ENGINE

Engine (V8 5.0L Petrol)

ENGINE (V8 5.0L PETROL)

SPECIFICATIONS

ENGINE DATA

Engine Description	Engine Capacity	Maximum Engine Torque (EEC)	Maximum Engine Power (EEC)	Compression Ratio	Bore	Stroke
90° "Vee" 8 Cylinder 32 Valves	4.999 ccm	510 Nm at 3.500 RPM	276 kW at 6.500 RPM	11.5 ± 0.5	92.5 mm	93 mm

ENGINE FIRING ORDER

Firing Order
1:2:7:3:4:5:6:8

ENGINE VALVE CLEARANCE (COLD)

Intake Valve	Exhaust Valve
N/A	0.25 mm ± 0.02

SPARK PLUGS

Specification	Spark Plug Gap
ILKR6C-10	1 mm

LUBRICANTS, FLUIDS, SEALERS AND ADHESIVES

Description	Specification
Engine Oil	WSS-M2C925-A
Sealant	WSE-M4G323-A6
Core plug and stub pipe retainer	WSK-M2G349-A7

CAPACITIES

Description	Liters
Engine oil, initial fill	9.5
Engine oil, service fill with oil filter change	8.0

CYLINDER HEAD AND VALVE TRAIN

Item	Specification
Cylinder head maximum permitted warp (mm)	

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(flatness specification)	
overall	0.08
over 150x150 mm area	0.05
over 25x25 mm area	0.02
Valve guide inner diameter (mm)	5.51 ± 0.01
Intake valve effective length (mm) (tip to gauge line)	97.63 ± 0.1
Exhaust valve effective length (mm) (tip to gauge line)	94.39 ± 0.1
Valve stem to guide clearance intake diametrical (mm)	0.022 - 0.057
Valve stem to guide clearance exhaust diametrical (mm)	0.03 - 0.065
Valve head diameter intake (mm)	36 ± 0.1
Valve head diameter exhaust (mm)	30 ± 0.1
Intake valve face angle (degrees)	44.875 ± 0.125
Exhaust valve face angle (degrees)	44.875 ± 0.125
Valve stem diameter intake (mm)	5.4705 ± 0.0075
Valve stem diameter exhaust (mm)	5.4625 ± 0.0075
Valve spring free length (mm) - inlet	43.43
Valve spring free length (mm) - exhaust	46.1
Valve spring installed height (mm) - inlet	34.49
Valve spring installed height (mm) - exhaust	35.1
Camshaft lobe lift intake (mm)	5.5 (low) 10.53 (high)
Camshaft lobe lift exhaust (mm)	9.36
Camshaft journal to cylinder head bearing surface clearance diametrical (mm)	0.025 - 0.065
Camshaft journal diameter - all positions	26.965 ± 0.01
Bearing diameter - all positions	27.01 ± 0.01
Camshaft journal maximum run out limit (mm)	
Camshaft journals to end journals	0.03
Camshaft journals to adjacent journals	0.015
Camshaft journal maximum out of round (mm) - all journals	0.005

NOTE: A = Refer to procedure for correct torque sequence.

TORQUE SPECIFICATIONS

Description	Nm	lb-ft	lb-in
Engine cover mounting bolts	10	7	-
Accessory drive belt tensioner retaining bolt	40	30	-
Supercharger belt idler/tensioner bracket retaining	25	18	-

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bolts			
Secondary drive belt idler retaining bolts	40	30	-
Power steering pump pulley retaining bolts	25	18	-
Power steering pump retaining bolts	25	18	-
Power steering pump bracket to engine retaining bolts	25	18	-
Generator retaining bolts	48	35	-
Starter motor retaining bolts	40	30	-
Air conditioning compressor retaining bolts	25	18	-
Engine mounting to engine mounting bracket retaining nuts	100	74	-
Engine mounting to subframe retaining bolts	56	41	-
Engine mounting bracket to engine retaining bolts	45 + 60°	33 + 60°	-
Crankshaft damper pulley retaining LH threaded bolt	200 + 270°	148 + 180°	-
Flexplate retaining bolts	45 + 90°	33 + 90°	-
Exhaust manifold heat shield retaining bolts	**A**	-	-
Exhaust manifold retaining bolts	**A**	-	-
Engine wiring harness bracket retaining bolts	10	7	-
Coolant outlet pipe	10	7	-
Intercooler retaining bolts	25	18	-
Intake manifold retaining bolts	25	18	-
Oil Cooler retaining bolts	13	10	-
Knock sensor (KS) retaining bolt	20	14	-
Ignition coil retaining bolts	8	-	71
Spark plugs	20	15	-
Fuel rail retaining bolts	**A**	-	-
High pressure fuel pipe retaining bolts	**A**	-	-
High pressure fuel pump retaining bolts	12	9	-
Oil filter housing assembly retaining bolts	12	9	-
Oil filter cap	25	18	-
Lifting eye bolts	25 + 90°	18 + 90°	-
Manifold absolute pressure and temperature (MAPT) sensor retaining bolts	5	-	44
Coolant pump retaining bolts	12	9	-
Variable valve timing (VVT) oil control solenoid retaining bolts	10	7	-
Camshaft position (CMP) sensor retaining bolts	10	7	-
Camshaft cover retaining bolts	13	10	-
Front upper timing cover retaining bolts	12	9	-
Front lower timing cover retaining bolts	**A**	-	-
Engine rear cover retaining bolts	**A**	-	-

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VVT to camshaft retaining bolts	32	24	-
Camshaft bearing caps retaining bolts	11	8	-
Primary timing chain fixed guide retaining bolts	12	9	-
Primary timing chain tensioner retaining bolts	12	9	-
Primary timing chain tensioner guide blade retaining bolts	25	18	-
Auxiliary chain tensioner guide retaining bolts	21	15	-
Auxiliary chain fixed guide retaining bolt	12	9	-
Oil pump sprocket retaining bolt	21	15	-
Cylinder head retaining bolts	**A**	-	-
Engine oil level (EOL) sensor retaining bolt	12	9	-
Crankshaft position (CKP) sensor retaining bolt	10	7	-
Oil sump body to engine retaining bolts	25	18	-
Oil pan drain plug	24	18	-
Oil transfer tube to Oil pan body retaining bolts	11	8	-
Oil pump to engine block retaining bolts	25	18	-
Pick-up pipe to oil pump retaining bolts	12	9	-
Windage tray retaining bolts	25	18	-
Piston cooling jet retaining bolts	12	9	-
Engine block coolant draining plug	50	37	-
Cooling fan pulley	25	18	-

DESCRIPTION & OPERATION

ENGINE

EXTERNAL VIEW

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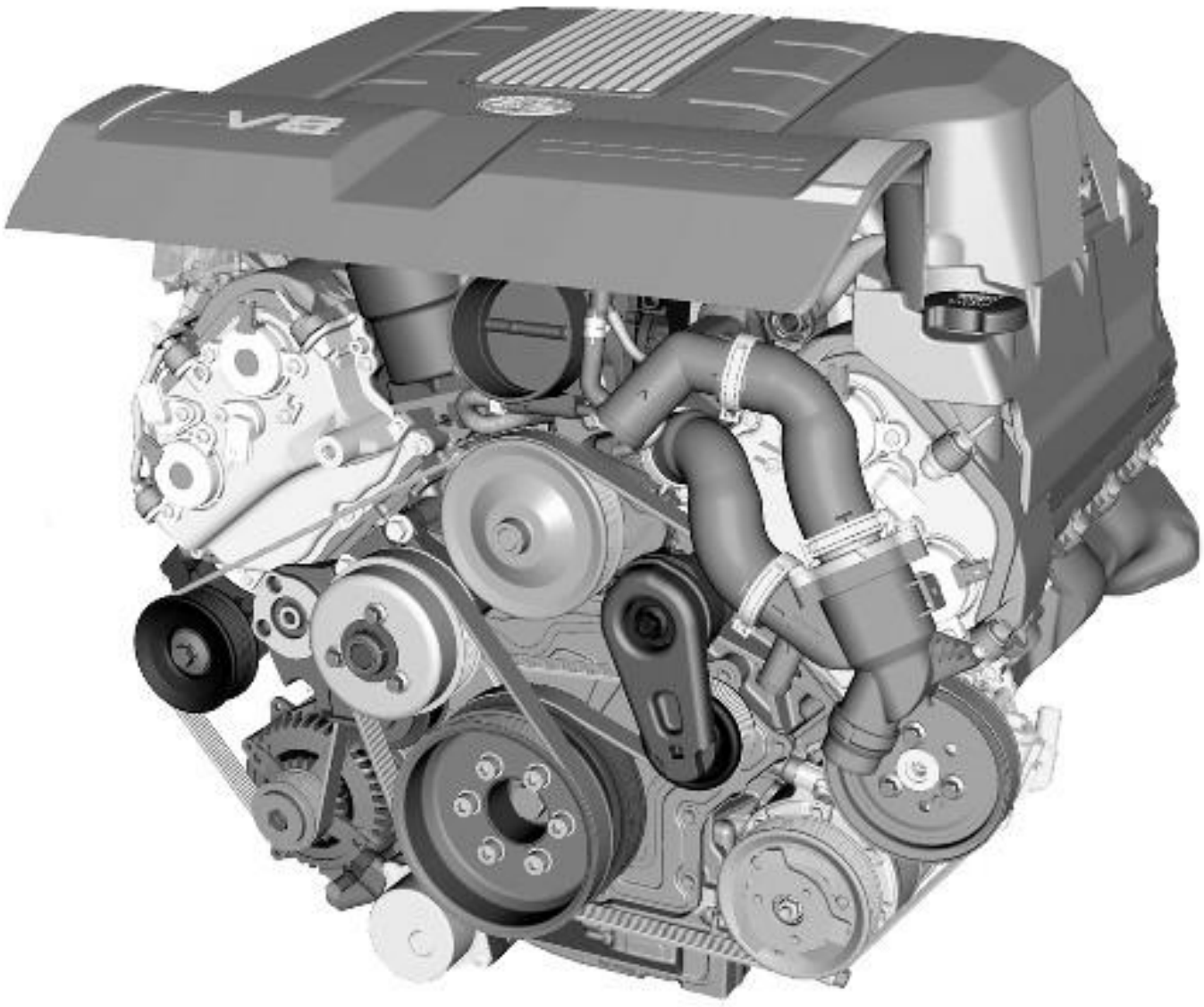

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INTRODUCTION

The 5.0L NA (naturally aspirated) gasoline engine is a liquid cooled V8 unit featuring direct fuel injection, four overhead camshafts and four valves per cylinder. All four camshafts incorporate variable camshaft timing (VCT). The intake camshafts and valves also incorporate CPS (camshaft profile switching).

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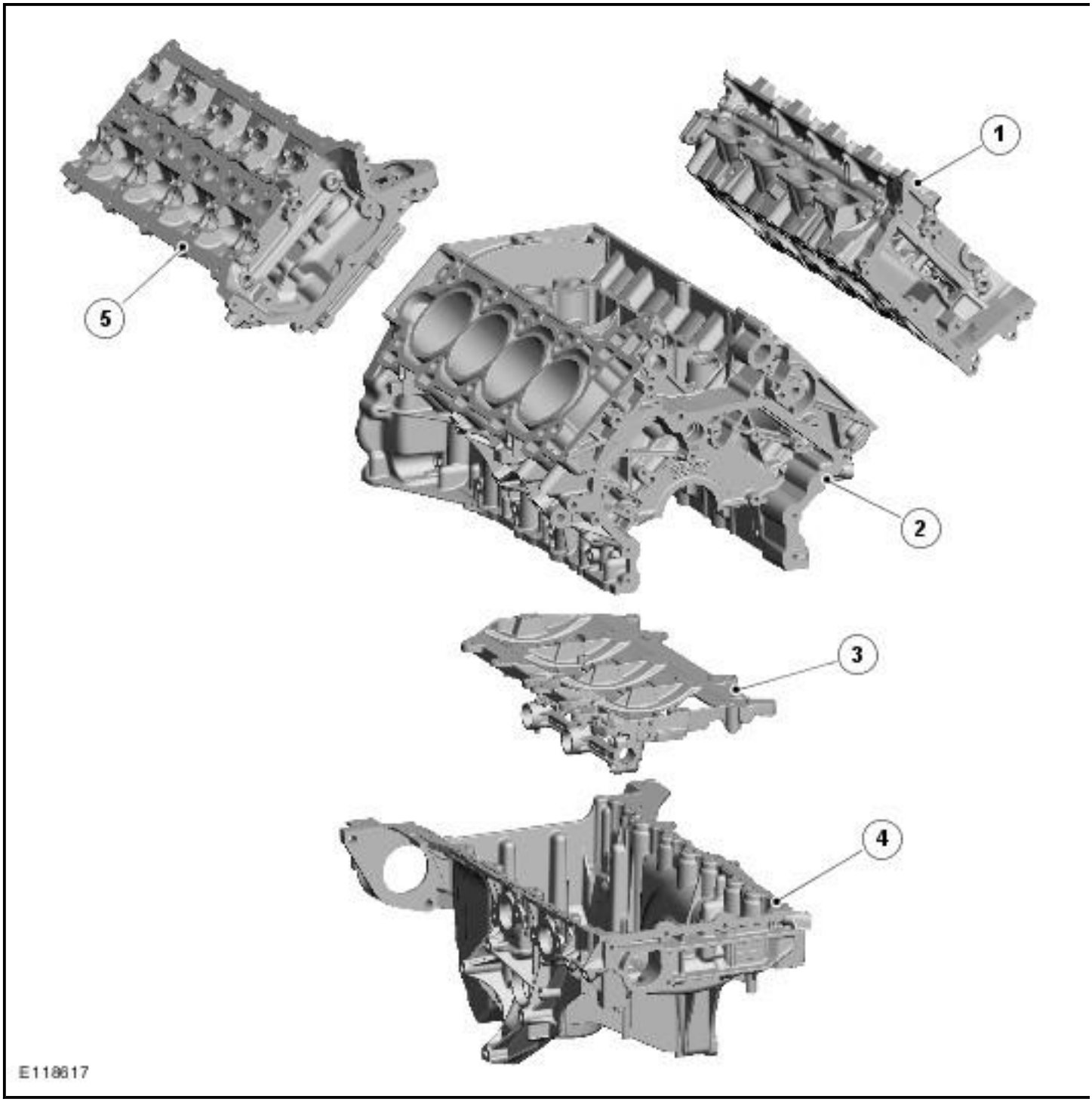
The main structural components of the engine are all manufactured from aluminum alloy. The engine is built around a very stiff, lightweight, enclosed V, deep skirt cylinder block. A structural windage tray is bolted to the bottom of the cylinder block to further improve the block stiffness, minimize noise, vibration and harshness (NVH) and help reduce oil foaming. To further enhance the stiffness of the lower engine structure, a heavily ribbed sump is installed. The sump also helps to reduce engine noise. A transverse hole is incorporated into the sump to accommodate the right-hand (RH) front drive halfshaft.



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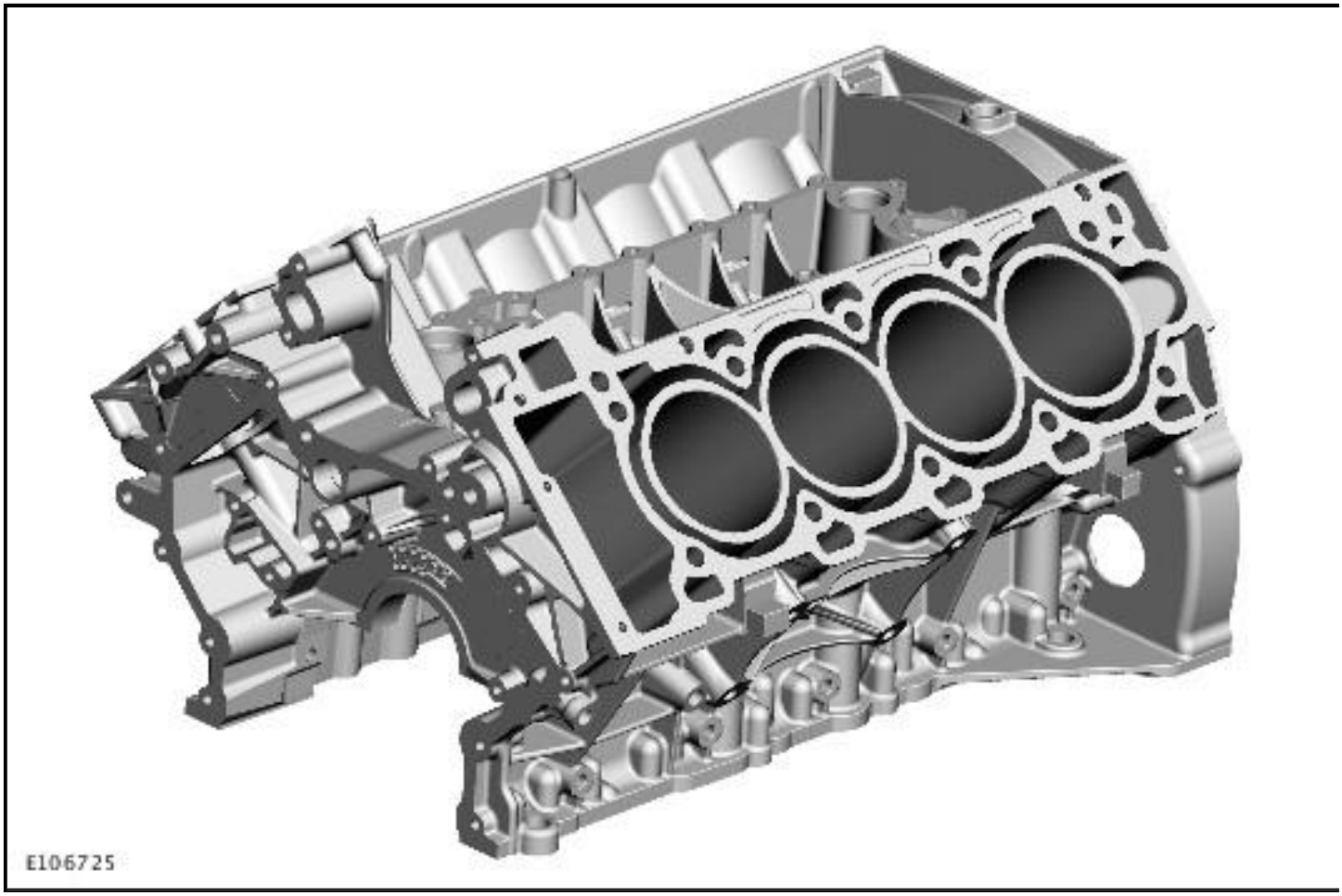
Item Number	Description
1	LH (left hand) cylinder head (bank B)
2	Cylinder block
3	Windage tray
4	Sump
5	RH (right hand) cylinder head (bank A)

CYLINDER BLOCK



The cylinder block is a 90 degree configuration with cast-in iron cylinder liners and an open deck die-cast coolant jacket. The low volume coolant jacket gives good warm-up times and low piston noise levels. The longitudinal flow design of the coolant jacket, with a single cylinder head coolant transfer port in each bank, provides good rigidity and head gasket sealing.

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

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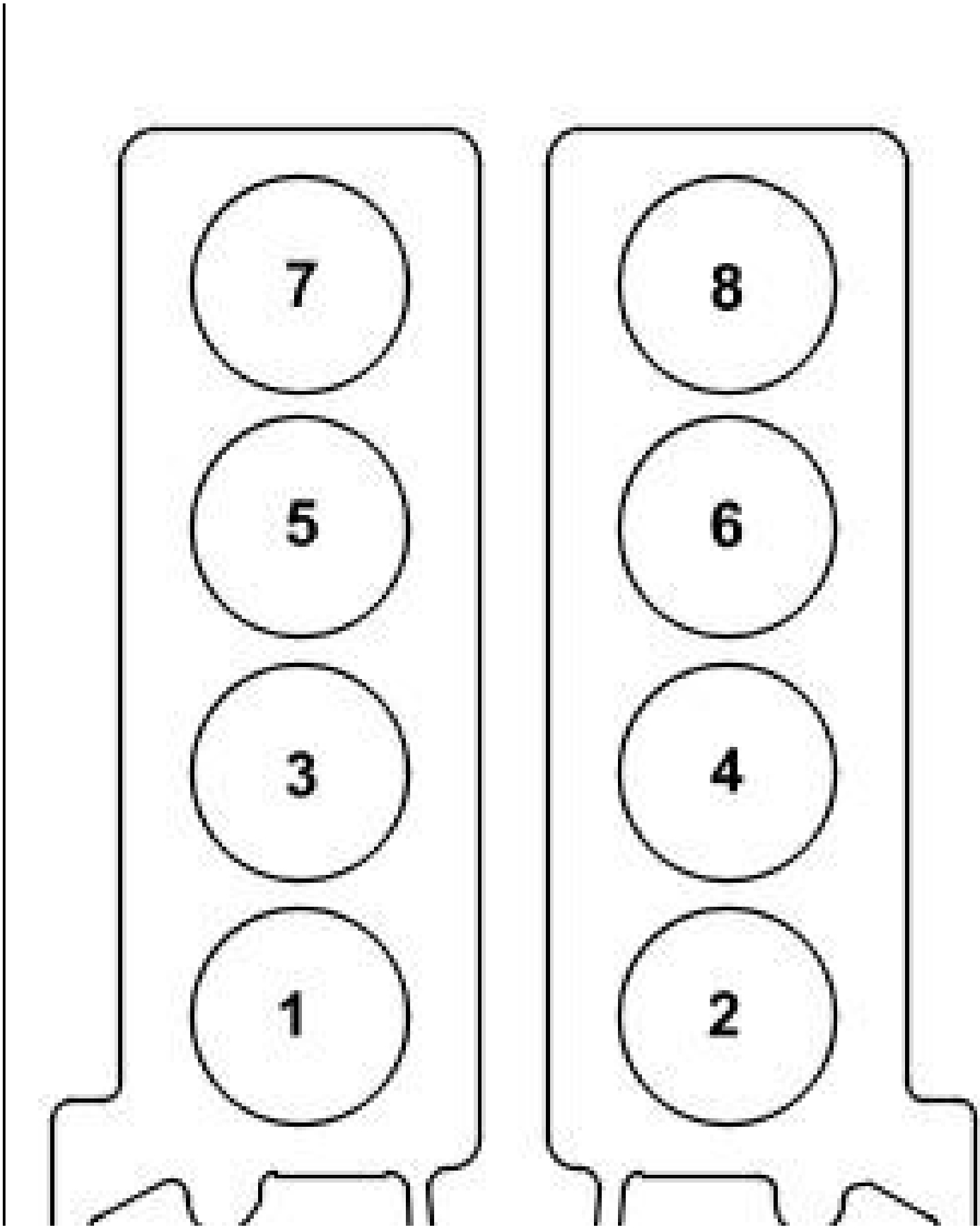

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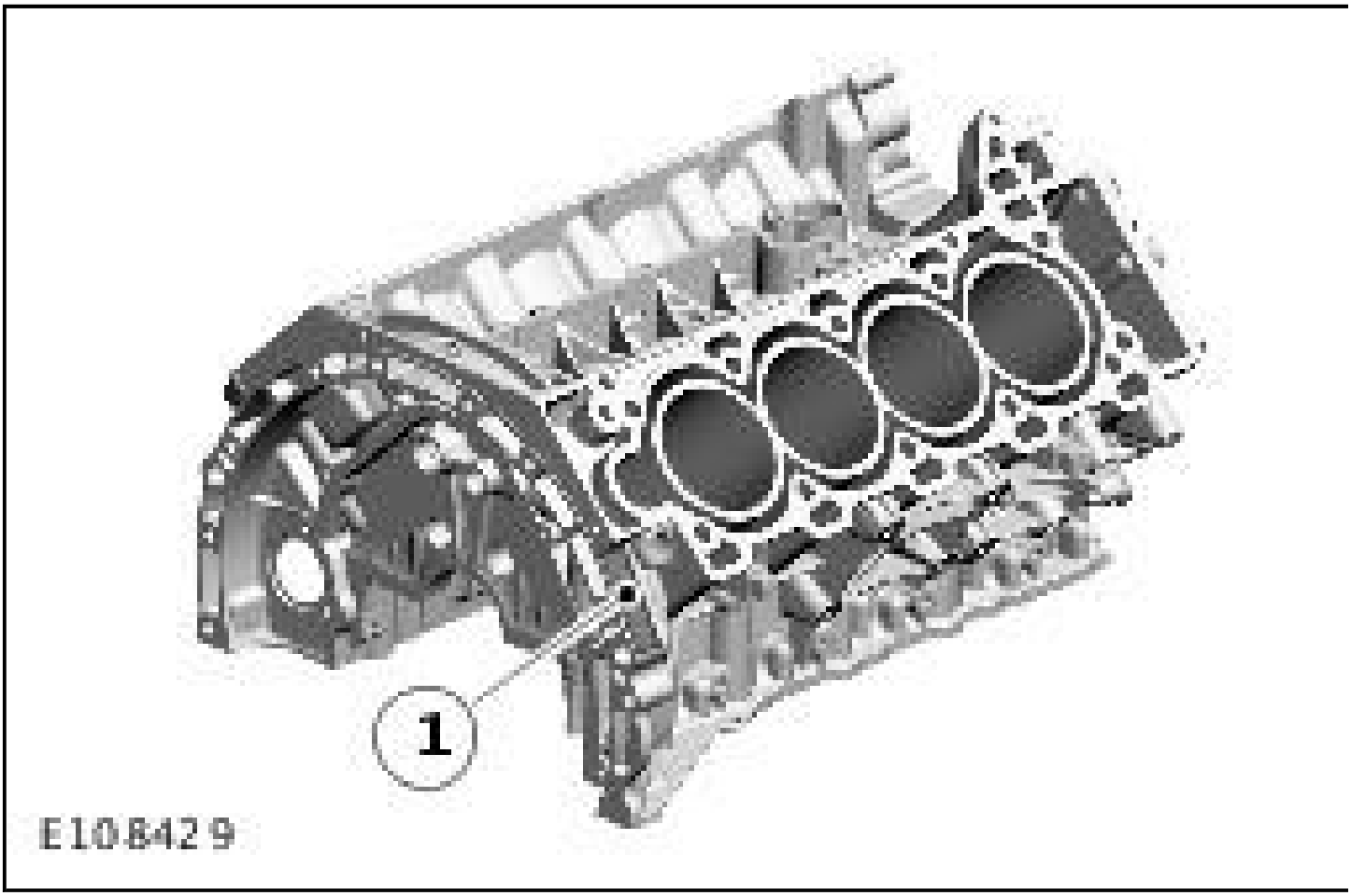

Item Number	Description
1	Engine data location

Engine data is marked on the cylinder block at the rear of the RH cylinder bank.

CRANKSHAFT

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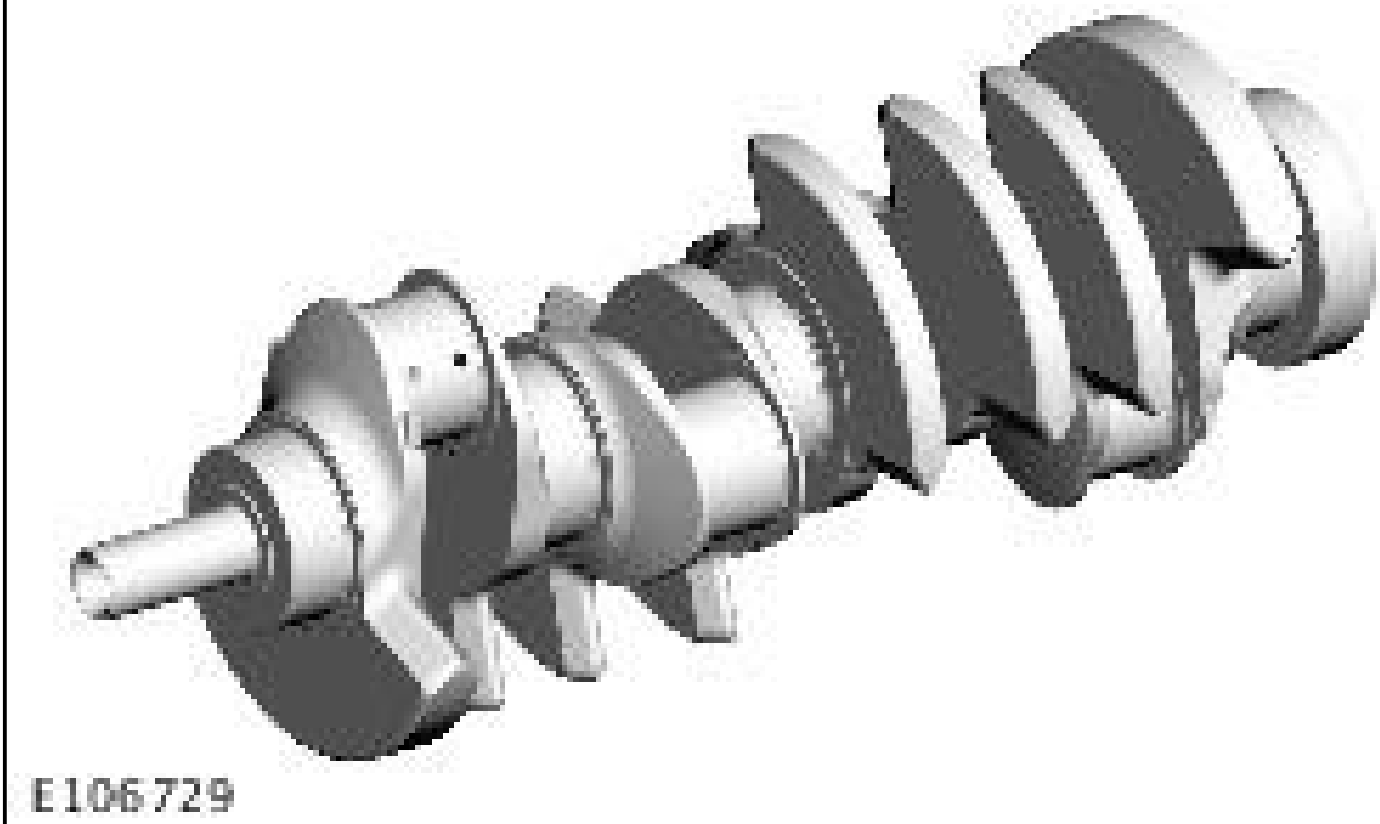

The crankshaft is made from spheroidal graphite cast iron, which, compared with grey cast iron, has higher mechanical strength, ductility and increased shock resistance. The undercut and rolled fillets also improve strength. Eight counter-balance weights ensure low vibration levels and the large, cross-drilled main bearing journals are designed to contribute to stiffness.

An oil groove in the upper half of each main bearing transfers the oil into the crankshaft for lubrication of the connecting rod bearings. A thrust washer is installed each side of the top half of the center main bearing.

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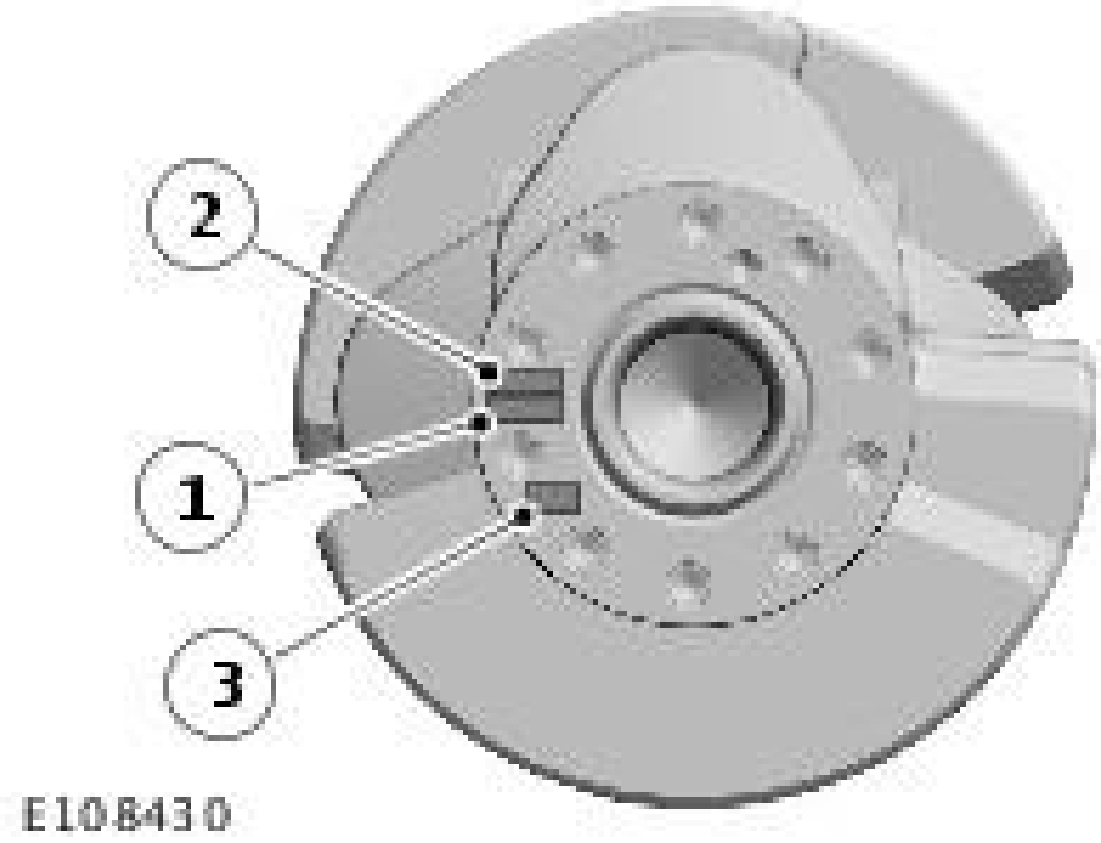

Item Number	Description
1	Pin journal classification and plant identification
2	Main journal classification
3	Date and time codes

The main bearings are numbered 1 to 5 starting from the front of the engine. There are five grades of main bearing available, each being color coded. Journal sizes are marked on the rear of the crankshaft. Refer to **Crankshaft Main Bearing Journal Clearance** .

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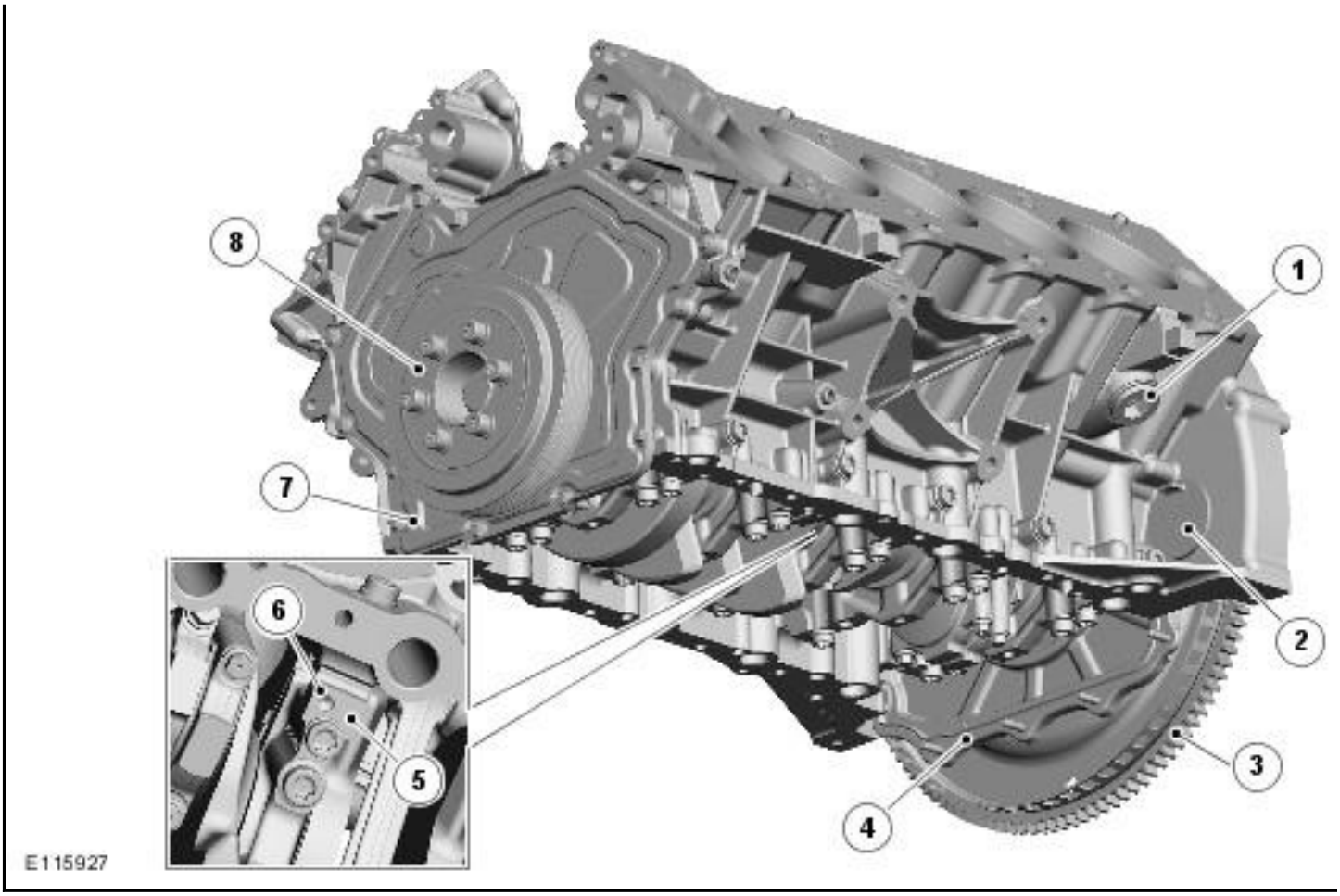

Item Number	Description
1	Coolant drain plug
2	Torque converter access plug
3	Drive plate
4	Rear cover
5	Main bearing cap
6	Identification mark
7	Front cover
8	Front pulley

The main bearing caps are made from cast iron and are cross bolted to increase rigidity. An identification mark on the bearing cap faces the front of the engine.

At the front of the crankshaft, a tuned torsional vibration damper is incorporated into the crankshaft front pulley. At the rear of the crankshaft a pressed steel drive plate, with a steel starter ring gear, is installed to transfer drive from the engine to the transmission. The reluctor ring for the crankshaft position (CKP) sensor is integrated into the perimeter of the drive plate.

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The crankshaft seals are located in the front and rear covers.

PISTONS AND CONNECTING RODS

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The diameter of each piston is graded and precisely matched to each cylinder bore to help reduce noise. In the vertical plane, the pistons have a slight barrel form, which helps to ensure a reliable oil film is maintained between the piston and the cylinder bore. A solid film lubricant coating is applied to both reaction faces of the piston to reduce wear and improve fuel economy.

A three-ring piston-sealing system is used. The steel top ring is treated with a PVD (physical vapor deposition) peripheral coating. PVD is a coating technique where material can be deposited with improved properties to ensure good cylinder bore compatibility and wear resistance. A Napier center ring helps cylinder pressure and oil management, while the three-piece oil control lower ring is produced from nitrided steel.

The connecting rods are forged from high strength steel. The cap is fracture-split from the rod to ensure precision re-assembly for bearing shell alignment. There are three grades of large end bearing available, each being color coded. Refer to **Connecting Rod Large End Bore** .

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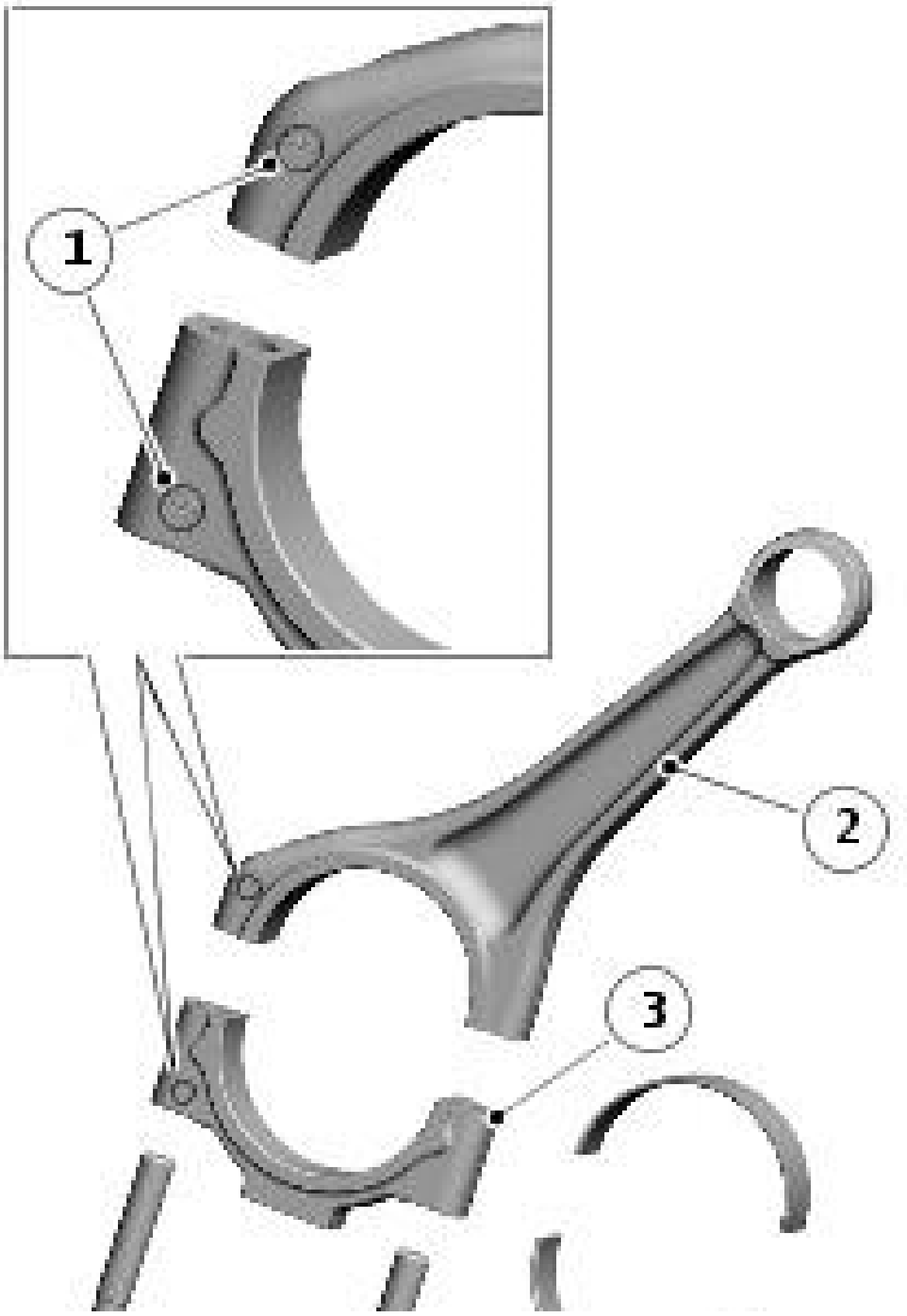

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Item Number	Description
1	Alignment marks
2	Connecting rod
3	Cap
4	Bearings

The correct alignment of the cap with the connecting rod is indicated by marks on adjacent faces of the two components.

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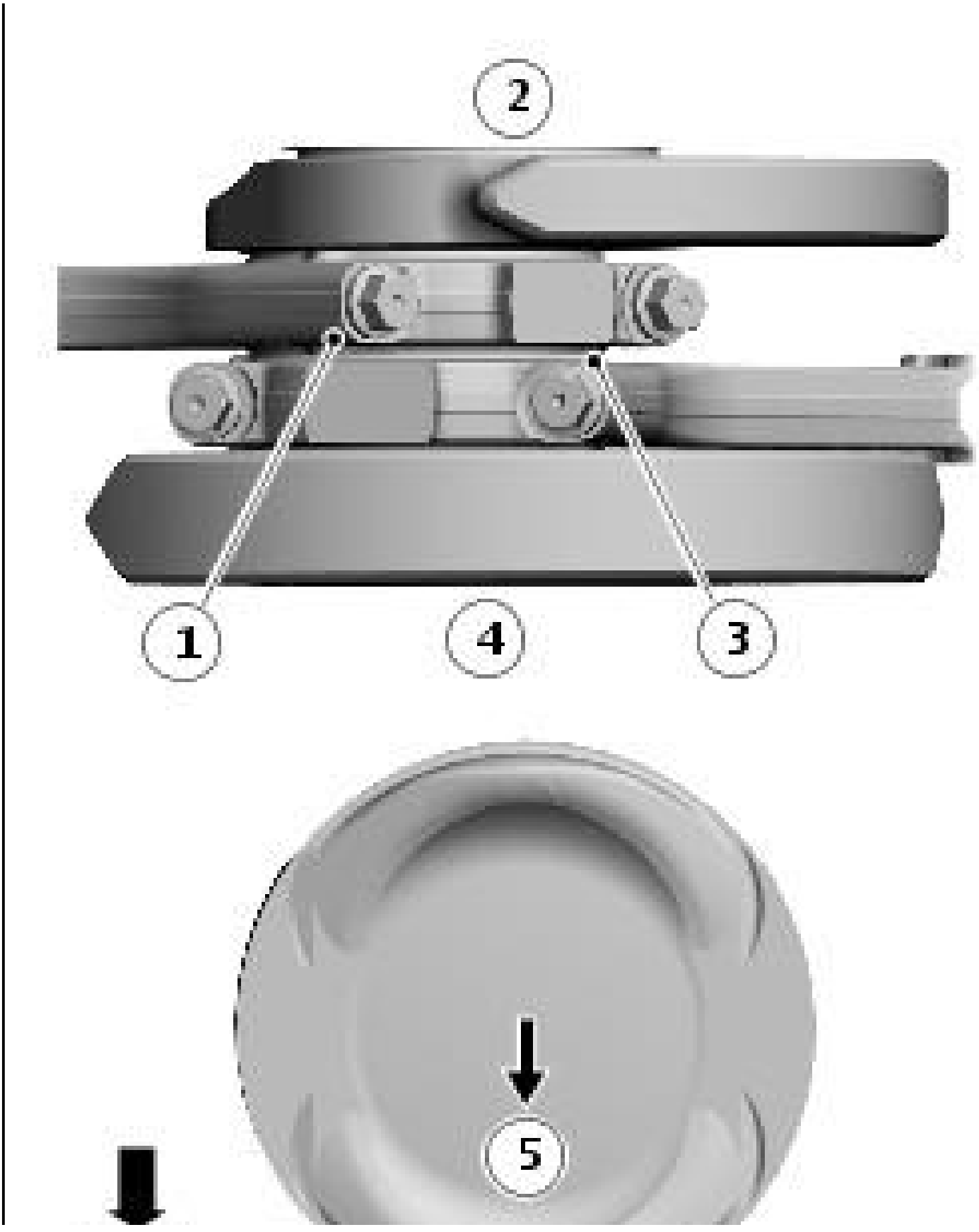

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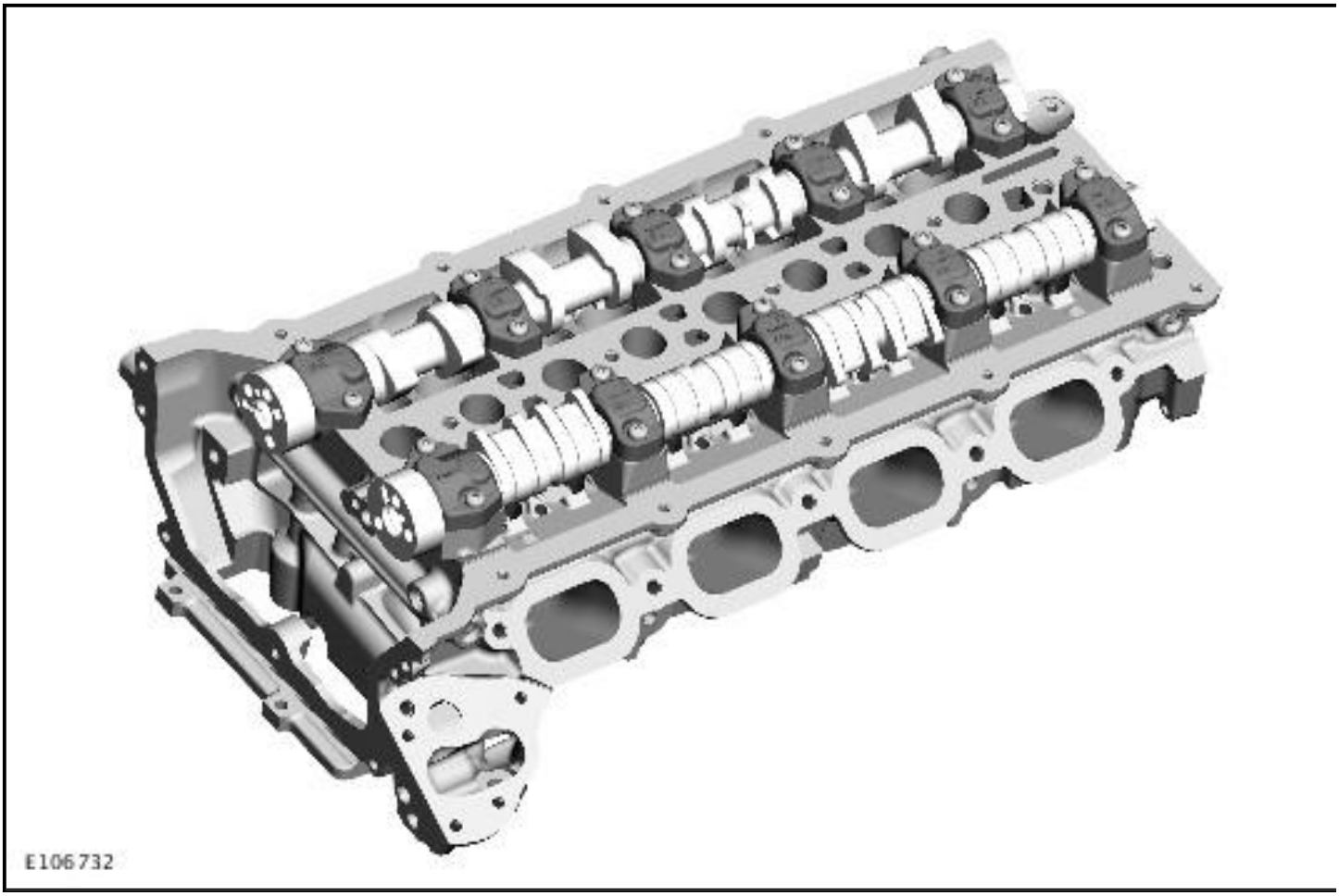
Item Number	Description
A	Front of engine
1	Alignment mark
2	LH side (bank B)
3	Alignment mark
4	RH side (bank A)
5	Piston orientation arrow

The orientation of the connecting rods and pistons on the crankshaft are given below:

- Bank A - The arrow on the piston crown must face the front of the engine and the cap and connecting rod alignment marks must face the rear of the engine.
- Bank B - The arrow on the piston crown must face the front of the engine and the cap and connecting rod alignment marks must face the front of the engine.

CYLINDER HEADS



NOTE: right-hand (RH) (A bank) cylinder head shown, left-hand (LH) (B bank) cylinder

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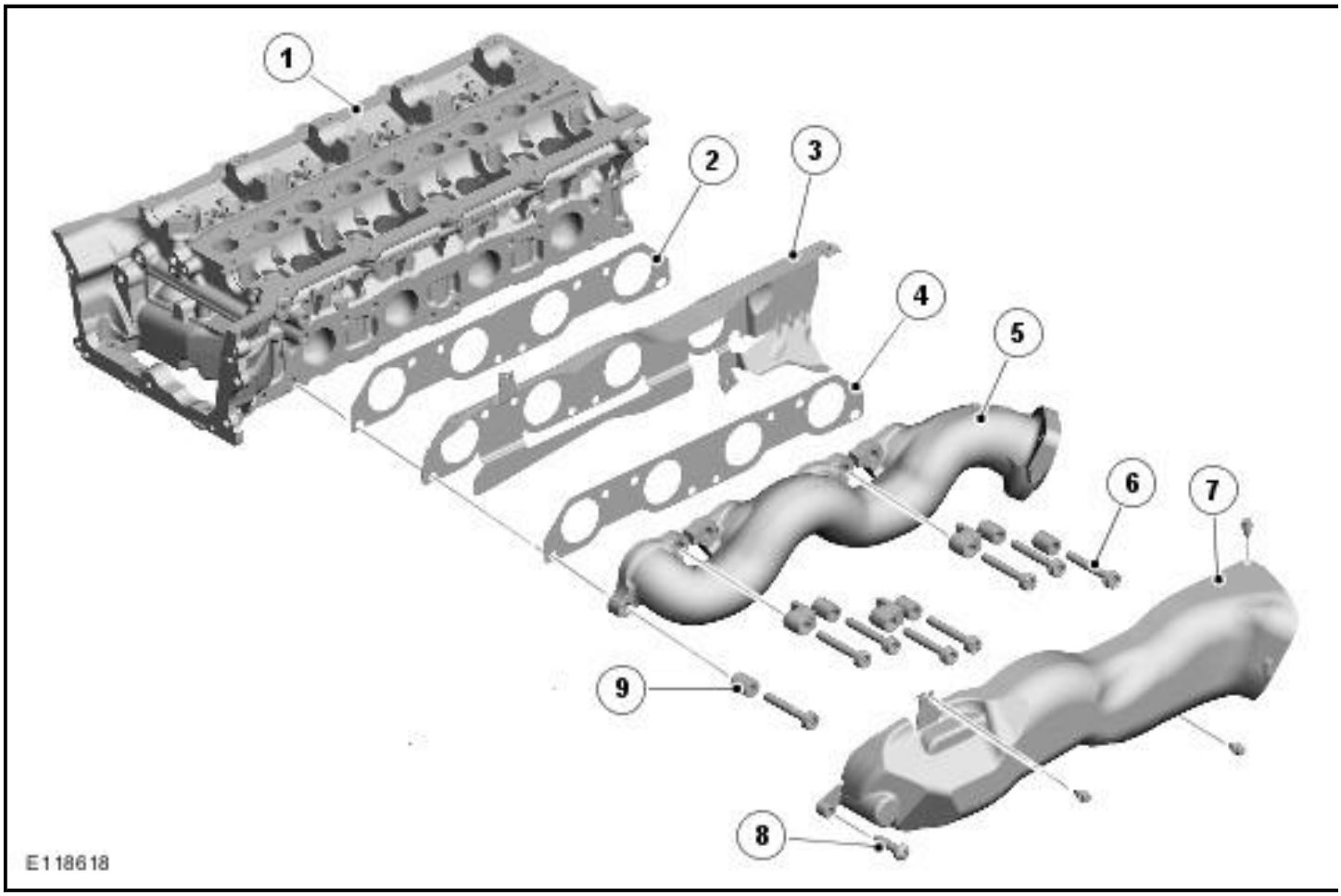
head similar.

The cylinder heads are manufactured in gravity die cast aluminum alloy and are unique for each cylinder bank. Deep-seated bolts reduce distortion and secure the cylinder heads to the cylinder block.

Each cylinder is served by four valves. To help achieve the required gas-flow characteristics, these are arranged asymmetrically around the cylinder bore. Each cylinder has a centrally mounted fuel injector and spark plug.

The cylinder head gasket is of a multi-layer steel construction.

EXHAUST MANIFOLD



Item Number	Description
1	Cylinder head
2	Gasket
3	Heat shield
4	Gasket
5	Exhaust manifold

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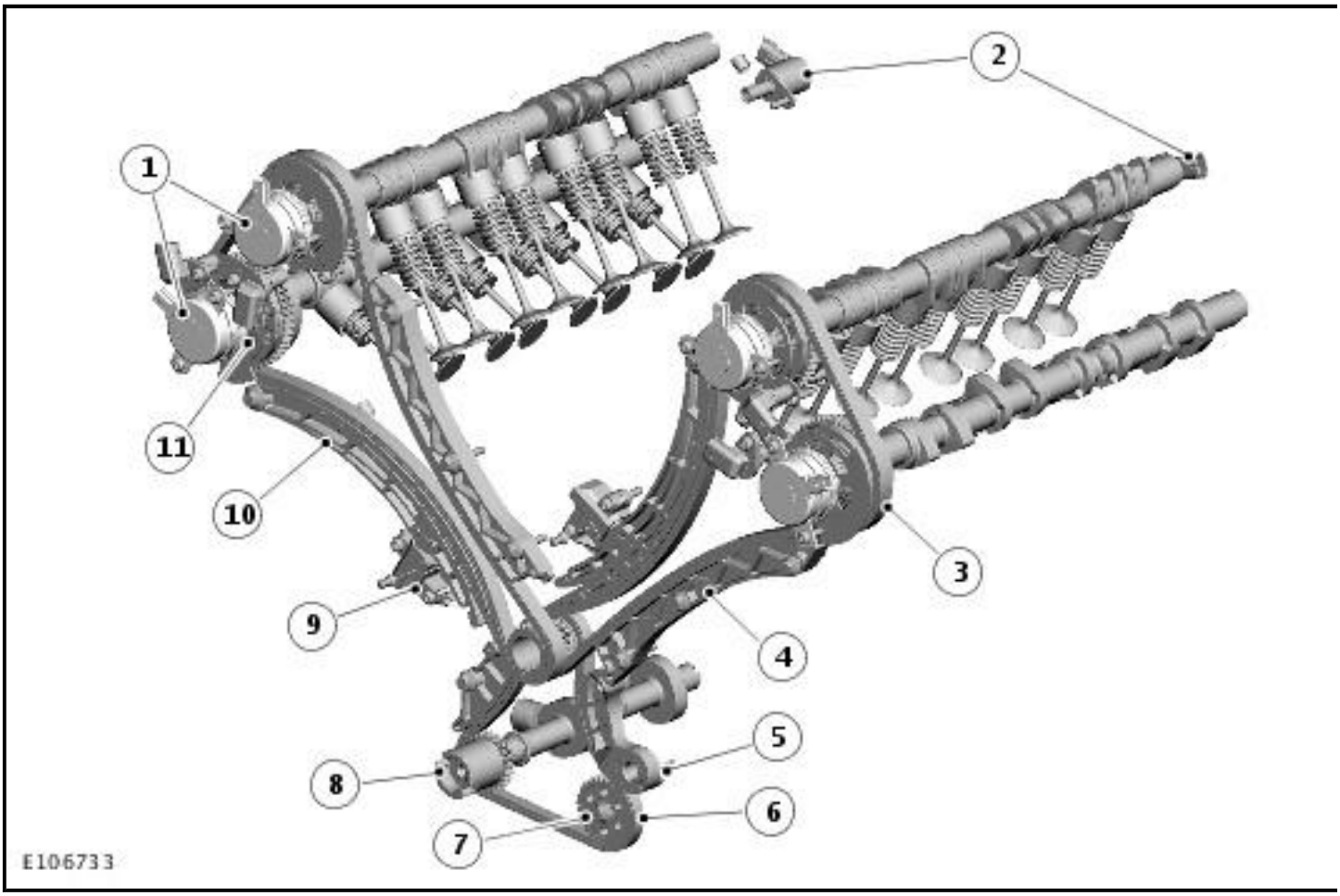
6	Bolt (8 off)
7	Heat shield
8	Bolt (4 off)
9	Spacer (8 off)

NOTE: LH (B bank) installation shown, RH (A bank) installation similar.

The high SiMo (silicon molybdenum) cast iron exhaust manifolds are unique for each cylinder bank. Each exhaust manifold installation includes two metal gaskets and two heat shields. Spacers on the securing bolts allow the manifolds to expand and contract with changes of temperature while maintaining the clamping loads.

VALVE TRAIN



Item Number	Description
1	VCT solenoids
2	CPS solenoids
3	Inverted tooth timing chain
4	Nylon chain guide

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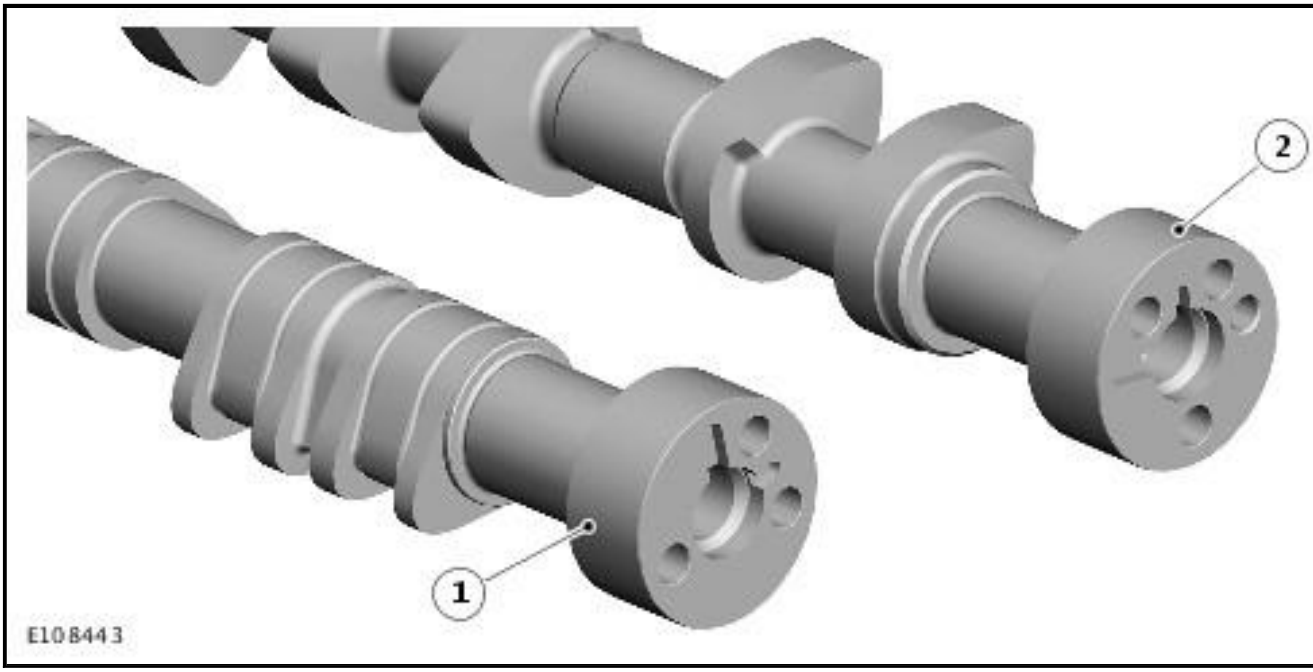
5	Auxiliary chain tensioner
6	Auxiliary drive chain
7	Oil pump drive
8	Auxiliary drive camshaft
9	Timing chain tensioner
10	Tensioner lever
11	VCT unit



Item Number	Description
1	Intake camshaft
2	Exhaust camshaft

The lightweight valve train provides good economy and noise levels and is chain driven from the crankshaft.

Double overhead camshafts on each cylinder head operate the valves. For each cylinder head, an inverted tooth timing chain transfers drive from the crankshaft to the variable camshaft timing (VCT) unit on the front of each camshaft. Graded tappets enable setting of exhaust valve clearances. Switchable tappets with hydraulic lash adjusters are installed on the intake valves.

Each timing chain has a hydraulic tensioner operated by engine oil pressure. The chain tensioners incorporate a ratchet mechanism, which maintains tension while the engine is stopped to eliminate start-up noise. The chains are lubricated with engine oil from jets located at the front of the engine block. Nylon chain guides control chain motion on the drive side.

VARIABLE CAMSHAFT TIMING

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Item Number	Description
1	VCT units
2	Intake camshaft VCT solenoid
3	Camshaft position sensors
4	Exhaust camshaft VCT solenoid

The variable camshaft timing (VCT) system varies the timing of the intake and exhaust camshafts to deliver optimum engine power, efficiency and emissions. The timing of the intake camshafts has a range of 62 degrees of crankshaft angle. The timing of the exhaust camshafts has a range of 50 degrees of crankshaft angle.

In the base timing position:

- The intake camshafts are fully retarded.
- The exhaust camshafts are fully advanced.

VARIABLE CAMSHAFT TIMING (VCT) OPERATING RANGES

Camshaft	Valve Opens	Valve Closes
Intake - Low Lift	27 degrees before top dead center	187 to 249 degrees after top dead center

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	(BTDC) to 35 degrees after top dead center (ATDC)	(ATDC)
Intake - High Lift	37 degrees before top dead center (BTDC) to 25 degrees after top dead center (ATDC)	213 to 275 degrees after top dead center (ATDC)
Exhaust	244 to 194 degrees before top dead center (BTDC)	6 to 56 degrees after top dead center (ATDC)

The system consists of a variable camshaft timing (VCT) unit and a variable camshaft timing (VCT) solenoid for each camshaft. The engine control module (ECM) controls the system using pulse width modulation (PWM) signals to the variable camshaft timing (VCT) solenoids.

The torsional energy generated by the valve springs and the inertia of the valve train components are used to operate the system.

Variable Camshaft Timing Units: The variable camshaft timing (VCT) units change the position of the camshafts in relation to the timing chains.

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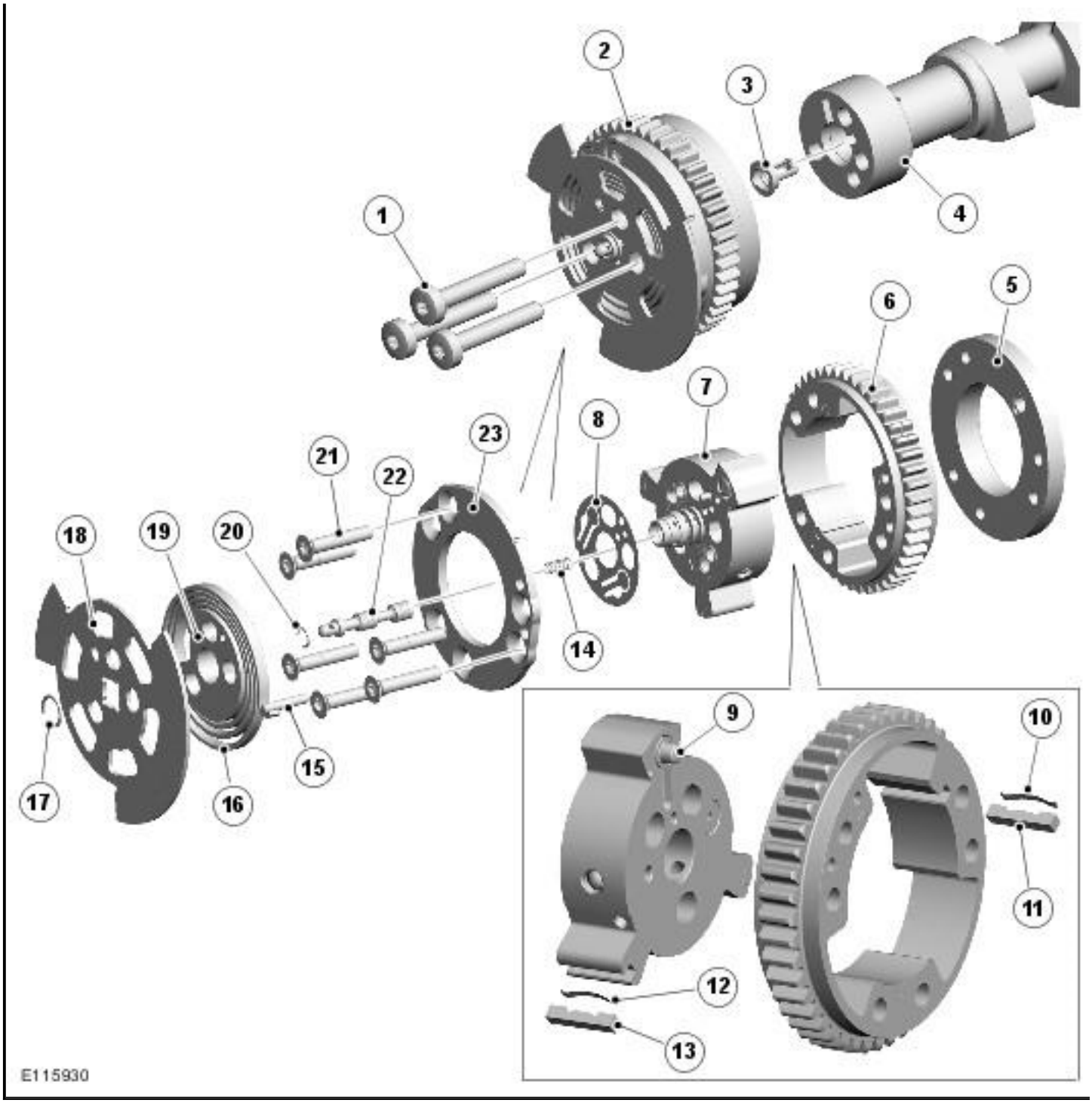

Item Number	Description
1	Bolt (3 off)
2	VCT unit
3	Filter
4	Camshaft

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5	Inner plate
6	Housing and sprocket
7	Rotor assembly
8	Reed plate
9	Spring and lock pin
10	Spring (3 off)
11	Tip seal (3 off)
12	Spring (2 off)
13	Tip seal (2 off)
14	Spring
15	Dowel pin
16	Bias spring
17	Snap ring
18	Reluctor ring
19	Center plate
20	Snap ring
21	Screw (6 off)
22	Spool valve
23	Outer plate

Each variable camshaft timing (VCT) unit is attached to the camshaft by three bolts. A rotor assembly and a reed plate are installed inside a sprocket housing, which consists of a sprocket, an outer plate and an inner plate held together by six screws.

A reluctor ring, for the camshaft position (CMP) sensor, a center plate and a bias spring are installed at the front of the variable camshaft timing (VCT) unit. The ends of the bias spring locate on the center plate assembly and the sprocket housing, to give a turning moment to the camshaft in the advance direction. A snap ring locates the reluctor ring on to a sleeve installed in the center of the rotor assembly. The opposite end of the sleeve locates in a bore in the front face of the camshaft, which contains a filter.

A spring and spool valve are installed in the rotor assembly sleeve and retained by a snap ring. The spring keeps the spool valve in contact with the armature of the related variable camshaft timing (VCT) solenoid.

Each variable camshaft timing (VCT) unit is supplied with engine oil from an oil gallery in the cylinder head, through the camshaft front bearing cap and a bore in the center of the camshaft.

Variable Camshaft Timing Solenoids: The variable camshaft timing (VCT) solenoids control the position of the spool valves in the variable camshaft timing (VCT) units.

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The variable camshaft timing (VCT) solenoids are installed in the front upper timing covers, immediately in front of their related variable camshaft timing (VCT) units. Each variable camshaft timing (VCT) solenoid is secured with two screws and sealed with an O-ring. A two pin electrical connector provides the interface with the engine harness.

Each variable camshaft timing (VCT) solenoid incorporates a spindle that acts on the spool valve in the related variable camshaft timing (VCT) unit to advance and retard the camshaft timing. The variable camshaft timing (VCT) solenoids operate independently and are controlled by a pulse width modulation (PWM) signal from the engine control module (ECM).

Variable Camshaft Timing Operation: When the engine is running, the compression and expansion of the valve springs causes momentary increases and decreases in the torque acting on the camshafts. These momentary changes of torque are sensed in the variable camshaft timing (VCT) units and used to change the camshaft timing.

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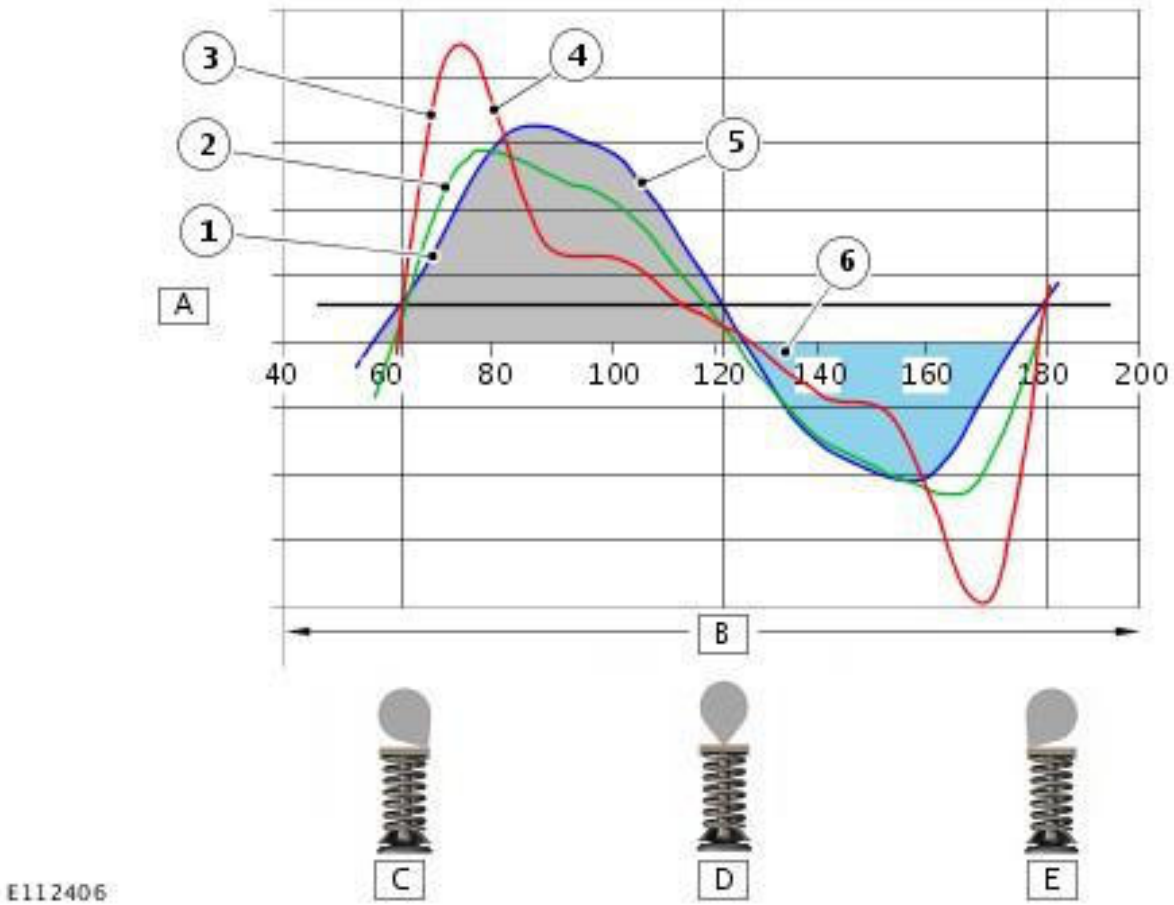

Item Number	Description
A	Camshaft torque
B	Camshaft rotation (degrees)
C	Valve opening
D	Peak lift
E	Valve closing
1	1000 rev/min
2	4000 rev/min
3	7000 rev/min
4	Inertia effects from valve train rotating components
5	Force caused by valve spring
6	Bias torque from friction

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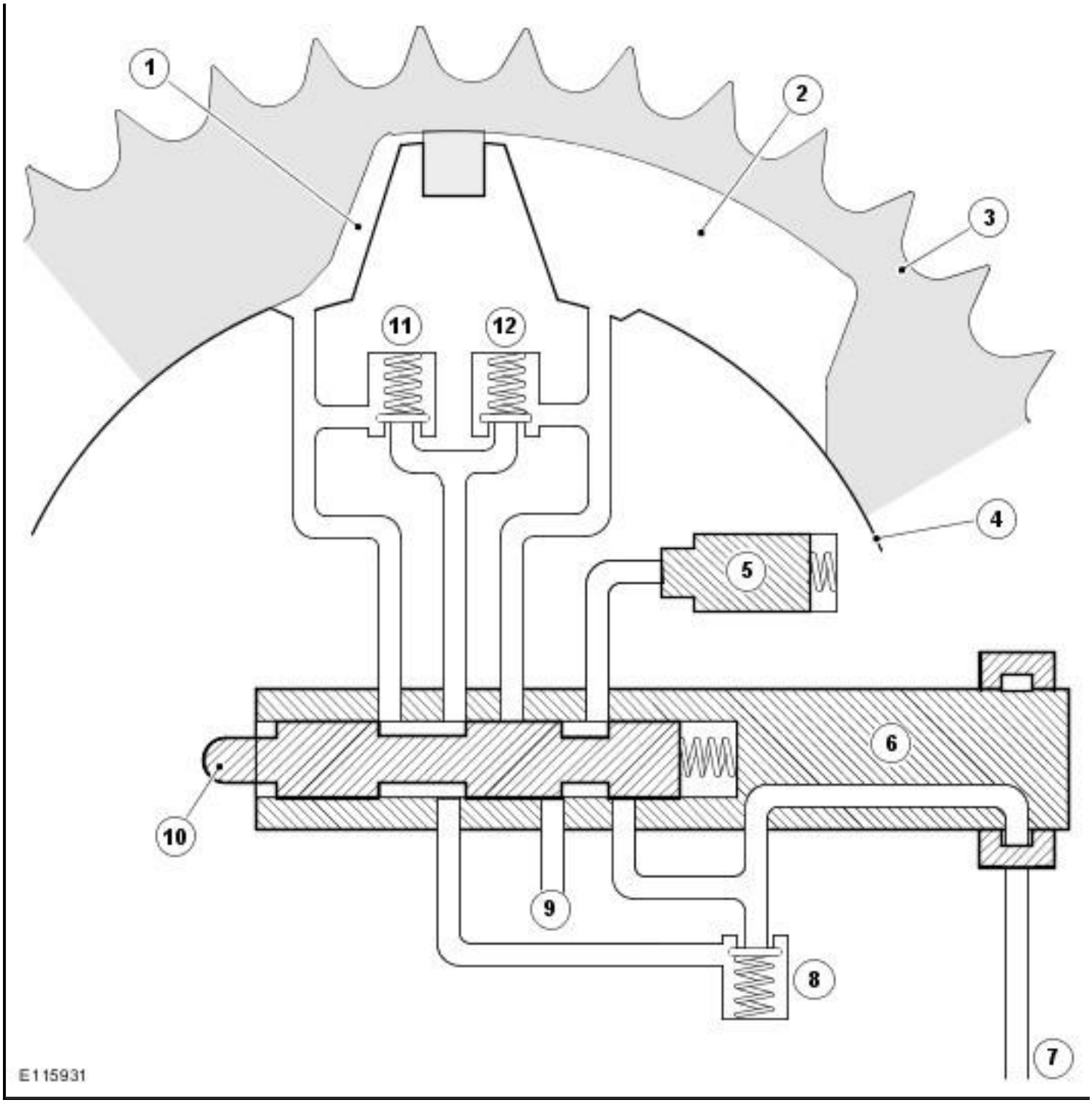

Item Number	Description
1	Advance chamber
2	Retard chamber
3	Sprocket housing
4	Rotor assembly

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5	Lock pin
6	Sleeve
7	Engine oil supply from camshaft
8	Inlet check valve
9	Lock pin drain
10	Spool valve
11	Advance check valve
12	Retard check valve

NOTE: Intake camshaft variable camshaft timing (VCT) unit shown. For exhaust camshaft variable camshaft timing (VCT) unit, read advance for retard and retard for advance.

NOTE: The following description is for intake camshaft variable camshaft timing (VCT) units. For exhaust camshaft variable camshaft timing (VCT) units, read advance for retard, and retard for advance.

At engine start-up, once the engine oil pressure in the camshaft is sufficient to open the inlet check valve, engine oil flows across the spool valve, through the advance and retard check valves and into the advance and retard chambers. During the start cycle, the engine control module (ECM) signals the variable camshaft timing (VCT) solenoid to move the spool valve into the sleeve and connect the lock pin to inlet oil pressure. The inlet oil pressure causes the lock pin to retract from the inner plate and unlock the rotor assembly and camshaft from the sprocket housing.

There is a constant supply of oil to the variable camshaft timing (VCT) to ensure the unit remains filled during operation.

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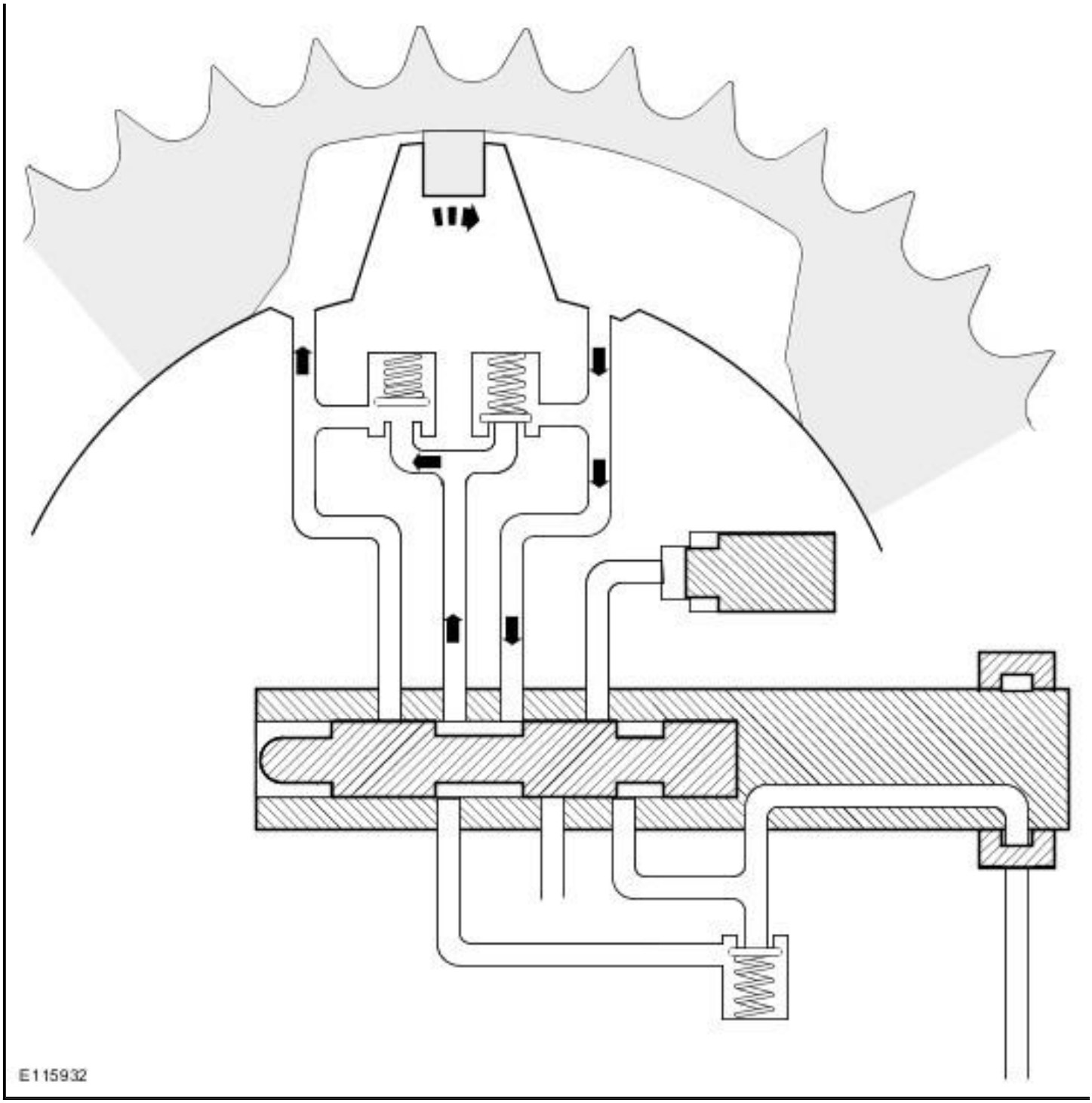

To advance the camshaft timing, the engine control module (ECM) adjusts the signal to the variable camshaft timing (VCT) solenoid to move the spool valve so that the advance chamber oil passage is closed and the retard chamber oil passage is connected to inlet oil.

Each momentary increase of the torque acting on the camshaft generates a pressure pulse in the retard chamber. Oil moves from the retard chamber, through the spool valve and the advance check valve to the advance

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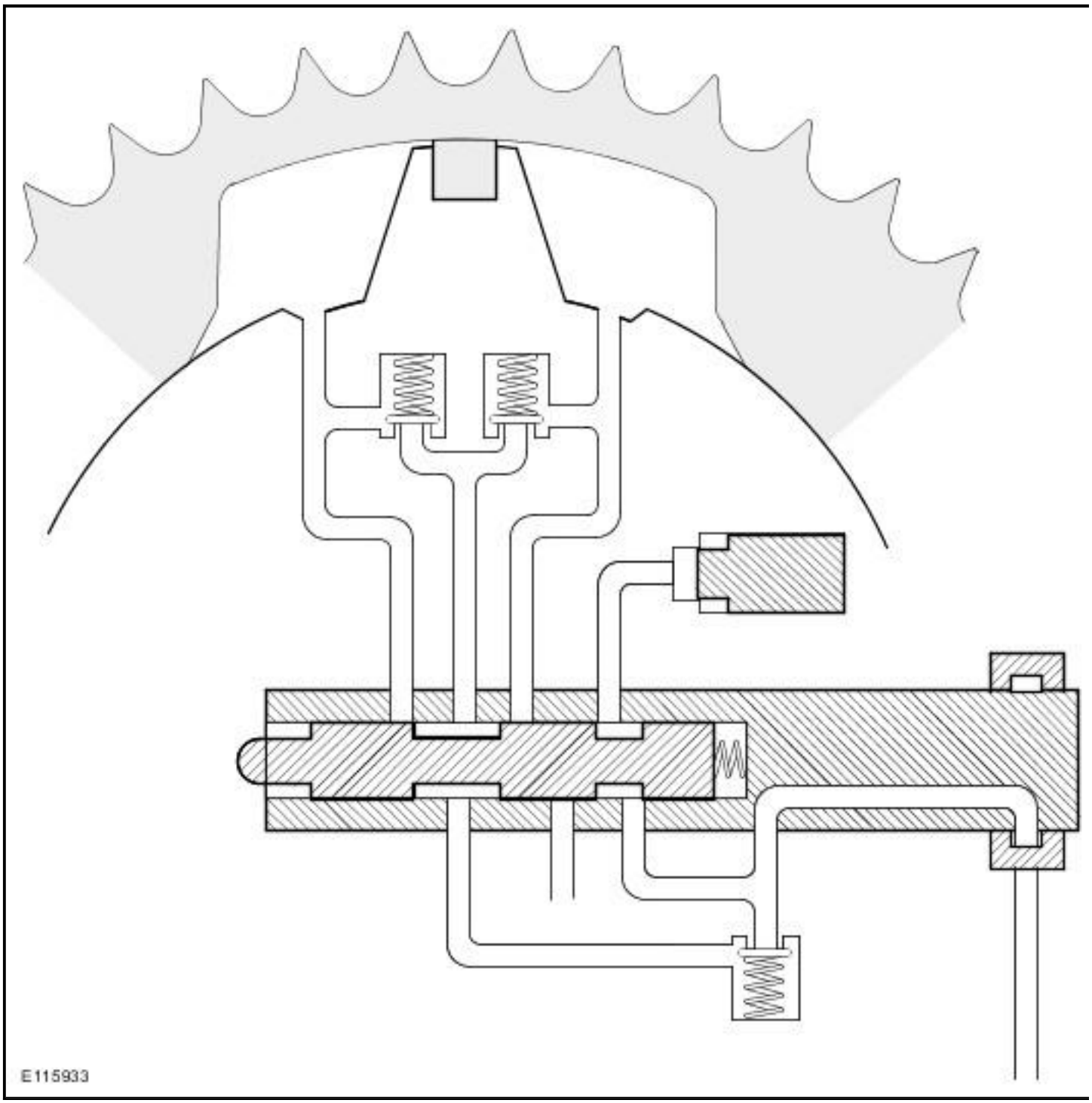
chamber, to equalize the pressures in the two chambers. The displacement of oil from the retard chamber causes the rotor assembly to advance in relation to the sprocket housing. Each momentary decrease of torque acting on the camshaft also generates a pressure pulse in the advance chamber, but, with the advance chamber oil passage closed, no movement of oil between the advance and retard chambers occurs and the rotor assembly cannot move in the retard direction.



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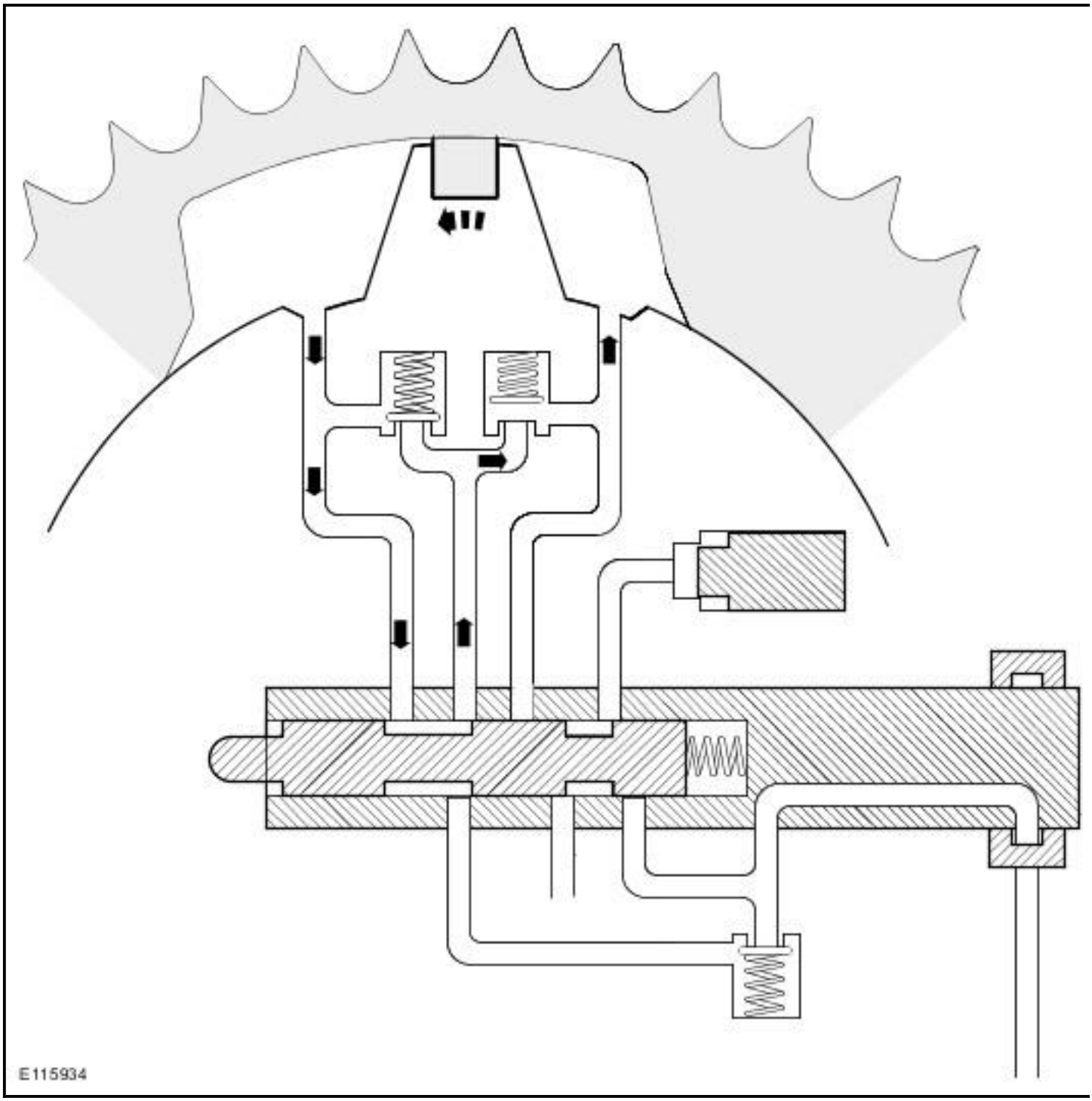
Once the camshaft has reached the required timing position the engine control module (ECM) adjusts the signal to the variable camshaft timing (VCT) solenoid to set the spool valve in the null position. In the null position, the advance and retard chamber oil passages are both closed by the spool valve and the rotor assembly is hydraulically locked to the sprocket housing.



To retard the camshaft timing, the engine control module (ECM) adjusts the signal to the variable camshaft

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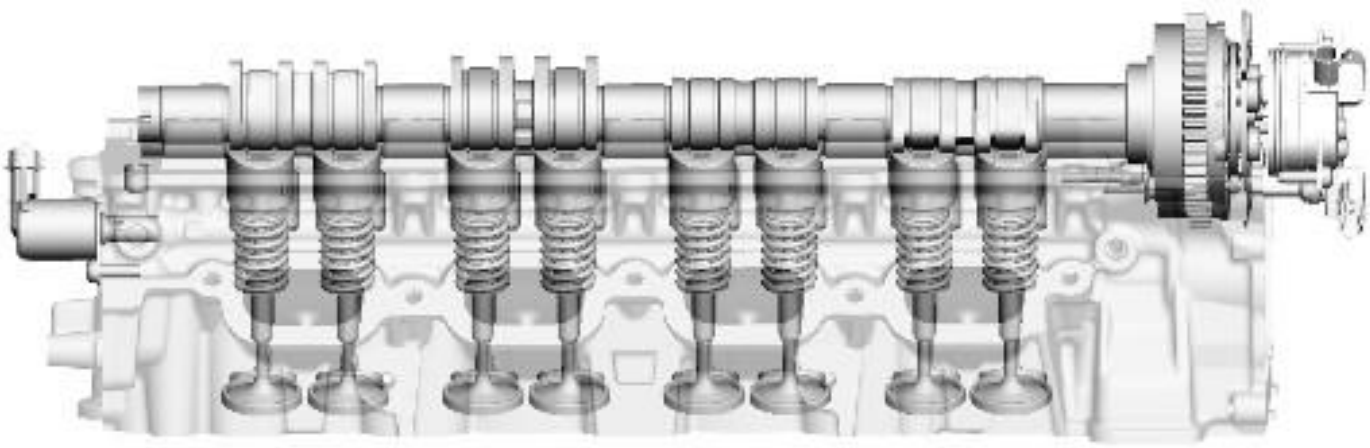
timing (VCT) solenoid to move the spool valve to close the retard chamber oil passage and connect the advance chamber oil passage to the inlet oil.

Each momentary decrease of the torque acting on the camshaft causes oil to transfer from the advance chamber, through the spool valve and the retard check valve to the retard chamber, and so retard the camshaft timing.

CAMSHAFT PROFILE SWITCHING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The CPS (camshaft profile switching) system switches the intake valves between two cam profiles which have different lift and period. The low lift profile improves driveability and emissions at lower engine speeds. The high lift profile improves power and torque output at higher engine speeds.

The intake camshafts have three lobes for each valve. The two outer lobes have identical profiles that produce the high lift of 10.53 mm (0.415 in.). The central lobe produces the low lift of 5.50 mm (0.217 in.). Switching between cam profiles is performed by a switchable tappet on each intake valve. The switchable tappets are operated by engine oil controlled by a CPS solenoid on each cylinder head. Operation of the CPS solenoids is controlled by the engine control module (ECM).

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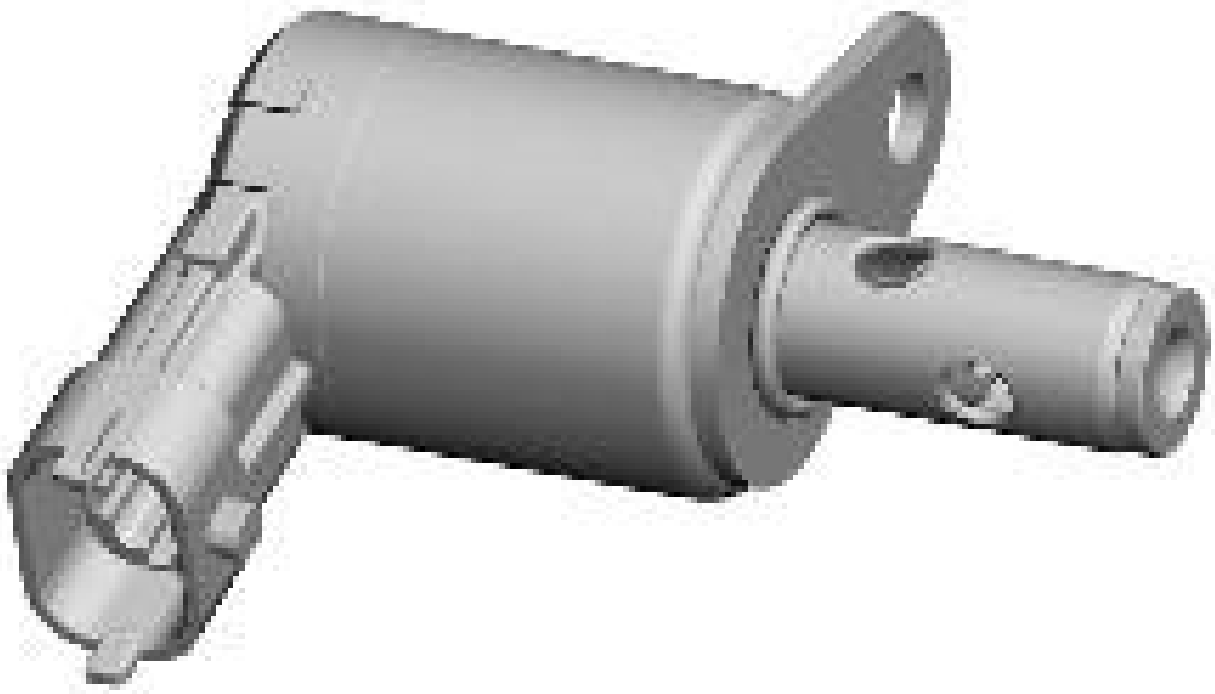

The CPS solenoids control the supply of engine oil pressure to the locking pins in the switchable tappets, to switch the tappets between the two cam profiles.

A CPS solenoid is installed on the rear of each cylinder block. Each CPS solenoid has a pintle installed in a sleeve, which incorporates oil inlet and outlet holes. The sleeve is installed at the junction of oil galleries in the cylinder head, with the oil inlet and outlet holes aligned with the galleries. Movement of the pintle in the sleeve controls a connection between the oil galleries. When the CPS solenoid is energized, the pintle connects an oil supply gallery to the gallery along the outboard side of the switchable tappets. When the CPS solenoid is de-energized, the oil gallery along the outboard side of the switchable tappets is connected to drain.

The CPS solenoids receive a fused battery supply from the main relay. The engine control module (ECM) switches a ground connection to operate the solenoids.

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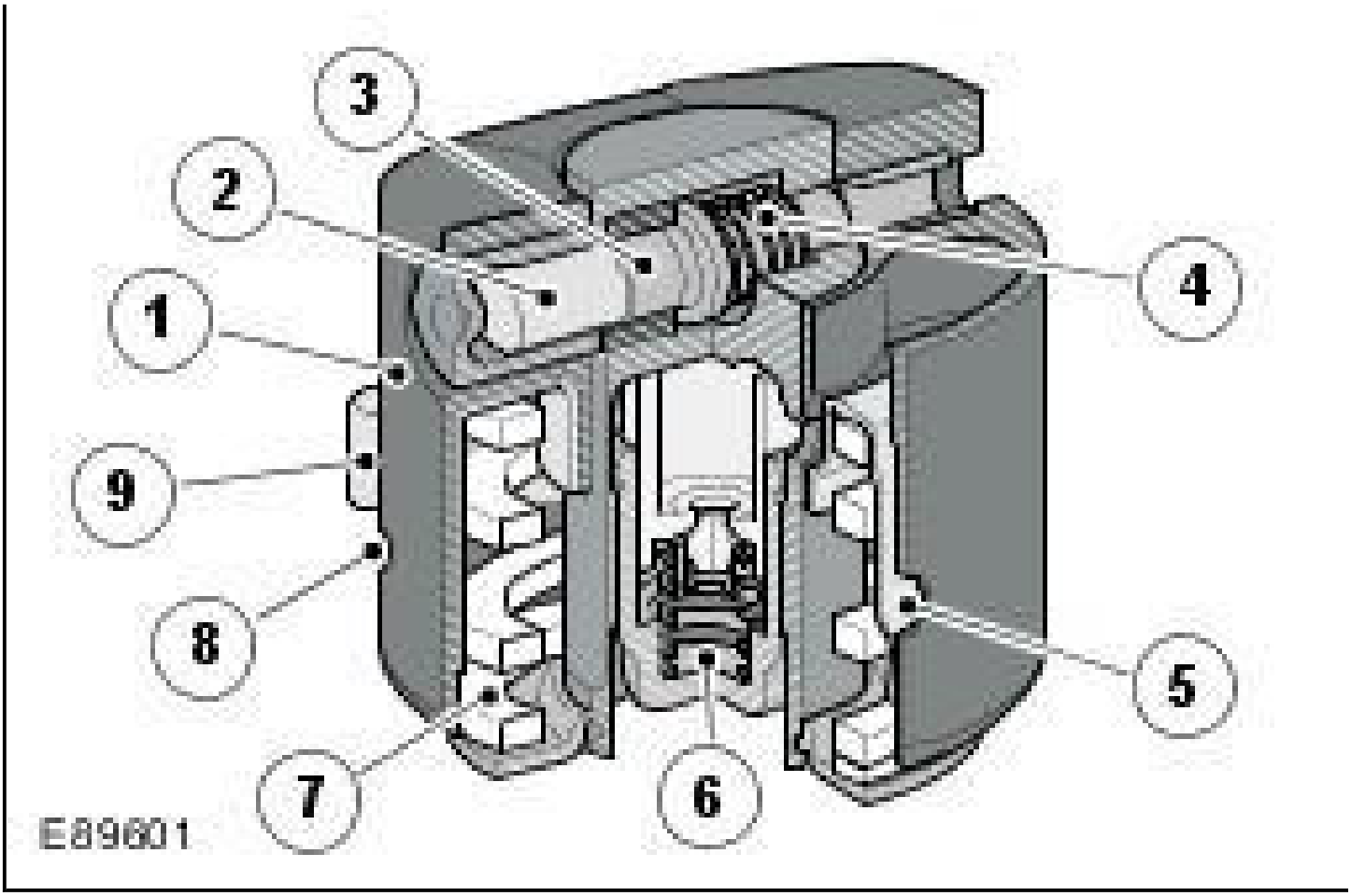

Item Number	Description
1	Outer tappet
2	Outer locking pin
3	Inner locking pin
4	Return spring
5	Lash adjuster oil inlet
6	Lash adjuster
7	Lost motion spring
8	CPS oil inlet
9	Anti-rotation lug

The switchable tappets are installed on the intake valves, in bores in the cylinder heads. The cylinder heads incorporate engine oil galleries along the inboard and outboard sides of the bores. The inboard oil galleries (between the tappets and the spark plug/fuel injector bores) supply an oil feed to the locking pins in the switchable tappets. The outboard oil galleries (over the inlet ports) supply an oil feed to the hydraulic lash adjusters in the switchable tappets.

Each switchable tappet consists of inner and outer tappets, which can operate independently or be locked

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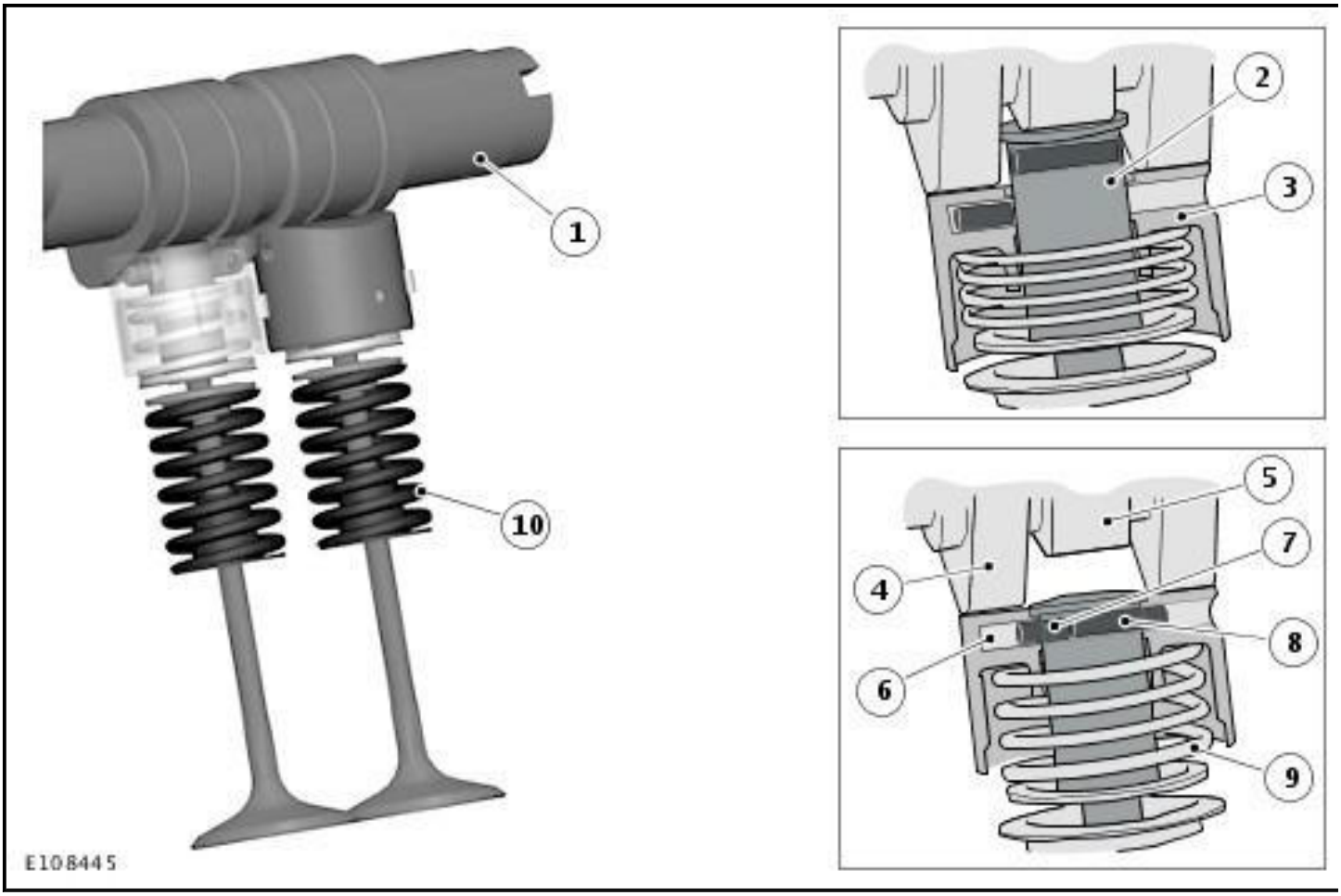
together by locking pins. A hydraulic lash adjuster on the bottom of the inner tappet locates on the intake valve stem.

In low lift, the intake valve lift is controlled by the inner tappets, which run on the center lobes of the intake camshafts. The outer tappets run on the outer lobes of the intake camshafts, and move up and down the inner tappets without affecting the valve lift. The lost motion springs keep the outer tappets in contact with the outer lobes. Movement of the inner tappets is transferred to the intake valves through the hydraulic lash adjusters.

In high lift, engine oil is supplied to the locking pins, which lock the outer tappets to the inner tappets. Intake valve lift is controlled by the outer tappets, which run on the outer lobes of the intake camshafts. Movement of the outer tappets is transferred to the intake valves through the locking pins, the inner tappets and the hydraulic lash adjusters.



Item Number	Description
1	Intake camshaft
2	Inner tappet
3	Outer tappet
4	Outer cam profile (high lift)
5	Inner cam profile (low lift)

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6	Locking pin oil pressure inlet
7	Outer locking pin
8	Inner locking pin
9	Outer tappet lost motion spring
10	Valve spring

Camshaft Profile Switching Operation: The switching point is speed and load dependent. This strategy ensures that switching occurs at air flow neutral points in the engine's operation and is imperceptible to the driver.

At engine speeds from idle up to the range of 2825 - 4250 rev/min (depending on engine load), the CPS solenoids are de-energized and the switchable tappets are set to low lift. At engine speeds above the 2825 - 4250 rev/min range, the CPS solenoids are energized by the engine control module (ECM) and the switchable tappets are set to high lift. There is a 200 rev/min hysteresis when switching from high lift to low lift with decreasing engine speed. Switching between lift settings occurs within one revolution of the camshaft.

Switching is only enabled at engine oil temperatures of 20 °C (68 °F) and above. At oil temperatures below 20 ° C (68 °F), CPS operation is disabled and the switchable tappets remain in the low lift setting. CPS operation is also disabled if a CPS solenoid fails. When CPS operation is disabled, engine speed is limited to 5000 rev/min.

The engine control module (ECM) can diagnose the operation of the CPS solenoids and store fault related diagnostic trouble code (DTC) if it detects a failure.

LUBRICATION SYSTEM

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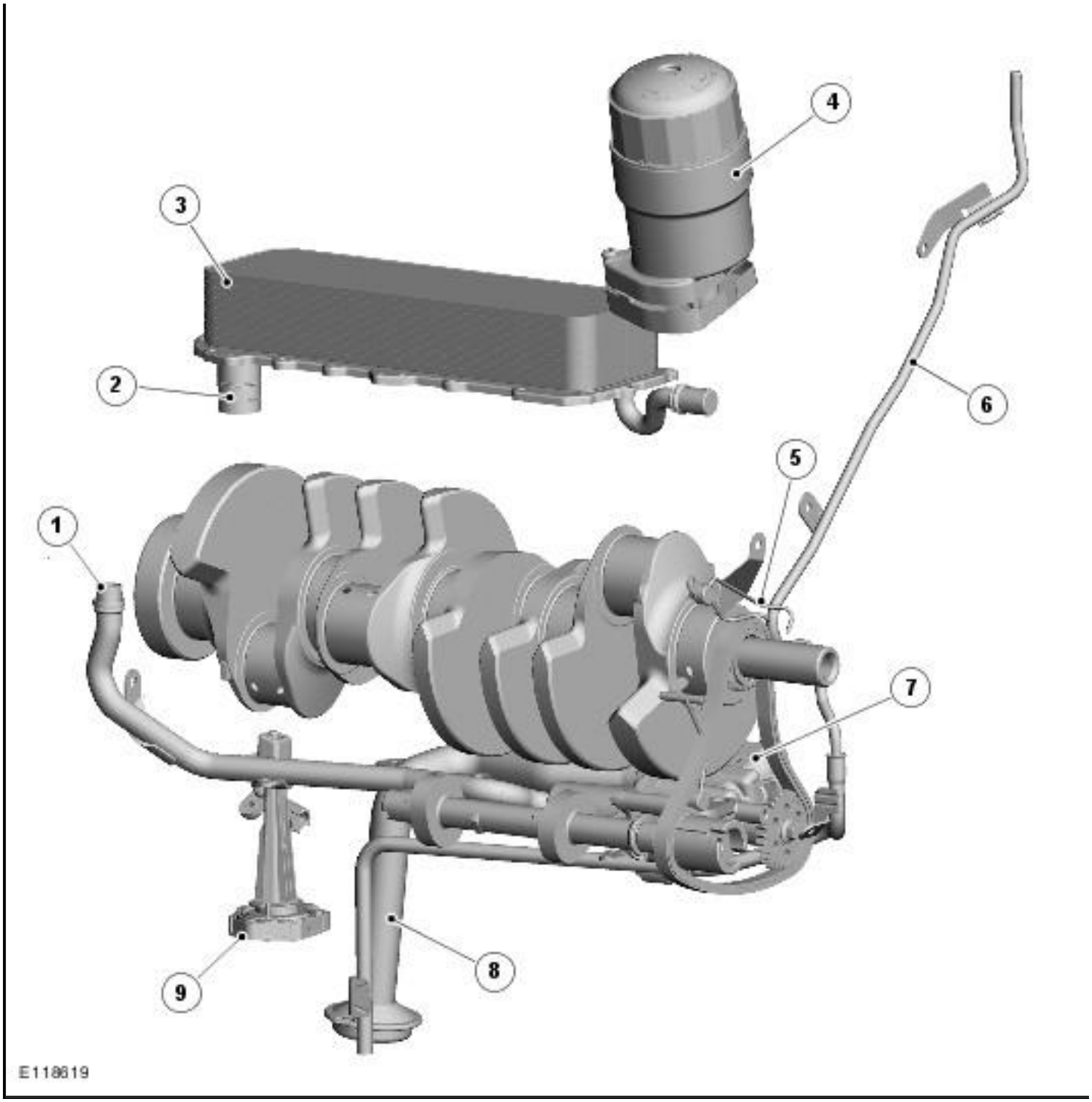

Item Number	Description
1	Oil pump outlet tube
2	Anti-drain valve
3	Oil cooler
4	Oil filter

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5	Timing chain lubrication jet (2 off)
6	Oil evacuation tube
7	Oil pump
8	Oil pick-up
9	Oil temperature and level sensor

The oil pump is attached to the underside of the windage tray. The input shaft of the oil pump is driven from the front of the crankshaft, by the auxiliary chain, at 0.87 engine speed.

The oil pump draws oil from the sump through a centrally mounted pick-up pipe. The oil is pressurized and pumped through an output tube to the cylinder block. After passing through an anti-drain valve and a plate type oil cooler, the oil is filtered by a replaceable cartridge installed on the front of the right-hand (RH) cylinder head.

The output from the oil filter is distributed through oil galleries in the cylinder heads and cylinder block. All moving parts are lubricated by pressure or splash oil. Pressurized oil is also provided for the variable camshaft timing (VCT) system, the CPS system, the timing chain tensioners and the timing chain lubrication jets.

The oil returns to the oil pan under gravity. Large drain holes through the cylinder heads and cylinder block ensure the rapid return of the oil to the sump. System replenishment is through the oil filler cap on the left-hand (LH) cylinder head cover.

An oil evacuation tube is installed to allow oil to be drawn from the sump. The upper end of the oil evacuation tube is located under the oil filler cap.

An oil drain plug is installed in the right-hand (RH) side of the sump.

OIL PUMP NOMINAL OPERATING PRESSURES

Engine Speed, rev/min	Temperature, °C (°F)	Pressure, bar (lbf/in^2)
Idle	20 (68)	2.0 (29.0)
1500	20 (68)	6.0 (87.0)
3000	40 (104)	6.2 (90.0)
3000	110 (230)	5.0 (72.5)
3000	130 (266)	4.0 (58.0)

OIL LEVEL MONITORING

Oil level monitoring is provided by an oil level and temperature sensor that measures the oil level in the sump. The oil level can be displayed in the message center of the instrument cluster.

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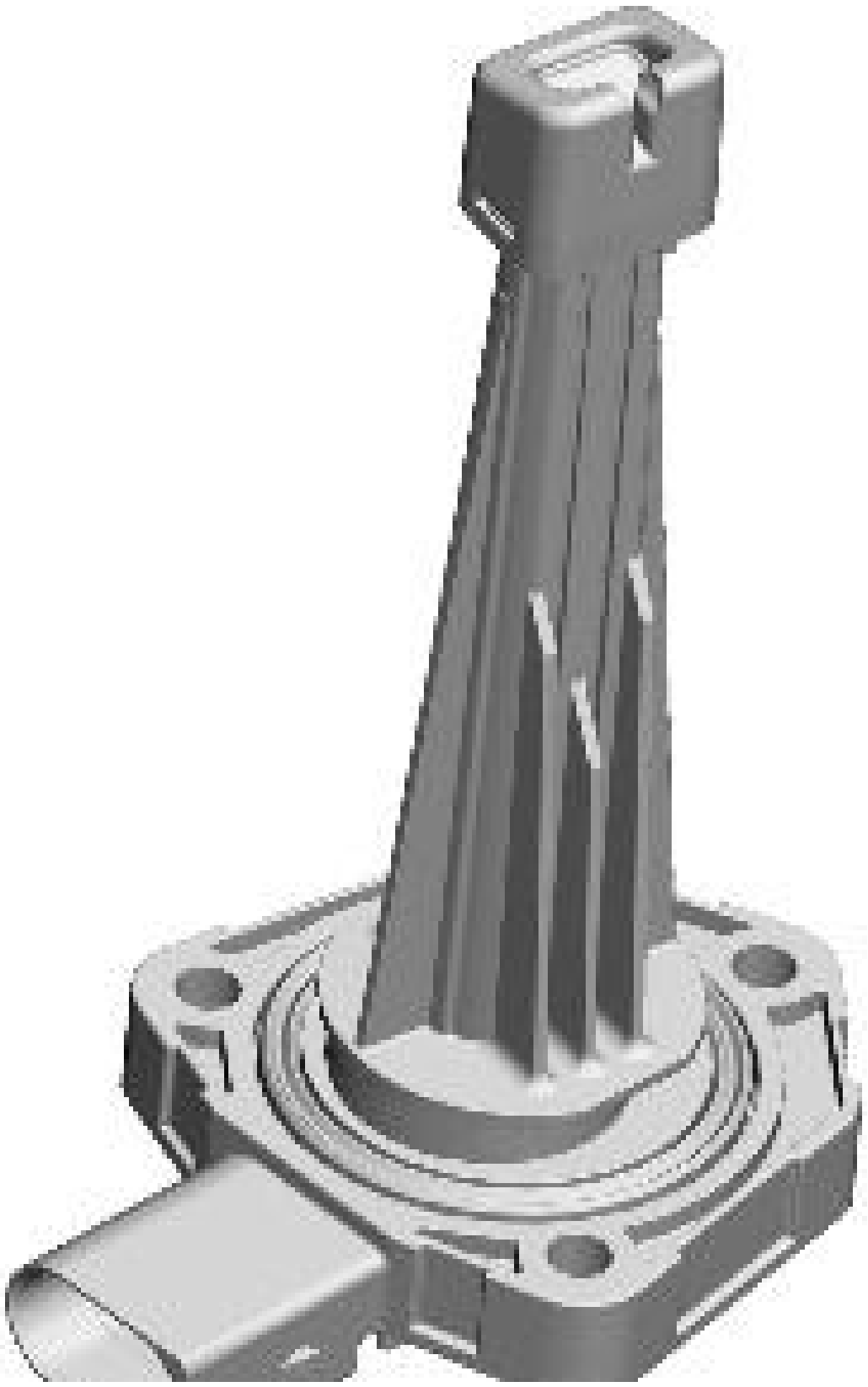

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The oil level and temperature sensor supplies the engine control module (ECM) with a signal containing the level and temperature of the oil in the sump. The oil level and temperature sensor is secured to the bottom of the sump with three screws and sealed with a gasket.

The oil level and temperature sensor sends an ultrasonic pulse vertically upward and measures the time taken for the pulse to be reflected back from the top surface of the oil. This time is compared with the time taken for an ultrasonic pulse to travel a reference distance within the oil level and temperature sensor to determine the oil level. The oil level reading is combined with the oil temperature reading and transmitted in a pulse width modulation (PWM) signal to the engine control module (ECM).

OIL LEVEL AND TEMPERATURE SENSOR SPECIFICATIONS

Feature	Details
Power Source	Battery Voltage
Level Accuracy	±2 mm (±0.08 in.) at temperatures of -30 °C (-22 °F)) and above; (±4 mm (±0.16 in.) at temperatures below -30 °C (-22 °F))
Temperature Accuracy	±2 °C (±3.6 °F)
Operating Level Range	116 to 147 mm (4.57 to 5.79 in.)
Operating Temperature Range	-40 to 160 °C (-40 to 320 °F)

OIL LEVEL CHECK

Refer to **ENGINE OIL DRAINING AND FILLING - GENERAL PROCEDURES**.

For accuracy, oil level checks should be performed with the vehicle on level ground when the oil is hot. The vehicle needs to stand for approximately 10 minutes, after the engine is switched off, to allow the oil to drain back into the sump and the oil level to stabilize. The oil level system will not give a reading until the oil level has stabilized.

To check the oil level, make sure that the ignition is on, the engine stopped and the transmission is in P (park). Access the vehicle information and settings menu, then select **Oil Level Display** from the **Service Menu** . An **Engine Oil Level** sight glass will be displayed in the message center. The current oil level will be displayed in the sight glass. One of the following messages will also be displayed:

- If the oil level is within acceptable limits, the message **OK** is displayed.
- If the oil level is less than acceptable, a message advising how much oil to add is displayed e.g. **Add 0.5 Liter Refer to handbook for oil type** , or **Add 0.5 Quart Refer to handbook for oil type** , depending on the market.
- If the message **Overfilled Refer to handbook** is displayed, the oil level must be reduced to within acceptable limits before starting the engine again.
- If the message **Not available** is displayed, the oil level is still stabilizing. Wait 10 minutes and then recheck level.

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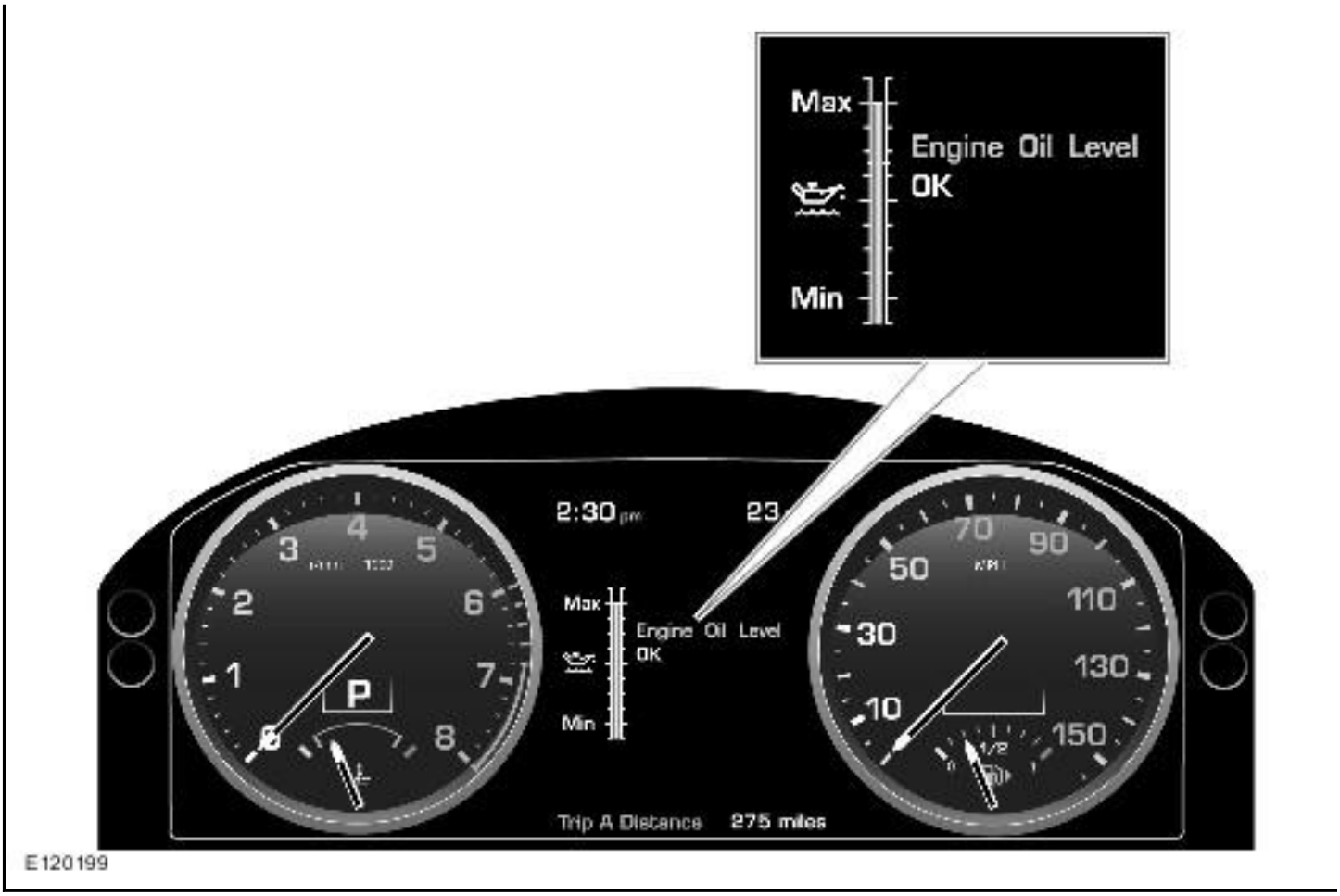

DIAGNOSTIC PROCEDURES

ENGINE

For additional information. Refer to **Engine - 5.0L Petrol** .

GENERAL PROCEDURES

ENGINE OIL DRAINING AND FILLING

DRAINING

WARNING: The spilling of hot engine oil is unavoidable during this procedure, care must be taken to prevent scalding.

CAUTION: Correct installation of the oil filler cap can be obtained by tightening the cap until hard stop.

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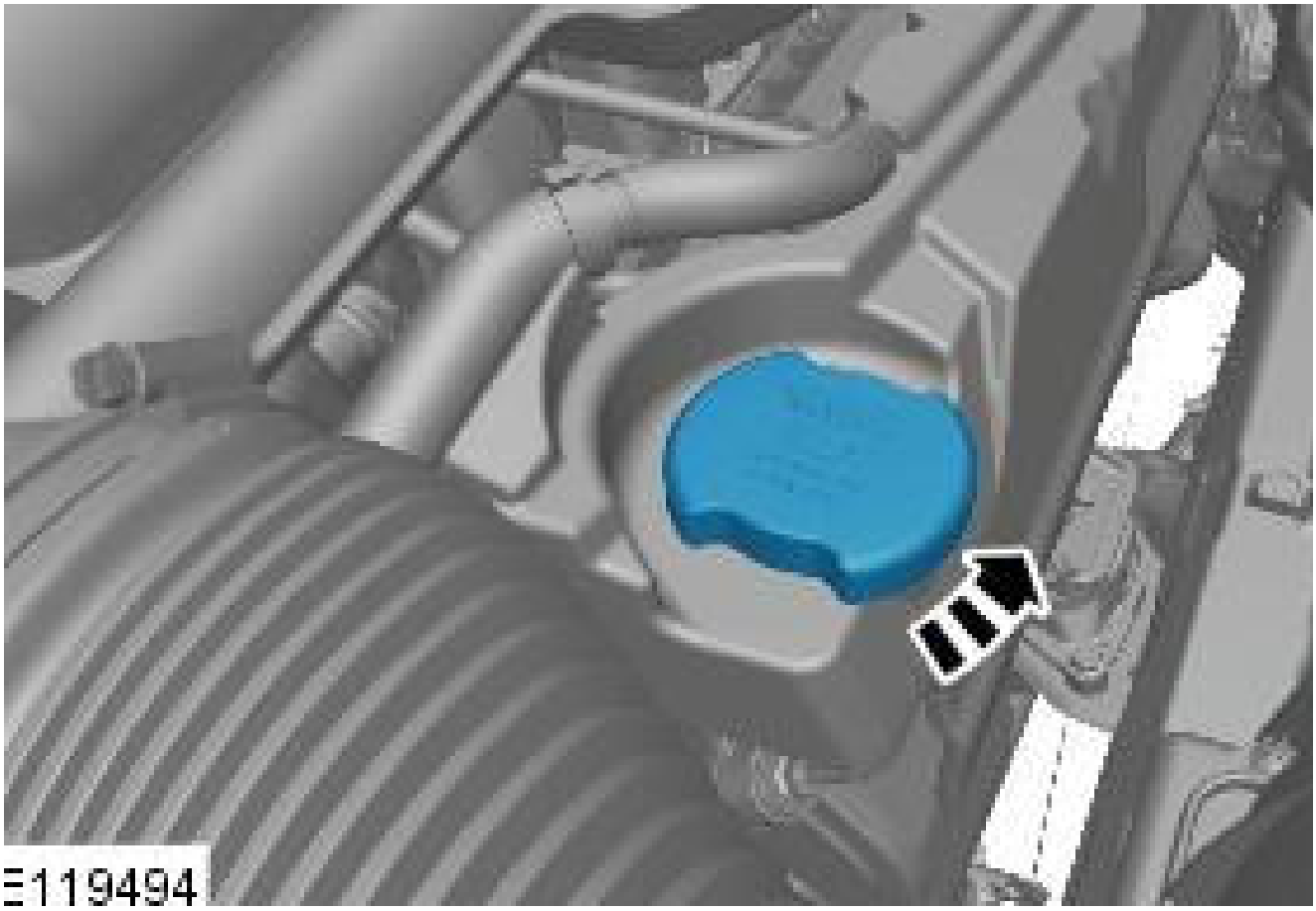
NOTE: Clean the components general area prior to dismantling.

1. Engine warm-up

   CAUTION: Make sure the engine is warm.

   Start the engine and allow to run for 10 minutes, stop the engine.

2. See figure



3. Refer to: **ENGINE COVER - REMOVAL AND INSTALLATION** .
4. See figure

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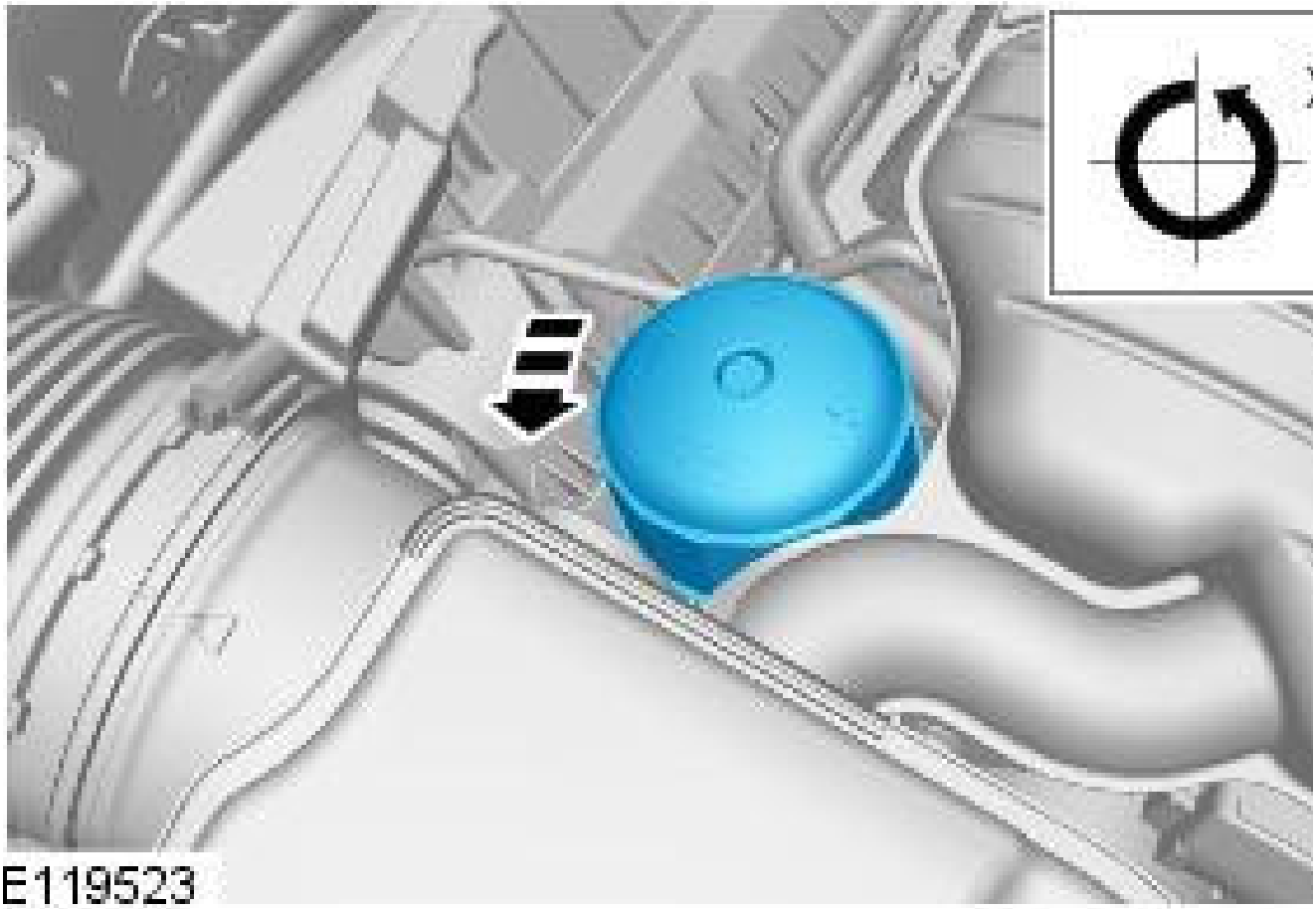

- Loosen the element cover 4 complete turns to allow engine oil to drain from the filter cover.
- Make sure that the O-ring seal is exposed.

5. Oil draining

NOTE: Allow 10 minutes for the engine oil to drain from the oil filter housing.

6. See figure

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NOTE: Remove and discard the O-ring seal.

7. Remove and discard the oil filter element.

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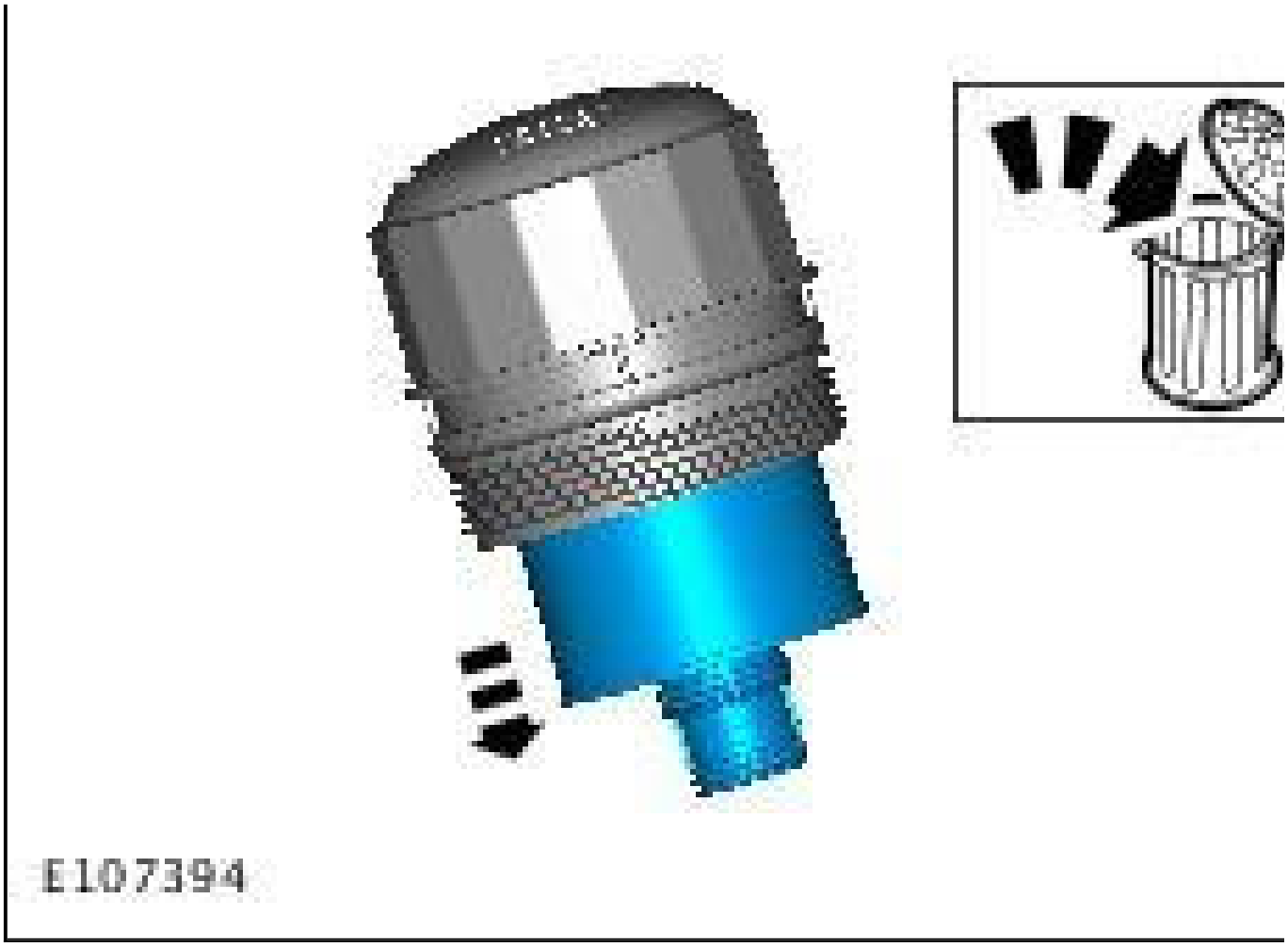

8. Raise and support the vehicle.

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

9. Refer to: **ENGINE UNDERSHIELD - REMOVAL AND INSTALLATION** .
10. See figure

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CAUTION: Be prepared to collect escaping oil.

CAUTION: Allow at least 10 minutes for the engine oil to drain.

NOTE: Discard the sealing washer.

FILLING

1. See figure

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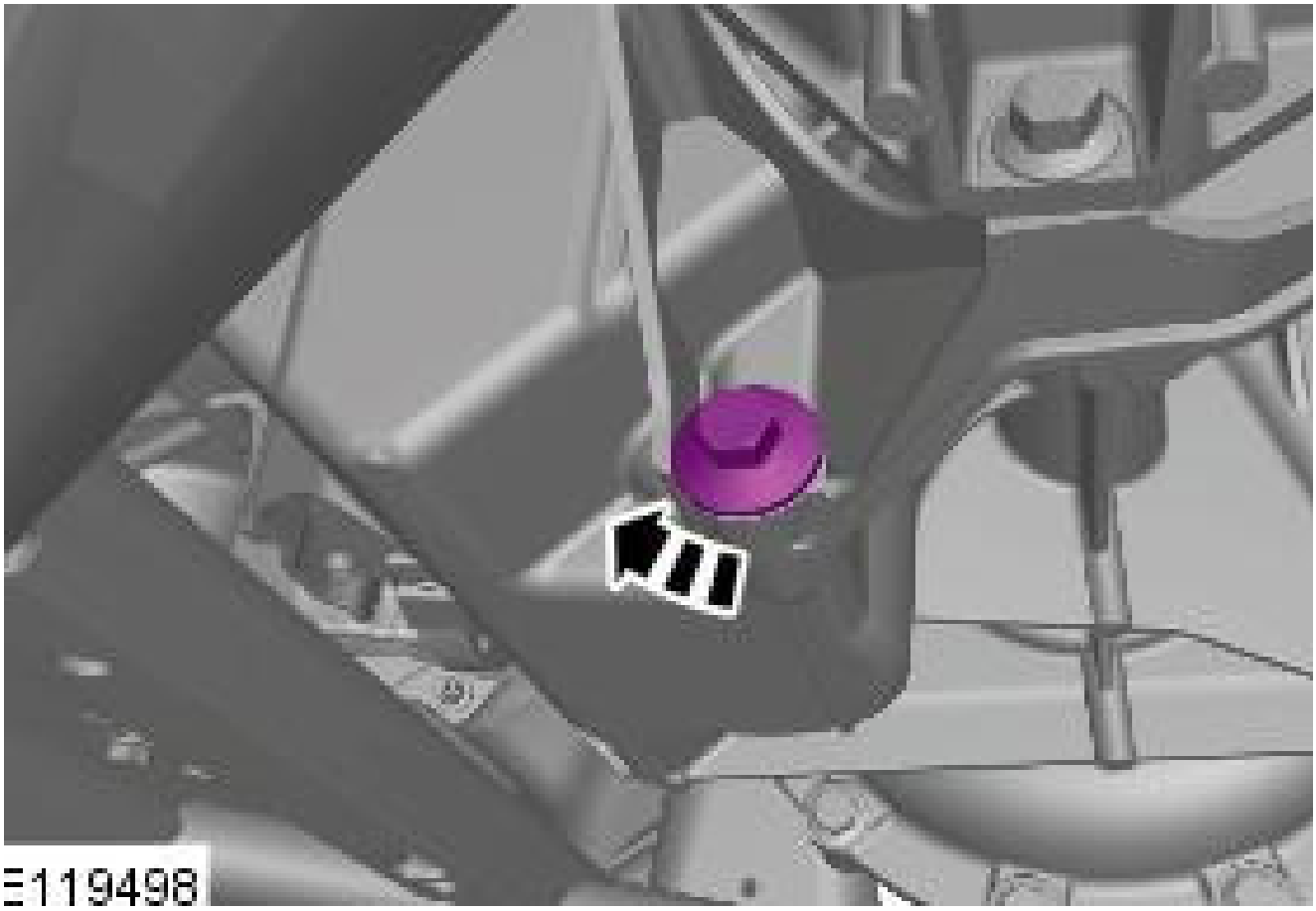

CAUTION: Make sure that the area around the component is clean and free of foreign material.

NOTE: Install a new sealing washer.

Torque: 24 Nm

2. Refer to: **ENGINE UNDERSHIELD - REMOVAL AND INSTALLATION** .
3. Lubricate the oil filter element O-ring seal with clean engine oil.

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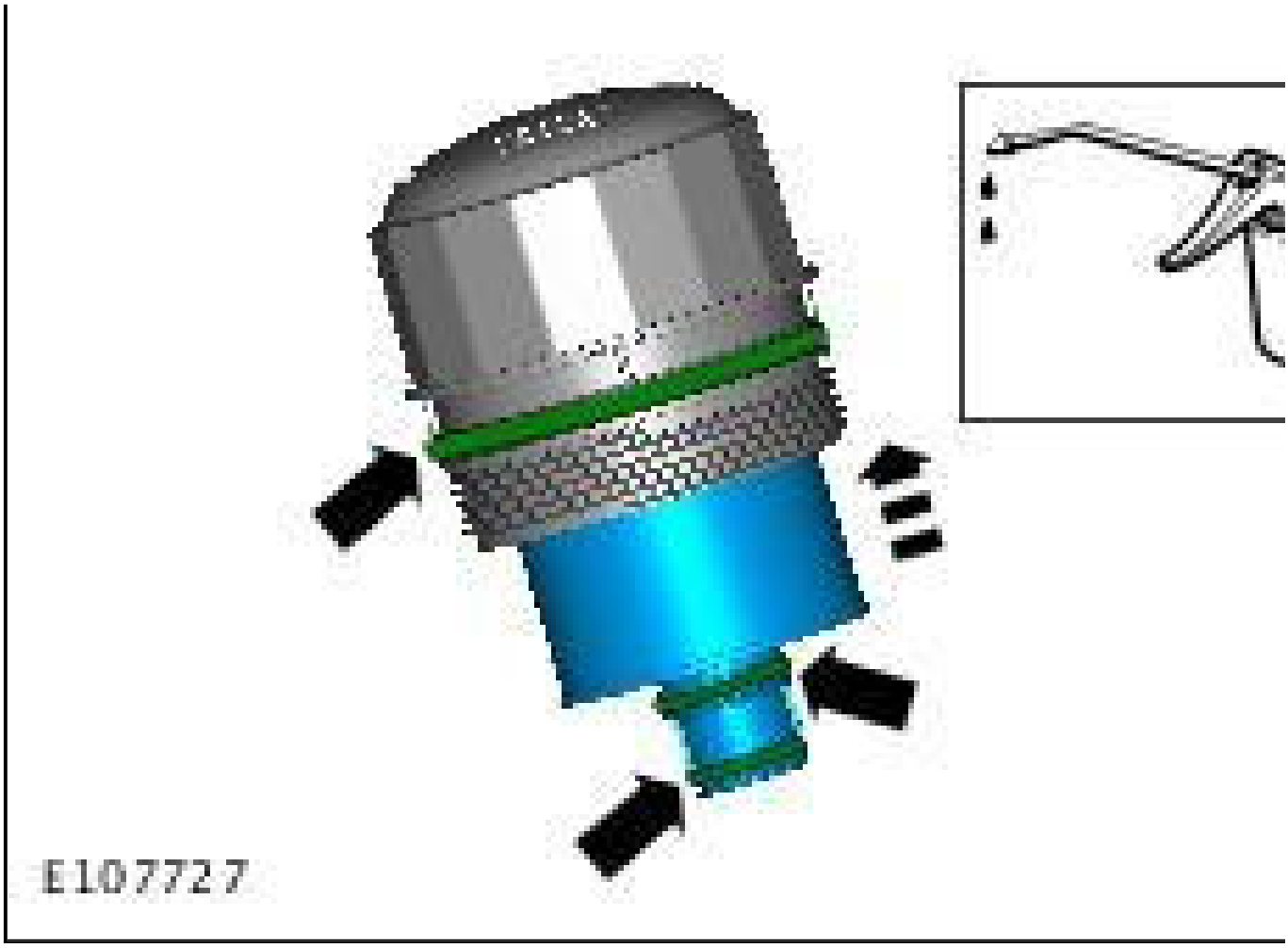

NOTE: Install new O-ring seals.

4. See figure

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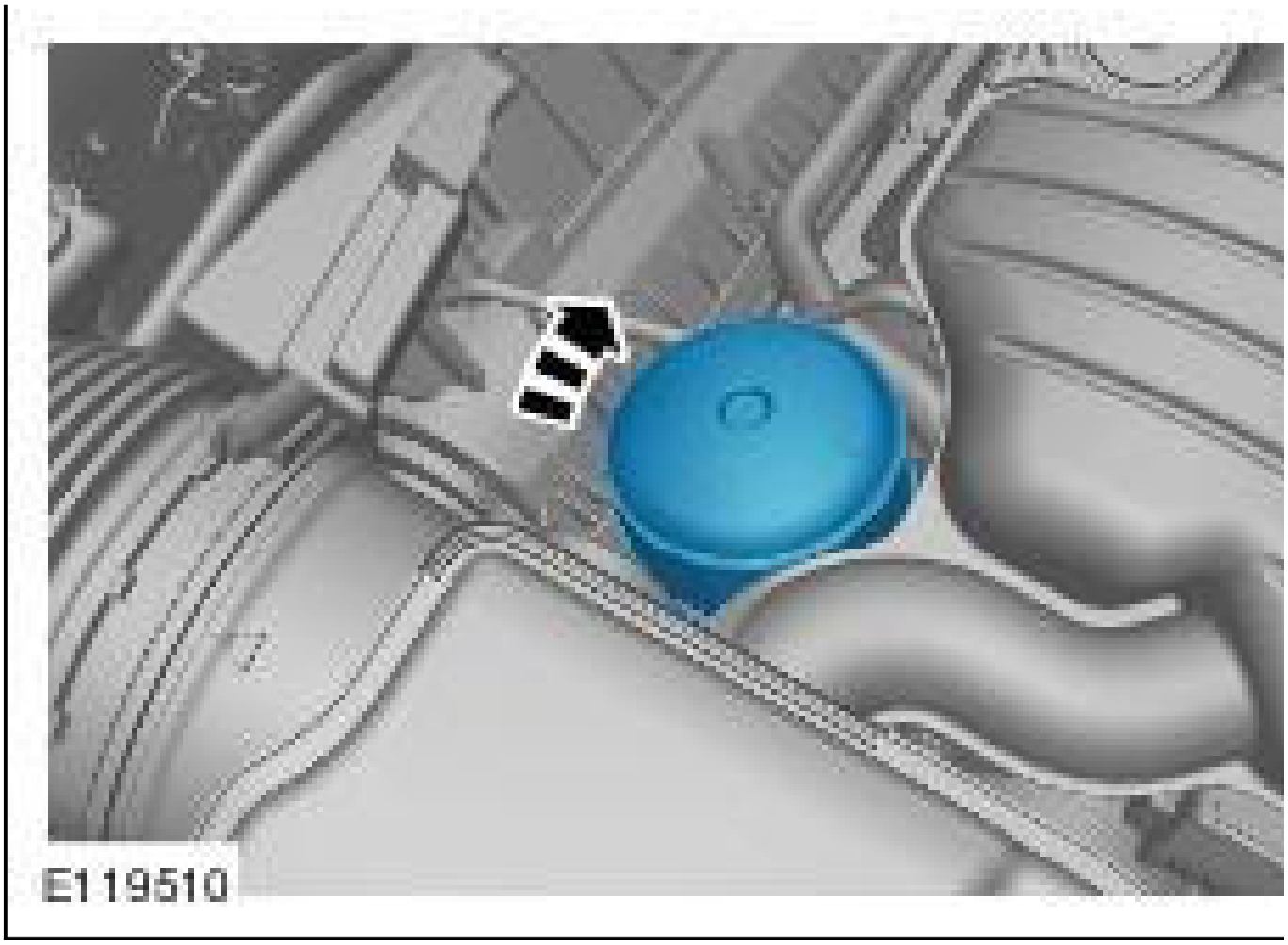

CAUTION: Tighten the component finger tight first.

- Torque: 25 Nm

5. Engine oil, filling

CAUTION: Make sure that the vehicle is left for 5 minutes from filling with oil and that the engine oil level is reading at least minimum (by following Steps 9-16), before starting the engine.

- **Fill the engine with oil - for filling values on vehicles without supercharger:**

  Refer to: ENGINE OIL DRAINING AND FILLING - GENERAL PROCEDURES.

- **Fill the engine with oil - for filling values on vehicles with**

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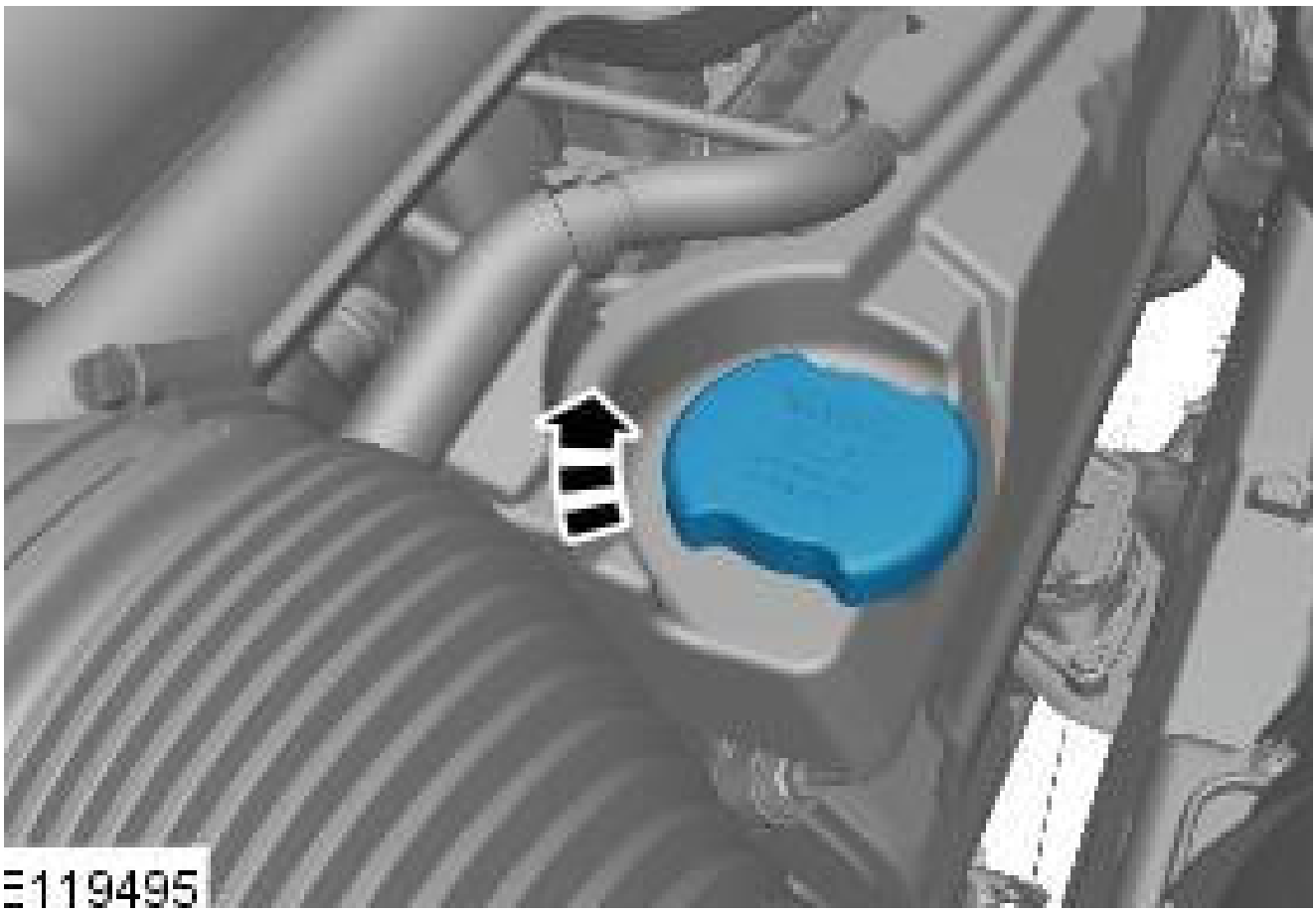
supercharger:

Refer to: ENGINE (V8 S/C 5.0L PETROL) .

- **Clean any residual engine oil from the oil filler cap area.**

6. See figure



7. Follow the Steps 9-16 before starting the engine.

CAUTION: CAUTION: Make sure that the vehicle has been left for 5 minutes from filling with oil.

8. Leak check
   - Start the engine and allow to run for 10 minutes, stop the engine.
   - Check for leaks.
9. Engine on

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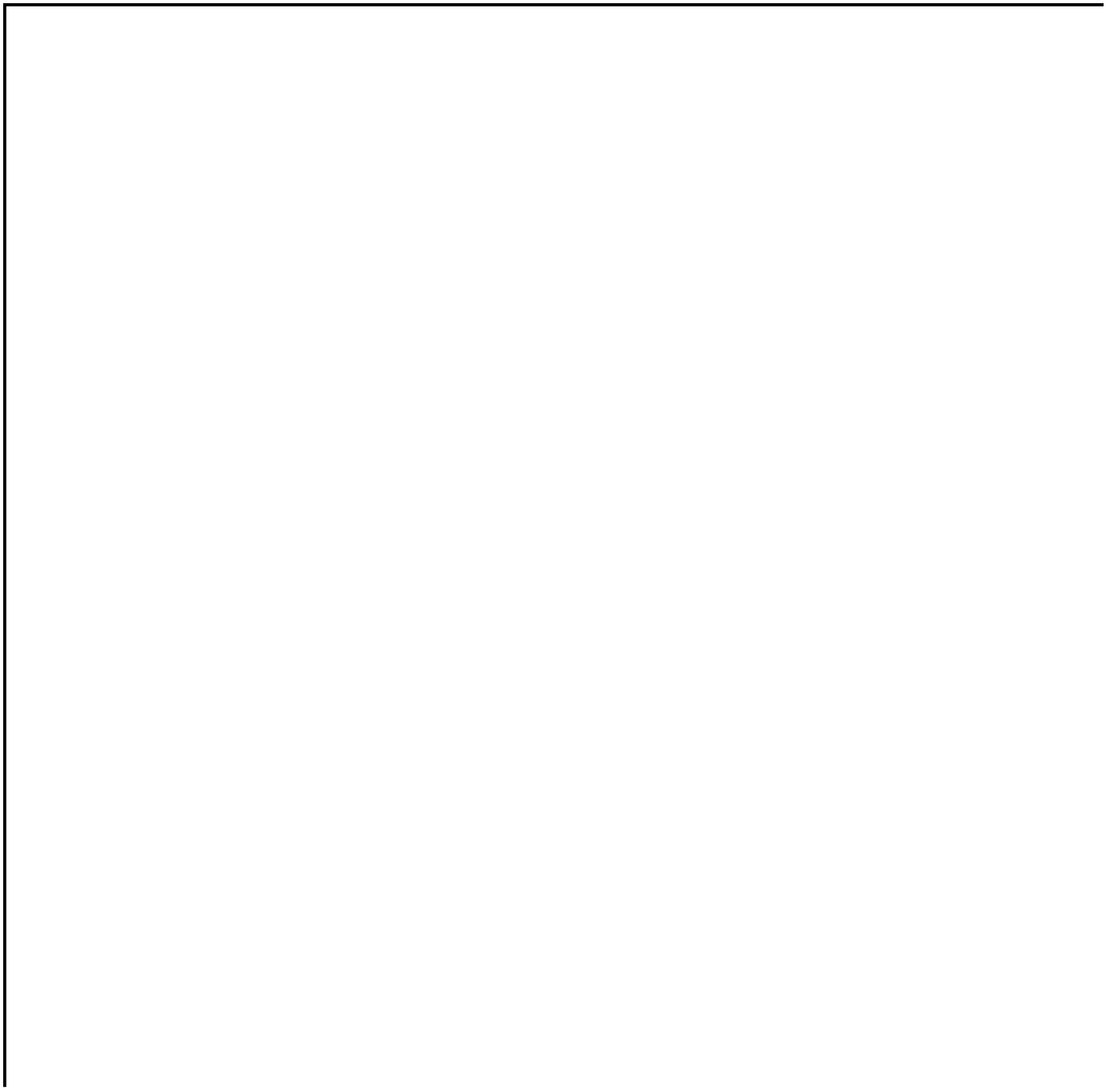
CAUTION: Make sure that the selector lever and the gearshift mechanism are in the park (P) position.

CAUTION: Make sure that the hood is open.

- Turn the ignition on.

10. See figure



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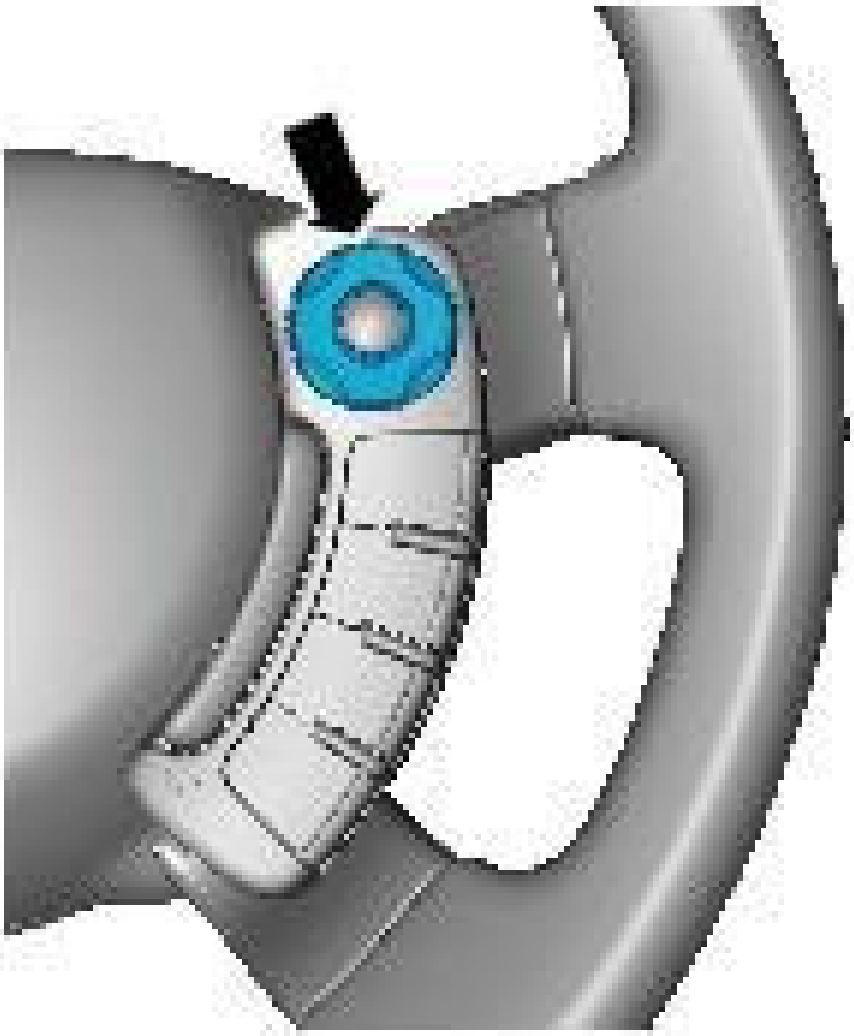

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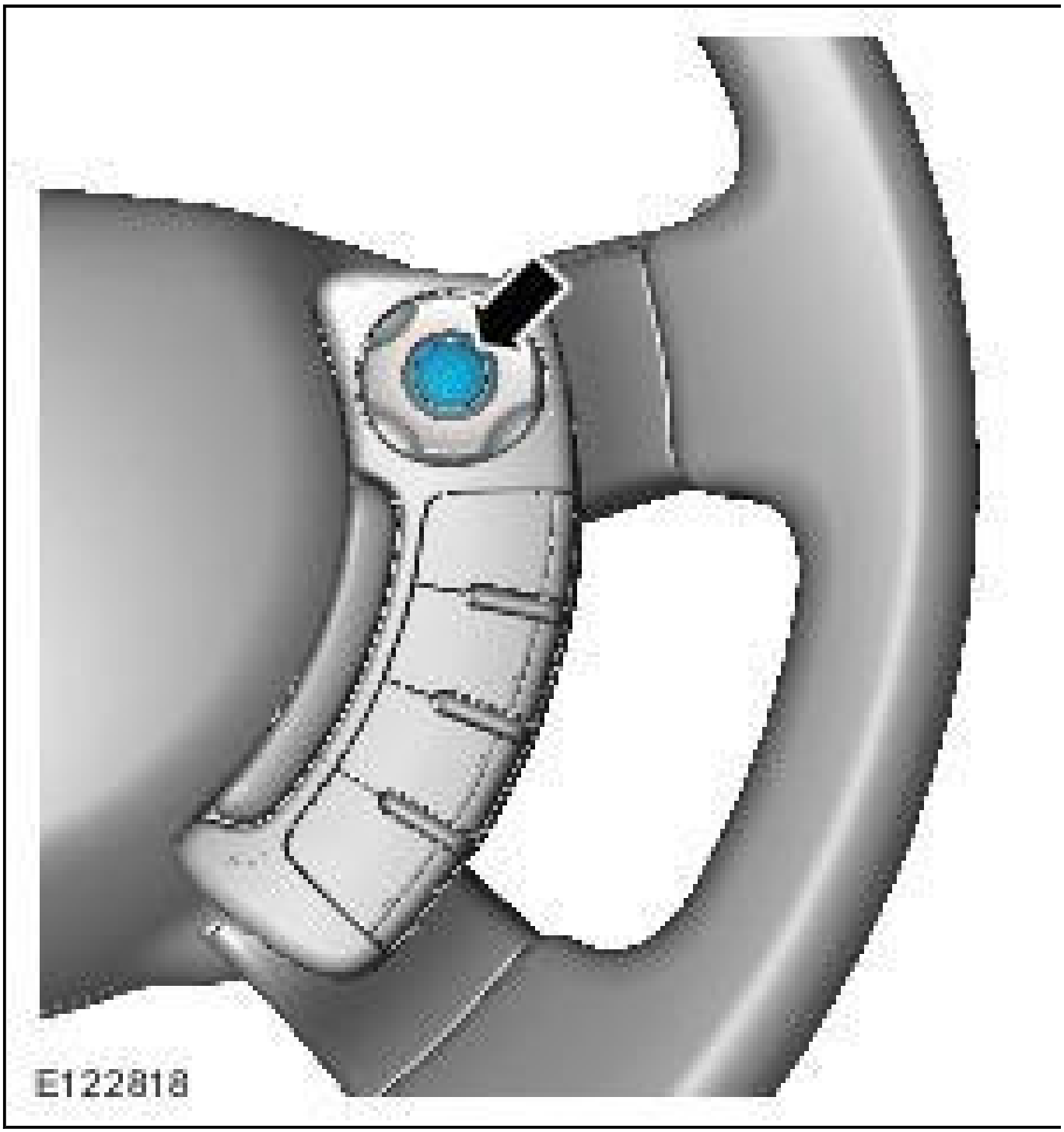
- Press the right-hand directional button to access the instrument cluster menu.

11. See figure



- Press the right-hand OK button.

12. See figure

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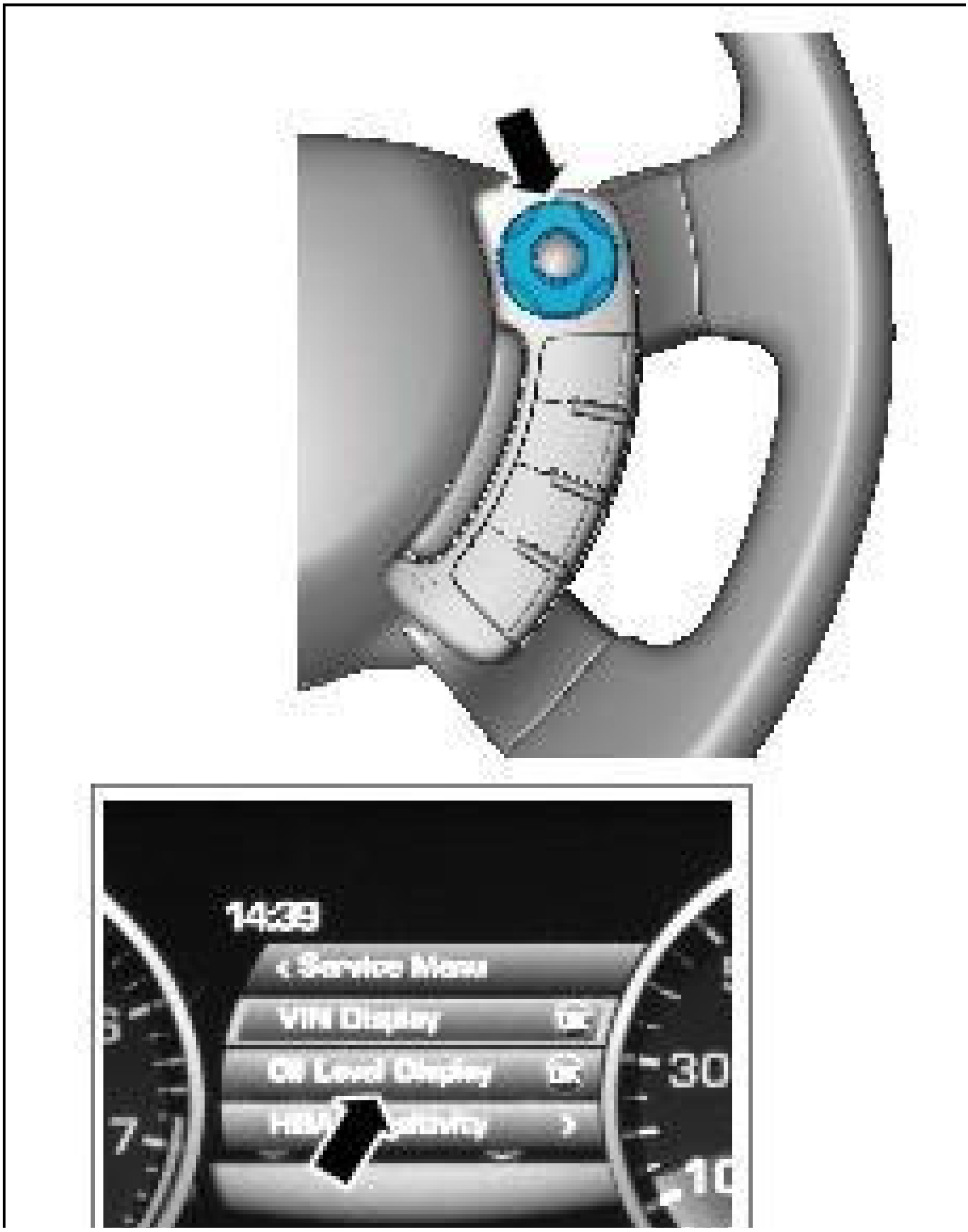

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- Press the right-hand directional button to access the Oil Level Display.

13. See figure

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- Press the right-hand OK button and follow the instructions.

14. See figure

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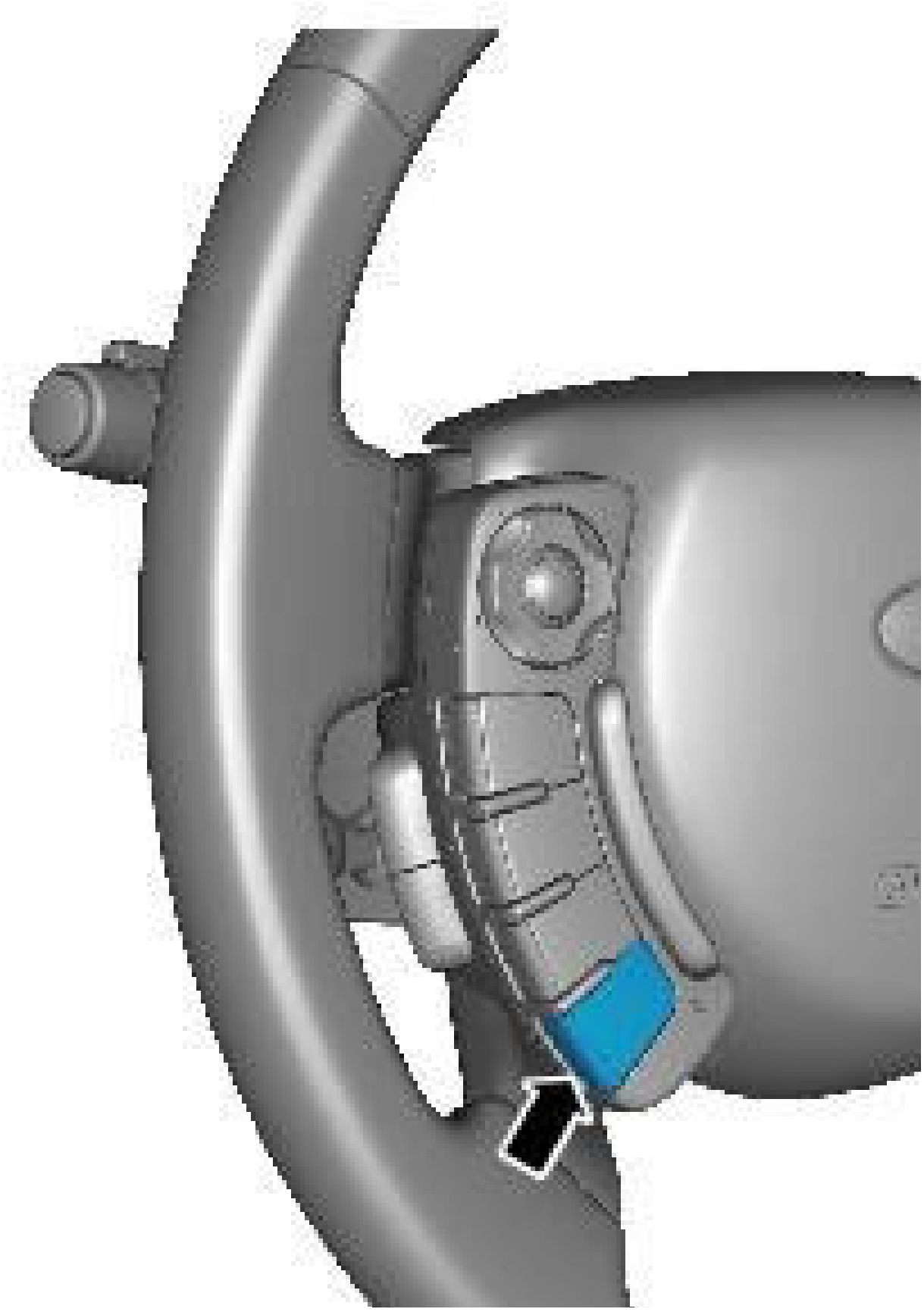

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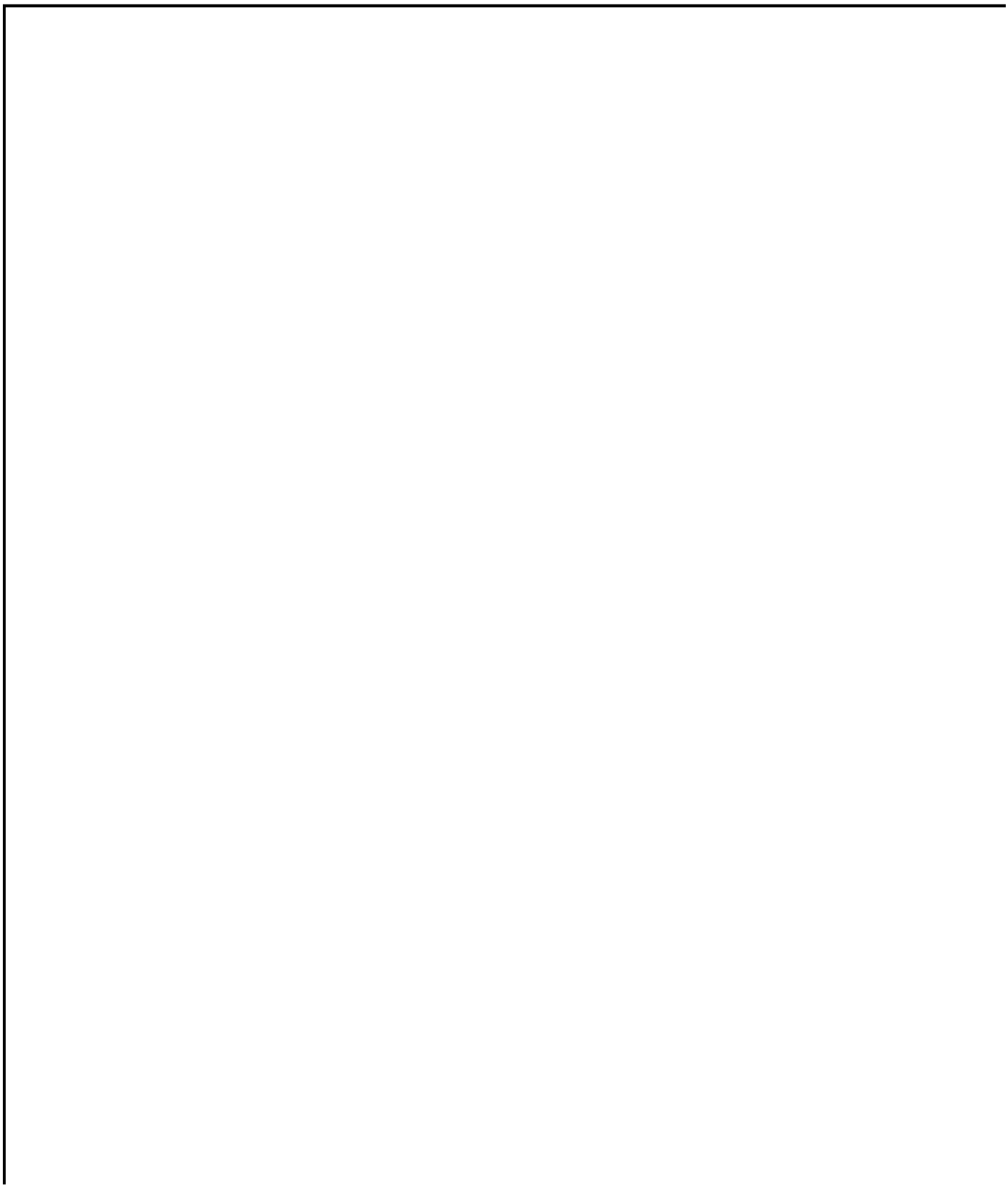
- Press the cruise control cancel button twice within 2 seconds.

15. See figure



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- The message center display will revert to the normal display in the trip computer.
- Press the right-hand OK button and follow the instructions.
- Check that the oil level display shows an oil level reading.
- Only after having started and run the engine for 10 minutes (as indicated in Step 8), switch off the engine, then stabilizing for 10 minutes, take a reading from the oil level display and, if necessary top up with engine oil.

16. Turn the ignition off.

NOTE: If instructed to follow Steps 9-16 in a previous step, return to Step 8 and continue the procedure.

17. Allow 10 minutes for the engine oil level to stabilize if there has been additional oil top up.
18. See figure

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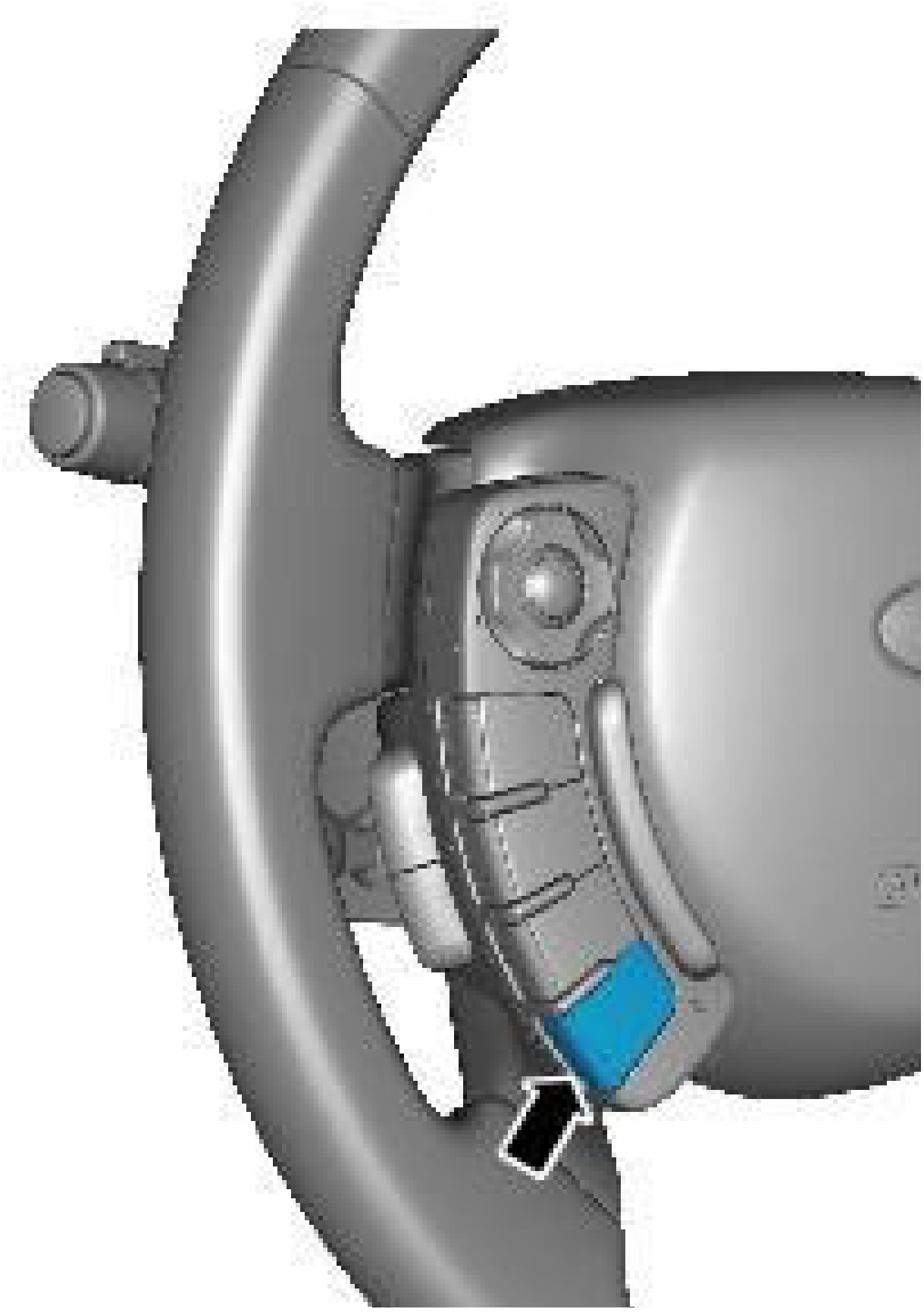

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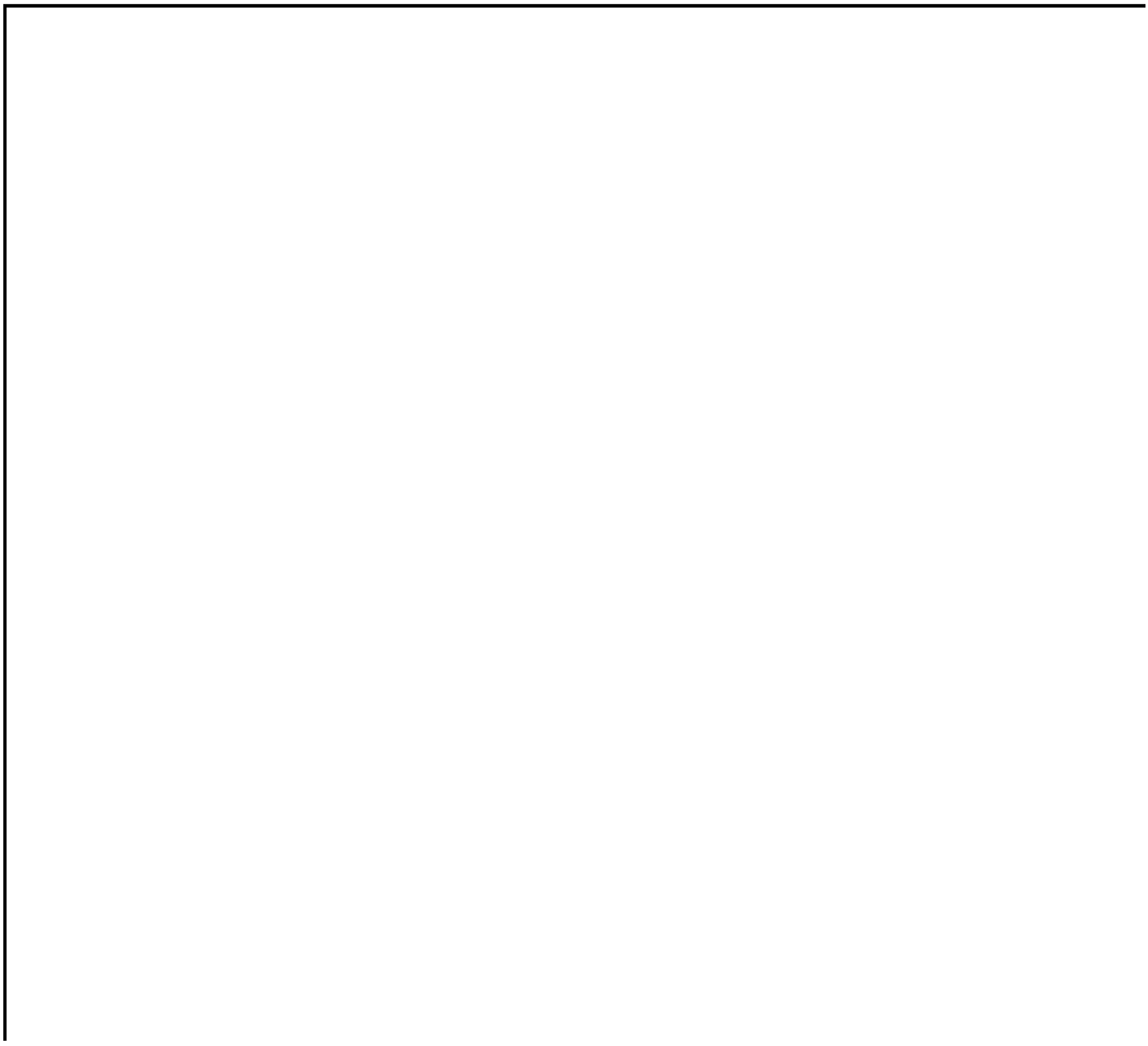
NOTE: The following steps are to update the average oil level value.

- **Turn the ignition on.**
- **Press and hold the cruise control cancel button for more than 2 seconds.**

19. Message info
    - The message center display will revert to the normal display in the trip computer.
20. Turn the ignition off.
21. Turn the ignition on.
22. See figure



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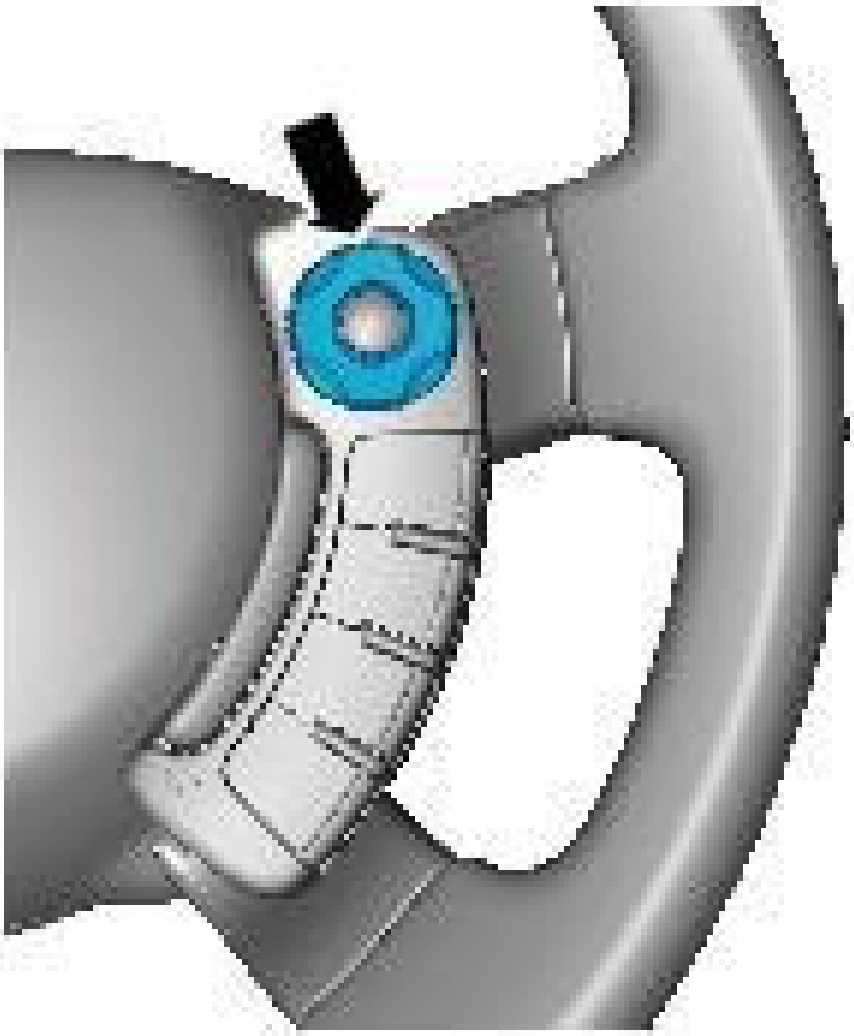

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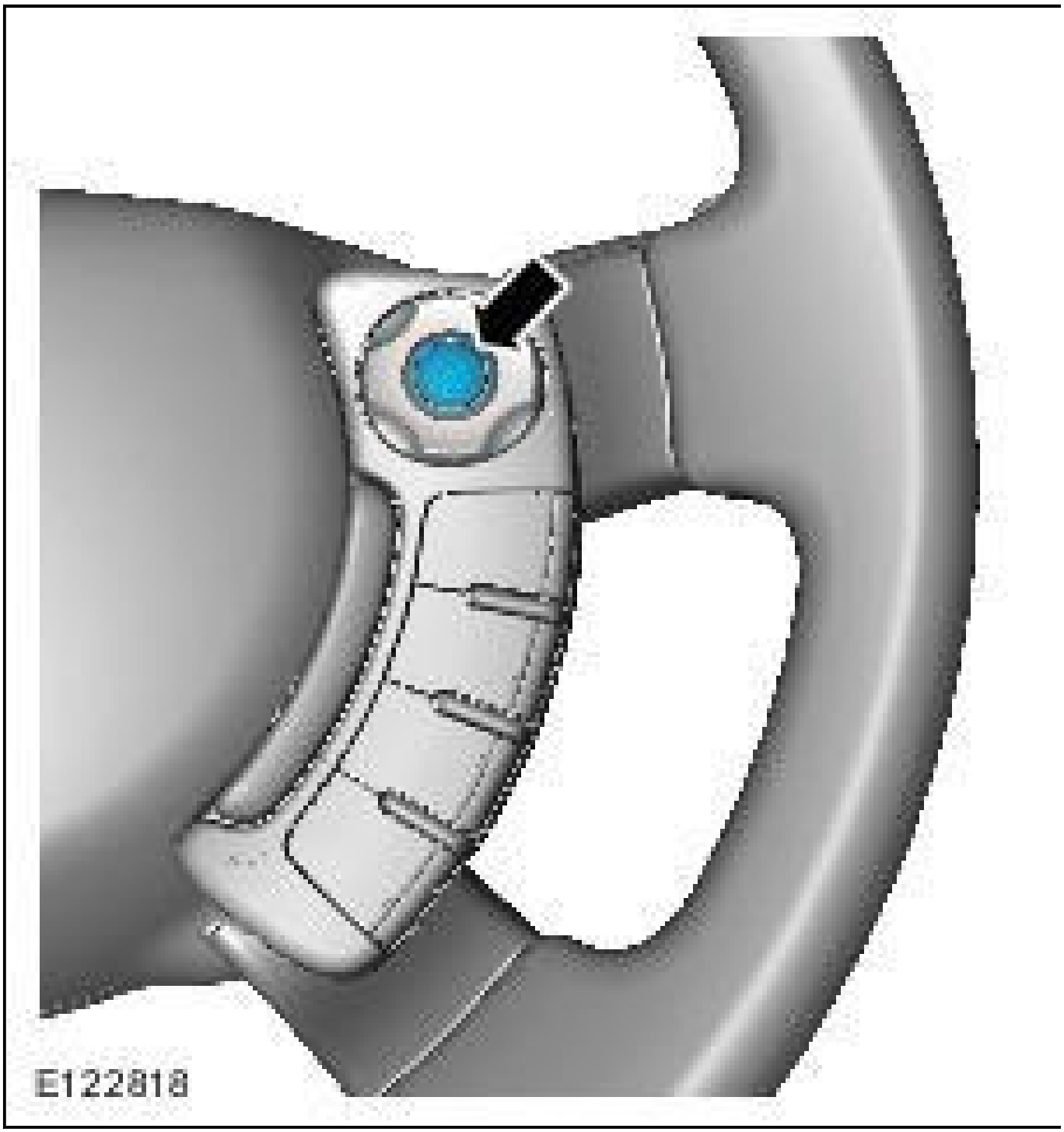
- Press the right-hand directional button to access the instrument cluster menu.

23. See figure



- Press the right-hand OK button.

24. See figure

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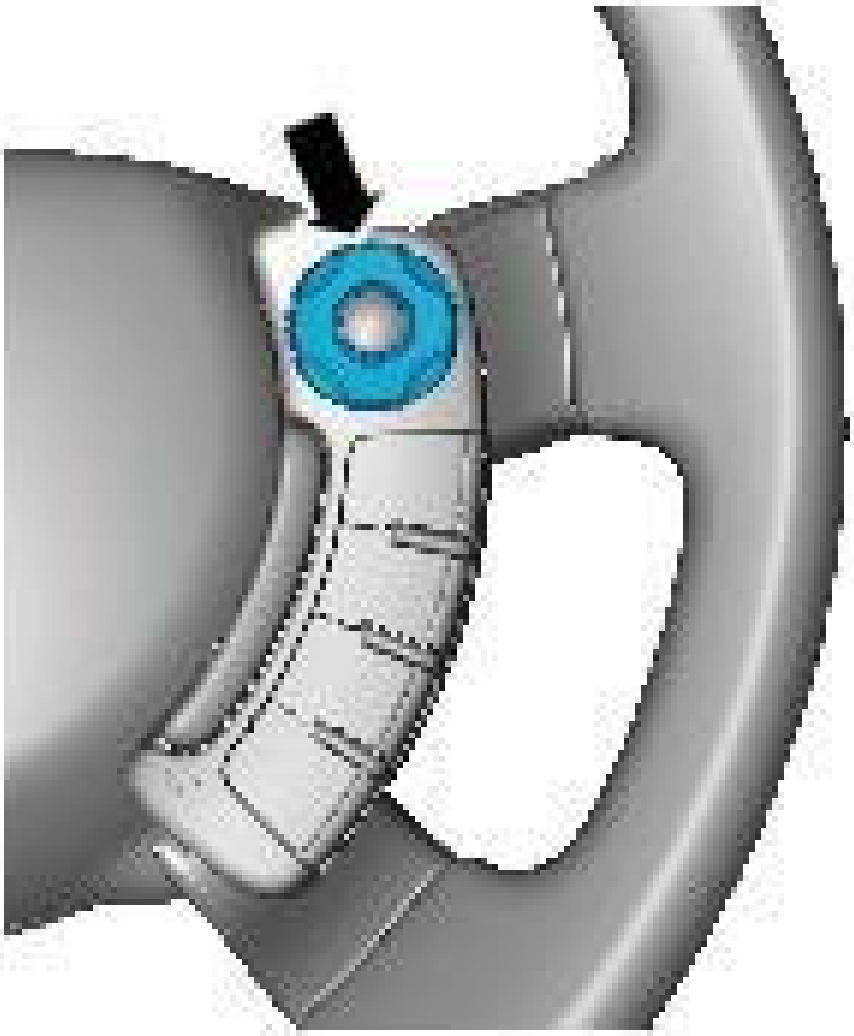

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- Press the right-hand directional button to access the Oil Level Display.

25. See figure

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- Press the right-hand OK button and follow the instructions.
- Make sure that the average oil level value has now been updated.

26. Refer to: **ENGINE COVER - REMOVAL AND INSTALLATION** .

ENGINE OIL VACUUM DRAINING AND FILLING

DRAINING

WARNING: The spilling of hot engine oil is unavoidable during this procedure, care must be taken to prevent scalding.

CAUTION: Correct installation of the oil filler cap can be obtained by tightening the cap until hard stop.

NOTE: Make sure that the vehicle is parked on level ground.

NOTE: Clean the components general area prior to dismantling.

1. Engine warm-up
   - Start the engine and allow to run for 10 minutes, stop the engine.
2. See figure

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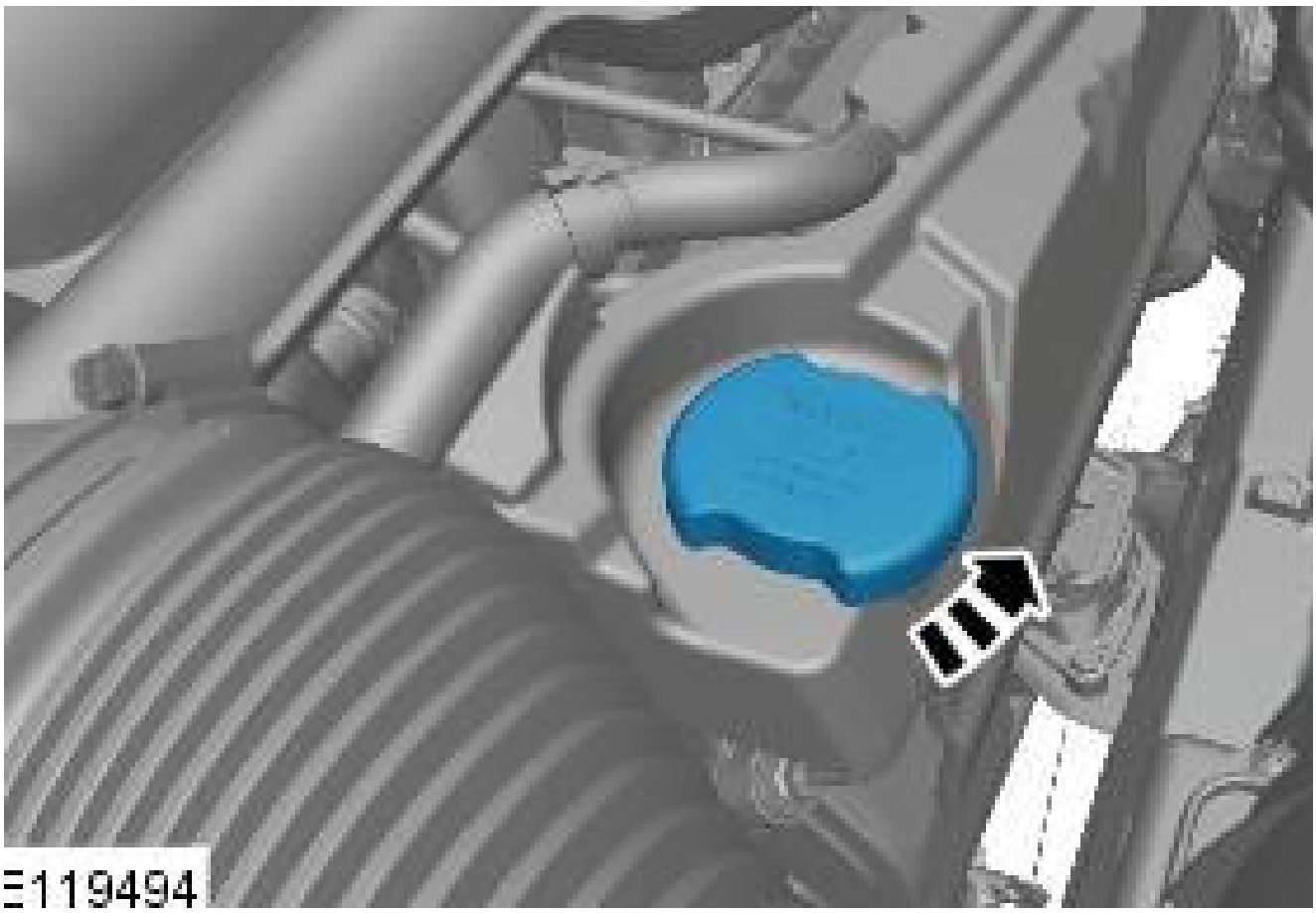

CAUTION: Allow 10 minutes from turning the engine off before starting oil extraction.

3. Refer to: **ENGINE COVER - REMOVAL AND INSTALLATION**
4. See figure

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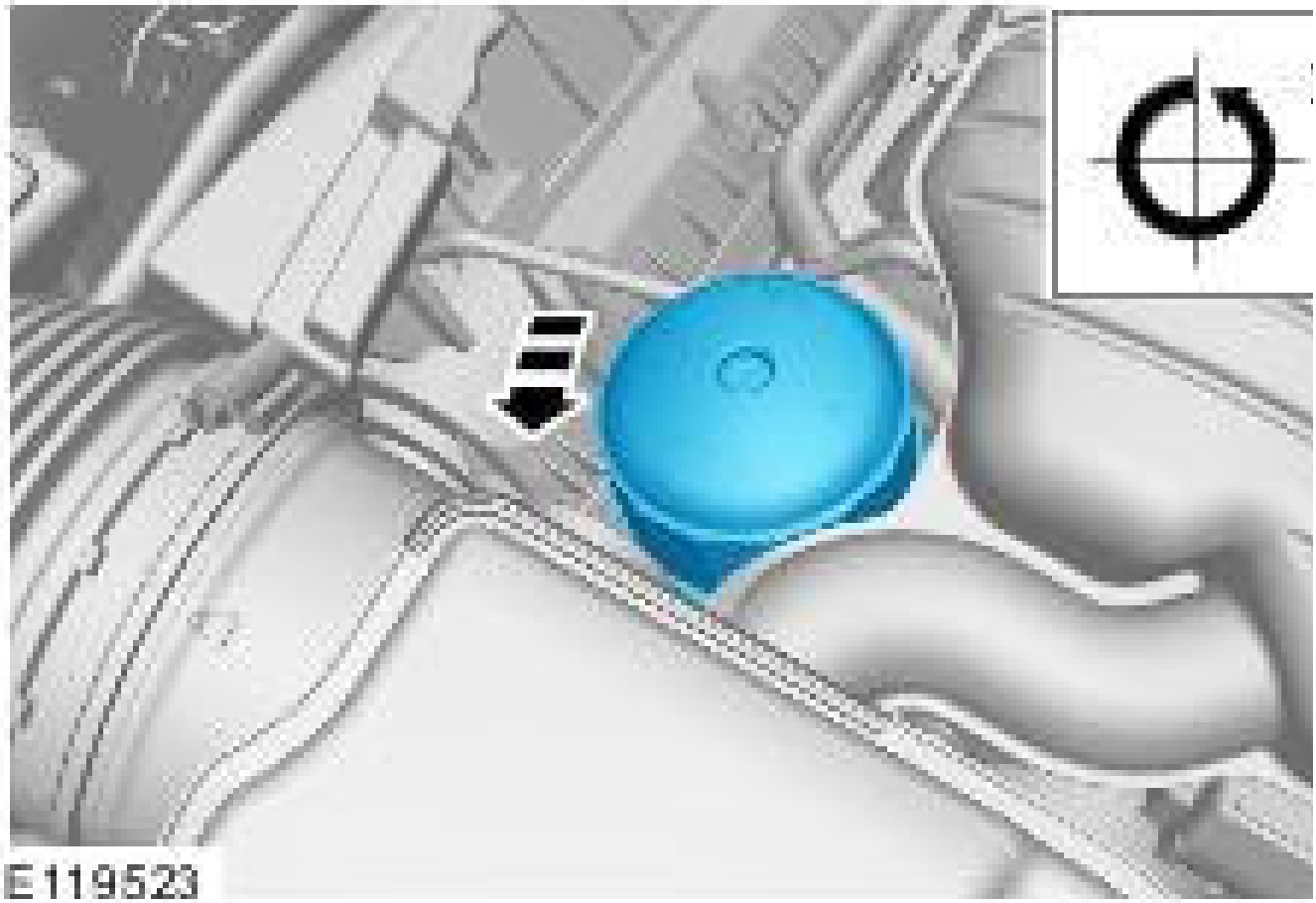

- Loosen the element cover 4 complete turns to allow engine oil to drain from the filter cover.

5. See figure

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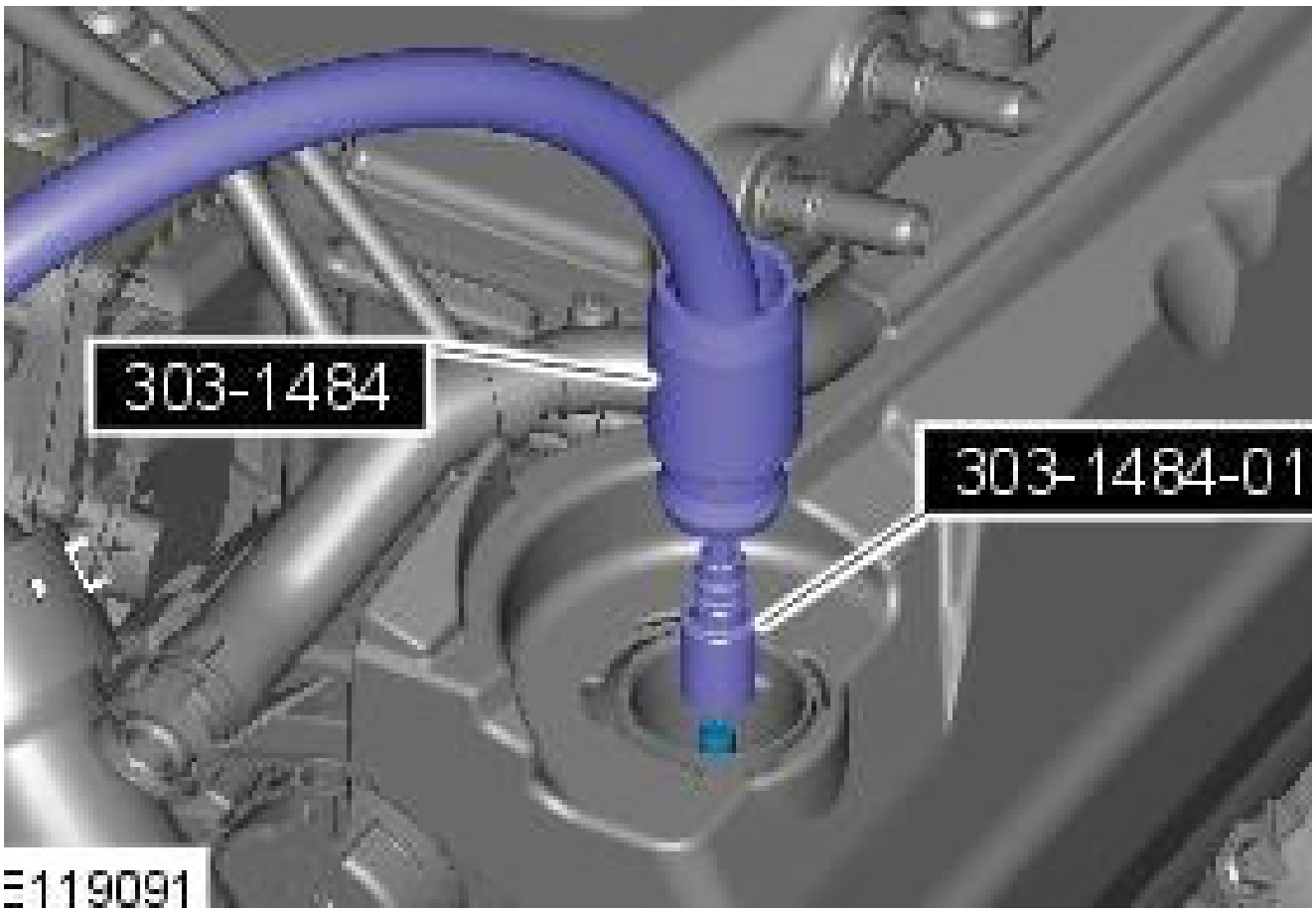

- Using the oil vacuum pump drain the oil out through the oil extraction tube.

6. Vacuum oil pump
   - Remove the oil vacuum pump.
7. See figure

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8. See figure

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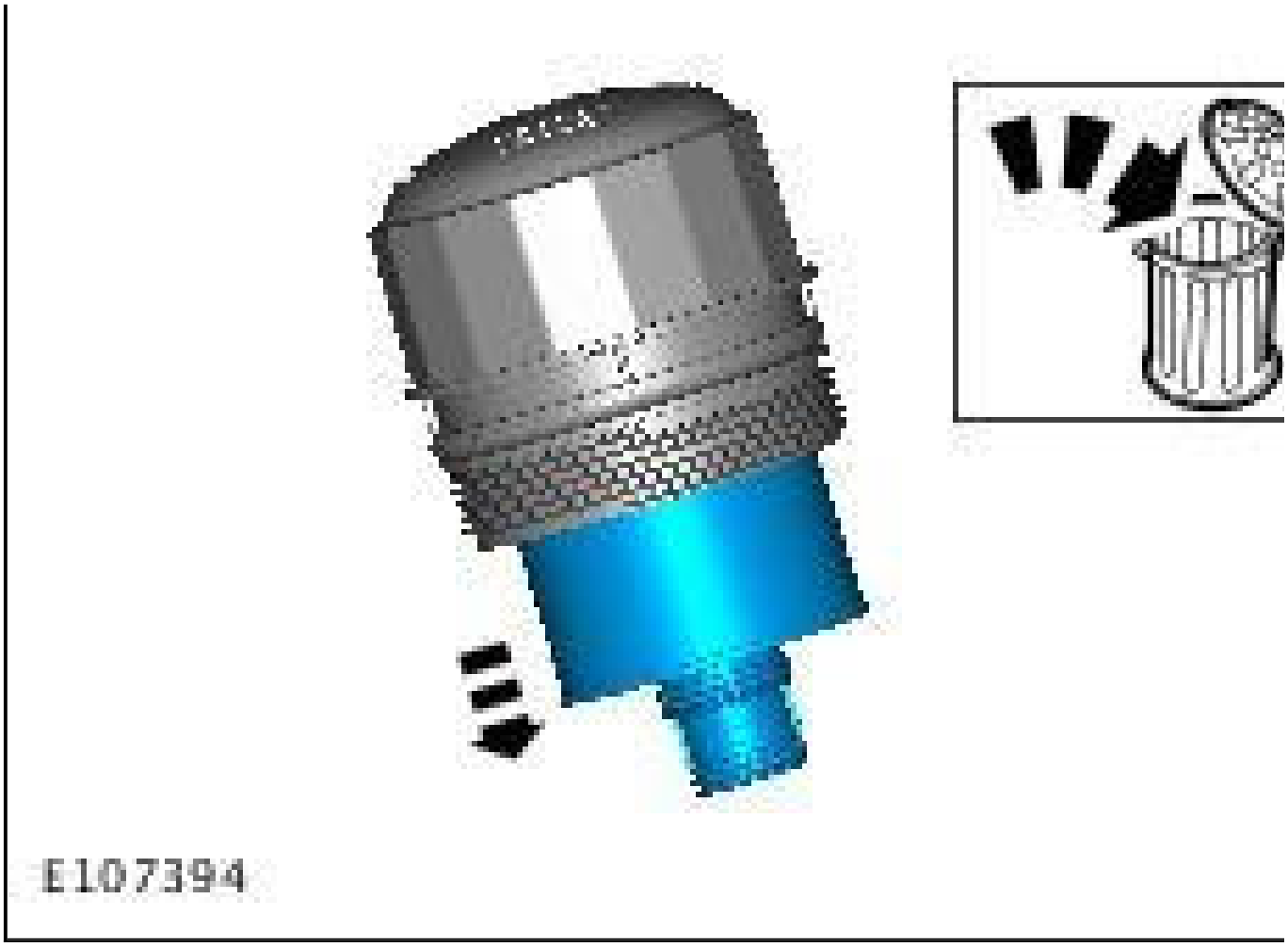

NOTE: Discard the O-ring seals.

FILLING

1. Lubricate the oil filter element O-ring seal with clean engine oil.

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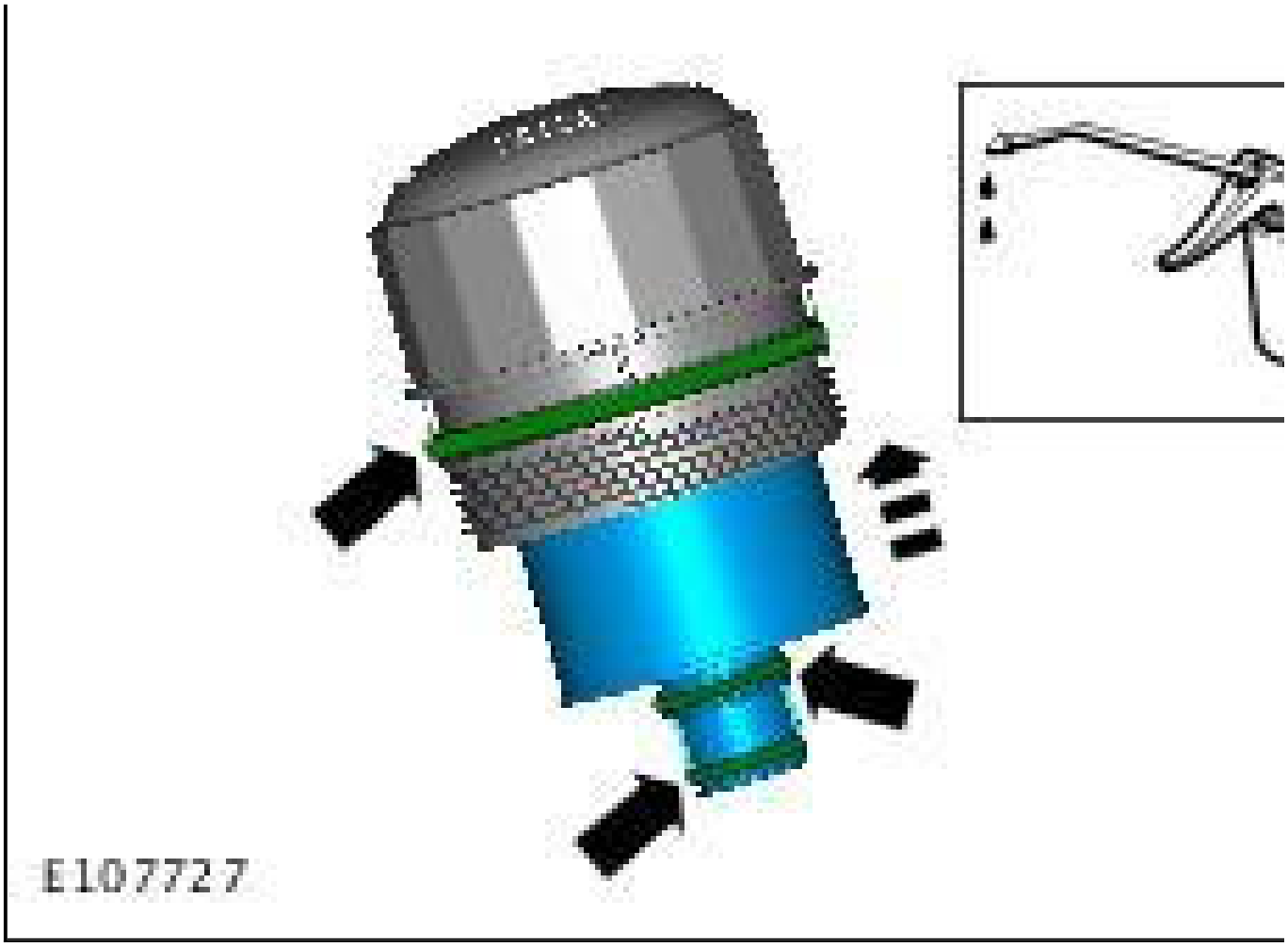

NOTE: Install new O-ring seals.

2. See figure

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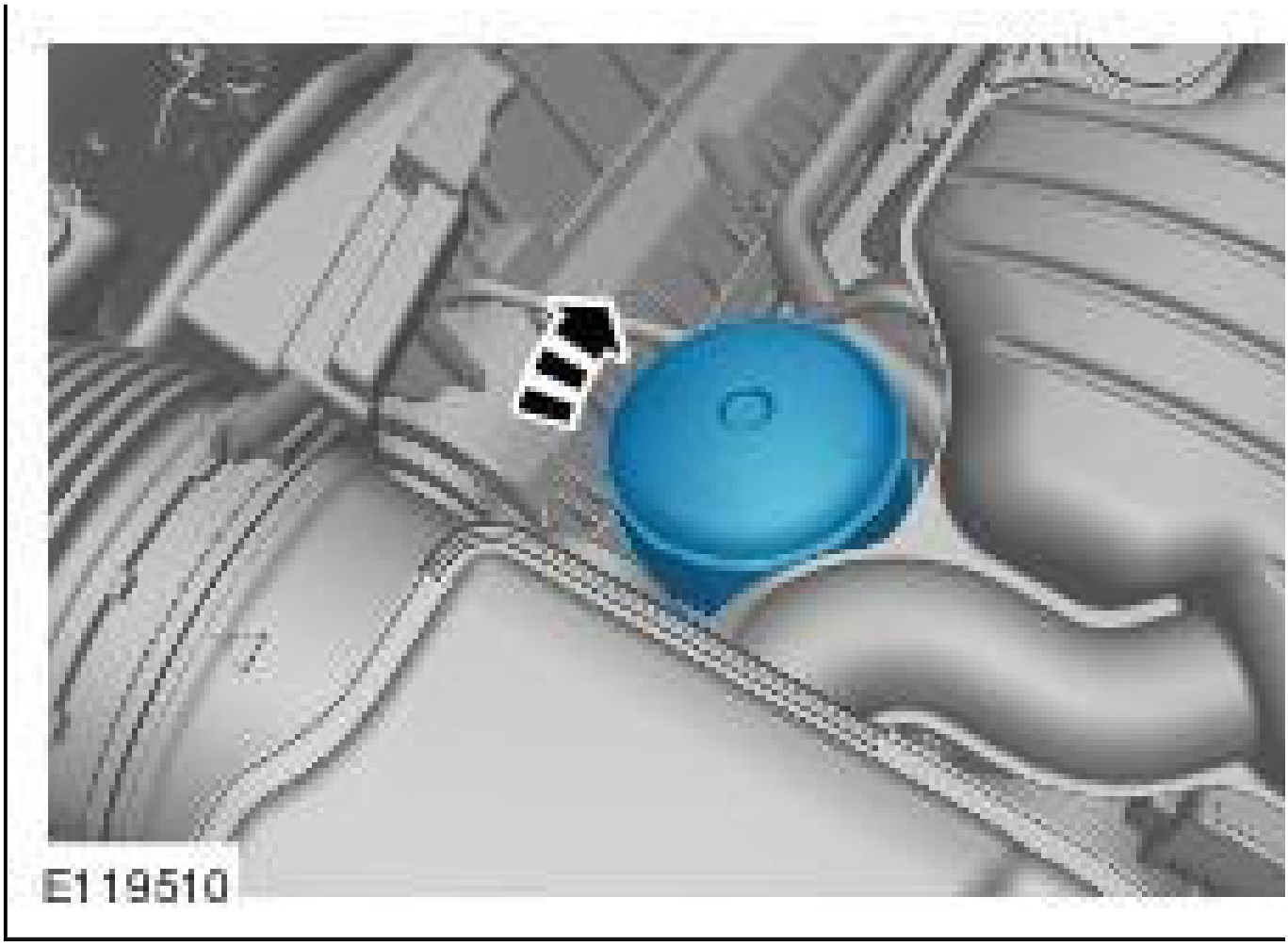

CAUTION: Tighten the component finger tight first.

- Torque: 25 Nm

3. Engine oil, filling

CAUTION: Make sure that the vehicle is left for 5 minutes from filling with oil and that the engine oil level is reading at least minimum (by following Steps 7-14), before starting the engine.

- Fill the engine with oil - for filling values on vehicles without supercharger:

  Refer to: **ENGINE OIL DRAINING AND FILLING - GENERAL PROCEDURES**.

- Fill the engine with oil - for filling values on vehicles with supercharger:

  Refer to: **ENGINE (V8 S/C 5.0L PETROL)** .

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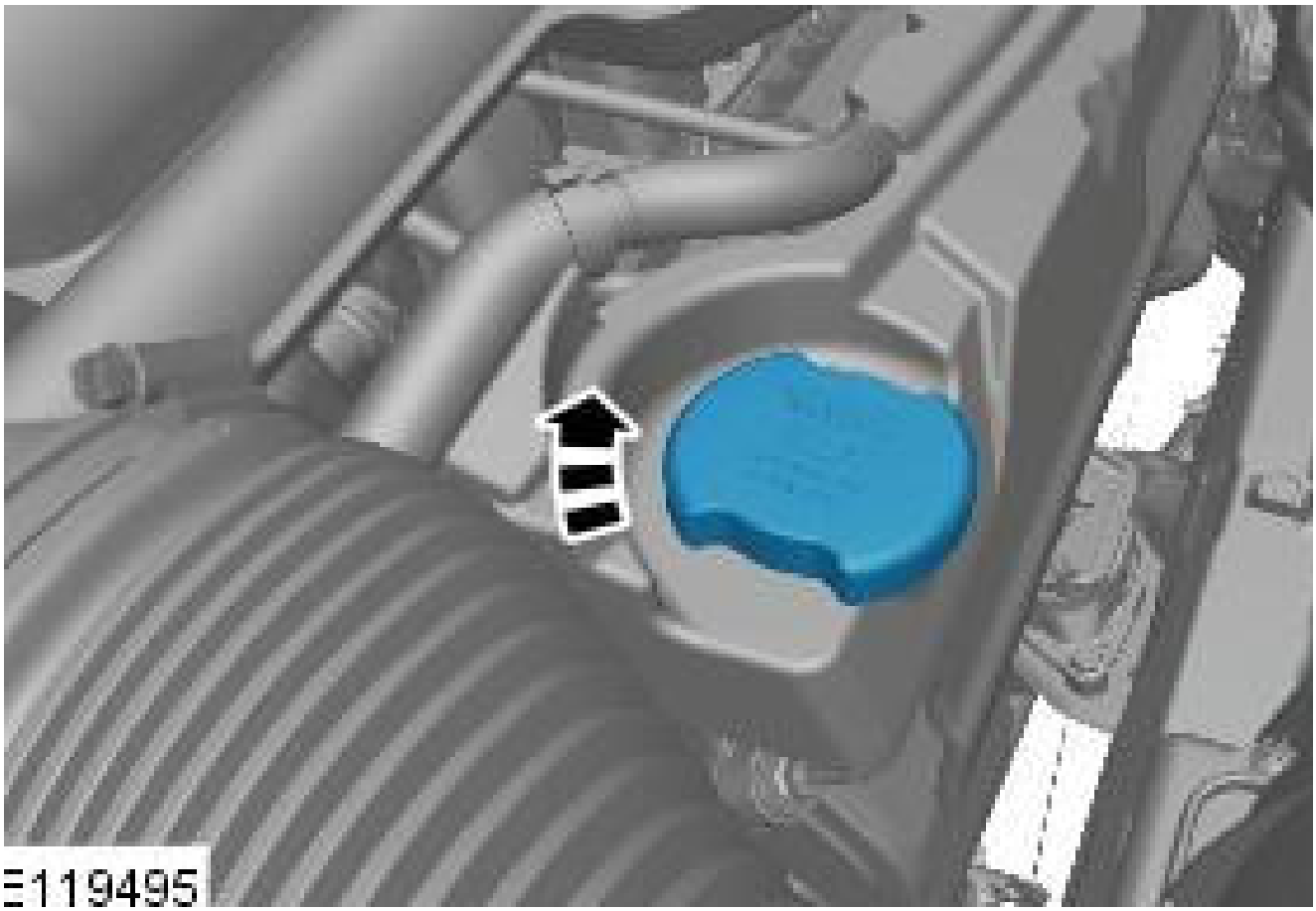
- Clean any residual engine oil from the oil filler cap area.

4. See figure



5. Follow the Steps 7-14 before starting the engine.

CAUTION: Make sure that the vehicle has been left for 5 minutes from filling with oil.

6. Leak check
   - Start the engine and allow to run for 10 minutes, stop the engine.
   - Check for leaks.
7. Engine on

CAUTION: Make sure that the selector lever and the gearshift mechanism are in the park (P) position.

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CAUTION: Make sure that the hood is open.

- Turn the ignition on.

8. See figure

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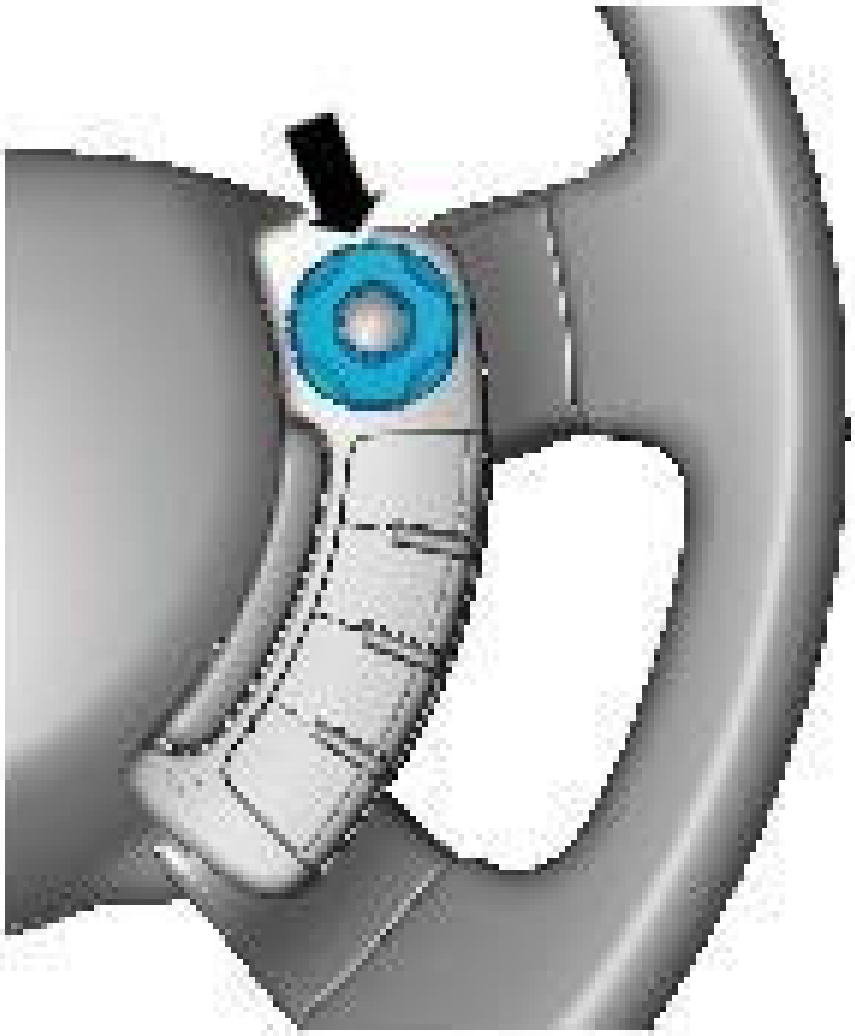

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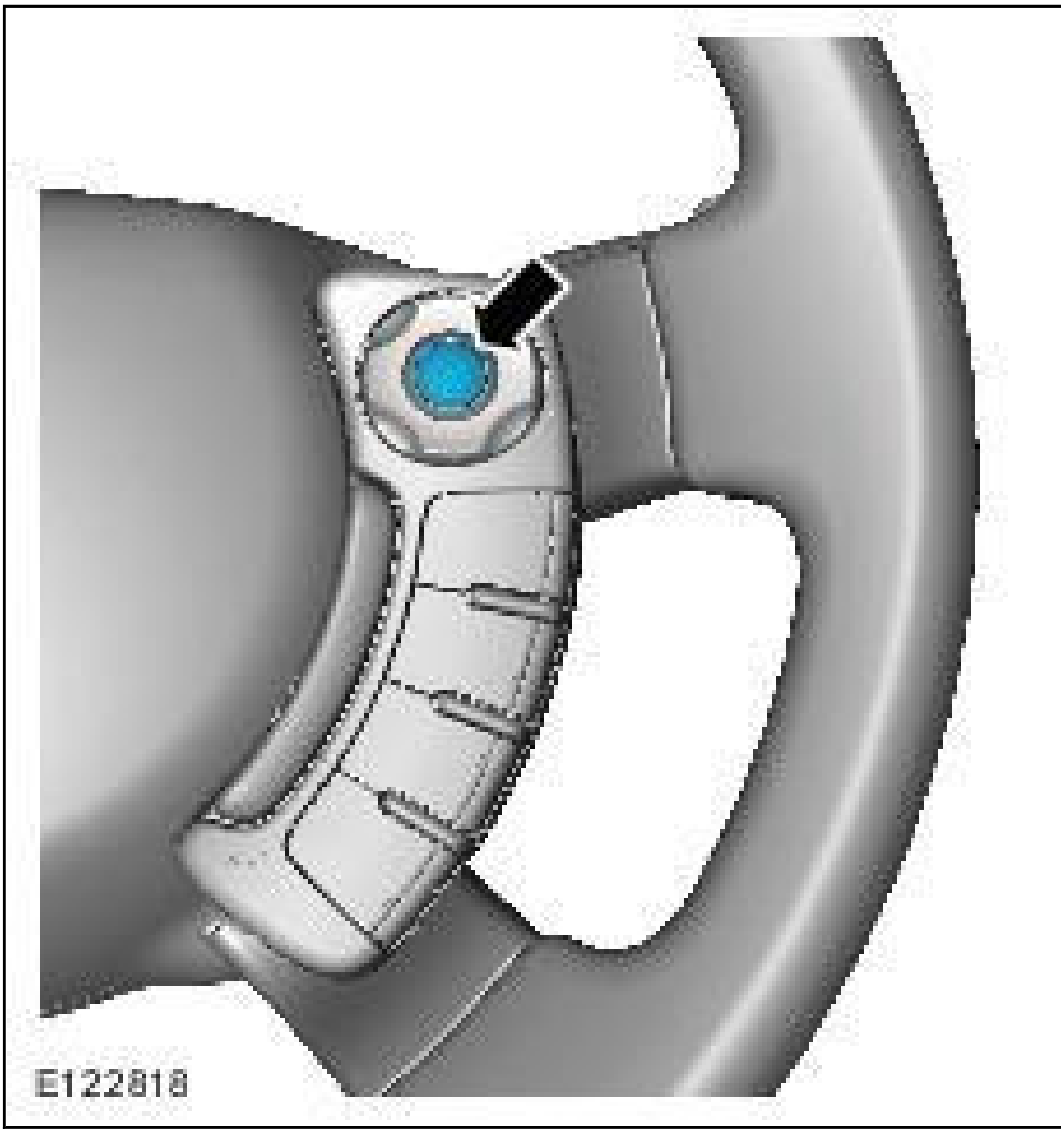
- Press the right-hand directional button to access the instrument cluster menu.

9. See figure



- Press the right-hand OK button.

10. See figure

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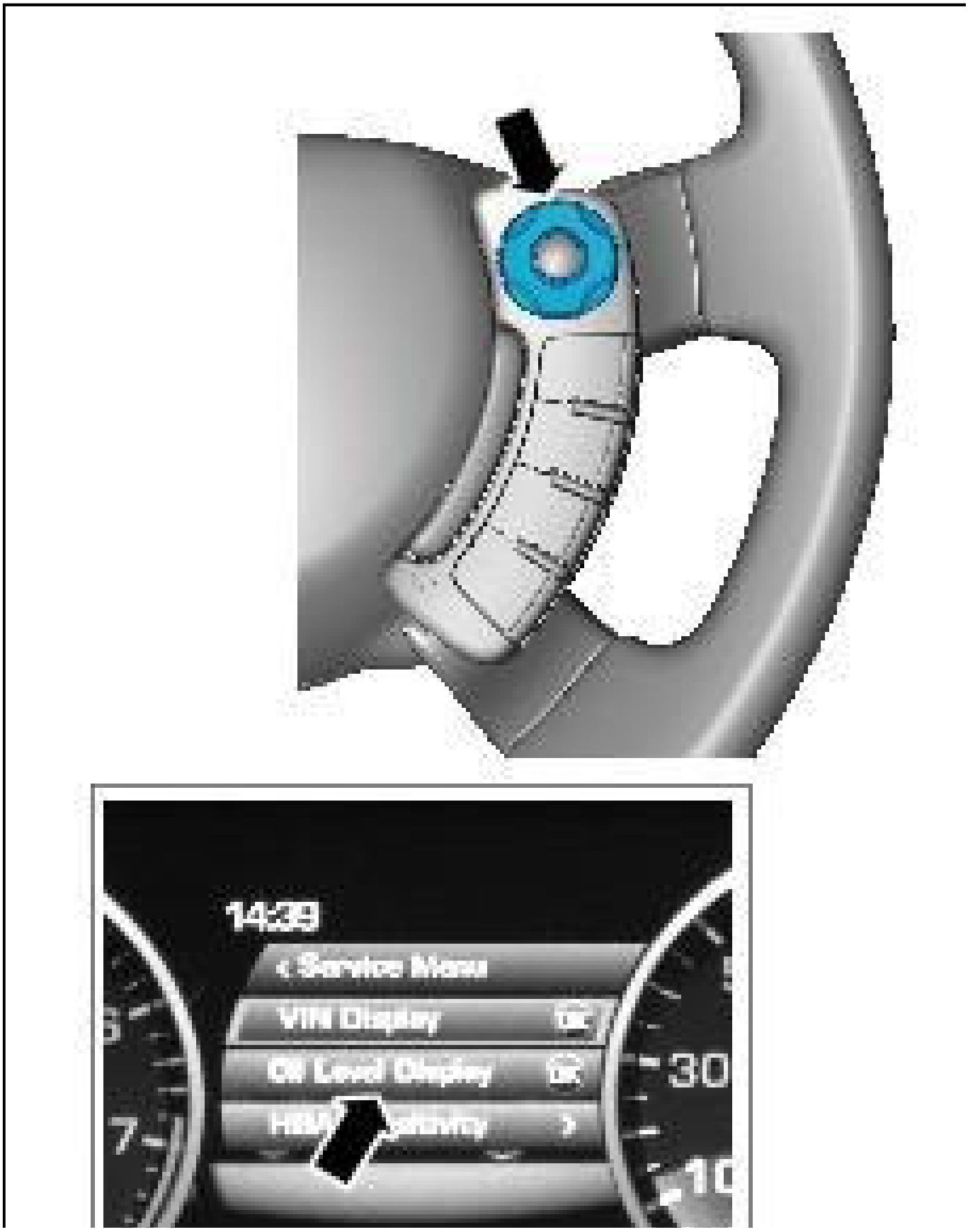

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- Press the right-hand directional button to access the Oil Level Display.

11. See figure

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- Press the right-hand OK button and follow the instructions.

12. See figure

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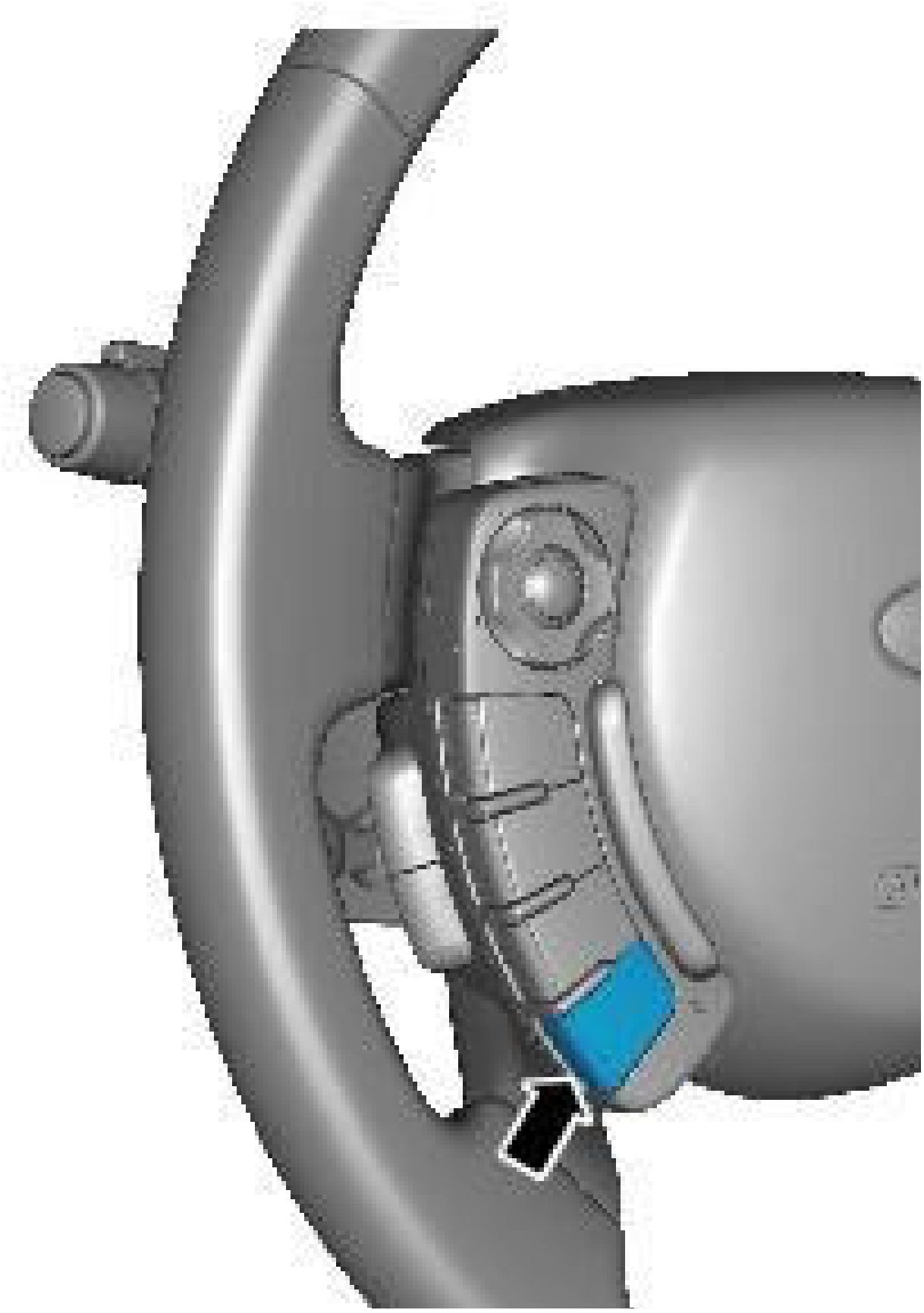

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- Press the cruise control cancel button twice within 2 seconds.

13. See figure

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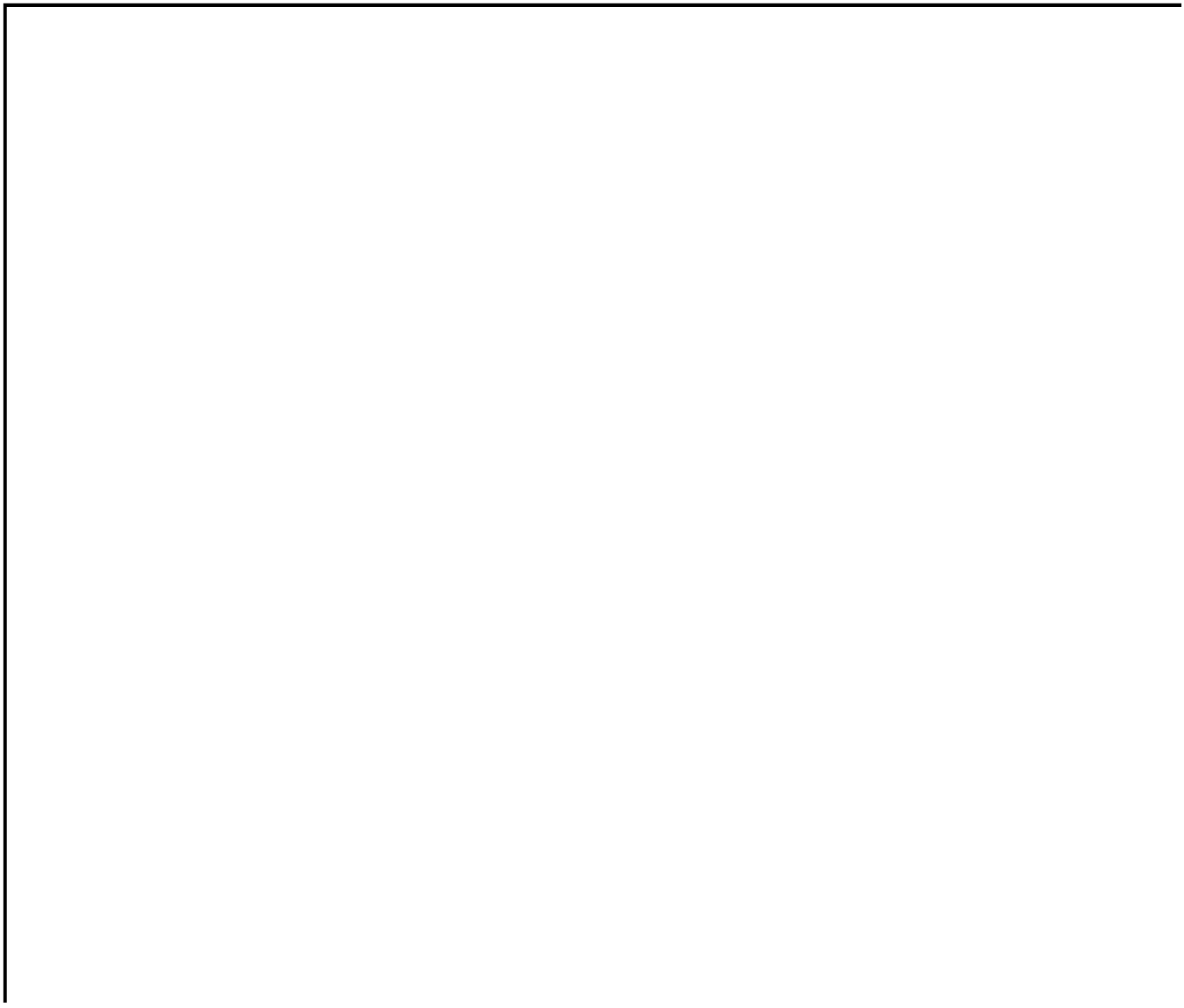
- The message center display will revert to the normal display in the trip computer.
- Press the right-hand OK button and follow the instructions.
- Check that the oil level display shows an oil level reading.
- Only after having started and run the engine for 10 minutes (as indicated in Step 6), switch off the engine, then stabilizing for 10 minutes, take a reading from the oil level display and, if necessary top up with engine oil.

14. Turn the ignition off.

NOTE: If instructed to follow Steps 7-14 in a previous step, return to Step 6 and continue the procedure.

15. Allow 10 minutes for the engine oil level to stabilize if there has been additional oil top up.
16. See figure



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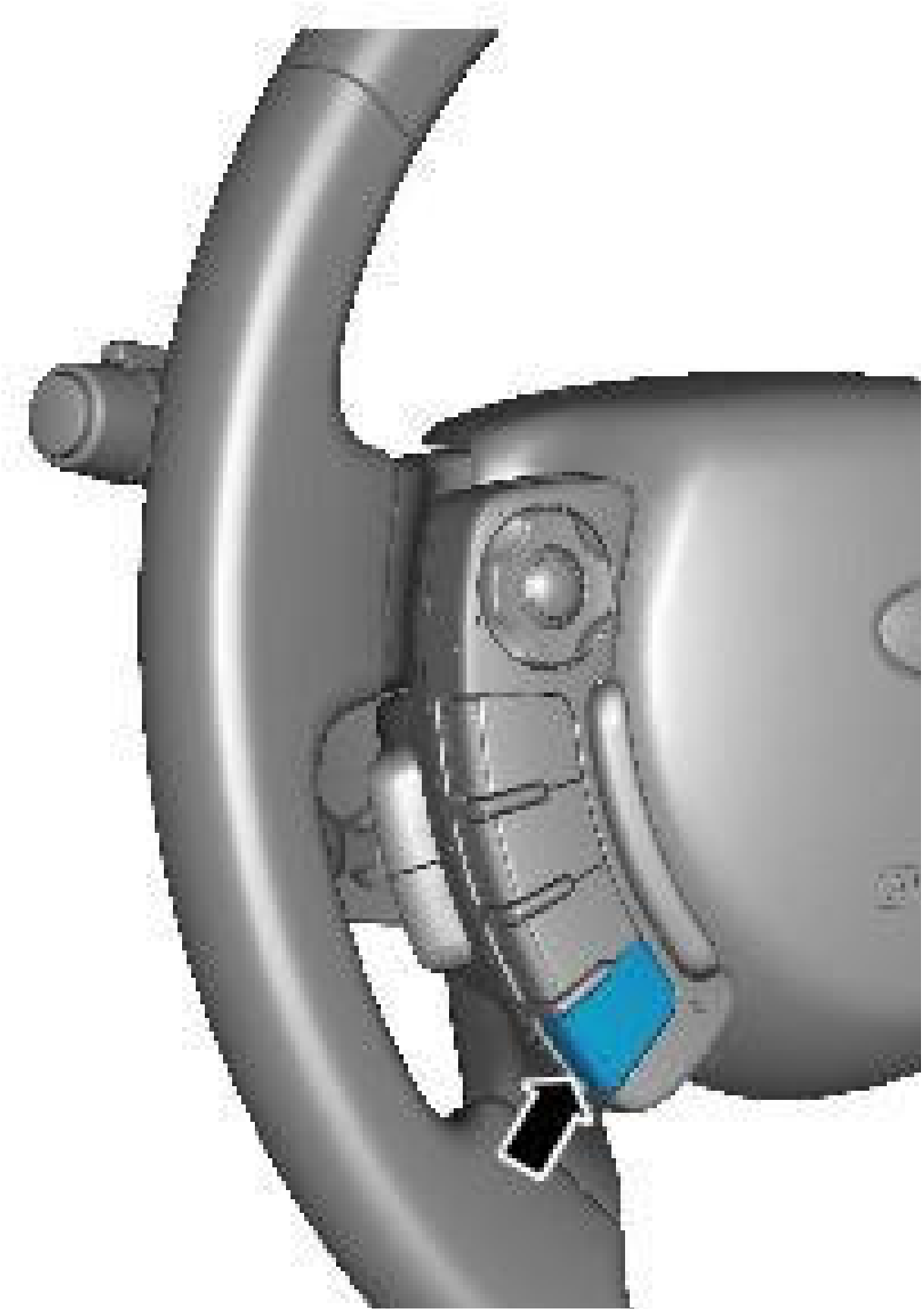

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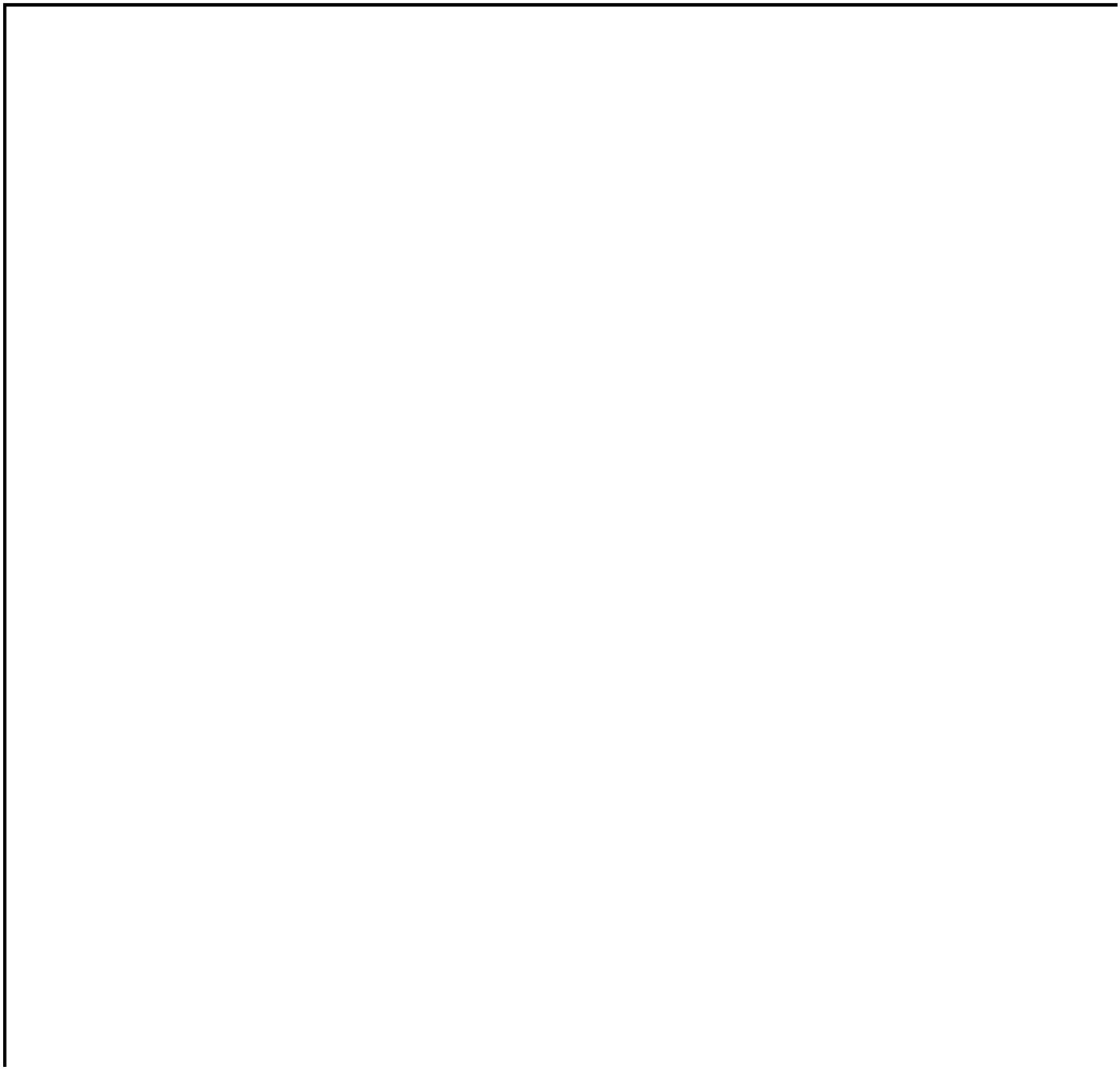
NOTE: NOTE: The following steps are to update the average oil level value.

- Turn the ignition on.
- Press and hold the cruise control cancel button for more than 2 seconds.

17. Message center display
    - The message center display will revert to the normal display in the trip computer.
18. Turn the ignition off.
19. Turn the ignition on.
20. See figure



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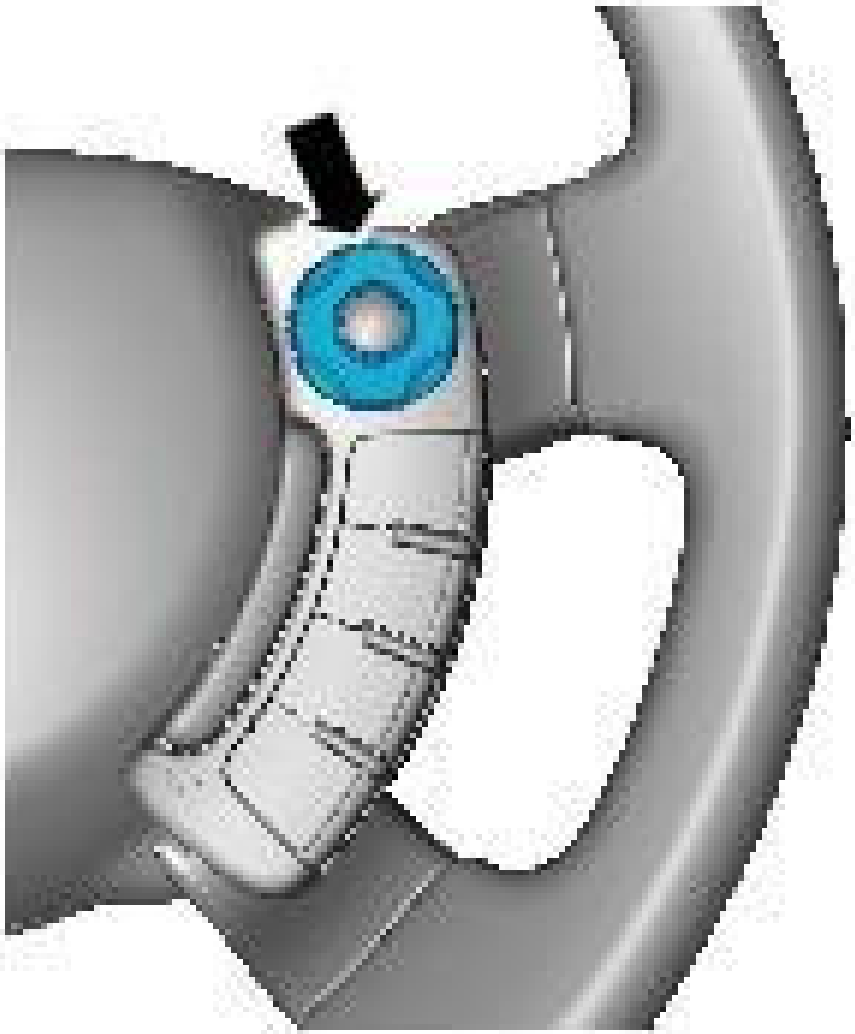

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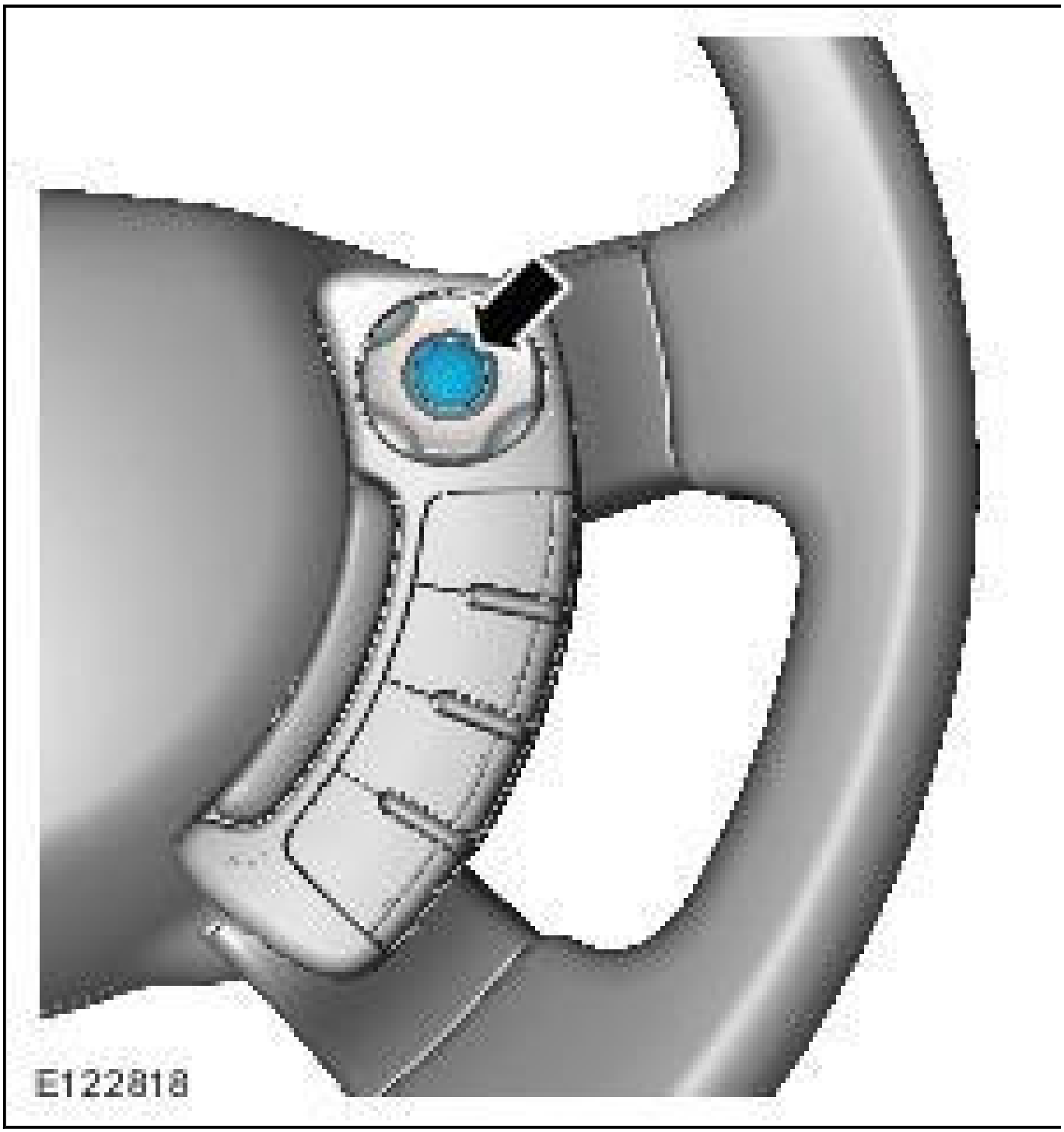
- Press the right-hand directional button to access the instrument cluster menu.

21. See figure



- Press the right-hand OK button.

22. See figure

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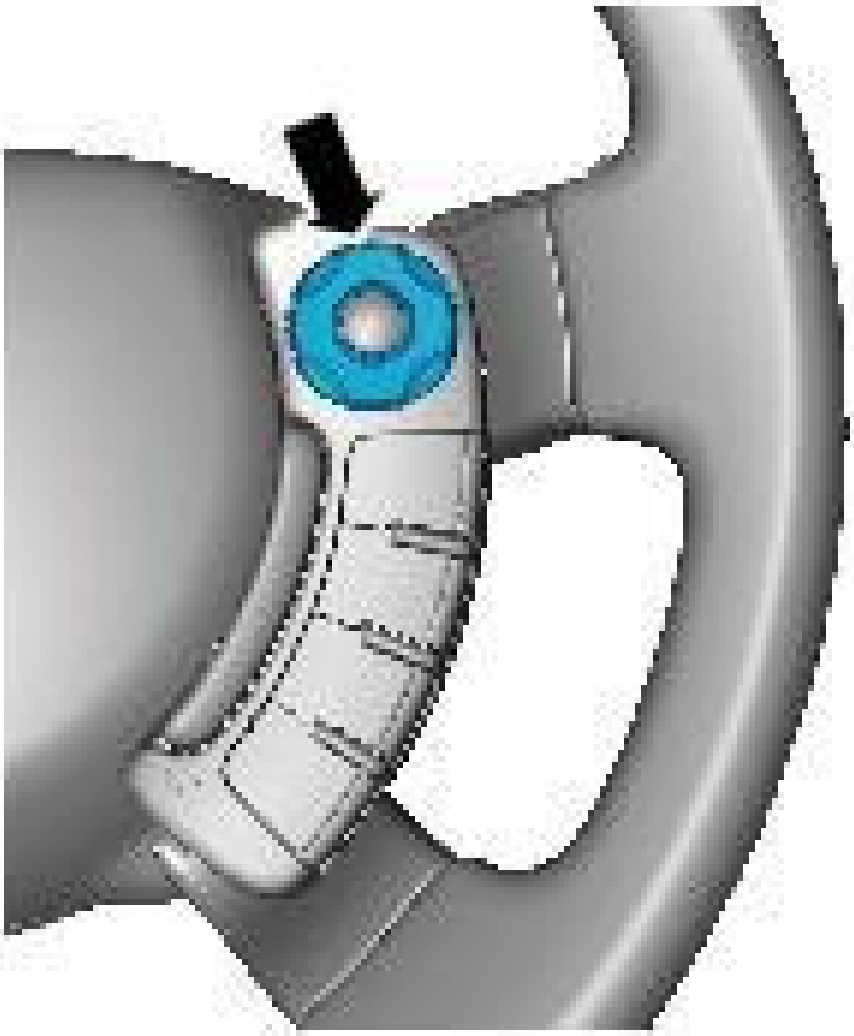

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- Press the right-hand directional button to access the Oil Level Display.

23. See figure

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- Press the right-hand OK button and follow the instructions.
- Make sure that the average oil level value has now been updated.

24. Refer to: **ENGINE COVER - REMOVAL AND INSTALLATION** .

FUEL PUMP CAMSHAFT TIMING CHECK

SPECIAL TOOL(S)

E115265	303-1447 Timing Tool
	JLR-303-1613 Alignment Tool, Fuel Pump Camshaft Timing

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CHECK

1. Disconnect the battery ground cable.

   Refer to: **Specifications**

2. Raise and support the vehicle.

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

3. Refer to: **ENGINE UNDERSHIELD - REMOVAL AND INSTALLATION** .
4. Refer to: **Radiator Splash Shield** .
5. See figure

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CAUTION: Be prepared to collect escaping oil.

NOTE: Discard the sealing washer.

NOTE: Collect the engine oil in a clean container.

6. See figure

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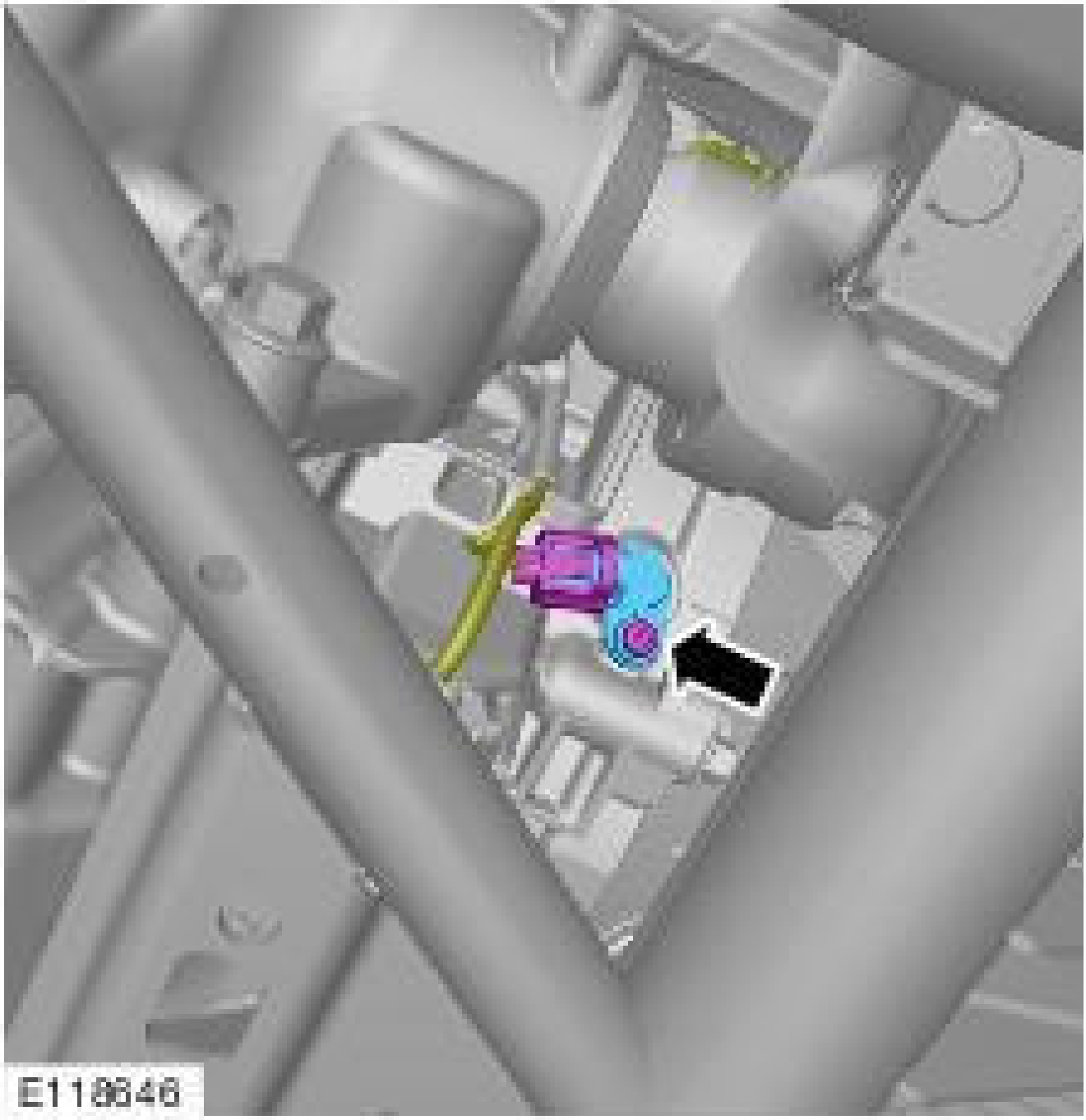

7. Install the Special Tool(s): 303-1447, refer to: **SPECIAL TOOL(S)**

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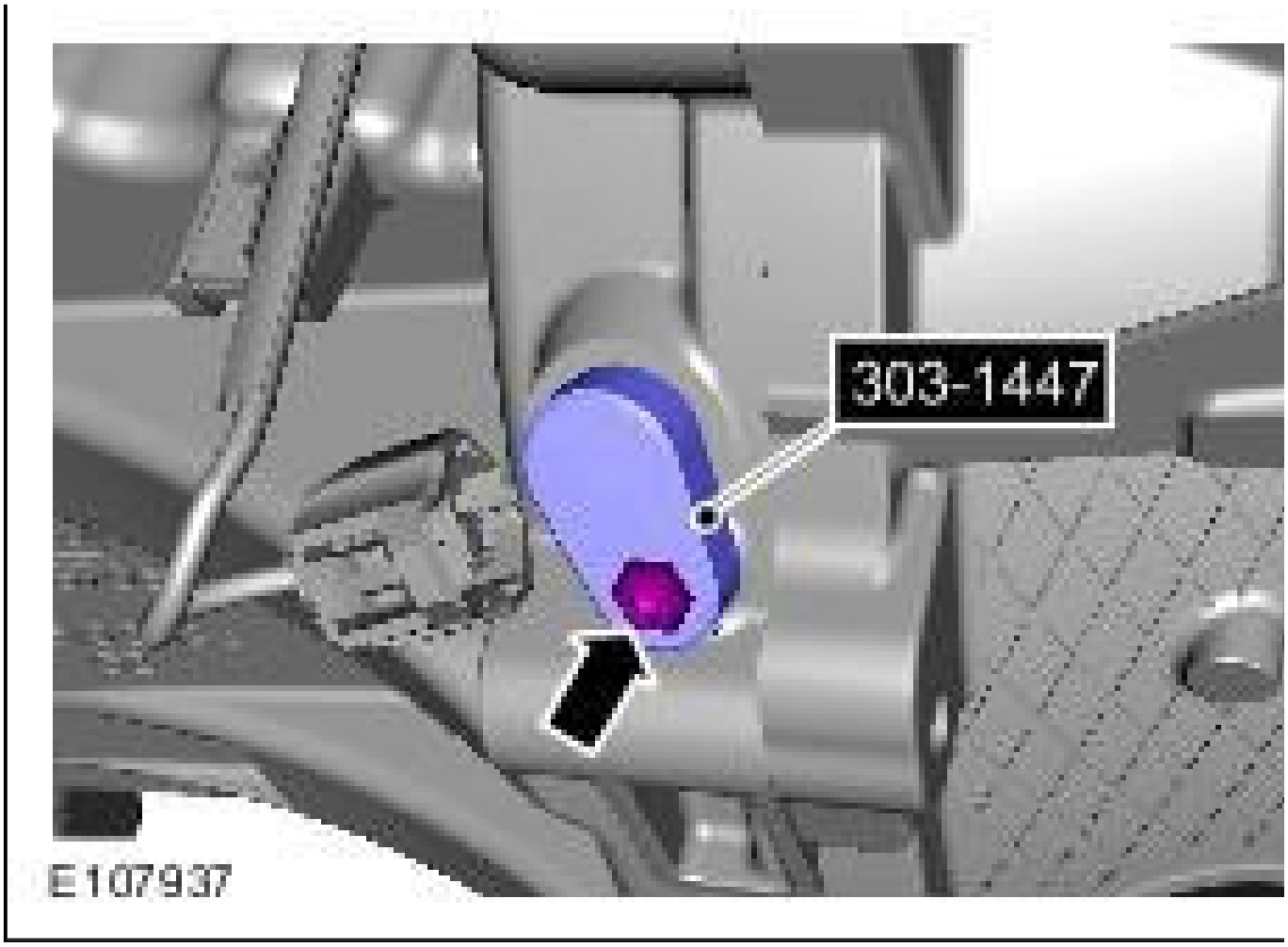

CAUTION: Only rotate the crankshaft clockwise.

CAUTION: Make sure that the crankshaft is fully locked.

8. Using a suitable marker, mark the position of the crankshaft pulley as illustrated.

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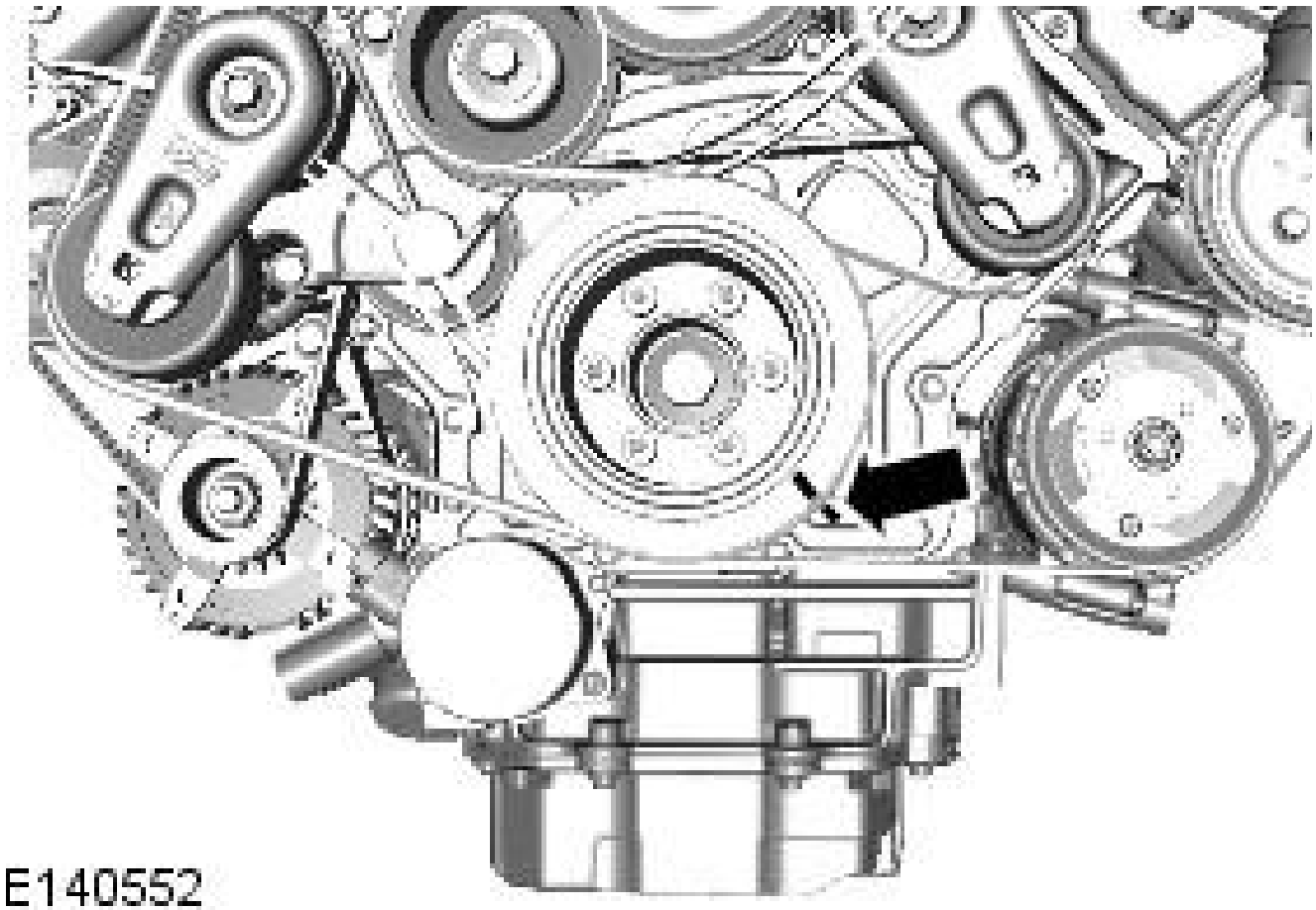

9. See figure

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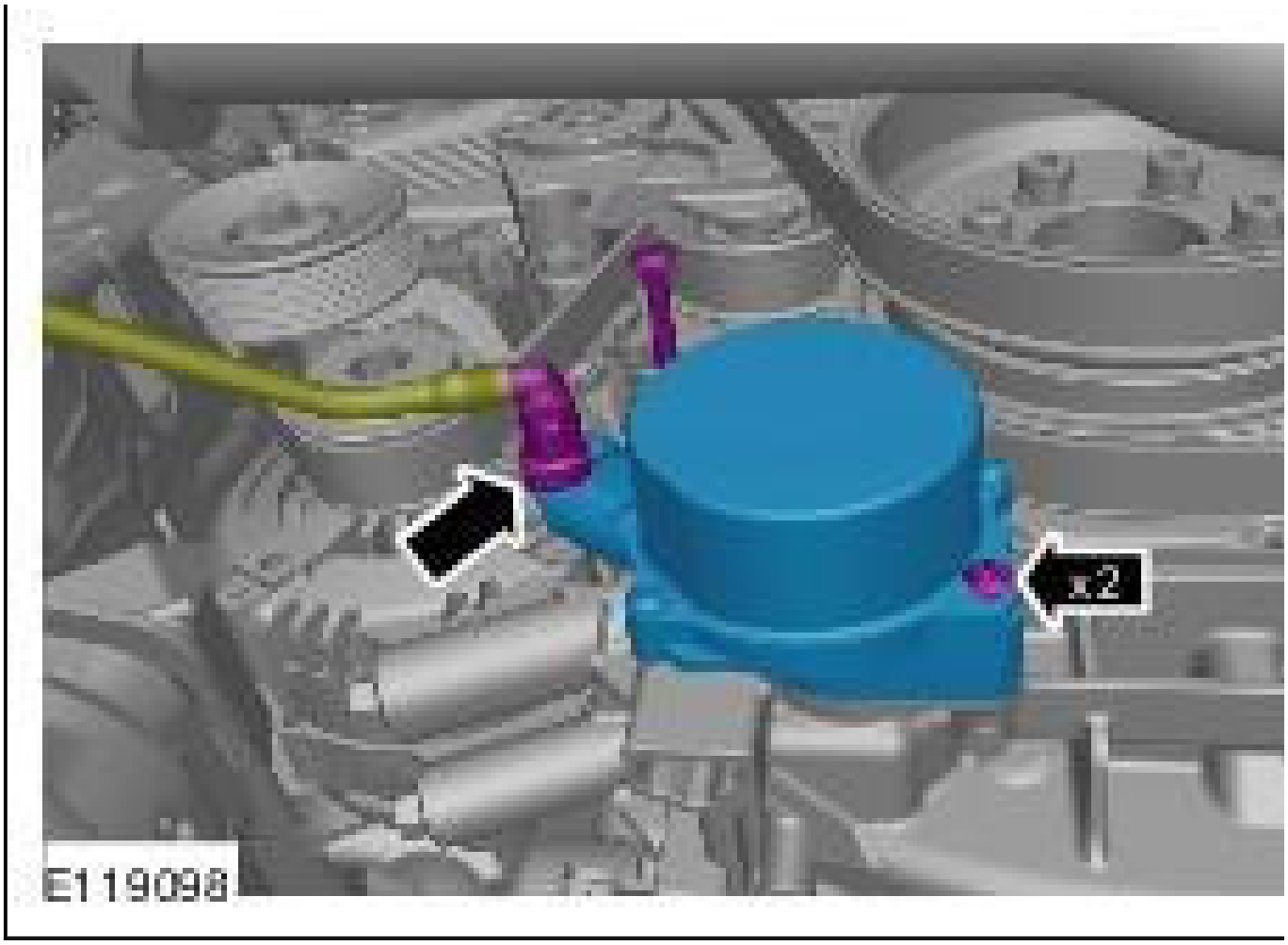

NOTE: Discard the seal.

10. Remove the Special Tool(s): 303-1447, refer to: **SPECIAL TOOL(S)**

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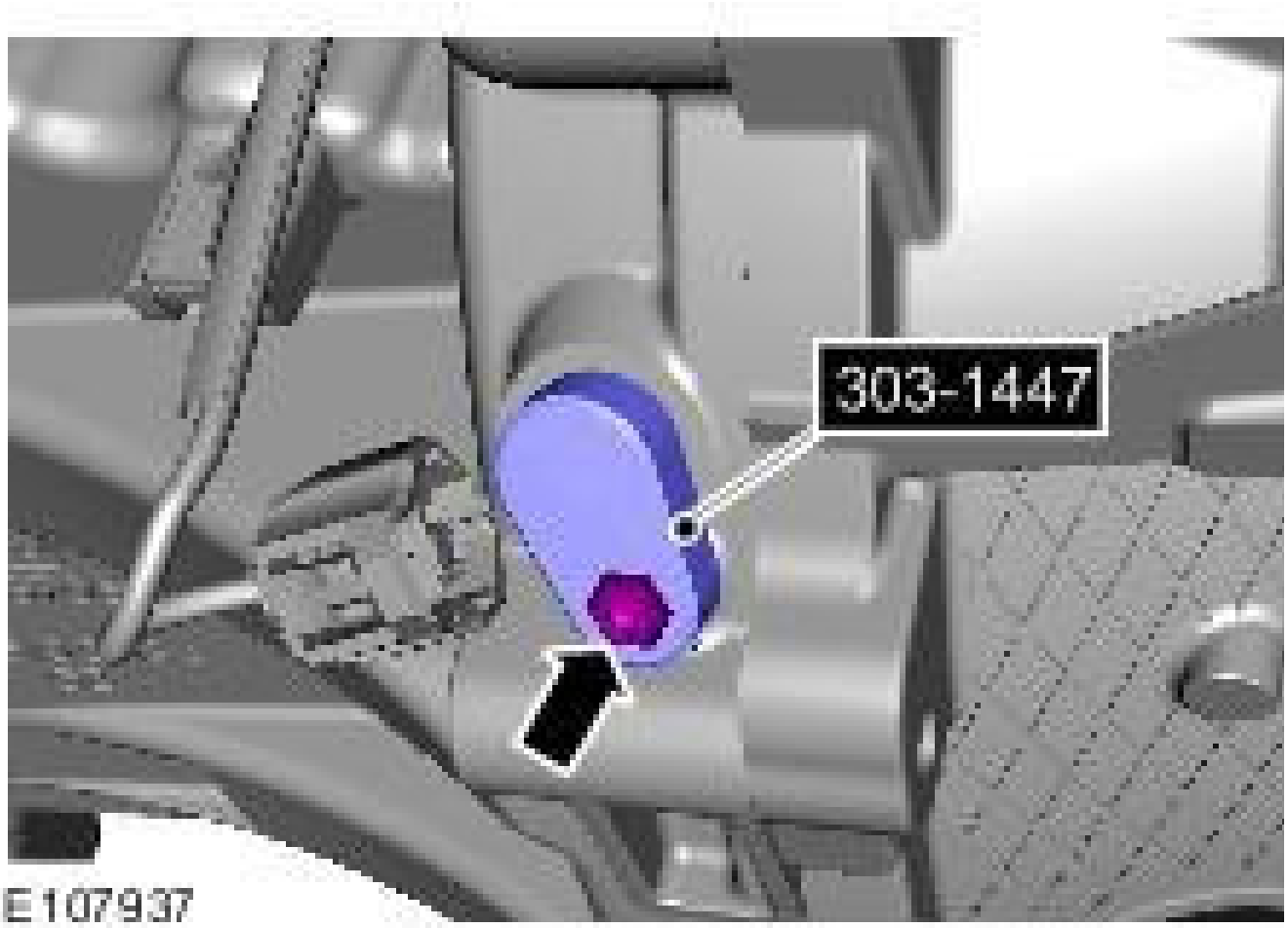

11. If required, carefully adjust the crankshaft position to allow correct installation of the special tool.

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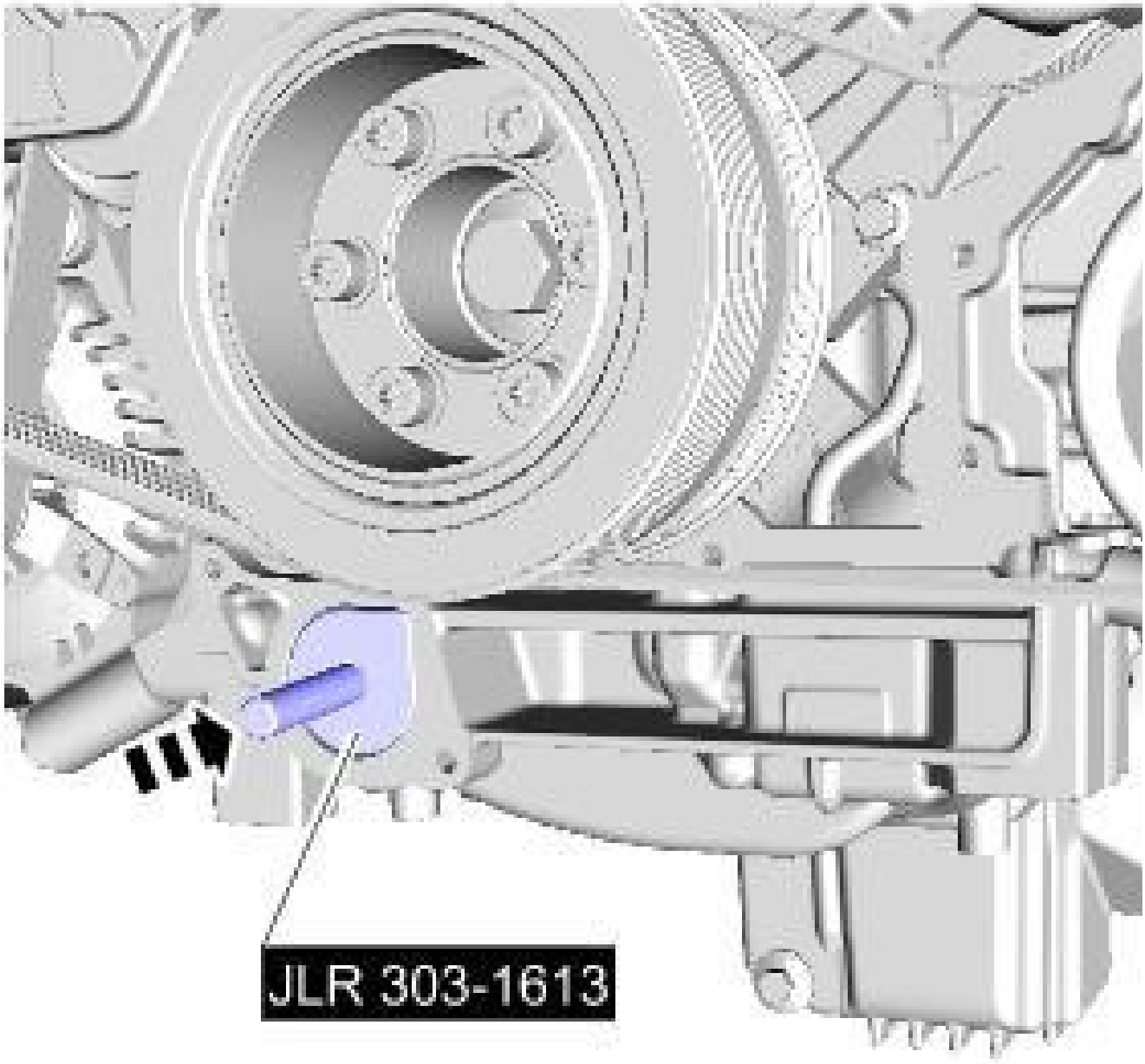

Install the Special Tool(s): JLR-303-1613, refer to: **SPECIAL TOOL(S)**

12. See figure

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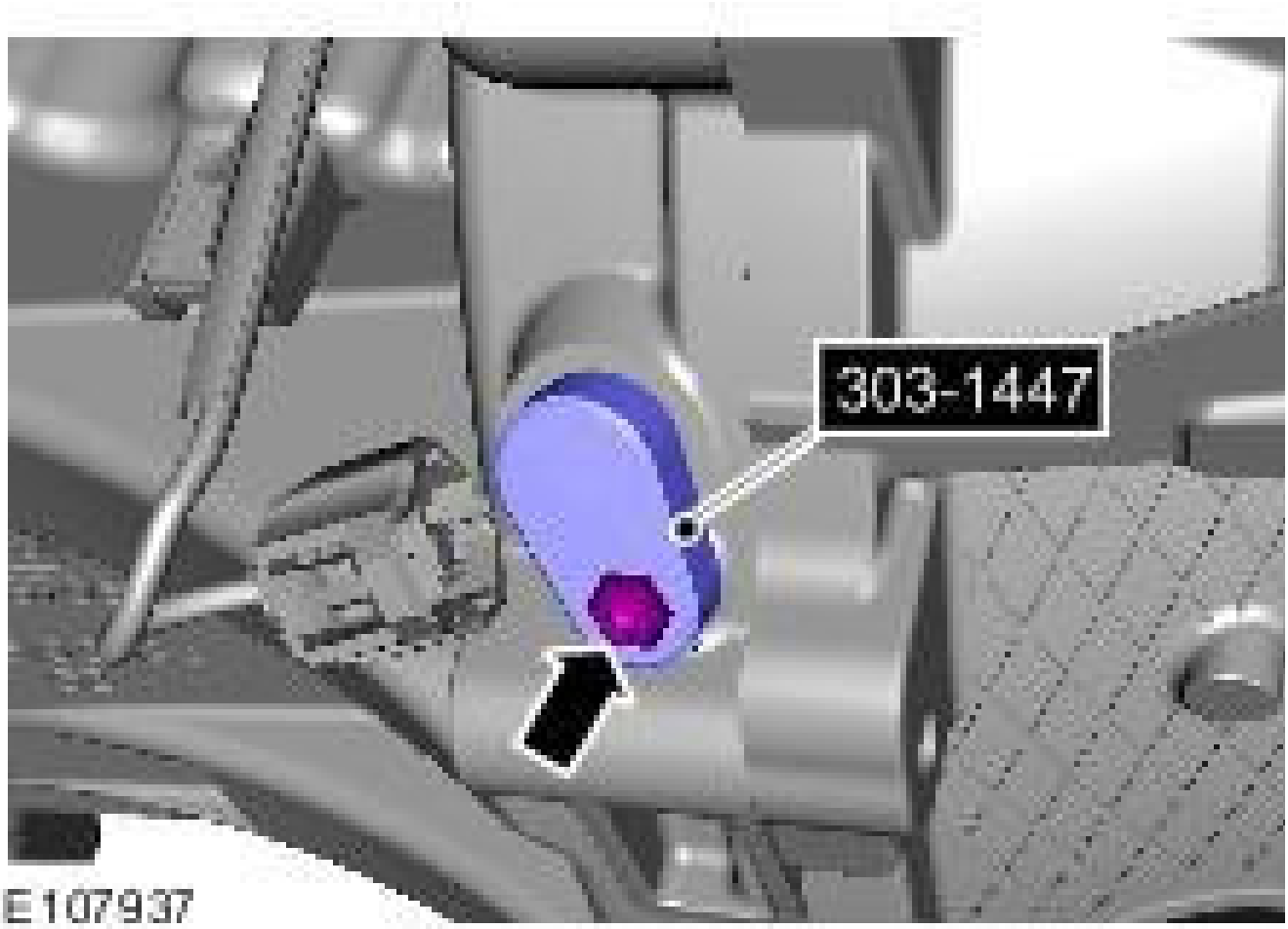

CAUTION: Do not use excessive force when adjusting the crankshaft position.

NOTE: If the crankshaft timing tool cannot be installed, adjustment of the fuel pump camshaft timing will be required.

- If required, carefully adjust the crankshaft position to allow correct installation of the special tool.

  Remove the Special Tool(s): 303-1447, refer to: **SPECIAL TOOL(S)**

- If the crankshaft timing tool cannot be installed, adjustment of the fuel pump camshaft timing will be required.

  Refer to: **FUEL PUMP CAMSHAFT TIMING ADJUSTMENT - GENERAL PROCEDURES**.

13. Remove the Special Tool(s): JLR-303-1613, refer to: **SPECIAL TOOL(S)**

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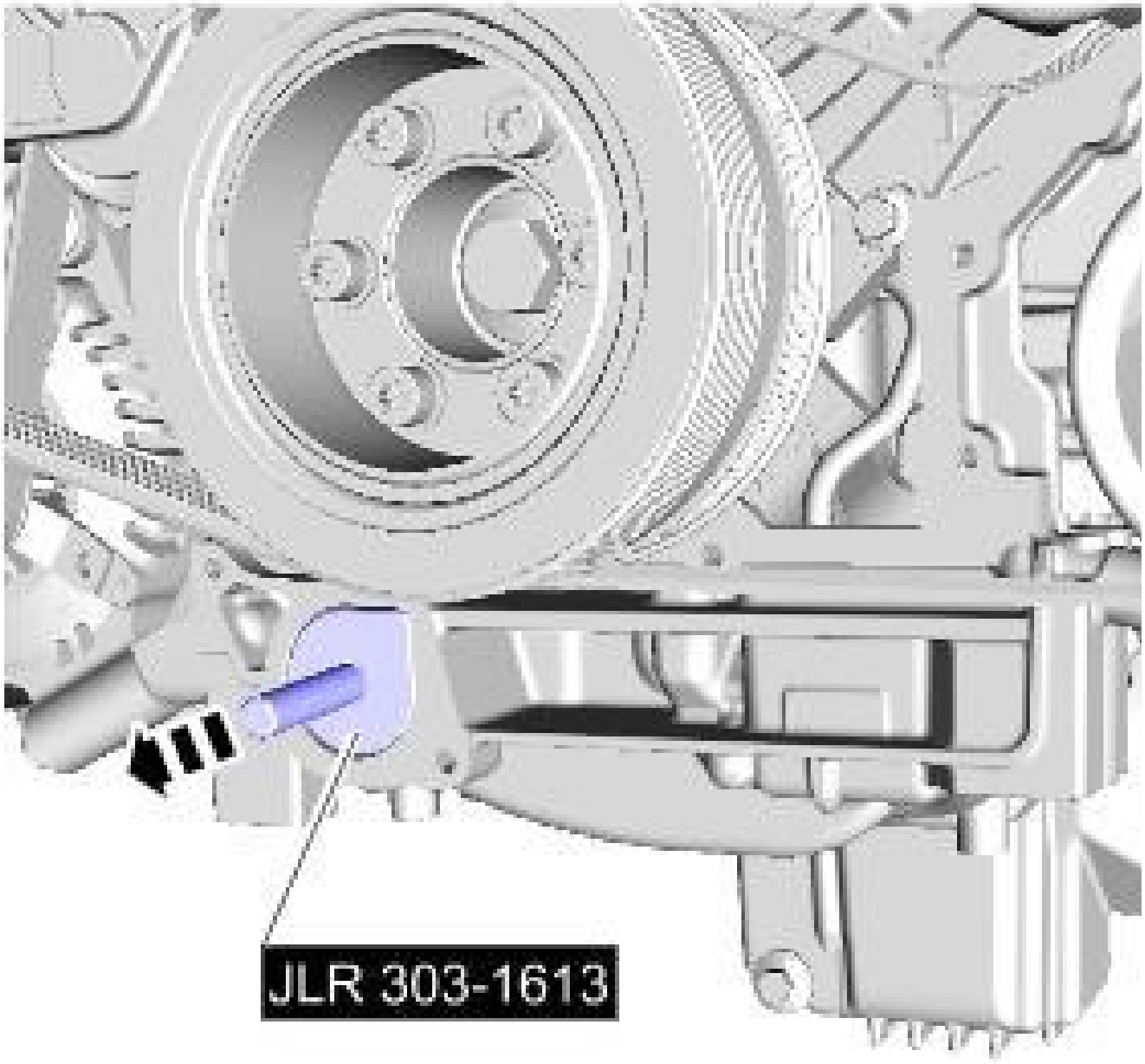

14. Torque: 12 Nm

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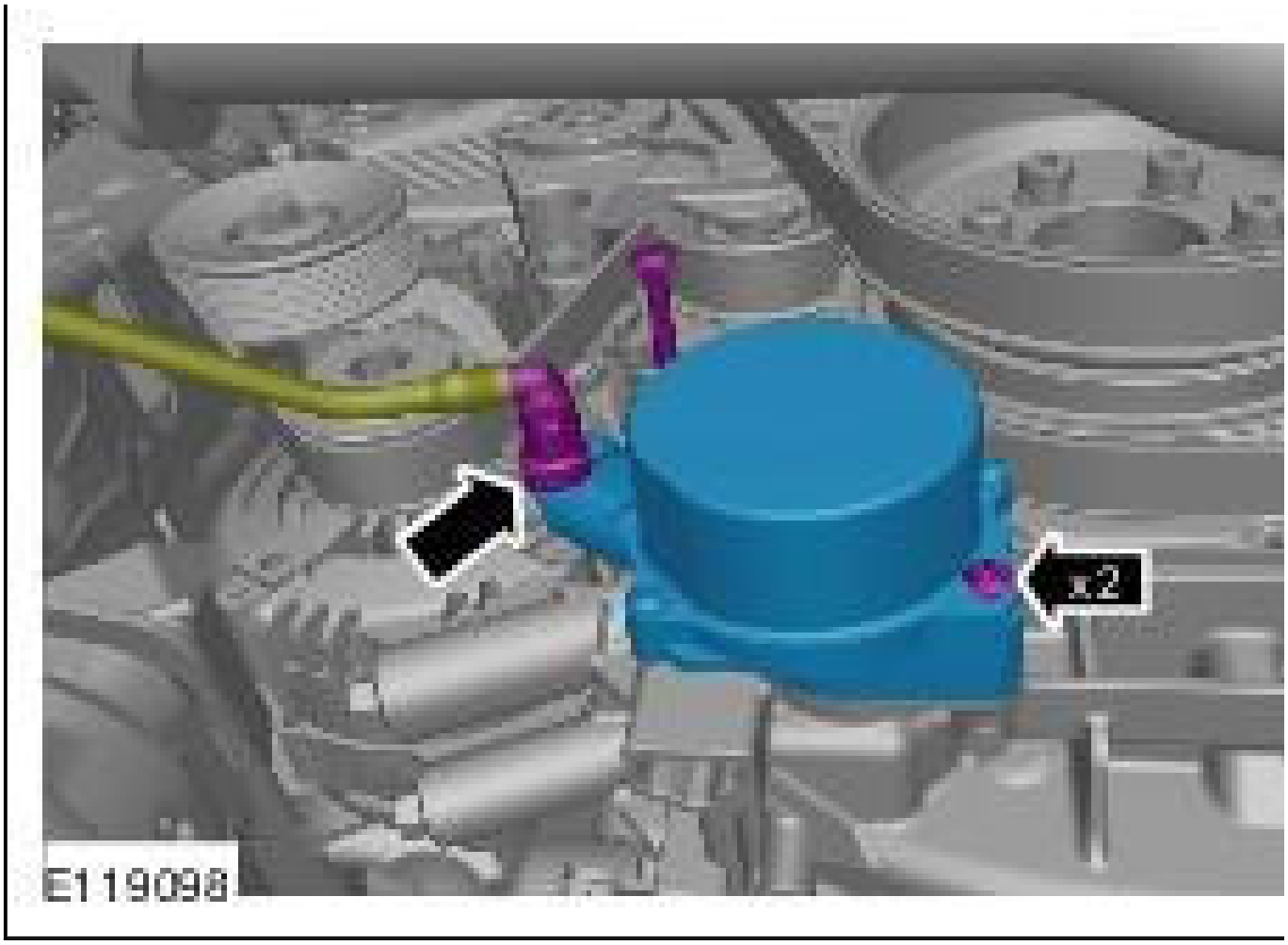

NOTE: Install a new seal.

15. See figure

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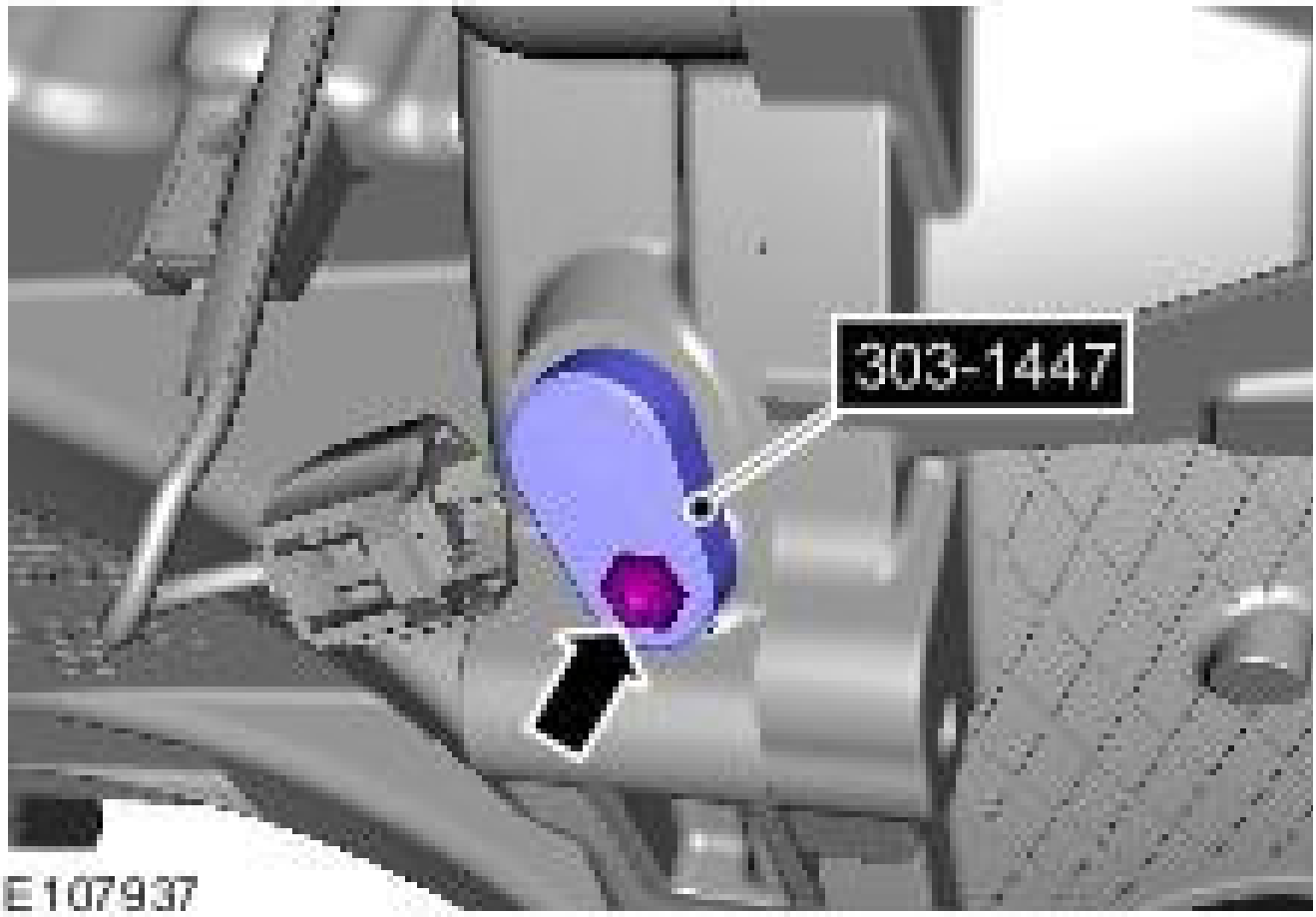

Remove the Special Tool(s): 303-1447, refer to: **SPECIAL TOOL(S)**

16. See figure

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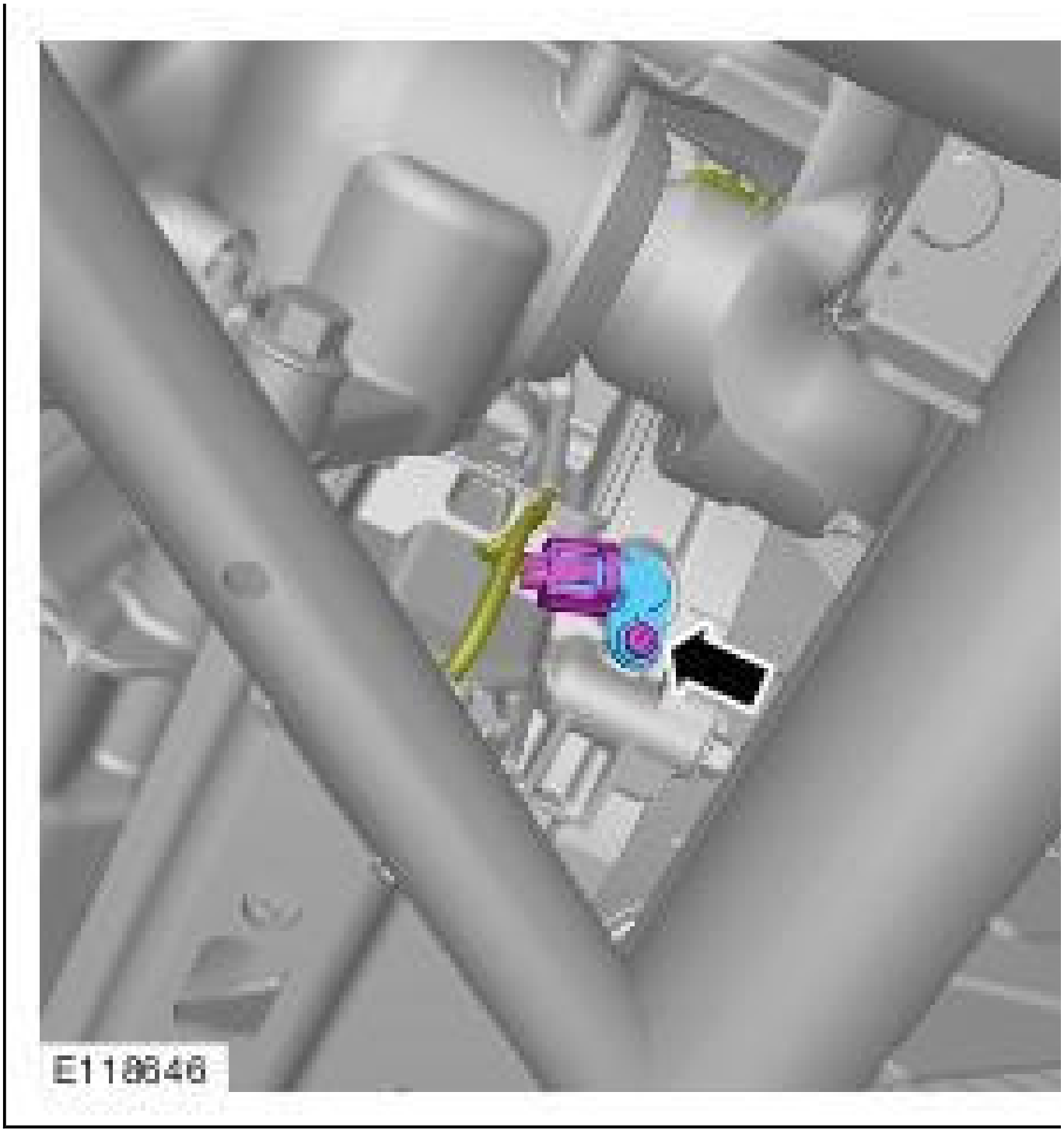

Torque: 10 Nm

17. Torque: 24 Nm

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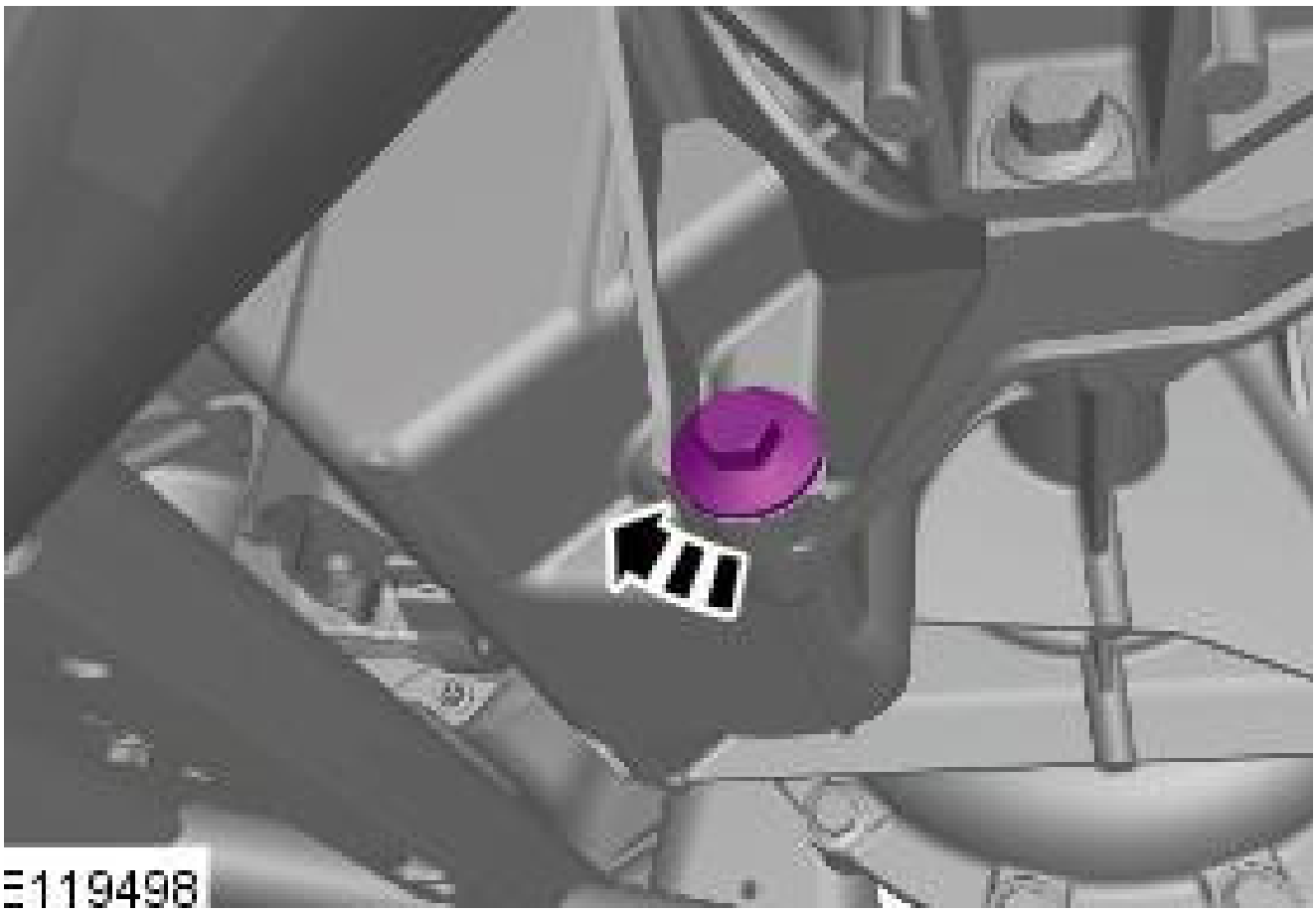

NOTE: Install a new sealing washer.

18. Connect the battery ground cable.

    Refer to: **SPECIFICATIONS** .

19. Engine oil, filling

    CAUTION: Make sure that the vehicle is left for 5 minutes from filling with oil and that the engine oil level is reading at least minimum (by following Steps 22-29), before starting the engine.

    - Fill the engine with oil - for filling values on vehicles without supercharger:

      Refer to: **ENGINE OIL DRAINING AND FILLING - GENERAL PROCEDURES**.

    - Fill the engine with oil - for filling values on vehicles with supercharger:

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Refer to: **ENGINE (V8 S/C 5.0L PETROL)** .

- Clean any residual engine oil from the oil filler cap area.

20. Follow the Steps 22-29 before starting the engine.

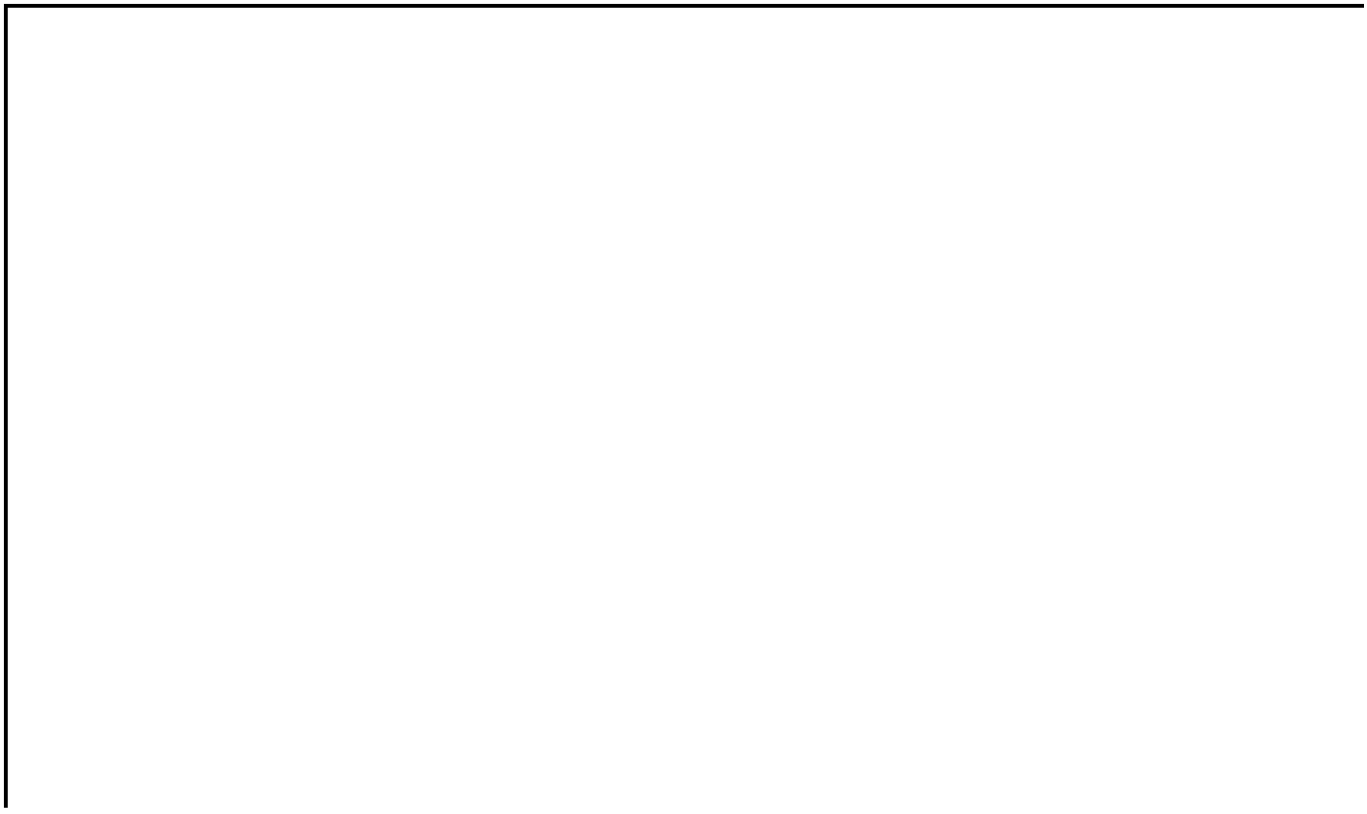
CAUTION: Make sure that the vehicle has been left for 5 minutes from filling with oil.

21. Leak check
    - Start the engine and allow to run for 10 minutes, stop the engine.
    - Check for leaks.
22. Engine on

CAUTION: Make sure that the selector lever and the gearshift mechanism are in the park (P) position.

CAUTION: Make sure that the hood is open.

    - Turn the ignition on.
23. See figure



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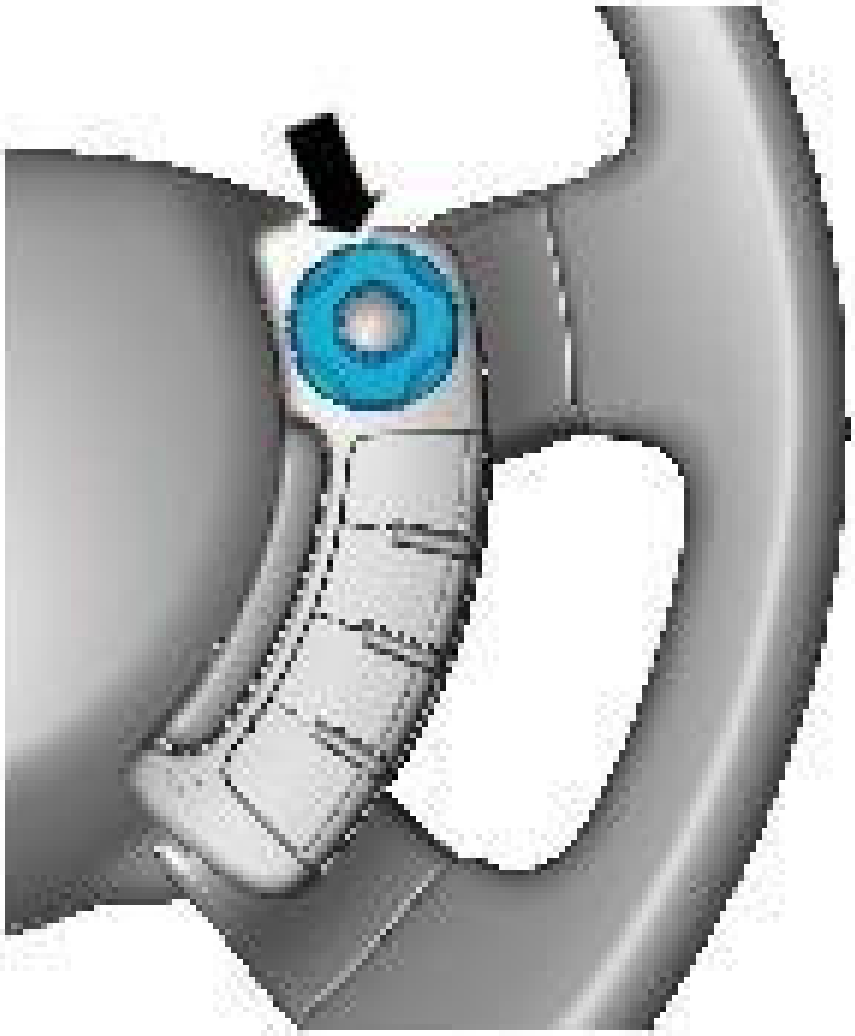

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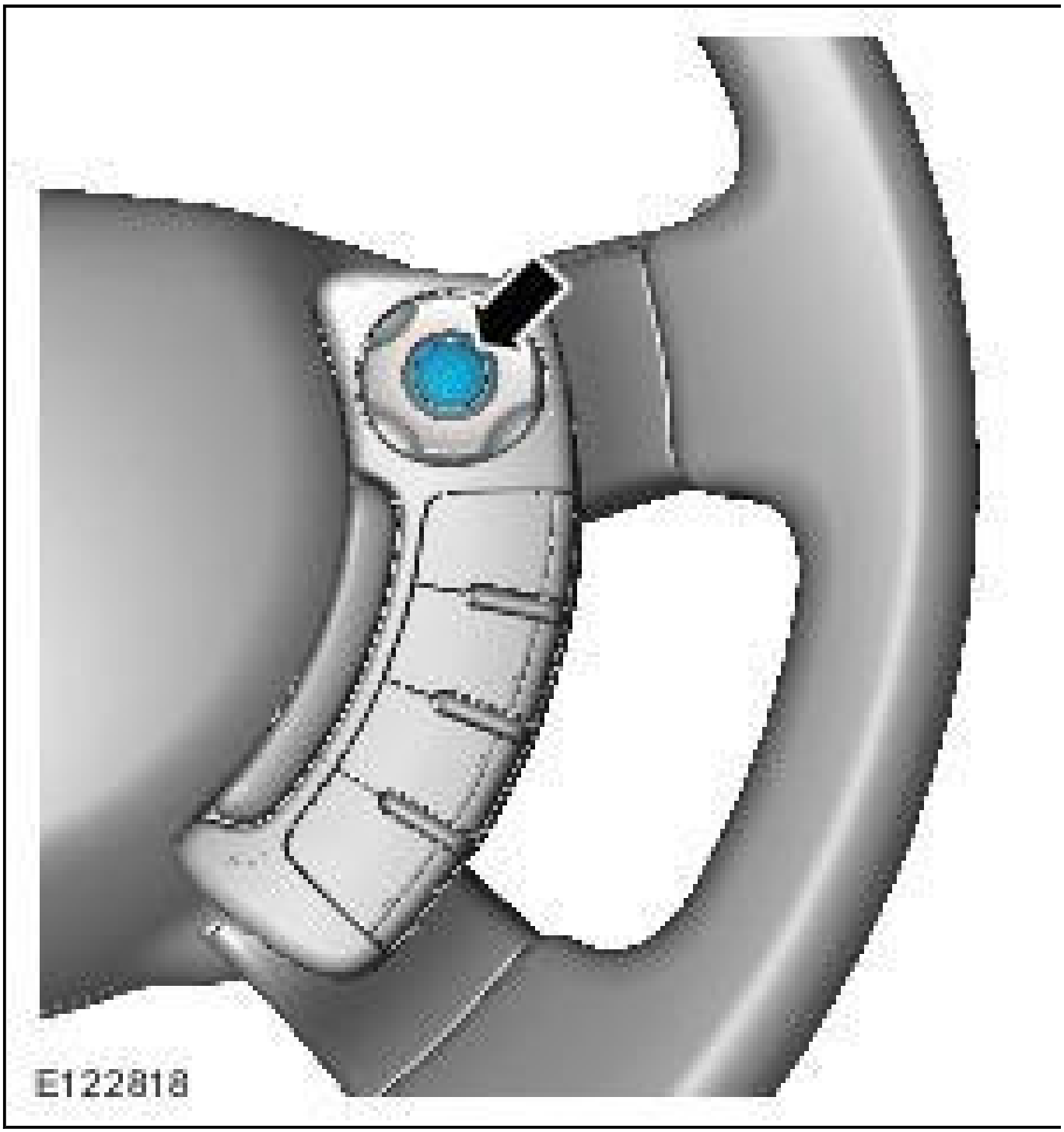
- Press the right-hand directional button to access the instrument cluster menu.

24. See figure



- Press the right-hand OK button.

25. See figure

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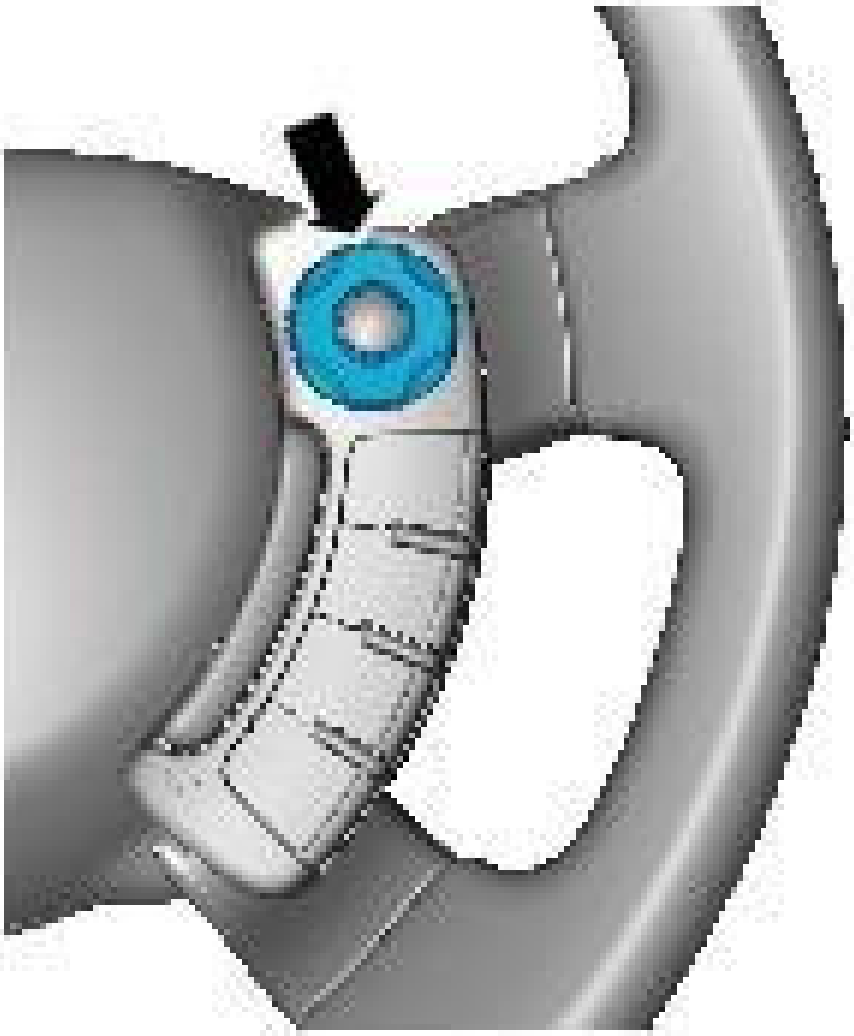

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- Press the right-hand directional button to access the Oil Level Display.

26. See figure

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- Press the right-hand OK button and follow the instructions.

27. See figure

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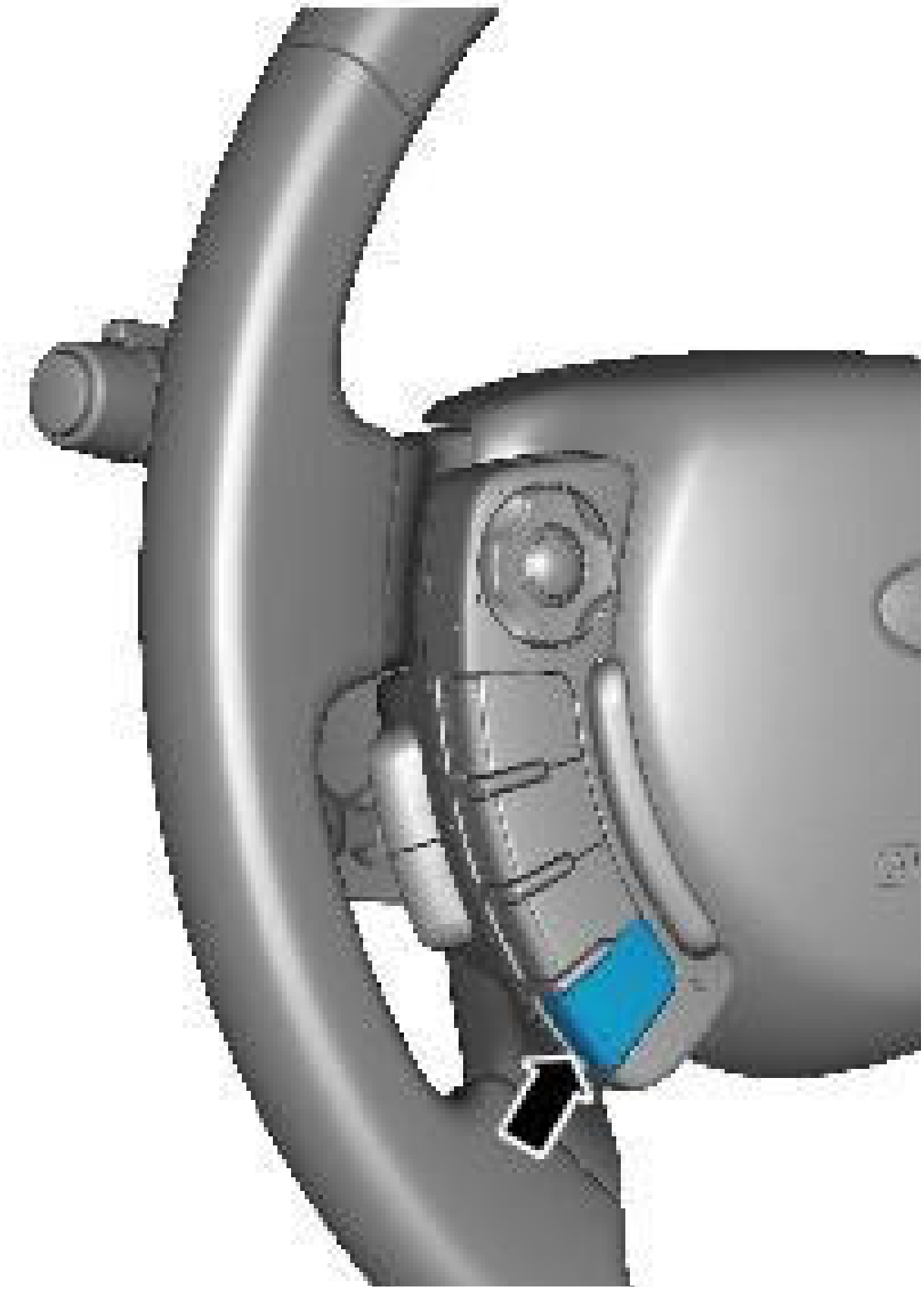

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- Press the cruise control cancel button twice within 2 seconds.

28. See figure

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- The message center display will revert to the normal display in the trip computer.
- Press the right-hand OK button and follow the instructions.
- Check that the oil level display shows an oil level reading.
- Only after having started and run the engine for 10 minutes (as indicated in Step 21), switch off the engine, then stabilizing for 10 minutes, take a reading from the oil level display and, if necessary top up with engine oil.

29. Turn the ignition off.

NOTE: If instructed to follow Steps 22-29 in a previous step, return to Step 21 and continue the procedure.

30. Allow 10 minutes for the engine oil level to stabilize if there has been additional oil top up.
31. See figure

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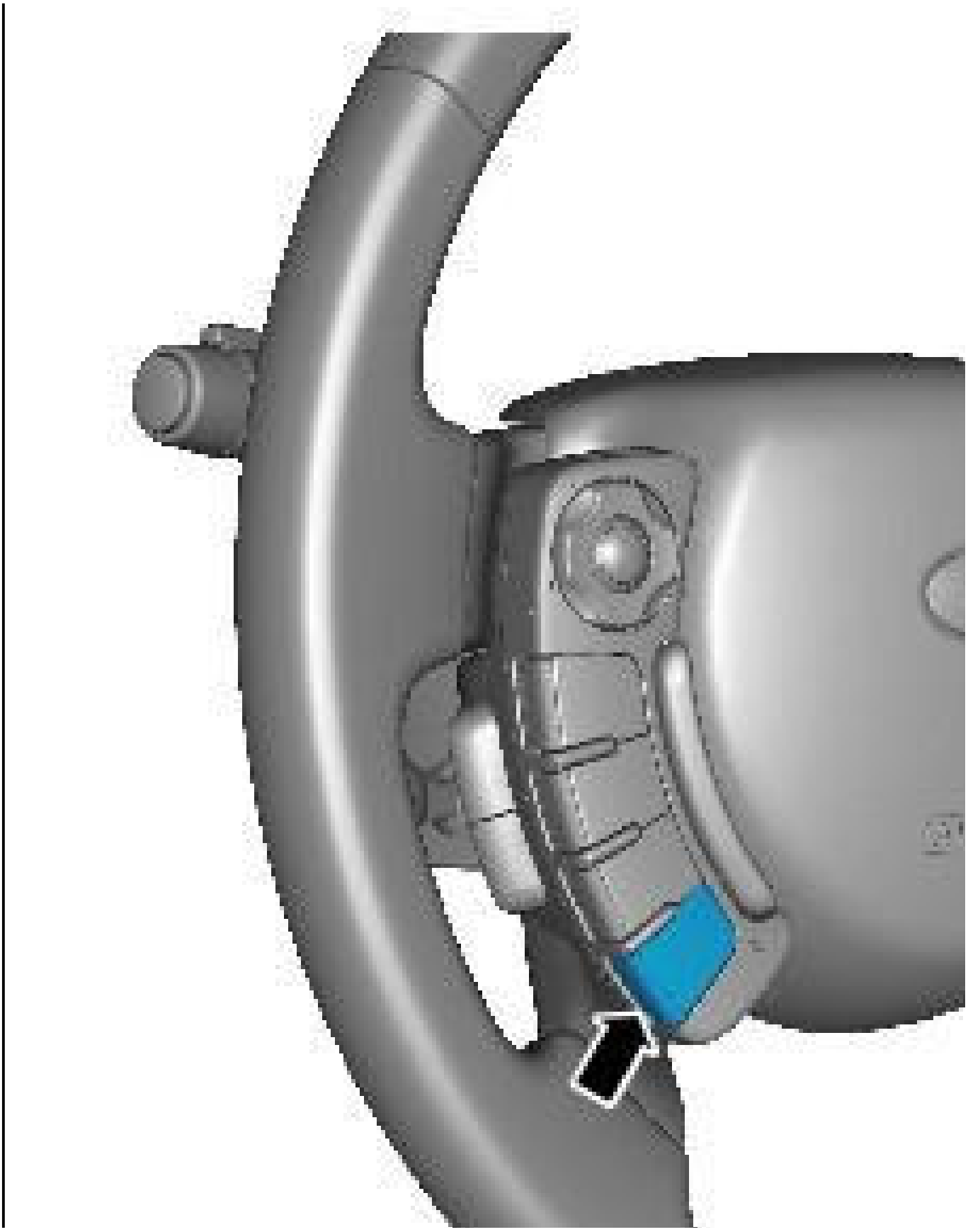

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NOTE: The following steps are to update the average oil level value.

- Turn the ignition on.
- Press and hold the cruise control cancel button for more than 2 seconds.

32. Message display
    - The message center display will revert to the normal display in the trip computer.
33. Turn the ignition off.
34. Turn the ignition on.
35. See figure

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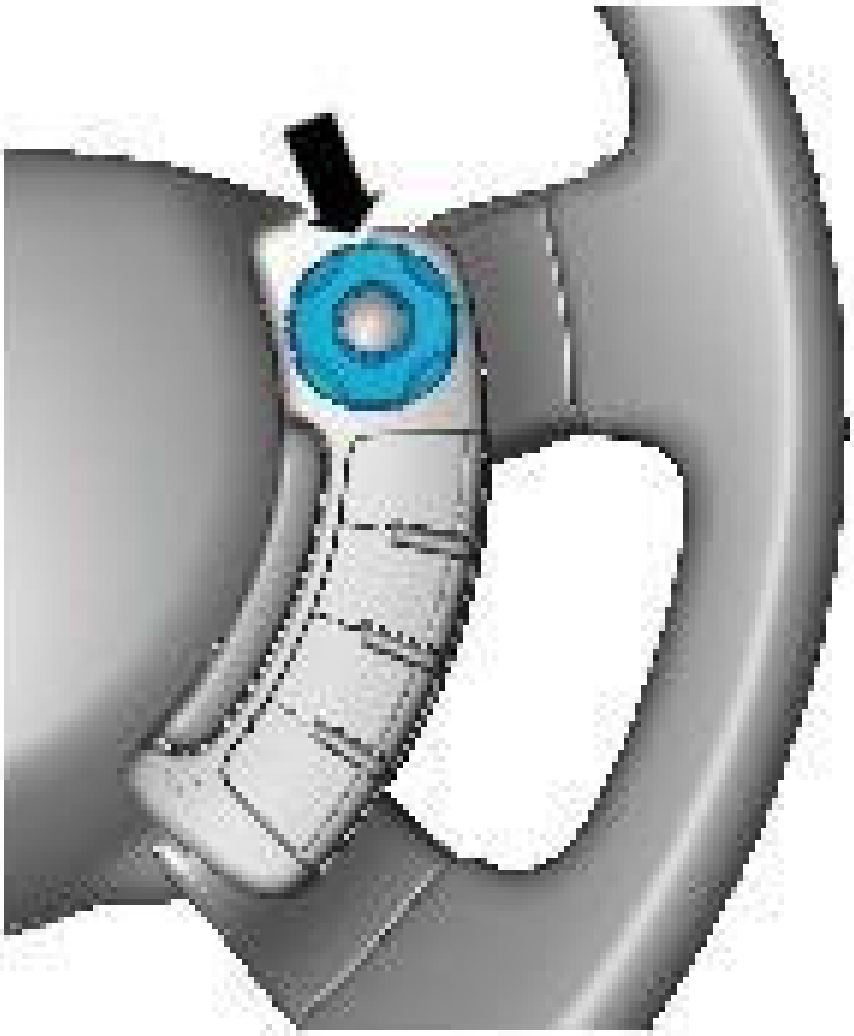

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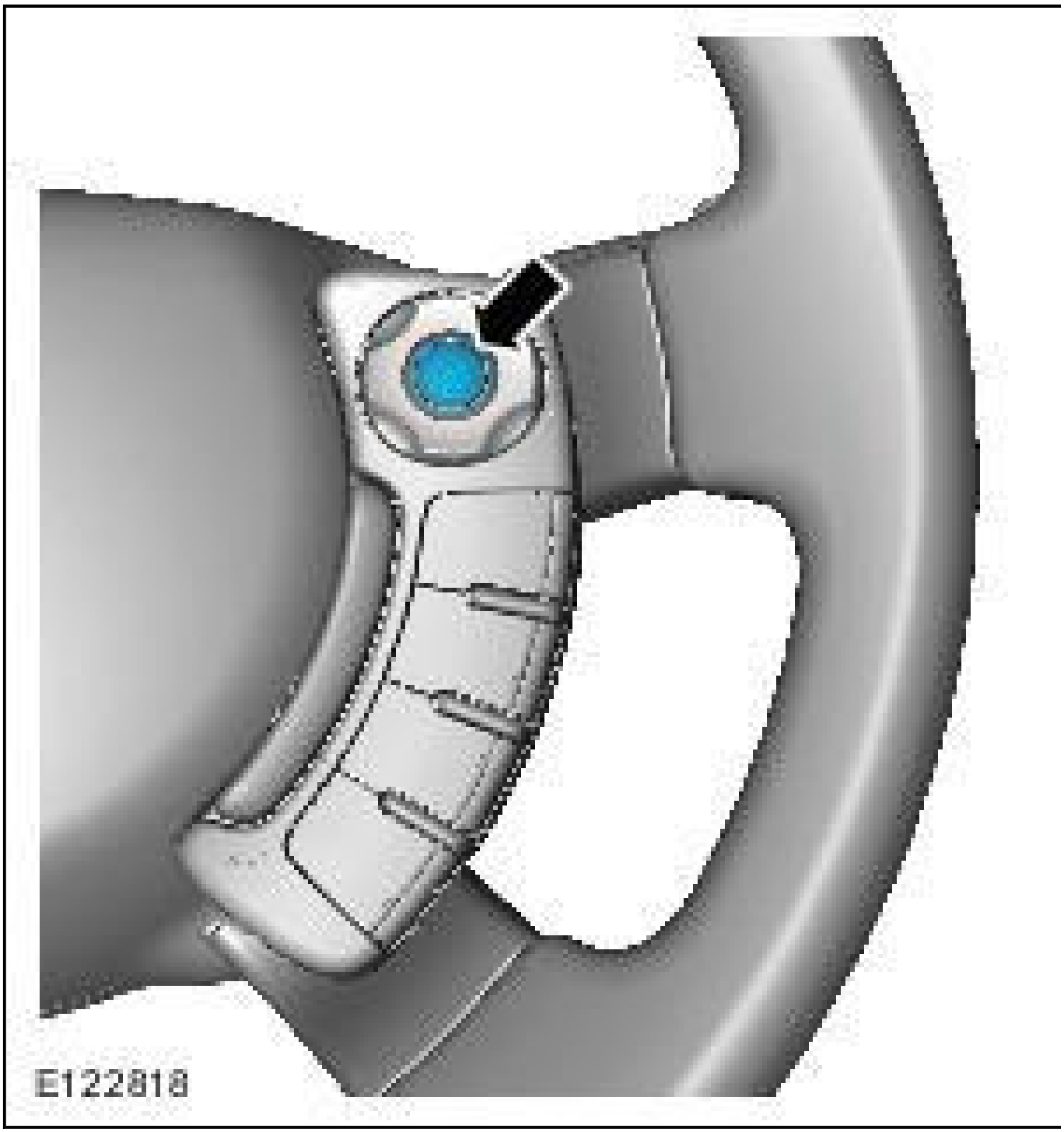
- Press the right-hand directional button to access the instrument cluster menu.

36. See figure



- Press the right-hand OK button.

37. See figure

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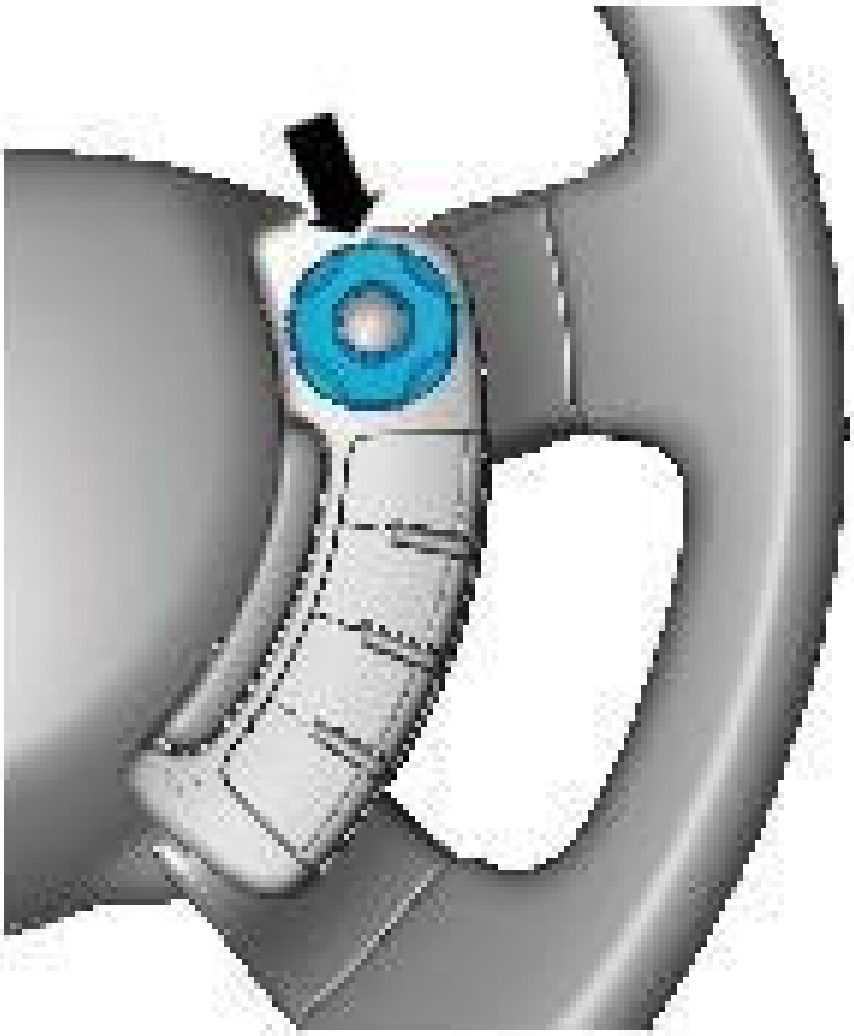

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- Press the right-hand directional button to access the Oil Level Display.

38. See figure

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- Press the right-hand OK button and follow the instructions.
- Make sure that the average oil level value has now been updated.

39. Refer to: **ENGINE UNDERSHIELD - REMOVAL AND INSTALLATION** .
40. Refer to: **FENDER SPLASH SHIELD - REMOVAL AND INSTALLATION** .

FUEL PUMP CAMSHAFT TIMING ADJUSTMENT

SPECIAL TOOL(S)

	303-1447 Timing Tool
	JLR-303-1613 Alignment Tool, Fuel Pump Camshaft Timing

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ADJUSTMENT

1. Disconnect the battery ground cable.

   Refer to: **Specifications**

2. Raise and support the vehicle.

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

3. Refer to: **FUEL PUMP CAMSHAFT TIMING CHECK - GENERAL PROCEDURES**.
4. Refer to: **LOWER TIMING COVER (V8 5.0L PETROL) - REMOVAL AND INSTALLATION**.

   Refer to: **LOWER TIMING COVER (V8 S/C 5.0L PETROL) - REMOVAL AND INSTALLATION** .

5. See figure

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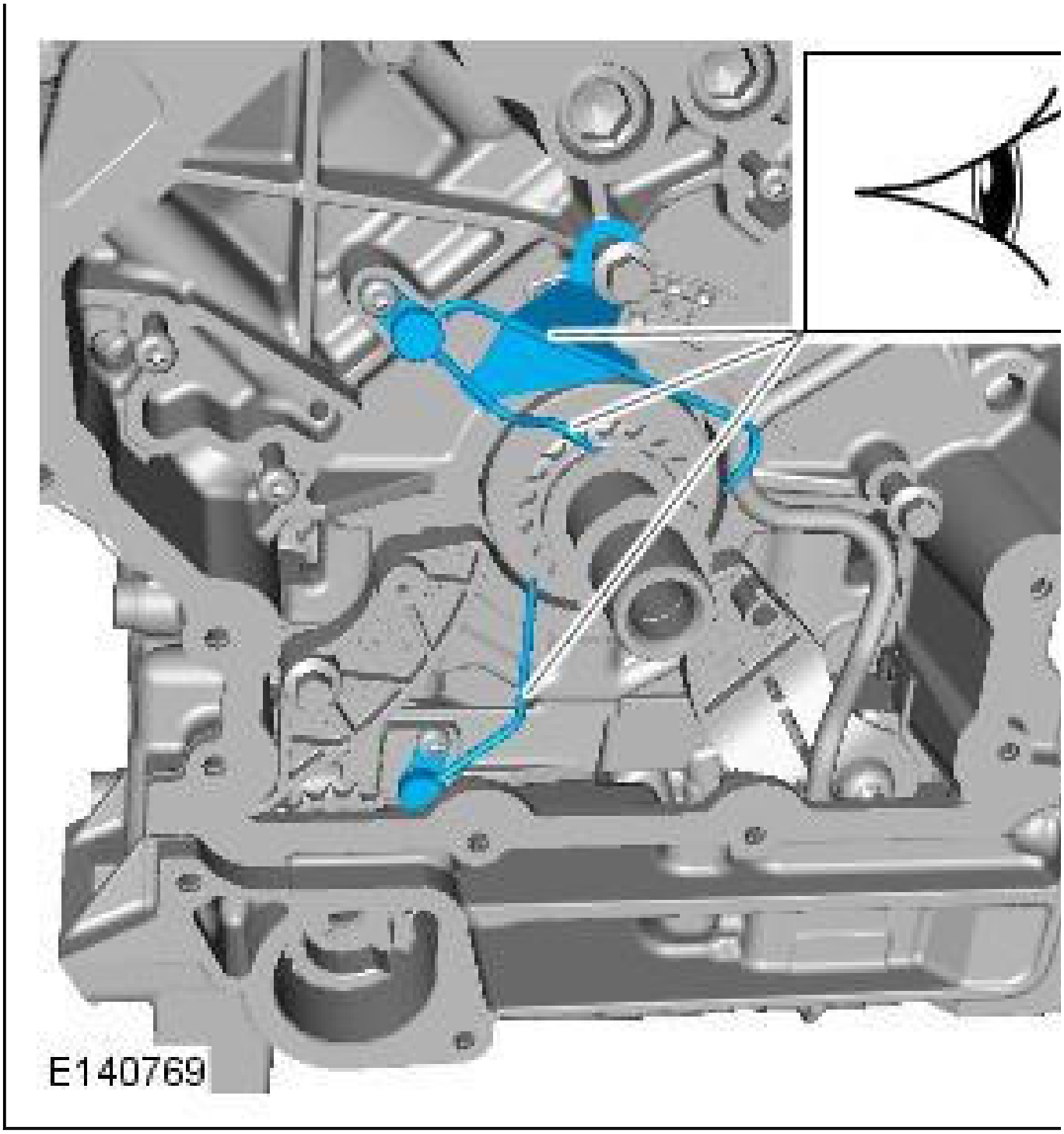

CAUTION: Make sure that the area around the component is clean and free of foreign material.

CAUTION: Inspect the 3 timing chain oil nozzles for signs of damage, install as necessary.

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6. Install the Special Tool(s): 303-1447, refer to: **SPECIAL TOOL(S)**

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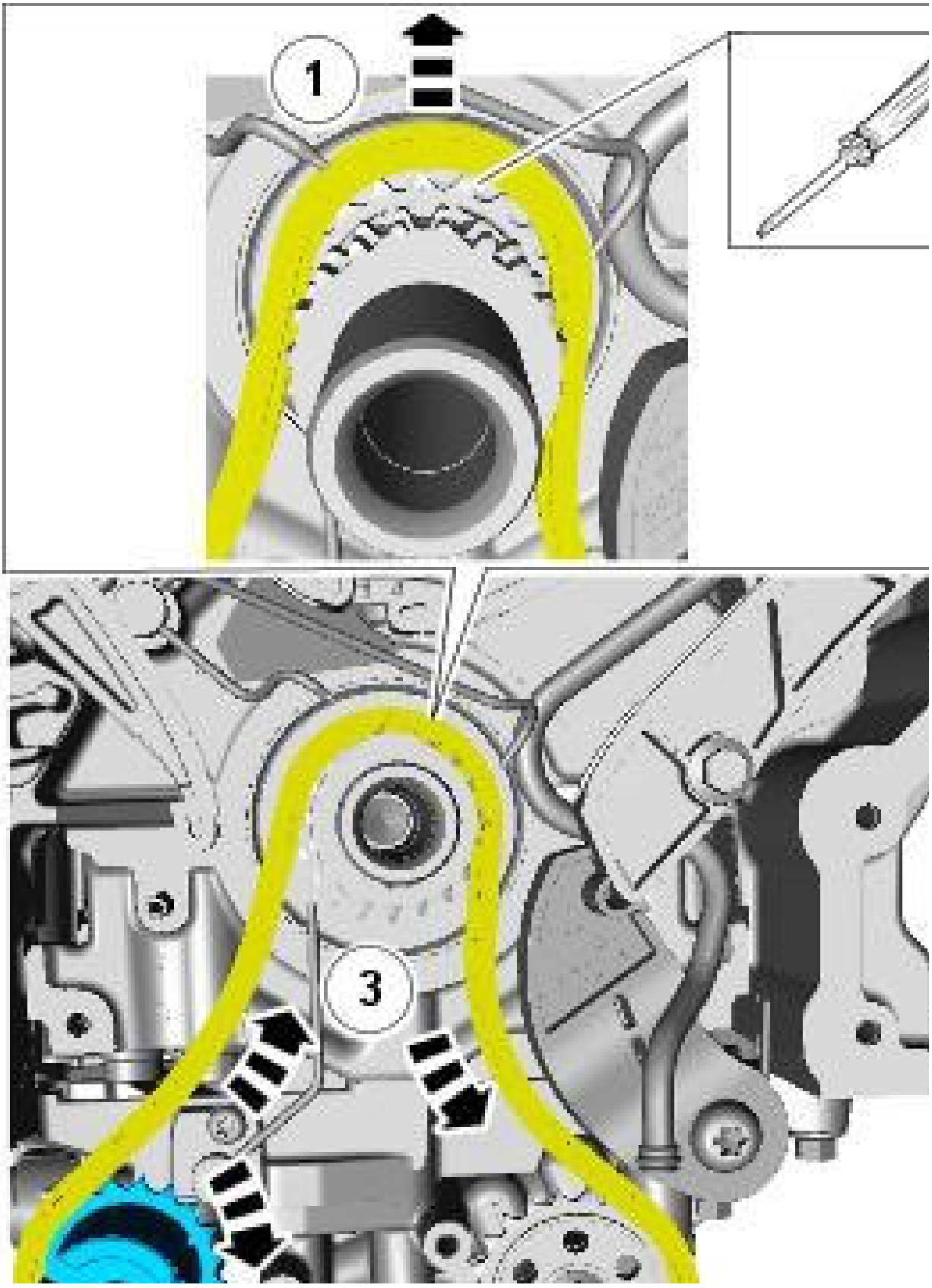

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CAUTION: Only rotate the crankshaft clockwise.

CAUTION: Make sure that the crankshaft is fully locked.

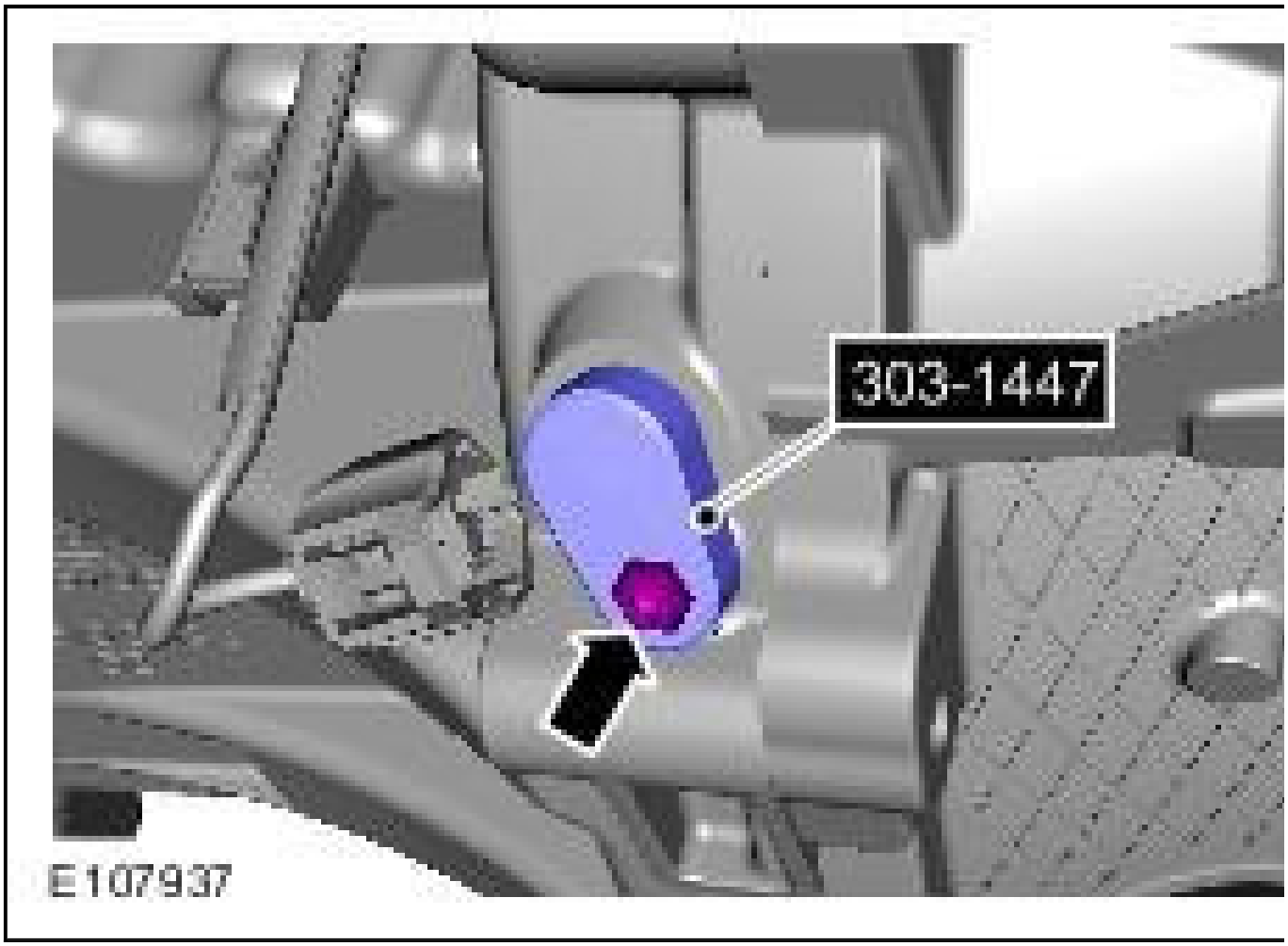
Torque: 12 Nm

7. See figure

   Refer to: **LOWER TIMING COVER (V8 5.0L PETROL) - REMOVAL AND INSTALLATION**.

   Refer to: **LOWER TIMING COVER (V8 S/C 5.0L PETROL) - REMOVAL AND INSTALLATION** .

8. Remove the Special Tool(s): 303-1447, refer to **SPECIAL TOOL(S)**.



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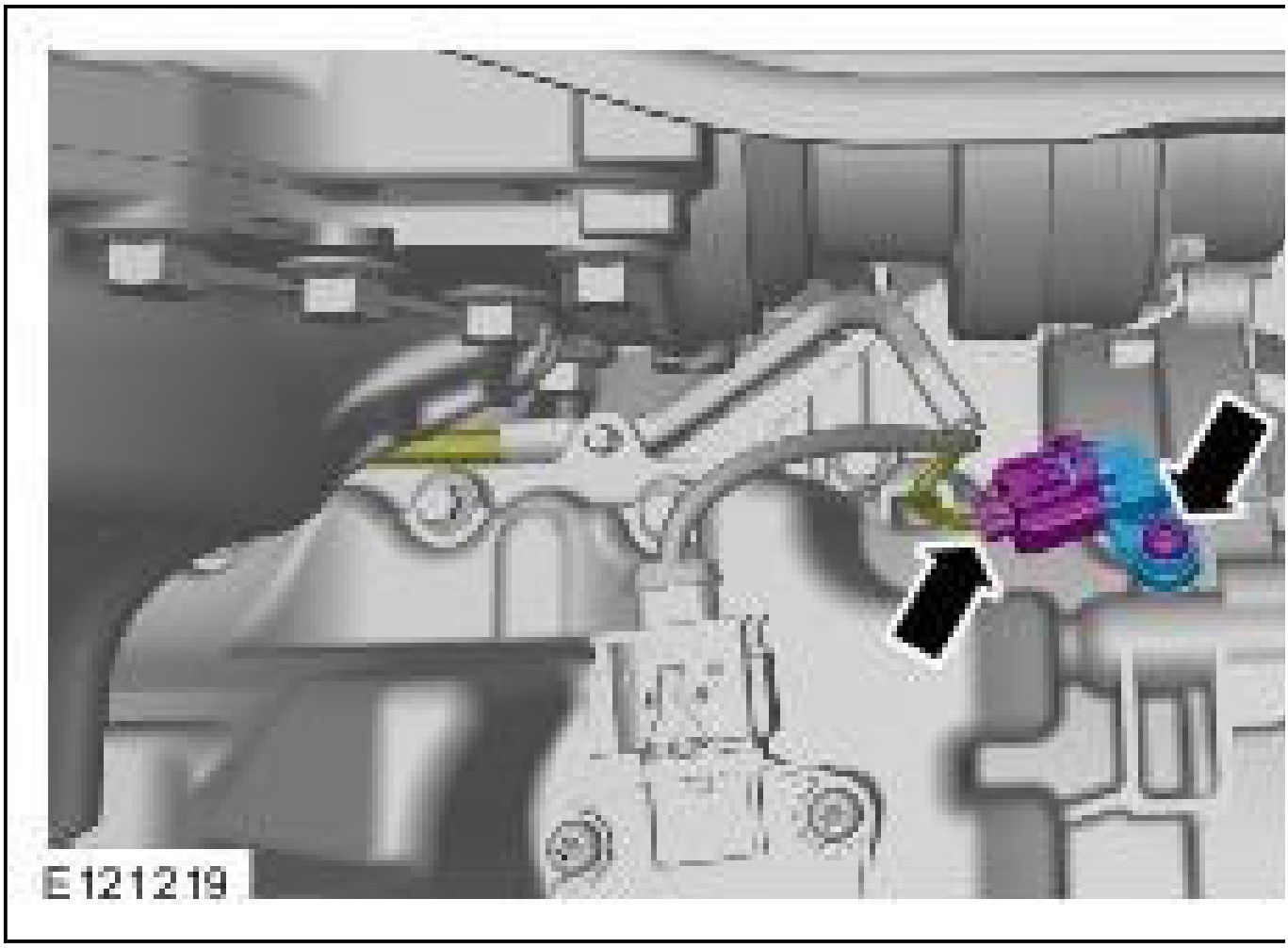
9. Torque: 10 Nm



10. Torque: 24 Nm

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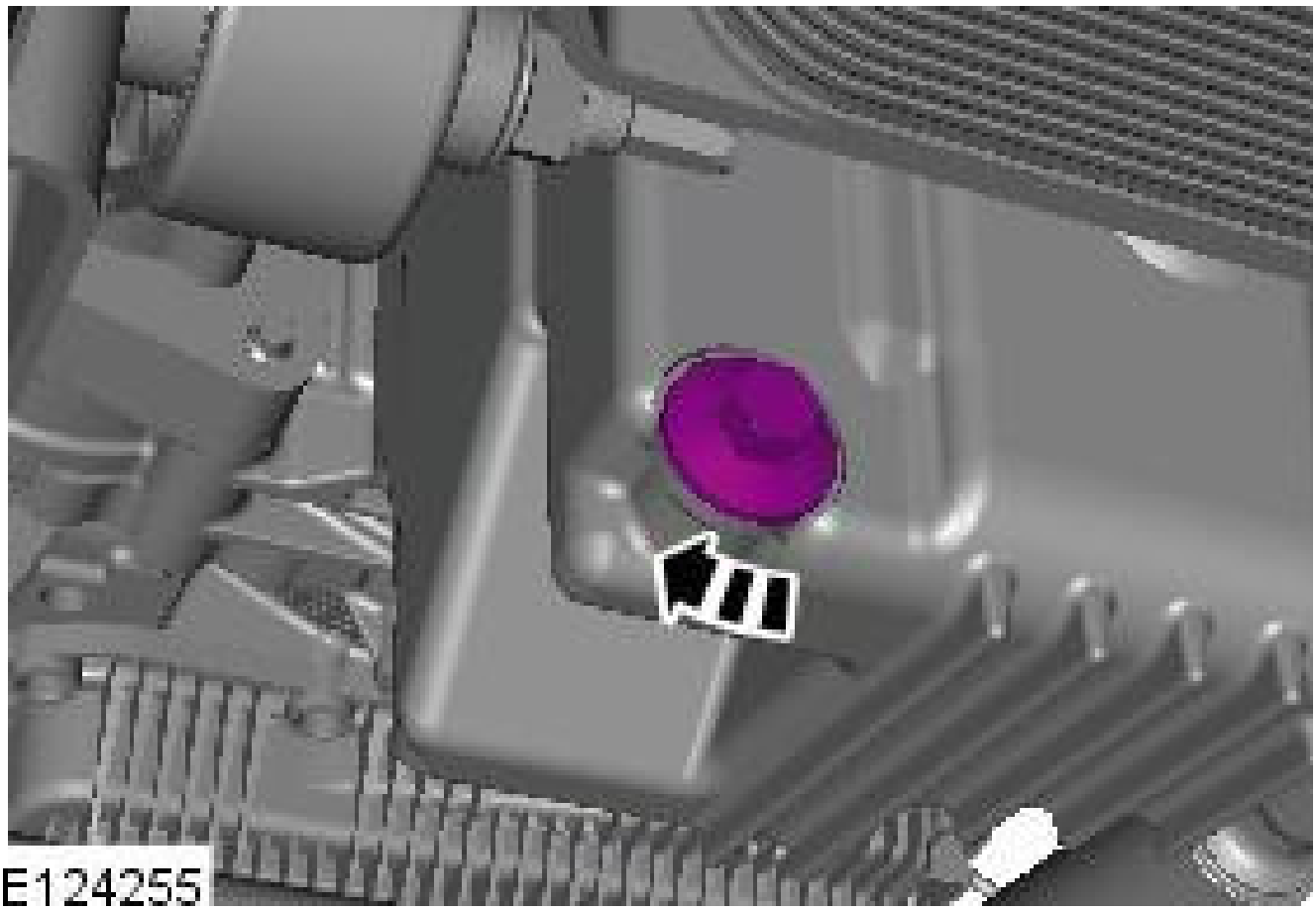

NOTE: Install a new sealing washer.

11. Connect the battery ground cable.

    Refer to: **Specifications** .

12. Engine oil, filling

    CAUTION: CAUTION: Make sure that the vehicle is left for 5 minutes from filling with oil and that the engine oil level is reading at least minimum (by following Steps 15-22), before starting the engine.

    - Fill the engine with oil - for filling values on vehicles without supercharger:

      Refer to: **ENGINE OIL DRAINING AND FILLING - GENERAL PROCEDURES**.

    - Fill the engine with oil - for filling values on vehicles with supercharger:

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Refer to: **ENGINE (V8 S/C 5.0L PETROL)** .

- Clean any residual engine oil from the oil filler cap area.

13. Follow the Steps 15-22 before starting the engine.

CAUTION: Make sure that the vehicle has been left for 5 minutes from filling with oil.

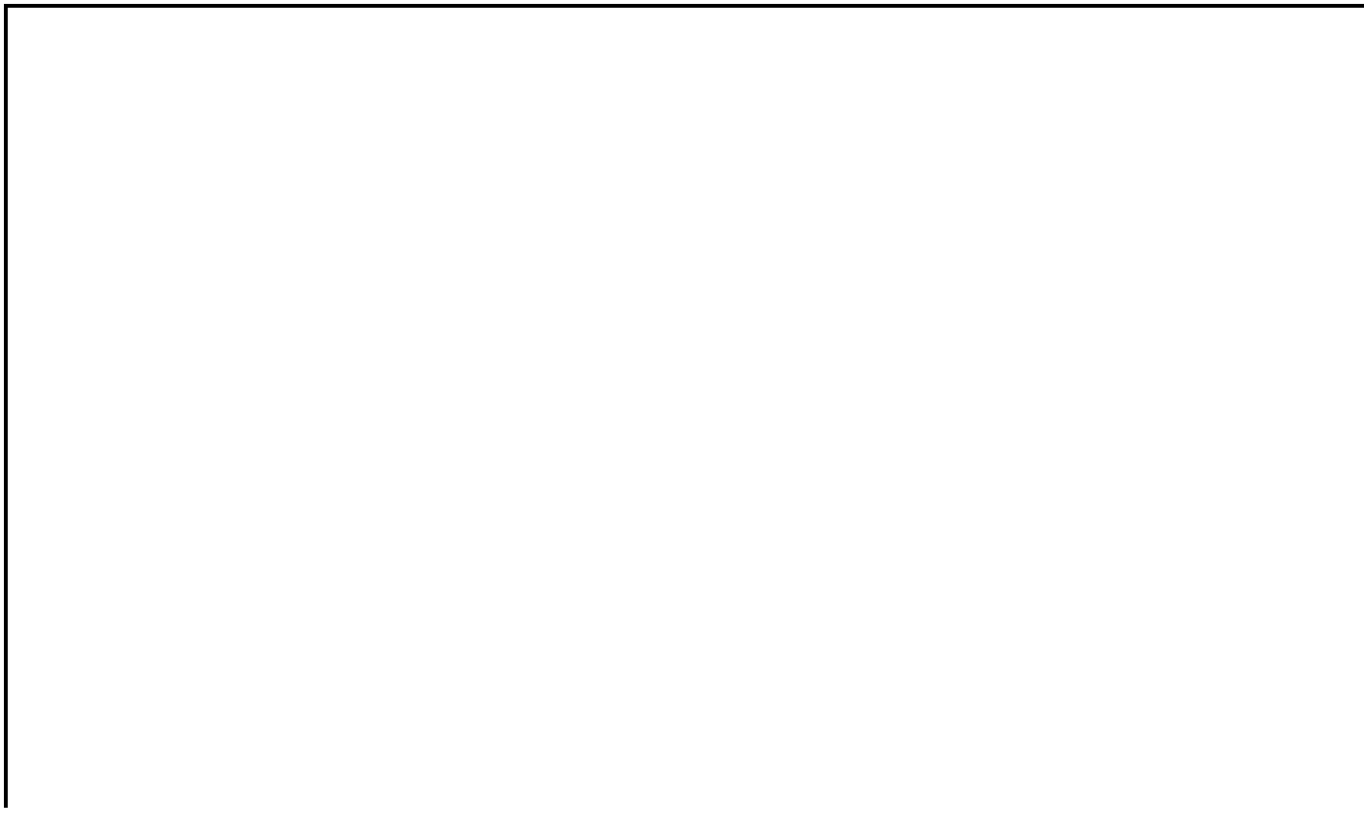
14. Leak check
    - Start the engine and allow to run for 10 minutes, stop the engine.
    - Check for leaks.
15. Engine on

CAUTION: Make sure that the selector lever and the gearshift mechanism are in the park (P) position.

CAUTION: Make sure that the hood is open.

- Turn the ignition on.

16. See figure



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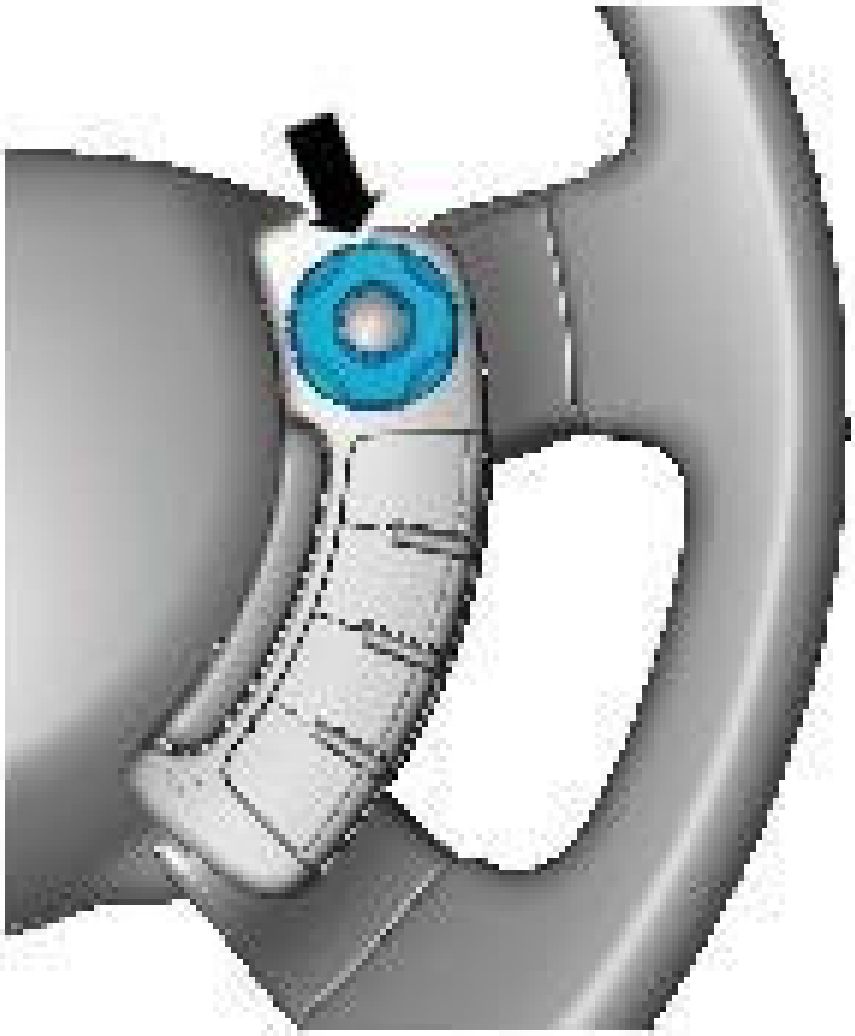

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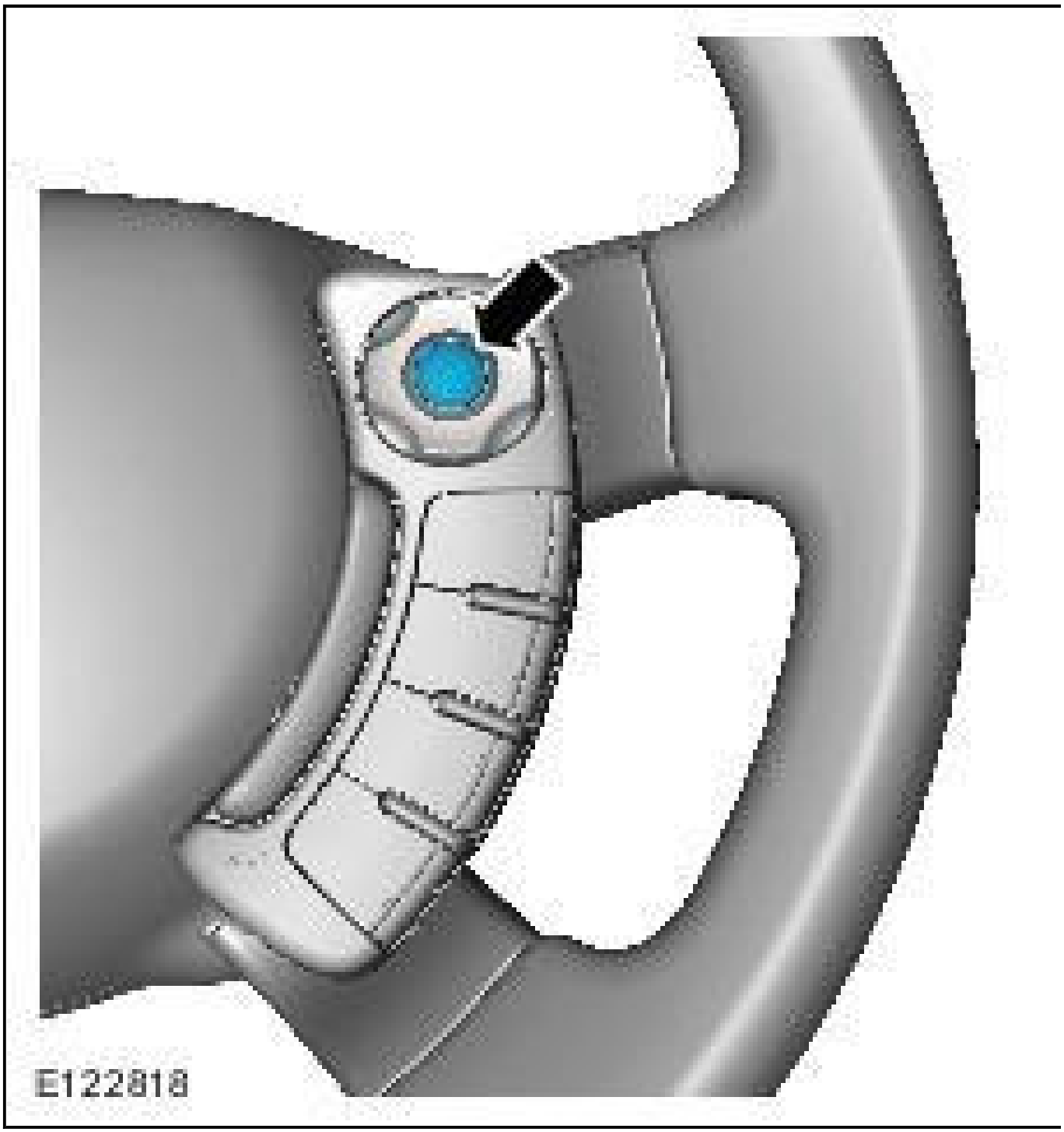
- Press the right-hand directional button to access the instrument cluster menu.

17. See figure



- Press the right-hand OK button.

18. See figure

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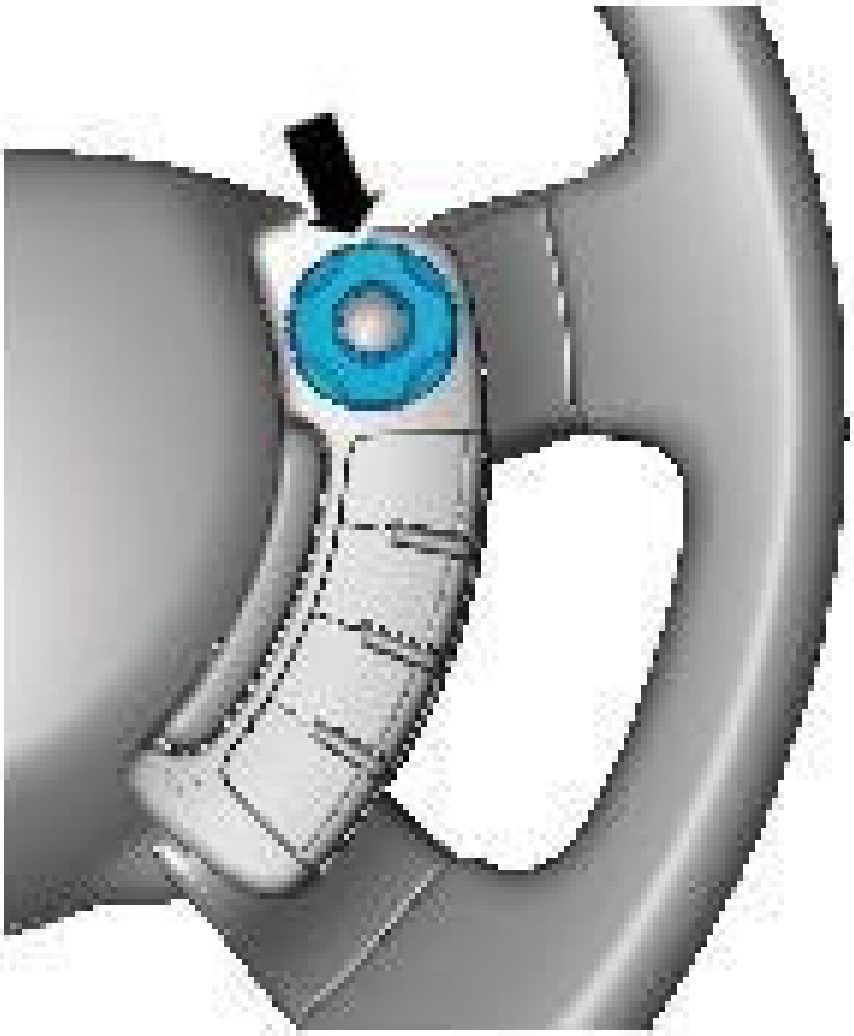

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- Press the right-hand directional button to access the Oil Level Display.

19. See figure

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- Press the right-hand OK button and follow the instructions.

20. See figure

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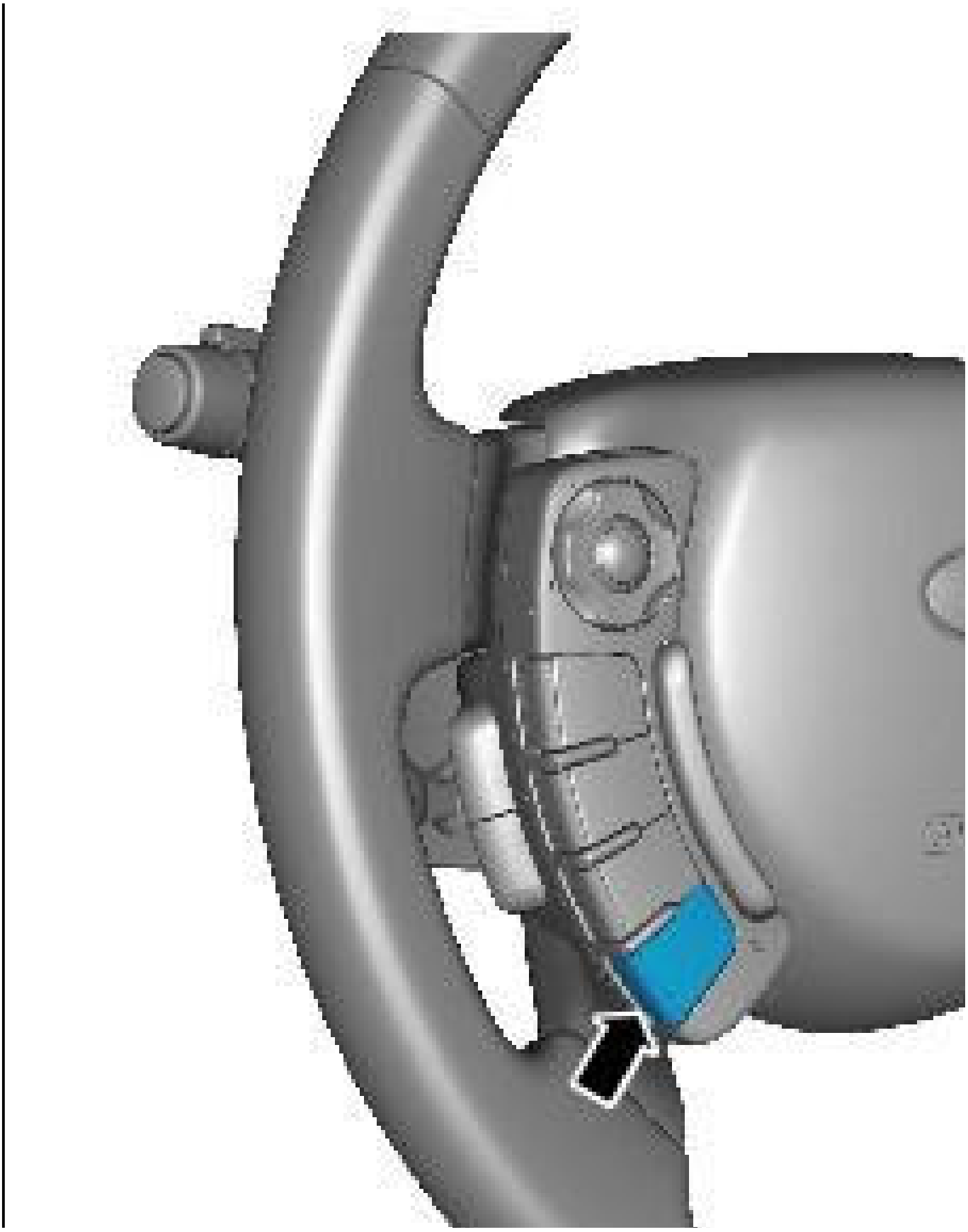

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- Press the cruise control cancel button twice within 2 seconds.

21. See figure

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- The message center display will revert to the normal display in the trip computer.
- Press the right-hand OK button and follow the instructions.
- Check that the oil level display shows an oil level reading.
- Only after having started and run the engine for 10 minutes (as indicated in Step 14), switch off the engine, then stabilizing for 10 minutes, take a reading from the oil level display and, if necessary top up with engine oil.

22. Turn the ignition off.

NOTE: **NOTE: If instructed to follow Steps 15-22 in a previous step, return to Step 14 and continue the procedure.**

23. Allow 10 minutes for the engine oil level to stabilize if there has been additional oil top up.
24. See figure

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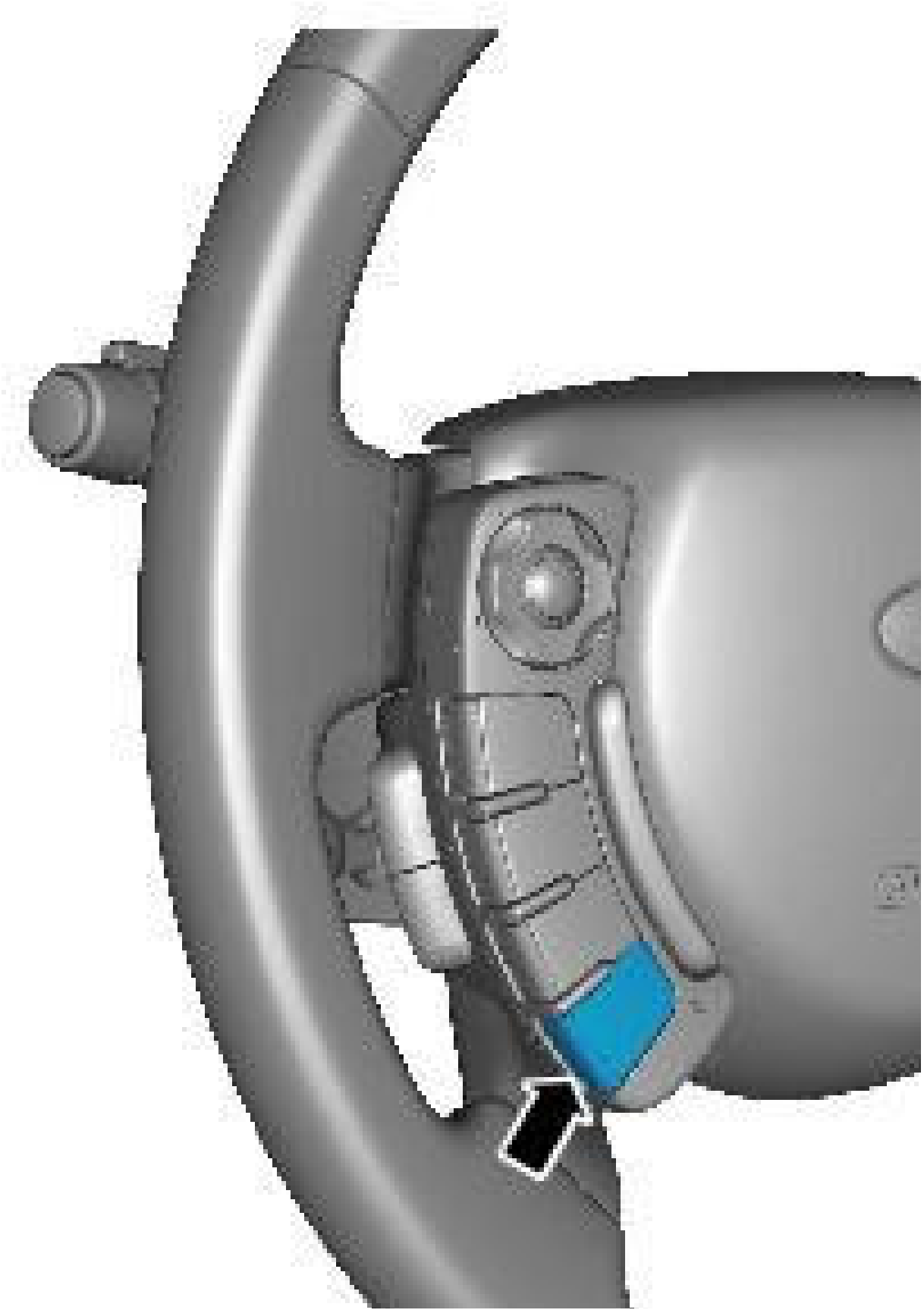

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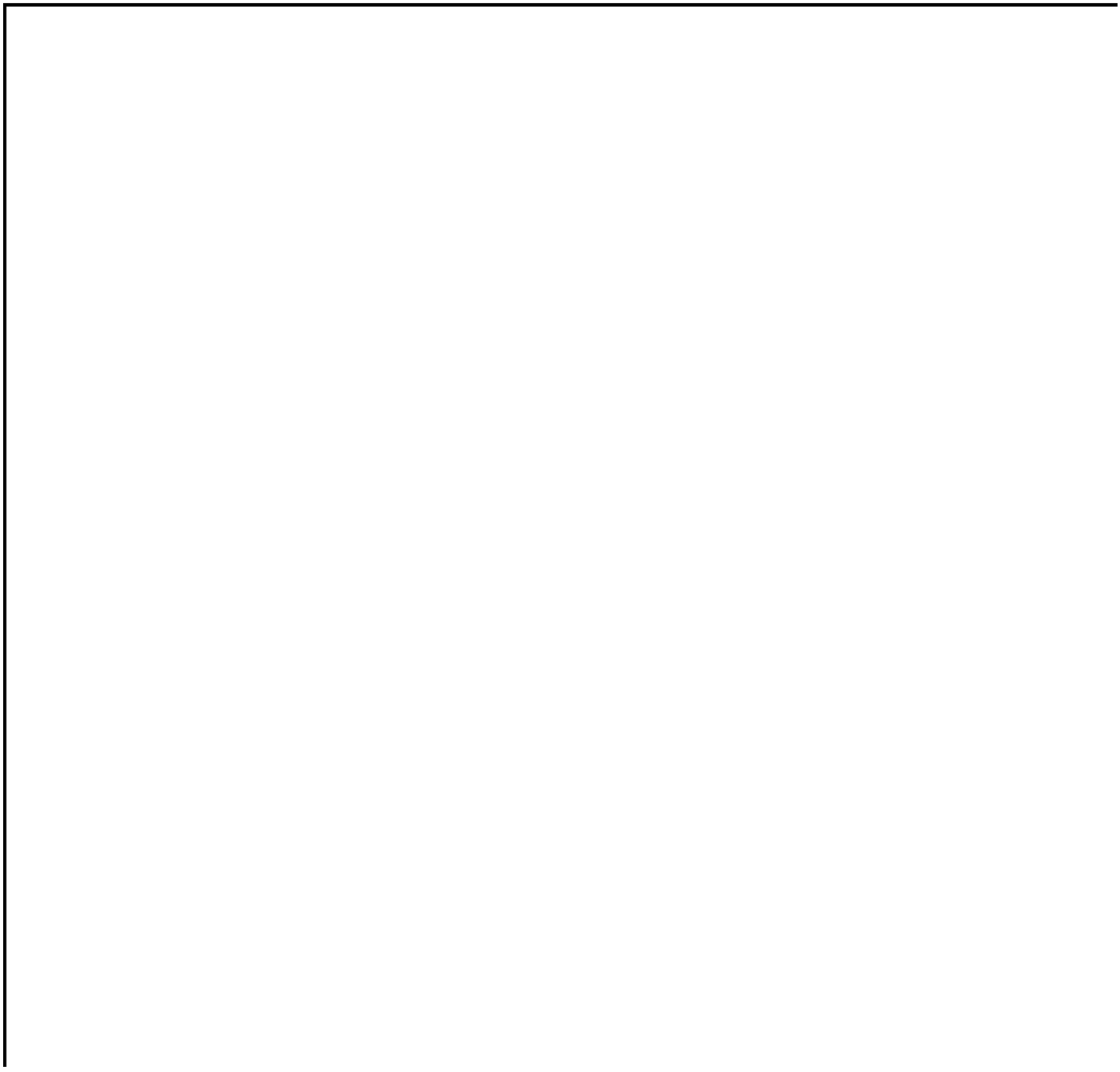
NOTE: The following steps are to update the average oil level value.

- Turn the ignition on.
- Press and hold the cruise control cancel button for more than 2 seconds.

25. Message display
    - The message center display will revert to the normal display in the trip computer.
26. Turn the ignition off.
27. Turn the ignition on.
28. See figure



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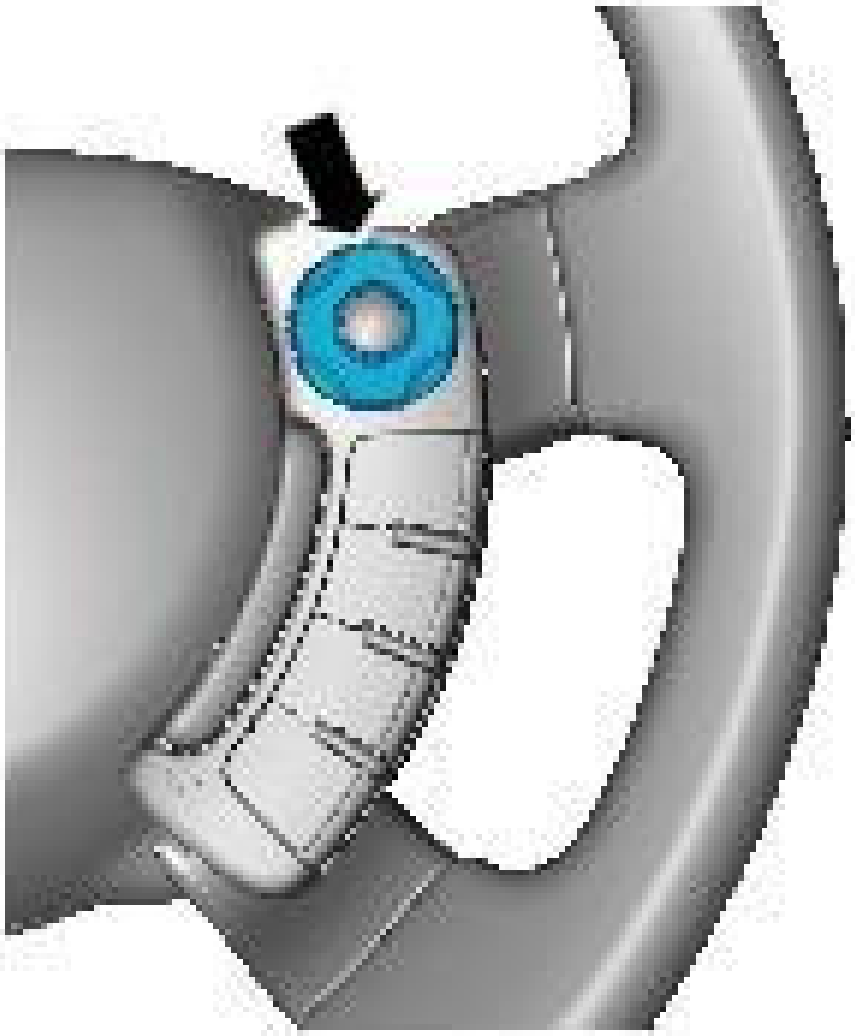

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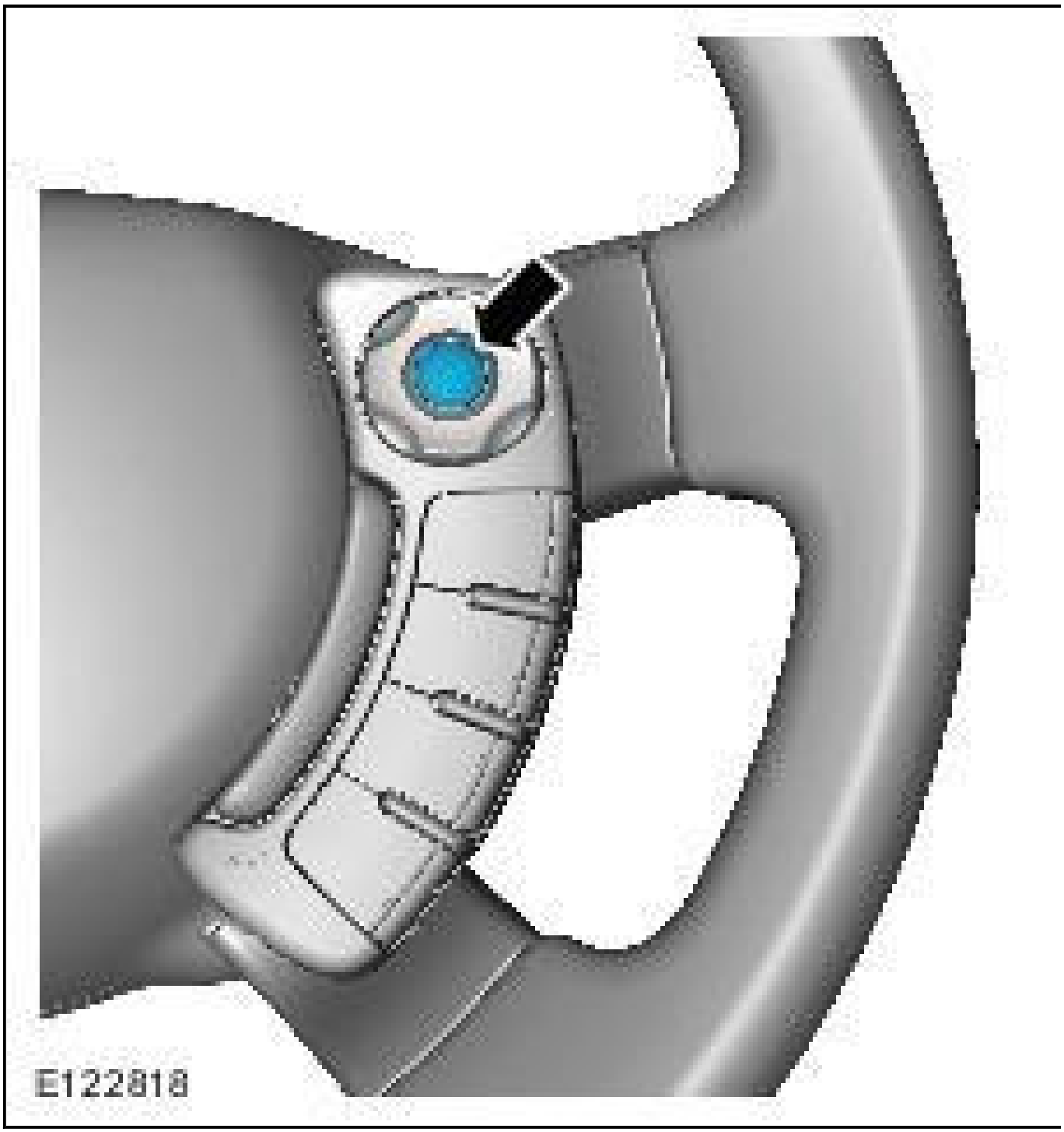
- Press the right-hand directional button to access the instrument cluster menu.

29. See figure



- Press the right-hand OK button.

30. See figure

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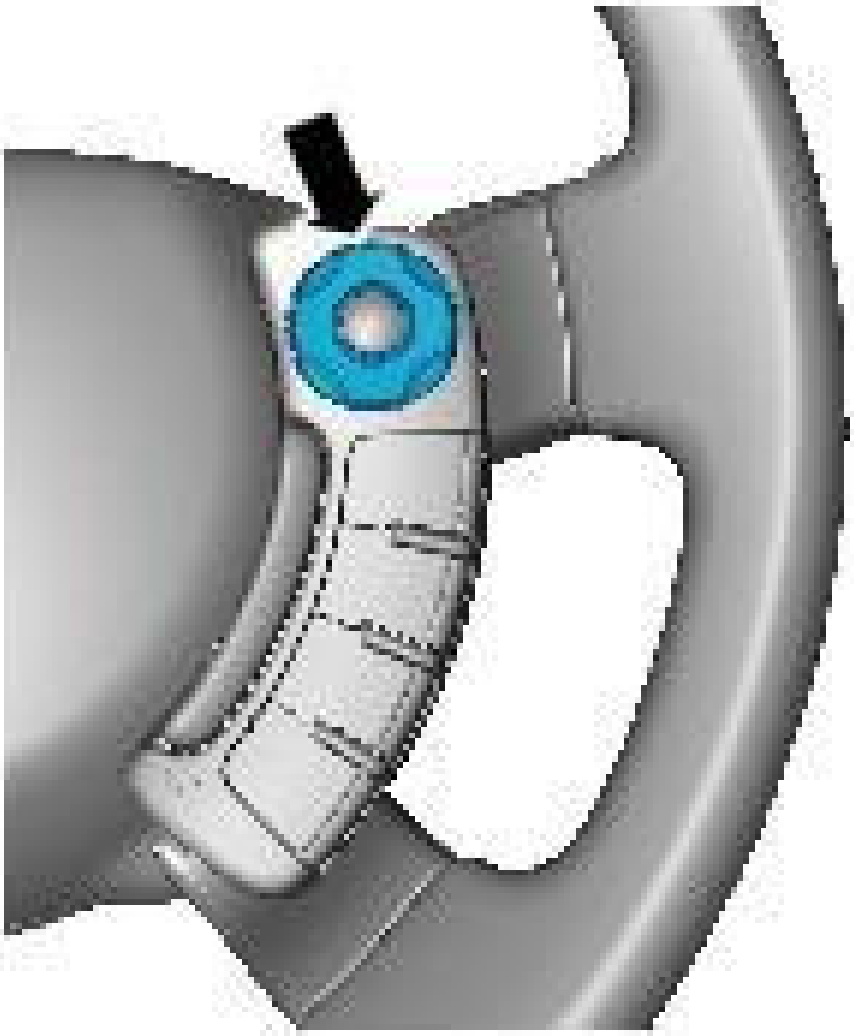

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- Press the right-hand directional button to access the Oil Level Display.

31. See figure

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- Press the right-hand OK button and follow the instructions.
- Make sure that the average oil level value has now been updated.

32. Refer to: **ENGINE UNDERSHIELD - REMOVAL AND INSTALLATION** .
33. Refer to: **FENDER SPLASH SHIELD - REMOVAL AND INSTALLATION** .

REMOVAL AND INSTALLATION

CAMSHAFT LH

REMOVAL

CAUTION: Make sure that the orientation and code on the top of the camshaft bearing caps is noted (along with the bank - A or B), so that on installation the components are installed to their original position. Failure to follow this instruction may cause damage to the vehicle.

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

1. 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. See **Timing Drive Components**.
4. Camshaft bearing caps

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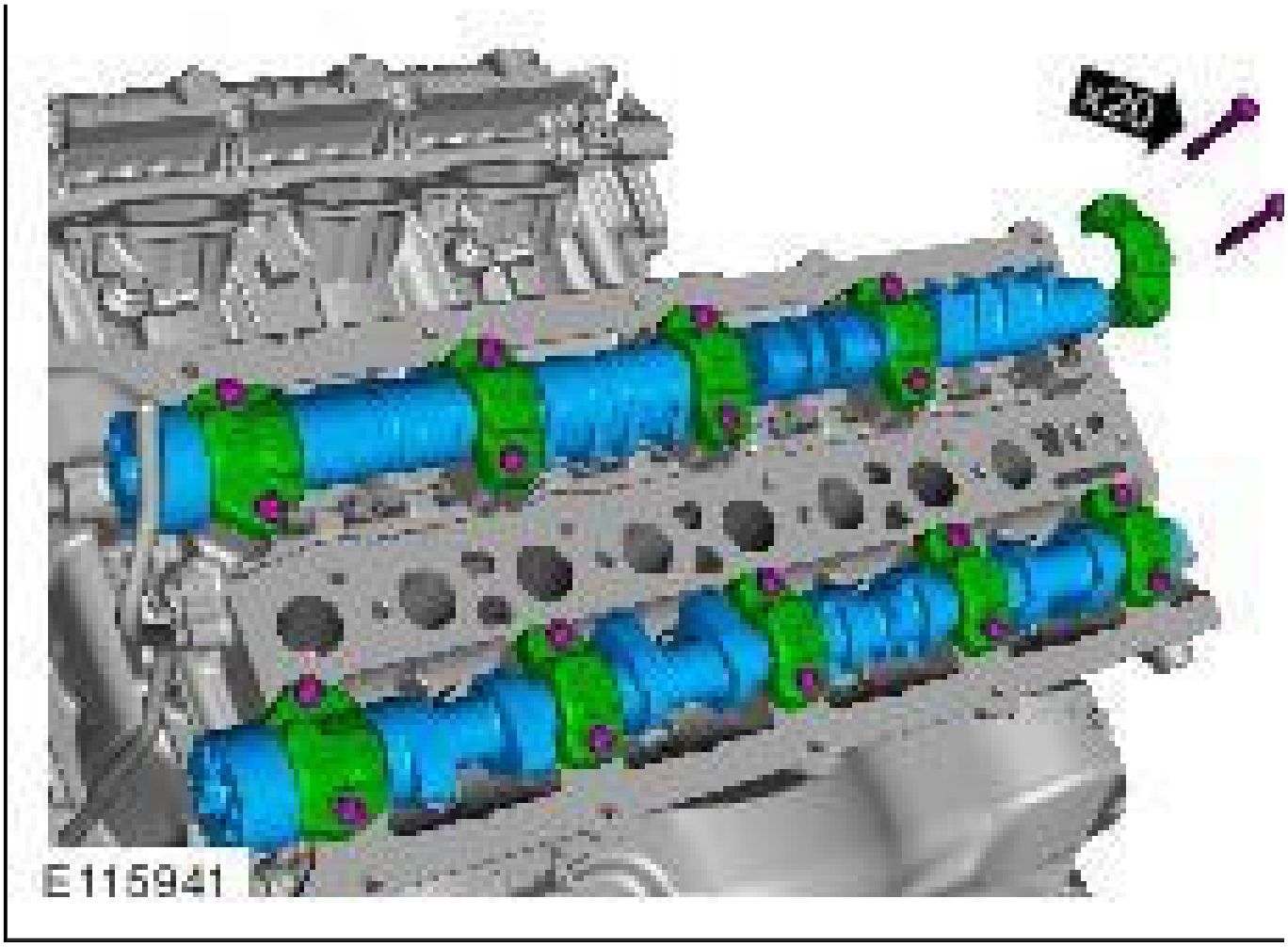

CAUTION: Rotate the camshafts until all the valves are at their minimum open point.

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

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

INSTALLATION

1. Torque: 3 Nm

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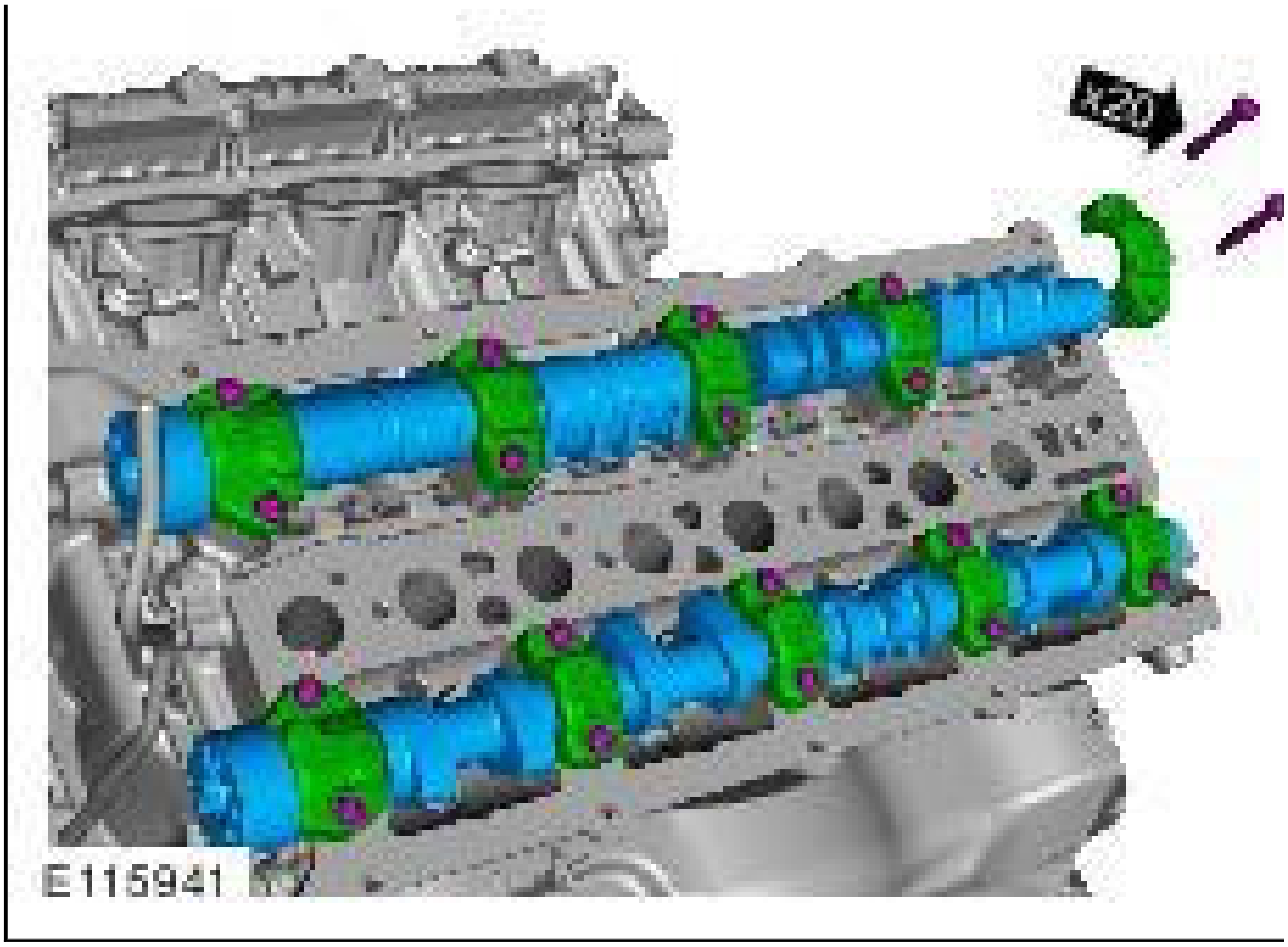

CAUTION: Prior to installing the camshafts, position the crankshaft 45 degrees ATDC cylinder 1A to prevent valve/piston collision.

CAUTION: Make sure that the camshafts and camshaft bearing caps are installed in their original locations.

CAUTION: Evenly and progressively install and tighten the camshaft bearing caps.

NOTE: Lubricate the camshafts and the camshaft bearing caps with EP90 oil (or 75/90 viscosity oil will suffice) prior to installation.

2. Torque: 12 Nm

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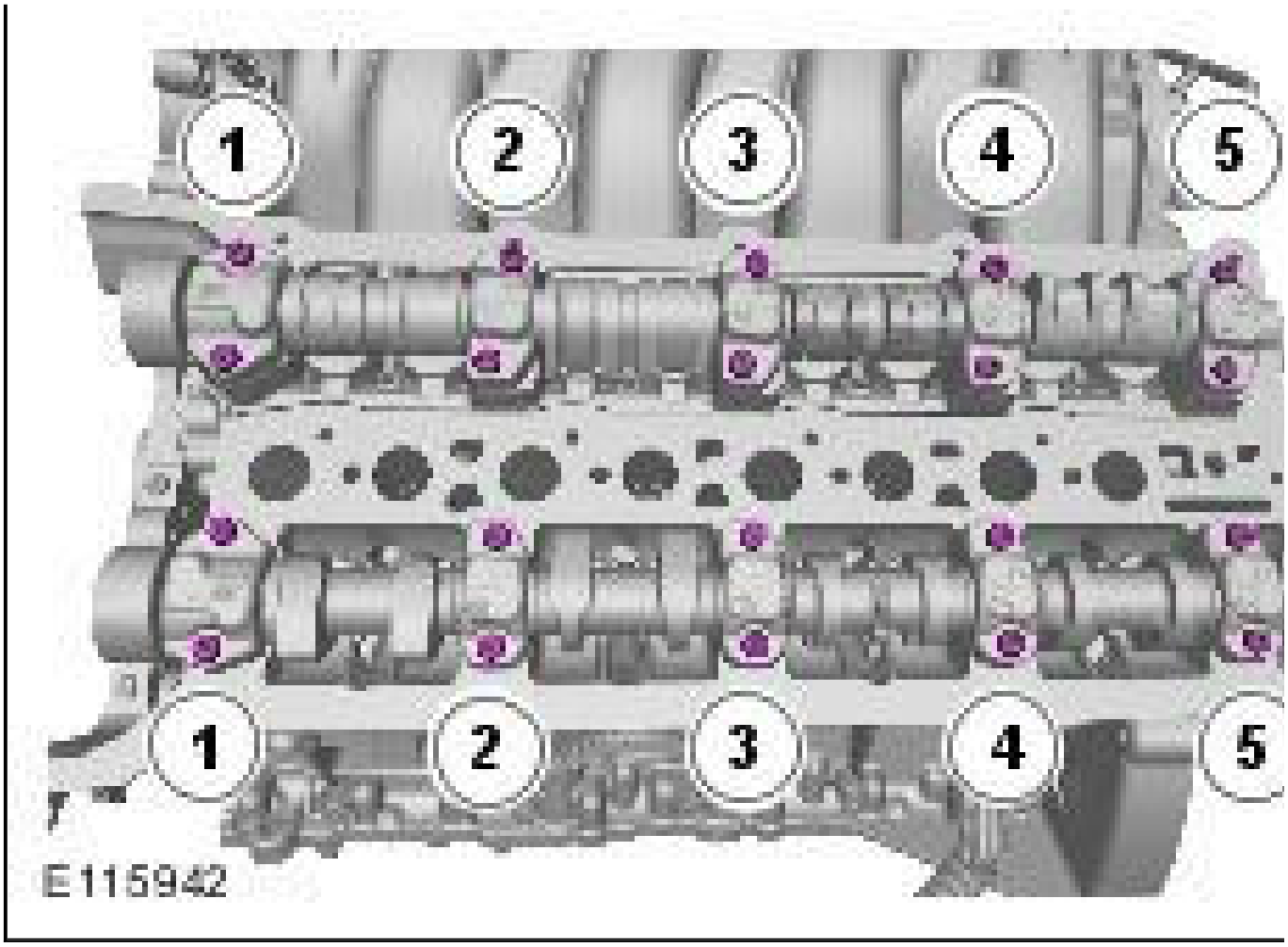

NOTE: Tighten the bolts in the indicated sequence.

CAUTION: Only rotate the crankshaft clockwise.

3. Rotate the crankshaft until the camshaft lobe on the valve being checked is 180 degrees from the maximum opening position.

NOTE: If the valve clearance is incorrect, continue to the next step. If the valve clearance is correct, continue to step 8.

NOTE: On vehicles without supercharger the inlet camshaft valve clearances cannot be checked.

4. Using feeler gauge check the gap between the tappet and the camshaft lobe and check against specifications table.

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CAUTION: Do not use a magnet to remove the tappet.

CAUTION: Use the following formula to calculate the required bucket thickness. Original thickness + measured clearance - desired clearance = required bucket thickness.

5. Remove the tappet and measure the thickness.

NOTE: If a new tappet is installed then go back to step 1 of the install procedure.

6. Install a new tappet if required.
7. Using feeler gauge check the gap between the tappet and the camshaft lobe and check against specifications table.
8. See **Timing Drive Components**.
9. Connect the battery ground cable. Refer to **Specifications** .

CAMSHAFT RH

REMOVAL

CAUTION: Make sure that the orientation and code on the top of the camshaft bearing caps is noted (along with the bank - A or B), so that on installation the components are installed to their original position. Failure to follow this instruction may cause damage to the vehicle.

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.

1. 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. See **Timing Drive Components**.
4. Camshaft bearing caps

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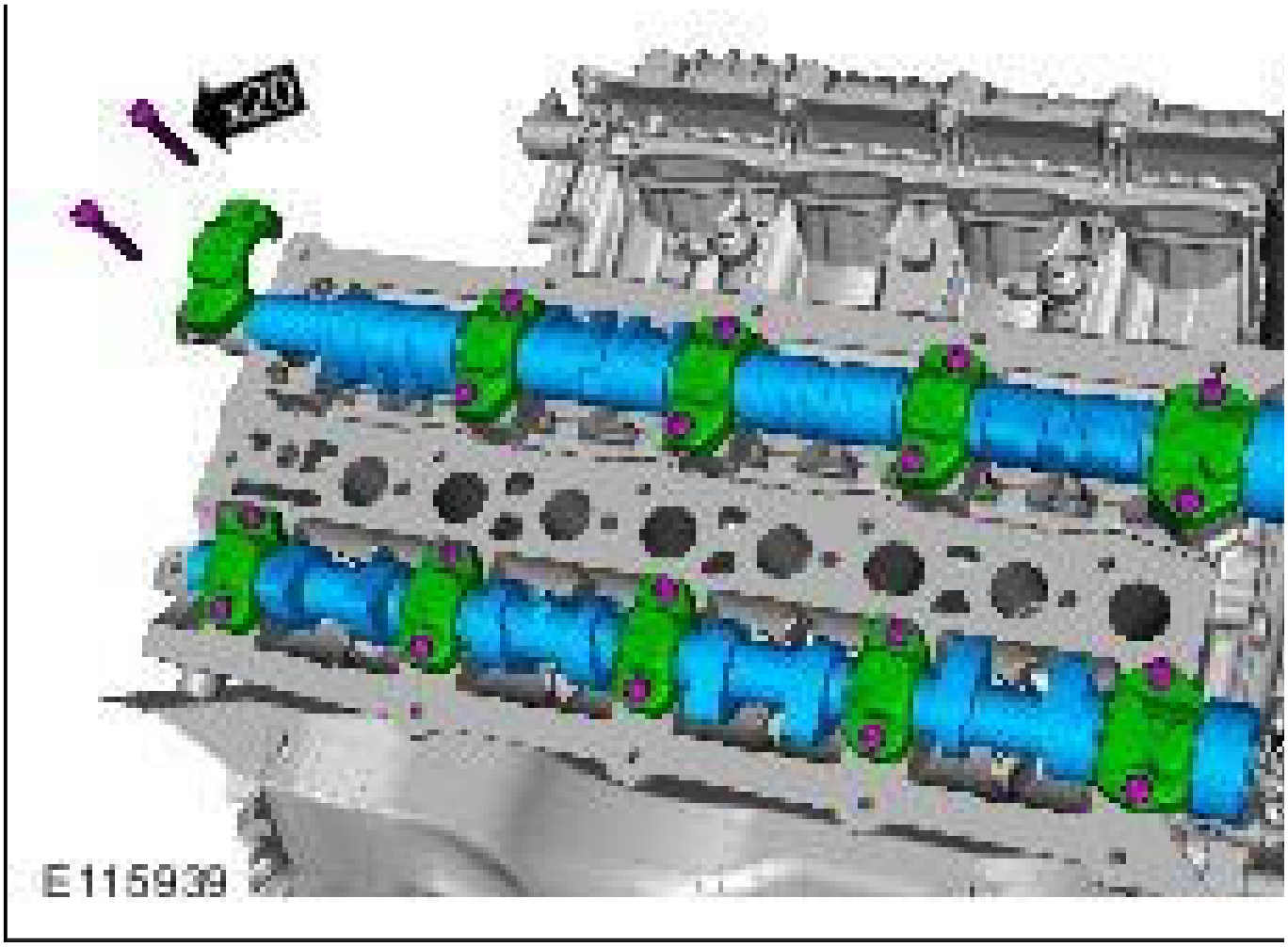

CAUTION: Rotate the camshafts until all the valves are at their minimum open point.

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

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

INSTALLATION

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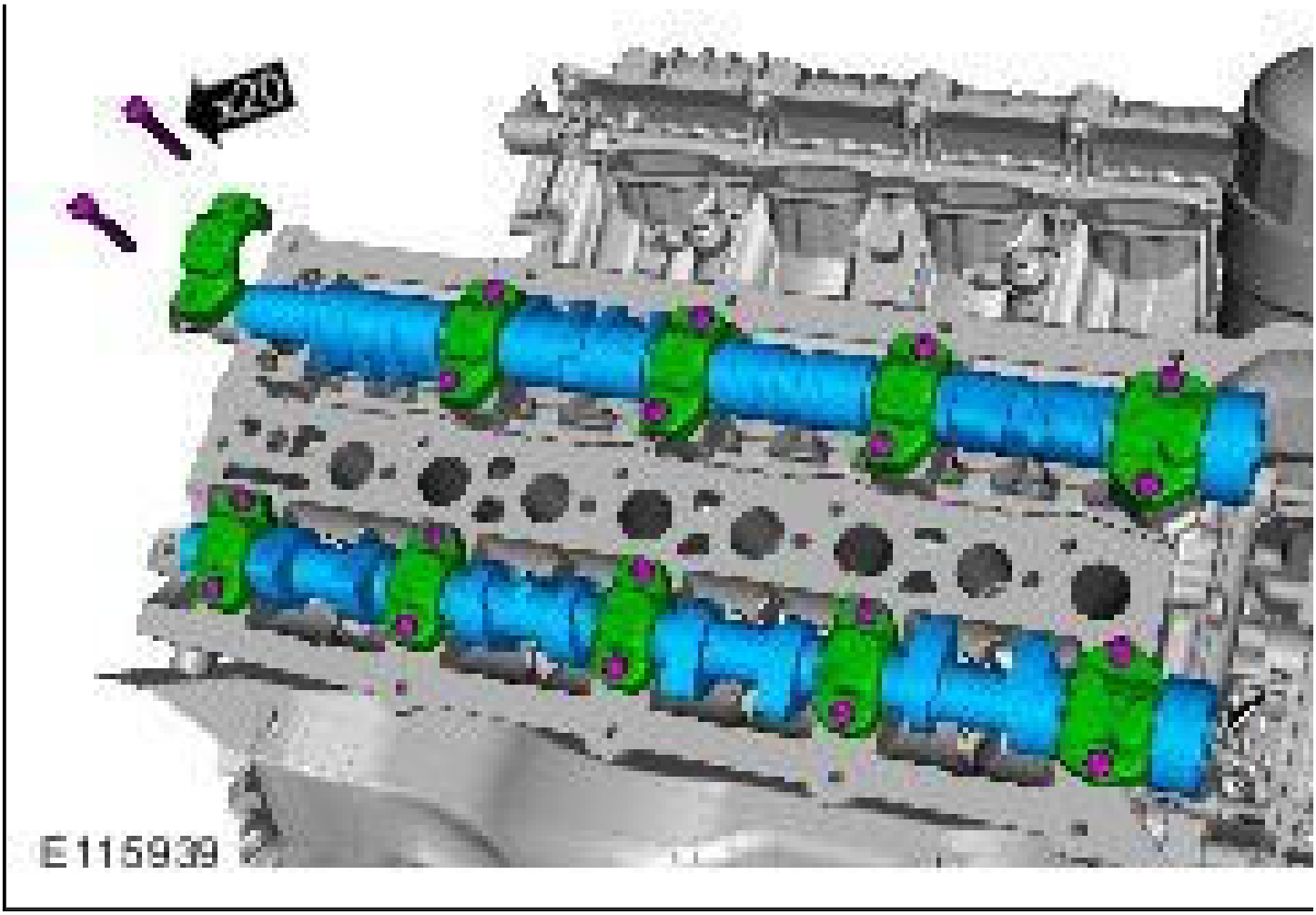

1. Torque: 3 Nm

CAUTION: Prior to installing the camshafts, position the crankshaft 45 degrees ATDC cylinder 1A to prevent valve/piston collision.

CAUTION: Make sure that the camshafts and camshaft bearing caps are installed in their original locations.

CAUTION: Evenly and progressively install and tighten the camshaft bearing caps.

NOTE: Lubricate the camshafts and the camshaft bearing caps with EP90 oil (or 75/90 viscosity oil will suffice) prior to installation.

2. Torque: 12 Nm

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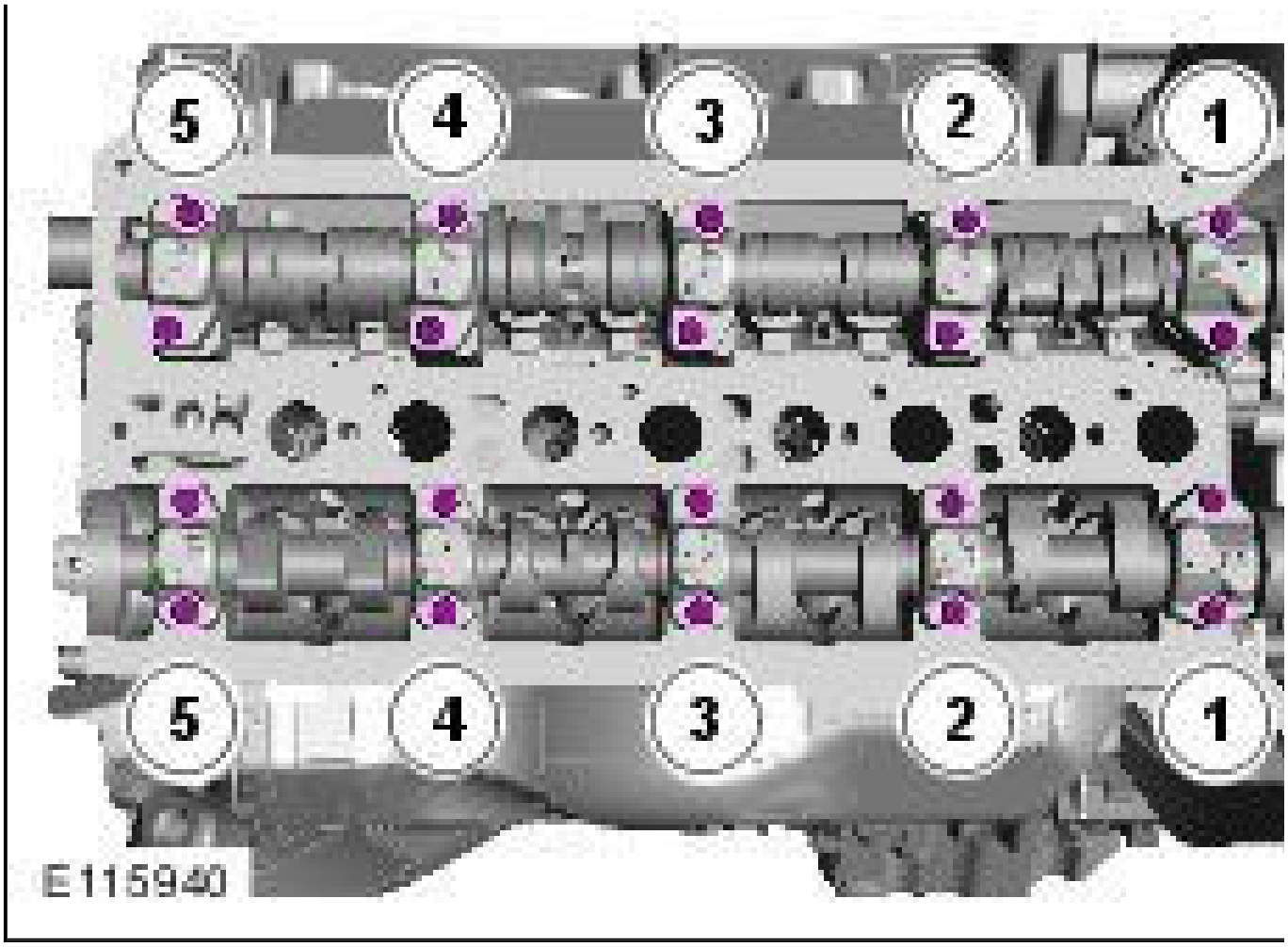

NOTE: Tighten the bolts in the indicated sequence.

CAUTION: Only rotate the crankshaft clockwise.

3. Rotate the crankshaft until the camshaft lobe on the valve being checked is 180 degrees from the maximum opening position.

NOTE: If the valve clearance is incorrect, continue to the next step. If the valve clearance is correct, continue to step 8.

NOTE: On vehicles without supercharger the inlet camshaft valve clearances cannot be checked.

4. Using feeler gauge check the gap between the tappet and the camshaft lobe and check against specifications table.

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CAUTION: Use the following formula to calculate the required bucket thickness. Original thickness + measured clearance - desired clearance = required bucket thickness.

CAUTION: Do not use a magnet to remove the tappet.

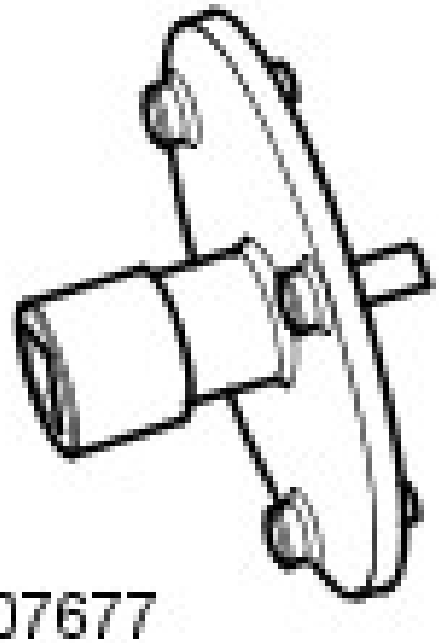
5. Remove the tappet and measure the thickness.

NOTE: If a new tappet is installed then go back to step 1 of the install procedure.

6. Install a new tappet if required.
7. Using feeler gauge check the gap between the tappet and the camshaft lobe and check against specifications table.
8. See **Timing Drive Components**.
9. Refer to **Specifications** .

CRANKSHAFT FRONT SEAL

SPECIAL TOOL(S)

	303-1434 Remover/Installer, Front Crankshaft Seal

REMOVAL

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NOTE: Removal steps in this procedure may contain installation details. Some variation in the illustrations may occur, but the essential information is always correct.

1. Disconnect the battery ground cable. Refer to **Specifications** .
2. See **Crankshaft Pulley**.
3. Installer/remover, Front Crankshaft Seal (303-1434), refer to **SPECIAL TOOL(S)**

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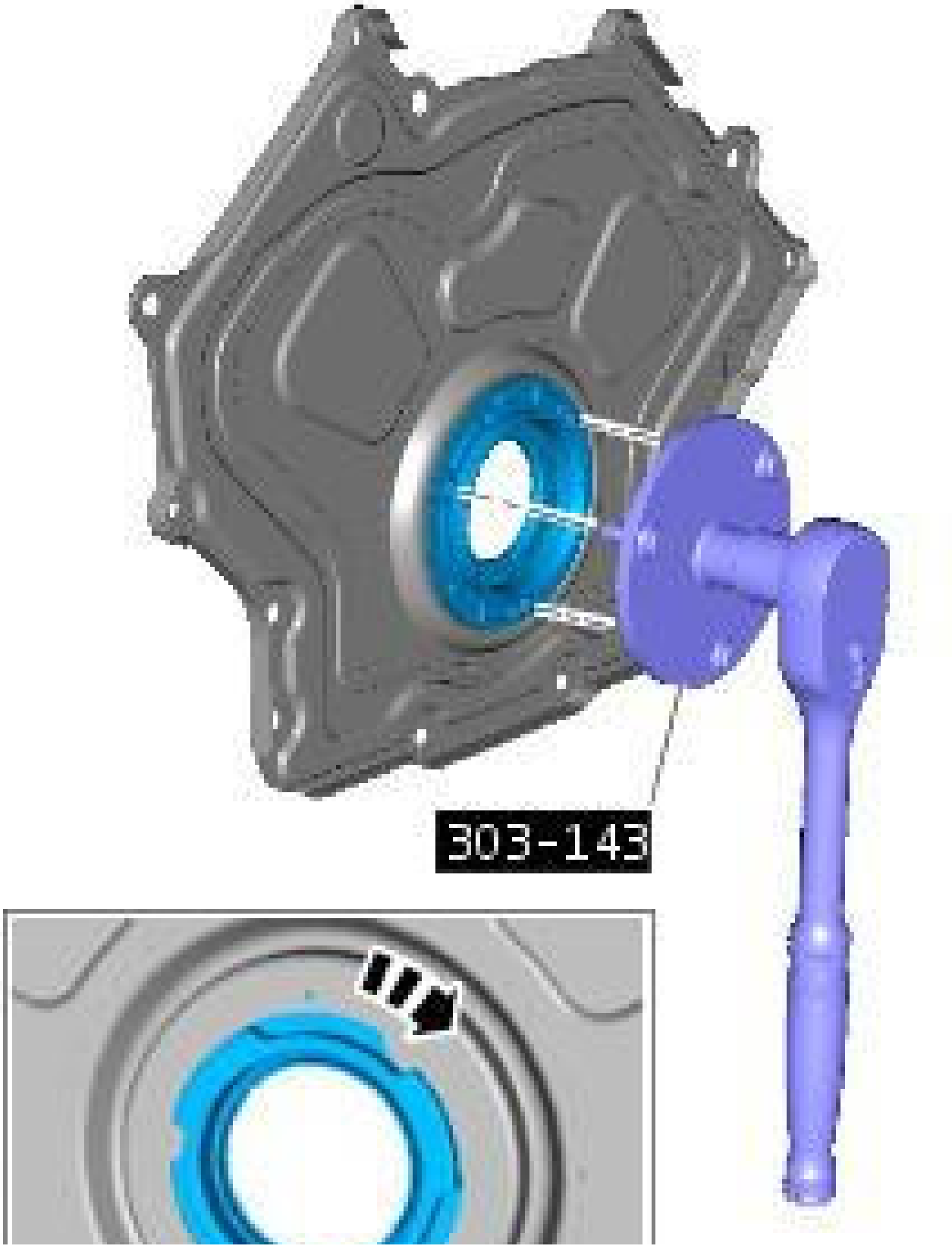

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INSTALLATION

CAUTION: Do not over tighten the crankshaft front seal. Failure to follow this instruction may result in damage to the vehicle.

CAUTION: Take extra care not to damage the seal.

1. To install, reverse the removal procedure.

CRANKSHAFT PULLEY

SPECIAL TOOL(S)

E115256	303-1437 Crankshaft Damper Remover/Installer
	303-1438 Crankshaft Damper Bolt Remover/Installer

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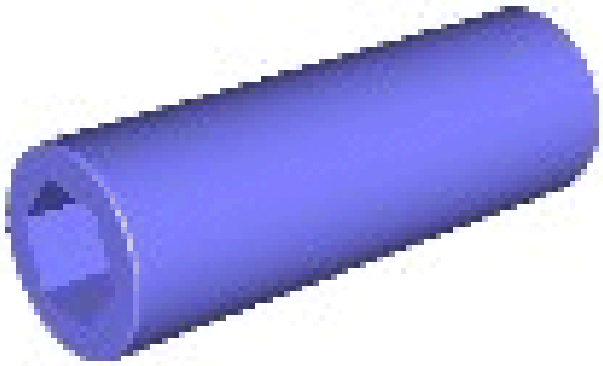 E115257	
 E115258	303-1439 Crankshaft Damper Removal Plate
	303-1440 Crankshaft Damper Removal/Installation Stud

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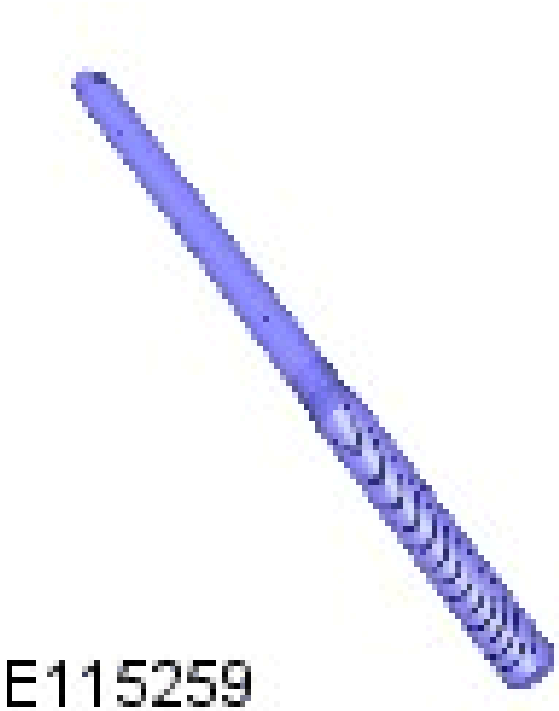 E115259	
E115260	303-1441 Crankshaft Damper Remover/Installer Body
	303-1448 Locking Tool

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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.

1. 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. Refer to **Cooling Fan Belt** .
4. Refer to **Radiator - Vehicles Without: Supercharger** .
5. Refer to **Starter Motor** .
6. See figure

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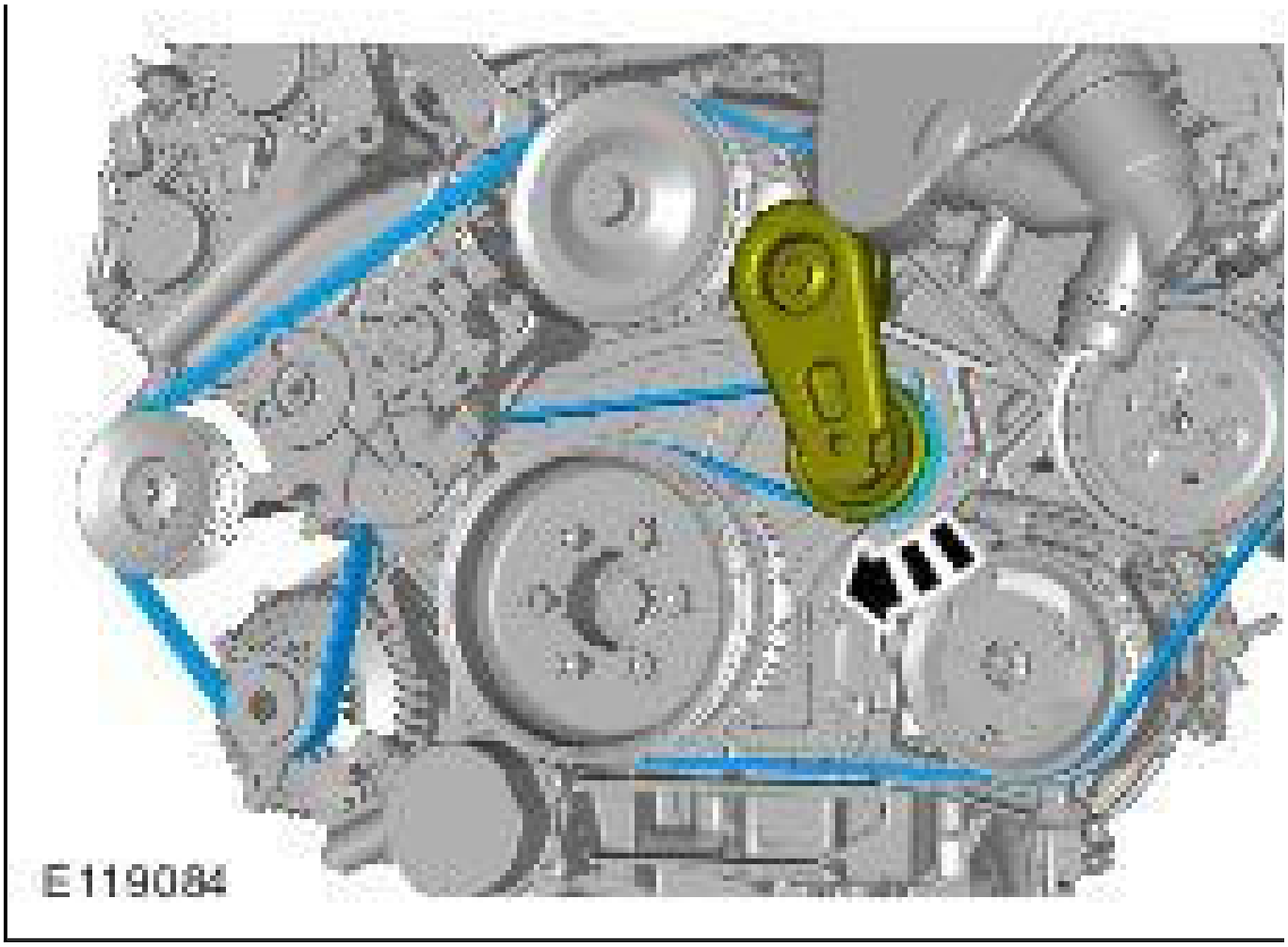

7. Install the special tool.

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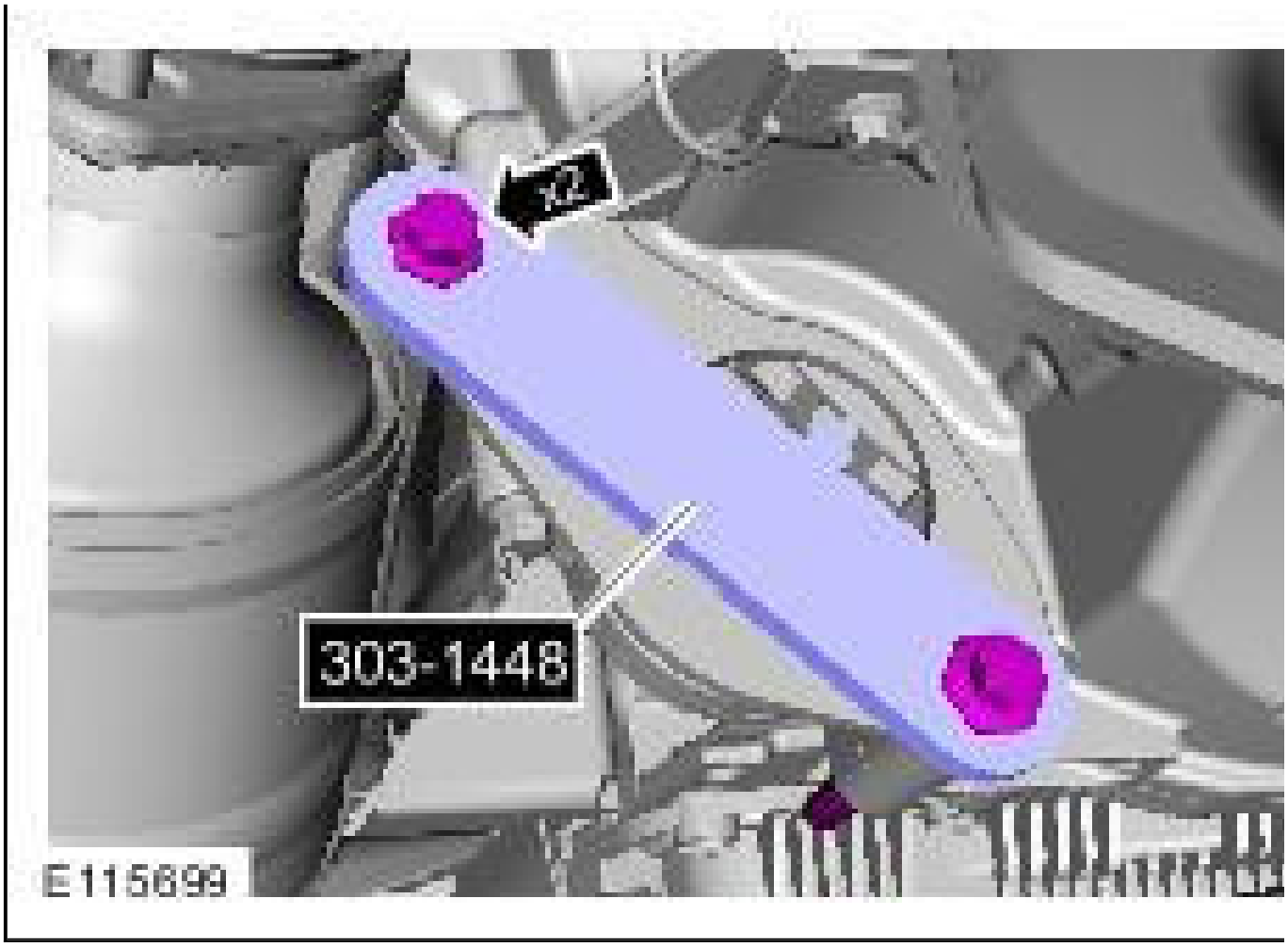

Locking Tool (303-1448), refer to: **SPECIAL TOOL(S)**

8. Note the markings on the crankshaft pulley bolt.

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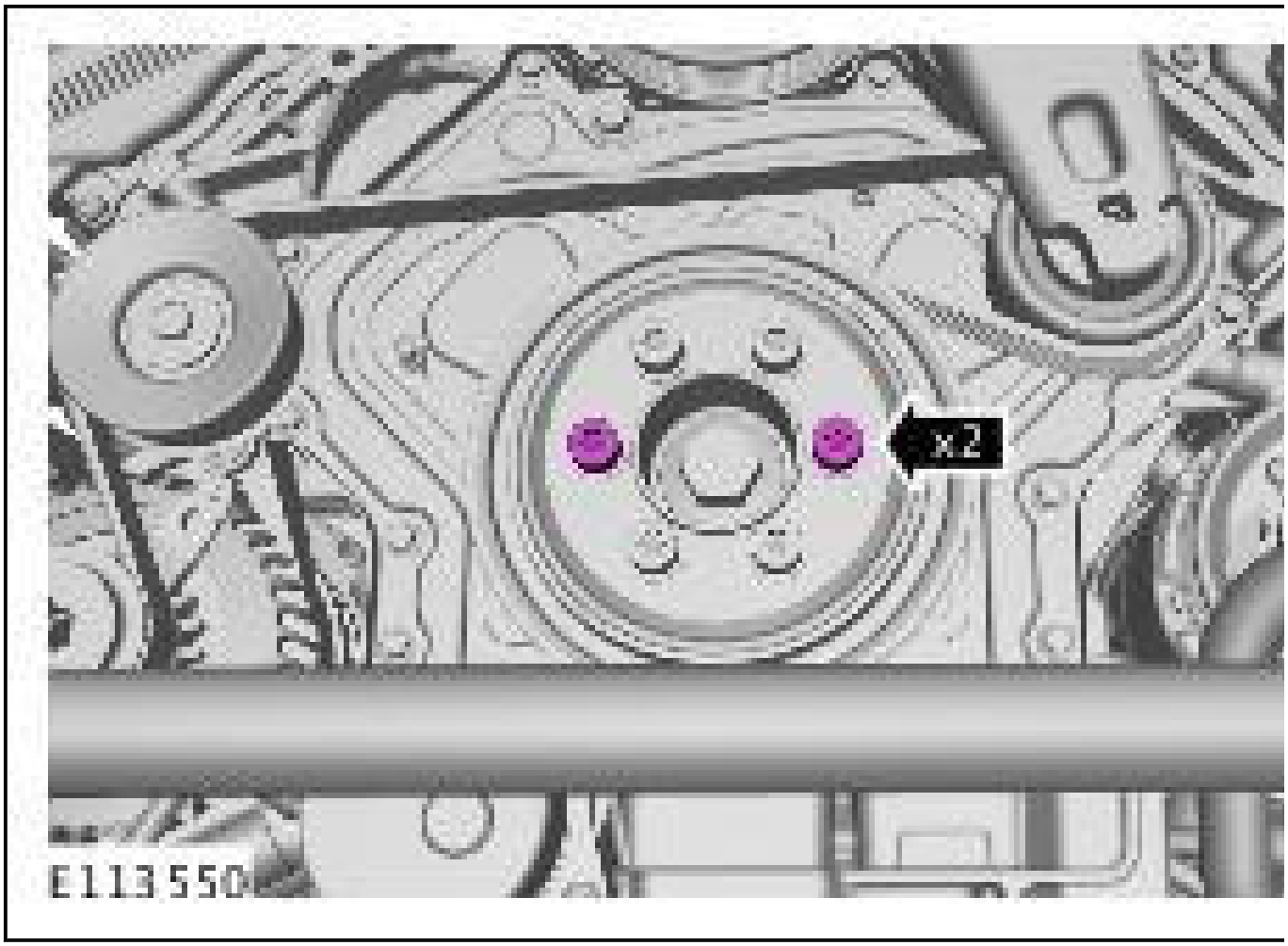
CAUTION: Before removing the crankshaft pulley bolt, note the numbers on the bolt head. If the bolt head shows 10.9, the bolt must be removed counter clockwise. If the bolt head shows 12.9, the bolt must be removed clockwise. Failure to follow this instruction may result in damage to the crankshaft.

9. See figure



10. Install the special tool.

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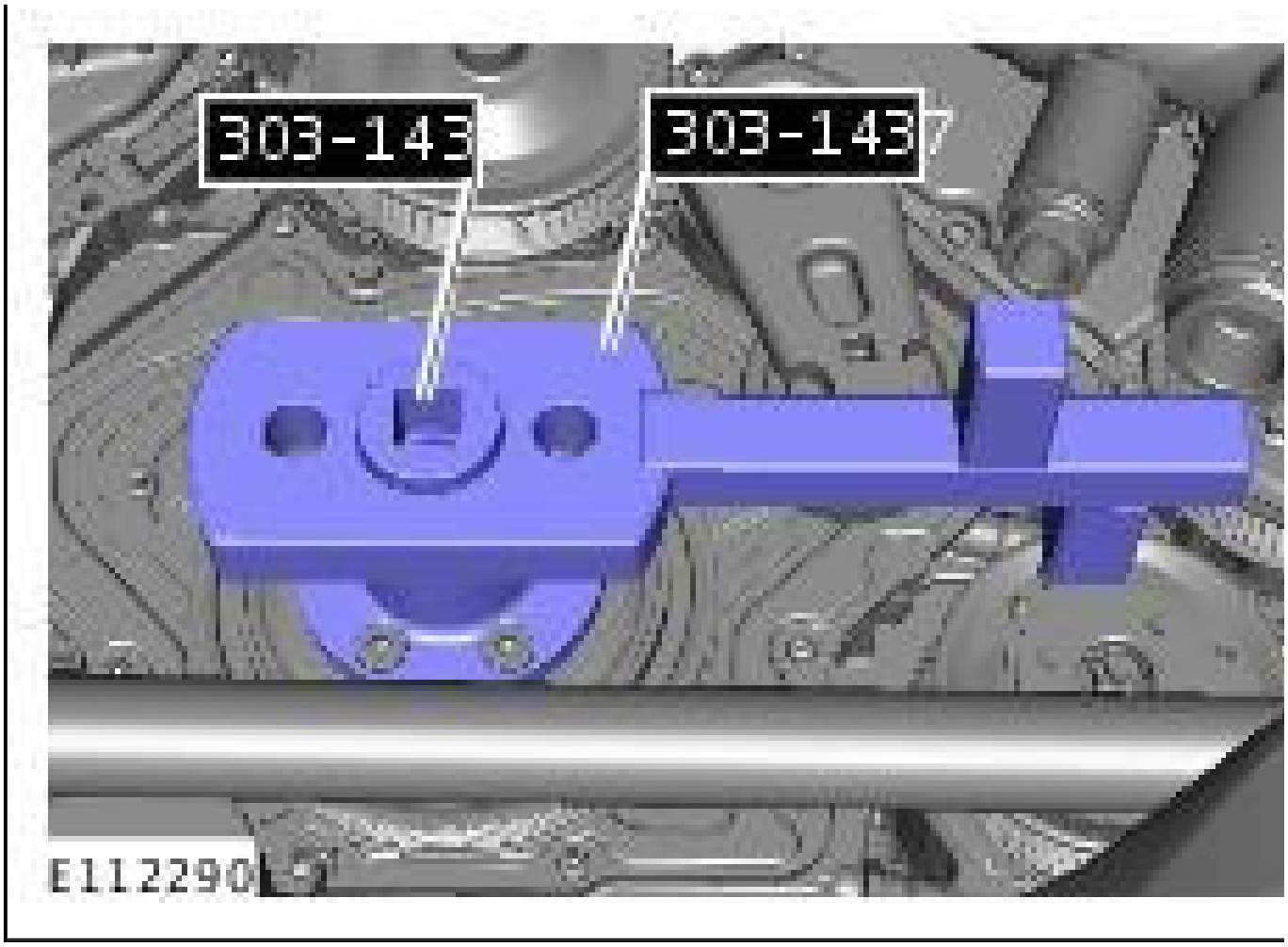

Crankshaft Damper Bolt Remover/Installer (303-1438), refer to: **SPECIAL TOOL(S)**

Crankshaft Damper Remover/Installer (303-1437), refer to: **SPECIAL TOOL(S)**

11. Torque: 65 Nm

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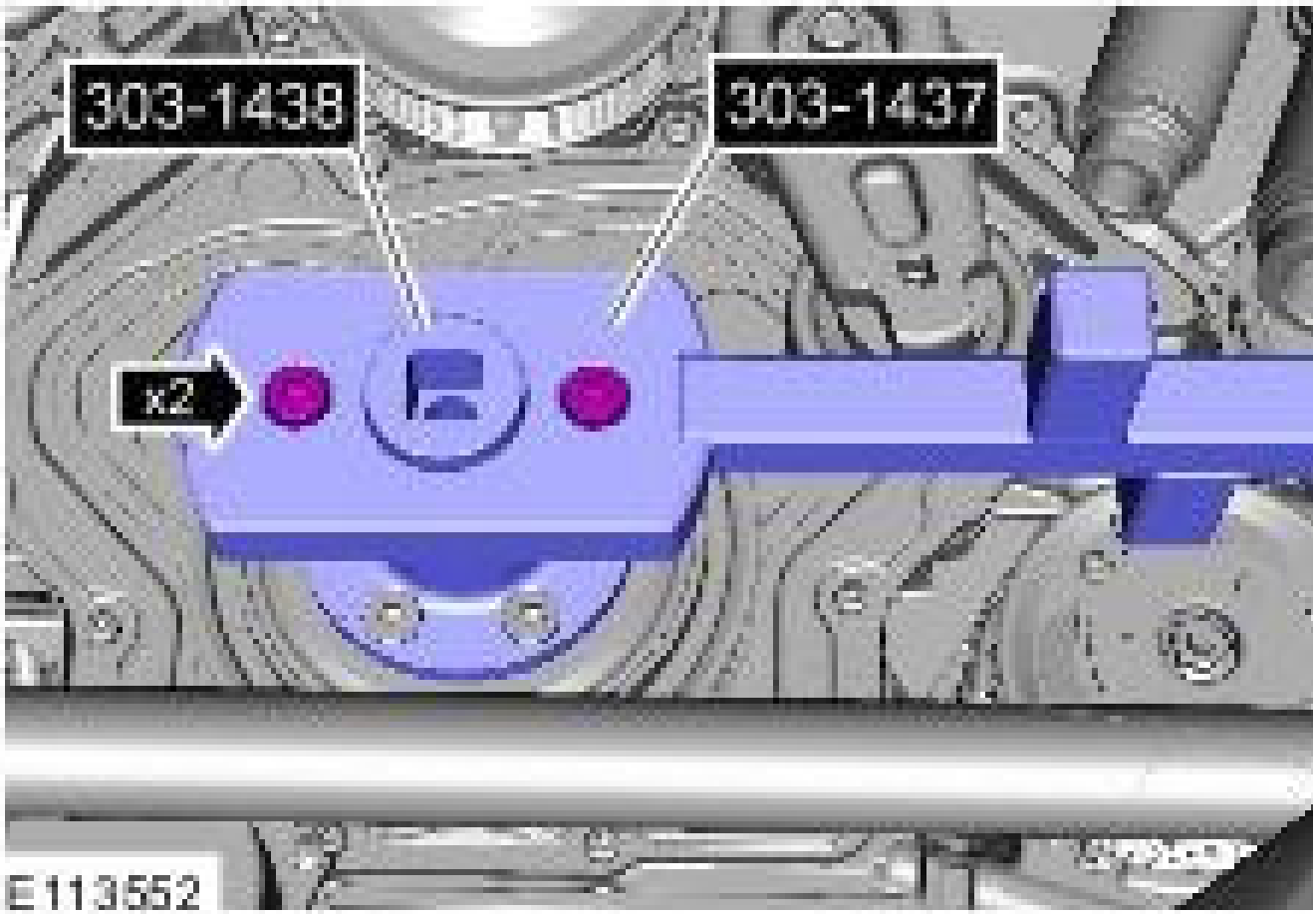

12. Using a suitable wooden block and an axle stand extension, support the special tool.

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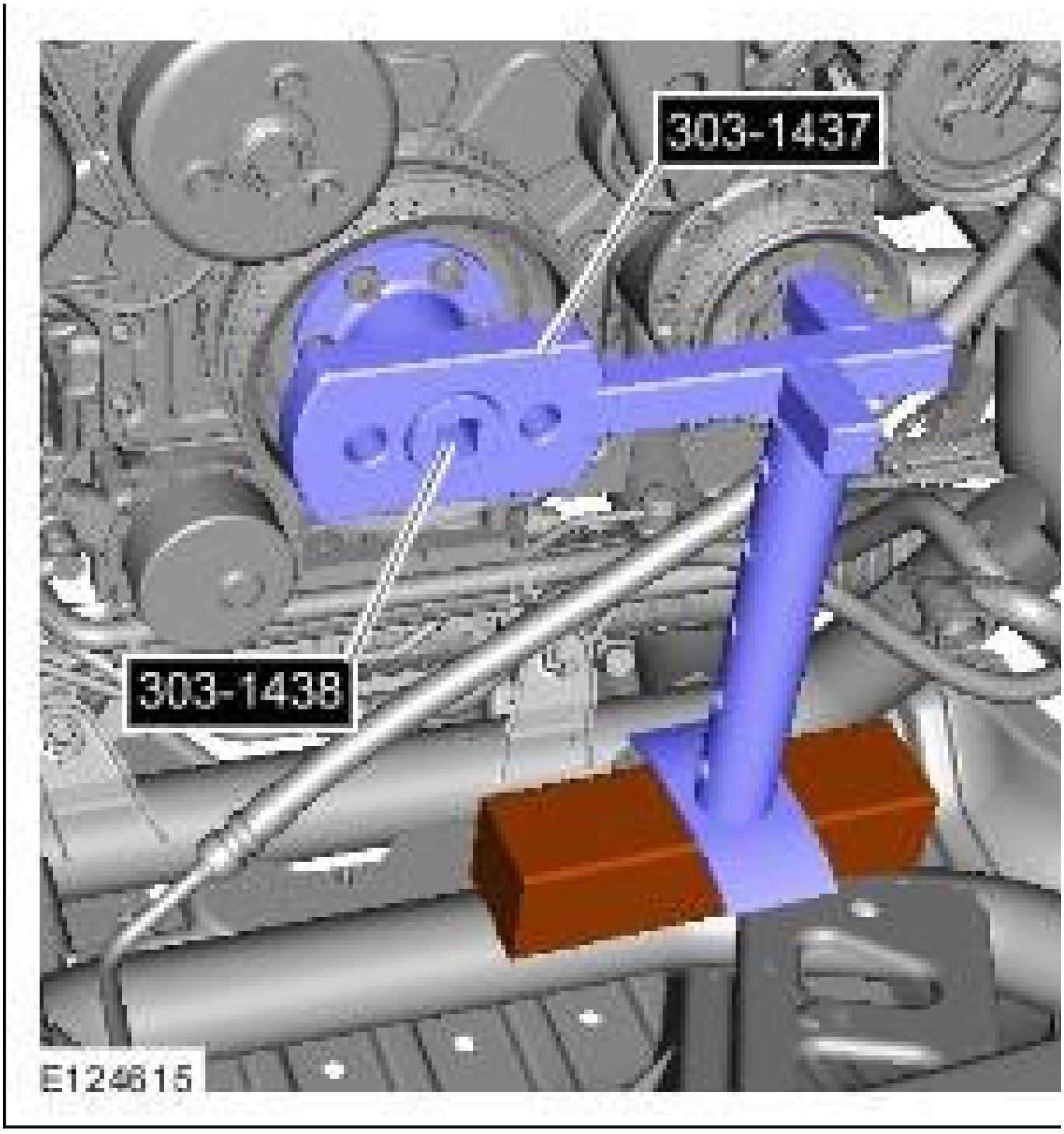

NOTE: **The graphic shows the tool position for LH thread only, RH thread will be the opposite.**

13. See figure

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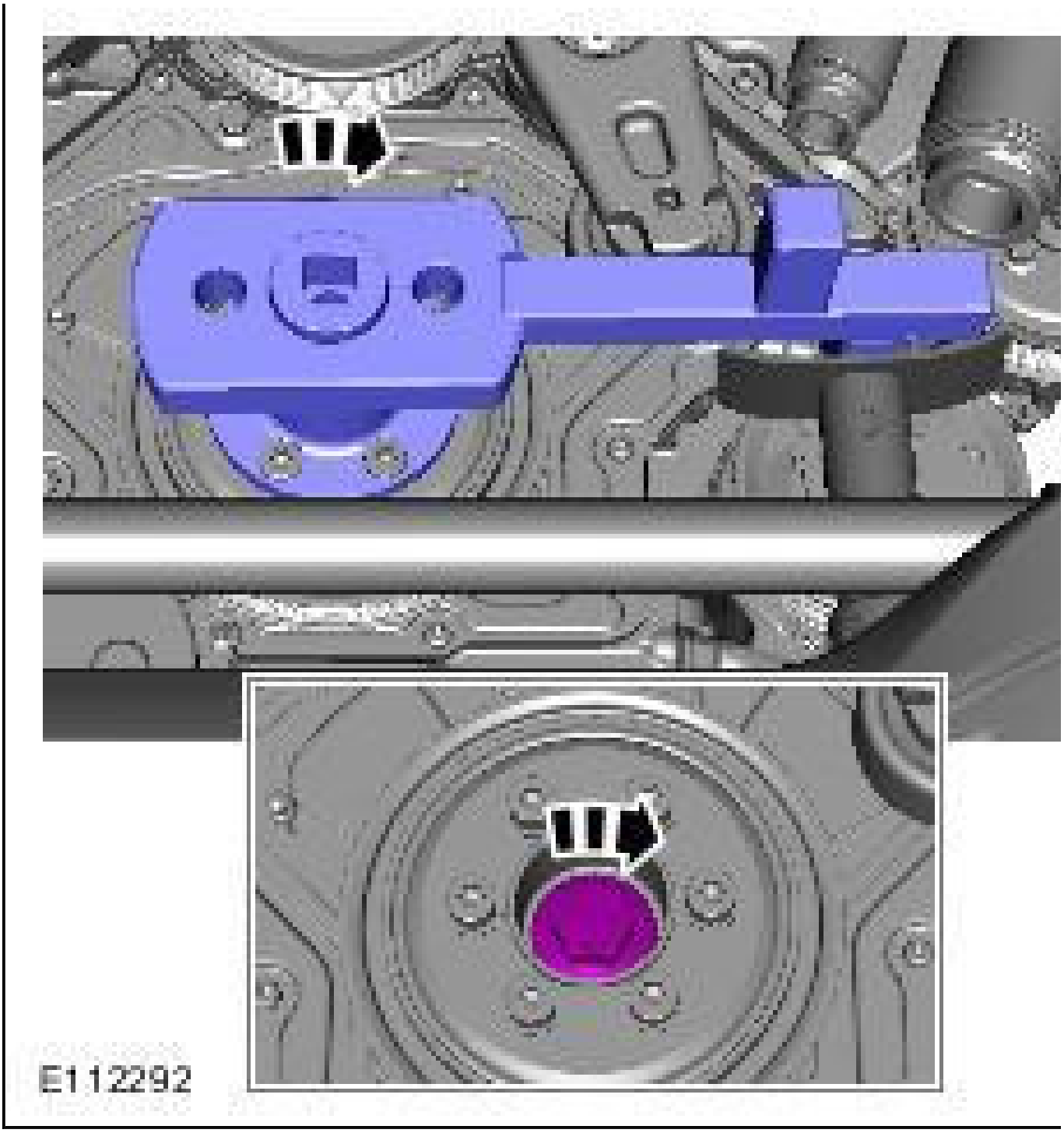

NOTE: **The crankshaft pulley bolt will be very tight.**

NOTE: **Discard the bolt after removal.**

NOTE: **The graphic shows the step for LH thread only, RH thread will be the**

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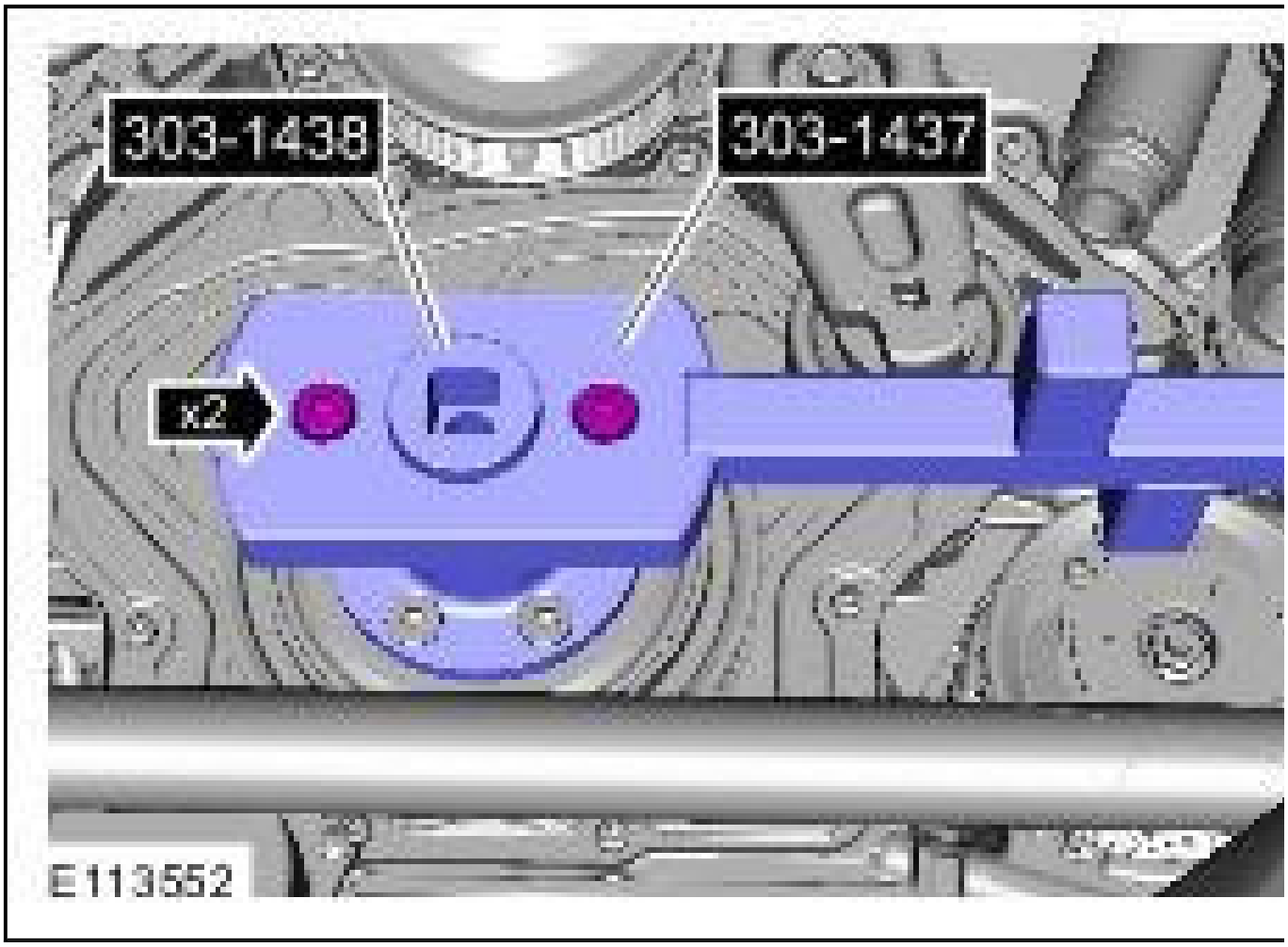
opposite.

14. See figure



15. Remove the special tool.

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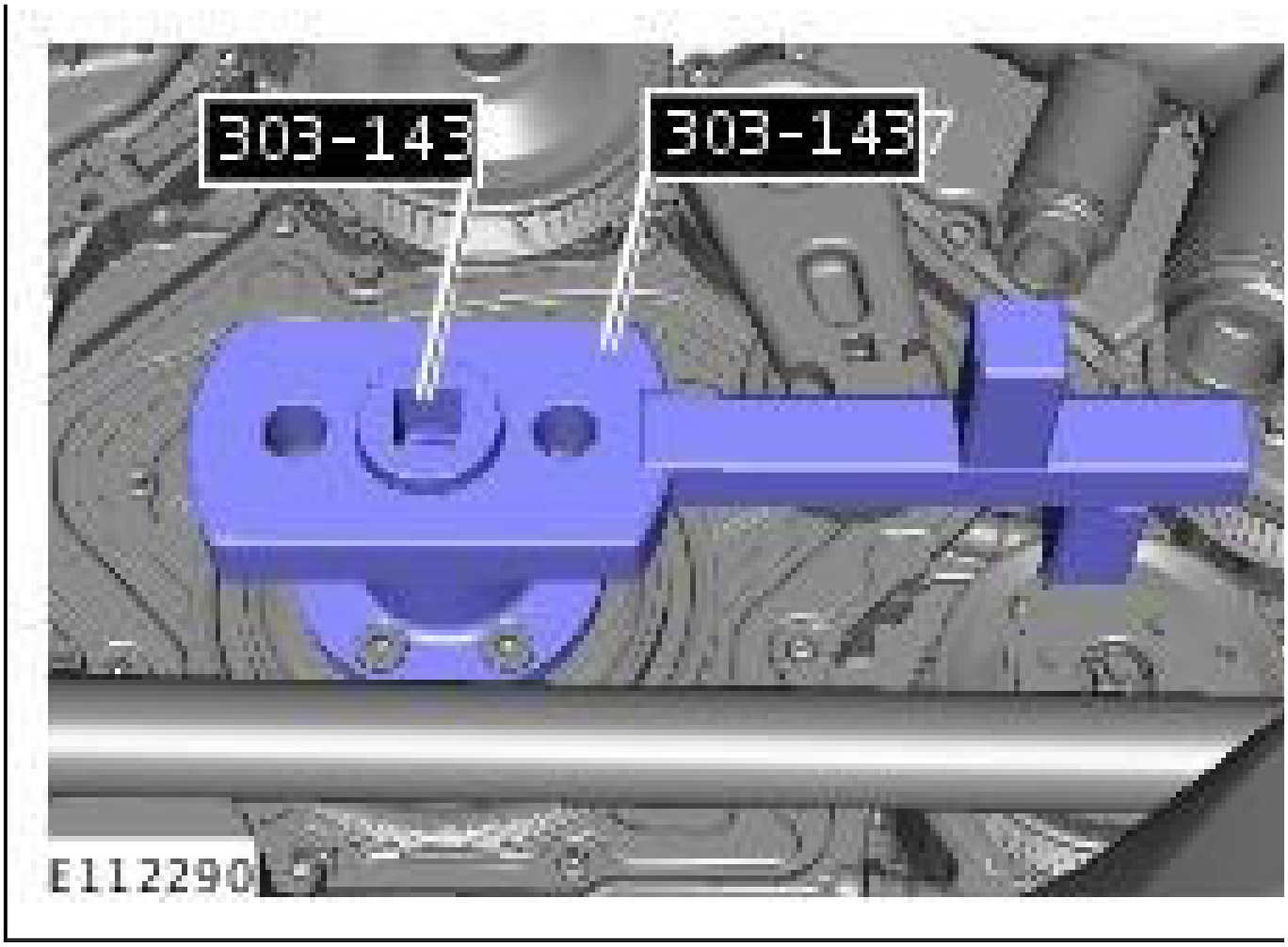

NOTE: **If the crankshaft damper is fitted with an early RH thread crankshaft bolt then the pulley can be removed with a standard puller.**

16. See figure

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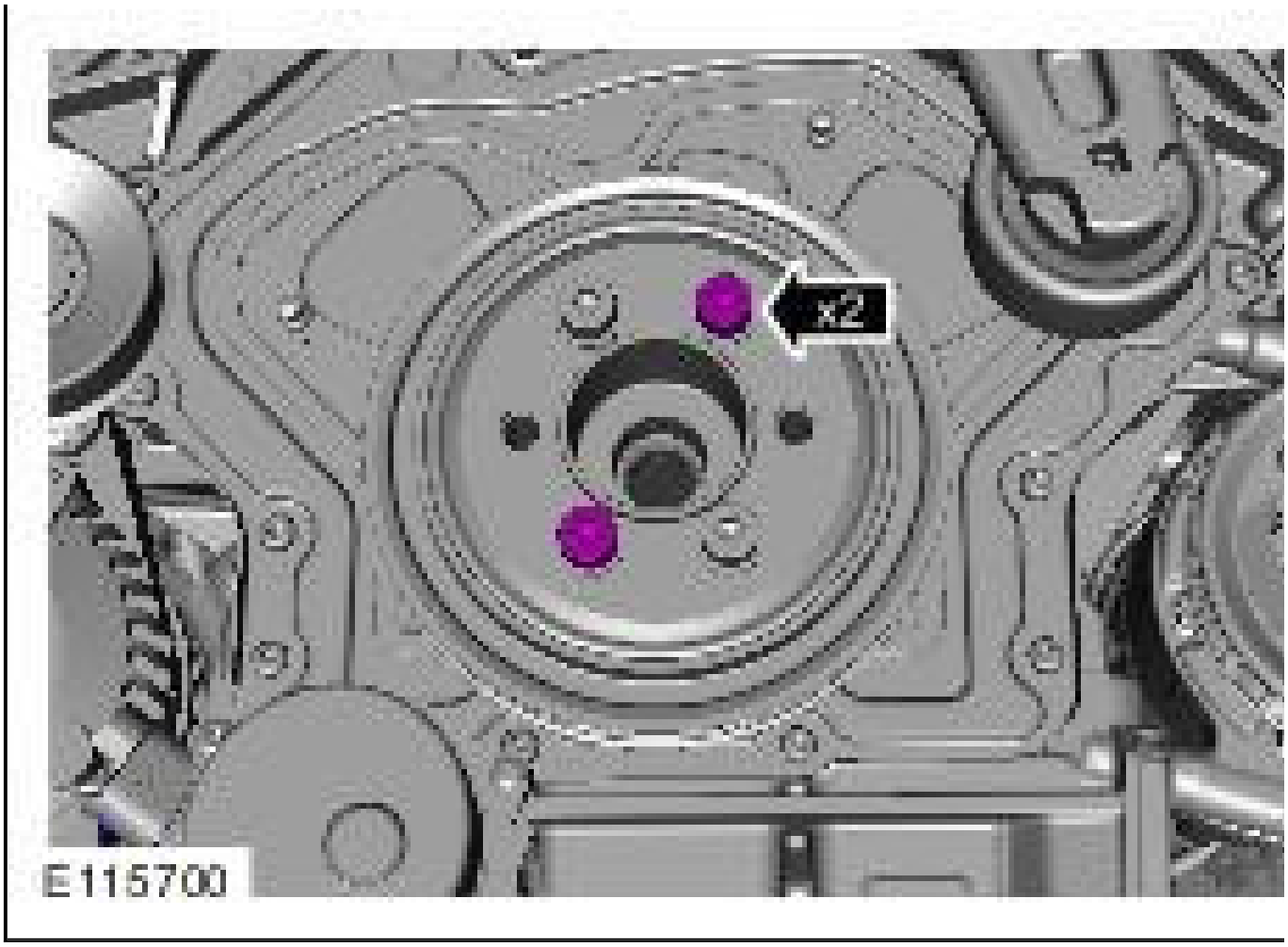

17. Install the special tool.

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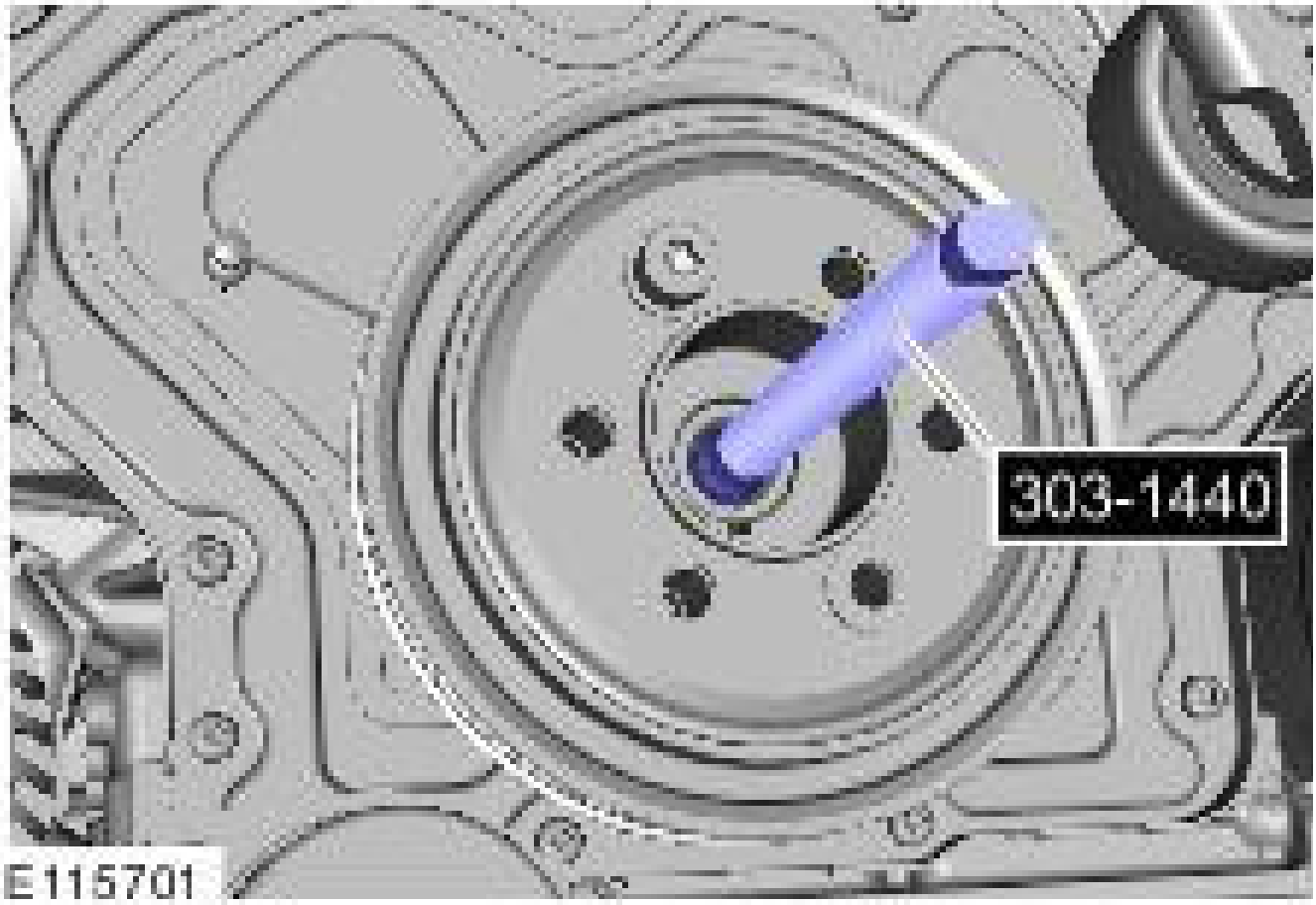

Crankshaft Damper Removal/Installation Stud (303-1440), refer to: **SPECIAL TOOL(S)**

18. Install the special tool.

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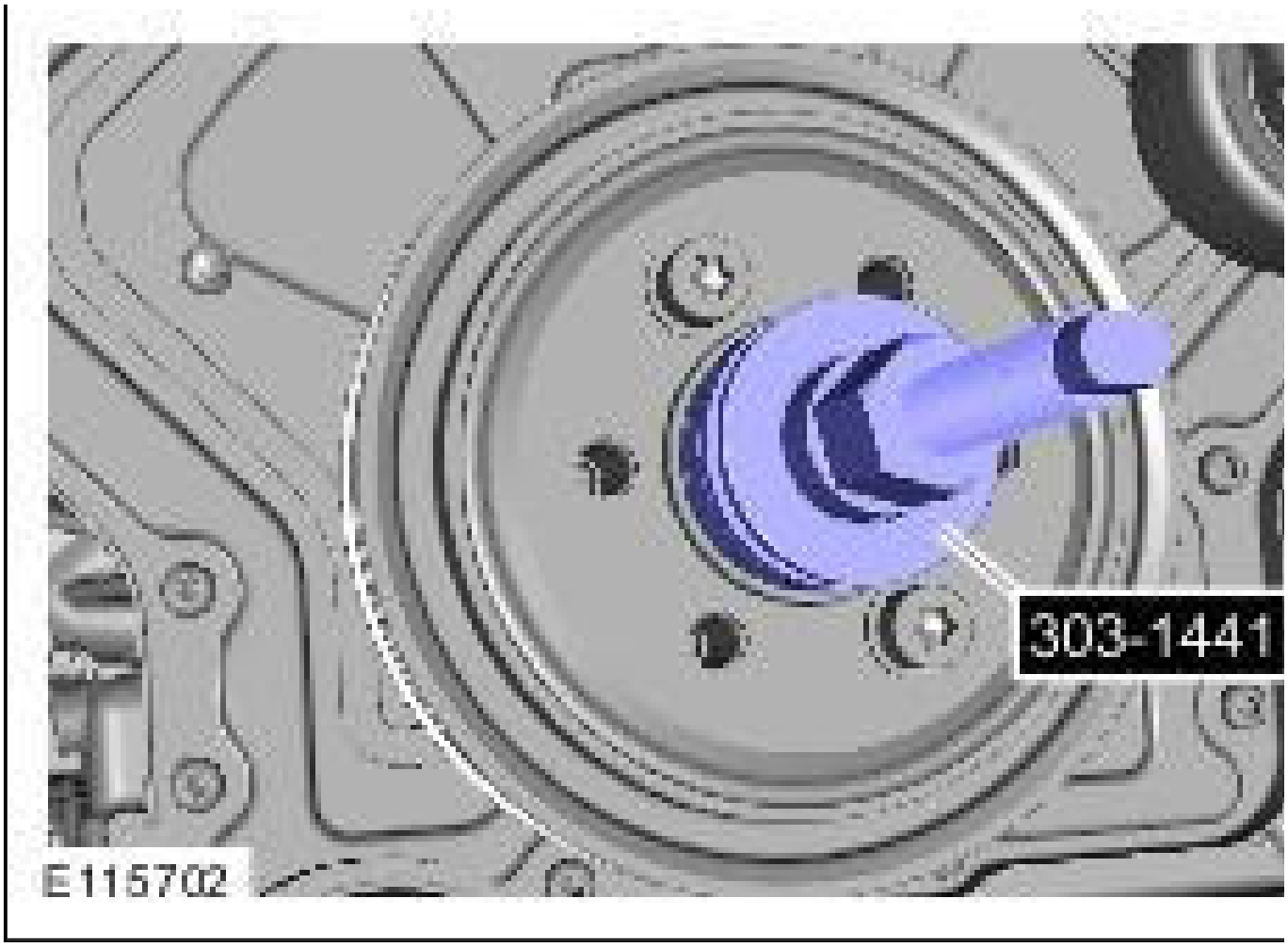

Crankshaft Damper Remover/Installer Body (303-1441), refer to: **SPECIAL TOOL(S)**

19. Install the special tool.

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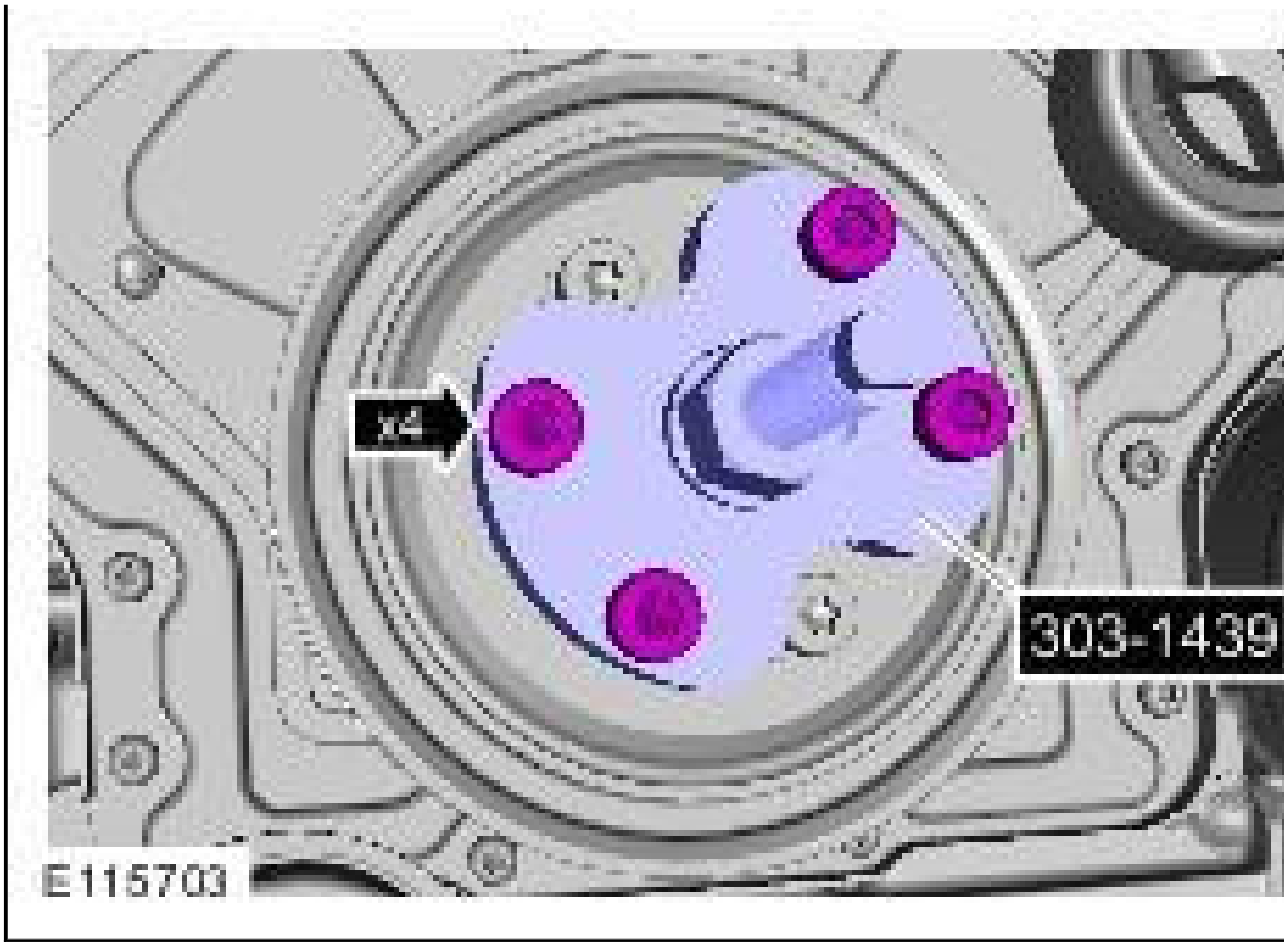

Crankshaft Damper Removal Plate (303-1439), refer to: **SPECIAL TOOL(S)**

20. See figure

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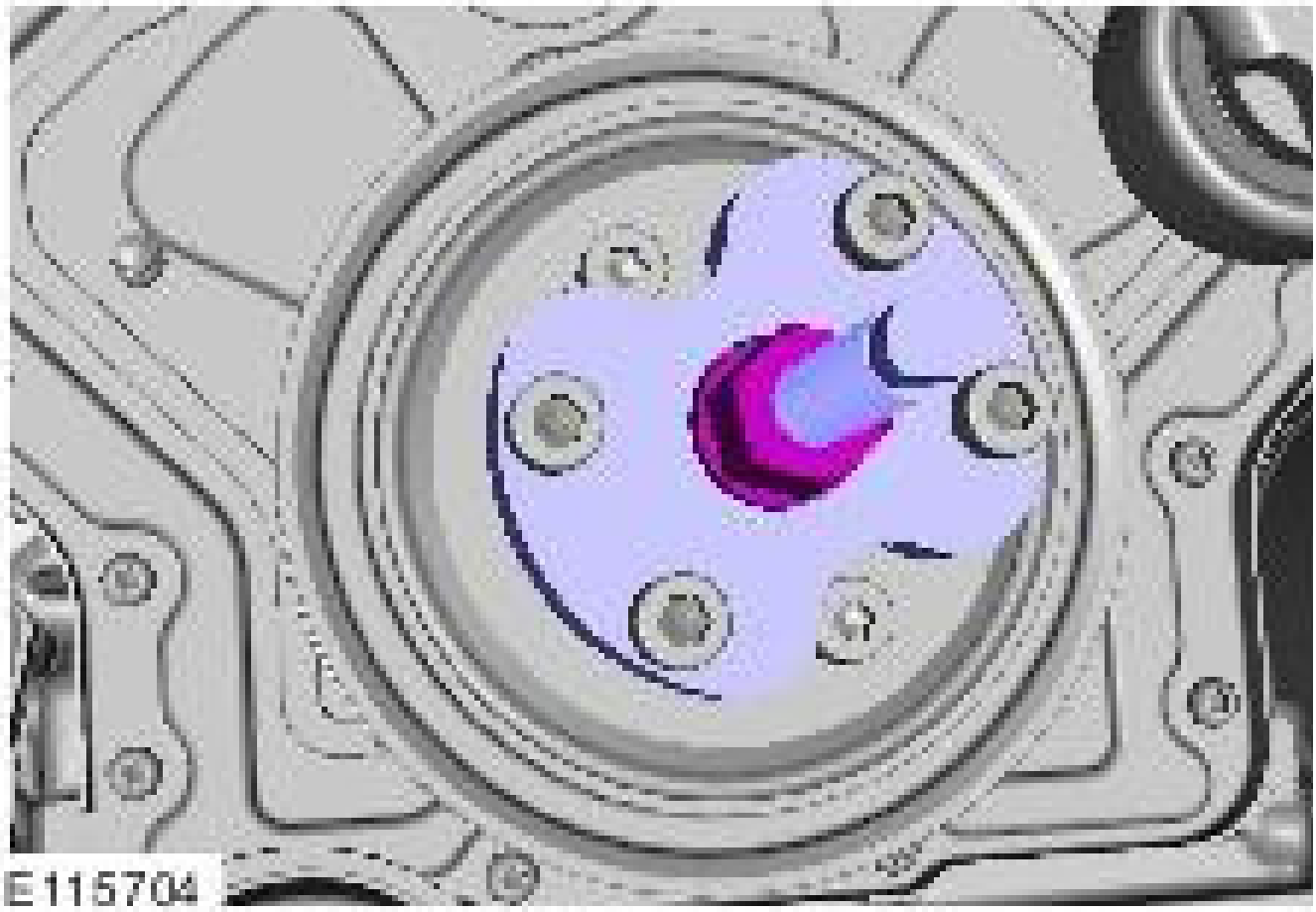

21. See figure

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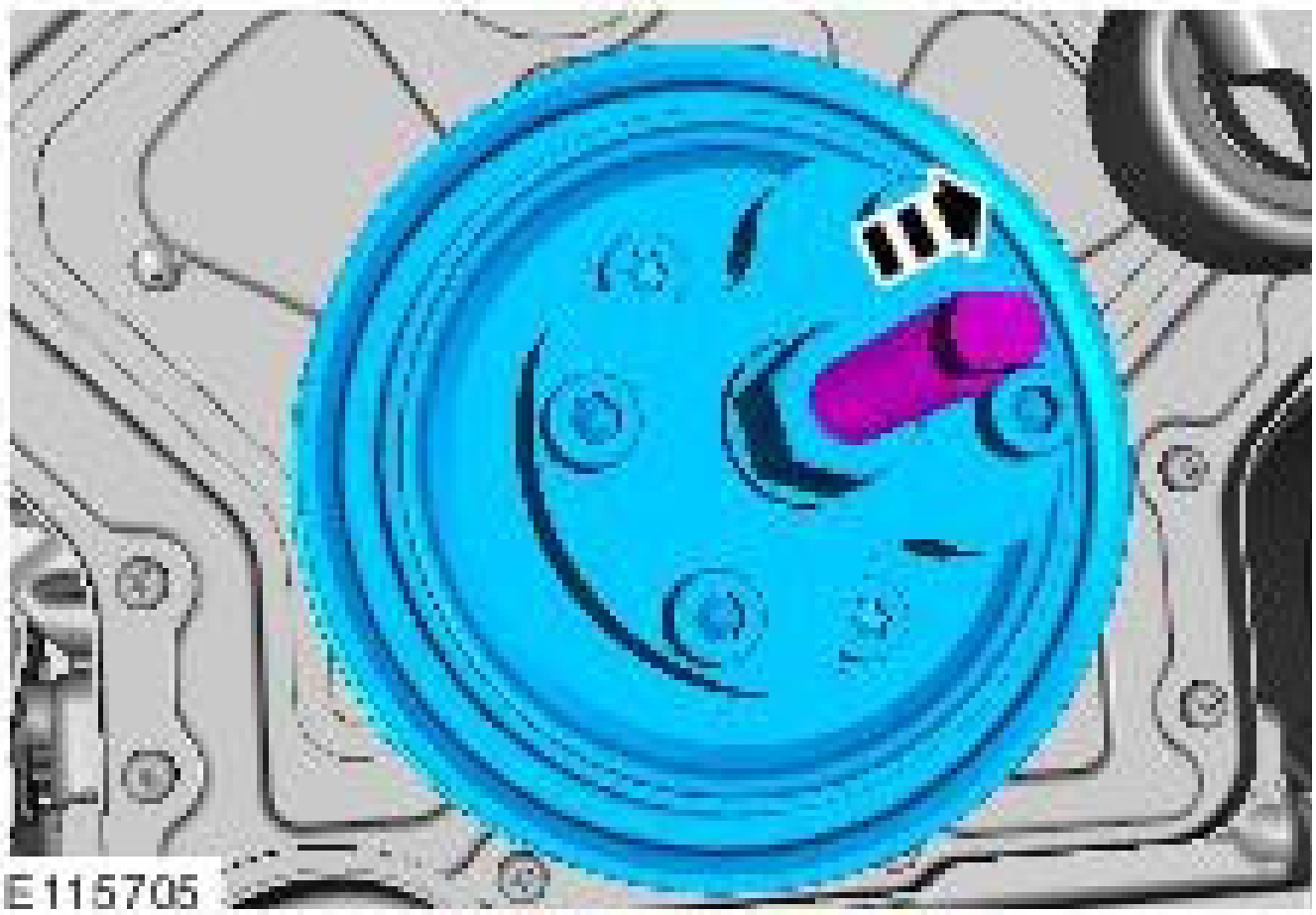

CAUTION: Discard the friction washer after removing the crankshaft pulley.

NOTE: Make sure to clean the threads in the end of the crankshaft and that the crank nose is free of any foreign materials.

22. See figure

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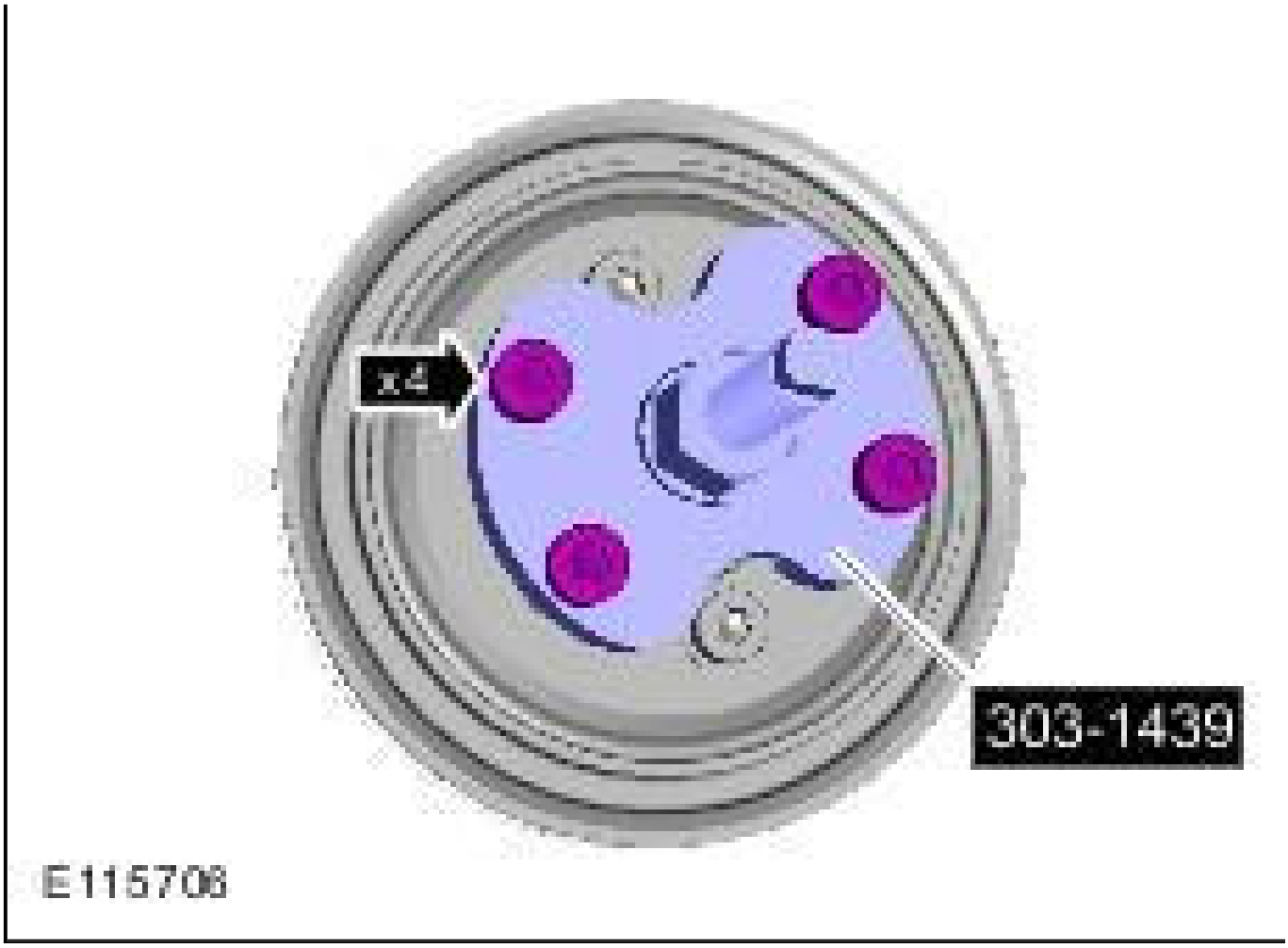

23. See figure

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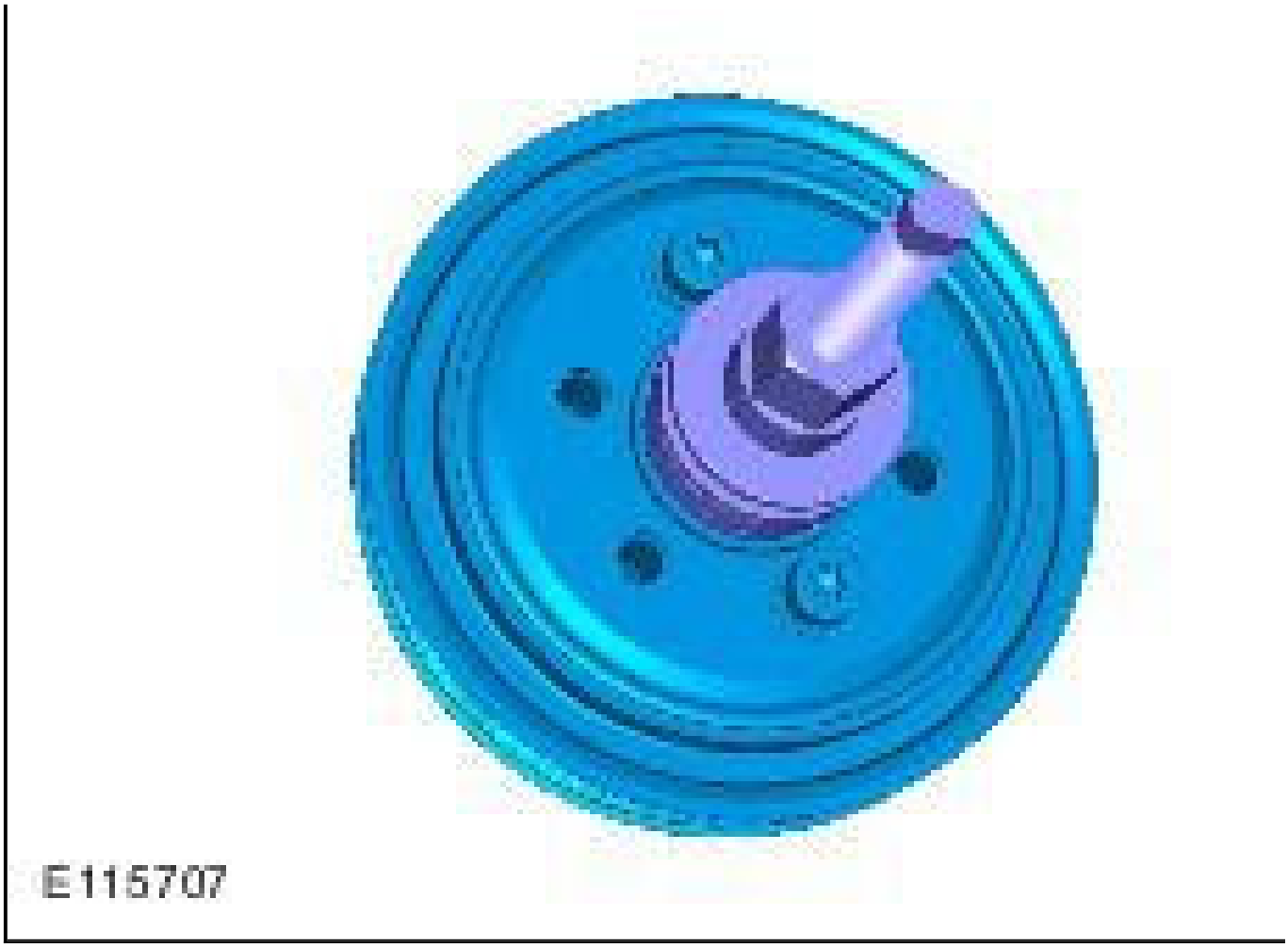

INSTALLATION

1. See figure

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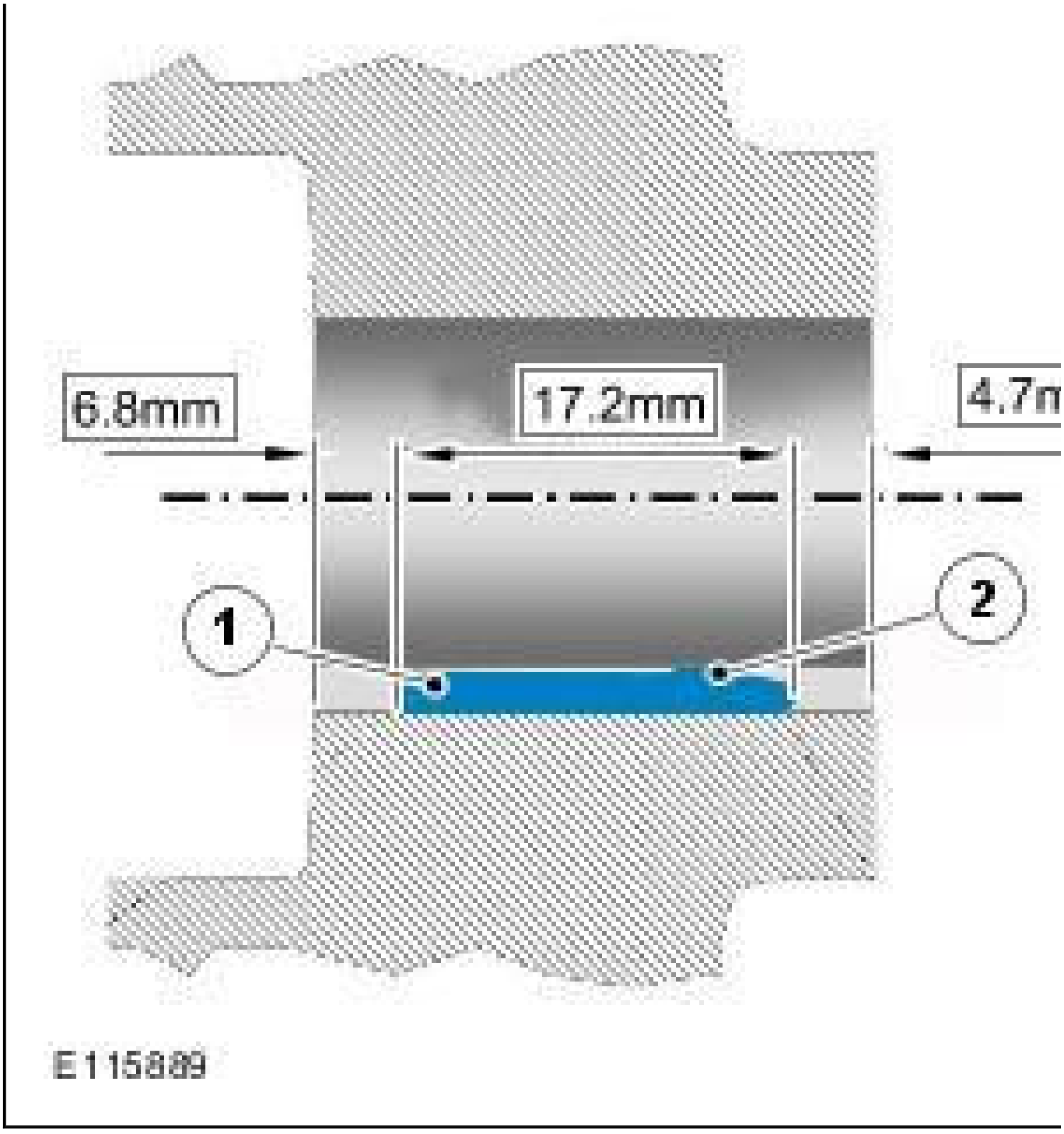

- Apply RTV sealant to the crankshaft pulley keyway.
- Make sure that the RTV sealant is applied in a 2mm diameter bead.
- Make sure that when the RTV sealant is applied that the RTV sealant is level with the top of the keyway.

2. See figure

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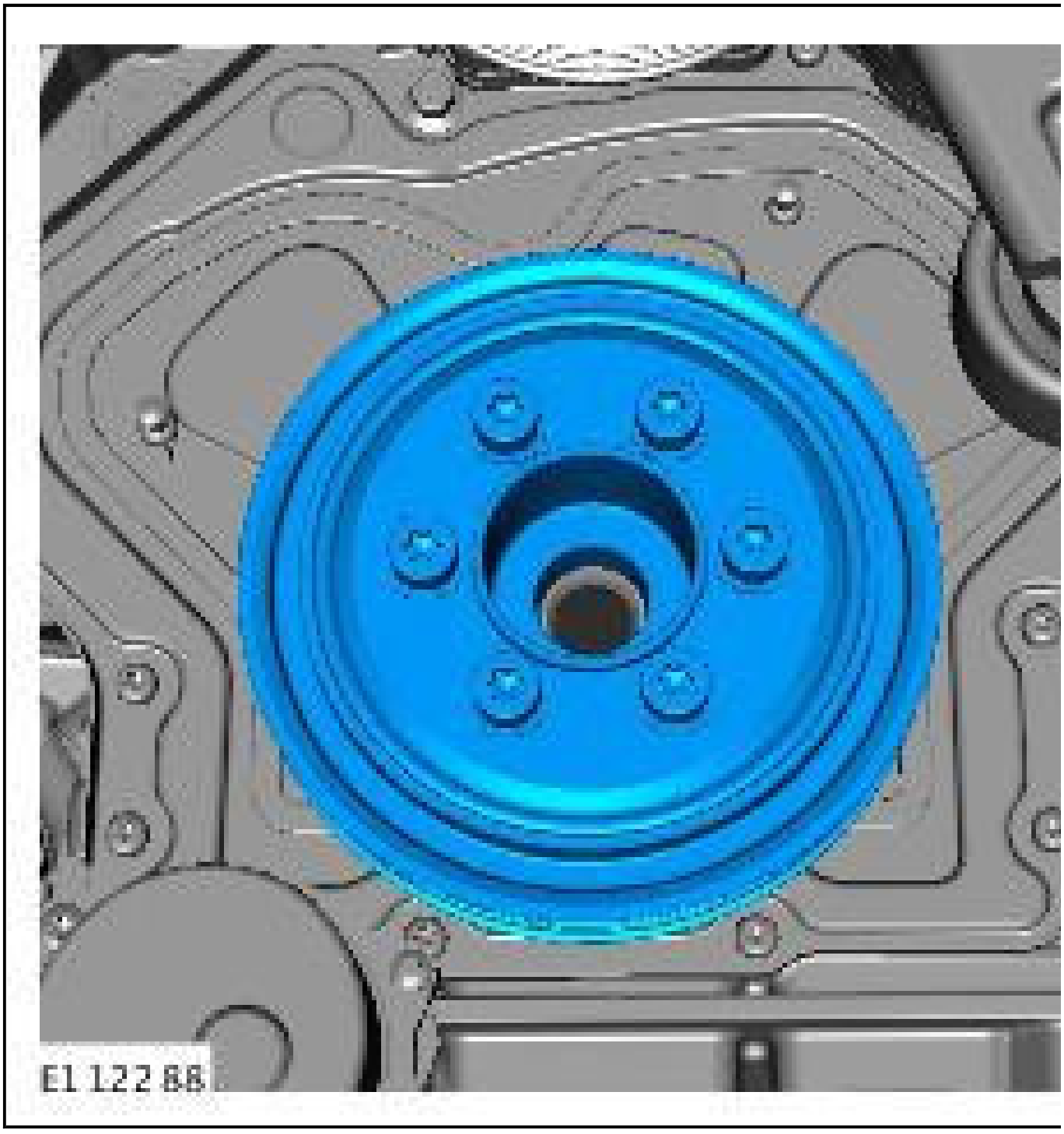

CAUTION: Install a new friction washer before installing the crankshaft pulley.

NOTE: Skip to step 11 for engines fitted with early RH thread crankshaft bolt.

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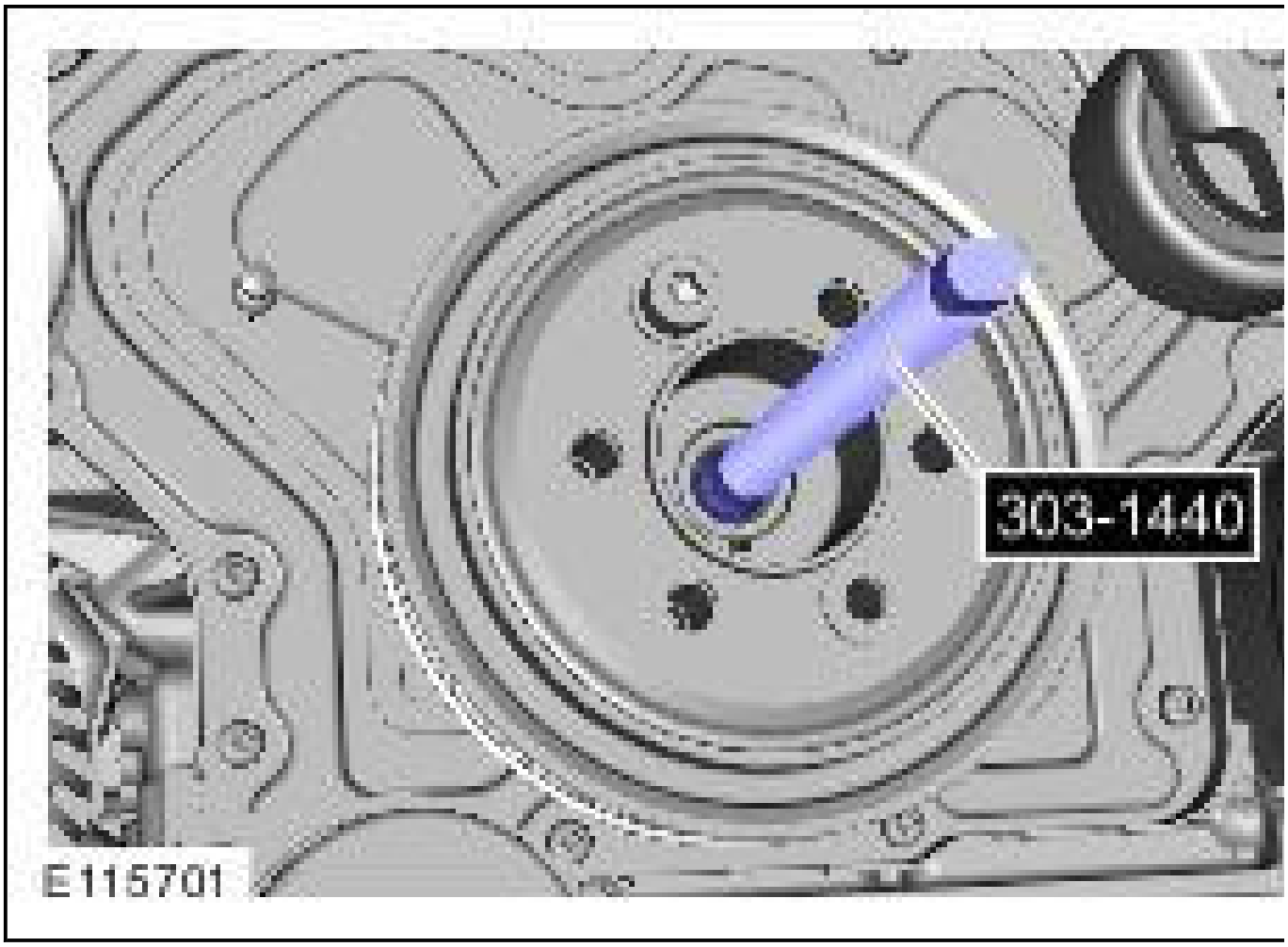
NOTE: **Make sure to clean the threads in the end of the crankshaft and that the crank nose is free of any foreign materials.**

3. Install the special tool, refer to: **SPECIAL TOOL(S)**



4. Install the special tool, refer to: **SPECIAL TOOL(S)**

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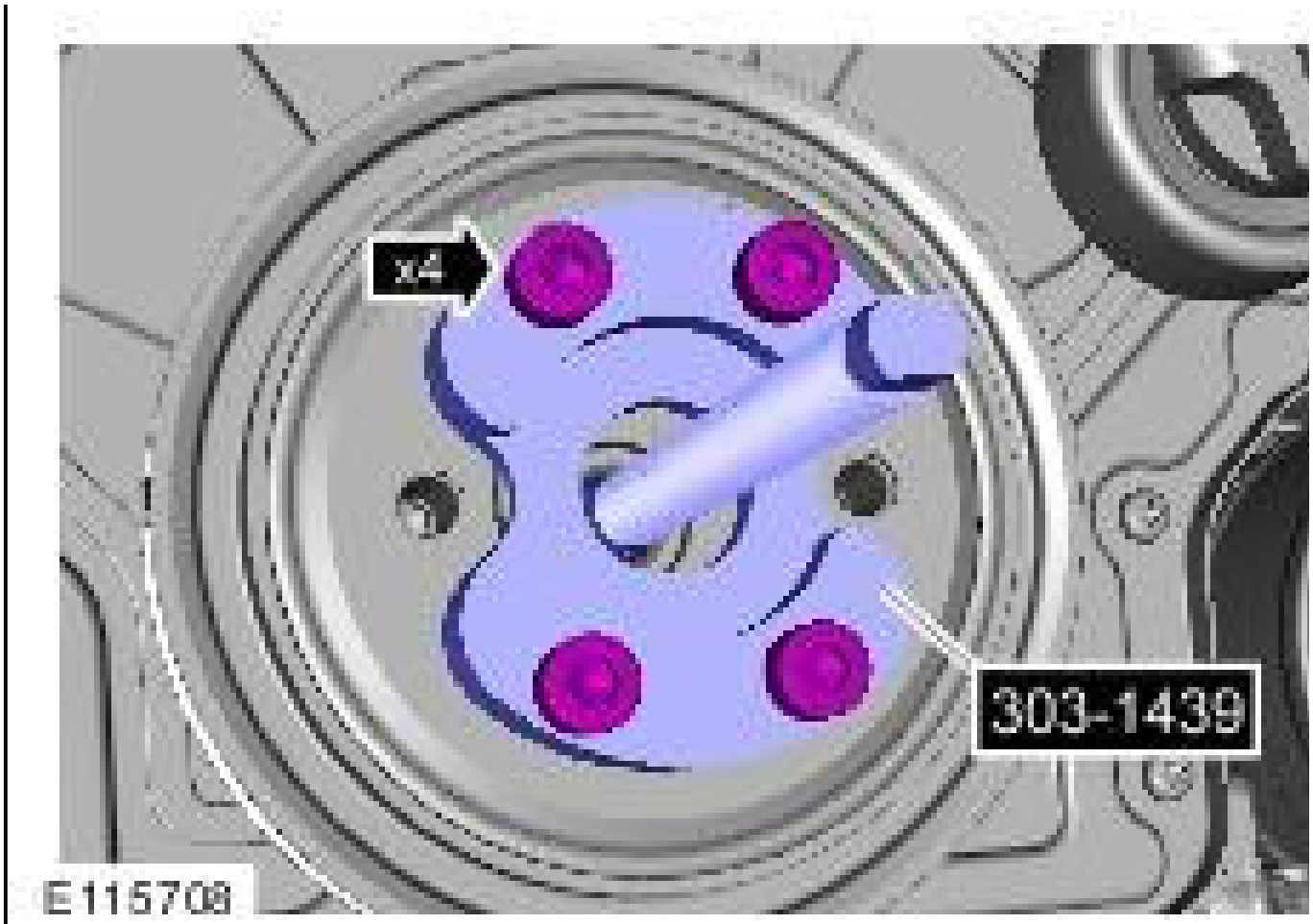

5. Install the special tool, refer to: **SPECIAL TOOL(S)**

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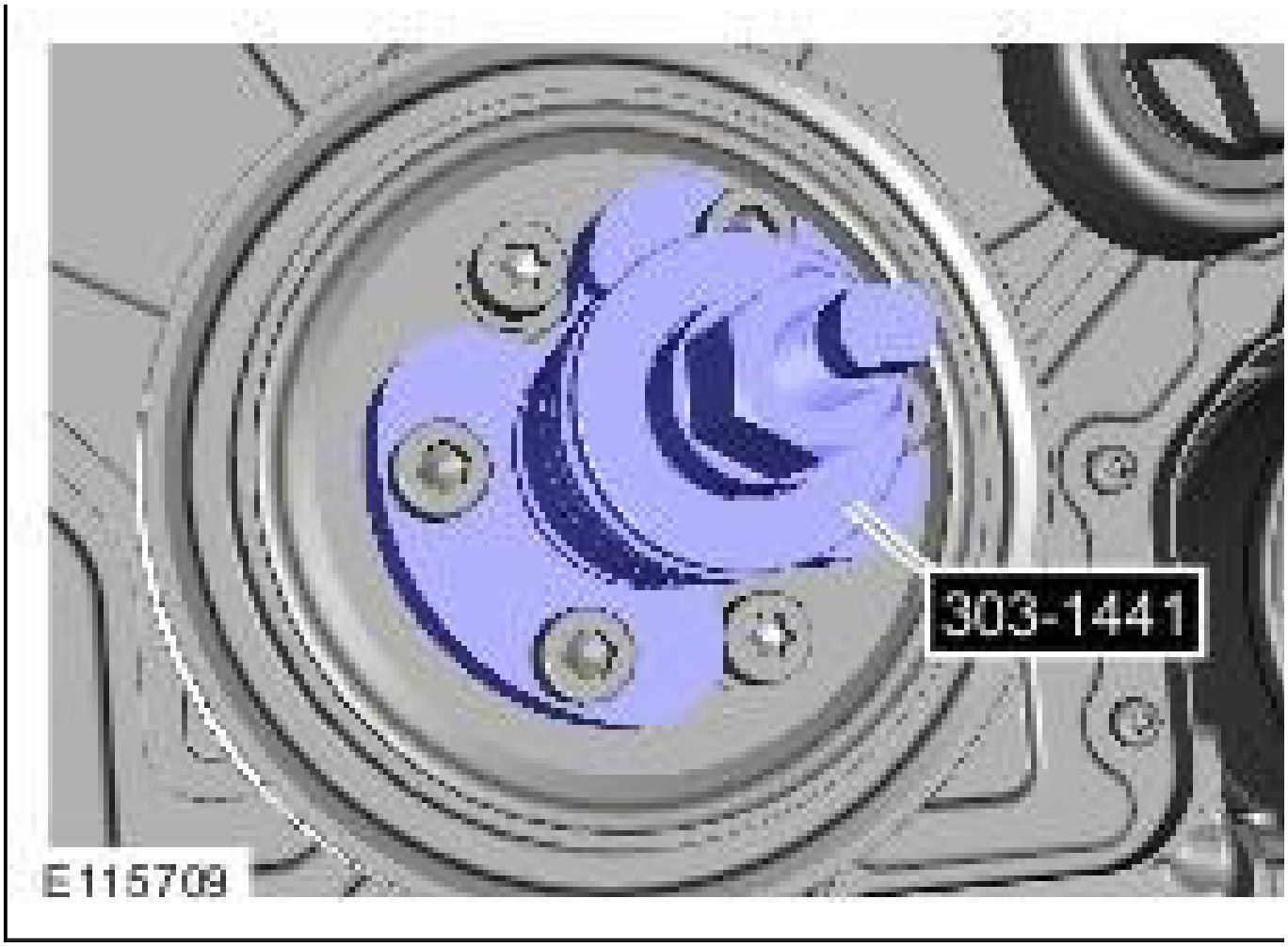

6. See figure

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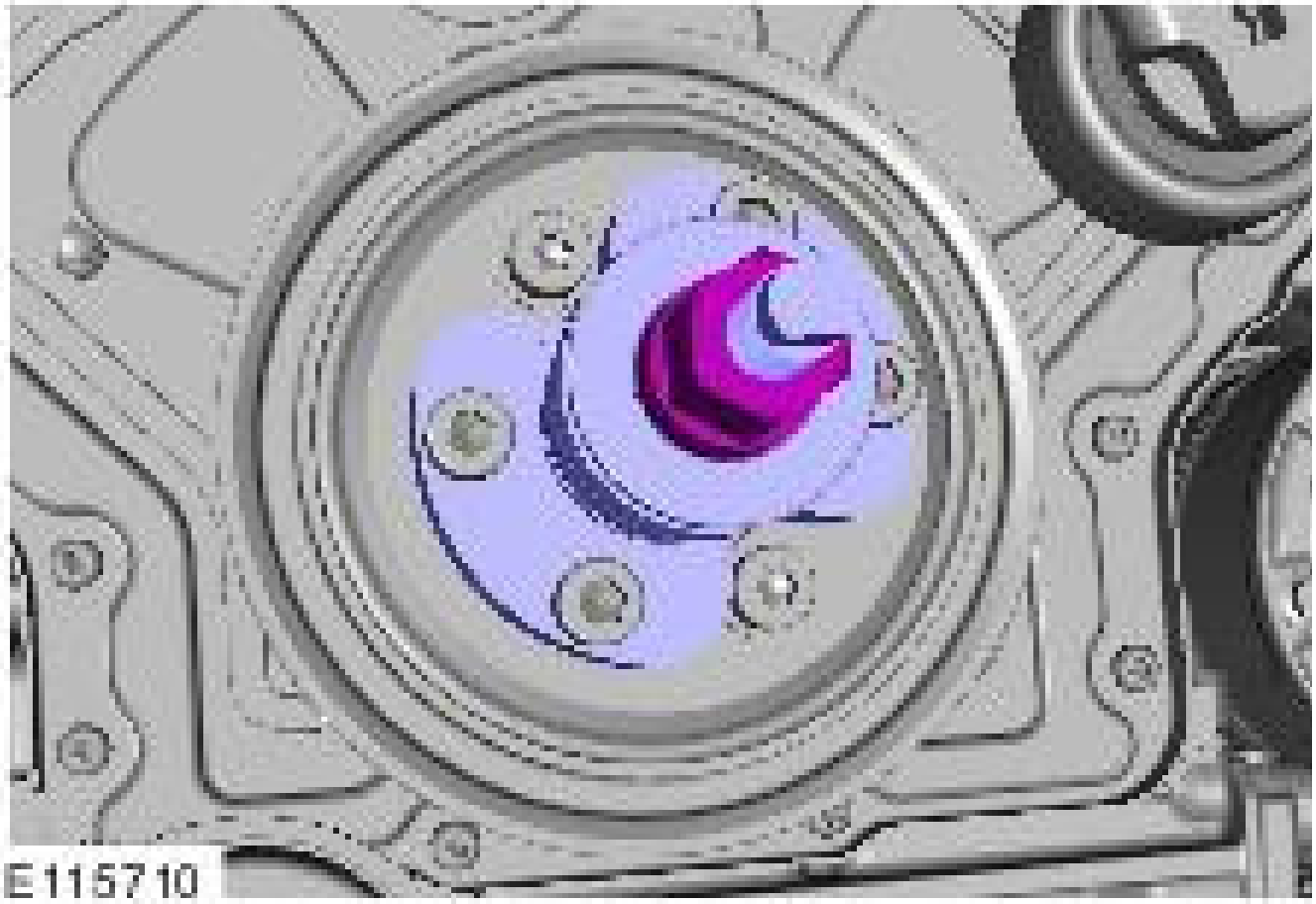

CAUTION: Rotate the crankshaft pulley installation tool anti-clockwise until the pulley is fully located, do not over tighten. Failure to do this may result in damage to the components.

7. Remove the special tool, refer to: **SPECIAL TOOL(S)**

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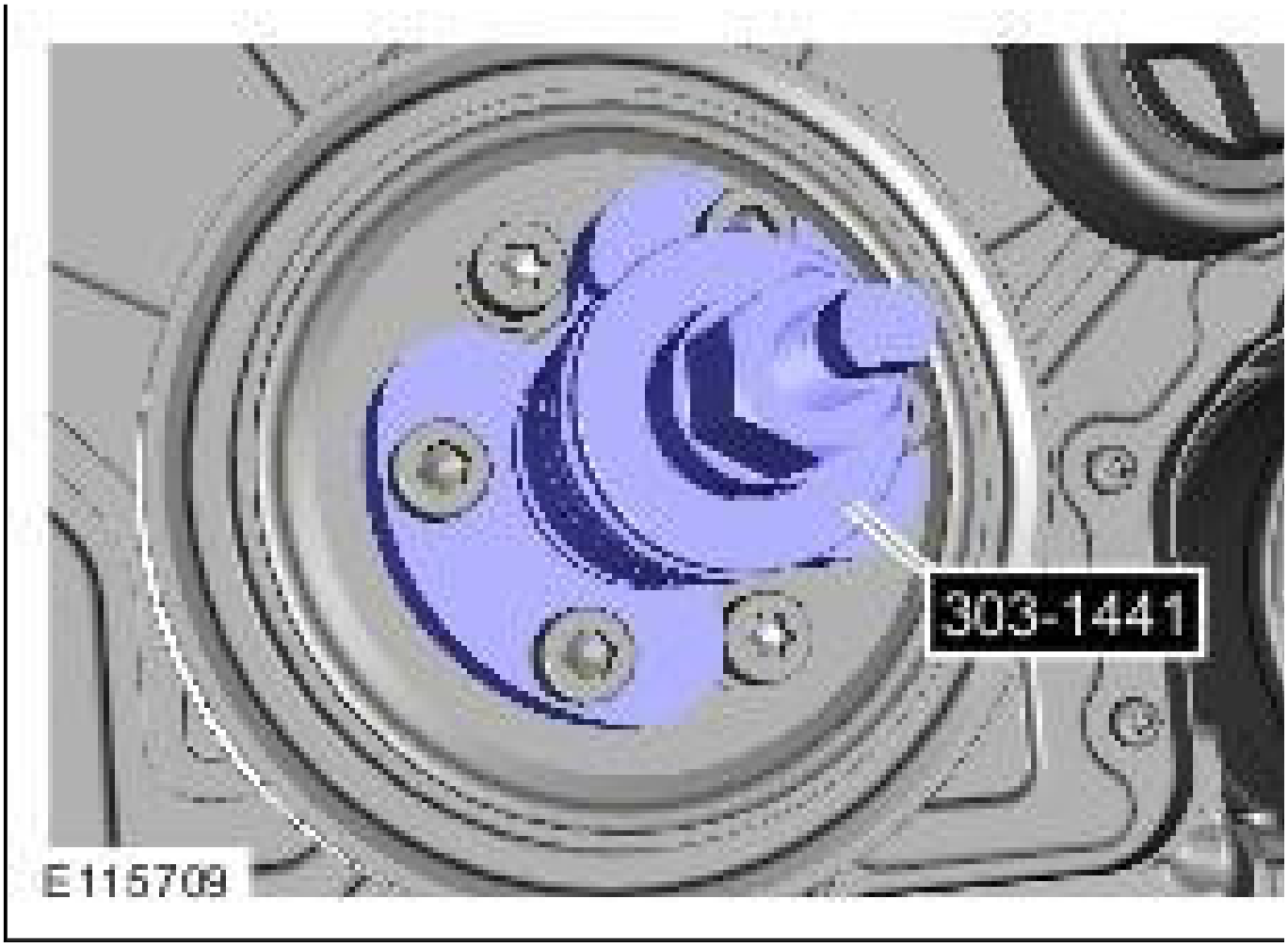

8. See figure

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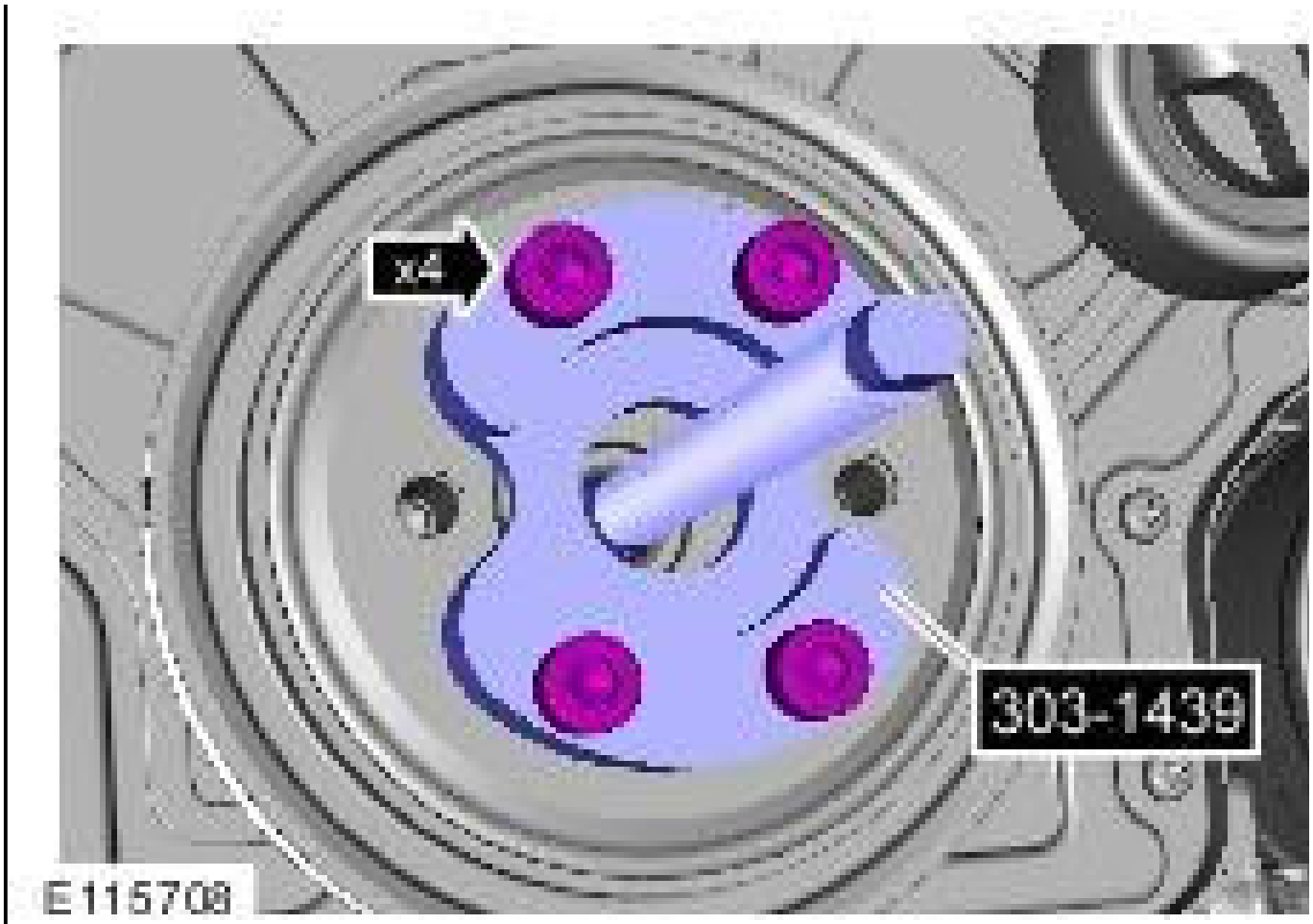

- Remove the special tool, refer to: **SPECIAL TOOL(S)**

9. Remove the special tool, refer to: **SPECIAL TOOL(S)**

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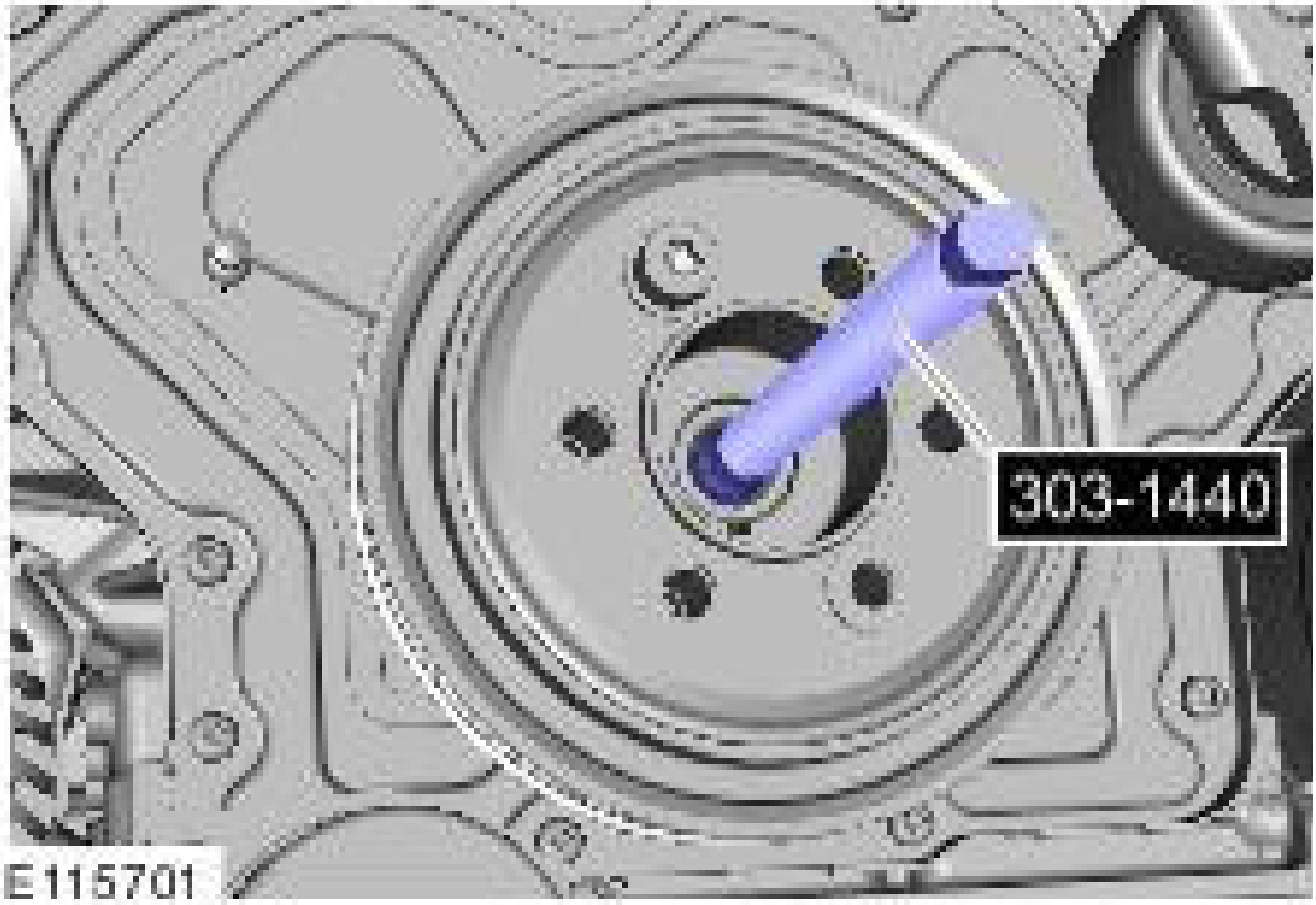

10. See figure

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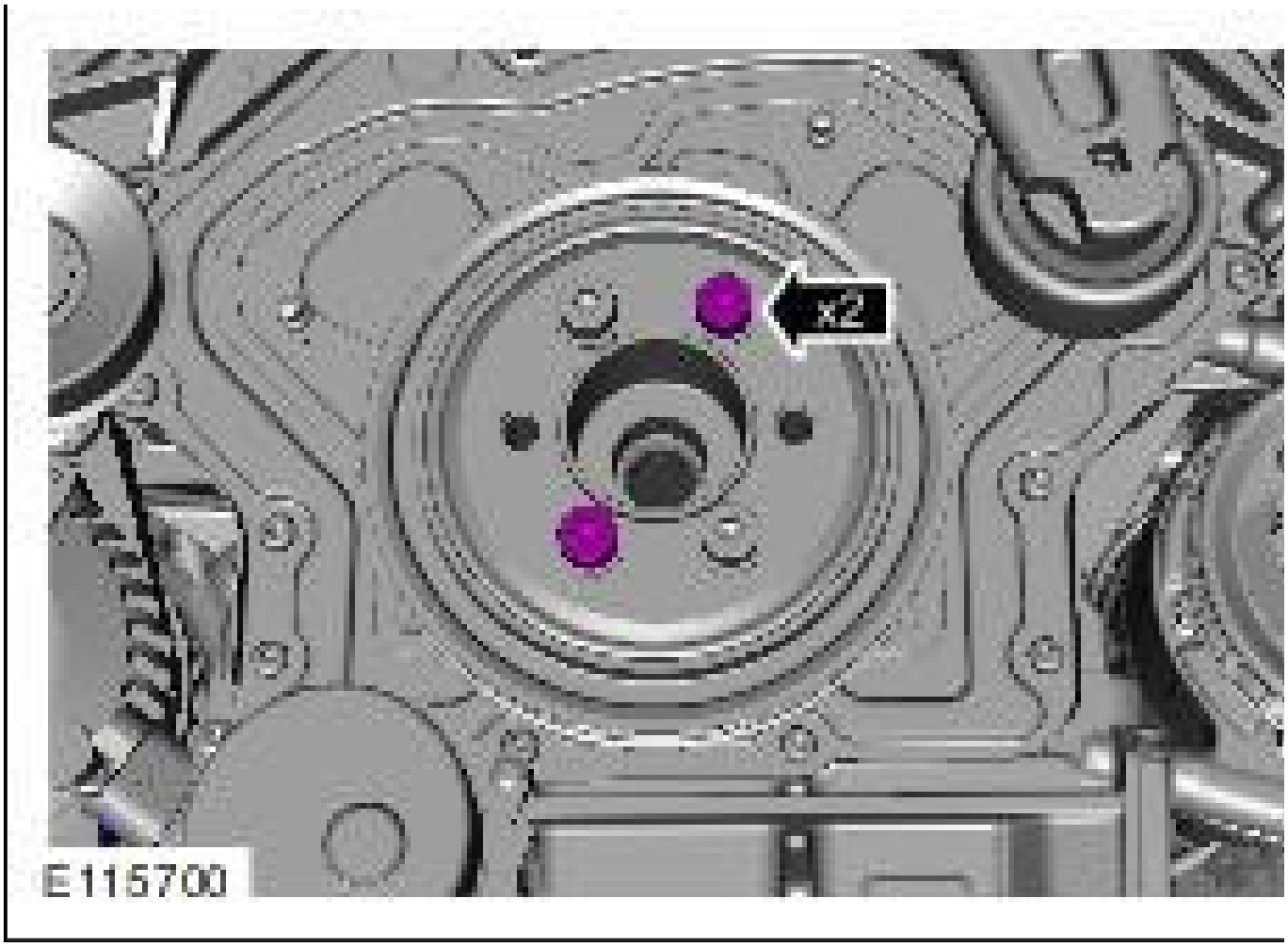

WARNING: **Make sure that a new bolt is installed.**

- Apply Loctite 270 to the thread of the bolts.
- Torque: 65 Nm

11. Remove the special tool, refer to: **SPECIAL TOOL(S)**

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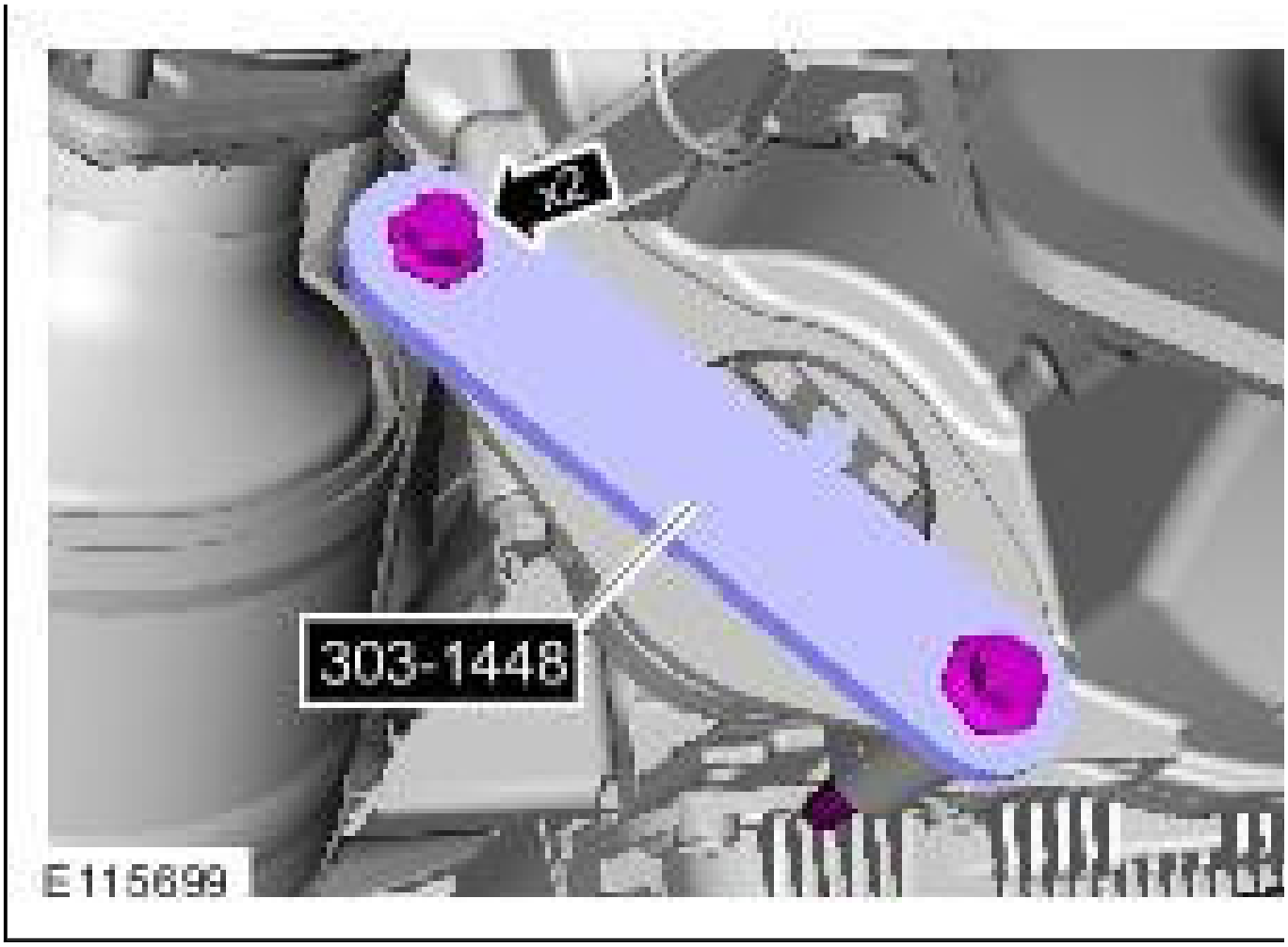

12. See figure

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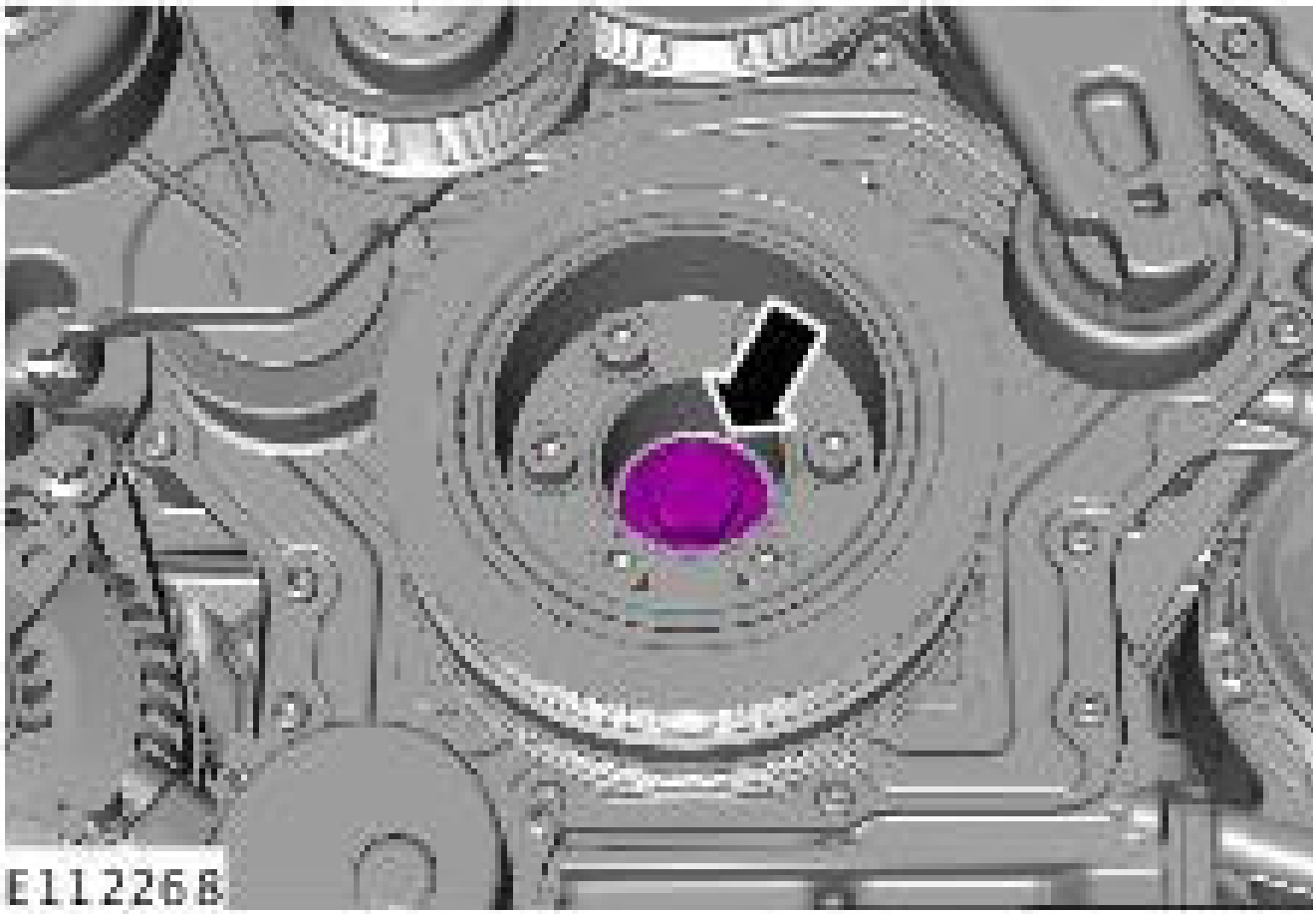

WARNING: **Make sure that a new bolt is installed.**

13. Install the special tool, refer to: **SPECIAL TOOL(S)**

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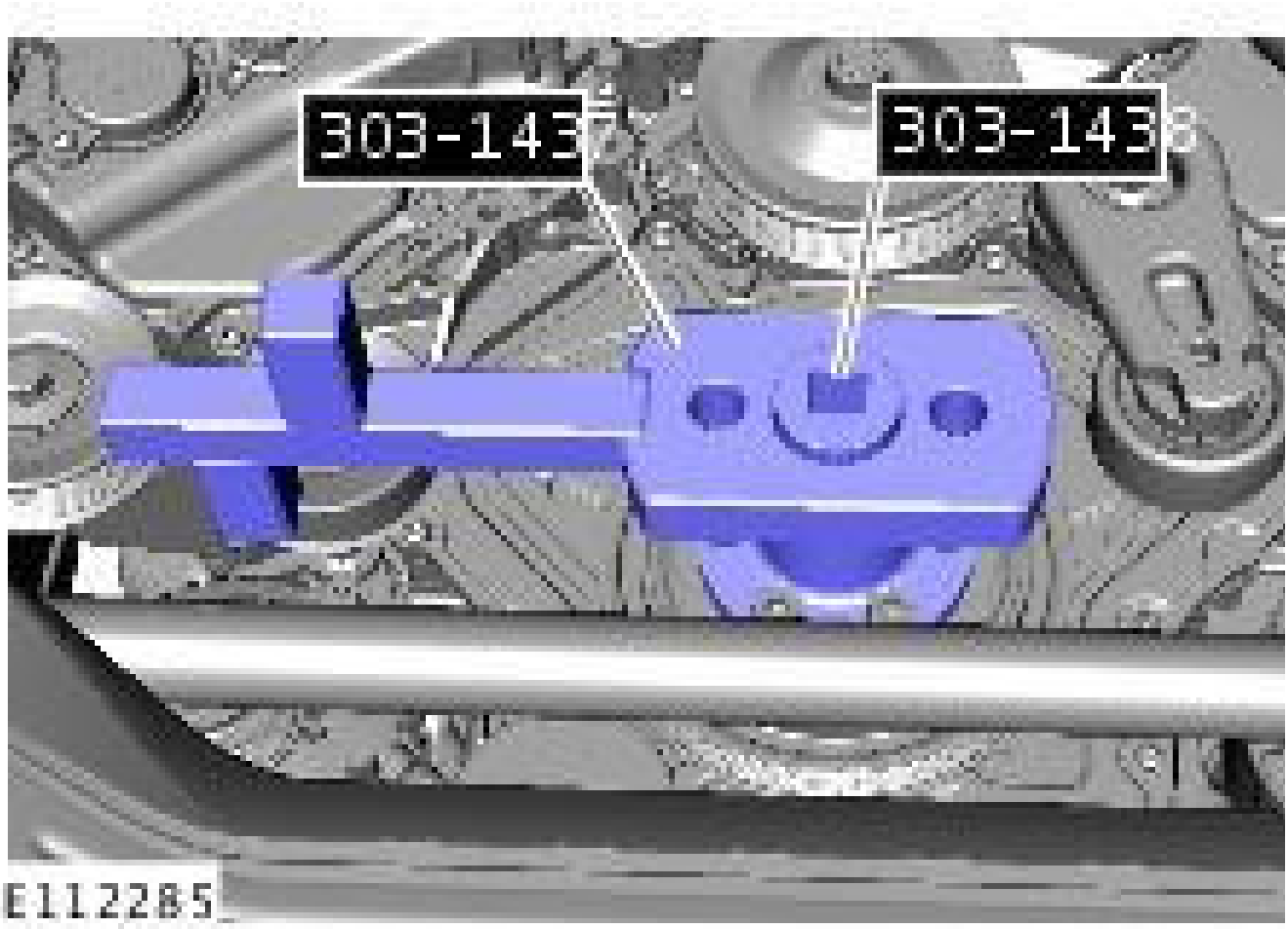

14. Torque: 65 Nm

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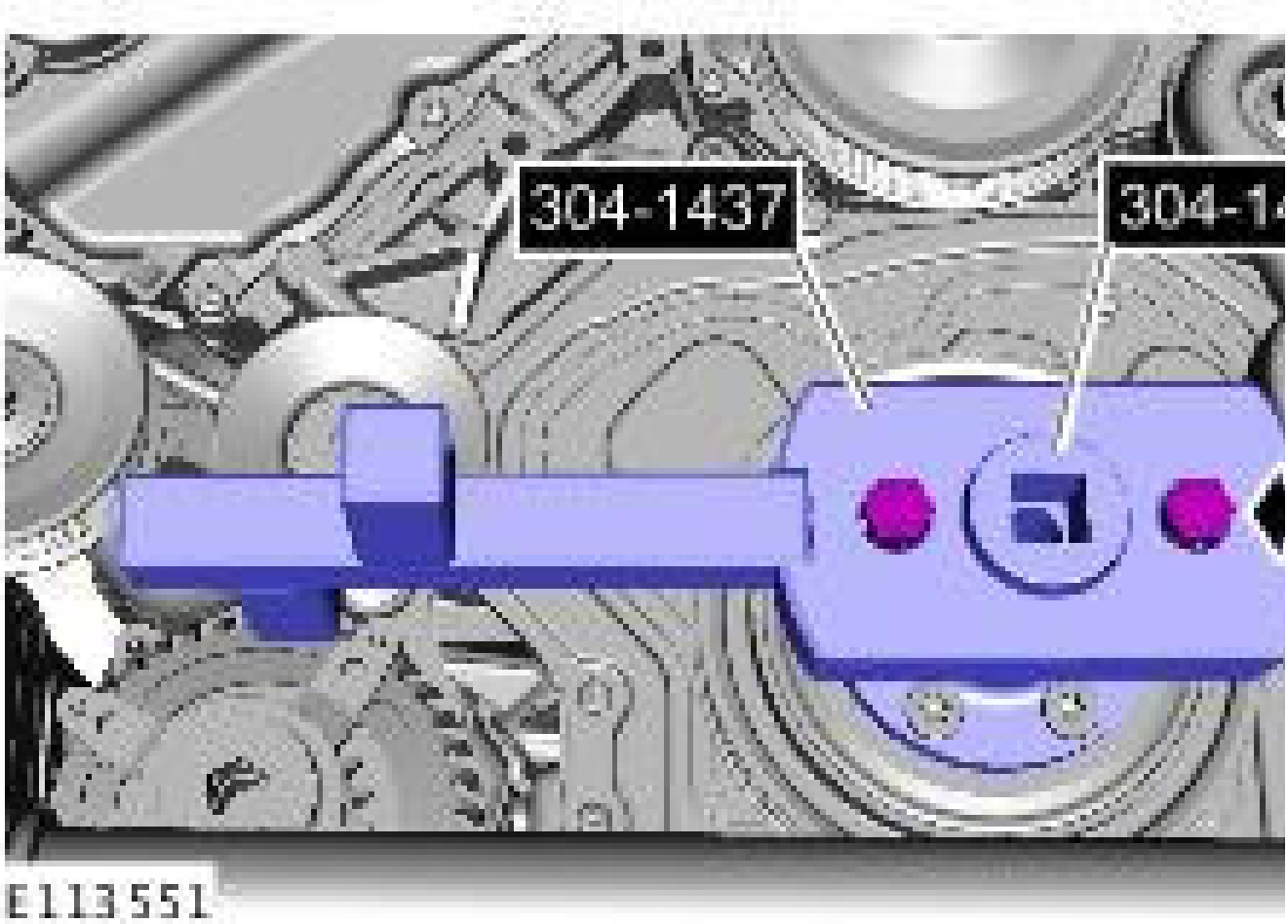

15. See figure

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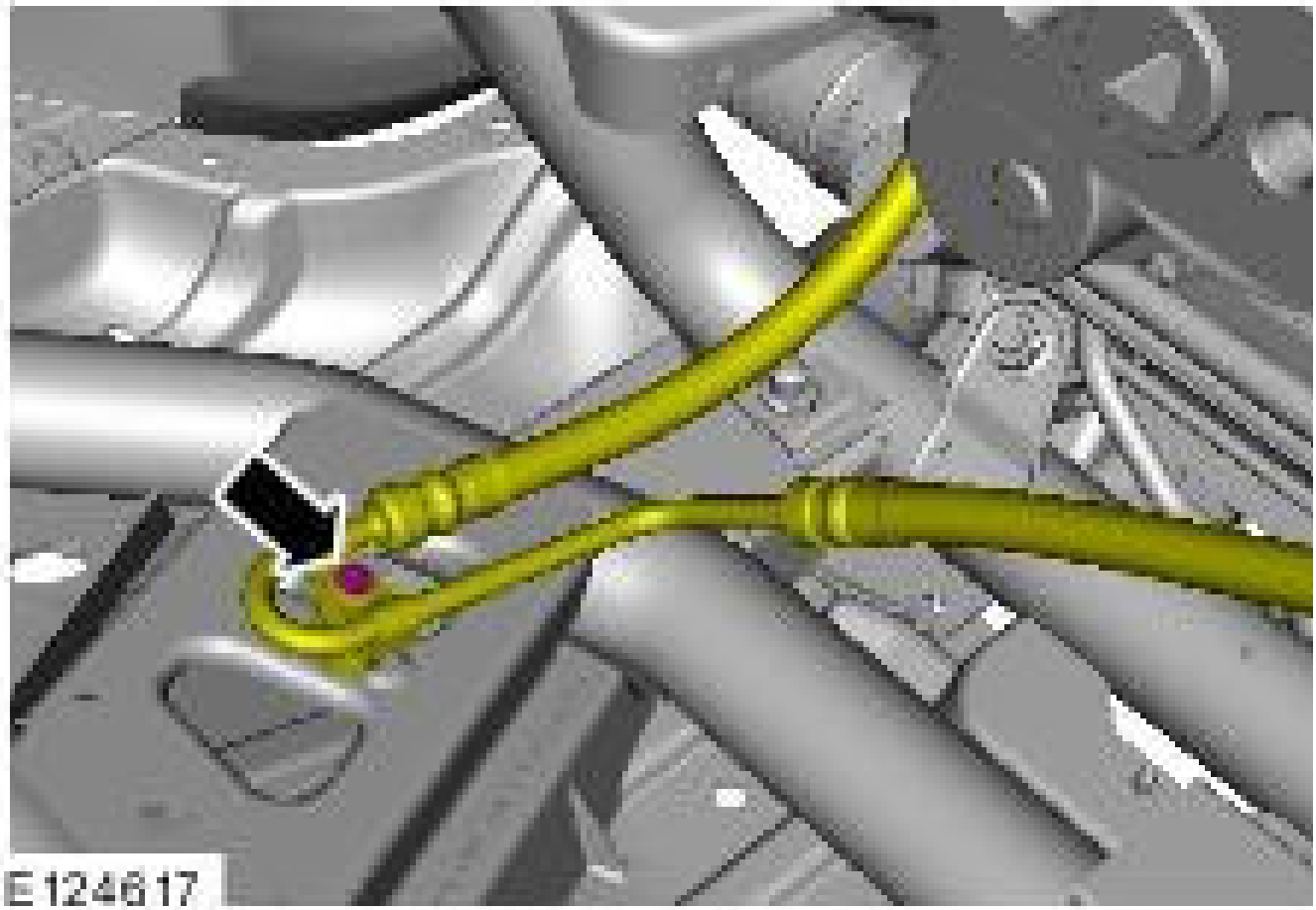

16. Using a suitable wooden block and an axle stand extension, support the special tool.

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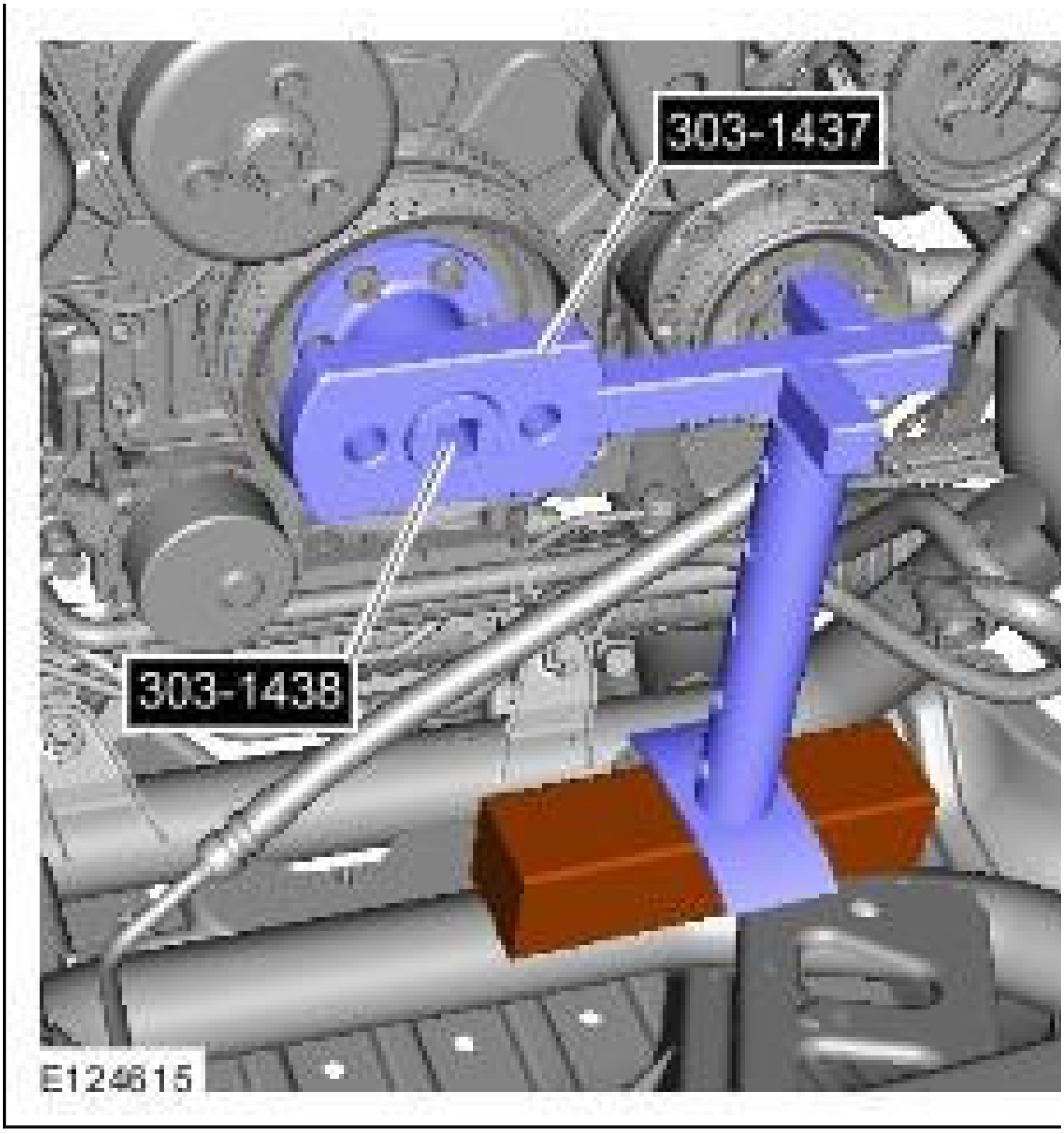

17. Torque: 200 Nm

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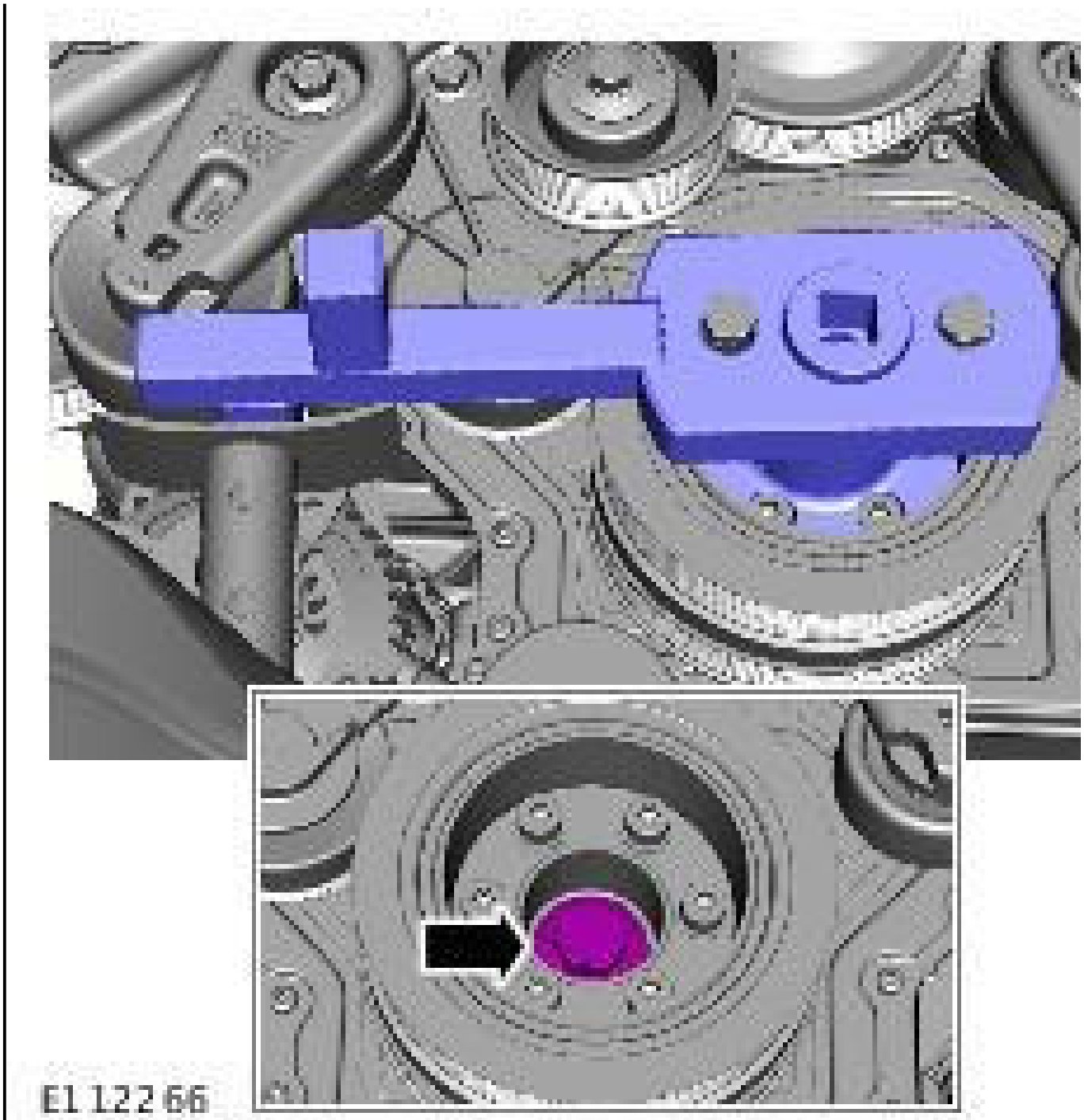

18. See figure

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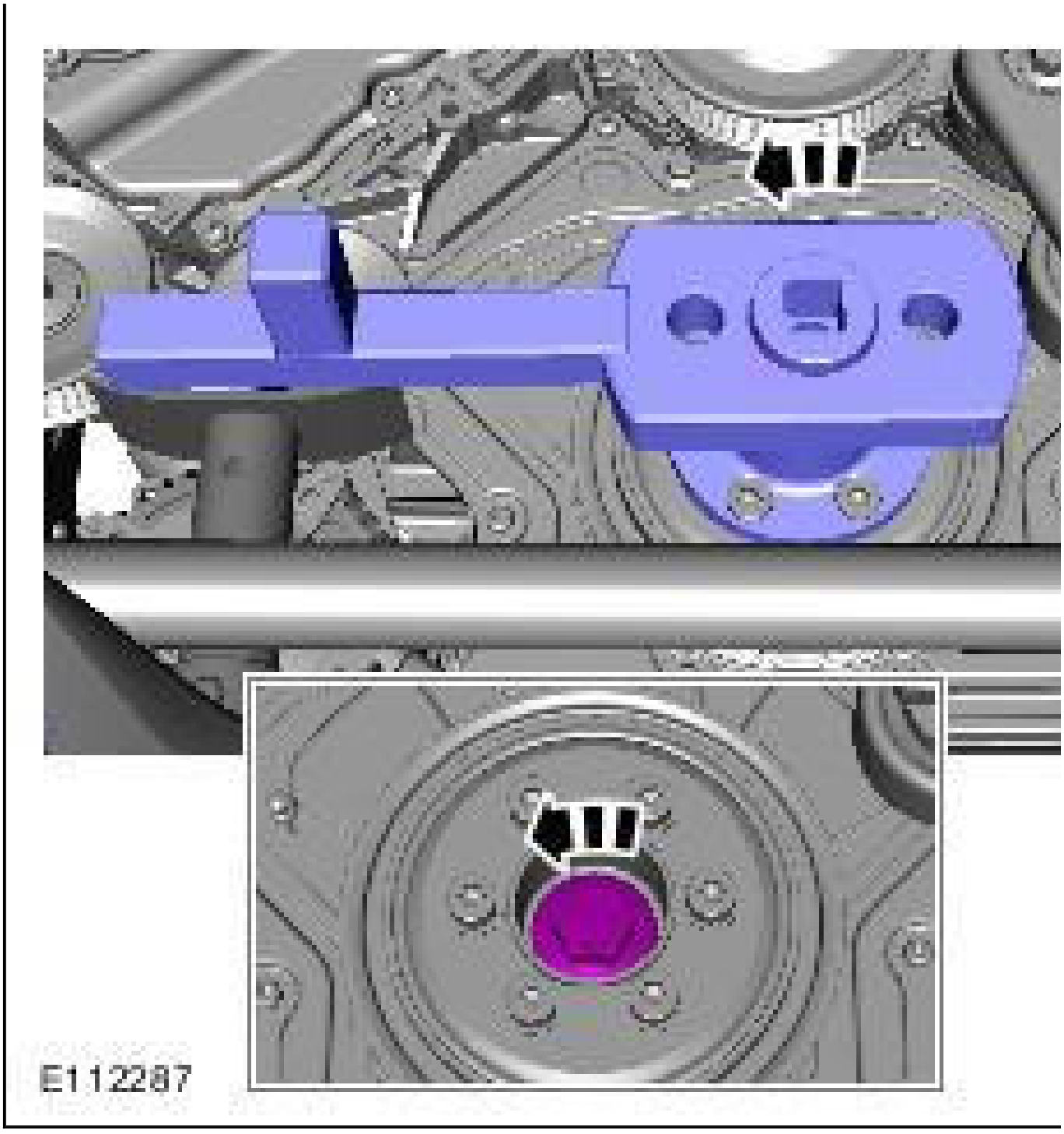

NOTE: The use of a torque multiplier capable of 600Nm will be required.

- Torque: 270°
- Make sure that the socket is turned through 270 degrees not the torque wrench.

19. See figure

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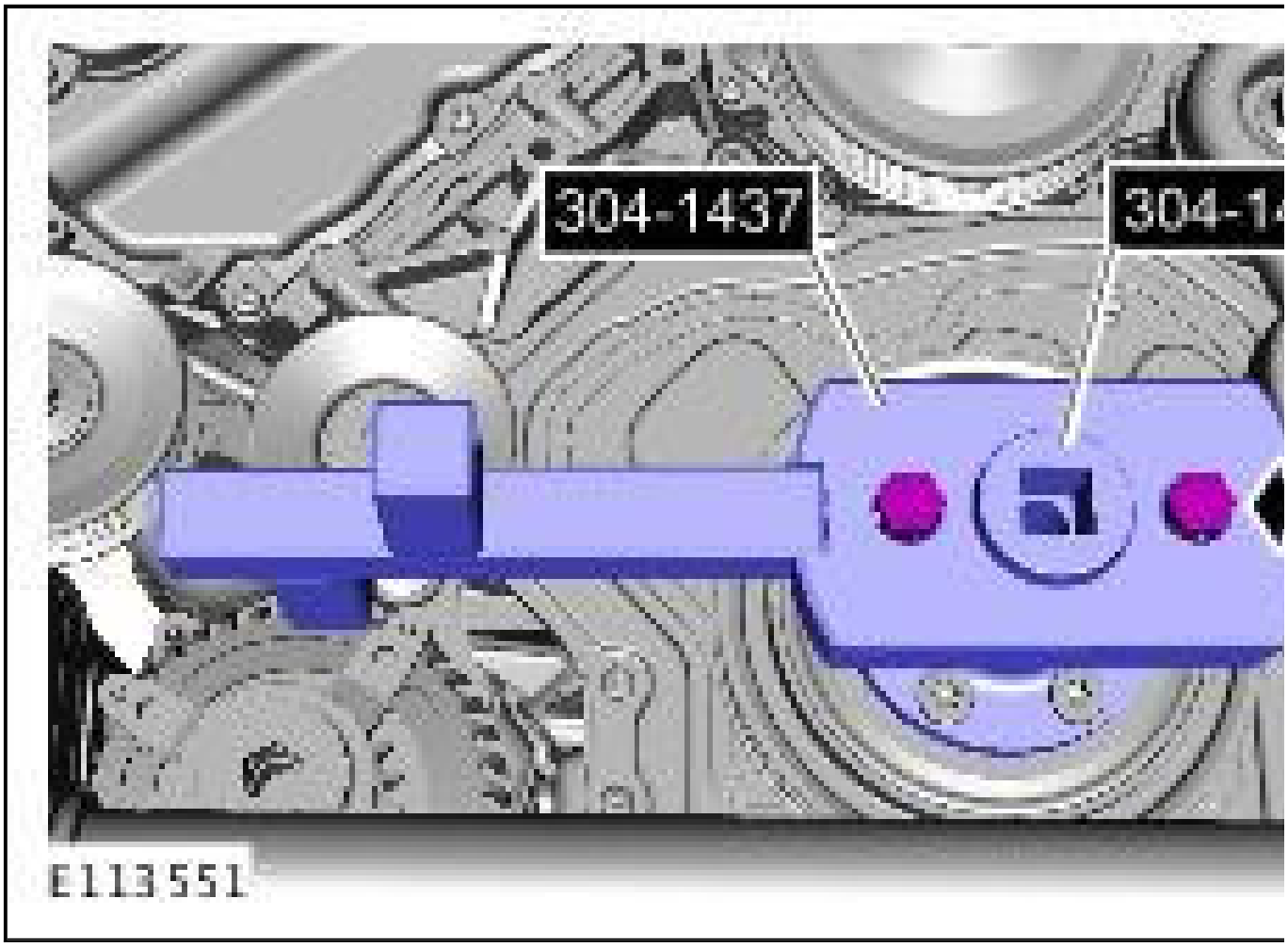

20. Remove the special tool, refer to: **SPECIAL TOOL(S)**

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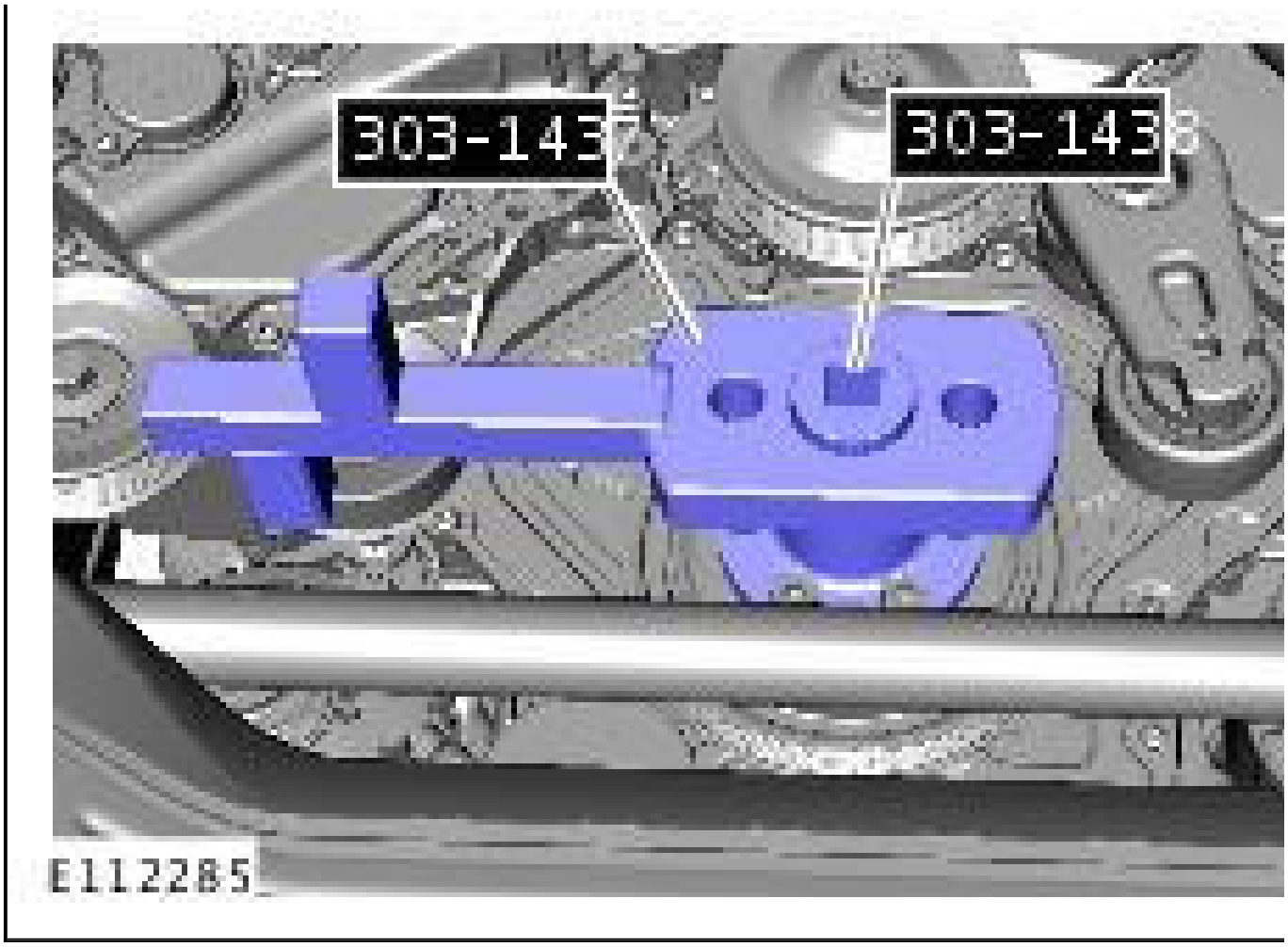

21. See figure

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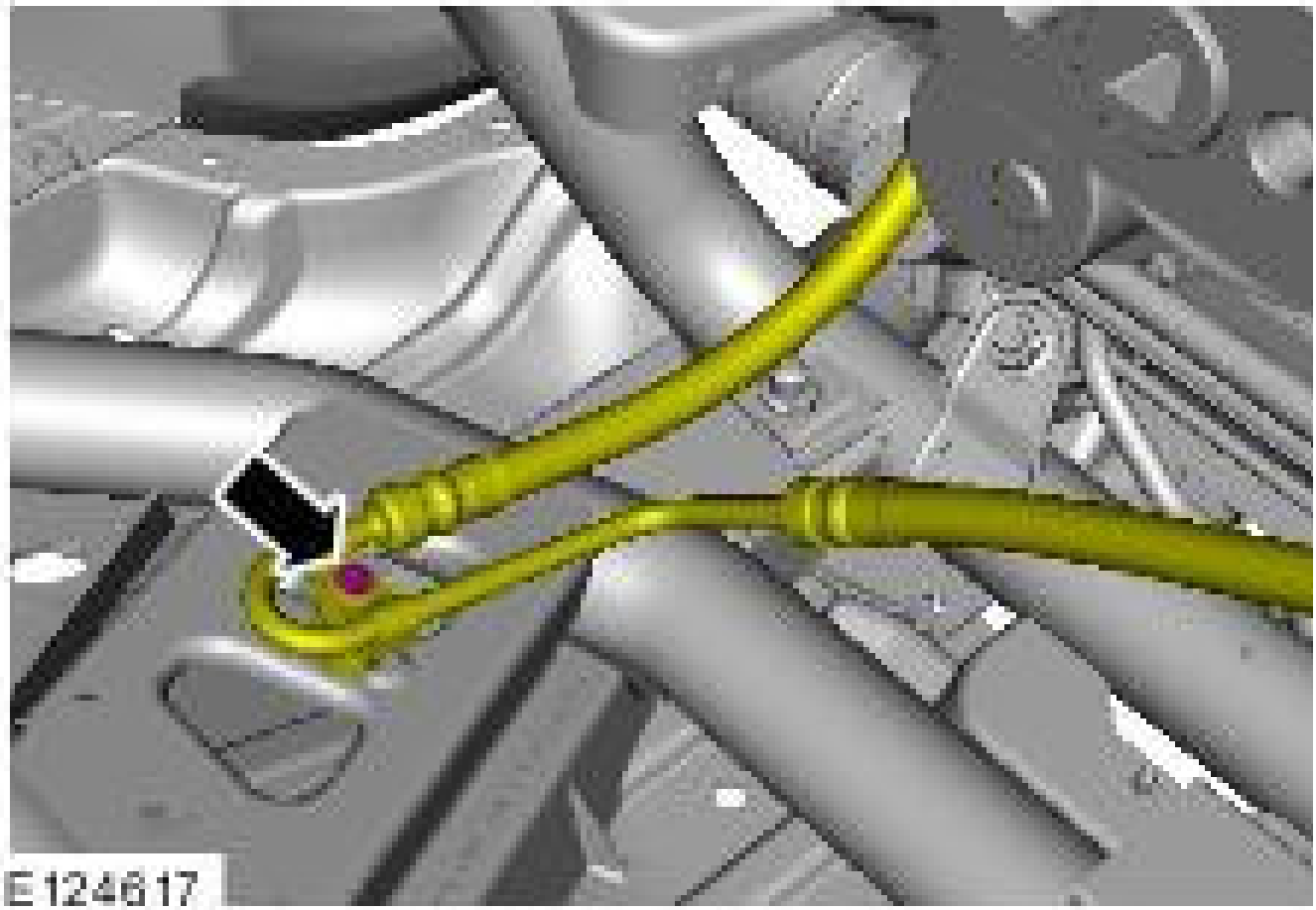

22. See figure

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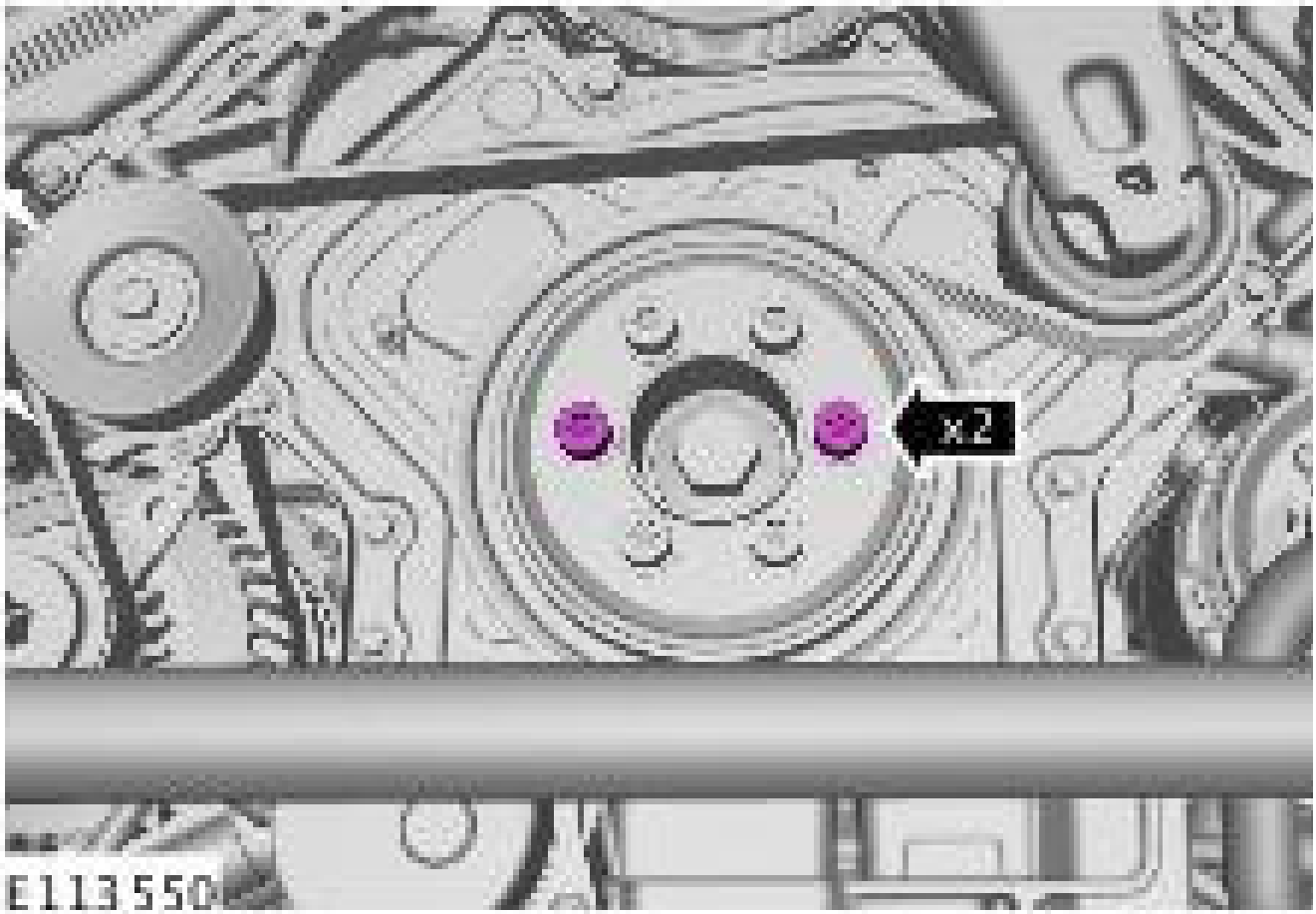

NOTE: Make sure to clean the threads prior to installation.

- Apply Loctite 270 to the thread of the bolts.
- Torque: 65 Nm

23. See figure

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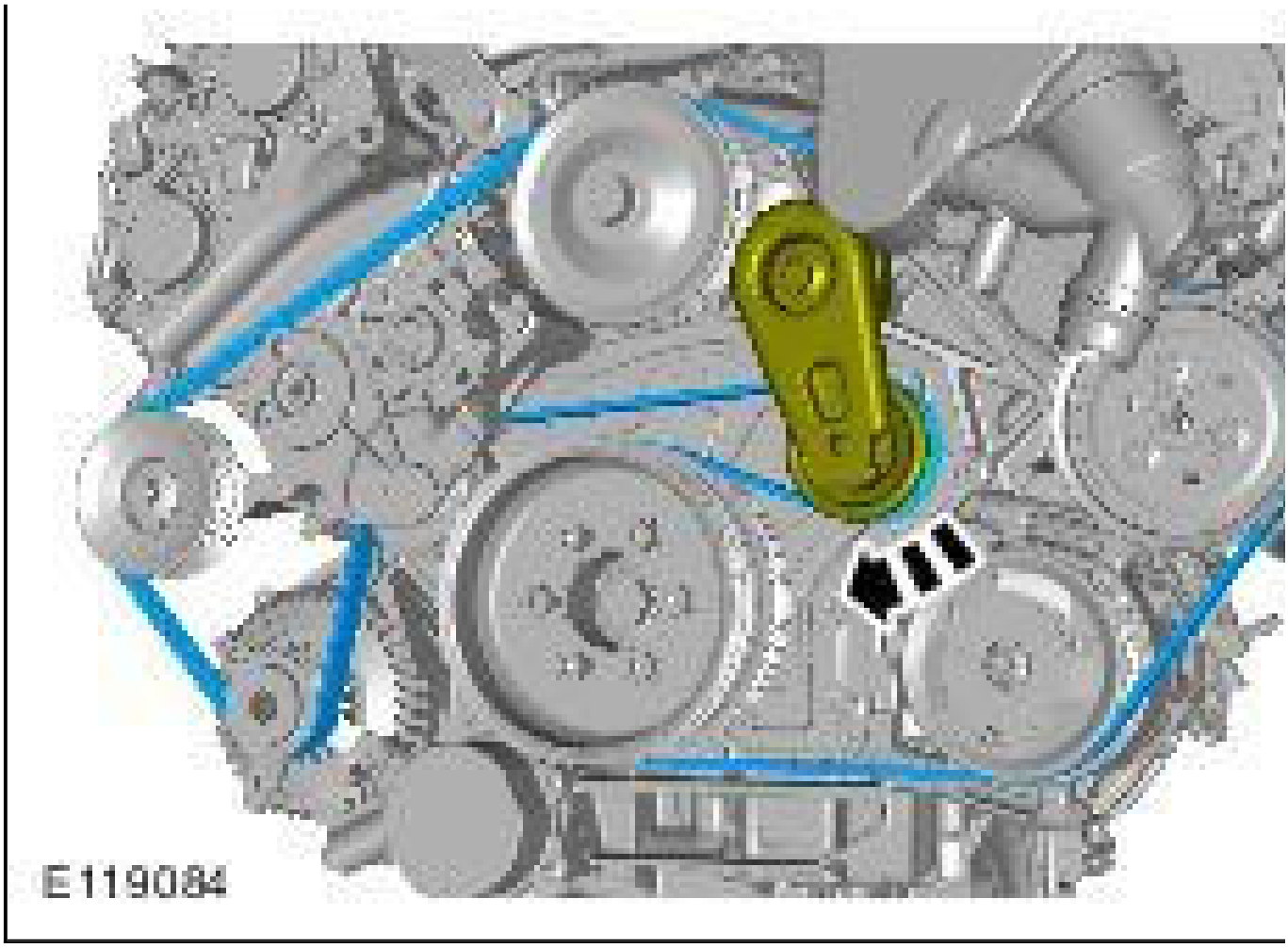

24. Refer to **Starter Motor** .
25. Refer to **Radiator - Vehicles Without: Supercharger** .
26. Refer to **Cooling Fan Belt** .
27. Connect the battery ground cable. Refer to **Specifications** .

CRANKSHAFT REAR SEAL

SPECIAL TOOL(S)

	303-1442 Rear Crankshaft Seal Installer

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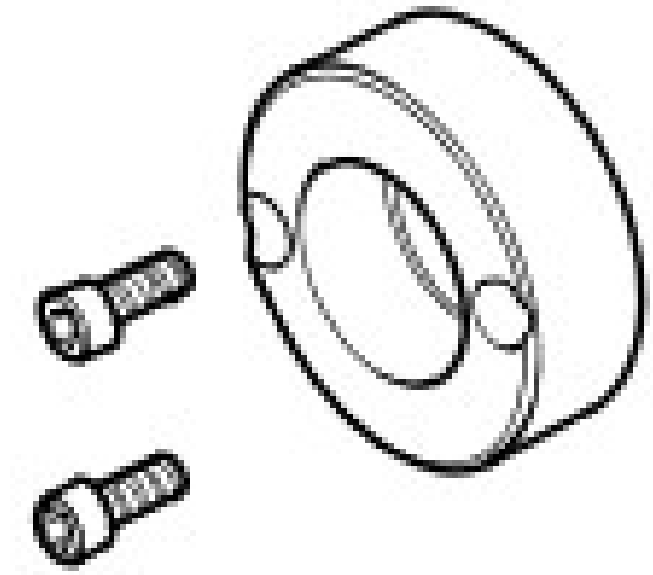
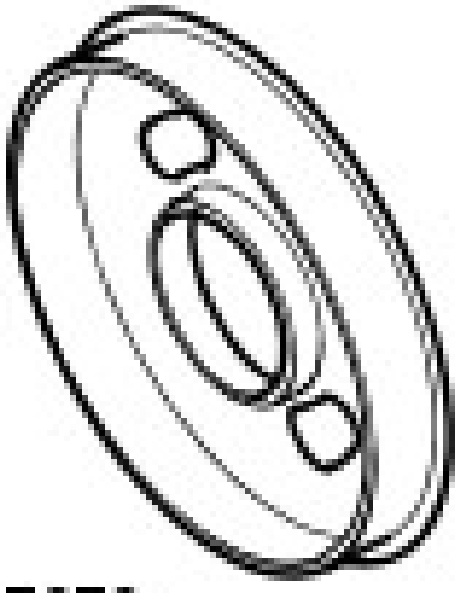
 E107678	
 E107679	303-1443 Rear Crankshaft Cover Alignment Tool

REMOVAL

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

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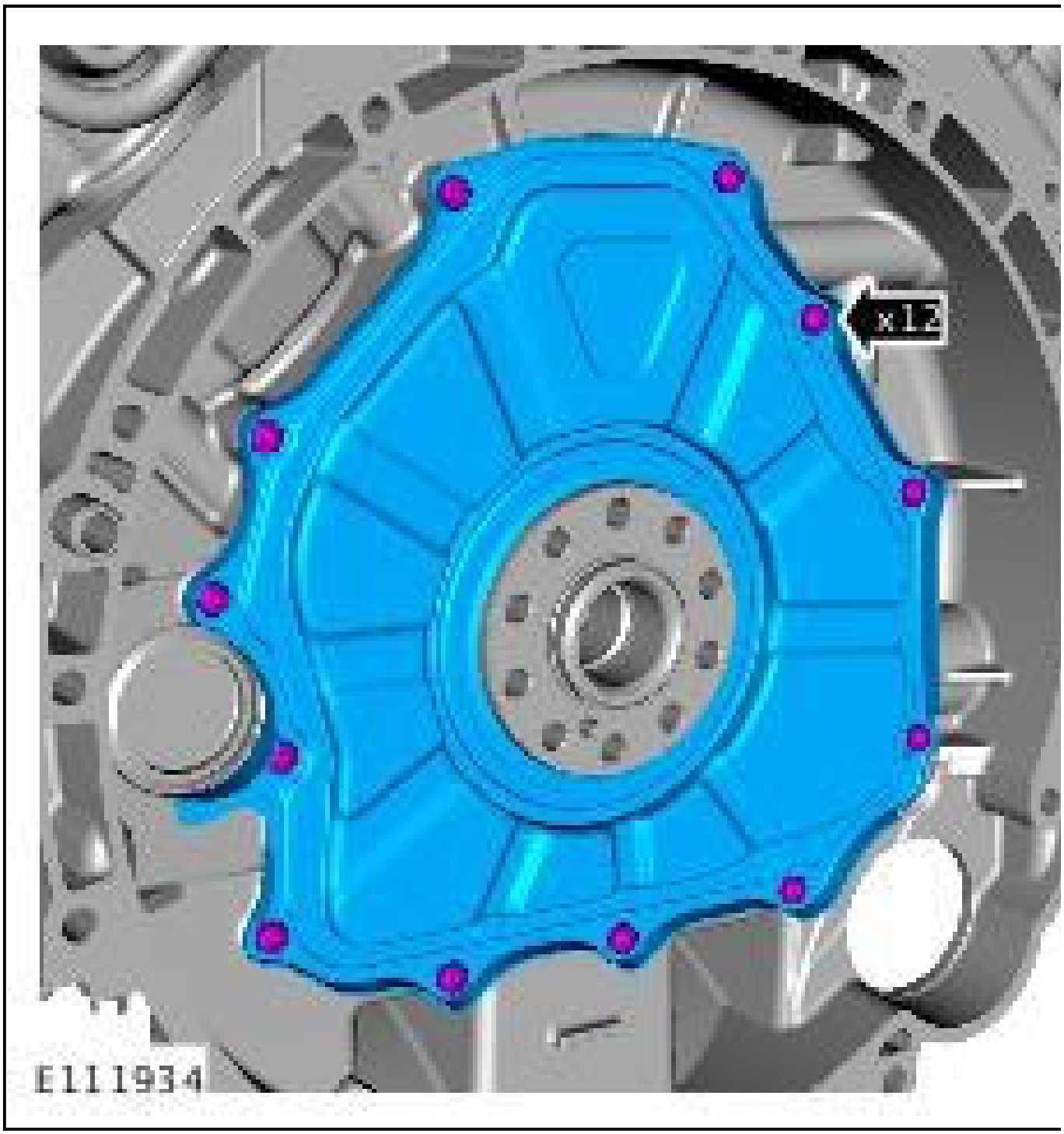
1. See **Flexplate**.
2. See figure



INSTALLATION

1. Install the special tool.

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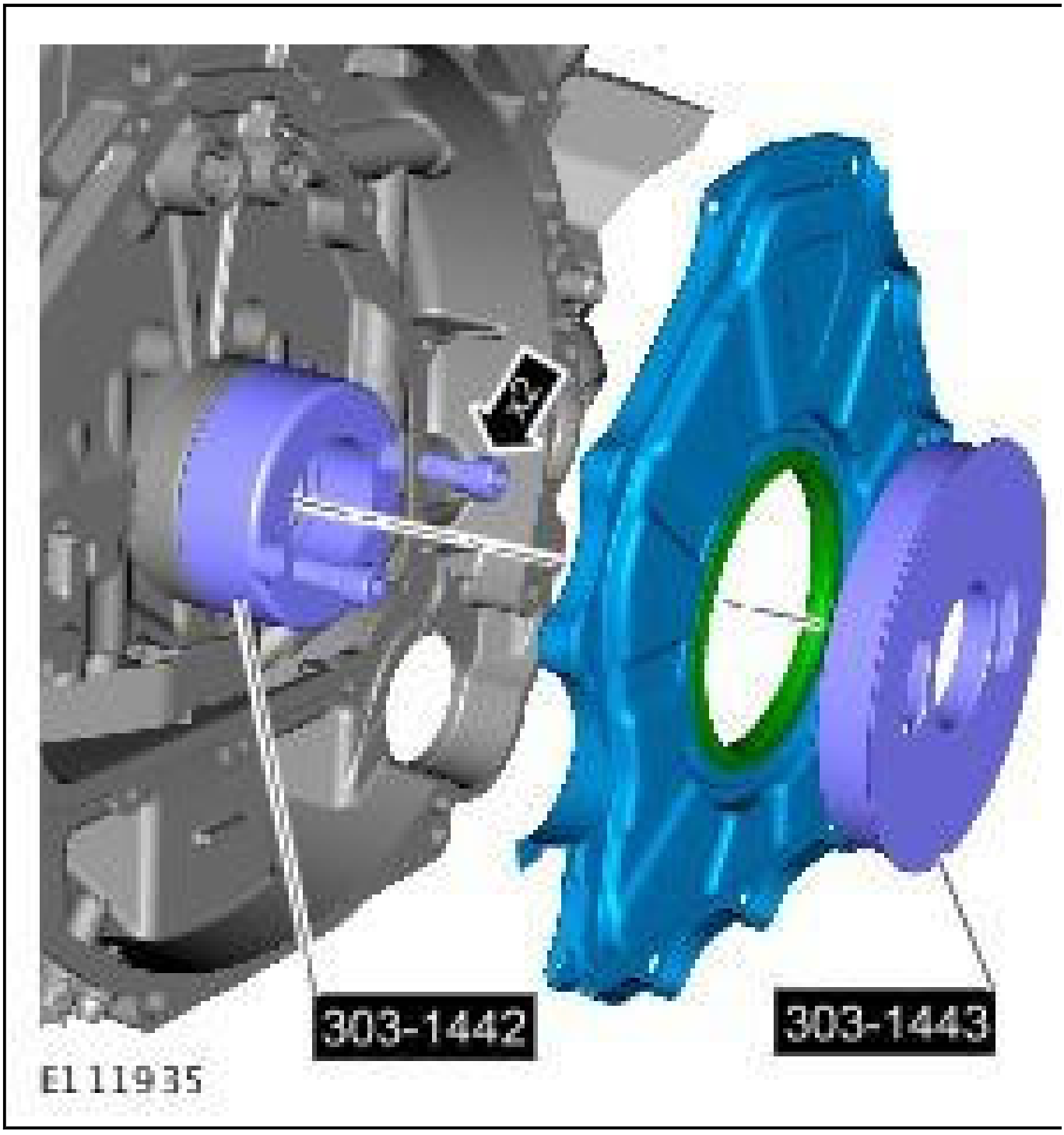

Rear Crankshaft Seal Installer (303-1442), refer to: **SPECIAL TOOL(S)**.

Rear Crankshaft Cover Alignment Tool (303-1443), refer to: **SPECIAL TOOL(S)**.

2. Torque: 11 Nm

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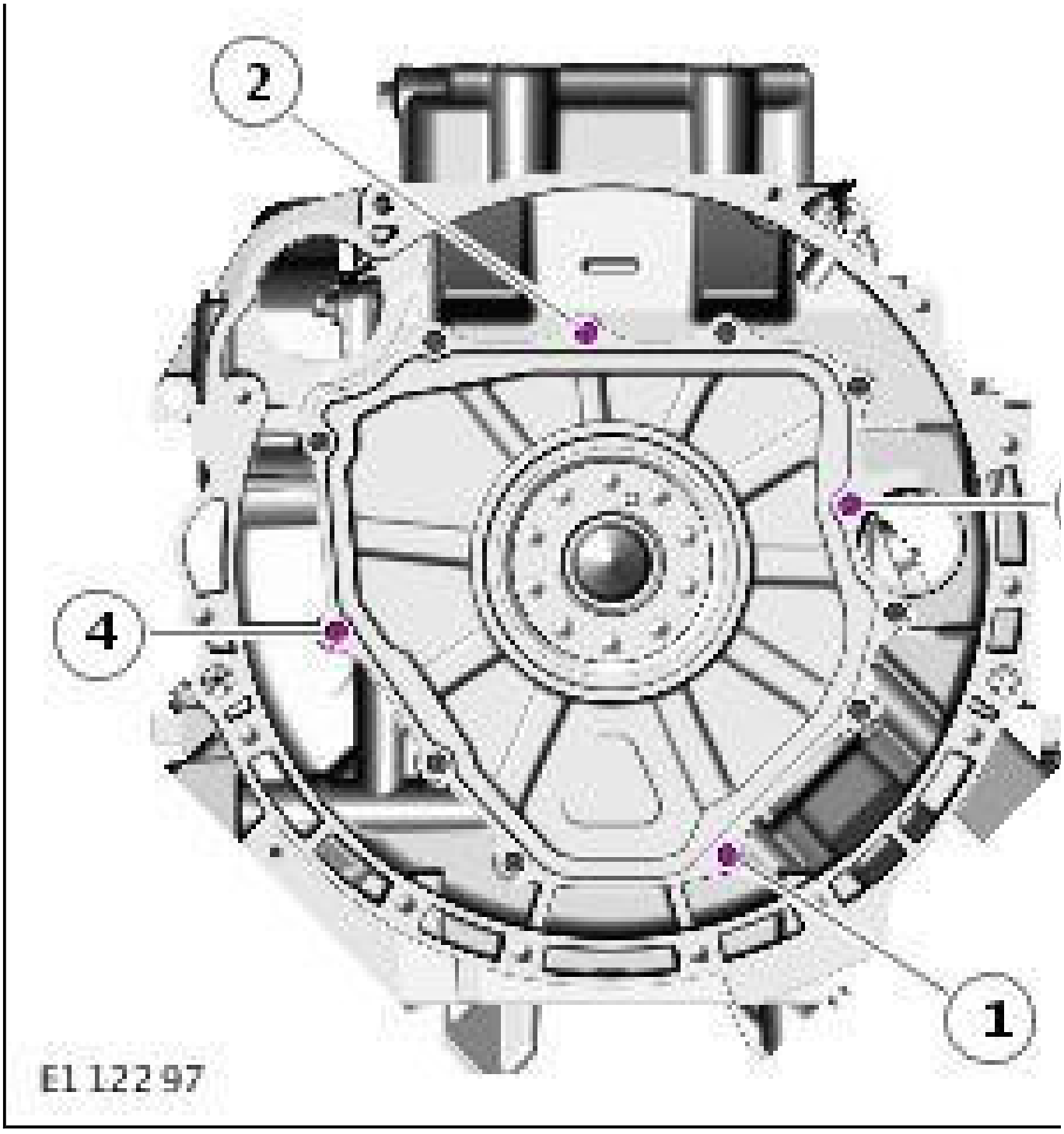

NOTE: Tighten the bolts in the indicated sequence.

3. Torque: 11 Nm

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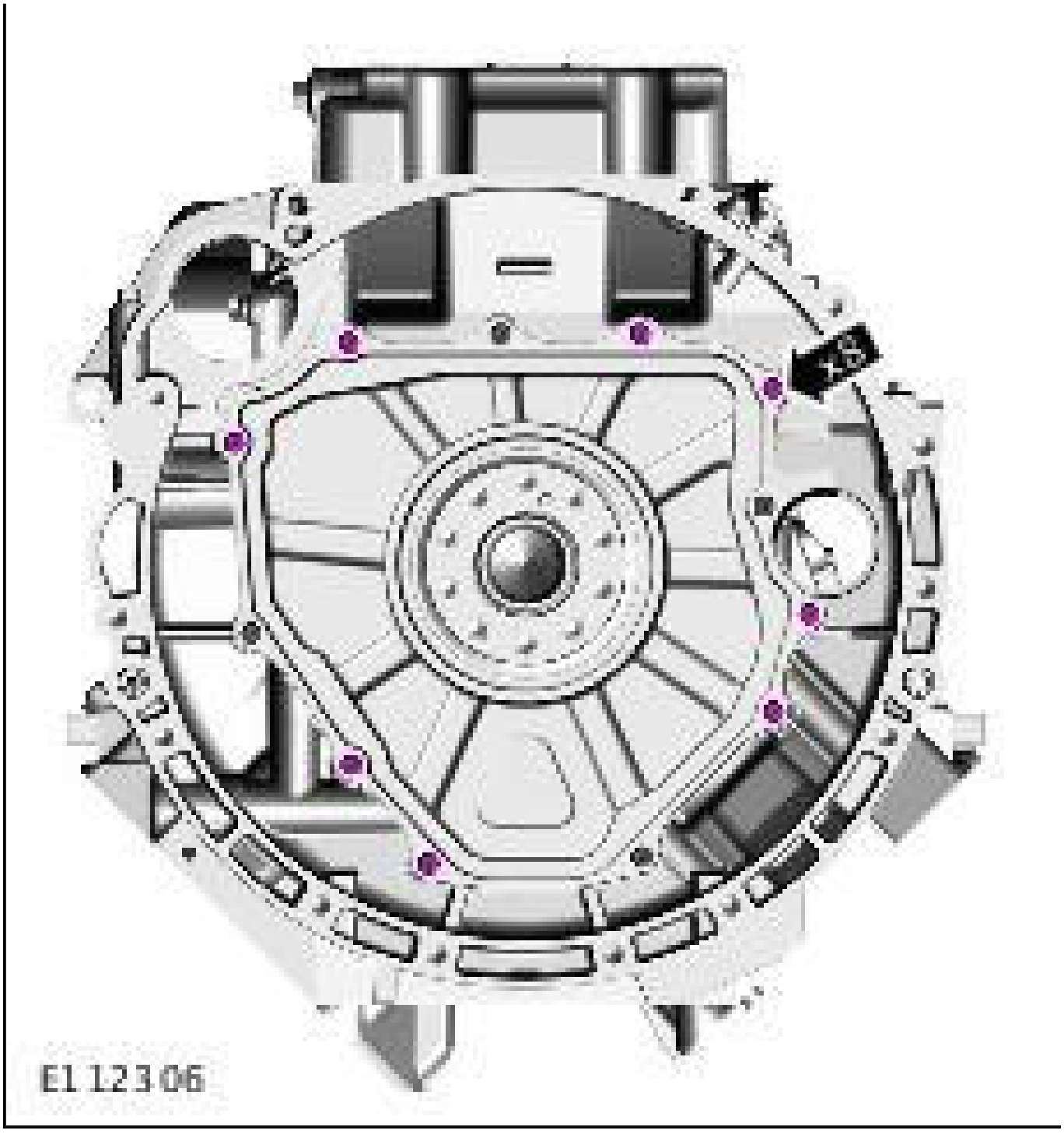

4. See **Flexplate**.

CYLINDER HEAD LH

REMOVAL

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

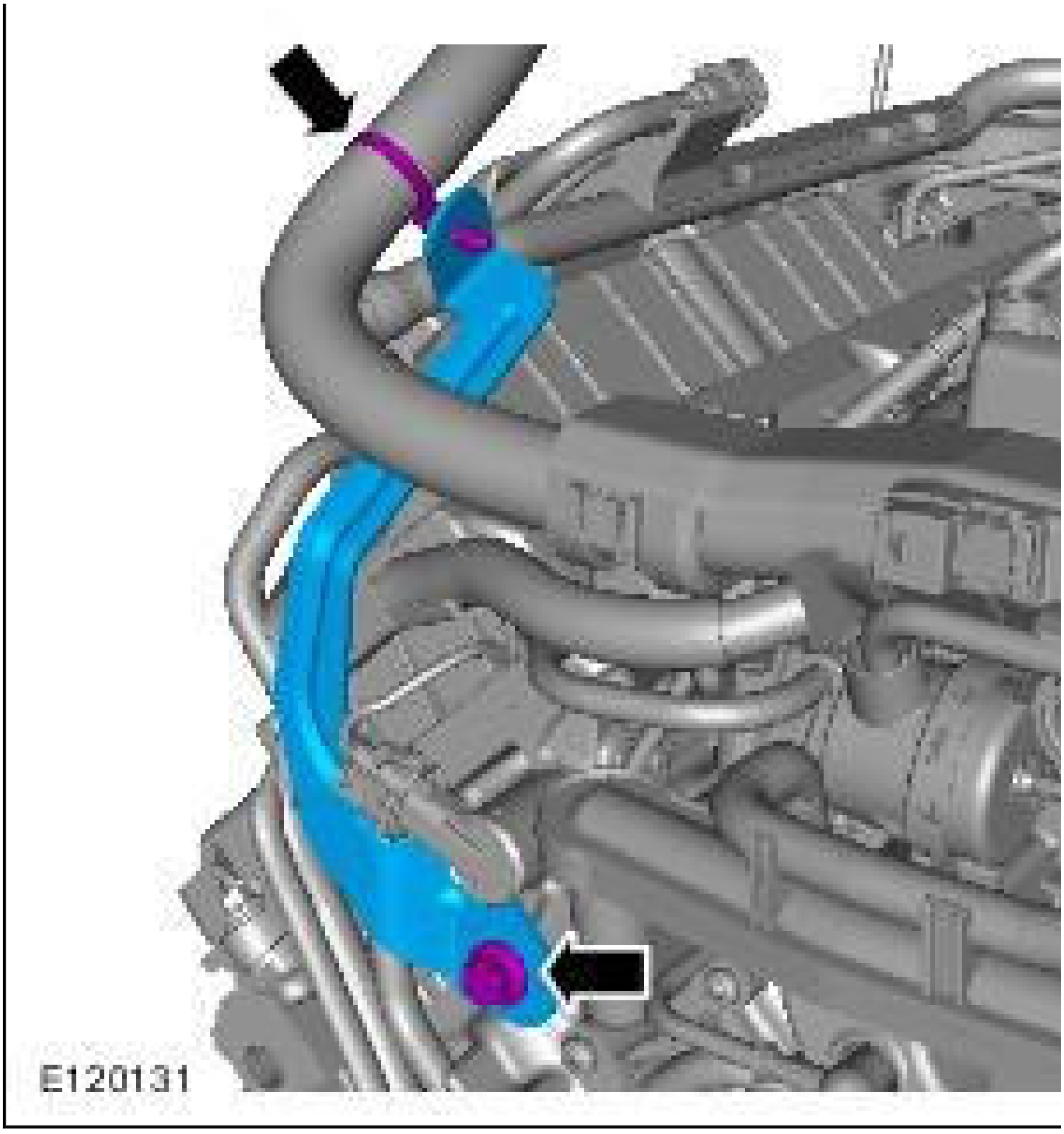
NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

1. 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. See **Camshaft LH**.
4. See **Exhaust Manifold LH**.
5. See **Intake Manifold**.
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



7. See figure

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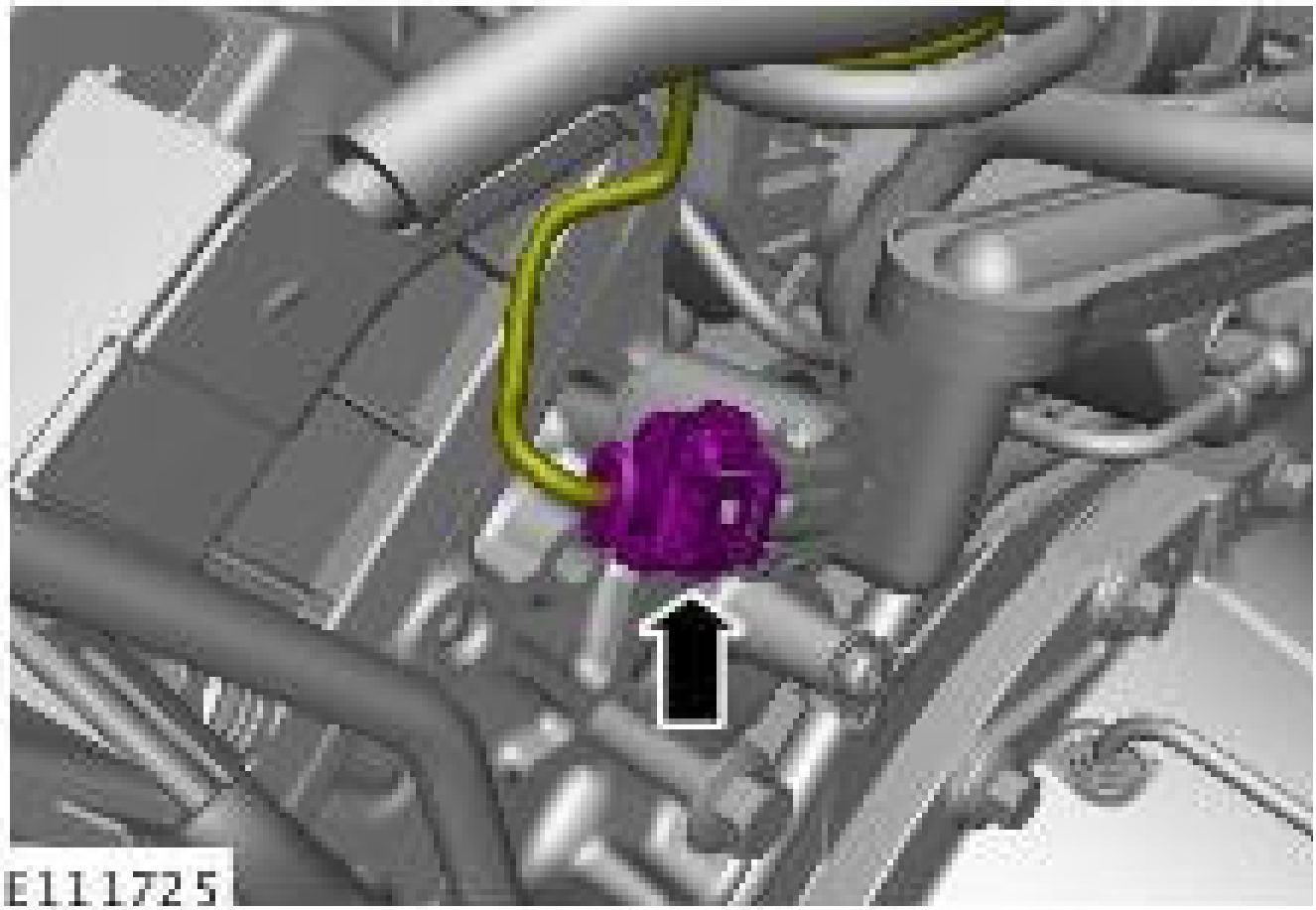
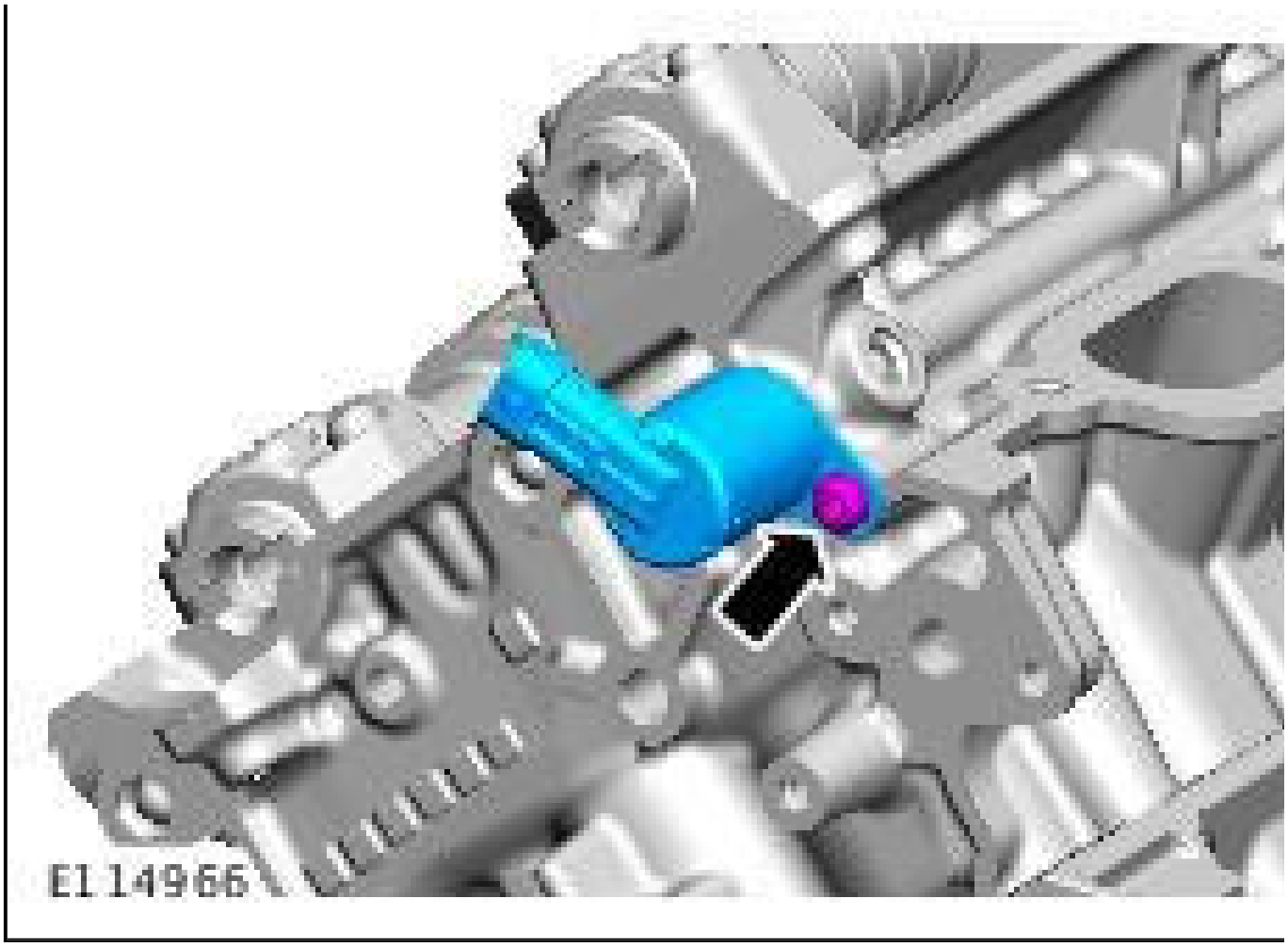


8. See figure

 © 2011 Mitchell Repair Information Company, LLC.

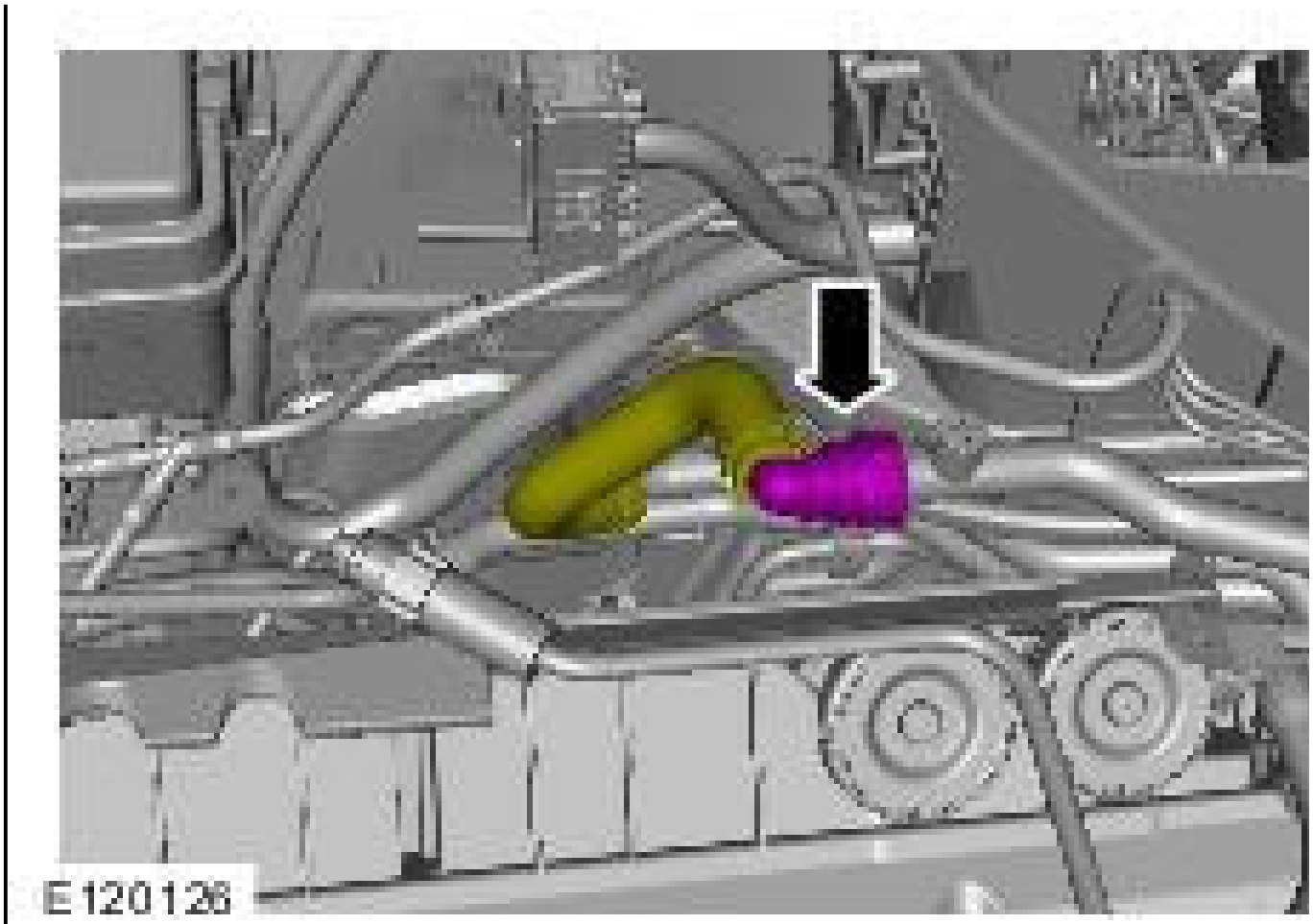


CAUTION: Discard the seal.

NOTE: Engine shown removed for clarity.

9. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Be prepared to collect escaping coolant.

10. See figure

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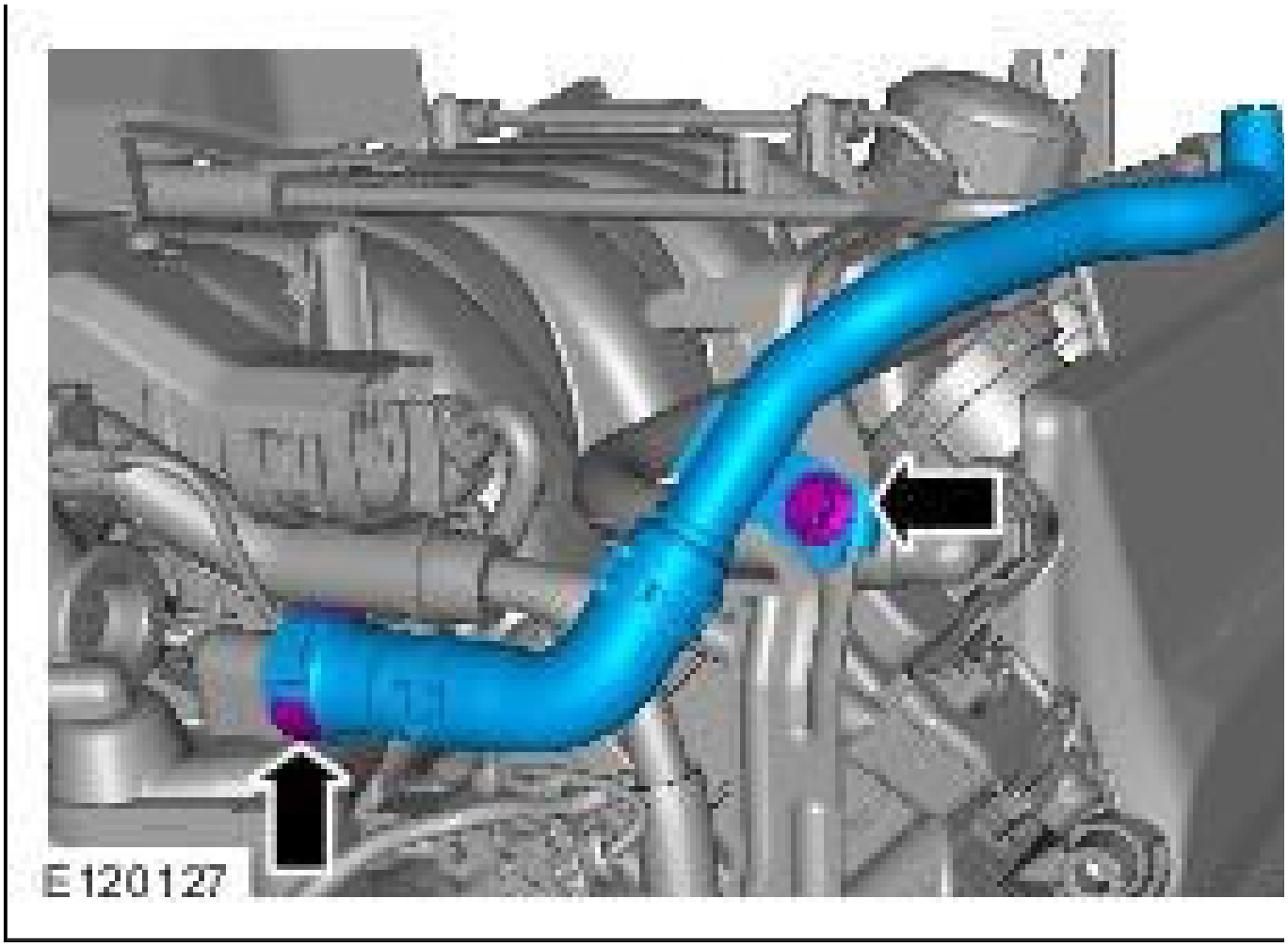
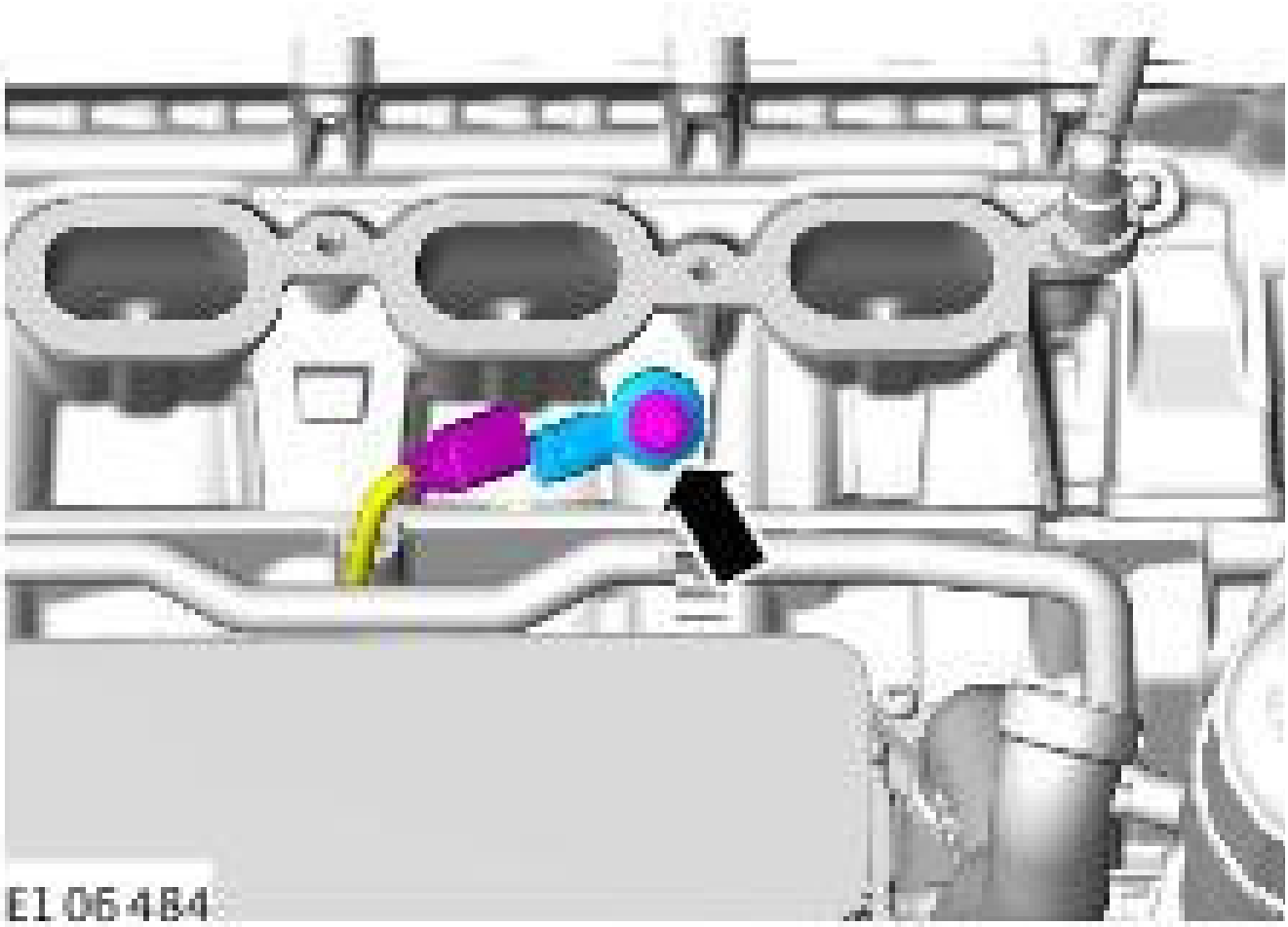


CAUTION: Be prepared to collect escaping coolant.

11. See figure

 © 2011 Mitchell Repair Information Company, LLC.



12. See figure

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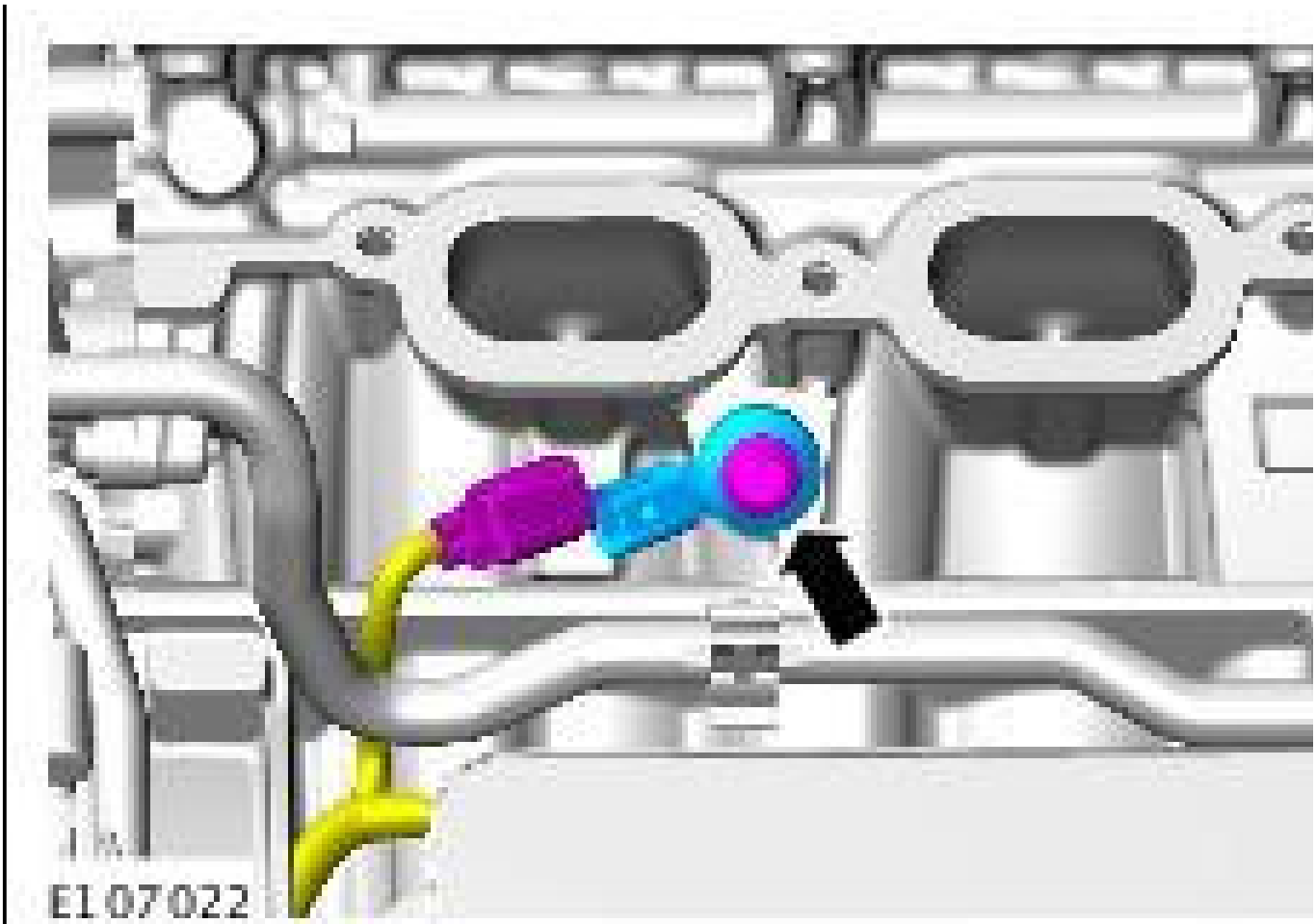
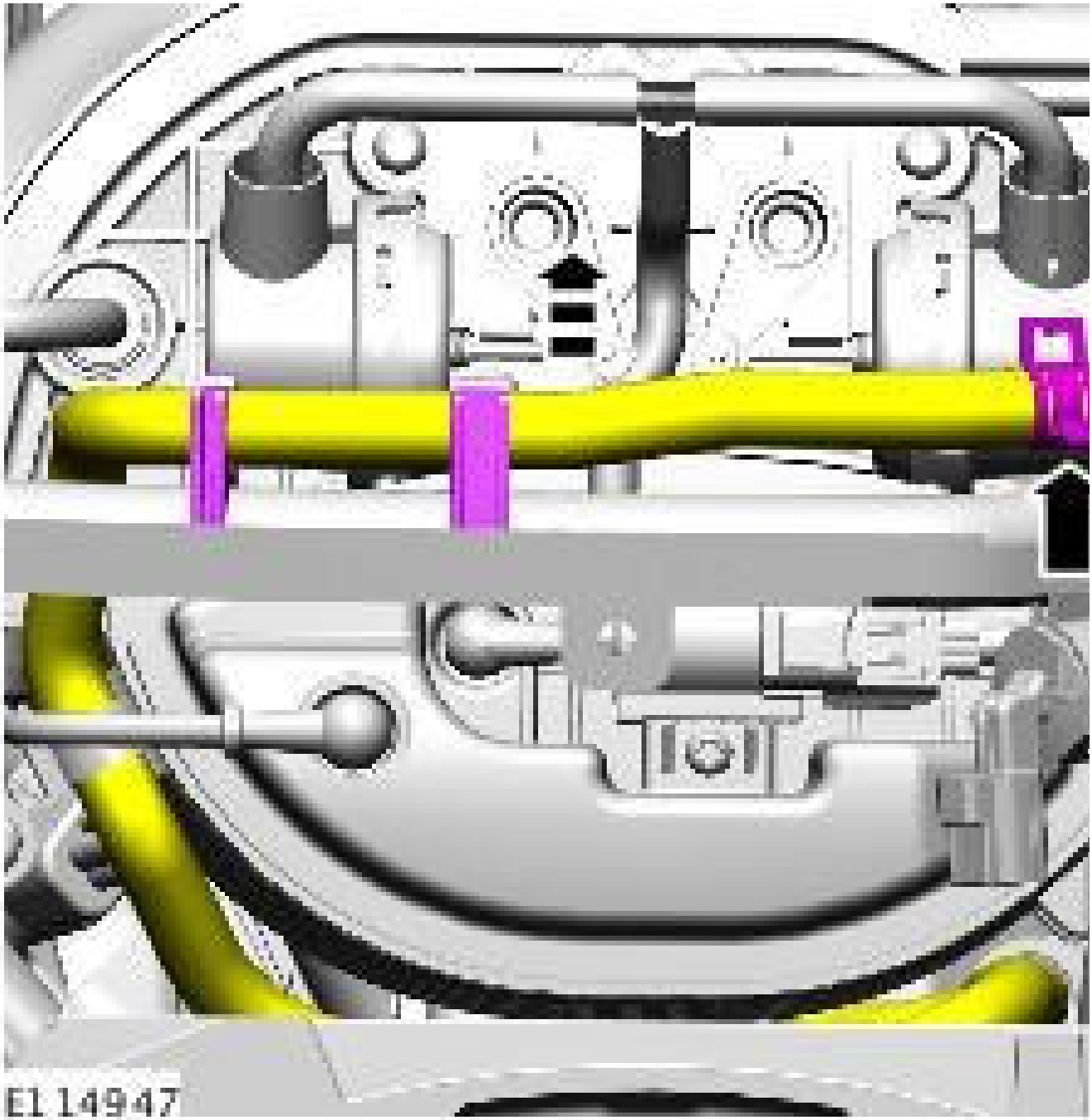


13. See figure

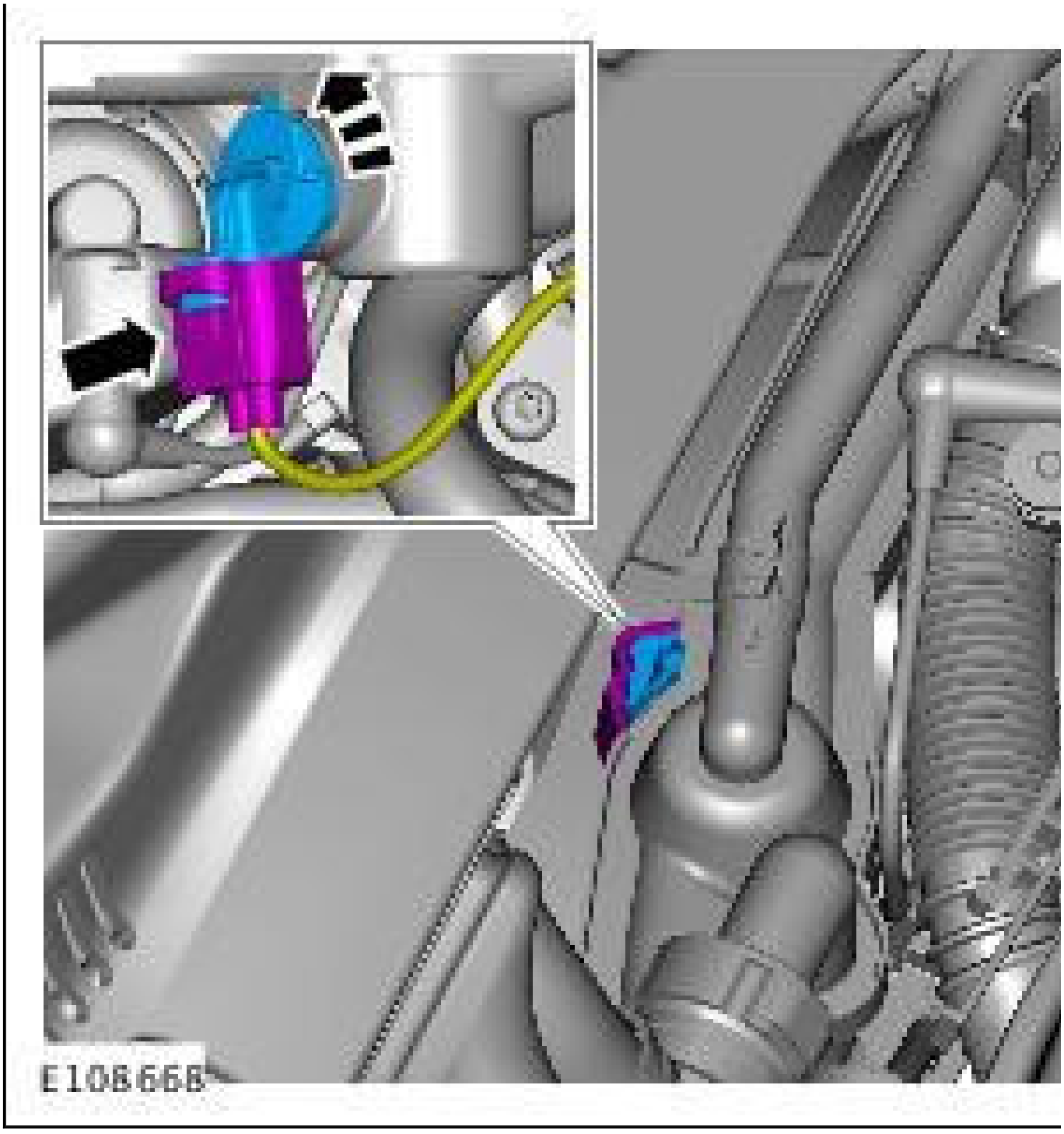
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Clamp the hose to minimize coolant loss.

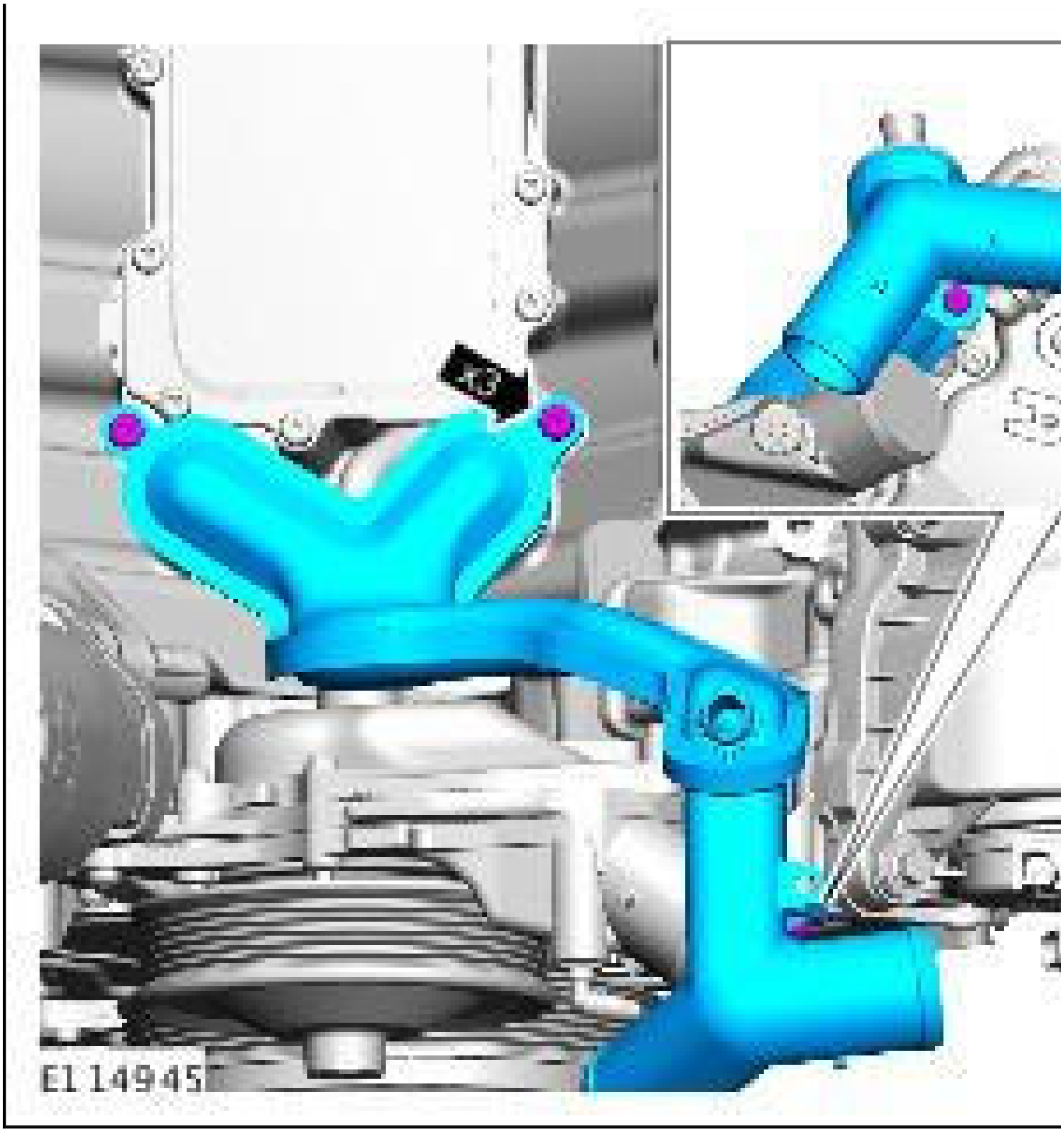
14. See figure

 © 2011 Mitchell Repair Information Company, LLC.



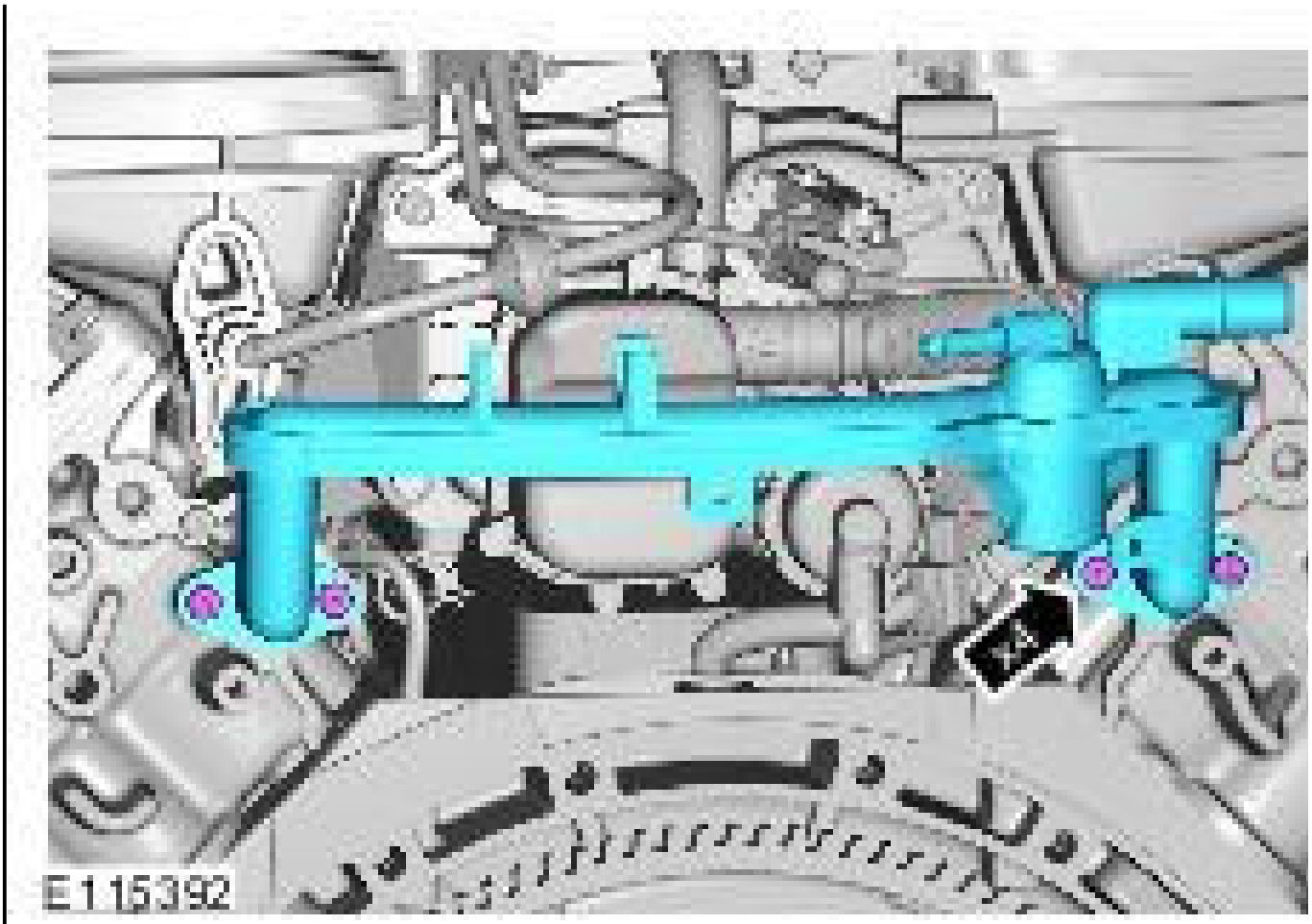
15. See figure

 © 2011 Mitchell Repair Information Company, LLC.



16. See figure

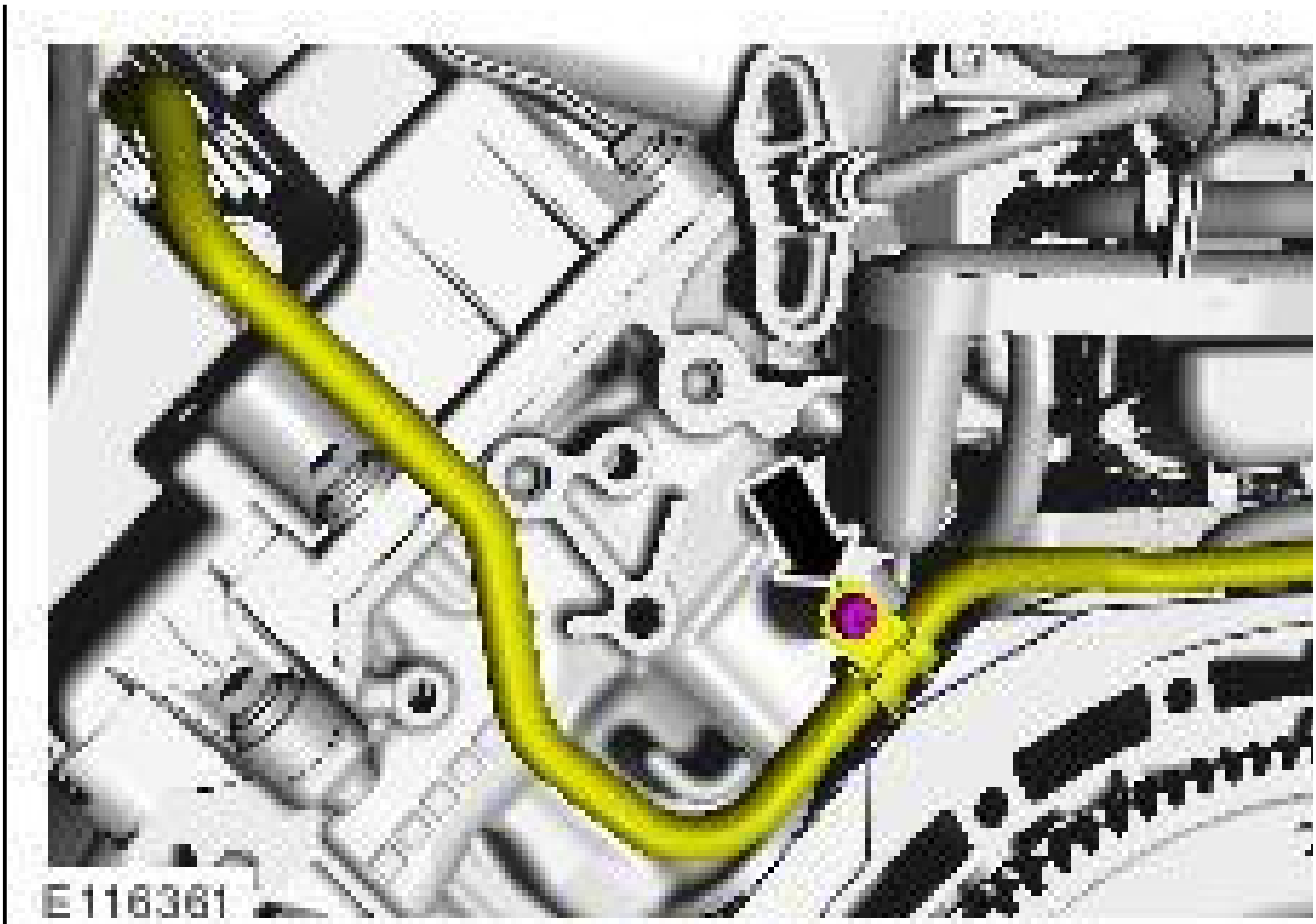
 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Discard the seals.

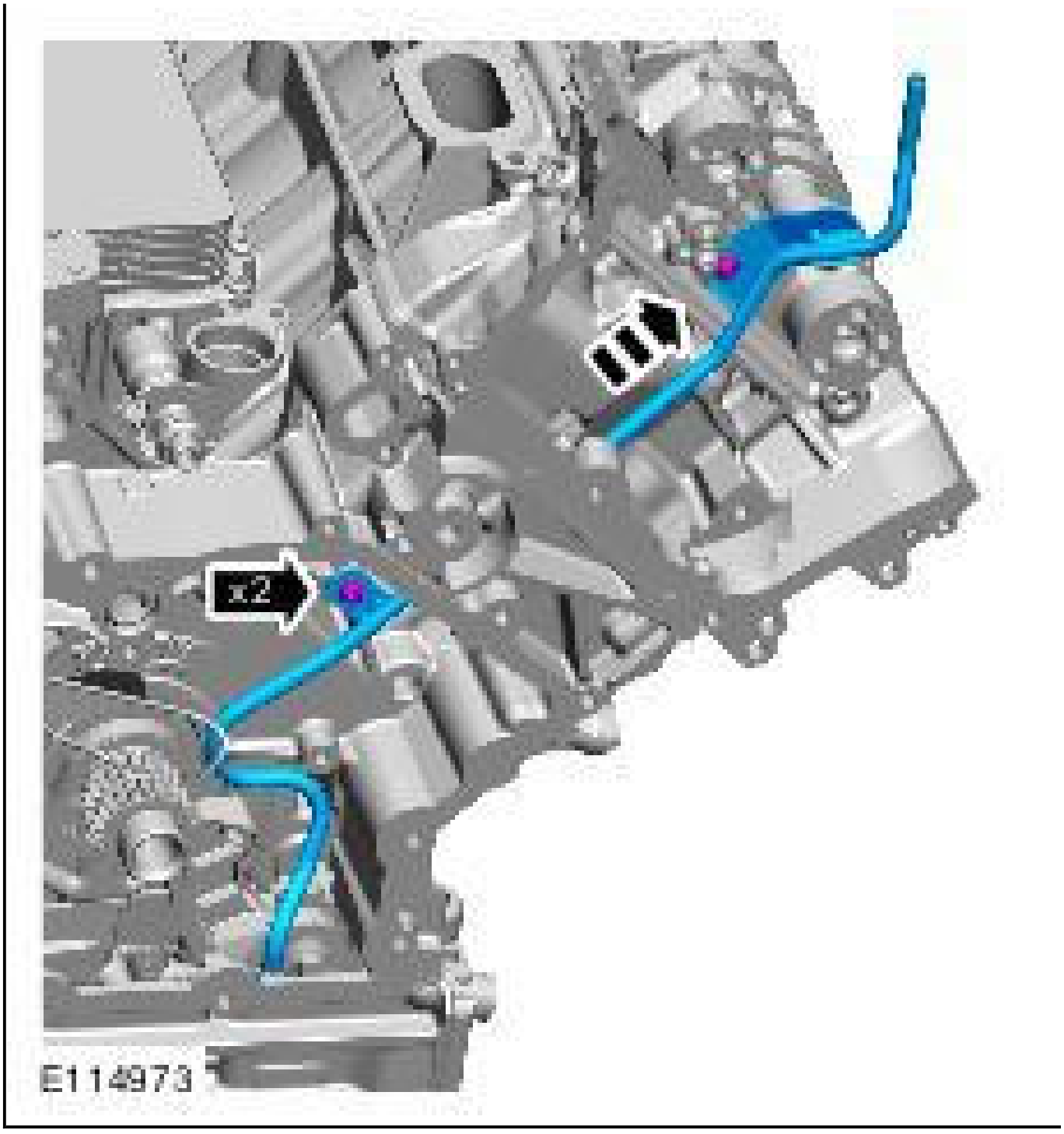
17. See figure

 © 2011 Mitchell Repair Information Company, LLC.



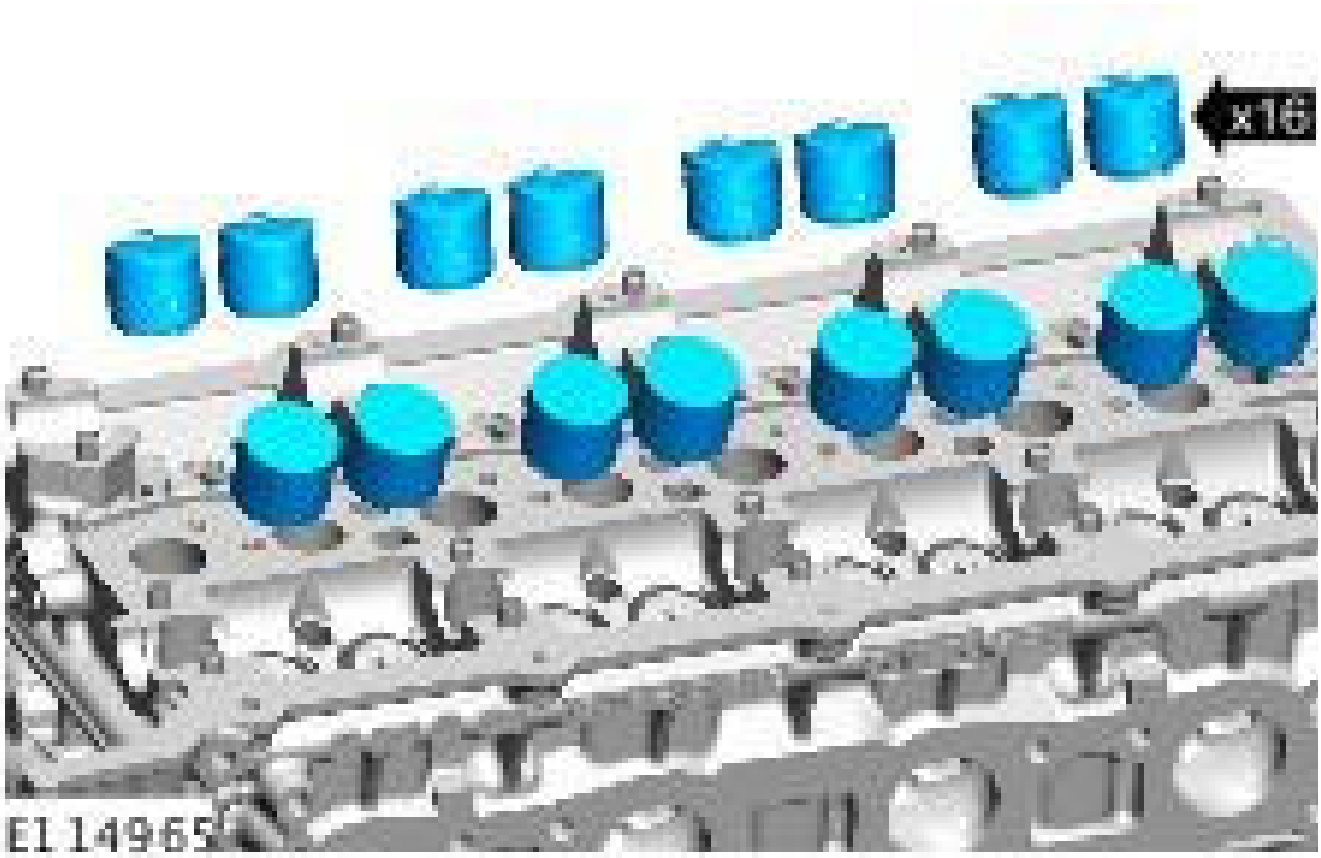
18. See figure

 © 2011 Mitchell Repair Information Company, LLC.



19. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: If a new cylinder head has been installed then new tappets must be installed.

CAUTION: If the cylinder head is being removed without a new component being installed, the tappets must be installed in their original positions.

NOTE: Left-hand shown, right-hand similar.

20. See figure

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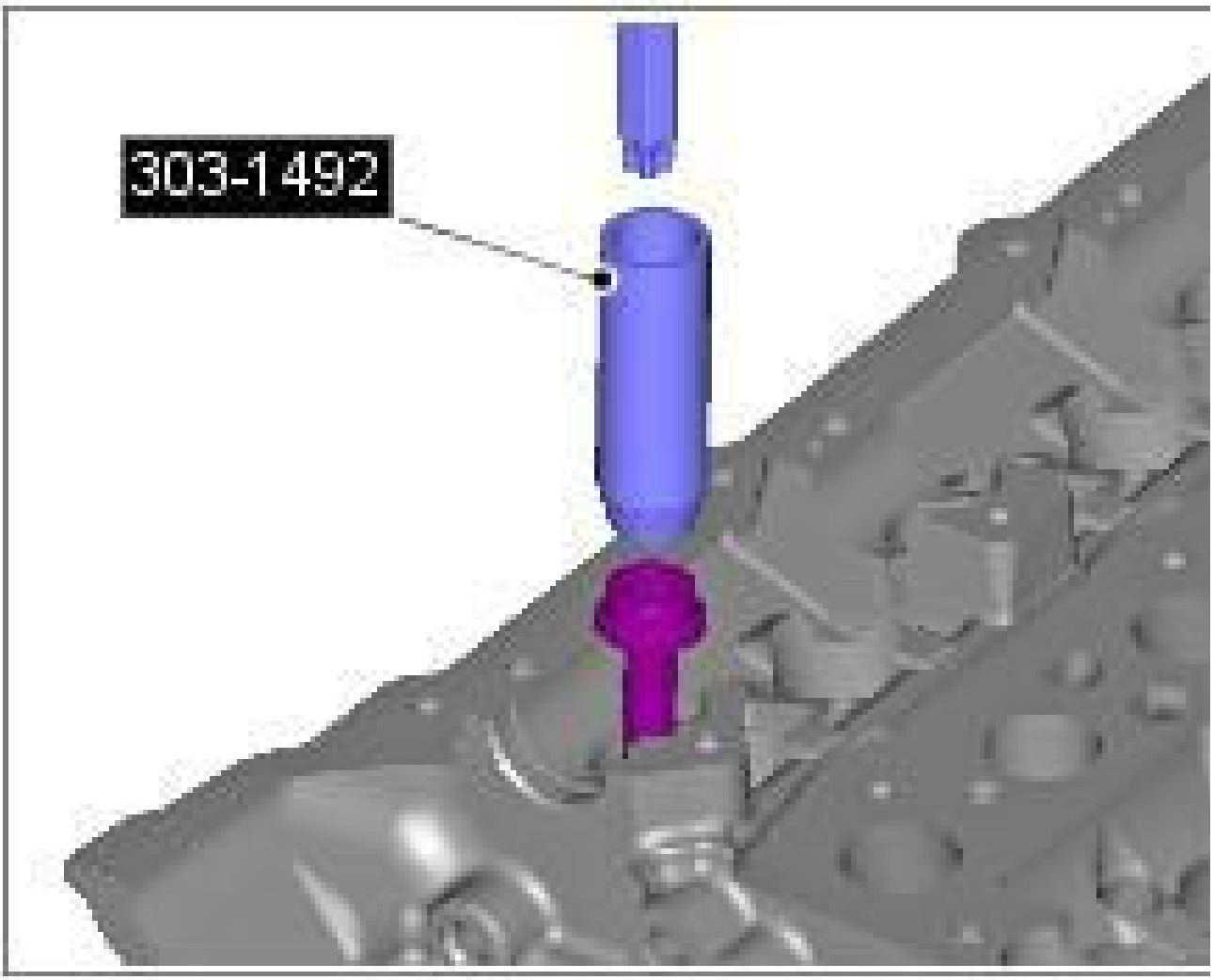

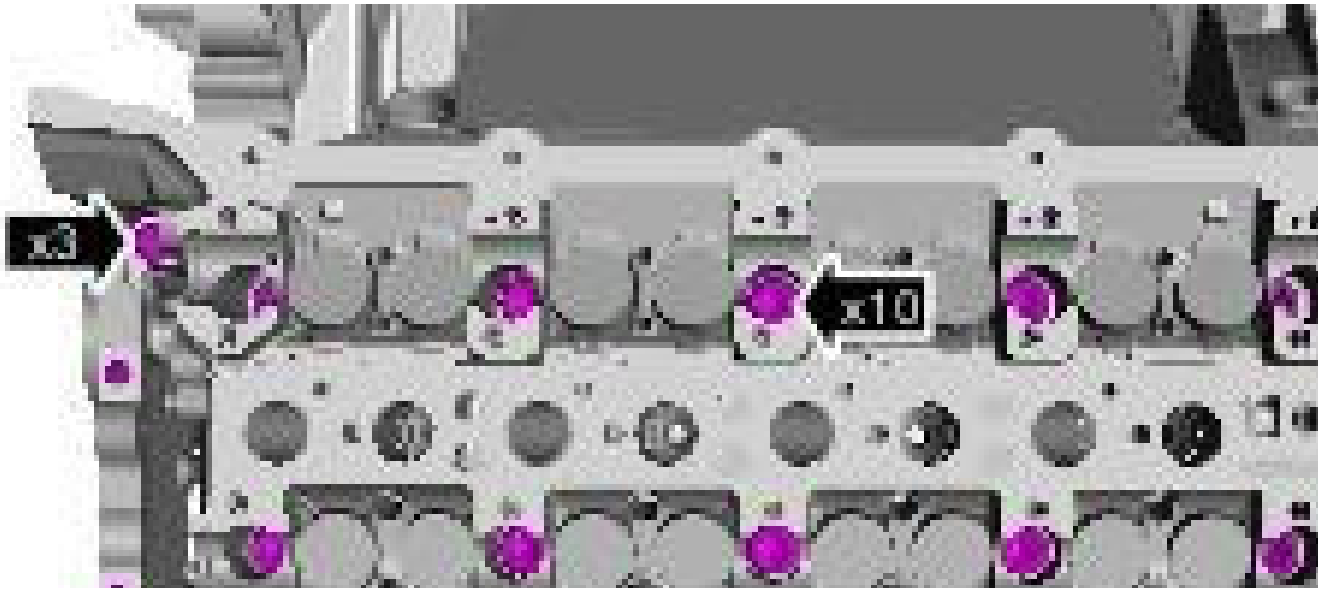

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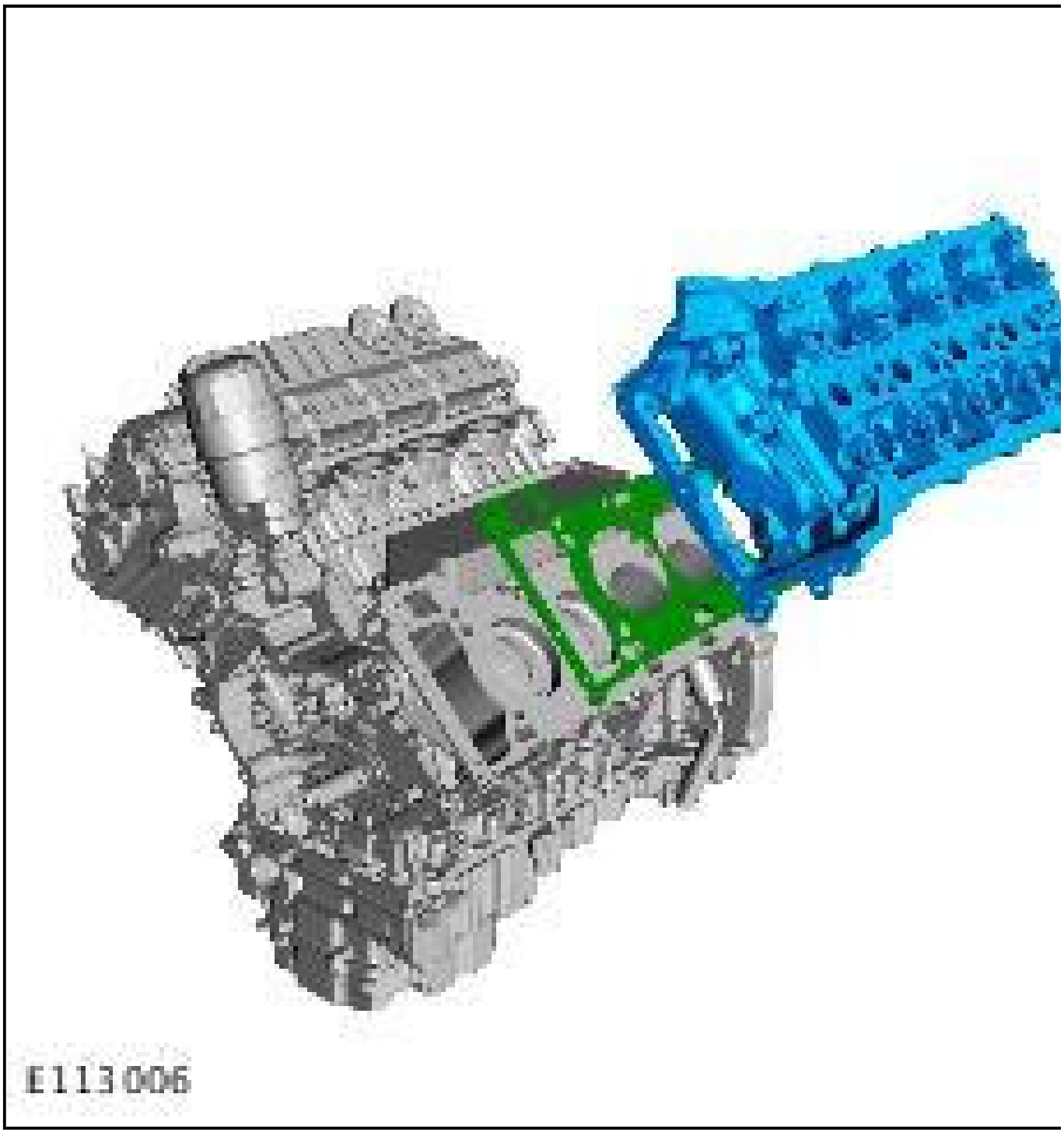
CAUTION: Discard the bolts.

21. See figure

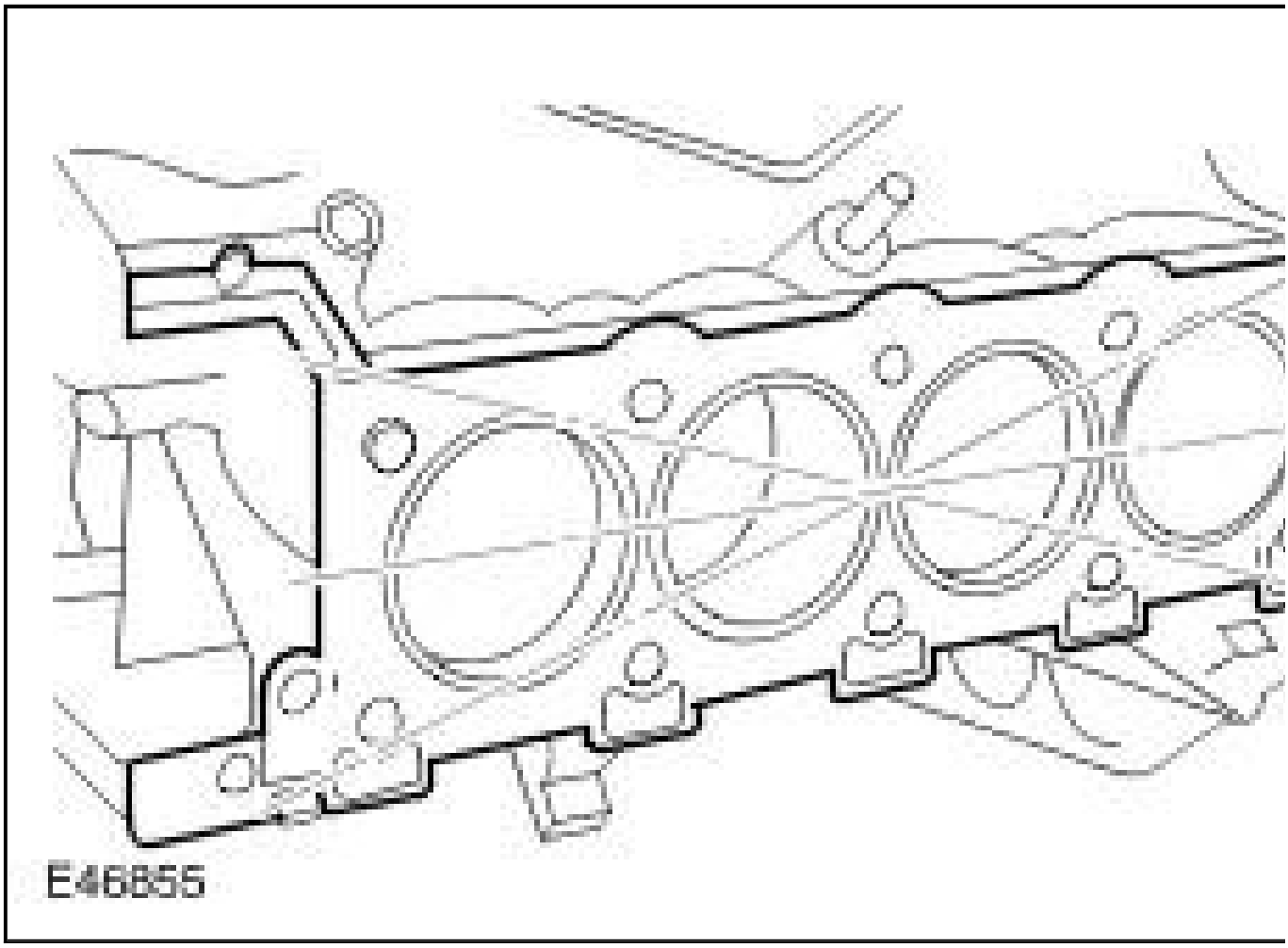


 © 2011 Mitchell Repair Information Company, LLC.

NOTE: Discard the gasket.

INSTALLATION

1. Check cylinder head face for distortion, across the center and from corner to corner.



CAUTION: An acceptable flatness of the cylinder head is 0.1mm.

2. See figure

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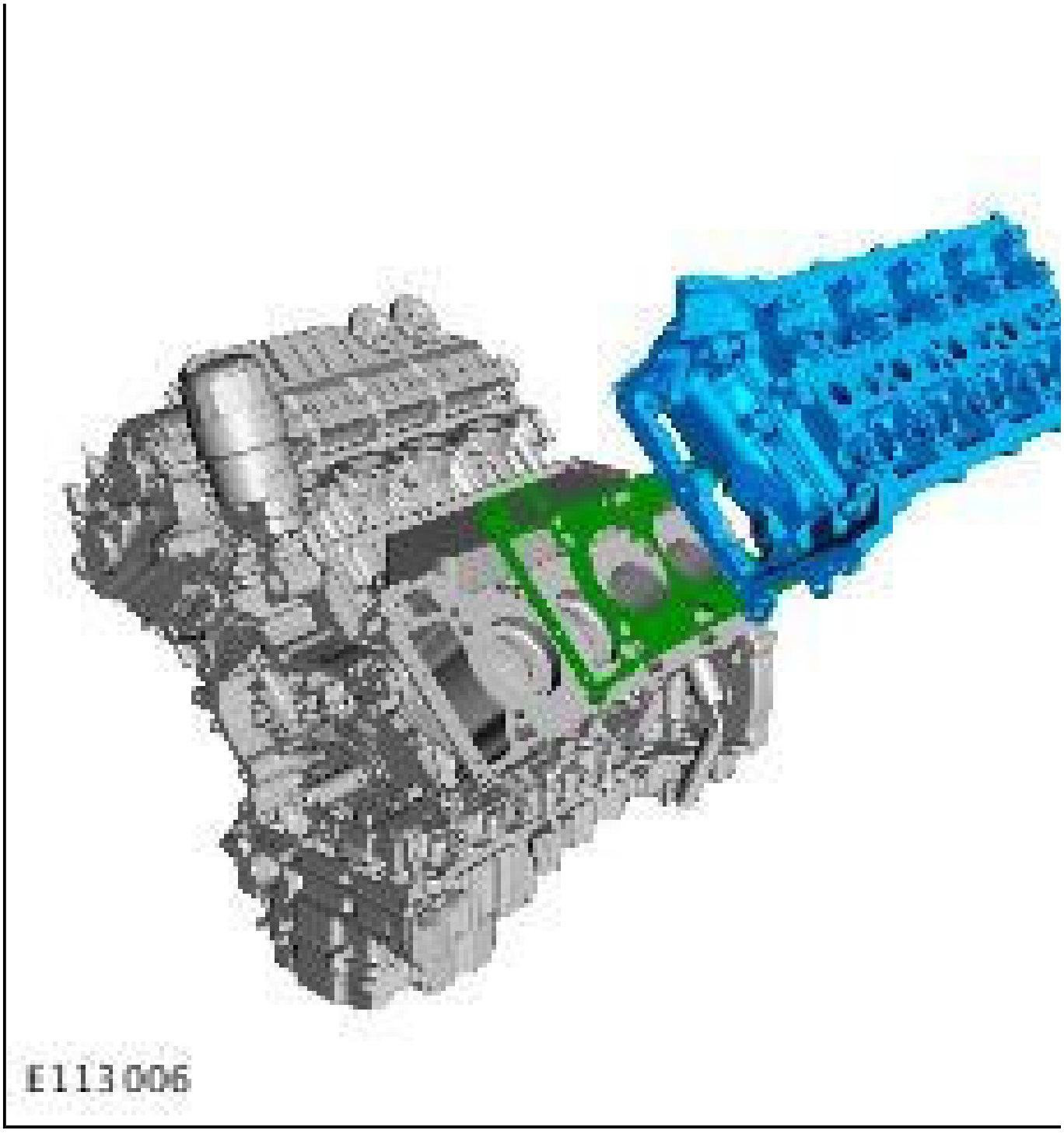

WARNING: **Make sure care is taken when handling the cylinder head gasket.**

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

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

NOTE: Install a new cylinder head gasket.

3. Torque: 20 Nm

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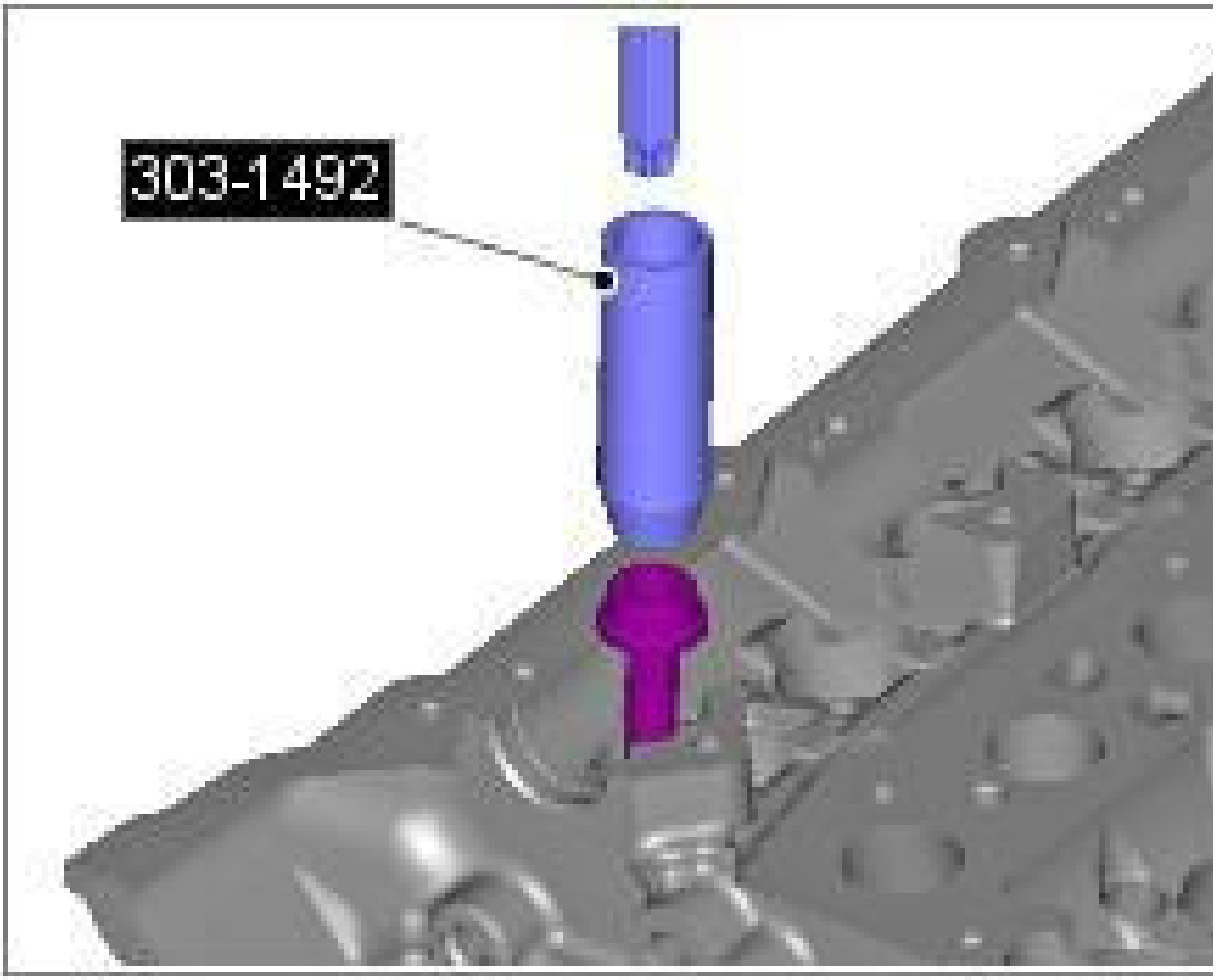

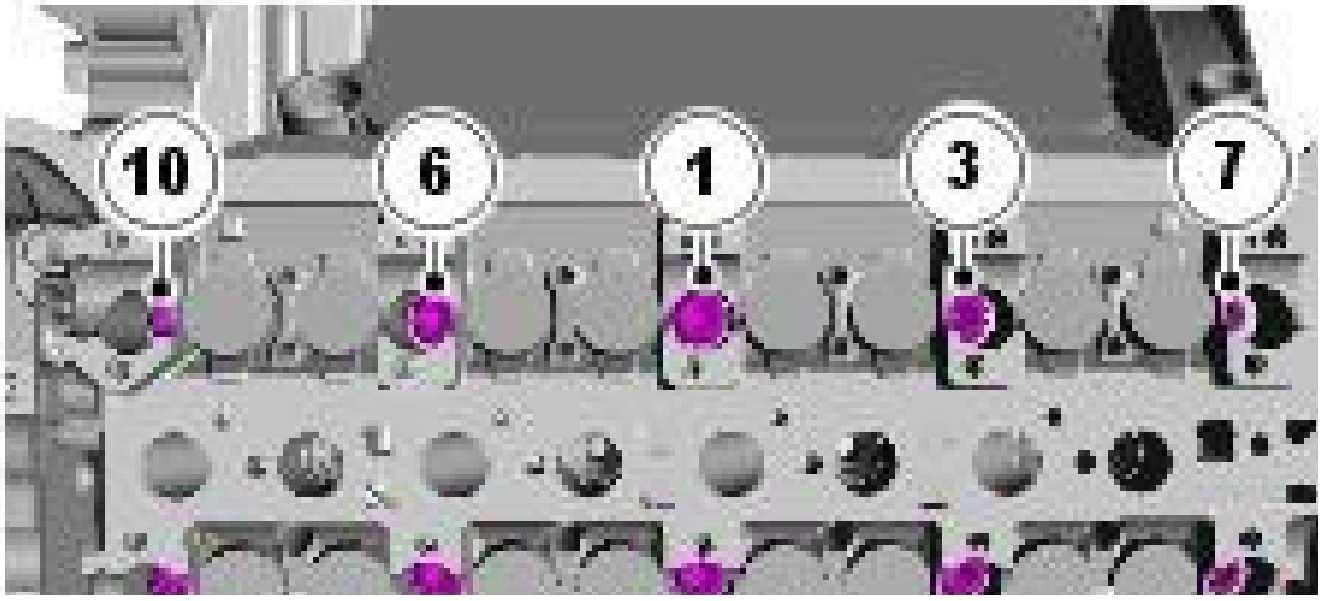

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CAUTION: Make sure that new cylinder head bolts are installed.

NOTE: Tighten the bolts in the indicated sequence.

4. Torque: 35 Nm

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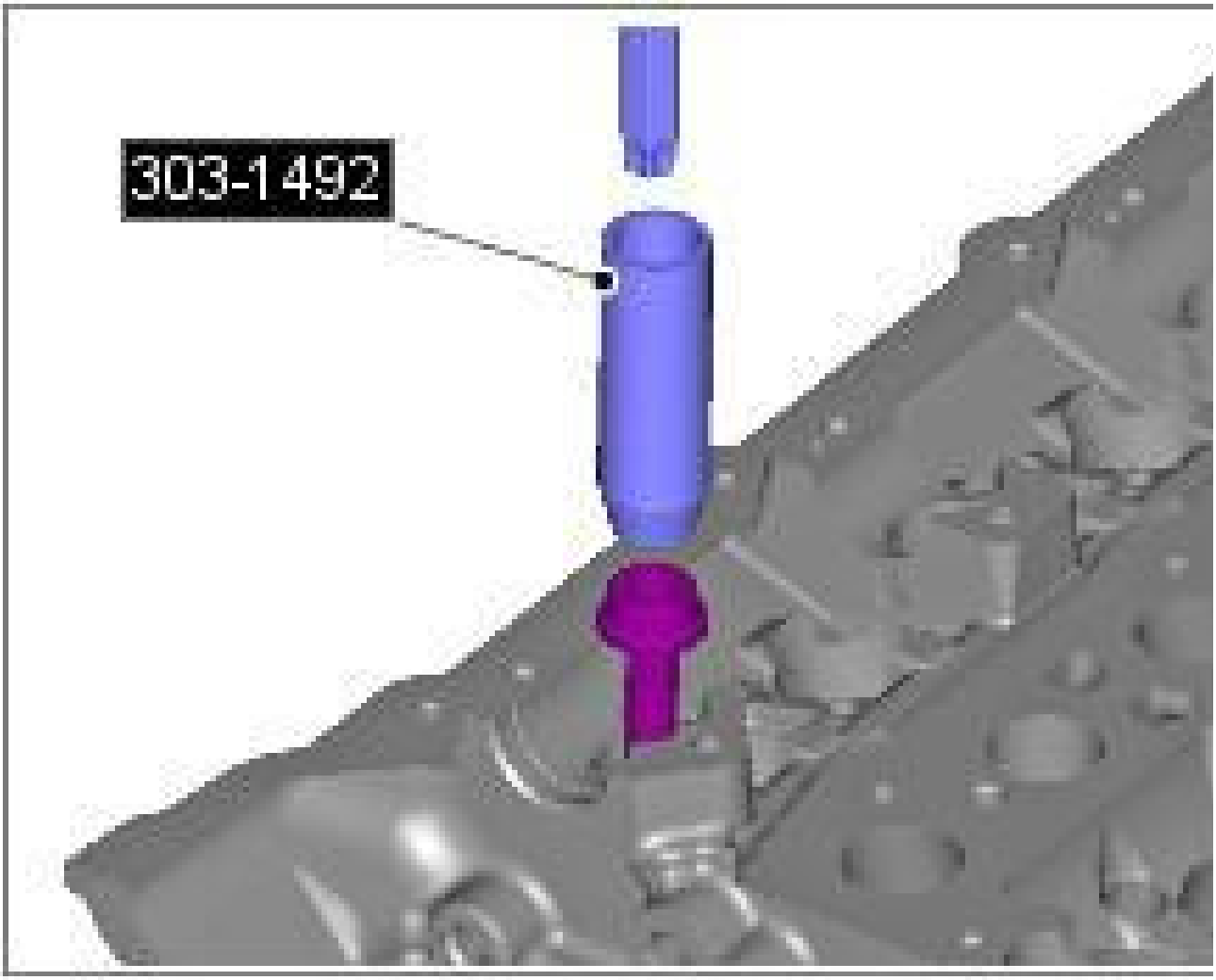

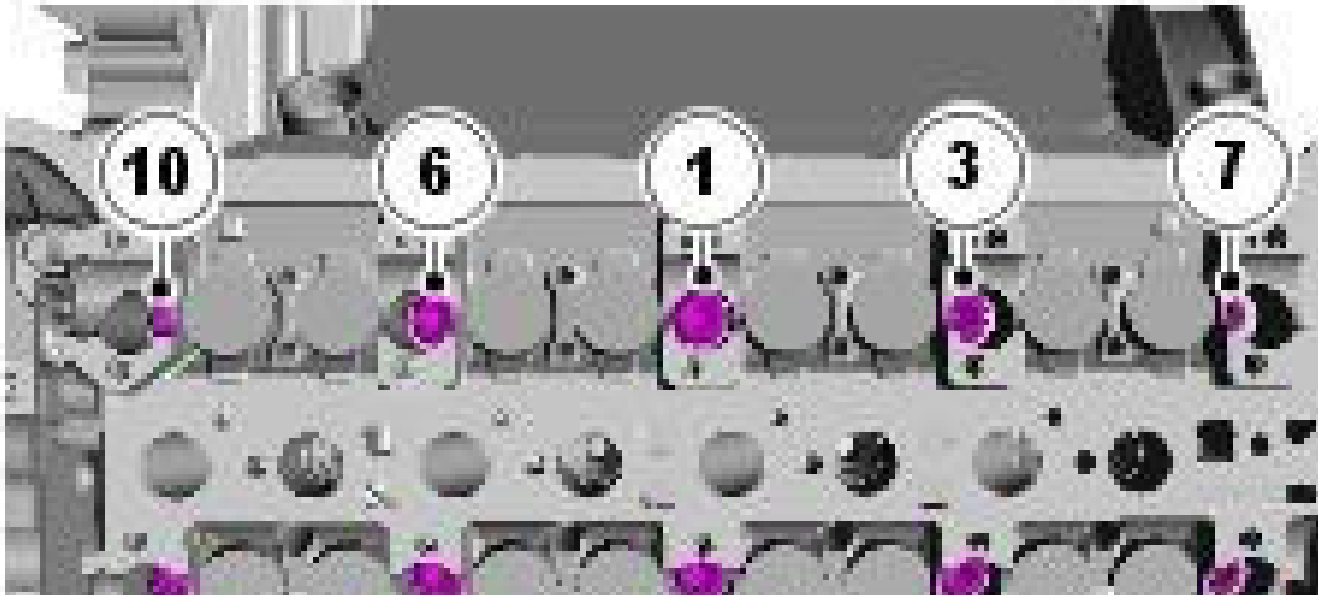

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NOTE: Tighten the bolts in the indicated sequence.

5. Tighten the bolts 1 to 10, a further 90 degrees.

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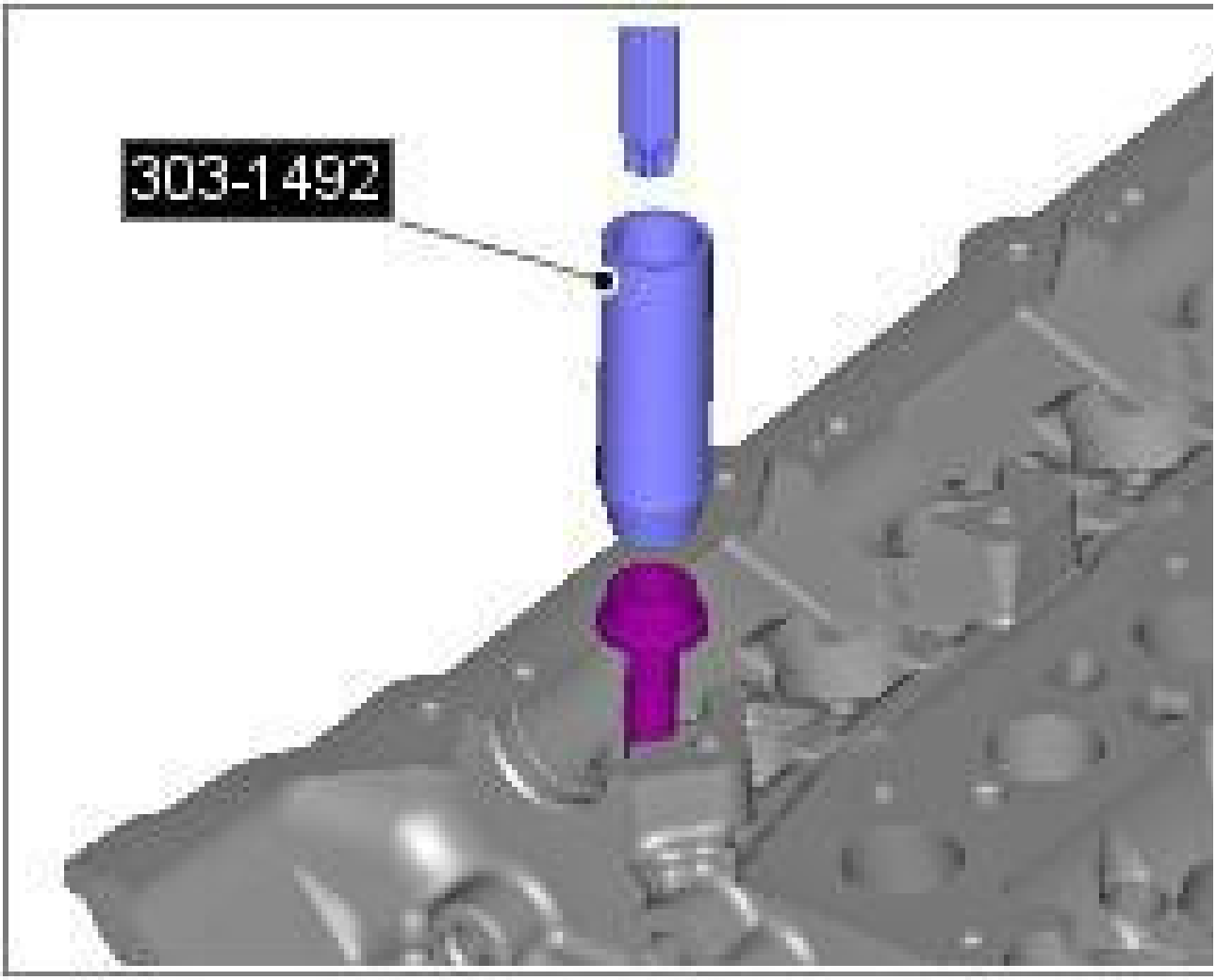

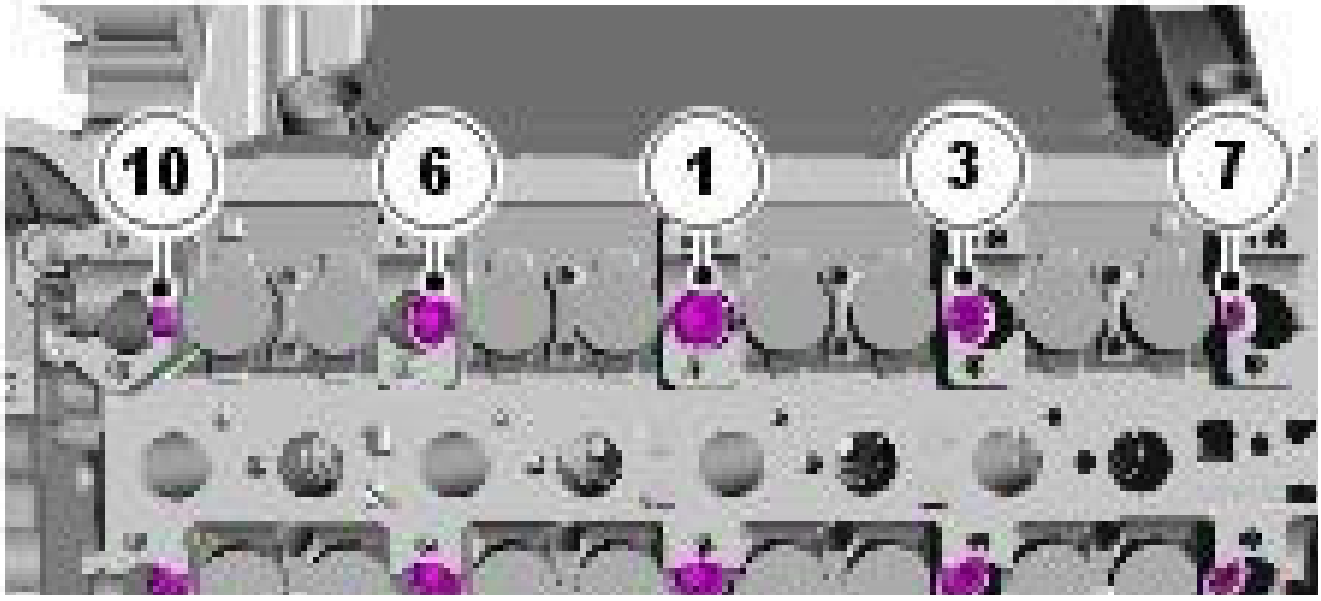

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NOTE: Tighten the bolts in the indicated sequence.

6. Tighten the bolts 1 to 10, a further 120 degrees.

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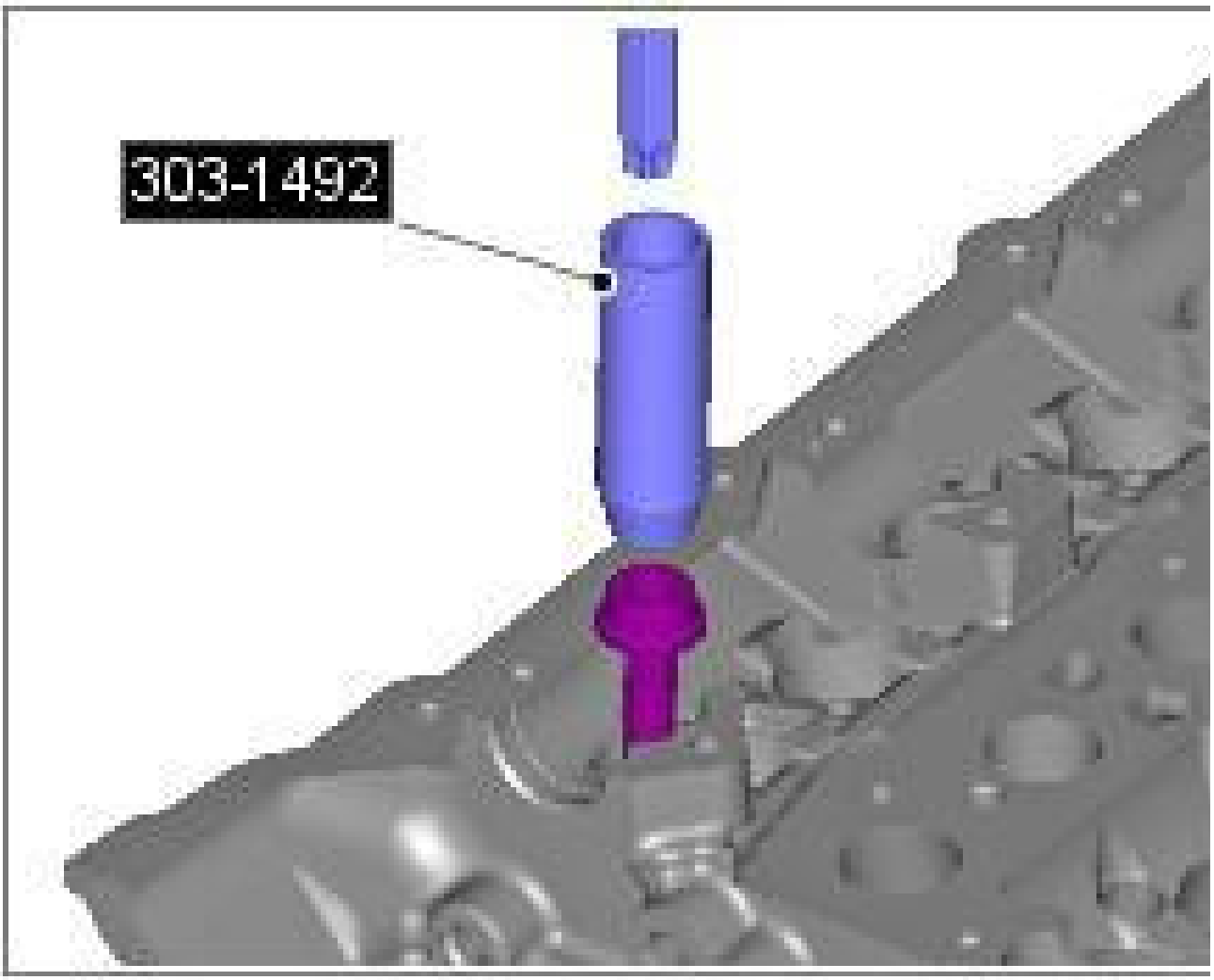

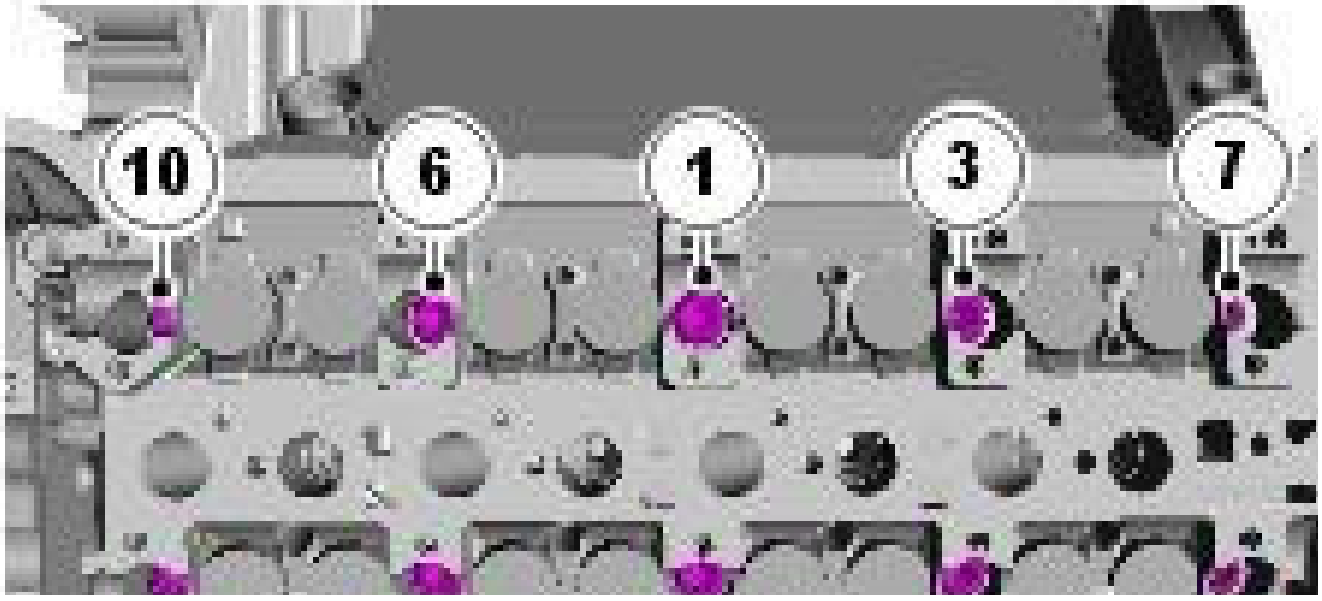

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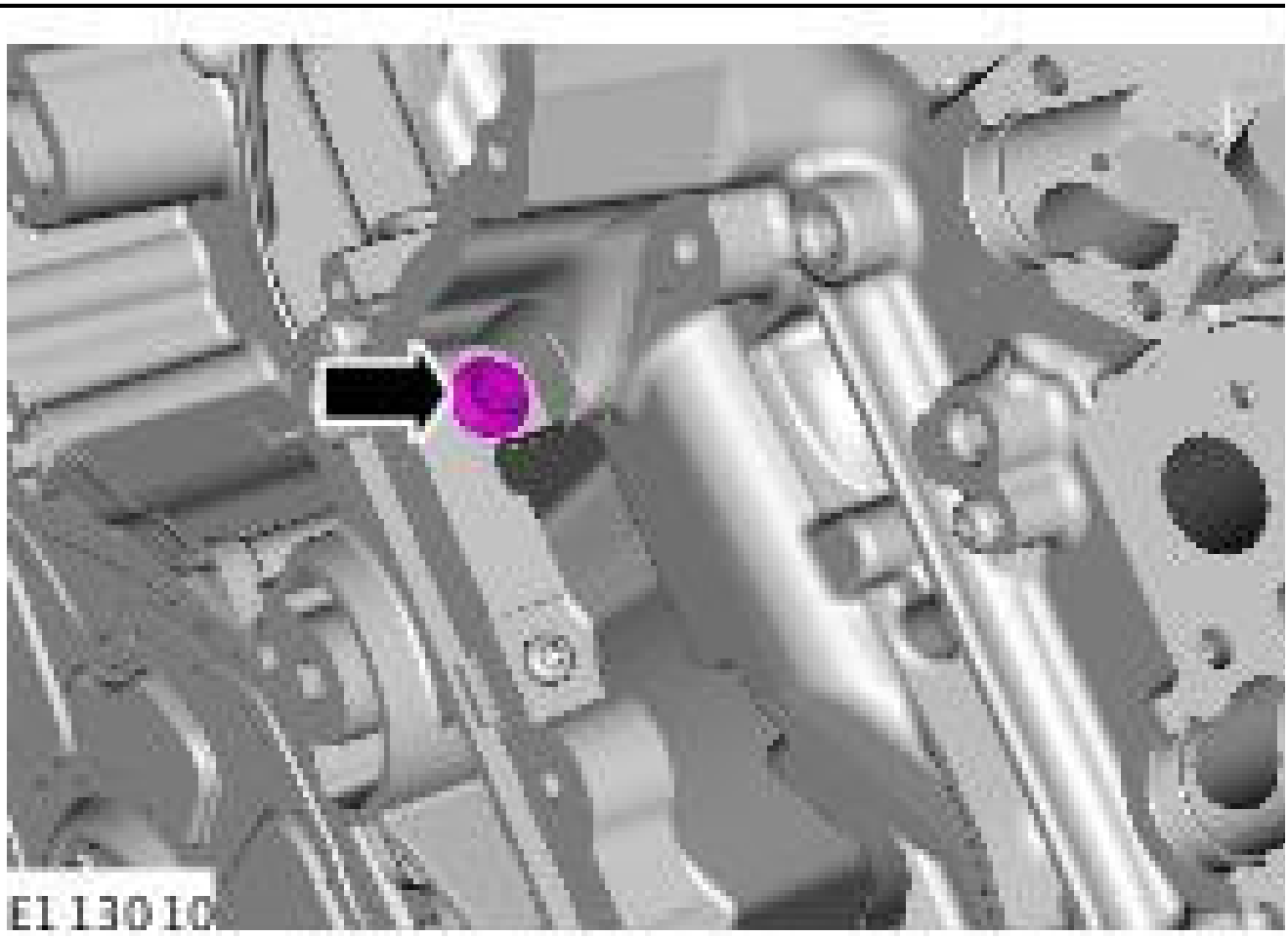
NOTE: Tighten the bolts in the indicated sequence.

7. Torque: 25 Nm



8. Torque: 12 Nm

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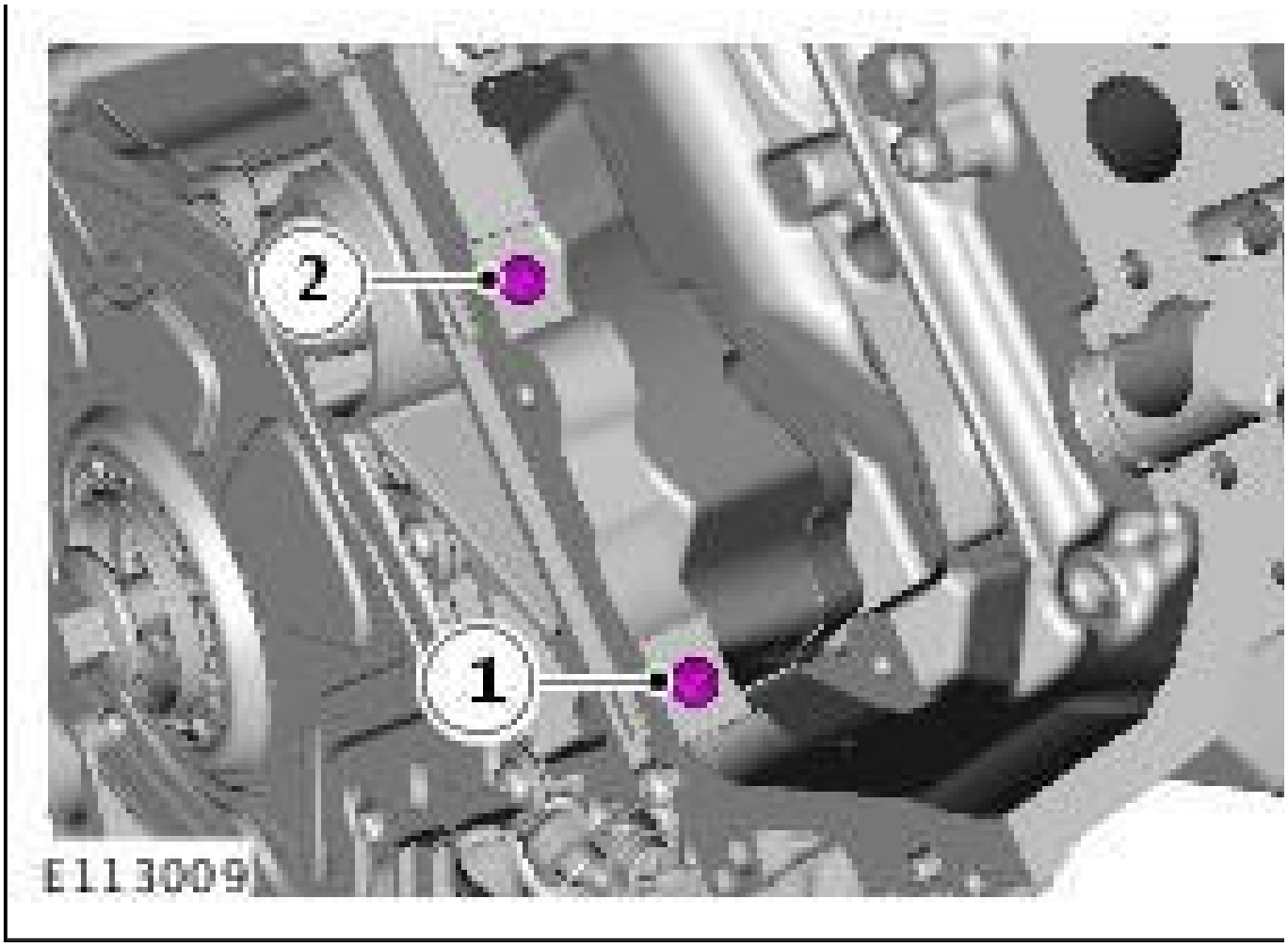

NOTE: Tighten the bolts in the indicated sequence.

9. Lubricate the valve tappets with clean engine oil.

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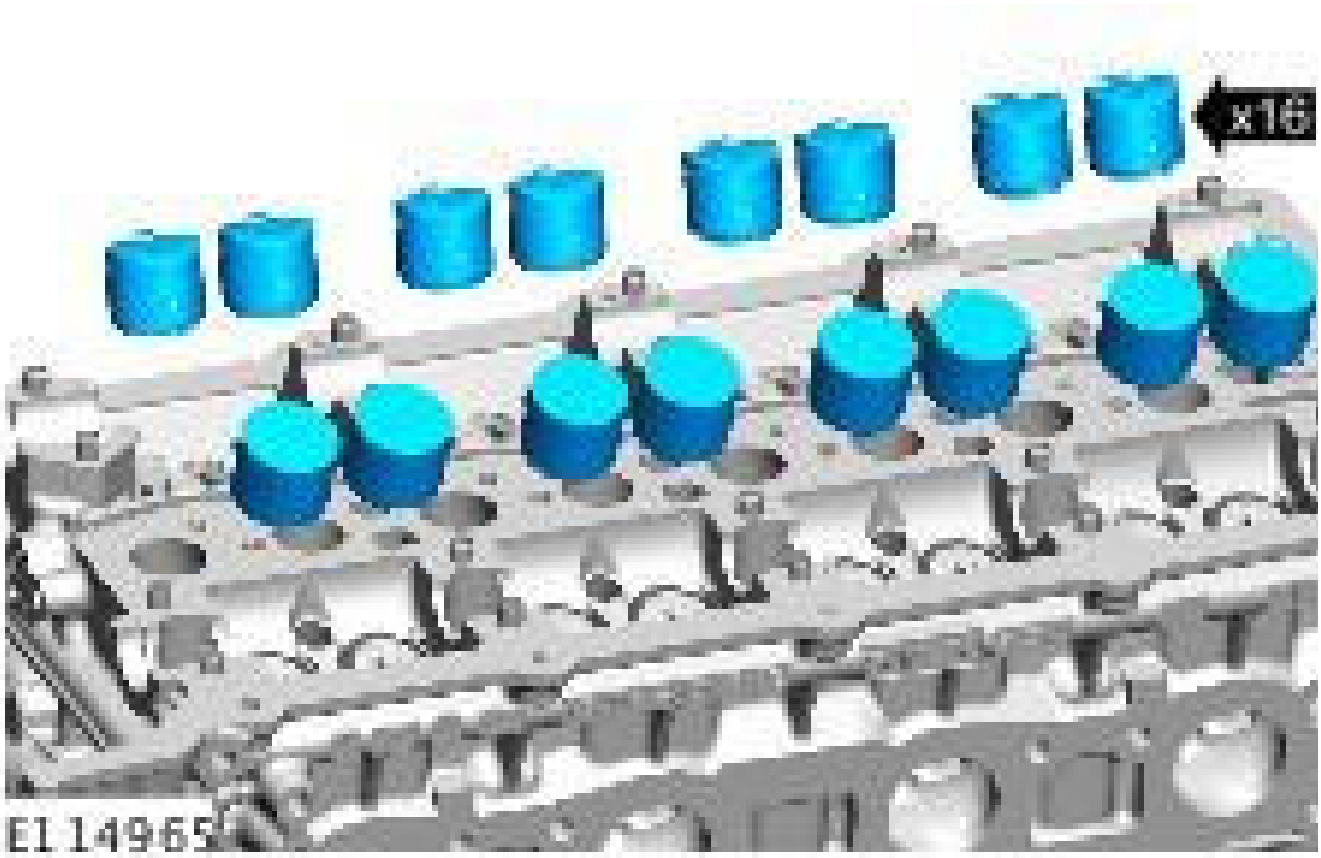

CAUTION: If a new cylinder head has been installed then new tappets must be installed.

CAUTION: If the cylinder head is being removed without a new component being installed, the tappets must be installed in their original positions.

10. Torque: 12 Nm

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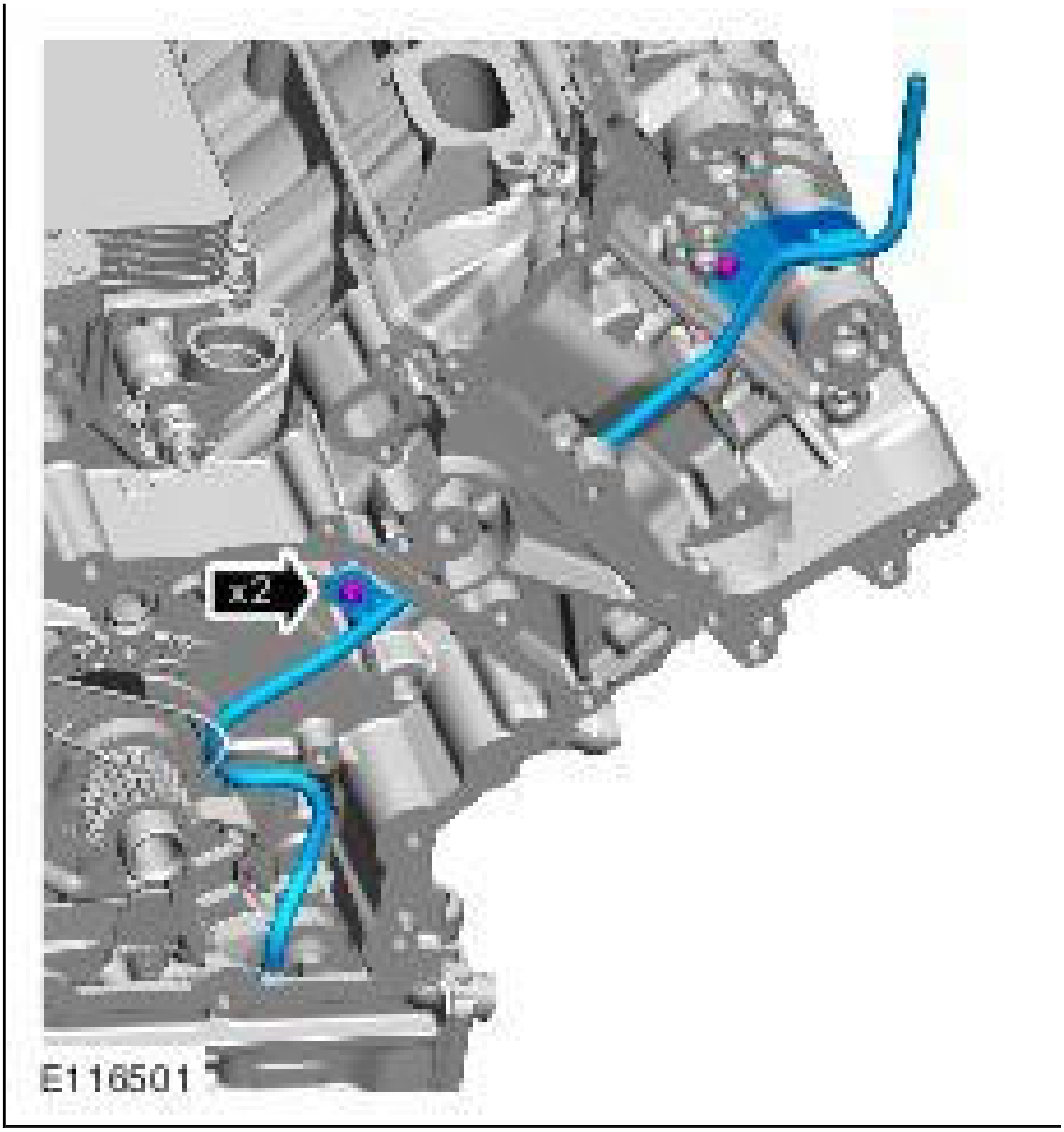

11. Torque: 12 Nm

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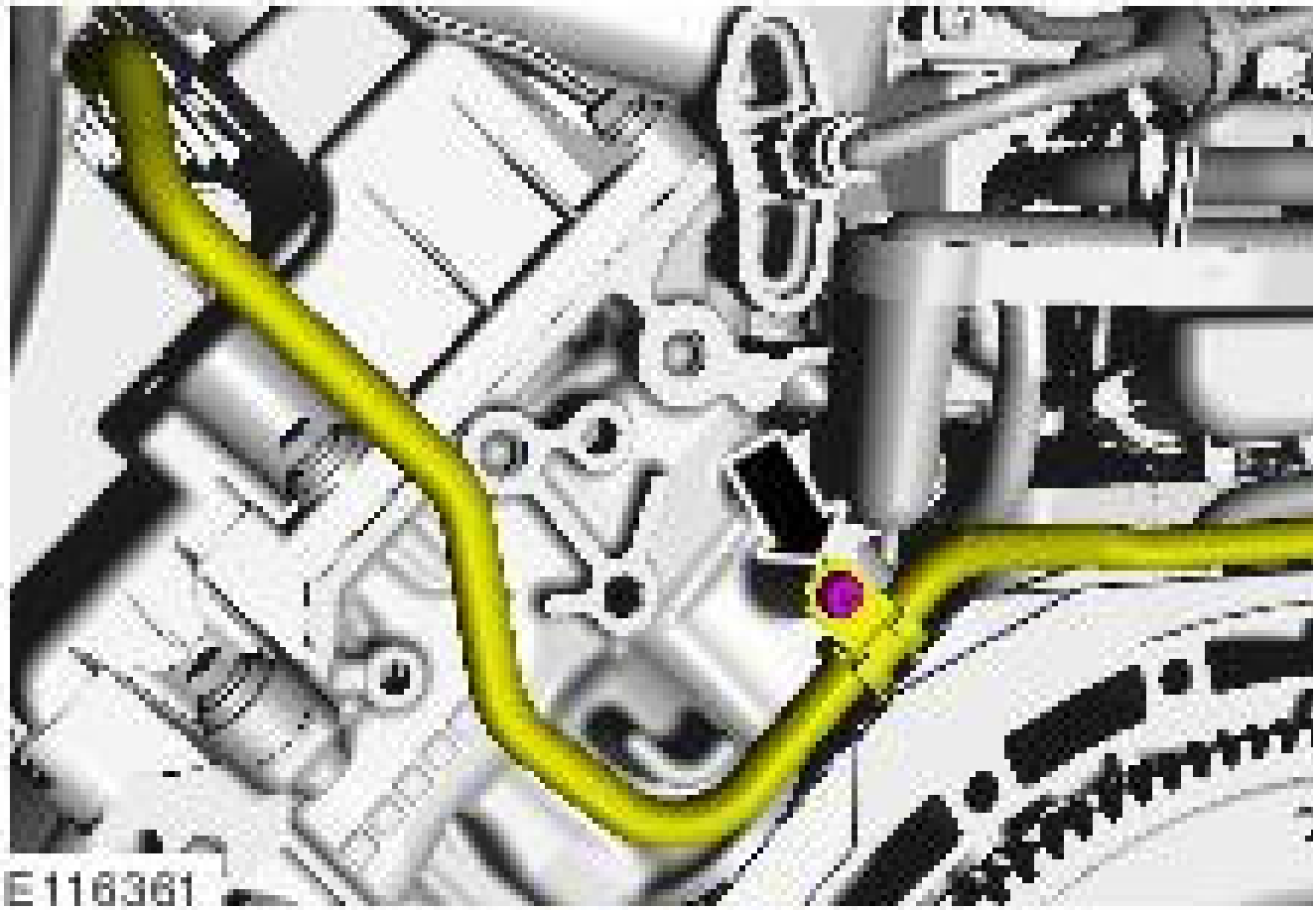

12. Torque: 10 Nm

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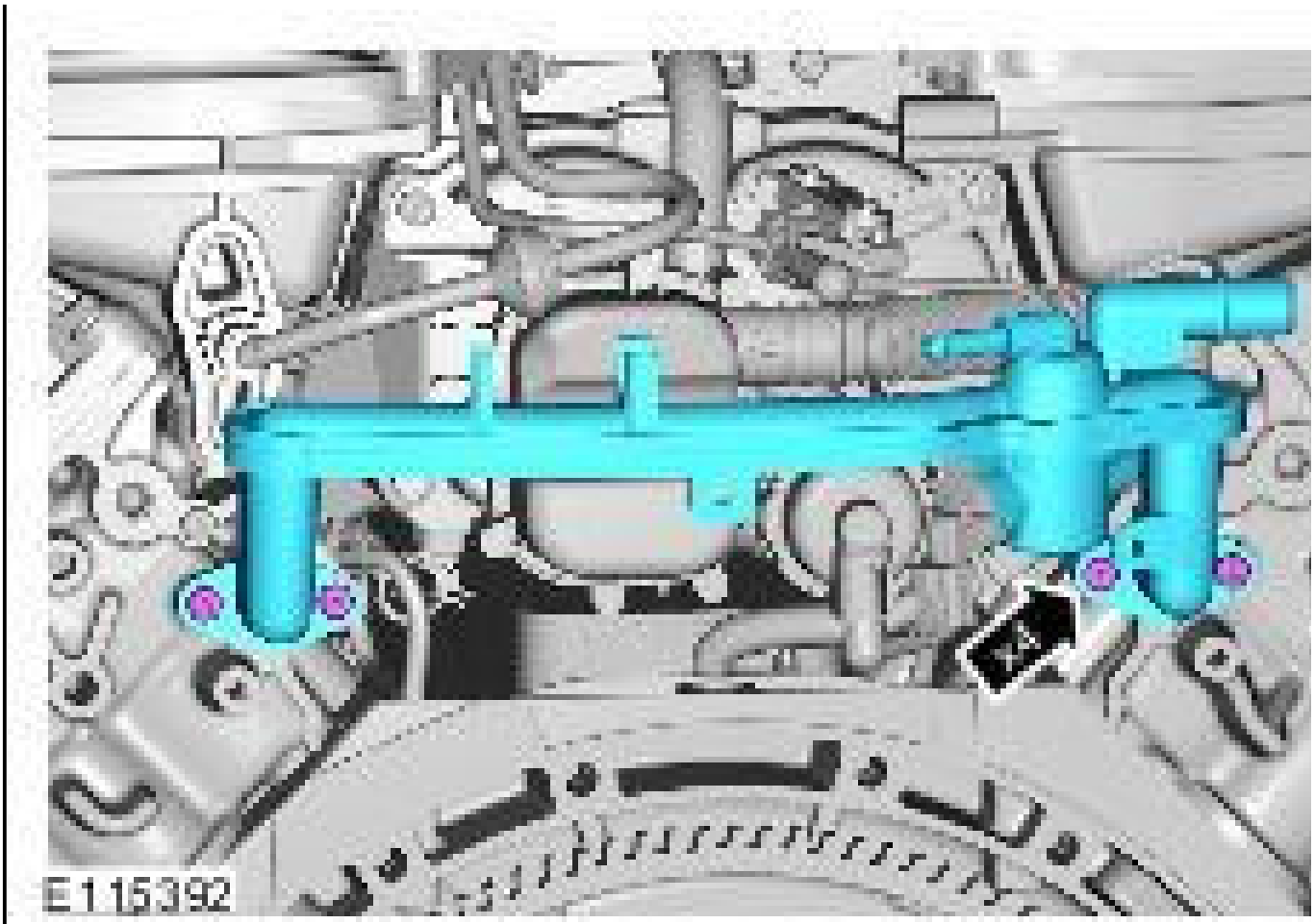

CAUTION: Install the new seals.

13. See figure

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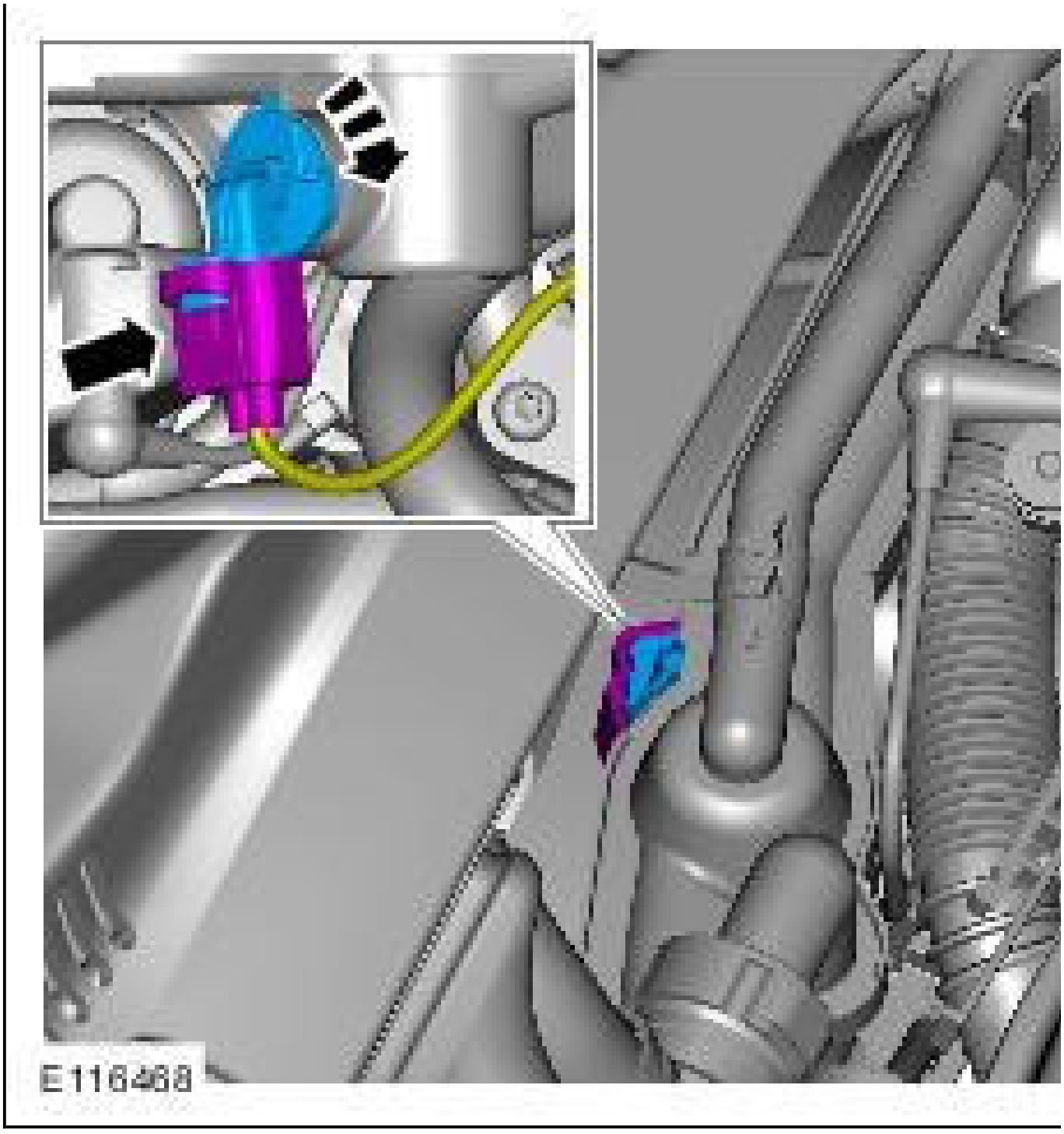

14. See figure

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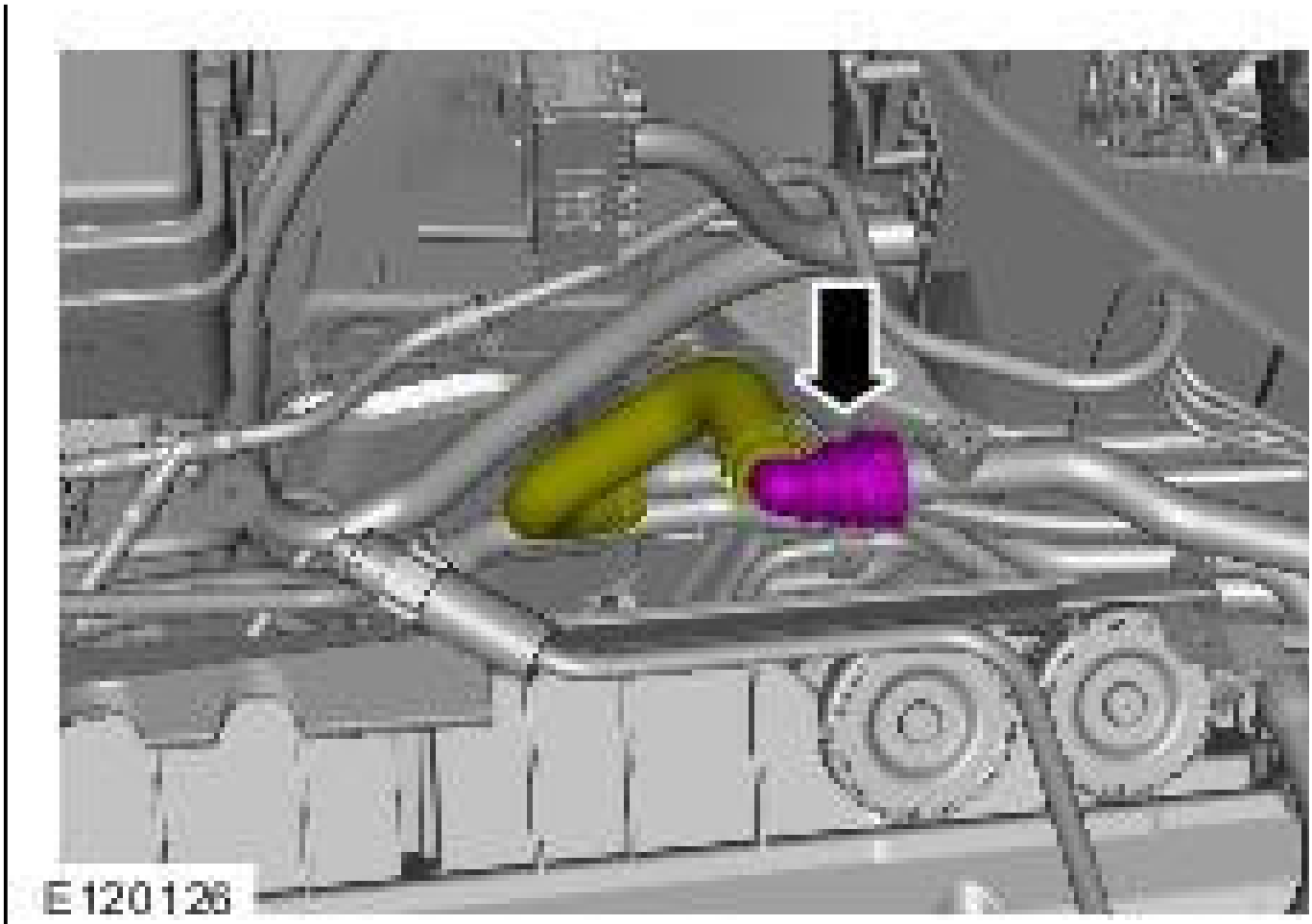

15. Torque: 10 Nm

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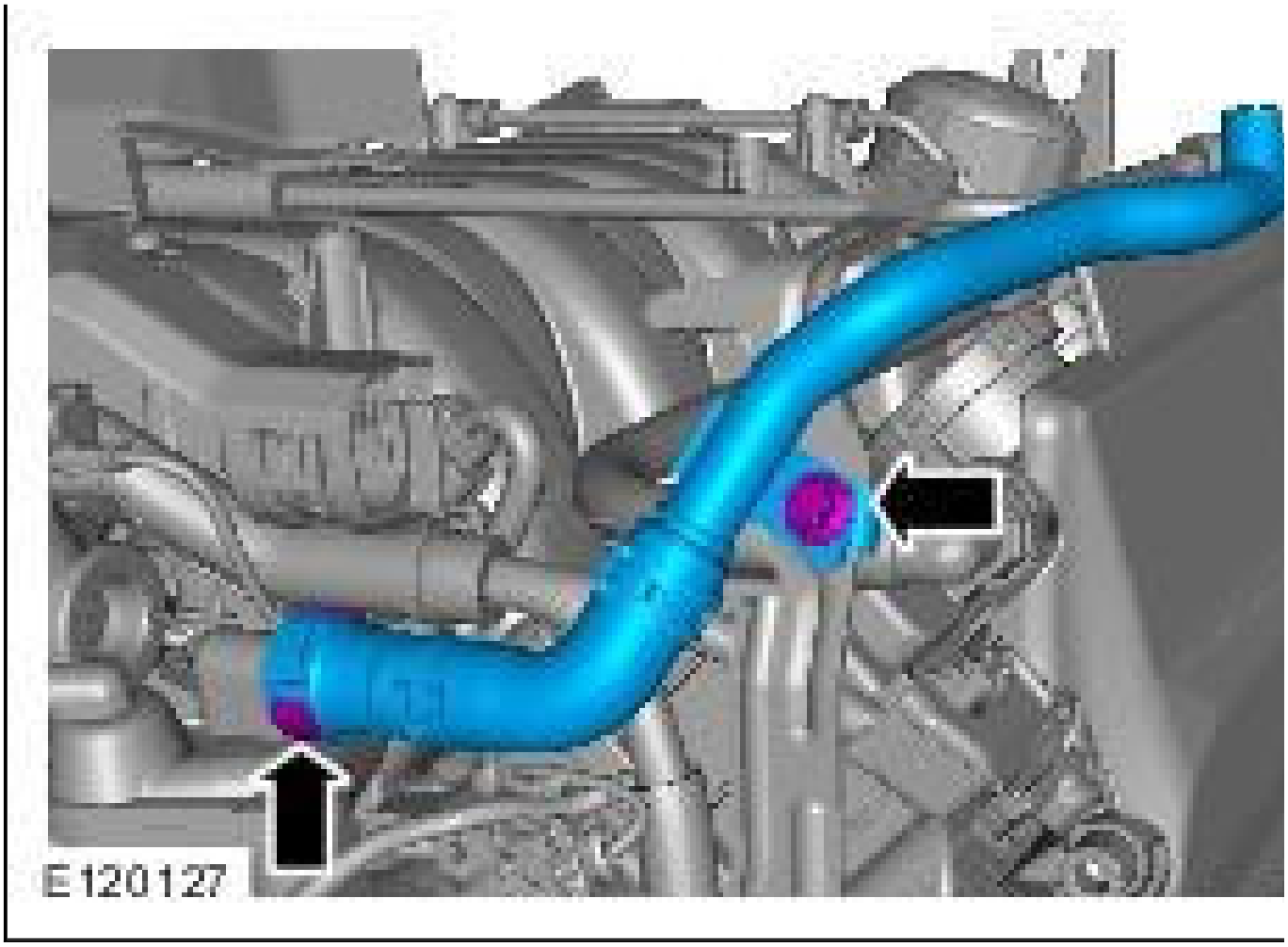

16. See figure

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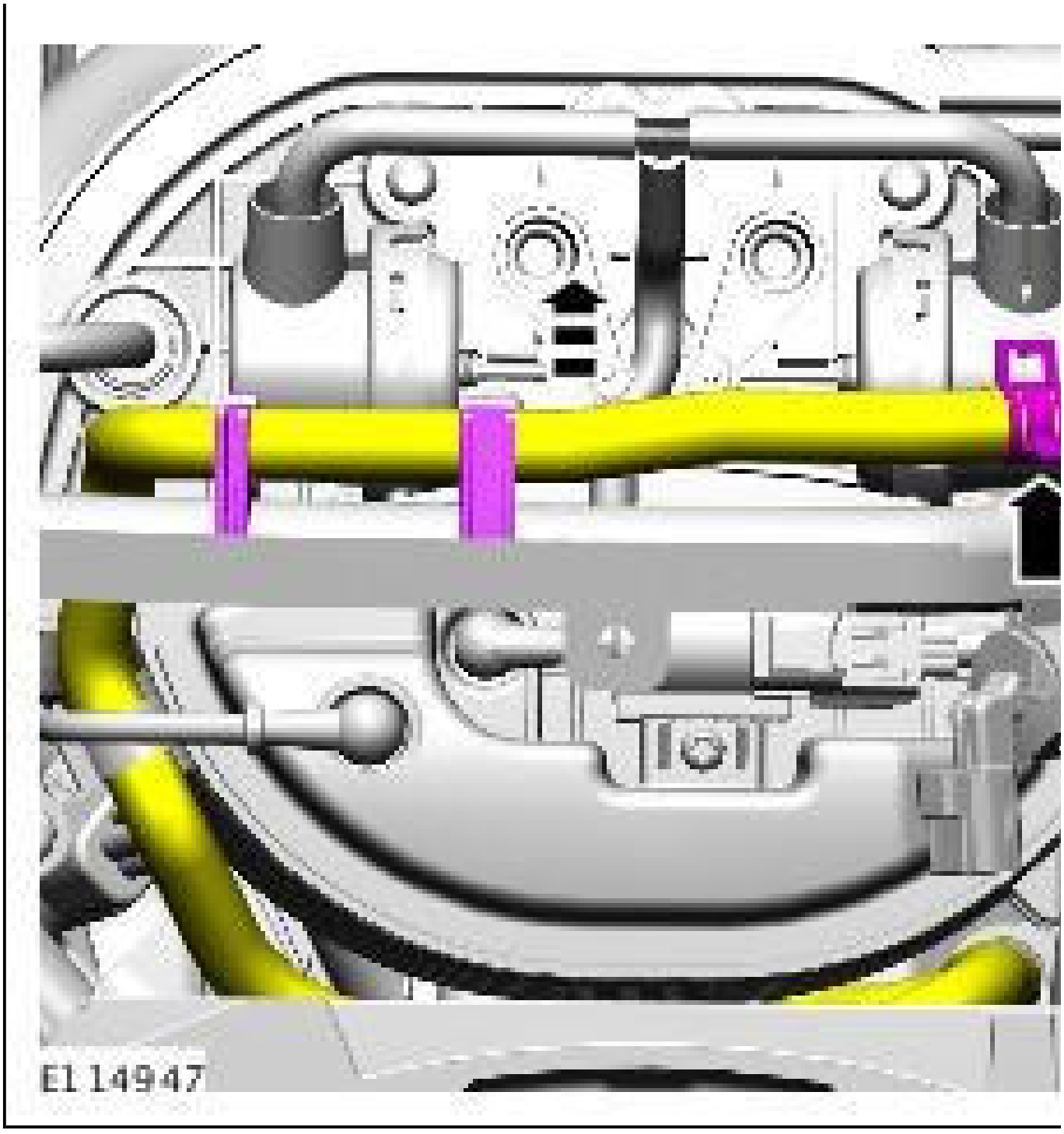

17. Torque: 12 Nm

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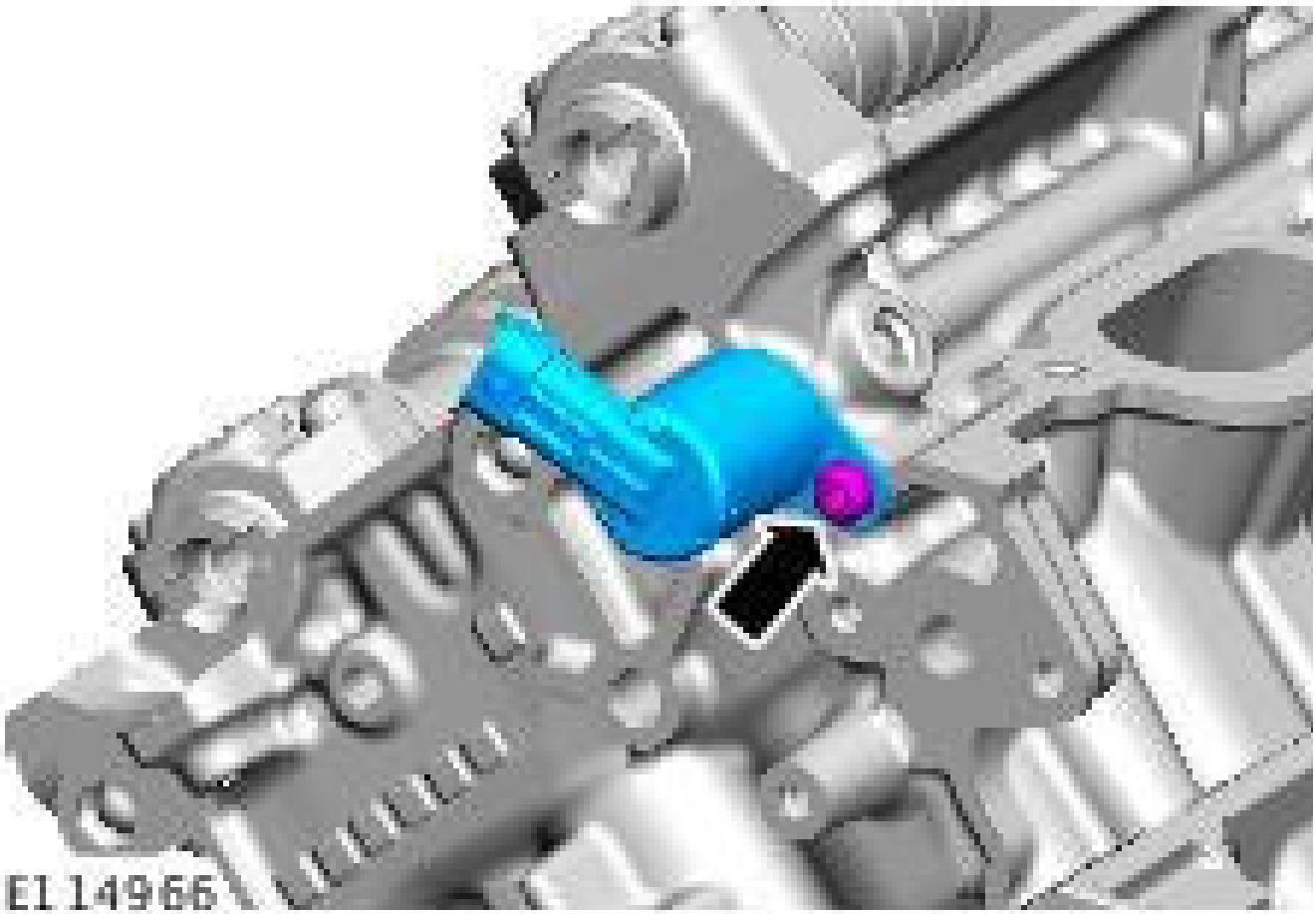
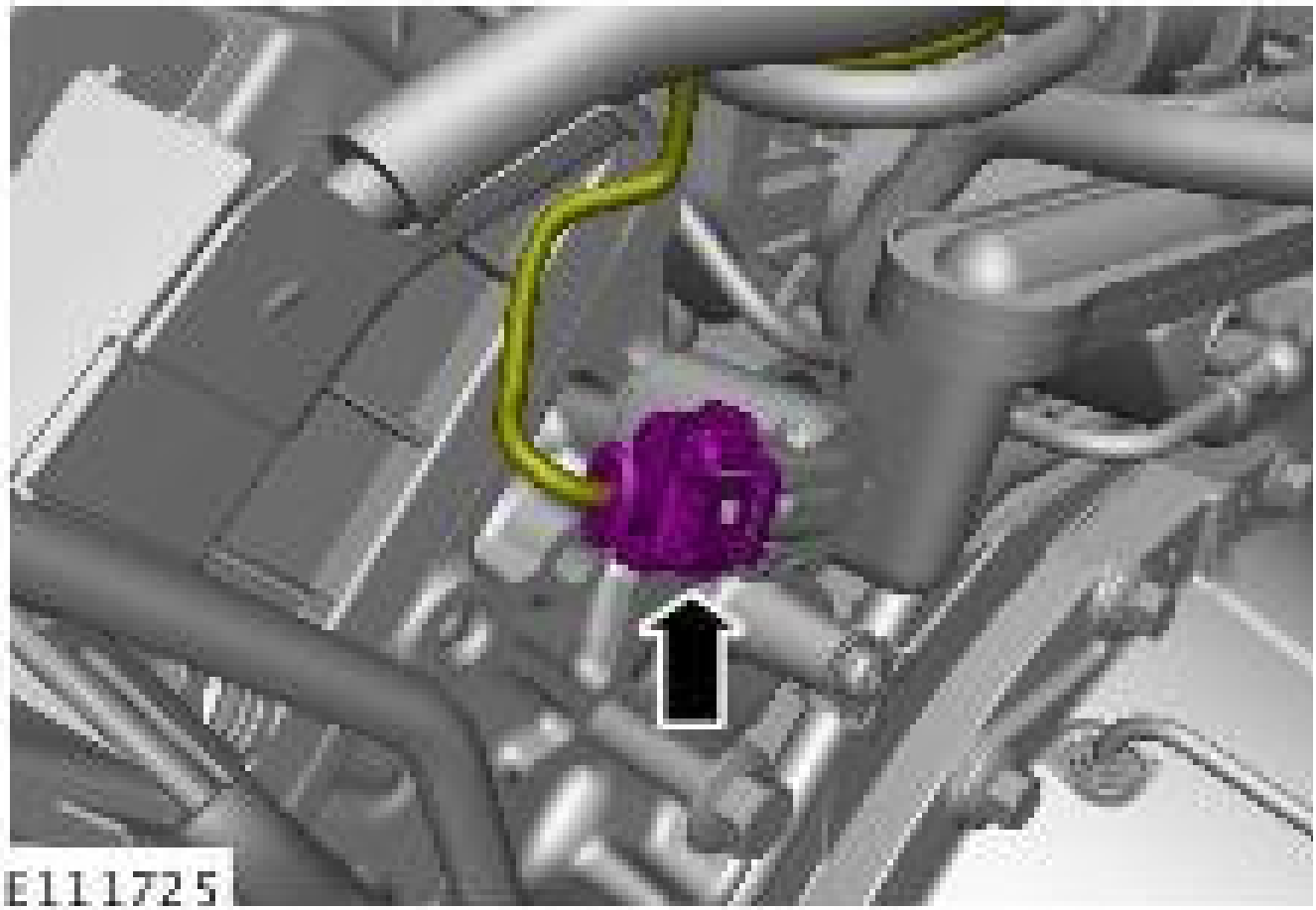


NOTE: Engine shown removed for clarity.

18. See figure

 © 2011 Mitchell Repair Information Company, LLC.



19. Torque: 12 Nm

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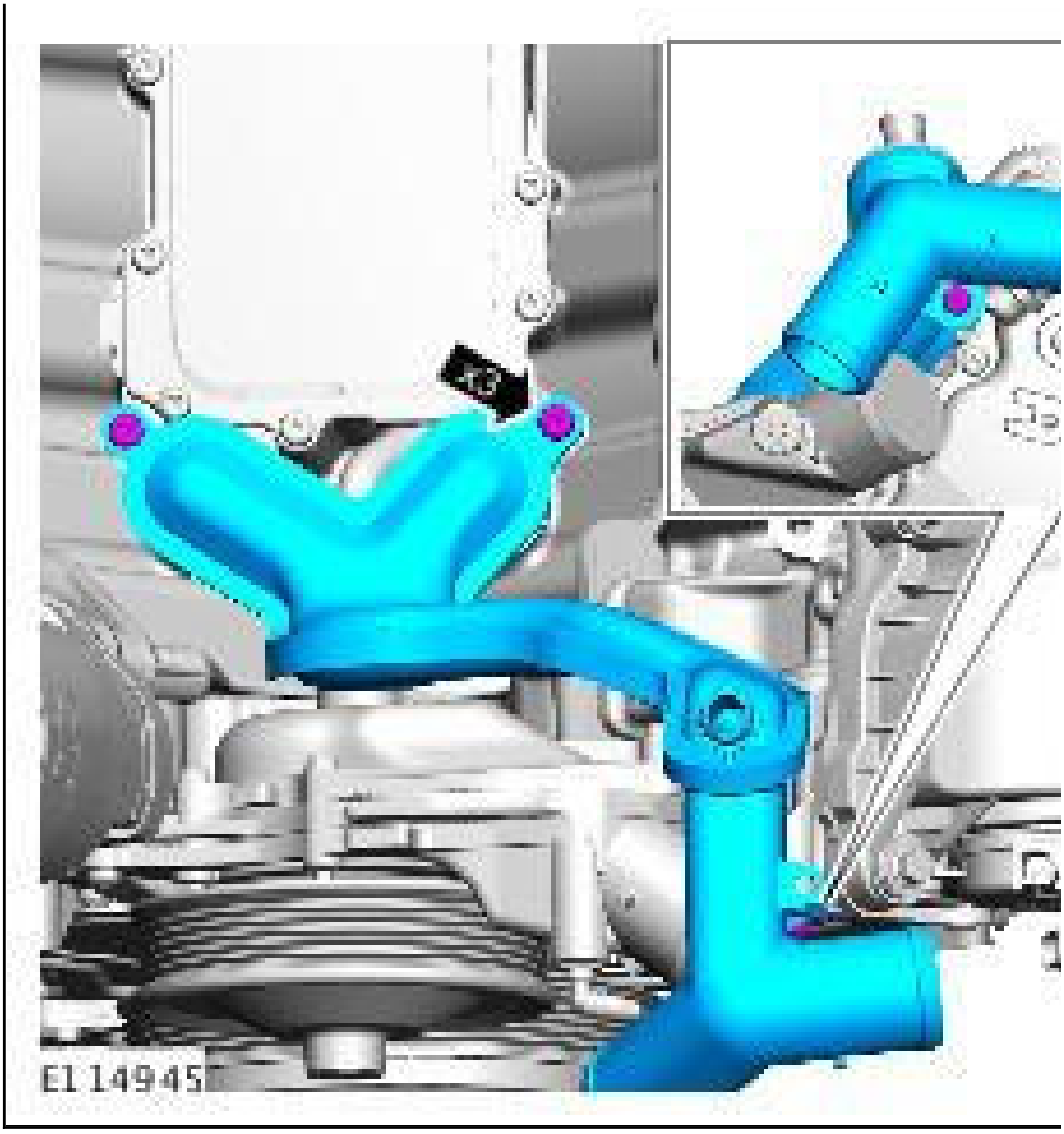

CAUTION: Install new o-ring seals

20. See figure

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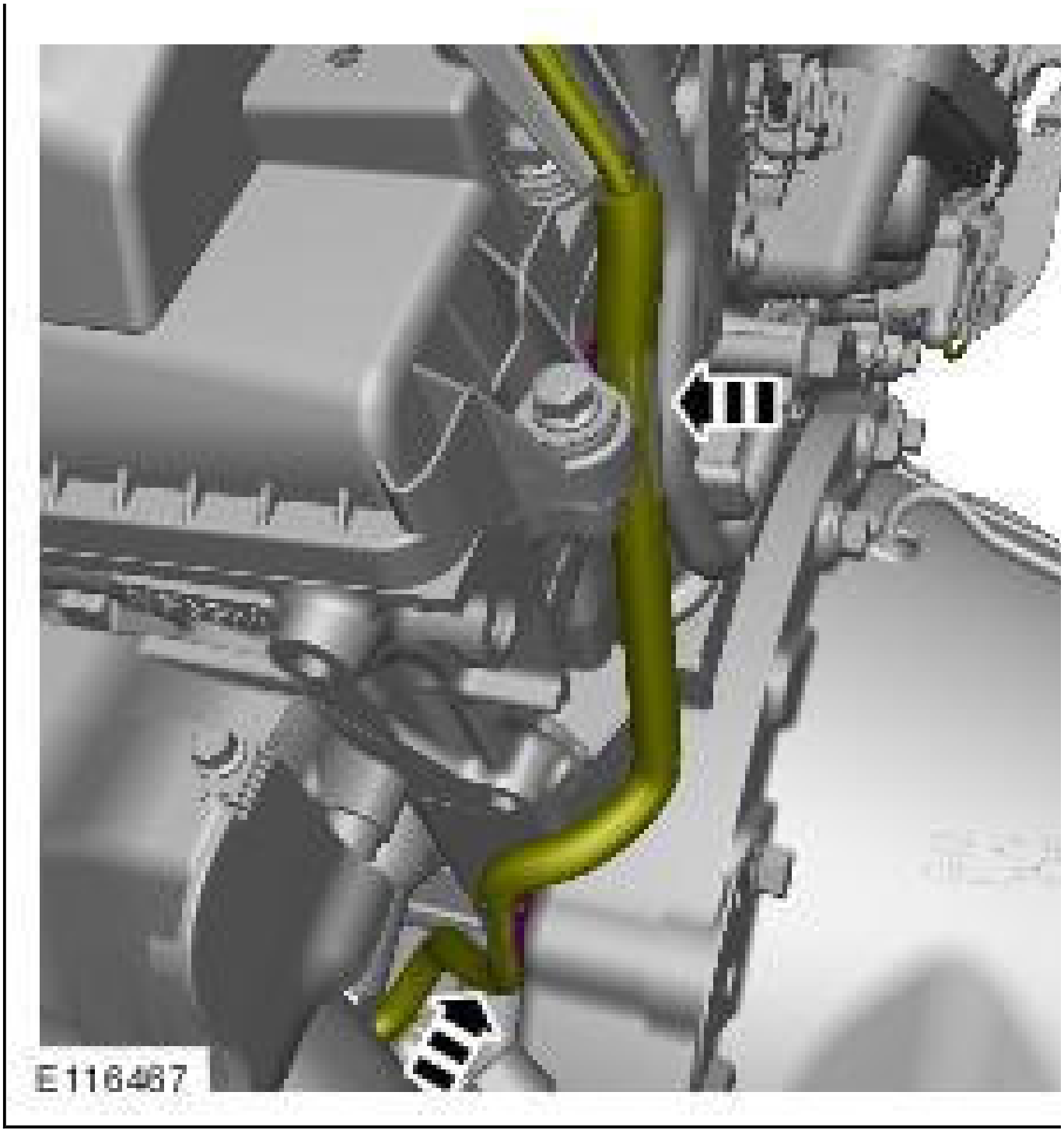

21. Torque: 20 Nm

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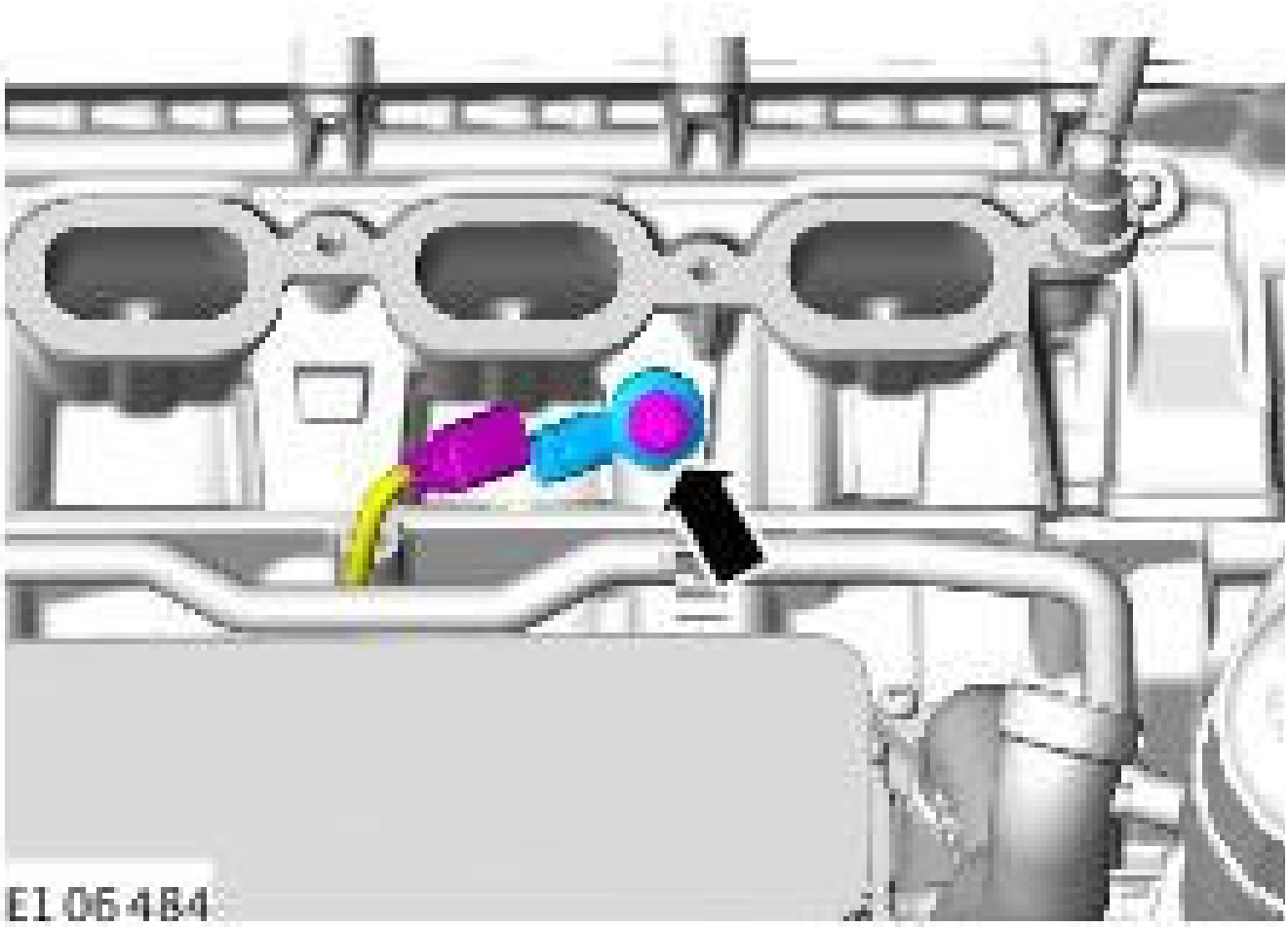

22. Torque: 20 Nm

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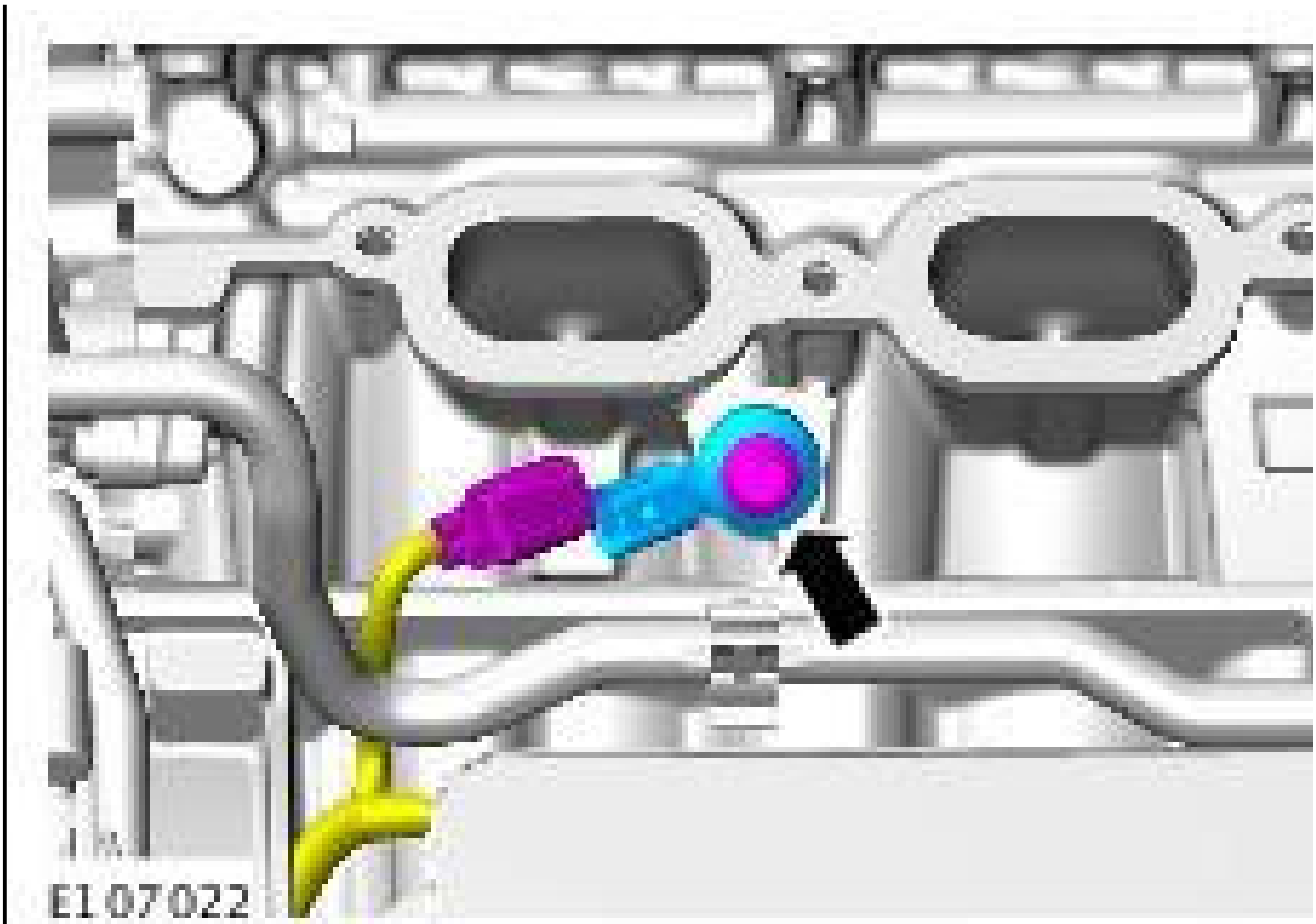

23. Torque: 25 Nm

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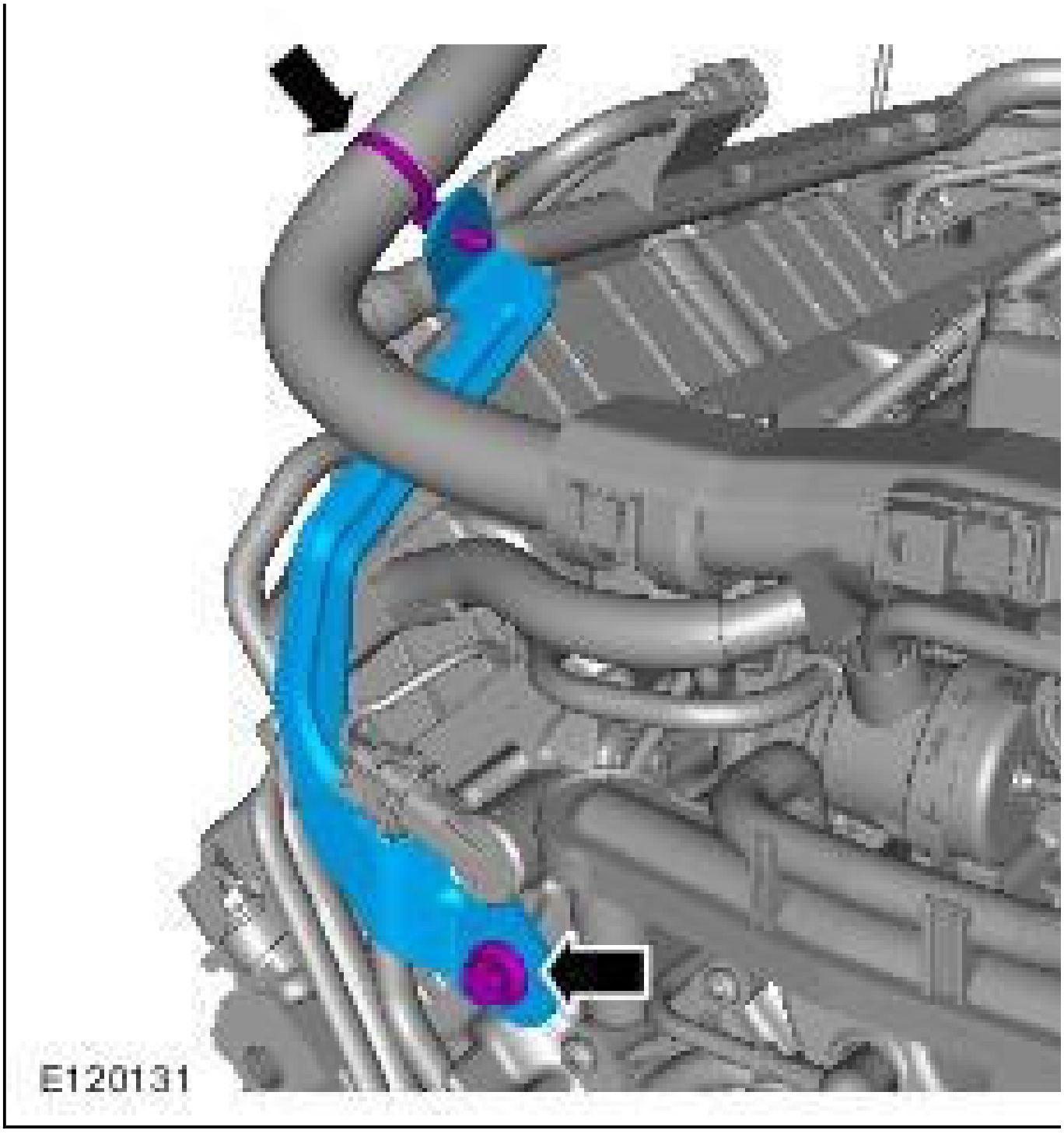

24. See **Intake Manifold**.
25. See **Exhaust Manifold LH**.
26. See **Camshaft LH**.
27. Connect the battery ground cable. Refer to **Specifications** .

CYLINDER HEAD RH

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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.

1. 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. See **Intake Manifold**.
4. See **Camshaft RH**.
5. See **Exhaust Manifold RH**.

CAUTION: Be prepared to collect escaping coolant.

6. See figure

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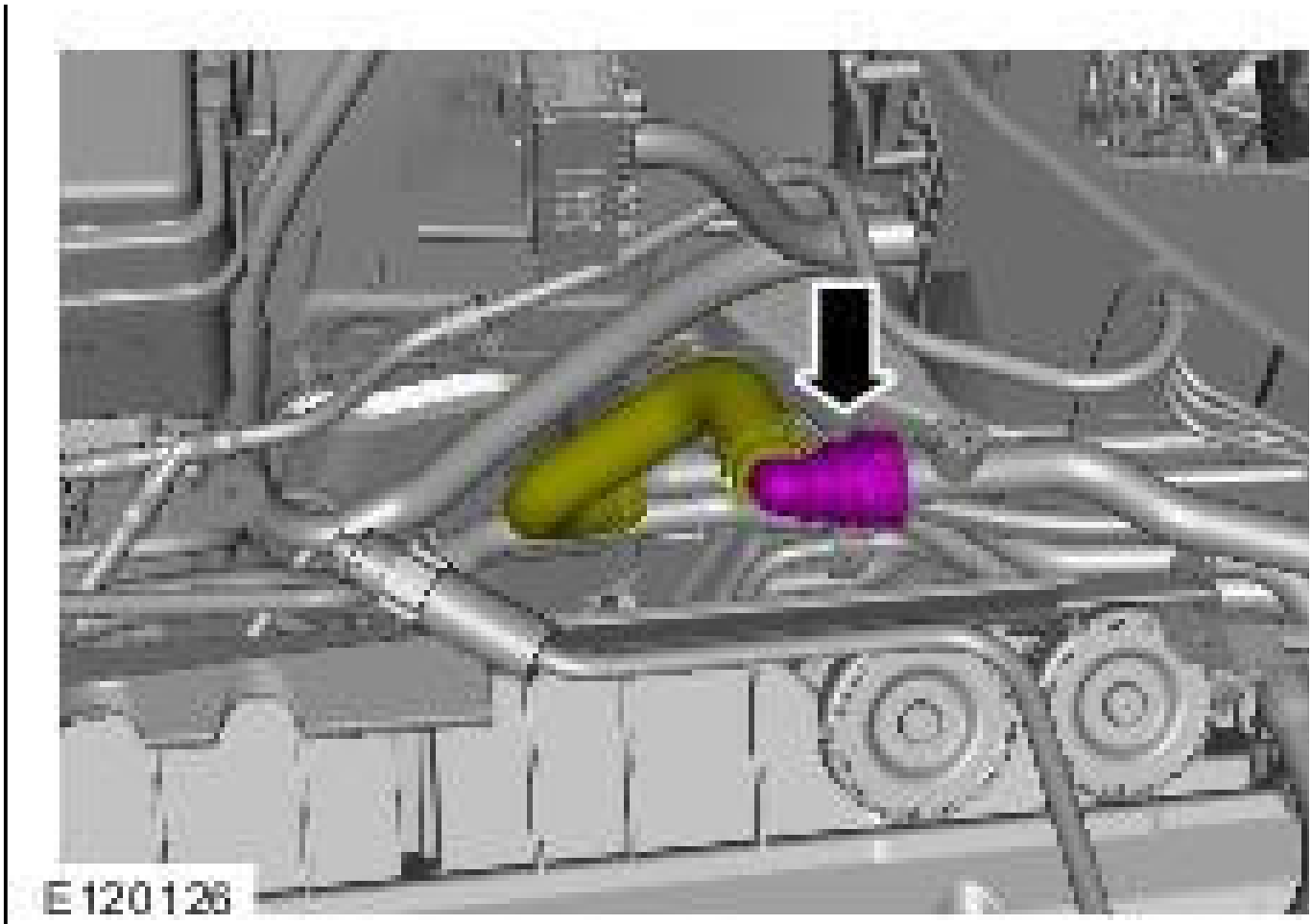
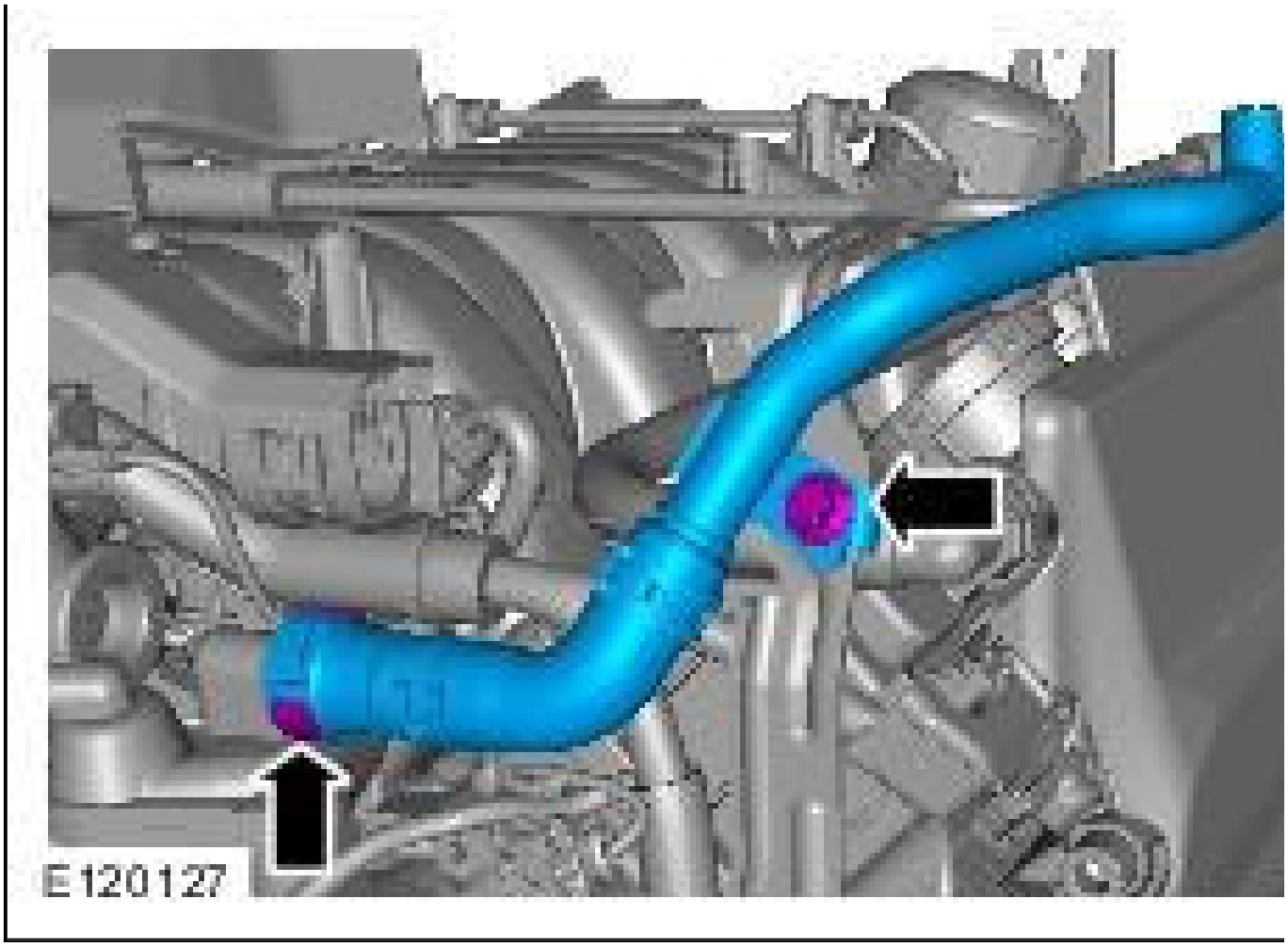


CAUTION: Be prepared to collect escaping coolant.

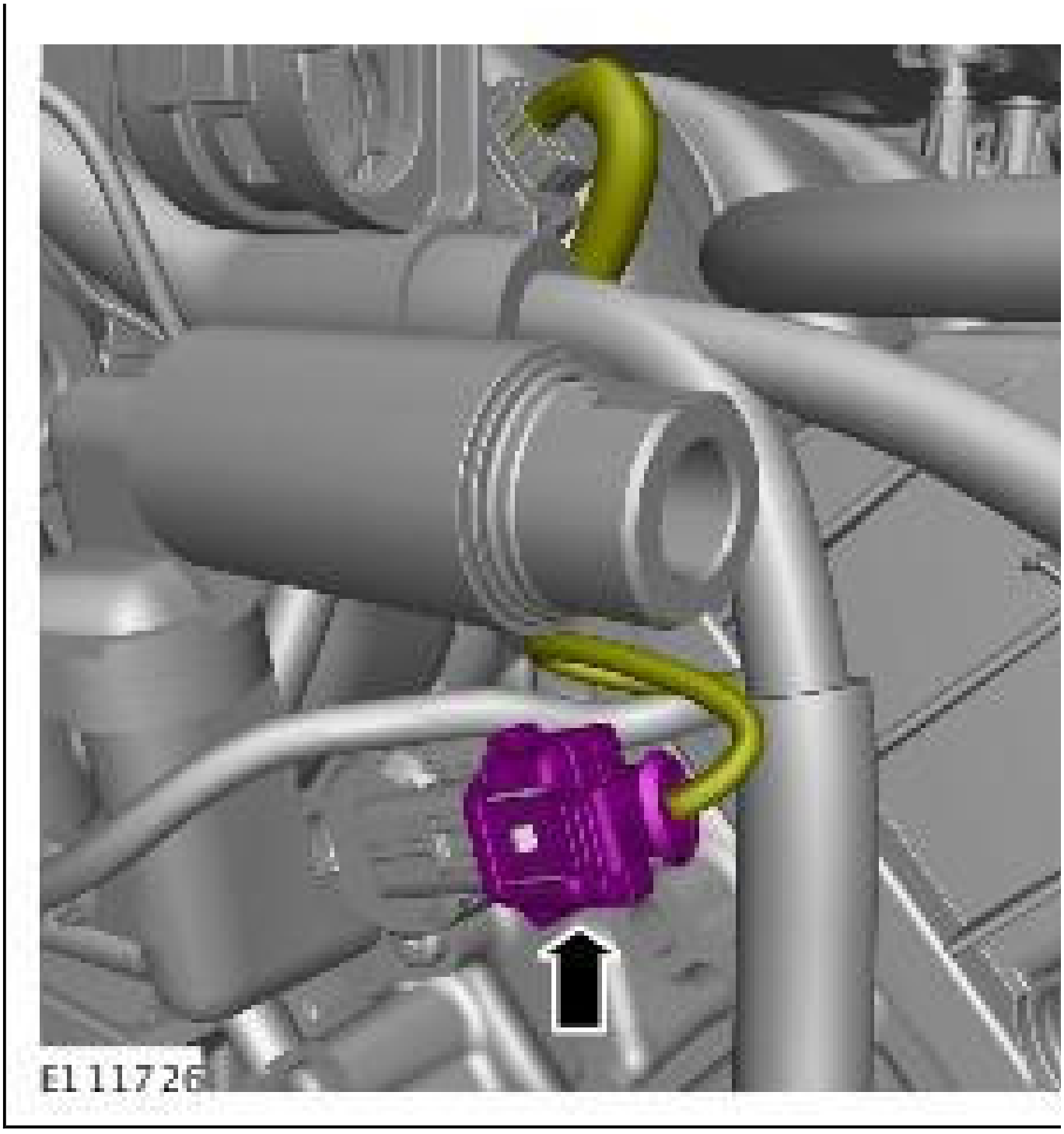
7. See figure

 © 2011 Mitchell Repair Information Company, LLC.



8. See figure

 © 2011 Mitchell Repair Information Company, LLC.



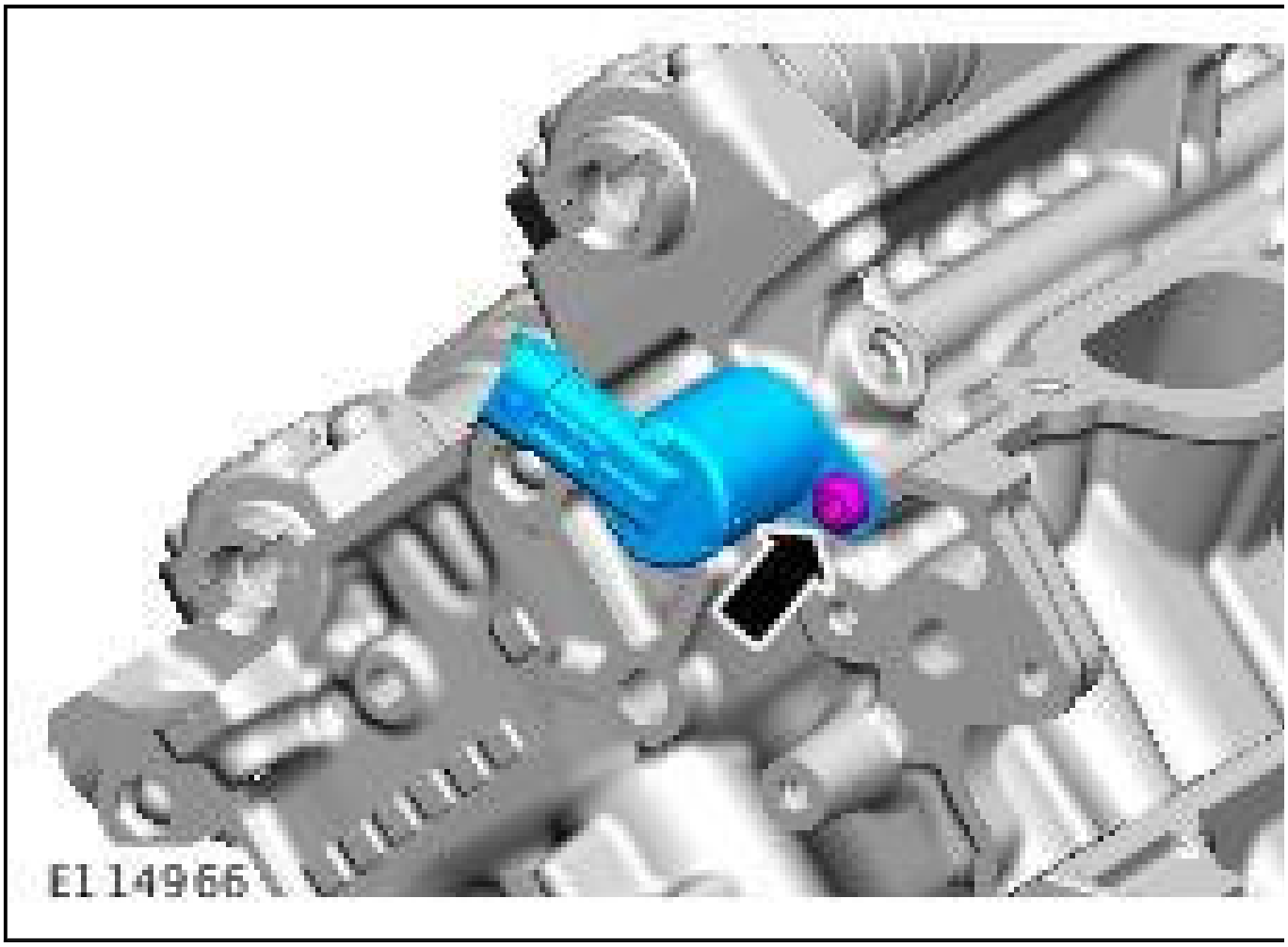
CAUTION: Discard the seal.

CAUTION: LH illustration shown, RH is similar.

 © 2011 Mitchell Repair Information Company, LLC.

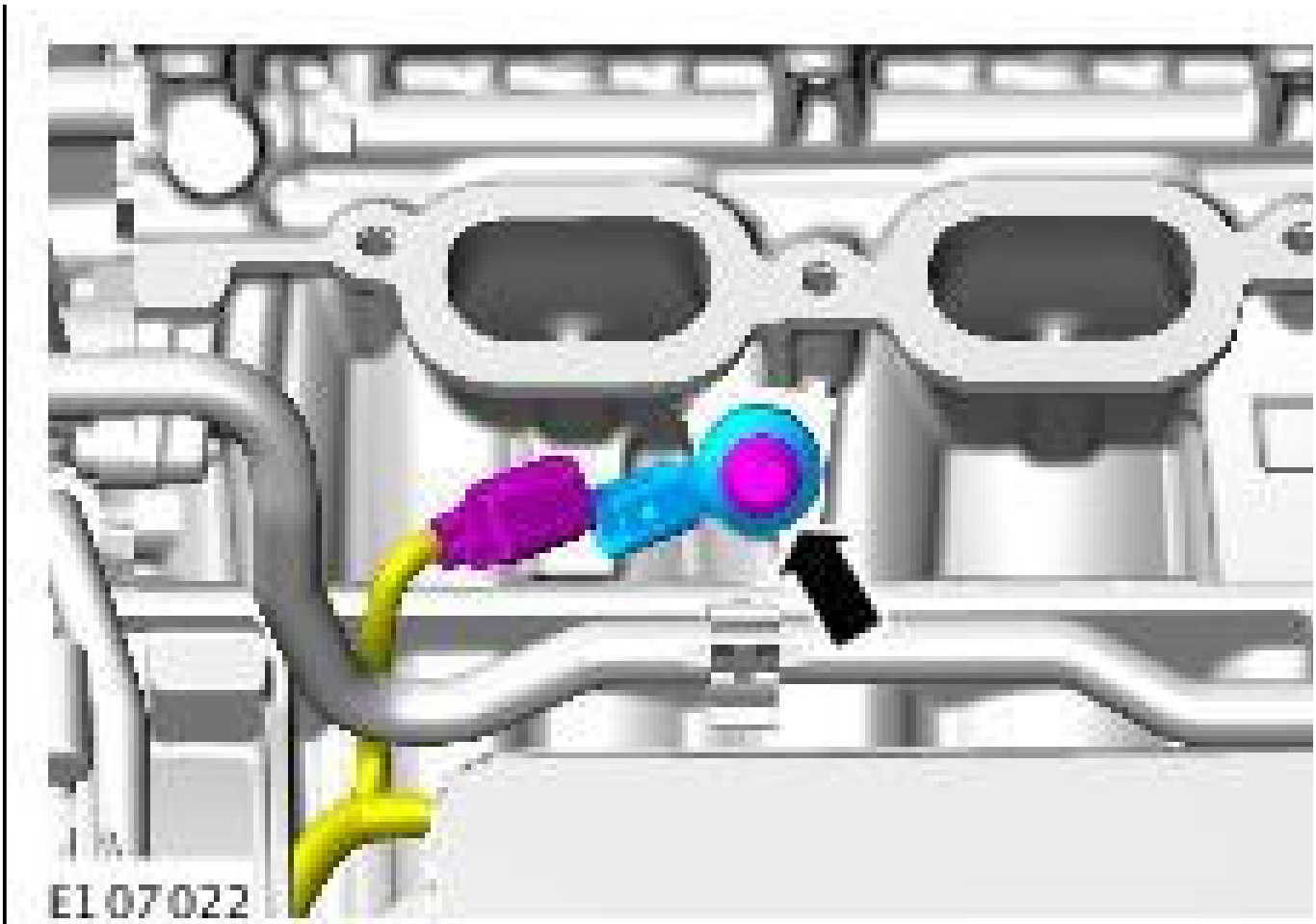
NOTE: Engine shown removed for clarity.

9. See figure



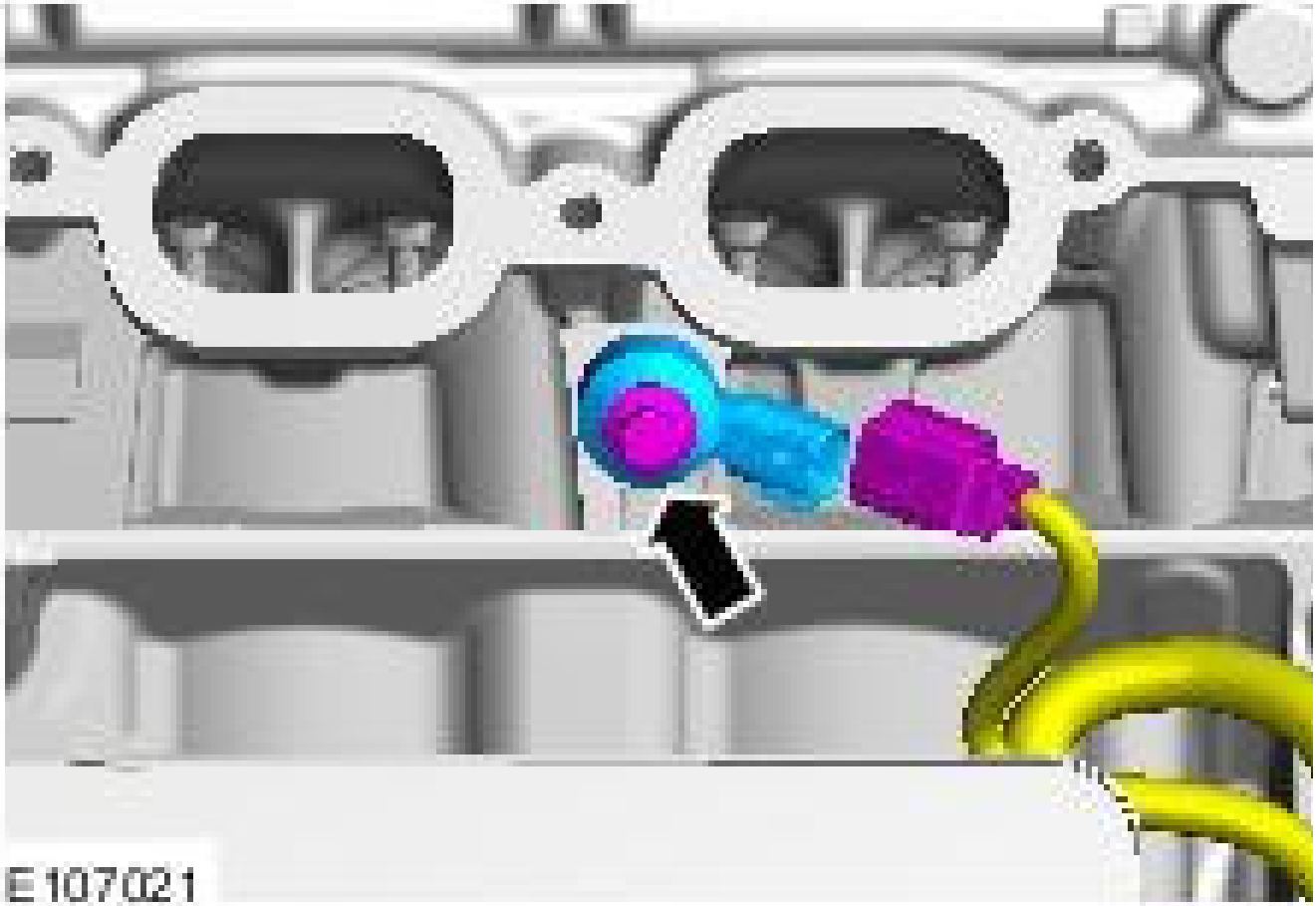
10. See figure

 © 2011 Mitchell Repair Information Company, LLC.



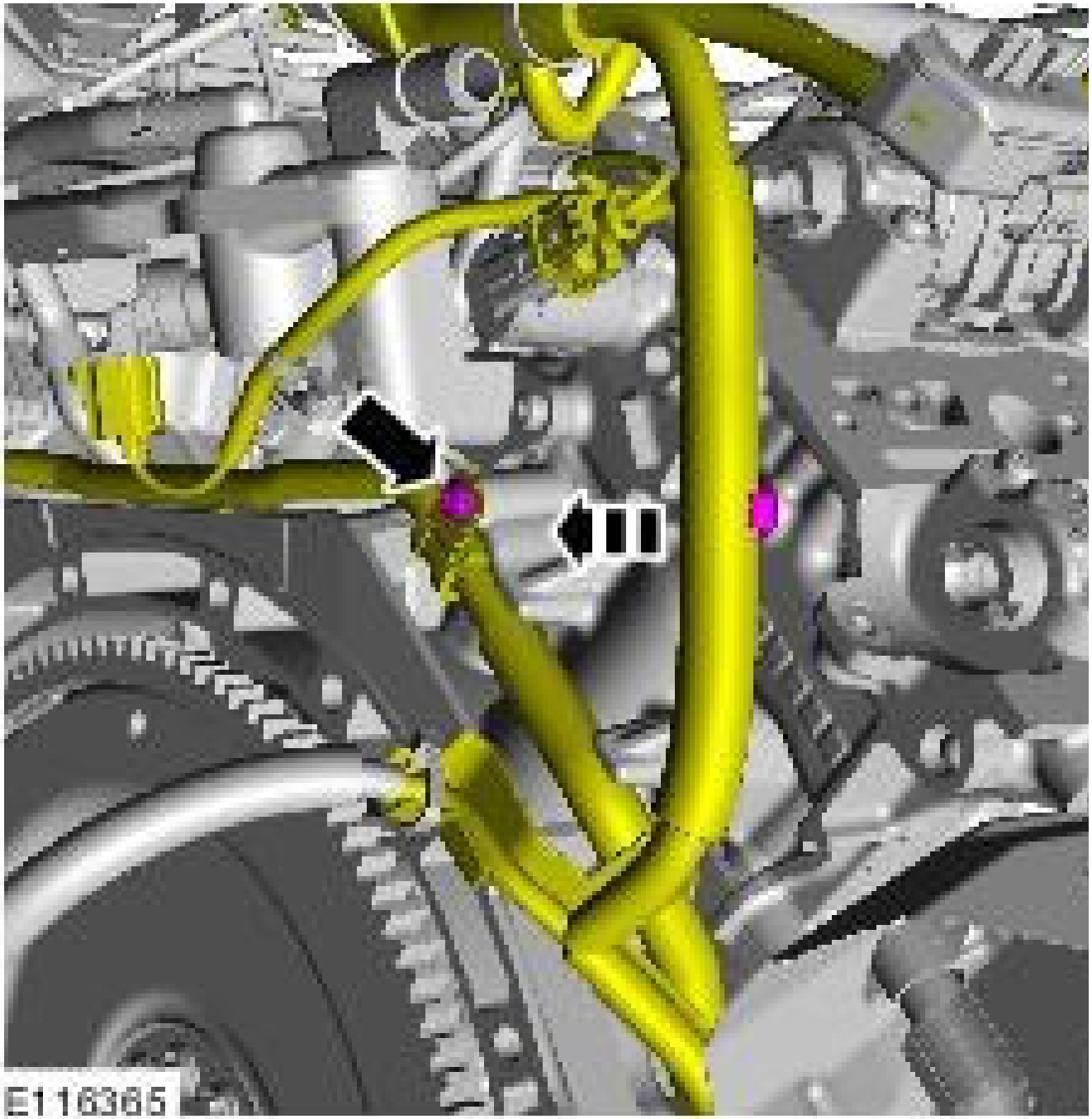
11. See figure

 © 2011 Mitchell Repair Information Company, LLC.



12. See figure

 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Clamp the hose to minimize coolant loss.

13. See figure

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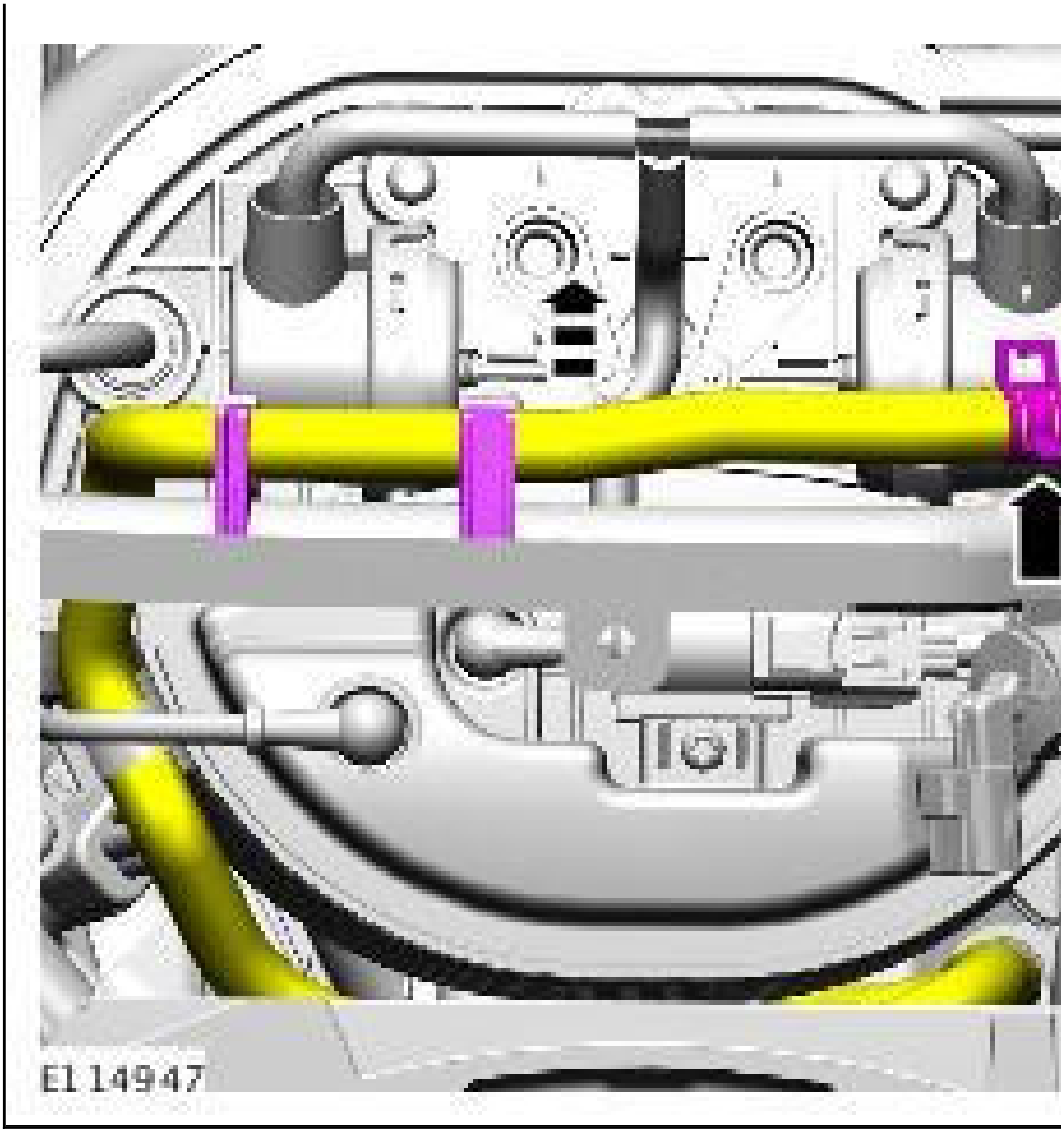
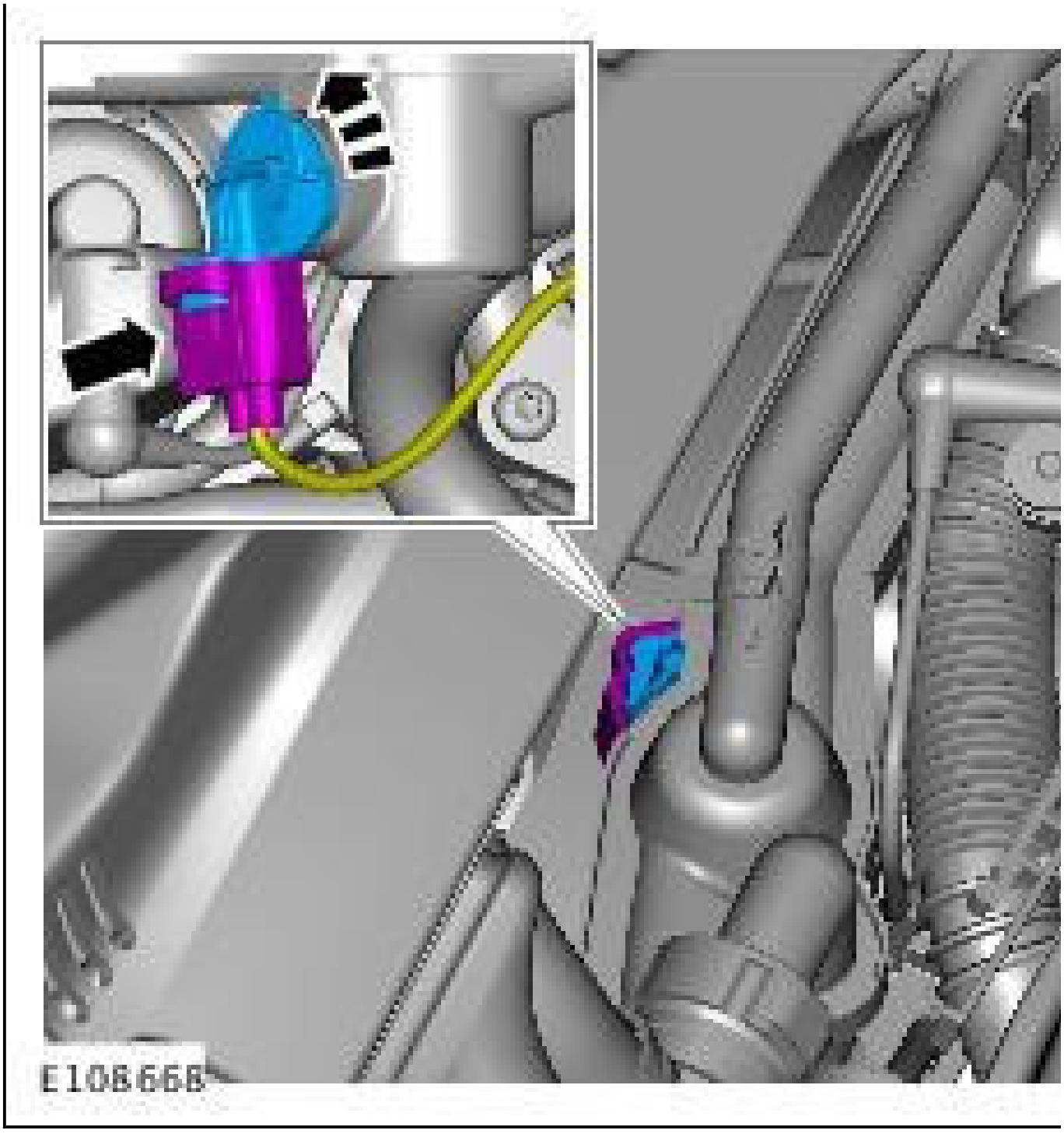


14. See figure

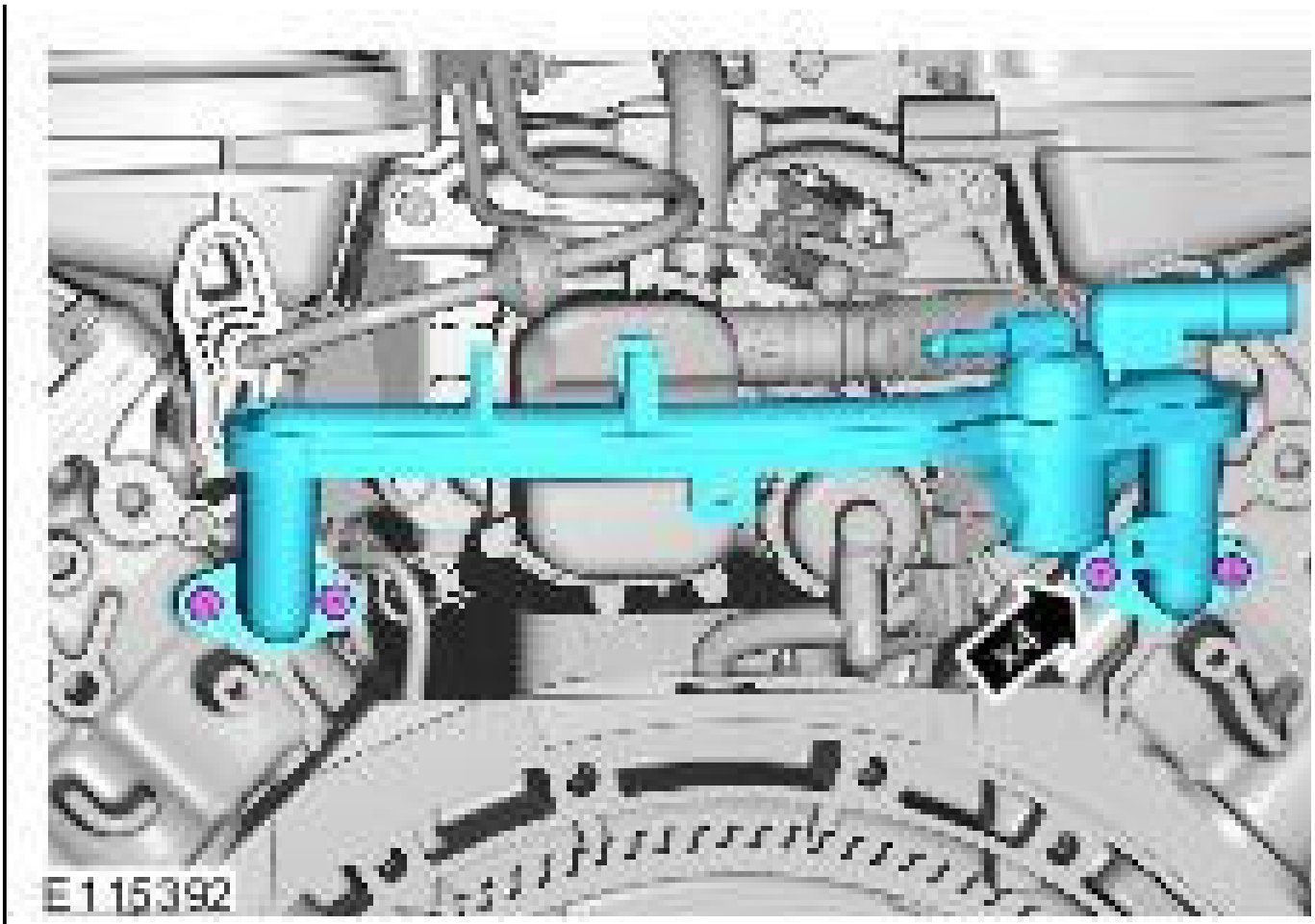
 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Discard the seals.

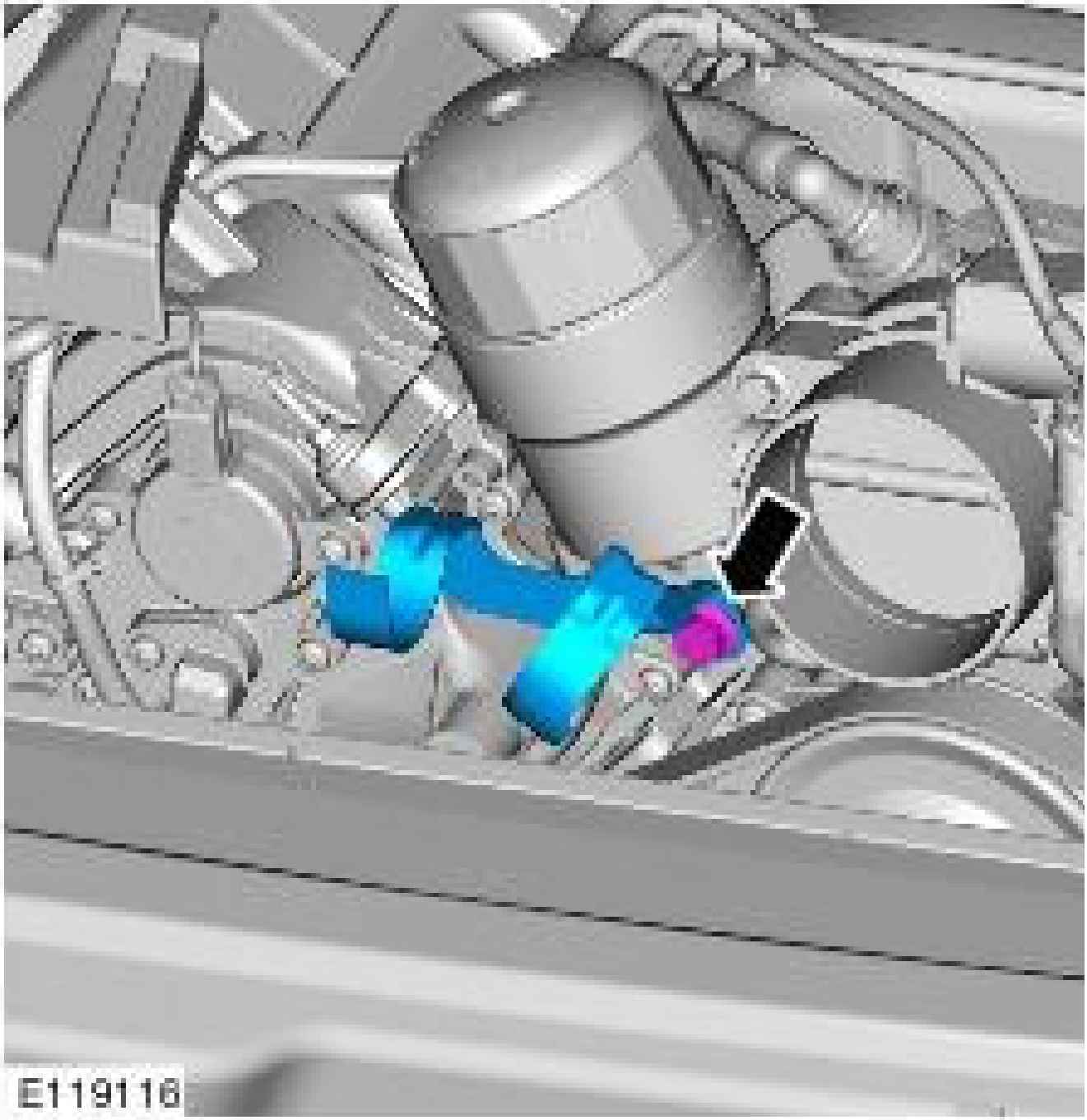
15. See figure

 © 2011 Mitchell Repair Information Company, LLC.



16. See figure

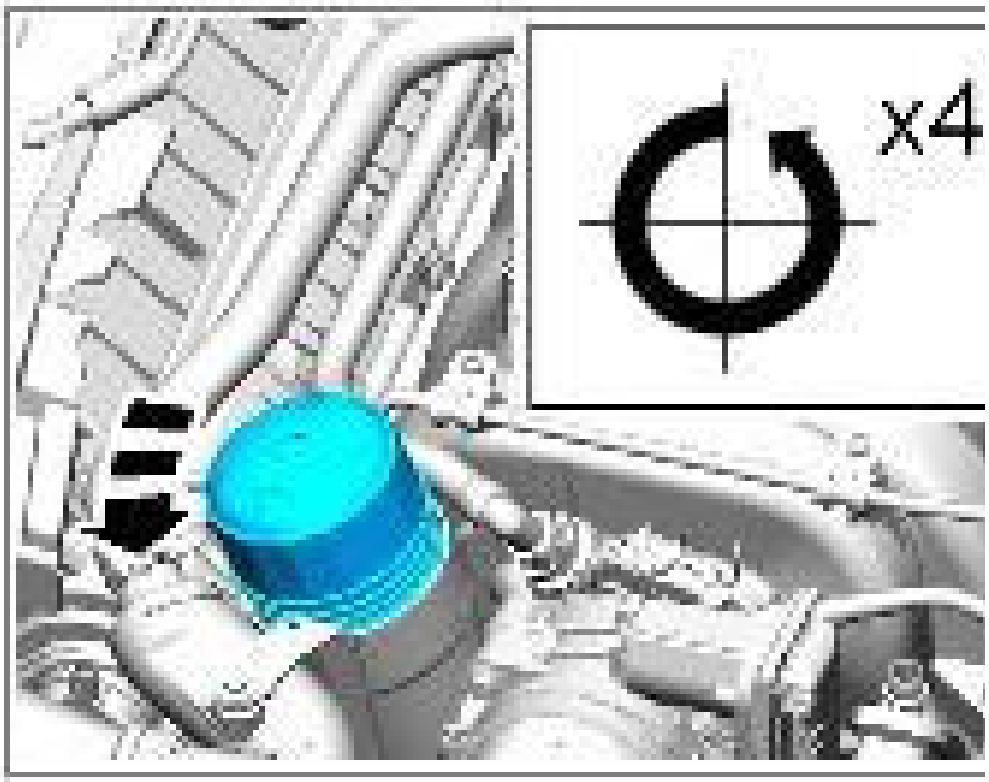
 © 2011 Mitchell Repair Information Company, LLC.

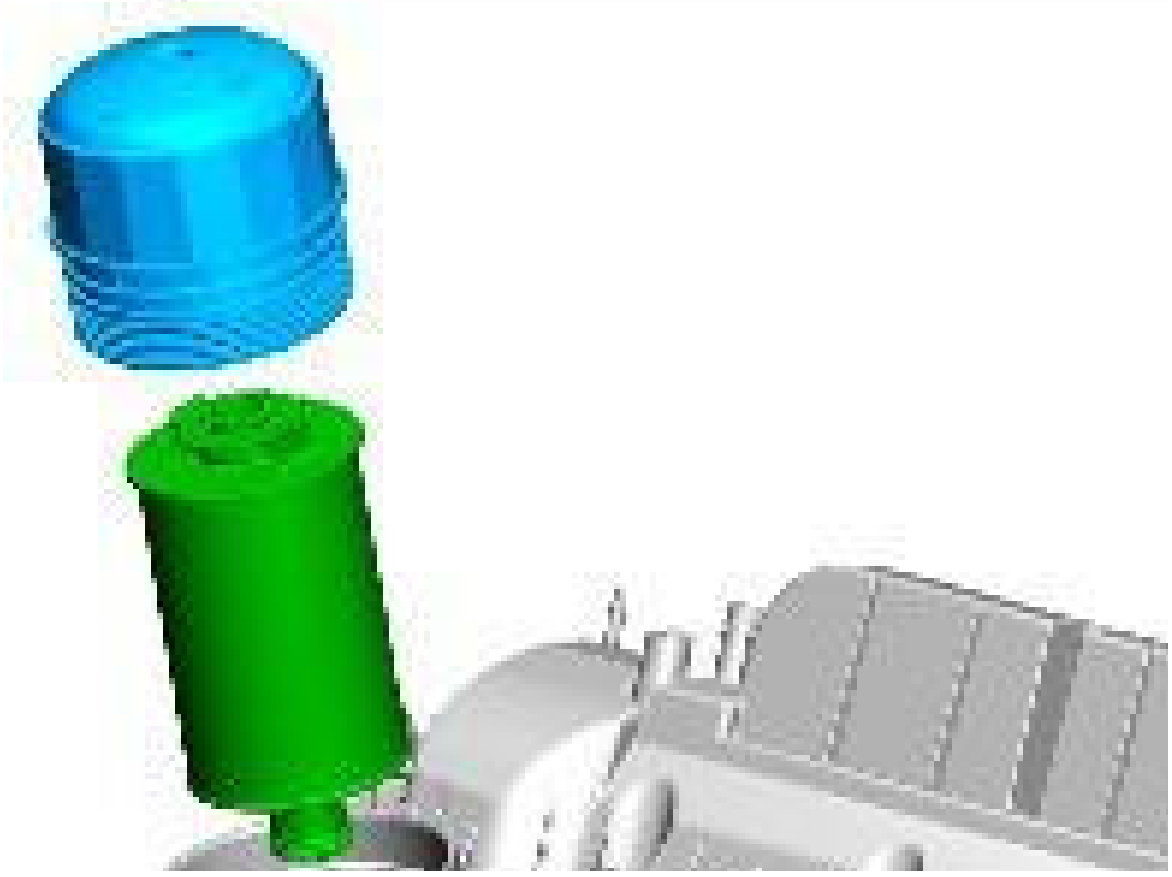


NOTE: Remove and discard the O-ring seal.

17. See figure

 © 2011 Mitchell Repair Information Company, LLC.





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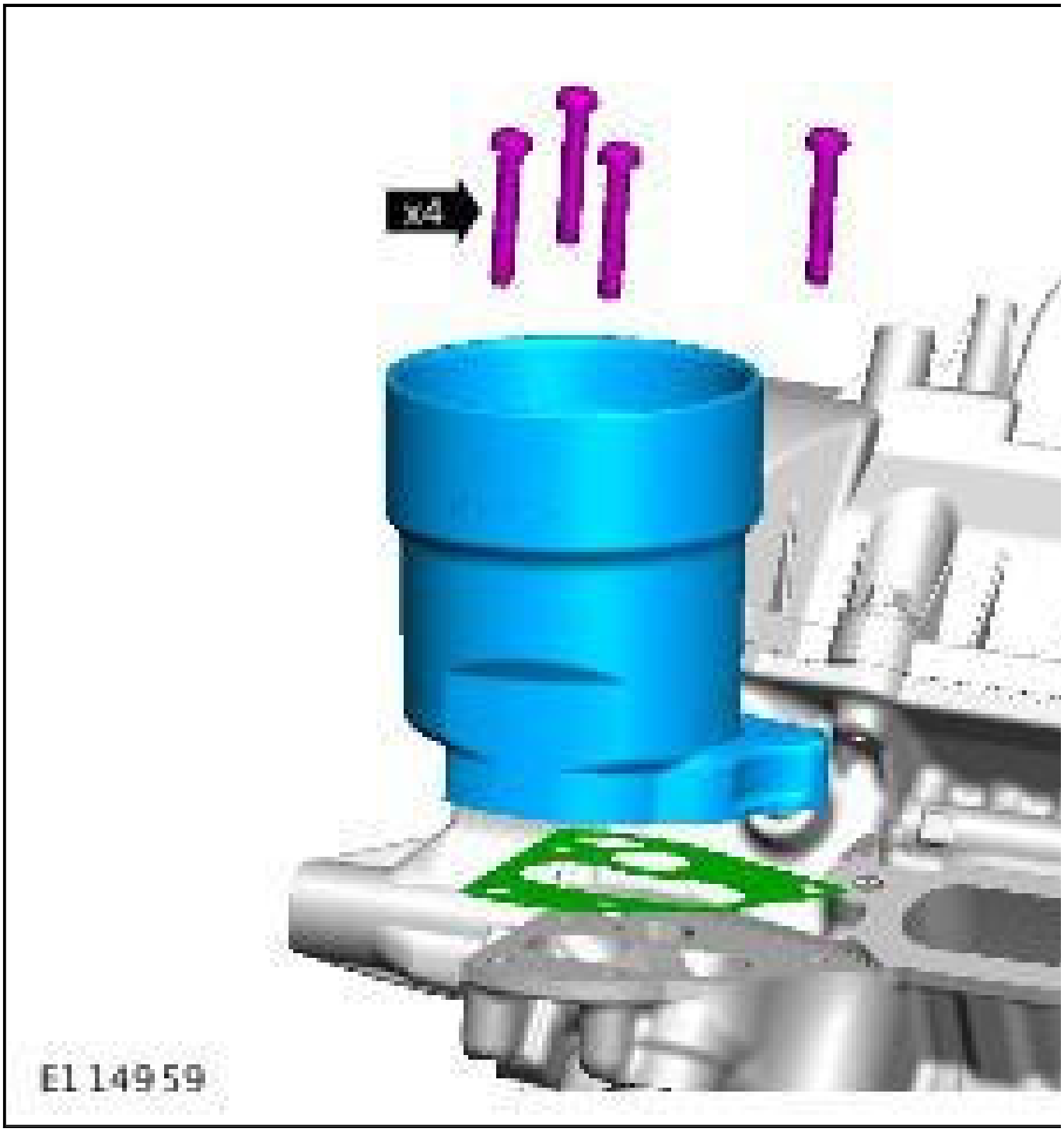
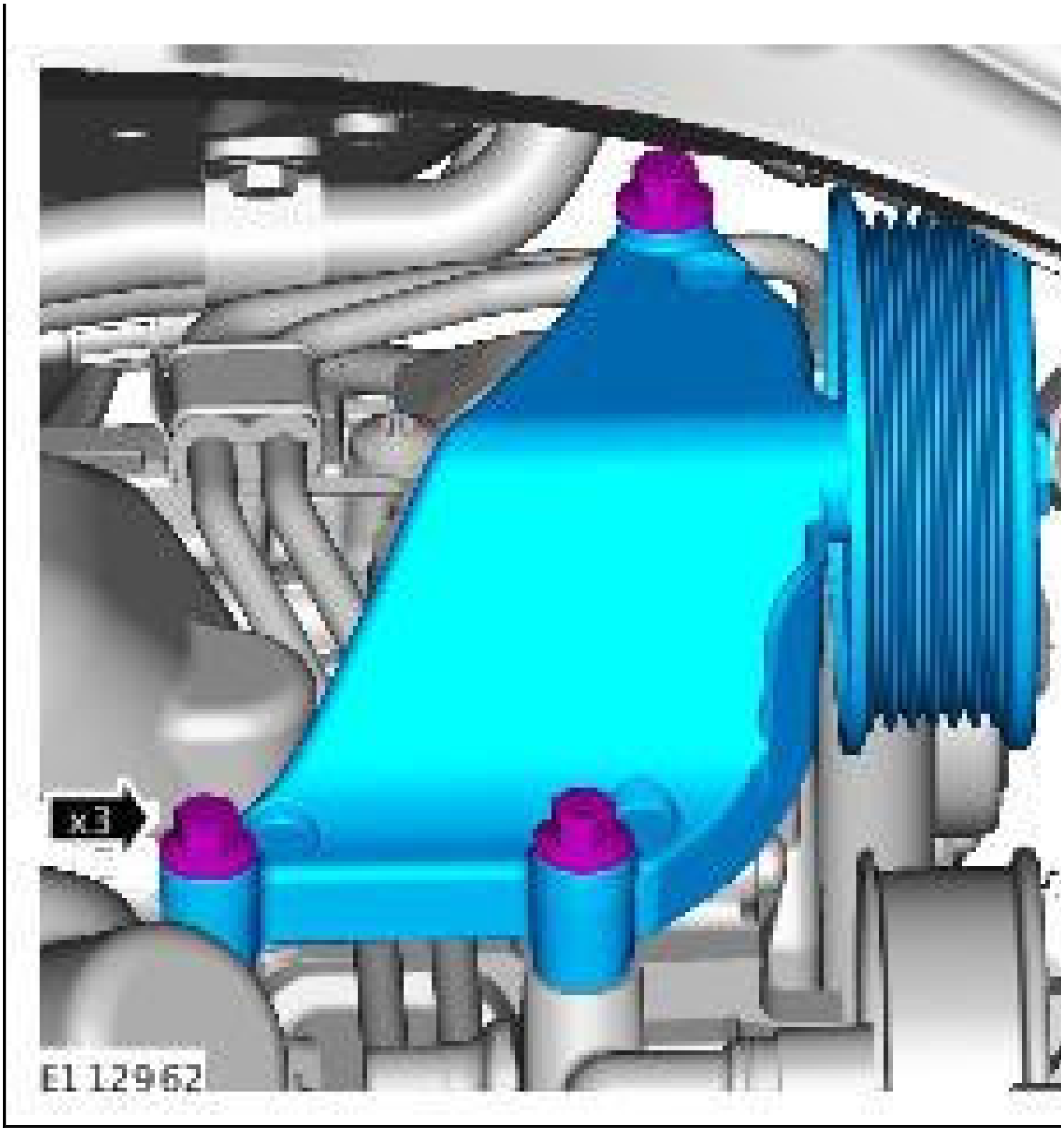
NOTE: Discard the gasket.

18. See figure



19. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: If a new cylinder head has been installed then new tappets must be installed.

CAUTION: If the cylinder head is being removed without a new component being installed, the tappets must be installed in their original positions.

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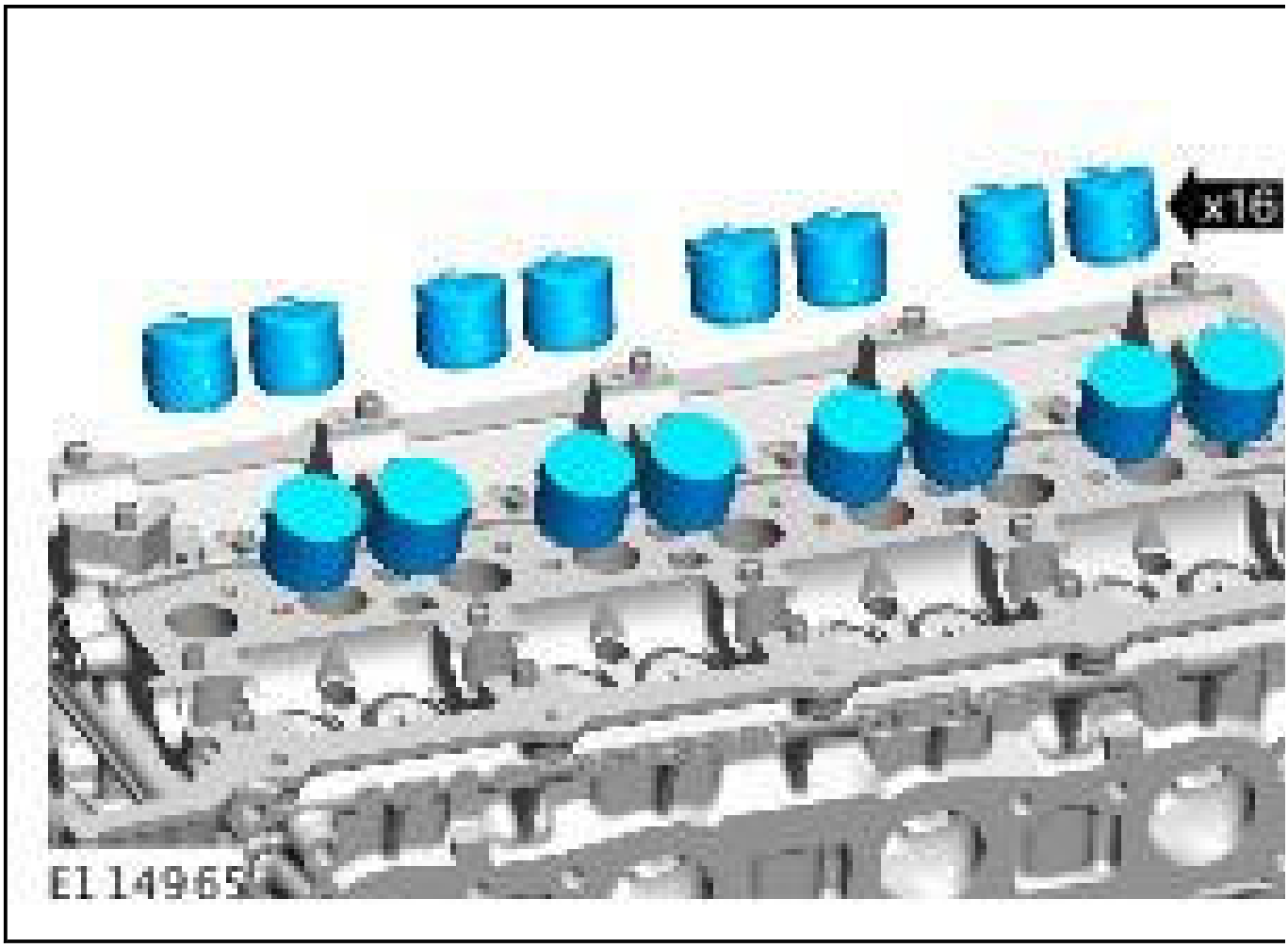
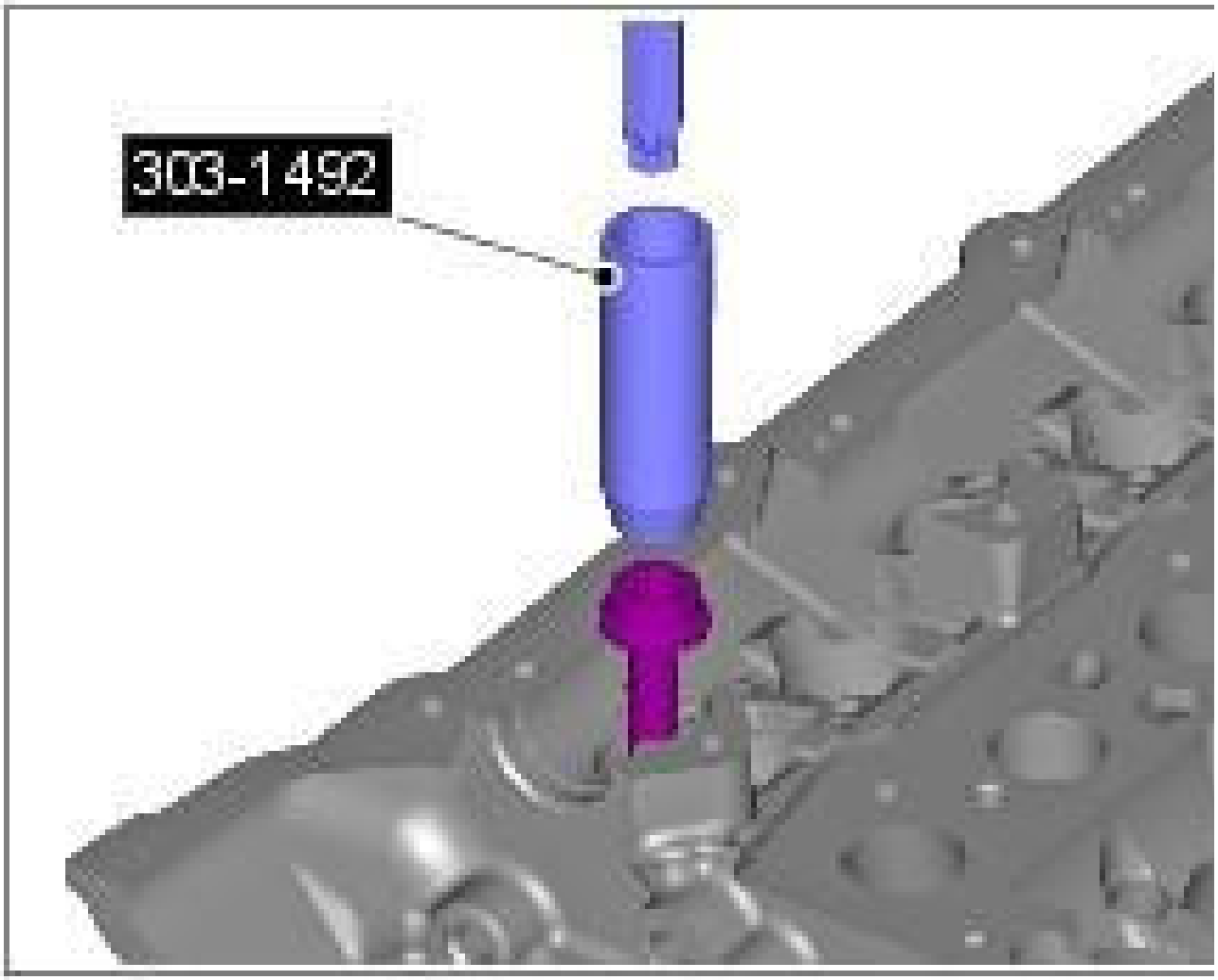
20. See figure

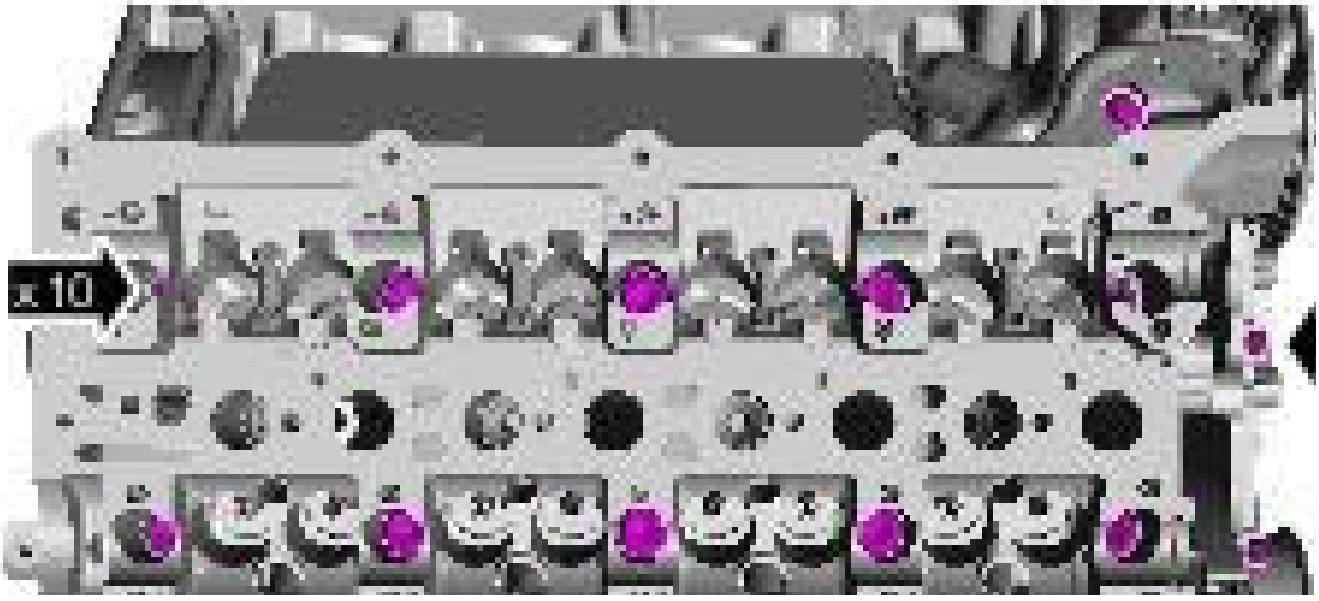


CAUTION: Discard the bolts.

21. See figure

 © 2011 Mitchell Repair Information Company, LLC.

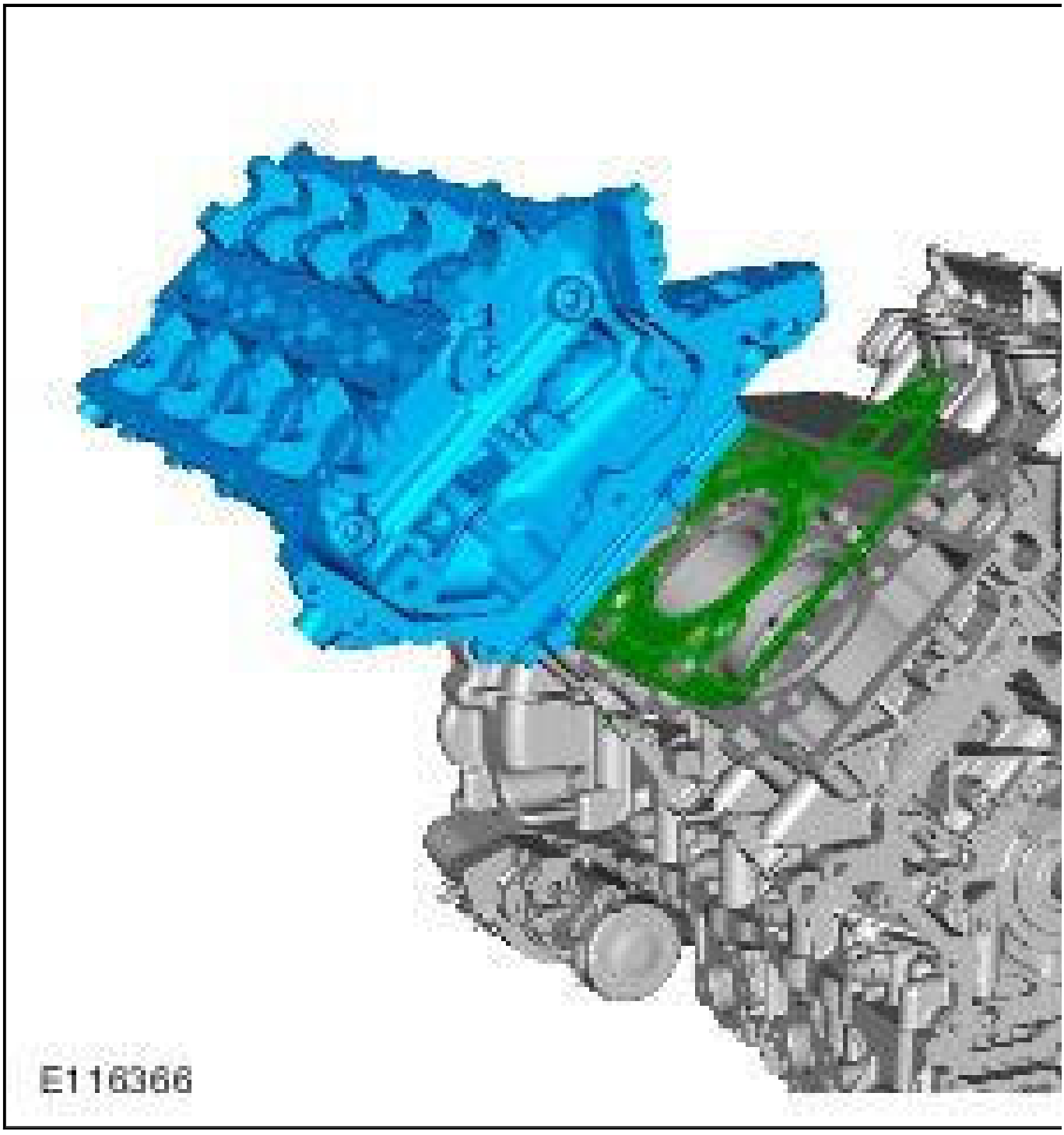




 © 2011 Mitchell Repair Information Company, LLC.

NOTE: Discard the gasket.

22. See figure



INSTALLATION

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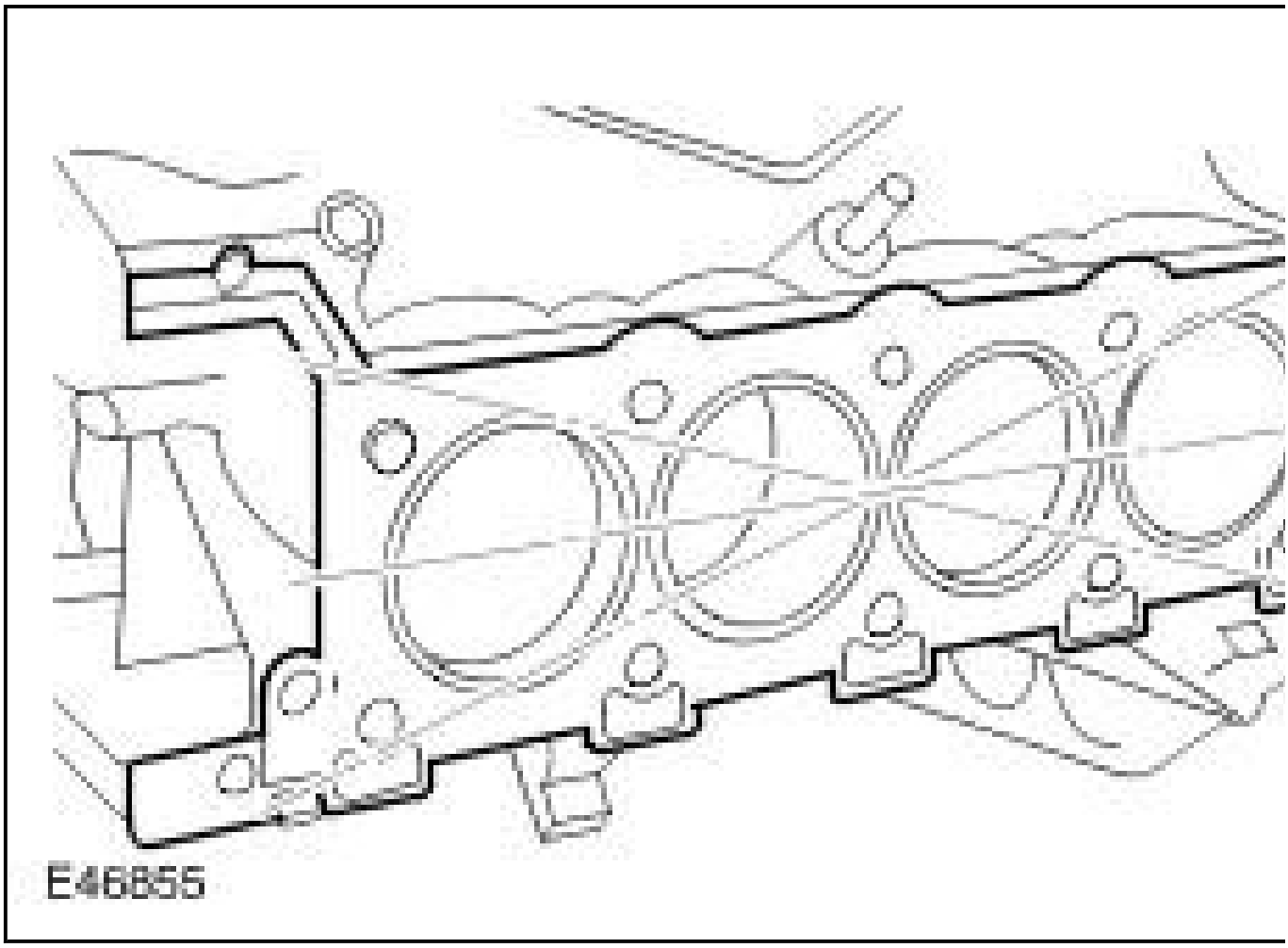
1. Check cylinder head face for distortion, across the center and from corner to corner.



CAUTION: An acceptable flatness of the cylinder head is 0.1mm.

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

2. See figure

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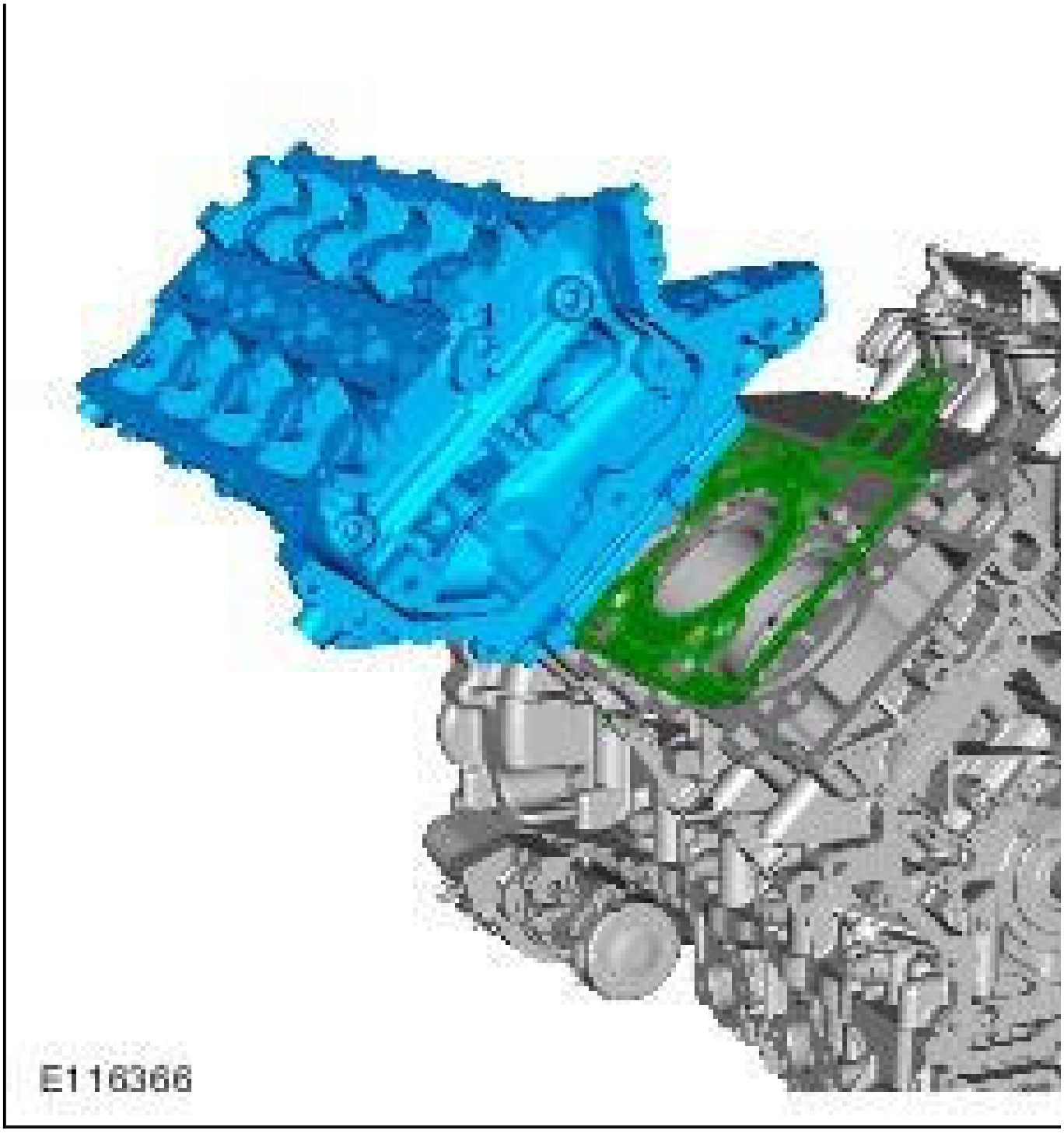

WARNING: **Make sure care is taken when handling the cylinder head gasket.**

NOTE: **Install a new gasket.**

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3. Torque: 20 Nm

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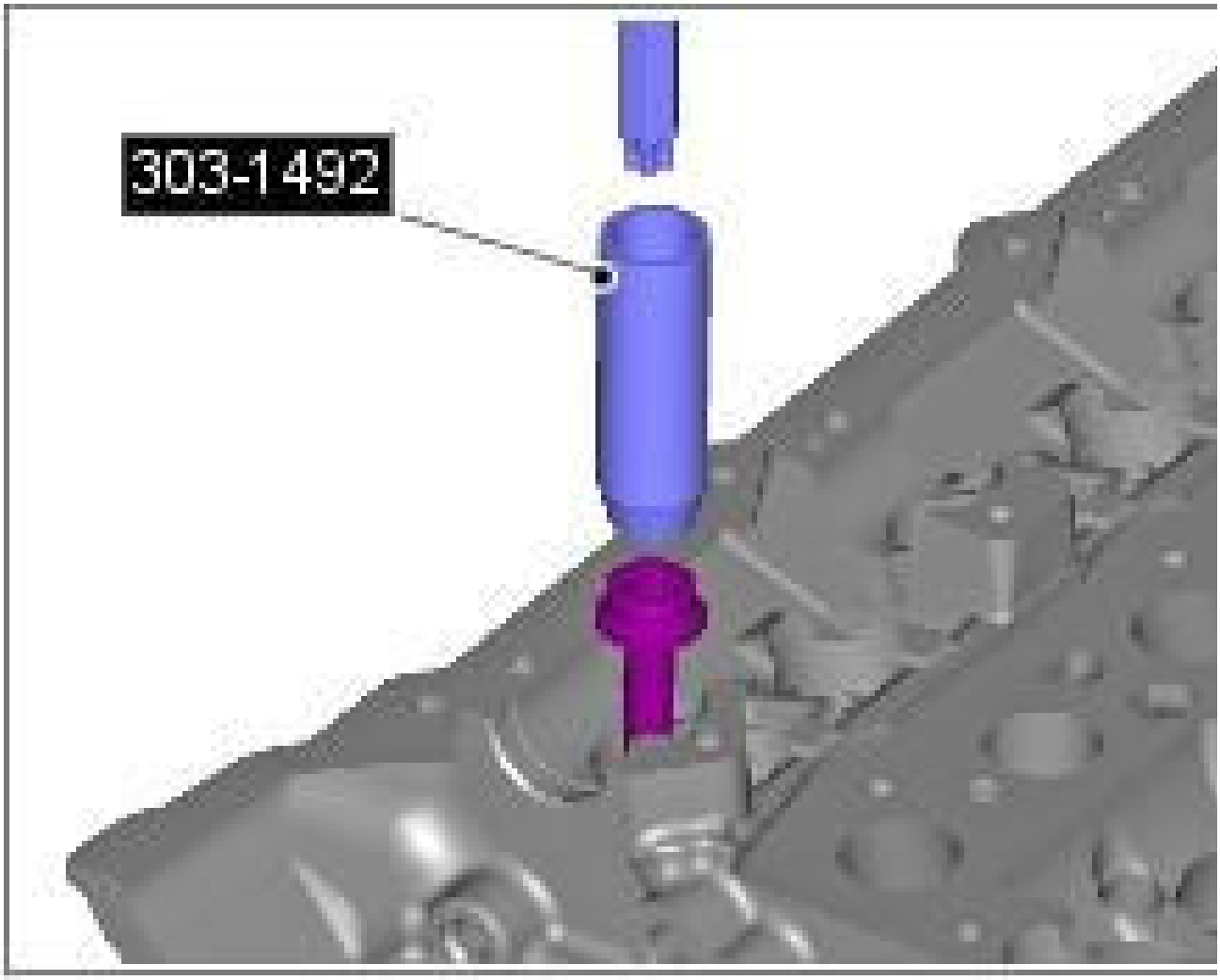
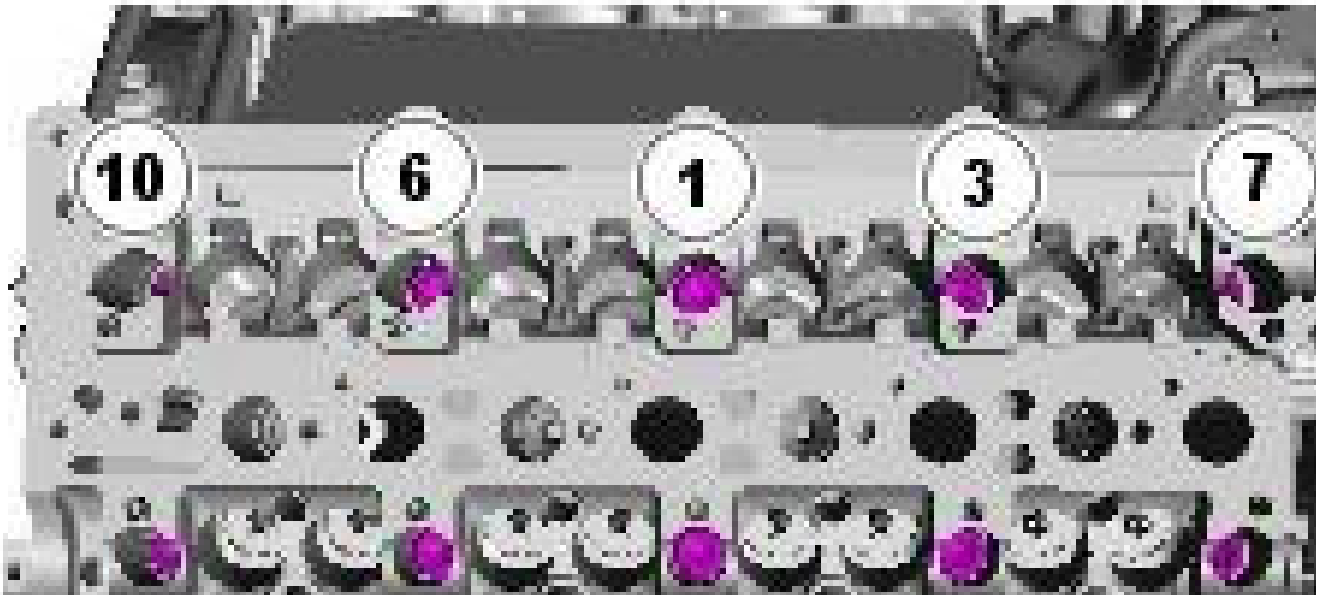
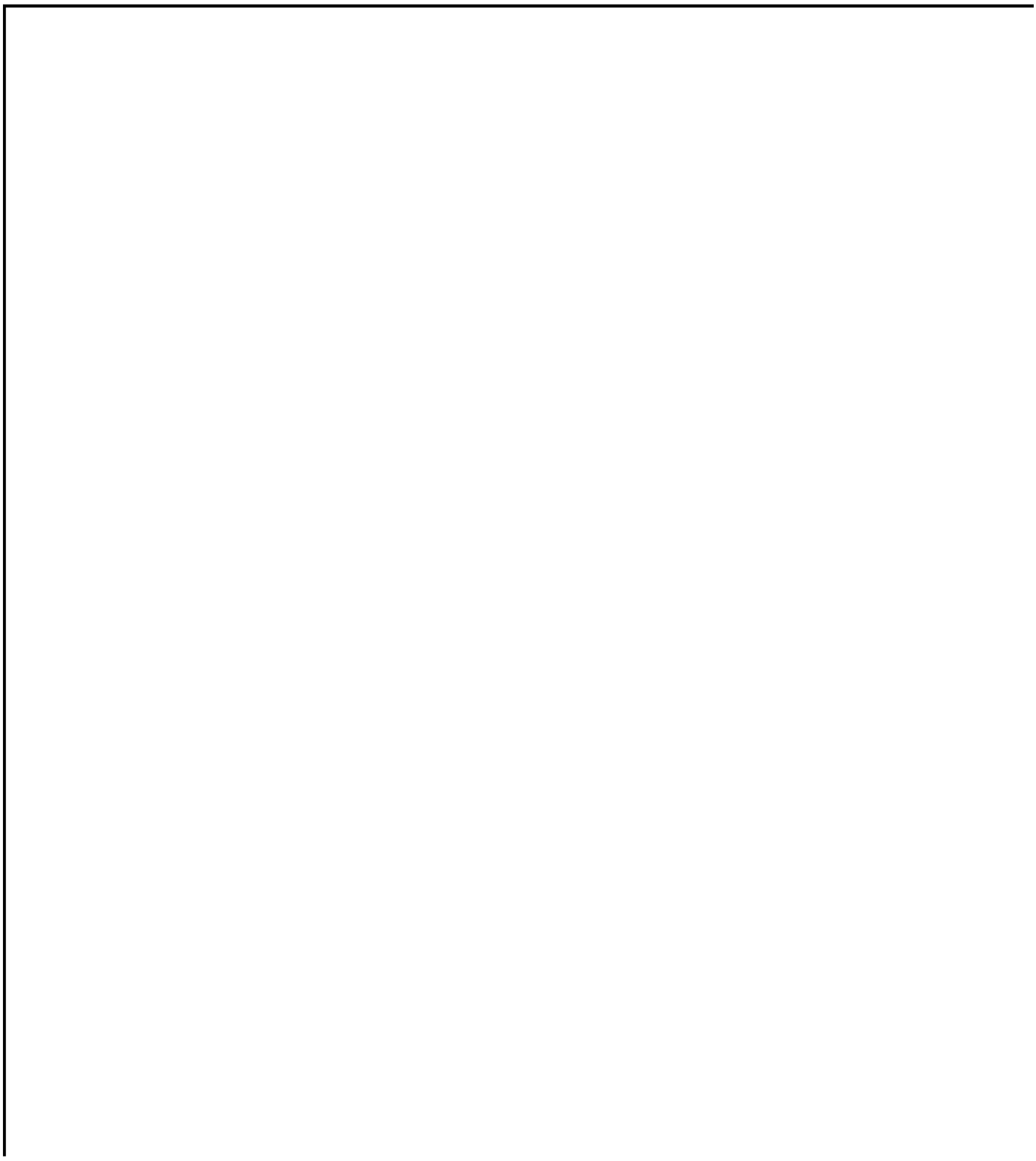




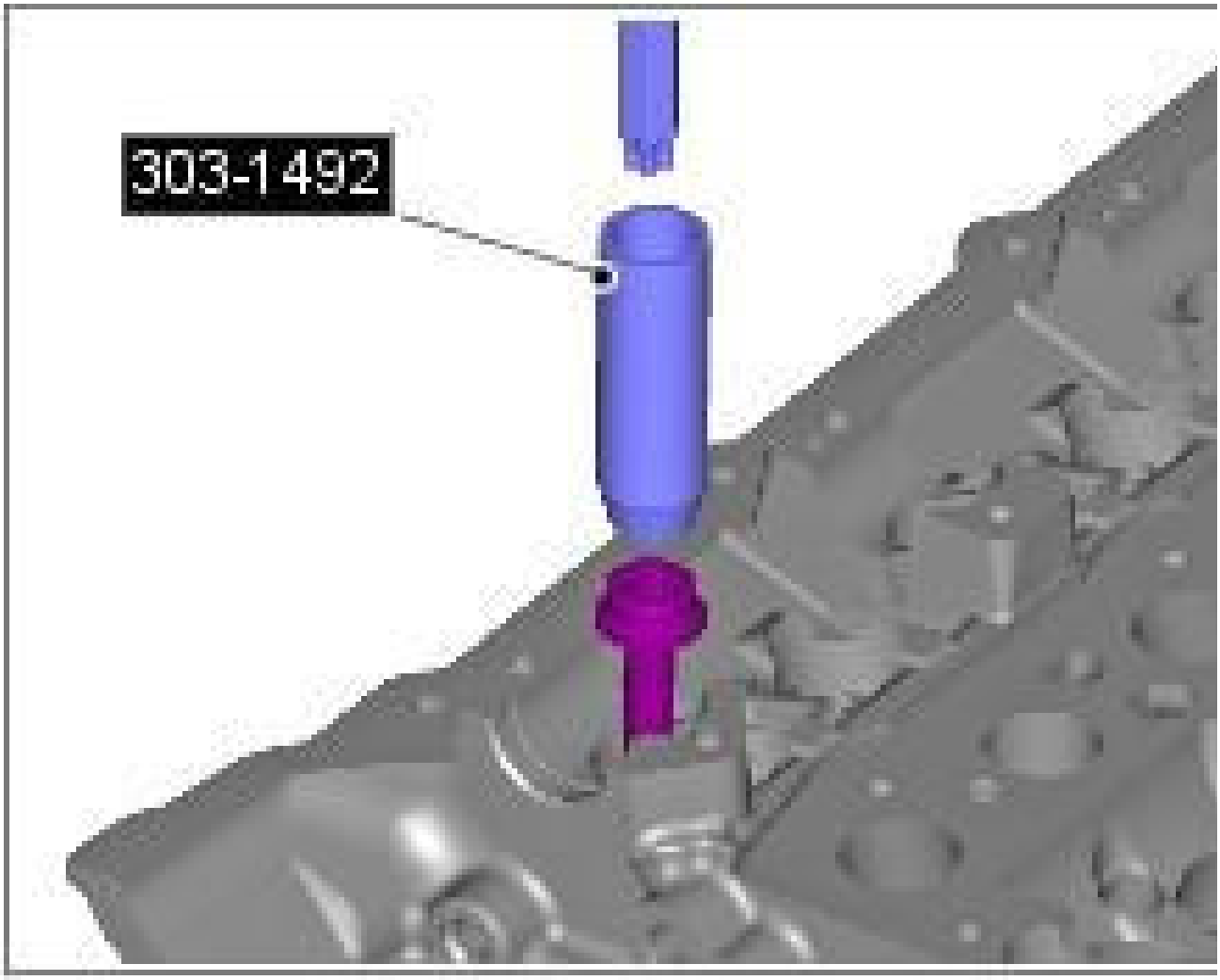
© 2011 Mitchell Repair Information Company, LLC.

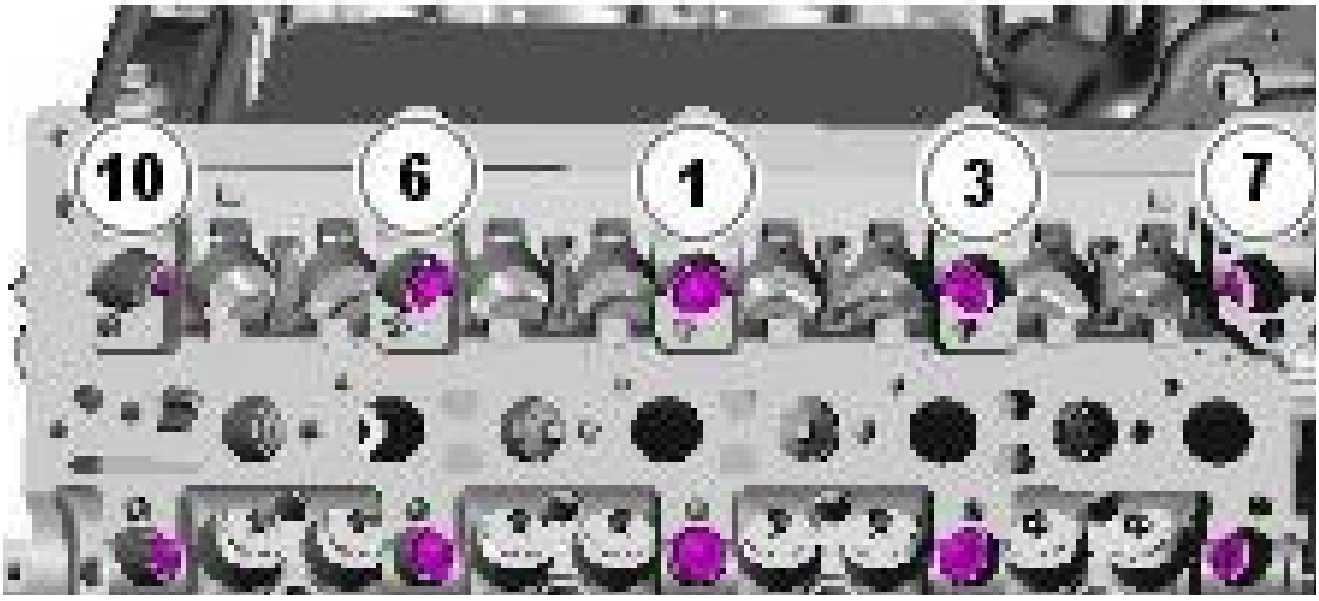
CAUTION: Make sure that new cylinder head bolts are installed.

4. Torque: 35 Nm



 © 2011 Mitchell Repair Information Company, LLC.





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5. Tighten the bolts 1 to 10, a further 90 degrees.

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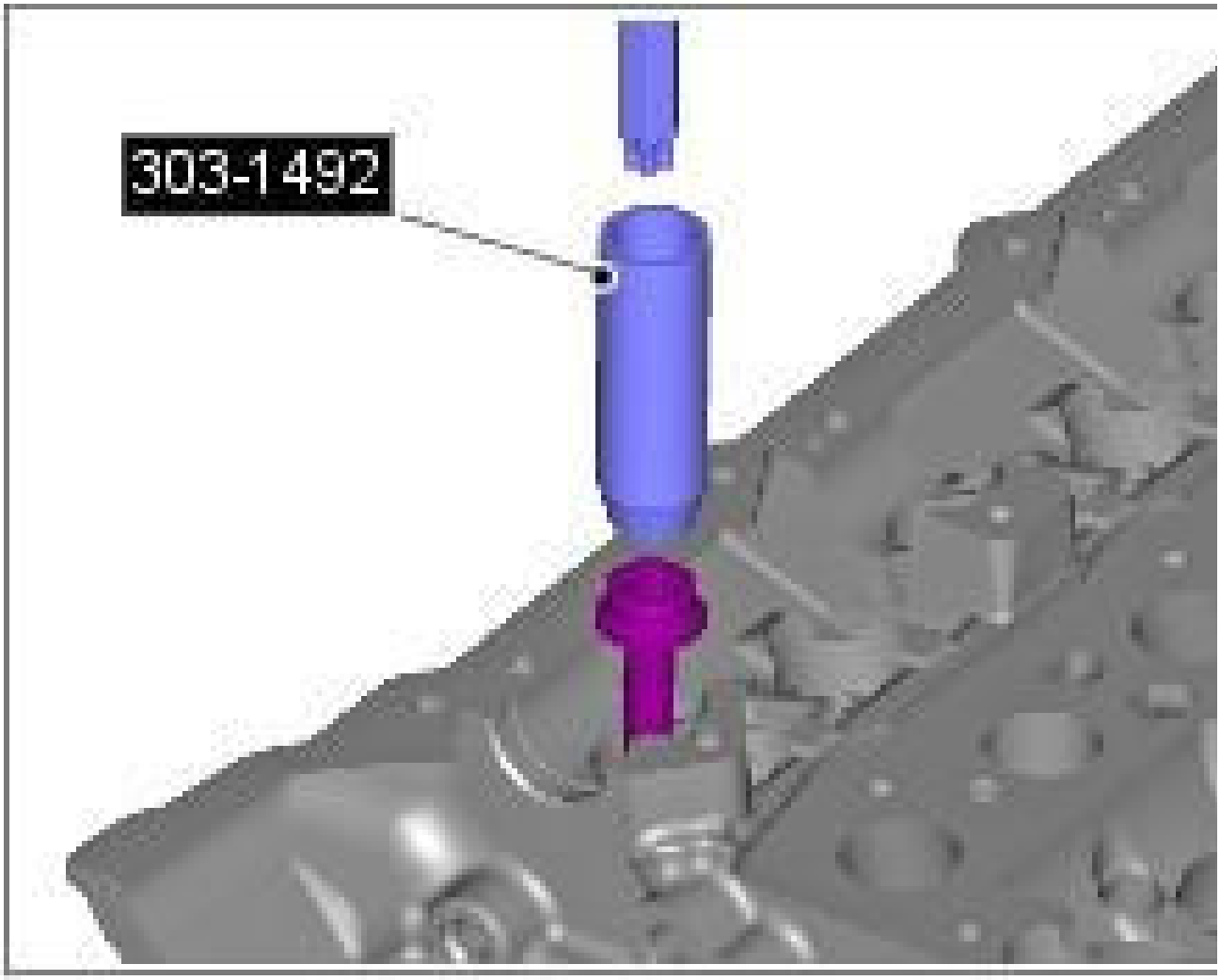

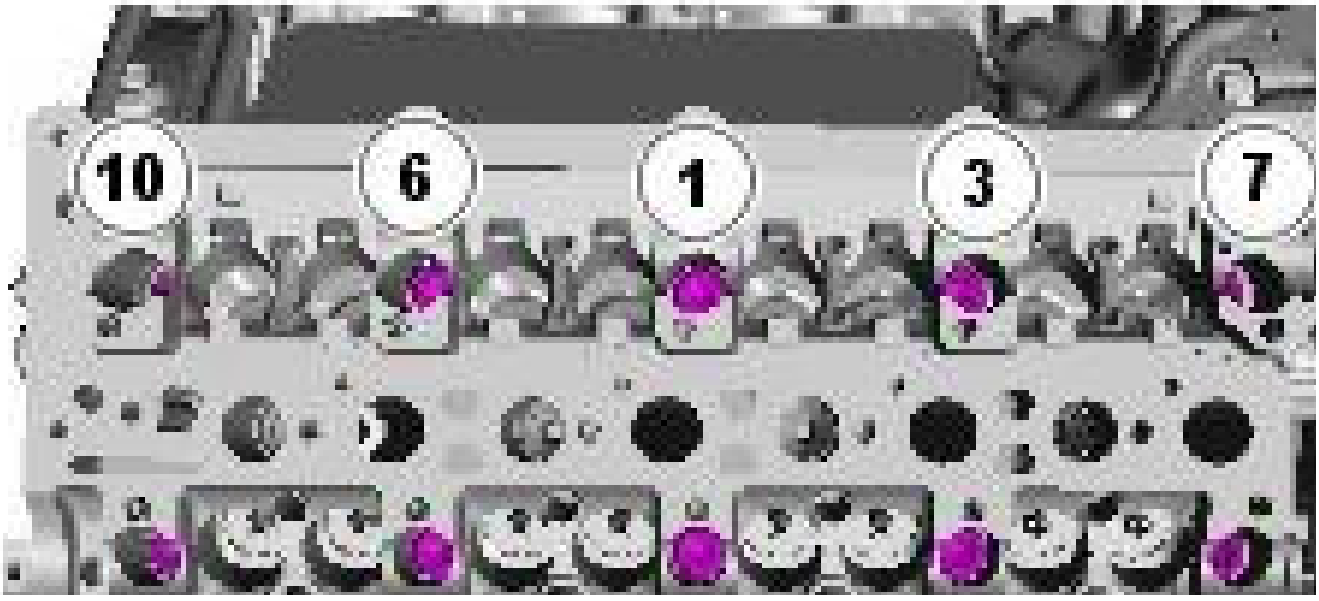

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6. Tighten the bolts 1 to 10, a further 120 degrees.

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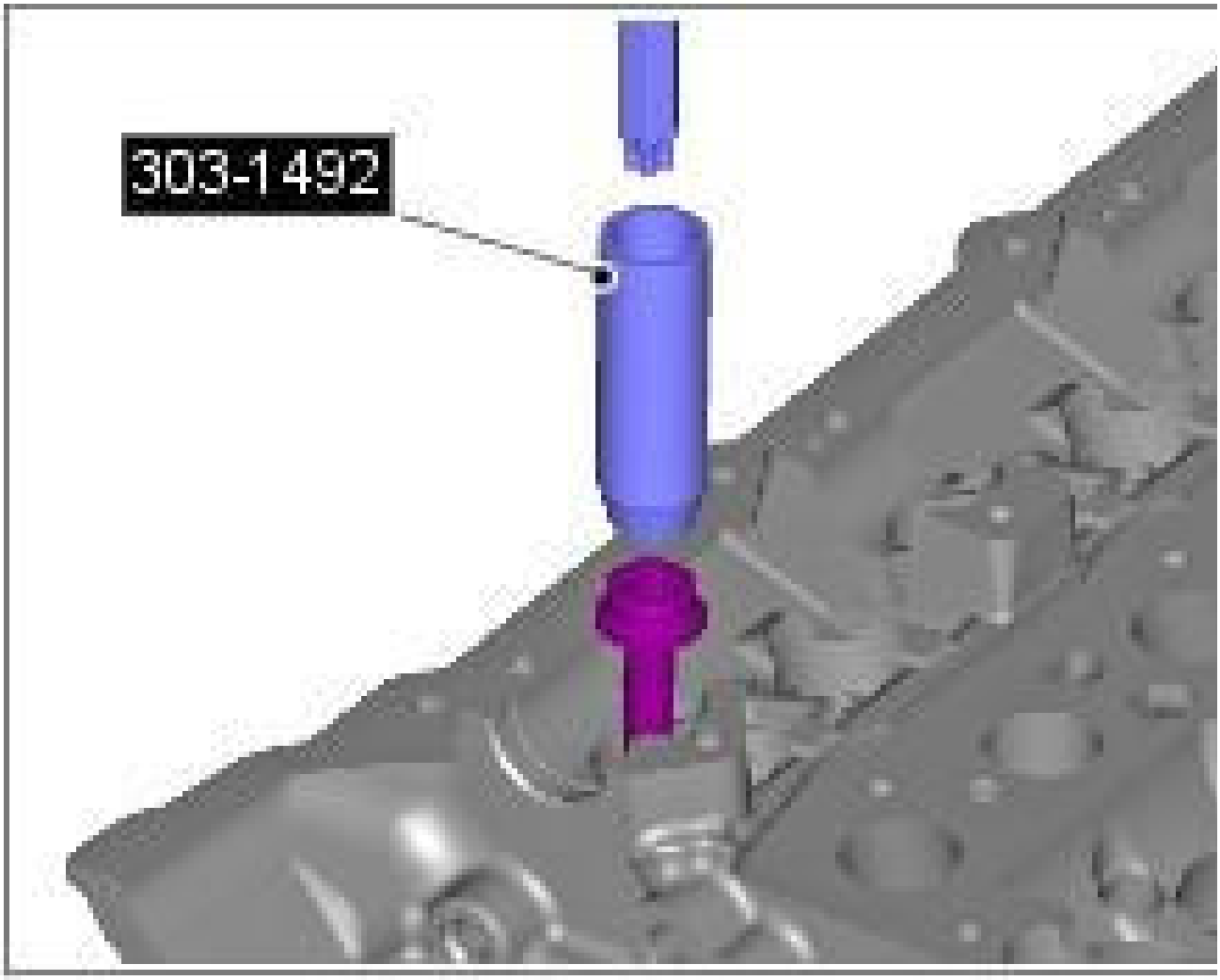

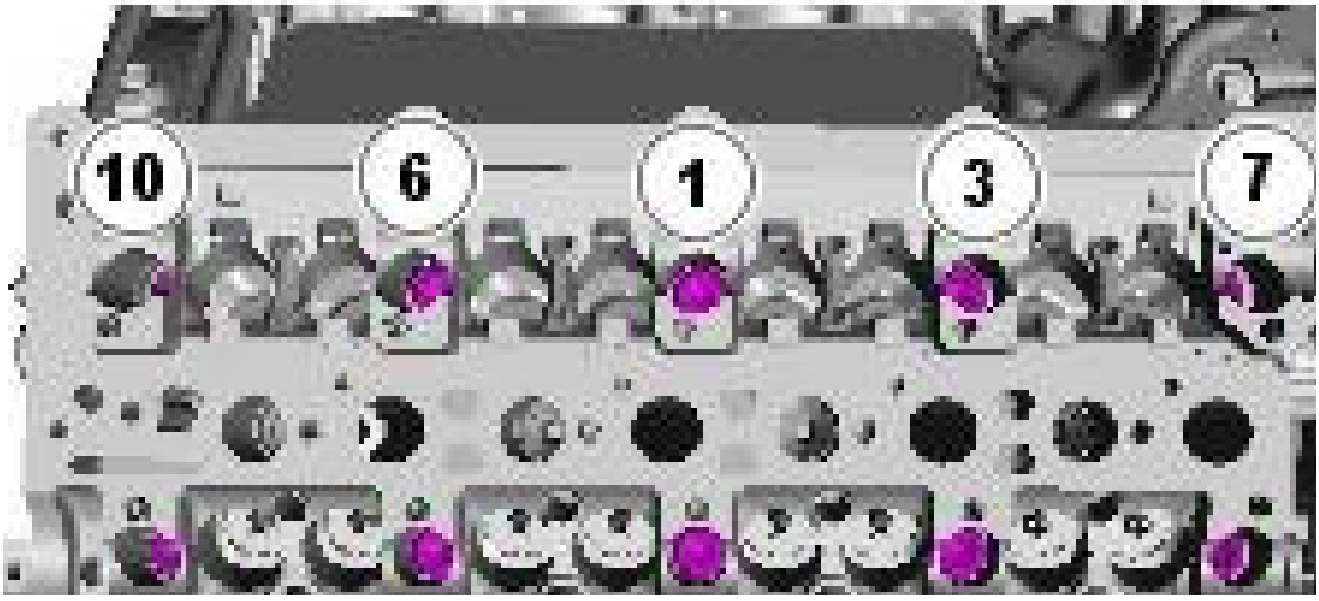

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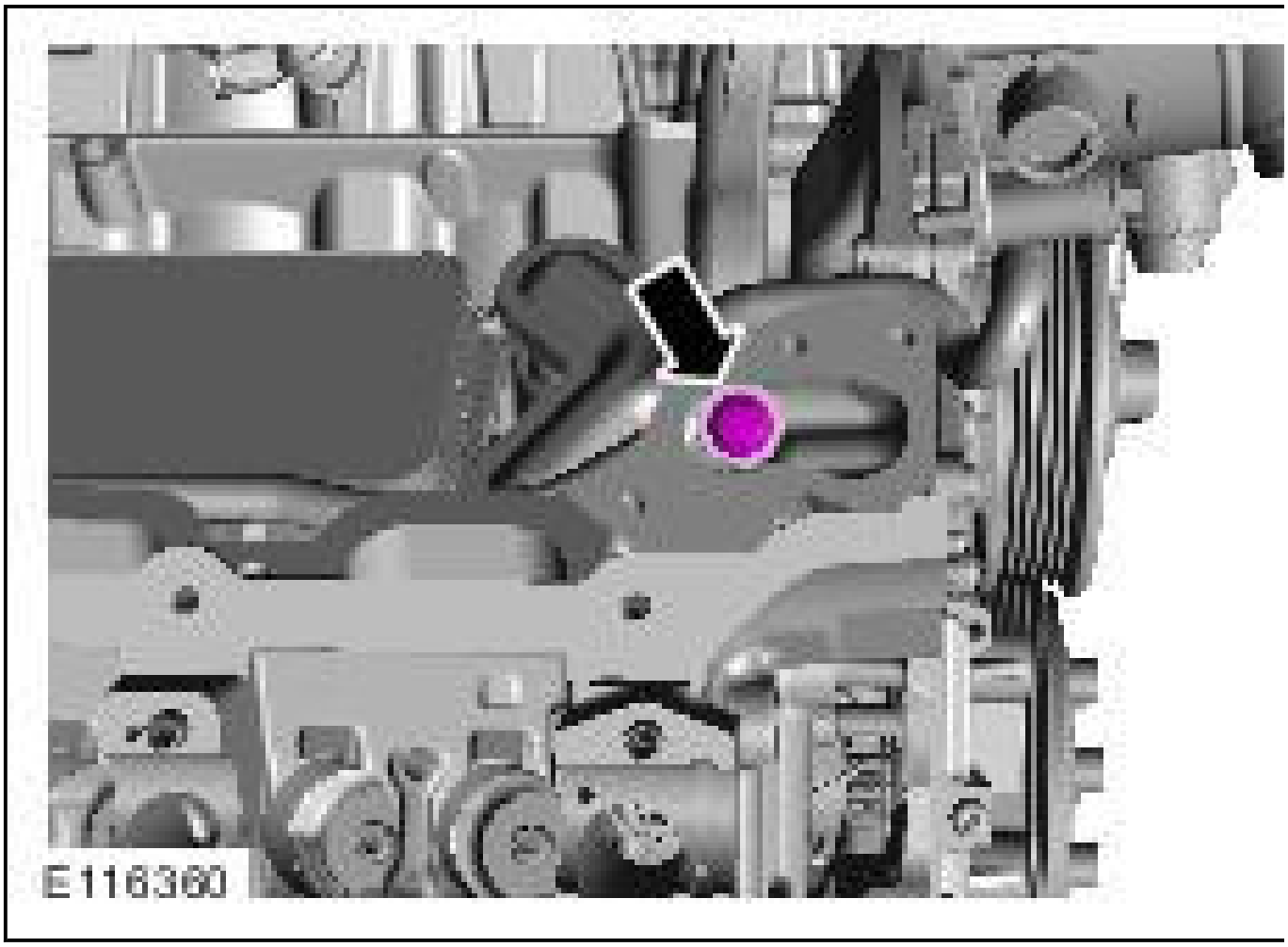
7. Torque: 25 Nm



8. Torque: 12 Nm

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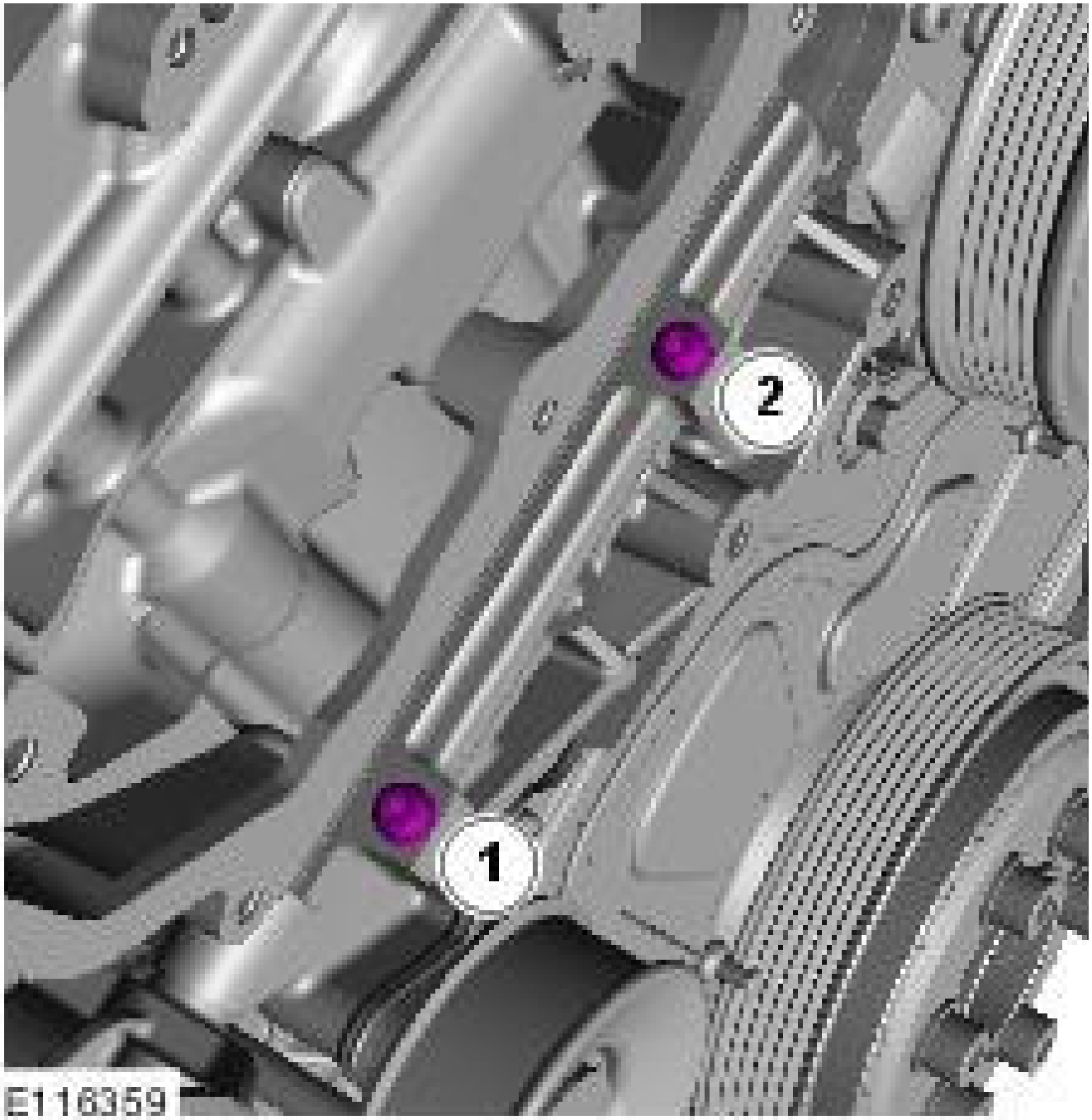

9. Lubricate the valve tappets with clean engine oil.

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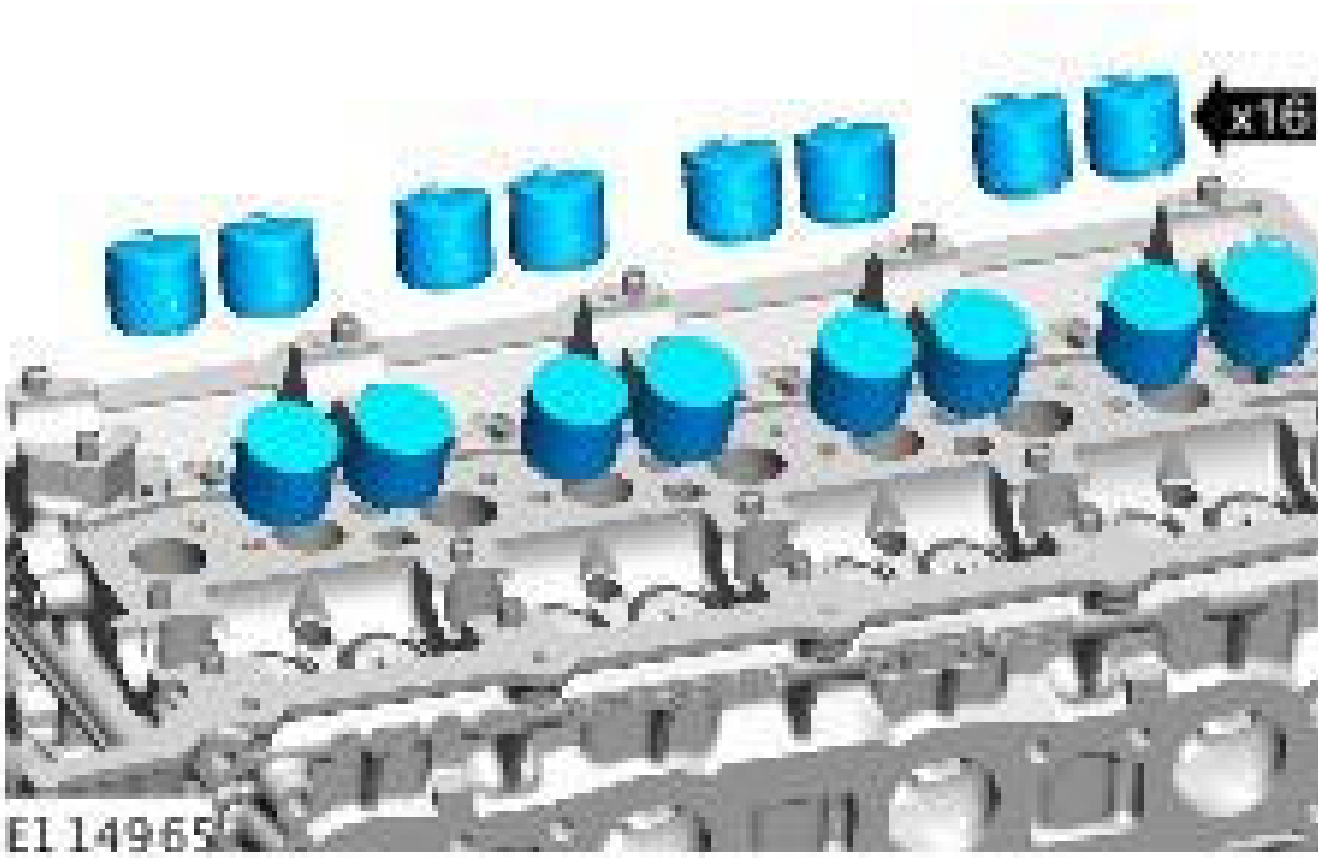
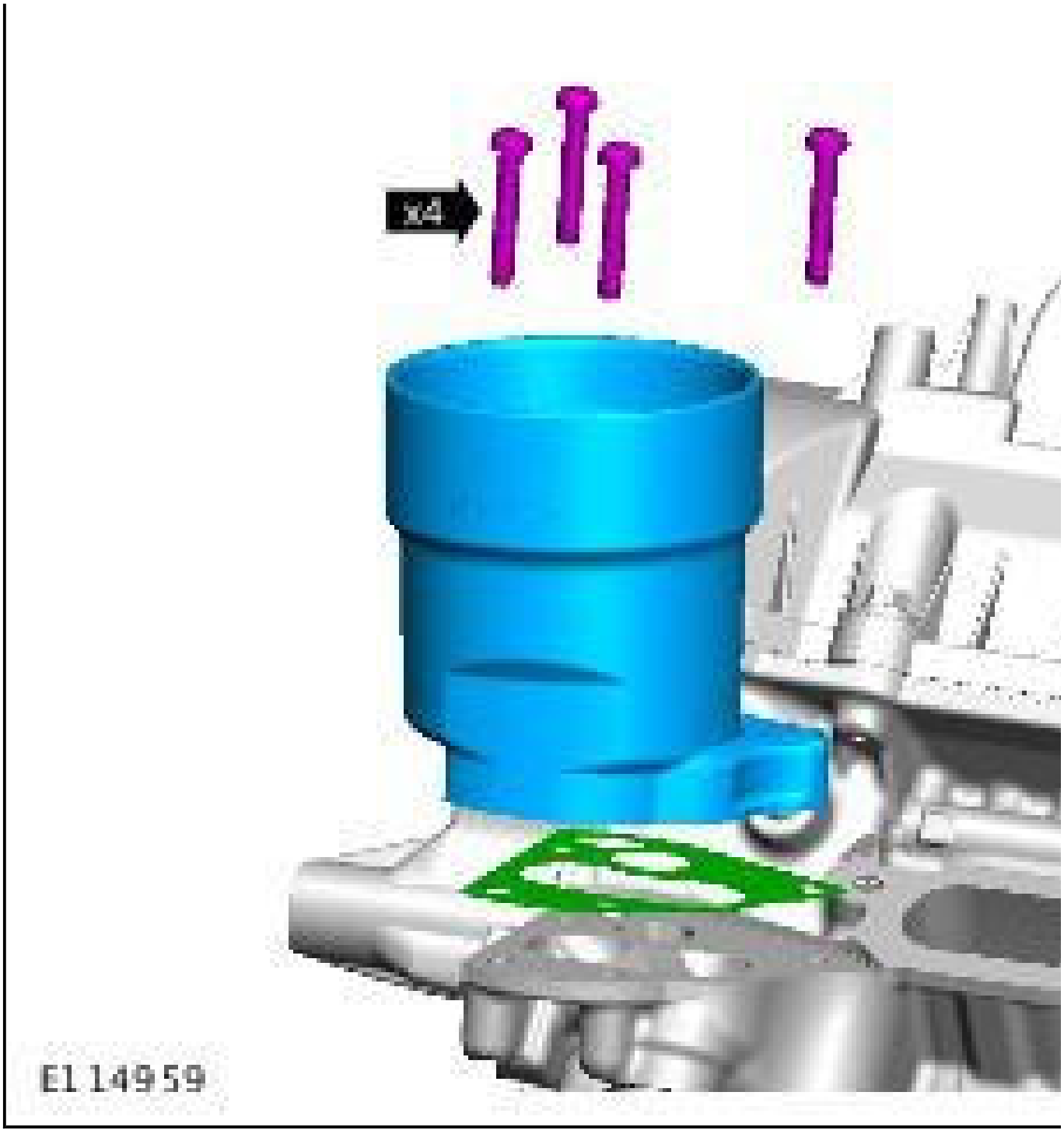


CAUTION: If a new cylinder head has been installed then new tappets must be installed.

CAUTION: If the cylinder head is being removed without a new component being installed, the tappets must be installed in their original positions.

10. See figure

 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Install a new gasket.

11. See figure

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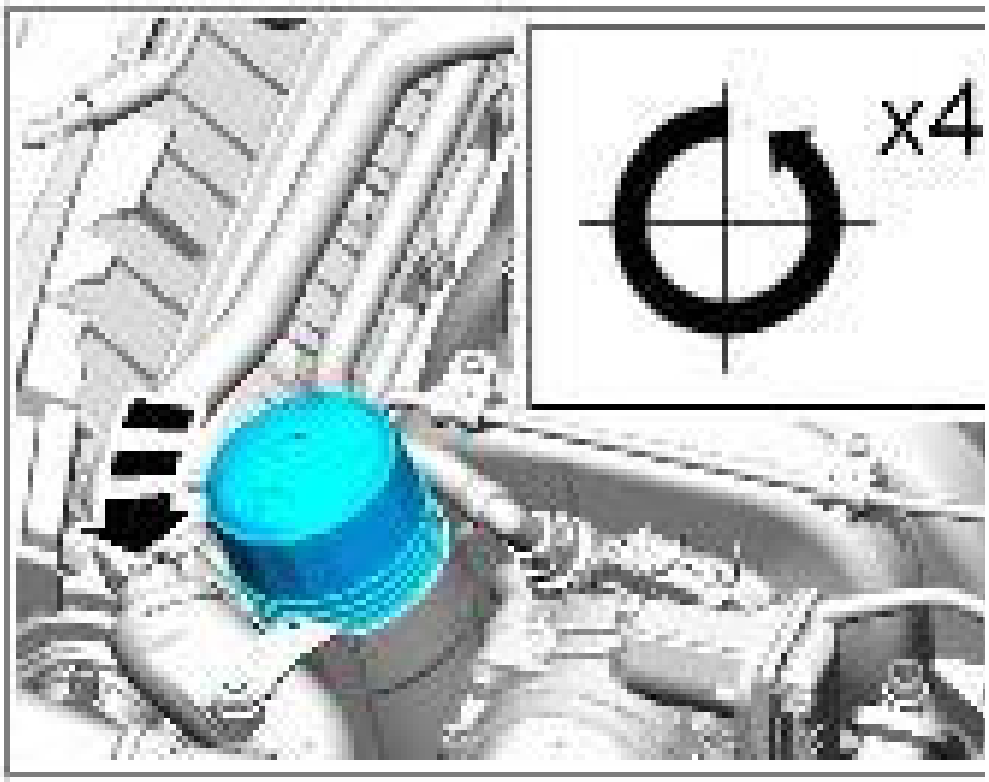

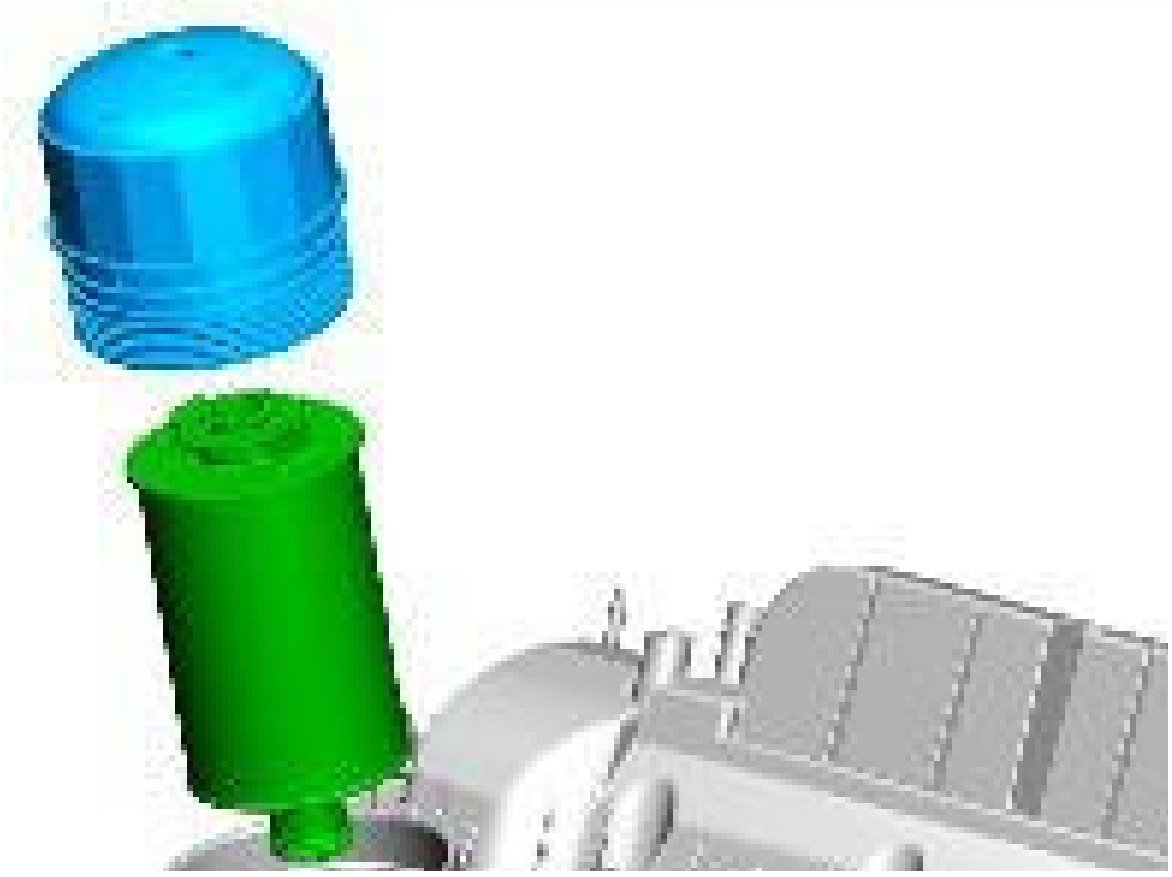

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CAUTION: A new O-ring seal is to be installed.

NOTE: Install a new engine oil filter.

12. Torque: 12 Nm

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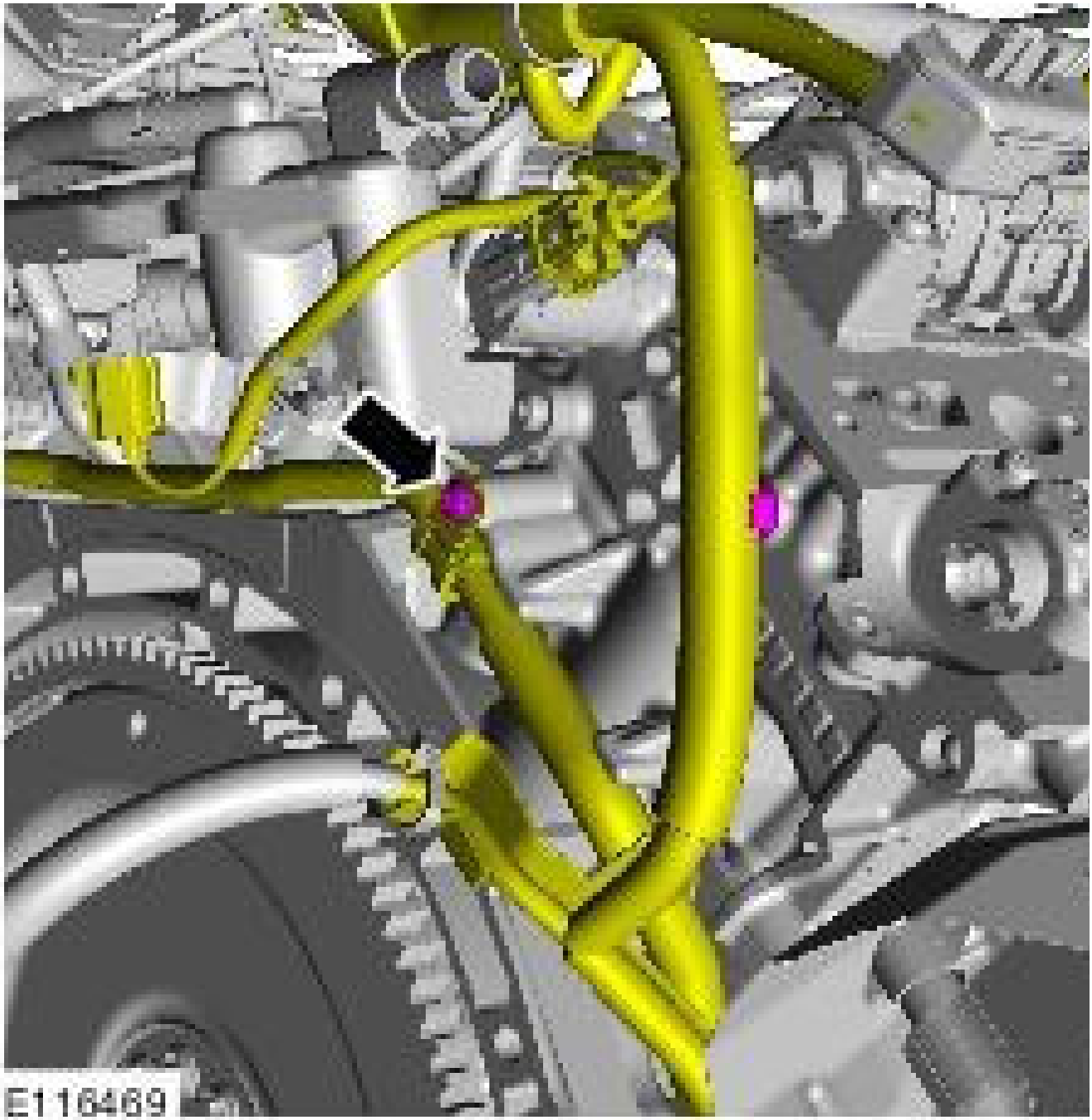

13. Torque: 10 Nm

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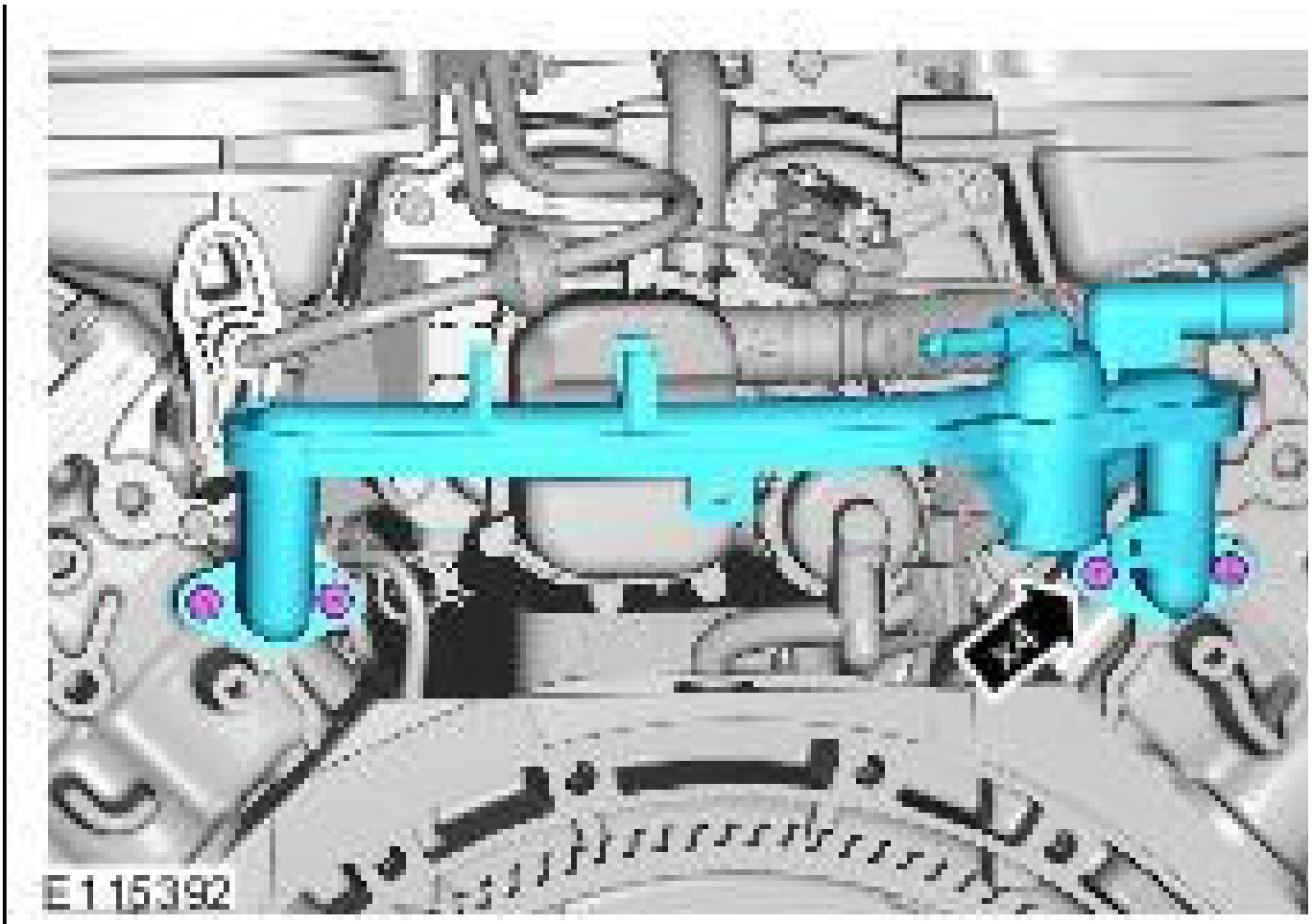

CAUTION: Install the new seals.

14. See figure

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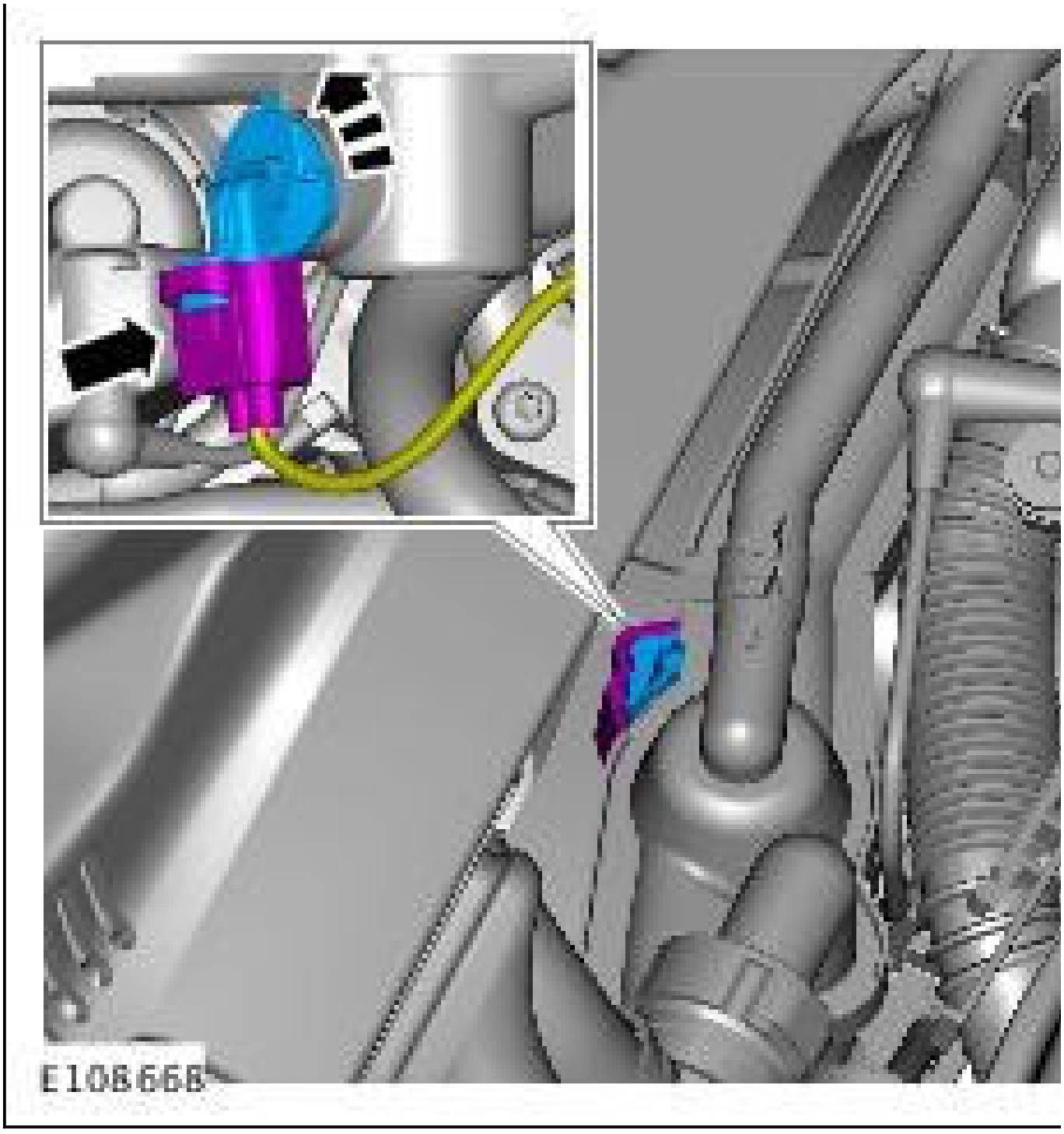
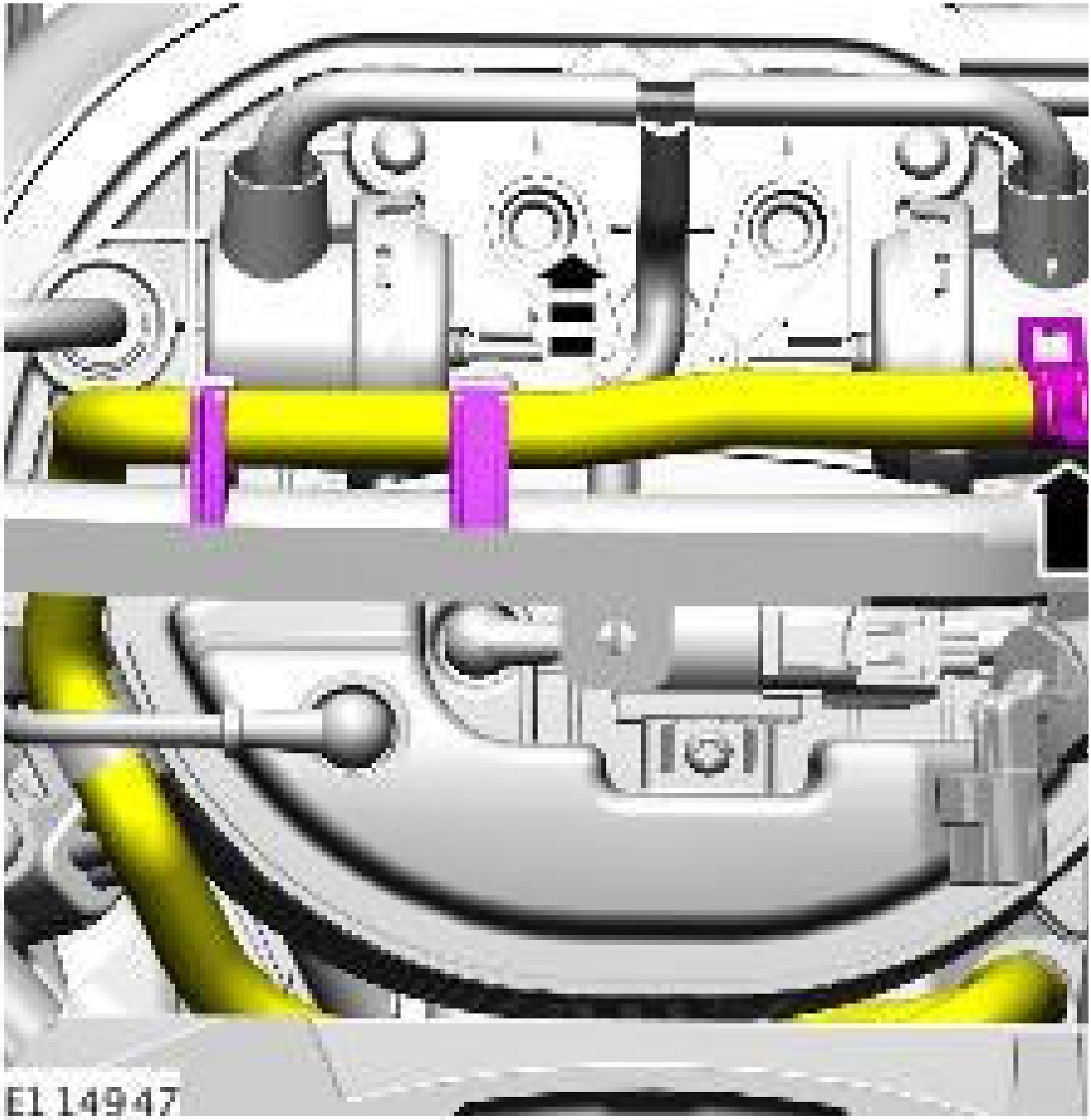


15. See figure

 © 2011 Mitchell Repair Information Company, LLC.



16. Torque: 12 Nm

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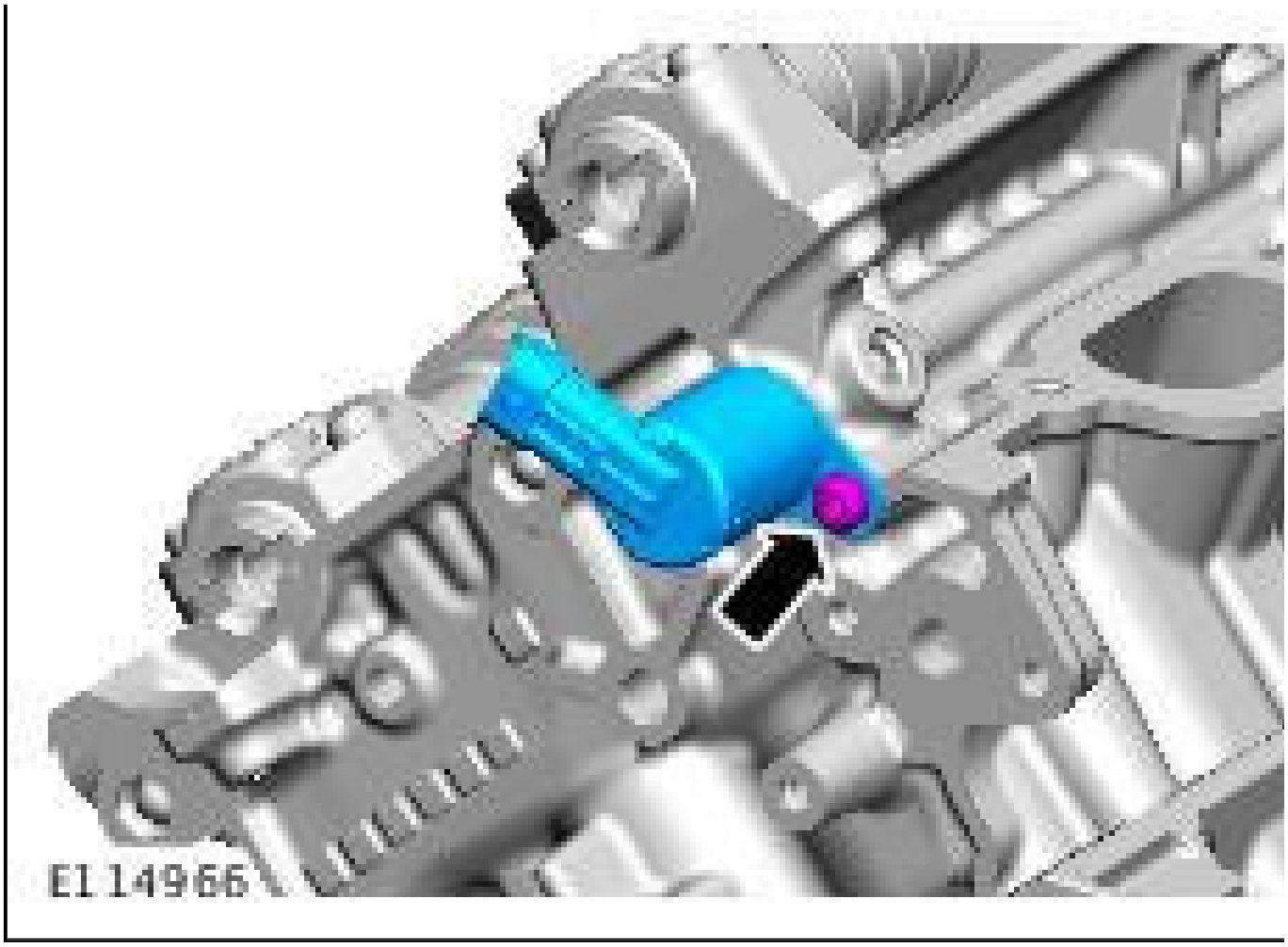
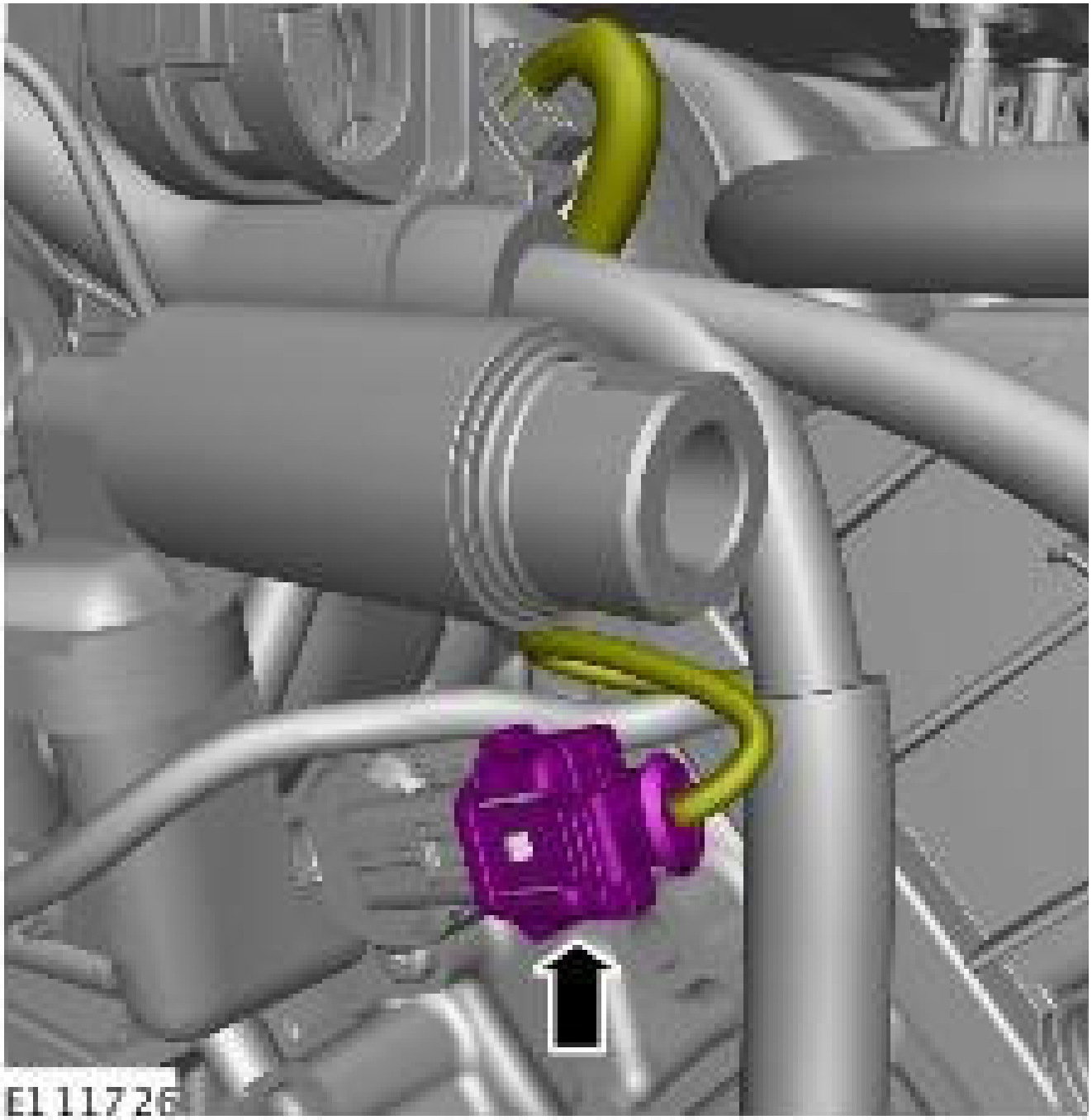


CAUTION: Install a new seal.

CAUTION: LH illustration shown, RH is similar.

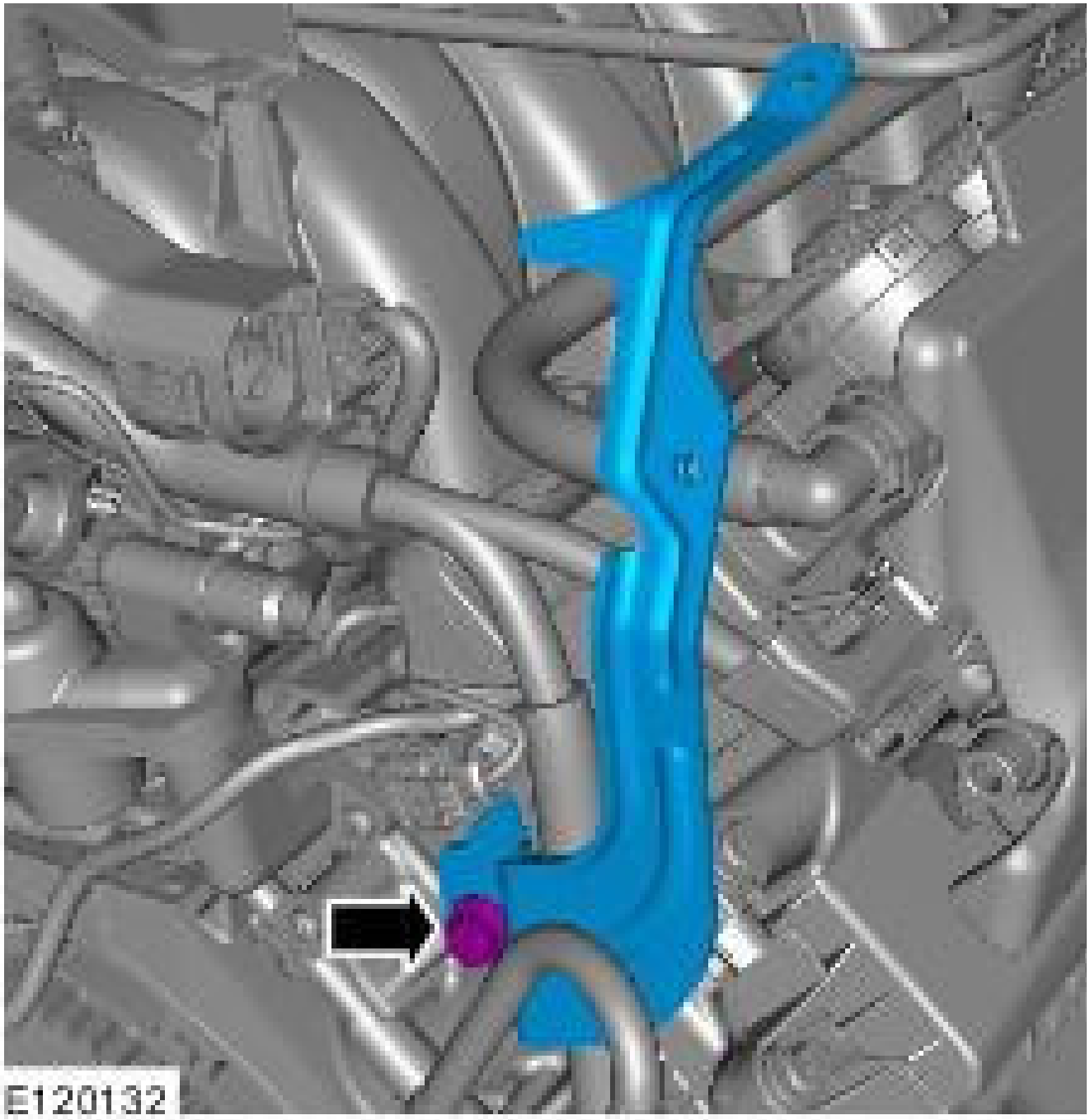
17. See figure

 © 2011 Mitchell Repair Information Company, LLC.



18. See figure

 © 2011 Mitchell Repair Information Company, LLC.



19. Torque: 10 Nm

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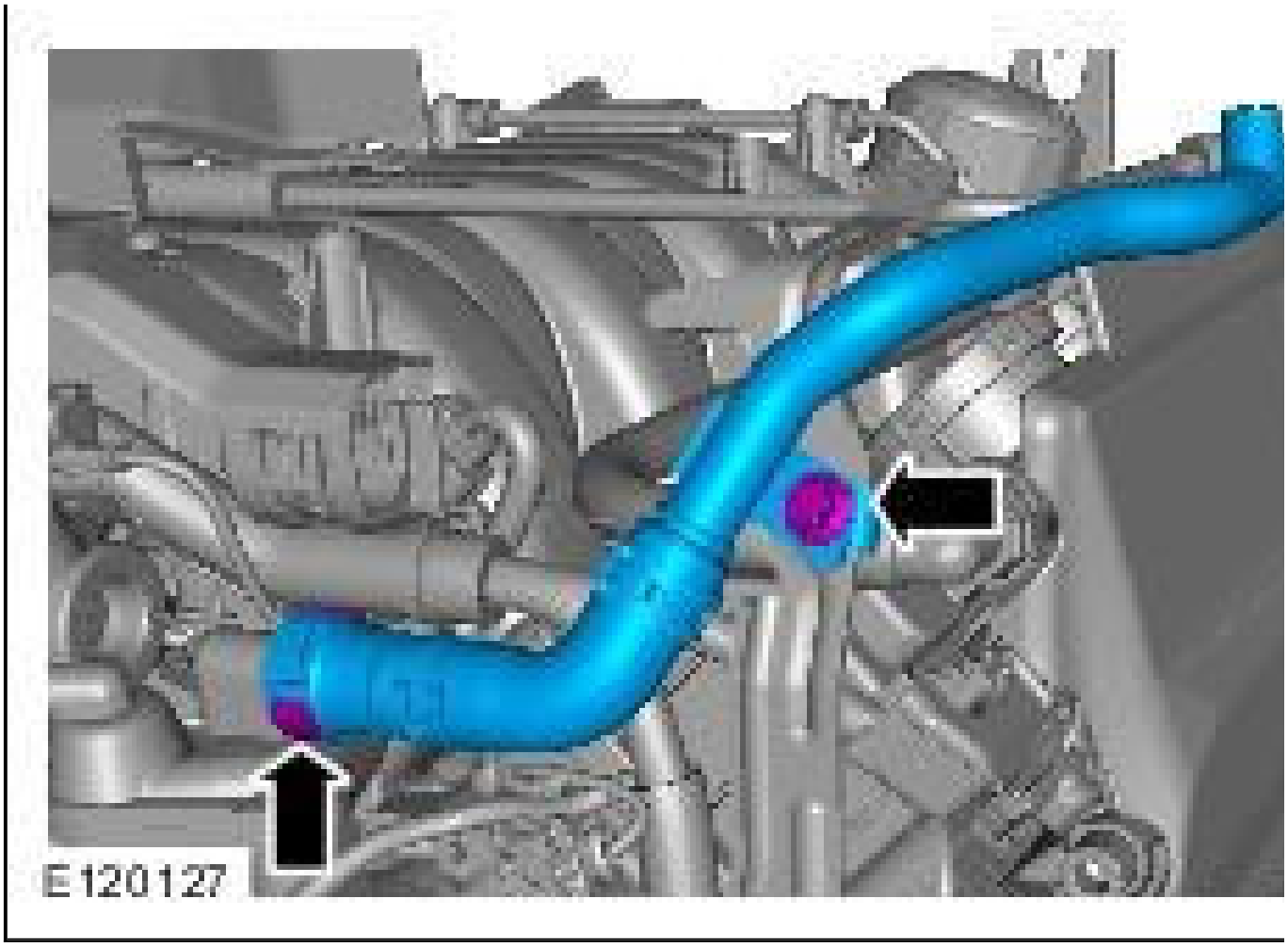
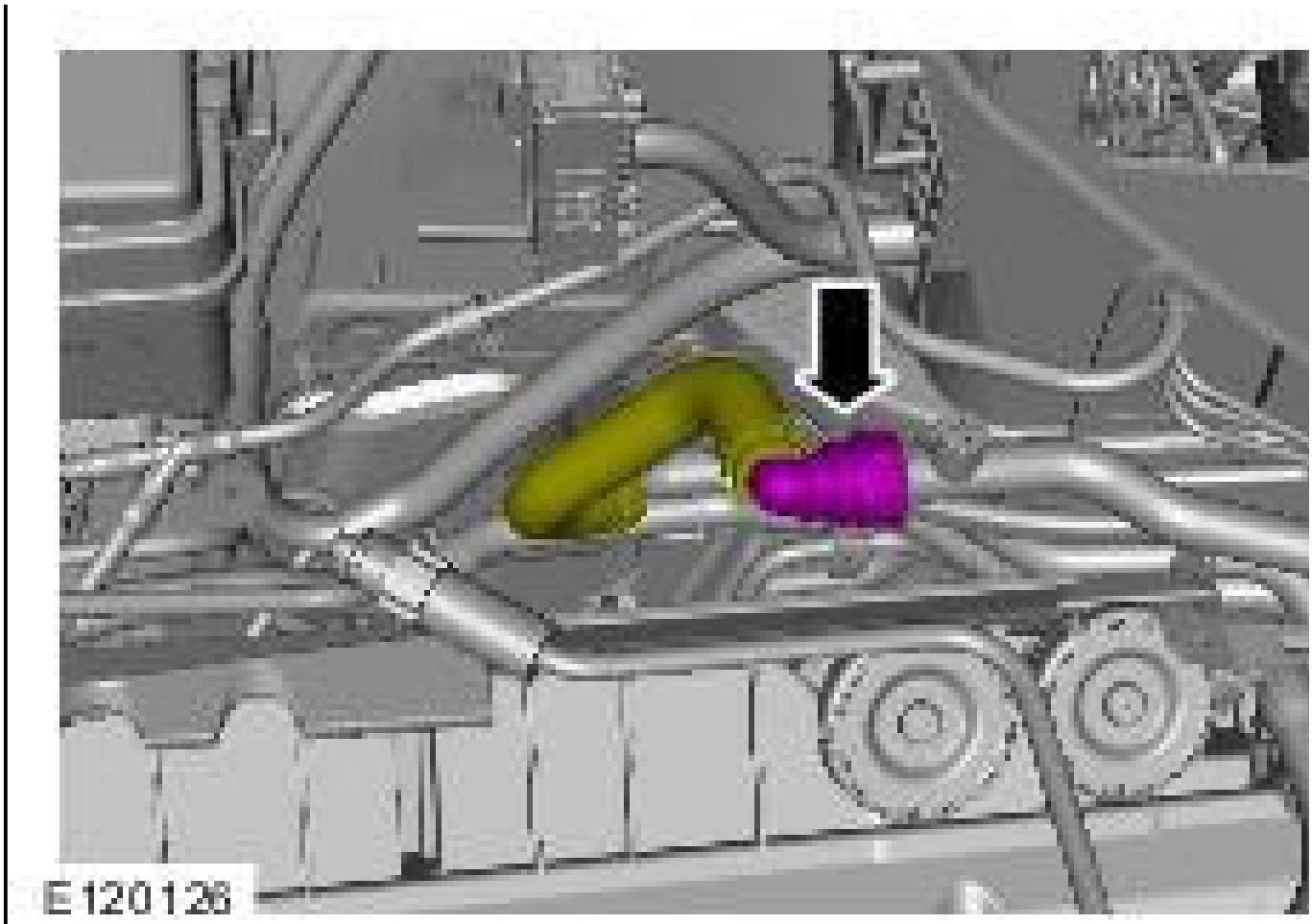


20. See figure

 © 2011 Mitchell Repair Information Company, LLC.



21. Torque: 20 Nm

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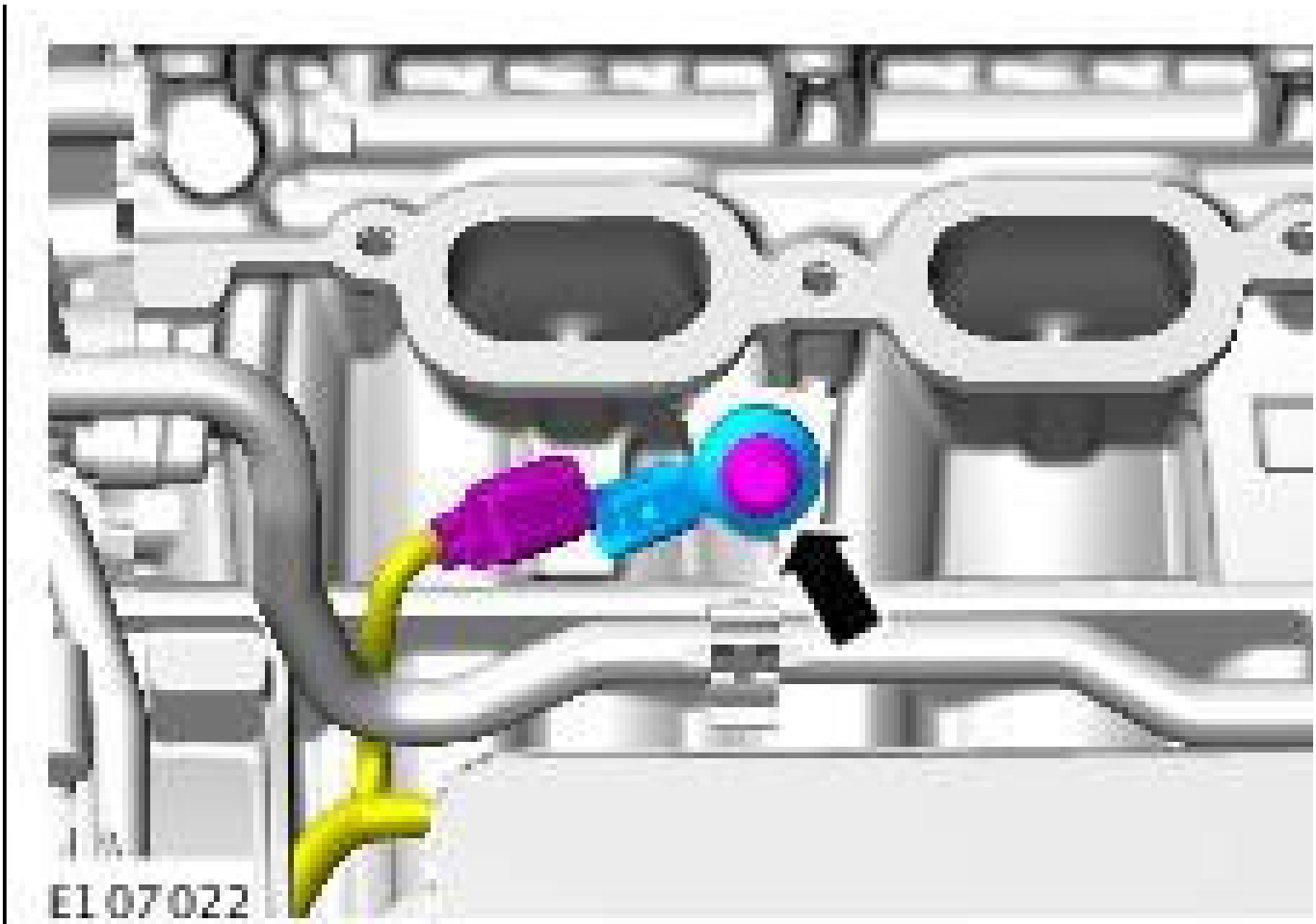

22. Torque: 20 Nm

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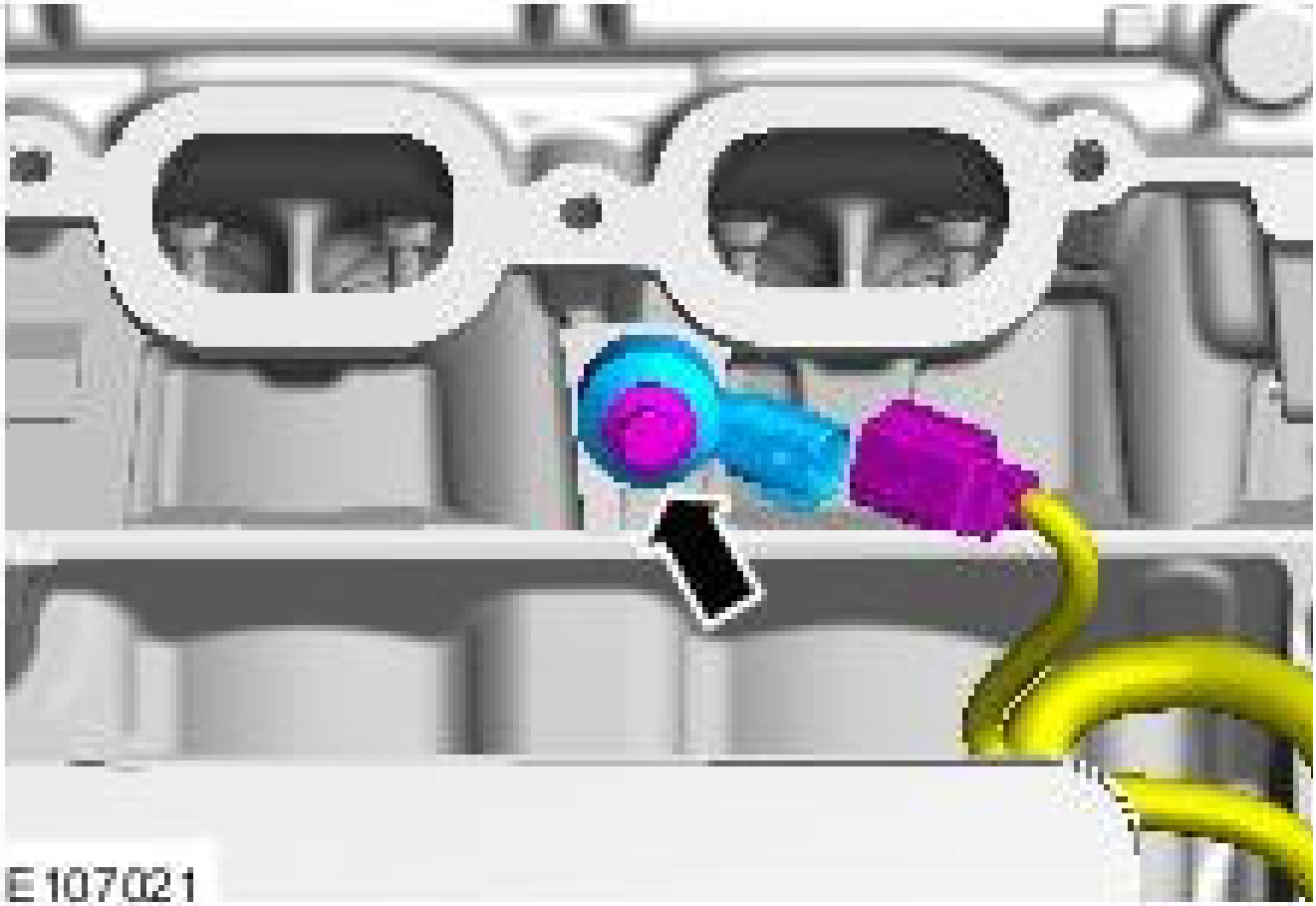

23. Torque: 25 Nm

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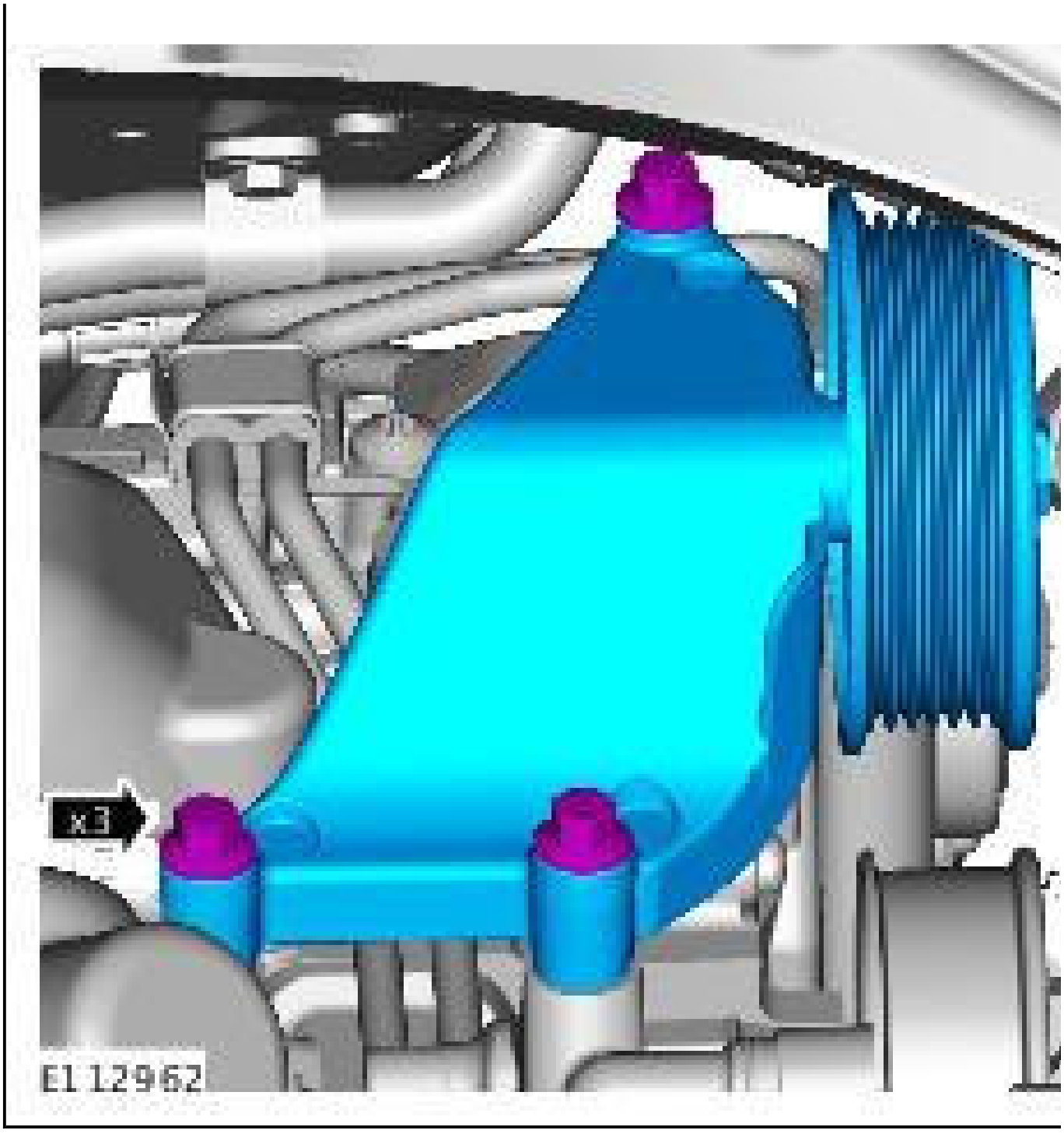

24. Torque: 25 Nm

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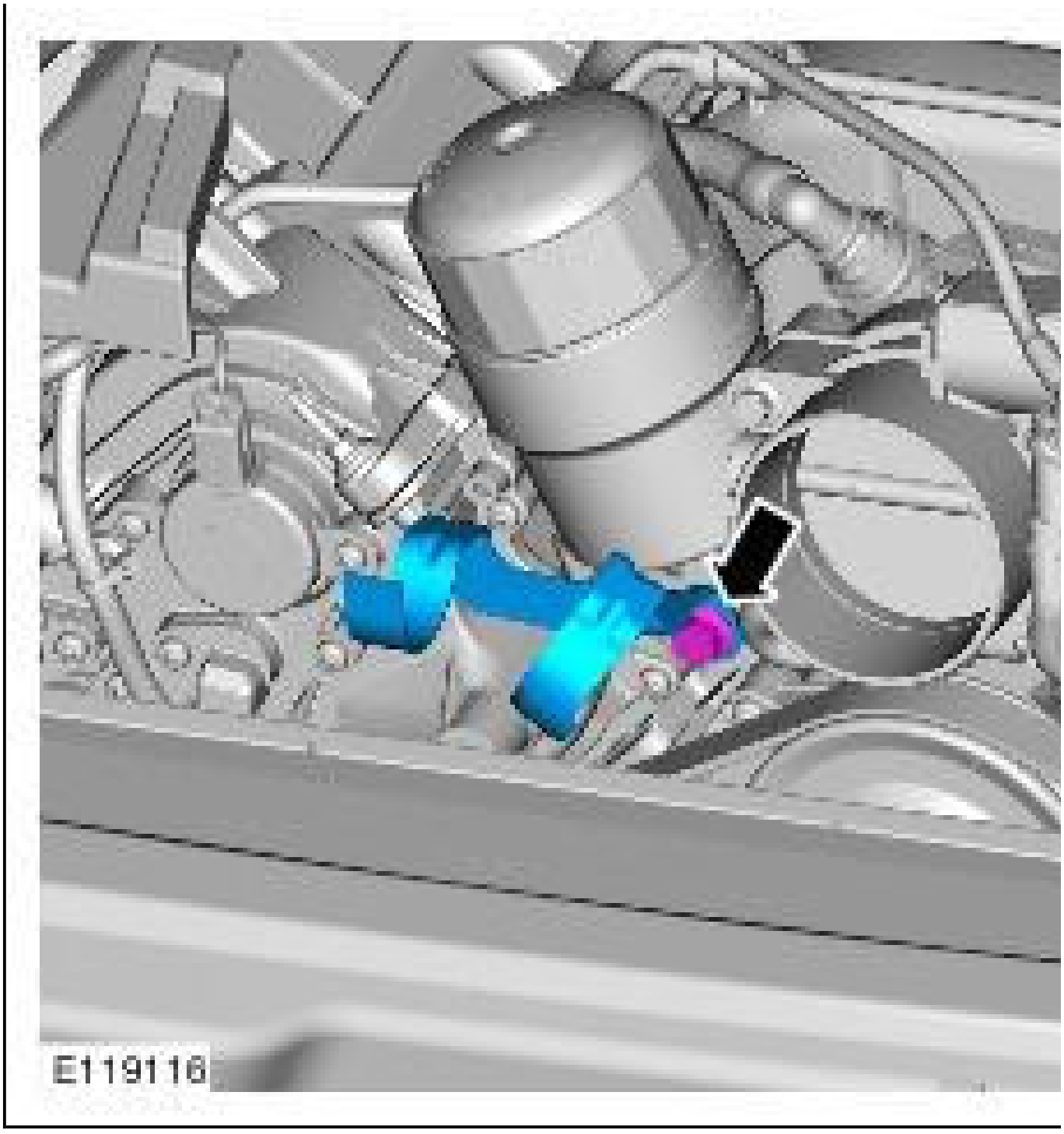

25. See **Exhaust Manifold RH**.
26. See **Camshaft RH**.
27. See **Intake Manifold**.
28. Connect the battery ground cable. Refer to **Specifications** .

ENGINE MOUNT LH

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SPECIAL TOOL(S)

	100-012 Slide Hammer
	205-735 Remover, Halfshaft Inner Joint
	303-1142 Viscous Coupling Wrench

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	303-1143 Viscous Coupling Holding Tool
	308-621-2 Installer/Guide, Halfshaft Oil Seal

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	308-626 Installer - Halfshaft Seal

REMOVAL

ALL VEHICLES

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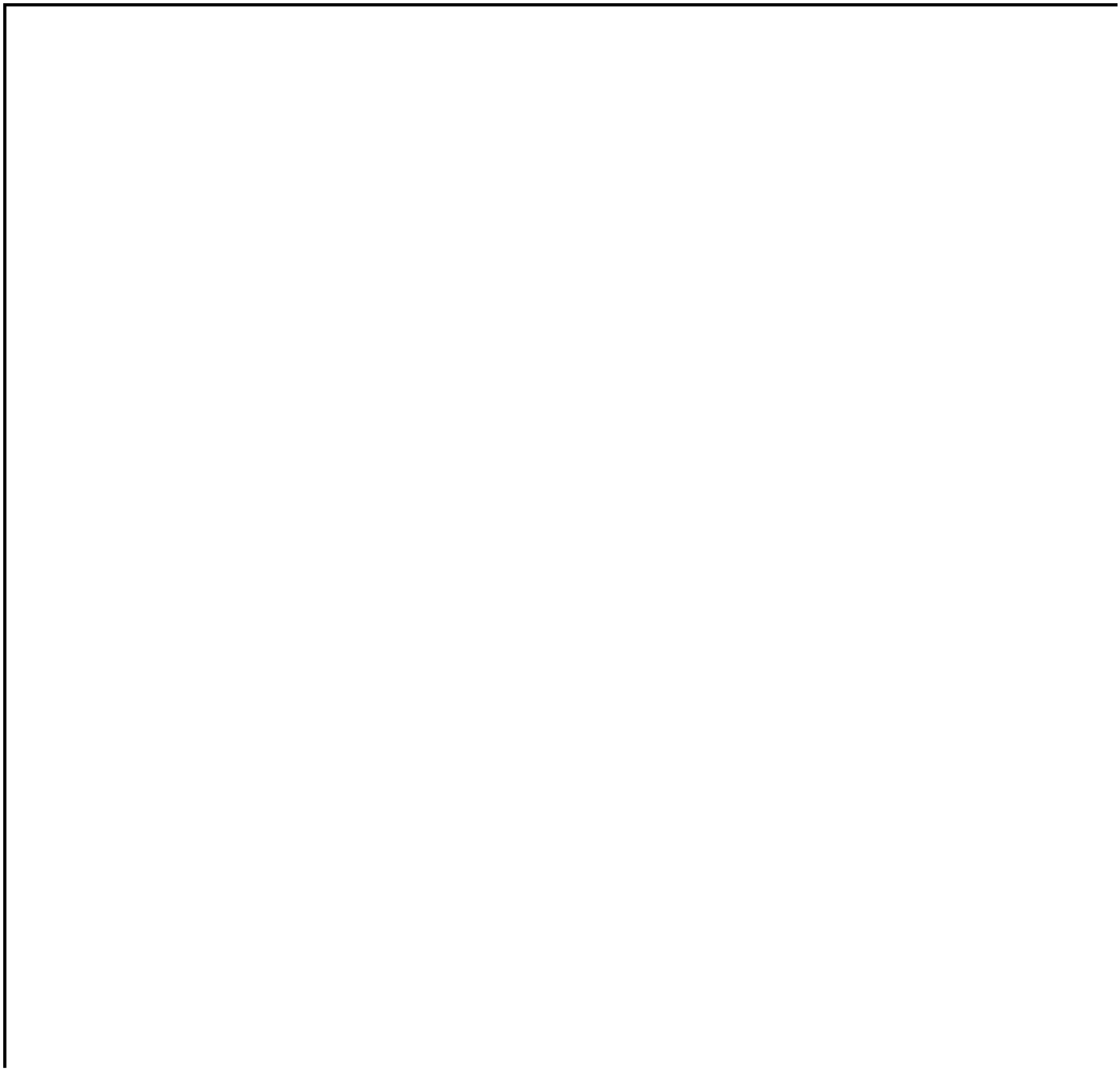
1. Disconnect the battery ground cable. Refer to **Specifications** .

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

2. Raise and support the vehicle.
3. Refer to **AIR CLEANER OUTLET PIPE T-CONNECTOR**
4. Refer to **Differential Draining and Filling** .
5. See figure



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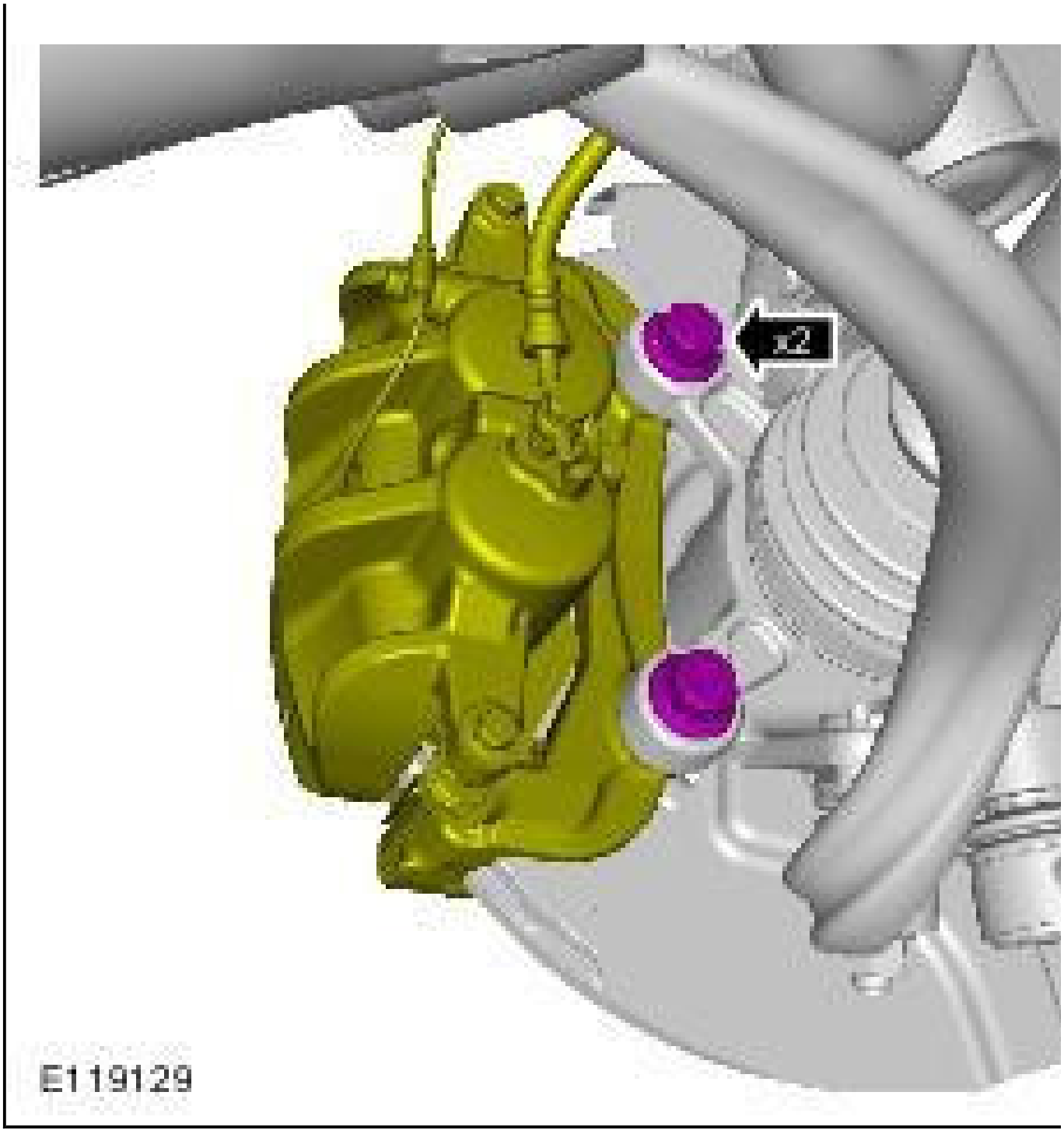
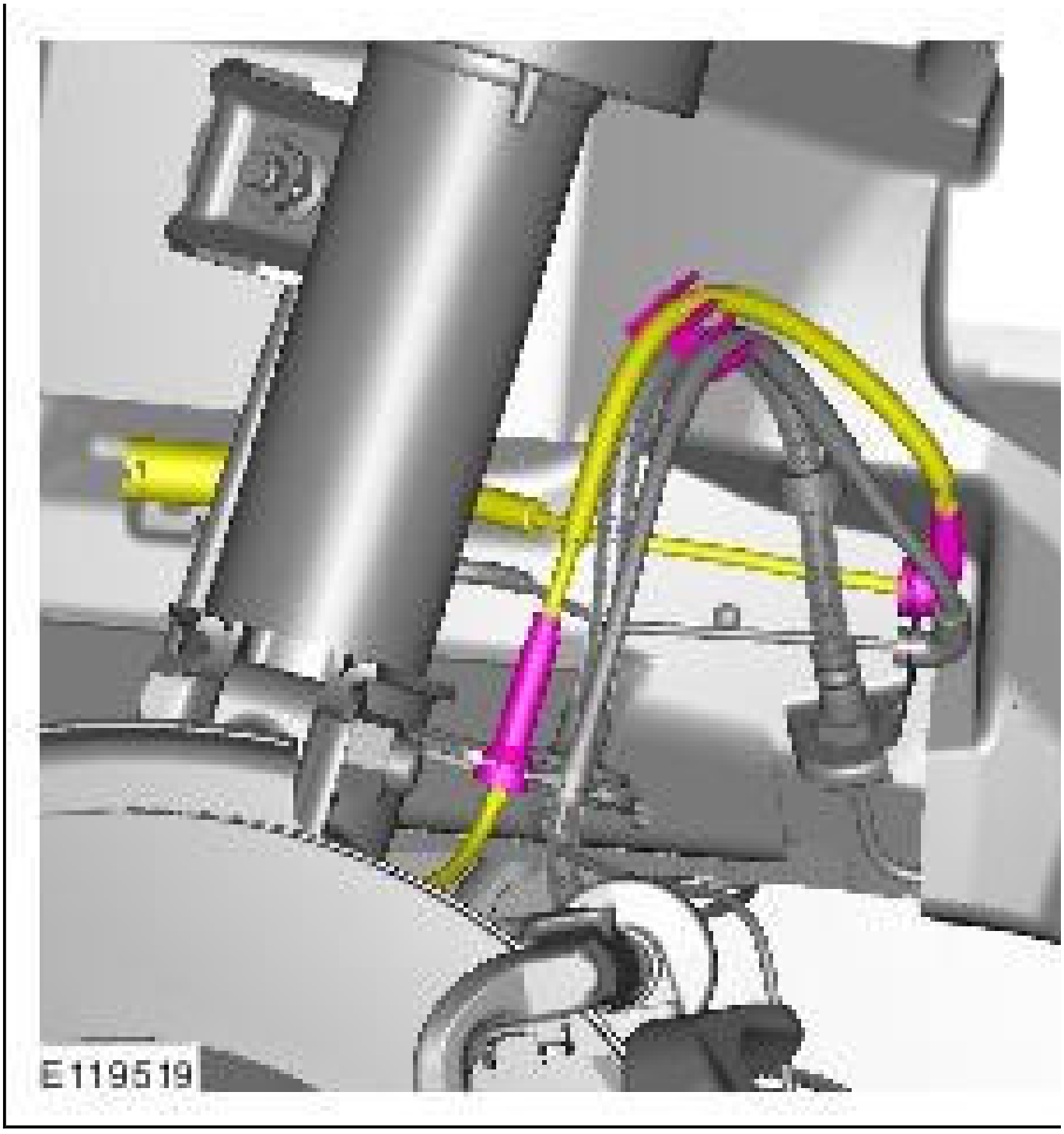


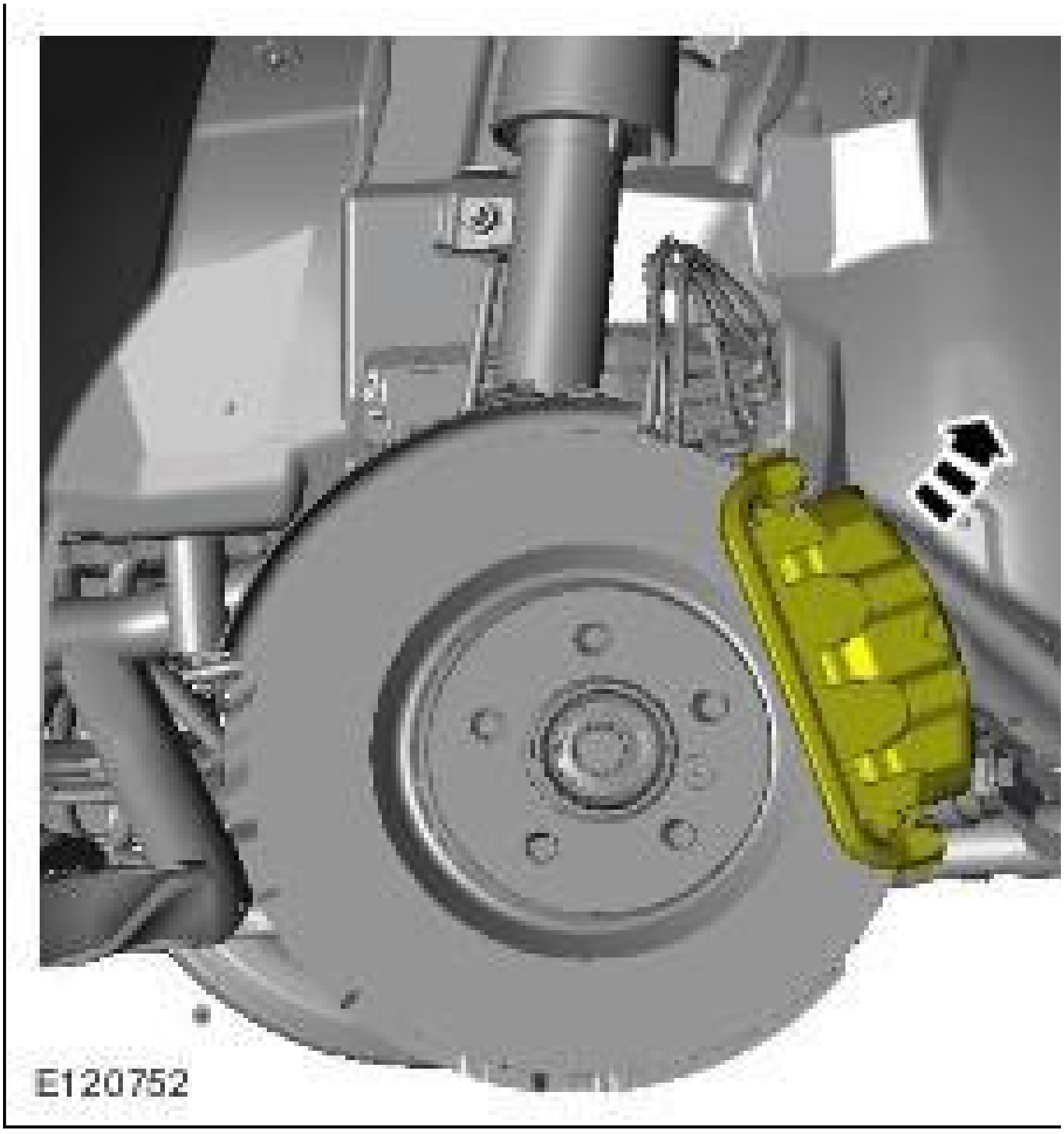
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



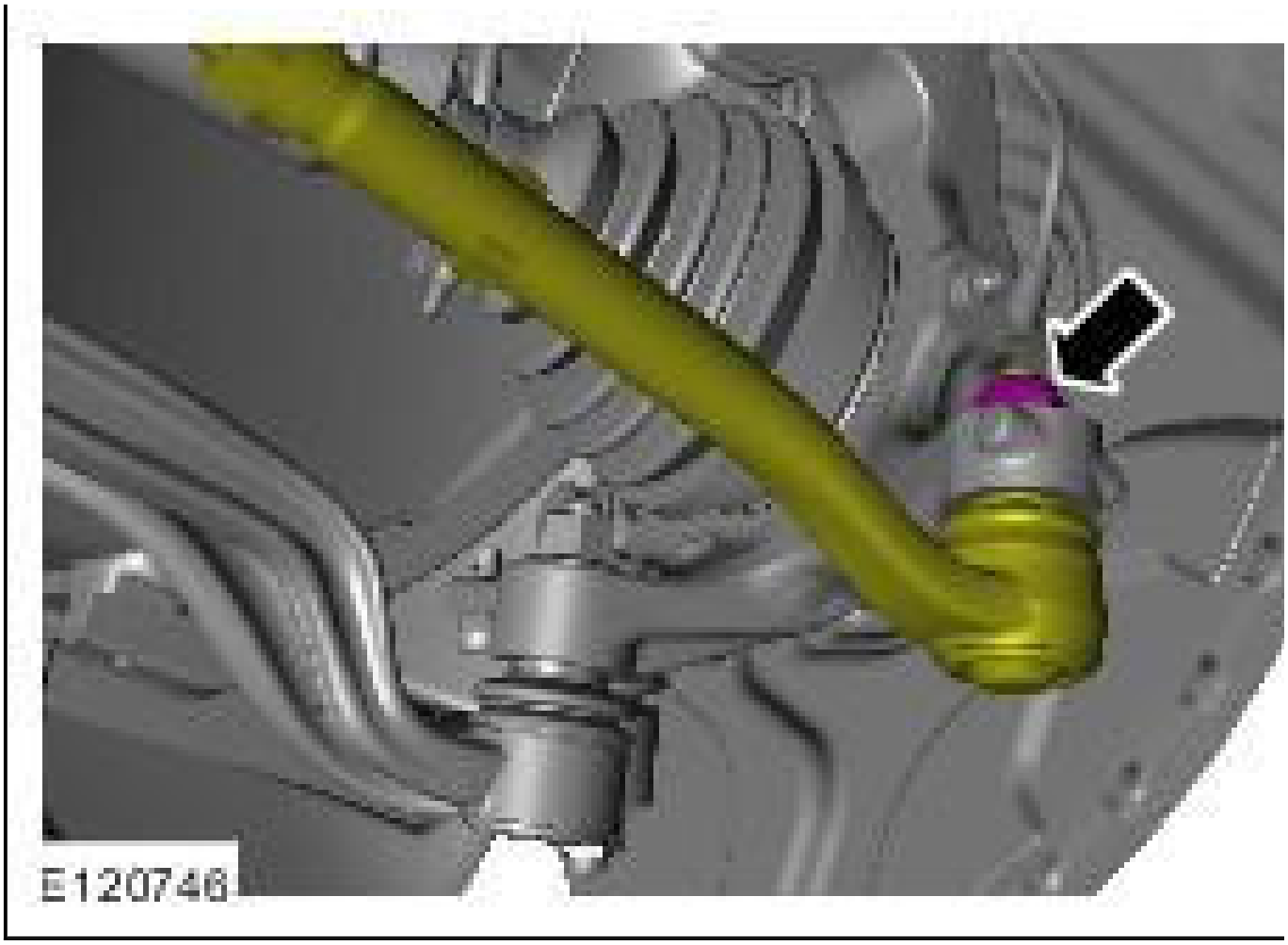
7. See figure

 © 2011 Mitchell Repair Information Company, LLC.



8. See figure

 © 2011 Mitchell Repair Information Company, LLC.



9. See figure

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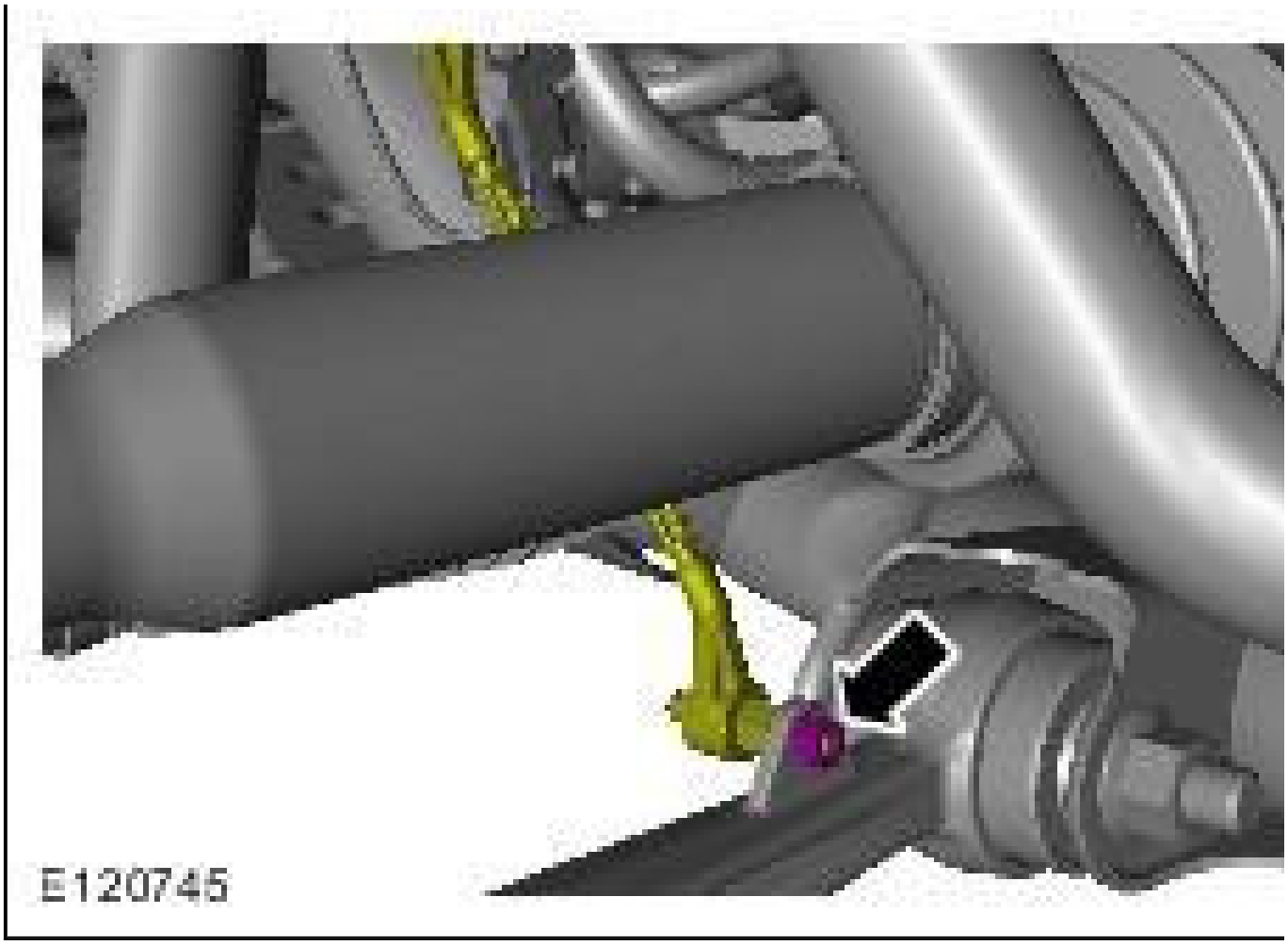

10. See figure

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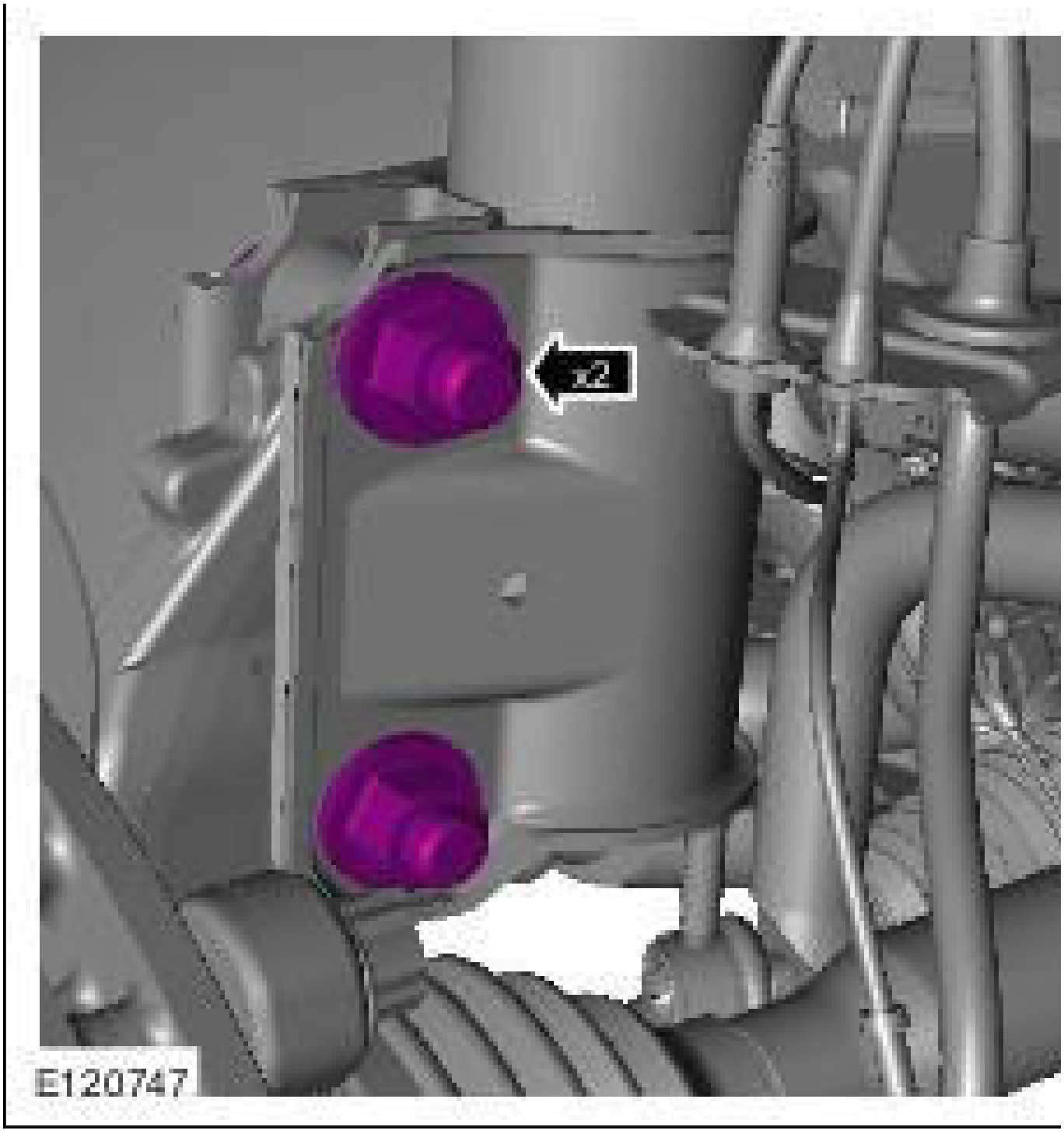

11. See figure

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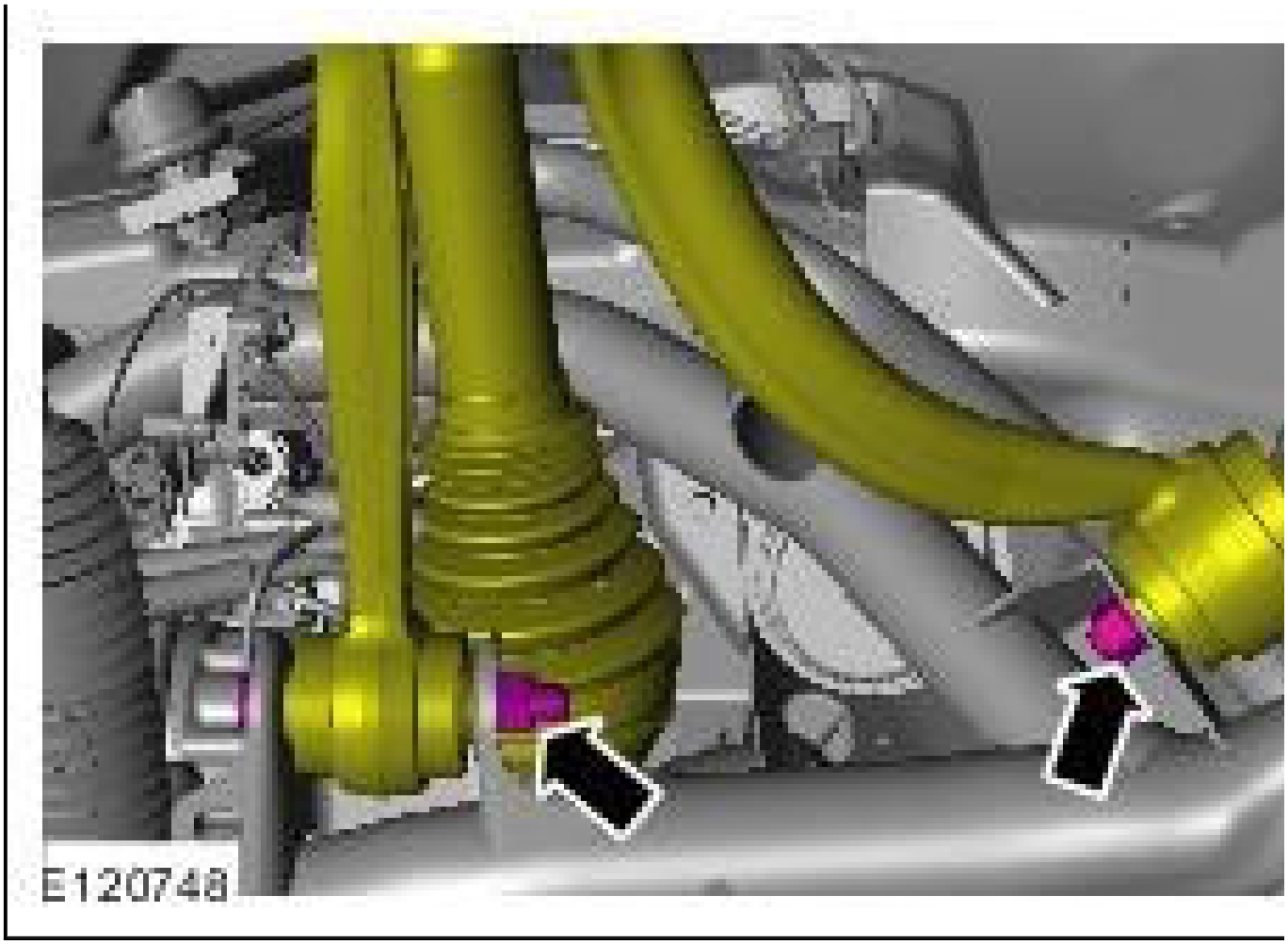

12. LH side: Using the special tool, disconnect the halfshaft from the differential.

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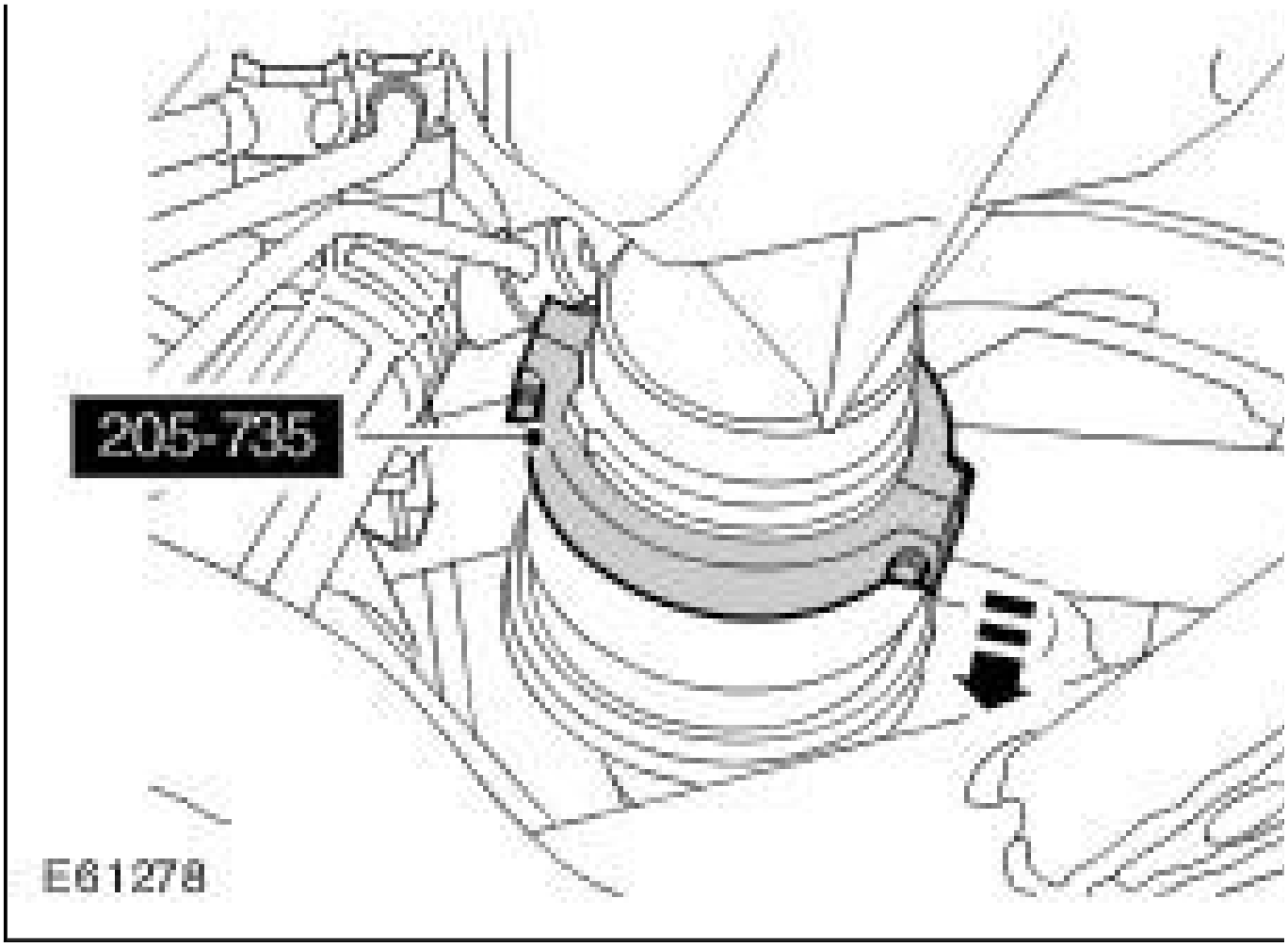

CAUTION: Support the halfshaft.

Remover, Halfshaft Inner Joint (205-735), refer to **SPECIAL TOOL(S)**

13. See figure

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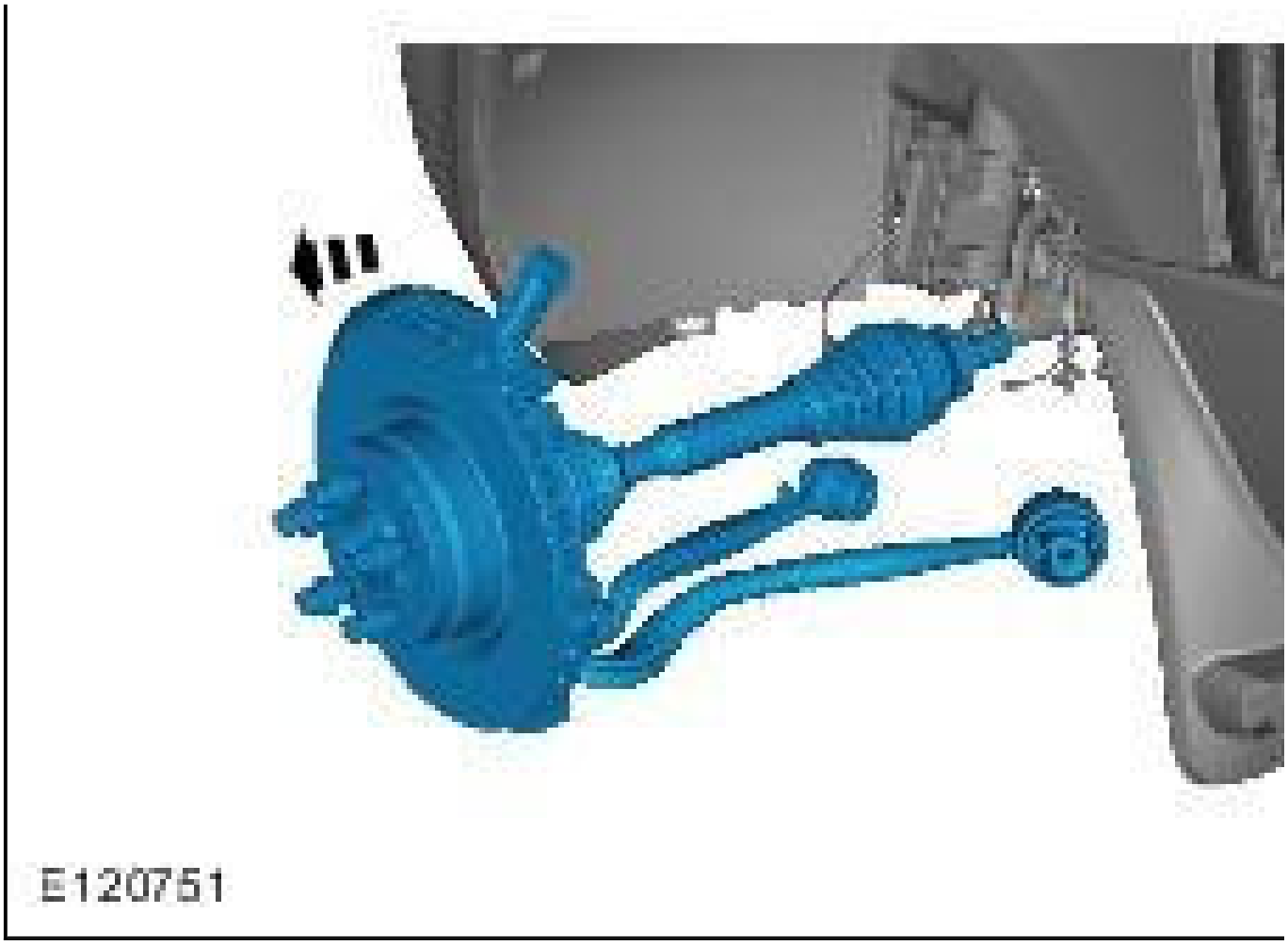


CAUTION: Keep the halfshaft horizontal to avoid damaging the oil seal.

CAUTION: Make sure no damage occurs to the halfshaft seal when installing the halfshaft.

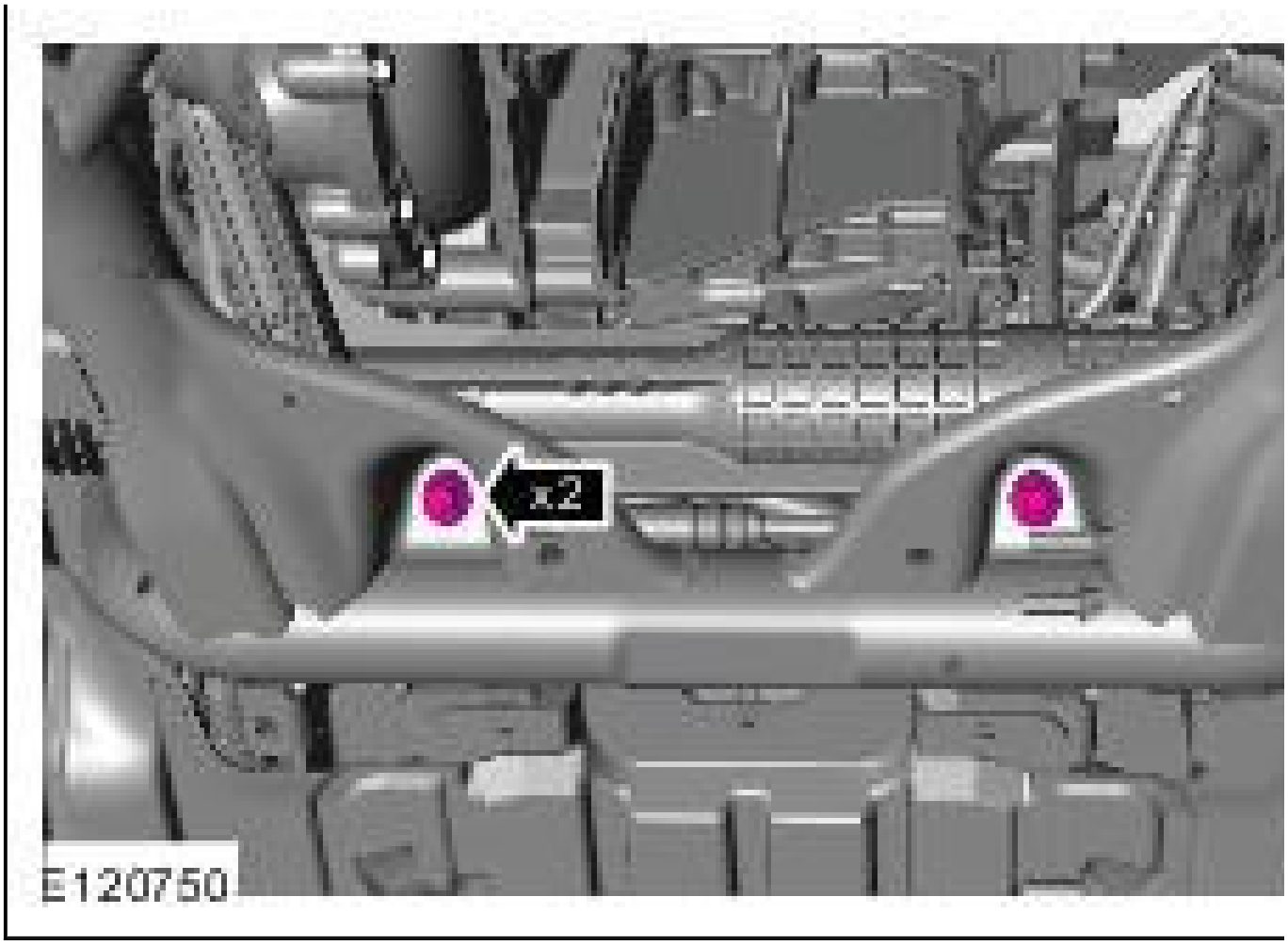
NOTE: With assistance remove the components.

- Install a new halfshaft oil seal.

LEFT-HAND DRIVE VEHICLES

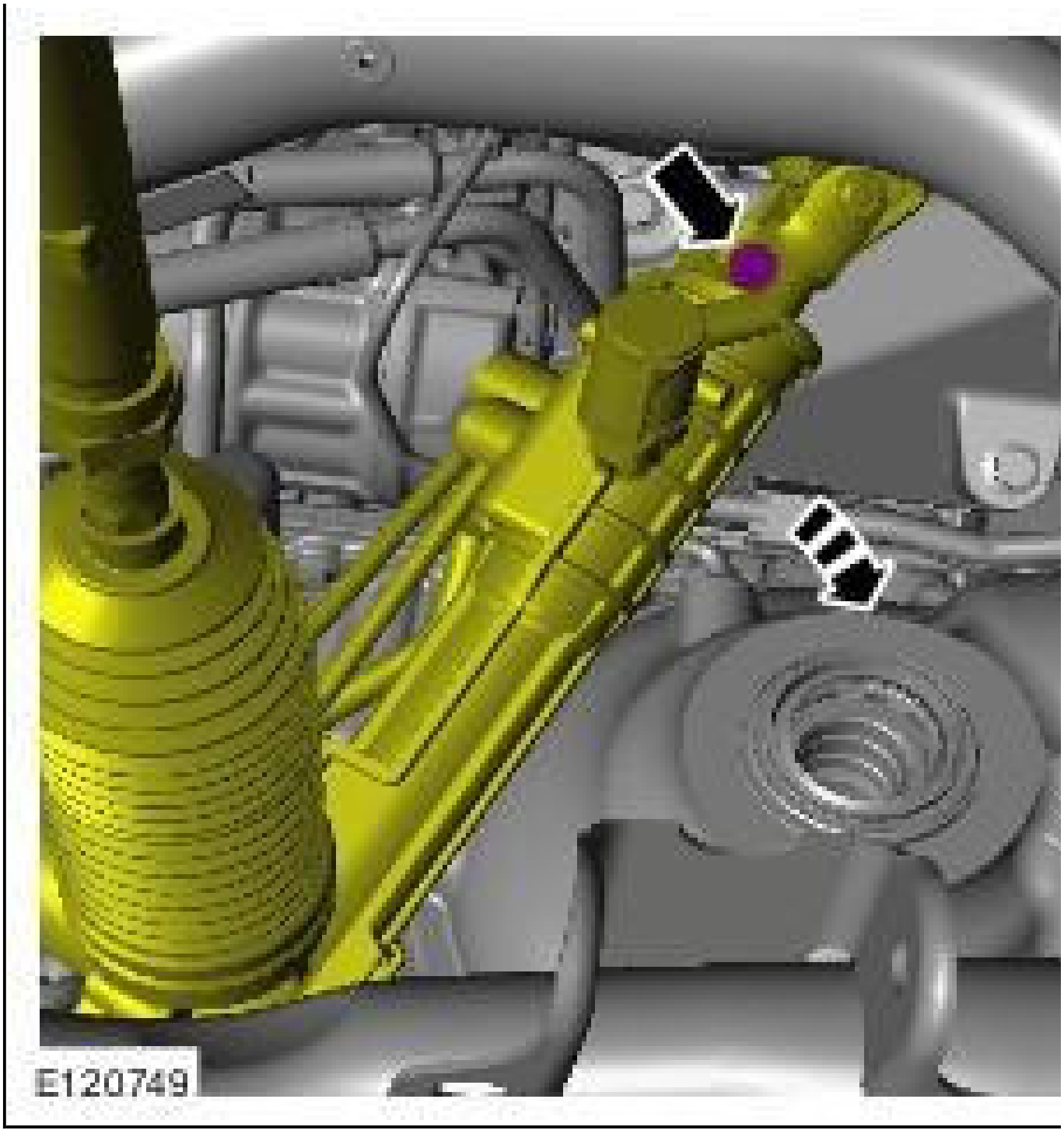
1. See figure

 © 2011 Mitchell Repair Information Company, LLC.



2. See figure

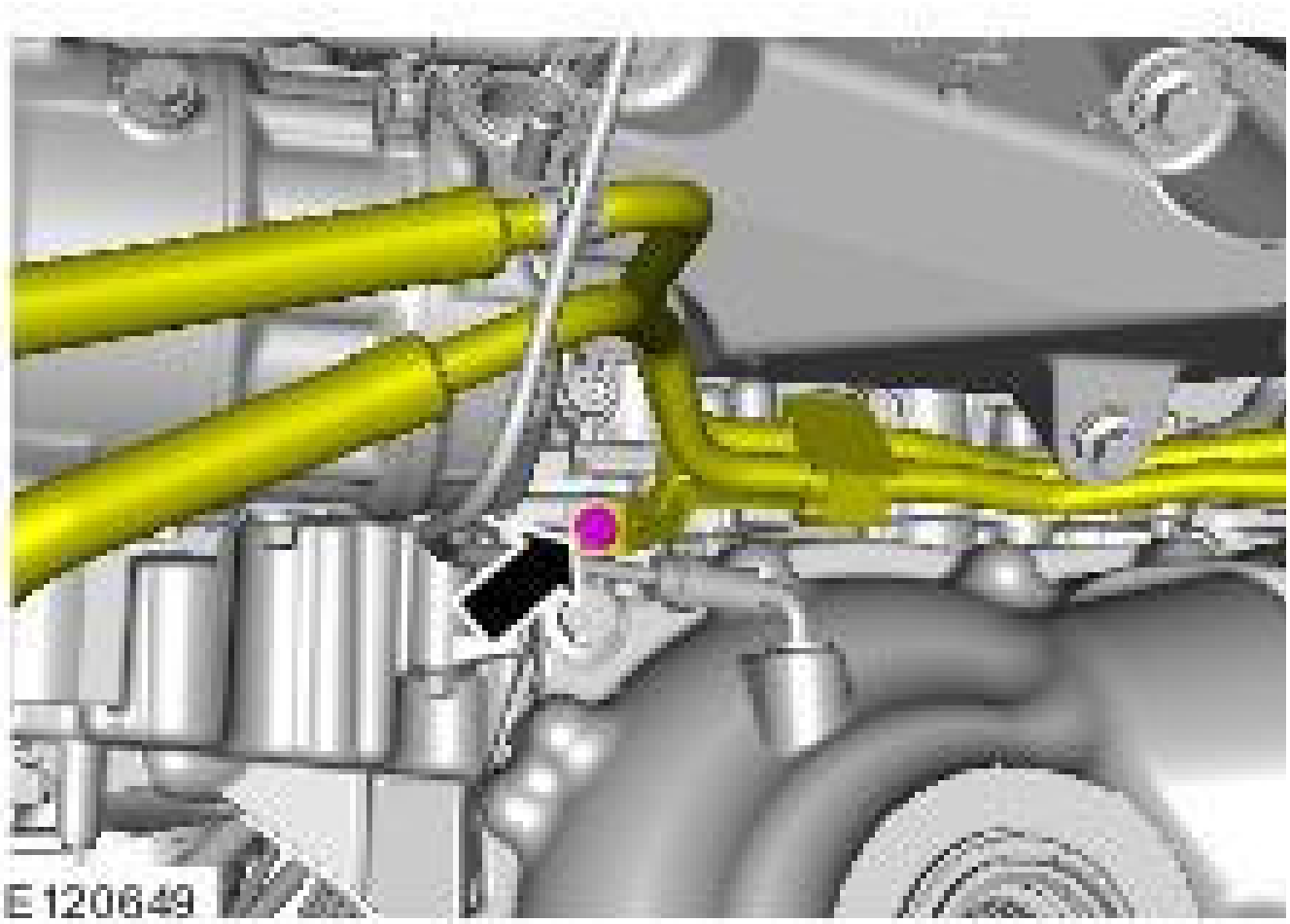
 © 2011 Mitchell Repair Information Company, LLC.



ALL VEHICLES

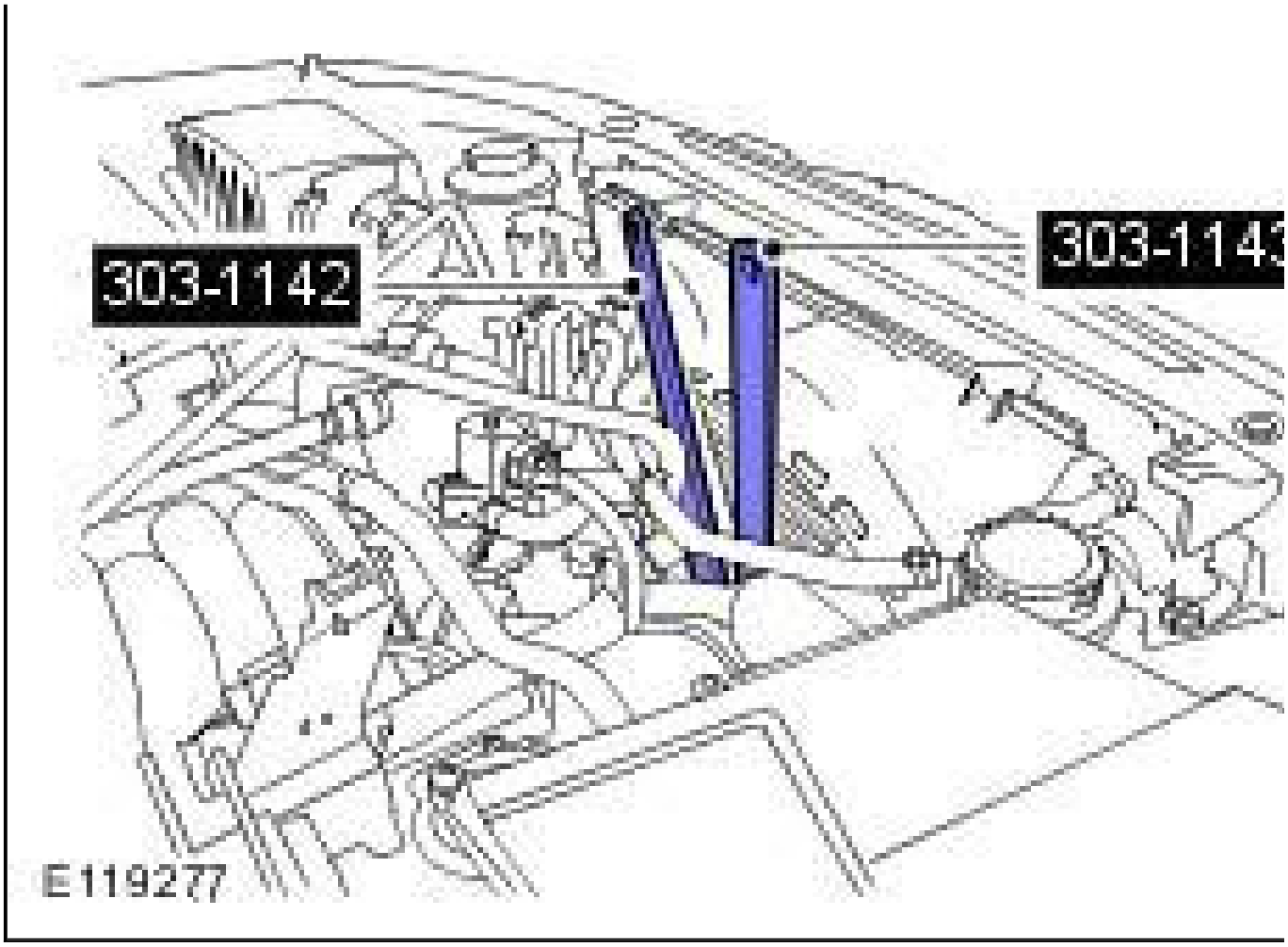
1. See figure

 © 2011 Mitchell Repair Information Company, LLC.



2. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Always protect the cooling pack elements to prevent accidental damage.

NOTE: The thread is right handed.

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

Viscous Coupling Wrench (303-1142), refer to **SPECIAL TOOL(S)**

Viscous Coupling Holding Tool (303-1143), refer to **SPECIAL TOOL(S)**

3. See figure

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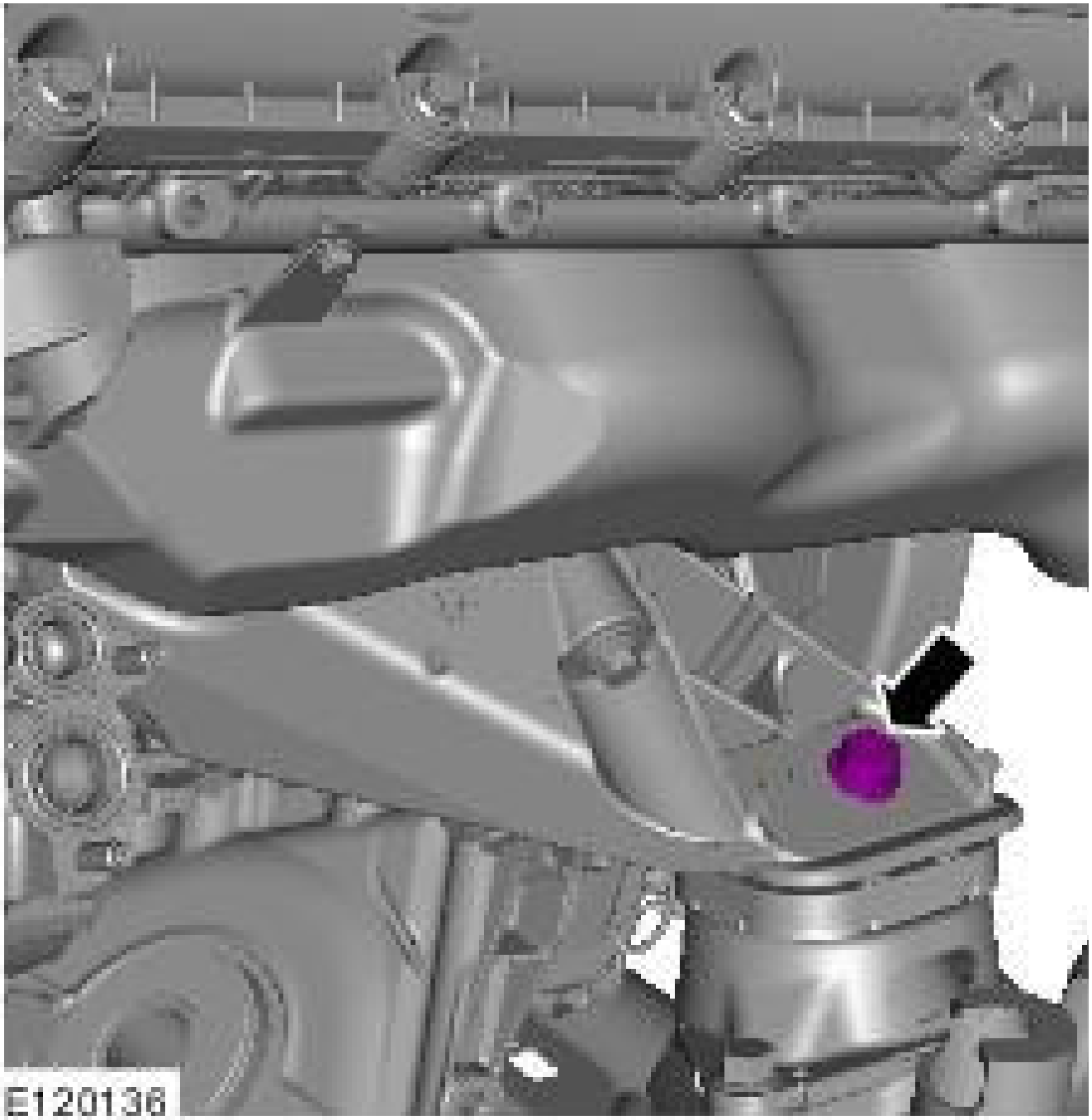

4. Using a suitable hydraulic jack, raise and support the engine.

CAUTION: Use a wooden block to protect the oil pan when supporting the engine.

5. See figure

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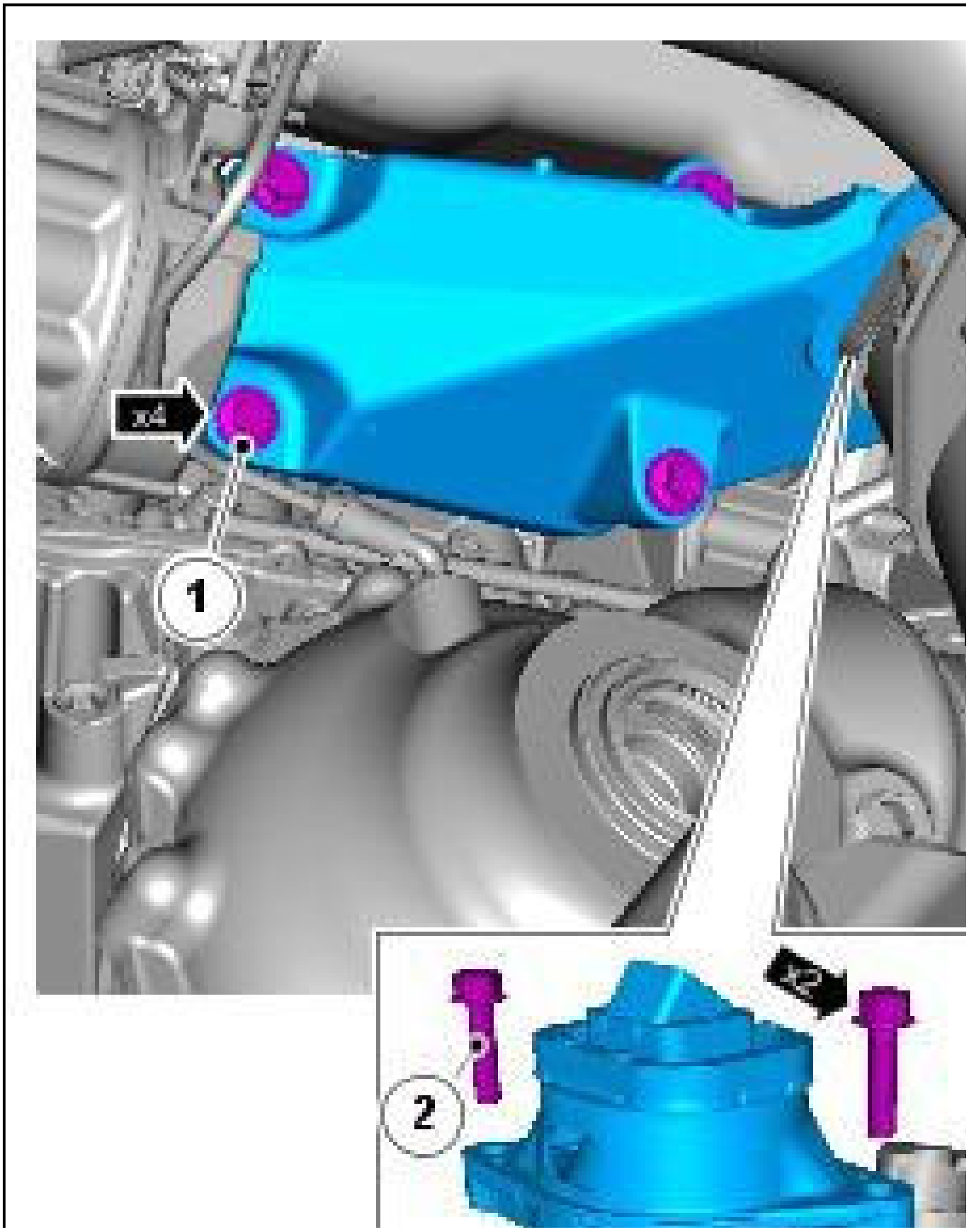

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INSTALLATION

ALL VEHICLES

1. Torques:

   1: 45 Nm

   1: 60°

   2: 56 Nm

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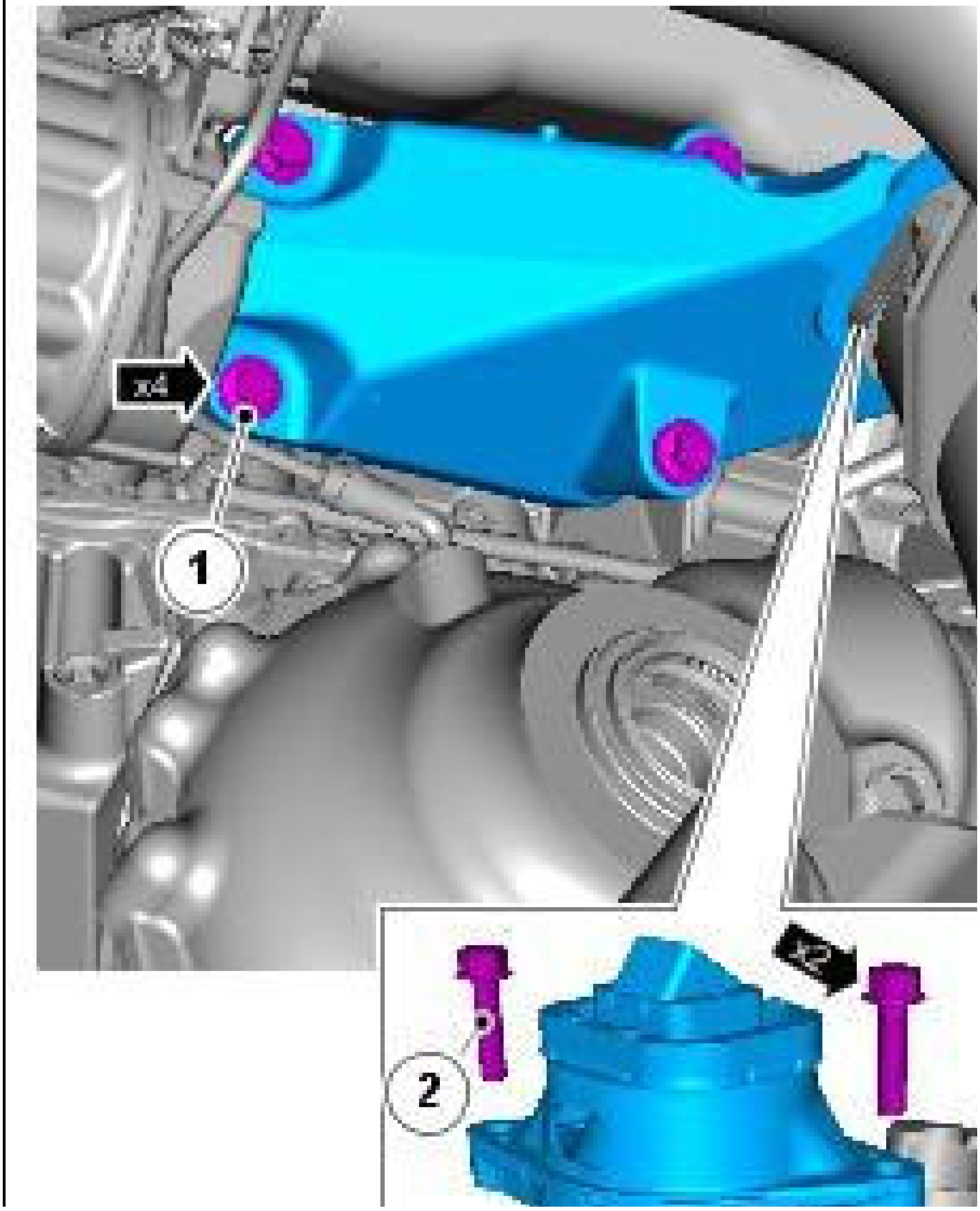

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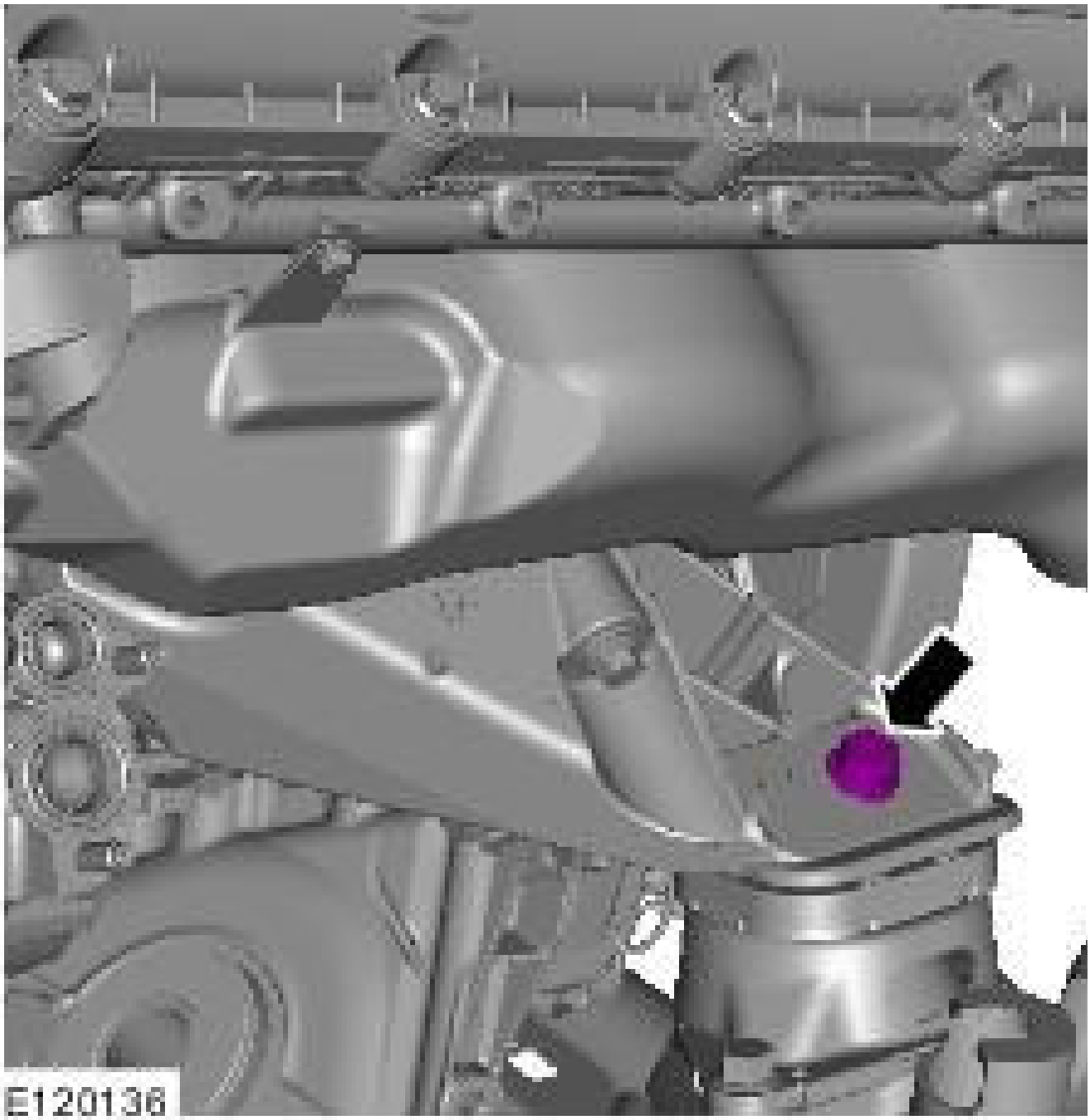
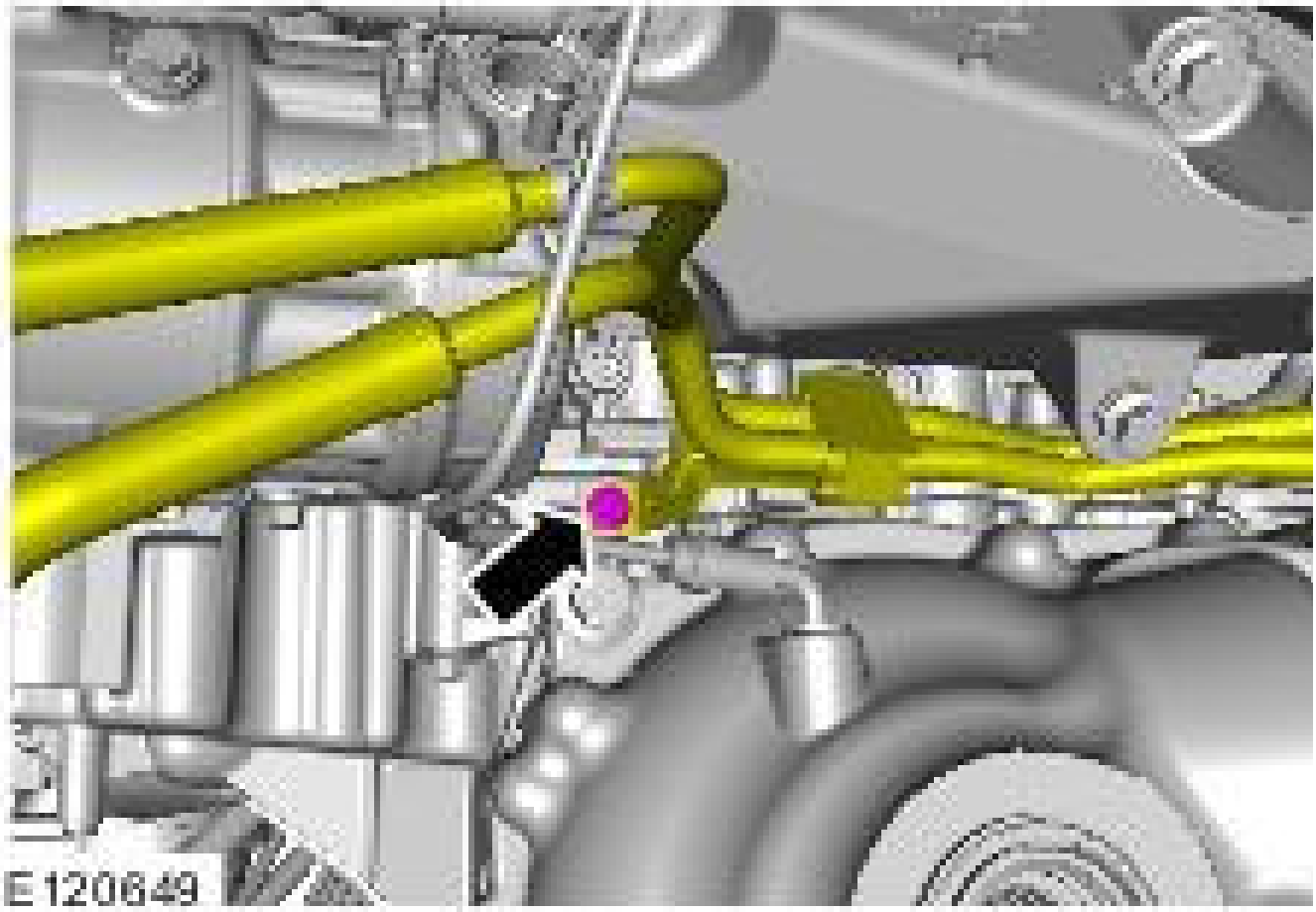
2. Torque: 100 Nm



3. Torque: 10 Nm

 © 2011 Mitchell Repair Information Company, LLC.



LEFT-HAND DRIVE VEHICLES

1. Torque: 24 Nm

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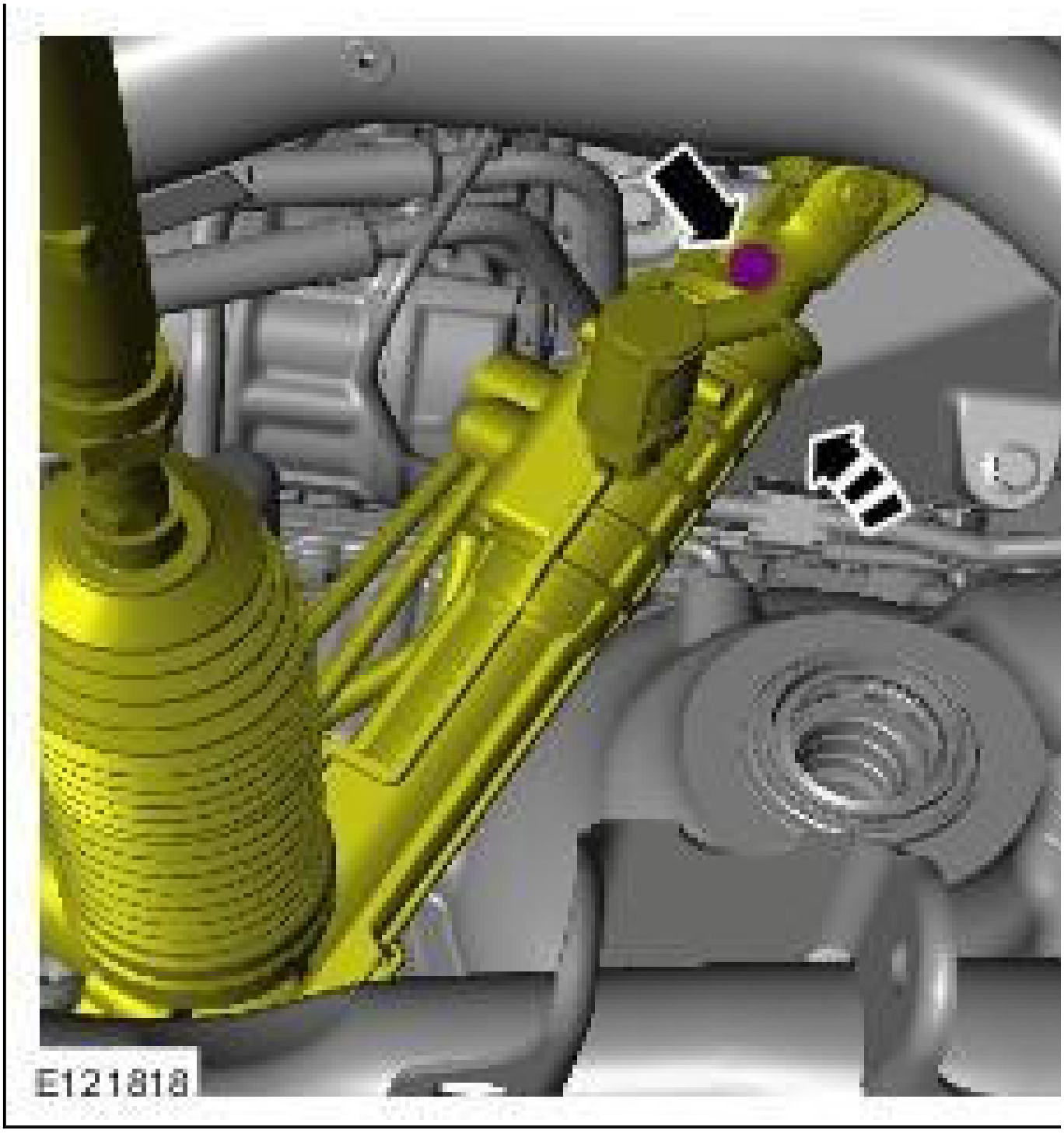

2. Torque: 100 Nm

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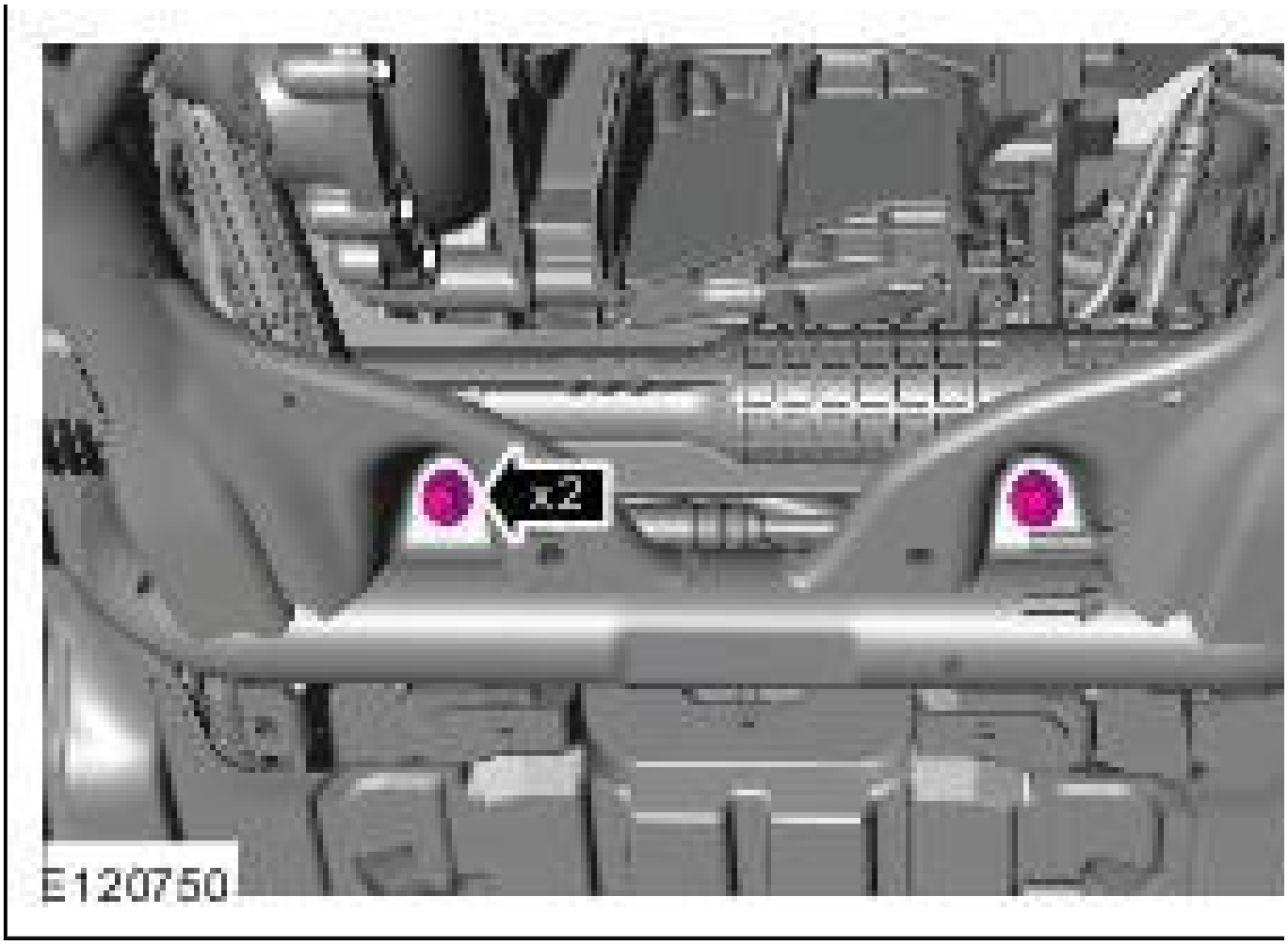
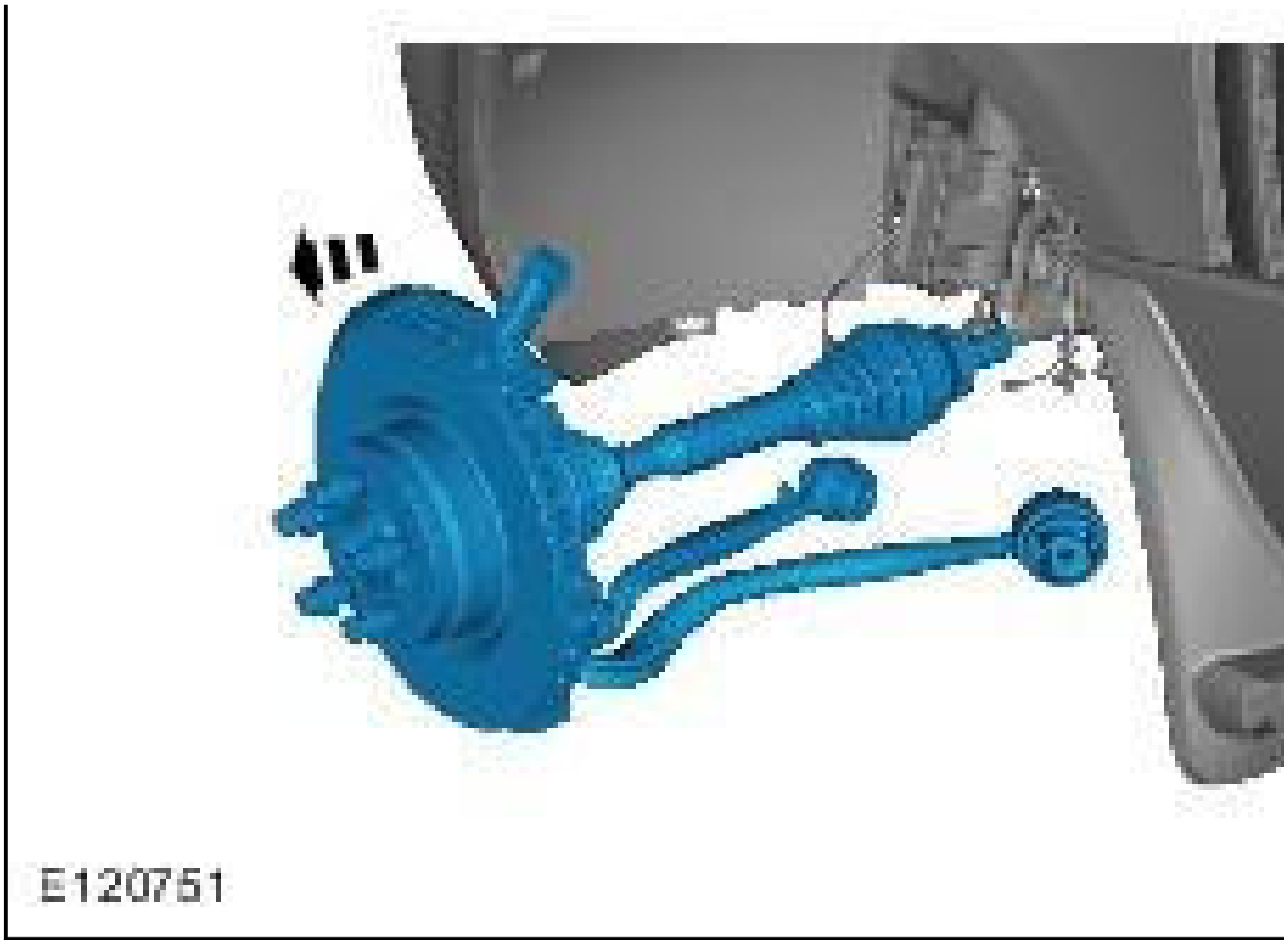


ALL VEHICLES

1. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Keep the halfshaft horizontal to avoid damaging the oil seal.

CAUTION: Make sure no damage occurs to the halfshaft seal when installing the halfshaft.

- Install a new halfshaft oil seal.

2. See figure

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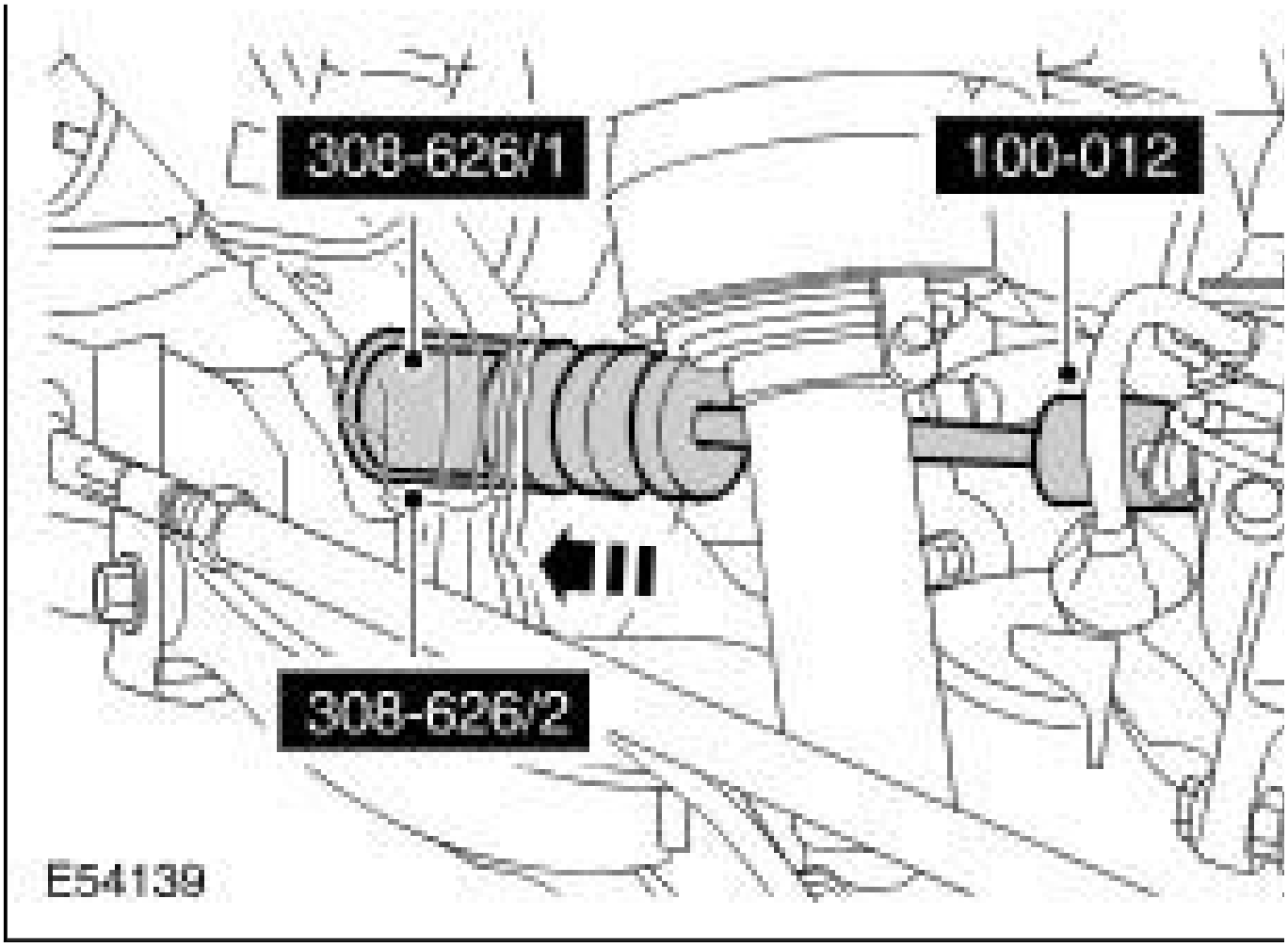

CAUTION: The seal protector must be left in place until the halfshaft has been installed.

NOTE: LH illustration shown, RH is similar.

- Clean the component mating faces.

  Slide Hammer (100-012), refer to **SPECIAL TOOL(S)**

  Installer - Halfshaft Seal (308-626), refer to **SPECIAL TOOL(S)**

  Installer/Guide halfshaft oil seal (308-621-2), refer to **SPECIAL TOOL(S)**

3. See figure

CAUTION: Keep the halfshaft horizontal to avoid damaging the oil seal.

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CAUTION: Pull on the halfshaft inboard joint to make sure the clip has fully engaged and retains the halfshaft inboard joint within the differential case.

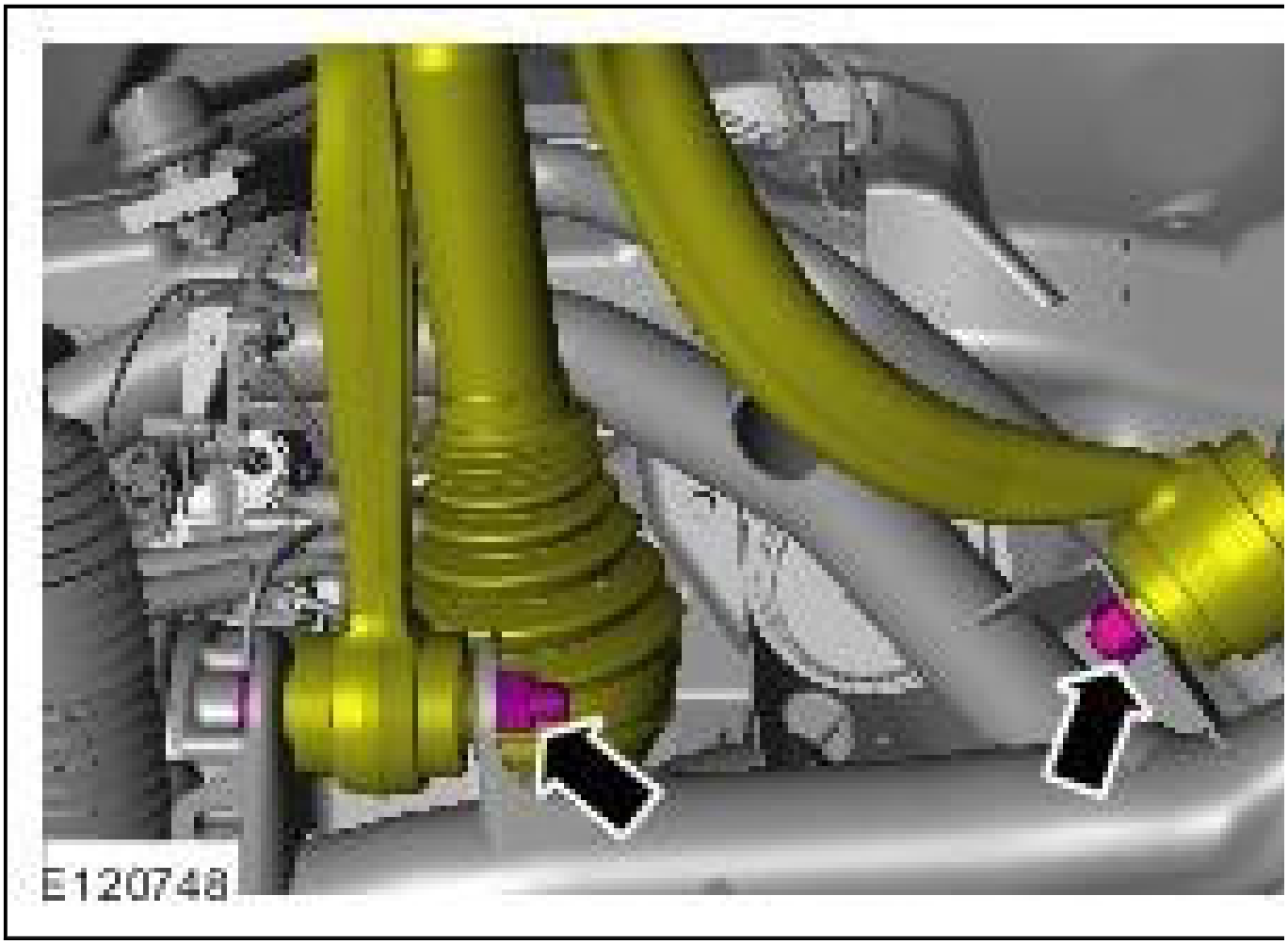
NOTE: Do not fully engage the halfshaft until the oil seal protector has been removed.

- Install a new retaining clip.
- Open the halfshaft oil seal protector.
- Lubricate the seal with clean differential fluid.

4. Torque:

   Stage 1: 165 Nm

   Stage 2: 90°



5. Torque: 250 Nm

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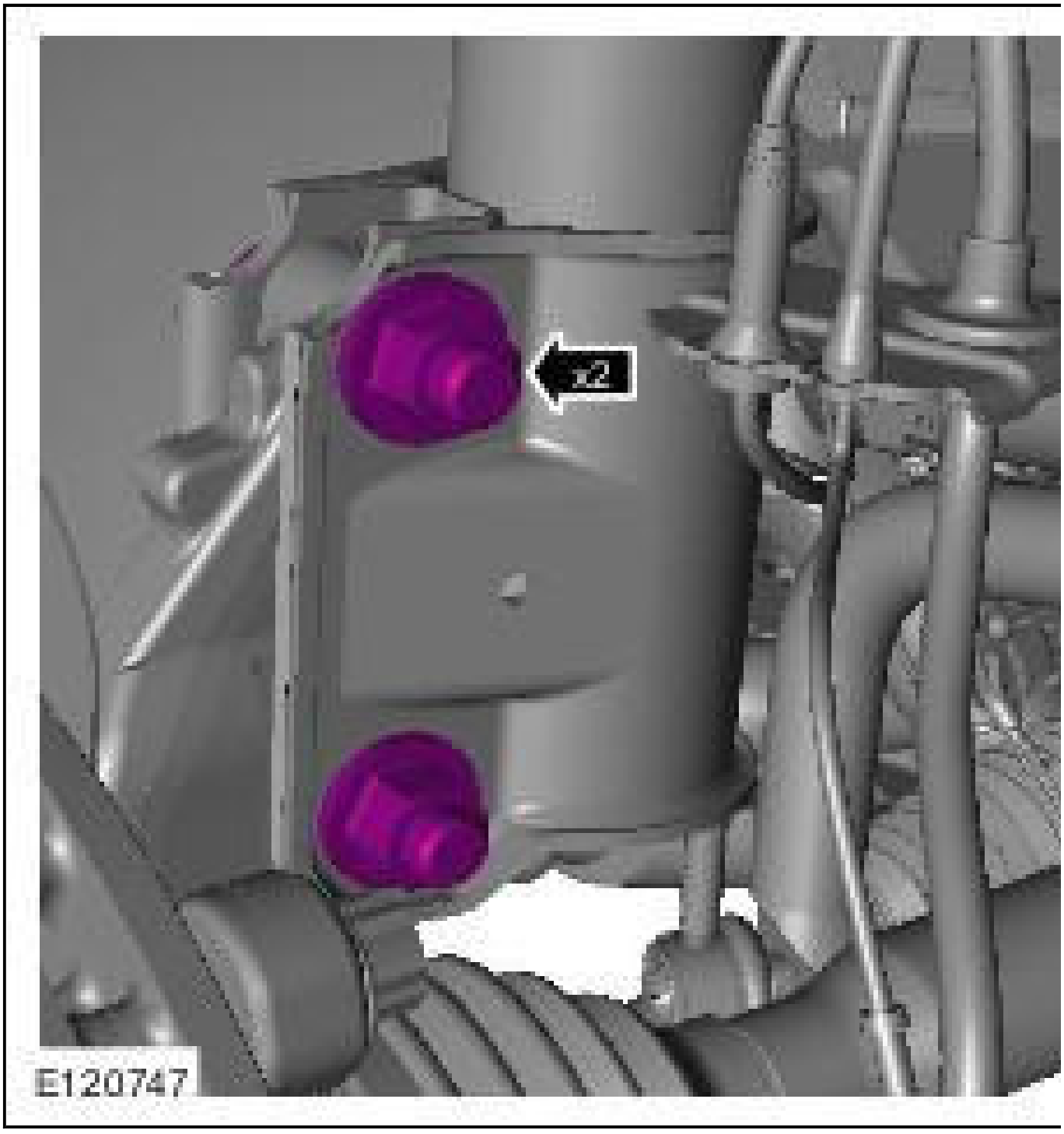

6. Torque: 8 Nm

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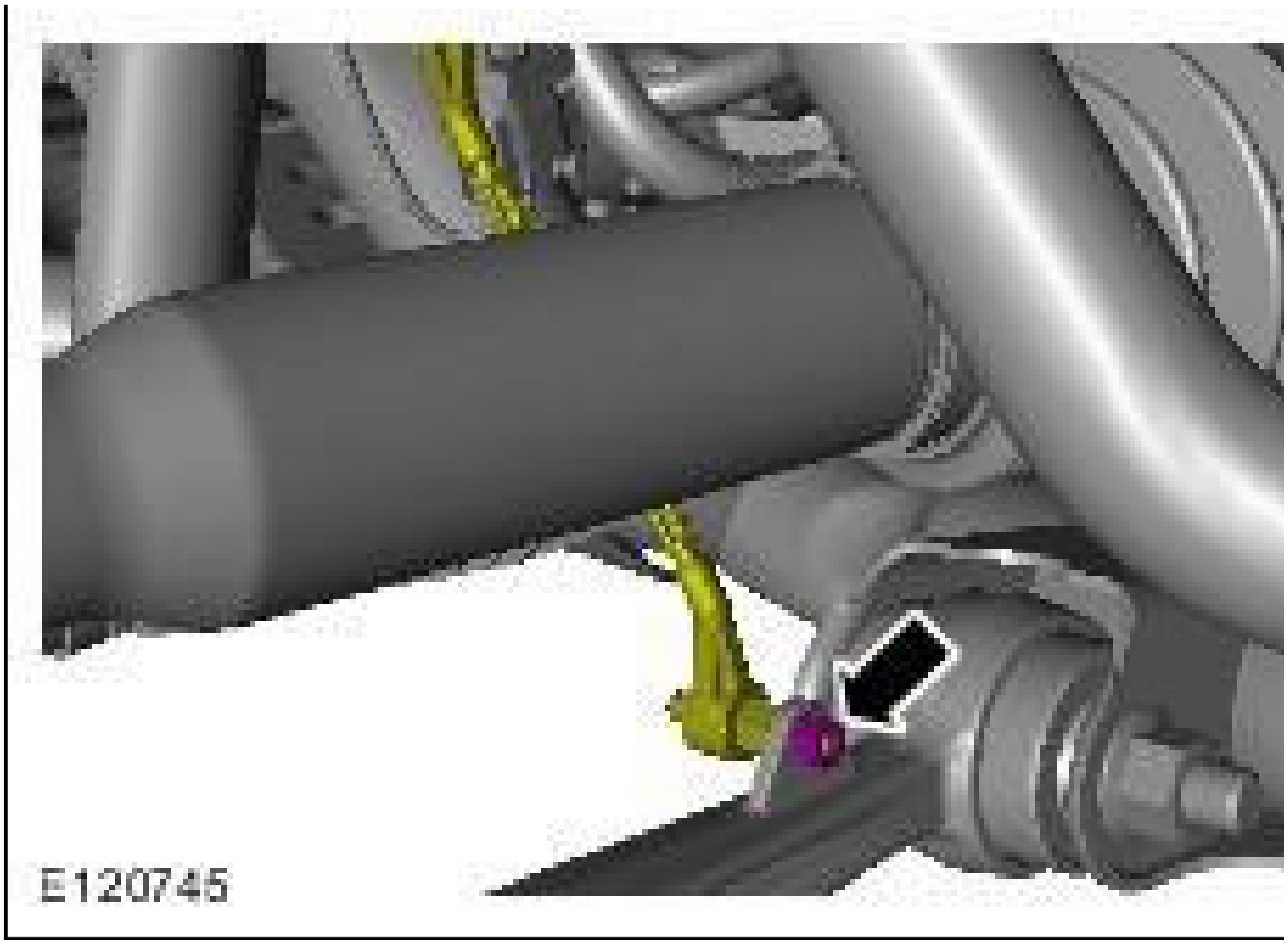

7. Torque: 80 Nm

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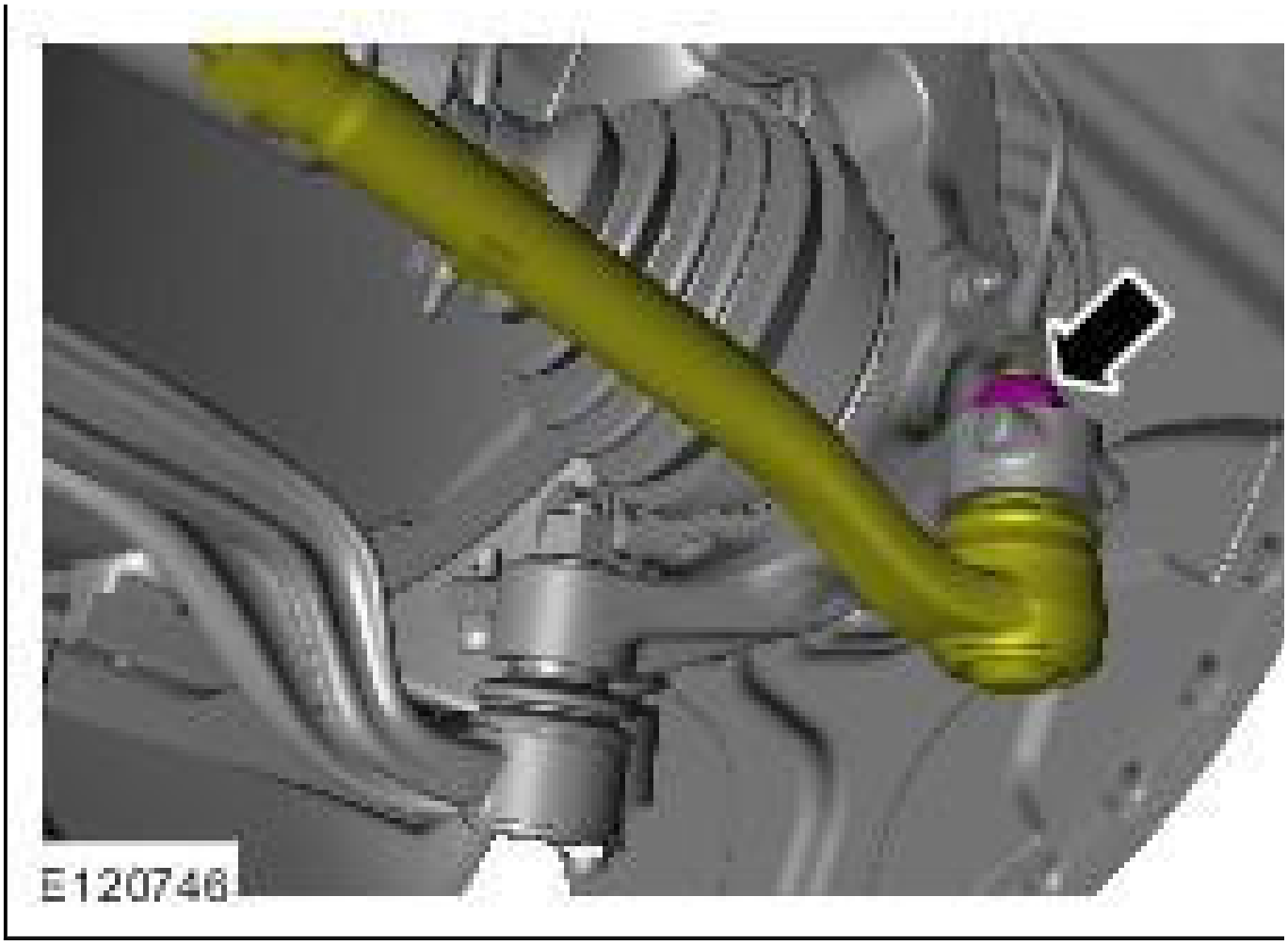

8. See figure

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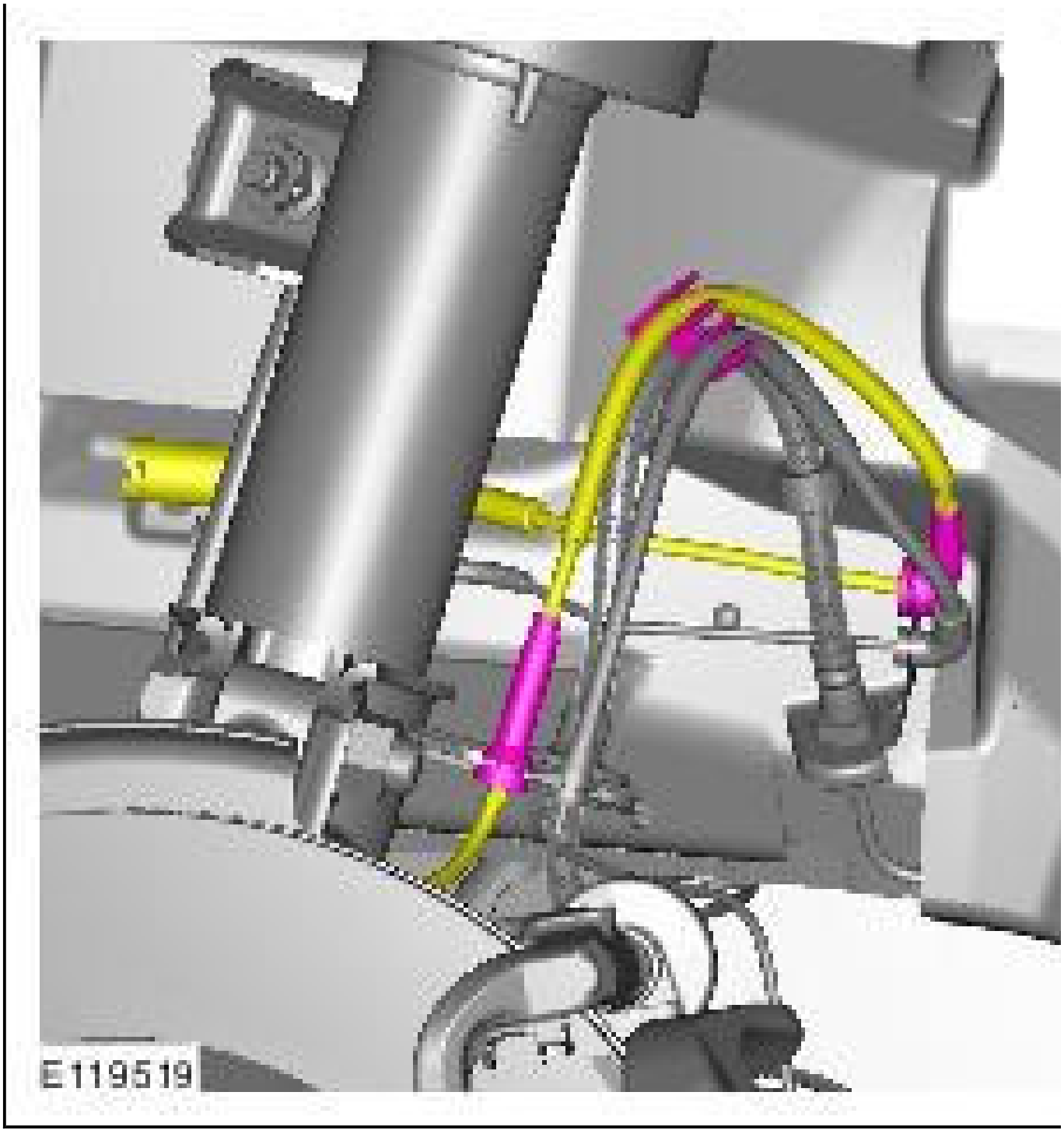

9. Torque: 275 Nm

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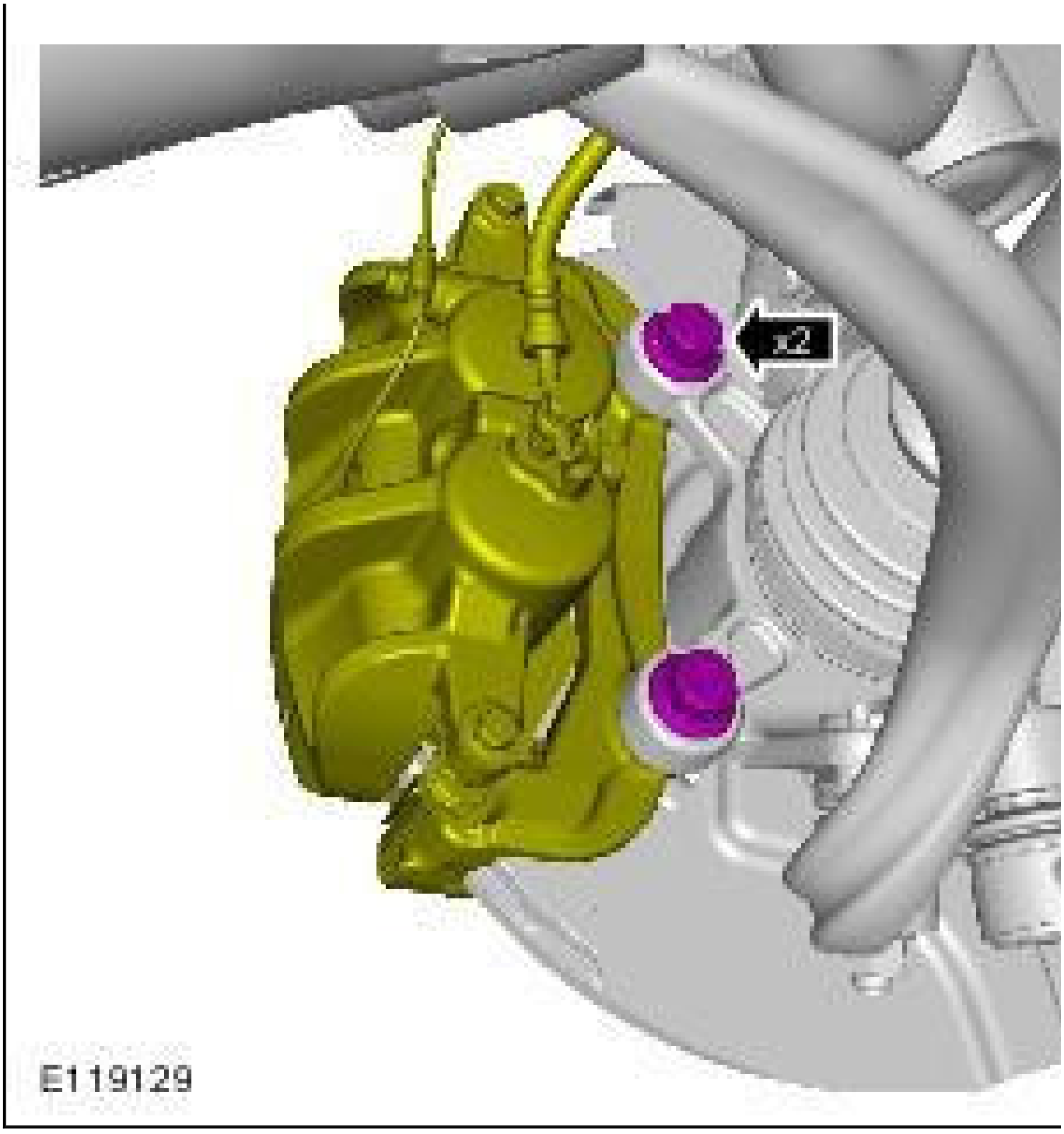

CAUTION: Always protect the cooling pack elements to prevent accidental damage.

NOTE: The thread is right handed.

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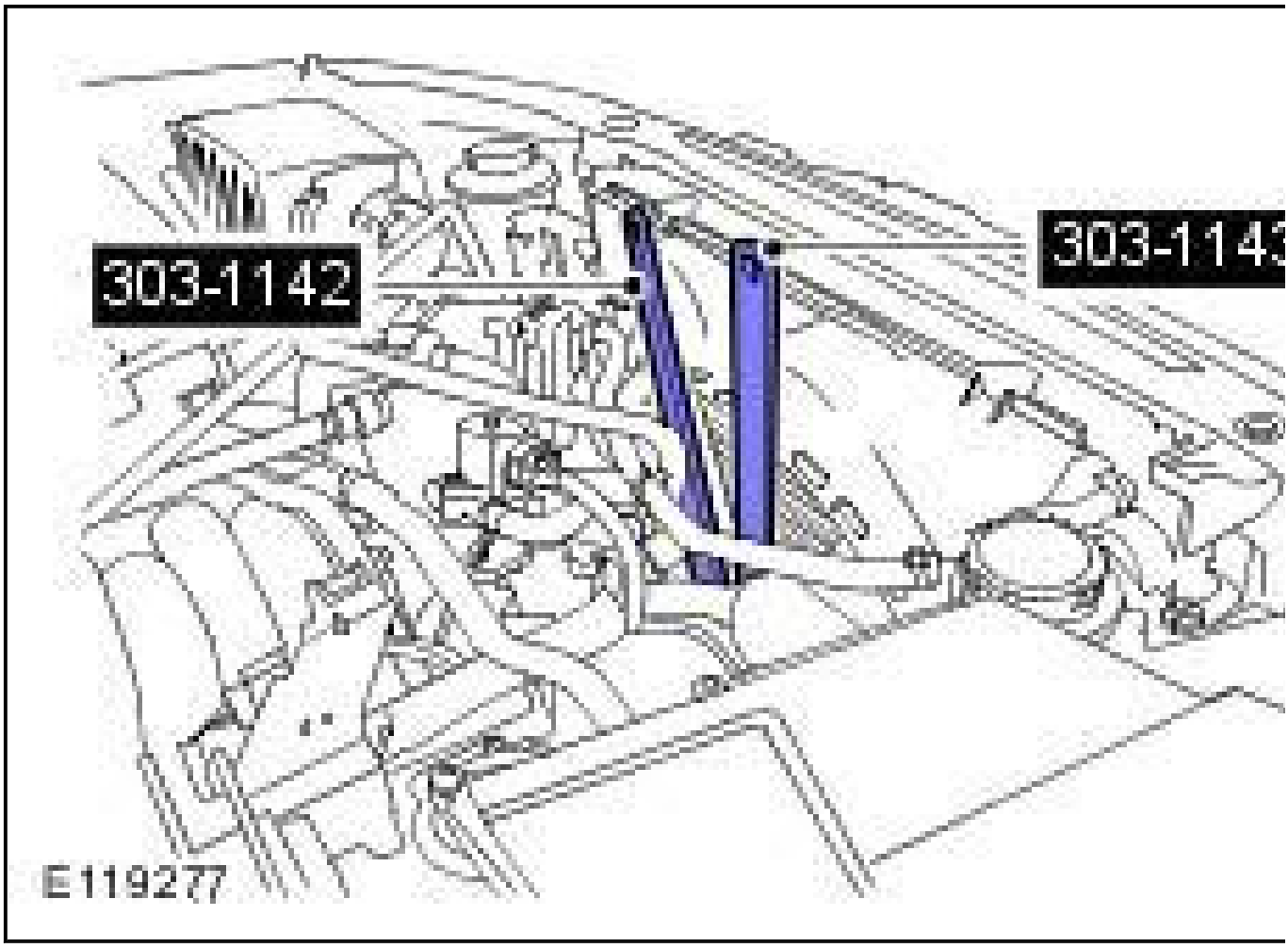
NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

10. Viscous Coupling Wrench (303-1142), refer to **SPECIAL TOOL(S)**

    Viscous Coupling Holding Tool (303-1143), refer to **SPECIAL TOOL(S)**

    Torque: 65 Nm



11. Refer to **Differential Draining and Filling** .
12. Refer to **AIR CLEANER OUTLET PIPE T-CONNECTOR**
13. Connect the battery ground cable. Refer to **Specifications** .

ENGINE MOUNT RH

SPECIAL TOOL(S)

	303-1142

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	Viscous Coupling Wrench
	303-1143 Viscous Coupling Holding Tool

REMOVAL

ALL VEHICLES

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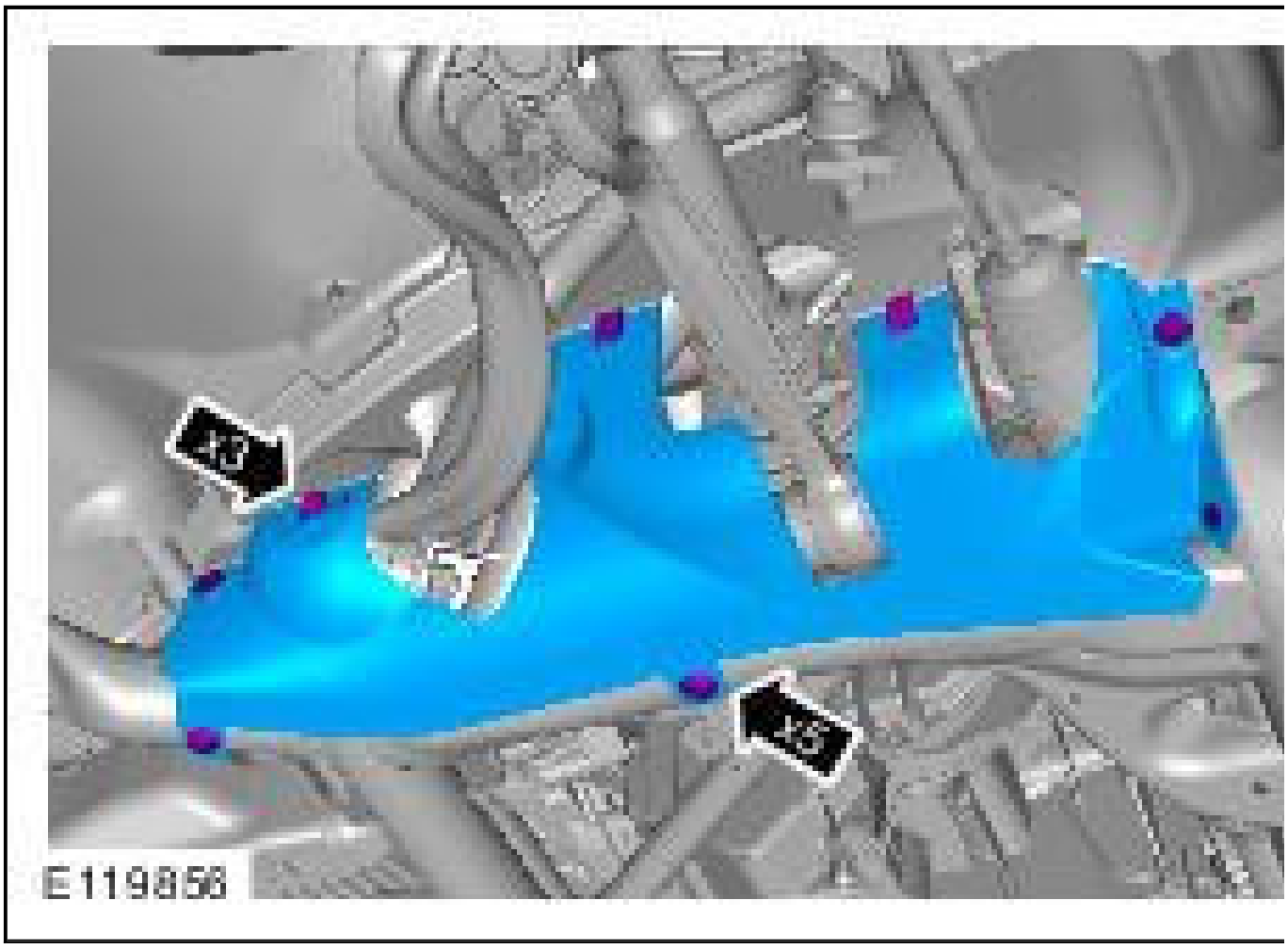
1. Disconnect the battery ground cable. Refer to **Specifications** .

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

2. Raise and support the vehicle.
3. Refer to **Exhaust System** .
4. Refer to **AIR CLEANER OUTLET PIPE T-CONNECTOR**
5. Refer to **Air Cleaner RH** .
6. See figure



7. See figure

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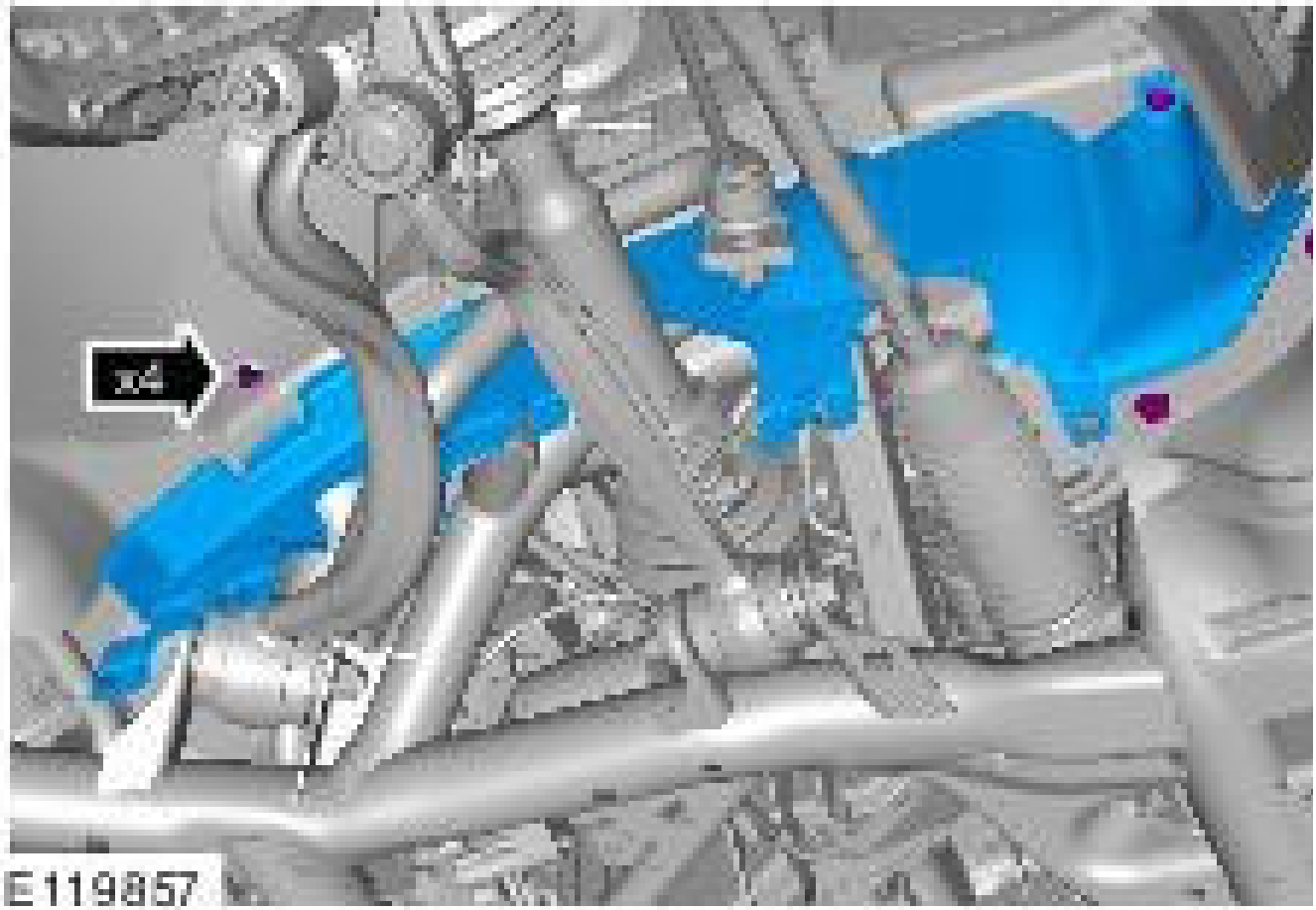

RIGHT-HAND DRIVE VEHICLES

1. See figure

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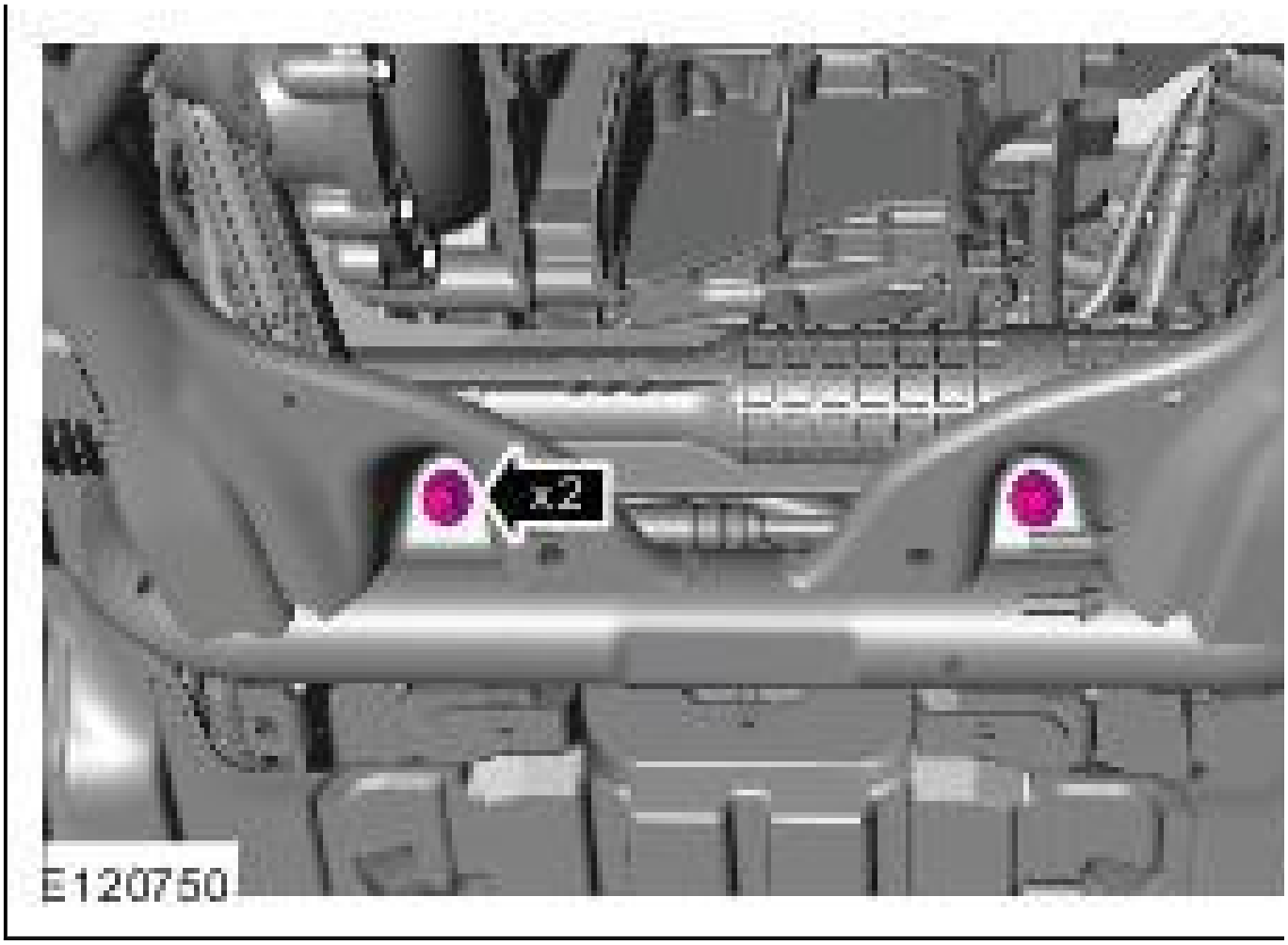

CAUTION: LH illustration shown, RH is similar.

2. See figure

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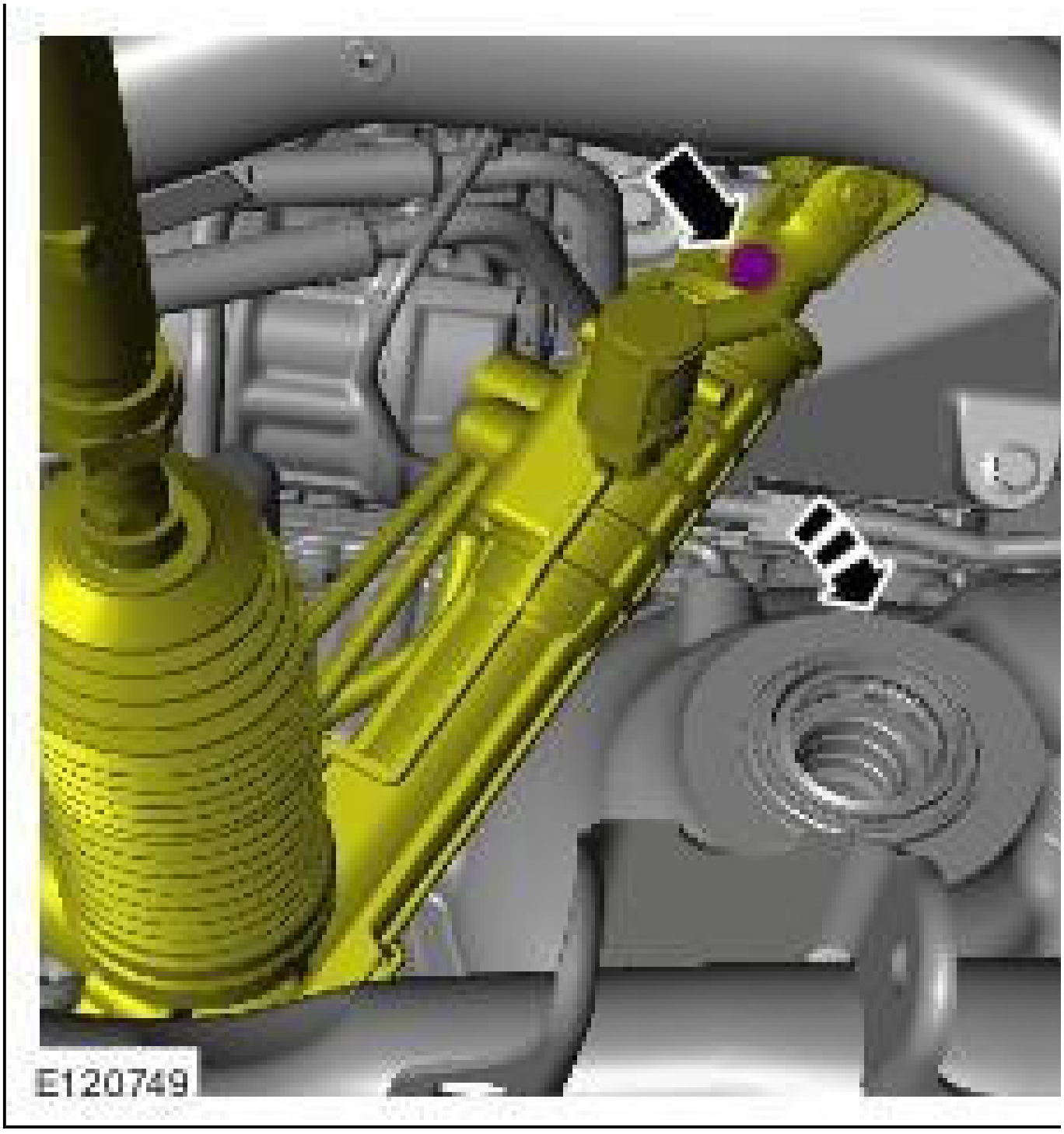

CAUTION: Do not turn the steering wheel with the steering column lower shaft disconnected as damage to the clockspring and steering wheel switches may occur.

CAUTION: LH illustration shown, RH is similar.

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- Note the fitted position.
- Align the steering wheel to straight ahead.
- Remove and discard the Torx bolt.

3. See figure

CAUTION: LH illustration shown, RH is similar.

ALL VEHICLES

1. See figure

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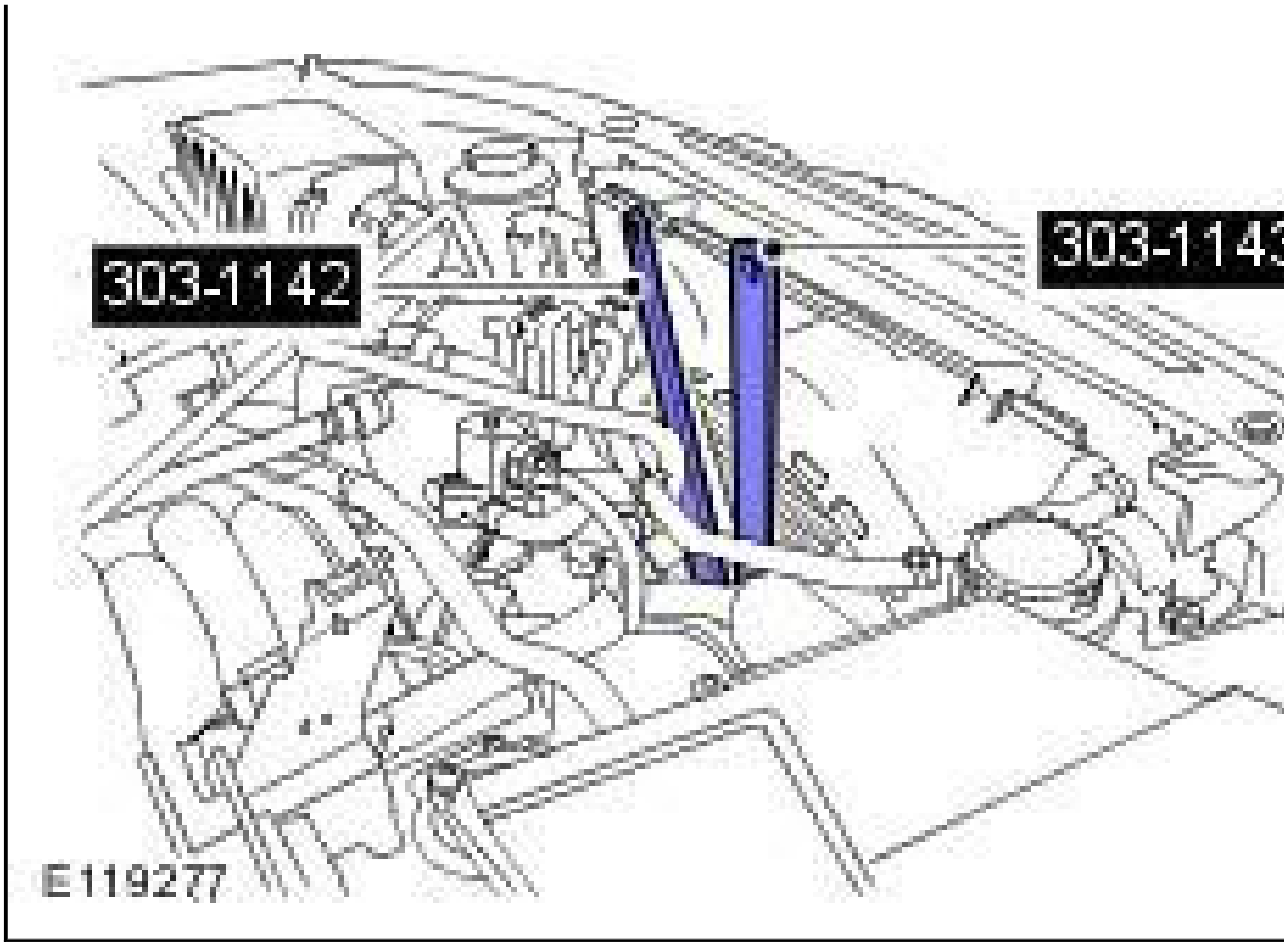

CAUTION: Always protect the cooling pack elements to prevent accidental damage.

NOTE: The thread is right handed.

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

Viscous Coupling Wrench (303-1142), refer to **SPECIAL TOOL(S)**

Viscous Coupling Holding Tool (303-1143), refer to **SPECIAL TOOL(S)**

2. See figure

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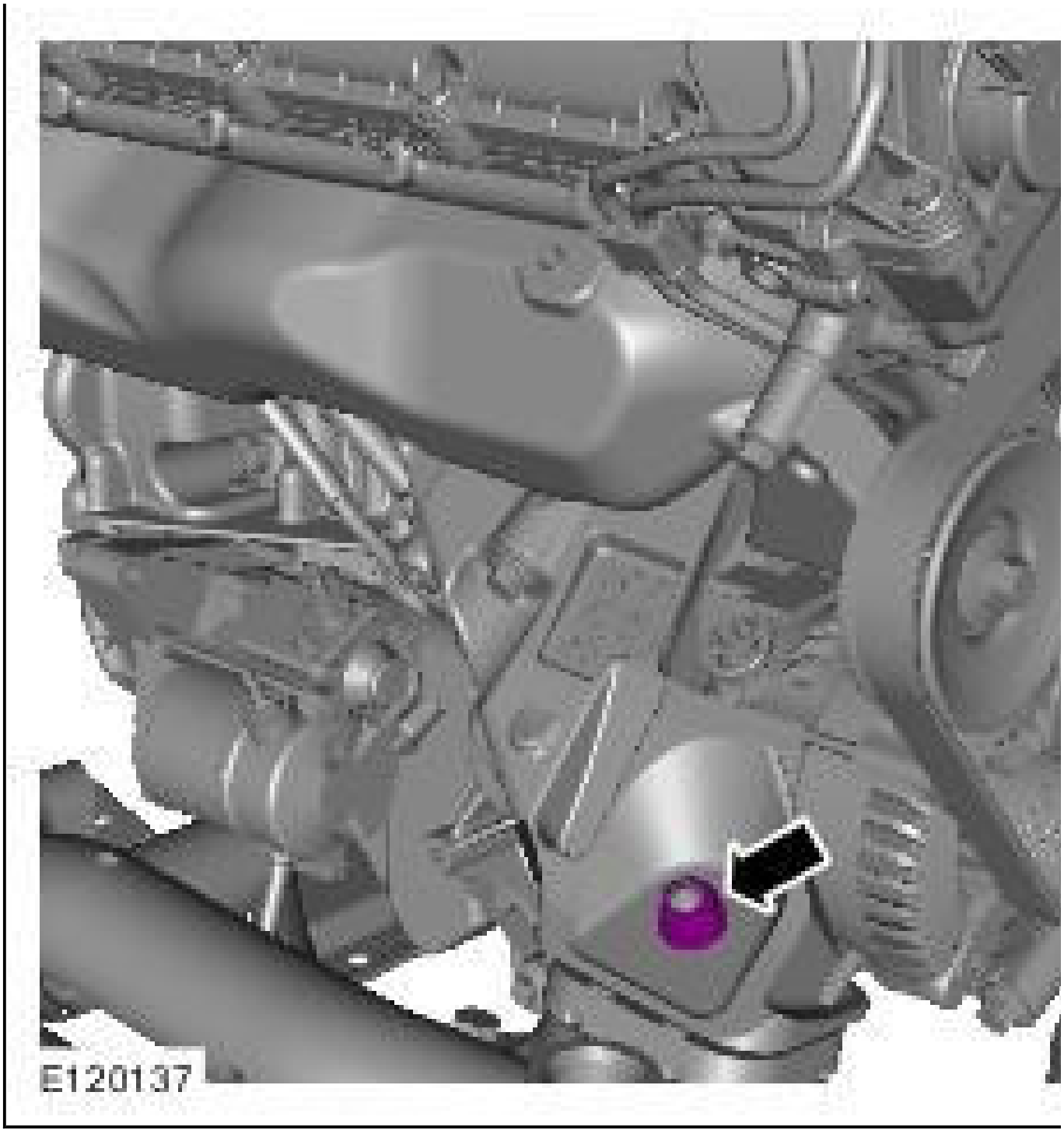

CAUTION: Use a wooden block to protect the oil pan when supporting the engine.

3. Using a suitable hydraulic jack, raise and support the engine.
4. See figure

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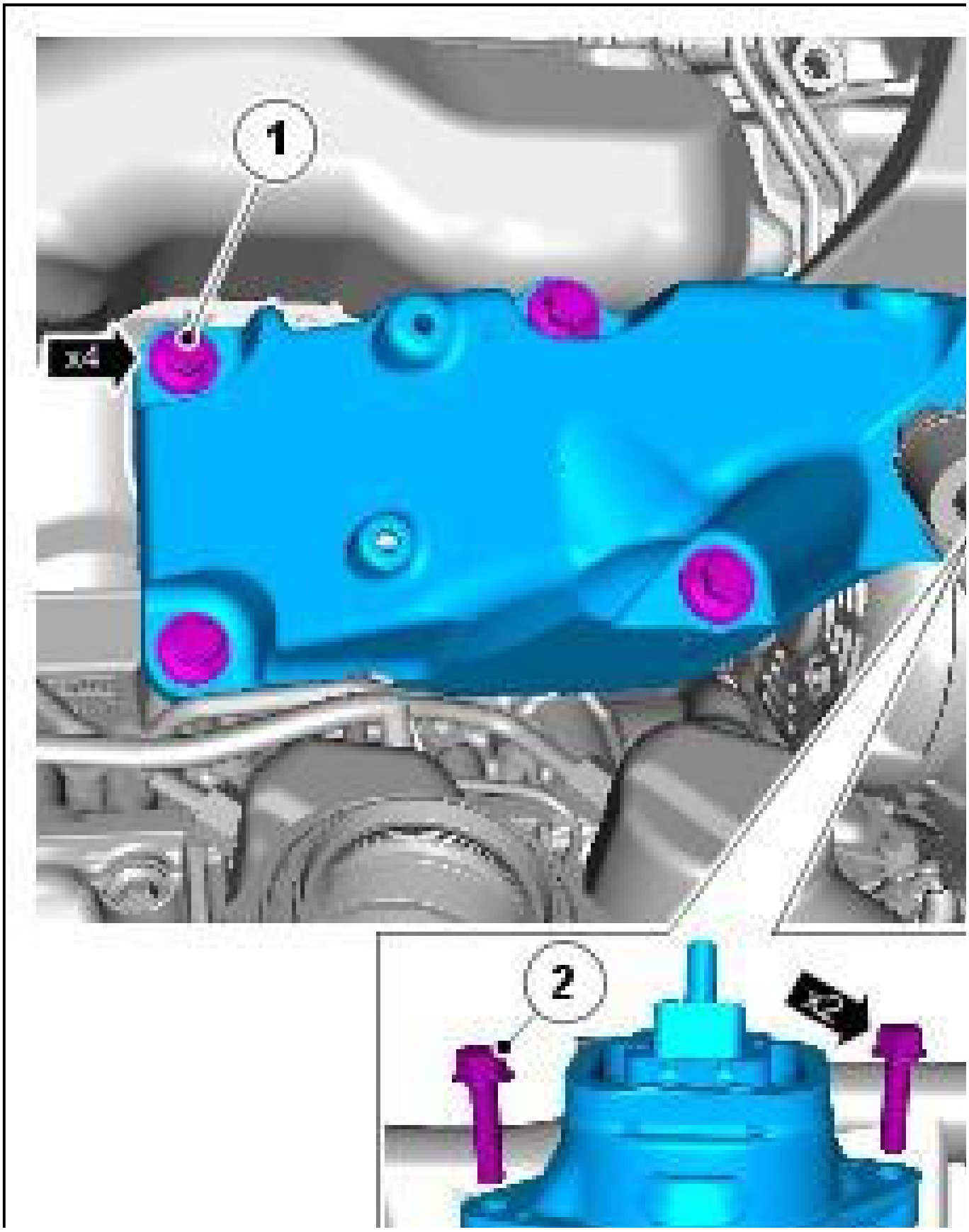

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INSTALLATION

ALL VEHICLES

1. Torques:

   1: 45 Nm

   1: 60°

   2: 56 Nm

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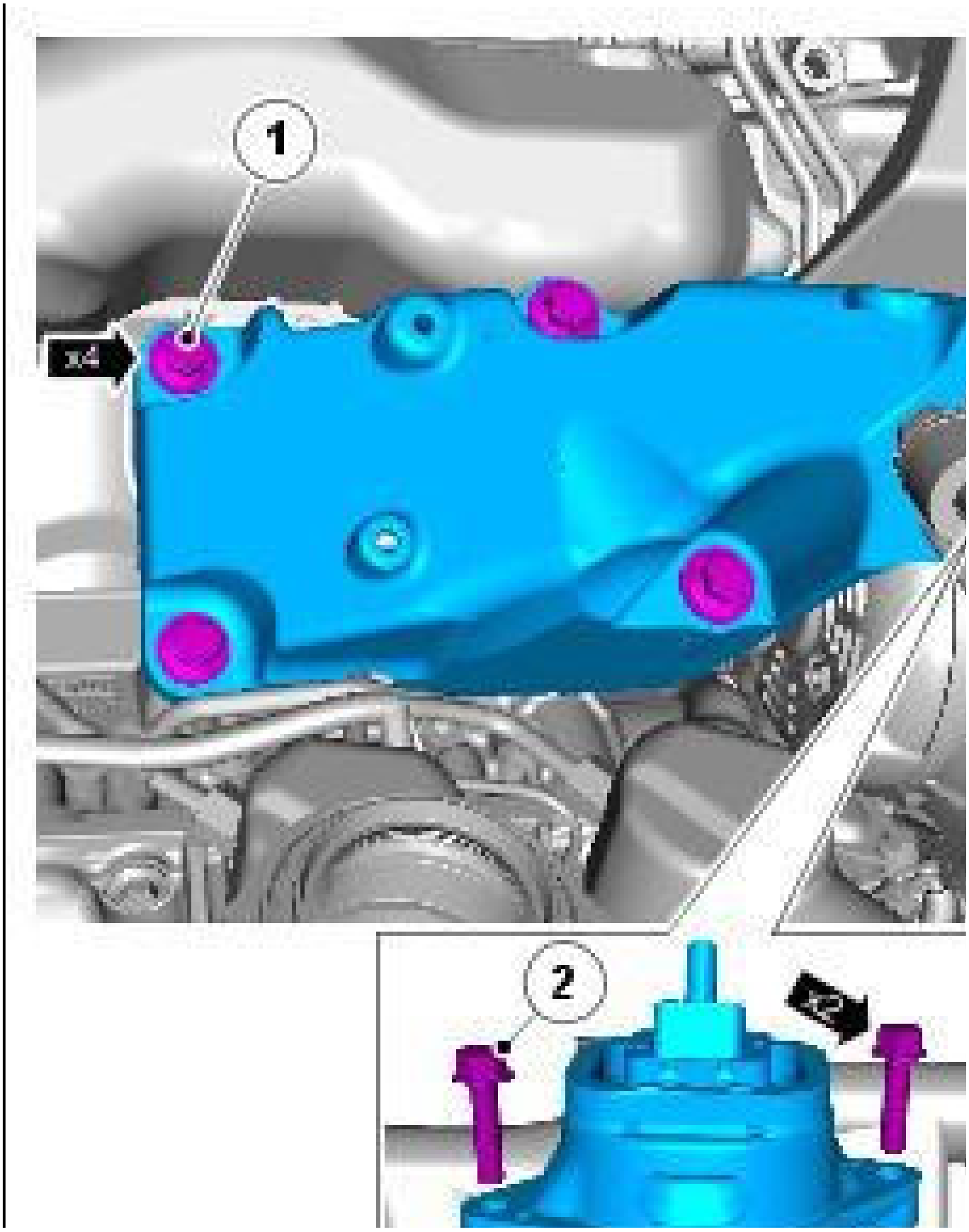

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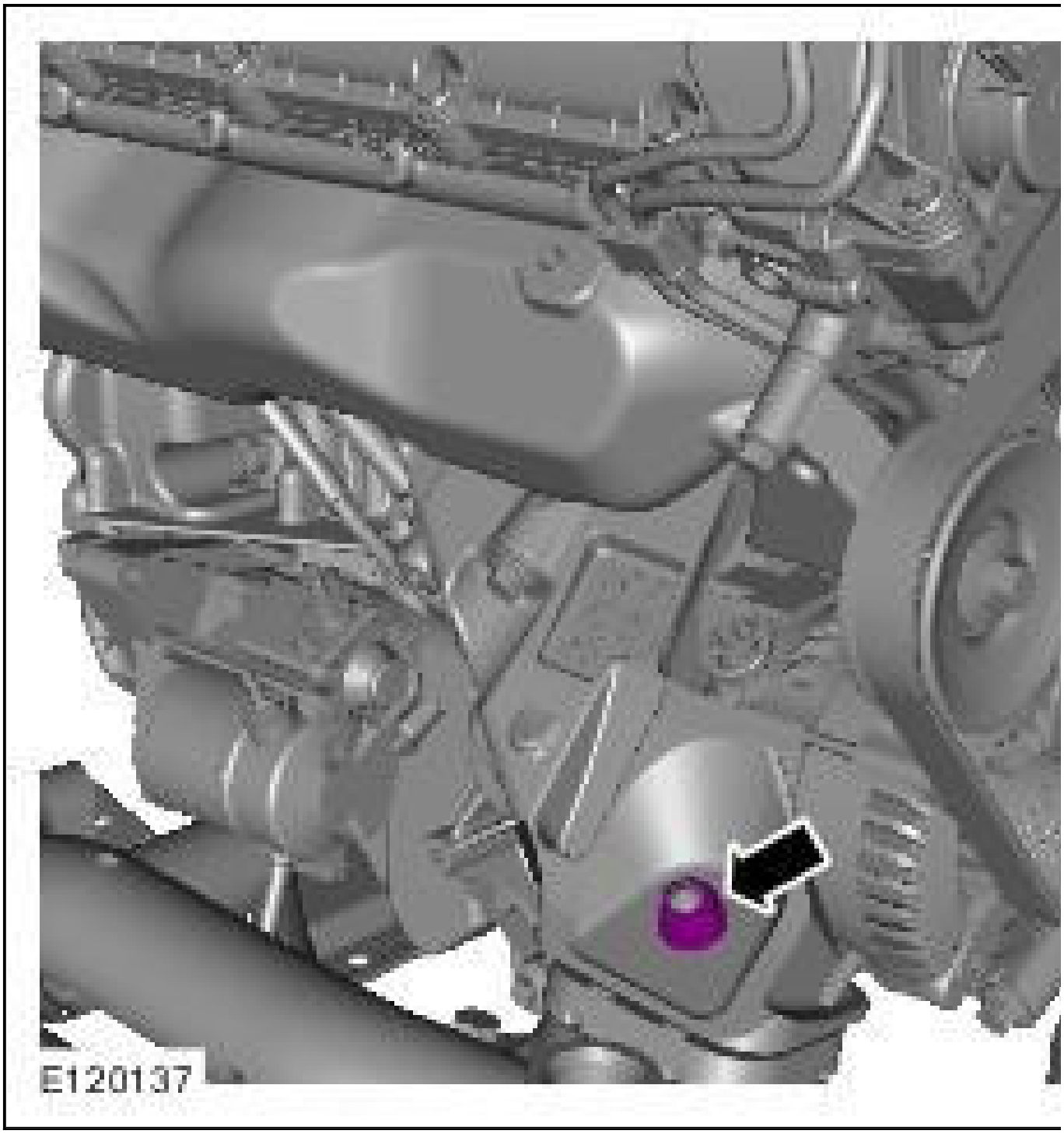
2. See figure



CAUTION: Always protect the cooling pack elements to prevent accidental damage.

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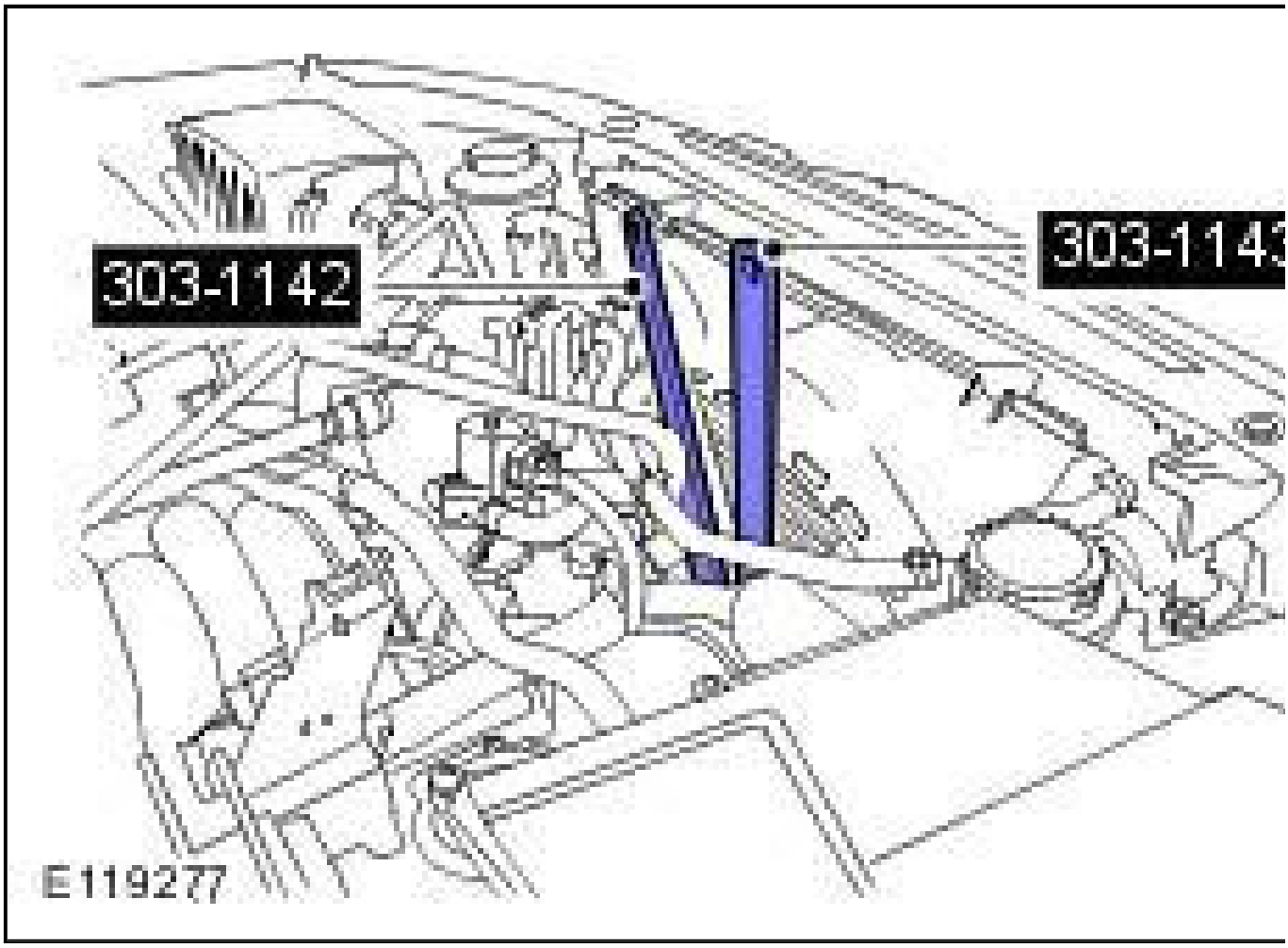
NOTE: **The thread is right handed.**

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

3. Viscous Coupling Wrench (303-1142), refer to **SPECIAL TOOL(S)**

   Viscous Coupling Holding Tool (303-1143), refer to **SPECIAL TOOL(S)**

   Torque: 65 Nm



RIGHT-HAND DRIVE VEHICLES

1. Torque: 100 Nm

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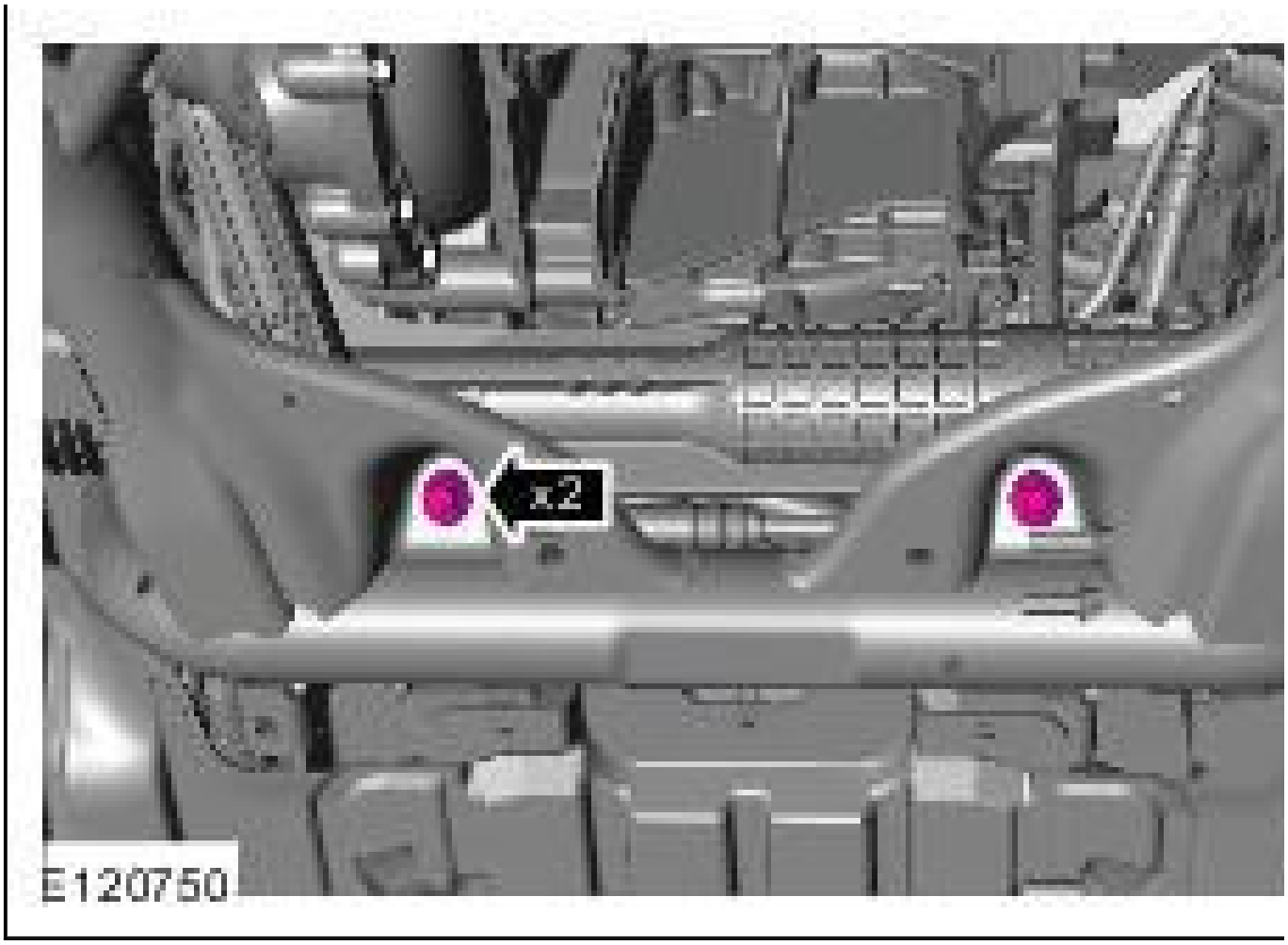

NOTE: **Some variation in the illustrations may occur, but the essential information is always correct.**

2. See figure

 © 2011 Mitchell Repair Information Company, LLC.

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

3. See figure

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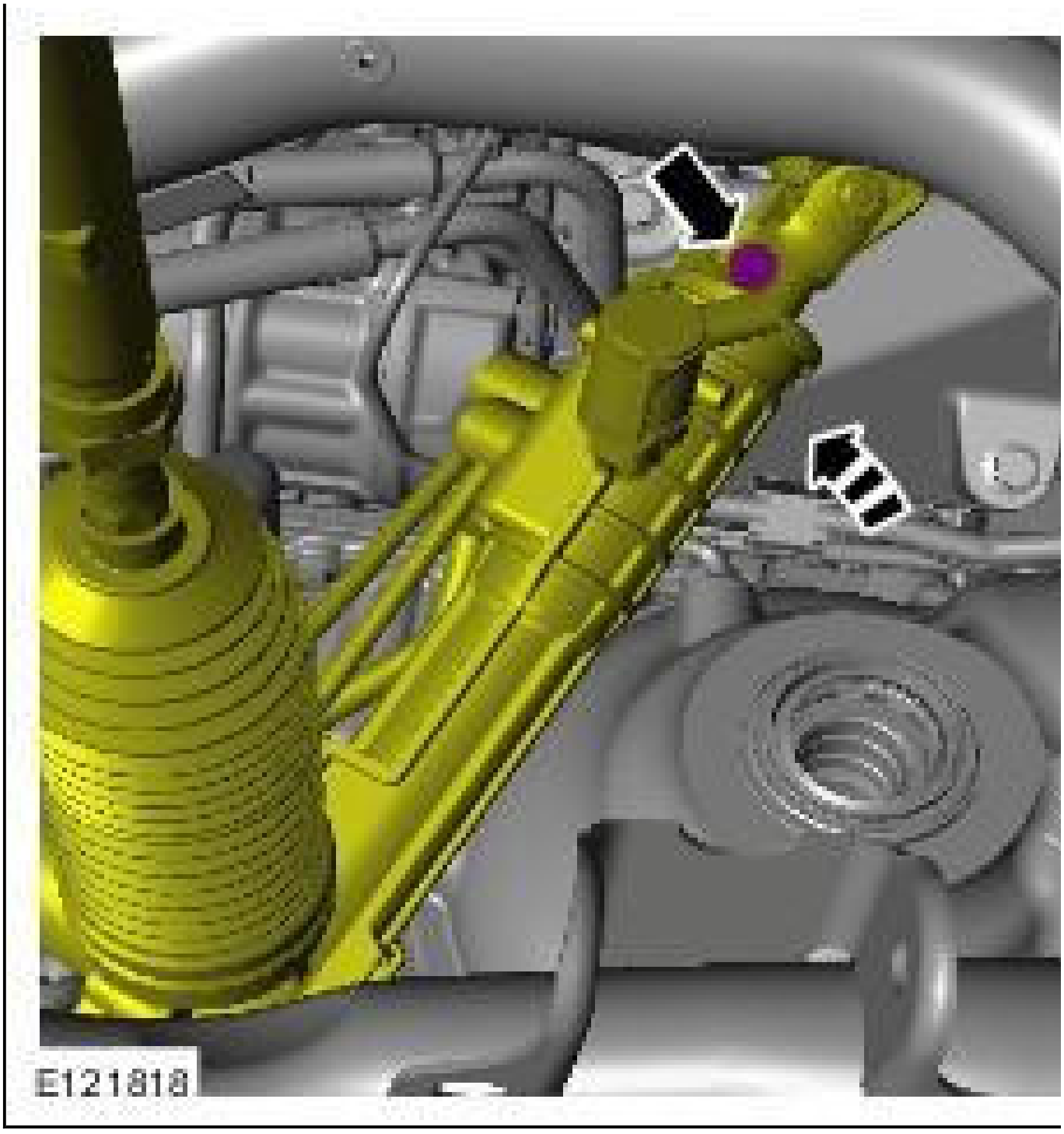

CAUTION: Do not turn the steering wheel with the steering column lower shaft disconnected as damage to the clockspring and steering wheel switches may occur.

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

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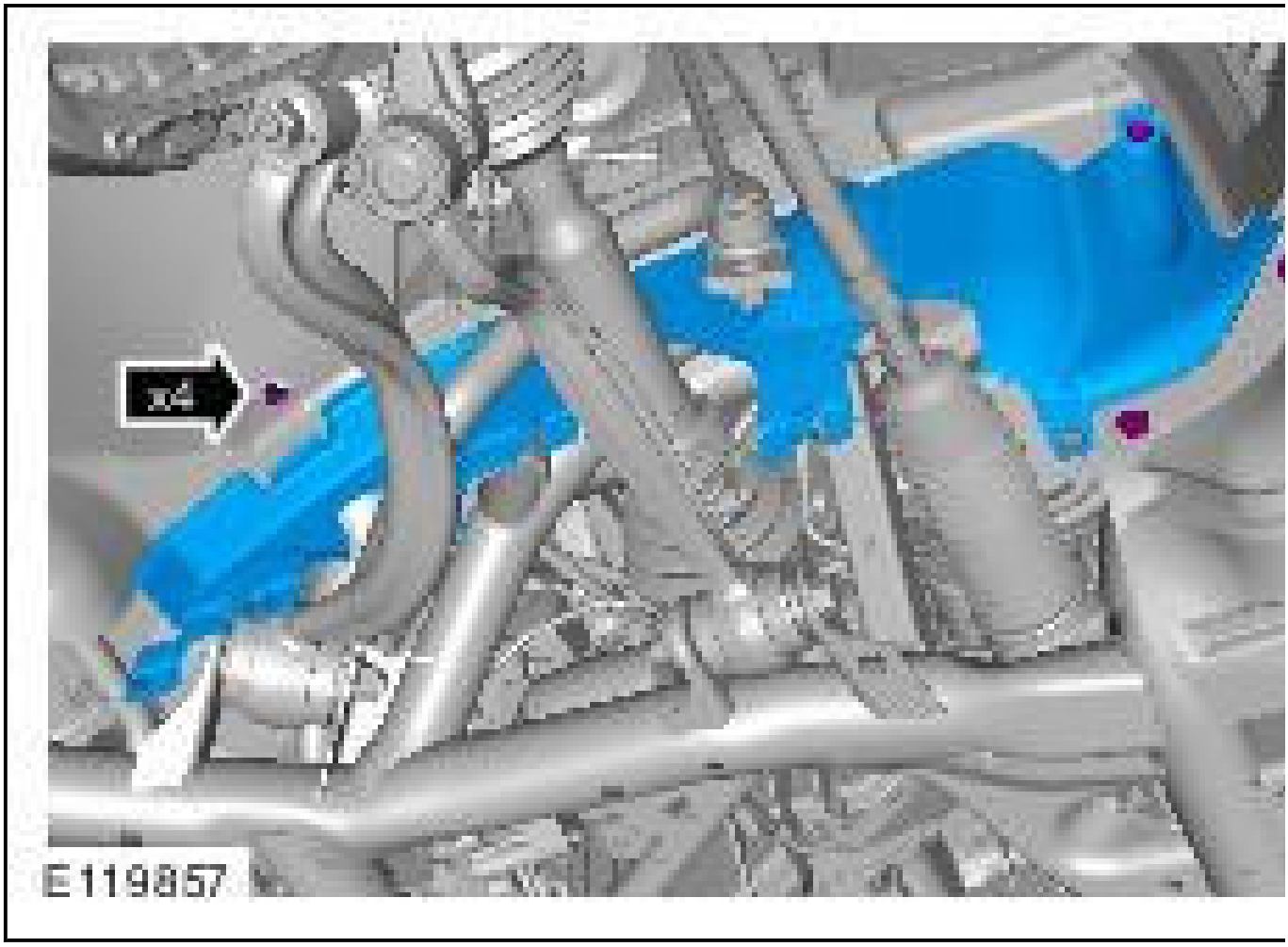
- Align the steering wheel to straight ahead.
- Return the steering column to its original position.

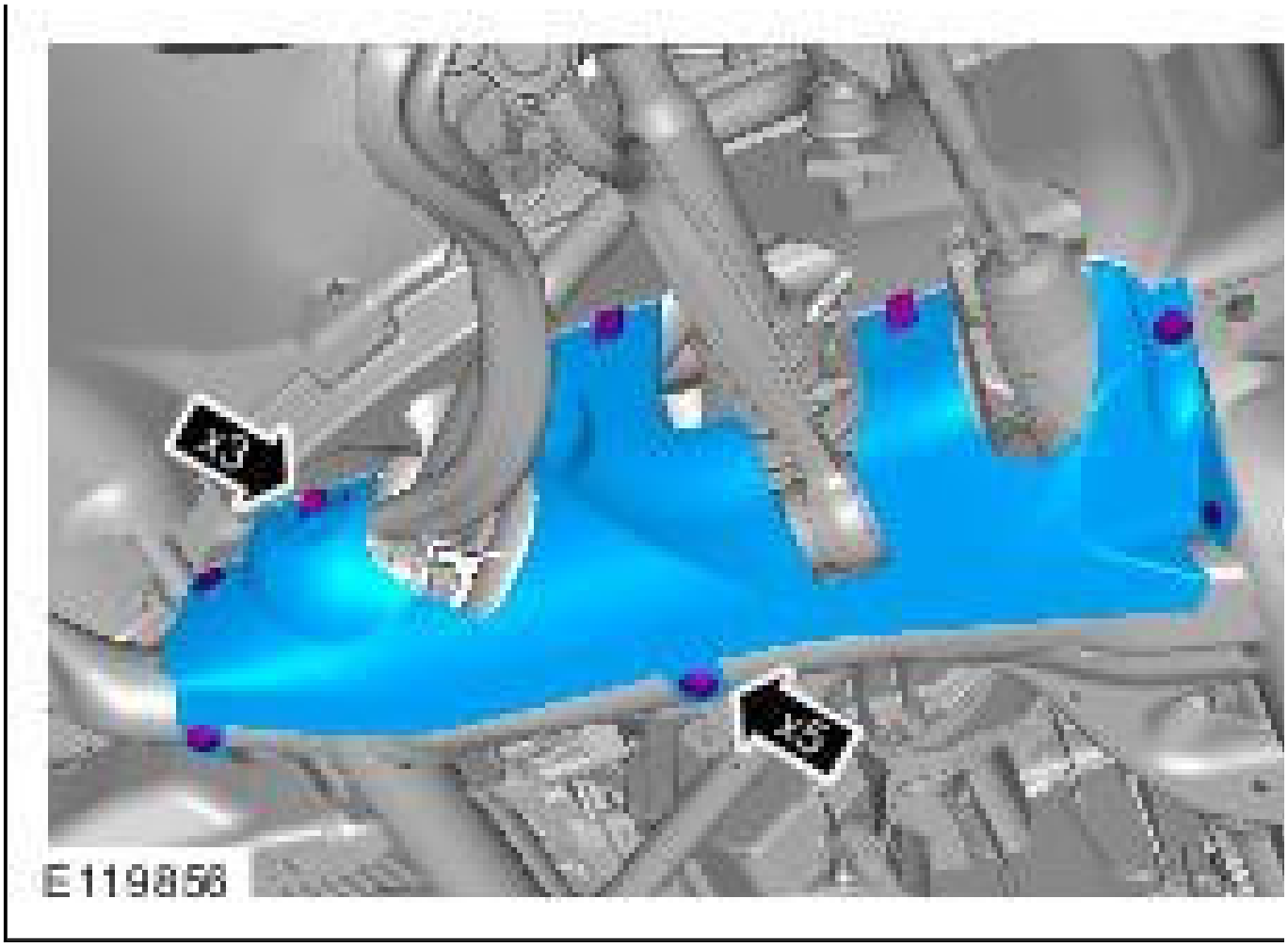
ALL VEHICLES

1. See figure



2. See figure

 © 2011 Mitchell Repair Information Company, LLC.



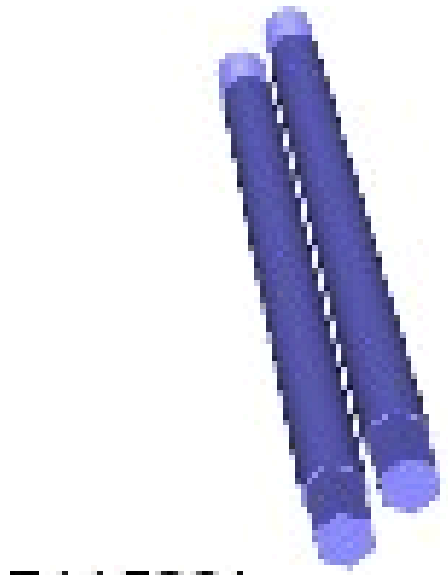
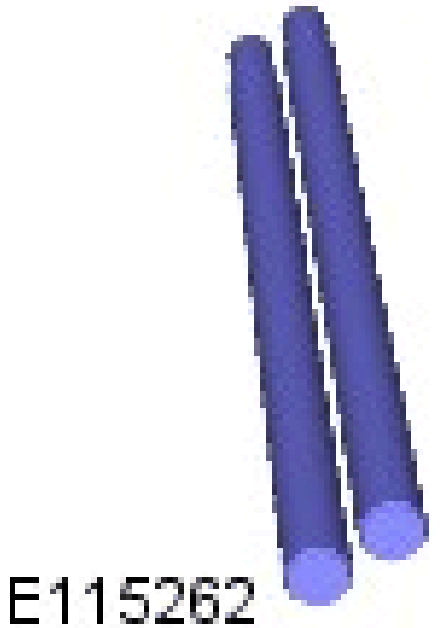
3. Refer to **Air Cleaner RH** .
4. Refer to **AIR CLEANER OUTLET PIPE T-CONNECTOR**
5. Refer to **Exhaust System** .
6. Connect the battery ground cable. Refer to **Specifications** .

EXHAUST MANIFOLD LH

SPECIAL TOOL(S)

	303-1444-01 Exhaust Manifold Installation Guide Pins - Threaded

 © 2011 Mitchell Repair Information Company, LLC.

 E115261	
 E115262	303-1444-02 Exhaust Manifold Installation Guide Pins - Unthreaded

REMOVAL

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

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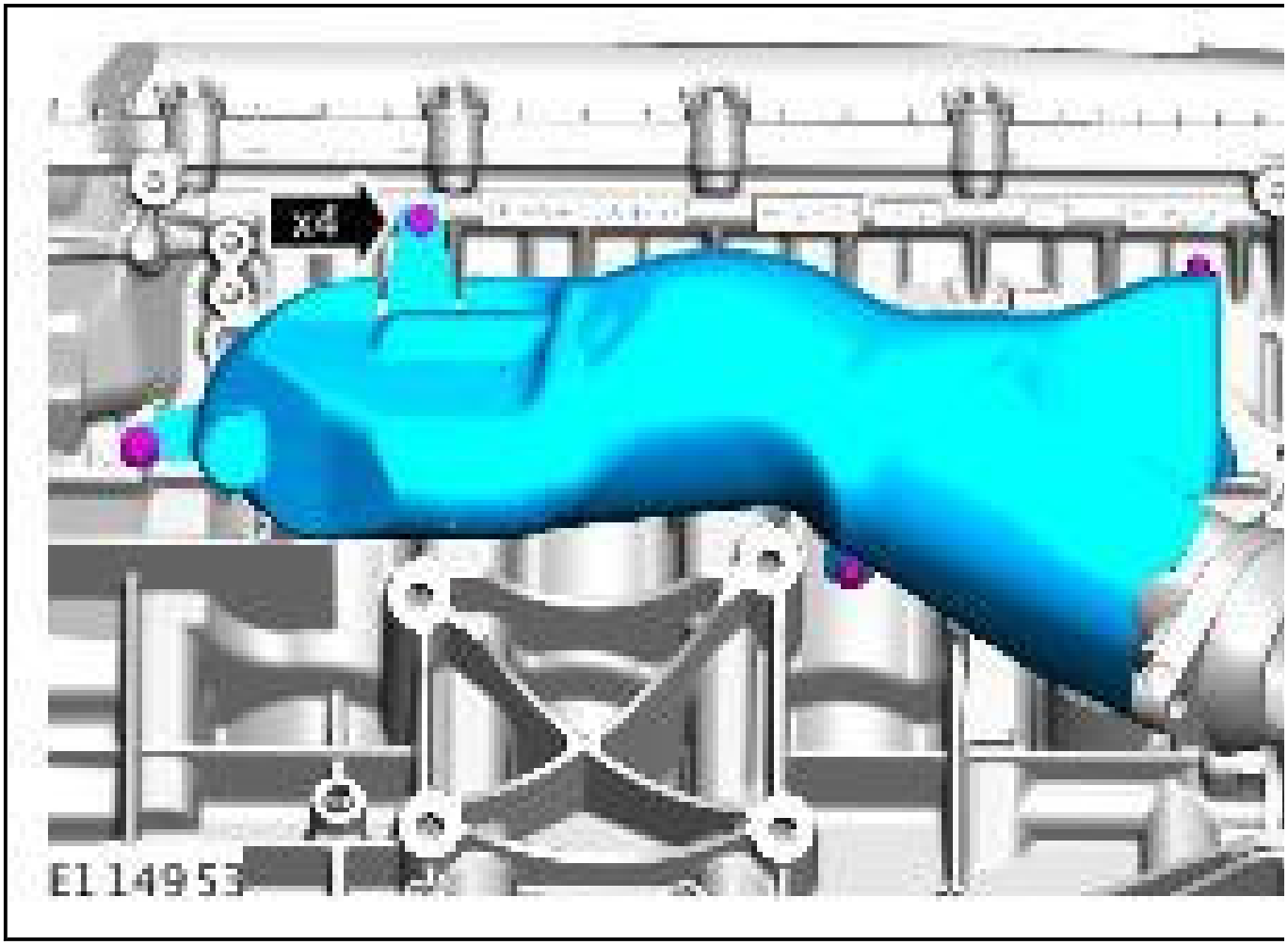
NOTE: **Some variation in the illustrations may occur, but the essential information is always correct.**

1. Disconnect the battery ground cable. Refer to **Specifications** .

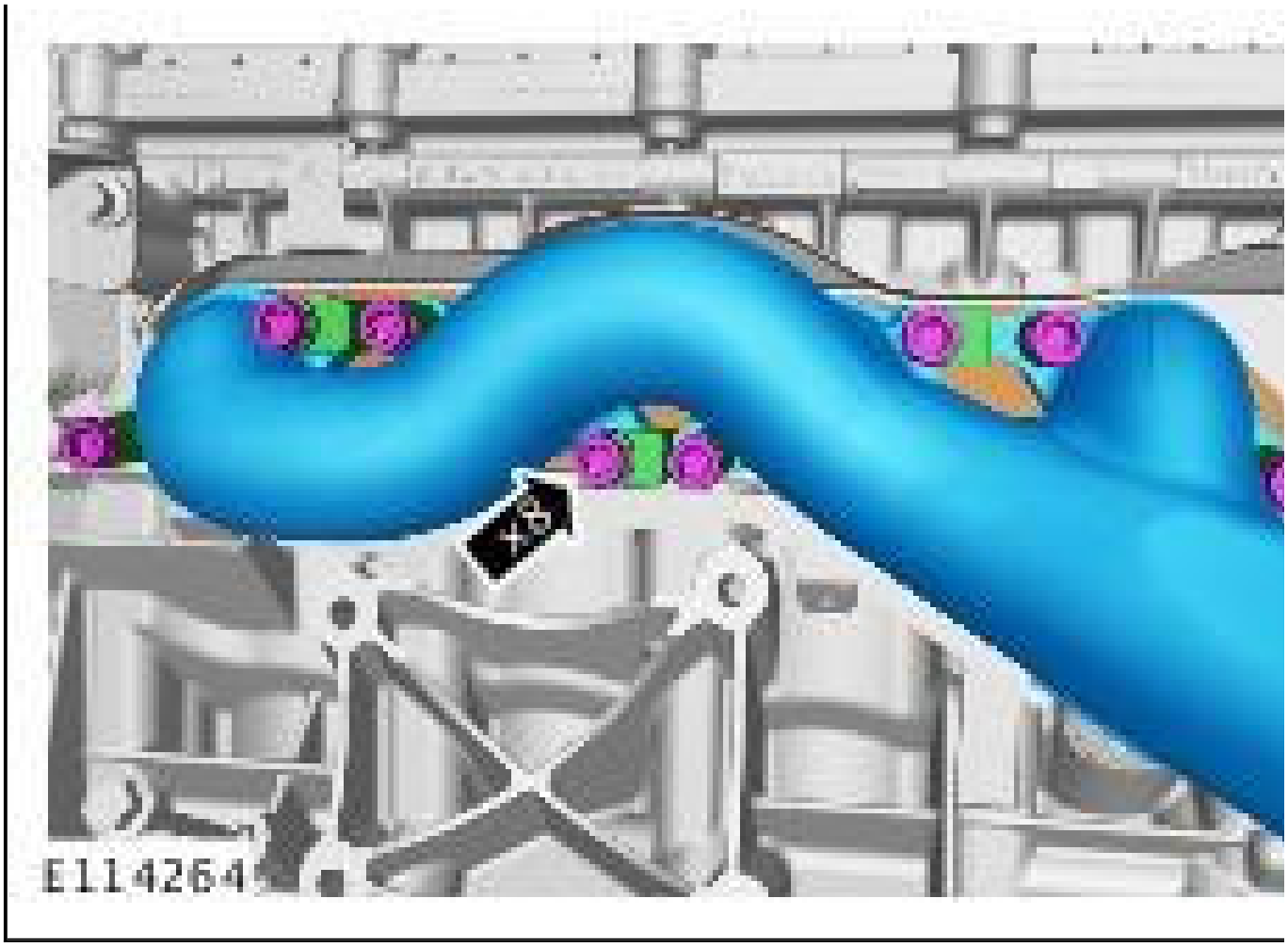
WARNING: **Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.**

2. Raise and support the vehicle.
3. Refer to **Power Steering Pump - 5.0L** .
4. Refer to **Exhaust System** .
5. See figure



6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



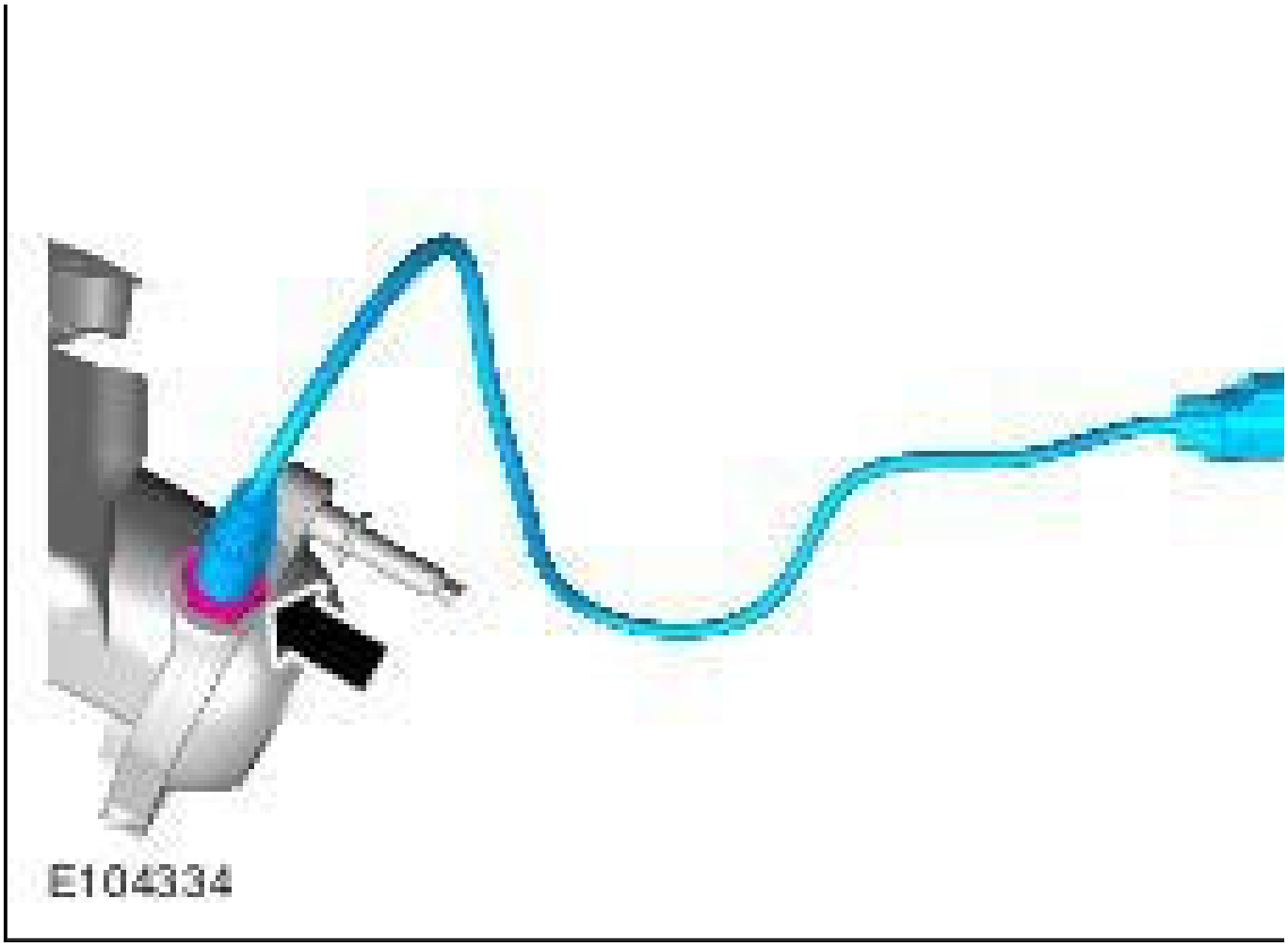
CAUTION: Discard the bolts.

NOTE: Discard the gasket.

NOTE: Make sure that the position of the spacers is noted before removal of the manifold.

7. See figure

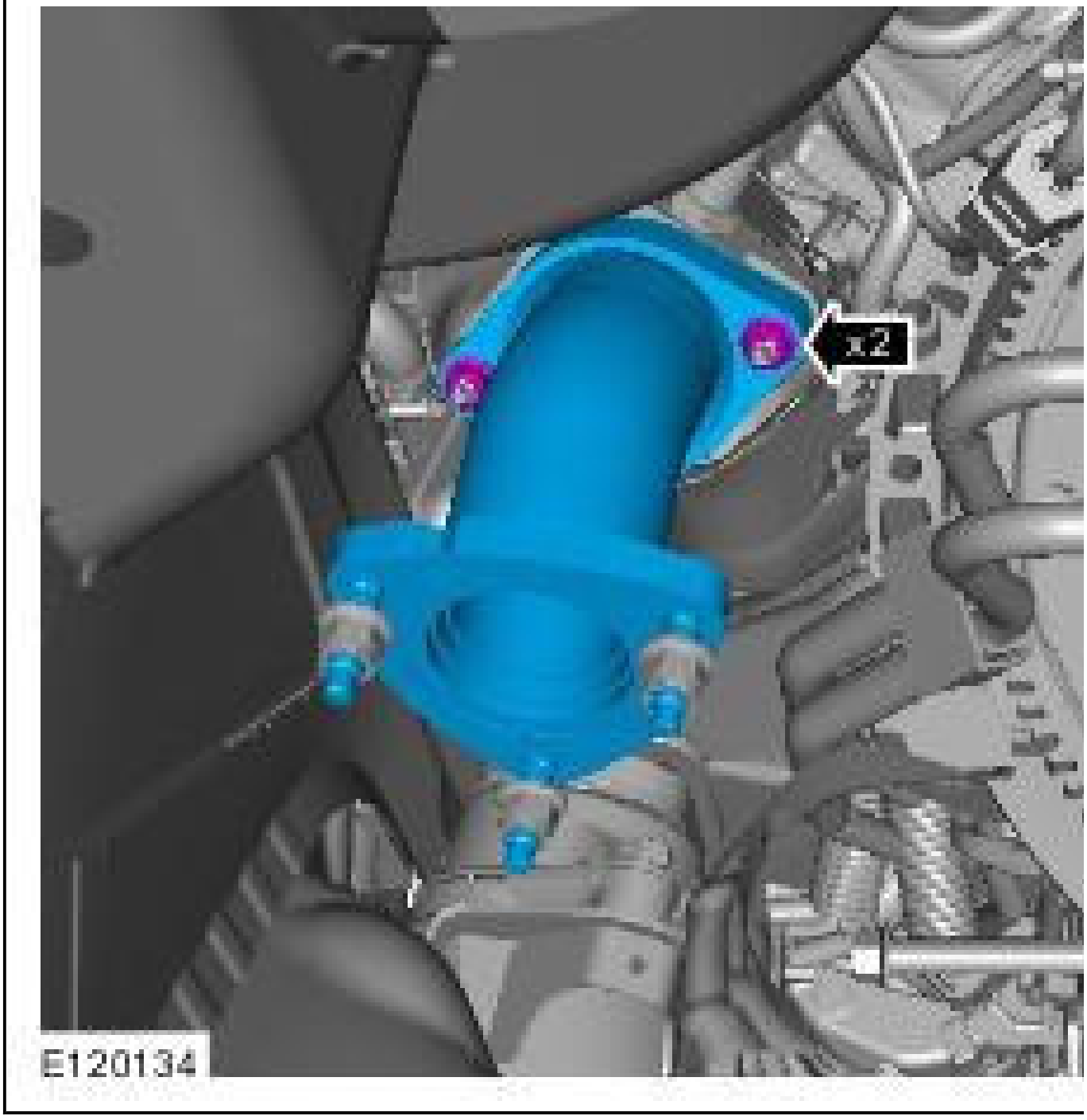
 © 2011 Mitchell Repair Information Company, LLC.



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

8. See figure

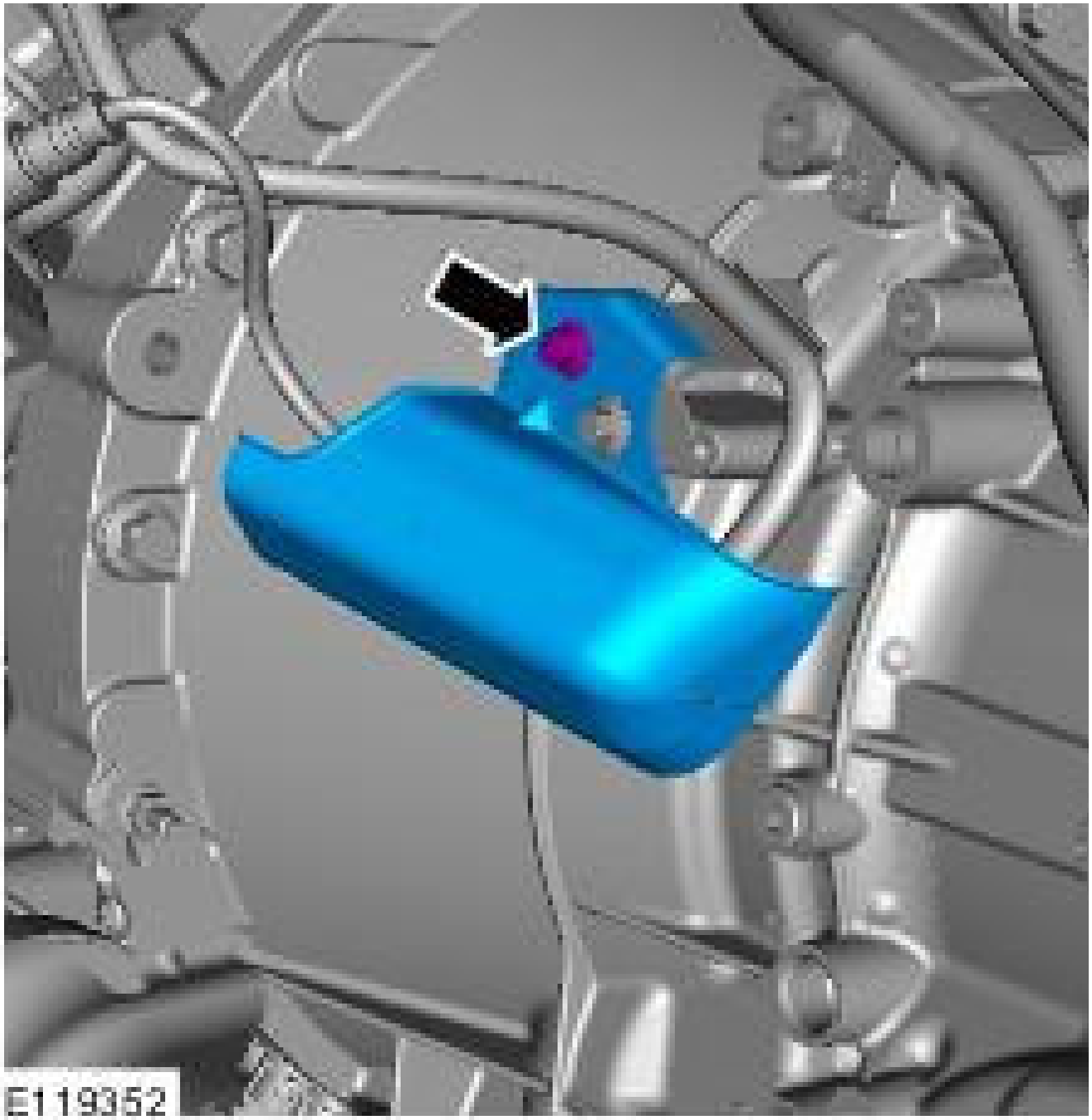
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Remove and discard the gasket.

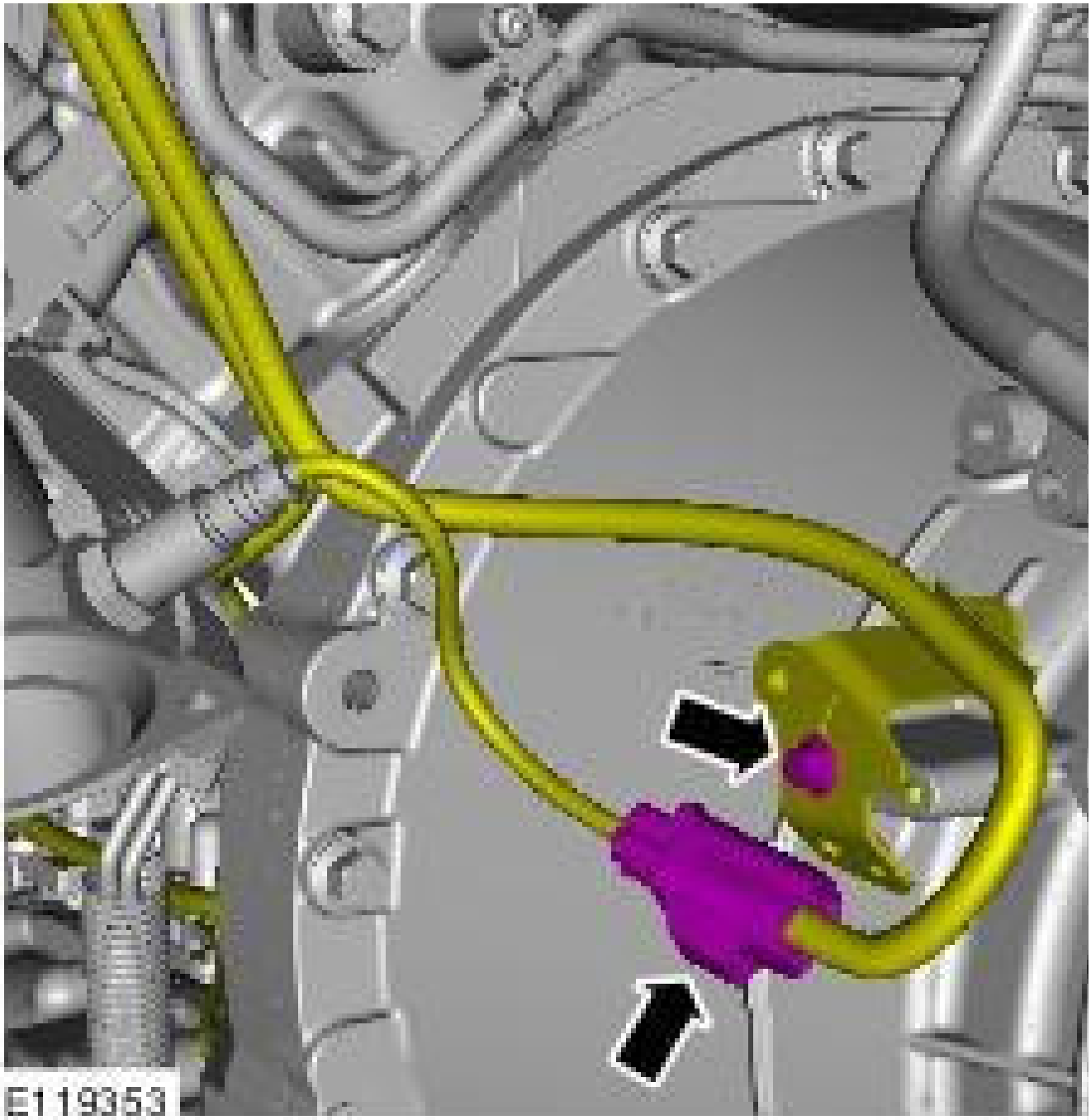
9. See figure

 © 2011 Mitchell Repair Information Company, LLC.



10. See figure

 © 2011 Mitchell Repair Information Company, LLC.



INSTALLATION

1. Torque: 45 Nm

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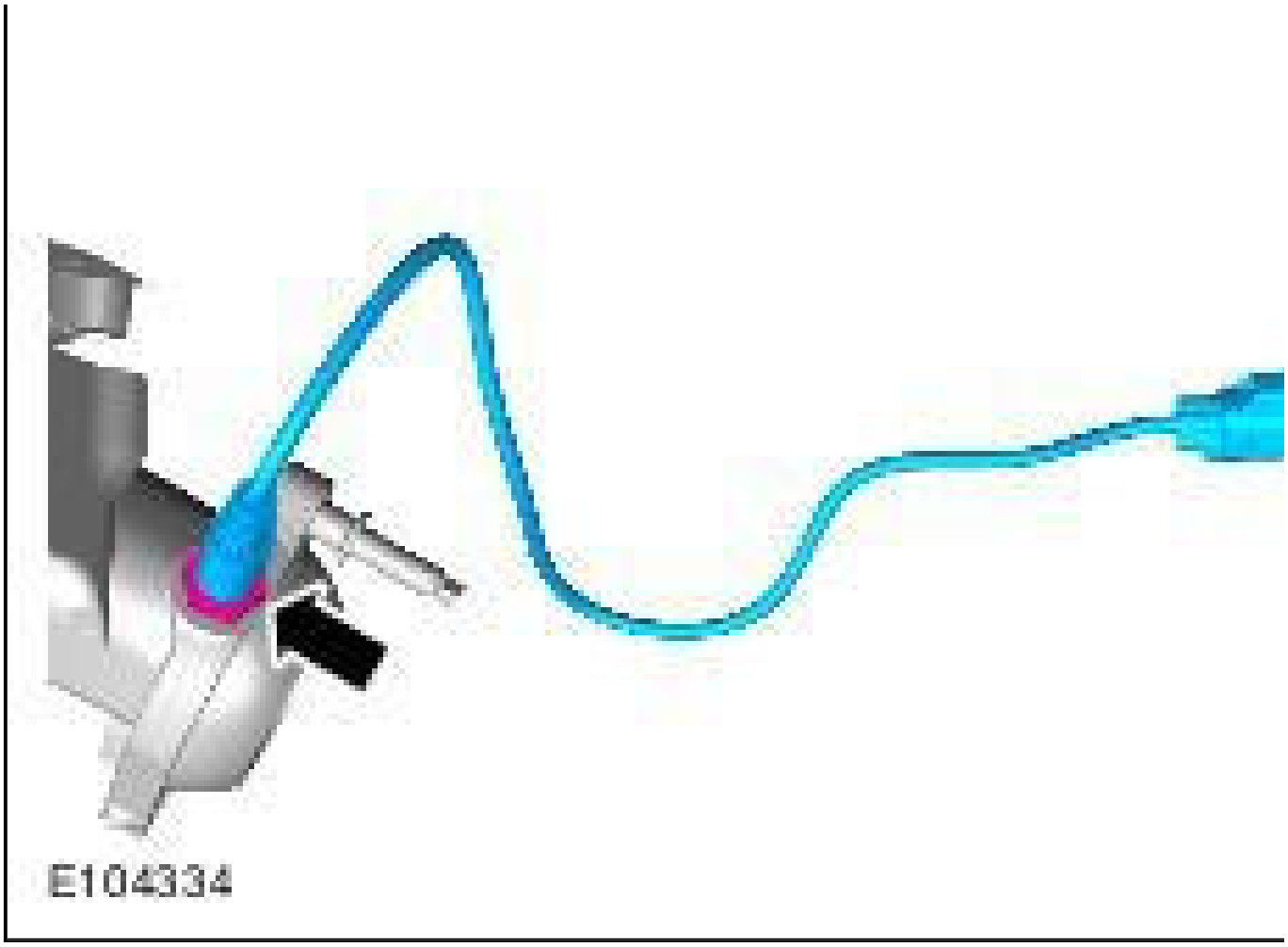

CAUTION: Make sure that the mating faces are clean and free of foreign material.

CAUTION: Make sure the anti-seize compound does not contact the catalyst monitor sensor tip.

CAUTION: If accidentally dropped or knocked install a new sensor.

CAUTION: Make sure the catalyst monitor sensor wiring harness is not twisted more than 180 degrees and is not in contact with either the exhaust or driveshaft.

NOTE: If the original sensor is to be installed, apply lubricant meeting specification ESE-M12A4-A to the thread of the sensor.

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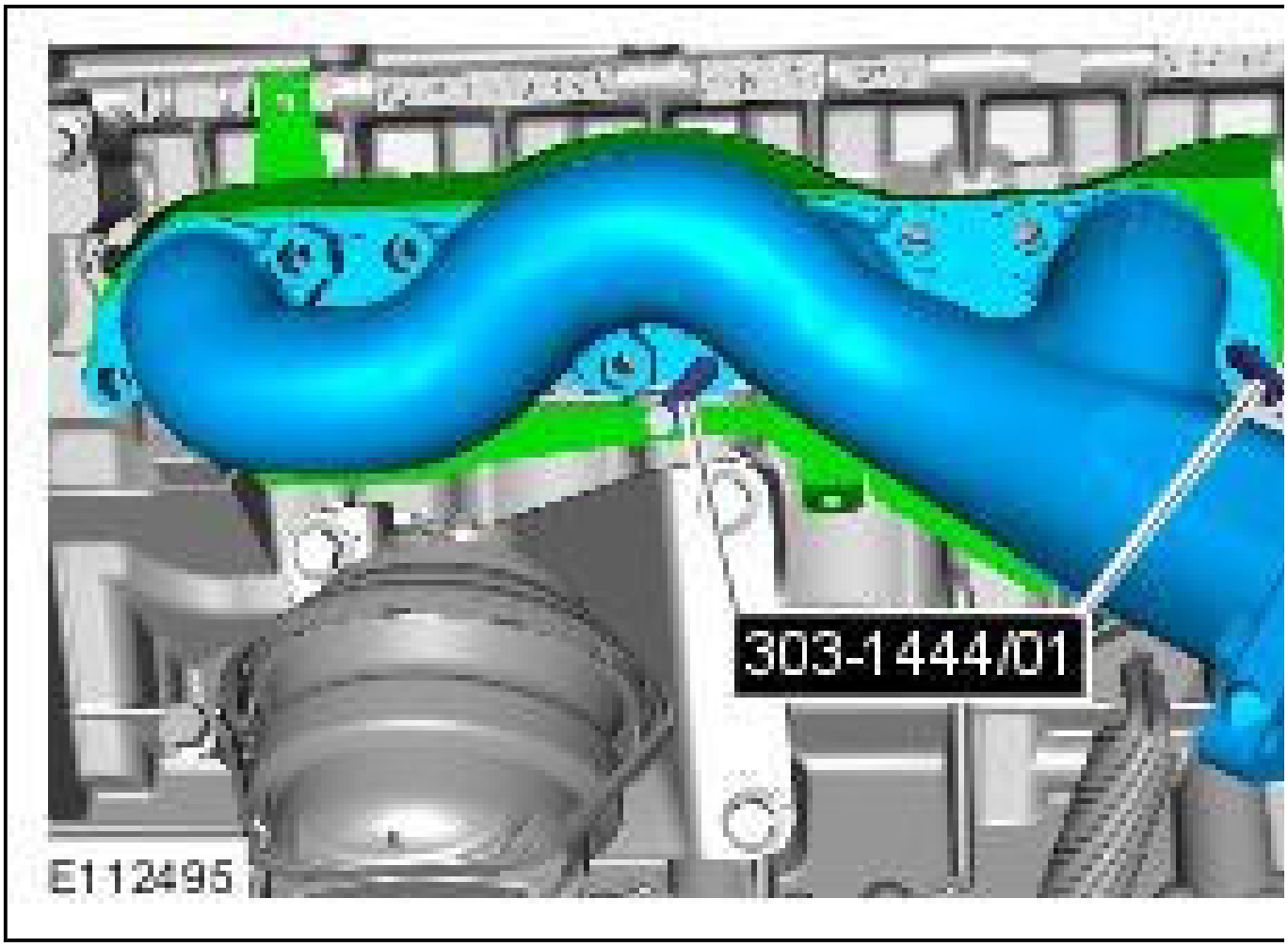
2. See figure

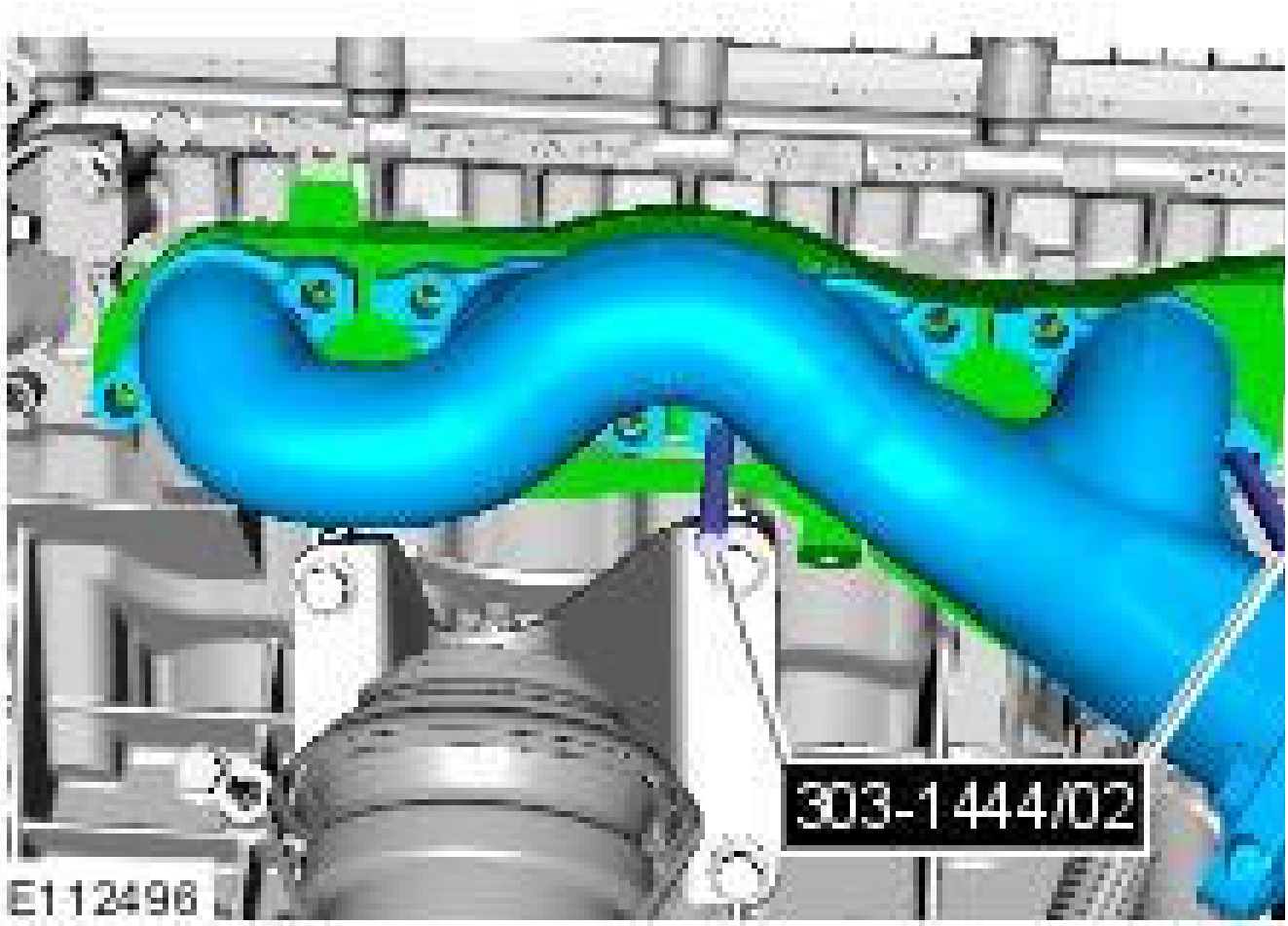


NOTE: Install a new gasket.

Exhaust Manifold Installation Guide Pins - Threaded (303-1444-01), See figure **Special Tool(s)**

3. See figure

 © 2011 Mitchell Repair Information Company, LLC.



NOTE: If a new cylinder head is installed use the special tools in the illustration.

Exhaust Manifold Installation Guide Pins - Unthreaded (303-1444-02), refer to **Special Tool(s)**

4. Torque: 10 Nm

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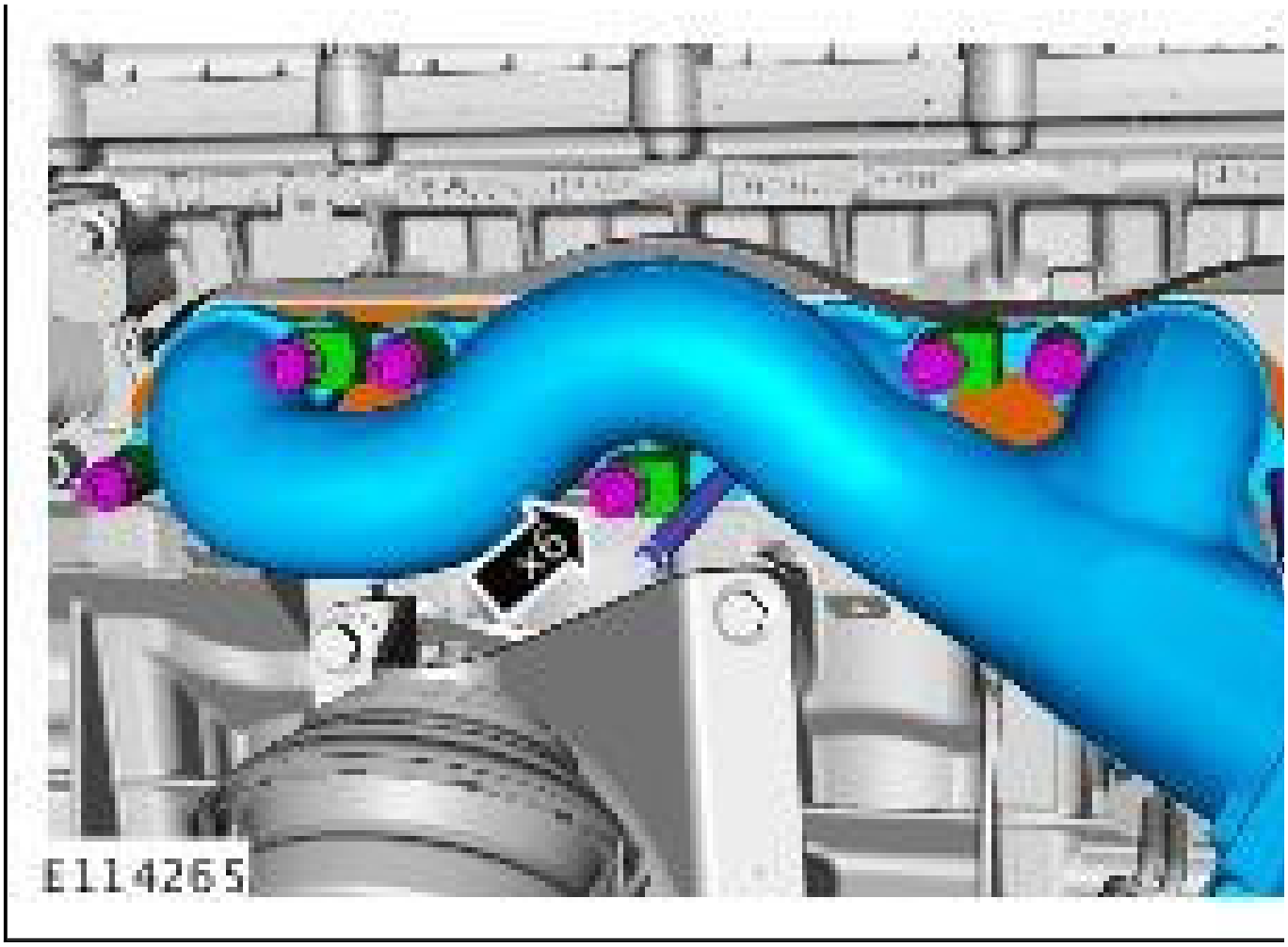

CAUTION: Make sure that new bolts are installed.

NOTE: Install the spacers in the noted position.

5. Remove the special tool.

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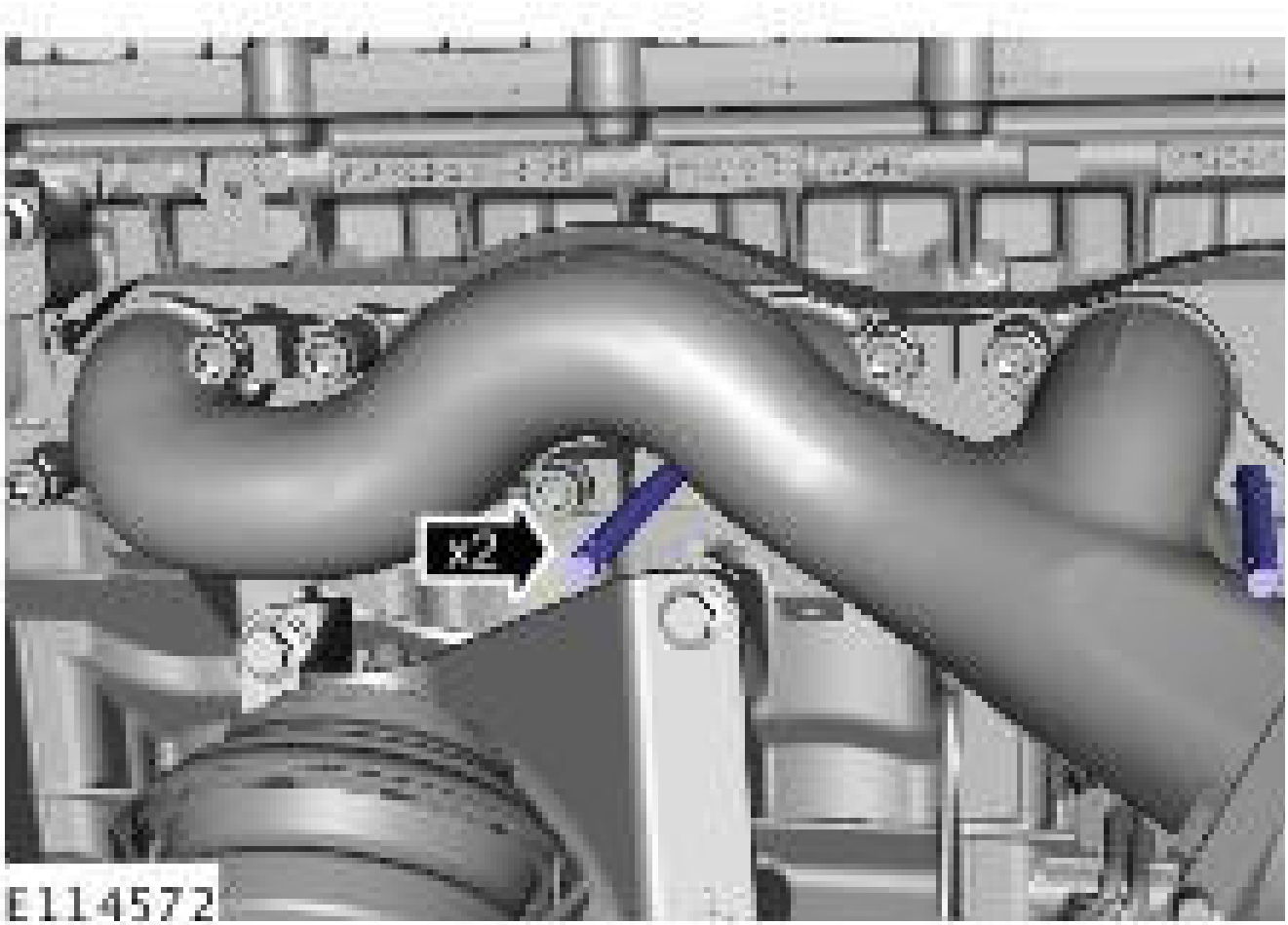

6. Torque: 10 Nm

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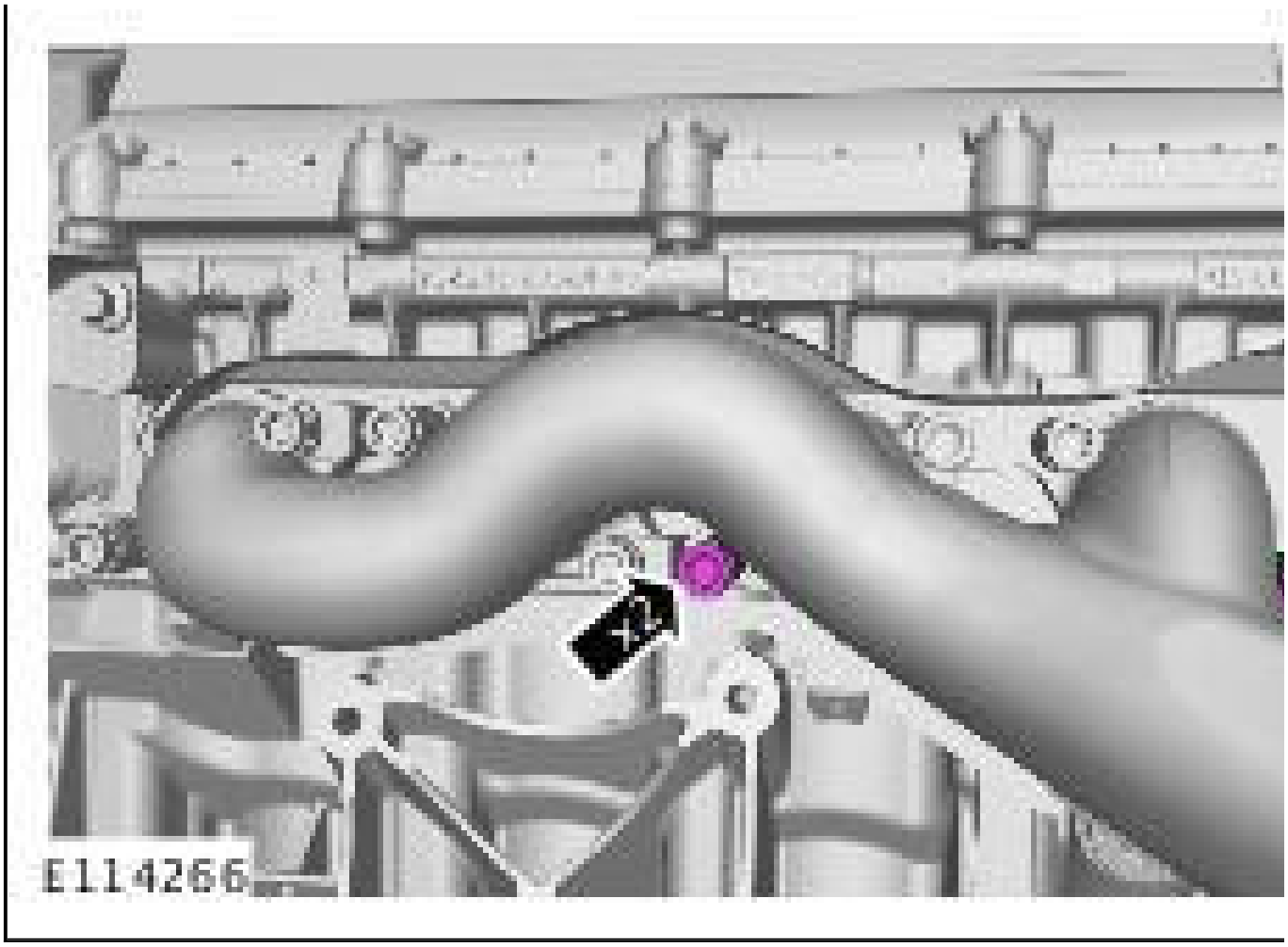

CAUTION: Make sure that new bolts are installed.

NOTE: Install the spacers in the noted position.

7. Torque: 18 Nm

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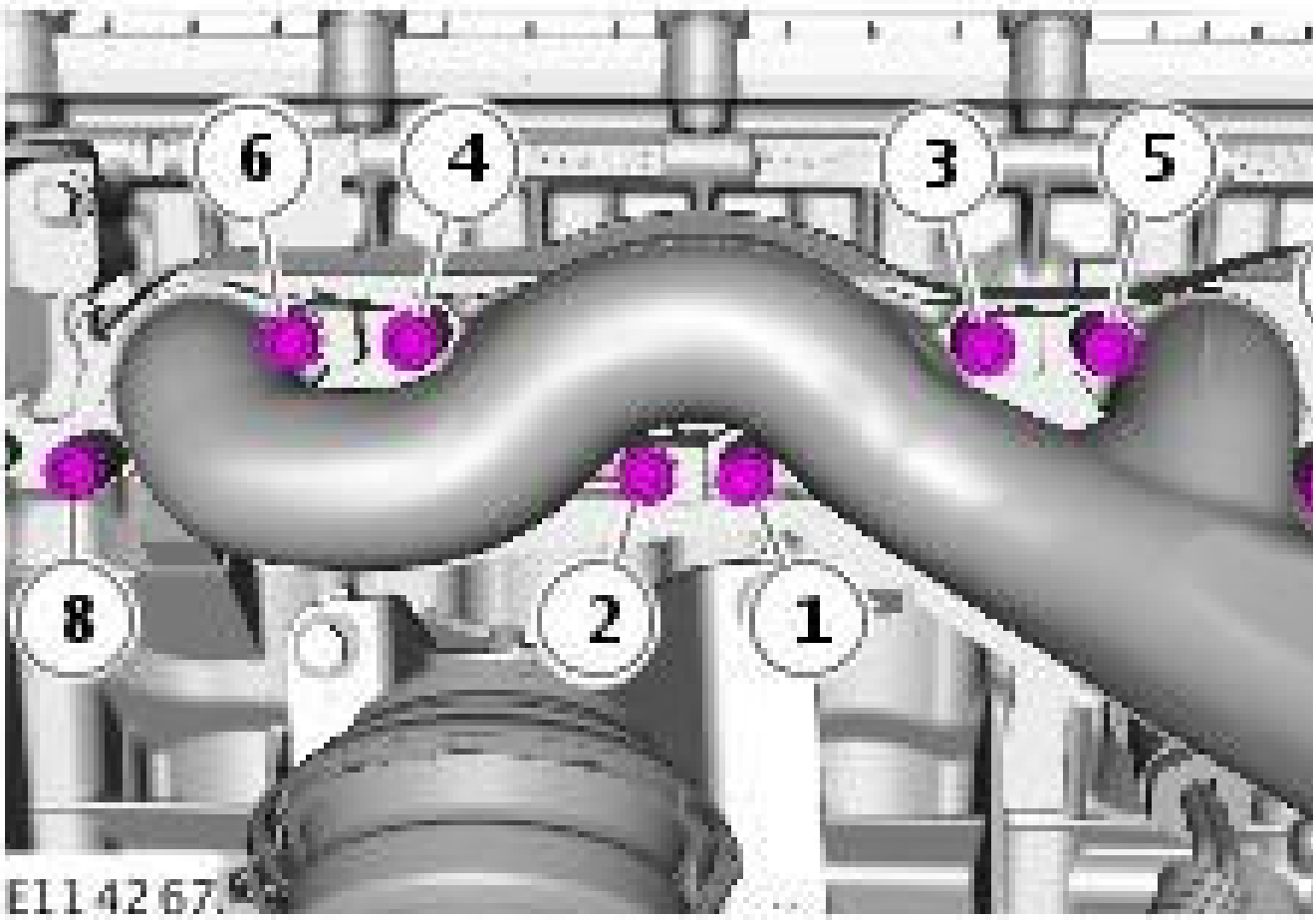
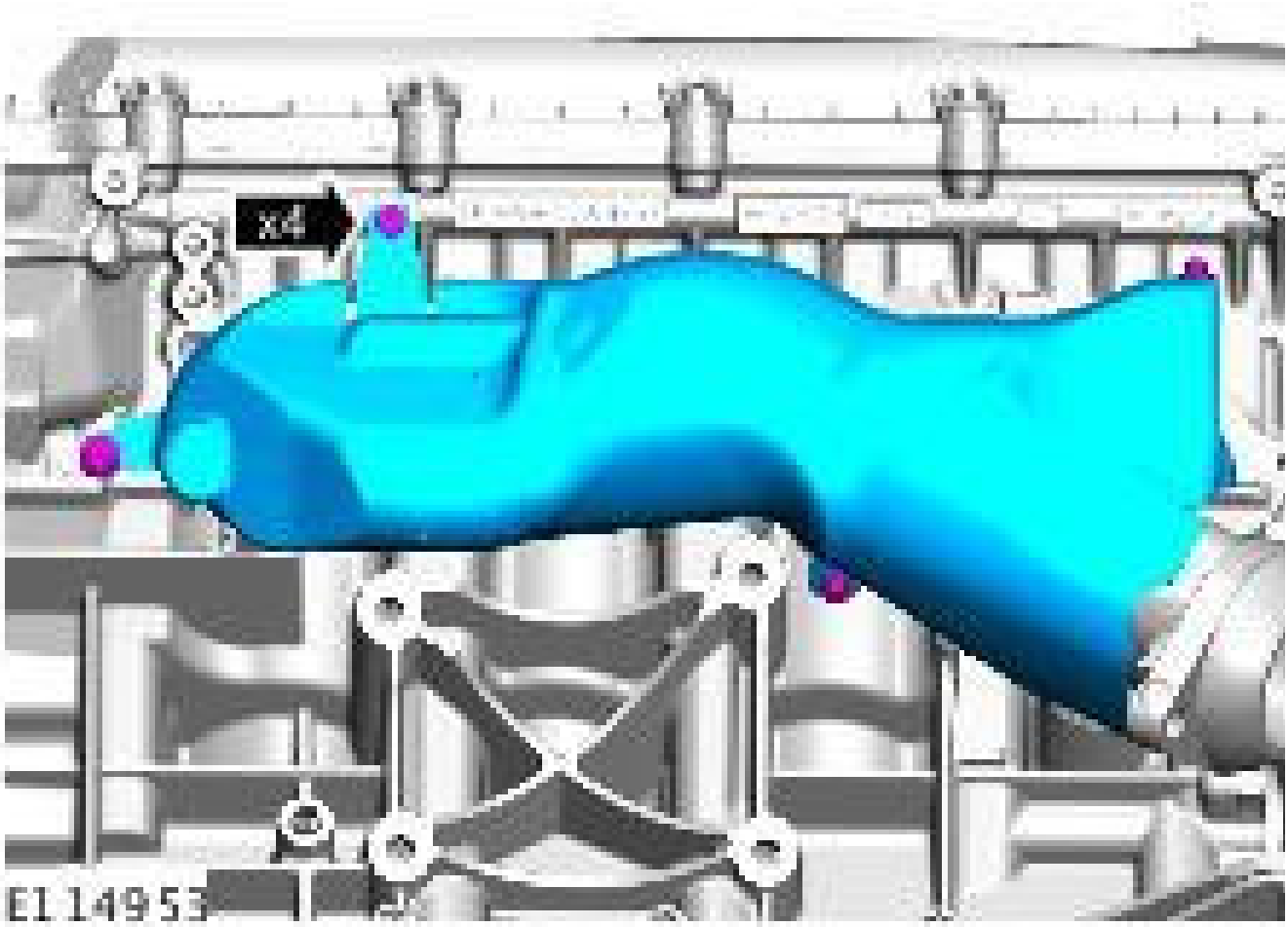


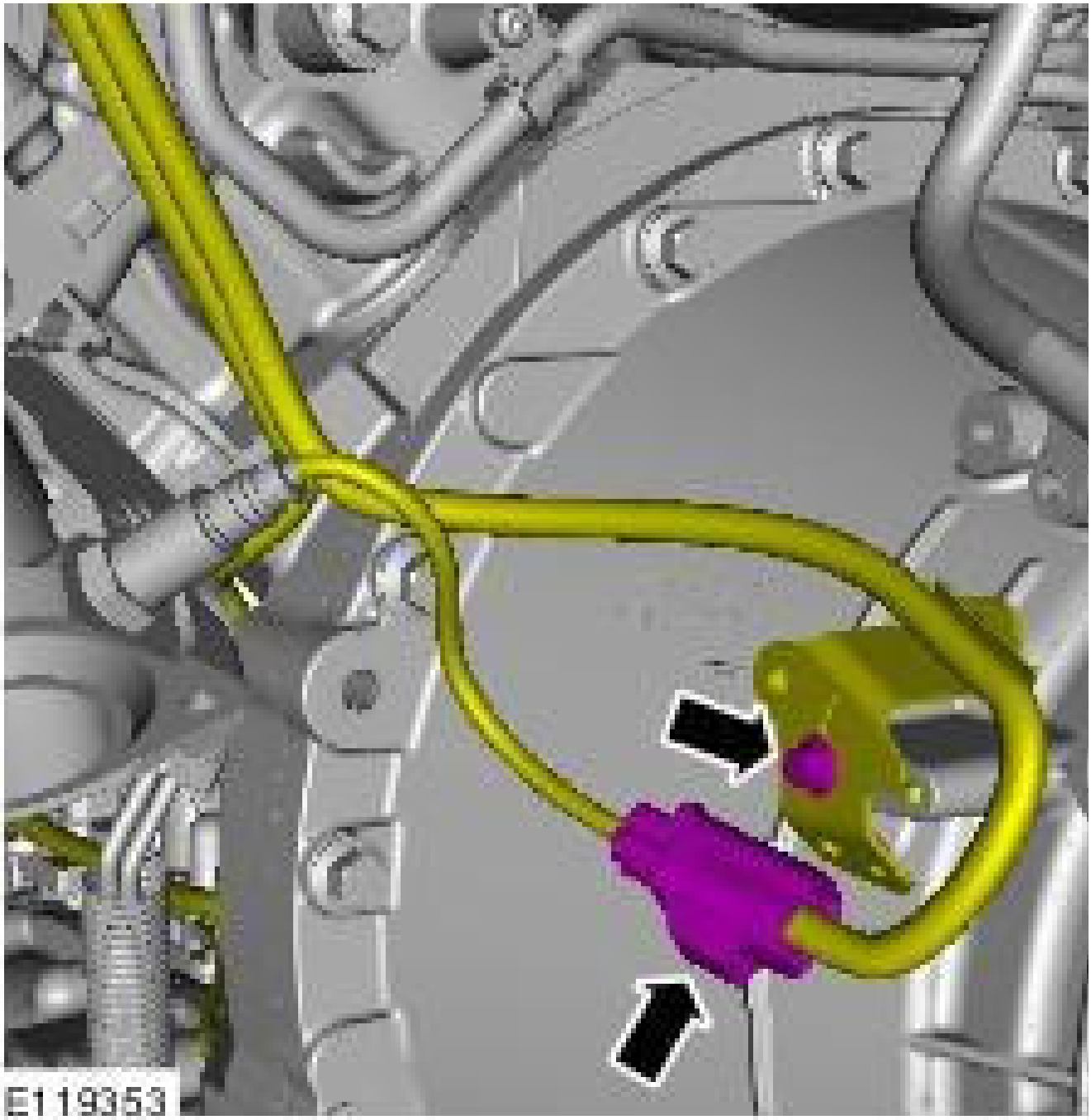
8. Torque: 3 Nm

 © 2011 Mitchell Repair Information Company, LLC.



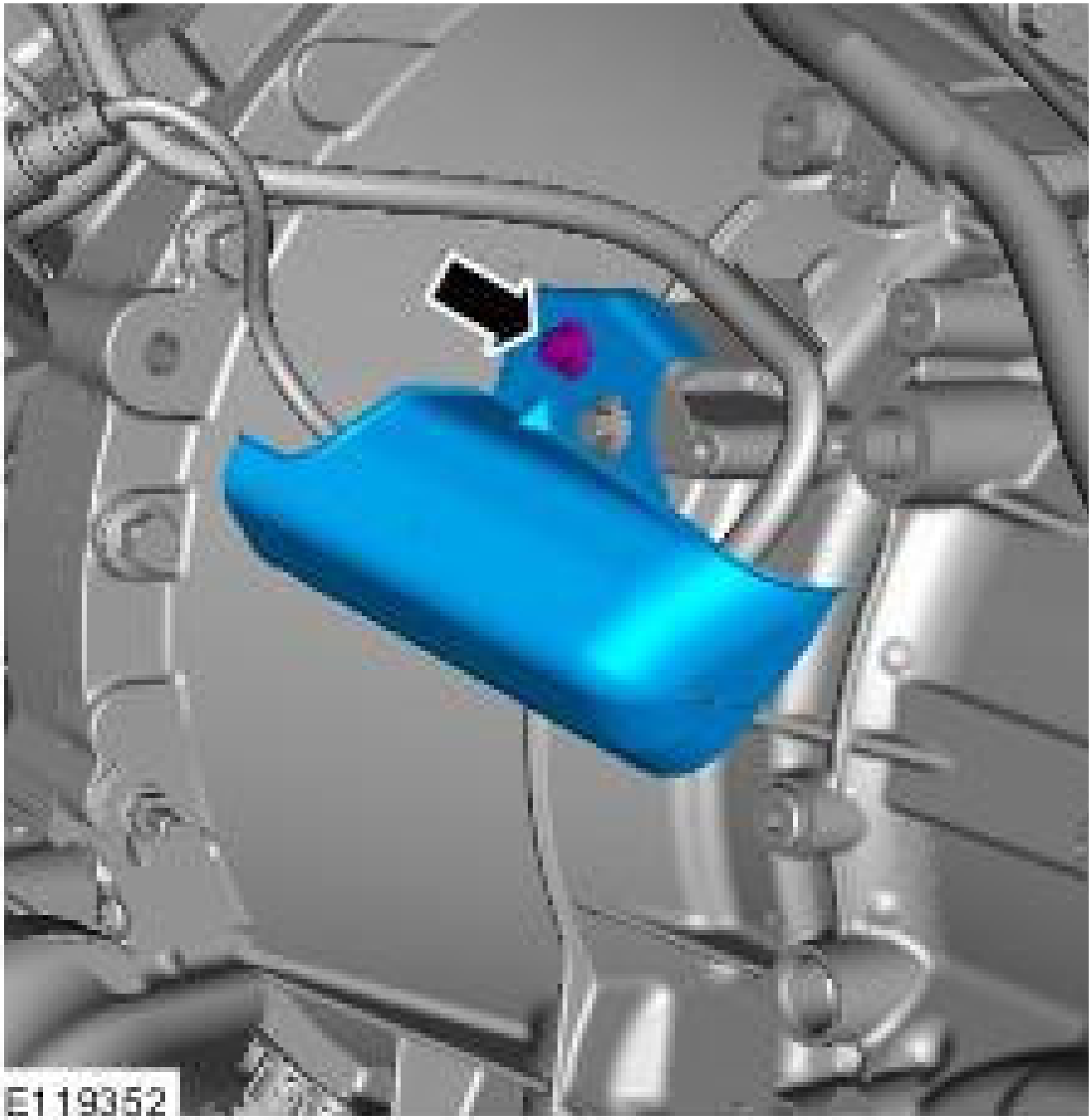
9. Torque: 10 Nm

 © 2011 Mitchell Repair Information Company, LLC.



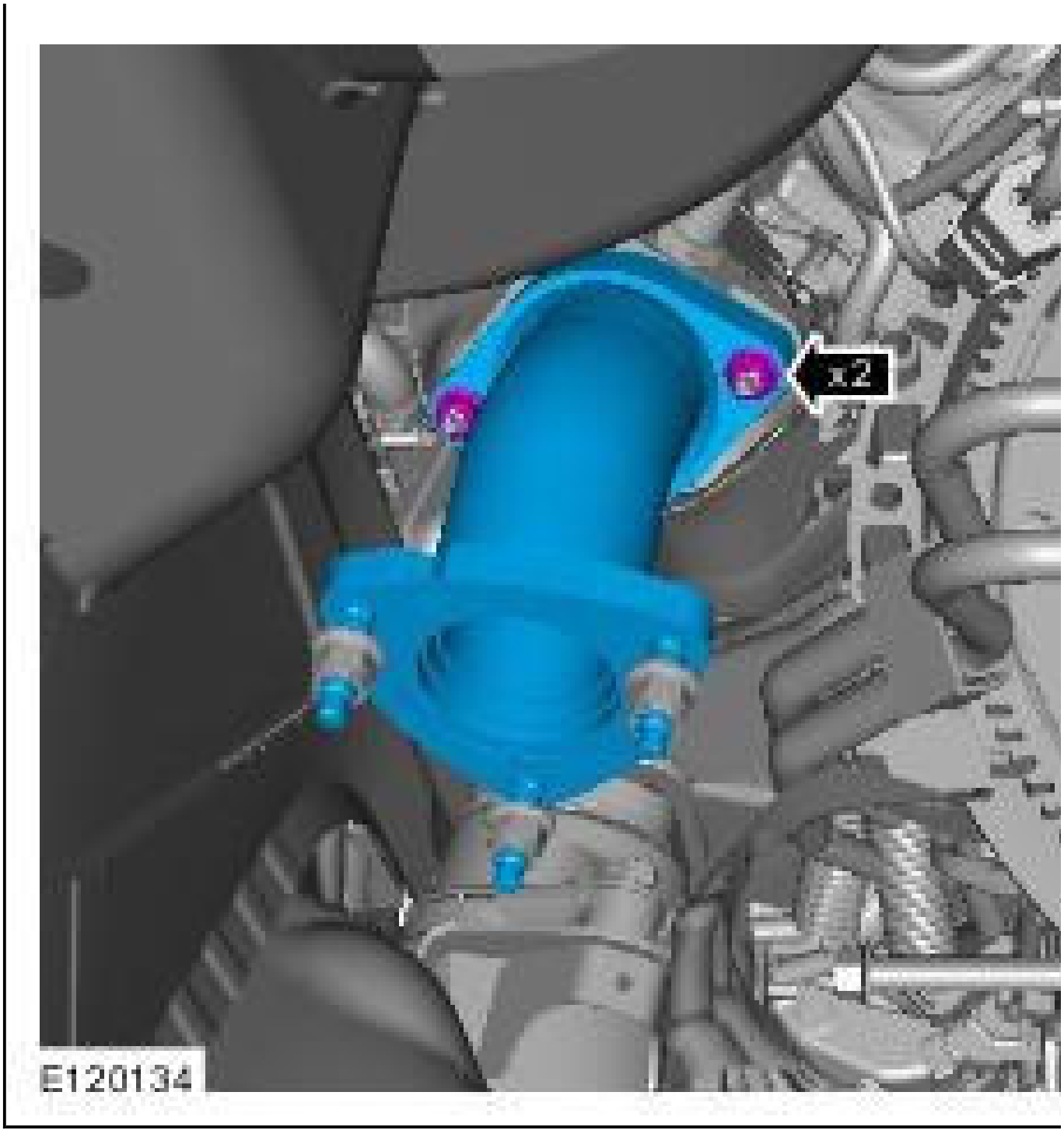
10. Torque: 10 Nm

 © 2011 Mitchell Repair Information Company, LLC.



11. Torque: 48 Nm

 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Install a new gasket.

12. Refer to **Exhaust System** .
13. Refer to **Power Steering Pump - 5.0L** .
14. Connect the battery ground cable. Refer to **Specifications** .

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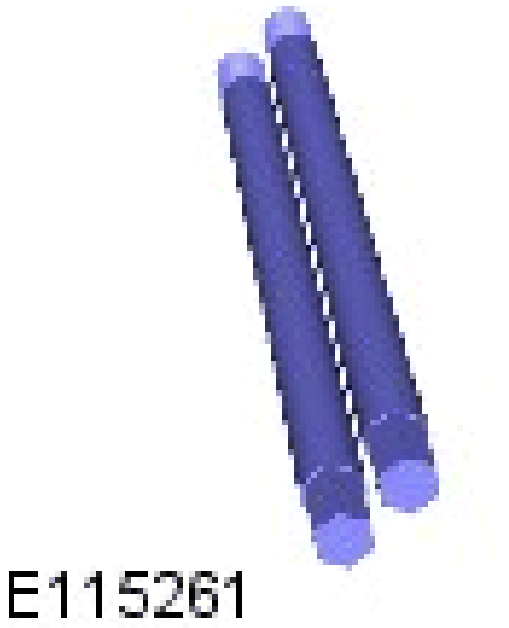
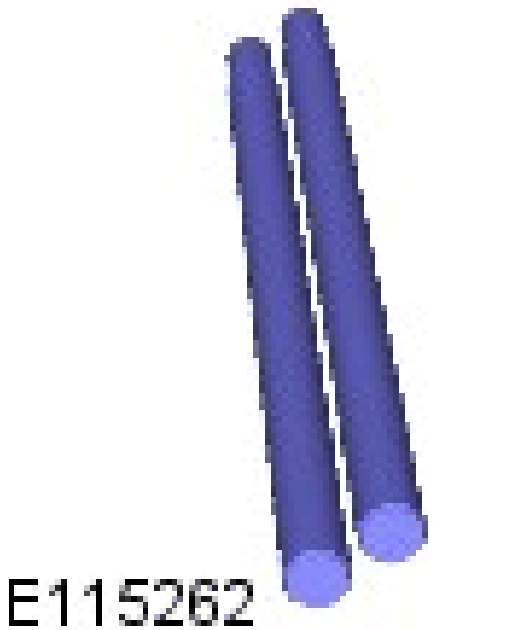
EXHAUST MANIFOLD RH

SPECIAL TOOL(S)

 E115261	303-1444-01 Exhaust Manifold Installation Guide Pins - Threaded
 E115262	303-1444-02 Exhaust Manifold Installation Guide Pins - Unthreaded

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REMOVAL

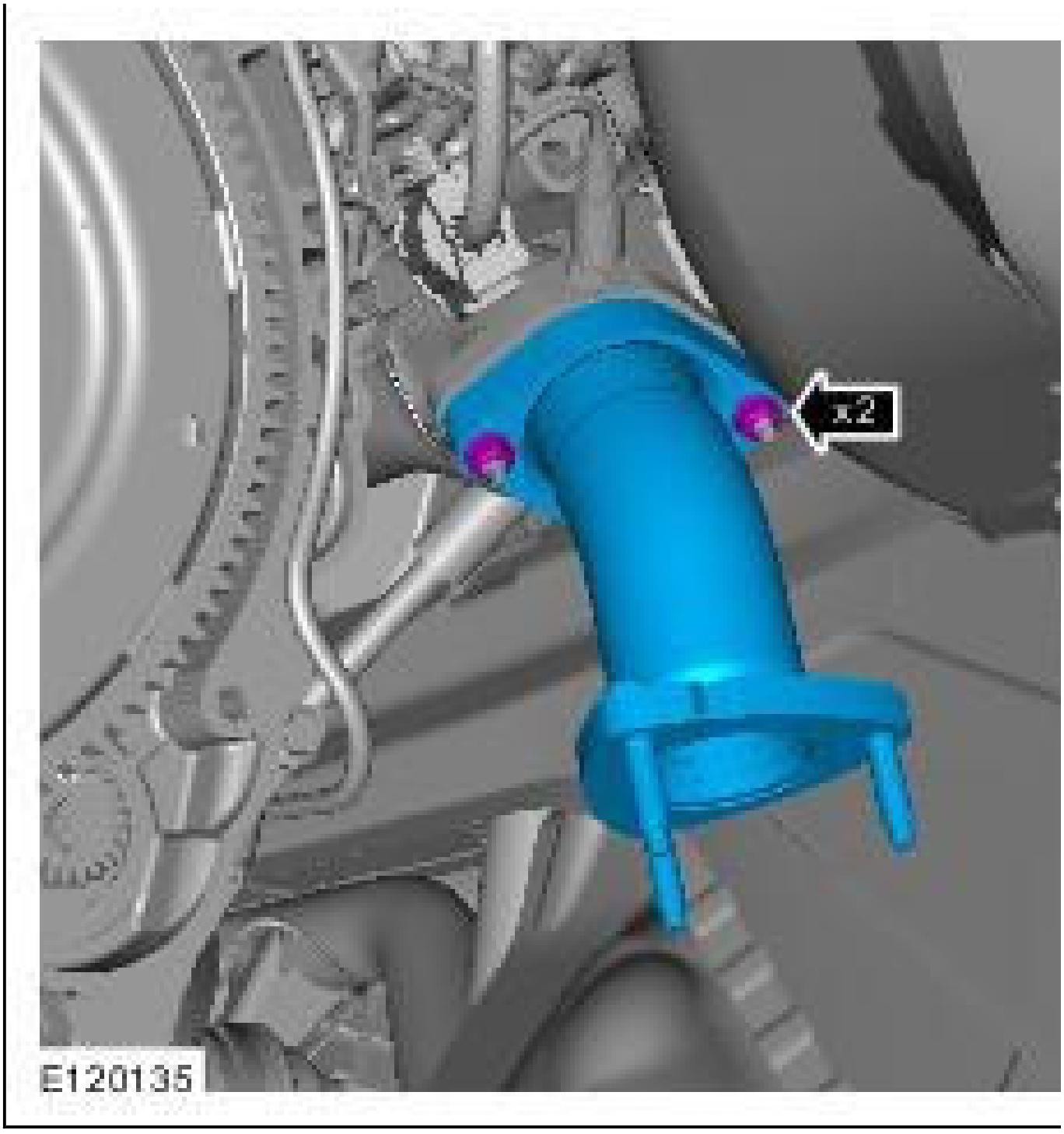
NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

1. 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. Refer to **Exhaust System** .
4. See figure

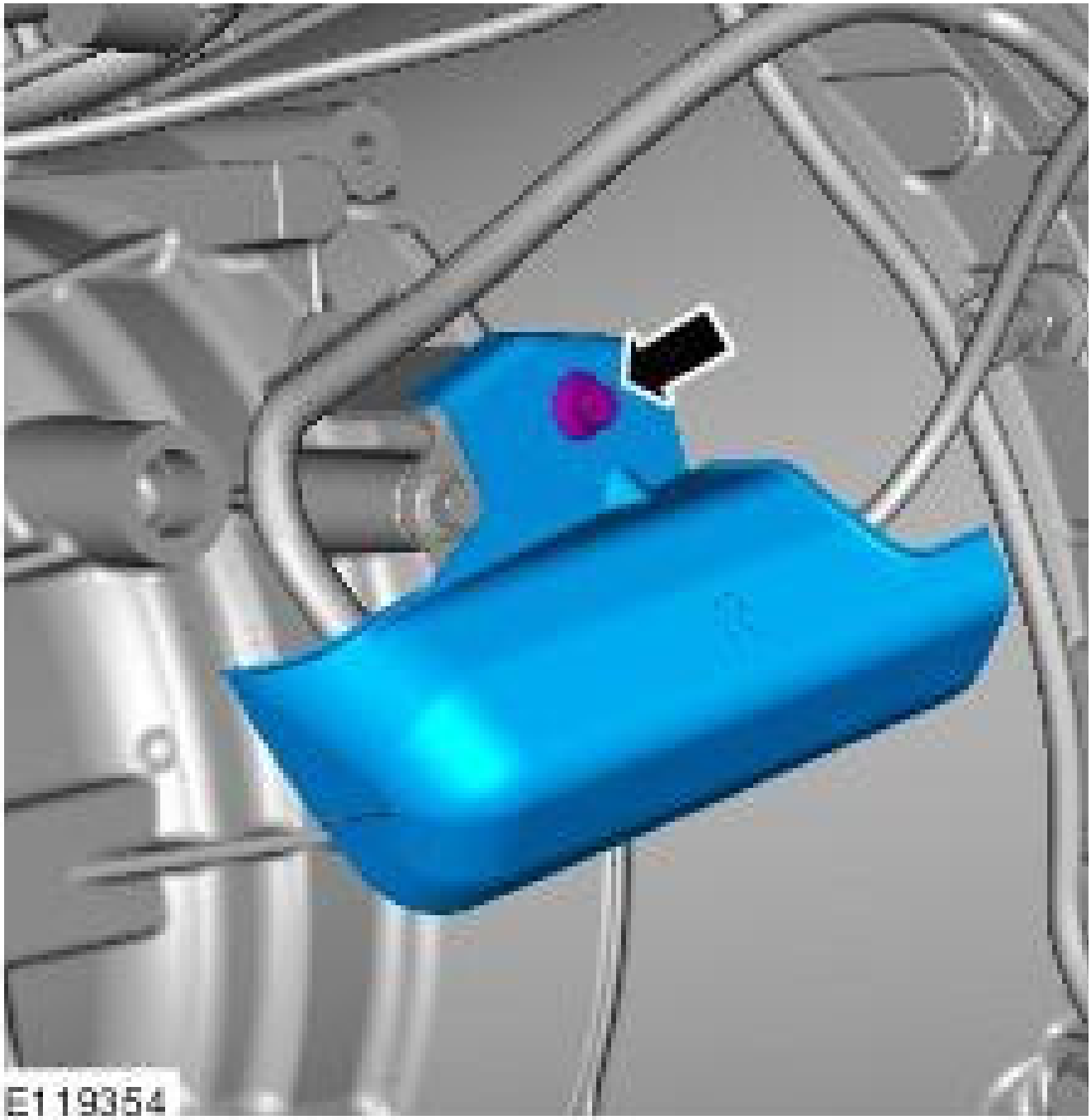
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Remove and discard the gasket.

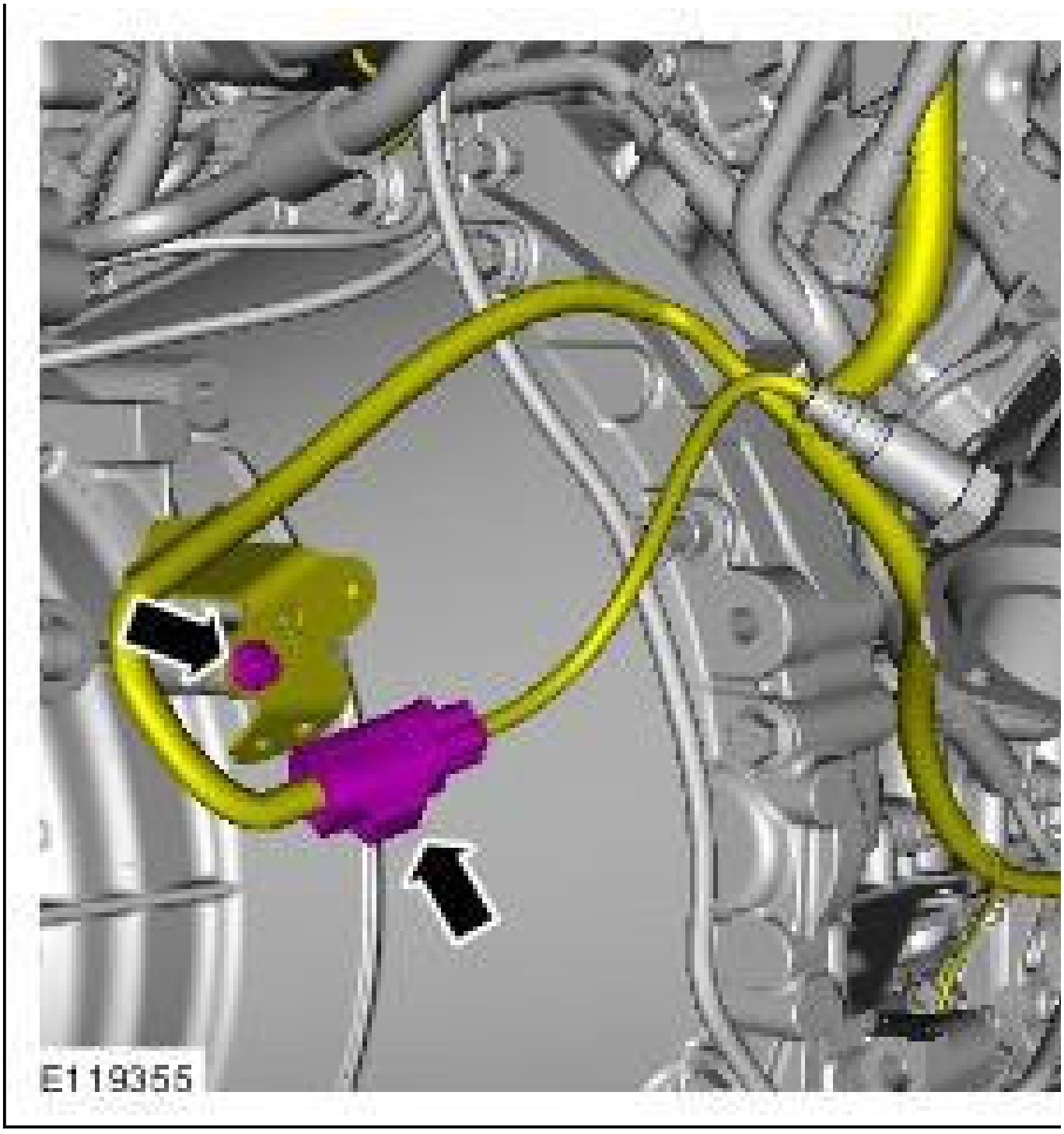
5. See figure

 © 2011 Mitchell Repair Information Company, LLC.



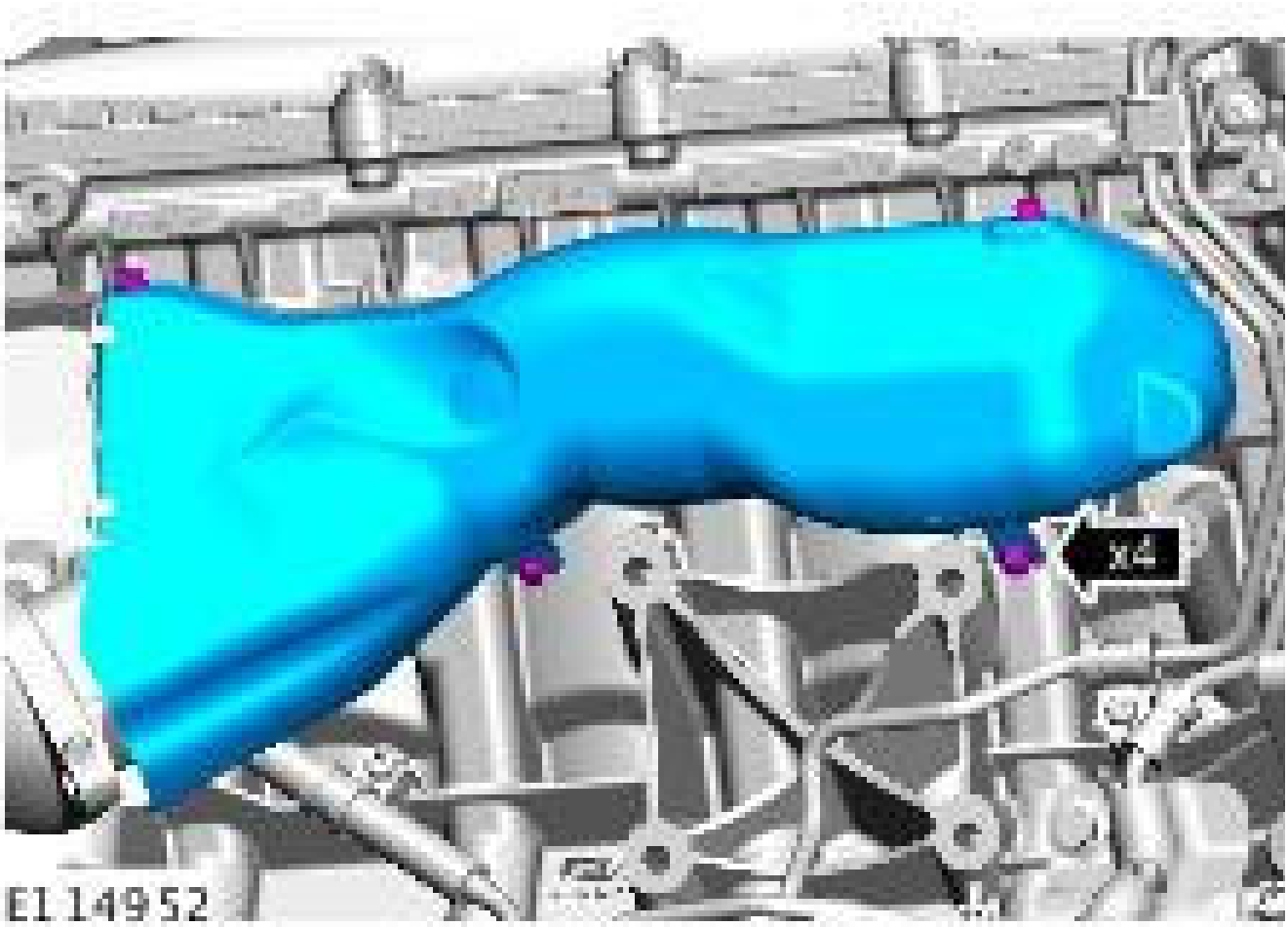
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



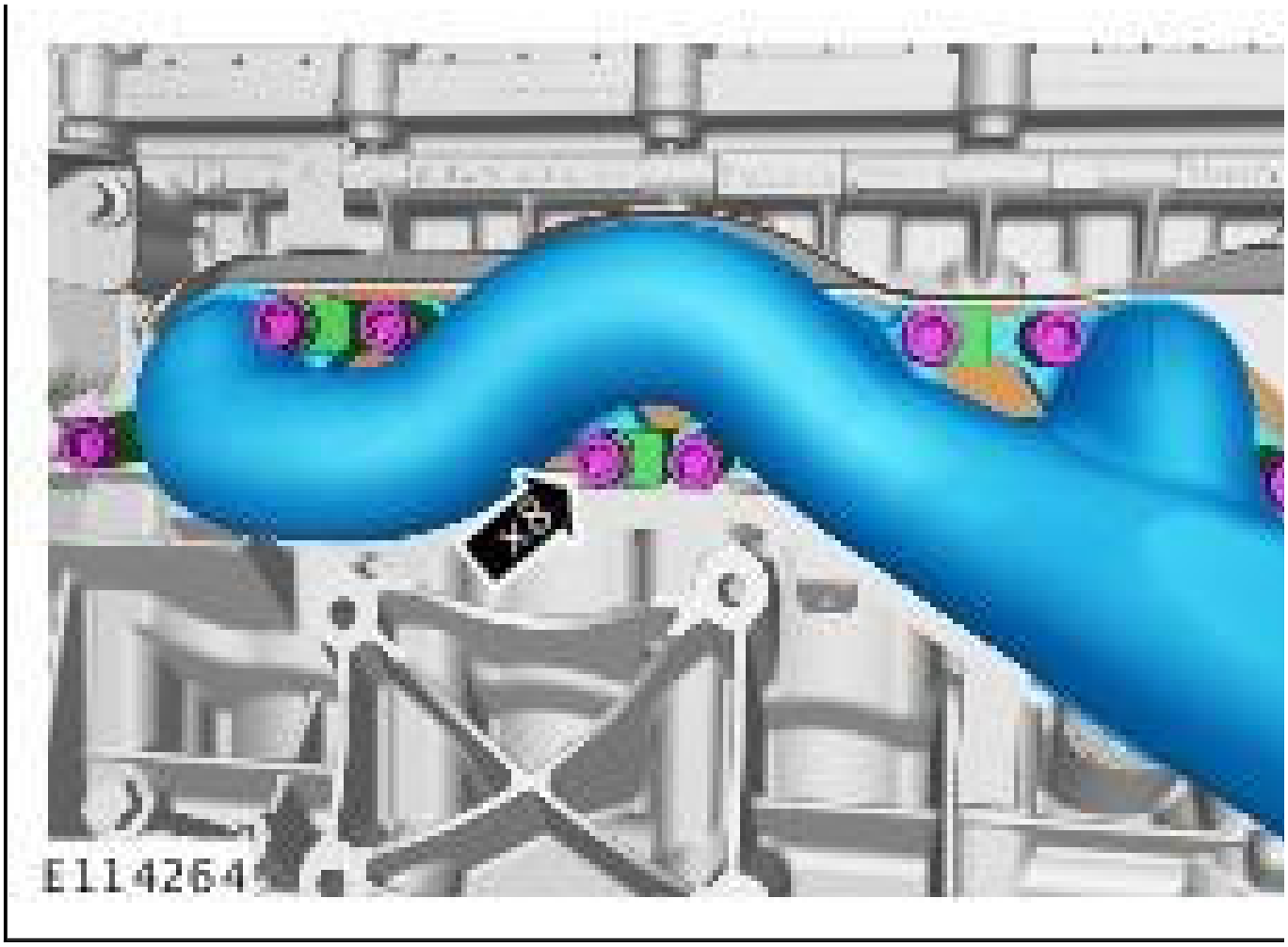
7. See figure

 © 2011 Mitchell Repair Information Company, LLC.



8. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Discard the bolts.

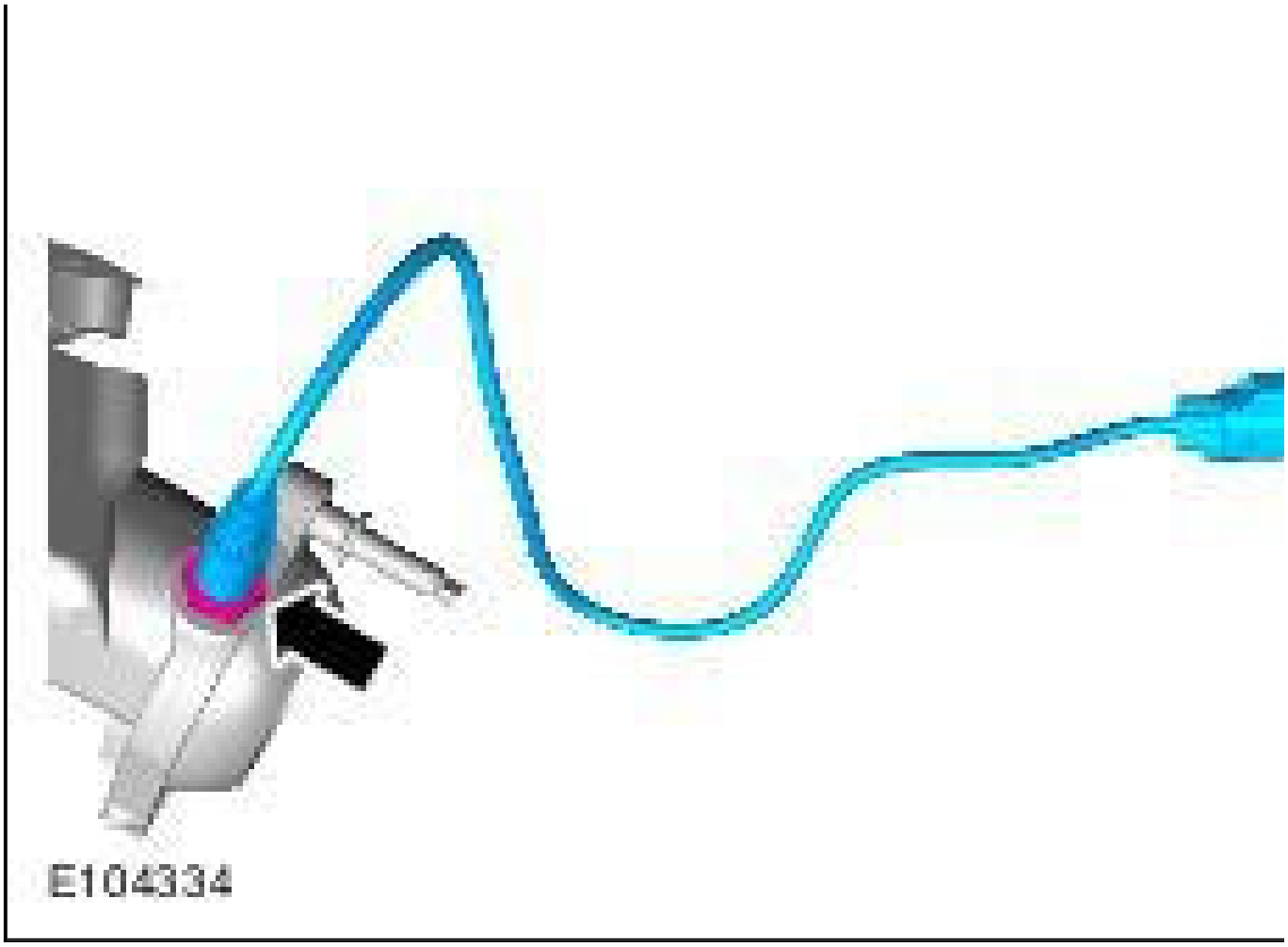
CAUTION: LH illustration shown, RH is similar.

NOTE: Discard the gasket.

NOTE: Make sure that the position of the spacers is noted before removal of the manifold.

9. See figure

 © 2011 Mitchell Repair Information Company, LLC.



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

INSTALLATION

1. Torque: 45 Nm

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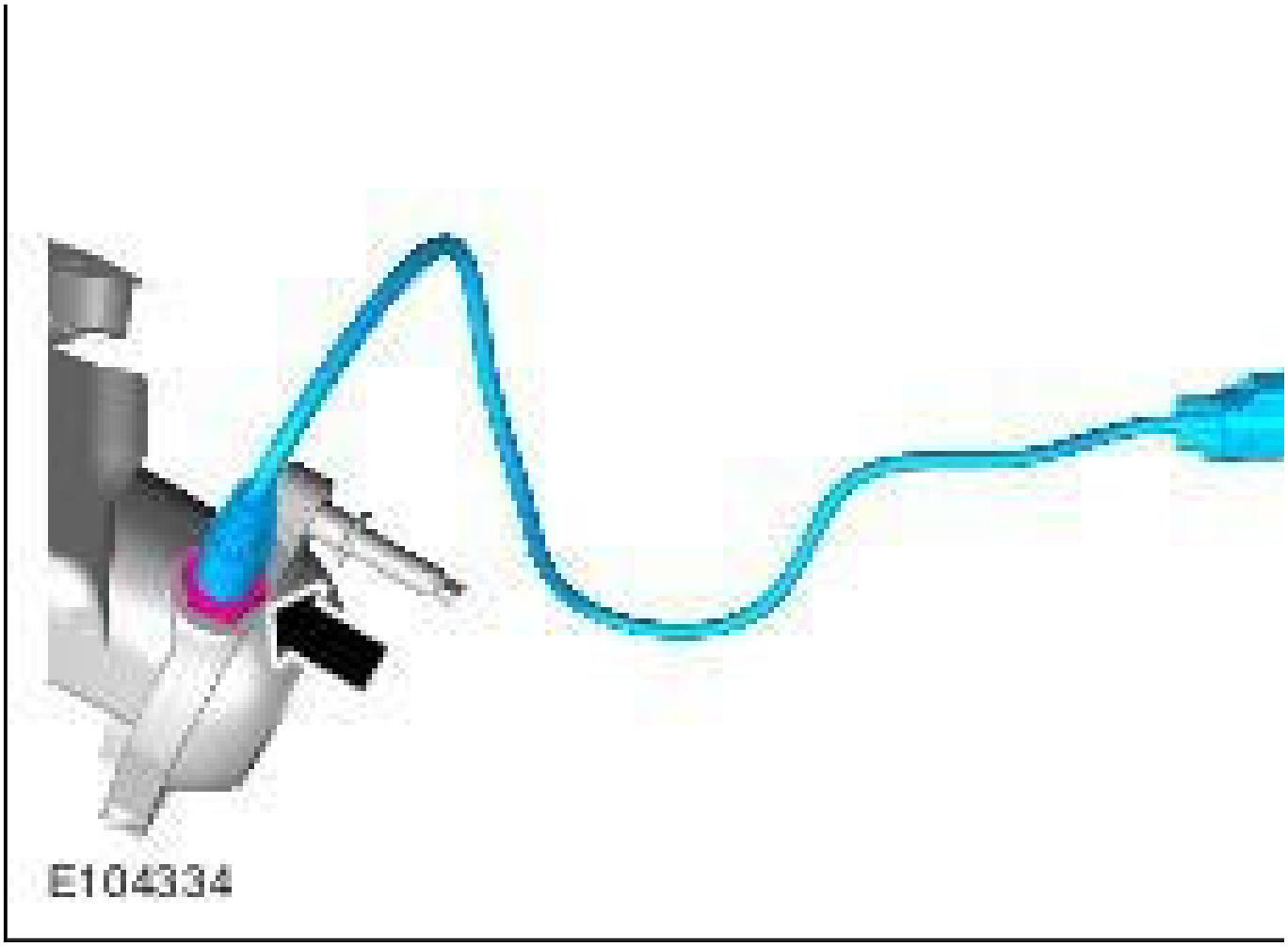

2. Install the special tool.

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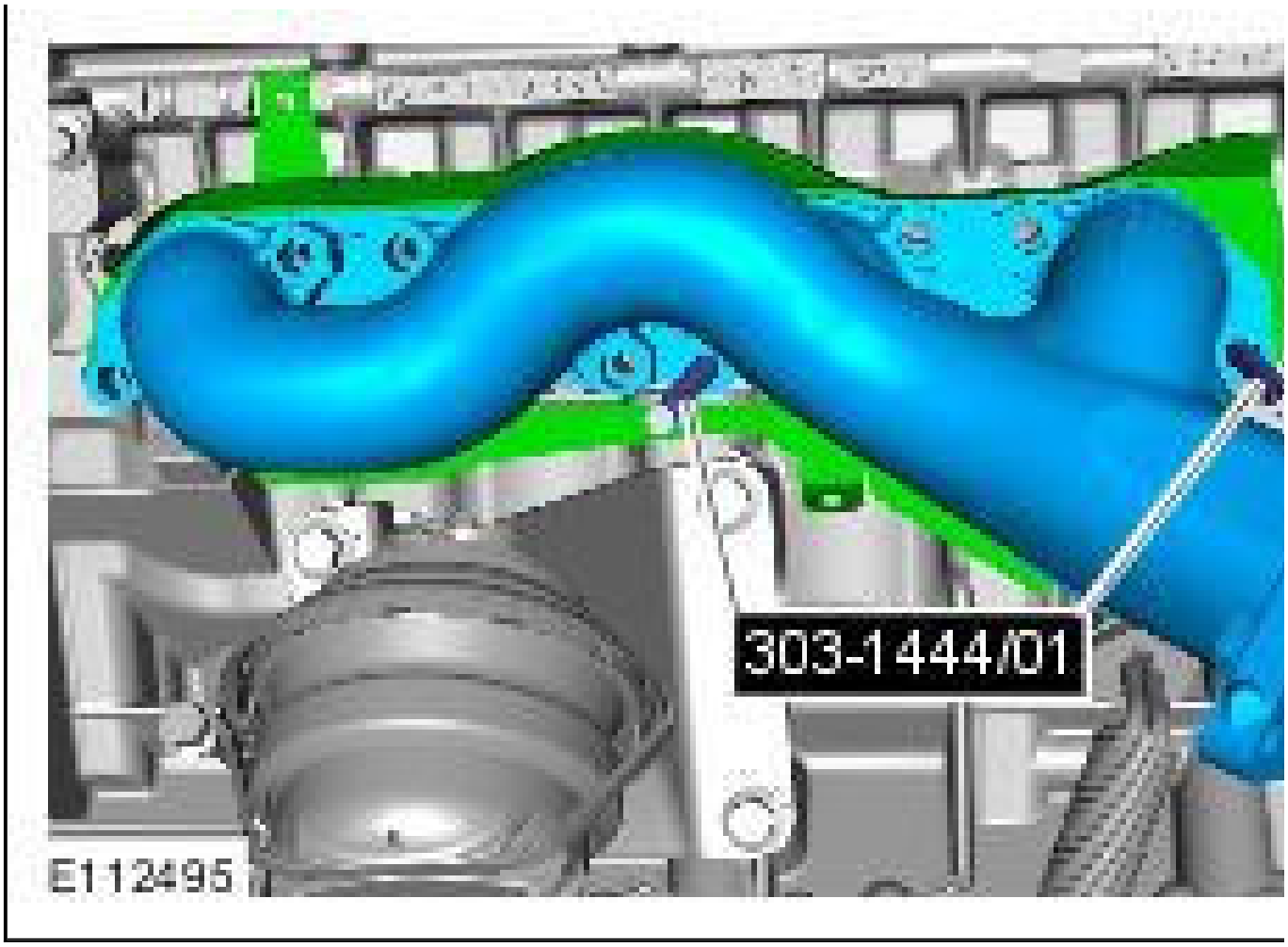

CAUTION: LH illustration shown, RH is similar.

NOTE: Install a new gasket.

Exhaust Manifold Installation Guide Pins - Threaded (303-1444-01), refer to **SPECIAL TOOL(S)**

3. Install the special tool.

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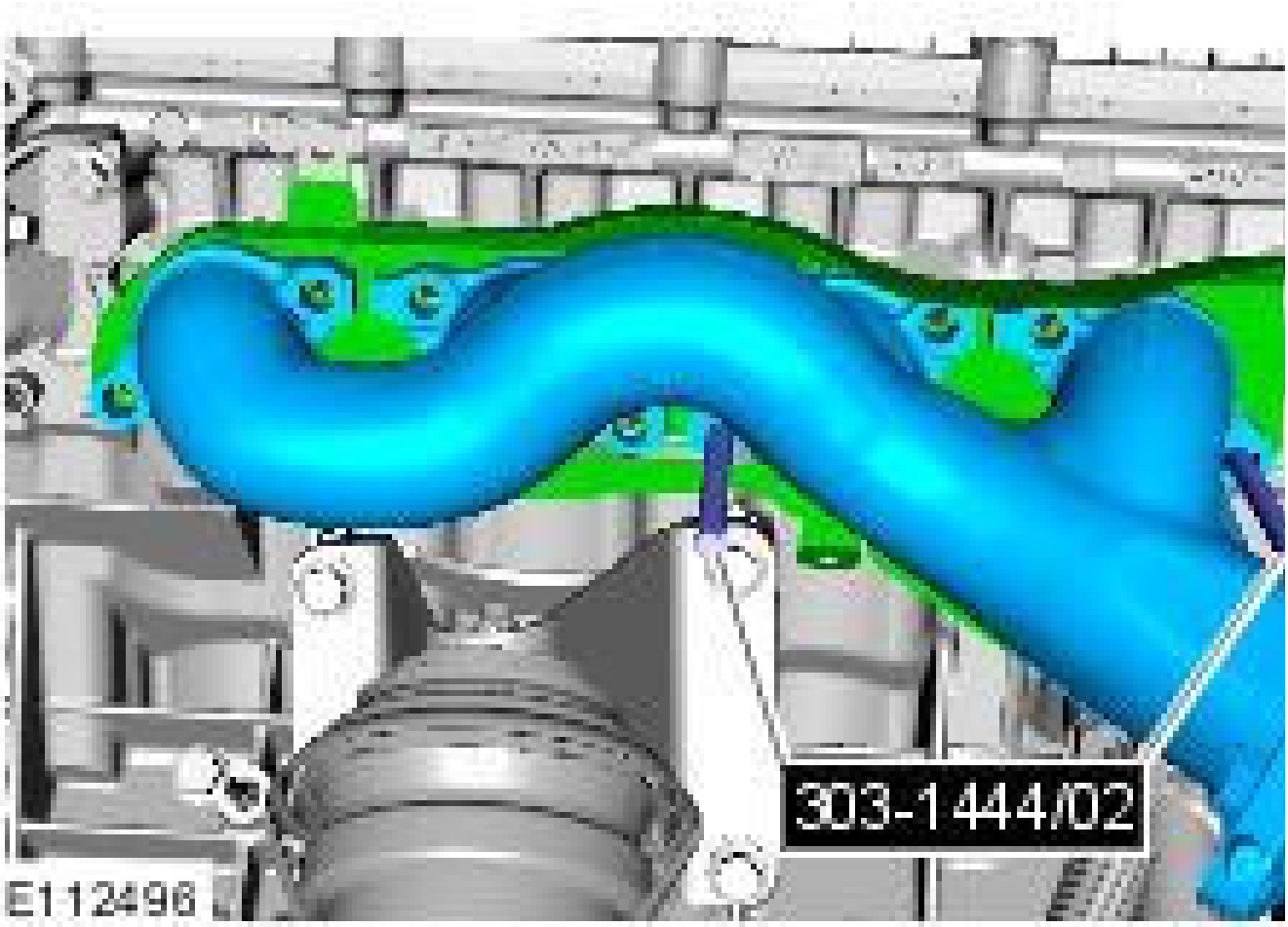

CAUTION: LH illustration shown, RH is similar.

NOTE: If a new cylinder head is installed use the special tools in the illustration.

Exhaust Manifold Installation Guide Pins - Unthreaded (303-1444-02), refer to **SPECIAL TOOL(S)**

4. Torque: 10 Nm

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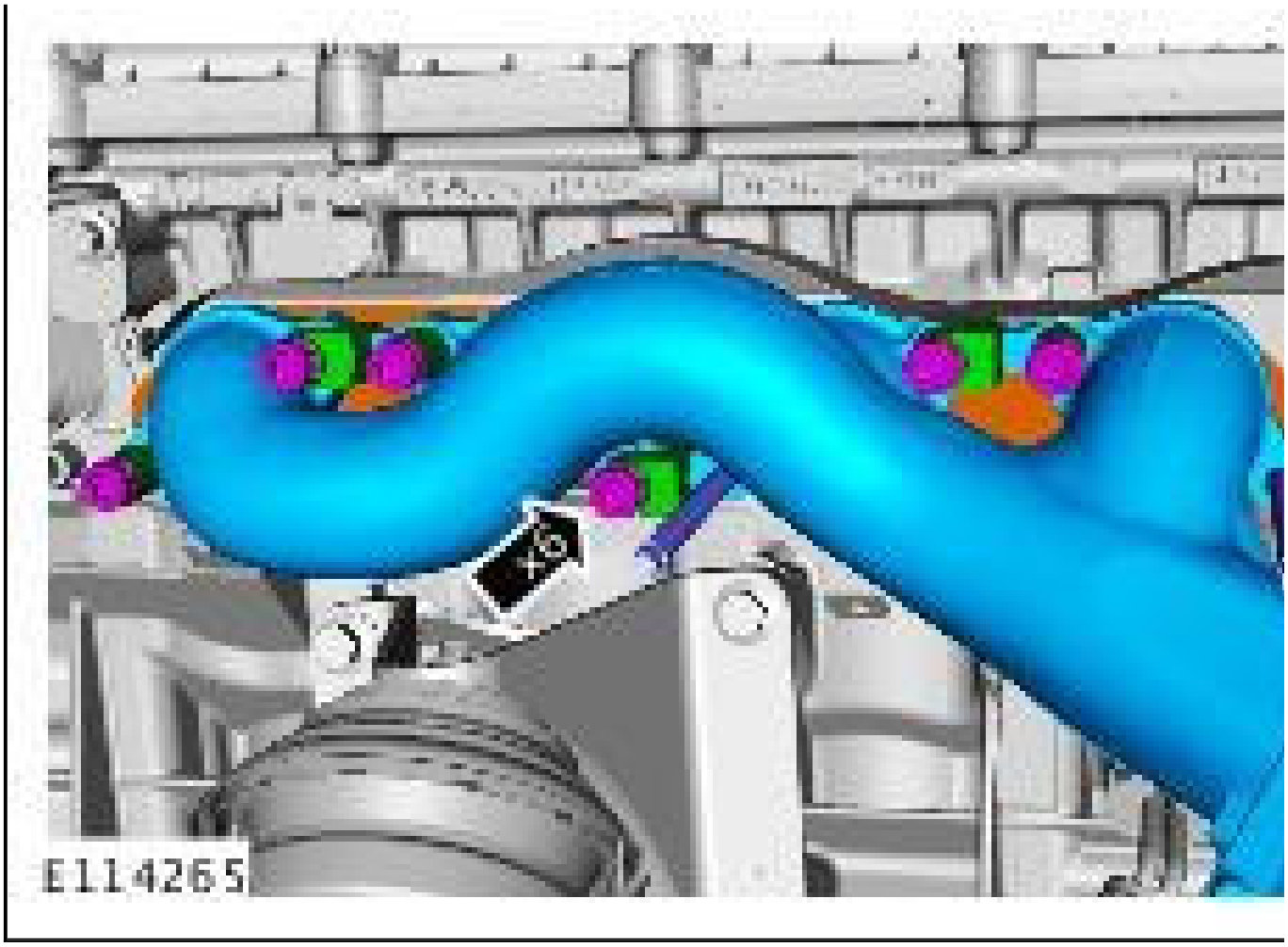

CAUTION: Make sure that new bolts are installed.

CAUTION: LH illustration shown, RH is similar.

NOTE: Install the spacers in the noted position.

5. Remove the special tool.

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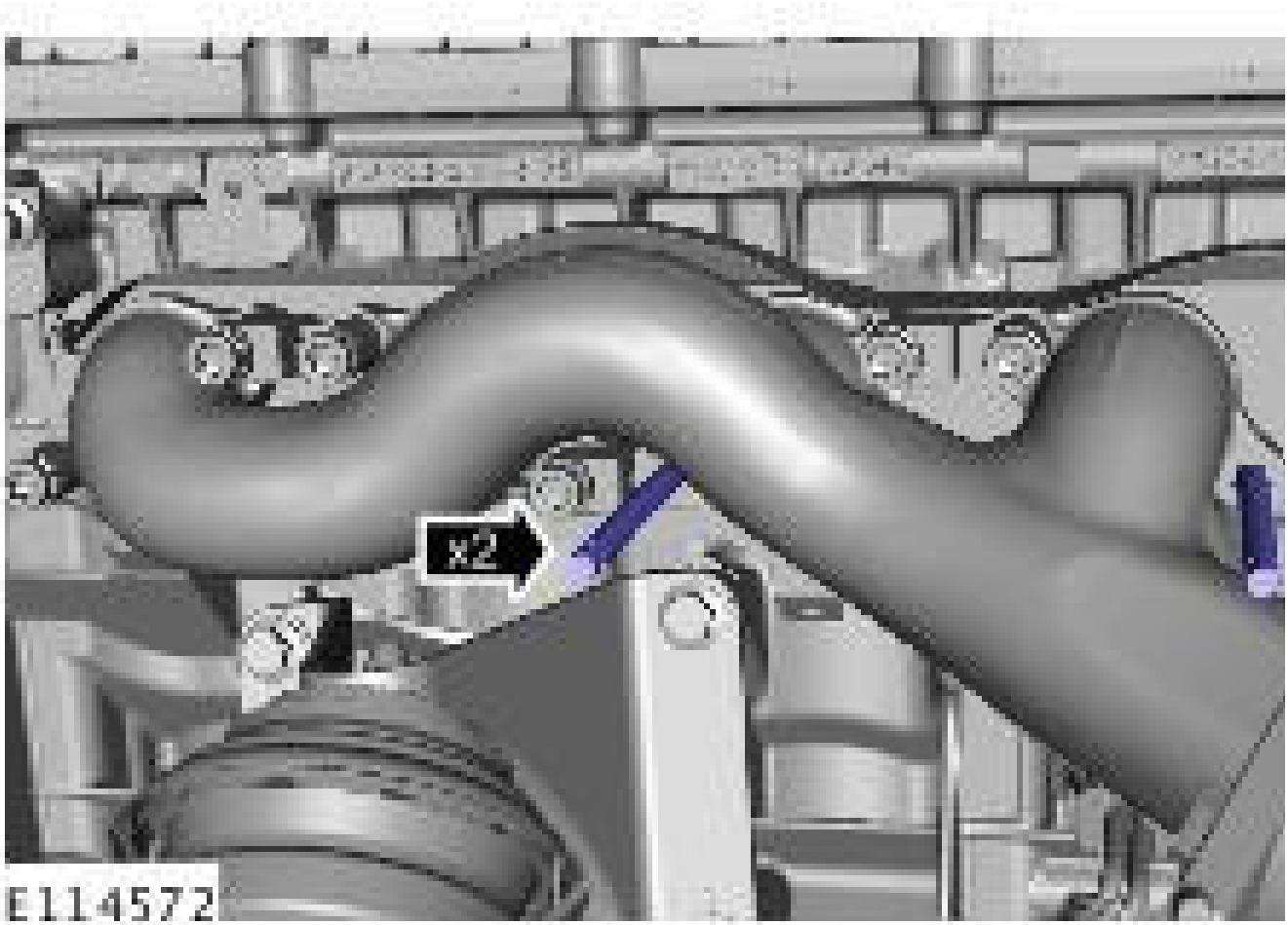

CAUTION: LH illustration shown, RH is similar.

6. Torque: 10 Nm

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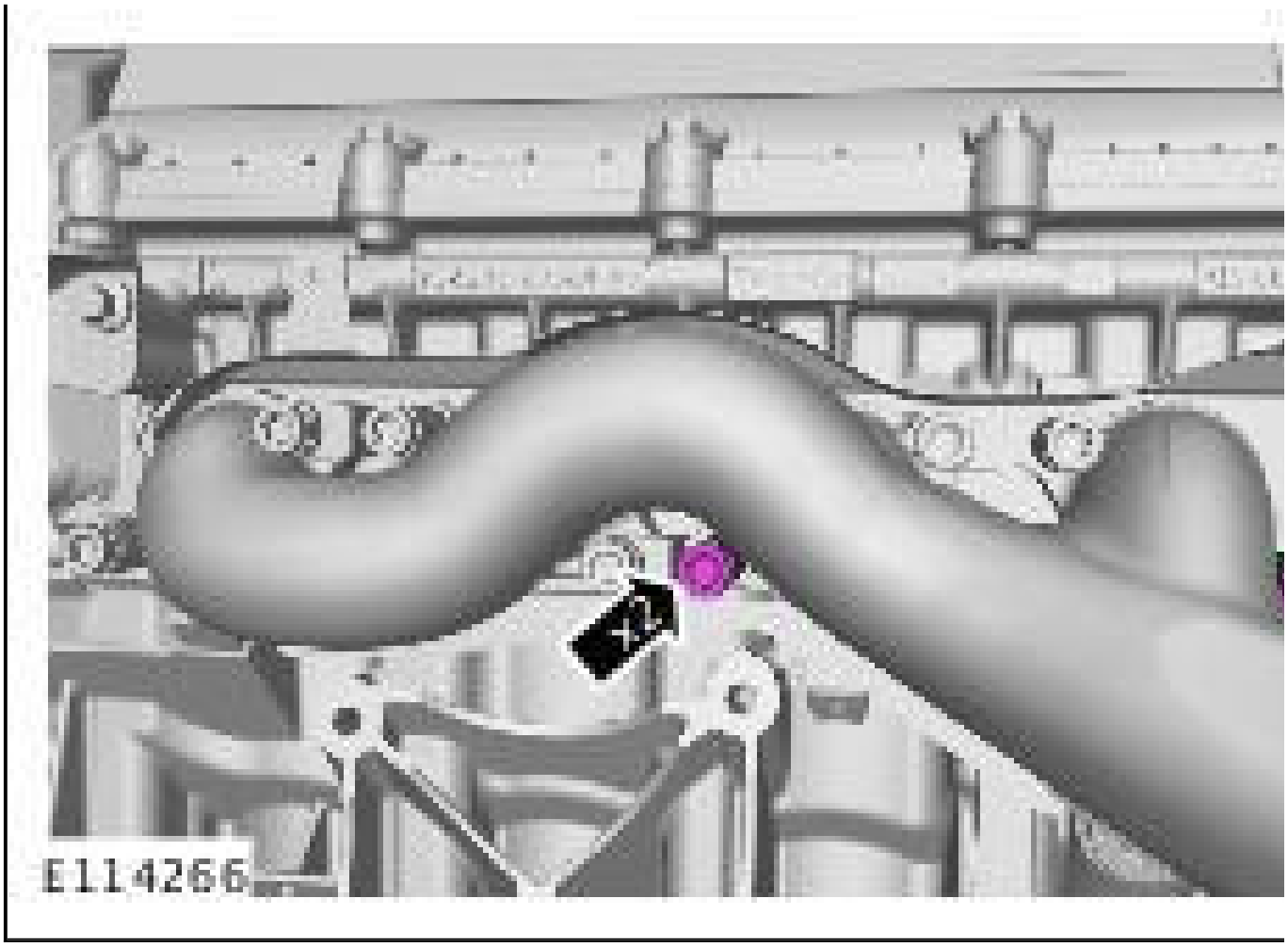


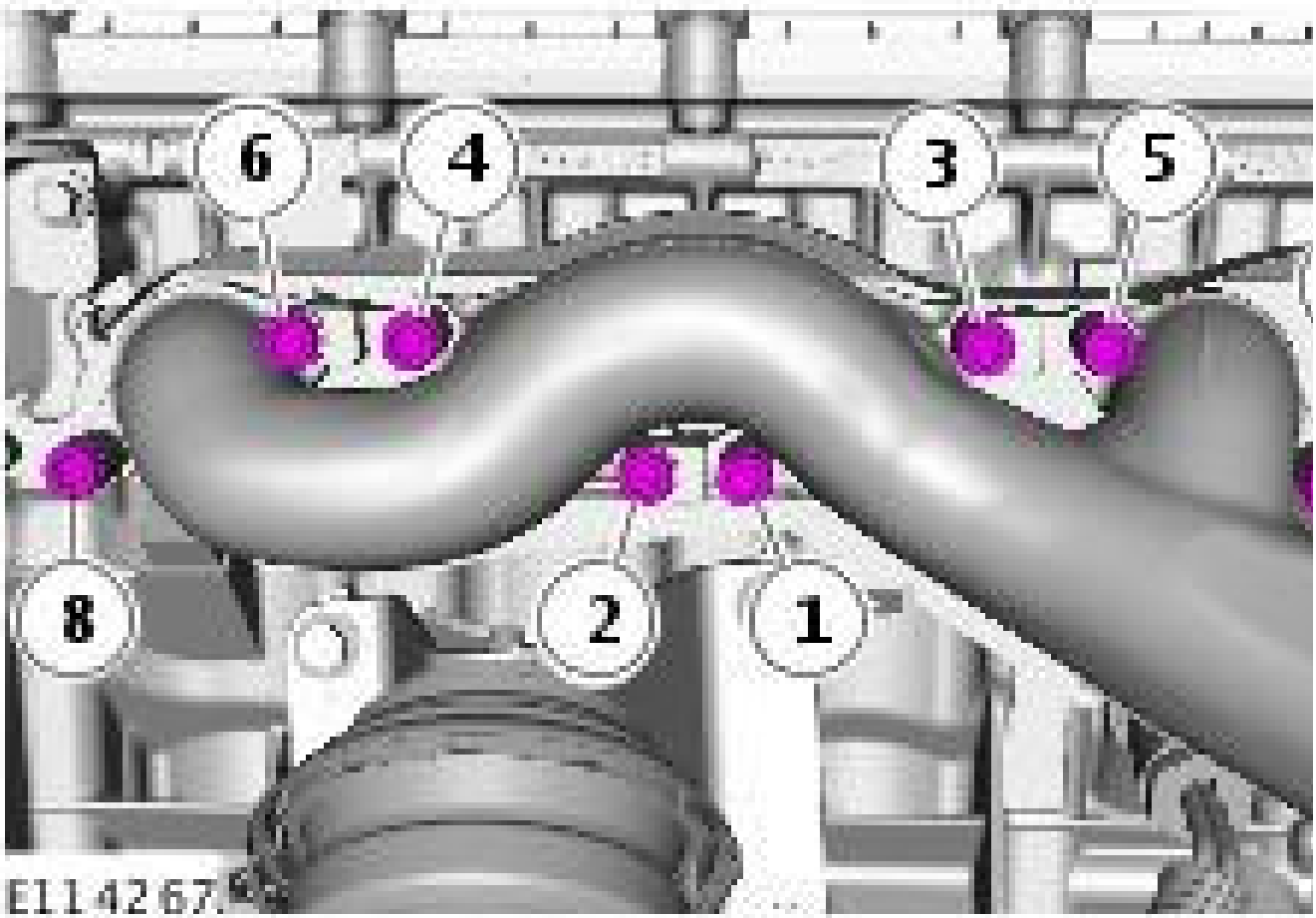
CAUTION: Make sure that new bolts are installed.

CAUTION: LH illustration shown, RH is similar.

NOTE: Install the spacers in the noted position.

7. Torque: 18 Nm

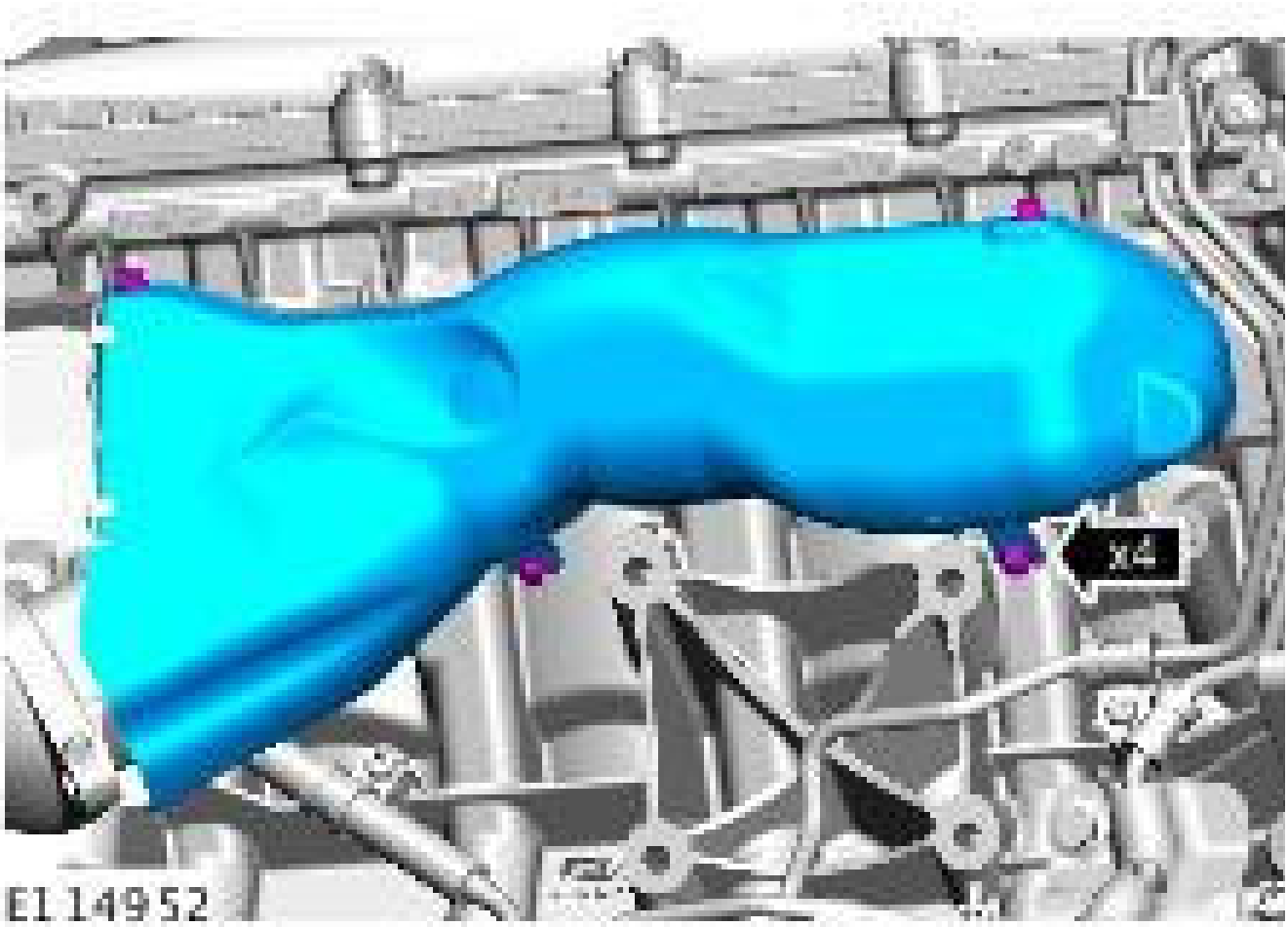
 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: LH illustration shown, RH is similar.

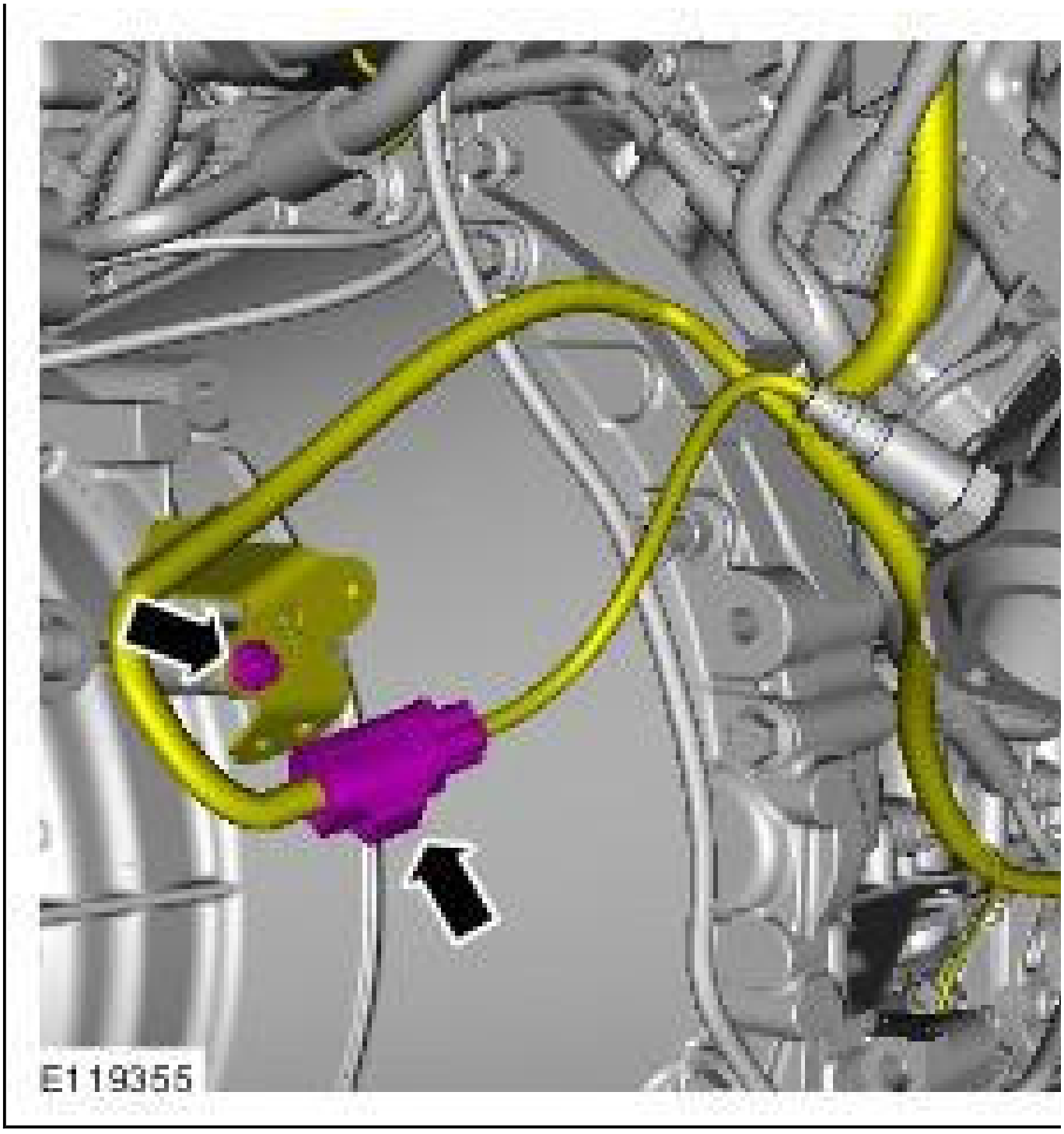
8. Torque: 3 Nm

 © 2011 Mitchell Repair Information Company, LLC.



9. Torque: 10 Nm

 © 2011 Mitchell Repair Information Company, LLC.



10. Torque: 10 Nm

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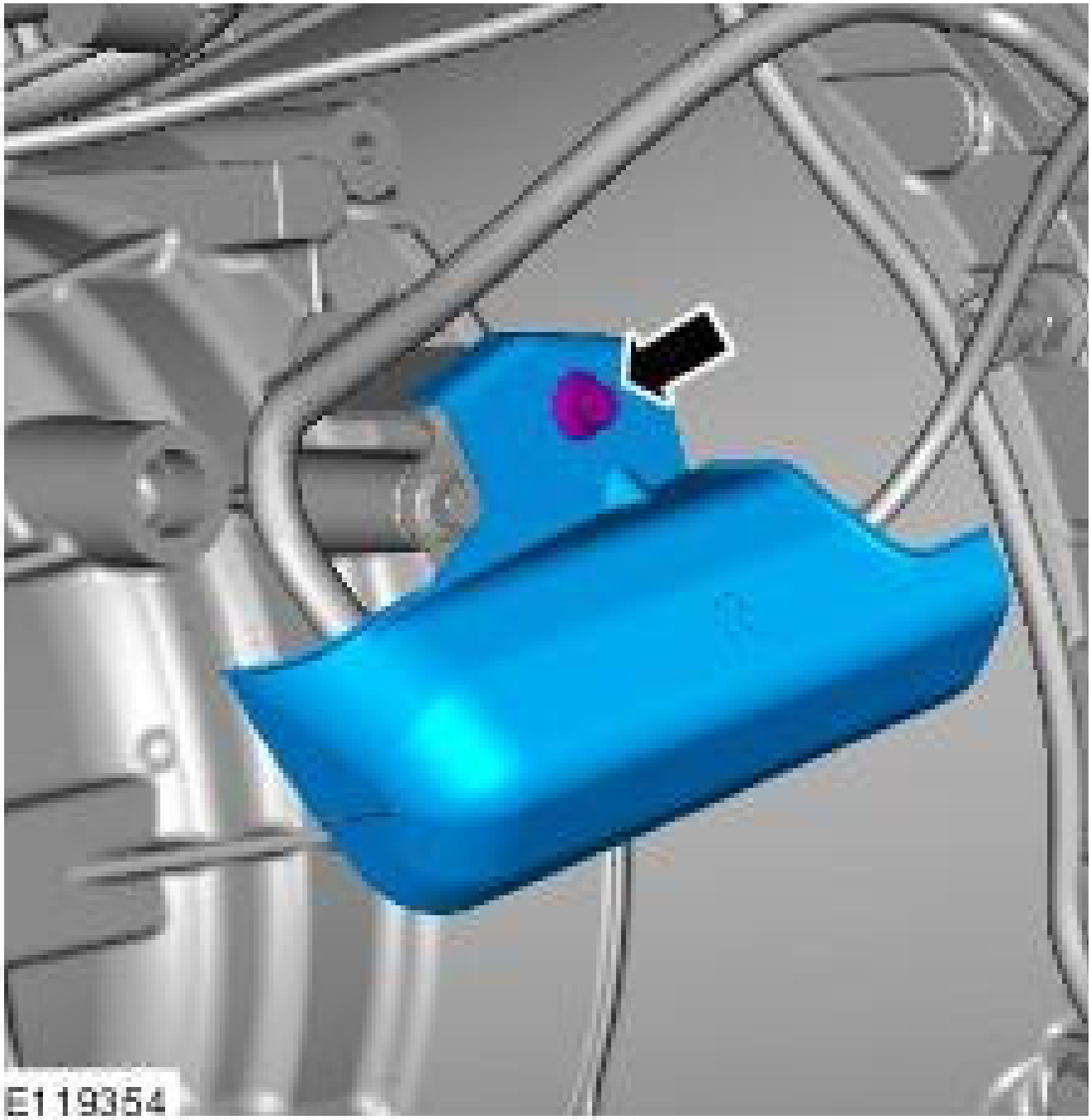
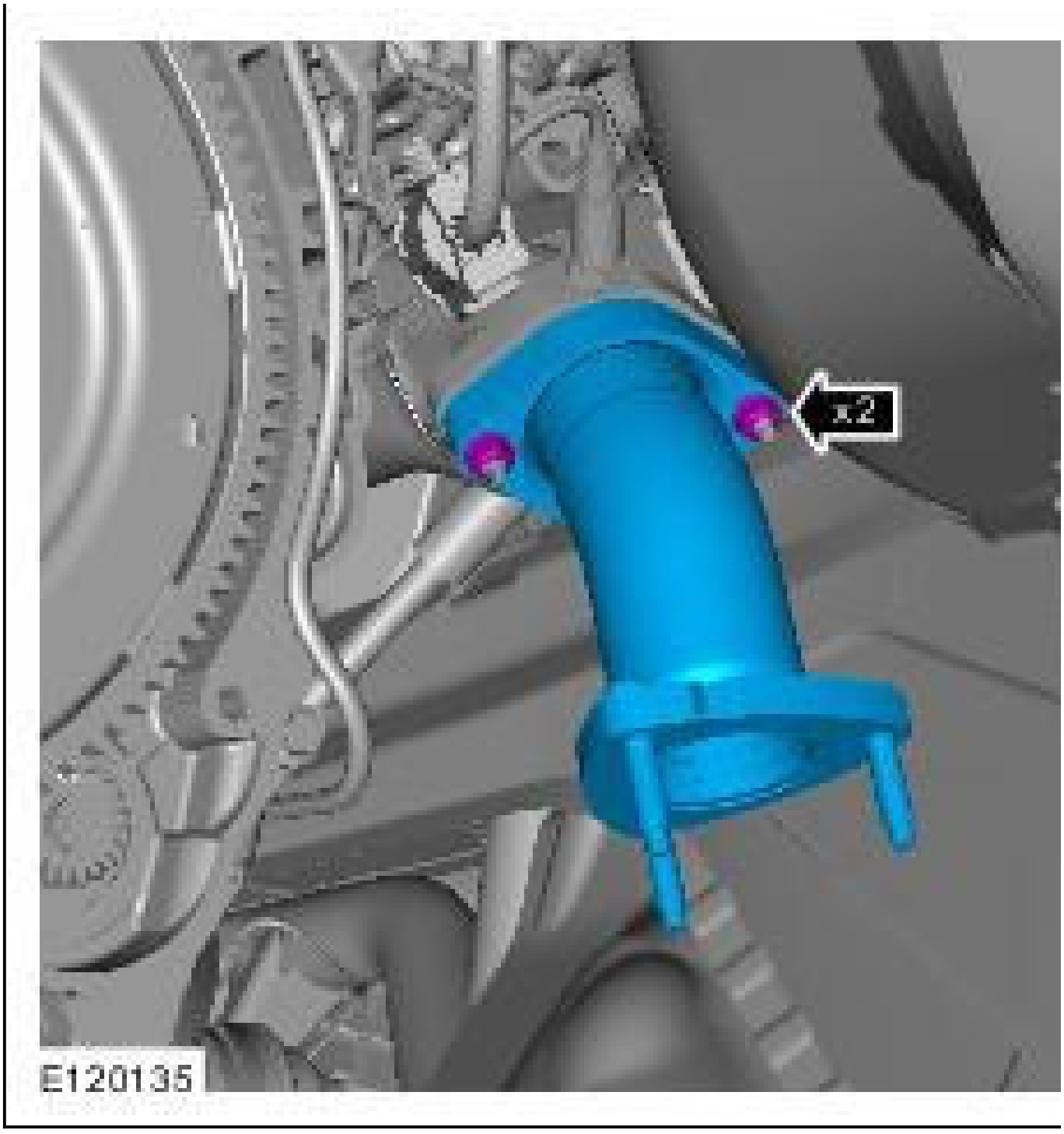


11. Torque: 48 Nm

 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Install a new gasket.

12. Refer to **Exhaust System** .
13. Connect the battery ground cable. Refer to **Specifications** .

FLEXPLATE

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REMOVAL

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

1. 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. Refer to **Automatic Transmission/Transaxle (V8 5.0L Petrol/V8 S/C 5.0L Petrol, 5.0L)**

   CAUTION: Install all the bolts finger tight before final tightening.

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

   CAUTION: Make sure that no components fall off during removal.

   CAUTION: Install the bolts in the noted position.

   NOTE: Make sure that the crankshaft is not rotated.

   NOTE: Make sure the crankshaft and flexplate mating faces are clean before installation.

   NOTE: Tighten the retaining bolts working diagonally.

4. Torque:

   Stage 1: 45 Nm

   Stage 2: 90°

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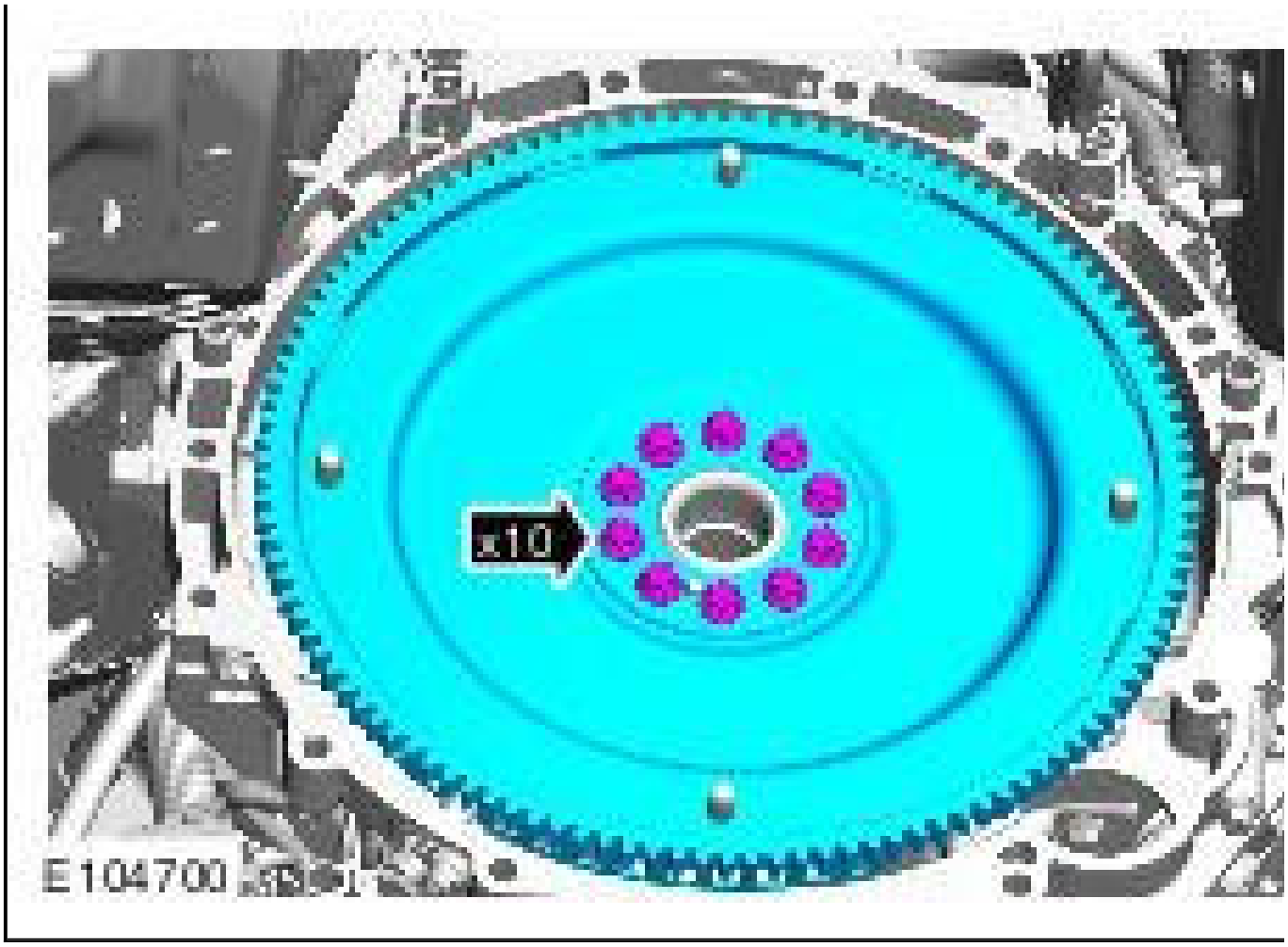

INSTALLATION

1. To install, reverse the removal procedure.

INTAKE MANIFOLD

REMOVAL

NOTE: Removal steps in this procedure may contain installation details. Some variation in the illustrations may occur, but the essential information is always correct.

1. Disconnect the battery ground cable. Refer to **Specifications** .

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

2. Raise and support the vehicle.

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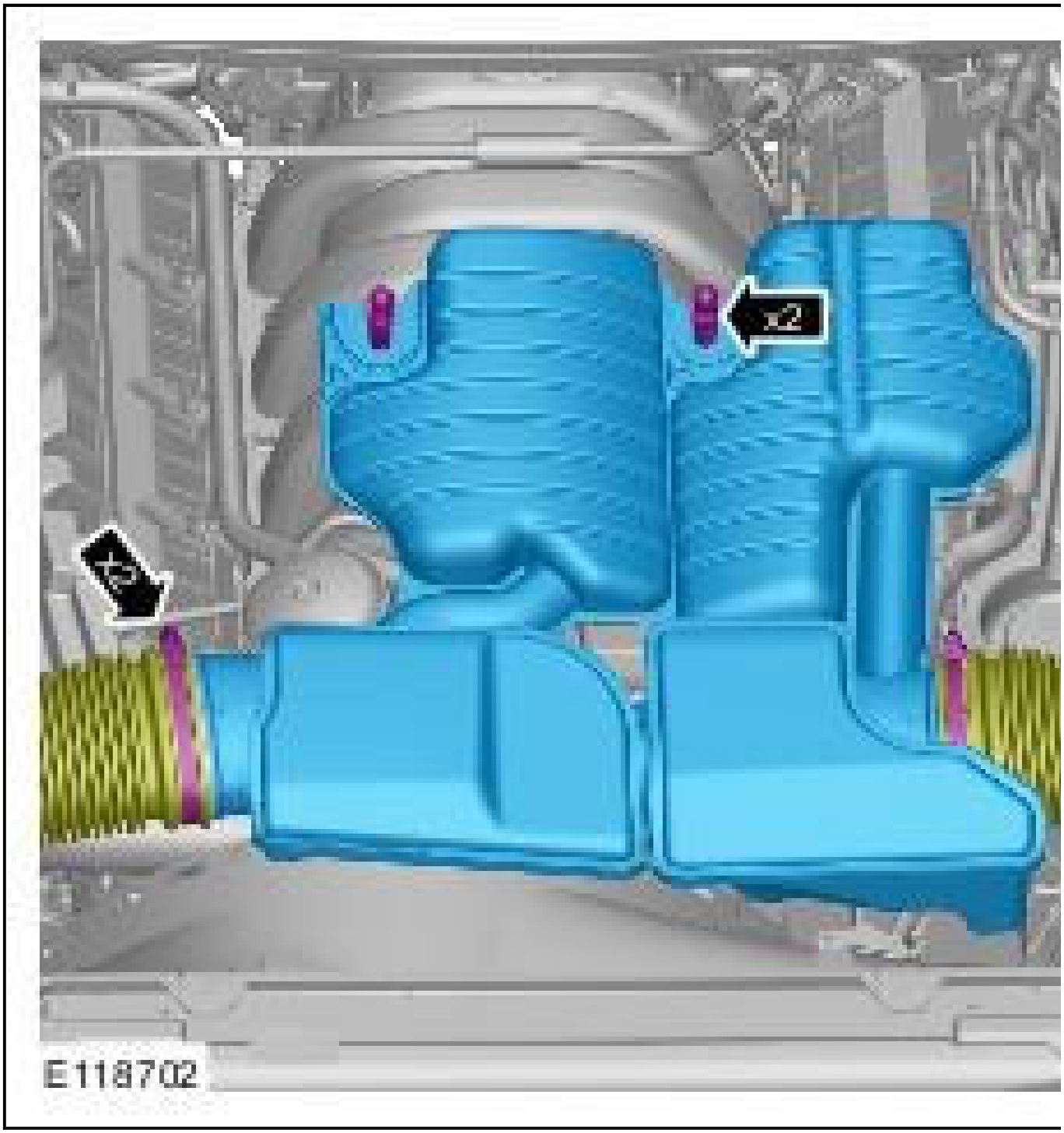
3. Refer to **Engine Cover - 5.0L** .
4. See figure



5. See figure

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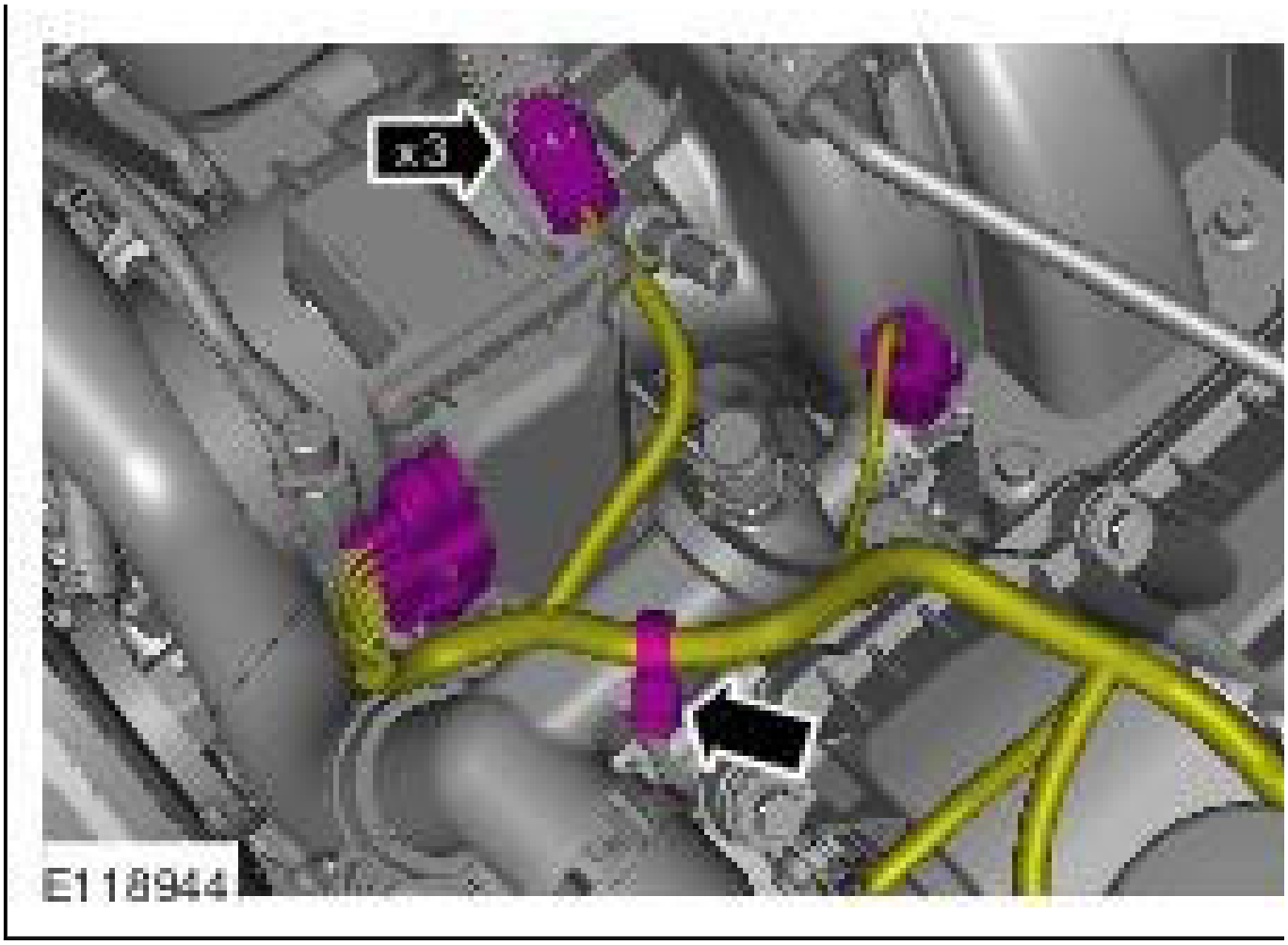

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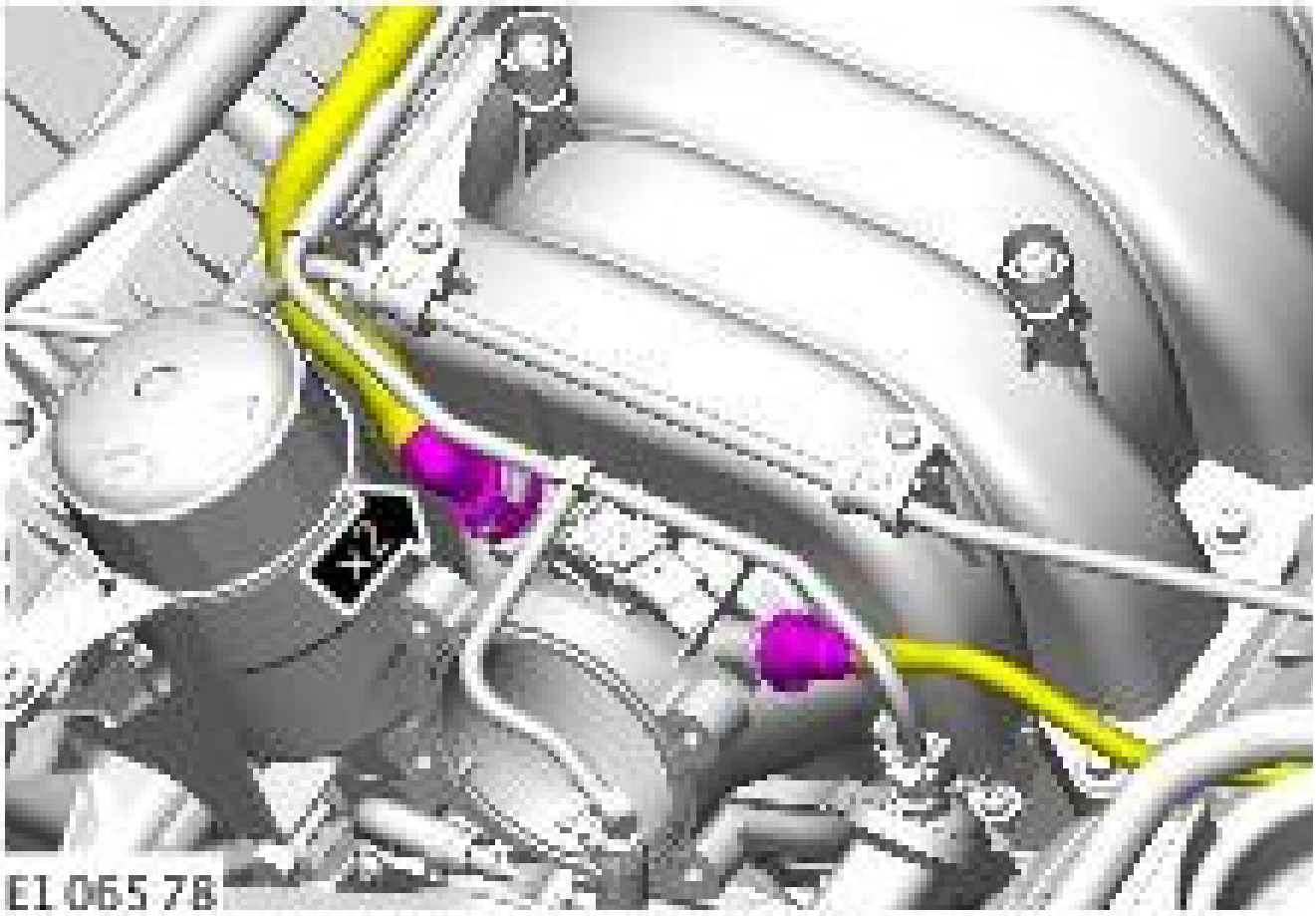

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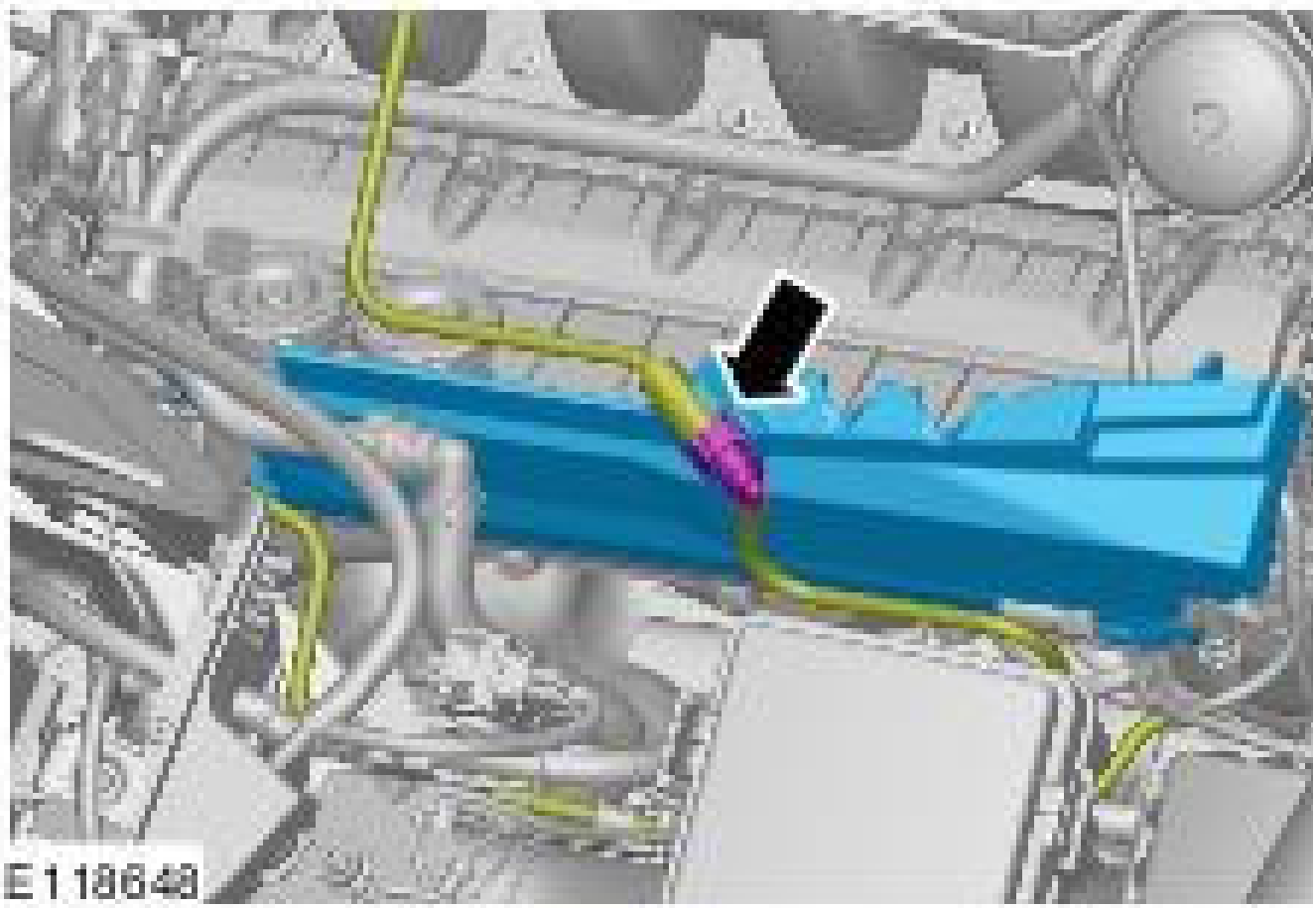

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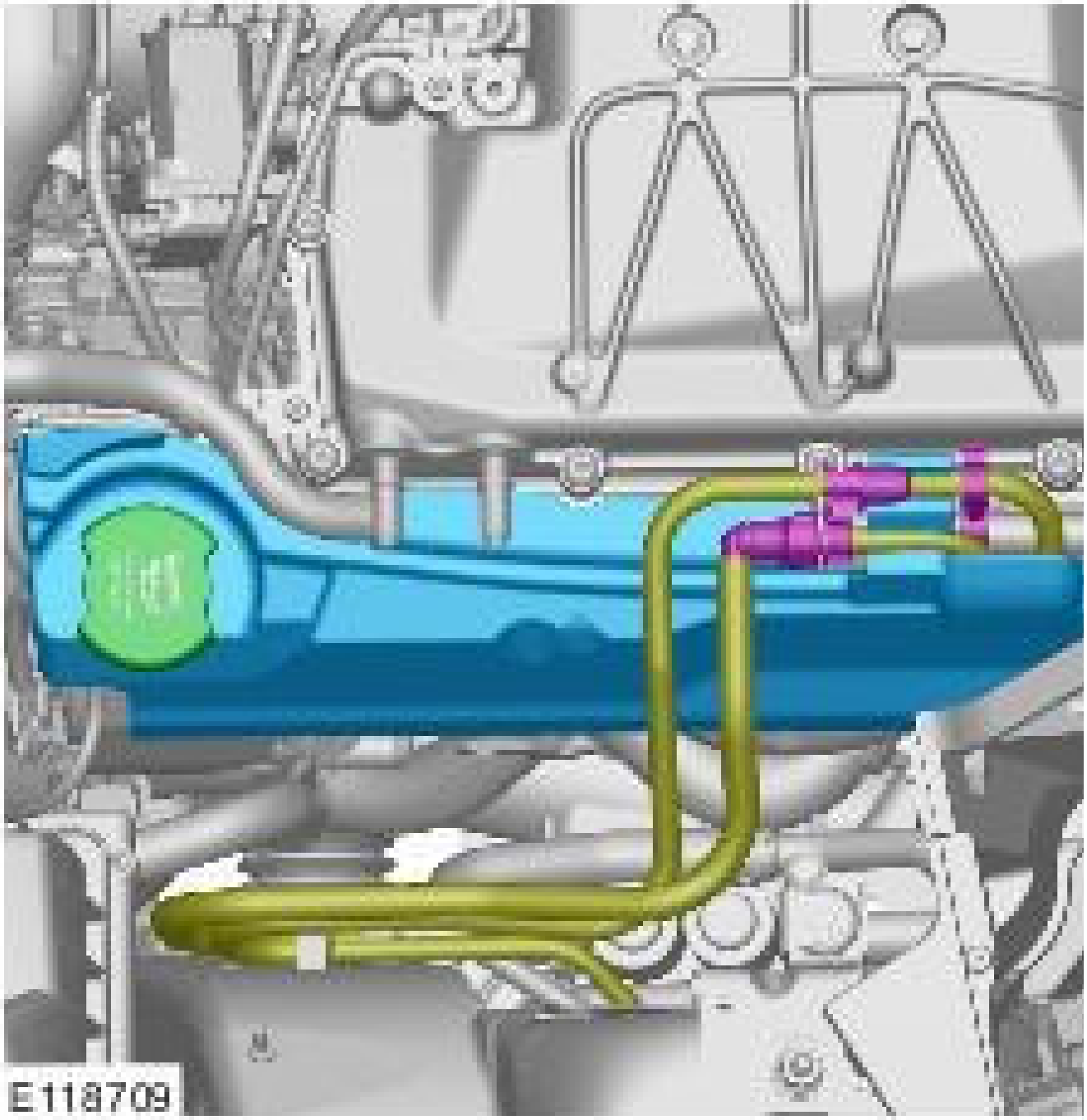

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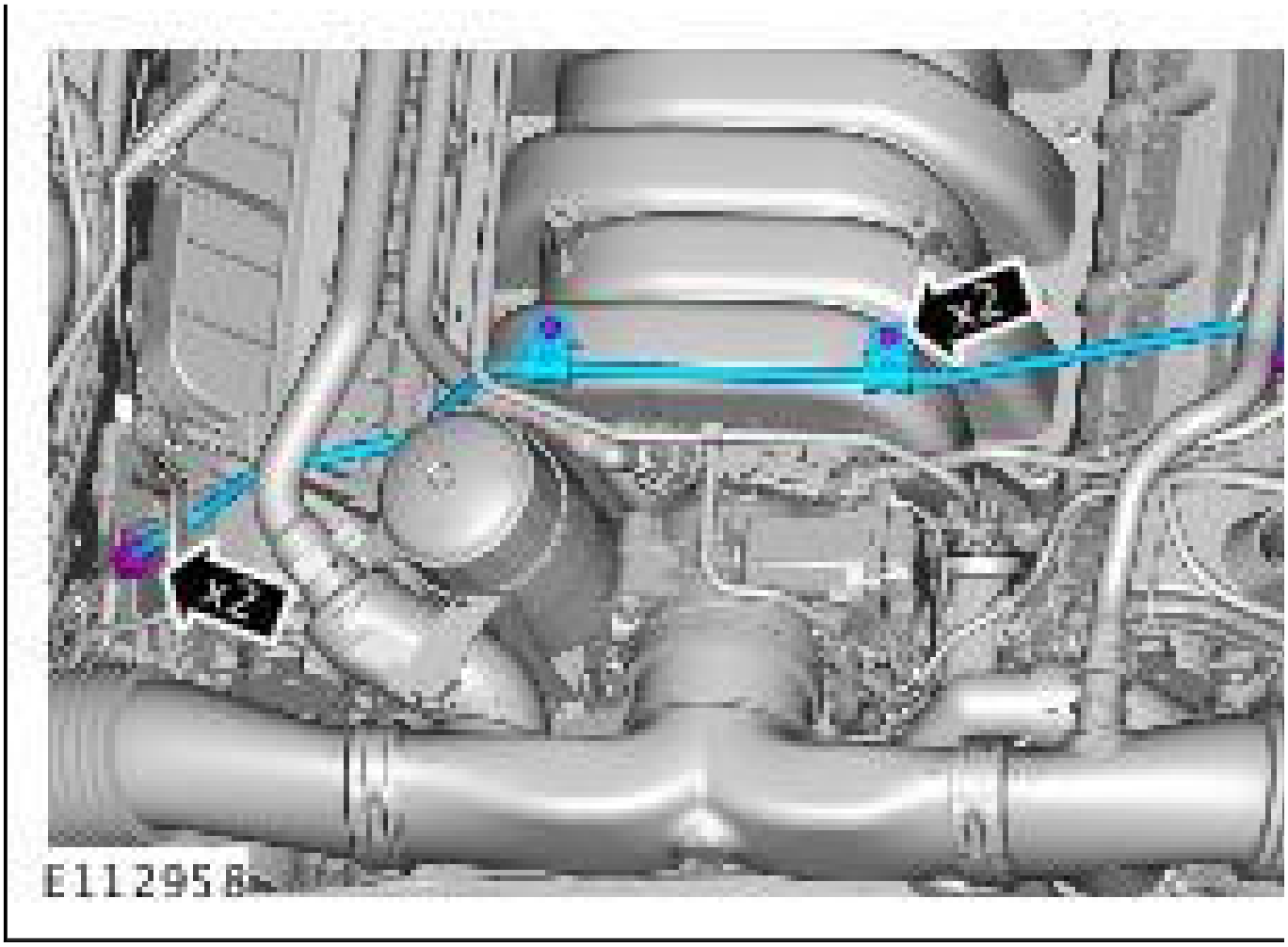

CAUTION: Be prepared to collect escaping fluids.

CAUTION: Make sure that all openings are sealed. Use new blanking caps.

10. See figure

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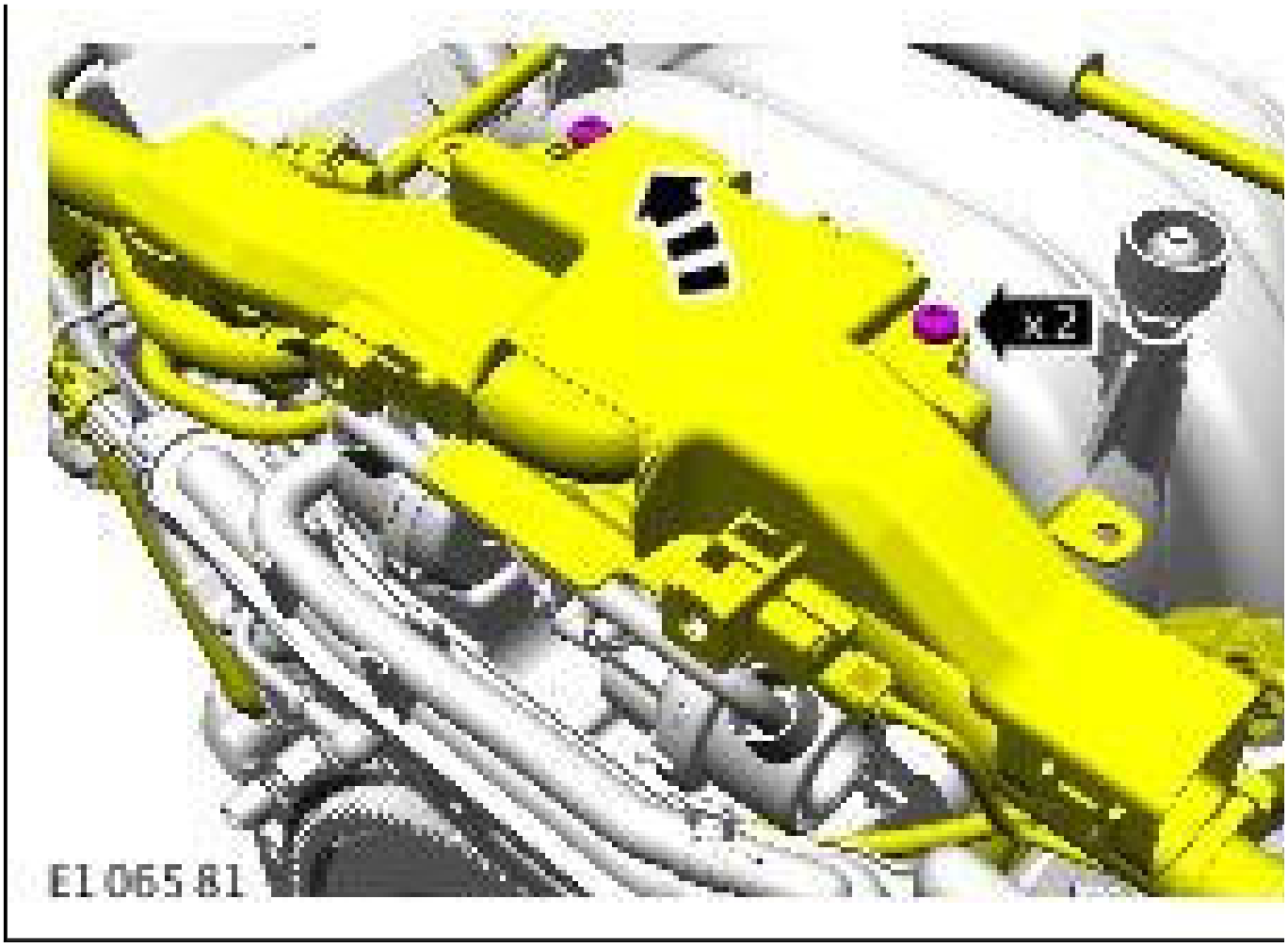

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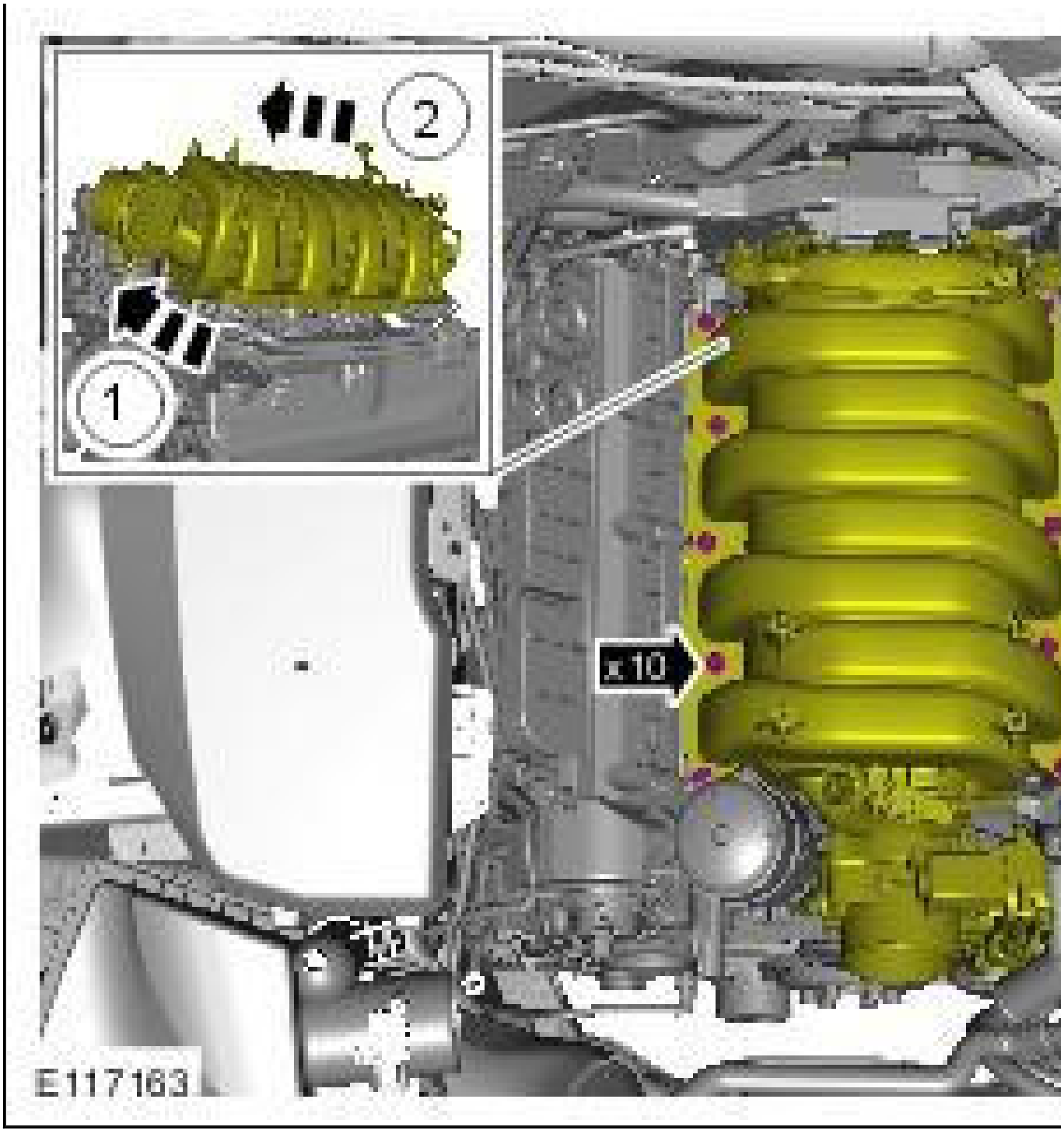

12. See figure

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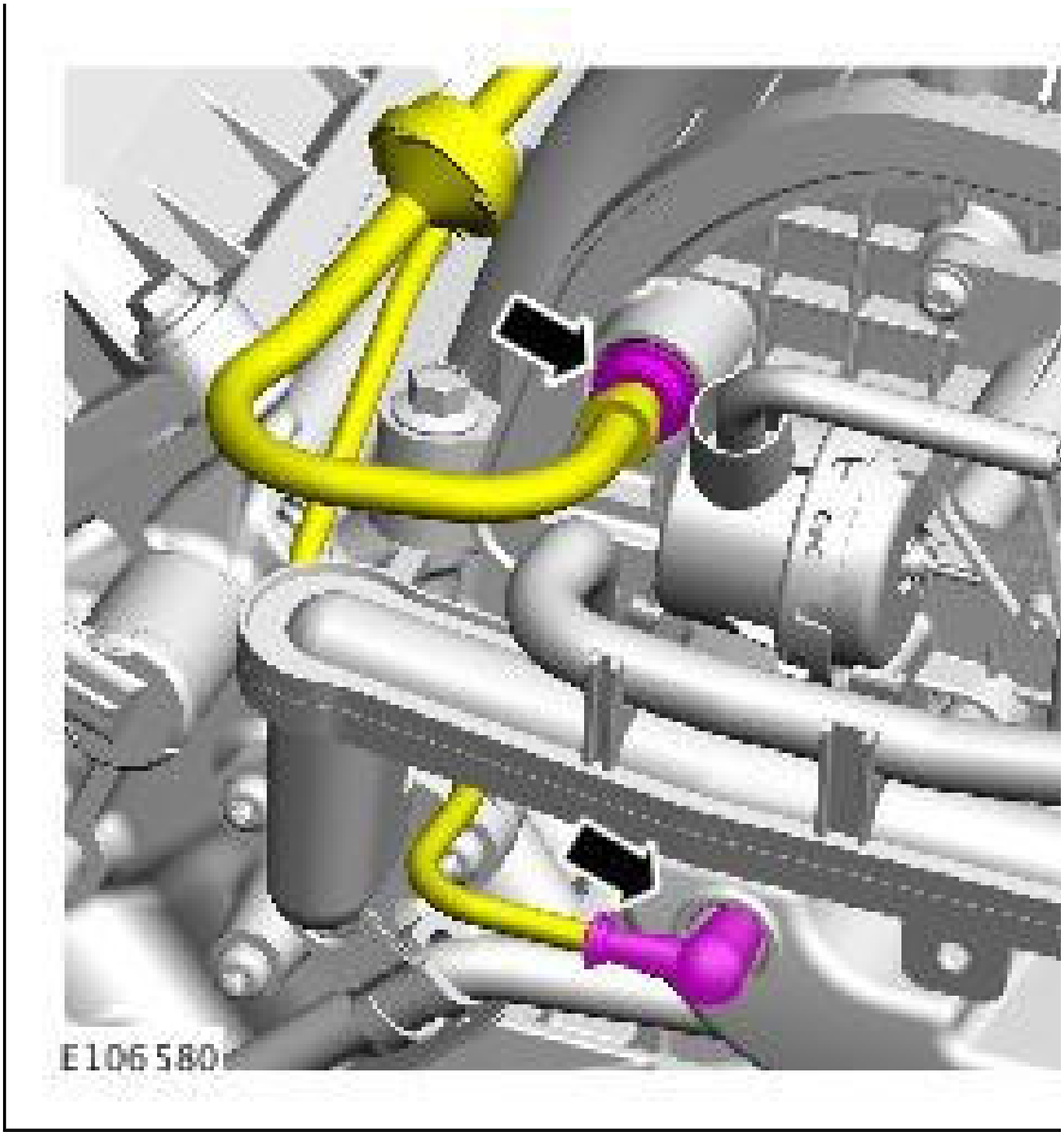

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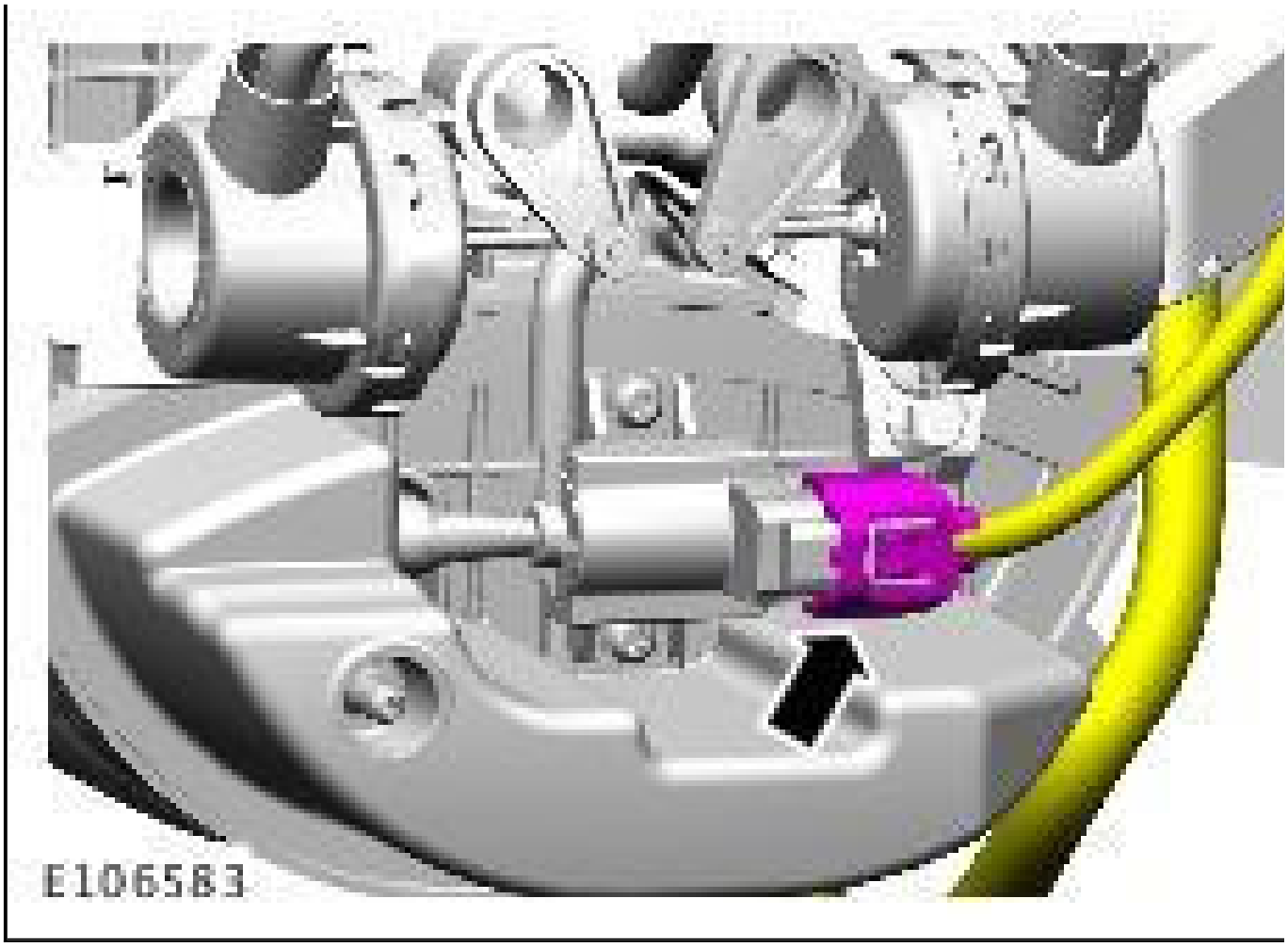

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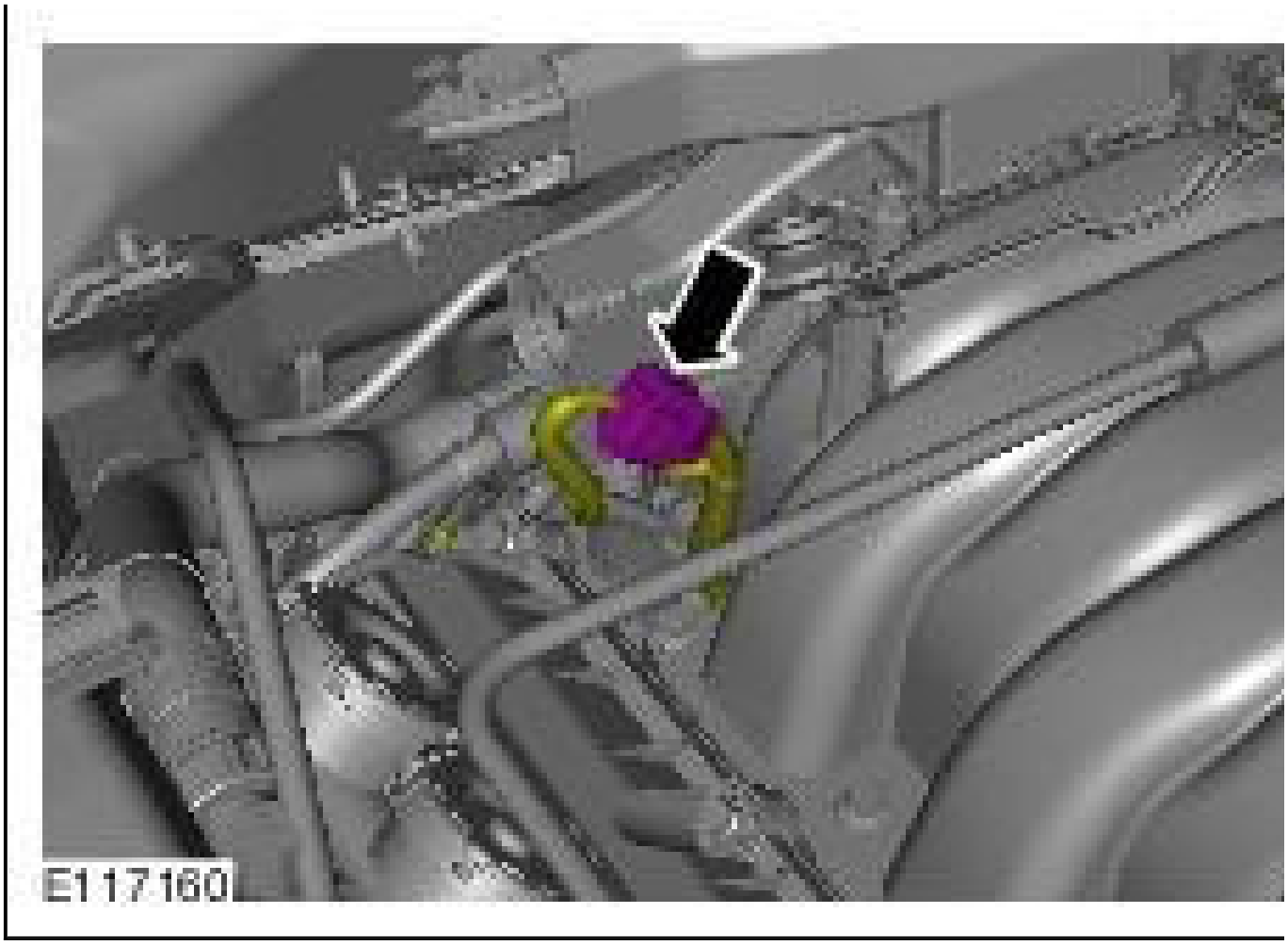

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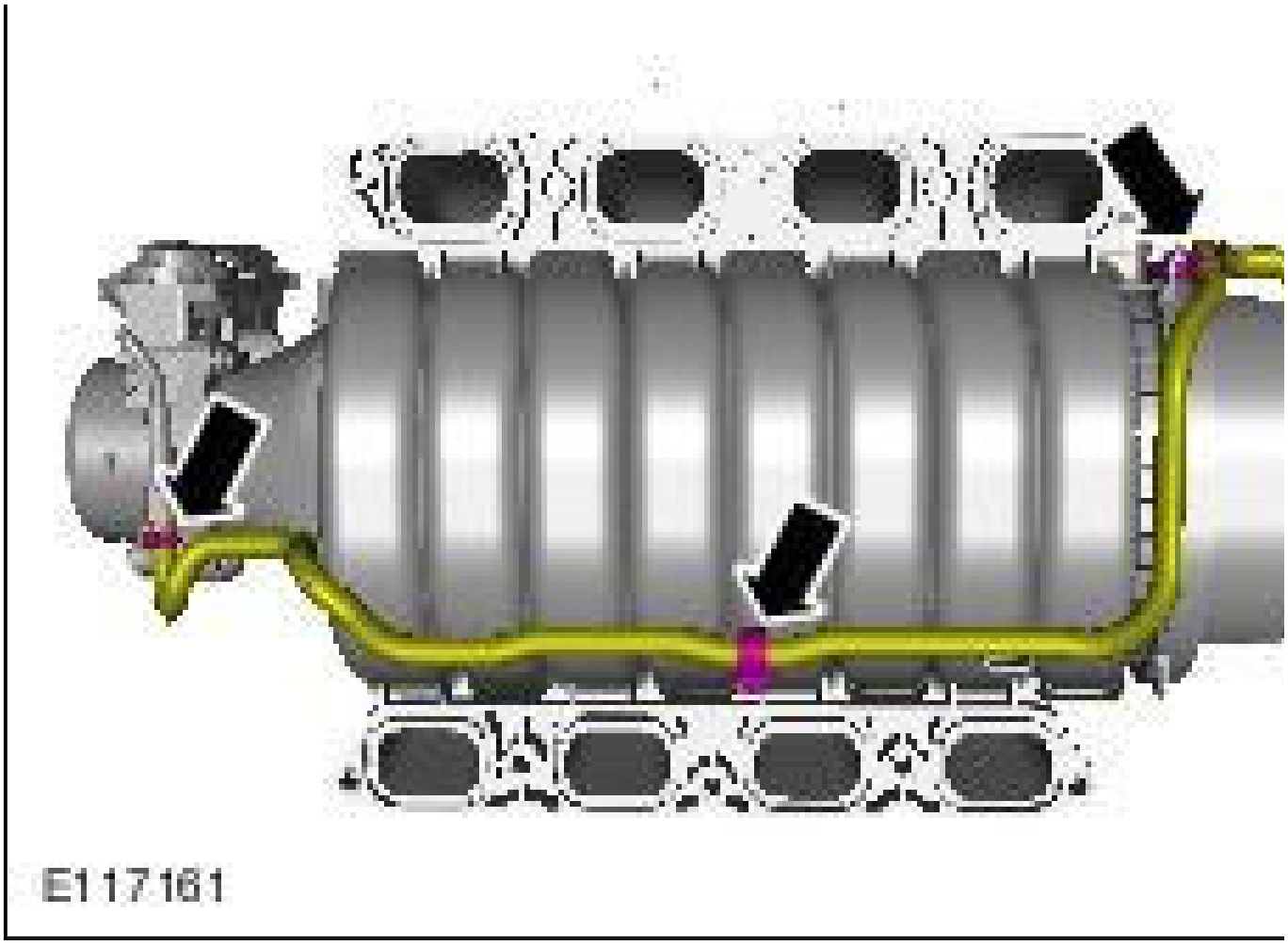

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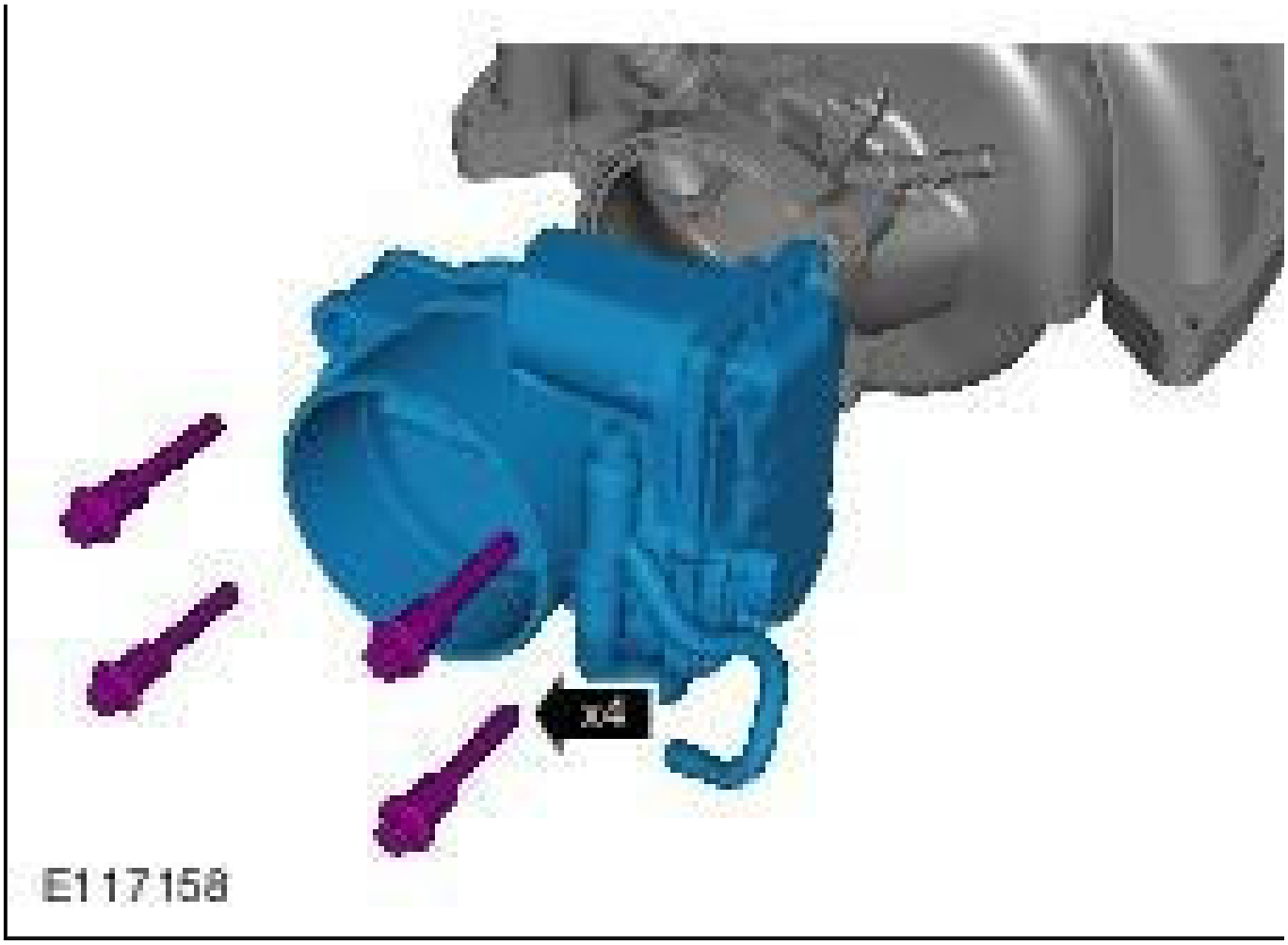

NOTE: Remove and discard the O-ring seal.

17. See figure

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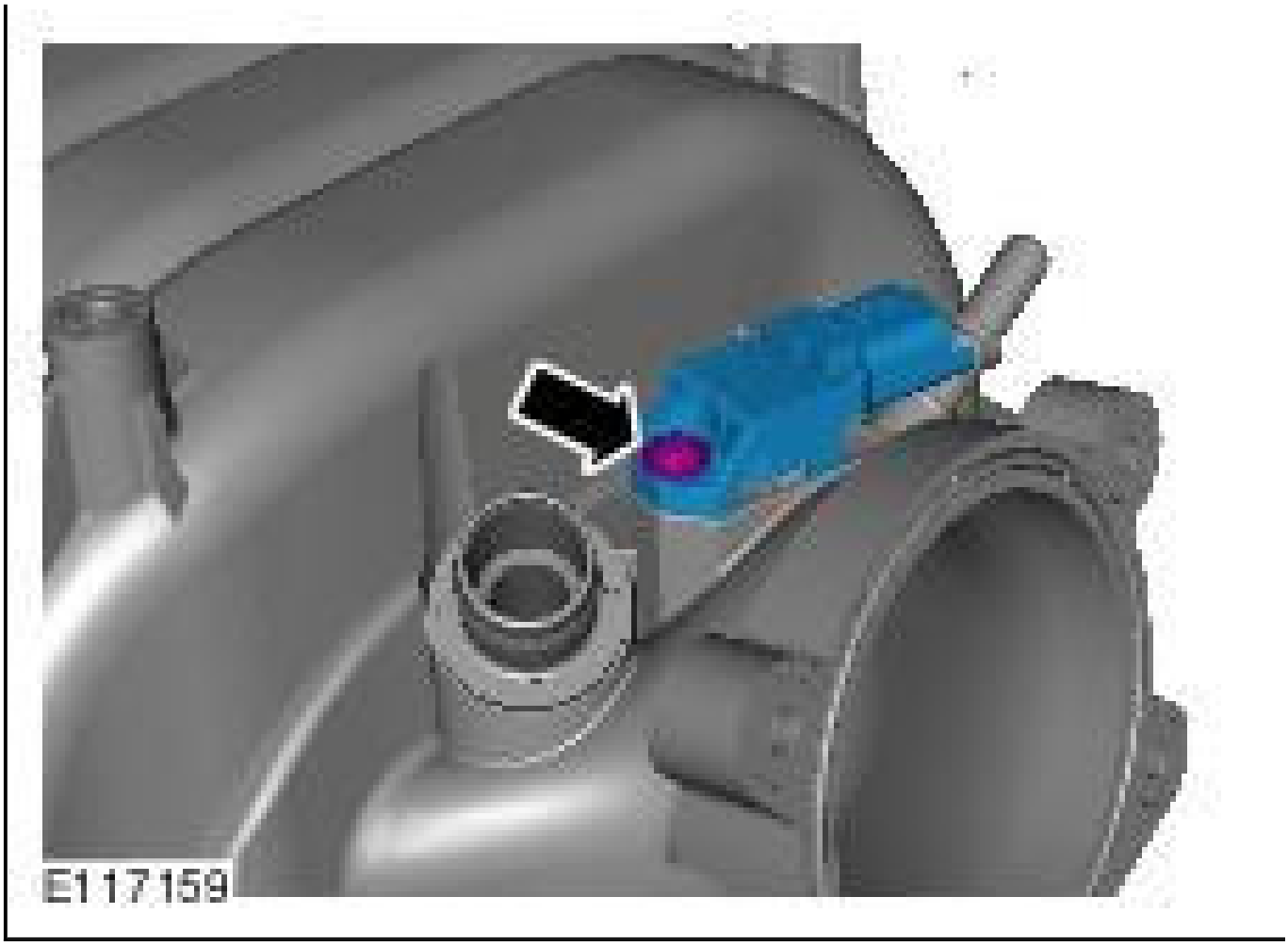

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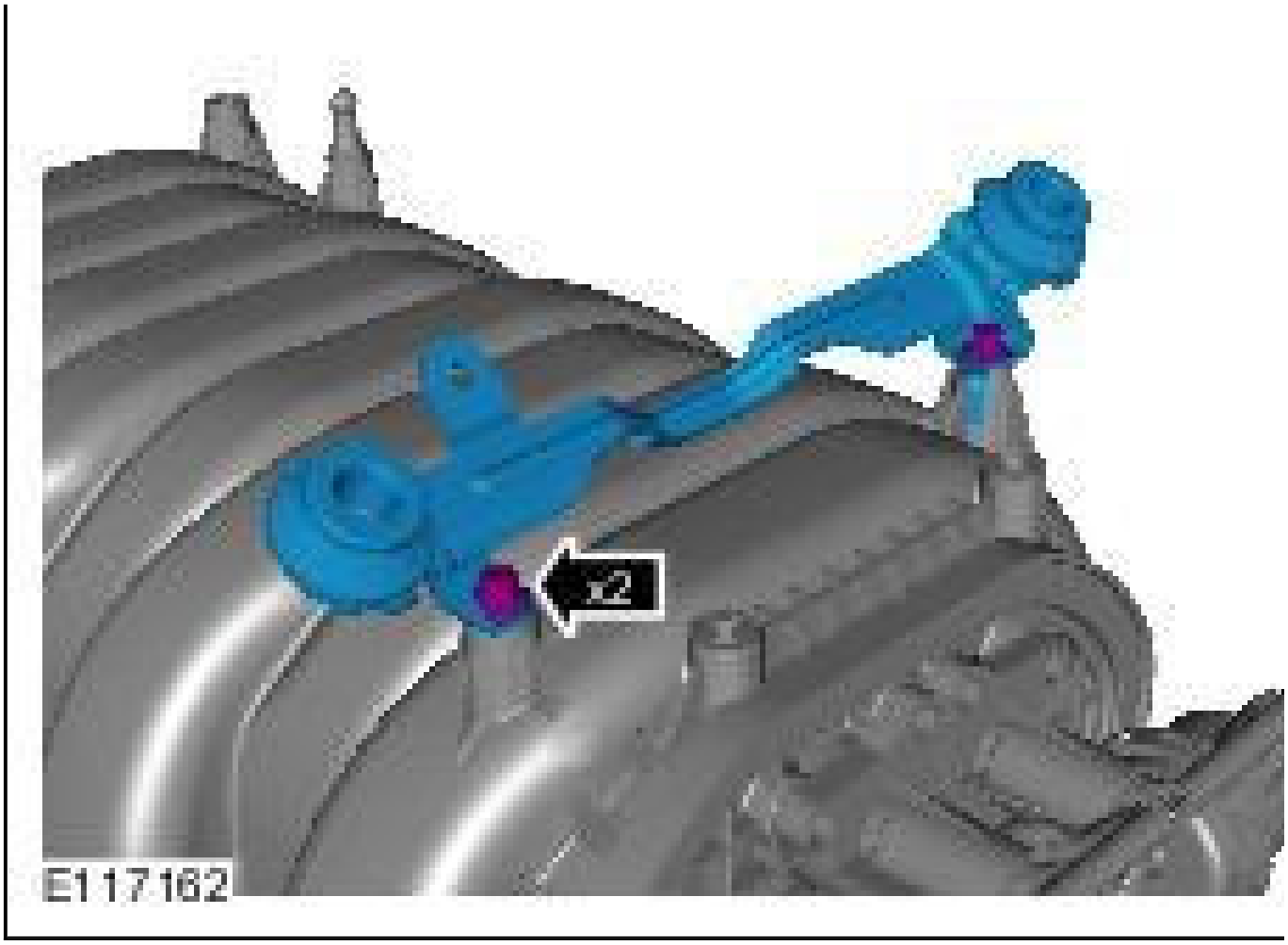

19. See figure

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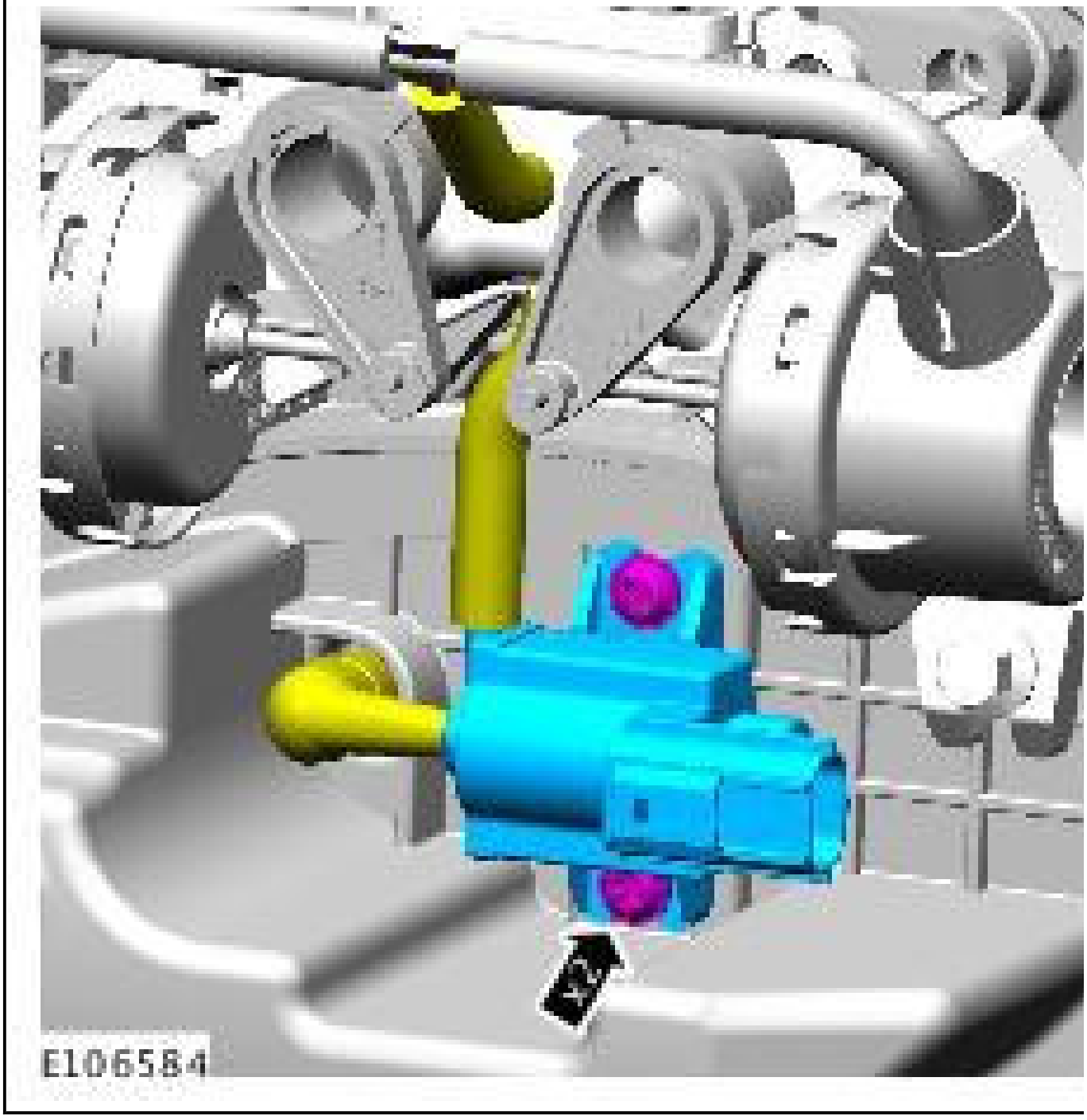

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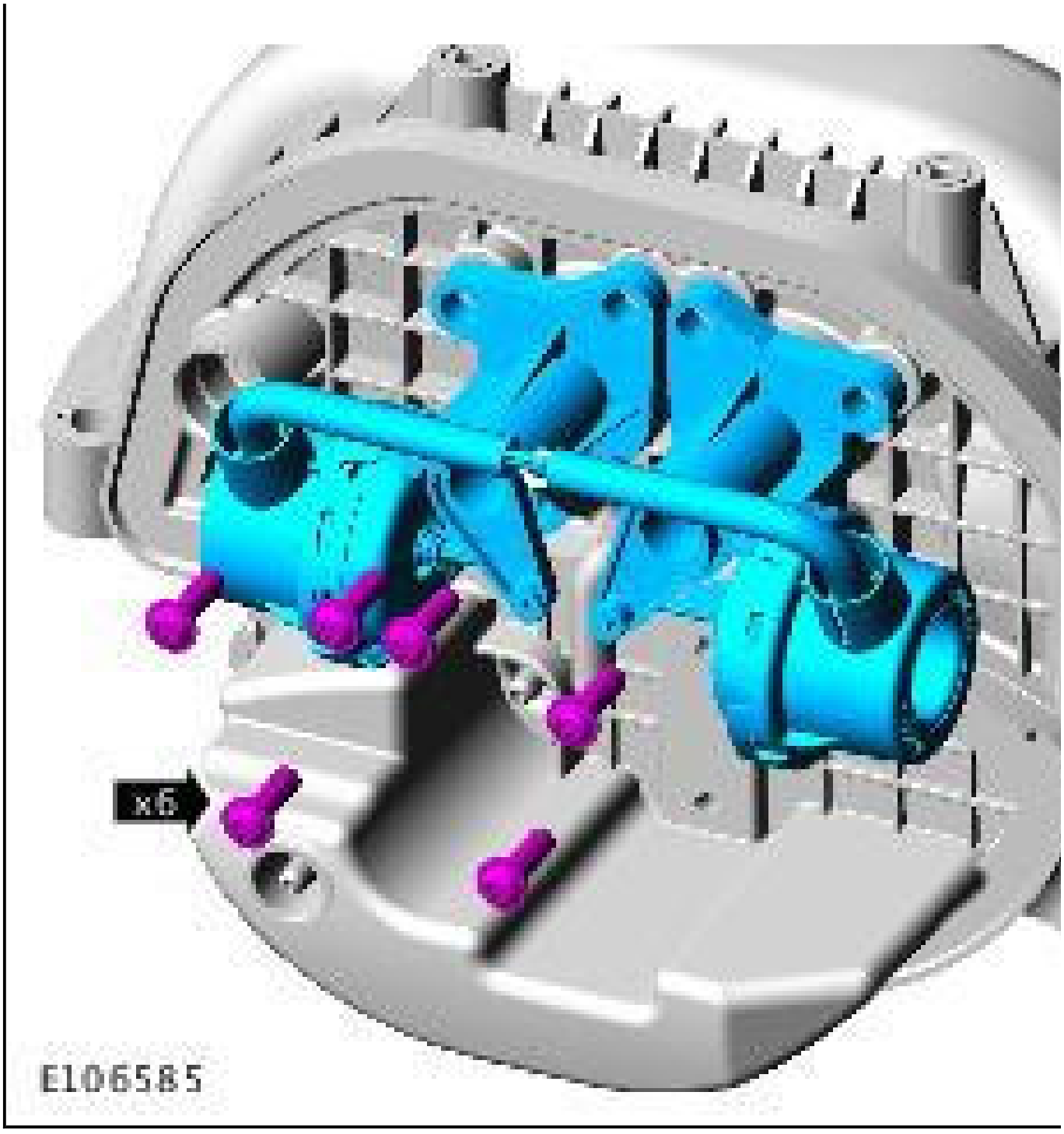

INSTALLATION

1. Torque: 5 Nm

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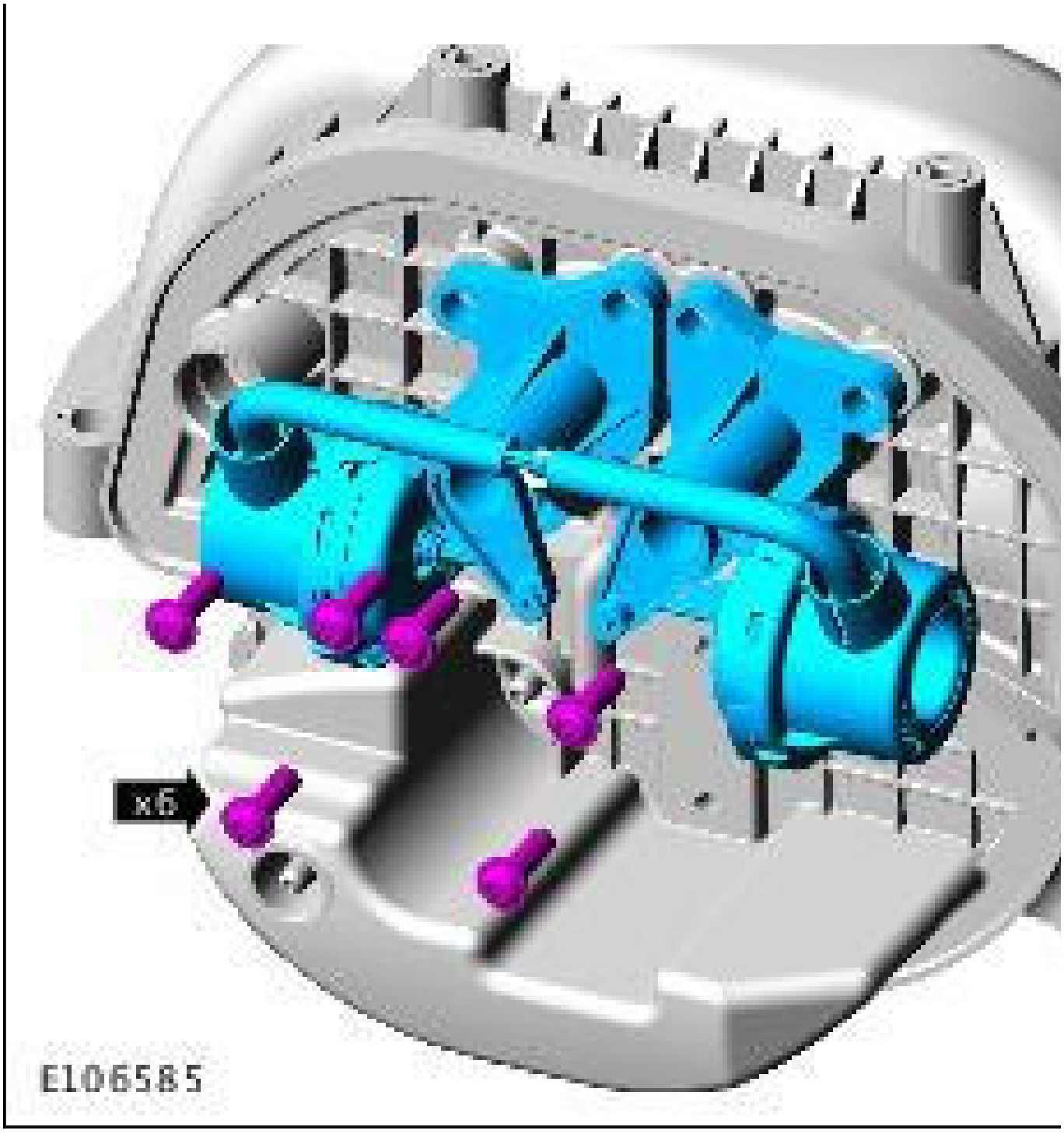

2. Torque: 10 Nm

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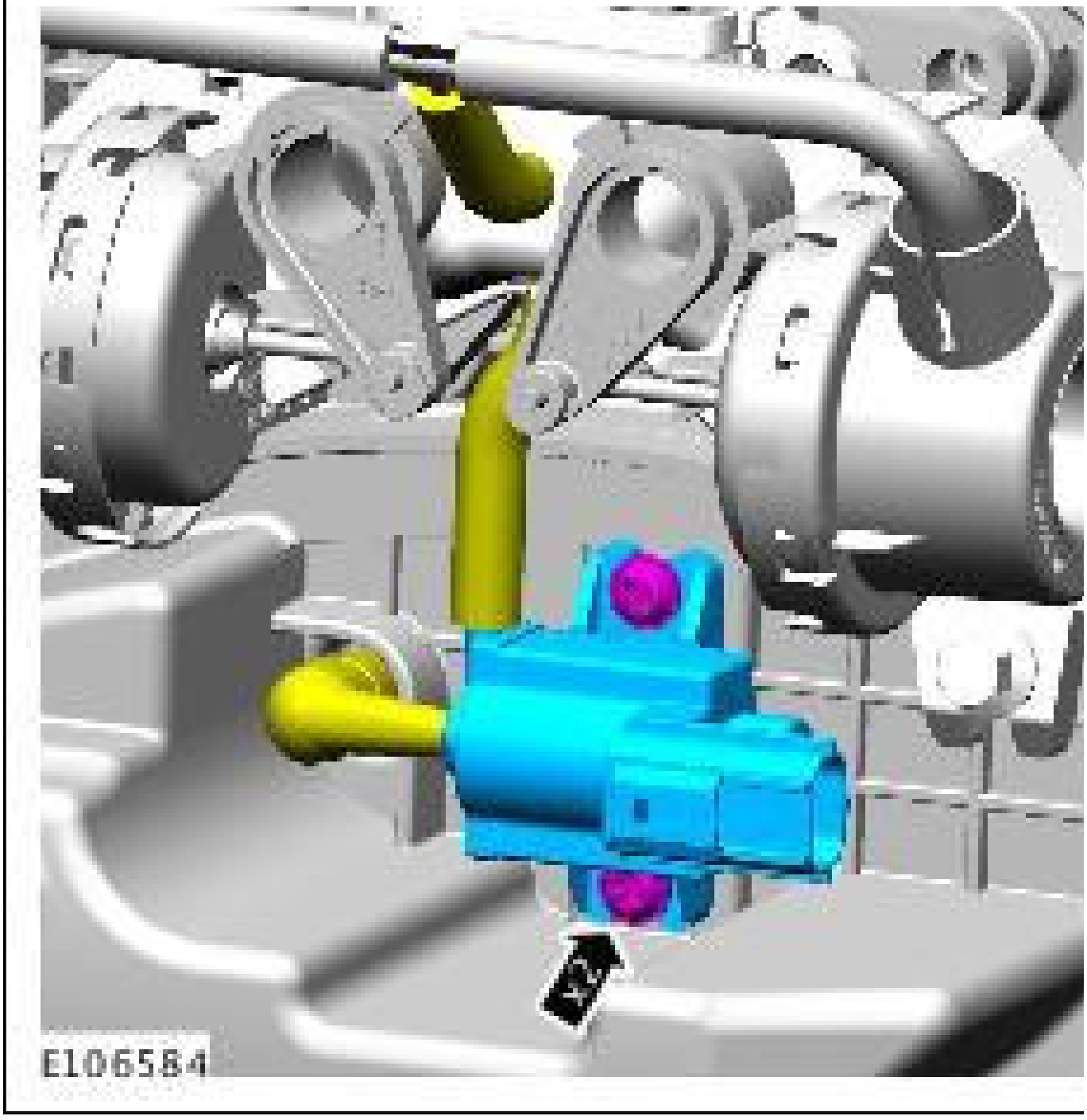

3. Torque: 10 Nm

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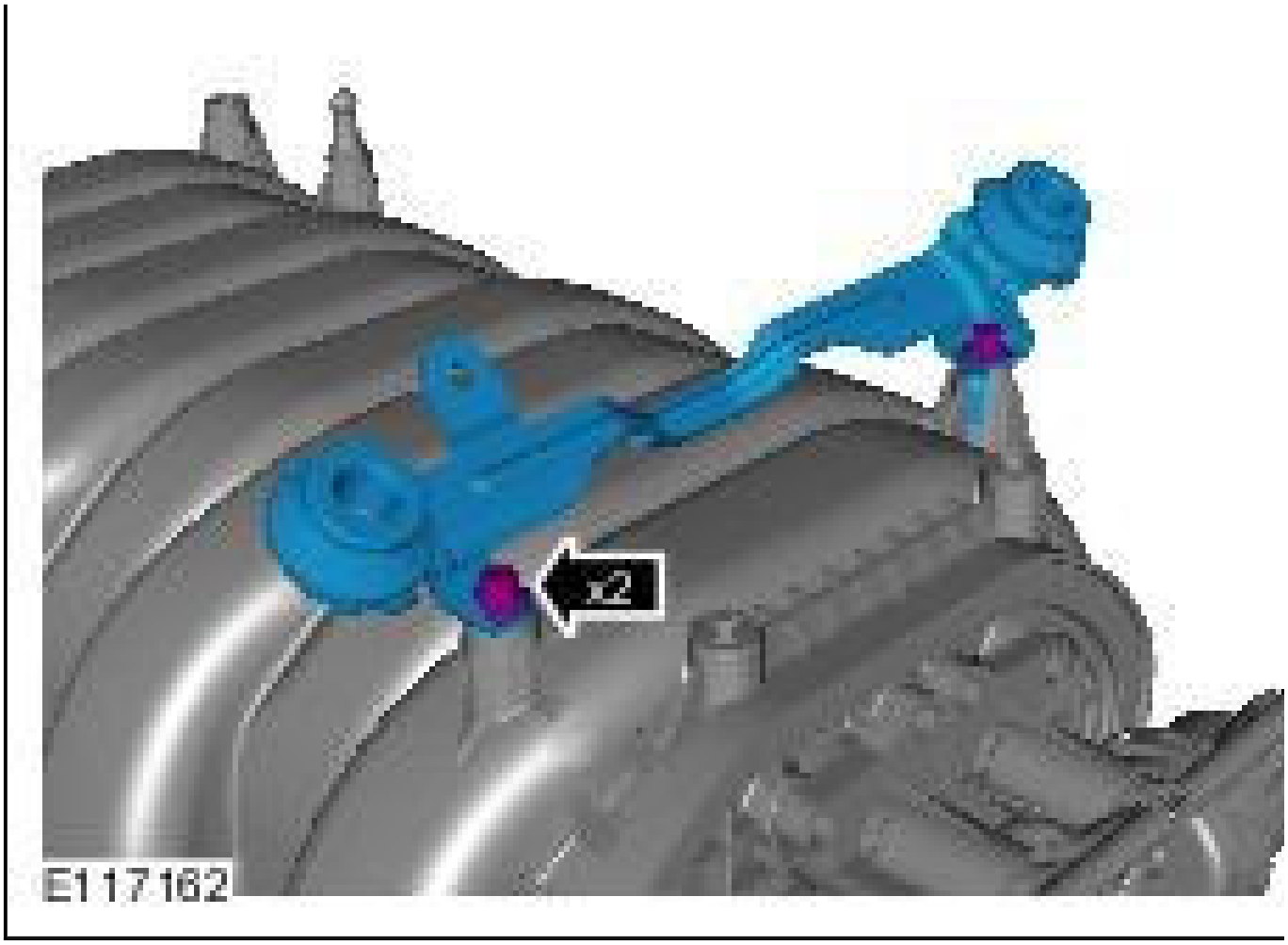

4. Torque: 5 Nm

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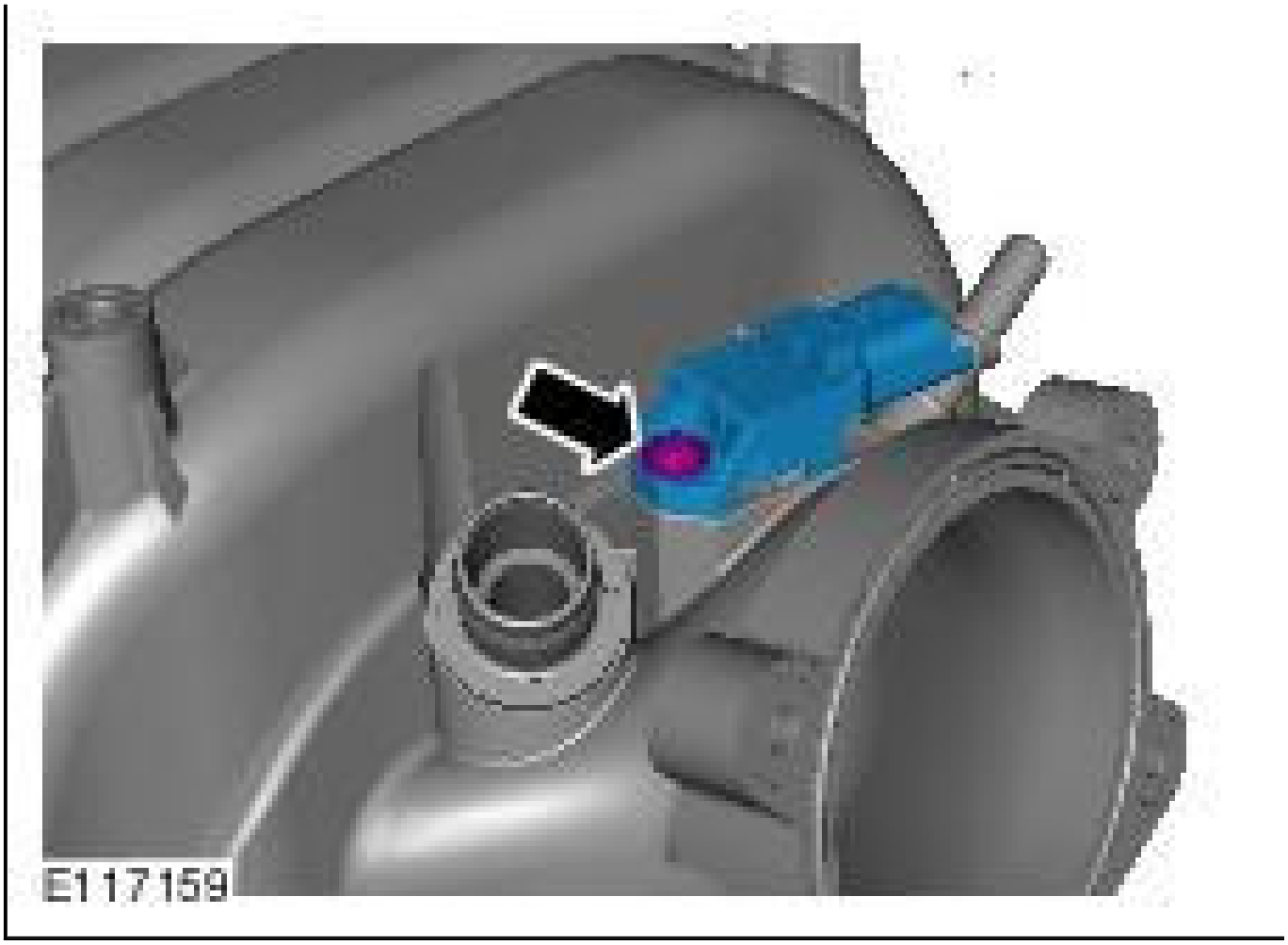

5. Torque: 18 Nm

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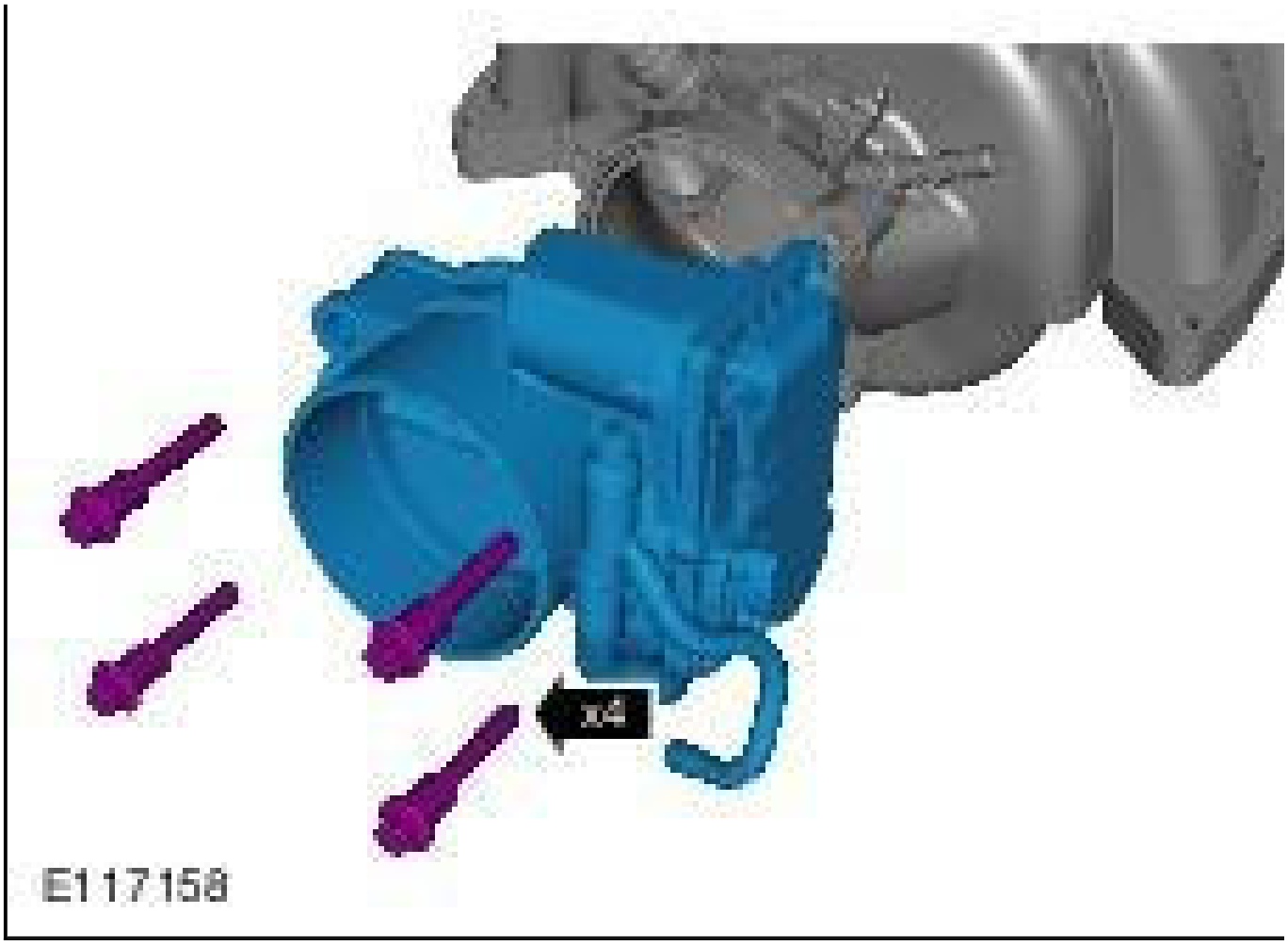

CAUTION: A new O-ring seal is to be installed.

6. See figure

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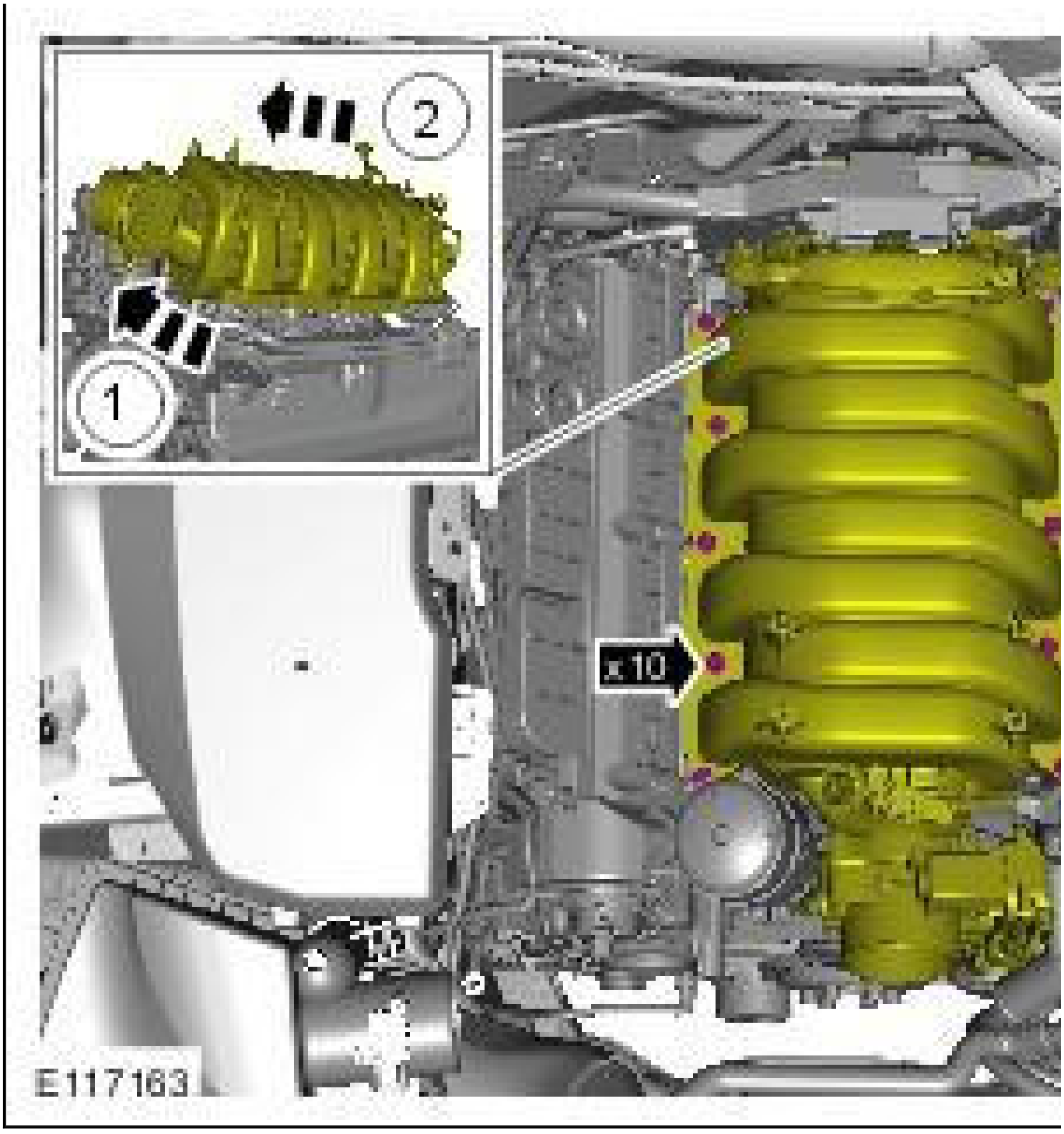

CAUTION: Make sure that the mating faces are clean and free of corrosion and foreign material.

CAUTION: Install new o-ring seals

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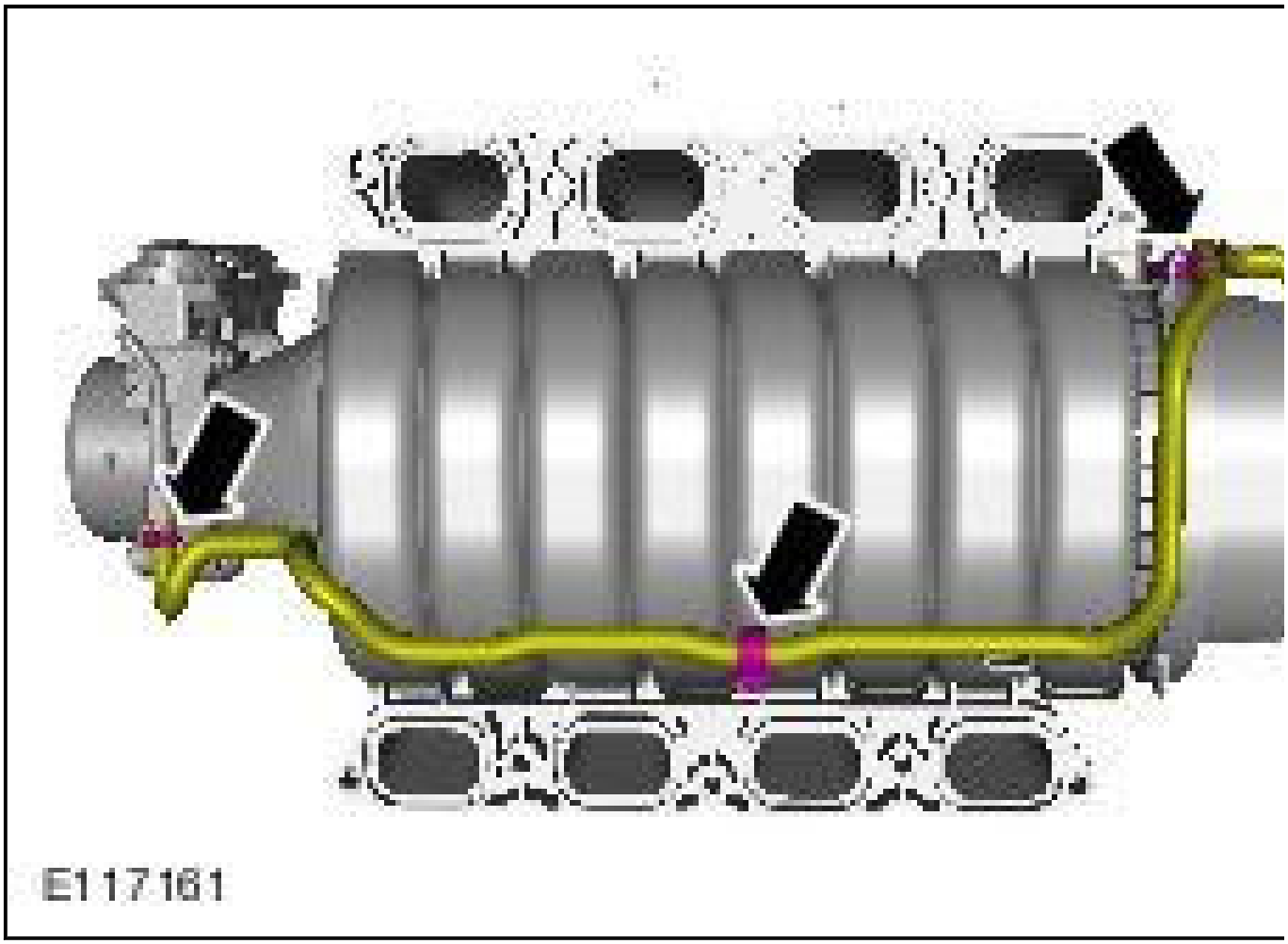
NOTE: Do not tighten at this stage.

7. See figure



8. See figure

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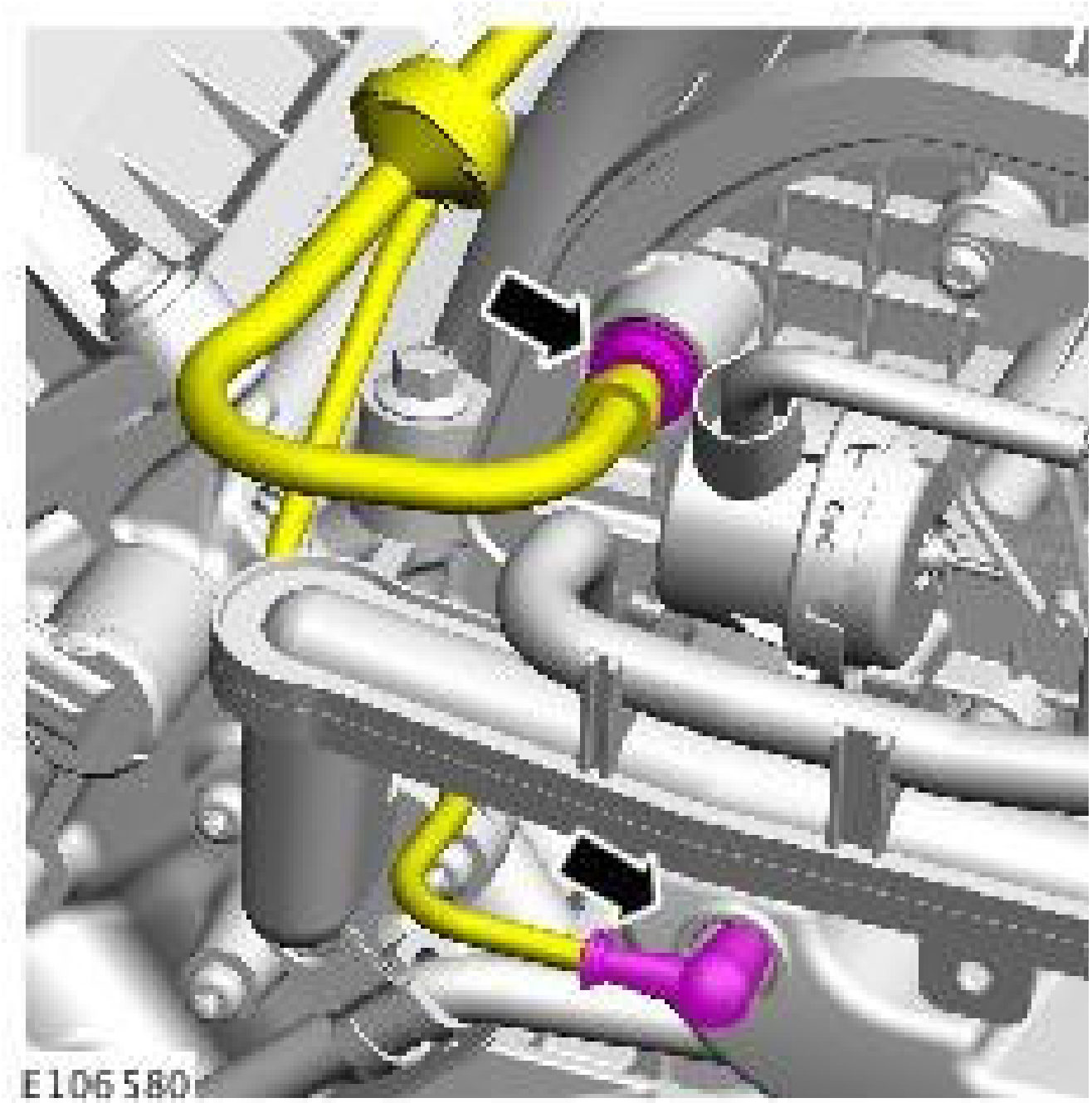

9. See figure

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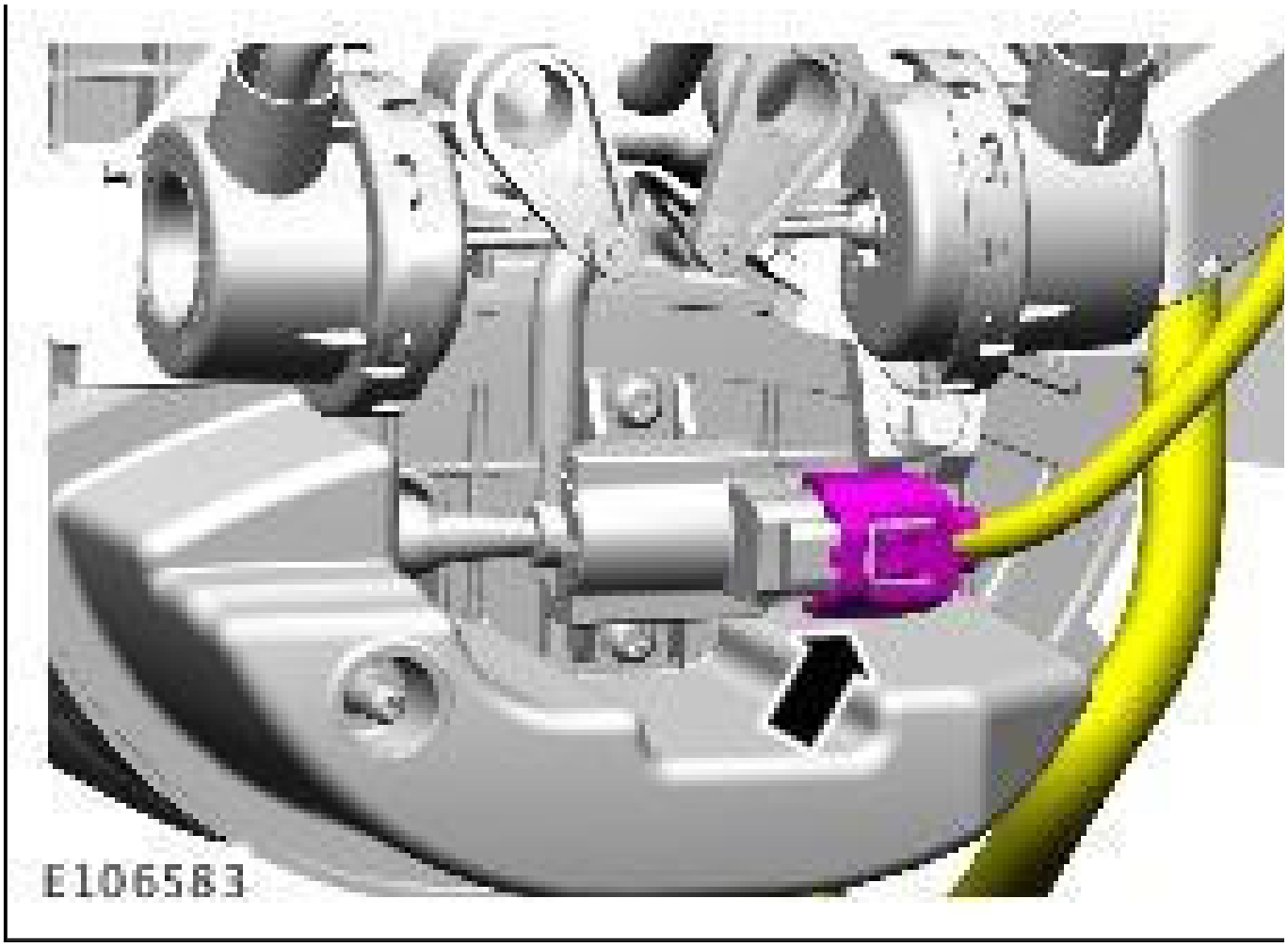

10. See figure

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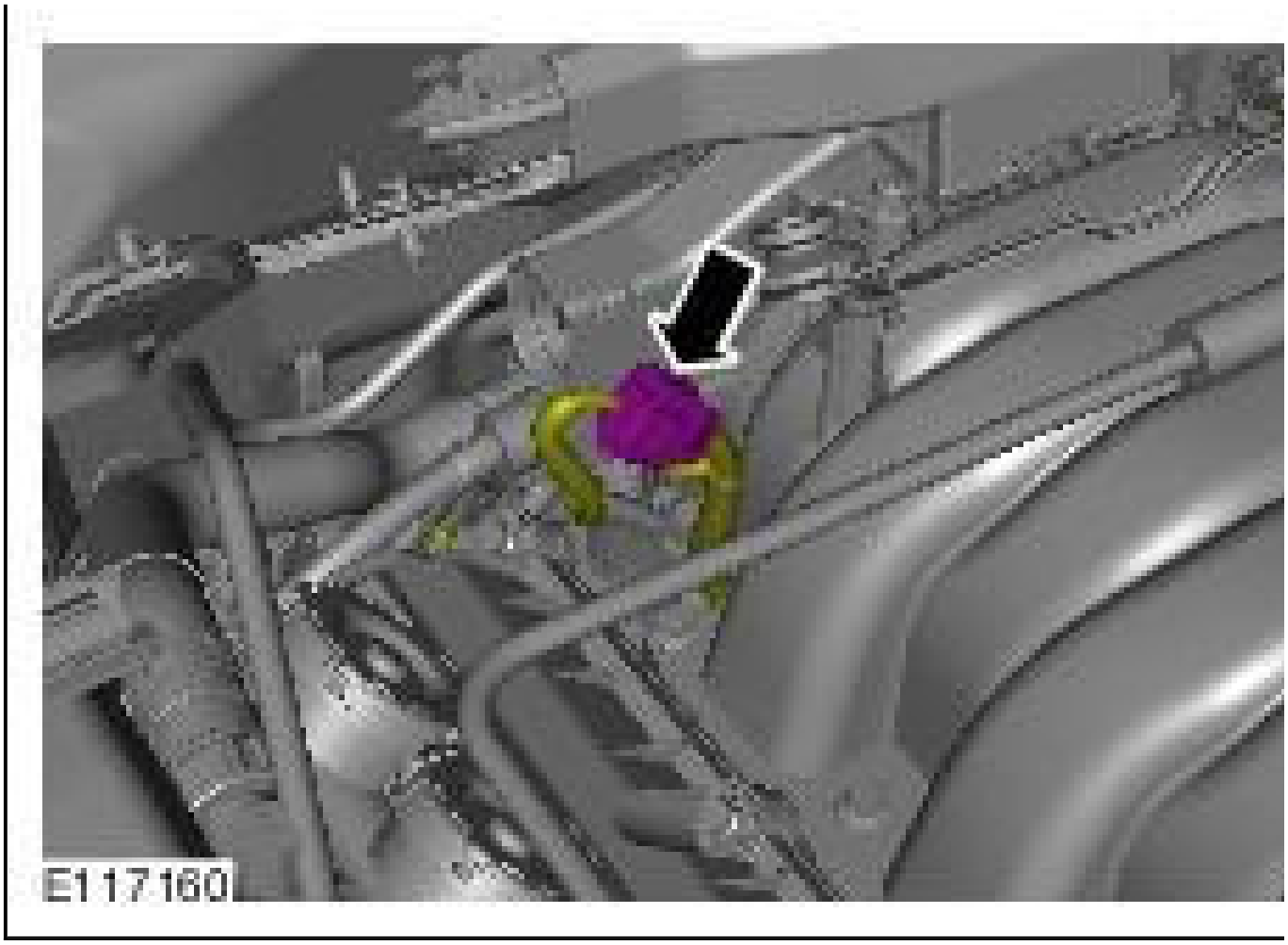

11. Torque: 25 Nm

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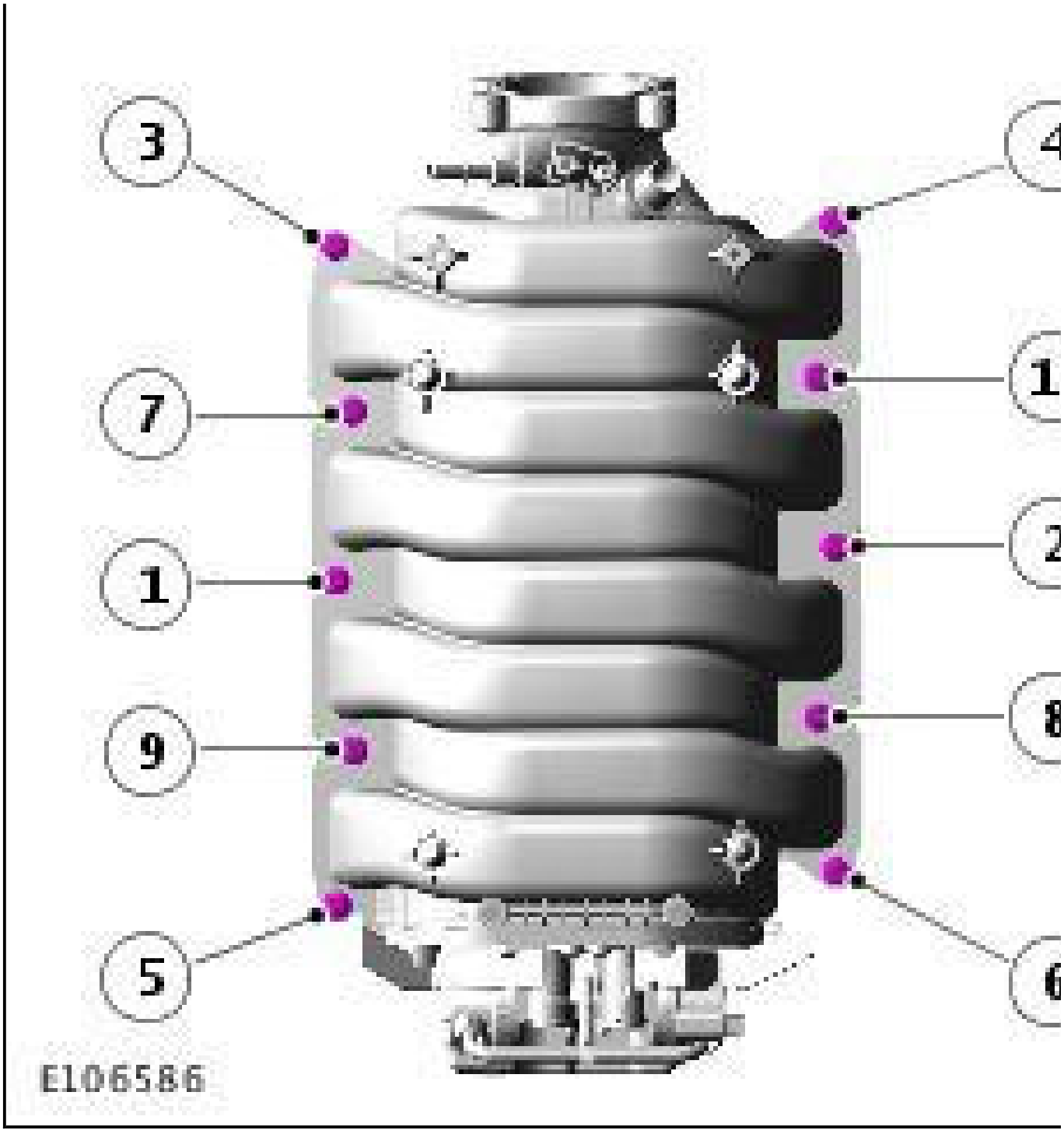

12. Torque: 8 Nm

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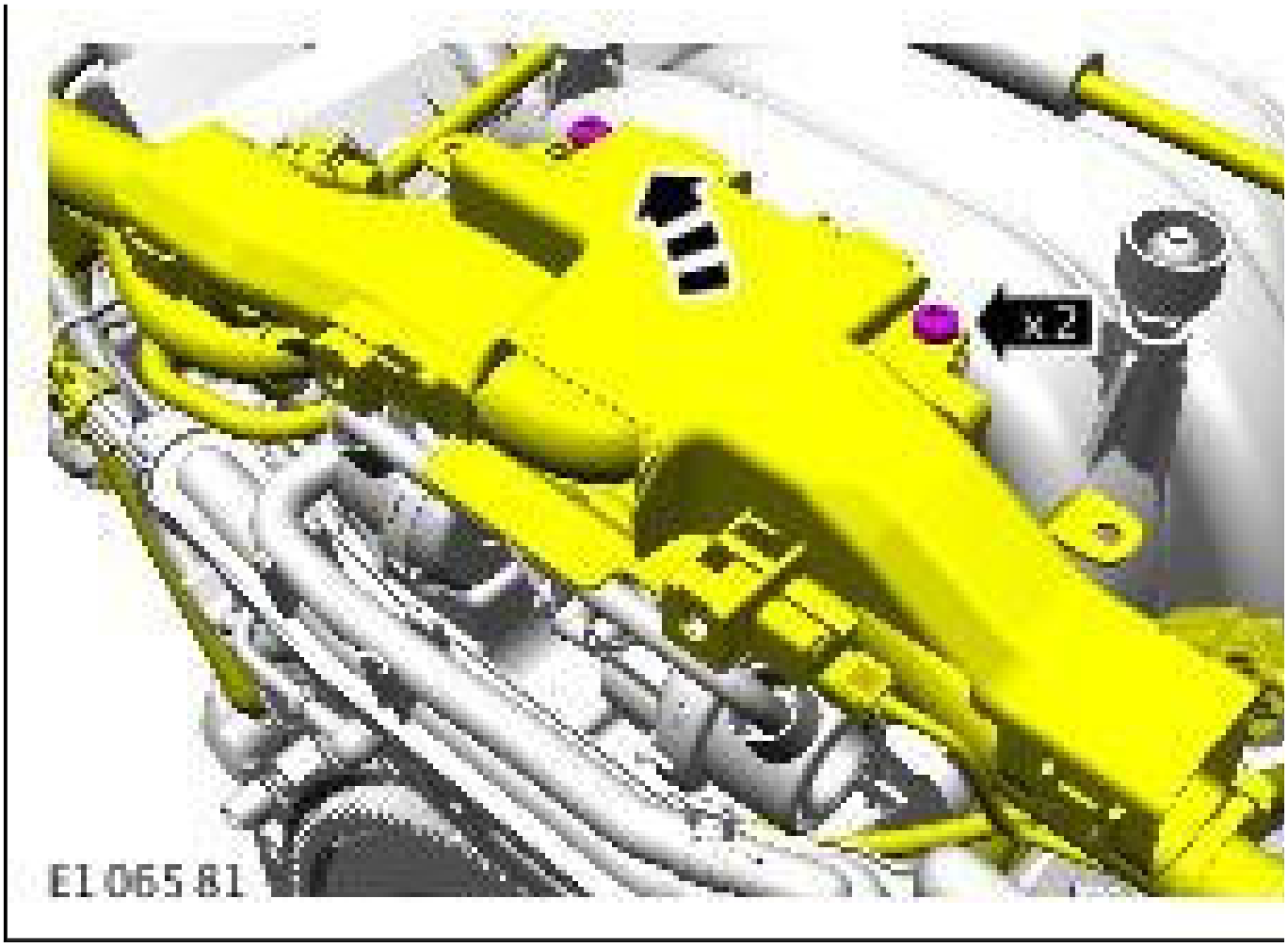

13. See figure

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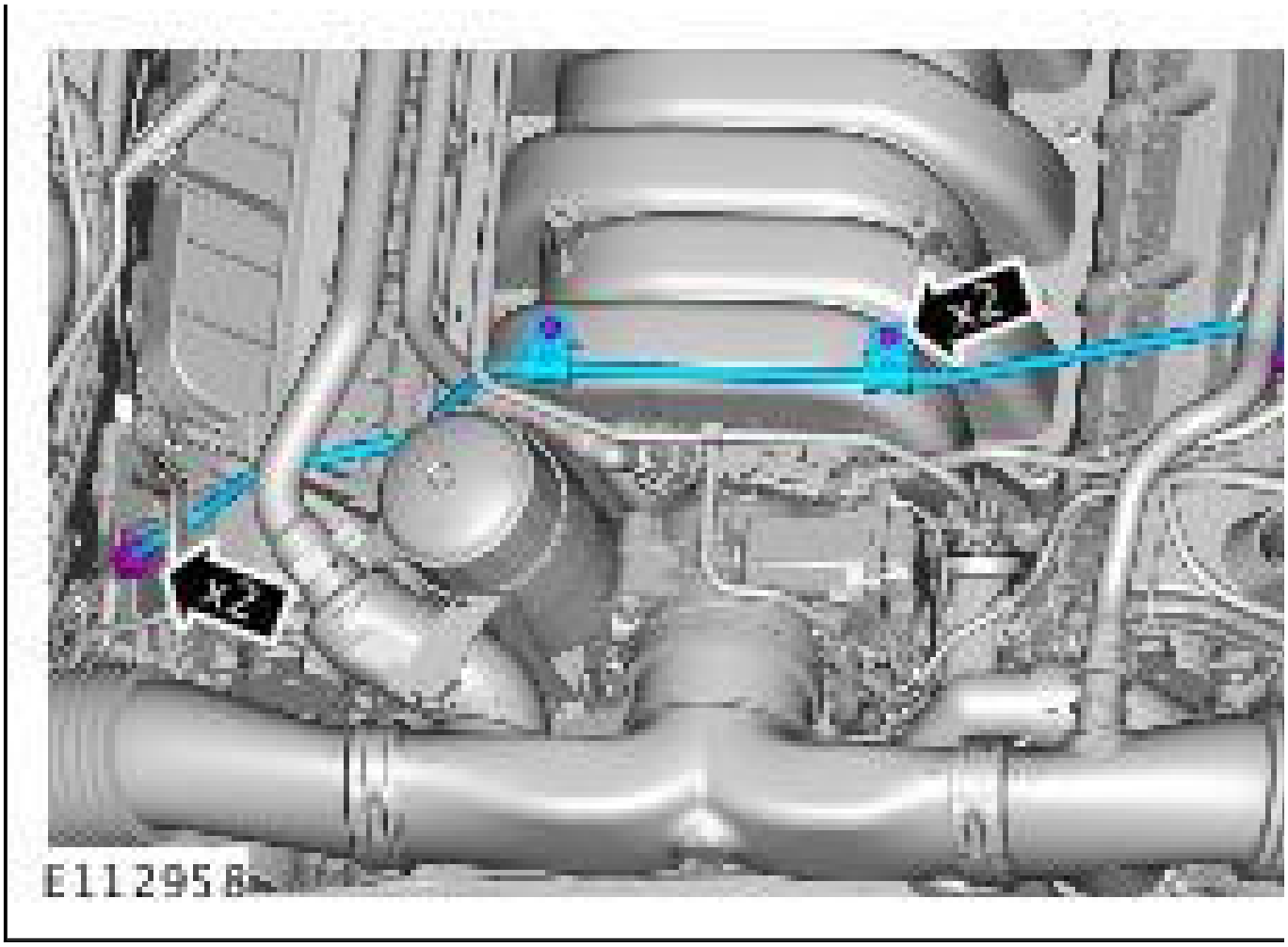

NOTE: **Do not tighten at this stage.**

NOTE: **Remove and discard the blanking caps.**

14. Torques:

    Unions: 21 Nm

    Bolts: 8 Nm

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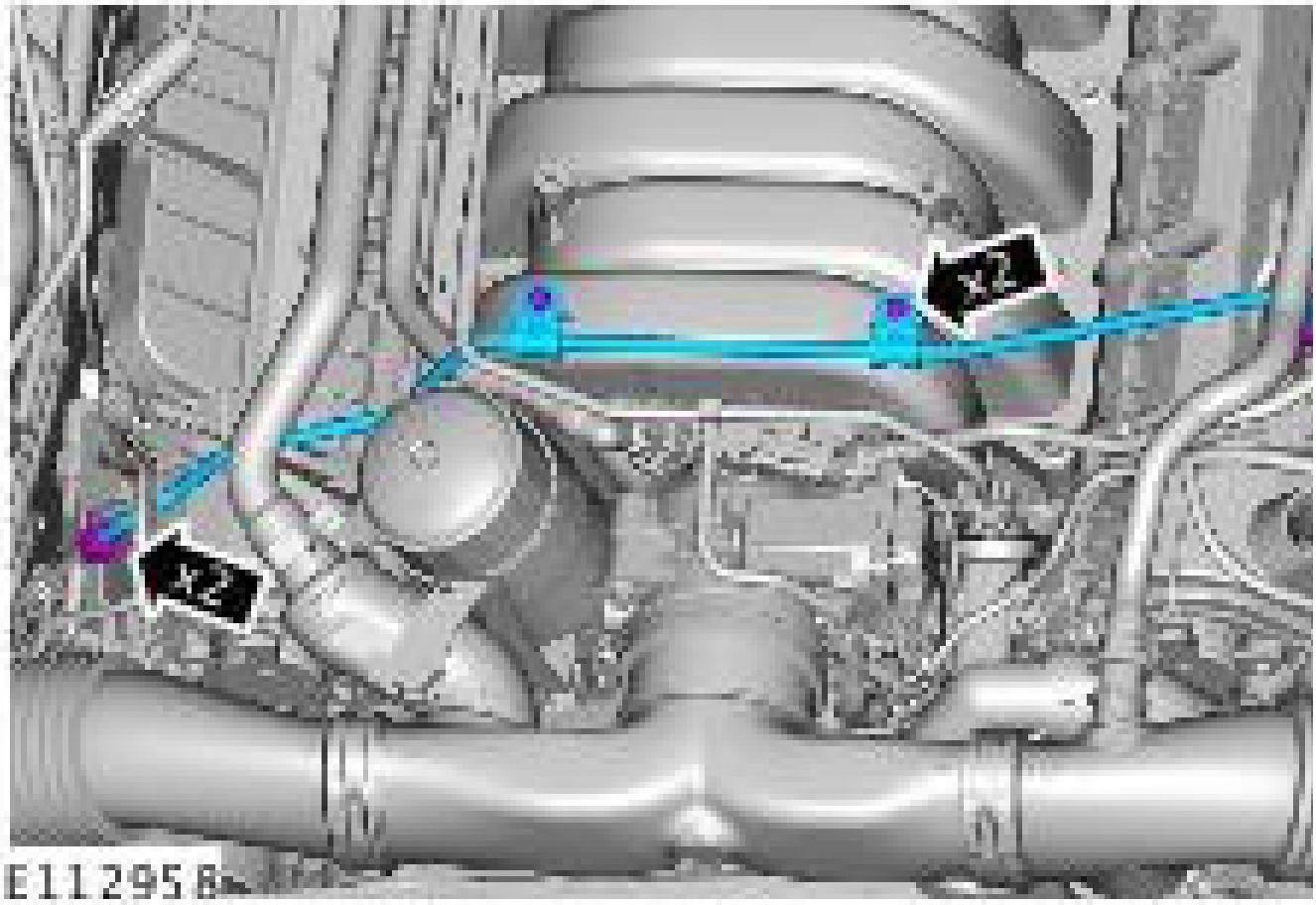

15. Torque: 21 Nm

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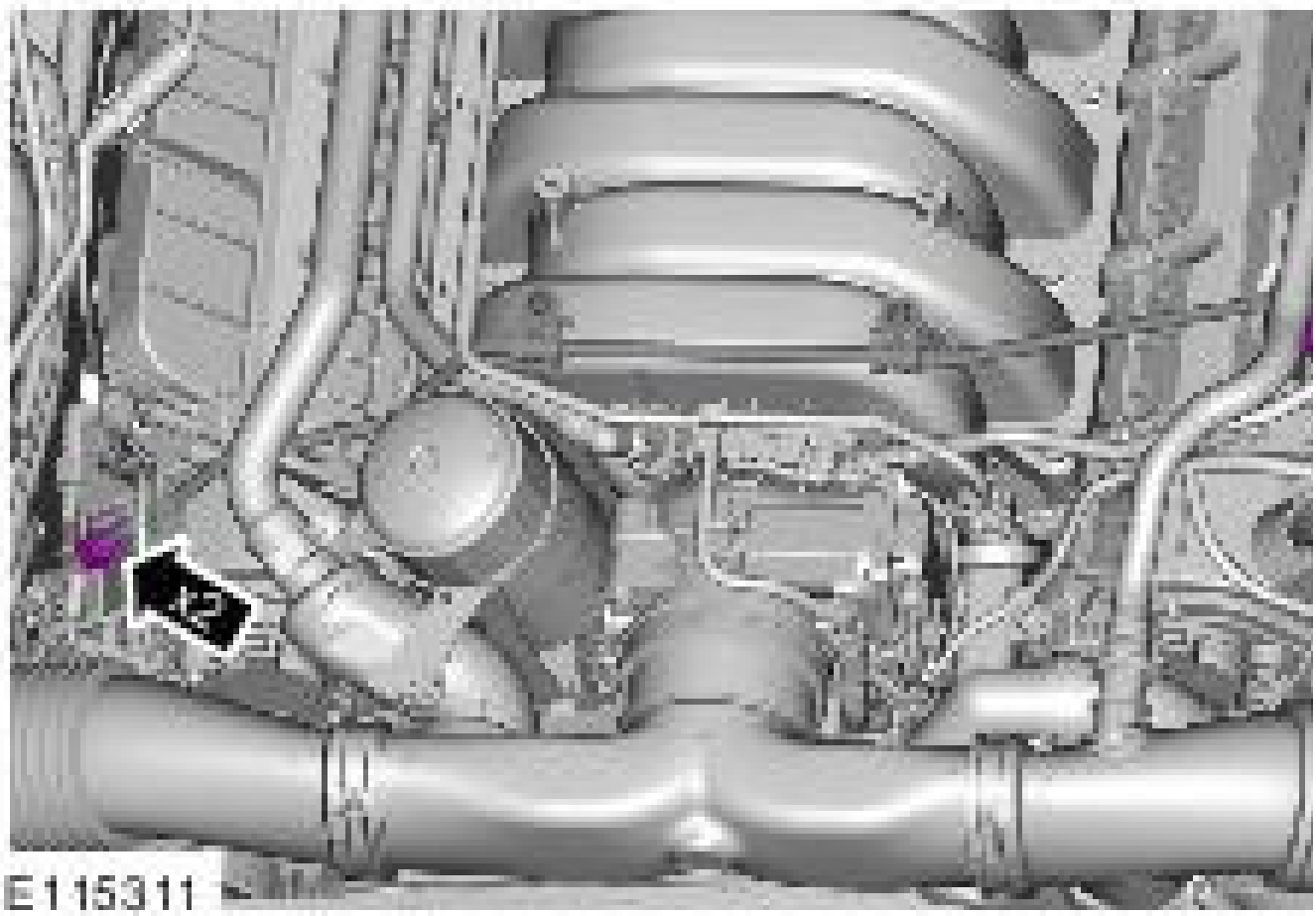

16. See figure

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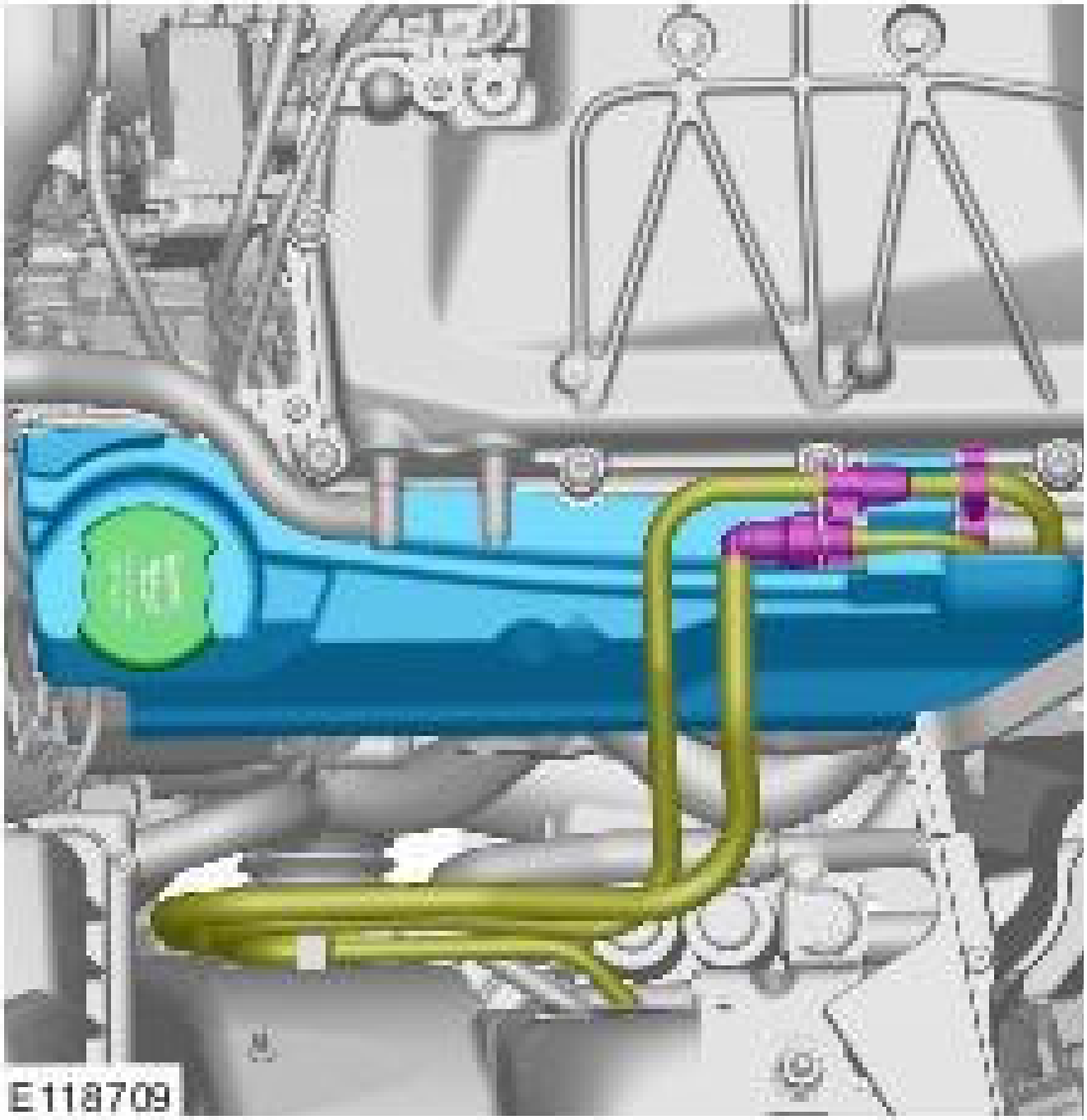

17. See figure

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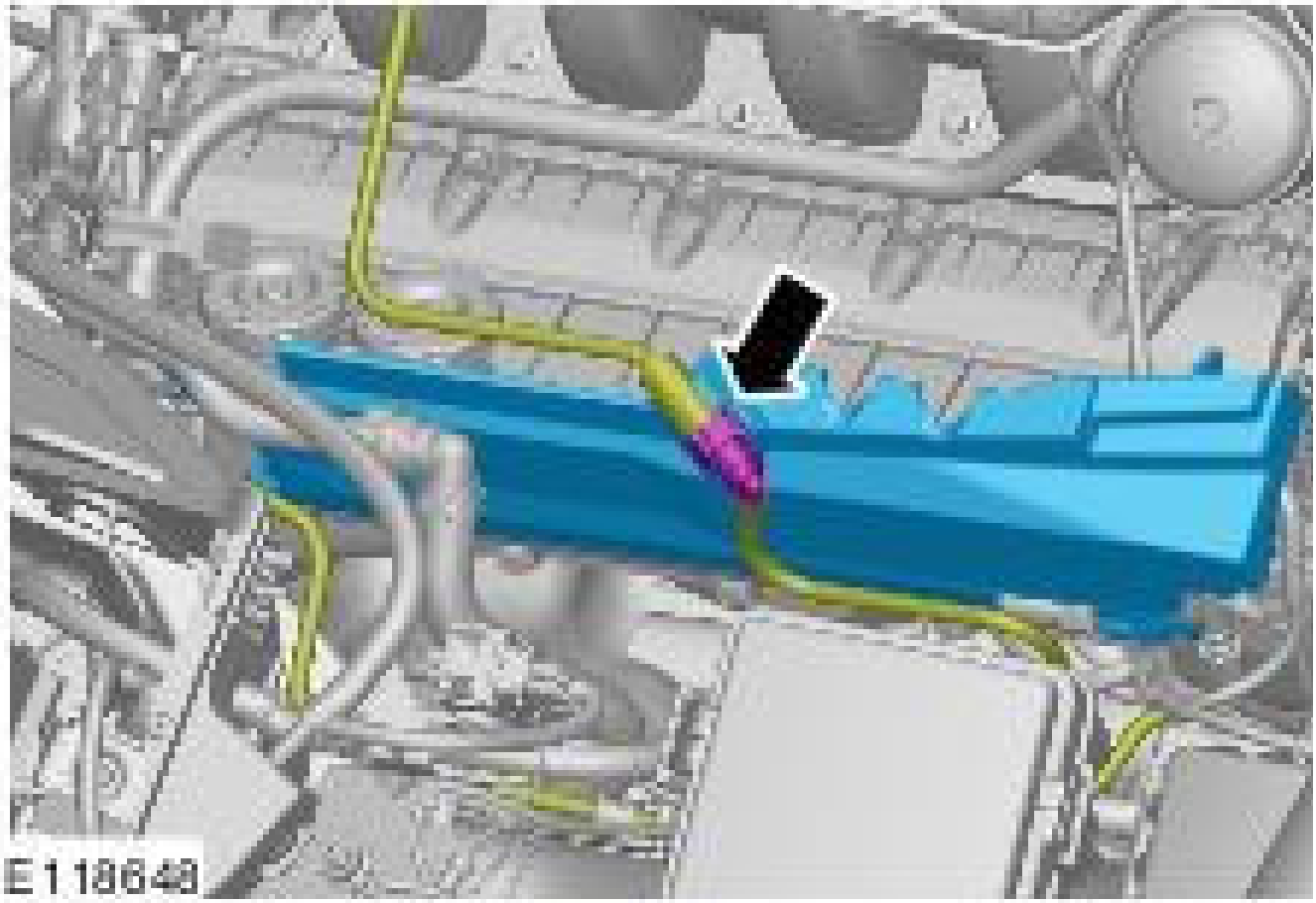

18. See figure

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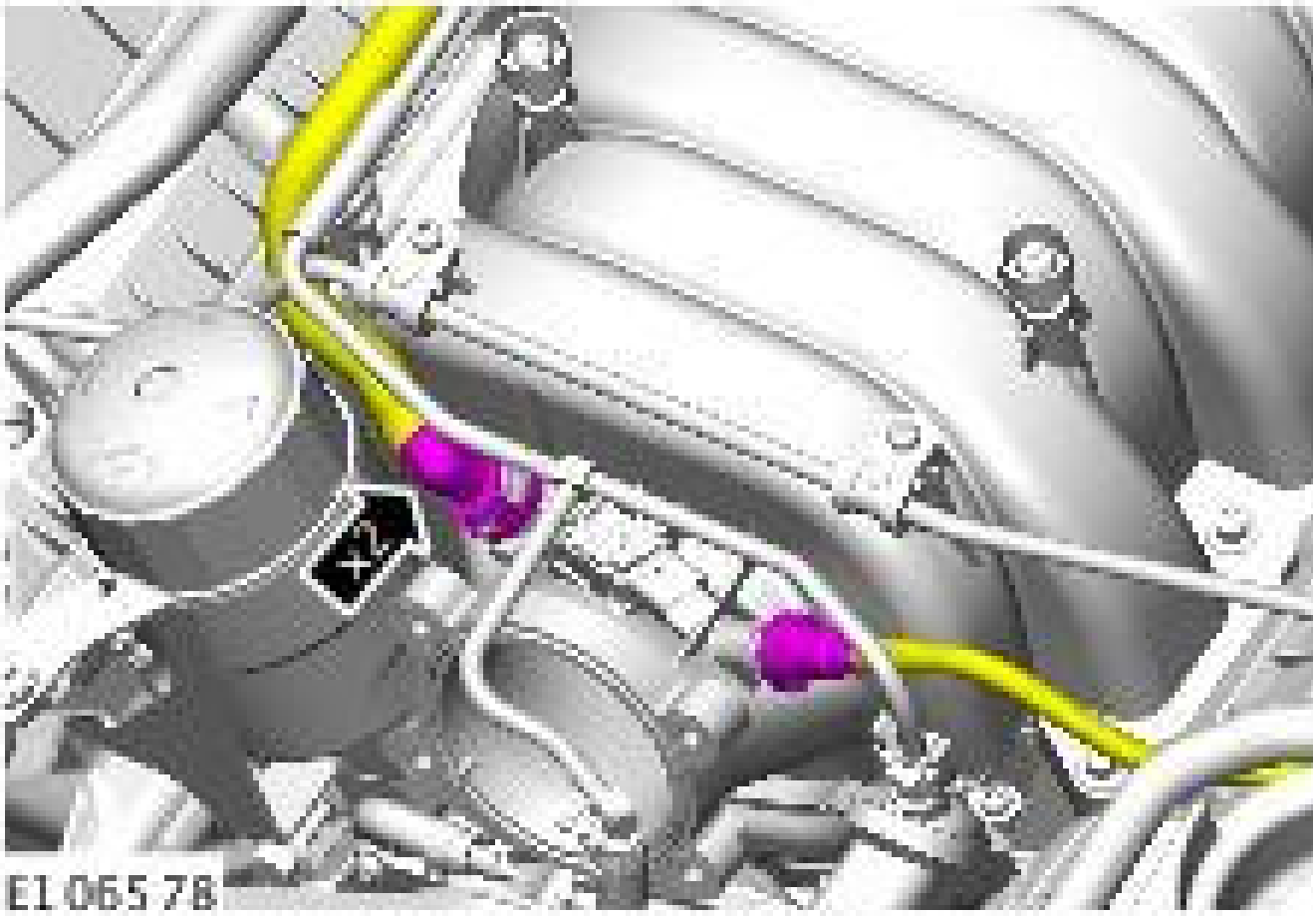

19. See figure

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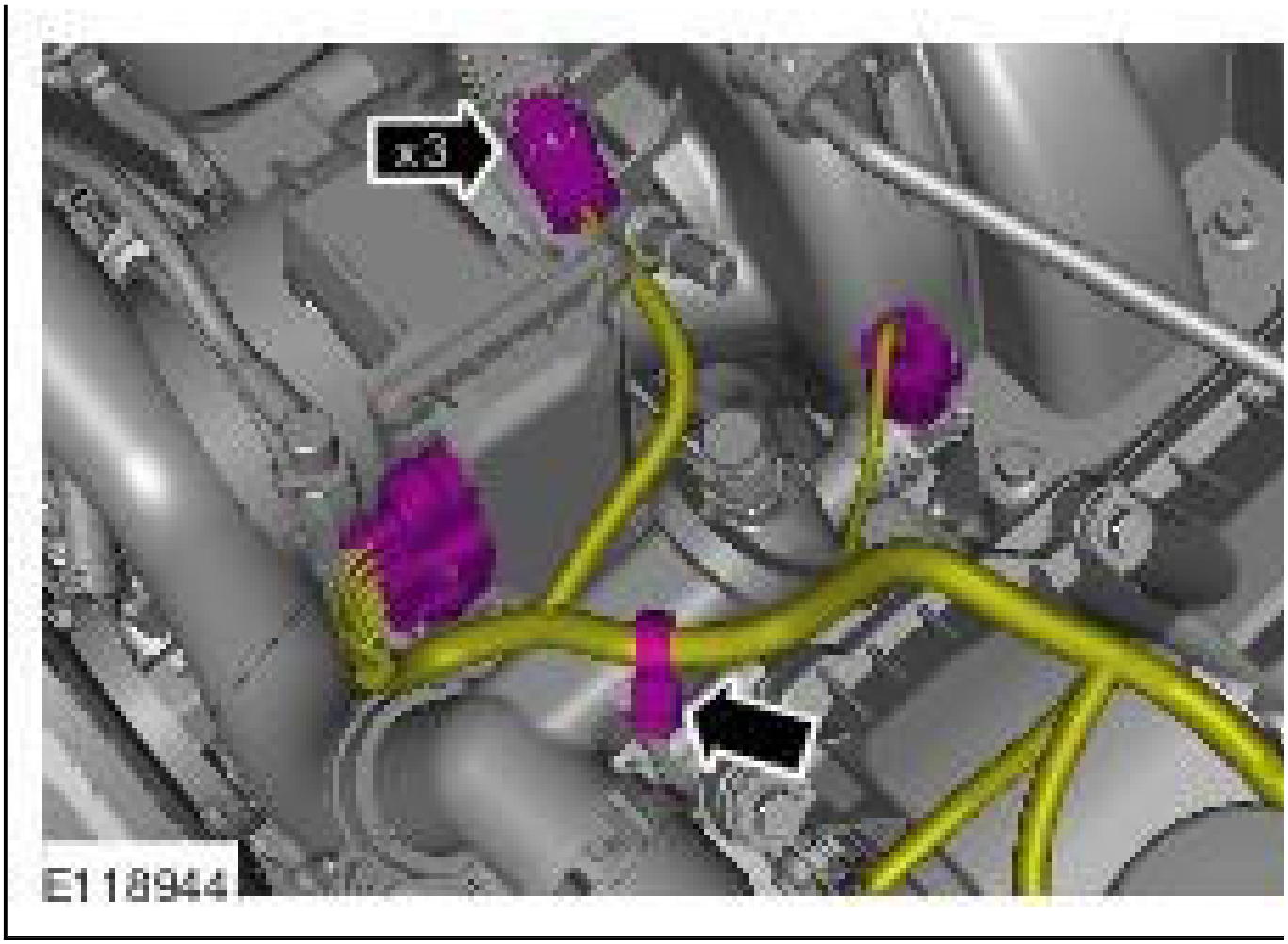

20. Torque: 10 Nm

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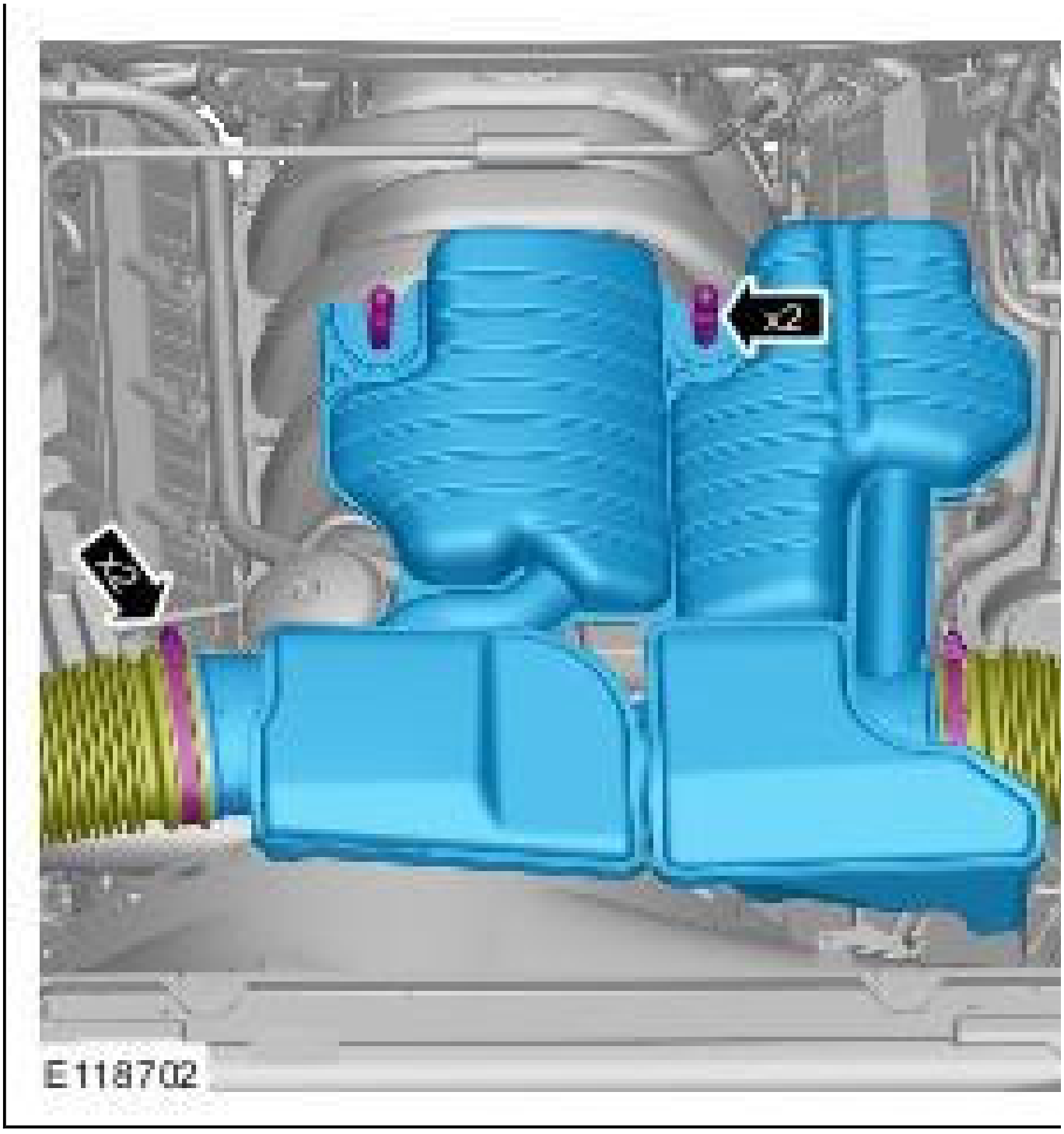

21. Refer to **Engine Cover - 5.0L** .
22. Lower the vehicle.
23. Connect the battery ground cable. Refer to **Specifications** .

OIL COOLER

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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.

1. 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. Refer to **ENGINE OIL DRAINING AND FILLING - GENERAL PROCEDURES**
4. Cooling System Draining, Filling and Bleeding - Vehicles Without: Supercharger. Refer to **Engine Cooling (V8 5.0L Petrol/V8 S/C 5.0L Petrol)**
5. See **Intake Manifold**.
6. See figure

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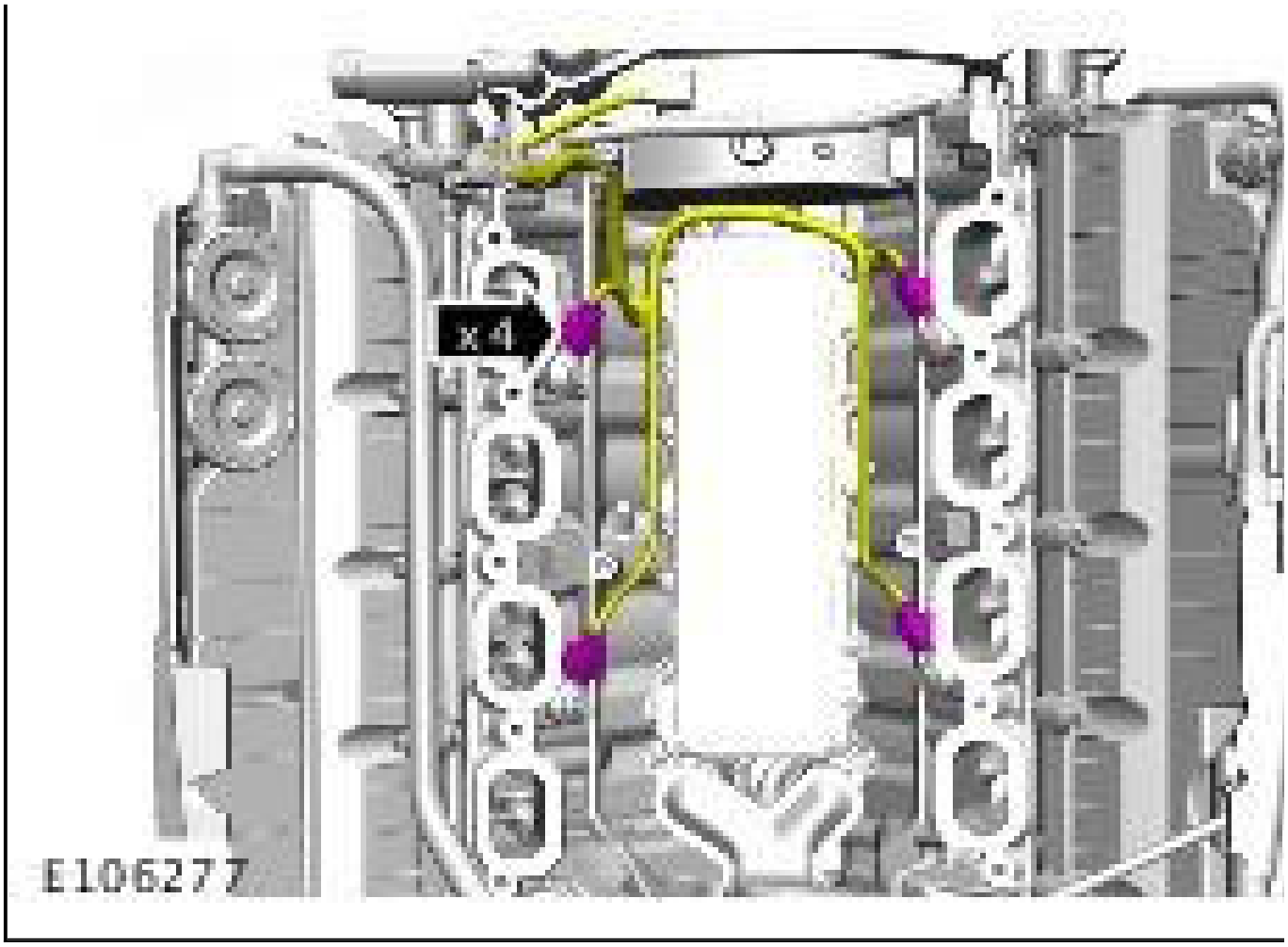

7. See figure

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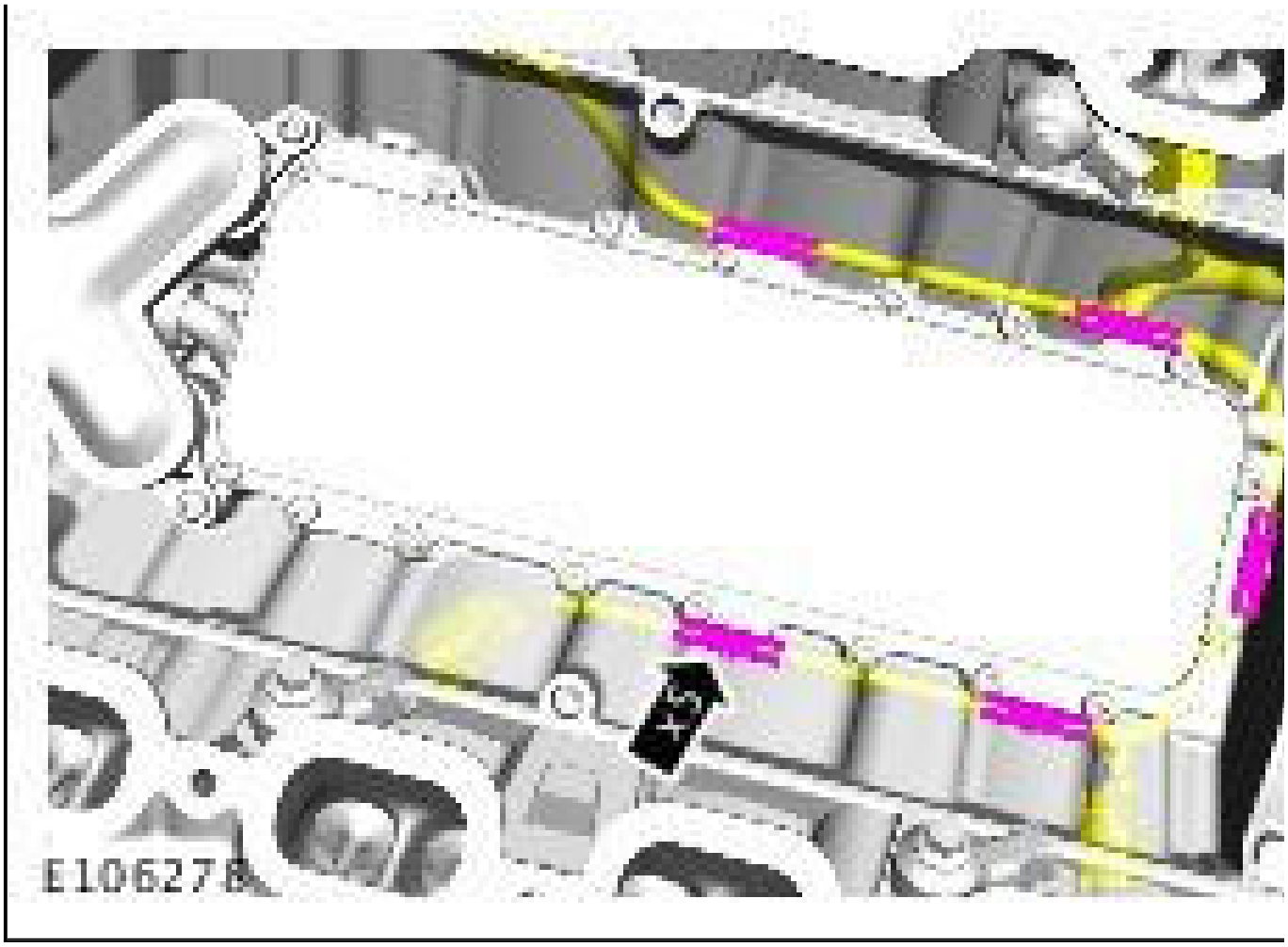

8. Torque: 13 Nm

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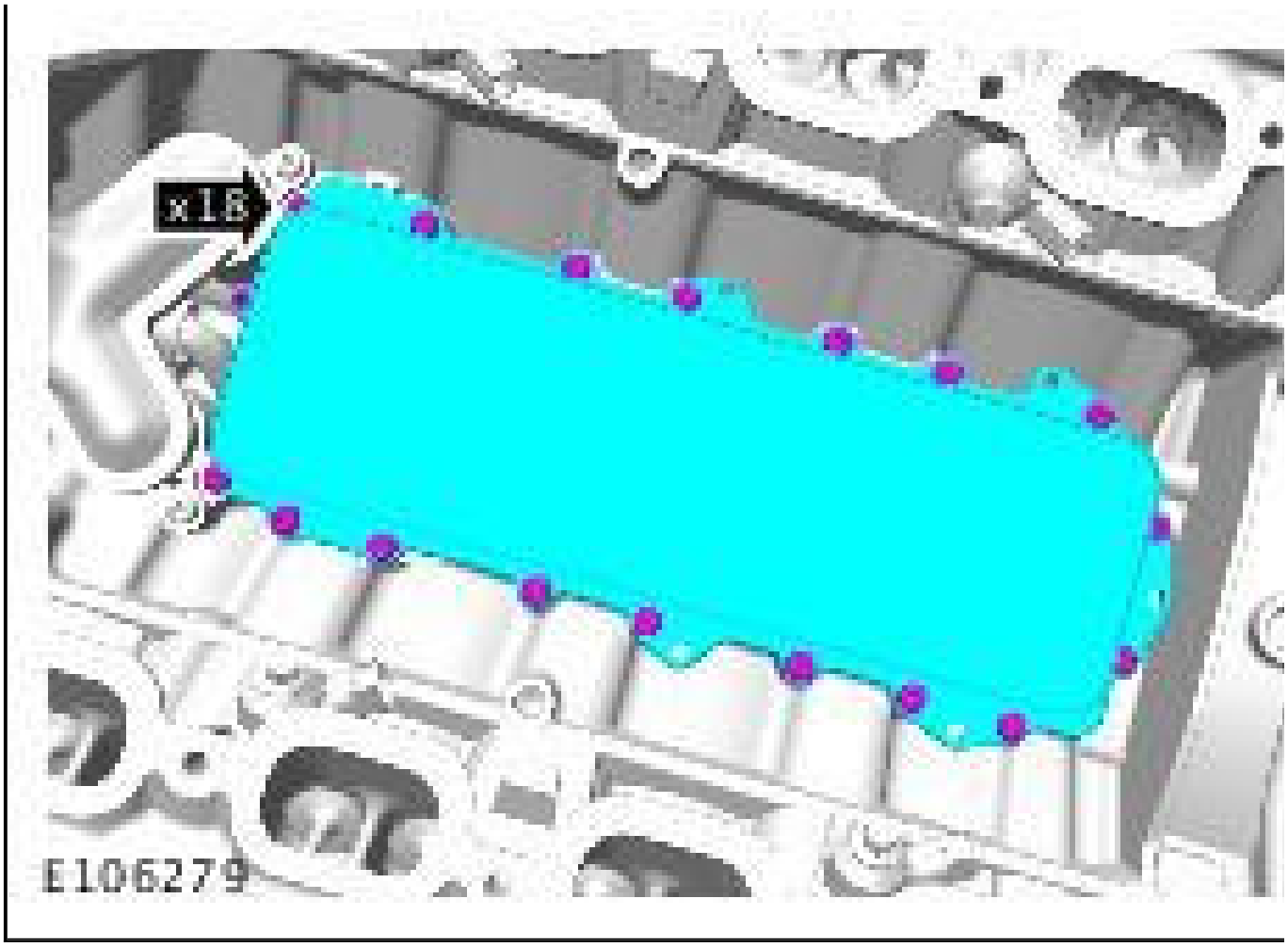

CAUTION: Be prepared to collect escaping oil.

CAUTION: Be prepared to collect escaping coolant.

9. See figure

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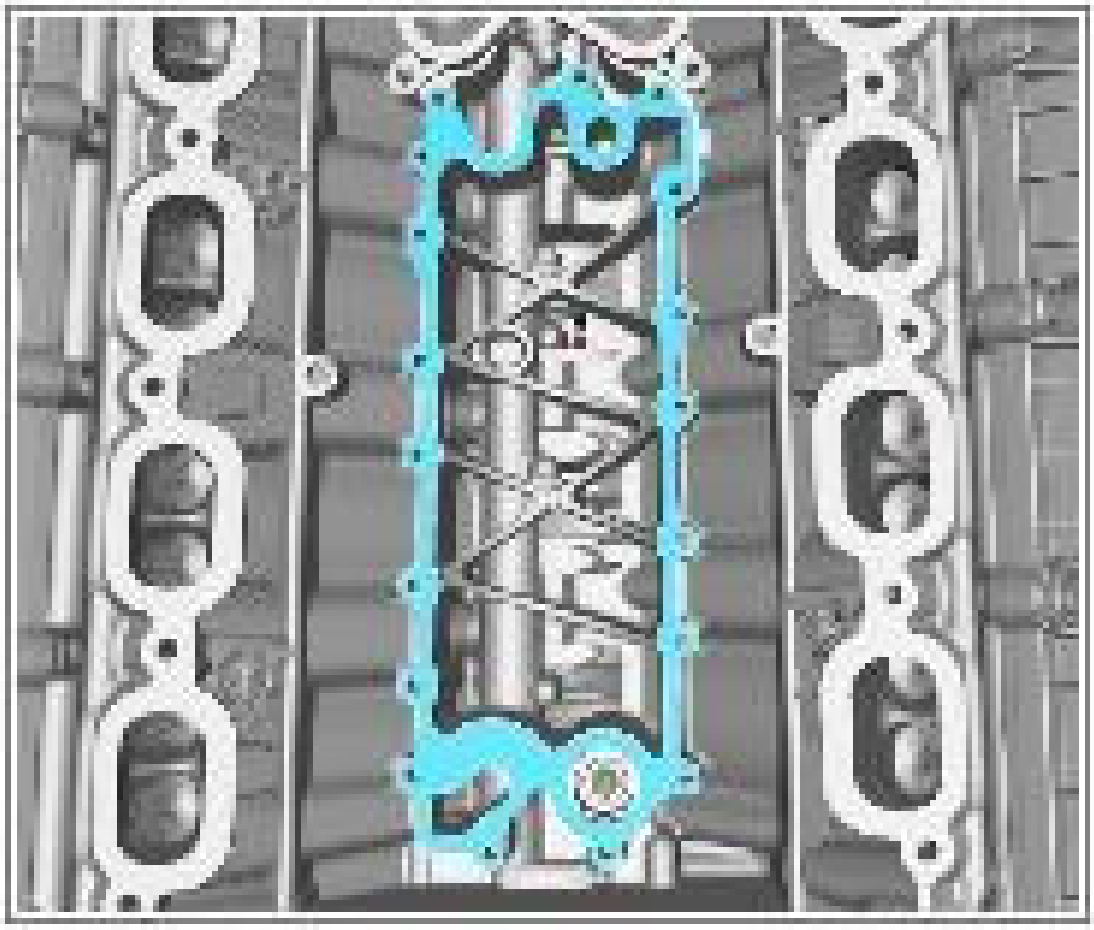

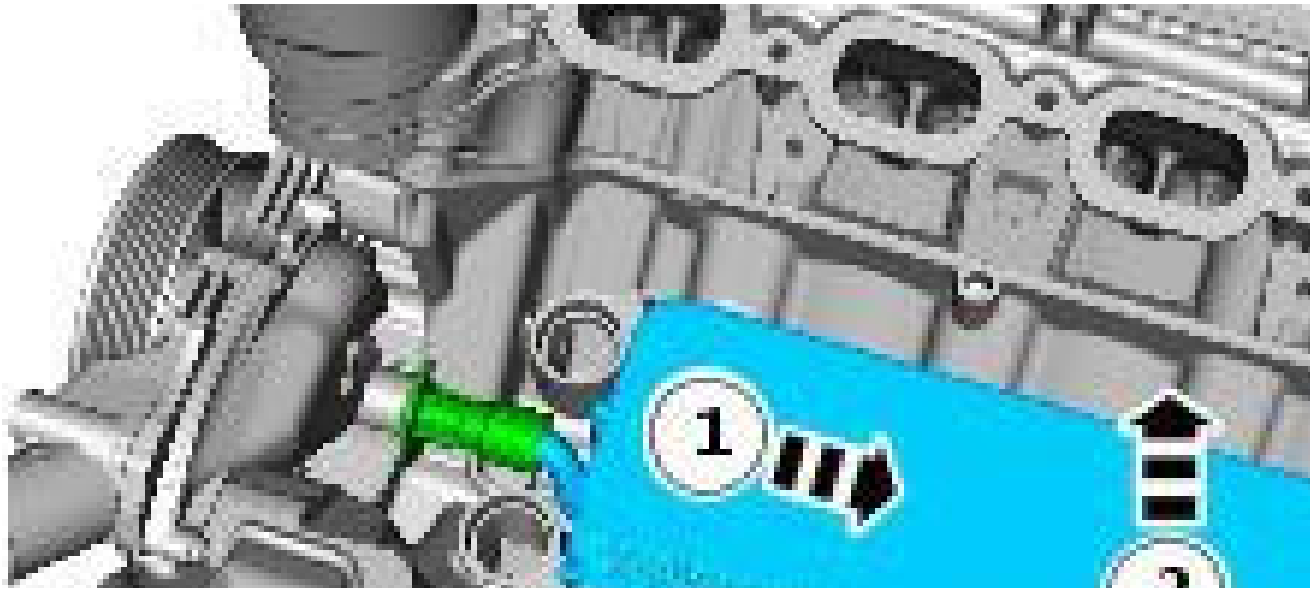

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CAUTION: Make sure that these components are installed to the noted removal position.

NOTE: Install a new gasket.

10. See figure

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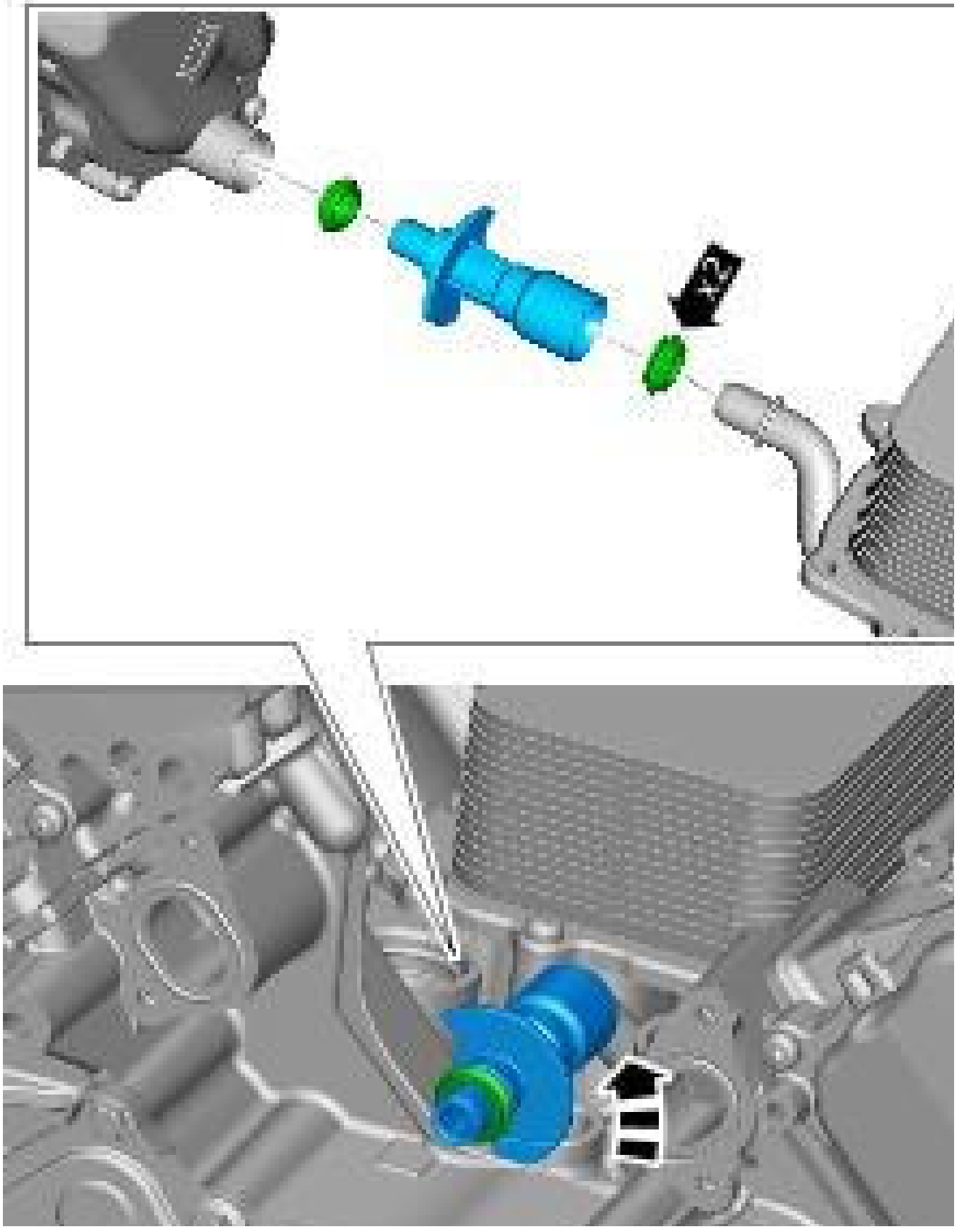

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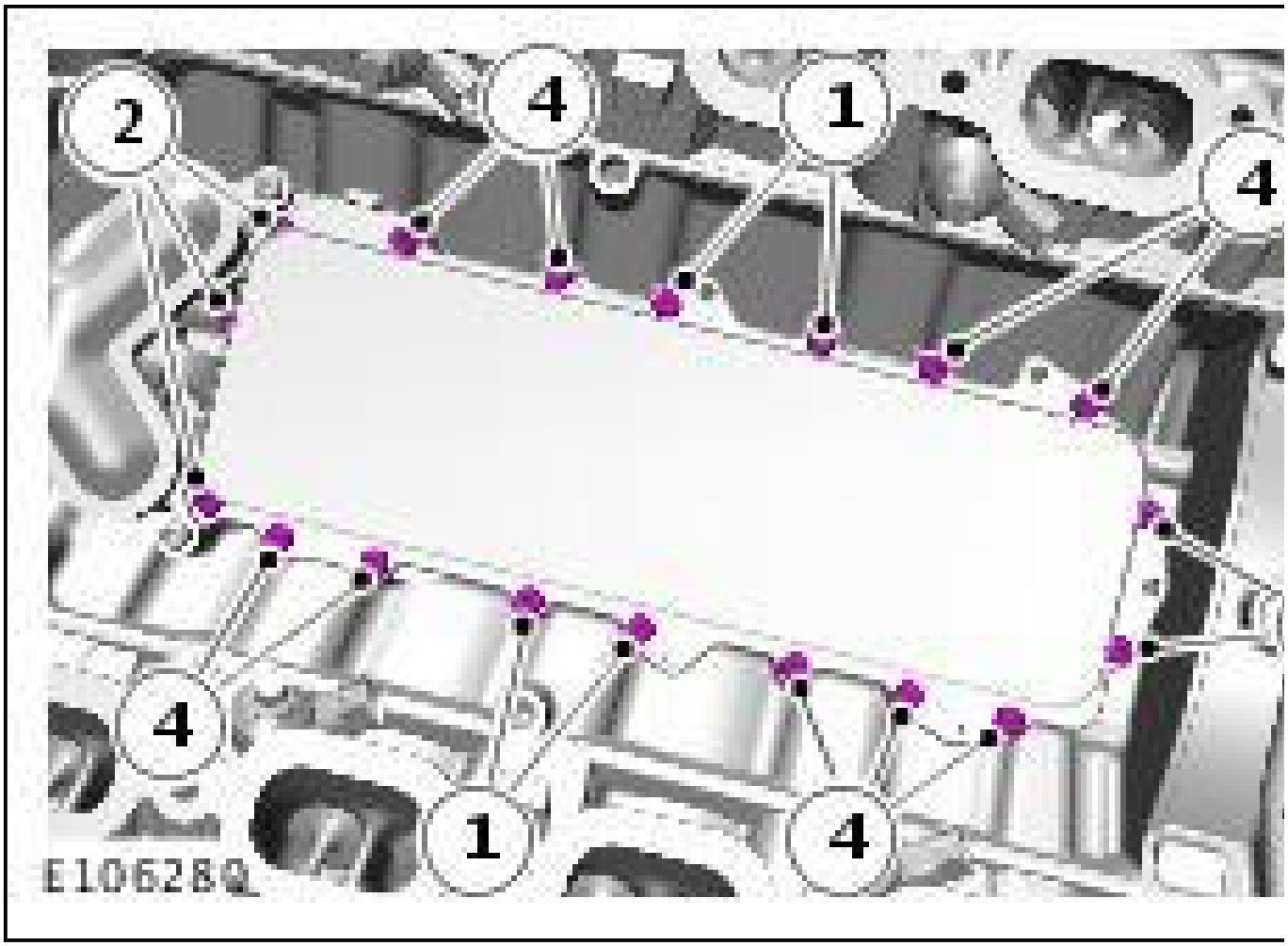
CAUTION: Make sure that these components are installed to the noted removal position.

CAUTION: Install new o-ring seals

INSTALLATION

1. To install, reverse the removal procedure.



CAUTION: Install all the bolts finger tight before final tightening.

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

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CAUTION: Install the new seals.

NOTE: Tighten the bolts in the indicated sequence.

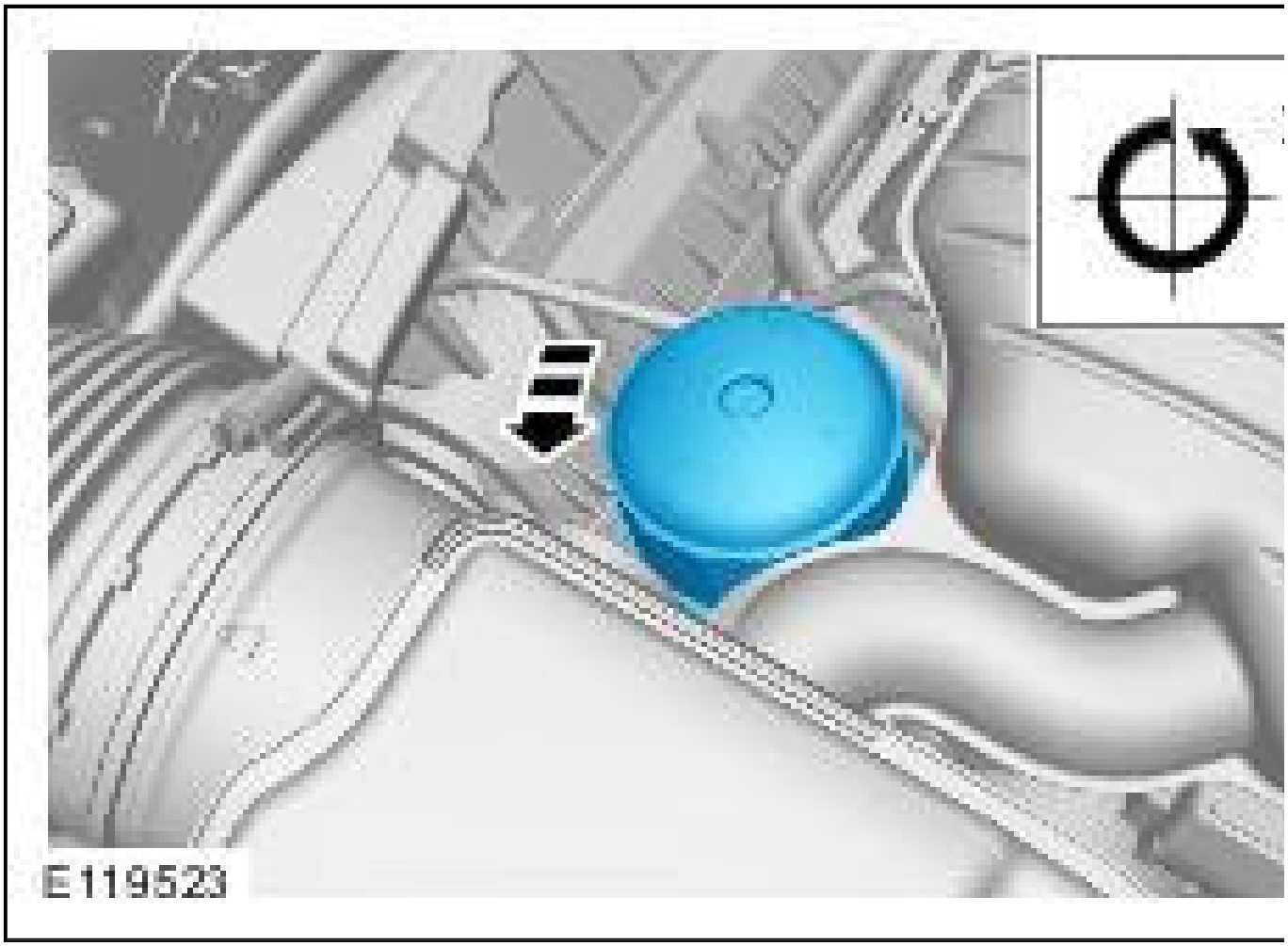
OIL FILTER ELEMENT

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.

1. Refer to **Engine Cover - 5.0L** .
2. See figure



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- Allow the engine oil to drain from the oil filter element housing for two minutes.

3. See figure

4. See figure

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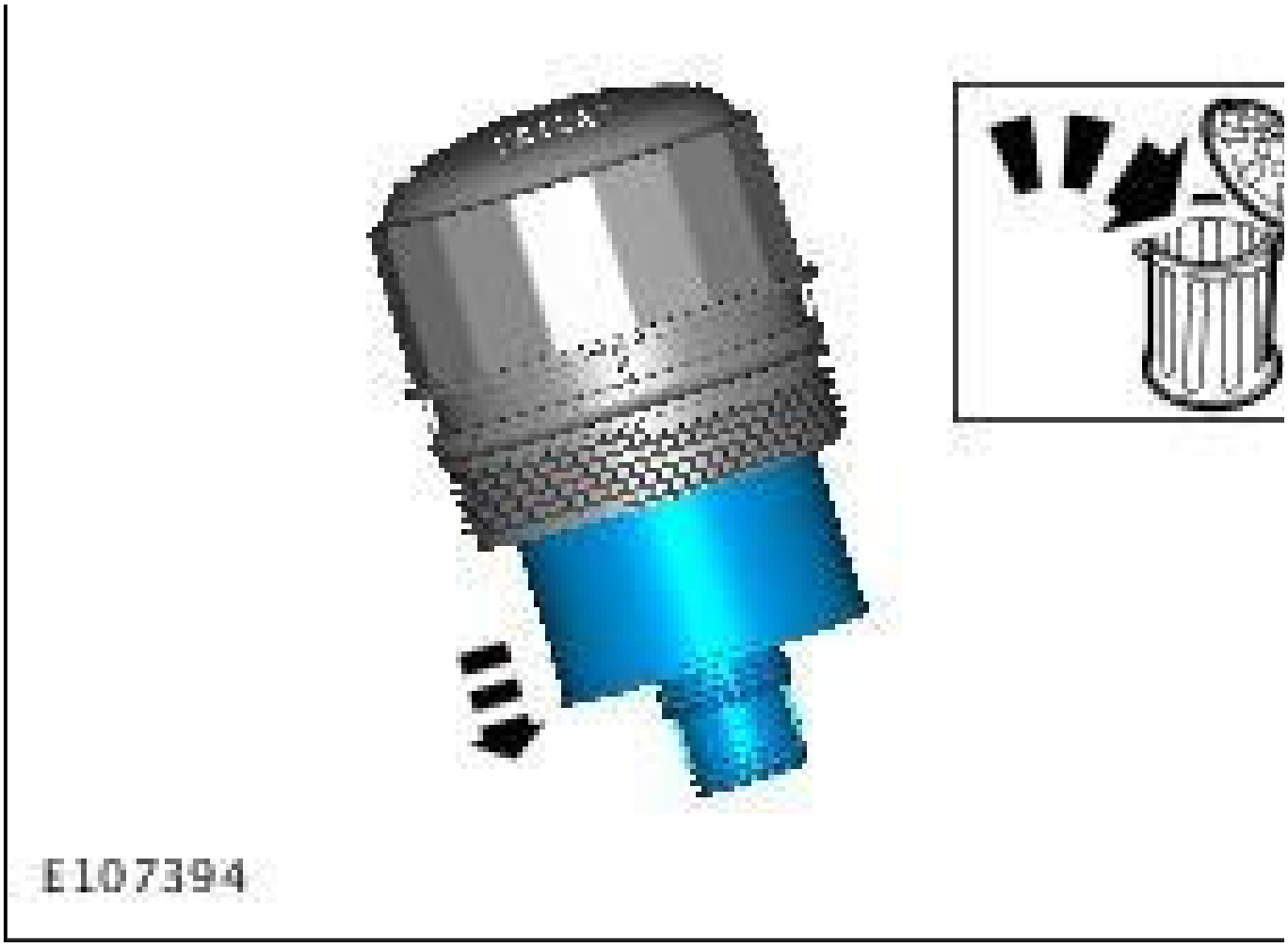

INSTALLATION

1. See figure

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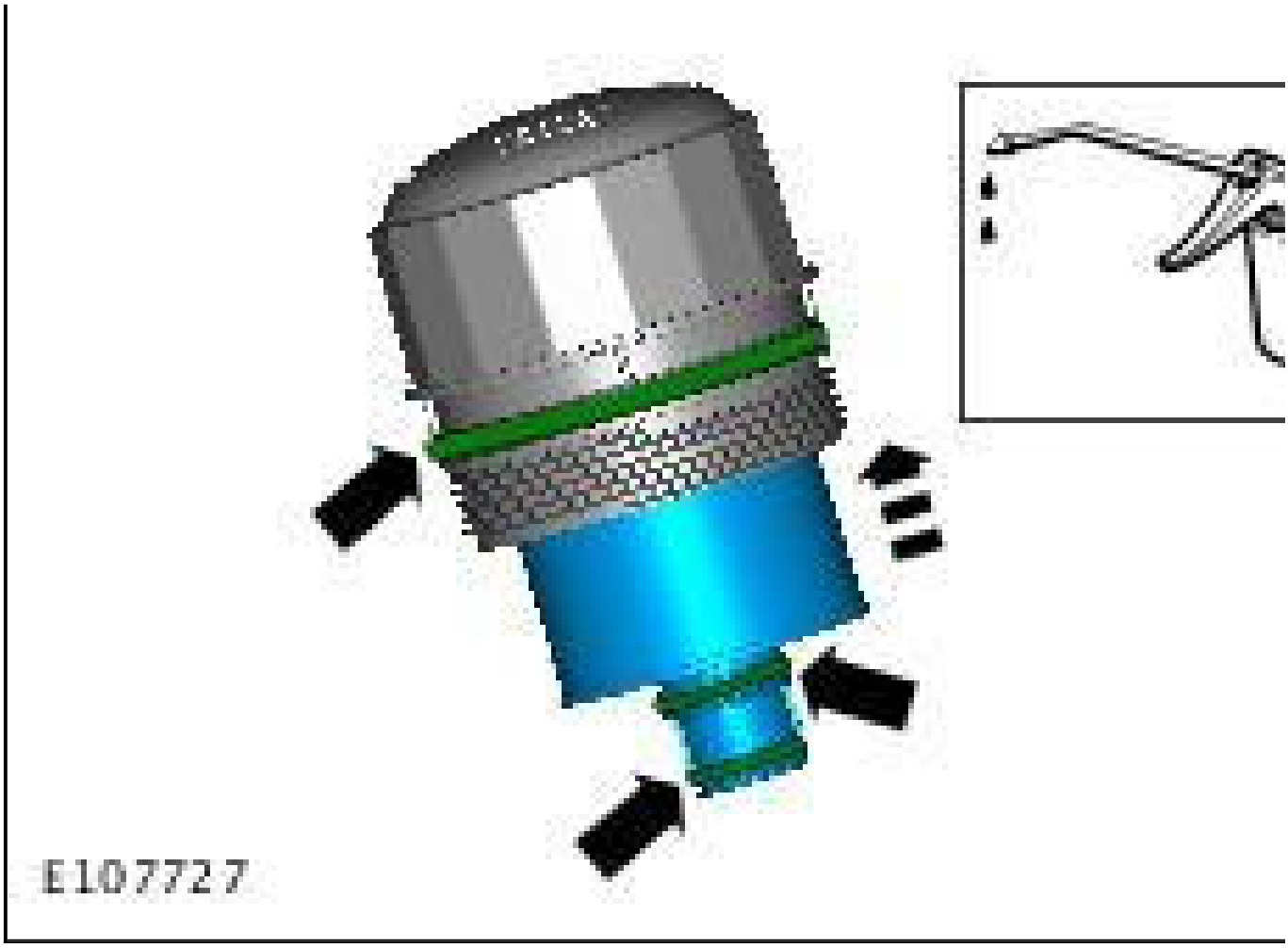

2. Torque: 25 Nm

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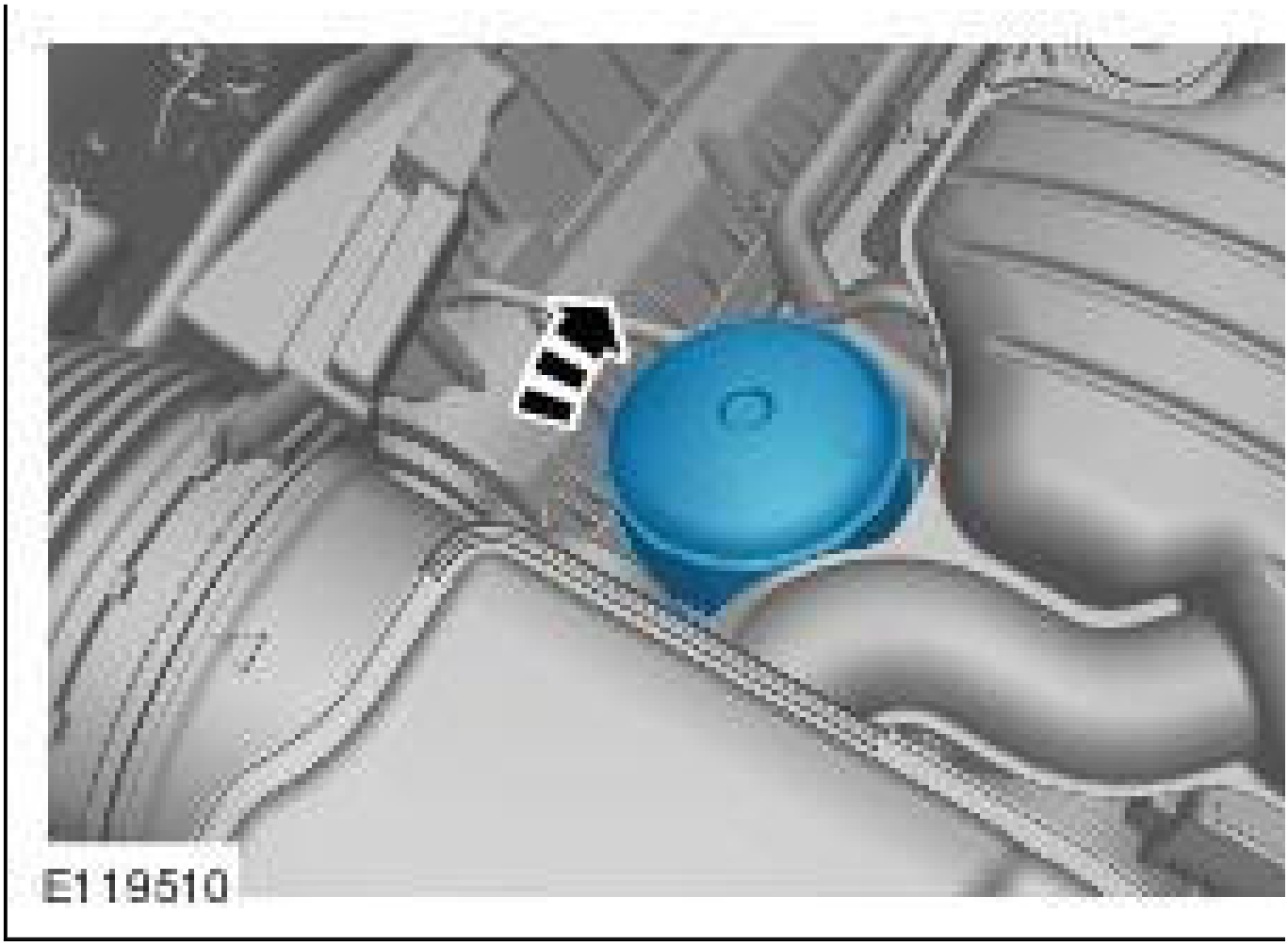

3. Check and top-up the engine oil.
4. Start and run the engine.
5. Refer to **Engine Cover - 5.0L** .

OIL PAN EXTENSION

SPECIAL TOOL(S)

	303-1433 Lower Timing Cover Alignment tool

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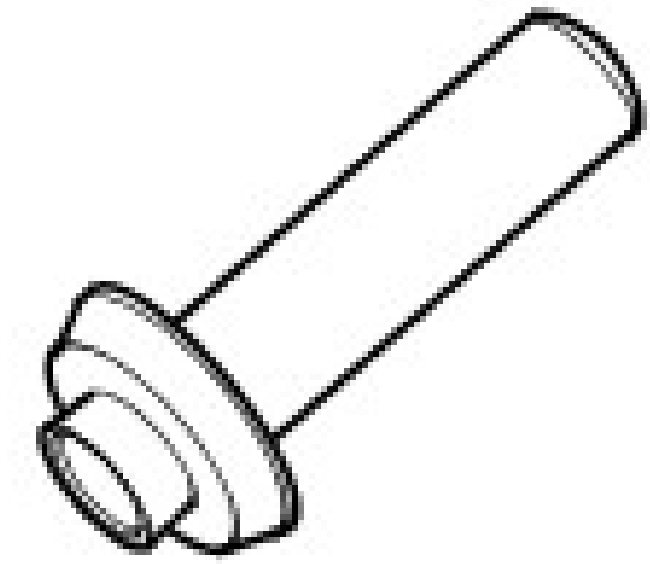
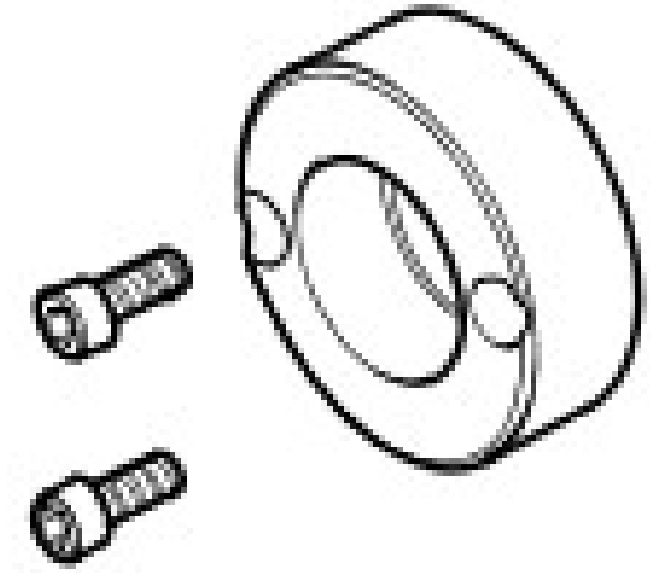
 E107676	
 E107678	303-1442 Rear Crankshaft Seal Installer
	303-1443 Rear Crankshaft Cover Alignment Tool

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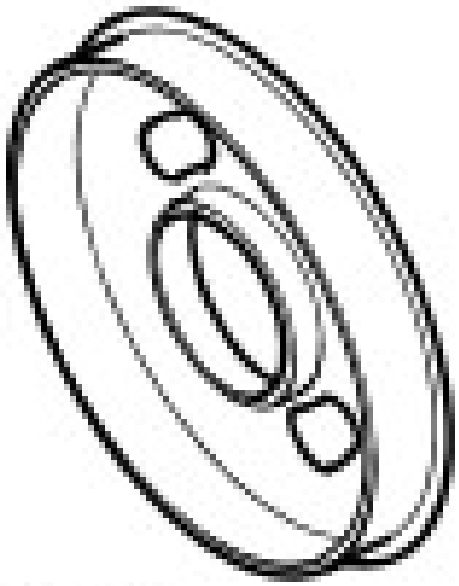
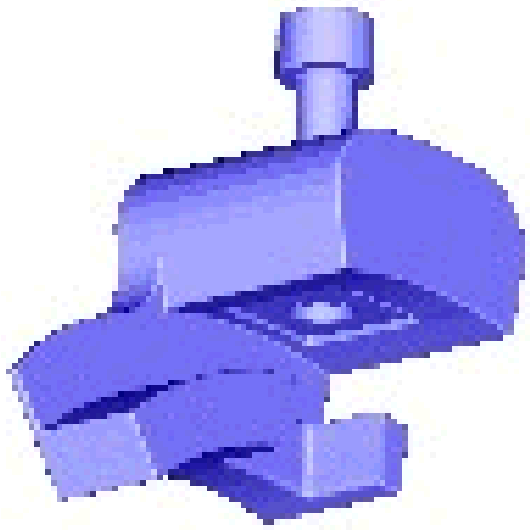
 E107679	
 E119168	303-1500 Installer, Stretchy Belt

REMOVAL

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

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

1. 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. See **Crankshaft Pulley**.
4. Refer to **ENGINE (V8 5.0L PETROL)**
5. See figure

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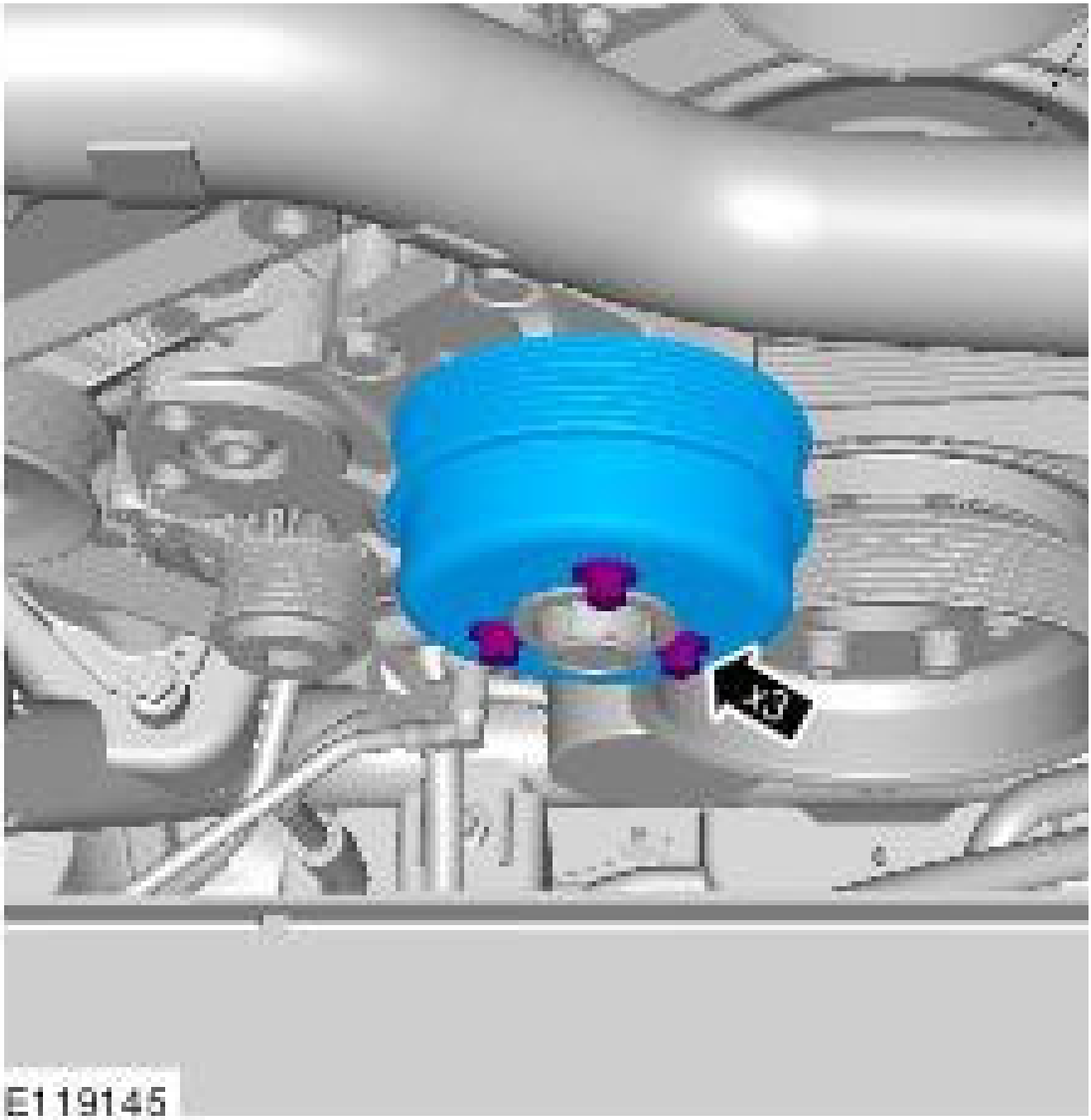

6. See figure

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7. See figure

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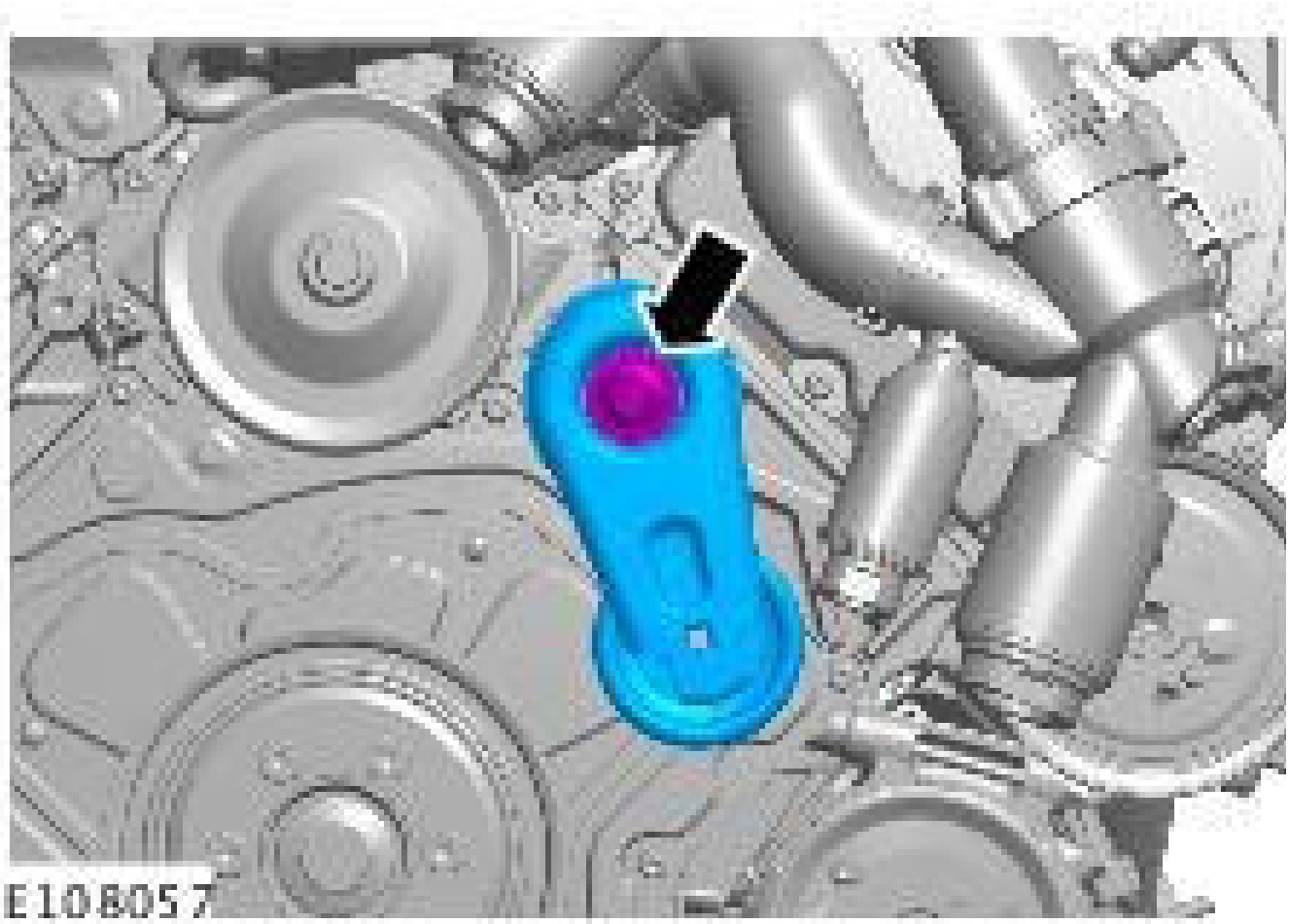

8. See figure

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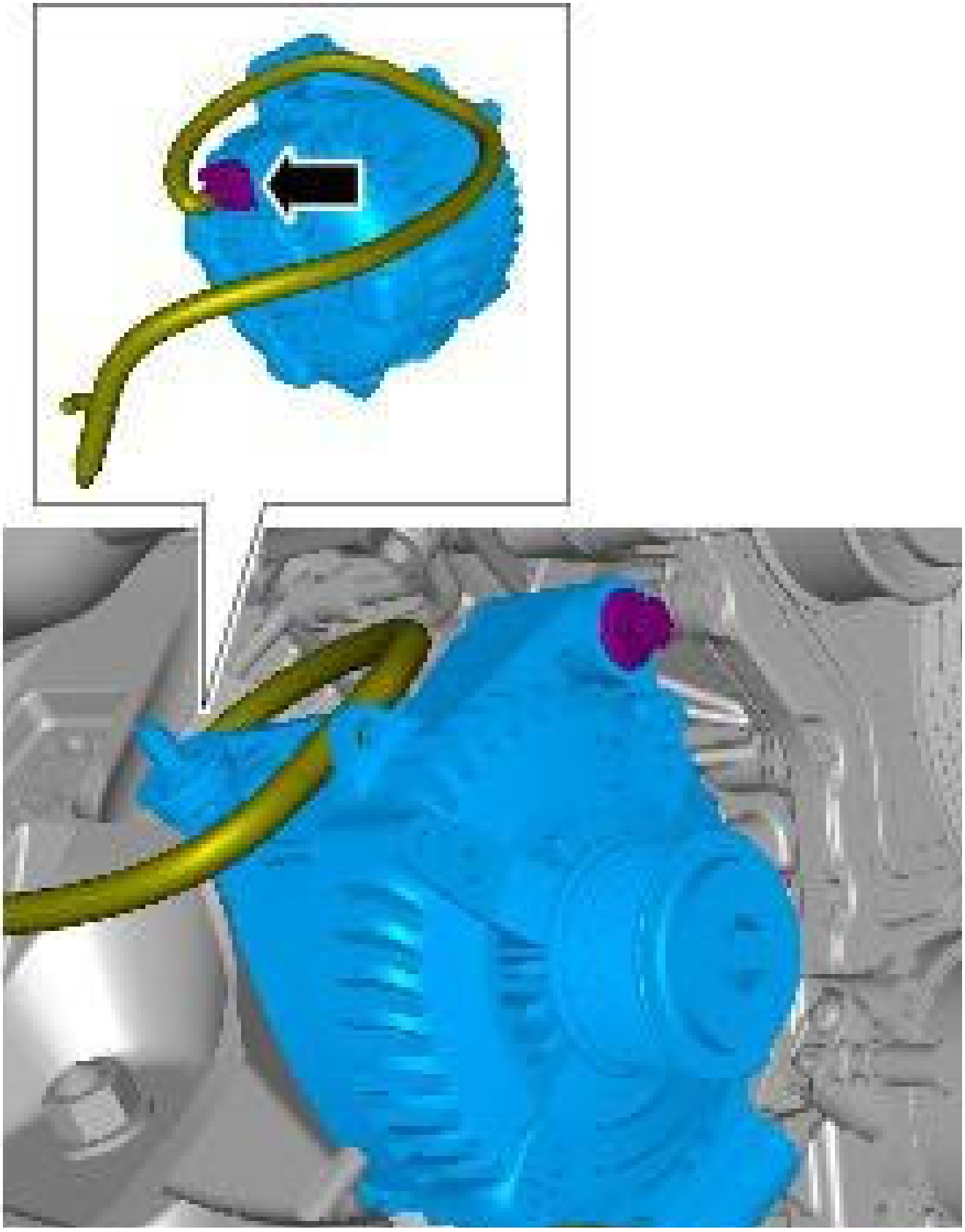

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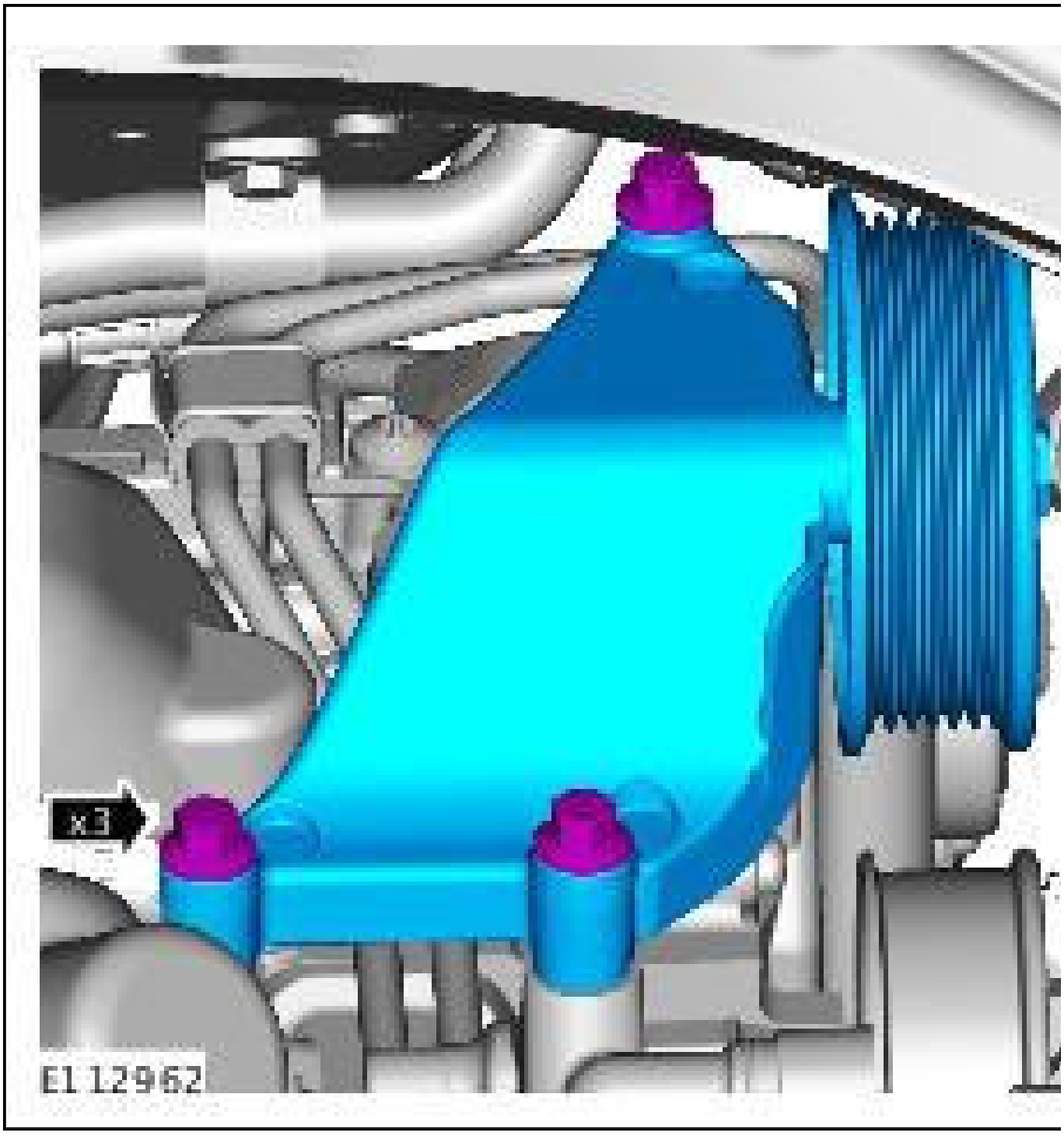
9. See figure



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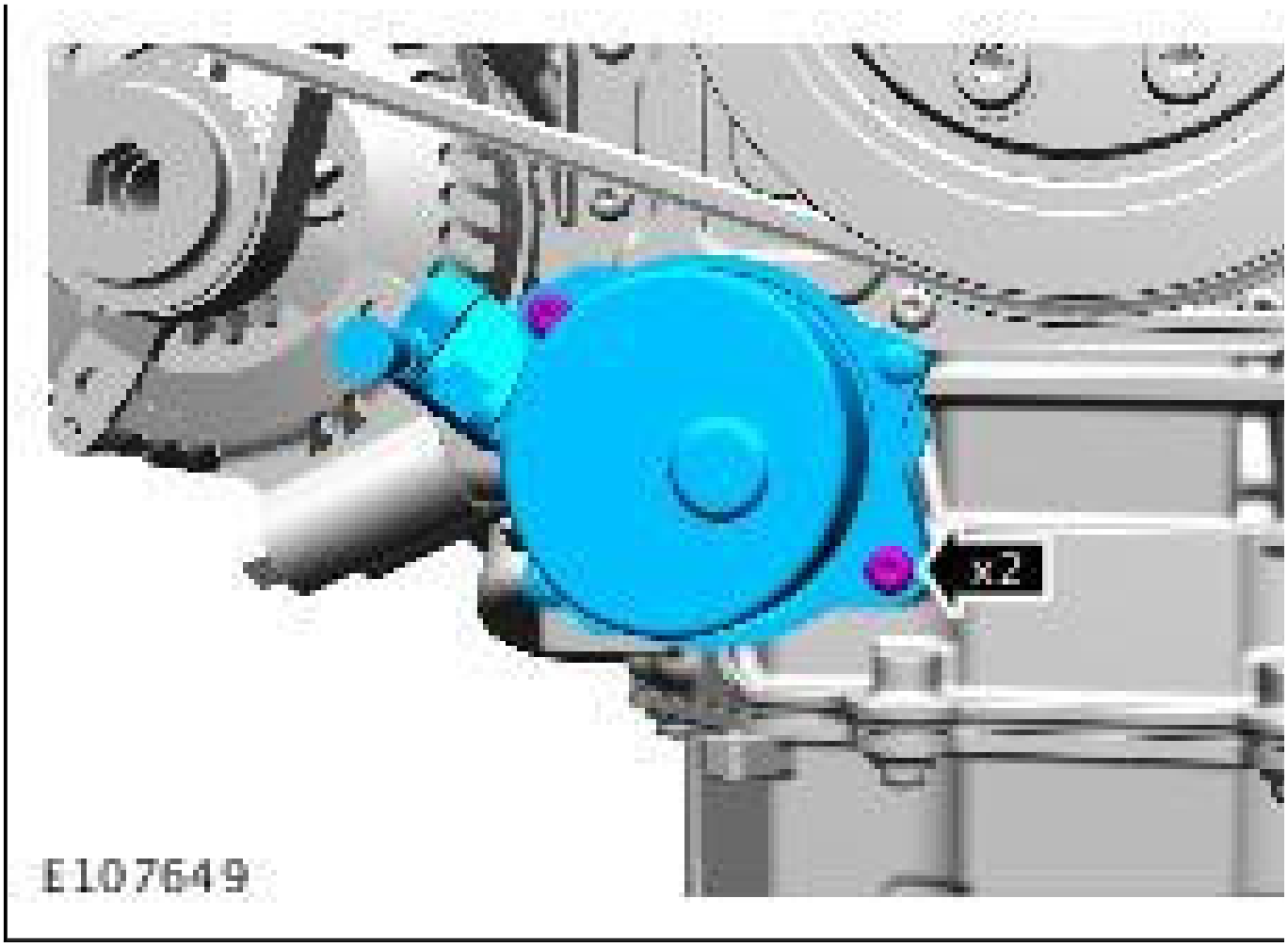

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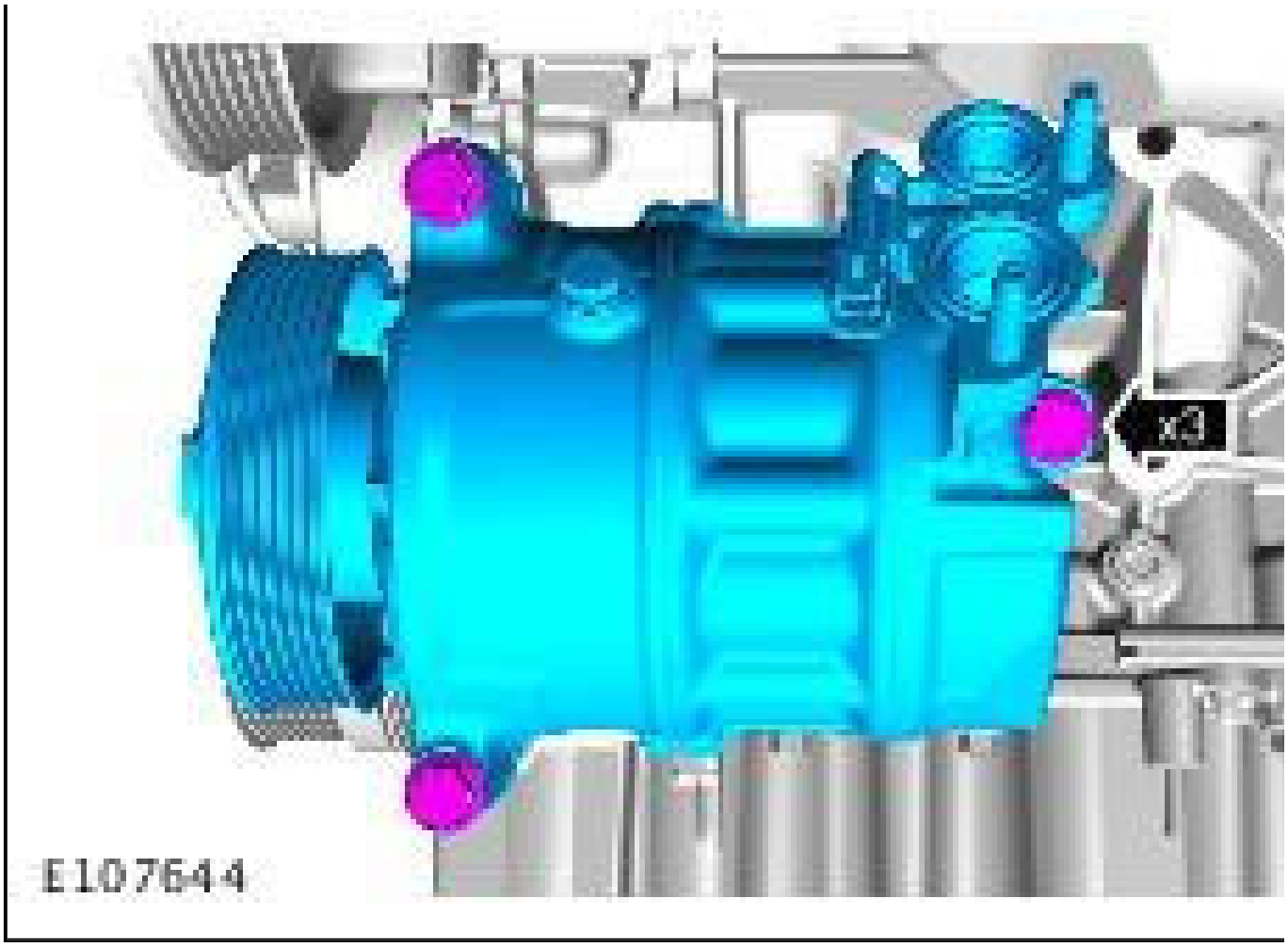

12. See figure

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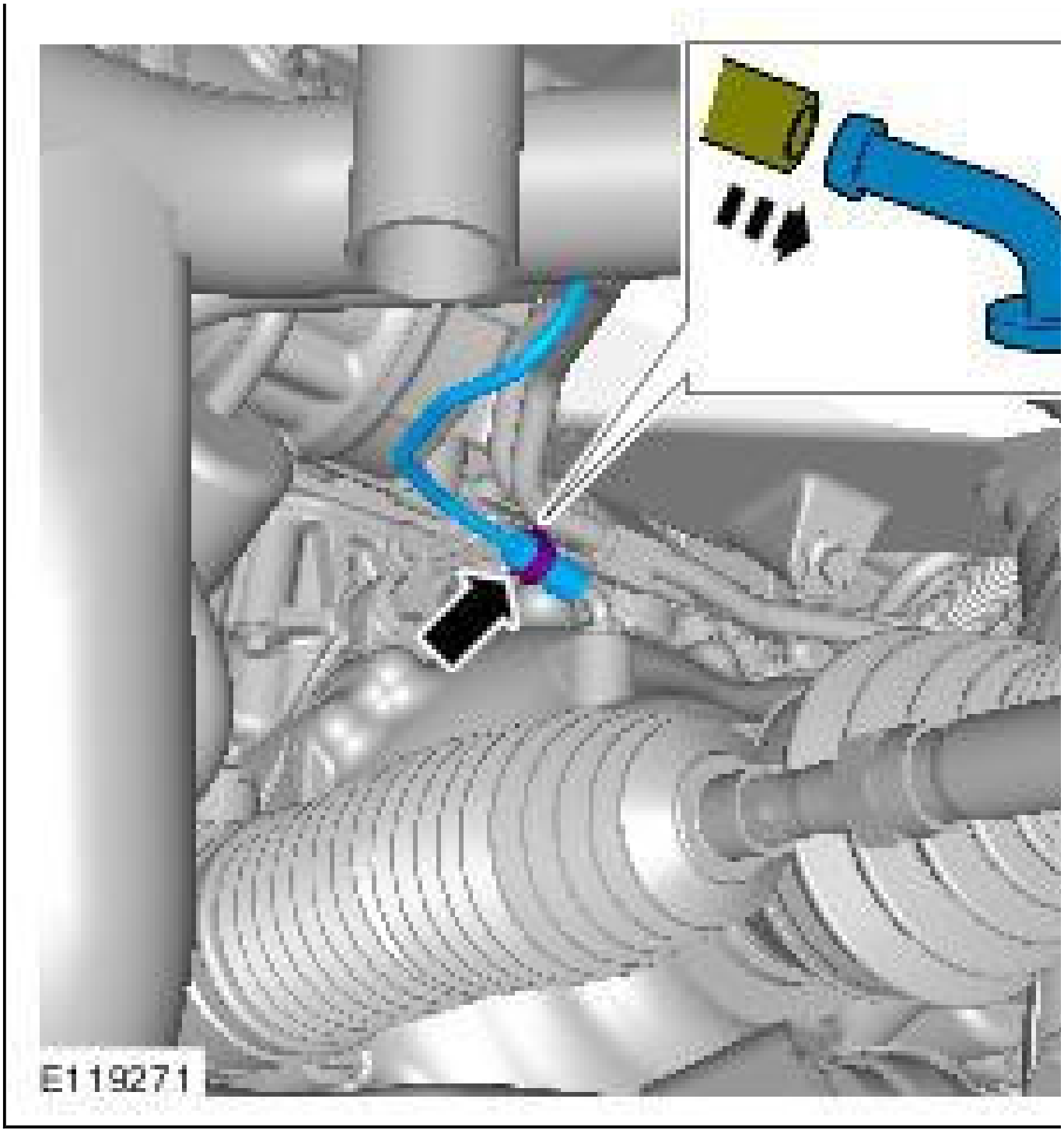

13. See figure

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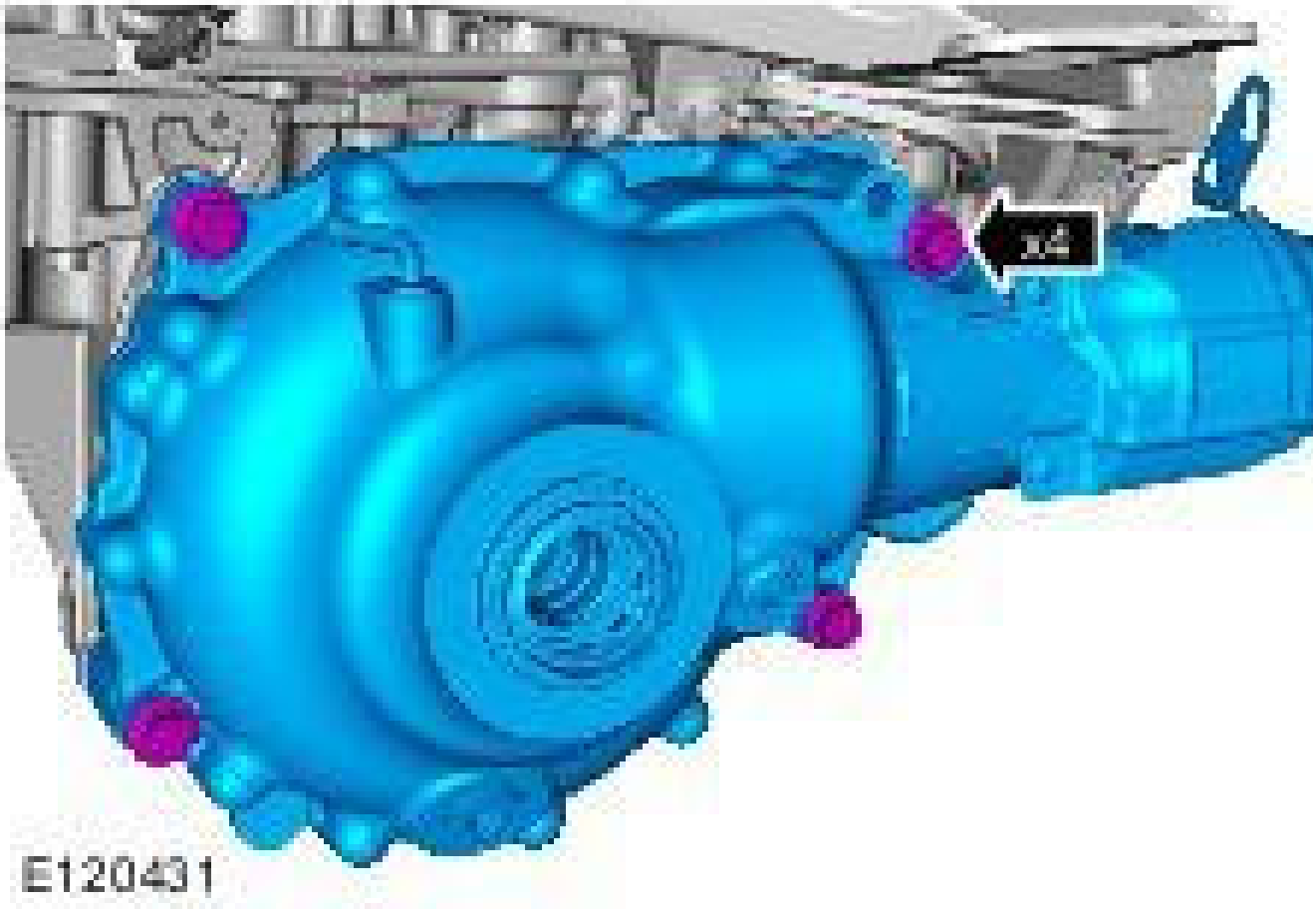

- Discard the O-ring seal.
- Remove and discard the halfshaft oil seal.

14. See figure

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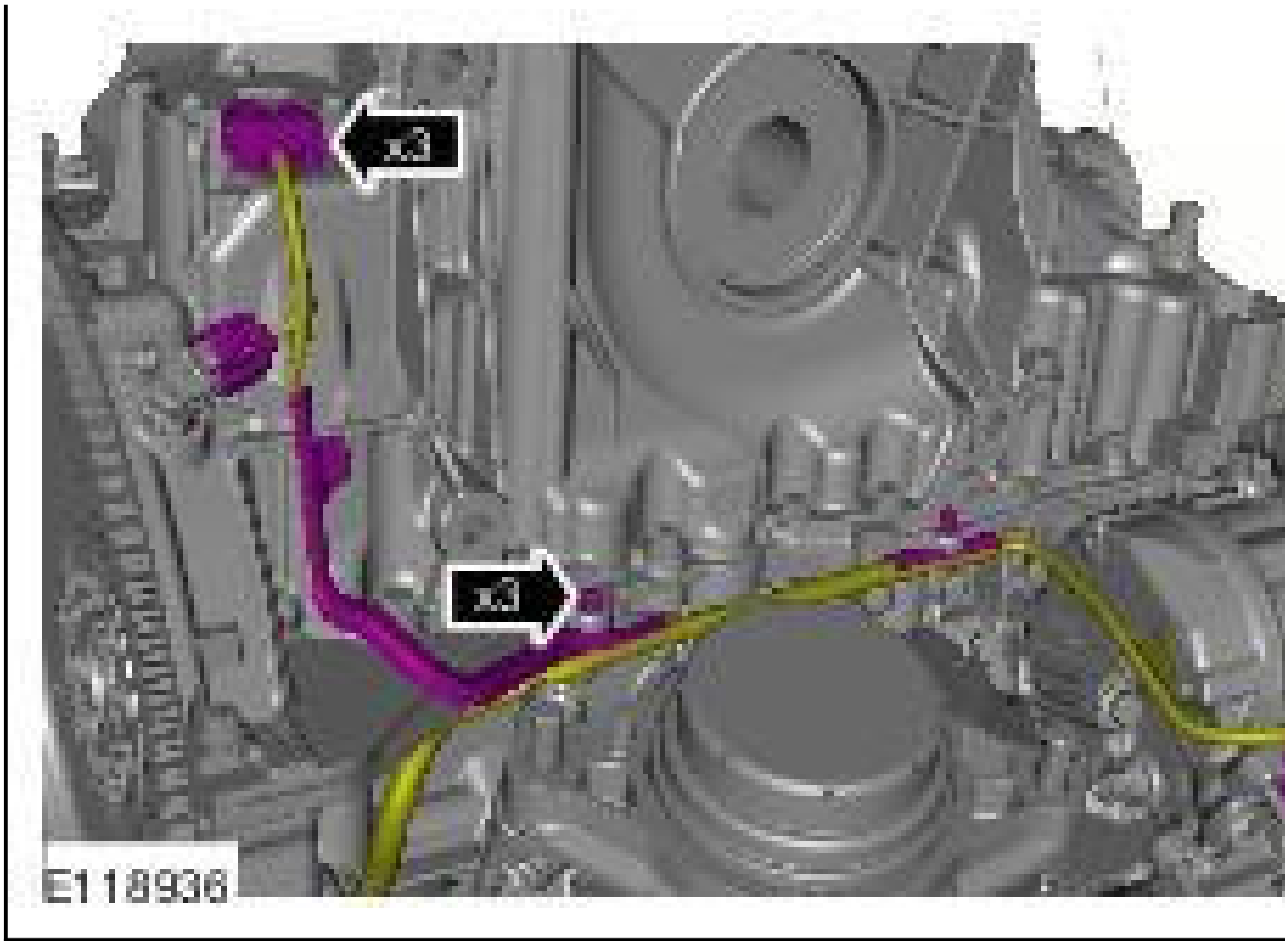

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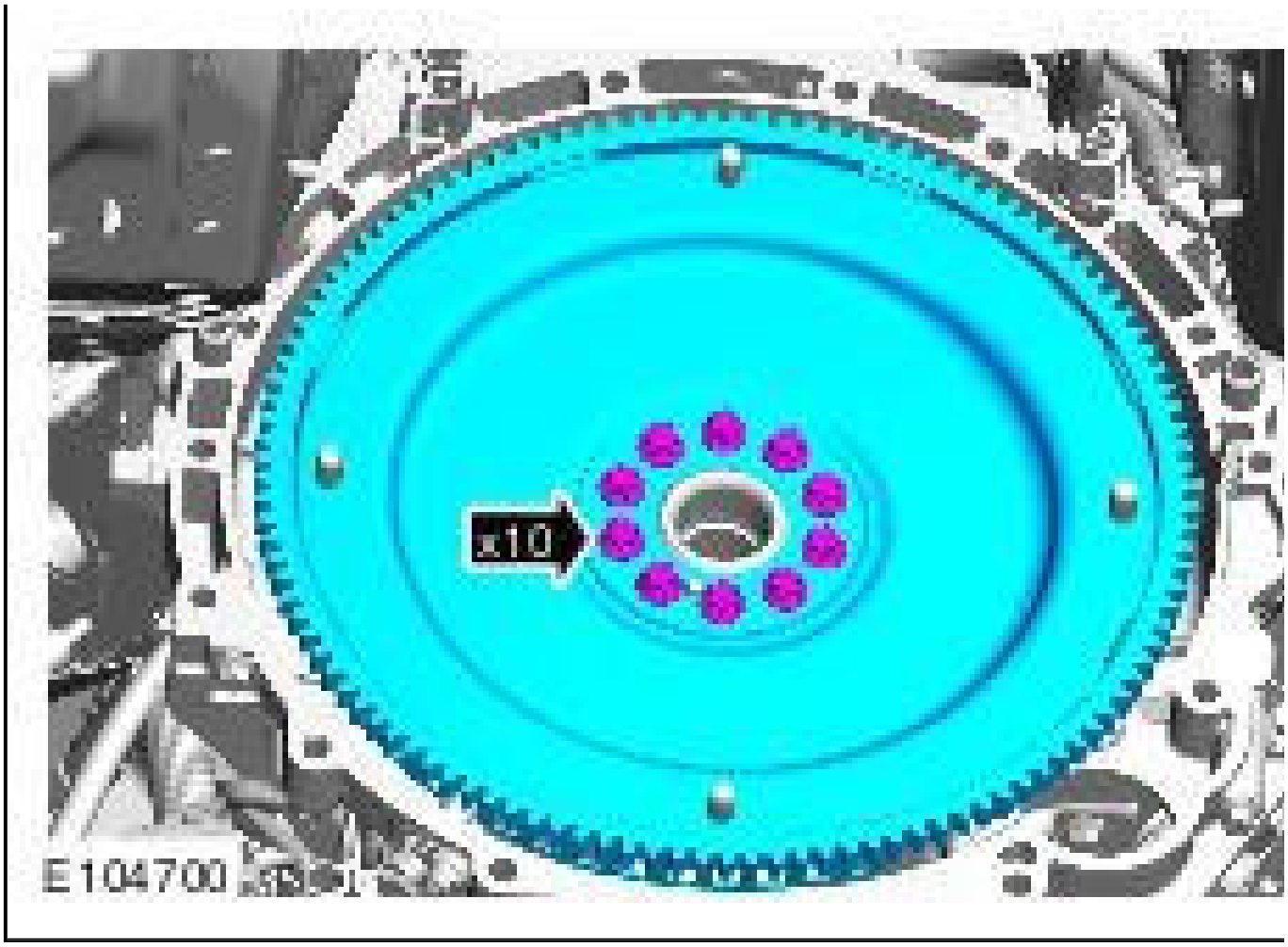

CAUTION: The bolts can only be used 3 times, mark the bolts with a center punch. If 2 punch marks are visible, discard the bolts.

CAUTION: Make sure that no components fall off during removal.

NOTE: Make sure that the crankshaft is not rotated.

NOTE: Make sure the crankshaft and flexplate mating faces are clean before installation.

16. See figure

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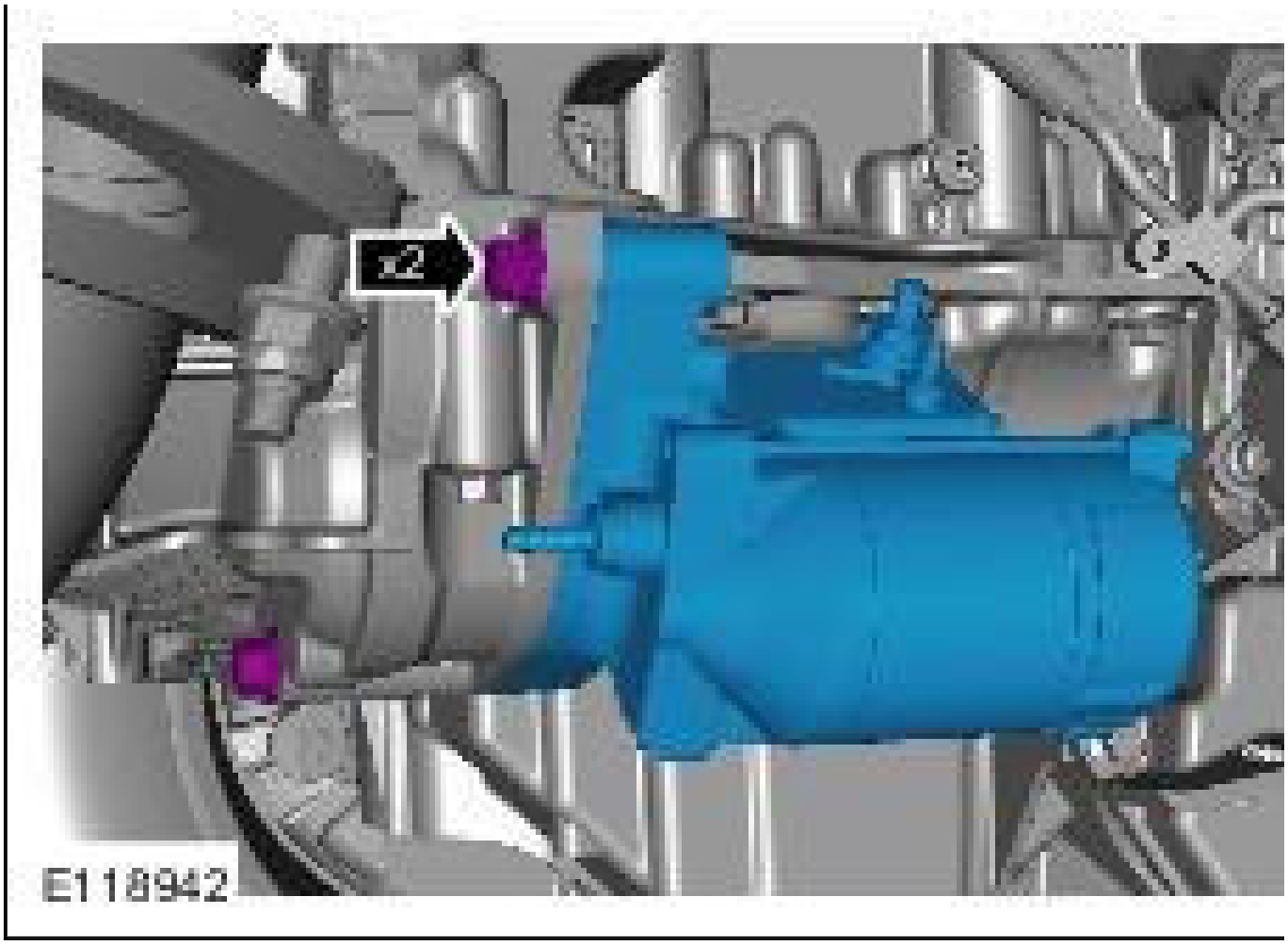

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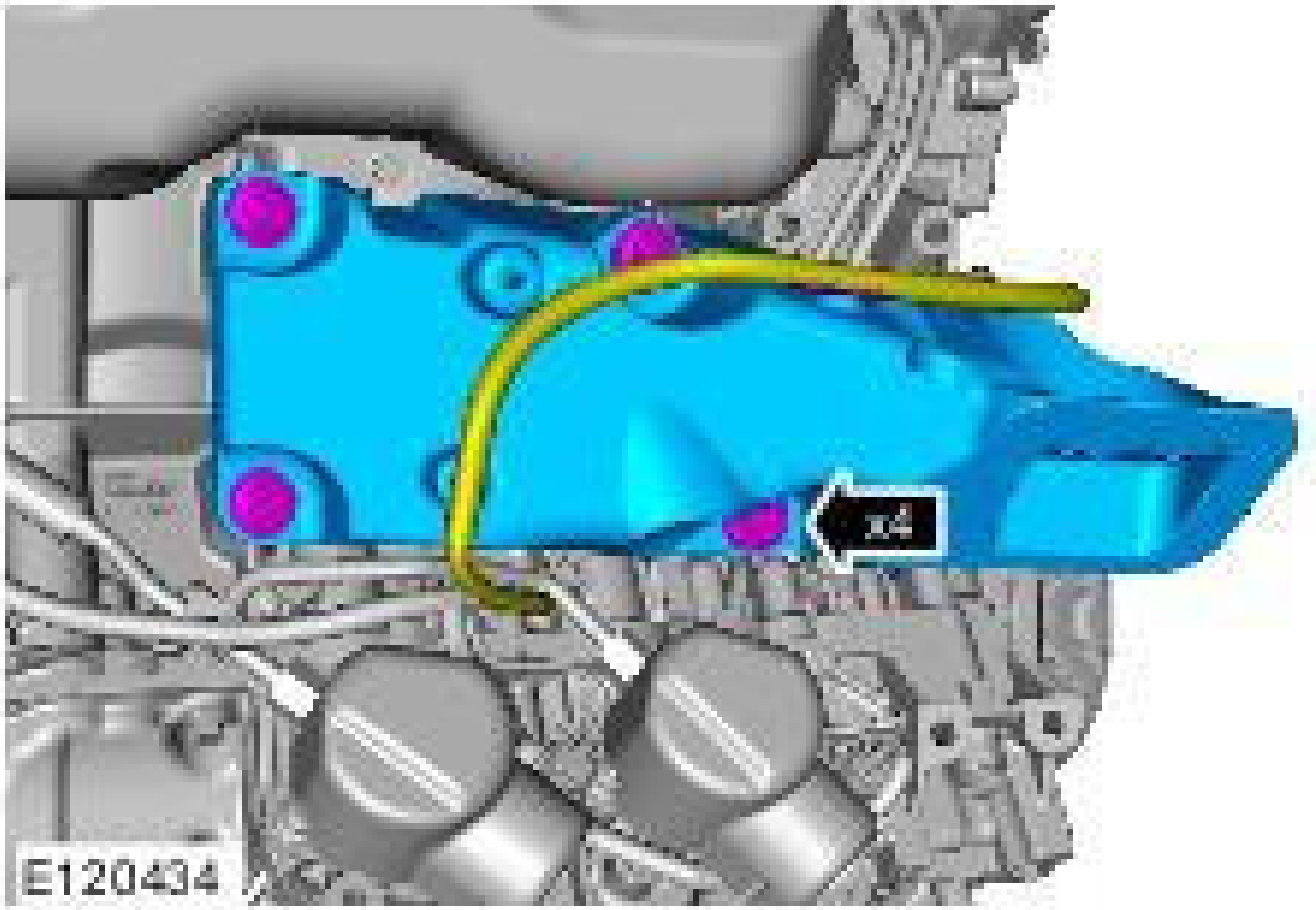

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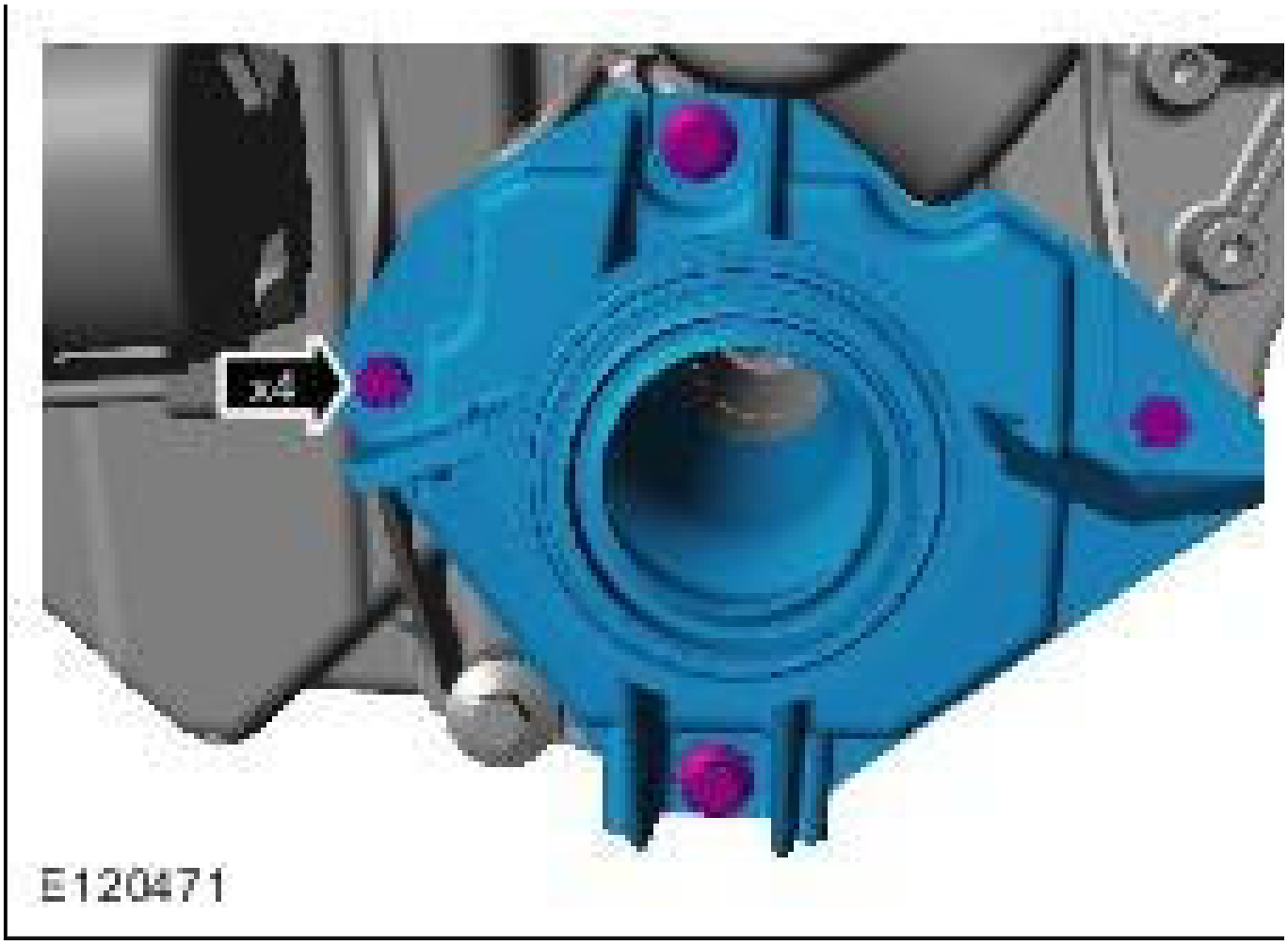

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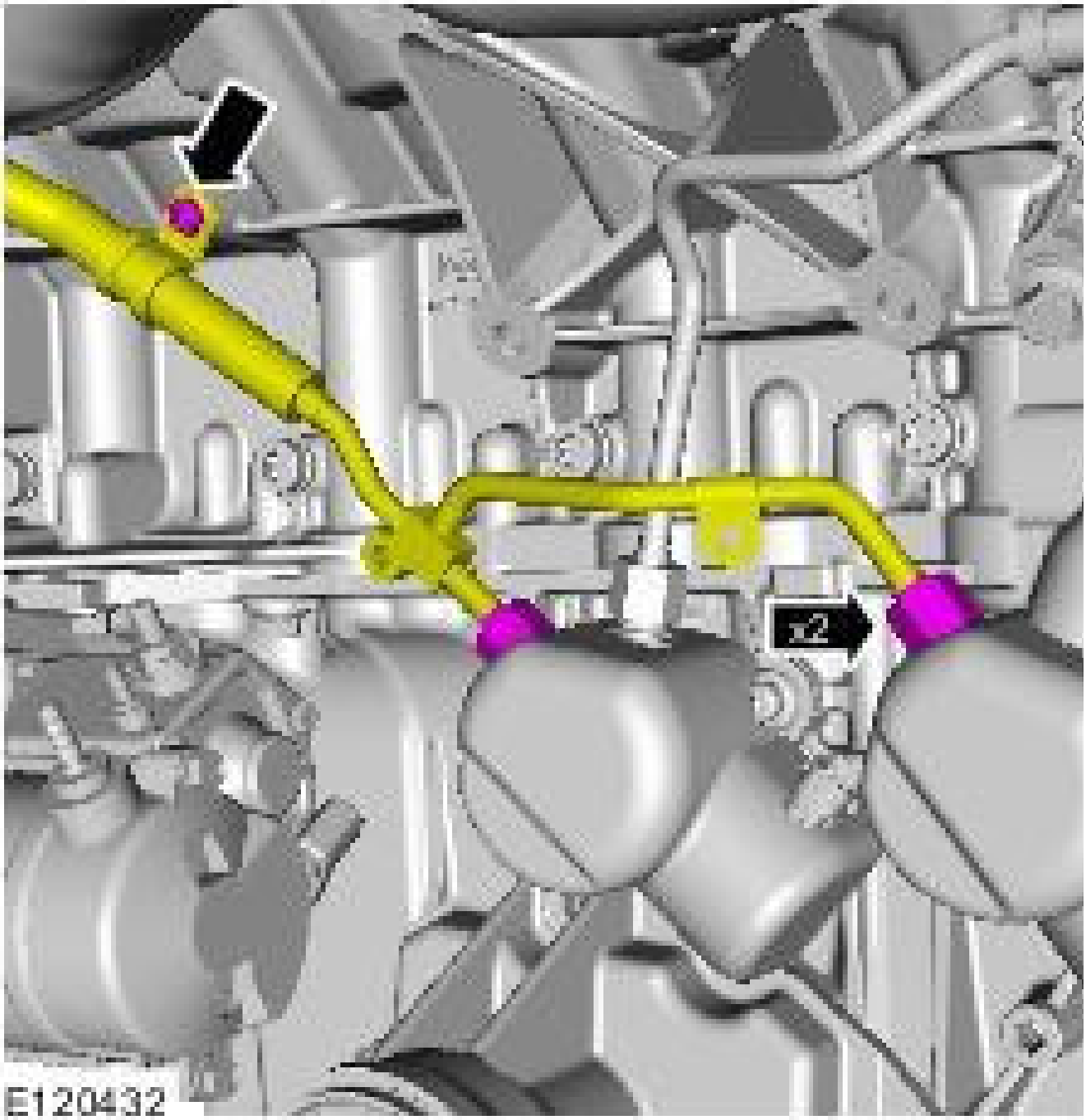

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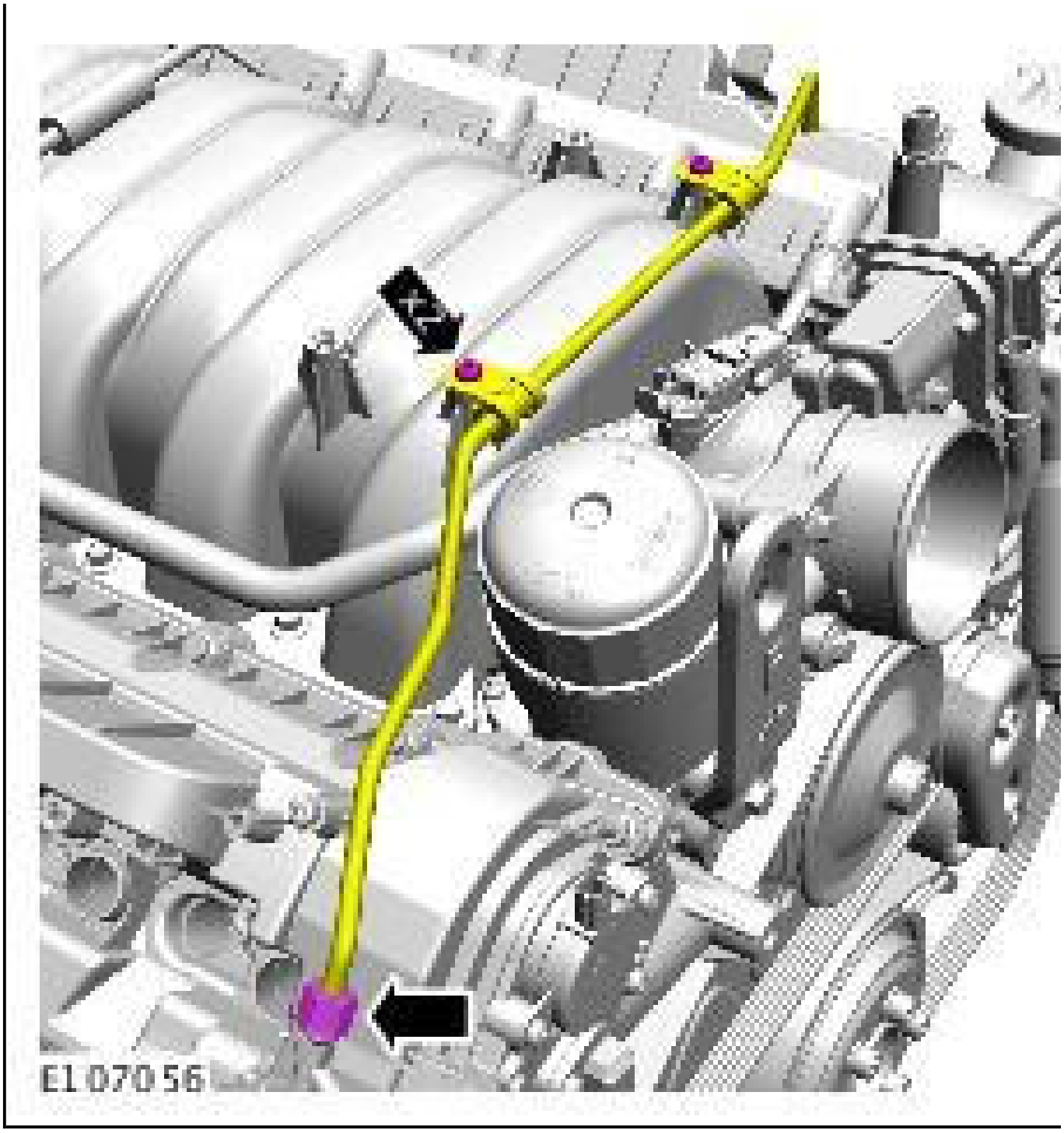

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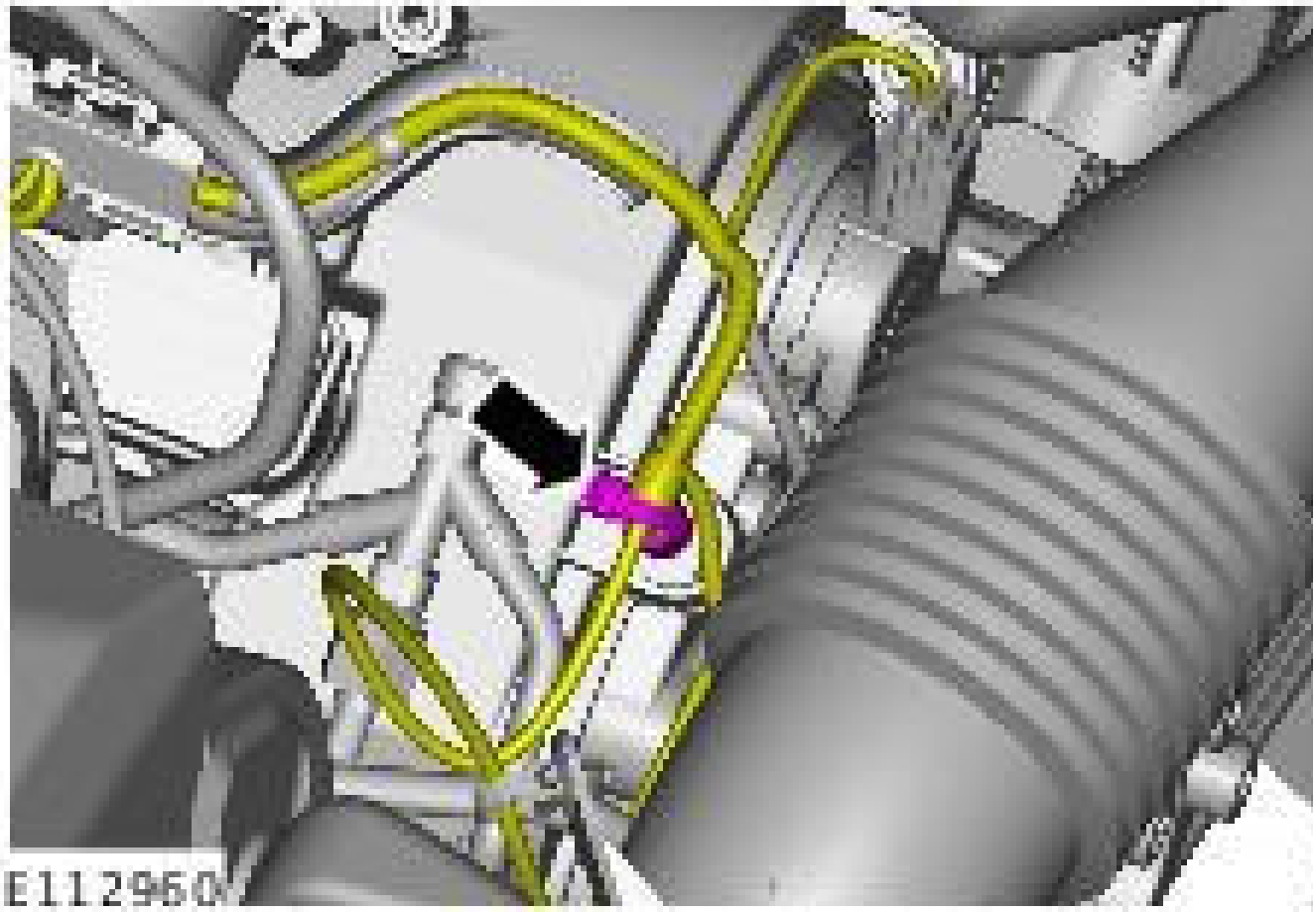

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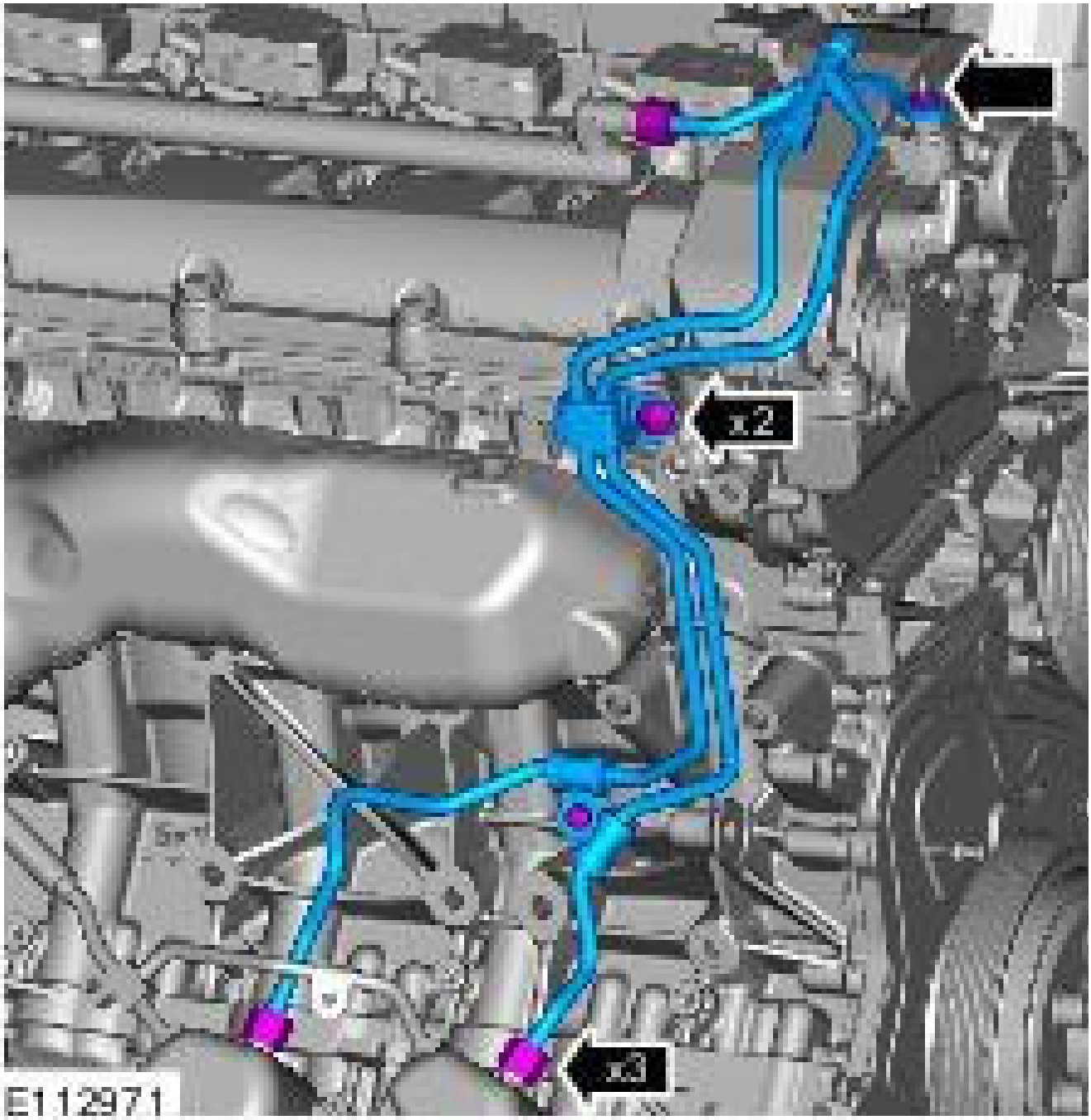

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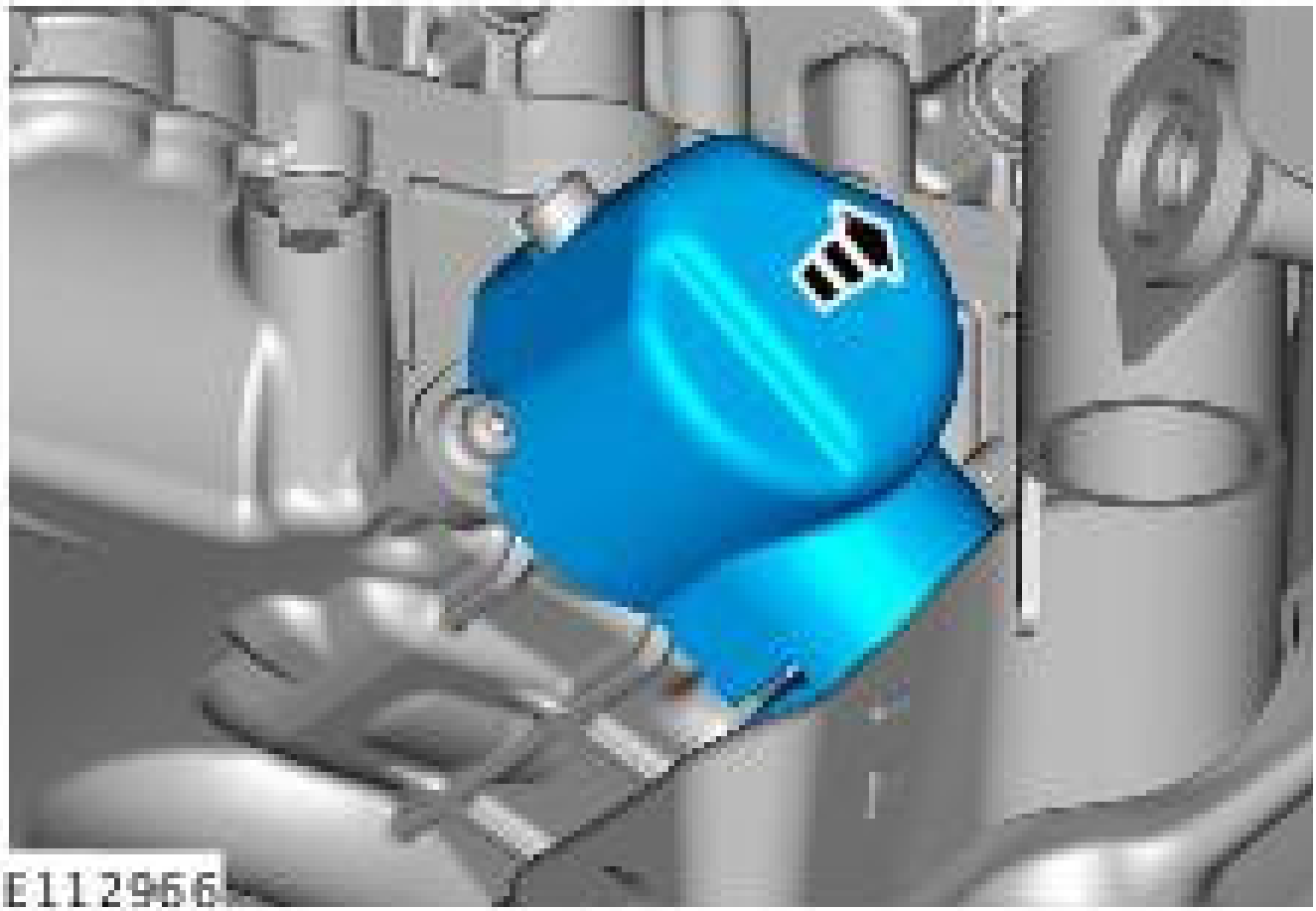

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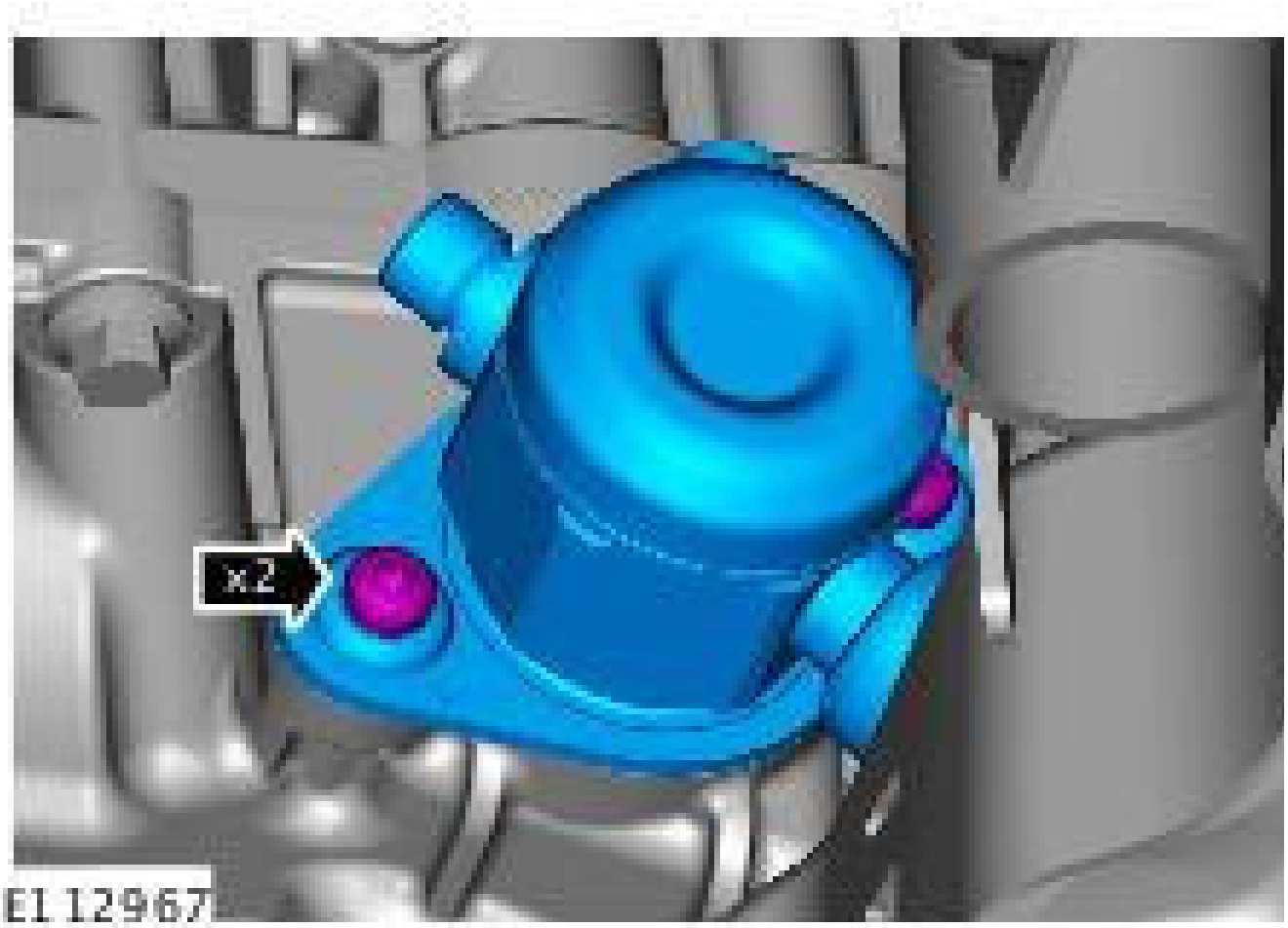

CAUTION: Be prepared to collect escaping fluids.

25. See figure

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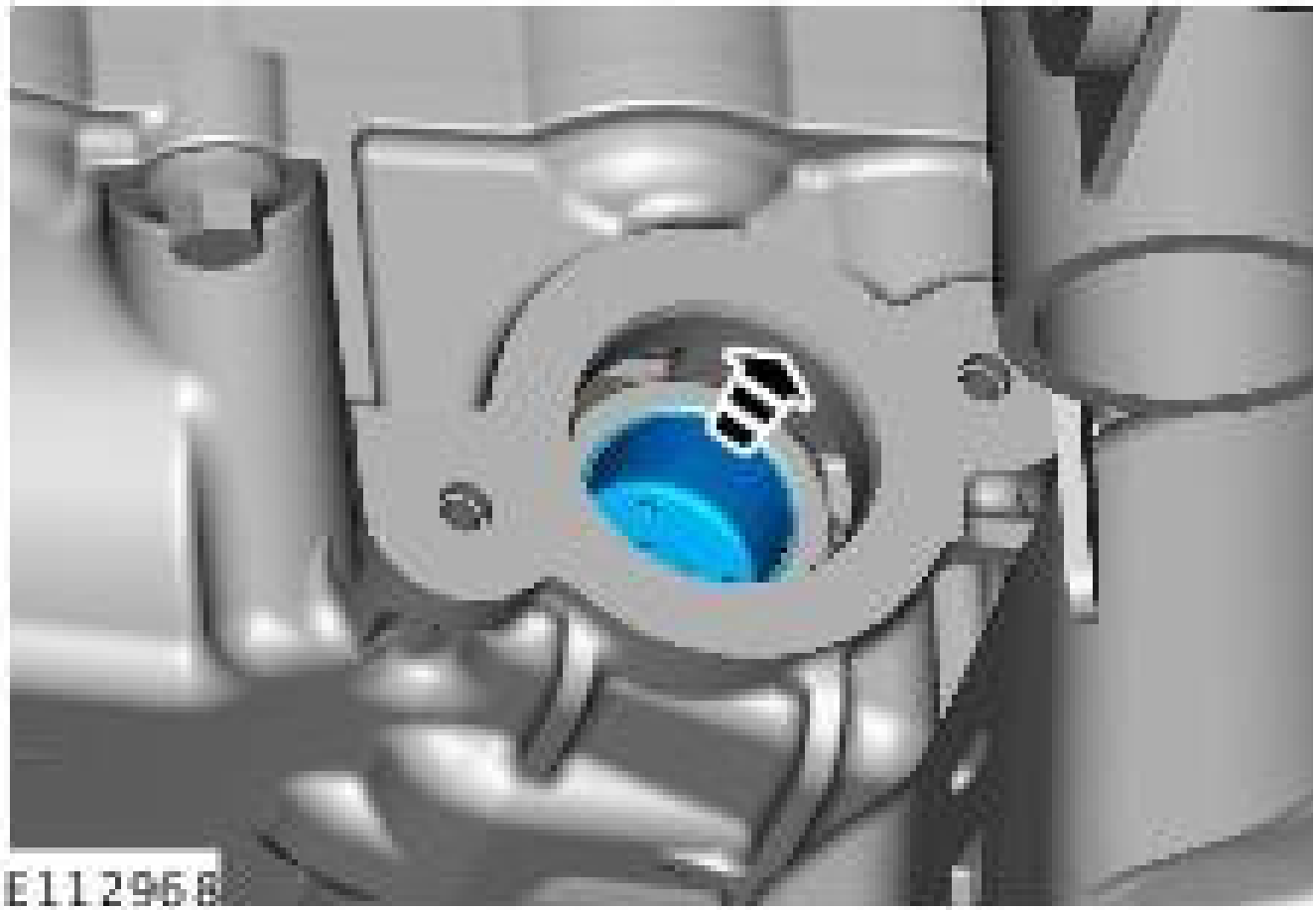

CAUTION: Be prepared to collect escaping fluids.

26. See figure

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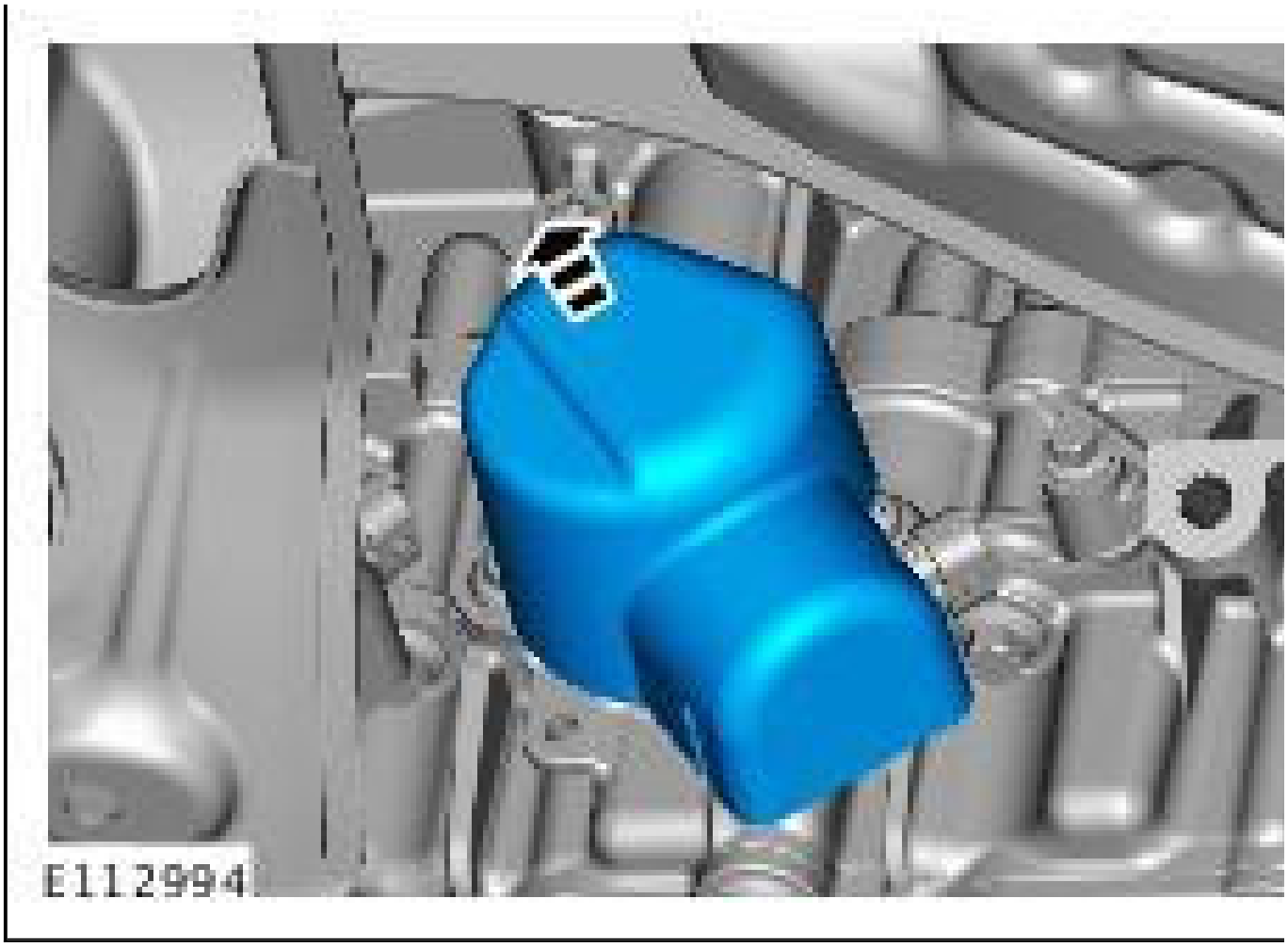

27. See figure

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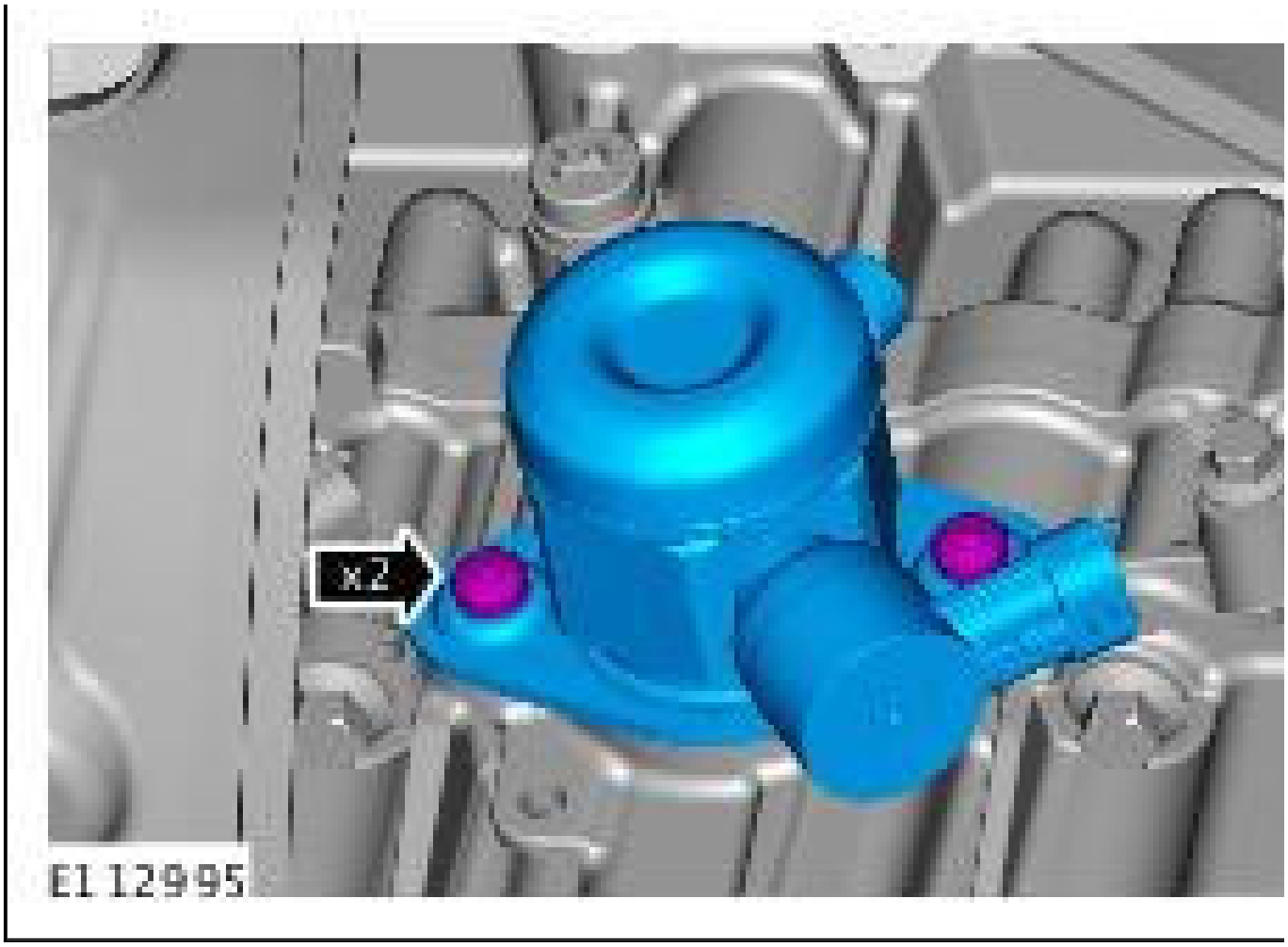

CAUTION: Be prepared to collect escaping fluids.

28. See figure

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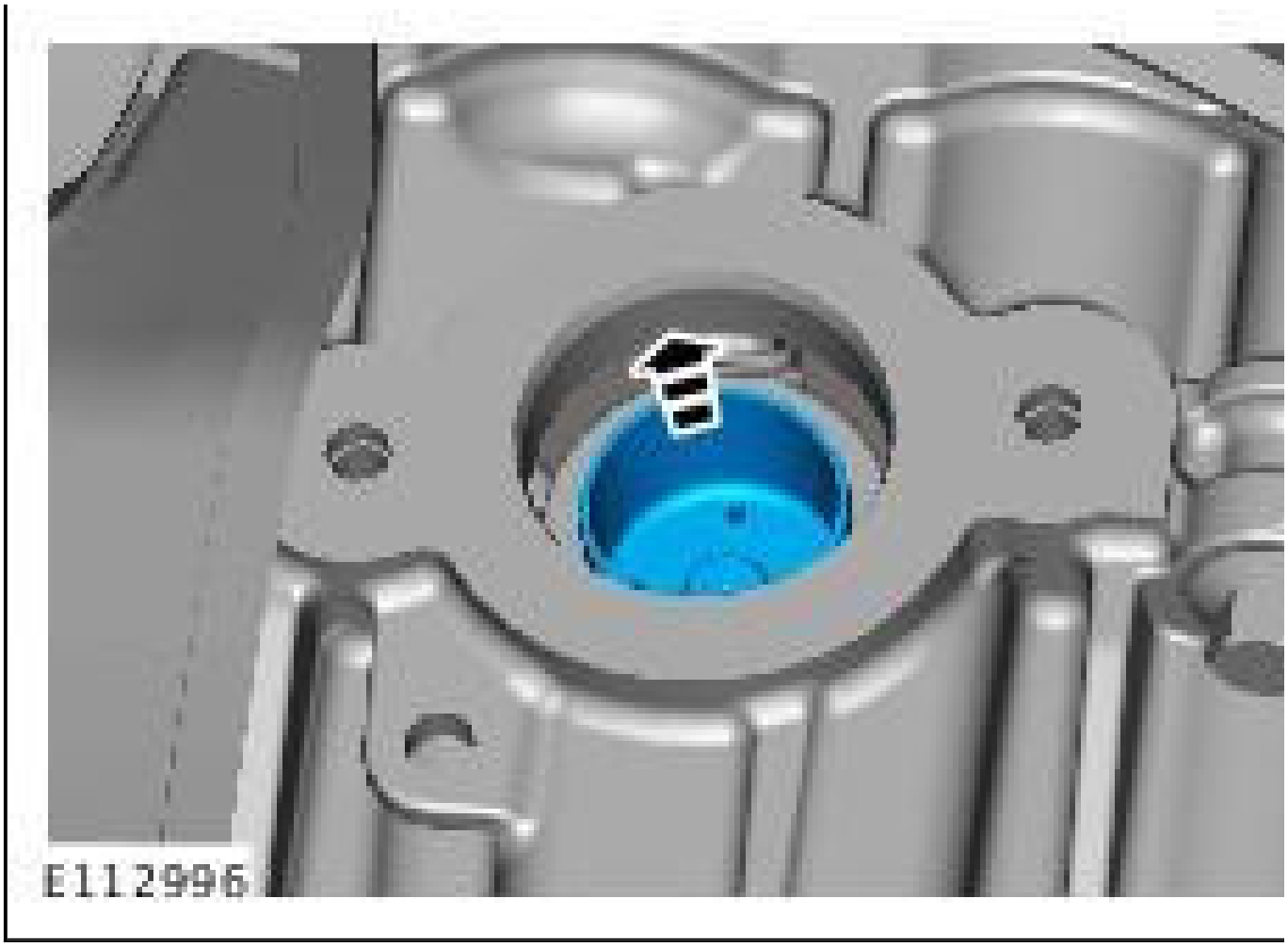

CAUTION: Be prepared to collect escaping fluids.

29. See figure

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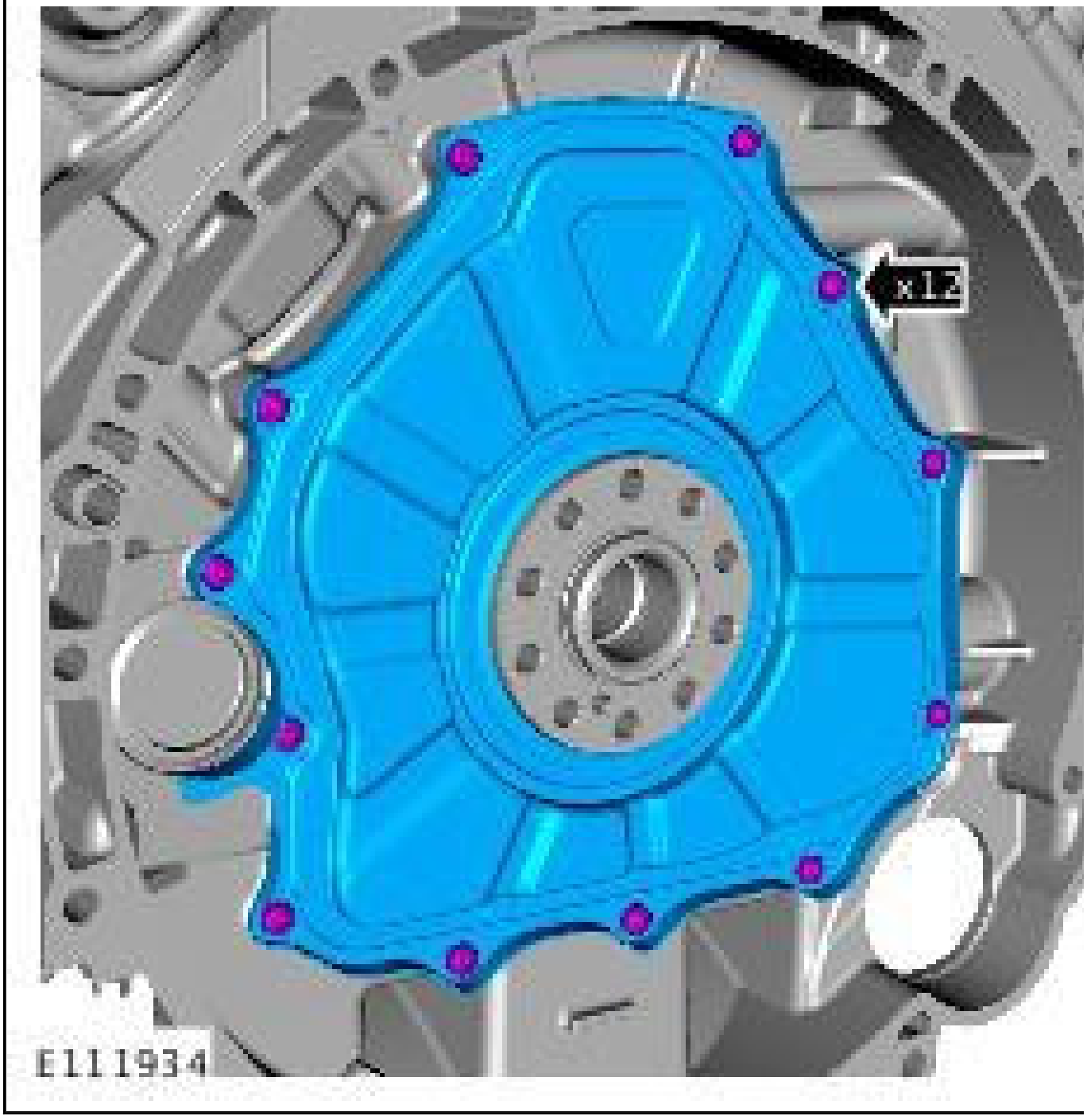

30. See figure

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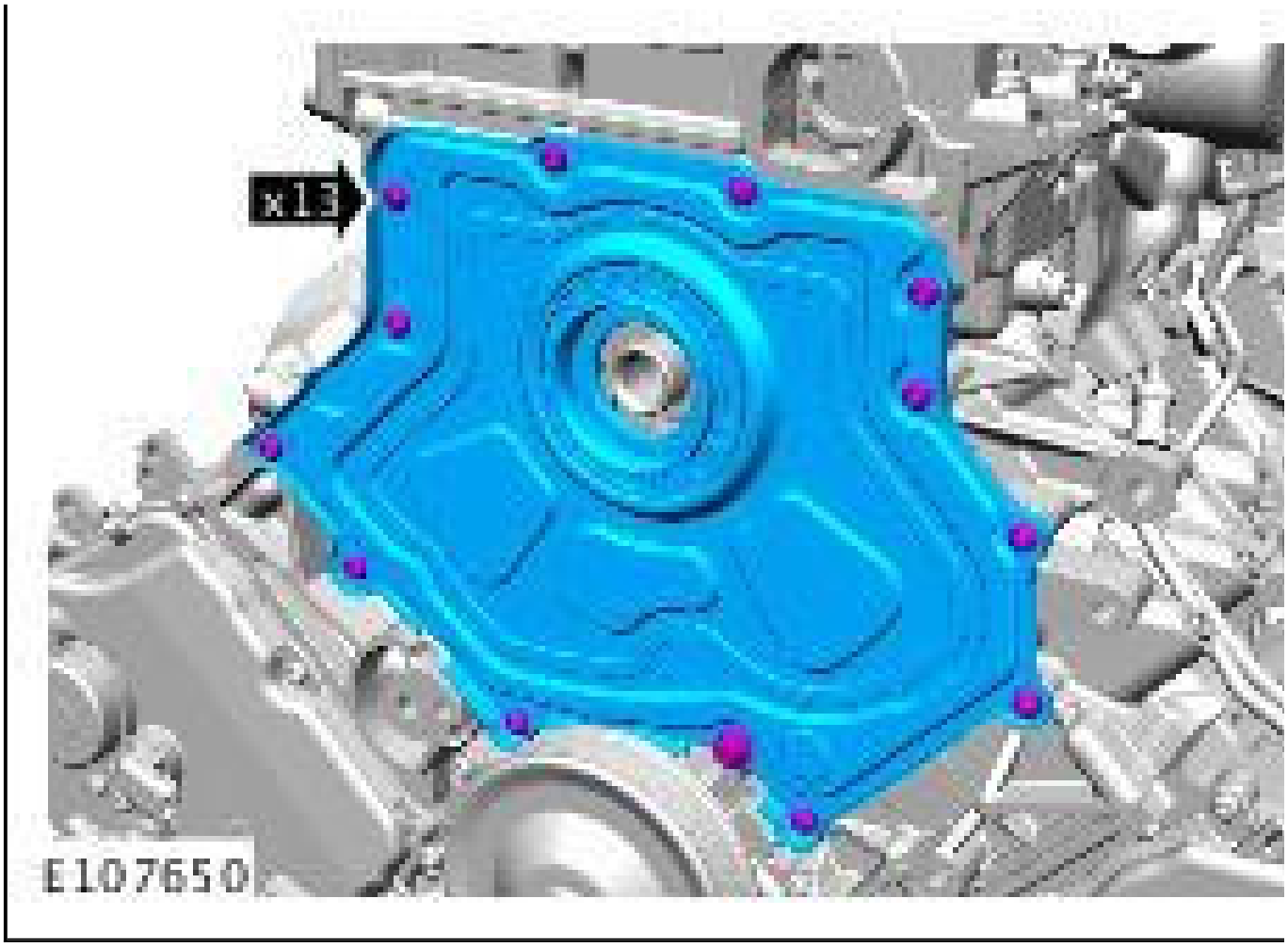

NOTE: Discard the component.

31. See figure

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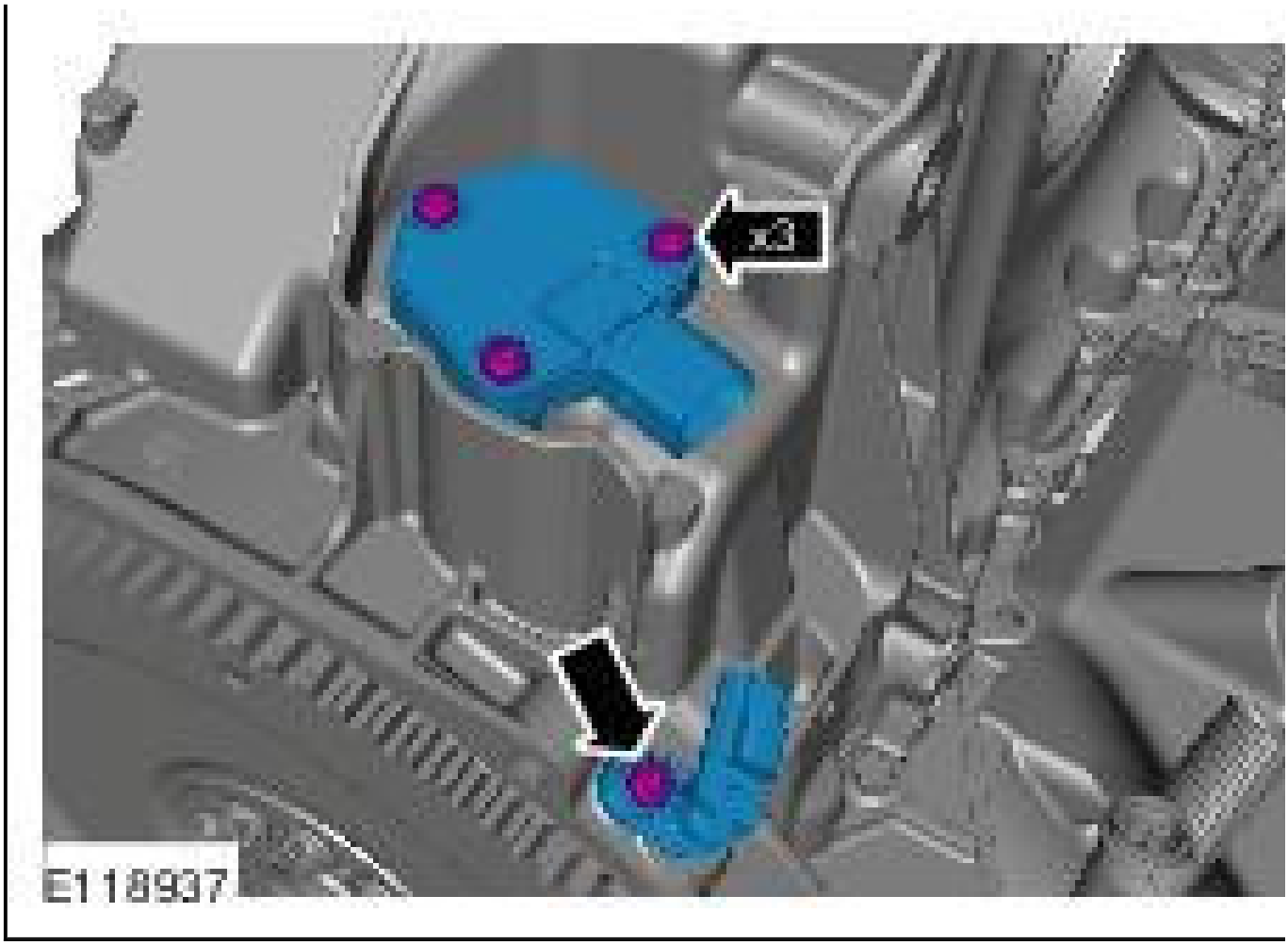

32. See figure

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33. See figure

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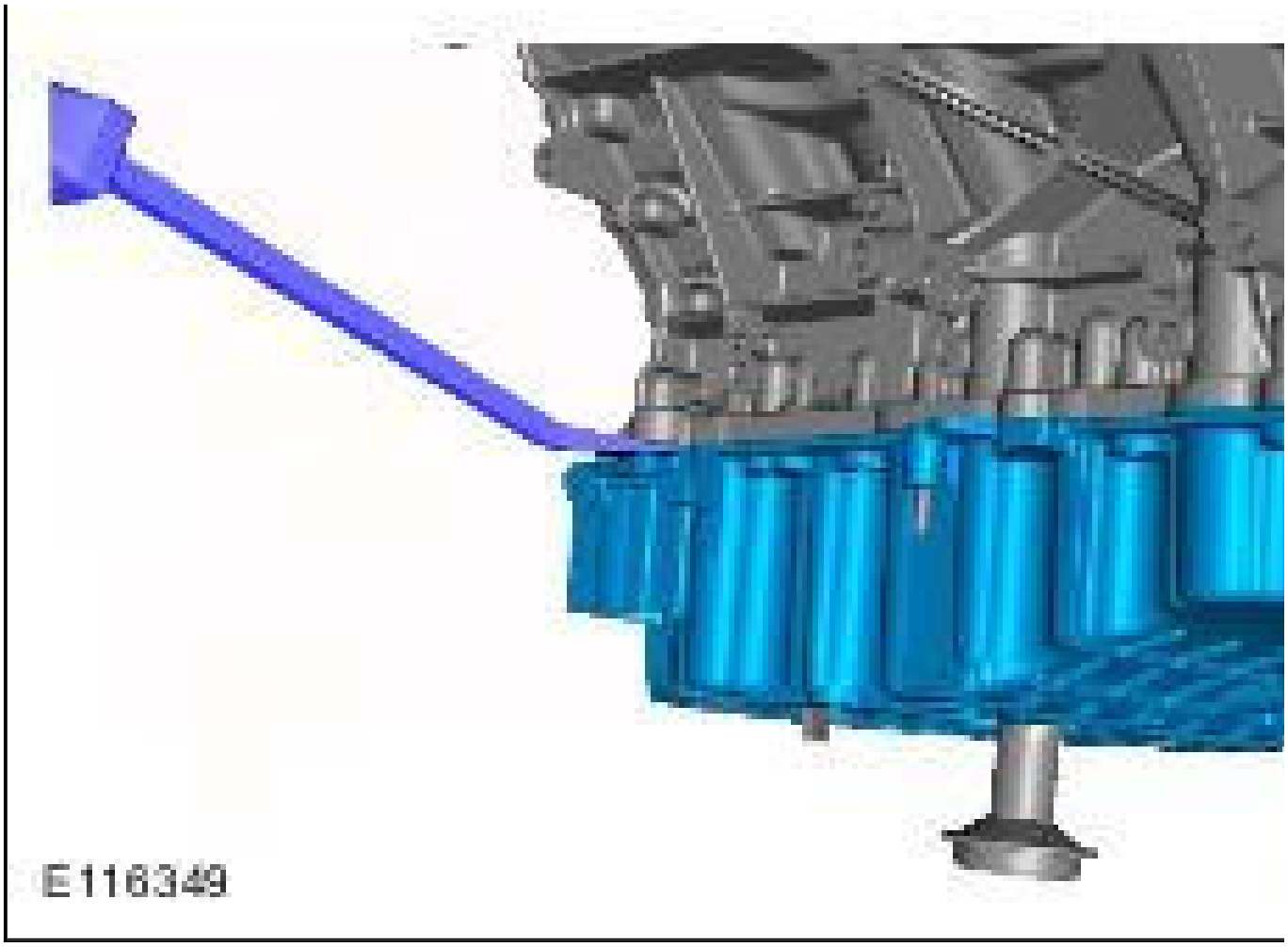

NOTE: **Make sure to use the aluminum lug provided on the oil pan extension to lever against.**

34. See figure

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

INSTALLATION

1. Torque: 10 Nm

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2. See figure

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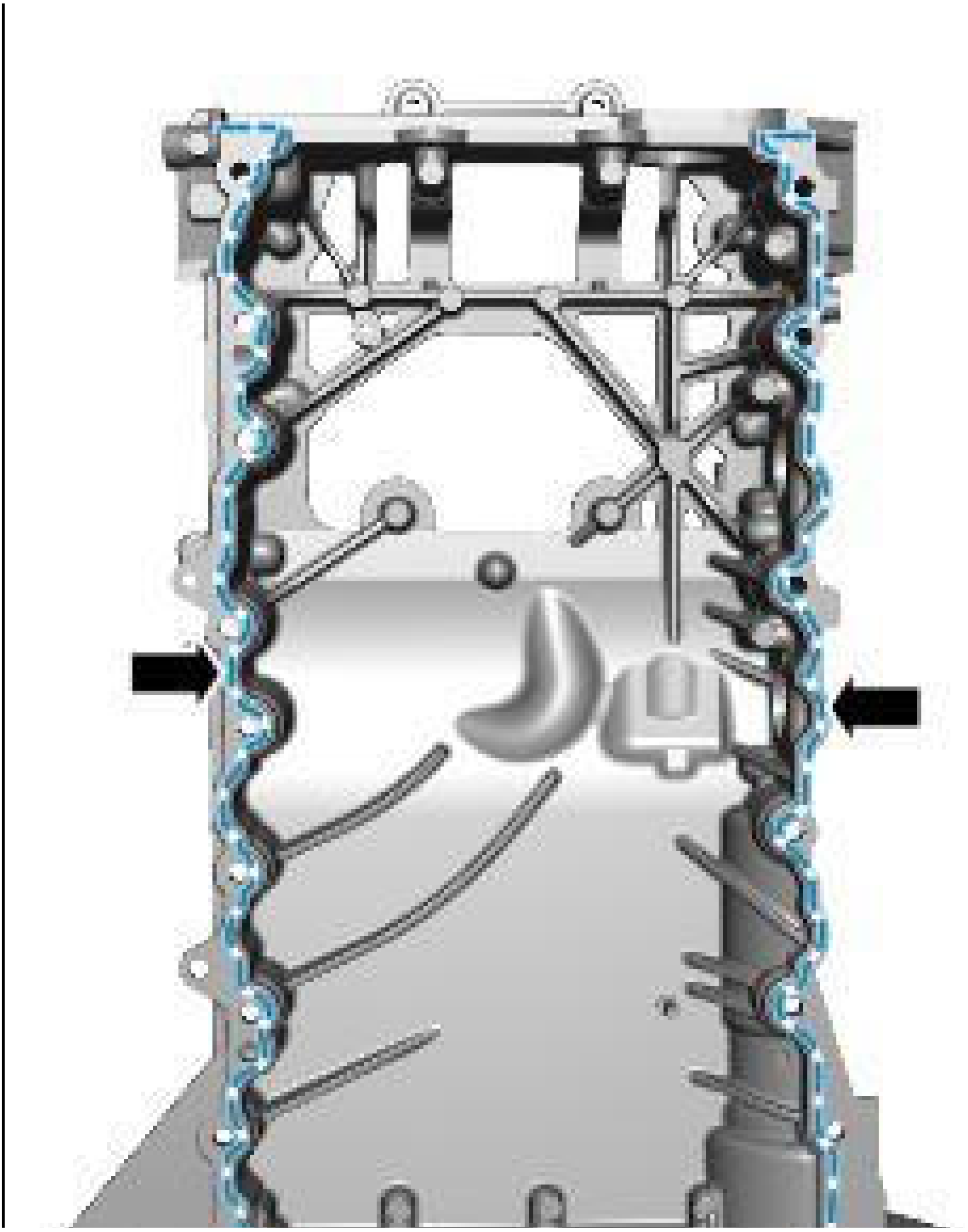

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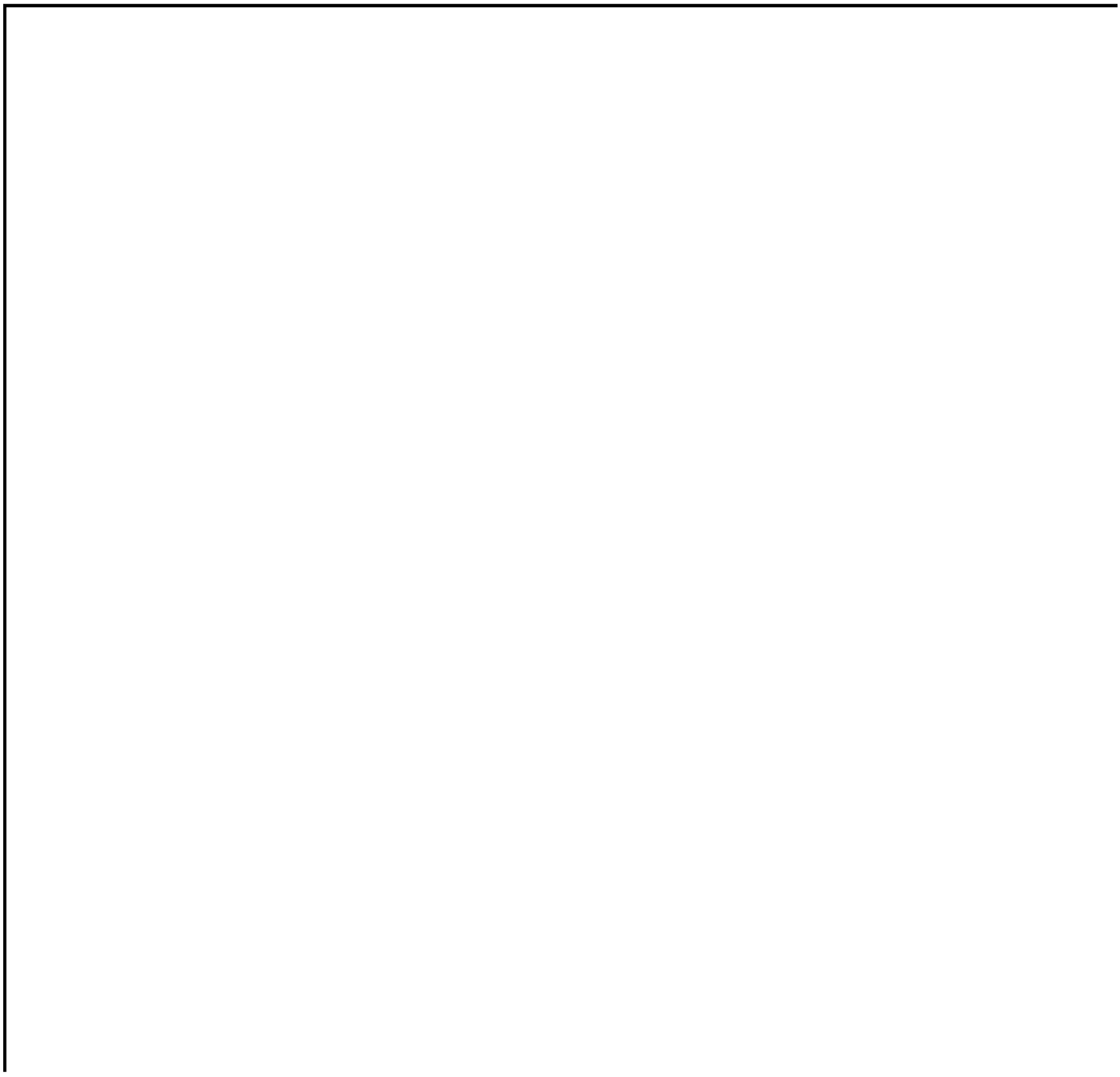
CAUTION: Make sure that the mating faces are clean and free of foreign material.

CAUTION: Use only a plastic scraper when removing the sealing material.

- Apply RTV sealant WSE-M4G323-A6 (Loctite 5901G) to the areas shown, and tighten the bolts within 7 minutes.

3. Torque: 25 Nm



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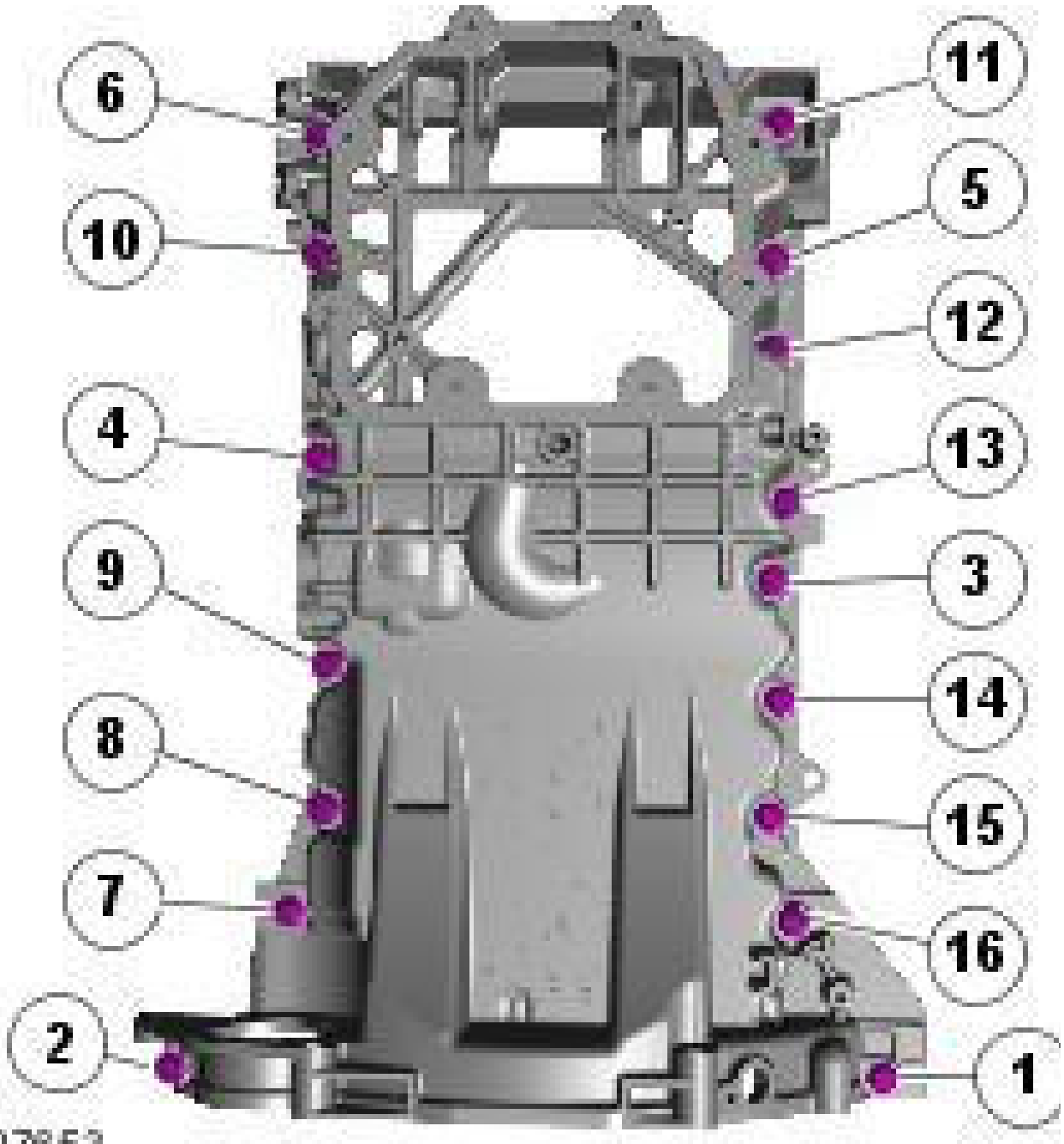

NOTE: Tighten the bolts in the indicated sequence.

4. Apply RTV sealant WSE-M4G323-A6 (Loctite 5901G) to the areas shown, and tighten the bolts within 7 minutes.

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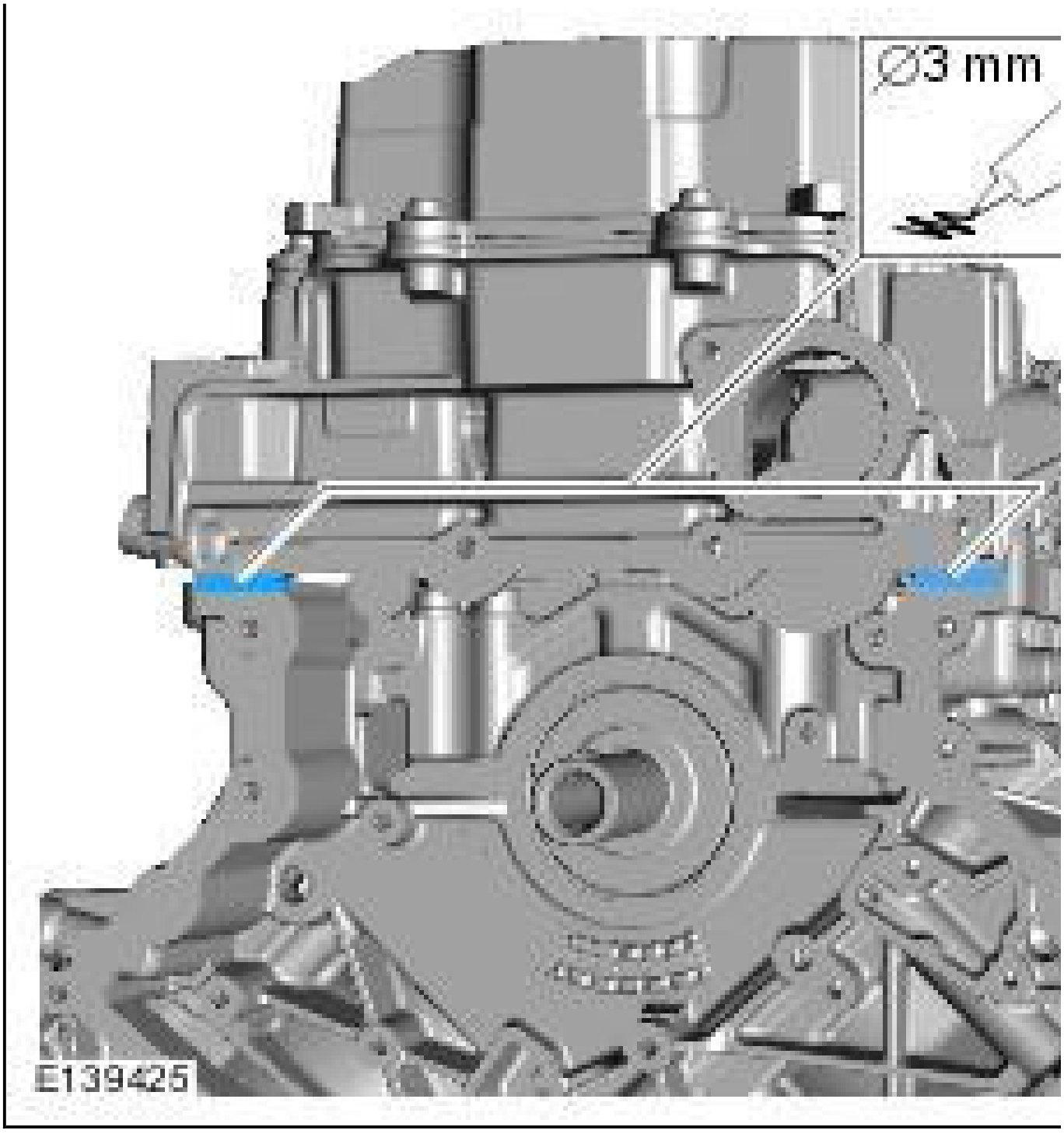

CAUTION: Make sure that the mating faces are clean and free of foreign material.

5. Install the bolts, but do not tighten fully at this stage.

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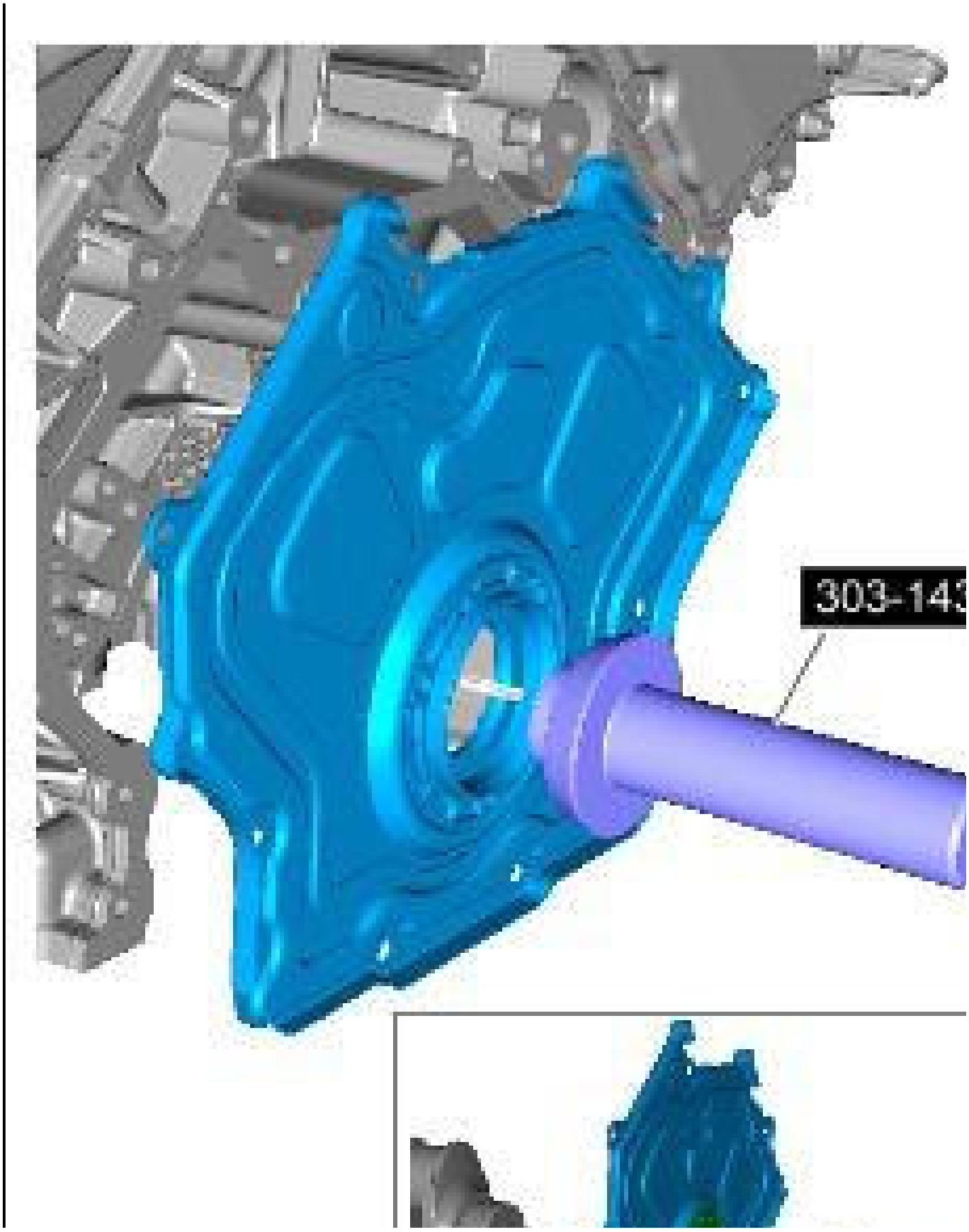

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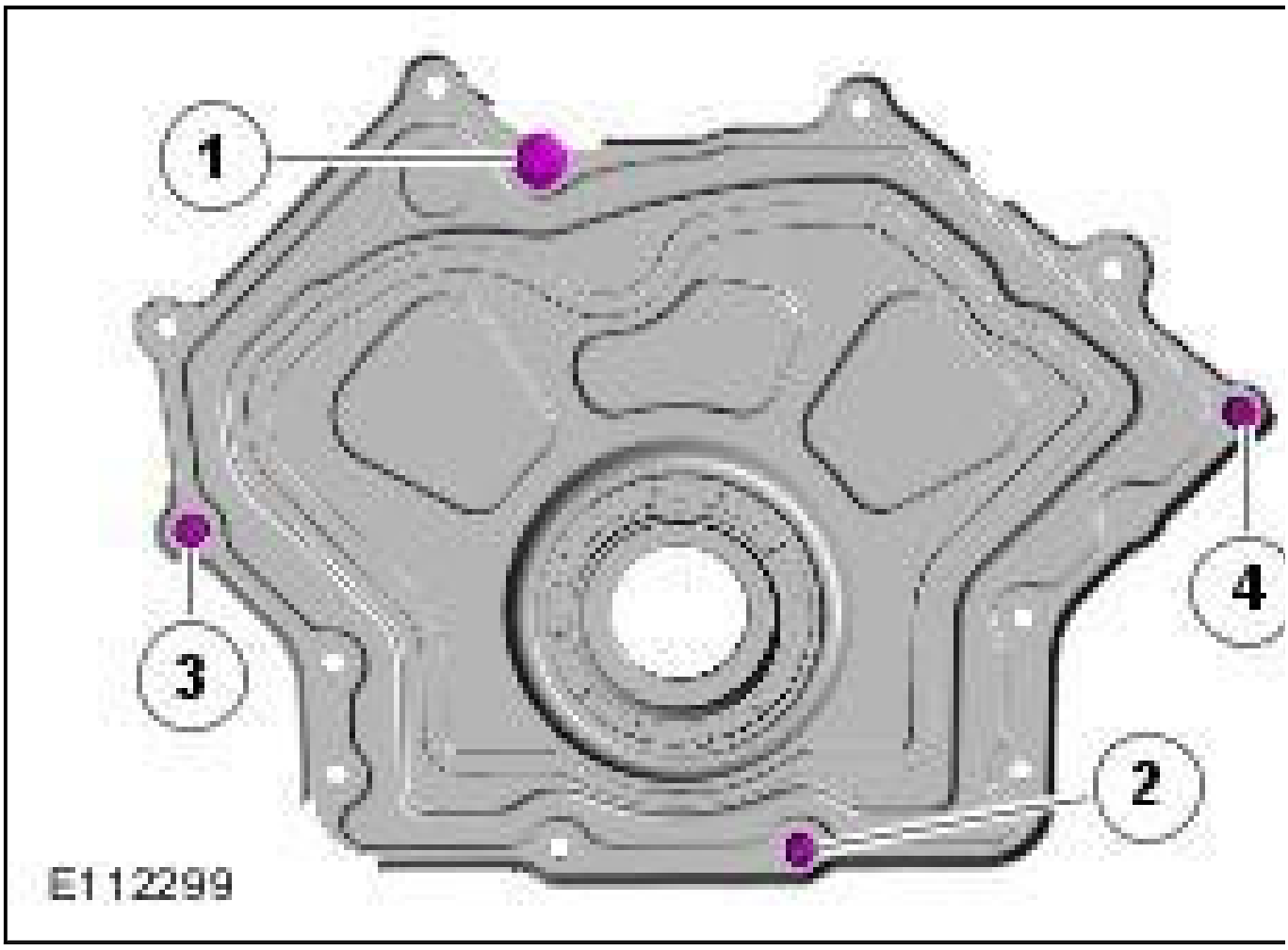
CAUTION: Make sure that the mating faces are clean and free of foreign material.

NOTE: Install new lower timing cover.

Lower Timing Cover Alignment tool (303-1433), refer to **SPECIAL TOOL(S)**

6. See figure



NOTE: Tighten the bolts in the indicated sequence.

- Torques:

  M8: 20 Nm

  M6: 12 Nm

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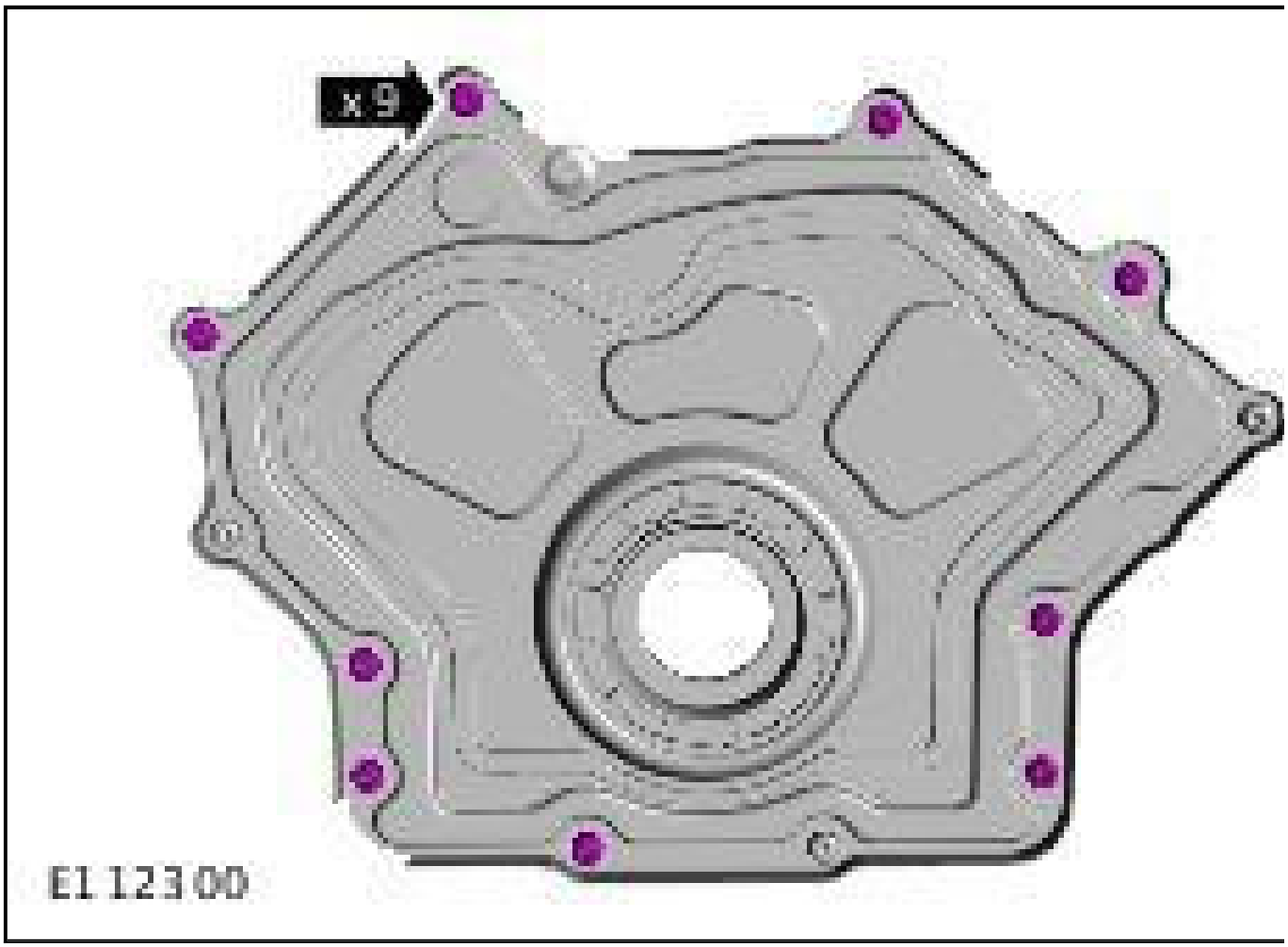
7. Remove the special tools.
8. Torque: 12 Nm



9. See figure

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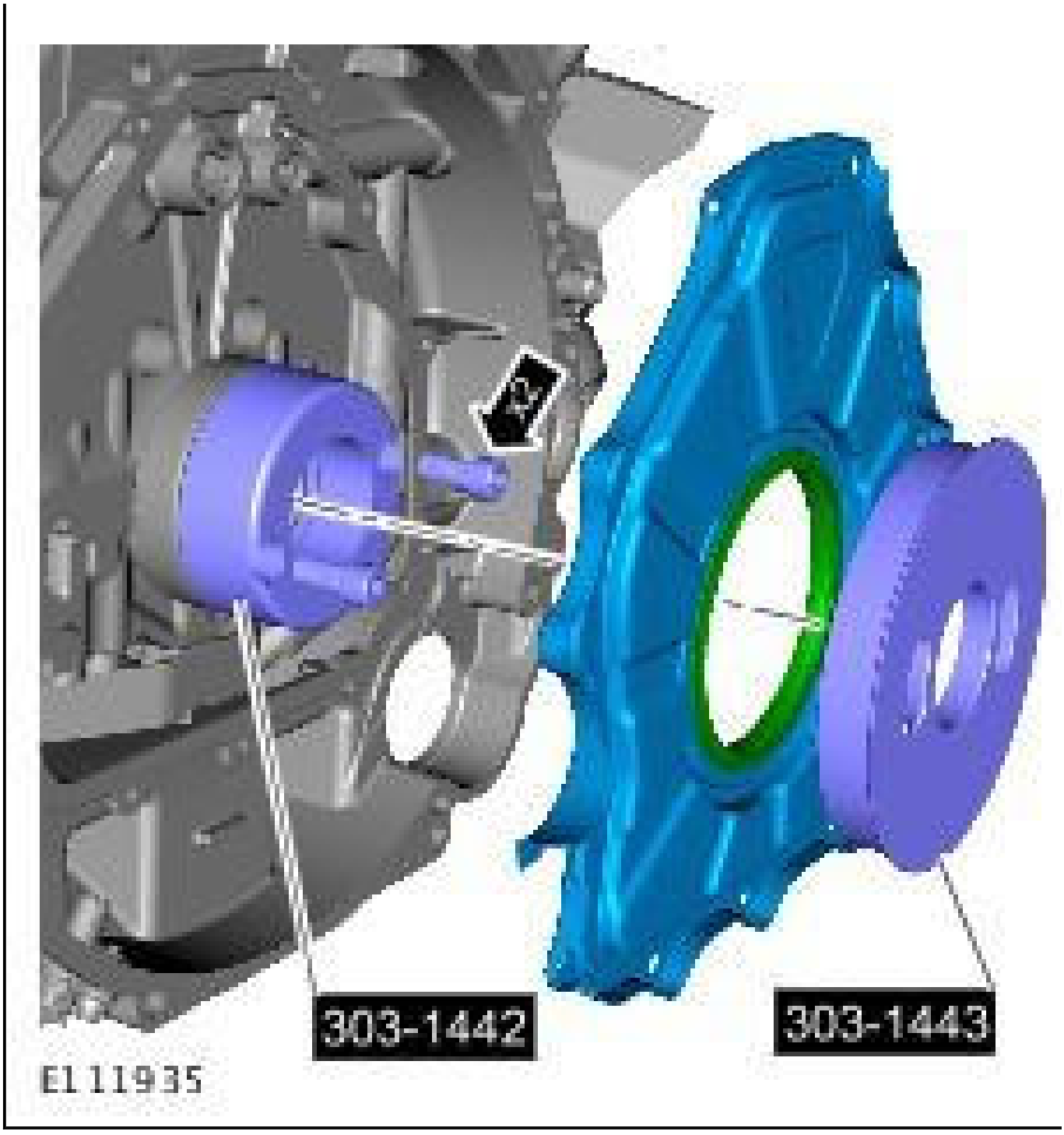

- Rear Crankshaft Seal Installer (303-1442), refer to **SPECIAL TOOL(S)**
- Rear Crankshaft Cover Alignment Tool (303-1443), refer to **SPECIAL TOOL(S)**

10. Remove the special tools.
11. Torque: 11 Nm

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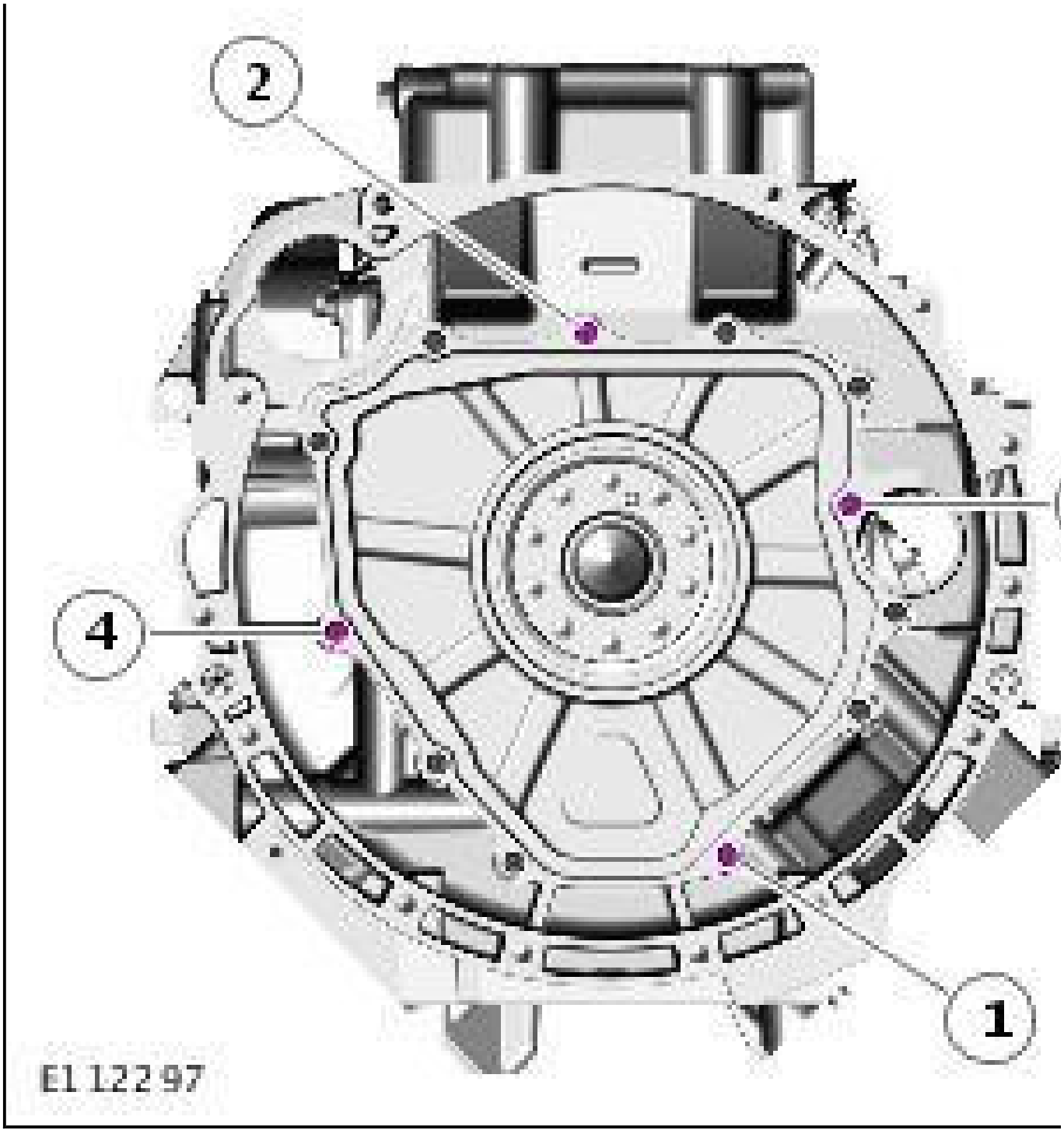

NOTE: Tighten the bolts in the indicated sequence.

12. Torque: 11 Nm

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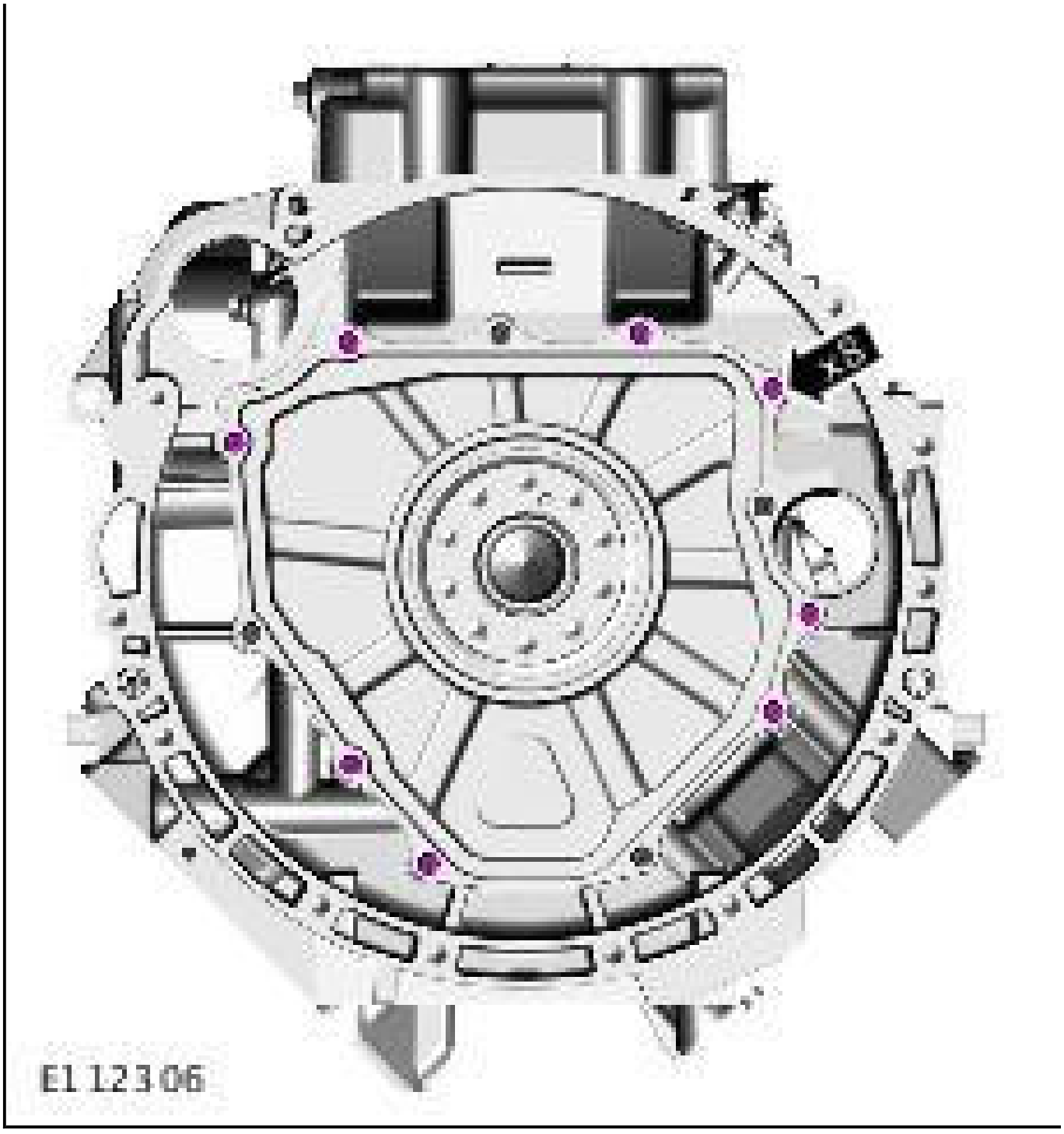

13. Torque: 11 Nm

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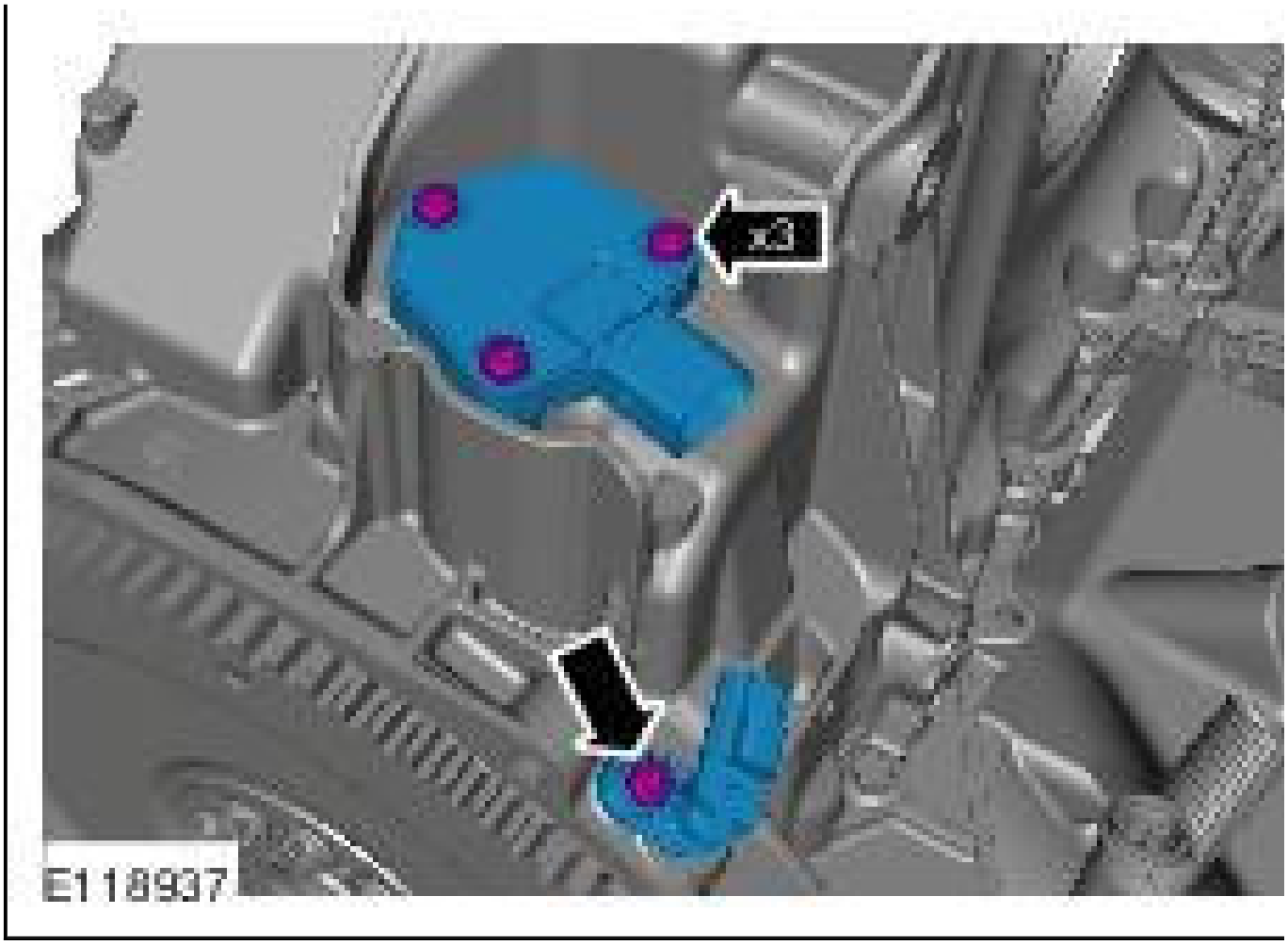

14. See figure

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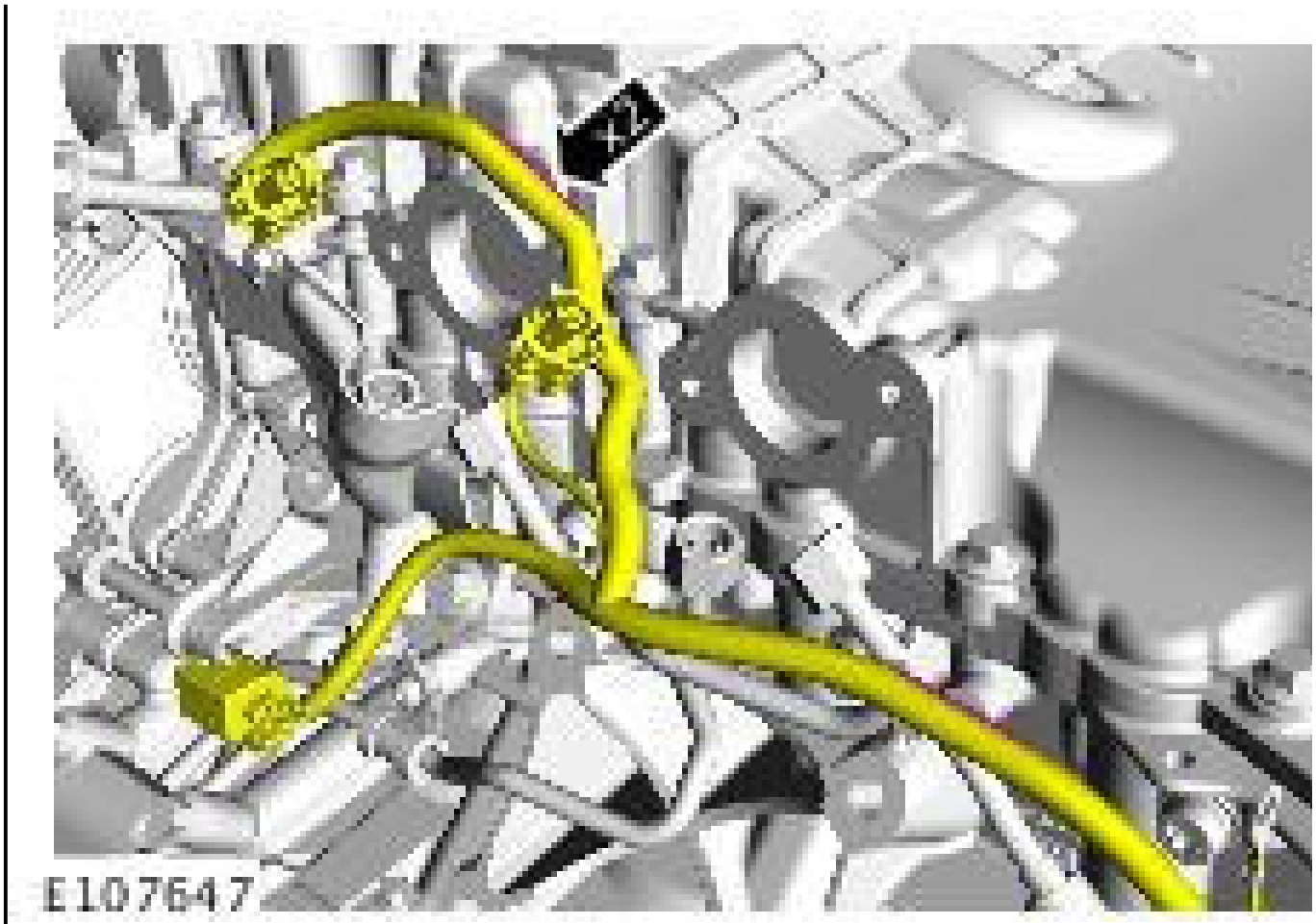

NOTE: The high-pressure fuel pumps are removed from the illustration for clarity.

15. See figure

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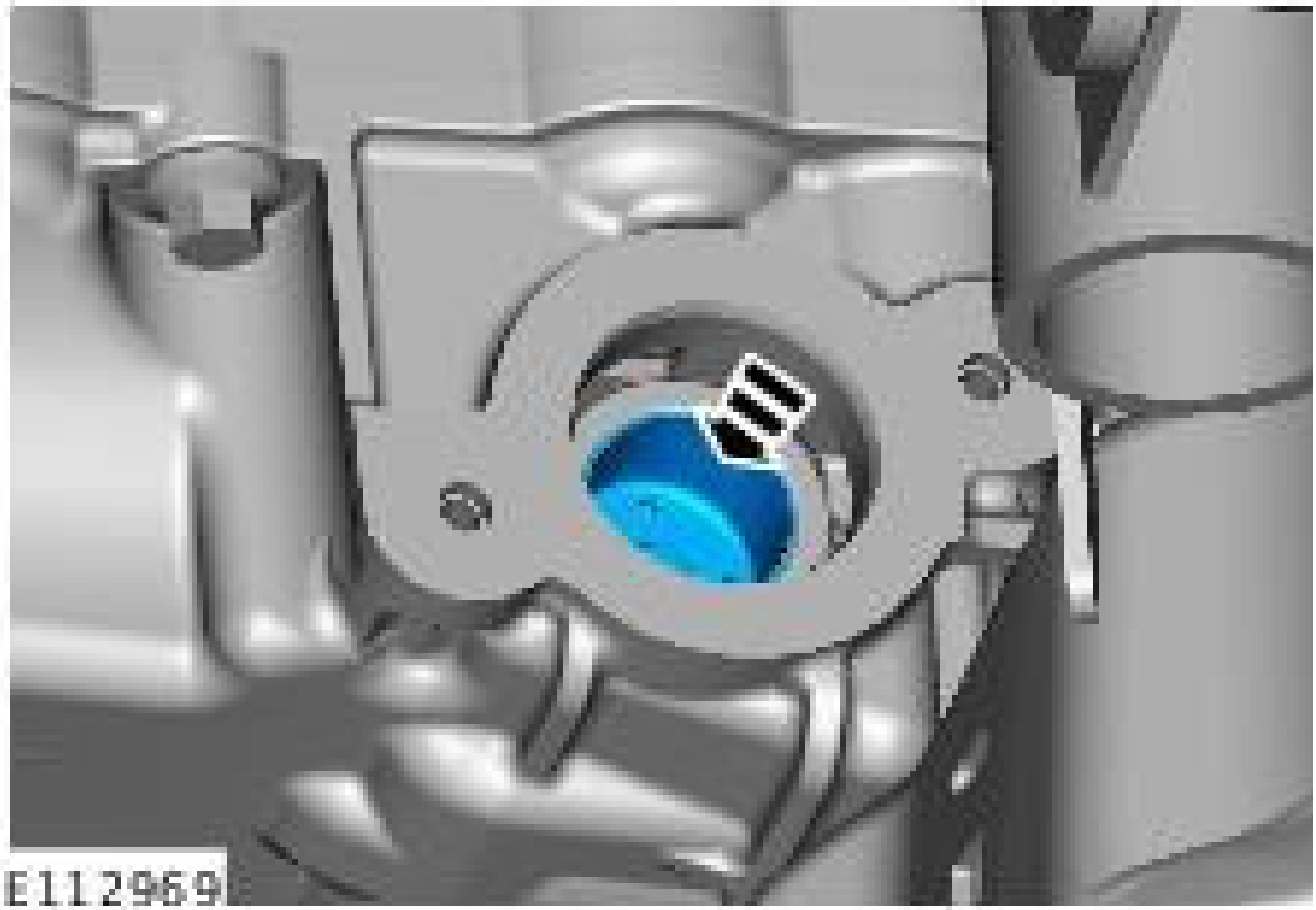

NOTE: **Lubricate the fuel rail high-pressure fuel pump bucket with clean engine oil.**

16. Torque: 11 Nm

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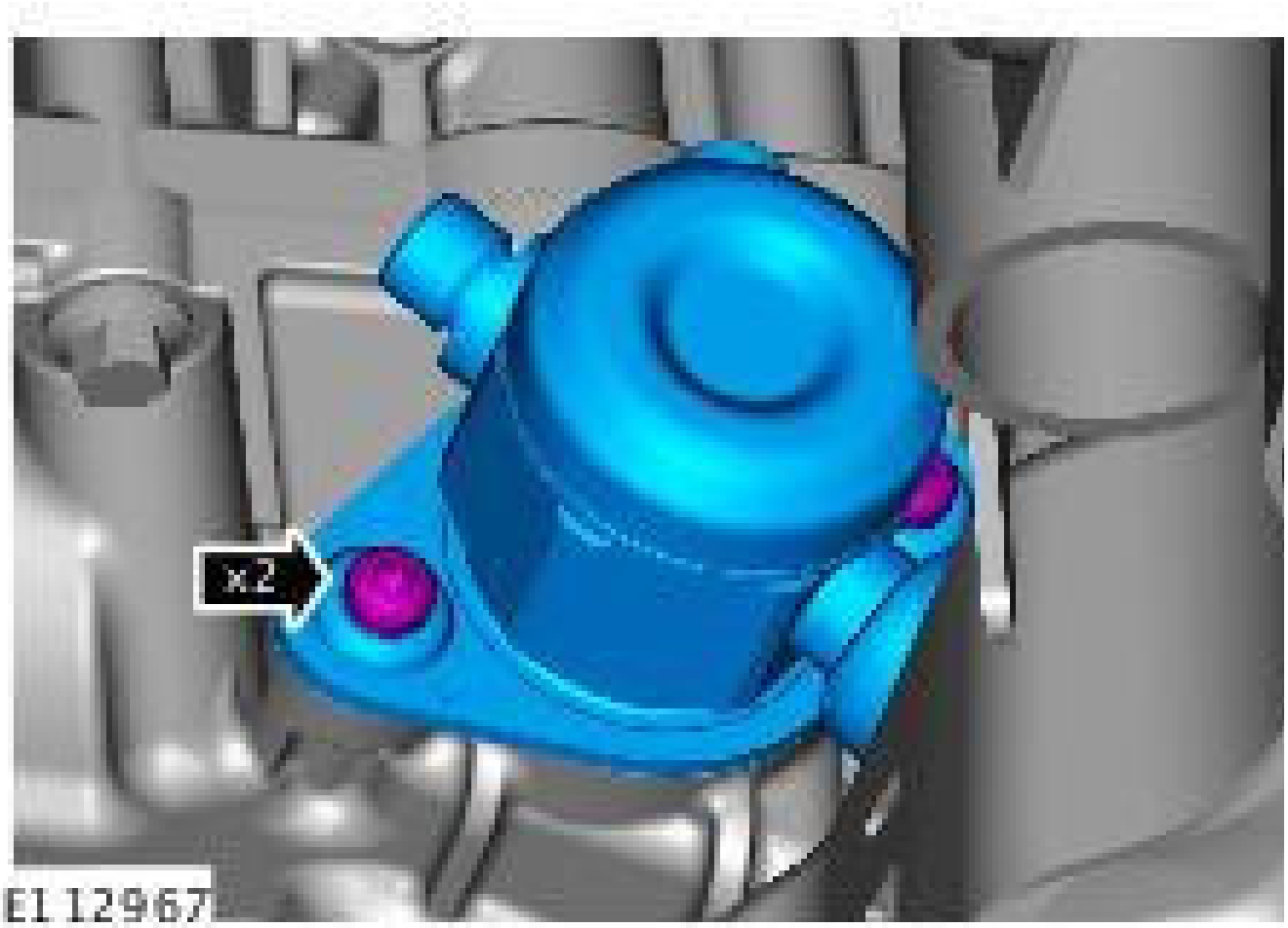

CAUTION: Tighten the Torx screws a turn at a time until the correct torque is achieved.

NOTE: Lubricate the fuel rail high-pressure fuel pump O-ring seal with clean engine oil.

17. Loosen the Torx screws half a turn each.

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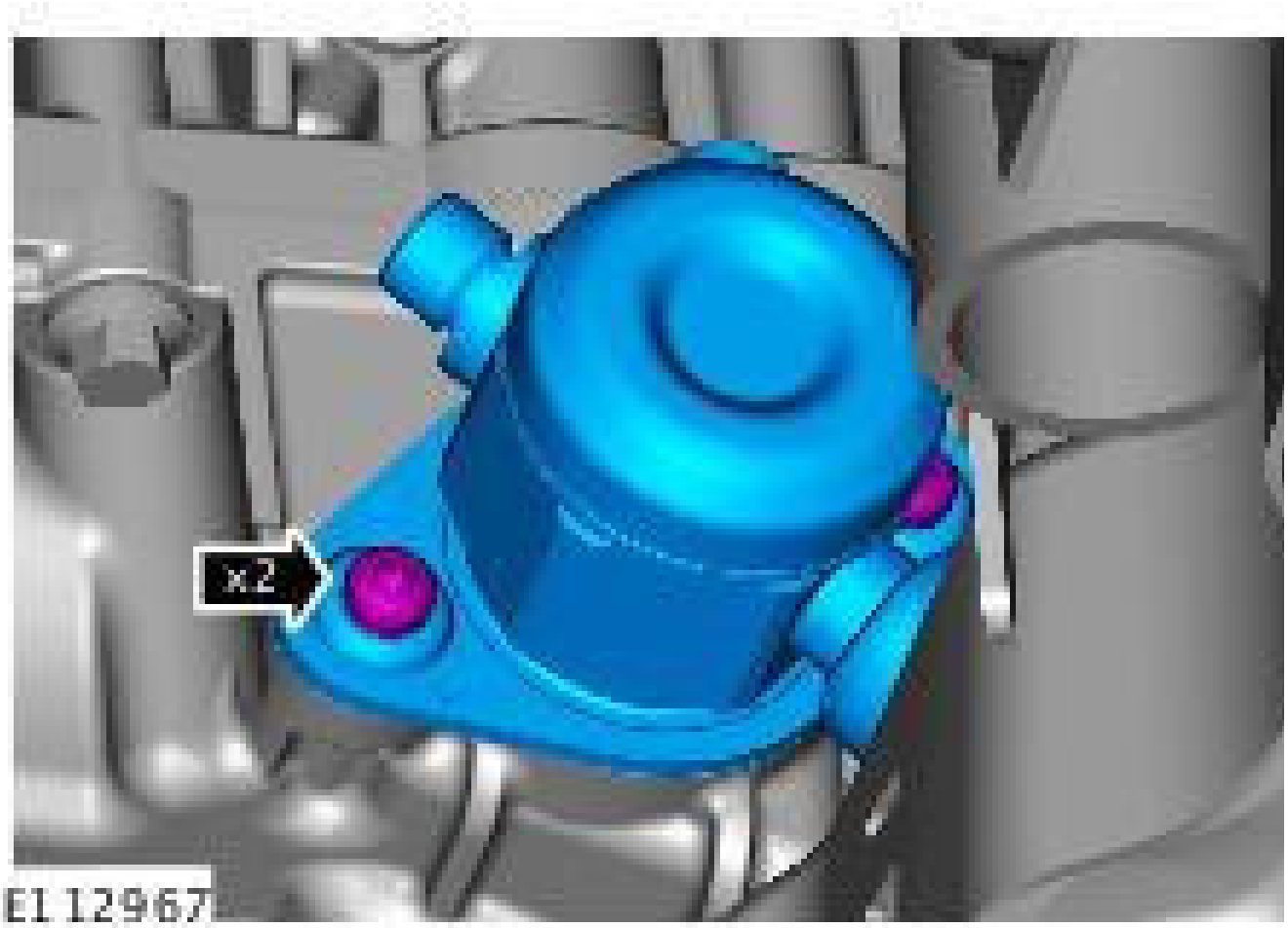

18. See figure

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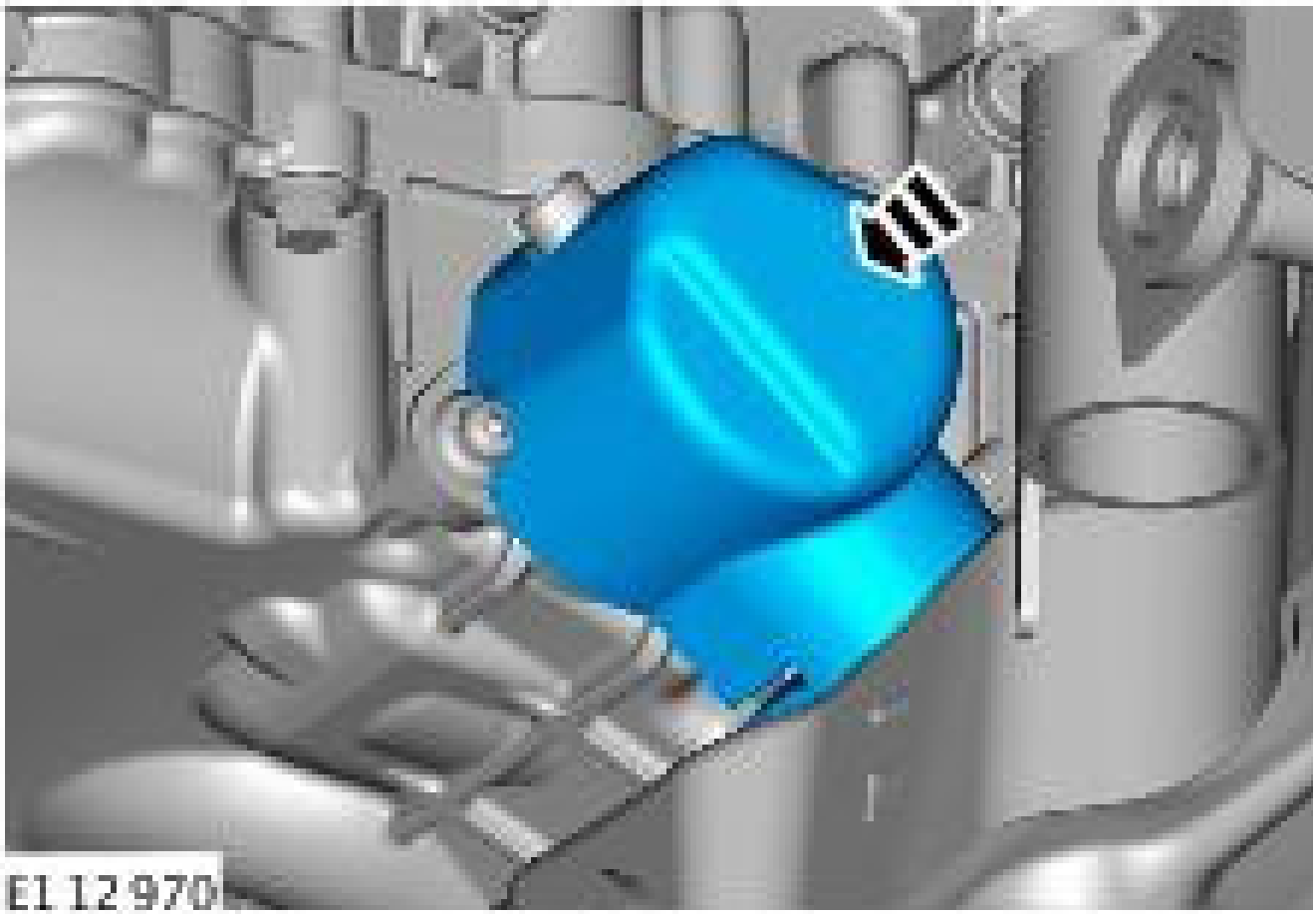

19. See figure

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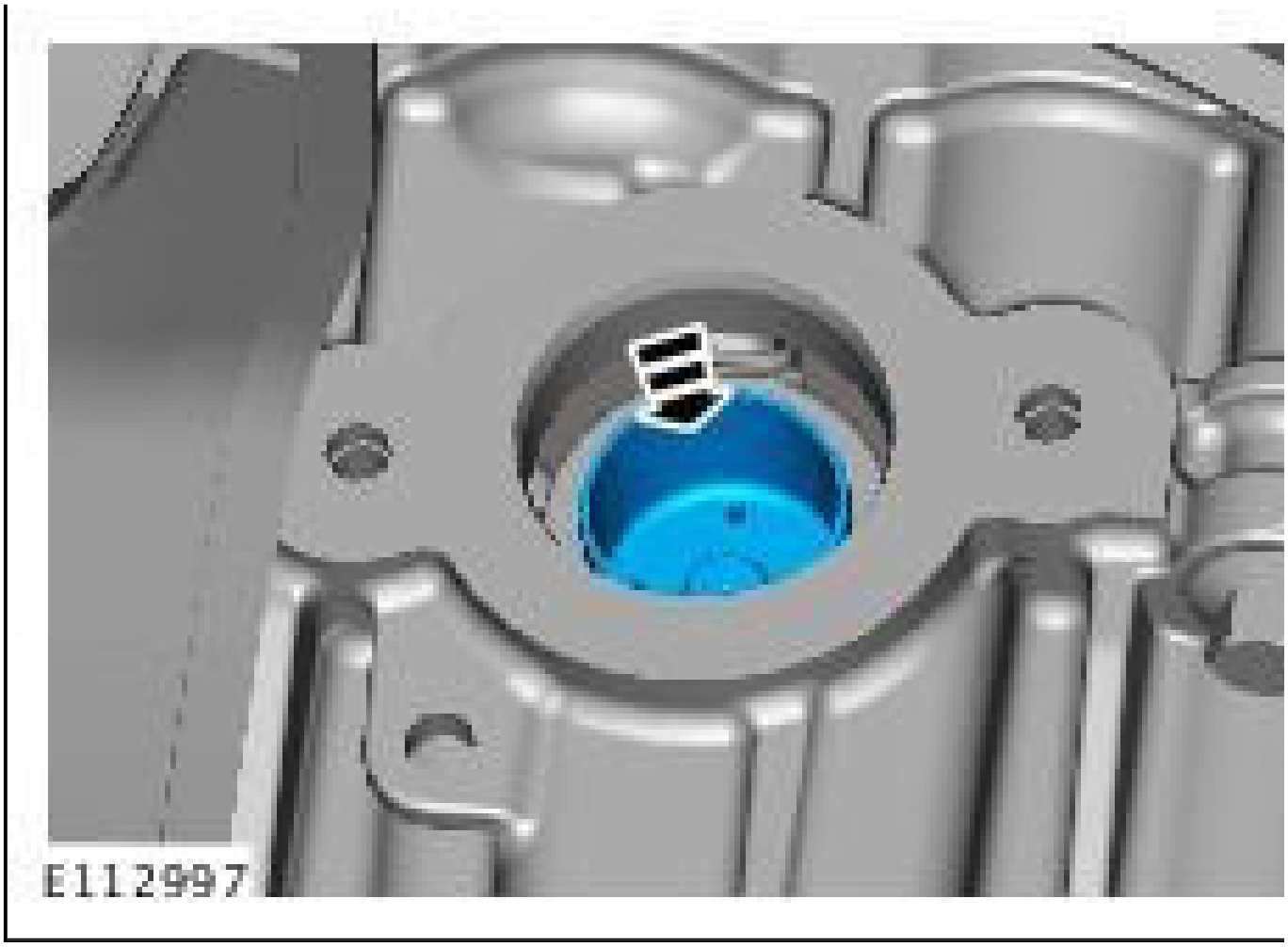

NOTE: **Lubricate the fuel rail high-pressure fuel pump bucket with clean engine oil.**

20. Torque: 11 Nm

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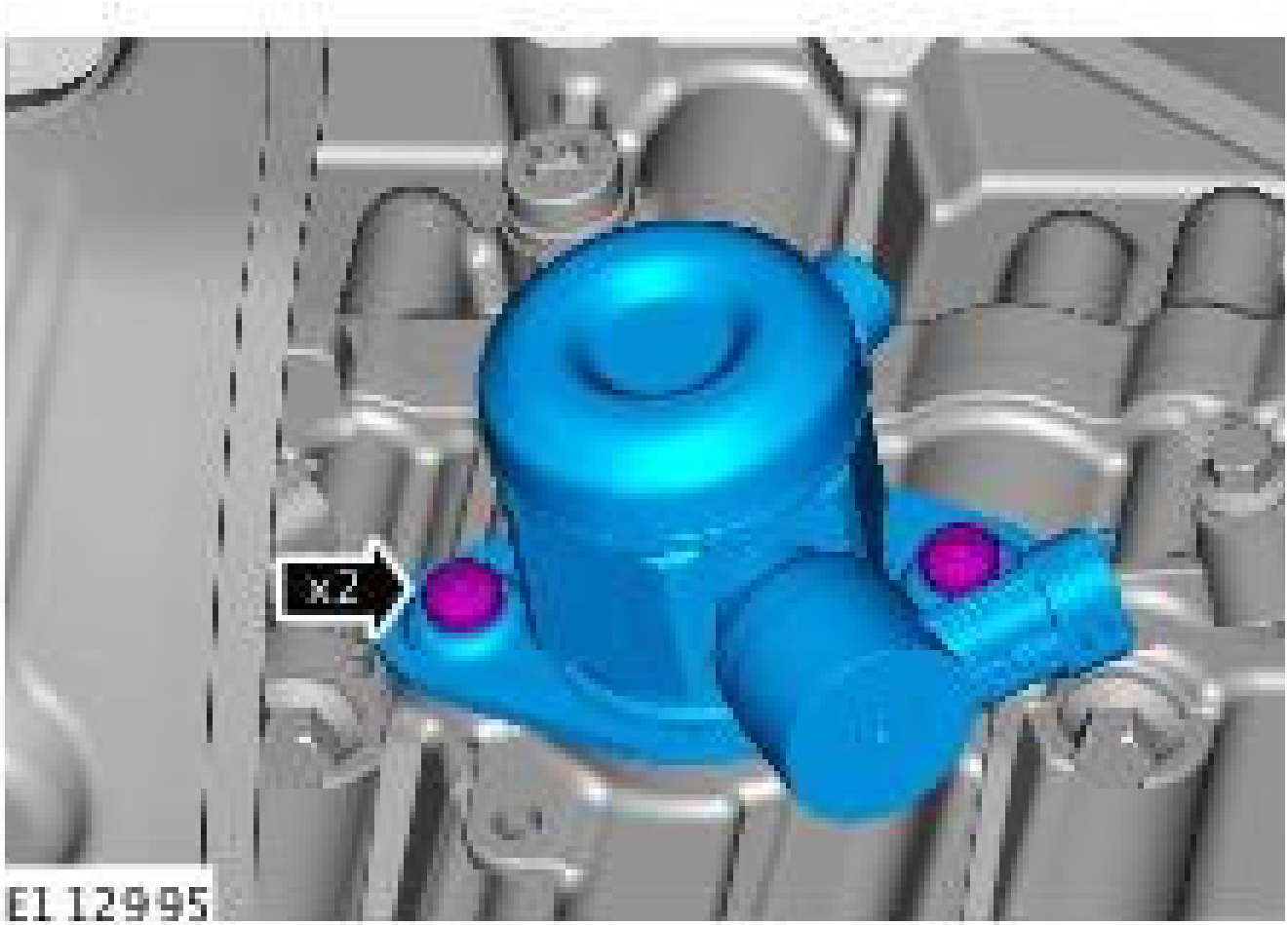

CAUTION: Tighten the Torx screws a turn at a time until the correct torque is achieved.

NOTE: Lubricate the fuel rail high-pressure fuel pump O-ring seal with clean engine oil.

21. Loosen the Torx screws half a turn each.

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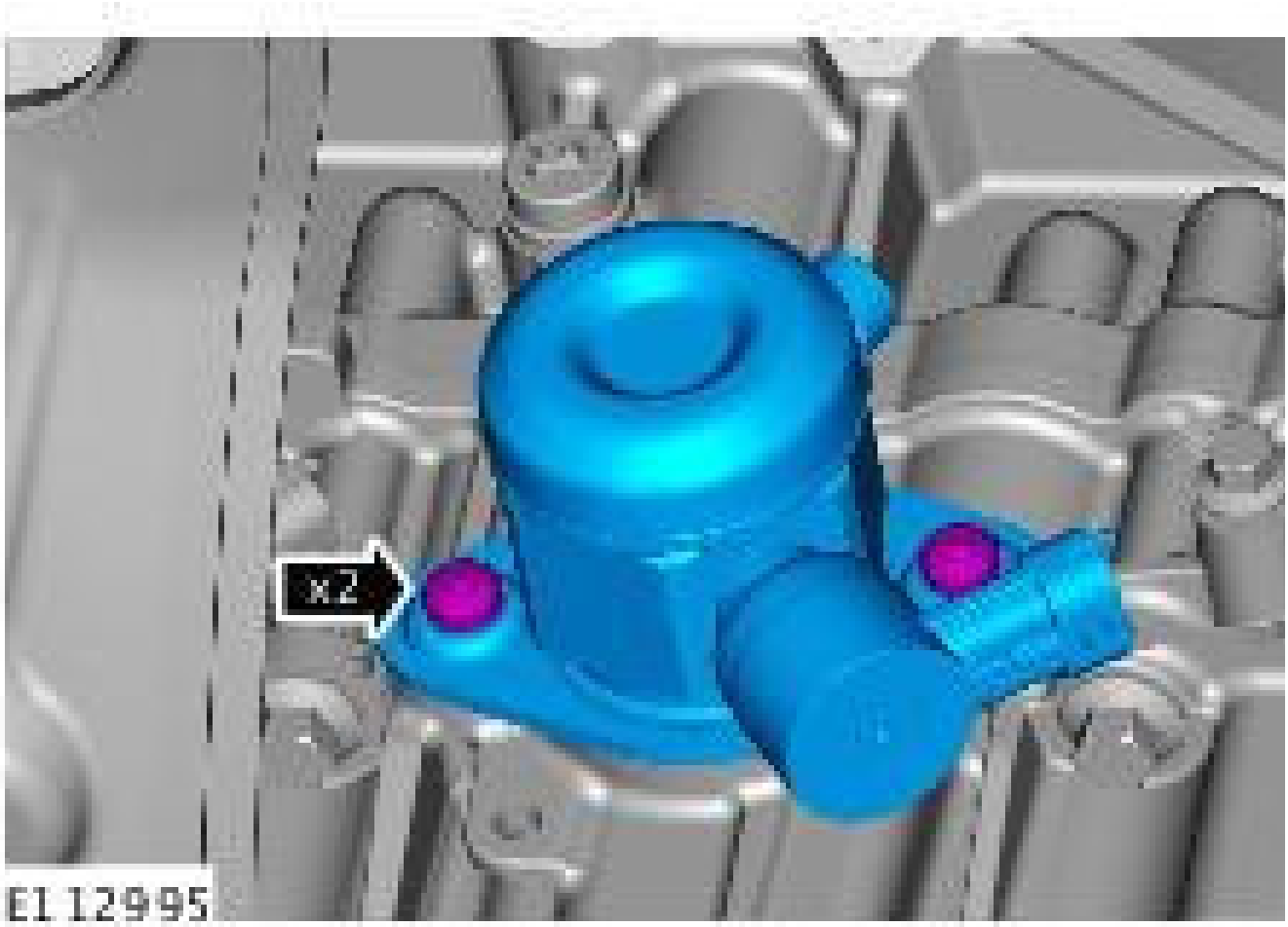

22. See figure

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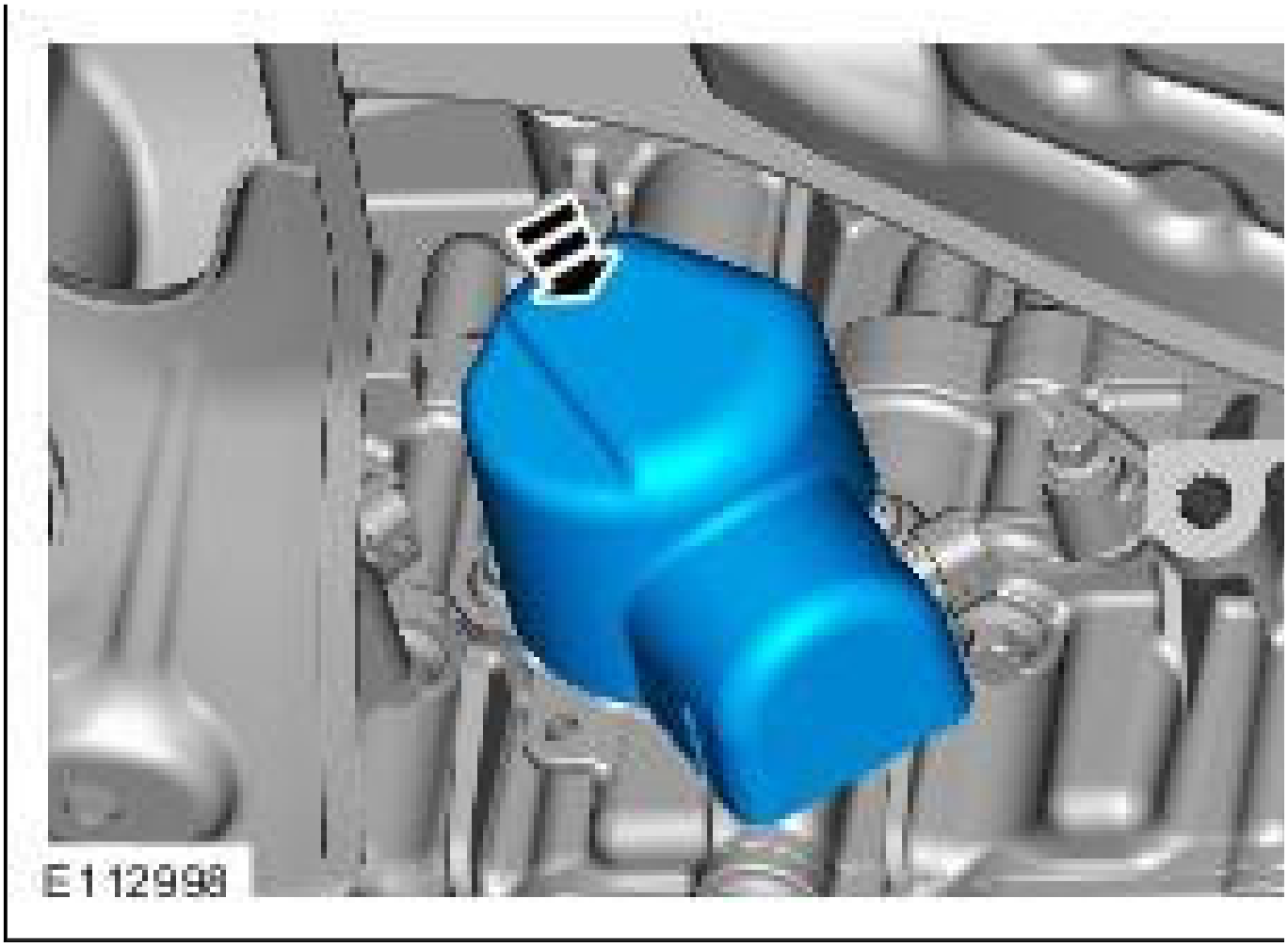

23. Torque: 11 Nm

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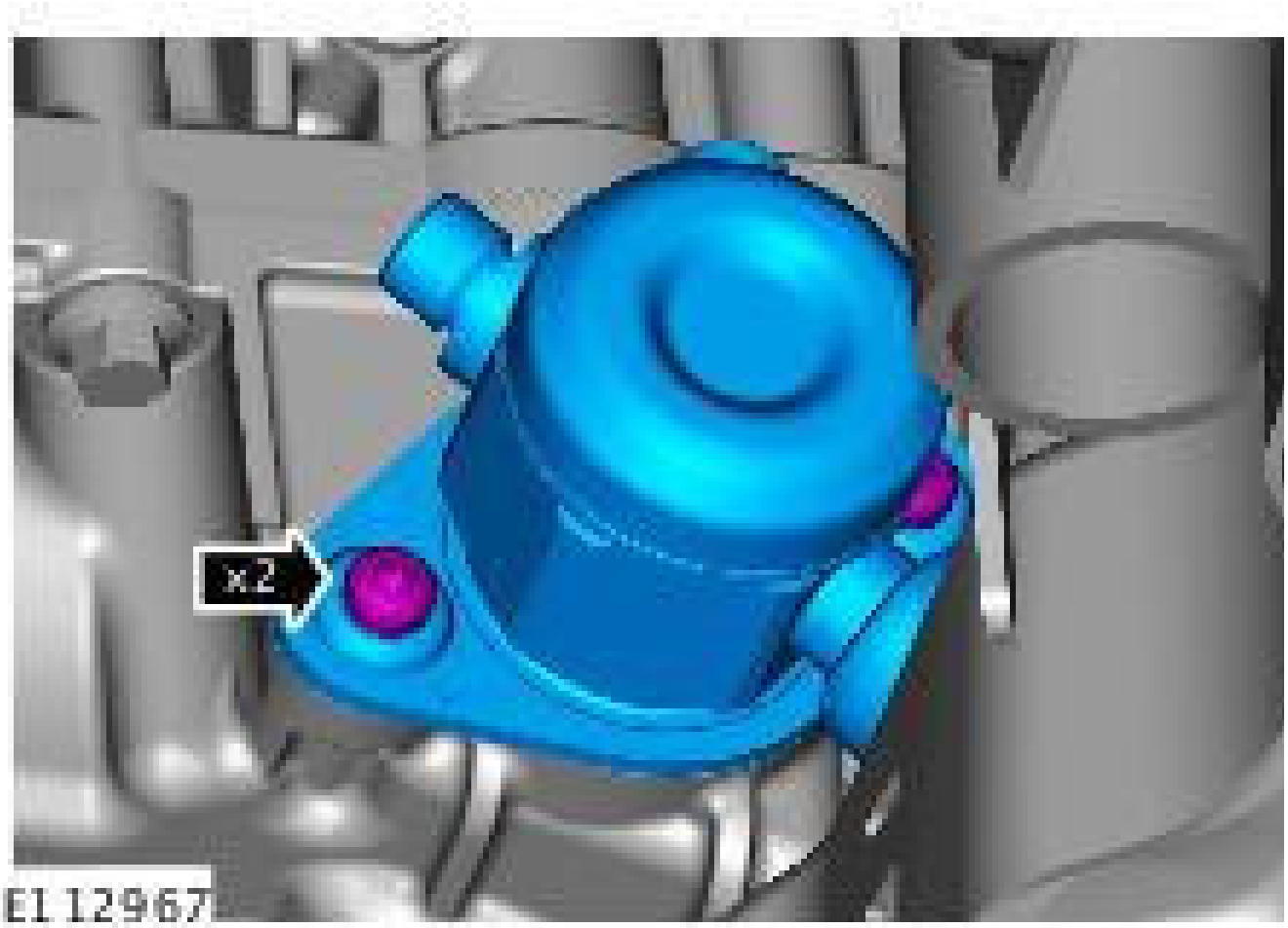

CAUTION: Care must be taken when positioning the fuel rail high-pressure fuel pump cover to one side.

NOTE: Fuel rail high-pressure fuel pump cover shown removed for clarity.

24. Torque: 11 Nm

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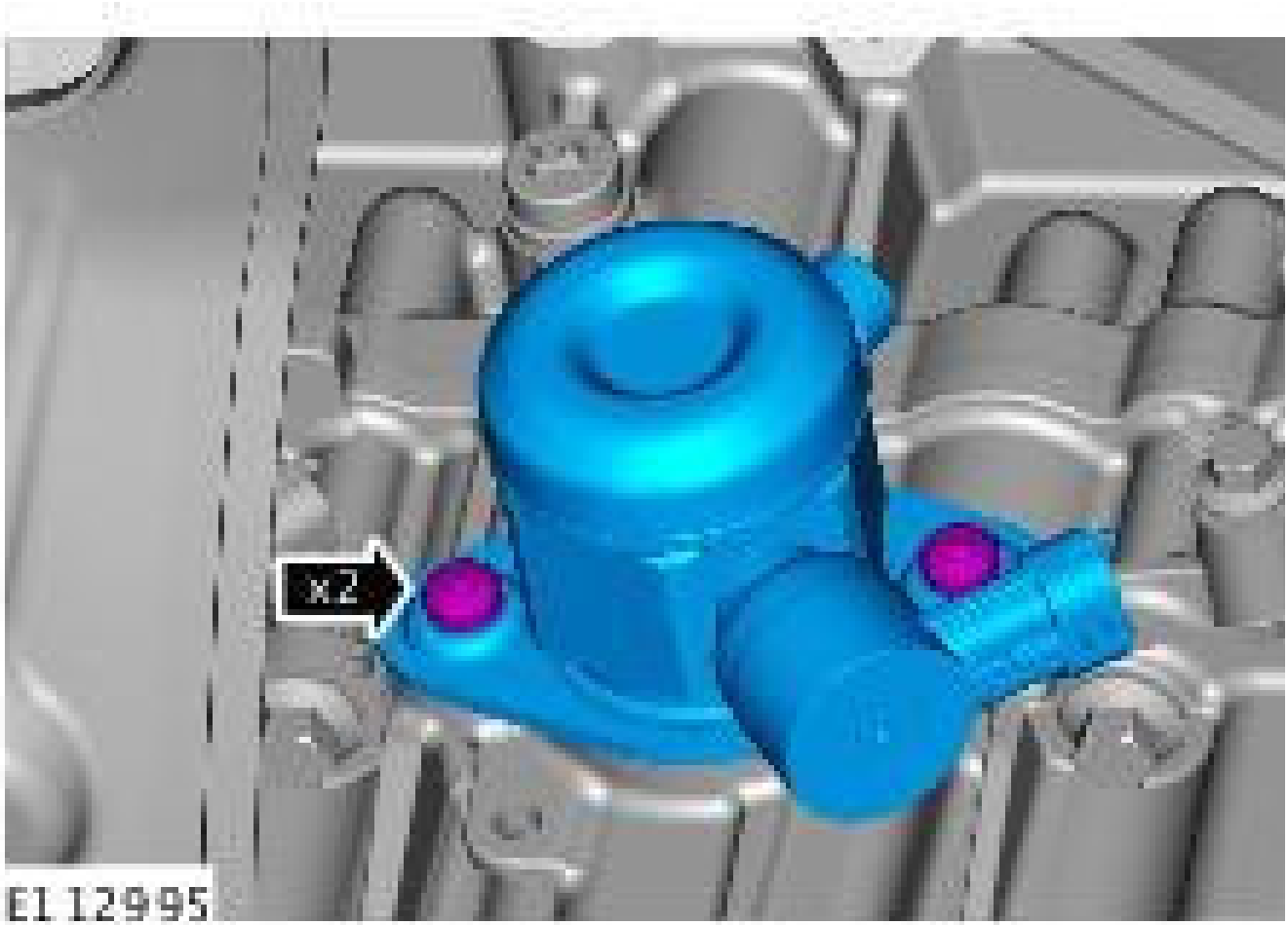

CAUTION: Care must be taken when positioning the fuel rail high-pressure fuel pump cover to one side.

NOTE: Fuel rail high-pressure fuel pump cover shown removed for clarity.

25. Do not fully tighten at this stage.

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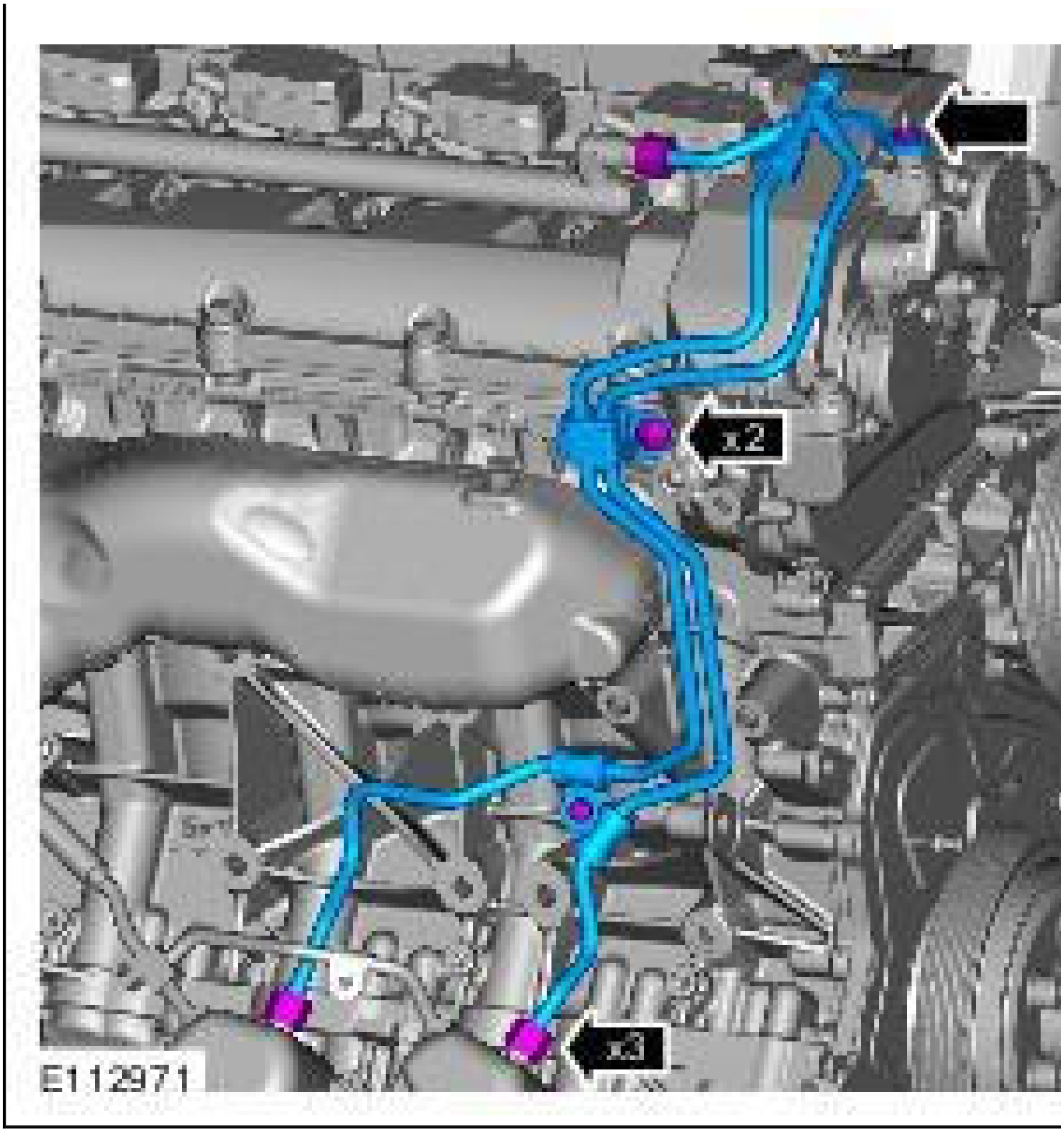

CAUTION: Install new high-pressure fuel supply lines.

CAUTION: Lubricate only the union threads with clean engine oil.

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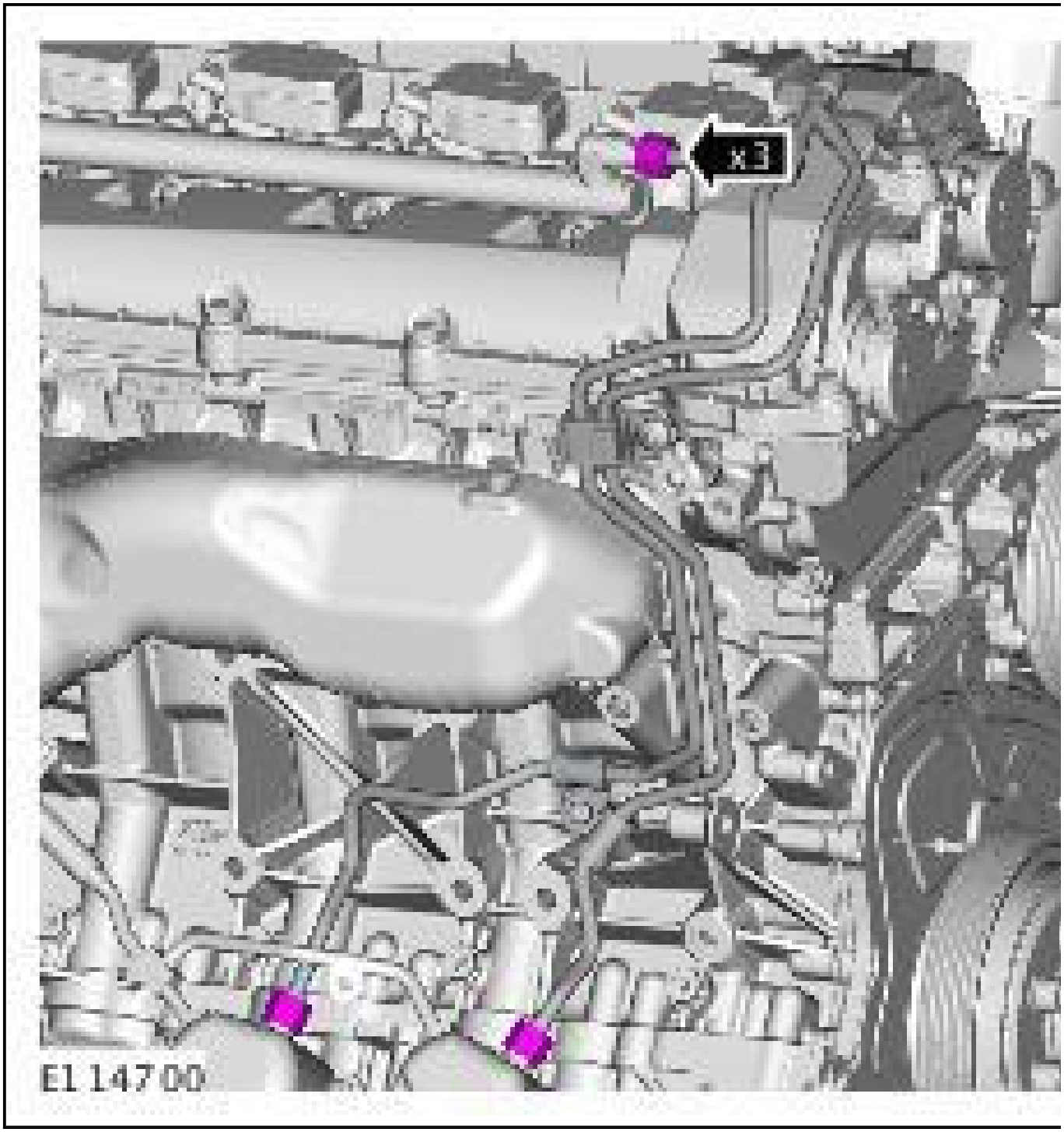
NOTE: Remove and discard the blanking caps.

NOTE: Install the bolt and unions fully finger tight before final tightening.

26. See figure



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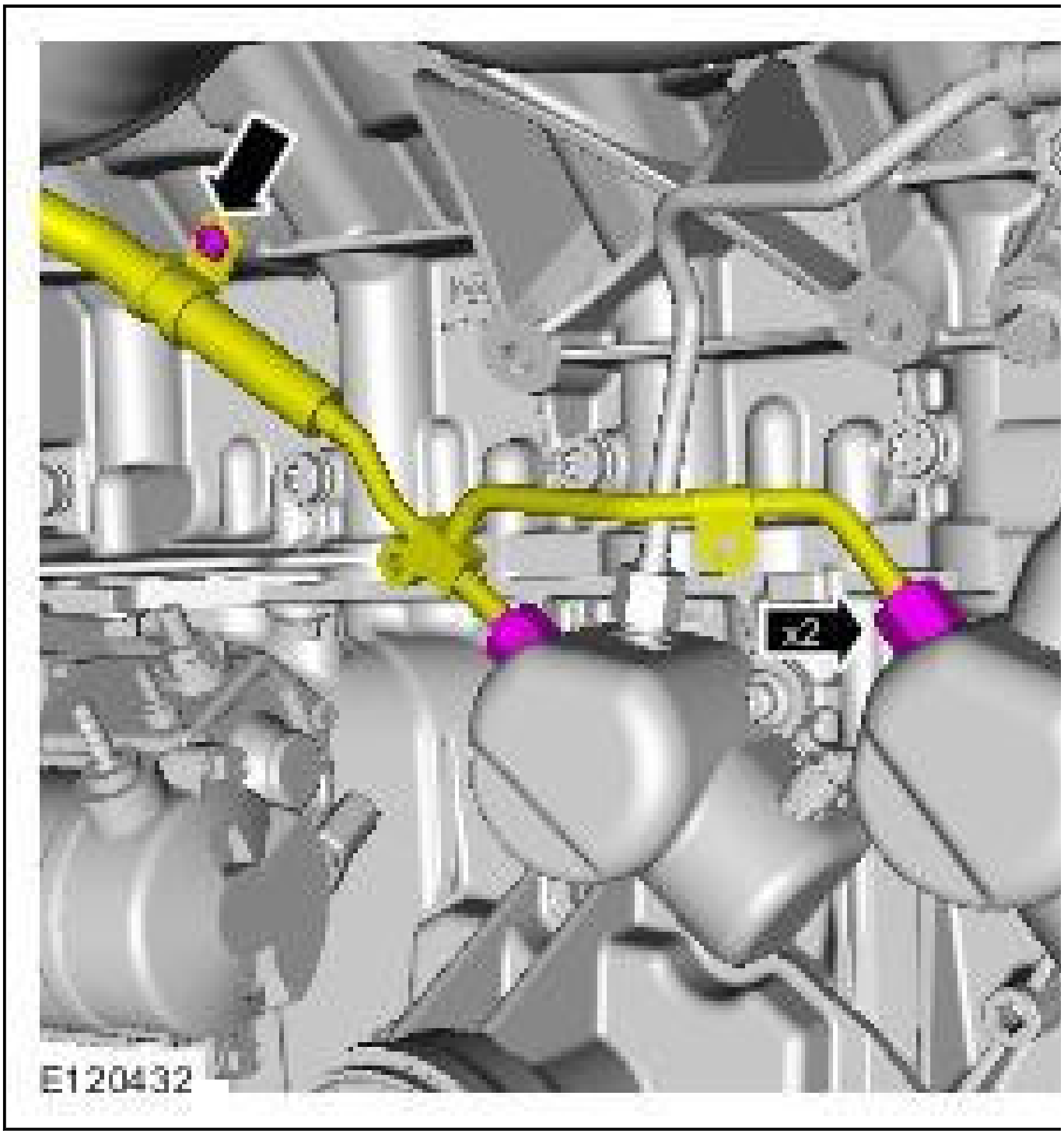
- Torque: 21 Nm

27. See figure



NOTE: Install the bolt and unions finger tight before final tightening.

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NOTE: Remove and discard the blanking caps.

- Torques:

  Unions: 21 Nm

  M6: 11 Nm

28. See figure

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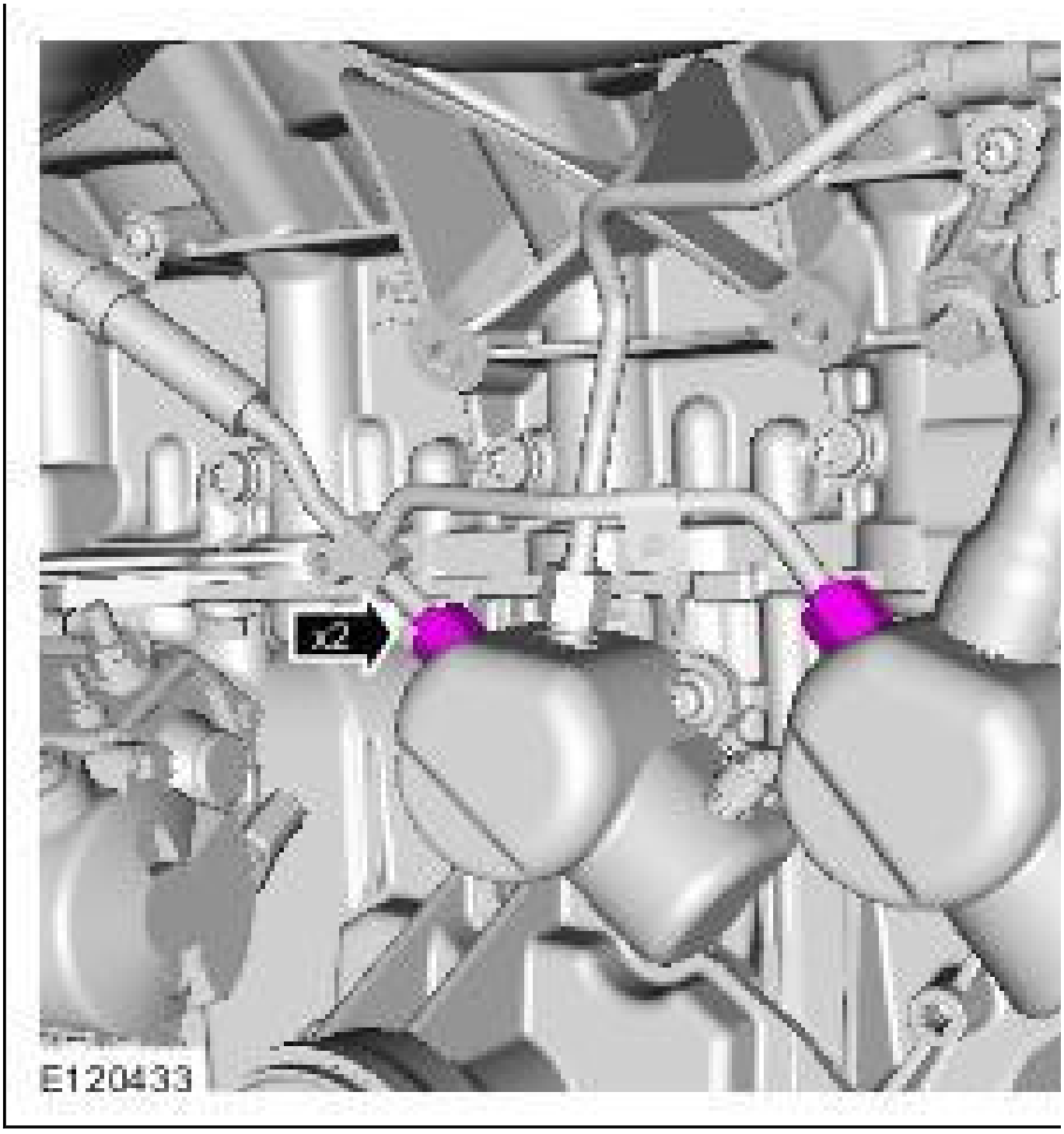

CAUTION: Make sure that a new component is installed.

- Torque: 21 Nm

29. See figure

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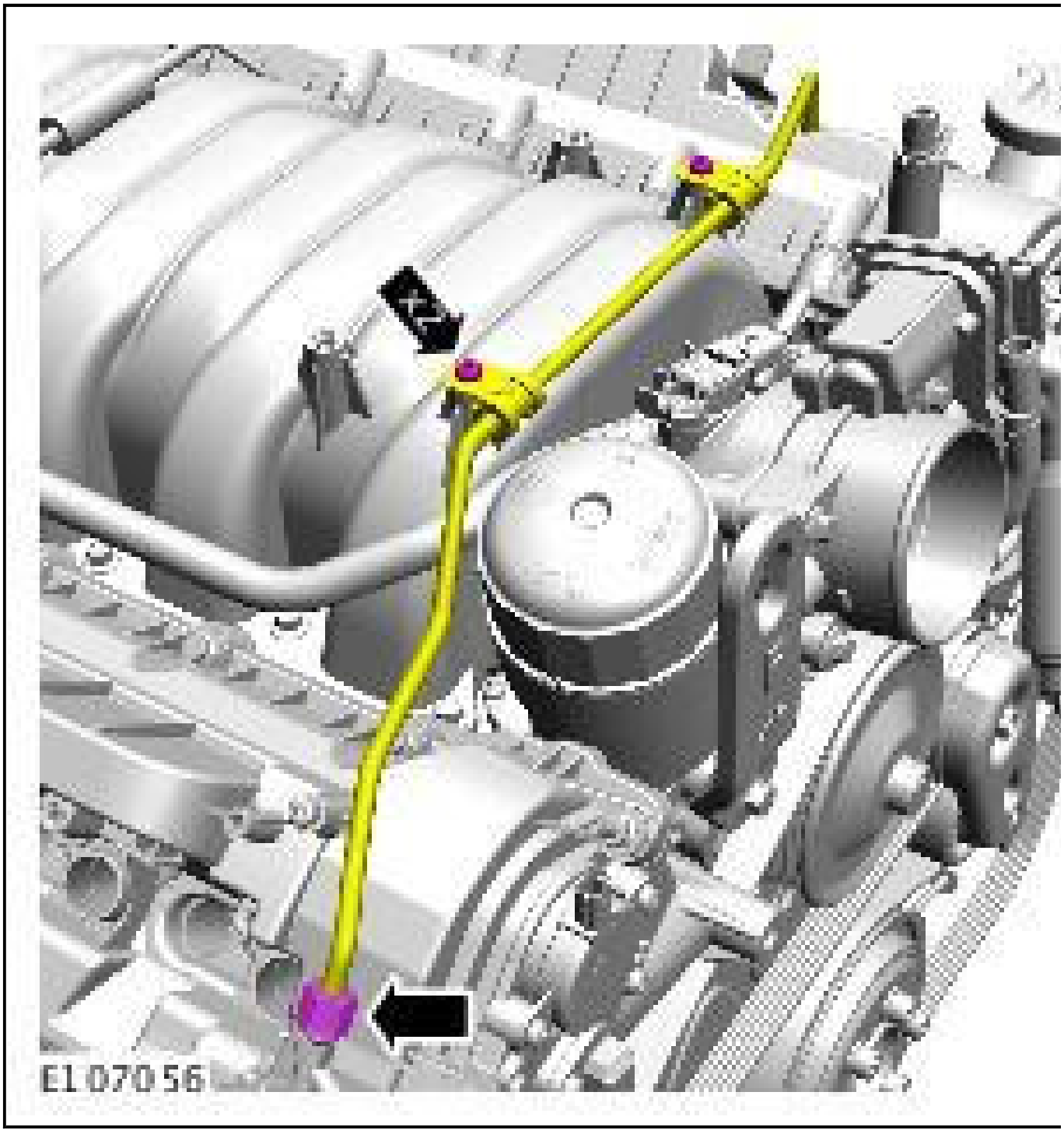

Torques:

Unions: 21 Nm

M6: 8 Nm

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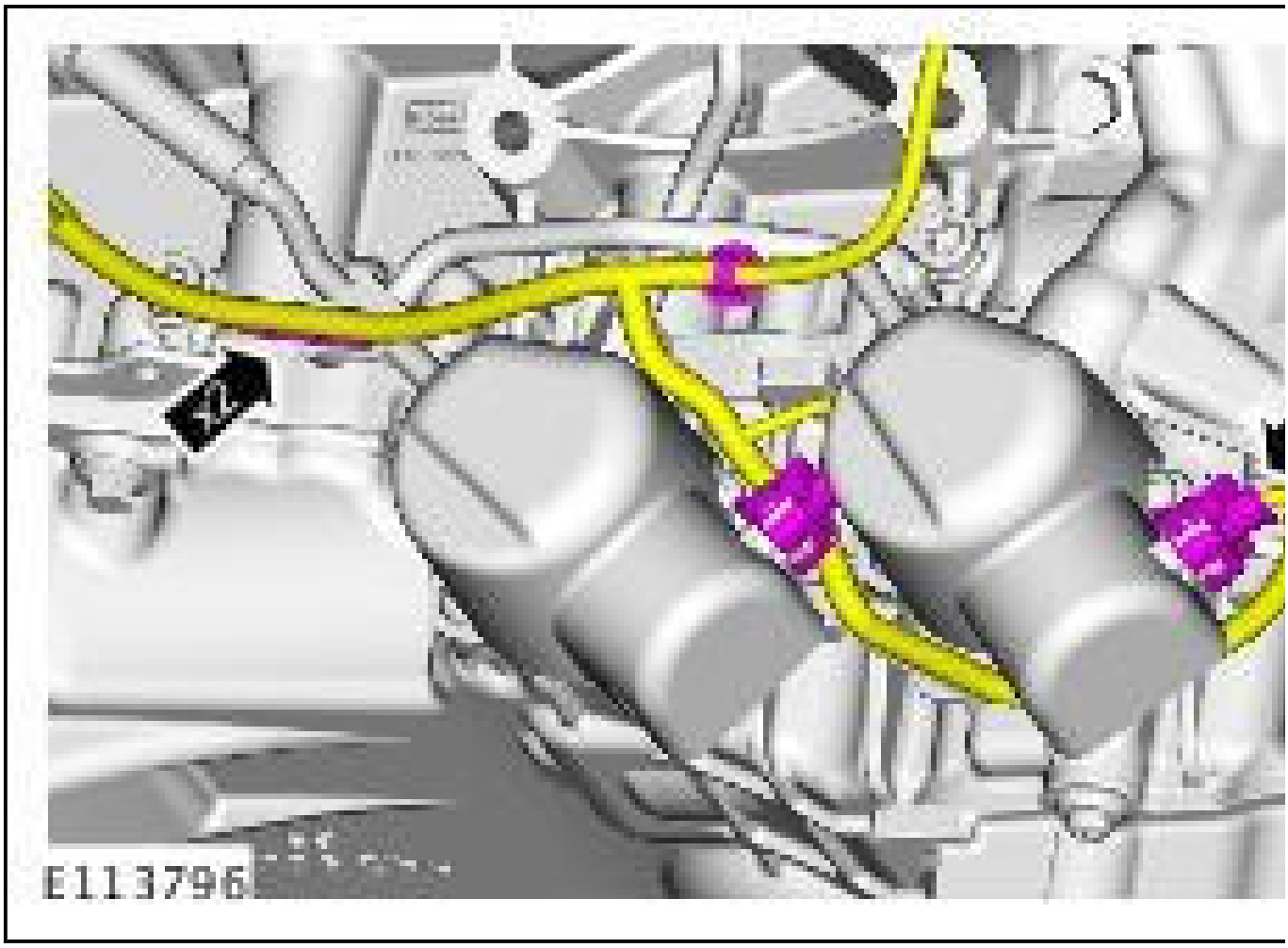
30. See figure



31. Torque: 22 Nm

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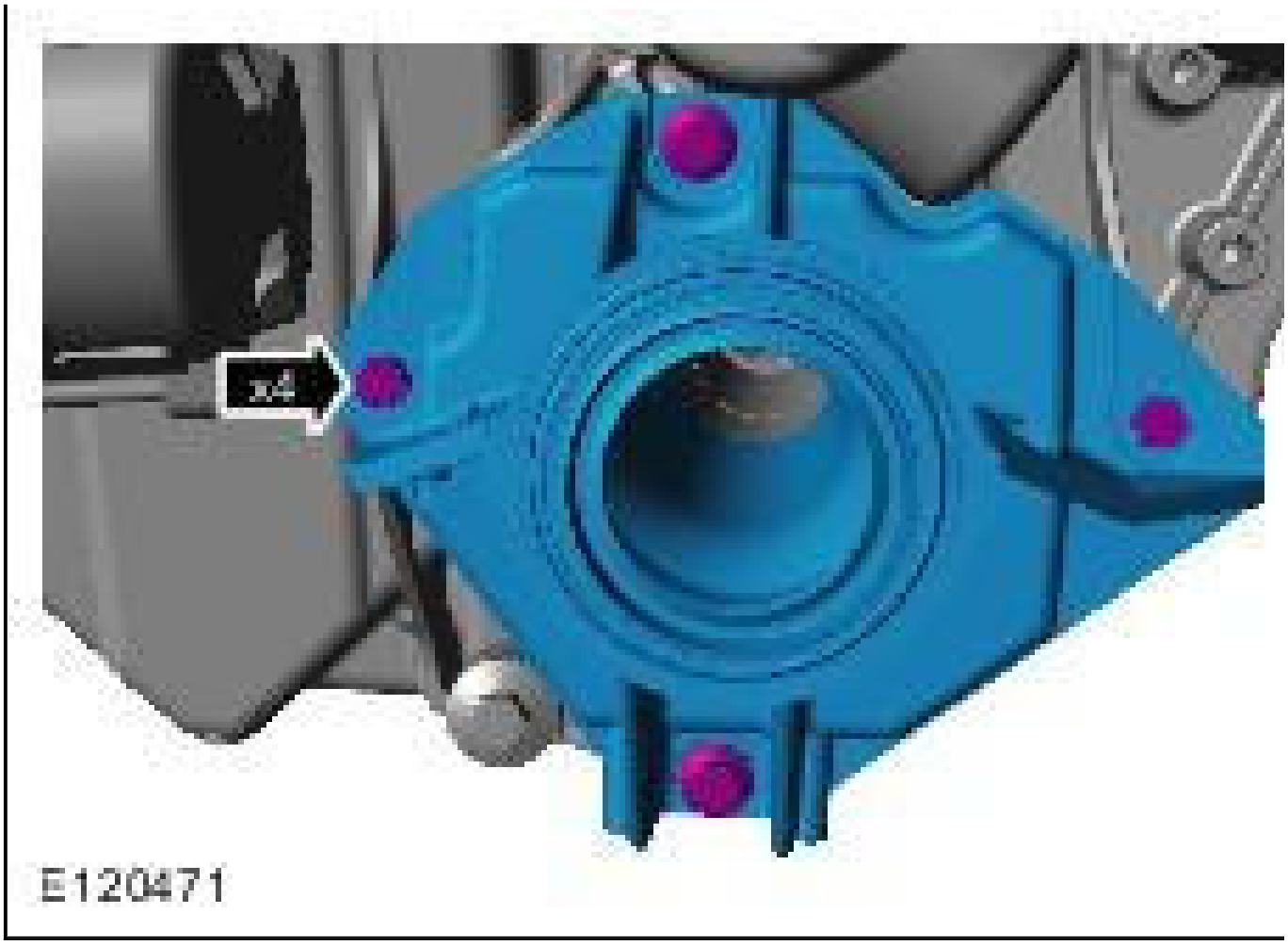

32. Torque: 25 Nm

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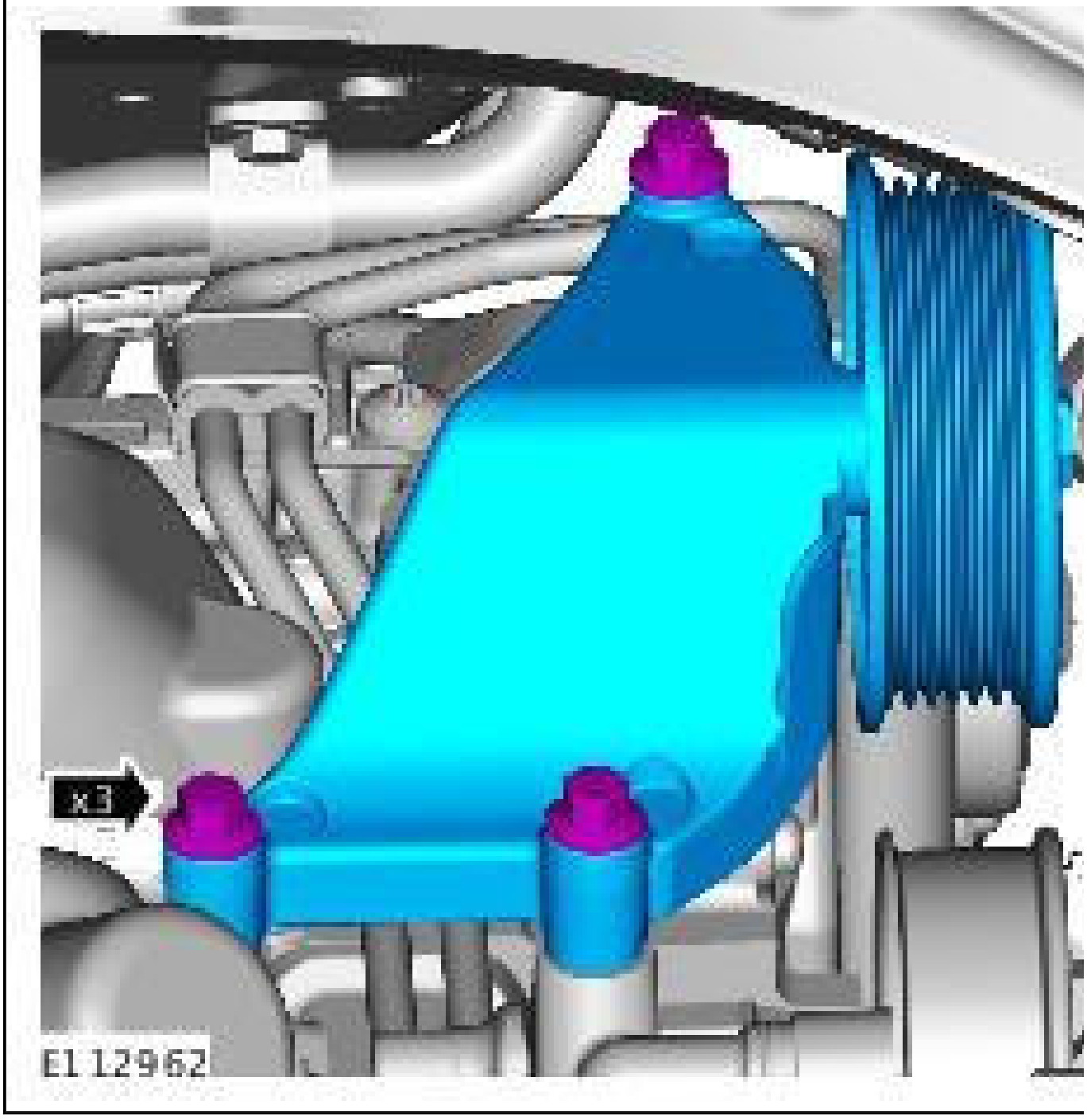

33. See figure

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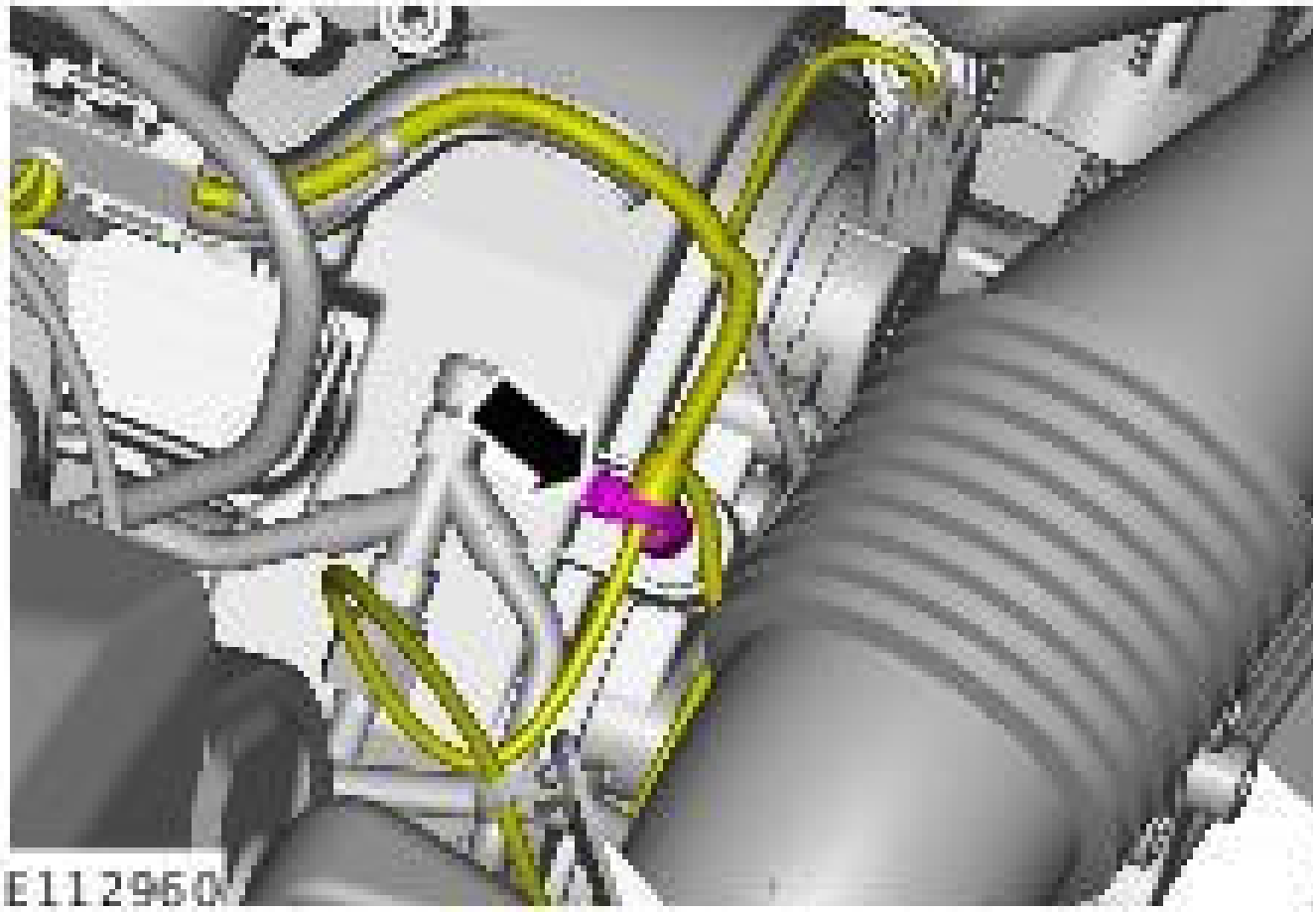

34. Torque: 25 Nm

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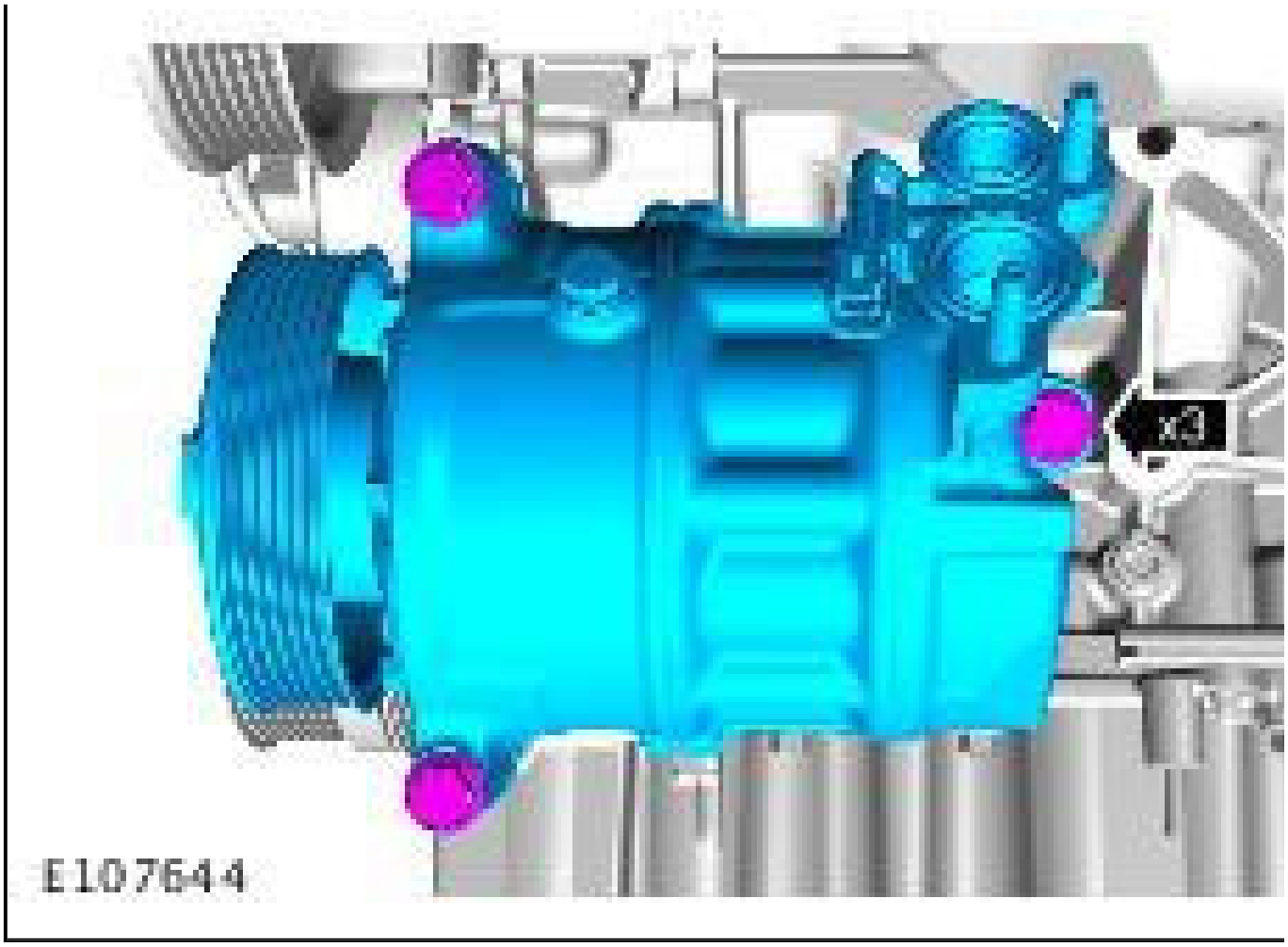

CAUTION: Install all the bolts finger tight before final tightening.

35. See figure

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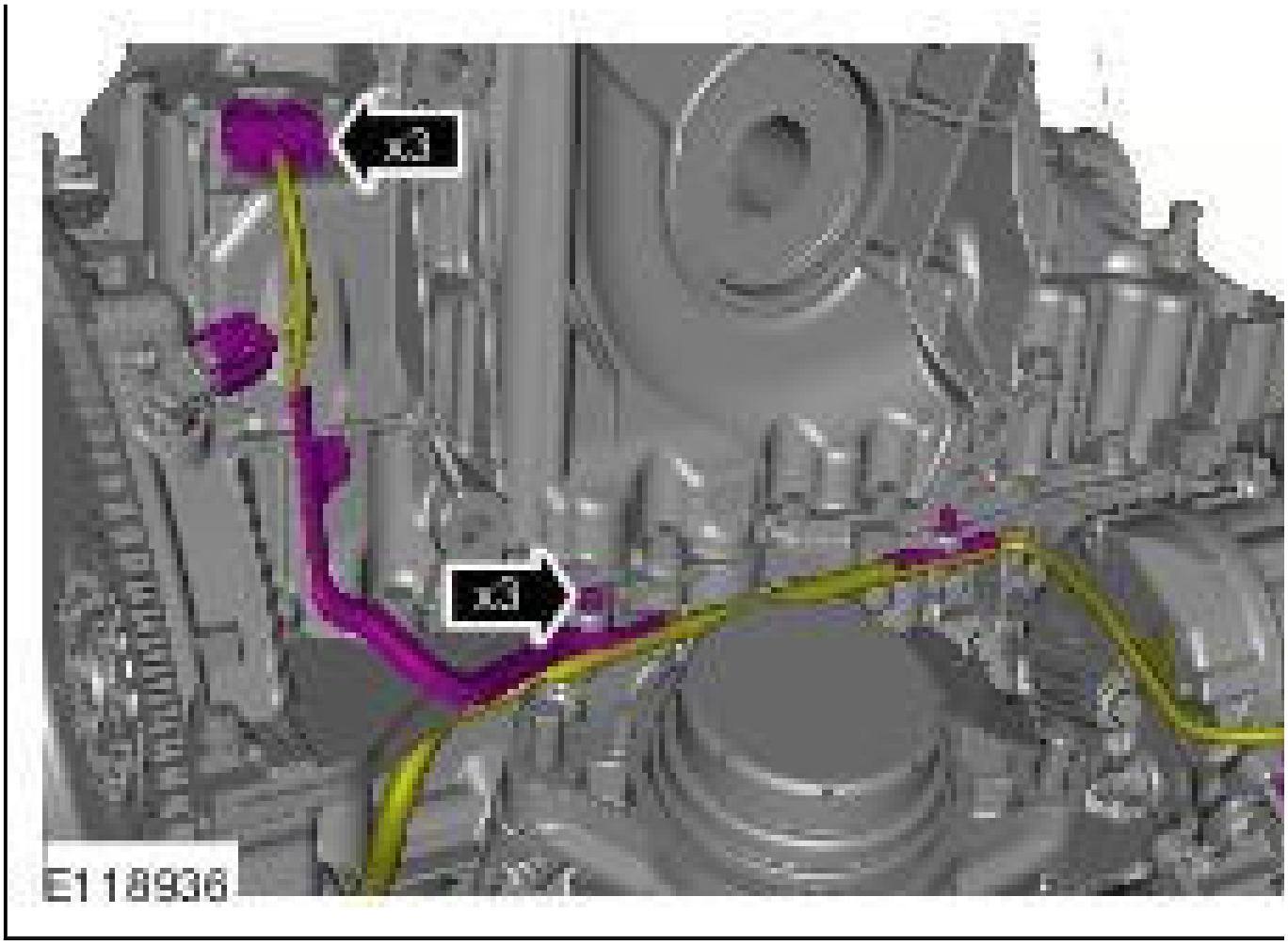

36. Torque: 12 Nm

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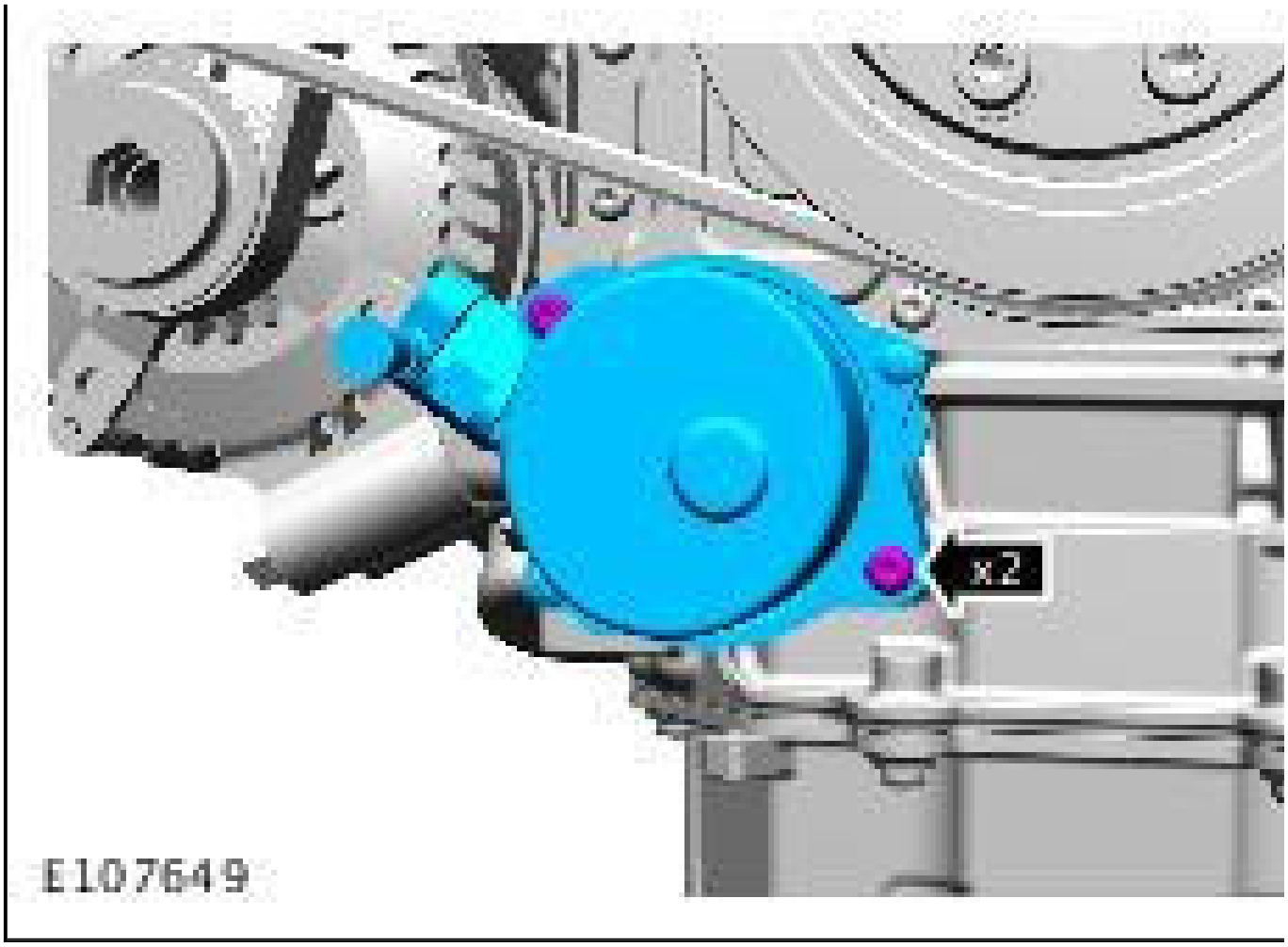

37. See figure

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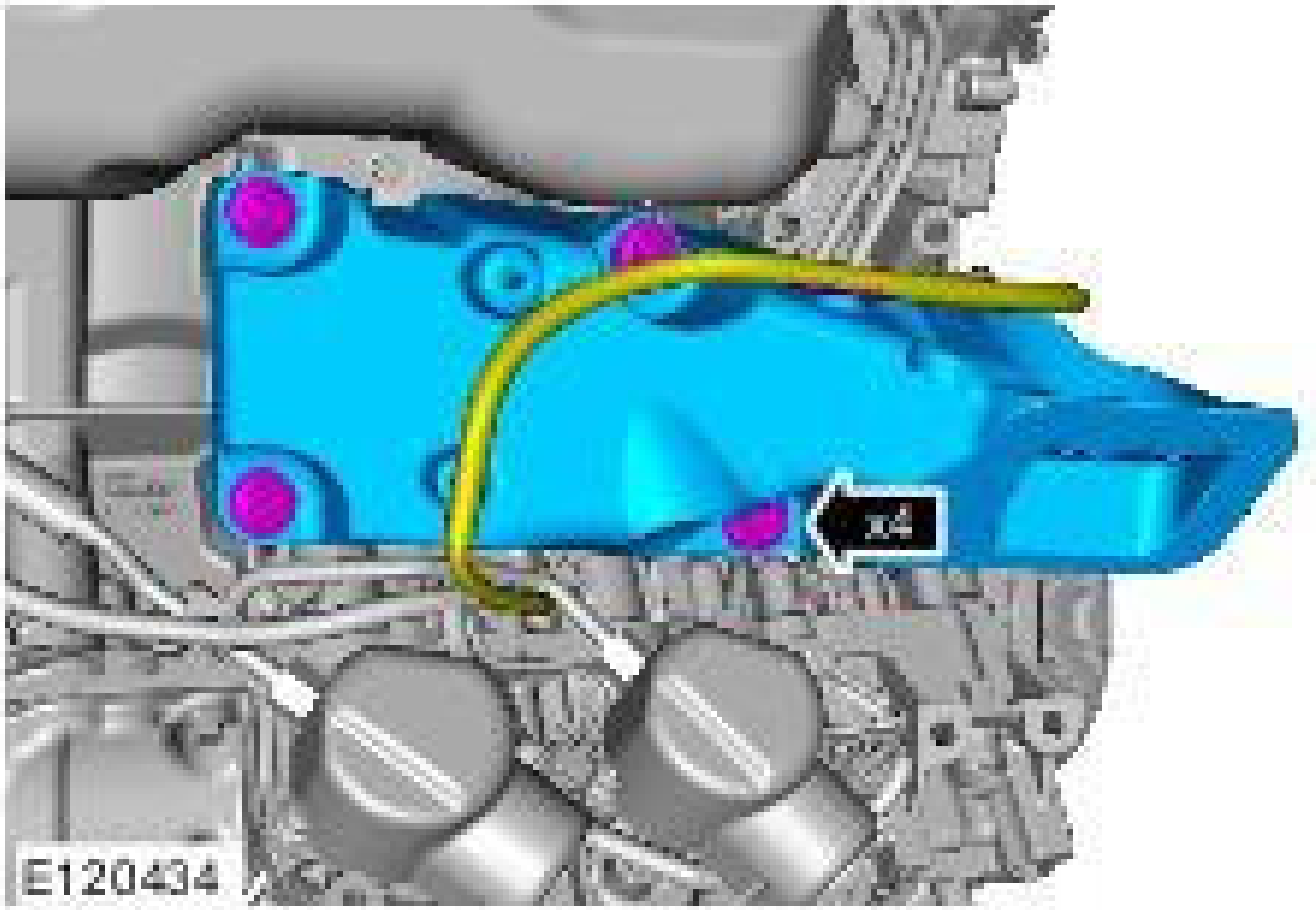

Torque:

Stage 1: 45 Nm

Stage 2: 60°

38. Torque: 48 Nm

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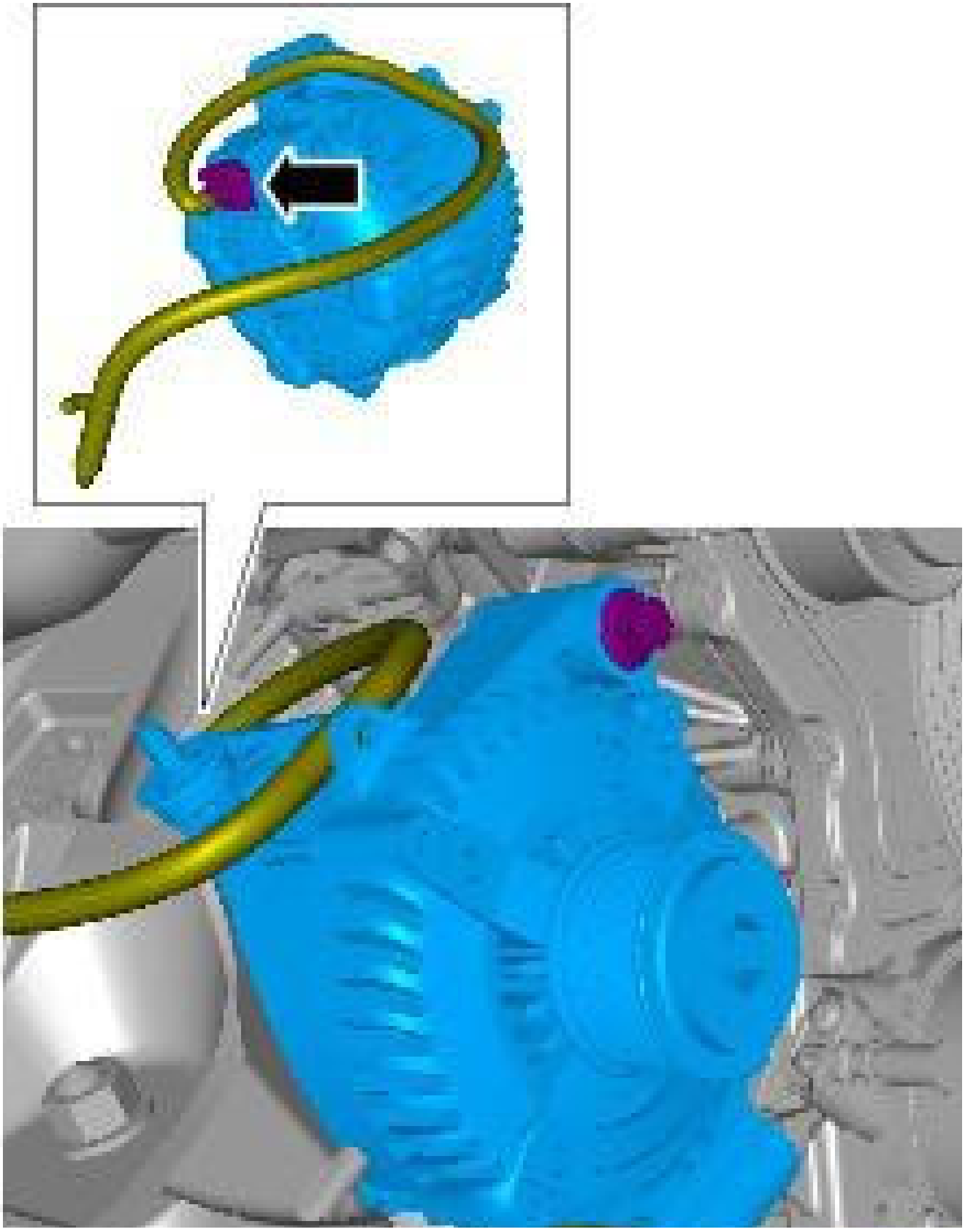

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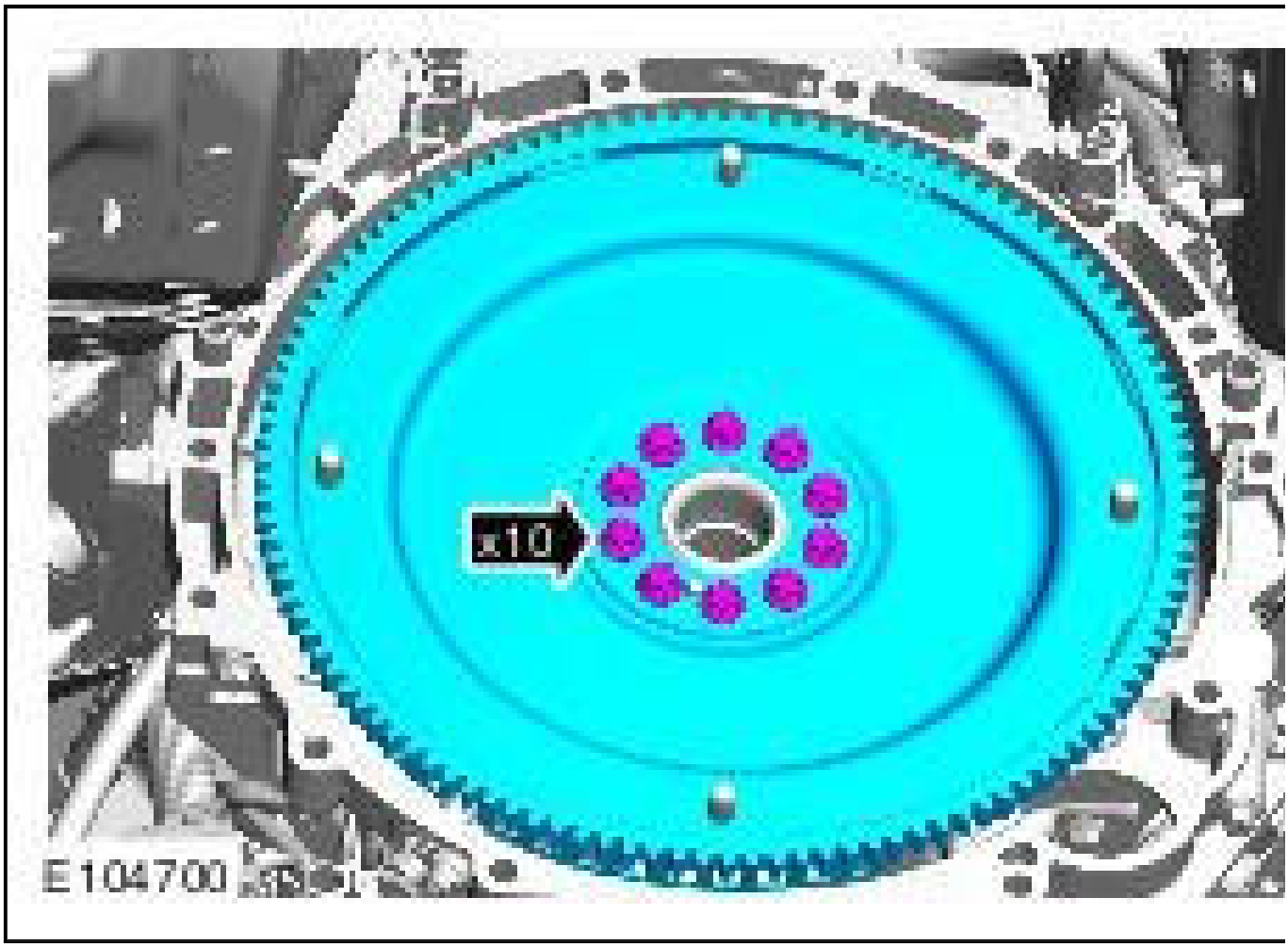
CAUTION: Install all the bolts finger tight before final tightening.

NOTE: Tighten the bolts in the indicated sequence.

39. See figure



CAUTION: Install all the bolts finger tight before final tightening.

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

CAUTION: Install the bolts in the noted position.

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NOTE: **Make sure that the crankshaft is not rotated.**

NOTE: **Make sure the crankshaft and flexplate mating faces are clean before installation.**

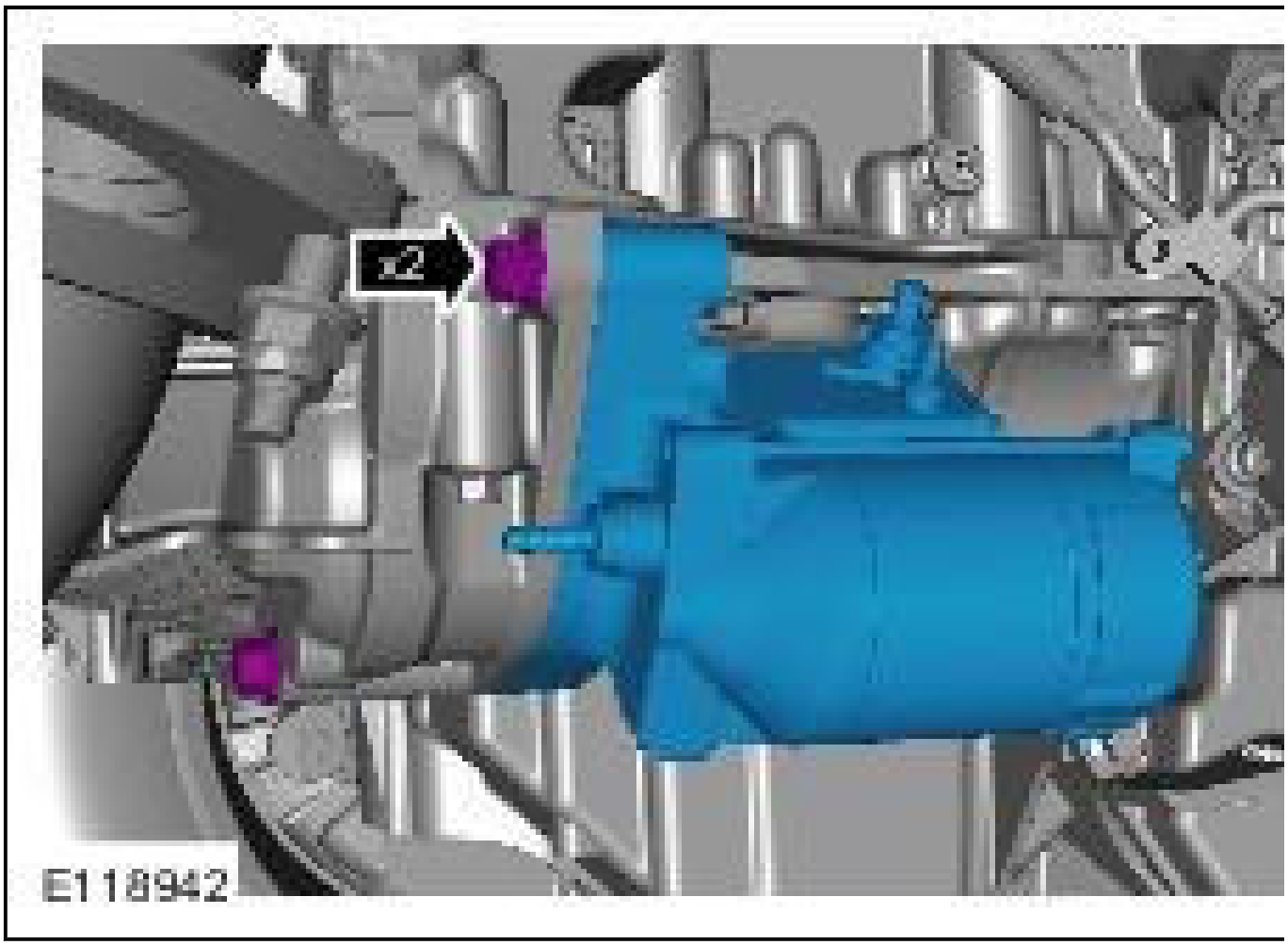
NOTE: **Tighten the retaining bolts working diagonally.**

Torque:

Stage 1: 45 Nm

Stage 2: 90°

40. Torque: 48 Nm



41. Install a new O-ring seal to the differential case.
42. With assistance, align and secure the front differential case.

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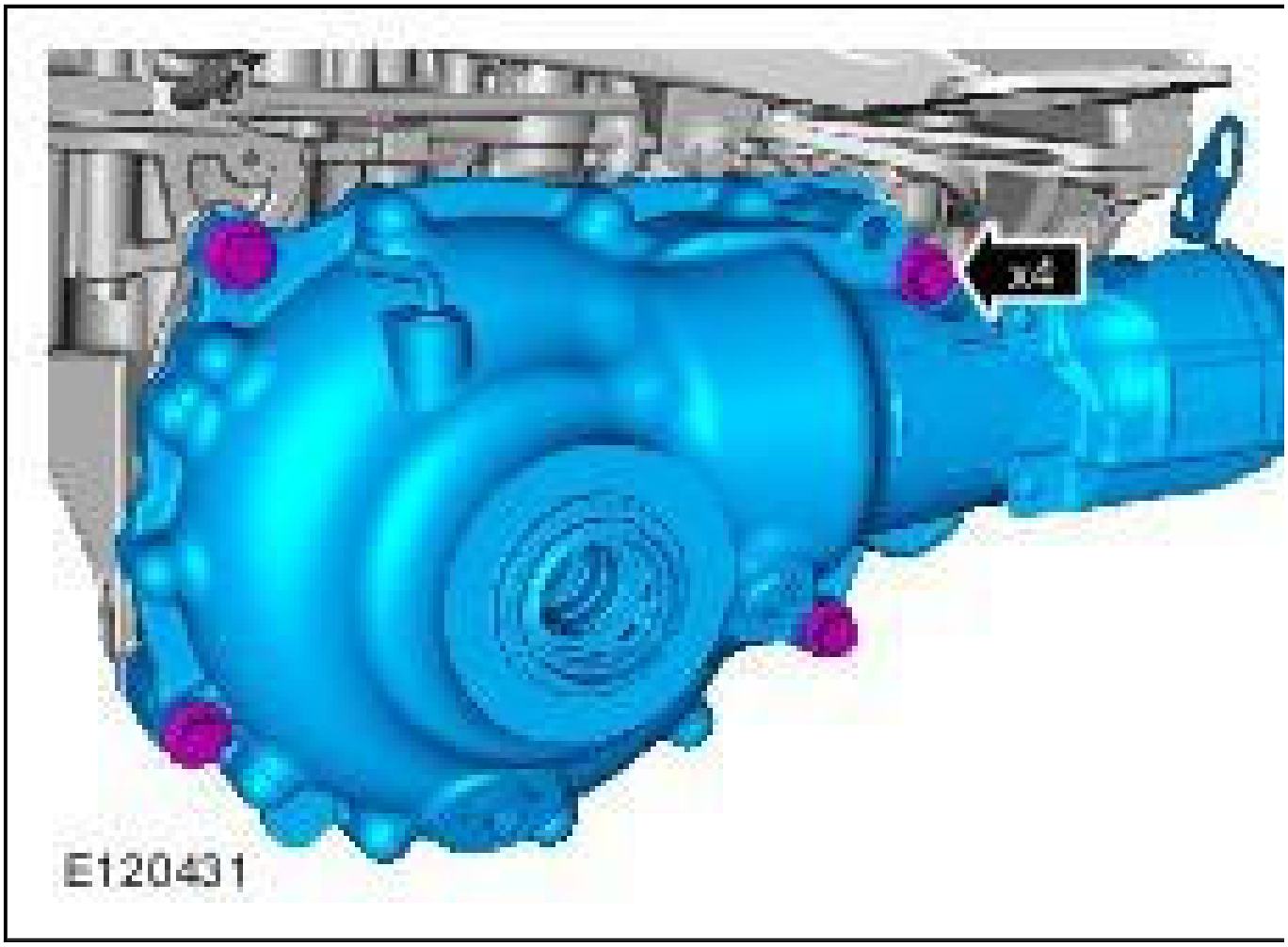

CAUTION: Make sure the O ring seal remains in its fitted position.

CAUTION: Make sure that new bolts are installed.

43. Tighten the 100 mm length bolts.

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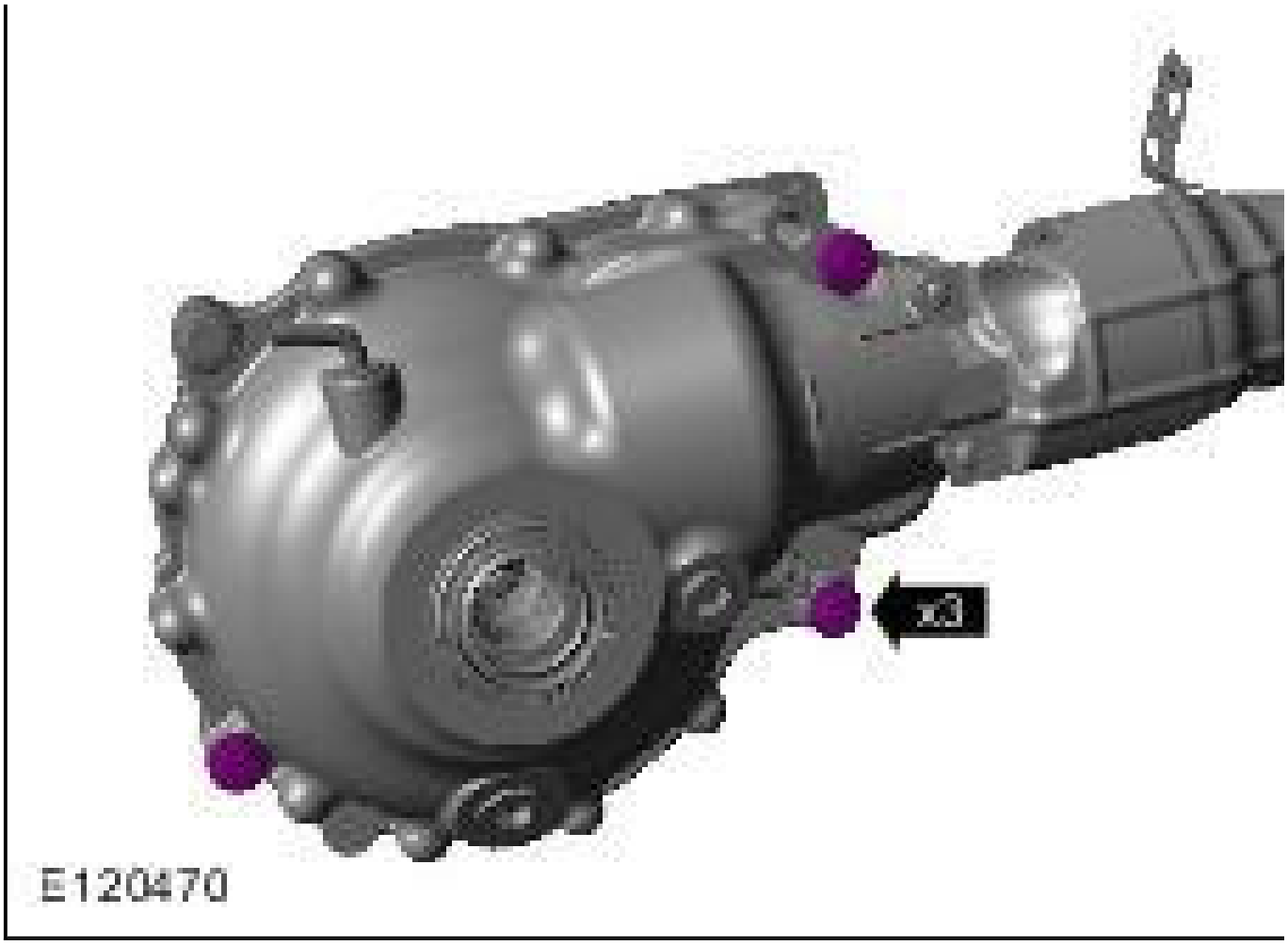

Torque:

Stage 1: 50 Nm

Stage 2: 90°

44. Tighten the 55 mm length bolts.

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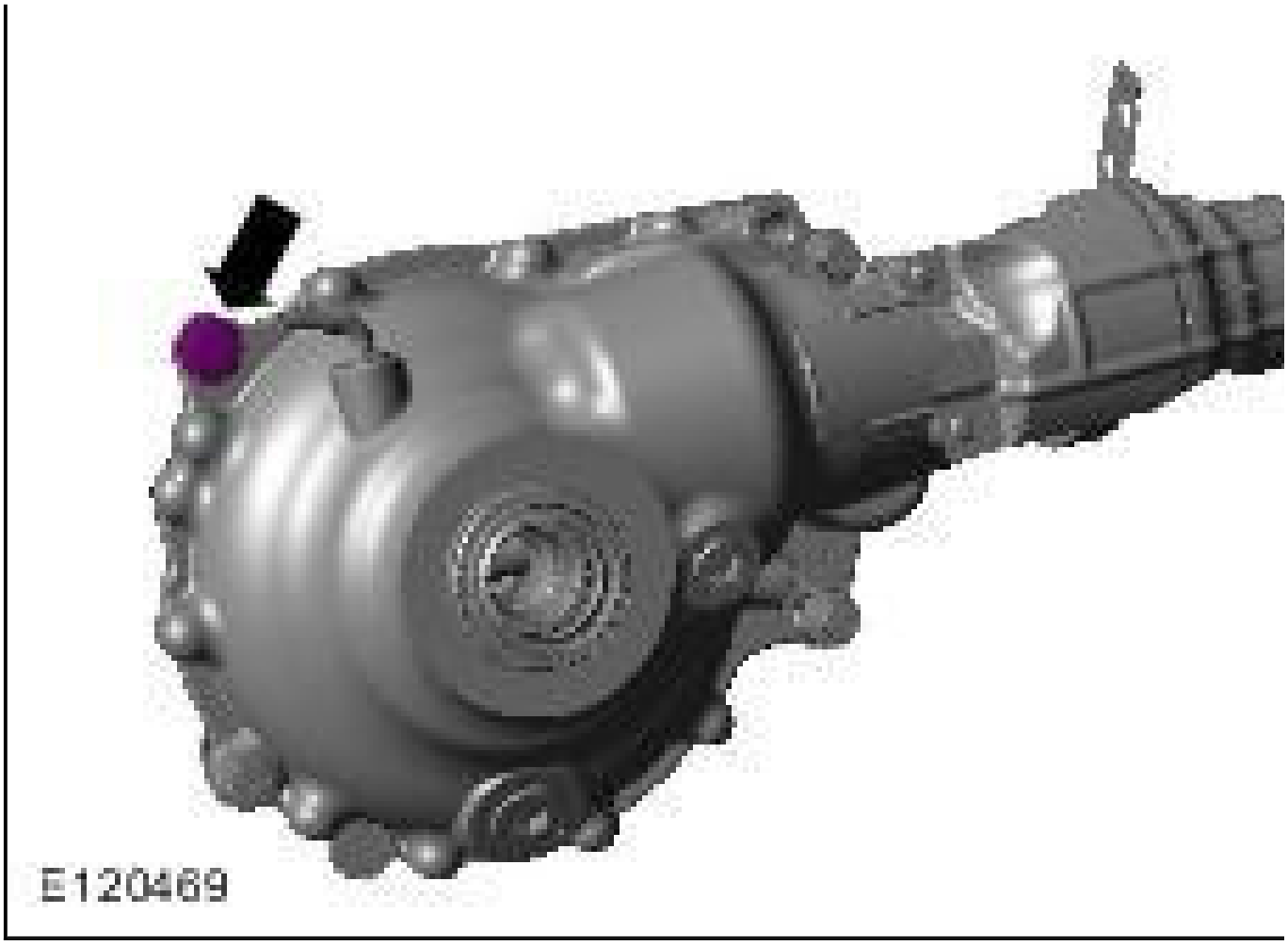

Torque:

Stage 1: 50 Nm

Stage 2: 60°

45. See figure

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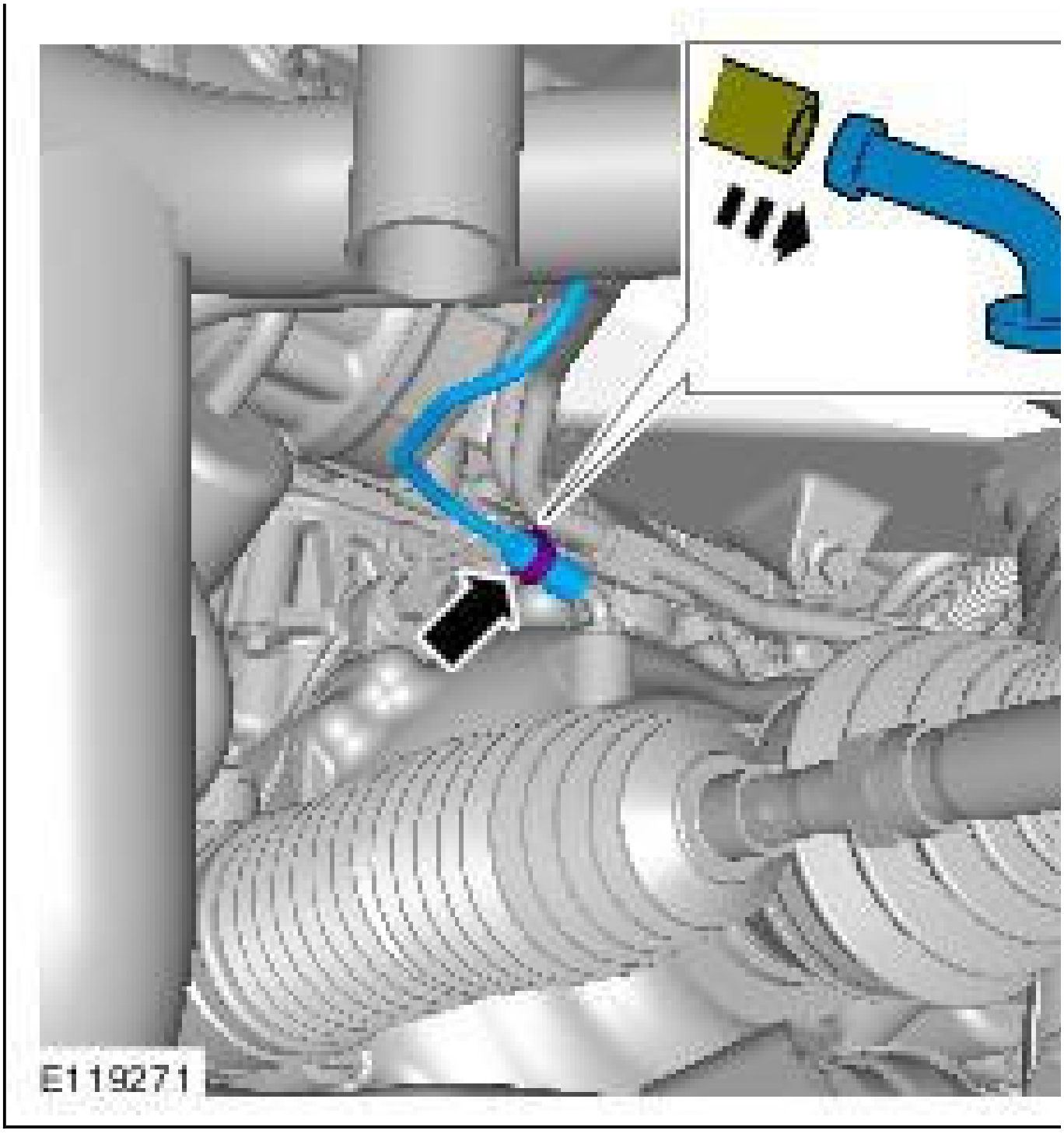

46. Torque: 40 Nm

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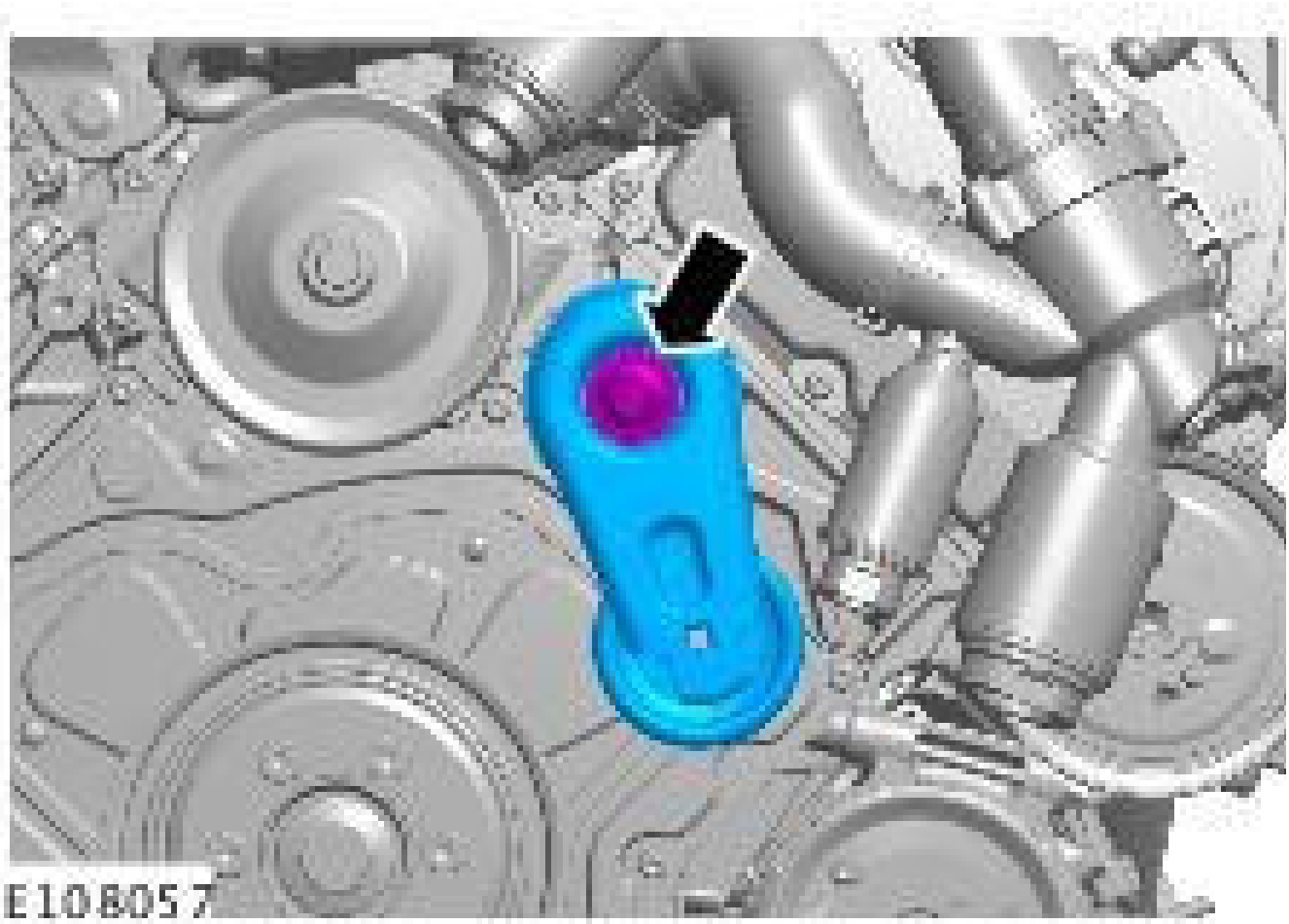

NOTE: Install the bolt finger tight before final tightening.

47. Torque: 25 Nm

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48. Torque: 25 Nm

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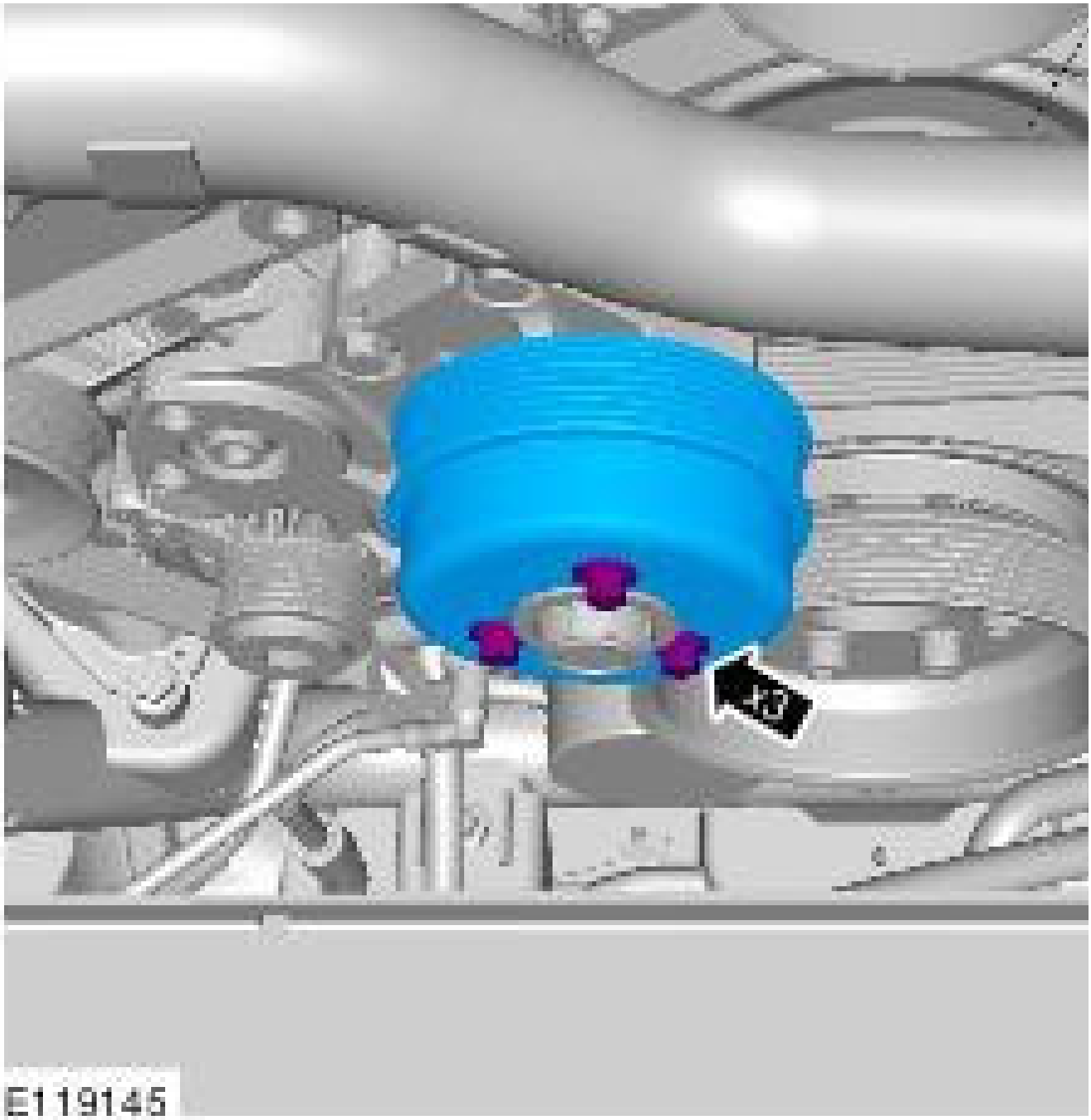

49. See **Crankshaft Pulley**.
50. See figure

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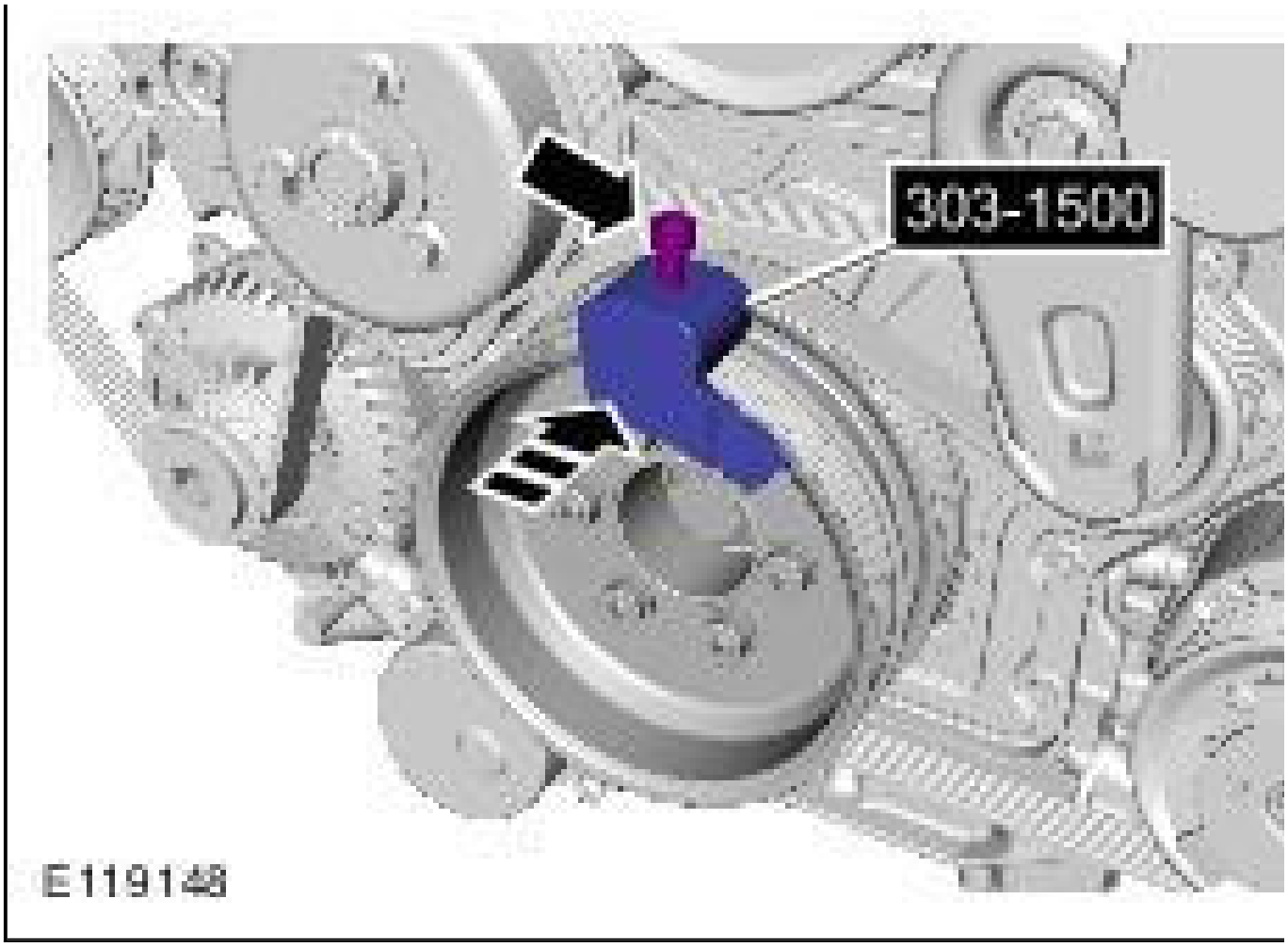

Installer, Stretchy Belt (303-1500), refer to **SPECIAL TOOL(S)**

51. See figure

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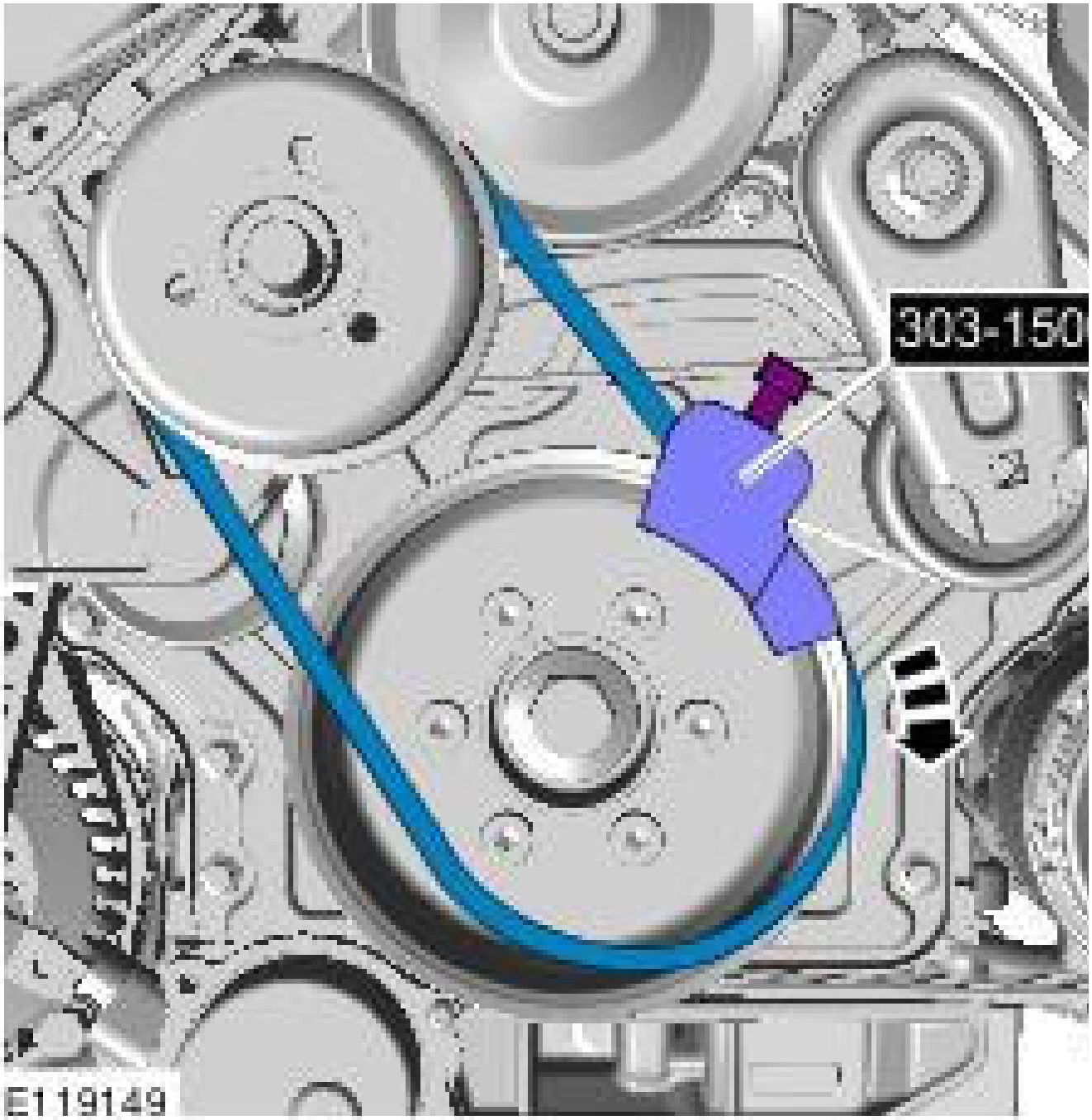

- Install the cooling fan belt.
- Rotate the engine clockwise twice, making sure that the belt is seated on both pulleys correctly.
- Remove the special tool.

52. Torque: 25 Nm

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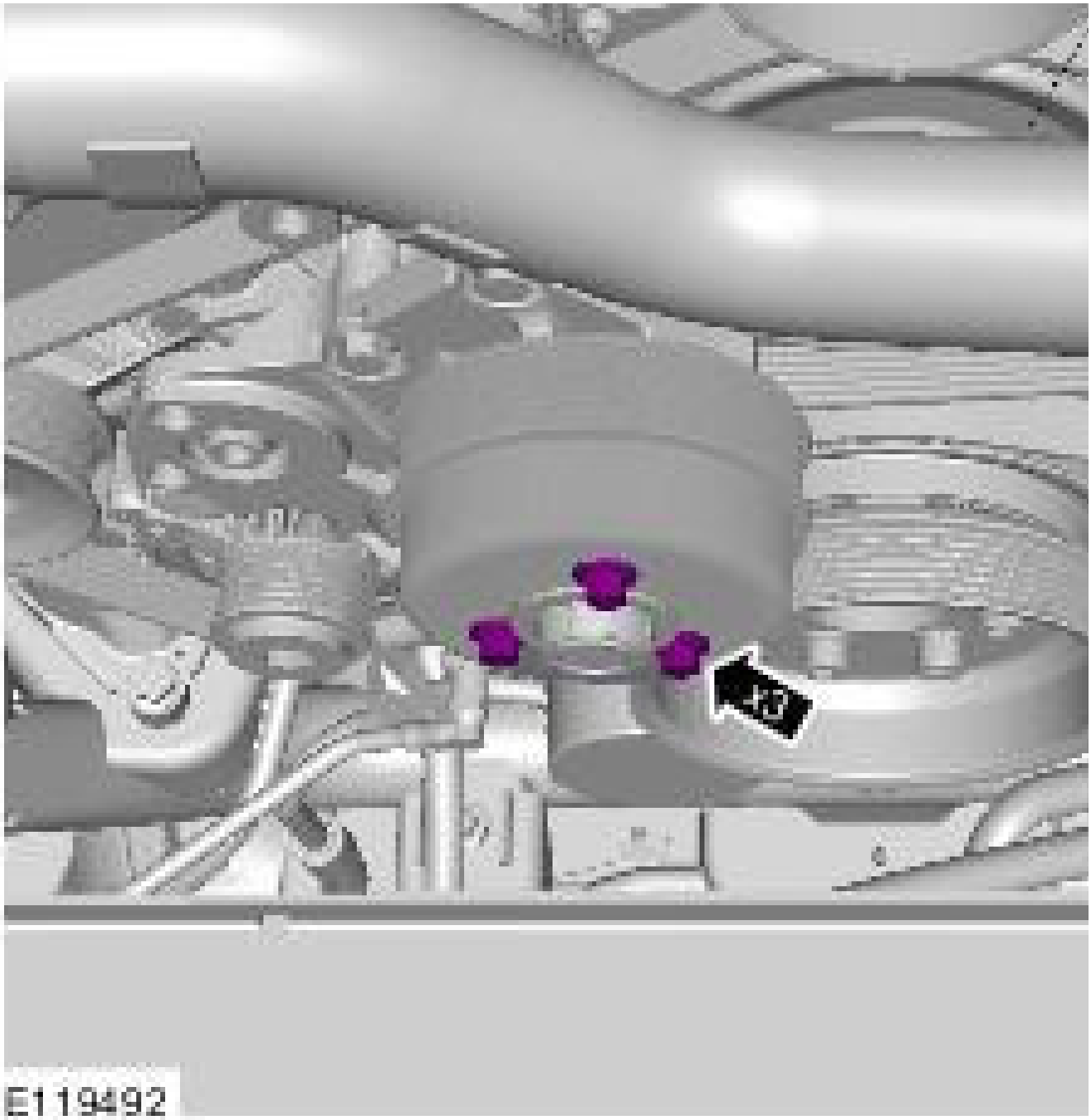

53. Refer to **ENGINE (V8 5.0L PETROL)**
54. Lower the vehicle.
55. Connect the battery ground cable. Refer to **Specifications** .

OIL PUMP

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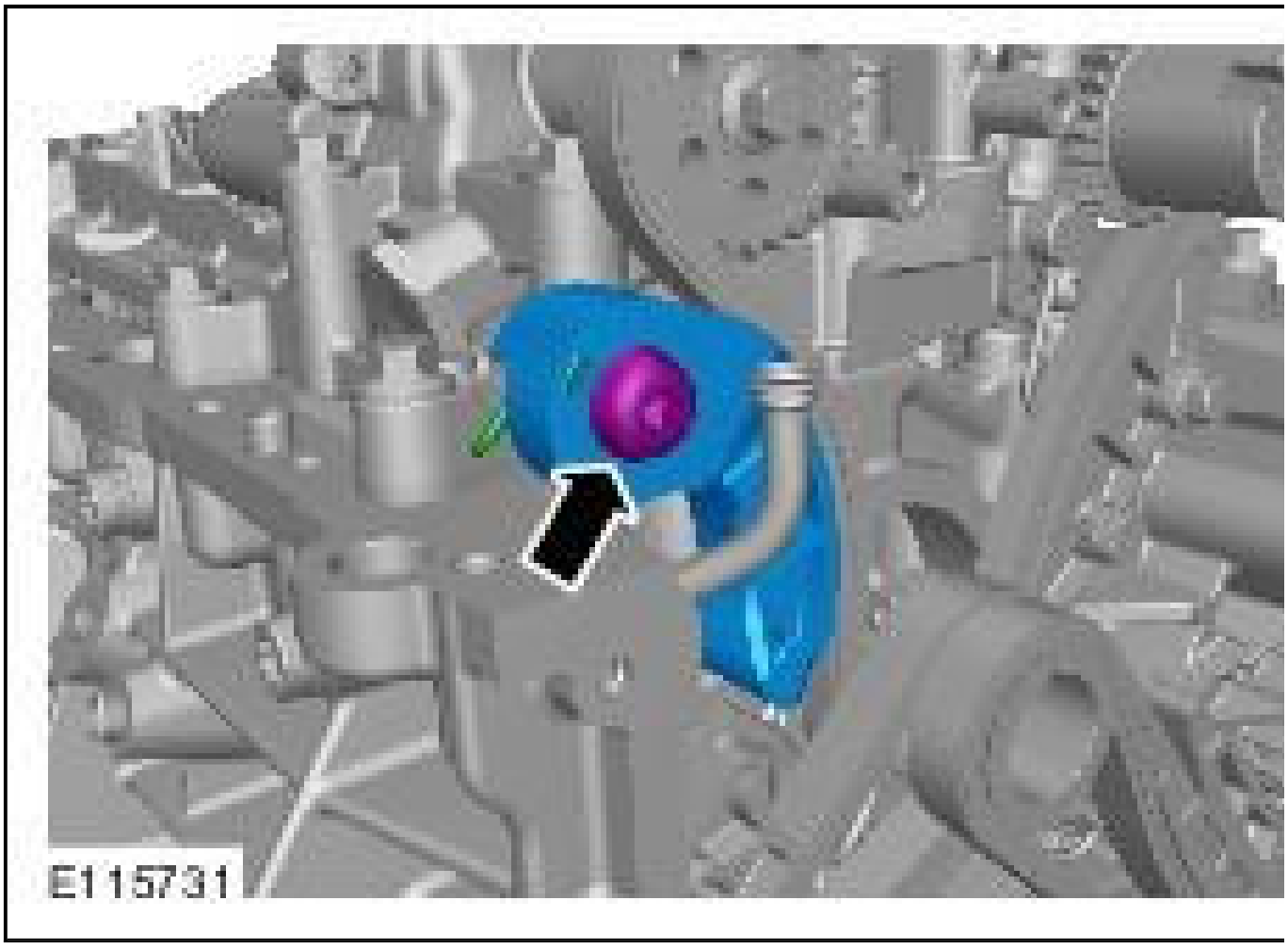
REMOVAL

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

1. 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. See **Oil Pan Extension**.
4. See figure



NOTE: Tsubaki timing drive only.

5. See figure

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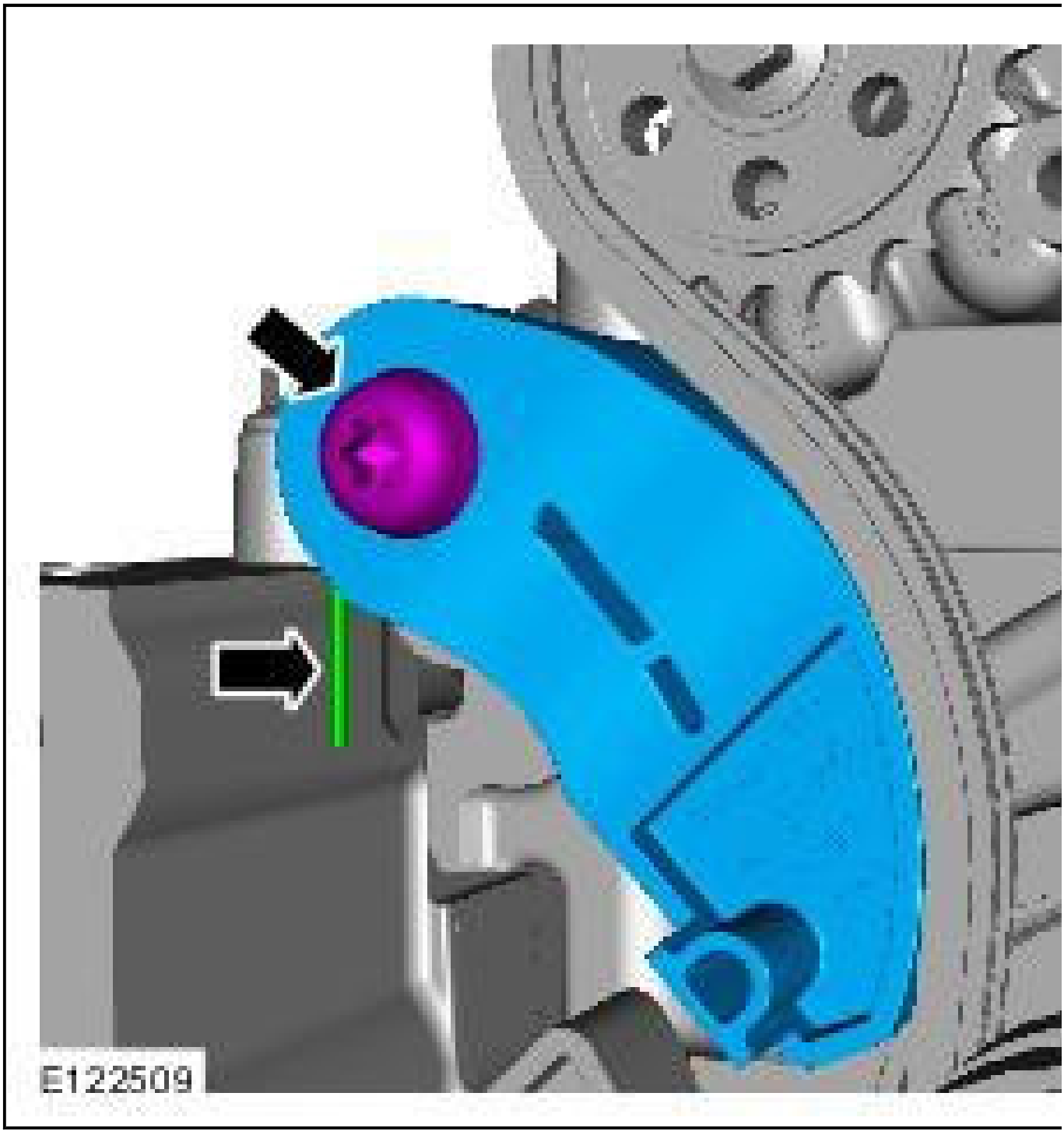

NOTE: INA timing drive only.

6. See figure

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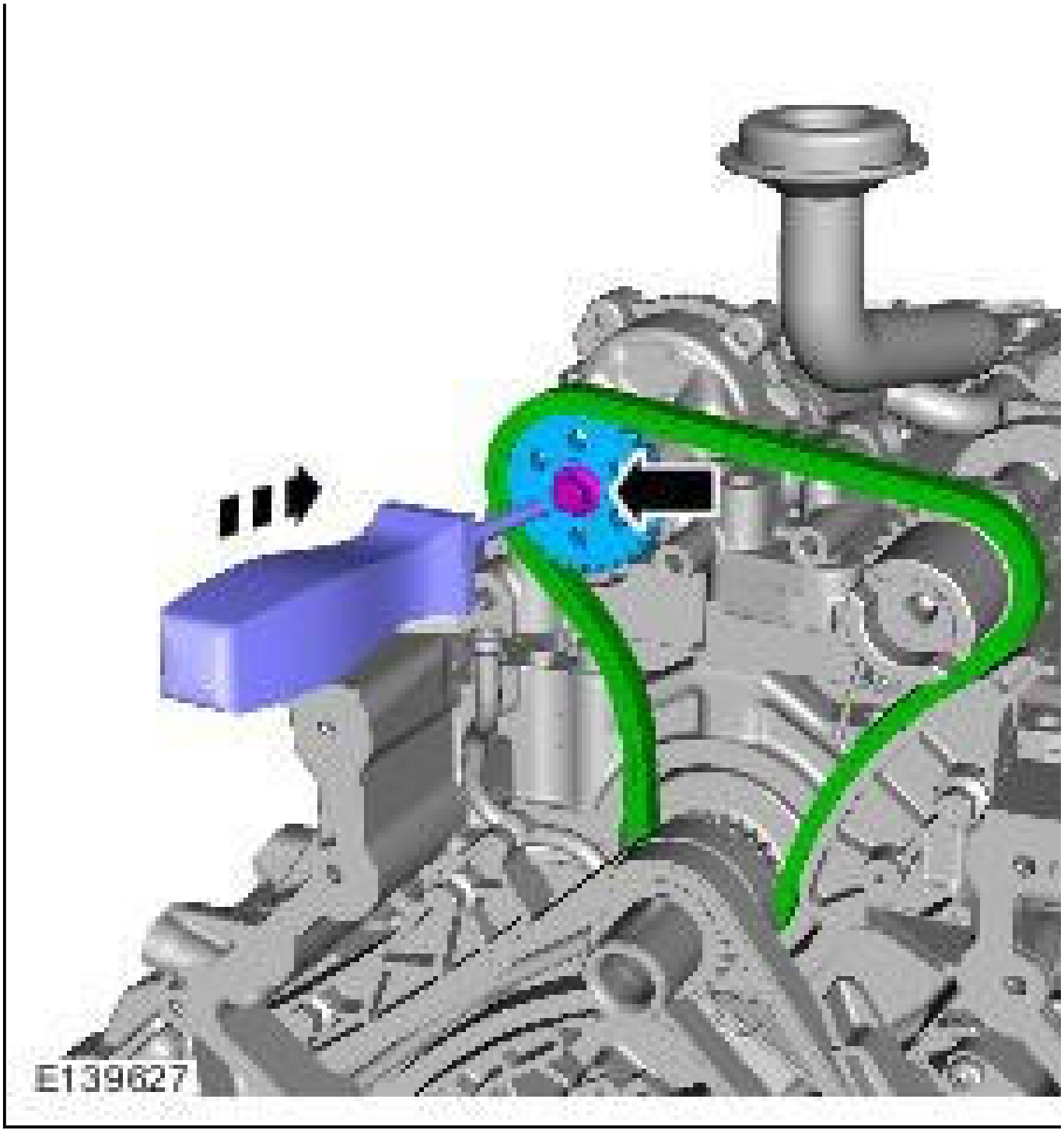

7. See figure

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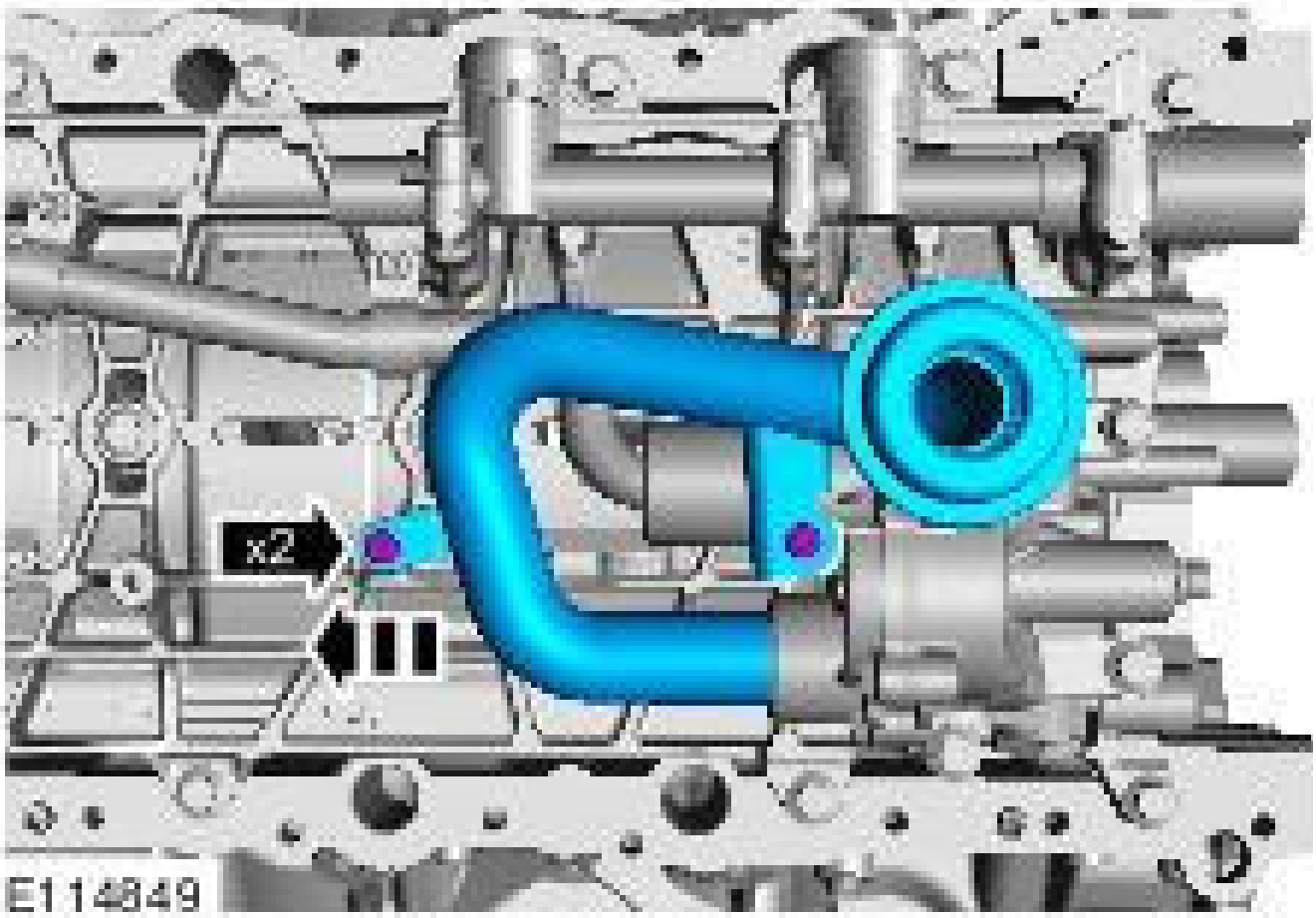

NOTE: Remove and discard the O-ring seal.

8. See figure

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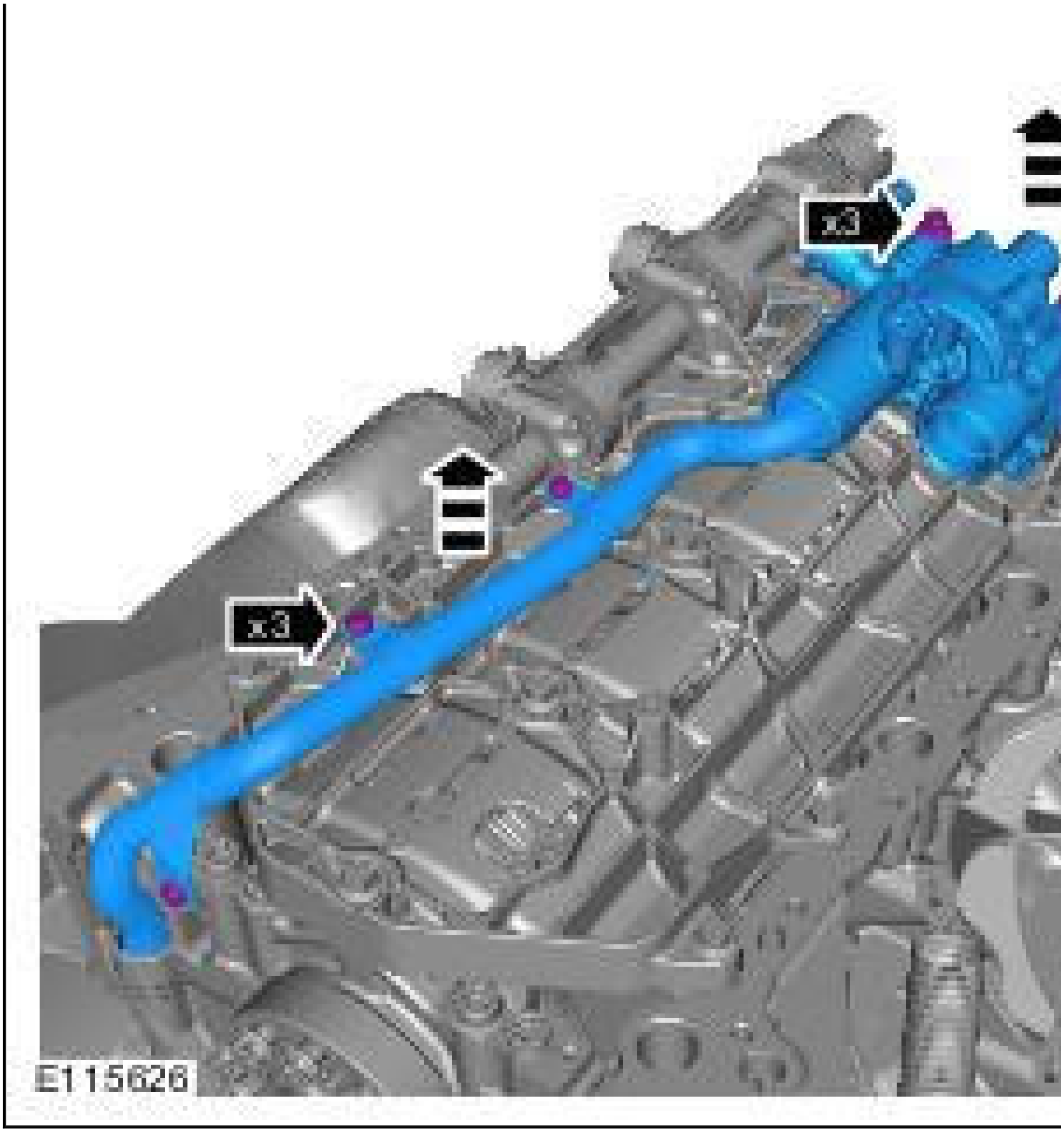

CAUTION: Remove and discard the O-ring seals.

9. See figure

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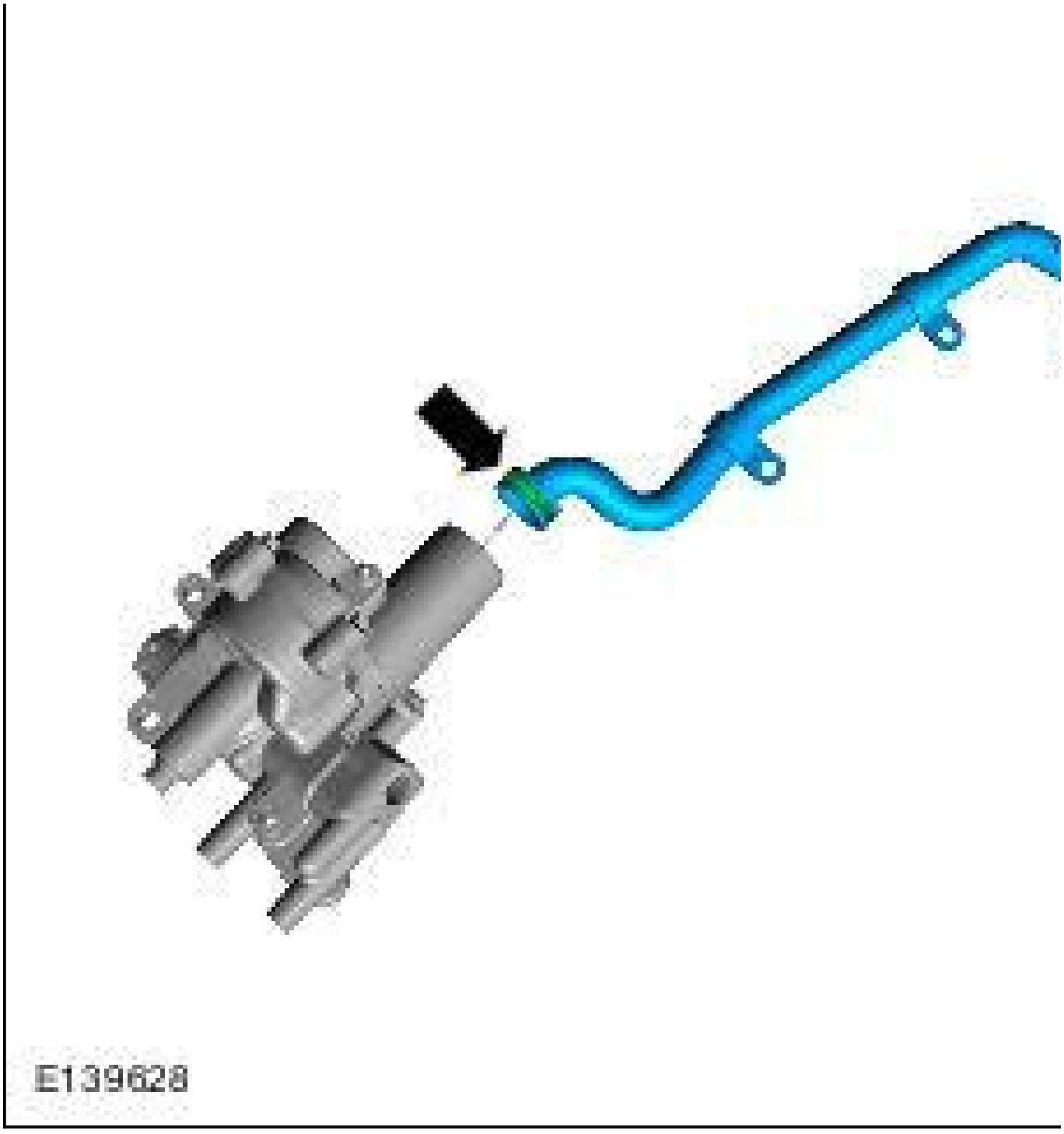

NOTE: Remove and discard the O-ring seal.

INSTALLATION

1. Lubricate and install the new O-ring seals.

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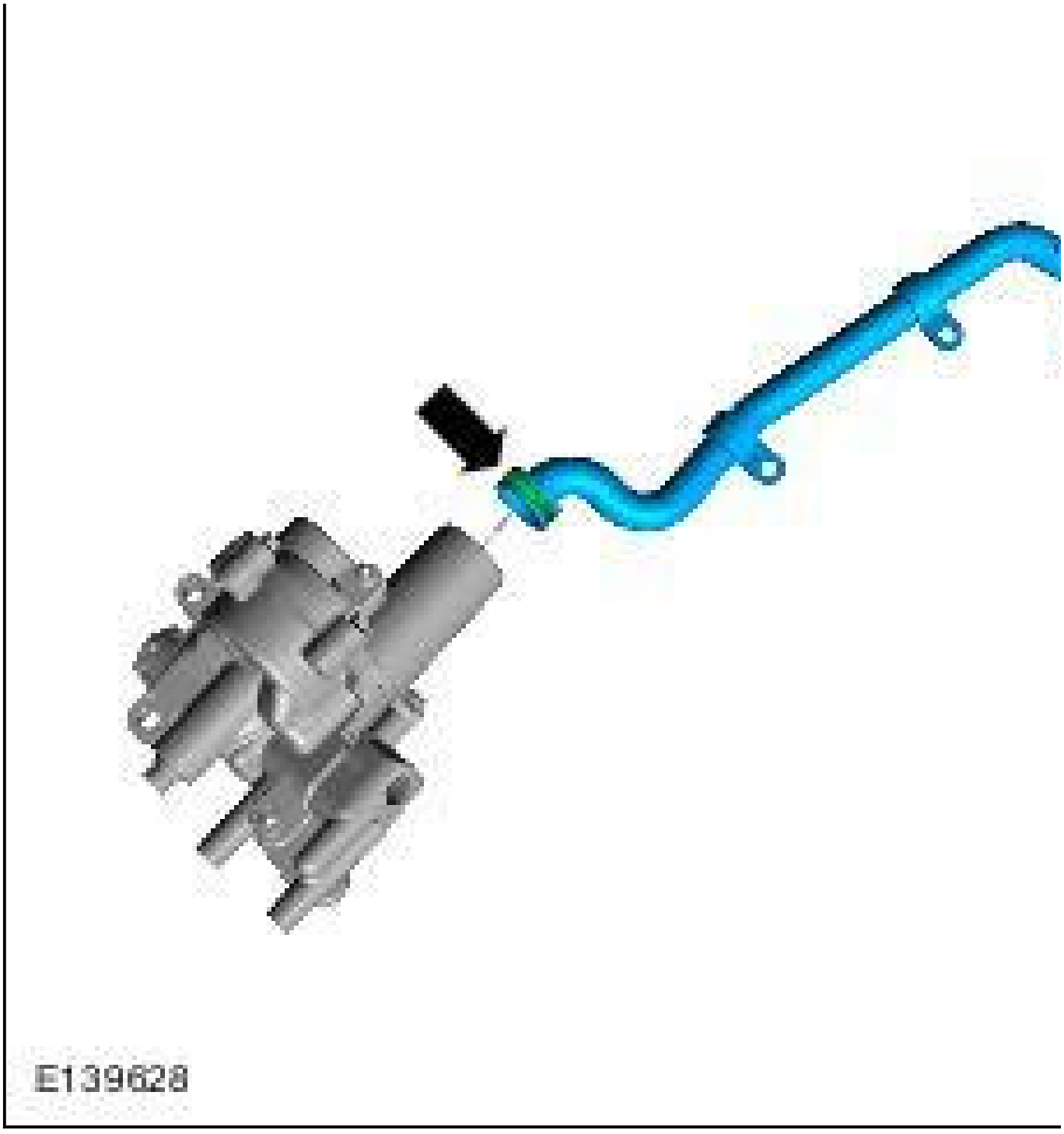

2. Torques:

   M8: 25 Nm

   M6: 12 Nm

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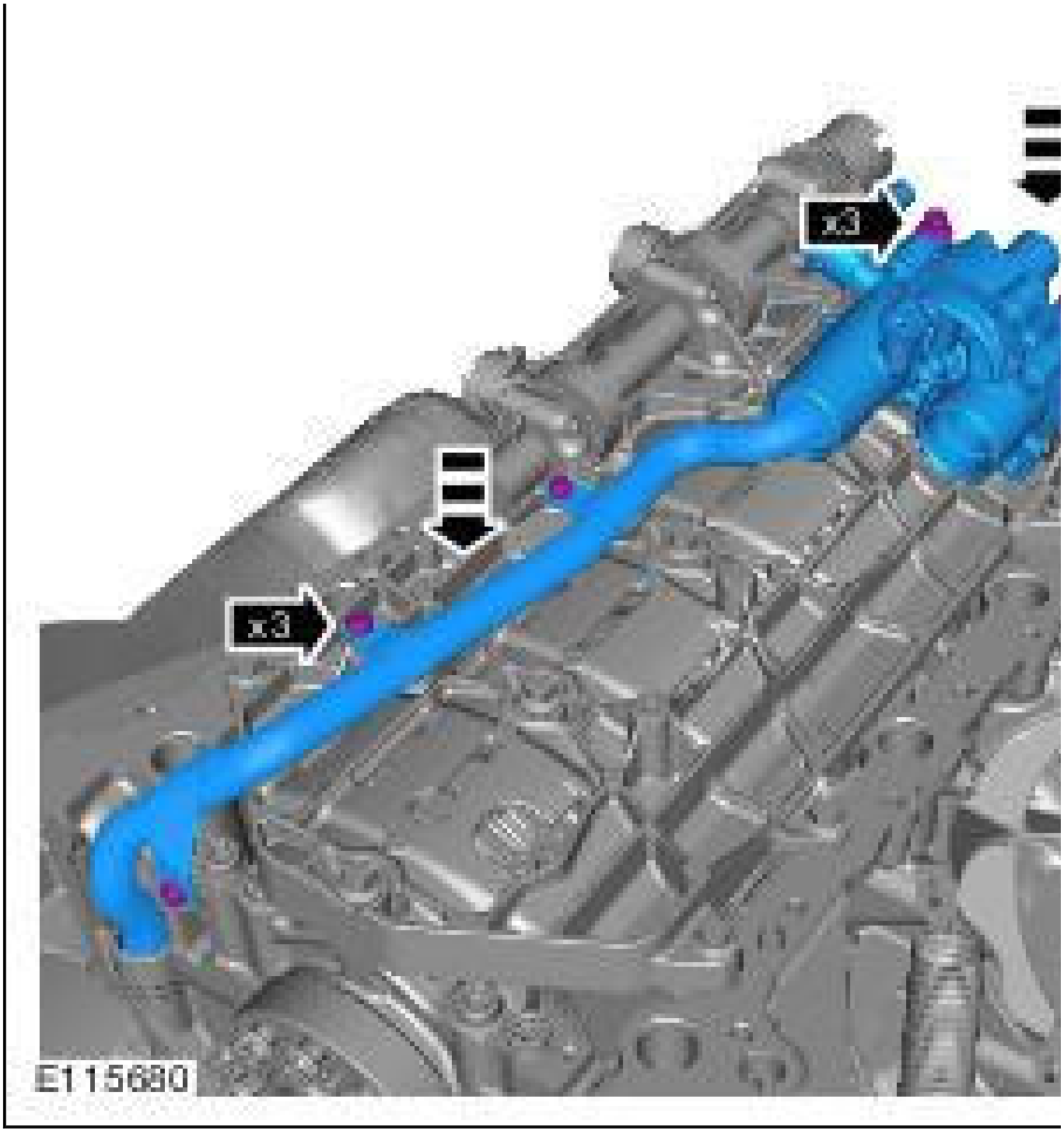

3. Lubricate and install a new O-ring seal.

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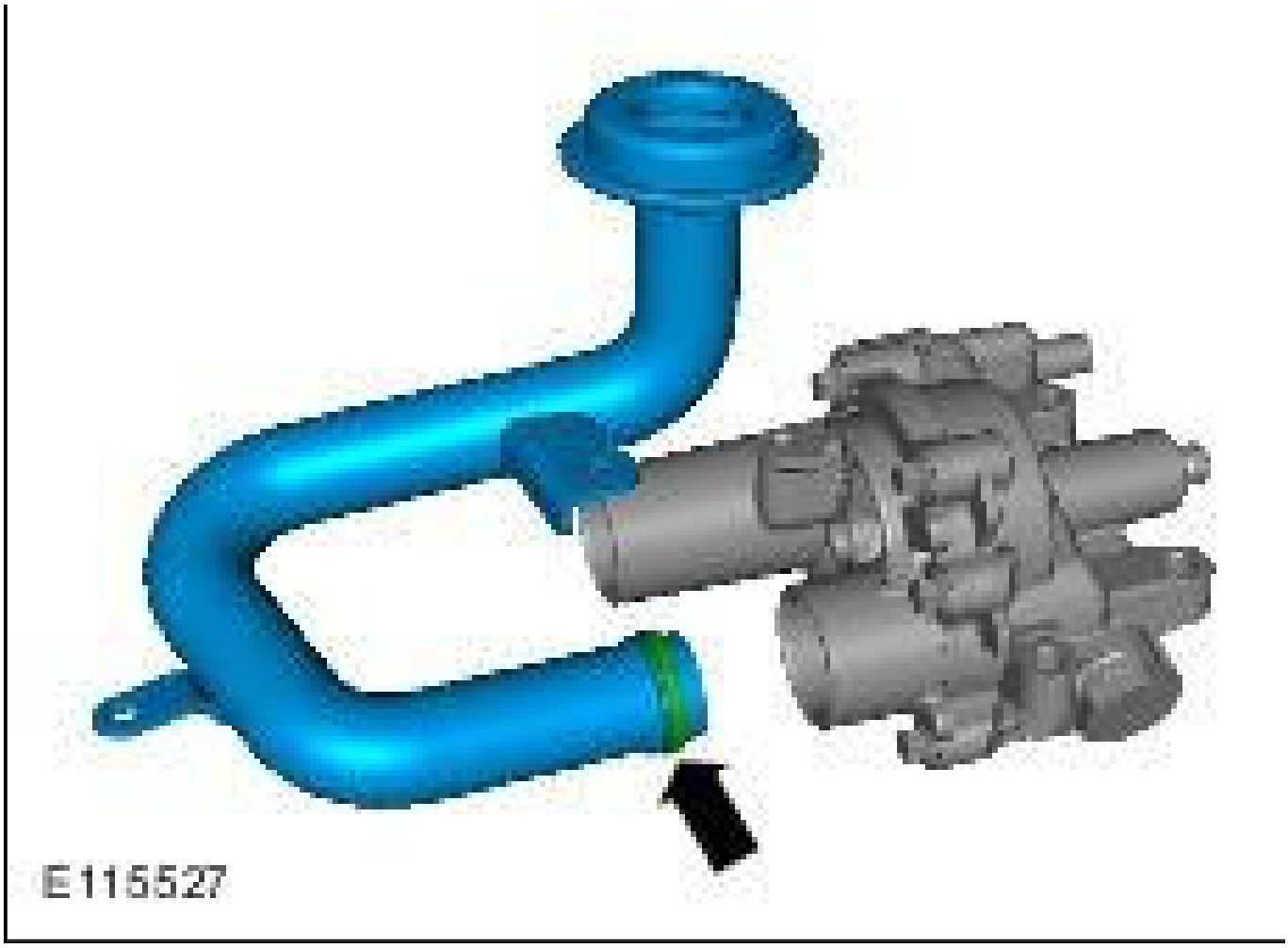

4. Torque: 12 Nm

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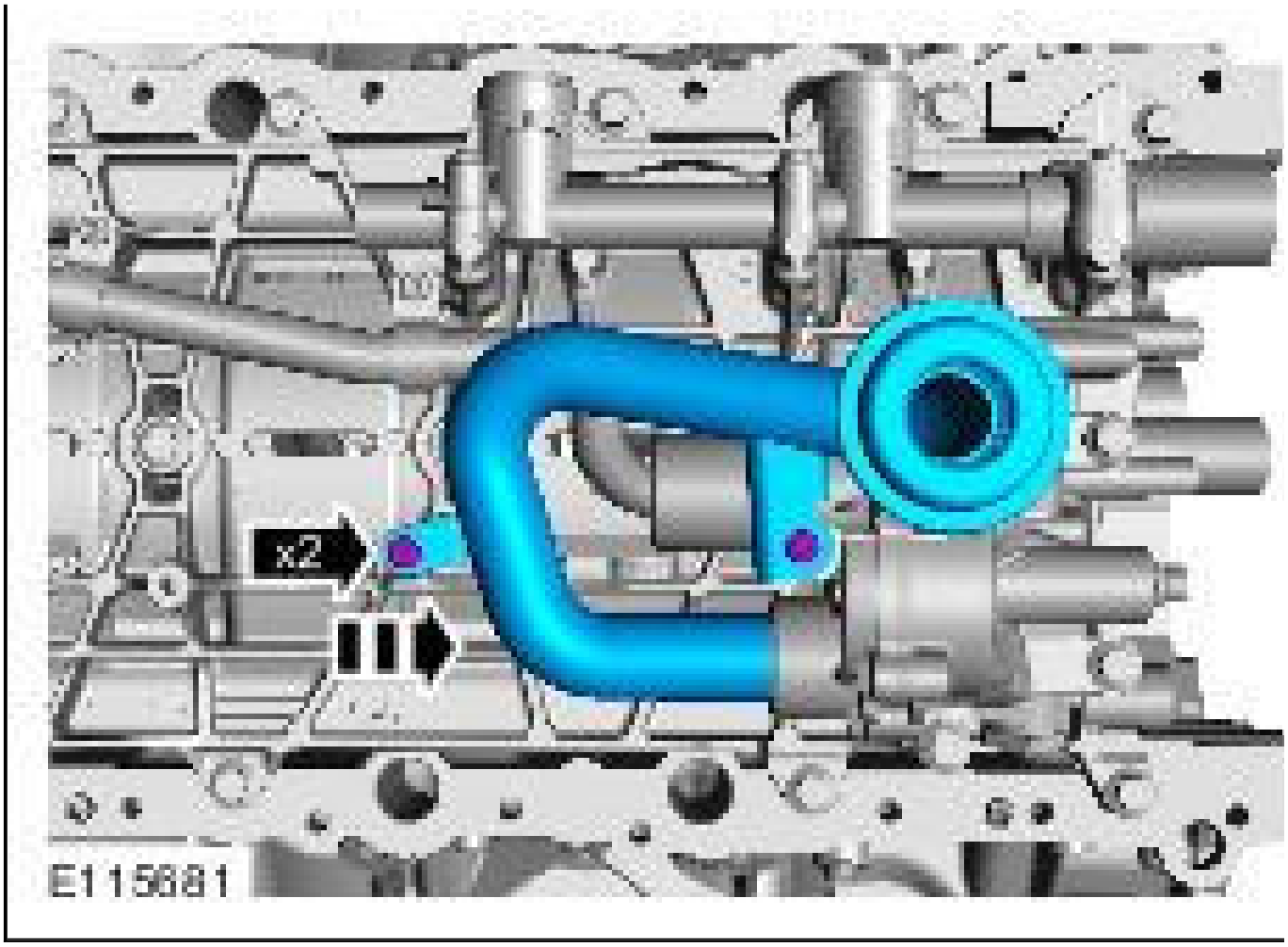

5. Torque: 21 Nm

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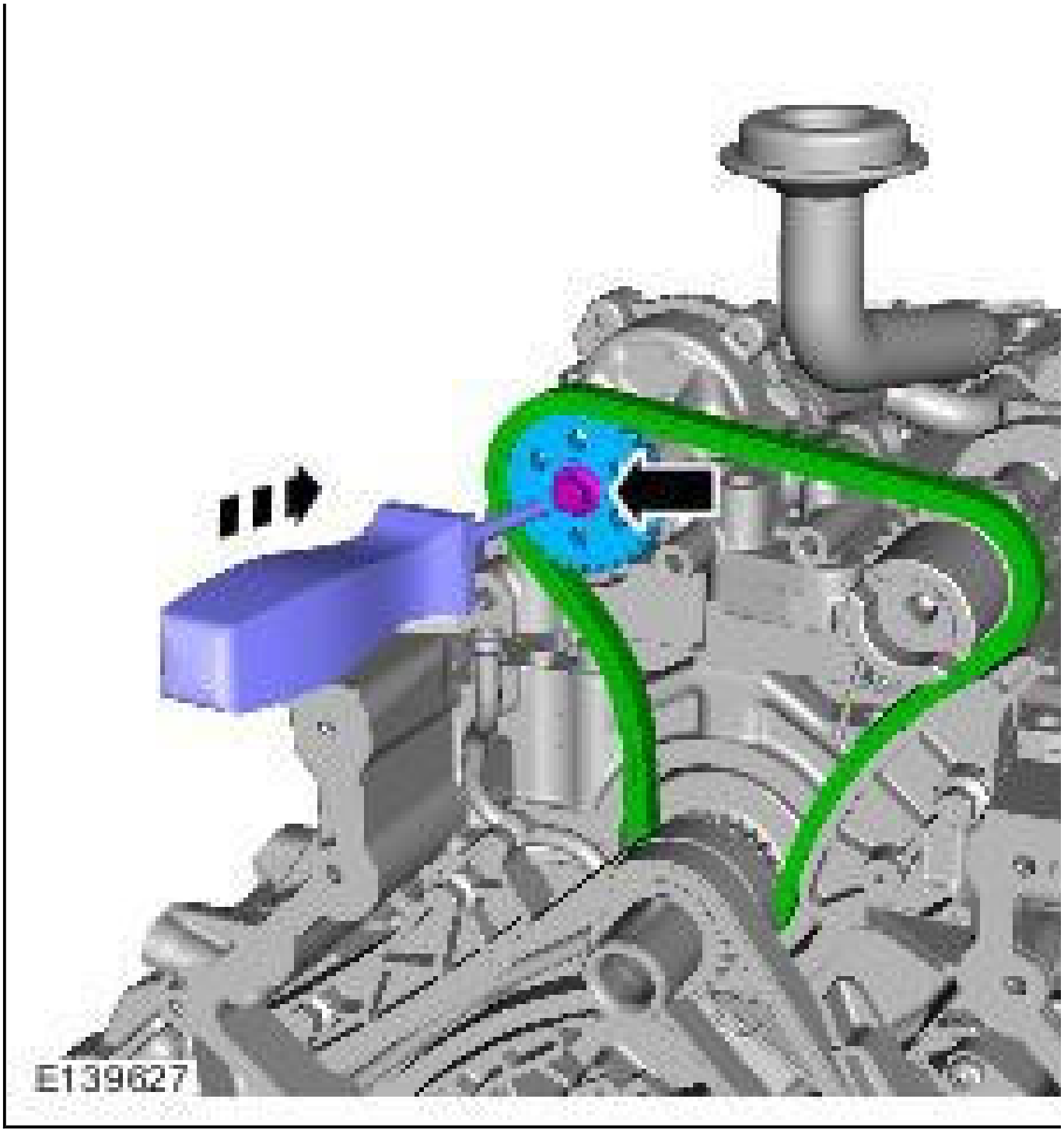

6. Install the lower timing chain making sure the colored chain links align correctly with the fuel rail high-pressure fuel pumps camshaft and crankshaft sprocket markings.

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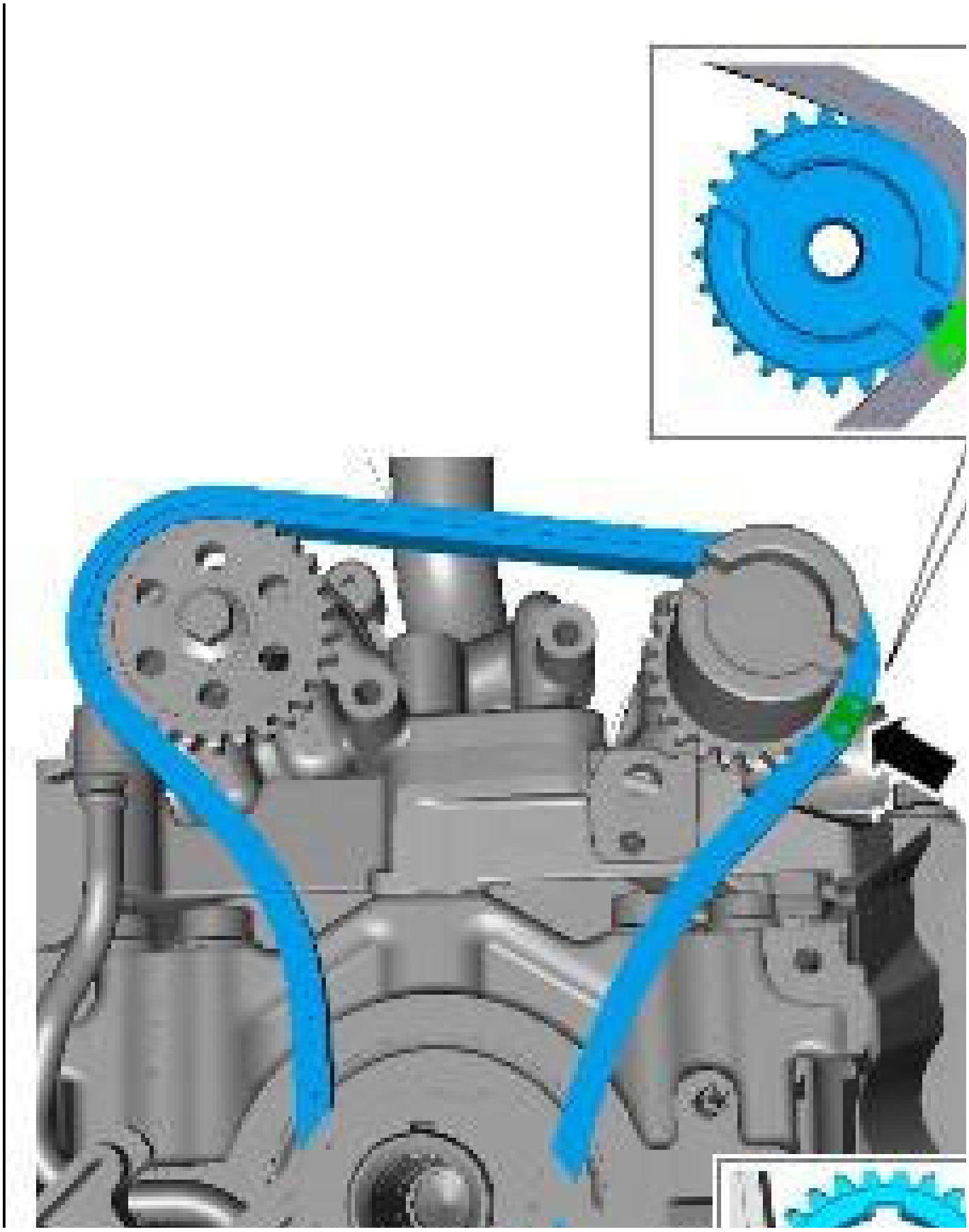

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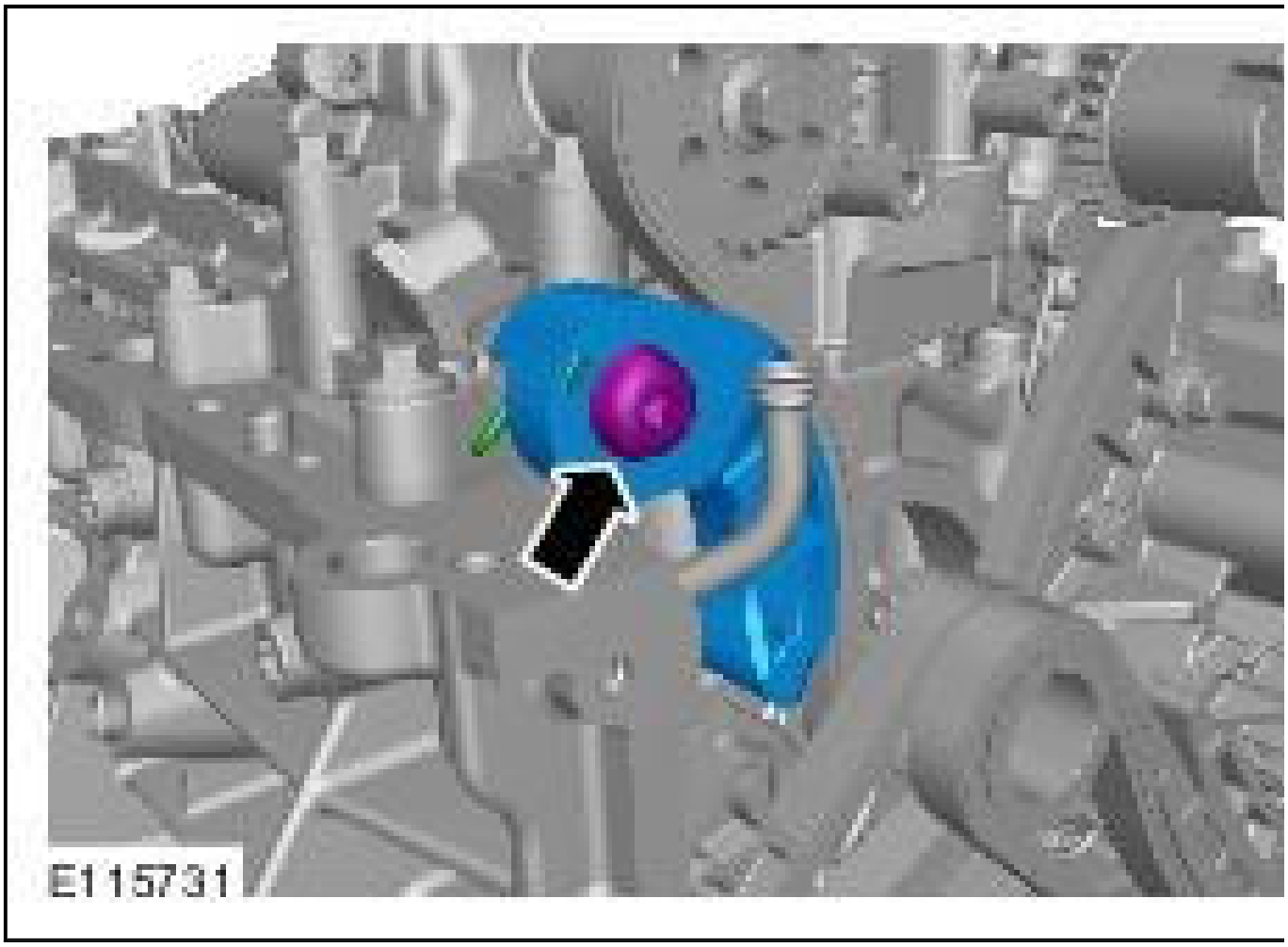
NOTE: Tsubaki timing drive only.

7. Torque: 21 Nm



CAUTION: Make sure that the tensioner spring is correctly located.

NOTE: Tsubaki timing drive only.

8. Install the lower timing chain making sure the colored chain links align correctly with the fuel rail high-pressure fuel pumps camshaft and crankshaft sprocket markings.

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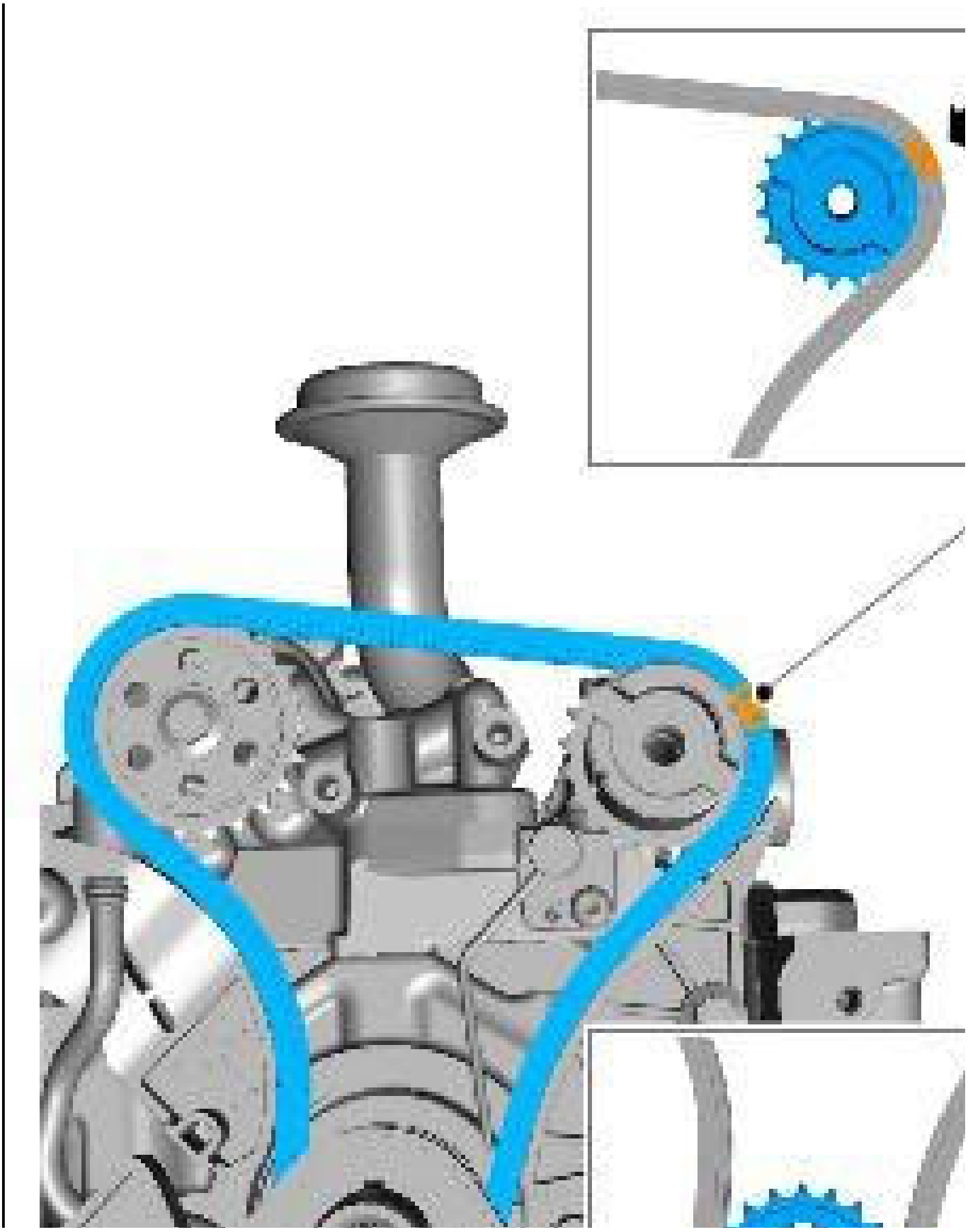

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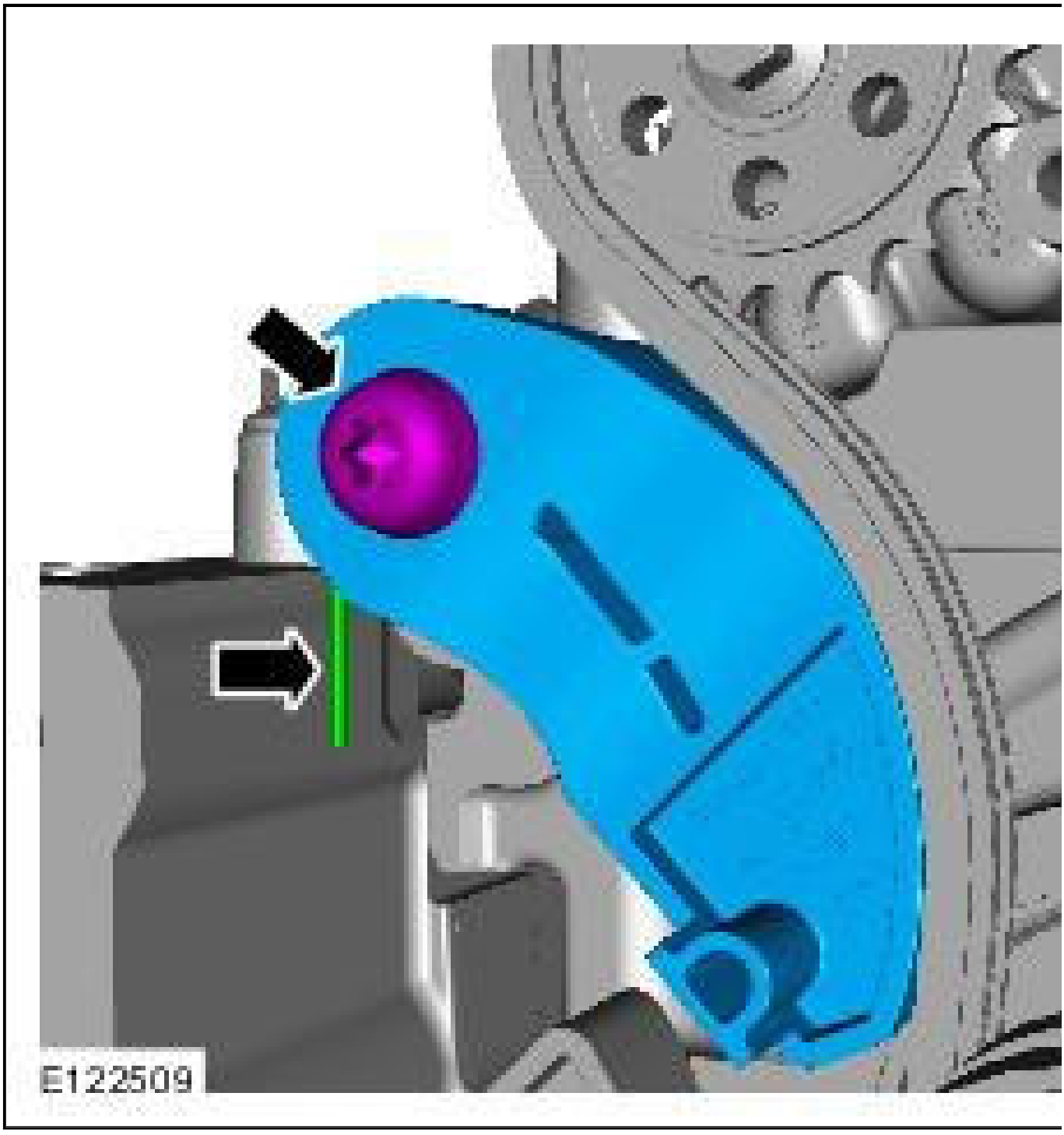
NOTE: INA timing drive only.

9. Torque: 21 Nm



CAUTION: Make sure that the tensioner spring is correctly located.

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NOTE: INA timing drive only.

10. See **Oil Pan Extension**.
11. Connect the battery ground cable. Refer to **Specifications** .

OIL RESTRICTOR

REMOVAL

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

1. See **Timing Drive Components**.
2. Torque: 7 Nm

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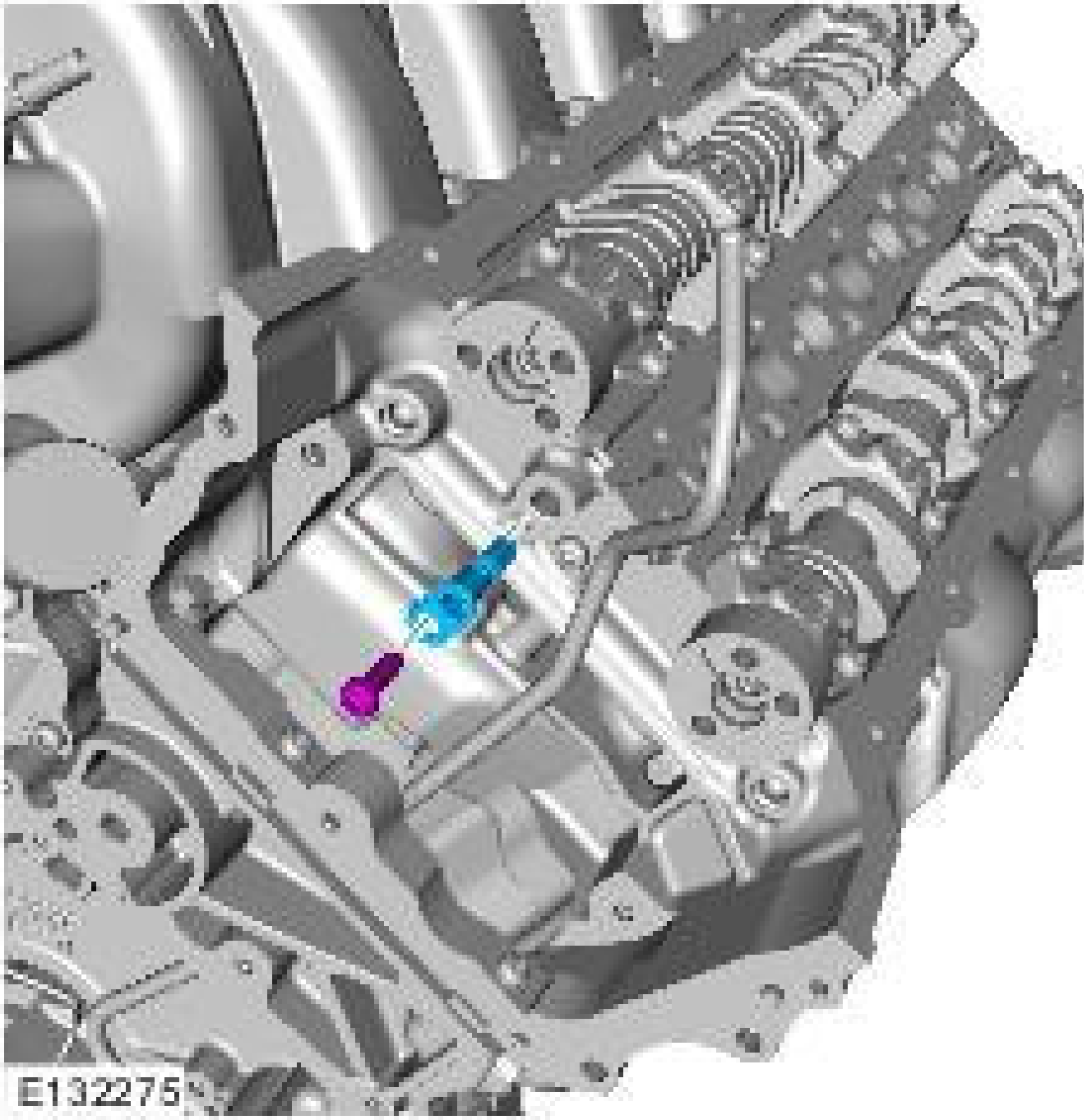

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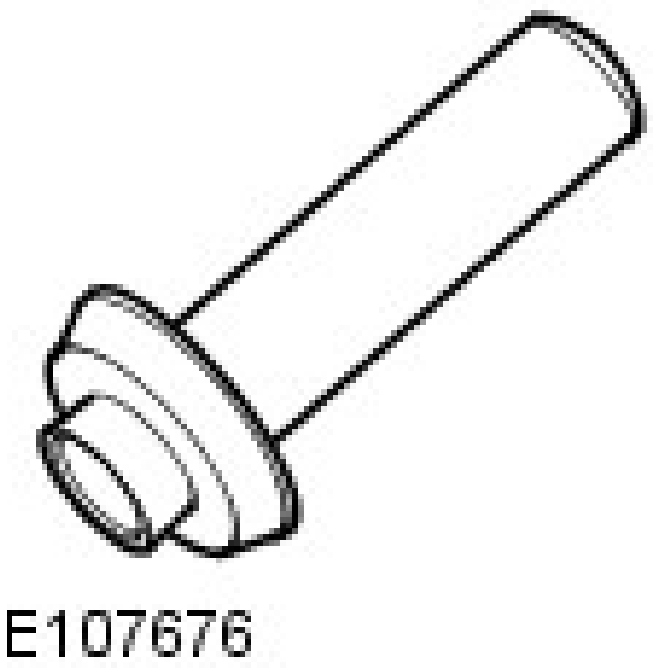
INSTALLATION

1. To install, reverse the removal procedure.

TIMING COVER

SPECIAL TOOL(S)

 E107676	303-1433 Lower Timing Cover Alignment tool

REMOVAL

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

1. 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. See **Crankshaft Pulley**.
4. See figure

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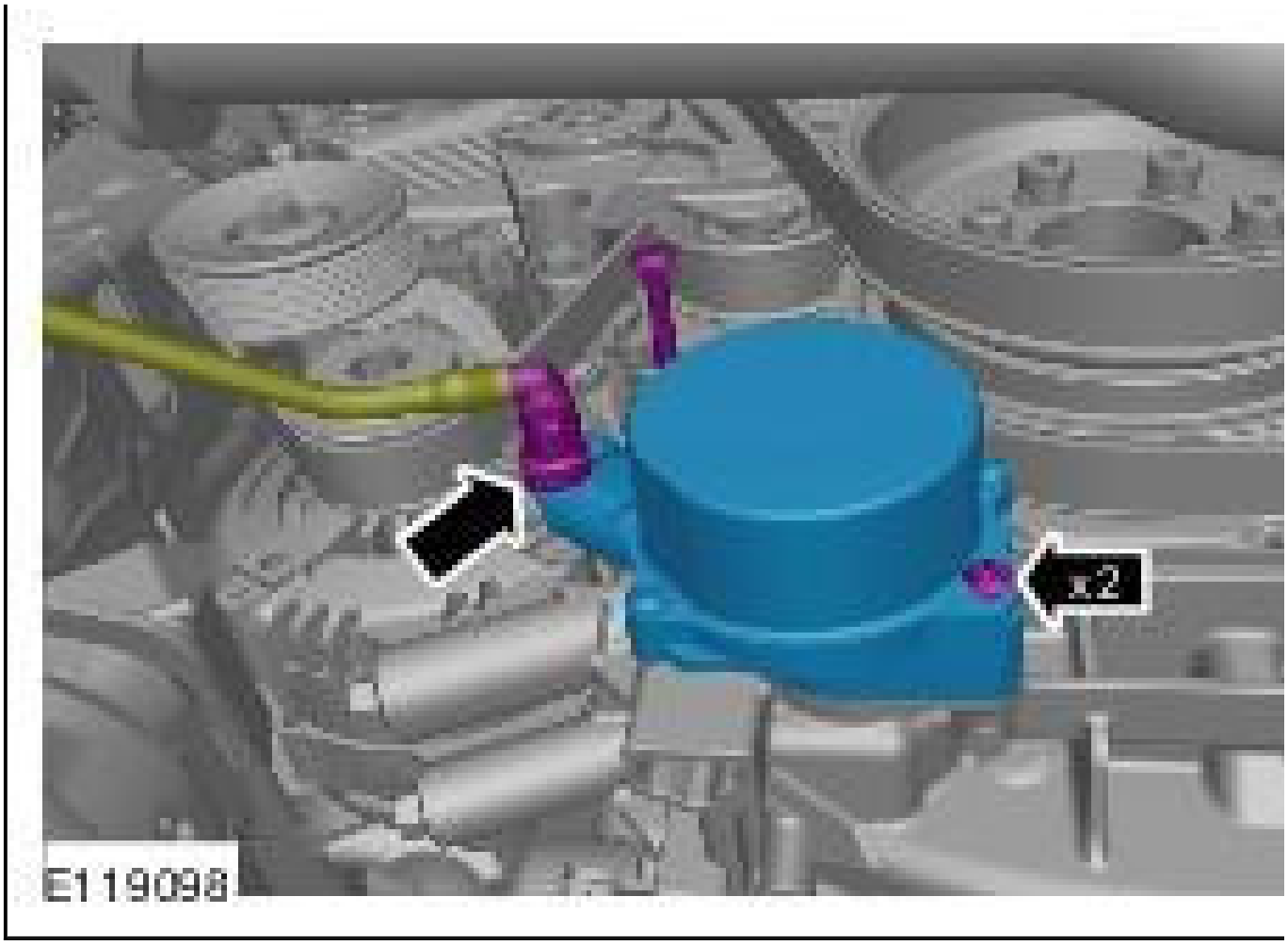

CAUTION: Be prepared to collect escaping oil.

NOTE: Discard the seal.

5. See **Valve Cover LH**.
6. See **Valve Cover RH**.
7. Cooling System Draining, Filling and Bleeding - V8 5.0L Petrol. Refer to **Engine Cooling (V8 5.0L Petrol/V8 S/C 5.0L Petrol)**
8. See figure

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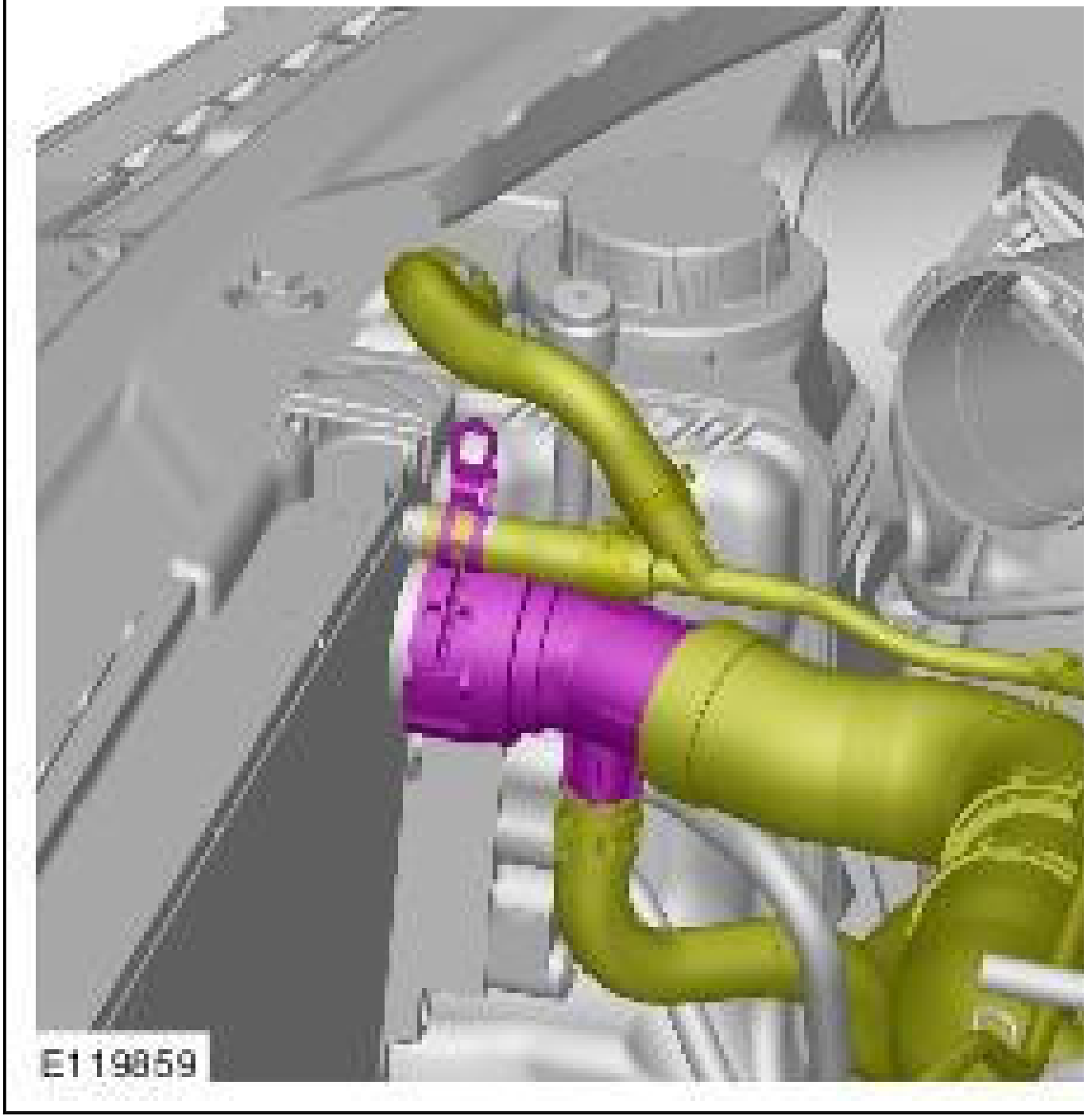

9. See figure

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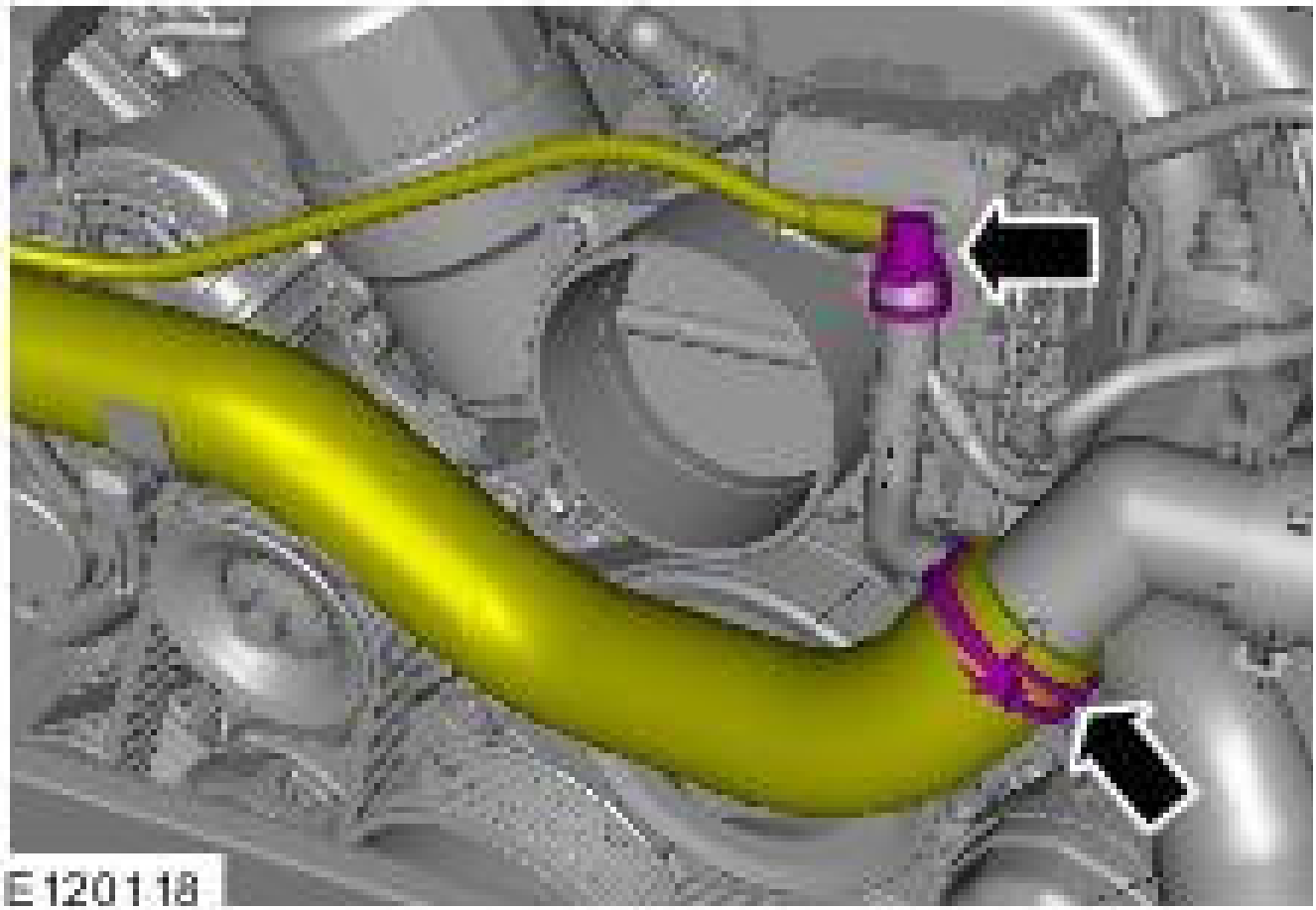

10. See figure

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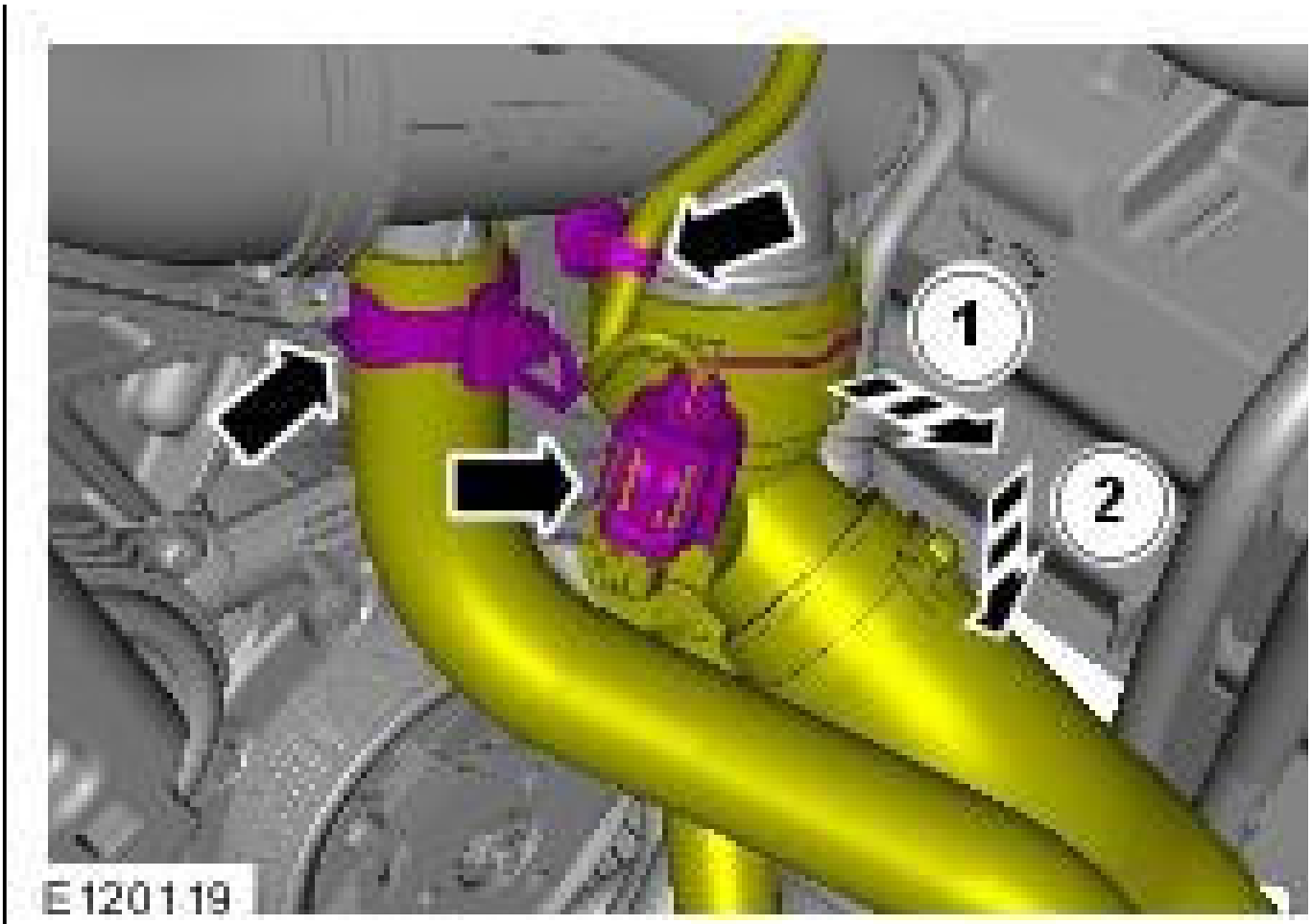

CAUTION: Be prepared to collect escaping coolant.

11. See figure

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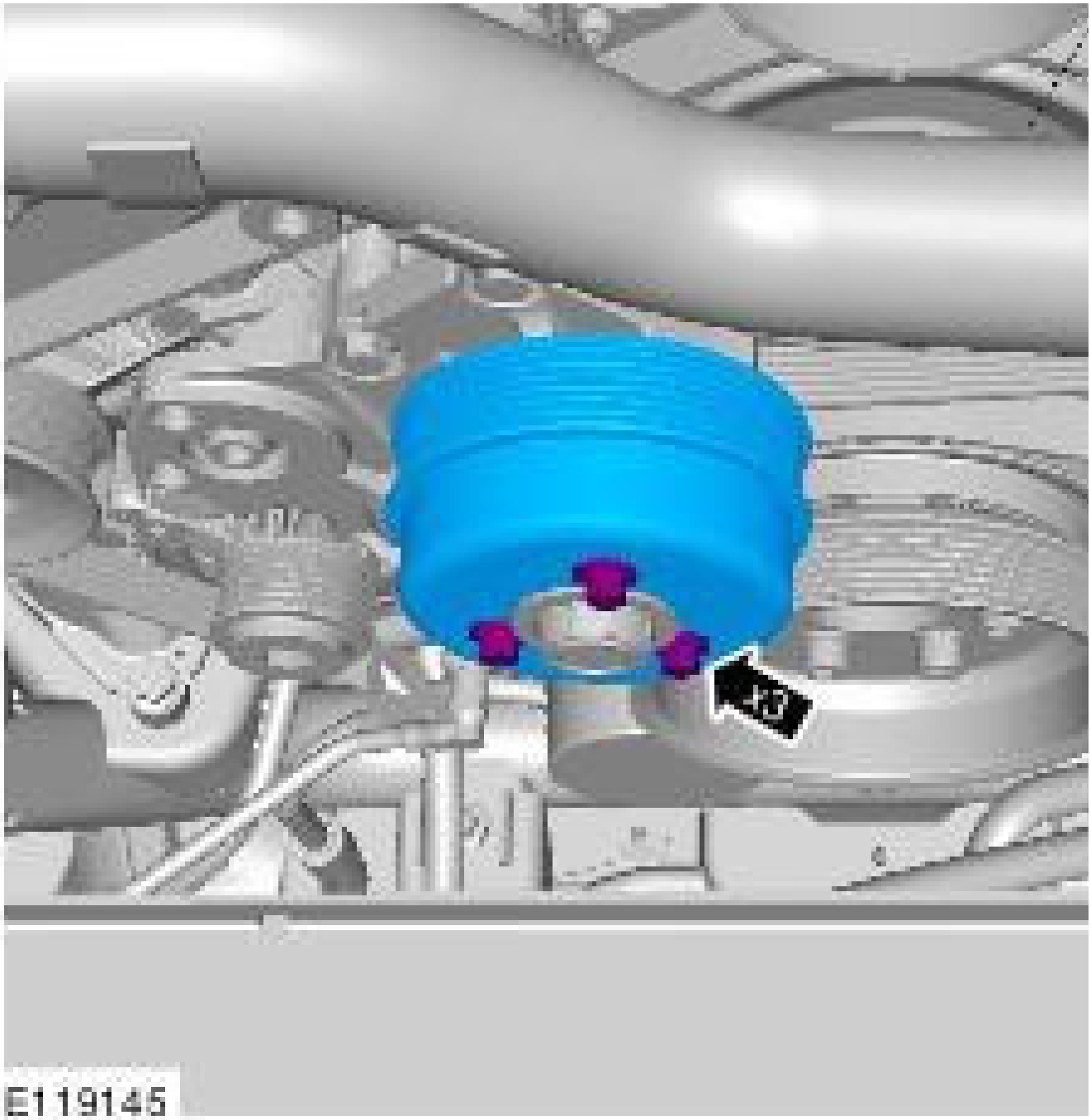

12. See figure

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13. See figure

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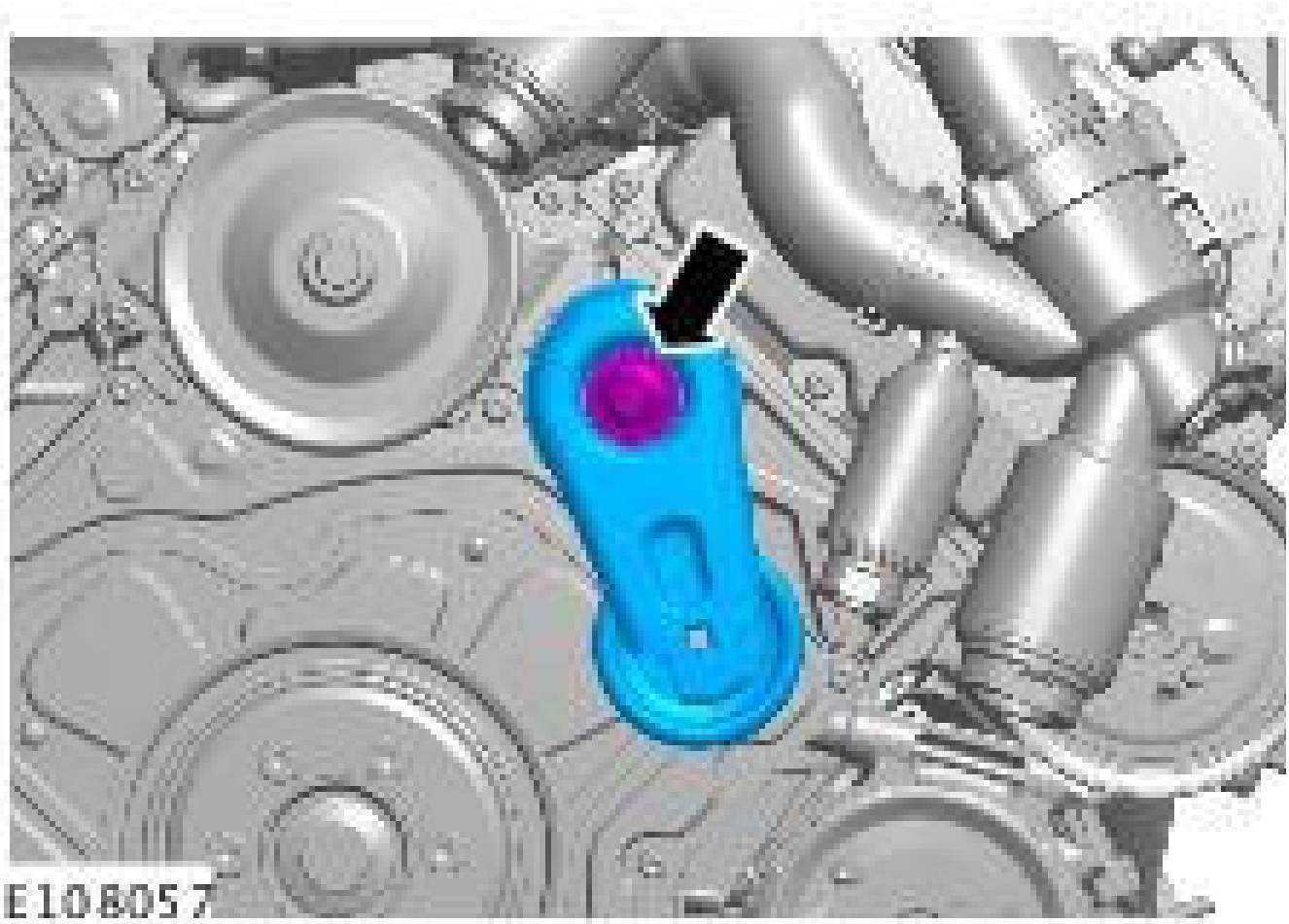

14. See figure

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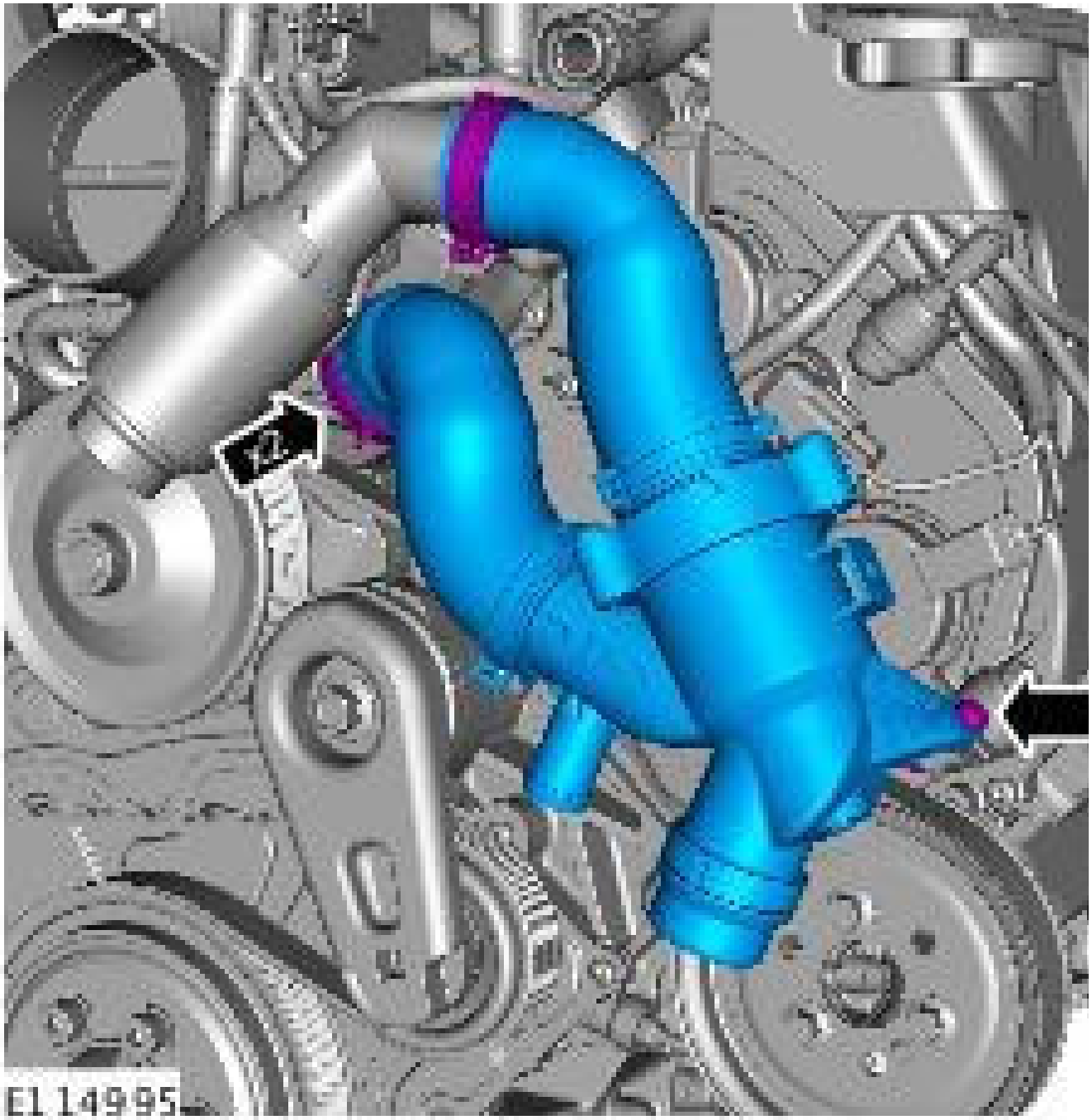

15. See figure

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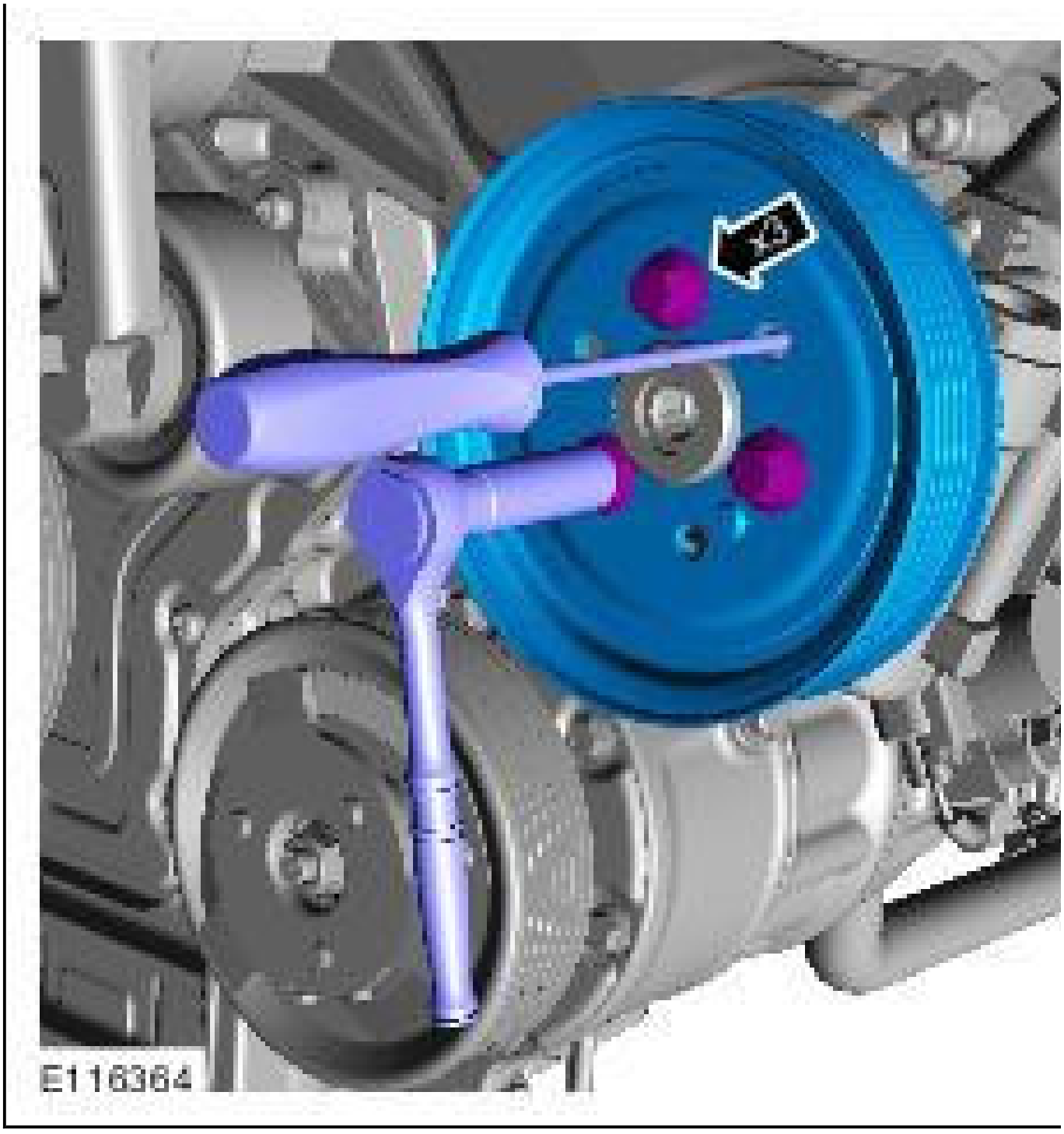

16. See figure

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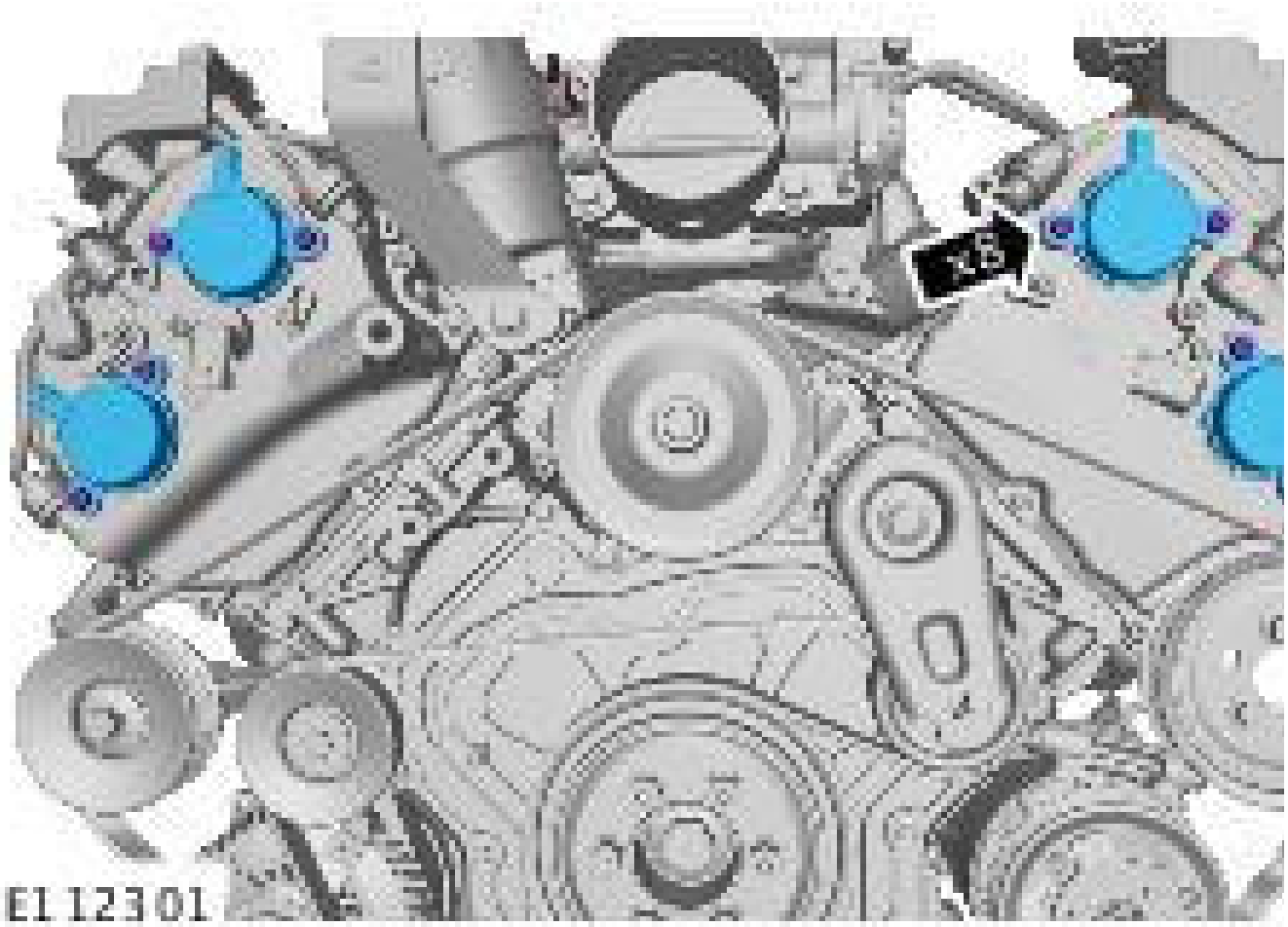

17. See figure

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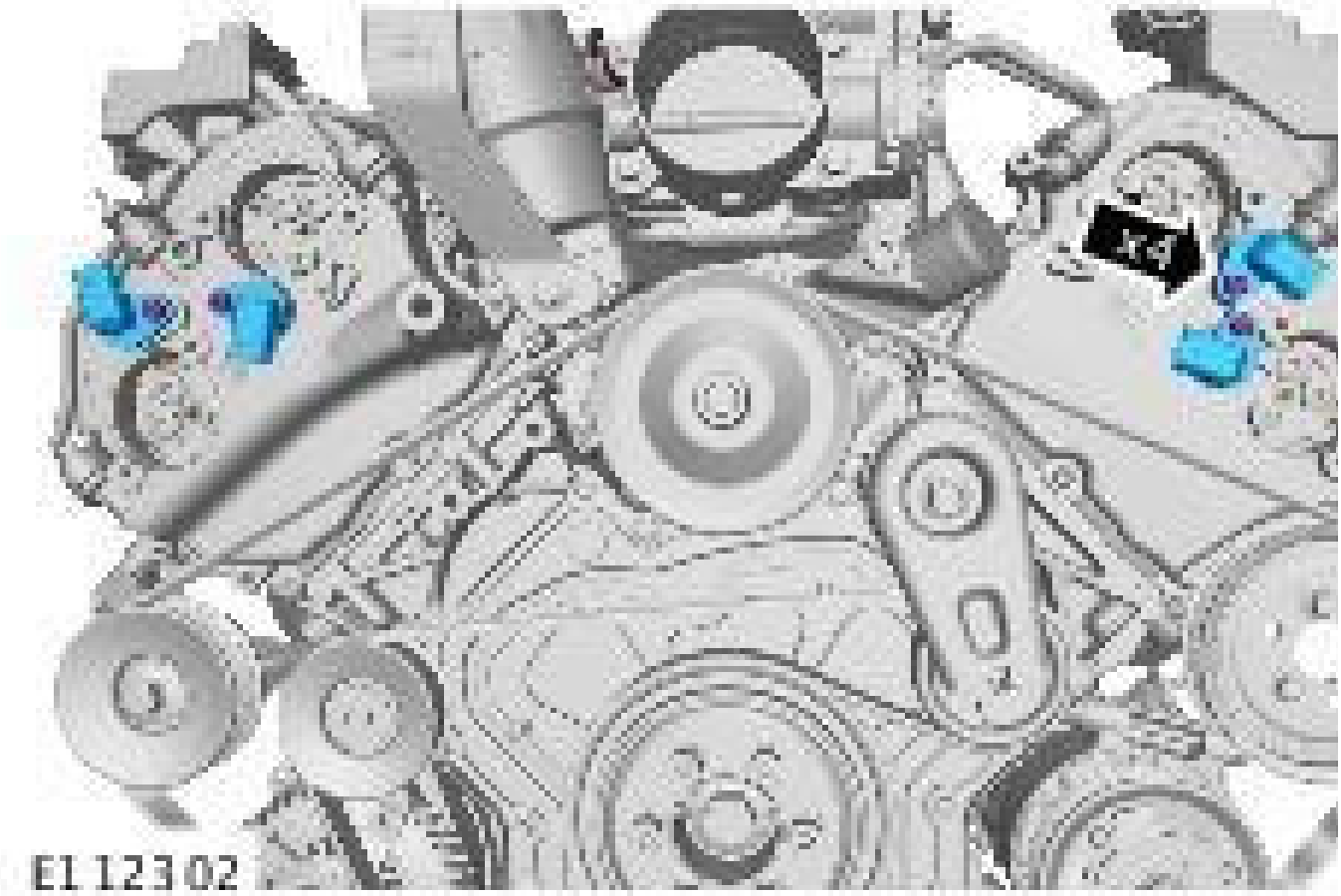

18. See figure

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INSTALLATION

1. See figure

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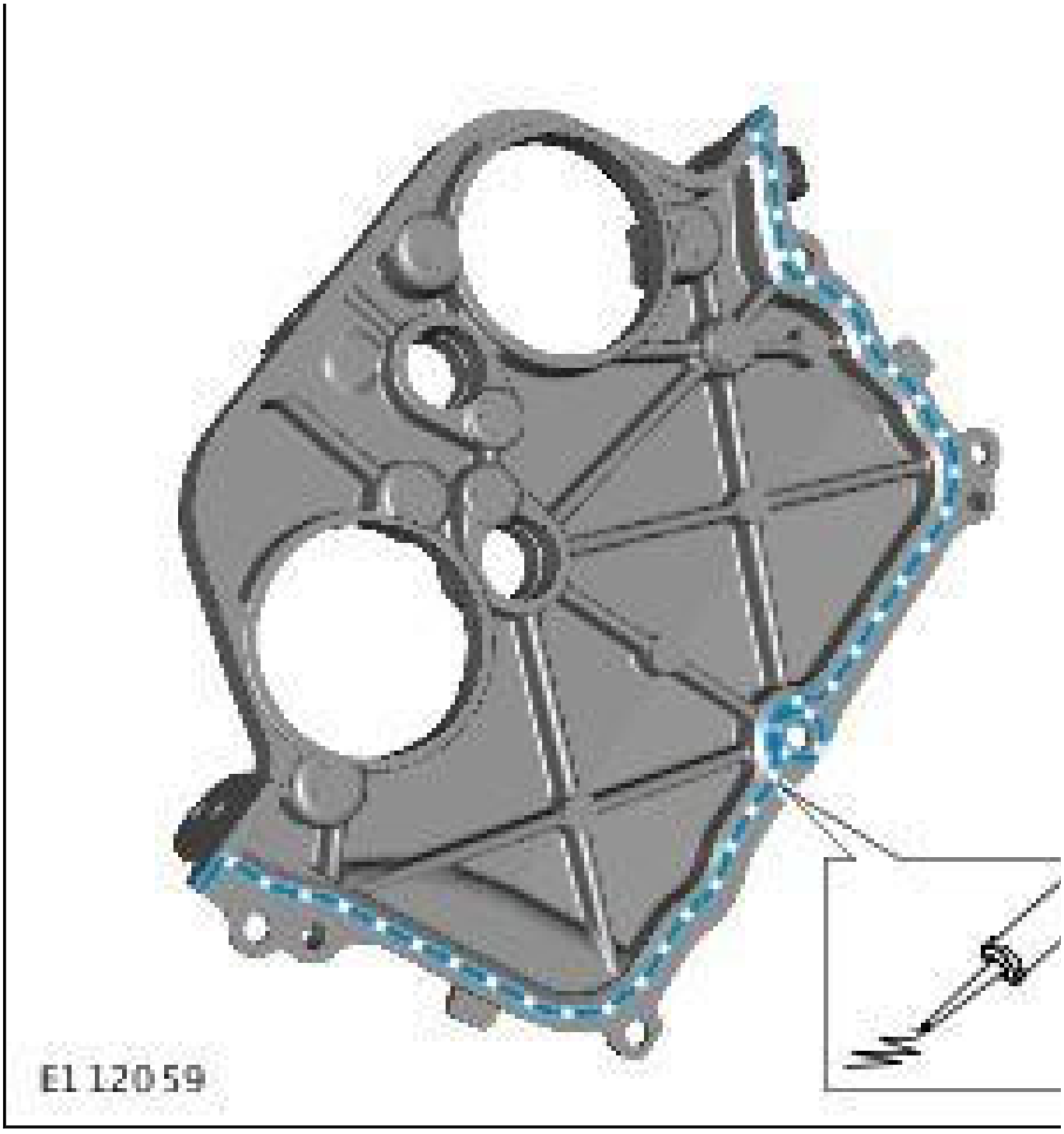

CAUTION: Make sure that the mating faces are clean and free of foreign material.

- Apply RTV sealant WSE-M4G323-A6 (Loctite 5901G) to the areas shown, and tighten the bolts within 7 minutes.

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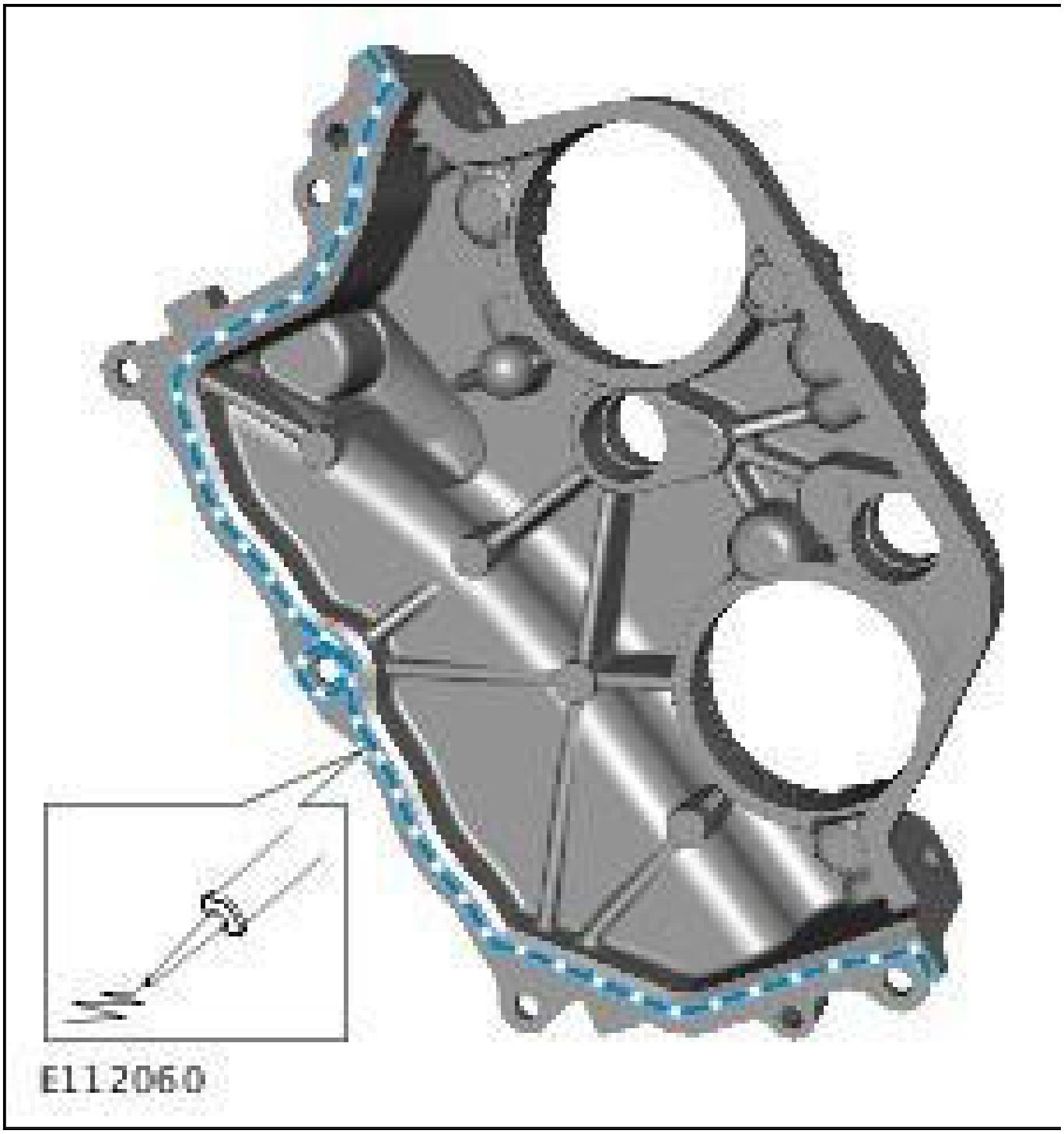
2. See figure



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

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- Apply RTV sealant WSE-M4G323-A6 (Loctite 5901G) to the areas shown, and tighten the bolts within 7 minutes.

3. Torque: 12 Nm

NOTE: Tighten the bolts in the indicated sequence.

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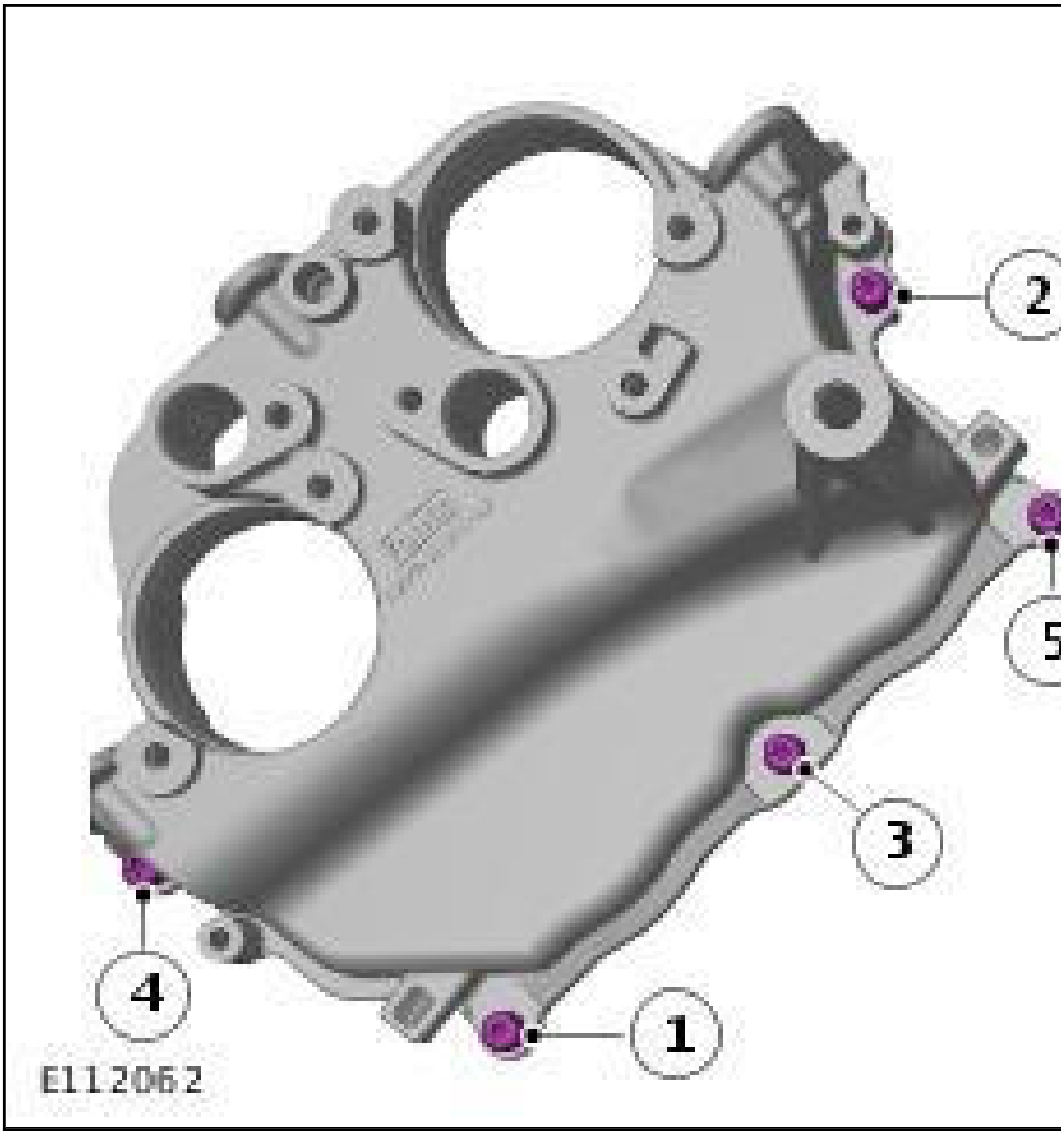
4. Torque: 12 Nm



NOTE: Tighten the bolts in the indicated sequence.

5. Apply RTV sealant WSE-M4G323-A6 (Loctite 5901G) to the areas shown, and tighten the bolts within 7 minutes.

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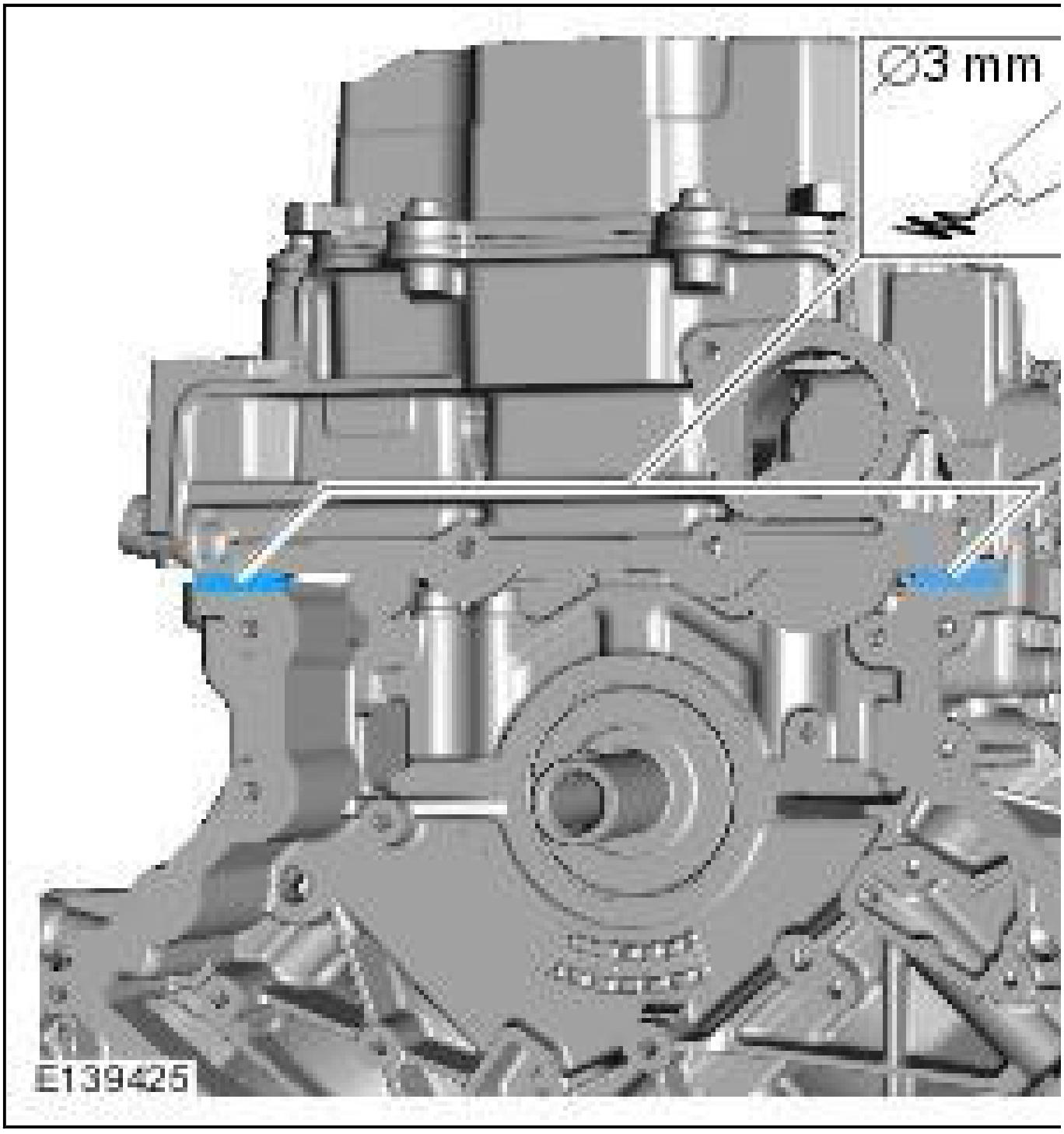

CAUTION: Make sure that the mating faces are clean and free of foreign material.

6. Install the bolts, but do not tighten fully at this stage.

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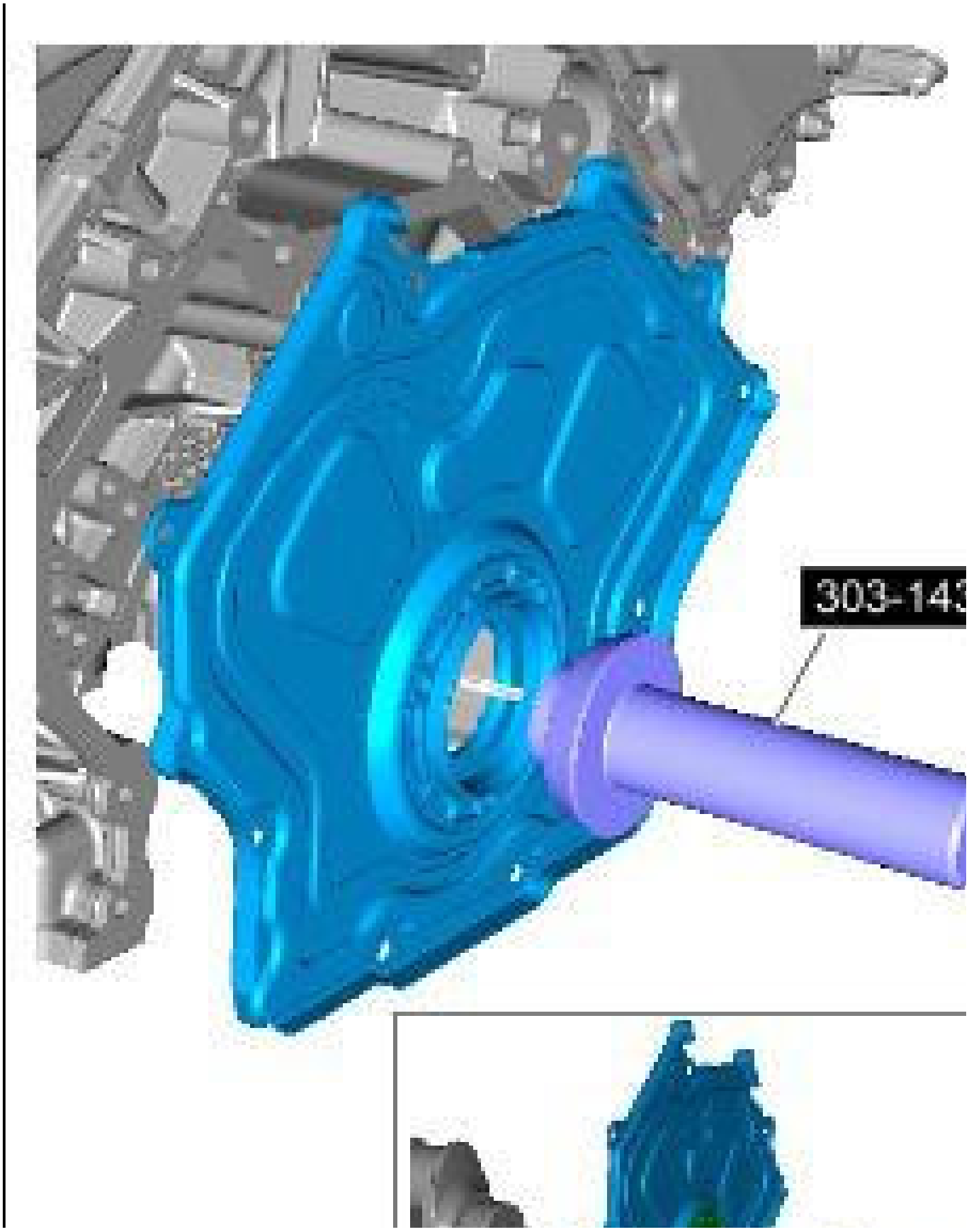

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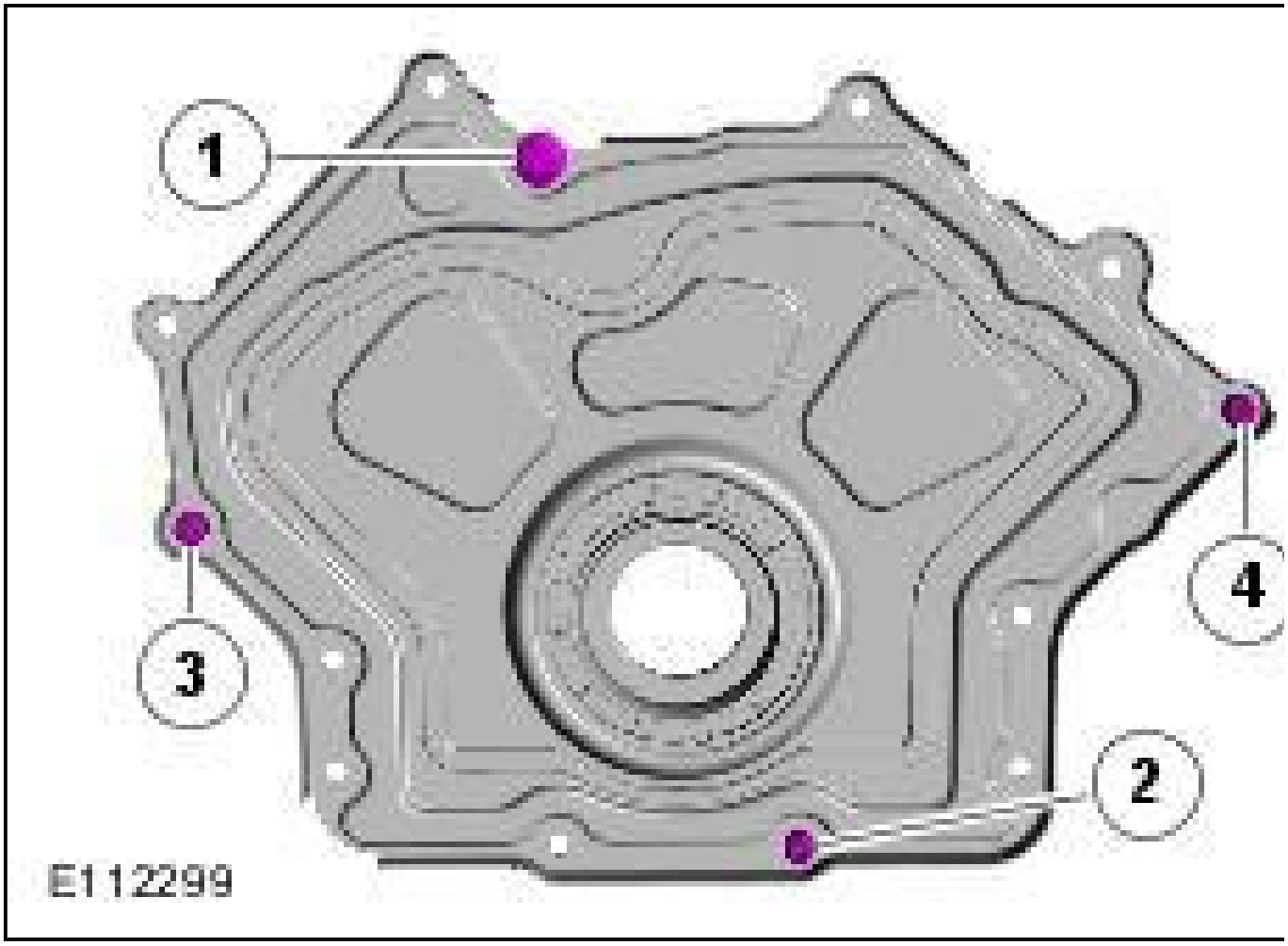
CAUTION: Make sure that the mating faces are clean and free of foreign material.

Lower Timing Cover Alignment tool (303-1433), refer to **SPECIAL TOOL(S)**

7. Torques:

   M6: 12 Nm

   M8: 20 Nm



8. Torque: 12 Nm

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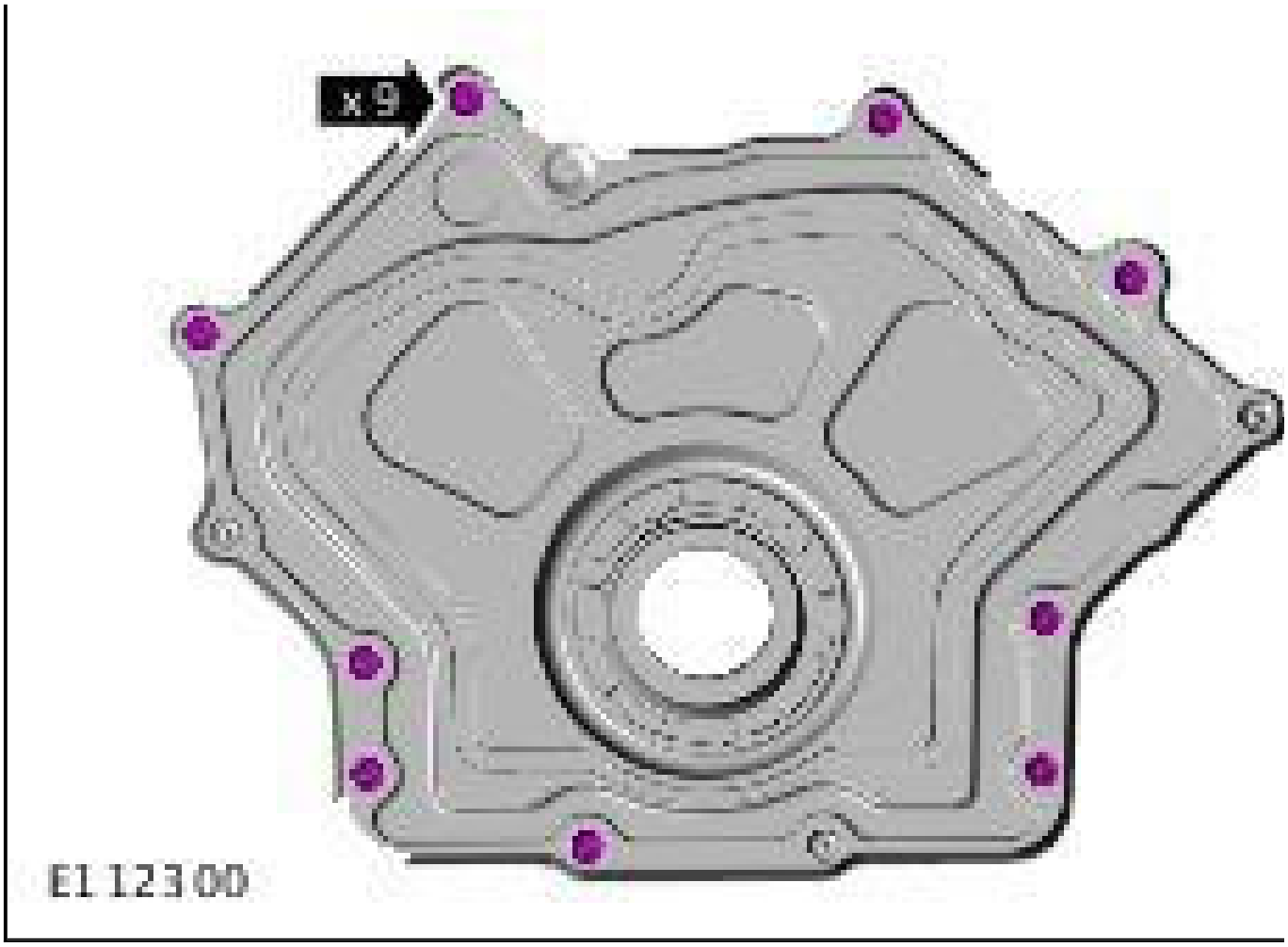

9. Torque: 12 Nm

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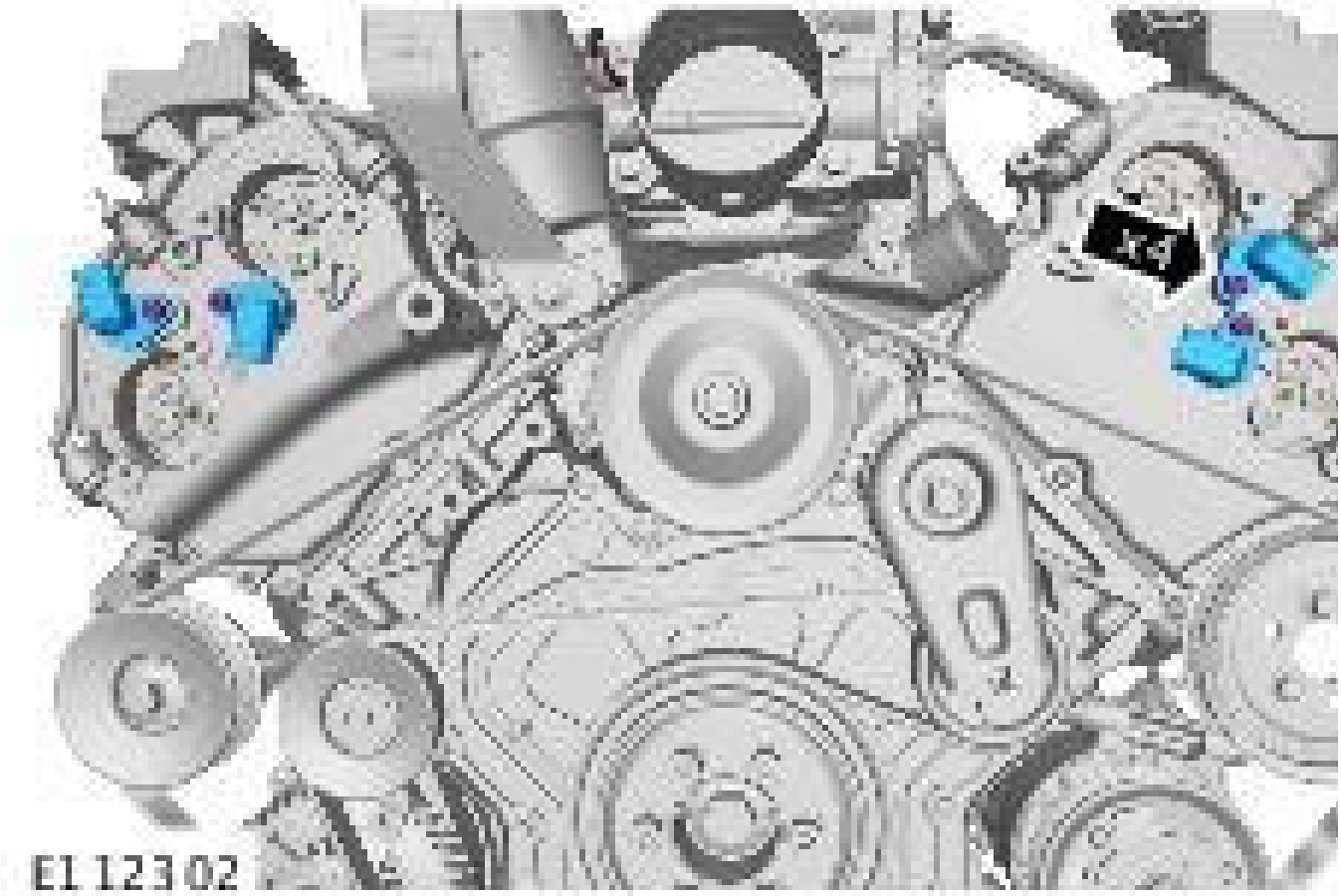

10. Torque: 25 Nm

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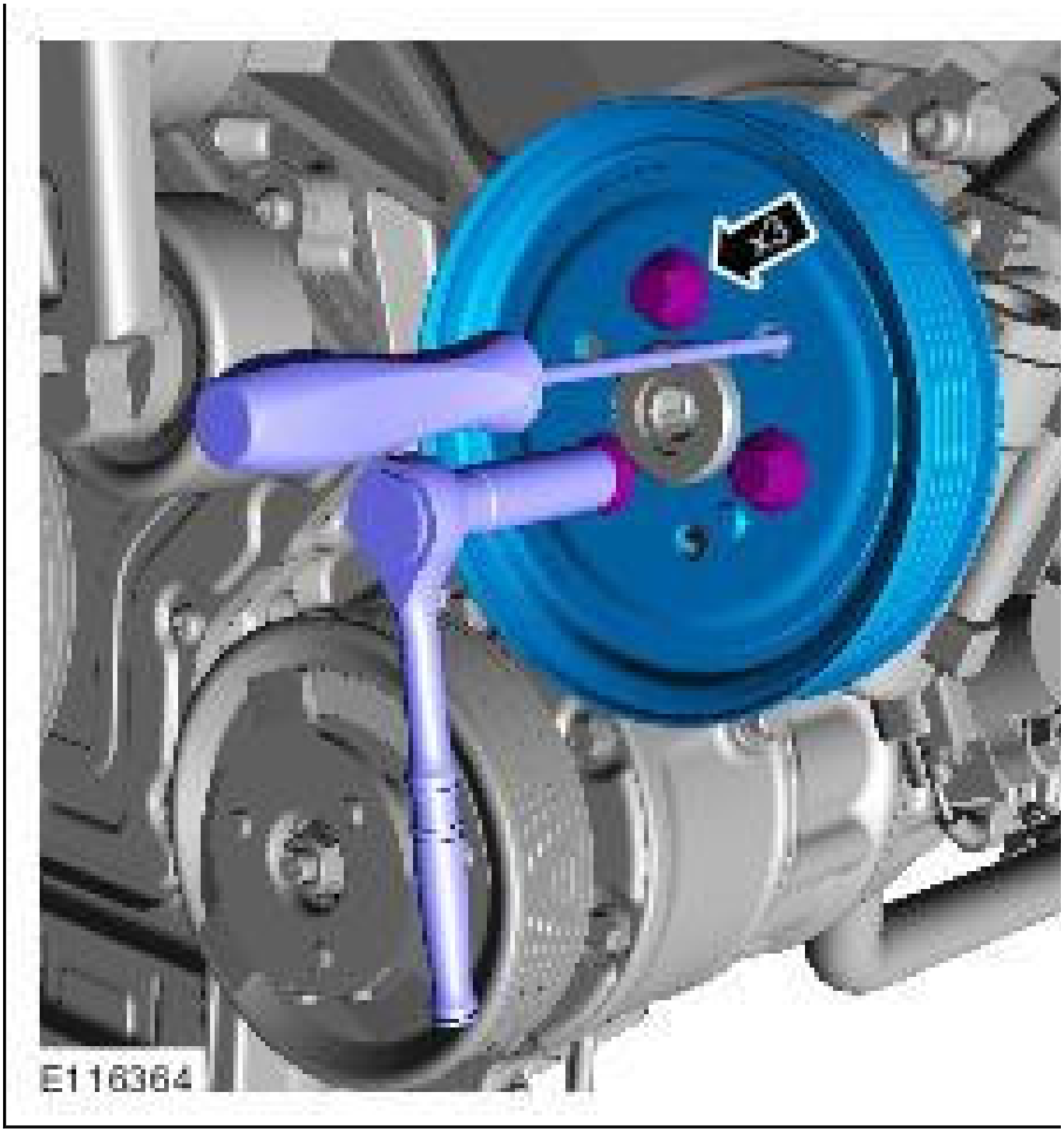

11. Torque: 12 Nm

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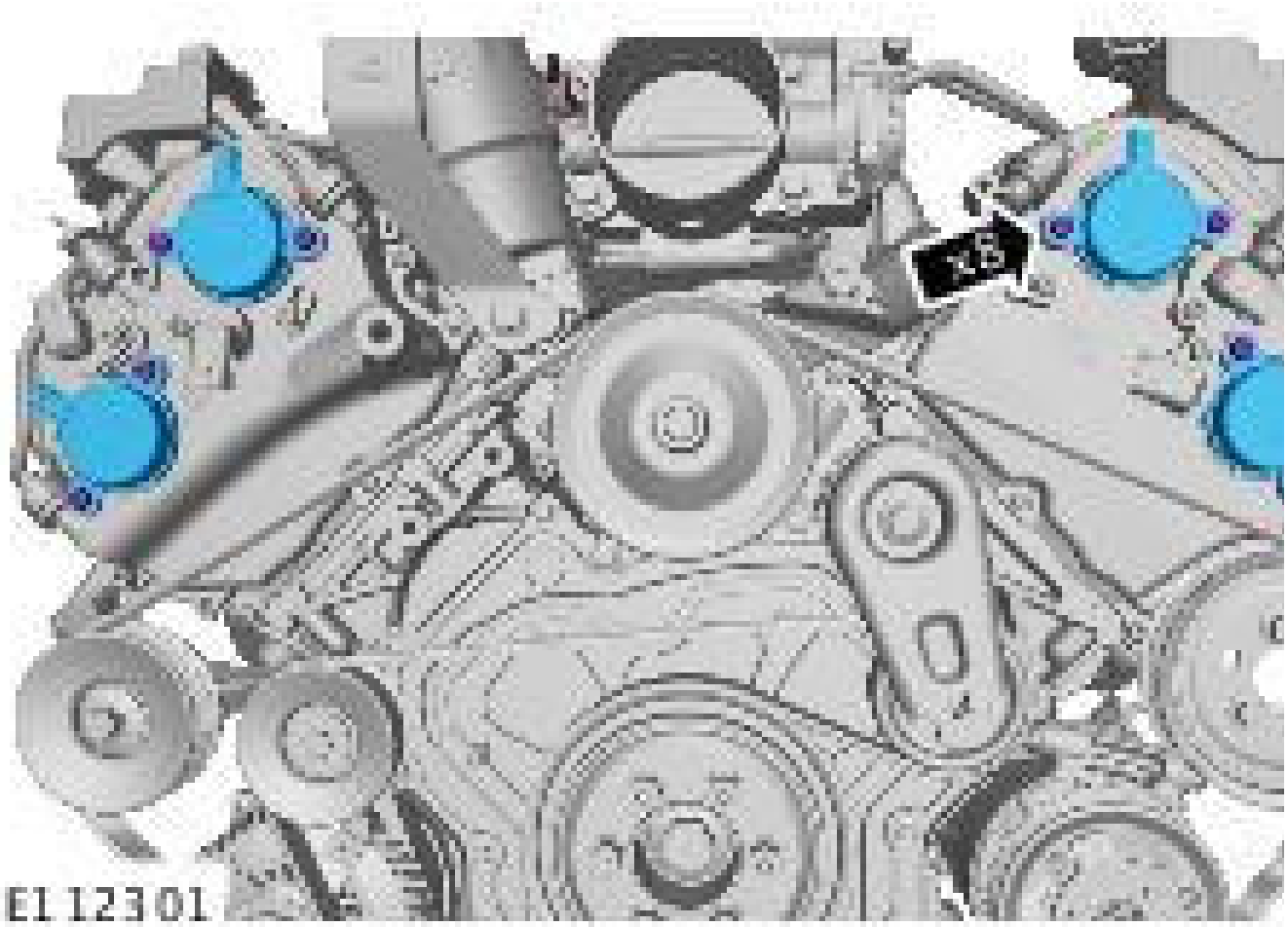

12. Torque: 40 Nm

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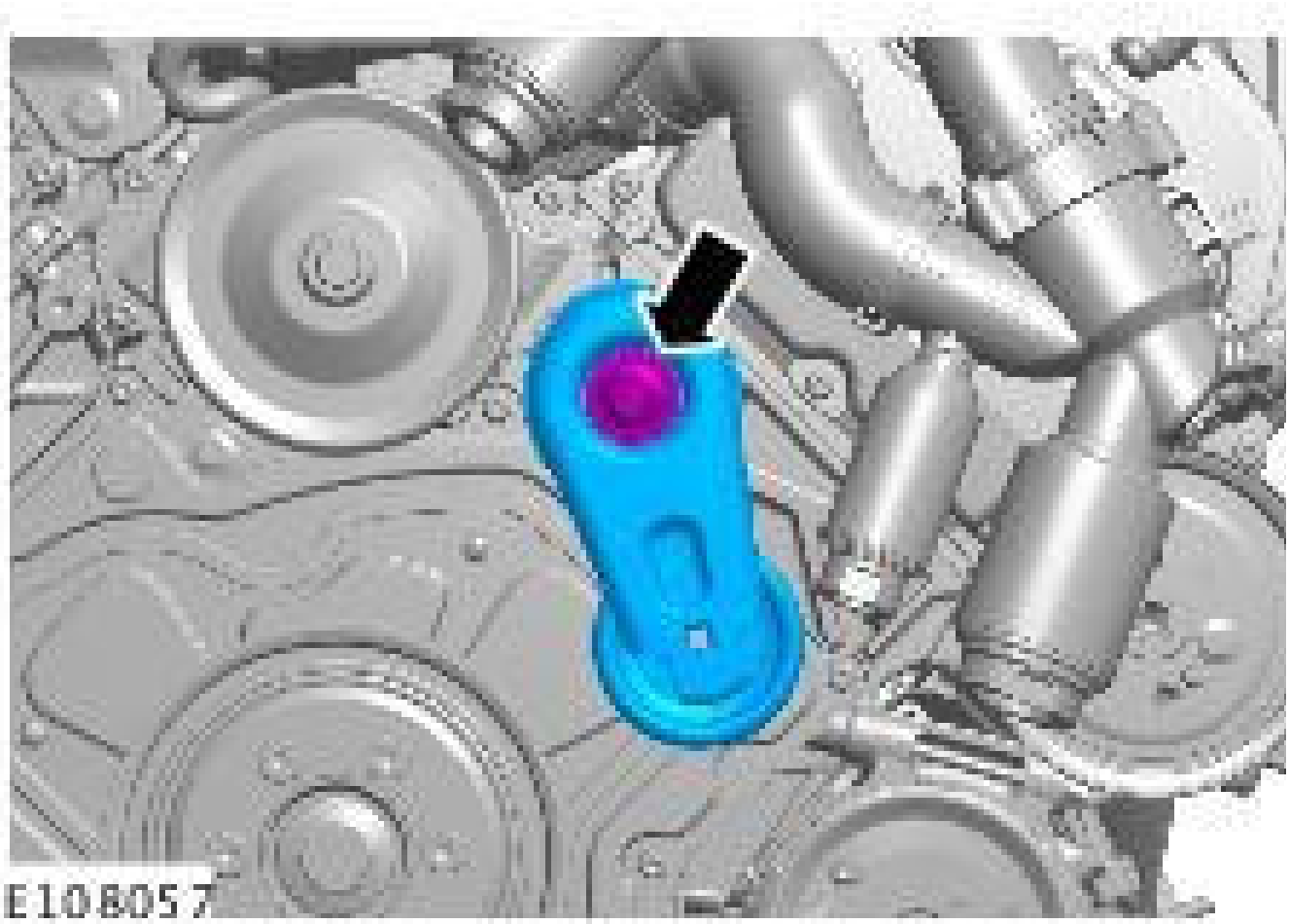

NOTE: Install the bolt finger tight before final tightening.

13. See figure

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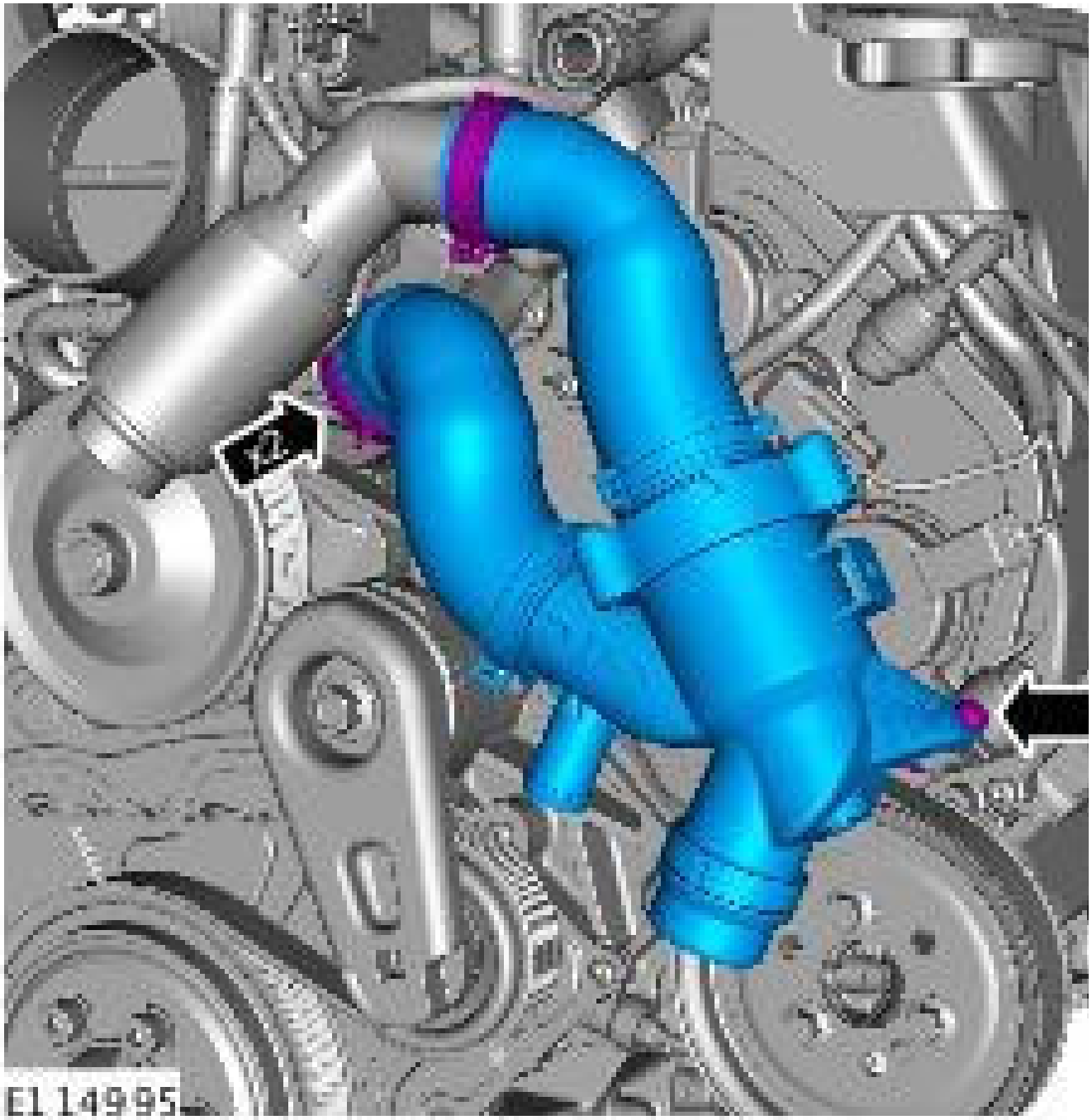

14. Torque: 25 Nm

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15. Torque: 25 Nm

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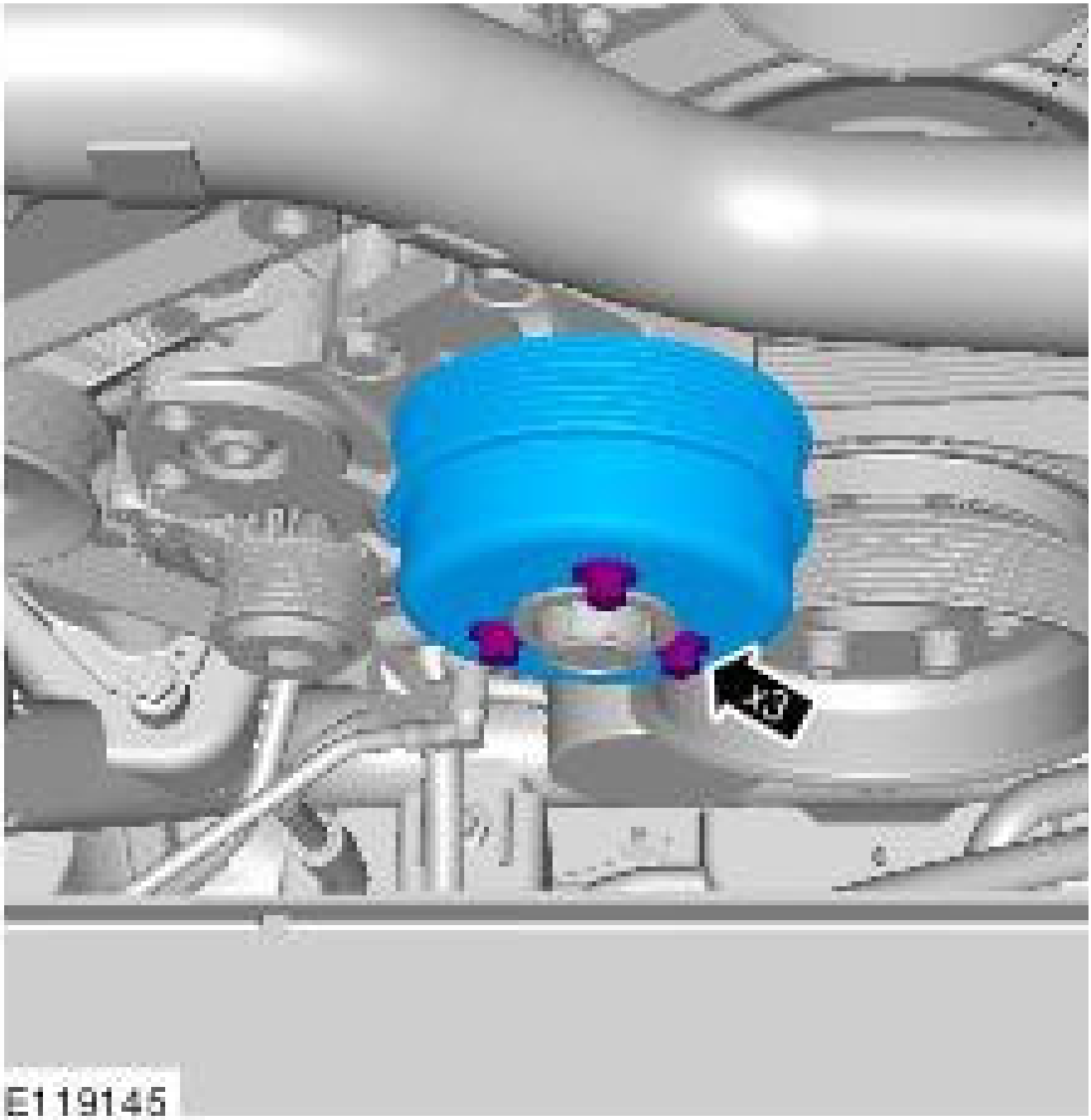

16. See figure

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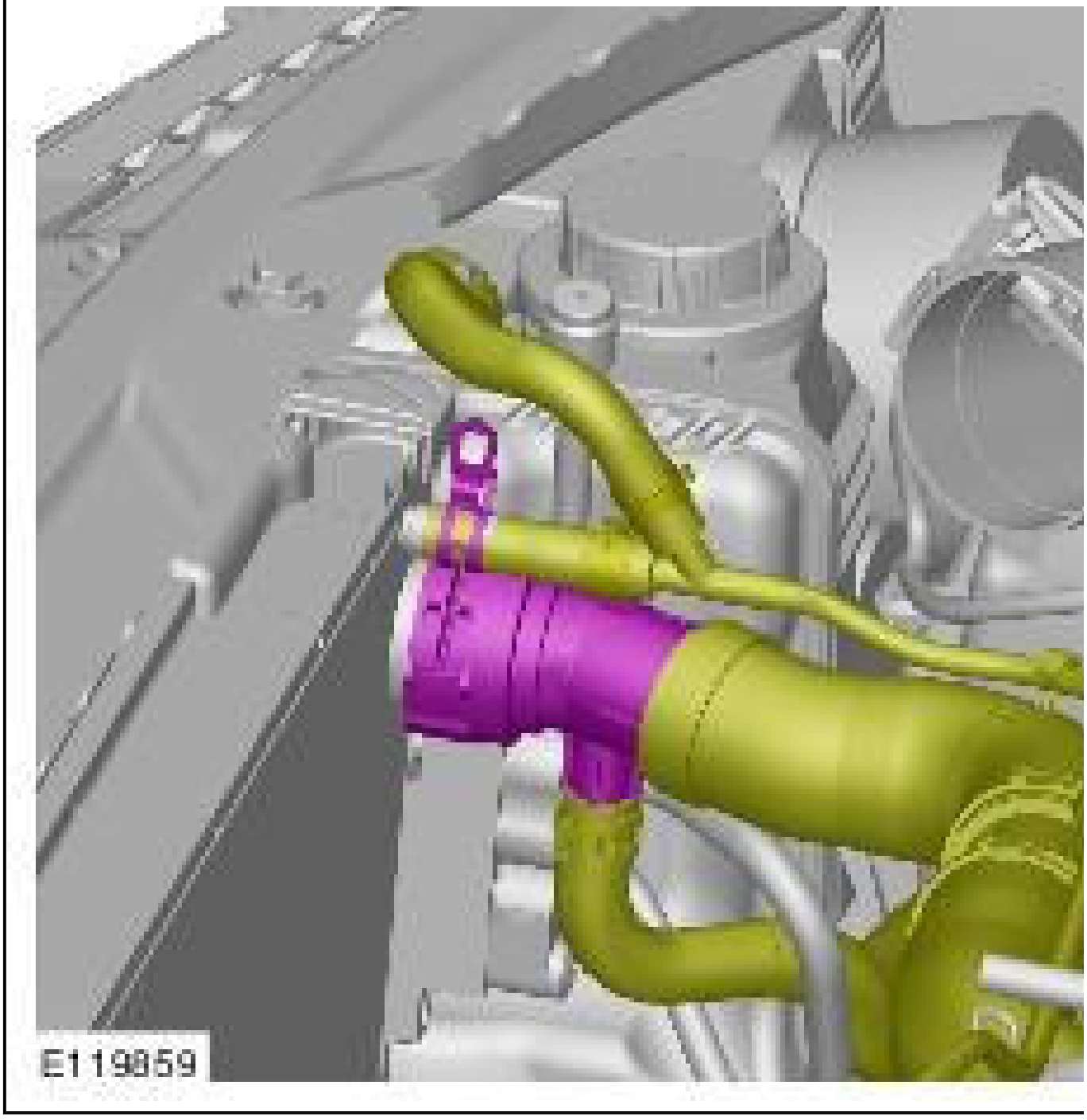

17. See figure

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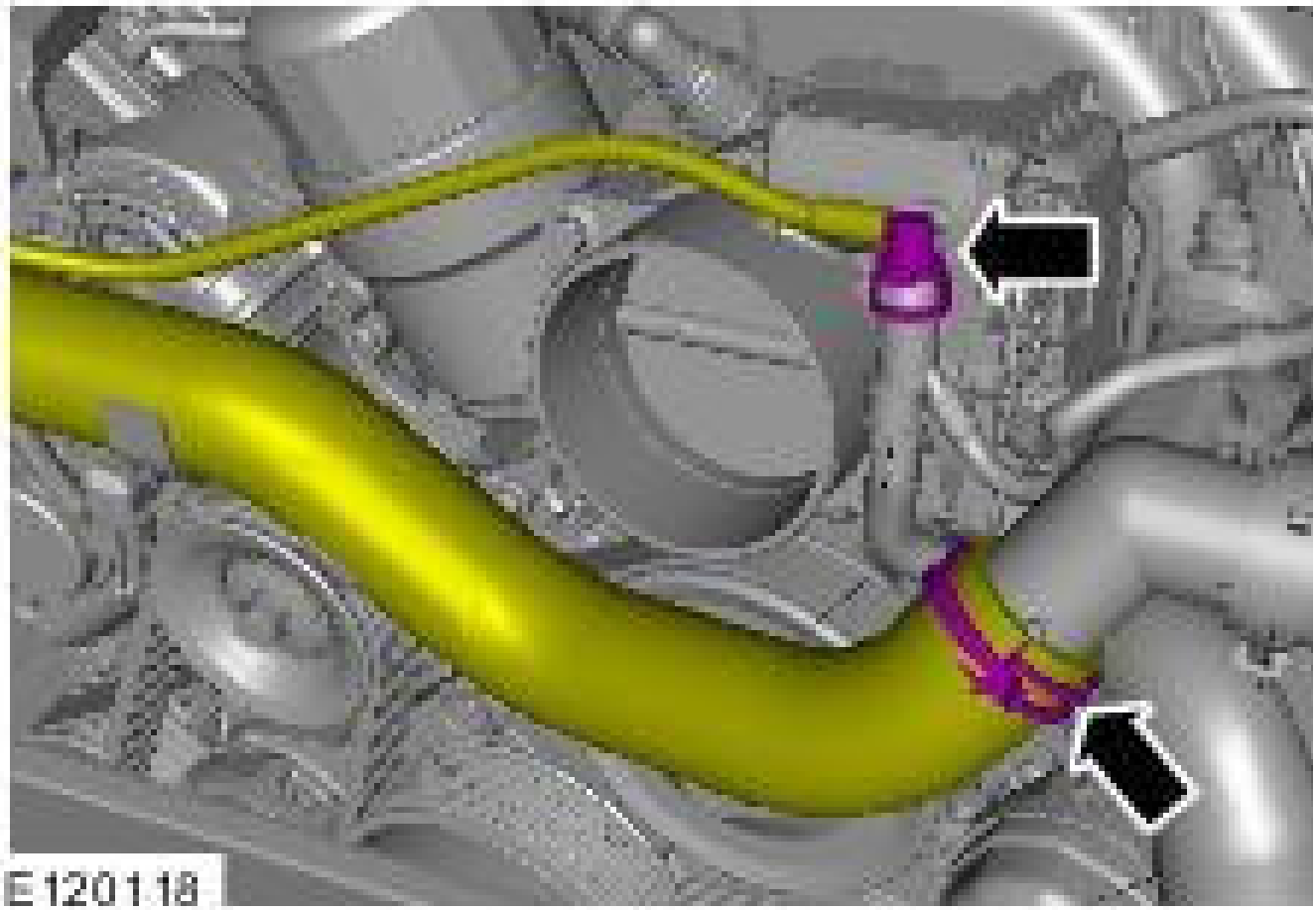

18. See figure

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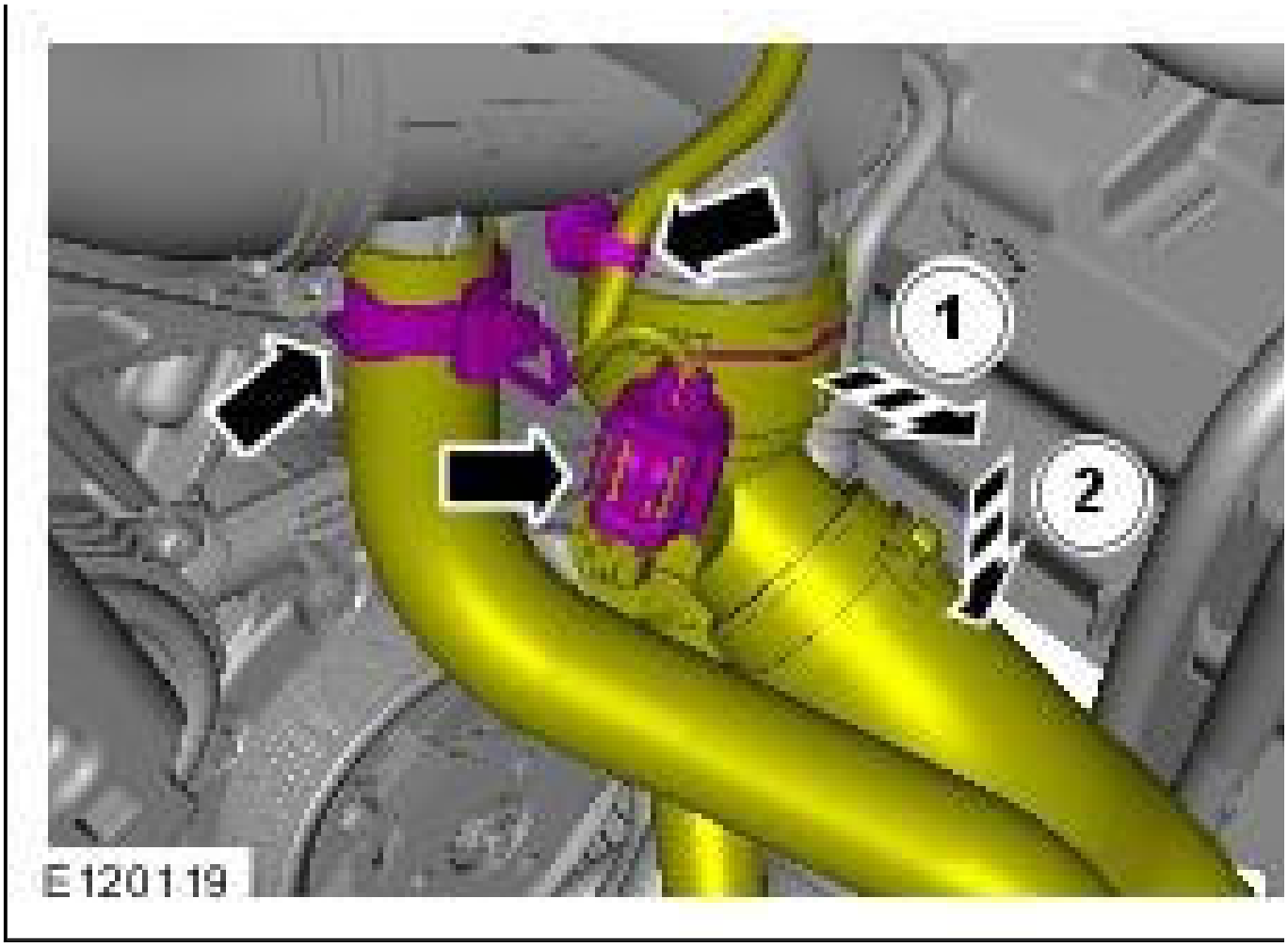

19. Torque: 12 Nm

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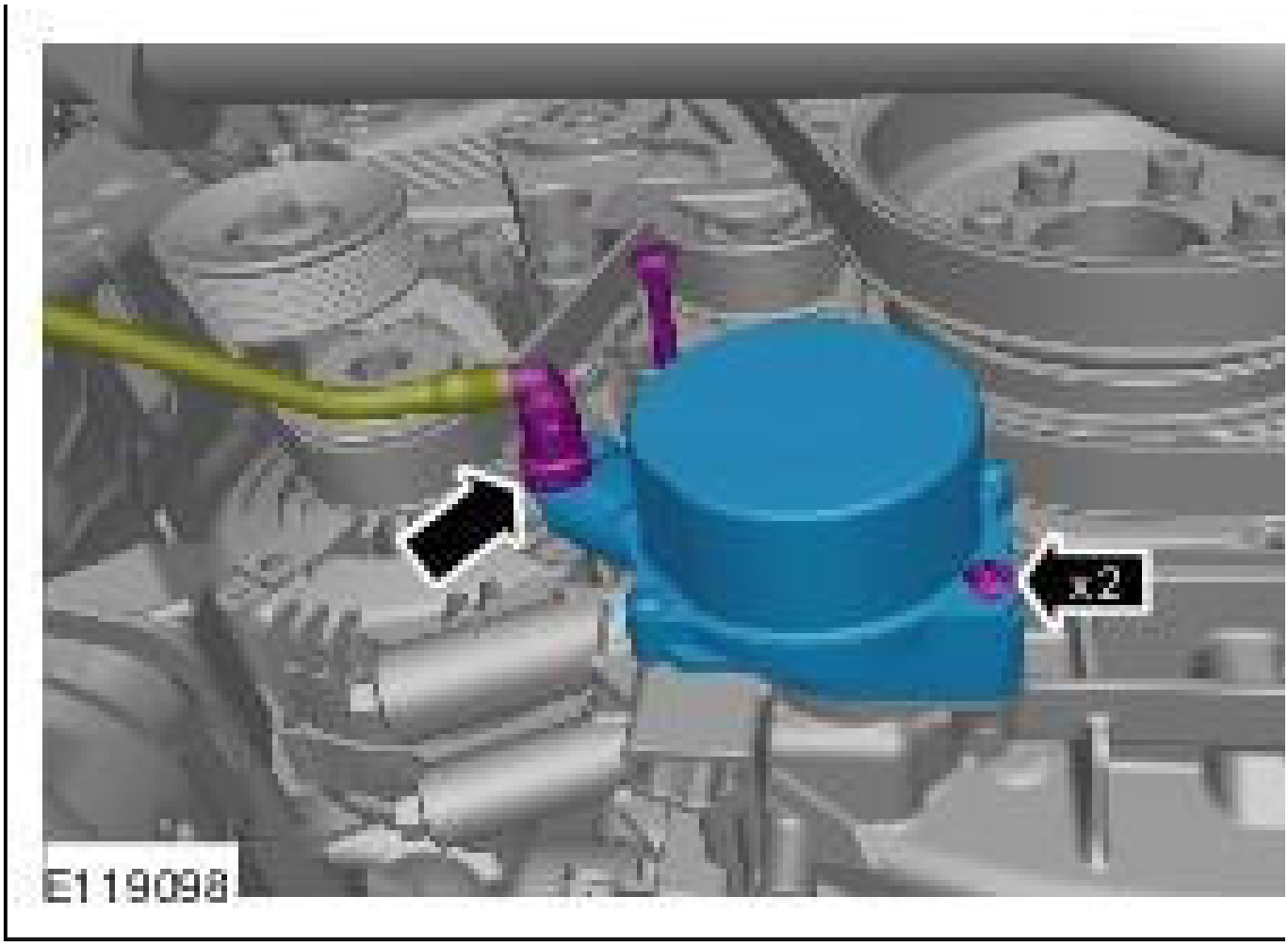

NOTE: Install a new seal.

20. See **Crankshaft Pulley**.
21. See **Valve Cover LH**.
22. See **Valve Cover RH**.
23. Cooling System Draining, Filling and Bleeding - V8 5.0L Petrol. Refer to **Engine Cooling (V8 5.0L Petrol/V8 S/C 5.0L Petrol)**
24. Connect the battery ground cable. Refer to **Specifications** .
25. Check and top up the engine oil.

TIMING DRIVE COMPONENTS

SPECIAL TOOL(S)

	303-1445 Timing Tool - Camshaft Alignment

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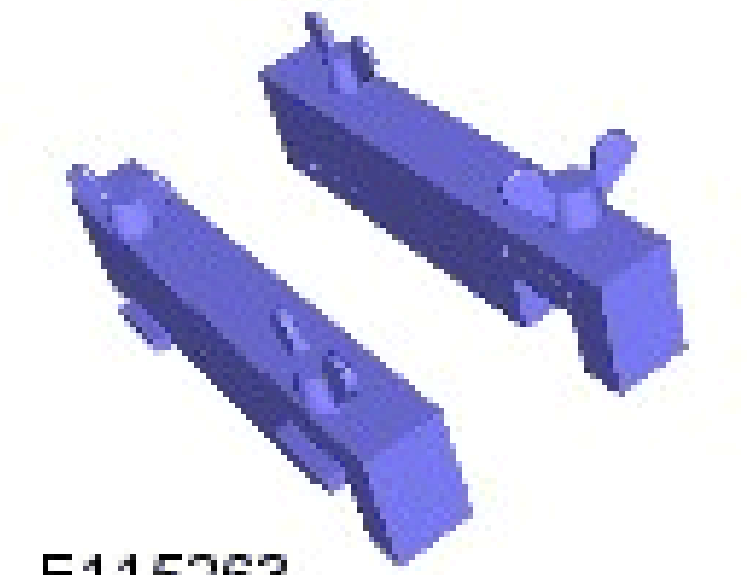 E115263	
E115265	303-1447 Timing Tool
	303-1448 Locking Tool

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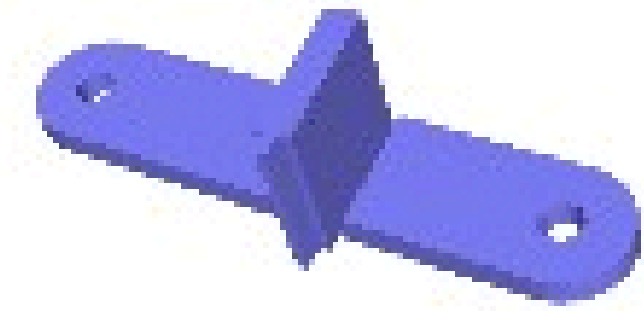 E115266	
E115270	303-1452 Camshaft Rotating Tool
	303-1482 Tensioner Tool

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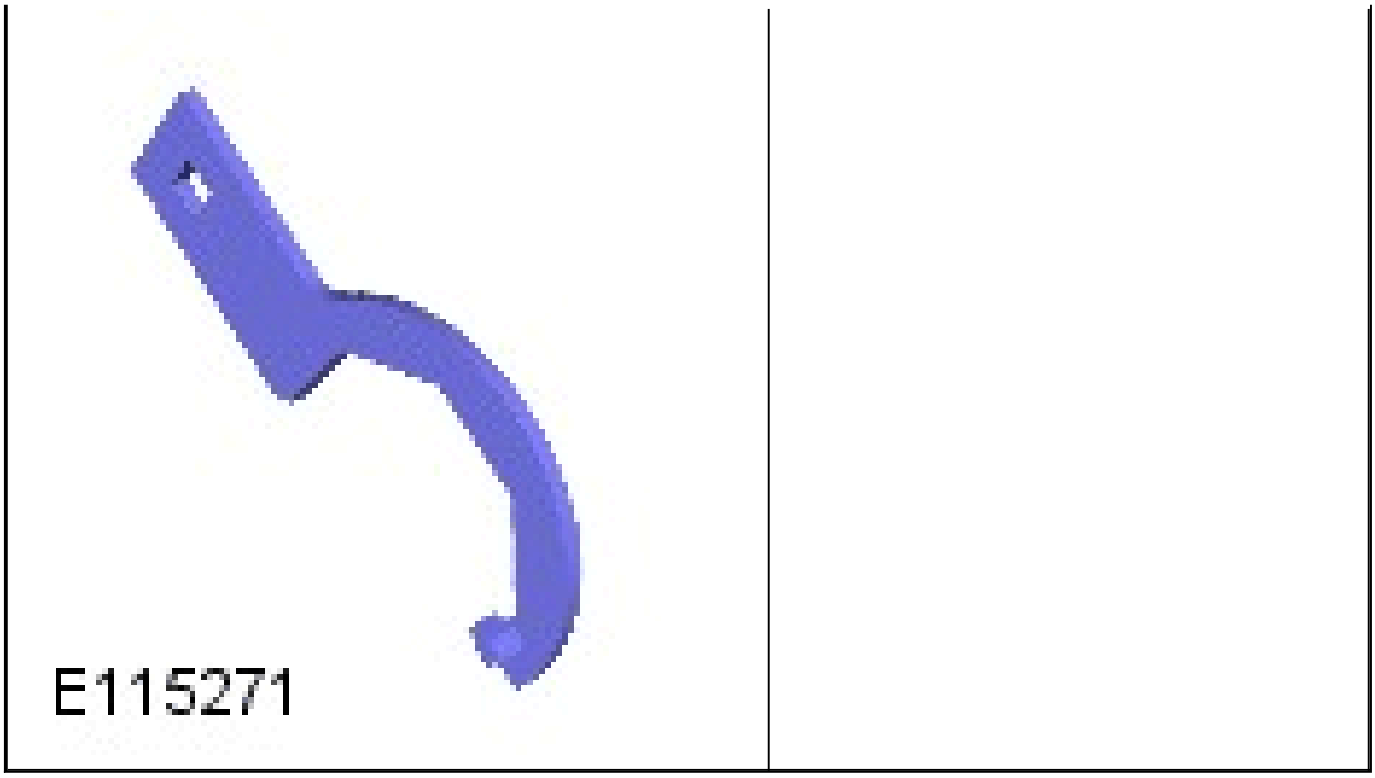

REMOVAL

CAUTION: Check all timing components for wear and install new components if required.

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.

1. 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. Refer to **Timing Cover** .
4. See figure

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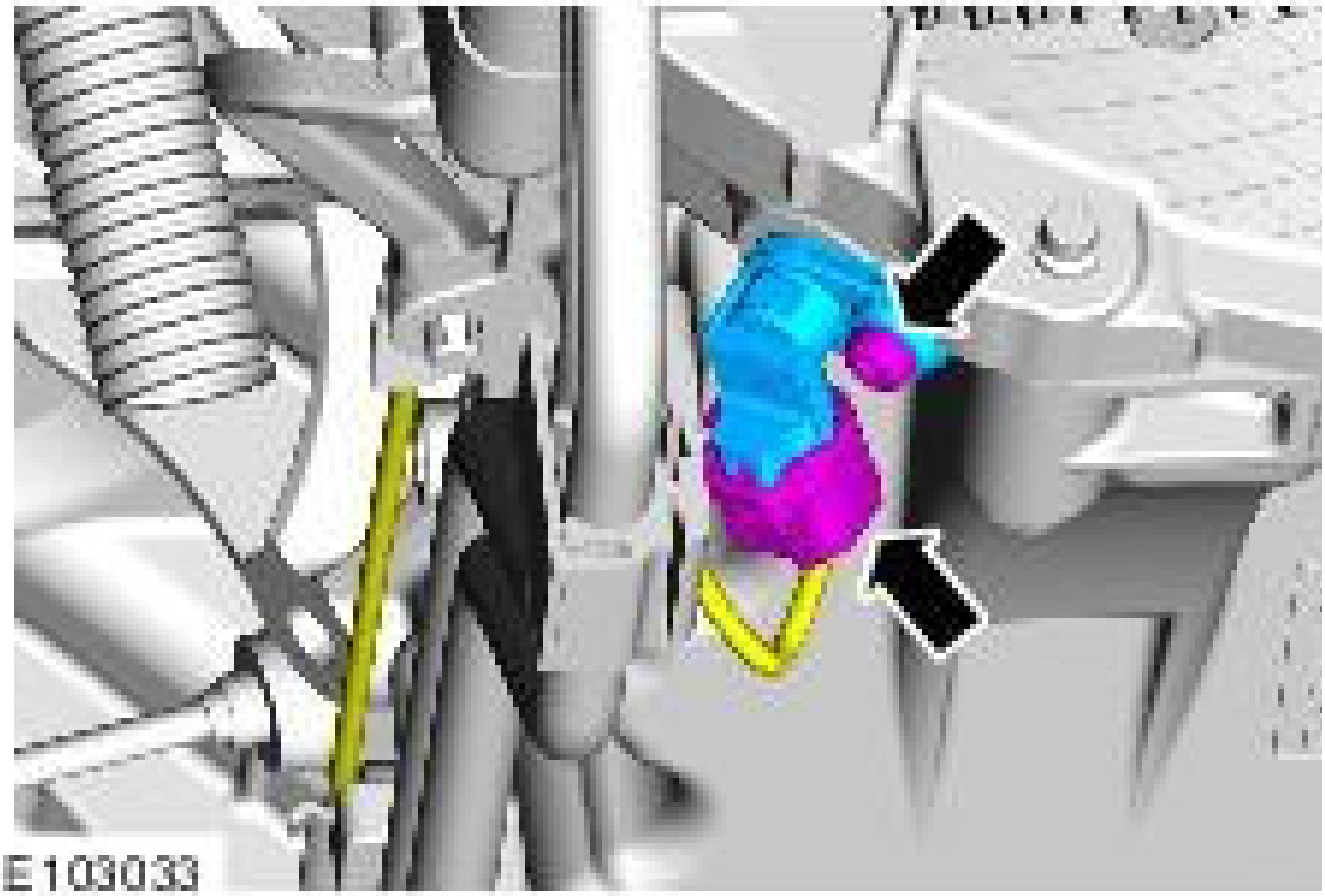

5. Install the special tool.

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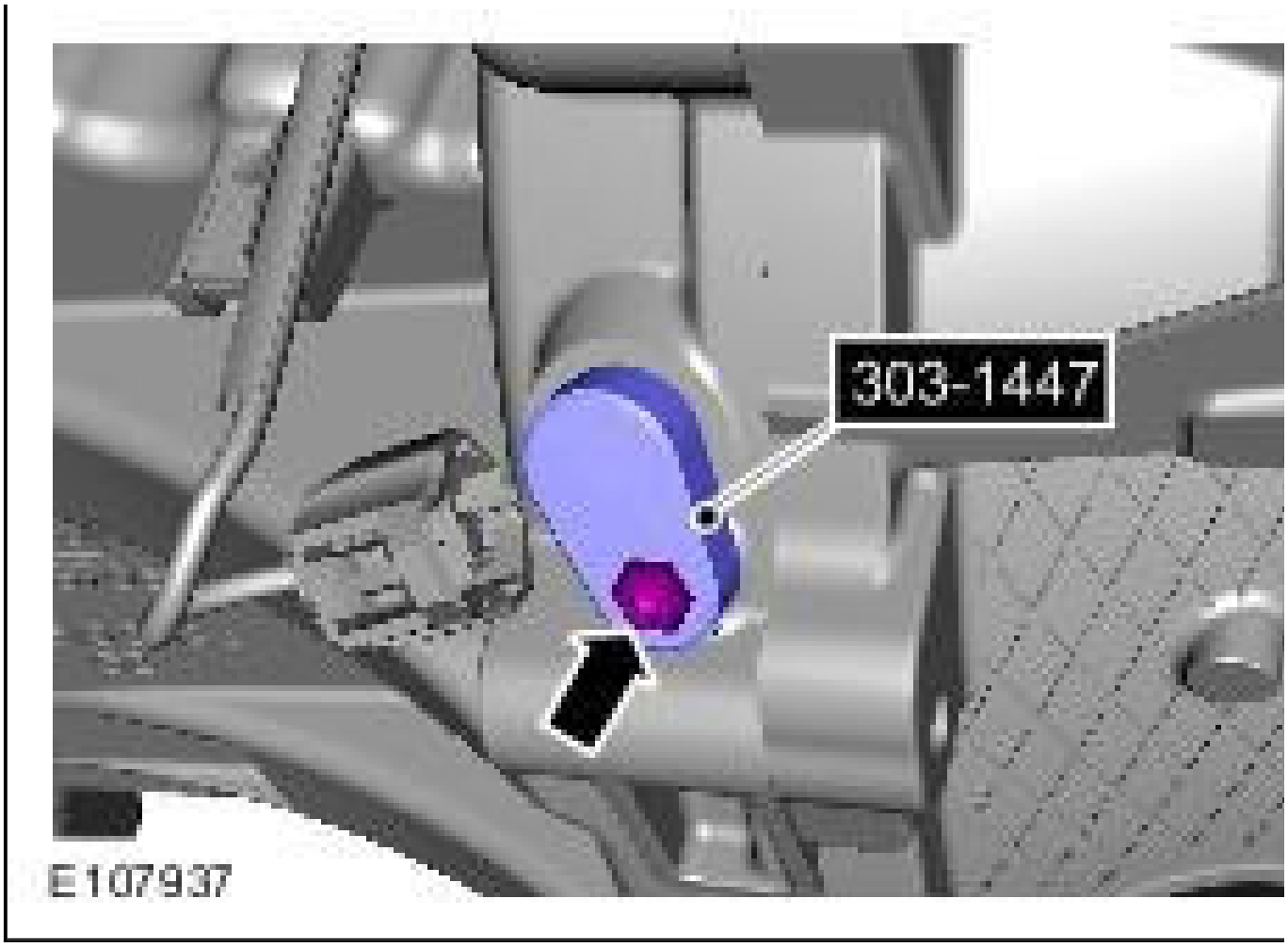

CAUTION: Only rotate the crankshaft clockwise.

Timing Tool (303-1447), refer to **SPECIAL TOOL(S)**

6. Note the position of the crankshaft woodruff key.

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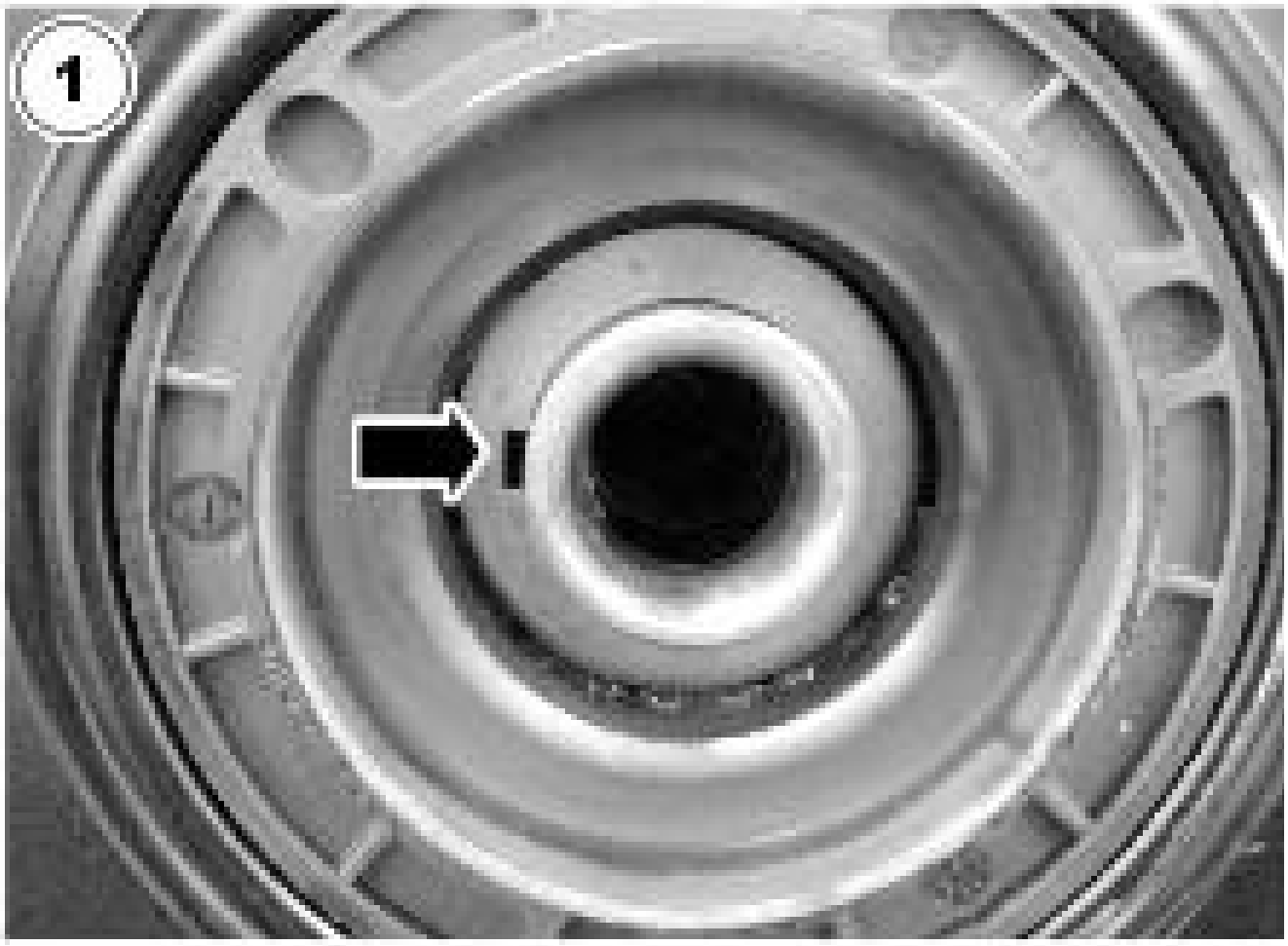

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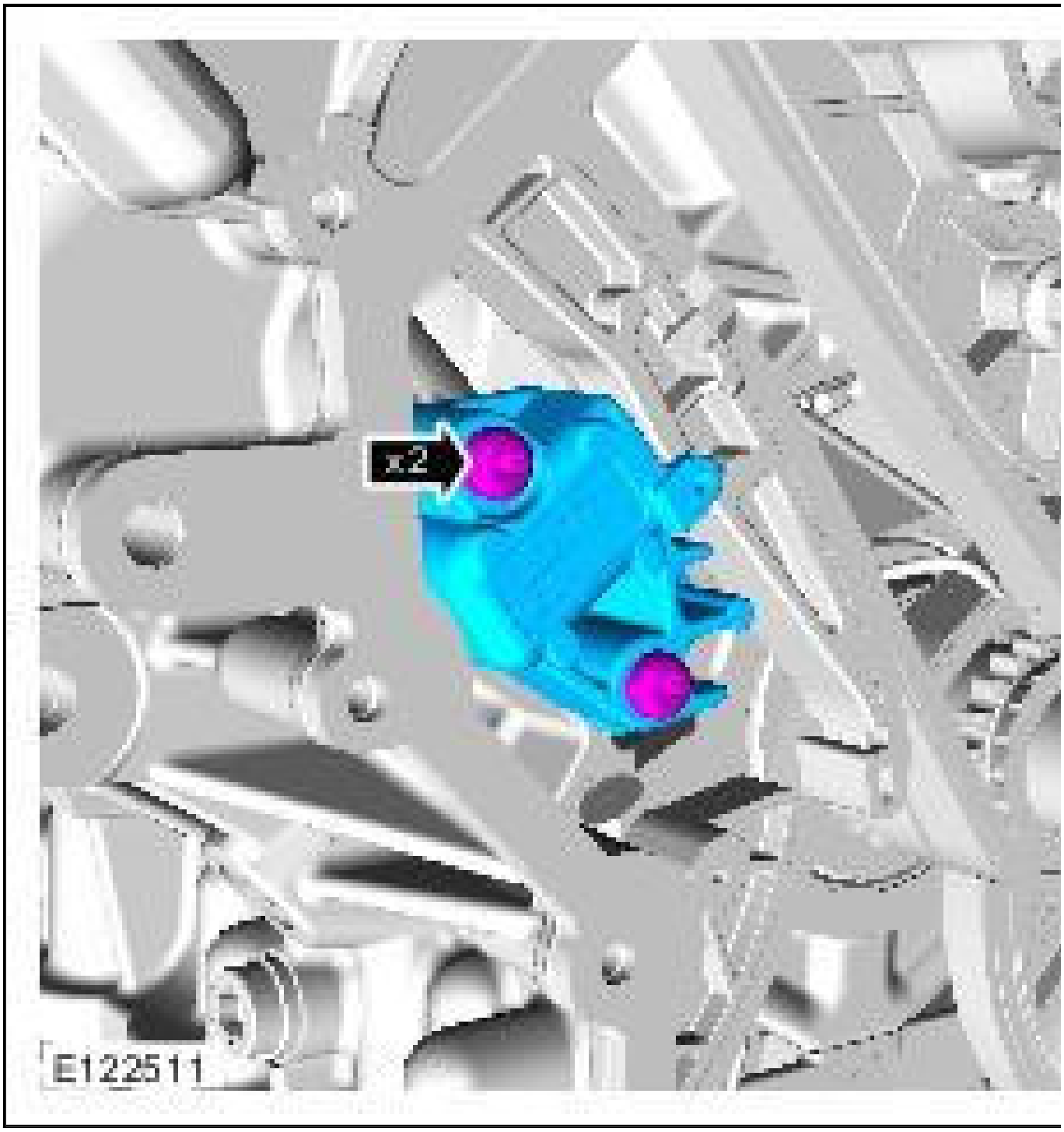
CAUTION: If the noted position of the woodruff key is at the 9 o'clock position, then a new flexplate must be installed. If the woodruff key is in the 6 o'clock position then proceed with the next step.

7. See figure



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8. See figure

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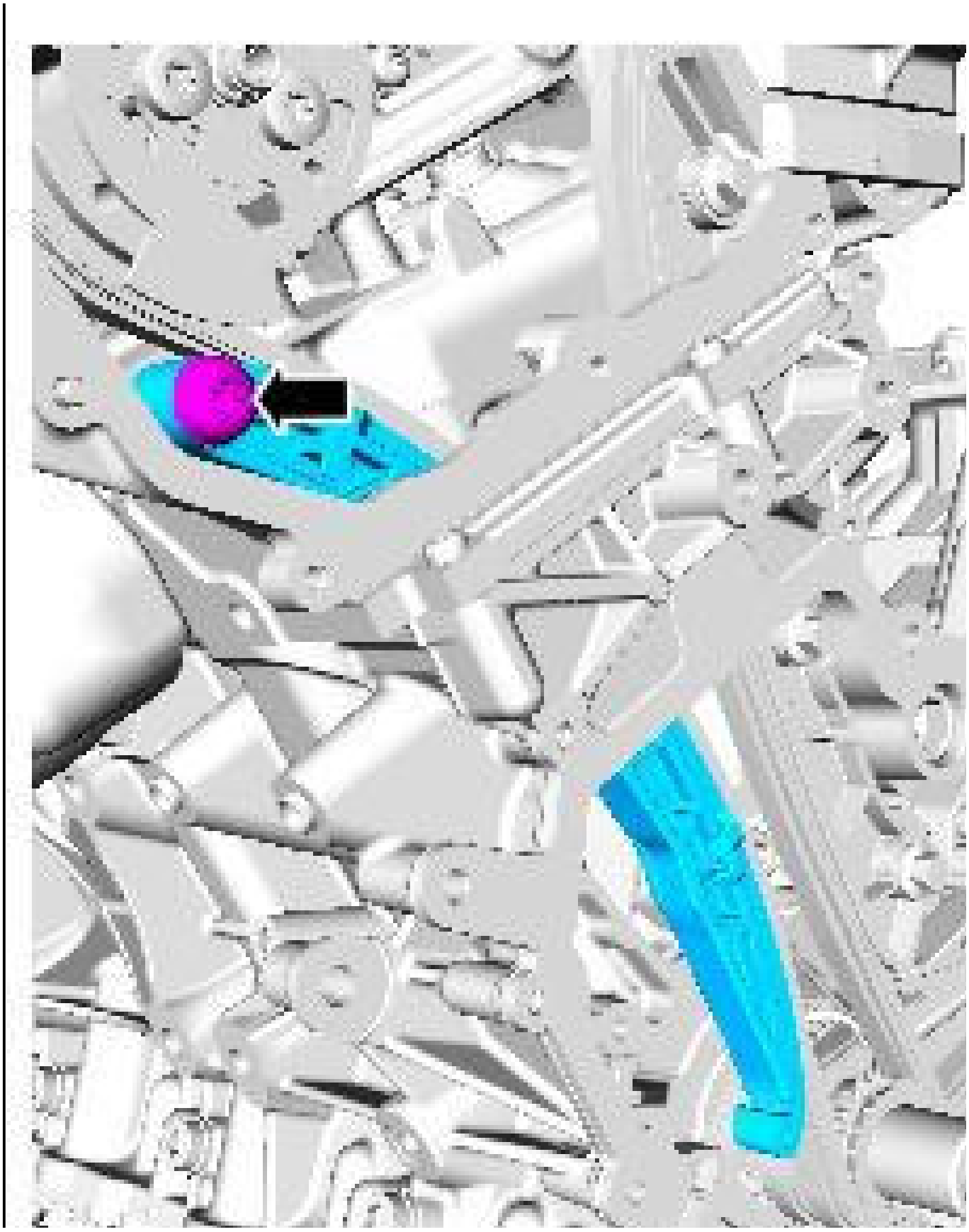

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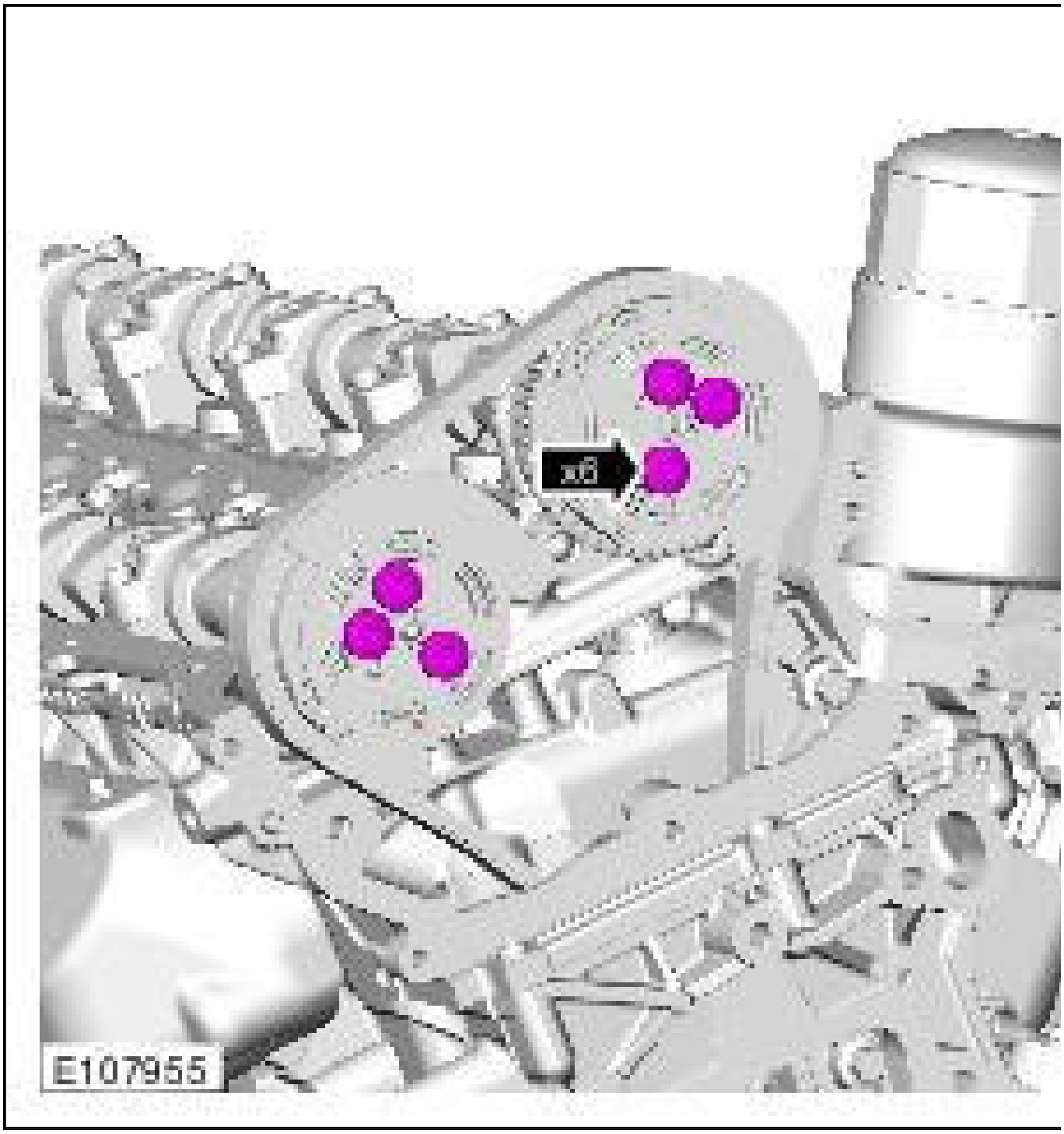
9. See figure



10. Remove the timing chain with the VVT units.

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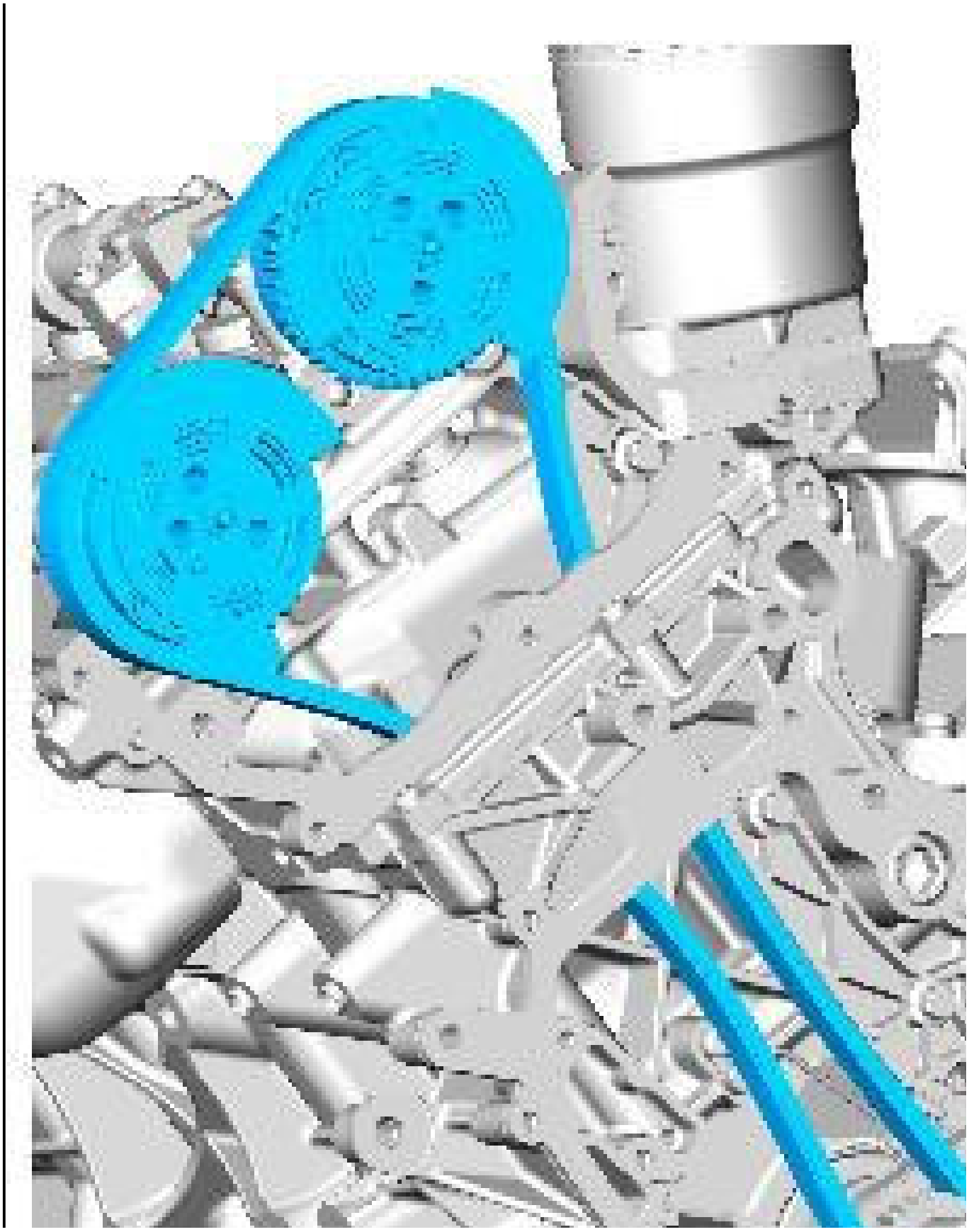

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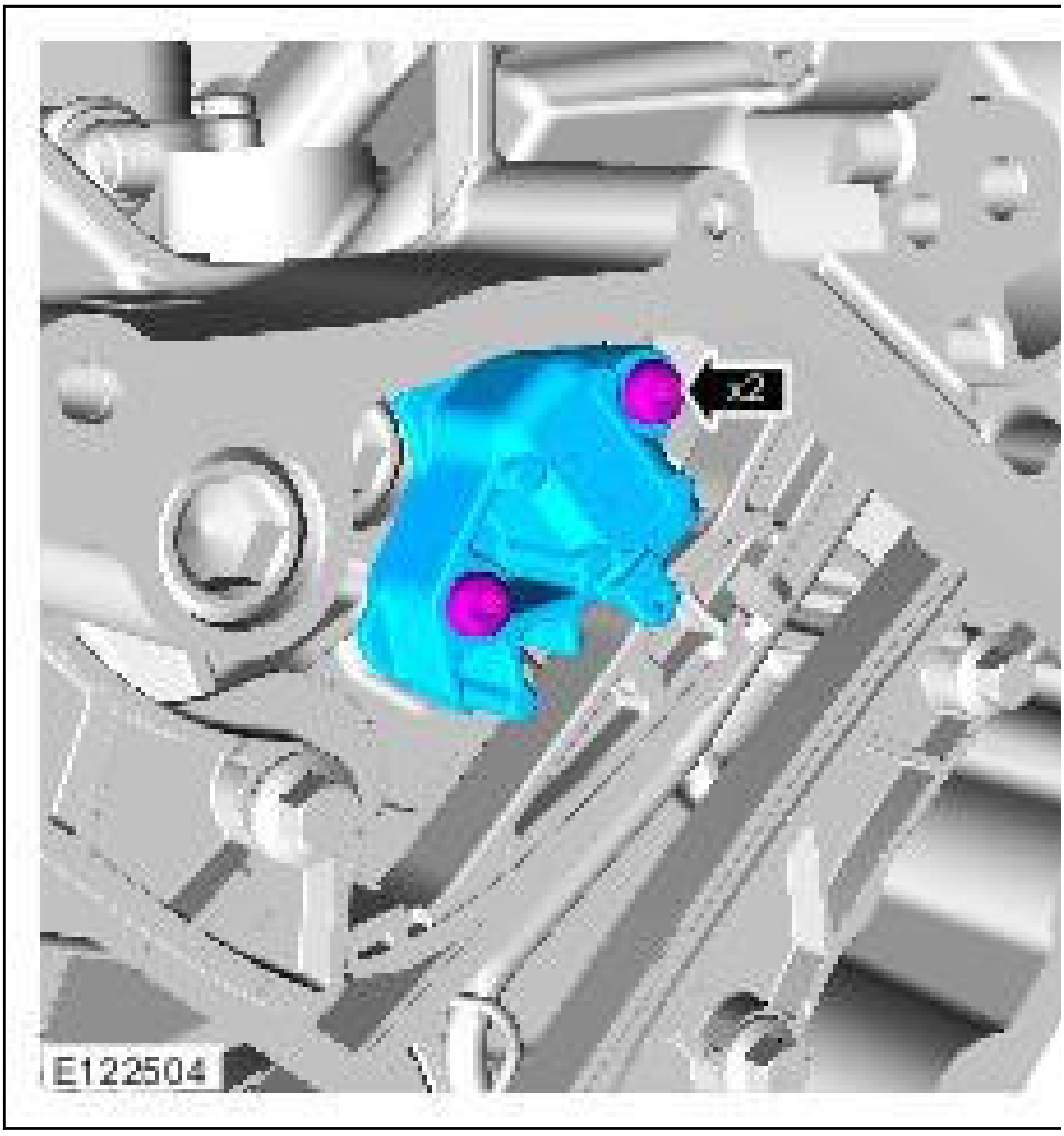
CAUTION: If the variable valve timing (VVT) units are knocked or dropped then the VVT must be replaced.

11. See figure



12. See figure

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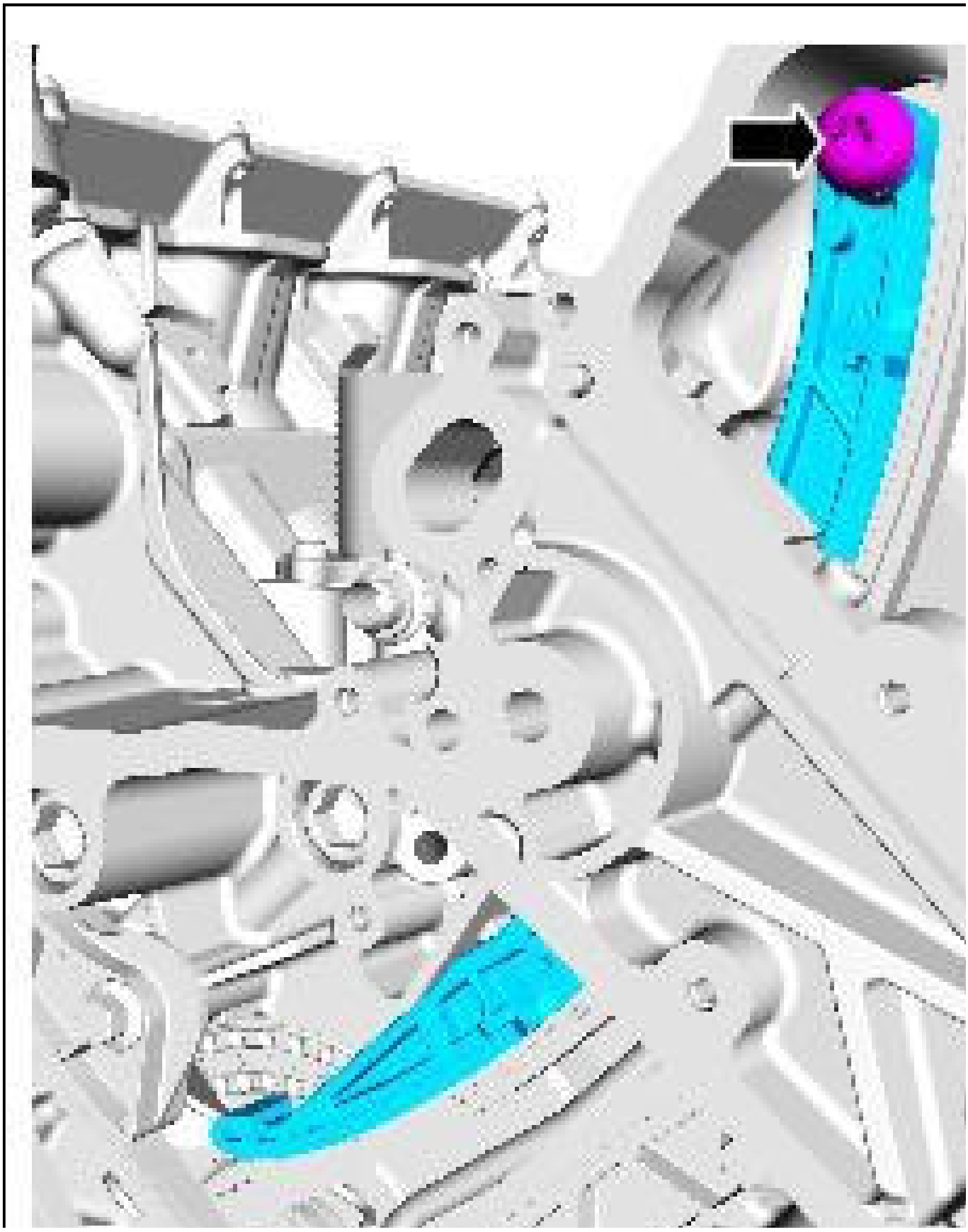

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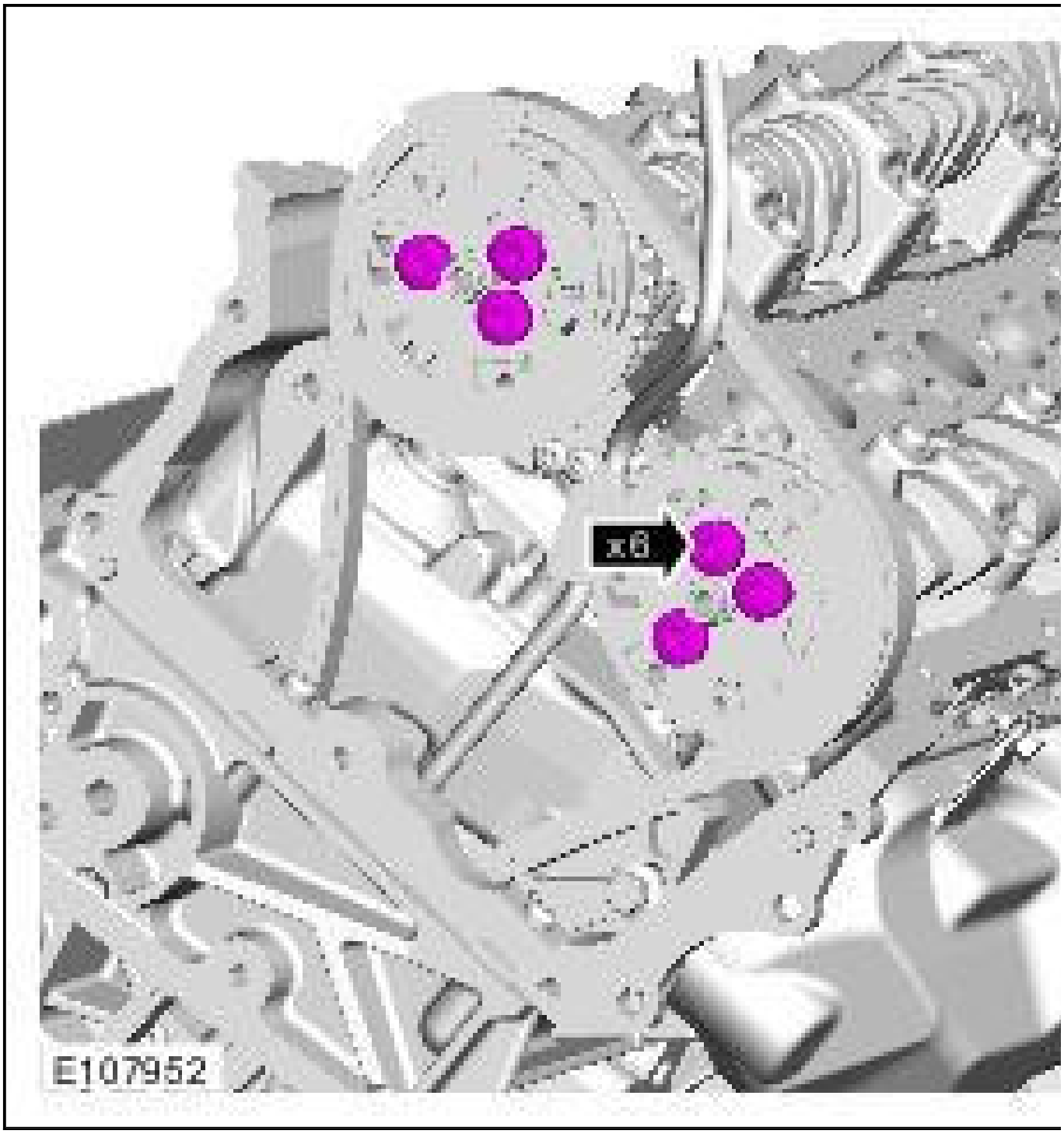
13. See figure



14. Remove the timing chain with the VVT units.

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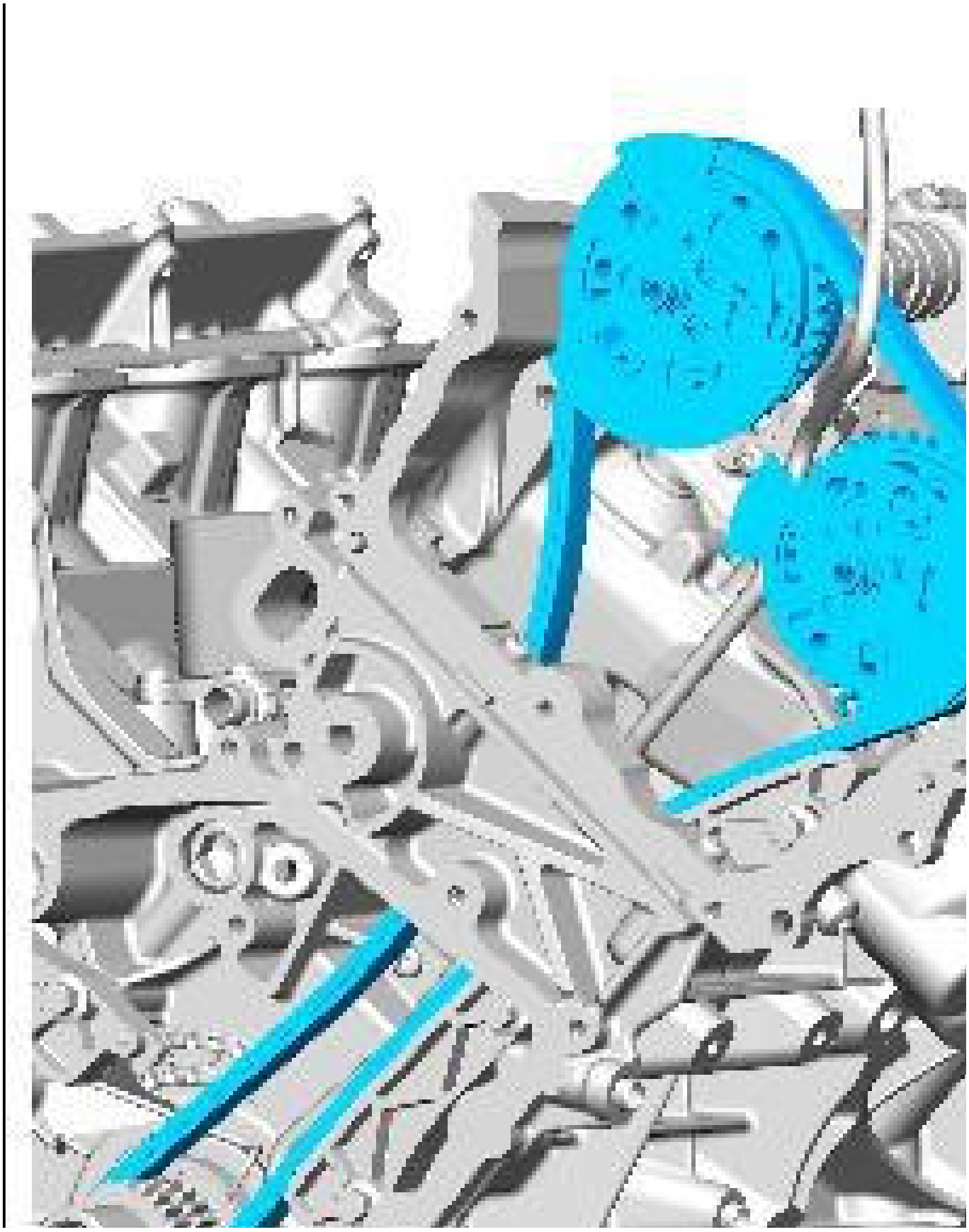
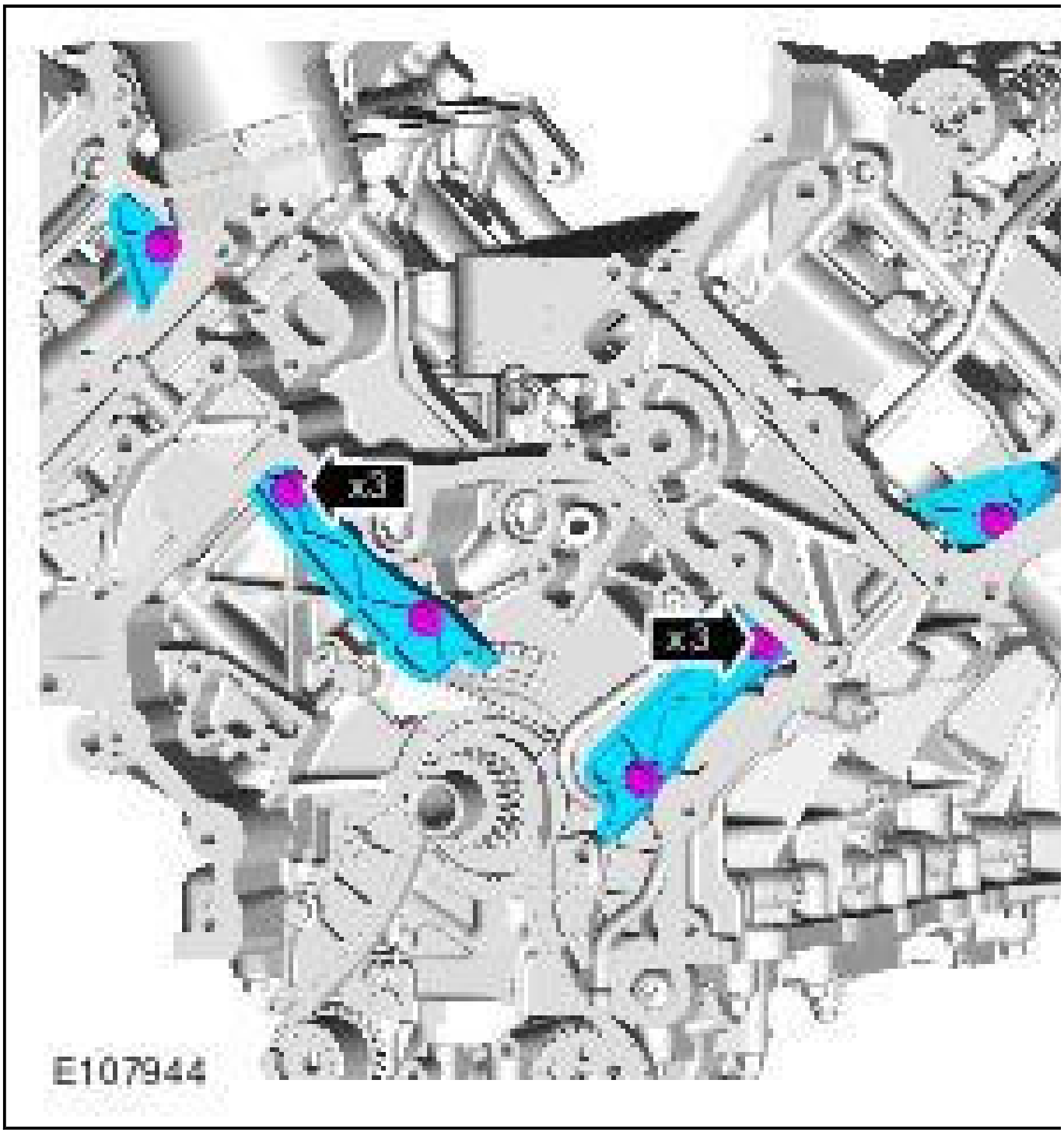


 © 2011 Mitchell Repair Information Company, LLC.

CAUTION: If the VVT is knocked or dropped then the VVT must be replaced.

15. See figure



16. See figure

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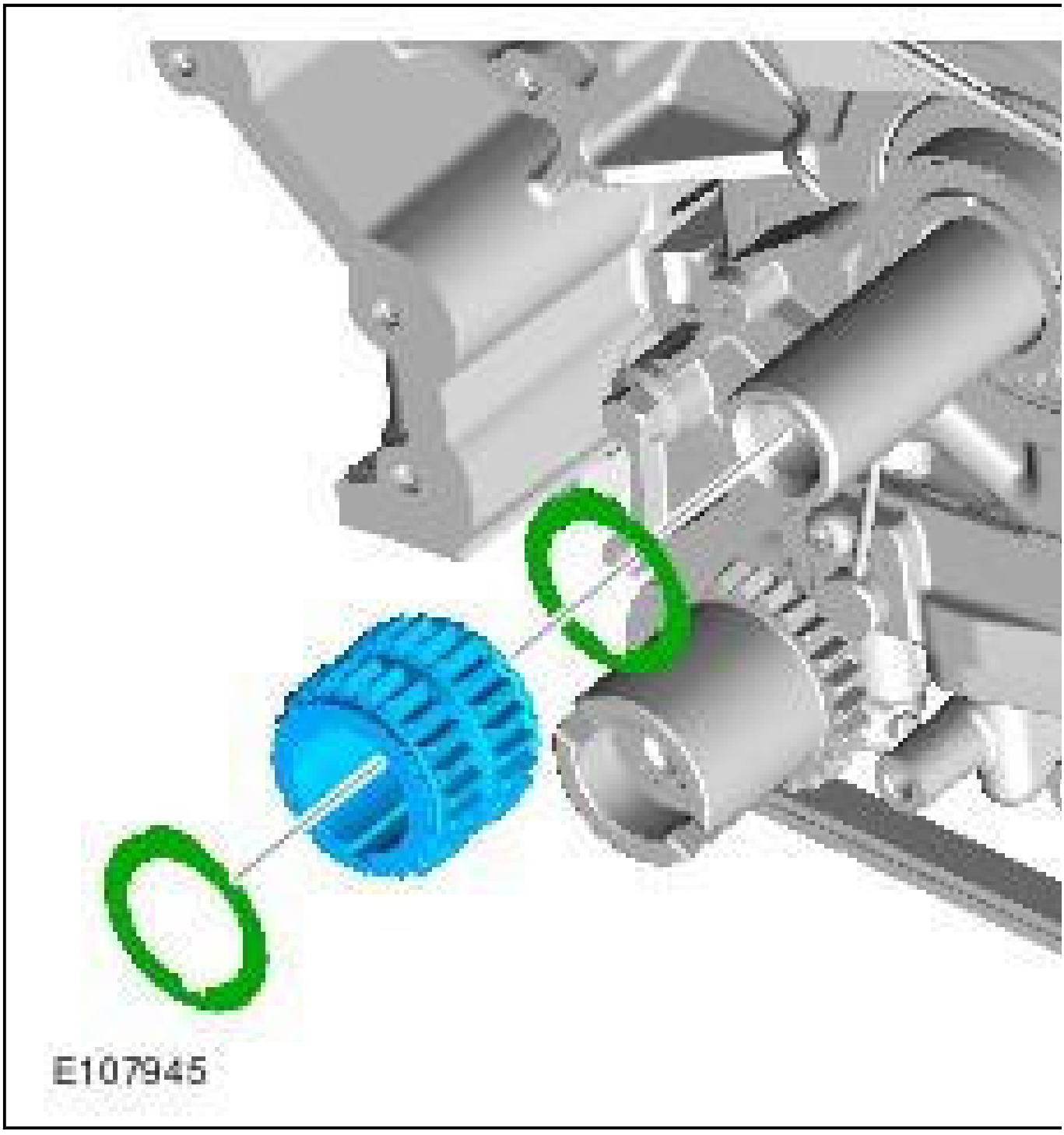

CAUTION: Discard the friction washers.

INSTALLATION

1. See figure

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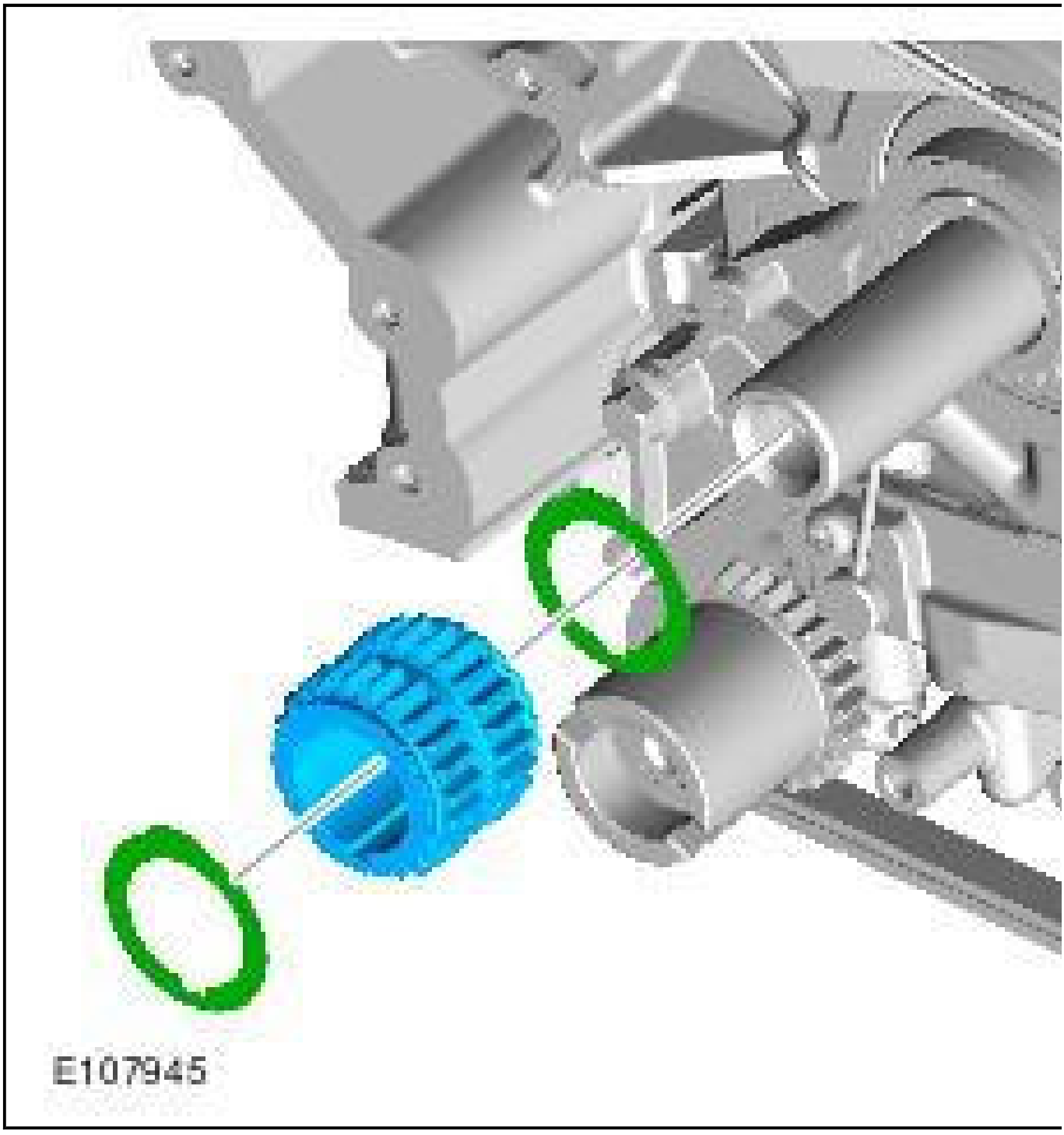

CAUTION: Install new friction washers.

2. Torque: 12 Nm

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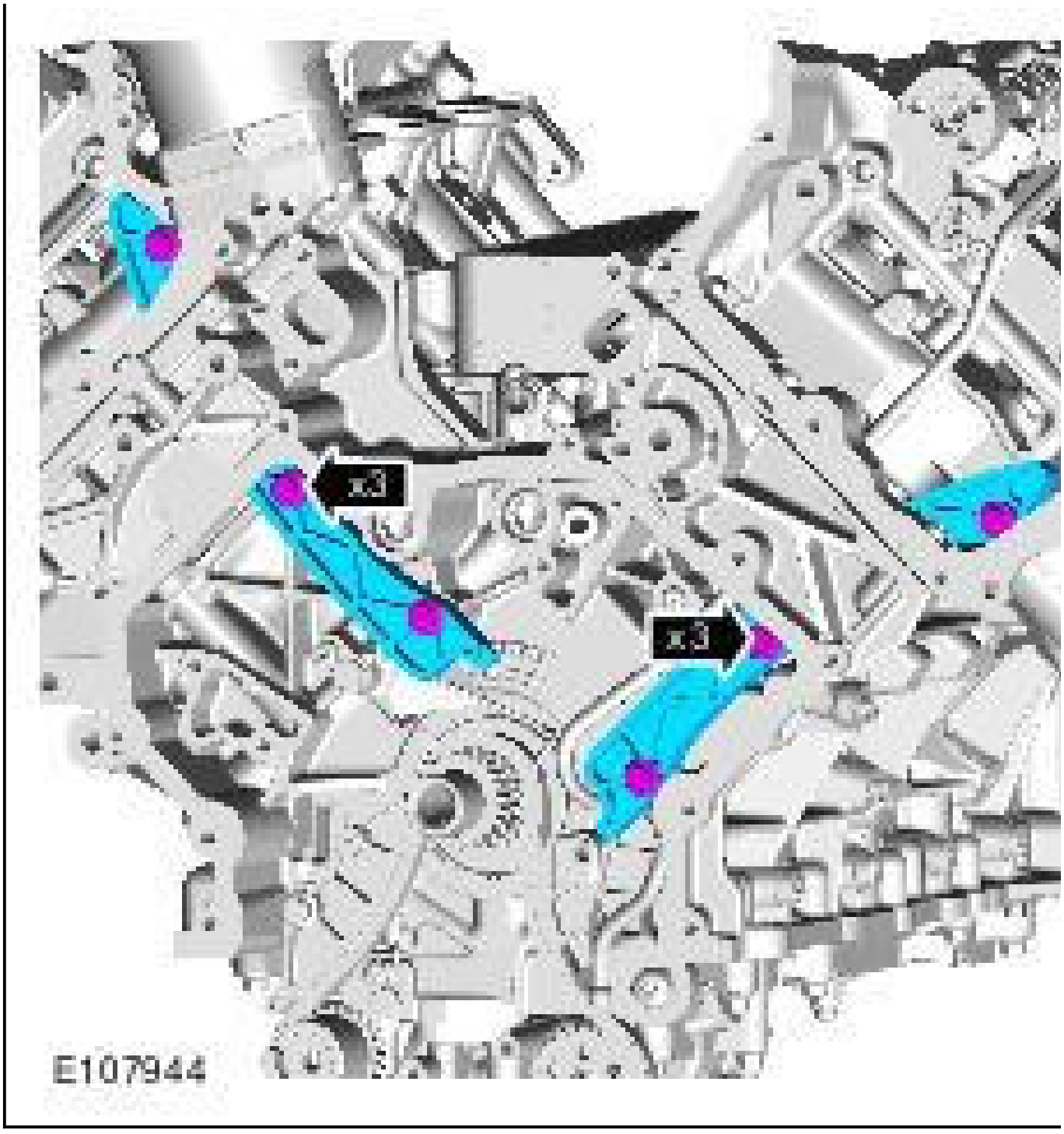

3.

- Install the special tool to each Camshaft.
- Camshaft Rotating Tool (303-1452), refer to **SPECIAL TOOL(S)**
- Torque: 10 Nm

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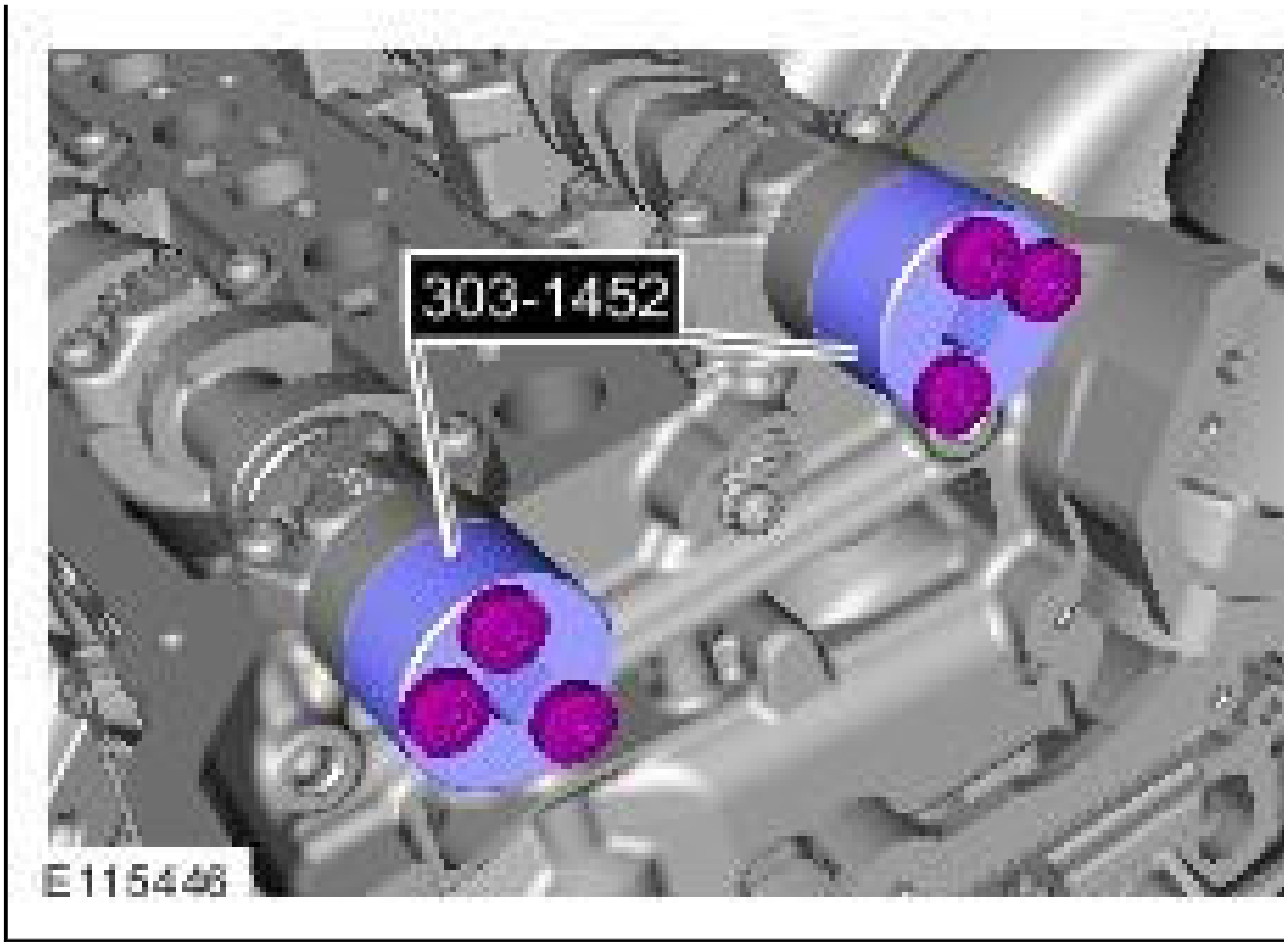

4. See figure

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- Carefully rotate the camshafts if the position is not as shown.

5. See figure

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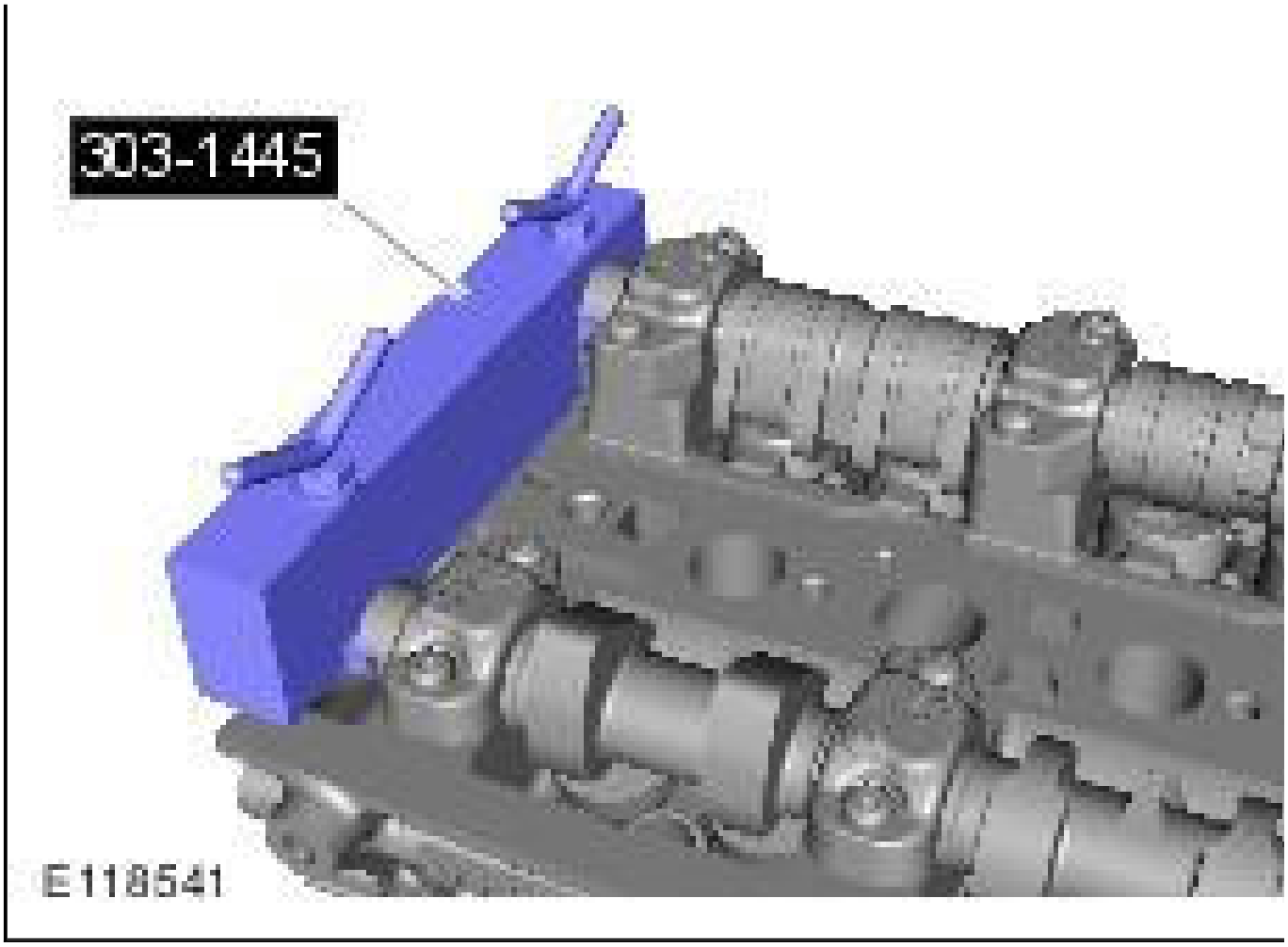

- Install the special tool 303-1445 to the rear of the camshafts making sure the key way's are correctly located into each slot on each of the camshafts.

6. See figure

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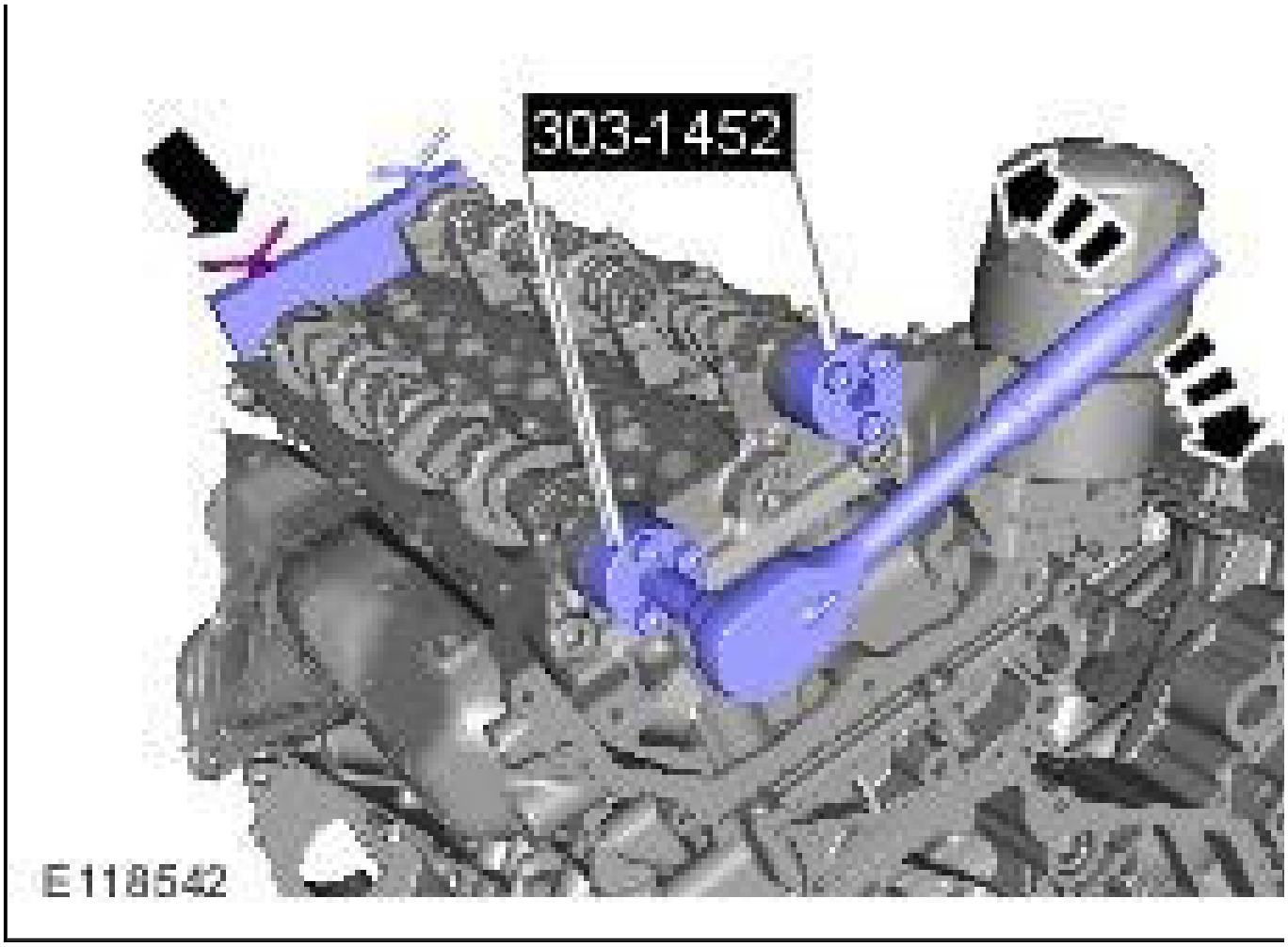

CAUTION: Do not overturn the camshafts.

CAUTION: Tighten the wing nuts finger tight. Failure to follow this instruction may result in damage to the components.

- Using a suitable tool, carefully rock the camshaft clockwise then anti-clockwise. Turn the special tool locking nuts until there is no movement left in camshafts.
- Repeat steps 3- 6 for the camshafts on the other cylinder head.

7. See figure

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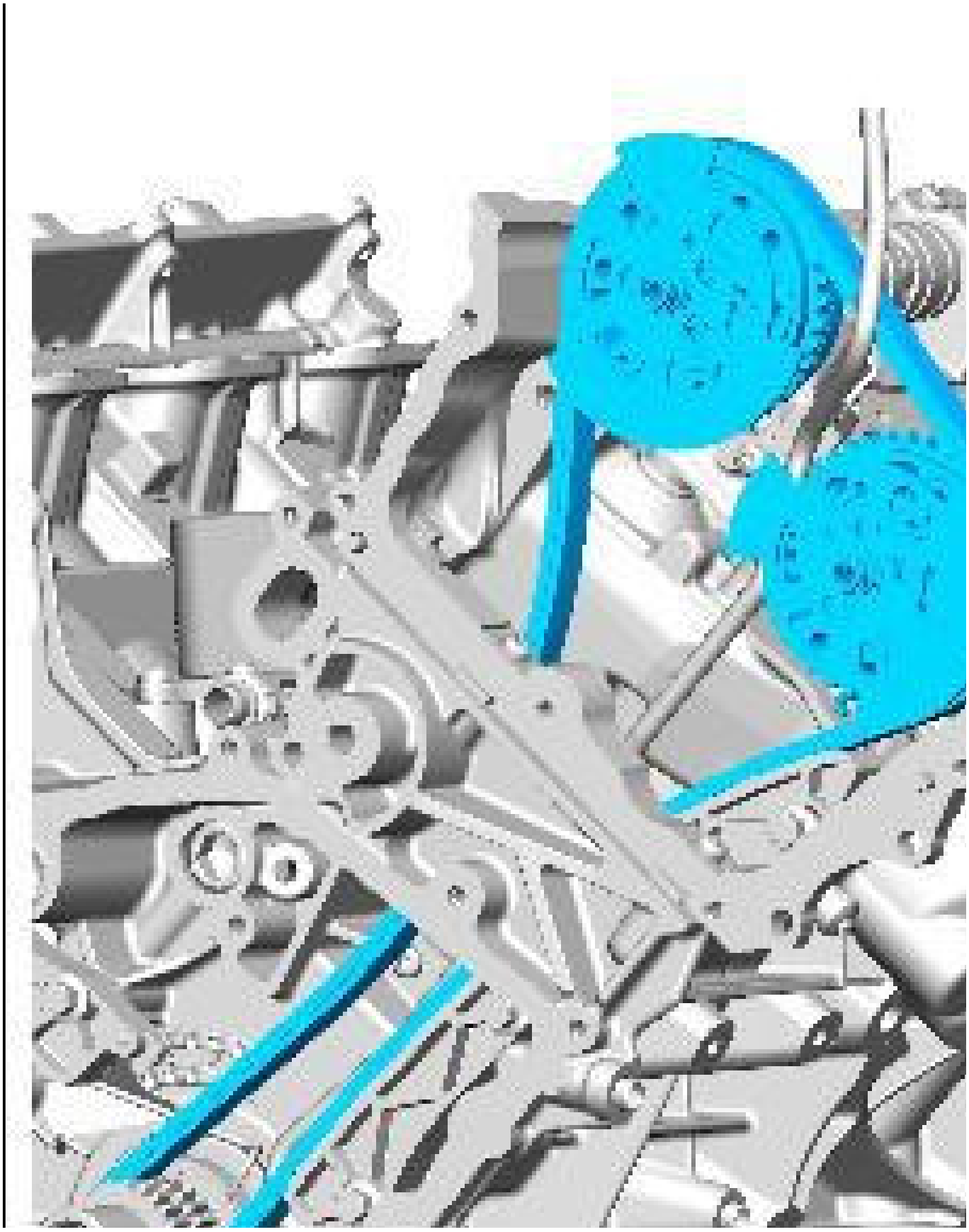


 © 2011 Mitchell Repair Information Company, LLC.

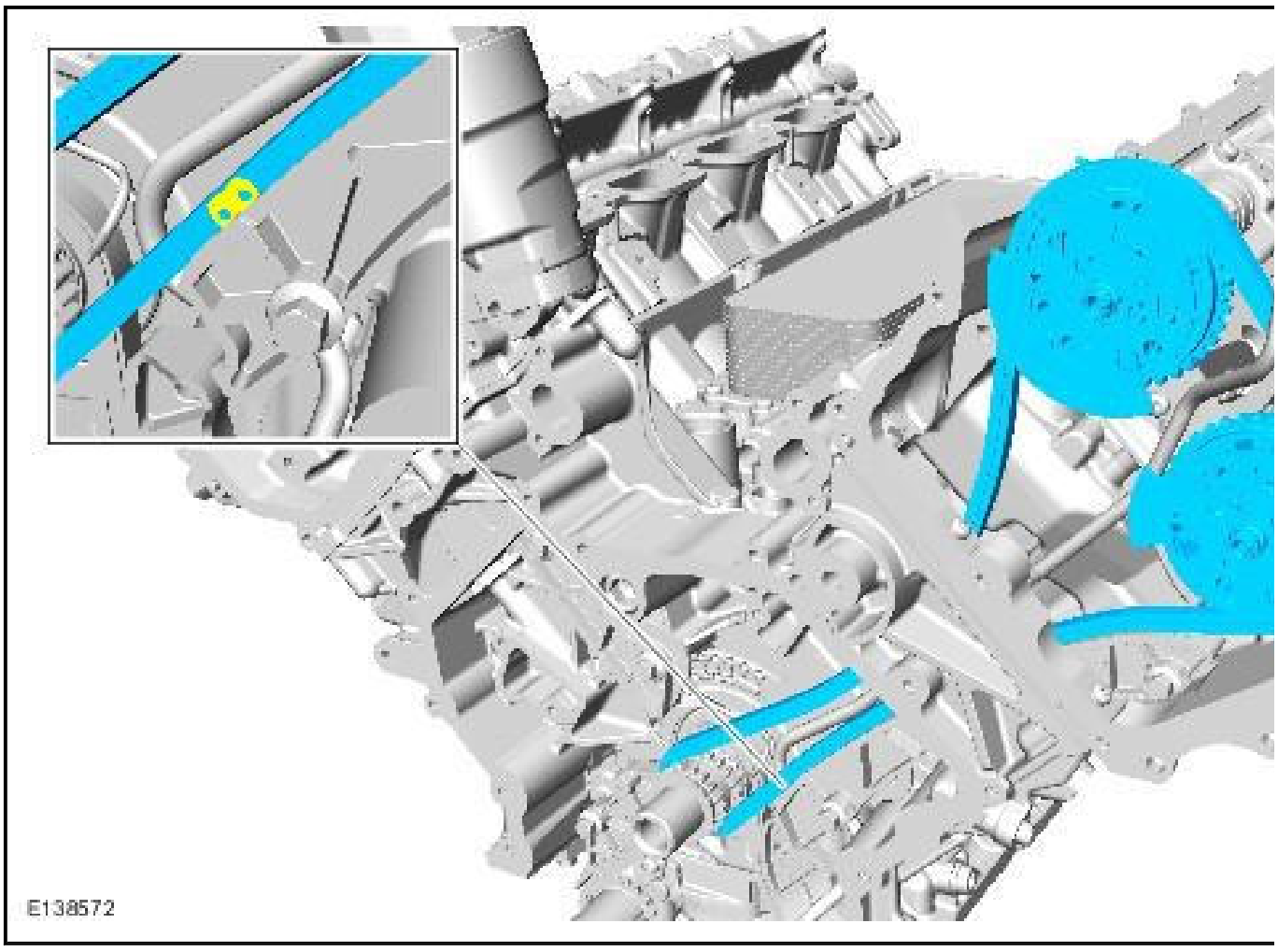
CAUTION: Do not allow the camshaft to rotate.

CAUTION: If the VVT is knocked or dropped then the VVT must be replaced.

NOTE: Do not tighten at this stage.

- Install the timing chain with the variable valve timing (VVT) units.

8. See figure



- Make sure that all the timing chain alignment marks are in the positions shown.

9. Torque: 25 Nm

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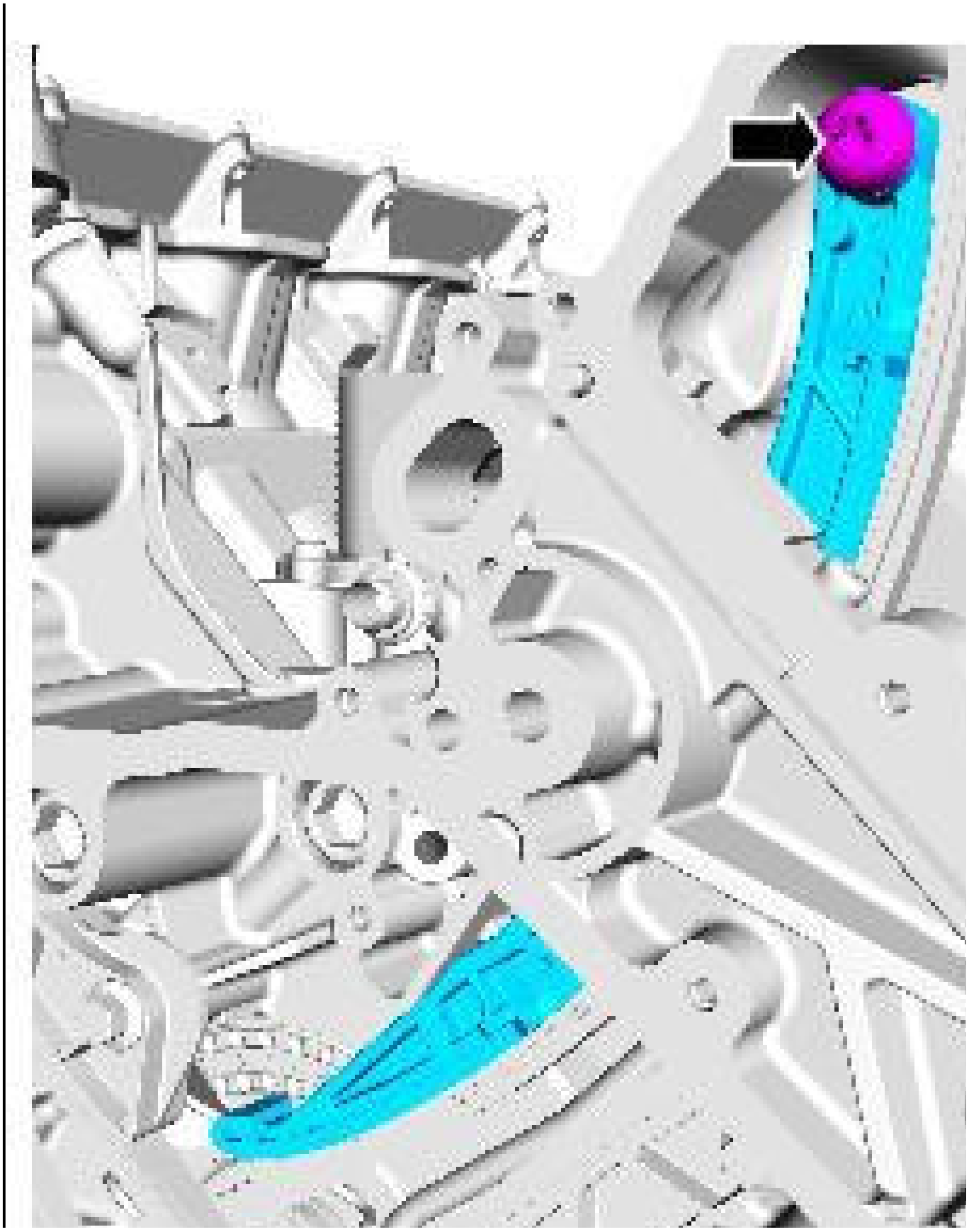

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10. Make sure the tensioner piston is fully extended. Then fully depress and lock the tensioner piston with the grenade pin before installation, failure to do this may result in damage to the engine.

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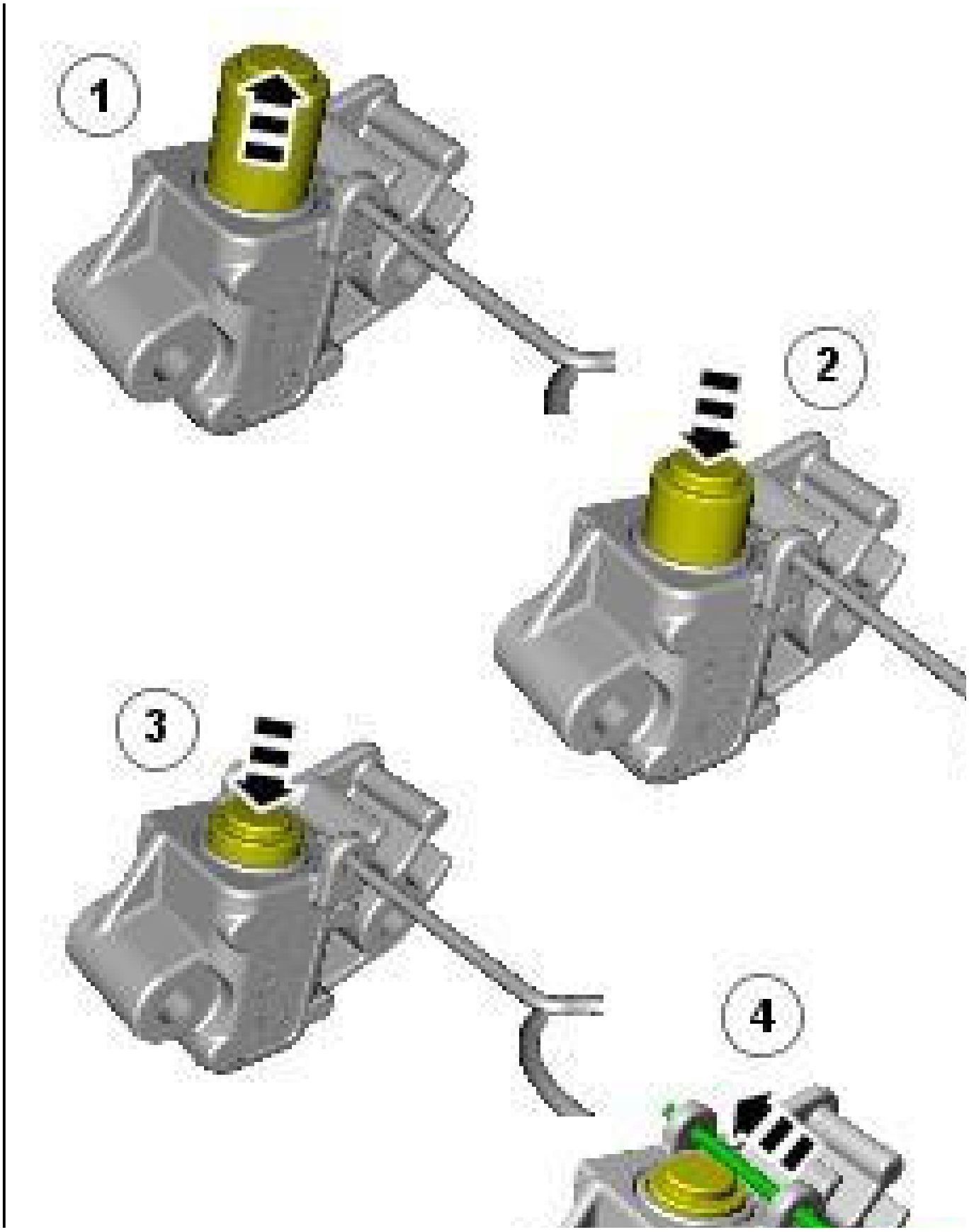

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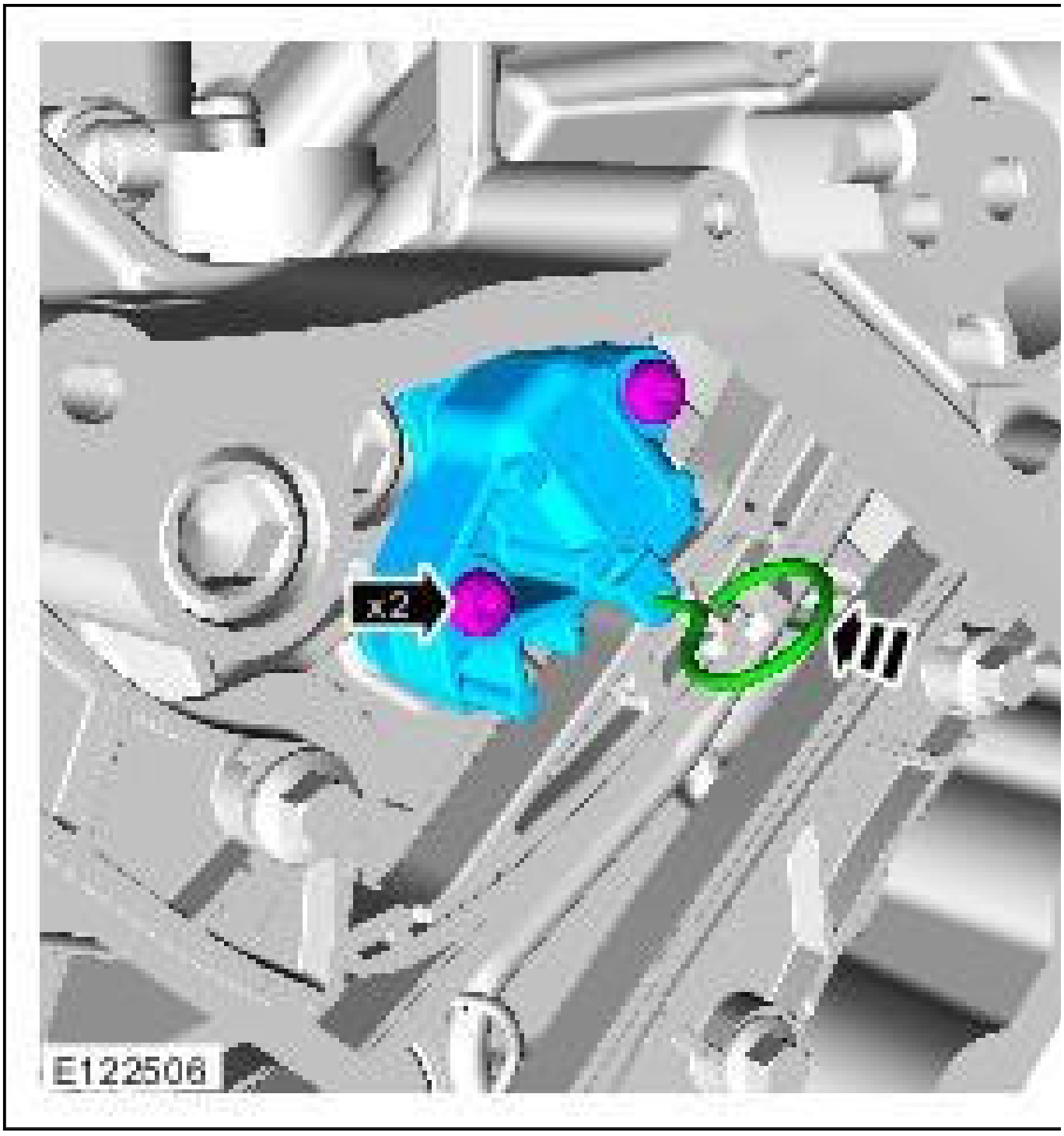
11. Torque: 10 Nm



CAUTION: Do not release the timing chain tensioner locking pin at this stage.

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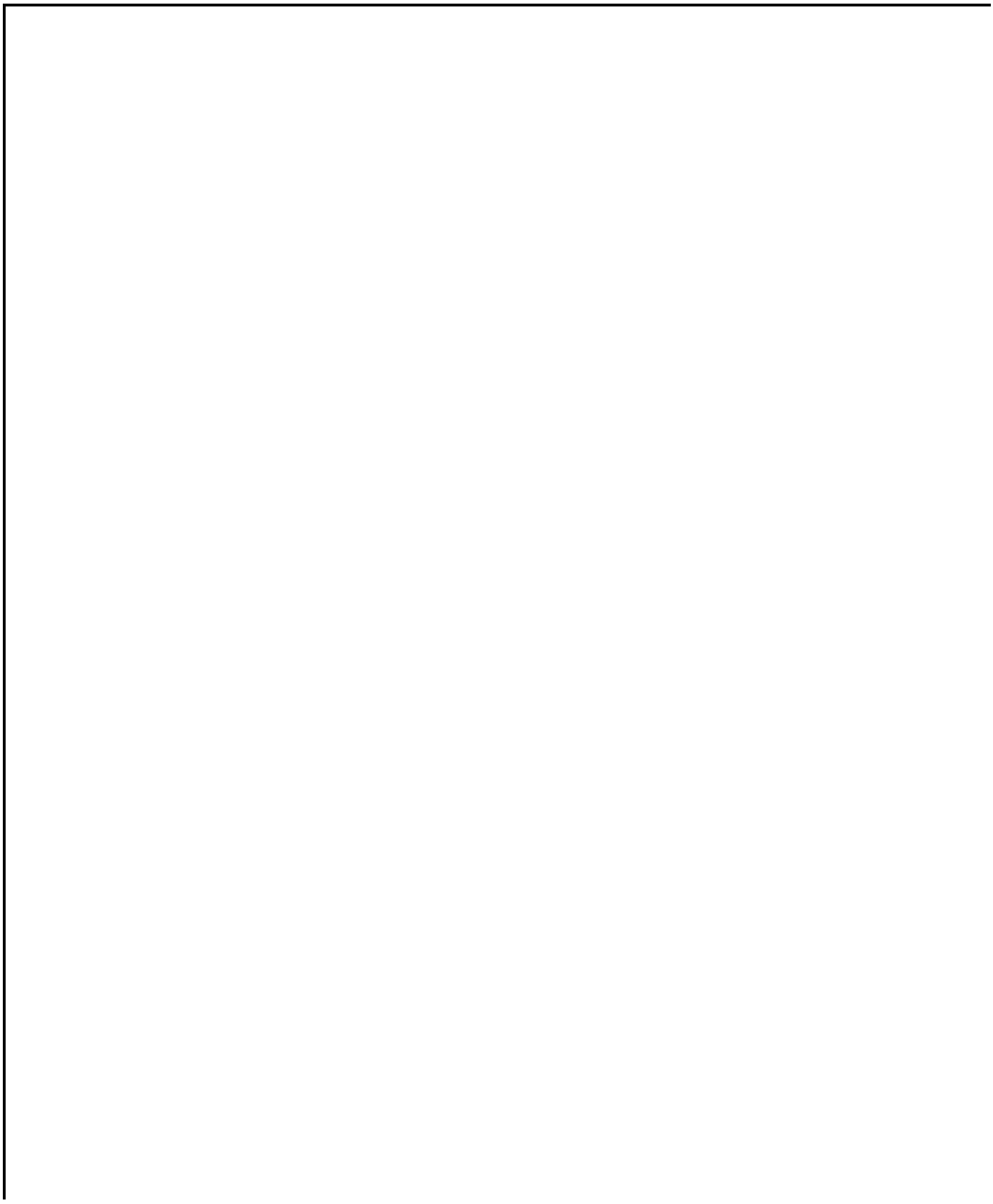
12. See figure



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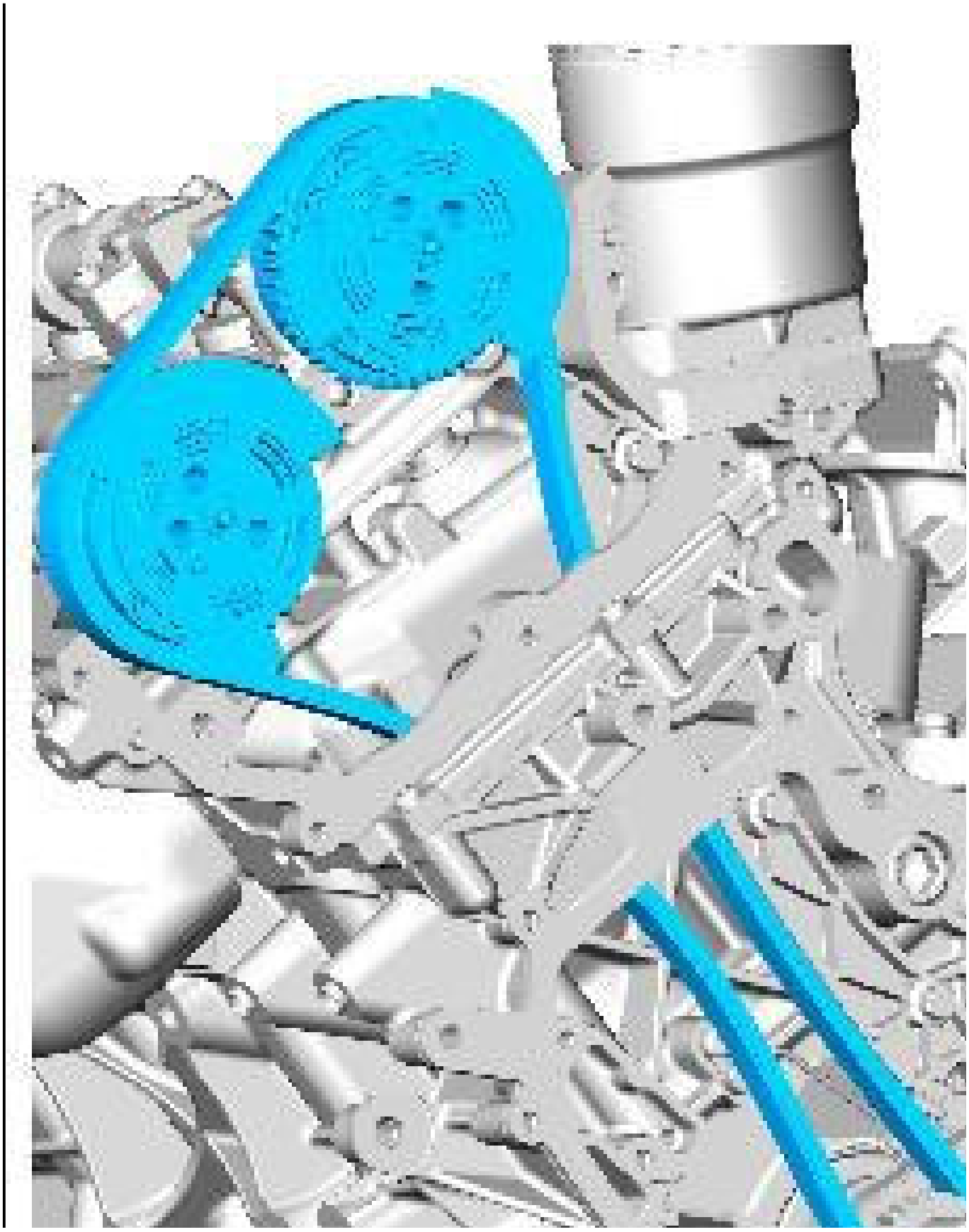

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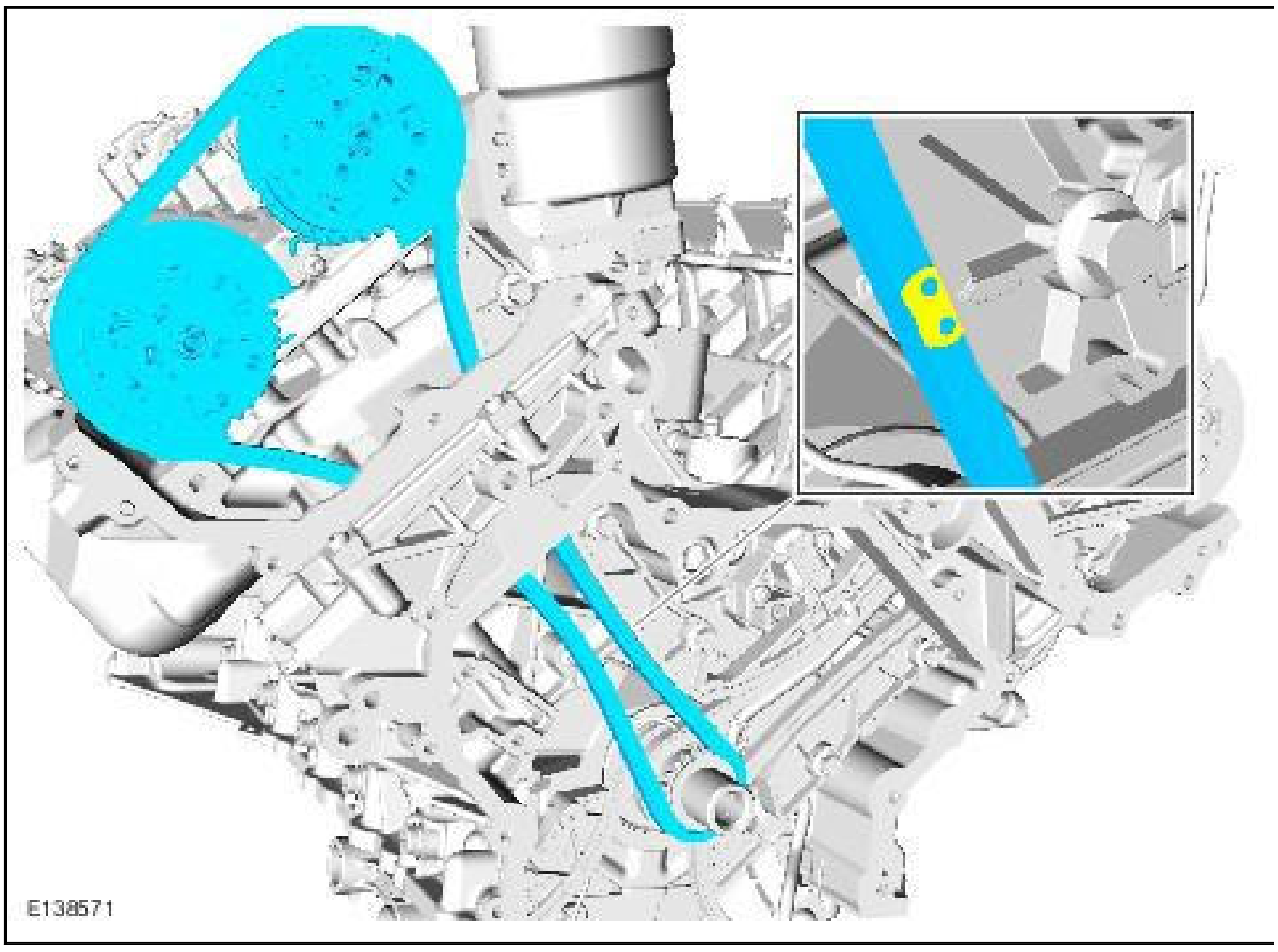
CAUTION: Do not allow the camshafts to rotate.

CAUTION: If the VVT is knocked or dropped then the VVT must be replaced.

NOTE: Do not tighten at this stage.

- Install the timing chain with the VVT units.

13. See figure



- Make sure that all the timing chain alignment marks are in the positions shown.

14. Torque: 25 Nm

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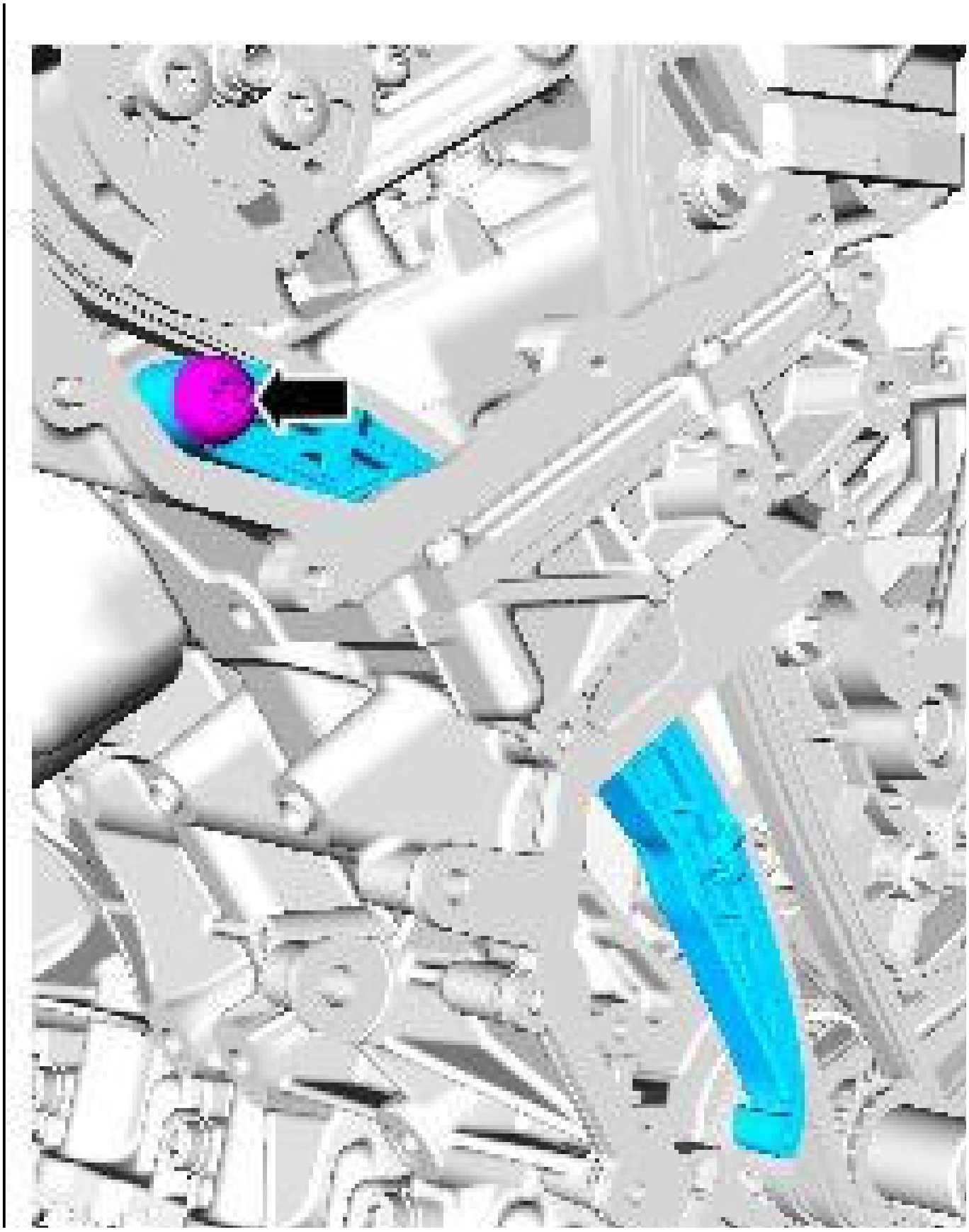
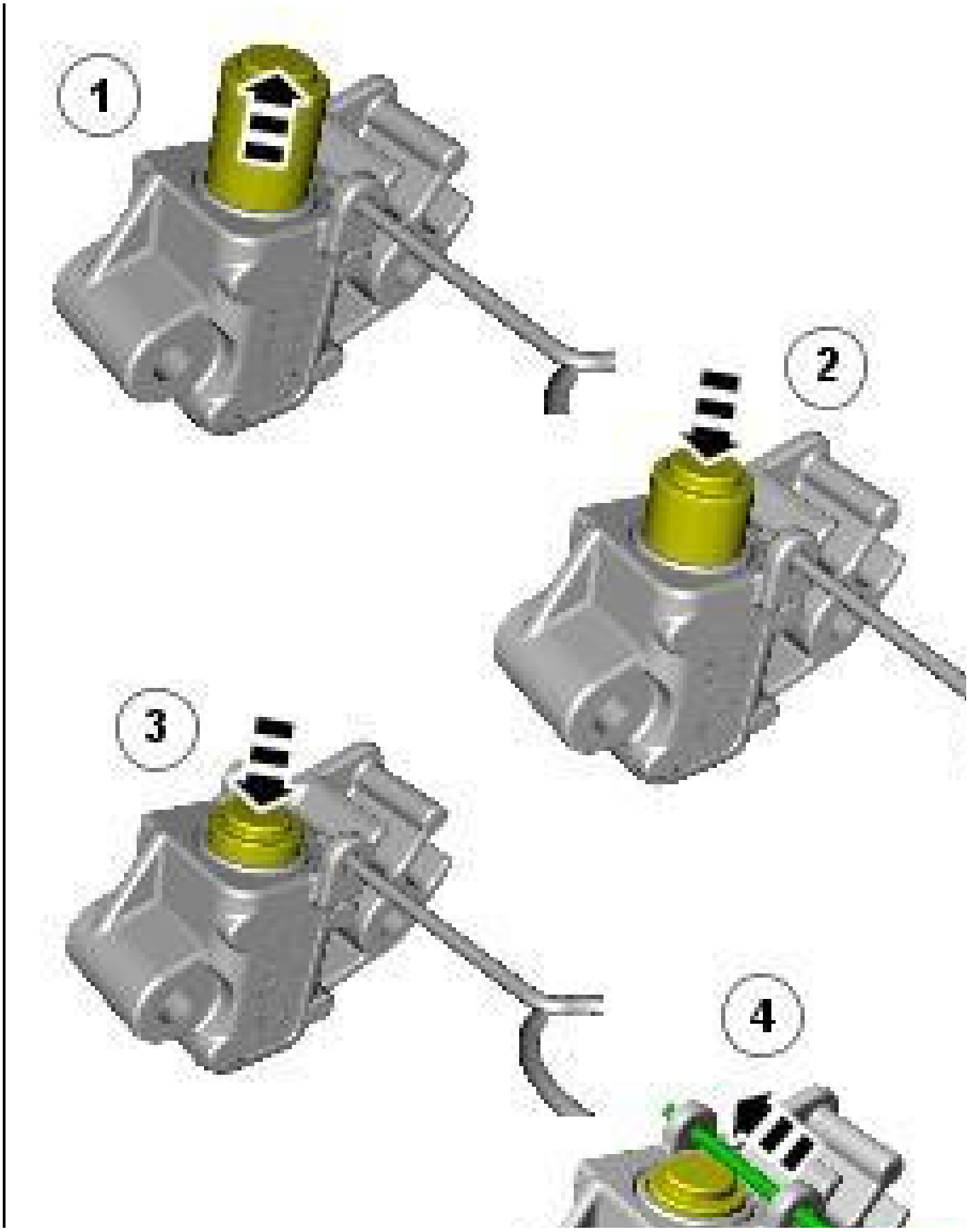


 © 2011 Mitchell Repair Information Company, LLC.

15. Make sure the tensioner piston is fully extended. Then fully depress and lock the tensioner piston with the grenade pin before installation, failure to do this may result in damage to the engine.

 © 2011 Mitchell Repair Information Company, LLC.



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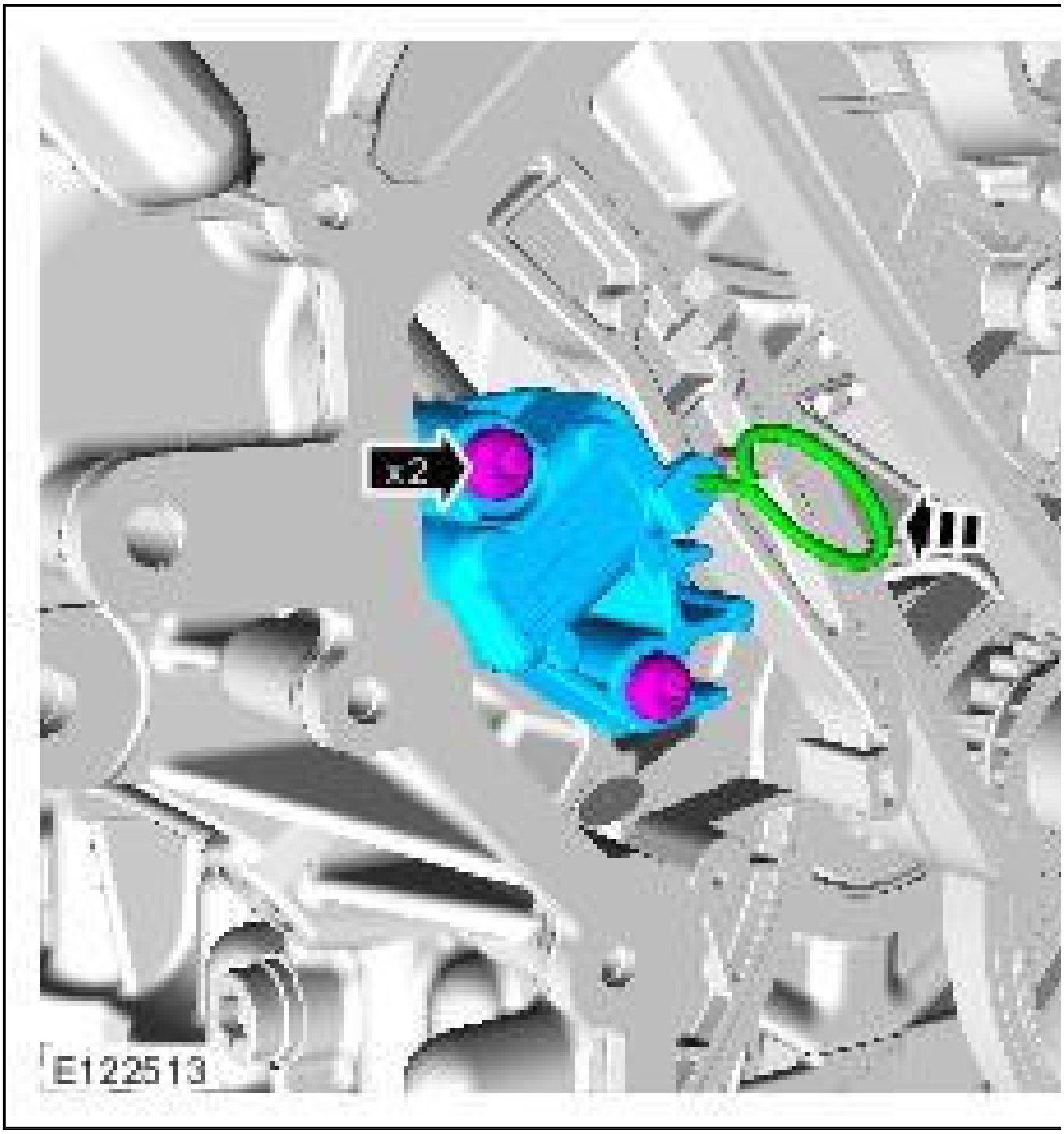
16. Torque: 10 Nm



CAUTION: Do not release the timing chain tensioner locking pin at this stage.

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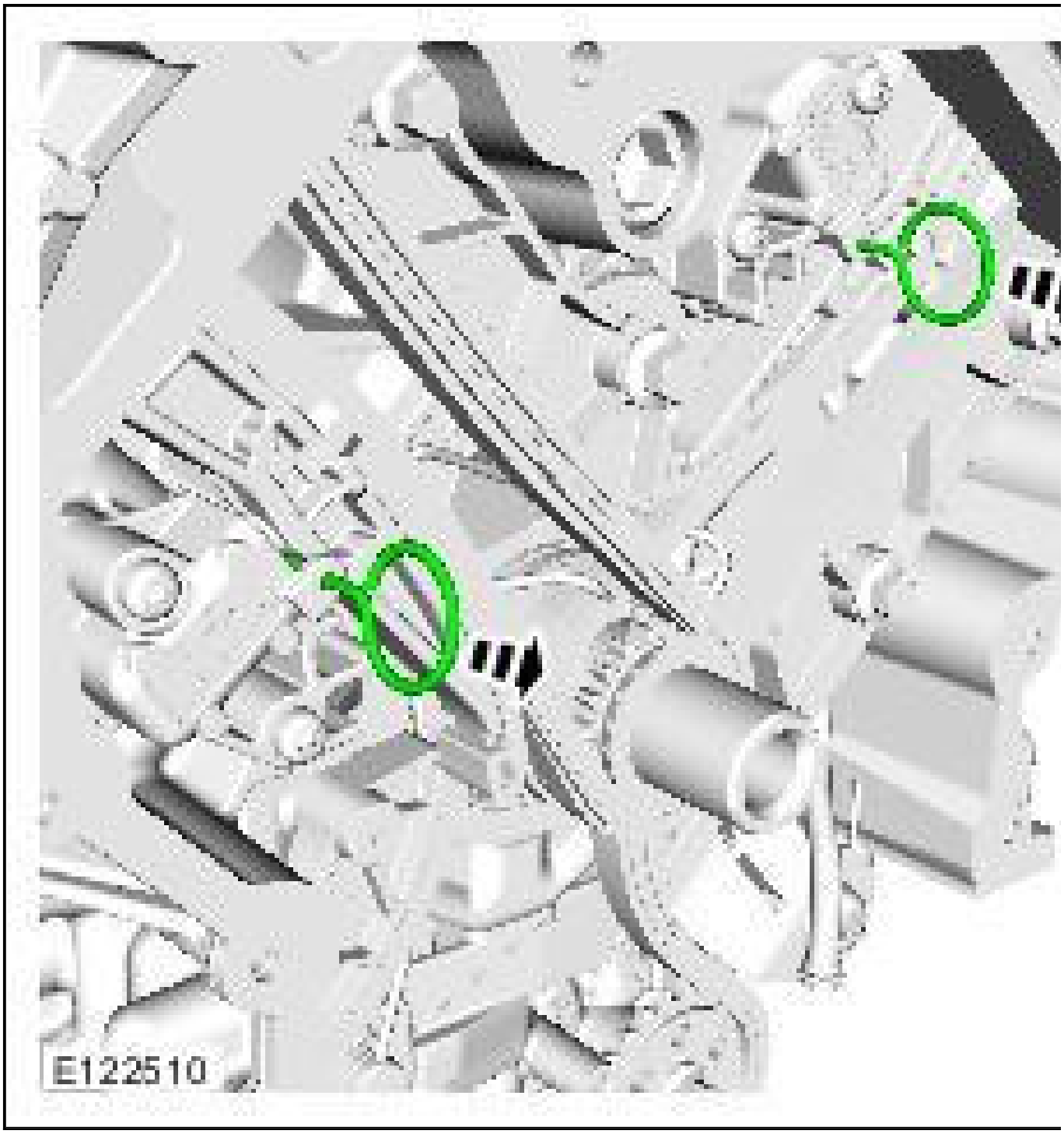
17. See figure



CAUTION: Do not use mechanical force.

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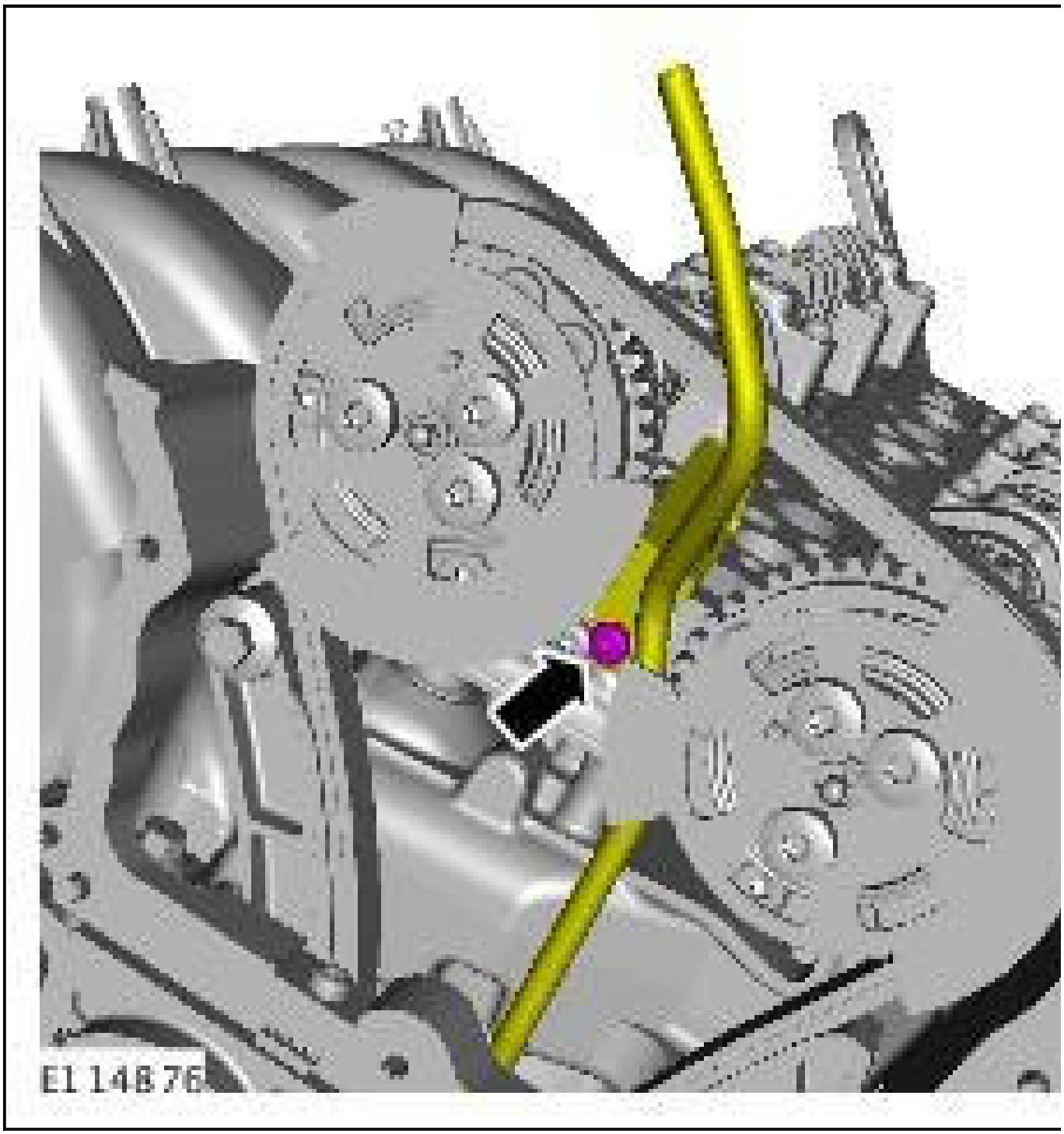
18. Make sure that the tensioners are fully deployed.
19. See figure



- Release and reposition the oil suction tube to one side.

20. See figure

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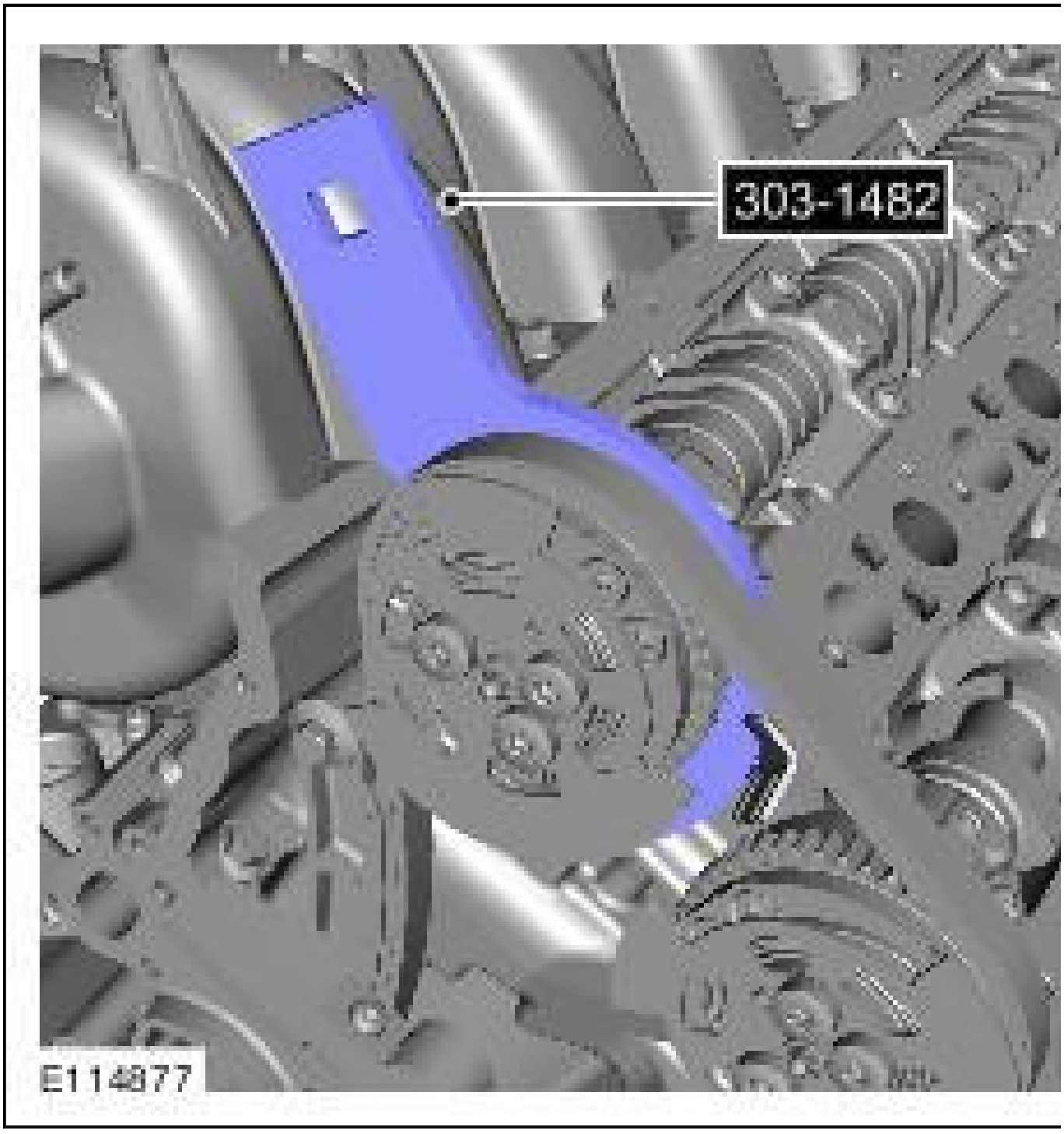

- Install the special tool.
- Tensioner Tool (303-1482), refer to **SPECIAL TOOL(S)**

21. See figure

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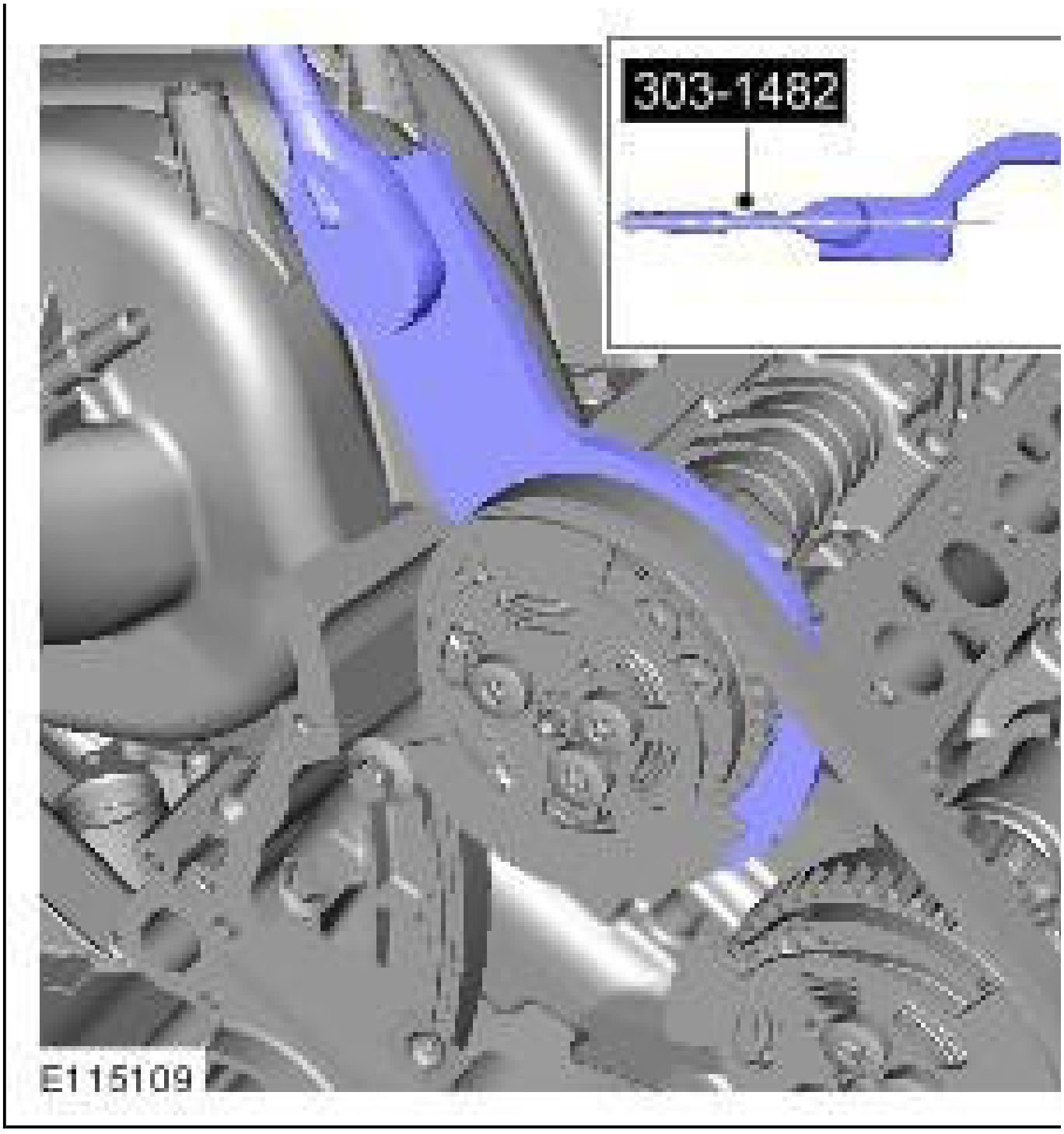

CAUTION: Apply the torque to the end of the special tool.

CAUTION: Make sure that the torque wrench is aligned with the special tool as illustrated in the graphic.

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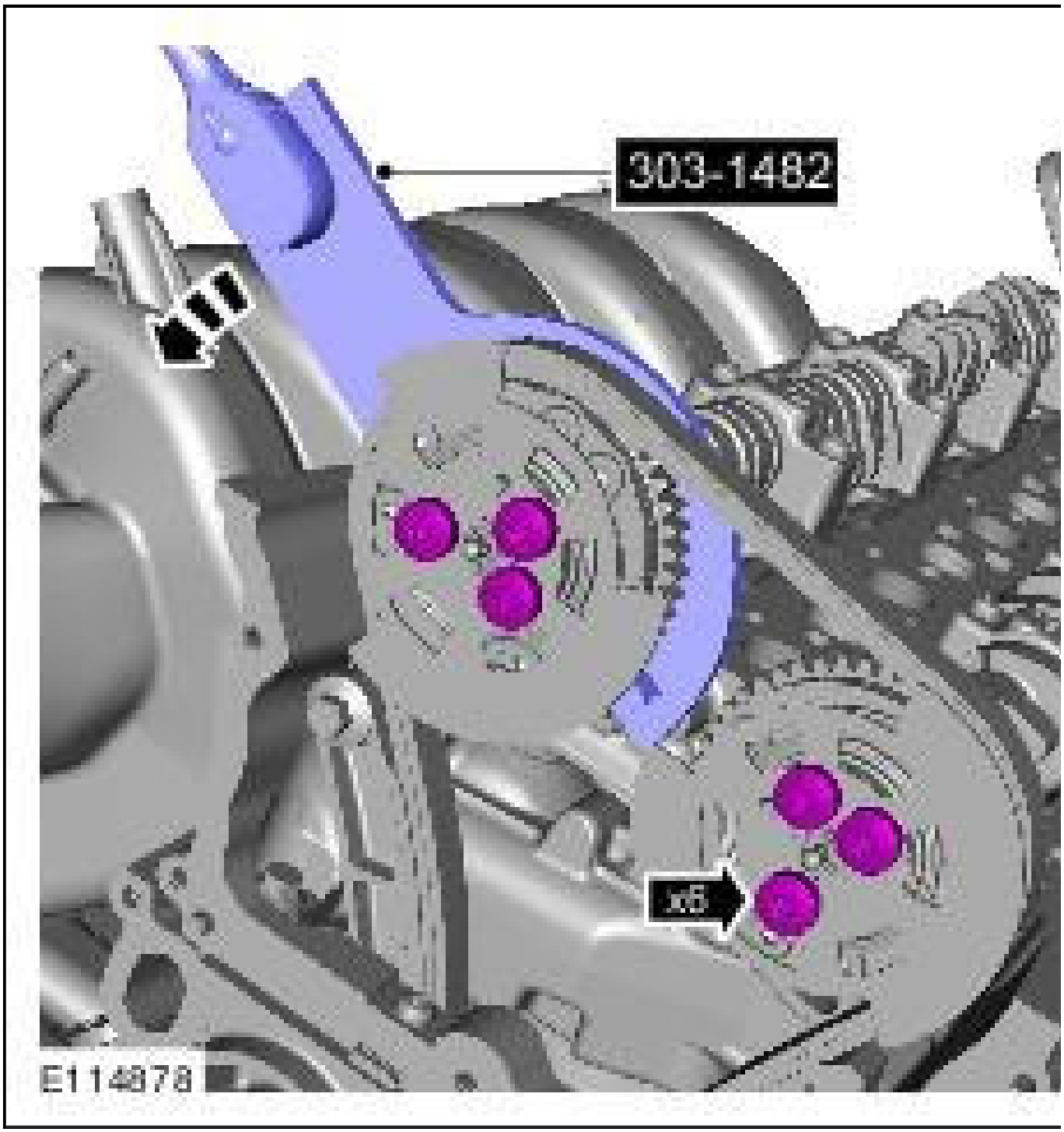
- Install the torque wrench to the special tool.
- Torque: 35 Nm

22. See figure



CAUTION: Make sure that the torque wrench does not move while tightening the

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VVT bolts.

NOTE: Make sure to tighten the exhaust VVT unit bolts first.

- Torque: 32 Nm
- Tensioner Tool (303-1482), refer to **SPECIAL TOOL(S)**

23. See figure

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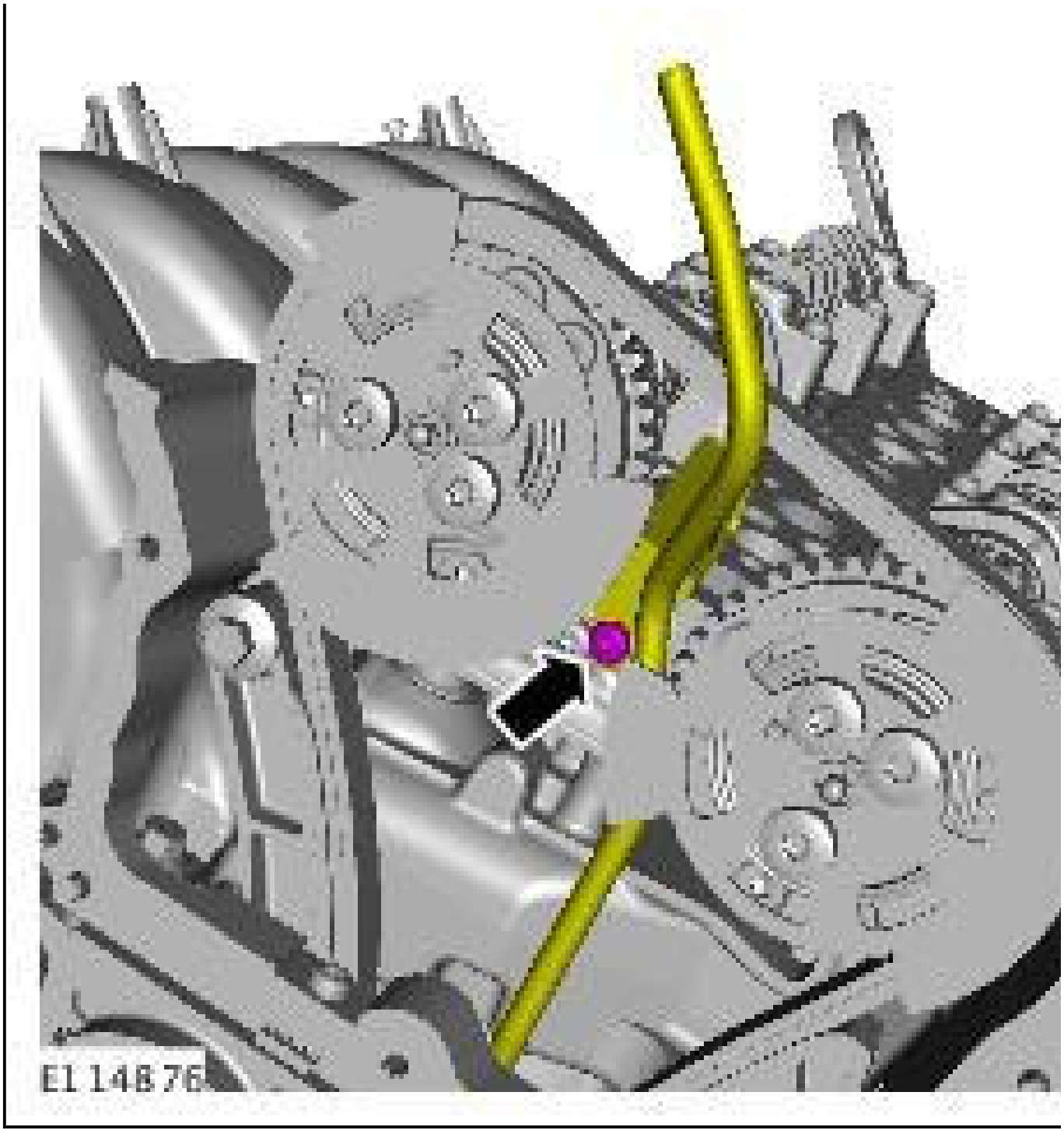

- Install the oil suction tube.
- Torque: 10 Nm

24. See figure

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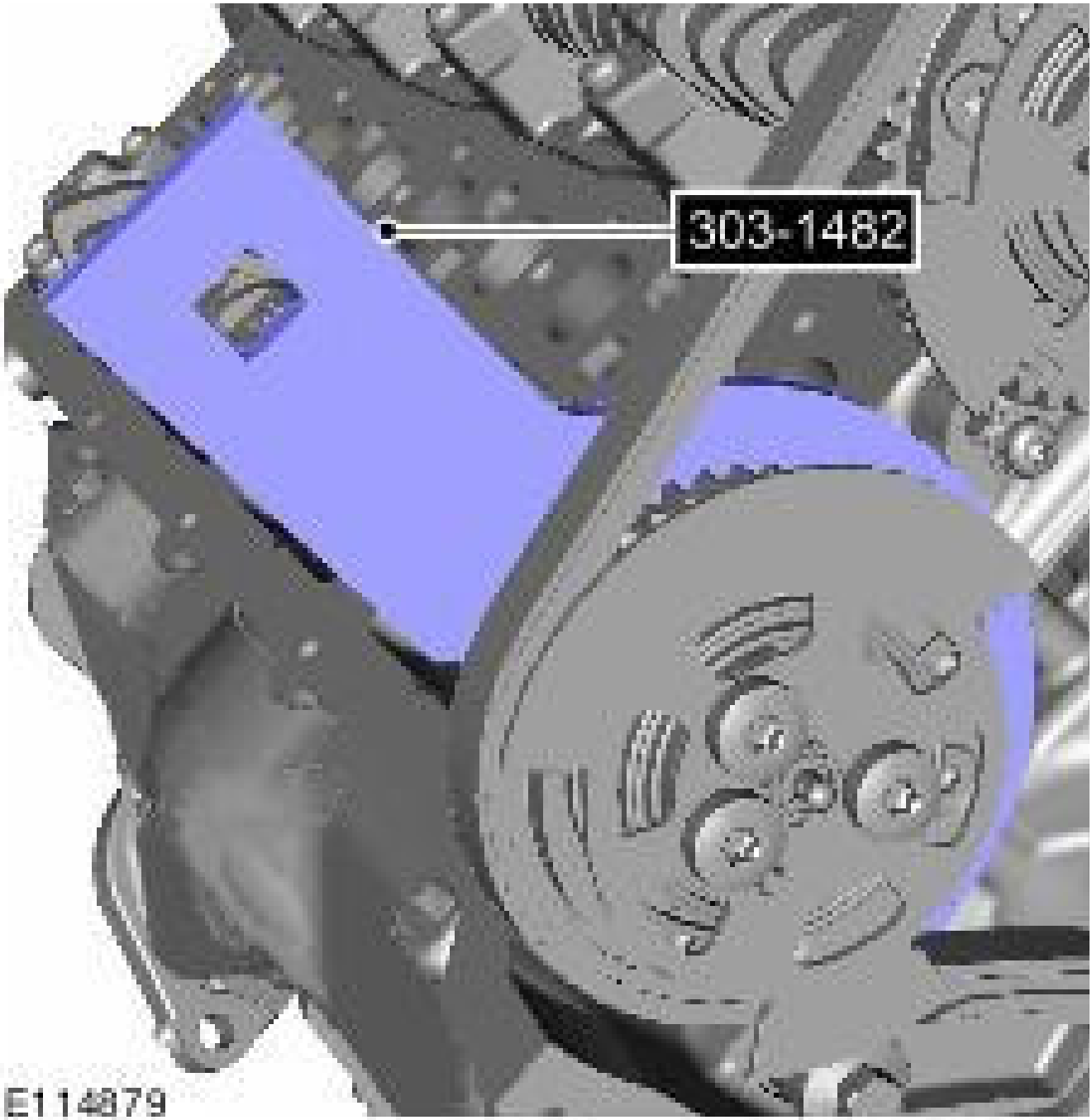

- Install the special tool.
- Tensioner Tool (303-1482), refer to **SPECIAL TOOL(S)**

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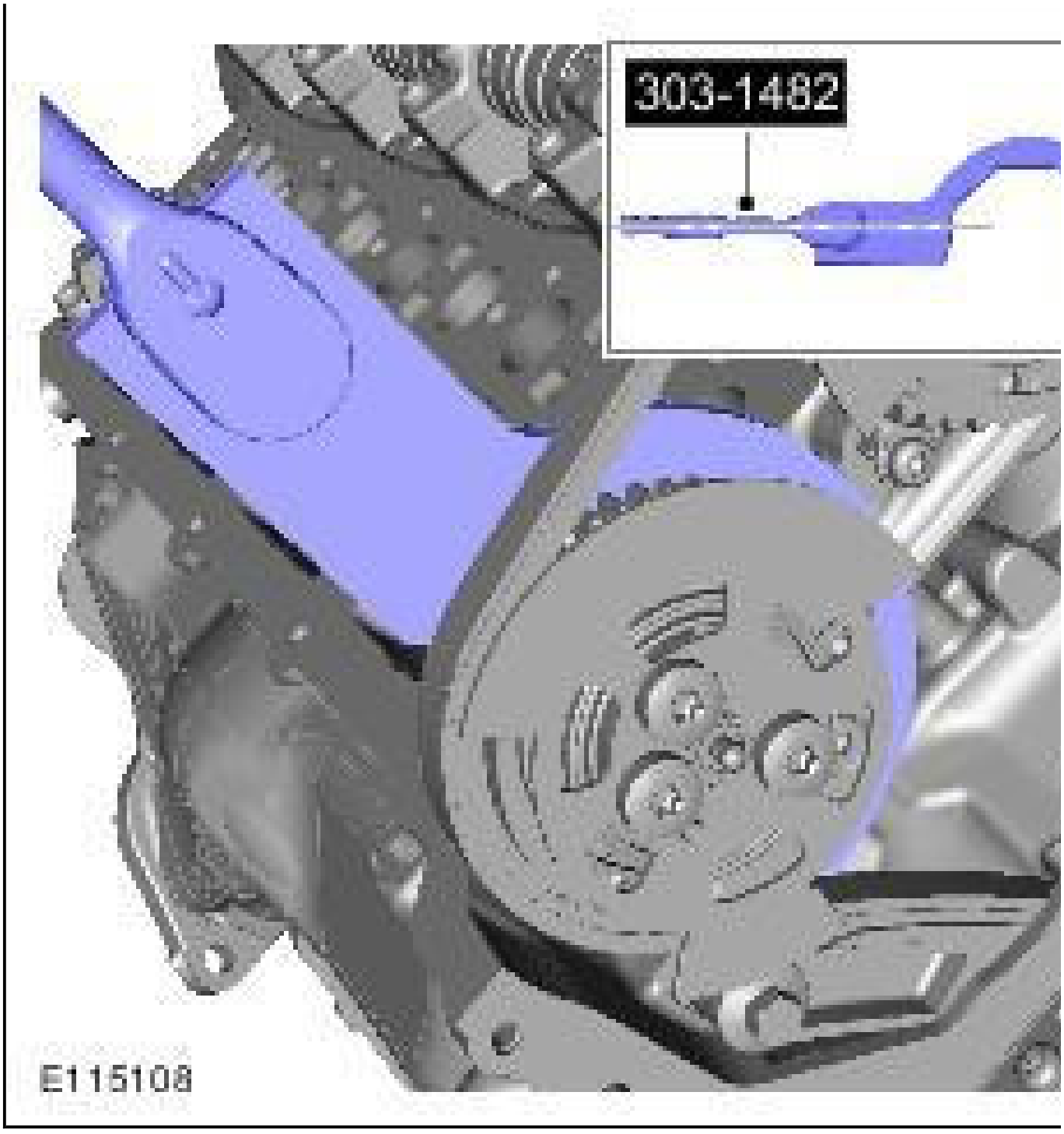

25. See figure

CAUTION: Apply the torque to the end of the special tool.

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CAUTION: Make sure that the torque wrench is aligned with the special tool as illustrated in the graphic.

- Install the torque wrench to the special tool.
- Torque: 35 Nm

26. Torque: 32 Nm

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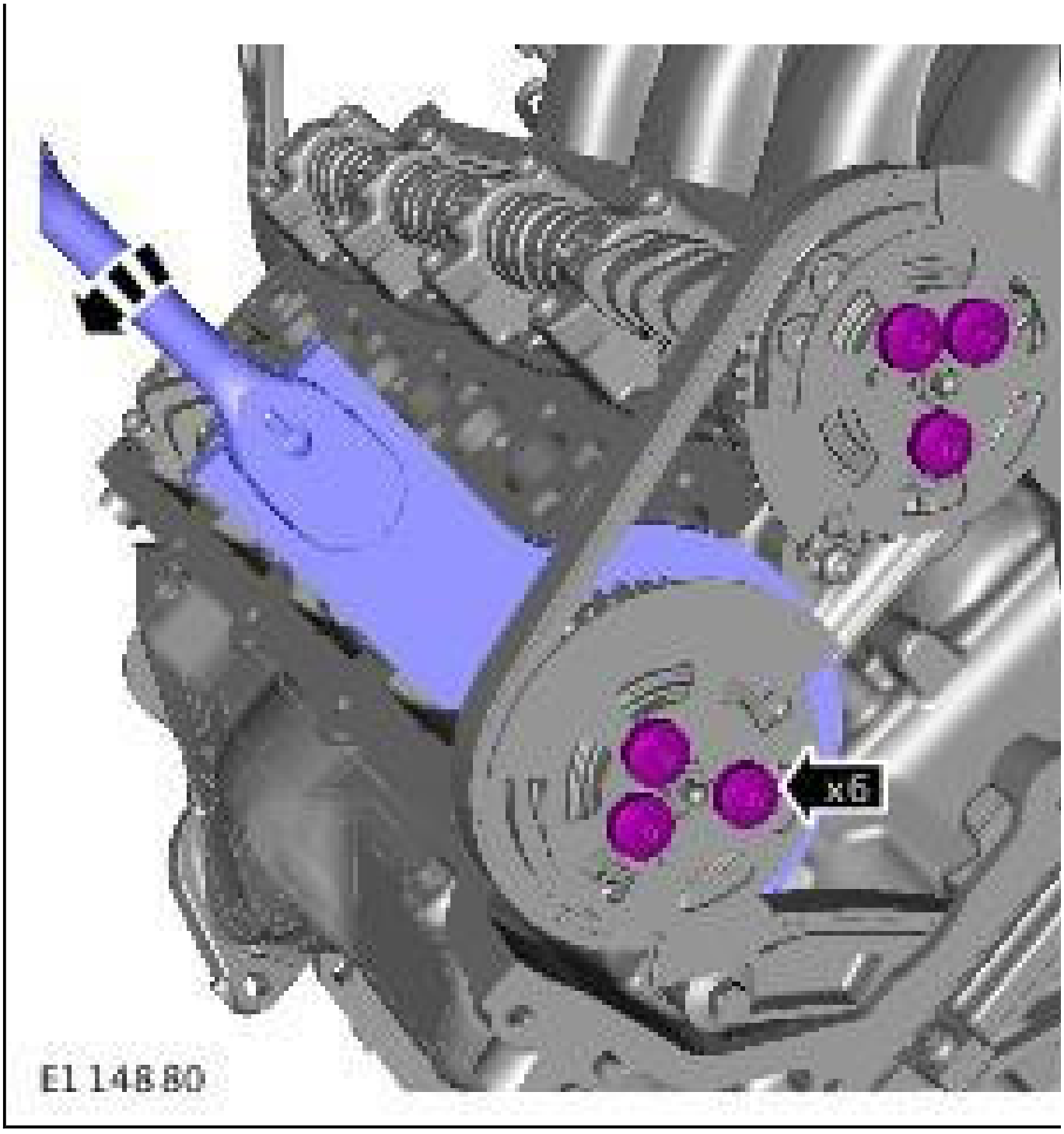

CAUTION: Make sure that the torque wrench does not move while tightening the VVT bolts.

NOTE: Make sure to tighten the inlet VVT unit bolts first.

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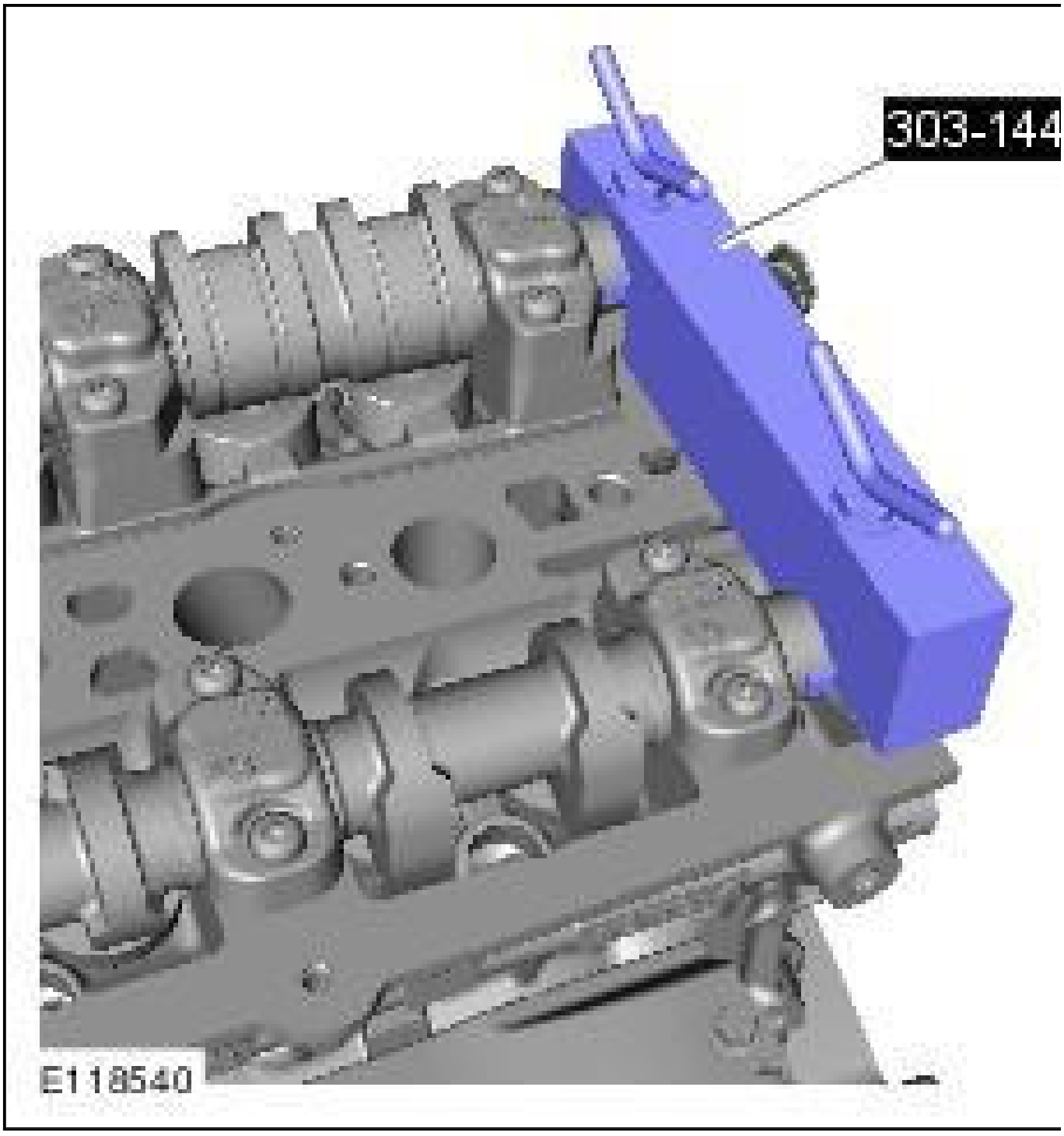
27. See figure



- Remove the special tool.

28. See figure

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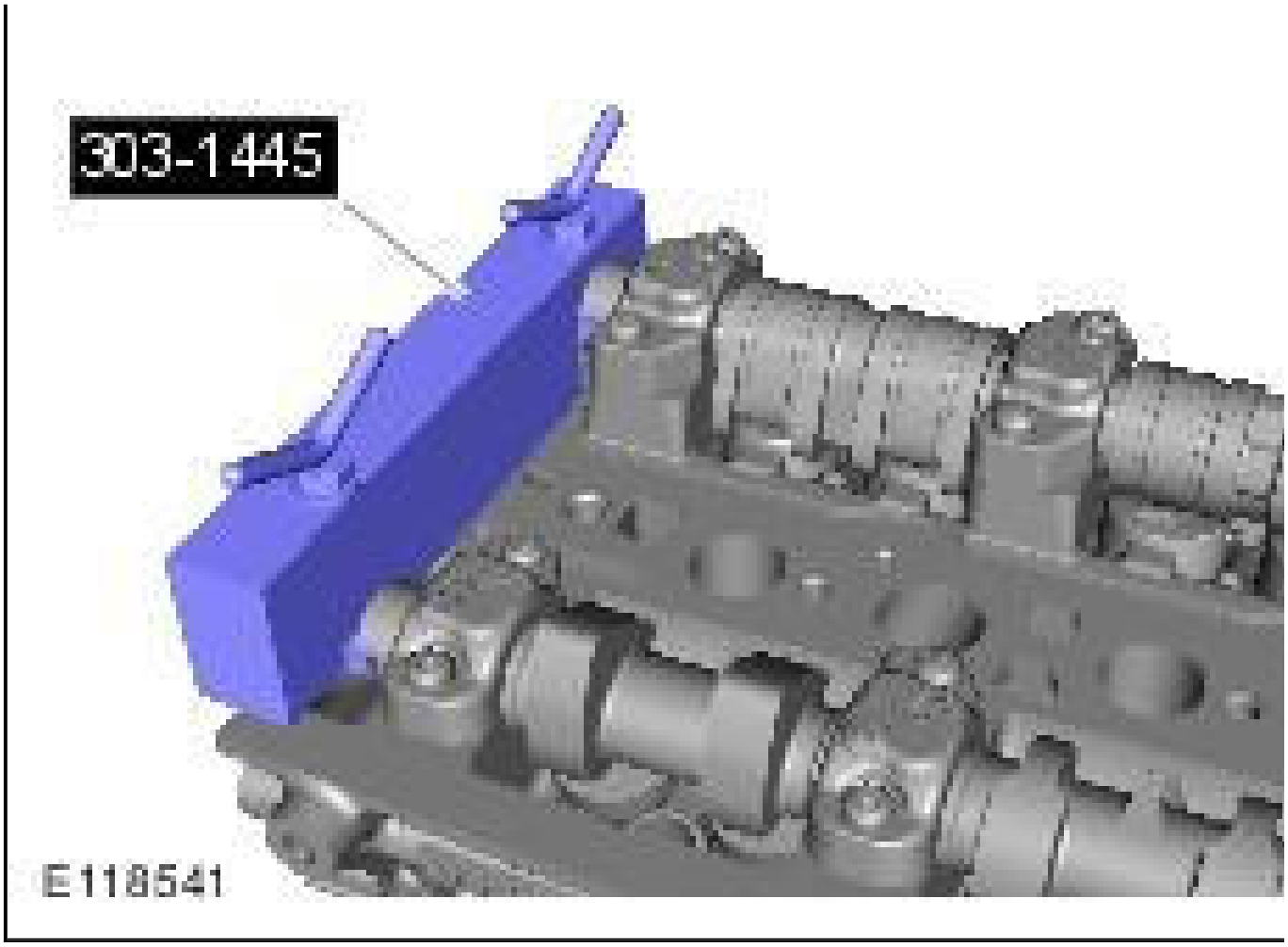

- Remove the special tool.

29. See figure

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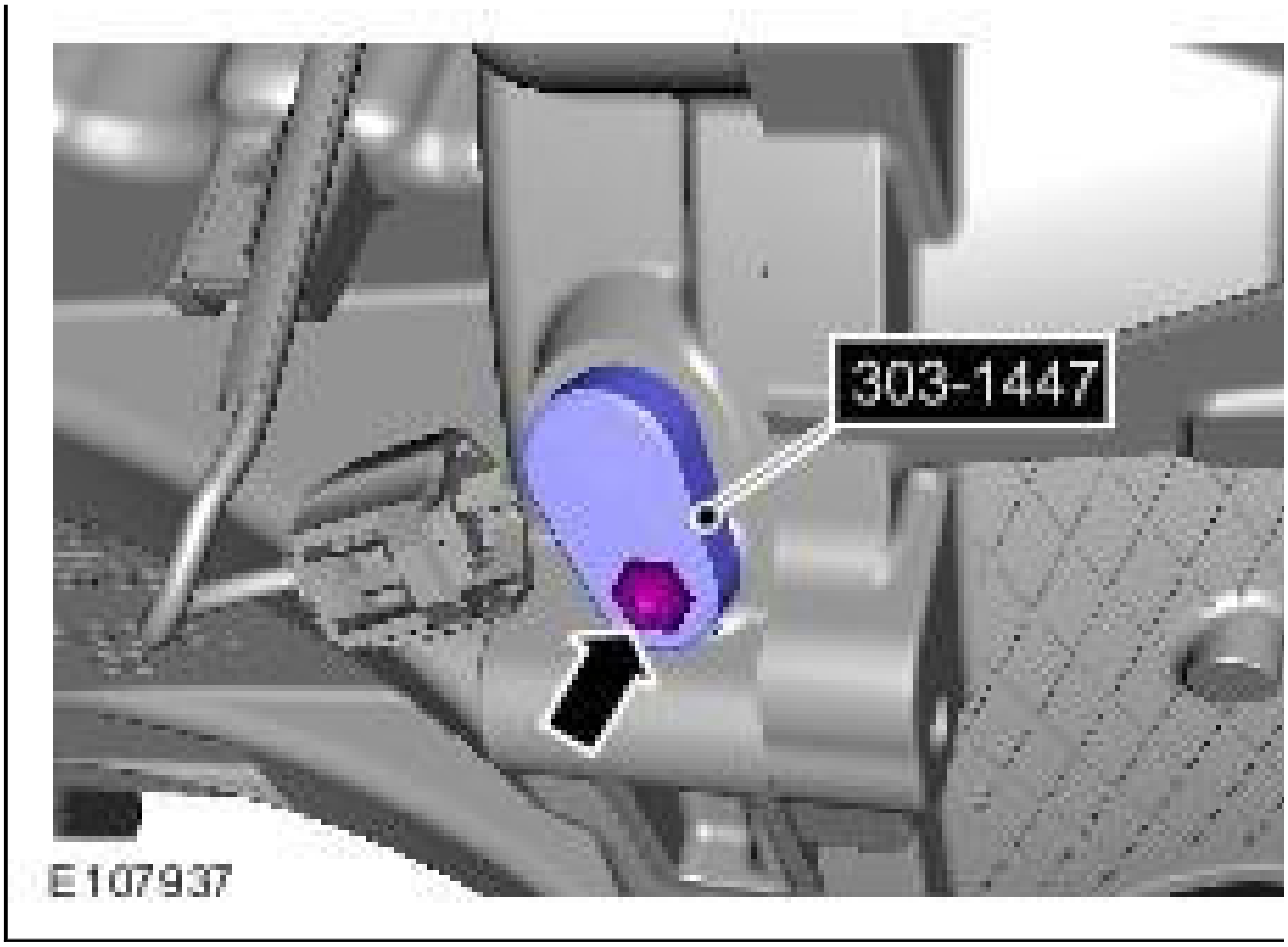

- Remove the special tool.
- Timing Tool (303-1447), refer to **SPECIAL TOOL(S)**

30. See figure

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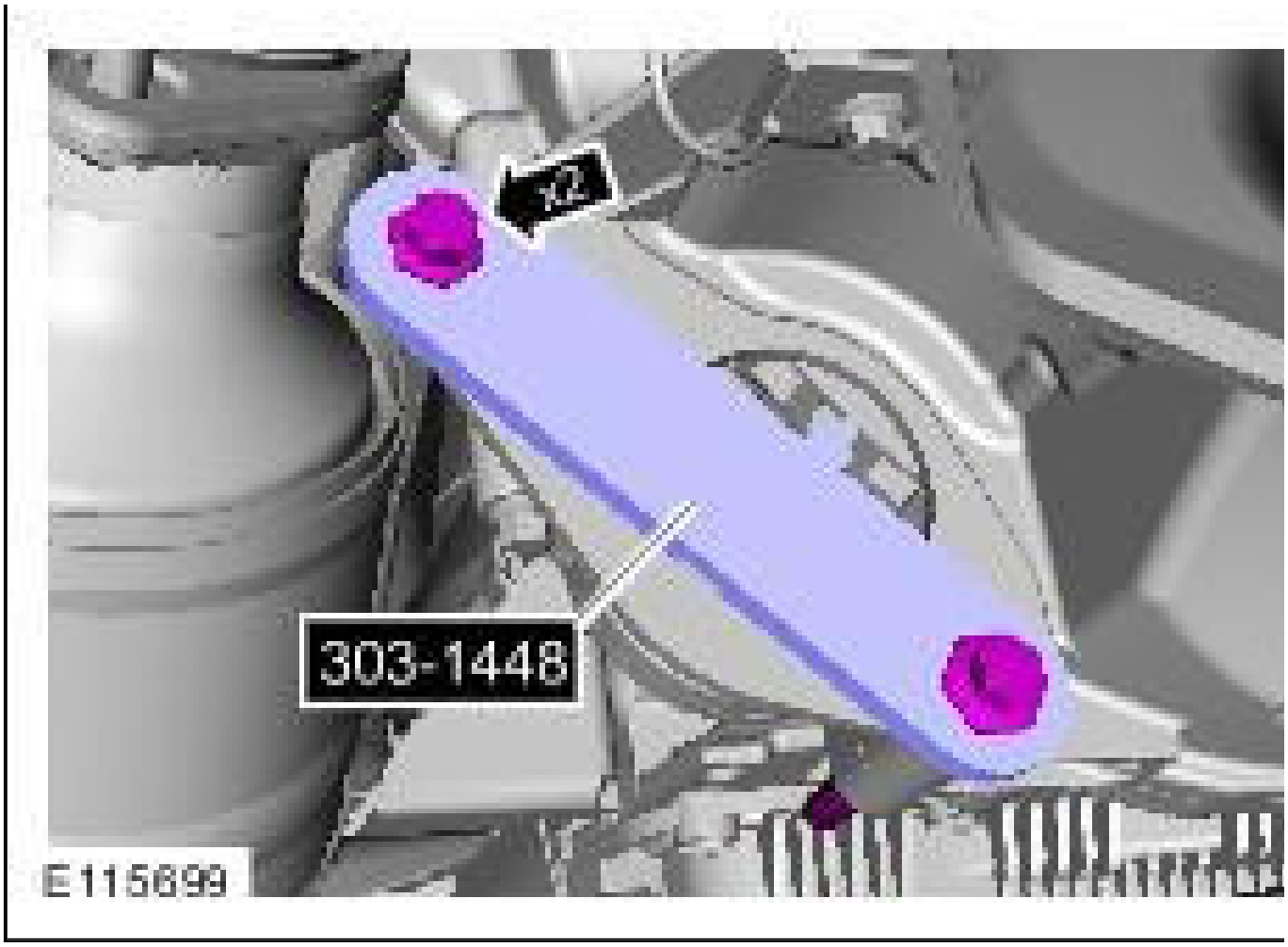

- Install the special tool.
- Locking Tool (303-1448), refer to **SPECIAL TOOL(S)**

31. Torque: 50 Nm

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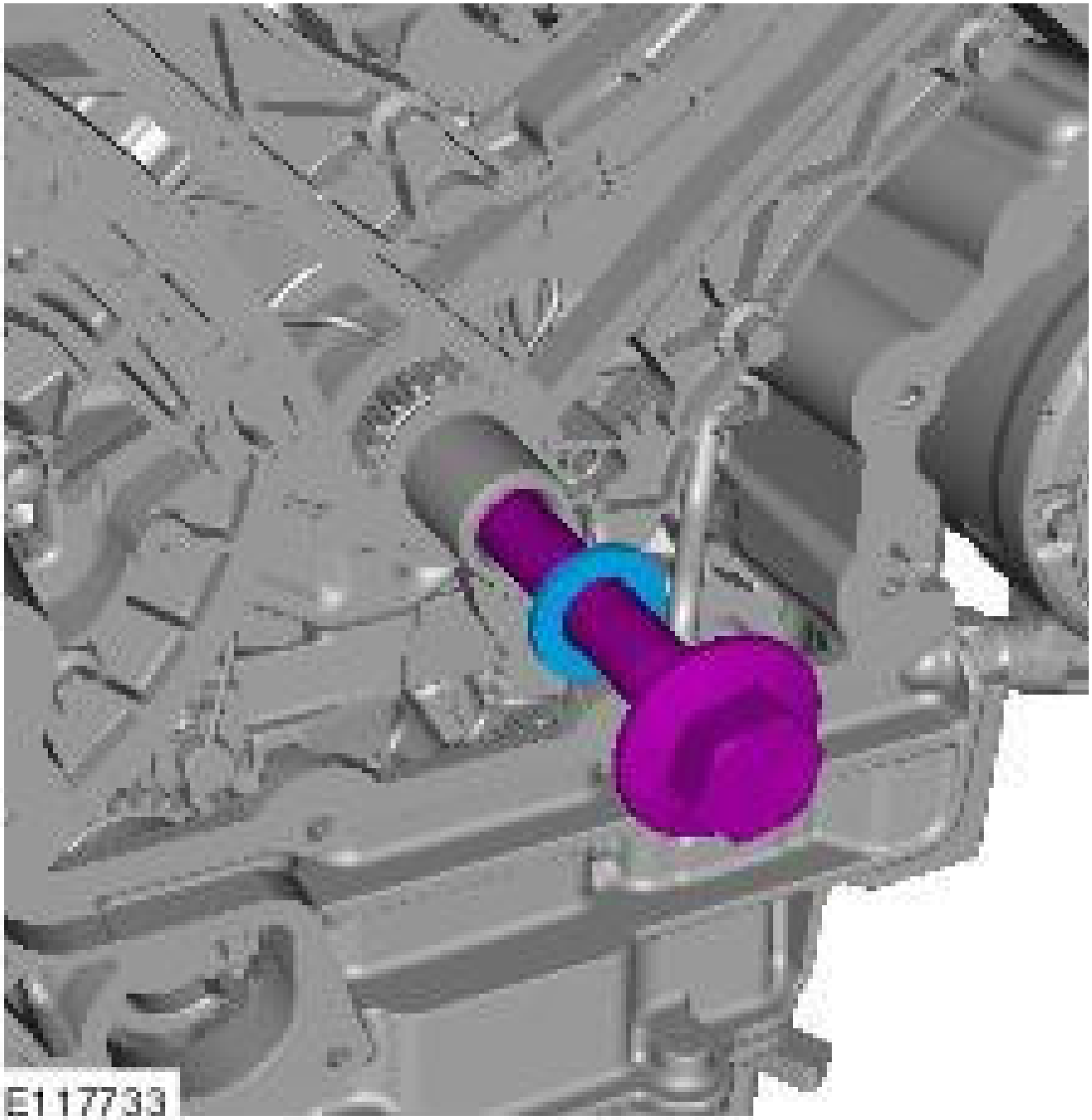

CAUTION: Install the crankshaft pulley bolt with an M16 washer to prevent damage to the crankshaft on installation.

32. See figure

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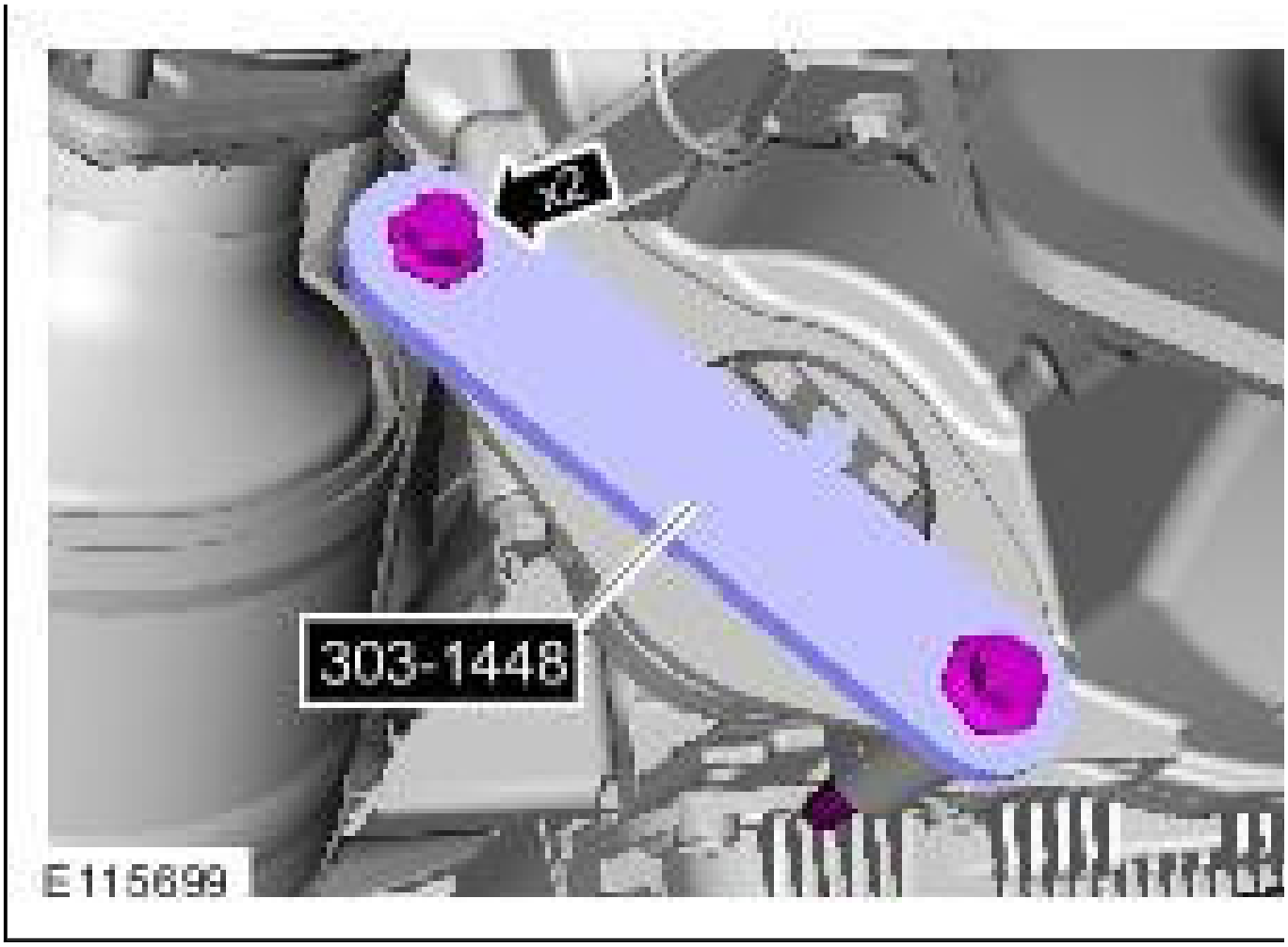

- Remove the special tool.
- Locking Tool (303-1448), refer to **SPECIAL TOOL(S)**

33. Rotate the engine two complete turns clockwise.
34. See figure

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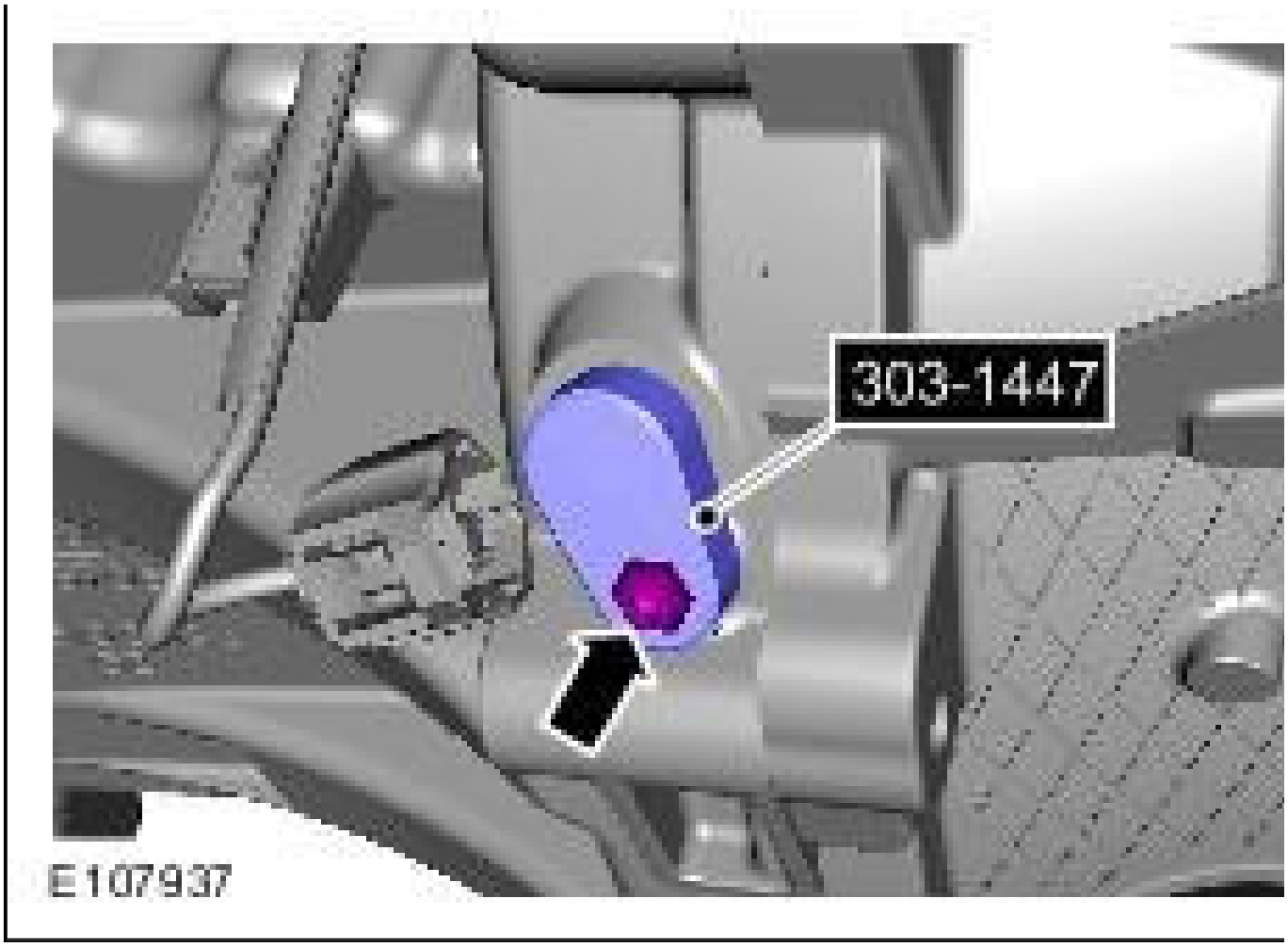

CAUTION: Only rotate the crankshaft clockwise.

- Install the special tool.
- Timing Tool (303-1447), refer to **SPECIAL TOOL(S)**

35. See figure

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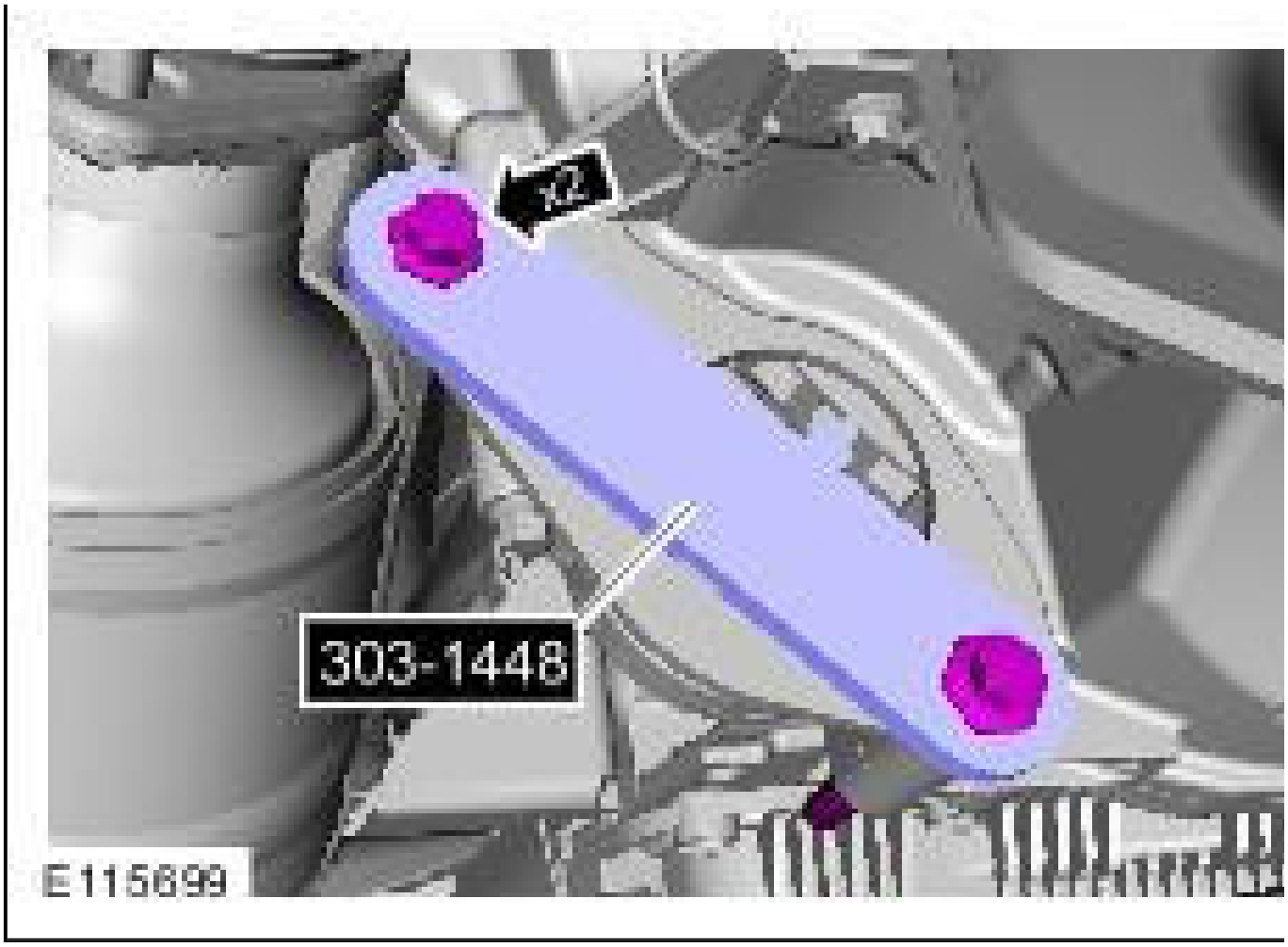

- Install the special tool.
- Locking Tool (303-1448), refer to **SPECIAL TOOL(S)**

36. See figure

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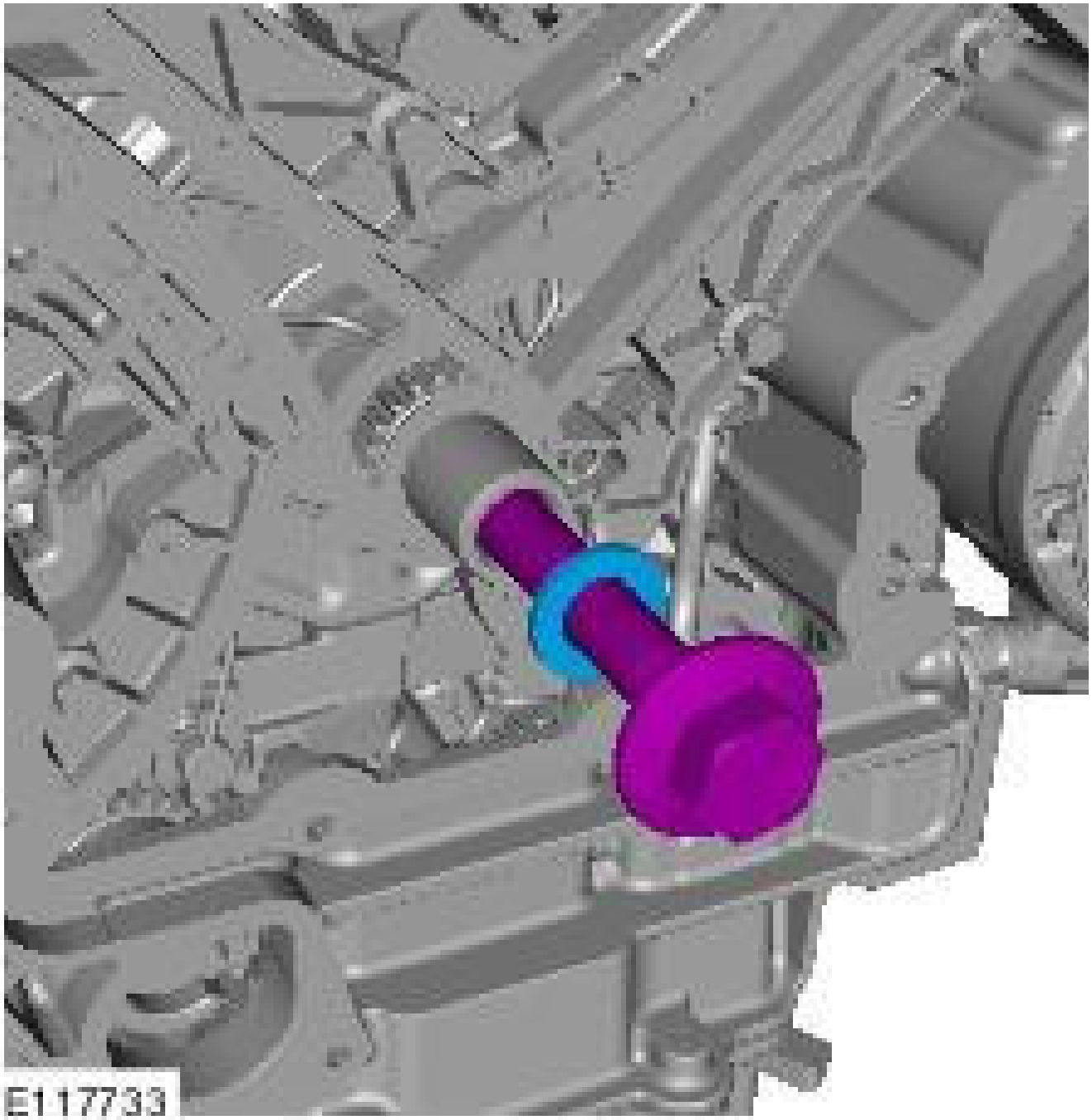

37. See figure

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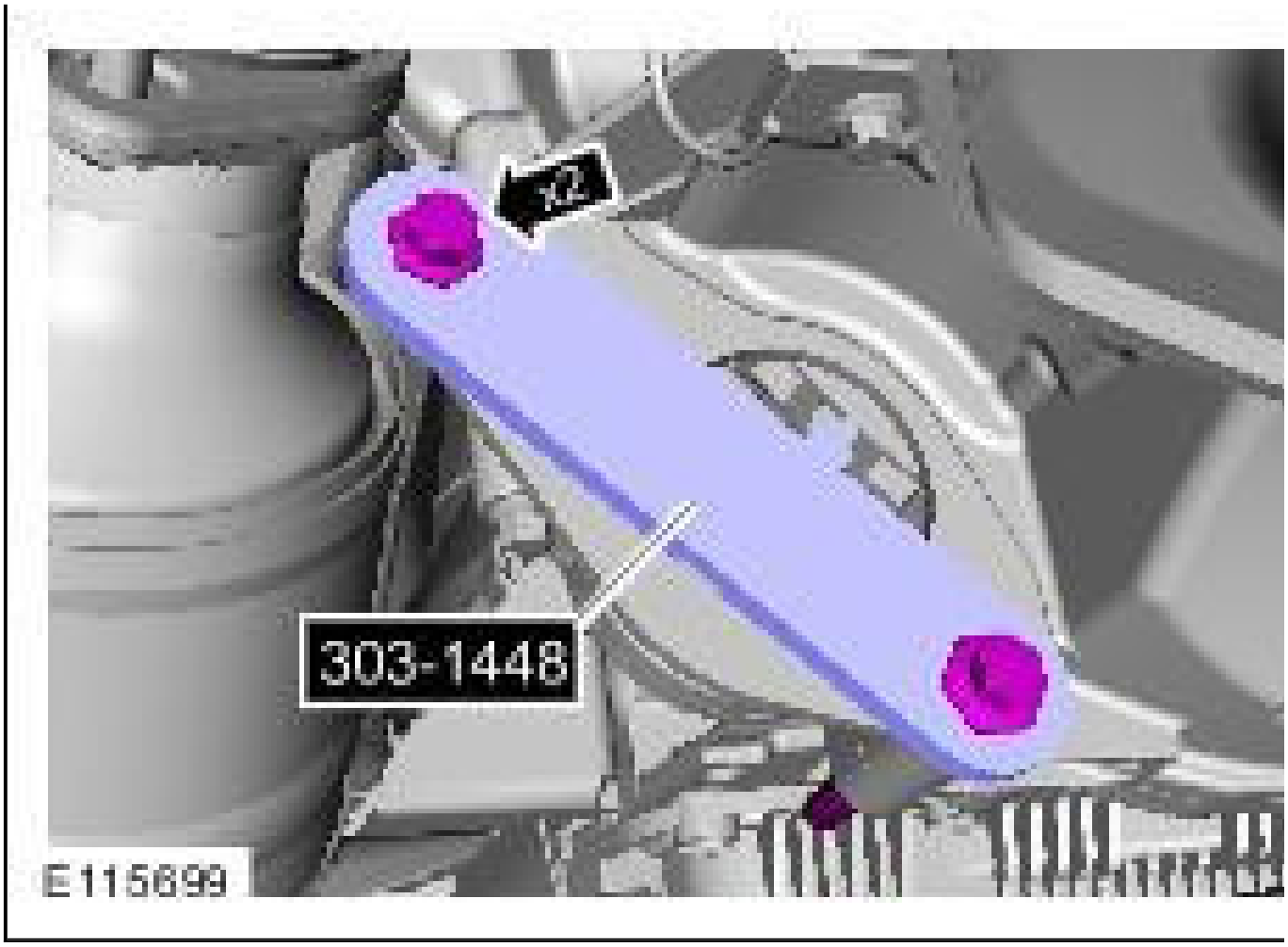

- Remove the special tool.
- Locking Tool (303-1448), refer to **SPECIAL TOOL(S)**

38. Install the special tool.

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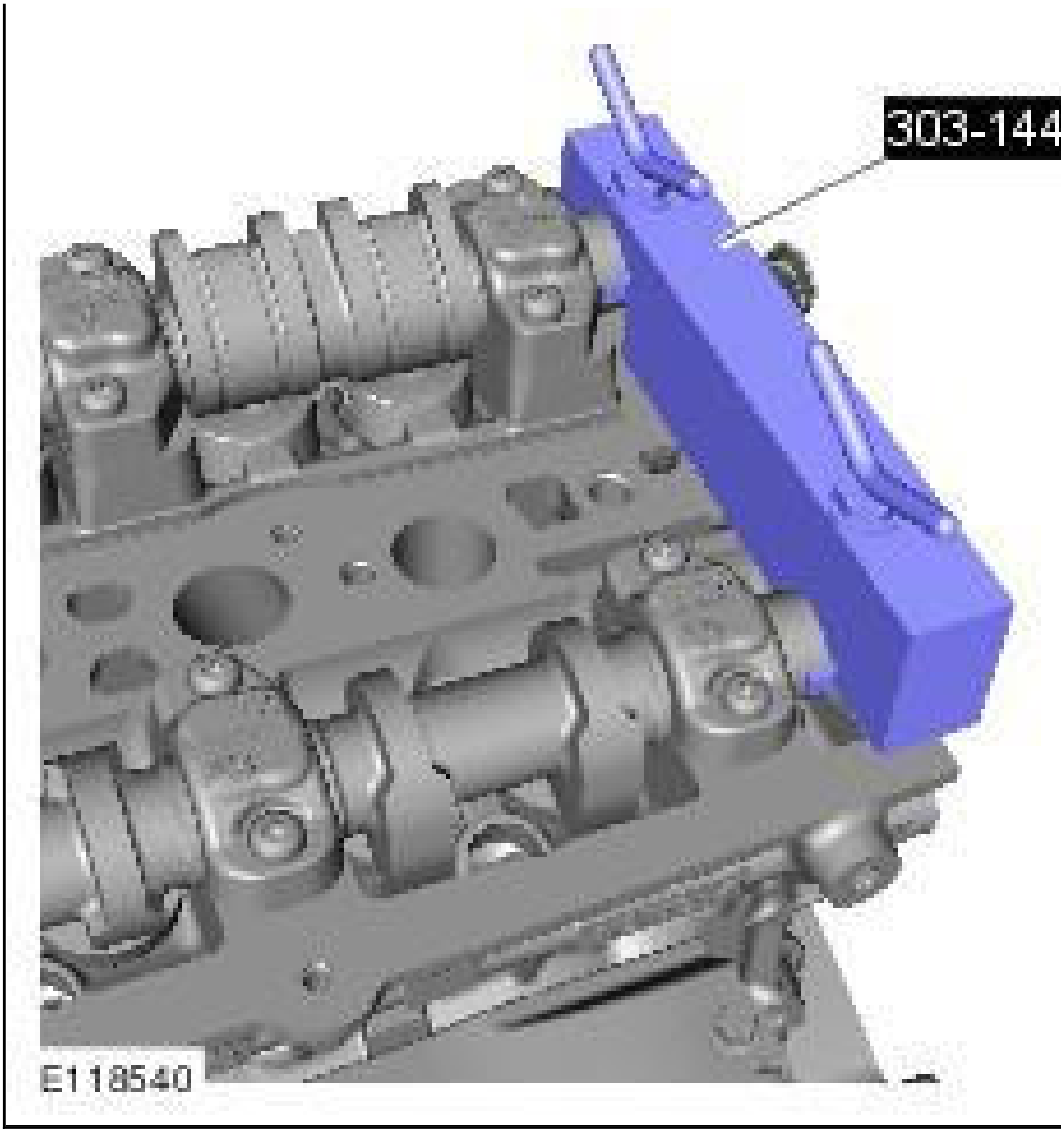

CAUTION: If the special tool cannot be installed, return to step 22 of the installation until the special tool 303-1445 is installed correctly.

CAUTION: If directed to step 22, make sure that the VVT unit retaining bolts are loosened prior to installing the special tool(s).

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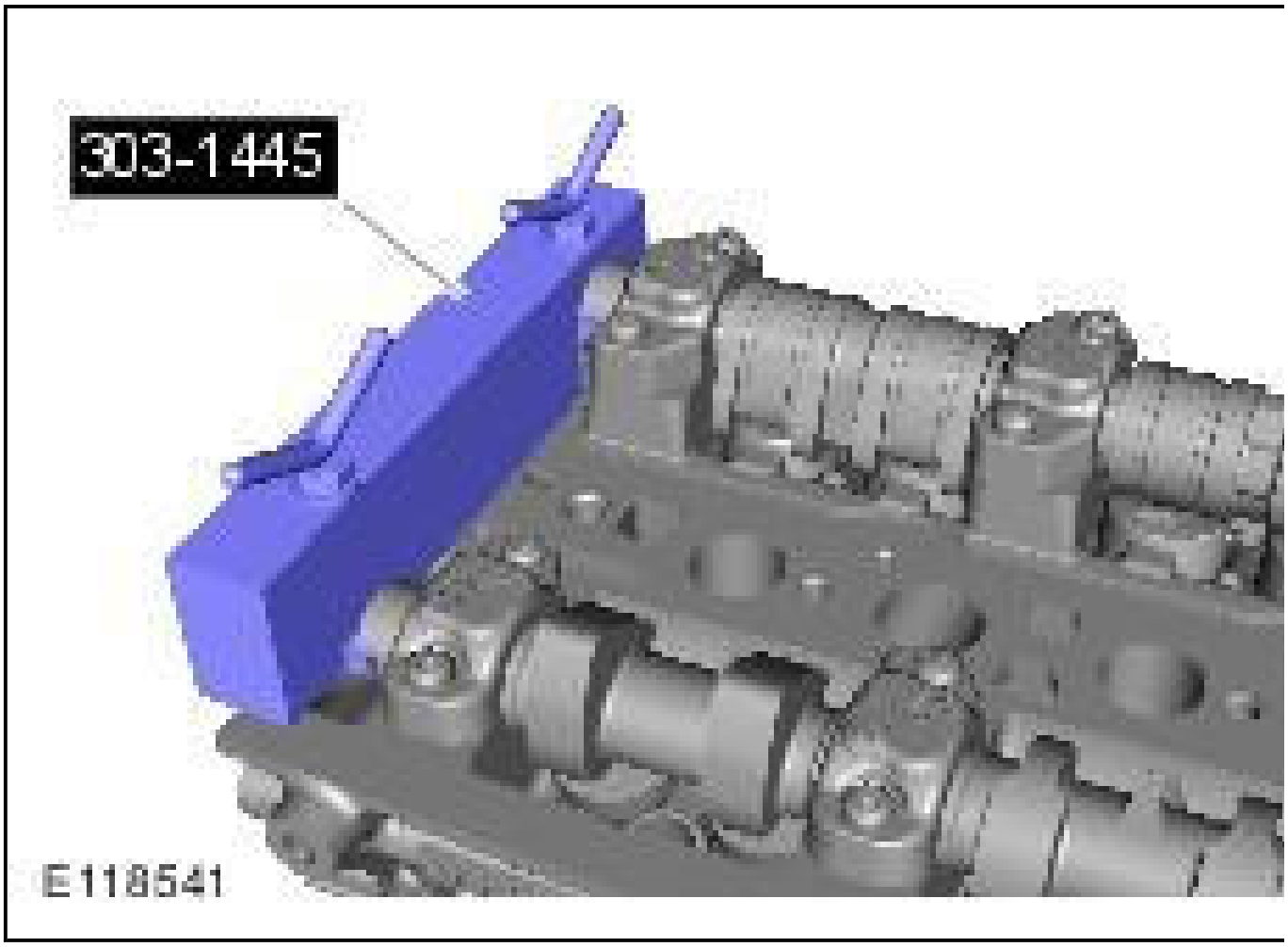
Timing Tool - Camshaft Alignment (303-1445), refer to **SPECIAL TOOL(S)**

39. Install the special tool.



CAUTION: If the special tool cannot be installed, the timing chain installation steps must be repeated.

40. See figure

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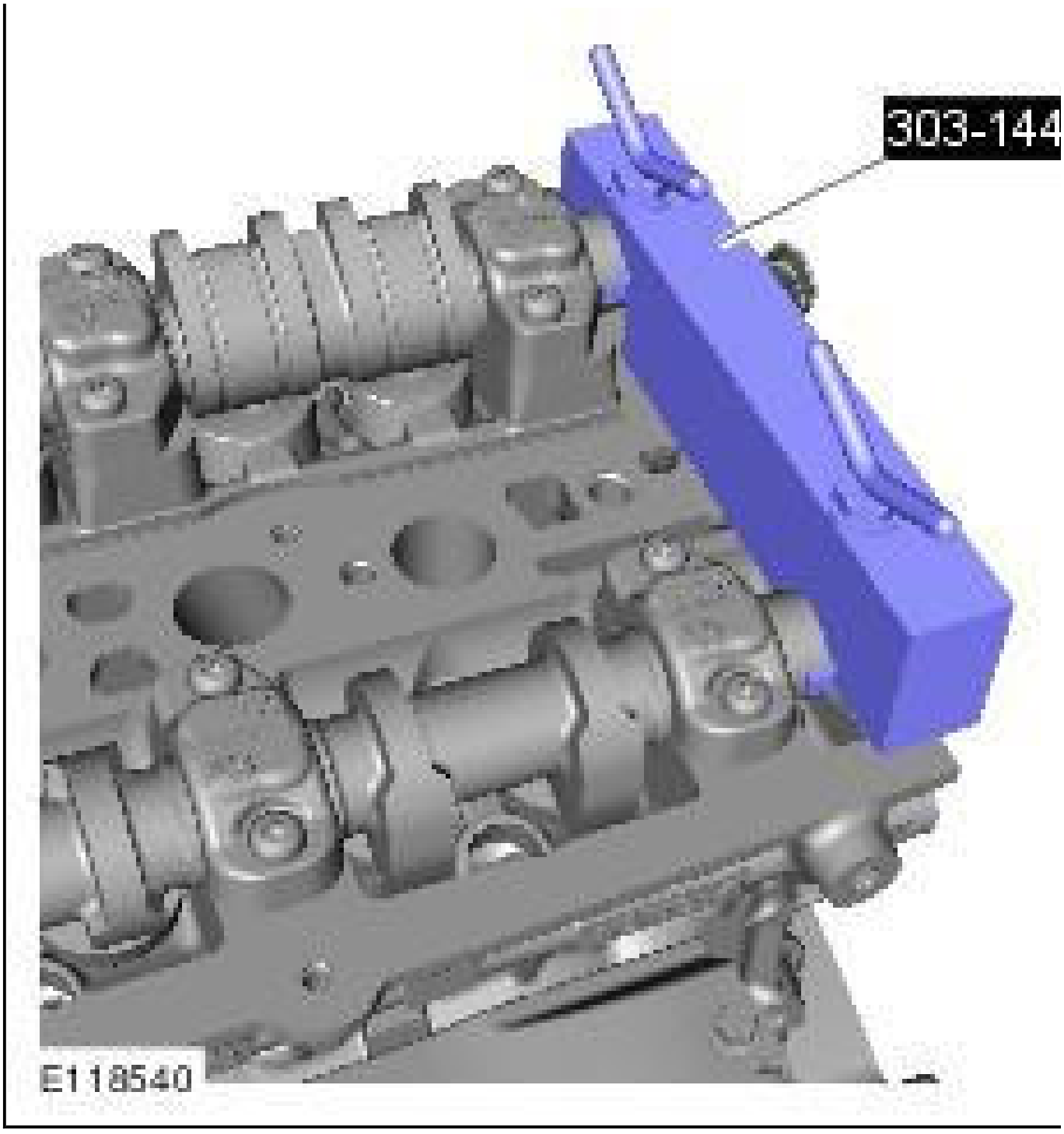

- Remove the special tool.

41. See figure

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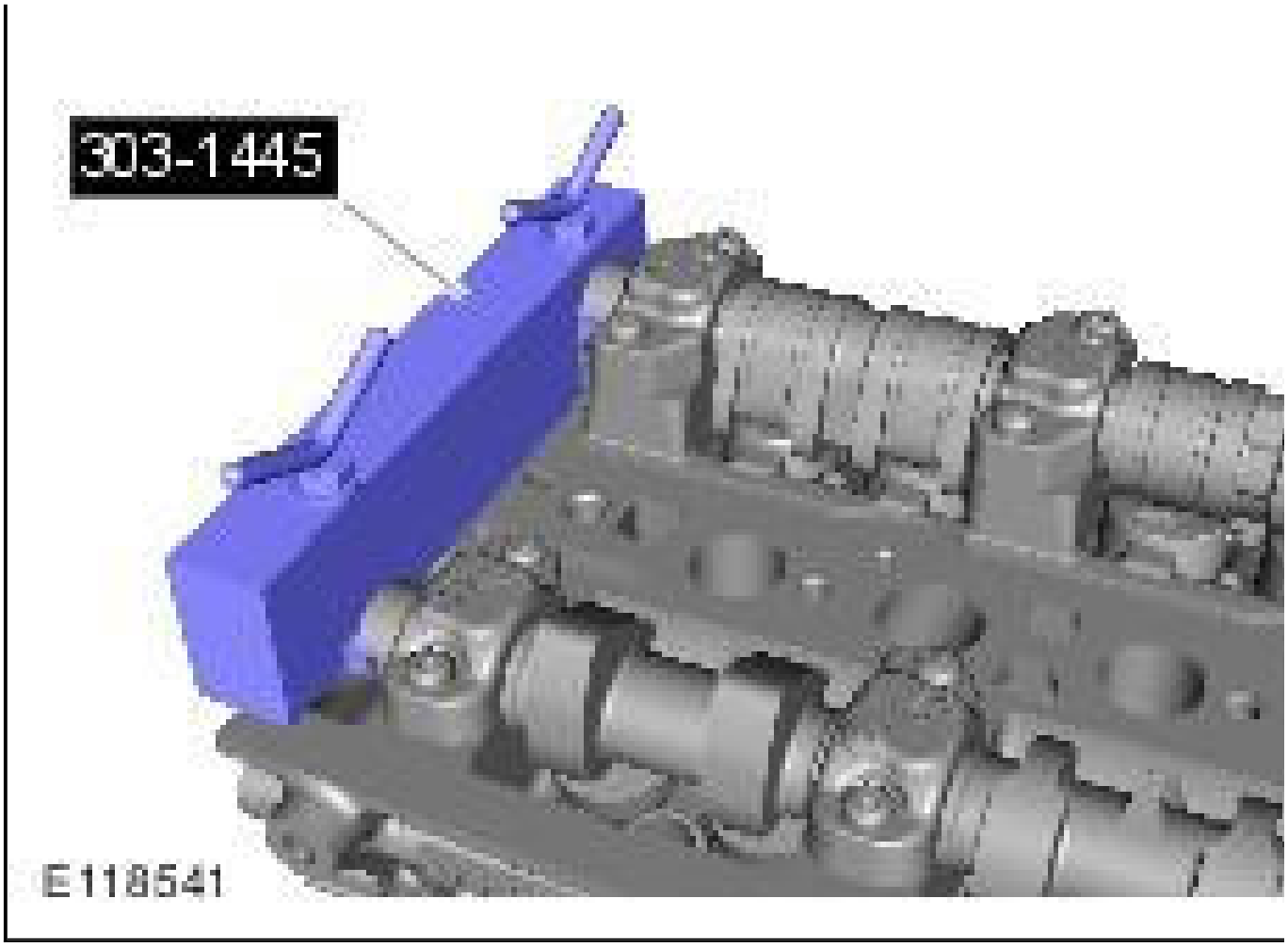

- Remove the special tool.

42. See figure

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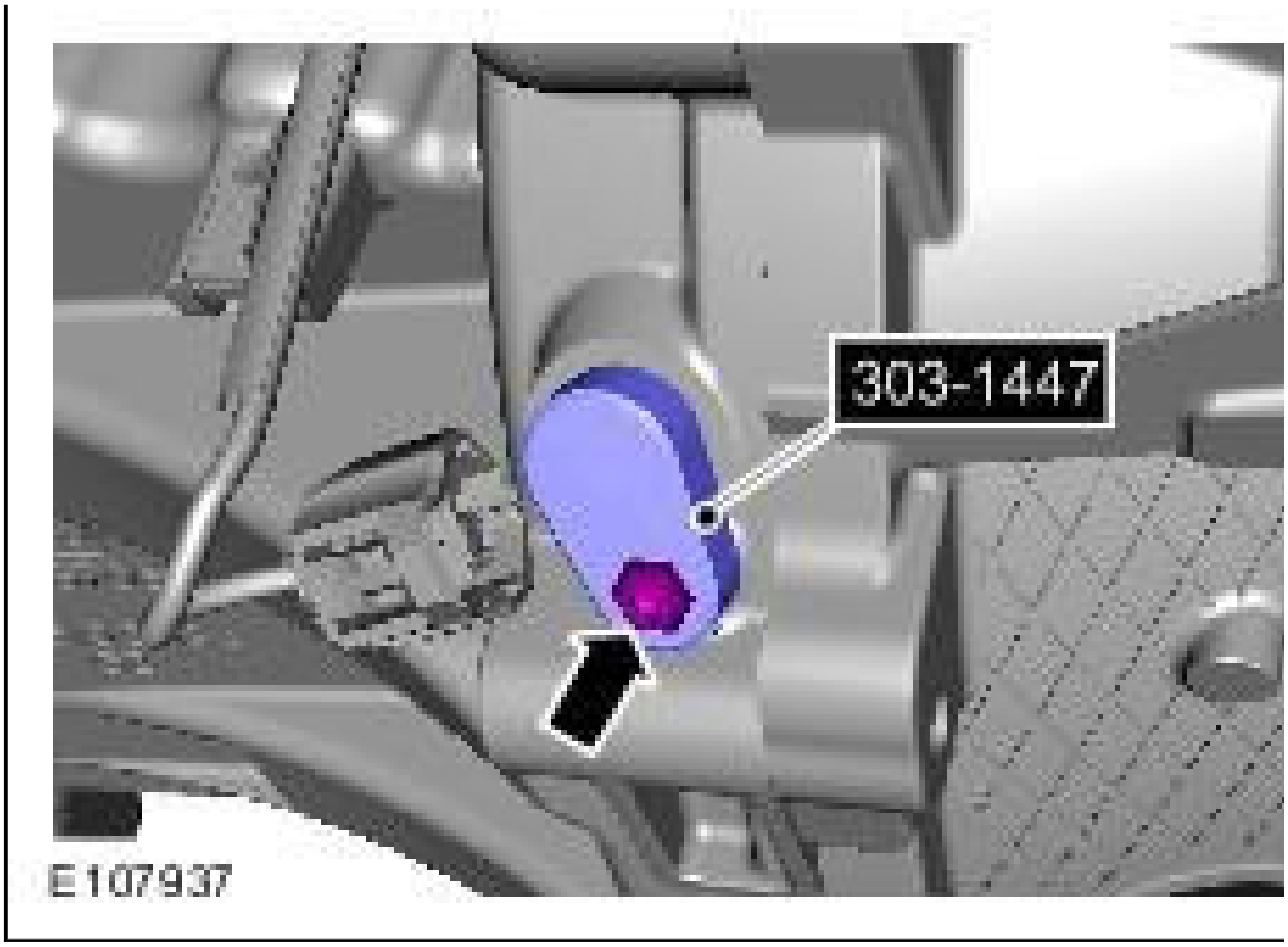

- Remove the special tool.
- Timing Tool (303-1447)

43. Torque: 10 Nm

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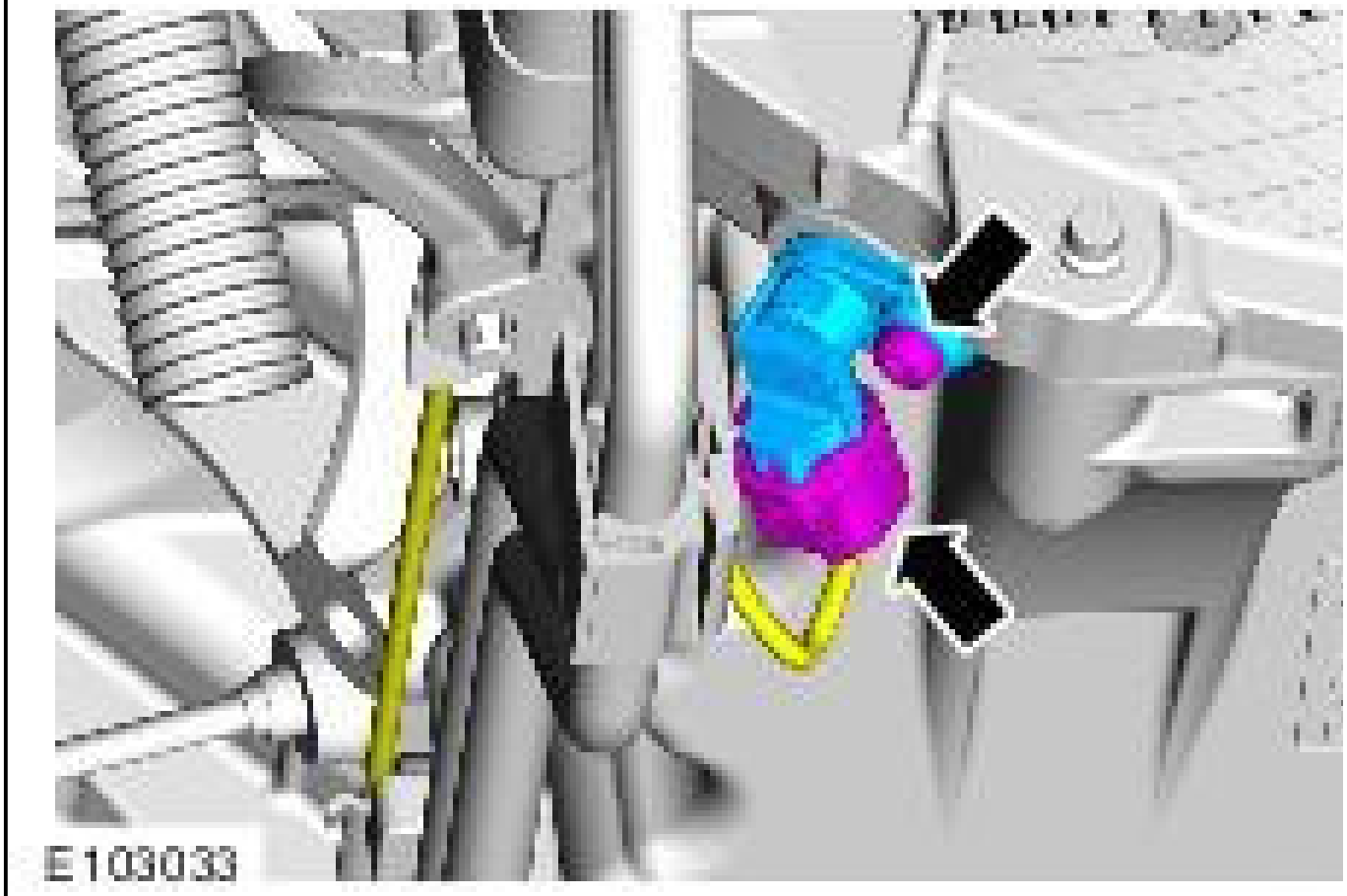

44. Refer to **Timing Cover** .
45. Connect the battery ground cable. Refer to **Specifications** .

VALVE COVER LH

SPECIAL TOOL(S)

	303-1446 Valve Cover Alignment Tool

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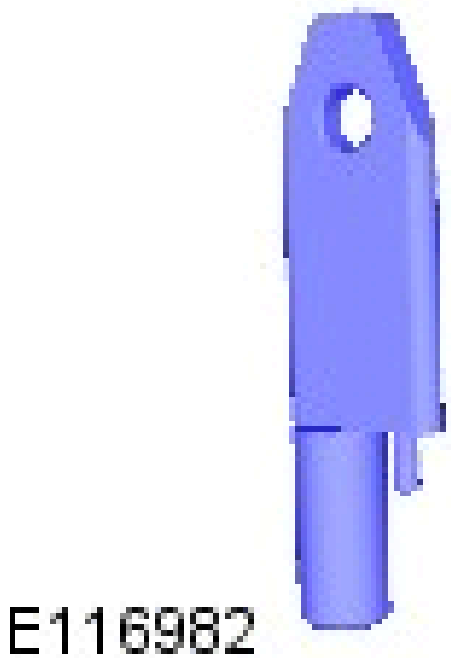


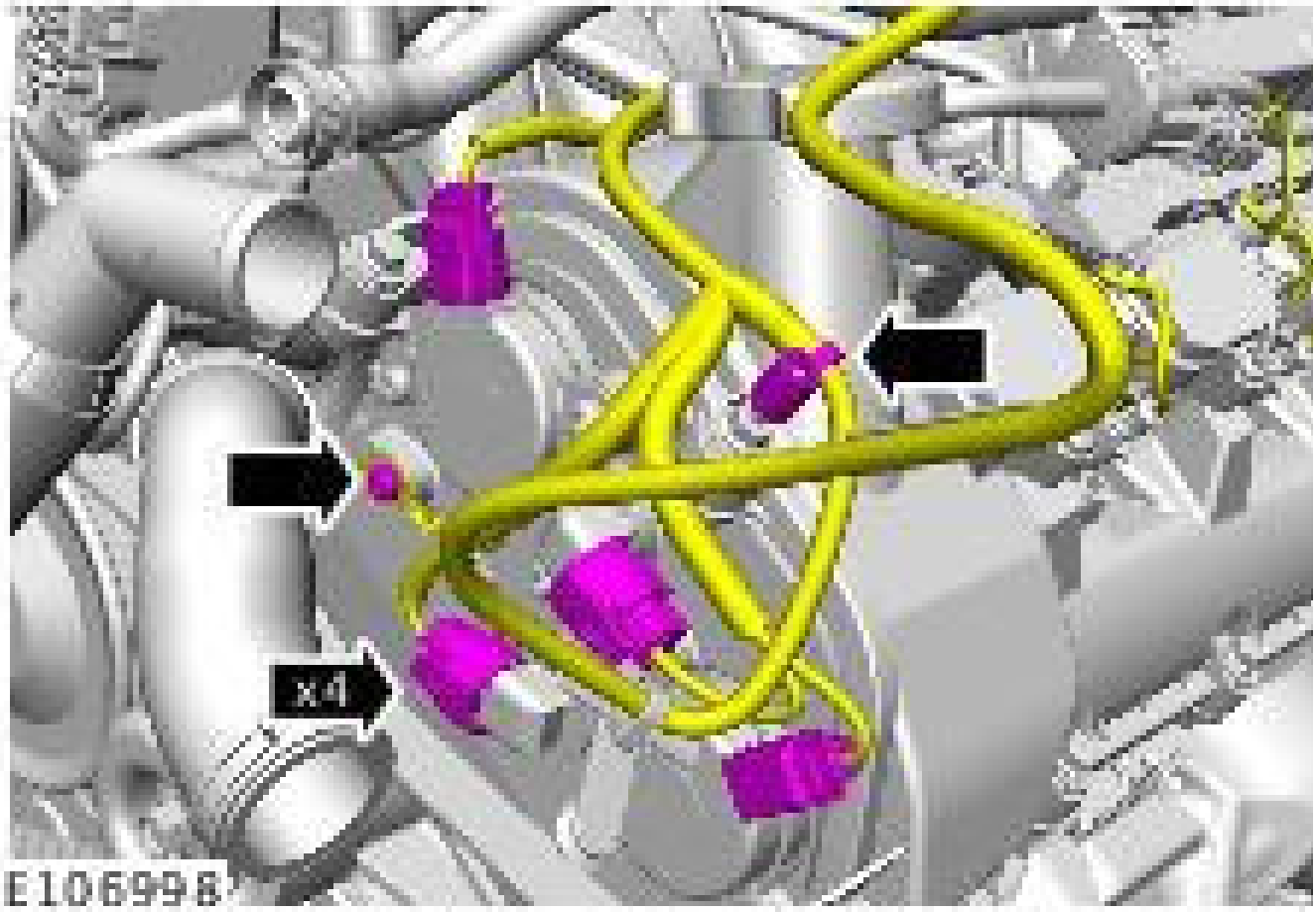
REMOVAL

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.

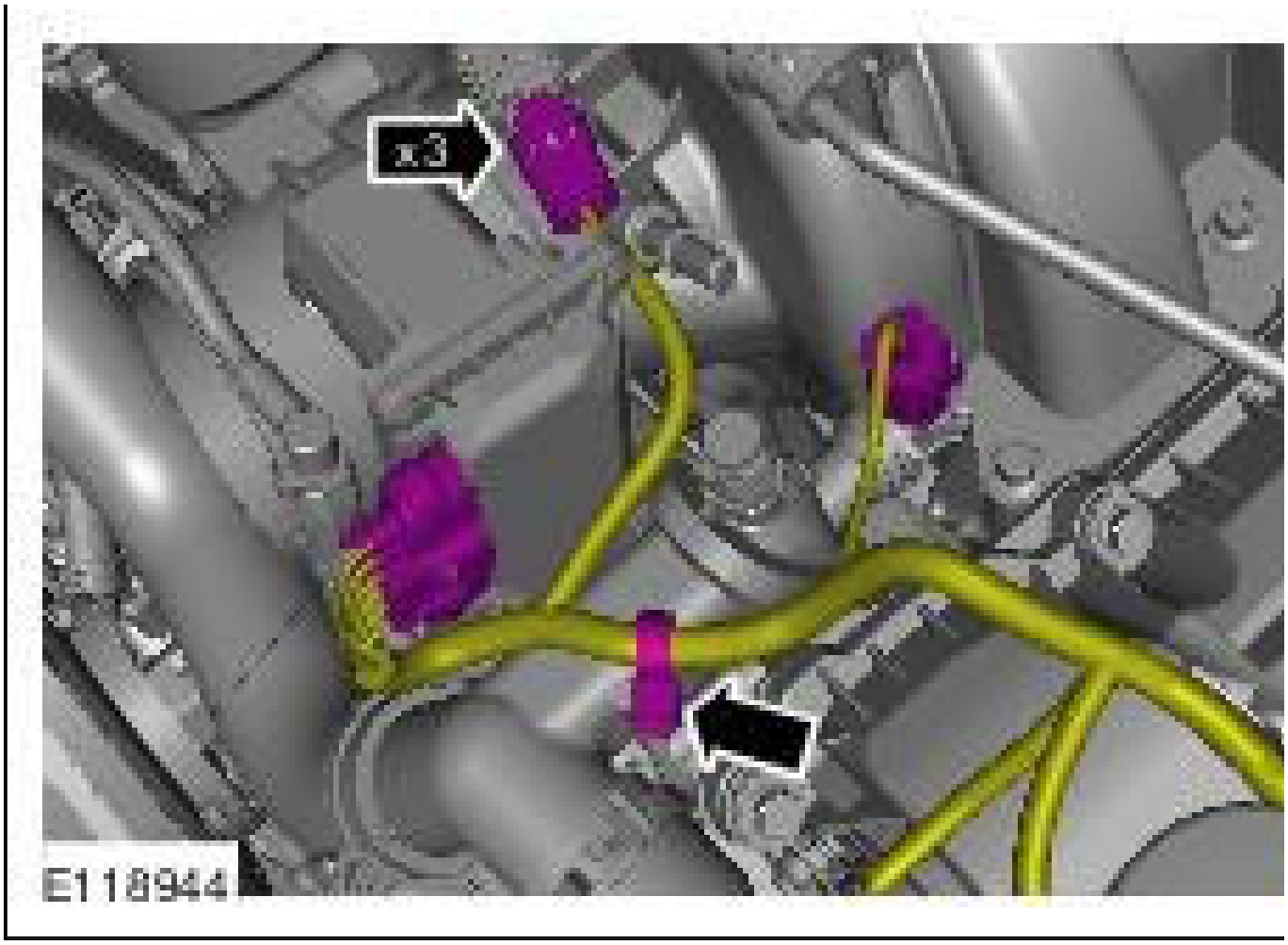
1. Disconnect the battery ground cable. Refer to **Specifications** .
2. Refer to **AIR CLEANER OUTLET PIPE T-CONNECTOR**
3. Refer to **Air Cleaner Outlet Pipe LH** .
4. Refer to **Fuel Rail LH** .
5. Torque: 10 Nm

 © 2011 Mitchell Repair Information Company, LLC.



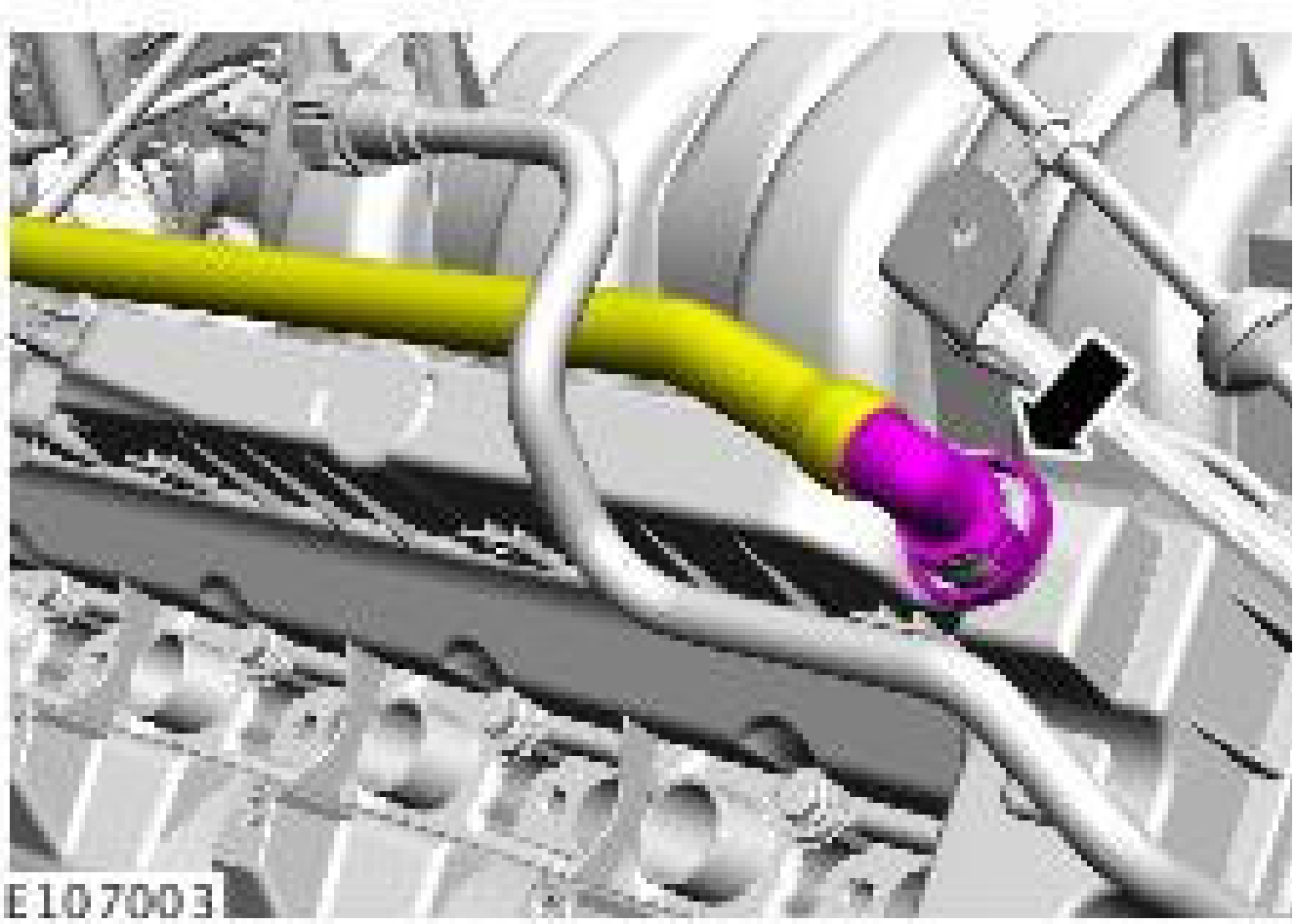
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



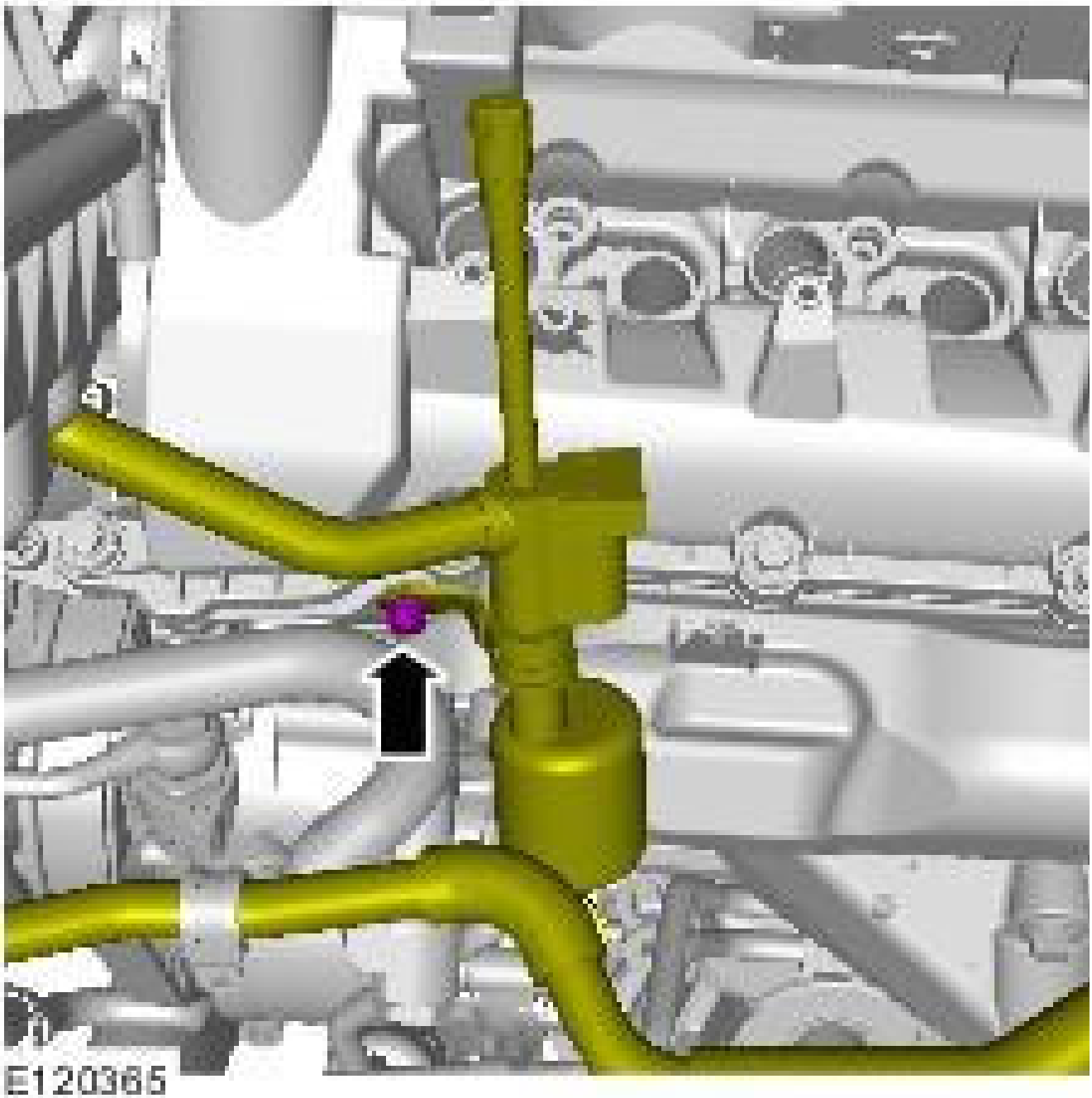
7. See figure

 © 2011 Mitchell Repair Information Company, LLC.



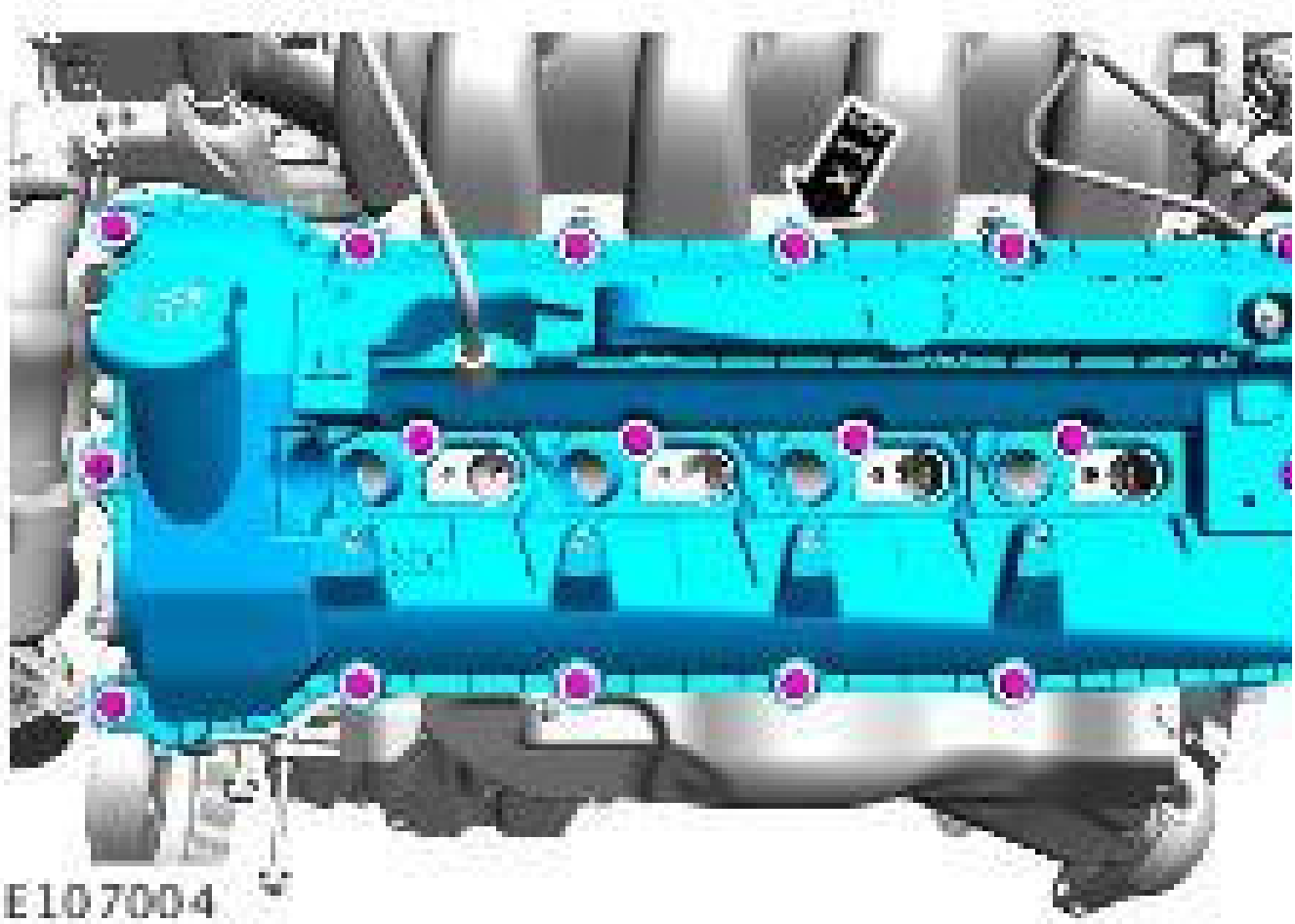
8. Torque: 25 Nm

 © 2011 Mitchell Repair Information Company, LLC.



9. See figure

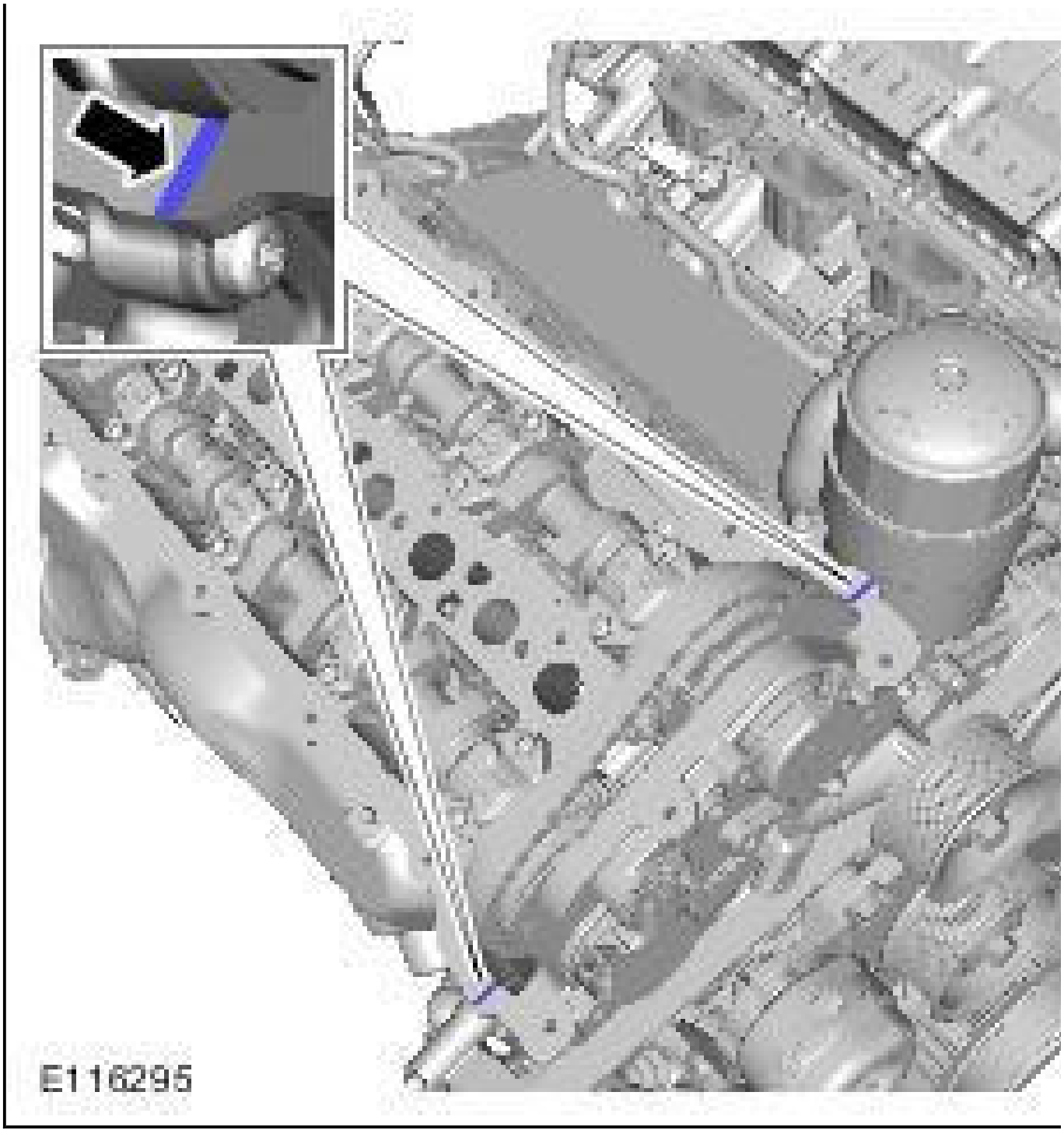
 © 2011 Mitchell Repair Information Company, LLC.



INSTALLATION

1. To install, reverse the removal procedure.

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Use only a plastic scraper when removing the sealing material.

CAUTION: Use lint free cloth.

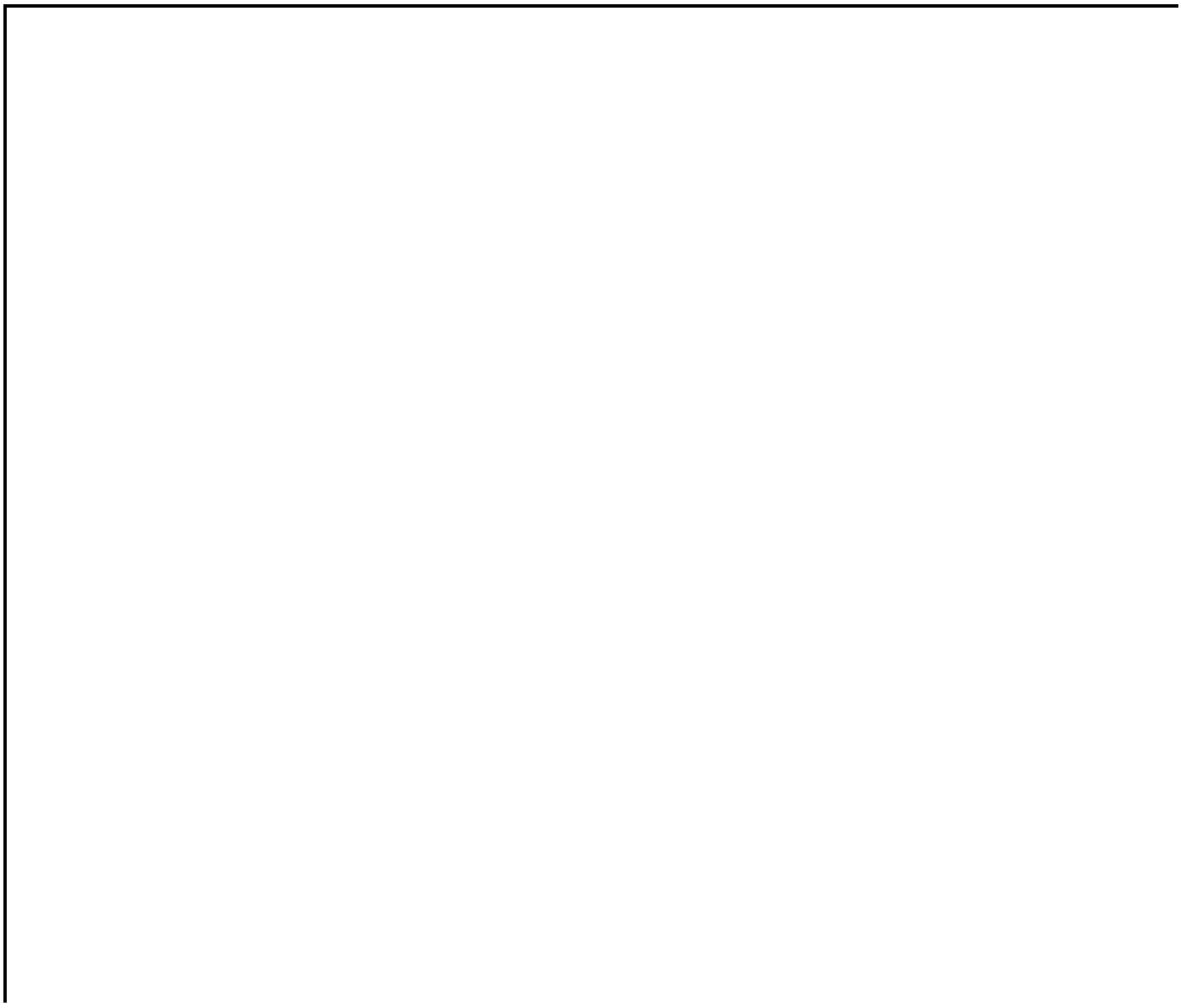
 © 2011 Mitchell Repair Information Company, LLC.

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

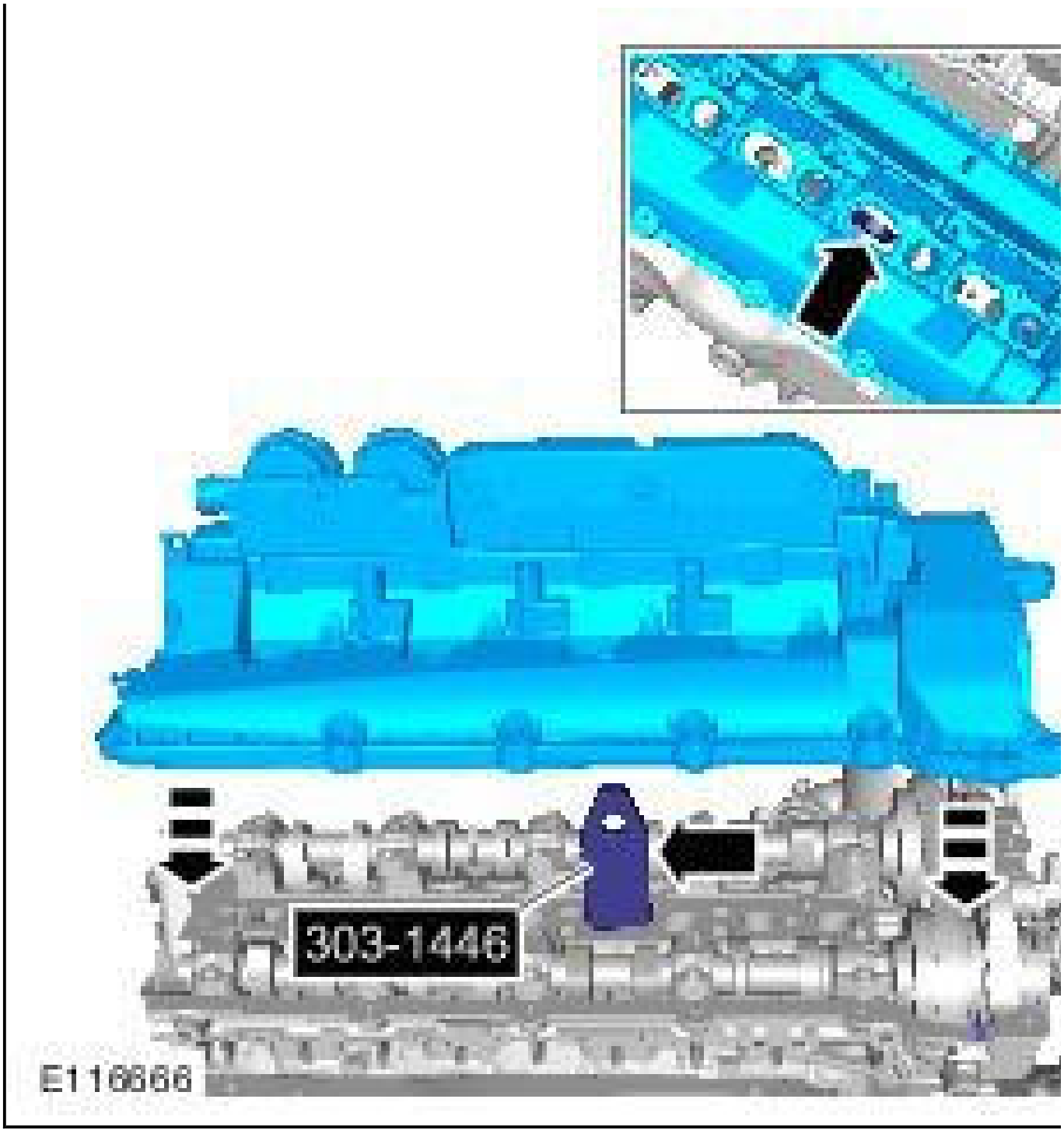
CAUTION: Installation of the valve cover and tightening must be carried out within 7 minutes of applying the sealant.

NOTE: Apply two beads of silicone gasket sealant (Loctite 5901) as shown on the illustration. The application of the sealant must be 1.5mm diameter 12mm long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

2. See figure



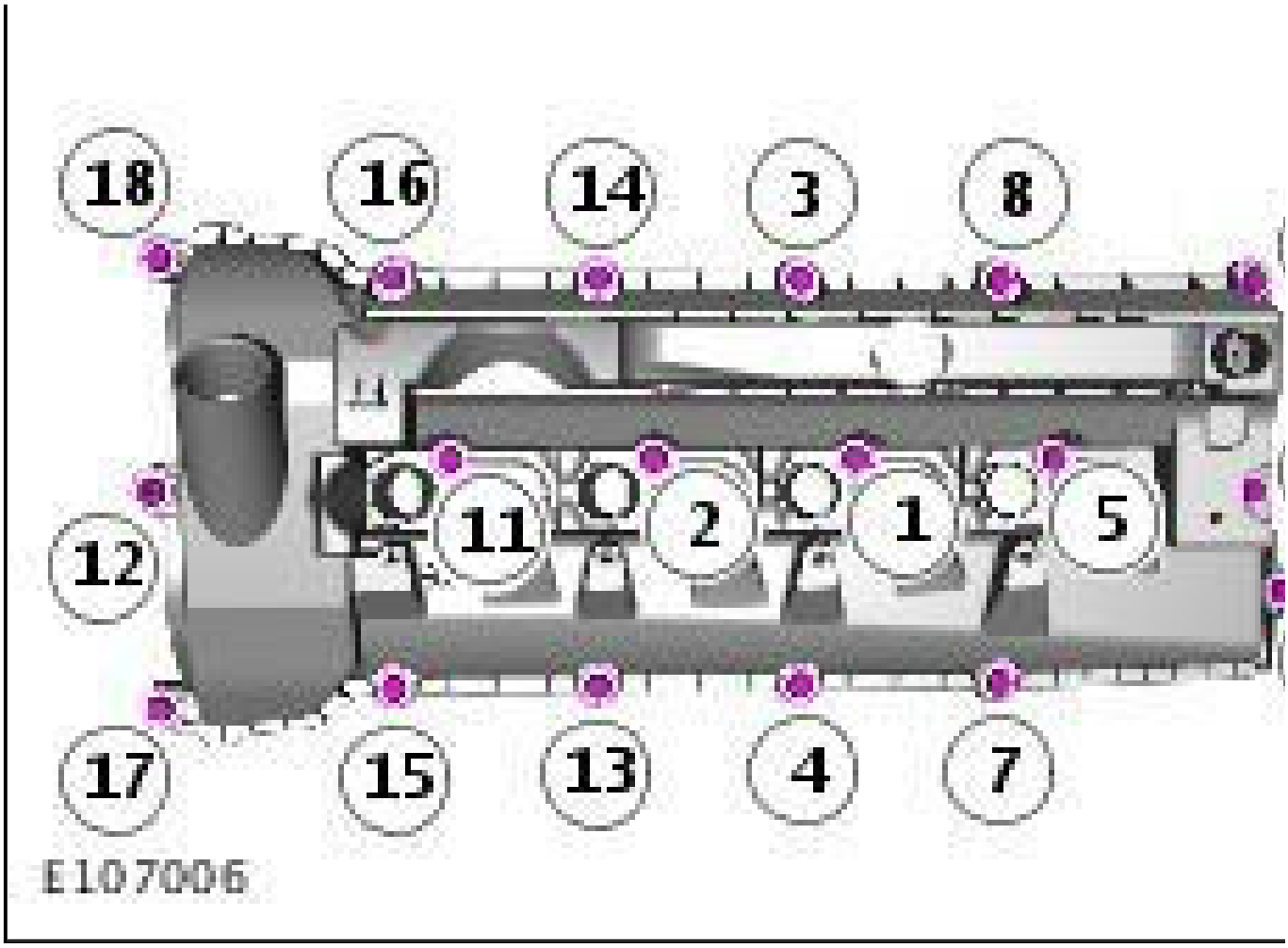
 © 2011 Mitchell Repair Information Company, LLC.



Valve Cover Alignment Tool (303-1446), refer to **SPECIAL TOOL(S)**

3. Torque: 13 Nm

 © 2011 Mitchell Repair Information Company, LLC.



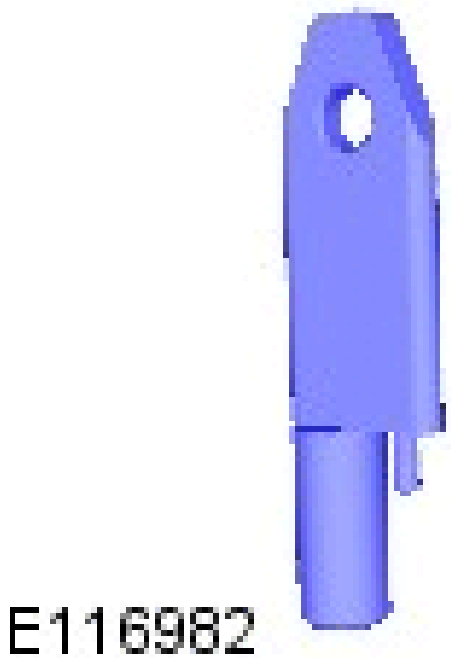
NOTE: Tighten the bolts in the indicated sequence.

VALVE COVER RH

SPECIAL TOOL(S)

	303-1446 Valve Cover Alignment Tool

 © 2011 Mitchell Repair Information Company, LLC.



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.

1. Disconnect the battery ground cable. Refer to **Specifications** .
2. Refer to **AIR CLEANER OUTLET PIPE T-CONNECTOR**
3. Refer to **Air Cleaner Outlet Pipe RH** .
4. Refer to **Fuel Rail RH** .
5. See figure

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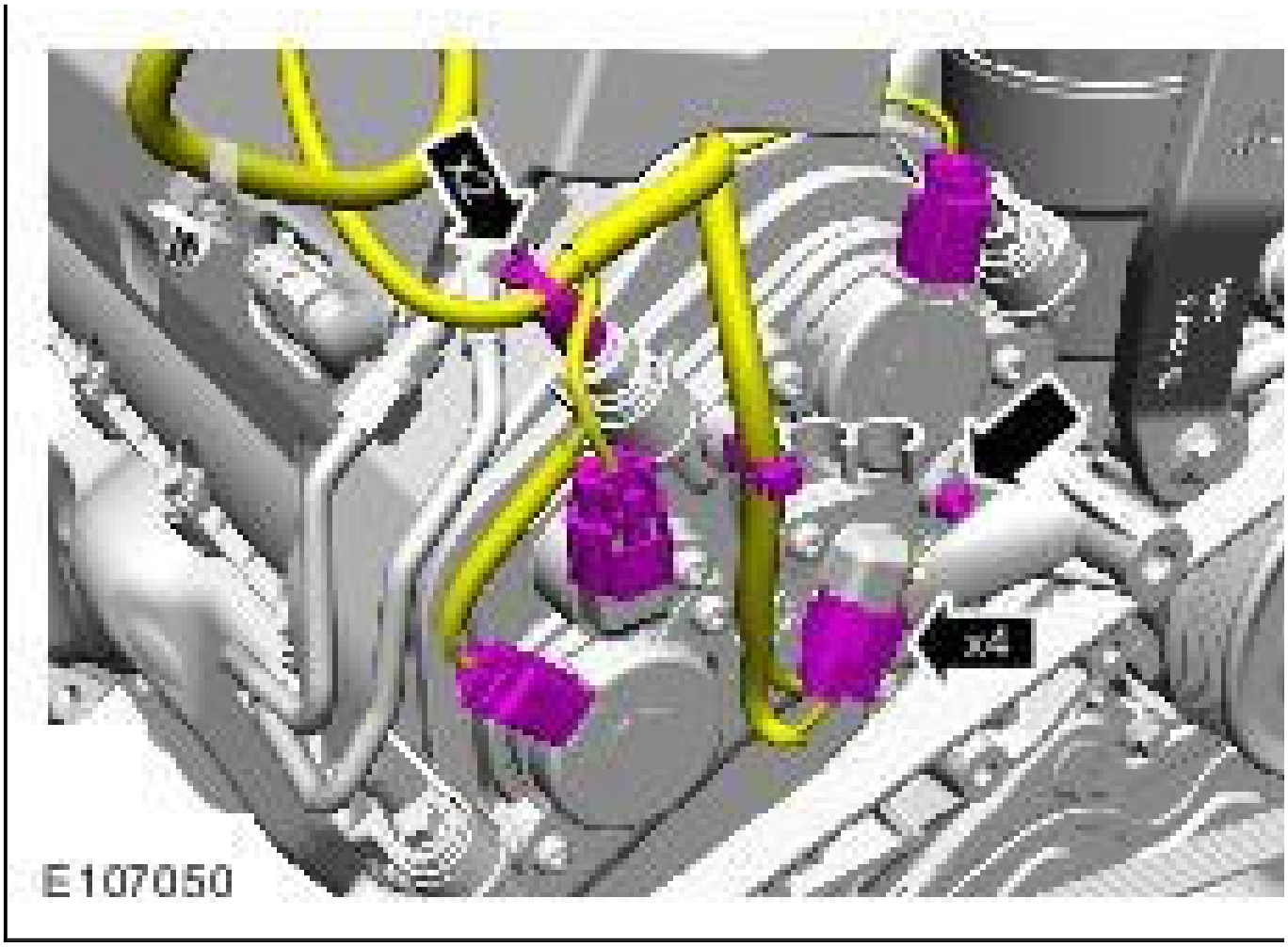
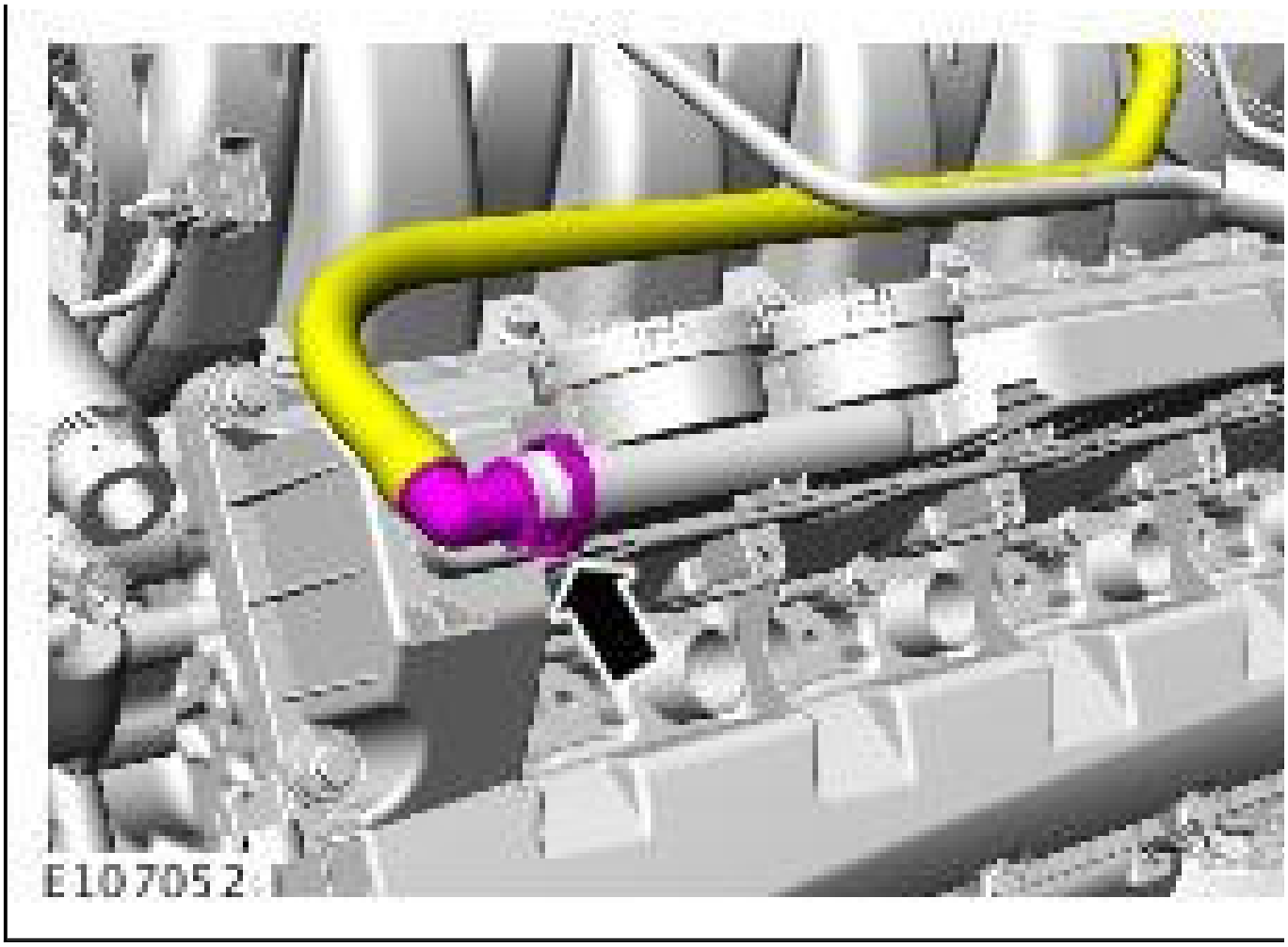


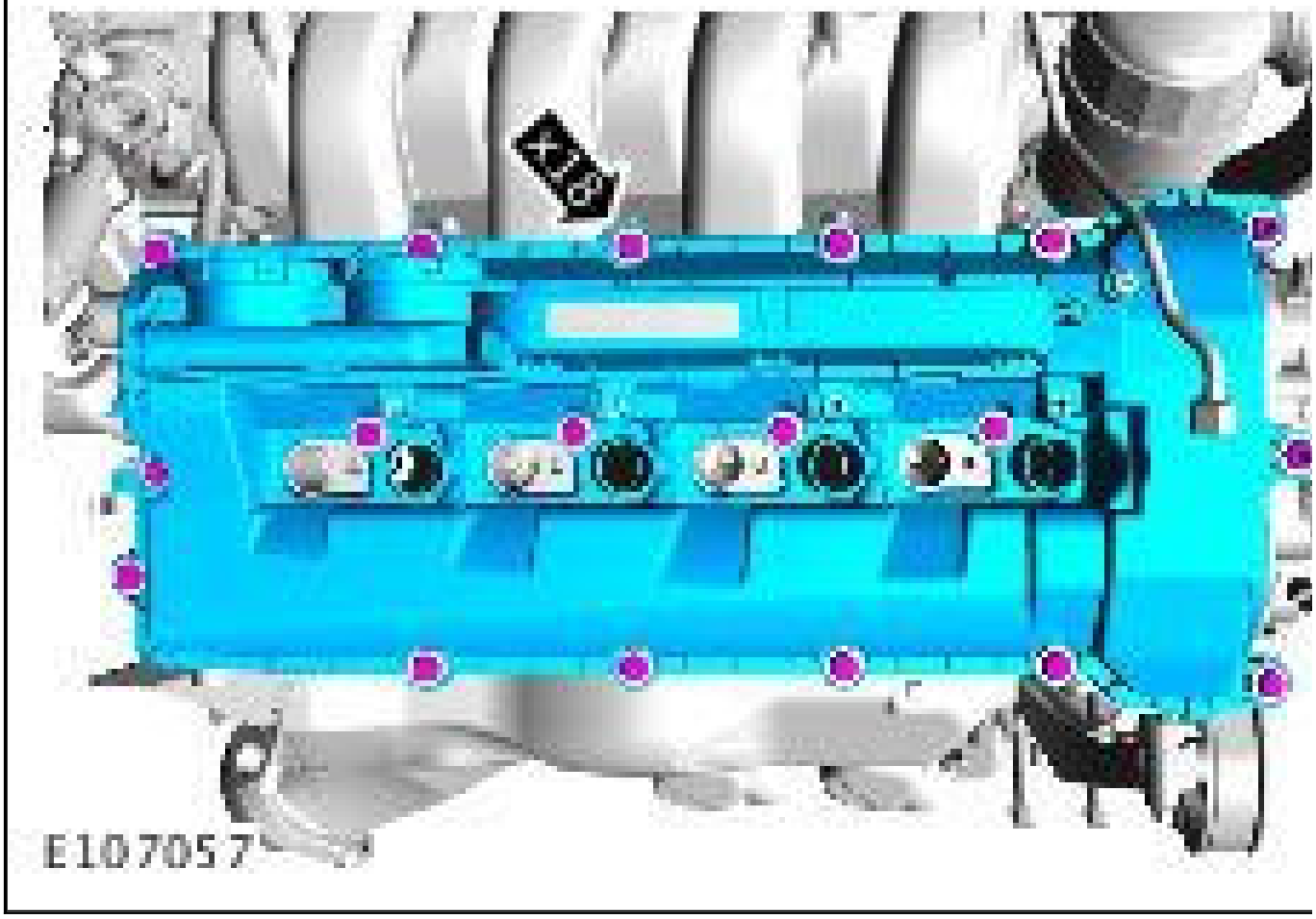
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



7. See figure

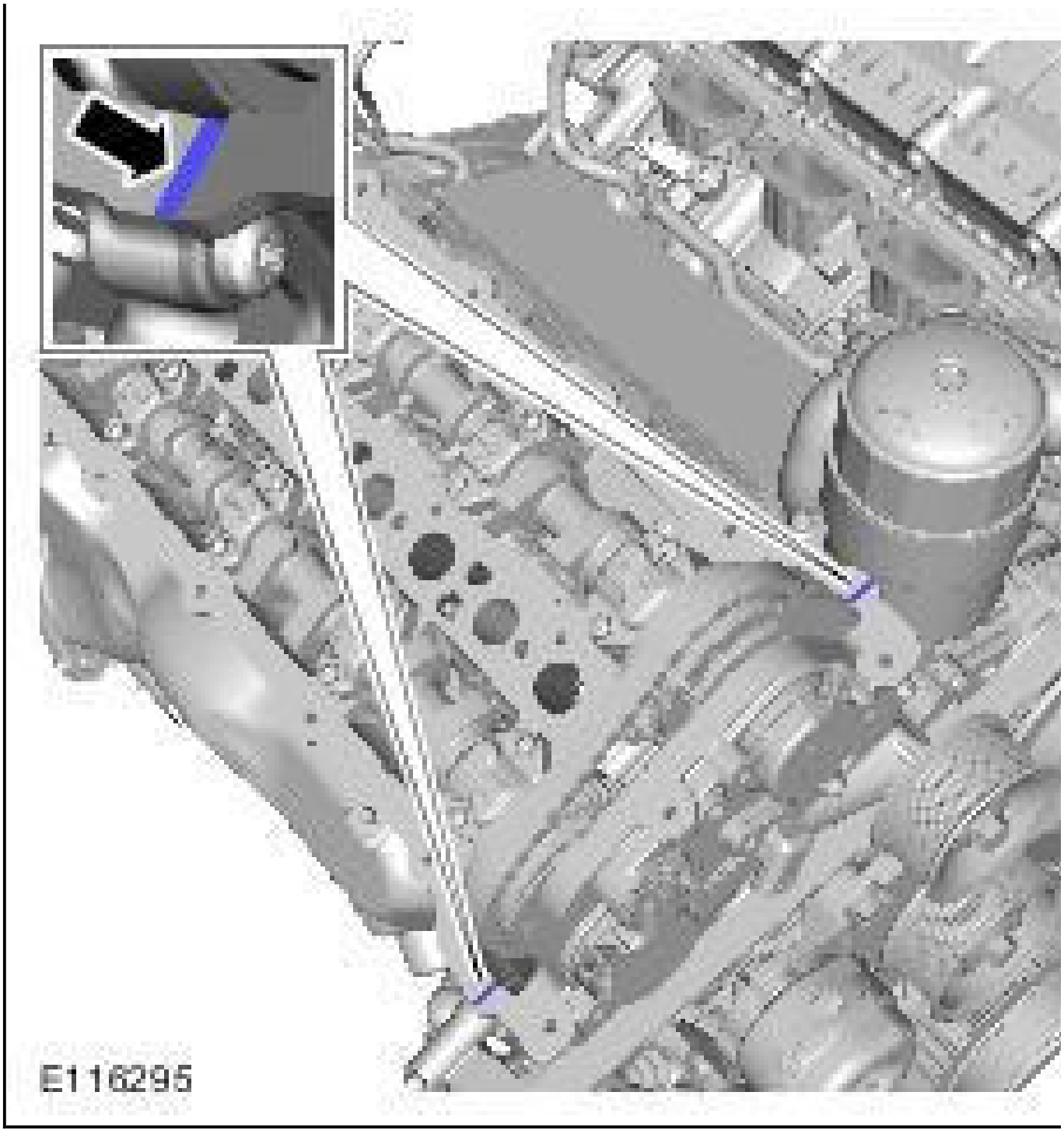
 © 2011 Mitchell Repair Information Company, LLC.



INSTALLATION

1. To install, reverse the removal procedure.

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Use only a plastic scraper when removing the sealing material.

CAUTION: Use lint free cloth.

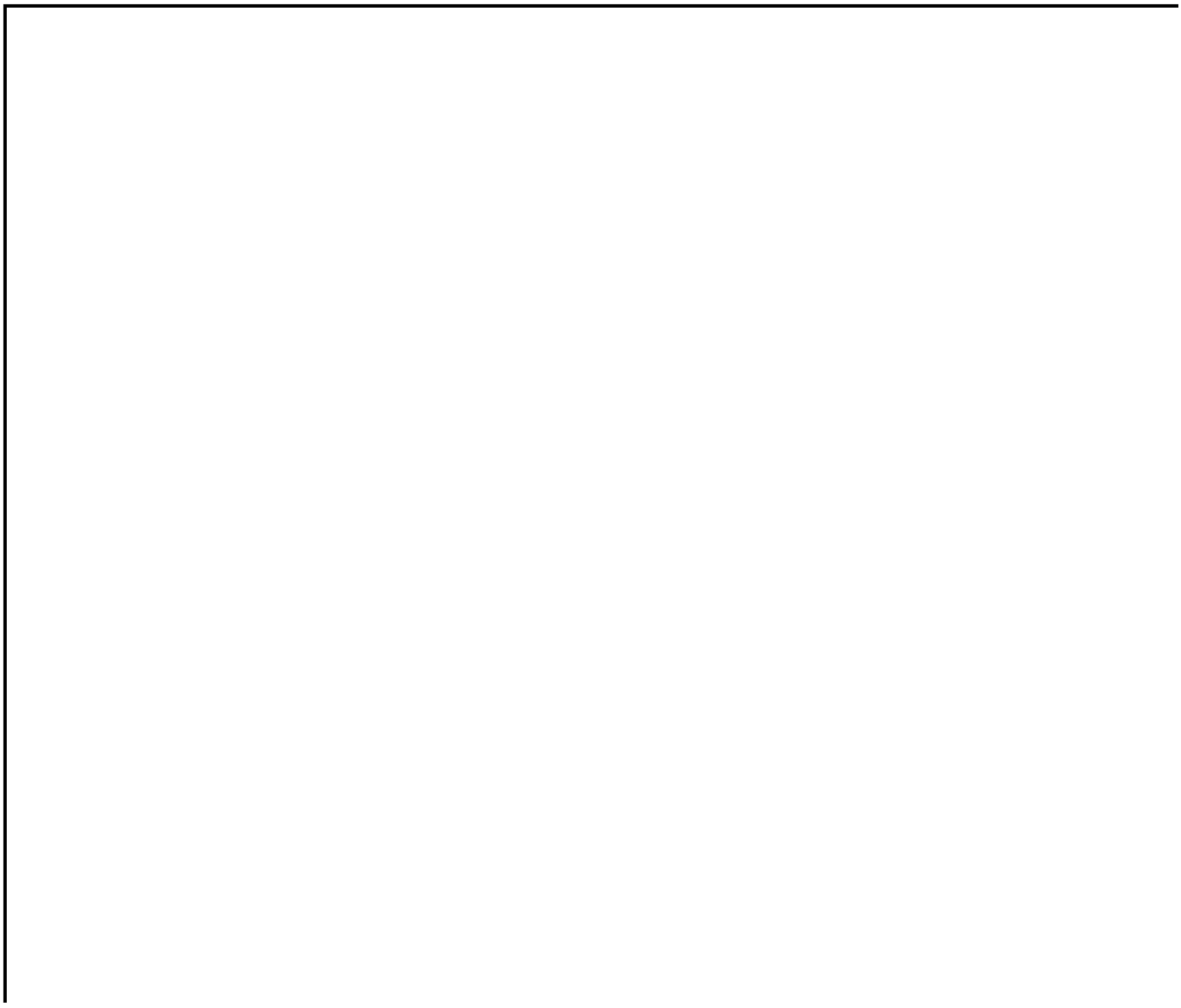
 © 2011 Mitchell Repair Information Company, LLC.

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

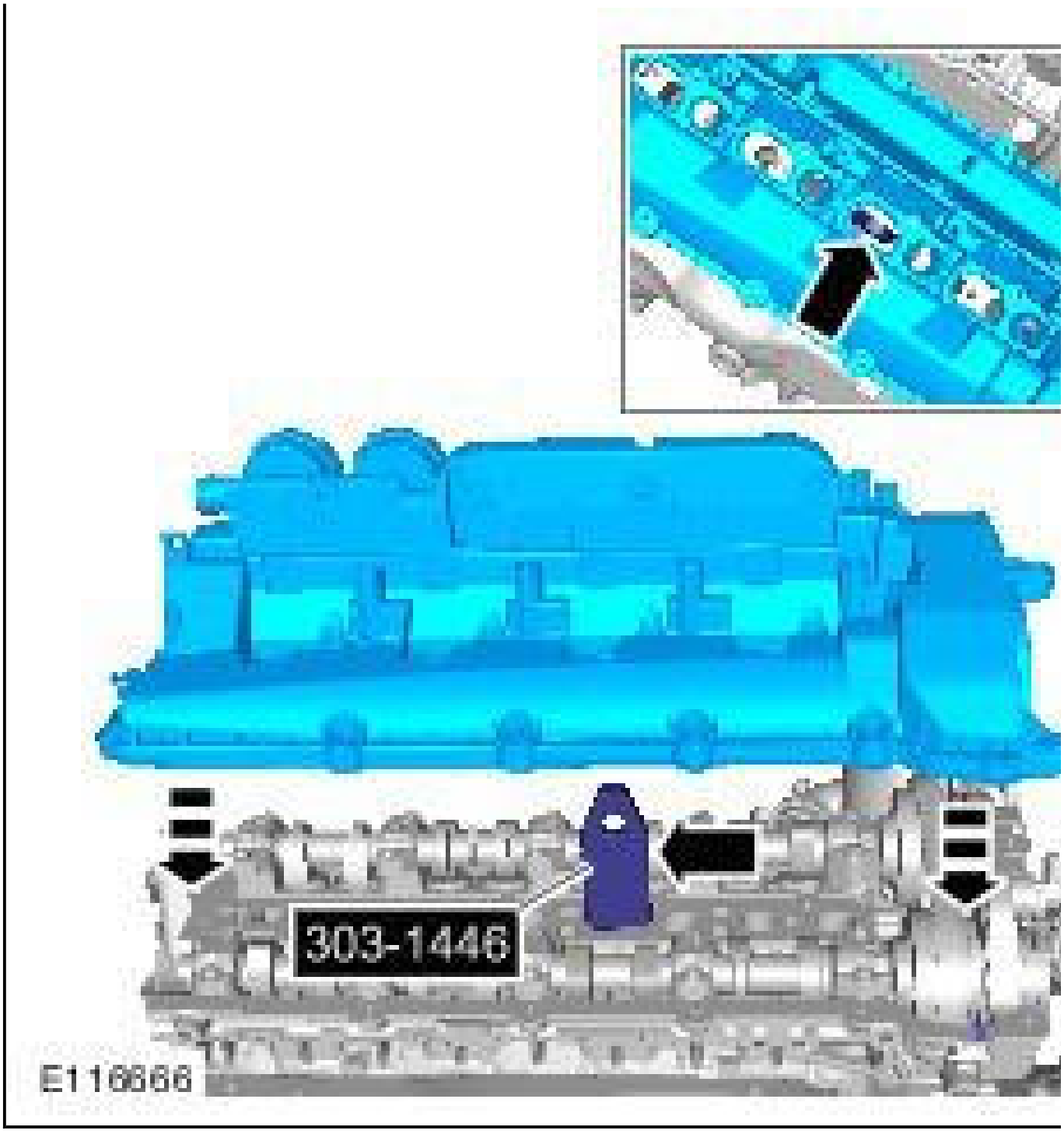
CAUTION: Installation of the valve cover and tightening must be carried out within 7 minutes of applying the sealant.

NOTE: Apply two beads of silicone gasket sealant (Loctite 5901) as shown on the illustration. The application of the sealant must be 1.5mm diameter 12mm long. Install the valve cover immediately after applying the sealant. The cover should be fitted directly to the head without smearing the sealant or the seals.

2. See figure



 © 2011 Mitchell Repair Information Company, LLC.



Valve Cover Alignment Tool (303-1446), refer to **SPECIAL TOOL(S)**

3. Torque: 13 Nm

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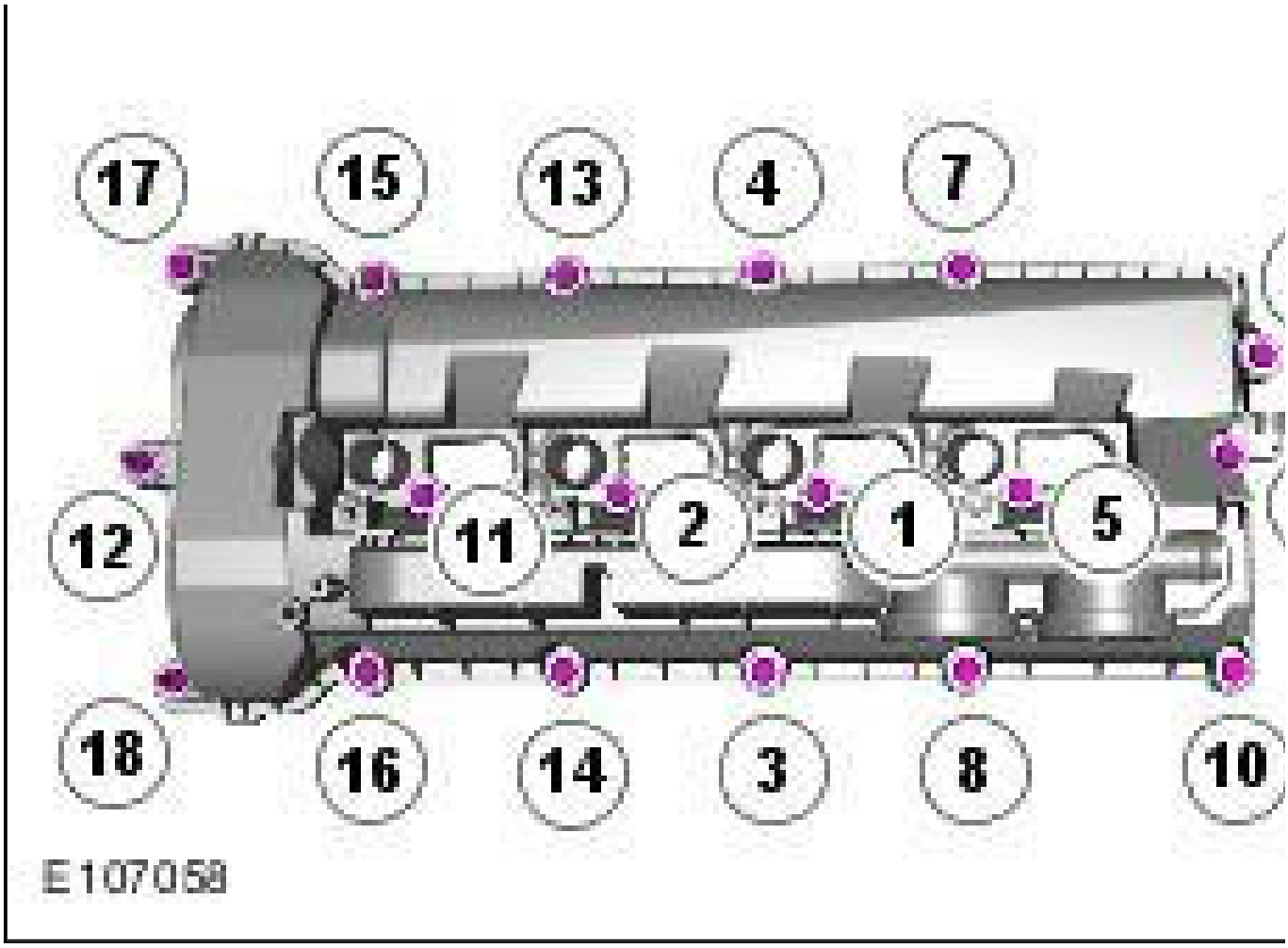

NOTE: **Tighten the bolts in the indicated sequence.**

CYLINDER BLOCK OIL GALLERY PLUG

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.**

1. Refer to **Plenum Chamber** .

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

2. Raise and support the vehicle.

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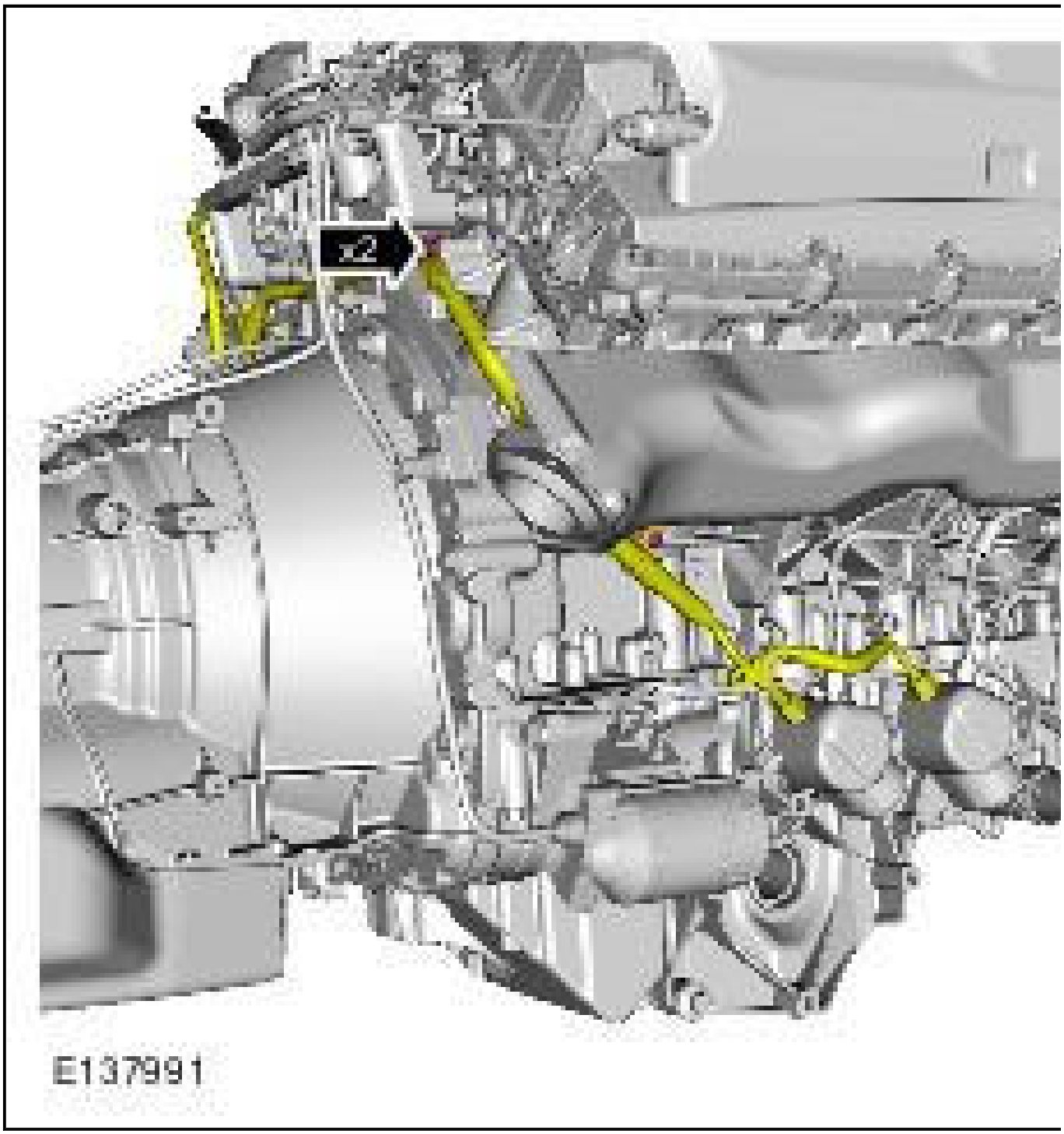
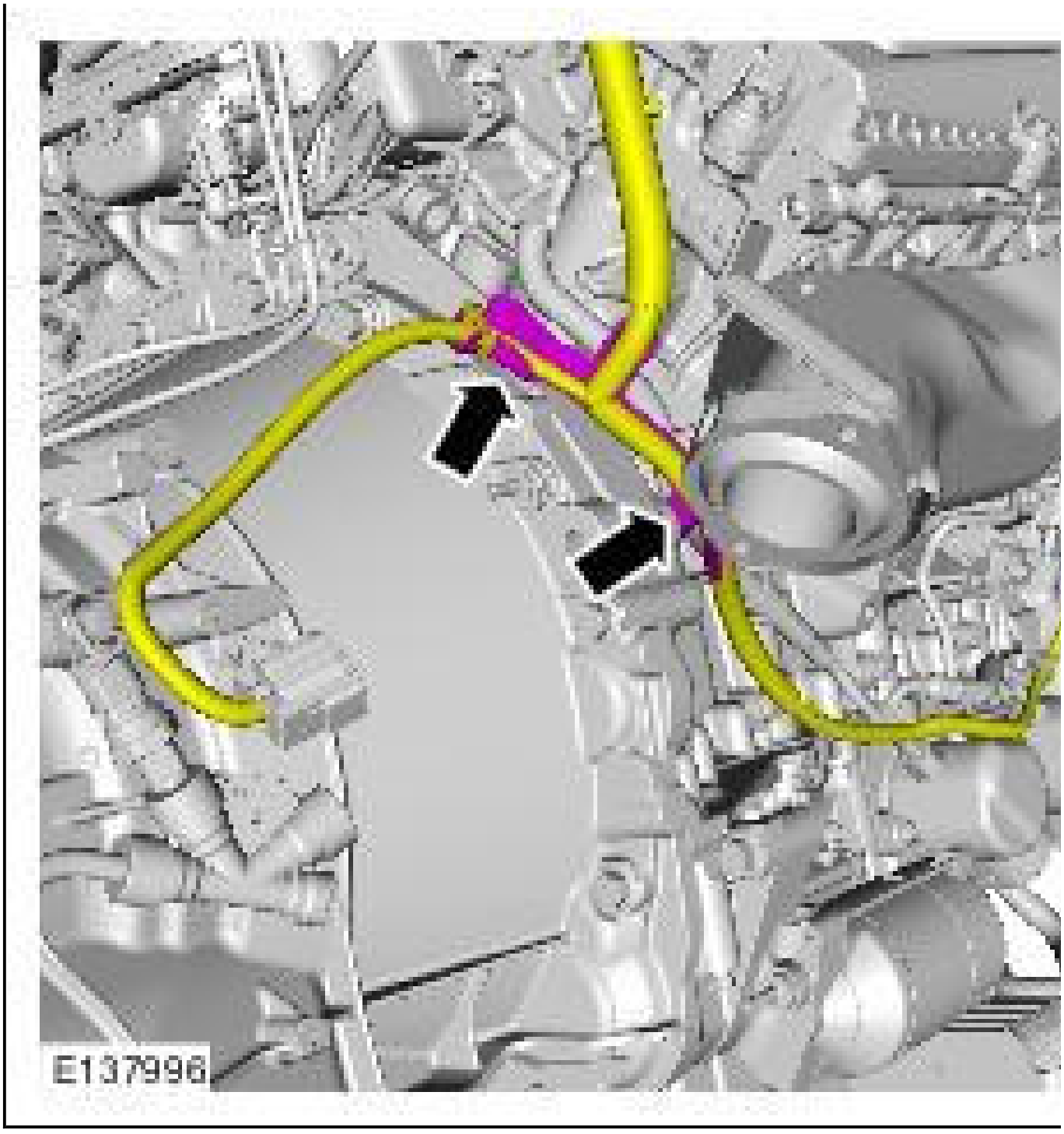
3. Refer to **Engine Undershield** .
4. Torque: 12 Nm



5. See figure

 © 2011 Mitchell Repair Information Company, LLC.



6. Torque:

   Stage 1: 40 Nm

   Stage 2: 180°

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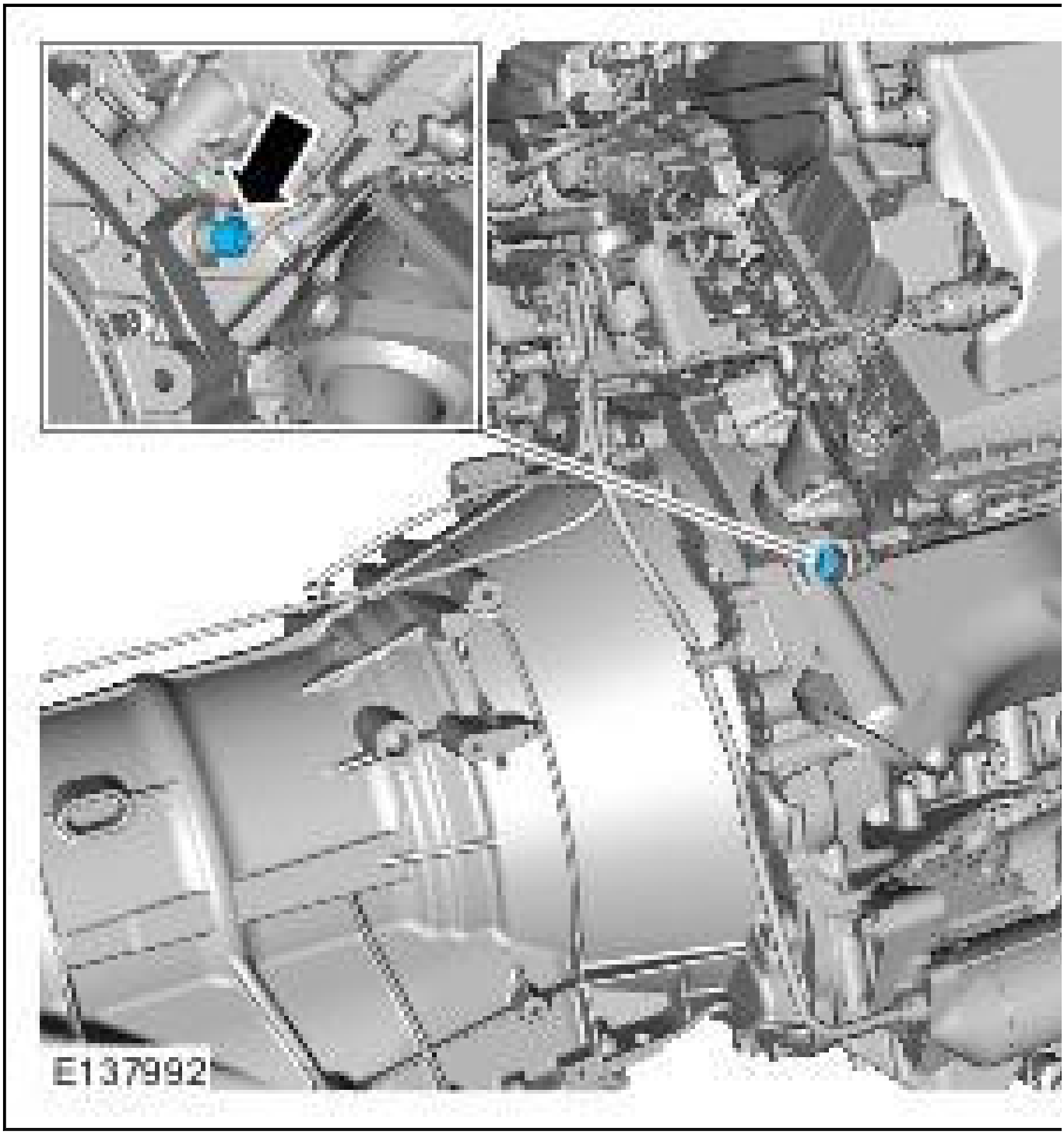
CAUTION: Make sure that the mating faces are clean and free of corrosion and foreign material.



INSTALLATION

1. To install, reverse the removal procedure.

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FUEL PUMP CAMSHAFT

REMOVAL

1. Authoring Template

INSTALLATION

1. Authoring Template

FUEL PUMP CAMSHAFT

REMOVAL

NOTE: Some illustrations may show the engine removed for clarity.

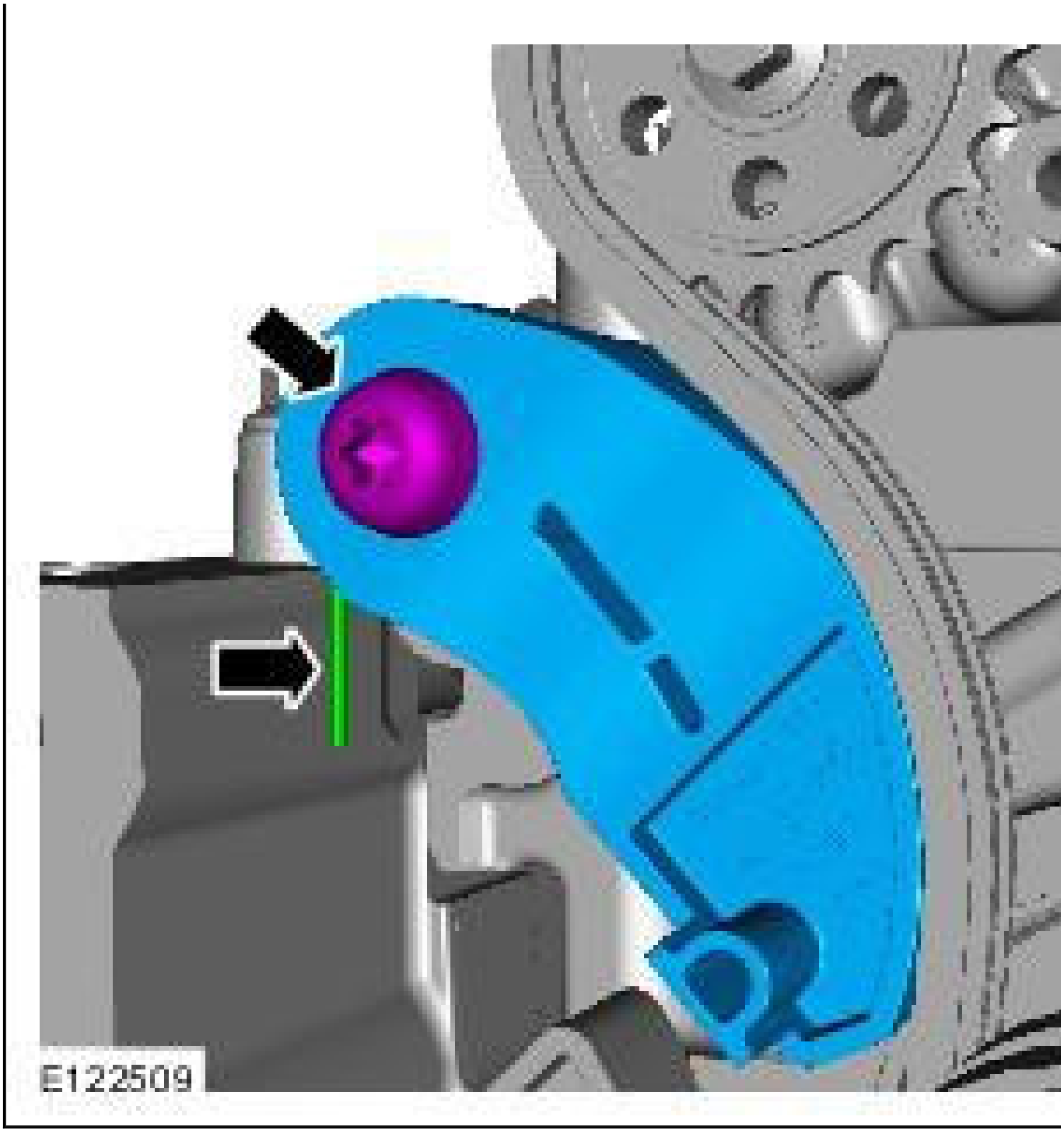
NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

1. Disconnect the battery ground cable. Refer to **Specifications** .

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

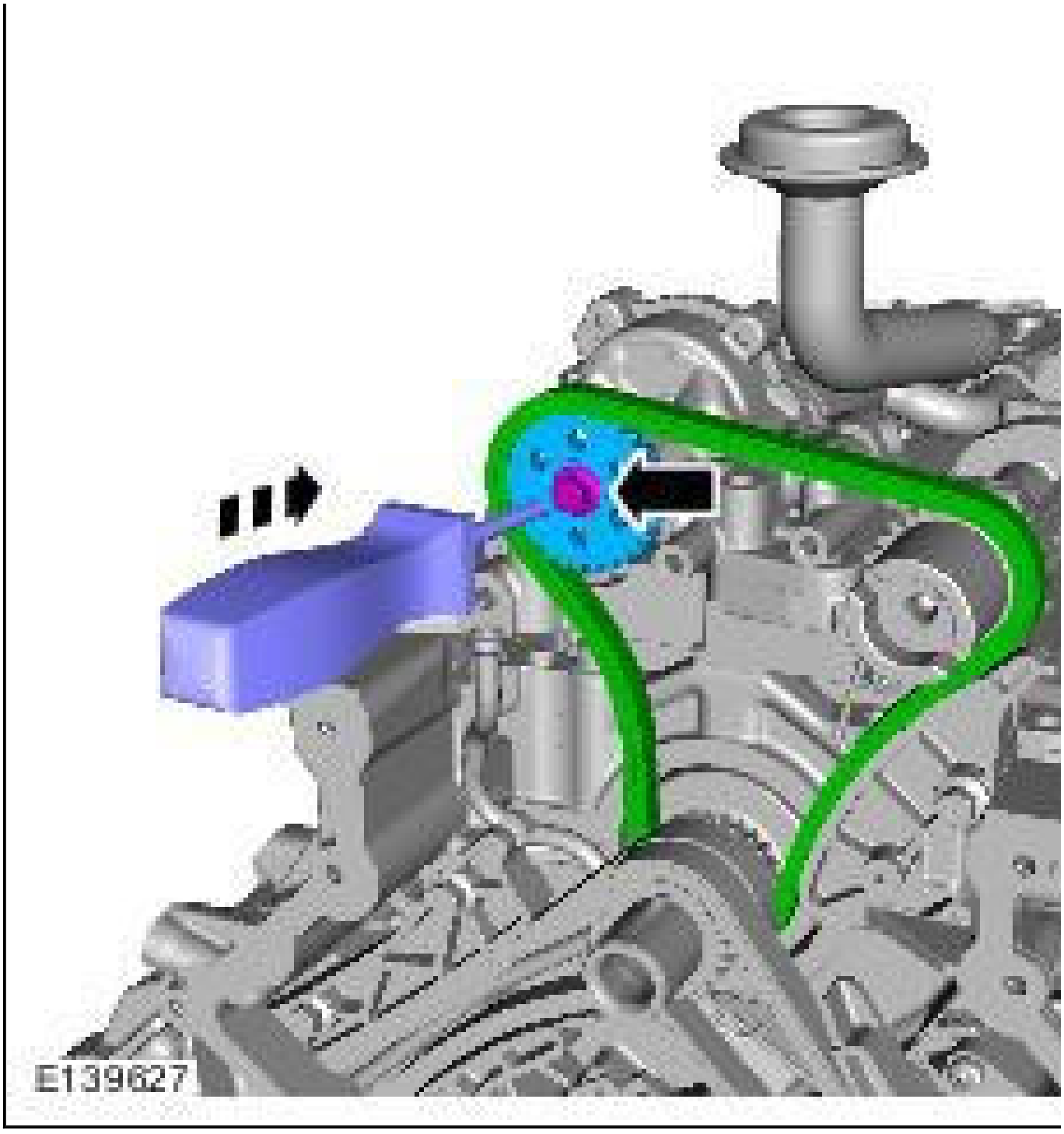
2. Raise and support the vehicle.
3. See **Oil Pan Extension**.
4. See figure

 © 2011 Mitchell Repair Information Company, LLC.



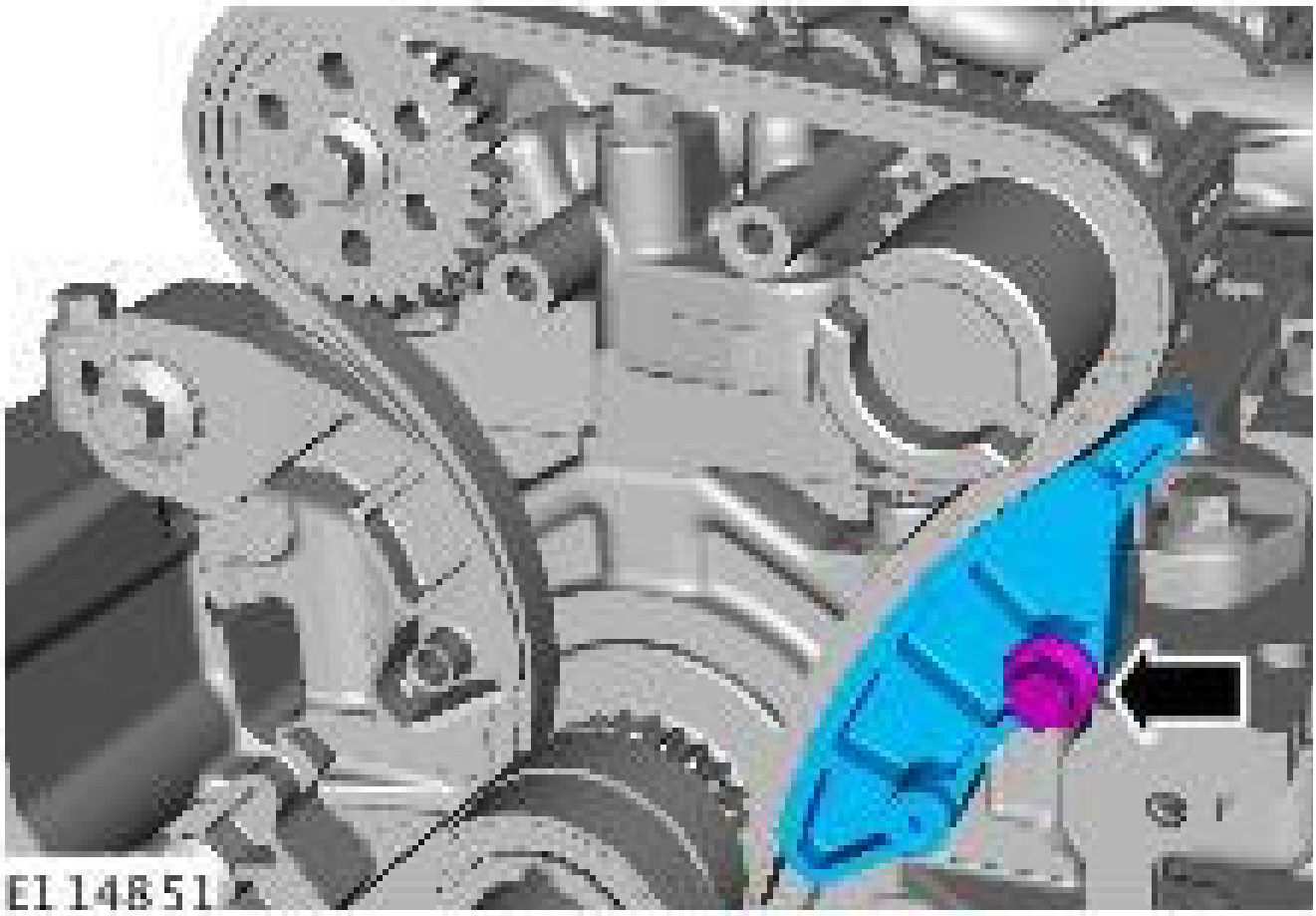
5. See figure

 © 2011 Mitchell Repair Information Company, LLC.



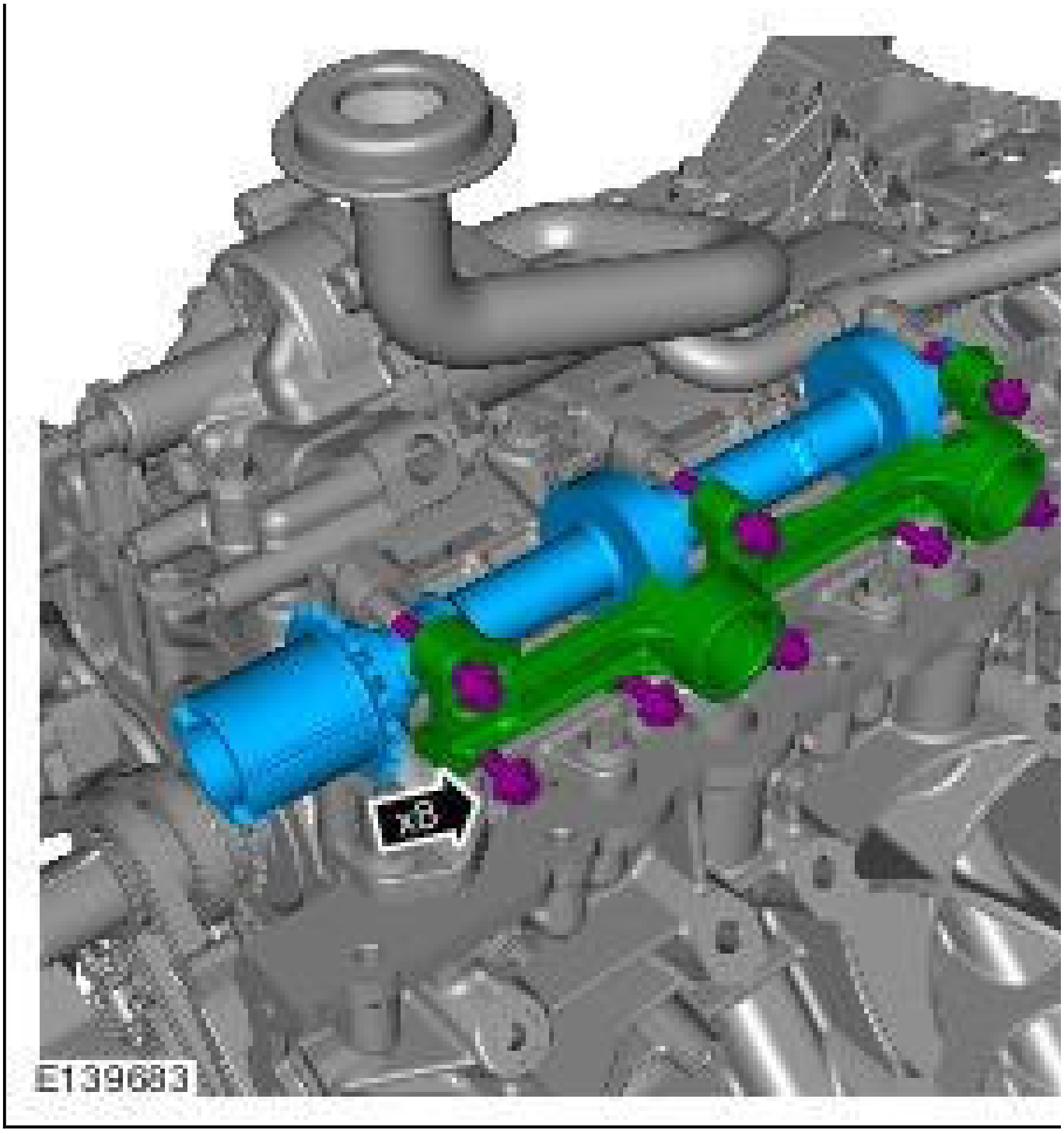
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



7. See figure

 © 2011 Mitchell Repair Information Company, LLC.

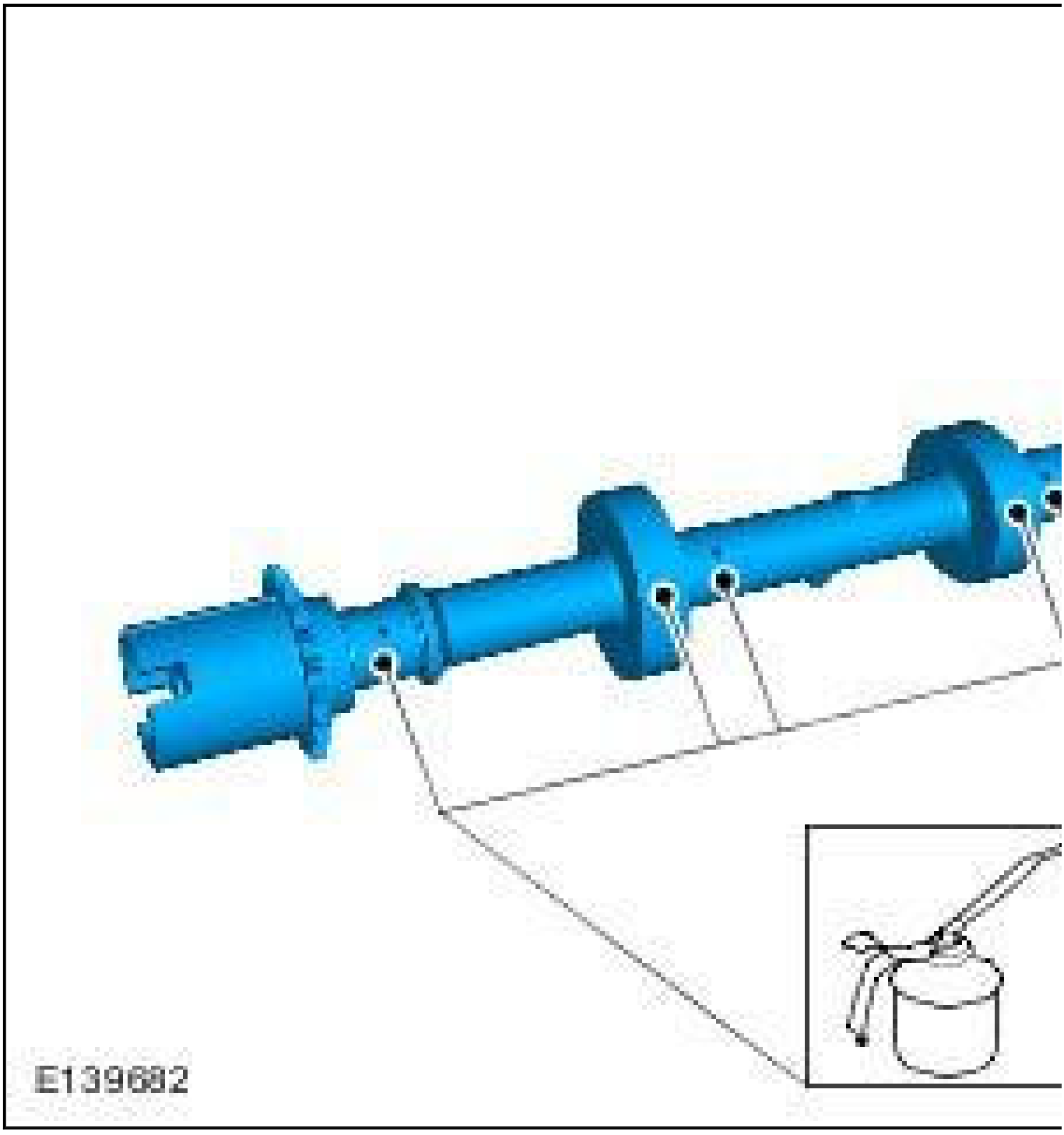


CAUTION: Take extra care when removing the component, prevent damage to the mating faces.

INSTALLATION

1. See figure

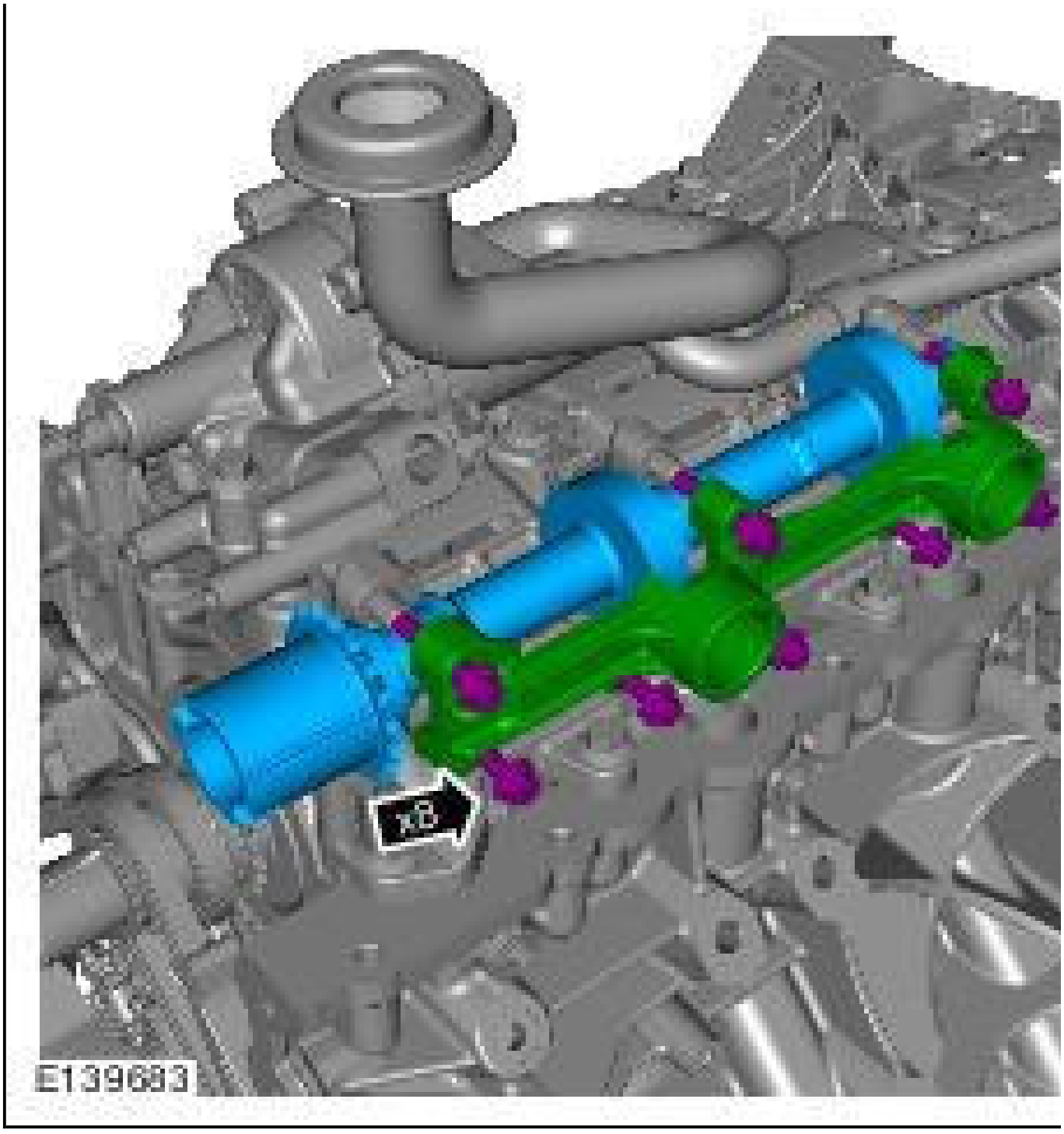
 © 2011 Mitchell Repair Information Company, LLC.



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

2. Torque: 12 Nm

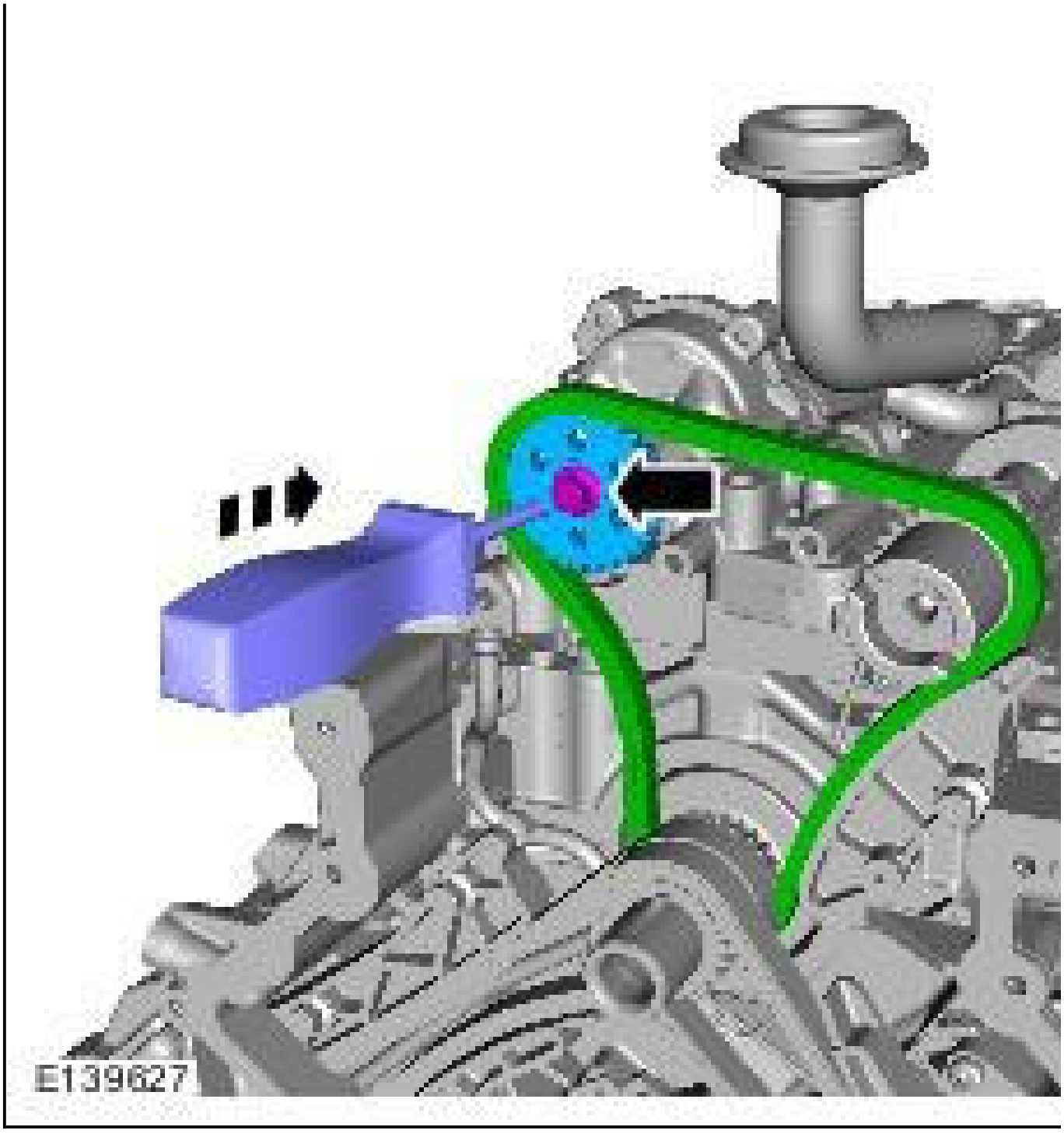
 © 2011 Mitchell Repair Information Company, LLC.



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

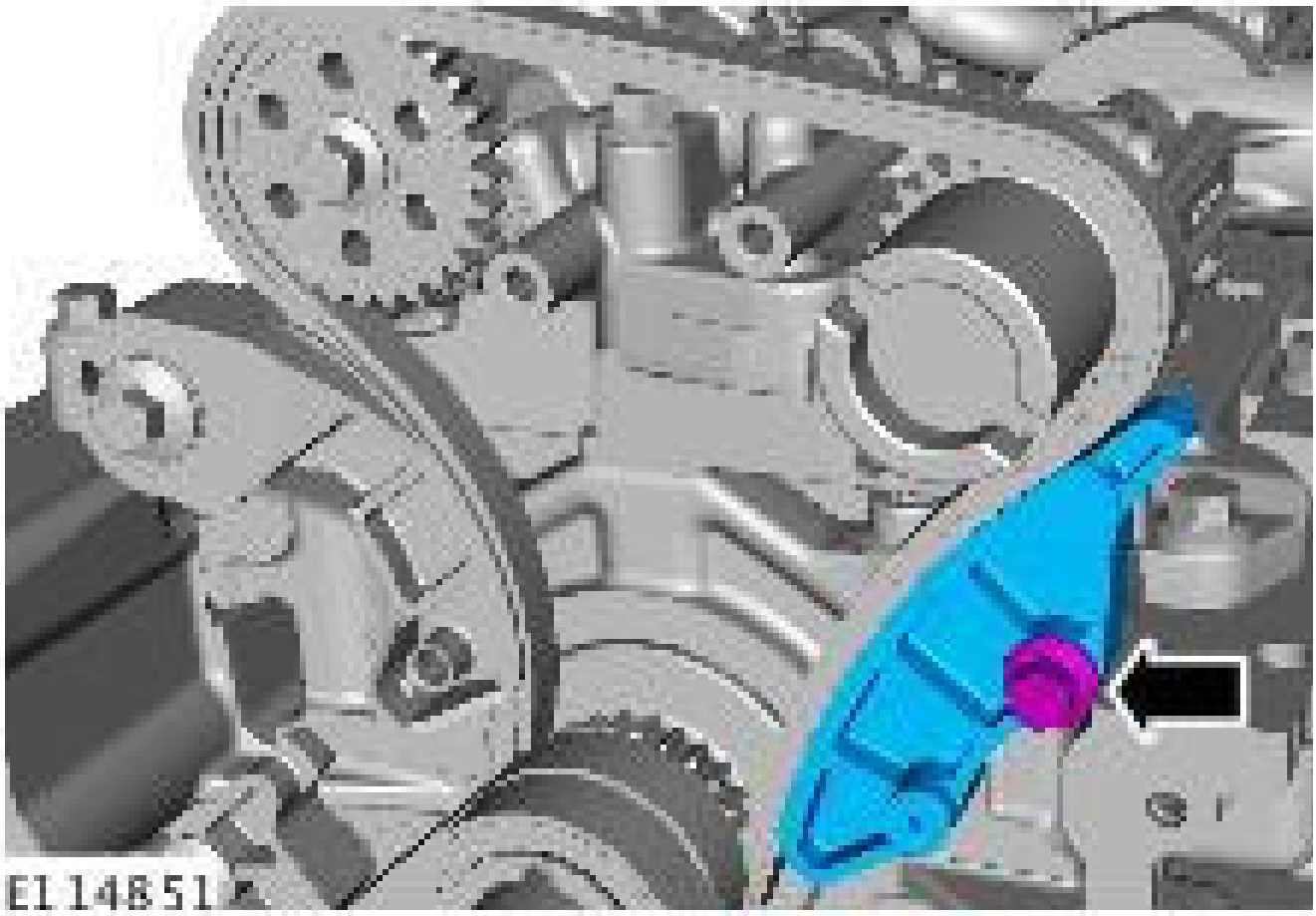
3. Torque: 21 Nm

 © 2011 Mitchell Repair Information Company, LLC.



4. Torque: 12 Nm

 © 2011 Mitchell Repair Information Company, LLC.



5. Install the lower timing chain making sure the colored chain links align correctly with the fuel rail high-pressure fuel pumps camshaft and crankshaft sprocket markings.

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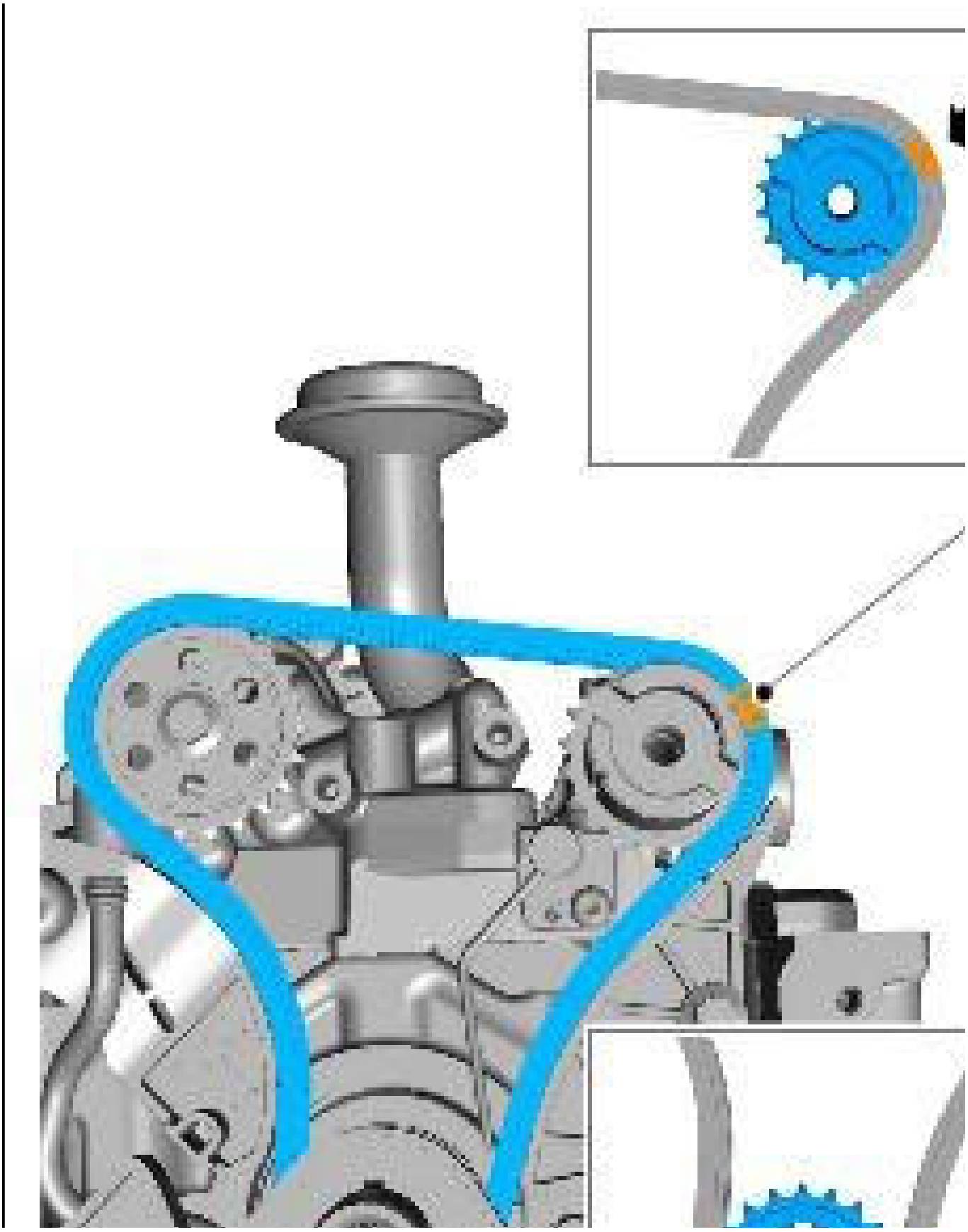
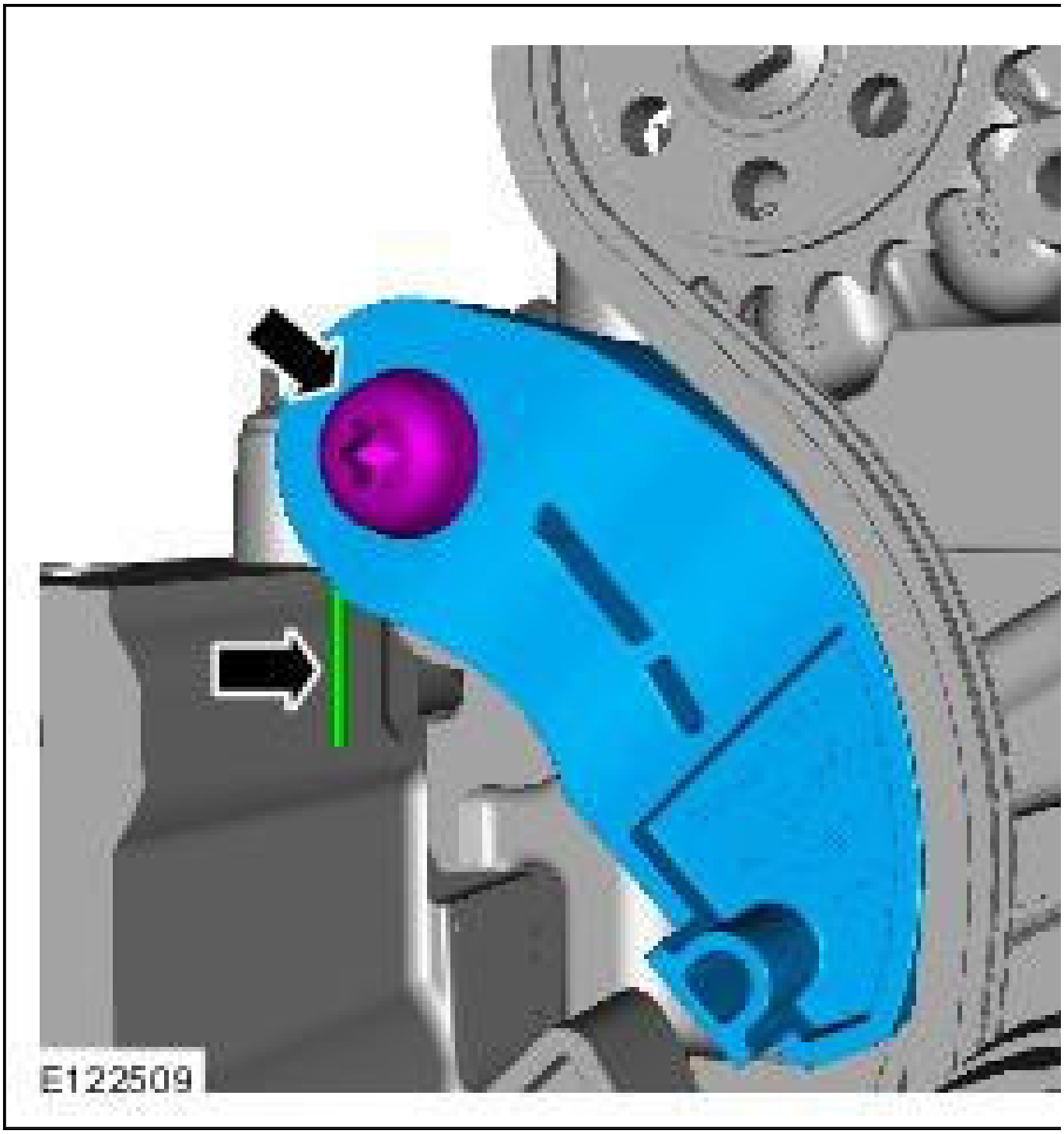


 © 2011 Mitchell Repair Information Company, LLC.

6. Torque: 21 Nm



CAUTION: Make sure that the tensioner spring is correctly located.

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7. See **Oil Pan Extension**.
8. Connect the battery ground cable. Refer to **Specifications** .

FUEL PUMP CAMSHAFT

REMOVAL

NOTE: Some illustrations may show the engine removed for clarity.

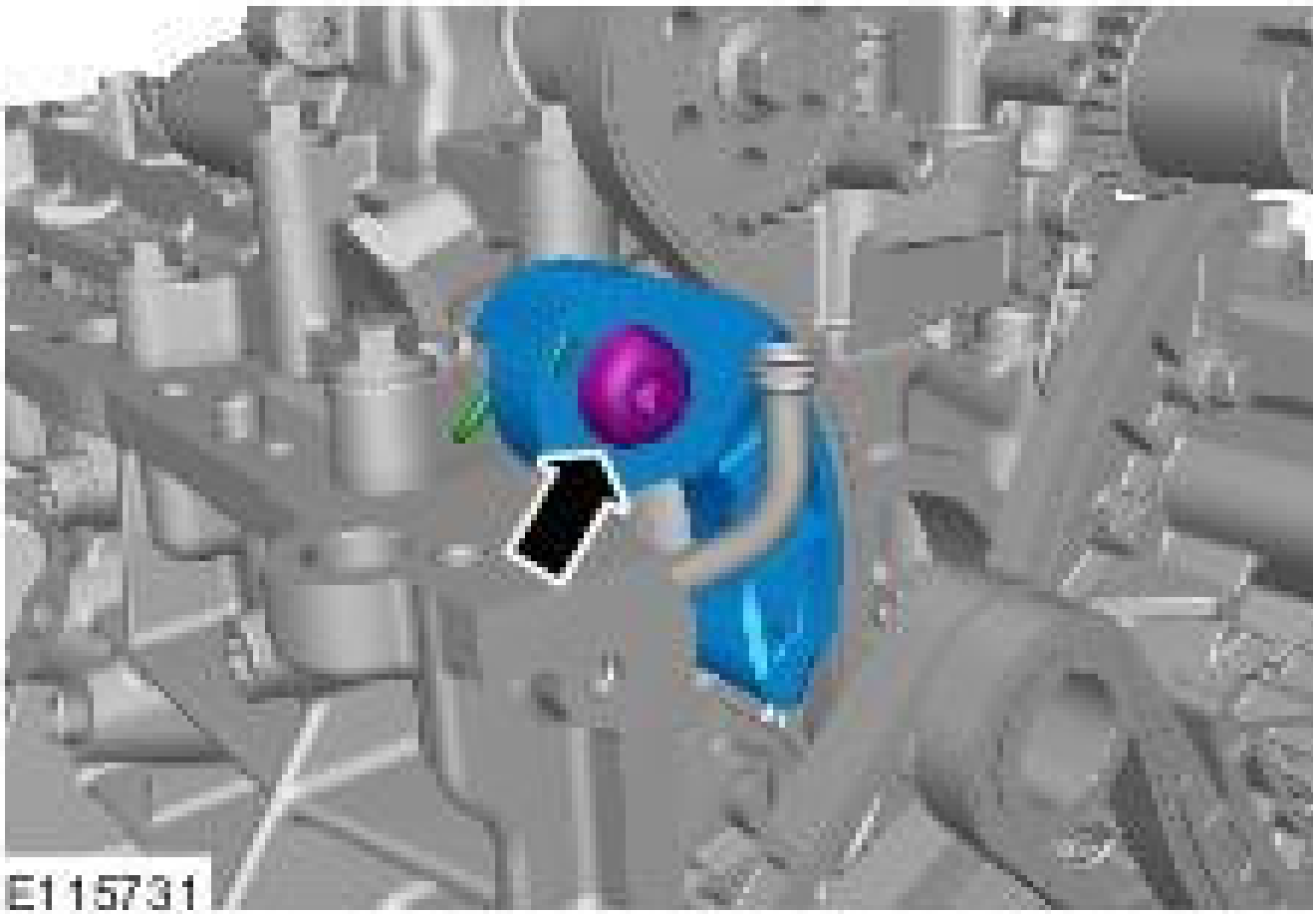
NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

1. Disconnect the battery ground cable. Refer to **Specifications** .

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

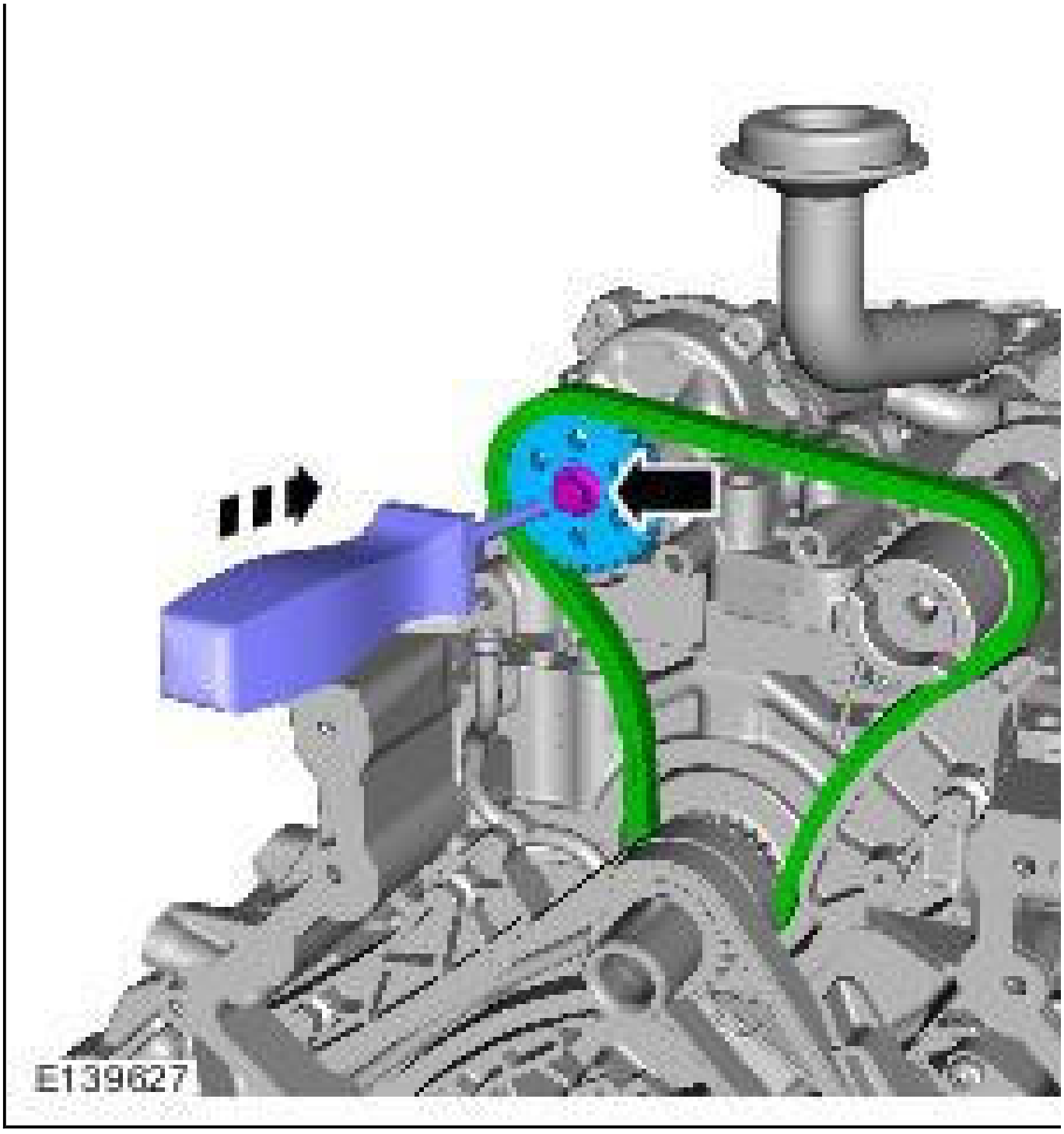
2. Raise and support the vehicle.
3. See **Oil Pan Extension**.
4. See figure

 © 2011 Mitchell Repair Information Company, LLC.



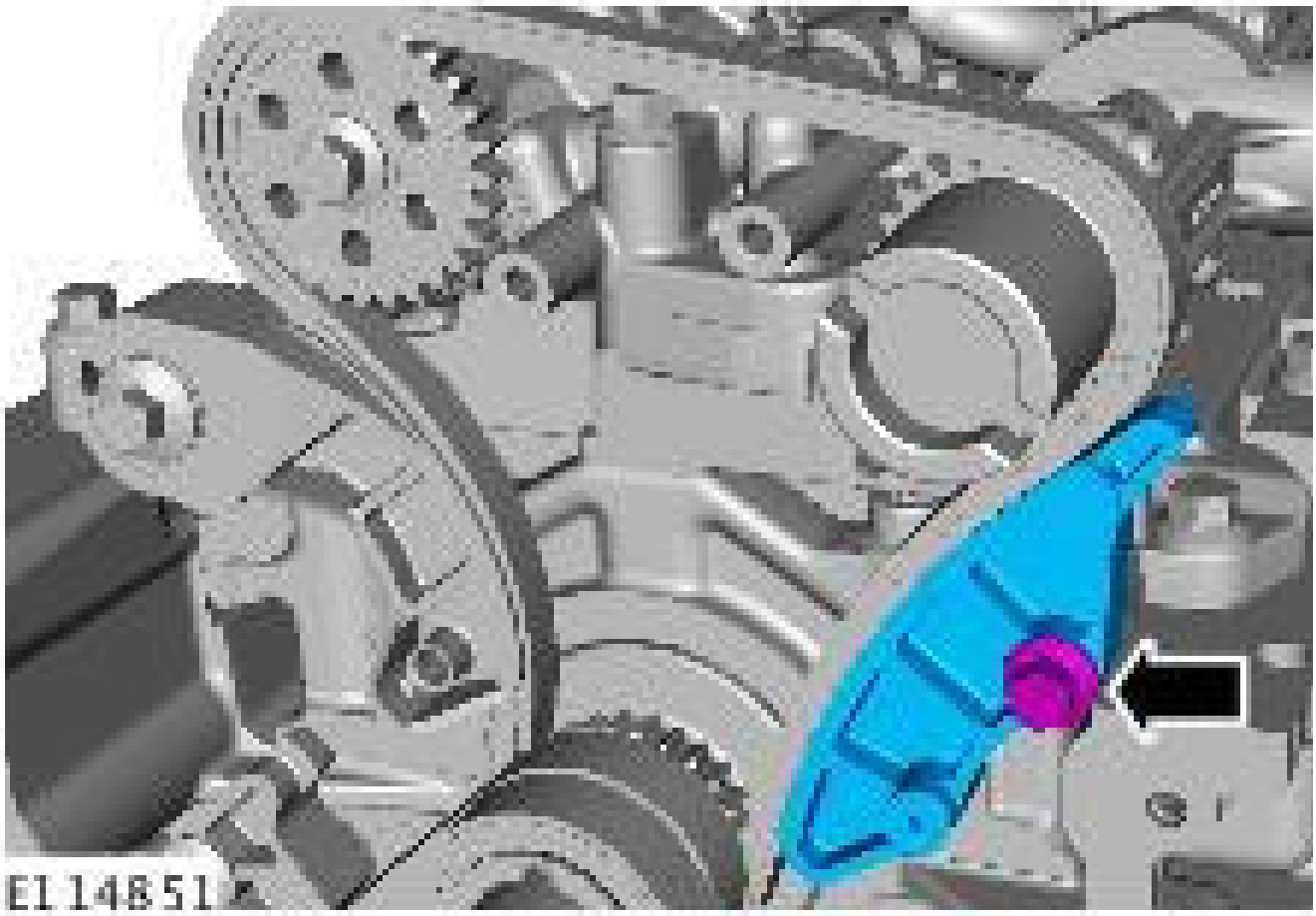
5. See figure

 © 2011 Mitchell Repair Information Company, LLC.



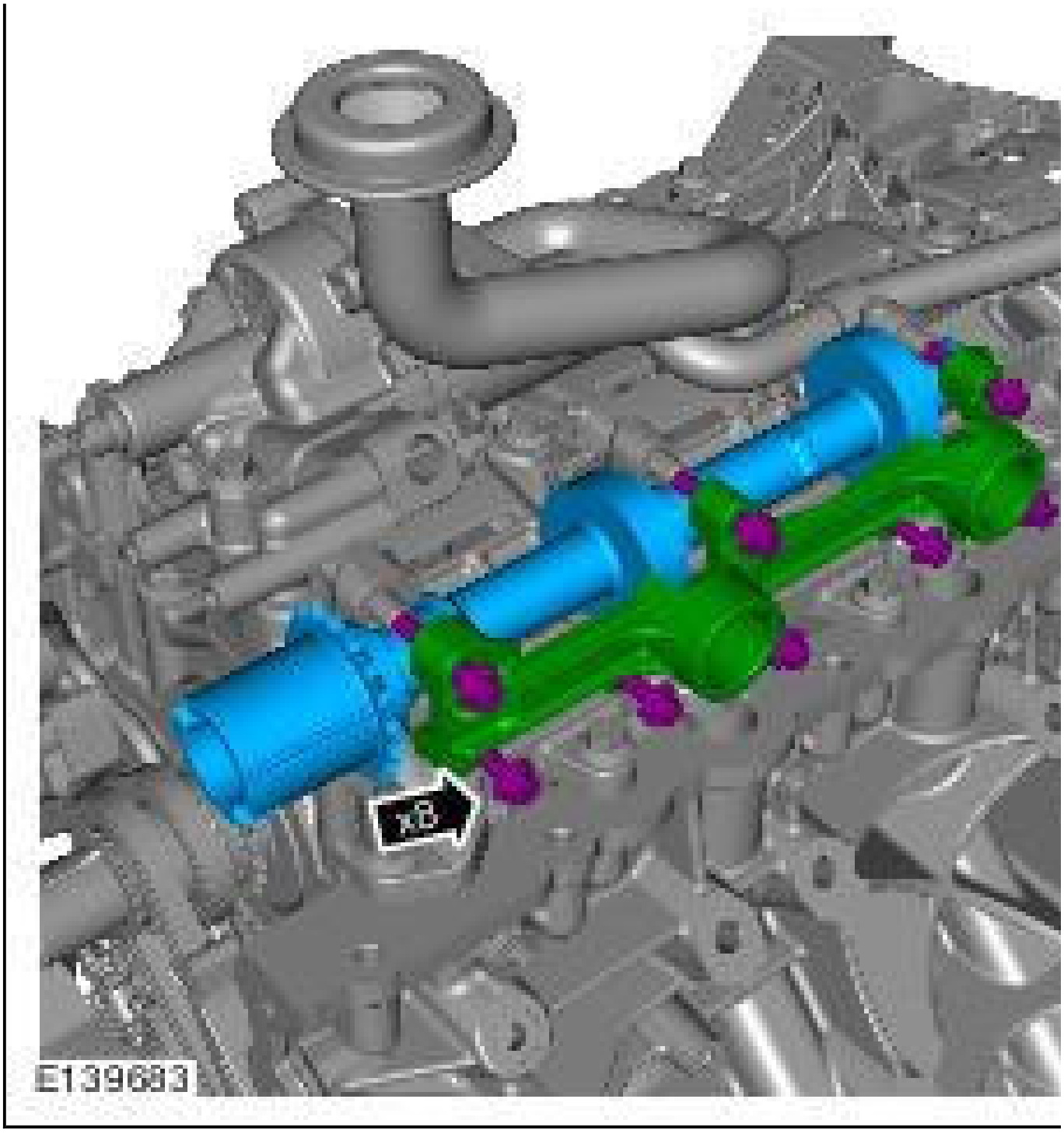
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



7. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Take extra care when removing the component, prevent damage to the mating faces.

INSTALLATION

1. See figure

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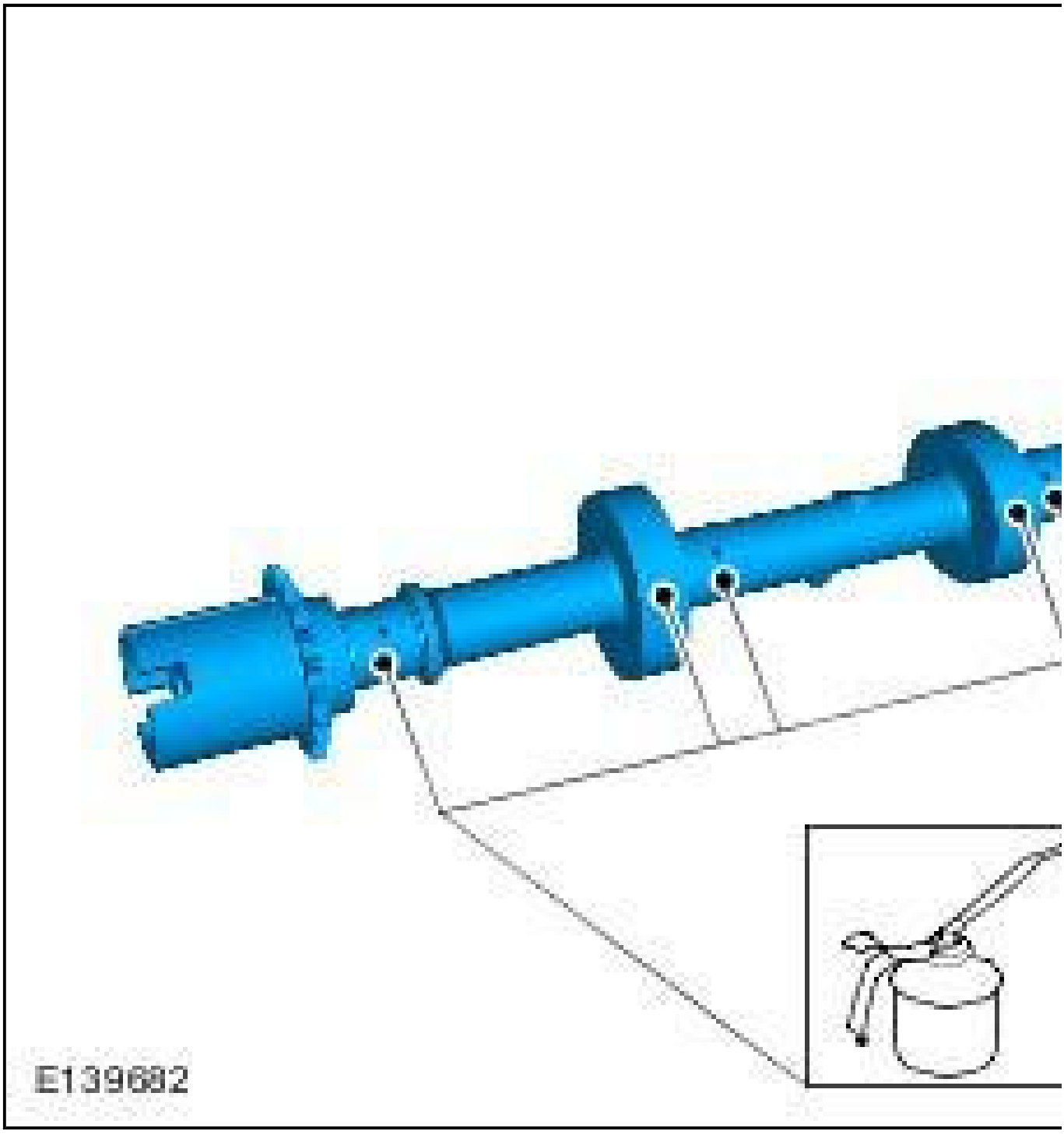
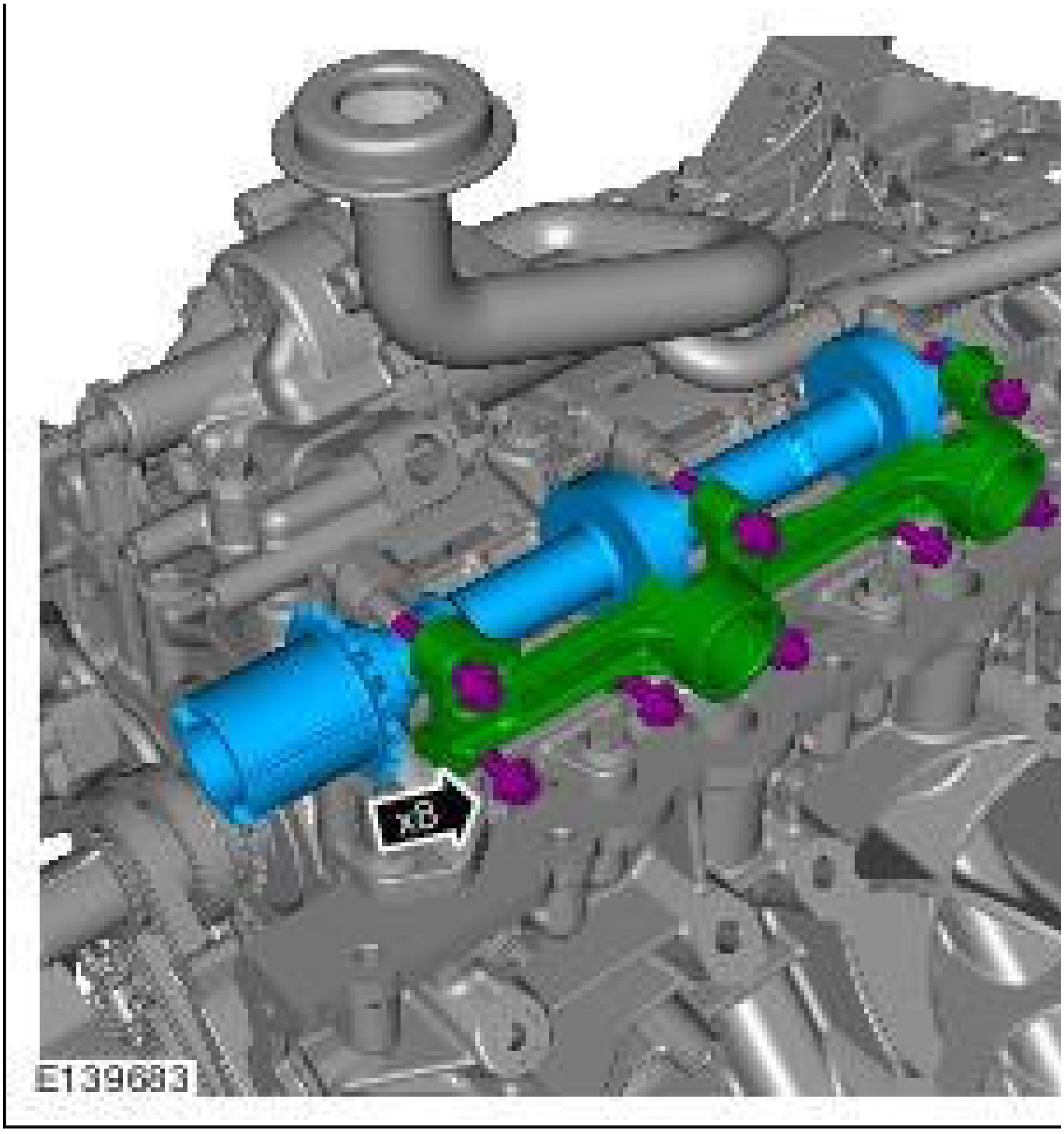


CAUTION: Make sure that the mating faces are clean and free of foreign material.

2. Torque: 12 Nm

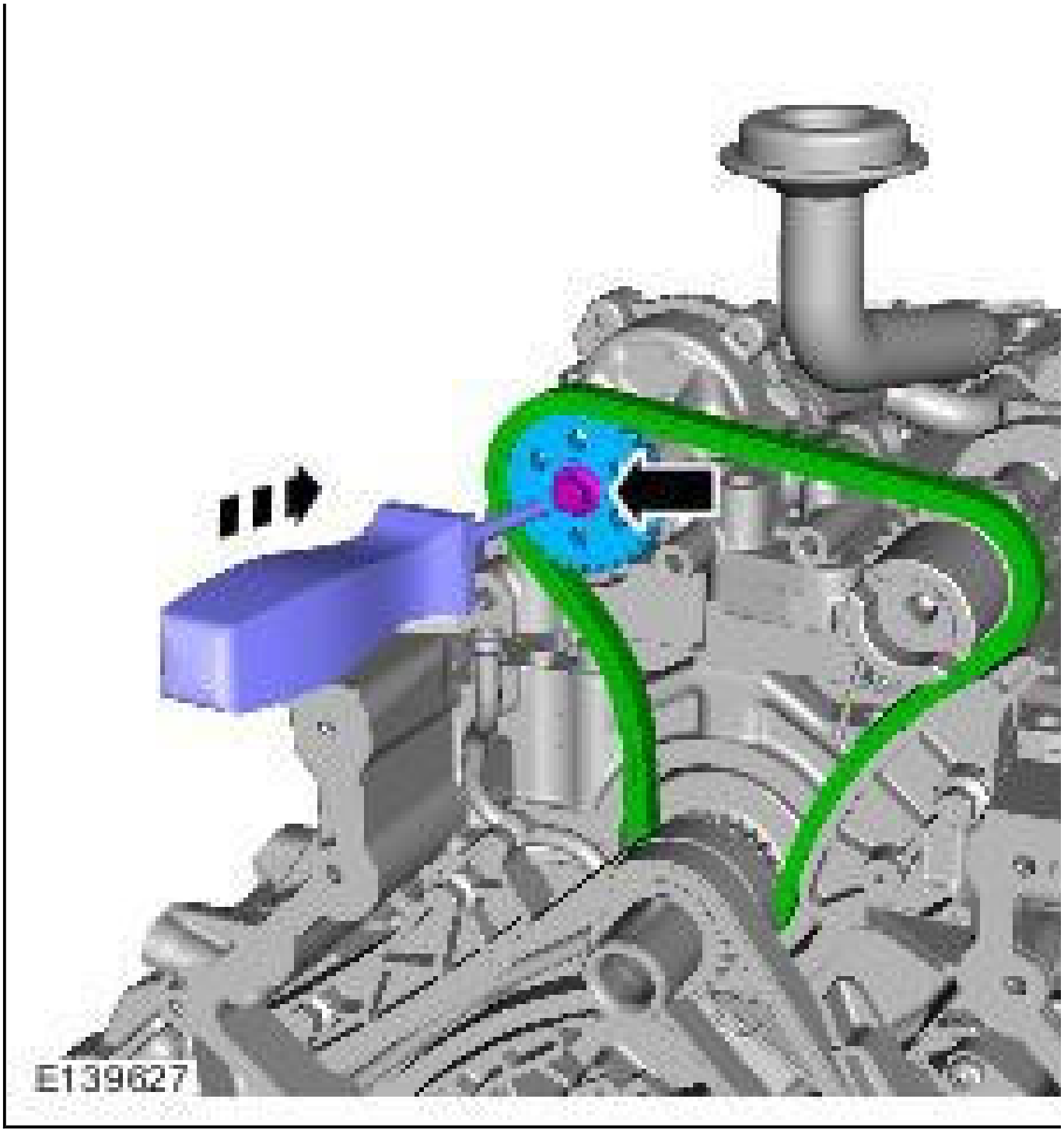
 © 2011 Mitchell Repair Information Company, LLC.



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

3. Torque: 21 Nm

 © 2011 Mitchell Repair Information Company, LLC.



4. Torque: 12 Nm

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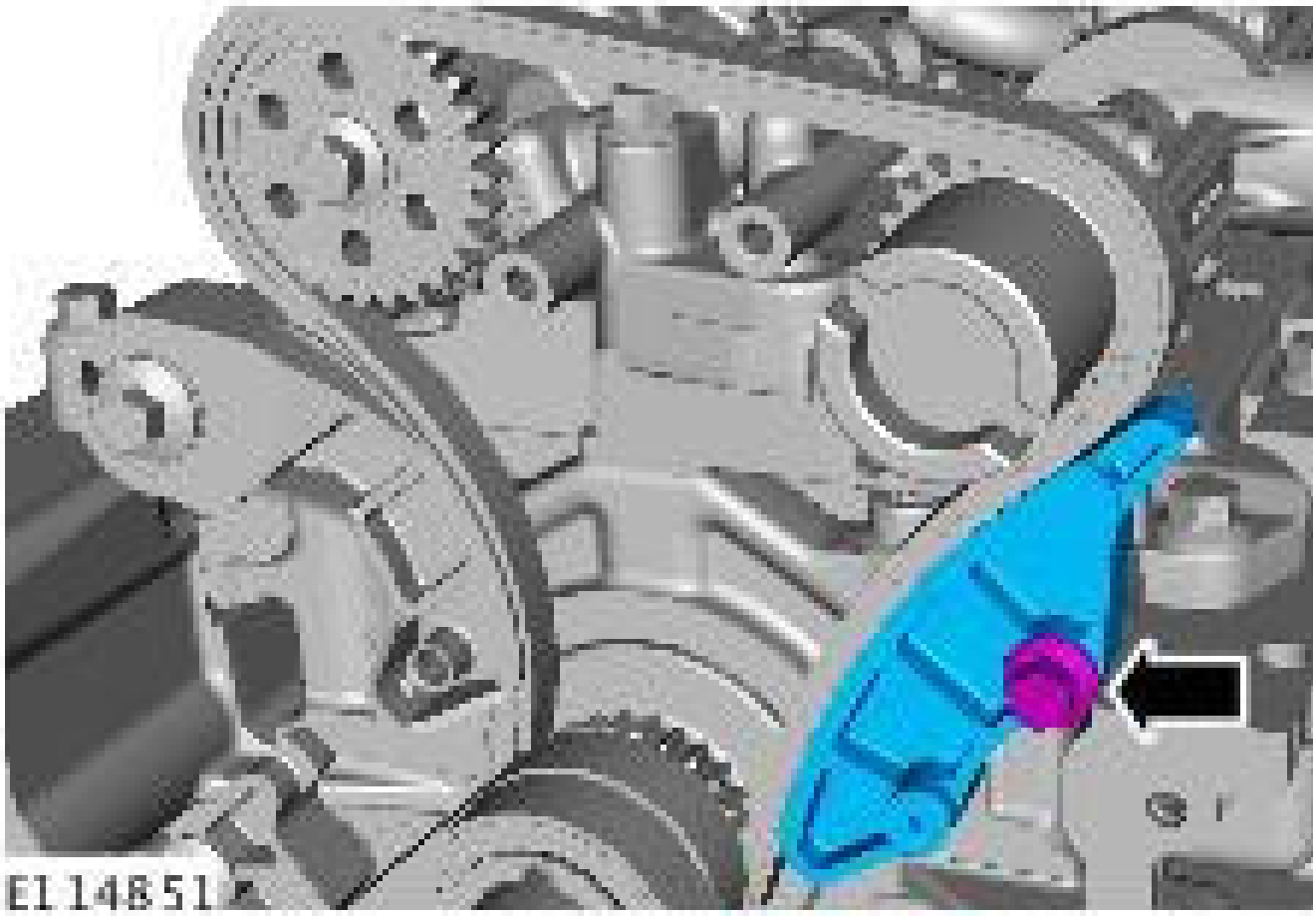

5. Install the lower timing chain making sure the colored chain links align correctly with the fuel rail high-pressure fuel pumps camshaft and crankshaft sprocket markings.

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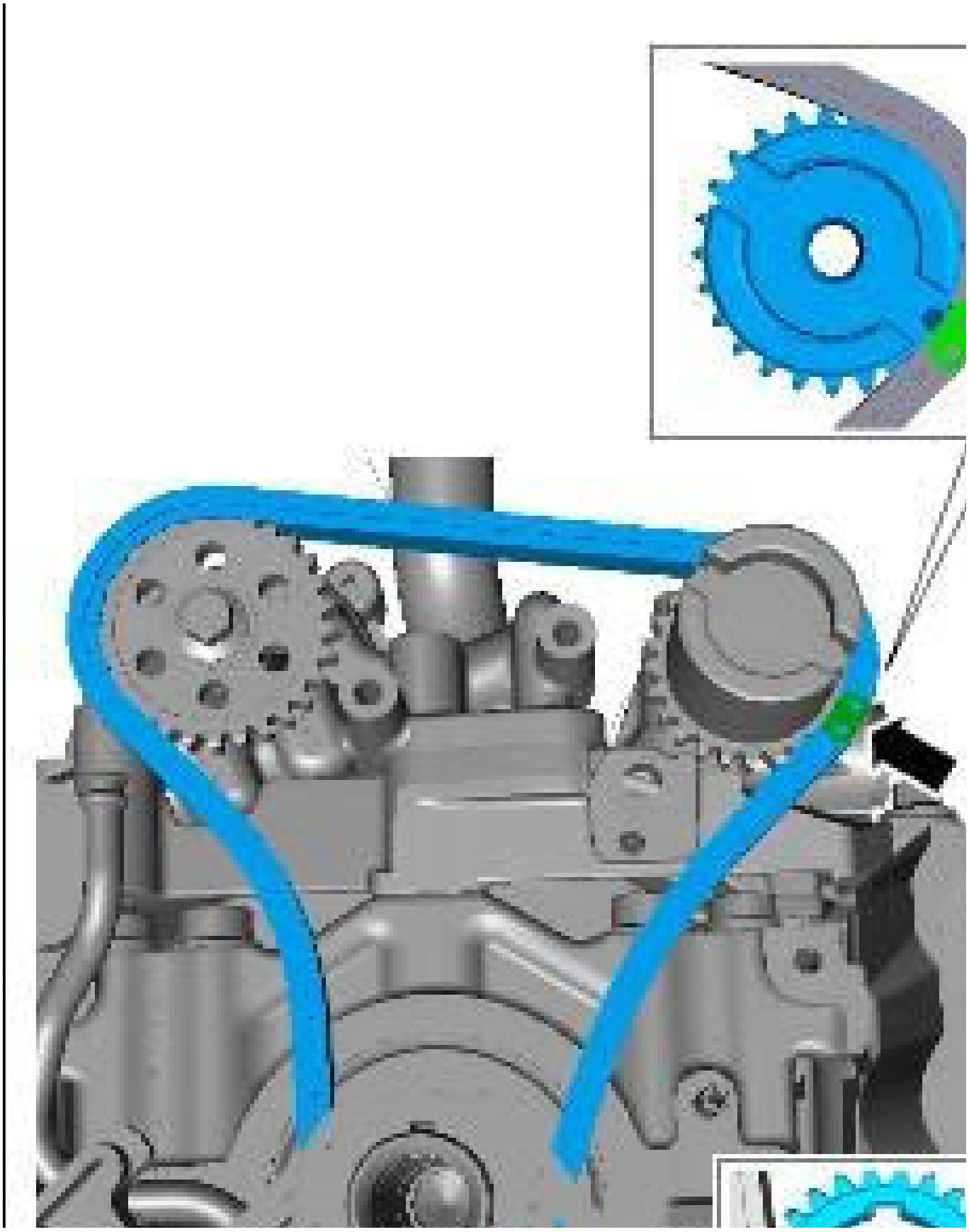
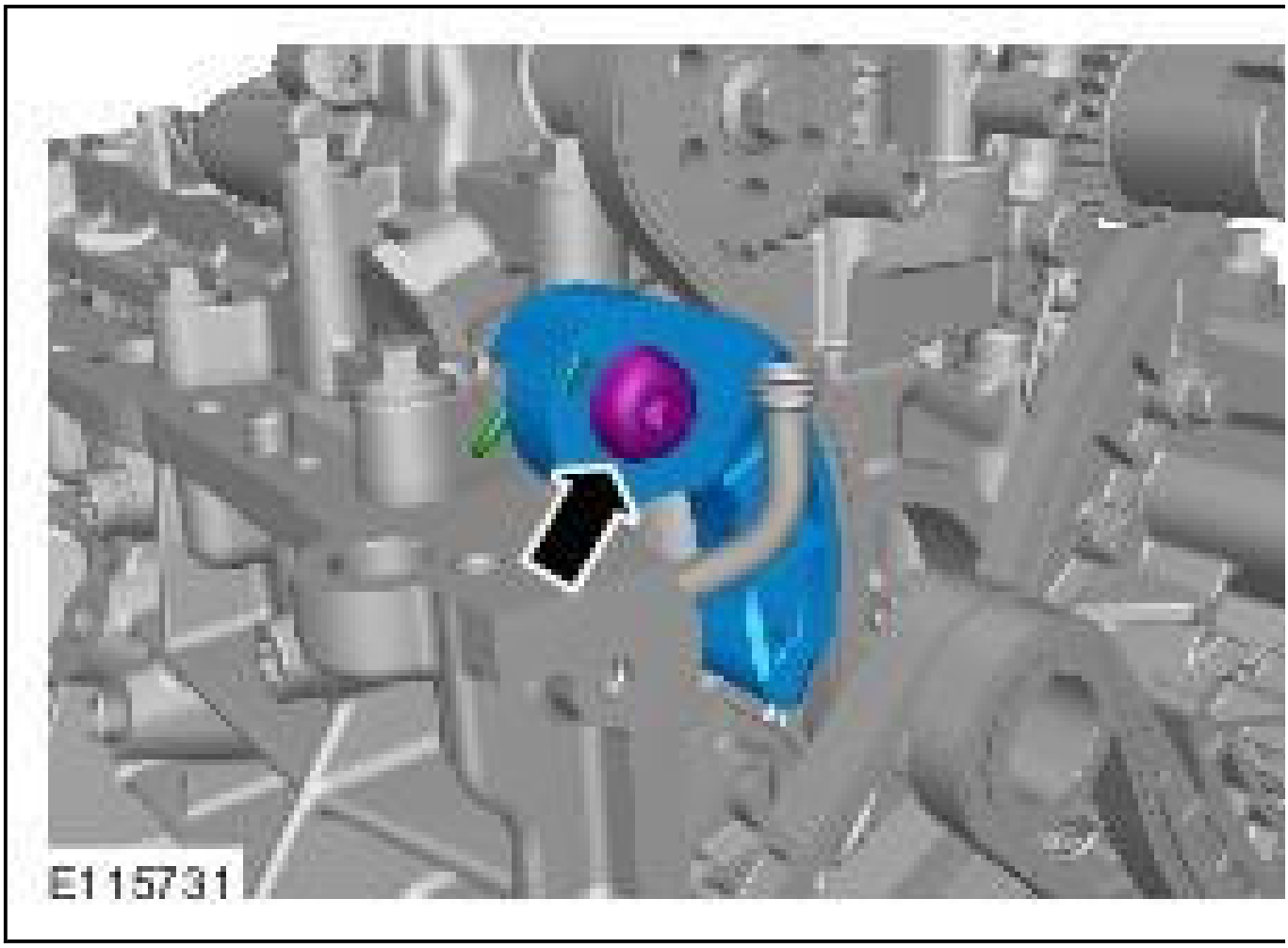


 © 2011 Mitchell Repair Information Company, LLC.

6. Torque: 21 Nm



CAUTION: Make sure that the tensioner spring is correctly located.

7. See **Oil Pan Extension**.
8. Connect the battery ground cable. Refer to **Specifications** .

LOWER TIMING COVER

SPECIAL TOOL(S)

	303-1433 Lower Timing Cover Alignment tool

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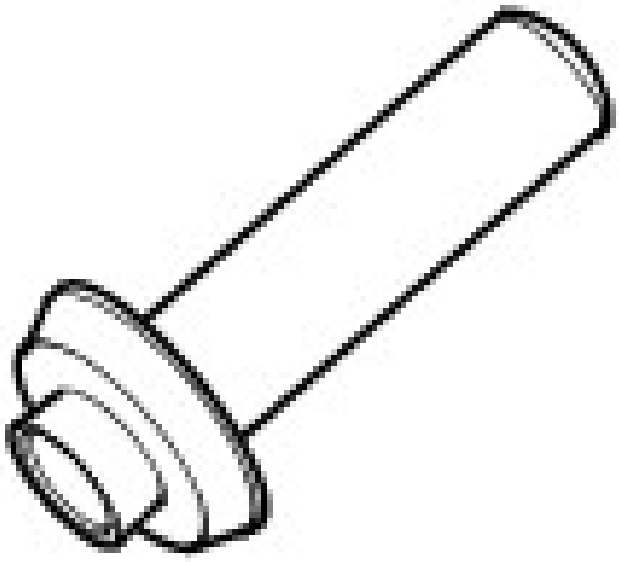

REMOVAL

1. 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. See **Crankshaft Pulley**.
4. Refer to **Brake Vacuum Pump - V8 5.0L Petrol/V8 S/C 5.0L Petrol** .
5. See figure

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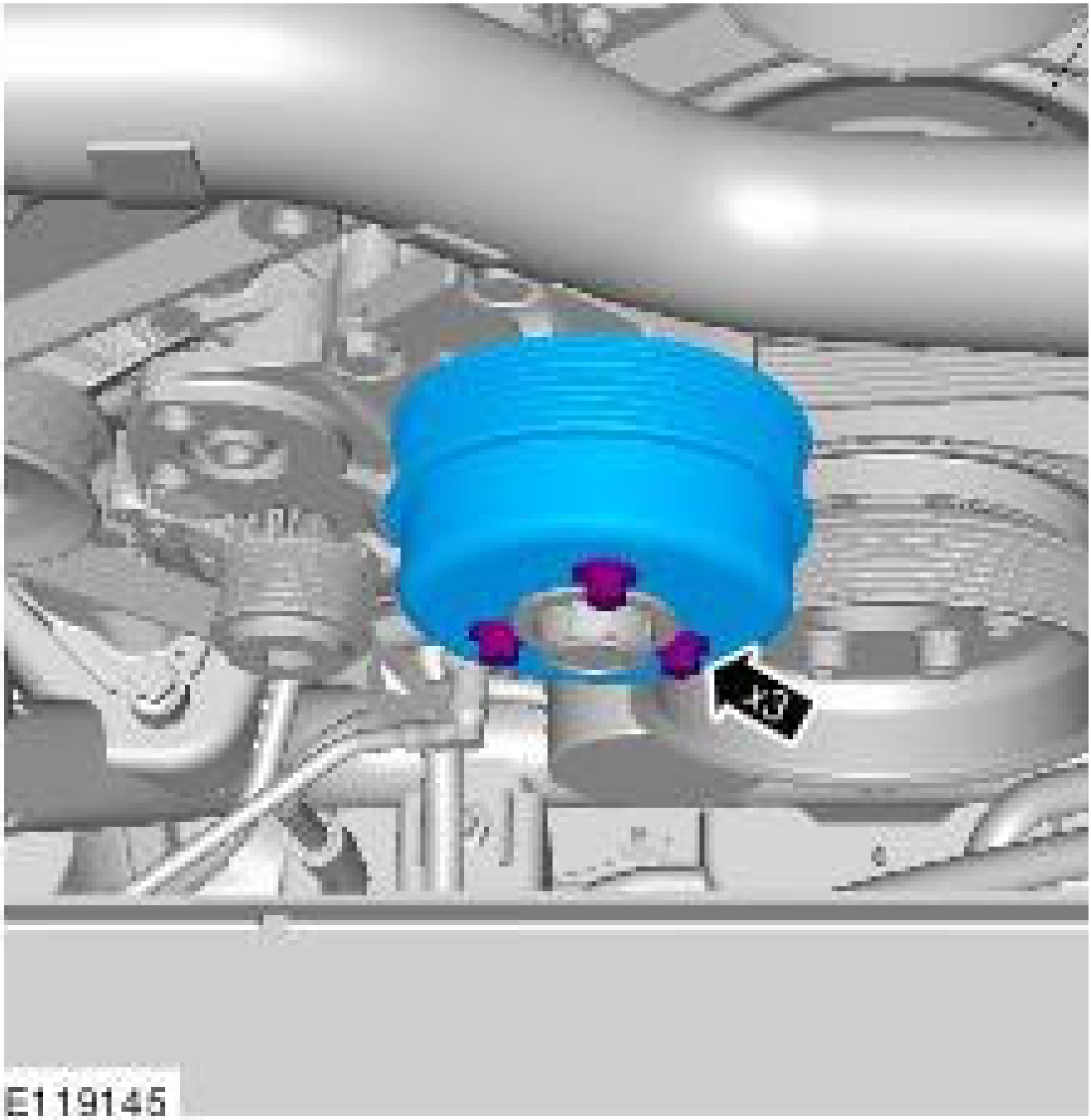

6. See figure

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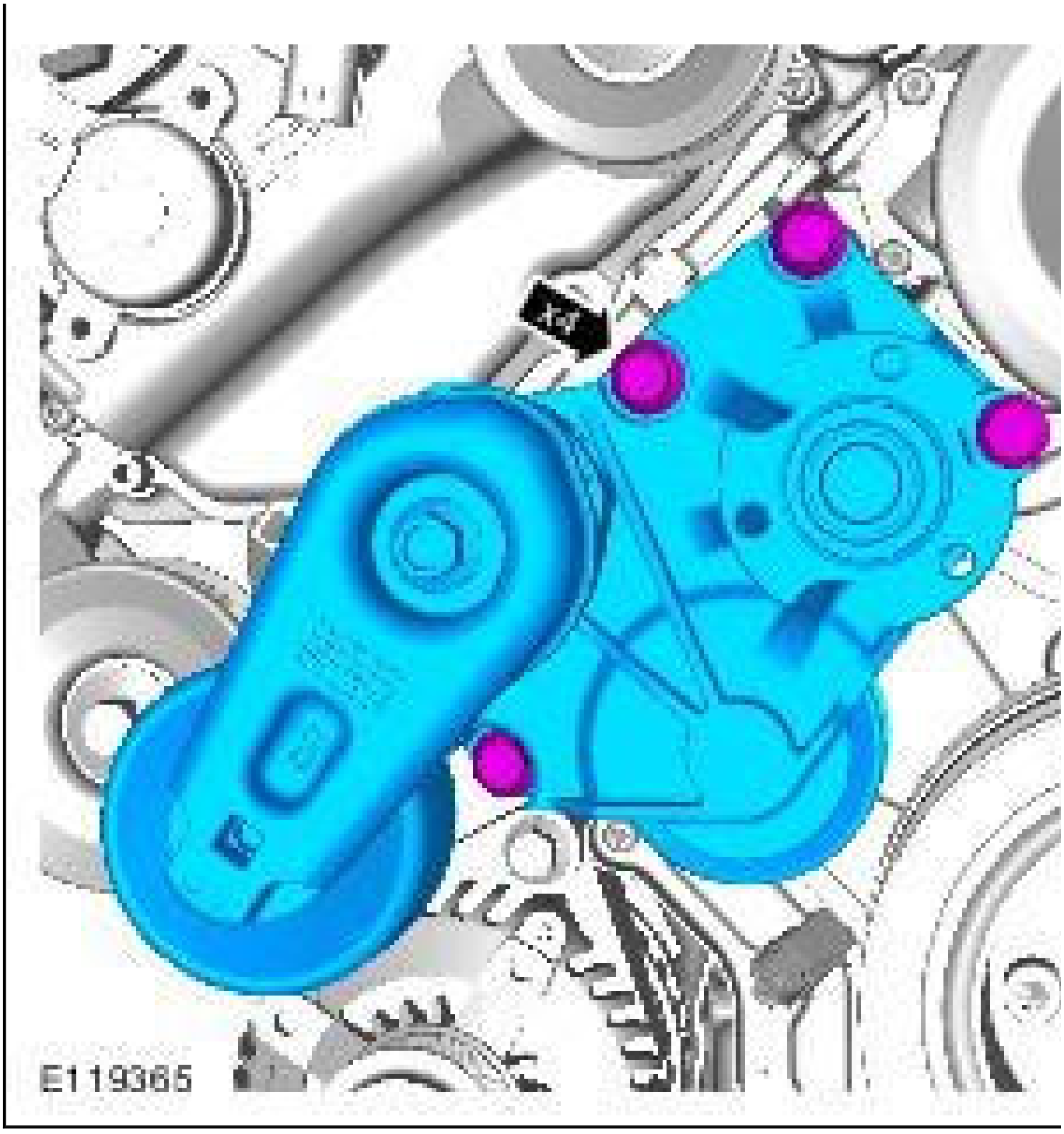

7. See figure

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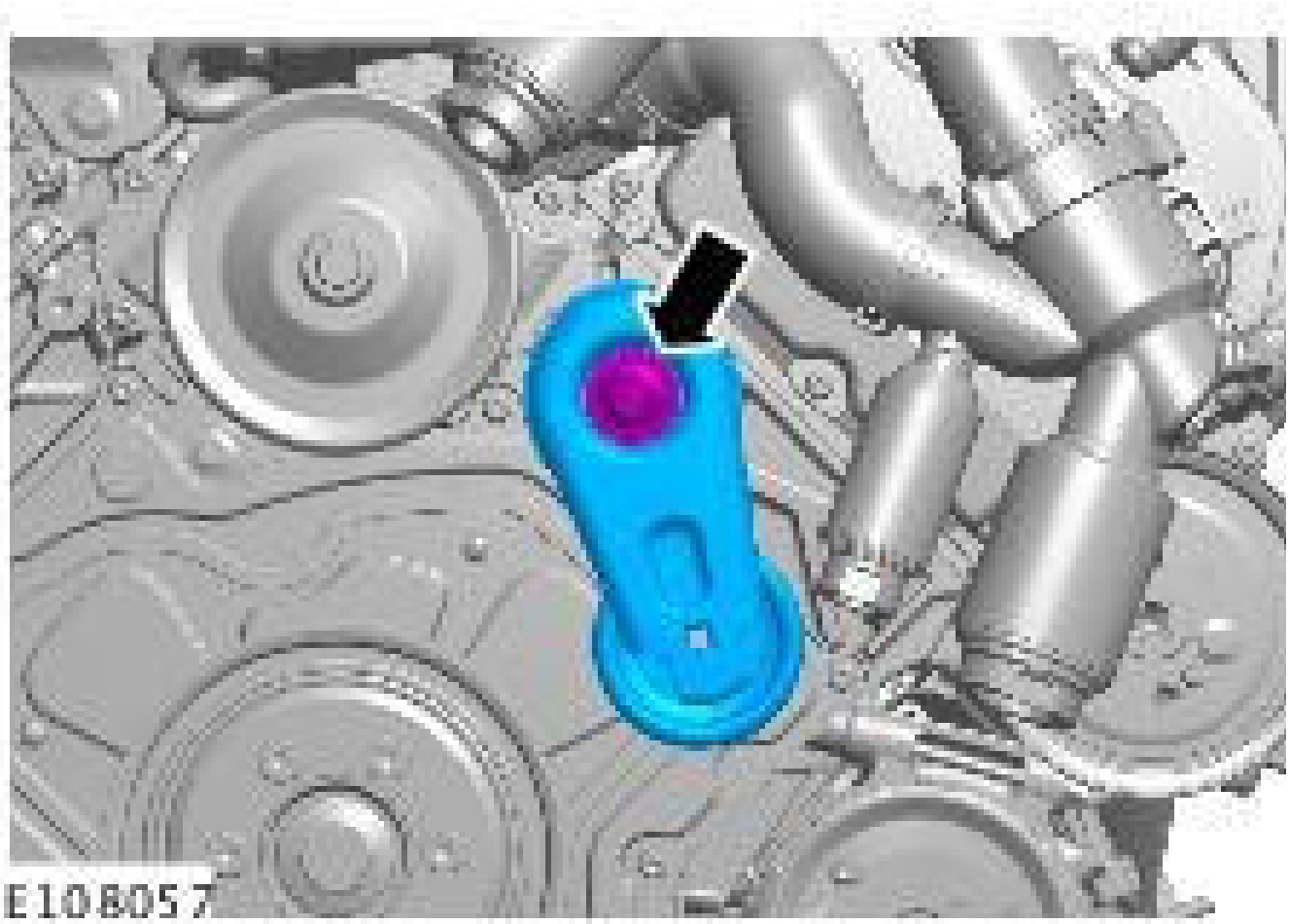

8. See figure

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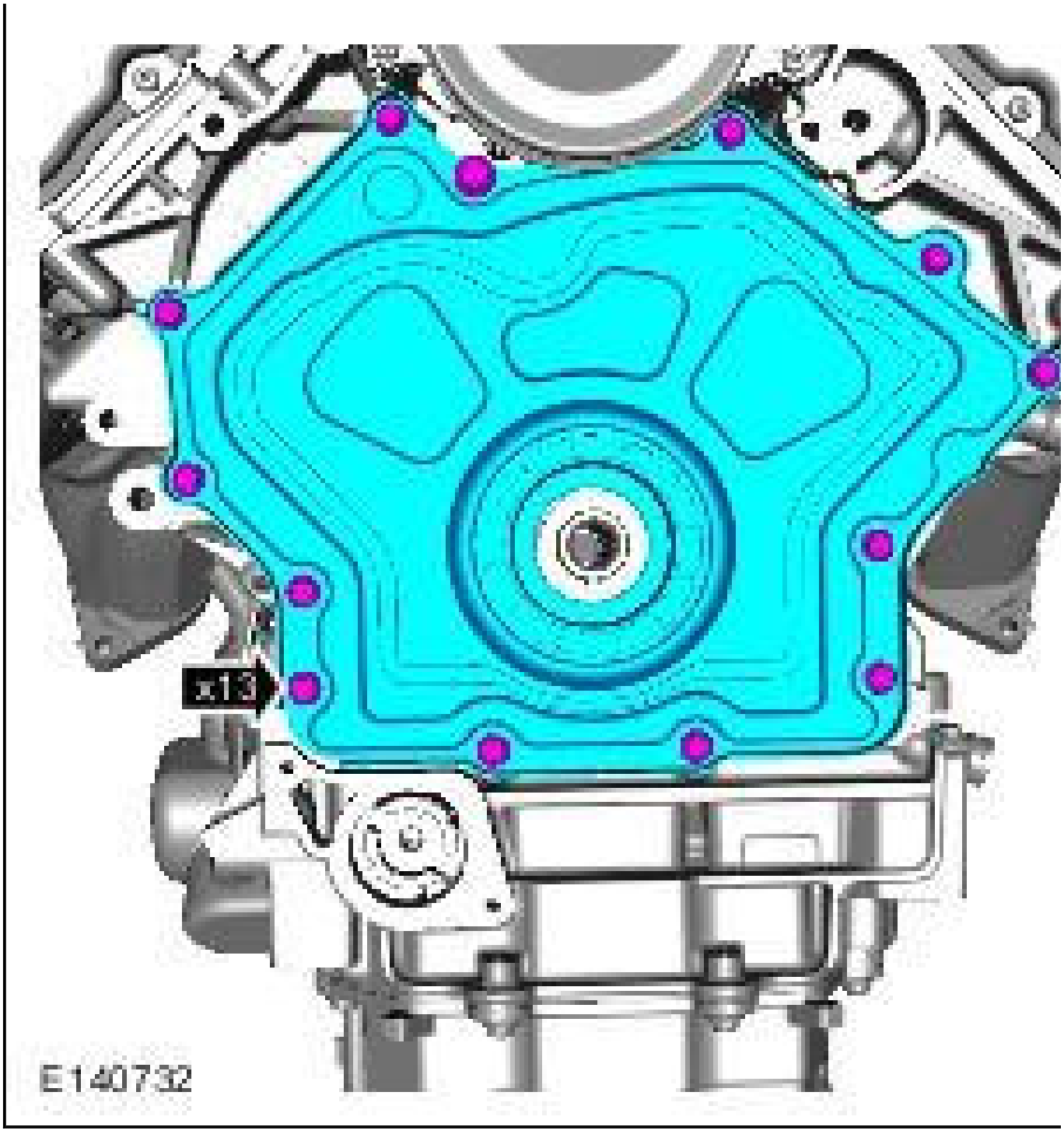

INSTALLATION

1. Apply RTV sealant WSE-M4G323-A6 (Loctite 5901G) to the areas shown, and tighten the bolts within 7 minutes.

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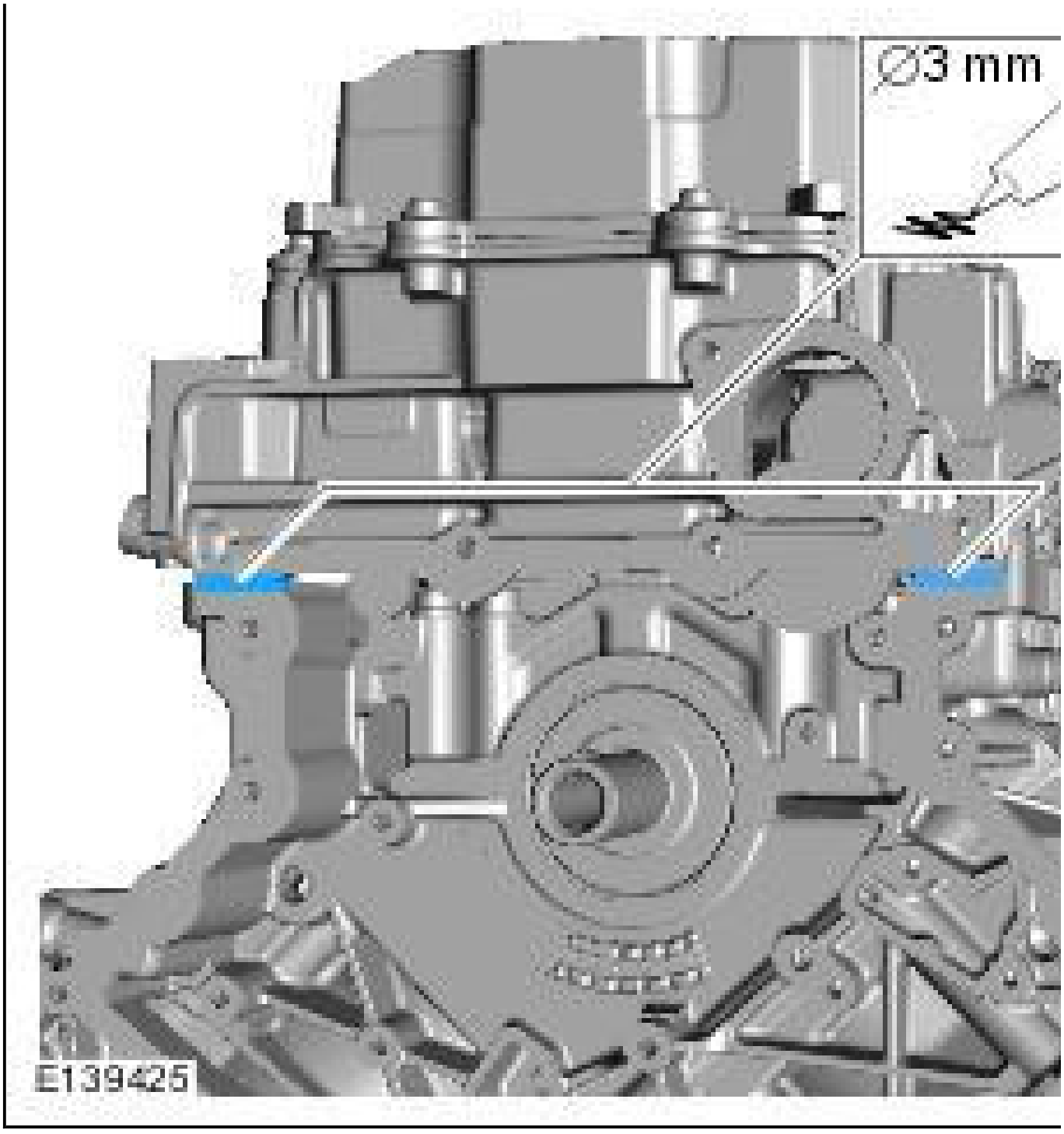

2. Install the bolts, but do not tighten fully at this stage.

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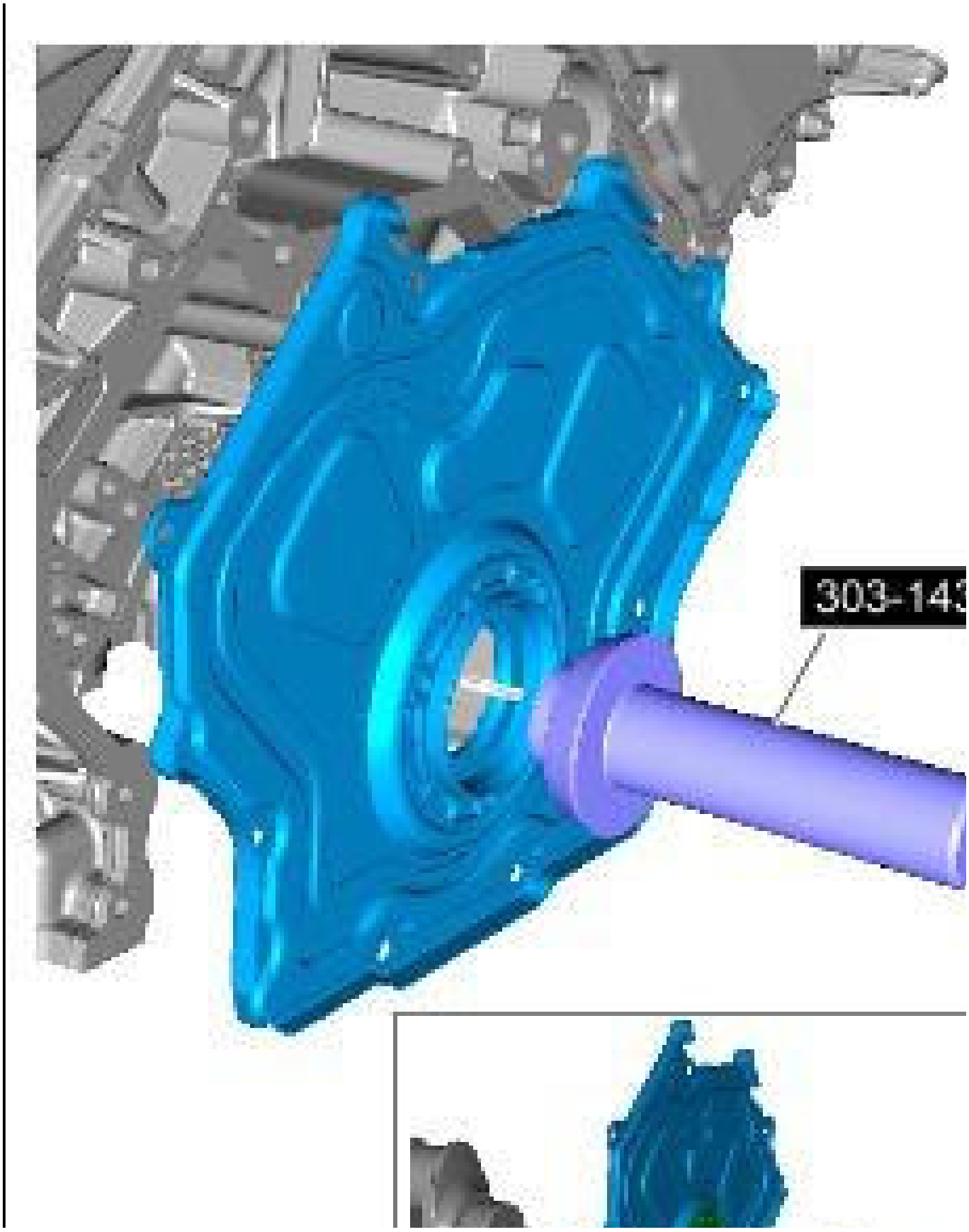

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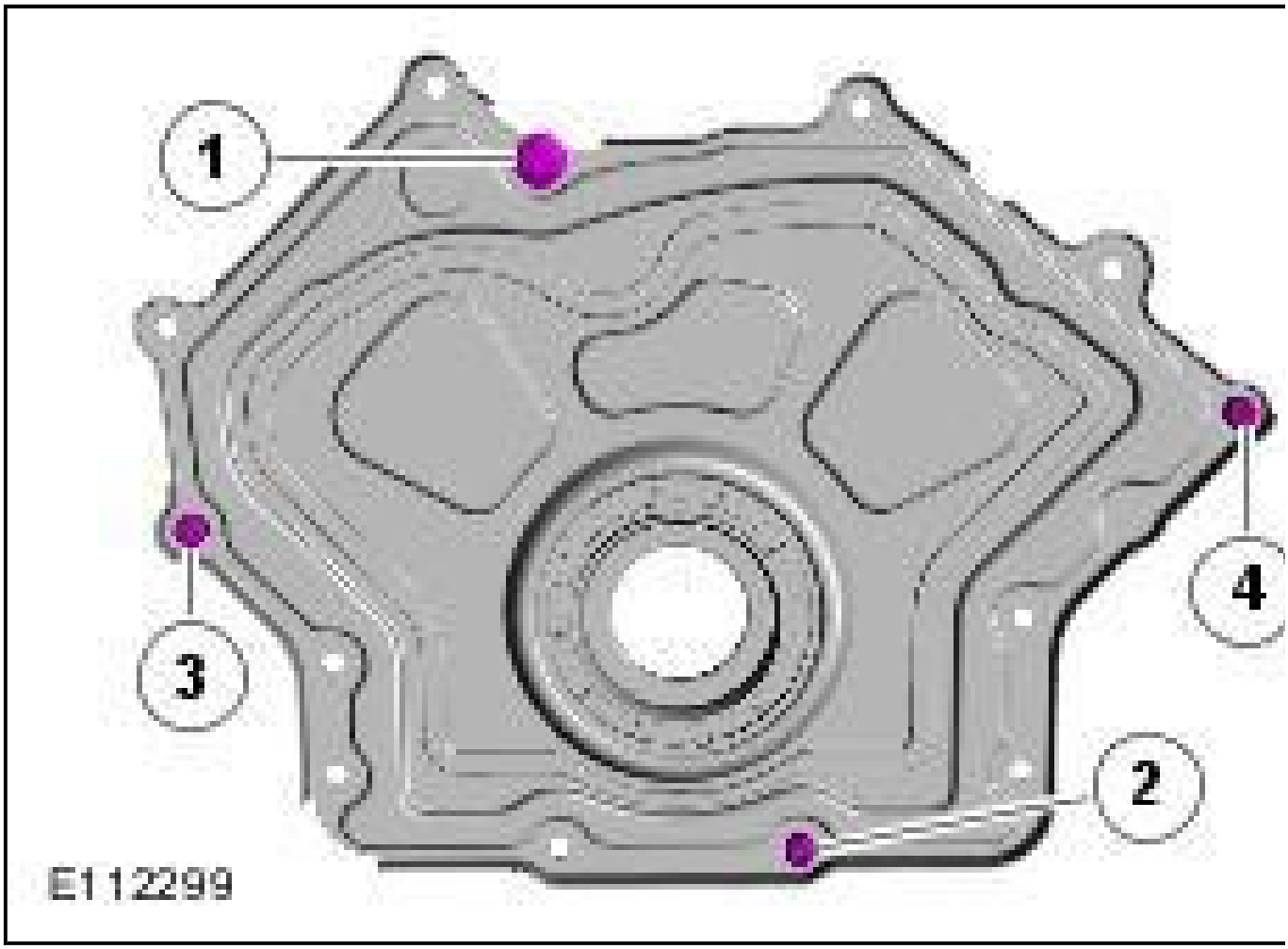
CAUTION: Make sure that the mating faces are clean and free of foreign material.

Lower Timing Cover Alignment tool (303-1433), refer to **SPECIAL TOOL(S)**

3. See figure



NOTE: Tighten the bolts in the indicated sequence.

Torques:

M6: 12 Nm

M8: 20 Nm

4. Torque: 12 Nm

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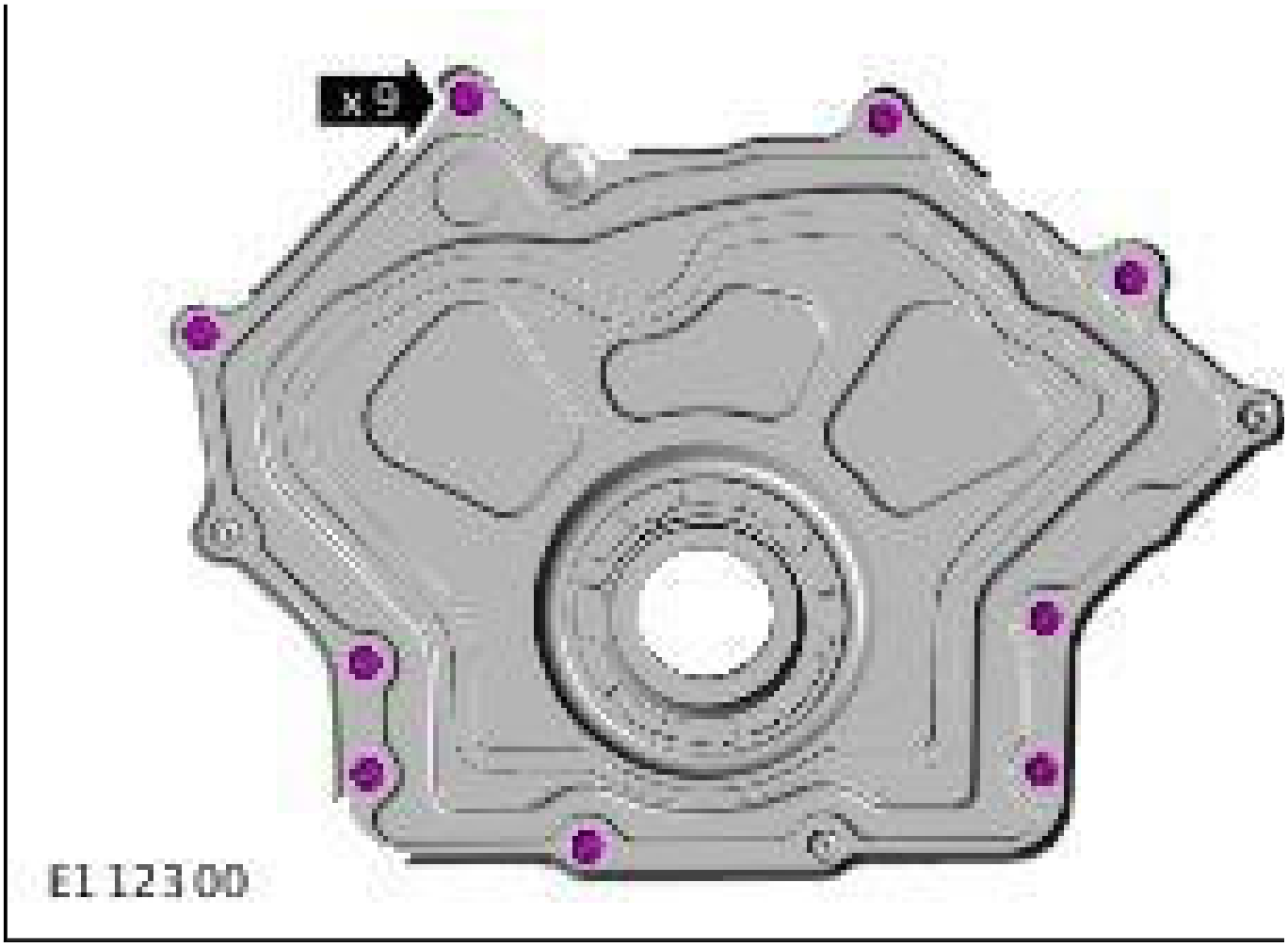

5. Torque: 40 Nm

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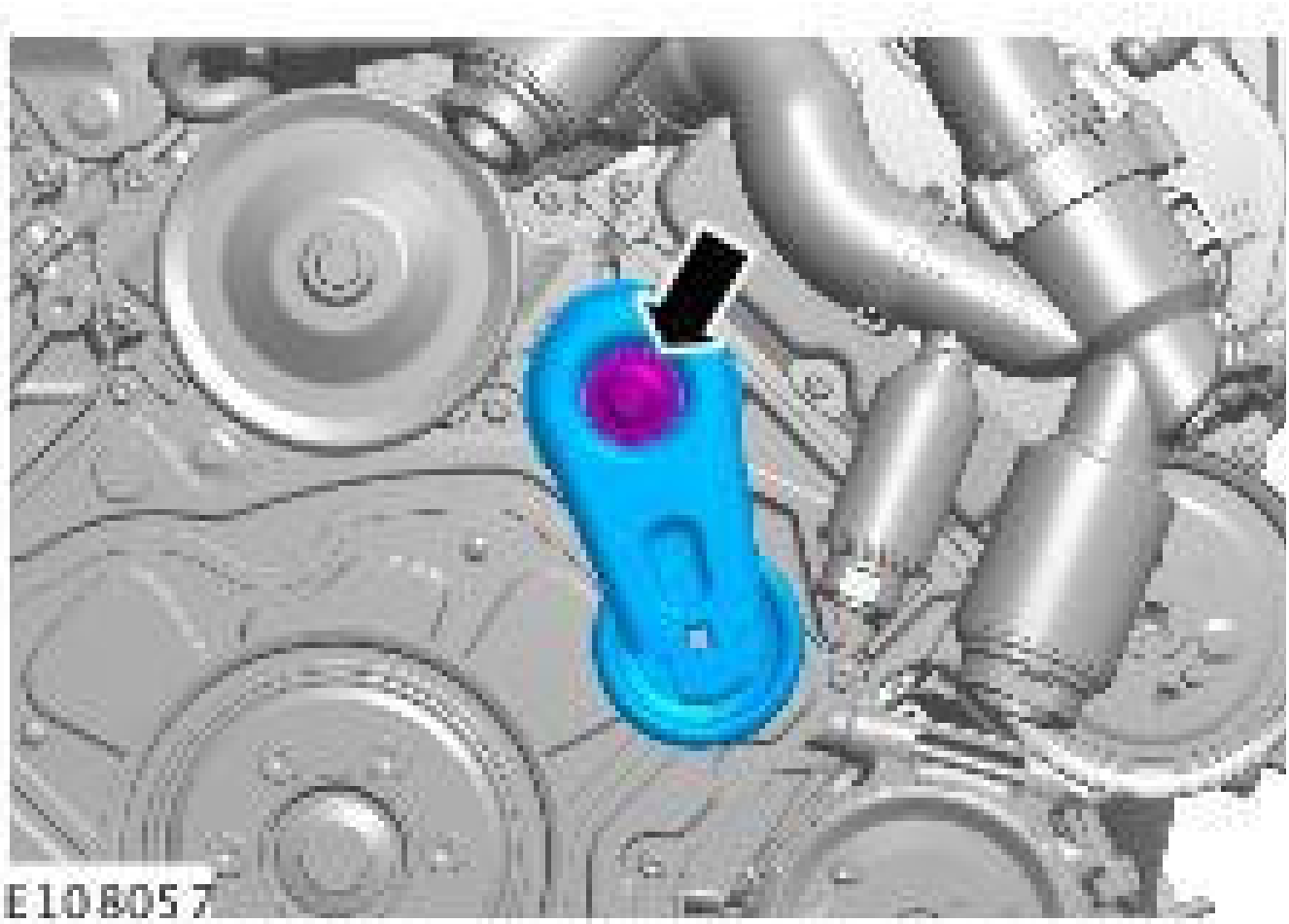

6. Torque: 25 Nm

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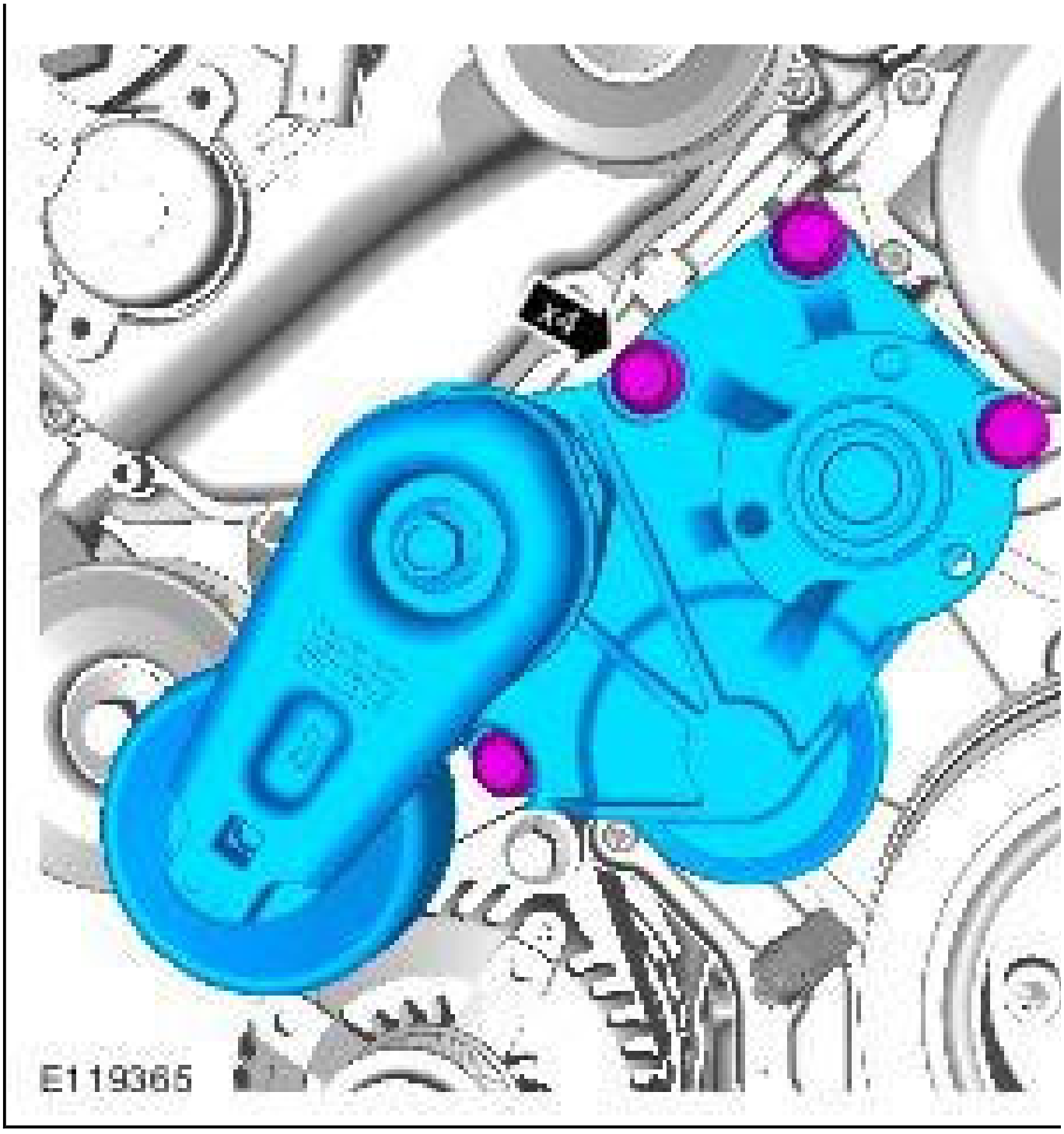

7. Torque: 25 Nm

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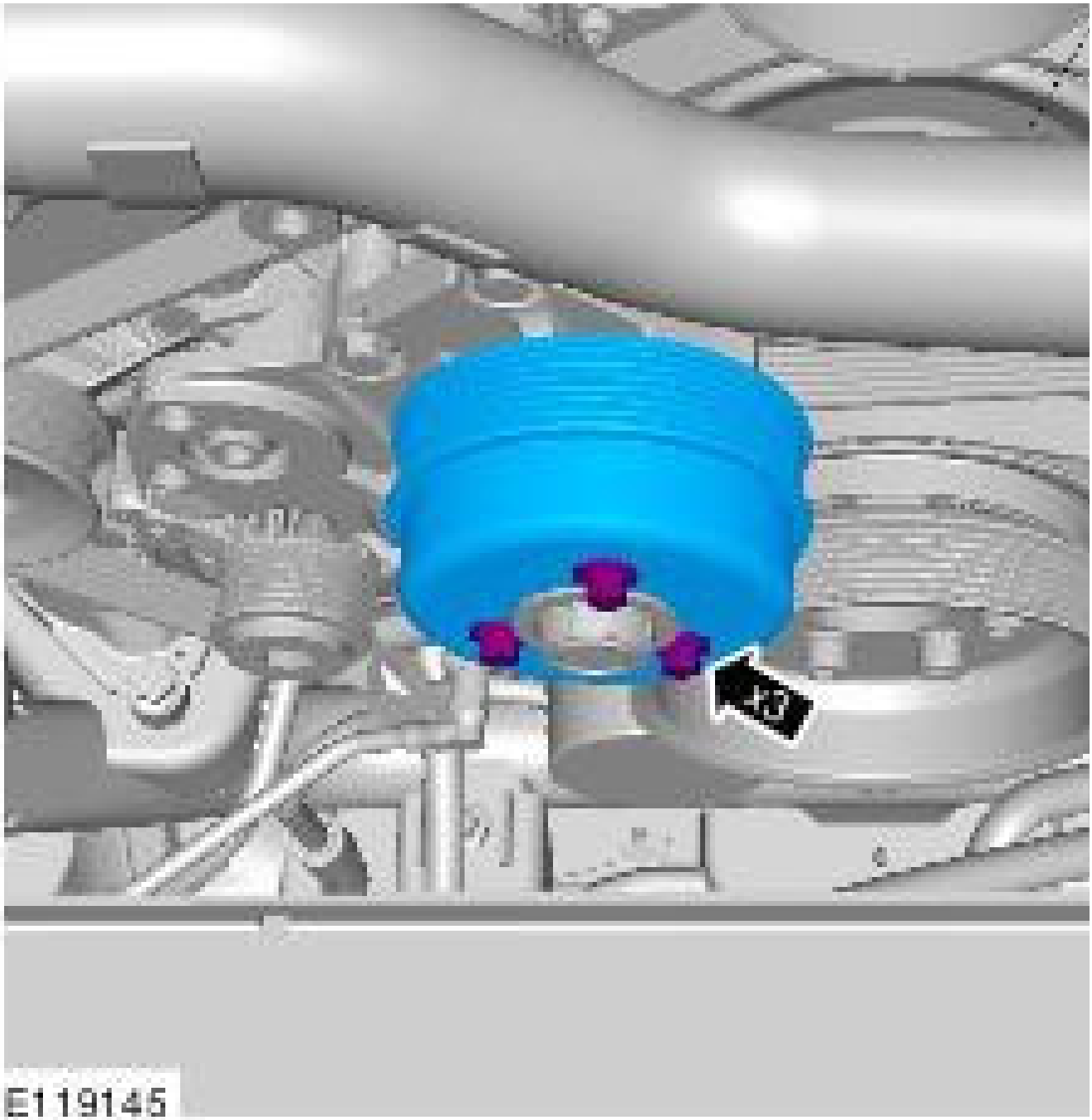

8. Refer to **Brake Vacuum Pump - V8 5.0L Petrol/V8 S/C 5.0L Petrol** .
9. See **Crankshaft Pulley**.
10. Connect the battery ground cable. Refer to **Specifications** .
11. Engine oil, filling

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CAUTION: Make sure that the vehicle is left for 5 minutes from filling with oil and that the engine oil level is reading at least minimum (by following Steps 14-21), before starting the engine.

- Fill the engine with oil - for filling values on vehicles without supercharger: See **Specifications**.
- Fill the engine with oil - for filling values on vehicles with supercharger: Refer to **Specifications** .
- Clean any residual engine oil from the oil filler cap area.

CAUTION: Make sure that the vehicle has been left for 5 minutes from filling with oil.

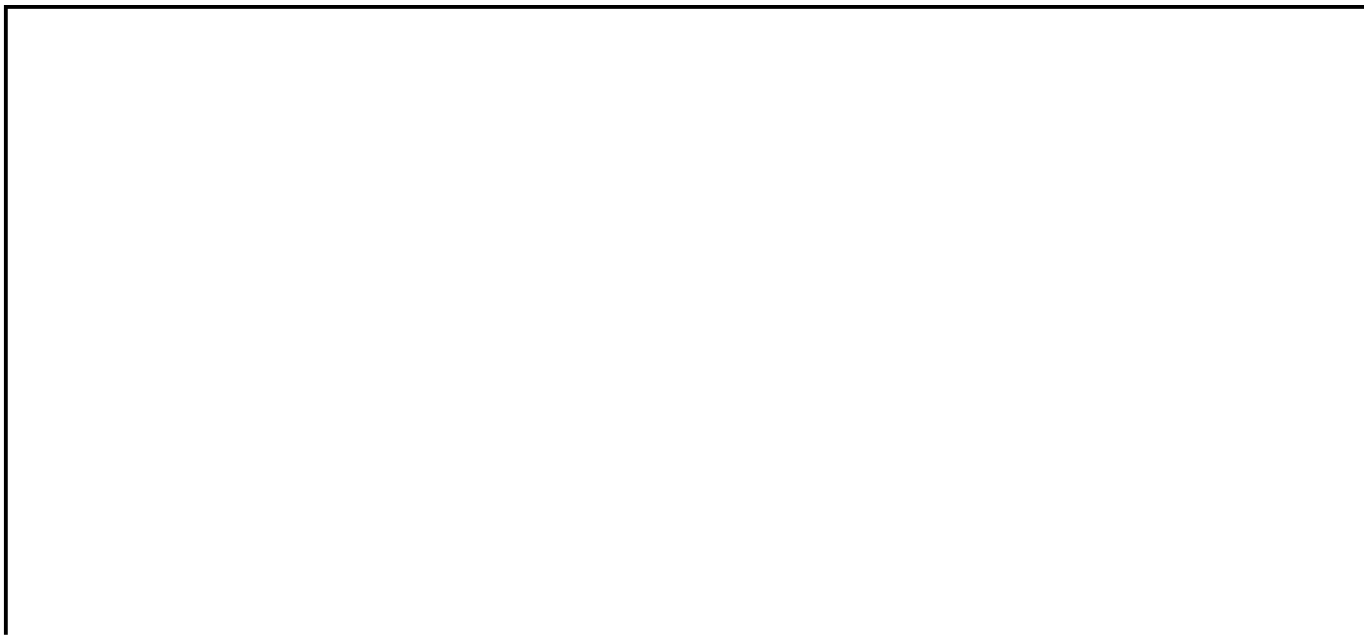
12. Follow the Steps 14-21 before starting the engine.
13. Leak check
    - Start the engine and allow to run for 10 minutes, stop the engine.
    - Check for leaks.
14. See figure

CAUTION: Make sure that the selector lever and the gearshift mechanism are in the park (P) position.

CAUTION: Make sure that the hood is open.

- Turn the ignition on.

15. See figure



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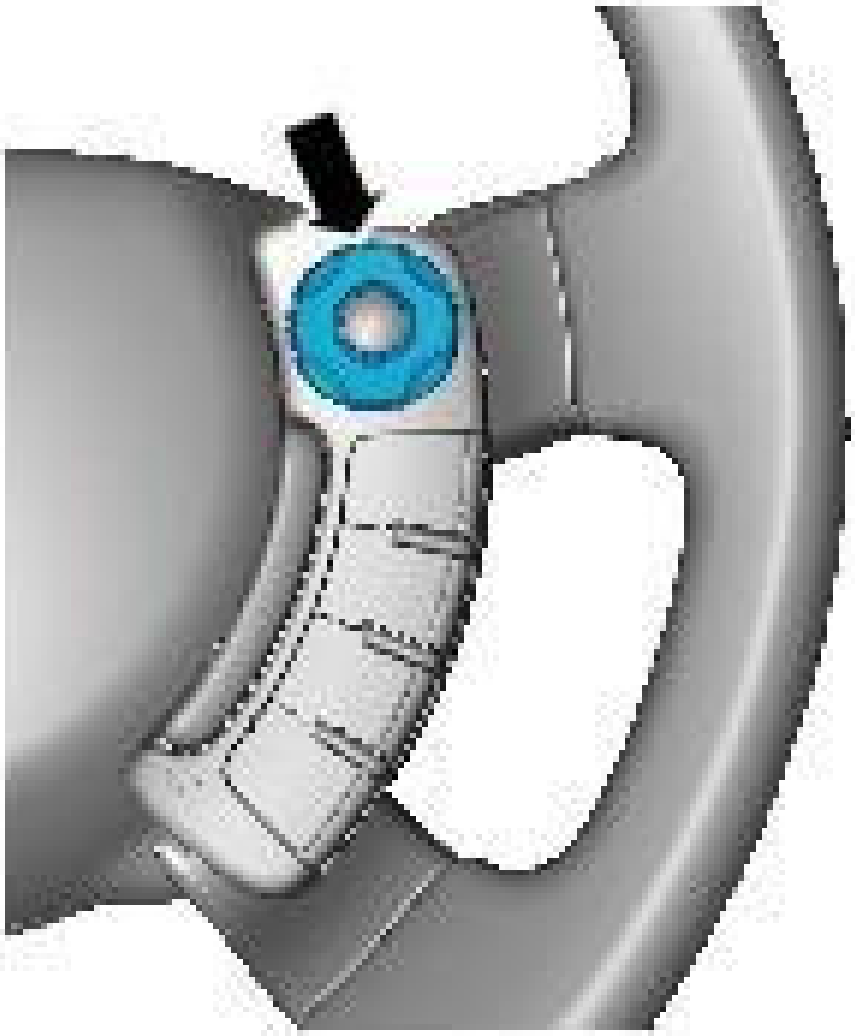

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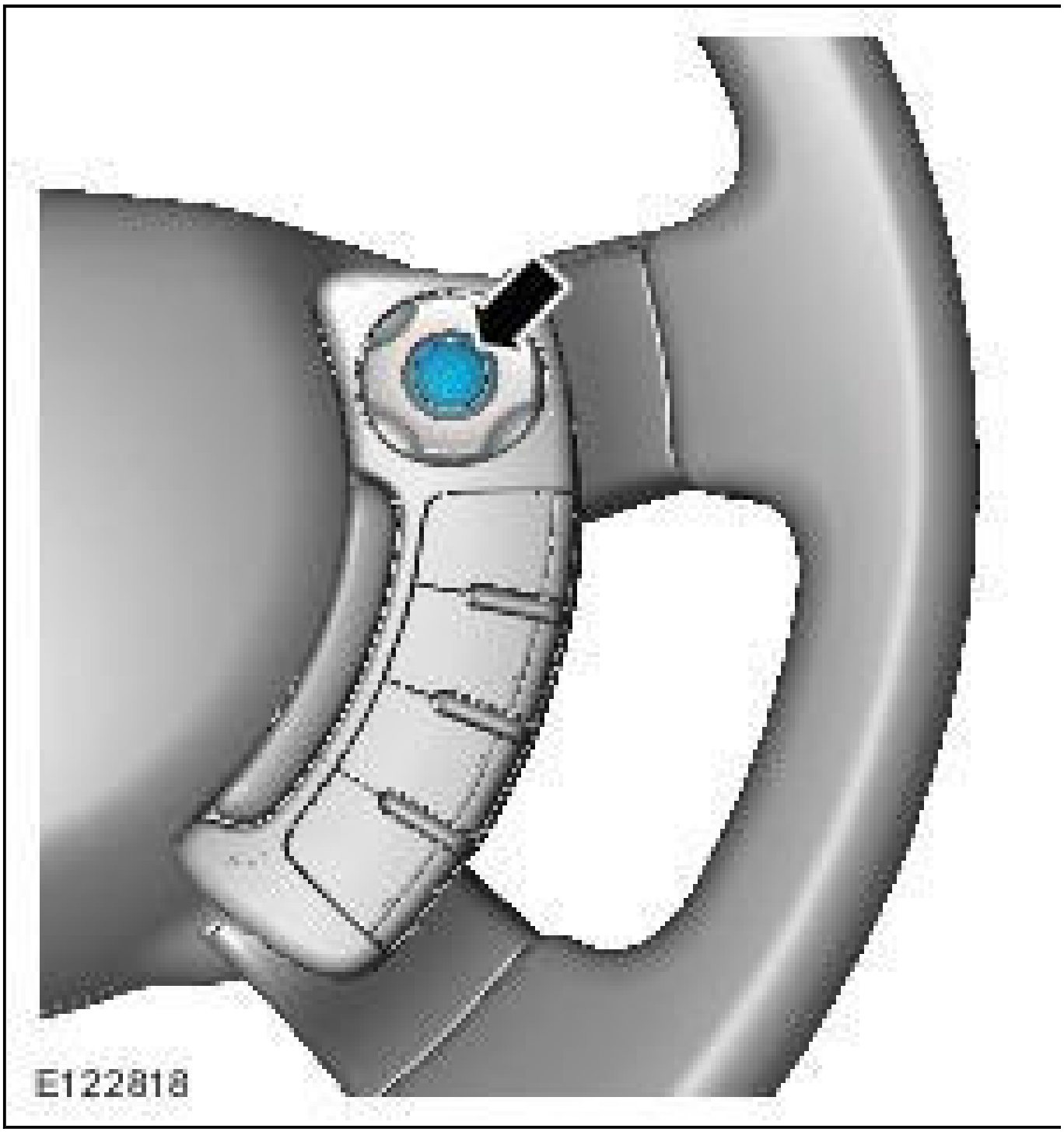
- Press the right-hand directional button to access the instrument cluster menu.

16. See figure



- Press the right-hand OK button.

17. See figure

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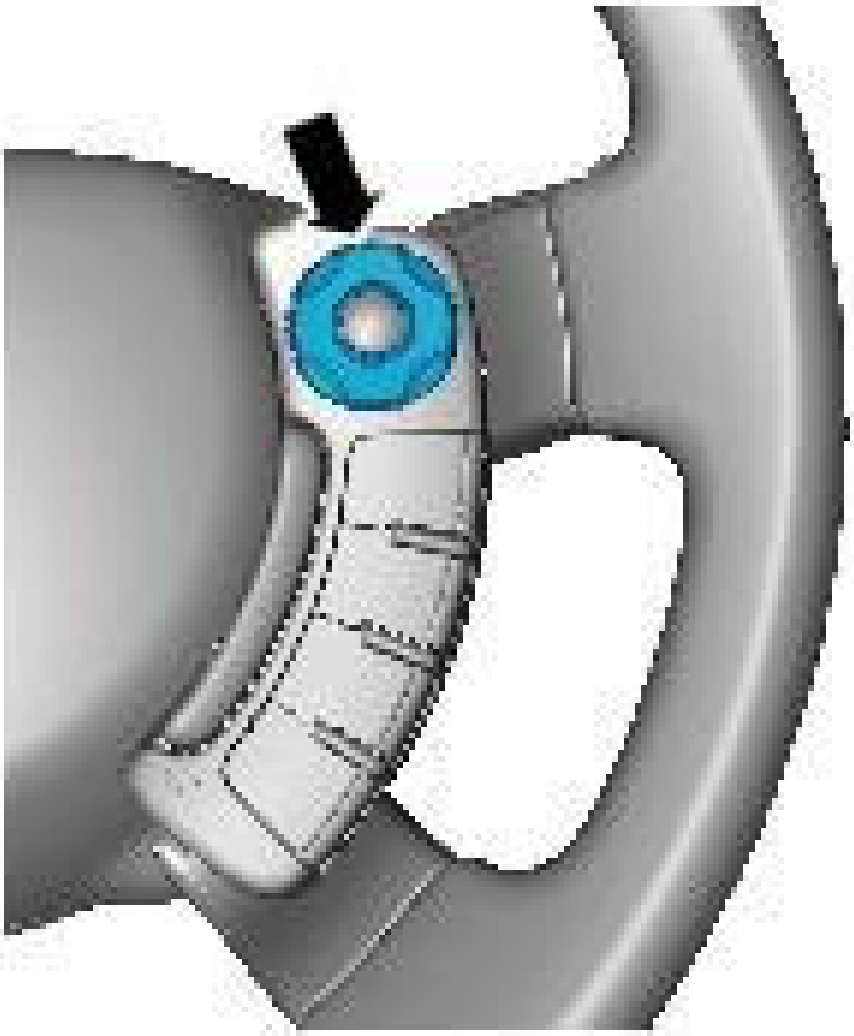

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- Press the right-hand directional button to access the Oil Level Display.

18. See figure

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- Press the right-hand OK button and follow the instructions.

19. See figure

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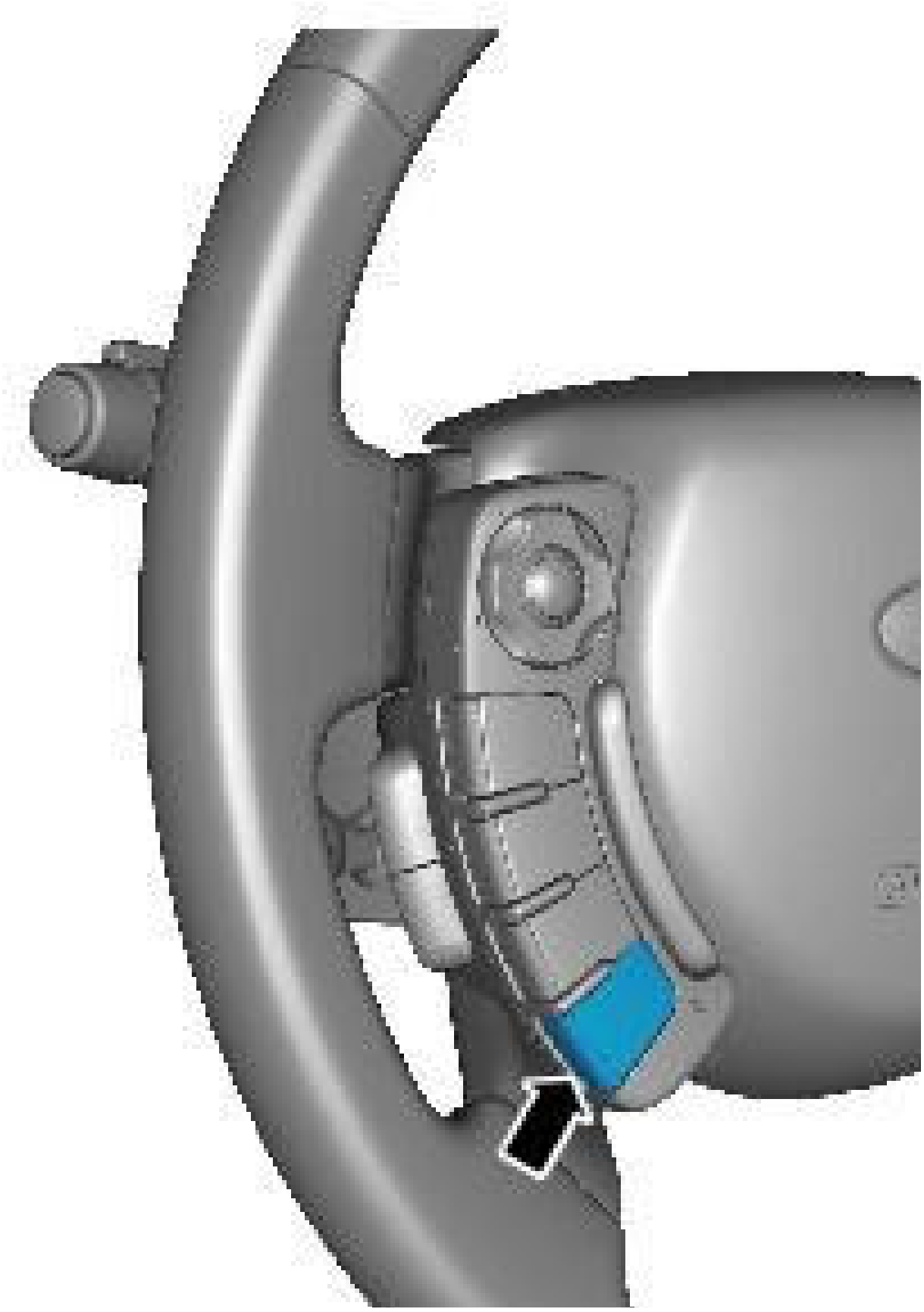

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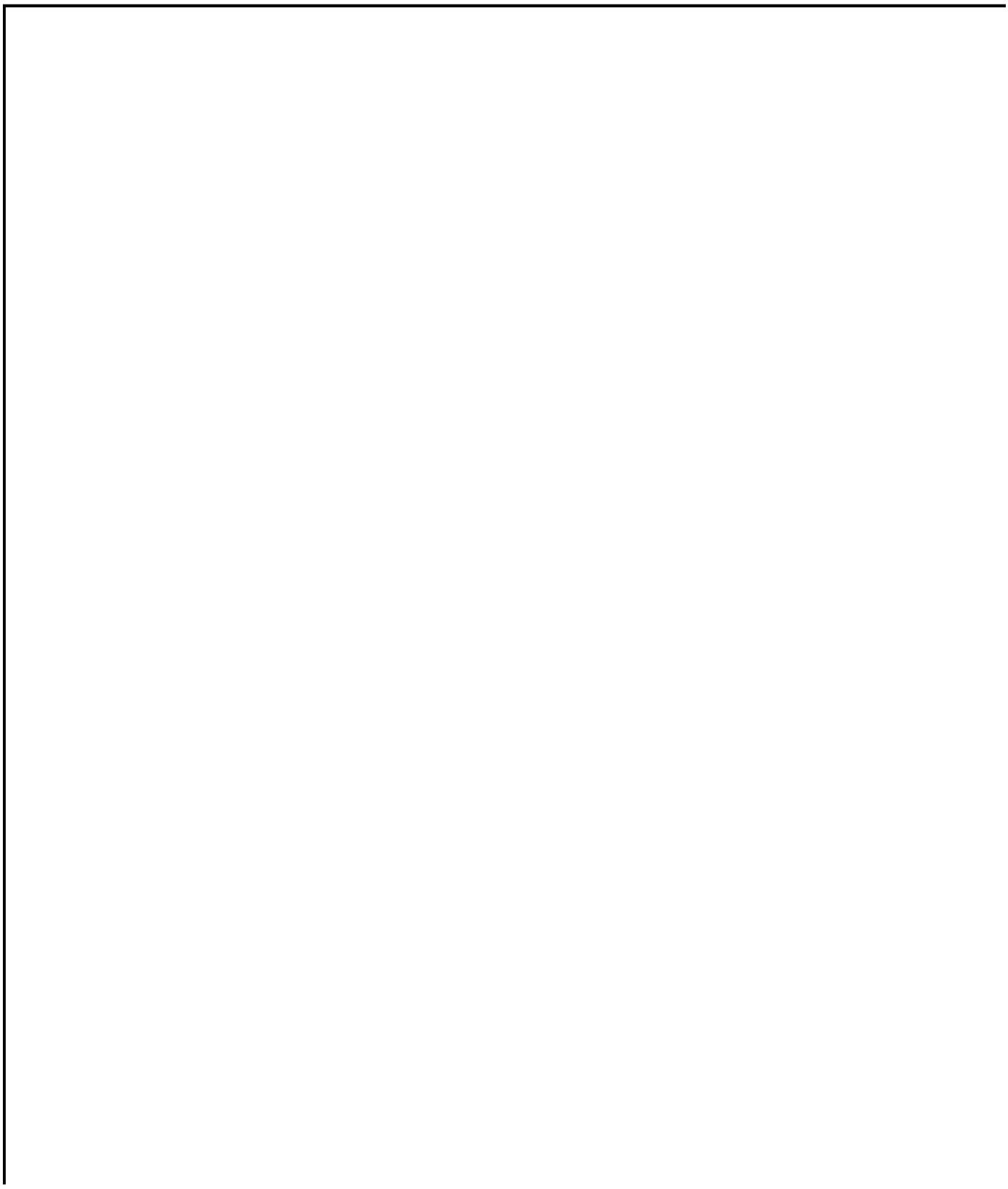
- Press the cruise control cancel button twice within 2 seconds.

20. See figure



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- The message center display will revert to the normal display in the trip computer.
- Press the right-hand OK button and follow the instructions.
- Check that the oil level display shows an oil level reading.
- Only after having started and run the engine for 10 minutes (as indicated in Step 13), switch off the engine, then stabilizing for 10 minutes, take a reading from the oil level display and, if necessary top up with engine oil.

NOTE: If instructed to follow Steps 14-21 in a previous step, return to Step 13 and continue the procedure.

21. Turn the ignition off.
22. Allow 10 minutes for the engine oil level to stabilize if there has been additional oil top up.
23. See figure

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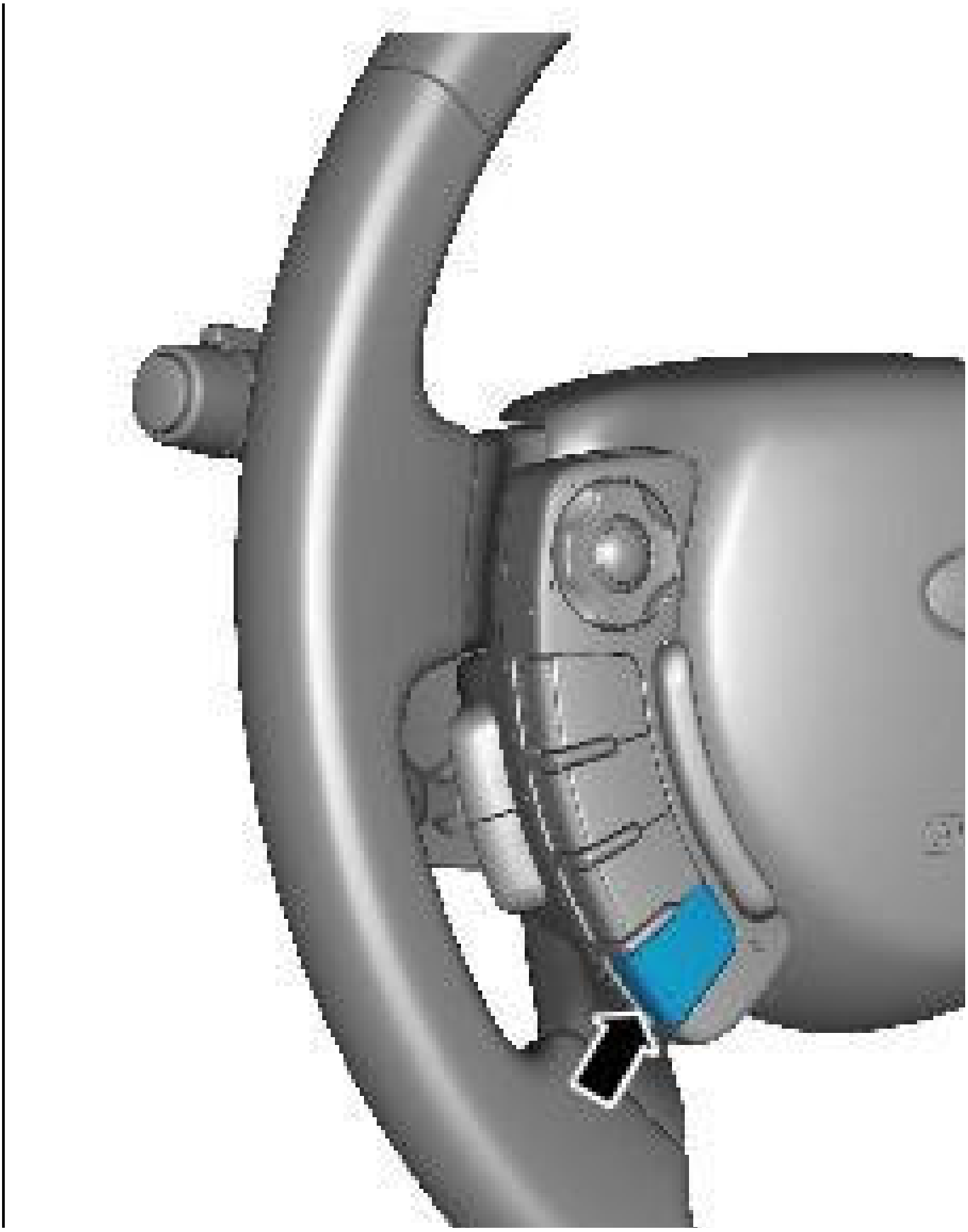

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NOTE: The following steps are to update the average oil level value.

- Turn the ignition on.
- Press and hold the cruise control cancel button for more than 2 seconds.

24. See figure
    - The message center display will revert to the normal display in the trip computer.
25. Turn the ignition off.
26. Turn the ignition on.
27. See figure

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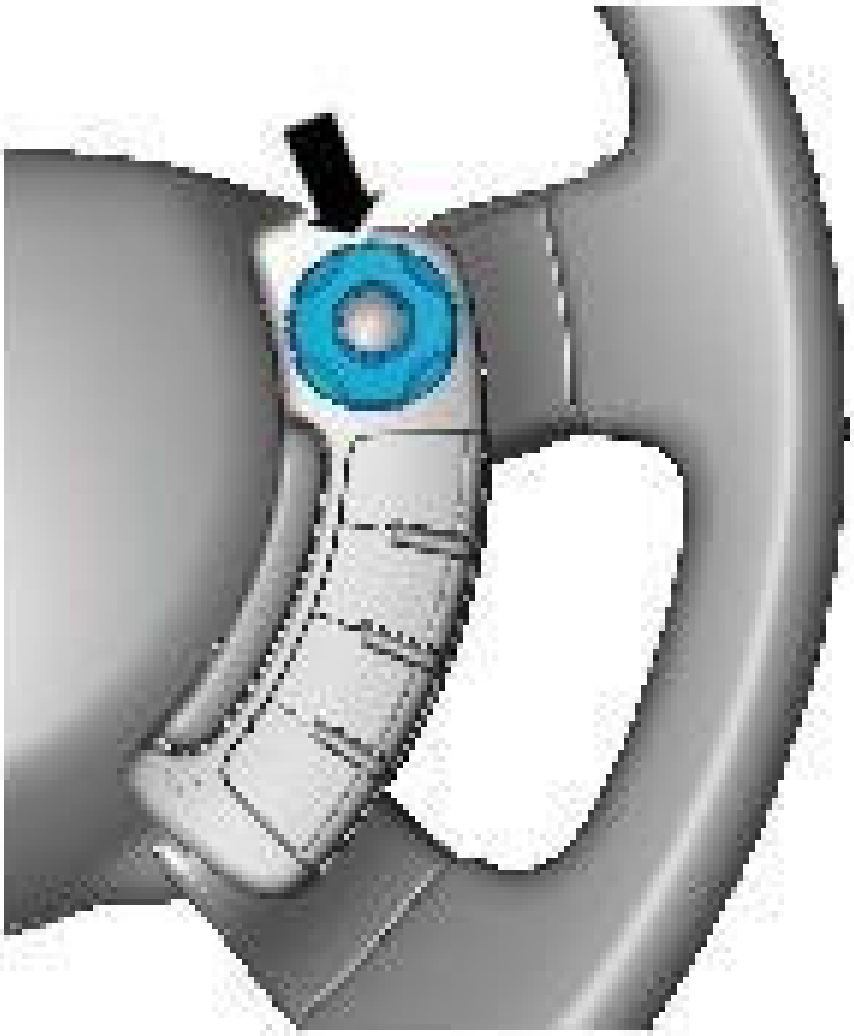

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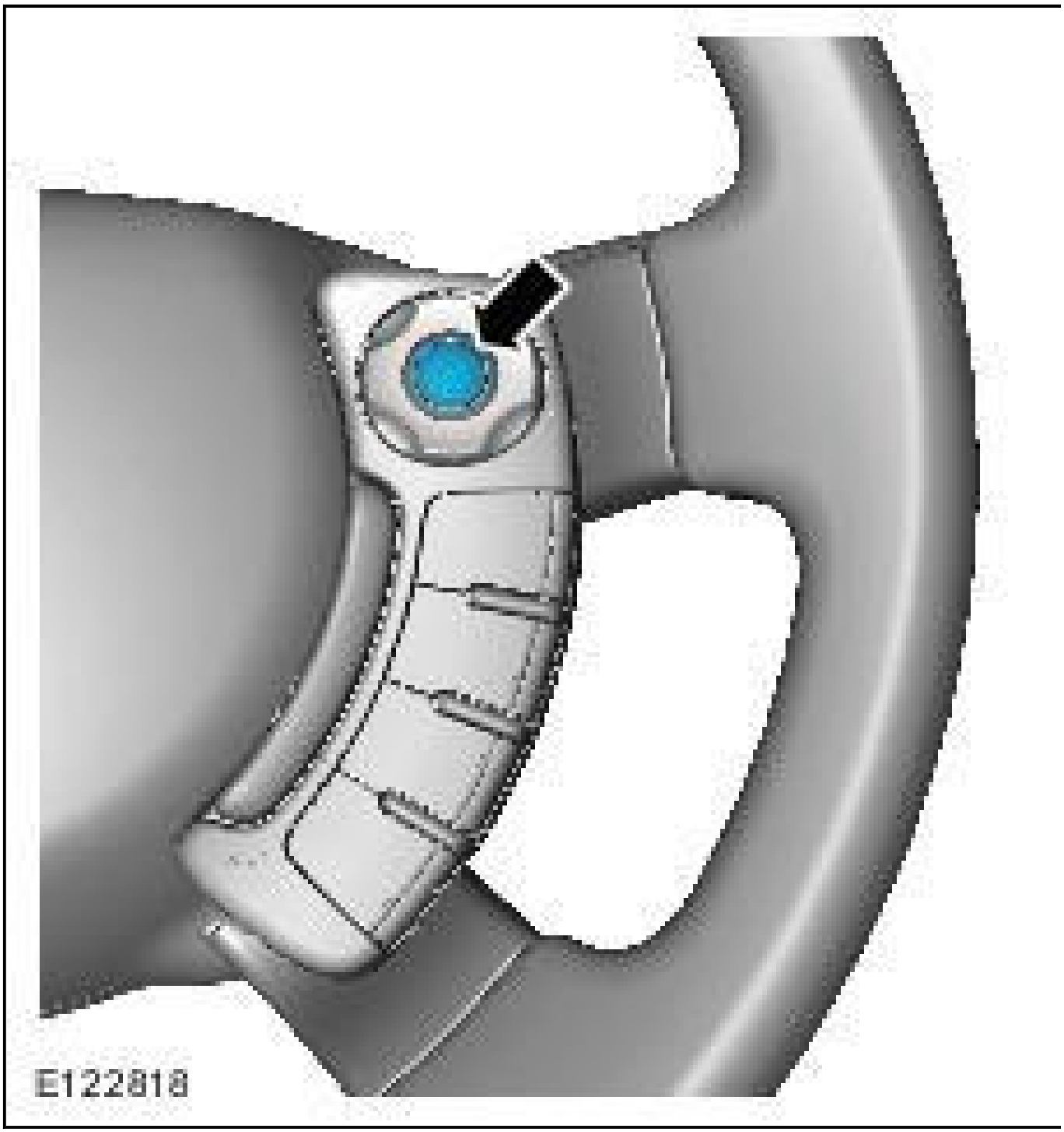
- Press the right-hand directional button to access the instrument cluster menu.

28. See figure



- Press the right-hand OK button.

29. See figure

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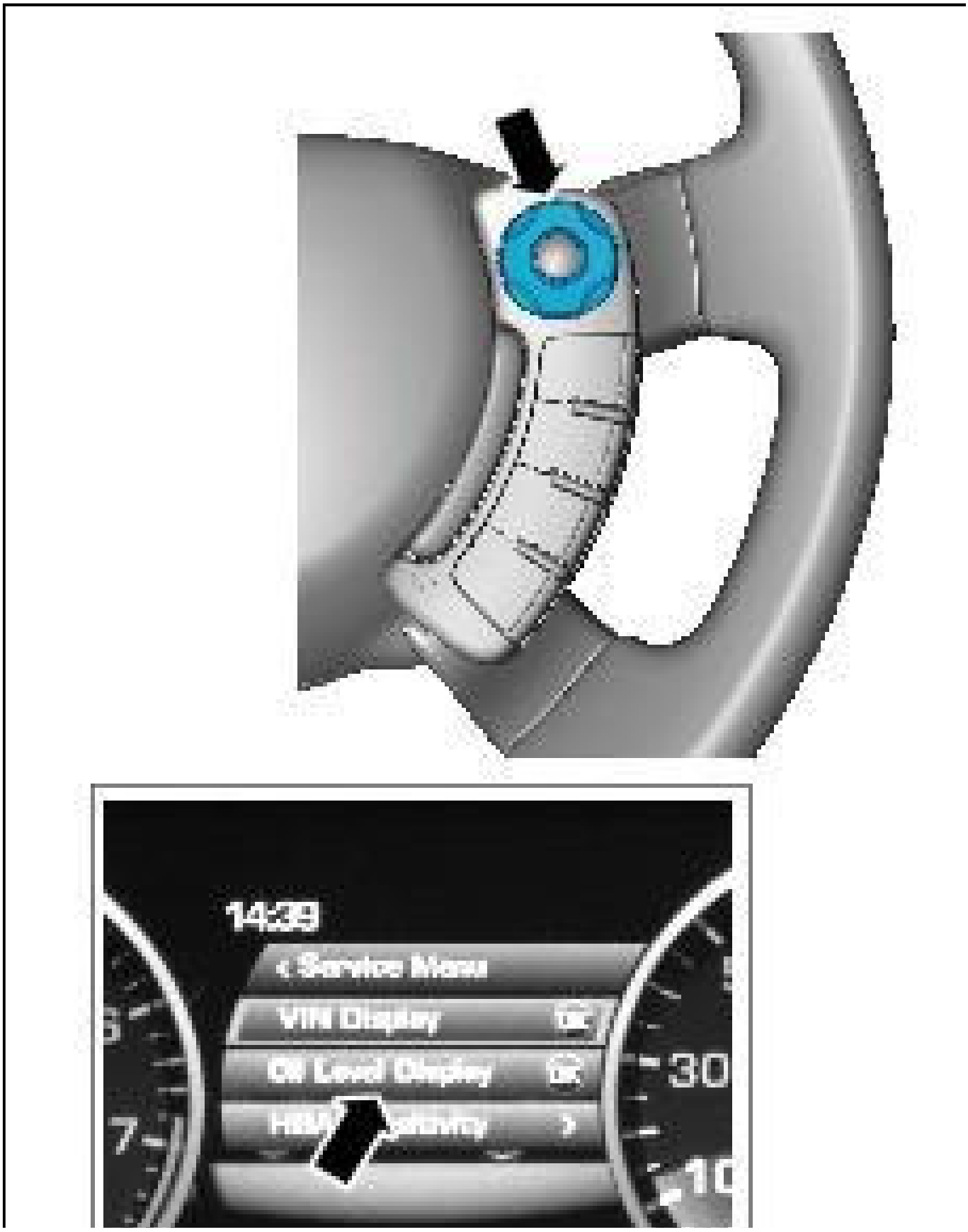

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- Press the right-hand directional button to access the Oil Level Display.

30. See figure

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- Press the right-hand OK button and follow the instructions.
- Make sure that the average oil level value has now been updated.

31. Refer to **Engine Undershield** .
32. Refer to **Radiator Splash Shield** .

REMOVAL

ENGINE

REMOVAL

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

ALL VEHICLES

1. Disconnect the battery ground cable.
2. Raise and support the vehicle.

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

3. Refer to: **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING - GENERAL PROCEDURES (5.0L NA V8 - AJ133/5.0L SC V8 - AJ133)** .
4. Refer to: **AUTOMATIC TRANSMISSION/TRANSAXLE (V8 5.0L PETROL/V8 S/C 5.0L PETROL, 5.0L)** .
5. Refer to: **COOLING FAN (V8 5.0L PETROL)** .
6. Refer to: **ENGINE COOLING (V8 5.0L PETROL/V8 S/C 5.0L PETROL)** .
7. Refer to: **FRONT DRIVE HALFSHAFTS** (Front Halfshaft LH - Vehicles Without: High Performance Brakes).
8. Refer to: **FRONT DRIVE HALFSHAFTS** (Front Halfshaft RH - Vehicles Without: High Performance Brakes).
9. Secure the hood in the service position.
10. See figure

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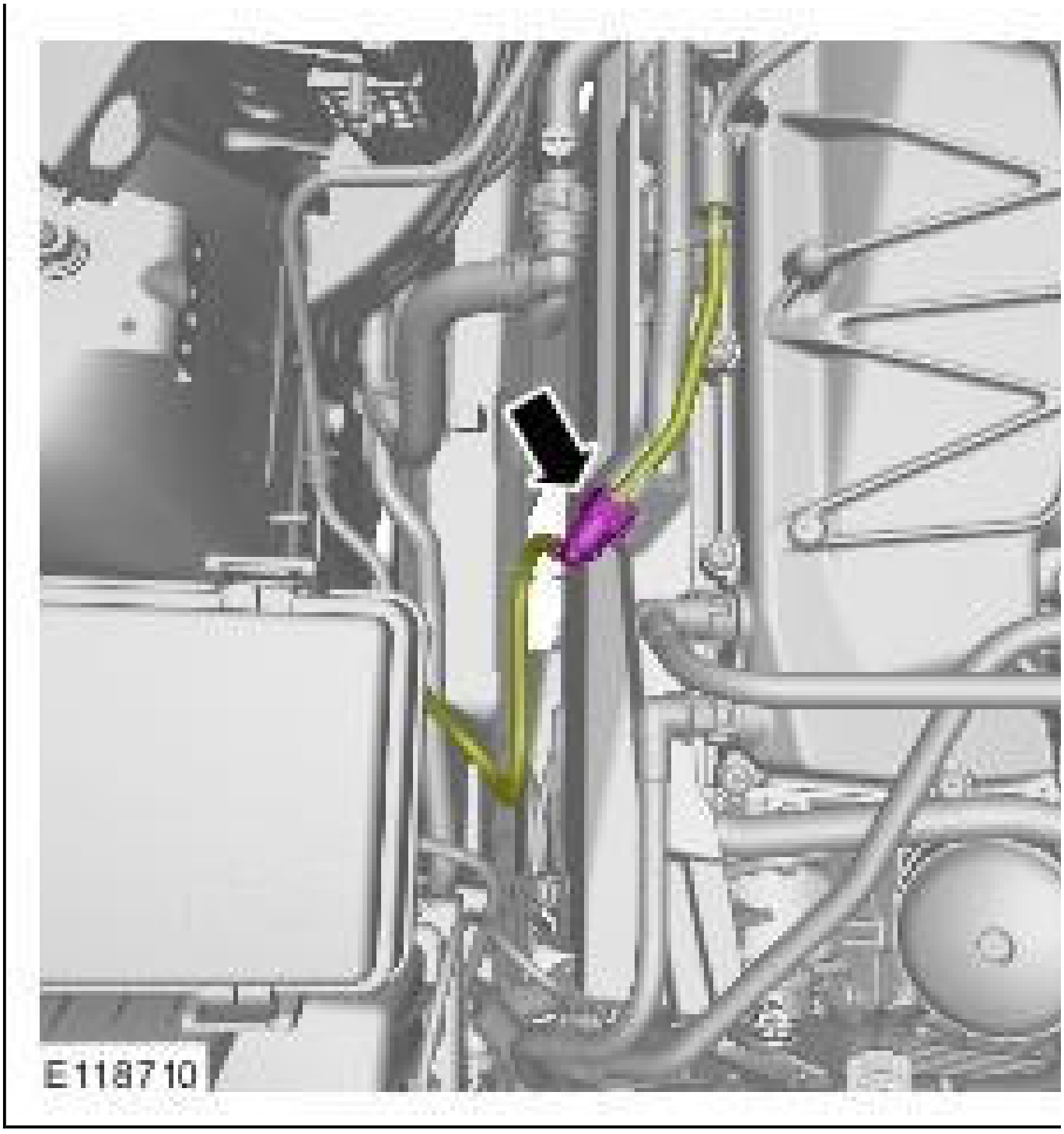

11. See figure

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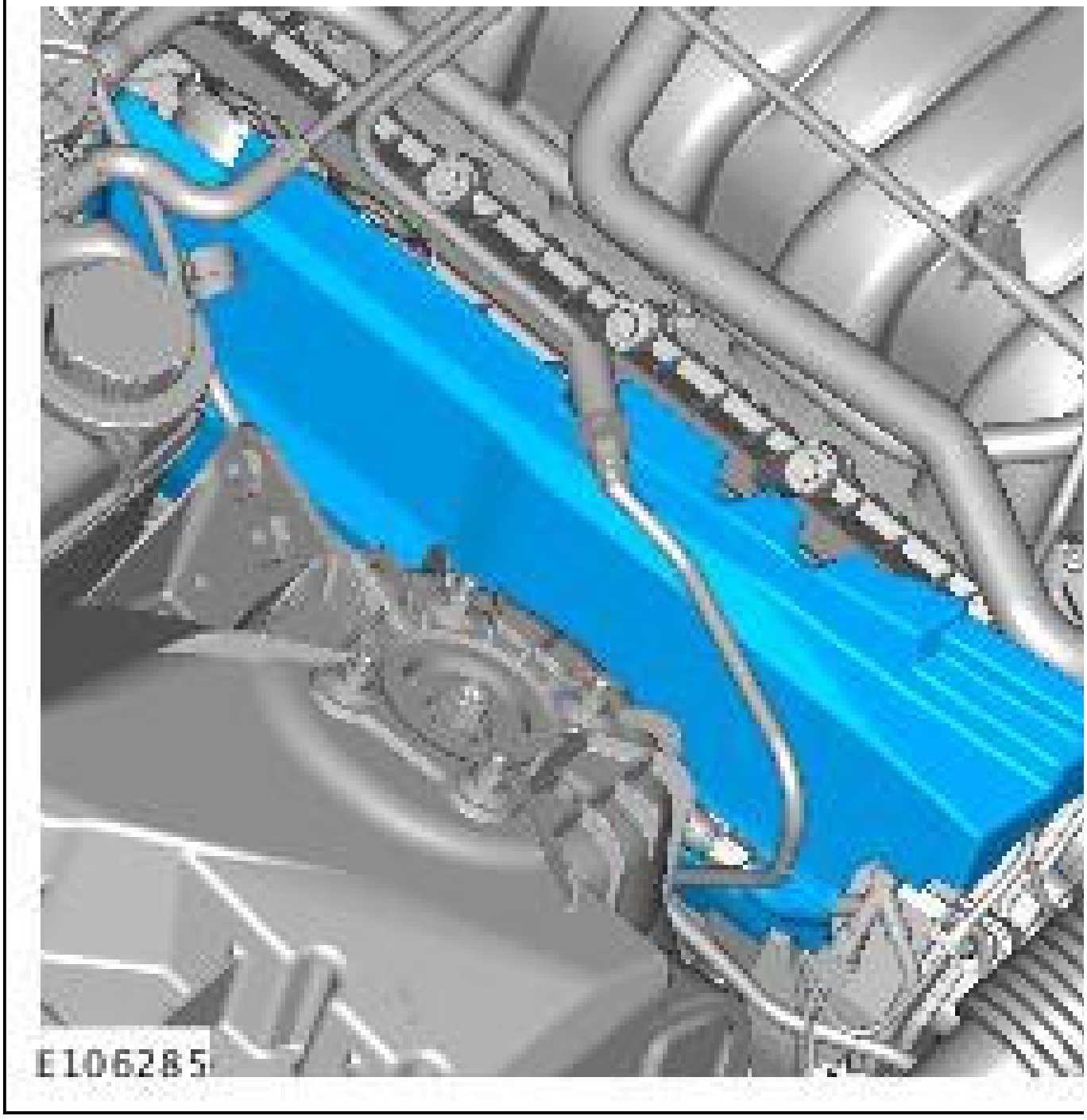

12. See figure

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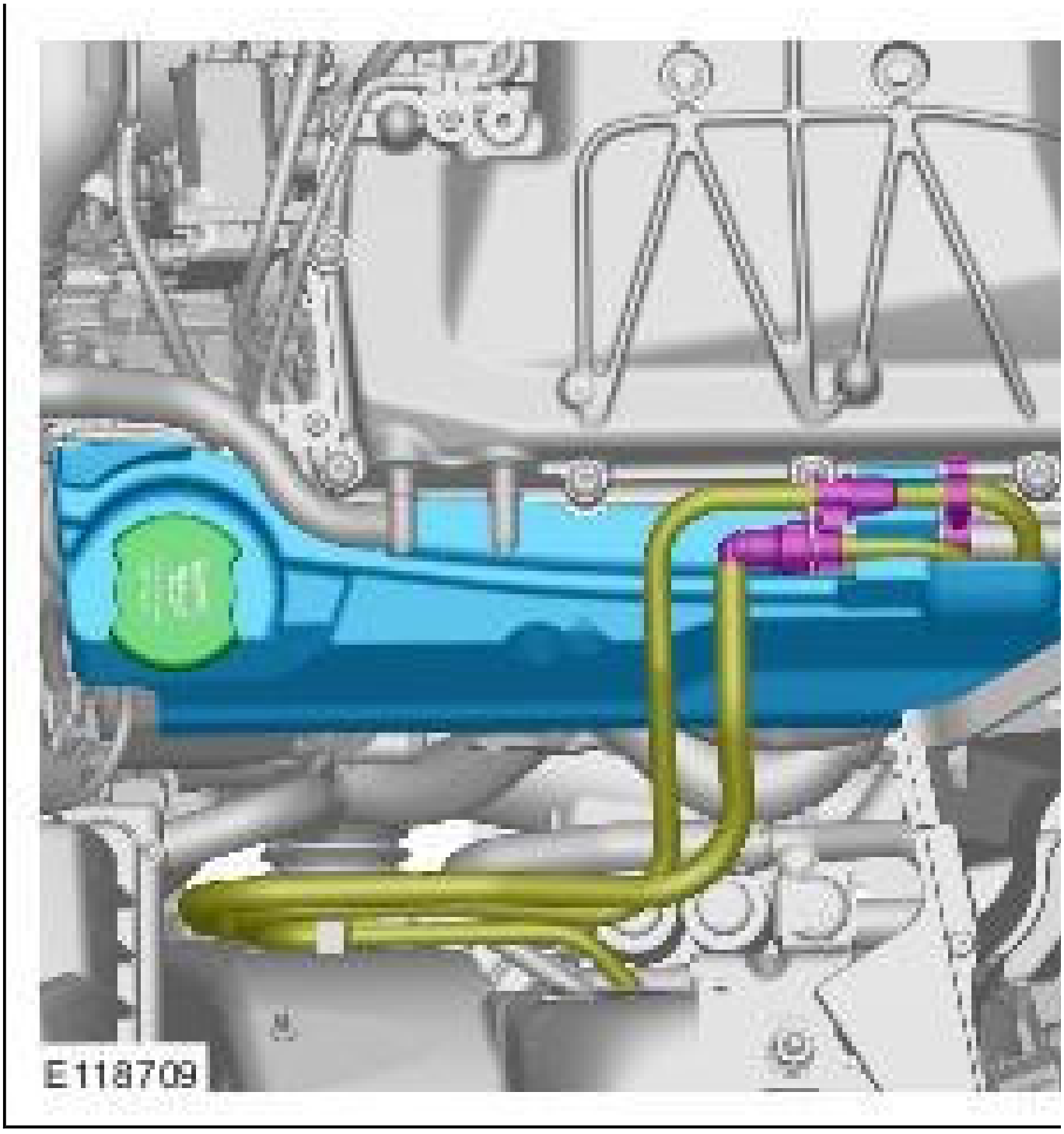

WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

CAUTION: Be prepared to collect escaping coolant.

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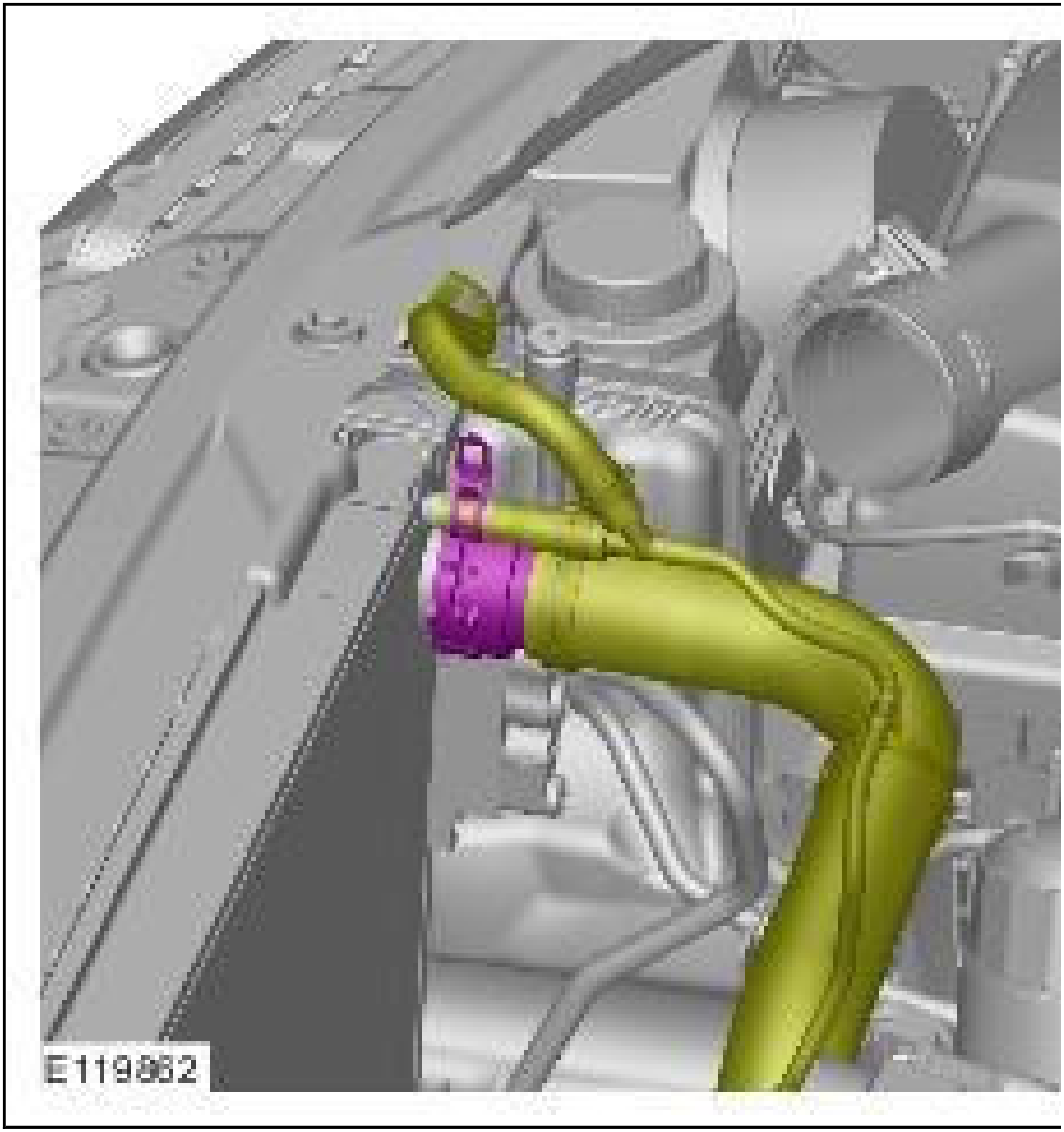
13. See figure



CAUTION: Be prepared to collect escaping coolant.

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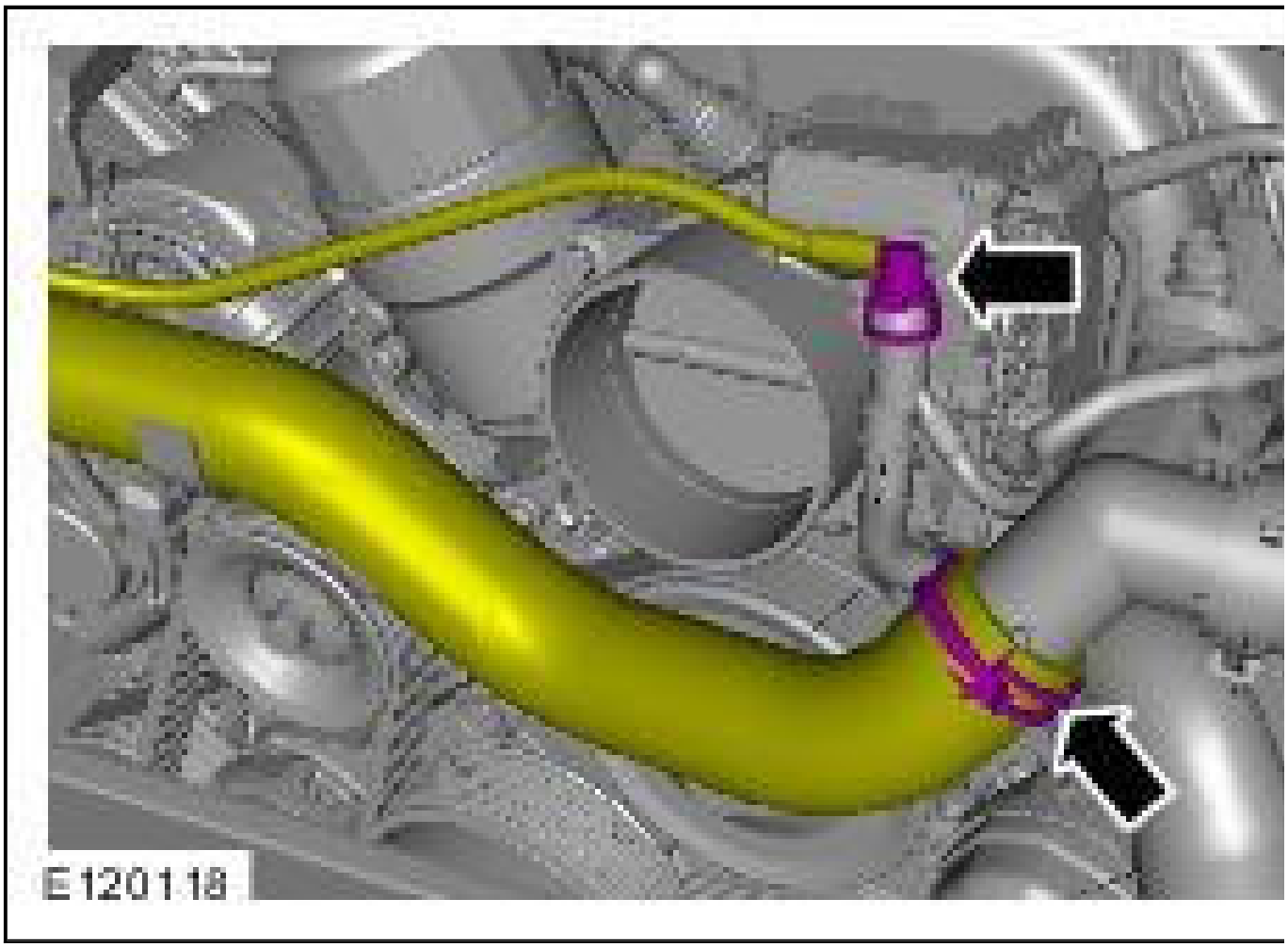
14. See figure



CAUTION: Be prepared to collect escaping coolant.

15. See figure

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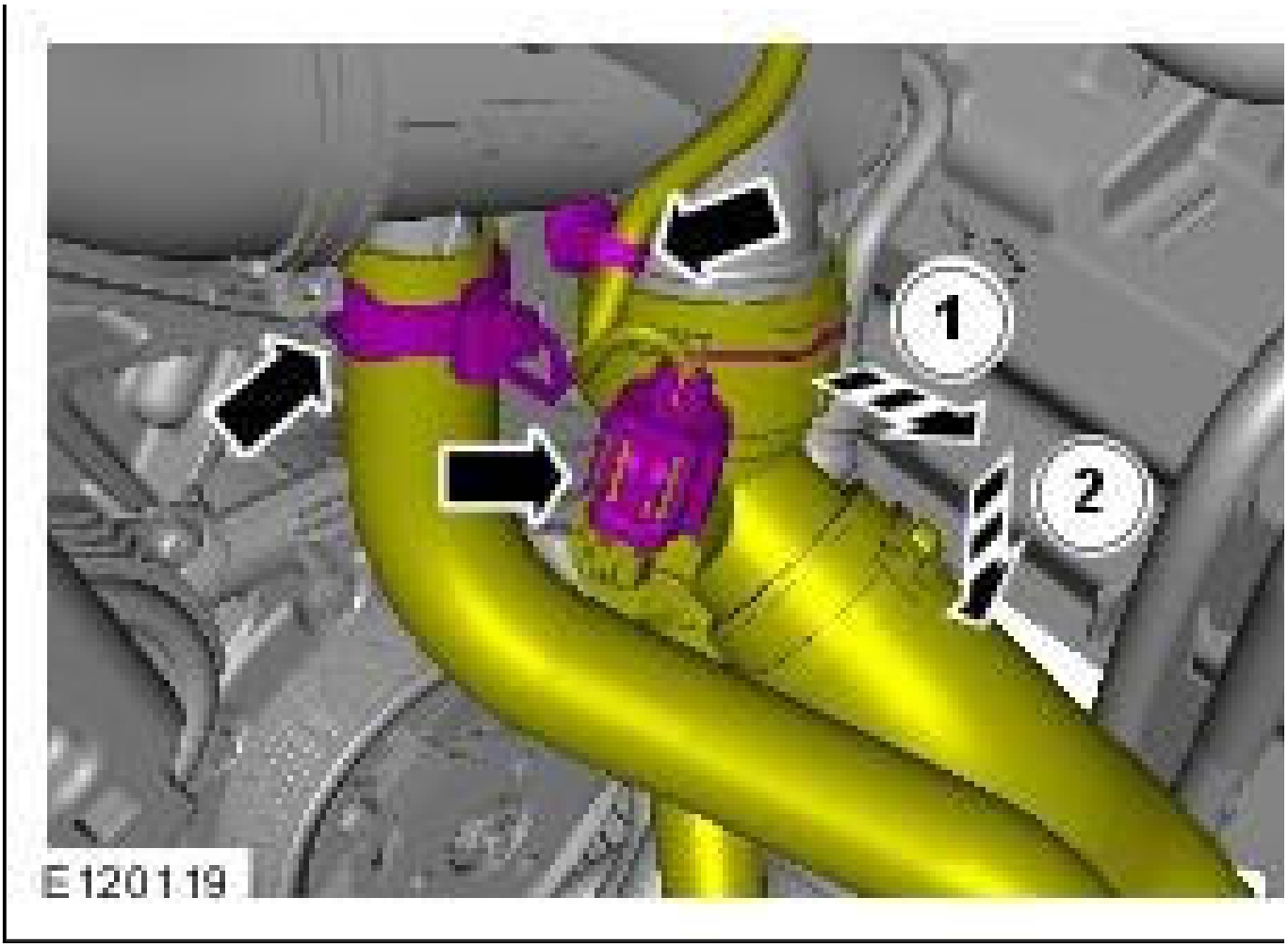

CAUTION: Be prepared to collect escaping coolant.

16. See figure

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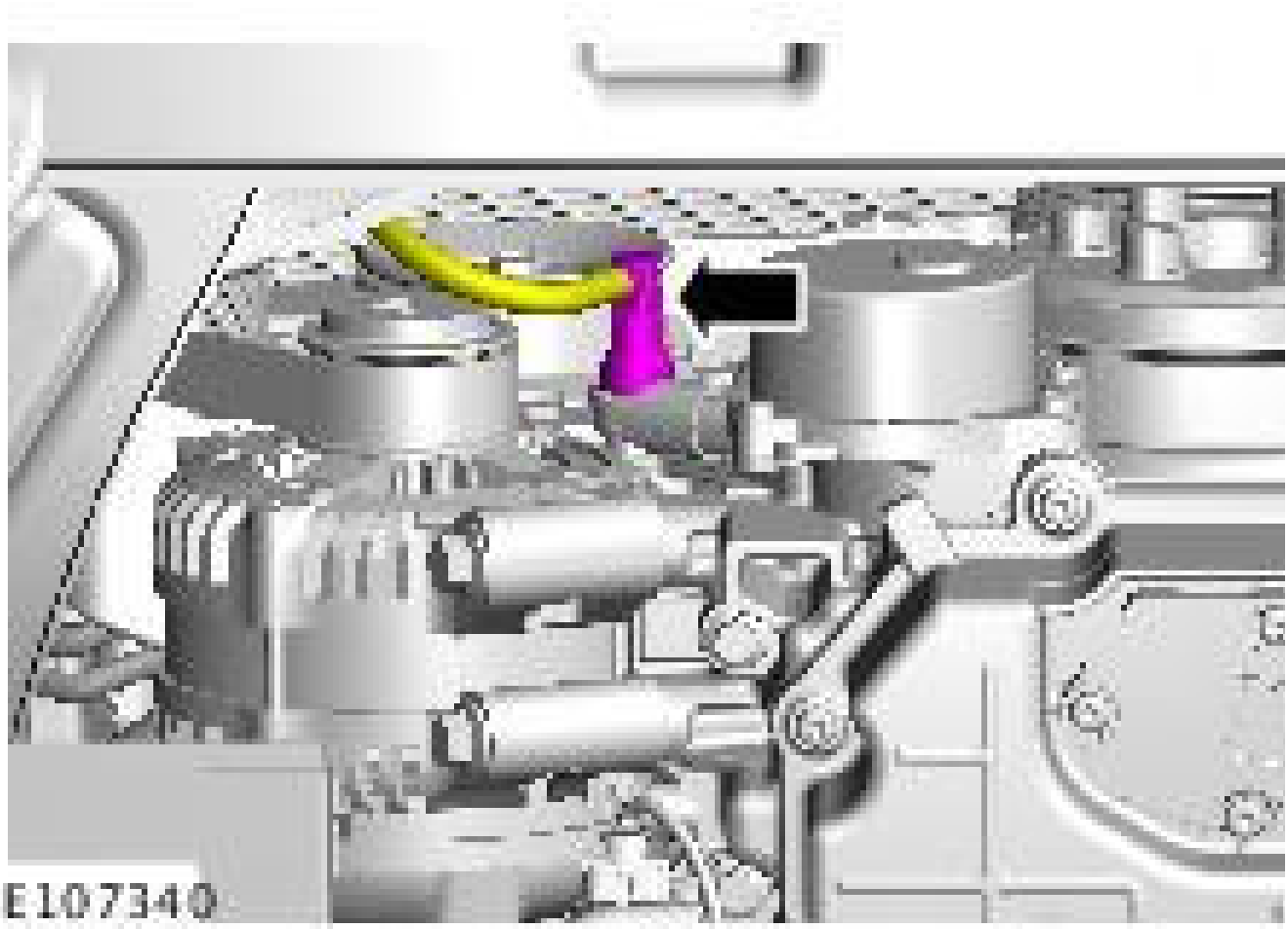

17. See figure

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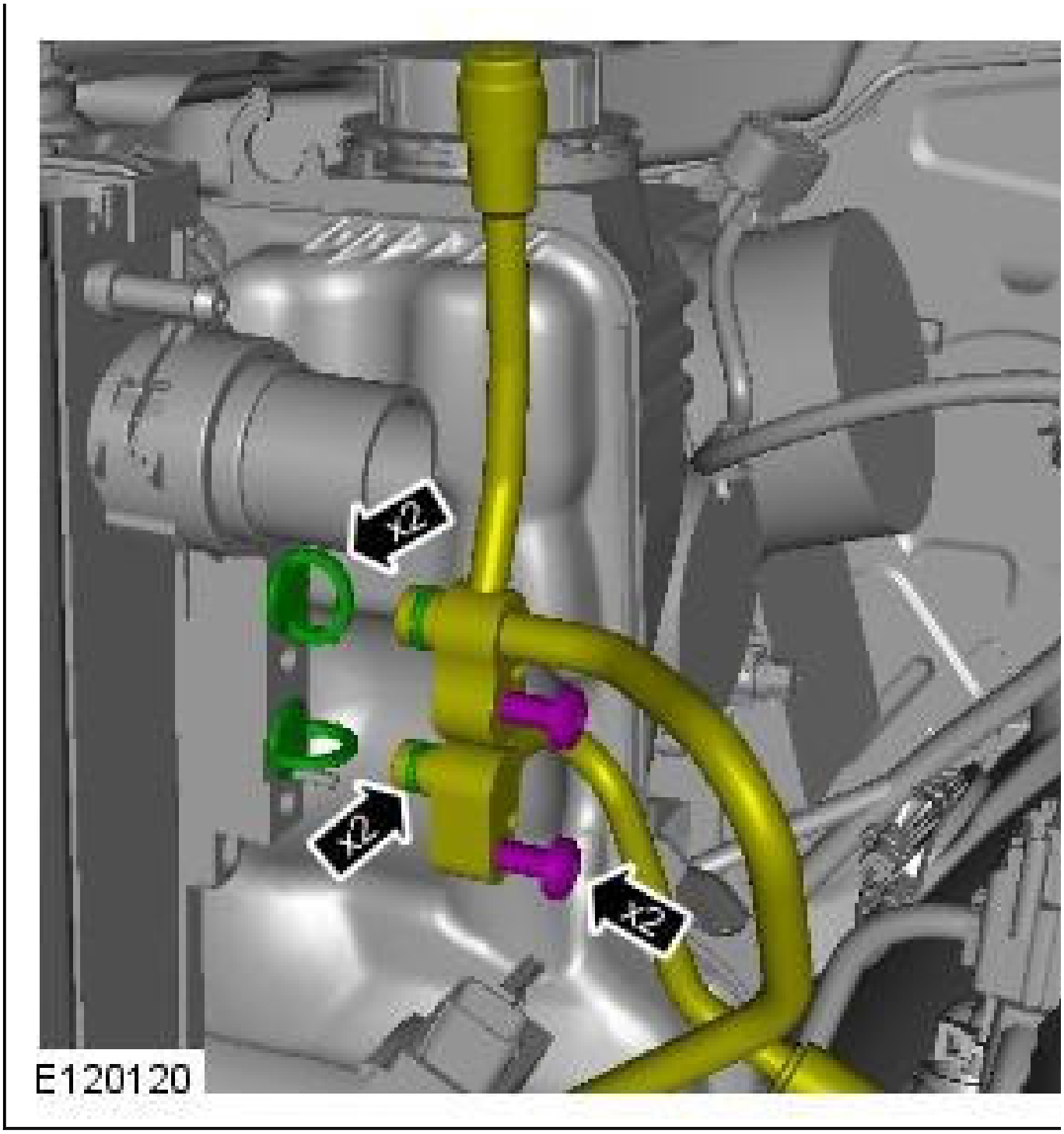

CAUTION: Make sure that all openings are sealed. Use new blanking caps.

18. See figure

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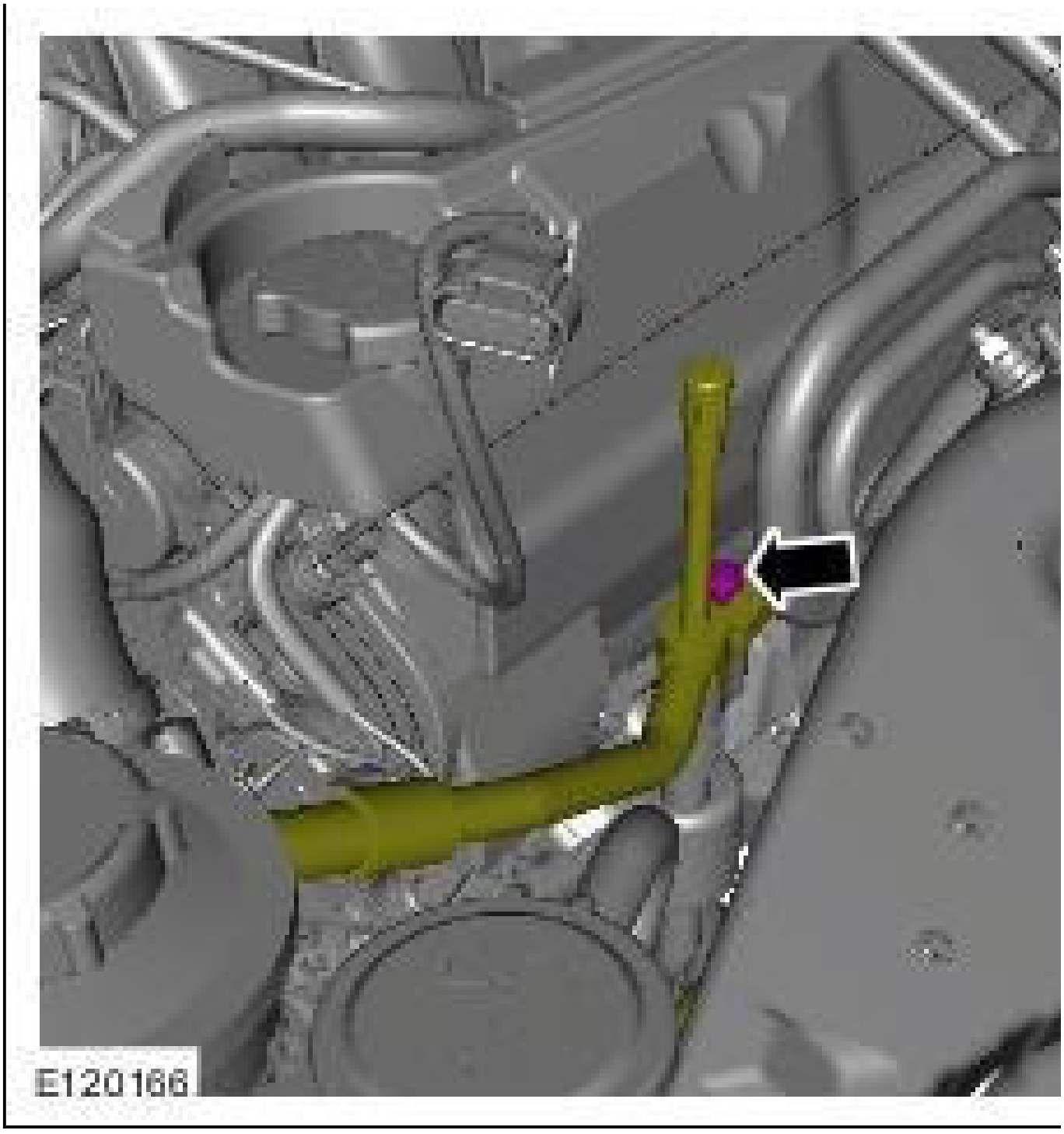

CAUTION: Make sure that all openings are sealed. Use new blanking caps.

19. See figure

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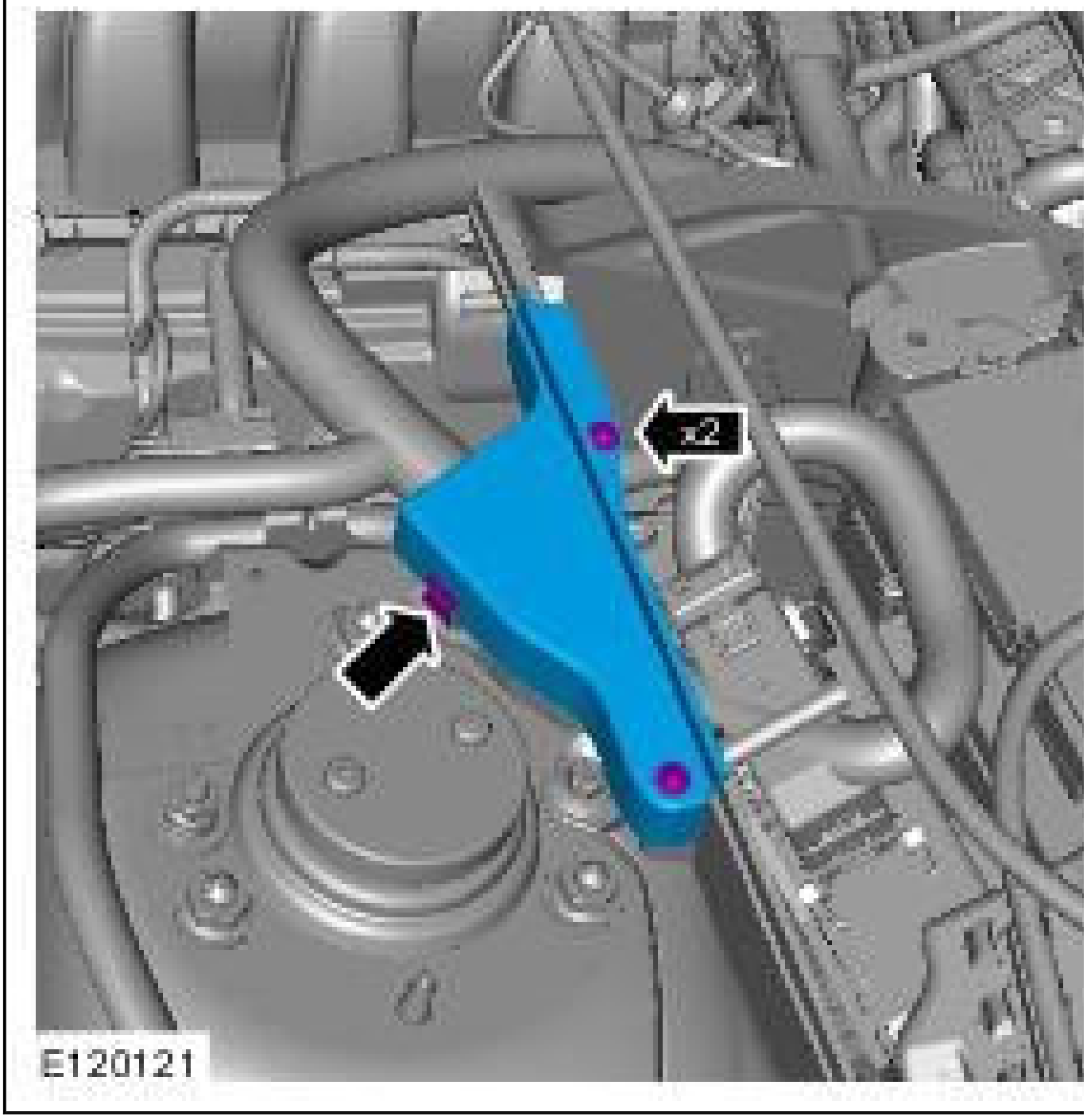

NOTE: RHD illustration shown, LHD is similar.

20. See figure

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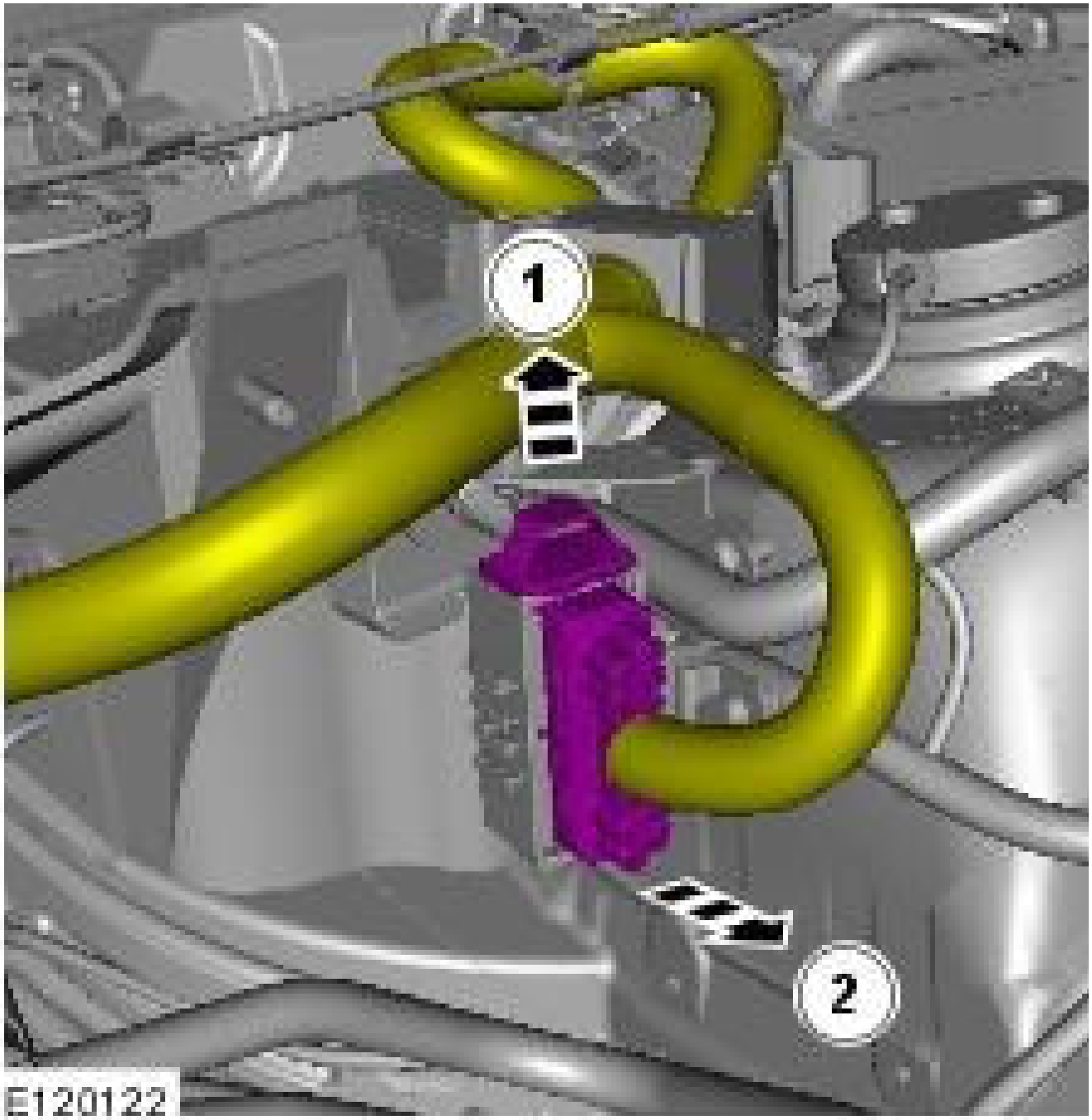

21. See figure

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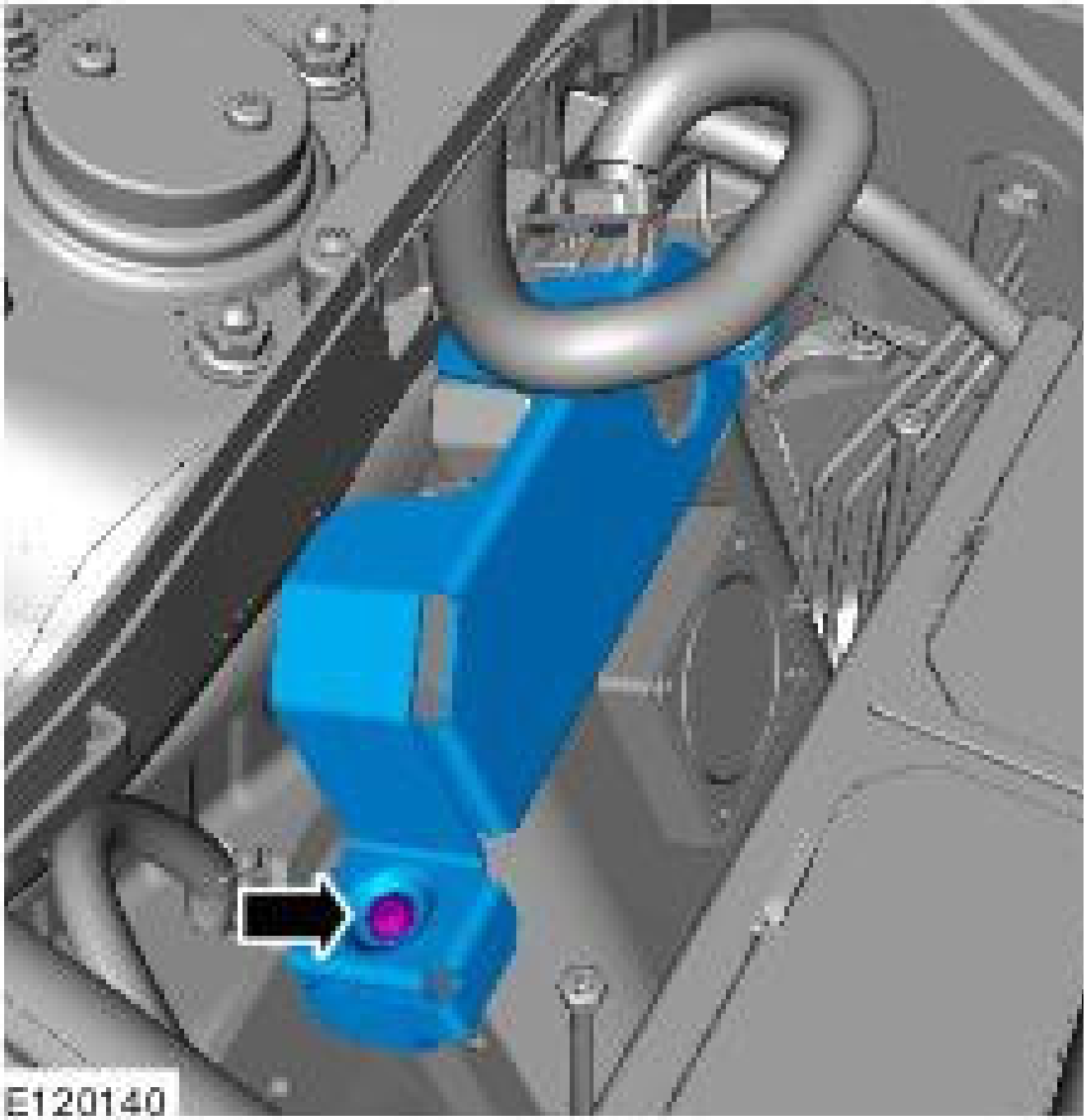

22. See figure

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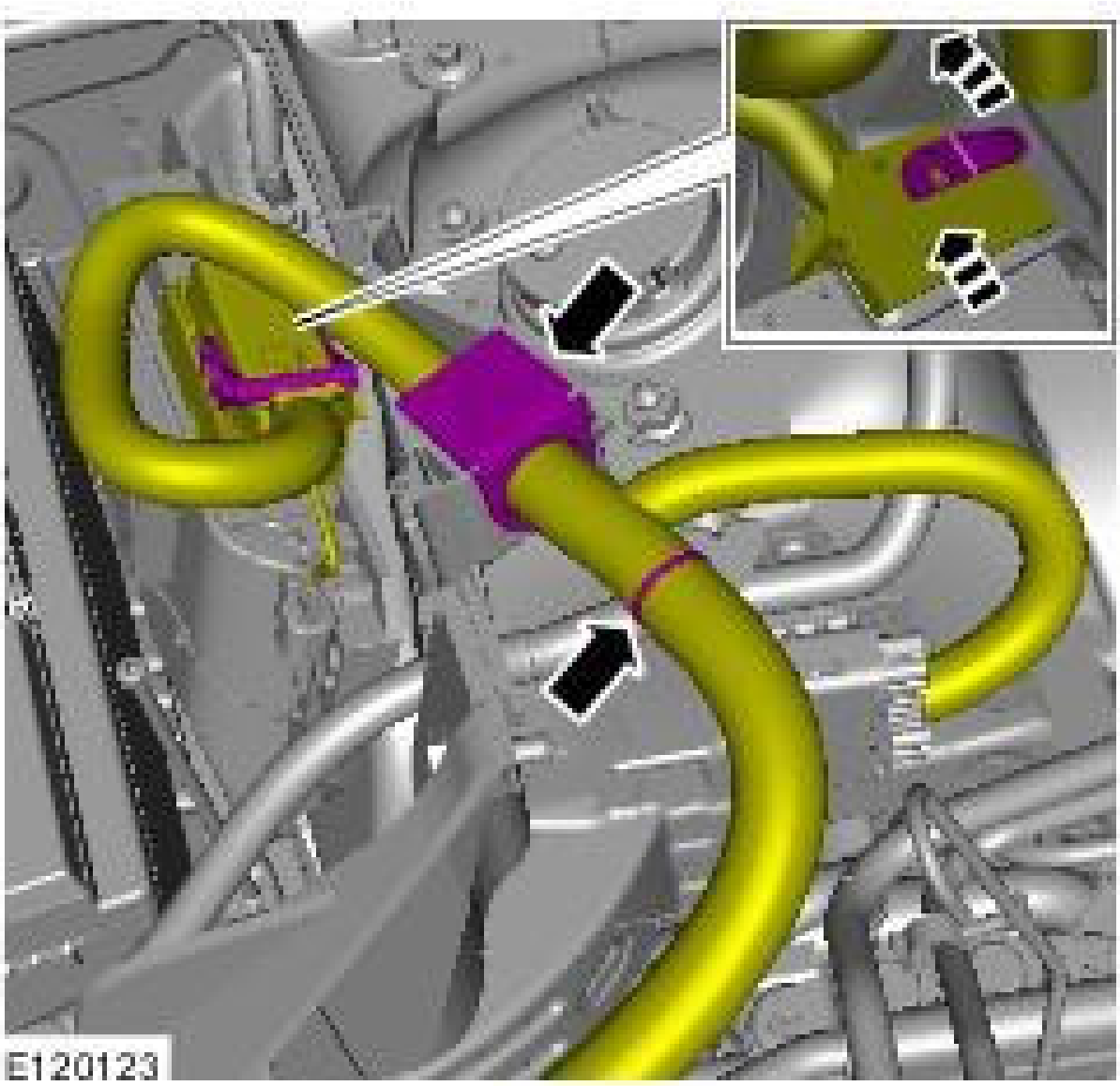

23. See figure

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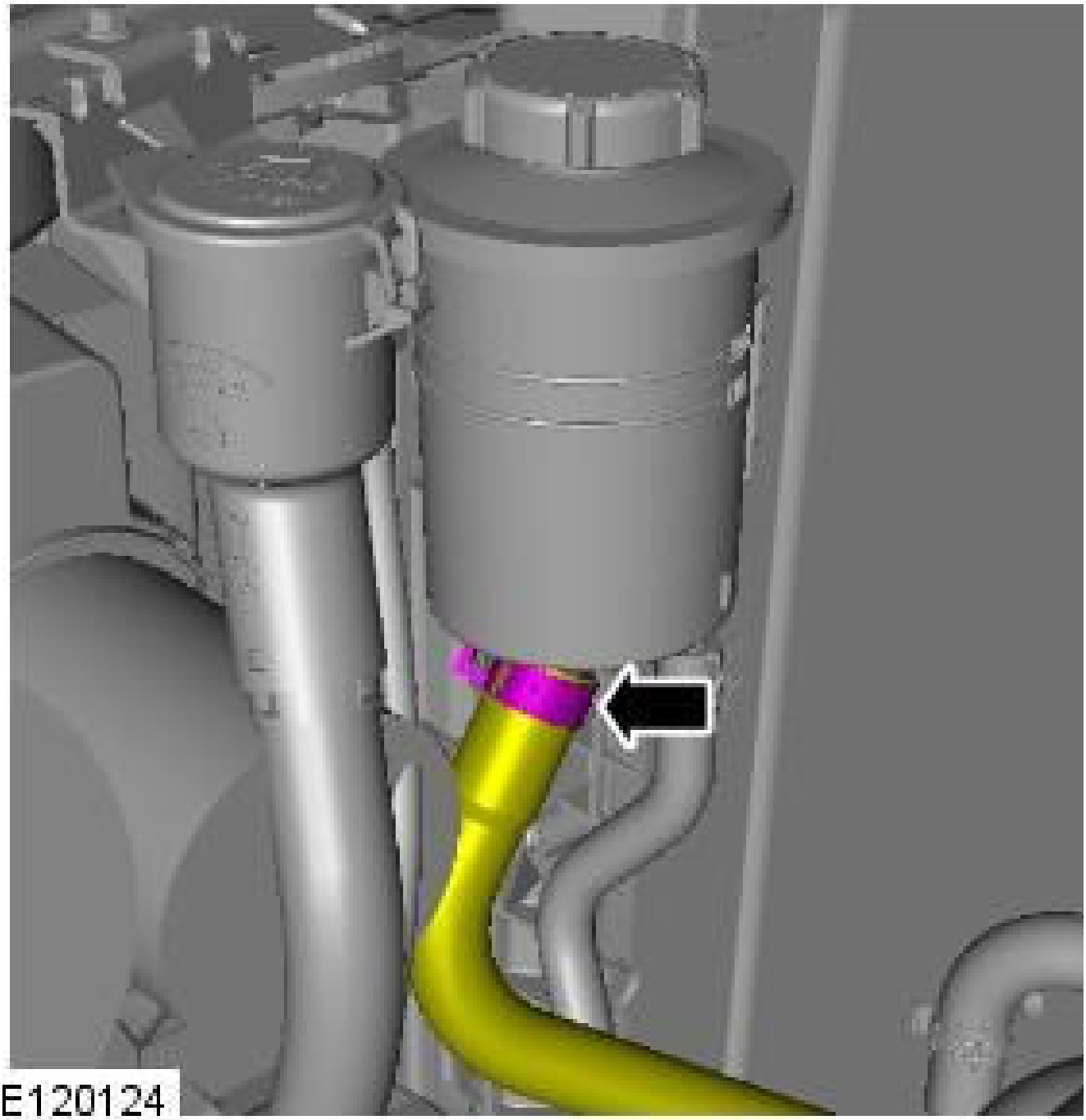

24. See figure

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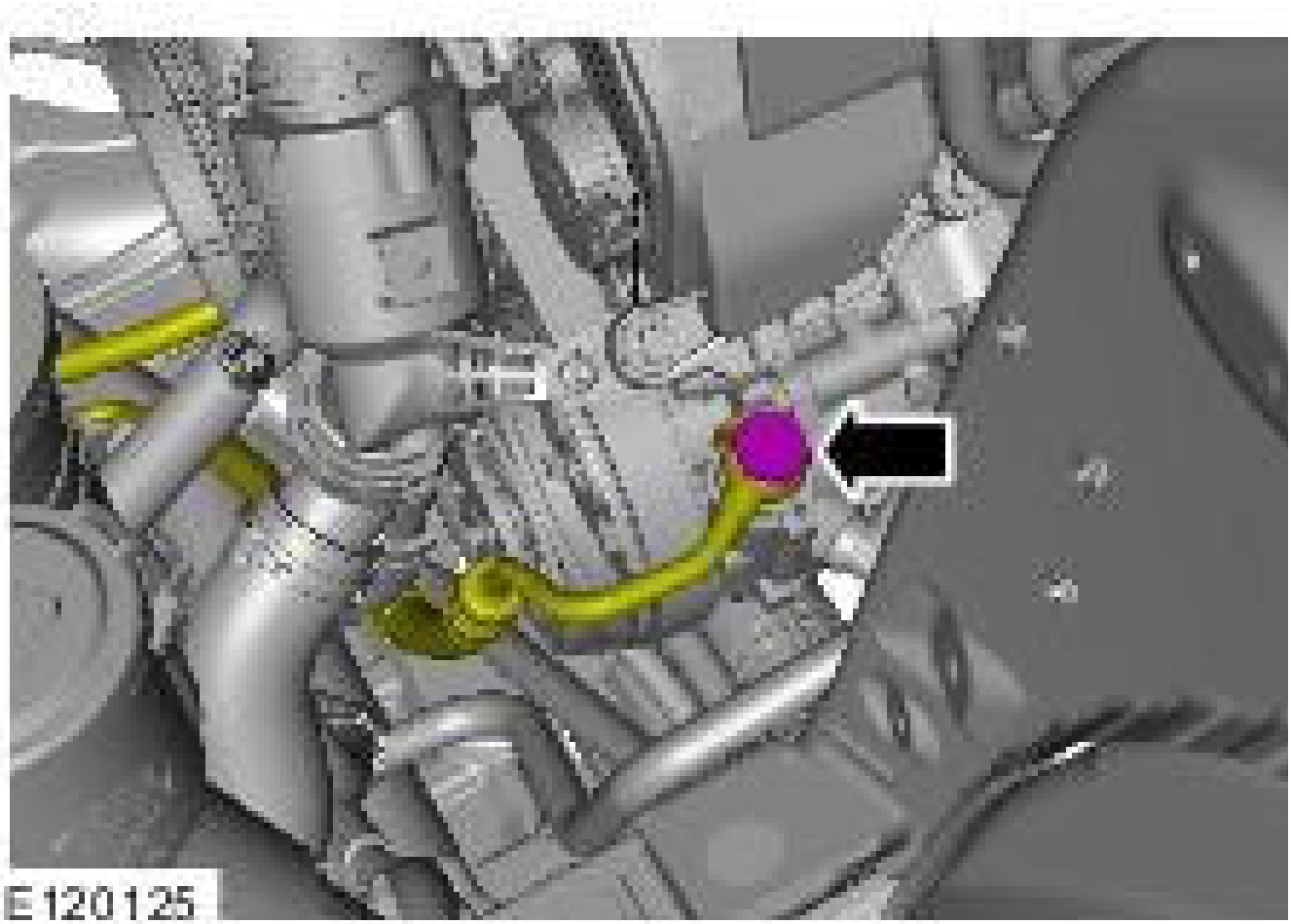

CAUTION: Install new o-ring seals

25. See figure

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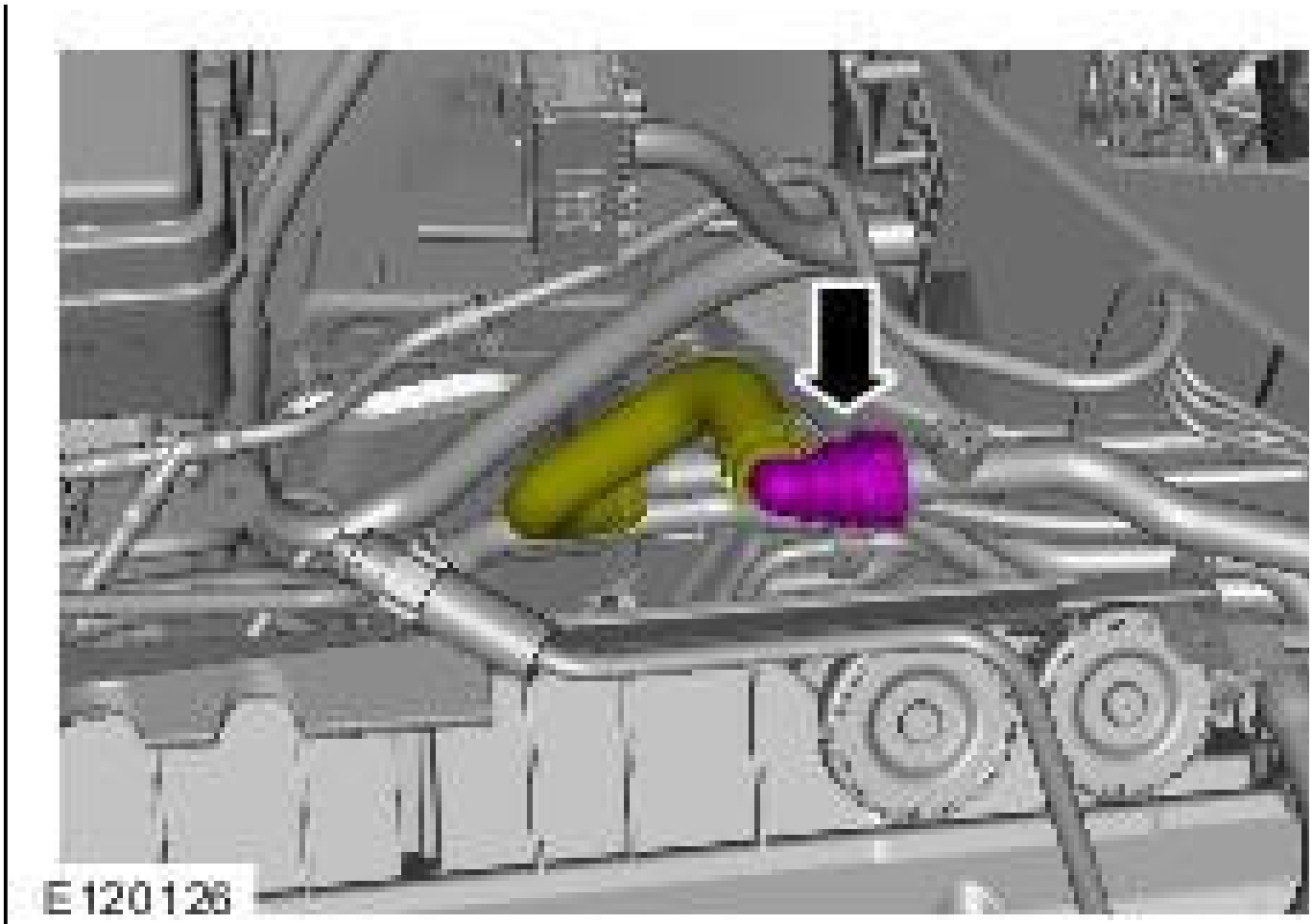

CAUTION: Be prepared to collect escaping coolant.

26. See figure

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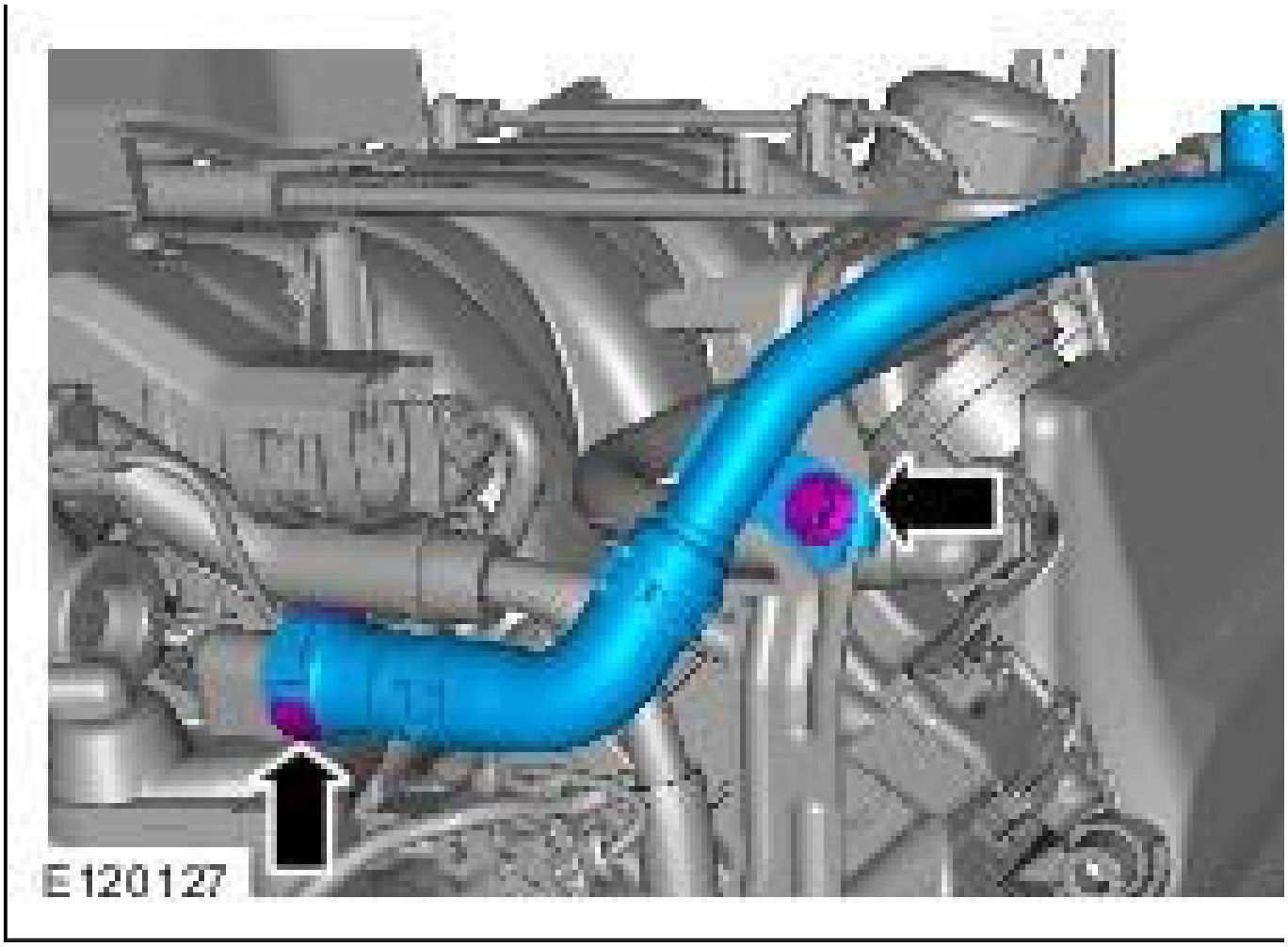

CAUTION: Be prepared to collect escaping coolant.

RIGHT-HAND DRIVE VEHICLES

1. See figure

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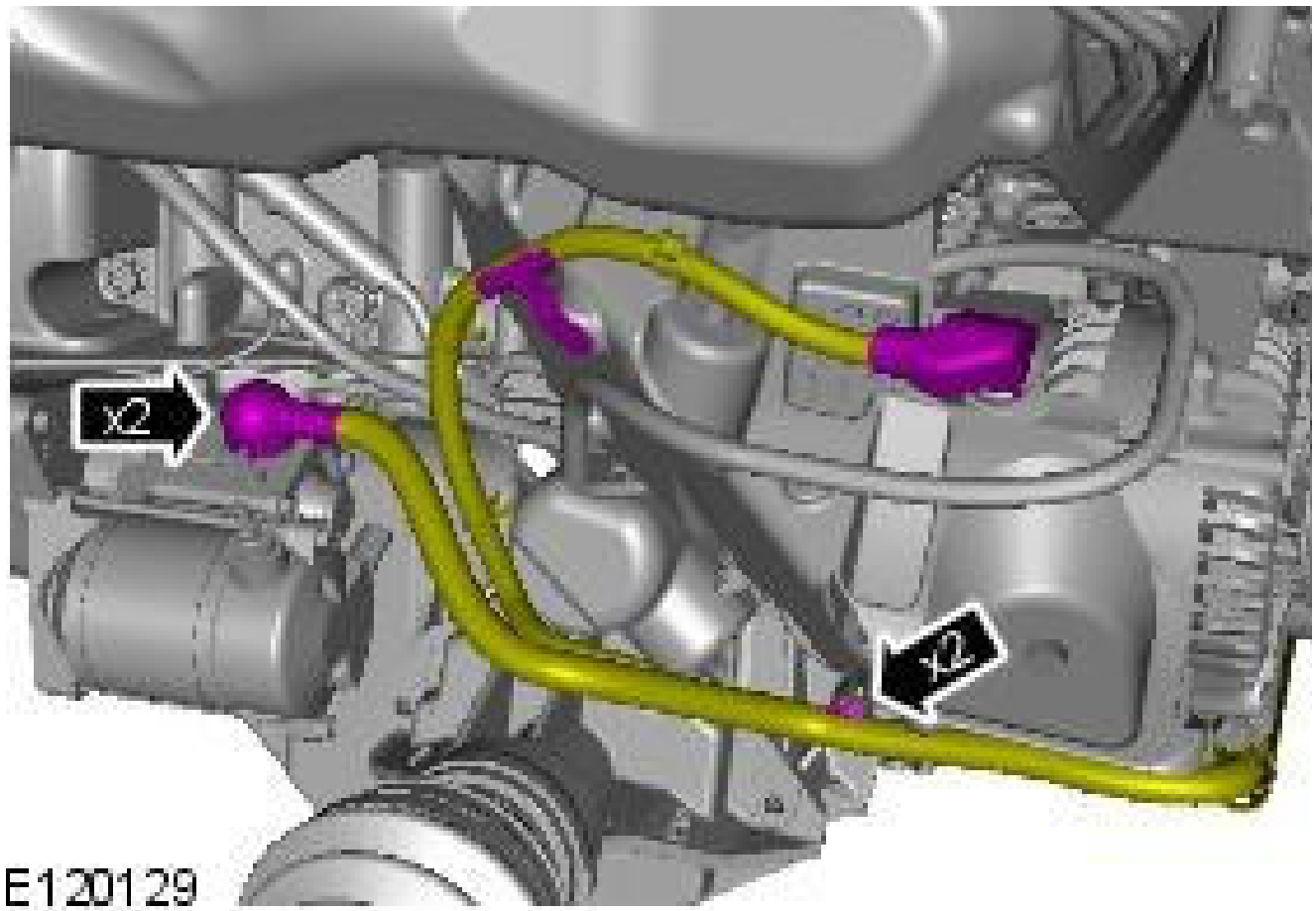

2. See figure

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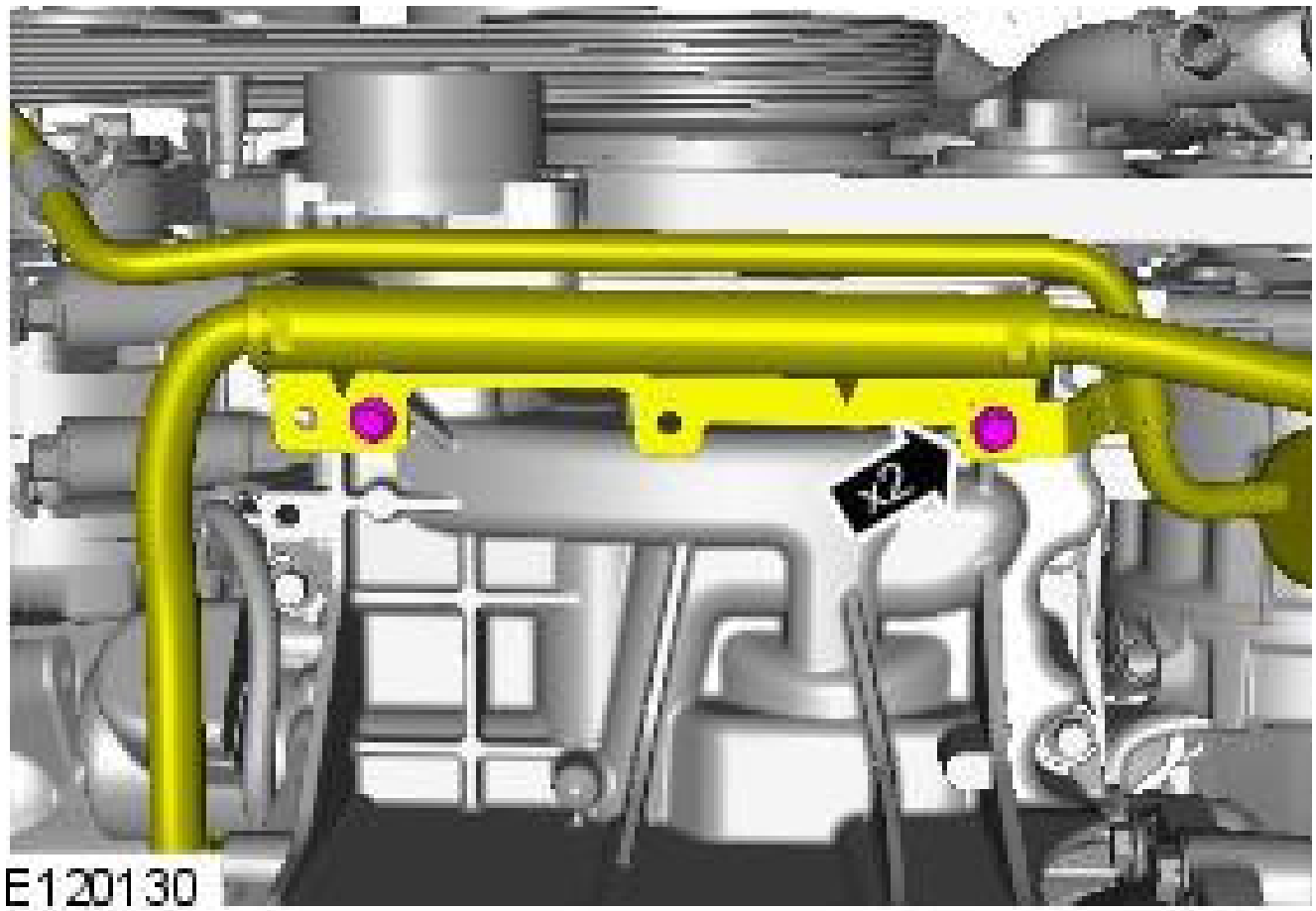

LEFT-HAND DRIVE VEHICLES

1. See figure

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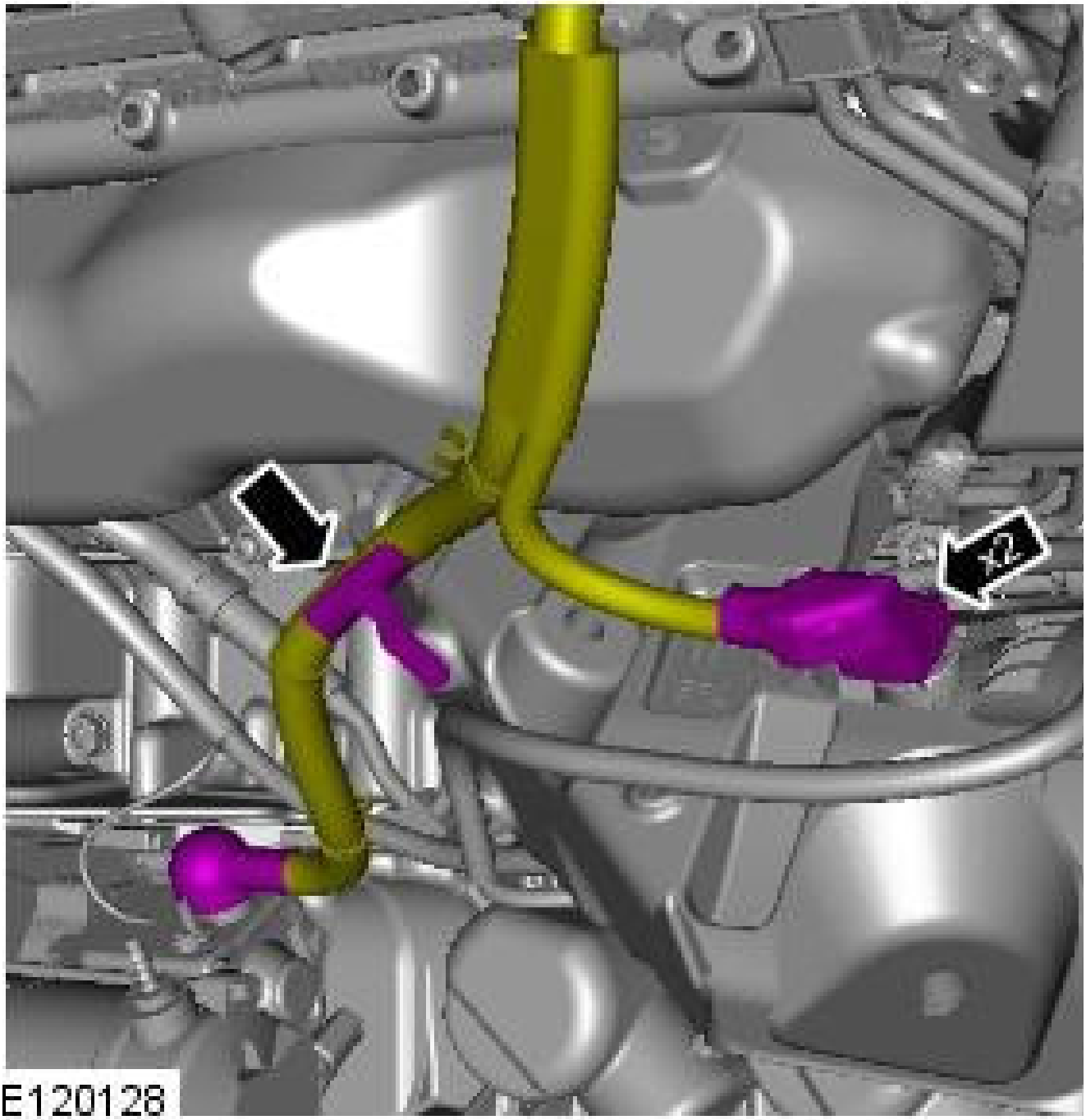

ALL VEHICLES

1. See figure

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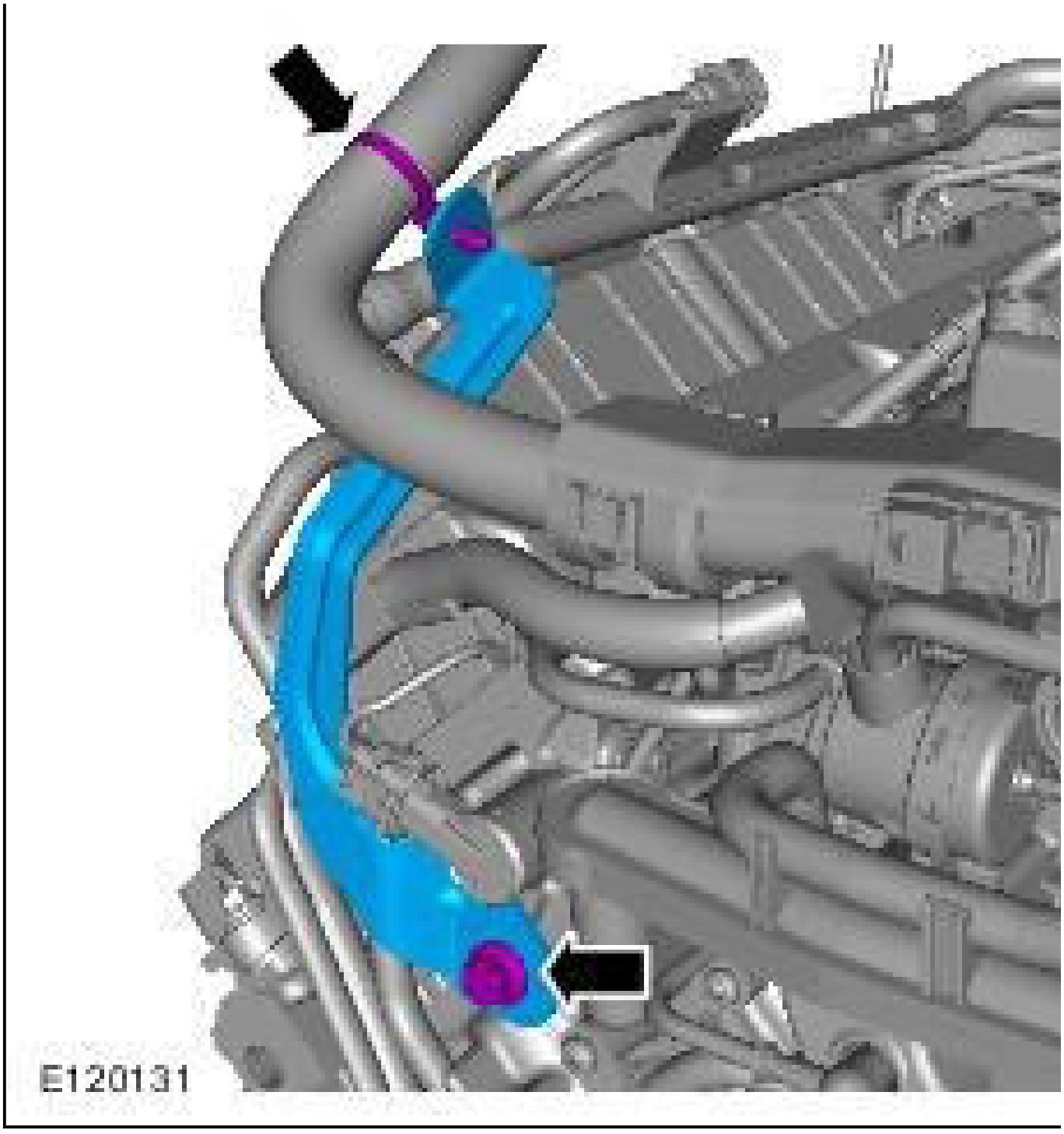
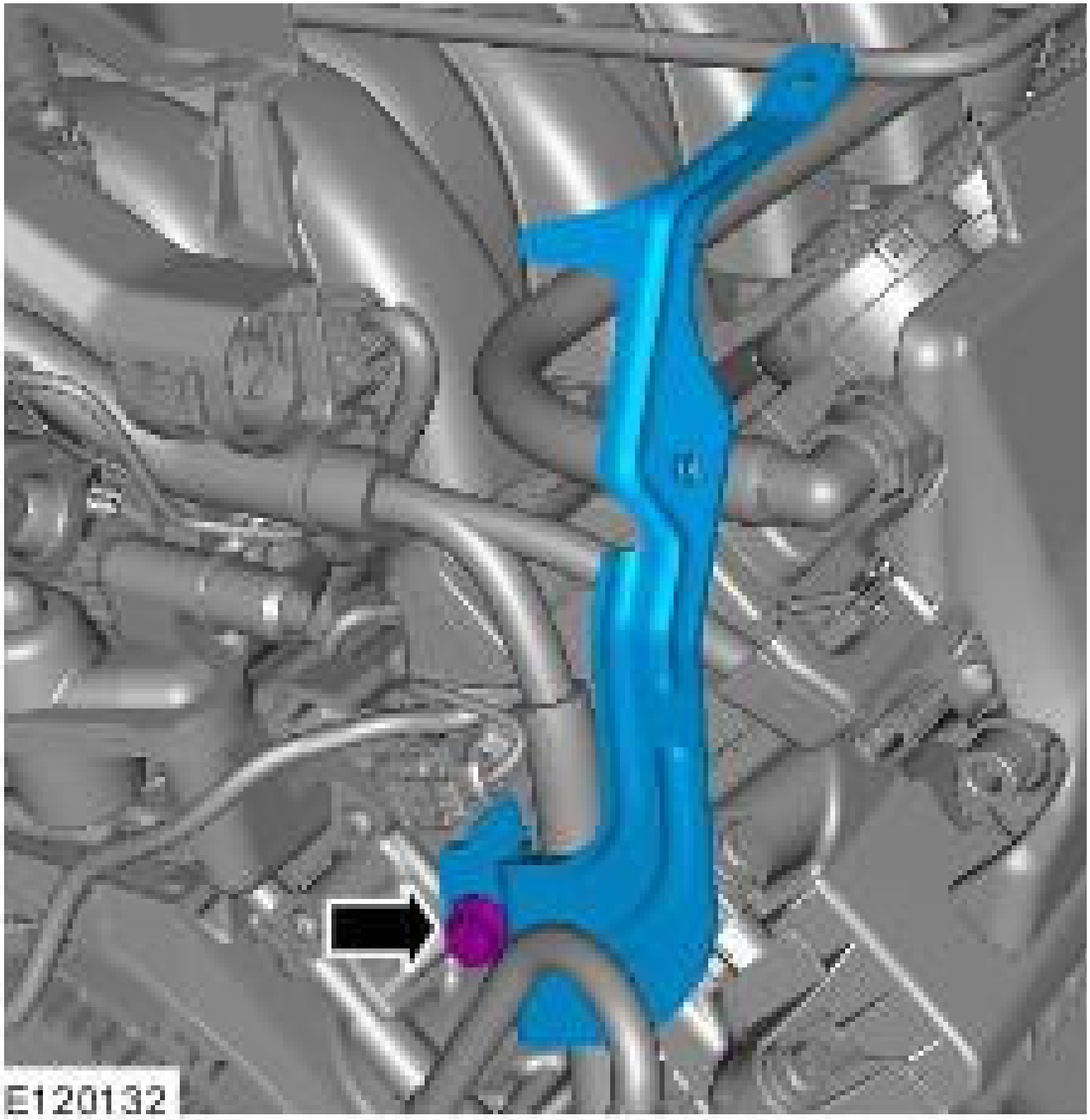


NOTE: RHD illustration shown, LHD is similar.

2. See figure

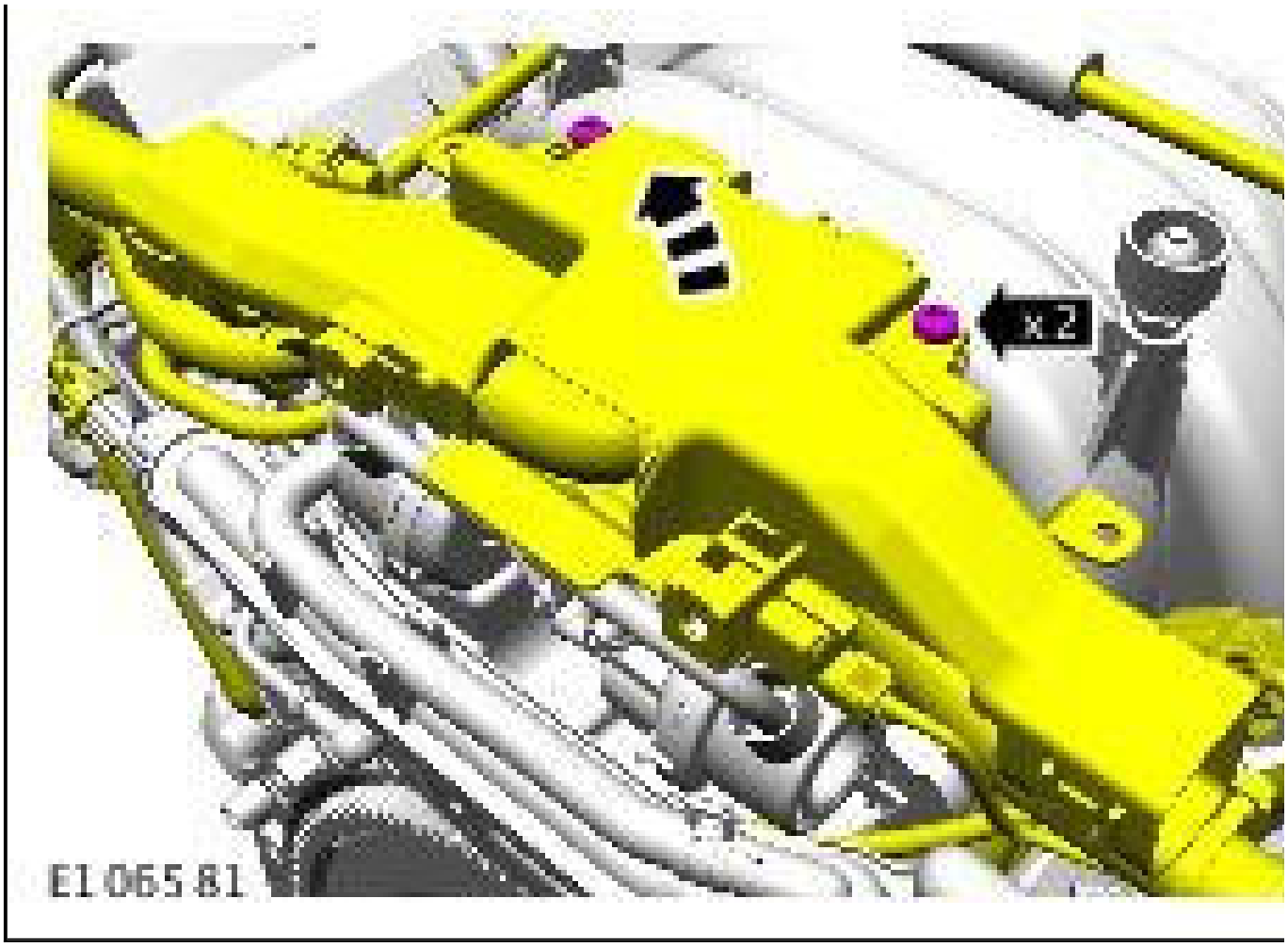
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: RHD illustration shown, LHD is similar.

3. See figure

 © 2011 Mitchell Repair Information Company, LLC.



4. Torque: 25 Nm

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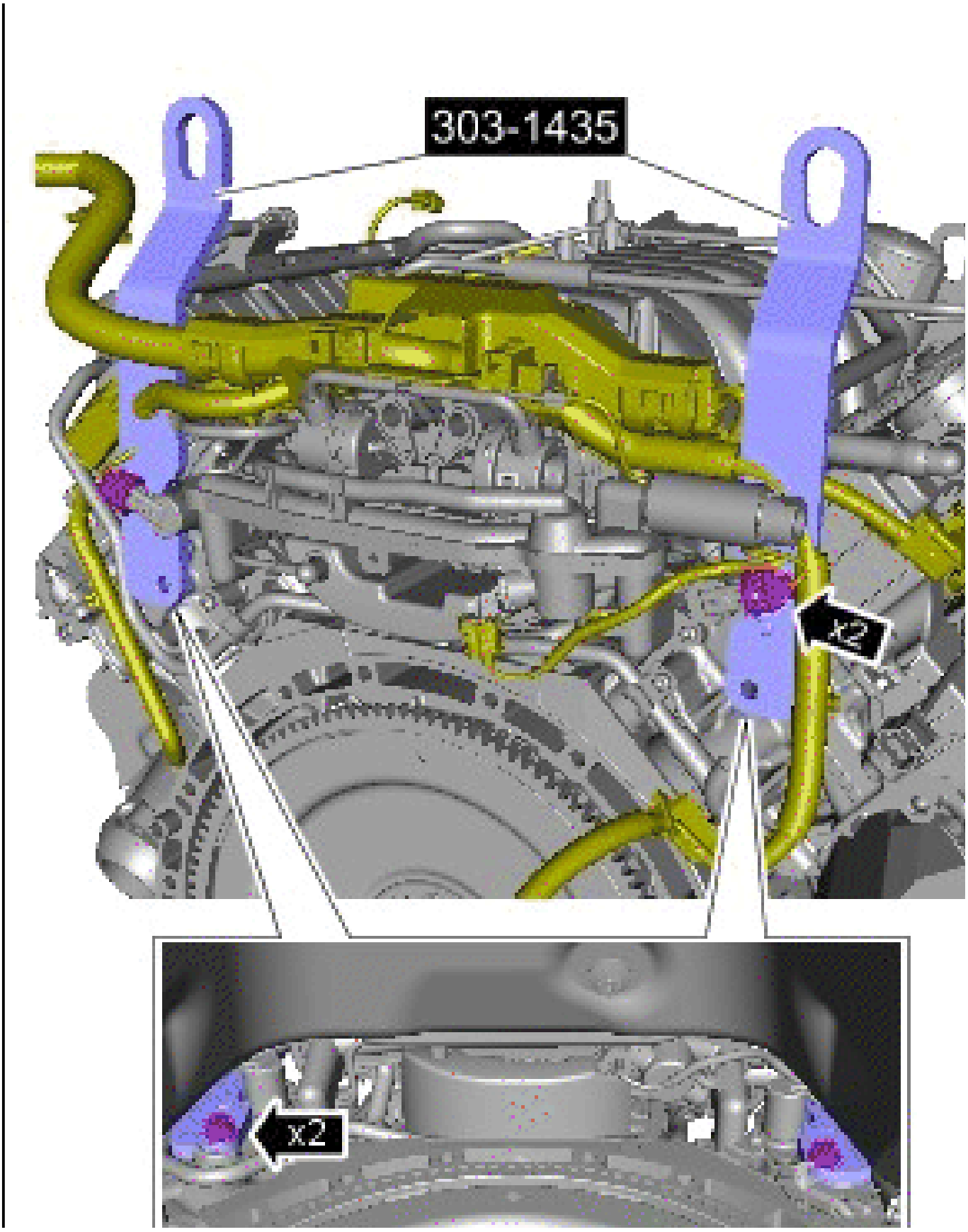
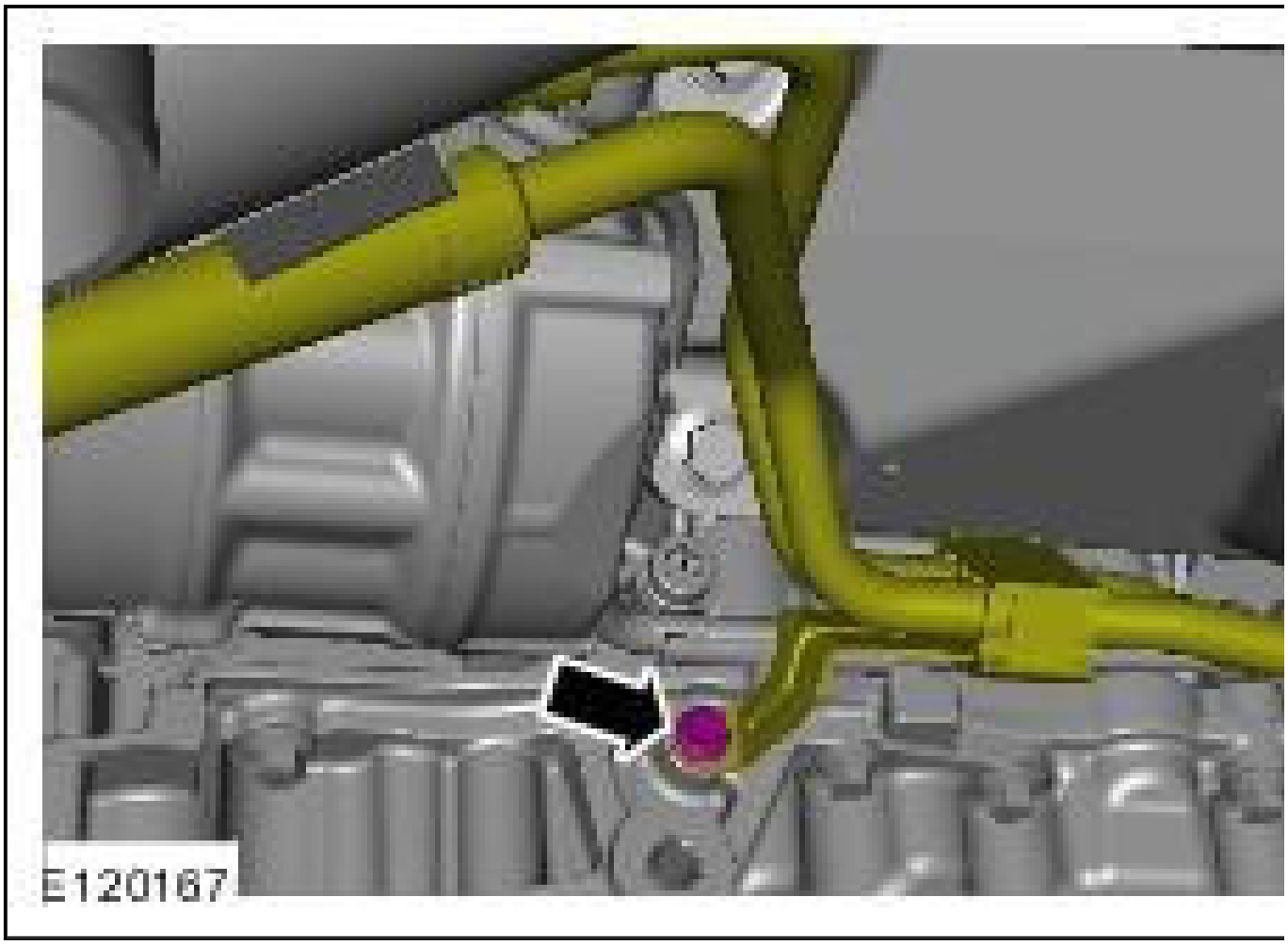


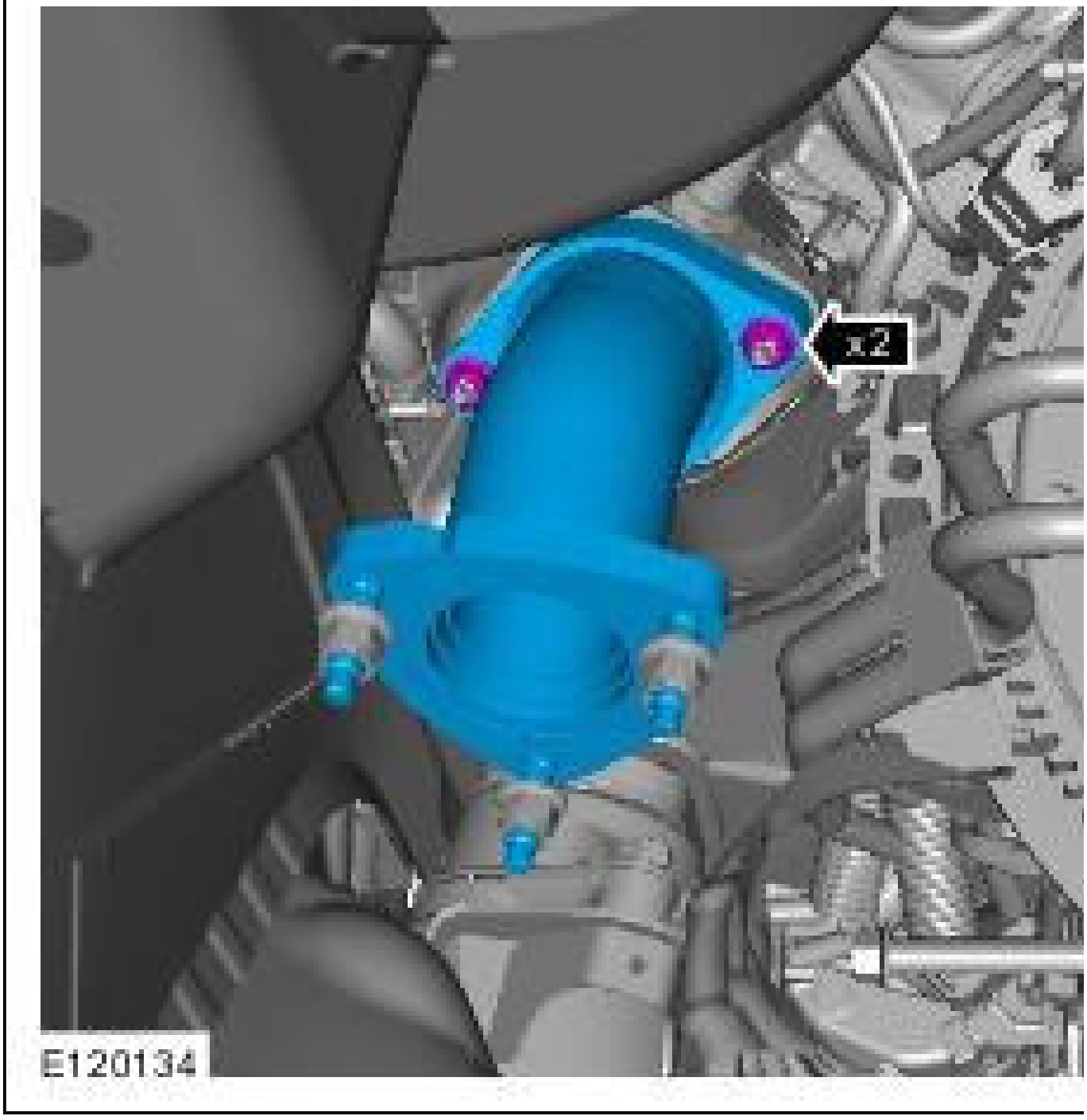
 © 2011 Mitchell Repair Information Company, LLC.

5. See figure



6. See figure

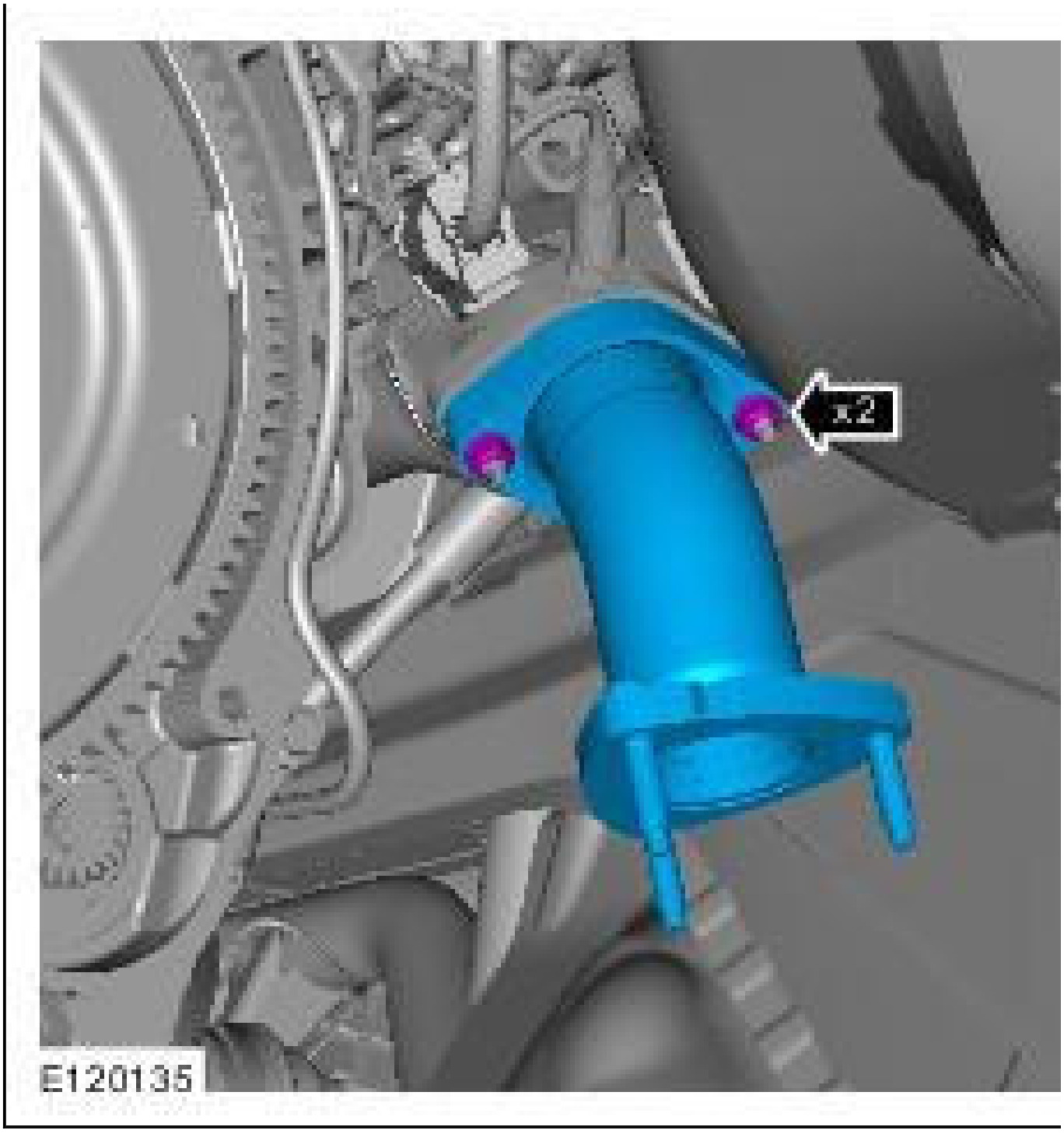
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Remove and discard the gasket.

7. See figure

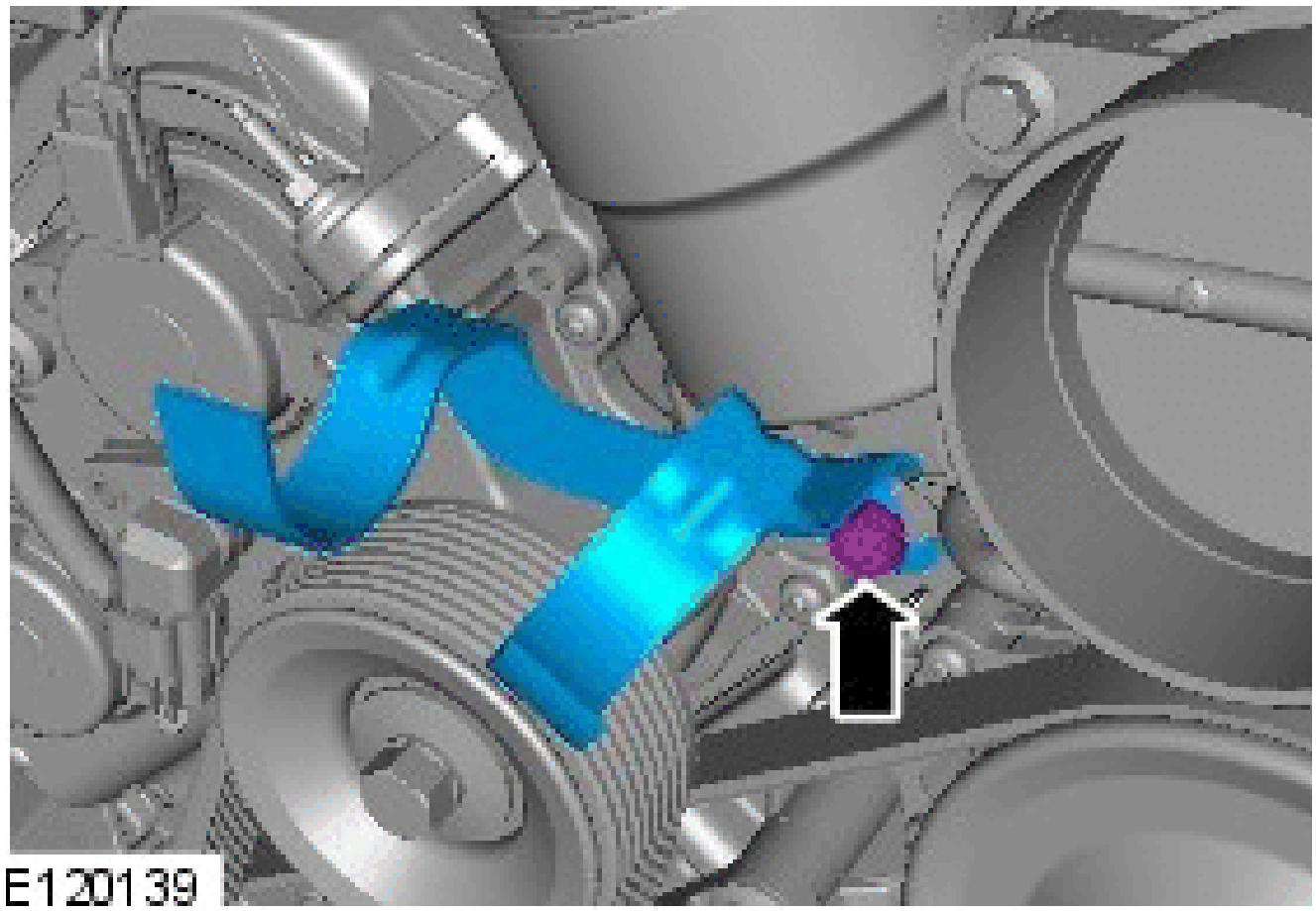
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Remove and discard the gasket.

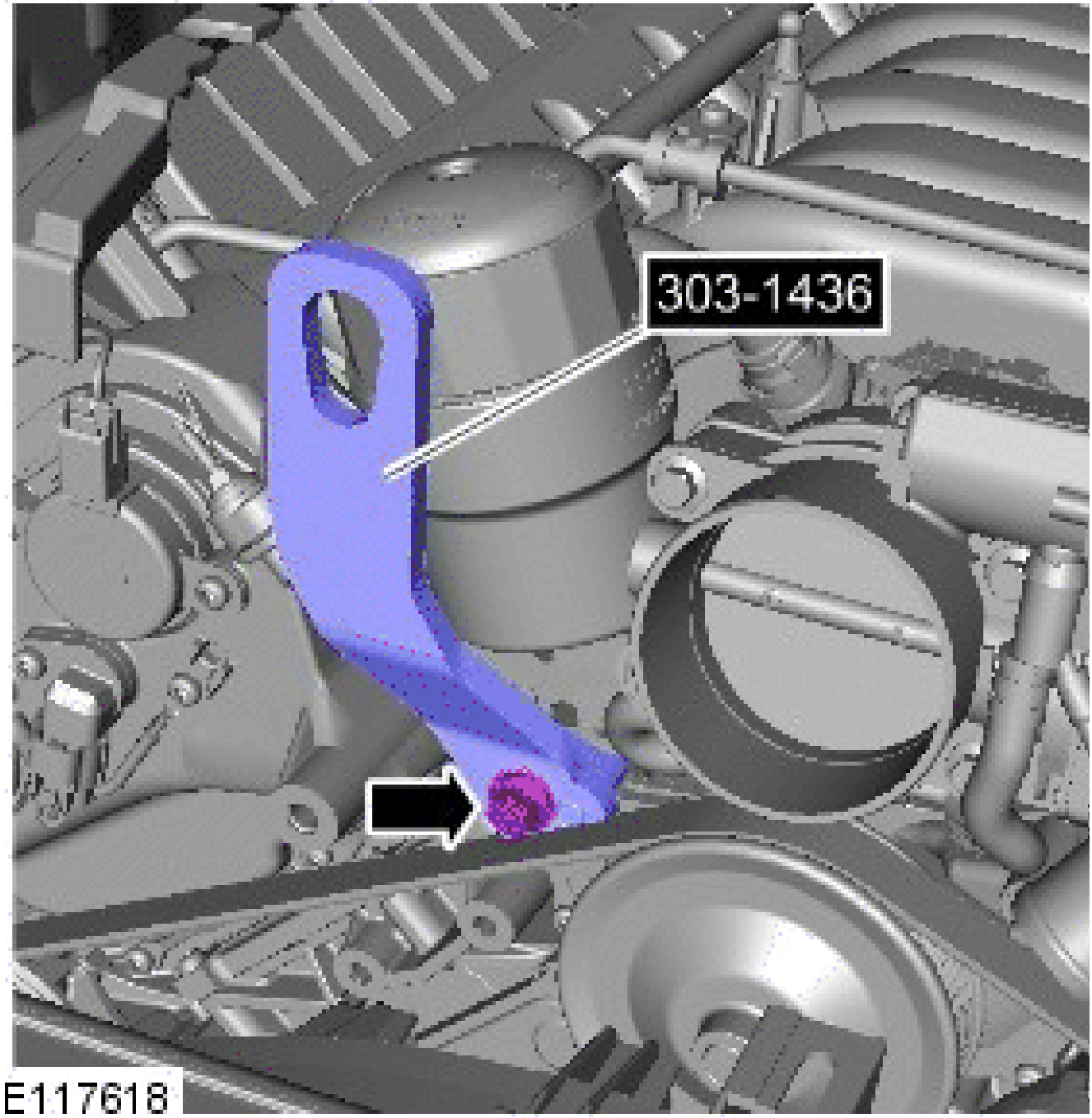
8. See figure

 © 2011 Mitchell Repair Information Company, LLC.



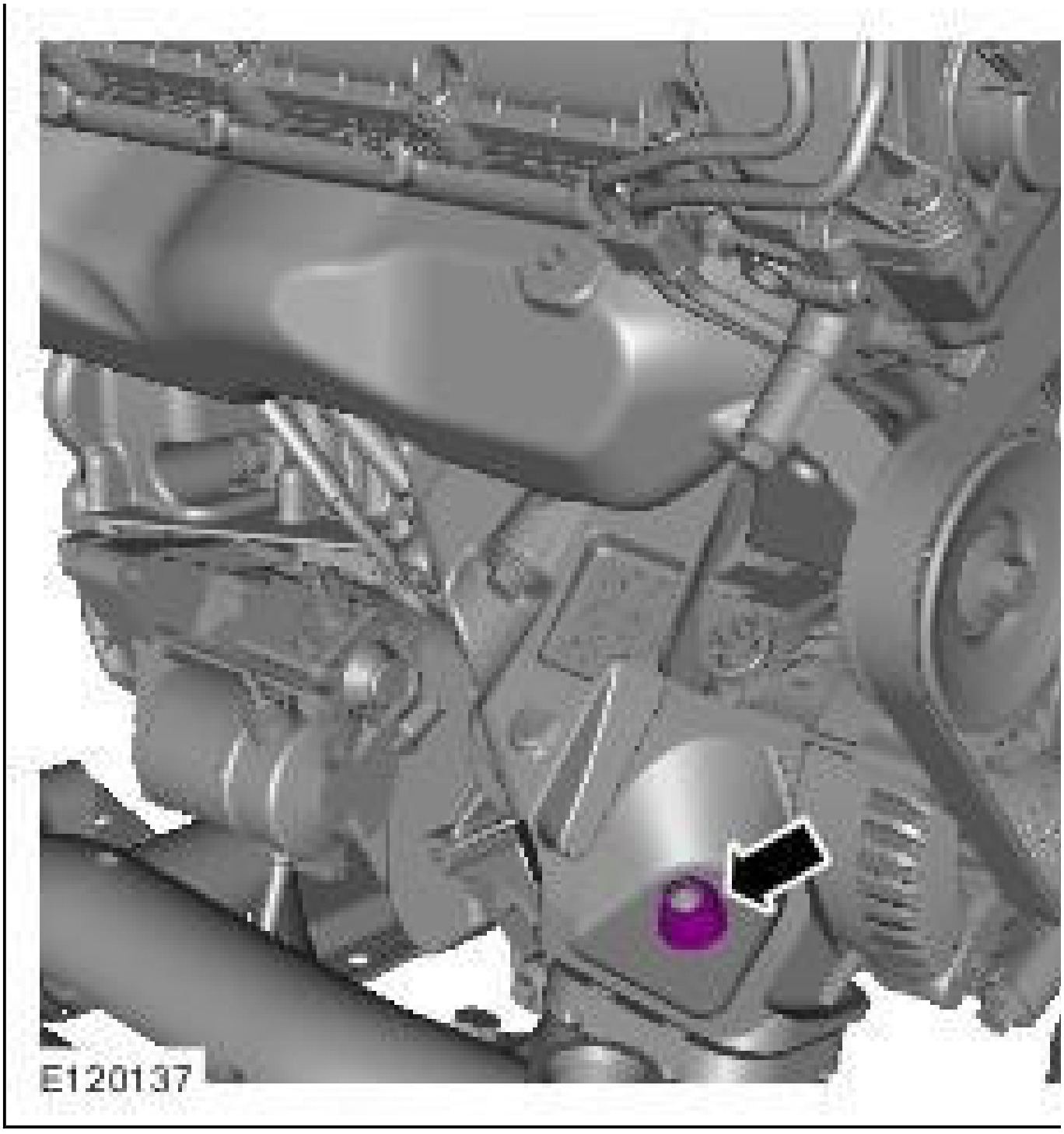
9. Torque: 25 Nm

 © 2011 Mitchell Repair Information Company, LLC.



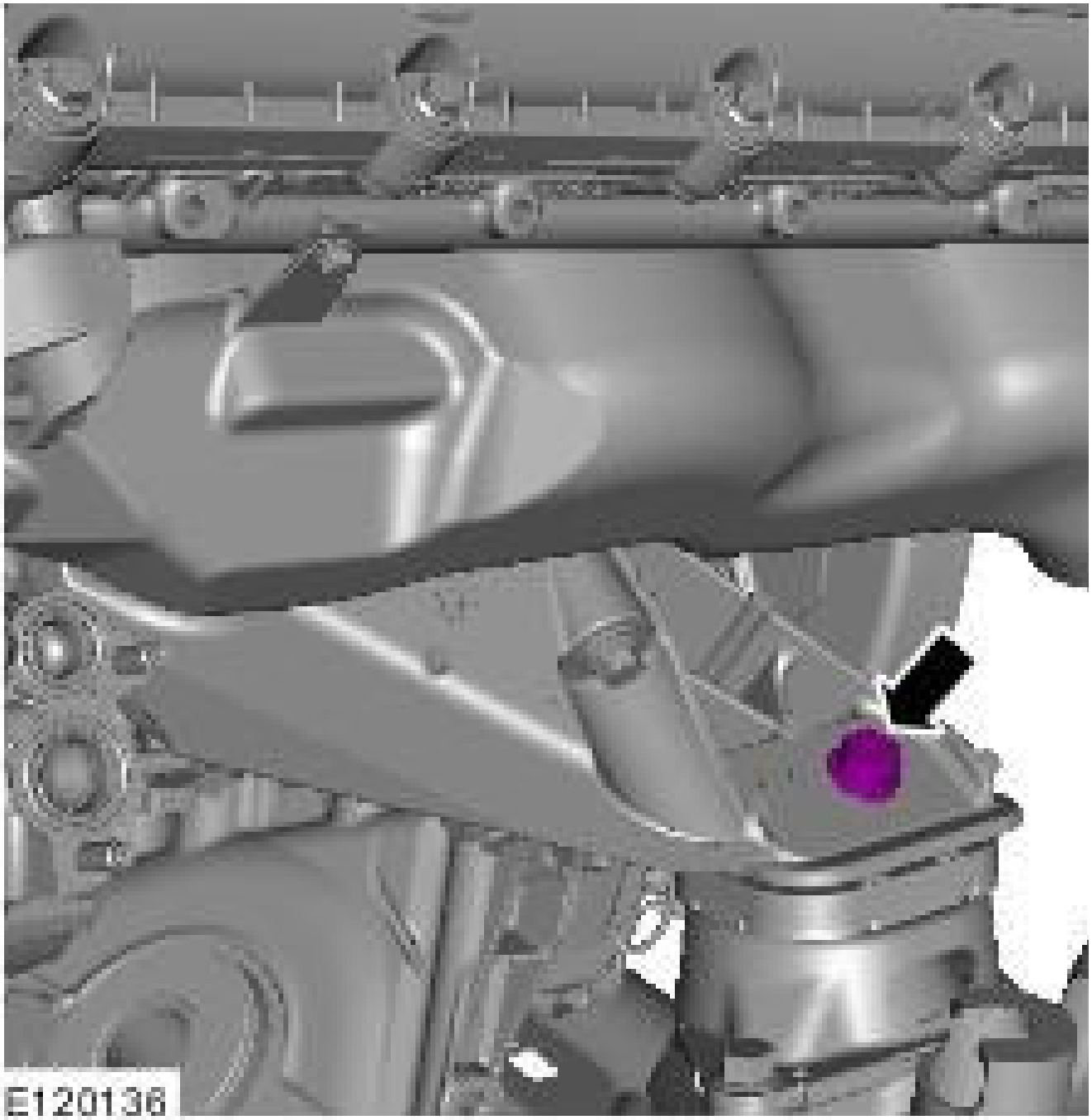
10. See figure

 © 2011 Mitchell Repair Information Company, LLC.



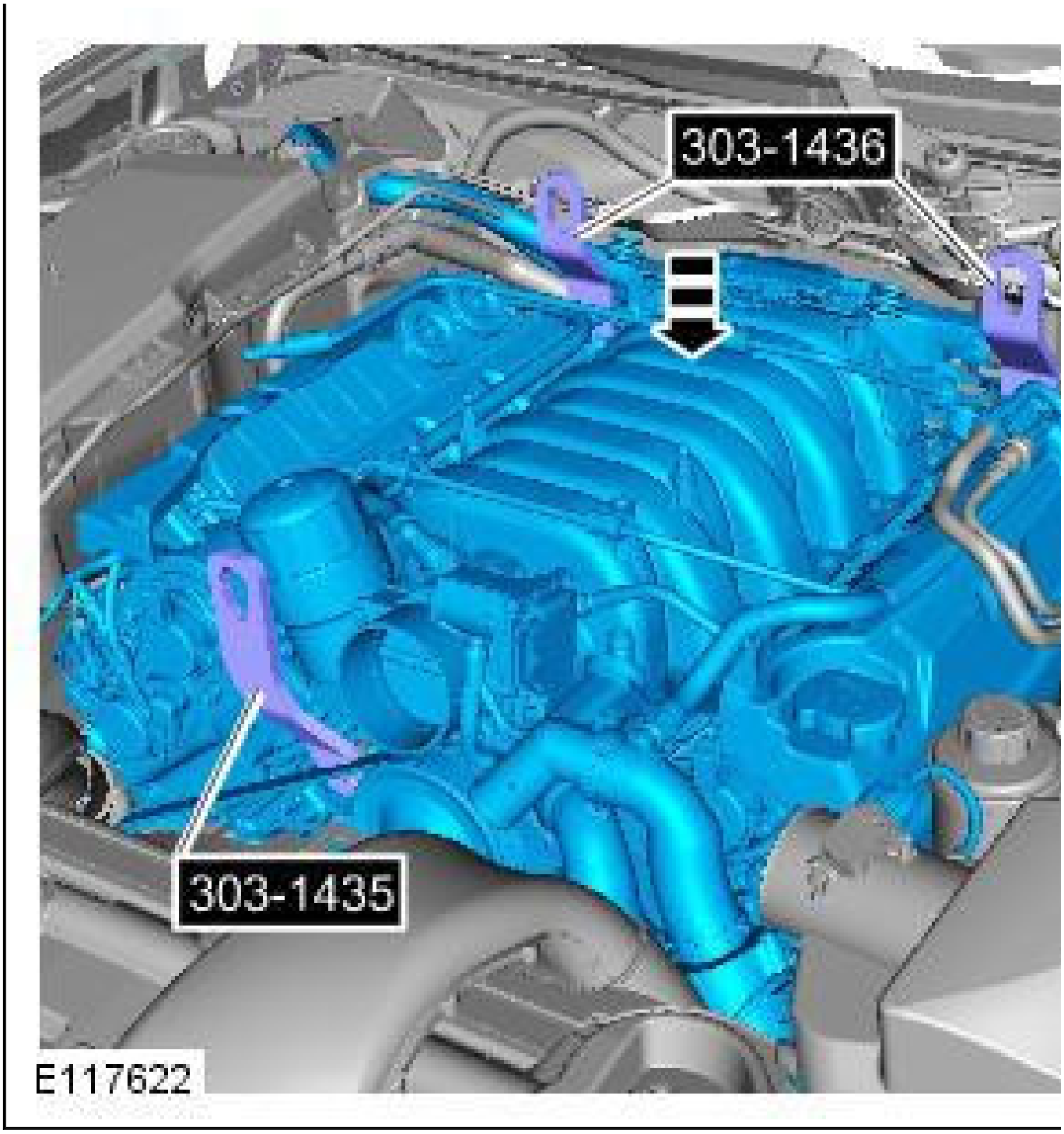
11. See figure

 © 2011 Mitchell Repair Information Company, LLC.



12. See figure

 © 2011 Mitchell Repair Information Company, LLC.



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

INSTALLATION

ENGINE

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INSTALLATION

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

NOTE: If a new engine is to be installed, remove the intake manifold to access the top transmission retaining bolts.

ALL VEHICLES

1. See figure

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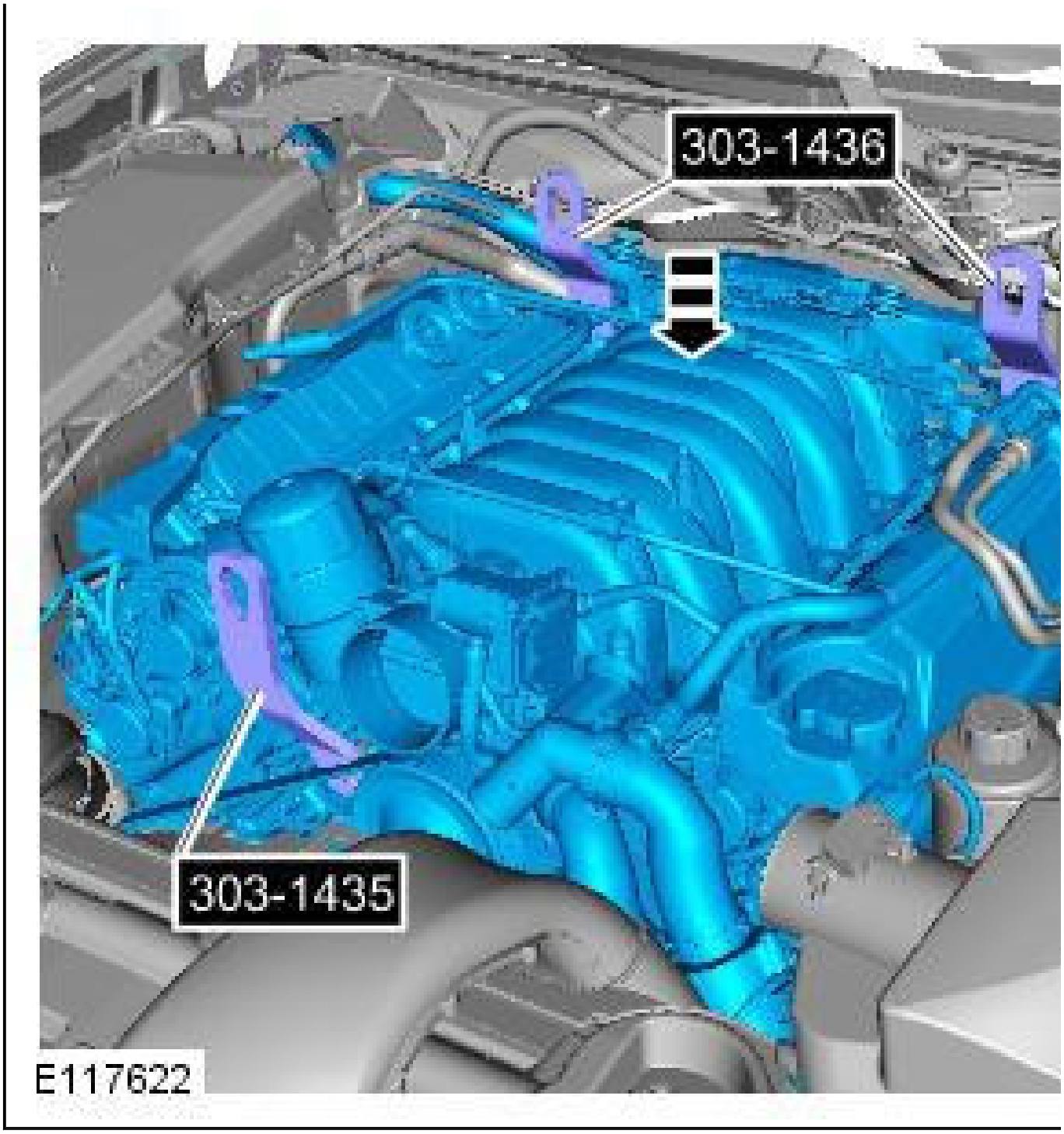

NOTE: **This step requires the aid of another technician.**

2. Torque: 100 Nm

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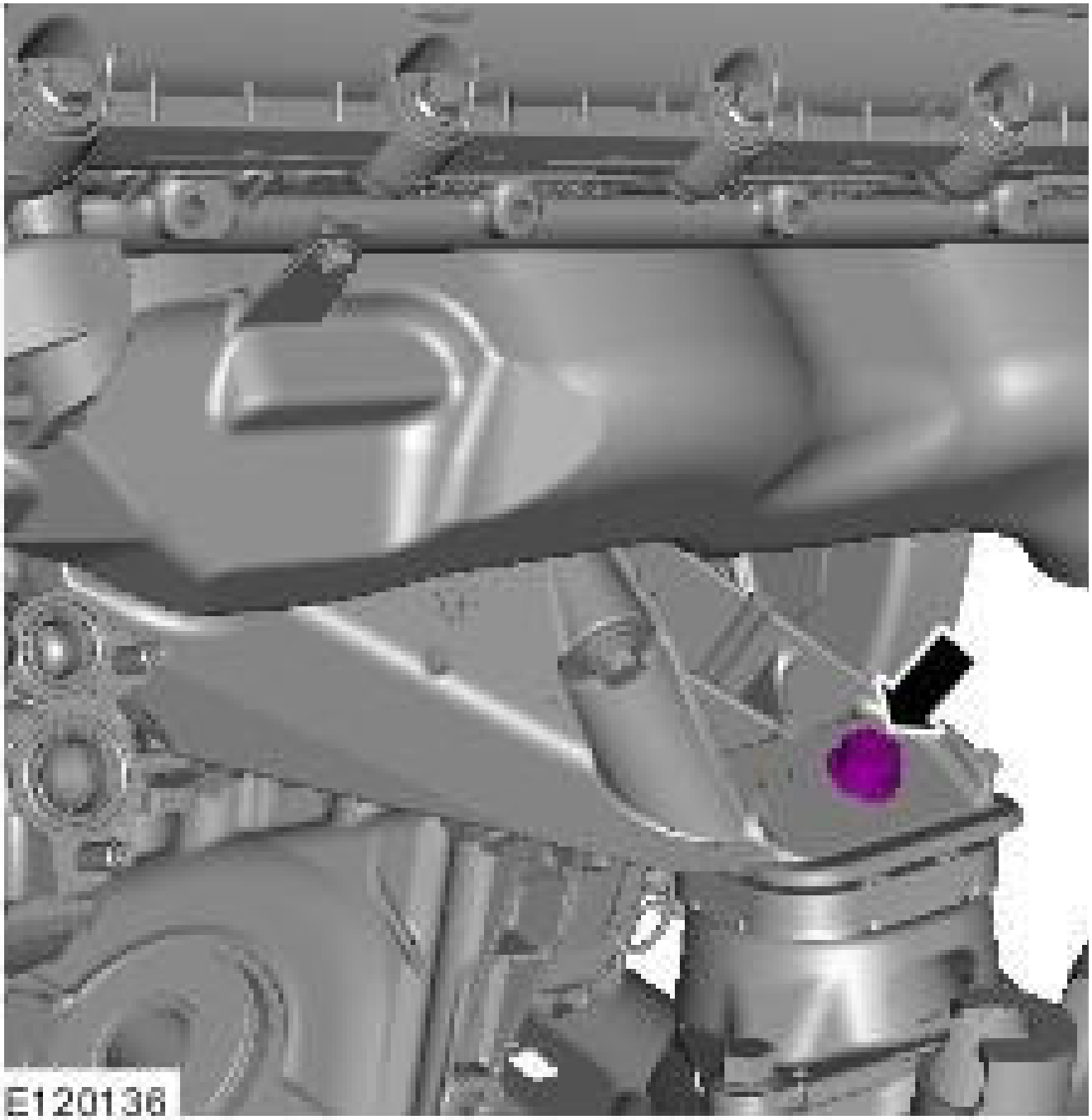

3. Torque: 100 Nm

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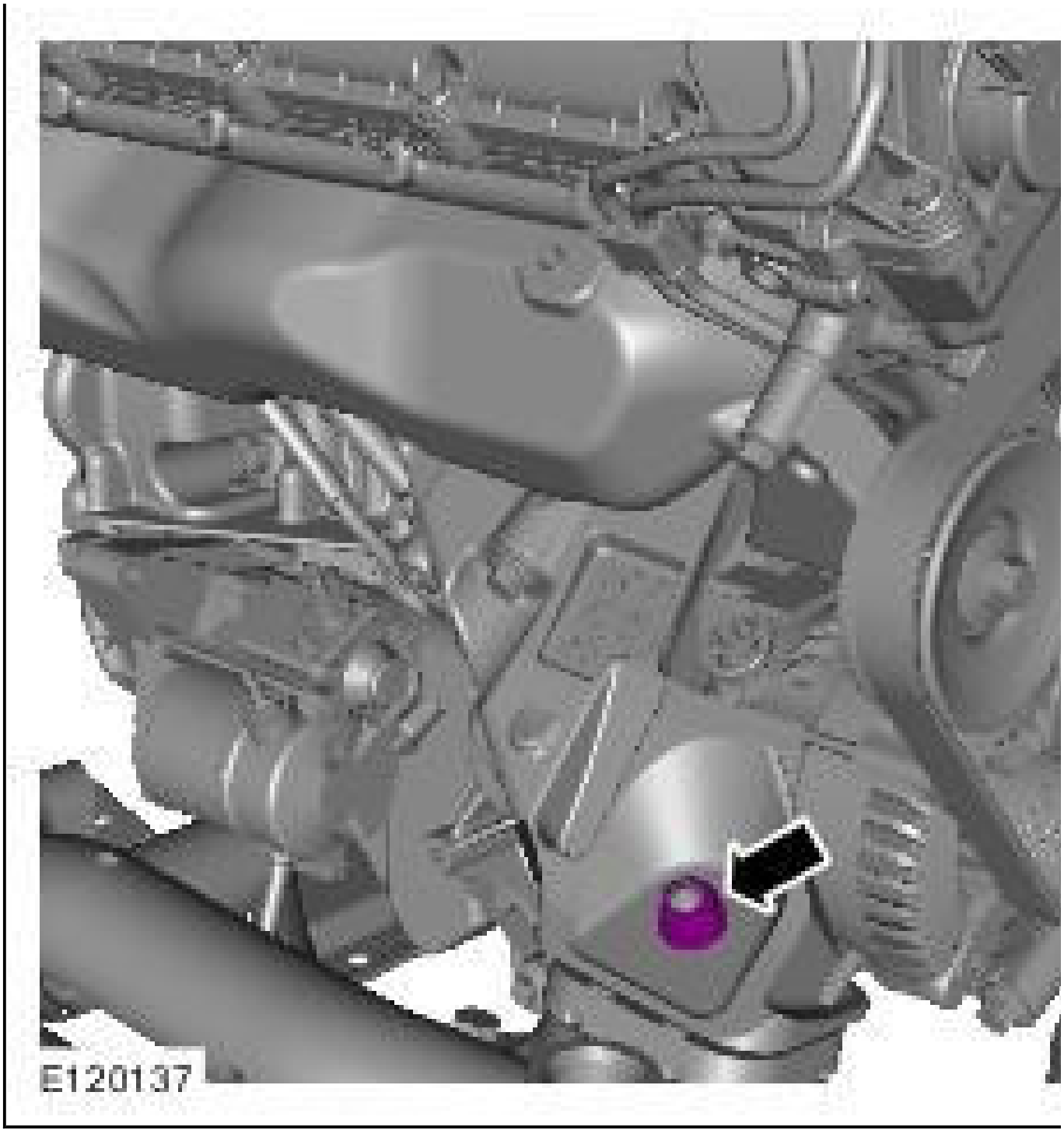

4. See figure

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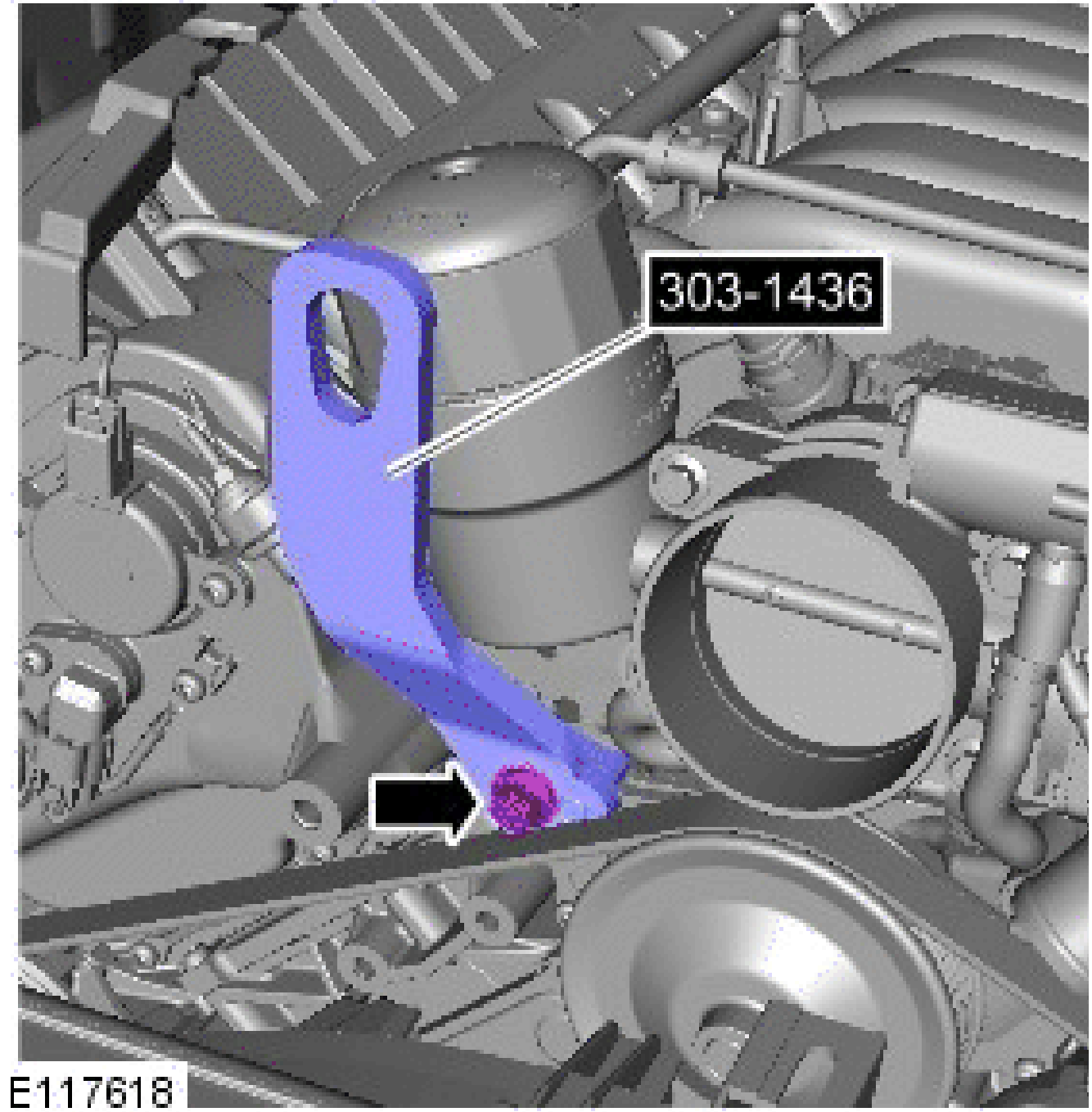
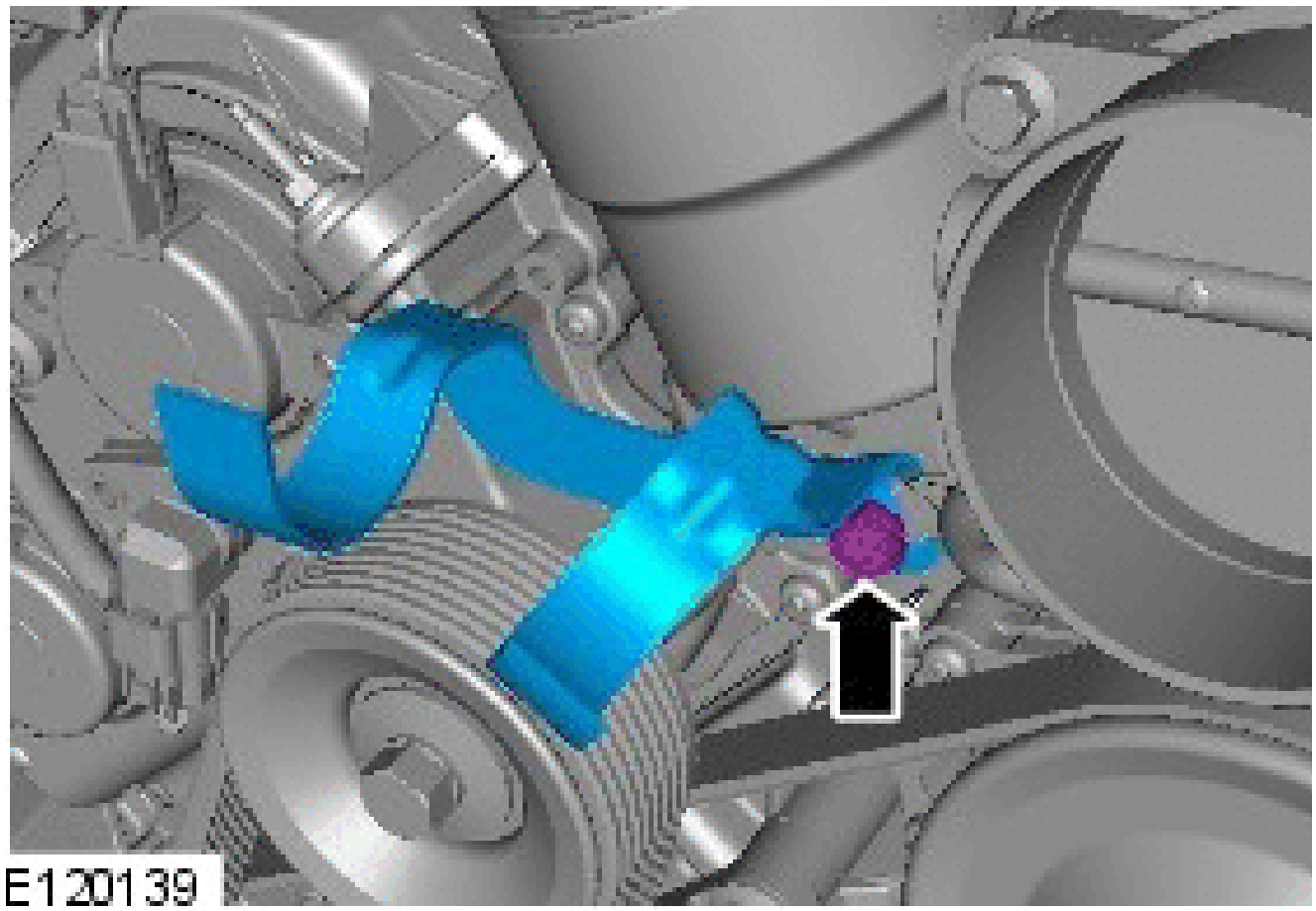


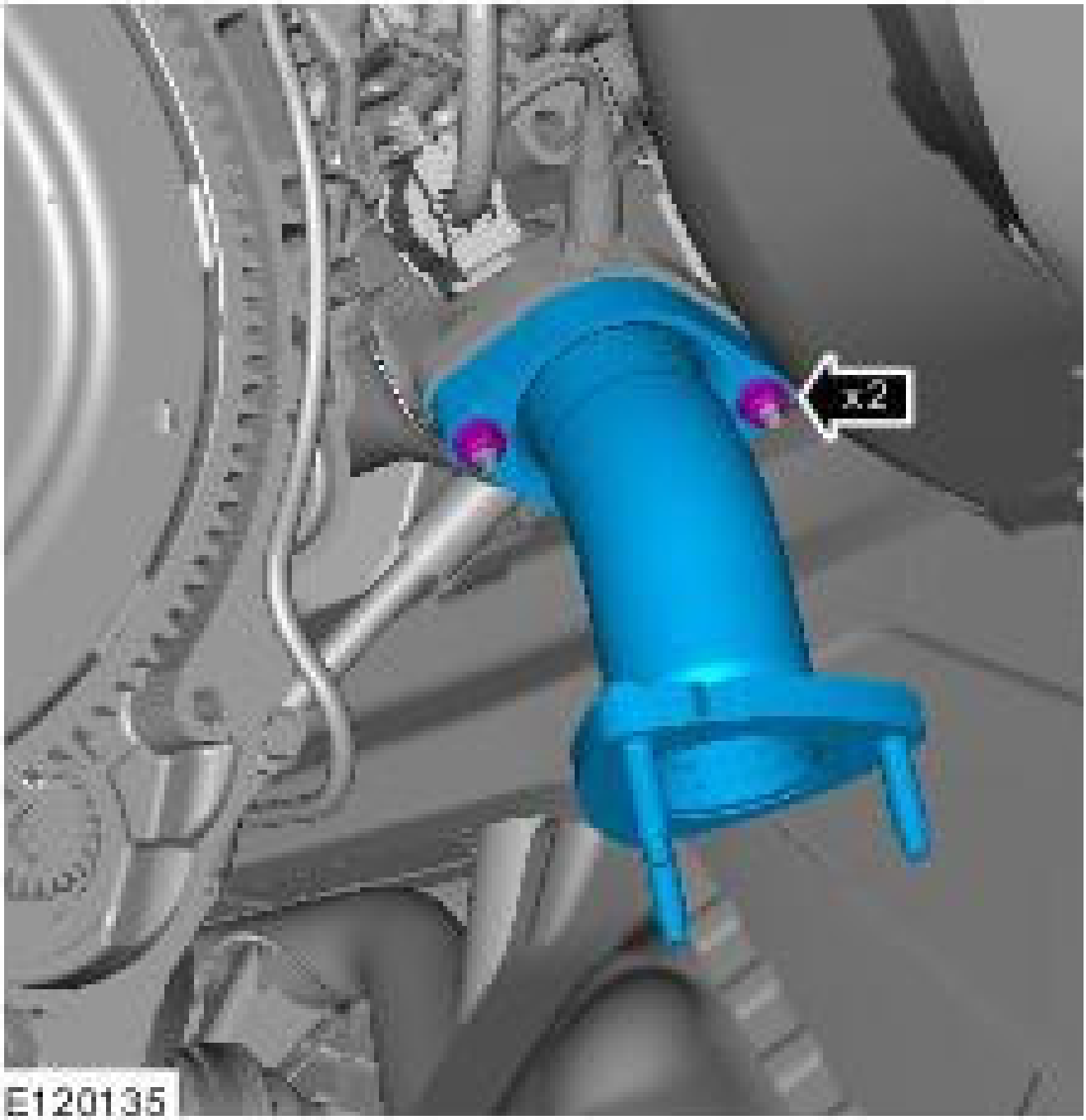
5. Torque: 25 Nm

 © 2011 Mitchell Repair Information Company, LLC.



6. Torque: 48 Nm

 © 2011 Mitchell Repair Information Company, LLC.



NOTE: Install a new gasket.

7. Torque: 48 Nm

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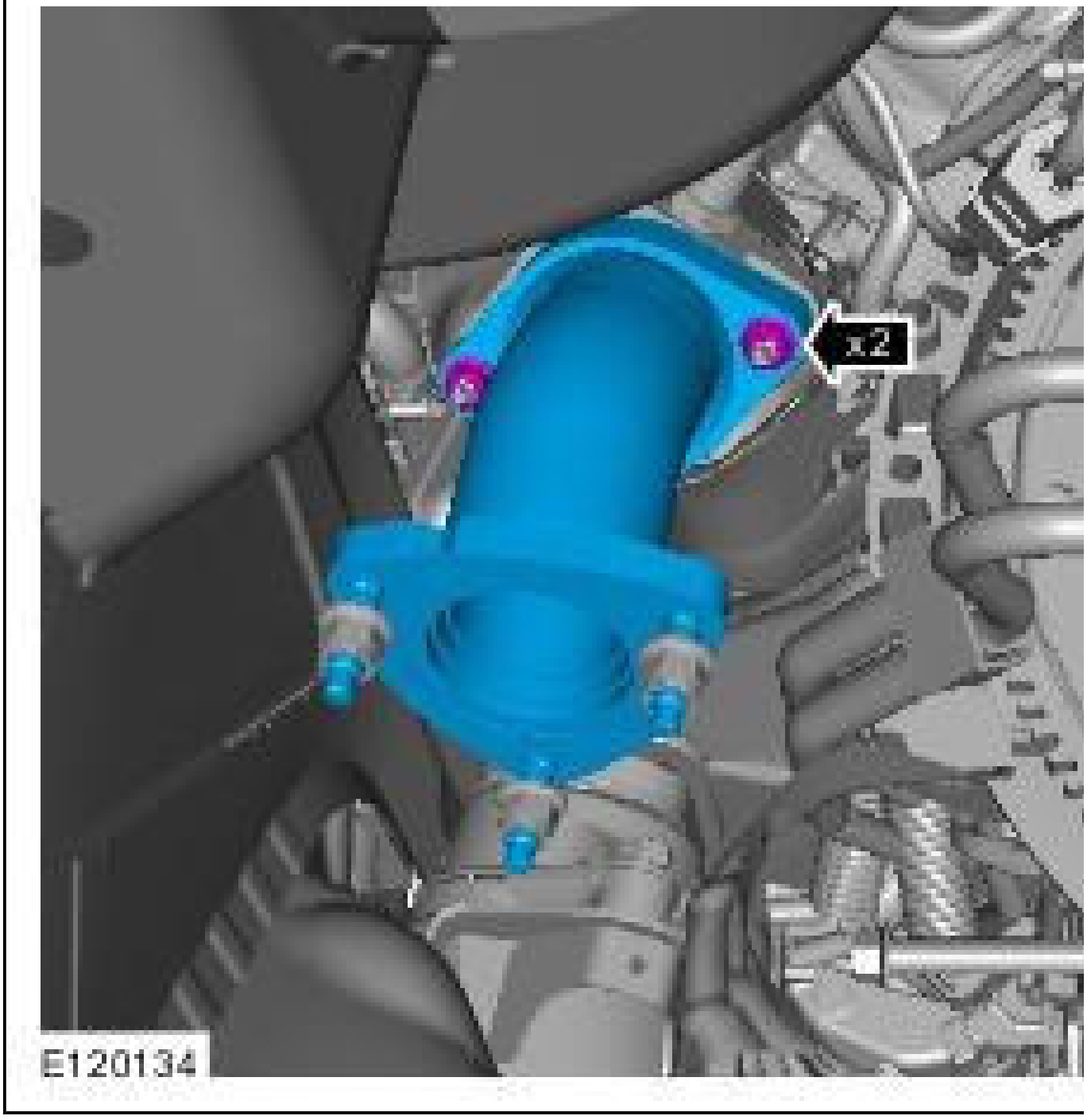

NOTE: Install a new gasket.

8. Torque: 10 Nm

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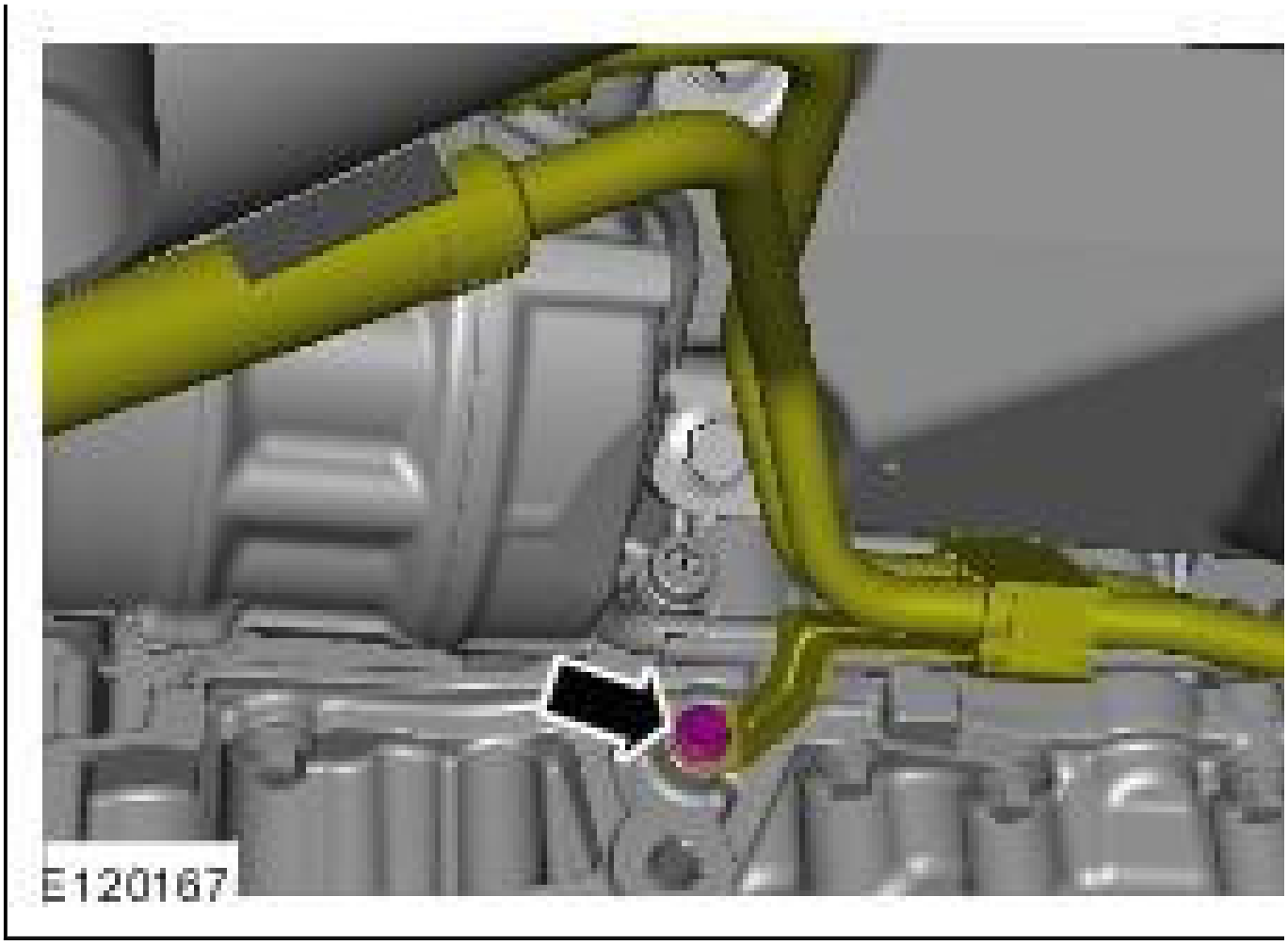
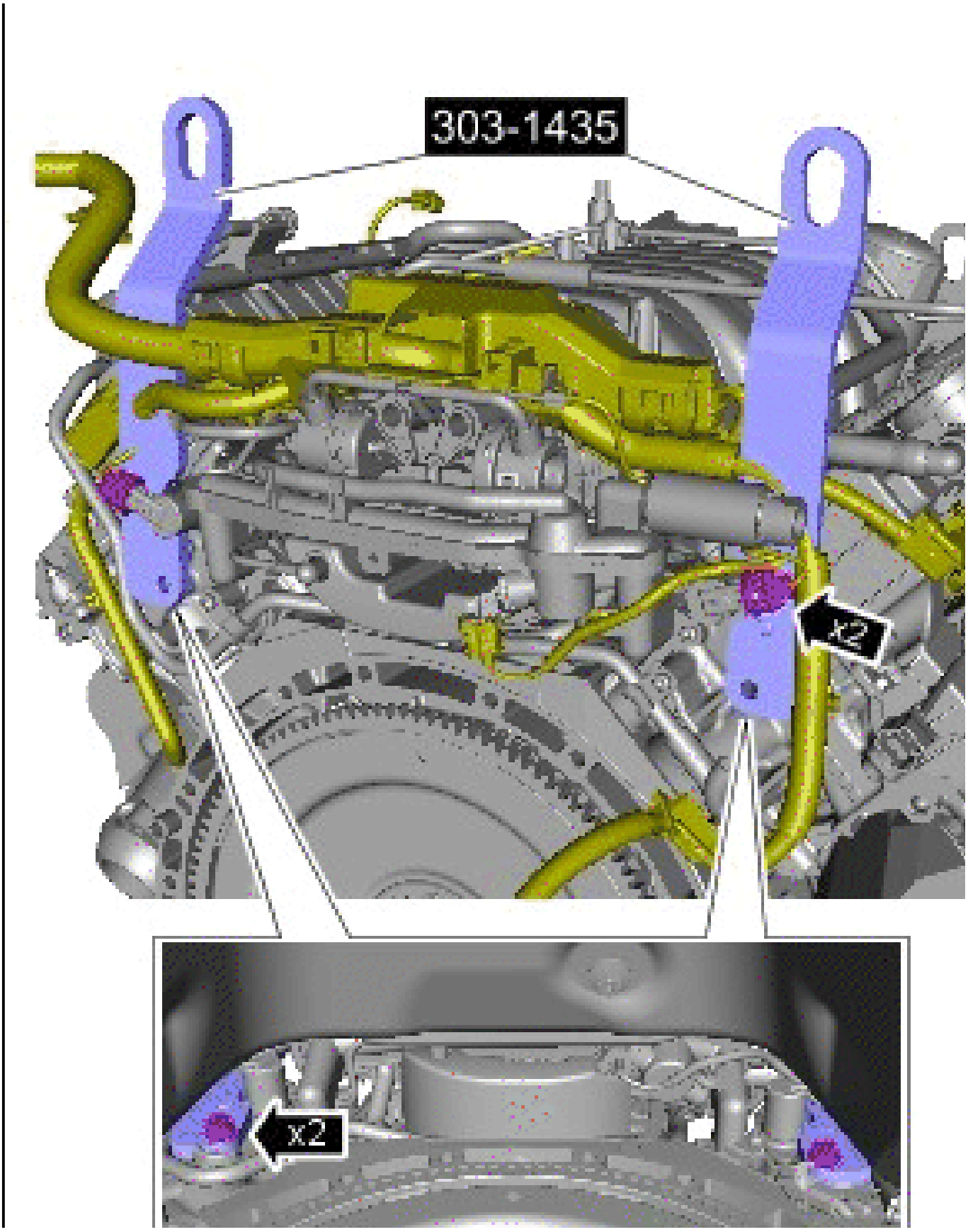


9. Torque: 25 Nm

 © 2011 Mitchell Repair Information Company, LLC.



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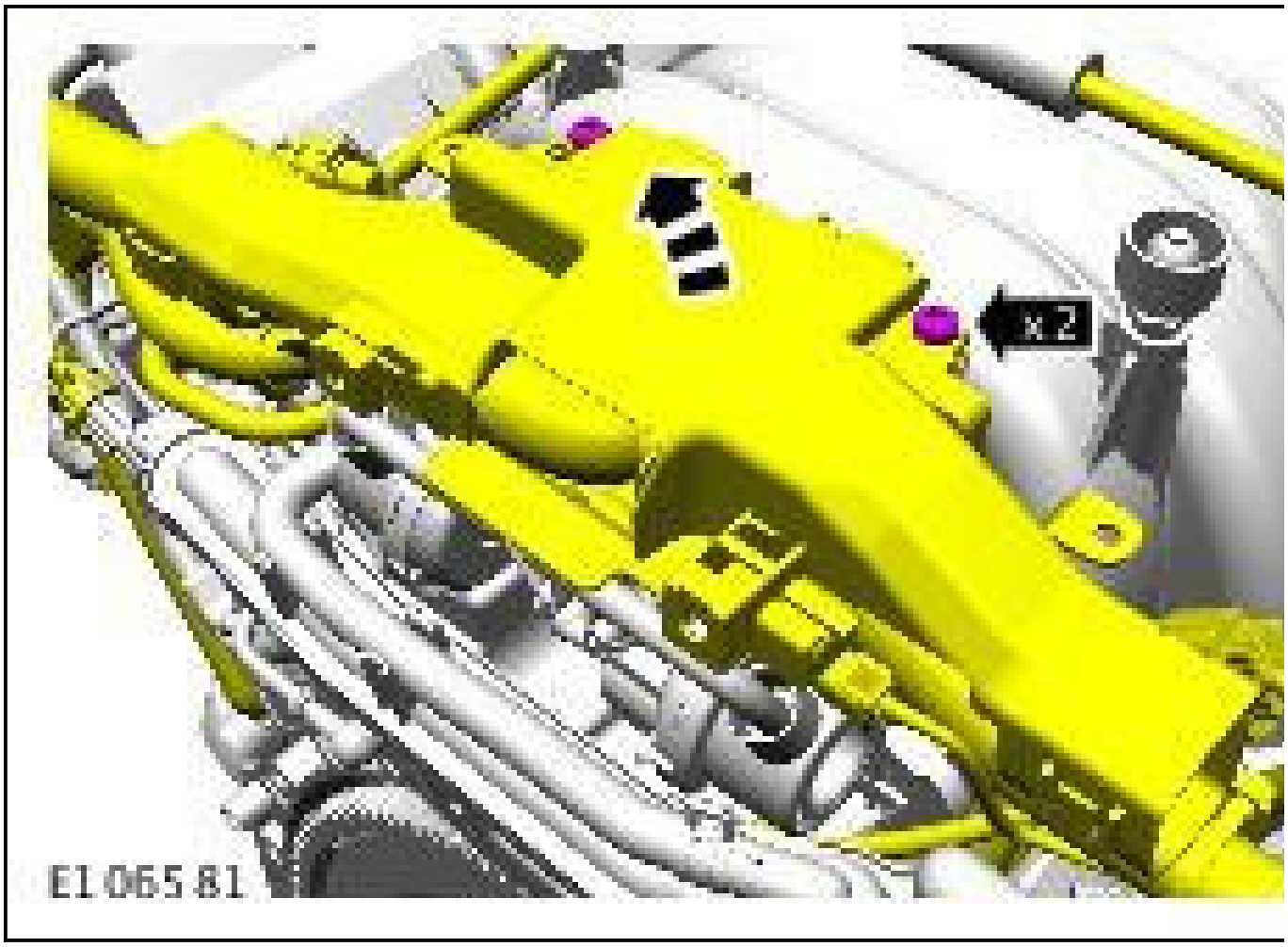
10. Torque: 10 Nm



11. Torque: 25 Nm

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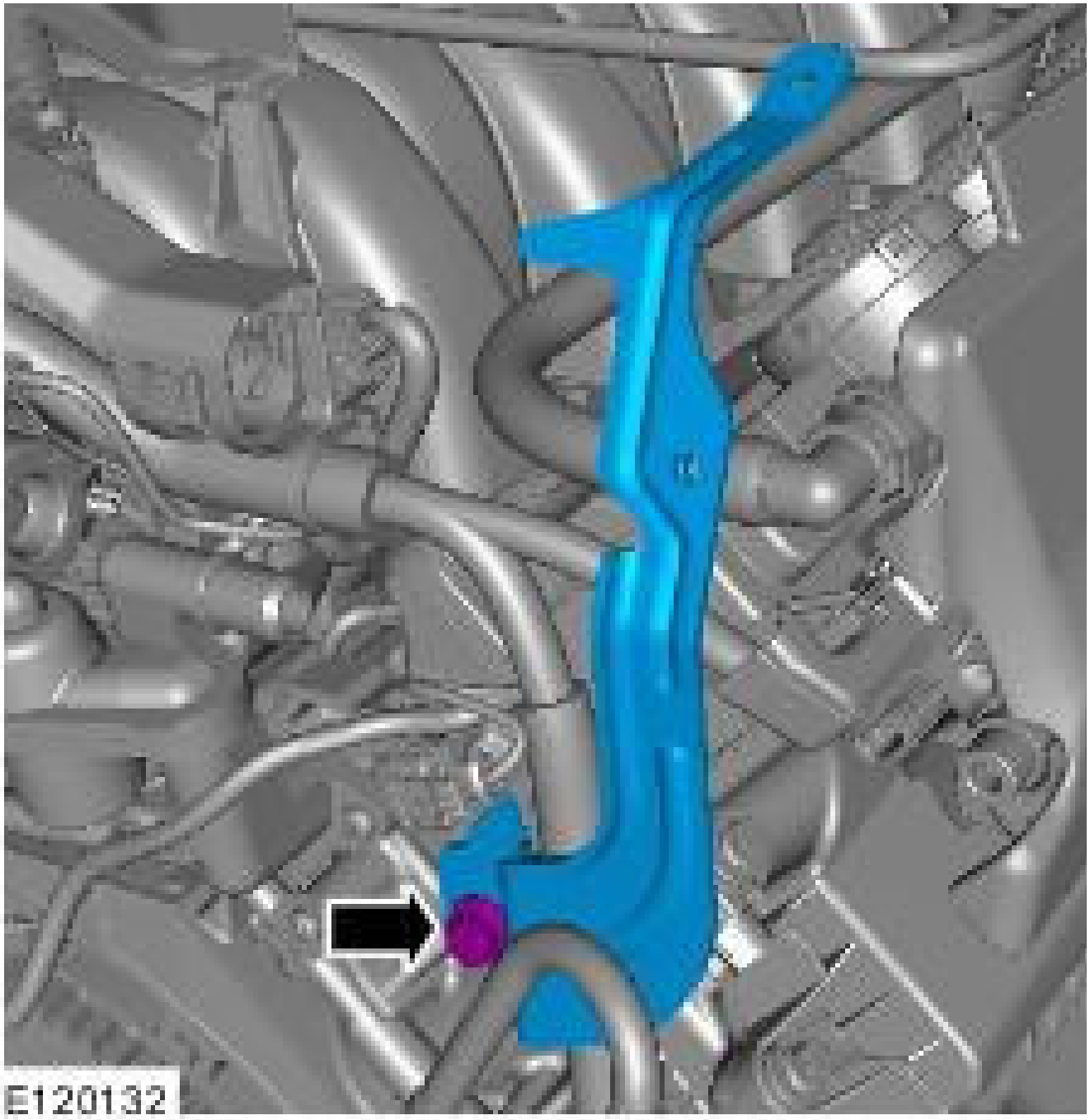

NOTE: RHD illustration shown, LHD is similar.

12. Torque: 25 Nm

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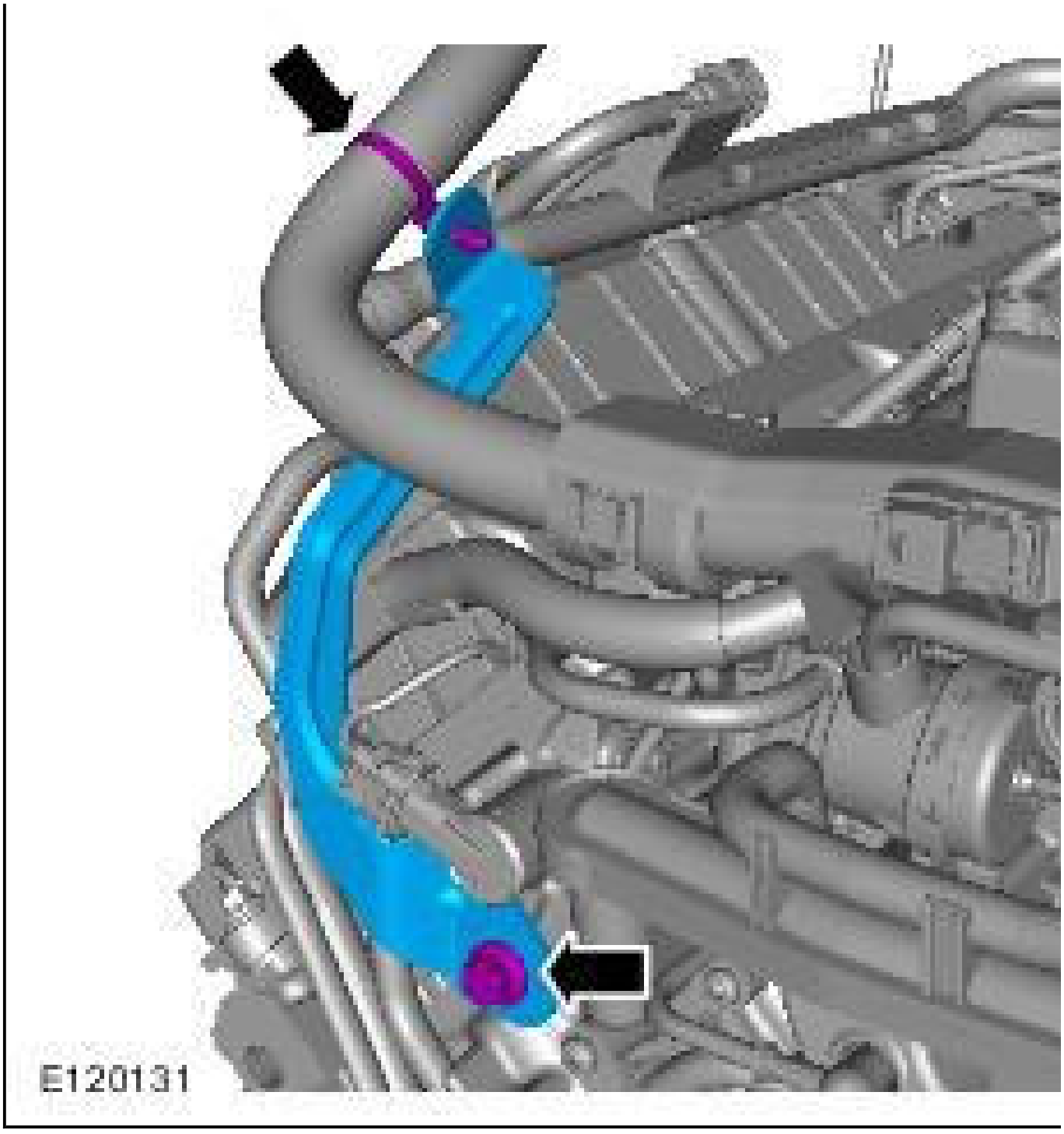

NOTE: RHD illustration shown, LHD is similar.

LEFT-HAND DRIVE VEHICLES

1. Torque: 10 Nm

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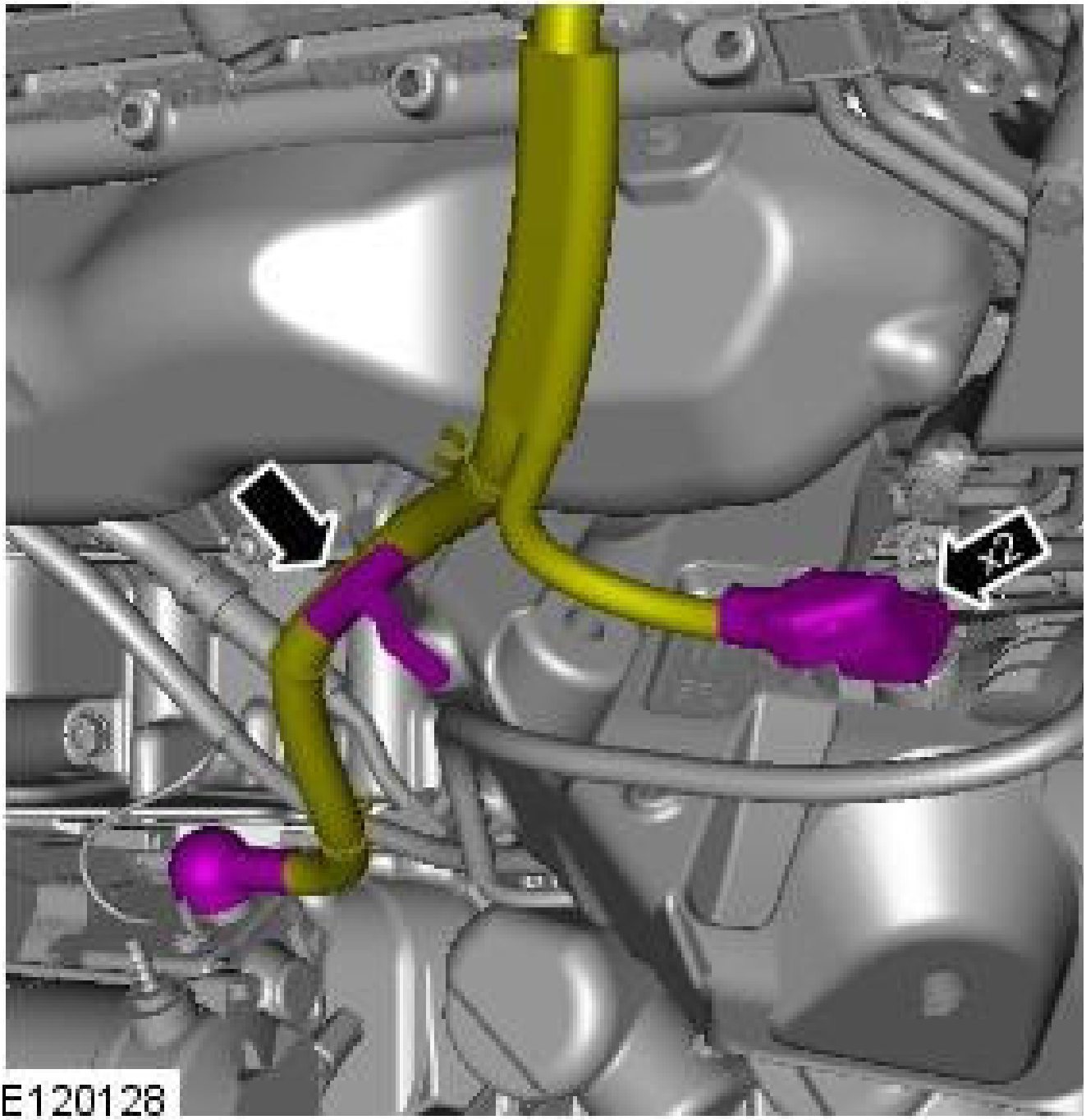
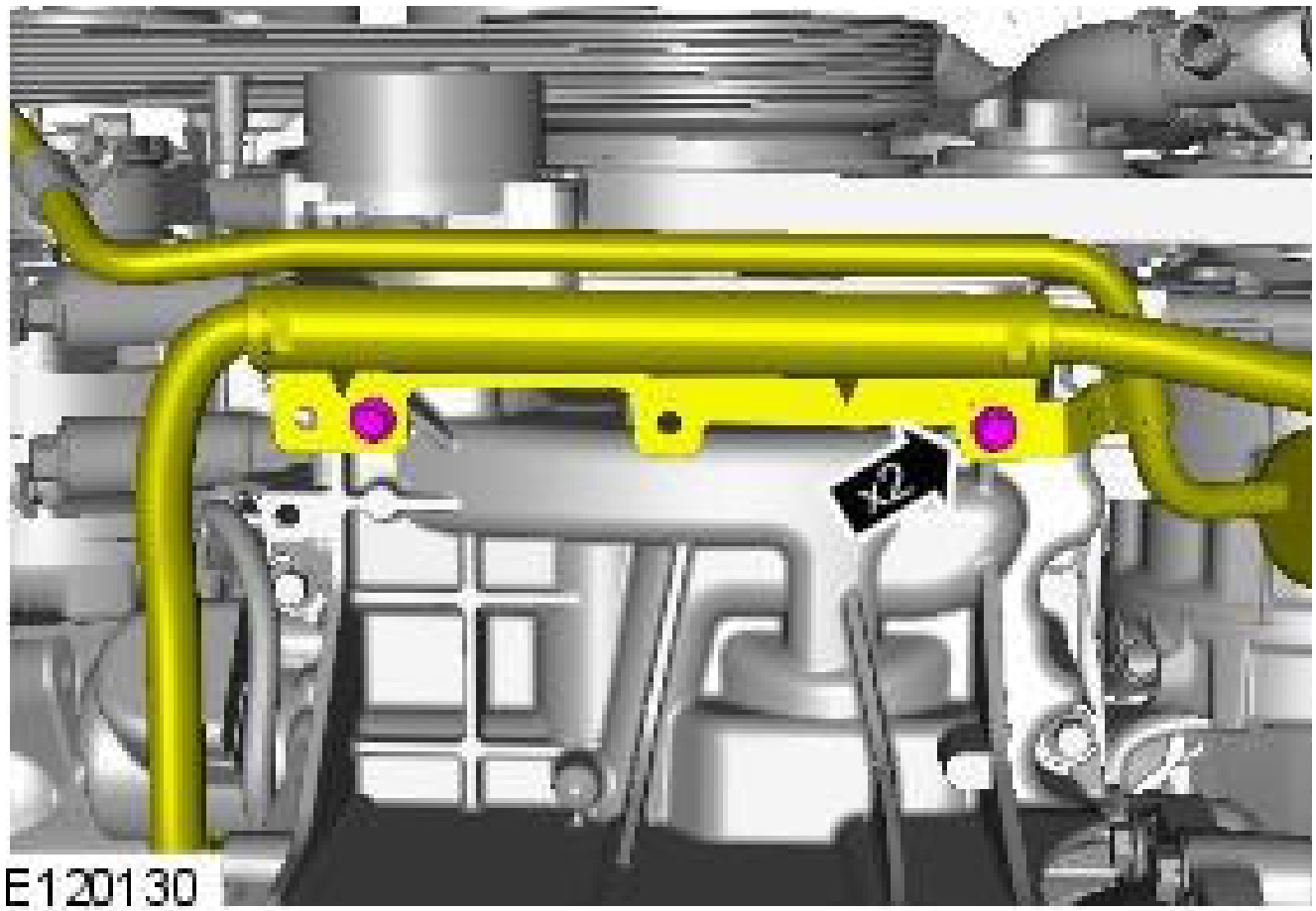


RIGHT-HAND DRIVE VEHICLES

1. Torque: 10 Nm

 © 2011 Mitchell Repair Information Company, LLC.



2. Torque: 10 Nm

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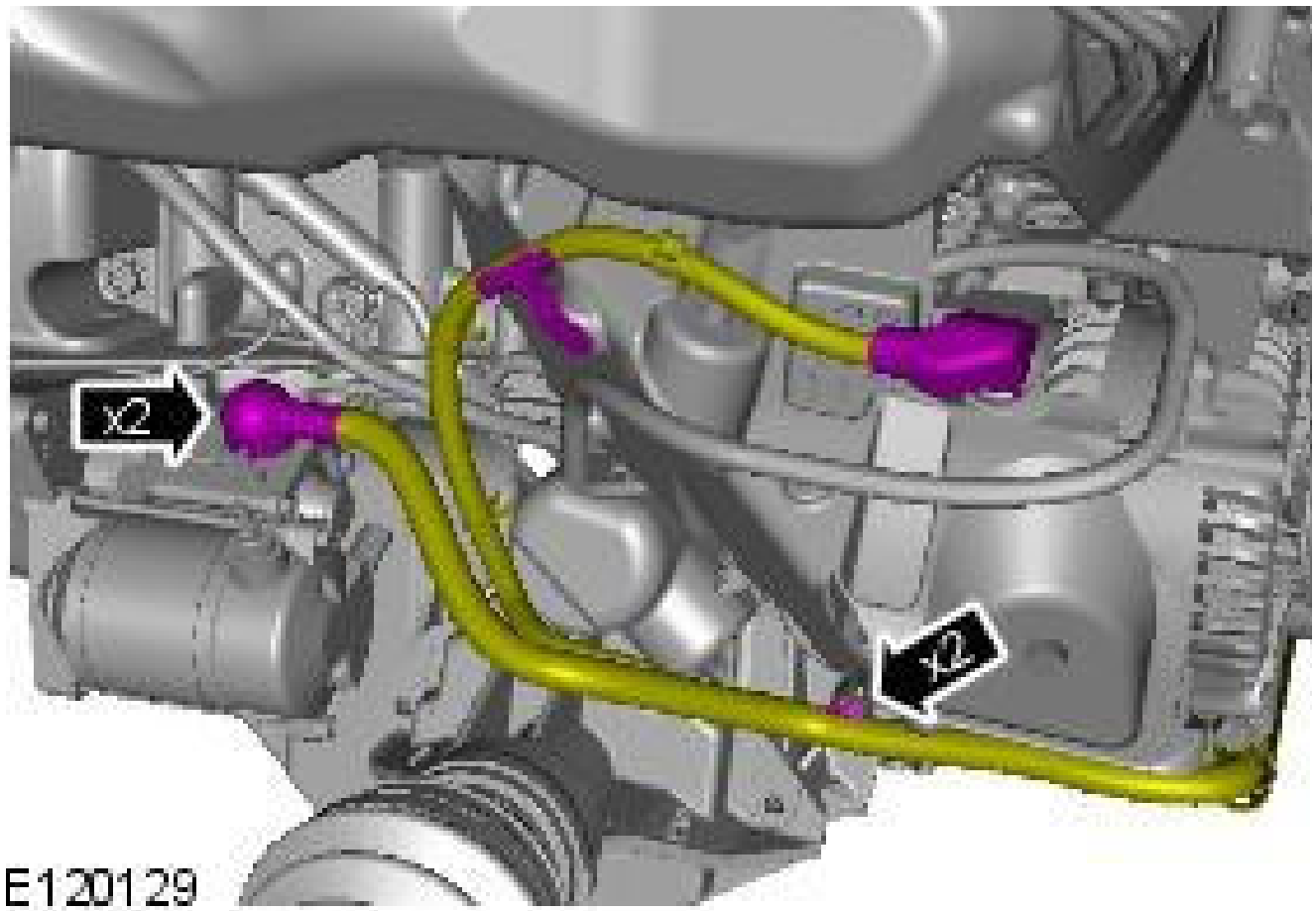

ALL VEHICLES

1. Torque: 12 Nm

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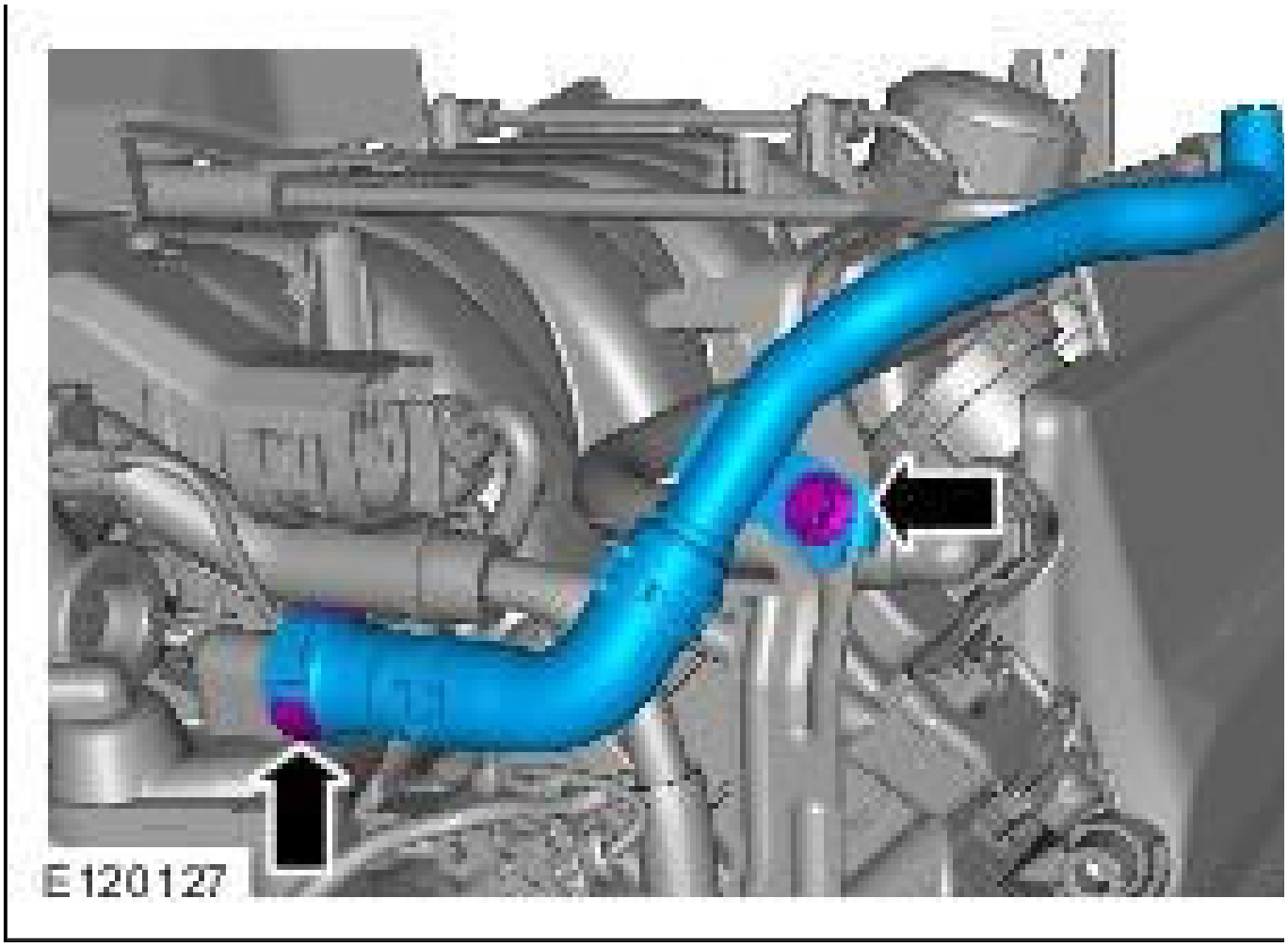
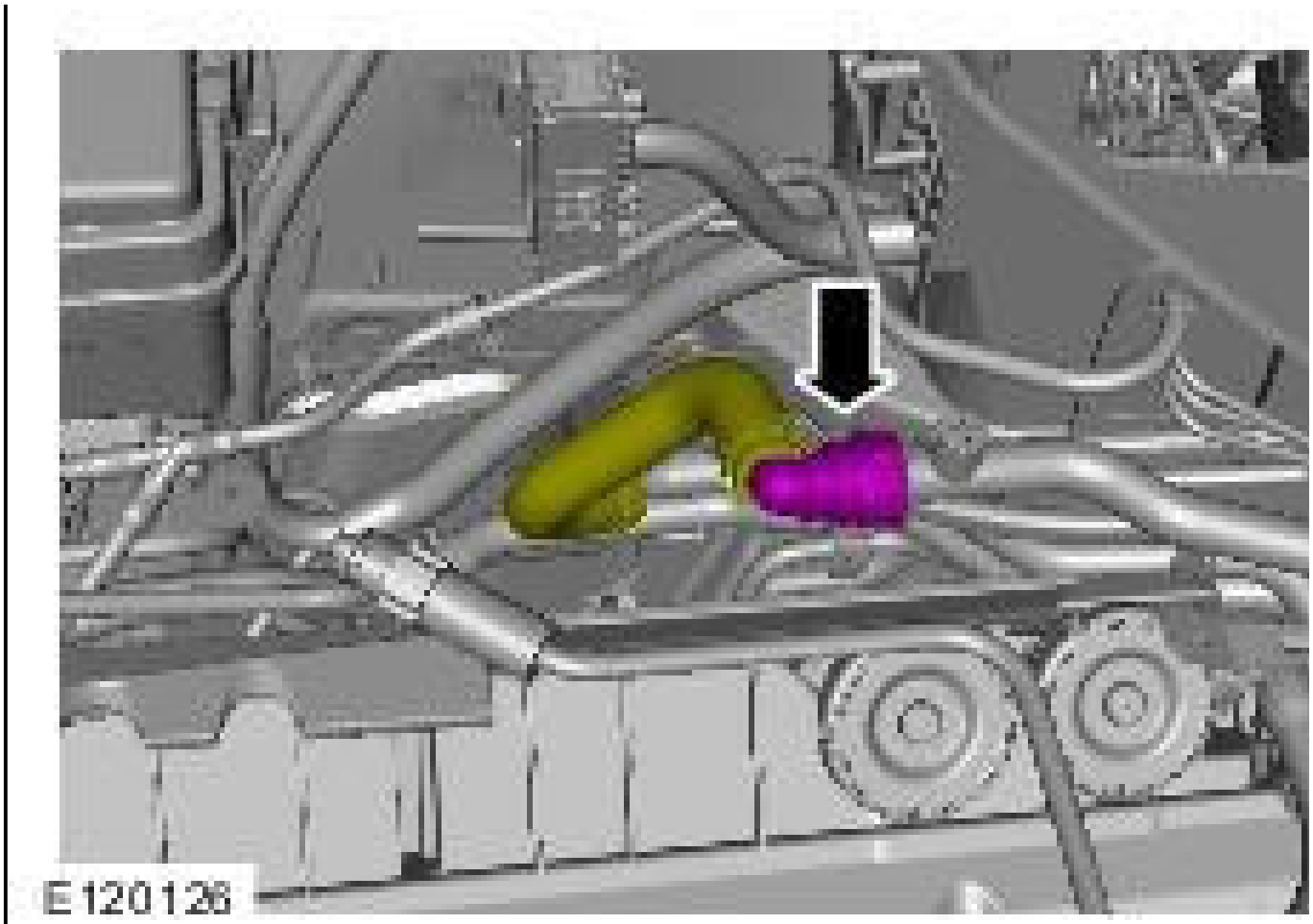


CAUTION: Be prepared to collect escaping coolant.

2. See figure

 © 2011 Mitchell Repair Information Company, LLC.



CAUTION: Be prepared to collect escaping coolant.

3. Torque: 25 Nm

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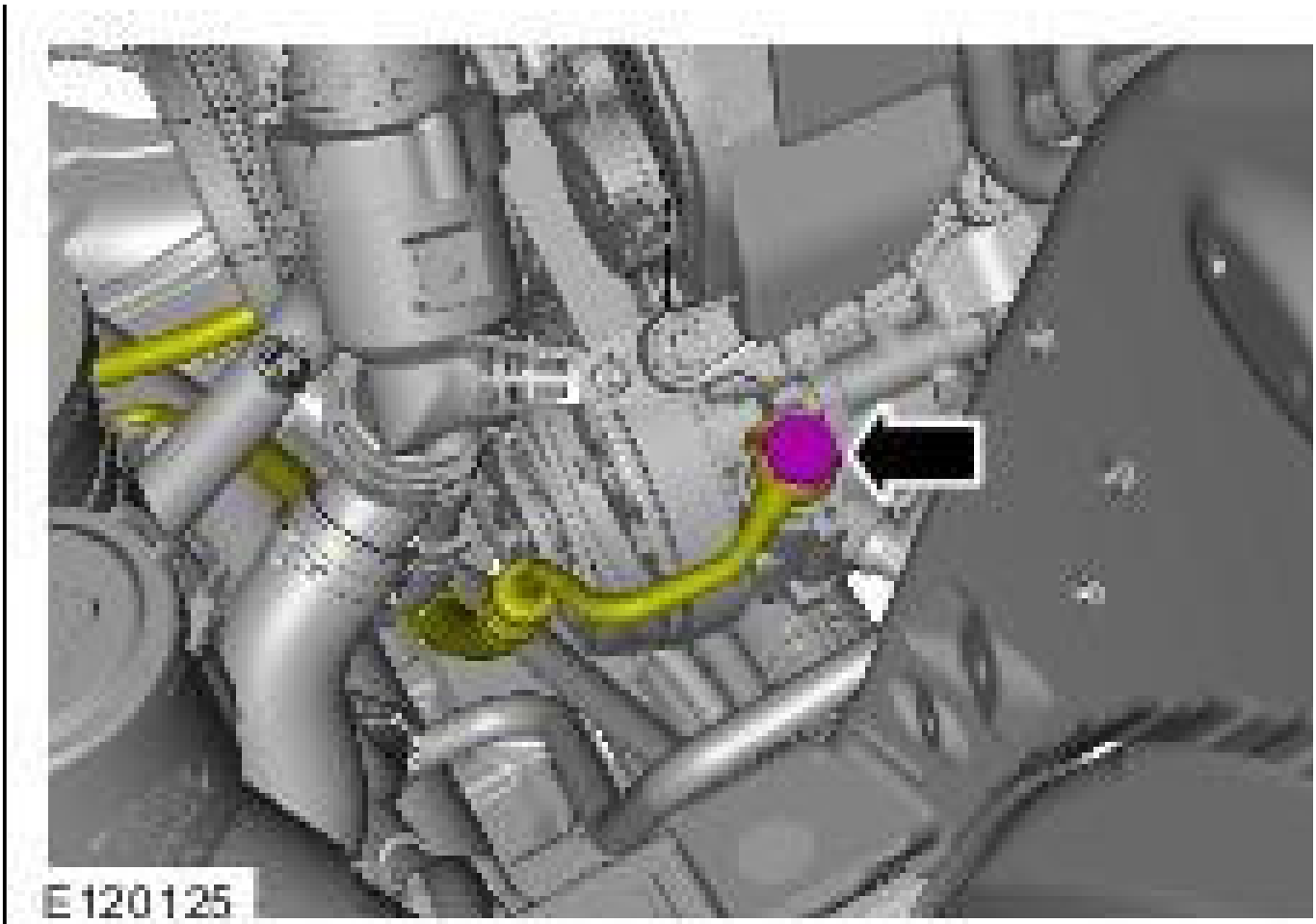

CAUTION: Install new o-ring seals

CAUTION: Lubricate the O-ring seals.

4. See figure

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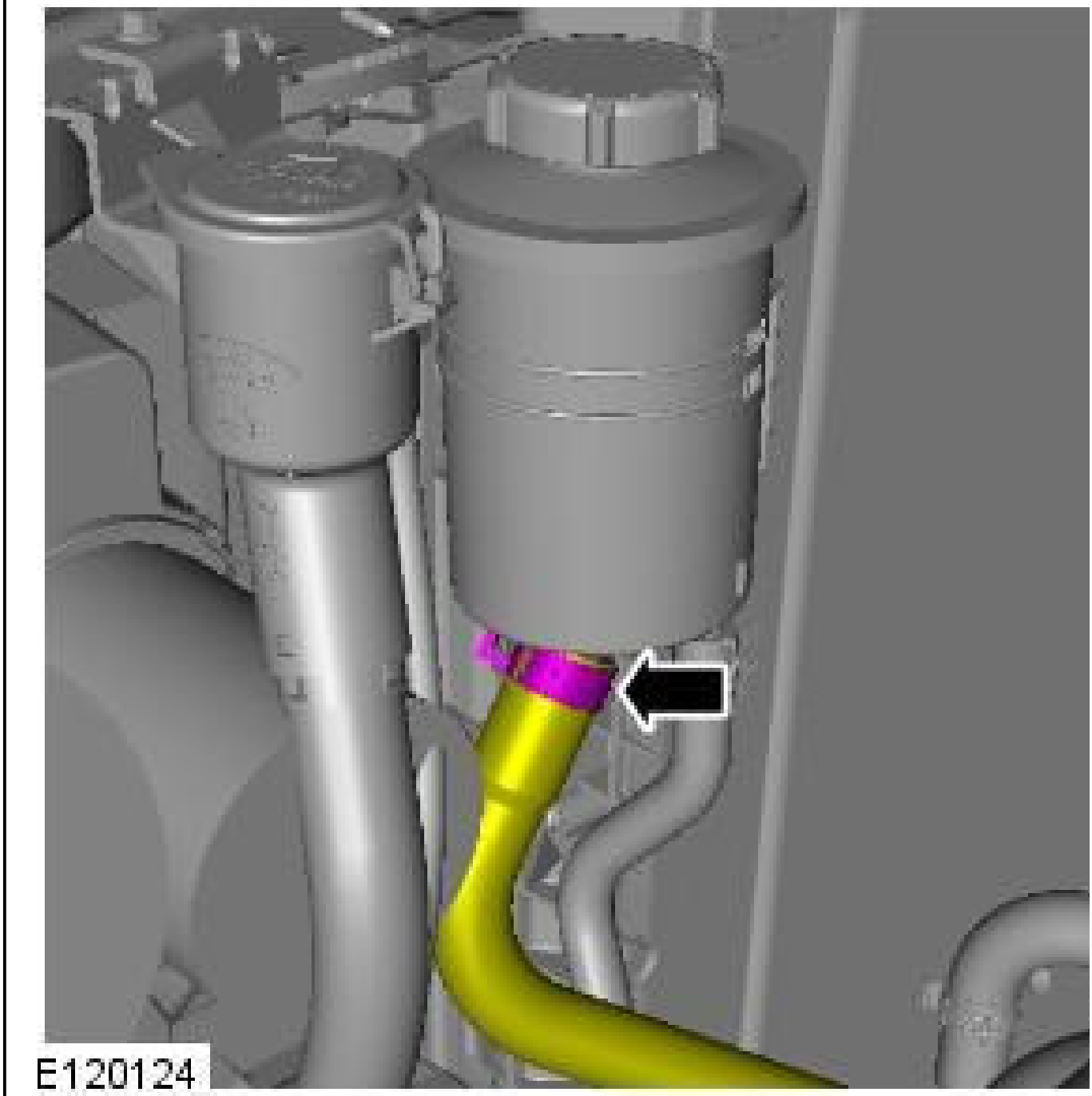
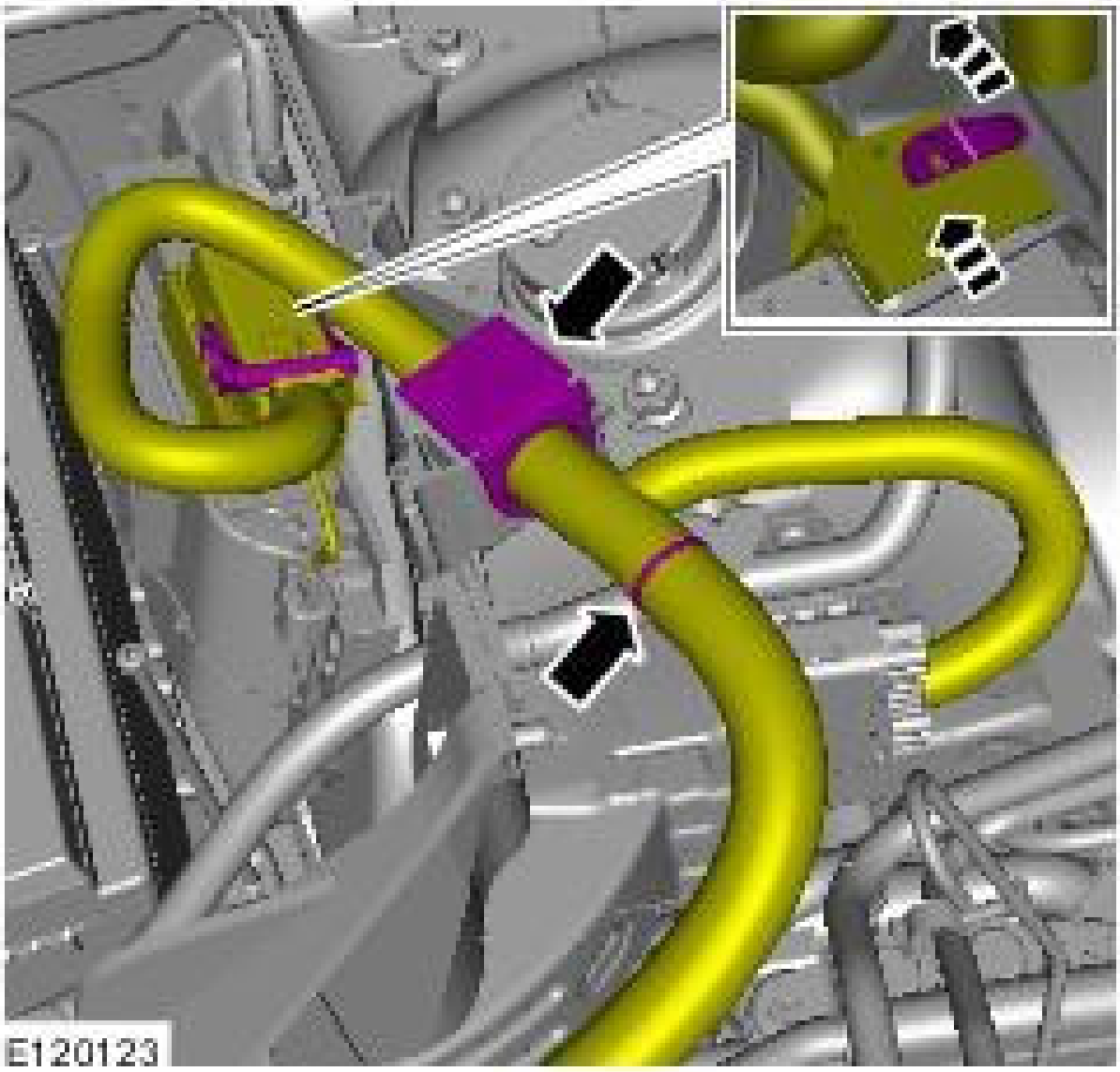


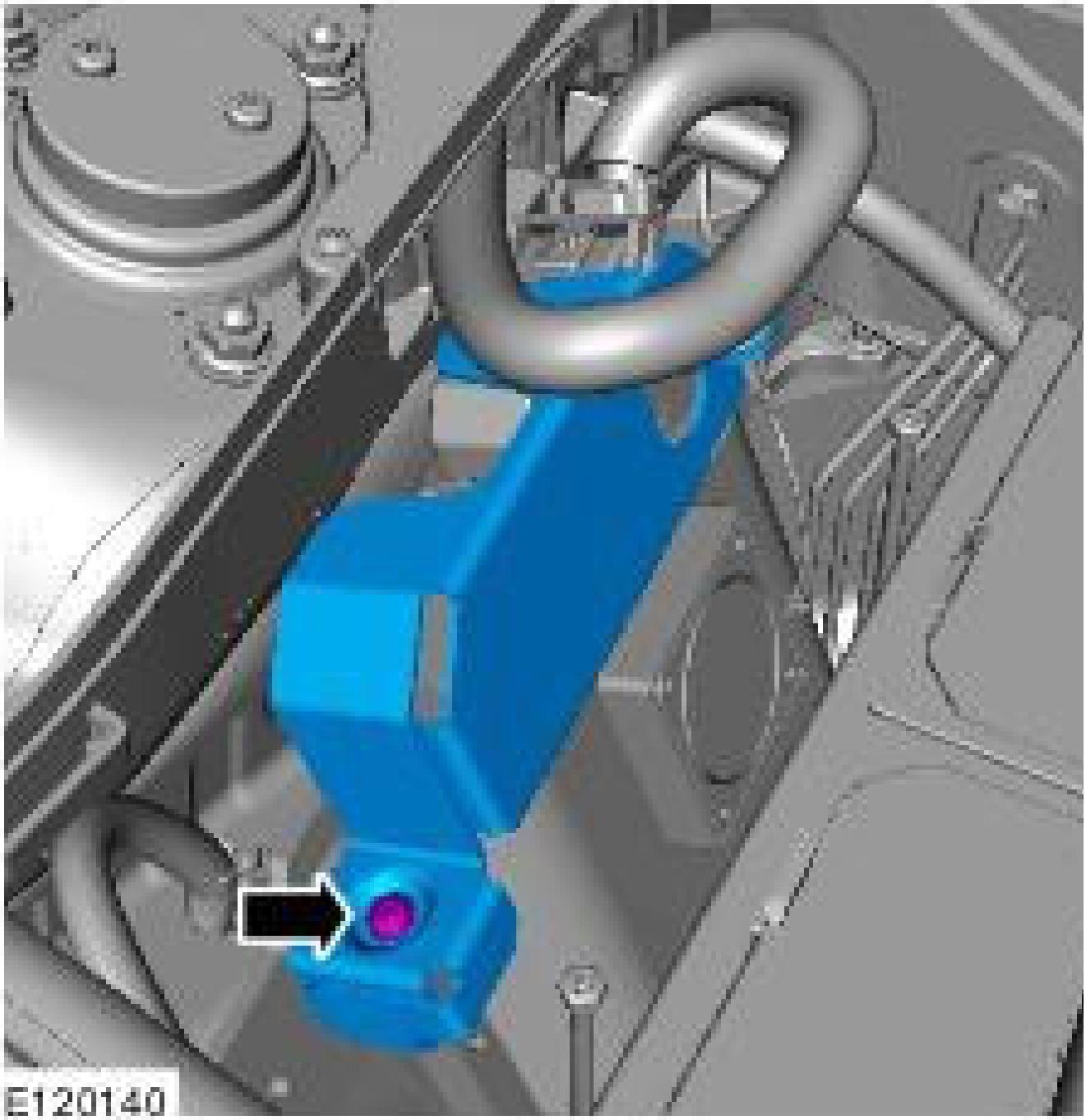
5. See figure

 © 2011 Mitchell Repair Information Company, LLC.



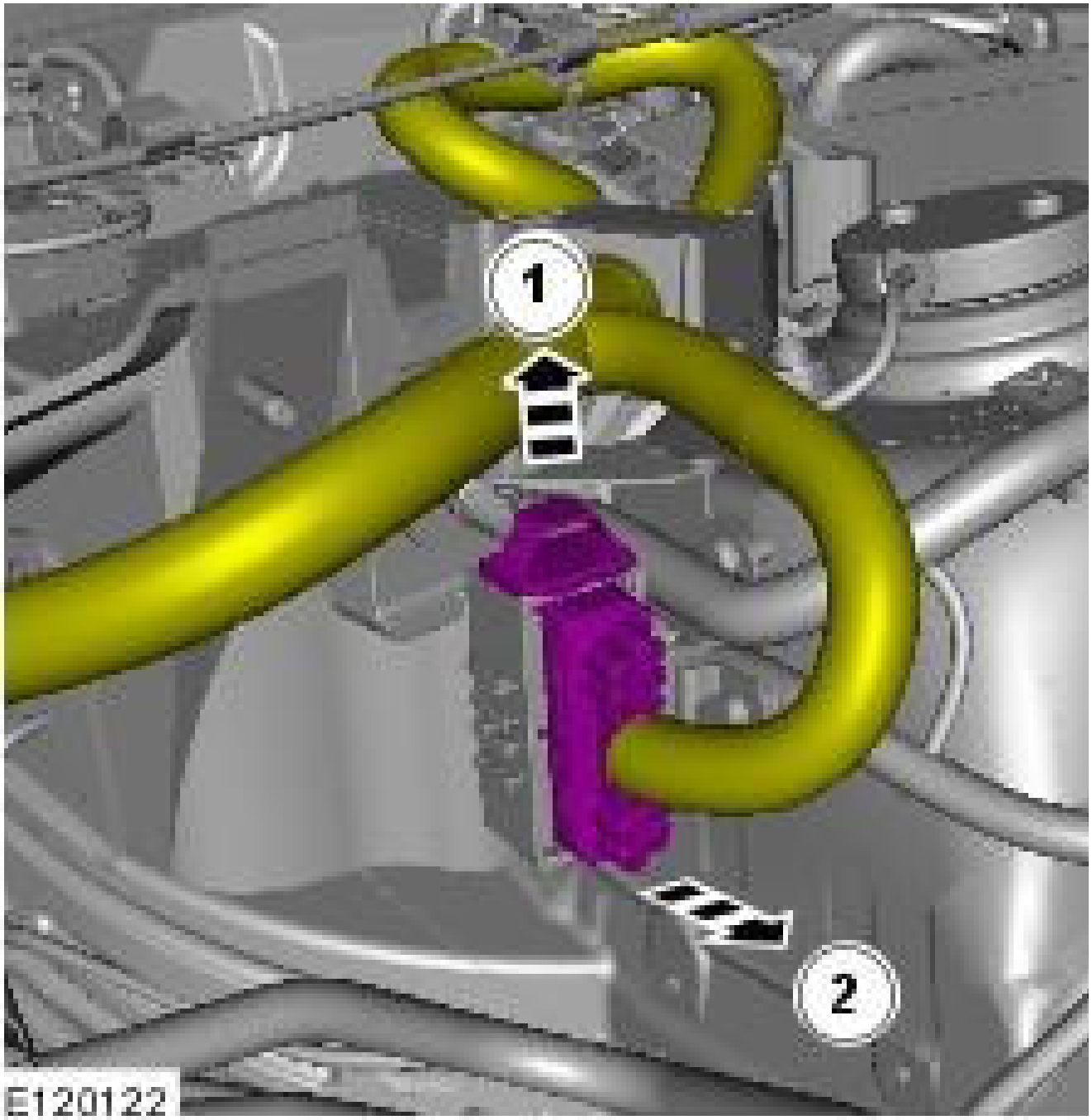
6. See figure

 © 2011 Mitchell Repair Information Company, LLC.



7. See figure

 © 2011 Mitchell Repair Information Company, LLC.



8. Torque: 8 Nm

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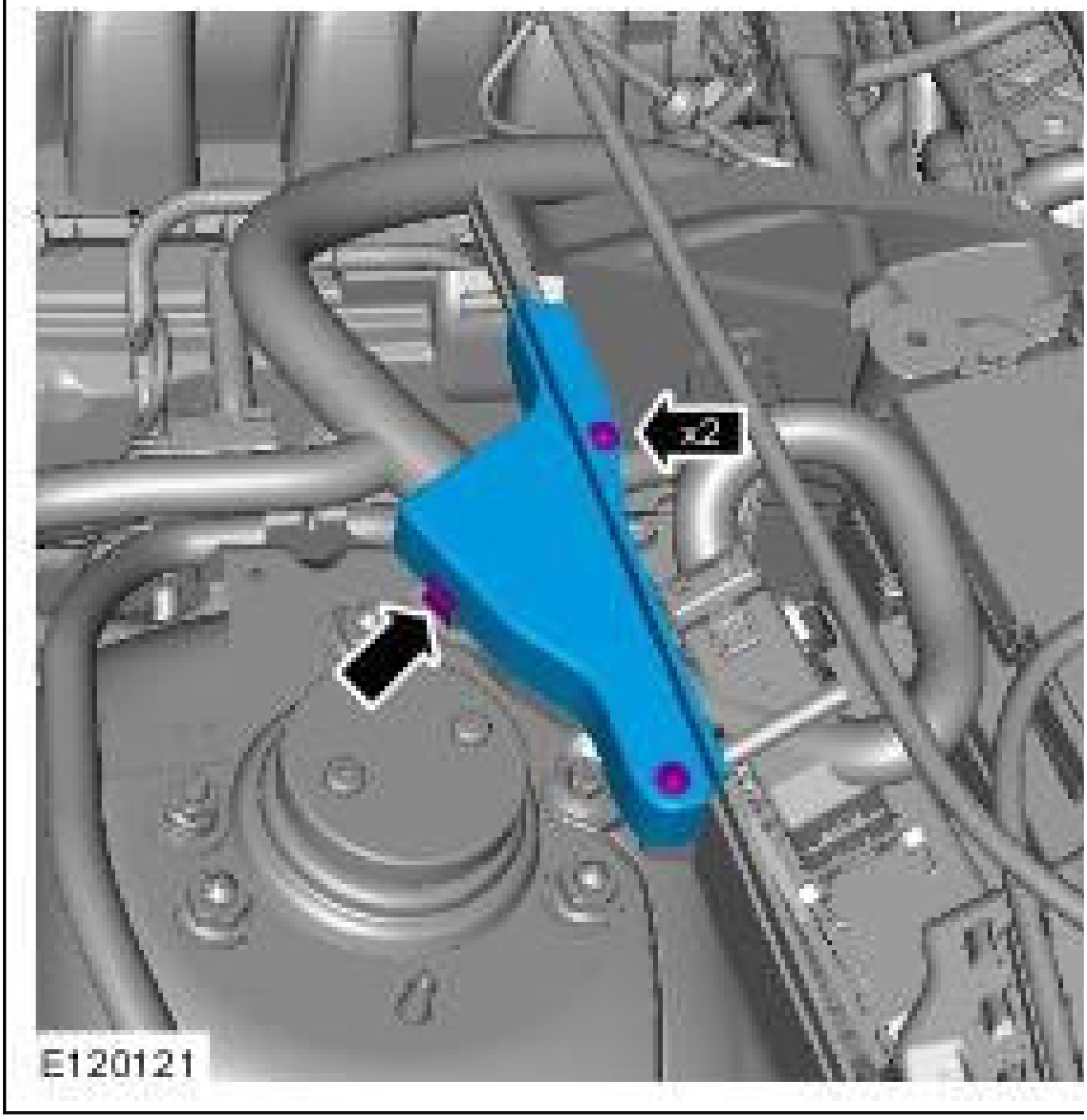
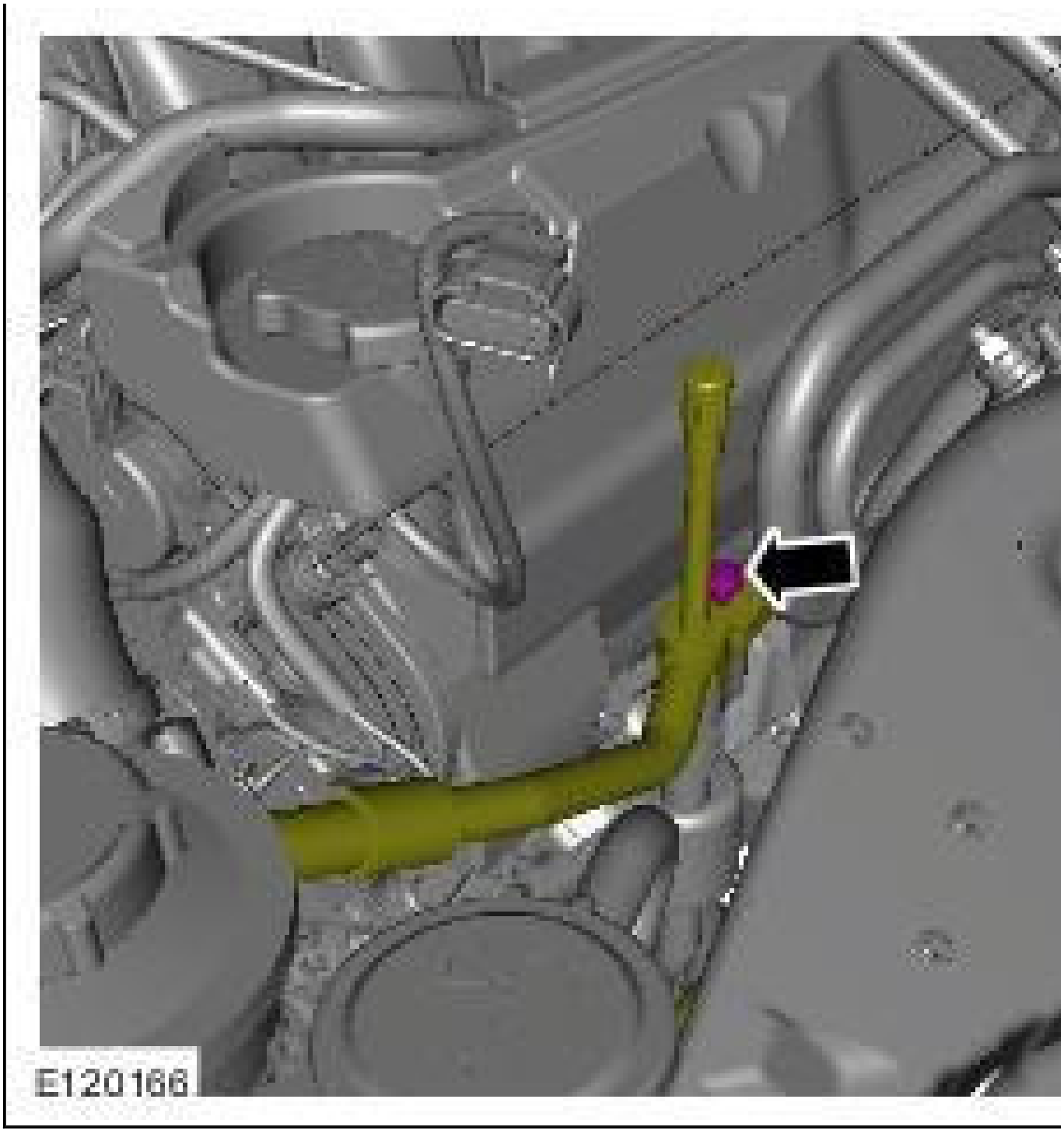


NOTE: RHD illustration shown, LHD is similar.

9. Torque: 25 Nm

 © 2011 Mitchell Repair Information Company, LLC.



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

10. Torque: 25 Nm

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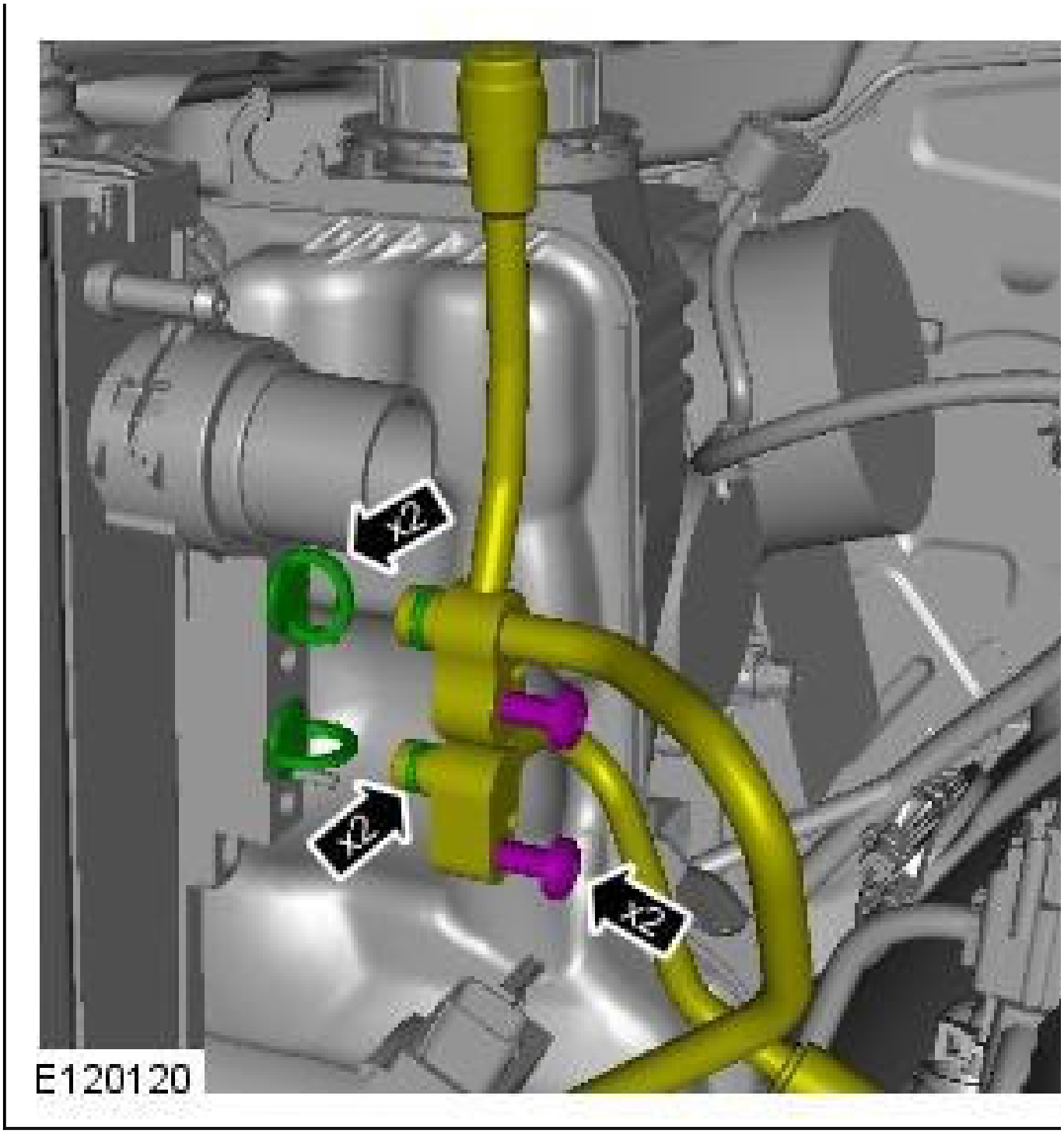

CAUTION: Make sure that the area around the component is clean and free of foreign material.

NOTE: Remove and discard the blanking caps.

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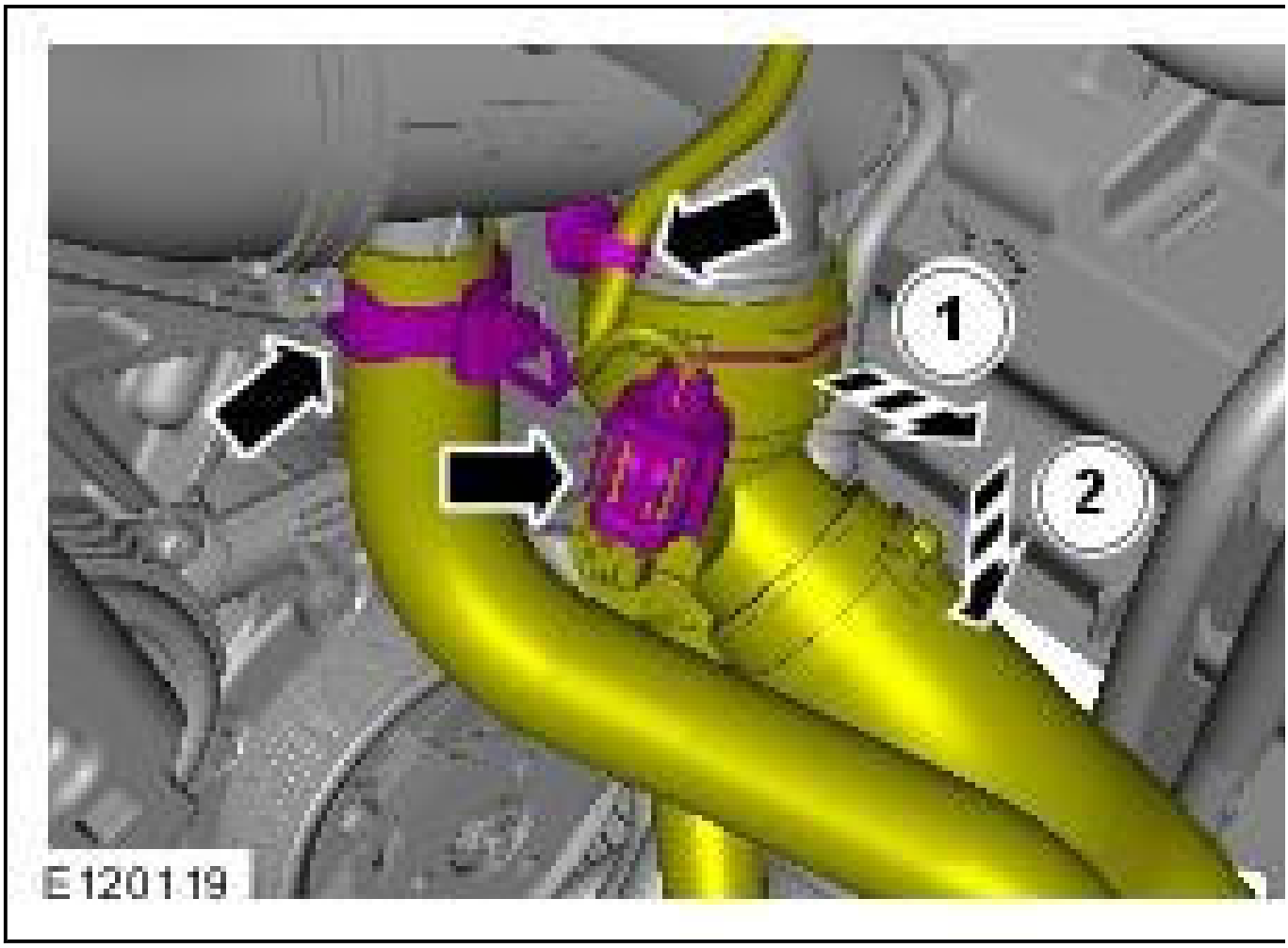
11. See figure



12. See figure

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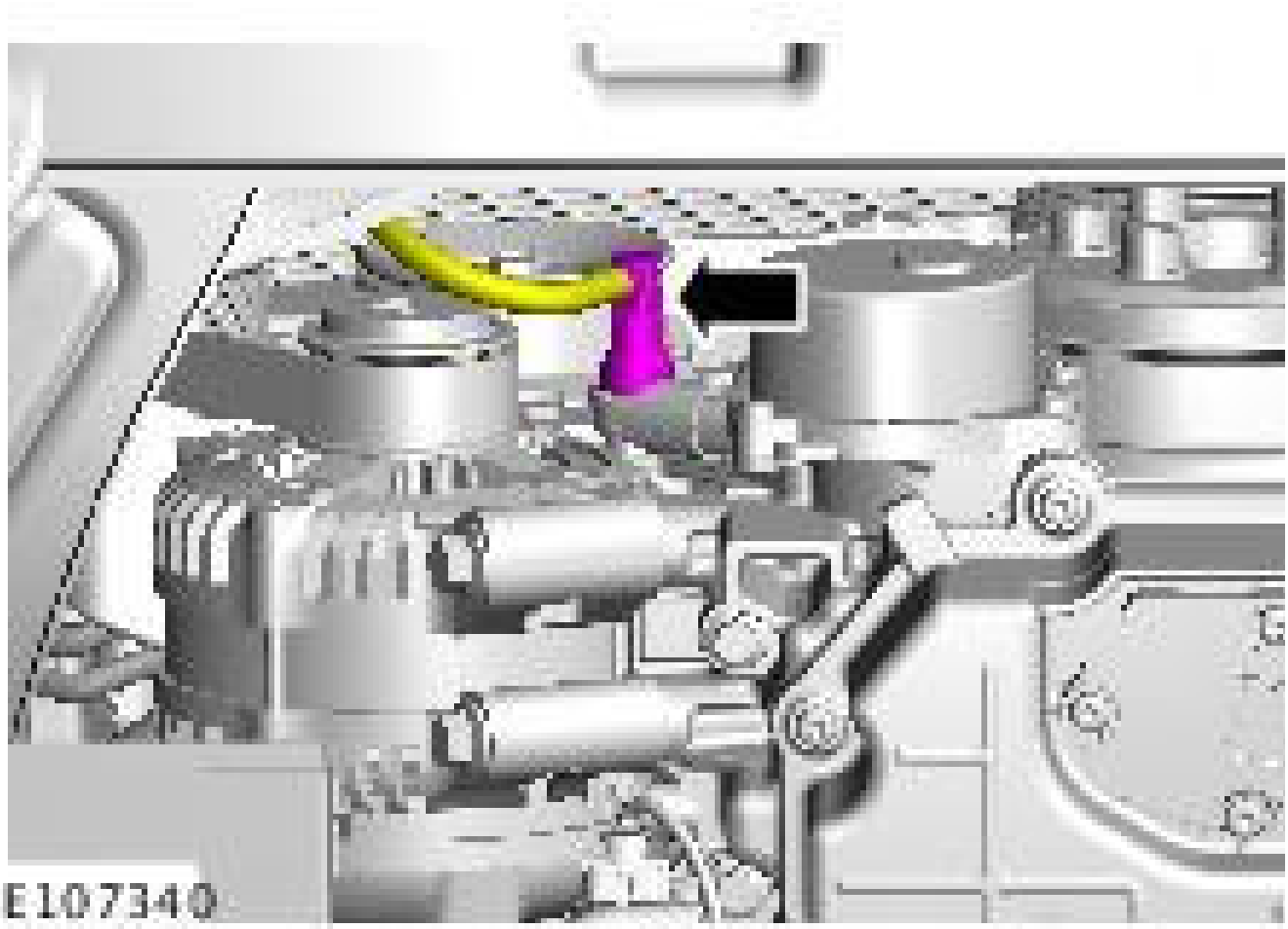
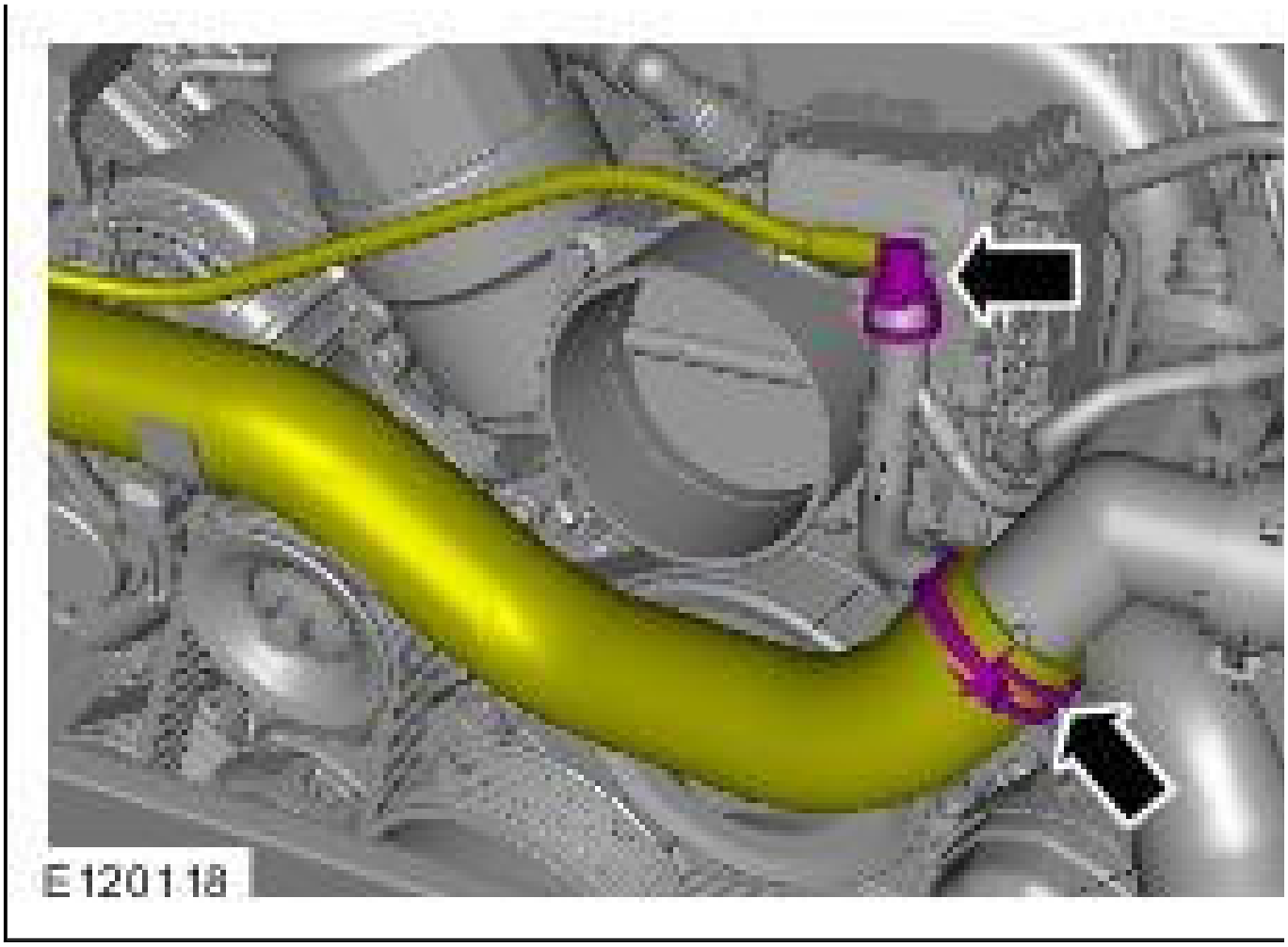


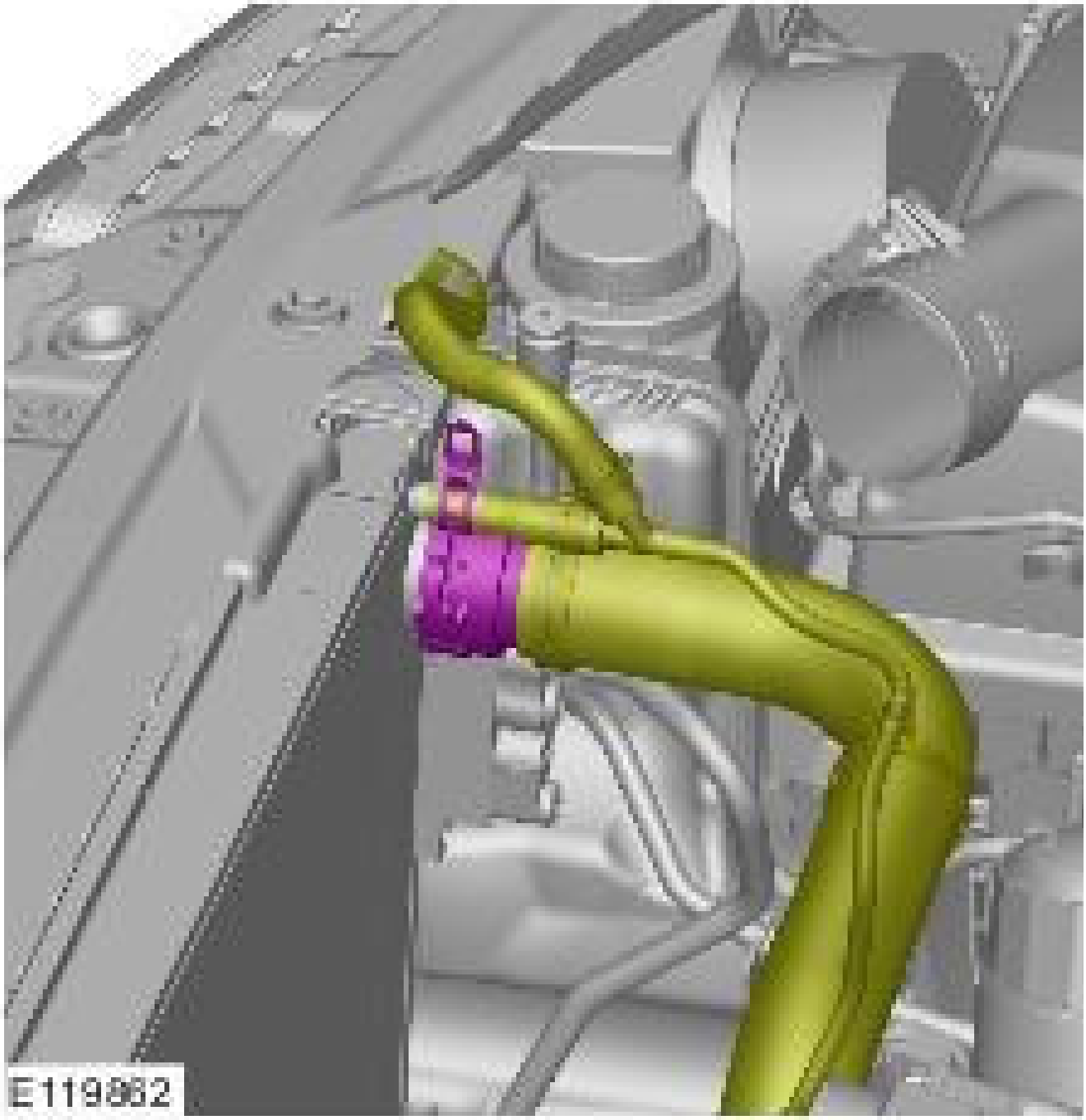
13. See figure

 © 2011 Mitchell Repair Information Company, LLC.



14. See figure

 © 2011 Mitchell Repair Information Company, LLC.



15. See figure

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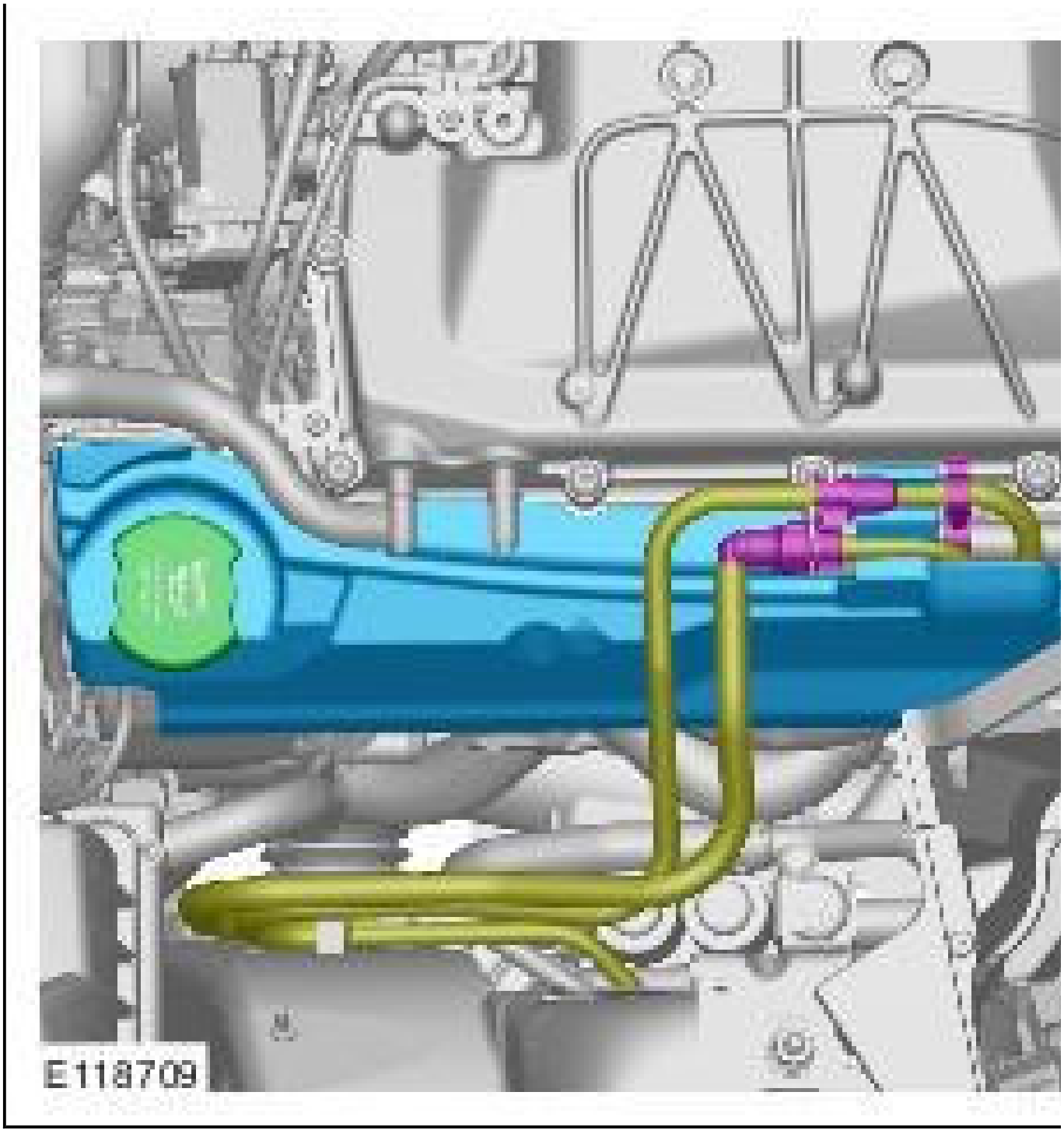

WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

CAUTION: Be prepared to collect escaping coolant.

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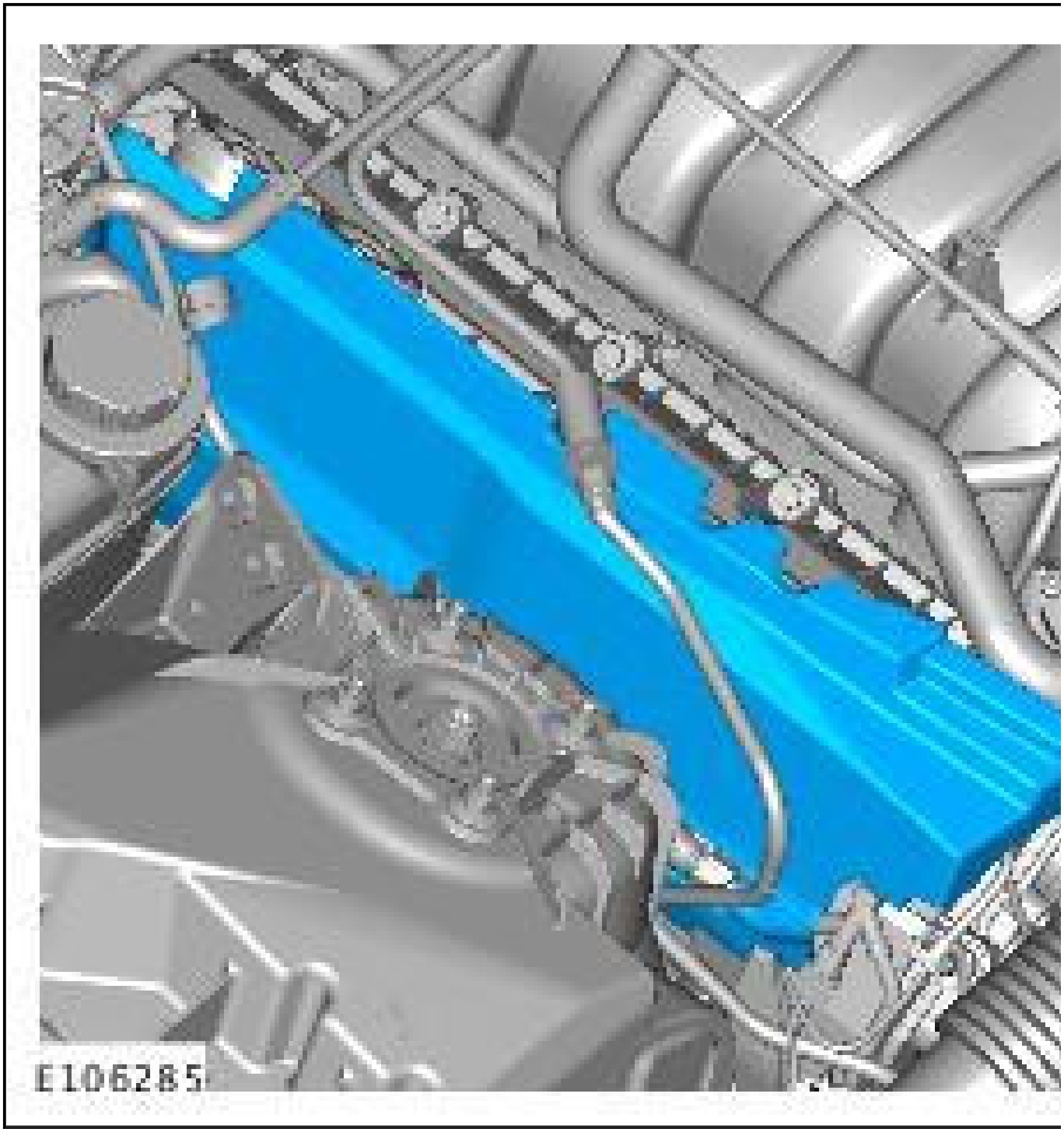
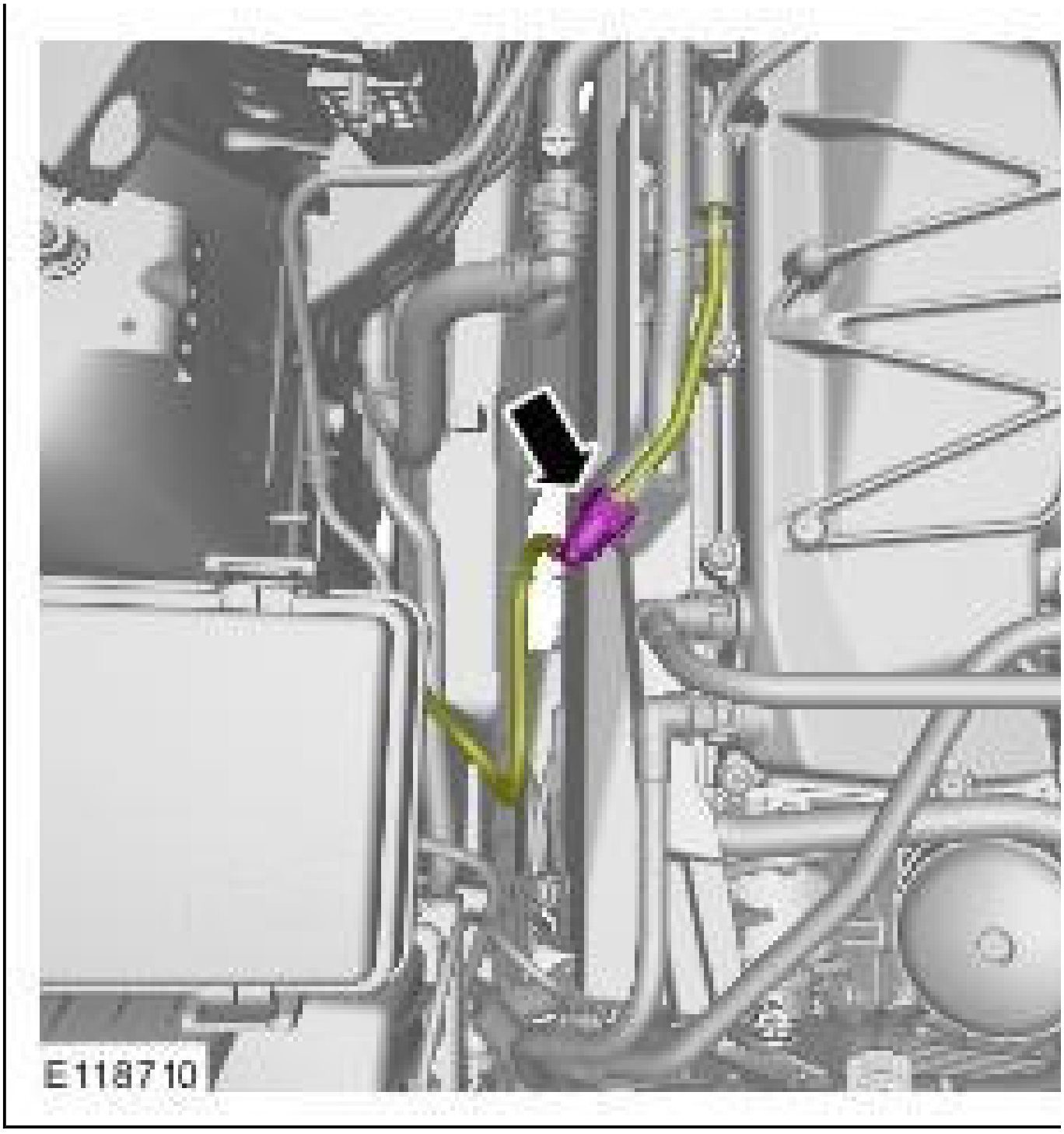
16. See figure



17. See figure

 © 2011 Mitchell Repair Information Company, LLC.



18. Refer to: **FRONT DRIVE HALFSHAFTS** (Front Halfshaft RH - Vehicles Without: High Performance Brakes).
19. Refer to: **FRONT DRIVE HALFSHAFTS** (Front Halfshaft LH - Vehicles Without: High Performance Brakes).
20. Refer to: **ENGINE COOLING (V8 5.0L PETROL/V8 S/C 5.0L PETROL)** (Cooling System Partial Draining, Filling and Bleeding).

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21. Refer to: **COOLING FAN (V8 5.0L PETROL)** .
22. Refer to: **AUTOMATIC TRANSMISSION/TRANSAXLE (V8 5.0L PETROL/V8 S/C 5.0L PETROL, 5.0L)** .
23. Refer to: **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING - GENERAL PROCEDURES (5.0L NA V8 - AJ133/5.0L SC V8 - AJ133)** .
24. Lower the vehicle.

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

25. Connect the battery ground cable. Refer to **Specifications** .
26. Return the hood from the service position.

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