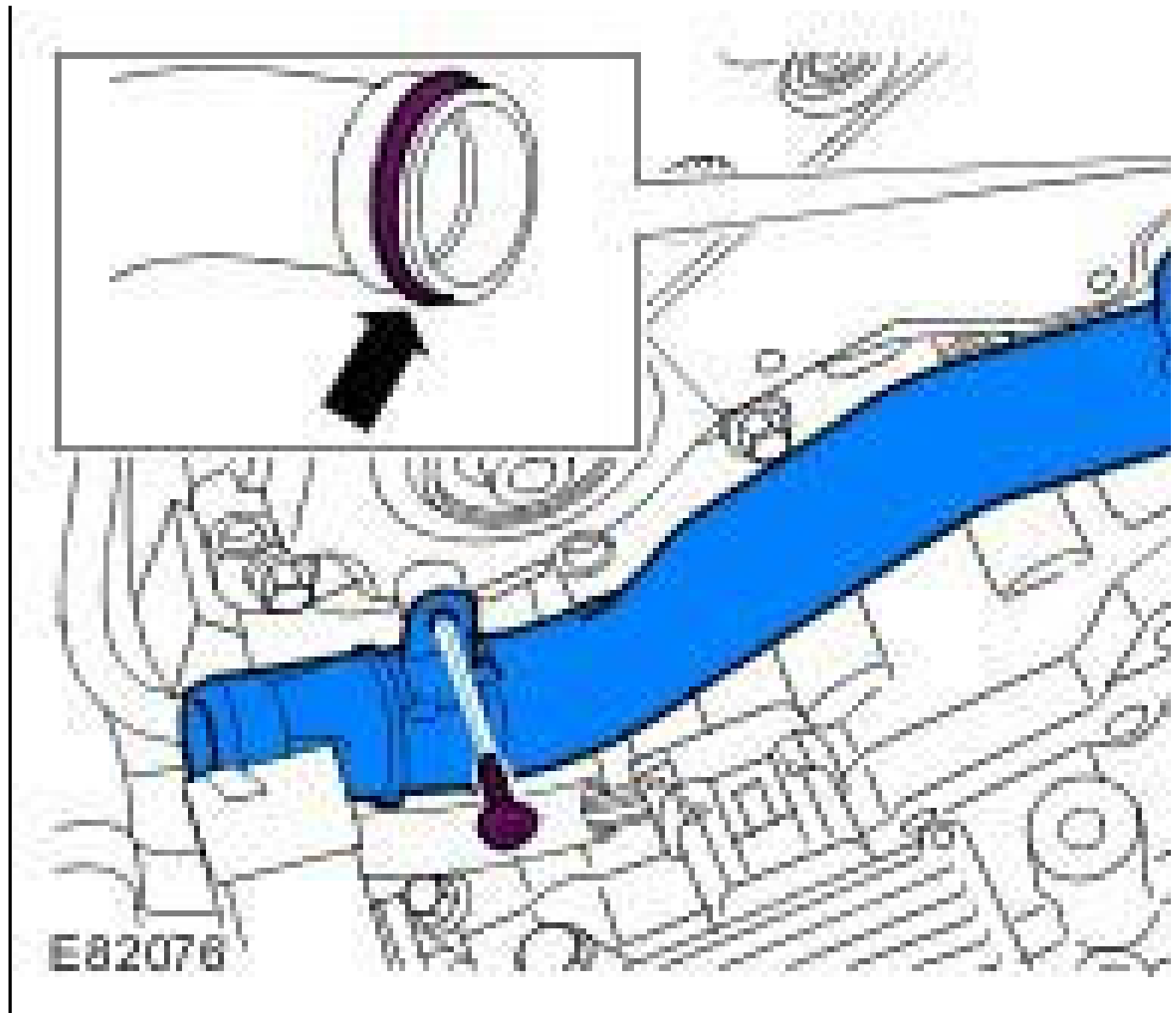


8. Remove the accessory drive belt idler pulley.



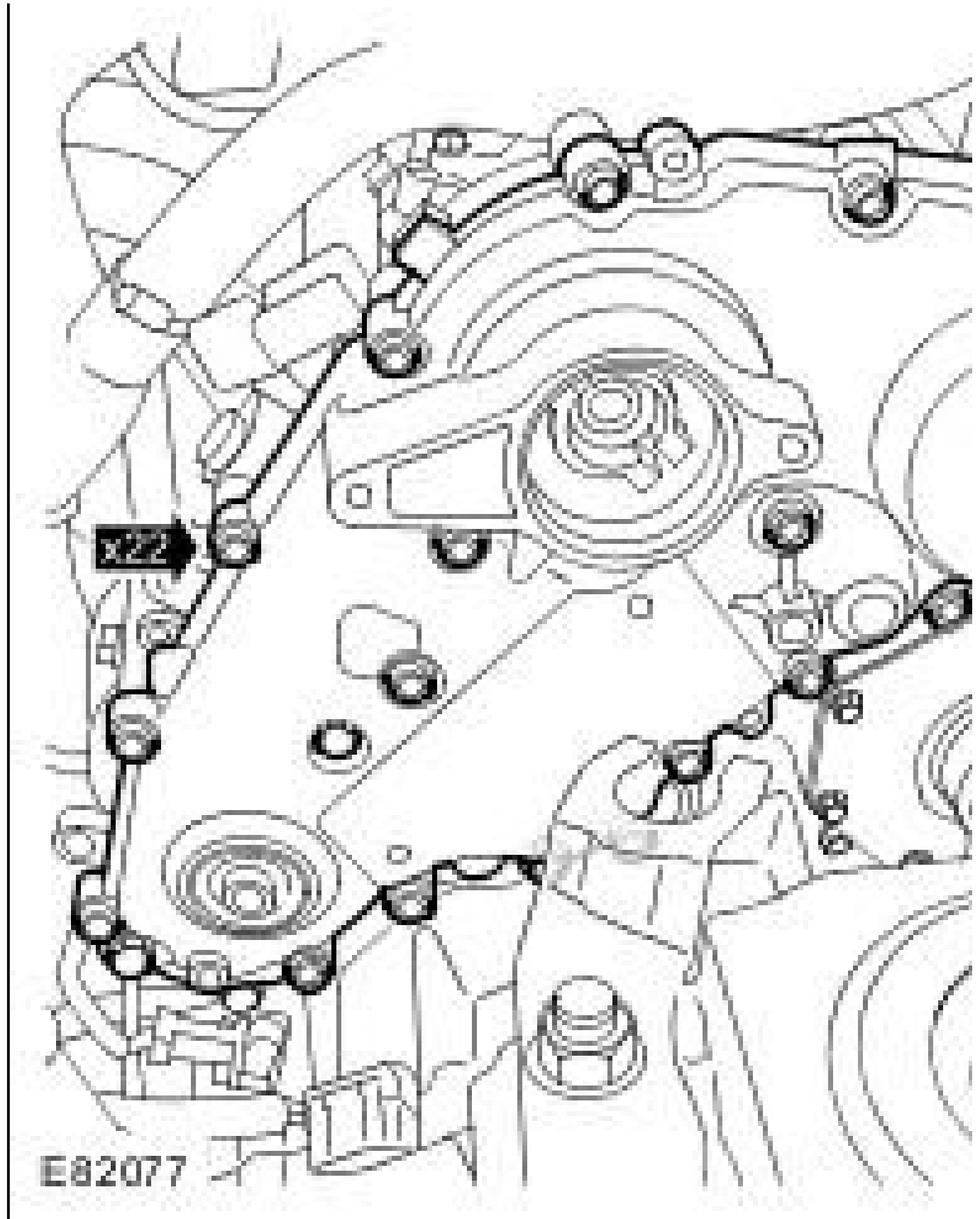
**CAUTION:** The O-ring seal is to be reused unless damaged.

9. Remove the coolant pump inlet pipe.

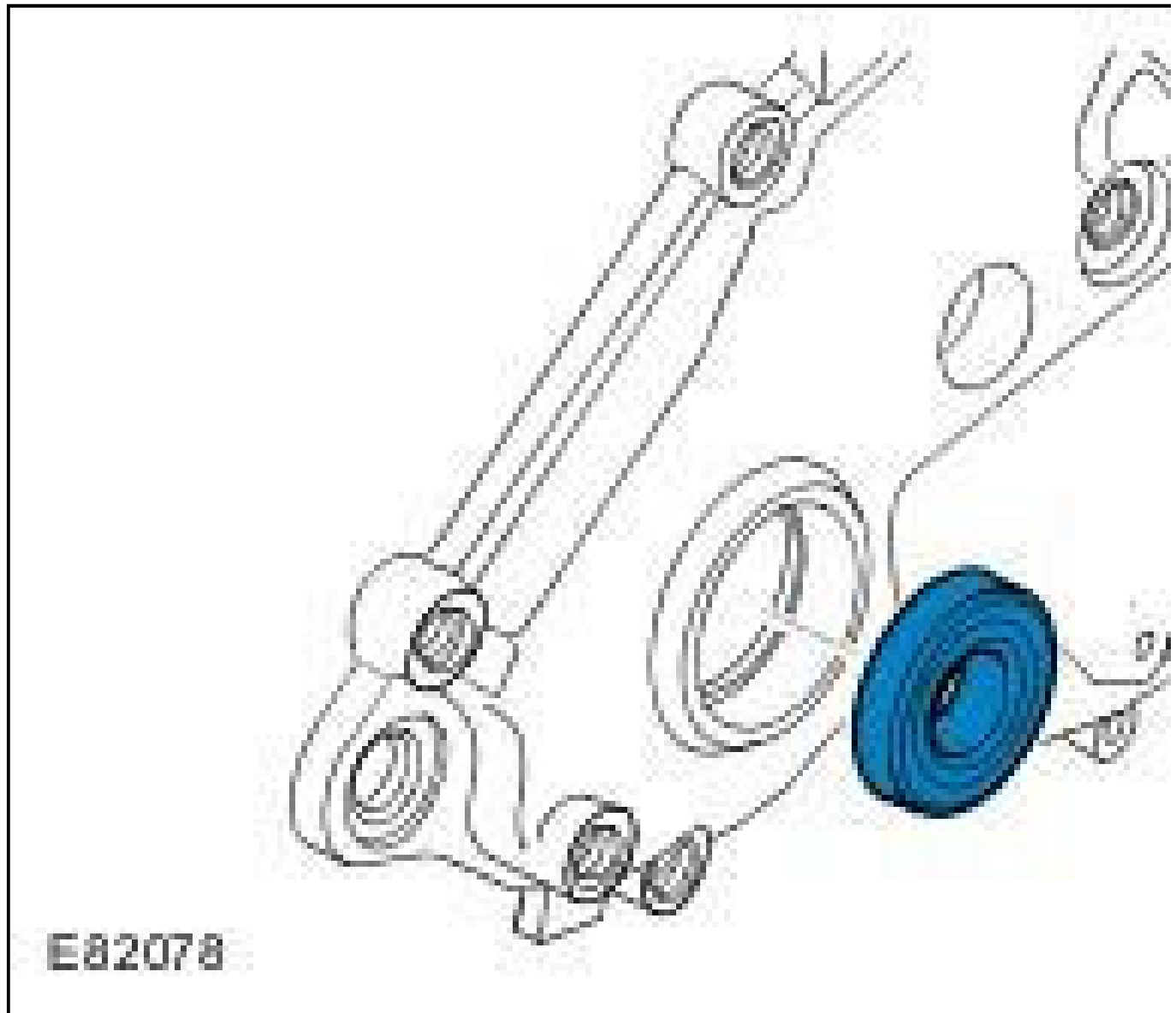


**NOTE:** Note the different lengths of the bolts.

10. Remove the timing cover.



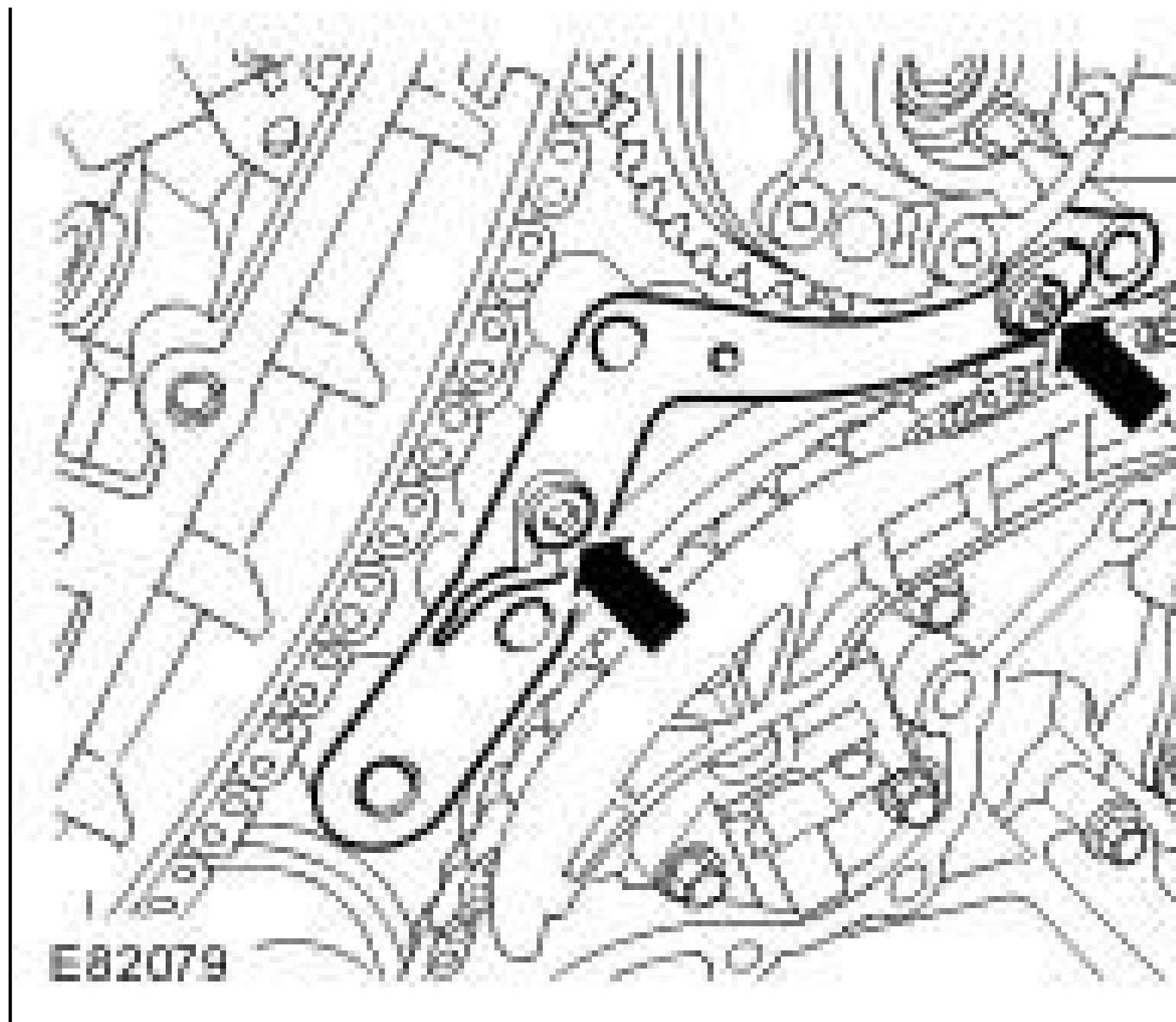
11. Remove and discard the gasket.
12. Remove and discard the seal.



**CAUTION:** Mark the components to aid installation.

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

13. Remove the gasket and oil squirt jet.

**INSTALLATION**

**CAUTION:** Make sure that the component aligns with the installation mark.

1. Install the gasket and oil squirt jet.

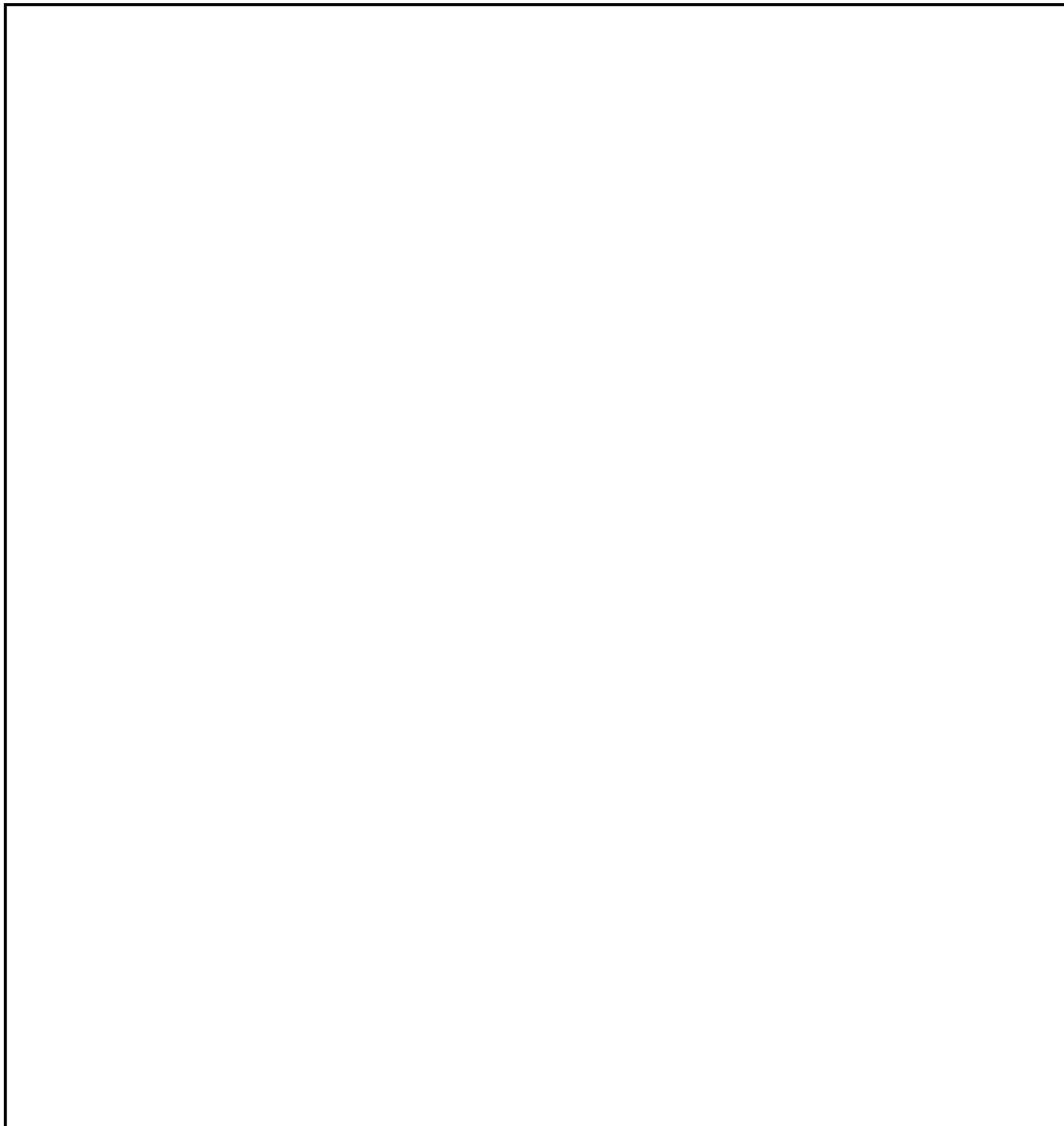
Torque: 6 Nm.

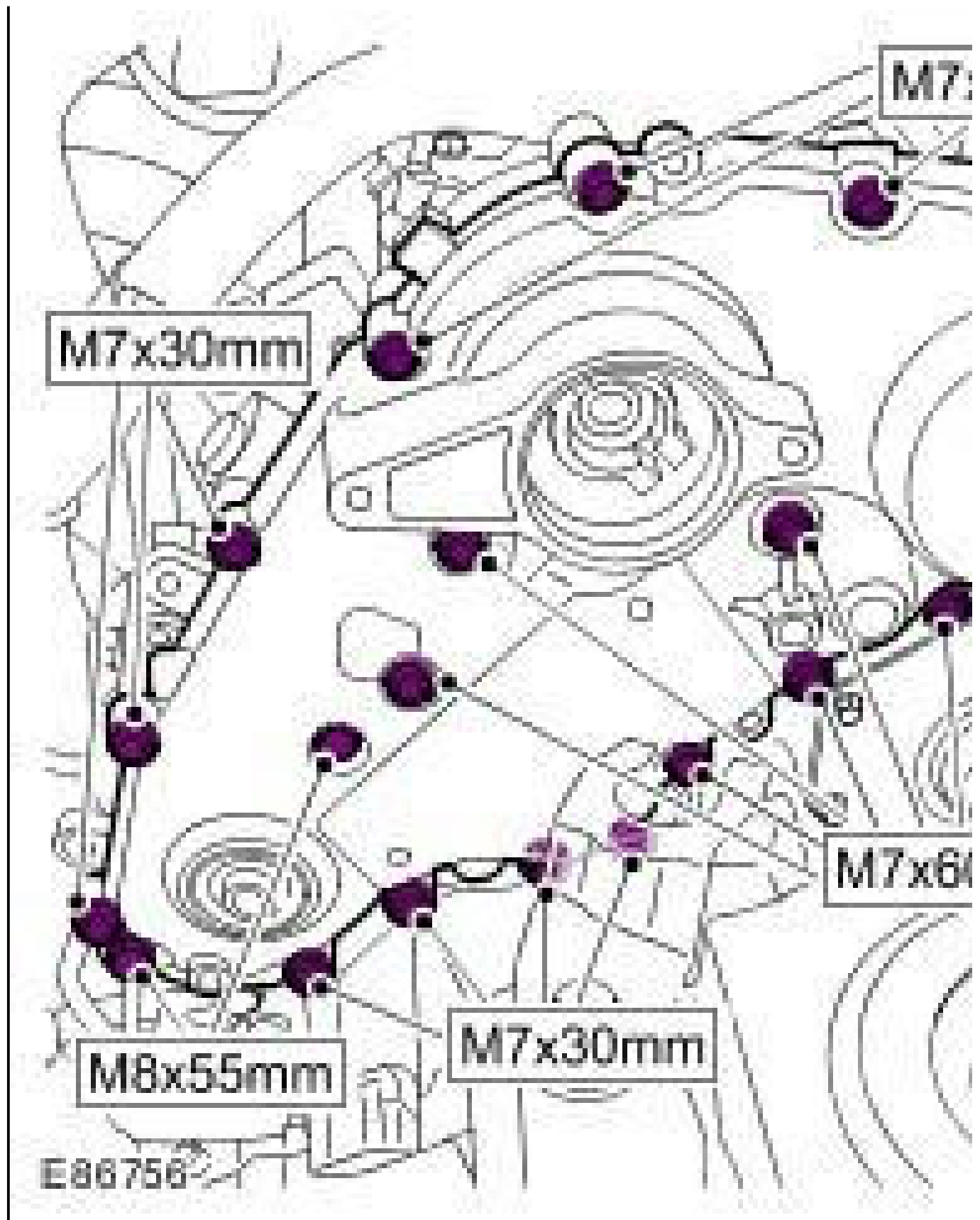
**CAUTION:** Make sure that the component is correctly located on the locating dowels.

2. Install a new gasket.

**CAUTION: Only tighten the bolts finger-tight at this stage.**

3. Install the bolts as illustrated.

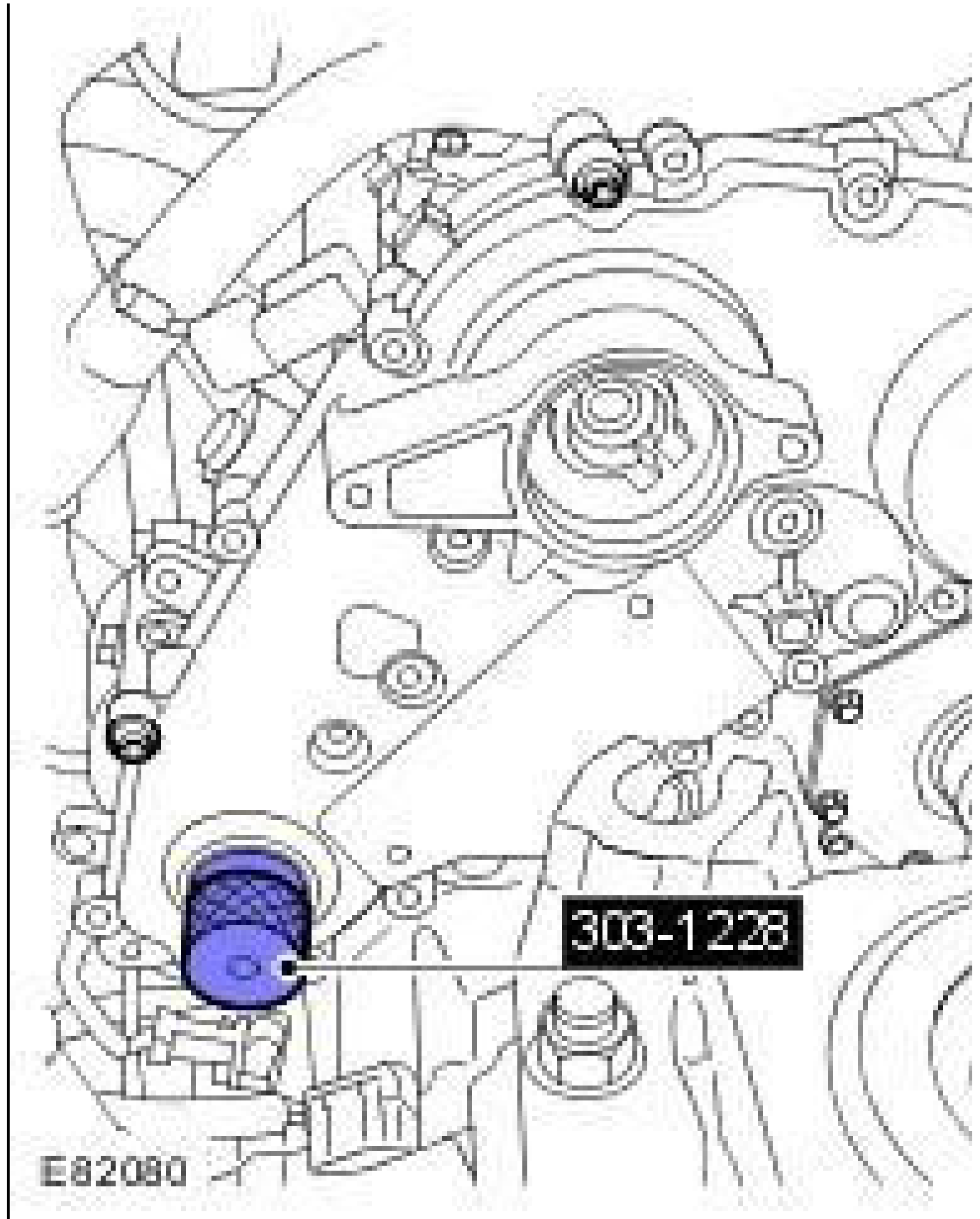




**CAUTION:** Make sure that the area around the component is clean and free of foreign material.

4. Align the timing cover.

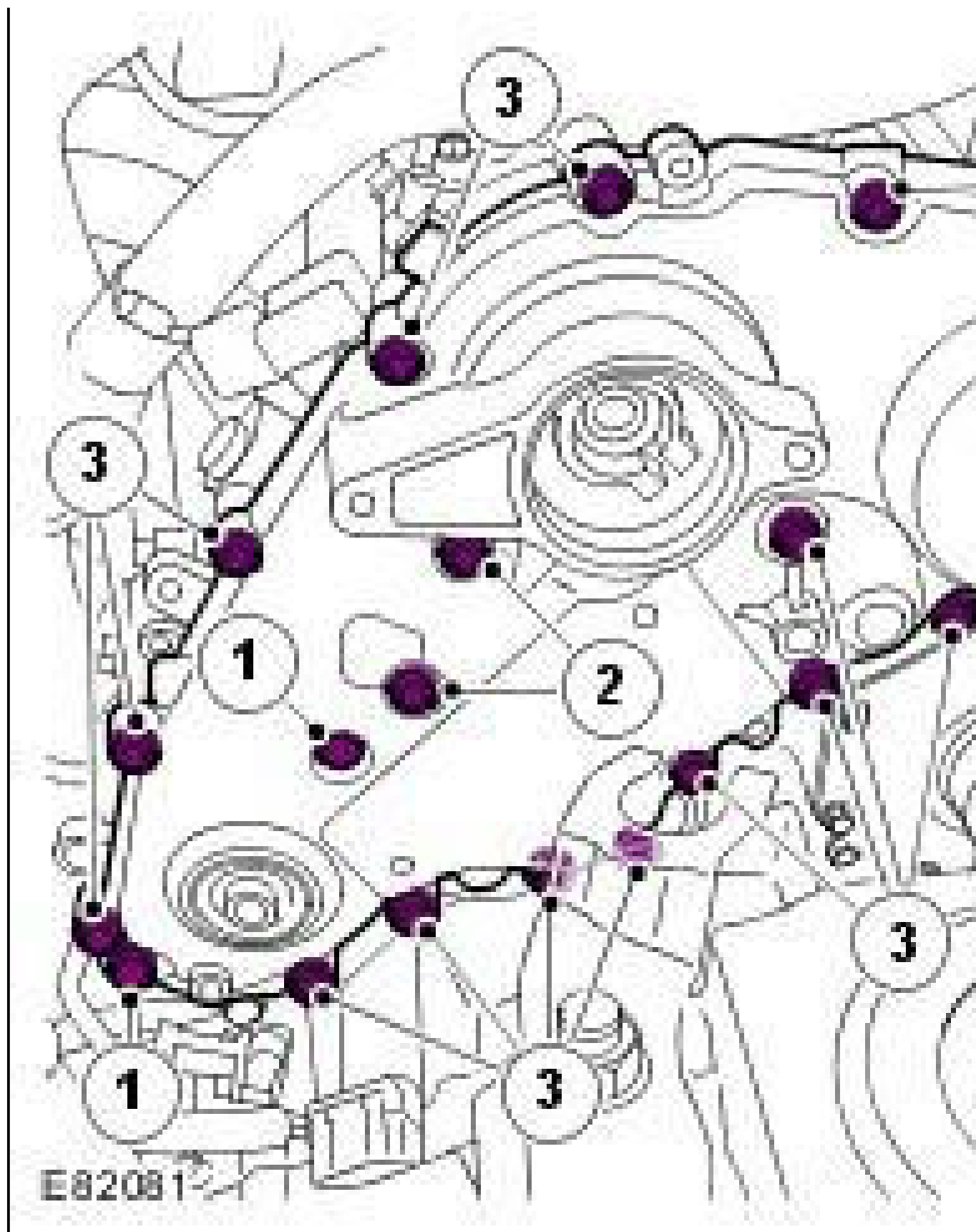
Holder, Generator Pulley (303-1228)



5. Tighten the bolts in the sequence illustrated.

M8 Torque: - 25 Nm.

M7 Torque: - 16 Nm.



6.

- Install the seal to the special tool.

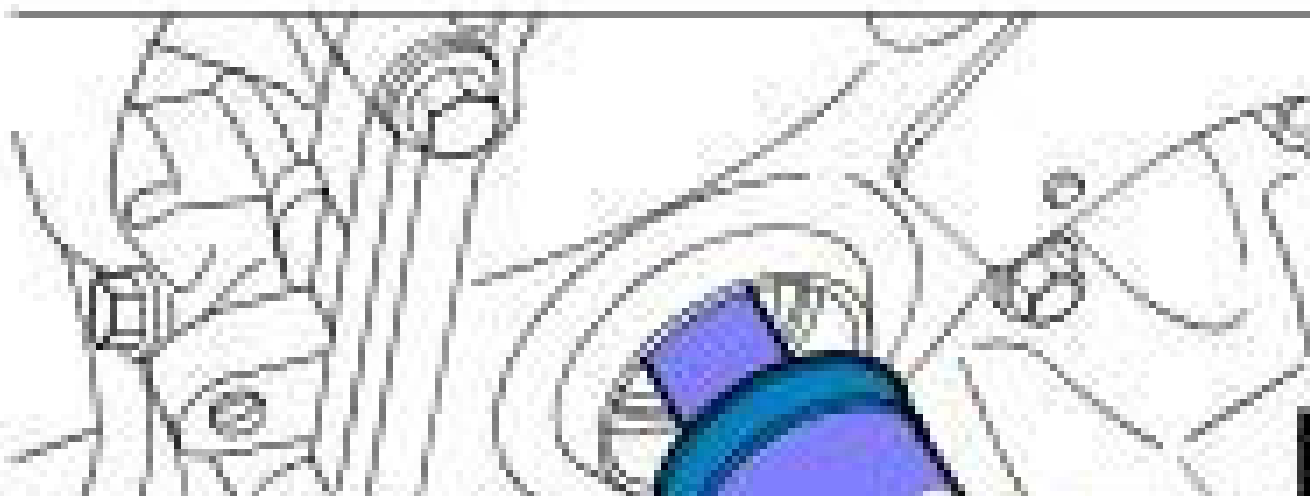
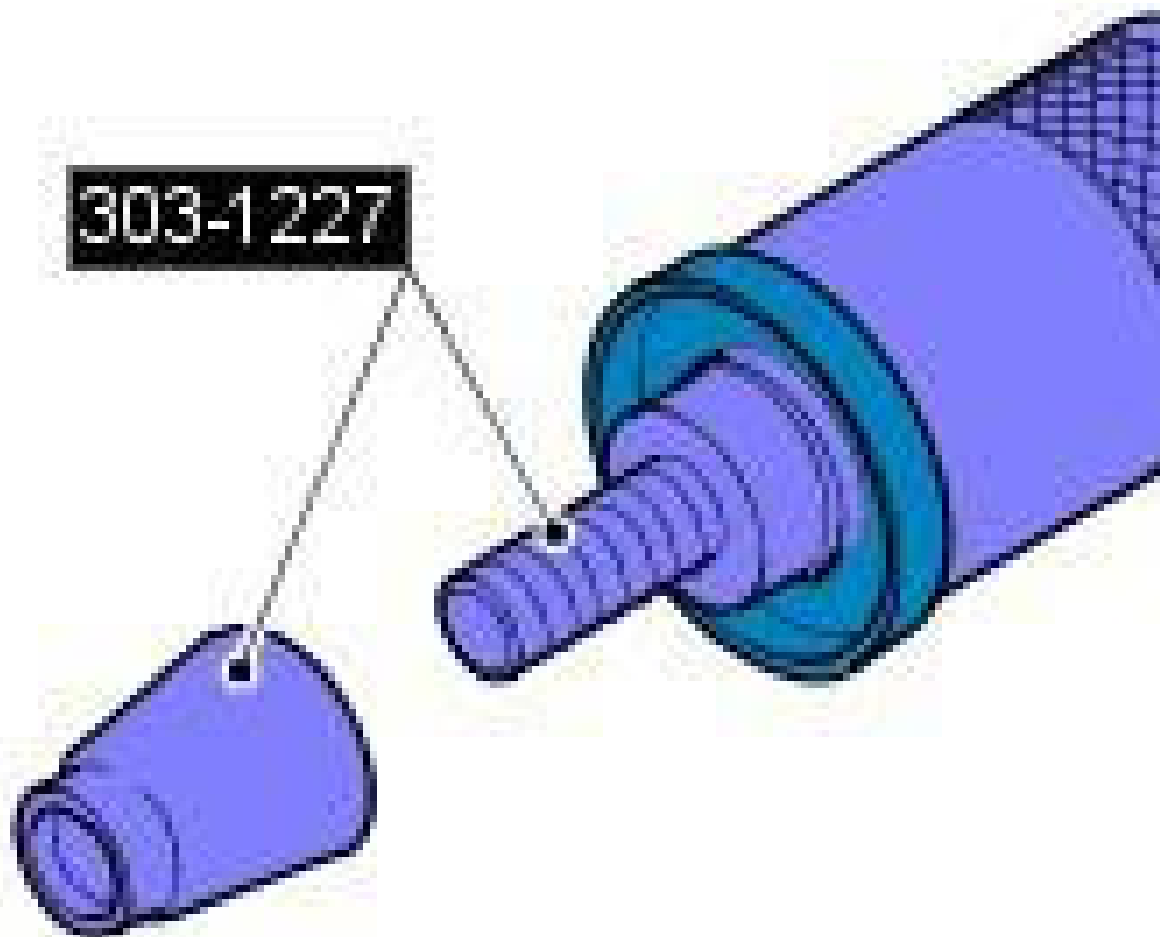
Installer, Auxiliary Drive Seal (303-1227)

- Remove the seal guide.

**CAUTION: Make sure that the mating faces are clean and free of corrosion and foreign material.**

7.

- Install the special tool and seal assembly into the accessory drive shaft.
- Install the seal.



**CAUTION: A new O-ring seal is to be installed.**

**CAUTION: Take extra care not to damage the seal.**

**NOTE: Lubricate the new O-ring seal with clean engine coolant.**

8. Install the coolant pump inlet pipe.

Torque: 10 Nm.

9. Install the power steering pump and support bracket.

Torque: 25 Nm.

**CAUTION: A new O-ring seal is to be installed.**

**CAUTION: Make sure that the component is clean, free of foreign material and lubricant.**

10. Install the brake vacuum pump.

Torque: 17 Nm.

11. Install the accessory drive belt idler pulley.

Torque: 25 Nm.

12. Install the accessory drive pulley. Refer to Accessory Drive Pulley .

13. Fill and bleed the cooling system. Refer to Cooling System Draining, Filling and Bleeding .

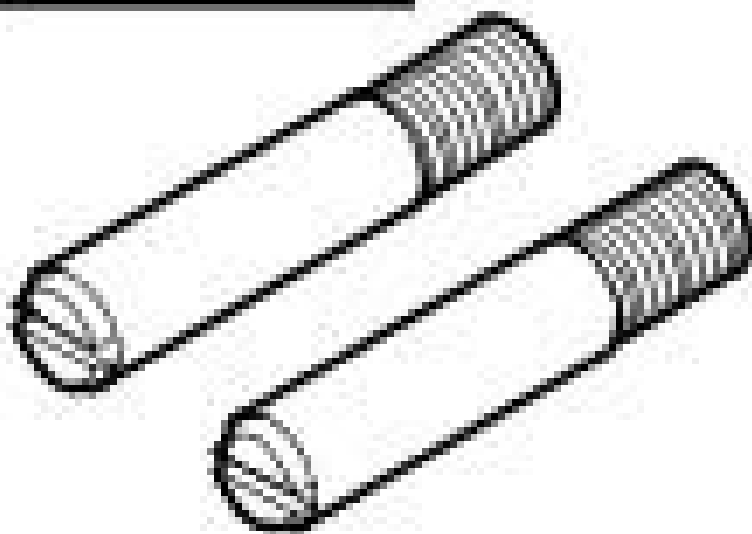
14. Connect the battery ground cable and install the cover. Refer to Specifications .

#### TIMING COMPONENTS HOUSING

##### Special Tool(s)

|  |                     |
|--|---------------------|
|  | 303-1232 Guide Pins |
|--|---------------------|

303-1232



E82372

**REMOVAL**

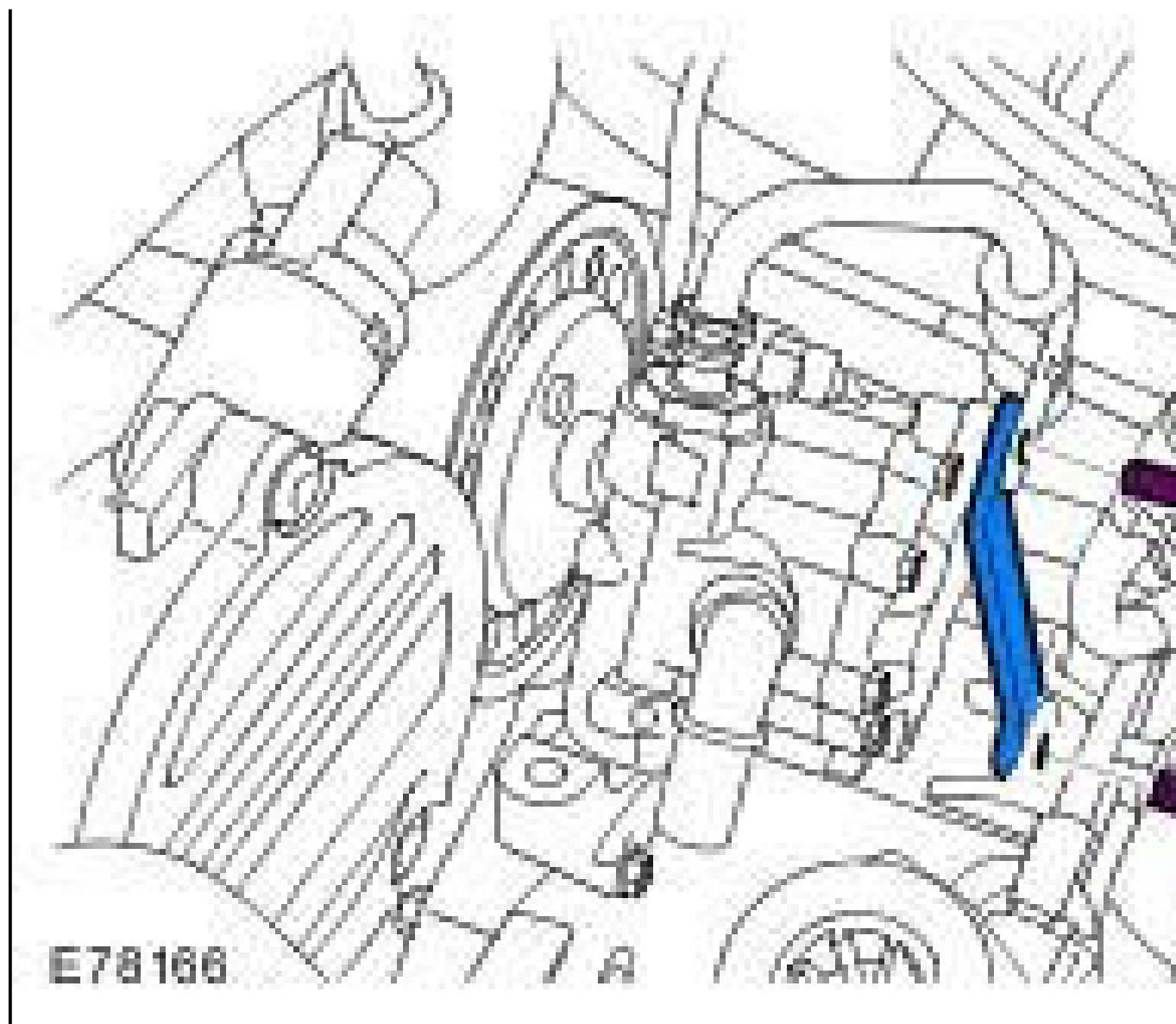
**NOTE:** Take extra care when aligning and refitting the timing housing, as the seals can easily be damaged.

**WARNING:** Make sure to support the vehicle with axle stands.

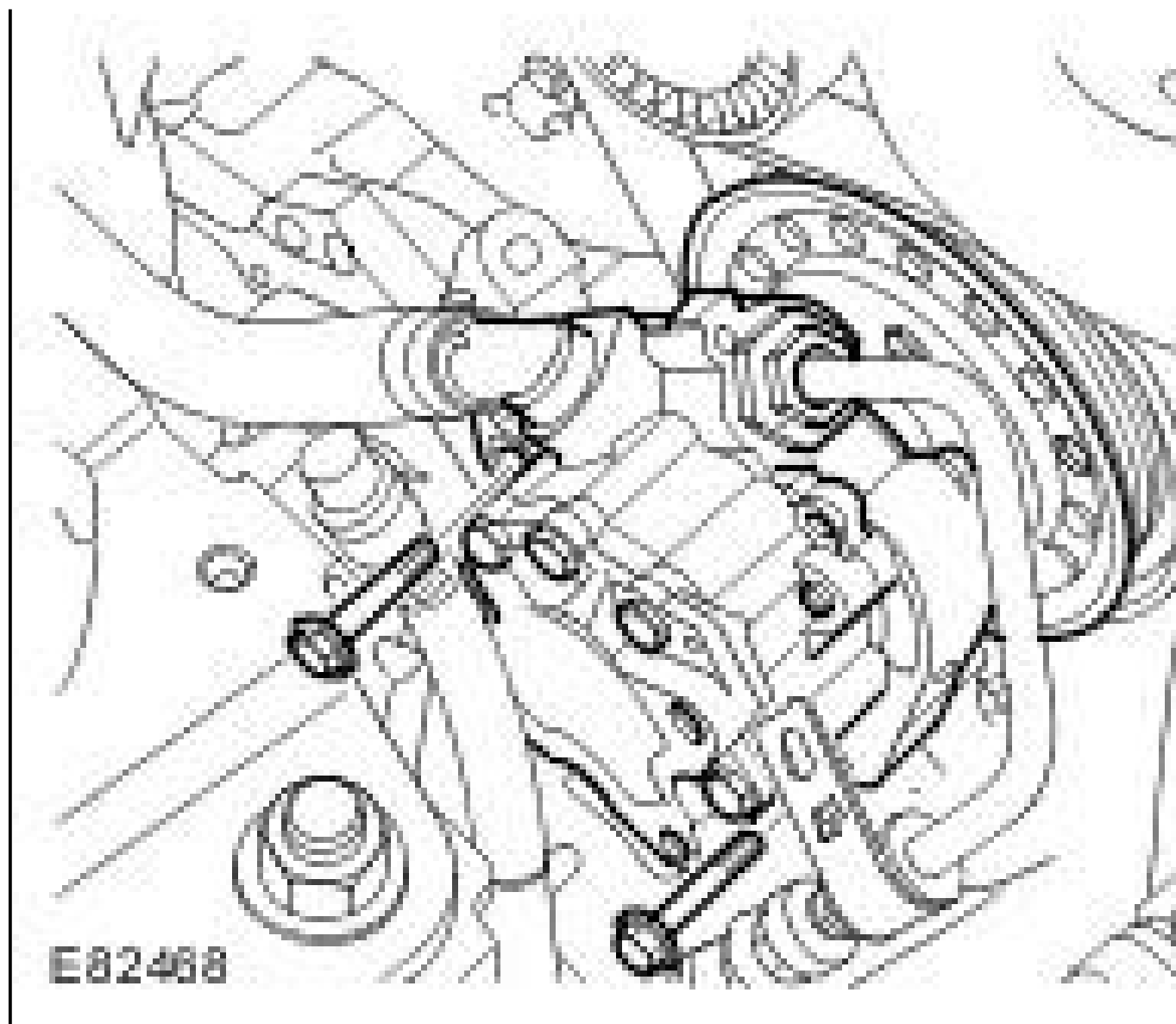
1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable. Refer to **Specifications** .
3. Remove the timing chain and sprockets. See **Timing Chain**.
4. Disconnect the front LH HO2S and release the clip.



5. Remove the power steering pump support bracket

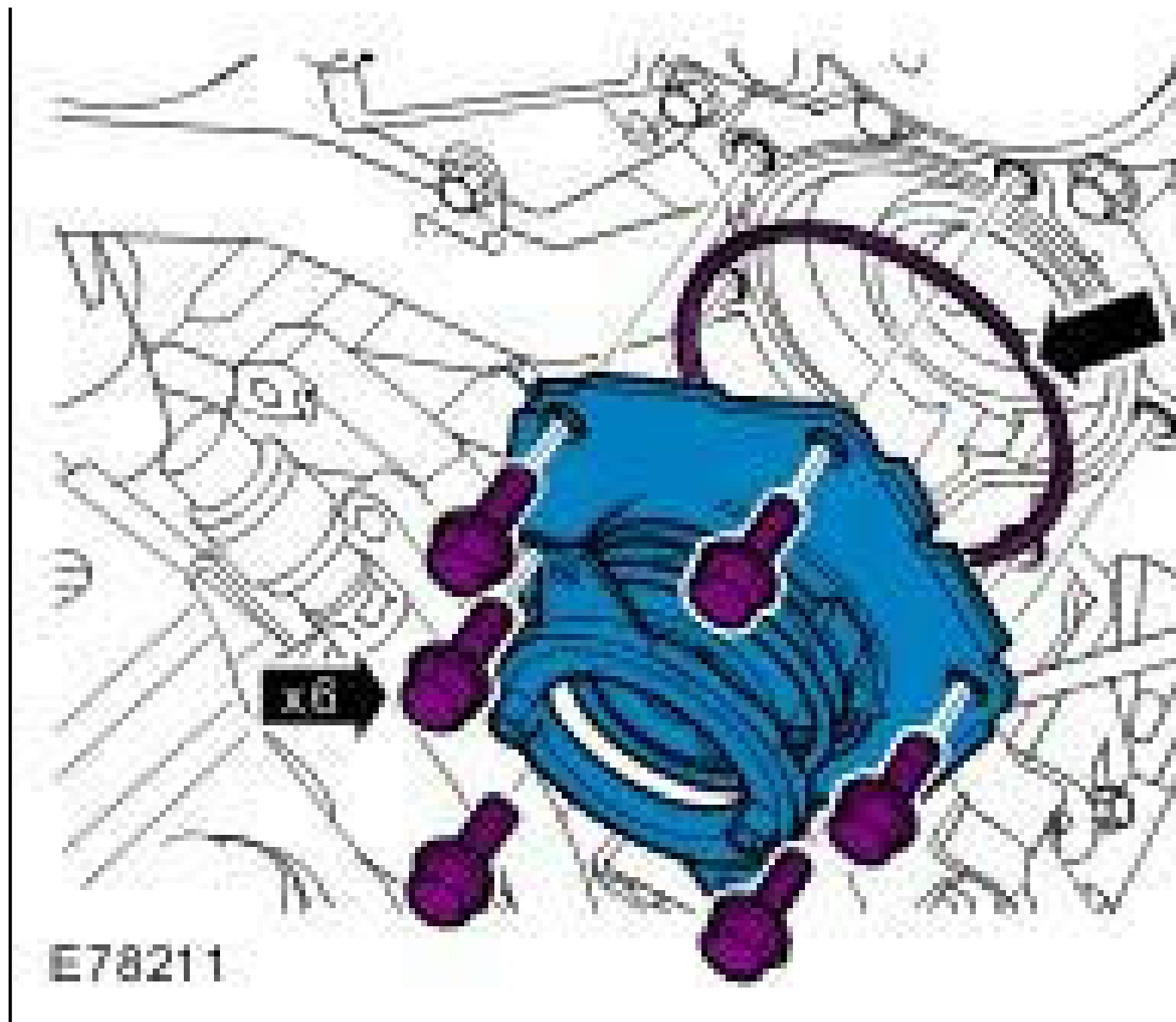


6. Release the power steering pump.

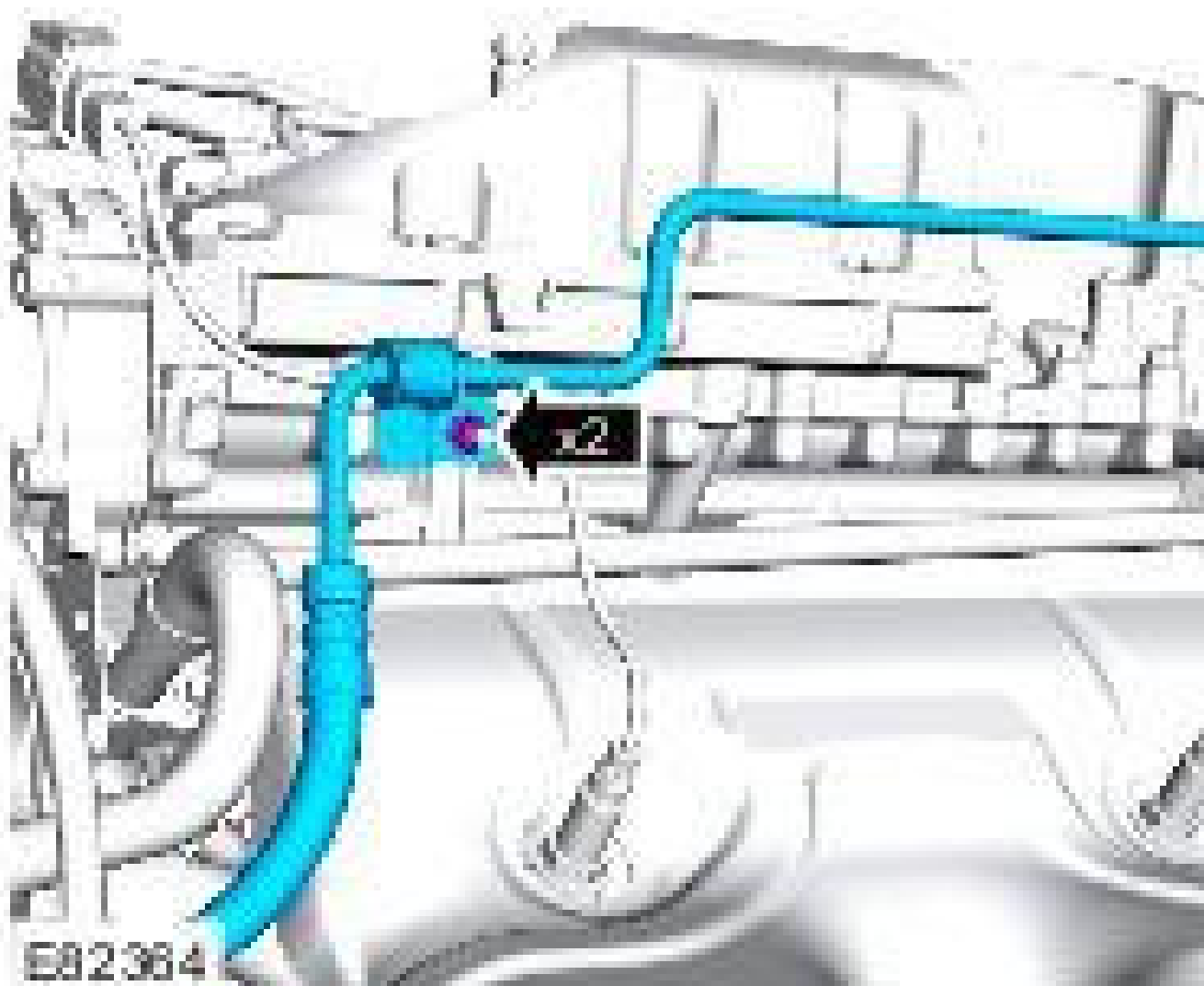


7. See Figure

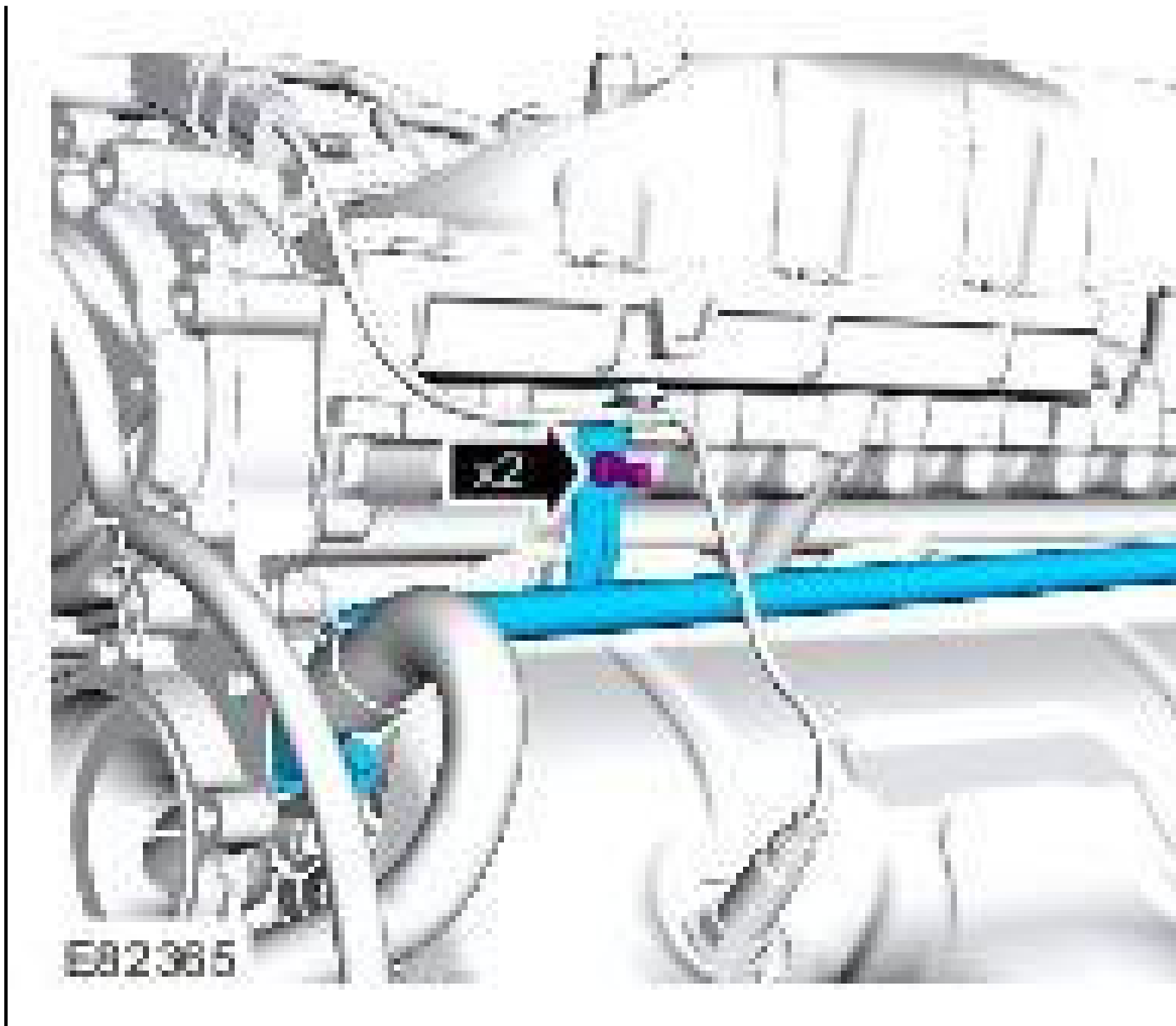
**CAUTION: Discard the seal.**



8. Release the power steering gear line.

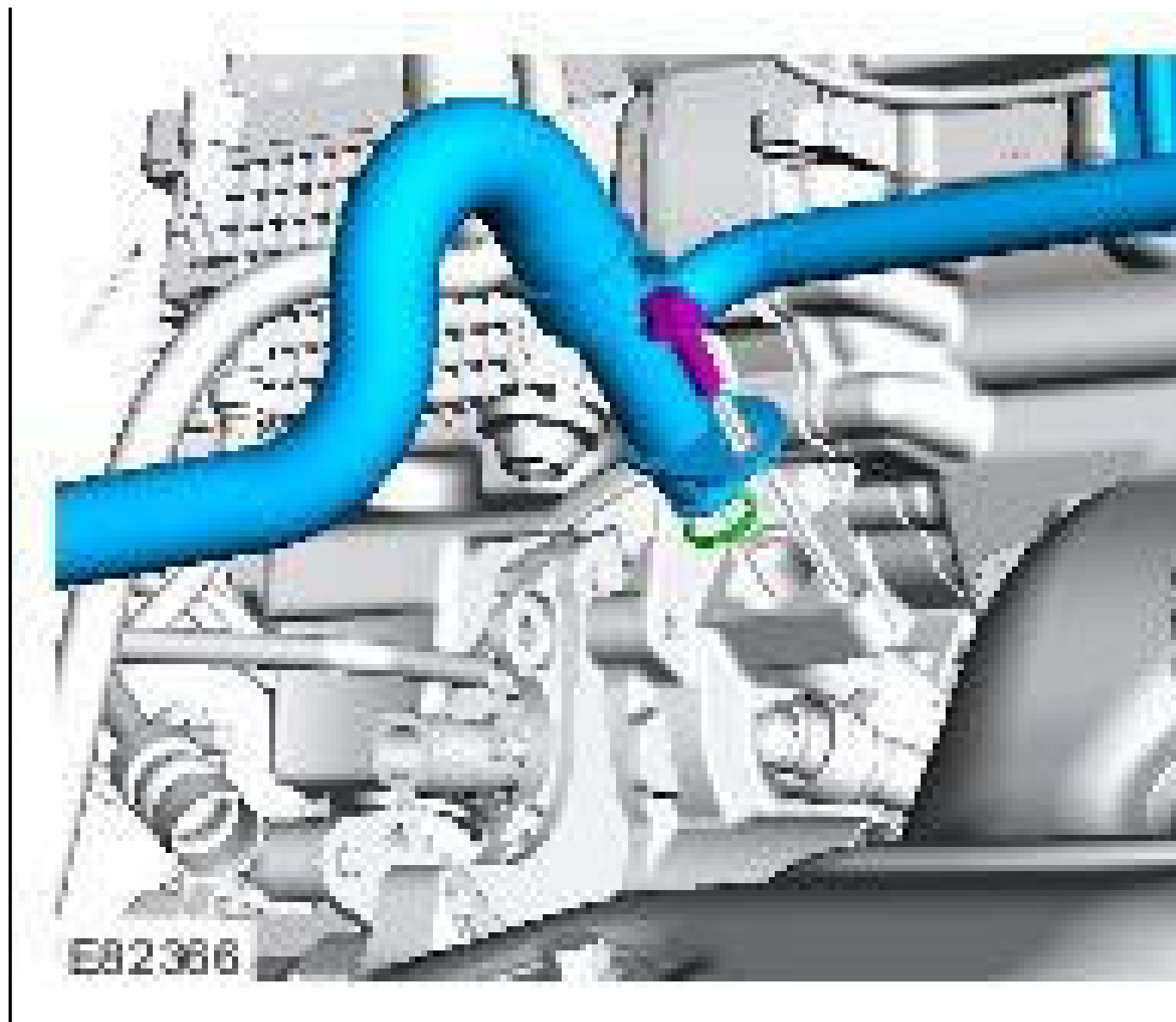


9. Release the coolant rail.

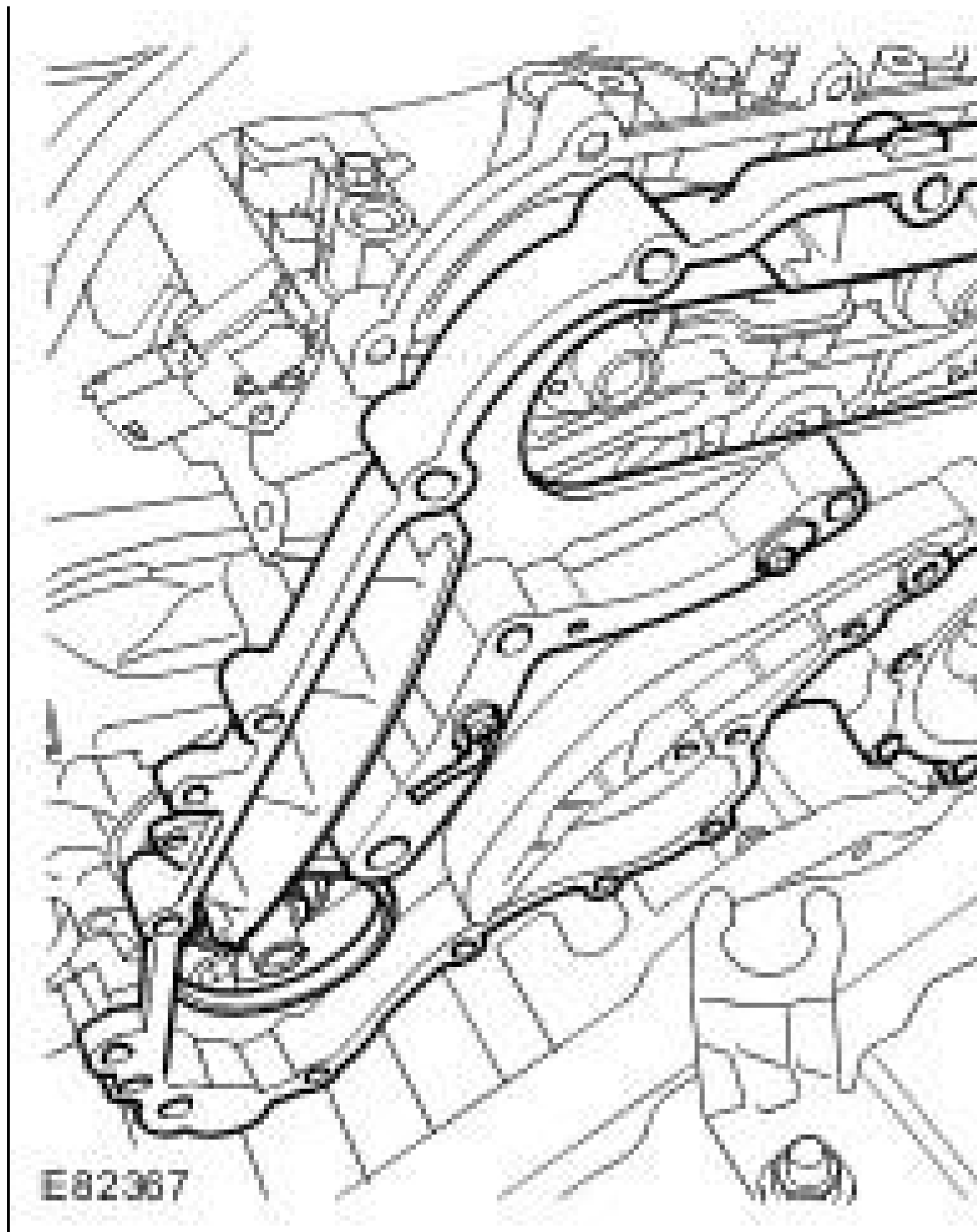


10. Disconnect the coolant rail hose from the coolant pump housing.

**CAUTION: The O-ring seal is to be reused unless damaged.**



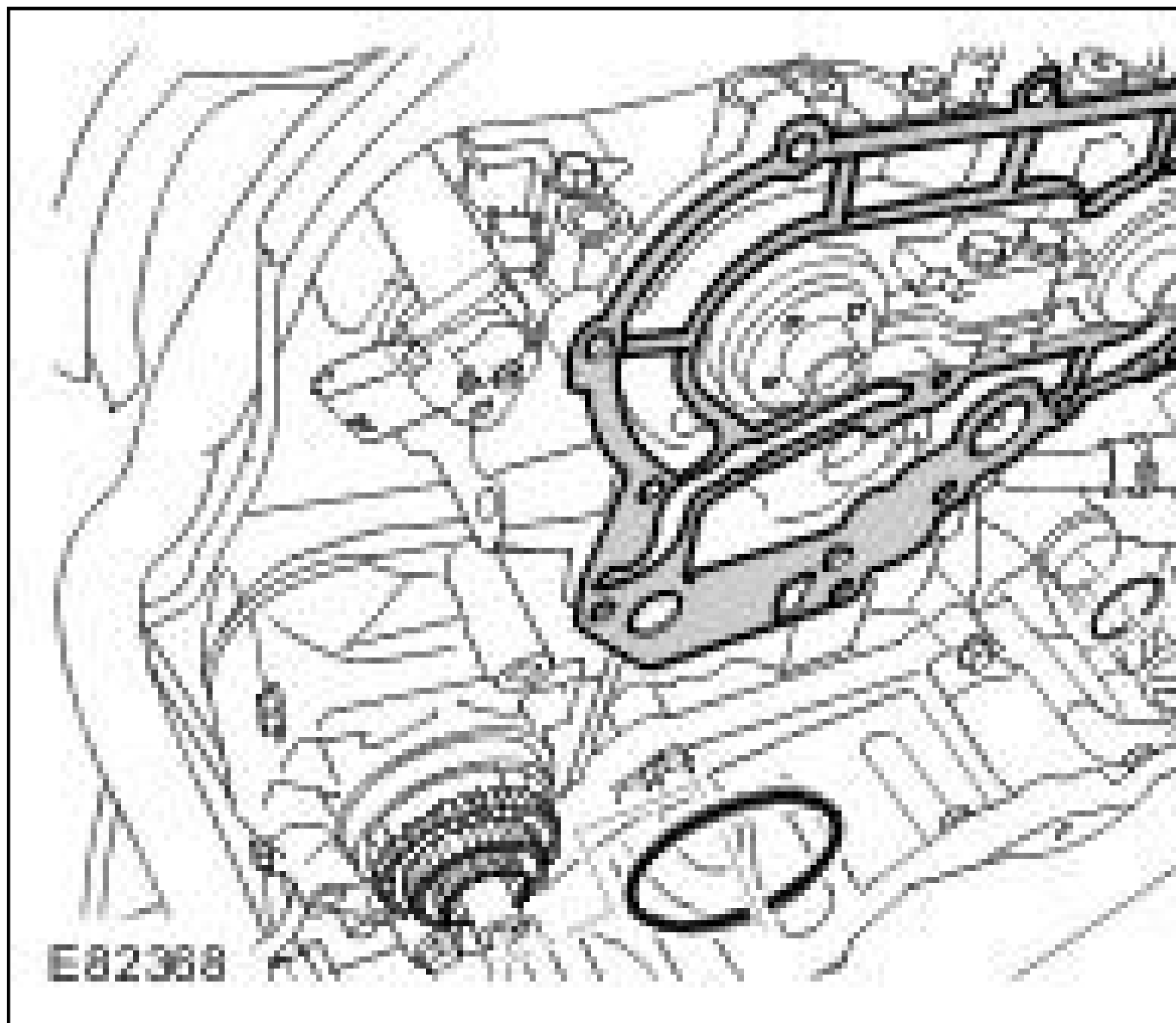
11. See figure.



12. See figure.

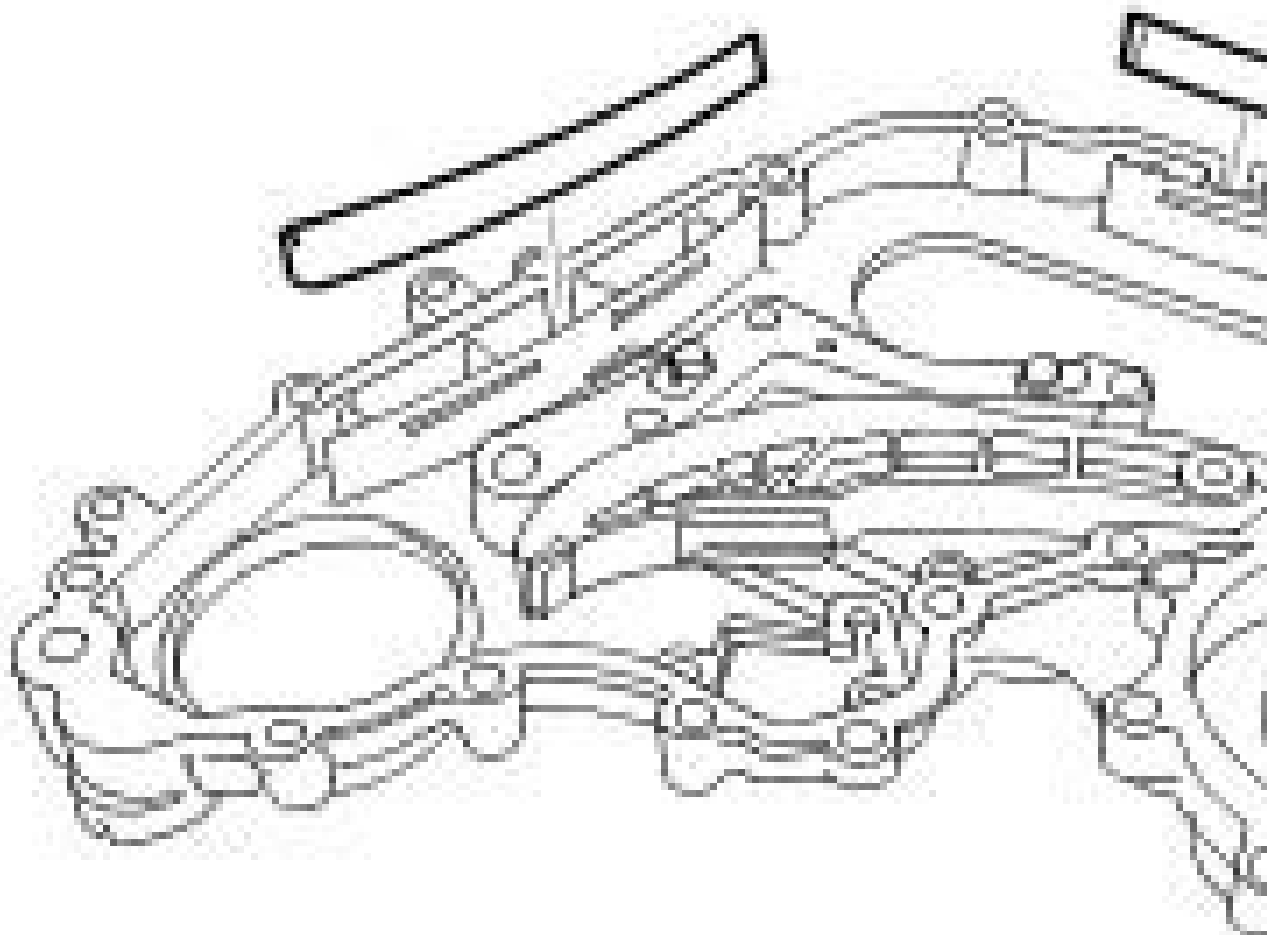
**CAUTION:** Discard the seal.

**NOTE:** Discard the gasket.



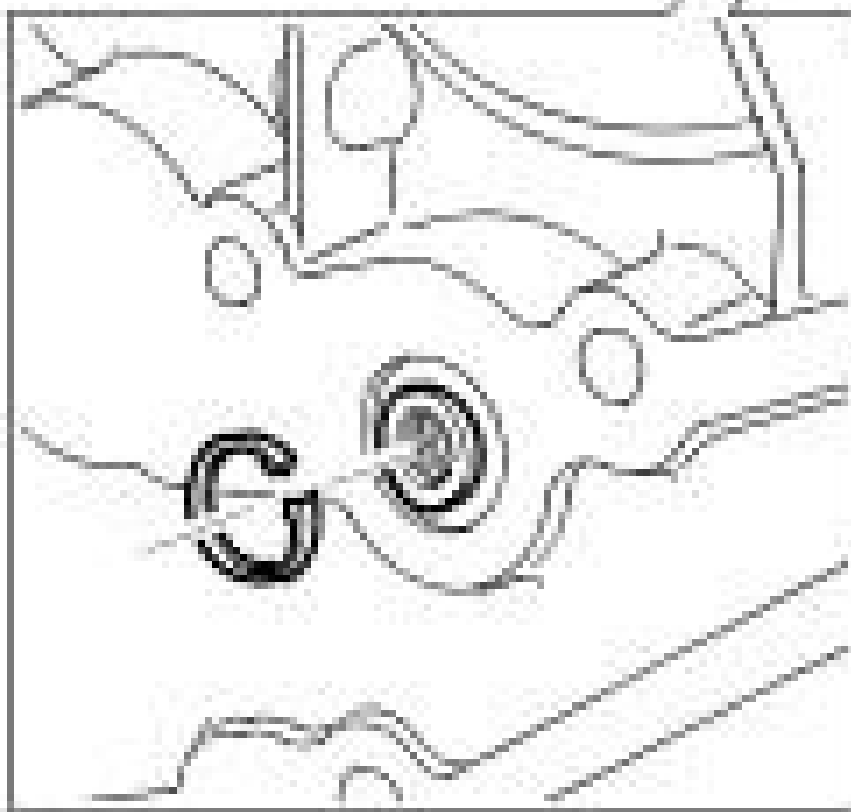
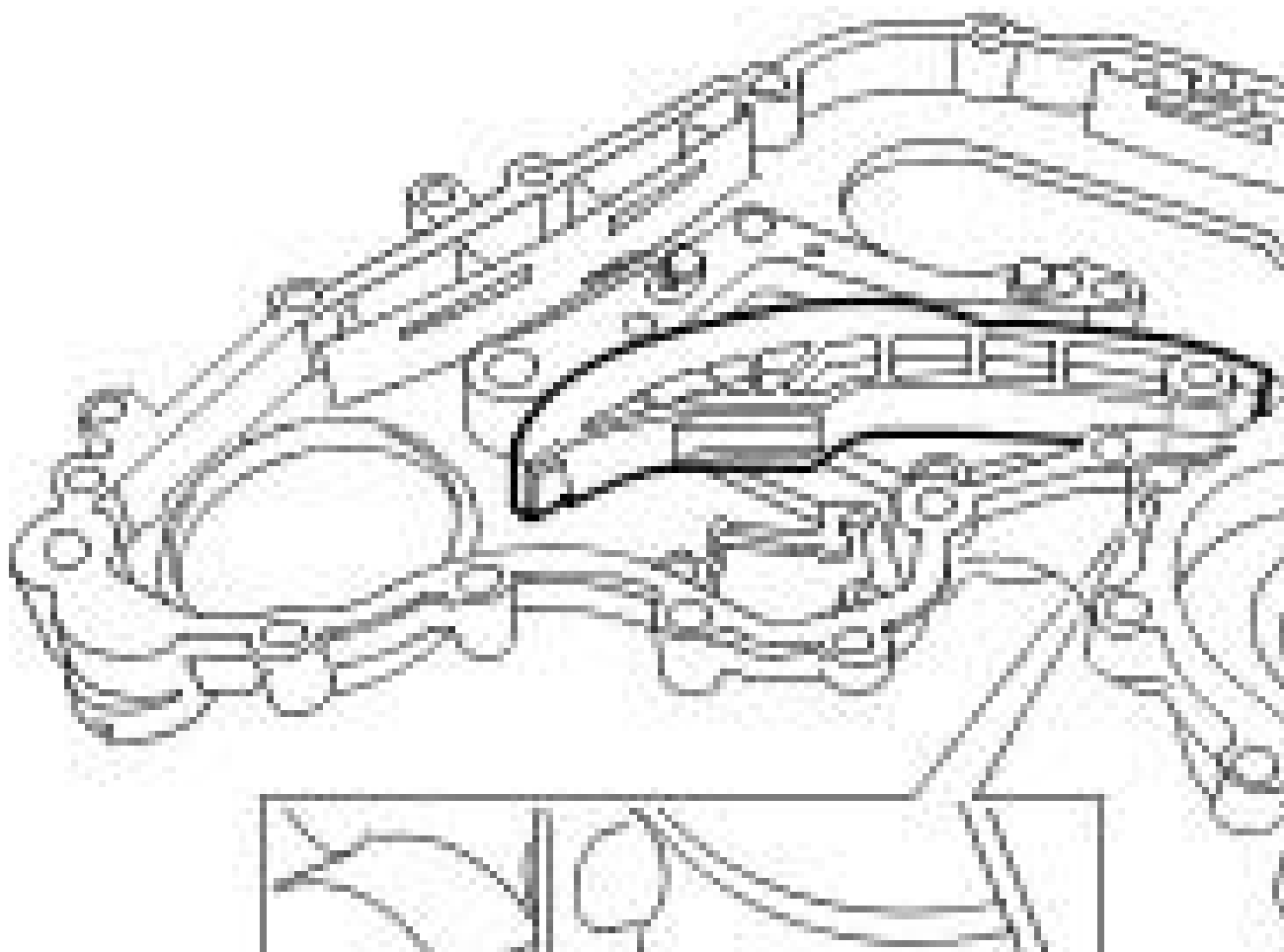
**NOTE:** Do not disassemble further if the component is removed for access only.

13. Remove the 2 timing chain slippers.



E82389

14. Remove the timing chain tensioner slipper.

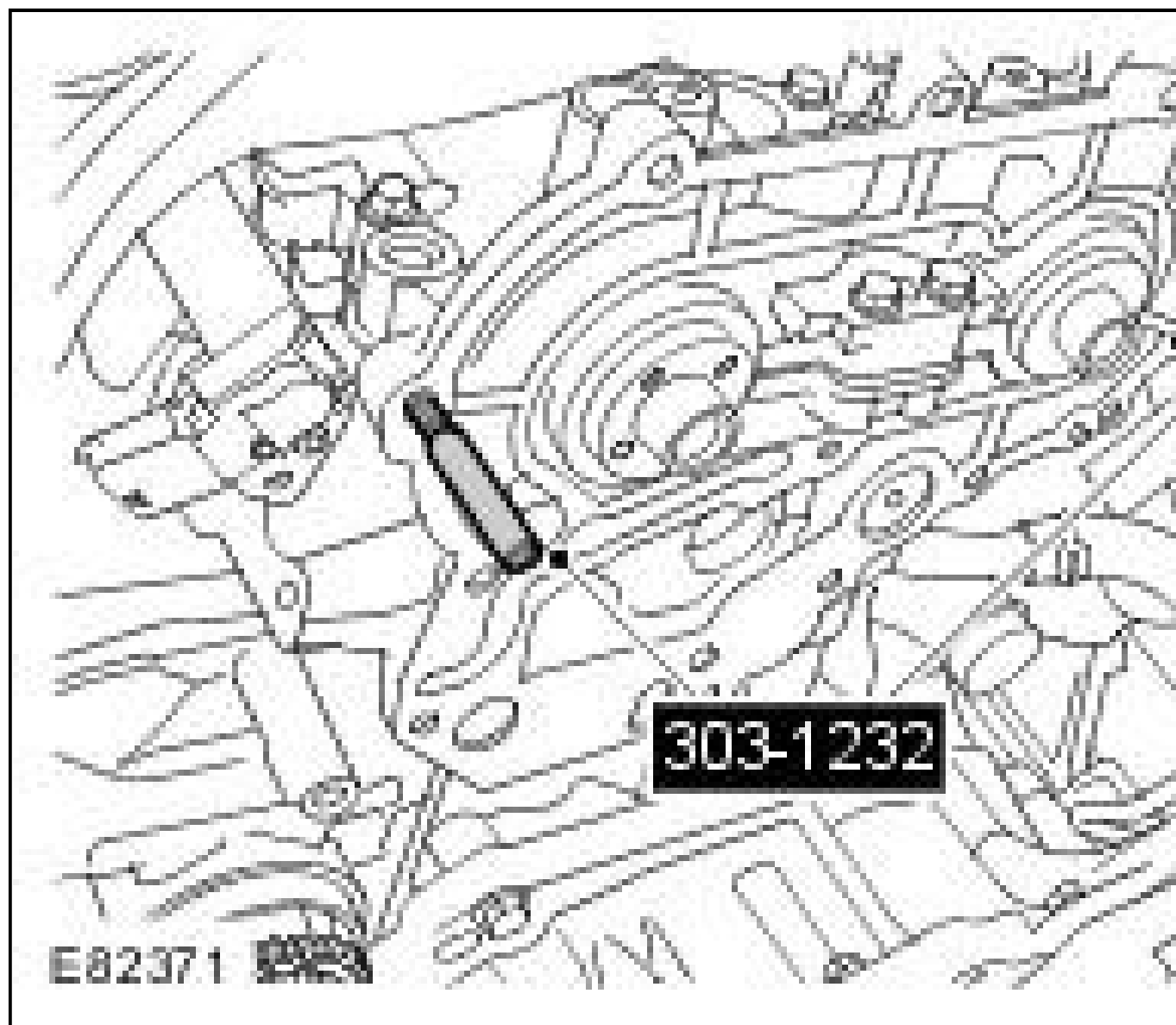


E82370

**INSTALLATION**

1. Install the timing chain slippers.
2. Install the timing chain tensioner slipper.
3. Install 2 guide pins to aid installation.

Guide Pins (303-1232)



**CAUTION:** Make sure that the component is clean, free of foreign material and lubricant.

4. Install the gasket and new seals.

**CAUTION:** Make sure that the gaskets are correctly located.

**CAUTION:** Make sure that the mating faces are clean and free of corrosion and foreign material.

**CAUTION:** Take extra care not to damage the seal.

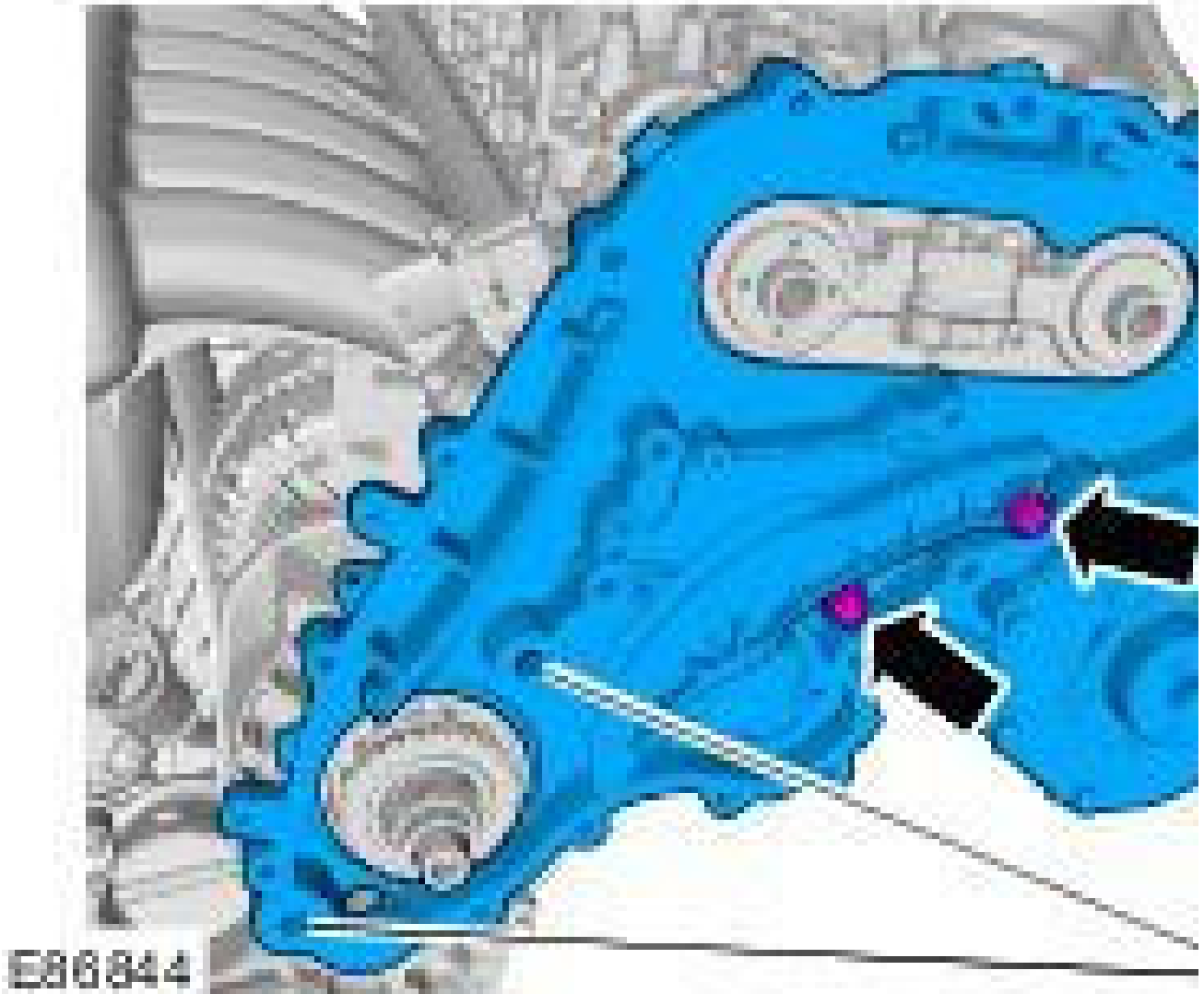
**CAUTION:** Only tighten the bolts finger-tight at this stage.

5. Install the timing component housing.
6. Remove the guide pins.

Guide Pins (303-1232)

7.
    - Install the timing component housing.
- Torque: 16 Nm.
- Check the timing component housing alignment. Correct alignment is when the adjusters are in contact with the cylinder block gear housing.
  - Set adjusters if required, there should be no requirement of adjustment if the housing has not been replaced.

Torque: 1 Nm.



**CAUTION:** Make sure that the seal is correctly located.

**CAUTION:** Make sure that the mating faces are clean and free of corrosion and foreign material.

**NOTE:** Lubricate the O-ring seal with clean coolant.

8. Connect the coolant rail.

Torque: 17 Nm.

9. Install the coolant rail.

Torque: 17 Nm.

10. Install the power steering line.

Torque: 17 Nm.

**CAUTION:** Make sure that the mating faces are clean and free of corrosion and foreign material.

**CAUTION:** Make sure that the seal is correctly located.

11. Install the coolant pump.

Torque: 17 Nm.

12. Install the power steering pump.

Torque: 25 Nm.

13. Connect and secure the HO2S electrical connectors.

14. Install the power steering pump support bracket.

Torque: 25 Nm.

15. Install the timing chain and sprockets. See Timing Chain.

16. Connect the battery ground cable and install the cover. Refer to Specifications.

## ENGINE FRONT SEAL

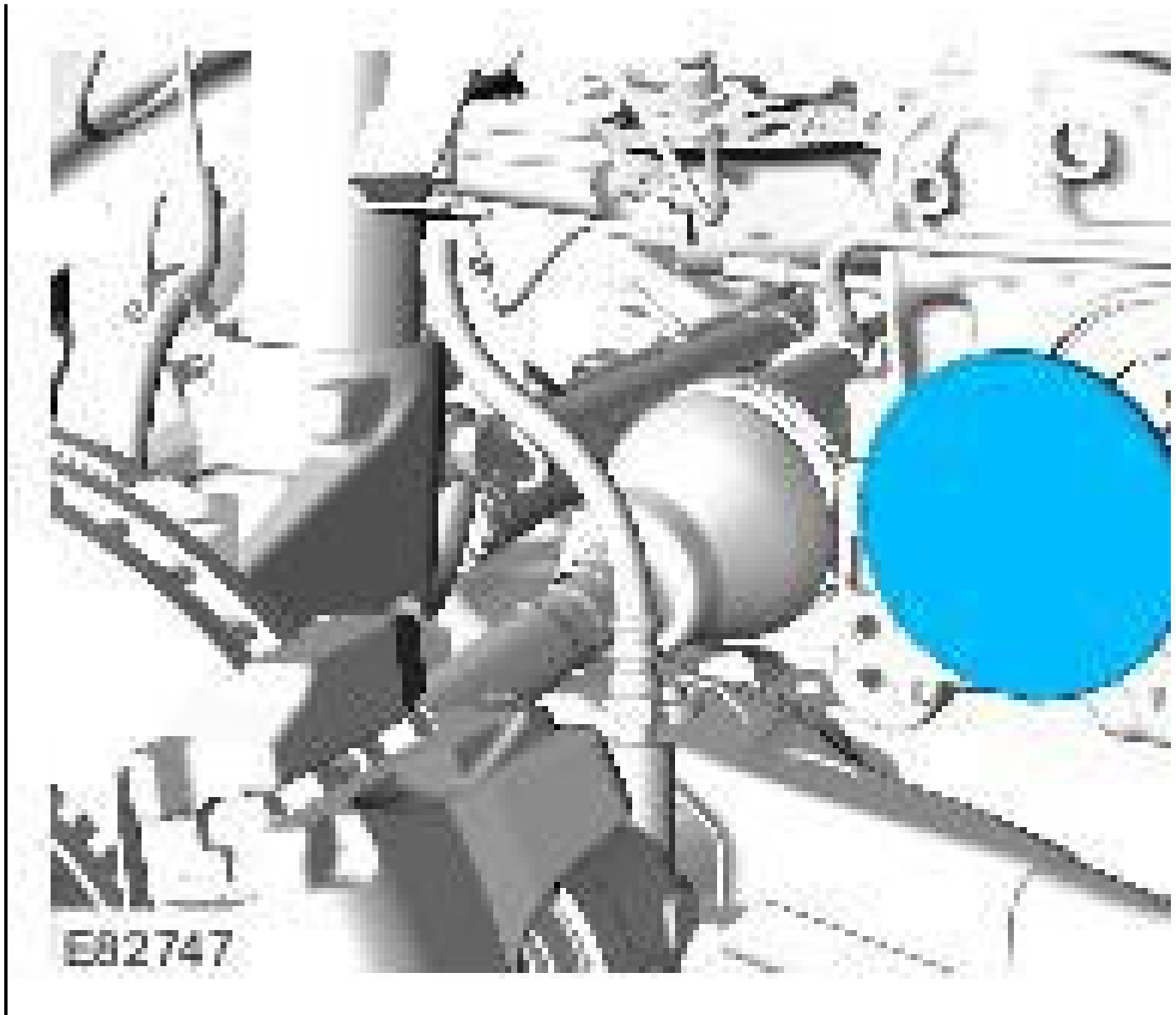
### REMOVAL

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

1. Raise and support the vehicle.
2. Remove the front wheel. Refer to Wheel and Tire.
3. Remove the fender splash shield extension panel.



4. Remove the crankshaft front oil seal.



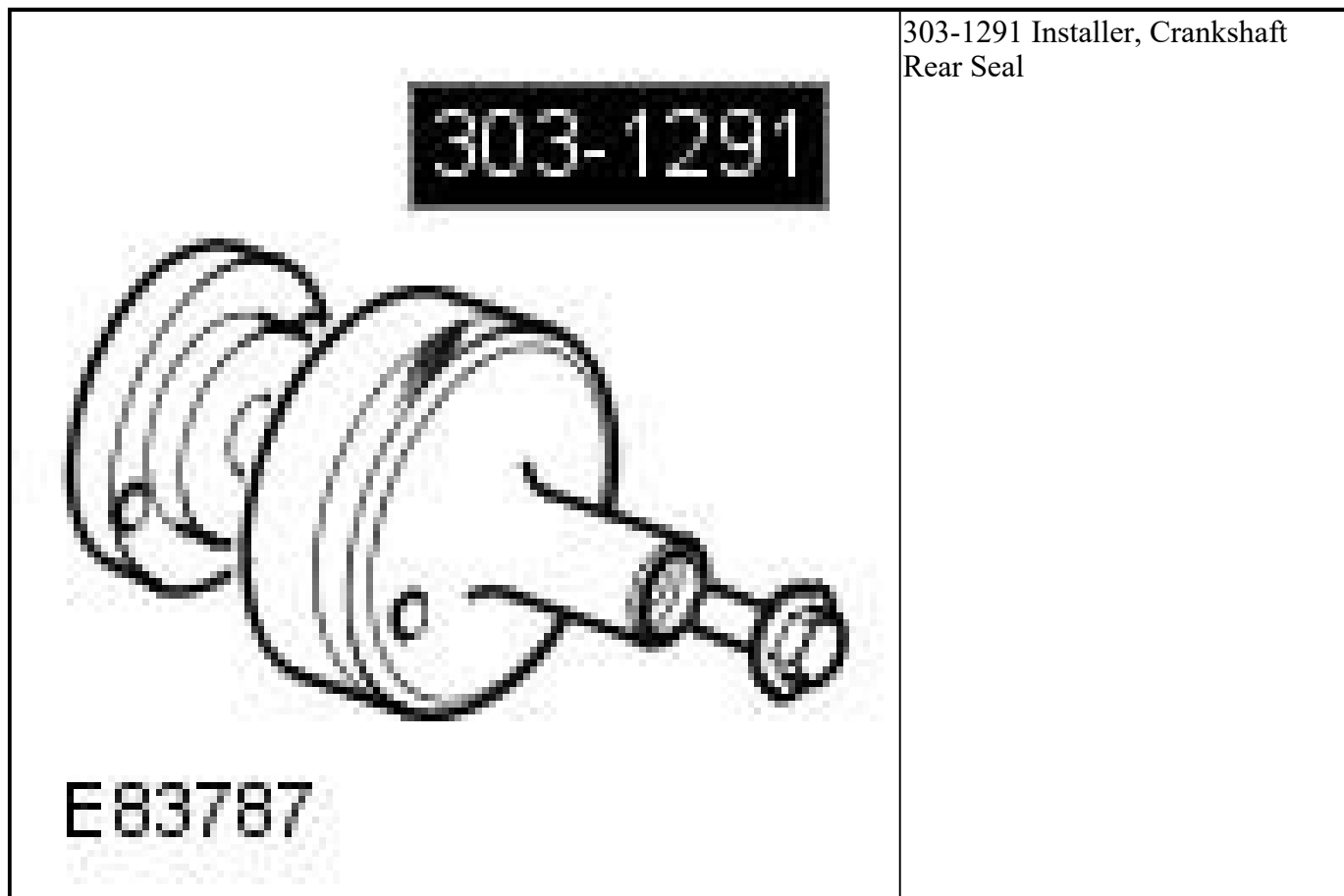
## INSTALLATION

**CAUTION:** The oil seal must be installed dry.

1. Install the crankshaft front oil seal.
2. Install the fender splash shield extension panel.
3. Install the front wheel. Refer to **Wheel and Tire** .
4. Check and top-up the engine oil.

## CRANKSHAFT REAR SEAL

## Special Tool(s)



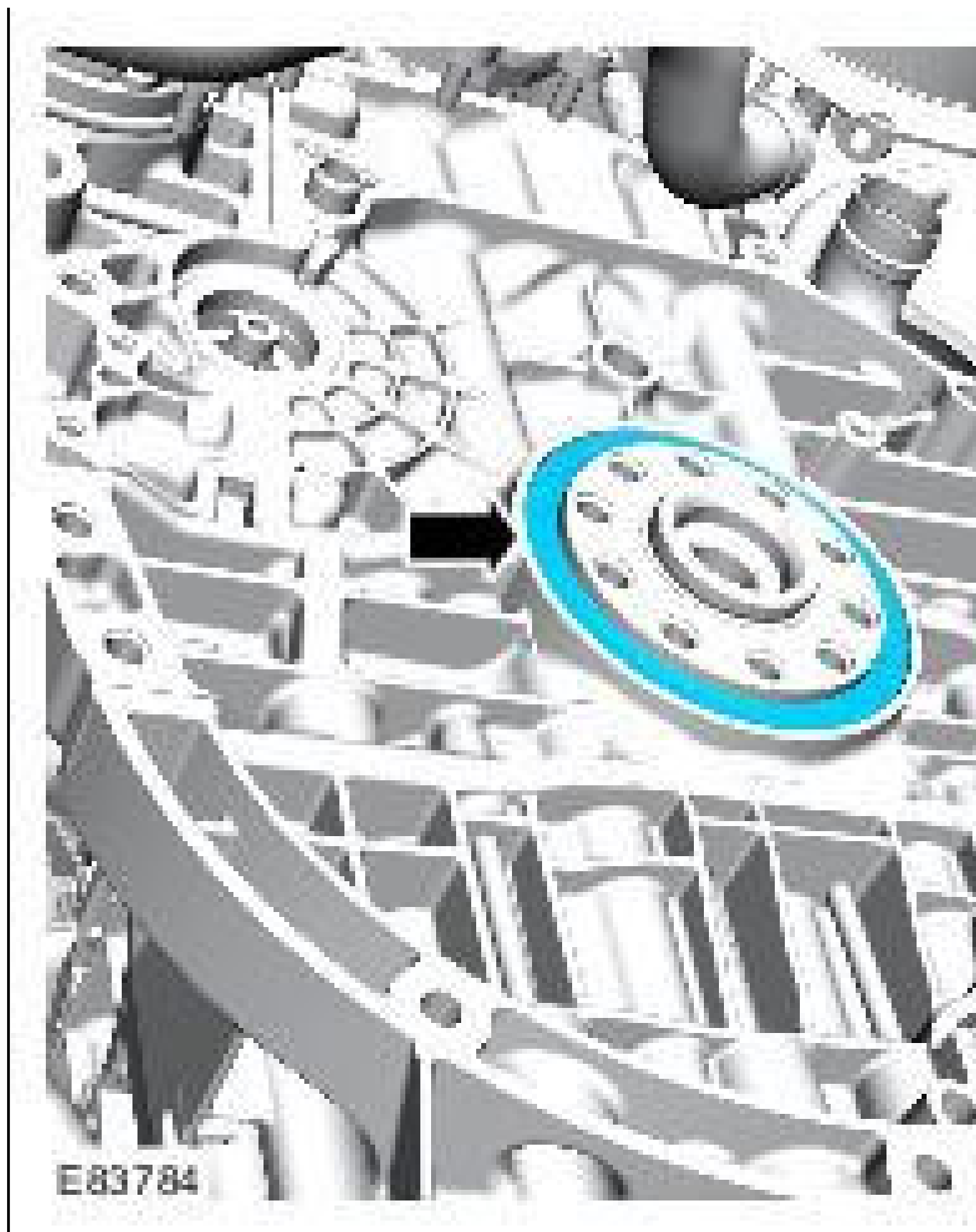
## REMOVAL

1. Remove the cover and disconnect the battery ground cable. Refer to Specifications.

**WARNING:** Make sure to support the vehicle with axle stands.

2. Raise and support the vehicle.
3. Remove the flexplate. See Flexplate.
4. See figure.

**CAUTION:** Discard the seal.



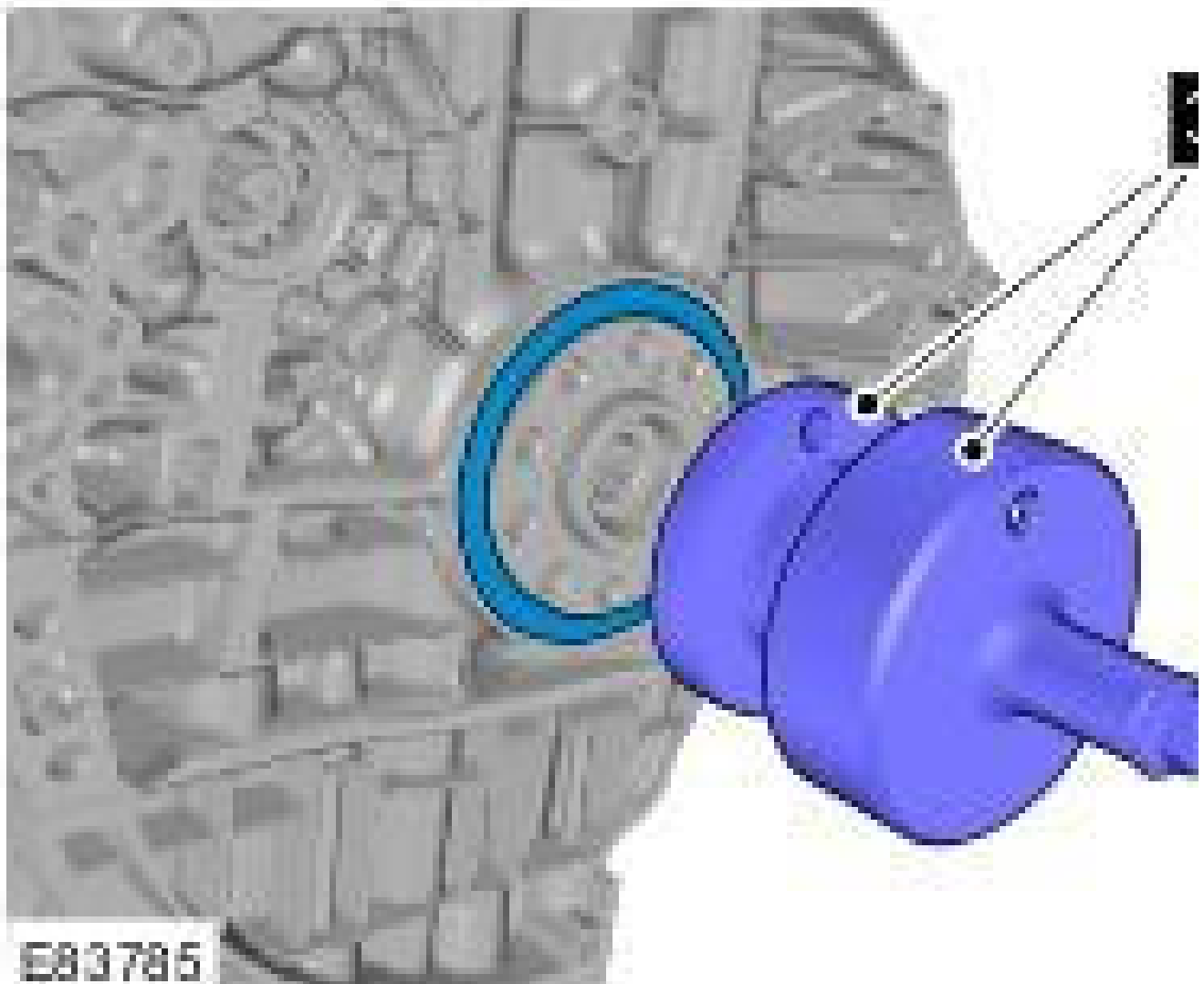
## INSTALLATION

**CAUTION:** Extreme cleanliness must be exercised when handling this component.

**CAUTION:** "Make sure that a new component is installed. "

1. Install the crankshaft rear seal.

Installer, Crankshaft Rear Seal (303-1291)



**CAUTION: Extreme cleanliness must be exercised when handling these components.**

**CAUTION: Make sure that new bolts are installed.**

2. Install the flexplate. See **Flexplate**.
3. Connect the battery ground cable and install the cover. Refer to **Specifications**.

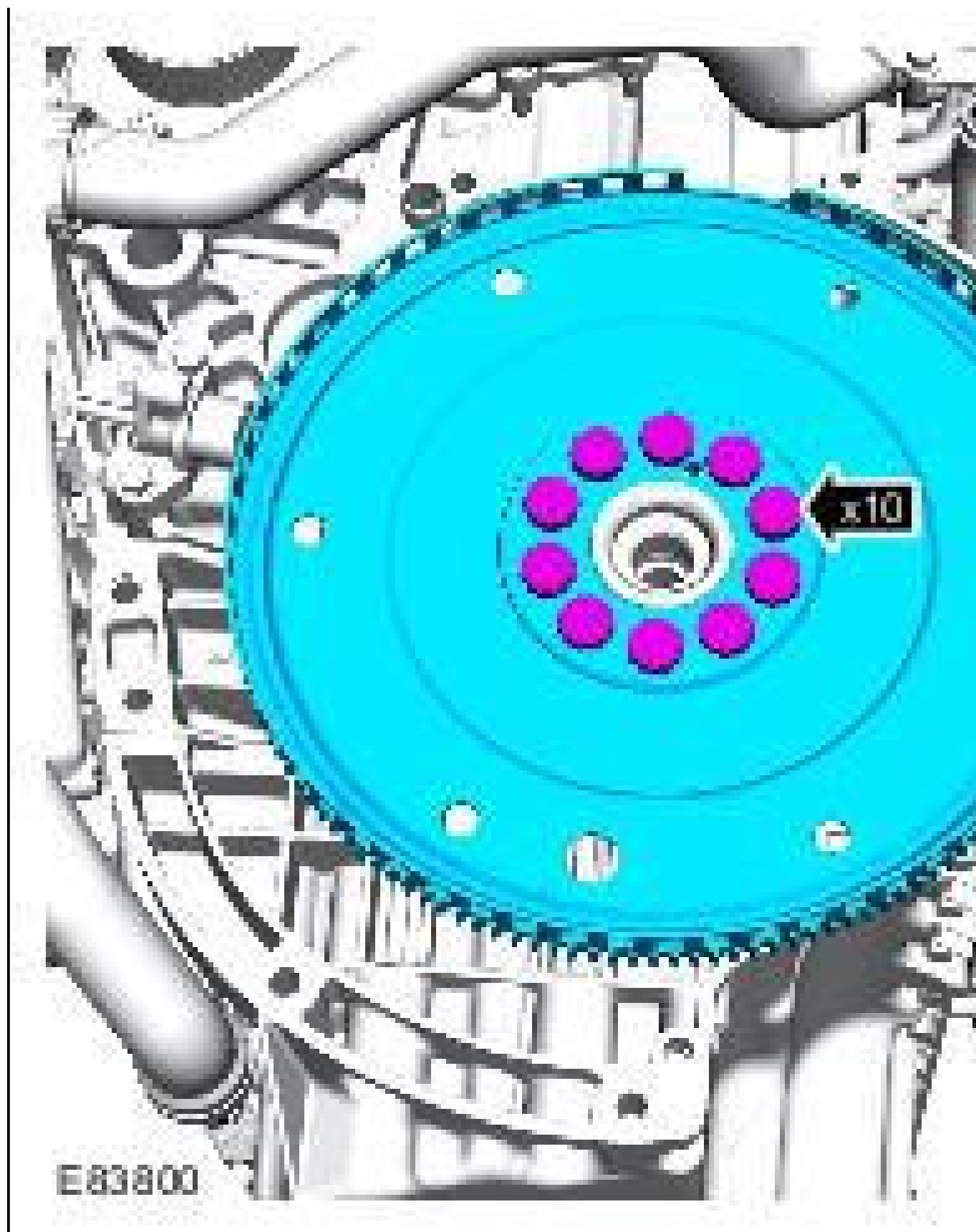
#### **FLEXPLATE**

#### **REMOVAL**

1. Remove the cover and disconnect the battery ground cable. Refer to **Specifications**.

**WARNING: Make sure to support the vehicle with axle stands.**

2. Raise and support the vehicle.
3. Remove the transmission and converter. Refer to **Transmission - 3.2L**.
4. Remove the flexplate.



## INSTALLATION

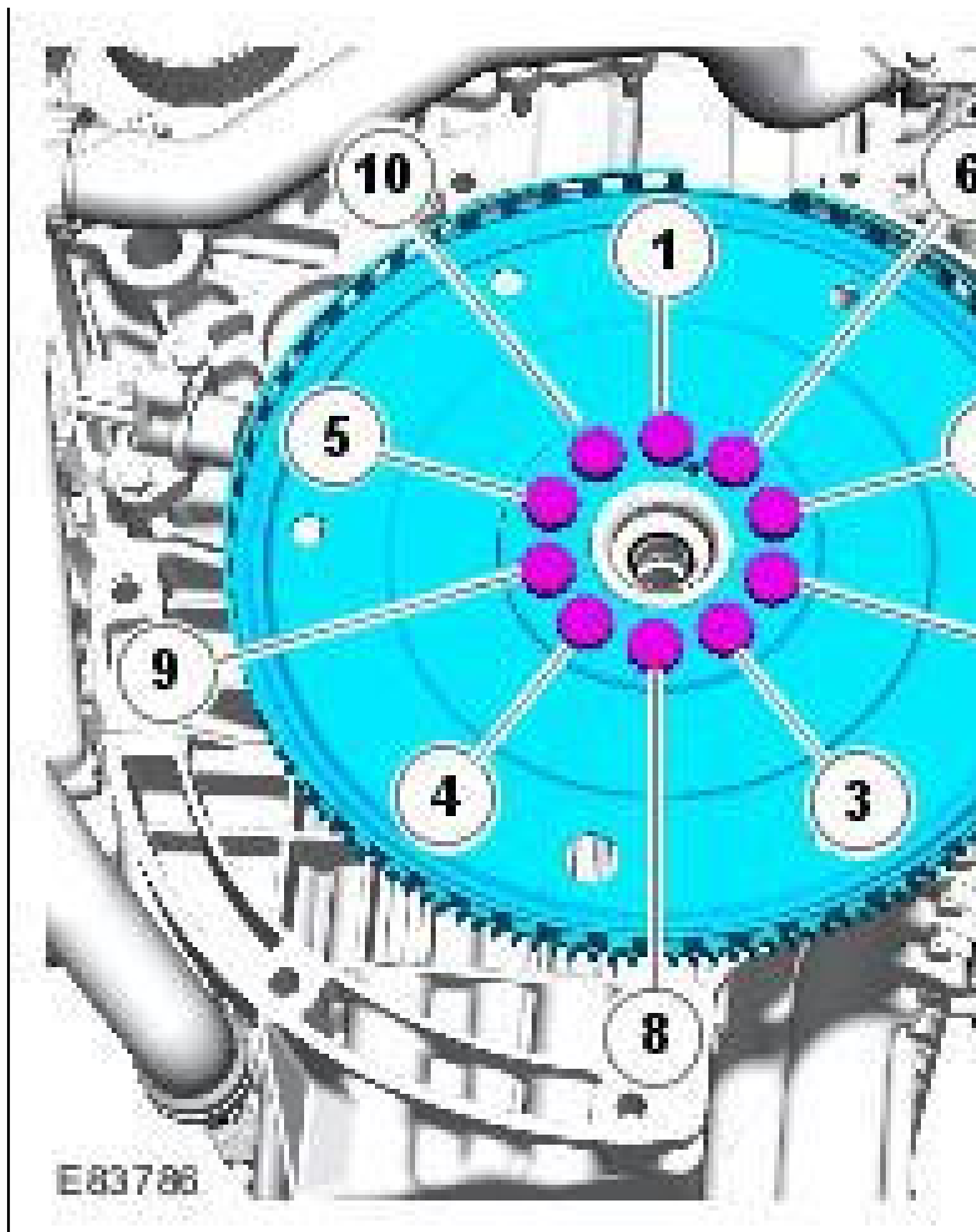
**CAUTION: Extreme cleanliness must be exercised when handling these components.**

**CAUTION: Make sure that new bolts are installed.**

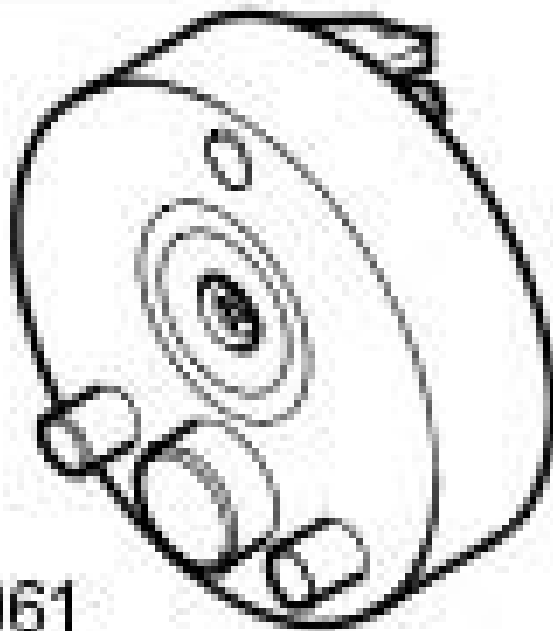
1. Install the flexplate and tighten the bolts as illustrated.

Torque:

- Stage 1: 45 Nm
- Stage 2: 50°

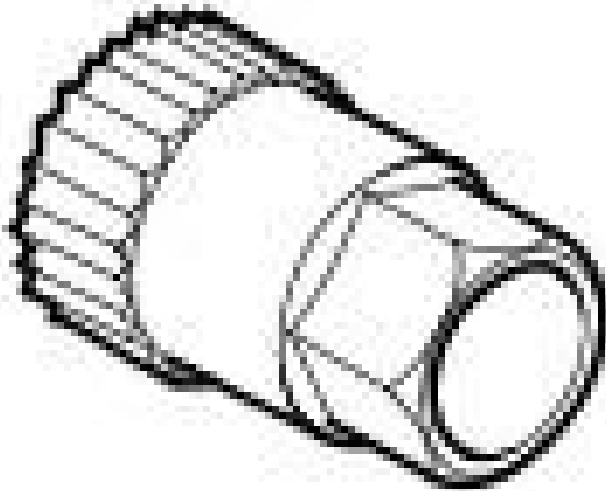


2. Install the transmission and converter. Refer to **Transmission - 3.2L** .
3. Connect the battery ground cable and install the cover. Refer to **Specifications** .

**CRANKSHAFT MAIN BEARING CARRIER****Special Tool(s)****303-1219****E82061**303-1219 Locking Tool,  
Crankshaft

303-1278 Aligner, Timing Cover

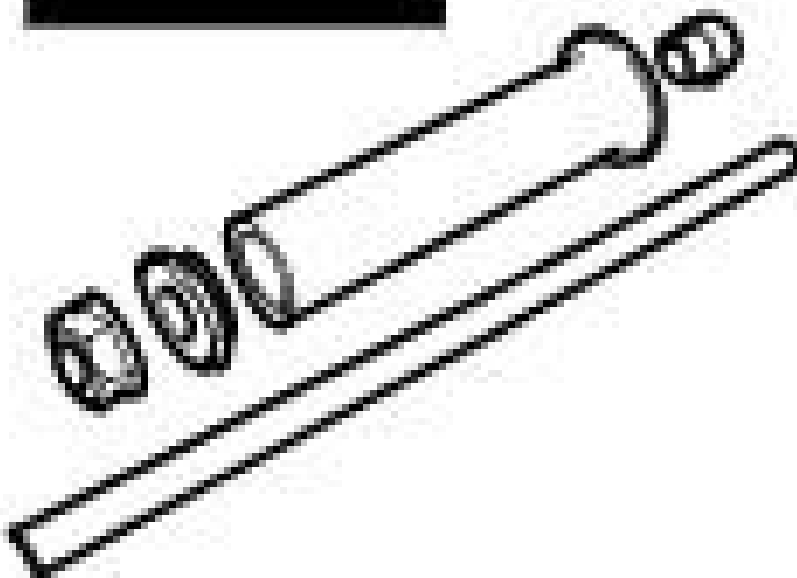
303-1278



E83825

303-1280 Remover, Oil Pump Pin

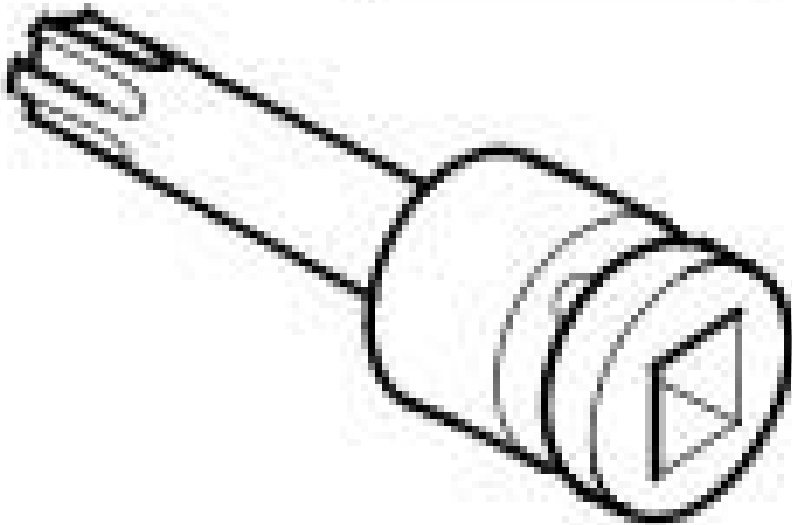
303-1280



E83825

303-1284 Torx Socket, Accessory  
Drive Pulley

303-1284



E83826

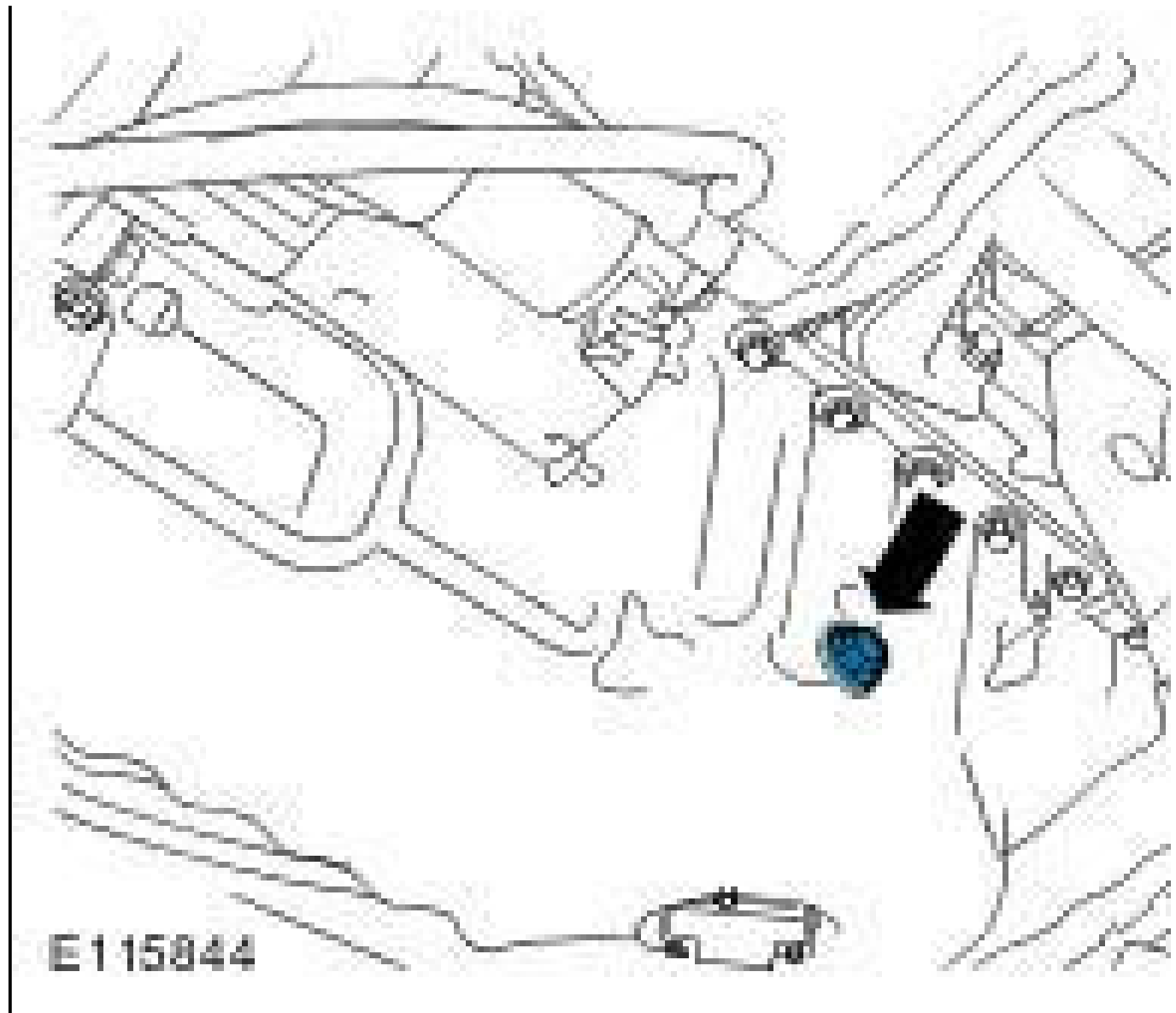
#### REMOVAL

**NOTE:** Removal steps in this procedure may contain installation details.

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

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

1. Raise and support the vehicle.
2.
  - Torque: 38 Nm.
  - Remove and discard the sealing washer.

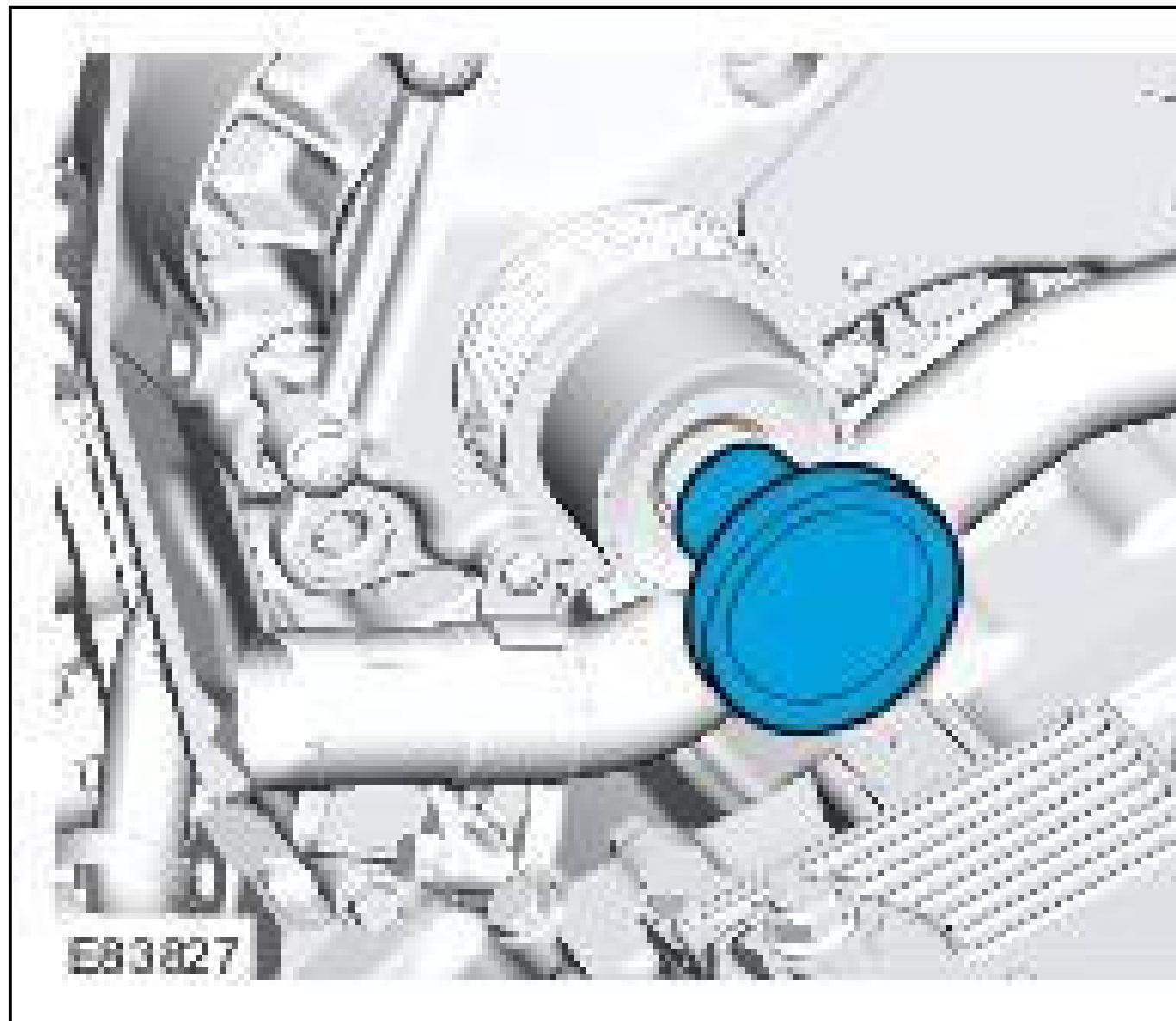


**WARNING:** Avoid skin contact with the specified material.

**CAUTION:** Hot fluid.

**CAUTION:** Be prepared to collect escaping fluids.

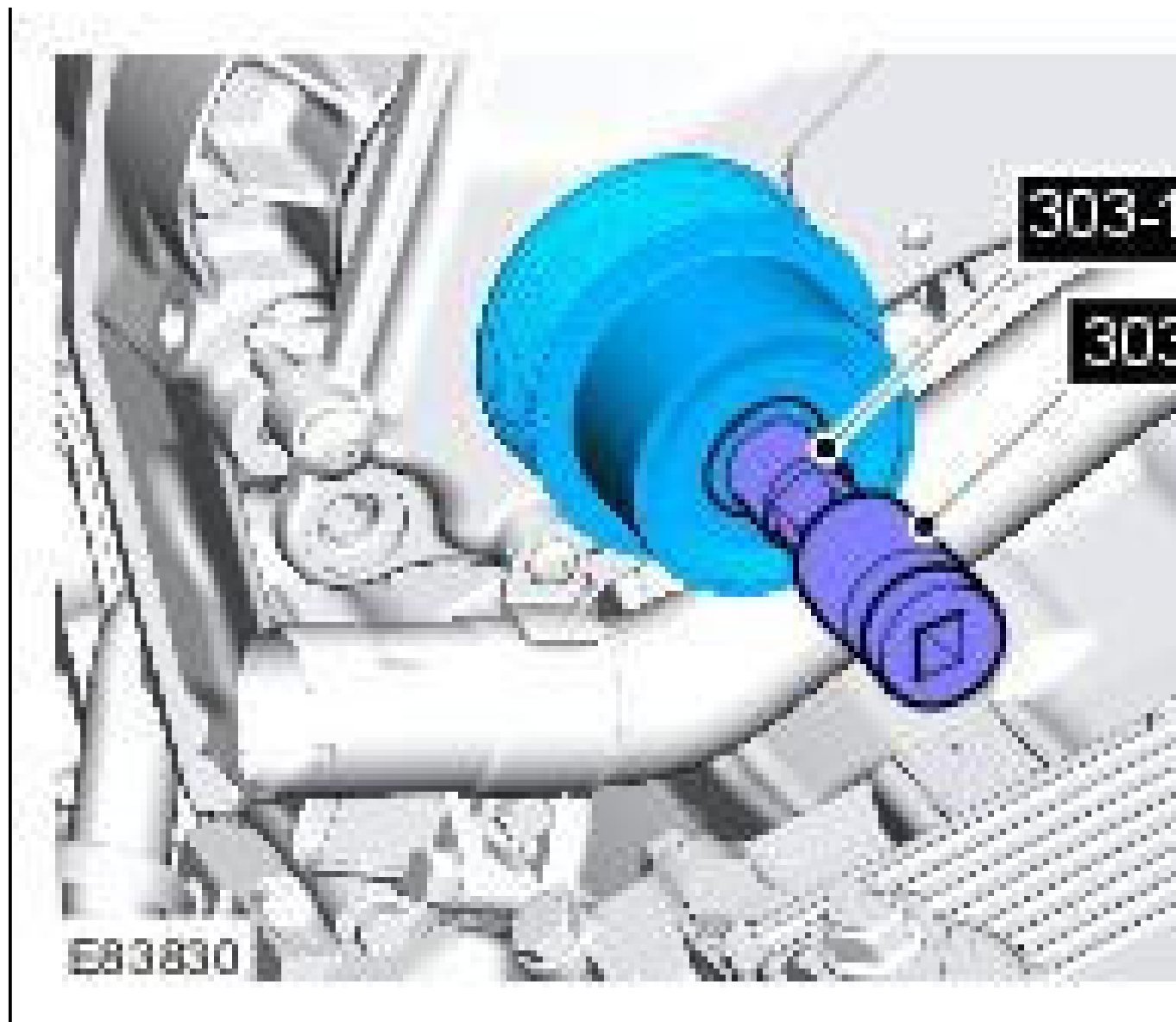
3. Refer to: **Removal**
4. See figure.



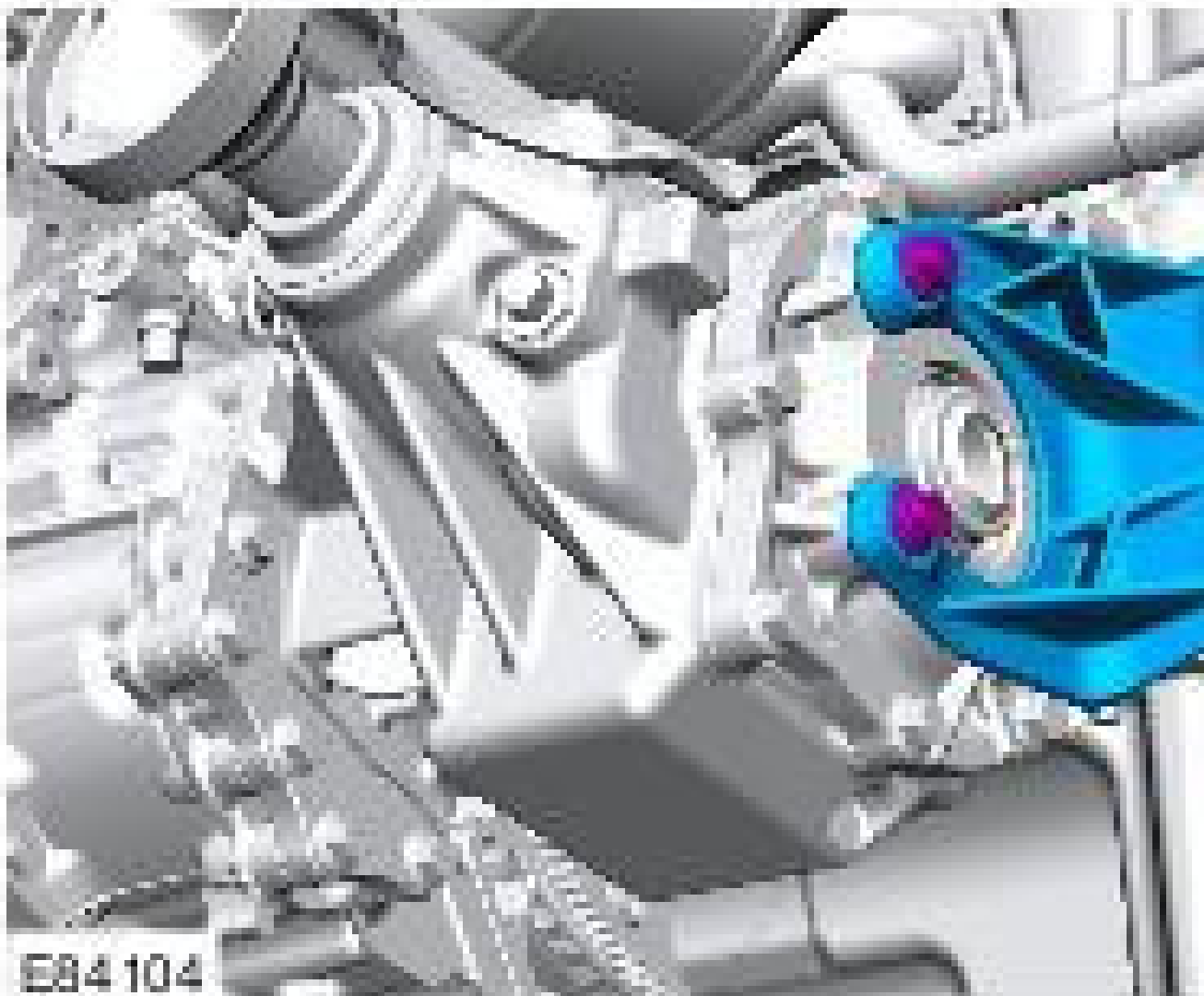
5. Torx Socket, Accessory Drive Pulley (303-1284)

Aligner, Timing Cover (303-1278)

Torque: 60 Nm.

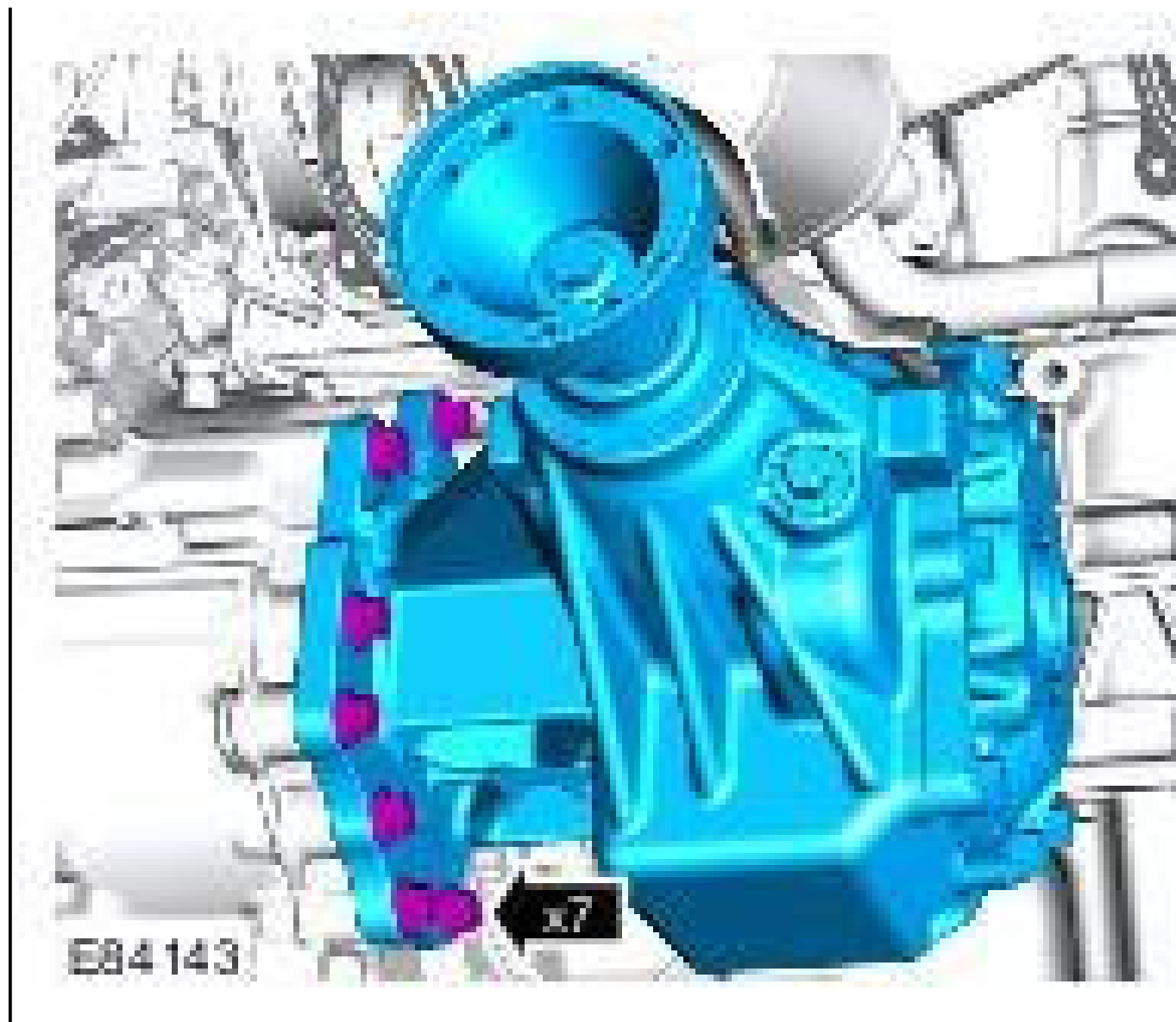


6. Torque: 65 Nm.



**NOTE:** This step requires the aid of another technician.

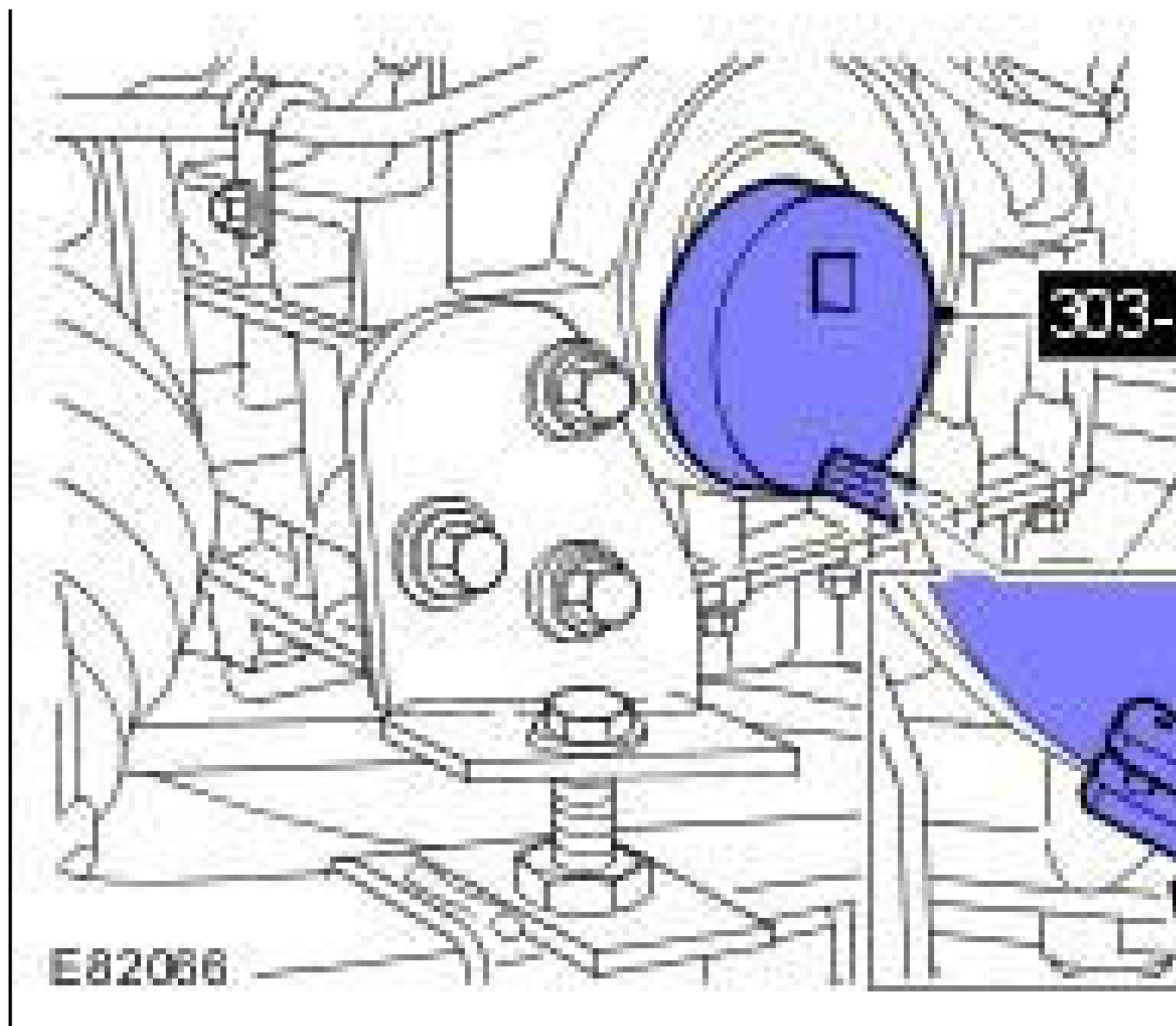
7. Torque: 65 Nm.



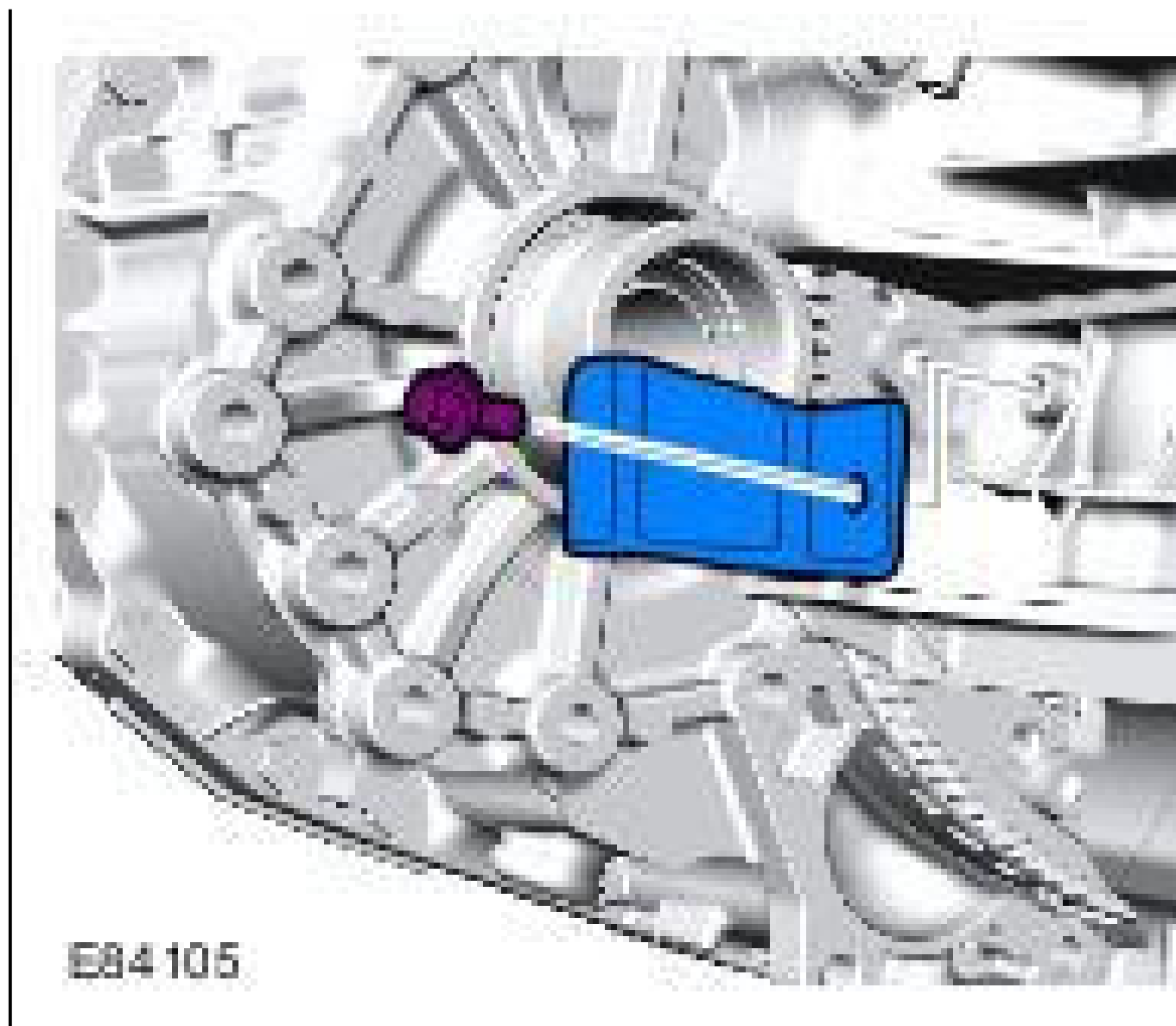
8.

- If the locking pin on the special tool is disengaged, the crankshaft can be rotated.
- Locking Tool, Crankshaft (303-1219)

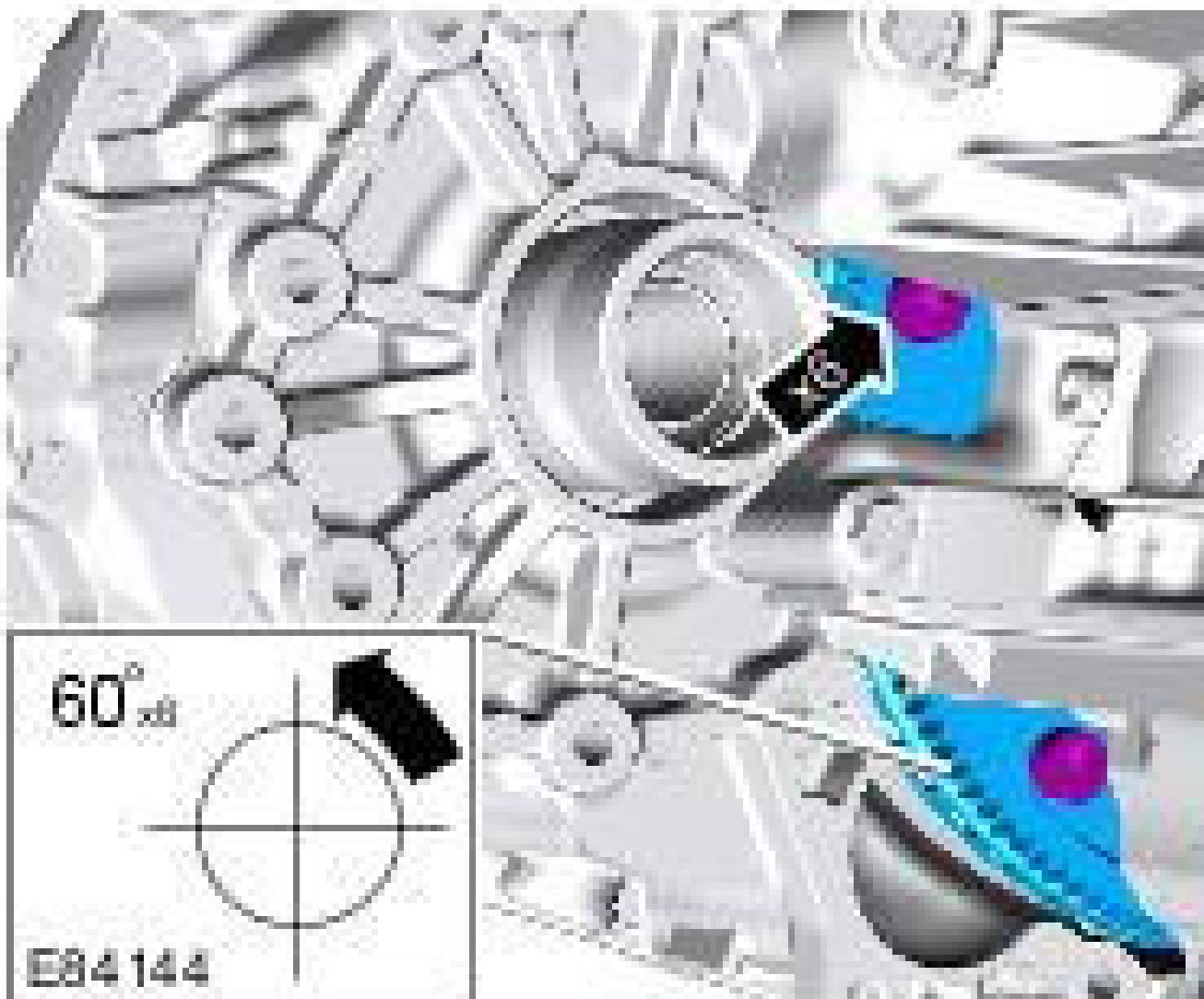
**NOTE:** Some variation in the illustrations may occur, but the essential information is always correct.



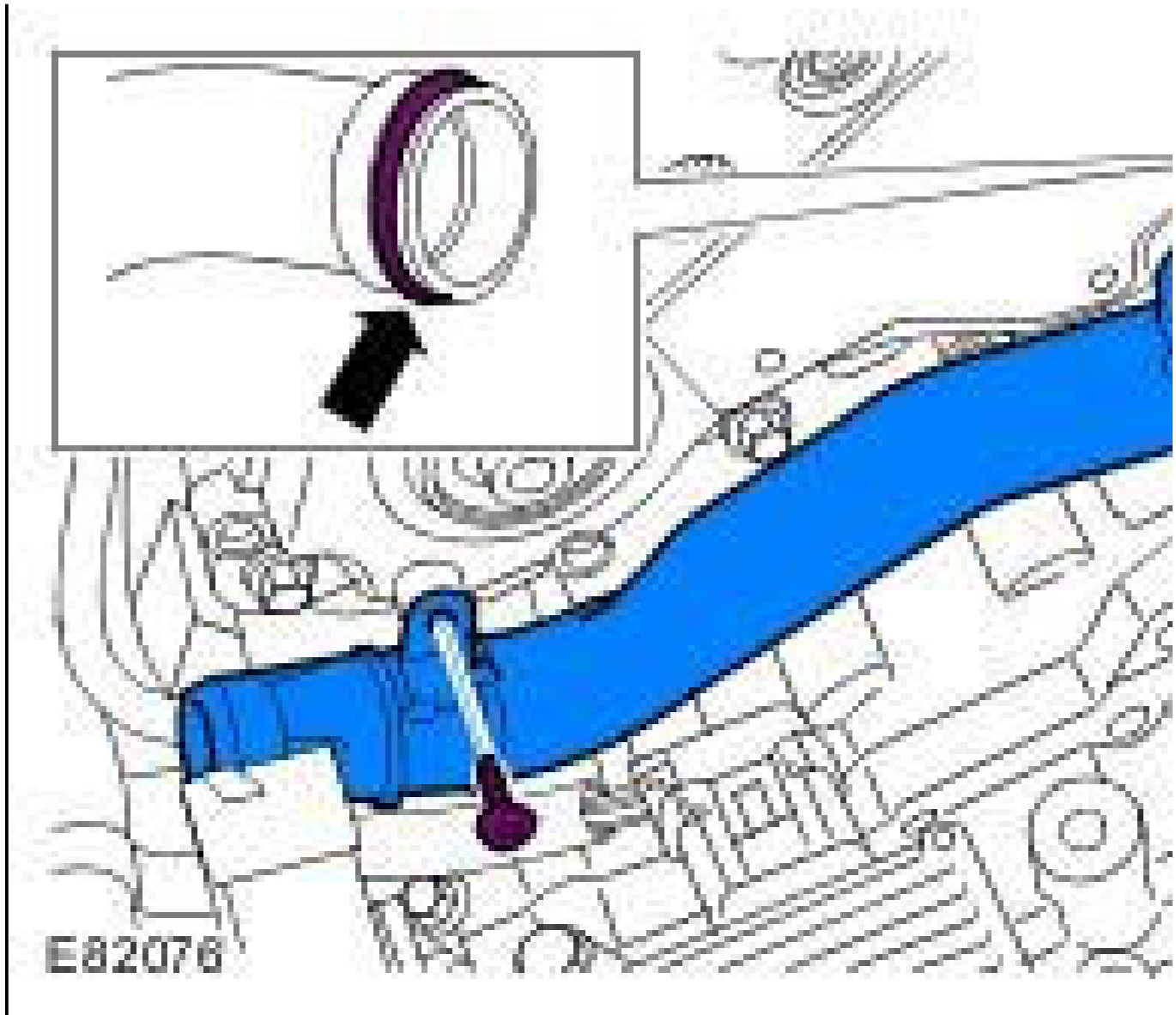
9. Torque: 10 Nm.



10. Torque: 47 Nm.



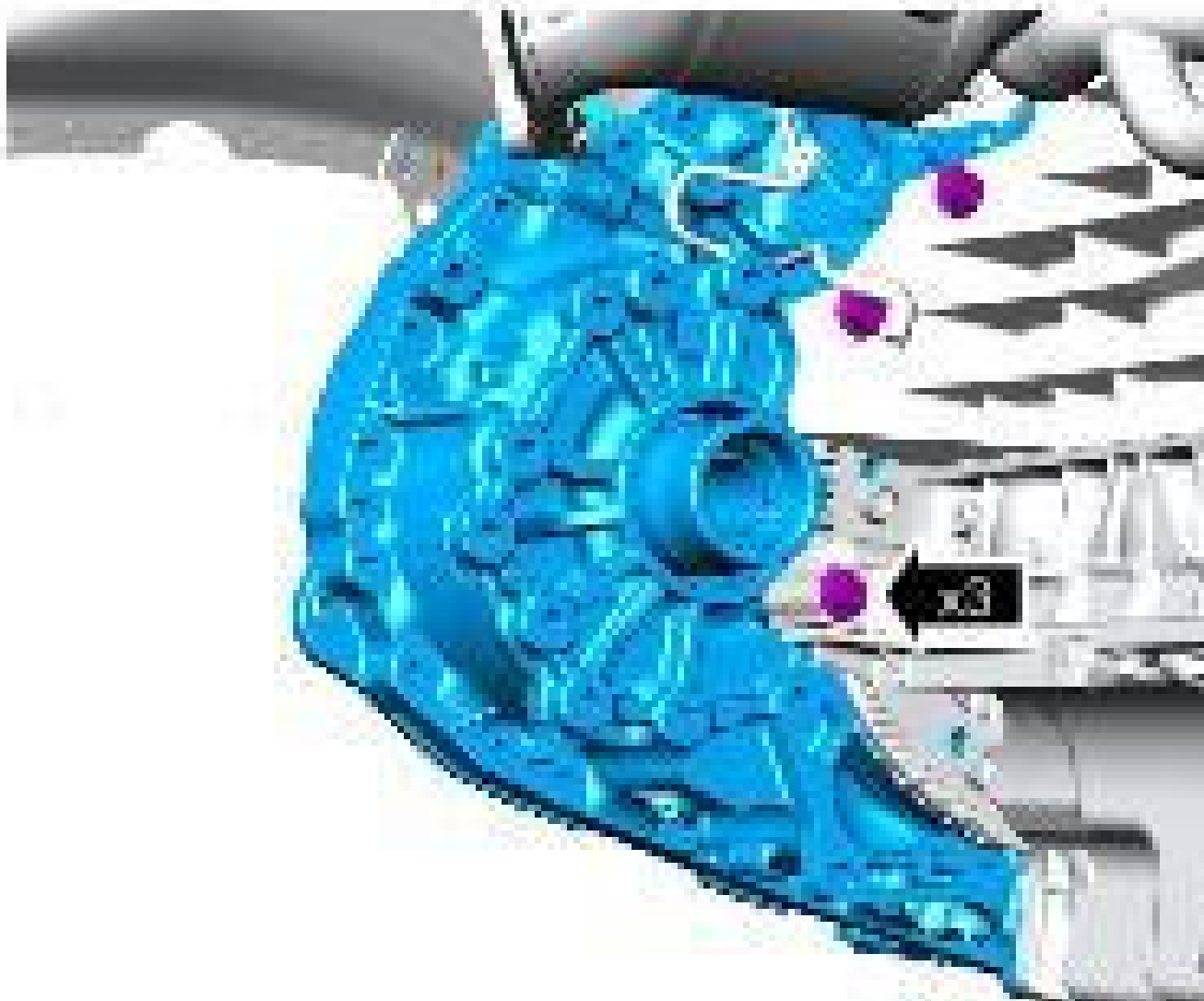
11. Torque: 10 Nm.



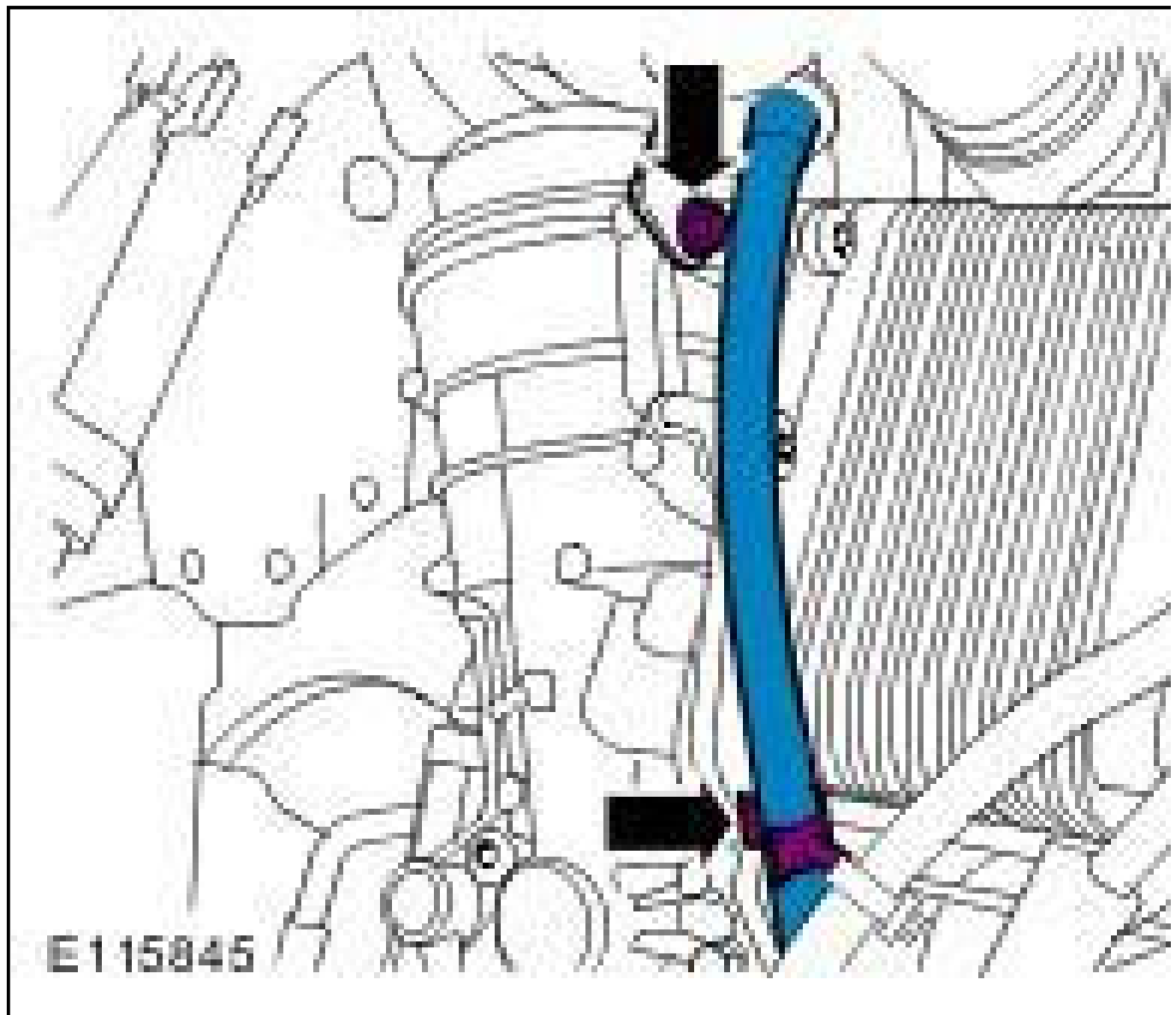
**CAUTION:** Make sure that the torque converter remains in the transmission.

**NOTE:** This step requires the aid of another technician.

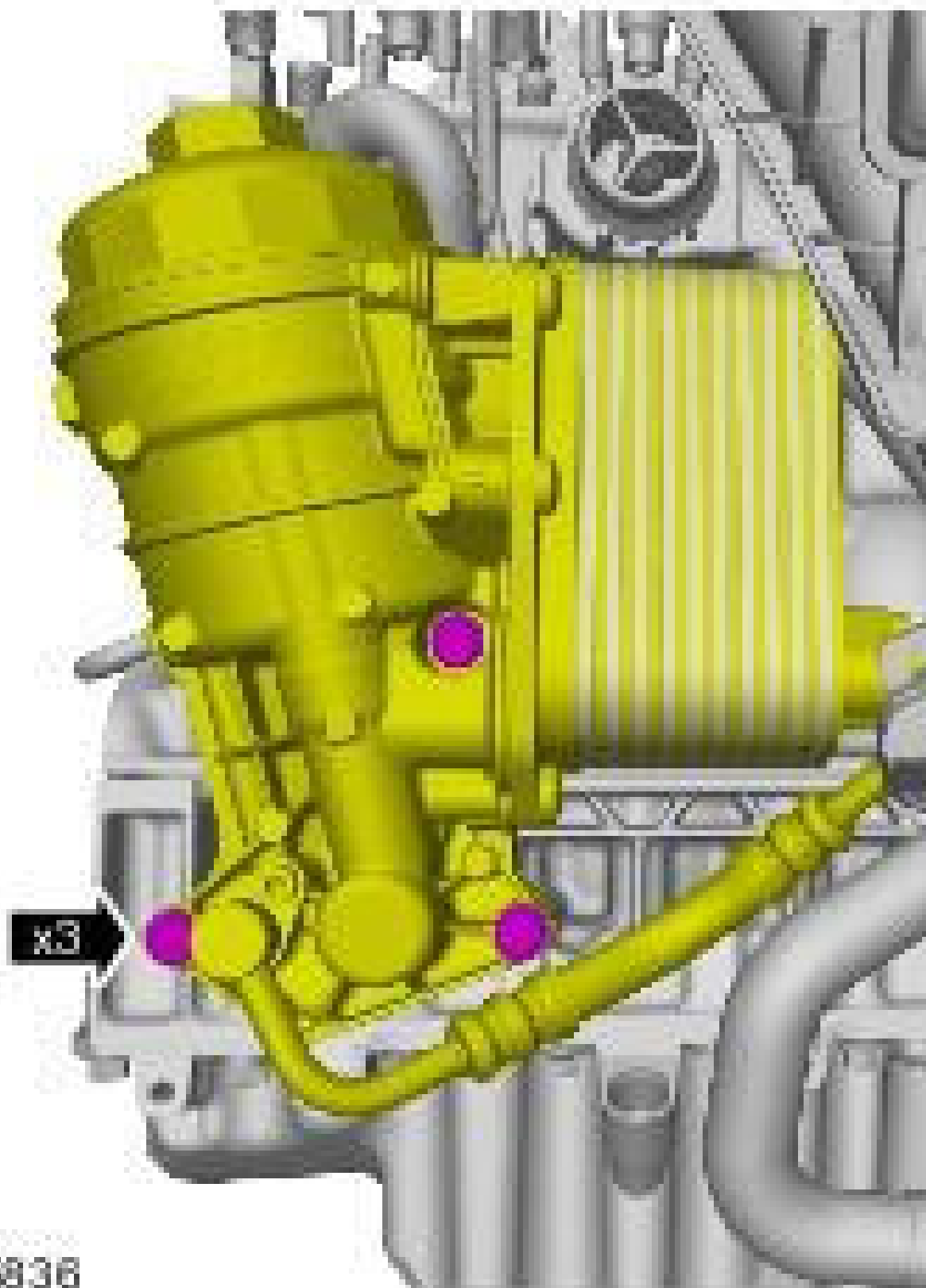
12. Torque: 47 Nm.



13. Mount the engine to an engine stand.
14. Torque: 10 Nm.

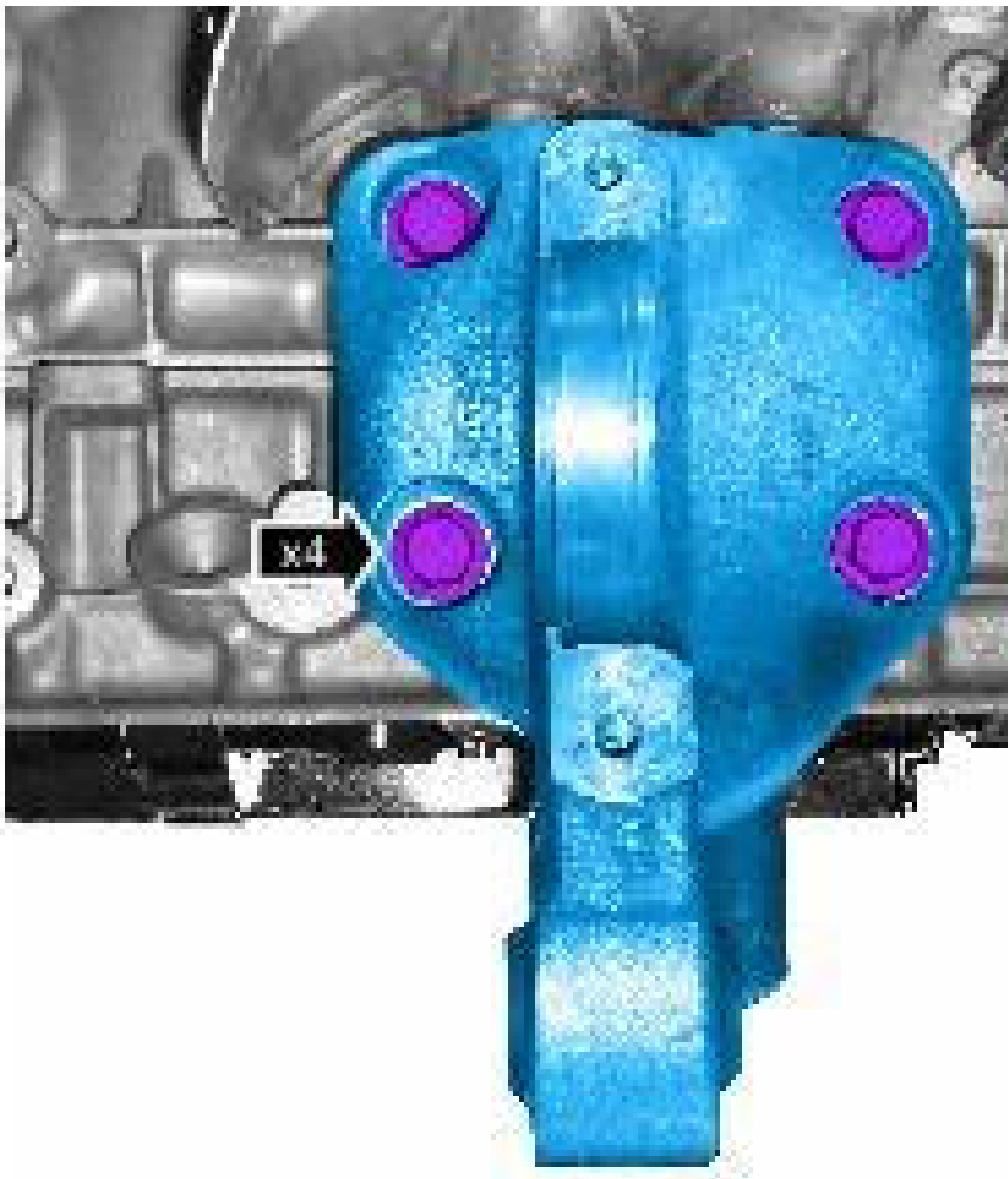


15. Torque: 10 Nm.



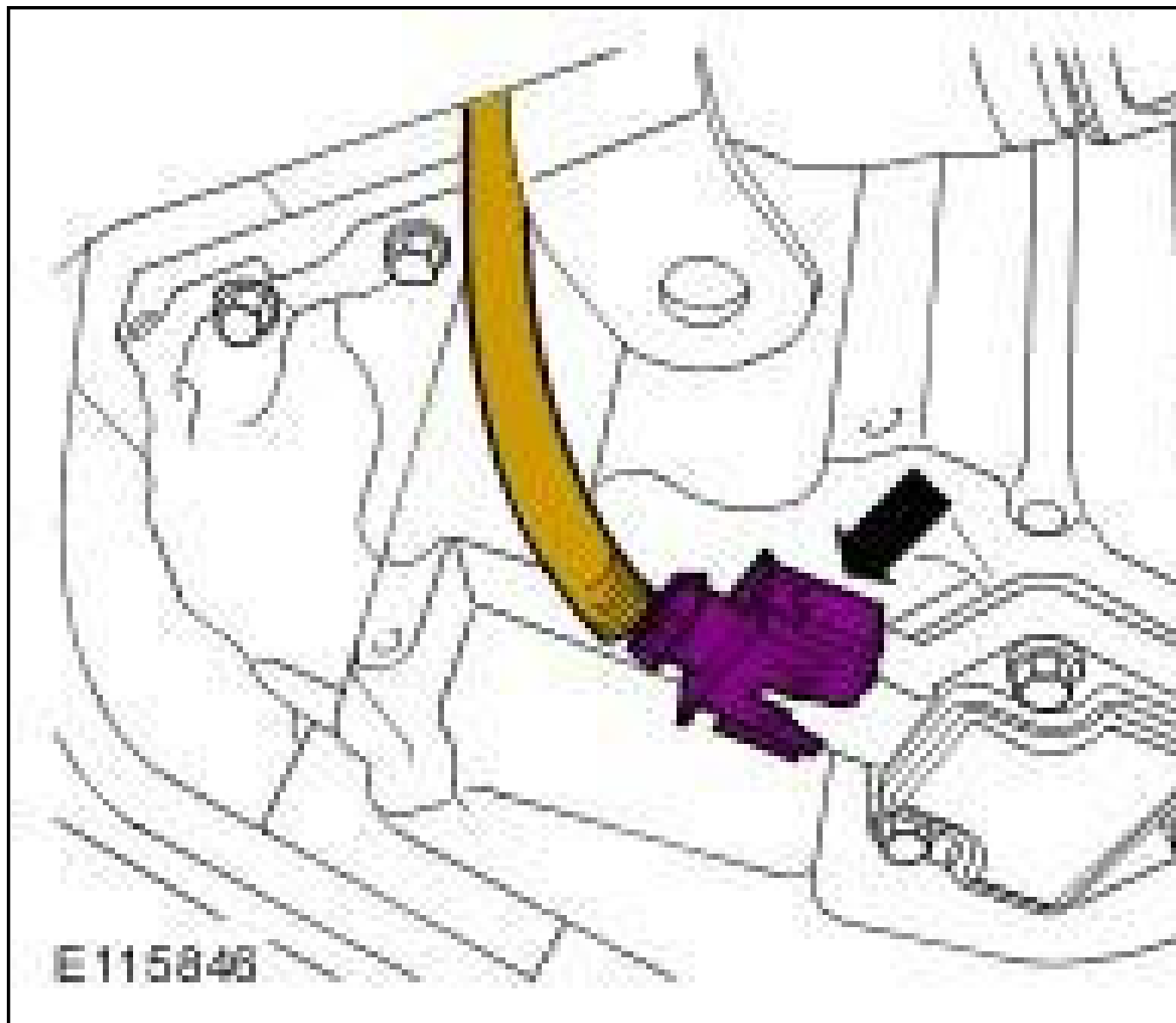
E115836

16. Torque: 48 Nm.

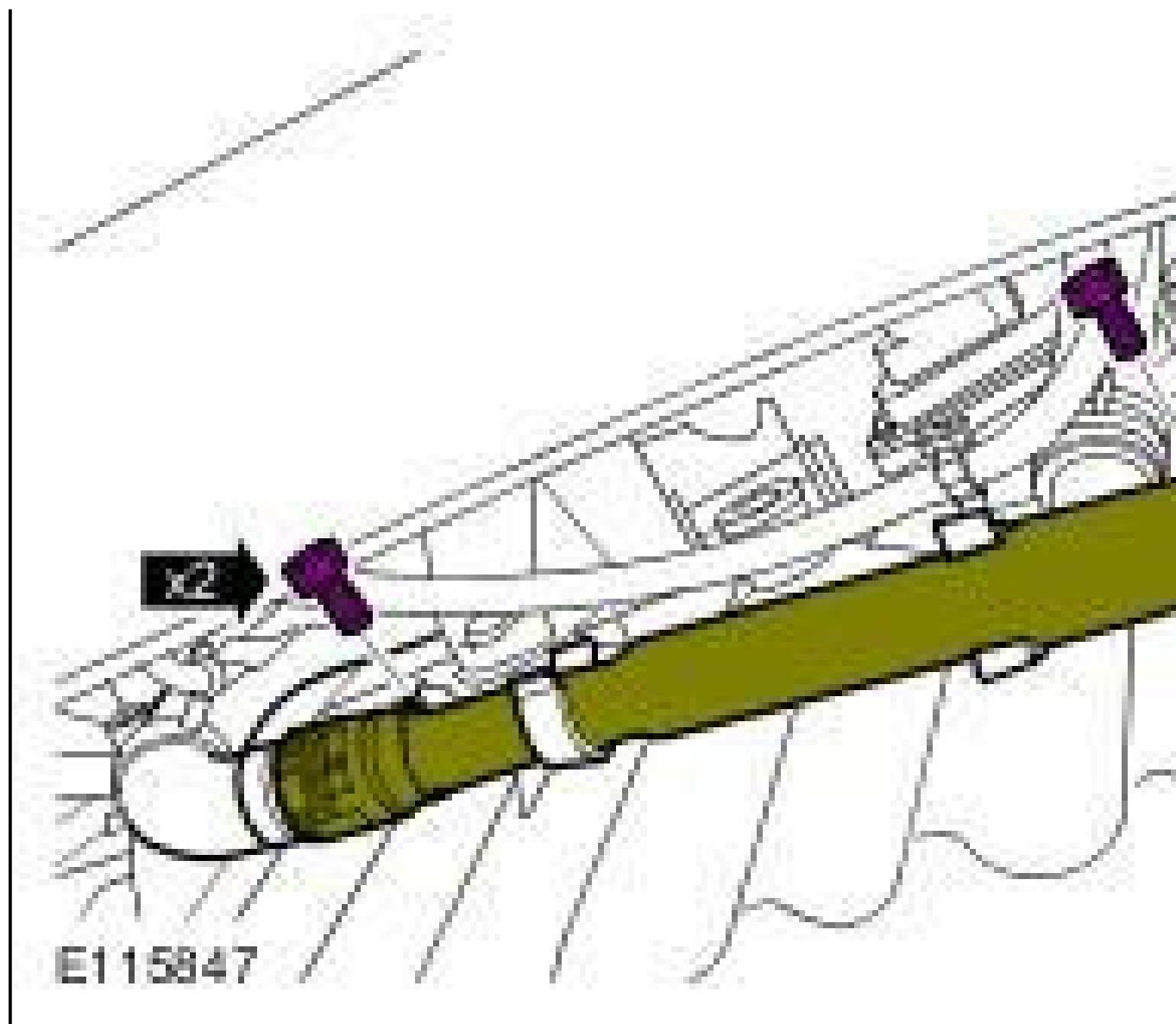


E115849

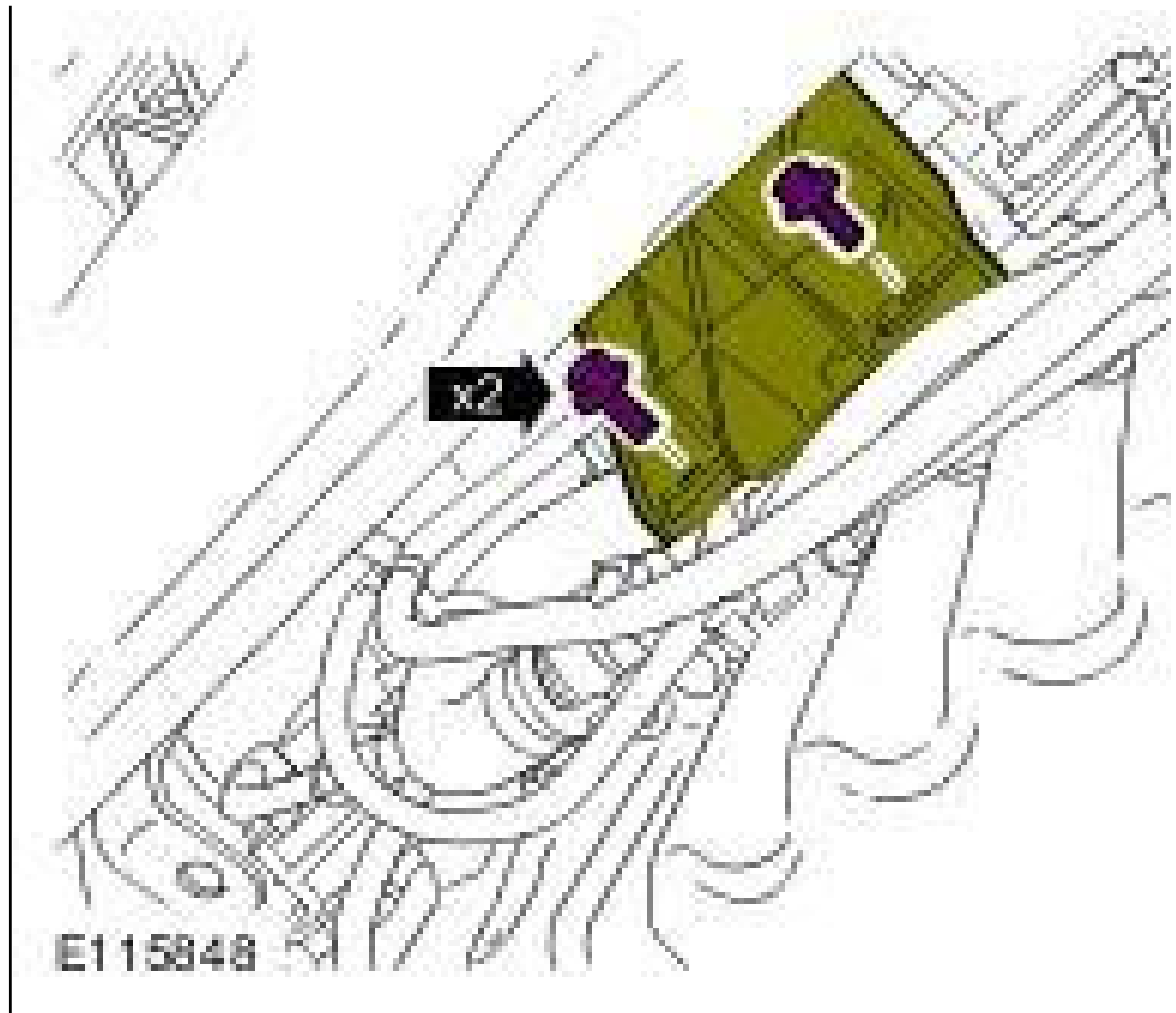
17. See figure.



18. Torque: 10 Nm.

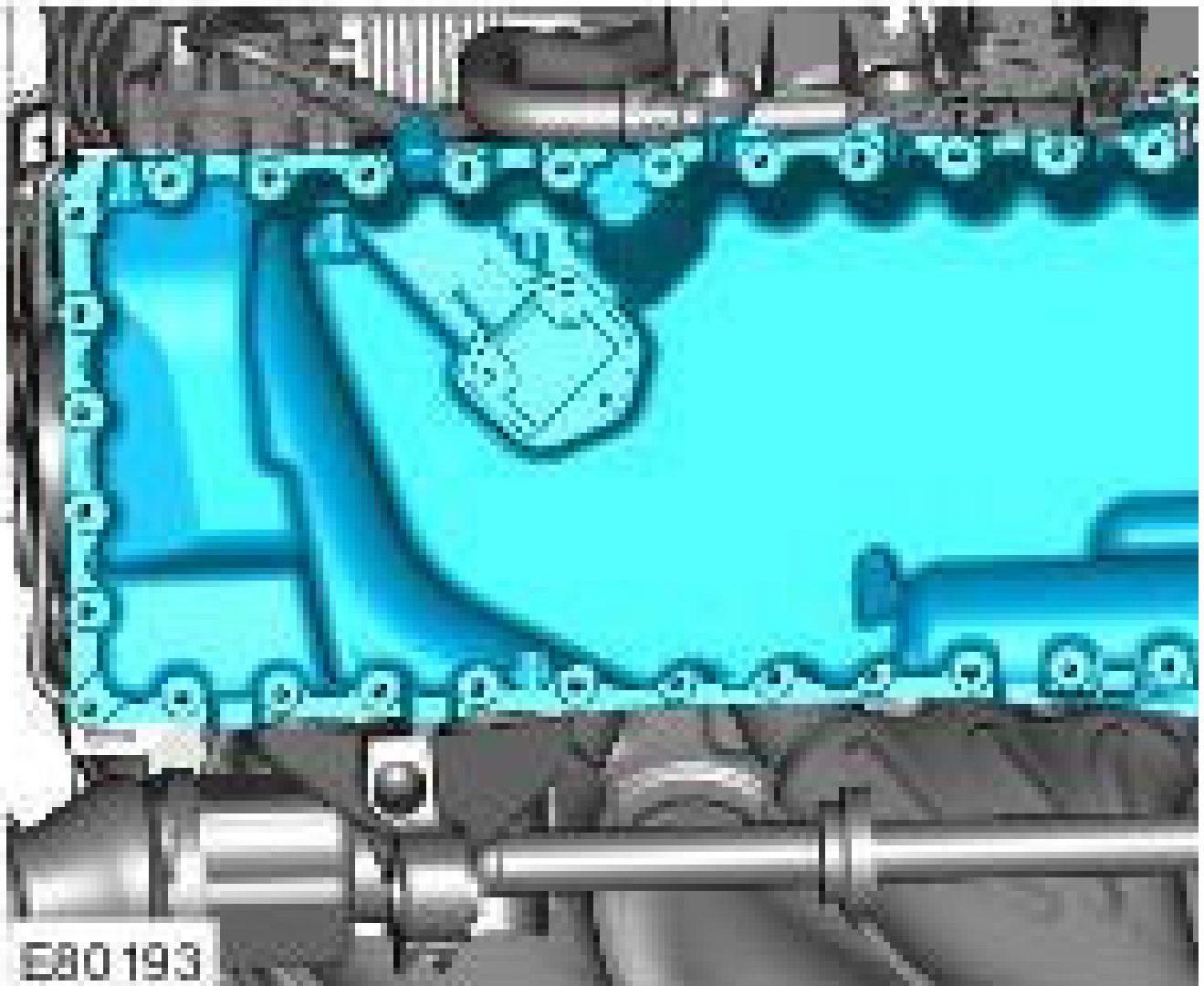


19. Torque: 10 Nm.



20. See figure.

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

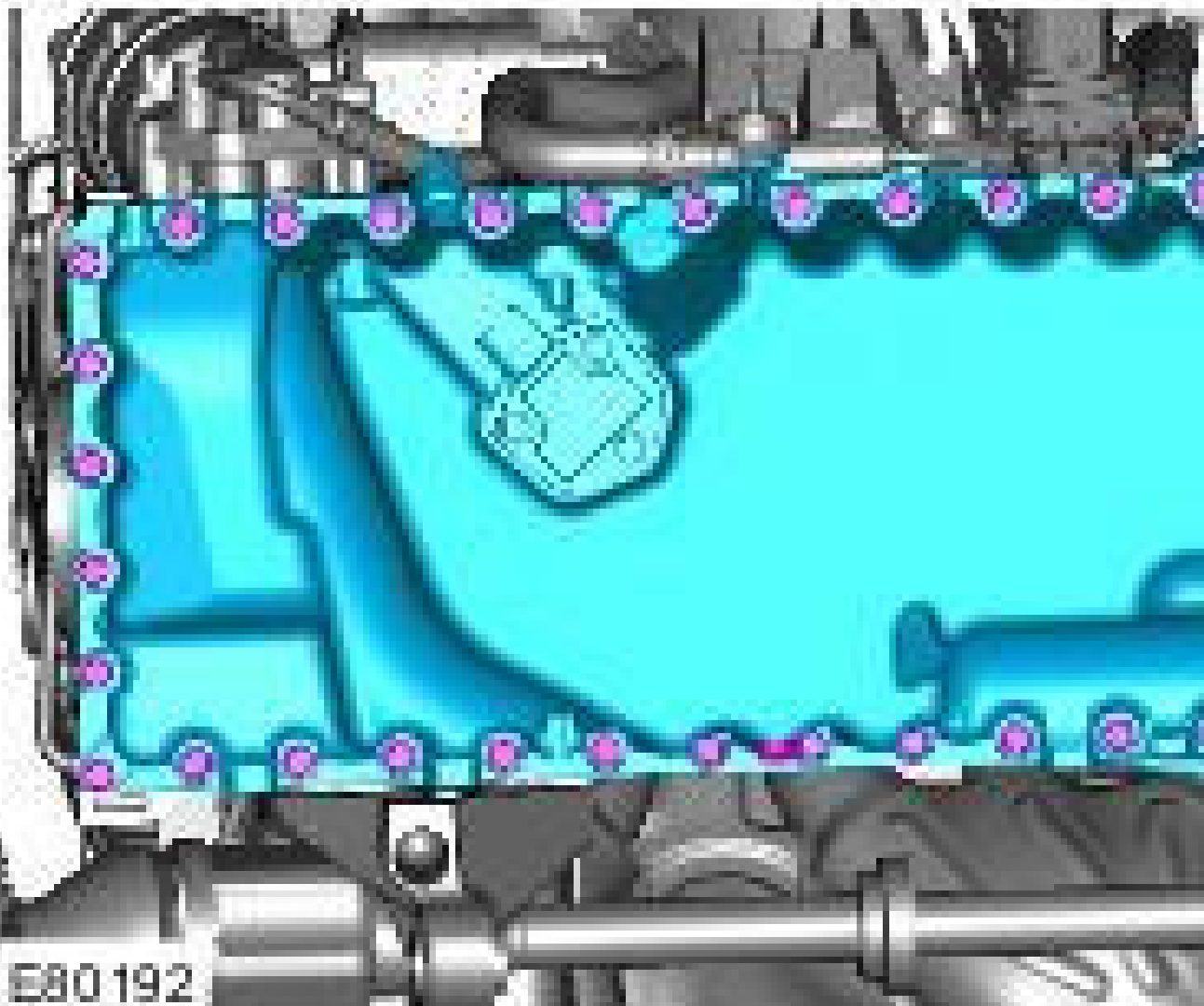


**NOTE:** Make sure that all traces of the old sealant are removed from the mating faces.

21. Torque:

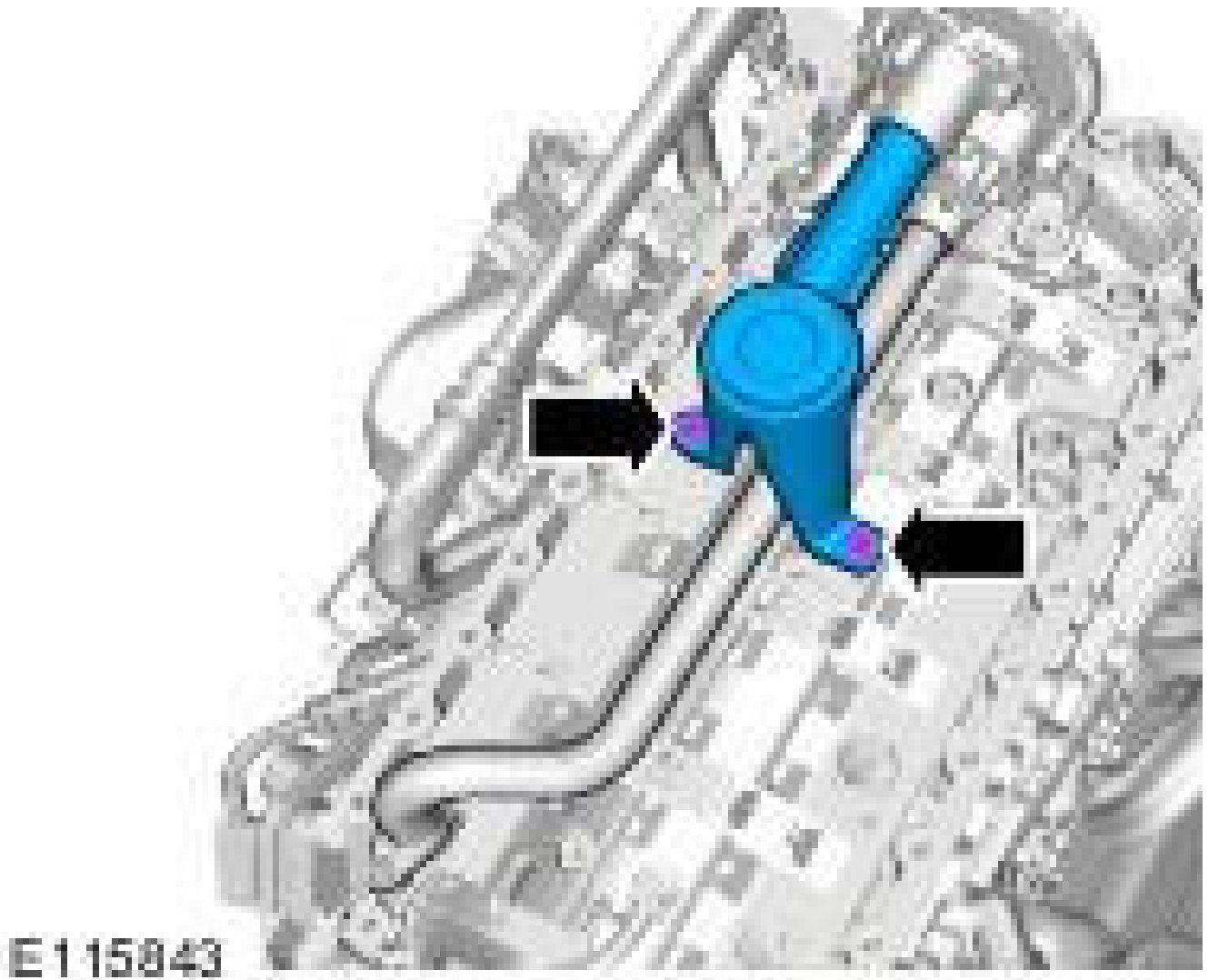
M7: 17 Nm

M10: 45 Nm



**CAUTION:** Discard the seal.

22. Torque: 17 Nm.



Vehicles built up to VIN:148530

**CAUTION: Discard the seals.**

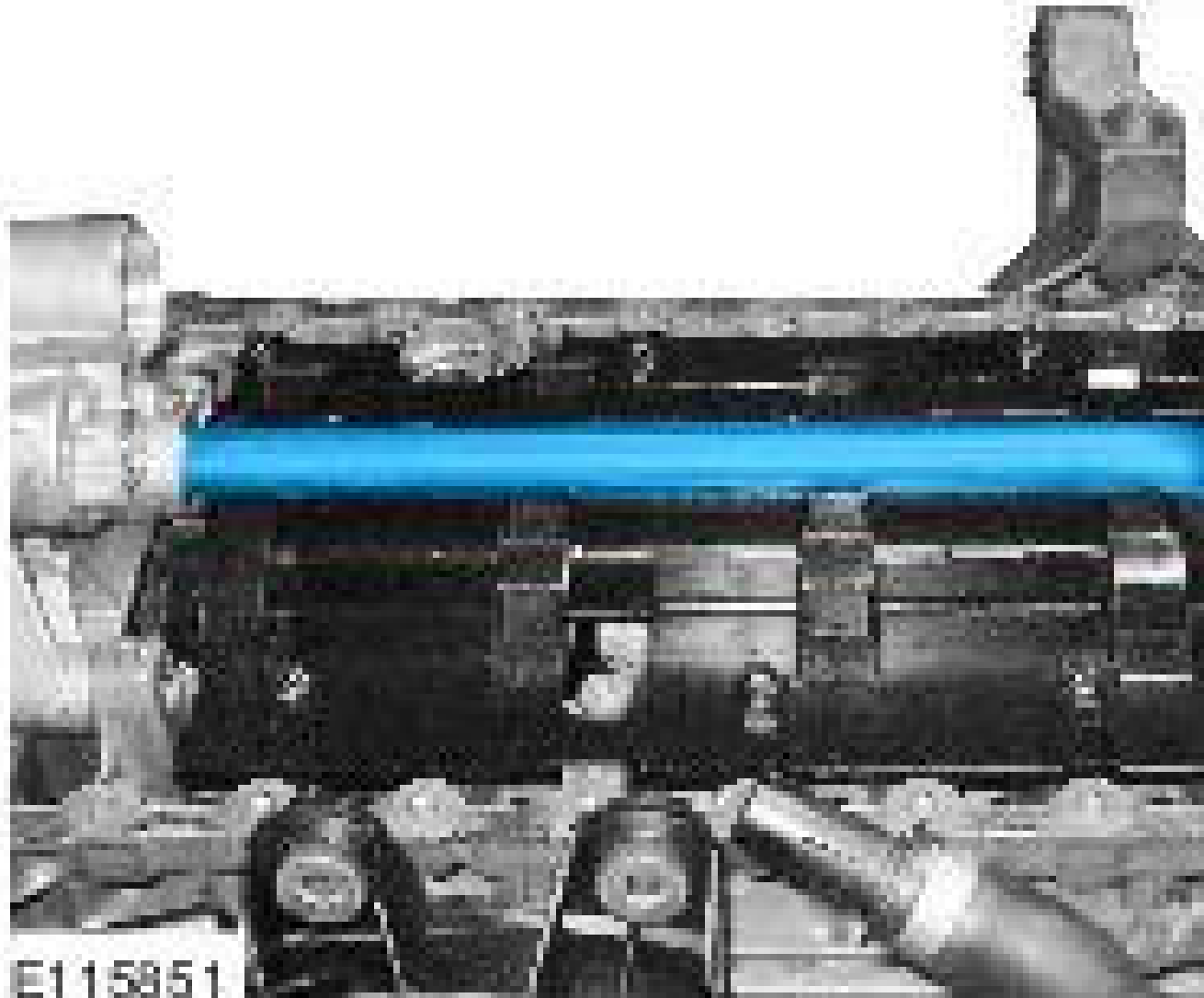
23. Torque: 17 Nm.



All vehicles

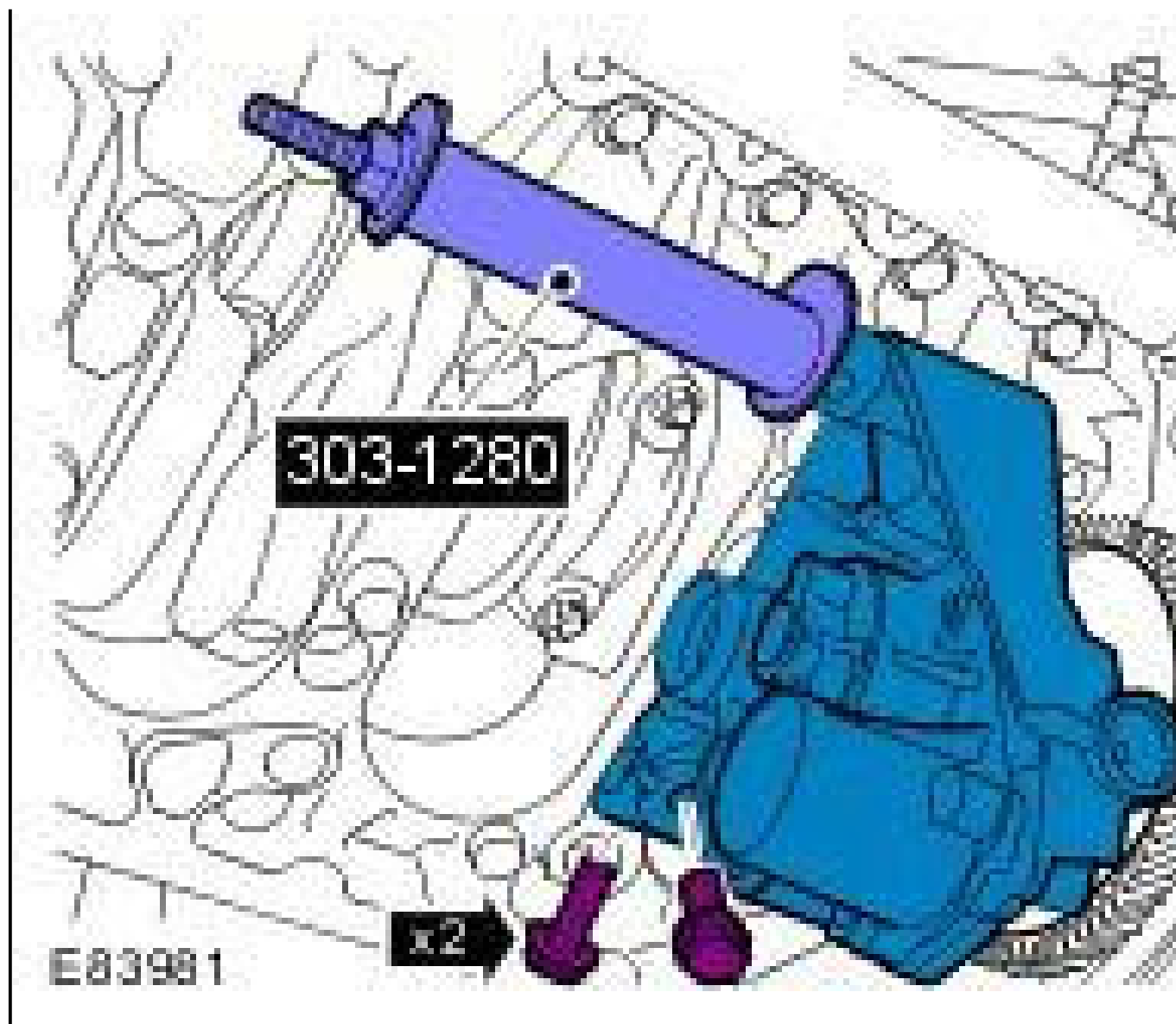
**CAUTION: Discard the seals.**

24. Torque: 17 Nm.

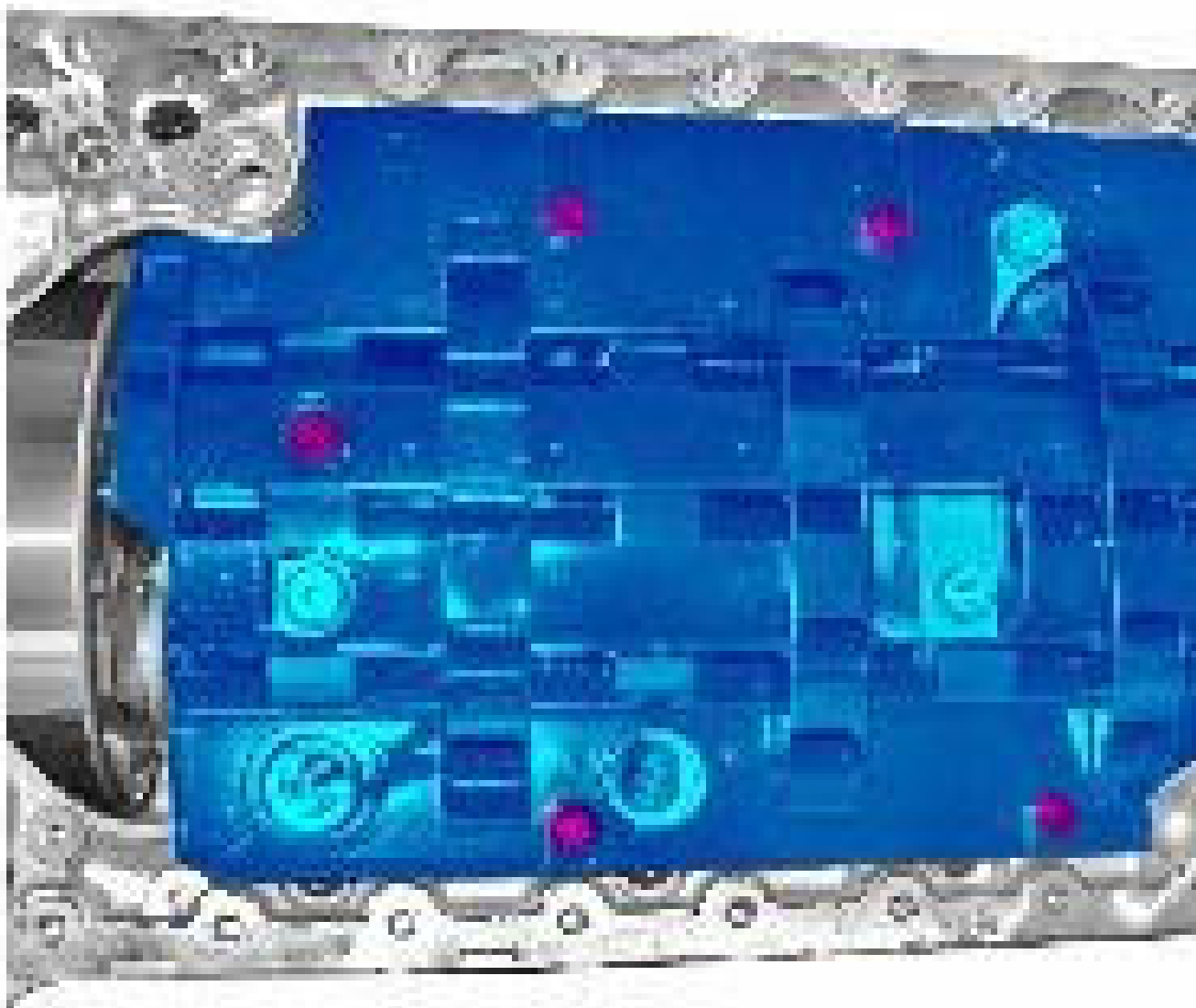


25.

- Remove the oil pump pivot pin.
- Remover, Oil Pump Pin (303-1280)

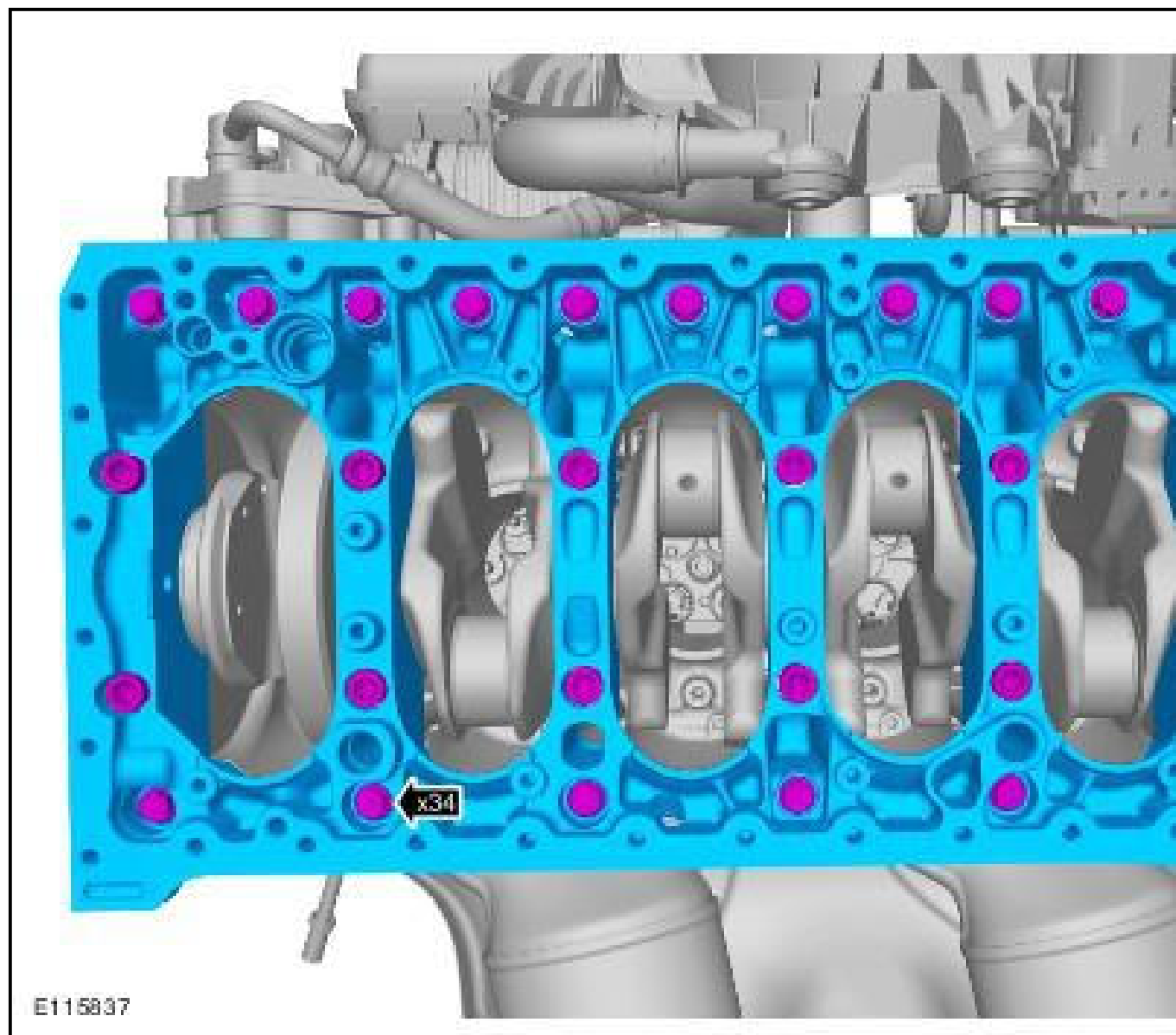


26. See figure.

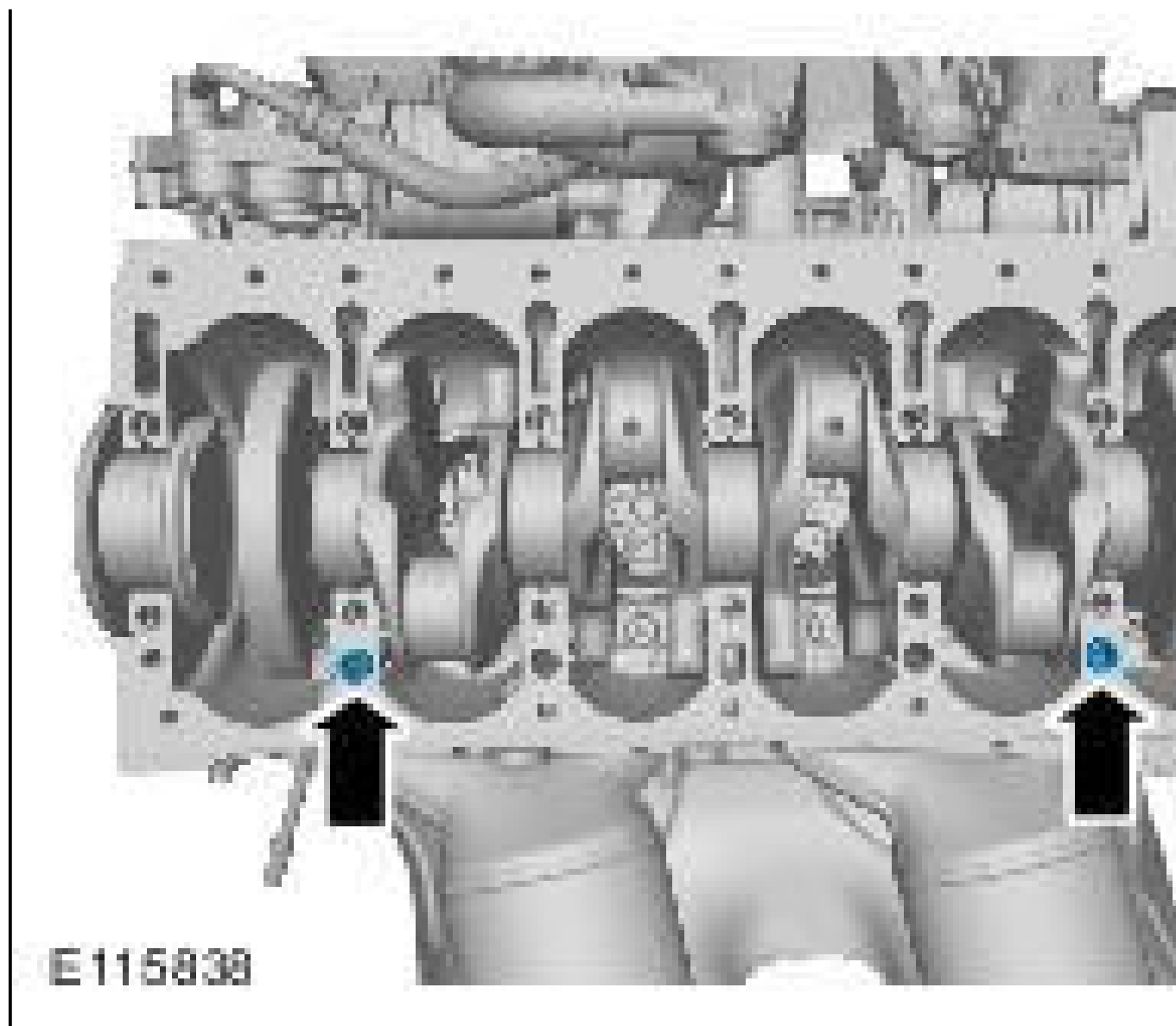


E138944

27. See figure.

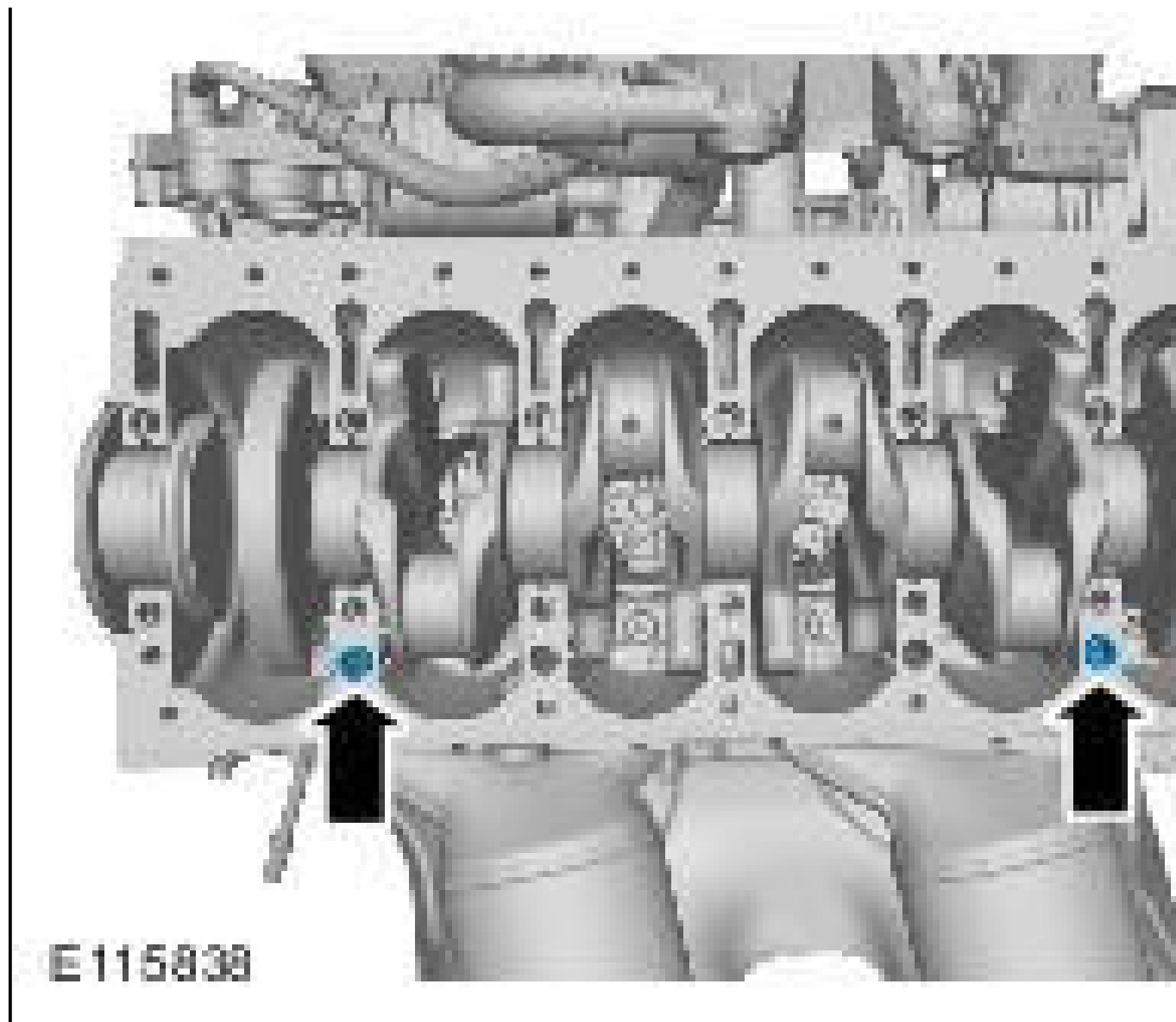


28. See figure.



## INSTALLATION

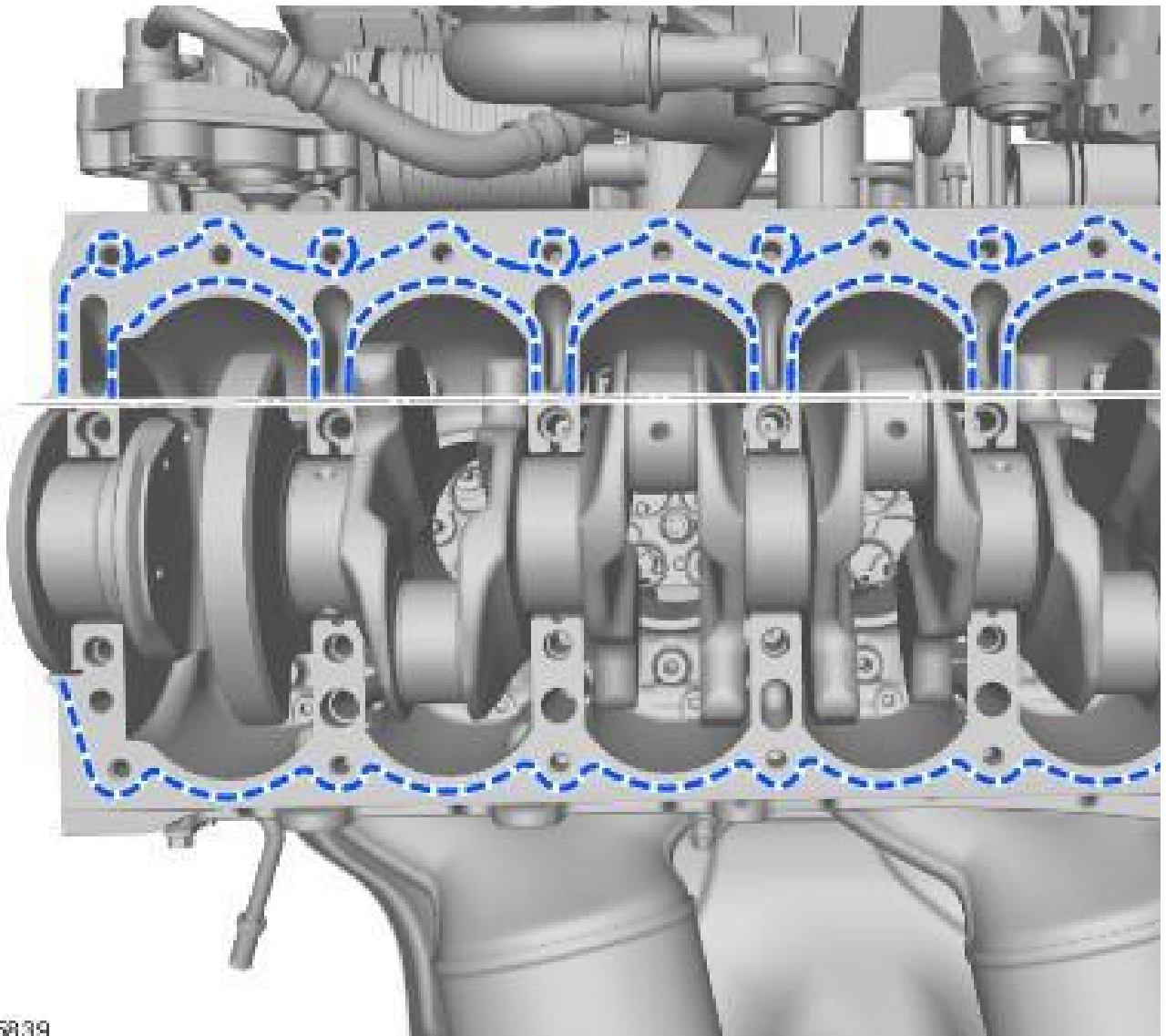
1. See figure.



2.

- Apply a 2.5mm bead of sealant STC50550 (Loctite 5900) to the areas shown.

**CAUTION:** Make sure that the mating faces are clean and free of foreign material.



**CAUTION:** Tighten the bolts in the sequence shown.

3. Torque:

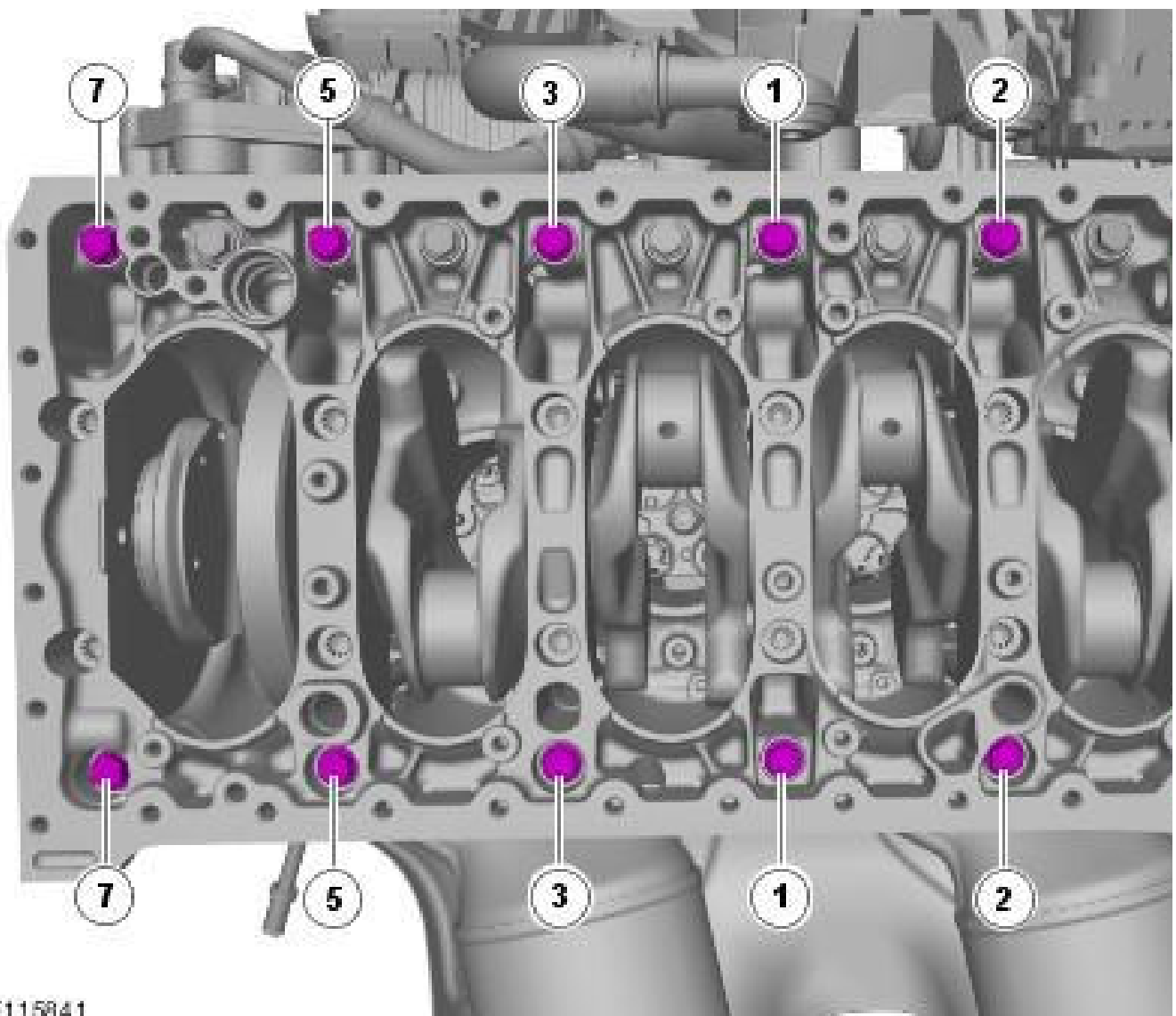
Stage 1: 5 Nm

Stage 2: 30 Nm



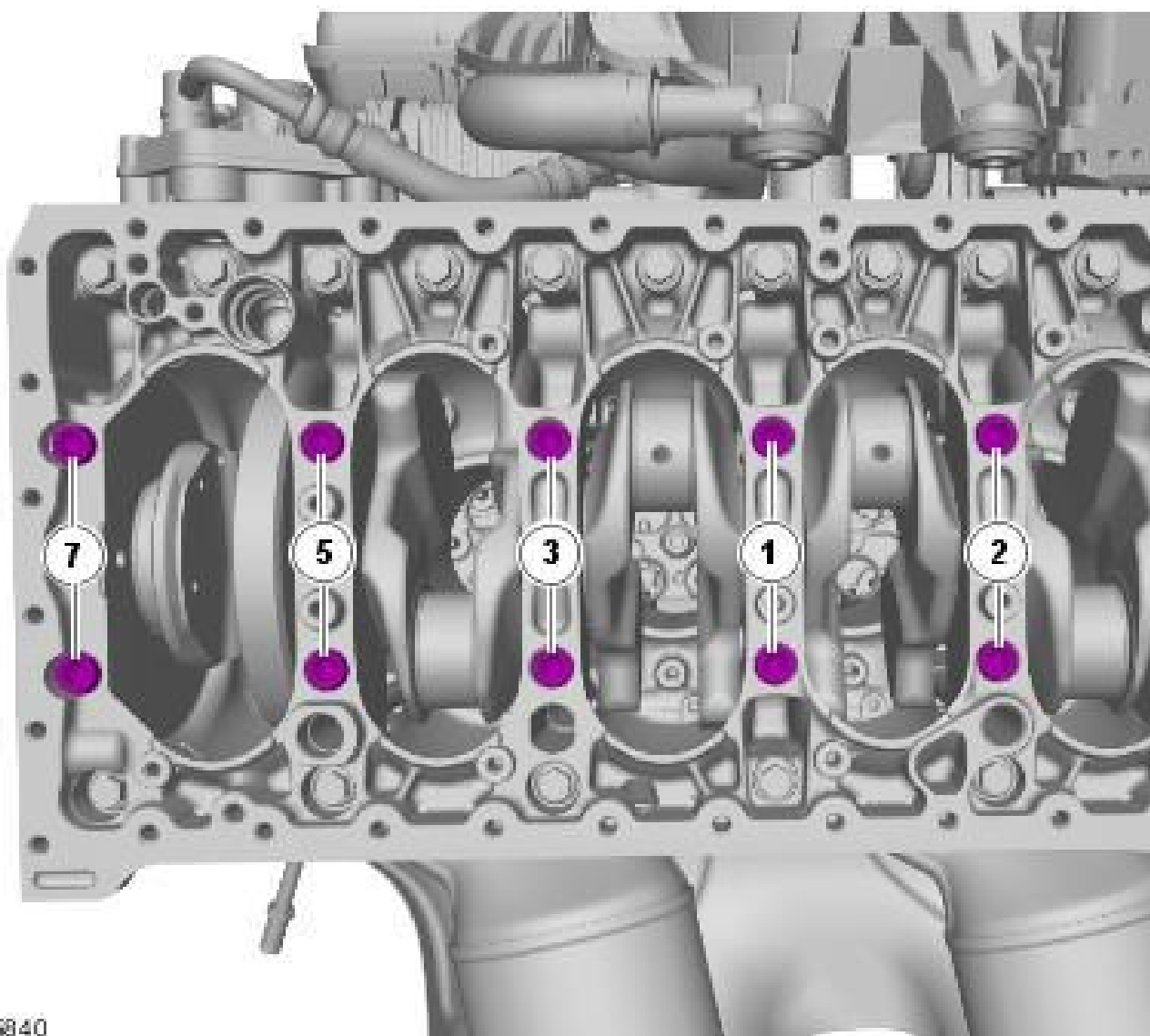
4. Torque:

Stage 2: 25 Nm

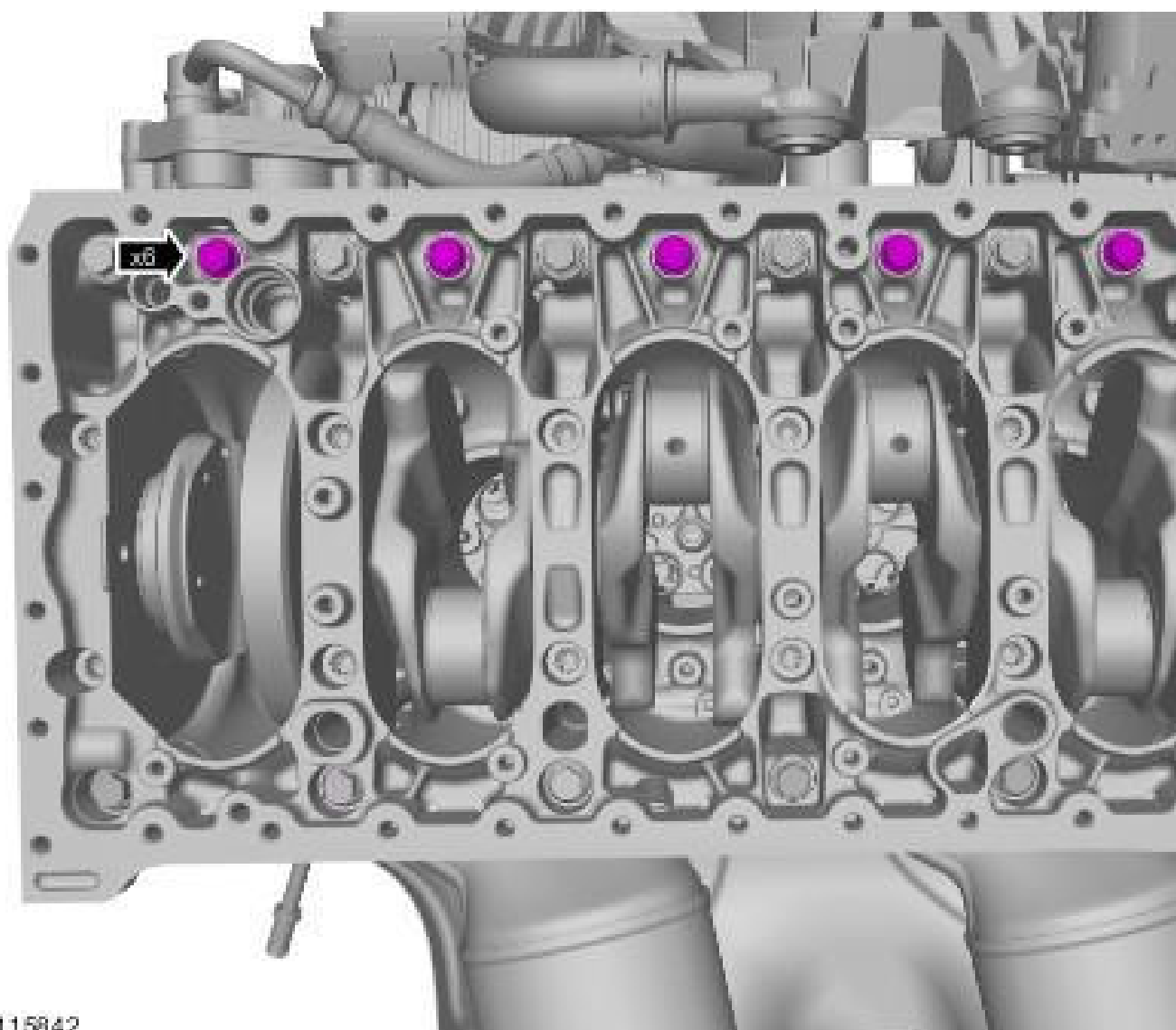


**CAUTION:** Tighten the bolts in the sequence shown.

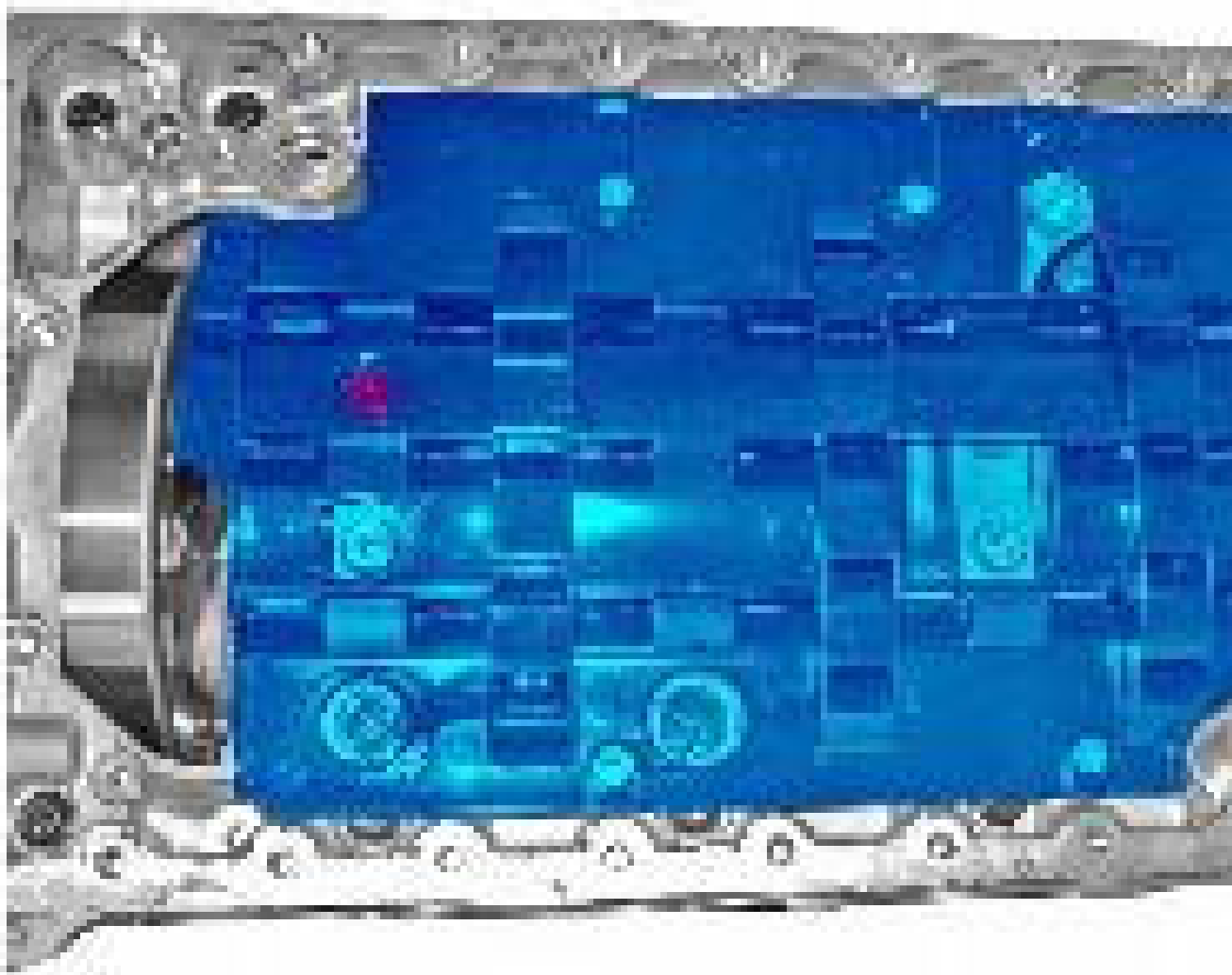
5. Torque: 105°



6. Torque: 25 Nm.

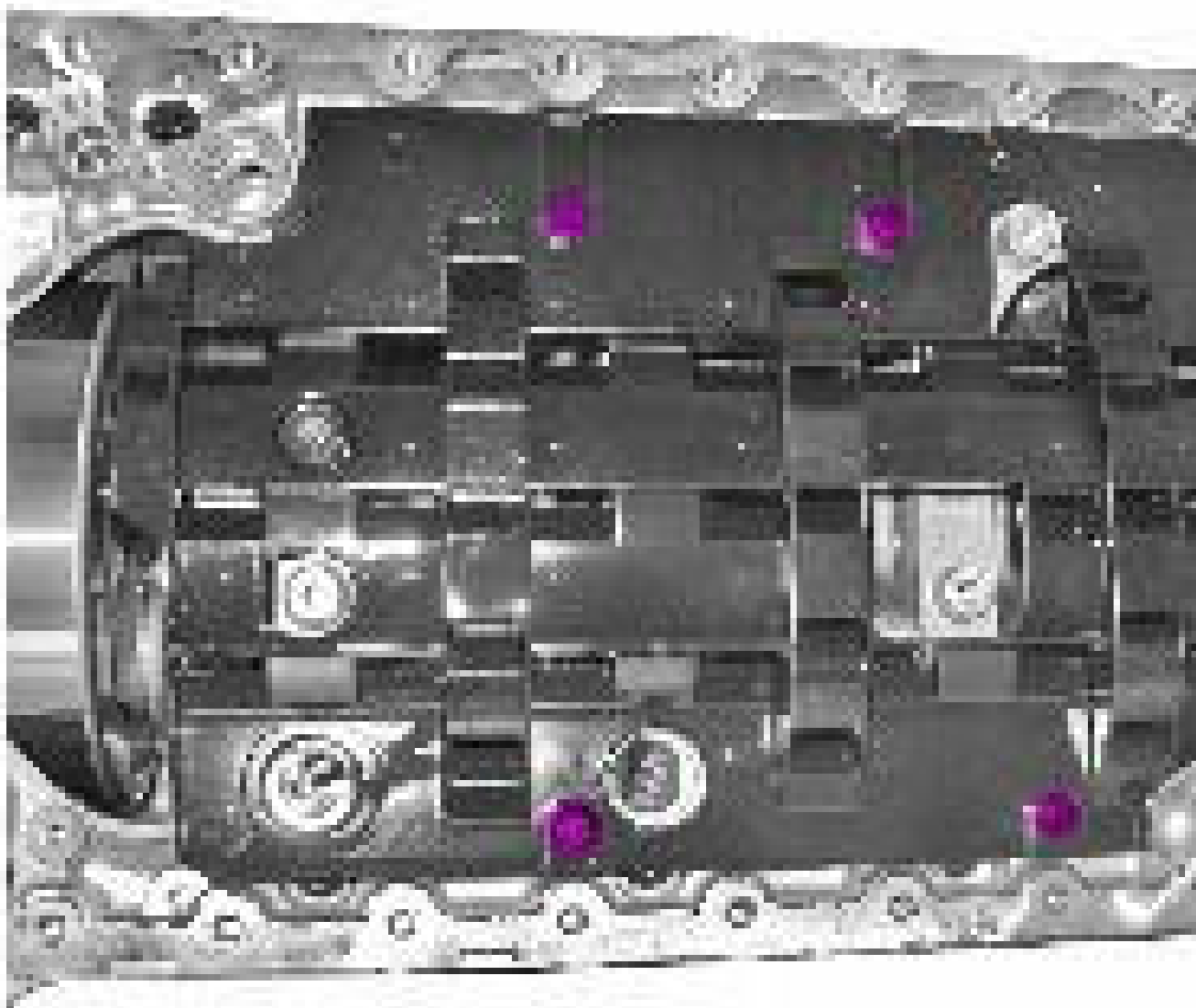


7. Torque: 10 Nm.



E138942

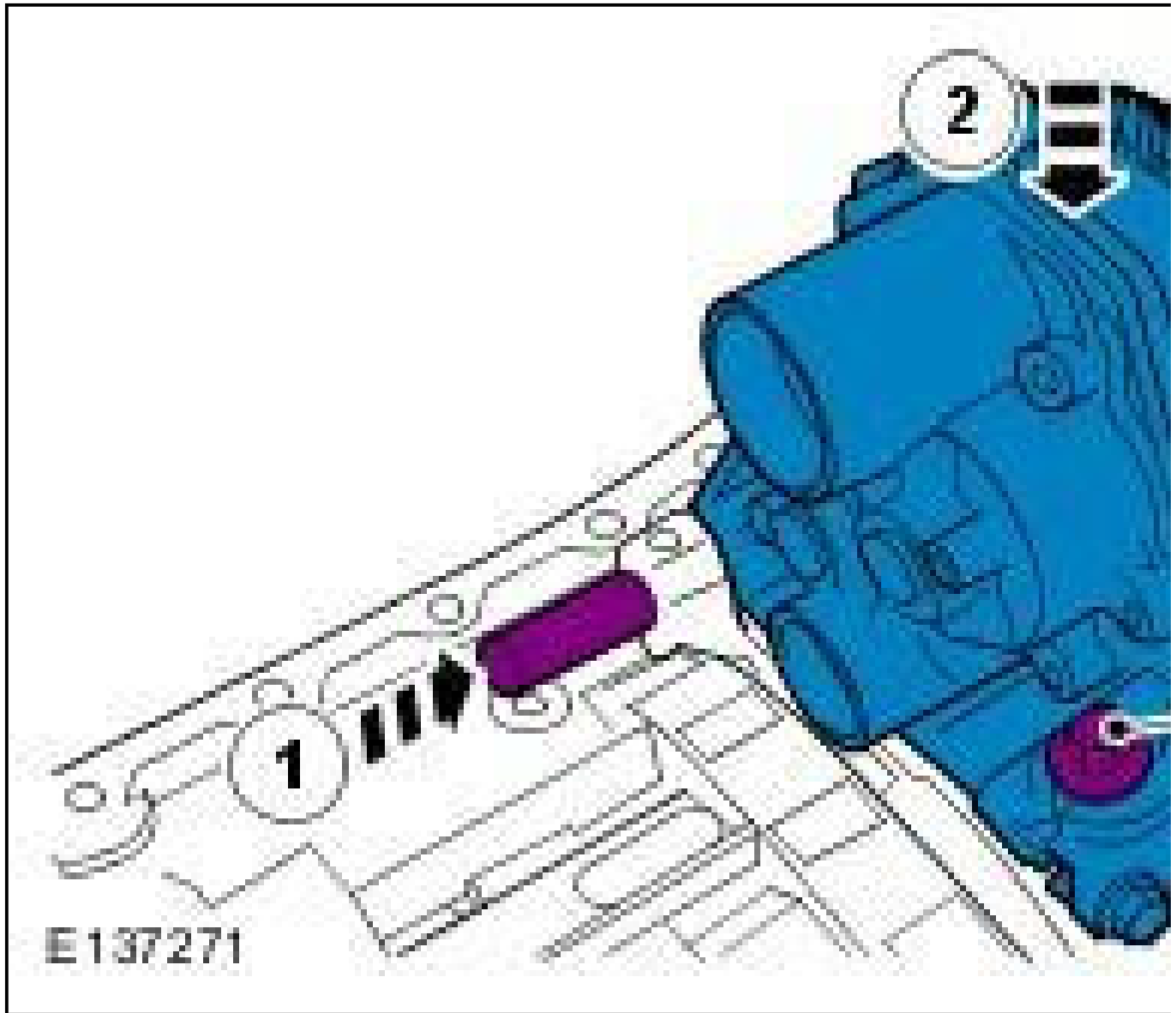
8. Torque: 10 Nm.



E138943

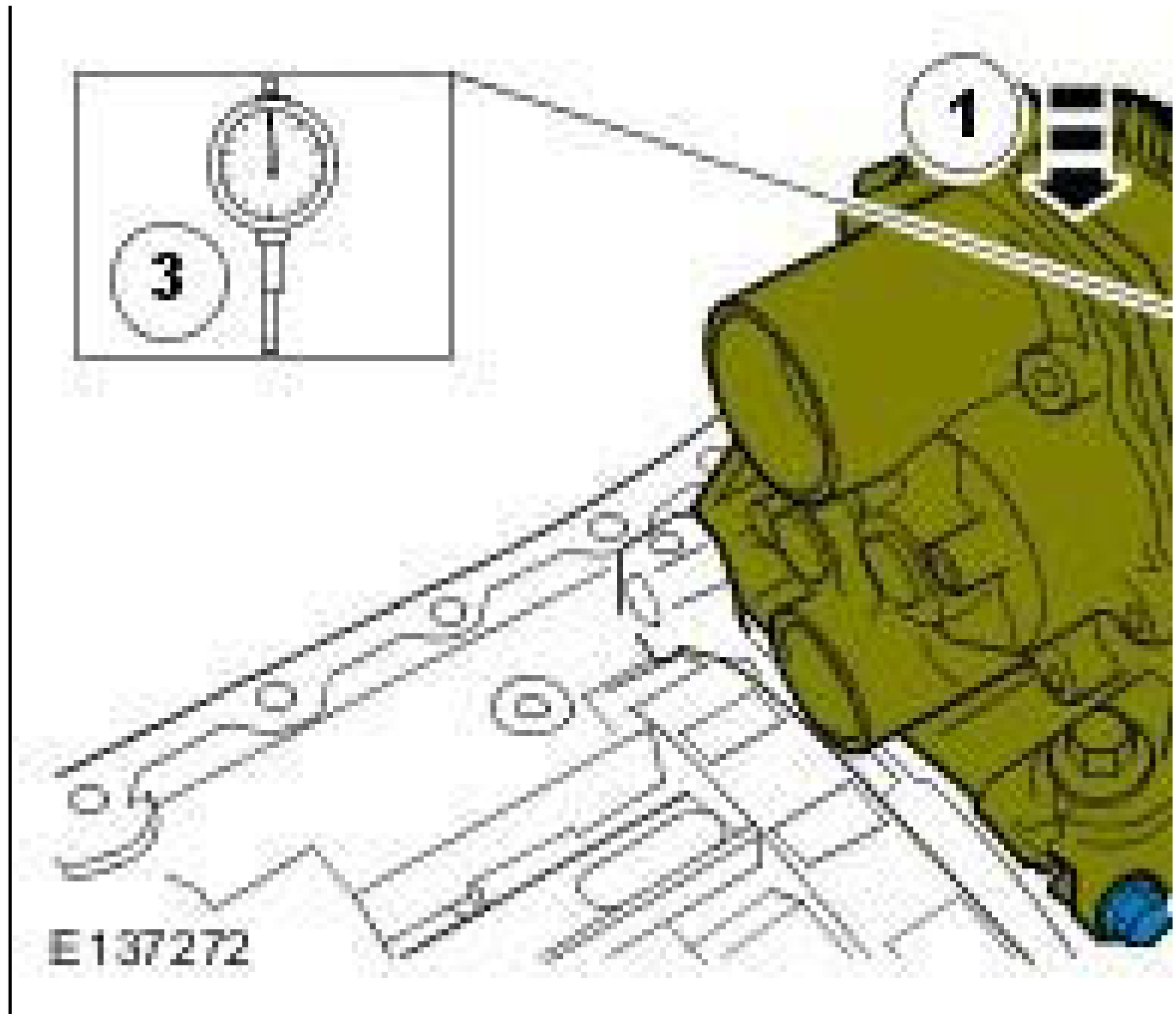
9.

1. Install the pin.
2. Apply light pressure to the pump body.
3. Torque: 17 Nm.



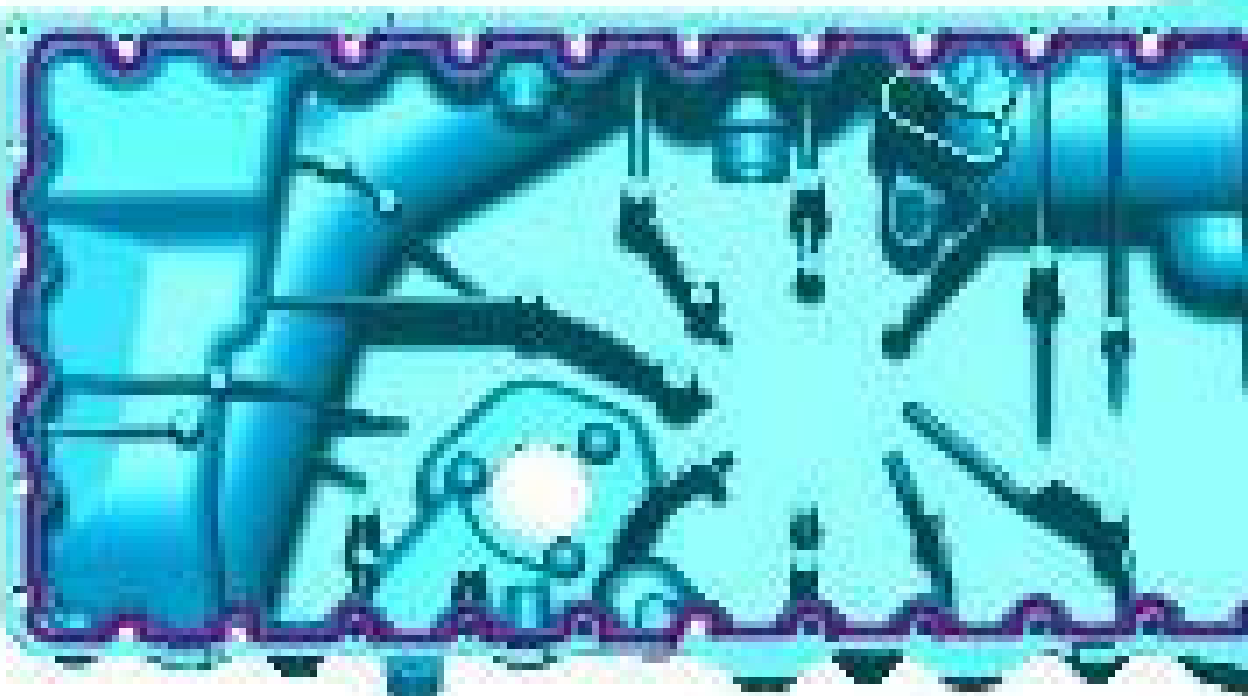
10.

1. Apply light pressure to the pump body.
2. Torque: 10 Nm.
3. Measure the backlash See **Specifications**.
4. If necessary, repeat the above procedure.



11. Apply a 2.5mm bead of sealant STC50550 (Loctite 5900) to the areas shown.

**CAUTION:** Make sure that the mating faces are clean and free of foreign material.



E80195

12.

- Fill the engine with the recommended oil to the correct level. See Specifications.

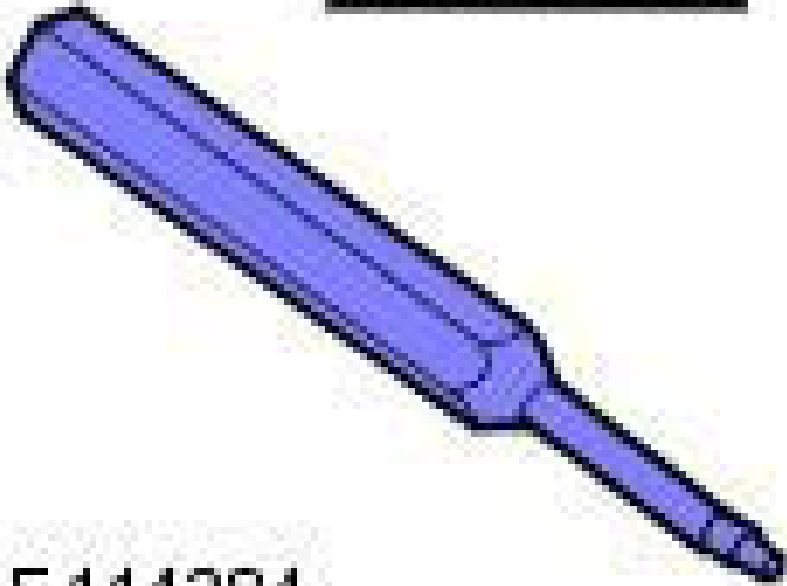
**CAUTION: Make sure that new sealing washers are installed.**

#### REAR END ACCESSORY DRIVE (READ) IDLER SHAFT ASSEMBLY

##### Special Tool(s)

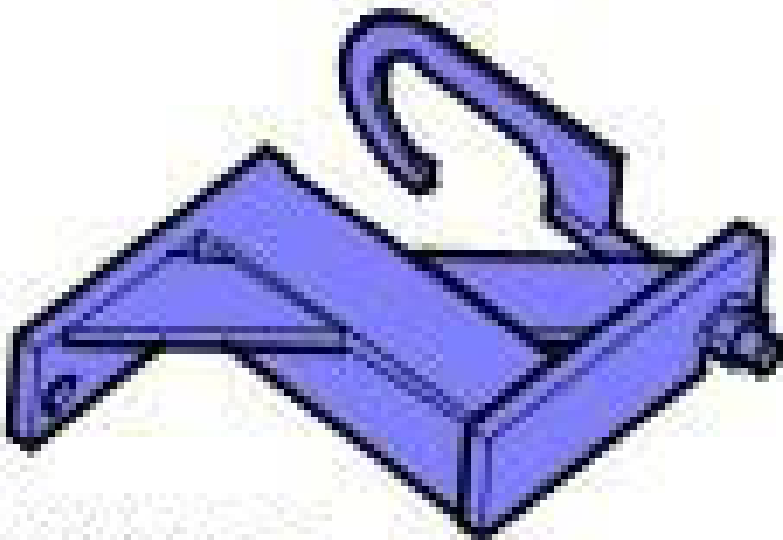
|  |                  |
|--|------------------|
|  | 303-1486 Mandrel |
|--|------------------|

303-1486



E 114384

303-1488



F 114386

303-1488 Rear End Accessory  
Drive (READ) Idler Shaft  
Assembly Extractor

## REMOVAL

**NOTE:** Removal steps in this procedure may contain installation details.

1. Refer to Specifications .

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

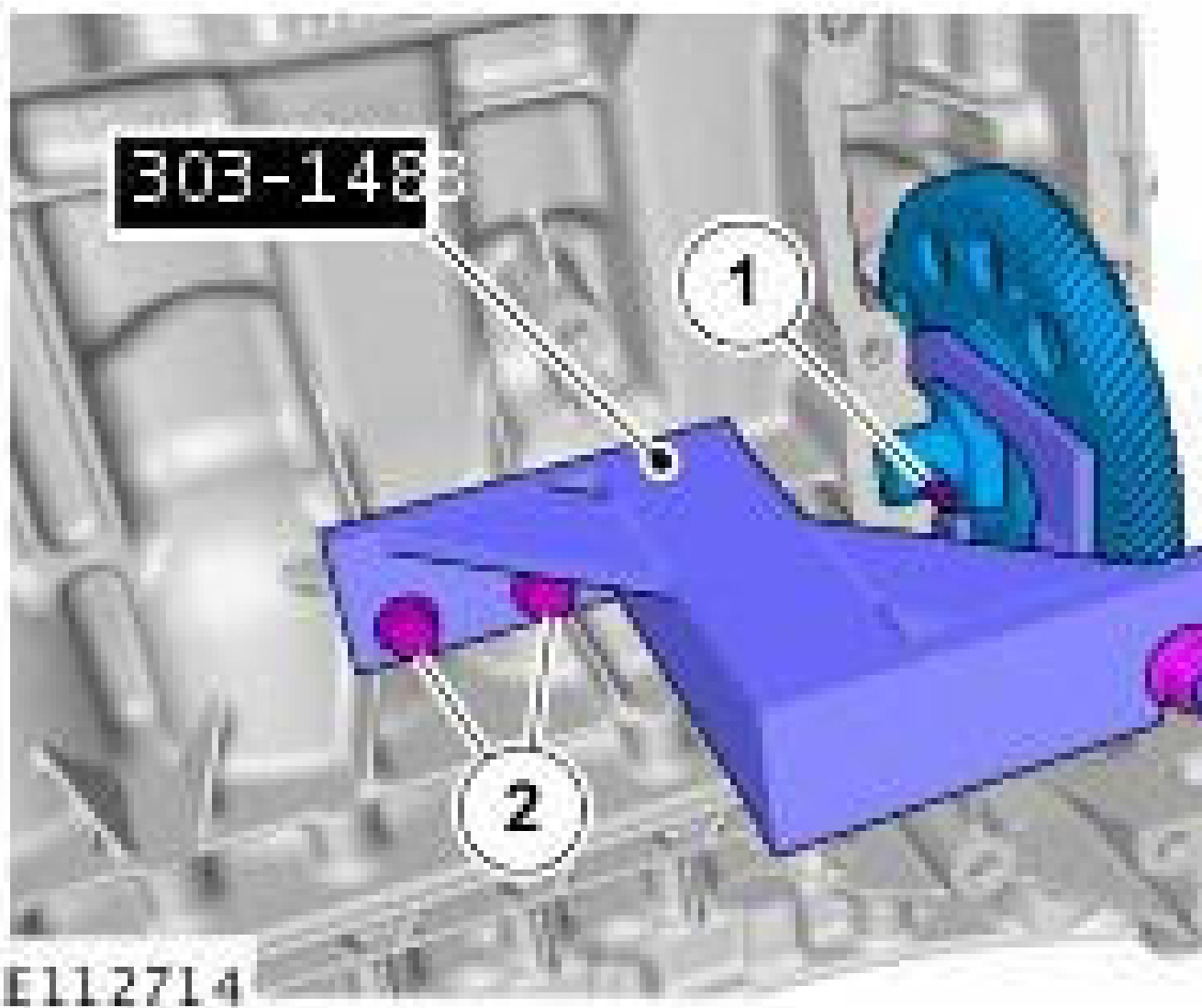
2. Raise and support the vehicle.
3. Refer to Rear End Accessory Drive (READ) .

**CAUTION:** Make sure that the locking pin is removed with the READ idler shaft assembly. Failure to do so may result in damage to the vehicle.

4.
  - Install a suitable screw into the locking pin.
  - Install with the special tool.

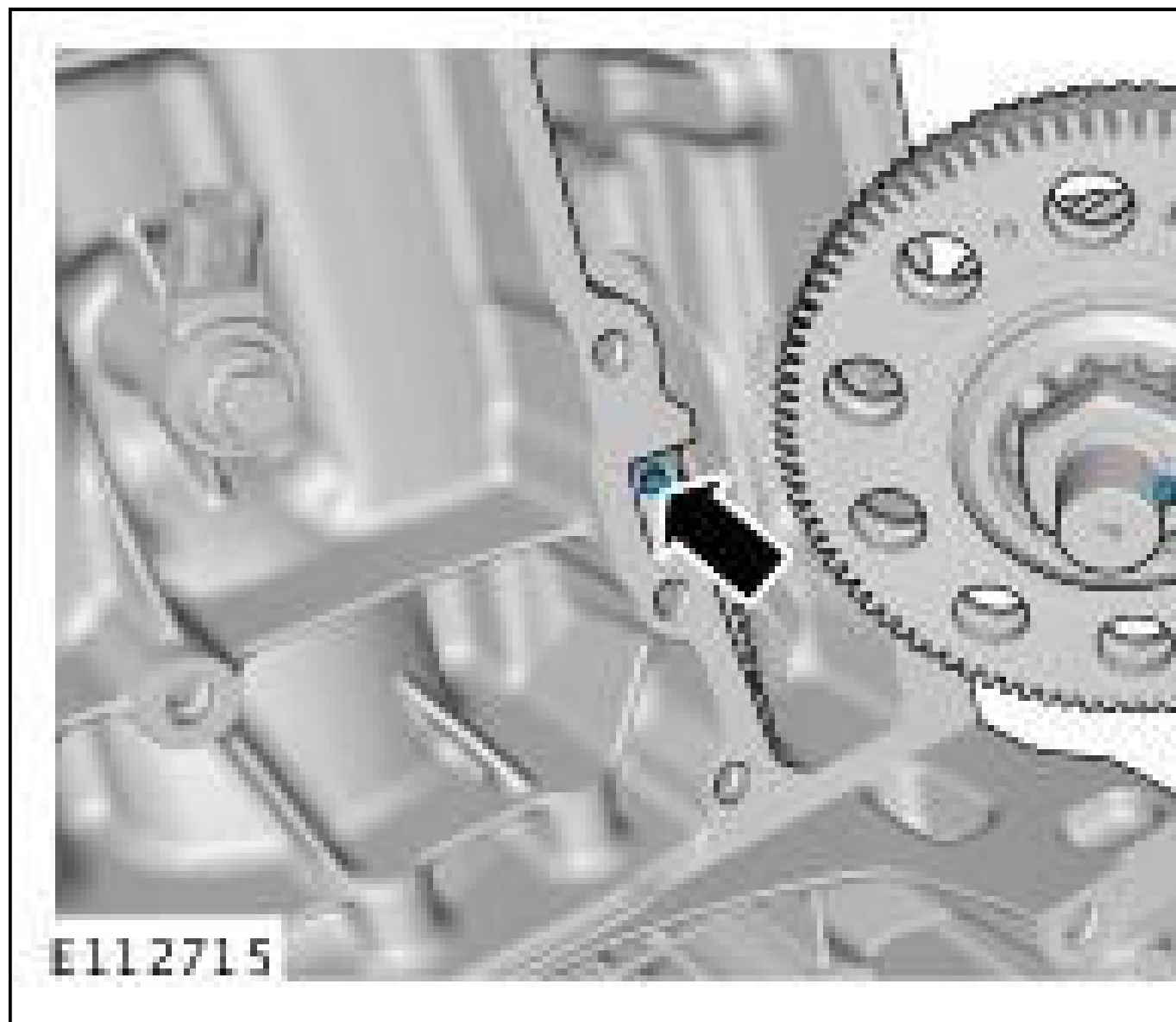
Rear End Accessory Drive (READ) Idler Shaft Assembly Extractor (303-1488)

- Tighten the nut to remove the READ idler shaft assembly and the locking pin.



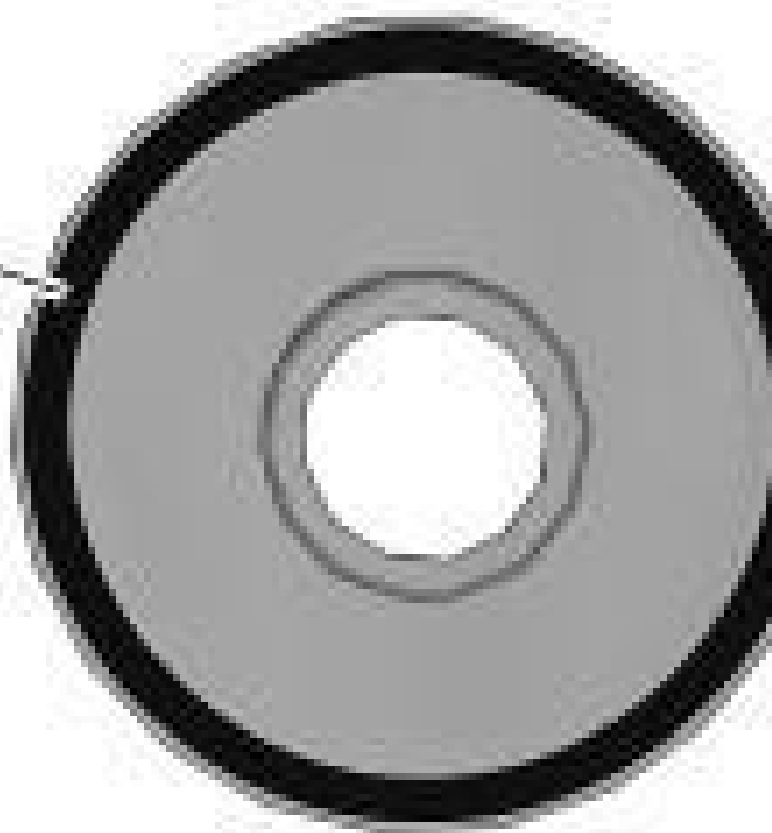
5. See figure.

**CAUTION:** Inspect the locking pin for damage. If the locking pin is broken in the engine block, the engine block must be replaced. Failure to follow this instruction may result in damage to the vehicle.



#### INSTALLATION

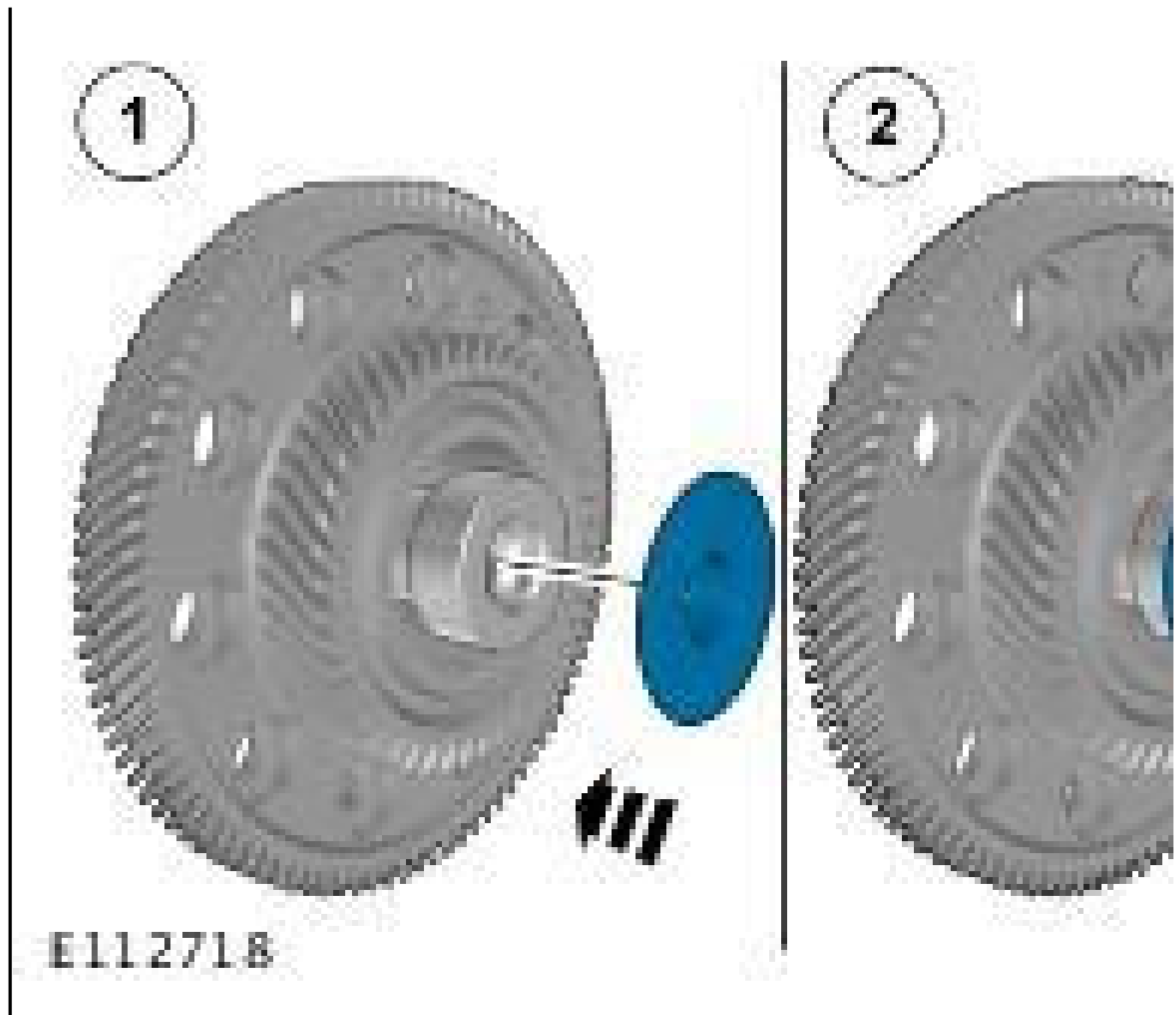
1. Apply a 2.5mm bead of sealant STC50550 (Loctite 5900) to the areas shown.



**E112717**

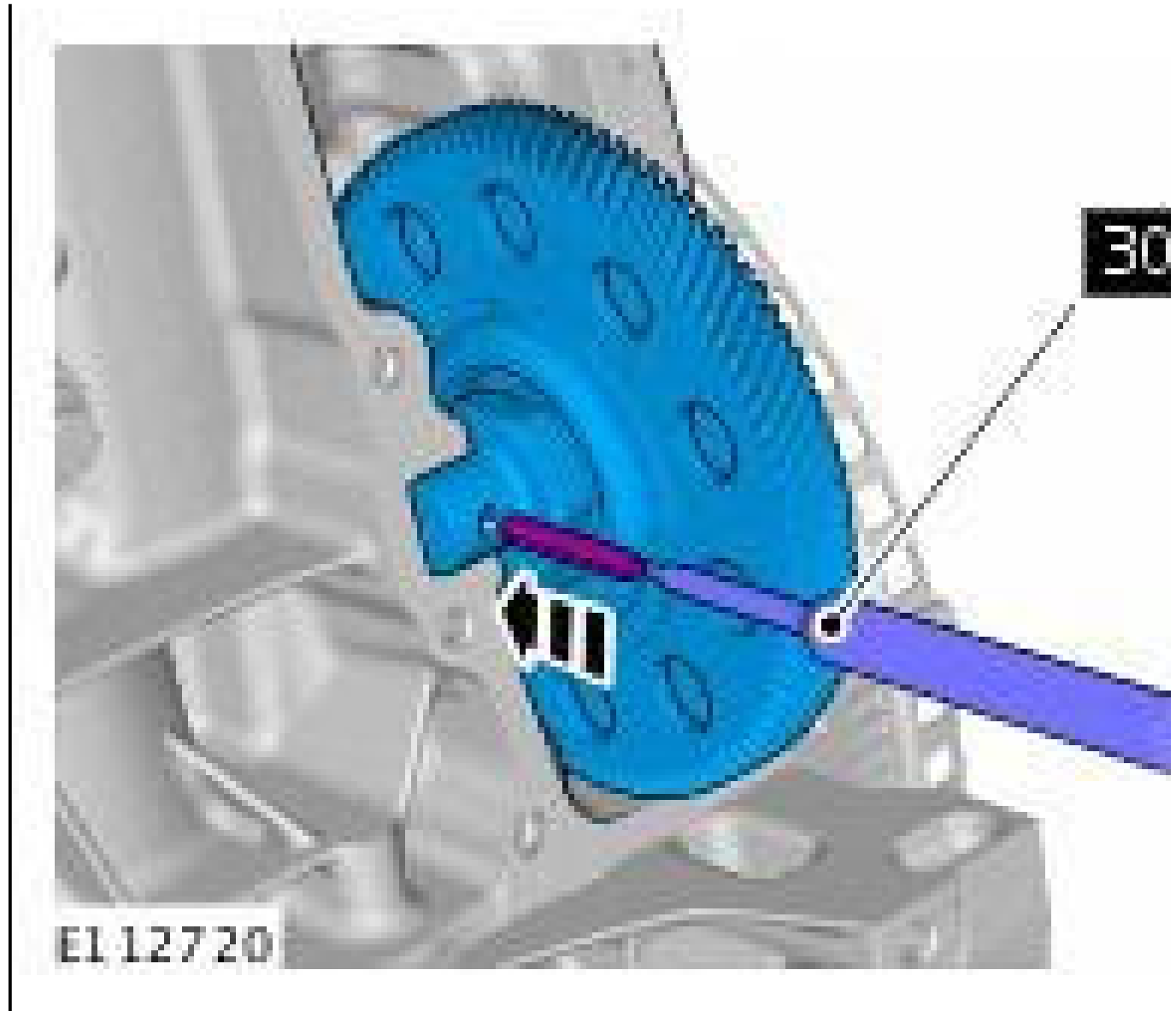
**CAUTION:** Make sure that the mating faces are clean and free of foreign material.

2.
  1. Install the sealing washer to the READ idler shaft assembly.
  2. Using a suitable tool, deform the sealing washer to secure it to the READ idler assembly.



**CAUTION:** Make sure that the mating faces are clean and free of foreign material.

3. Mandrel (303-1486)



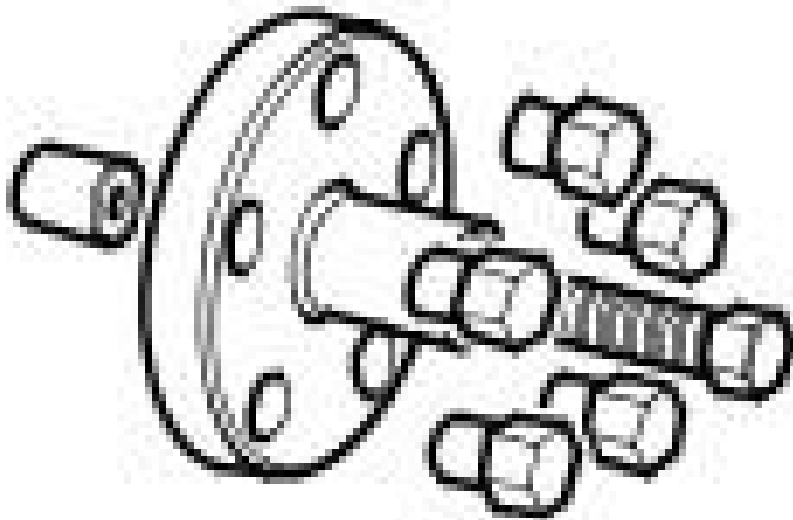
4. Refer to **Rear End Accessory Drive (READ)** .
5. Lower the vehicle.
6. Refer to **Specifications** .

#### ENGINE

#### Special Tool(s)

|  |                            |
|--|----------------------------|
|  | 205-857 Remover, Halfshaft |
|--|----------------------------|

205-857



E79462

**REMOVAL**

**WARNING:** Make sure to support the vehicle with axle stands.

1. Raise and support the vehicle.
2. Remove the cover and disconnect the battery ground cable.

Refer to: **Specifications** .

3. Remove the engine cover.

Refer to: **Engine Cover - 3.2L** .

4. Remove the plenum box access panel.

Refer to: **Plenum Chamber** .

5. Remove the battery tray.

Refer to: **Battery Tray** .

6. Remove the air cleaner assembly.

Refer to: **Air Cleaner** .

7. Drain the coolant.

Refer to: **Cooling System Draining, Filling and Bleeding** .

8. Remove the starter motor.

Refer to: **Starter Motor - Petrol** .

9. Remove the catalytic converters.

Refer to: **Catalytic Converter** .

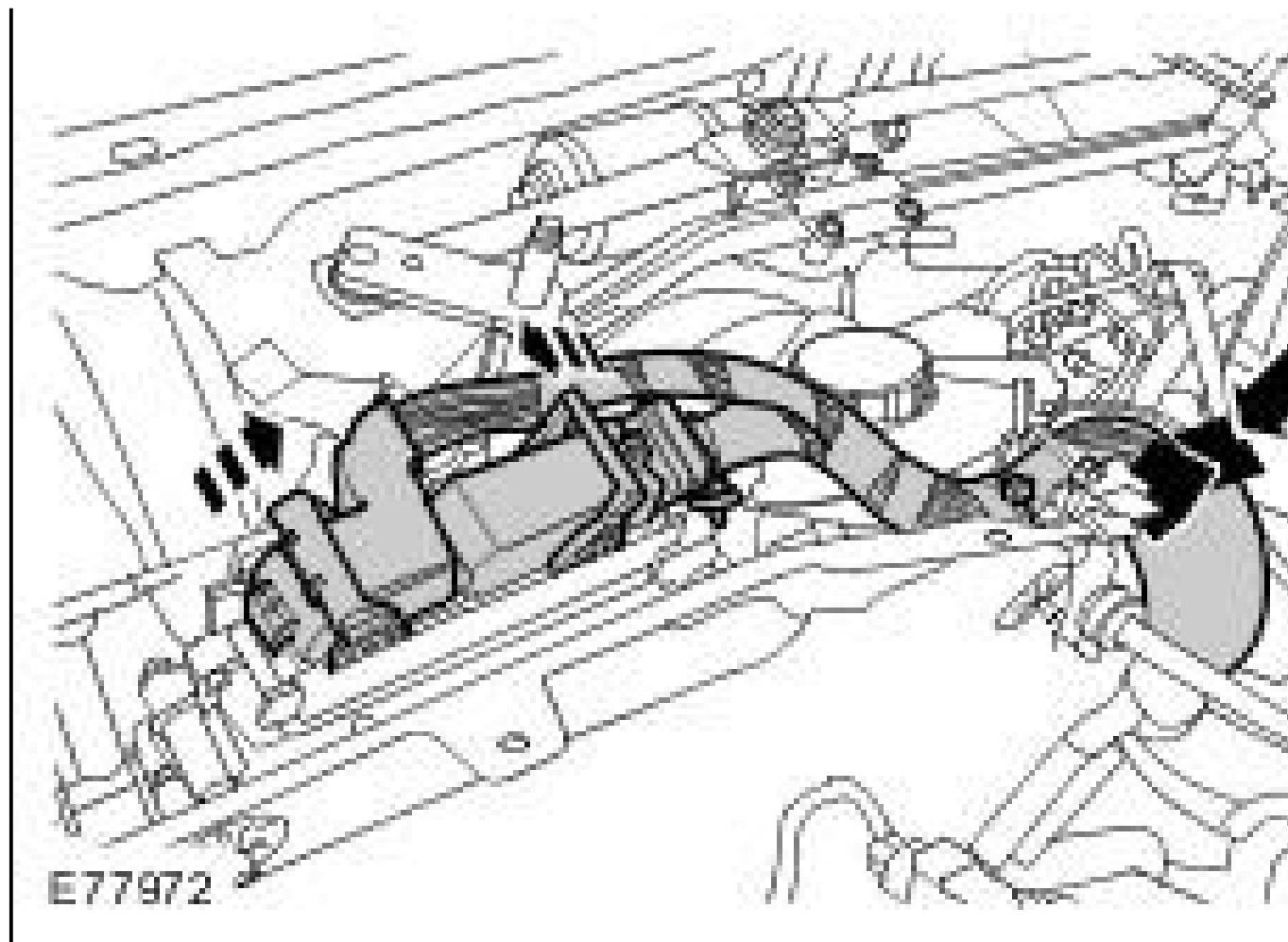
10. Remove the lower engine stabilizer bar.

Refer to: **Engine Lower Support Insulator**.

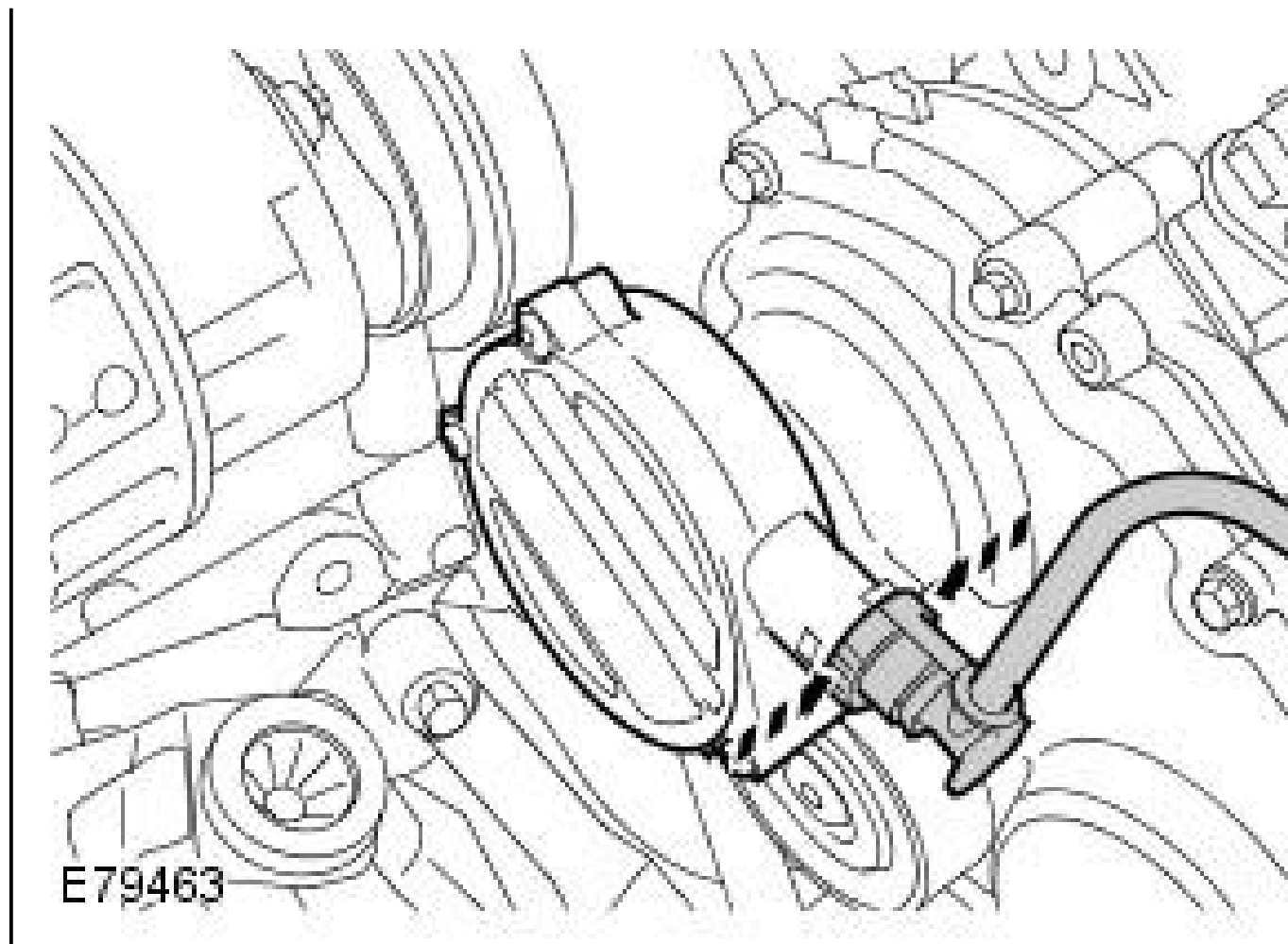
11. Remove the front subframe assembly.

Refer to: **Front Subframe** .

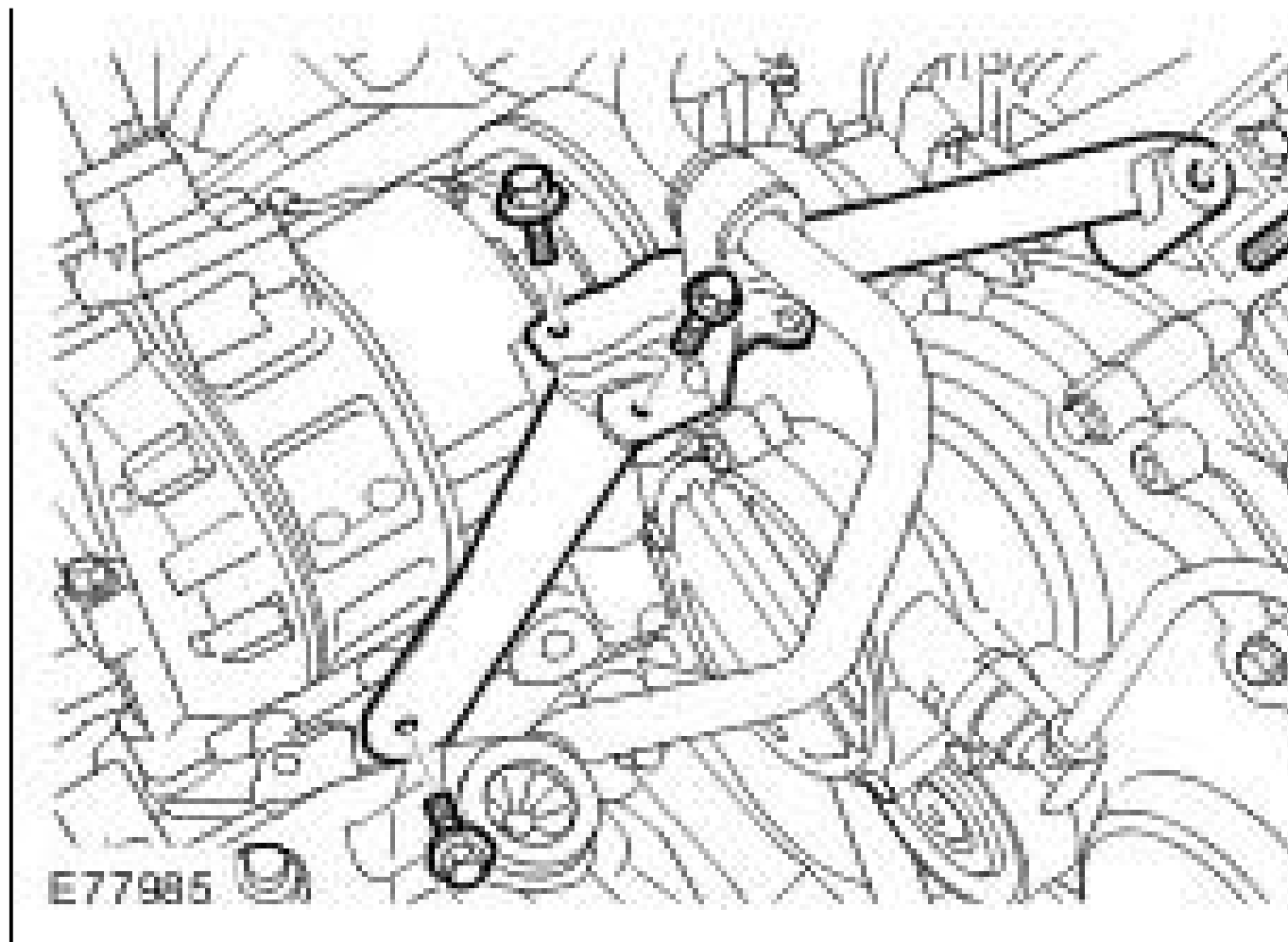
12. Siphon the fluid from the power steering reservoir.
13. Disconnect the engine control module (ECM).



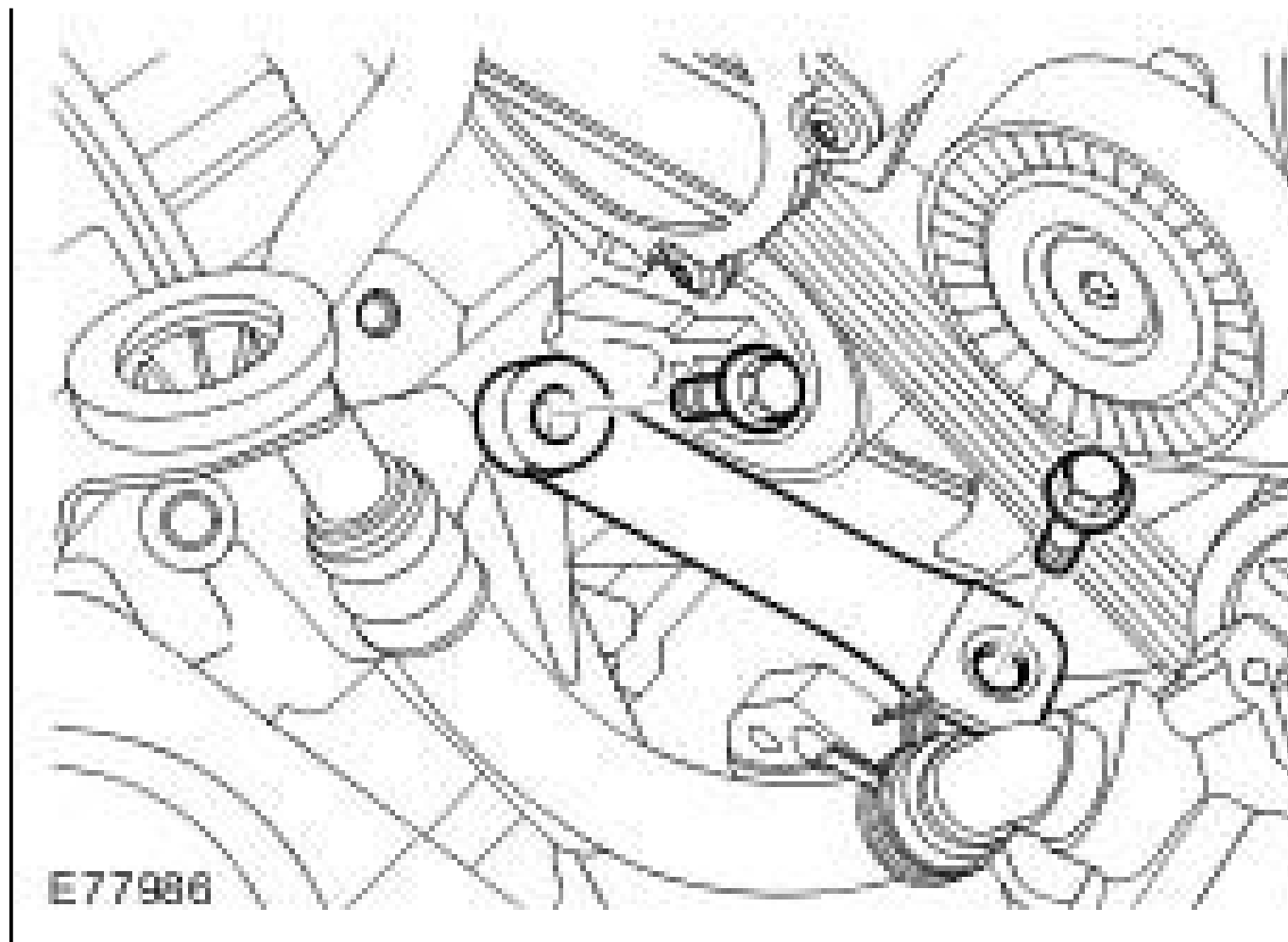
14. Disconnect the brake booster vacuum hose.



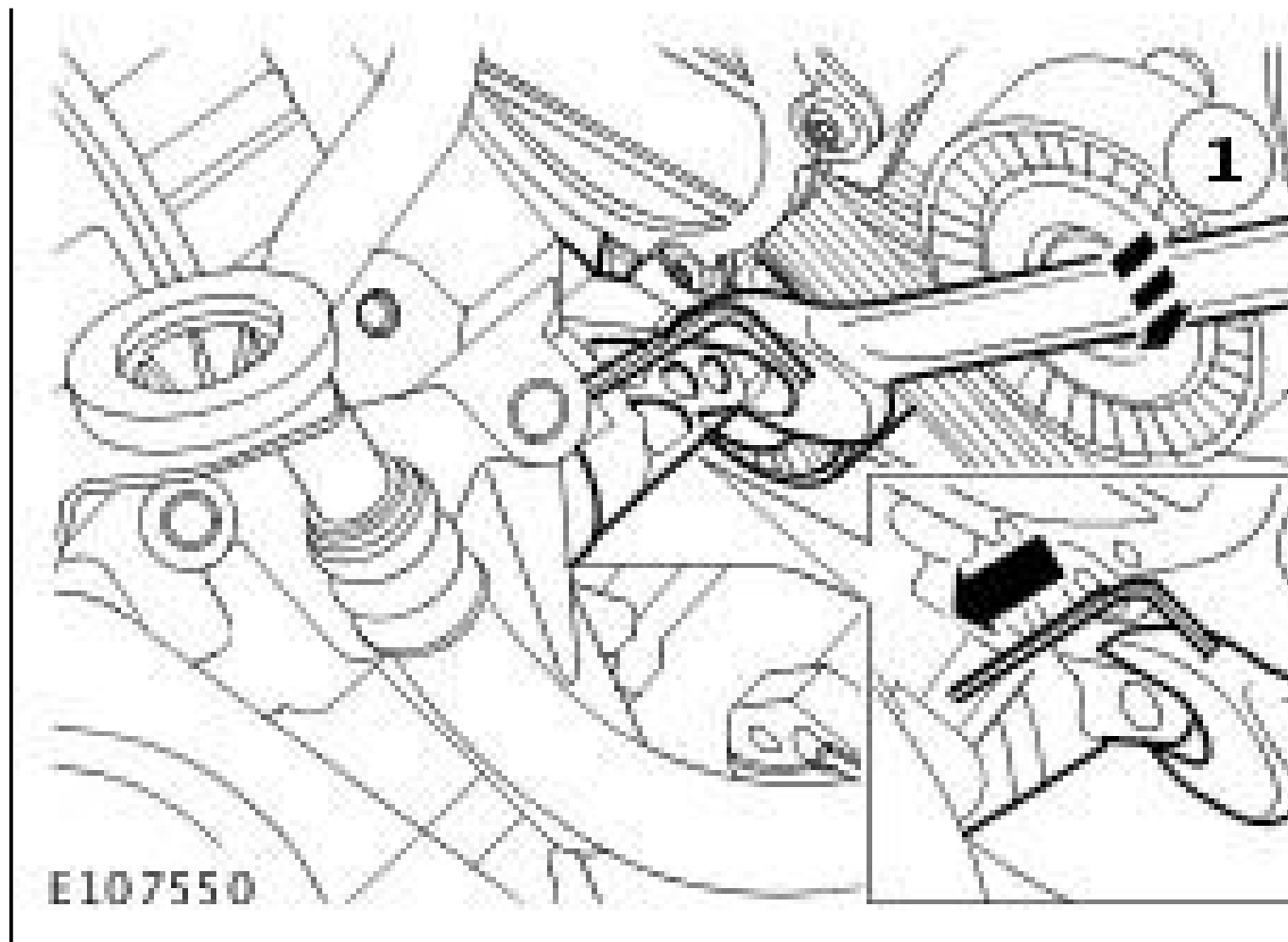
15. Remove the A/C compressor, upper support bracket.



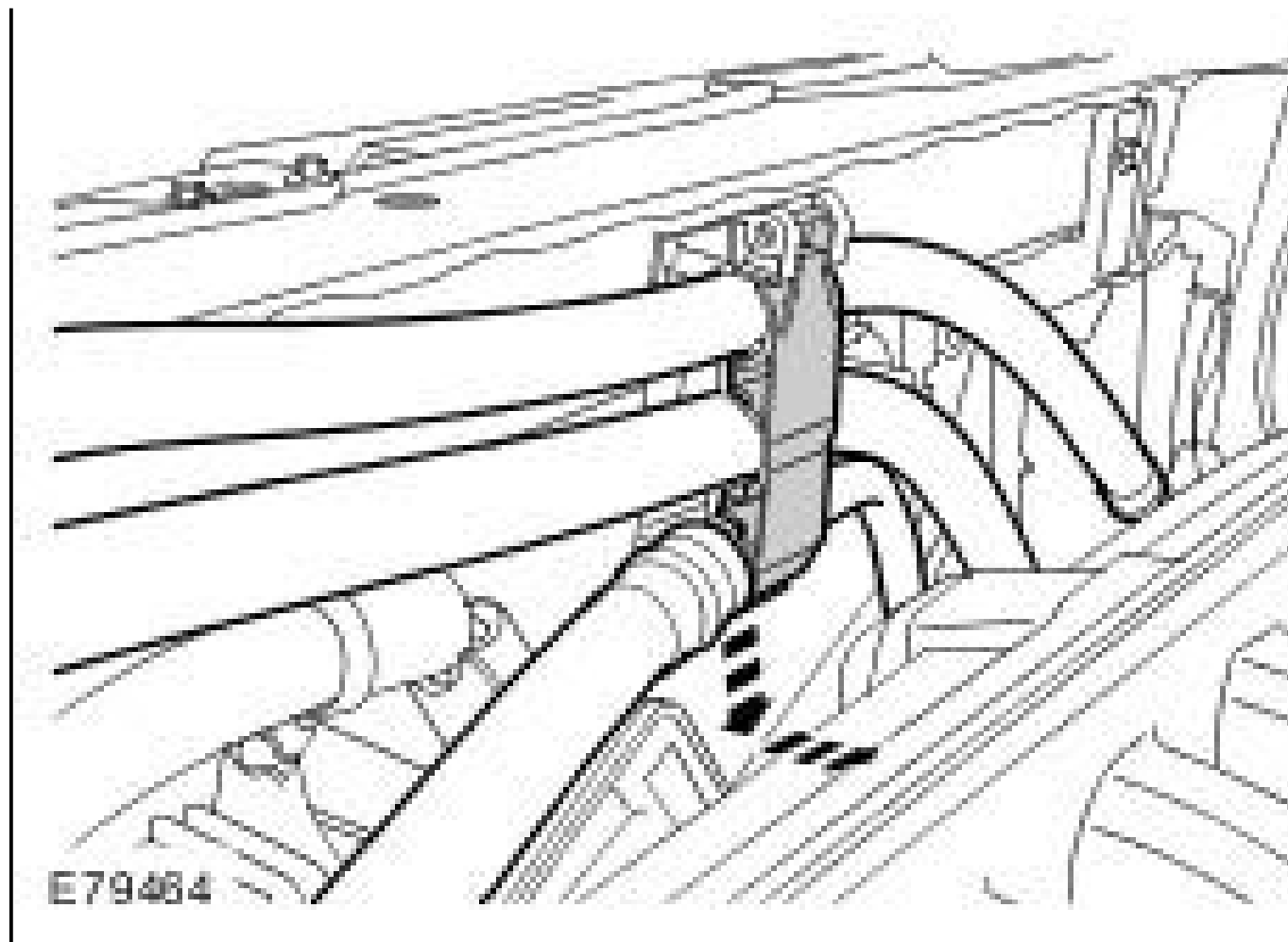
16. Remove the A/C compressor, lower support bracket.



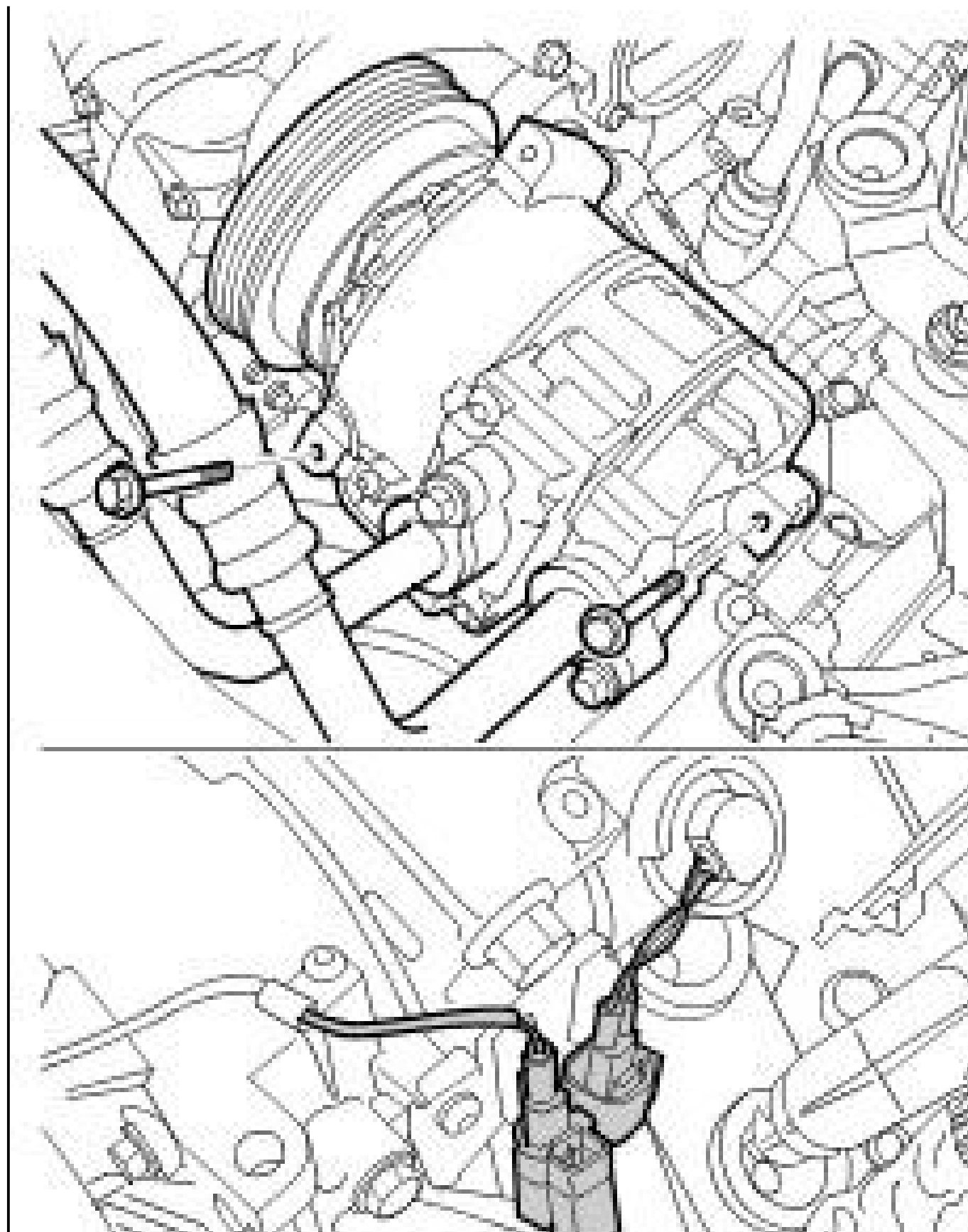
17. Using suitable tools, release the accessory drive belt tension.



18. Release the A/C and PAS lines from the clip.

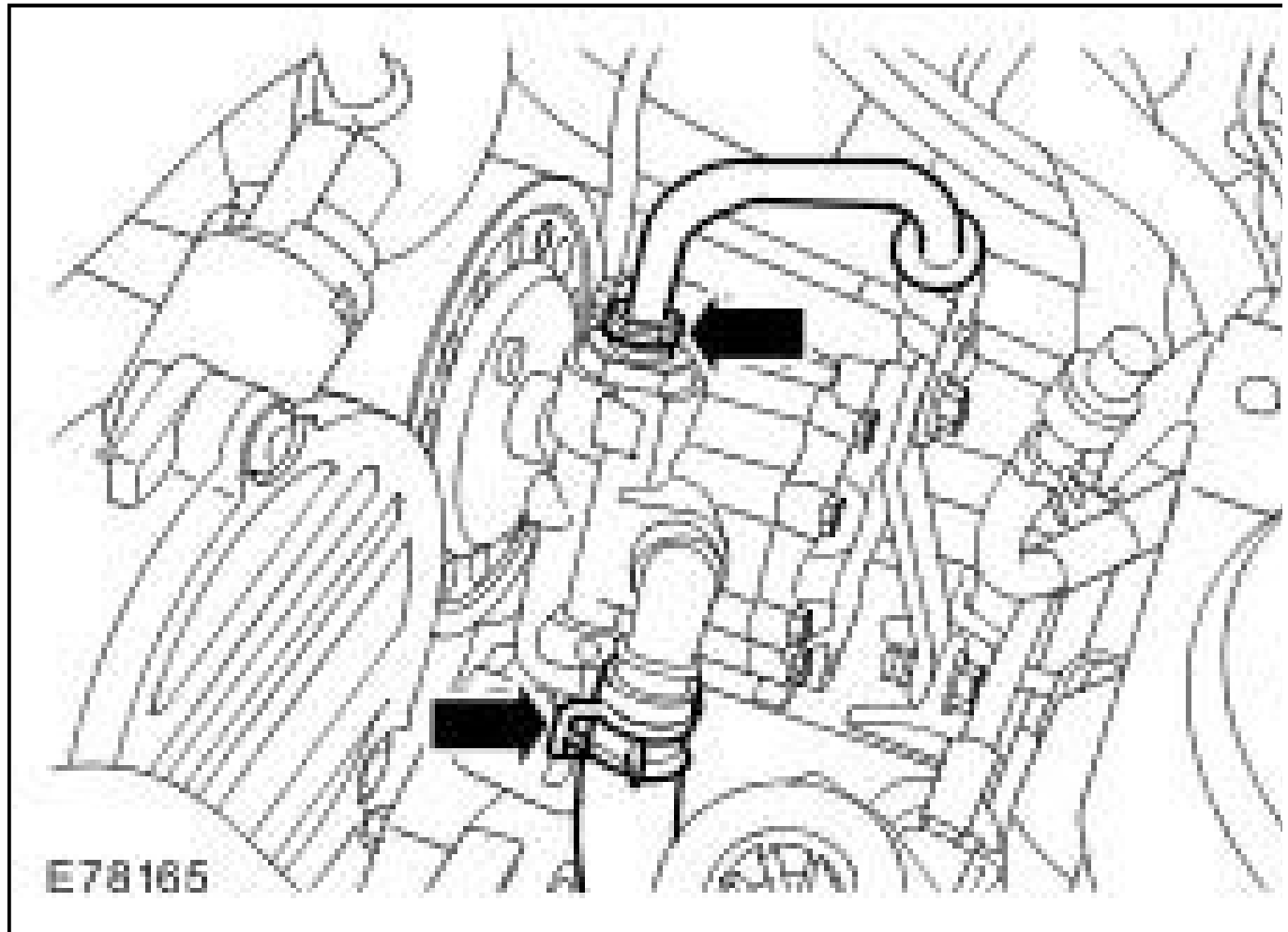


19. Release the A/C compressor and tie aside.

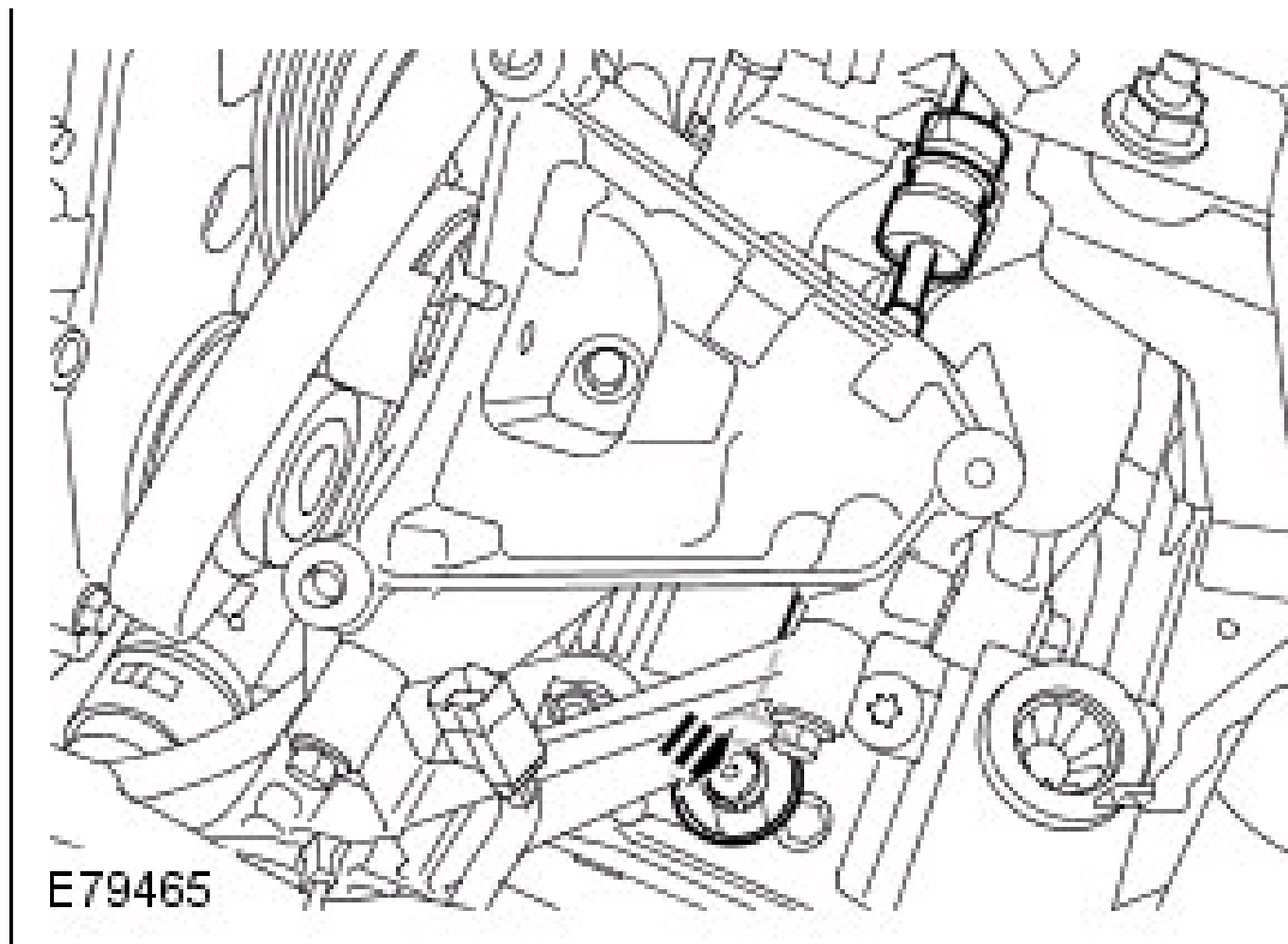


**CAUTION: Discard the O-ring seal.**

20. Disconnect the power steering fluid line.



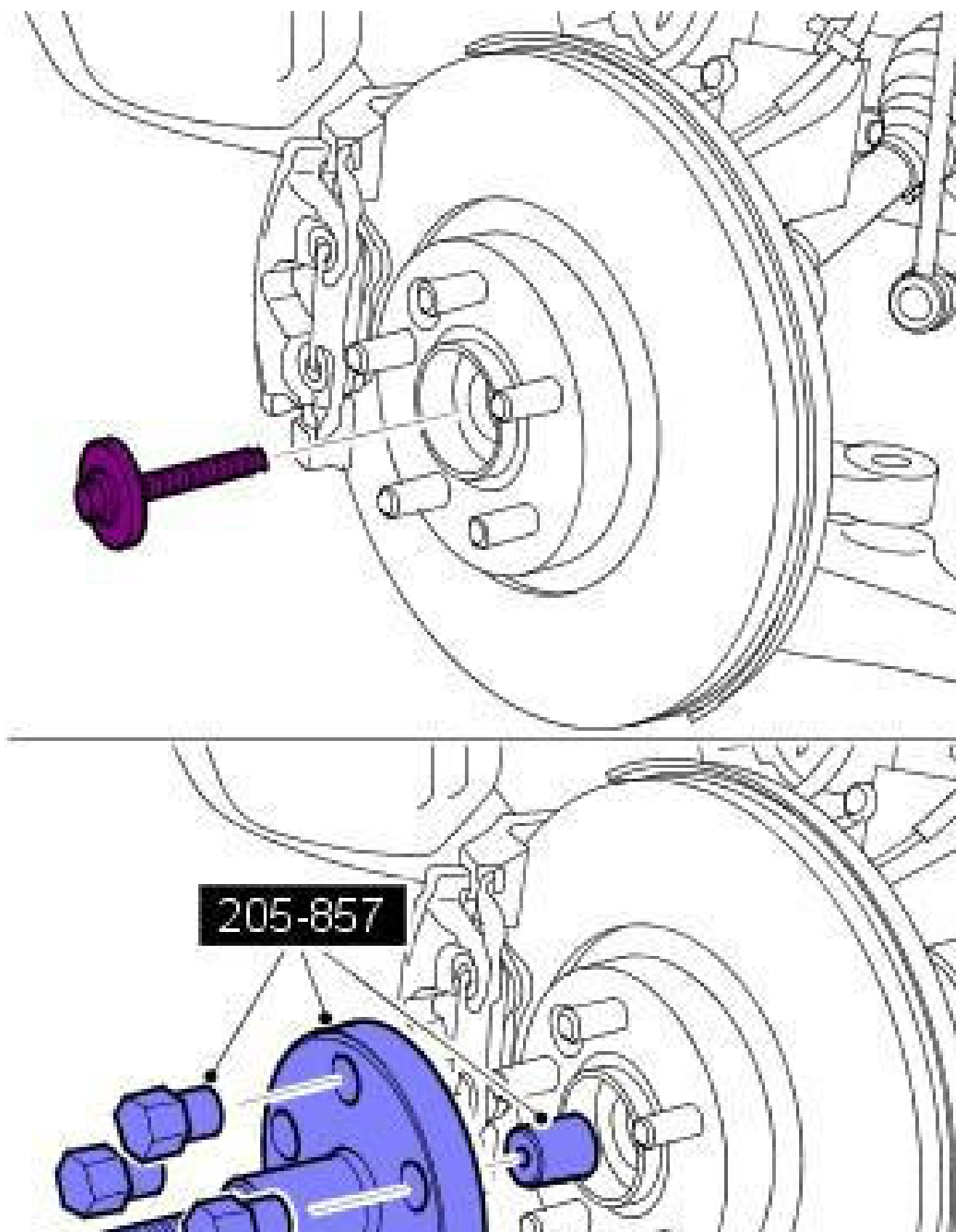
21. Release the selector lever cable.



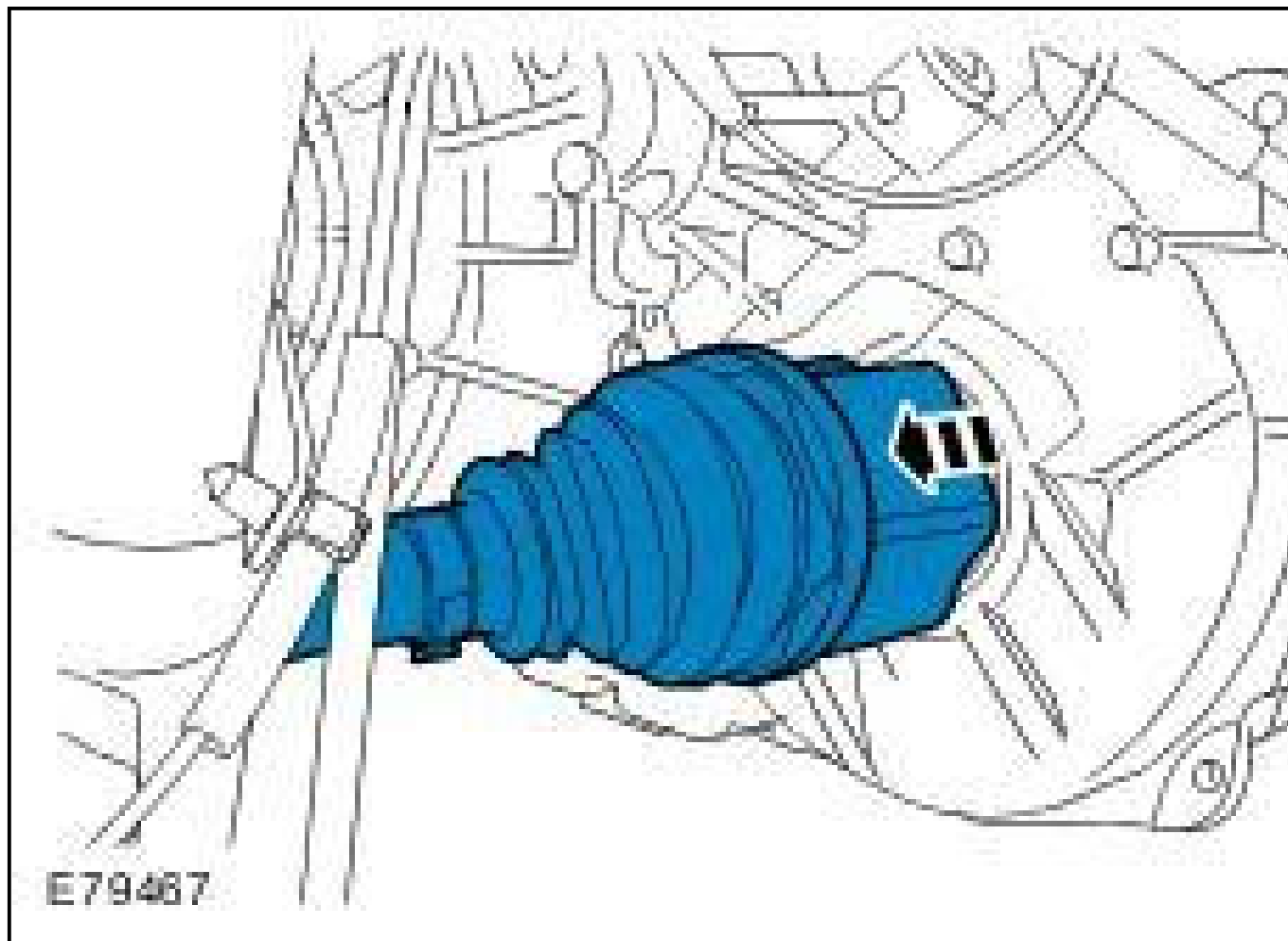
**WARNING: Discard the bolt.**

22. Release the LH and RH halfshafts.

Special Tool(s): 205-857

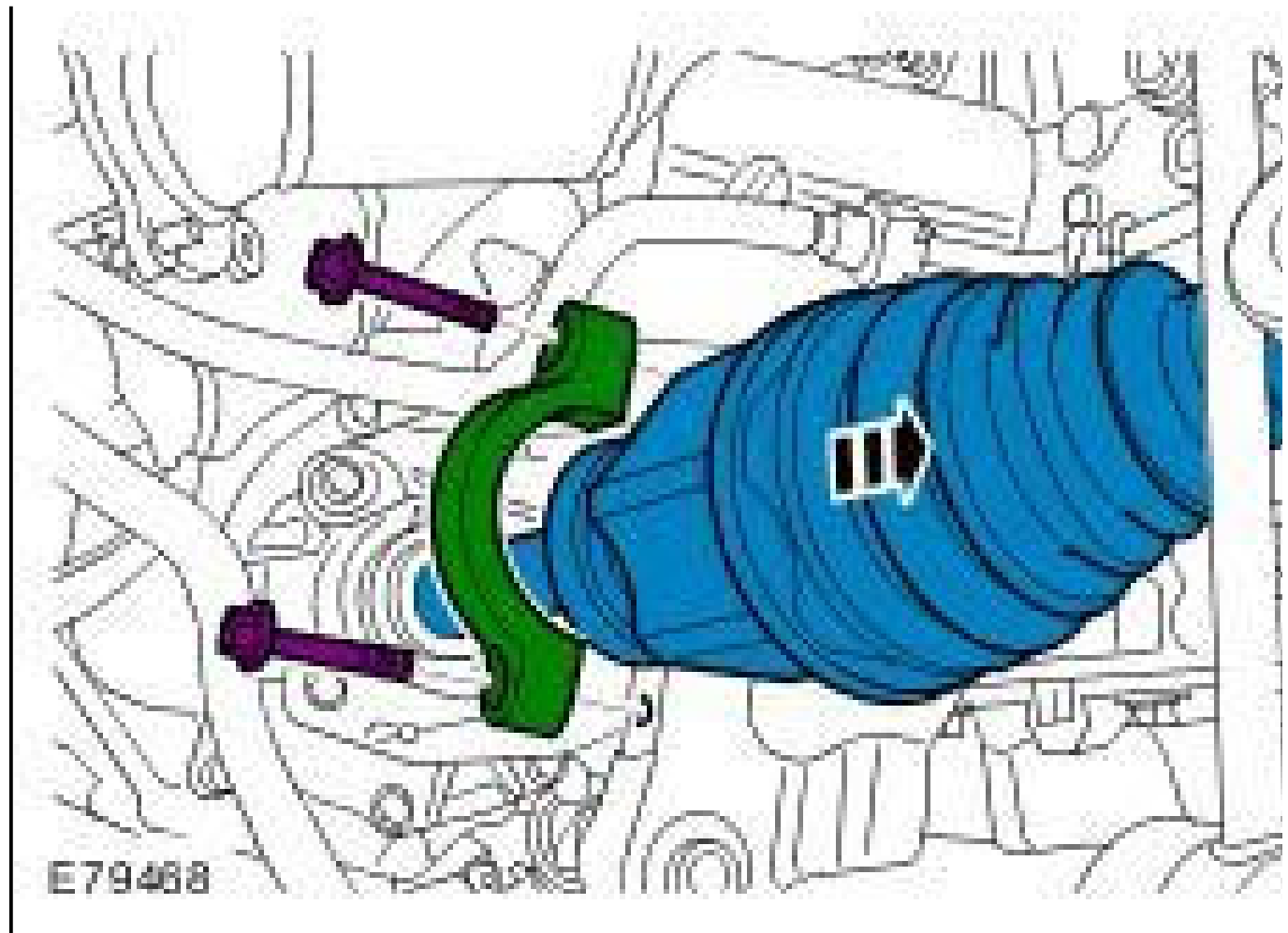


23. Remove the LH halfshaft.



24. Remove the RH halfshaft.

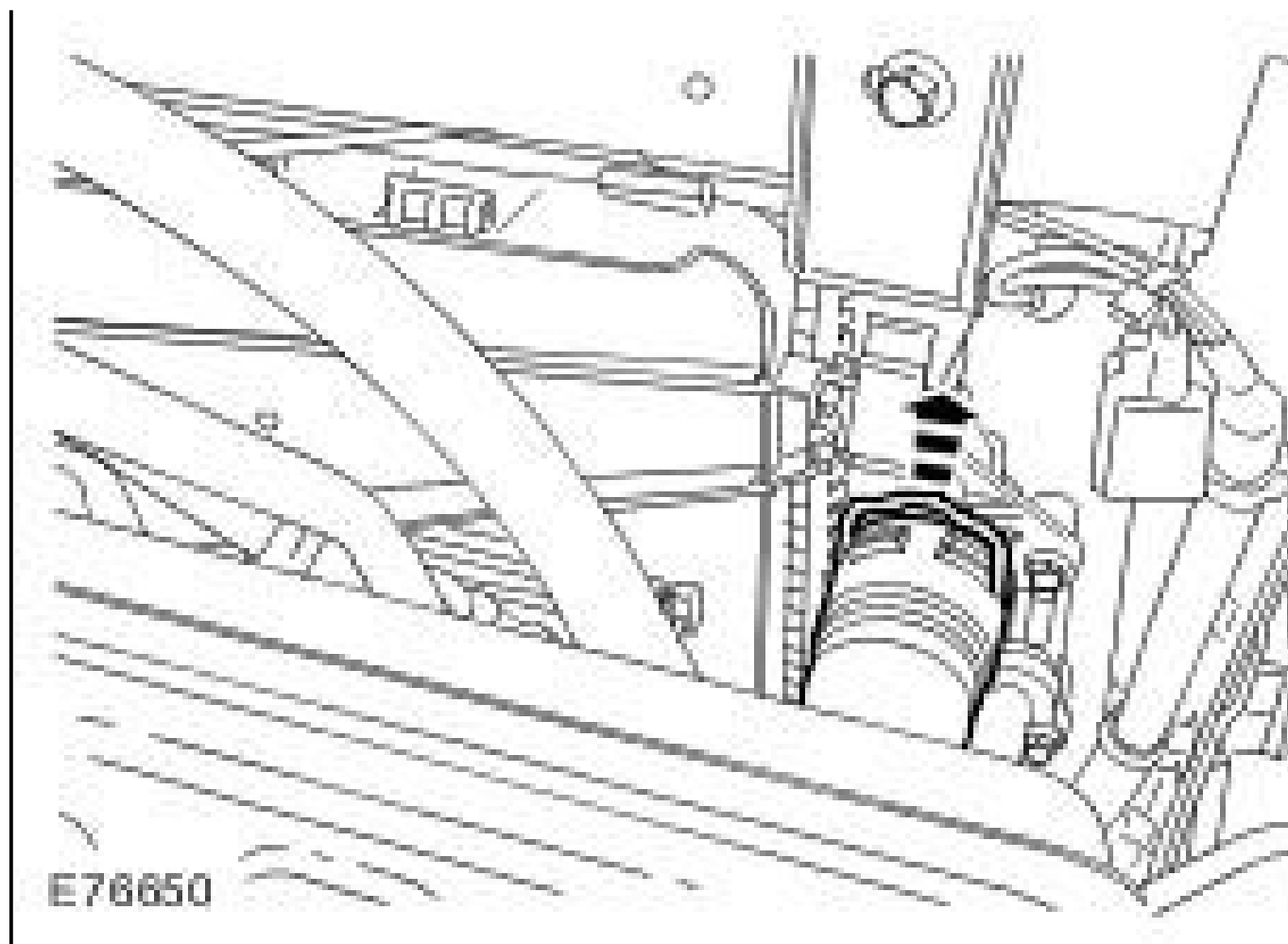




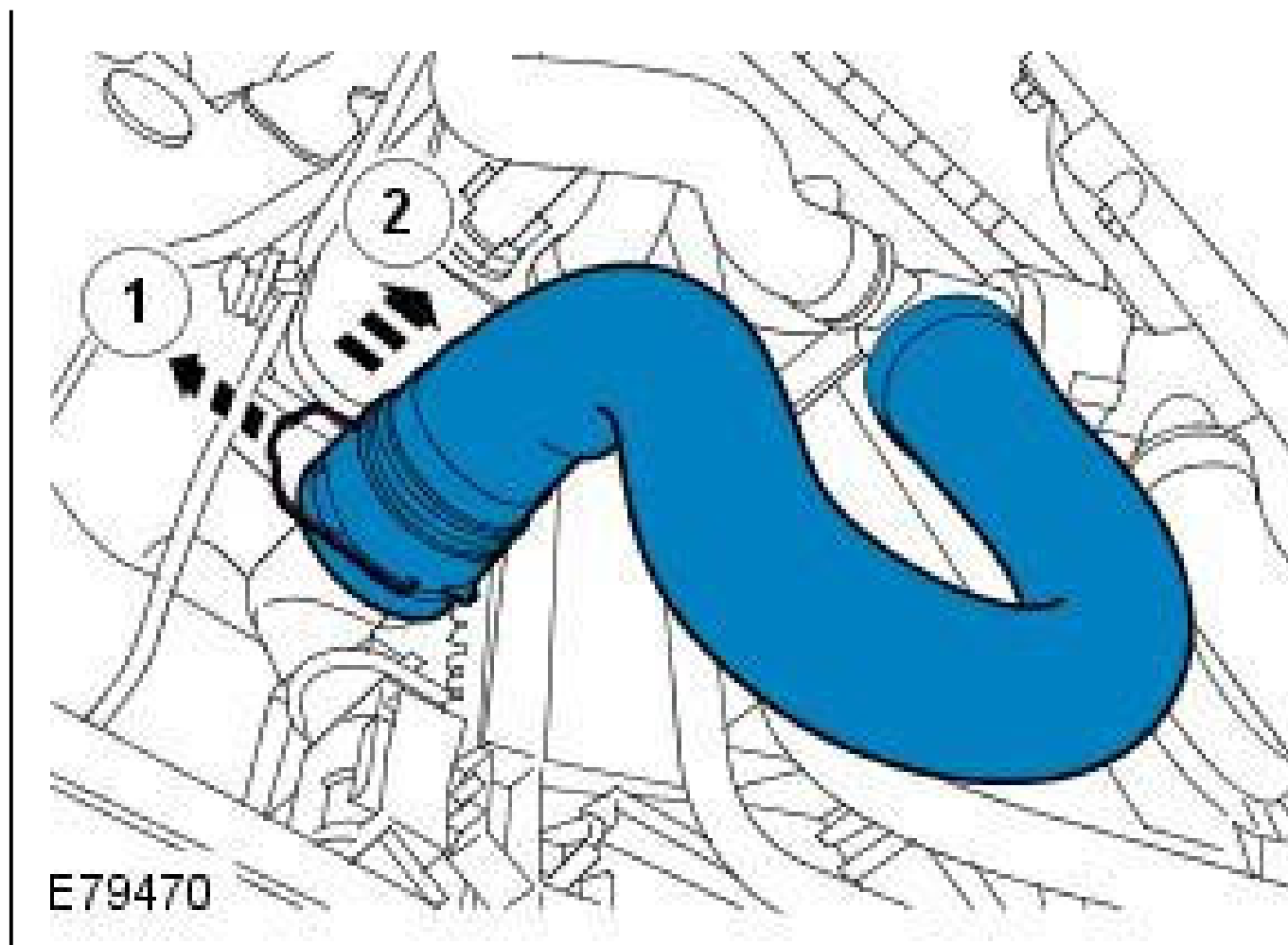
25. Tie the suspension arms aside for access.
26. Disconnect the cooling fan control electrical connector.



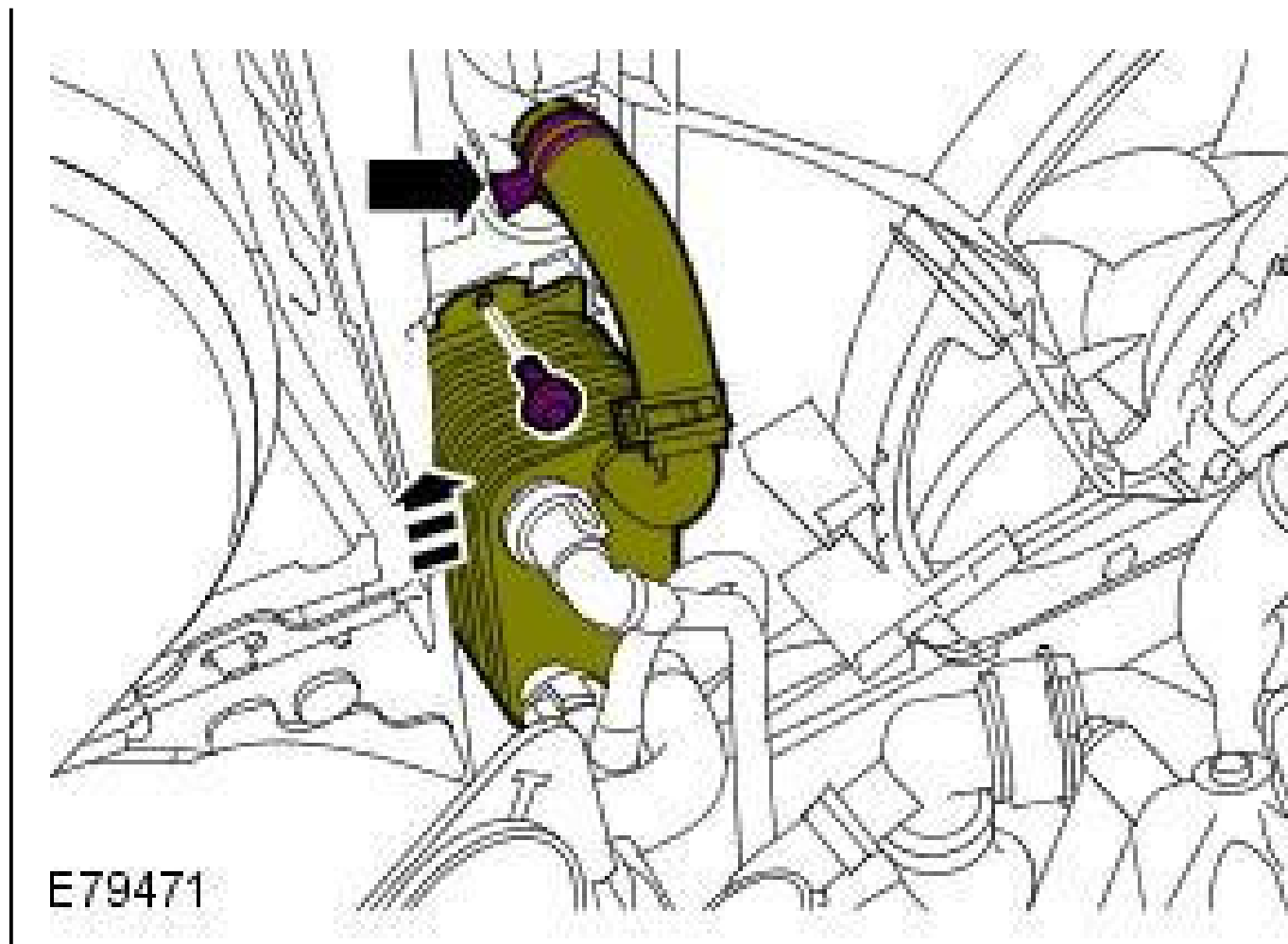
27. Remove the top hose.



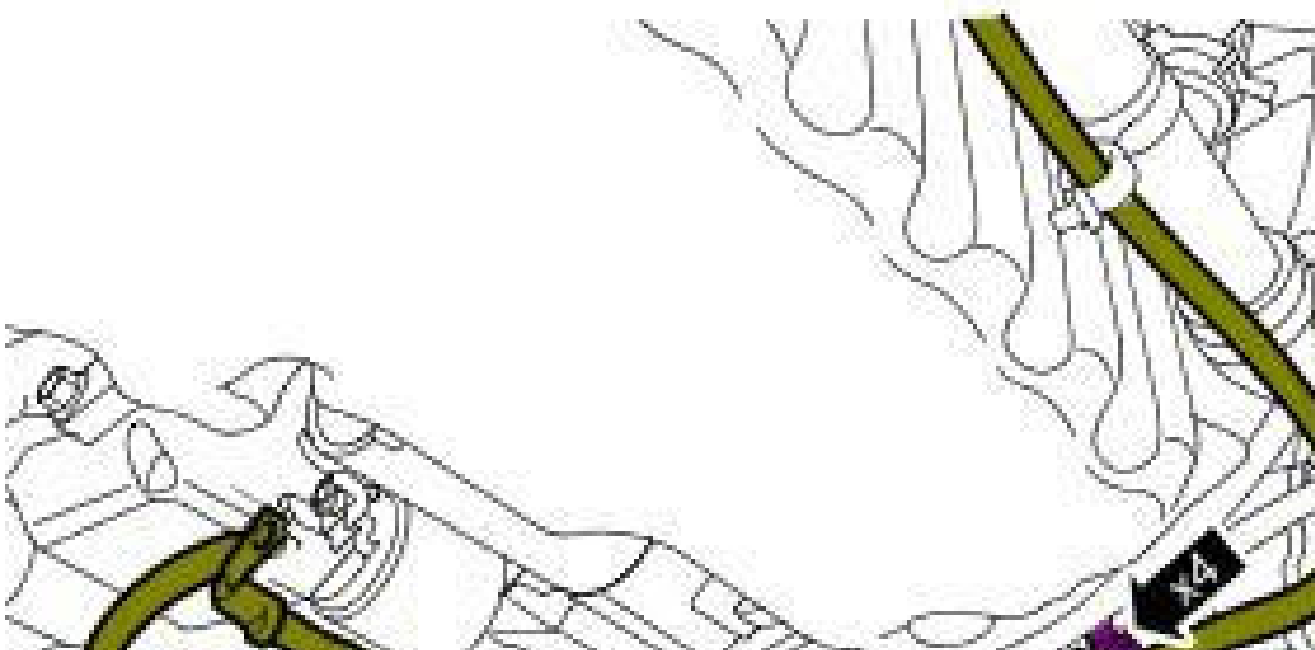
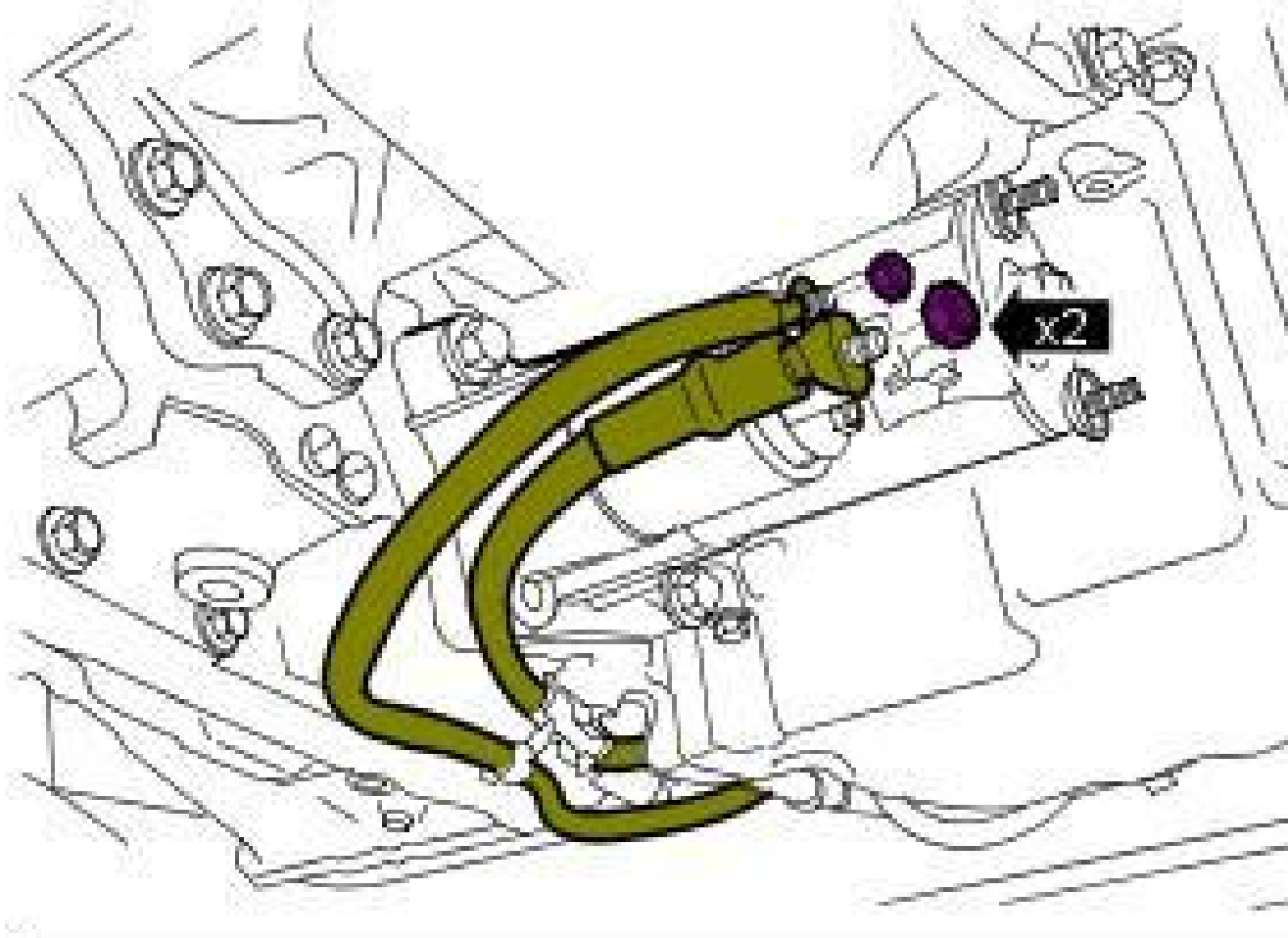
28. Disconnect the bottom hose.



29. Release the transmission fluid cooler.

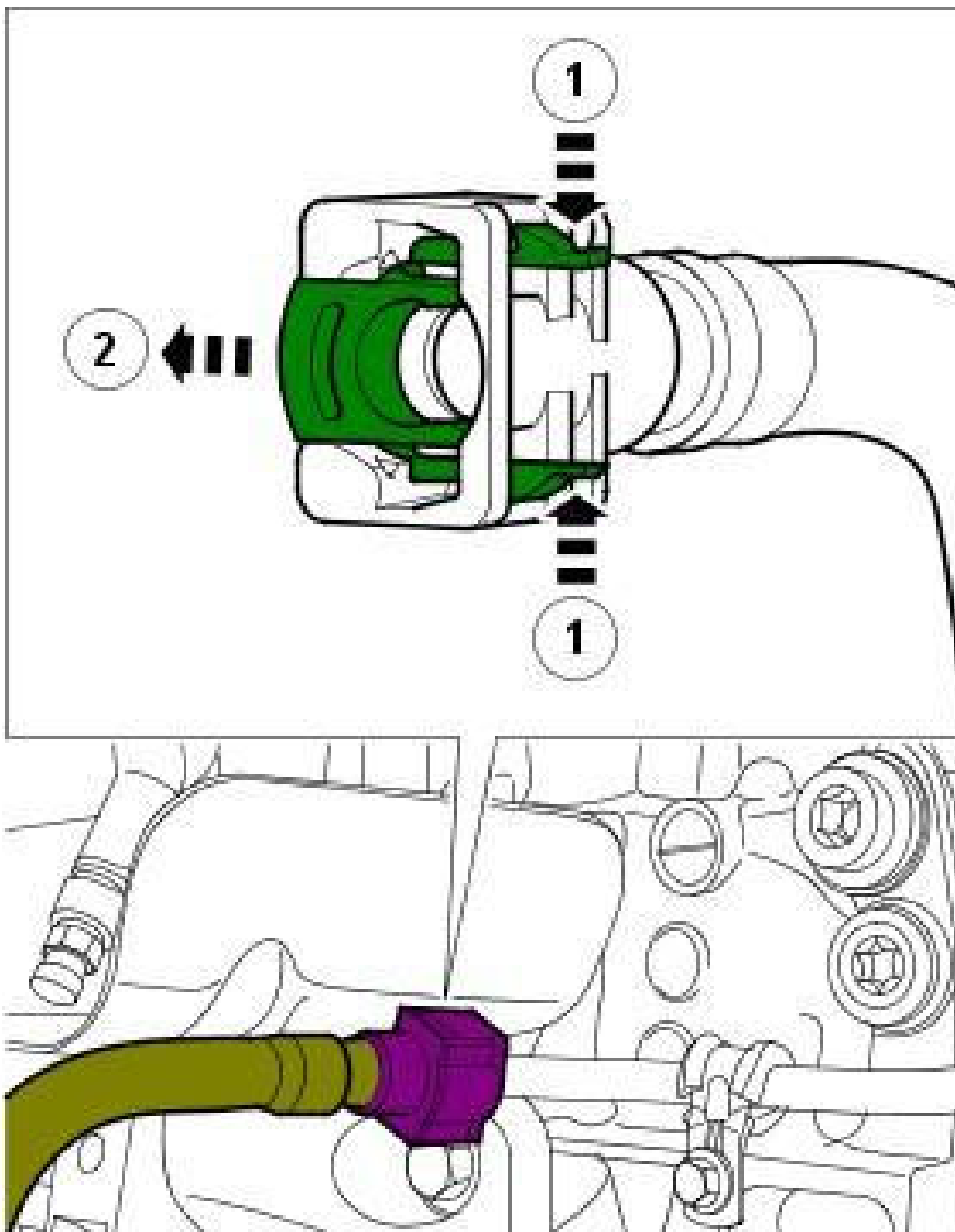


30. Disconnect the starter motor electrical connections.



**CAUTION: Be prepared to collect escaping fuel.**

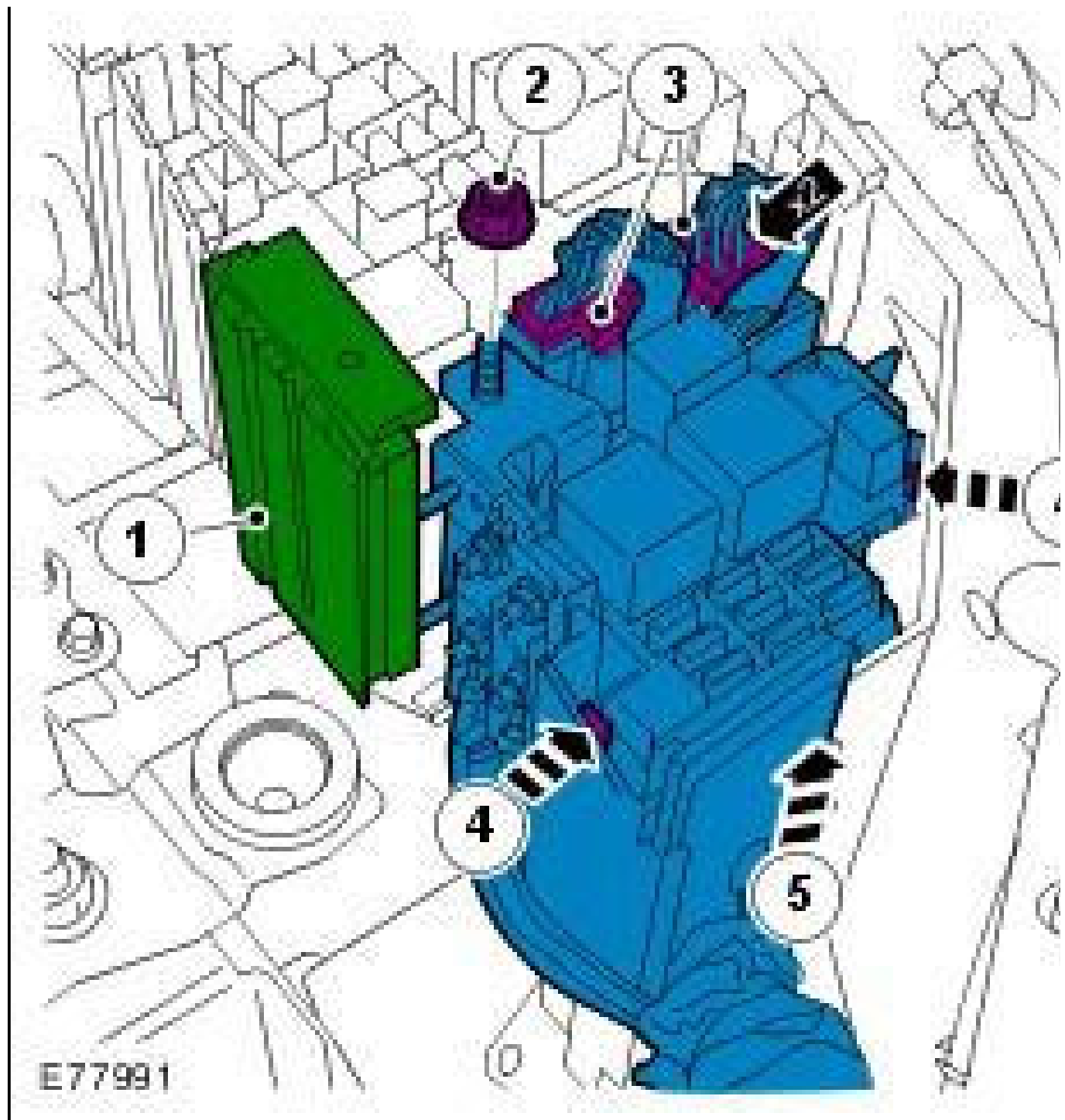
31. Disconnect the fuel line.



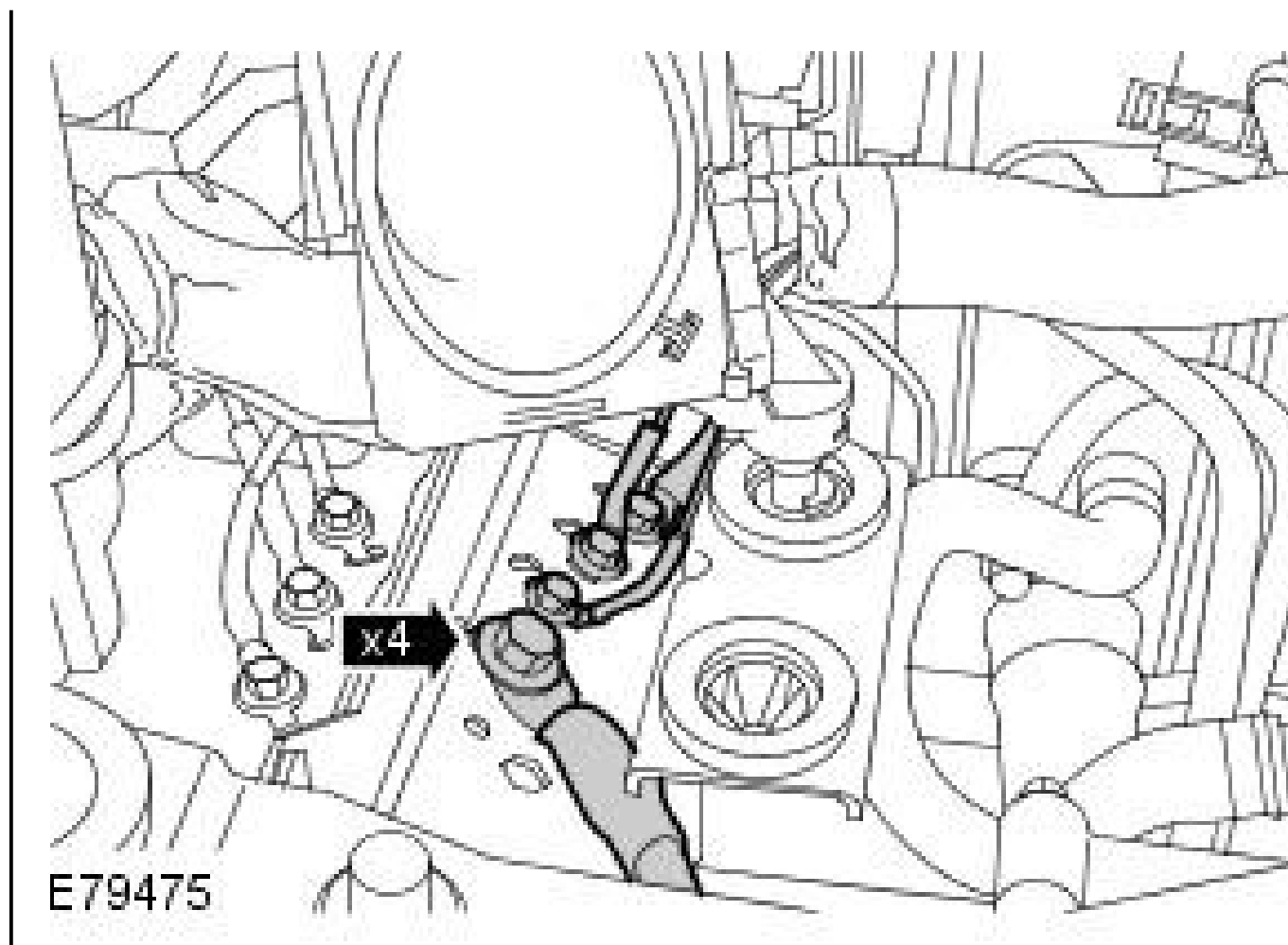
32. Release the RH ground cable.



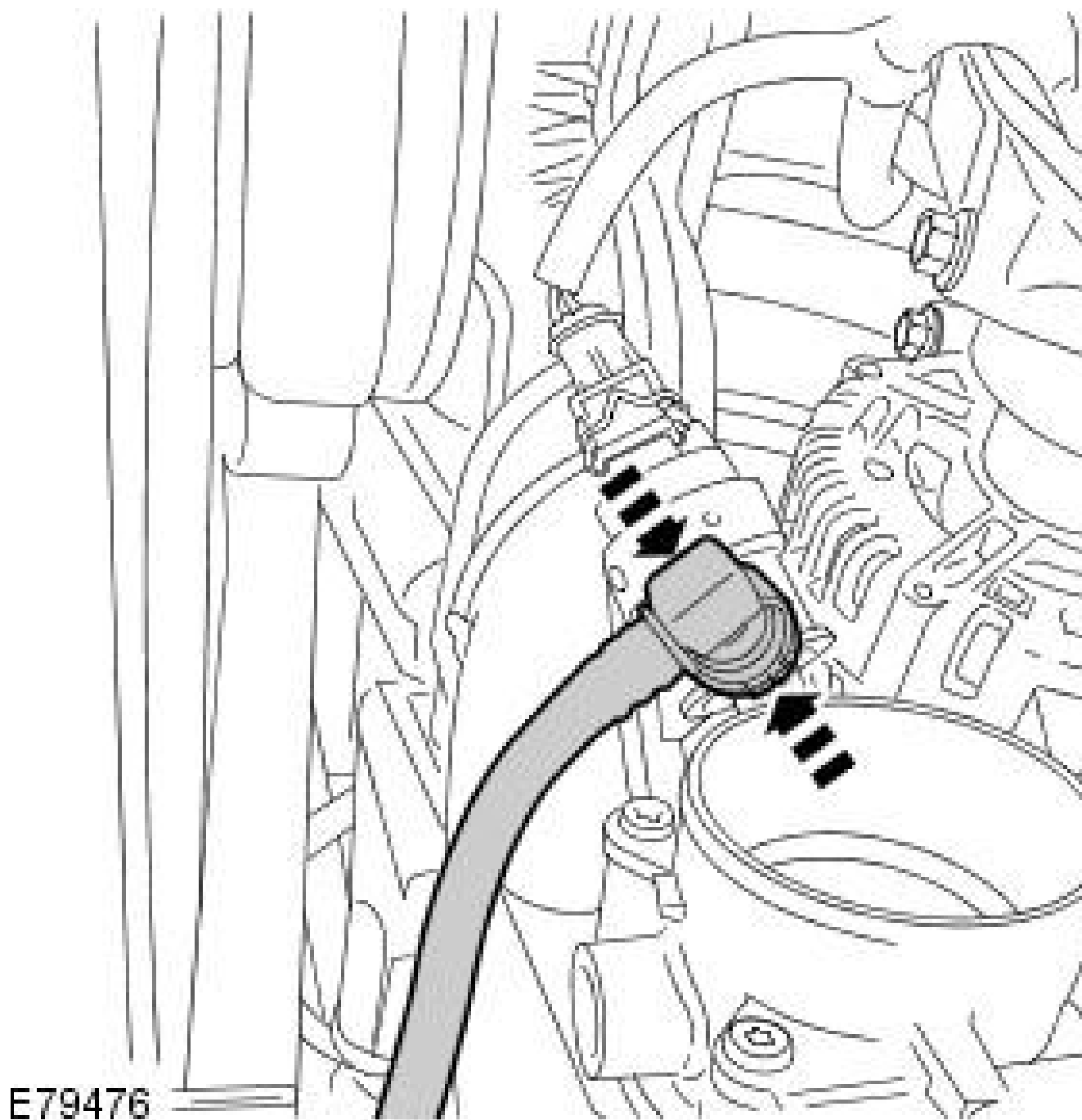
33. Disconnect the engine wiring harness.



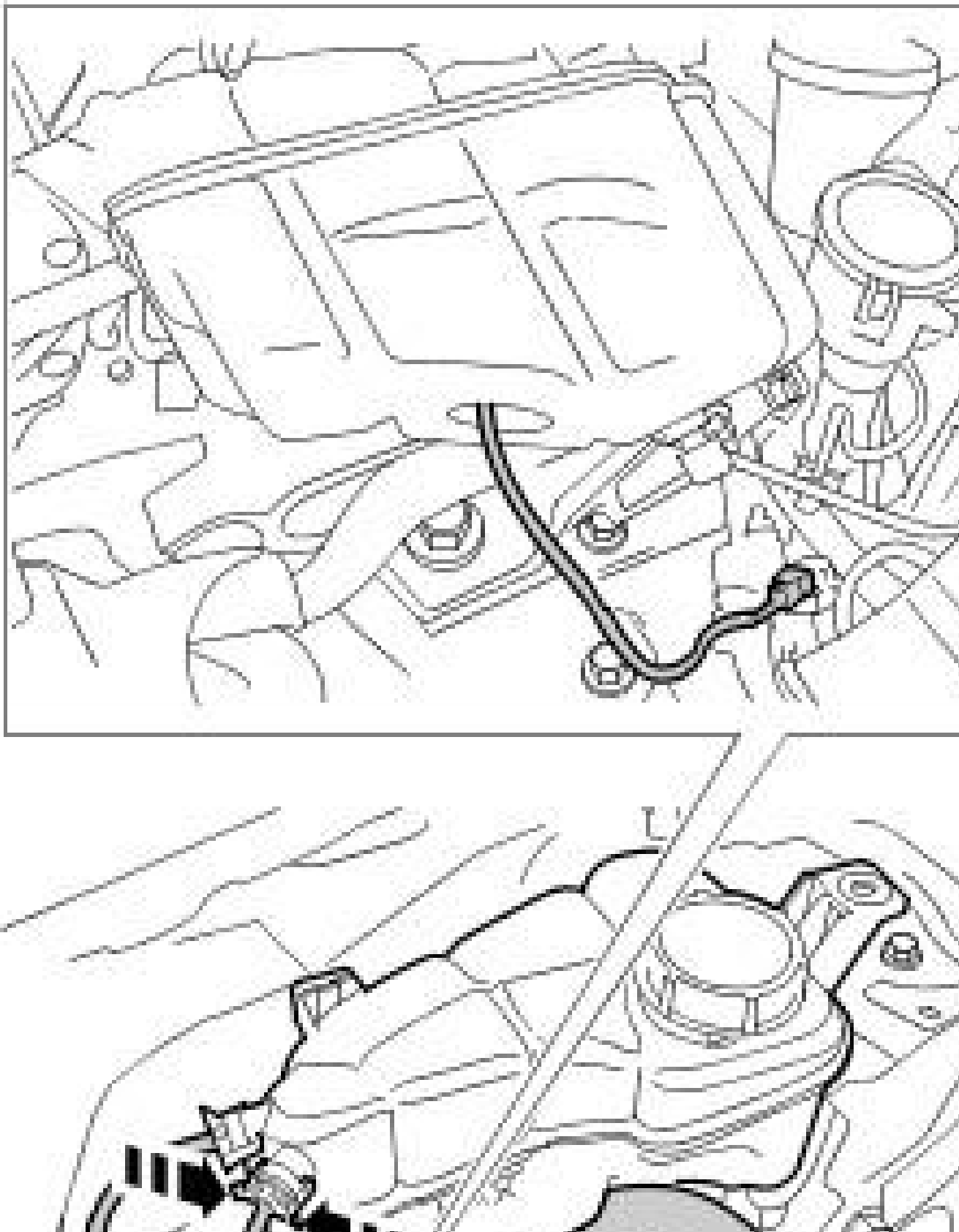
34. LH side: Release 4 engine compartment ground cables.



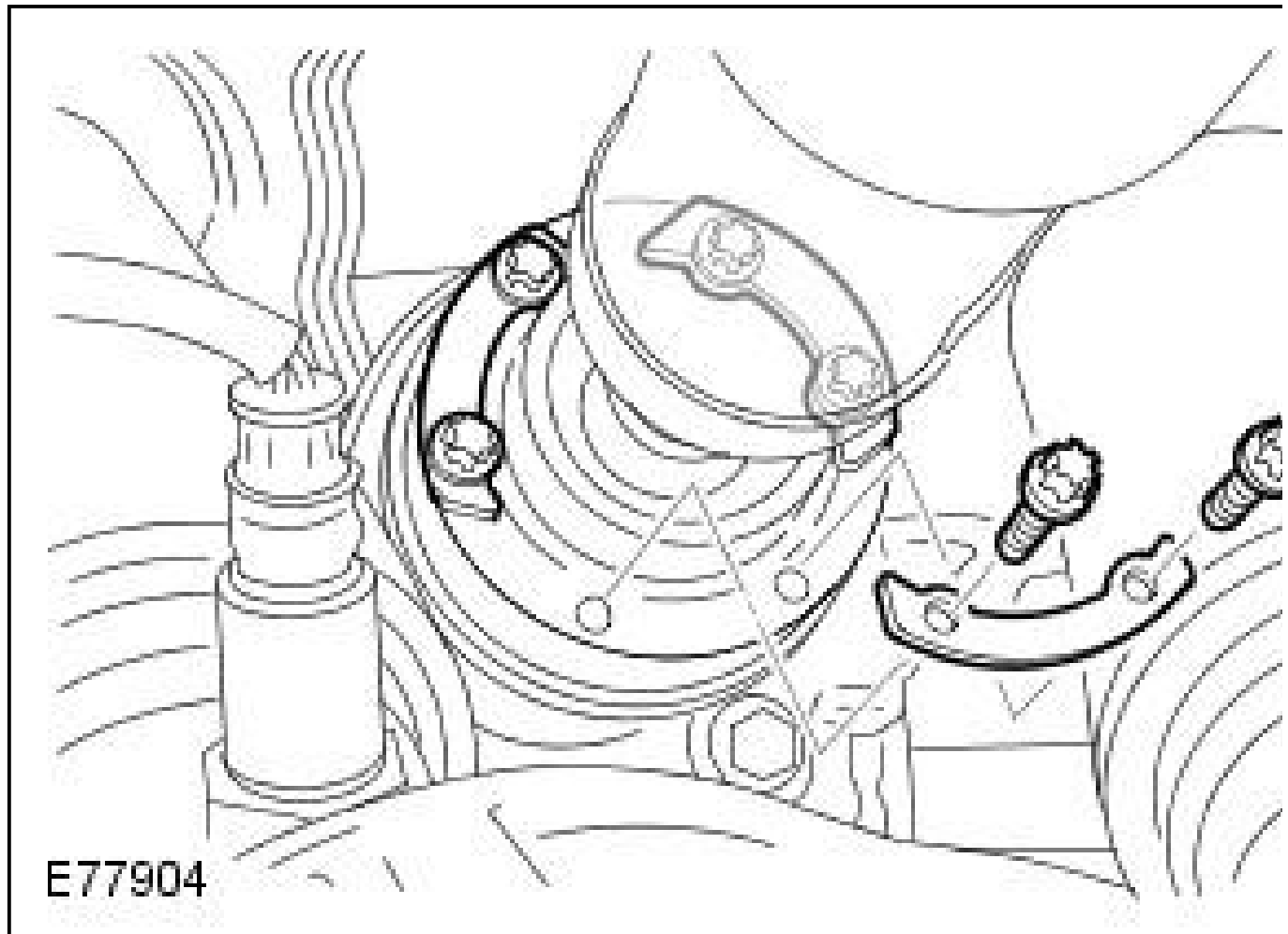
35. Release the clip and disconnect the purge line.



36. Remove the coolant expansion tank.

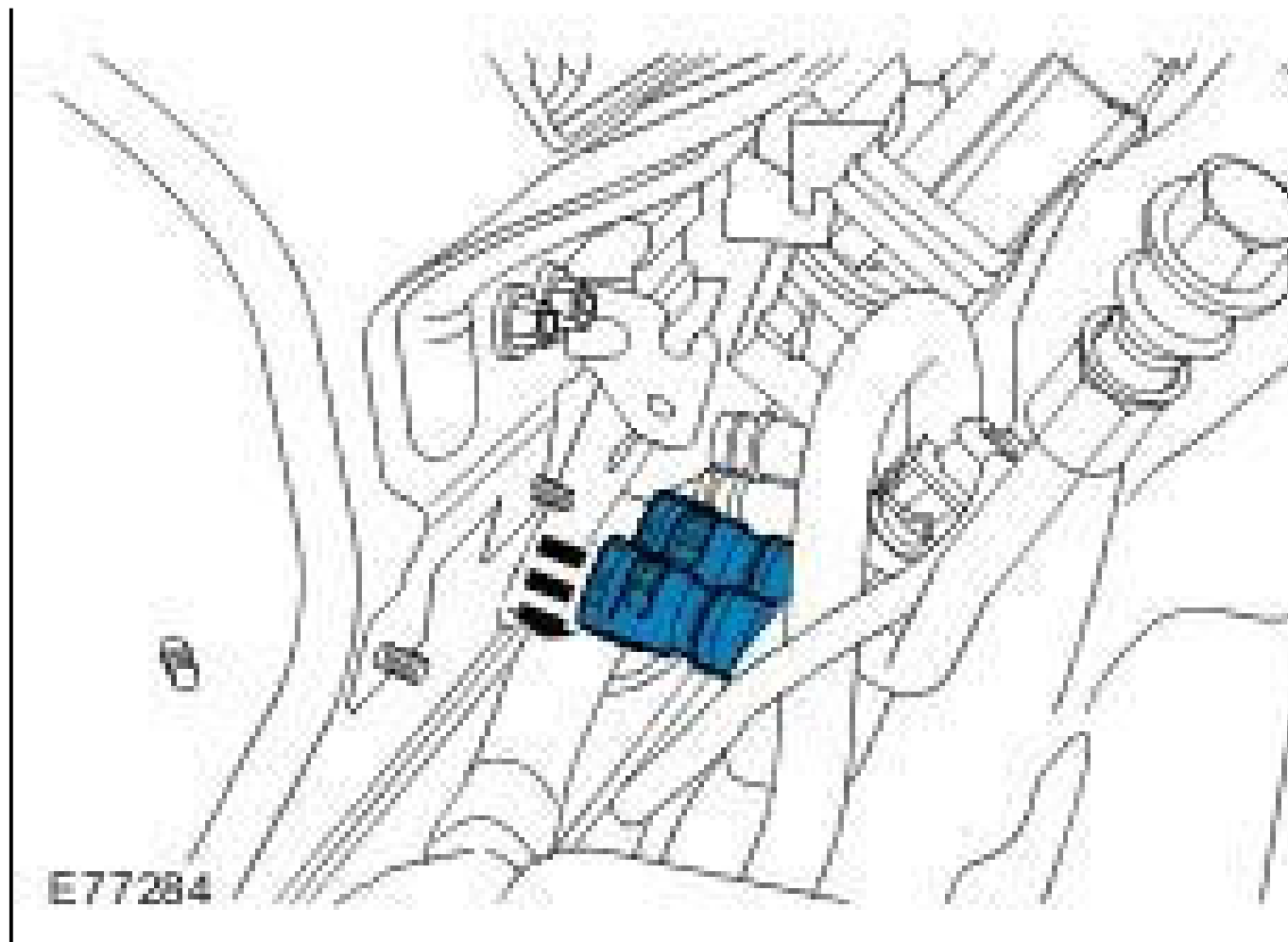


37. Release the driveshaft from the transmission drive flange.



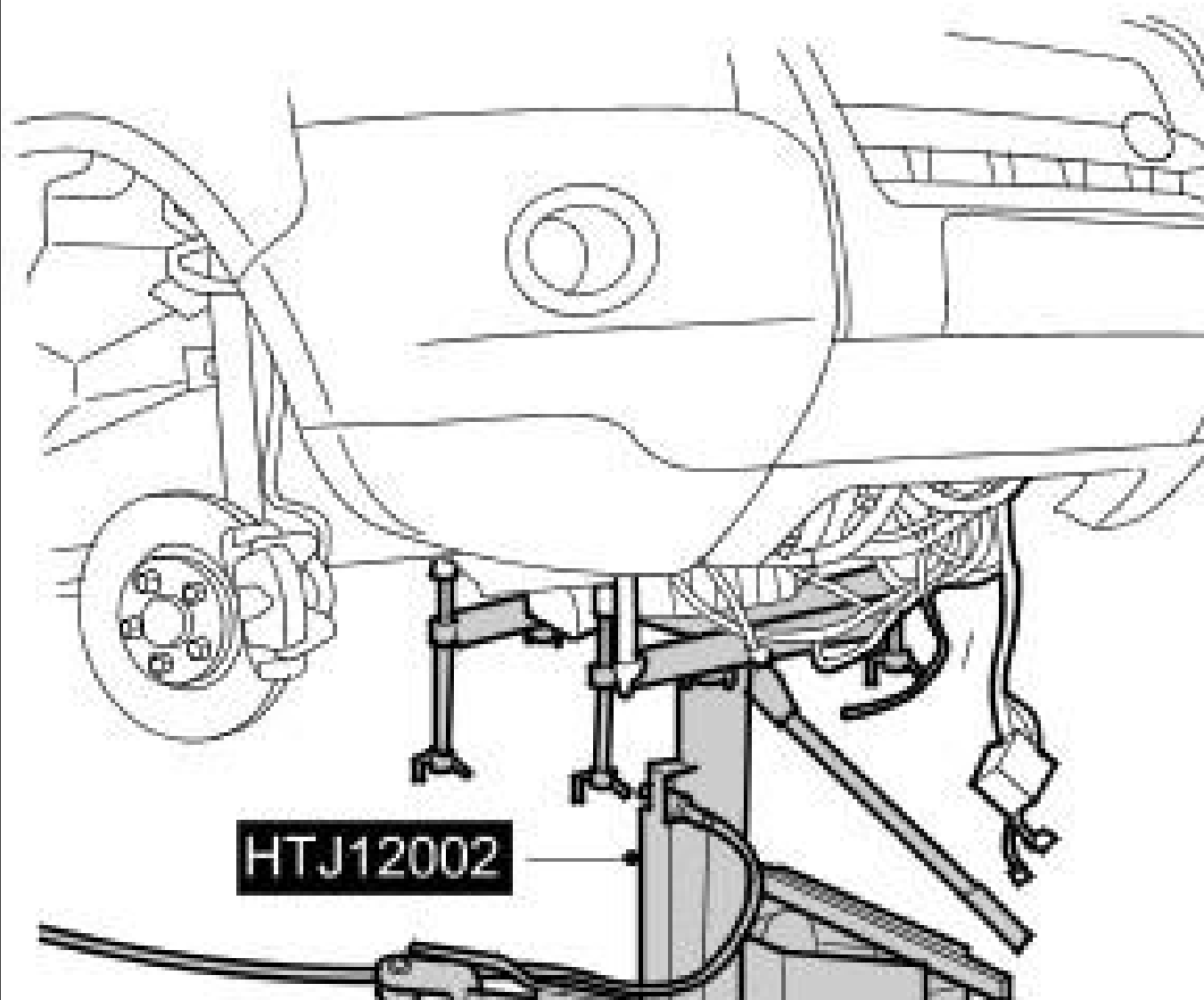
38. Disconnect 2 heater hoses from the bulkhead.





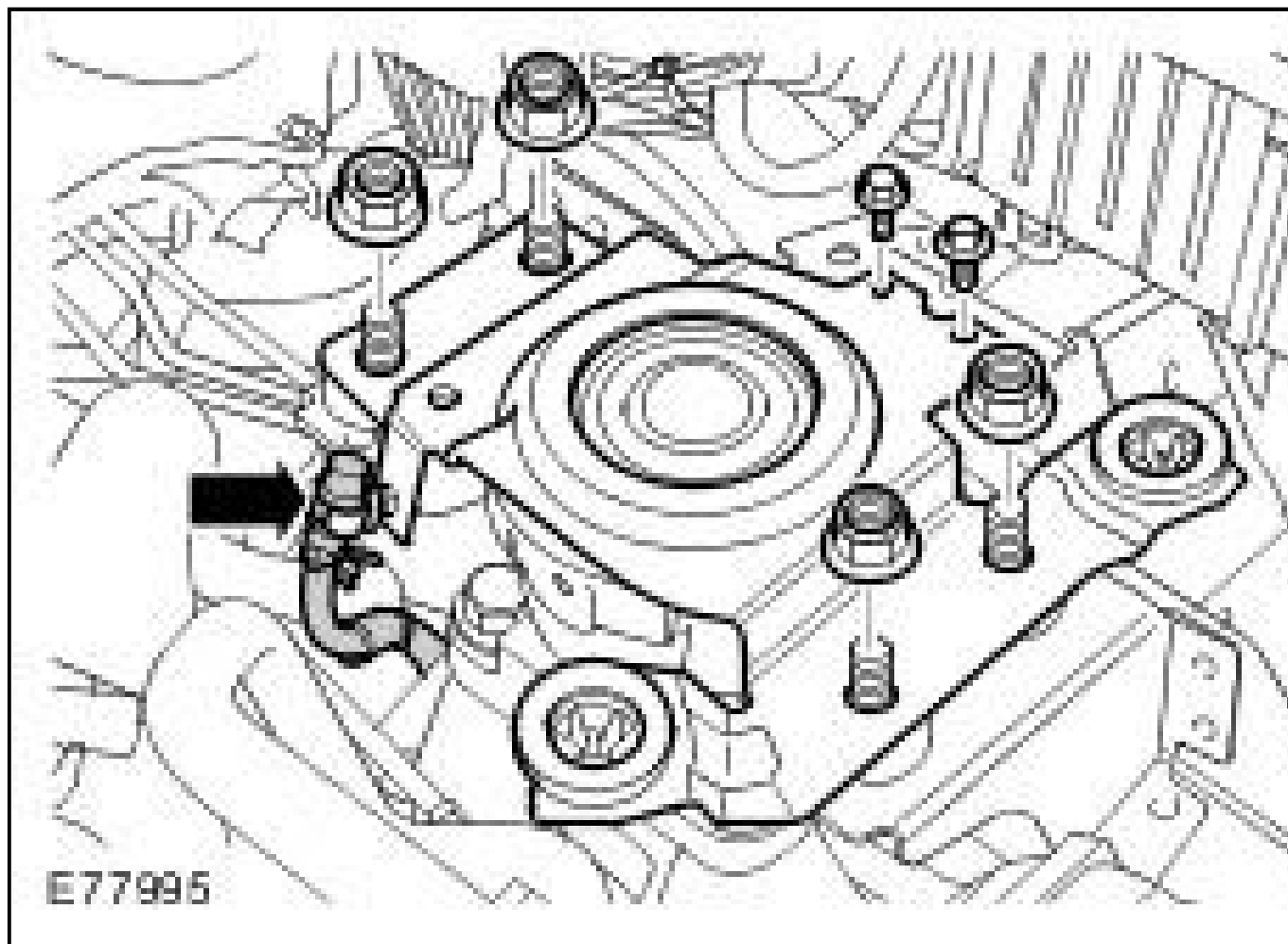
39. Support the engine.

General Equipment: Powertrain Jack

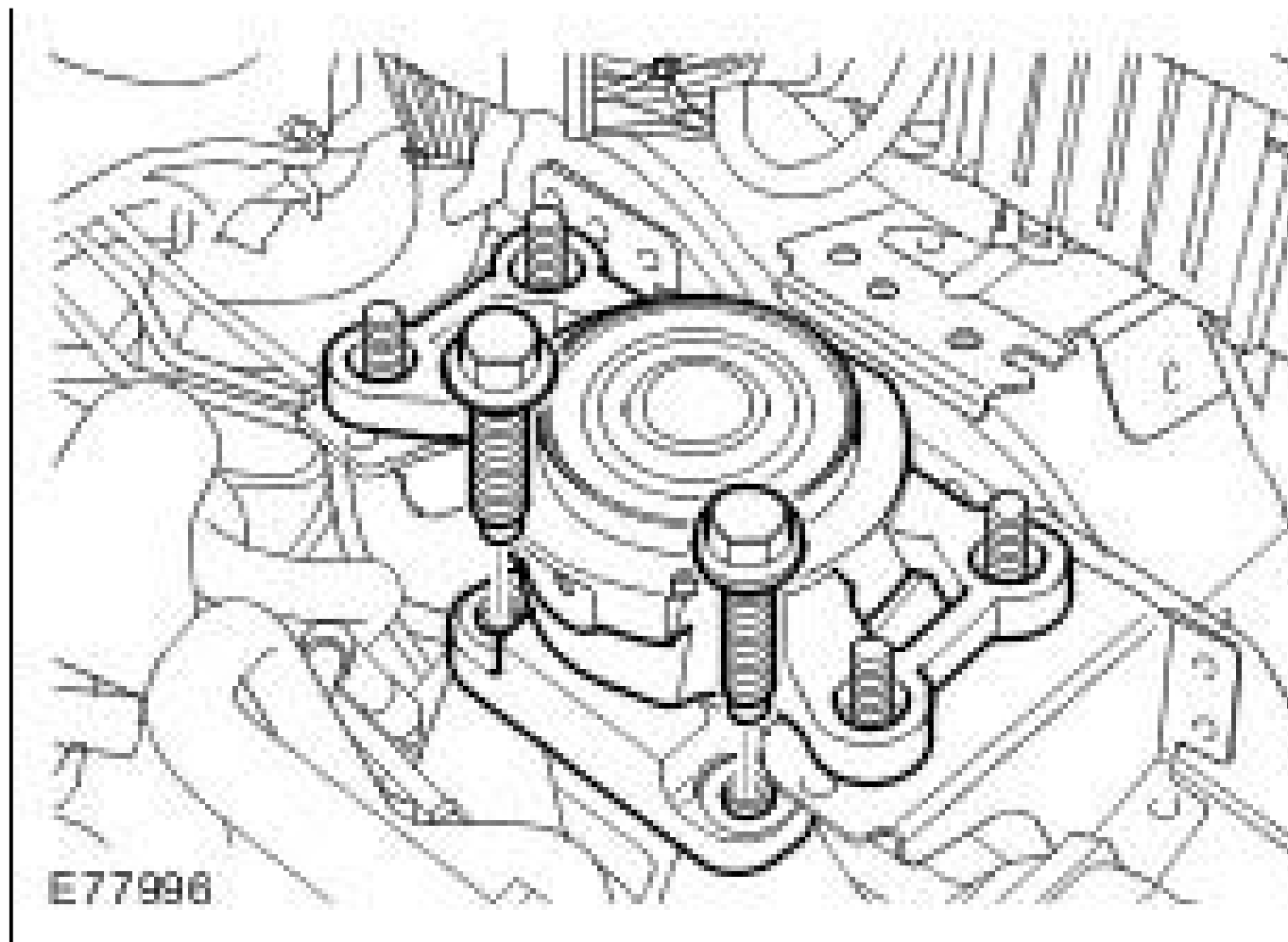


**WARNING: Make sure that new nuts are installed.**

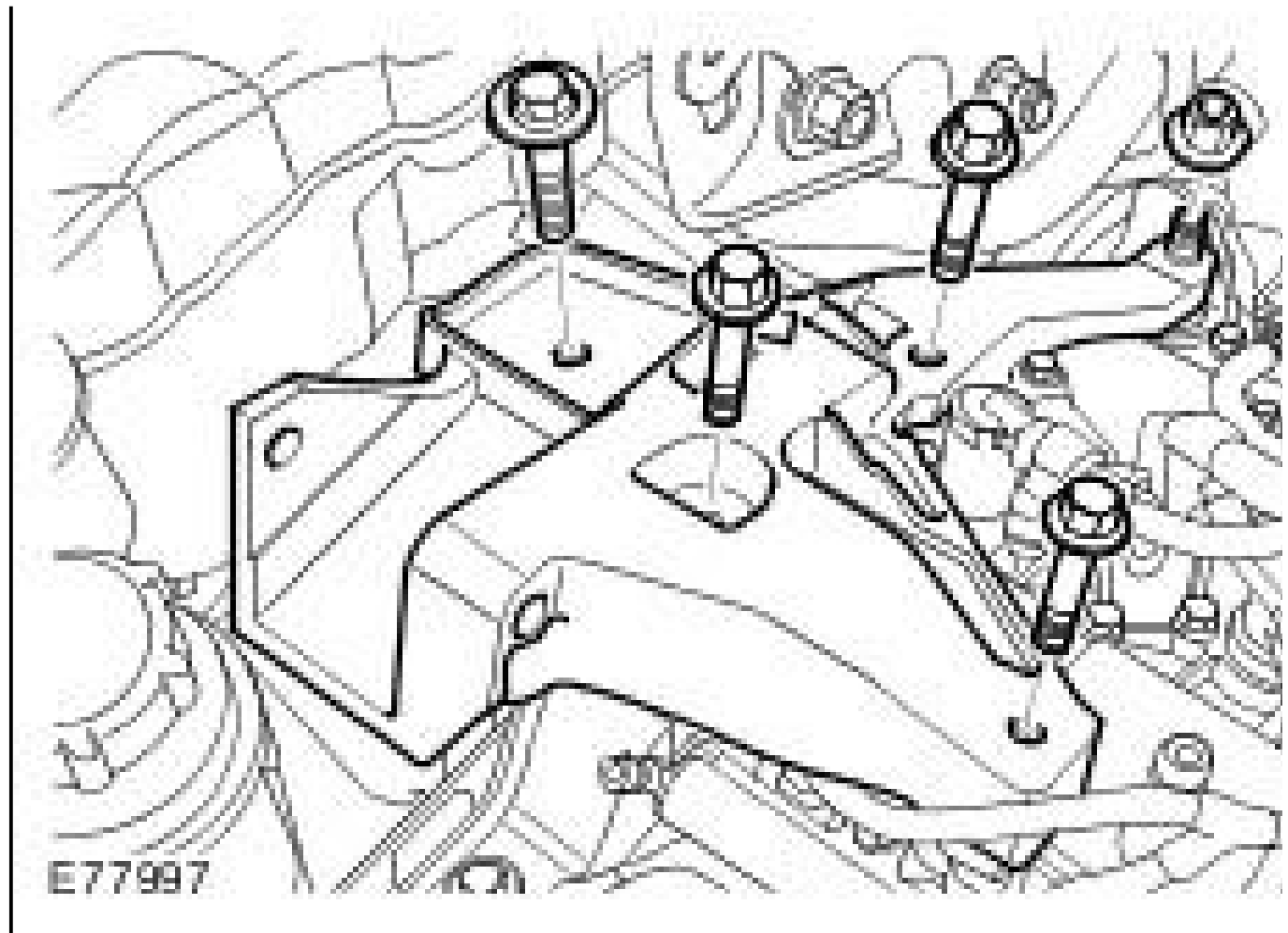
40. Remove the LH engine mount bracket.



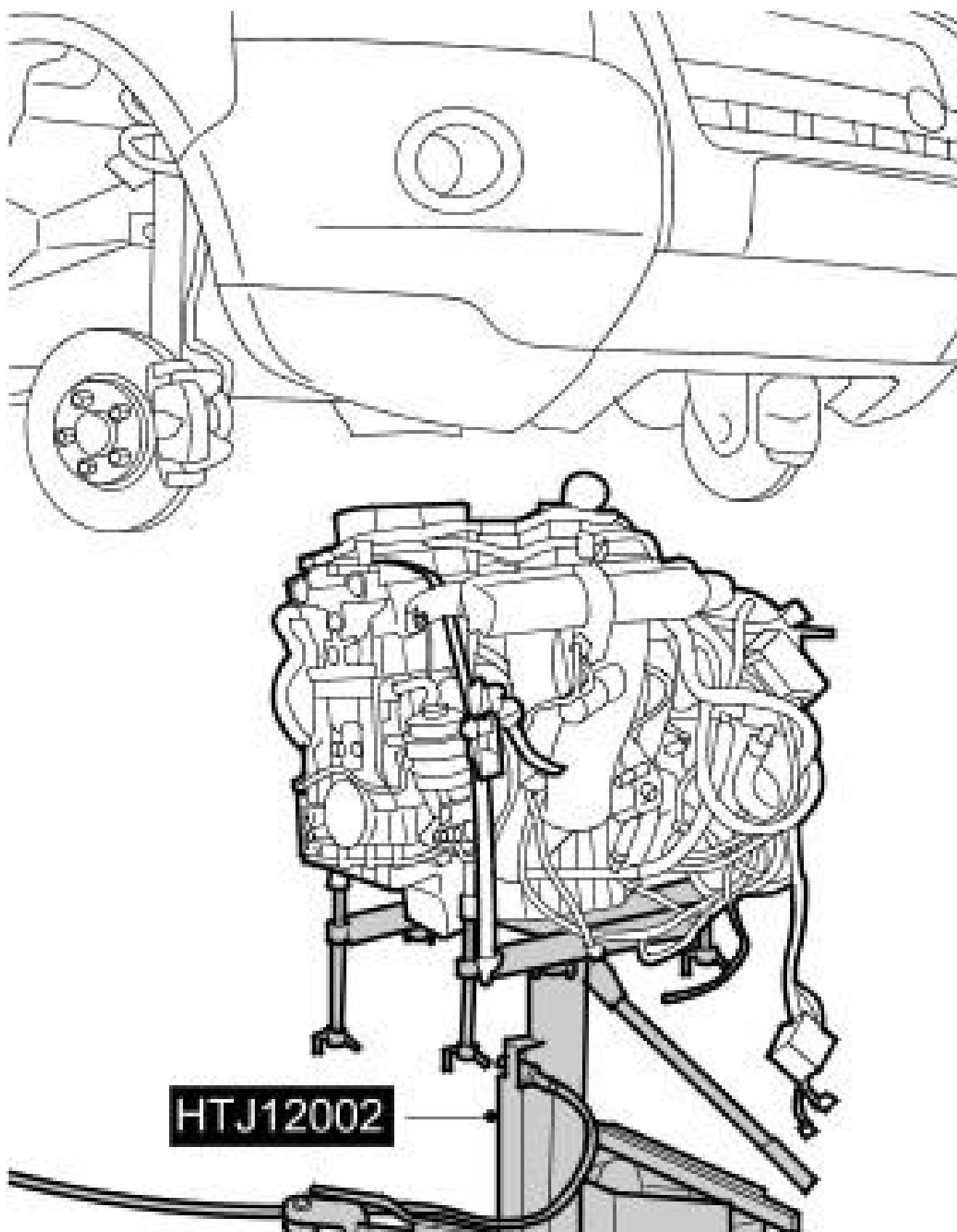
41. Remove the LH engine mount.



42. RH side: Release the engine mount.



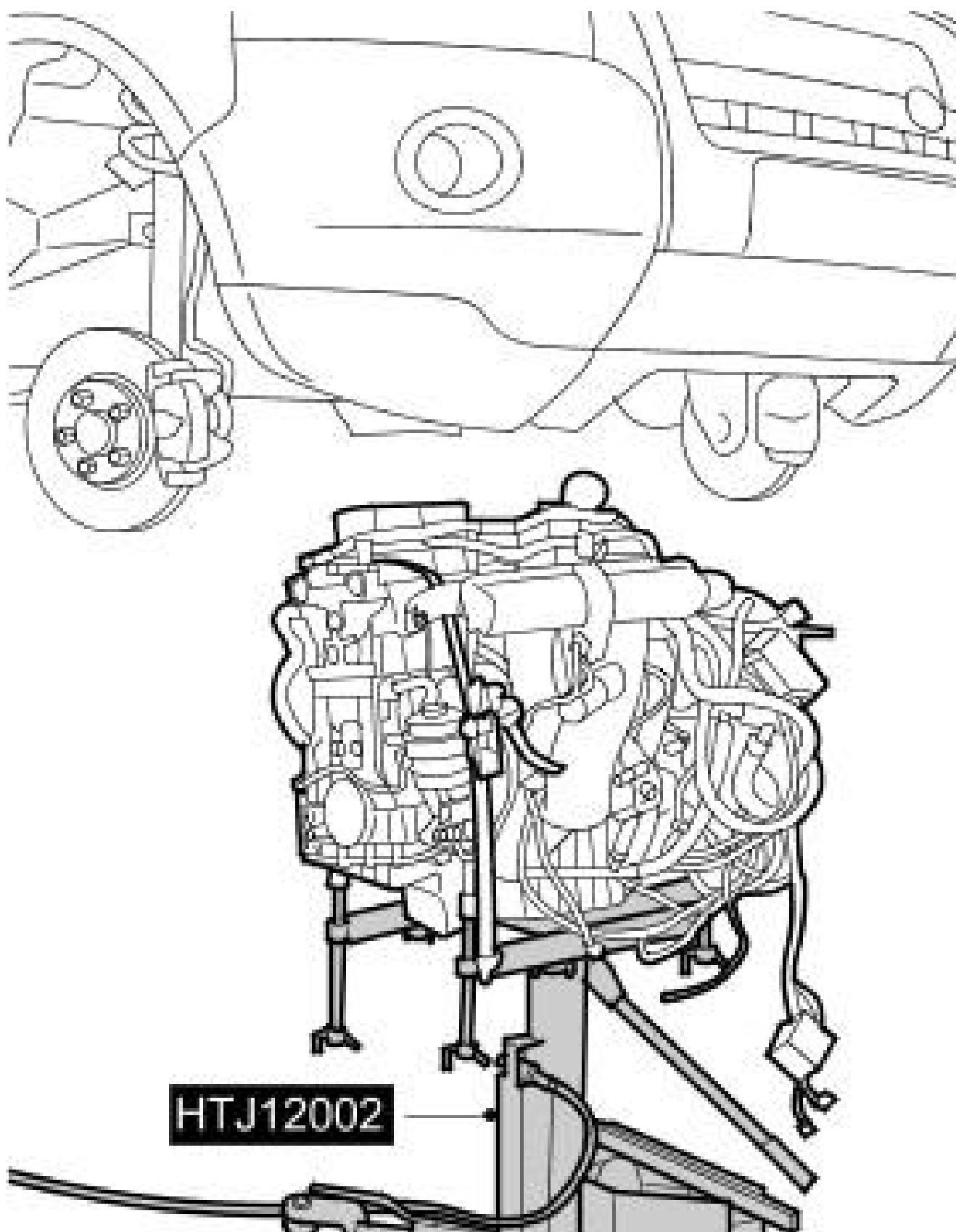
43. With assistance, carefully remove the engine and transmission.



**INSTALLATION**

1. With assistance, carefully install the engine and transmission.

General Equipment: Powertrain Jack



2. RH side: Install the engine mount.

Torque: 80 Nm

3. Install the LH engine mount.

Torque: 175 Nm

4. Install the bracket.

Torque:

M12 80 Nm

M8 25 Nm

5. Remove the engine support.
6. Connect the bulkhead heater hoses.

**CAUTION: Make sure that the component is clean, free of foreign material and lubricant.**

**CAUTION: Make sure that new bolts are installed.**

7. Install the driveshaft.

Torque: 40 Nm

8. Install the coolant expansion tank.

Torque: 10 Nm

9. Connect the purge line.
10. Connect the engine compartment ground cables.

Torque:

M8 25 Nm

M6 10 Nm

11. Secure the engine wiring harness.

Torque: 10 Nm

12. Install the RH ground cable.

Torque: 10 Nm

**CAUTION: A new O-ring seal is to be installed.**

**CAUTION: Extreme cleanliness must be exercised when handling these components.**

13. Connect the fuel line.
14. Install the transmission fluid cooler.
15. Connect the coolant top hose.
16. Connect the coolant bottom hose.
17. Connect the cooling fan electrical connector.
18. Install the RH halfshaft support.

Torque: 25 Nm

19. Install the LH halfshaft.
20. With assistance, install the halfshaft to the hub.

**WARNING: Make sure that a new bolt is installed.**

21. Install the halfshafts.

Torque:

Stage 1: 45 Nm

Stage 2: 60°

22. Connect the selector cable to the transmission.
23. Connect the low pressure line to the power steering pump.

**CAUTION: A new O-ring seal is to be installed.**

**CAUTION: Extreme cleanliness must be exercised when handling these components.**

24. Secure the A/C and power steering lines.

25. Install the A/C compressor.

Torque: 25 Nm

26. Install the A/C compressor, upper support bracket.

Torque:

M10 45 Nm

M8 25 Nm

M6 10 Nm

27. Install the A/C compressor, lower support bracket.

Torque: 25 Nm

28. Connect the brake booster vacuum hose.

29. Connect the ECM electrical connectors.

30. Install the starter motor.

Refer to: **Starter Motor - Petrol** .

31. Remove the front subframe assembly.

Refer to: **Front Subframe** .

32. Install the lower engine stabilizer bar.

Refer to: **Engine Lower Support Insulator**.

33. Remove the catalytic converters.

Refer to: **Catalytic Converter** .

34. Refill and bleed the cooling system.

Refer to: **Cooling System Draining, Filling and Bleeding** .

35. Install the air cleaner assembly.

Refer to: **Air Cleaner** .

36. Remove the battery tray.

Refer to: **Battery Tray** .

37. Remove the plenum box access panel.

Refer to: **Plenum Chamber** .

38. Remove the engine cover.

Refer to: **Engine Cover - 3.2L** .

39. Connect the battery ground cable and install the cover.

Refer to: **Specifications** .

40. Refill and bleed the power steering.

Refer to: **Power Steering System Filling and Bleeding** .

41. Carry out the final halfshaft and suspension tightening with the vehicle on its wheels.