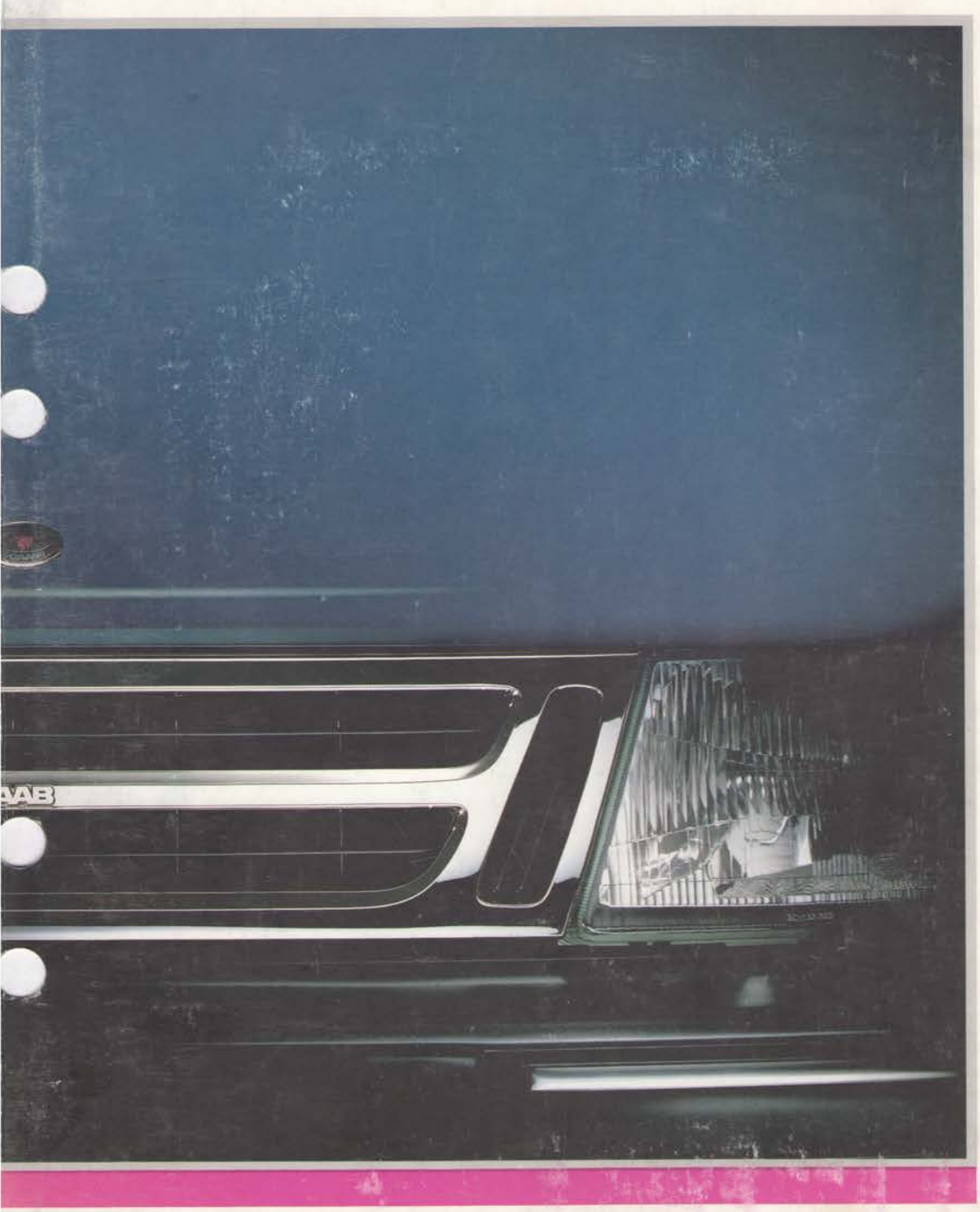
Saab 9000

SERVICE MANUAL



SAAB

2:1 Basic engine B234
News supplement

M 1990-

$18.70 3.6 HP

Saab 9000

SERVICE MANUAL

2:1 Basic engine B234 News supplement

M 1990–

Units

The basic and derived units used throughout the Service Manual are in accordance with the SI system.

For users not familiar with the SI units, some non-Continental units are given in brackets after the respective SI unit.

The following symbols and abbreviations are used:

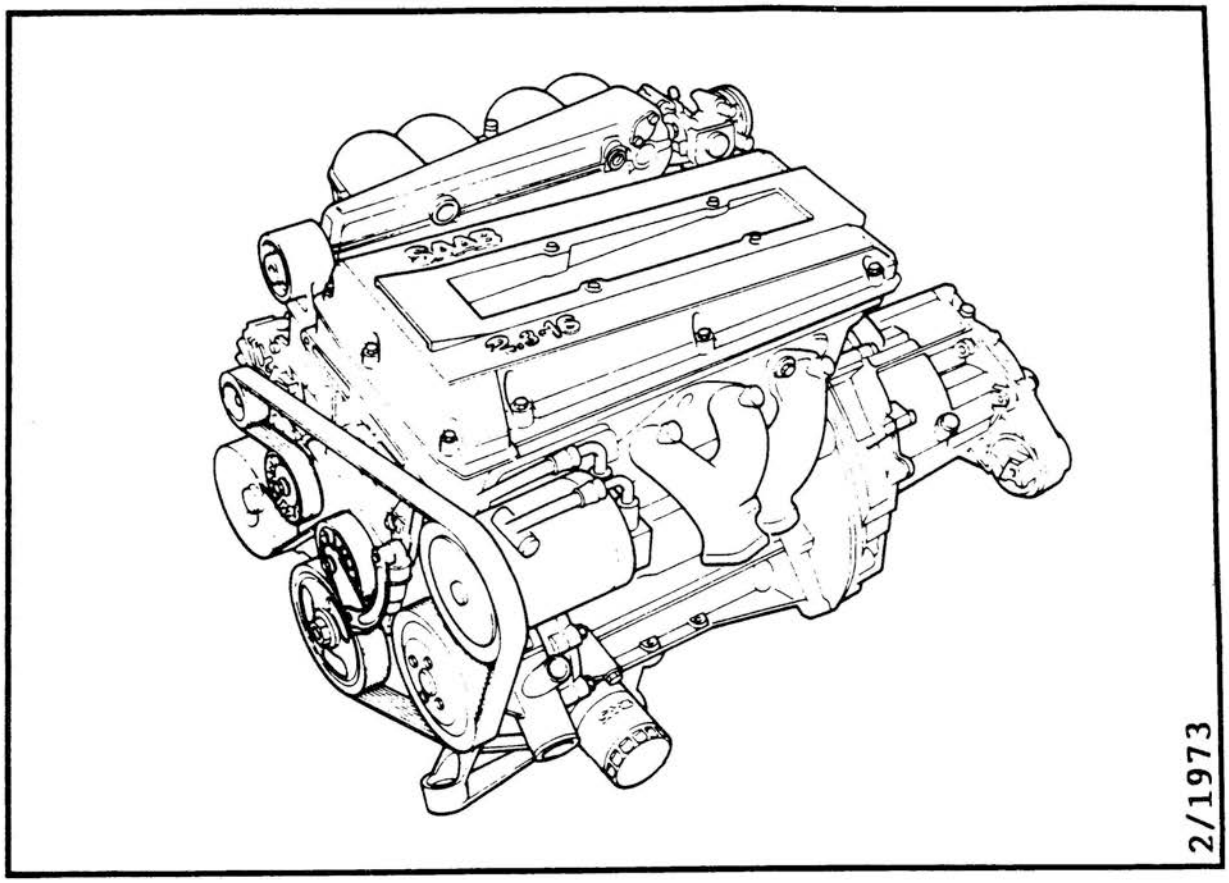
SI unit	Equivalent unit and symbol
mm	inch (in)
kg	pound (lb)
N	pound-force (lbf)
Nm	pound-force foot (lbf ft)
bar	pound-force per square inch (lbf/in^2) (Also abbreviated: psi)
l (liter)	US liquid quart (liq qt) (Also abbreviated: qts) US gallon (USgal)
°C	°F

Conversion factors

1 in = 25.4 mm	1 mm = 0.039 in
1 lbf = 4.45 N	1 N = 0.23 lbf
1 lbf ft = 1.36 Nm	1 Nm = 0.74 lbf ft
1 psi = 0.07 bar	1 bar = 14.5 lbf/in^2
1 liq qt = 0.95 l	1 l = 1.05 liq qt
1 US liq qt = 0.83 UKqt	1 USgal = 0.83 UKgal
°F = °C x 9/5 + 32	°C = (°F − 32) x 5/9

Production: Technical Publications, Saab-Scania, Trollhättan, Sweden jxh

Technical data



General data

Engine type		Transverse 4-cylinder, 4-stroke 16-valve engine with twin overhead camshafts and twin balance shafts.
Cylinder bore	mm (in)	90 (3.54)
Stroke	mm (in)	90 (3.54)
Swept volume	cm^3 (in^3)	2290 (139.7)
Firing border		1-3-4-2
Approximate weight	kg (lb)	160 (350)

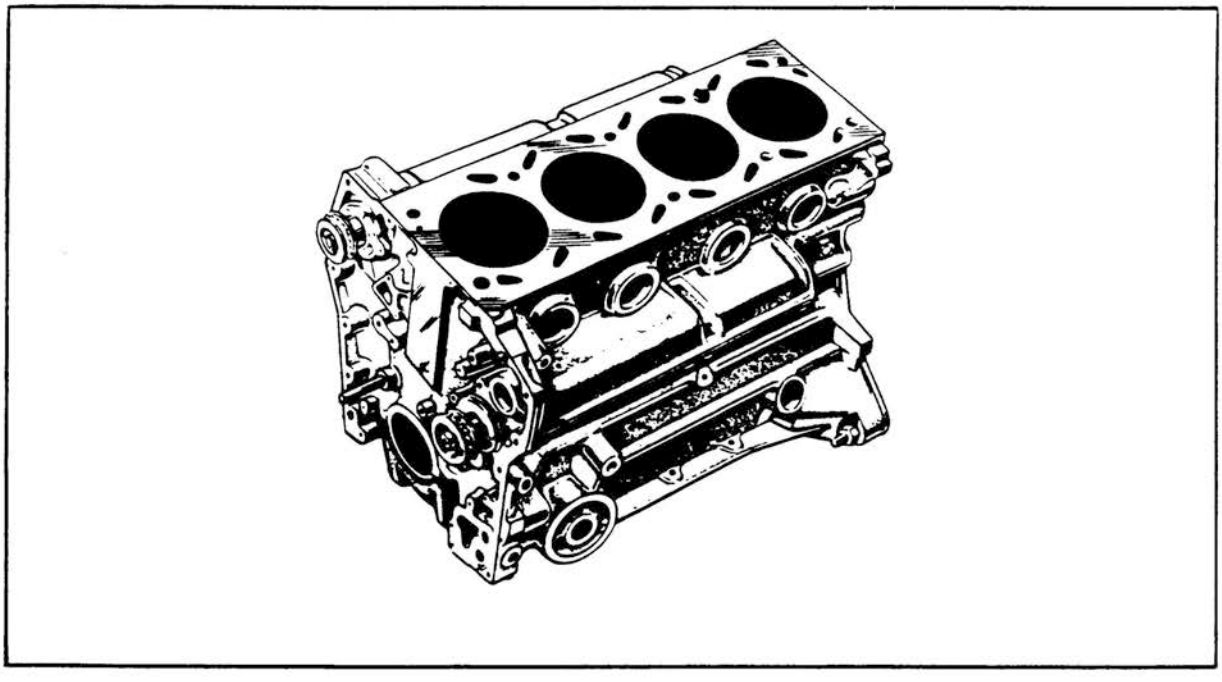
Performance, compression ratio, fuel octane number, etc.

Engine variant	Model year	Octane requirement, RON (AKI)*	Suitable for unleaded fuel	Compression ratio	DIN rating, kW (bhp) at 5,500 rpm	Torque, Nm (lbf ft), at 3,800 rpm
B234i	1990	Min: 91 (87) Recommended: 95 (91)	Yes	10.1	110 (150)	212 (156)

* AKI = (MON + RON)/2 Premium = 91 AKI
Regular = 87 AKI

Block and cylinder head

Cylinder head



Cylinder bores

Standard (A)	mm (in)	90.000 - 90.012 (3.5433 - 3.5438)
Standard (B)	mm (in)	90.003 - 90.020 (3.5434 - 3.5441)
First oversize	mm (in)	90.500 - 90.512 (3.5630 - 3.5635)
Second oversize	mm (in)	91.000 - 91.012 (3.5827 - 3.5831)

Cylinder head

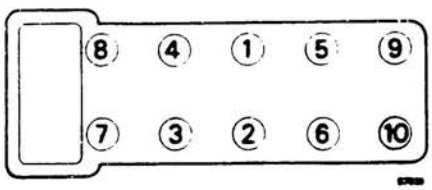
Height of new cylinder head	mm (in)	140.5 ± 0.1 (5.53 ± 0.004)
Minimum after regrinding	mm (in)	140.1 ± 0.1 (5.52 ± 0.004)

Tightening torques

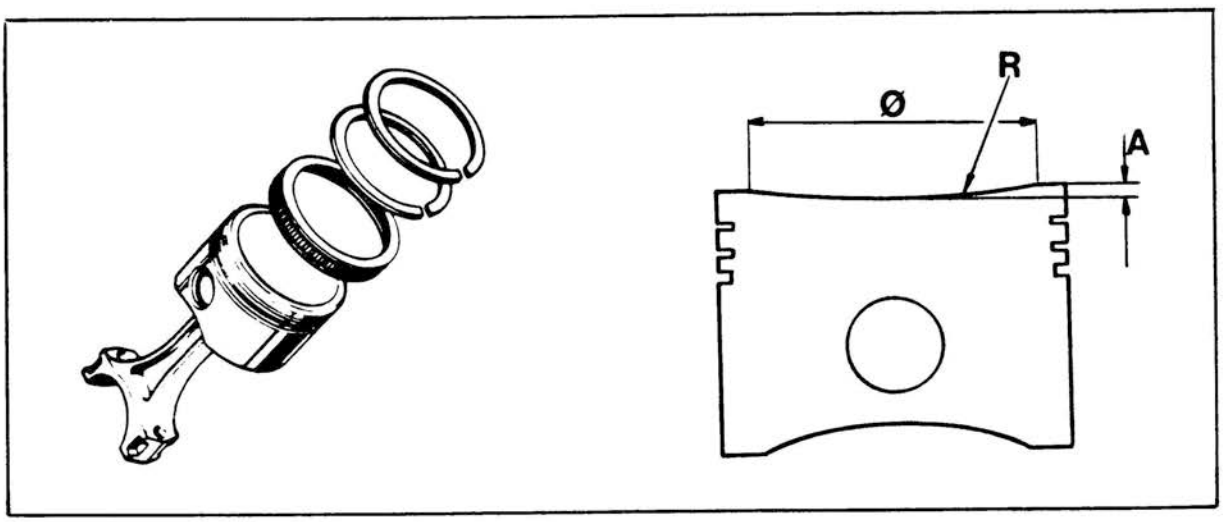
The specified torques apply to lubricated bolts and washers and when a new head gasket is fitted.

Stage I	Nm (lbf ft)	60 (44)
Stage II	Nm (lbf ft)	80 (59)
Stage III		Tighten a further quarter-turn (90°)

Tightening sequence



Pistons



Piston speed at 5,000 rpm	m/s	15

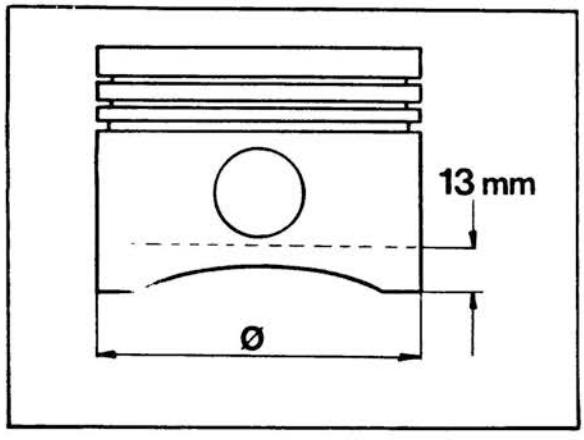
Different makes of piston must not be fitted in the same engine

Piston dimensions

Engine	Model year		Radius (R)	Ø	A
B234i	1990	mm (in)	257 (10.12)	75 (2.95)	3.05 (0.120)

Piston diameter

This is measured at right angles to the piston boss, 13 mm (0.52 in) from the bottom of the skirt.



Classification of pistons and cylinder bores

The piston classification code is stamped on the piston crown. The codes for servicing are:

AB

B

C

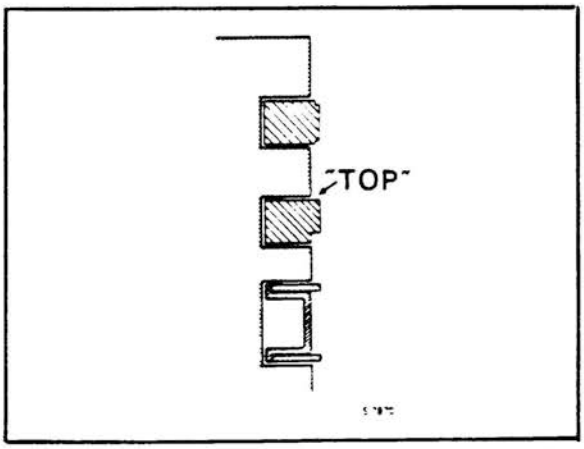
The cylinder classification code is stamped on the block adjacent to each cylinder.

Cylinders are either class A or class B, both of which may occur in the same block.

Piston sizes

Standard A (not spare part)	mm (in)	89.971 - 89.980 (3.5422 - 3.5425)
Standard AB	mm (in)	89.980 - 89.989 (3.5425 - 3.5429)
Standard B	mm (in)	89.989 - 89.997 (3.5429 - 3.5432)
Standard C	mm (in)	89.997 - 90.013 (3.5432 - 3.5438)
First oversize (0.5 mm)	mm (in)	90.472 - 90.488 (3.5619 - 3.5625)
Second oversize (1.0 mm)	mm (in)	90.972 - 90.988 (3.5816 - 3.5822)
Piston clearance (nominal)	mm (in)	0.007 - 0.037 (0.0003 - 0.0015)

Classification, Piston/cylinder		**Clearance**
A/A	mm x 10^{-3}	20 - 41
AB/A	mm x 10^{-3}	11 - 32
AB/B	mm x 10^{-3}	14 - 40
B/B	mm x 10^{-3}	6 - 31



Piston rings

		Top compression ring	Second compression ring	Oil-scraper ring
Width (thickness)	mm (in)	1.728 - 1.740 (0.0680 - 0.0685)	1.98 - 1.996 0.078 - 0.0779)	2.934 - 3.052* (0.1155 - 0.1202)
Side clearance in groove	mm (in)	0.040 - 0.072 (0.0016 - 0.0028)	0.040 - 0.072 (0.0016 - 0.0028)	
Working gap in new cylinder	mm (in)	0.3 - 0.5 (0.0118 - 0.0197)	0.30 - 0.45 0.0118 - 0.0177)	0.38 - 1.40** 0.0149 - 0.0551)

* Segment width (thickness): 0.51 mm (0.020)

** Applies to segment

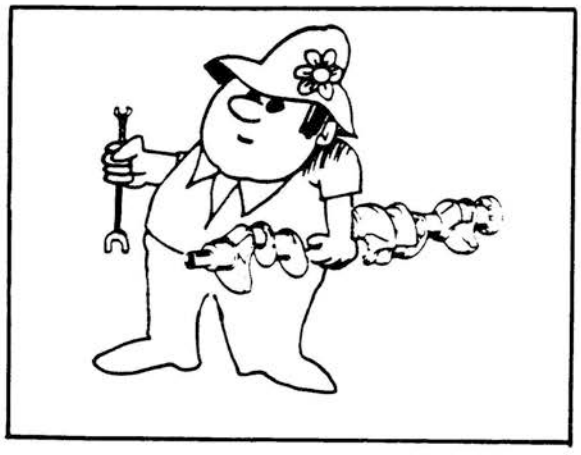
Gudgeon pins

Diameter	mm (in)	23.996 - 24.000 (0.9447 - 0.9449)
Fit	mm (in)	0.001 - 0.010 (0.0001 - 0.0004) (sliding fit under gentle thumb pressure)

Connecting rods

Diameter of big-end	mm (in)	56.000 - 56.019 (2.2047 - 2.2055)
Diameter of small-end bush (bush fitted)	mm (in)	24.005 - 24.010 (0.9451 - 0.9453)
Maximum permissible weight variation per set	g (oz)	6 (0.21)
Length	mm (in)	147 (5.79)

Crankshaft



Alignment - max variation in straightness	mm (in)	0.10 (0.004)
End float	mm (in)	0.06 - 0.31 (0.002 - 0.012)
Maximum journal out-of-round	mm (in)	0.05 - (0.002)
Maximum taper of journals	mm (in)	0.05 - (0.002)
Radius main journalfillet	mm (in)	1.65 - 1.85 (0.065 - 0.073)
Main bearing clearance	mm (in)	0.020 - 0.062 (0.0008 - 0.0024)
Length	mm (in)	543 (21.4)

Colour markings of main-bearing and big-end bearing shells

	Thin	Thick
Standard	Red	Blue
First undersize	Yellow	Green
Second undersize	White	Brown

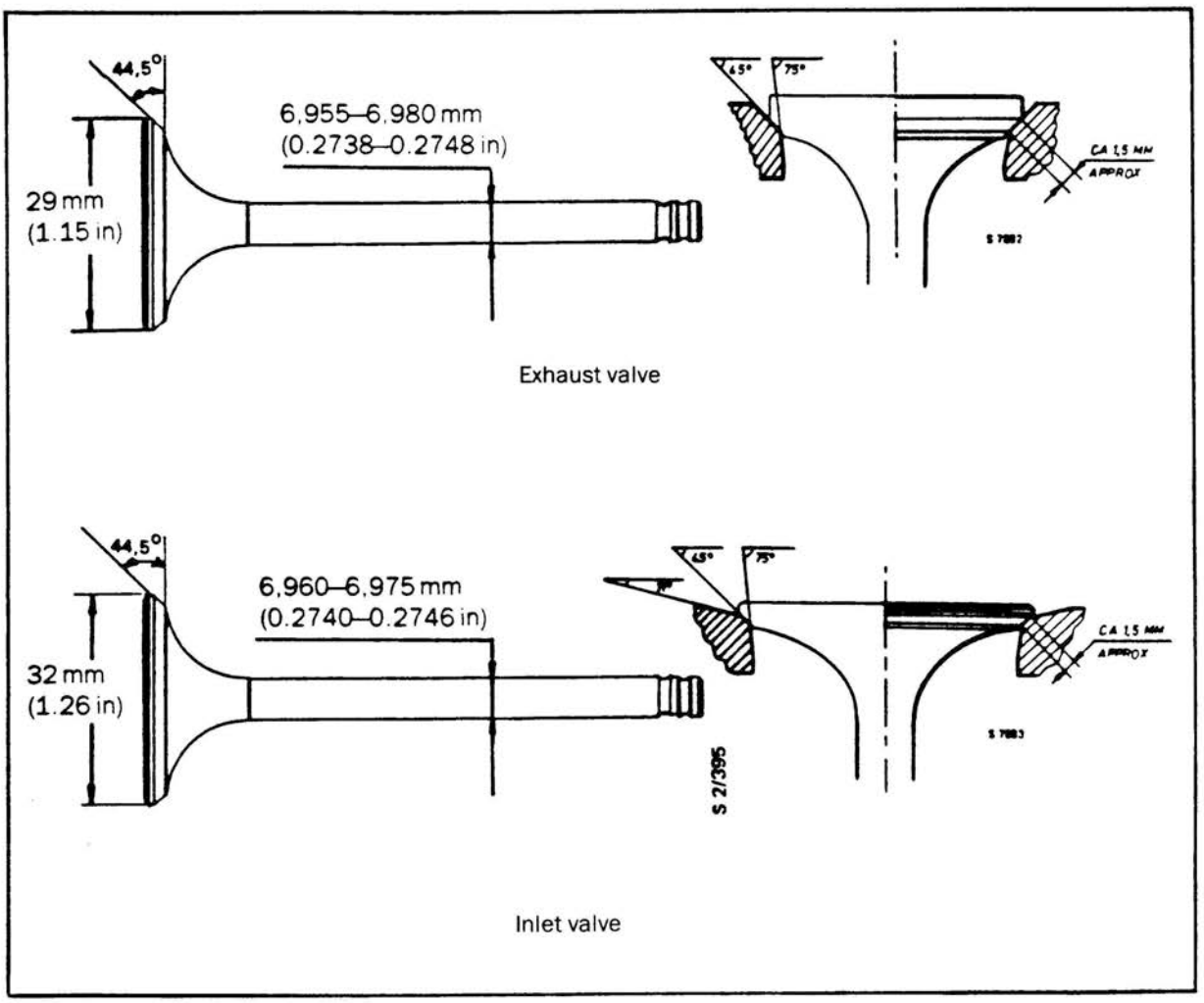
Crankpin diameter

Standard	mm (in)	51.981 - 52.000 (2.0465 - 2.0472)
First undersize	mm (in)	51.731 - 51.750 (2.0366 - 2.0374)
Second undersize	mm (in)	51.481 - 51.500 (2.0268 - 2.0276)
Third undersize	mm (in)	51.237 - 51.250 (2.0172 - 2.0177)
Fourth undersize	mm (in)	50.987 - 51.000 (2.0074 - 2.0079)
Big-end bearing clearance	mm (in)	0.026 - 0.062 (0.0010 - 0.0024)

Main journal diameter

Standard	mm (in)	57.981 - 58.000 (2.2827 - 2.2835)
First undersize	mm (in)	57.731 - 57.750 (2.2729 - 2.2736)
Second undersize	mm (in)	57.481 - 57.500 (2.2630 - 2.2638)
Third undersize	mm (in)	57.237 - 57.250 (2.2534 - 2.2539)
Fourth undersize	mm (in)	56.987 - 57.000 (2.2436 - 2.2441)

Valve gear

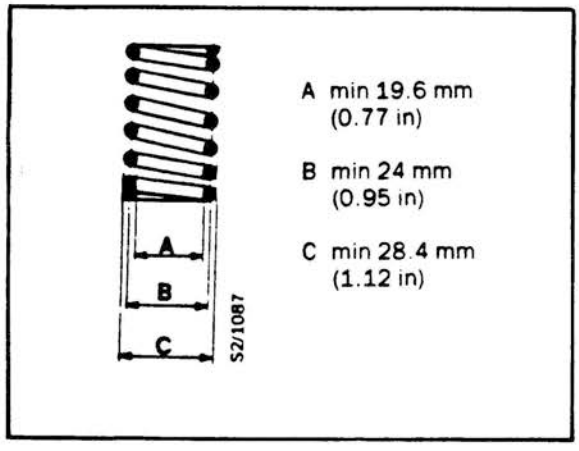


Caution
The exhaust valves are stellited and should therefore not be machined. Grinding using valve-grinding (lapping) paste is the only recommended method.

Valve guides

Length	mm (in)	45.0 (1.77)
Outside diameter	mm (in)	12.039 - 12.050 (0.4740 - 0.4744)
Bore for valve guides in cylinder head	mm (in)	12.000 - 12.018 (0.4724 - 0.4731)
Maximum clearance between valve stem and valve guide	mm (in)	0.5 (0.02) Measured on valve head raised 3 mm (0.12 in) above seat

Valve springs

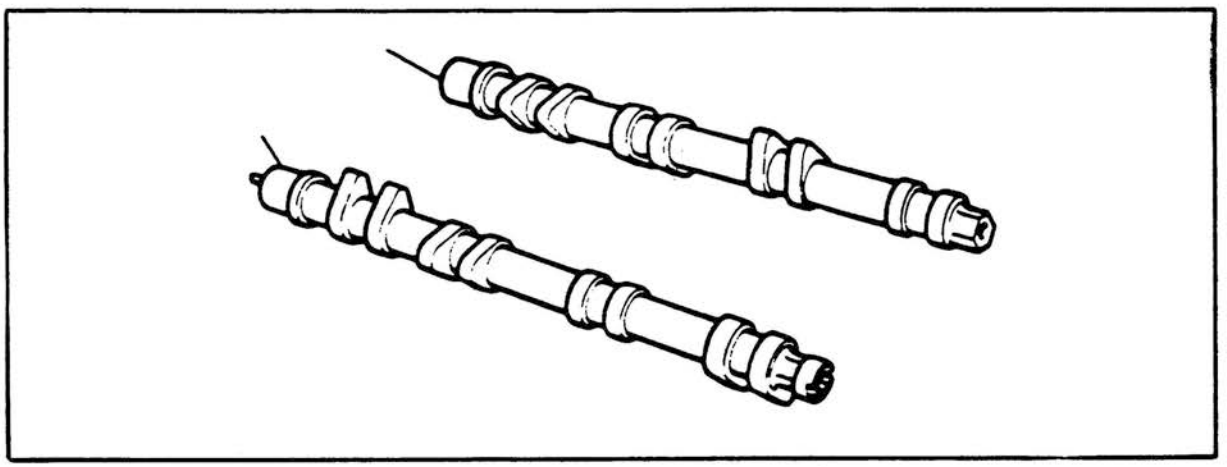


Length when fitted	mm (in)	37.0 (1.46)
Free length	mm (in)	45 ± 1.5 (1.77 ± 0.05)
Length when subjected to compressive force of 595 - 645 N (131 - 141 lbf)	mm (in)	28.4 (1.12)

Cam followers

Diameter	mm (in)	32.959 - 32.975 (1.2976 - 1.2982)
Height	mm (in)	26.0 (1.024)
Bore for cam followers in cylinder head (camshaft bearing assembly)	mm (in)	33.000 - 33.016 (1.2992 - 1.2998)

Camshafts



Number of bearings		5
Bearing diameter	mm (in)	28.922 - 28.935 (1.1387 - 1.1392)
End float	mm (in)	0.08 - 0.35 (0.003 - 0.014)

Cam lift at zero valve clearance

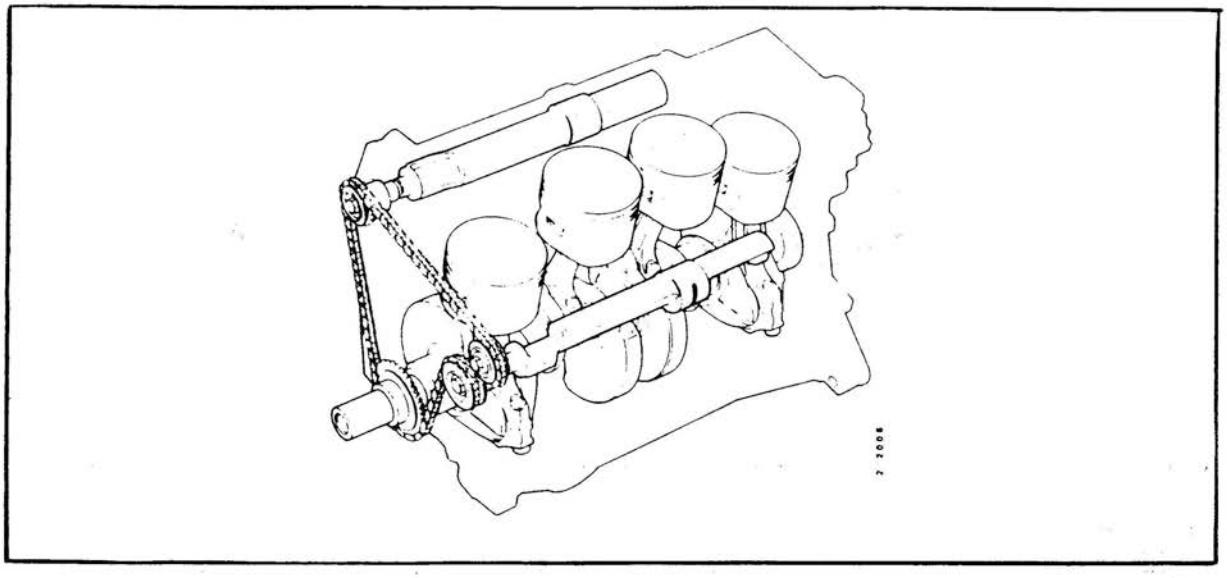
Engine variant	Model year		Inlet valves	Exhaust valves
B234i	1990	mm (in)	8.65 (0.3406)	8.65 (0.3406)

Valve timing

(at design clearance: 0.35 mm/0.014 in, inlet; 0.55 mm/0.022 in, exhaust)

		Inlet valves		Exhaust valves	
		Open BTDC	Close ABDC	Open BBDC	Close ATDC
B234i	1990	13°	53°	50°	16°

Balance shafts



Length	mm (in)	295.7 ± 0.5 (11.642 ± 0.020)
Diameter of balance-shaft journal (larger, outer)	mm (in)	39.9 ± 0.08 (1.571 ± 0.003)
Diameter of balance-shaft bearing (larger, outer)	mm (in)	39.988 - 40.043 (1.574 - 1.577)
Bearing clearance (larger, outer)	mm (in)	0.08 - 0.151 (0.003 - 0.006)
Maximum permissible bearing clearance when bedded in	mm (in)	0.18 (0.007)
Diameter of balance-shaft journal (smaller, inner)	mm (in)	19.947 - 19.960 (0.785 - 0.786)
Diameter of balance-shaft bearing (smaller, inner)	mm (in)	20.000 - 20.021 (0.787 - 0.788)
Bearing clearance (smaller, inner)	mm (in)	0.040 - 0.074 (0.0016 - 0.0029)

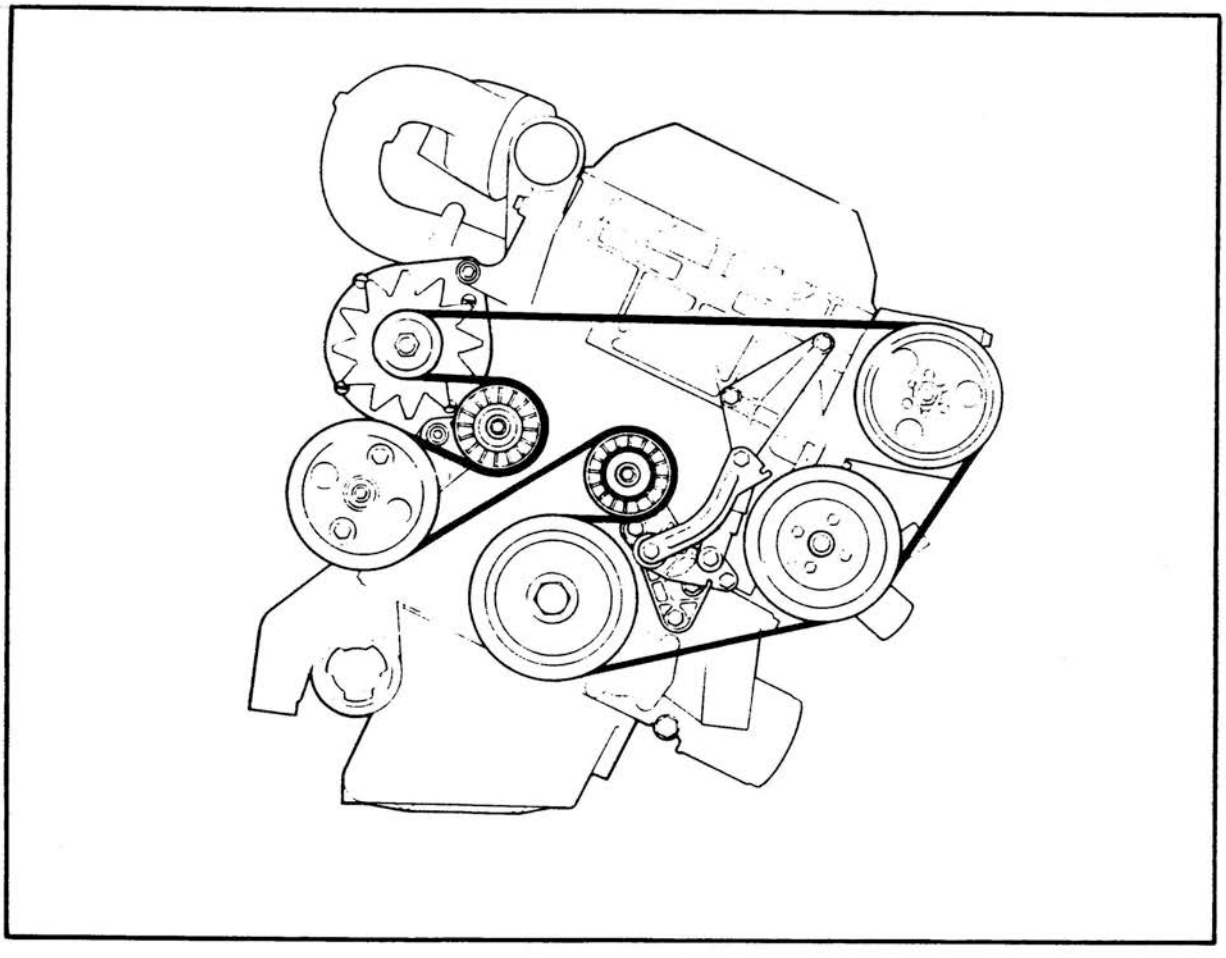
Tightening torques

	Torque, Nm	Torque, lbf ft	Bolt dimension
Main bearings	20 (+ tightening through a further quarter-turn/90°)	15 (+ tightening through a further quarter-turn/90°)	M12
Big-end bearings	20 (+ tightening through a further quarter-turn/90°)	15 (+ tightening through a further quarter-turn/90°)	M10
Camshaft bearing caps	15	11	M8
Camshaft cover	15	11	M8
Crankshaft pulley	190	140	M16
Flywheel	60	44	M10
Oil pump	8	6	M6
Timing chain tensioner	63	47	M22
Camshaft sprocket	65	48	M10
Inlet manifold	22	16	M8
Thermostat housing	22	16	M8
Throttle housing	22	16	M8
Exhaust manifold	18	13	M8
Timing cover	20	15	M8
Knock detector	20	15	
Balance-shaft chain tensioner	12	9	M6
Balance-shaft bearing holder	12	9	M6
Balance-shaft chain guides	12	9	M6
Balance-shaft sprokets	63	47	M10
Balance-shaft idler-wheel sprocket	22	17	M8

Tightening torques for other bolts

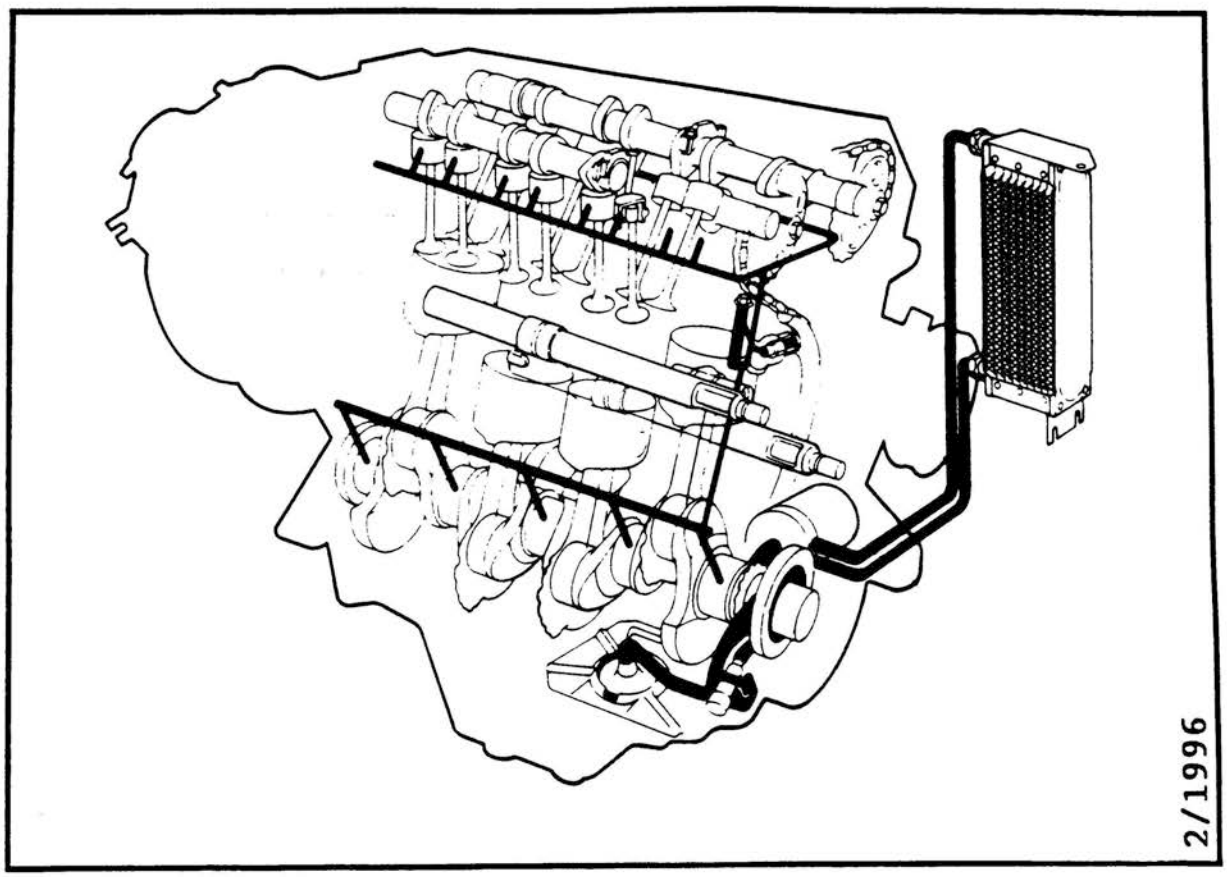
Bolt dimension	Torque, Nm	Torque, lbf ft
M5	5	3.7
M6	10	7.4
M8	20	15
M10	40	30

Drive-belt tension



Minimum value on checking	N (lbf)	170 (38)

Lubricating system



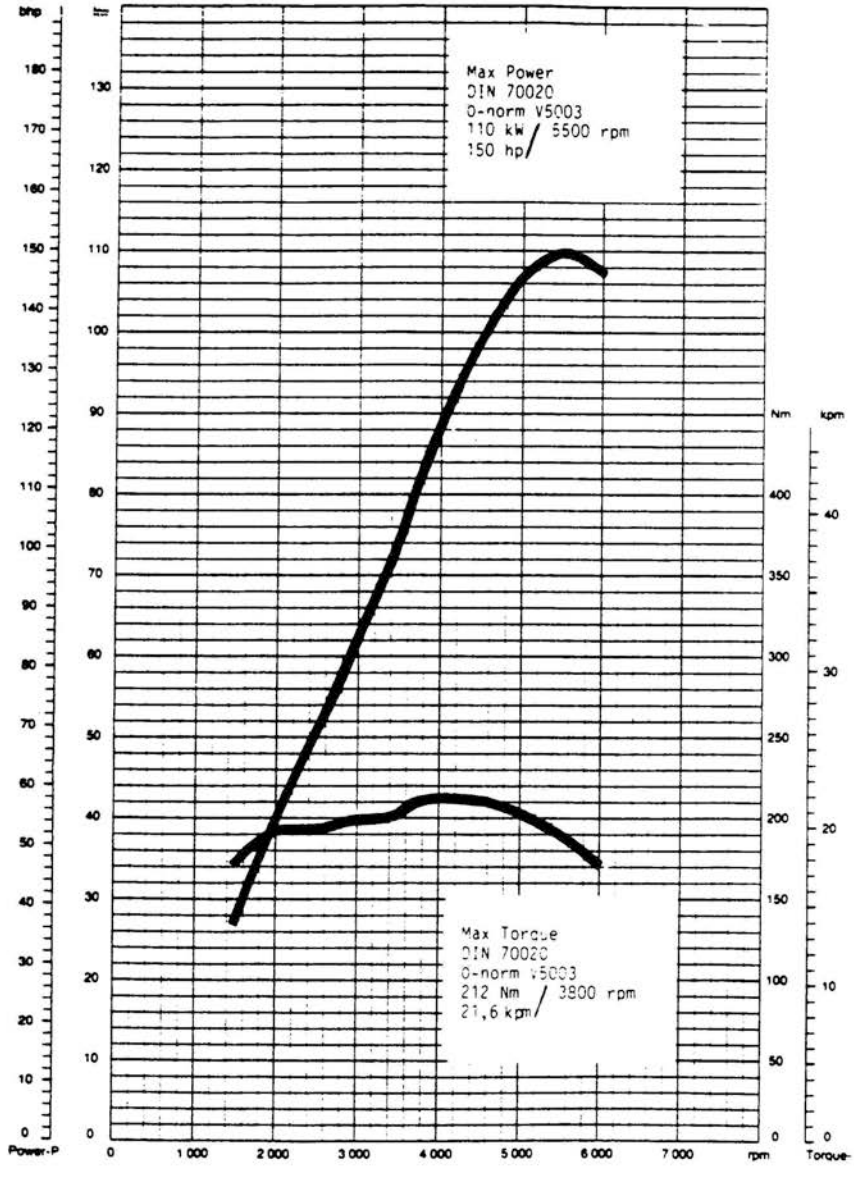
Oil capacity including that in oil filter	litres (liq qt)	4.3 (4.5)
Volume between MAX and MIN marks on dipstick	litres (liq qt)	1.0 (1.05)
Grade of oil		To API Service SF/CC, SF/CD or SG
Viscosity		SAE 10W-30 or 10W-40. Where these are unavailable, 15W-40 may be used. In climates with temperatures regularly below -20°C (-4°F) use 5W-30
Drain plug tightening torque	Nm (lbf ft)	25 (19)

Note
The recommended grades of oil contain all necessary additives and the use of additional additives should therefore be avoided.

Oil pressures

Oil pump reducing valve opens at:	bar (psi)	3.5 (50)
Warning light comes on at:	bar (psi)	0.3 - 0.5 (4.4 - 7.2)
Oil pressure at 2,000 rpm, engine temp. of 80°C (170°F) and 10W-30 oil	bar (psi)	2.7 (38.9) minimum
End float between pump rotor and housing	mm (in)	0.03 - 0.08 (0.0012 - 0.0031)
Engine oil cooler thermostat opens at:	°C (°F)	80 (176)

Engine performance graph



B234I

Engine no.

Example: B 23 4 I 4 M 00 L 000001

Pos. 1 **Engine type**
B = Petrol engine

Pos. 2 & 3 **Swept volume**
23 = 2,290 dm^3

Pos. 4 **Cylinder head**
4 = Cylinder head with twin camshafts and twin balance shafts

Pos. 5 **Version**
I = Fuel injection

Pos. 6 **Exhaust emission control specification**
4 = Saab 9000 to Swedish Regulation A12 and US federal register FTP-75

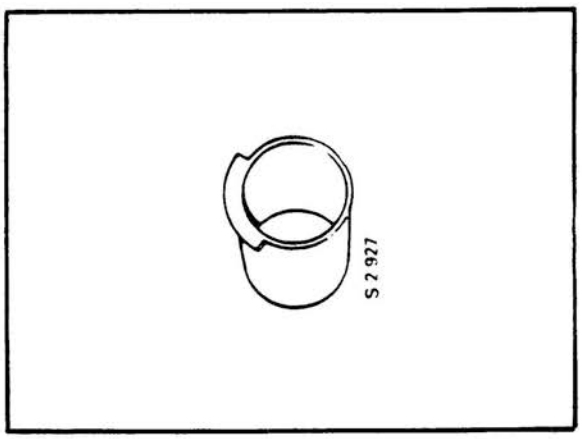
Pos. 7 **Transmission**
A = Automatic transmission
M = Manual gearbox

Pos. 8 & 9 **Variant**
Variant codes:
00 = Basic model (i.e. no variant)
01 = Engine adapted to meet future ELCD requirements
02 = Specially equipped for improved cold starting
05 = Special inlet valves
06 = Special inlet valves meeting future ELCD requirements

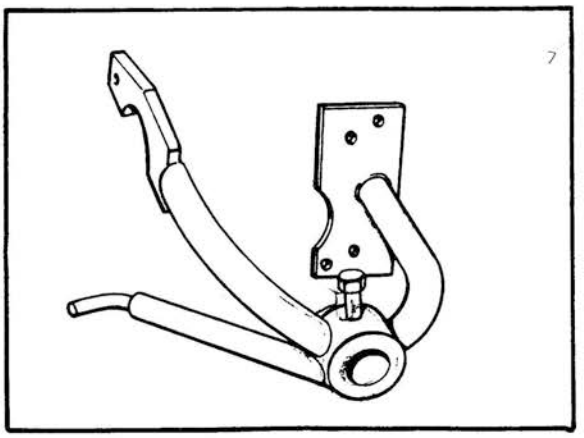
Pos. 10 **Model-year code as per FMVSS 115**
L = 1990

Pos. 11 - 16 **Serial number**

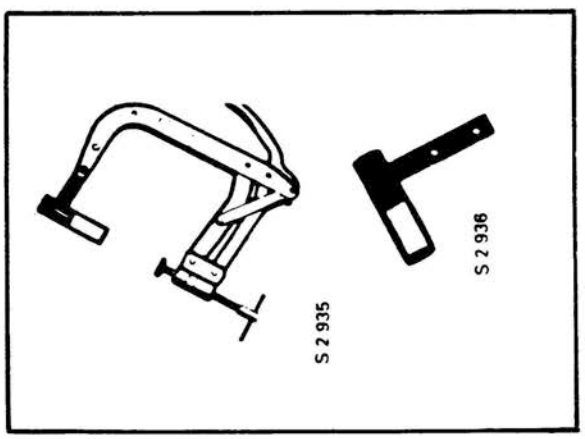
Special tools



83 93 746 Protective collar for tappet guides (set of 16)

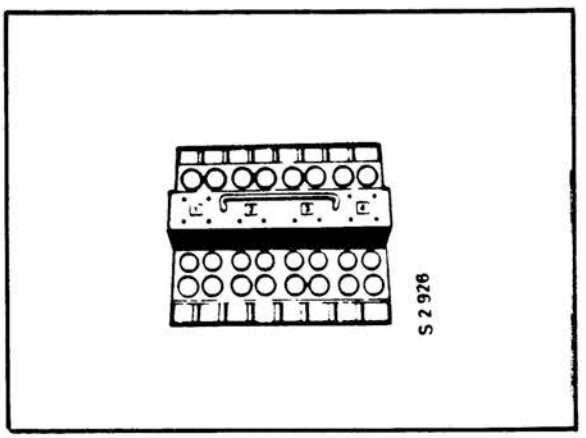


83 94 454 Engine bracket for use with floor stand

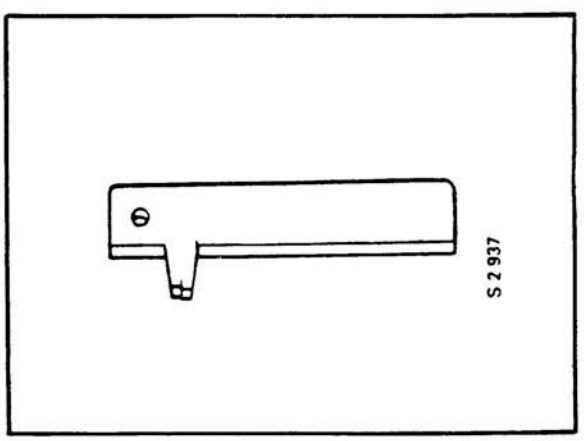


83 93 761 KD-Tools 308 valve spring compressor for use with special anvil 83 93 779

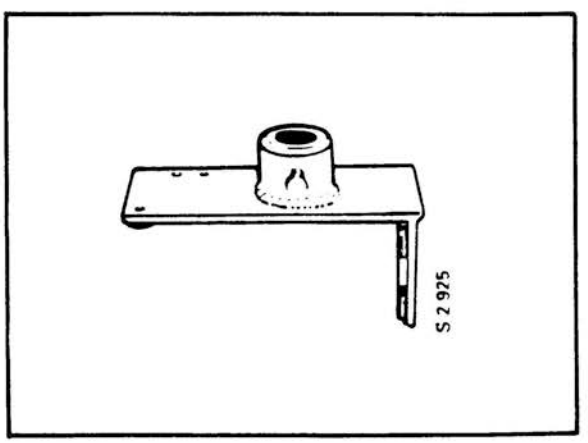
83 93 779 Special anvil for use with valve spring compressor 83 93 761



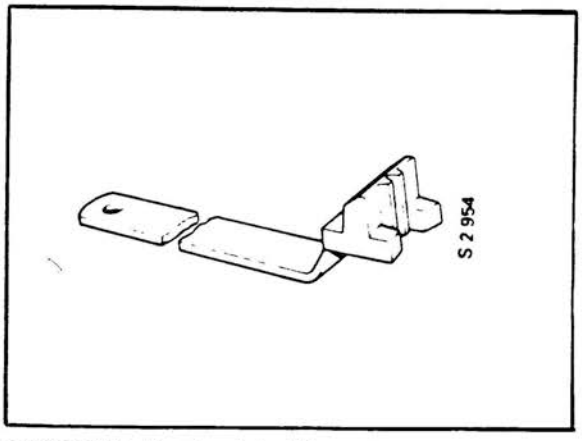
83 93 787 Valve stand



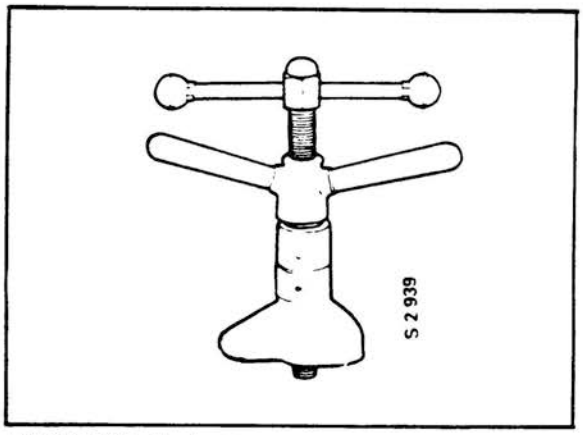
83 93 753 Valve-clearance measuring tool



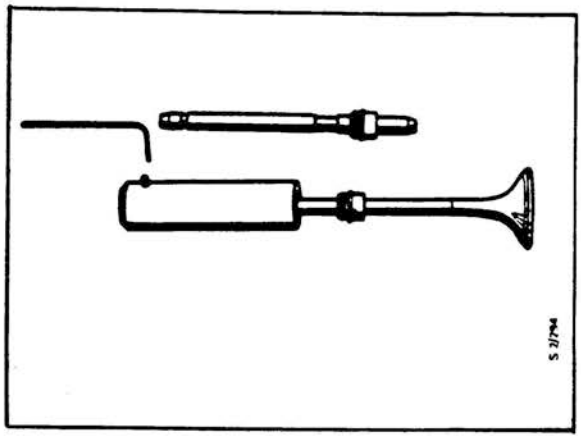
83 93 795 Cylinder head bracket for use with floor stand 78 61 479



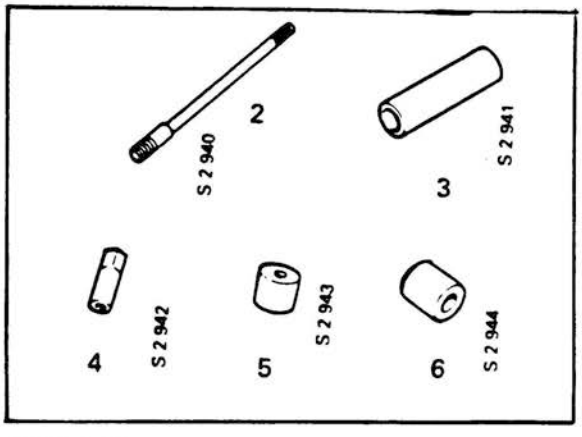
83 93 993 Flywheel locking attachment



83 90 494 Tool for fitting/removal of valve guide



83 93 803 Tool for fitting valve guide seal



83 93 811 (2) Pull rod for removal/fitting of the valve guide

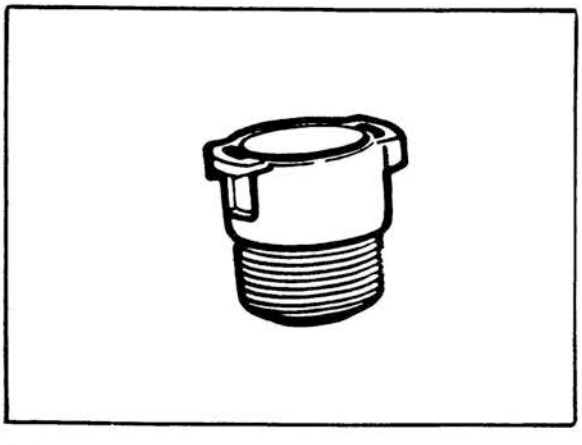
83 93 829 (3) Sleeve for removal of valve guide

83 93 837 (4) Depth gauge for fitting of valve guide

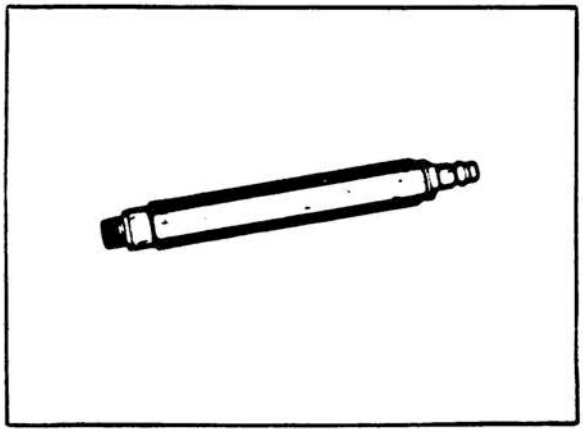
83 93 845 (5) Nut for removal/fitting of valve guide

83 90 379 (6) Mandrel

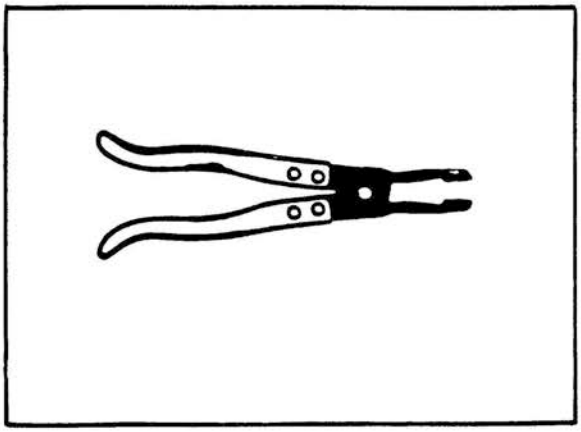
The above tools (2-6) are for use with valve guide tool 83 90 494



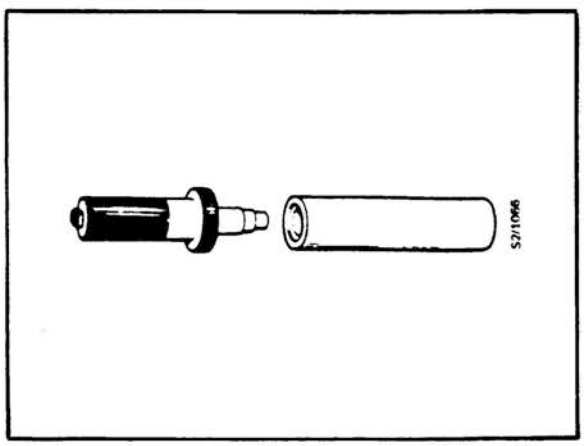
83 94 140 Adaptor for checking expansion tank pressure cap



83 94 173 Compressed-air adaptor for spark plug hole

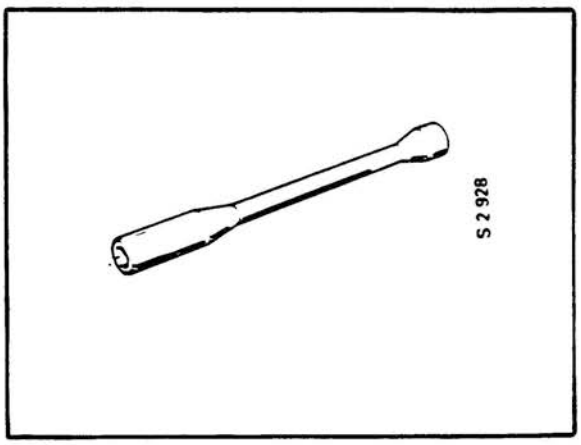


83 94 157 Tool for removal of valve guide seals

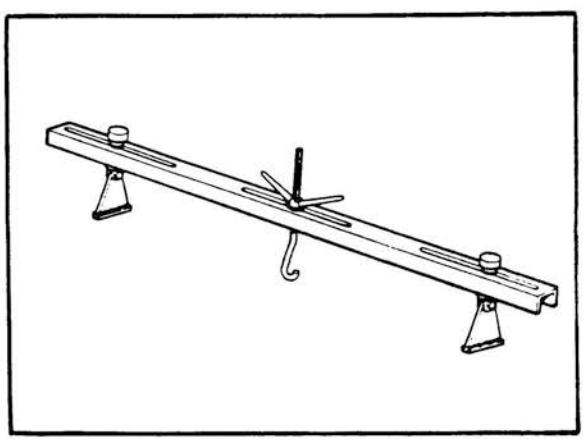


83 94 207 Tool for fitting valve collets

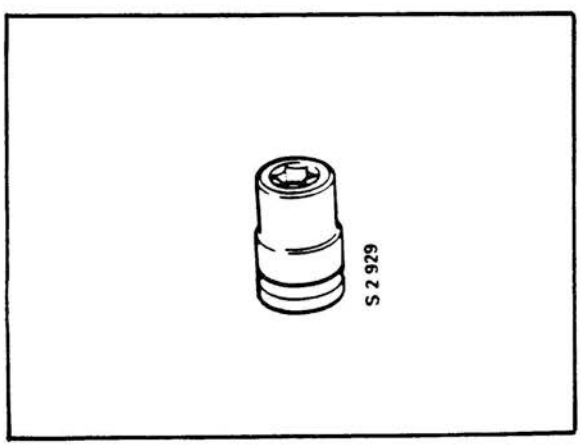
83 94 181 Sleeve for use with 83 94 207



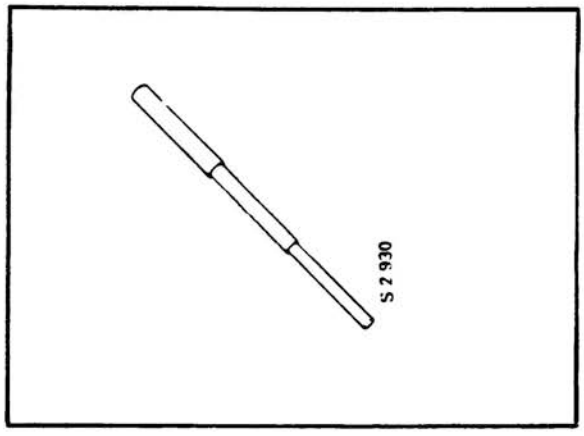
83 93 902 16-mm spark plug socket with 3/8-inch drive



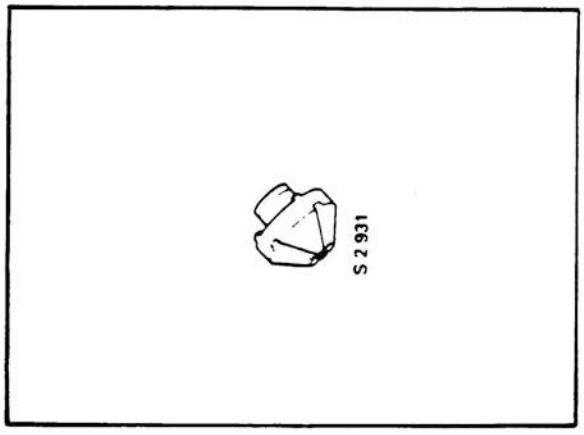
83 93 977 Engine lifting beam



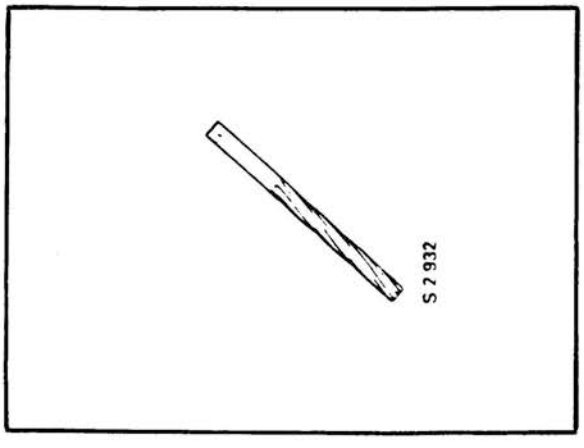
83 93 910 Torx E16 socket with 1/2-inch drive for cylinder head bolts



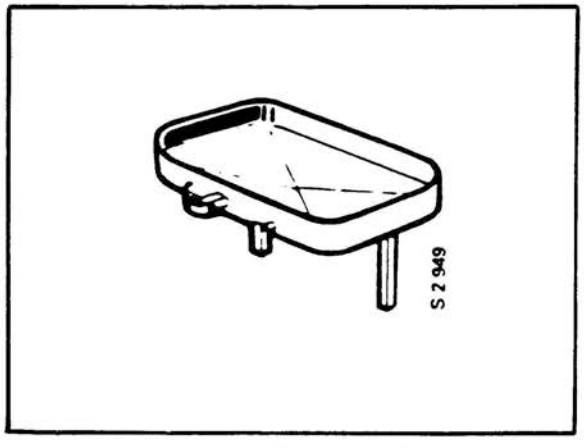
83 93 928 Neway type 008 150-7 (AGB) pilot for 45° and 60° cutters. Suitable for valve guides with inside diameter of 7 mm (H7 fit)



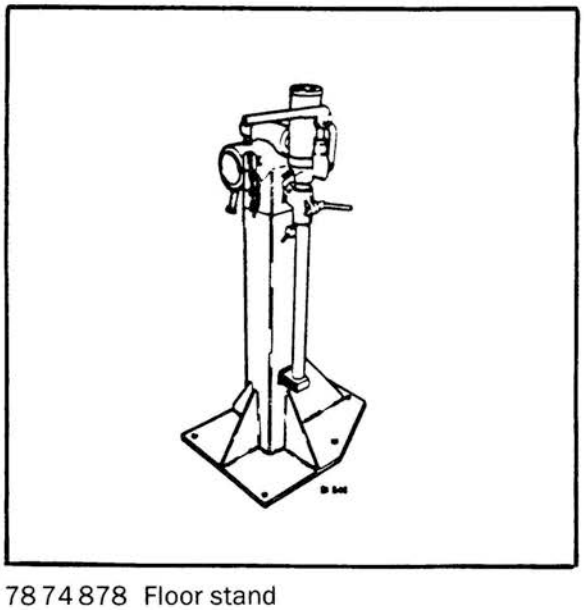
83 93 936 Neway type 8-270 60° (AGB) valve seat cutting tool for use with 45° and 60° cutters



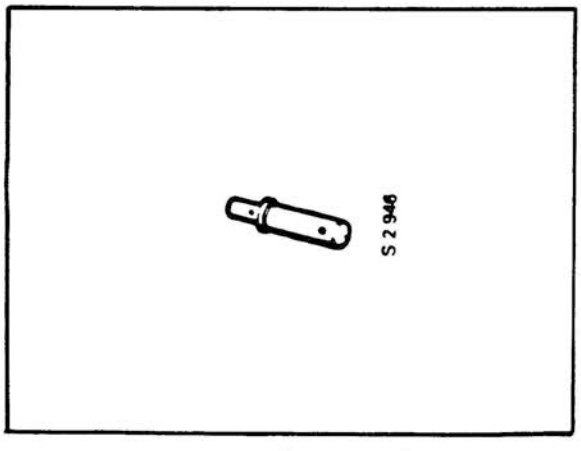
83 93 944 Valve guide reamer, 7-mm dia., for stiff H7 fit (6.97-mm dia. valve stem)



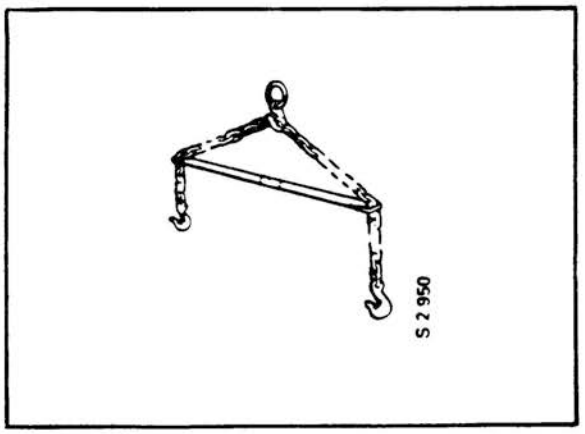
78 60 802 Oil pan for floor stand



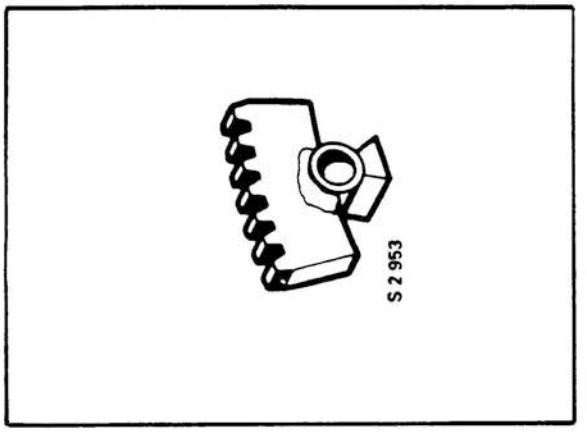
78 74 878 Floor stand



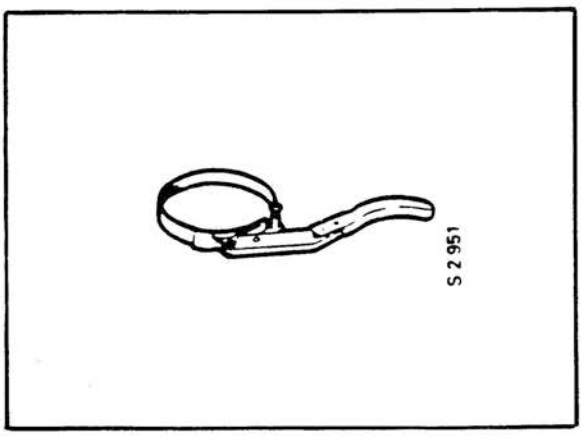
83 90 478 Spindle for floor stand



83 92 409 Lifting sling for power train

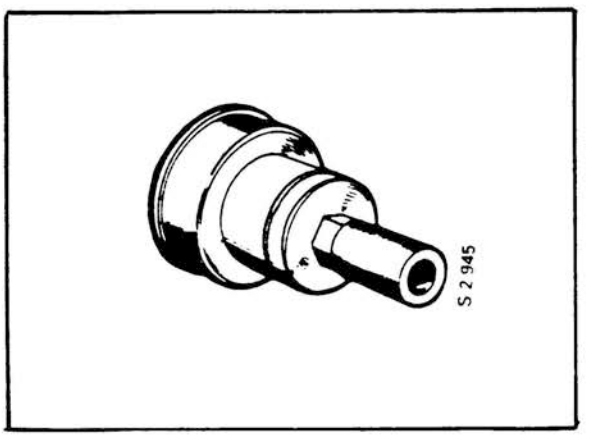


83 93 987 Flywheel locking segment

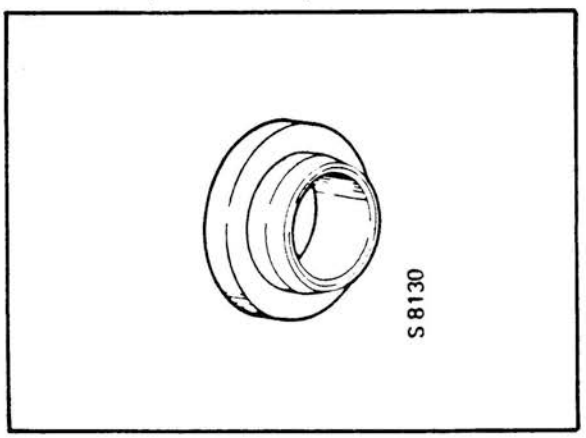


78 62 014 Strap wrench for oil filter (standard)

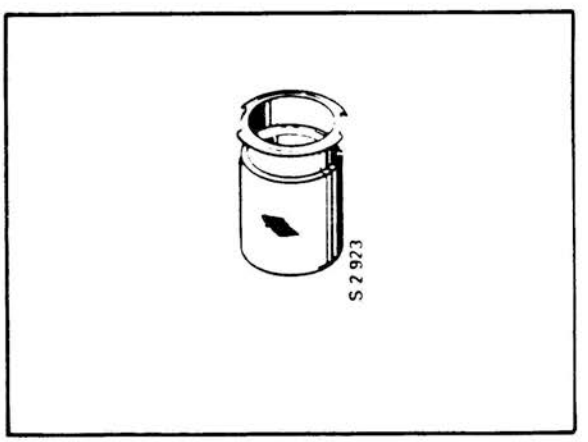
83 93 332 Strap wrench for factory-fitted (nonstandard) oil filter



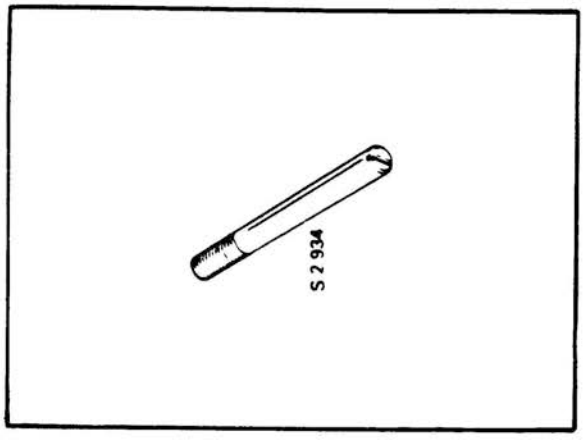
83 92 540 Tool for fitting crankshaft seal at flywheel end



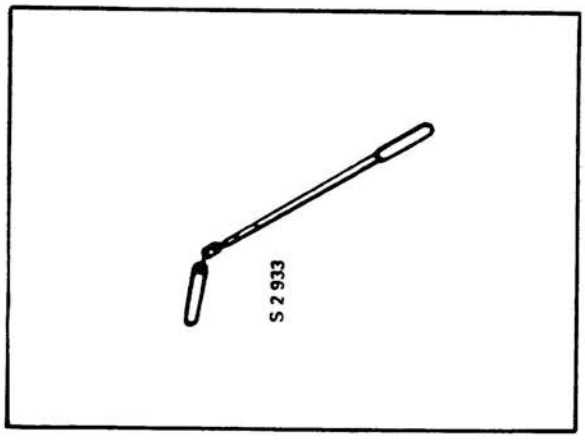
83 94 215 Tool for fitting crankshaft seal at timing-chain end



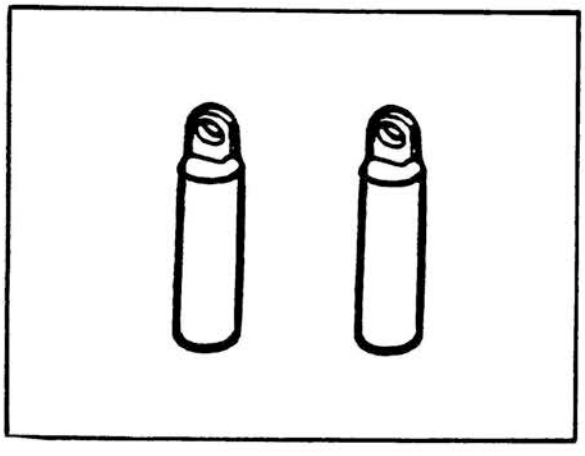
83 93 217 Adaptor for cooling-system tester



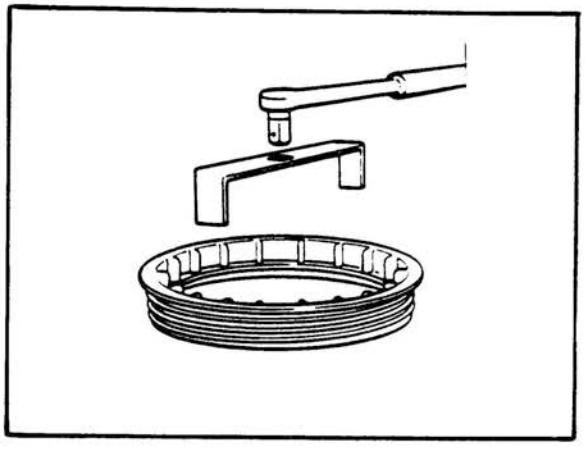
83 92 192 Locating stud for fitting of cylinder head



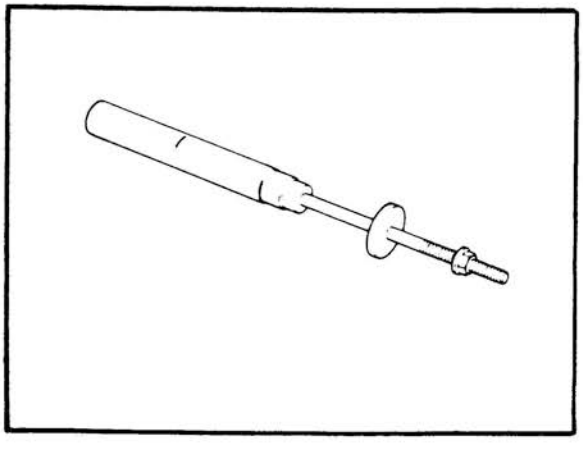
83 91 401 Magnetic tool



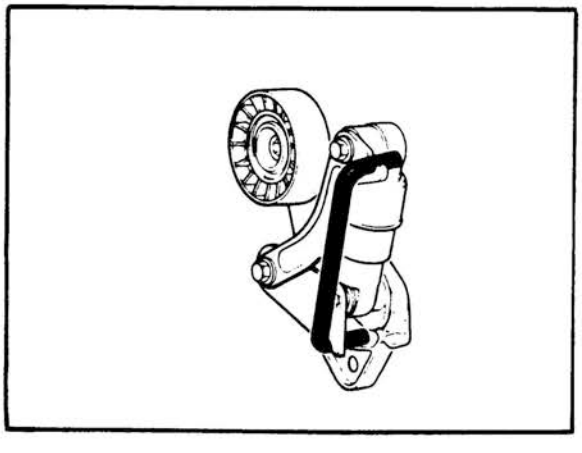
83 94 439 Extension pieces for bonnet (hood) struts



83 94 462 Key for fuel pump screw top

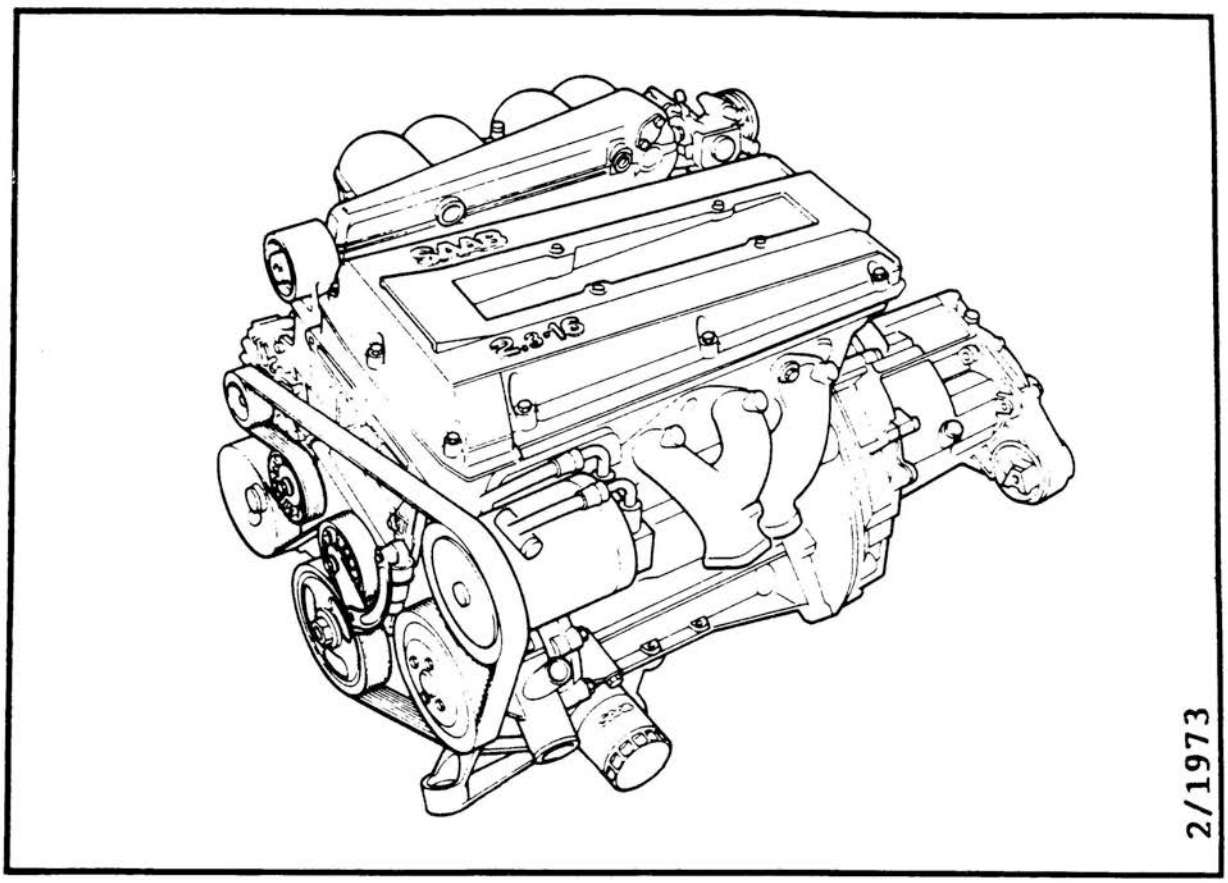


83 94 470 Tool for replacement of balance-shaft bearing



83 94 488 Locking pin for automatic belt tensioner

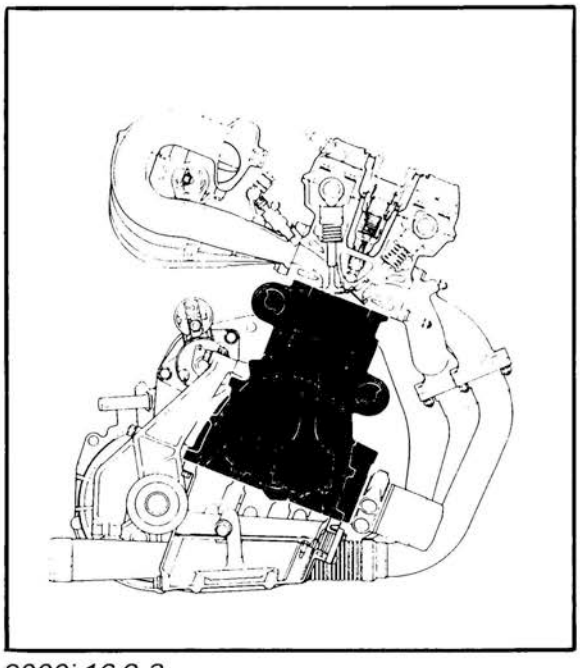
Technical description



Engine

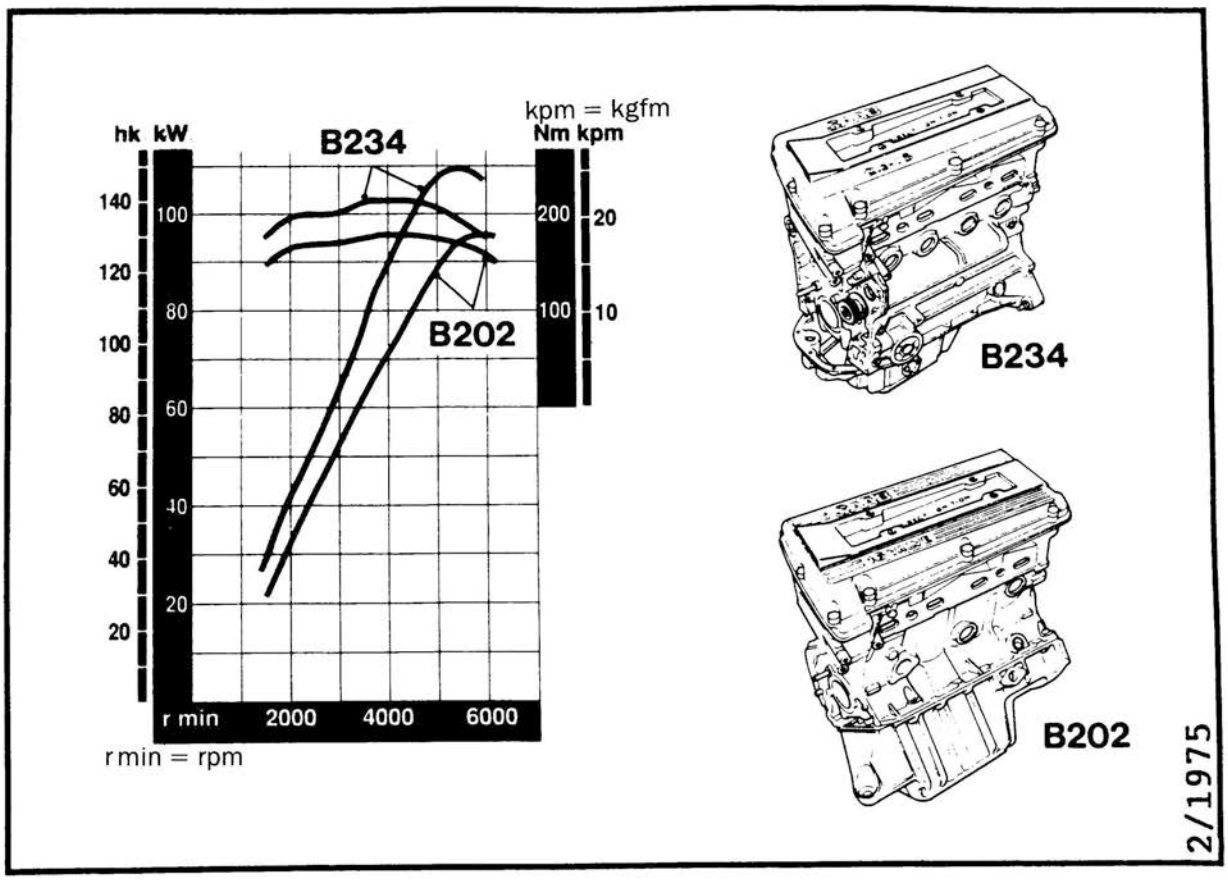
The B234 is a water-cooled, 4-cylinder in-line engine with 16 valves, twin overhead camshafts and twin balance shafts incorporated in the sides of the block. It is equipped with fuel injection and is of the cross-flow type, with the inlet valves on one side and the exhaust valves on the other.

The engine is mounted transversely and is inclined forward at an angle of 20°.



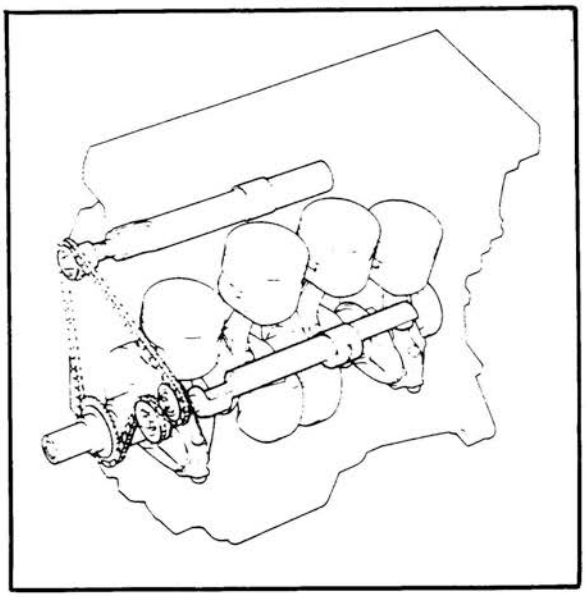
9000i 16 2,3

The swept volume of 2.3 litres helps to produce high torque even at low engine speeds, which is of particular benefit in normal driving conditions.

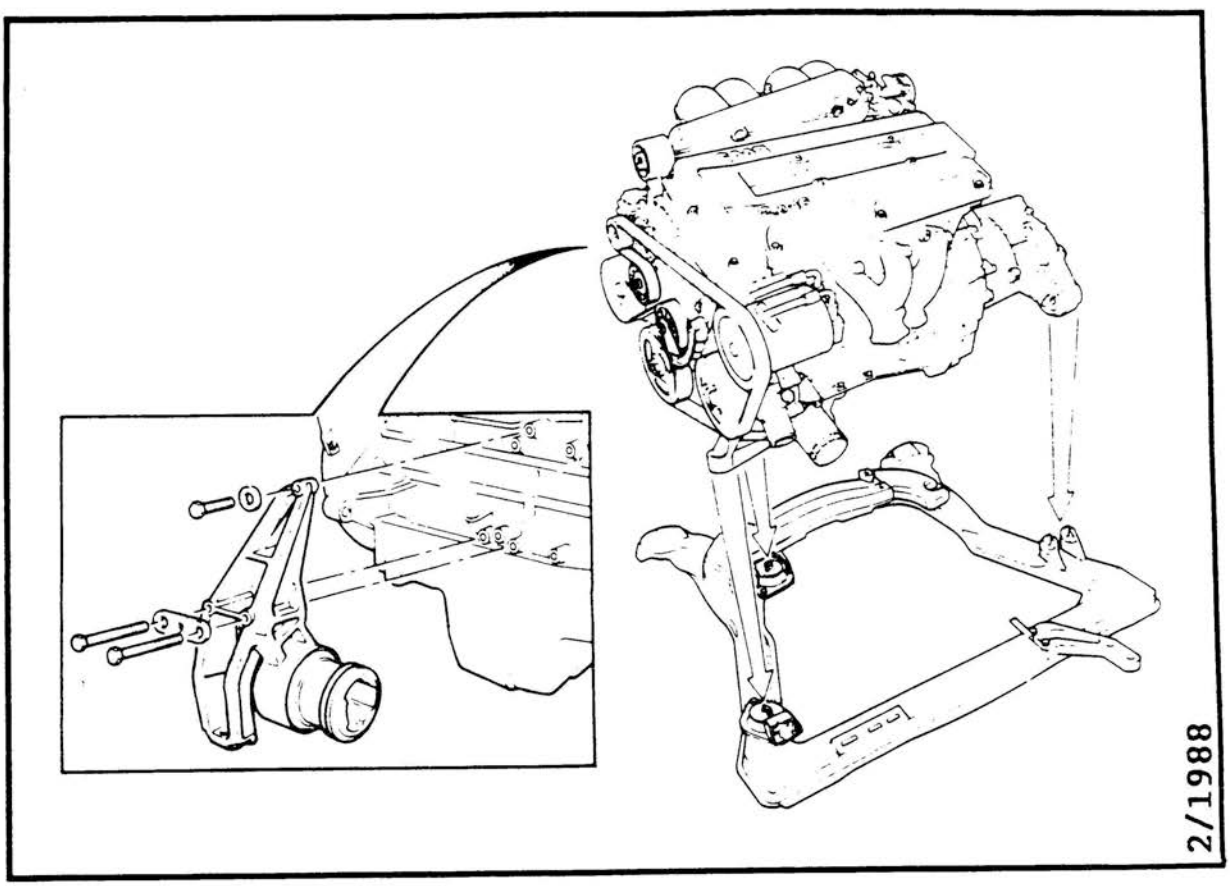


Torque and power curves for the B234 and B202 engines

The balance shafts are designed to overcome vibrations and forces generated by the moving parts of the engine, and hence to reduce the level of engine noise.



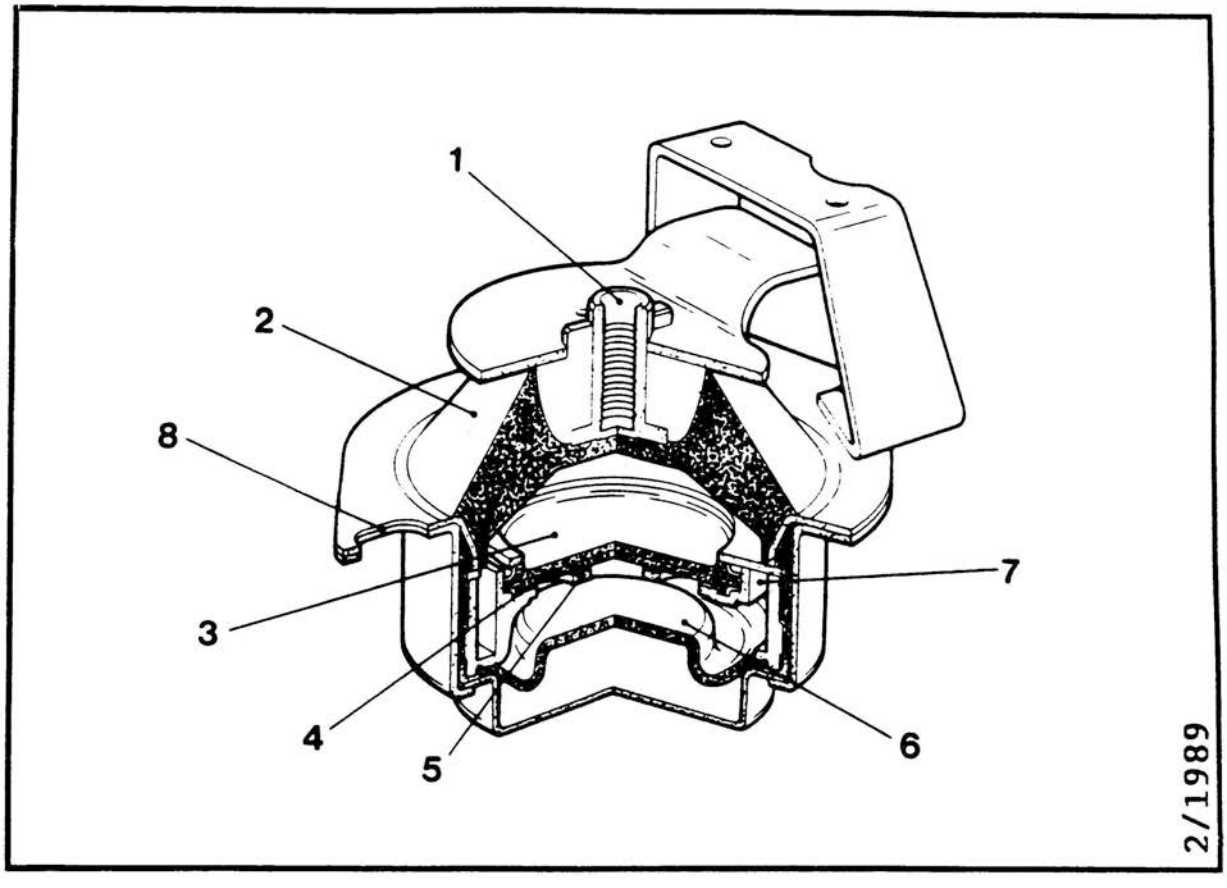
Engine mountings



The engine mounting integrated in the sump on earlier 9000 engines has been superseded by a separate bracket.

The balance shafts are most effective within the most common working speed range of the engine, i.e. 1,800 rpm and above.

At slower engine speeds, the balance shafts are unable to counter engine vibration. To provide effective damping of engine movement at speeds below 1,800 rpm, the B234 engine is equipped with large, hydraulic mountings that are designed to produce a maximum damping effect within this range.

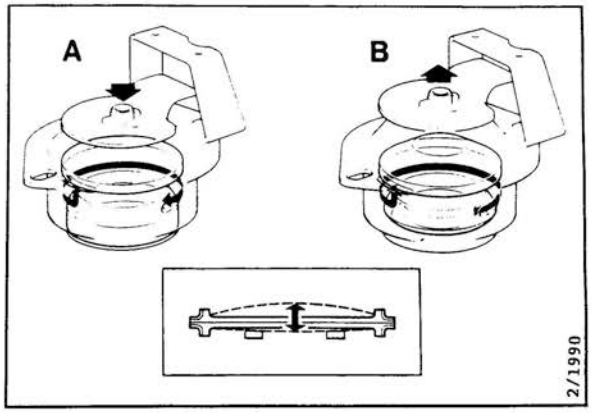


Cross-section through hydraulic mounting

1 Attachment point to engine
2 Rubber mounting
3 Upper chamber
4 Diaphragm
5 Reaction plate
6 Lower chamber
7 Inter-chamber passage
8 Mounting to engine subframe

The hydraulic mounting has two chambers containing a special hydraulic fluid. Interposed between the two chambers are a diaphragm and a passage, the length and diameter of which determine the damping characteristics of the mounting. The forces generated by normal small movements of the engine are absorbed by the diaphragm.

If the engine movement is more pronounced, the damping action of the diaphragm is insufficient, and fluid is forced from the upper into the lower chamber, equalizing the pressure. Thus, the damping action of the mounting is progressive, the damping force increasing as the load on the damper increases.



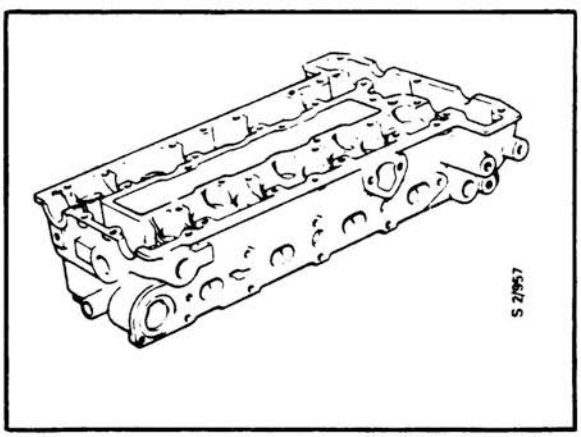
A = Compression
B = Expansion

Hydraulic mountings have the following advantages:

- Improved damping of horizontal engine movements during acceleration
- Improved damping of vertical engine movement on bumpy roads
- Improved damping of engine movement when idling
- Reduction in structure-borne sound between engine and body

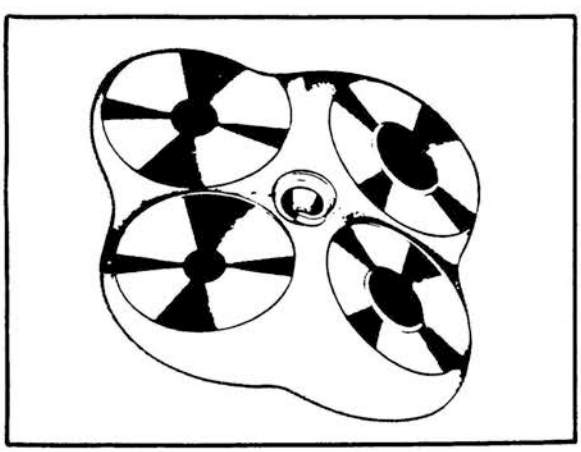
Cylinder head

The cylinder head, a light-alloy precision casting, is bolted onto the block.



The combustion chambers are hemispherical, with the spark plug in the centre, and there are four valves per cylinder. This design improves the flow of gases in the cylinders, ensuring effective combustion of the fuel-air mixture and thus greater efficiency.

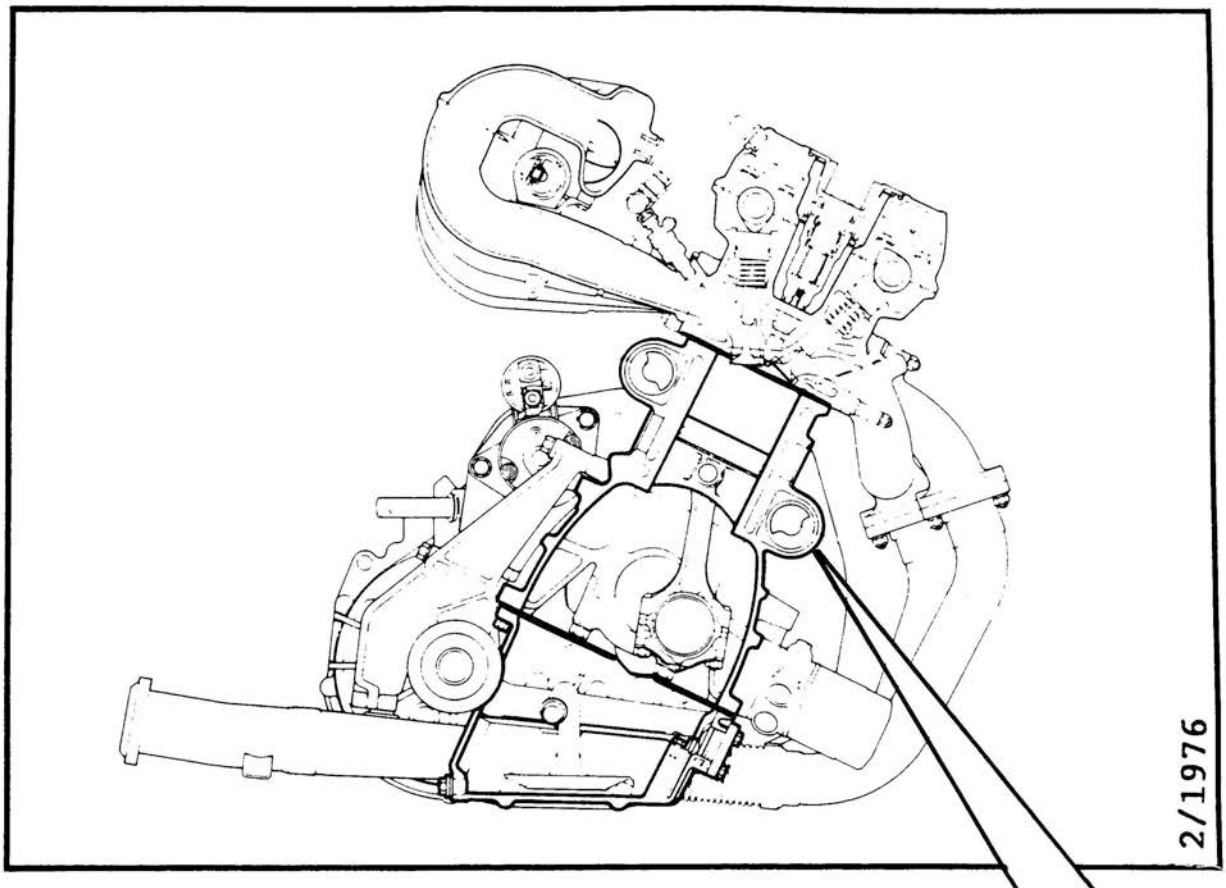
The B234 cylinder head differs from that on the B202 in that the inlet ports are larger and the design of the combustion chamber is slightly different.



Cylinder block

The block is of a totally new design, with the top and bottom faces being parallel. The height, measured from the centreline of the crankshaft to the mating flange for the cylinder head, is 19 mm more than on the B202 engine.

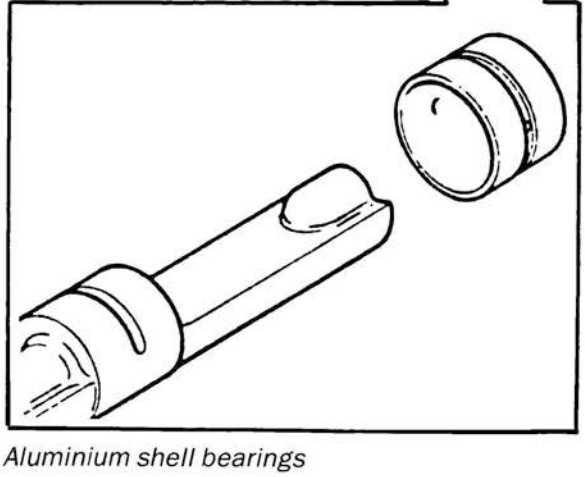
The distance between the cylinders, however, is the same as on the B202 engine.



The top and bottom faces of the block are parallel

The block is a special one-piece casting with the cylinders bored in the block. Special oilways for the lubricating system are also drilled in the block.

Incorporated in the sides are the balance shafts, the inner journals of which run in aluminium bearing shells, press-fitted in the block, which can be replaced without the need for any machining.



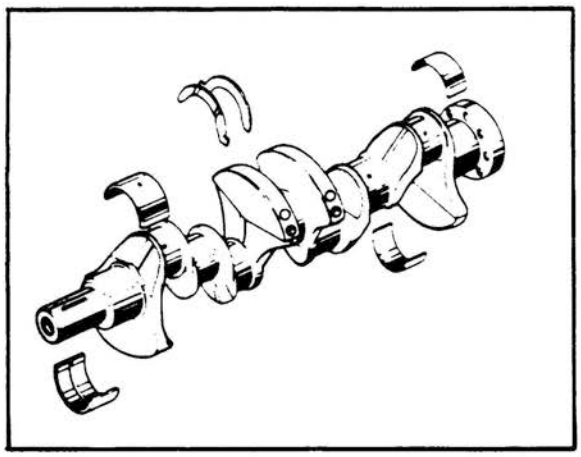
Aluminium shell bearings

Crankshaft assembly

The crankshaft forging has ground journals, which have been hardened by tenifer treatment to provide a hard, nonmetallic surface coating with hard-wearing properties.

There are five main bearings, with the middle (no. 3) bearing also serving to locate the shaft axially. Lubrication is provided through drilled oilways in the shaft.

All main bearing shells are replaceable.



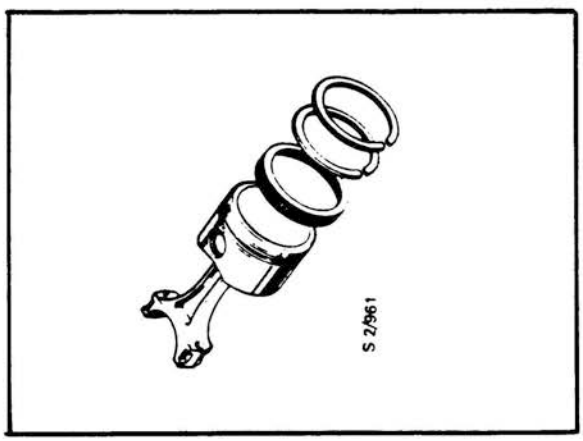
Pistons

The pistons are made of light alloy and have grooves for two compression rings and one oil-scraper ring.

The top compression ring is flat and coated with molybdenum.

The lower compression ring, which is slightly wider than the top one, also has an oil-scraper function.

The scraper ring itself is in three parts.

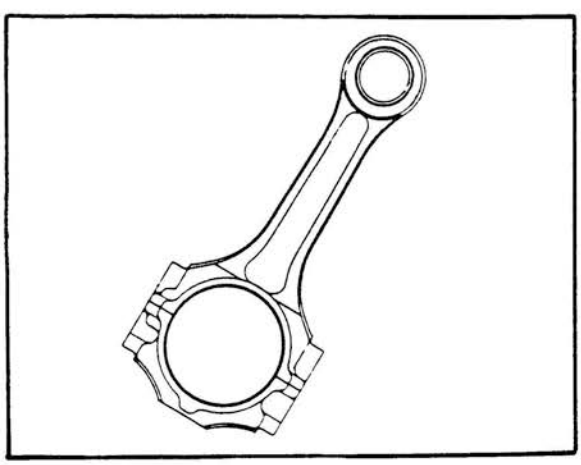


Connecting rods

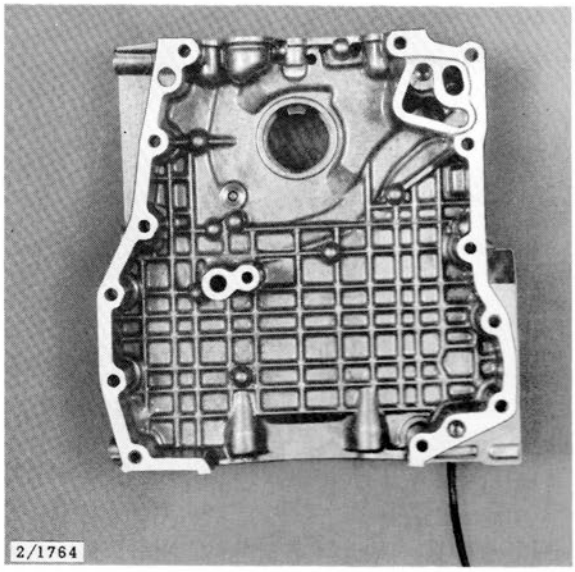
The connecting rods are forgings and incorporate bushes for the gudgeon pins. The gudgeon-pin bushes and big-end bearing shells are replaceable.

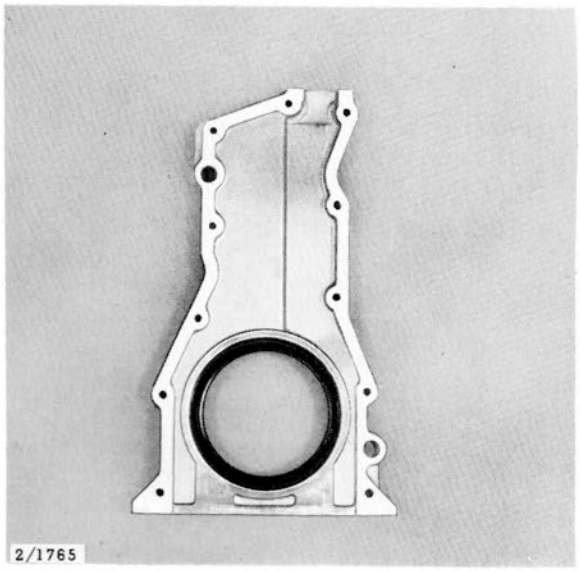
The gudgeon pins are of the fully-floating type, being free to turn in both piston and connecting rod. Axial movement of the pin is limited by a circlip inside the piston boss.

The long stroke (90 mm) not only improves the balance of the engine but also keeps down fuel consumption.

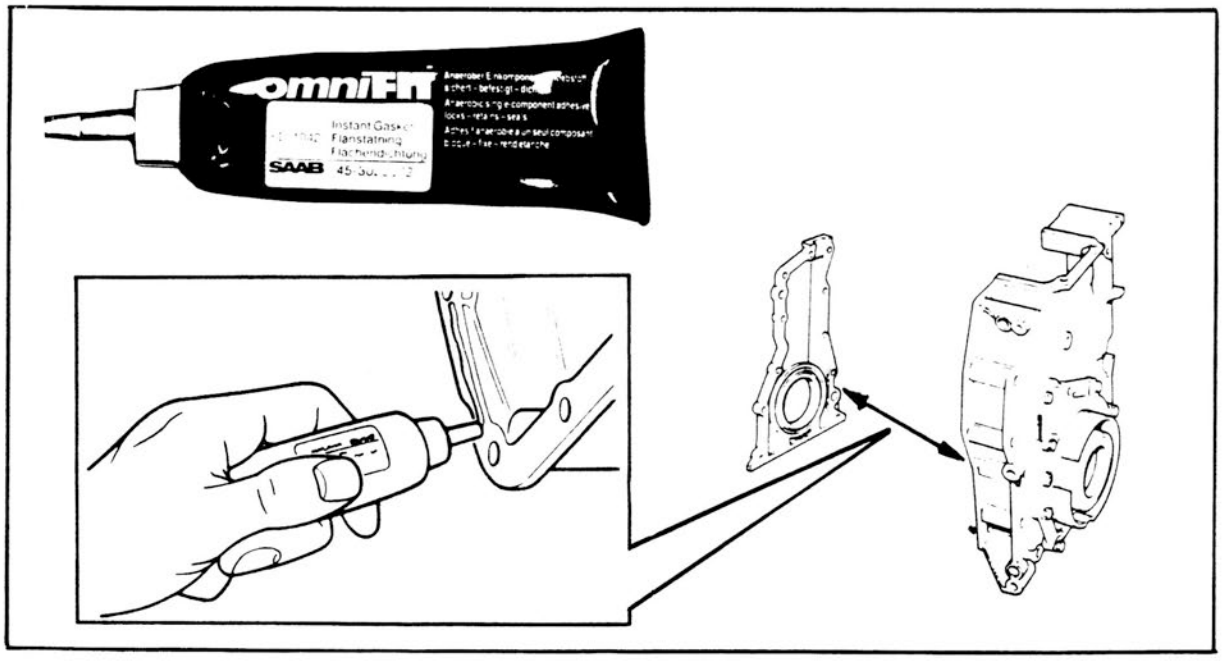


Timing cover and end plate





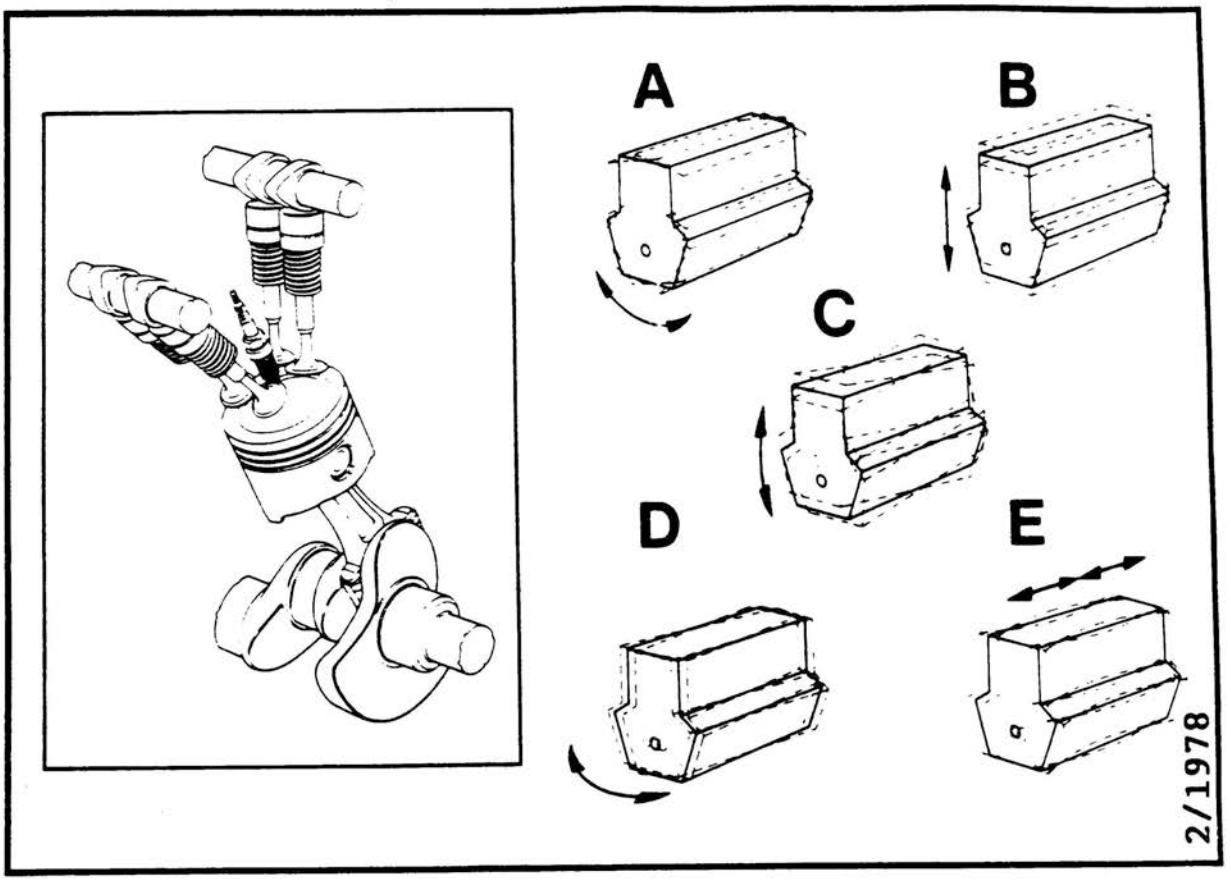
Both the timing cover and the end plate have been specially designed to match the cylinder block. As on the B202 engine, the timing cover incorporates the oil pump and reducing valve, although the reducing valve has been modified to make it less susceptible to fouling.



Single-component anaerobic adhesive

The flanges between both the timing cover and the end plate and the block are sealed by means of a secial single-component anaerobic adhesive (45-3020872).

Converting energy from combustion into tractive power



Engine vibration

Designers are constantly striving to improve passenger comfort. Two key factors here are engine vibration and engine noise, both of which are a product of the basic design of a multicylinder engine.

In a conventional internal combustion engine, the energy released by the combustion process is converted into mechanical energy (tractive power) by the pistons, connecting rods and crankshaft.

The combustion process also generates gas forces which act on the piston crown.

The reciprocating action of the pistons and connecting rods together with the rotation of the crankshaft generate inertia forces that act on the engine block, causing it to vibrate in various ways:

Gas and inertia forces can cause the engine to rock around the crankshaft centreline (A).

Unbalanced first and second-order inertia forces can cause the engine to move up and down (B).

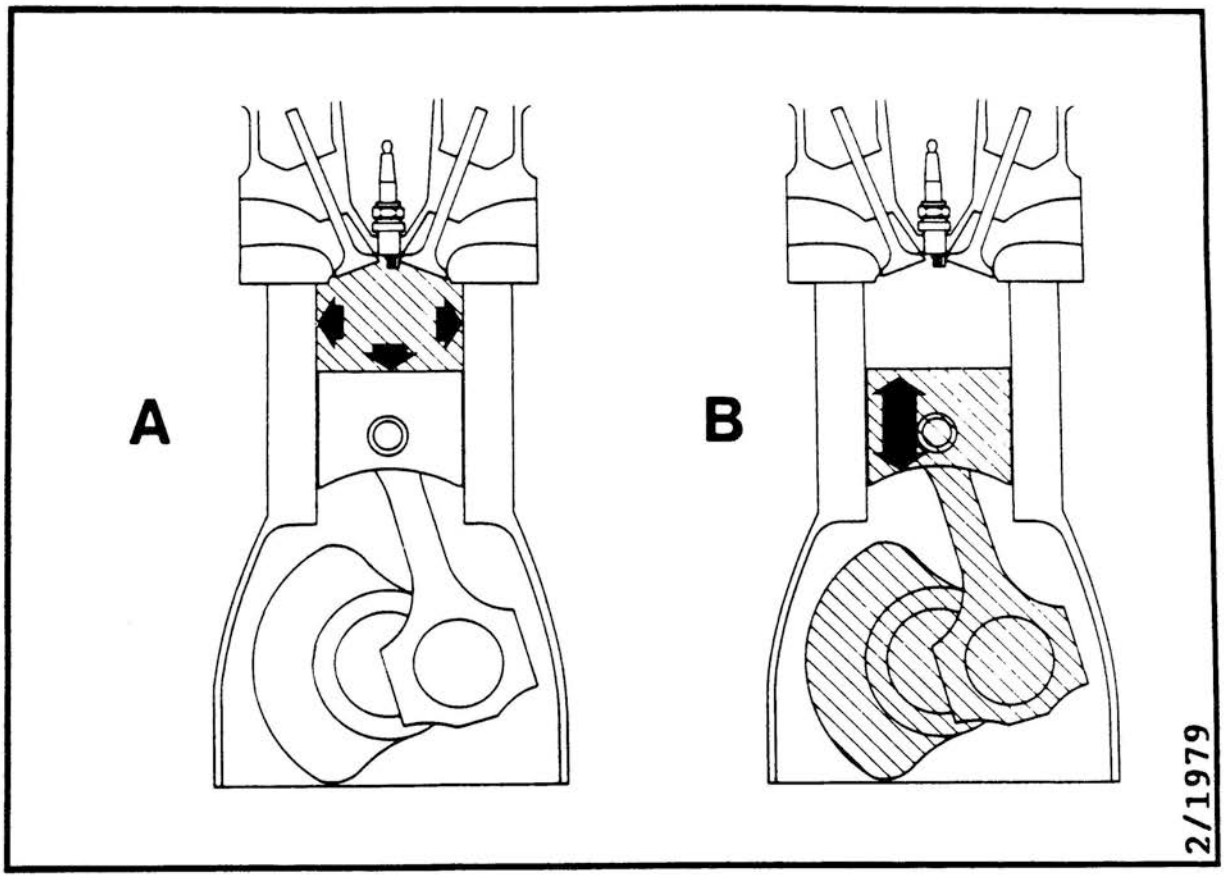
Torque produced by unbalanced first and second-order inertia forces can cause the engine to turn around its vertical axis (D) and its transverse axis (C).

Forces acting at different points along the longitudinal axis of the engine can cause bending along the crankshaft centreline (E).

In extreme cases such vibrations can impose loads on engine components, reducing their working life.

Gas forces and inertia forces

The dynamics of a multicylinder engine are highly complex. To make it easier to understand the forces involved and the effect they have, let's consider what happens in just one cylinder.



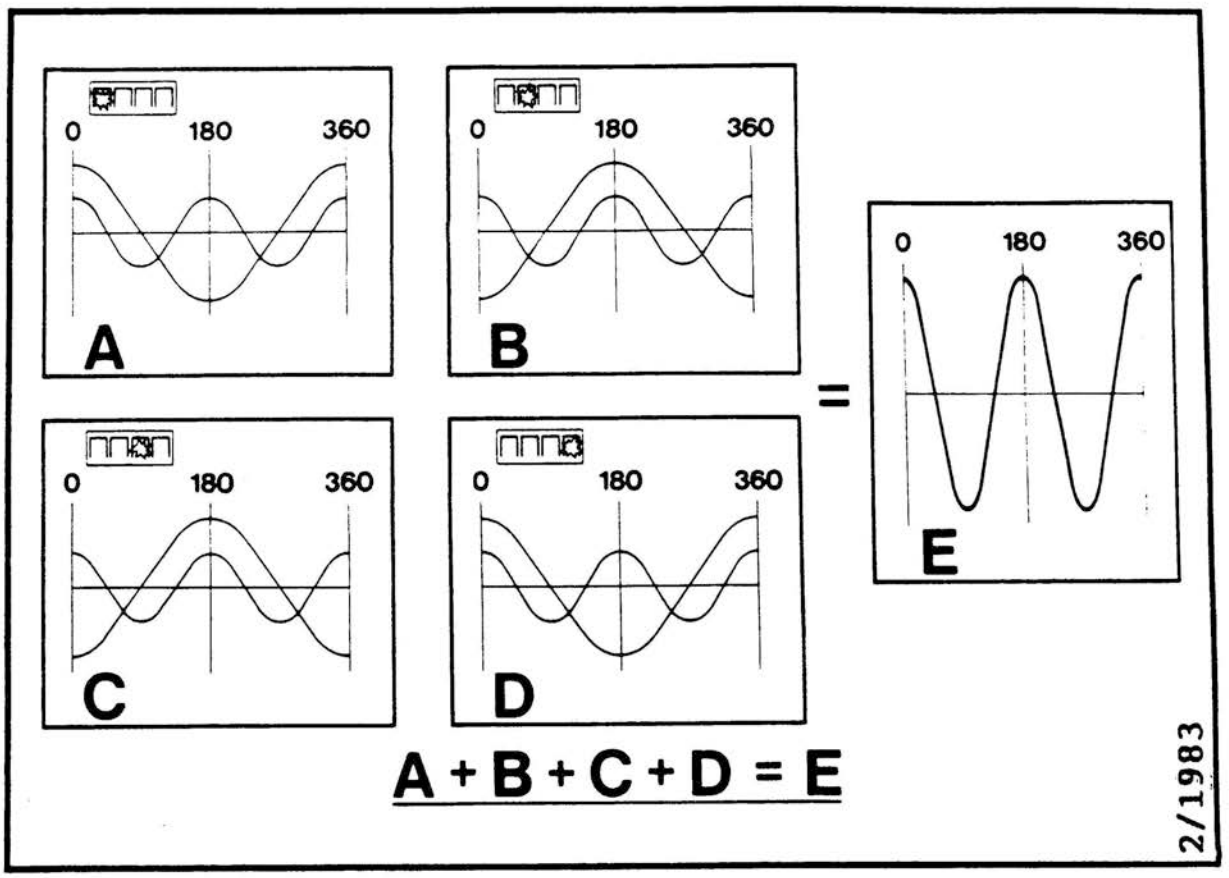
As mentioned earlier, forces can be divided into two types:

A Gas forces
Gas forces occur when the fuel-air mixture is ignited and explodes in the combustion chamber and act on the piston crown, cylinder wall and cylinder head.

B Inertia forces
These are the forces exerted by the inertia of the moving parts of the engine: the piston, connecting rod and crankshaft. These forces increase with engine speed.

At low engine speeds, the inertia forces are much lower than the gas forces, whereas at high engine speeds the converse is true.

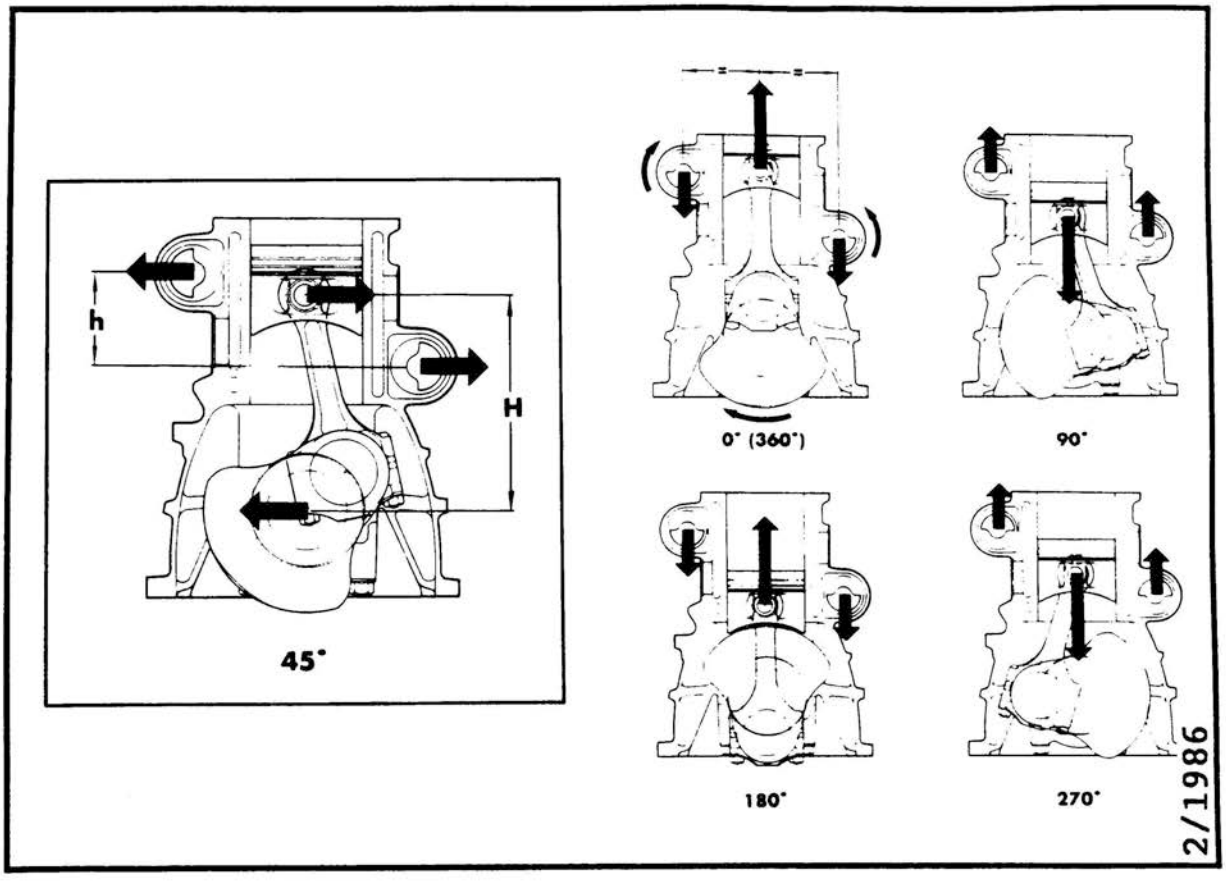
Effect of inertia forces



The force diagrams above for a conventional four-cylinder in-line engine show that the primary disturbing forces cancel each other out, as the direction of the forces for pistons two and three is exactly opposite to the forces for pistons one and four.

However, the diagrams also show that the second-order disturbing forces act in the same direction for all cylinders. Thus, when these forces are added together, they produce a large unbalanced force that occurs twice for each crankshaft revolution.

It is these second-order forces that must be balanced out to produce a smooth-running four-cylinder engine.



Saab has used the balance-shaft principle to overcome the second-order disturbing forces.

Two balance shafts are located symmetrically on the sides of the block at different heights above the crankshaft centerline (h and H).

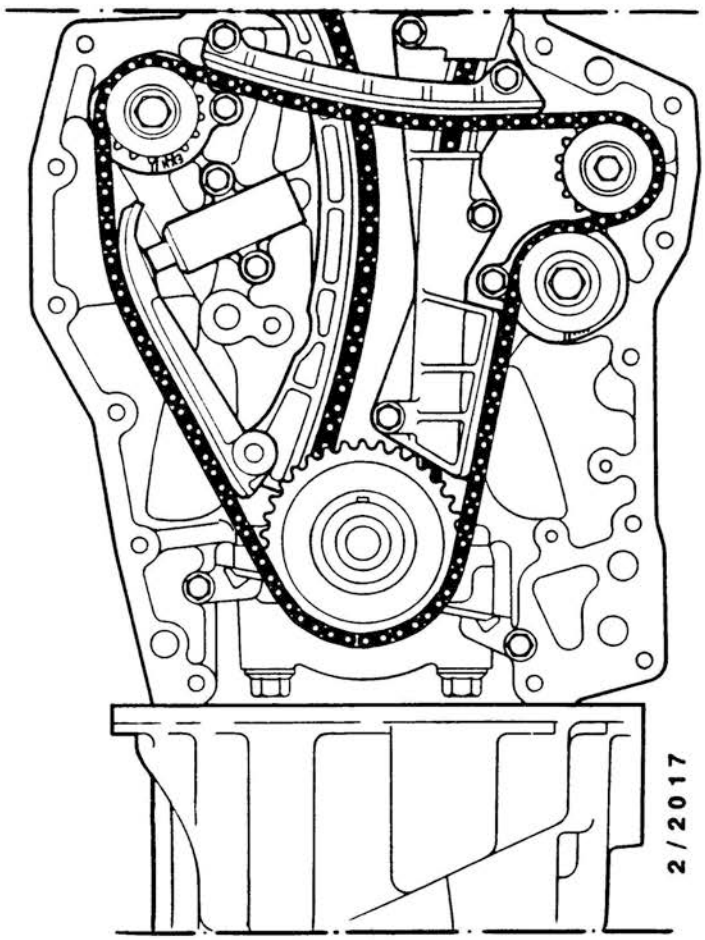
Each shaft incorporates eccentrically mounted balance weights. The shafts are driven by a chain from the crankshaft and rotate in opposite directions to each other at twice the crankshaft speed.

When the second-order force caused by the inertia of the oscillating parts is maximum in an upward direction (0° and 180°), the balance shafts exert an equivalent force downwards.

Similarly, when the second-order force caused by the inertia of the oscillating parts is maximum in a downward direction (90° and 270°), the balance shafts exert an equivalent force upwards.

Because the balance shafts are at different heights above the crankshaft centreline, they also exert sideways forces. The torque generated by these forces is designed to counteract the rocking motion caused by the gas and inertia forces (45°).

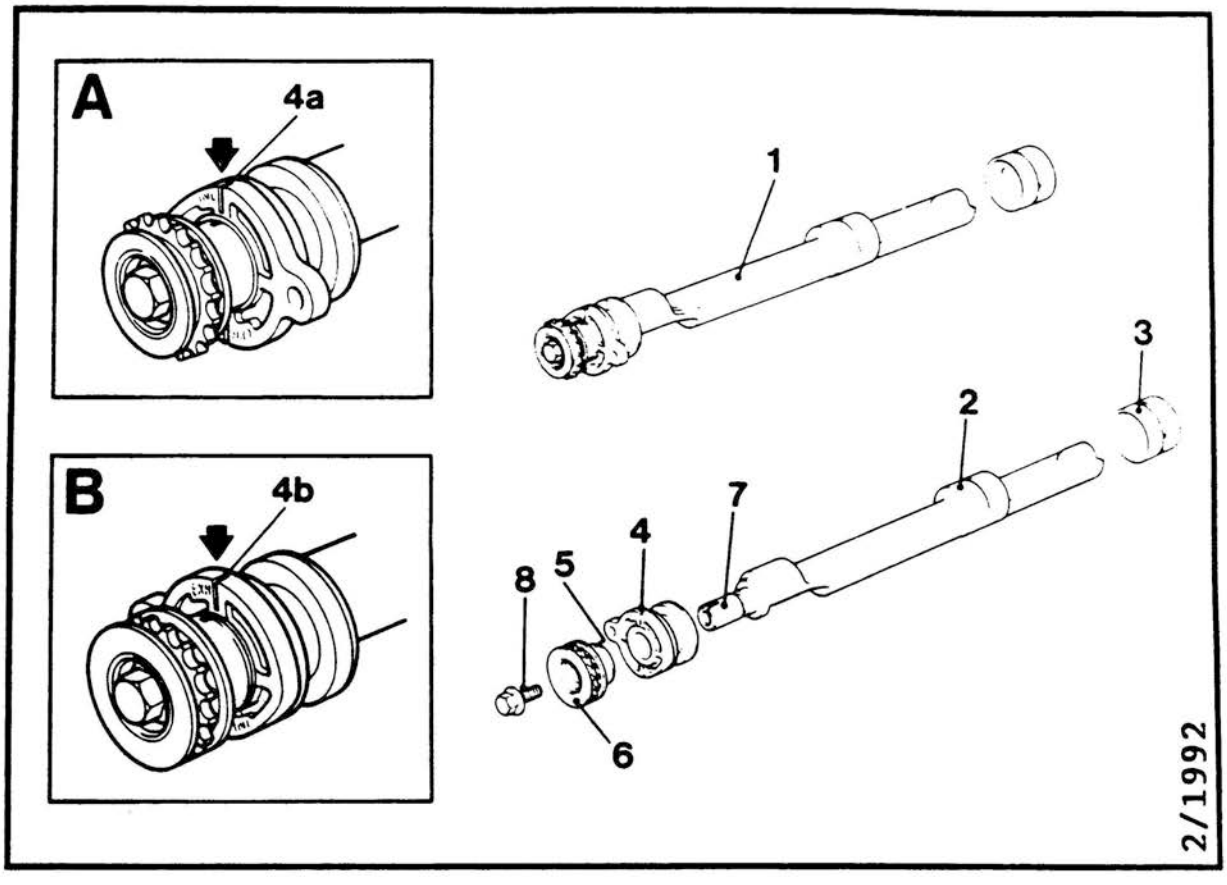
Balance-shaft drive



The balance shafts are driven from a sprocket on the crankshaft by a 7-mm-pitch chain at twice the crankshaft speed.

An idler-wheel sprocket interposed between the crankshaft sprocket and the inlet-side balance shaft causes the balance shafts to rotate in opposite directions.

Balance-shaft assembly



A = Inlet side
B = Exhaust side

4a Inlet-side alignment mark
4b Exhaust-side alignment mark

1 Balance shaft
2 Rear journal
3 Rear bearing shell
4 Front bearing holder
5 Key
6 Sprocket assembly
7 Front journal
8 Securing bolt

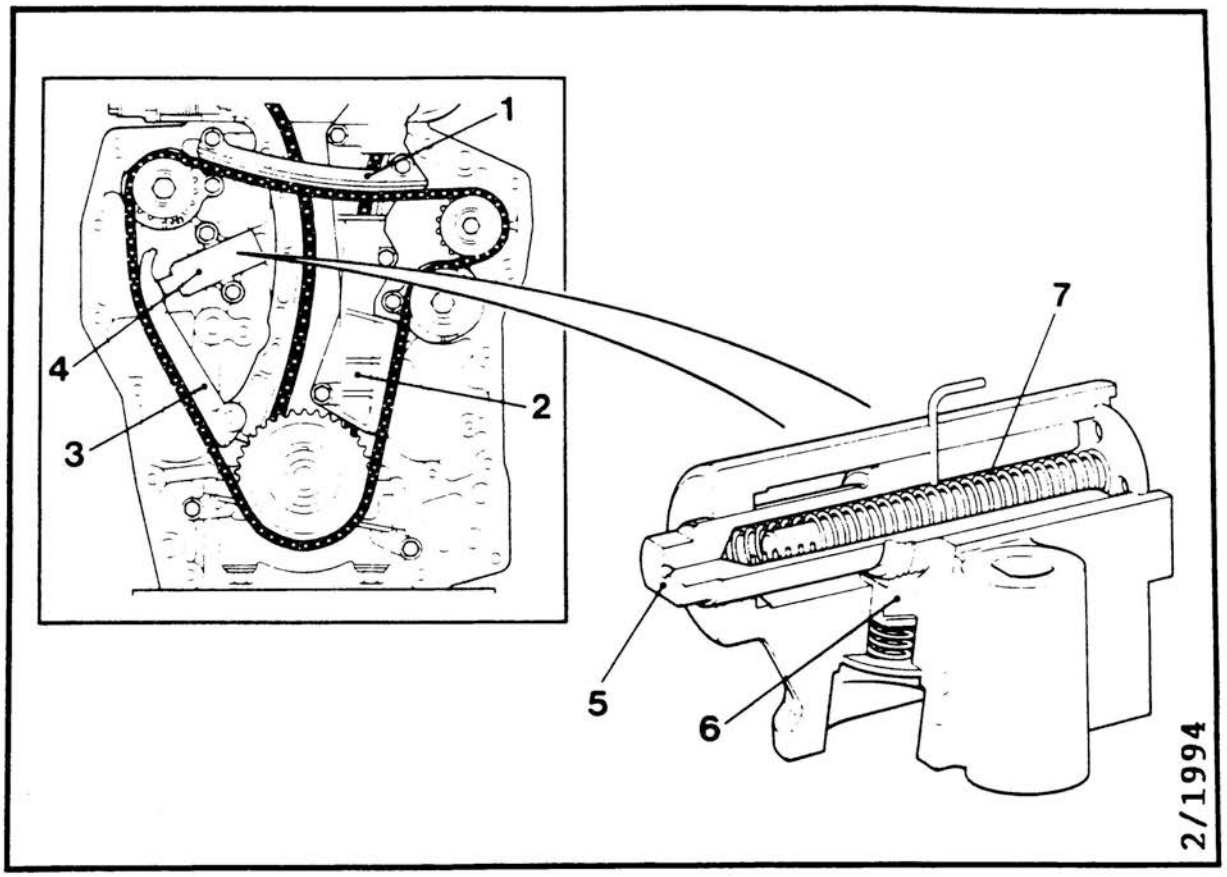
The balance shafts, which are of identical design, are supported by aluminium bearing shells located in the block, between no. 2 cylinder and no. 3 cylinder. The bearing shells are a press-fit in the block and are lubricated by special oilways.

At the front or sprocket end, the shafts are supported in aluminium bearing holders, which also secure the shafts in the block. In common with the idler-wheel sprocket, the bearing blocks are lubricated by means of separate oilways in the block.

It is imperative if the balance shafts are to perform as intended that they are aligned precisely on fitting. Different sprocket assemblies are therefore used for each shaft, with each bearing holder being marked to identify the side to which it belongs (INL or EXH).

The balance shaft, sprocket and bearing holder are fitted together as an assembly before being fitted in the correct side of the block as indicated by the appropriate marking.

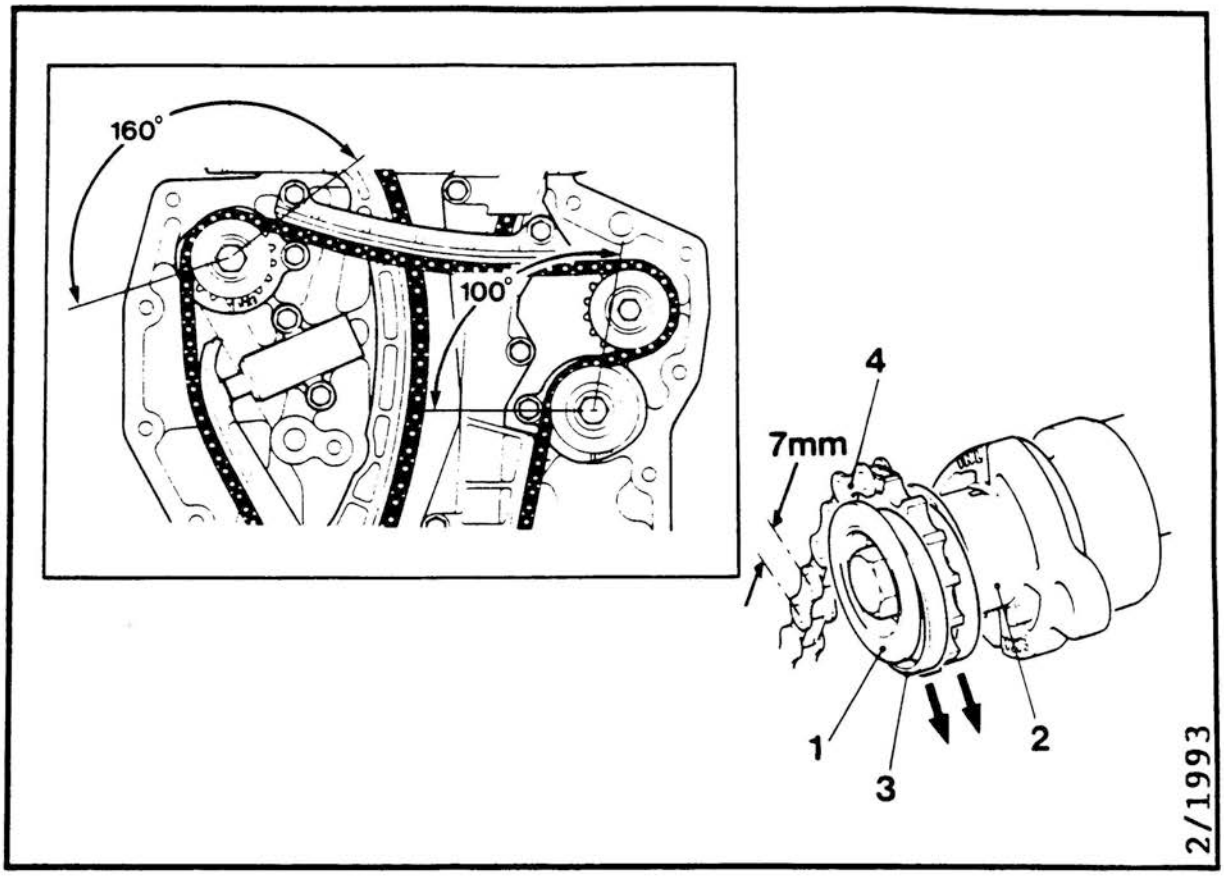
Chain tensioner and guides



1 Upper fixed chain guide
2 Side fixed chain guide
3 Pivoting chain guide
4 Chain tensioner assembly
5 Plunger
6 Ratchet
7 Spring

When the engine is running, pressurized engine oil acts in the opposite direction to the spring to control the force applied by the tensioner to the chain. This control of the tensioning force minimizes the noise from the chain.

There are two fixed chain guides and one pivoting one, controlled by the chain tensioner.



1 Sprocket
2 Front bearing holder
3 Thrust ring
4 Chain

Both the sprockets and the idler-wheel sprocket incorporate thrust rings to help minimize chain noise.

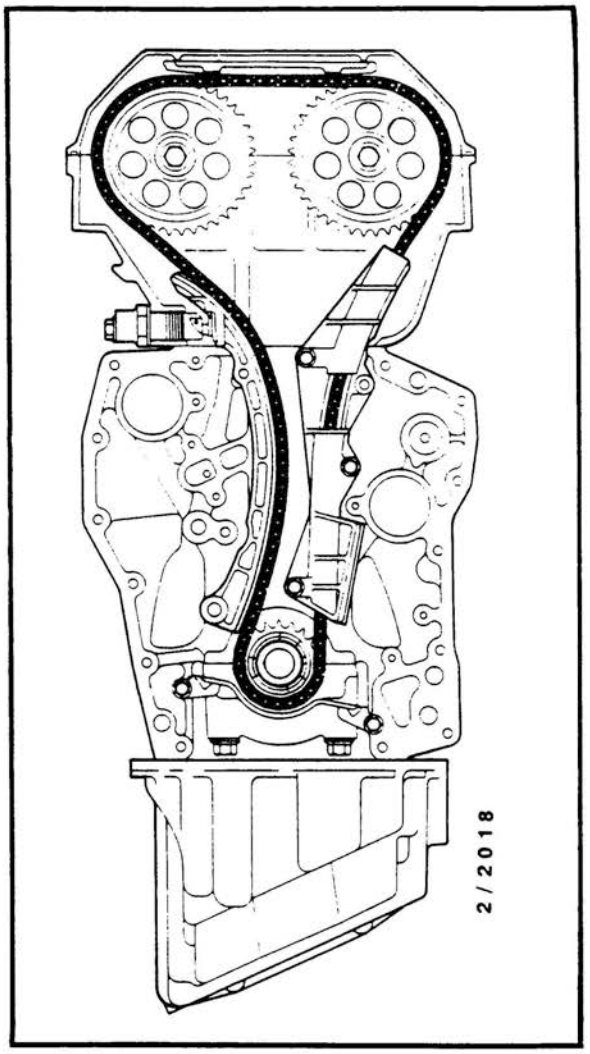
The thrust rings absorb the force of the chain where it engages the sprocket teeth, providing smoother operation and thus more silent operation.

Because the surface contact angle of the chain is smaller on the exhaust side, the thrust rings on this side are larger.

Camshaft drive

The camshaft drive chain assembly on the B234 engine is 5 mm (0.2 in) closer to the block than on the B202, which means that the sprockets and chain guides are different to those on the B202 engine.

Because the B234 block is also taller, the chain has been lengthened by four links.

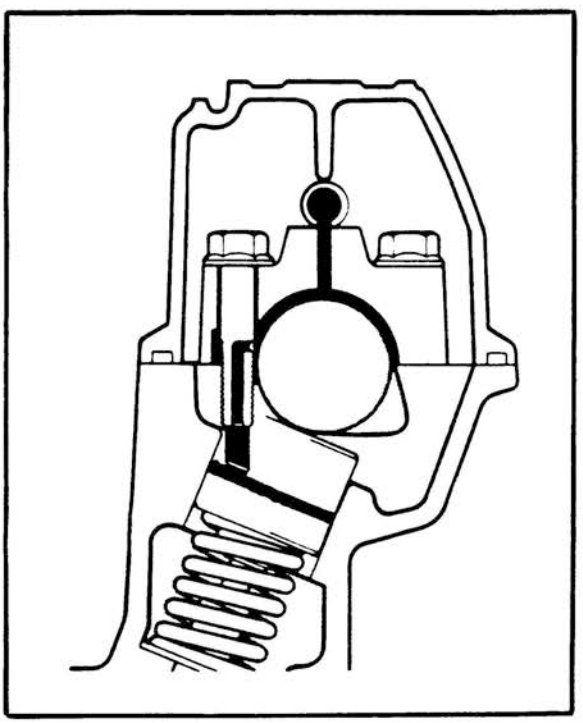


Camshaft assembly

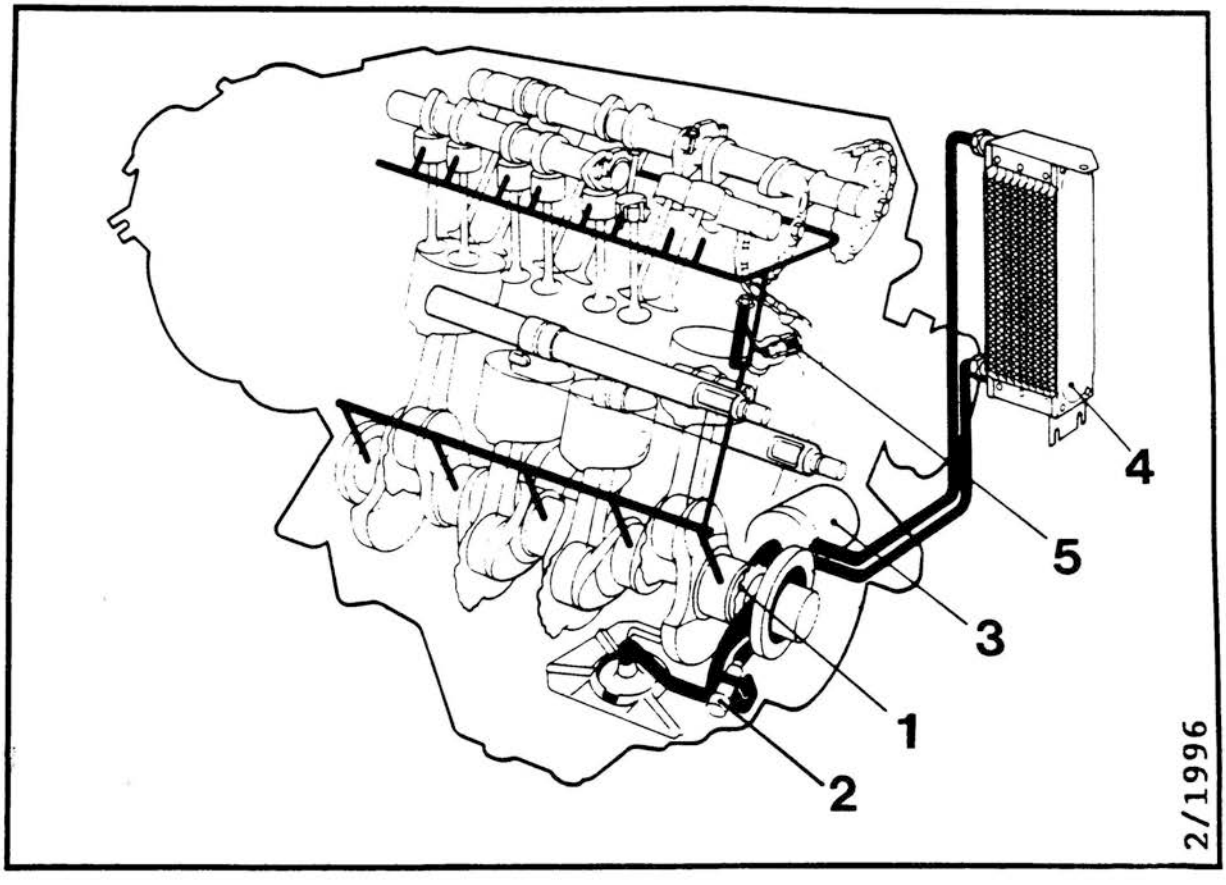
The engine has twin overhead camshafts with a wide base circle, providing a large amount of lift but little stress. The camshafts are driven by a timing chain equipped with a self-adjusting chain tensioner. The camshafts are direct acting on the valves via hydraulic bucket-type cam followers.

The cam followers adjust automatically to differences in valve clearance caused by variations in temperature. They operate in an oil bath, with oil supplied via oilways in the securing bolts for the camshaft bearing caps. The oil is purged of air as it flows through the camshaft bearing. The main advantage of these cam followers is that they operate silently and are extremely reliable.

The valves are made of steel and have chromium-plated stems. The heads on the inlet valves are induction hardened and those on the exhaust valves stellited.



Lubricating system



The engine lubricating system has forced-flow circulation, with the oil pressure being generated by a gear pump consisting of a pinion and an eccentric ring gear. The pump is driven by the crankshaft and is interposed between the timing cover and the crankshaft pulley.

Oil is drawn from the sump to the oil pump (1) via an inlet strainer and pipe.

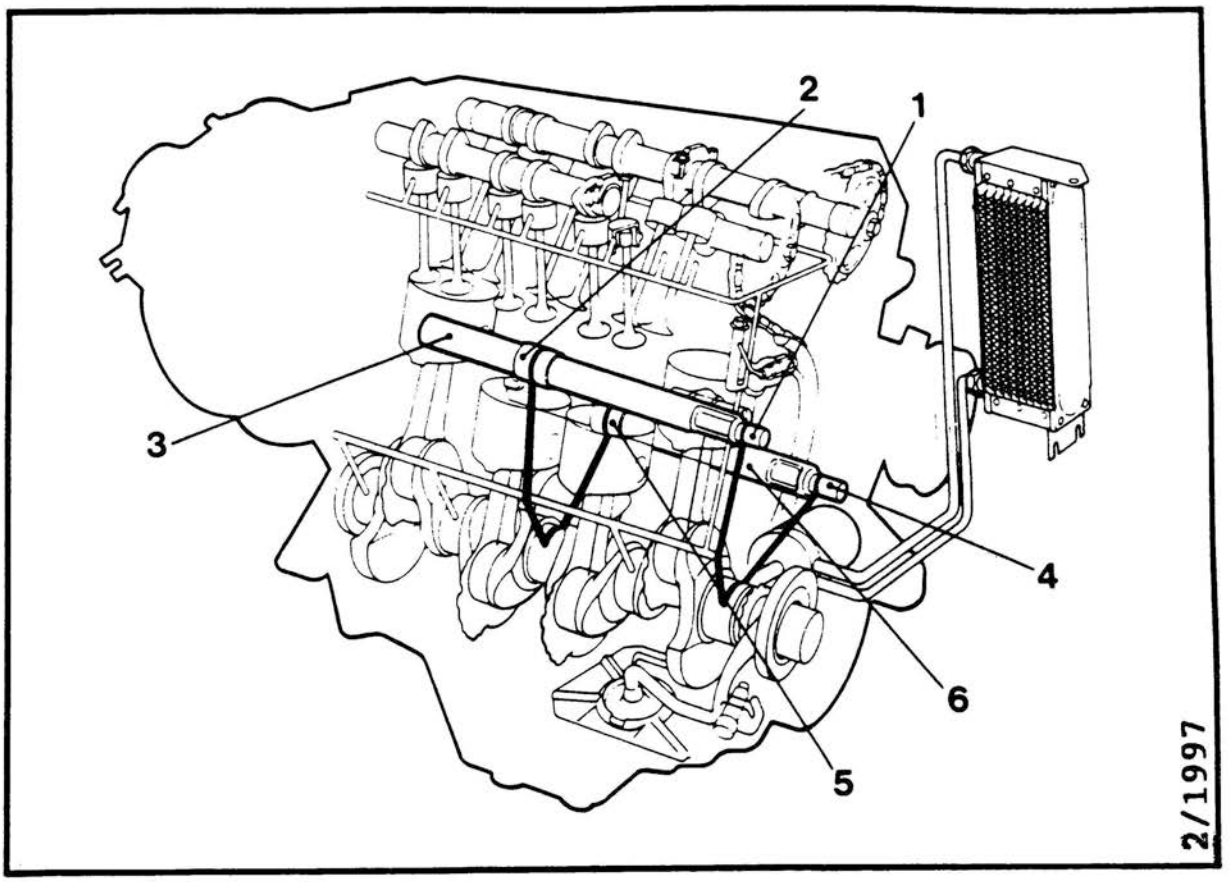
A relief valve (2) in the timing cover limits the oil pressure and returns surplus oil to the inlet side of the pump.

From the pump the oil flows through a passage in the block to the oil filter (3).

The filtered oil flows to a thermostat in the oil-pump adaptor. If the oil temperature is below 80°C (176°F) the thermostat delivers the oil to the main gallery. If the oil temperature is above 80°C (176°F), the thermostat opens and the oil circulates through the oil cooler (4) before being returned to the main gallery. The oil cooler is standard on all B234 engines.

The oil pressure switch (5), located in the main gallery, sends a signal to switch on the oil-pressure warning light on the instrument panel, to alert the driver if the pressure has fallen too low.

The crankshaft main bearings and big-end bearings are supplied with oil from the main gallery and via passages in the crankshaft, whereas the pistons and cylinder walls are splash lubricated.

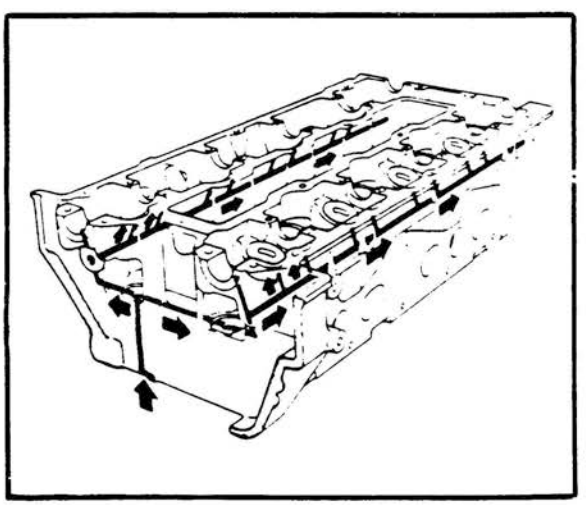


The front bearing (1) and the rear bearing (2) on the inlet-side balance shaft (3) are supplied with oil by the main gallery.

The front bearing (4) on the exhaust-side balance shaft (6) is supplied with oil through a drilling from the no. 1 main bearing.

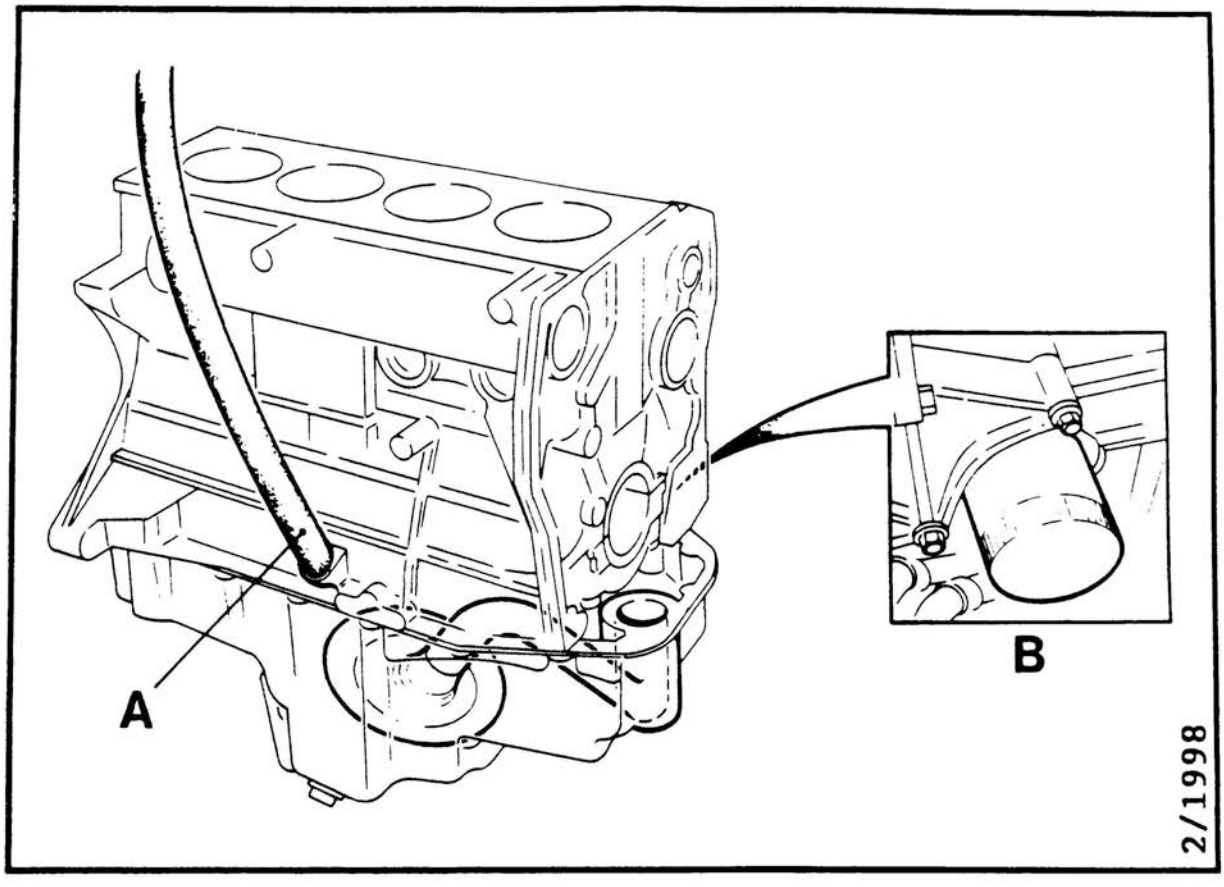
The rear bearing (5) on the exhaust-side balance shaft (6) is supplied with oil through a drilling from the no. 3 main bearing.

From the main gallery in the block, rising oilways to the cylinder head supply oil to the camshafts and cam followers. Via one of the cylinder head bolt holes, the oil flows to the camshaft bearings and cam followers through drilled passages in the head.



Oil sump

A new sump has been designed to match the cylinder head on the B234 engine. Unlike that on the B202 engine, the sump does not incorporate an engine mounting. As on 900 models, the oil filler pipe (A) is connected to the block.



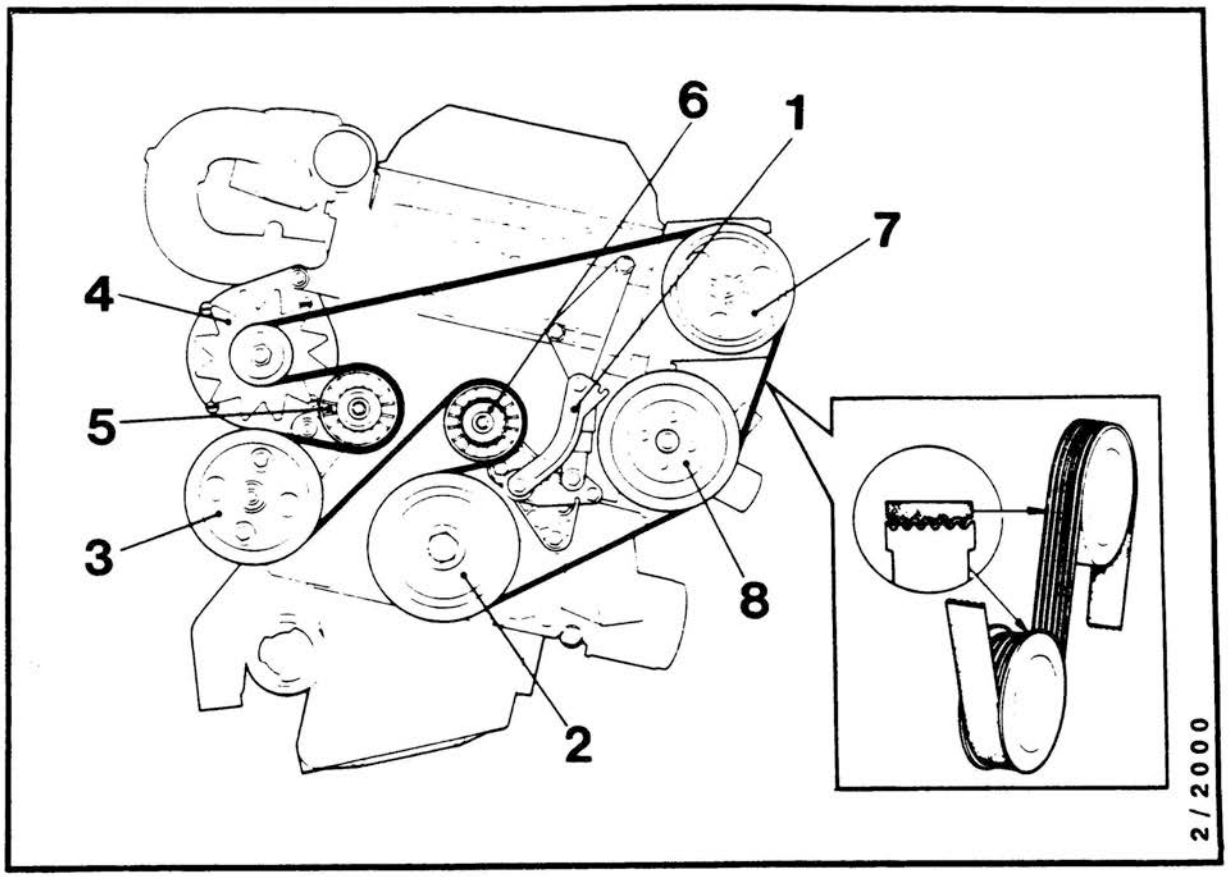
The flange on the sump does not incorporate a groove for sealant, sealant (Permatex Ultra Blue) instead being applied direct to the flat surface.

Oil filter

The oil filter is located where it is readily accessible on the exhaust side of the block. An adaptor (B) is fitted between the filter and the block.

Drive for auxiliaries

One multigroove belt provides the drive for all engine auxiliaries, including the AC compressor.



Auxiliary drive components

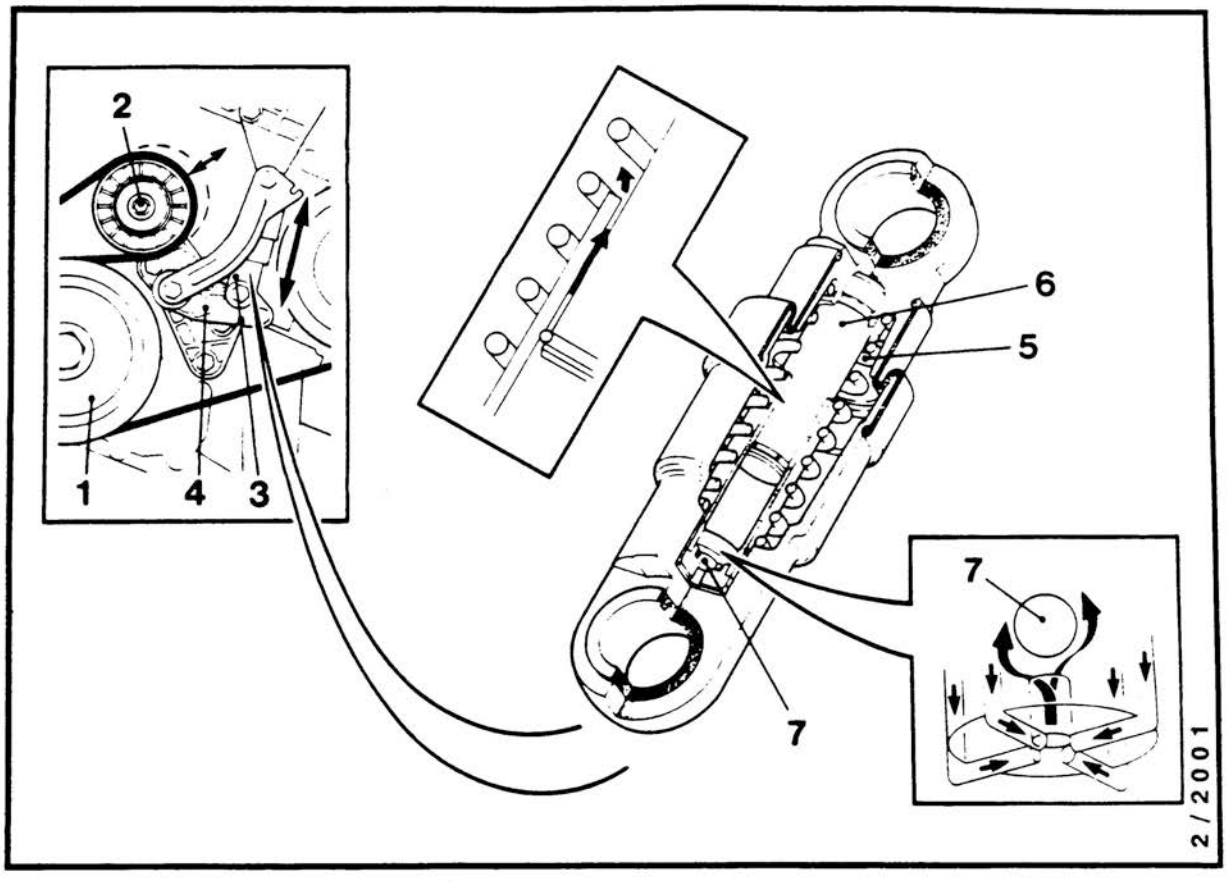
1 Hydraulic belt tensioner
2 Crankshaft pulley
3 Power steering pump pulley
4 Alternator
5 Idler-wheel pulley
6 Tensioning pulley
7 AC compressor
8 Water pump pulley

The drive for auxiliaries has an automatic belt tensioner which is easy to service and has a long working life.

The operating principle of the tensioner is similar to that of an hydraulic cam follower.

On a momentary increase in the load on the tensioner, compressing it, the ball valve closes, preventing oil from flowing out of the cylinder but forcing seepage to take place through the minute gap (1/100 mm) between the piston and cylinder wall.

On a momentary reduction in the load on the tensioner, allowing it to expand, the valve opens and oil flows into the cylinder.



Automatic belt tensioner

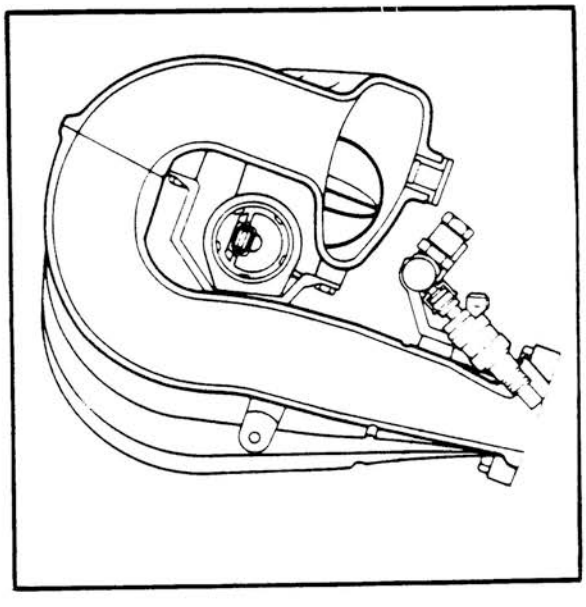
1 Crankshaft pulley
2 Tensioning pulley
3 Automatic tensioner
4 Pivoting arm
5 Spring
6 Piston
7 Ball-type nonreturn valve

A powerful coil spring in the tensioner always maintains a certain level of tension, regardless of whether the load on the tensioner is increasing or decreasing.

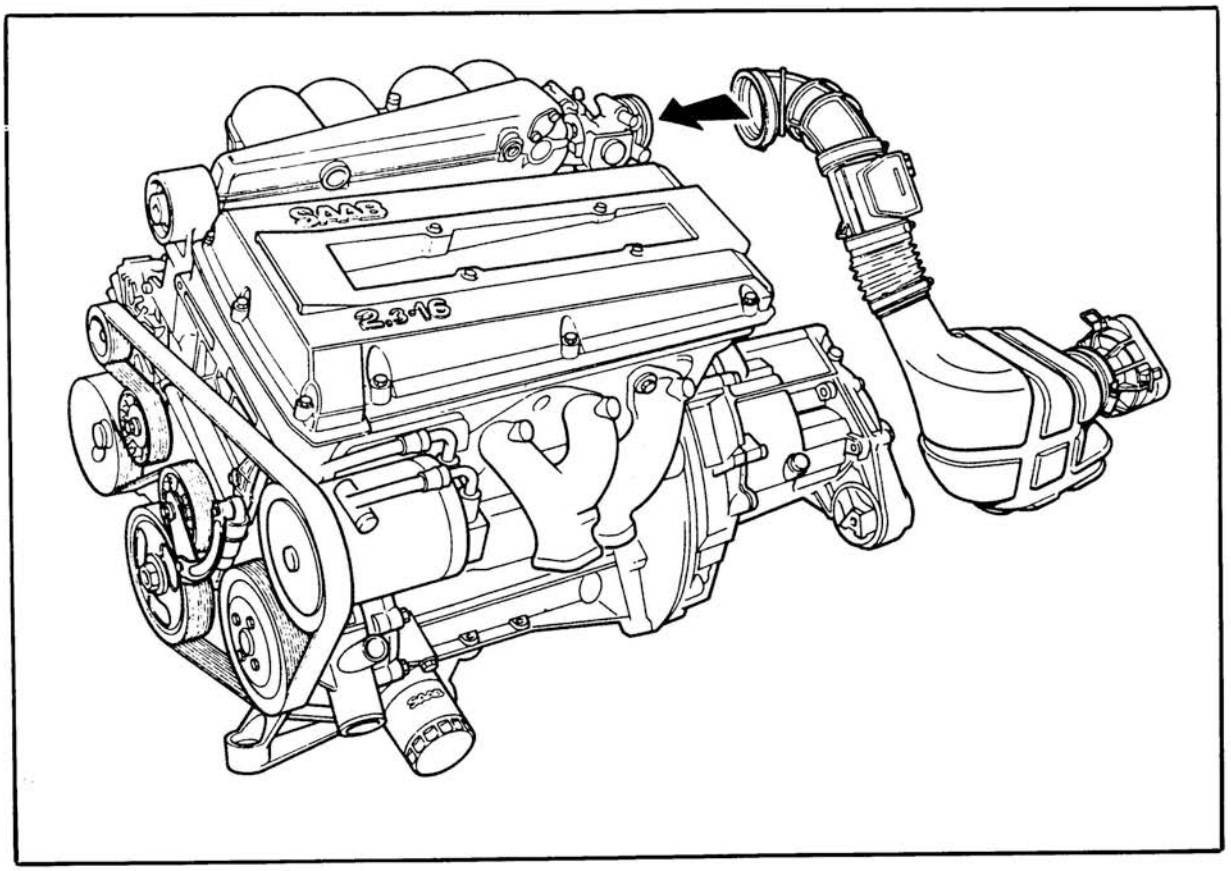
Inlet manifold

The inlet manifold has been designed to match the increased swept volume of the B234 engine, with the pipes being longer than on the B202 engine.

To facilitate access to adjacent components, the inlet manifold is in two parts.



Induction system



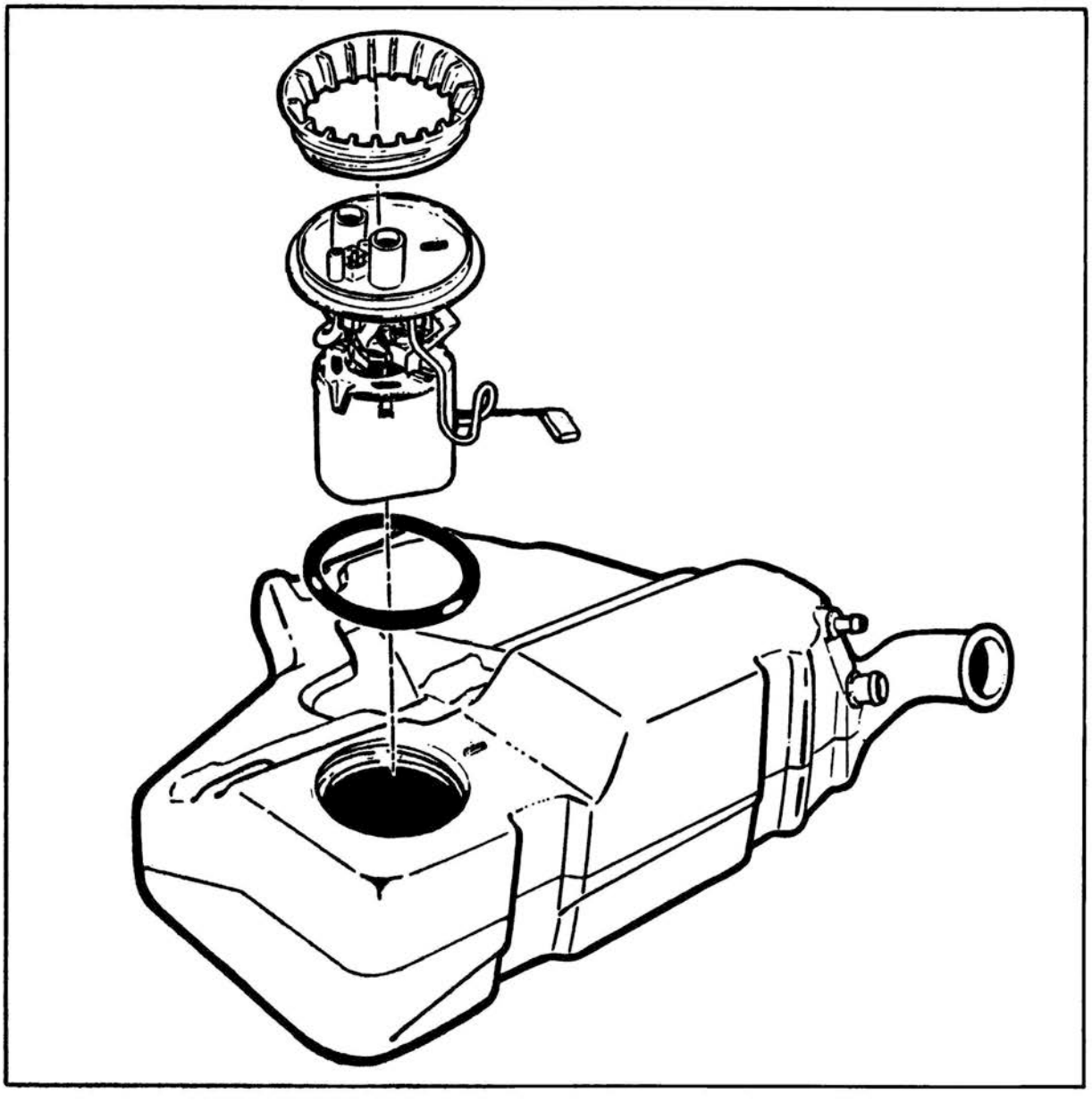
B234 induction system with air-intake silencer

Air-intake silencer

An air-intake silencer is fitted in the induction system between the air cleaner and the air mass meter.

The air-intake silencer is basically a reservoir which reduces the noise from the air intake by 2 dB (when measured inside the car during driving) or 10 dB measured at the air cleaner intake.

Fuel pump and fuel tank



Fuel tank and fuel pump B234

1 Reinforcement ring
2 Seal
3 Fuel pump
4 Top
5 Screw top
6 Alignment marks
7 Float for fuel-gauge sender unit
8 Fuel tank

The fuel pump is of the same type as on the B202 engine, with an ejector pump feeding the main pump, but now incorporates a number of modifications.

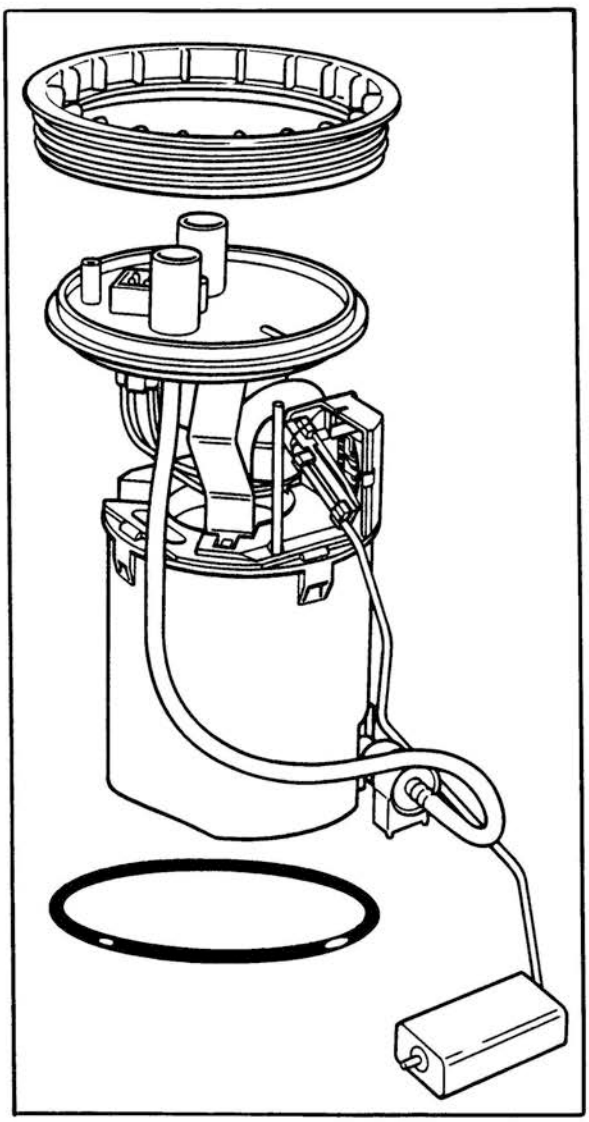
A new screw top and a new type of rubber seal have been introduced to facilitate fitting of the pump inside the tank. Simpler tools can be used for removal and fitting of the pump, and the pump is also less likely to leak.

The pump incorporates the fuel-gauge sender unit, which can be adjusted by the new EDU trip computer fitted in M90 vehicles.

In addition to adjustment of the fuel-gauge reading, it is also possible to adjust the amount of fuel remaining to match a range of zero miles.

The resistance of the sender unit is 35 ohm when the tank is empty and 350 ohm when the tank is full.

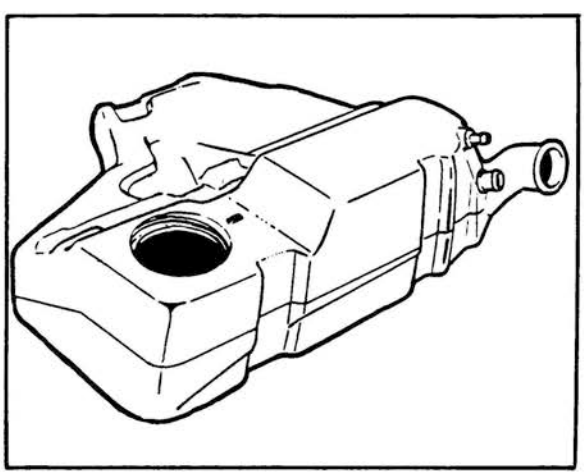
A breather pipe is incorporated in the fuel-pump strainer to evacuate any vapour.



Modifications to the tank to accommodate the new pump include a new reinforcement ring. The aperture for the earlier fuel-gauge sender unit has been discontinued, and all outlets are now welded to the tank. Modifications have also been made as a result of the fuel filter having been moved from the engine bay.

A tube inside the filler pipe leads fuel being added down to the bottom of the tank to prevent foaming.

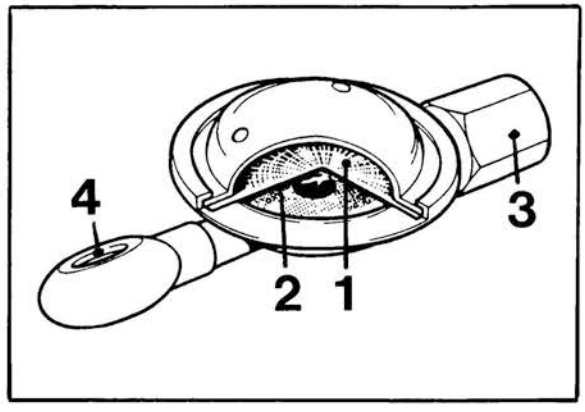
The fuel-tank capacity is 66 litres (17.4 US gal).



Pulsator

A sound-damping pulsator is fitted between the fuel line and the fuel-injection rail. The function of the pulsator is to reduce the pulsating sound caused by the injectors and to prevent its being transferred into the system.

A diaphragm inside the unit is pressed by fuel pressure against a sealed-in cushion of air. Pulsations in the pressure are absorbed by the air cushion, and disturbing noise is reduced.



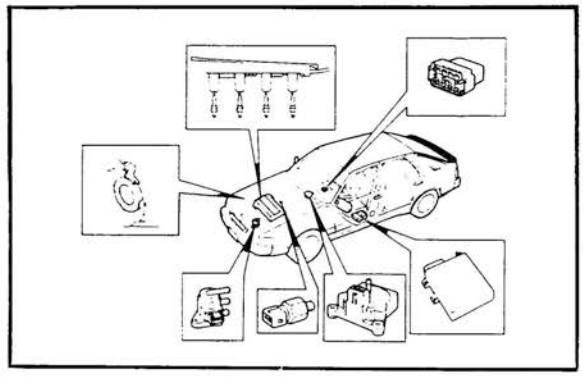
Pulsator

1 Air cushion
2 Diaphragm
3 From fuel line
4 To fuel-injection rail

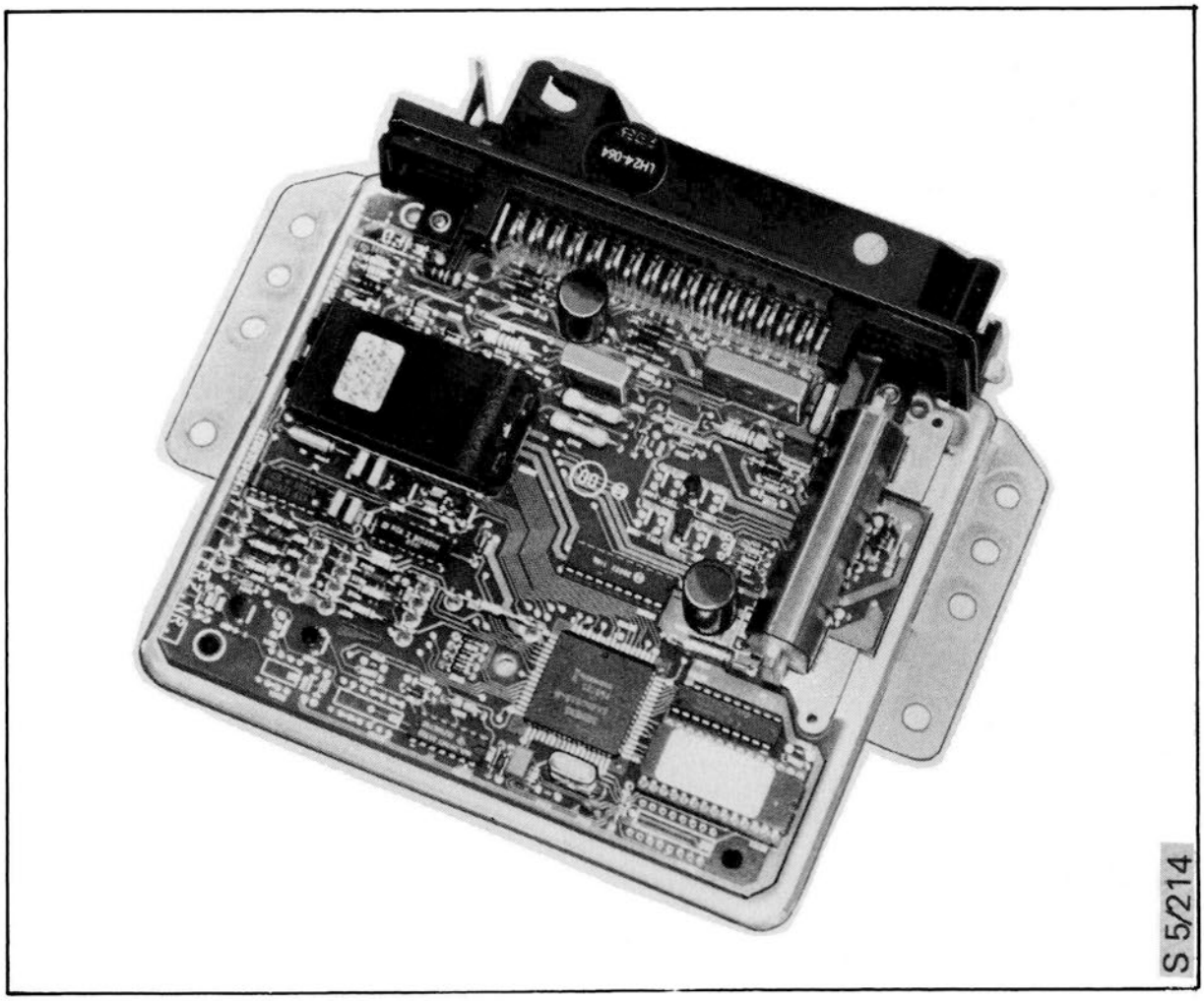
Saab DI system

The B234 engine is equipped with a modified version of the DI system, which controls the timing individually for each cylinder.

New plugs, designated BCPR 6ES, have been introduced.



The LH 2.4.1 fuel-injection system



The LH 2.4.1 injection system is a further development of the LH 2.4, which, in addition to the enhanced diagnostics available on all LH 2.4 systems for M90, also incorporates a number of new functions.

LH 2.4.1 is only fitted to cars having the new 2.3-litre B234 engine.

Improvements compared with the LH 2.4

- Time-delay function for AC cut-in integrated in ECU
- Air mass meter with greater measuring precision
- Improved AIC

Time-delay function for AC cut-in

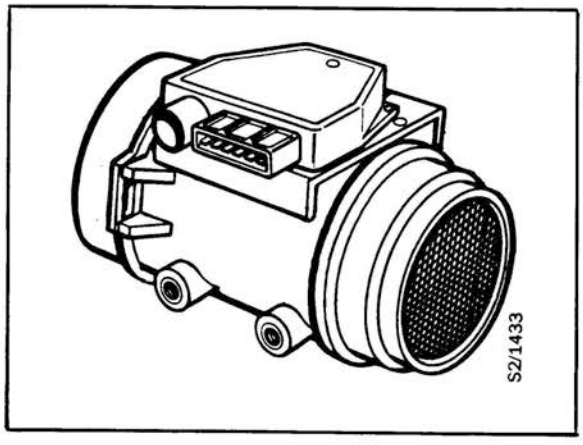
The time-delay function for AC cut-in, usually performed by the AC relay, has now been integrated in the LH-2.4.1 ECU.

The earlier AC relay has therefore been discontinued and a standard relay added.

Air mass meter with greater measuring precision

Greater measuring precision than in LH 2.4 has been achieved by increasing the temperature difference between the hot-wire sensor (filament) and the ambient air.

The temperature difference has been increased from 120°C to 155°C.



Improved AIC

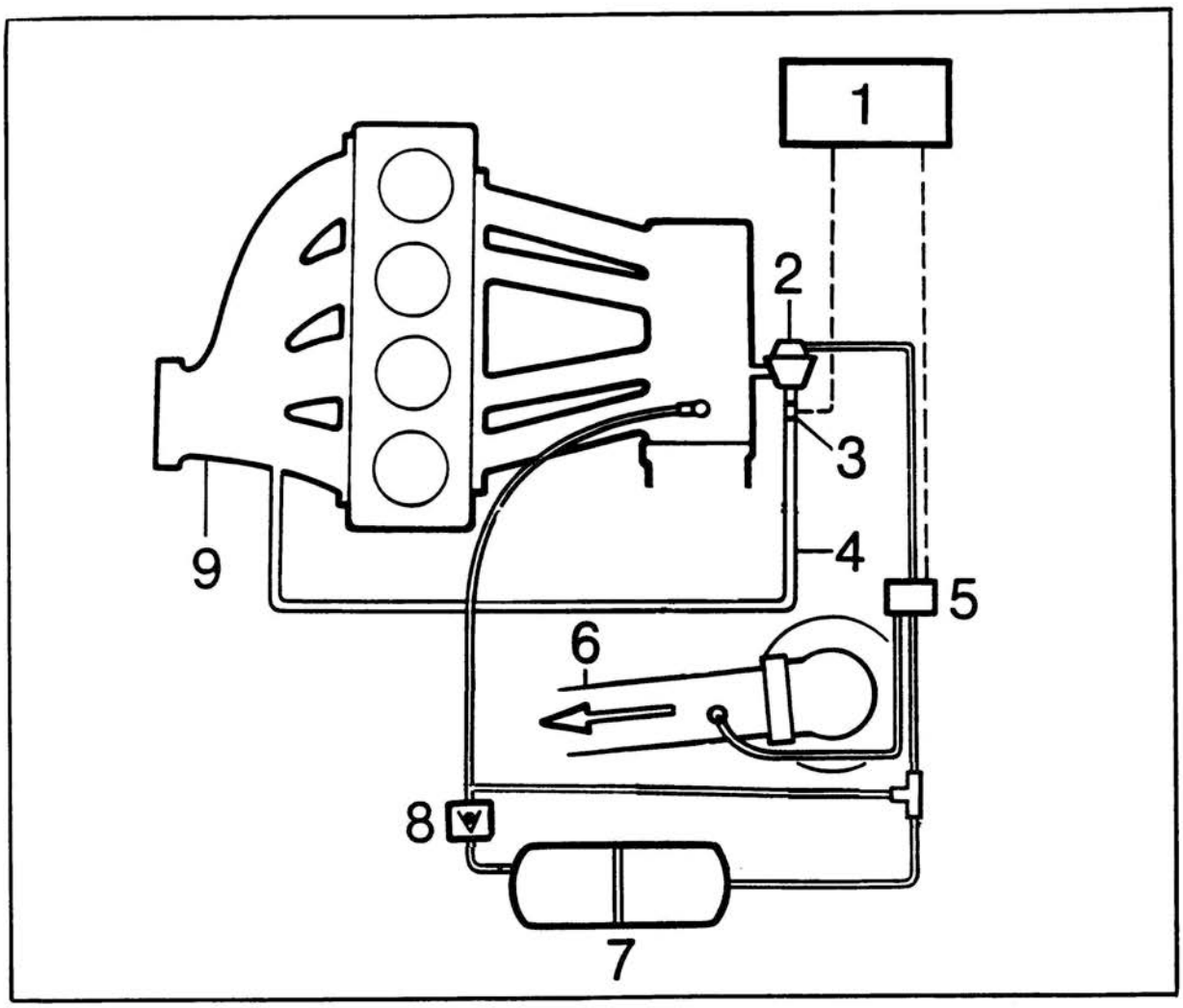
An added function in the form of a signal from a sensor on the speedometer enables the ECU to detect whether the car is moving or at a standstill.

With this information, the ECU is able to improve control of the AIC-valve setting and give enhanced drivability as compared with that achieved by LH 2.4.

Provided that the car is travelling faster than a predetermined minimum speed (4 or 5 mph; 6 - 8 km/h) the engine speed will be kept higher than idling speed; only when the road speed of the car has fallen below the preset limit will the engine speed be set to idling.

Thus, the car can now be brought to a standstill very smoothly.

Electronically controlled EGR



Electronically controlled EGR
(Schematic diagram)

1 LH-system ECU
2 EGR valve
3 Thermostatic switch
4 EGR pipe
5 Modulating valve with vacuum regulator
6 Turbo delivery pipe
7 Vacuum tank
8 Non-return valve
9 Exhaust manifold

All 2.3S cars to US-West specification have an electronically controlled EGR system.

The principle of exhaust-gas recirculation (EGR) for reducing emissions of oxides of nitrogen has previously been employed on cars to EU1 specification without catalytic converter.

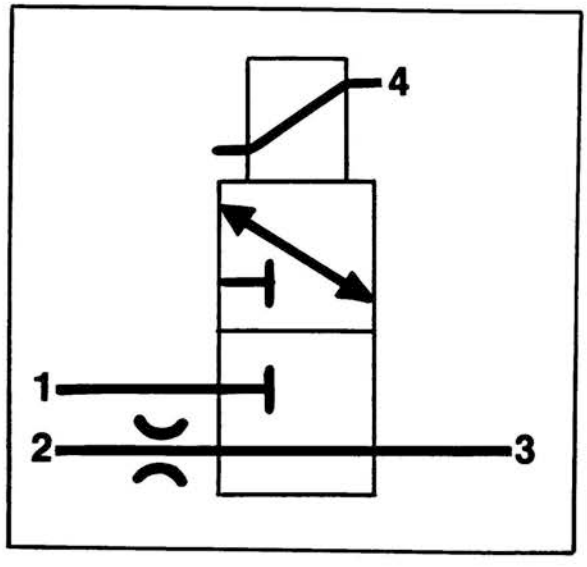
To meet the stricter regulations for California, an EGR system is now also being fitted to cars already equipped with catalytic converters. To maintain drivebility, and high precision in the EGR system combined with catalytic converter, the system is electronically controlled.

Description of operation

On cruising or gentle acceleration

Under normal conditions, the LH-system ECU collects information on the engine load, speed and temperature, and then computes the pulse ratio open/close cycle for the modulating valve to provide the required level of exhaust-gas recirculation.

The modulating valve functions like a three-way valve. A variation in the pulse ratio of the valve effects a similar variation in the control pressure to the EGR valve.



The valve is normally closed and opens when current is applied to the coil. The level of the control pressure is governed by the relationship between the time the valve is open and the time it is closed.

1 Vacuum tank
2 Venting
3 EGR valve
4 Coil

To ensure that a given pulse ratio will always provide the same control pressure, a vacuum regulator (incorporated in the modulating valve) is fitted in the line from the vacuum tank. The regulator maintains the vacuum acting on the modulating valve at a constant -200 mbar.

On acceleration

During acceleration, when exhaust-gas recirculation is needed most, the pressure in the inlet manifold approaches zero and the control pressure is therefore lost.

To maintain the necessary level of exhaust-gas recirculation, the control pressure for the EGR valve must be kept at about -120 mbar (the working range of the valve is between -50 and -150 mbar). This is where the vacuum tank and non-return valve come into play.

During normal driving conditions, the vacuum in the vacuum tank will drop to the same level as the depression in the inlet manifold, i.e. about -400 mbar.

On acceleration, the non-return valve prevents the vacuum inside the vacuum tank from being exhausted. The vacuum maintained inside the tank is then used to control the EGR valve during a period of 30 - 40 seconds (without the vacuum tank the EGR valve at this time would normally be closed).

In a manual car, a vacuum is built up inside the vacuum tank each time the driver changes gear, as the throttle butterfly closes and the depression inside the inlet manifold momentarily increases.

Fault indication and storage of fault data

If a fault occurs in the EGR system, the CHECK ENGINE light will come on and fault data will be stored in the memory of the LH-system ECU.

Fault data will be stored if the temperature sensor malfunctions (break in circuit) or if the temperature inside the EGR pipe falls a given amount when the following conditions apply:

- Light engine load prevailing for at least five seconds...
- engine temperature above 70°C ...
- and engine speed between 1,500 and 2,900 rpm.

The flashing code in the self-diagnostics function of the LH system is 12245 for an EGR fault.

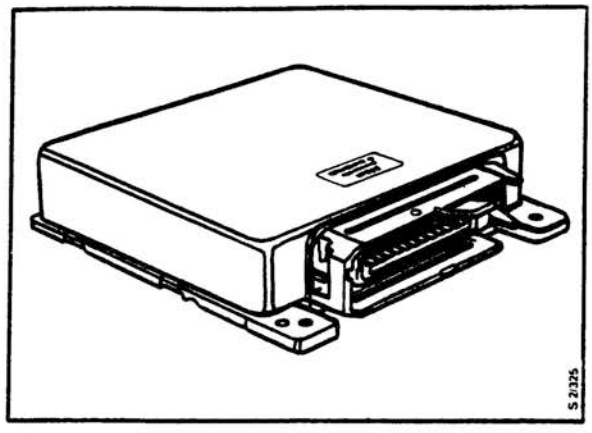
Further details on fault diagnosis are given starting on page 240-1.

EGR system components

LH-system ECU

The LH-system ECU processes the data it receives on engine load, speed and temperature to compute the optimum pulse ratio for the modulating valve to produce the required level of exhaust gas recirculation.

In the event of a fault in the EGR system, the integrated fault-diagnosis function of the ECU will store an error code (12245) in its memory that can subsequently be identified by means of the CHECK ENGINE light.

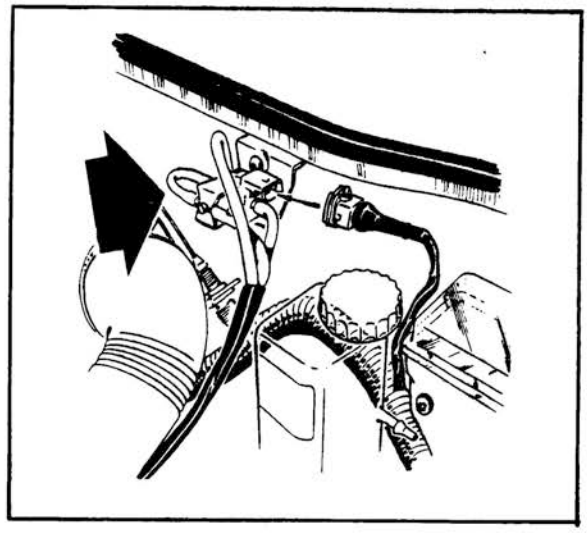


Modulating valve with vacuum regulator

The pulse ratio of the modulating valve, which functions like a three-way valve, controls the line pressure to the EGR valve.

All the ports on the modulating valve are colour coded to obviate hoses being misconnected in conjunction with fitting or servicing of the valve.

The modulating valve is fitted behind the throttle-housing, on the false bulkhead panel.



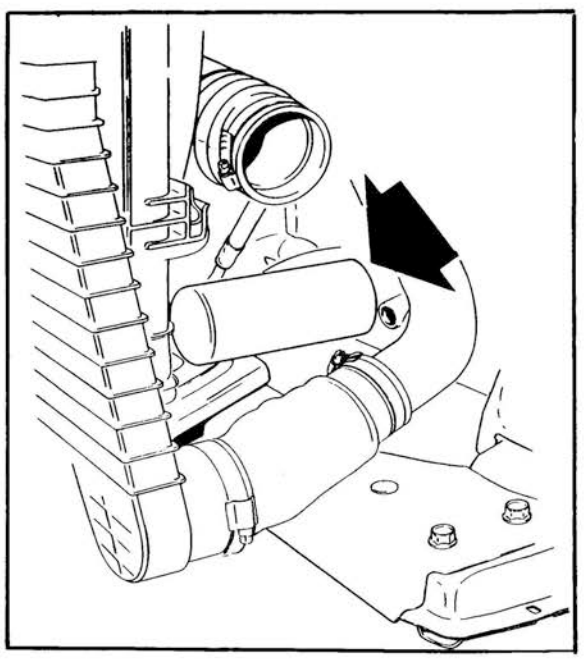
Vacuum regulator

A vacuum regulator is incorporated in the modulating valve to maintain a constant vacuum to the valve.

The regulator maintains a vacuum of -200 mbar.

Vacuum tank

The vacuum tank is connected via a non-return valve to the inlet manifold, which creates a vacuum in the tank under normal driving conditions. The vacuum will not exceed -400 mbar.



Non-return valve

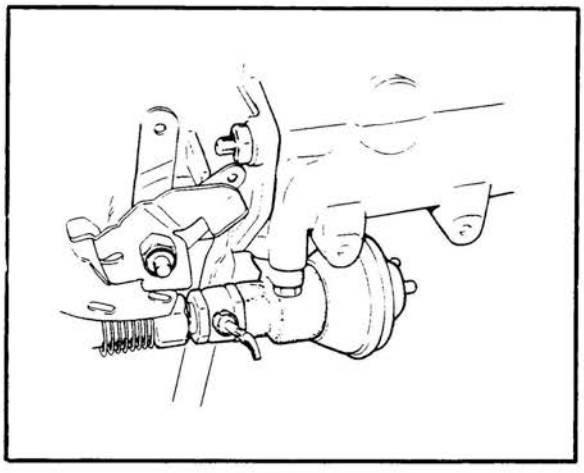
The non-return valve is fitted in the line between the vacuum tank and the inlet manifold. The purpose of the valve is to prevent the vacuum in the tank from being exhausted during acceleration.

EGR valve

The function of the EGR valve, which is controlled by the modulating valve, is to open or cut off the flow of exhaust gases from the exhaust manifold via the EGR pipe to the inlet manifold.

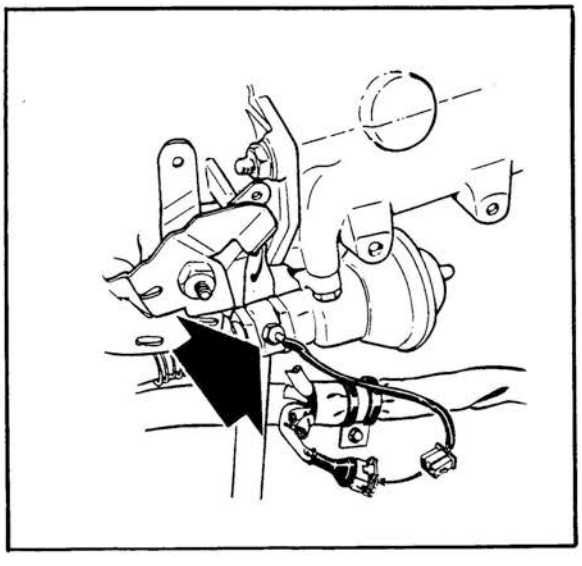
The EGR valve is opened by the control pressure (vacuum) acting on the diaphragm in the valve.

The valve is closed by means of a spring, assisted, when the engine is under full load, by the pressure from the overflow valve acting on the diaphragm.



Temperature sensor

Connected to the EGR valve is a temperature sensor, which provides continuous information to the LH-system ECU about the temperature in the EGR pipe. If the temperature deviates from the nominal range, a fault is indicated in the system and an error code is stored in the ECU memory.



Power train

To remove

The method described applies to the car when equipped with AC, automatic transmission, catalytic converter and a hydraulic automatic belt tensioner for the auxiliaries belt.

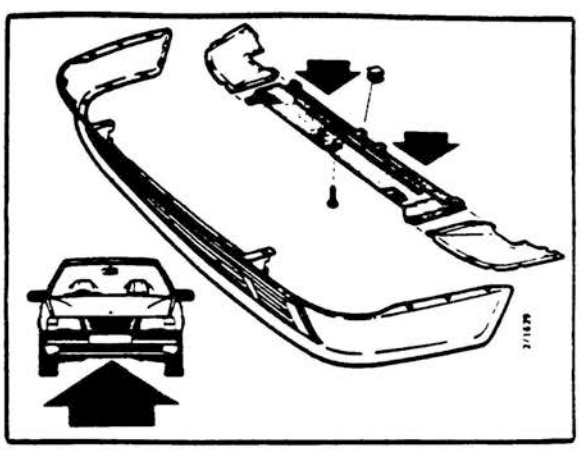
Caution
Numerous electrical leads, hoses, etc. are secured by plastic cable ties. After these ties have been pulled tight, the excess length is usually cut off, often leaving a sharp edge to the plastic.

Bear this in mind when securing ties to avoid leaving sharp edges that could do damage by chafing.

1 Raise the car on a lift and remove the front wheels.

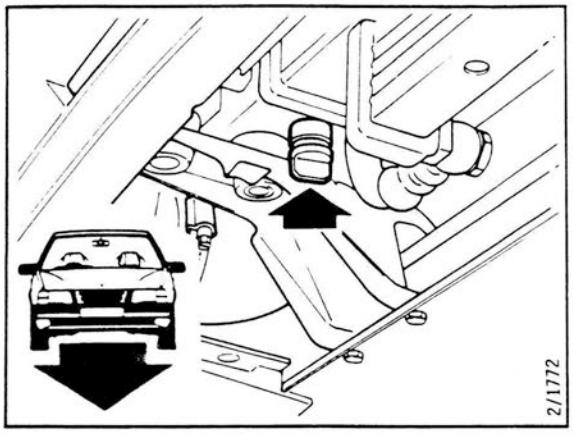
Remove the wing liners from the RH wing.

Remove the middle infill panel from under the spoiler.



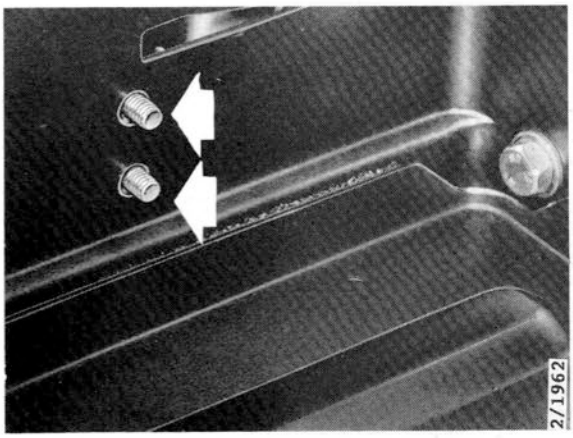
2 Unscrew the drain plug from the radiator and drain off the coolant.

To speed the process, lower the car and remove the filler cap from the expansion tank.



3 Disconnect the battery leads and remove the battery.

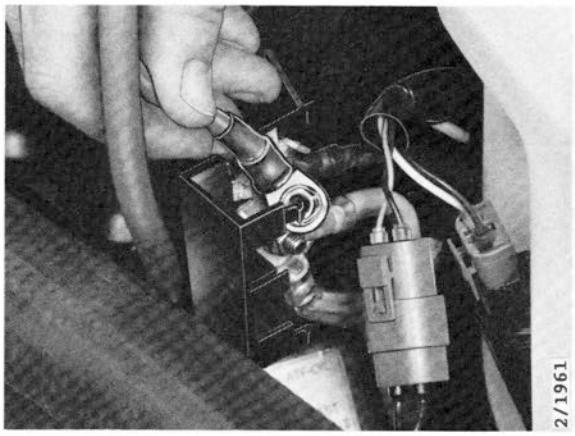
4 Make access for removal of the battery shelf as follows:



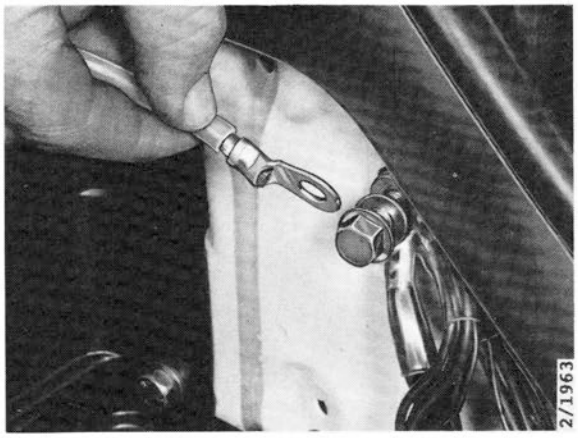
- Unbolt the steady bar for the ABS unit
- Unplug the three connectors for the DI-system wiring loom and release the clips for the leads from the bracket attached to the battery shelf.

- Disconnect the battery positive lead from the terminal block and remove the clip from the shelf.

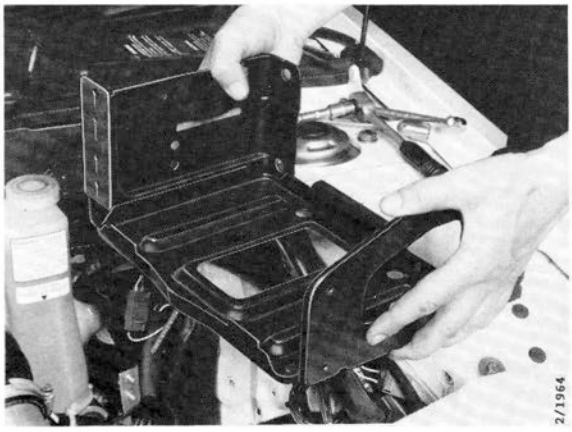
  Remove the terminal block.



- Disconnect the battery negative lead from the earthing point on the wing.



Remove the battery shelf and tuck the leads out of the way.

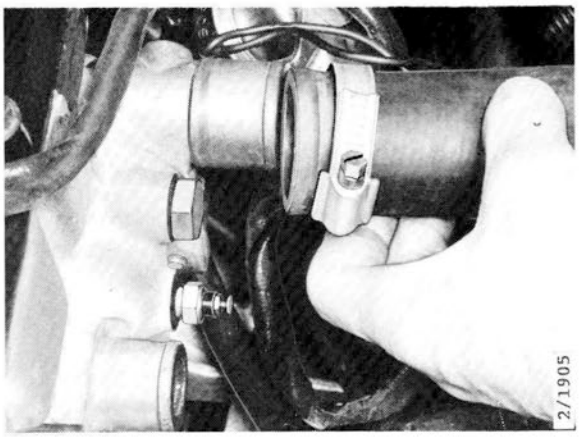


Caution
To avoid electrical problems and to maintain a high level of reliability, the connectors in the engine bay are designed to be a tight fit. Consequently, they are sometimes difficult to separate.

Never try to separate the connectors by pulling on the leads.

5 Unplug the connector for the DI wiring loom and the connector from the knock detector in the block (underneath the inlet manifold).

6 Slacken the clip and disconnect the top radiator hose.

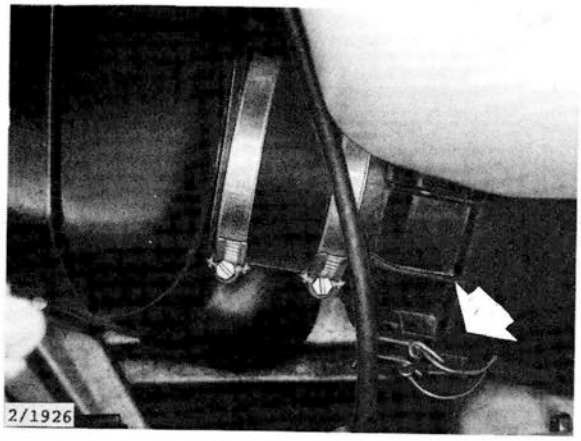


7 Make access for removal of the air intake as follows:

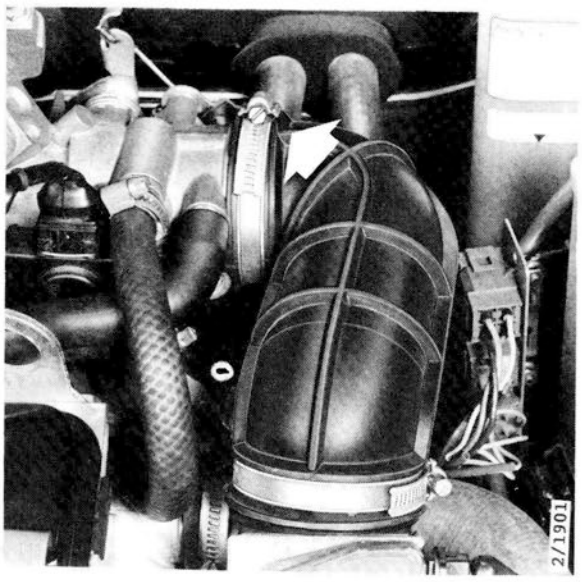
- Unplug the connector from the air mass meter

- Undo the steady bar for the air-intake silencer

- Release the toggle clips on the air cleaner



- Undo the hose clip at the throttle housing



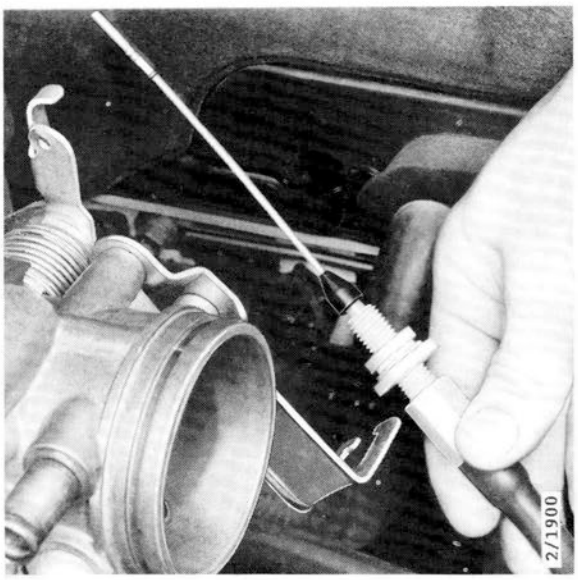
Lift off the air intake complete with silencer, air mass meter and rubber elbow.

8 Unplug the connectors for the washer-fluid level sensor and pump.

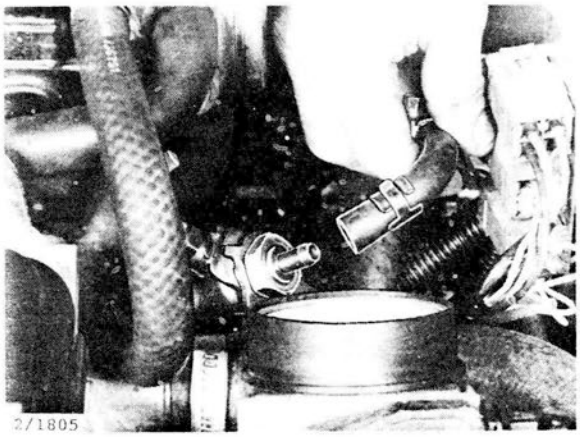
Unplug the hose from the tee piece and plug the end of the hose (e.g. with a suitably sized bolt).

Undo the two securing screws and lift out the reservoir.

9 Remove the clip, lift up the throttle lever and disconnect the cable from the linkage.



10 Disconnect the fuel return hose from the fuel-pressure regulator and tuck the end of the hose up against the false bulkhead panel.



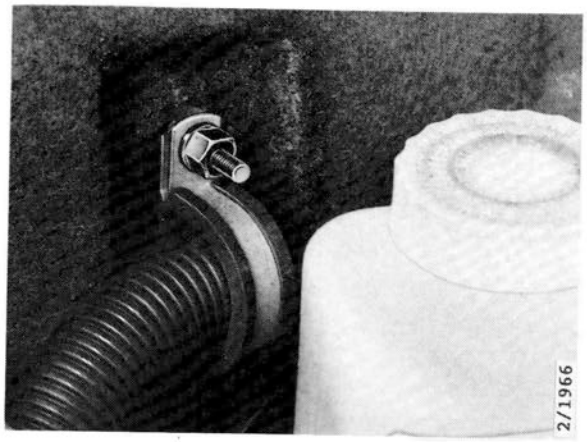
11 Place a piece of rag or absorbent paper under the connection, and disconnect the fuel supply hose from the fuel-injection rail.

Pull out the end of the hose and tuck it out of the way.

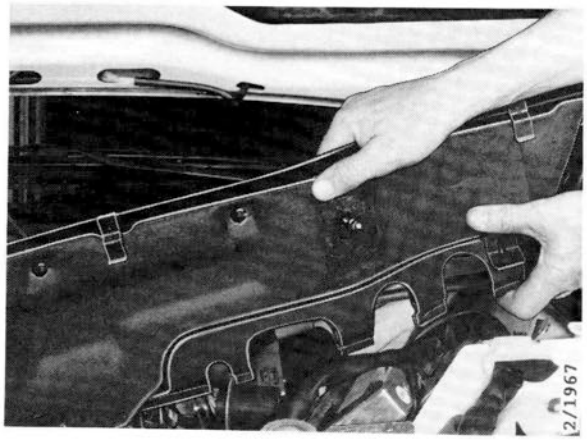
12 Remove the cover over the space behind the false bulkhead panel.

13 Remove the rubber moulding from the edge of the panel.

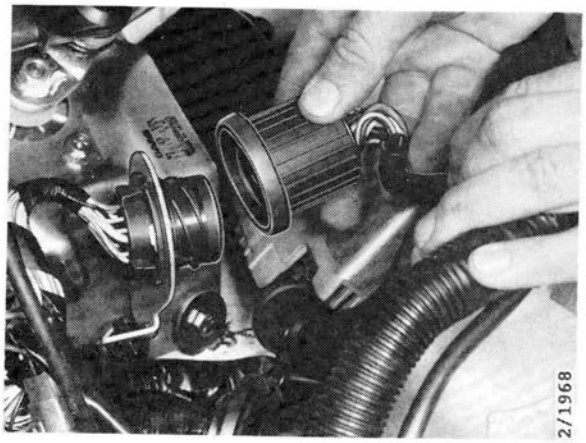
14 Undo the clip securing the engine wiring loom to the bulkhead panel.



Undo the securing bolts and lift out the false bulkhead panel.

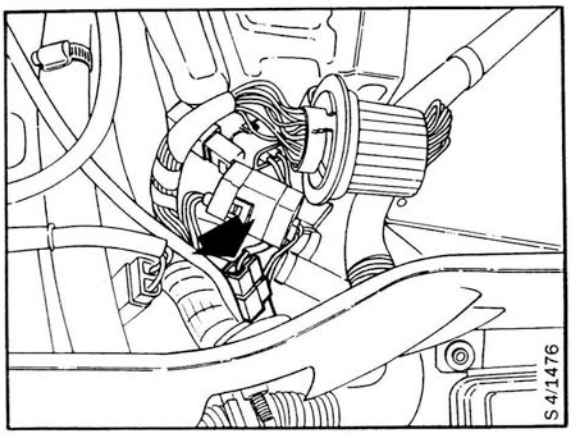


15 Unplug the connector in the engine wiring loom and tuck the loom away on top of the engine.

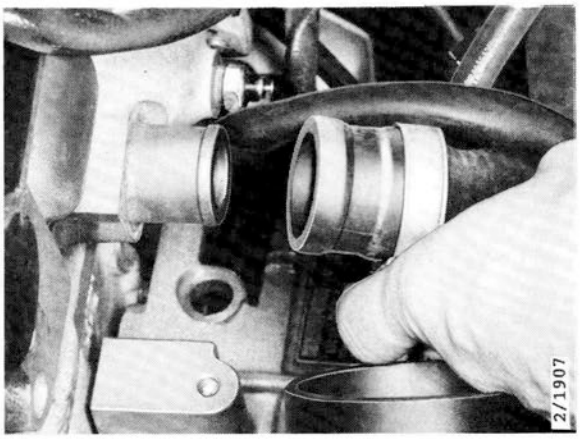


16 Unplug the connector for the road-speed sensor lead.

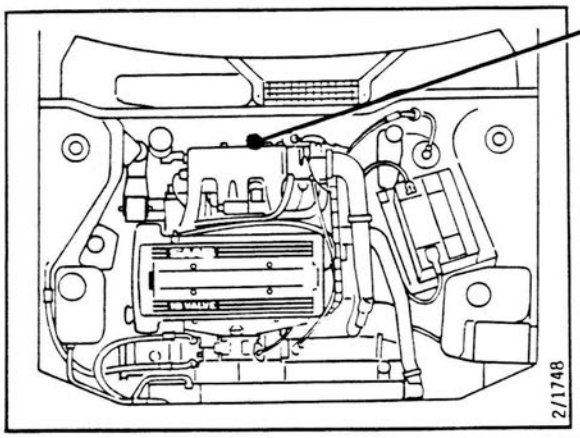
17 Pull the cable out of the grommet in the bottom of the bulkhead and tuck the lead away on top of the engine.

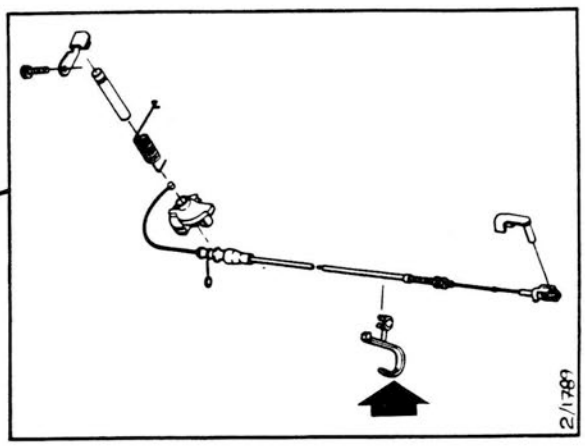


18 Disconnect the heater-box hoses from the cylinder head and tuck them away behind the brake fluid reservoir.



19 Unscrew the clip securing the kickdown cable to the pipe from the steering servo pump.

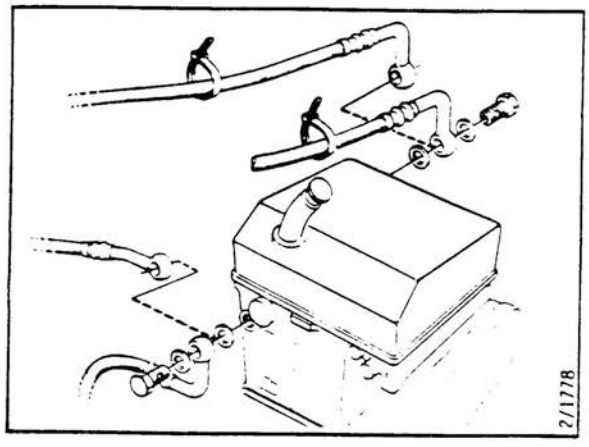




20 Clean the surrounding areas and disconnect the hoses from the oil cooler for the automatic transmission.

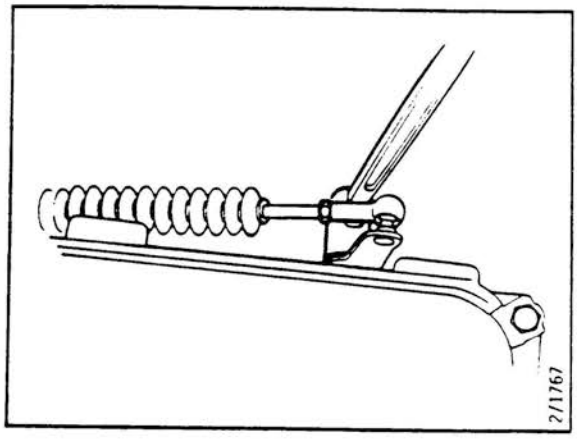
Blank off the ports in the transmission case and the fittings on the ends of the hoses.

Secure the hoses to the radiator crossmember.



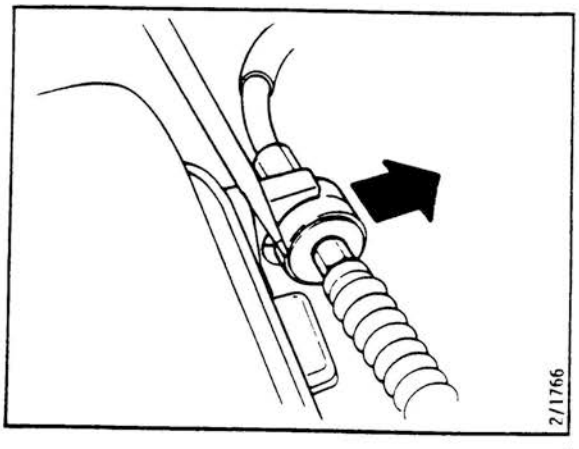
21 To avoid the leads being damaged when the power train is lifted out of the car, unplug the connector from the brake fluid reservoir.

22 Remove the nut from the gear-selector rod linkage.



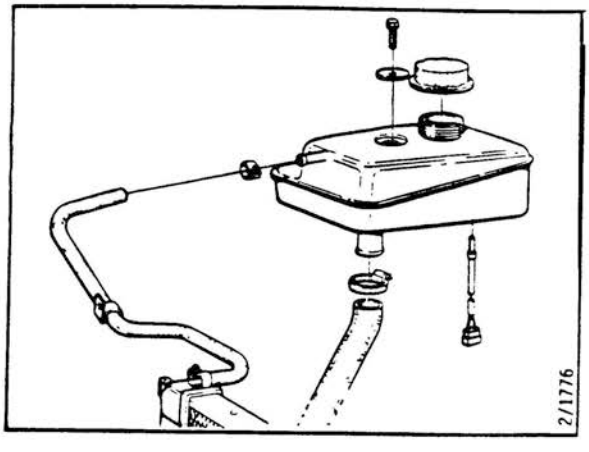
23 Slacken the cable and prise it complete with rubber bush out of the clip.

Tuck the cable behind the brake fluid reservoir.



24 Disconnect the hoses from the expansion tank.

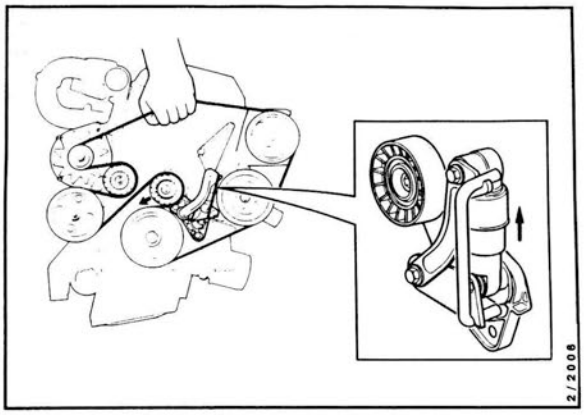
Undo the securing bolt, snip through the tie, unplug the connector and lift out the tank.



25 Use a spanner to release the tension applied by the belt tensioner and apply a hard upward pull on the belt.

As soon as the belt is slack enough, fit locking pin 83 94 488 to the tensioner.

Ease the belt off the AC compressor pulley.



26 Fit a protective steel panel or the like over the oil cooler and cover the RH section of the radiator crossmember with rags.

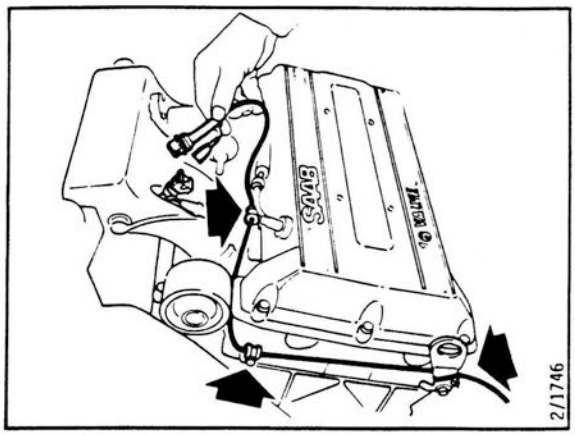
Unplug the connector from the AC compressor, undo the securing bolts and lift the compressor onto the radiator crossmember.

Secure the compressor for the time being by means of a tie or the like.

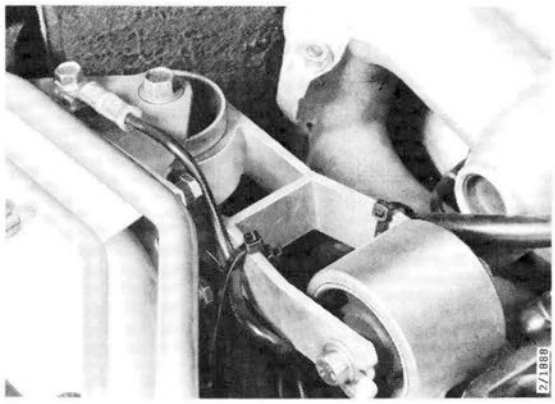
27 Disconnect the top radiator hose from the water pump.

Undo the clip and disconnect the bottom radiator hose from the pump.

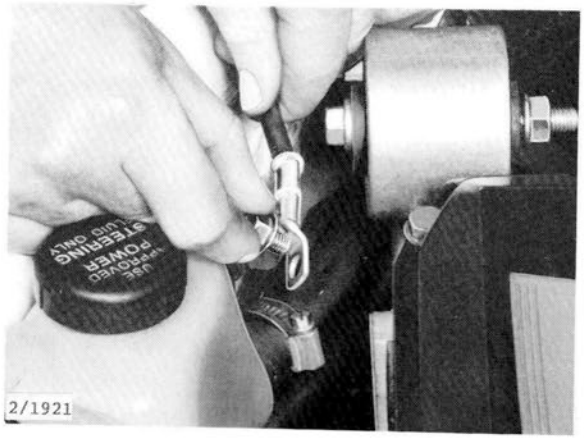
28 Disconnect the Lambda sensor by unplugging the connector underneath the inlet manifold.



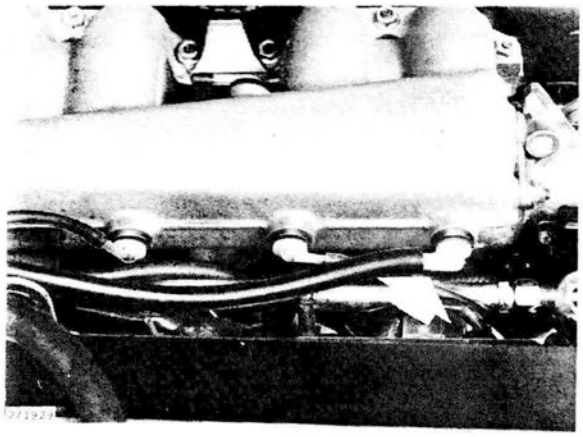
29 Snip through the ties securing the servo hoses, charcoal-canister hose and wiring loom to the top torque arm.



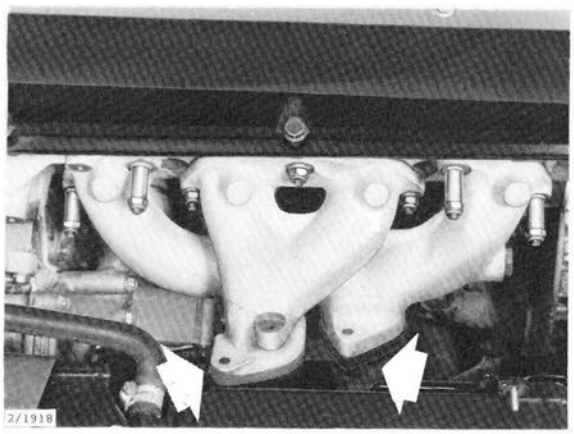
Disconnect the radio-suppressor (earth) lead from the torque arm fixing and remove the arm.



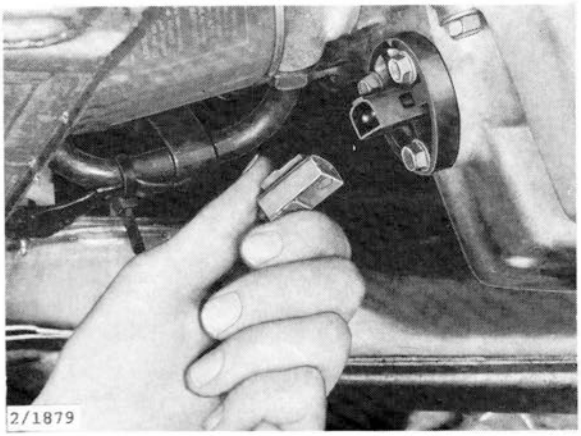
30 Disconnect the hose to the charcoal canister from the inlet manifold and tuck it out of the way.



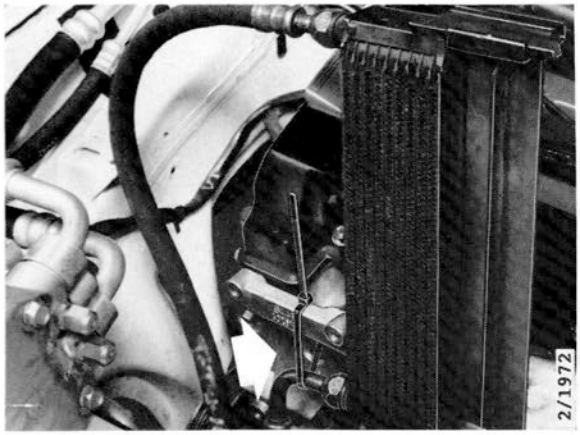
31 Unbolt the exhaust pipe from the exhaust manifold.

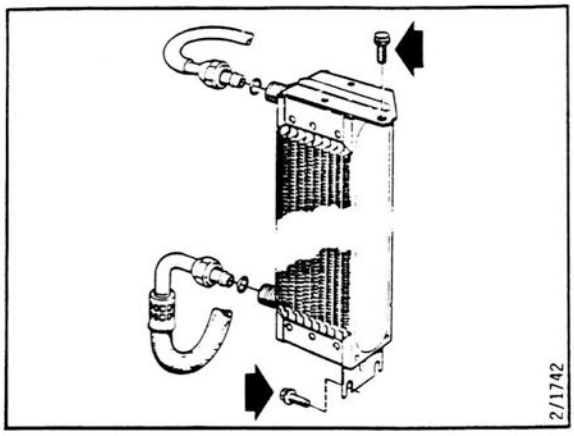


32 Unplug the connector from the oil-level sensor and place the lead along the edge of the wing.



33 Remove the top securing bolt and slacken the two bolts at the bottom of the oil cooler. Snip through any ties and tie the cooler to the engine.





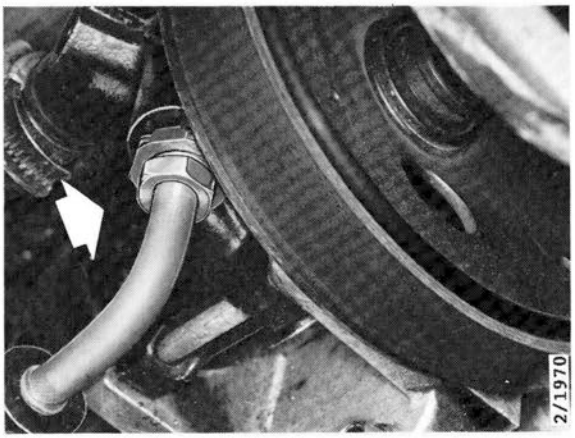
34 Undo the securing bolt for the power-steering fluid reservoir, lower the reservoir and siphon off the fluid.

35 Disconnect the servo hose from the reservoir and tuck the end underneath the inlet manifold. Stand the reservoir on the bulkhead.

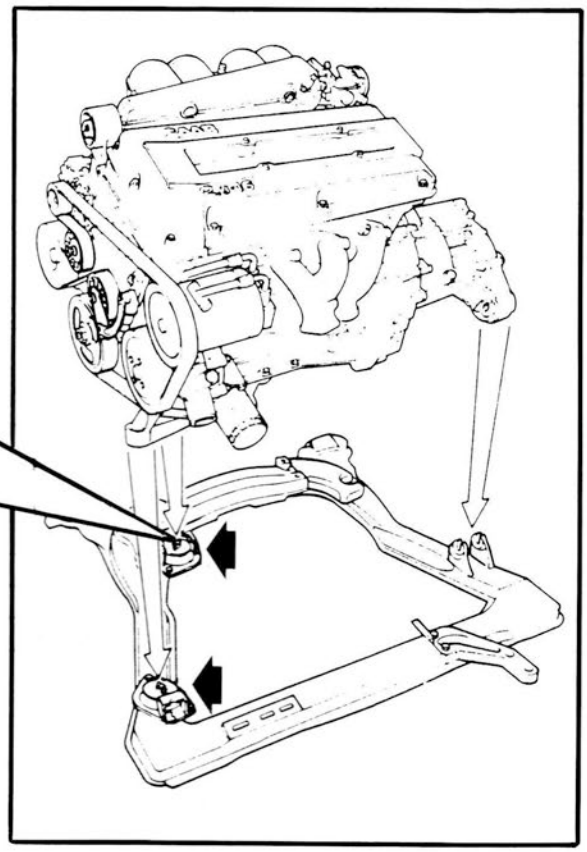
36 Raise the car and disconnect the steering servo delivery pipe from the pump. Use a second spanner across the flats to stop the fitting turning.

Fit a plug in the end of the pipe and deal with any spillage immediately.

Remove the pipe clip from the support bearing bracket/rear engine mounting.

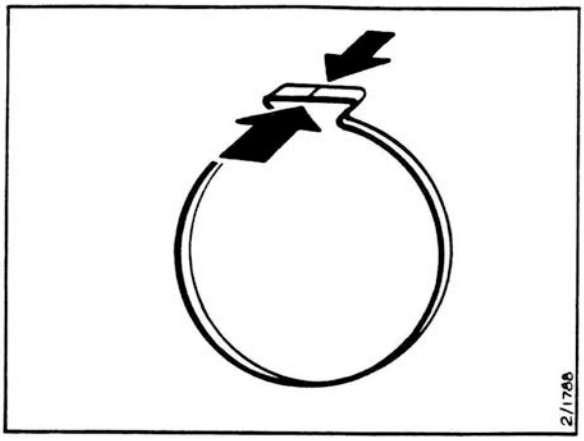


37 Remove the nuts from the engine mountings on the RH side.

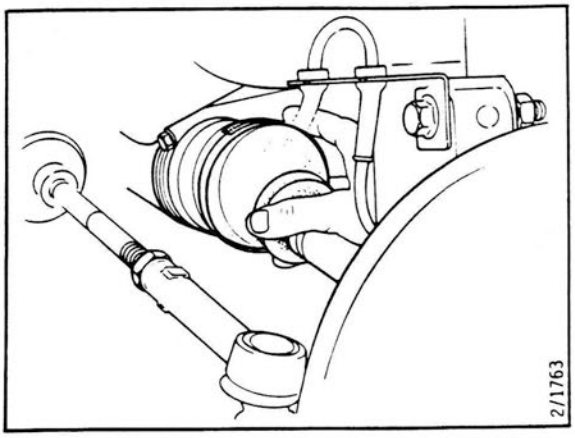


38 On both sides of the car:

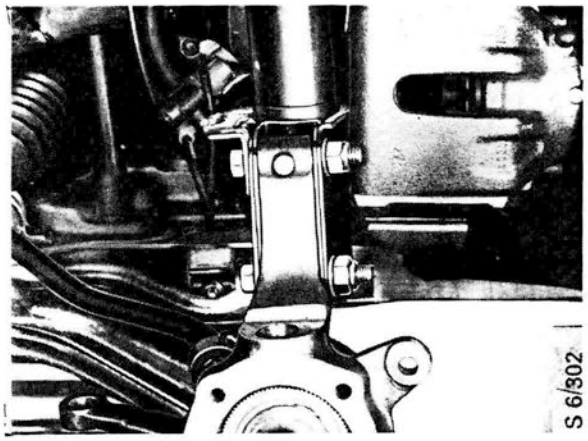
Note
Use a pair of pliers to snip through clips of the non-screw type. Take care not to damage the gaiter.



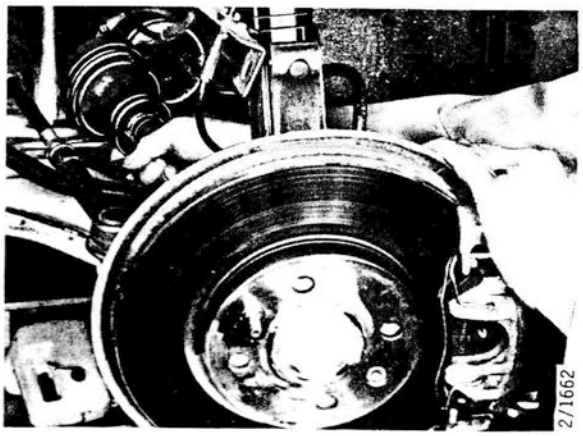
- Unscrew or remove the clips for the gaiters over the drive-shaft joints.



- Slacken off the bottom bolts securing the MacPherson struts to the steering swivel members and remove the top bolts.

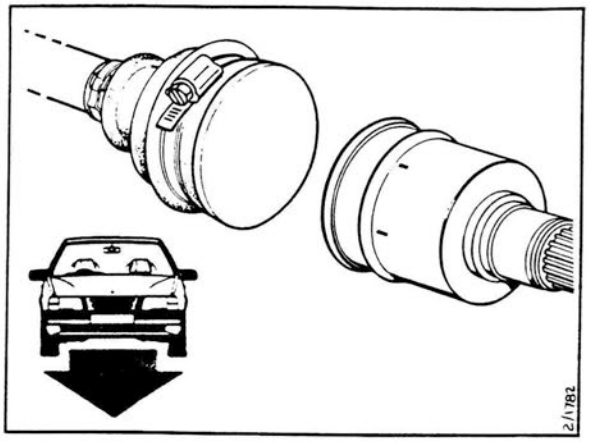


- Pull away the steering swivel members to separate the drive-shaft joints.



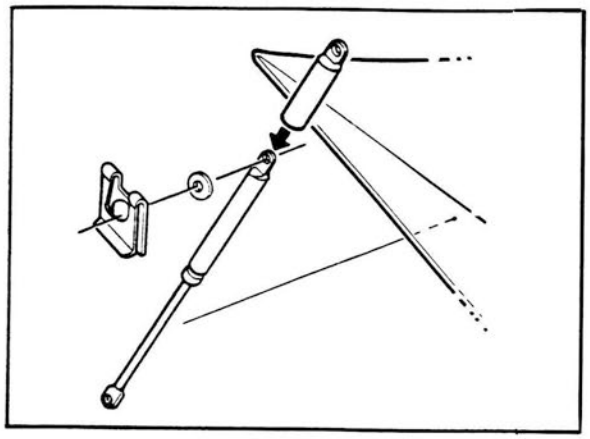
- Fit protective caps to both halves of the joints.

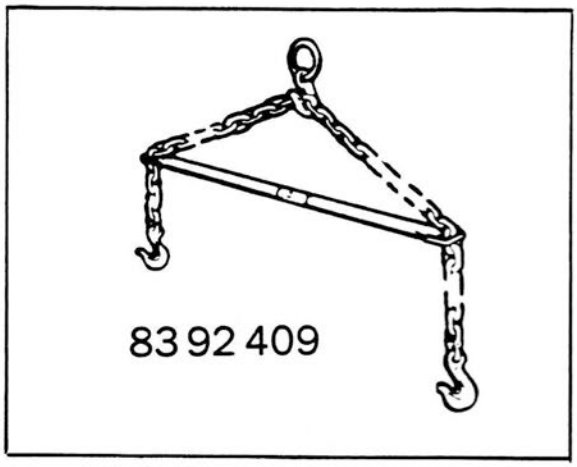
- Lower the car.



39 Unbolt the LH engine mounting.

40 Disconnect the struts from the bonnet (hood) and fit extension pieces 83 94 439 onto the ends.





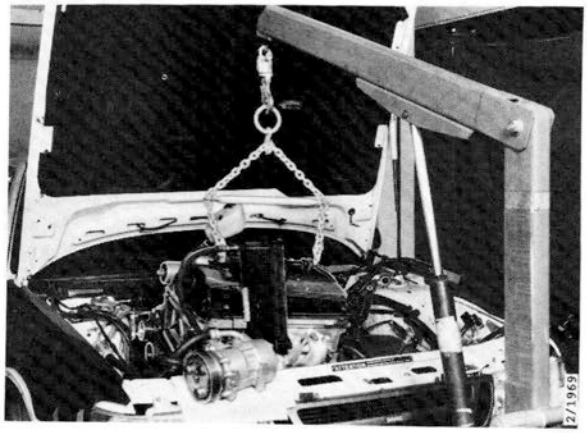
41 Attach lifting sling 83 92 409 to the eyes on the engine.

With extreme care, slowly raise the power train.

Pay particular attention to ensure that the following components do not snag:

In the engine bay:
ABS unit
Kickdown cable
Cooling fan

On the power train:
Steering servo pump
Alternator pulley



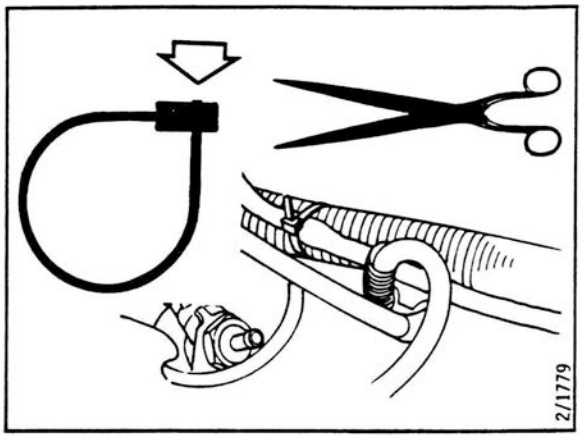
To fit

The method described applies to the car when equipped with AC, automatic transmission, catalytic converter and a hydraulic automatic belt tensioner for the auxiliaries belt.

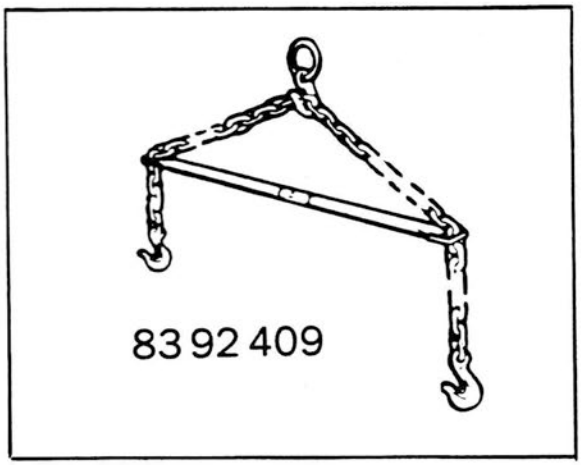
Caution
Numerous leads, hoses, etc. are secured by means of plastic ties.

After pulling it tight, cut off the end as close as possible to the clip.

Help to prevent the risk of chafing damage done by sharp edges.



1 Attach lifting sling 83 92 409 to the eyes on the engine.



Before lowering the power train, insert the bolt through the LH engine mounting.

Position the power train over the engine bay and lower it slowly and carefully into position.

Take great care not to do any damage.

Pay particular attention to ensure that the following components do not snag:

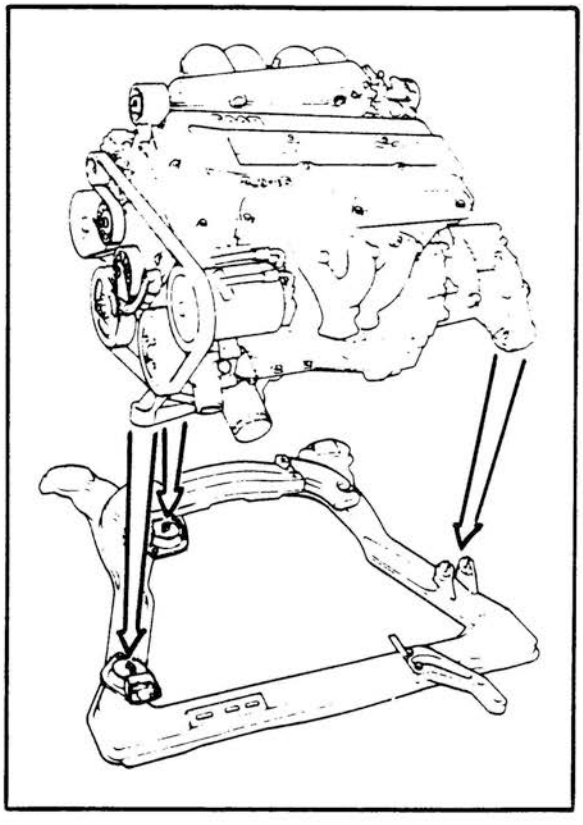
In the engine bay:
ABS unit
Kickdown cable
Cooling fan

On the power train:
Steering servo pump
Alternator pulley

Remove the lifting sling.

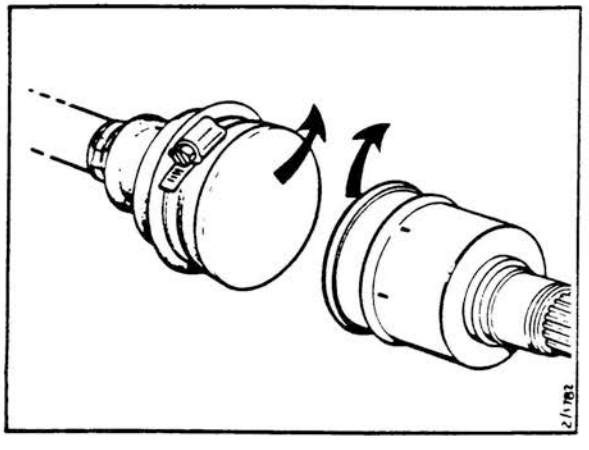
2 Tighten the LH engine mounting.

3 Raise the car and tighten the RH engine mountings.

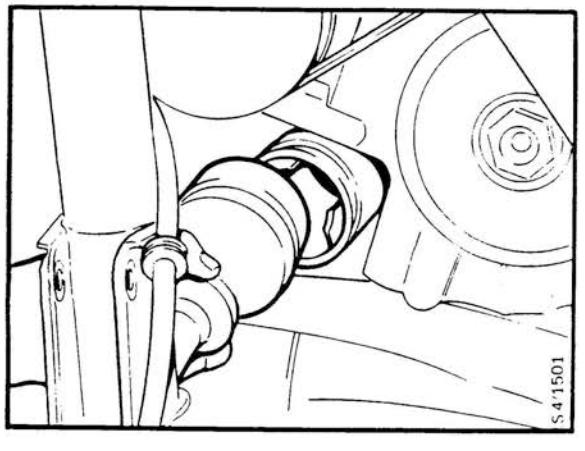


4 On both sides:

- Remove the protective caps from the drive-shaft joints and check that there is sufficient grease in the joints.

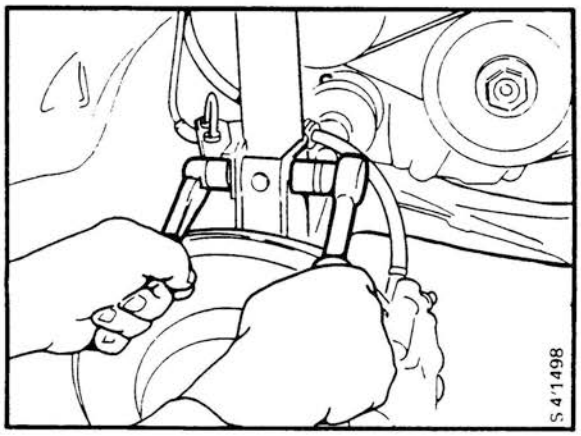


- Engage the two halves of the joints and slide the rubber gaiters into position.



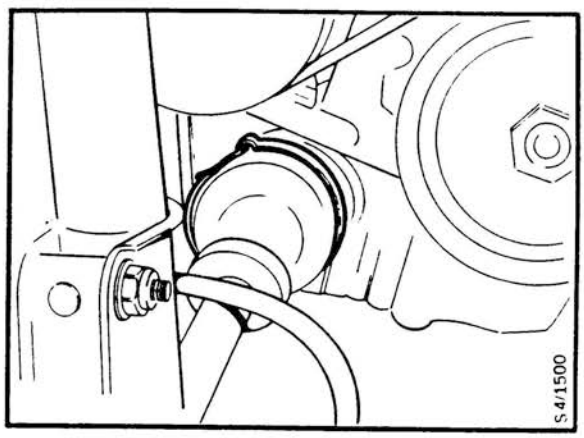
- Fit the top bolts securing the MacPherson struts to the steering-swivel members and tighten the top and bottom securing bolts to the specified torque:

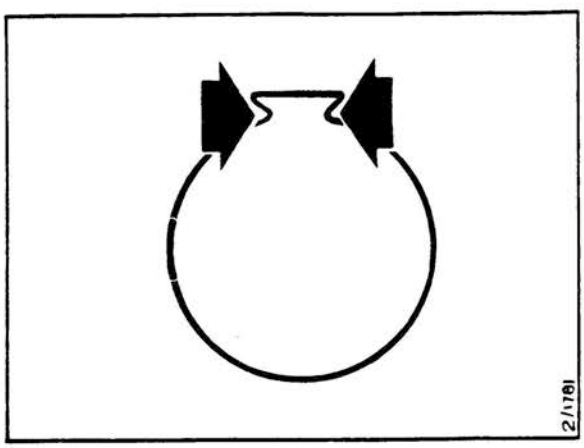
  Tightening torque:
  78 - 105 Nm (57.5 - 77.4 lbf ft)



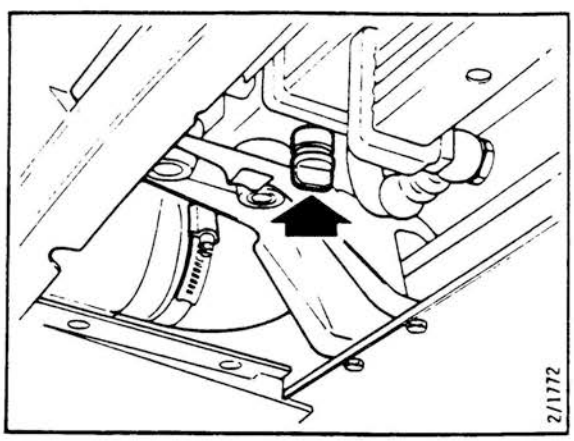
- Fit the clips on the rubber gaiters.

  If clips of the non-screw type are used, fit them as shown. Take care not to damage the gaiters.

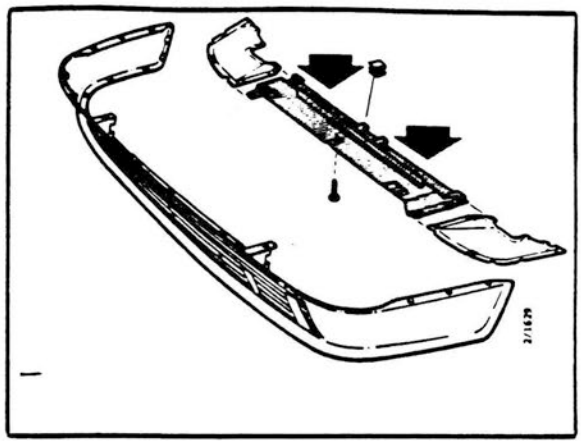




5 Check that the radiator drain plug is screwed in tight.

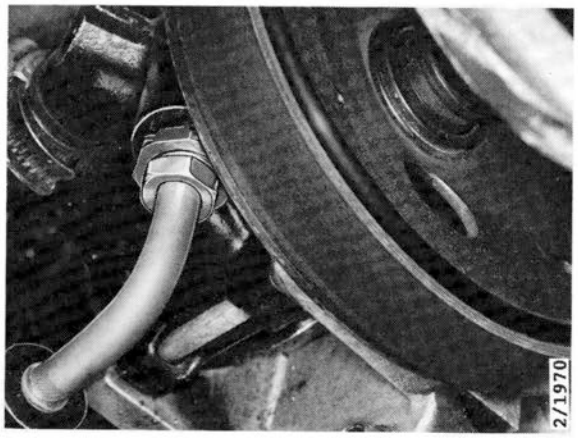


6 Fit the middle infill panel under the spoiler.



7 Remove the plug and connect the steering servo pipe to the pump.

Secure the pipe clip to the support bearing bracket.

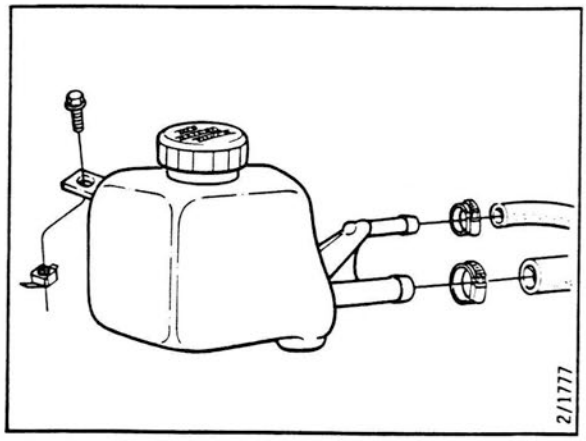


Lower the car.

8 Reconnect the charcoal-canister hose to the inlet manifold.

9 Fit the power-steering fluid reservoir.

10 Reconnect the servo pump hose to the reservoir.



11 Fit the oil cooler. Clip the top hose to the wheel arch.

12 Plug the connector onto the oil-level sensor.

13 Bolt the exhaust pipe to the exhaust manifold.

14 Reconnect the bottom radiator hose to the water pump.

15 Reconnect the hose to the top of the pump.

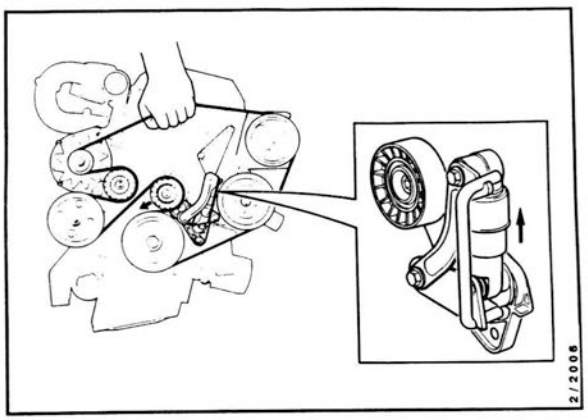
16 Fit the AC compressor.

Tightening torque:
20 Nm (14.8 lbf ft)

Plug on the connector and make sure the lead is well clear of the pulley.

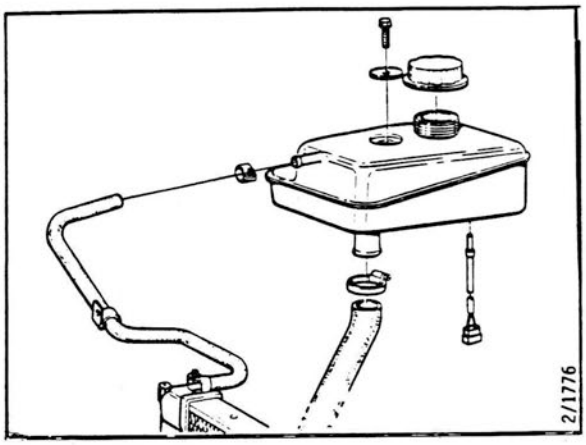
17 Ease the belt onto the compressor pulley.

Apply a hard upward pull to the belt and remove locking pin 83 94 488. Release the belt and check to see that it is correctly seated in all of the pulleys.

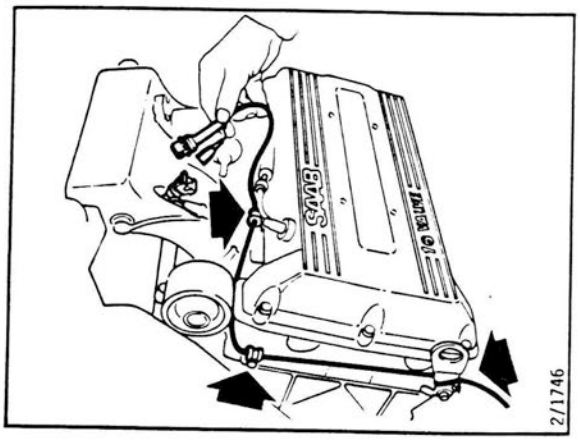


18 Reconnect the radiator hose to the expansion tank and plug on the connector. Put back the tank, secure it and reconnect the expansion hose.

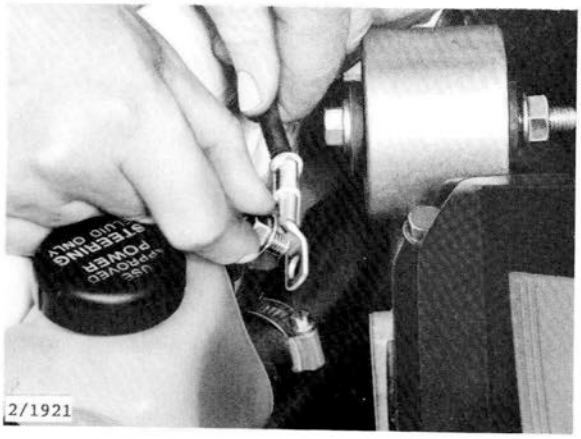
Fit a plastic tie round the leads and hoses.



19 Reconnect the connectors for the Lambda sensor loom (underneath the inlet manifold).



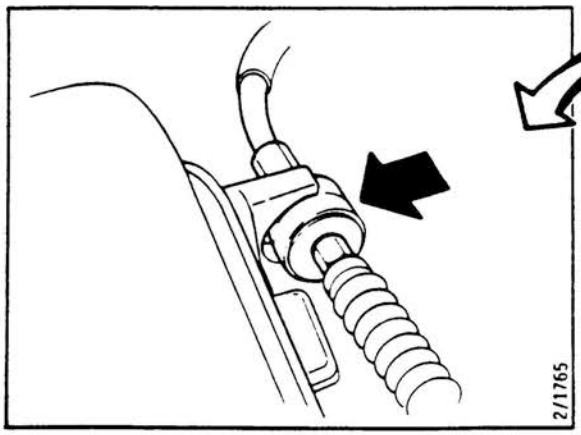
20 Fit the engine torque arm, remembering to secure the radio-suppressor (earth) lead under the fixing bolt.

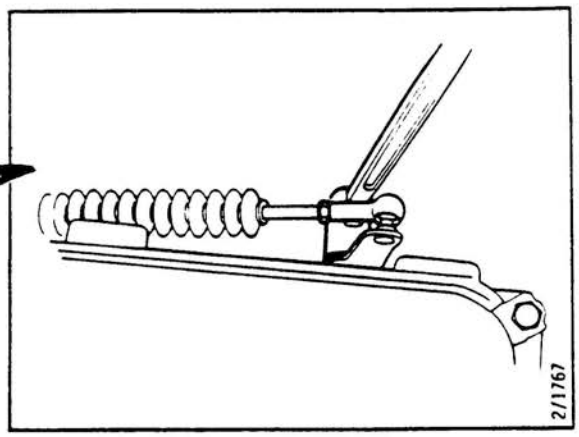


21 Secure the steering servo hoses, charcoal-canister hose and wiring to the torque arm by means of plastic ties.

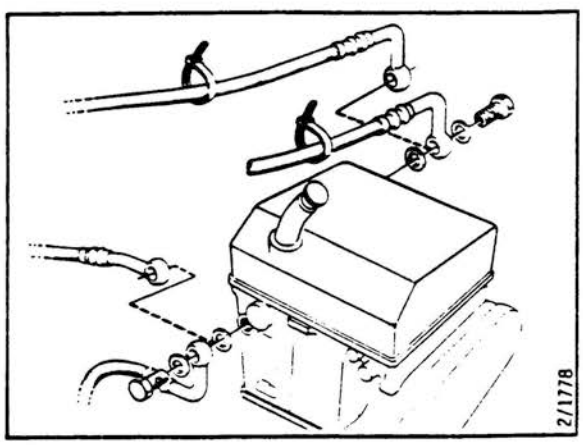
Note
Before reconnecting the gear-selector cable to the transmission, make sure that the kickdown cable is secured in the clip on the steering servo pipe.

22 Reconnect the gear-selector linkage and secure the cable bush in the bracket.



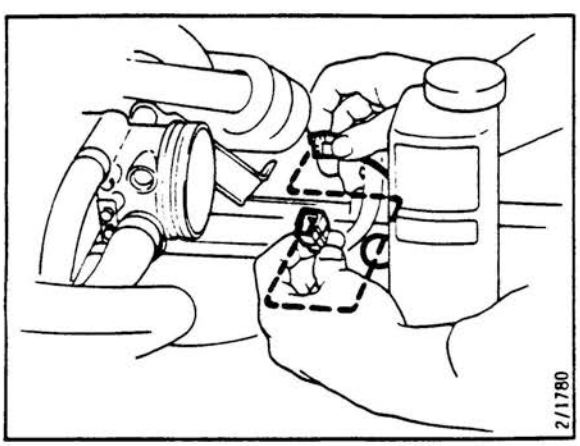


23 Remove the plugs and reconnect the oil-cooler hoses to the transmission. Secure the hoses with ties.



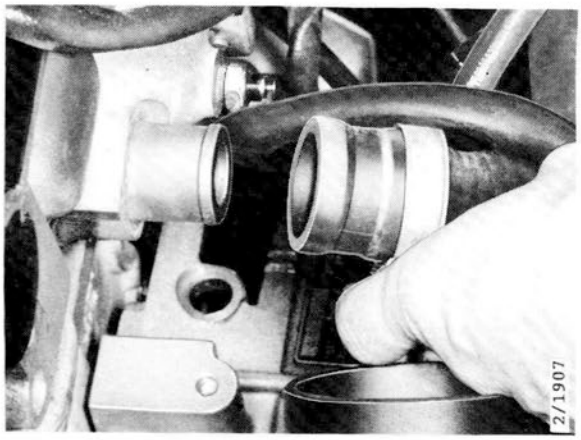
24 Plug the connector onto the brake fluid reservoir.

25 Insert the road-speed sensor lead through the grommet in the bottom of the bulkhead and plug on the connector.

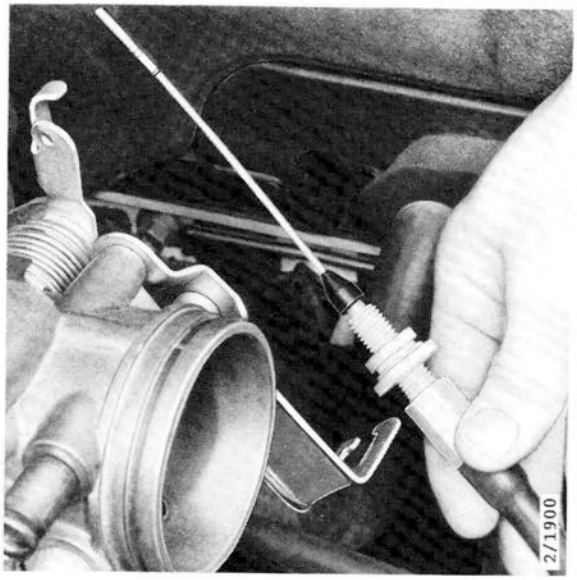


Note
On the hose underneath the inlet manifold, position the clip with the screw towards the left and at the top to facilitate fitting.

26 Reconnect the hoses from the heater box to the engine.

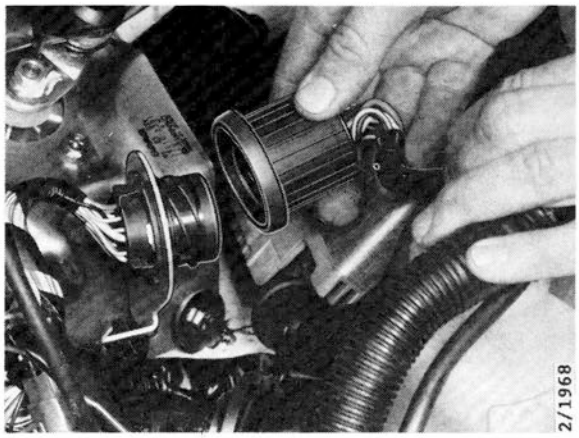


27 Reconnect the throttle cable.

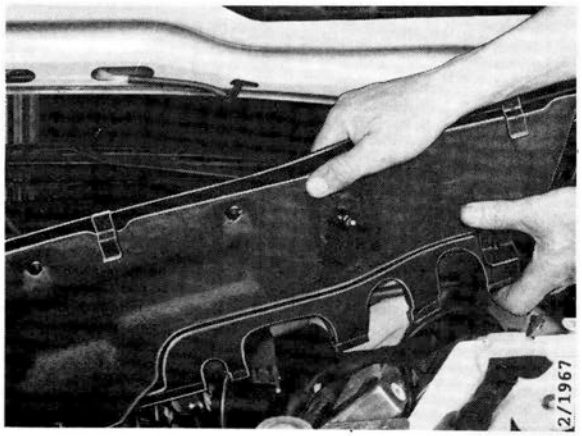


28 Plug the connector onto the knock detector.

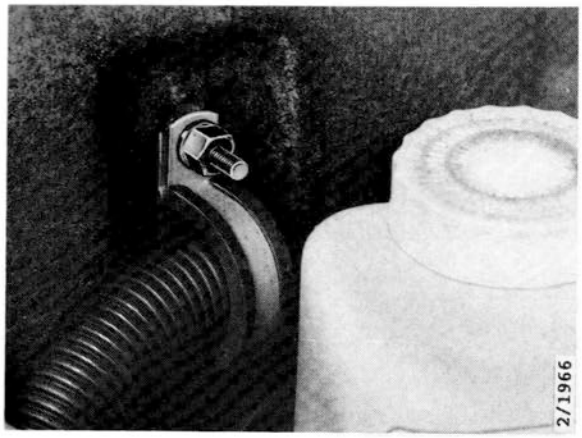
29 Plug in the connector in the engine wiring loom.



30 Refit the false bulkhead panel and the rubber moulding.

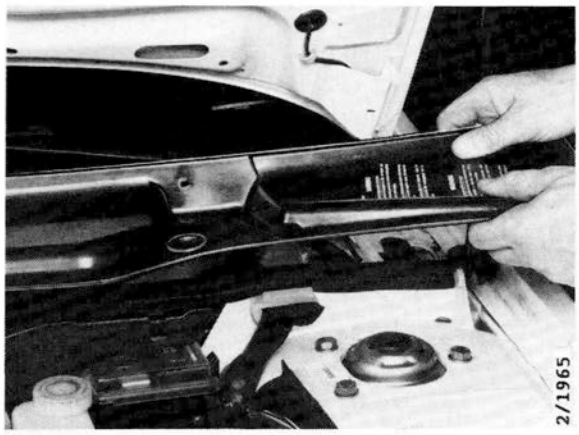


31 Fit the clip securing the engine wiring loom to the false bulkhead panel.



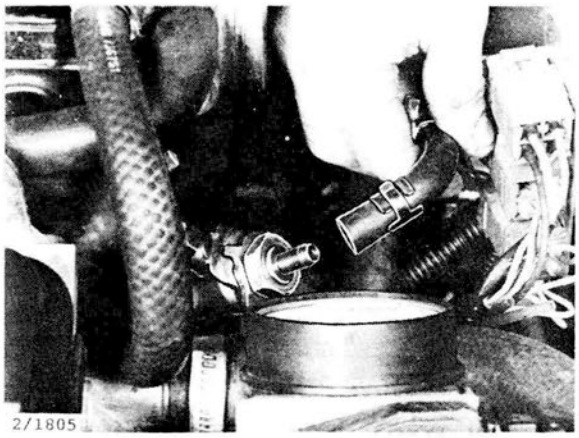
32 Fit the cover on top of the false bulkhead panel.

33 Reconnect the washer hose.

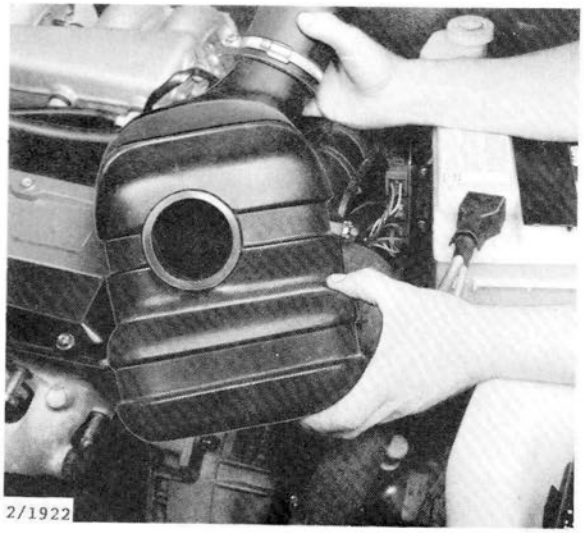


34 Reconnect the fuel hose to the fuel-injection rail.

35 Reconnect the fuel return hose to the fuel-pressure regulator.



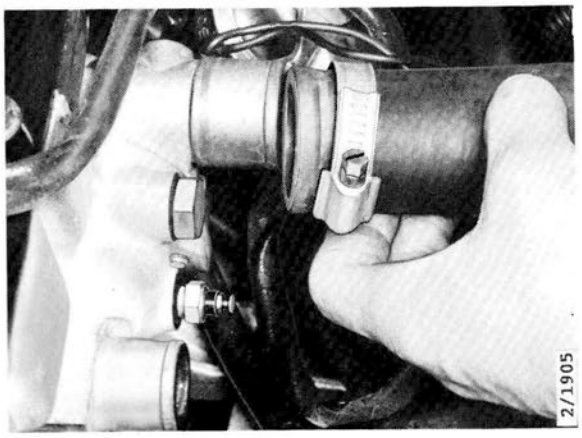
36 Fit the air intake complete with silencer, air mass meter and rubber elbow.



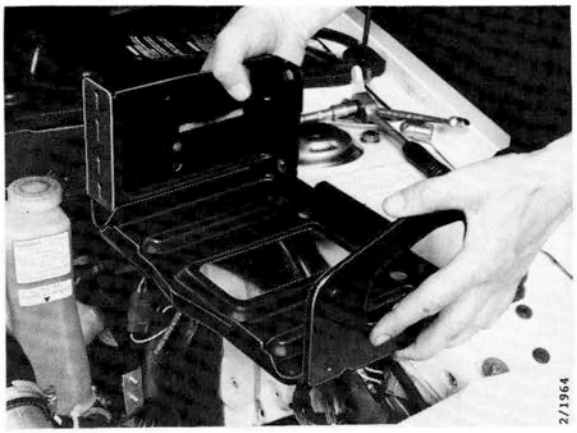
Plug the connector onto the air mass meter and tie the loom to the heater box hose.

Fit the steady bar to the air-intake silencer.

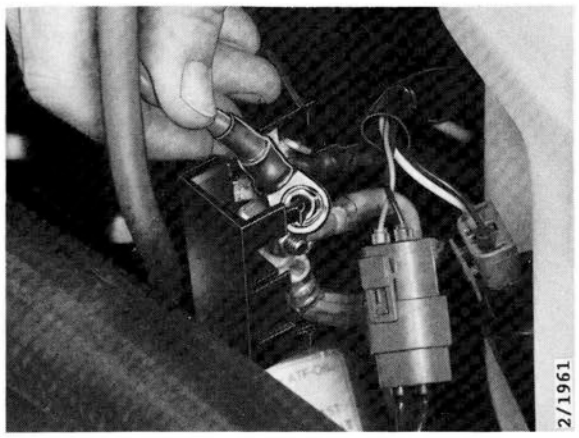
37 Reconnect the top radiator hose.



38 Refit the battery shelf and terminal block.



Clip the battery positive lead to the shelf and reconnect it to the terminal block.

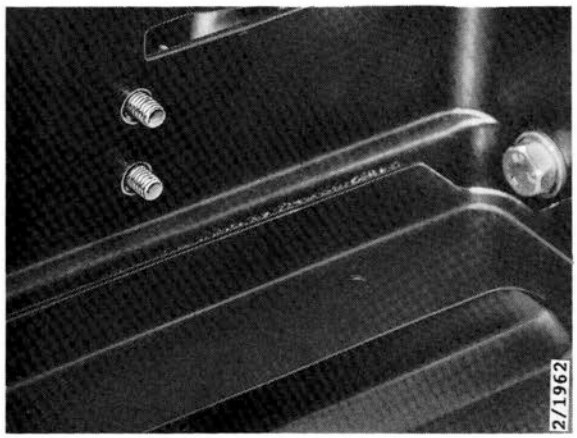


Reconnect the battery negative lead to the earthing point on the wing.

39 Plug in the three connectors on the DI wiring loom and hook them onto the bracket on the battery shelf.

Secure the leads in the clips on the bracket.

40 Bolt the bracket for the ABS unit to the battery shelf.

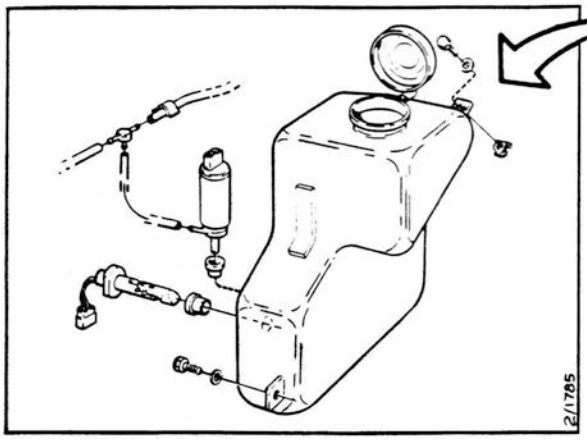


41 Tie the knock-detector lead to the inlet manifold steady bar.

42 Refit the washer fluid reservoir.

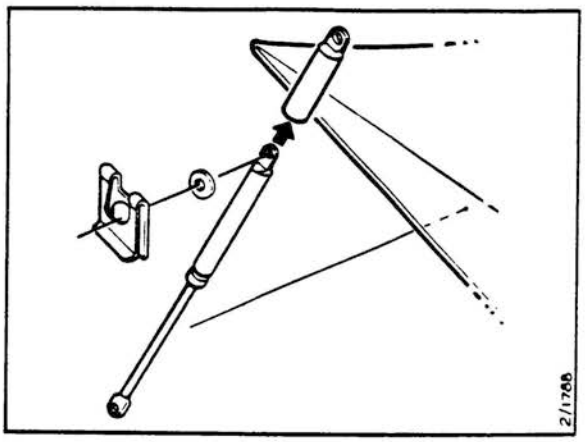
Reconnect the hose and plug on the connectors for the fluid-level sensor and pump (red and black).

Tie the hose to the battery positive lead underneath the battery shelf.



43 Fit the battery onto the shelf and reconnect the leads.

44 Remove the extension pieces from the bonnet (hood) struts.

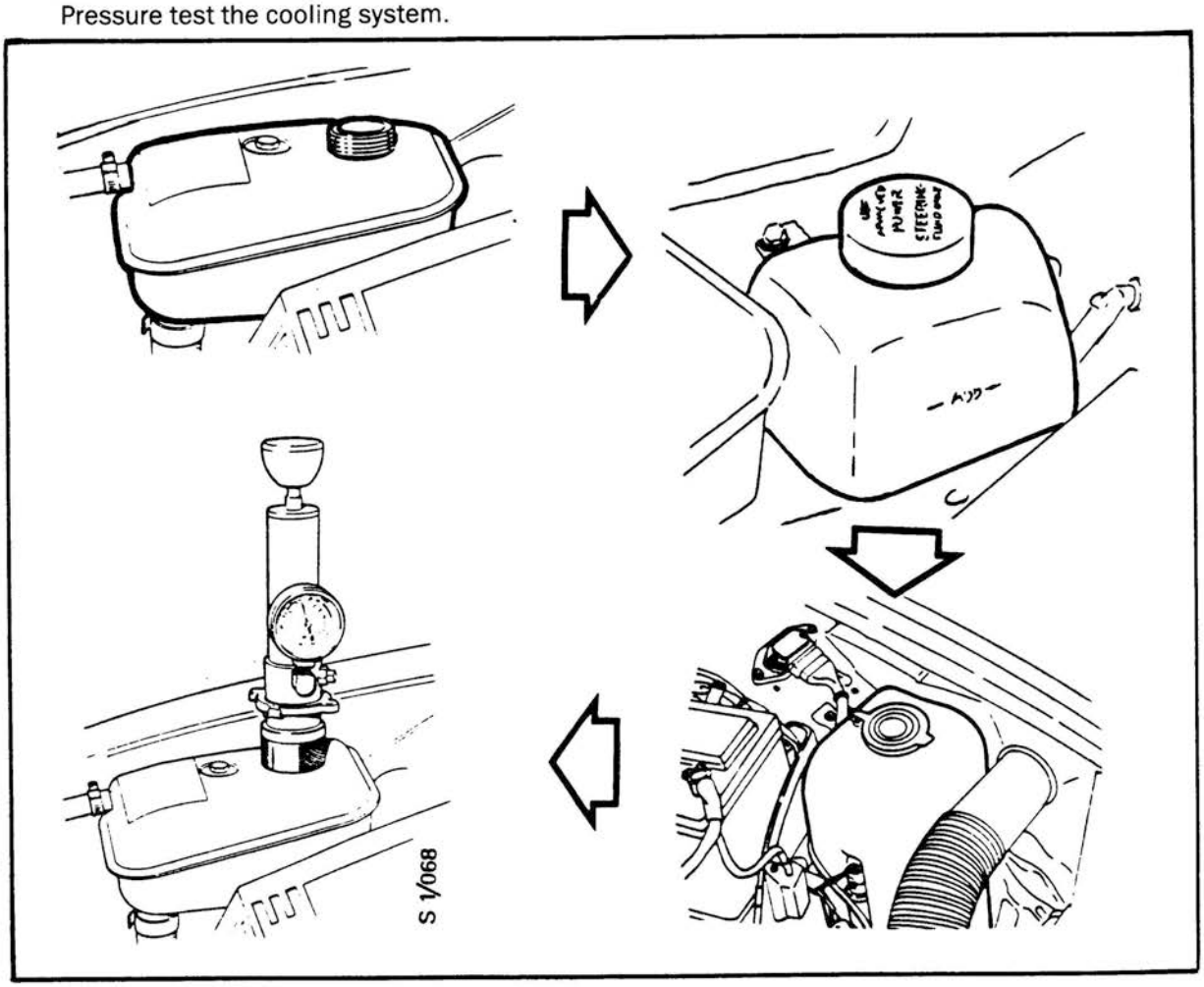


45 Raise the car.

Fit the RH wing liner and the front wheels (remember to torque the bolts).

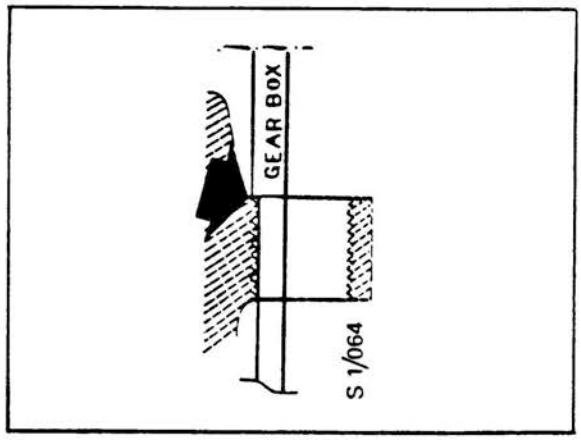
Tightening torque:
130 Nm (96 lbf ft)

46 Replenish the coolant and power steering fluid, and top up the washer fluid if necessary.
Pressure test the cooling system.



47 Test drive the car. Check that all systems are working properly and listen for rattles and noises indicating loose wiring looms, parts, etc. Inspect all hose connections for leaks.

48 Check the fluid level in the automatic transmission, topping up as necessary.

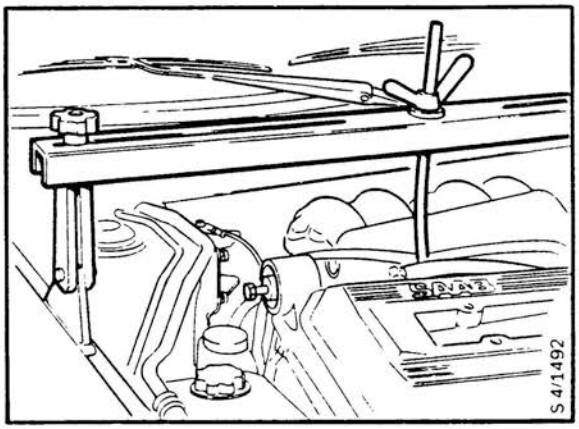


Engine mountings

Right front bracket and mounting

To remove

1 Fit the engine lifting beam (83 93 977) over the engine bay and attach a hook to the RH eye on the engine.



2 Remove the right front wheel.

3 Remove the front section of the wing liner.

4 Remove the bolt securing the bracket to the mounting and raise the engine slightly.

5 Undo the bolt securing the bracket to the block and lift off the bracket.

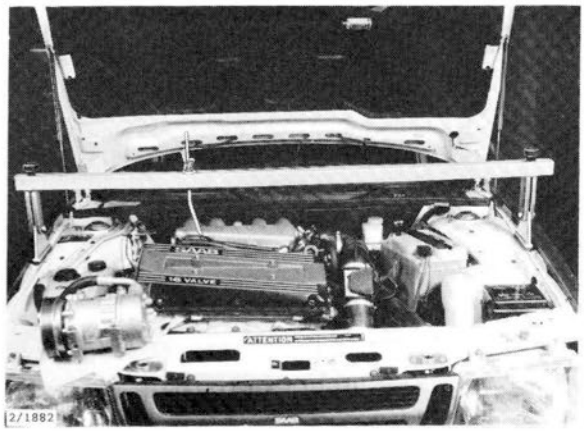
6 Undo the bolts securing the mounting to the subframe and remove the mounting.

To fit

1 Fit the engine mounting.

2 Fit the bracket for the oil pipe into the groove in the engine bracket and bolt the engine bracket to the block.

3 Lower the engine onto the mounting and remove the lifting beam.



4 Fit the bolt securing the engine bracket to the engine mounting.

5 Refit the wing liner.

6 Fit the wheel and torque the bolts.

Tightening torque:
130 Nm (96 lbf ft)

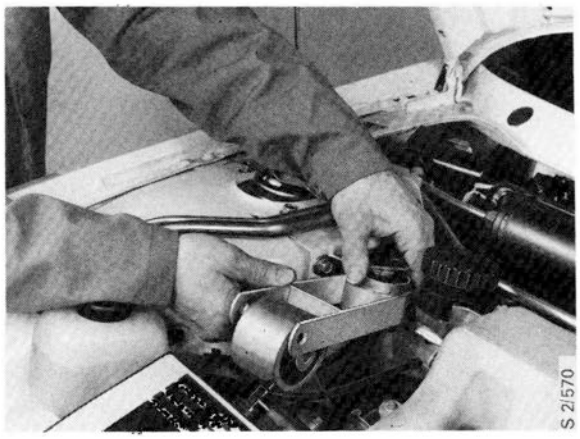
Right rear top engine mounting, bracket and torque arm

To remove

1 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

2 Snip through the ties securing the hydraulic hoses and wiring.

Remove the torque arm.

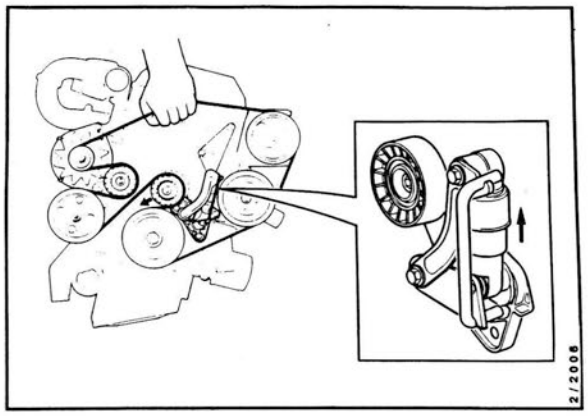


3 Disconnect the earth lead from the bracket and remove the bracket.

4 Remove the right front wheel.

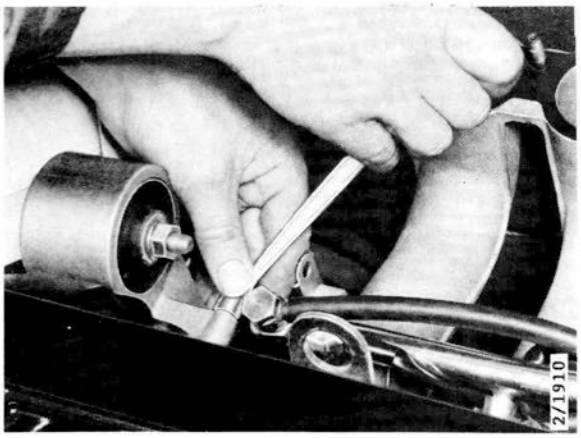
5 Remove the front section of wing liner.

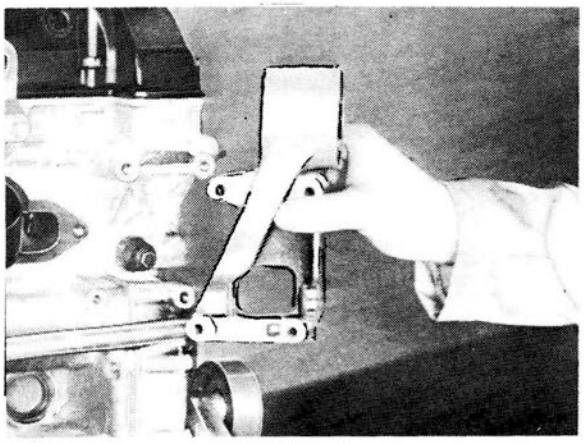
6 Ease off the drive belt for the engine auxiliaries (section 216 refers).



7 Slacken the bolts and swivel the alternator out of the way.

8 Undo the four securing bolts and remove the top engine mounting.



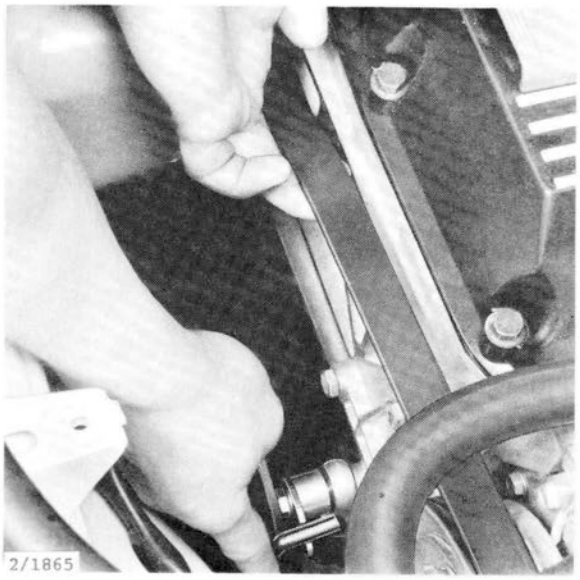


To fit

1 Fit the top engine mounting.

2 Swivel the alternator back into place and tighten the bolts.

3 Refit the drive belt (section 216 refers).



4 Refit the wing liner.

5 Fit the wheel and torque the bolts.

Tightening torque:
130 Nm (96 lbf ft)

6 Bolt the bracket to the wheel arch.

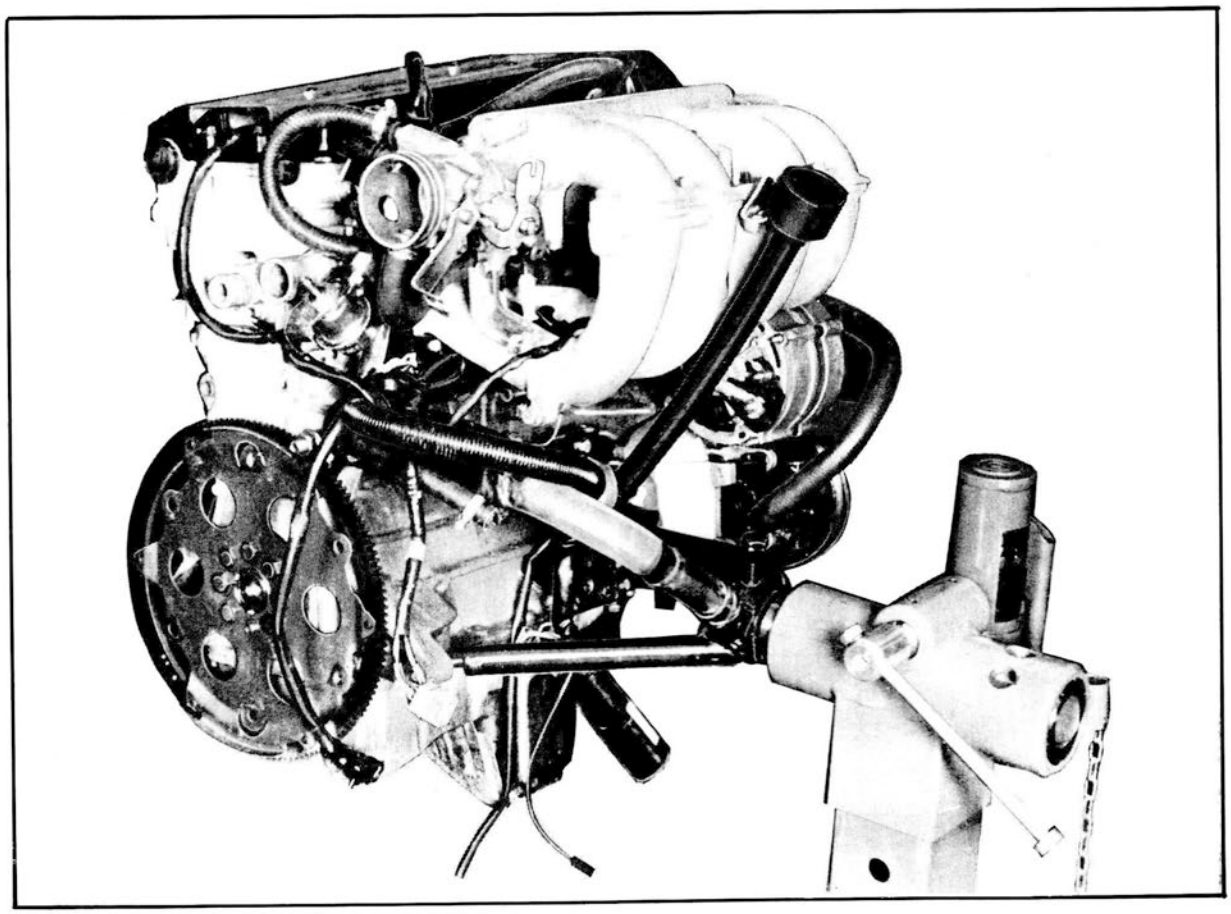
7 Reconnect the earth lead to the torque arm.

8 Fit the torque arm.

9 Fit a cable tie round the hydraulic hoses and wiring.

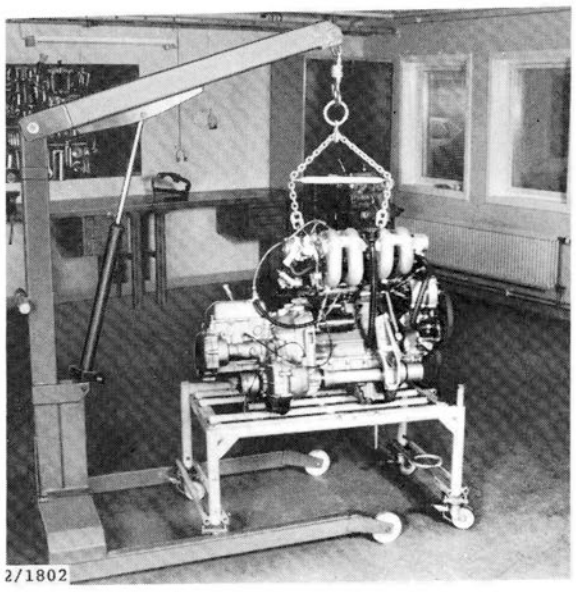
10 Reconnect the battery.

Engine



To dismantle

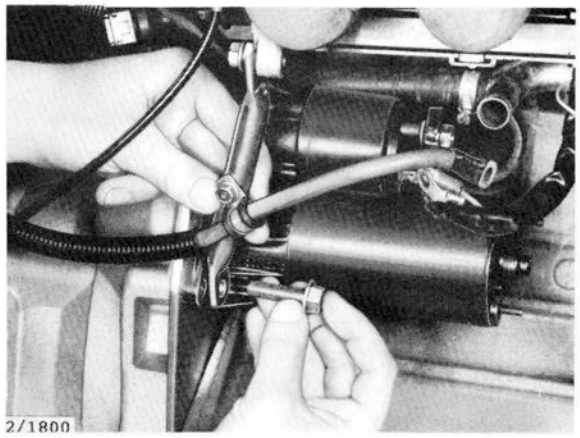
1 Stand the engine on a trolley.



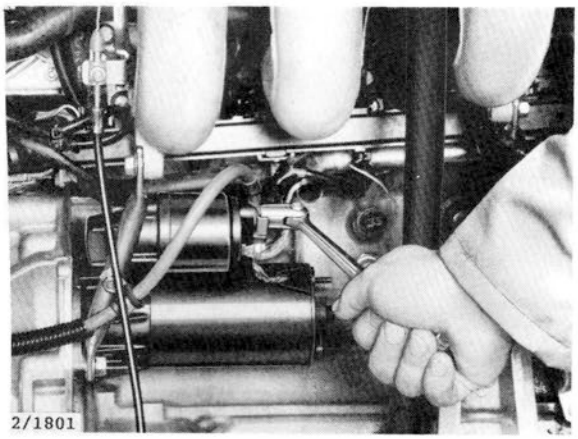
2 Remove the starter motor:

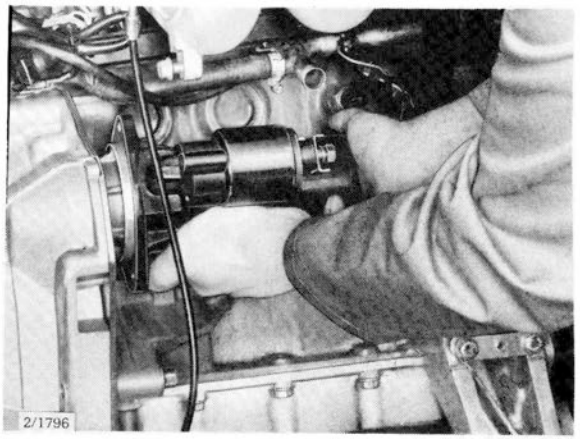
- Disconnect the alternator lead, the positive lead and the yellow lead to the solenoid from the ignition switch.

- Remove the outer securing bolt and the steady bar from the inlet manifold.

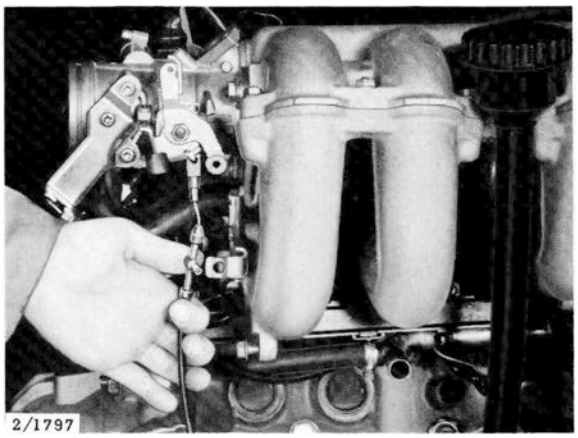


- Remove the inner securing bolt and lift off the motor.

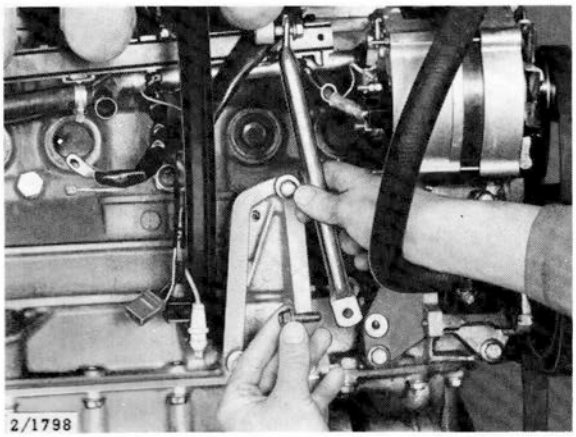




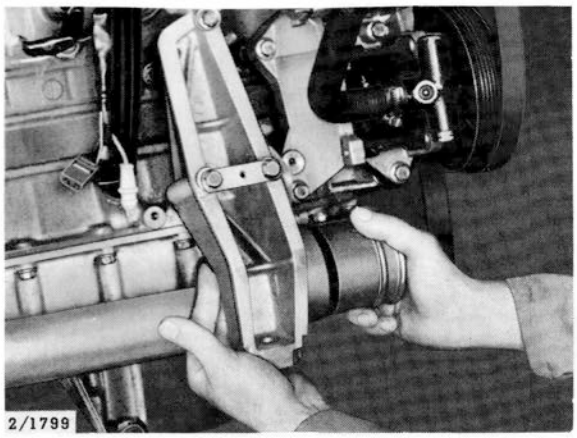
3 Remove the clip from the throttle linkage and the clip from the inlet manifold side bracket and disconnect the kickdown cable.


2/1797

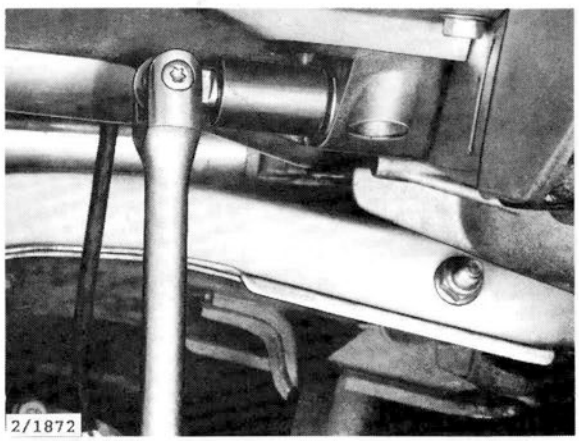
4 Remove the steady bar from the RH side of the inlet manifold.


2/1798

5 Remove the engine mounting/support bearing bracket complete with the tube and inner drive-shaft joint.

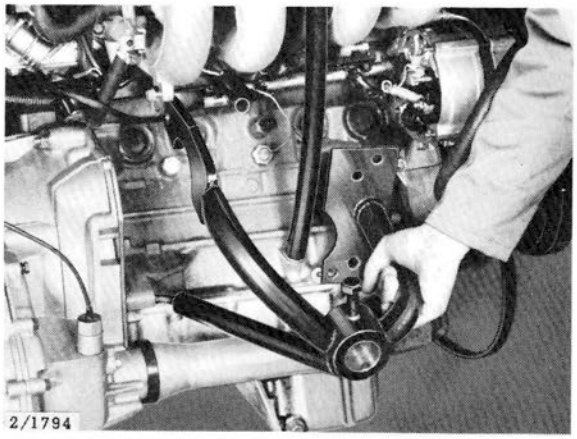

2/1799

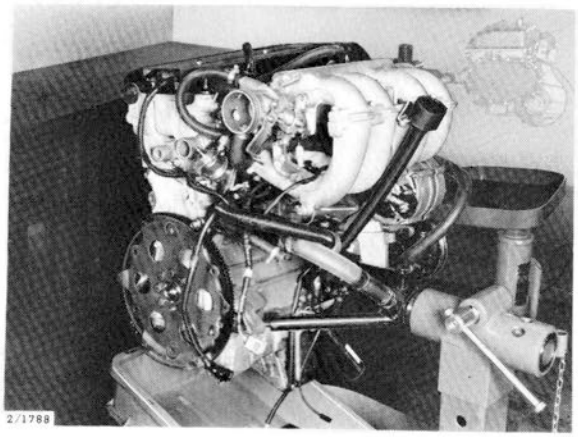
6 Remove the bottom bolt from the engine-gearbox flanges.


2/1872

Fit a second nut onto the stud to lock the first, and undo the stud.

Fit bracket 83 94 454 and lift the engine onto an engine stand.

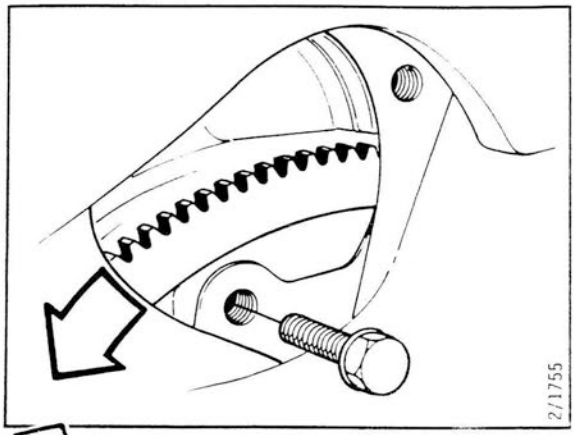




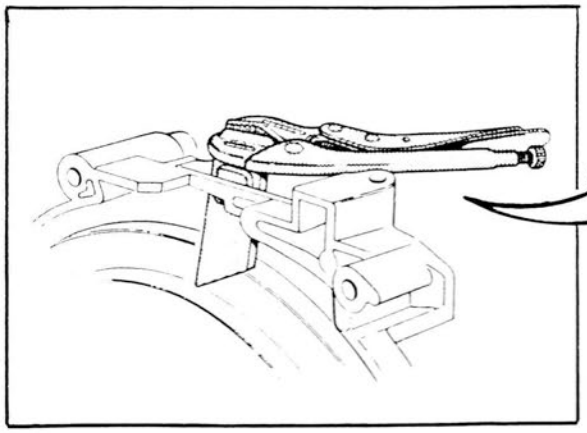
7 Remove the gearbox breather valve.

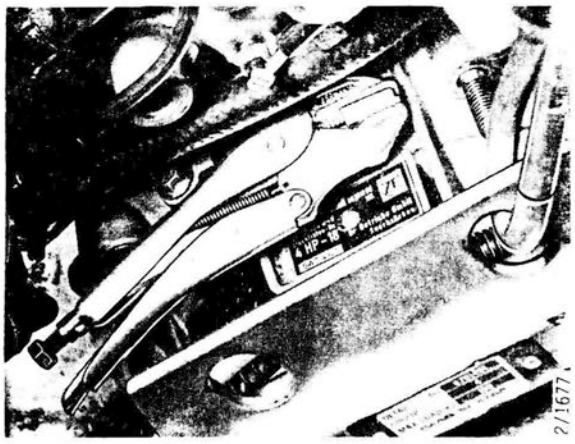
8 Undo the three bolts securing the flywheel to the torque converter:

By means of the crankshaft pulley, rotate the flywheel to bring each securing bolt, in turn, in line with the opening in the backplate.



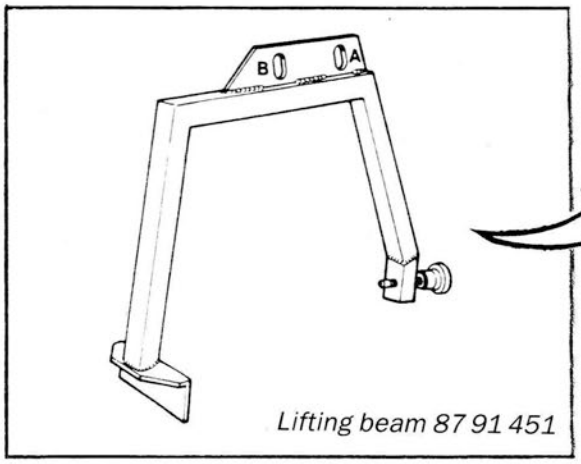
9 Immobilize the torque converter using grips 87 91 816.



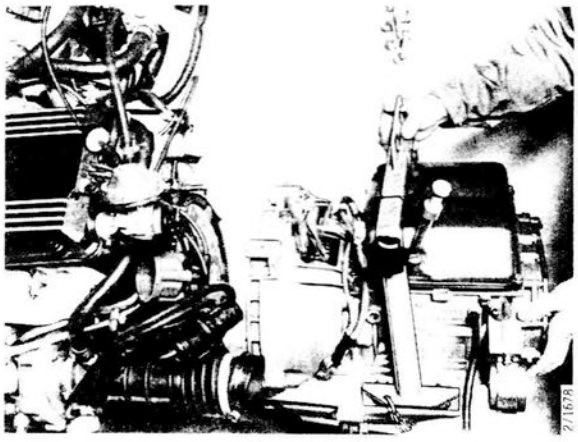


10 Fit lifting beam 87 91 451 onto the gearbox.

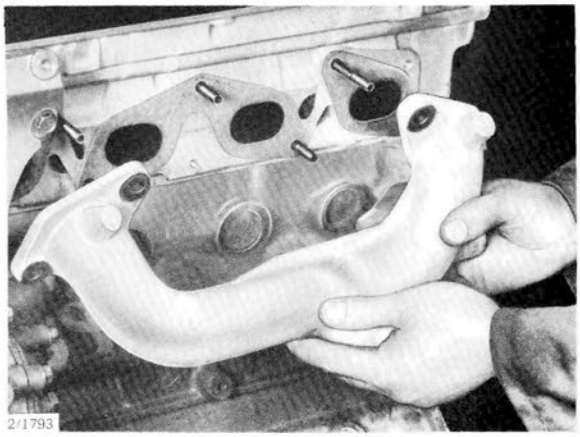
Undo the securing bolts and lift off the gearbox.



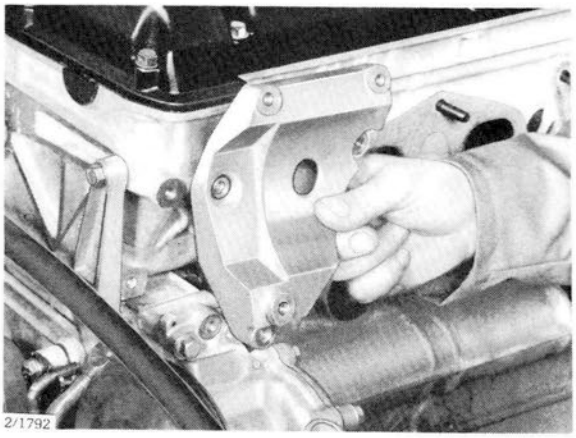
Lifting beam 87 91 451



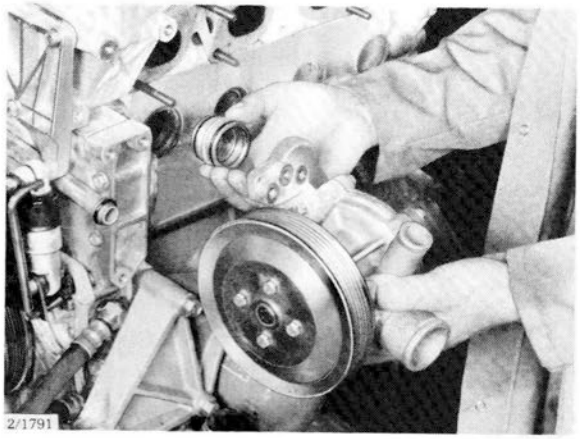
11 Remove the two-part exhaust manifold, inner section first and outer section last. Note the spacer sleeves on the bolts in the outer section.



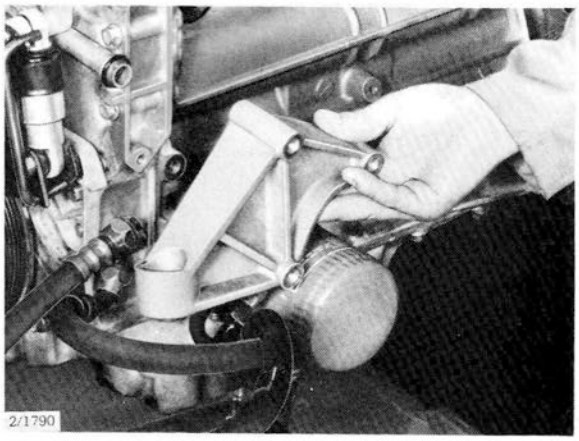
12 Remove the bracket for the AC compressor.



13 Remove the water pump complete with sleeve and 'O' rings.

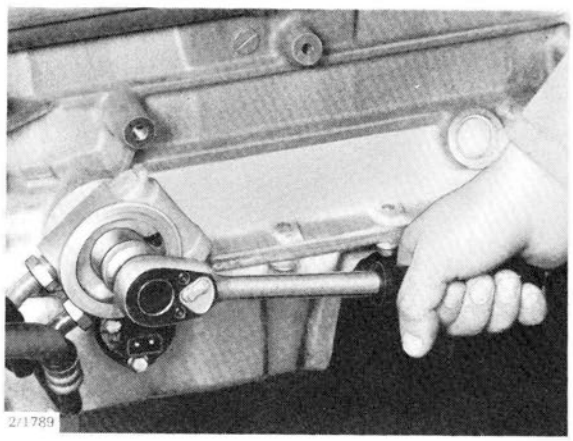


14 Remove the front engine mounting.



15 Remove the oil filter and adaptor. Note the seal.

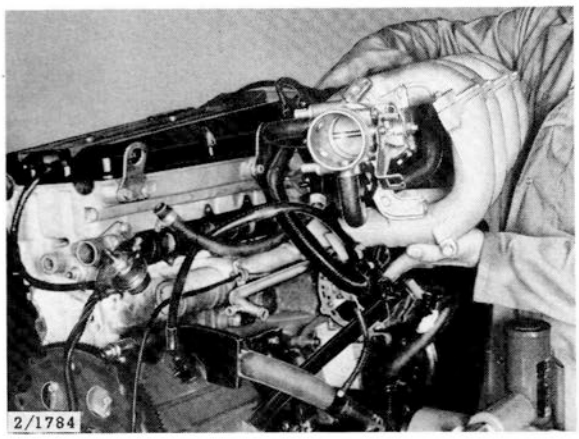
Caution
The engine mounting incorporates a locating groove and must therefore be refitted before the adaptor.



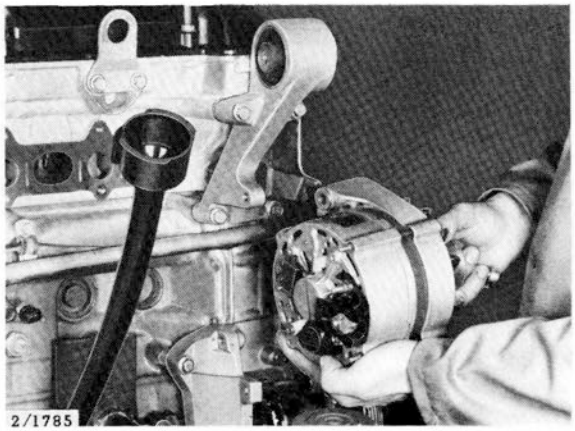
16 Remove the inlet manifold complete with engine wiring loom and throttle housing:

- Remove the bracket for the dipstick tube
- Disconnect the preheater hoses from the throttle housing
- Unplug the leads from the alternator
- Disconnect the crankcase breather hoses from the camshaft cover
- Disconnect the fuel line from the fuel-pressure regulator

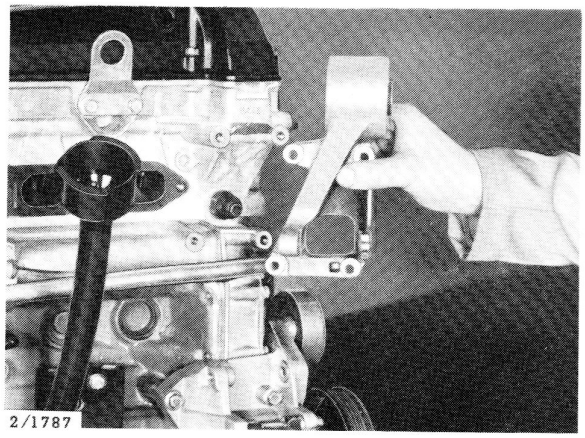
Undo the eight securing bolts and lift off the inlet manifold


2/1784

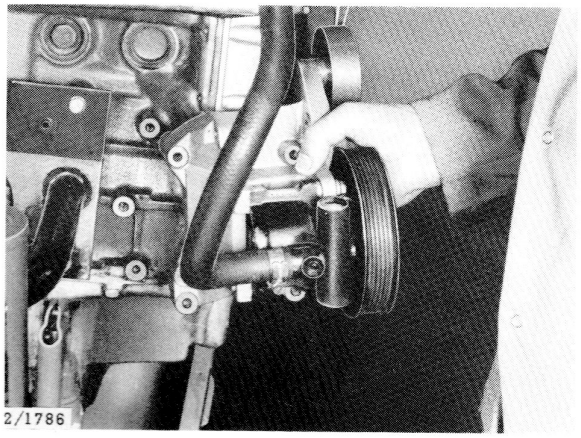
17 Remove the alternator.


2/1785

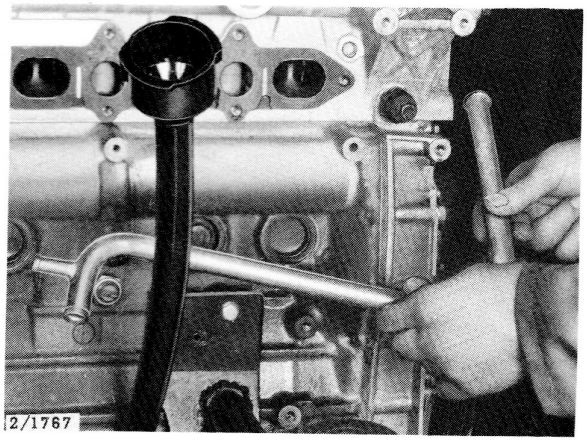
18 Remove the top engine mounting (four bolts).



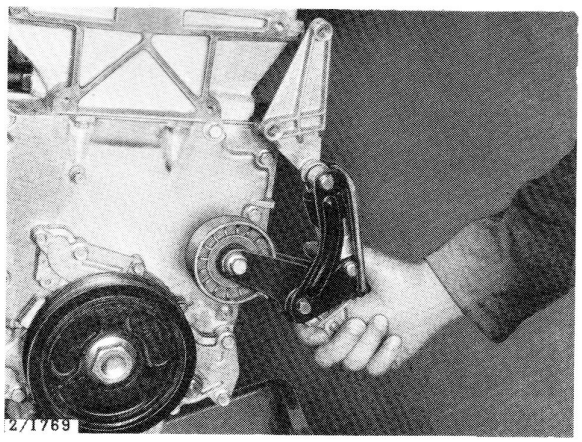
19 Remove the steering servo pump complete with bracket and idler-wheel pulley.



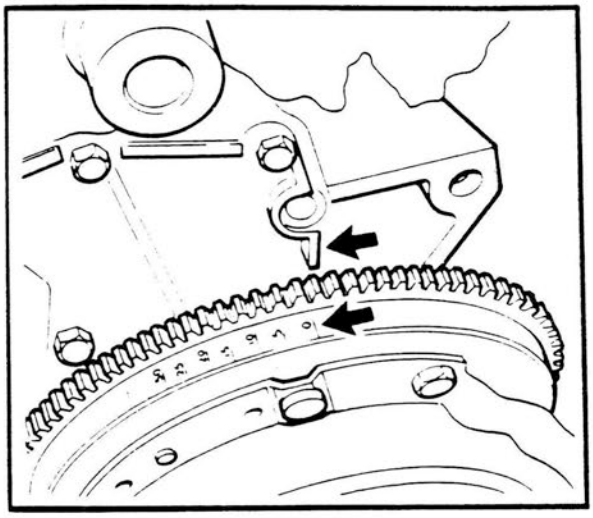
20 Remove the pipe connecting the water pump to the heater-box hoses. Release the clips holding the crankshaft-sensor leads and snip through the tie securing the leads to the pipe.



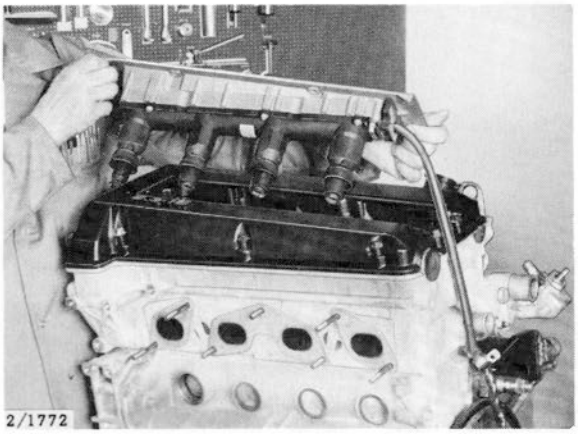
21 Remove the belt tensioner complete with bracket and idler-wheel pulley.



22 Align the mark (0°) on the flywheel with that on the end plate and check that the camshafts are also in line with the setting marks.

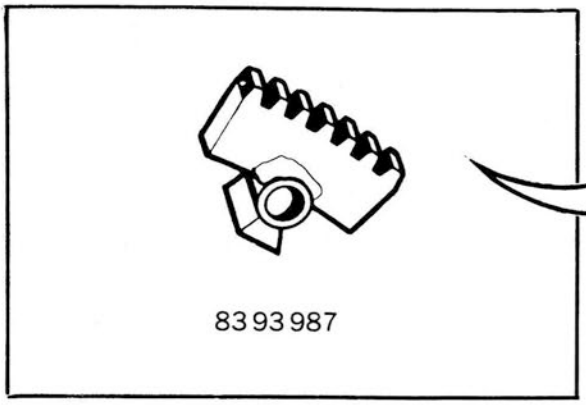


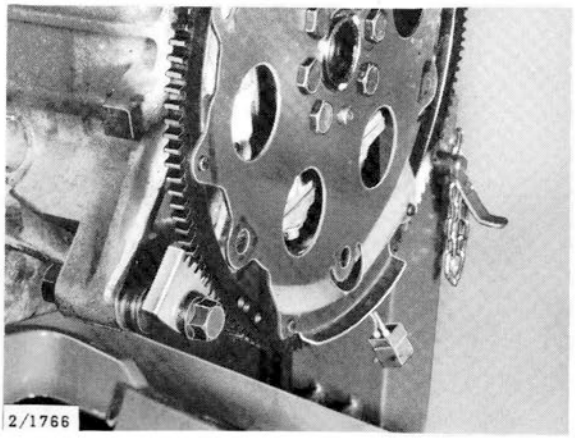
23 Disconnect the lead from the earthing point, release the clip on the fuel-pressure regulator bracket and remove the ignition module (cartridge).



24 Remove the camshaft cover.

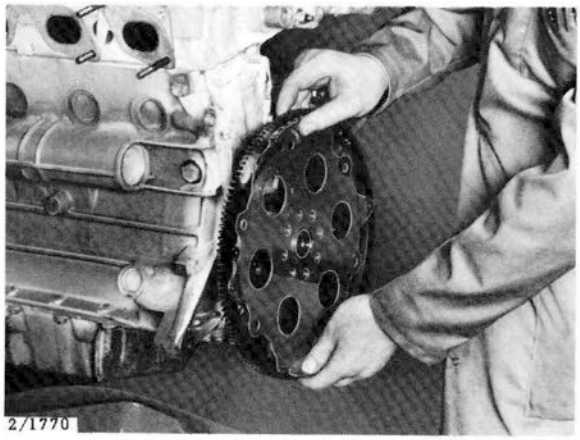
25 Fit locking segment 83 93 987 as shown.



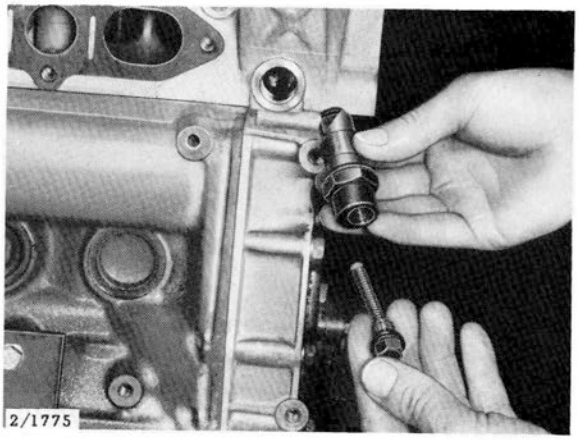


Remove the crankshaft pulley.

26 Remove the flywheel locking segment and then the flywheel.



27 Remove the chain tensioner: remove the adjusting screw first to enable a socket (27 mm) to be used.

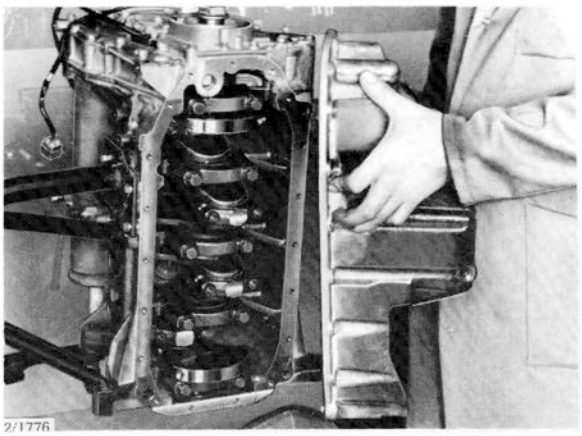


28 Remove the camshaft sprockets and position the chain where it will not obstruct removal of the cylinder head.

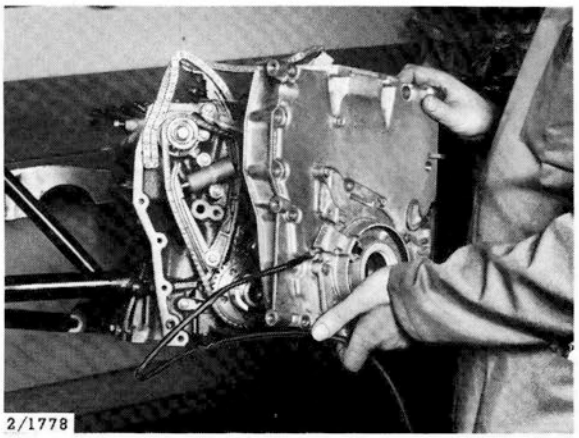
29 Remove the cylinder head (note the bolts at the timing end).

30 Swivel the engine into a suitable position and remove the sump.

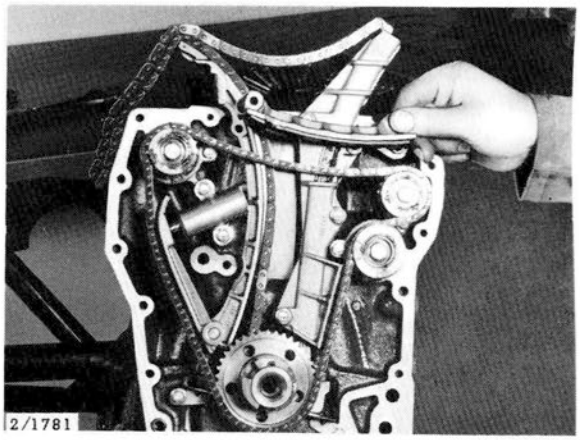
Do not remove the guide sleeve from the casting.



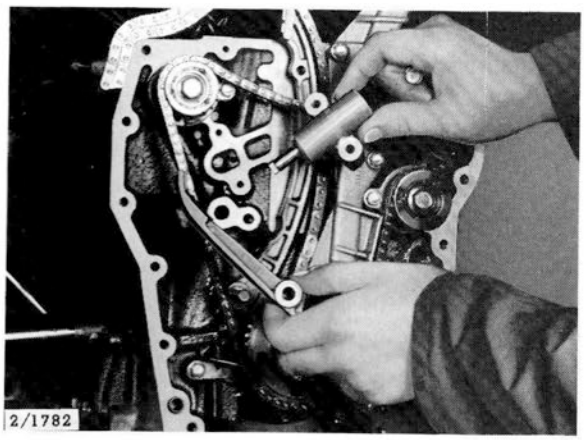
31 Remove the timing cover complete with oil pump, crankshaft sensor and reducing valve. Note that the bolts are different lengths.



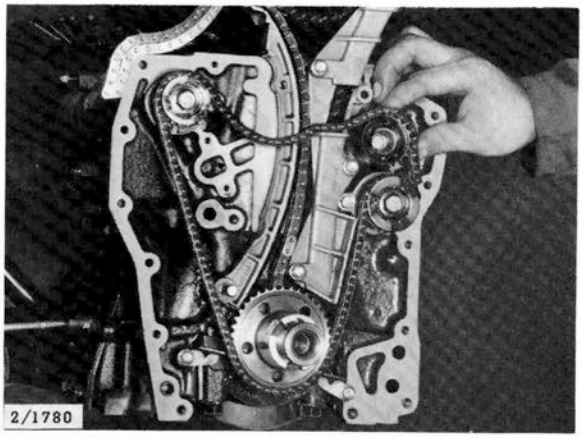
32 Remove the top guide for the balance-shaft chain.



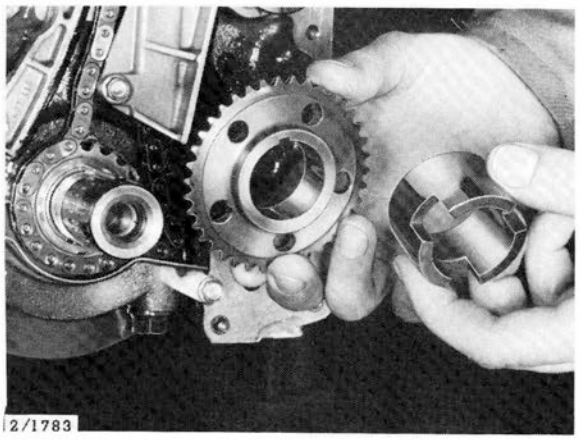
33 Remove the chain tensioner and pivoting guide.



34 Remove the idler-wheel sprocket and the balance-shaft chain.



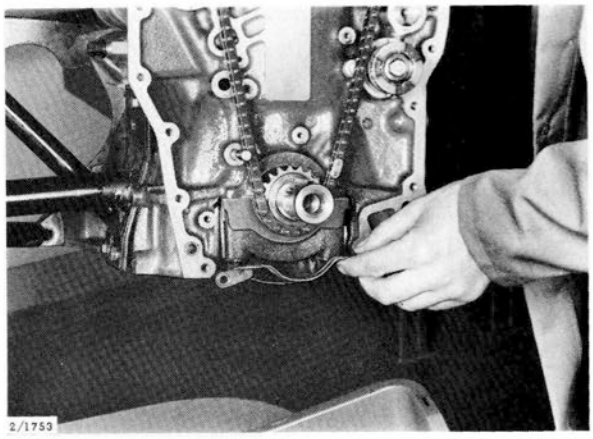
35 Remove the oil pump drive dog and the sprocket from the crankshaft.

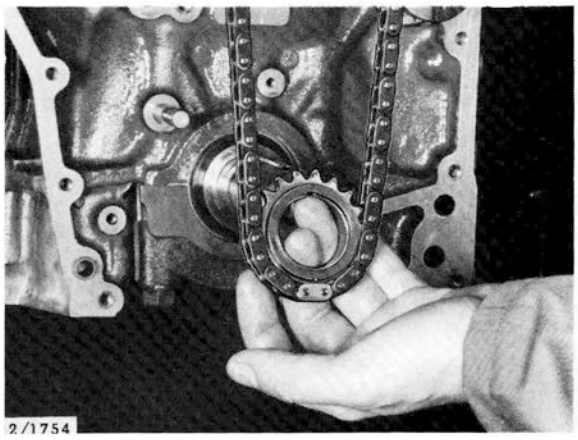


36 Remove the pivoting chain guide for the timing chain.

37 Remove the fixed chain guide for both the timing and balance-shaft chains.

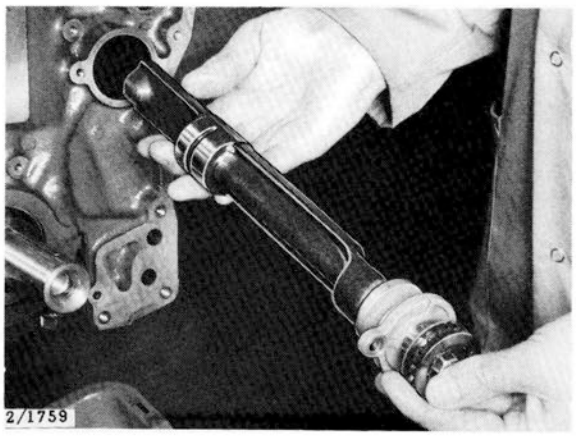
38 Remove the timing-chain guard followed by the chain and sprocket.



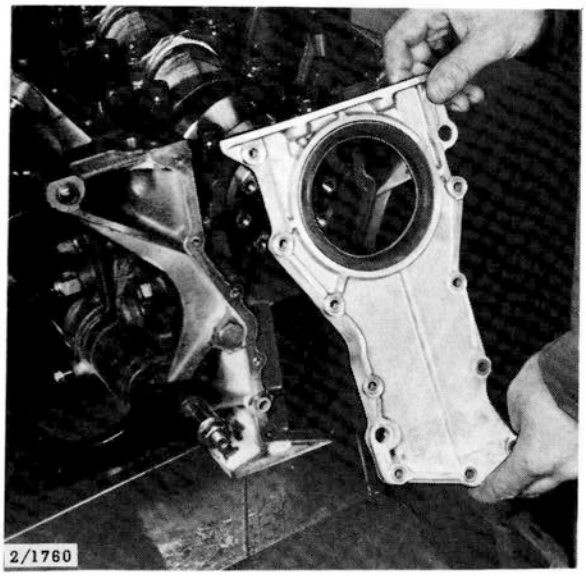


Caution
Observe the utmost care when removing the balance shafts to avoid damaging the inner bearing shells.

39 Remove the balance shafts complete with sprockets and bearing housings.

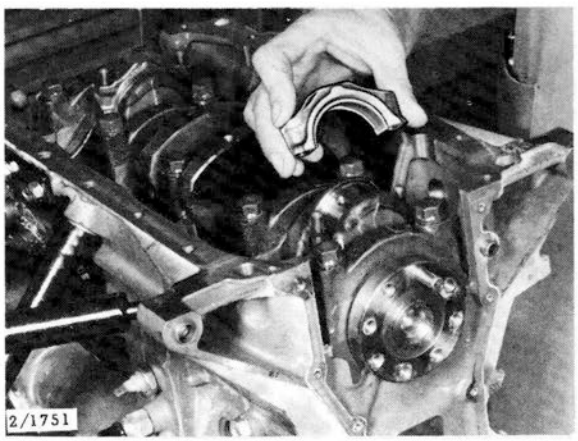


40 Remove the end plate.

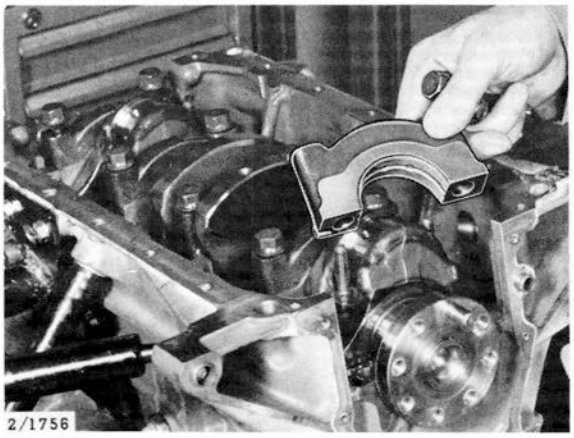


Caution
When dismantling bearing caps and bearings, store them carefully in order, so that they can be reassembled in their original positions.

41 Swivel the engine into a convenient position and remove the big-end bearing caps.



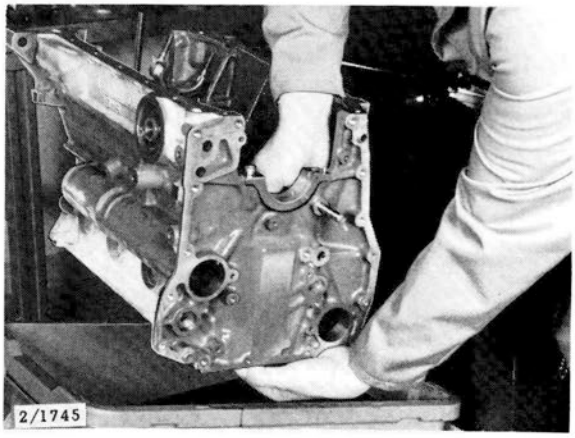
42 Remove the main bearing caps.



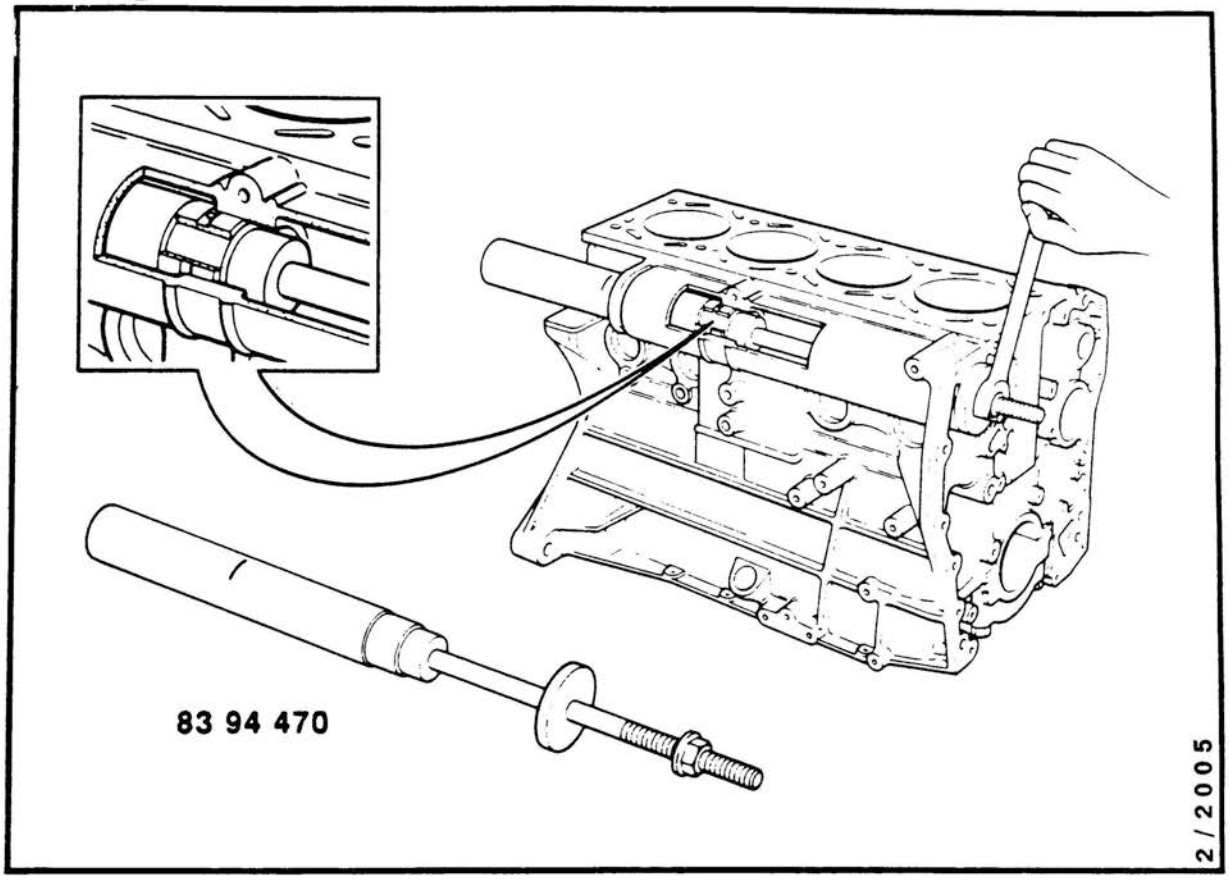
43 Lift out the crankshaft.

44 Remove all the bearing shells, for both the main bearings and big-end bearings. Also remove the two thrust washers from the no. 3 main bearing.

45 Press or carefully tap the pistons out of the bores.



Replacing balance-shaft rear-bearing shells



To remove

1 Remove the cover washer.

2 Insert the special tool from the flywheel end and fit the reaction arm and nut.

3 Slowly and steadily tighten the nut to pull the bearing out of its recess.

To fit

1 Assemble the bearing shell on the tool.

2 Insert the tool from the flywheel end and fit the reaction arm and nut.

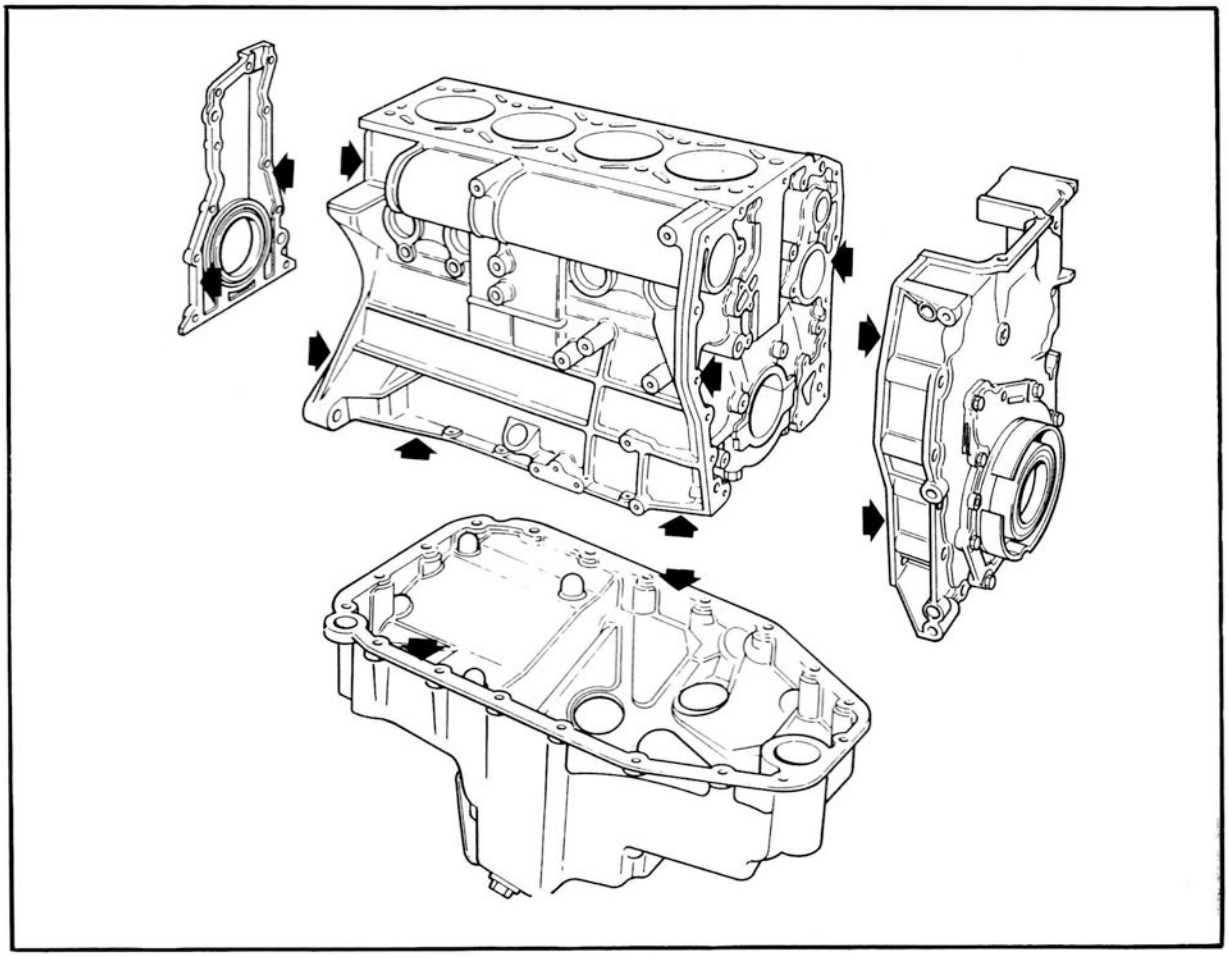
3 Slowly and steadily tighten the nut to pull the bearing into its recess, until the mark on the tool is in line with the cover washer housing.

4 Dismantle and remove the special tool.

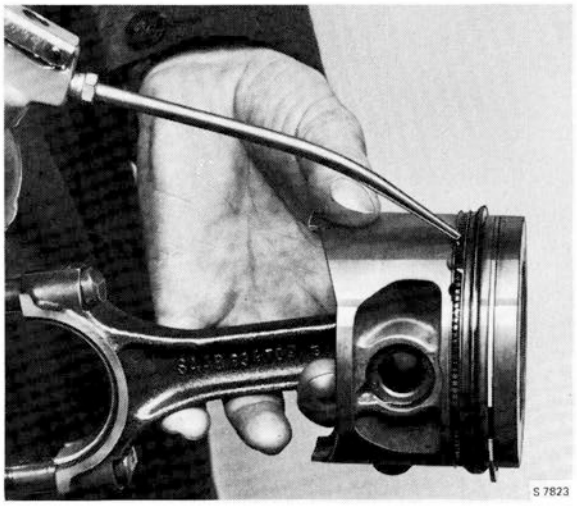
5 Fit a new cover washer.

To reassemble

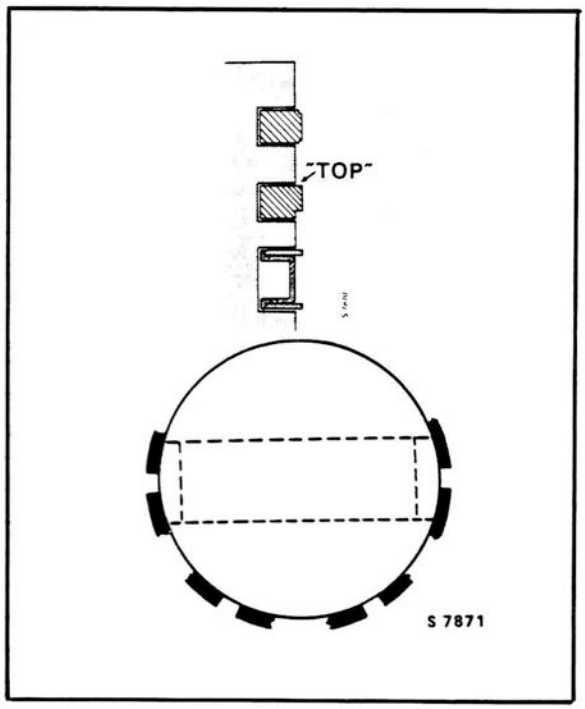
Use pure cleaning petrol to clean all flanges and mating surfaces thoroughly.

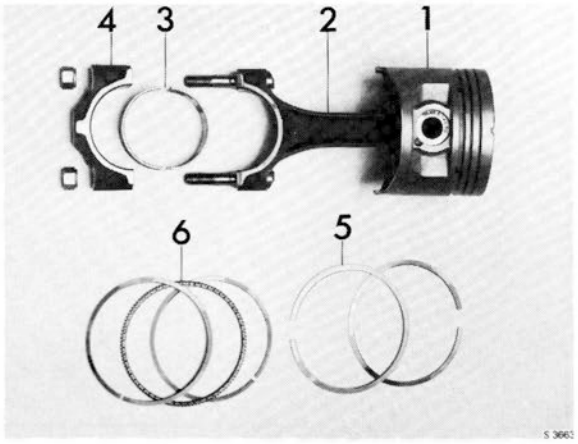


1 Lubricate pistons and rings before assembly.



- Rotate the compression rings through 180° to bring the gaps in line with the boss for the gudgeon pin.
- Rotate the scraper rings to ensure that the gaps are staggered.

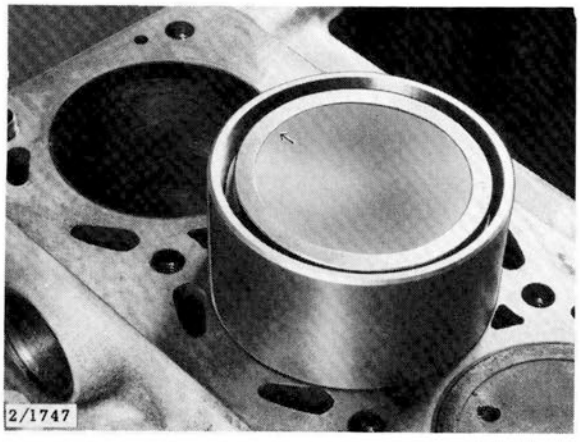




Piston, piston rings and big-end bearing

1 Piston
2 Connecting rod
3 Bearing shells
4 Big-end bearing cap
5 Compression rings
6 Oil-scraper rings

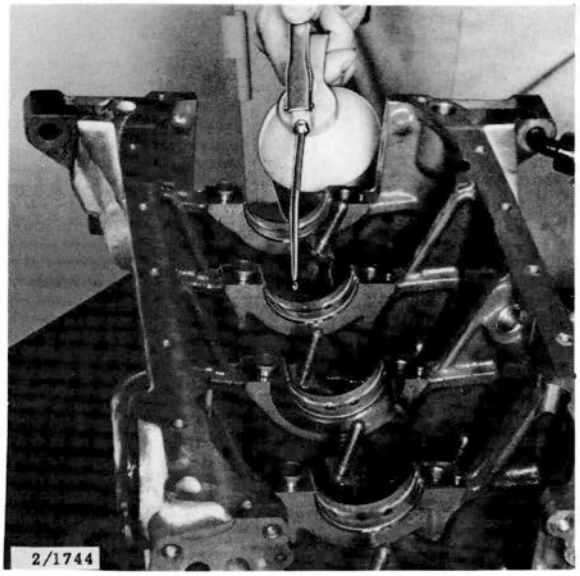
2 Insert the pistons in their respective bores. Ensure that the arrow on the piston crown is pointing towards the timing end.



Fit the piston using piston-ring clamp 78 62 287.

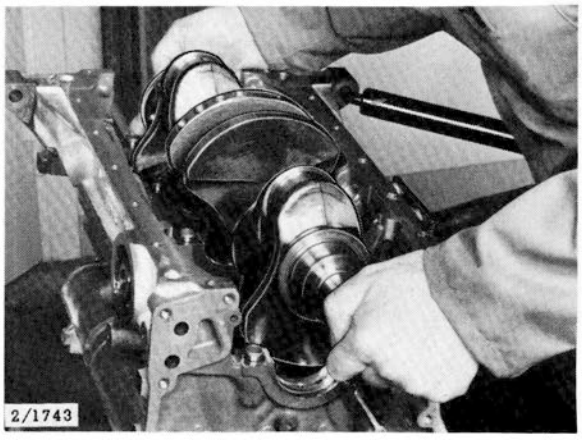
Tap the pistons gently down inside the bores.

3 Place the bearing shells in their original positions and lubricate them.



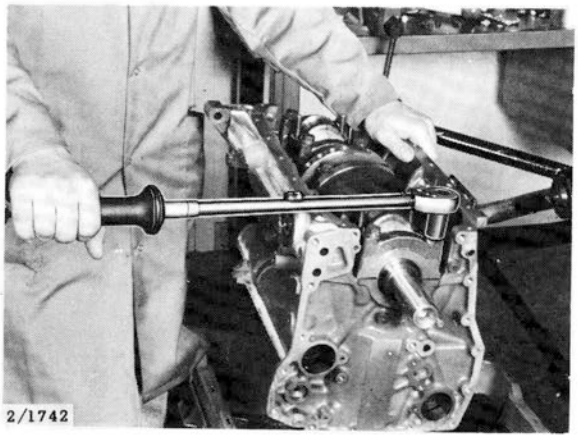
4 Lift the crankshaft into position.

Adjust the positions of the bearing shells and fit the two thrust washers for the main bearing between no. 2 and no. 3 cylinders, with the embossed side of the washers towards the main bearing.



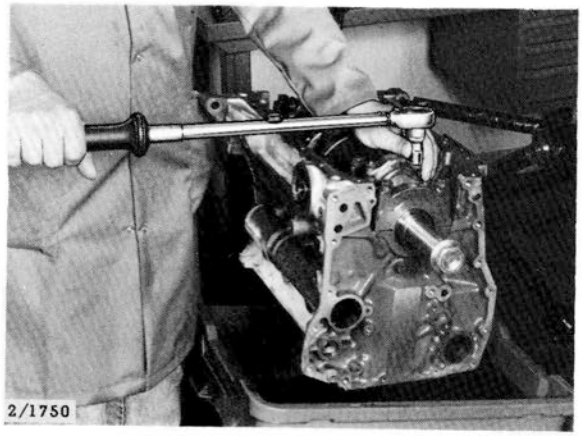
5 Lubricate and fit the main bearing caps on the respective bearings, making sure they are the right way round.

Tighten the bearing caps to a torque of 20 Nm (15 lbf ft) and tighten a further quarter-turn (90°).

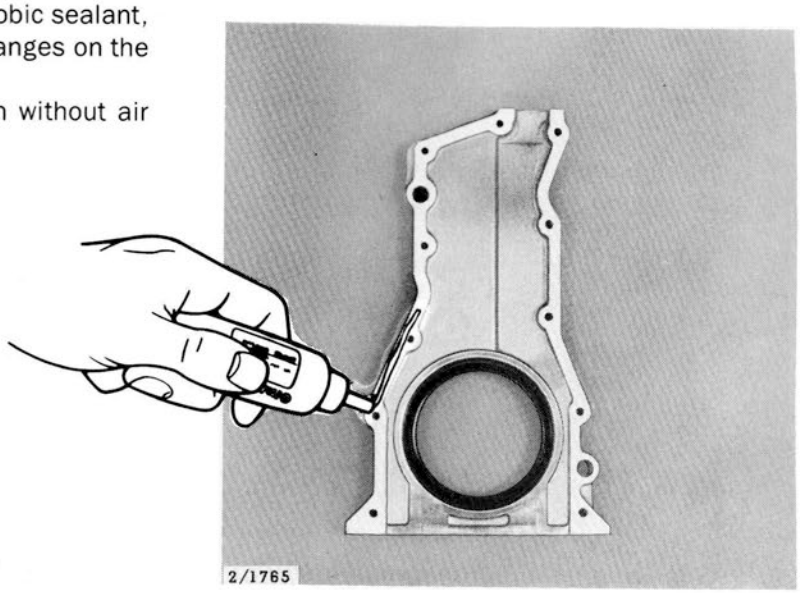


6 Lubricate and fit the big-end caps in their respective positions, ensuring they are the right way round (number to number, and groove in shell to groove in shell).

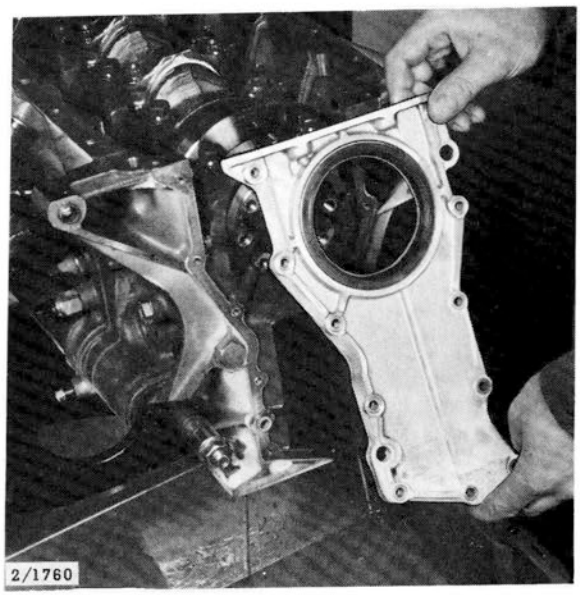
Tighten the bearing caps to a torque of 20 Nm (15 lbf ft) and tighten a further quarter-turn (90°).



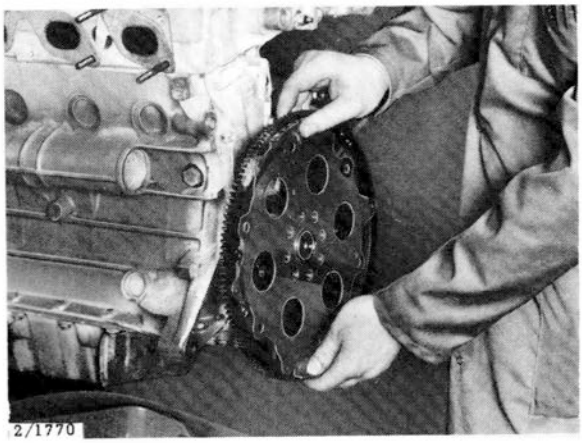
7 Apply a bead of suitable anaerobic sealant, about 1 mm thick, along the flanges on the end plate.
(Anaerobic sealant can harden without air being present.)



Fit the end plate.

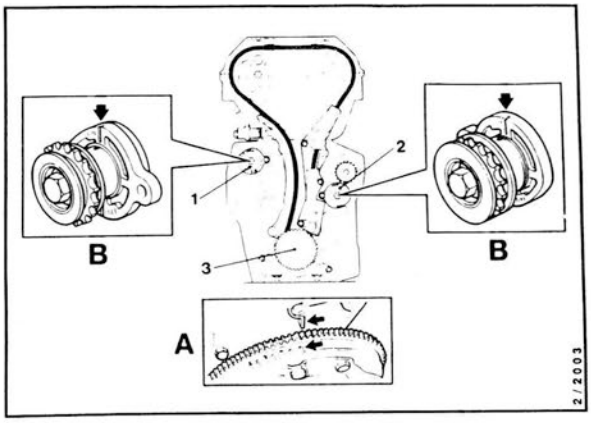


8 Fit the flywheel.



9 Fit the balance shafts:

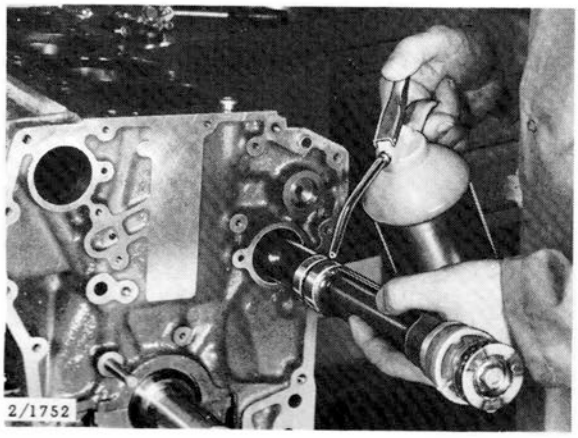
- Rotate the crankshaft to bring the pistons in the no. 1 and no. 4 cylinders to TDC.



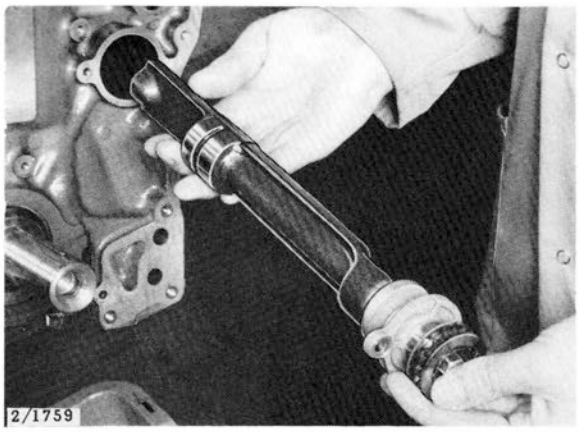
1 Balance shaft, inlet side
2 Balance shaft, exhaust side
3 Crankshaft

- Carefully inspect the flange on the timing cover to ensure that it is absolutely clean.

- Lubricate the balance-shaft journals and bearing housings.



- Insert the balance shafts into their respective tunnels, taking great care not to damage the delicate bearings inside.

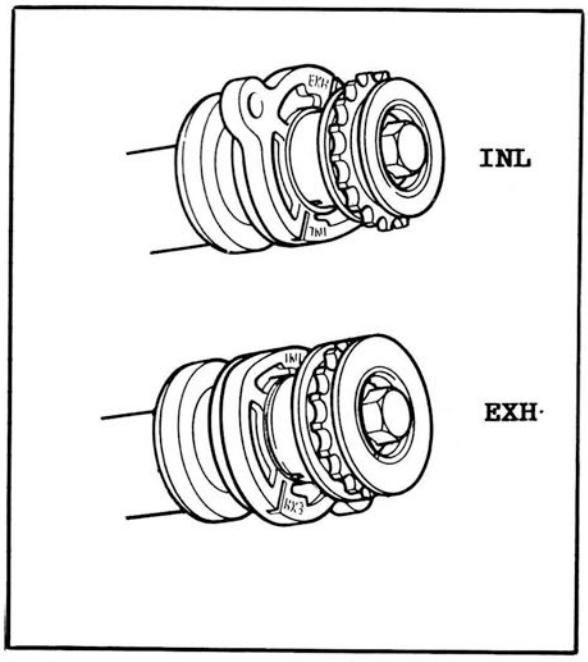


Note the markings on the sprockets:

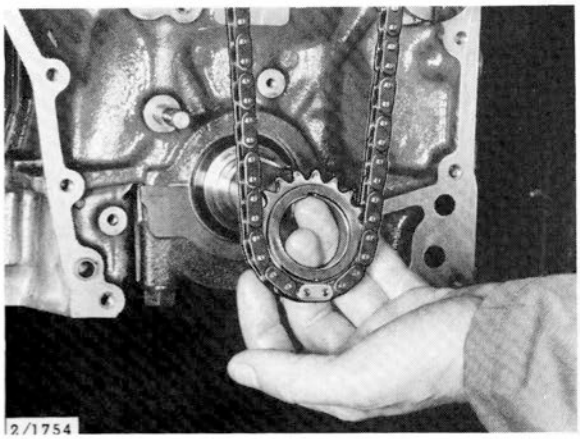
The shaft with the smaller thrust ring, marked INL, is the one for the inlet side of the engine.

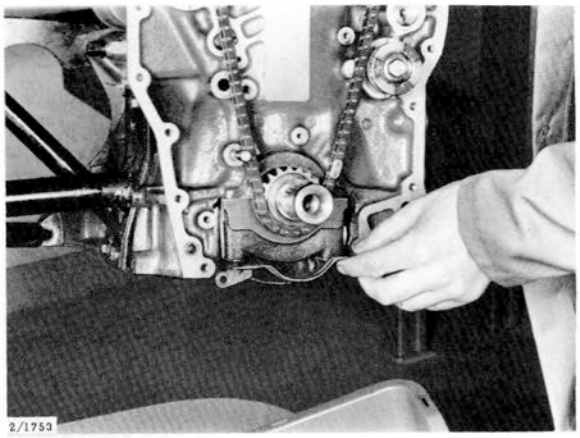
The shaft with the larger thrust ring, marked EXH, is the one for the exhaust side of the engine.

Tighten the bearing housings to a torque 12 Nm.



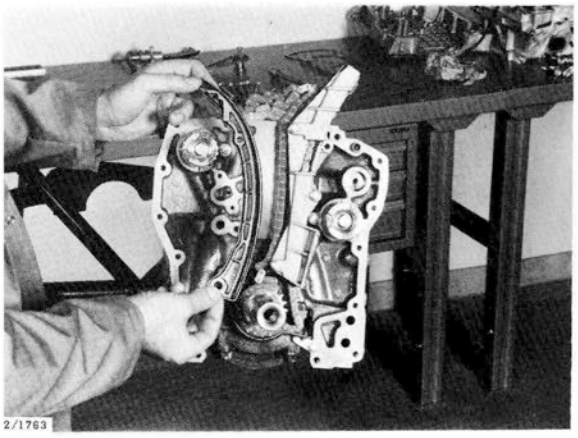
10 Fit the chain and sprocket on the crankshaft, and fit the chain guard.



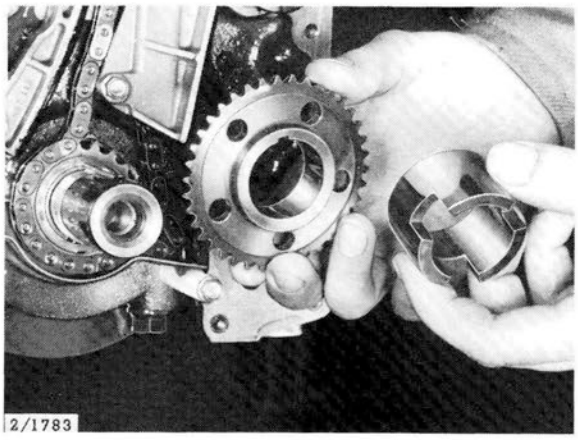


11 Fit the fixed chain guide that serves both the timing chain and the balance-shaft chain.

12 Fit the pivoting guide for the timing chain.

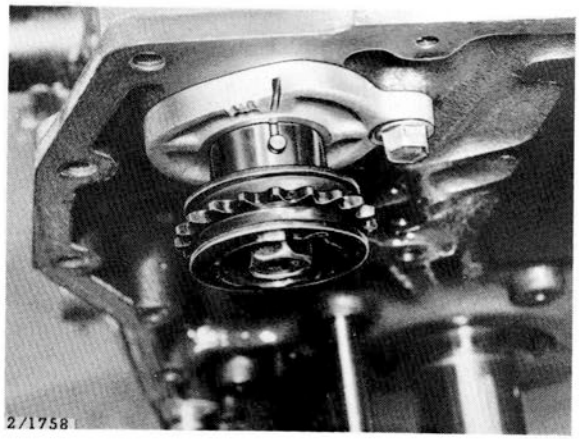


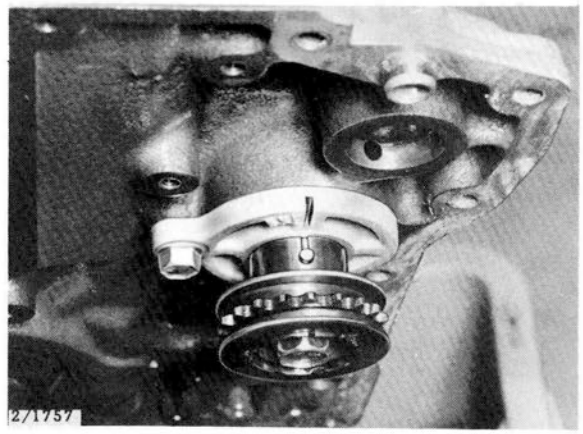
13 Fit the sprocket and oil-pump drive dog onto the crankshaft.

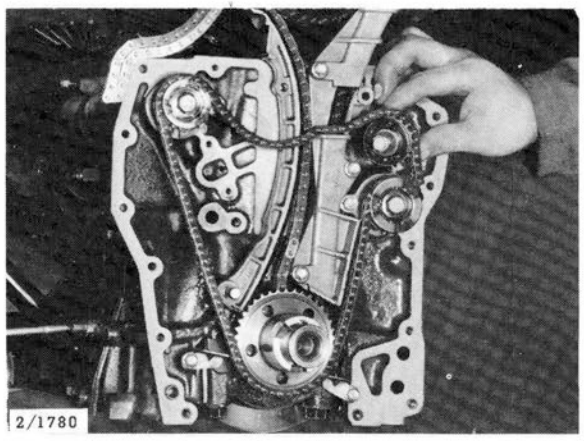


14 Fit the balance-shaft chain and idler-wheel sprocket, ensuring that the timing marks on the bearing housing and sprocket are in line. On fitting, leave some slack in the chain in line with the tensioner, and keep the chain reasonably taut by means of the top chain guide.

There is another way of fitting the balance-shaft chain:
Fit the top chain guide first and then adjust the run of the chain round the sprockets. Adjusting the chain is easier this way, although it will be more awkward to fit the idler-wheel sprocket.

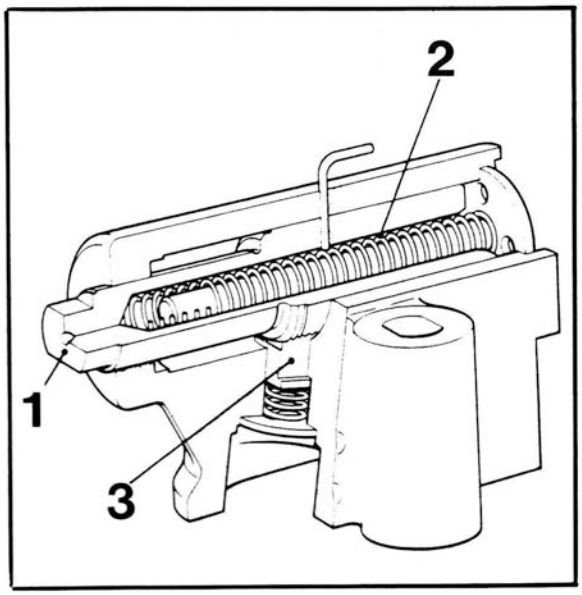






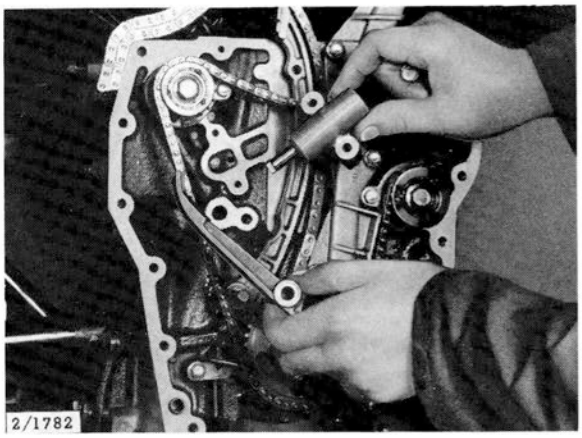
Fit the idler-wheel sprocket last

15 Cock the chain tensioner and insert a paper clip or the like through the hole in the cylinder to prevent the tensioner being triggered. Before securing it, make sure that the plunger is turned to the position in which the spring acts fully on it.



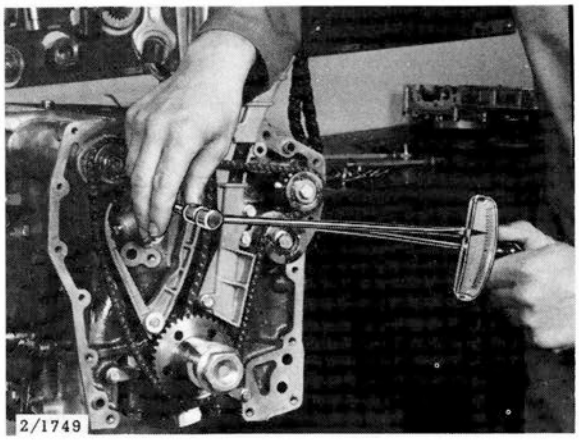
1 Plunger
2 Spring
3 Ratchet

Fit the pivoting chain guide and the tensioner.

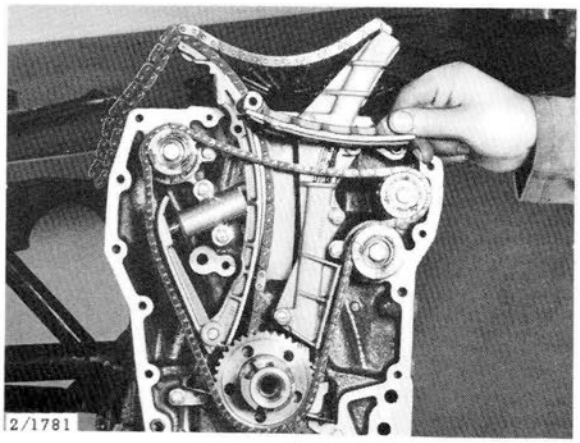


Caution
The tensioner must be correctly torqued to operate properly.

Tightening torque:
12 Nm (8.9 lbf ft)

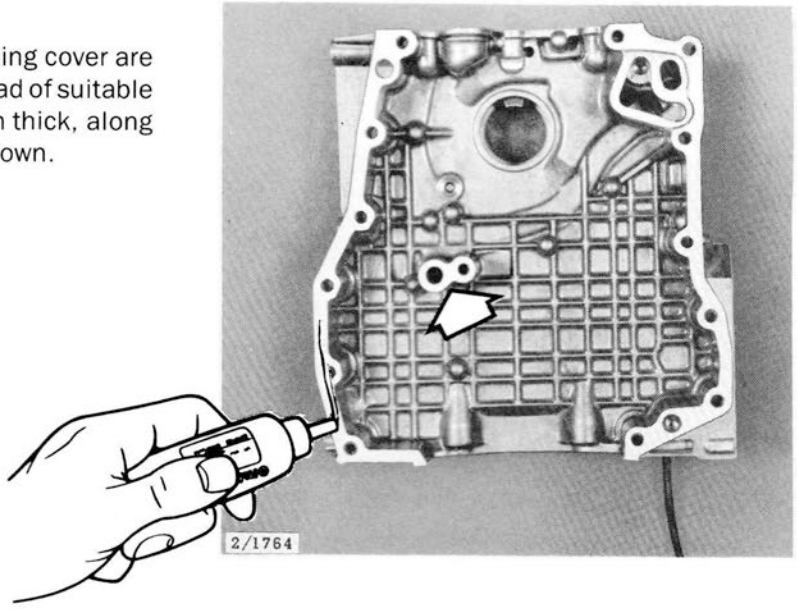


16 Fit the top chain guide and trigger the tensioner.

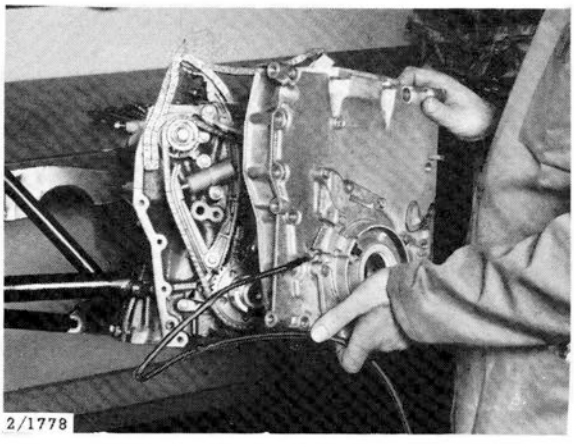


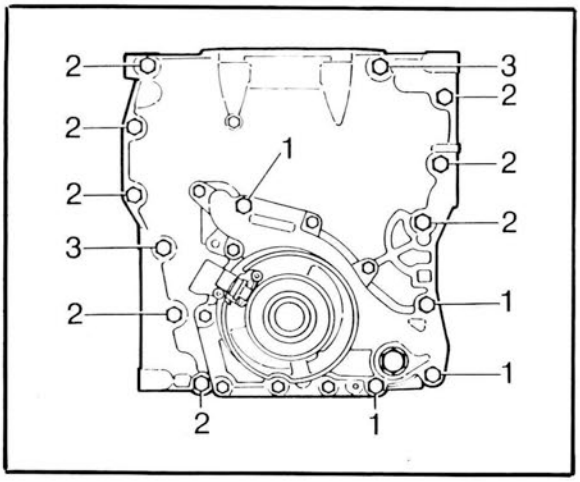
Rotate the crankshaft a few times to check that the chain is set up correctly.

17 See that the flanges on the timing cover are spotlessly clean and apply a bead of suitable anaerobic sealant, about 1 mm thick, along the middle of the flanges as shown.



Fit the timing cover complete with oil pump, crankshaft sensor and reducing valve. Note that the bolts have three different lengths and fit them as shown.

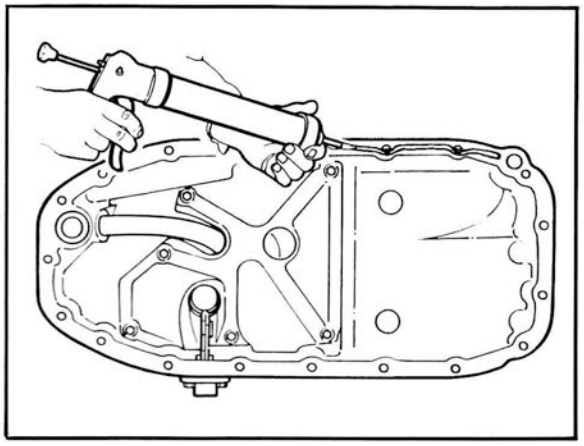




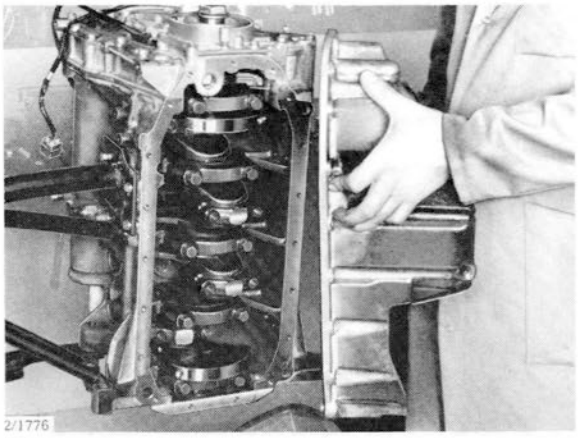
Timing cover bolts

1 = 80 mm (4)
2 = 55 mm (8)
3 = 60 mm (2)

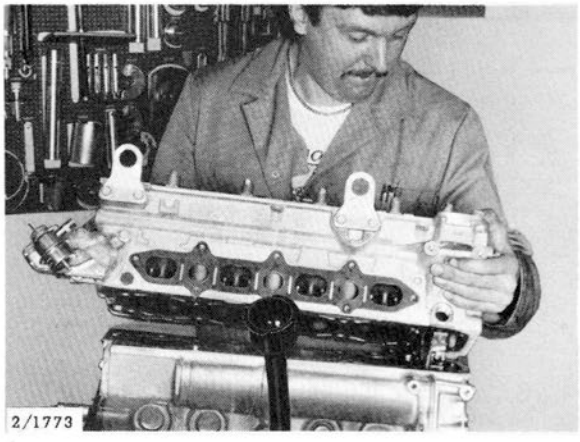
18 Make sure the flange on the sump is spotlessly clean and then apply Permatex Ultra Blue silicon sealant as shown.



Swivel the engine into a suitable position and fit the sump.



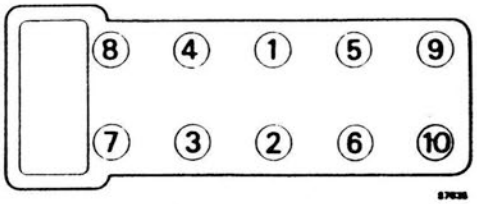
19 Swivel the engine round again and fit the cylinder head complete with a new gasket.



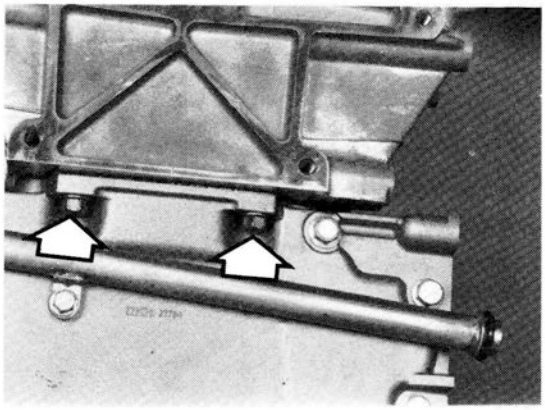
Tighten the cylinder-head bolts in three stages:

I 60 Nm (44 lbf ft)
II 80 Nm (59 lbf ft)
III A further quarter-turn (90°)

Tighten the head bolts in the sequence shown.

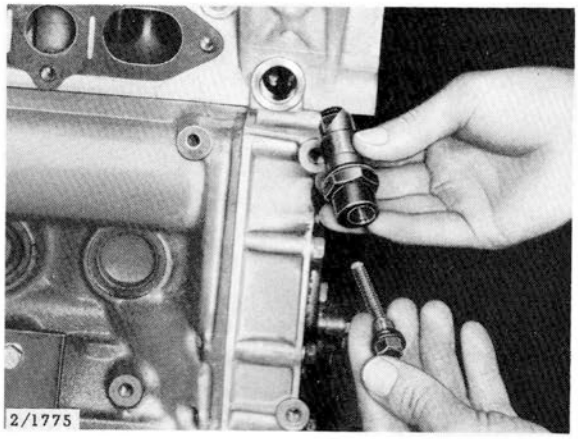


Remember the bolts fitted through the timing cover from underneath.



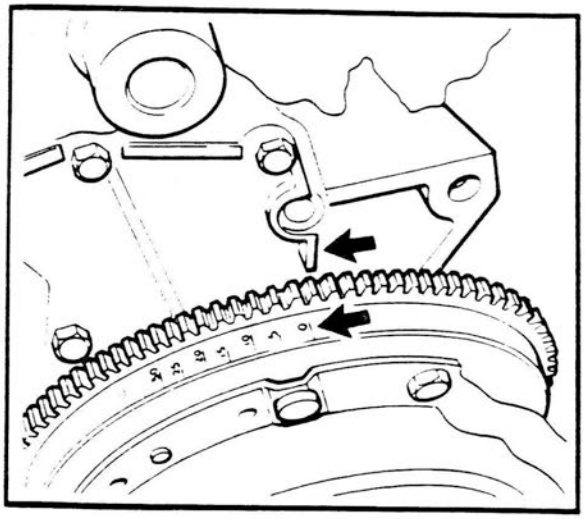
20 Fit the camshaft sprockets and chain, leaving the centre-bolts slack.

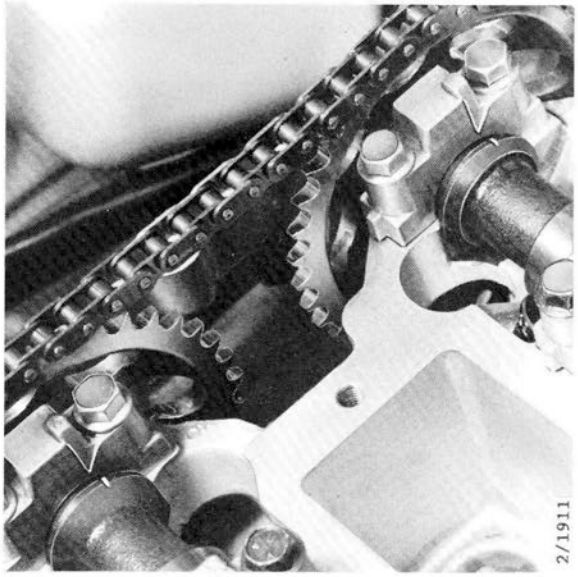
21 Fit the chain tensioner (subsection 215 refers). Note that a 27-mm socket is required.



22 Check that the chain is correctly seated in the guides.

Rotate the crankshaft a few times and check that the timing is set correctly (flywheel and camshafts).

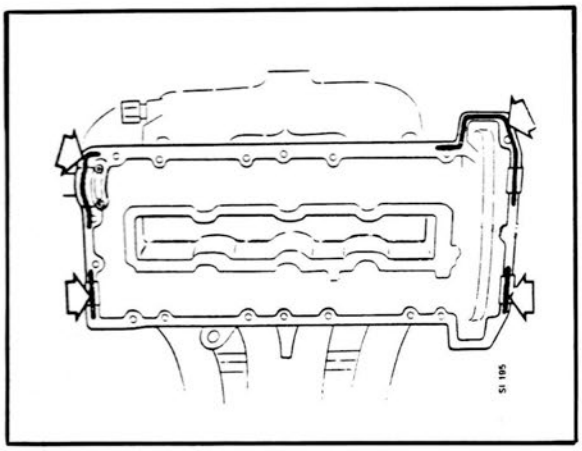




Torque the camshaft sprocket centre-bolts.

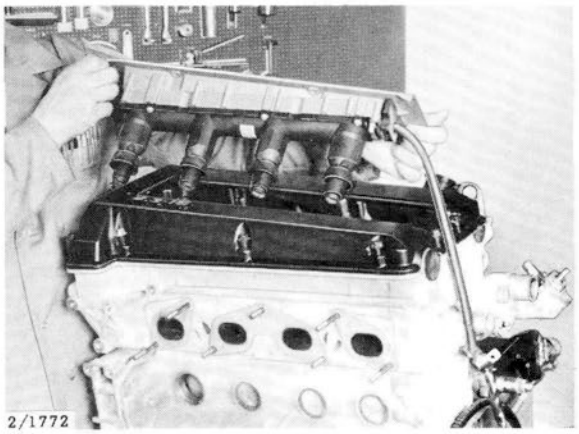
Tightening torque:
60 Nm (44 lbf ft)

23 Clean the flanges on the camshaft cover (cleaning petrol) and then apply a silicon sealant as shown.



Fit the camshaft cover.

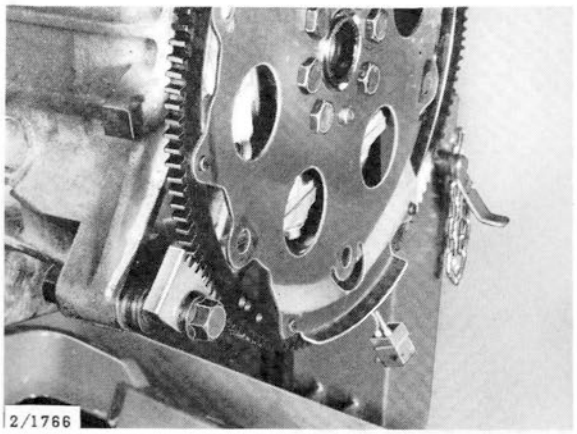
24 Fit the ignition module (cartridge) and connect the earth lead from the loom together with the clip to the fuel-pressure regulator bracket.

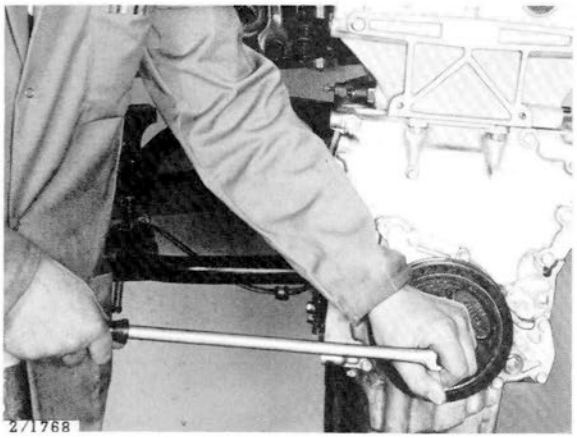


25 Fit the locking segment 83 93 987, followed by the crankshaft pulley.

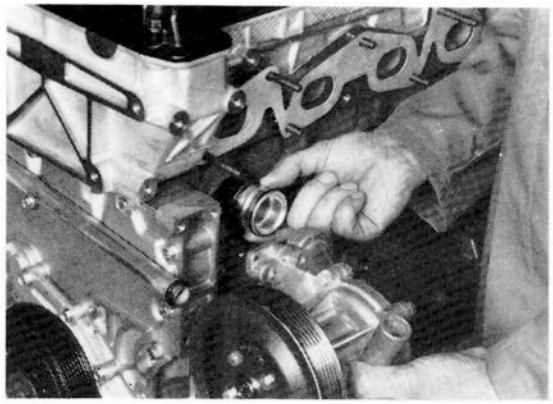
Tightening torque:
190 Nm (140 lbf ft)

Remove the locking segment.

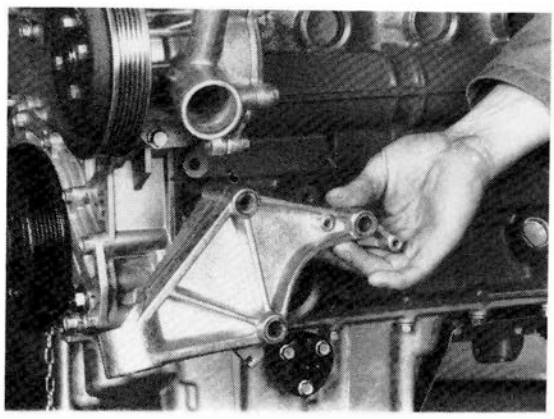




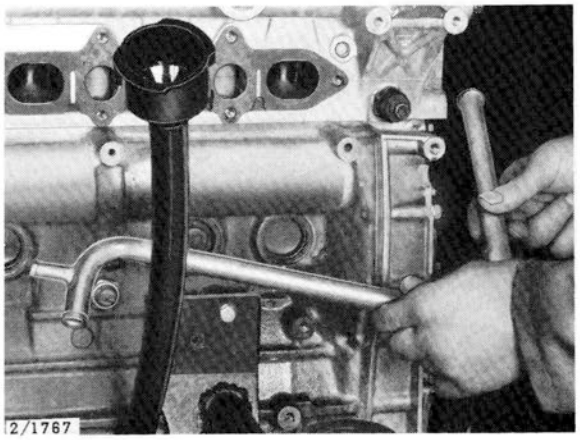
26 Lubricate the 'O' ring with Vaseline and fit the water pump.



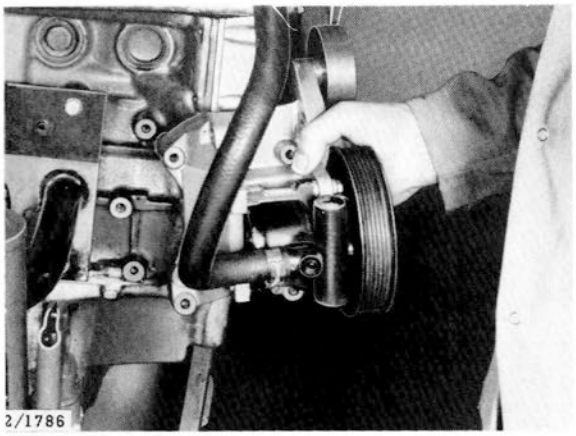
27 Fit the front engine mounting.



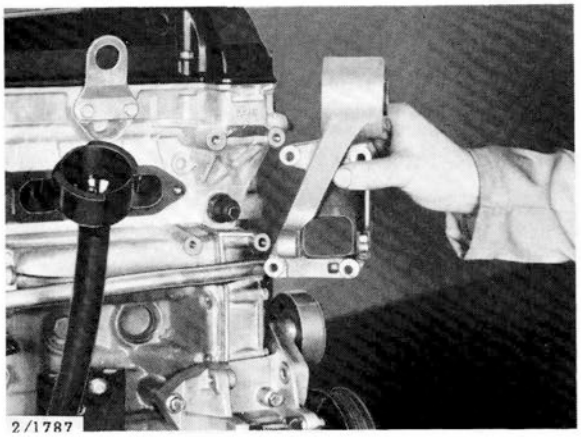
28 Lubricate the 'O' ring with Vaseline and connect the pipe between the water pump and the heater-box hoses. Fit the clip for the crankshaft-sensor lead and tie the lead to the pipe.



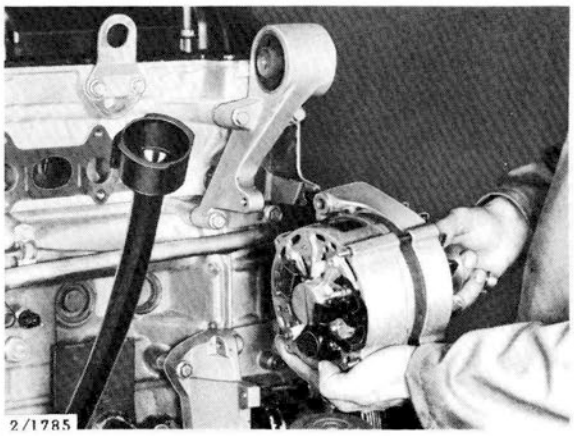
29 Fit the steering servo pump complete with bracket and idler-wheel pulley.



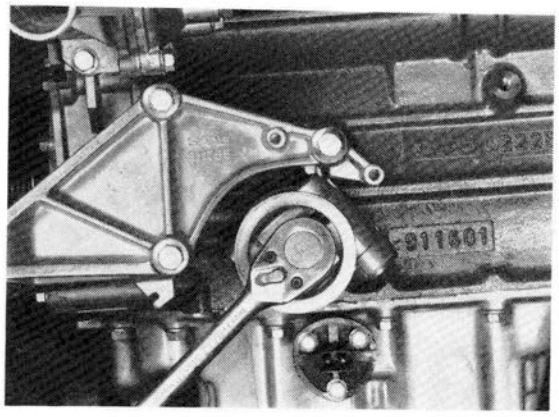
30 Fit the top engine mounting.



31 Fit the alternator.

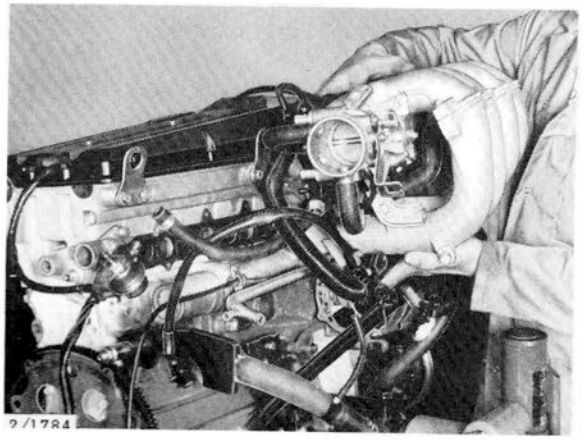


32 Fit the adaptor and oil filter.

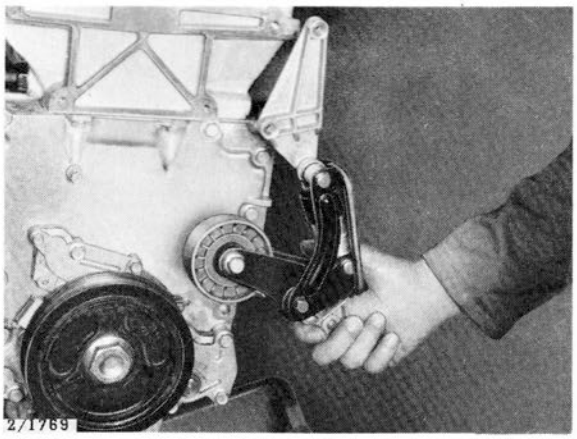


33 Fit the inlet manifold (with new gasket) complete with engine wiring loom and:

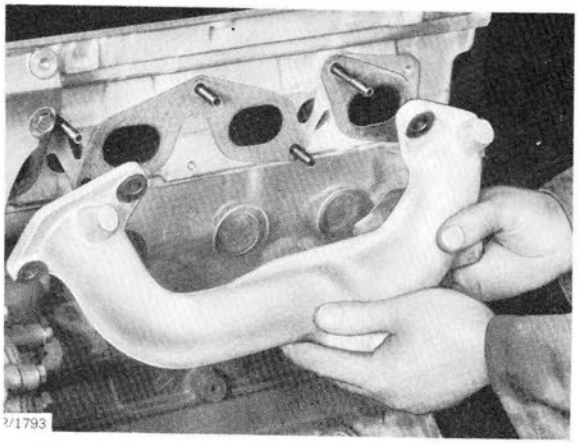
- connect the leads to the alternator
- connect the fuel hose to the fuel-pressure regulator
- connect the hoses to the throttle housing
- connect the crankcase breather hoses to the camshaft cover
- fit the bracket for the dipstick tube.



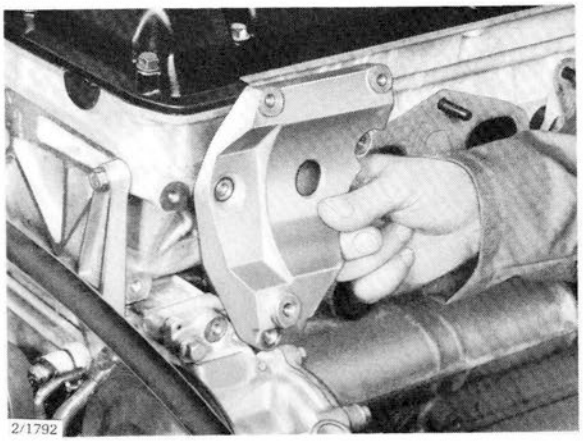
34 Fit the belt tensioner.



35 Using new gaskets, fit the exhaust manifold: outer section first and inner section last.

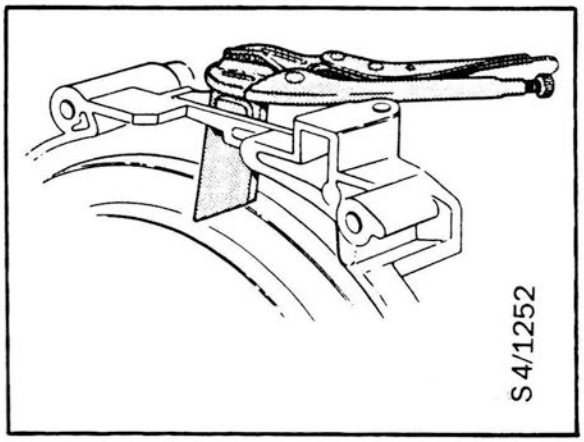


36 Fit the bracket for the AC compressor.

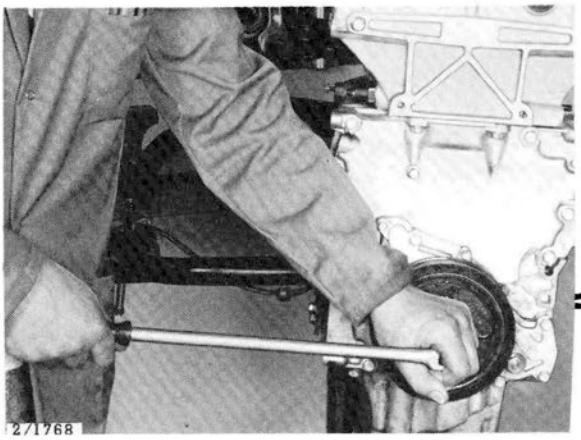


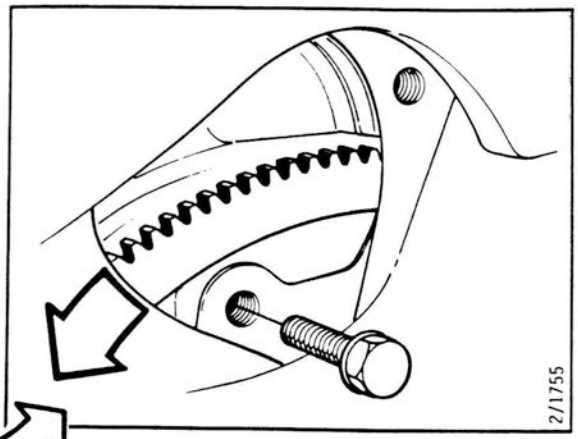
37 Check that the torque converter is proper seated inside the gearbox and that to 87 91 816 is fitted.

Lift the gearbox into position and tighten th securing bolts.



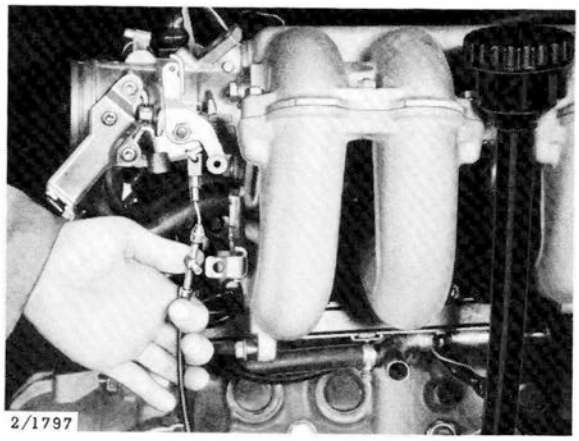
38 Fit the securing bolts for the flywheel (through the aperture in the backplate)



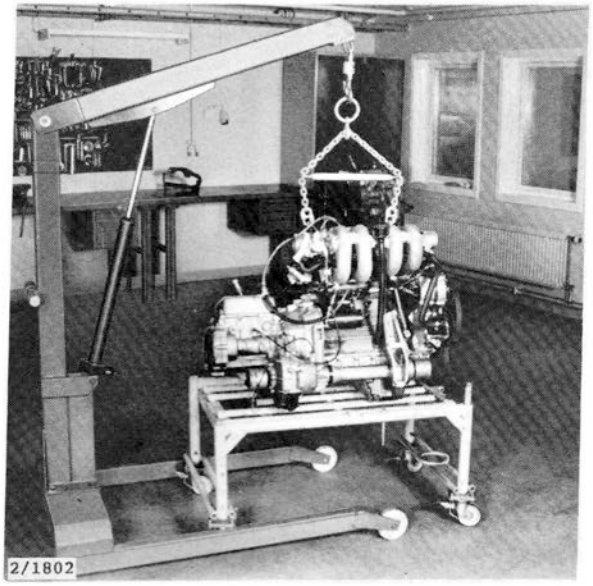


39 Remove the lifting beam 87 91 451 and fit the gearbox breather valve.

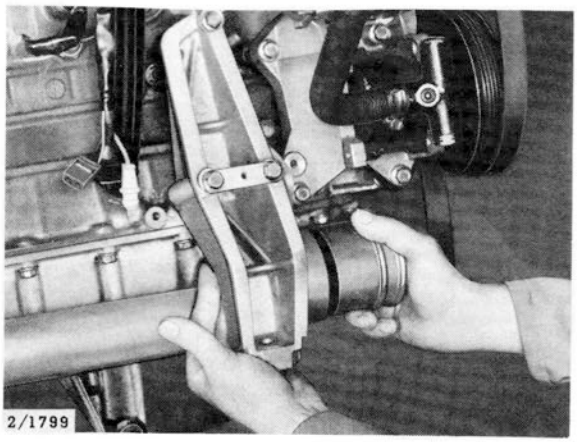
40 Connect the kickdown cable to the throttle linkage and fit the clip securing the cable to the bracket.



41 Fit a lifting sling to the engine and lift the engine off the stand. Remove the bracket and lower the engine onto a trolley.



42 Fit the engine mounting/support bearing bracket complete with the tube and inner drive-shaft joint.

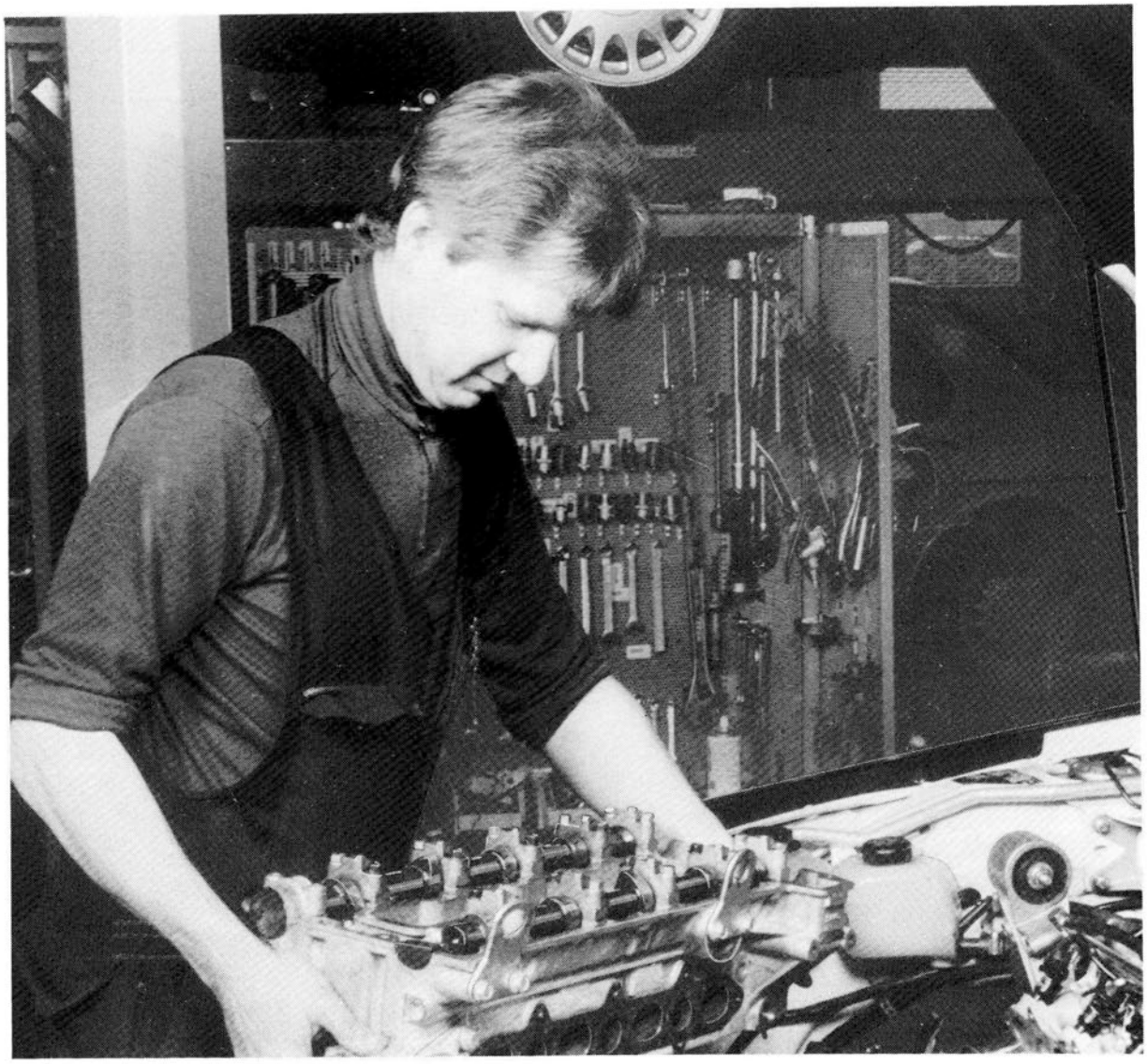


43 Fit the starter motor and reconnect the leads.

The engine is now ready for fitting in the car.

Cylinder head

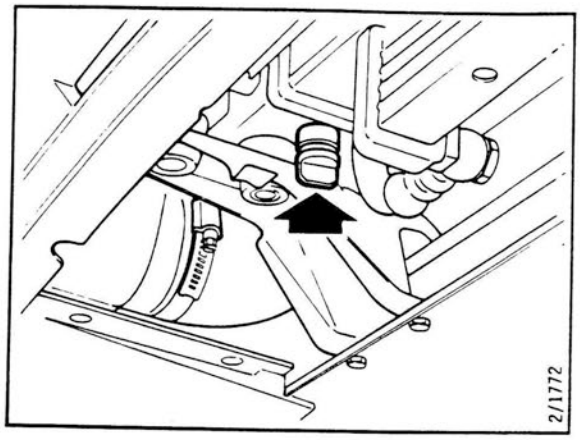
To remove



1 Raise the car on a lift and remove the right front wheel.

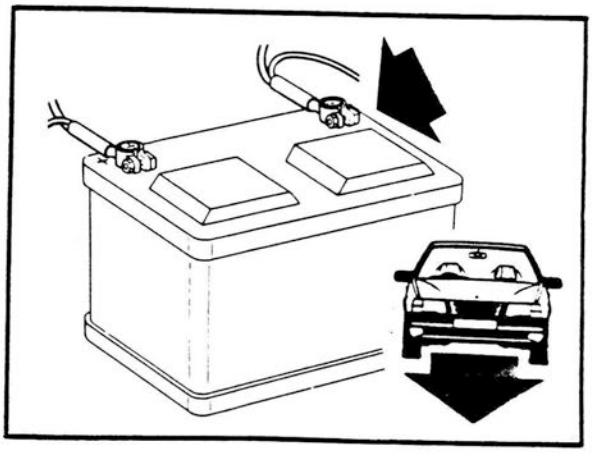
2 Remove the front section of wing liner.

3 Drain the coolant.



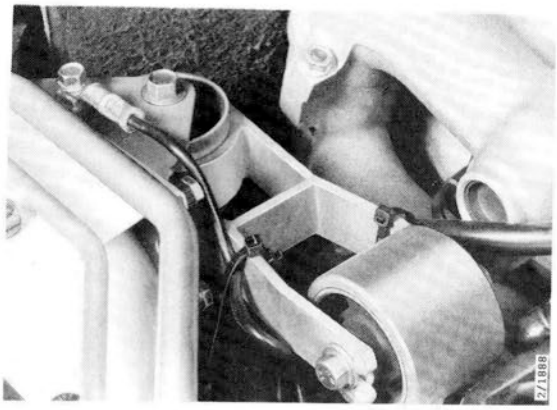
Lower the car.

4 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

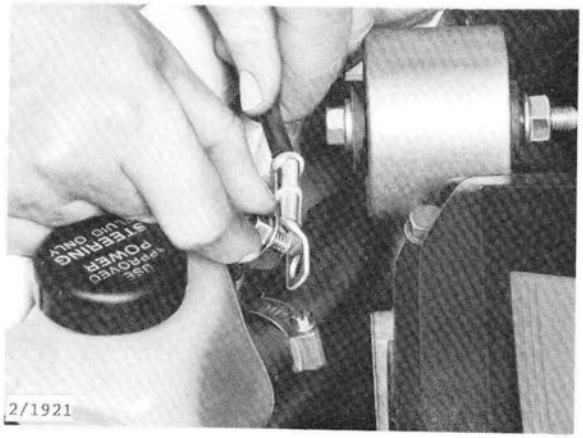


5 Snip through the ties securing the wiring and hoses to the torque arm.

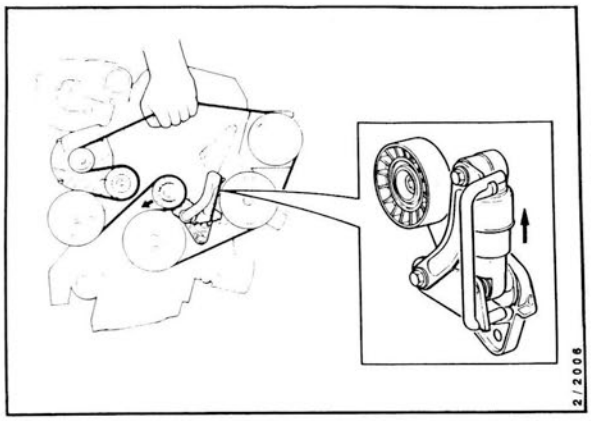
Remove the torque arm.



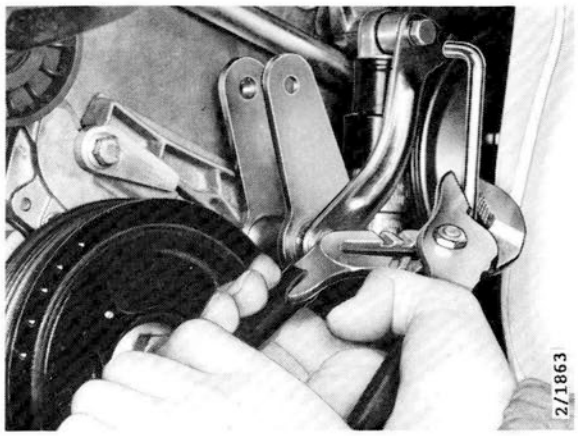
6 Disconnect the earth lead from the cylinder head and tuck it out of the way.

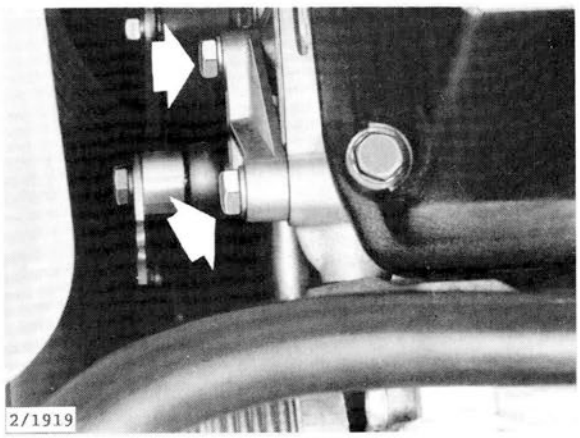


7 Ease the drive belt off the pulley (Section 216 refers).



8 Remove the locking pin from the belt tensioner and the tensioner securing bolts from the cylinder head.

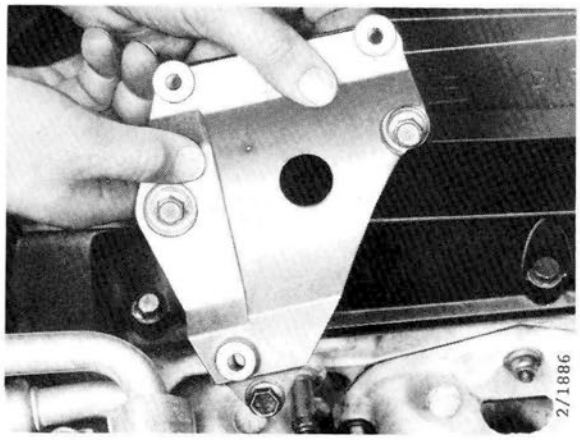




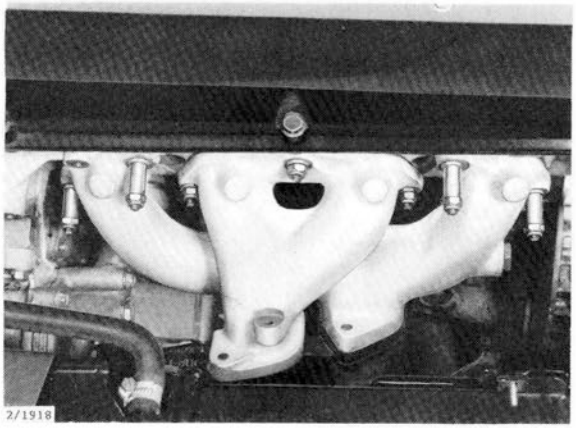
9 Place a protective steel panel or the like in front of the oil cooler.

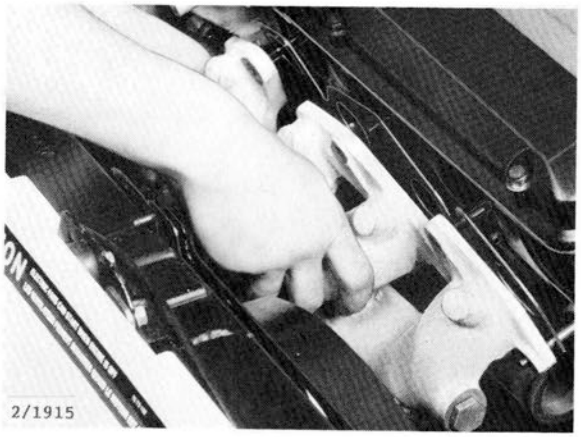
Unbolt the fixings for the AC compressor and place it, with suitable protection underneath, on the radiator crossmember.

10 Remove the compressor bracket.

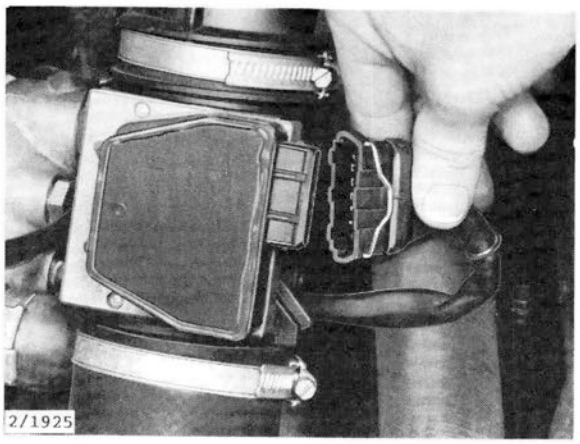


11 Undo the nuts, lift the exhaust manifold off the studs and then lower it onto the sub-frame.



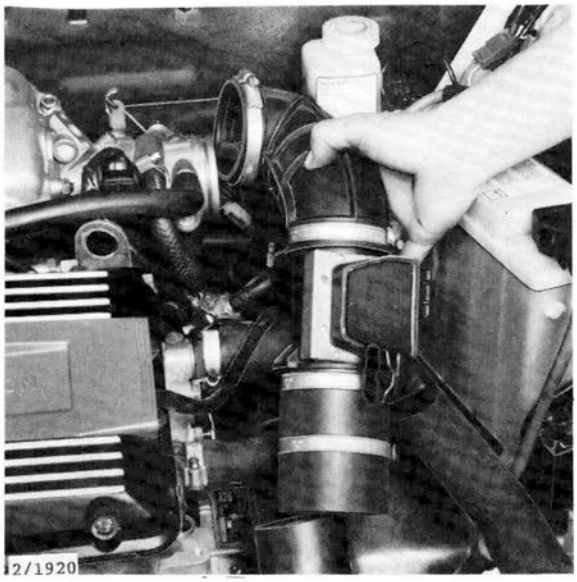


12 Unplug the connector from the air mass meter.

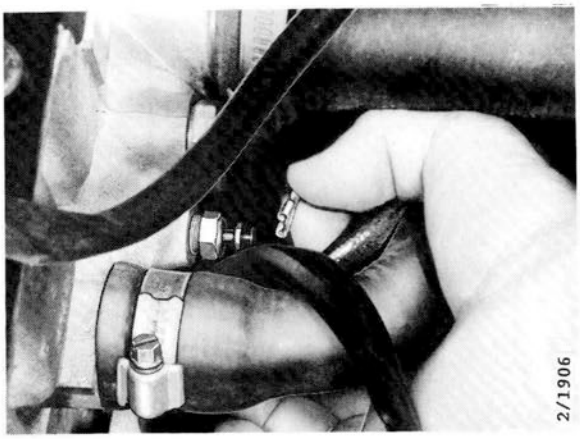


Remove the rubber elbow and air mass meter assembly from between the throttle housing and the intake-air silencer.

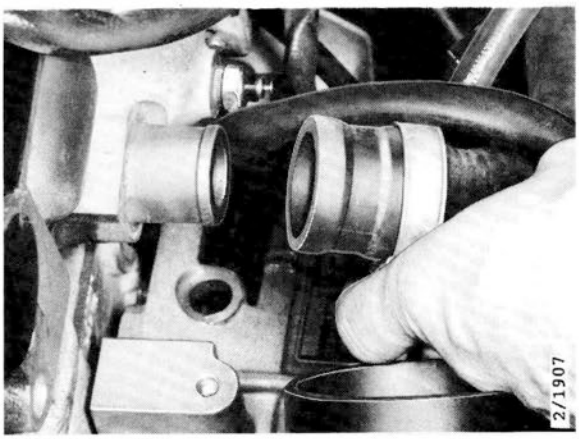
Stuff a rag into the open end of the silencer.



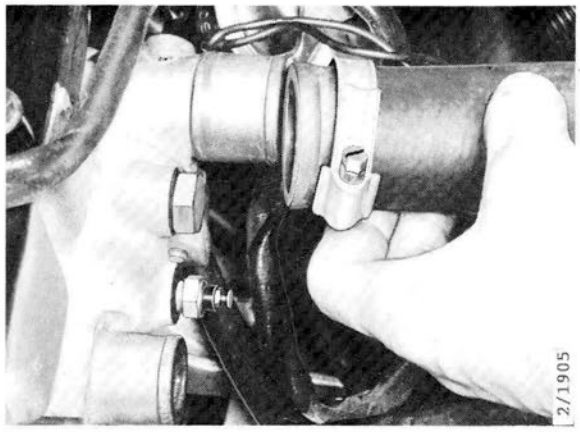
13 Disconnect the electrical lead from the thermostatic switch.



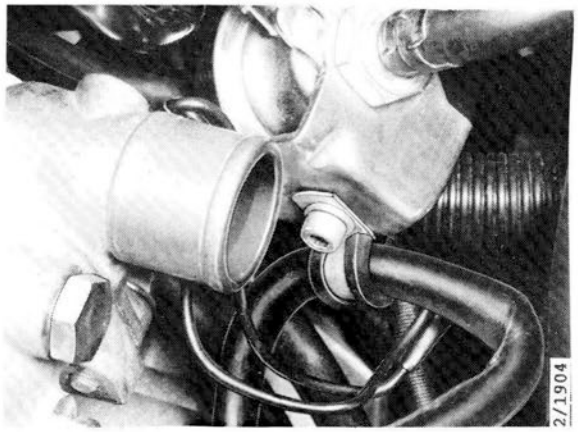
14 Disconnect the heater-box hose from the thermostat housing.



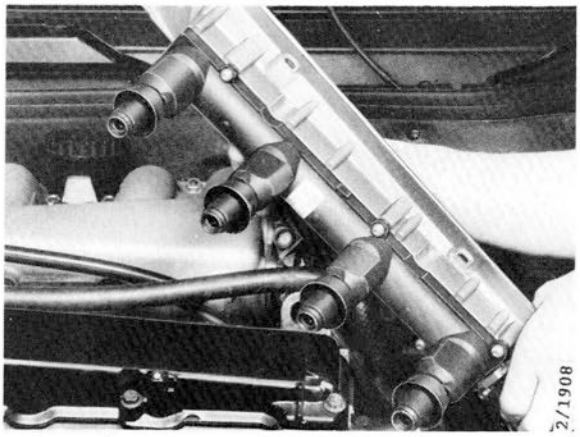
15 Disconnect the top coolant hose from the cylinder head.



16 Remove the clip for the DI wiring loom from the pressure-sensor bracket.

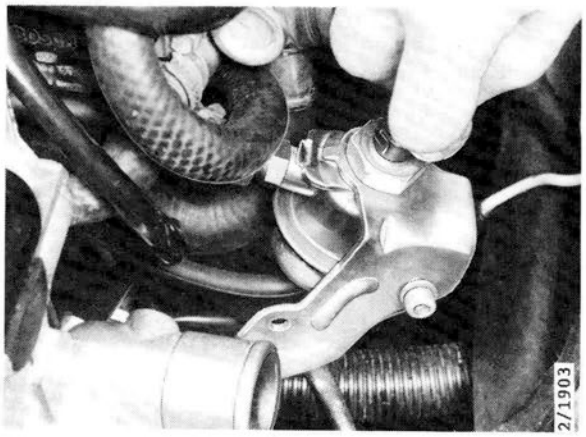


17 Undo the four screws and lift the ignition module (cartridge) out of the way.



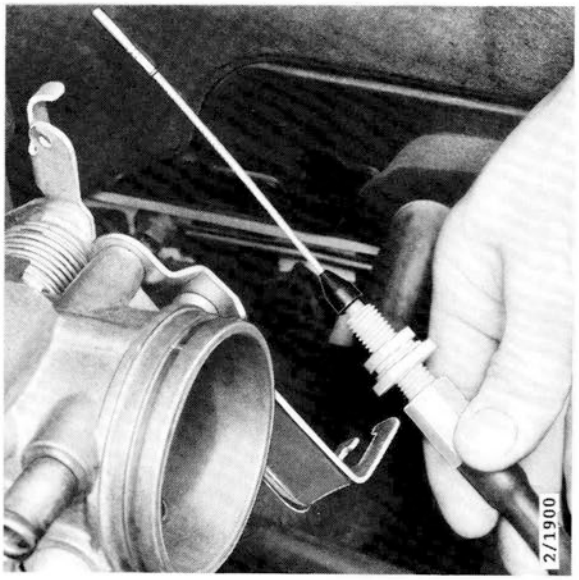
18 Undo the securing bolts for the fuel-pressure regulator and lift the regulator complete with bracket and hoses out of the way.

Note the earth lead.

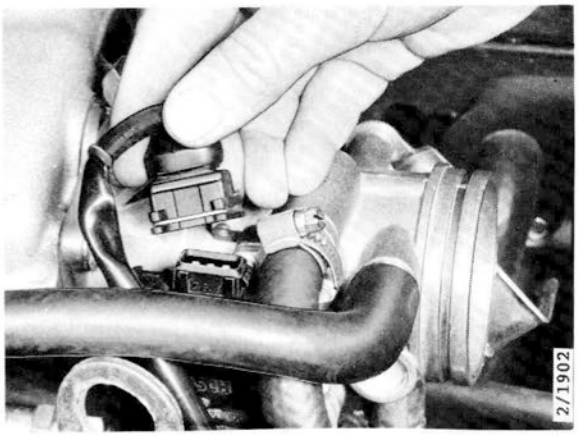


19 Remove the top bolts securing the top of the inlet manifold to the bottom half.

20 Disconnect the throttle cable from the throttle linkage (Automatics: and the kickdown cable).

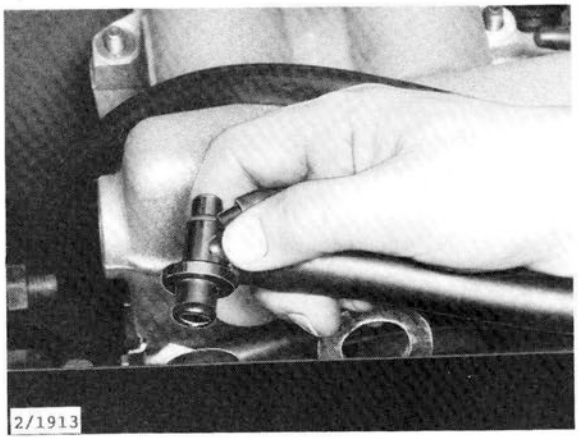


21 Unplug the connector from the throttle-position sensor.

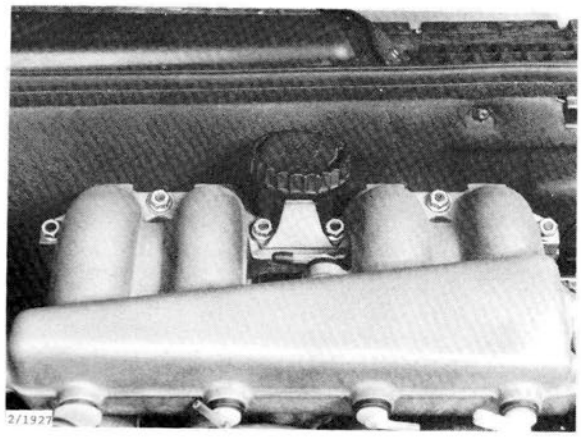


22 Disconnect the preheater hoses from the throttle housing.

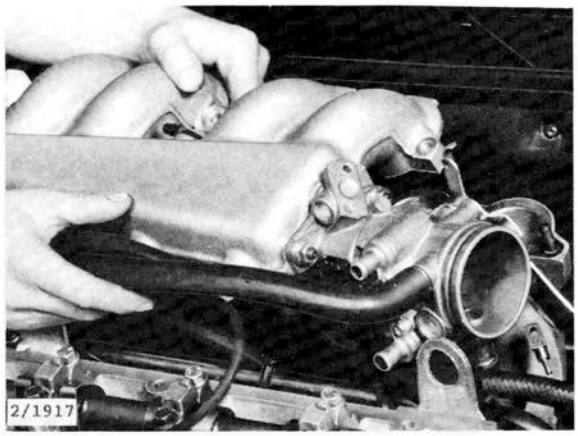
23 Disconnect the crankcase-breather and vacuum hoses from the camshaft cover.



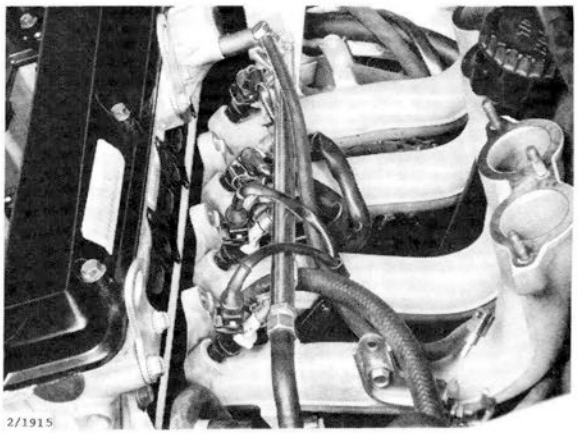
24 Undo the bolts in the top of the inlet manifold and set aside the bracket for the dipstick tube.



Lift off the top section of the inlet manifold complete with throttle housing and stand it on a cover on top of the false bulkhead panel.

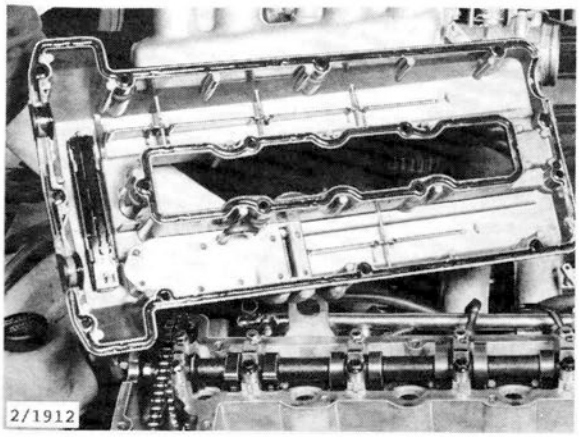


25 Slacken the securing bolts in the manifold steady bars, and remove the bolts securing the manifold to the cylinder head. Lift the manifold back towards the false bulkhead panel.

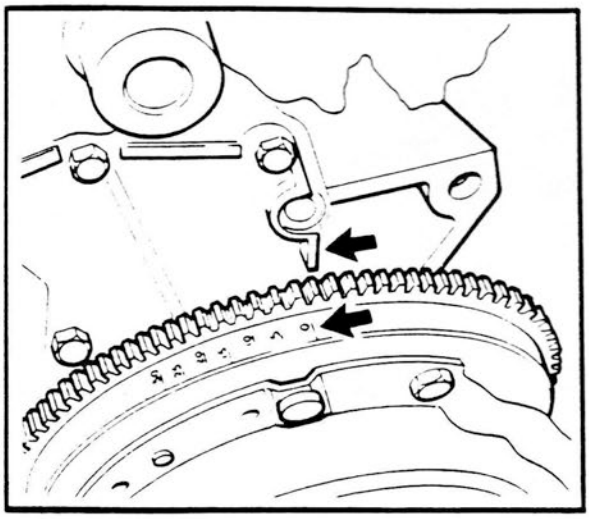


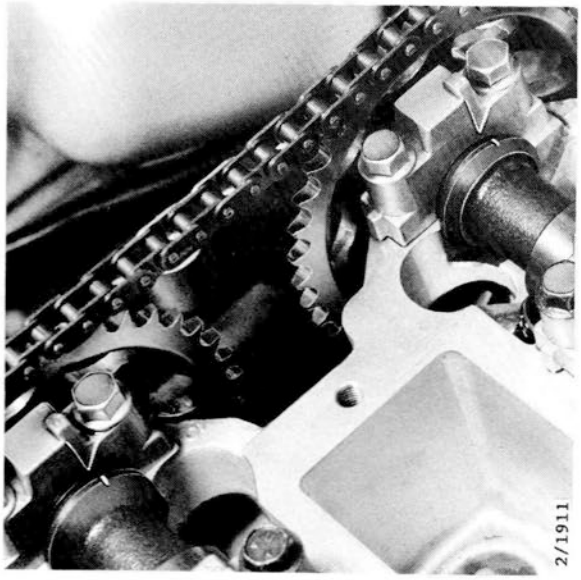
26 Remove the two securing bolts from the top of the engine-mounting bracket and slacken the two lower ones.

27 Remove the camshaft cover.



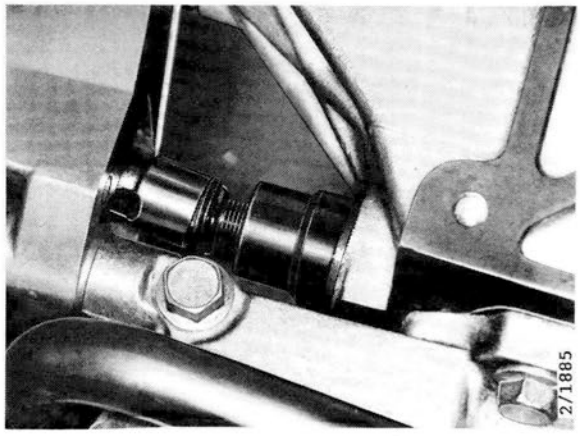
28 Line up the '0' mark on the flywheel with the timing mark on the end plate and ensure that the timing marks on the camshafts are also in line.



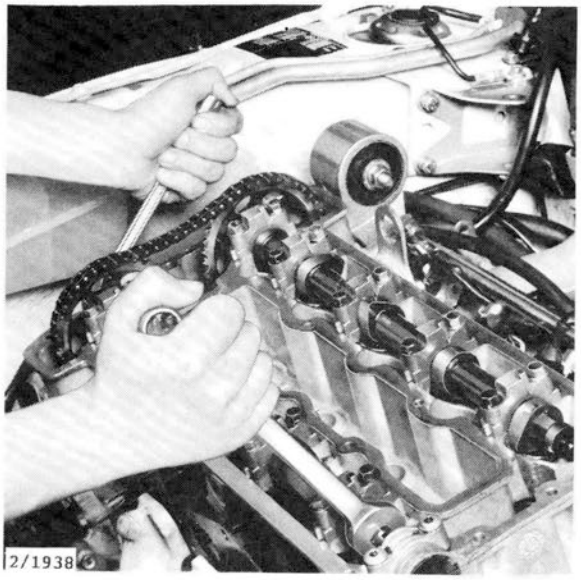


29 Remove the chain tensioner.

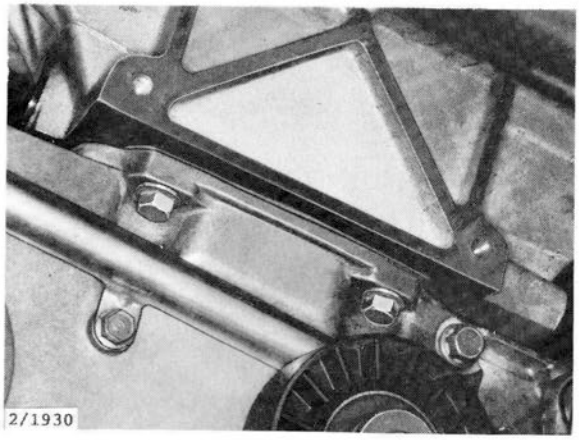
Use a 27-mm socket and extension, gaining access through the middle of the engine bracket.



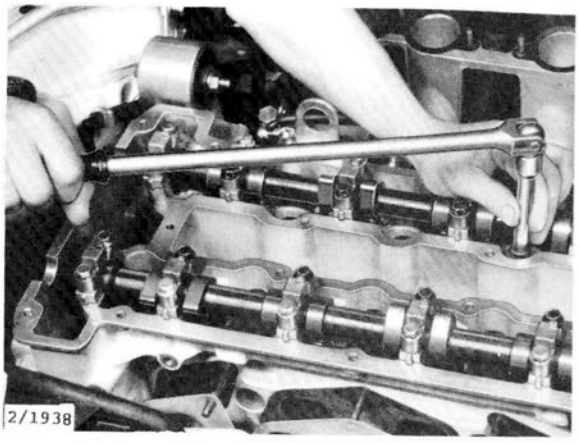
30 Remove the camshaft sprockets.



31 Remove the two bolts securing the timing cover to the cylinder head from underneath.



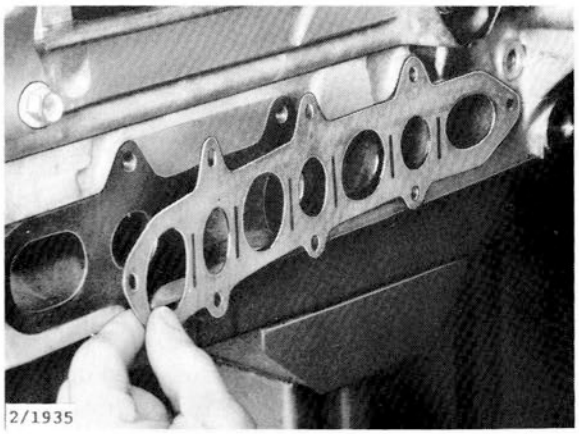
32 Remove the cylinder head bolts (ten Torx screws).



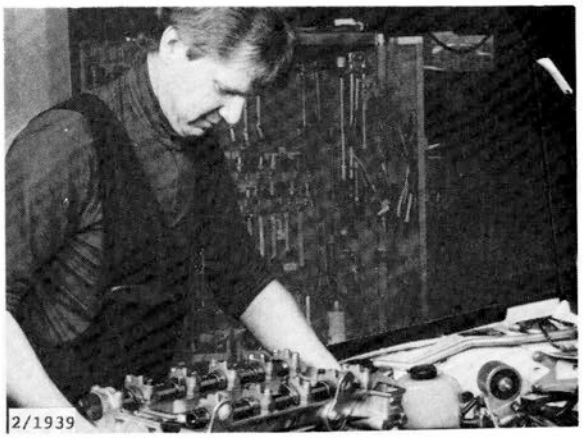
33 Soak up any oil. Making sure first that the timing chain is not in the way, lift off the cylinder head.

To fit

1 Thoroughly clean all the flanges and fit new gaskets. Use a few drops of gasket sealant or the like to hold the gasket onto the inlet-manifold flange.

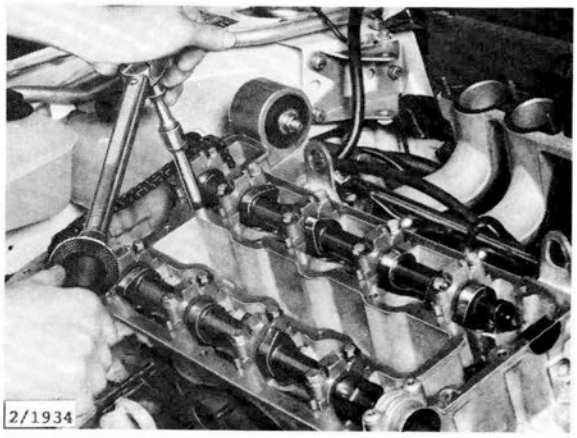


2 Lift the cylinder head onto the block, ensuring that it is properly seated in the locating pins and that the timing chain has not become trapped.

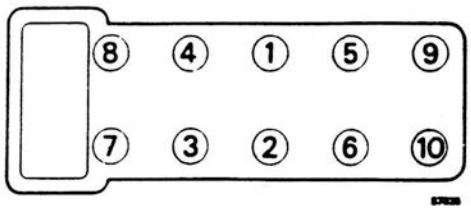


3 Fit the 10 cylinder head bolts, tightening them in three stages and in the sequence shown below:

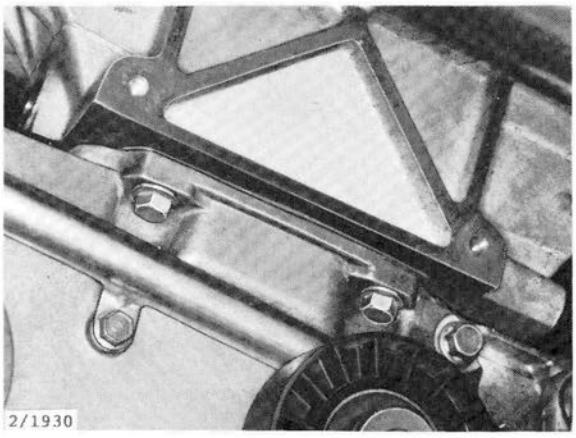
Stage I	60 Nm (44 lbf ft)
Stage II	80 Nm (59 lbf ft)
Stage III	Tighten a further quarter-turn (through 90°)



Tightening sequence for head bolts



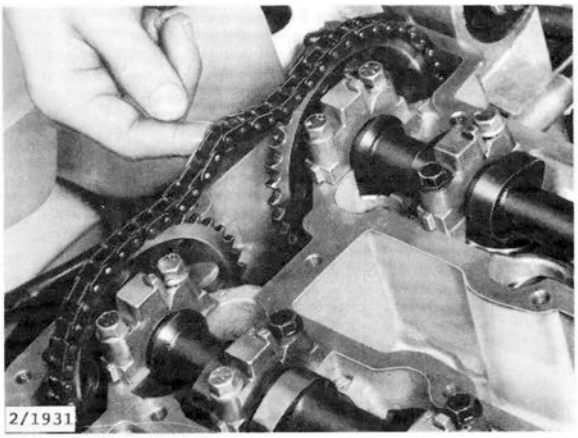
4 From underneath, fit the two bolts securing the timing cover to the cylinder head.



5 Check that the camshafts are lined up with their respective timing marks and that the 'O' mark on the flywheel is in line with the timing mark on the end plate.

6 Fit the camshaft sprockets (exhaust side first) leaving the centre-bolts slack. Check that the chain is correctly seated on the sprocket teeth and in the guides.

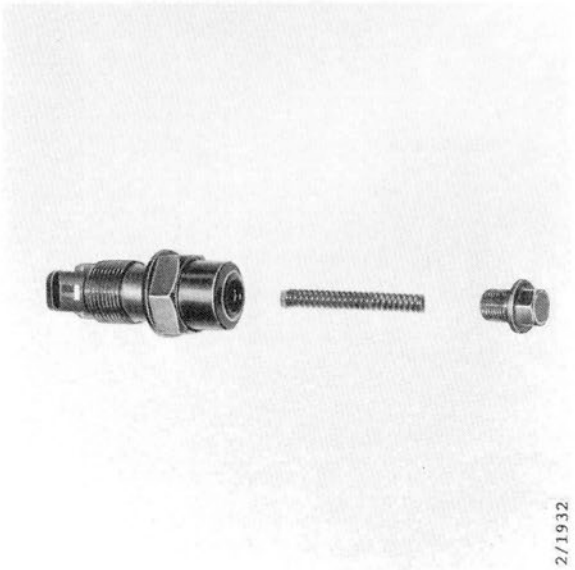
To facilitate alignment, leave some slack in the chain between the sprockets.



7 Unscrew the chain-tensioner plug and remove it complete with spring and plastic guide pin.

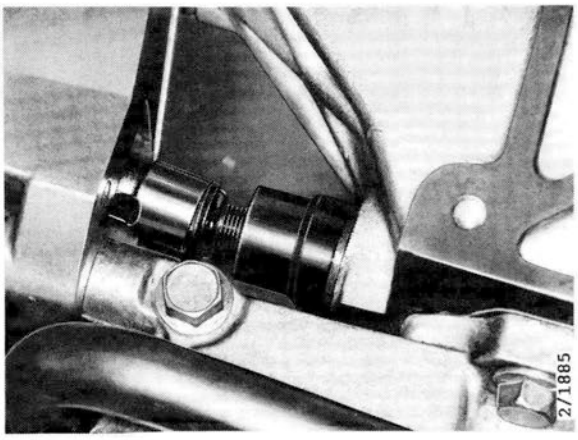
Cock and fit the tensioner (page 215-19 refers).

Tightening torque:
65 Nm (52 lbf ft)



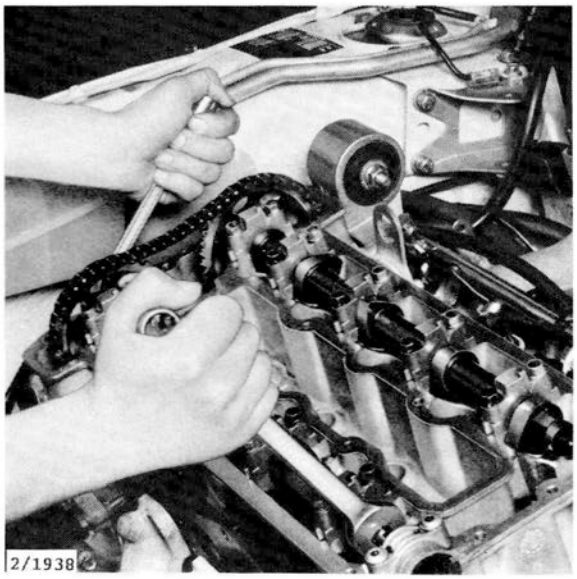
Fit the guide pin and spring, followed by the screw plug.

Tightening torque:
22 Nm (16 lbf ft)

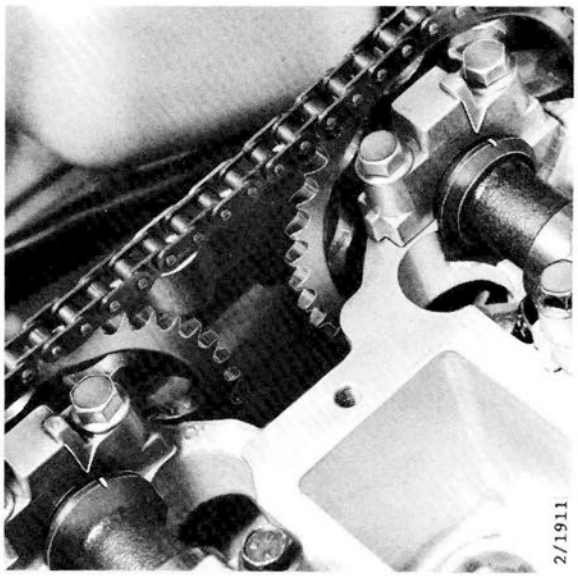


8 Tighten the centre-bolts in the camshaft sprockets.

Tightening torque:
65 Nm (48 lbf ft)

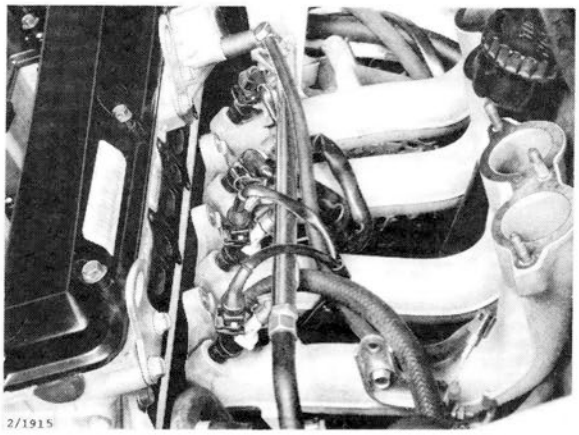


9 Rotate the crankshaft two complete turns and check that the timing marks on the camshafts and flywheel are still in alignment.

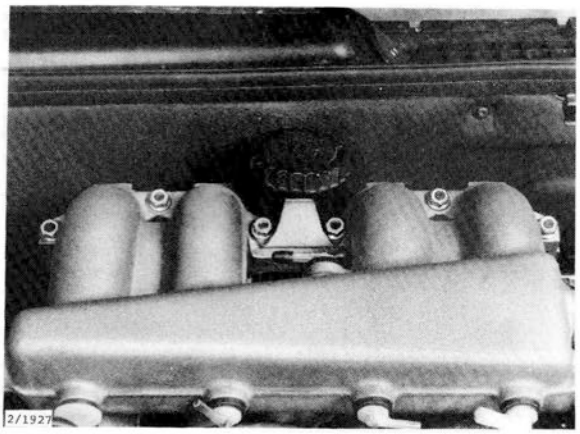


10 Fit the two bolts in the top of the engine-mounting bracket and tighten the lower ones at the same time.

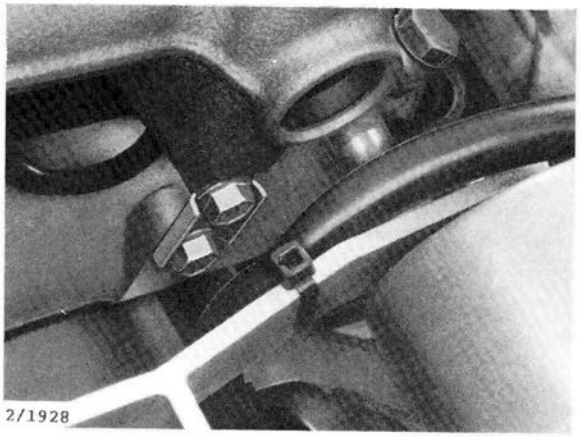
11 Tighten the bolts securing the lower part of the inlet manifold to the cylinder head and to the steady bars.



12 Fit the top half of the inlet manifold complete with dipstick-tube bracket.

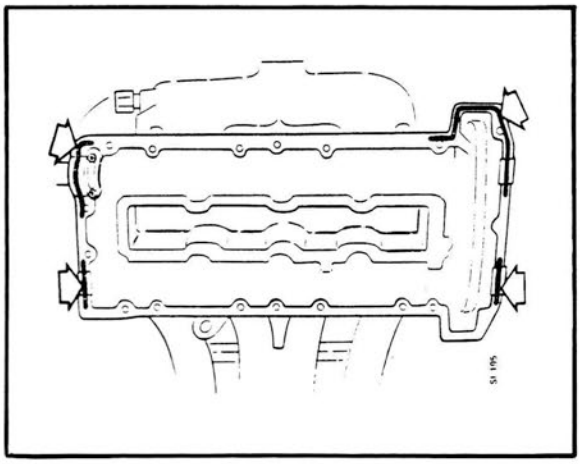


Fit the bolts holding the two halves of the inlet manifold together.

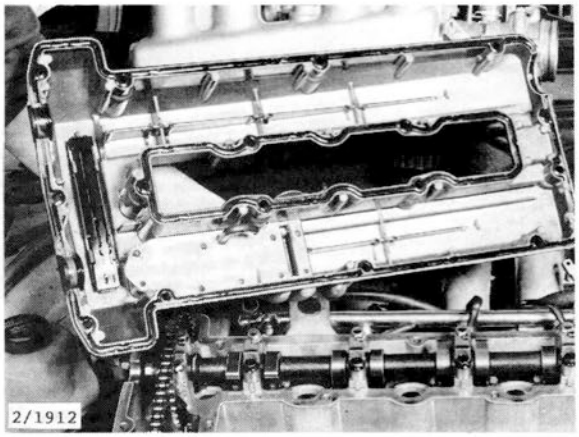


13 Fit the split rubber plugs in the cylinder head.

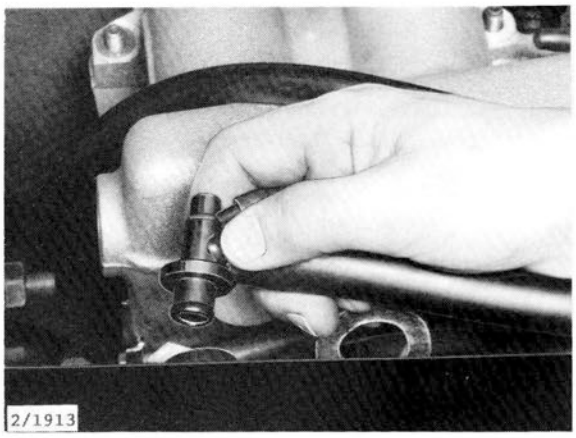
Apply beads of silicone sealant in the places shown.



Fit the camshaft cover.



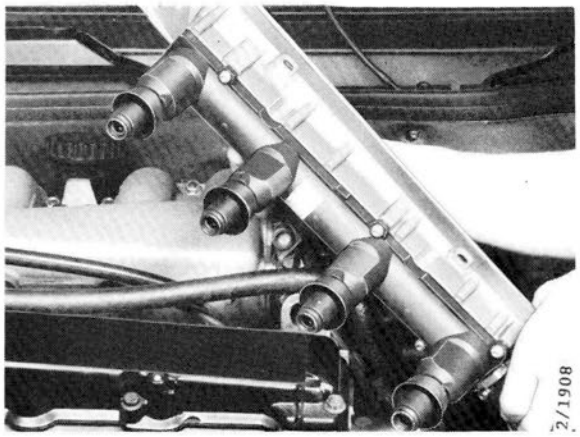
14 Reconnect the crankcase-breather and vacuum hoses.

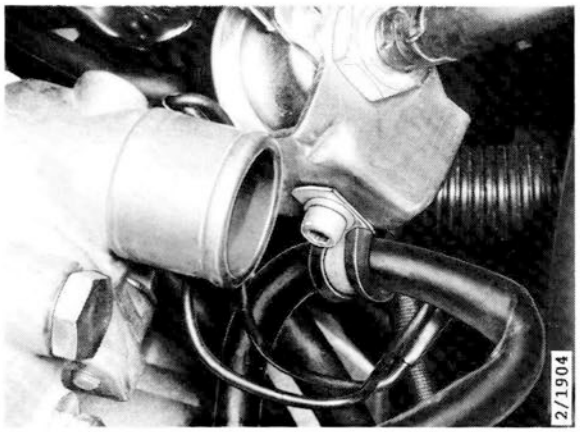


15 Reconnect the preheater hoses to the throttle housing and fit the throttle-position sensor.

16 Reconnect the throttle cable to the linkage (Automatics: and the kickdown cable).

17 Fit the ignition module (cartridge). Clip the lead to the pressure-sensor bracket.

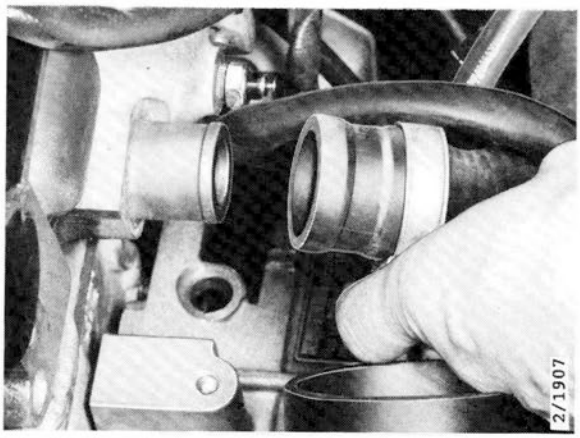




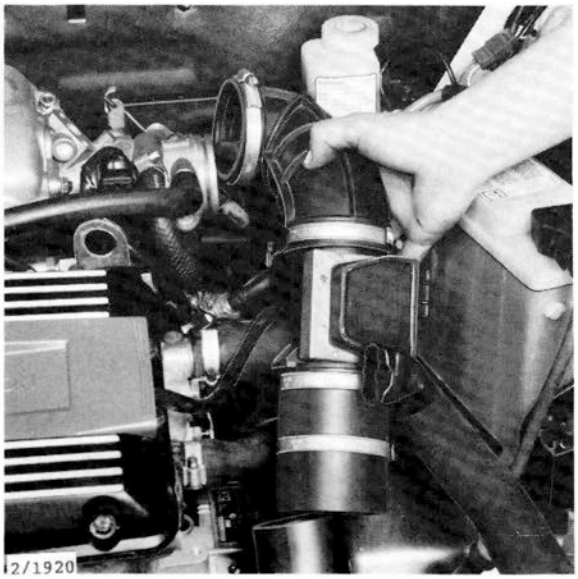
18 Fit the fuel-pressure regulator complete with bracket and hoses onto the cylinder head. Remember to reconnect the earth lead from the ignition module.

19 Plug on the temperature-sensor connector.

20 Reconnect the hose from the heater box to the thermostat housing, and the top coolant hose to the cylinder head.

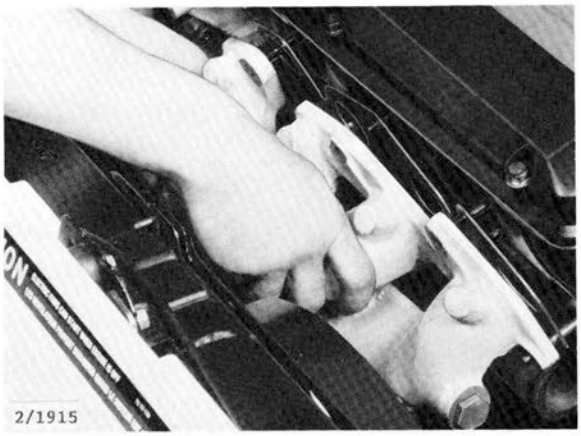


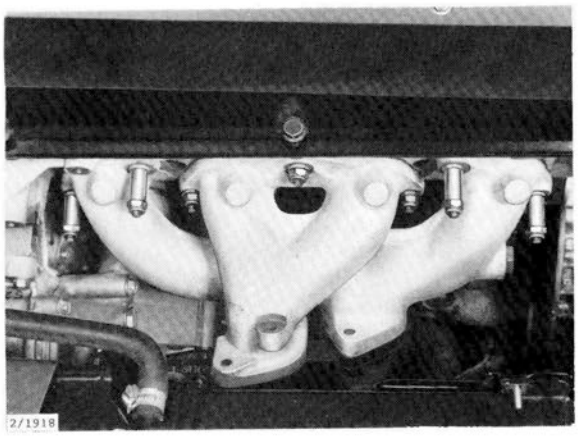
21 Refit the rubber elbow and air mass meter assembly between the throttle housing and air-intake silencer.



Plug on the air mass meter connector.

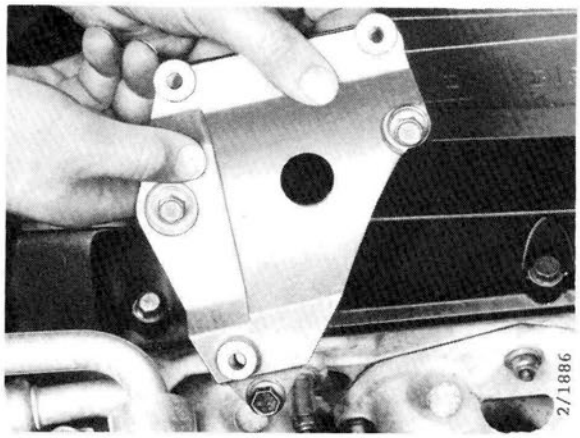
22 Using a new gasket, refit the exhaust manifold.





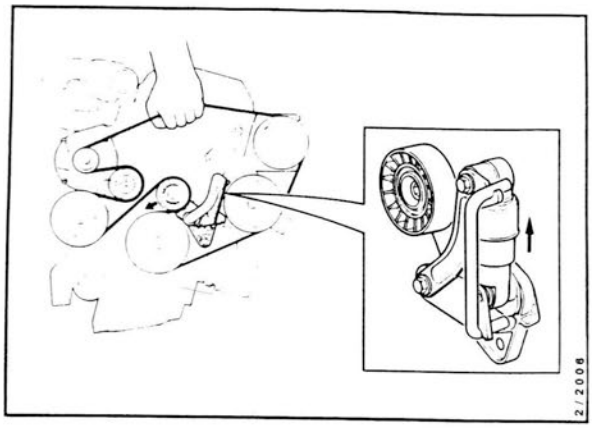
23 Fit the belt-tensioner bracket onto the cylinder head.

24 Fit the bracket for the AC compressor.

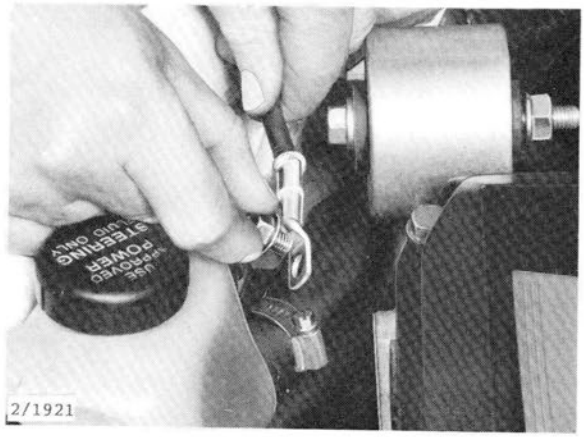


25 Fit the compressor, and plug on the connector.

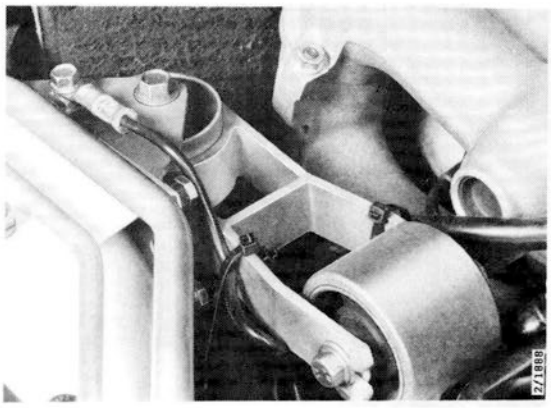
26 Fit the drive belt (Section 216 refers).



27 Reconnect the earth lead from the torque arm to the cylinder head.



28 Fit the torque arm. Secure the hoses and wiring to the torque arm using new ties.

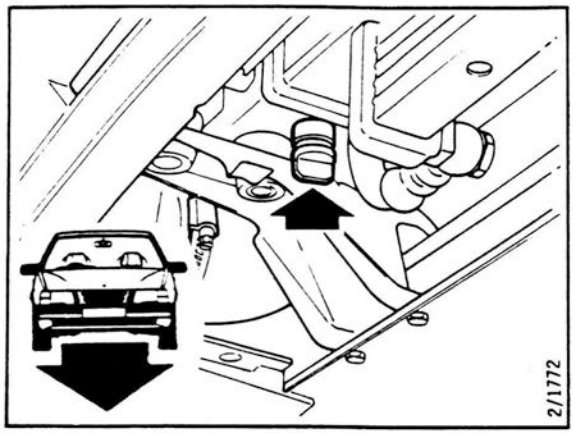


29 Raise the car and fit the wing liner.

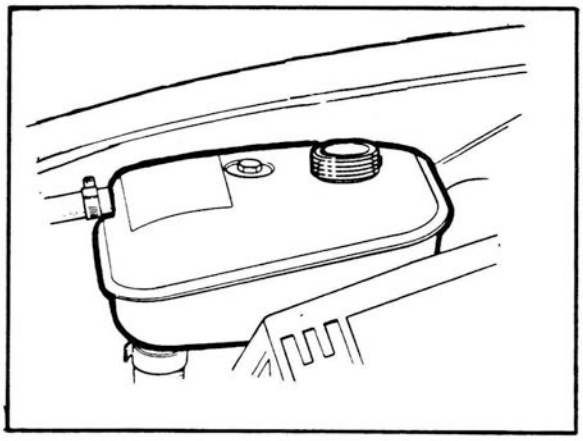
Refit the wheel and torque the bolts.

Tightening torque:
130 Nm (96 lbf ft)

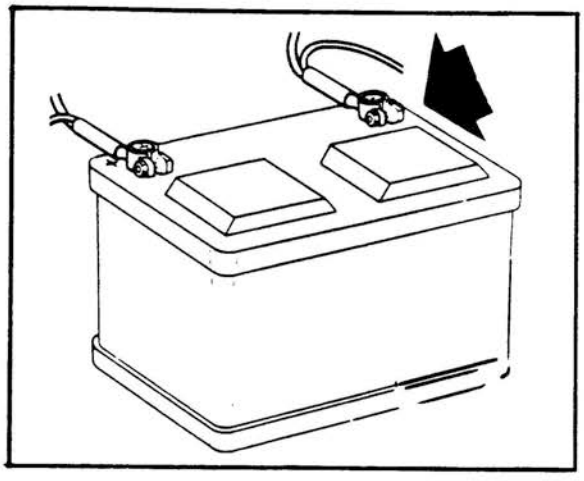
30 Check that the radiator drain plug is screwed in tight and lower the car.



Replenish the coolant.



31 Reconnect the battery.



32 Run the engine up to normal temperature.

Check the coolant level and top up as necessary. Make sure there are no leaks.

Pistons, connecting rods and cylinder bores

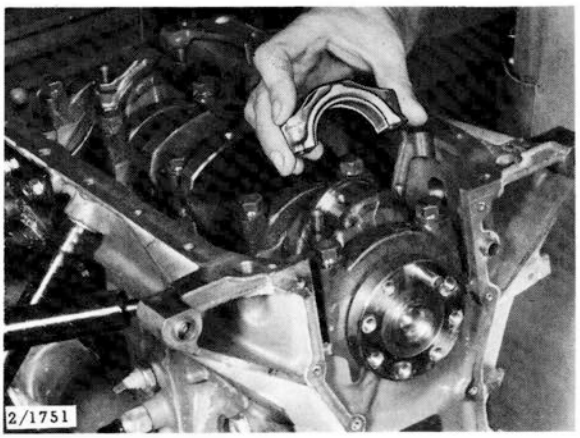
Replacing pistons, piston rings and big-end bearings

(Engine mounted in workstand, cylinder head removed)

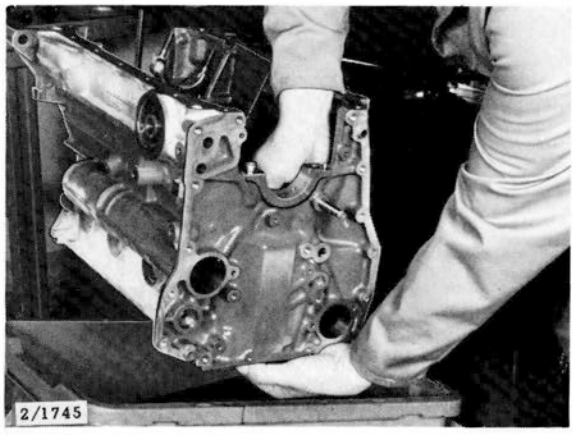
To remove

1 Remove any burrs or carbon deposits from the tops of the cylinder bores.

2 Remove the big-end bearing caps.



3 Fit the protective sleeves on the connecting rod studs. Push the pistons and the connecting rods out of the cylinder bores.



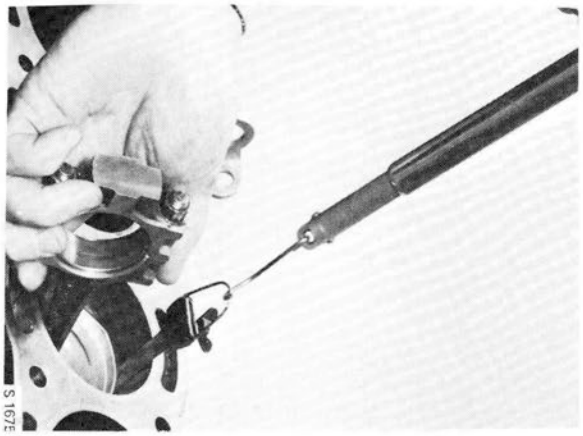
To ensure that the parts are refitted in their original positions, note the markings on the pistons and connecting rods, put the bearing shells and caps back in position on the respective connecting rods and keep each set separately.

For measurement of bearing clearance, section 216 refers.

Matching the pistons to the bores

To match pistons to the cylinder bores, use a feeler gauge, 1/2-in wide. To measure, first oil the bore lightly and insert the piston, without rings, in the bore in which it will be working. Attach the feeler gauge to a spring balance and insert it between the piston and cylinder wall at right angles to the axis of the gudgeon pin. At a tractive force of 8 - 12 N (1.8 - 2.7 lbf), the mean value of the clearance equals the thickness of the feeler gauge.

Repeat the test with the piston at several different depths.


S 1672E

For piston clearances, the 'Technical data' section refers.

Spare pistons are stocked in both standard and oversize diameters. Where the latter are used, the cylinder bore must be honed or rebored to obtain the correct piston clearance.

Proceed as follows:

Using a feeler gauge and spring balance, determine which piston (or pistons) has excessive clearance. Replace the piston (or pistons) with a piston (or pistons) of the next oversize. Check the piston clearance of the new piston (or pistons), using the feeler gauge and spring balance.

Example: class A cylinder and class A piston

When the piston clearances are measured in the engine by means of a 0.05-mm (0.0020-in) feeler gauge, no measurable force is recorded on the spring balance when withdrawing the feeler gauge from no. 2 and no. 3 cylinders.

In no. 1 and no. 4 cylinders, the pistons cannot be fitted into the cylinder bores with a 0.05-mm (0.002-in) or 0.04-mm (0.0016-in) feeler gauge inserted.

With a 0.03-mm (0.0012-in) feeler gauge, the force necessary to withdraw it will be 20 N (4.6 lbf) and, with a 0.02-mm (0.0008-in) feeler gauge, 6 N (1.4 lbf).

We can therefore assume a piston clearance in no. 1 and 4 cylinders of 0.032 mm, (0.0013 in), which means that the pistons in these cylinders need not be replaced.

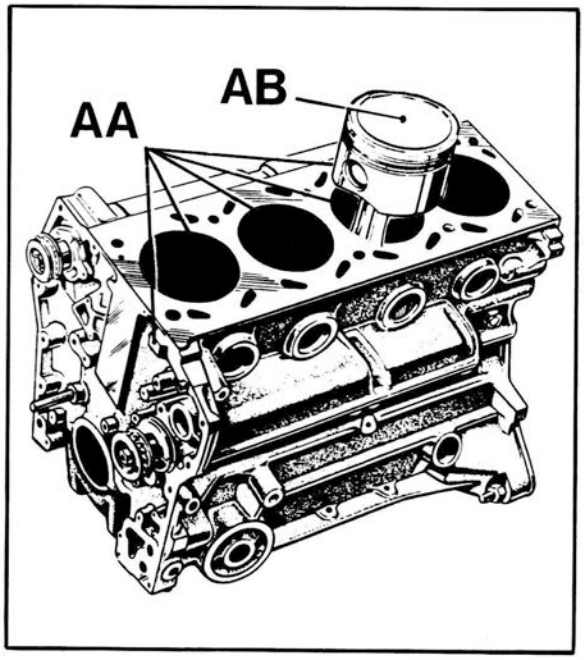
Since the piston clearance in no. 2 and no. 3 cylinders is greater than 0.05 mm (0.0020 in), we can assume that the maximum bore in these cylinders is 90.012 mm (3.5438 in) and, since the pistons have bedded in to a certain extent, giving a further 0.003 mm (0.0001 in), the bore can assumed to be 90.015 mm (3.5439 in).

Assume a standard B piston.

The theoretical piston clearance will then be 0.021 - 0.029 mm (0.0008 - 0.0011 in). Allowing a further 0.02 mm (0.0008 in) for bedding-in, this gives a maximum clearance of 0.049 mm (0.0019 in), which should be sufficient to eliminate unacceptable piston slap. Choose standard B pistons for these bores and check with a feeler gauge and spring balance that the correct piston clearance is obtained.

Caution
Pistons of different makes must not be used in the same engine. The name of the piston manufacturer is cast-in on the inside of the piston.

Classification of pistons and cylinder bores



The piston class is stamped on the piston crown. Piston classes for service are:

AB

B

C

The cylinder class is stamped on top of the block, for each cylinder. The cylinder class may be A or B, and both classes may occur in the same block.

Piston classification

(See the 'Technical data' section.)

Cylinder block

(See the 'Technical data' section.)

Resulting piston clearance

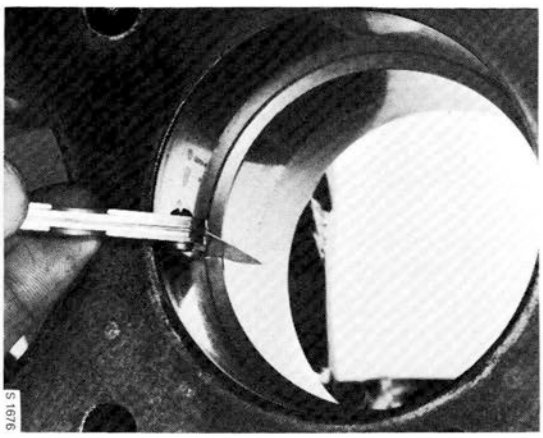
(See the 'Technical data' section.)

Matching piston rings to a new or re-bored cylinder

1 Push the piston rings down into the cylinder one at a time, using an inverted piston to position them correctly.

2 Measure the ring gap with a feeler gauge, as shown. Correct gap sizes are given in the 'Technical data' section. If necessary, widen the gap with a special file.

3 Try the piston rings in their respective grooves by rotating them. Measure the clearance at a few points as well.

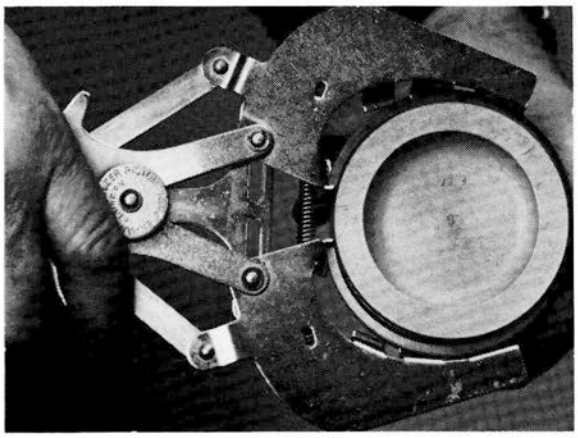


Fitting piston rings in a worn cylinder

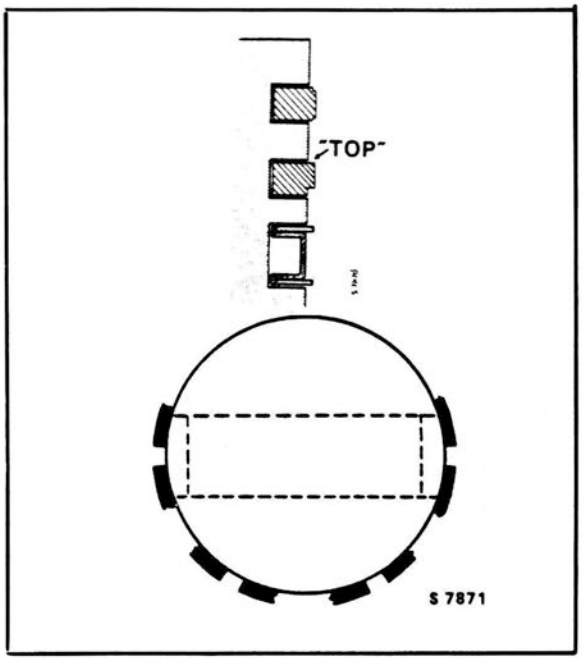
Rings to be fitted in a worn cylinder must be tried at the lower limit of travel of the piston (BDC), as the bore is narrowest at this point.

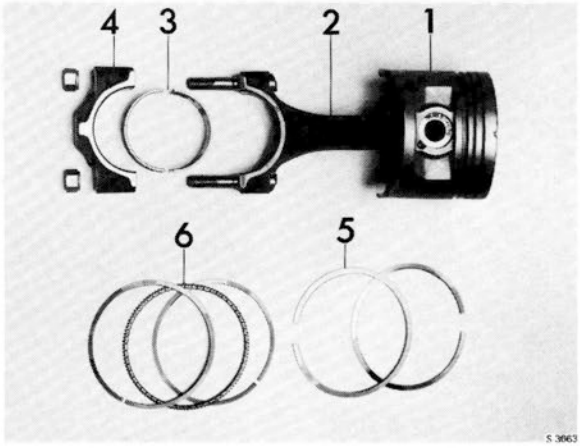
To fit piston rings to pistons

Use the piston ring clamp (special tool) to fit the rings as shown. The lower compression ring must be fitted with the side marked TOP uppermost.



Oil the piston and rings before assembly. Position the compression rings so that the gaps are at approx. 180° to each other, each positioned above one of the gudgeon pin holes. Also make sure that the gaps in the top and bottom pieces of the three-piece oil scraper ring are staggered round the piston, and not in line with one another.





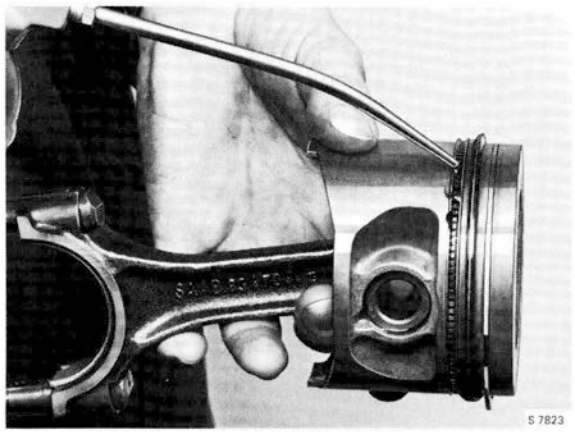
Piston and connecting rod with bearings and piston rings

1 Piston
2 Connecting rod
3 Bearing
4 Bearing cap
5 Compression rings
6 Oil scraper ring

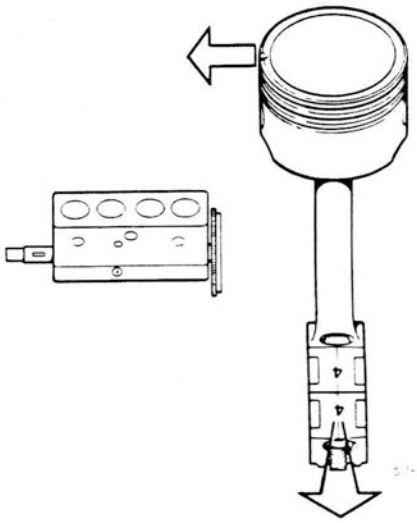
To fit the pistons in the cylinders

1 Place the bearing shells in position in the connecting rods and fit protective sleeves over the connecting rod studs.

2 Oil the piston rings and bearings.

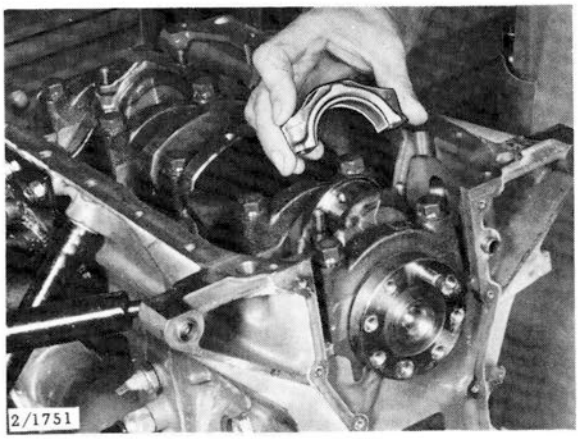


3 Refit the pistons using piston ring compressor 78 62 287.



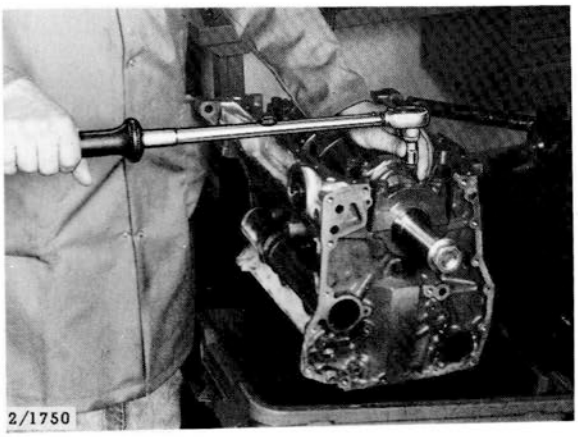
Ensure that the notch in the piston crown points towards the timing cover and that the numbers on the connecting rod face the exhaust side.

4 Refit the big-end bearing caps with bearing shells (with the identifying numbers on the bearing and bearing cap in line).



The big-end bearing nuts should be fitted with the flanges down (towards the connecting rods).

Tightening torque for big-end bearings: 54 Nm (40 lbf ft)



Valve gear

To dismantle the valve gear

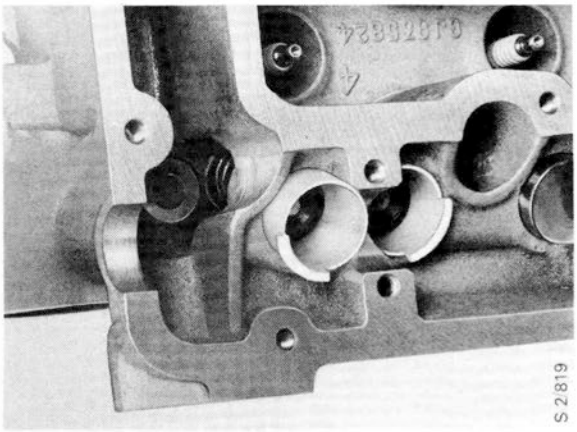
(cylinder head removed)

1 Remove the camshaft bearing caps and lift out the camshafts.

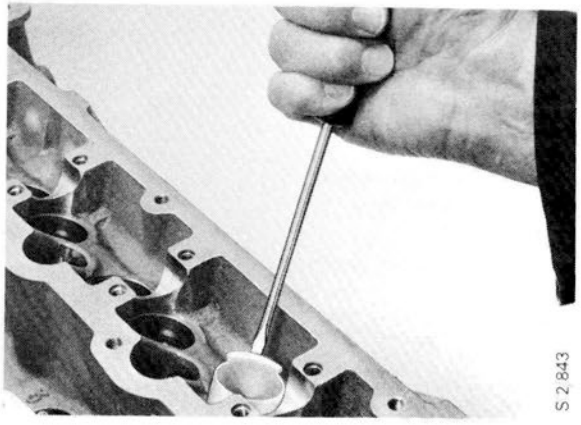
2 Remove the cam followers, placing them in order in stand 83 93 787, to ensure that they are refitted in their original positions.

3 Remove the valves, placing them in order in stand 83 93 787, to ensure that they are refitted in their original positions.

Caution
The tappet guides around the valve springs constitute the sealing surfaces for the cam followers and must therefore not be scratched or scored. Fit protective sleeves 83 93 746 in the guides to protect them. For removal of the valves, use valve spring compressor 83 93 761 with anvil 83 93 779.


S 2819

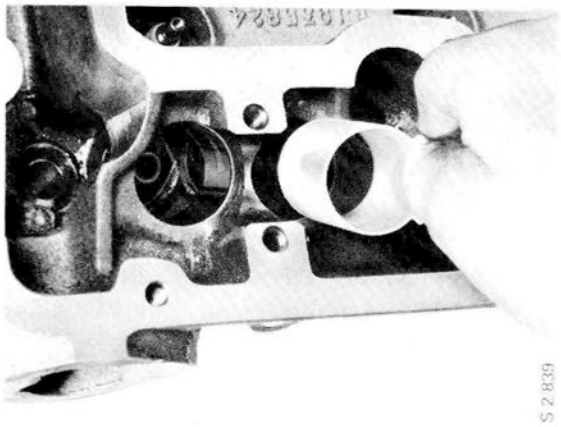
4 Remove the protective sleeves by applying a suitable lever underneath the lip on the sleeve.


S 2843

Reassembling the valve gear

Note
Prior to assembly, lubricate all the parts and replace any defective valve-stem seals.

1 Fit the valves and springs, with the protective sleeves in place in the tappet guides.



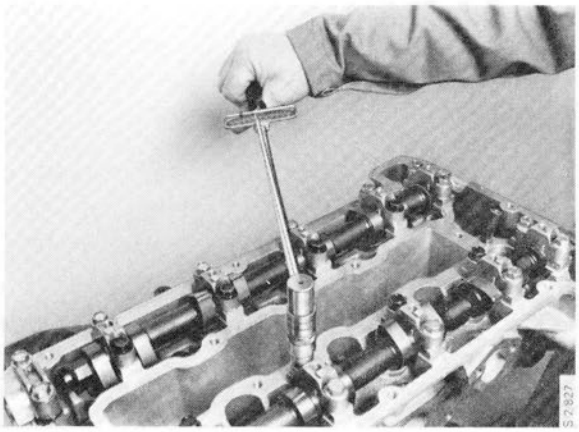
2 Check the valve clearance, as detailed on page 214-15.

3 Fit the cam followers.

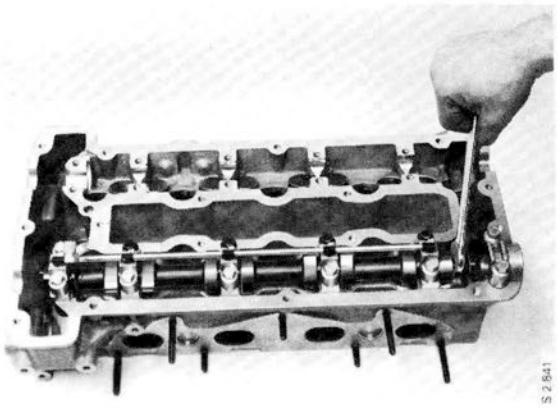
Caution
Support the cylinder head on blocks to prevent damage to the valves when the camshafts are tightened down.

4 Fit the camshafts and bearing caps. The bearing caps marked 1-5 go on the inlet side, and those marked 6-10 on the exhaust side. Tighten the bolts to the specified torque.

Tightening torque:
15 Nm (11 lbf ft)

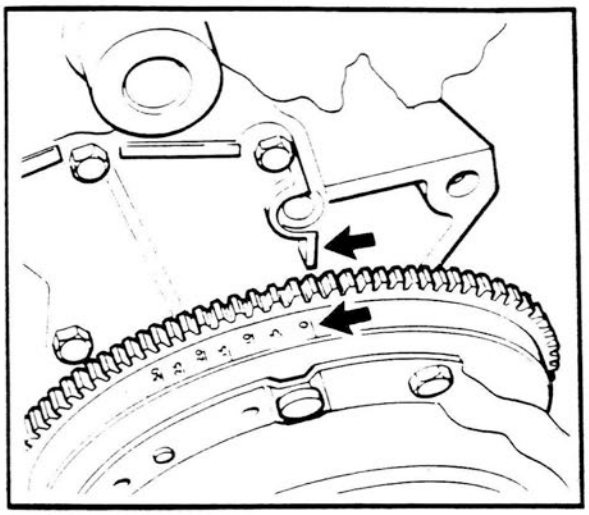


5 Line up the marks on the camshafts with their respective timing marks.

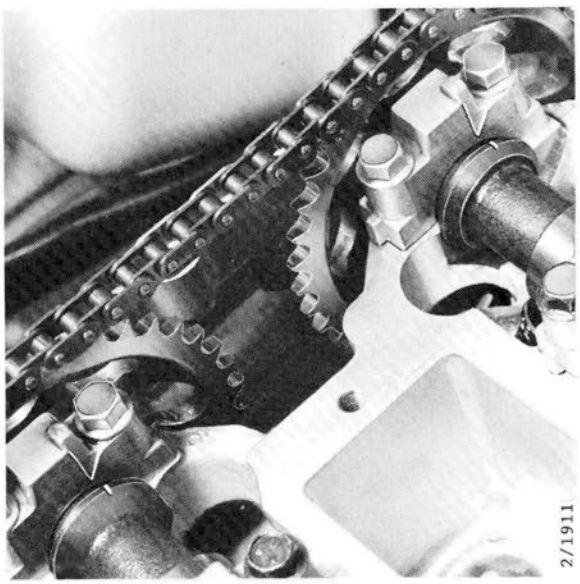


Valve-gear timing

When the pistons in no. 1 and no. 4 cylinders are at top dead centre, the 0° mark on the flywheel must be in line with the timing mark on the clutch cover (or end plate if the clutch cover has been removed).



When the timing marks on the camshafts are in line with those on the bearing caps, both the inlet and the exhaust valves for no. 1 and no. 4 cylinders are closed.



As the valves open, they extend beyond the face of the cylinder head and into the zone in which the pistons move (combustion chamber).

Thus, if the setting of the crankshaft and valve gear is altered, the valves may collide with the pistons, with ensuing damage to the valves and other vital components.

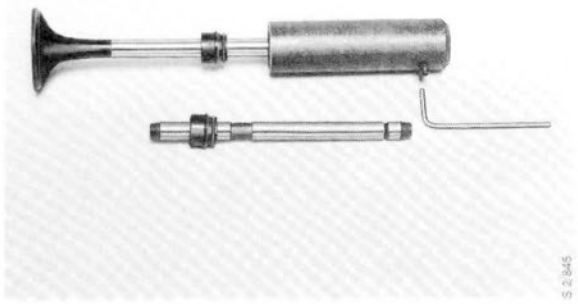
Replacing valve seals (cylinder head removed)

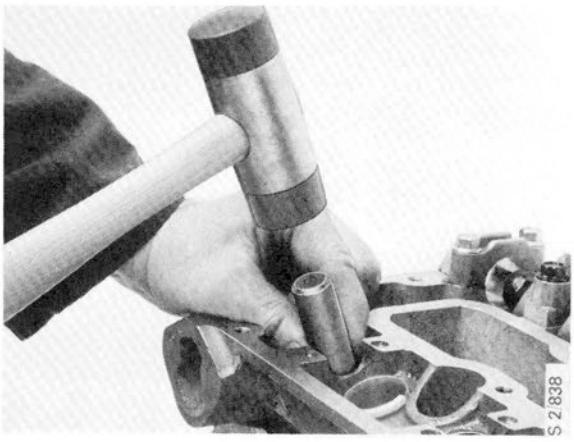
To remove

Remove the seals from the valve guides using special pliers 83 94 157. Make sure that the protective sleeves for the tappet guides are in place. If the valve guides also need replacing, remove these together with the seals.

To fit

Fit the seals using special tool 83 93 803. Remove the shank from the tool and fit the valve seal in the tool. Insert the tool in the guide and use a plastic-face mallet to tap the seal into position. If the valve is fitted, use the valve stem as a guide.



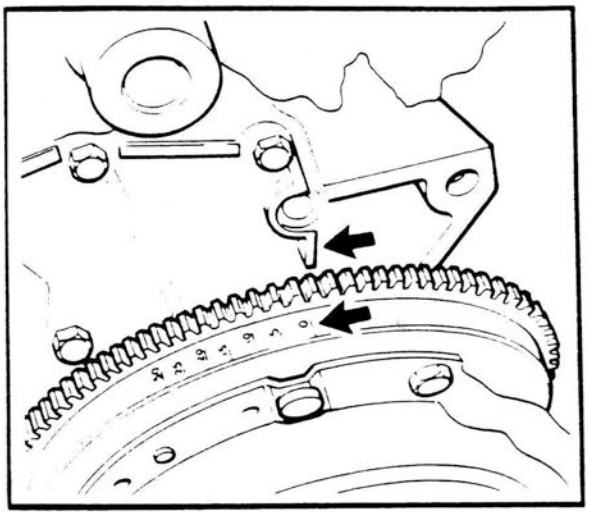


Replacing the valve seals (engine in situ)

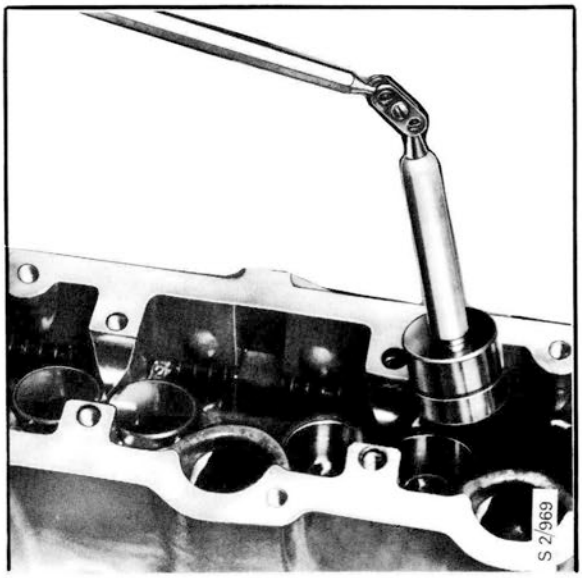
Use the same procedure for replacing valve springs, valve heads or collets.

To remove

1 Turn the crankshaft to bring the 0° mark in line with the timing mark (top dead centre for no. 1 and no. 4 cylinders) and remove the camshafts (all valves are closed in this position). Place a cover over the timing-cover aperture to prevent collets or seals falling inside.

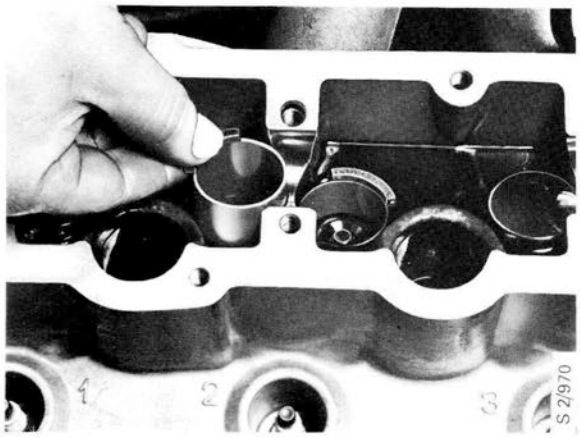


2 Using magnetic tool 83 91 401, lift out the camfollowers.

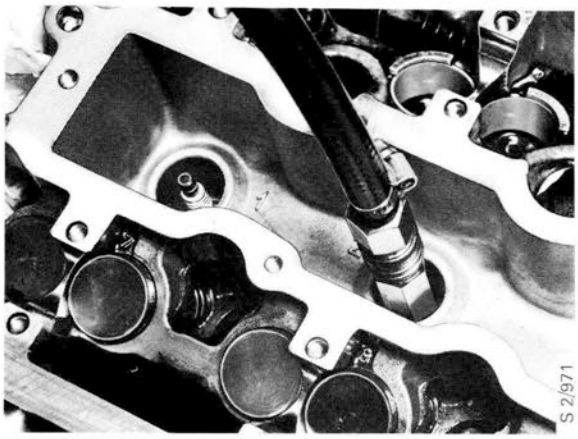


Note
Place all valve parts in order in stand 83 93 787, to ensure that they are refitted in their original positions.

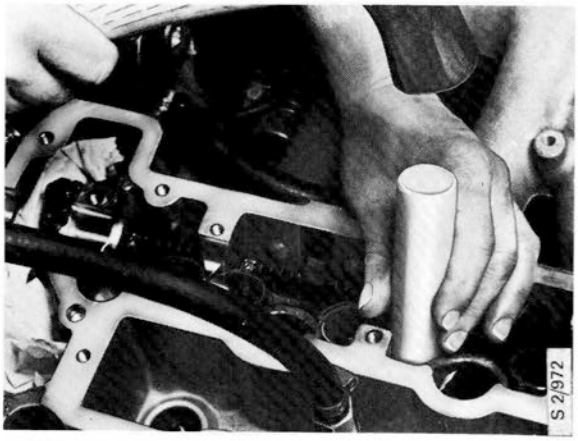
3 Fit protective sleeves 83 93 746 over the valve springs to prevent the tappet guides from being scored. Note how the sleeves are fitted.



4 Unscrew the spark plug for the cylinder concerned and fit compressed-air adaptor 83 94 173 in its place. Connect the air line to put the piston and valves under pressure.

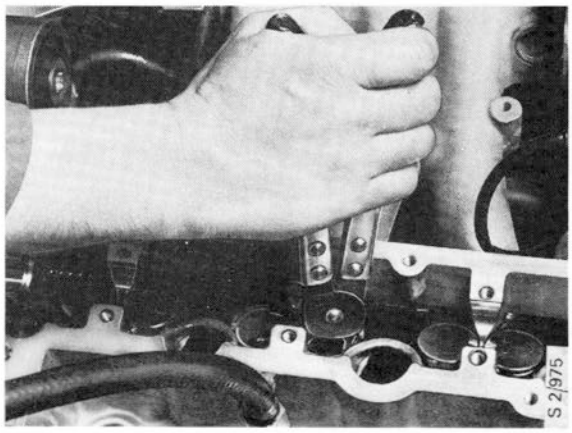


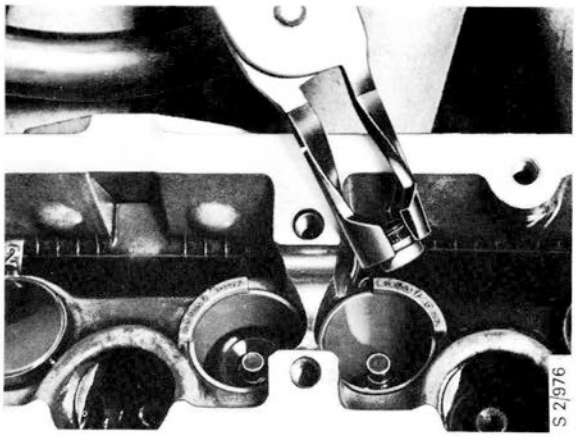
5 Holding sleeve 83 94 181 on the valve head and in line with the stem, tap the sleeve sharply with a hammer. This should free the collets, which should now follow the tool out.



6 Lift out the spring cap and valve spring.

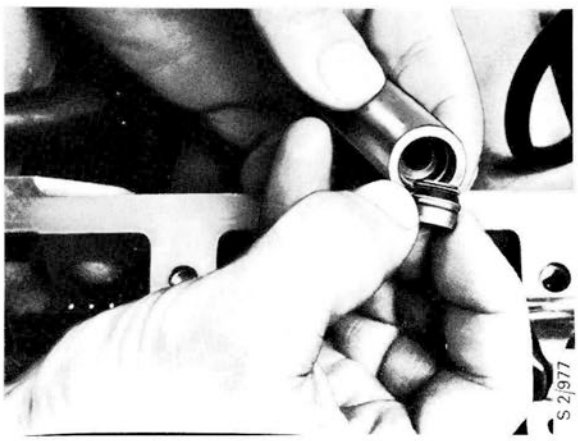
7 Remove the valve seal using special pliers 83 94 157.



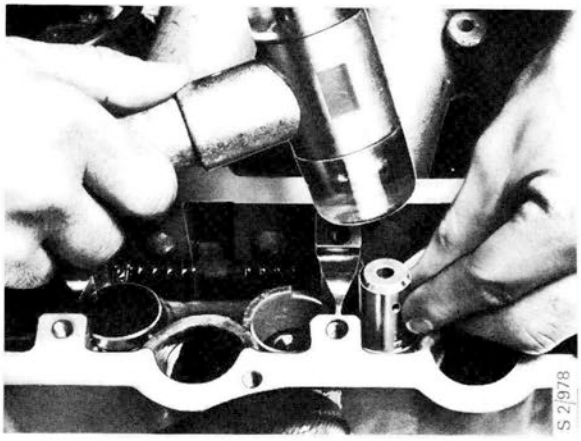


To fit

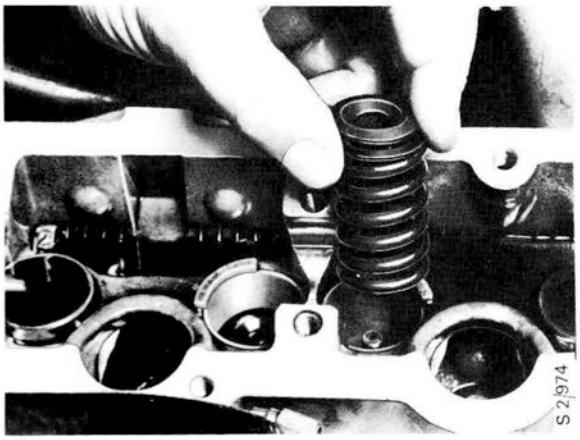
1 Remove the shank from tool 83 93 803 and fit the valve seal in the tool, with the taper facing inwards (away from the valve head).



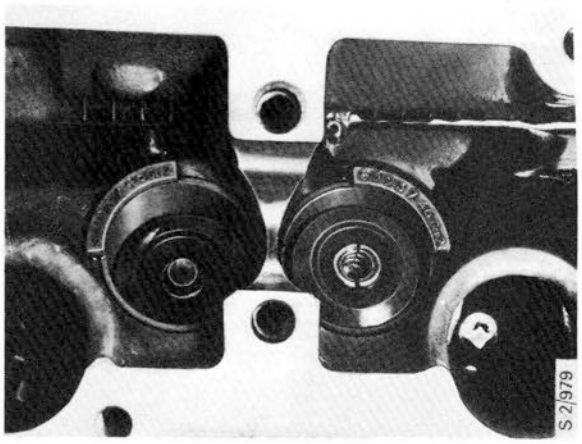
2 Fit the seal onto the valve stem, tapping it carefully into position by means of a plastic-face mallet.



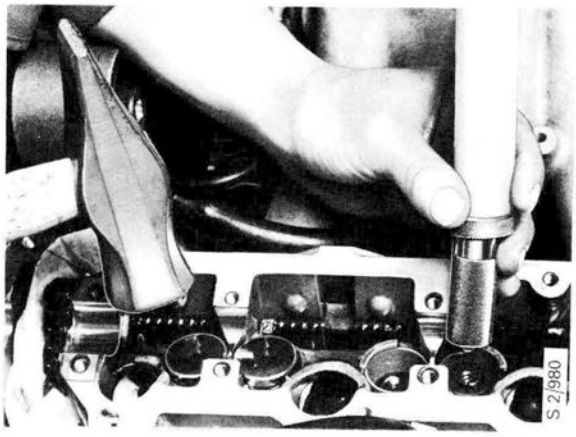
3 Fit the spring and spring cap.



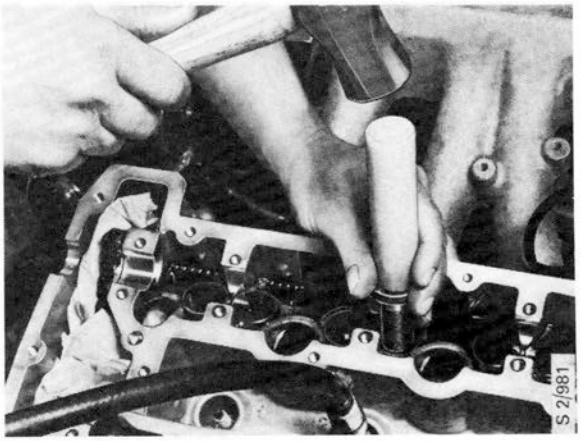
4 Position the collets in the groove in the spring cap as shown.



5 Using tool 83 94 181 with sleeve 83 94 207, carefully tap the collets home.



6 Remove the plastic sleeves and fit the cam followers.

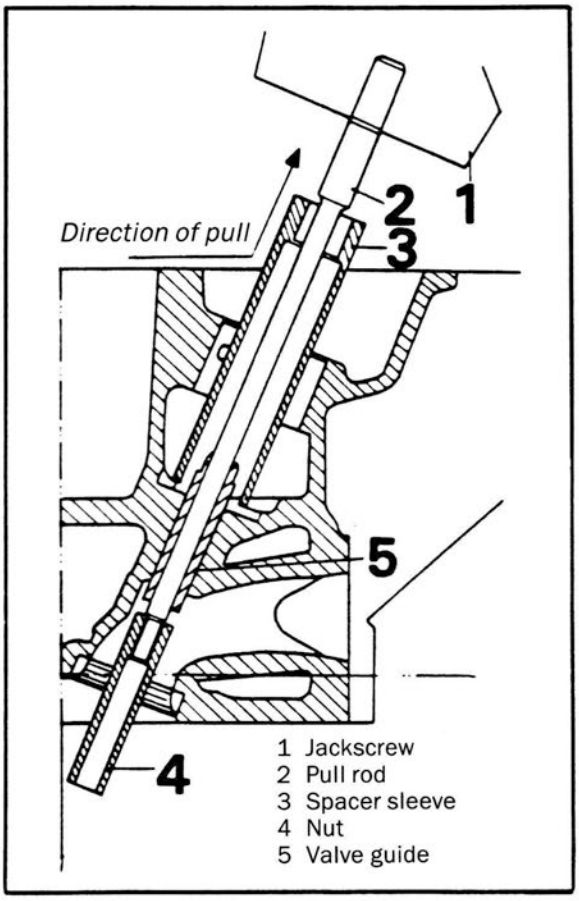


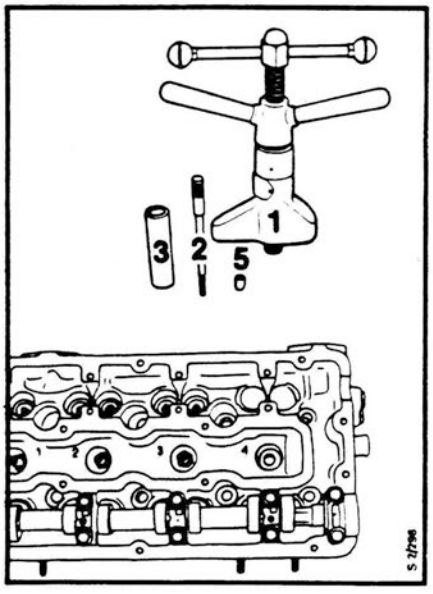
Valve guides

To remove (performed from above)

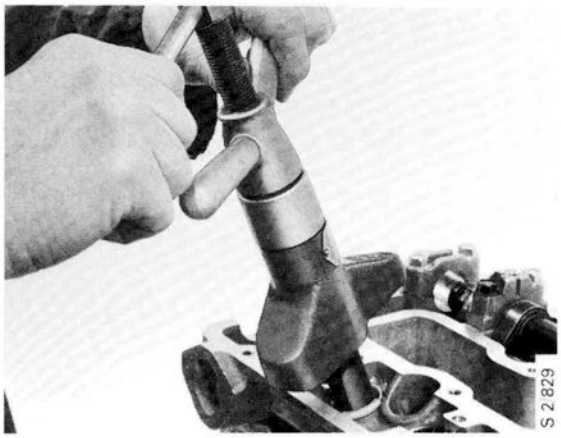
Note
Flush the cylinder head with hot water before removing the valve guides.

Withdraw the valve guides using special tool 83 93 803 with pull rod 83 93 811, spacer sleeve 83 93 829 and nut 83 93 845.





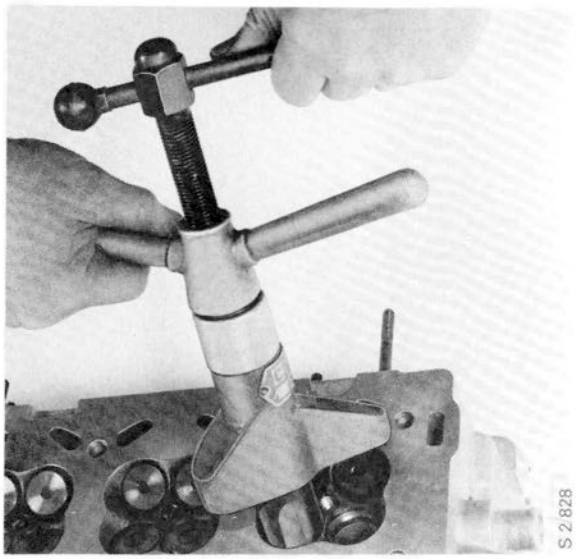
1 Jackscrew
2 Pull rod
3 Spacer sleeve
5 Nut



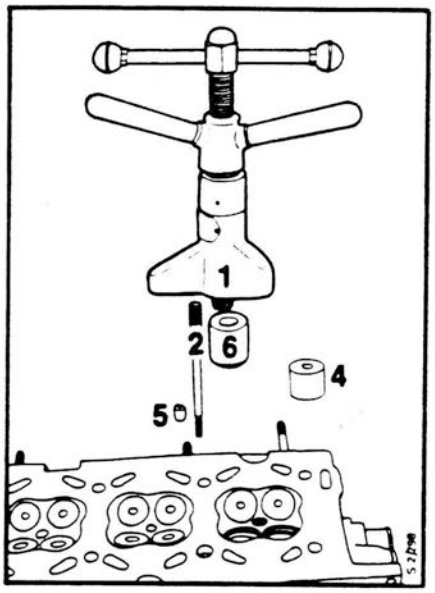
To fit

Note
Before fitting the guides, flush the cylinder head with hot water and cool the guides by immersing them in cold water.

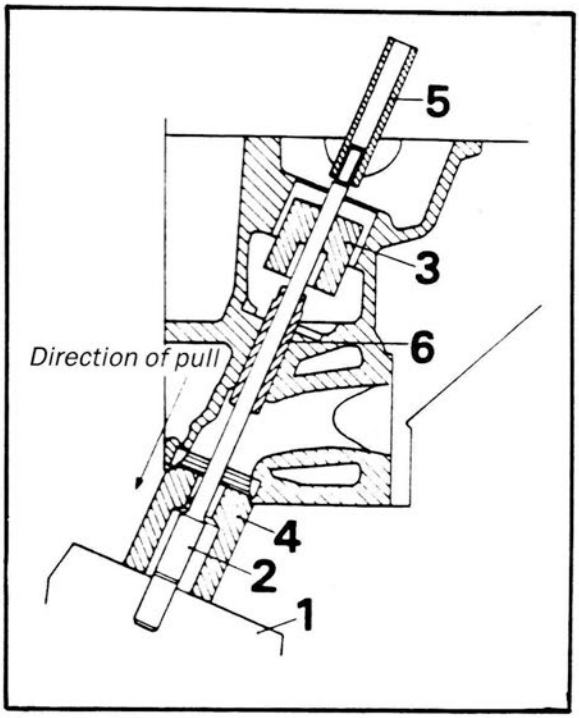
1 Insert the valve guide from above and apply the tool from below.



2 Centre the tool in the valve seat and fit the guides using special tool 83 93 803 together with pull rod 83 93 811, stop 83 93 837, centring sleeve 83 90 379 and nut 83 93 845.



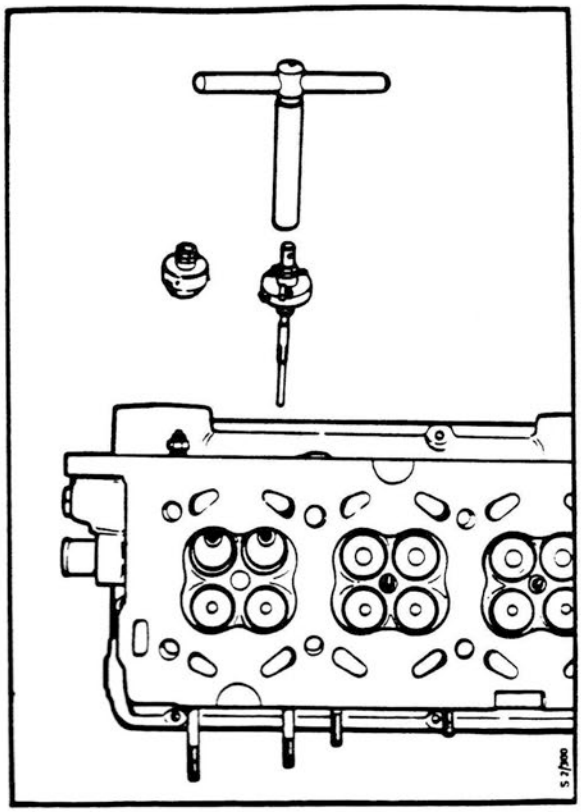
1 Jackscrew
2 Pull rod
4 Stop
5 Nut
6 Centring sleeve



1 Jackscrew
2 Pull rod
3 Stop
4 Centring sleeve
5 Nut
6 Valve guide

3 a Run the 7.0-mm undersize reamer, 83 93 944, through the guide.

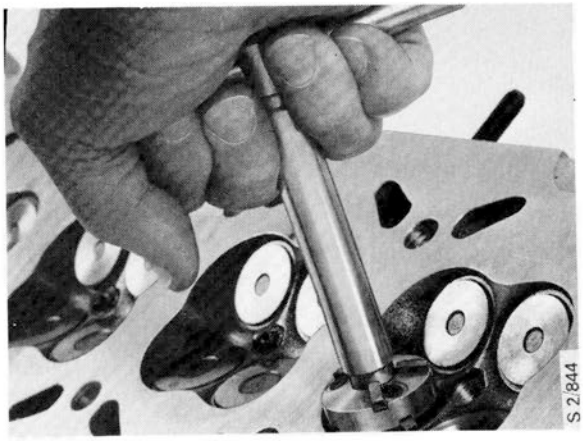
b Follow up with the 7.0-mm H7 valve guide reamer.



Valve seats

For recutting the valve seats, use the cutter kit comprising T-wrench, pilot 83 93 928 and cutters 83 93 936 (Neway 286 45° and Neway 270 60°).

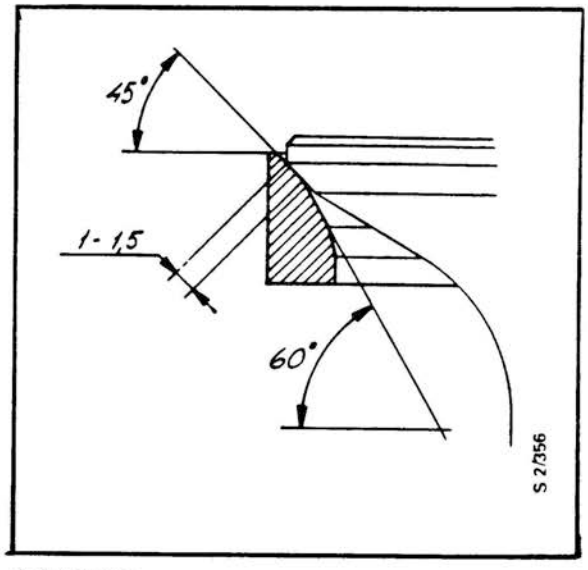
Valve seat angles for inlet and exhaust valves: 45°
Recutting angle: 60°
Width of inlet valve seat: 1 - 1.5 mm
Width of exhaust valve seat: 1.25 - 1.75 mm



Valves

Inlet valves

Face angle: 44.5°
Valve-head diameter: 32 ± 0.1 mm

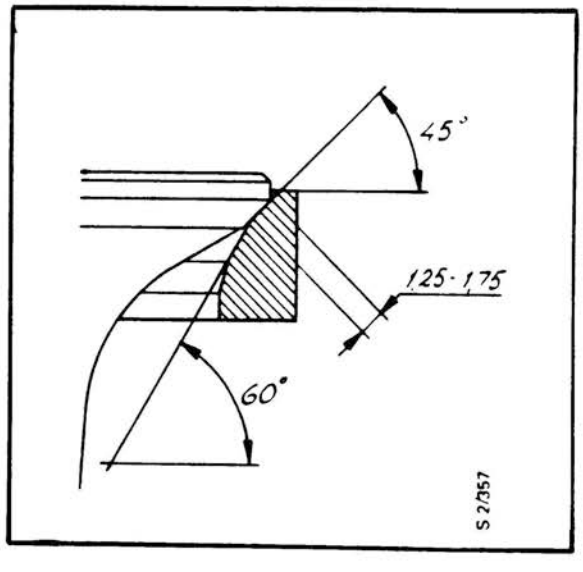


Inlet valve

Exhaust valves

The contact surface of the valve head has a 0.7-mm coating of stellite.
Face angle: 44.5°
Valve head diameter: 29 ± 0.1 mm.

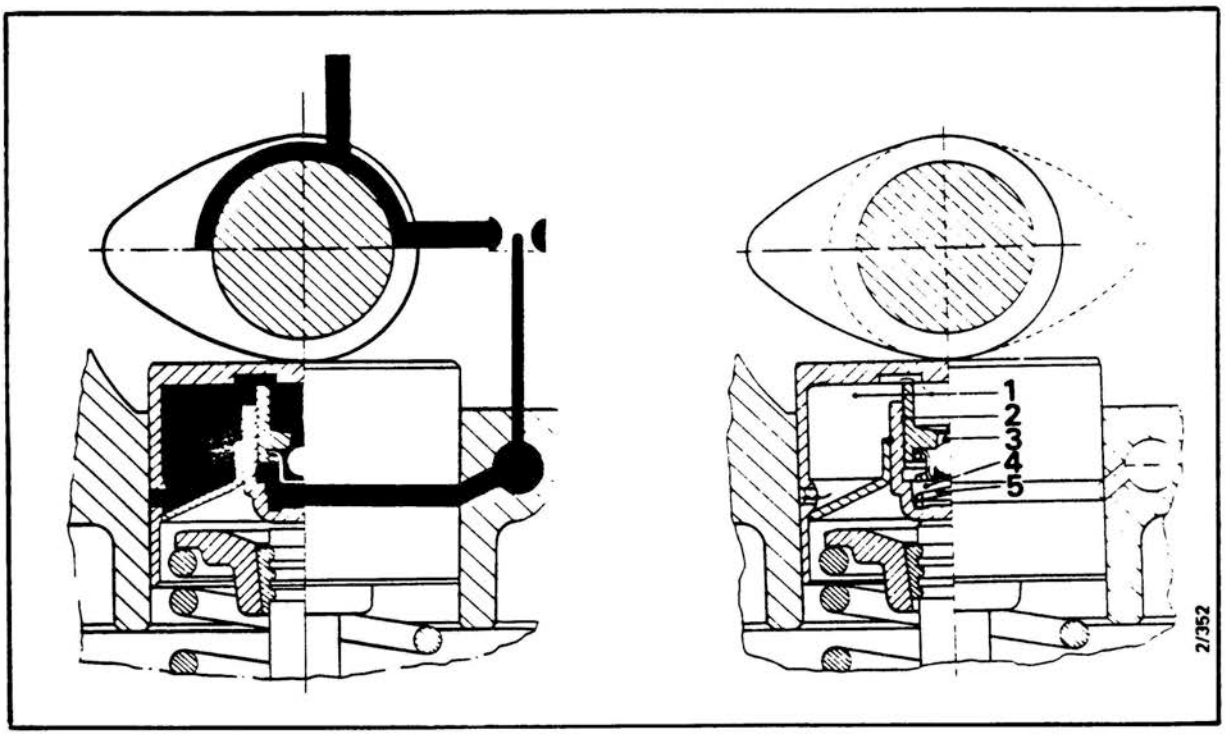
Note
Because the exhaust valve heads are stellited, only a very small amount of material should be removed on regrinding. Consequently, if the valve is badly pitted, it should be replaced.



Exhaust valve

Check the valve clearances as detailed on page 214-15.

Hydraulic cam followers



Oil path through cam follower

1 Storage chamber
2 Leakage passage
3 Check valve
4 High-pressure chamber
5 Spring

The valve gear incorporates hydraulic cam followers, which keep the valve clearance within a limited working range of 2.05 mm (0.081 in), between 18.75 and 20.8 mm (0.738-0.819 in) from the camshaft bearing seat to the end of the valve stem.

Each cam follower has two storage chambers and one high-pressure chamber. The opening of the port between the high-pressure chamber and the adjacent storage chamber is controlled by a spring-loaded ball valve. A return spring in the high-pressure chamber acts on the sliding piston, to eliminate any clearance between the cam follower and the cam. At the same time, the high-pressure chamber expands and makes up the oil volume, to compensate for leakage losses through the passage between the piston and the cylinder, occurring at actuating pressure.

Under some conditions, the hydraulic cam followers may give rise to a chattering noise of varying intensity. In most cases, the noise will be short-lived and no remedial action will need to be taken.

Details are given on the next page of the commonest conditions under which noise occurs, the likely cause of the noise and preliminary action that may be taken to get rid of the noise.

Noisy valve operation - causes and rectification

1 Valve chatter after car has been parked for longer than 48 hours.

During a period of prolonged parking, oil drains out of the high-pressure chambers in the cam followers, allowing air to get in. For a period of about 15 minutes after the engine has been started, valve chatter will be heard until the air has been purged from the cam followers.
The engine speed should not be allowed to exceed 3,000 rpm until the noise has ceased.
See also item 4 below.

2 Valve chatter on starting the engine after an oil change.
If the noise from the valves did not occur before the oil change, the noise will disappear of its own accord as soon as the oil in the engine has reached normal working pressure.

3 Temporary noise on starting a cold engine.
This noise is perfectly normal and will disappear of its own accord as soon as the oil in the engine has reached normal working pressure.

4 Valve chatter on starting after work on the car that has involved cranking the engine by hand or on the starter motor.

The noise is due to one or more of the cam followers having been drained of oil and will therefore disappear after the engine has been running for a while. At worst, it may take 15 minutes at between 2000 and 3000 rpm for the noise to disappear. At lower engine speeds, it will obviously take considerably longer to expel the air. Do not run the engine at a speed greater than 3,000 rpm as this may damage the cam followers.

5 Noise after fitting new cam followers.

The cause and rectification are the same as under item 4 above.

6 Noise occurring after a short period of idling with a hot engine (hot oil).
If the engine is run at 1500 rpm or more, the noise will disappear after a while.

The noise is due to low oil pressure in the hydraulic cam followers when the engine is idling. Check the oil feed pipe, connectors and 'O' rings for leaks.

7 Noise occurring at high engine speeds and disappearing after the engine has been at idling speed for a time (the period required can vary considerably).
This noise is due to an excessive amount of air in the oil at high engine speeds. The ingress of air is caused by leakage on the suction side of the oil pump, a poorly sealing 'O' ring in the inlet pipe or a leak in the inlet pipe caused, for instance, by a porous weld.

8 Noise from an individual cam follower regardless of how the car is driven.

The most likely cause is that a piece of dirt has become trapped in the check valve in one (or more) of the cam followers. The best way to identify a defective cam follower is to switch off the engine, remove the camshaft cover and use a screwdriver to depress the cam followers. A light or spongy feel indicates a defective cam follower.

Replace any defective cam followers.

Checking the valve clearance

(Cylinder head removed)

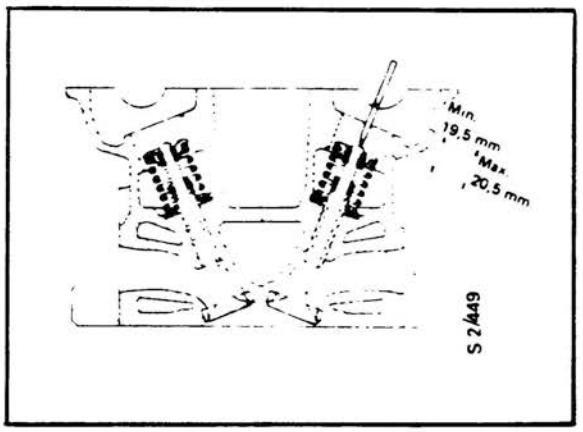
The valve clearance is checked relative to the working range of the cam follower.

The **checking values** for the valve clearance are 19.5 ± 0.05 mm (0.768 ± 0.002 in) minimum, and 20.5 ± 0.05 mm (0.807 ± 0.002 in) maximum.

The **setting values** are 20.0 mm (0.787 in) minimum, 20.4 mm (0.803 in) maximum, with a nominal value of 20.2 mm (0.795 in).

The valve clearance is equivalent to the distance between the end of the valve stem and the camshaft bearing seat.

Before the valve clearance can be checked, the camshafts and cam followers must be removed (page 214-1 refers).



Check the valve clearance using tool 83 93 753 as follows.

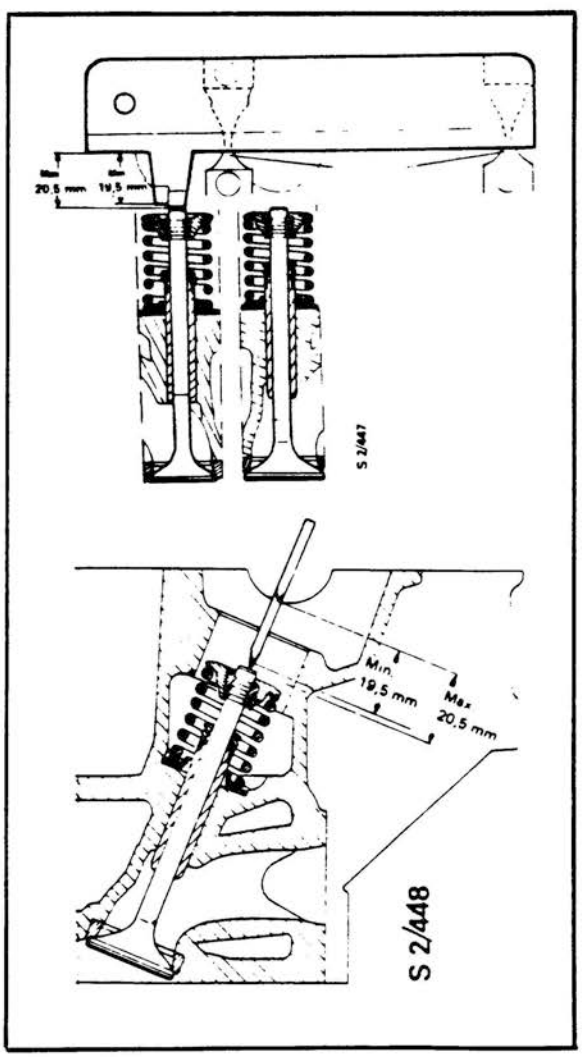
Place the measuring head across two of the camshaft bearing seats. Line up the instrument to read the depth to the end of the valve stem.

Check that when the instrument is displaying the maximum depth reading of 20.5 mm (0.807 in) it actually reaches the end of the valve stem, which will be confirmed by the fact that the measuring head does not make contact with the bottom of the bearing seat closest to the instrument.

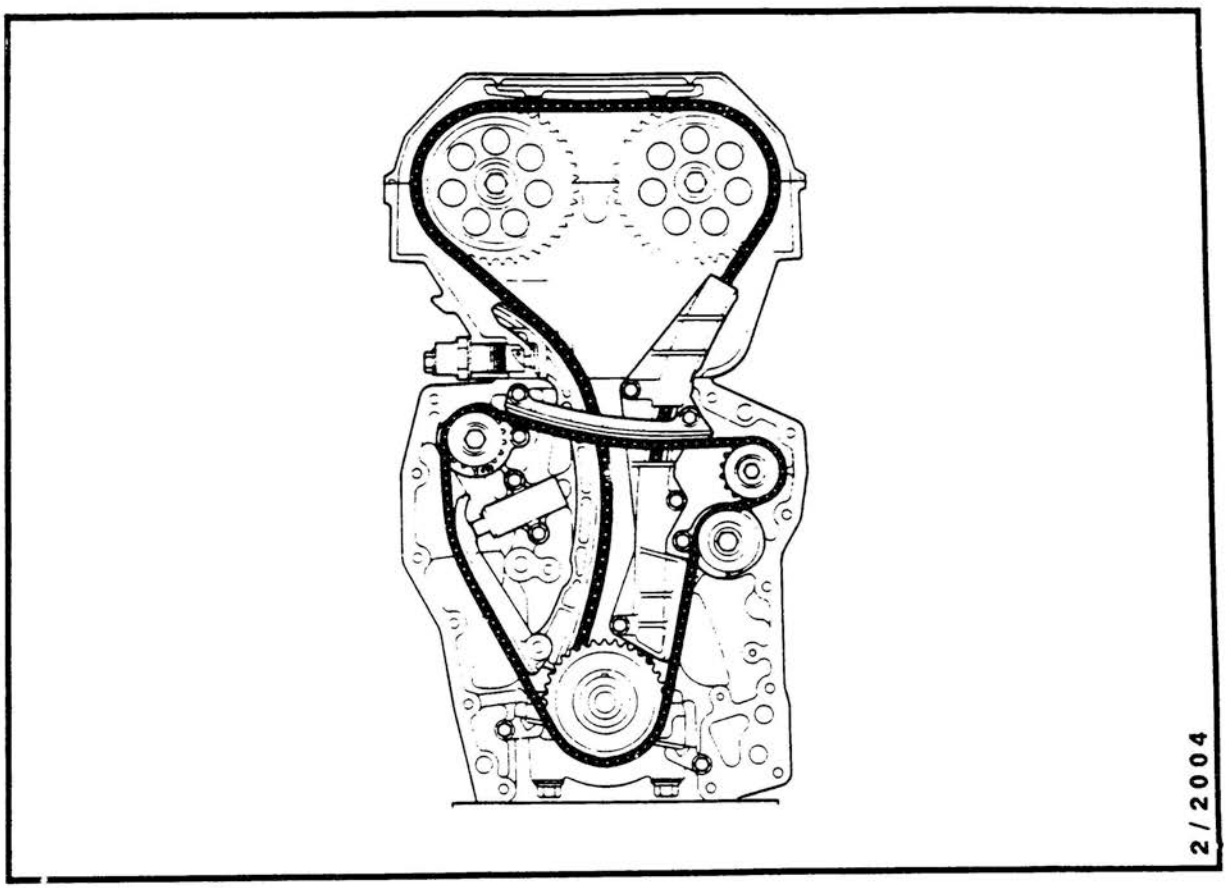
Thereafter, check that the contact point of the instrument does not touch the end of the valve stem when showing the minimum depth reading of 19.5 mm (0.768 in).

The valve clearance is correct when the reading obtained is between the minimum and maximum values.

If the valve clearance deviates from the specified checking values, adjustment must be made to the valve stem or the valve seat: if the value is lower than the minimum value then the length of the valve must be reduced; if the value is greater than the maximum value, then the valve seat must be milled. The nominal value for adjusting the position of the valve is 20.2 mm (0.795 in).



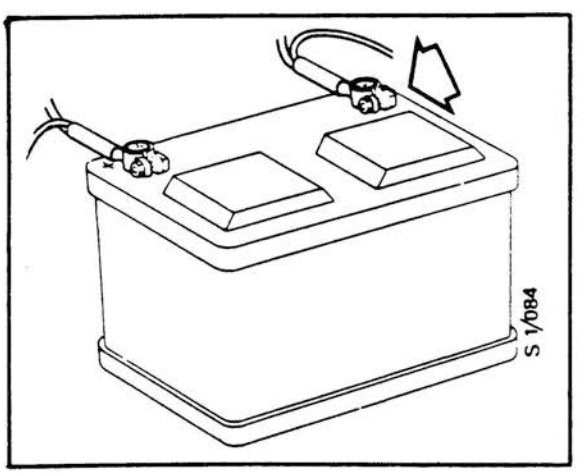
Timing chain



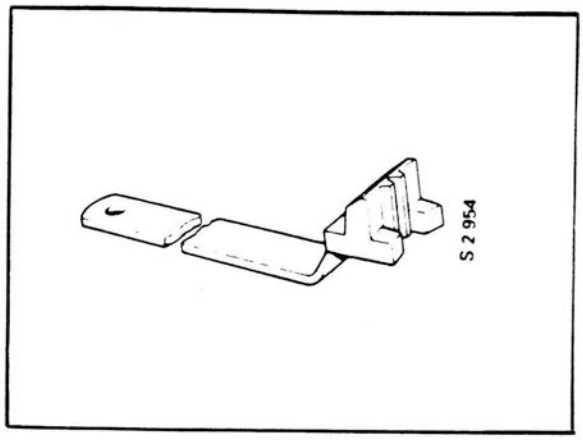
Timing cover

To remove (Engine in situ)

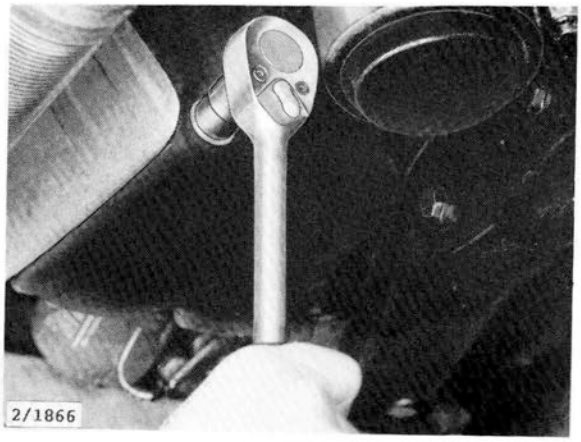
1 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

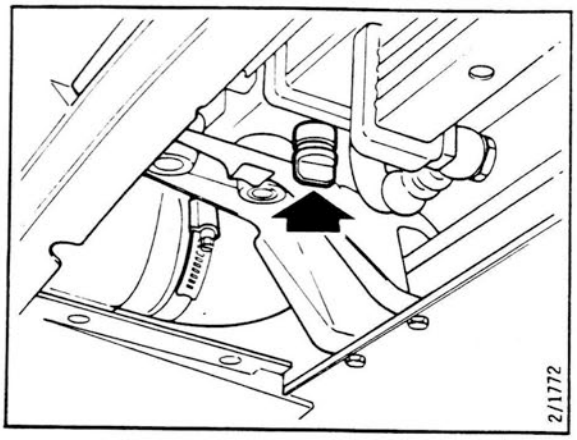


2 Fit locking segment 83 93 993 to the flywheel.



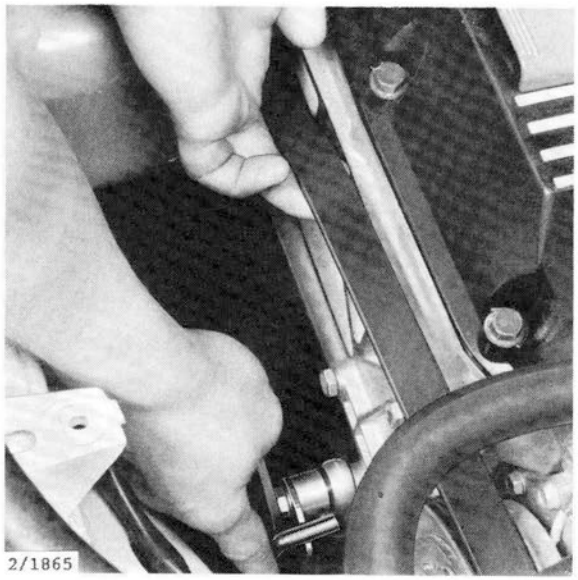
3 Raise the car and drain the engine oil and coolant.





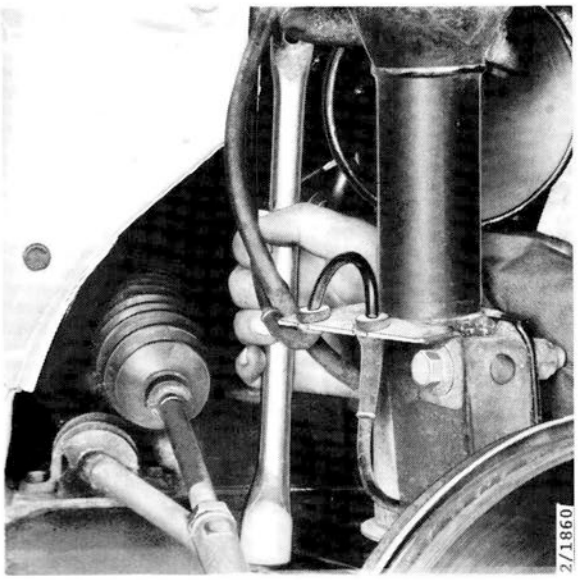
4 Remove the right front wheel and wing liner.

5 Remove the multigroove drive belt (page 216-10 refers).

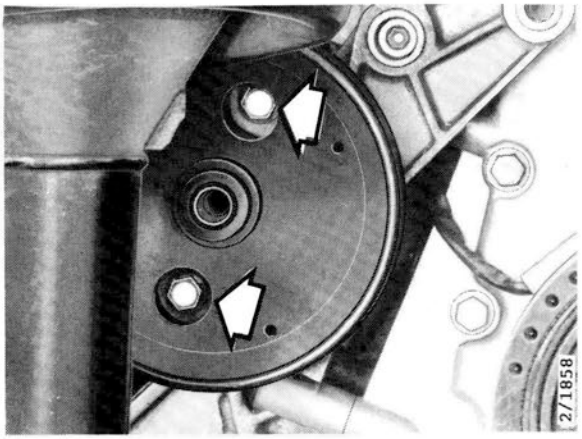


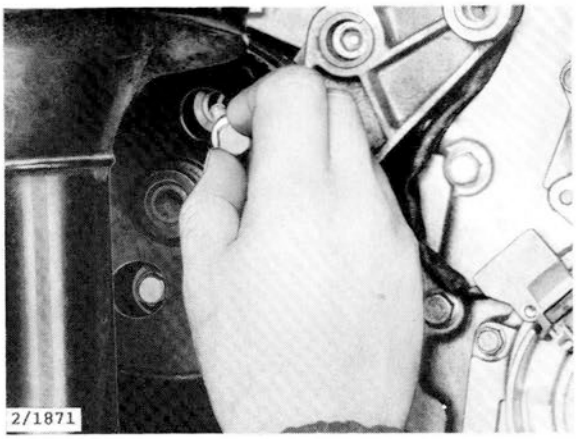
6 Remove the belt tensioner (page 216-10 refers).

7 Remove the tie bar from between the wheel arch and subframe.

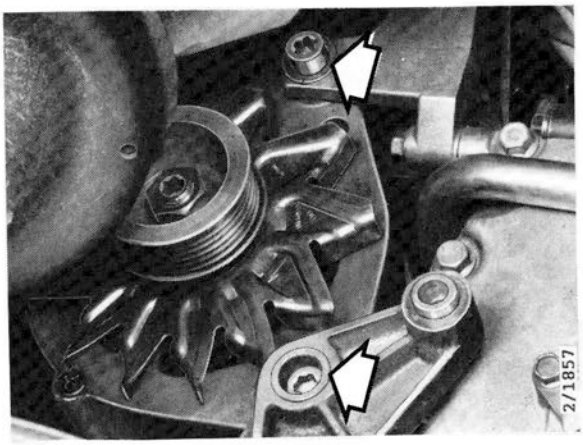


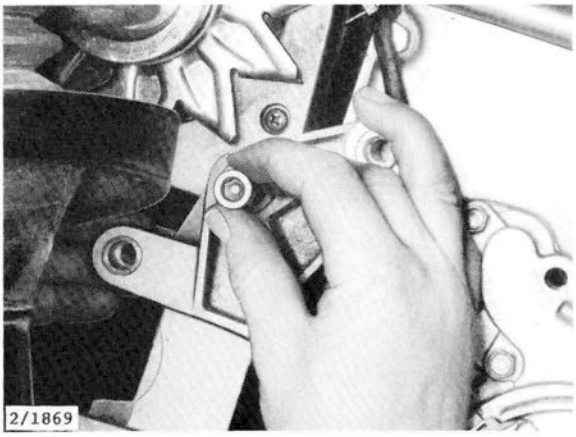
8 Through the holes in the pulley, remove the steering-servo pump bolts and lower the pump onto the subframe.



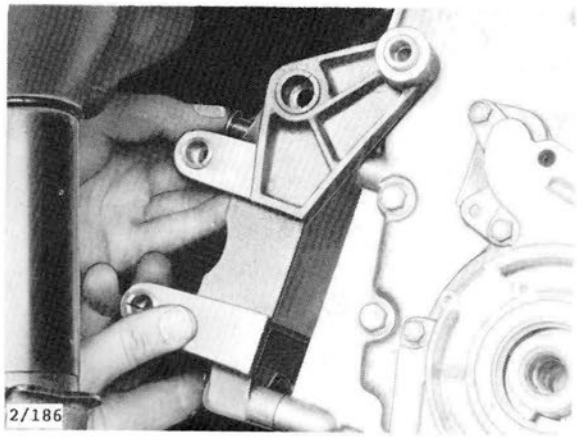


9 Remove the two securing bolts for the alternator and position the alternator inboard of the rear engine mounting.

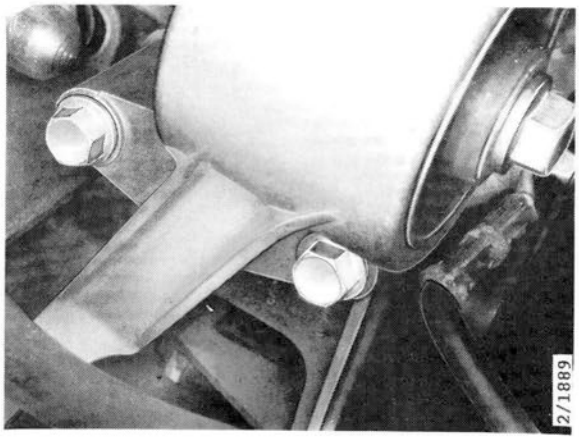




10 Remove the bracket for the servo pump.



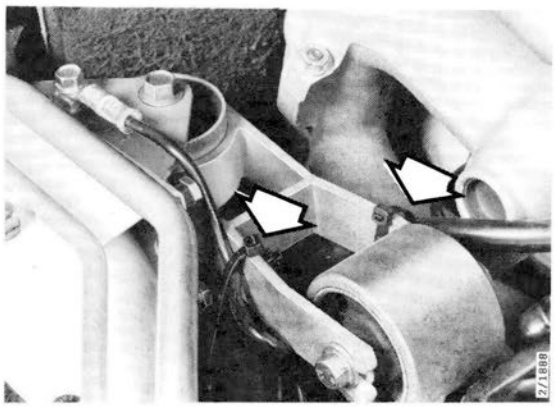
11 Remove the two bolts in the bottom of the top engine-mounting bracket. Note that the bolts are different lengths.



12 Snip through the tie for the crankshaft-sensor lead.

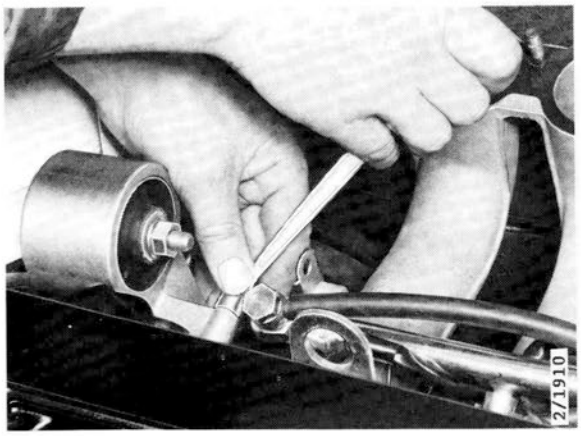
Lower the car.

13 Snip off the ties securing the hoses and wiring to the torque arm.



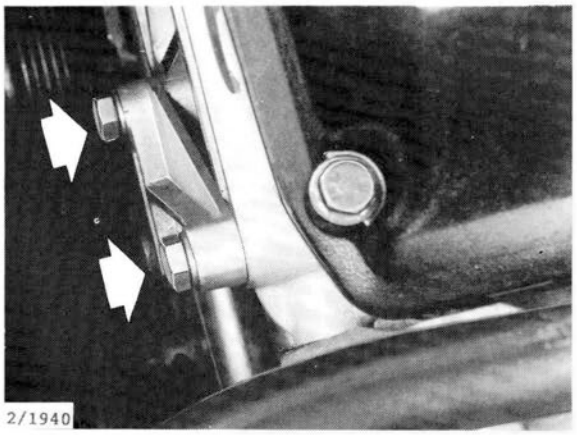
Remove the torque arm.

14 Undo the remaining bolts in the engine-mounting bracket and remove the bracket.



15 Undo the bolt in the coolant-pipe clip adjacent to the knock detector.

16 Remove the top bracket for the belt tensioner.



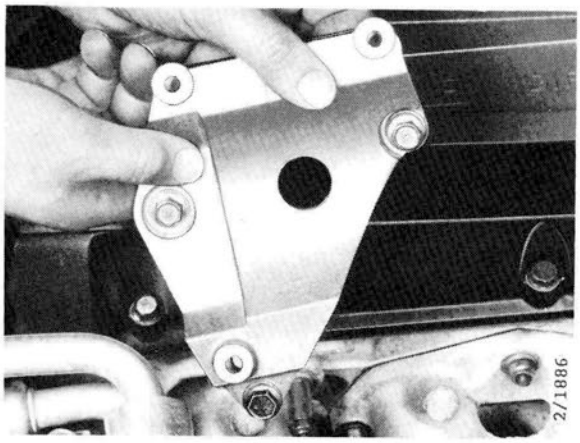
17 Snip through the ties around the AC-compressor hoses.

18 Unplug the connector for the AC compressor.

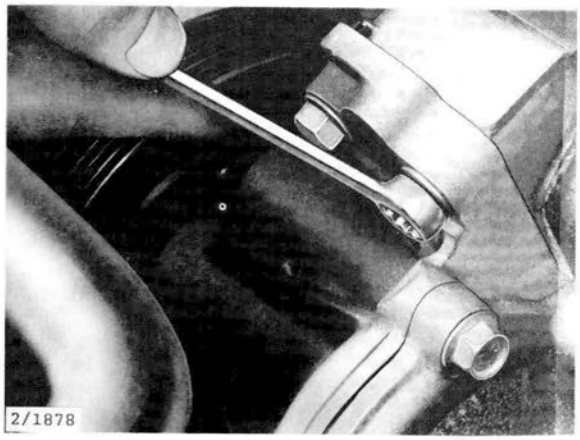
19 Place a steel panel or the like to protect the oil cooler and remove the compressor.

With suitable protection underneath it, stand the compressor on the radiator crossmember and secure it.

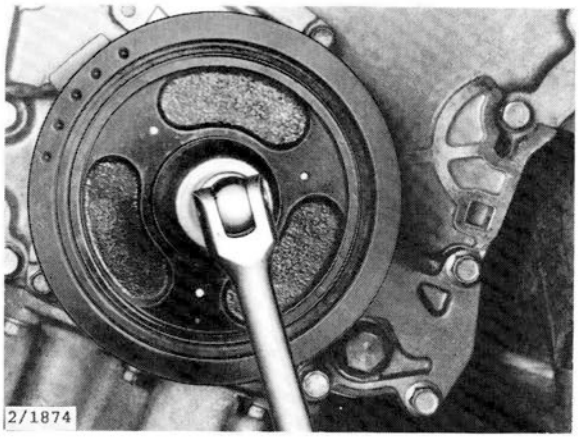
20 Remove the AC-compressor bracket.



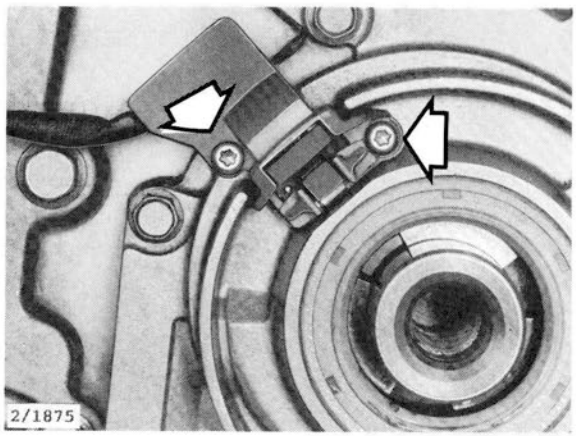
21 Disconnect the coolant hoses and remove the water pump.



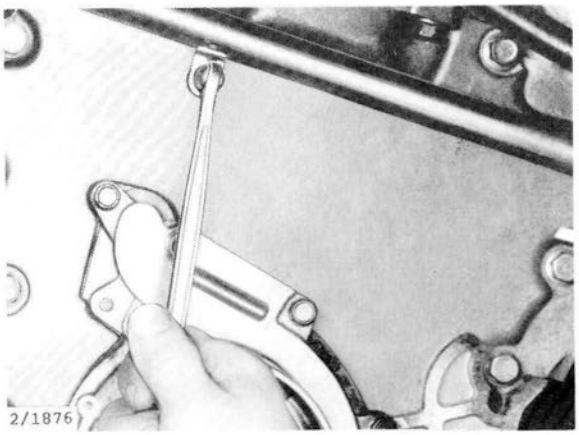
22 Raise the car and remove the crankshaft pulley.

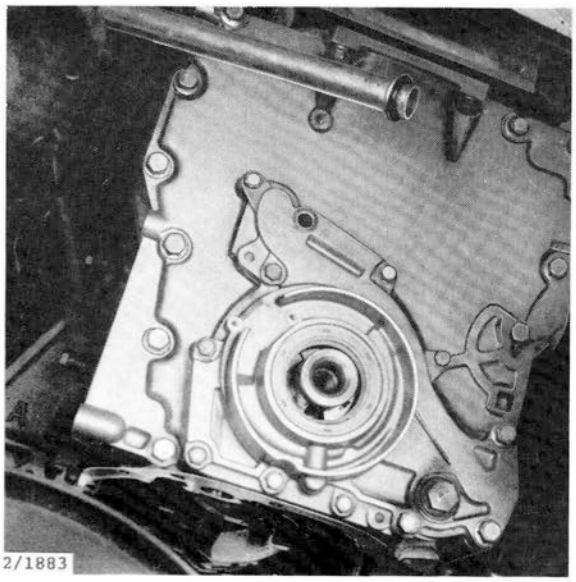


23 Remove the securing bolts and swivel the crankshaft sensor out of the way.

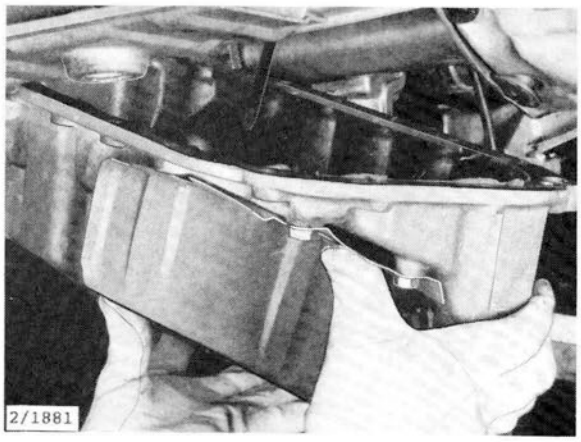


24 Unscrew the coolant-pipe clip and move the pipe to one side.





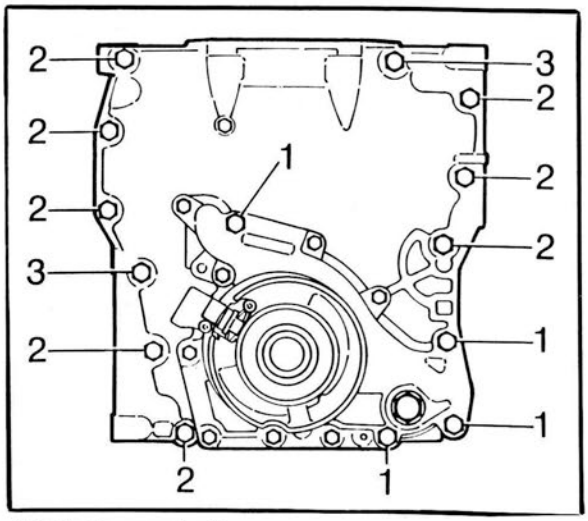
25 Remove the sump (page 220-2, steps 4 - 13 inclusive refer).



26 Remove all the timing-cover securing bolts.

Note the locations of the bolts and that the bolts are in three different lengths.

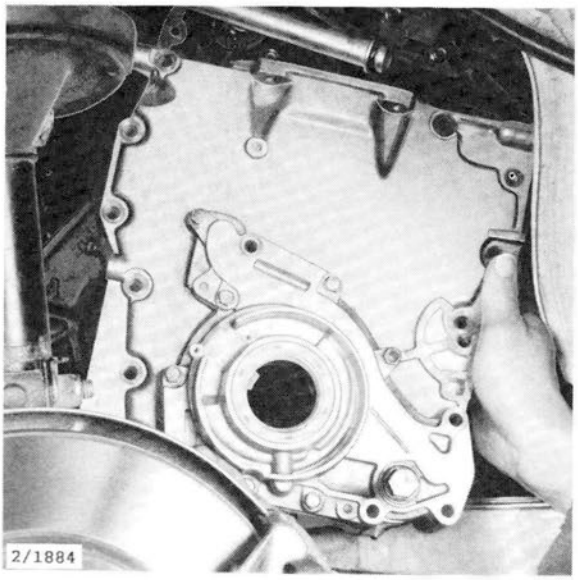
Remember also to remove the two bolts securing the timing cover to the cylinder head.



Timing-cover bolts

1 = 4 x 80 mm
2 = 8 x 55 mm
3 = 2 x 60 mm

27 Tap the cover carefully off the guide pins and remove it.

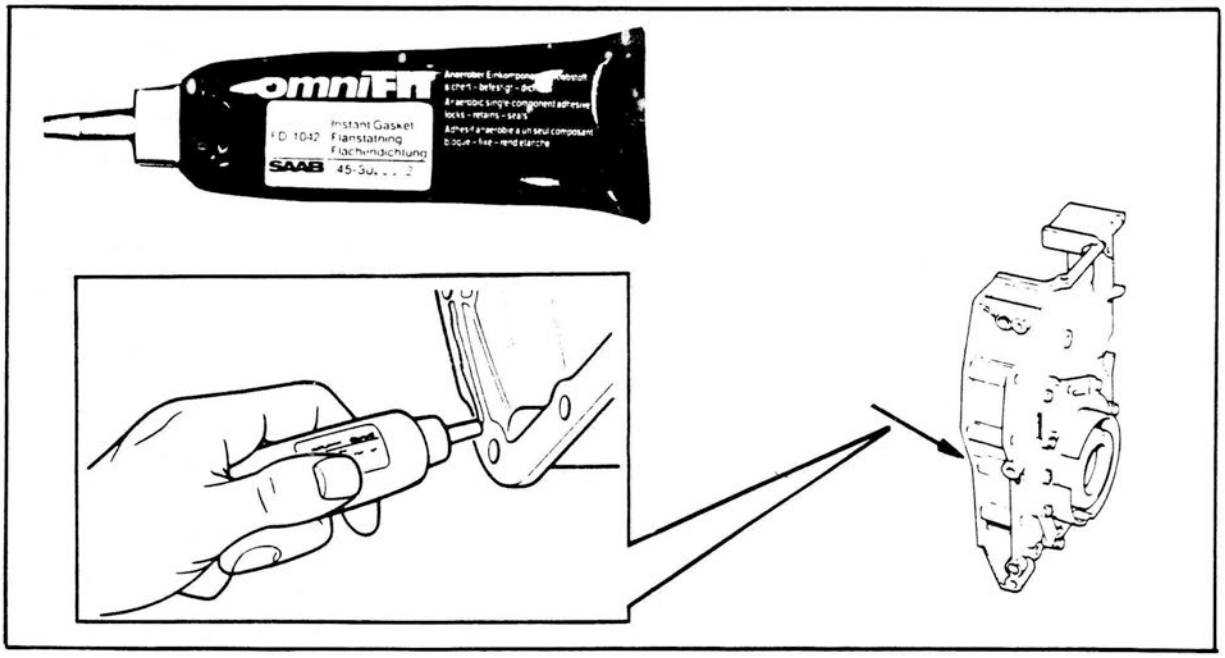


To fit

1 Remove all traces of old sealant from the flanges, and clean the surfaces with industrial petrol (benzine).

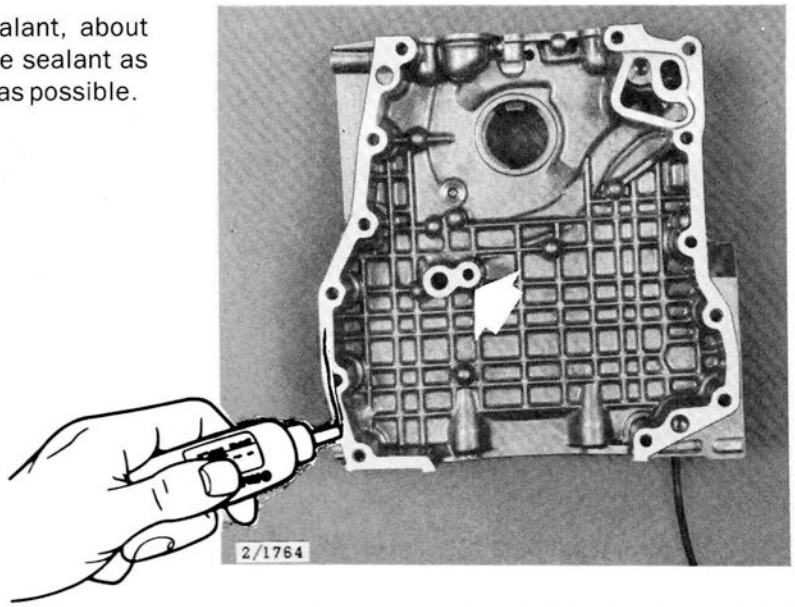
Caution
An anaerobic sealant 45-3028972 must be used on the flanges between the timing cover and block. As before, use Permatex Ultra Blue 45-3020856 for the sump flanges.

Use the sealant sparingly. Excess sealant can get into the oilways and do serious damage to the engine.

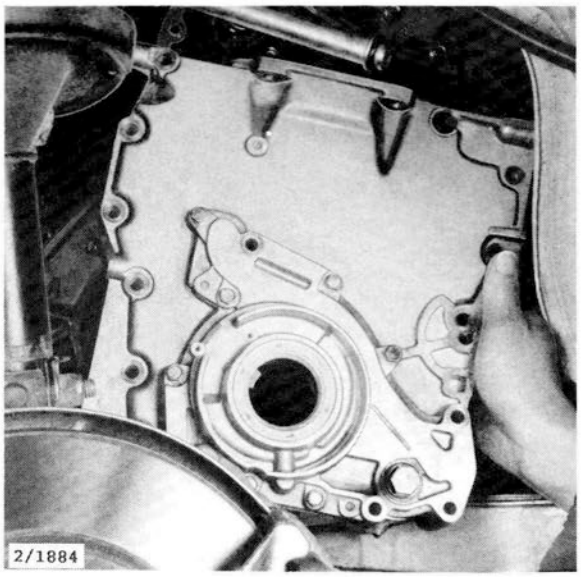


Single-component anaerobic sealant for the timing-cover flanges

2 Apply a bead of anaerobic sealant, about 1 mm wide, as shown. Keep the sealant as near to the middle of the flange as possible.



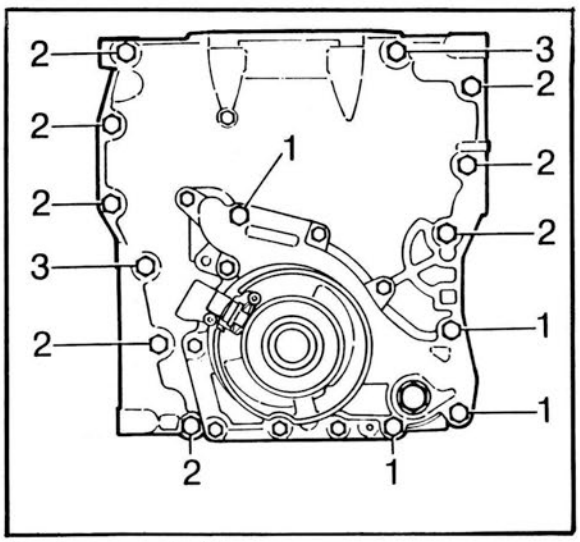
3 Offer up the timing cover, taking care not to damage the cylinder head gasket.



4 Refit the bolts in the correct positions according to their lengths and tighten to the specified torque.

Tightening torque:
20 Nm (15 lbf ft)

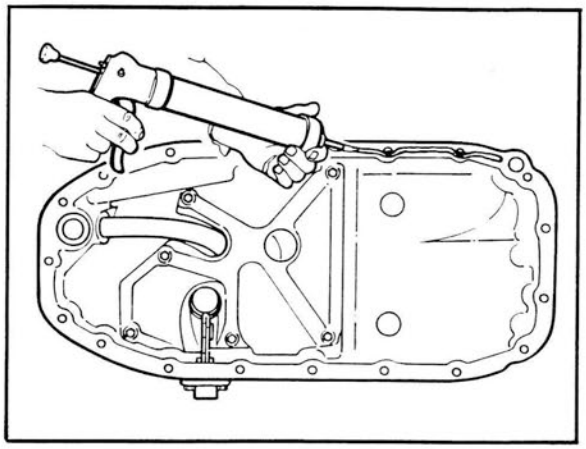
Remember the two bolts securing the cover to the cylinder head.



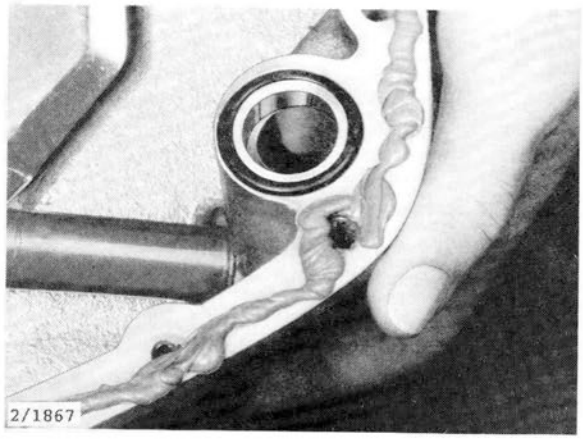
Timing-cover bolts

1 = 4 x 80 mm
2 = 8 x 55 mm
3 = 2 x 60 mm

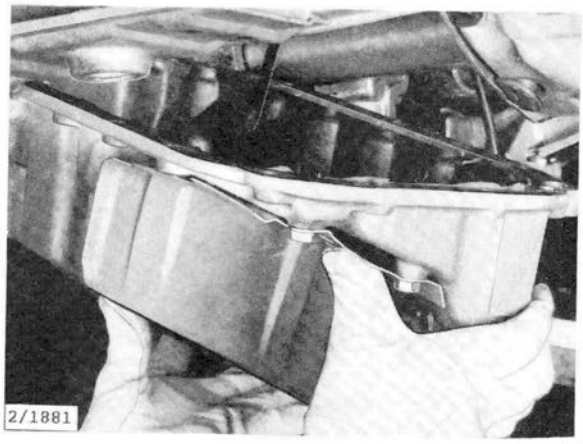
5 Apply an even bead of Permatex Ultra Blue along the sump flange.



6 Fit the rubber seal for the oil strainer in the groove on the sump.



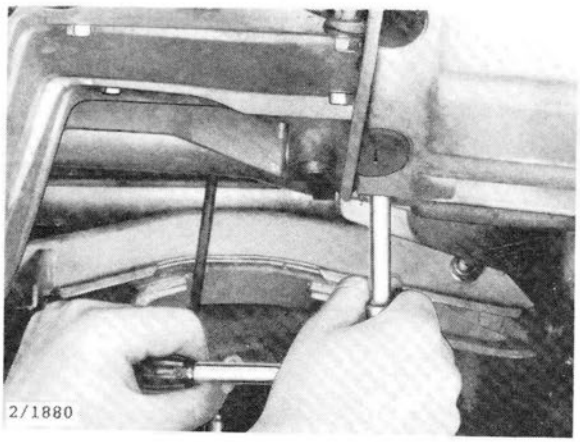
7 Offer up the sump, front edge first and then the back. Fit the bolts loosely to start with.



Tighten the bolts to the specified torque, starting with those in the middle of the sump.

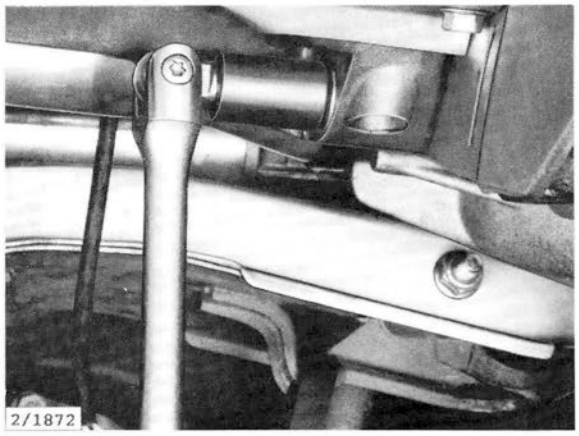
Note the longer bolt with washer which goes in the middle on the RH side.

Tightening torque: 20 Nm (15 lbf ft)

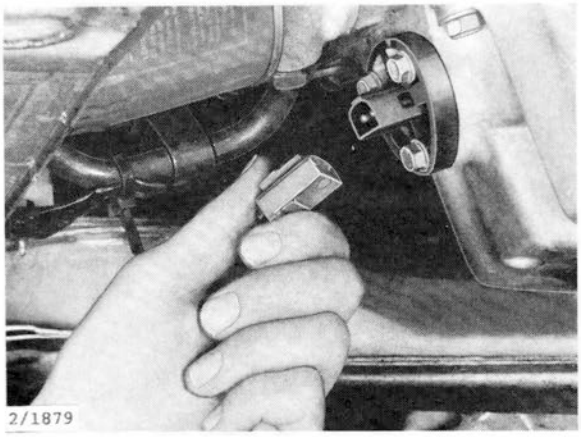


8 Fit the two rubber plugs in the back of the transmission case and return the edge of the splash plate to its original position.

9 Fit the bolt securing the sump to the transmission case at the bottom.



10 Plug the connector onto the oil-level sensor.

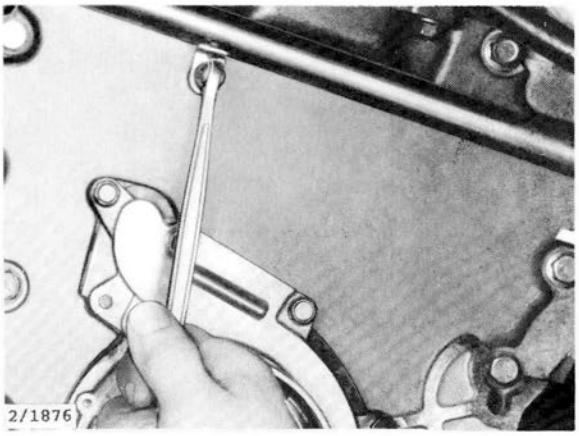


11 Fit the clip for the coolant pipe from the water pump to the timing cover, leaving it slack.

Lower the car.

12 Line up and lower the engine onto its mountings.

Remove the lifting beam.

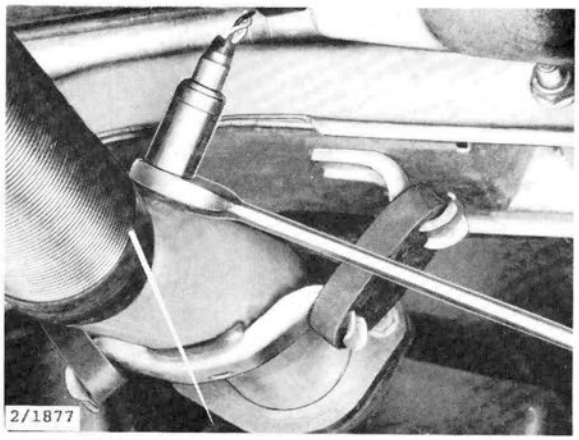


13 Fit the bolt in the coolant-pipe clip and secure the crankshaft-sensor lead by means of a tie (underneath the inlet manifold).

Raise the car.

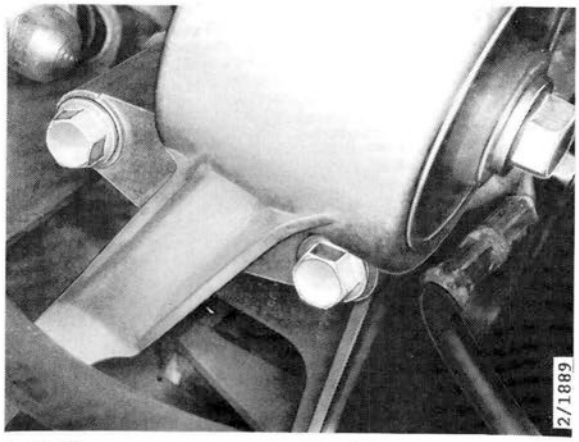
14 Fit the bolts in the engine mountings.

15 Fit the front section of the exhaust pipe. Rotate the Lambda sensor five or six turns anticlockwise and then refit it.

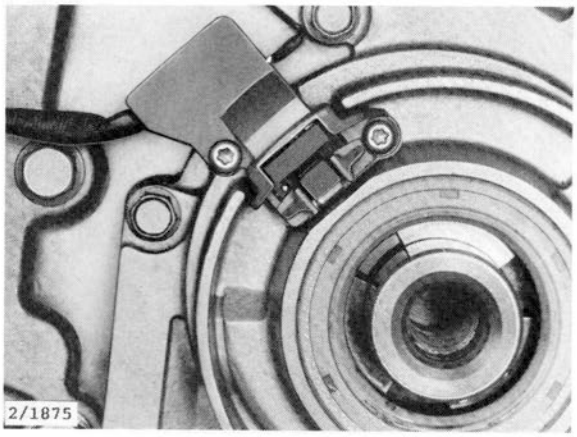


16 Tighten the bolt in the coolant-pipe clip on the timing cover.

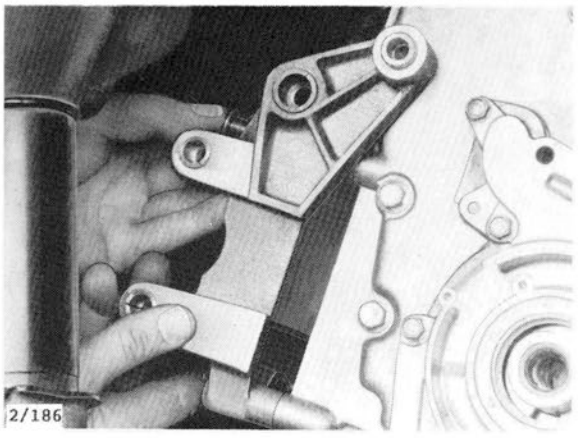
17 Fit the top engine mounting and tighten the two bolts in the bottom.



18 Fit the crankshaft sensor and tie the lead to the coolant pipe.

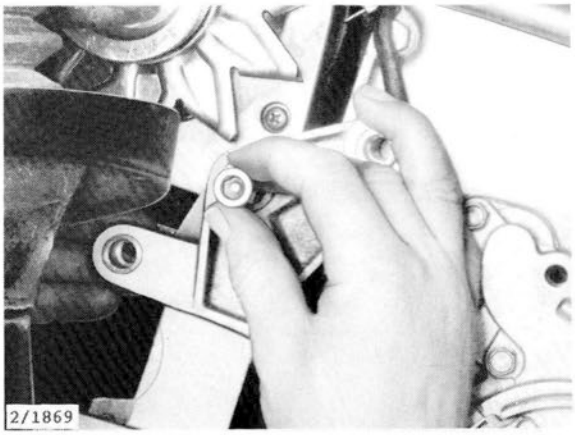


19 Fit the bracket for the power-steering pump.

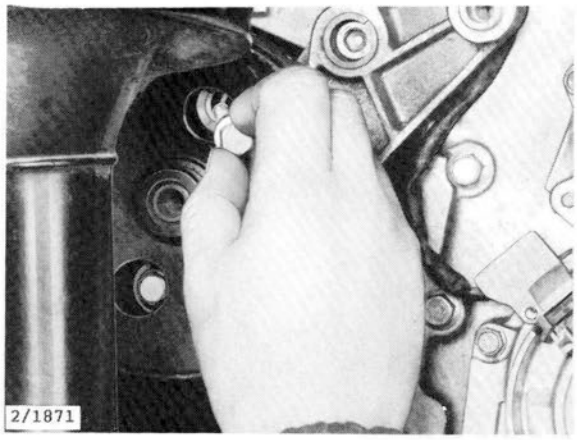


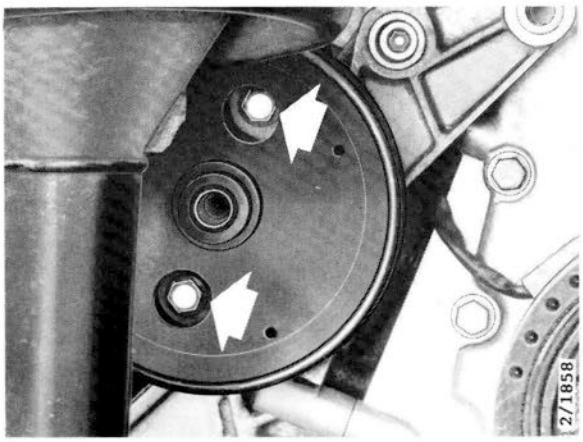
Note
Insert the top bolt in the altern ator before refitting.

20 Offer up the alternator and tighten the securing bolts.

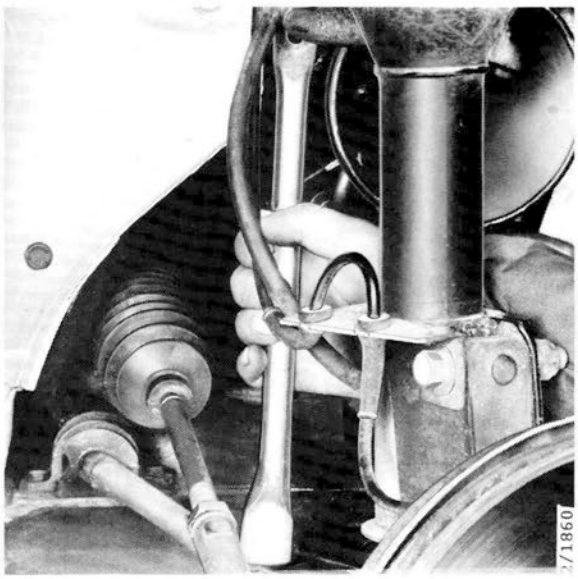


21 Fit the steering servo pump.



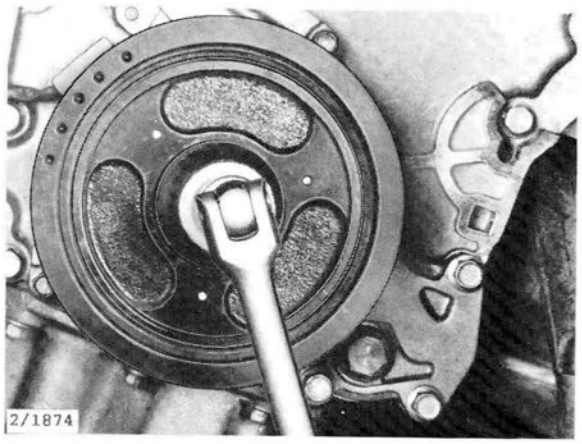


22 Fit the steady bar between the subframe and wheel arch.

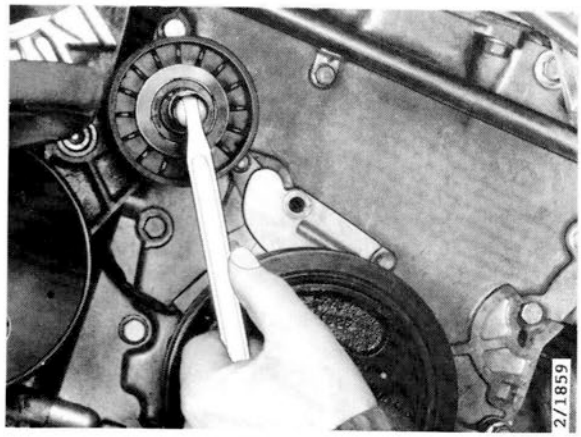


23 Fit the crankshaft pulley, tightening the bolt to the specified torque.

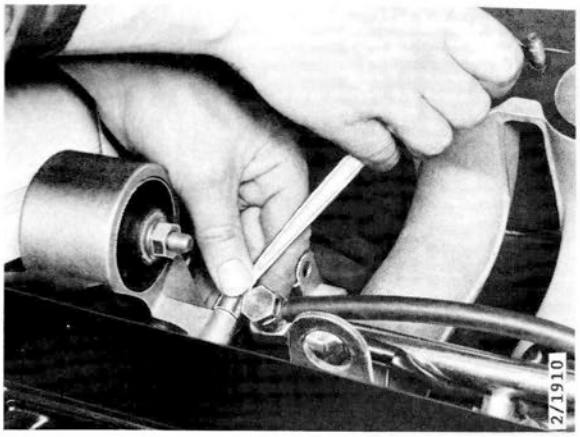
Tightening torque: 190 Nm (140 lbf ft)



24 Fit the idler-wheel pulley and lower the car.



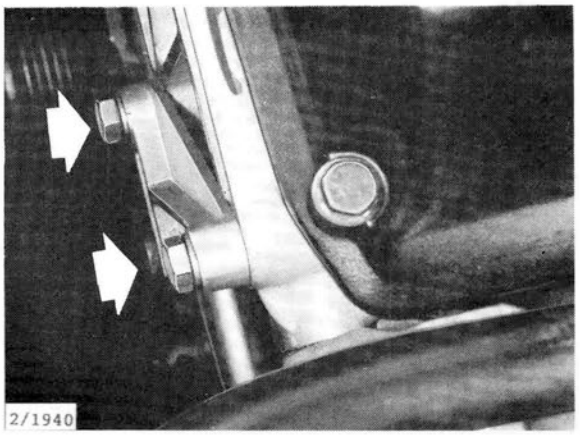
25 Fit the bolts in the top of the top engine mounting.



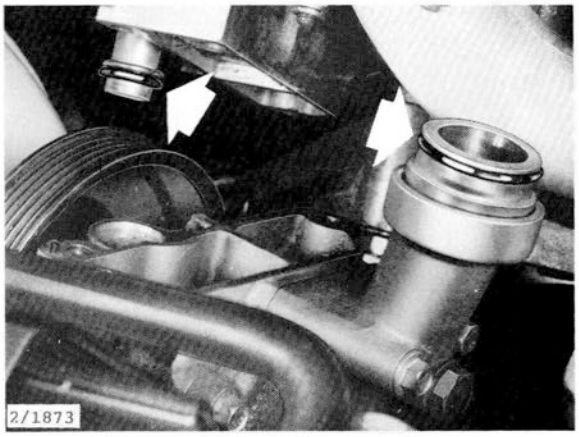
26 Fit the torque arm and secure the hoses and wiring to it by means of ties.

27 Remove the locking segment 83 93 993 from the flywheel.

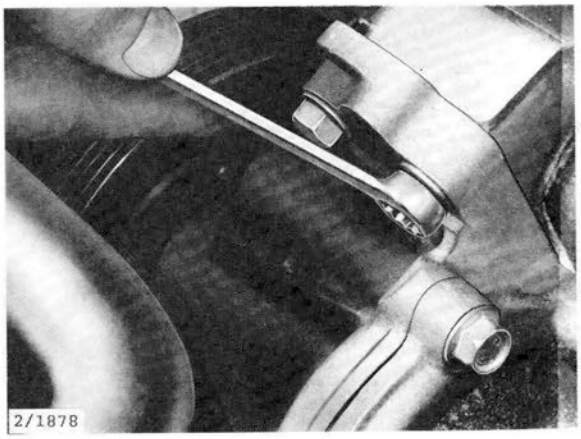
28 Fit the top bracket for the belt tensioner.



29 Inspect the 'O' rings on the water pump and replace if necessary. Lubricate the rings before fitting the pump.

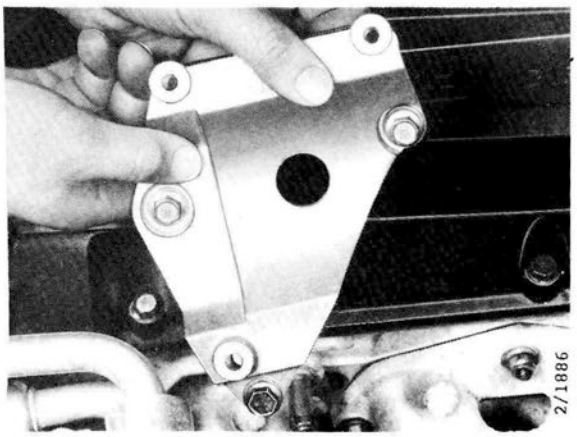


30 Fit the water pump, ensuring that the pipes are properly inserted in the pump.



31 Connect the hoses to the pump.

32 Fit the bracket for the AC compressor.



33 Fit the compressor and remove the protective panel from the oil cooler.

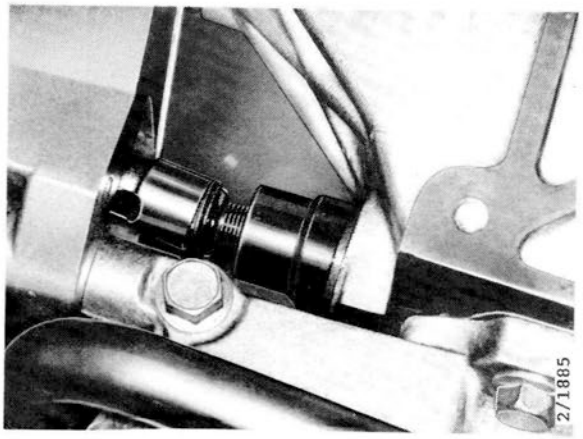
34 Plug the connector onto the compressor.

Secure the compressor hoses by means of a tie.

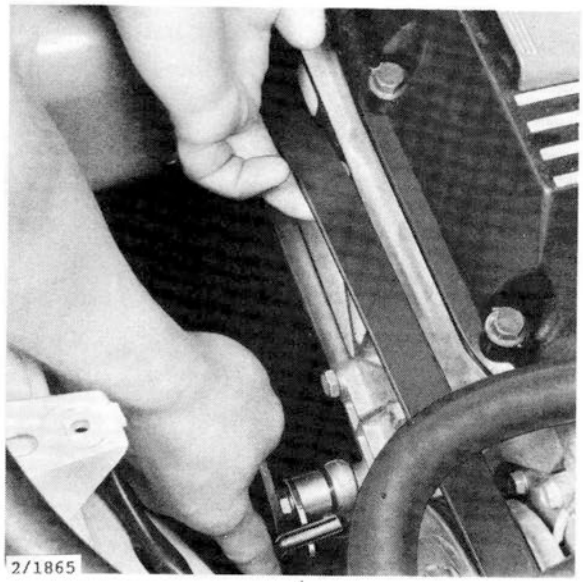
Raise the car.

35 Fit the belt tensioner and cock it by means of a ratchet handle.

Push in the tensioner slowly.



36 Fit the drive belt (page 216-10 et seq refers).

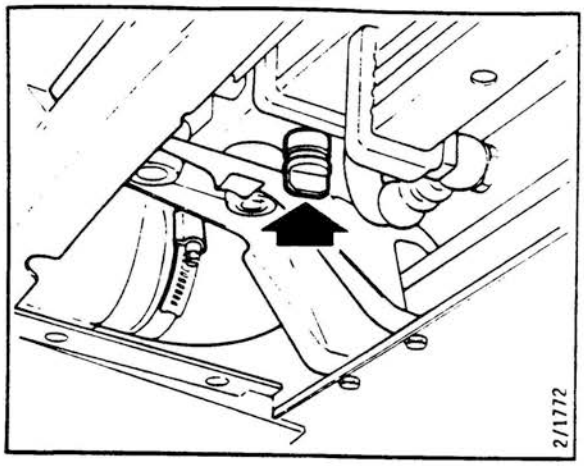


37 Fit the wing liner and the wheel, tightening the wheel bolts to the specified torque.

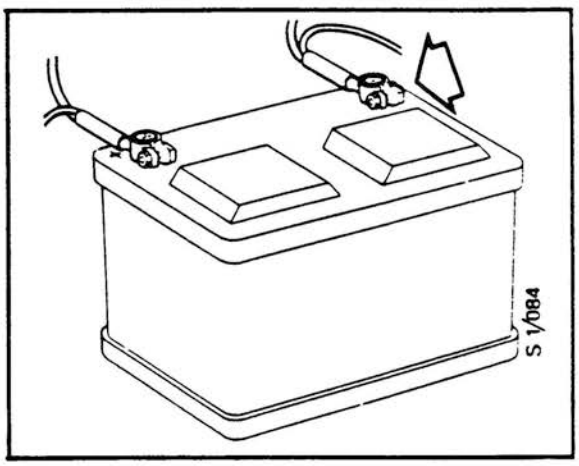
Tightening torque: 130 Nm (96 lbf ft)

38 Check that the oil and coolant drain plugs have been replaced tightly.

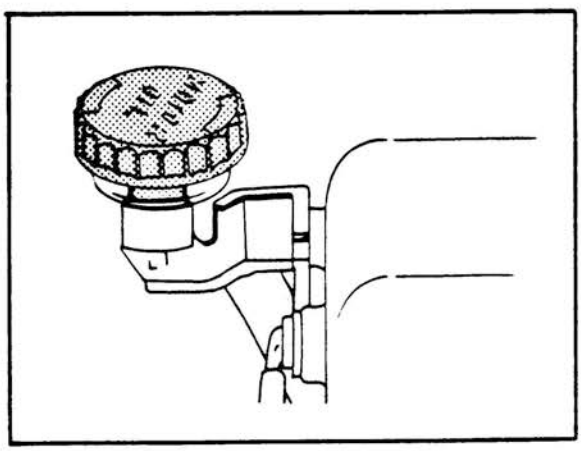
Lower the car.

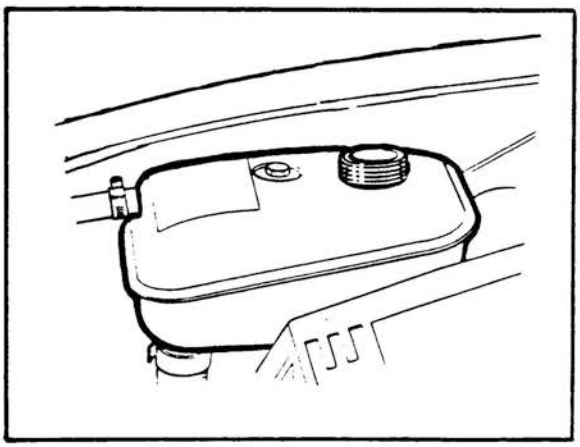


39 Reconnect the battery.



40 Fill up the engine oil and coolant.





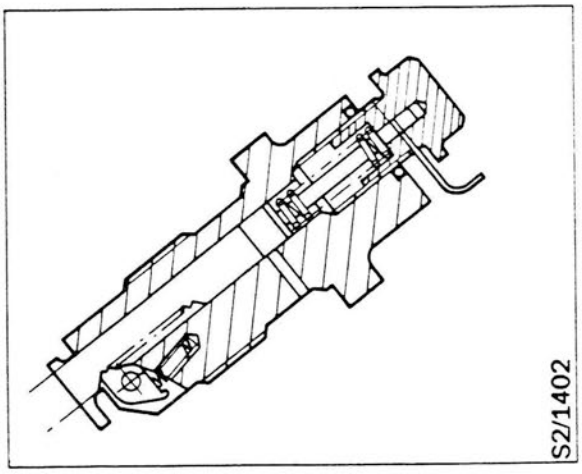
41 Run the engine up to normal temperature.

Top up the coolant as necessary and check that the cooling system is working properly and not leaking anywhere.

Chain tensioner

Because the chain tensioner has a tight adjustment range, it is able to compensate with precision for chain wear and also make for silent operation.

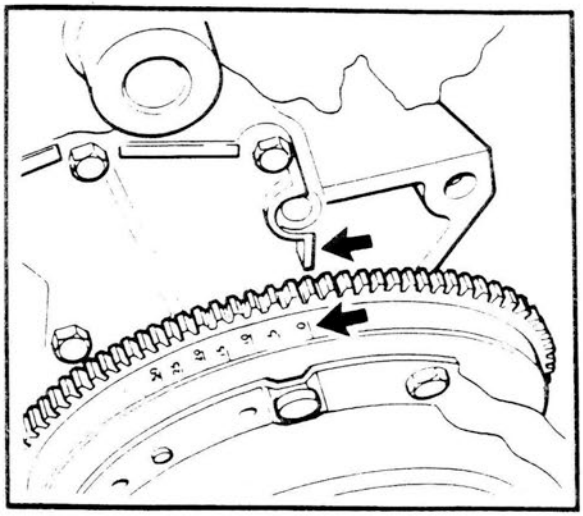
The function is both mechanical and hydraulic, the tensioning force being provided by a spring acting on the tensioning arm. A ratchet prevents return of the tensioning arm inside the tensioner unit.

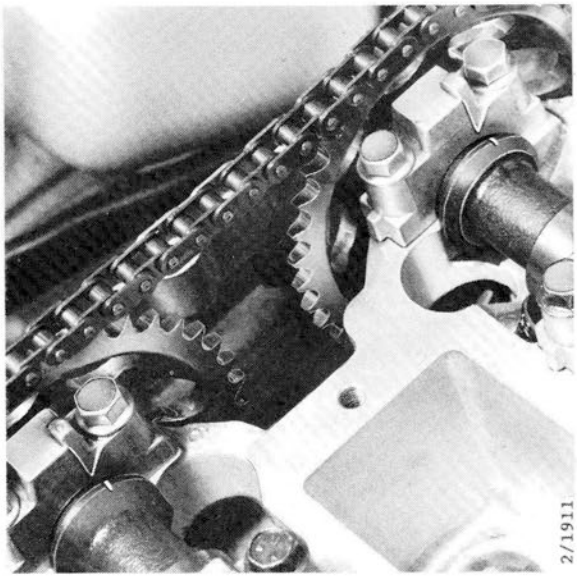


Removal/fitting of the timing chain

It is imperative before fitting or removing the timing chain to ensure that the crankshaft and camshafts are lined up with their timing marks. Never alter the setting of the crankshaft or valve gear unless the camshafts or cylinder head have first been removed.

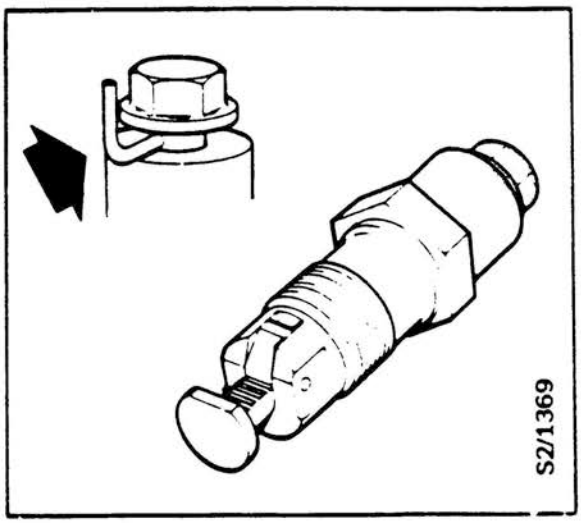
It is also imperative before fitting the cylinder head to ensure that the crankshaft and camshafts are lined up with their timing marks.





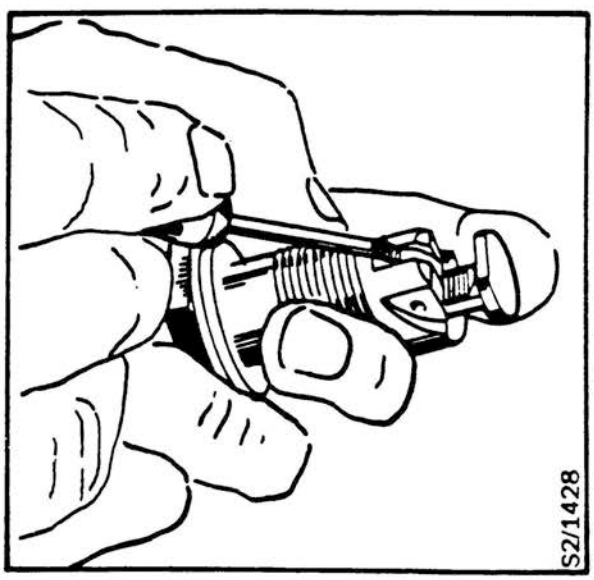
To fit the chain tensioner

Warning
New chain tensioners come with the spring under tension. Never remove the pin before the tensioner has been fitted.



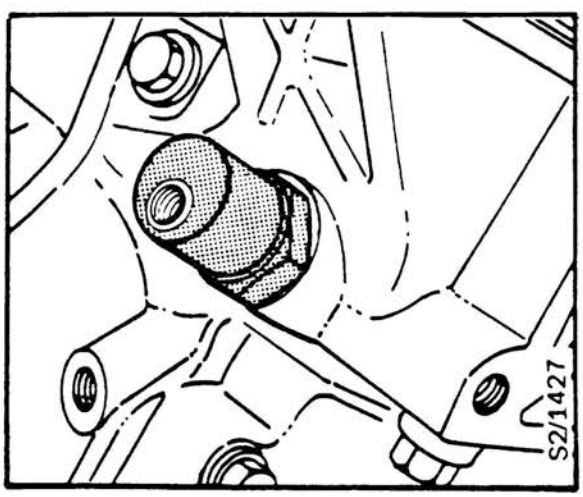
Withdraw the pin, whereupon the spring will push the tensioner arm out, tightening the chain.

1 Cock the tensioner unit by pressing down on the ratchet and pushing in the tensioner.

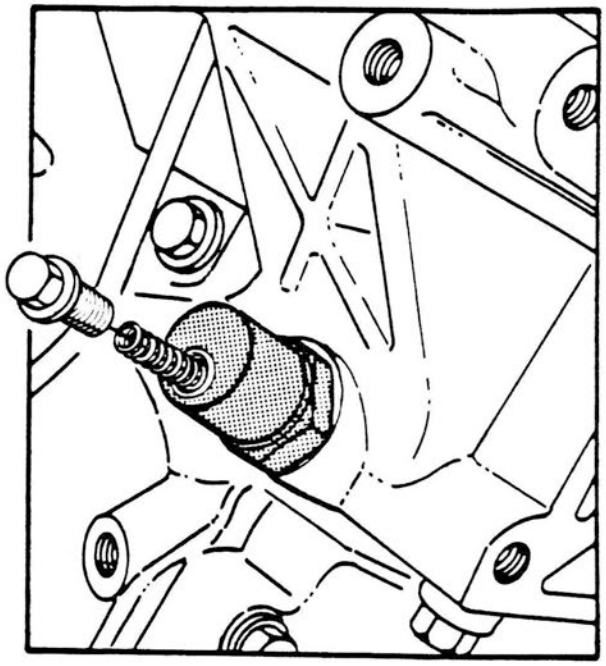


2 Fit the chain tensioner complete with gasket and tighten to the specified torque.

Tightening torque: 63 Nm (47 lbf ft)



3 Insert the spring and plastic guide pin into the tensioner body.



4 Fit the plug, ensuring that the 'O' ring is properly seated.

Tightening torque: 22 Nm (16 lbf ft)

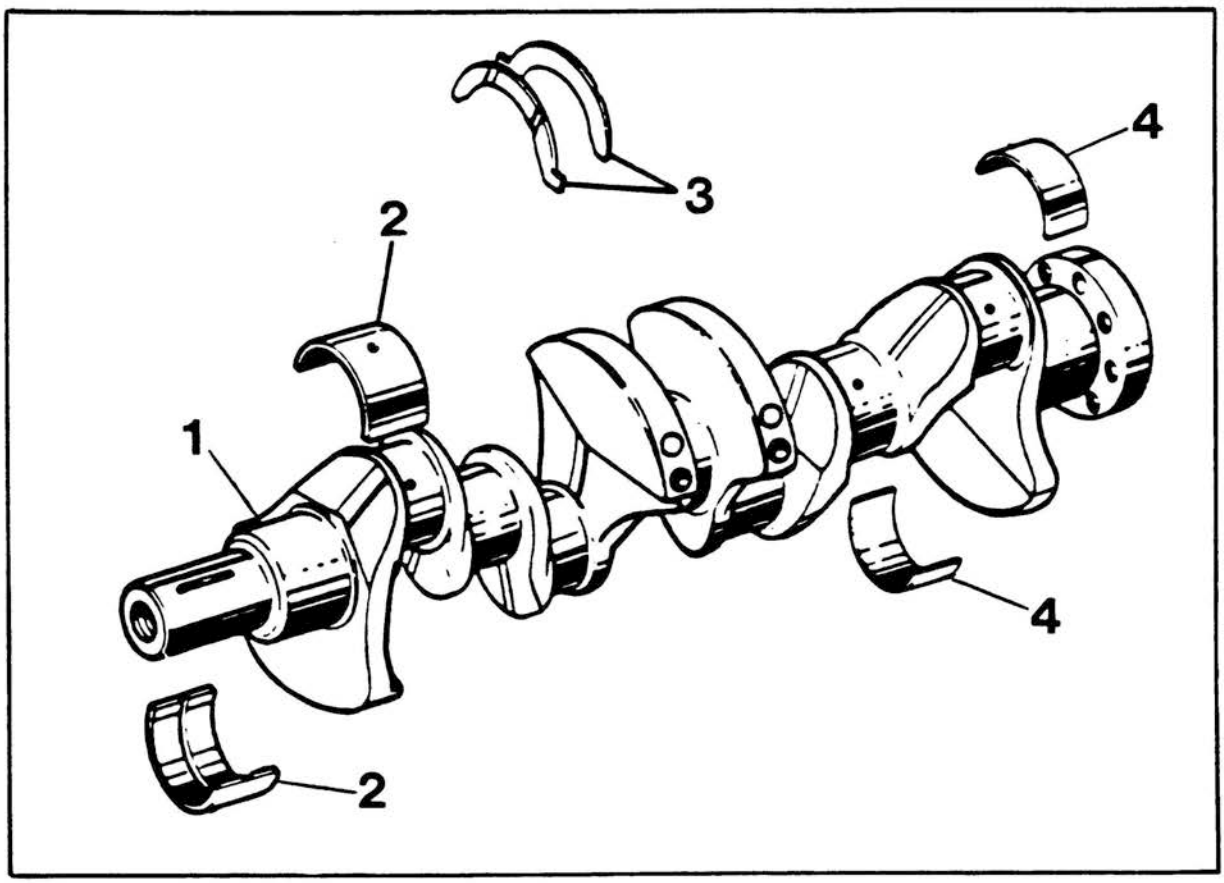
As the plug is screwed in, the spring pushes the tensioning arm out, thus tightening the chain.

5 Check the timing setting by rotating the crankshaft two complete turns in a clockwise direction, lining up the timing marks again. The camshaft timing marks should now also still be in alignment.

6 Tighten the centre-bolts in the camshaft sprockets to the specified torque, using a second spanner across the flats on the shaft to stop it turning.

Tightening torque: 65 Nm (48 lbf ft)

Crankshaft assembly



Crankshaft

1 Crankshaft
2 Main bearing shells
3 Thrust washers
4 Big-end bearing shells

Checking crankshaft tolerances

Clean the crankshaft and measure the crankpins and journals using a micrometer. Measurements should be made at several points around the circumference. Journal and crankpin out-of-round (ovality) should not exceed 0.05 mm (0.0020 in). If the measured values are close to or exceed this limit, the crankshaft must be ground down to the specified undersize. Journals and crankpins can be ground down to the first undersize without rehardening. Beyond that the shaft will need to be hardened by means of Tenifer treatment.

Check whether the shaft is distorted as follows. Mount the crankshaft in two V blocks, position the indicator plunger against the journal for the middle (no. 3) main bearing and rotate the shaft. Maximum permissible deflection is 0.10 mm (0.0040 in).

Checking bearing clearances

Before the bearing clearance is checked in conjunction with the fitting of new bearings, the crankpin out-of-round and taper must be inspected.

Bearing clearance is measured using Plastigage, available in three thicknesses under part no. (45) 30 06 558. Use type PG-1 (green).

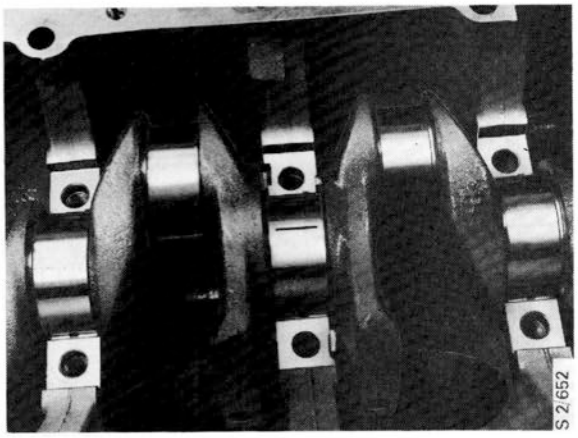
Main bearings

Plastigage can be used to measure both bearing clearance and out-of-round.

Main bearing clearance: 0.020 - 0.062 mm (0.0008 - 0.0024 in)

1 Turn the engine upside down on the stand so that the weight of the crankshaft will not affect the readings.

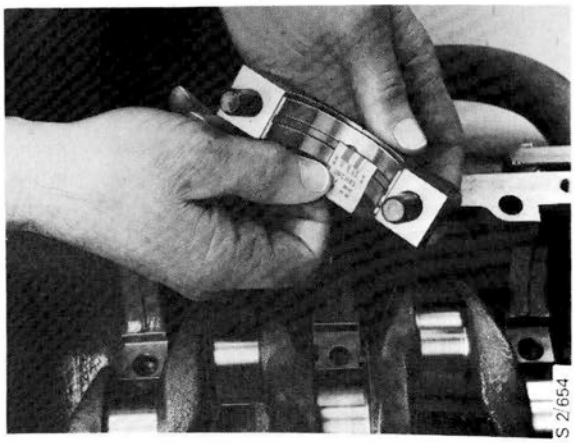
2 Clean the parts to be measured, making sure that all oil and dirt is removed. Place a strip of Plastigage about 6 mm (0.24 in) to one side of the centre-line of the journal.


S 2652

3 Fit the bearing cap, tightening to a torque of 20 Nm (15 lbf ft) and then tighten through a further quarter-turn (through 90°). The crankshaft must remain absolutely stationary during measuring.

4 Remove the bearing cap. The Plastigage strip should now be adhering either to the bearing shell or crankshaft journal.

5 Measure the width of the Plastigage strip using the scale printed on the package and read off the clearance. One side of the package is calibrated in mm and the other in thousandths of an inch. Measure the strip at its widest point, taking care not to touch it with your fingers.


S 2654

Big-end bearings

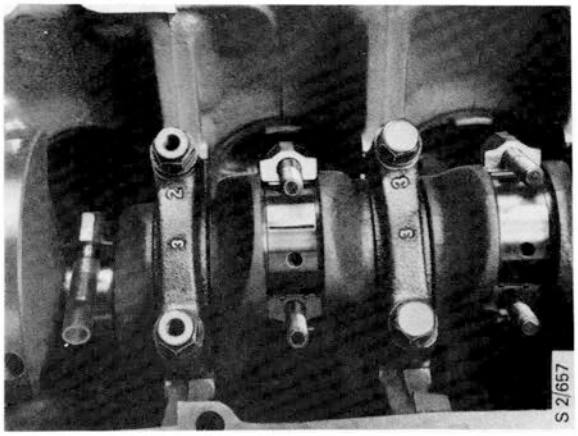
Plastigage strips cannot be used to measure the out-of-round of big-end bearings with the pistons fitted in the block. Use a micrometer instead (page 216-5 refers).

When fitting new bearings, check the big-end bearing clearance as follows.

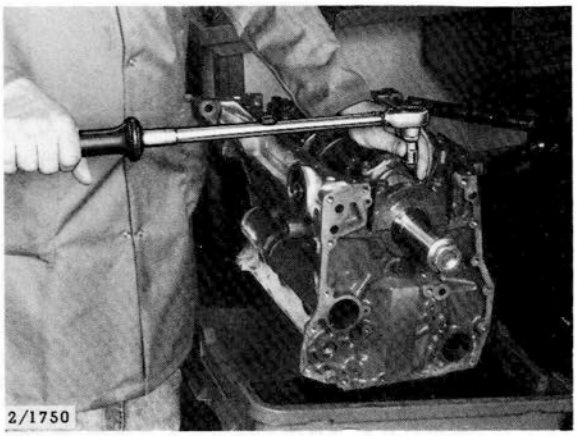
1 Rotate the crankpin to be measured to about 60° BTDC.

Big-end bearing clearance: 0.026 - 0.062 mm (0.0010 - 0.0024 in)

2 Clean the parts to be measured, making sure that all oil and dirt is removed. Position a strip of Plastigage about 6 mm (0.20 in) to one side of the crankpin centre-line.

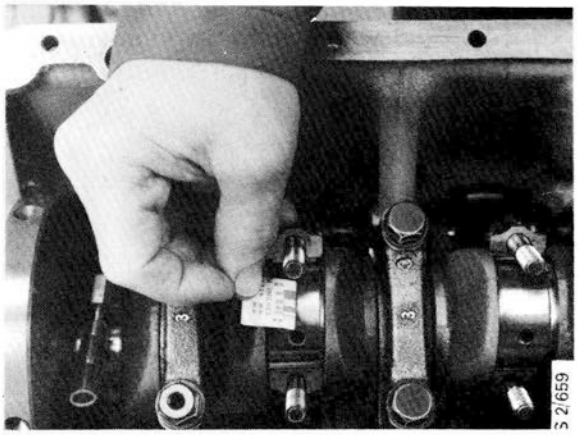


3 Fit the bearing cap, tightening it to a torque of 20 Nm (15 lbf ft) and then tighten through a further quarter-turn (through 90°). The crankshaft must remain absolutely stationary during measuring.



4 Remove the bearing cap. The Plastigage strip should now be adhering either to the bearing shell or to the crankpin.

5 Measure the width of the Plastigage strip using the scale printed on the package and read off the clearance. One side of the package is calibrated in mm and the other in thousandths of an inch. Measure the strip at its widest point, taking care not to touch it with your fingers.



Selecting bearing shells for main and big-end bearings

Bearing shells are available in two thickness classes for standard size, 1st undersize and 2nd undersize. The two thicknesses can be combined to obtain the specified clearance. Only one shell thickness is available for 3rd and 4th undersizes.

The different shells are colour-coded as follows.

Standard size:
Red: Thin bearing shell giving **increased** clearance
Blue: Thicker bearing shell giving **reduced** clearance

1st undersize:
Yellow: Thin bearing shell giving **increased** clearance
Green: Thicker bearing shell giving **reduced** clearance

2nd undersize:
White: Thin bearing shell giving **increased** clearance
Brown: Thicker bearing shell giving **reduced** clearance

Example

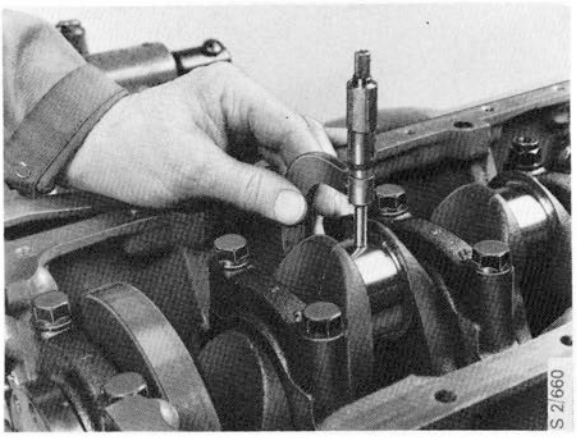
Try to obtain the correct clearance by fitting two thin bearing shells. If the clearance is excessive, reduce it by fitting one thin and one thick, or two thick shells.

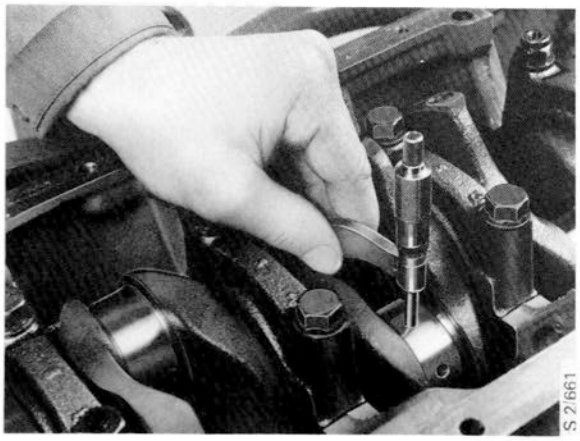
If the clearance is excessive even after two thick bearing shells have been fitted, the crankshaft must be ground down to the next undersize and the appropriate undersize bearing shells fitted. (Sizes are given in the Technical data section.)

Note
Crankpins and journals can be ground down one undersize (0.25 mm or 0.0098 in) without the need for rehardening of the shaft. Grinding to a further undersize will necessitate Tenifer treatment to reharden it.

Checking crankpin out-of-round

Use a micrometer to measure the crankpin at two points, positioned at 90° to each other.





Dimensions are given in the Technical data section.

Fitting the pistons and connecting rods

1 Lubricate the pistons and cylinder bores.

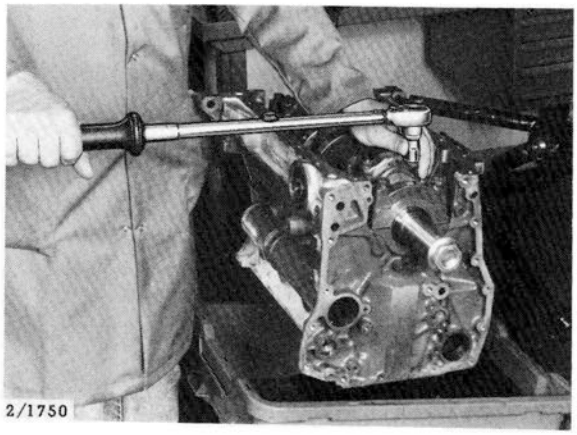
2 Fit protective sleeves (pieces of hose pipe) over the connecting-rod studs and fit the pistons using piston-ring compressor 78 62 287. Make sure that the arrow on the piston is pointing towards the timing cover.

3 Fit the big-end bearing caps with the identifying numbers on the caps on the same side as those on the connecting rods.

Tighten to the specified torque.

Tightening torque: 20 Nm (15 lbf ft)

Then through a further quarter-turn (through 90°)



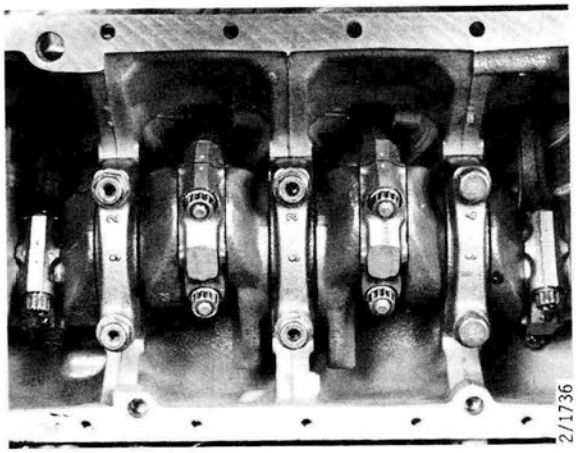
Checking main and big-end bearings (in situ)

The description assumes that the sump has already been removed.

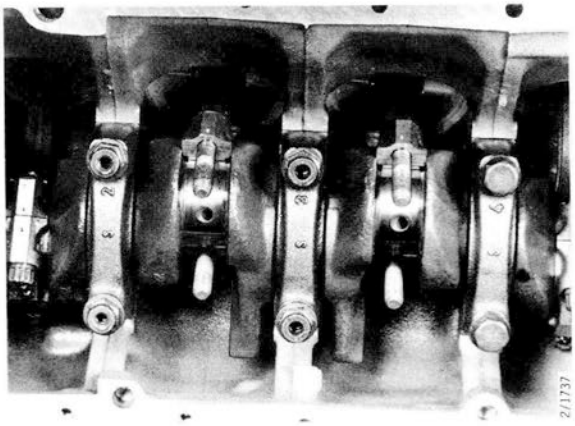
Details of how to remove the sump are given in subsection 220.

1 Wipe off all oil drips.

2 Rotate the crankshaft to bring the big-end bearings for no. 2 and no. 3 pistons into the position for checking.



3 Remove the bearing caps on no. 2 and no. 3 big-end bearings.



4 Inspect the bearings and crankshaft by eye.

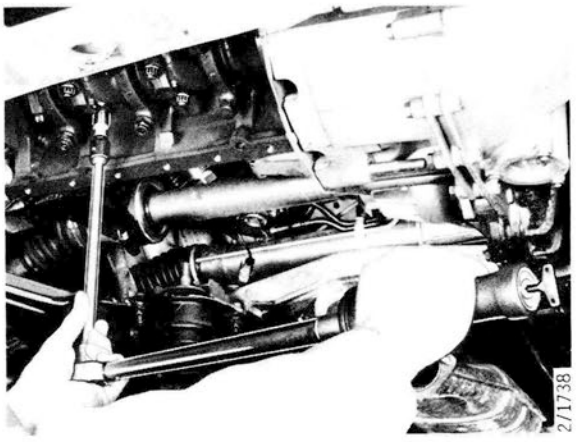
5 Lubricate the bearing caps.

Note
When refitting the bearing caps, make sure that the identifying numbers on the bearings are uppermost and the right way round.

6 Fit and tighten the bearing caps to the specified torque.

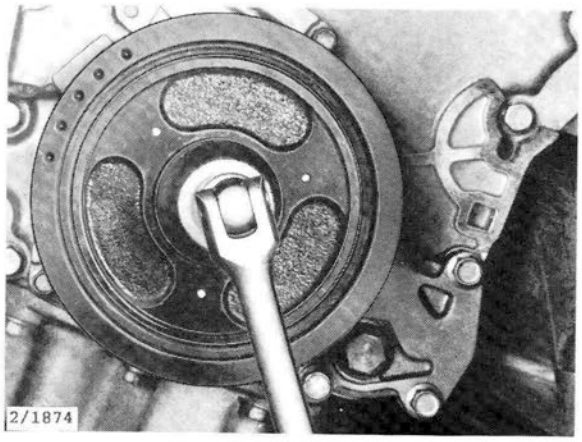
Tightening torque: 20 Nm (15 lbf ft)

Then tighten a further quarter-turn (through 90°)

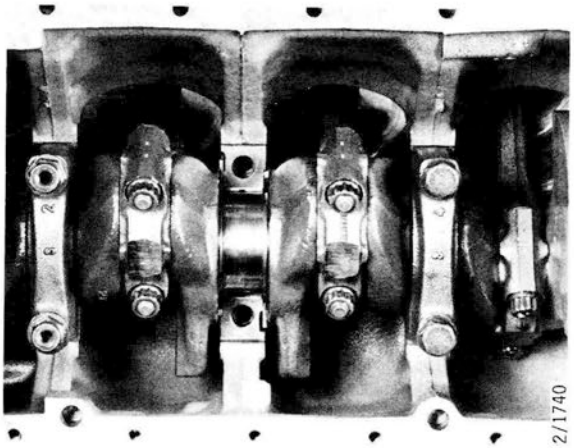


7 Rotate the crankshaft to bring the bearing caps for no. 1 and no. 4 cylinders into the position where they can be checked.

Repeat steps 4 - 7 inclusive for no. 1 and no. 4 bearings.



8 Remove the main bearing caps **one at a time** and inspect the caps and the crankshaft.

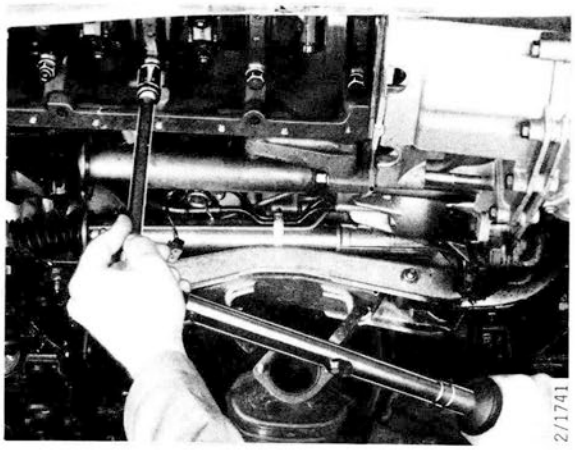


Note
The bearing caps must be fitting the right way round, i.e. with the identifying numbers facing forwards.

9 Lubricate and fit the bearing caps.

Tightening torque: 20 Nm (15 lbf ft)

Then tighten a further quarter-turn (through 90°)



10 Refit the sump (subsection 220 refers).

Replacing the crankshaft seal (in situ)

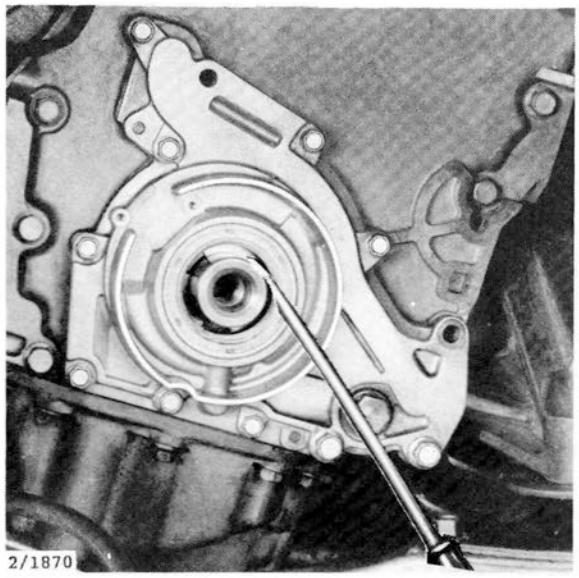
1 Raise the car.

2 Remove the right front wheel and the front section of the wing liner.

3 Remove the drive belt.

4 Remove the crankshaft pulley.

5 Use a screwdriver to break off the old seal.



6 Fit the new seal using tool 83 93 349.

7 Fit the pulley and tighten to the specified torque.

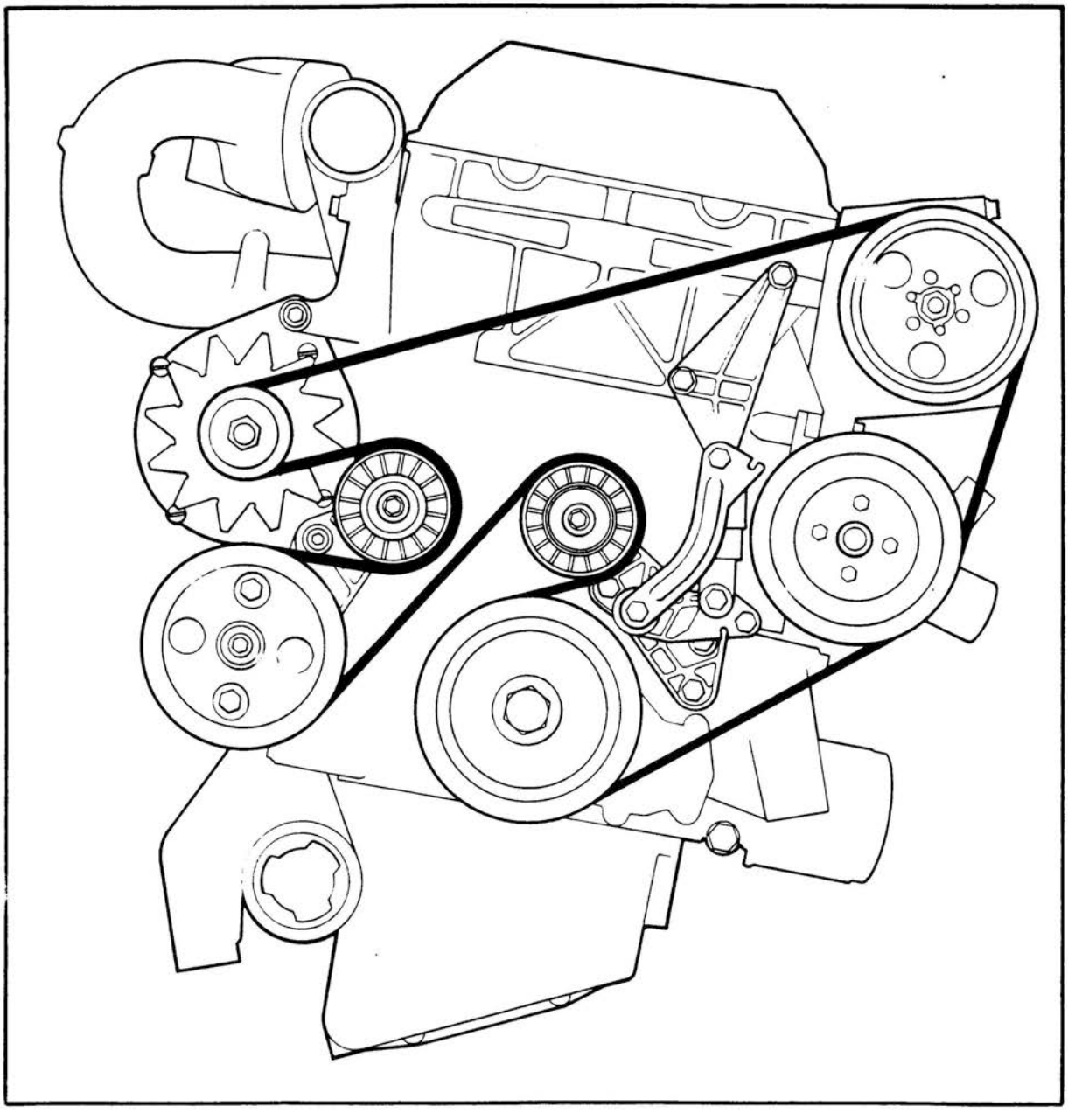
Tightening torque: 190 Nm (140 lbf ft)

8 Fit the drive belt. Use a belt-tension meter to check the tension.

9 Refit the wing liner.

10 Fit the wheel and lower the car.

Drive belt for auxiliaries



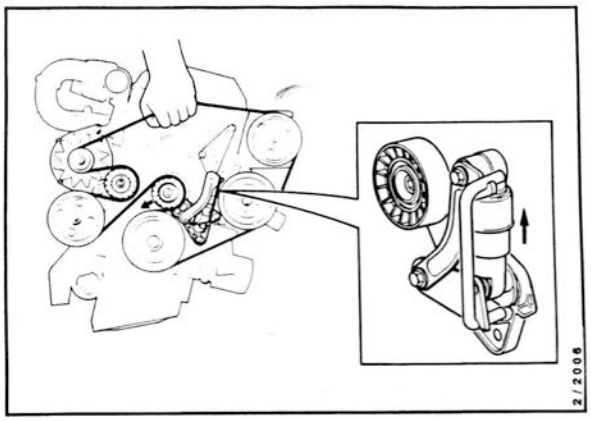
To remove

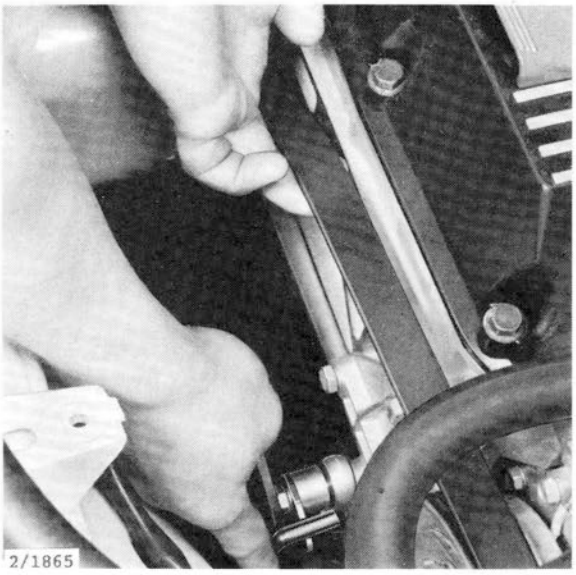
1 Raise the car and remove the right front wheel.

2 Remove the front section of the wing liner and lower the car.

3 Slacken the belt by applying a hard pull upwards.

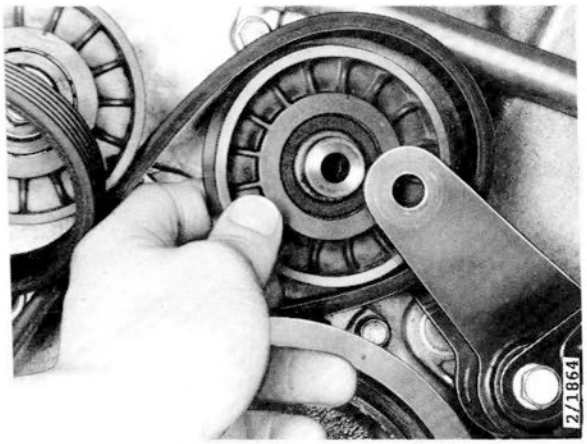
Fix the belt tensioner in the compressed position by means of locking pin 83 94 488.





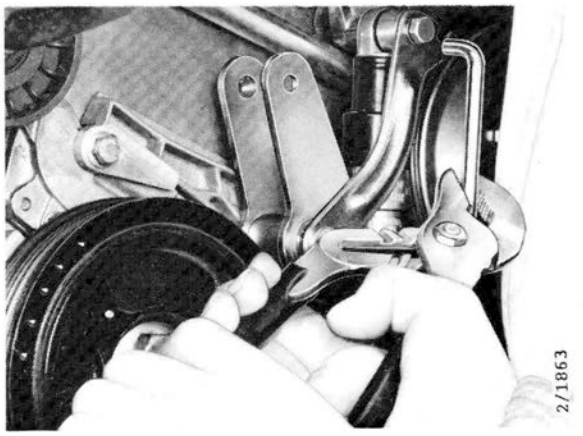
4 Raise the car.

Remove the tensioner idler-wheel pulley and the belt.

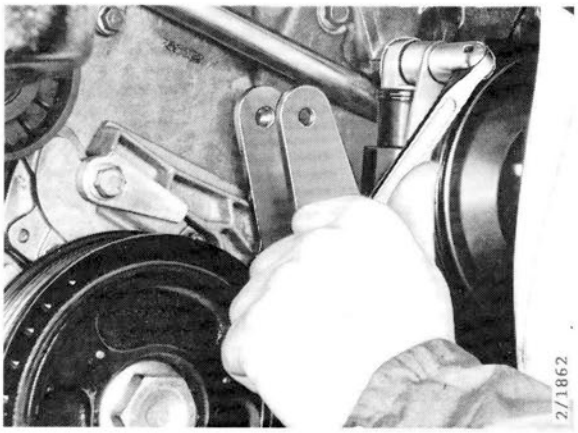


5 Remove the locking pin (e.g. use a pair of water-pump pliers or a large screwdriver).

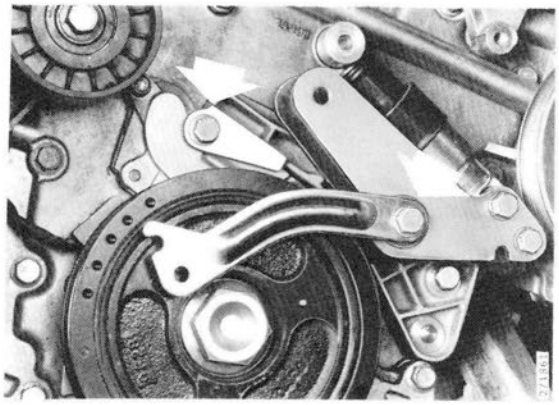
Watch your fingers!



6 Remove the top fixing bolt for the belt tensioner and swivel the tensioner down.



Remove the two fixing bolts in the mounting plate and lift off the plate complete with tensioner.

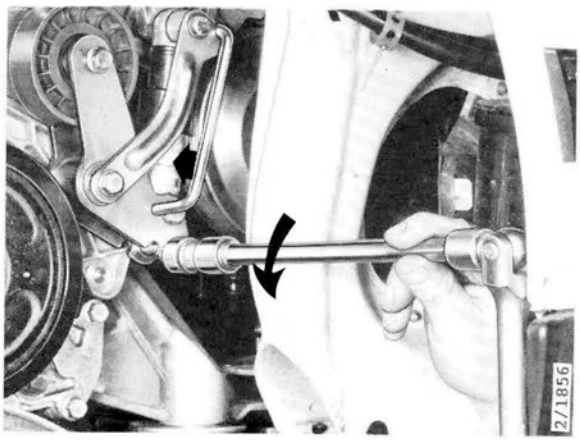


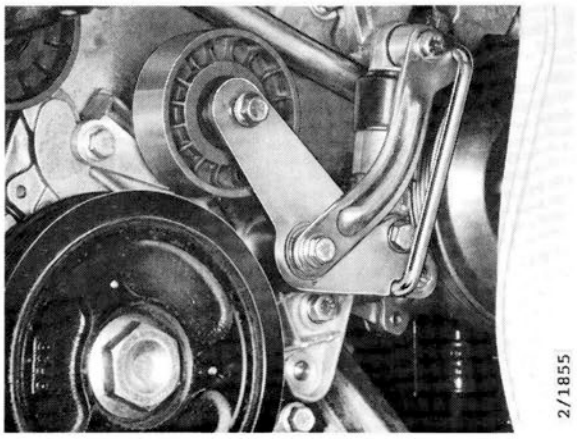
To fit

1 Fit the bolts in the mounting plate, swivel the tensioner down and fit the top bolt.

Note
As the tensioner is compressed, oil is forced through a tiny gap between the plunger and the cylinder wall, and it therefore takes time for the oil to flow from one chamber to the next. With this in mind, push the tensioner in slowly when tightening the belt.

2 Using a ratchet handle, advance the tensioner and then fix it in position by means of locking pin 83 94 488.

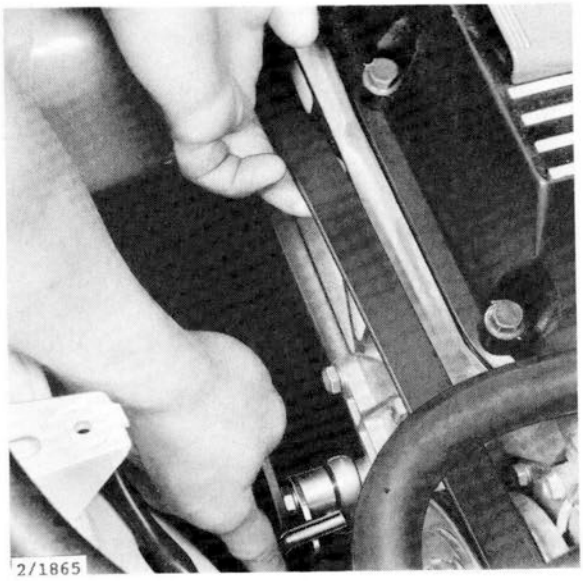




3 Fit the belt and the idler-wheel pulley.

Make sure that the belt is correctly seated round all the pulleys and then lower the car.

Apply a hard upward pull to the belt to release the pressure of the tensioner, and remove the locking pin.



Raise the car.

4 Refit the wing liner.

5 Fit the wheel and tighten the bolts to the specified torque.

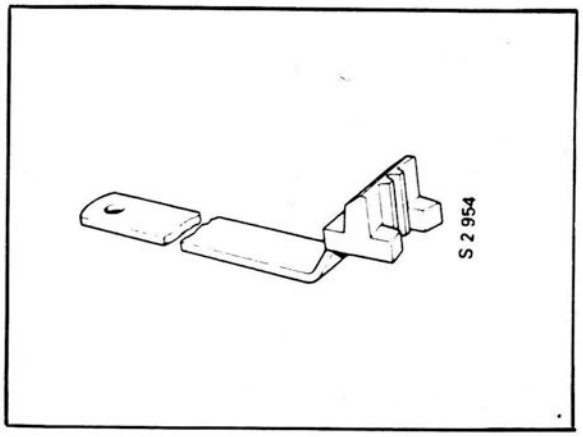
Tightening torque:
130 Nm (96 lbf ft)

Lower the car.

Crankshaft pulley

To remove

1 Fit locking segment 83 93 993 to immobilize the flywheel.

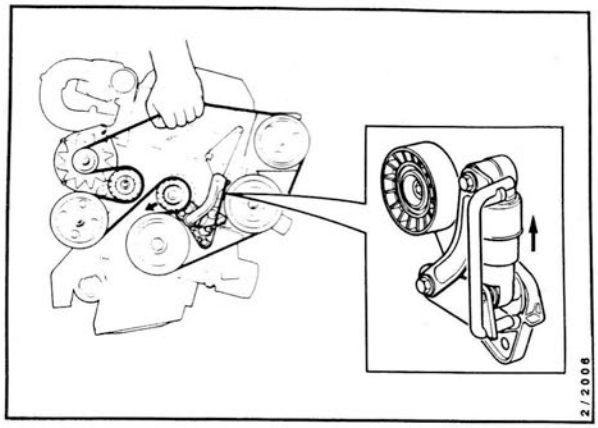


2 Raise the car.

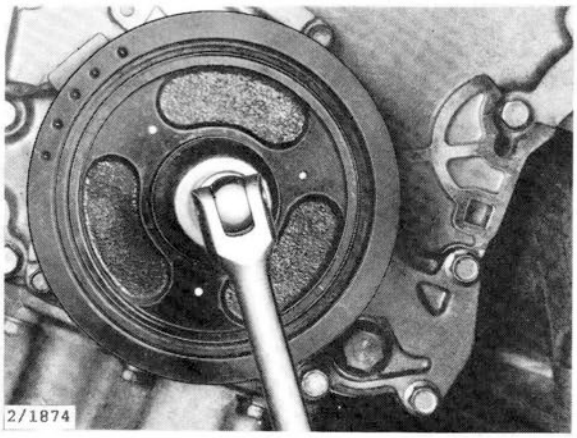
Remove the right front wheel and the front section of the wing liner.

3 Slacken the belt tensioner and fit locking pin 83 94 488 (page 216-11, step 3 refers).

Ease the drive belt off the crankshaft pulley.



4 Undo the pulley centre-bolt and lift off the pulley.



To fit

Refit in the reverse order.

Details of how to fit the drive belt are given on page 216-10 et seq.

Tightening torque for pulley centre-bolt:
190 Nm (140 lbf ft)

Tightening torque for wheel bolts:
130 Nm (96 lbf ft)

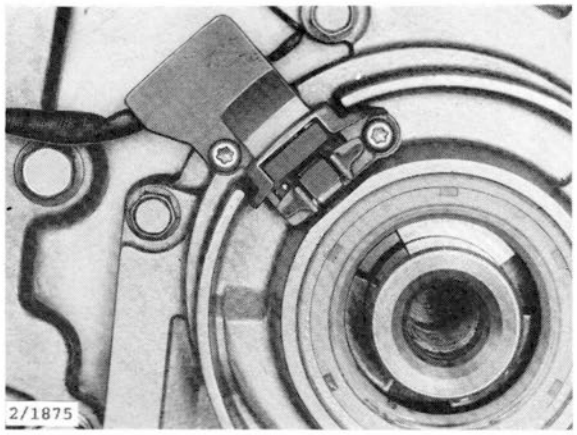
Lubricating system

Oil pump

To remove

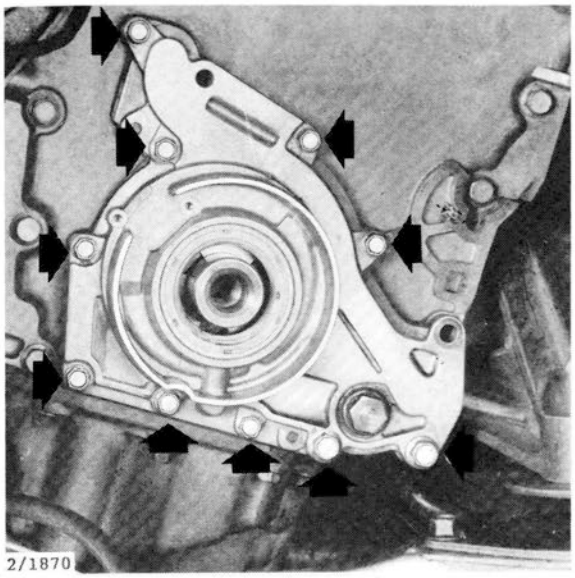
1 Remove the crankshaft pulley (page 216-14 refers).

2 Undo the crankshaft-sensor bolts and swivel it out of the way.



3 Remove the idler-wheel pulley.

4 Undo the pump securing bolts. Lift off the pump taking care not to lose the spring.



To fit

1 Fit the spring and, using the guide pins, lift the pump into position.

2 Fit and tighten the bolts.

Tightening torque: 8 Nm (5.9 lbf ft)

3 Fit the idler-wheel pulley.

4 Fit the crankshaft sensor.

5 Fit the crankshaft pulley.

Tightening torque: 190 Nm (140 lbf ft)

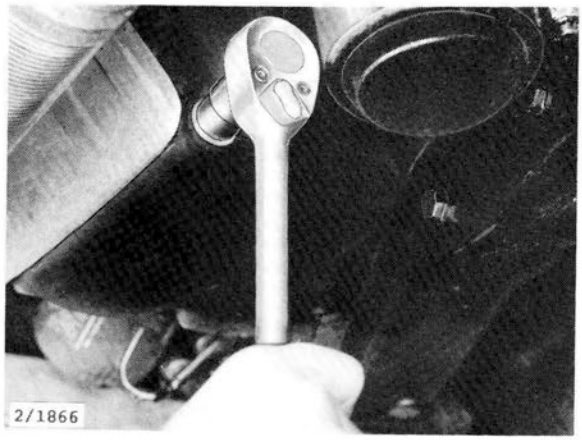
Sump

To remove (engine in car)

1 Remove the oil dipstick and stuff a rag into the end of the tube.

Raise the car.

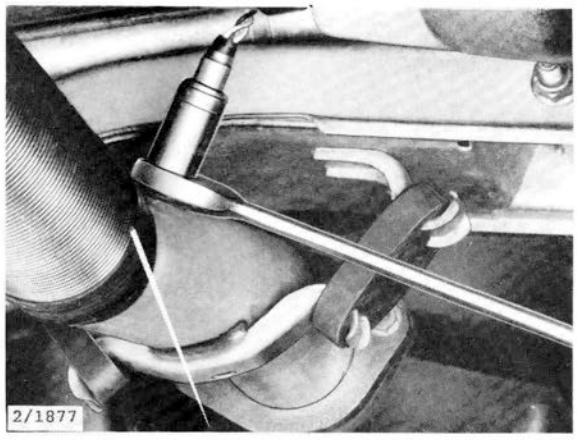
2 Drain the engine oil.



3 Remove the right front wheel and the front section of the wing liner.

4 Undo the bolts in the front and rear engine mountings.

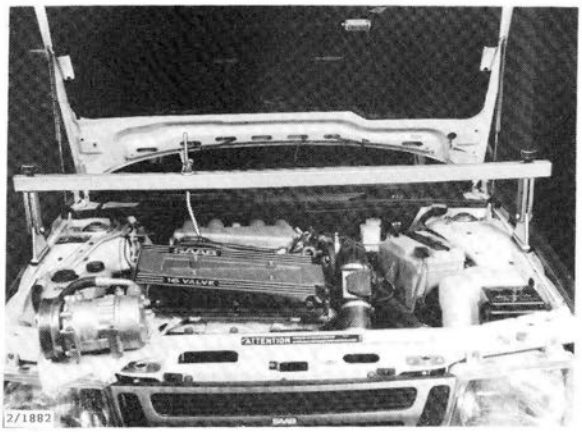
5 Remove the Lambda sensor and the front section of exhaust pipe.



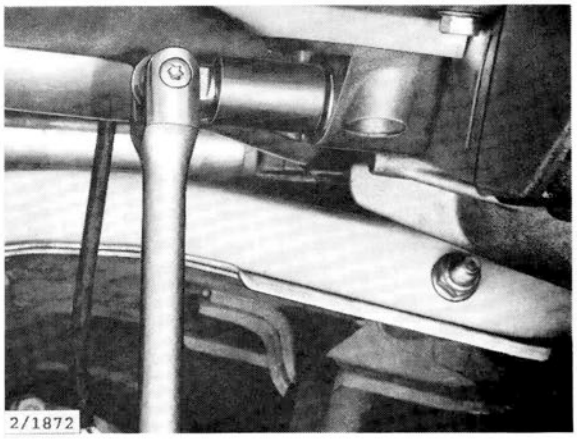
Lower the car.

6 Snip through the ties and remove the tie rod between the wheel arch and subframe.

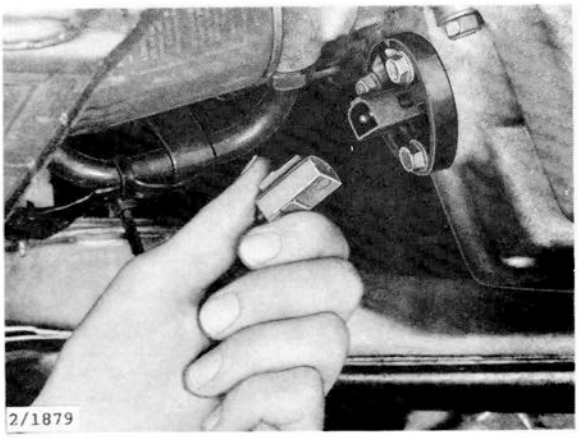
7 Fit engine-lifting beam 83 93 977 and raise the engine slightly.



8 Remove the bottom bolt holding together the transmission case and sump.

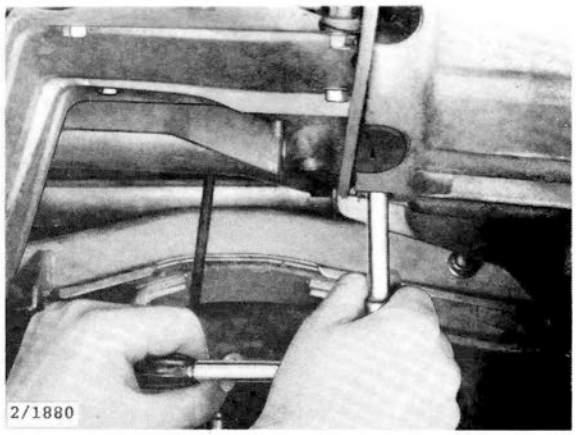


9 Unplug the connector from the oil-level sensor.



10 Fold down the edge of the splash plate and remove the two rubber plugs in the back of the transmission case.

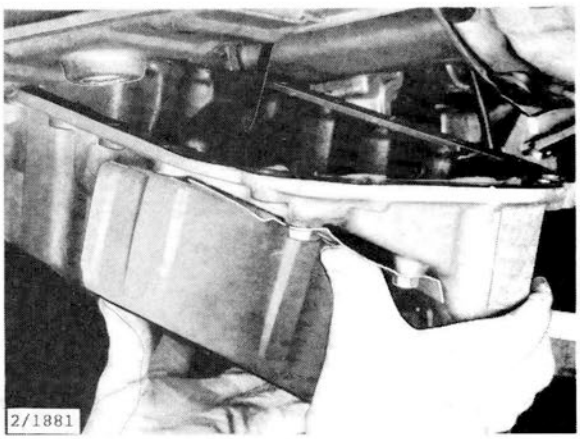
11 Remove the two bolts securing the sump to the block underneath the plugs.



Remove the remaining bolts.

12 Use a drift to tap the guide sleeve into the block.

13 Lift off the sump, easing off the back first.

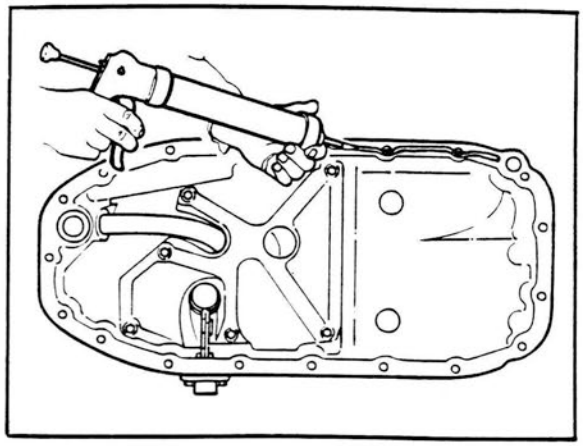


Remove the guide sleeve from the block.

To fit

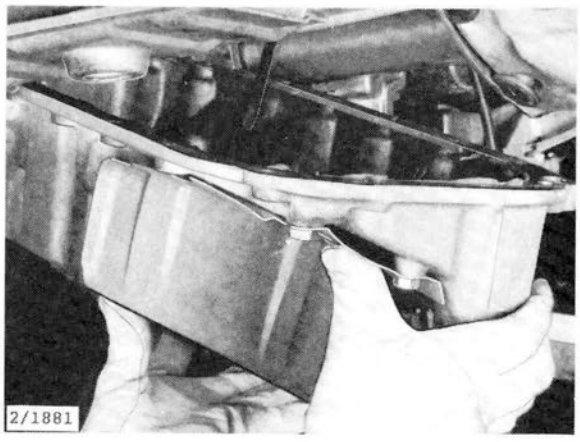
1 Thoroughly clean the flanges on the sump and block using industrial petrol (benzine).

2 Apply an even bead of Permatex Ultra Blue 45-3020856 along the sump flange.



3 Fit the rubber seal for the oil strainer in the groove on the sump.

4 Offer up the sump, front edge first and then the back.

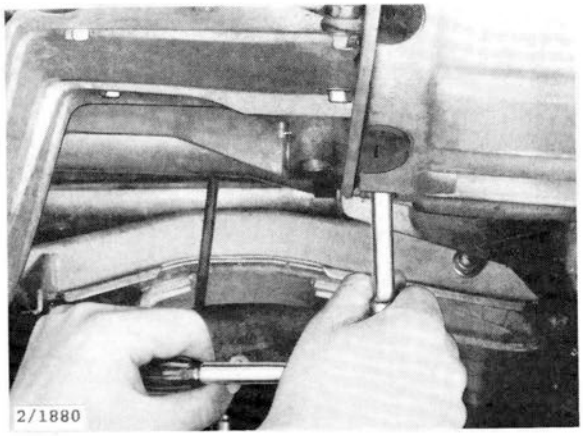


Fit the bolts, leaving them slack to start with.

5 Tighten the bolts to the specified torque, starting with those in the middle of the sump.

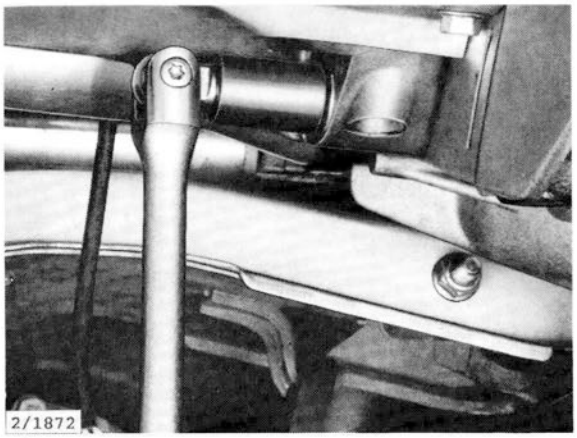
Note the longer bolt with washer which goes in the middle on the RH side.

Tightening torque: 20 Nm (15 lbf ft)



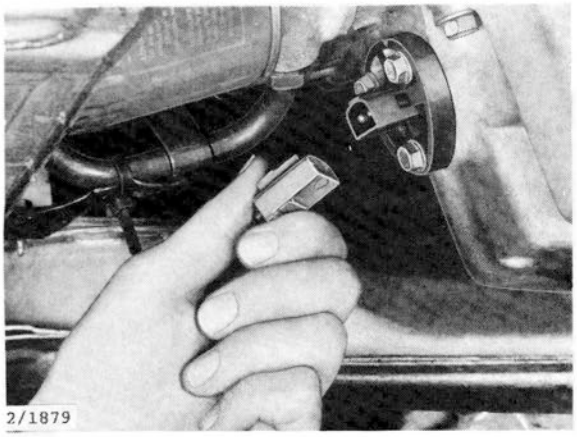
6 Fit the two rubber plugs in the back of the transmission case and return the edge of the splash plate to its original position.

7 Fit the bolt securing the sump to the transmission case at the bottom.



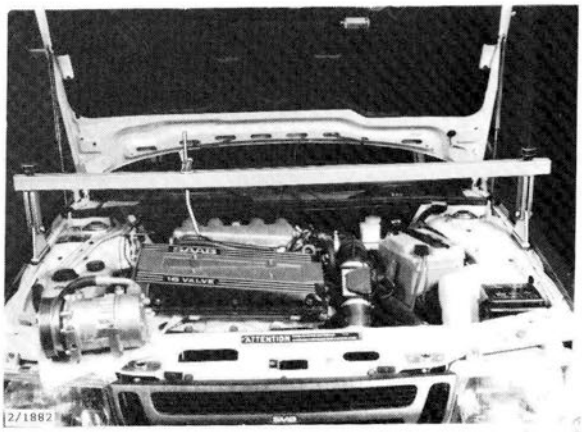
8 Plug the connector onto the oil-level sensor.

Lower the car.

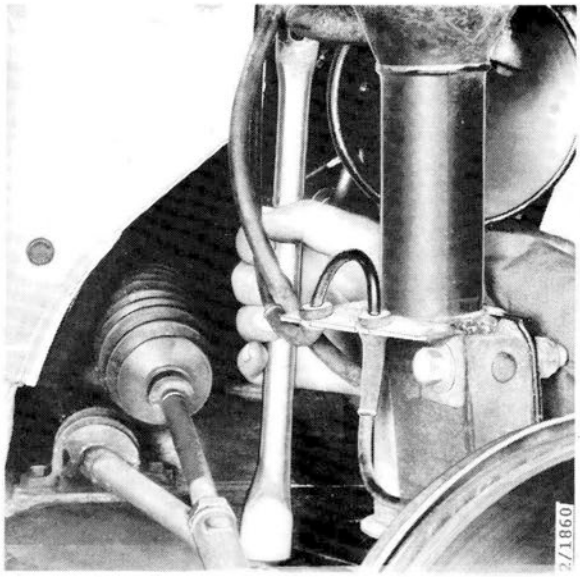


9 Align the engine over its mountings and lower it into position.

Remove the lifting beam.



10 Fit the tie rod between the wheel arch and subframe.

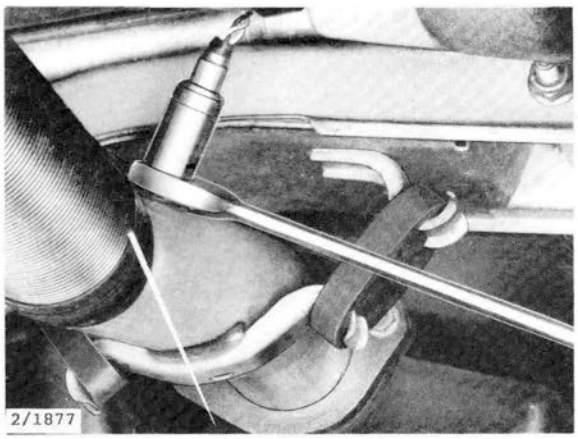


11 Remove the rag from the dipstick tube and put back the dipstick.

Raise the car.

12 Fit the bolts in the front and rear engine mountings.

13 Fit the front section of the exhaust pipe and the Lambda sensor.



14 Fit the wing liner.

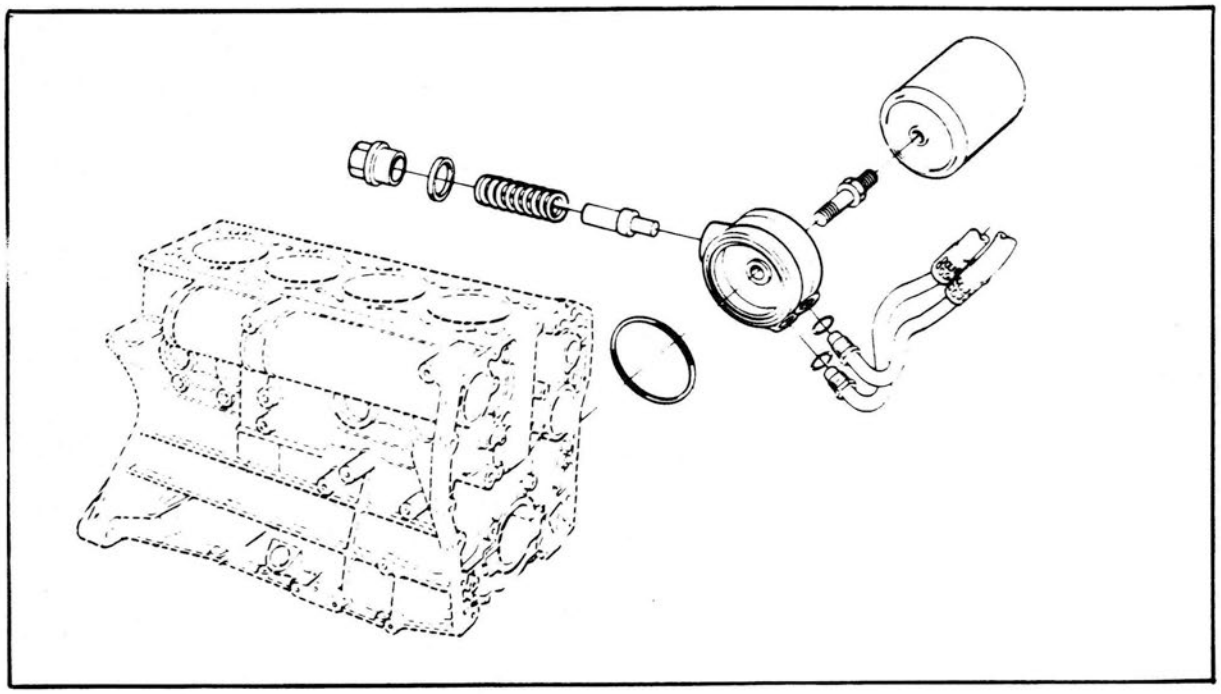
15 Fit the wheel, tightening the bolts to the specified torque.

Tightening torque: 130 Nm (96 lbf ft)

16 Lower the car and fill up the engine oil.

Run the engine up to normal temperature and check for leaks.

Oil filter adaptor

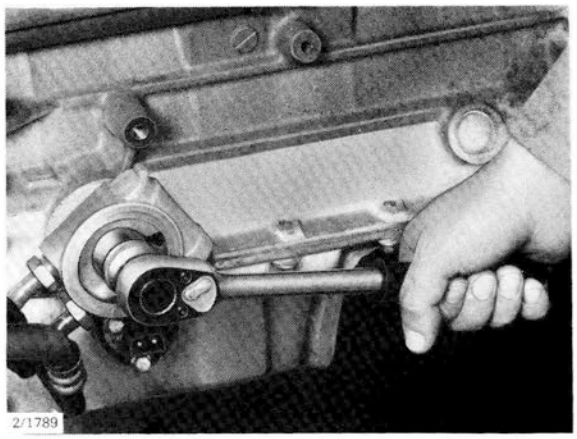


To remove

1 Raise the car, drain the engine oil and remove the oil filter.

2 Disconnect the hoses from the adaptor.

3 Remove the adaptor, taking care not to lose the sealing ring.



To fit

1 Fit the seal in the groove in the adaptor.

2 Lubricate the seal and fit the adaptor.

3 Fit the oil hoses.

4 Fit the oil filter and lower the car.

5 Fill up the engine oil.

Run the engine up to normal temperature and check for leaks.

Induction system

Intake-air silencer

Object code: 23230

To remove

1 Undo the hose clip at the air mass meter.
2 Undo the bracket securing screw.
3 Undo the hose clip at the air cleaner.
4 Lift off the silencer.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To fit

Fit in the reverse order.

Fuel pump and fuel tank

Fuel tank

The procedure for removing and reinstalling the fuel tank is essentially the same as that detailed in the Workshop Manual for the 9000, Section 2:3, subsection 234.

Fuel pump

Object code: 24110

To remove

Warning

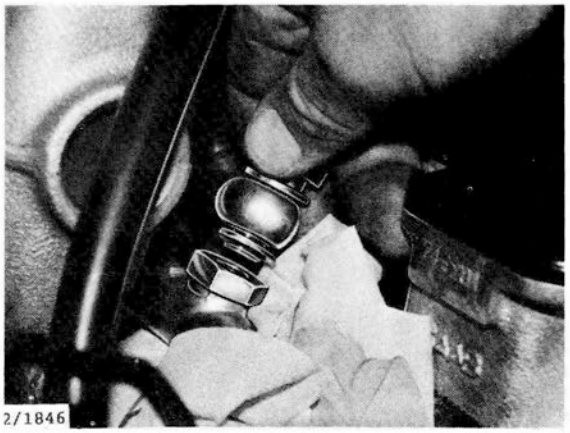
No smoking anywhere in vicinity.

Take care not to cause sparks, e.g. from short-circuiting, circuit-breaking, etc.
Have a suitable fire extinguisher on hand.
Work only in a well-ventilated area.
If approved extraction equipment for fuel vapour is available, use it.
Wear suitable gloves, as prolonged contact with fuel can cause dermatitis.

1 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

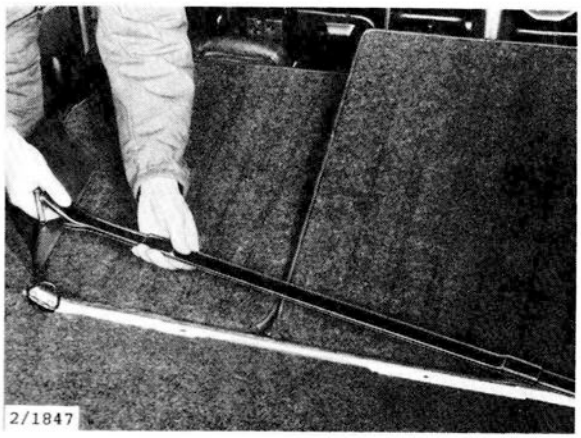
2 Undo the fitting on the fuel-injection rail to release the pressure in the system. Soak up any escaping fuel with absorbent paper or a rag.

Tighten the fitting.



3 **Hatchbacks only:** lift out the parcel shelf and fold down the backrest.

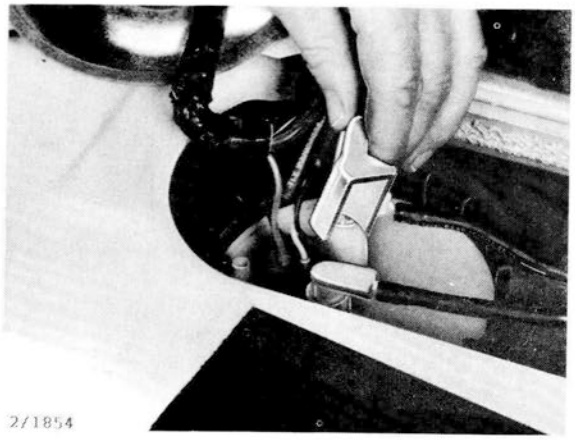
4 Remove the metal finisher.
CD cars: use a hexagon bit adaptor and a small adjustable spanner.


2/1847

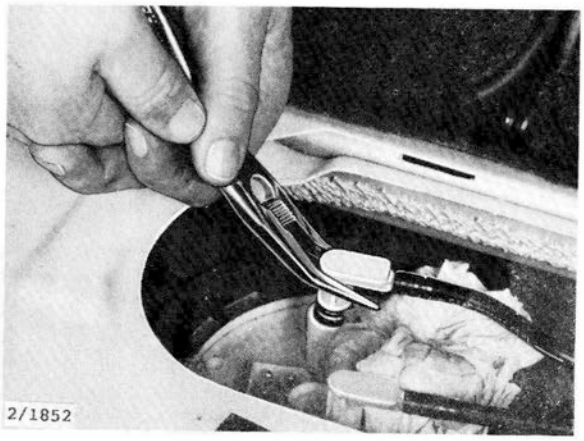
5 Fold back the rear section of the luggage compartment floor. Undo the two screws and remove the floor panel.

6 Undo and move aside the pump cover.

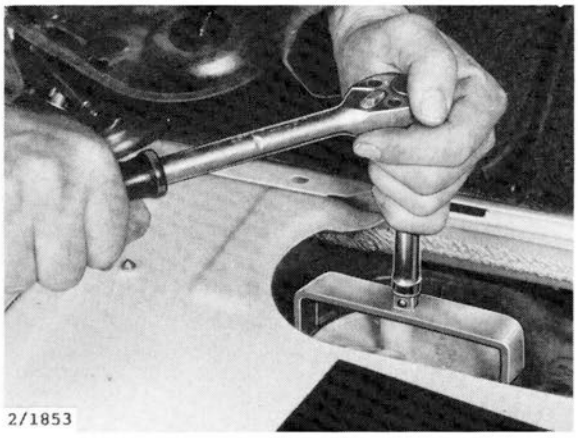
7 Release the clip and unplug the connector.


2/1854

8 Disconnect the fuel lines from the pump. Push them aside and wedge them under the edge of the panel.

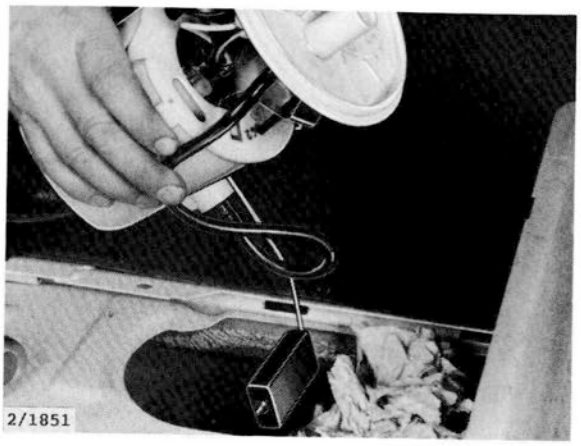

2/1852

9 Undo the screw top using special 83 94 462.


2/1853

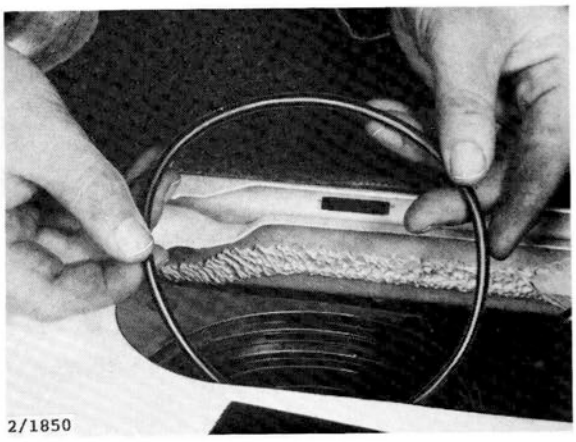
10 Lift the pump carefully, tilting the top to the right. Have some absorbent paper or rags handy to soak up any spilt fuel.

11 Transfer the pump to a suitable receptacle and tip out the fuel.


2/1851

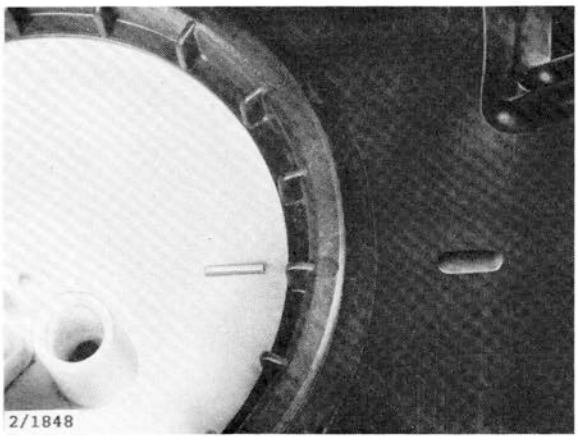
To fit

1 Always fit a new 'O' ring in the groove in the tank fitting.


2/1850

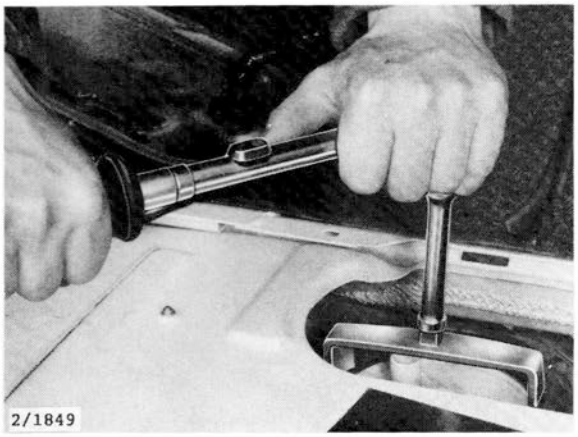
Caution
For the fuel-gauge sender unit to operate properly, the pump assembly must be correctly orientated.

2 Place the pump inside the tank with the marks in line.


2/1848

3 Fit and tighten the screw top using tool 83 94 462 and a torque wrench.

Tightening torque: 55 Nm (40 lbf ft)

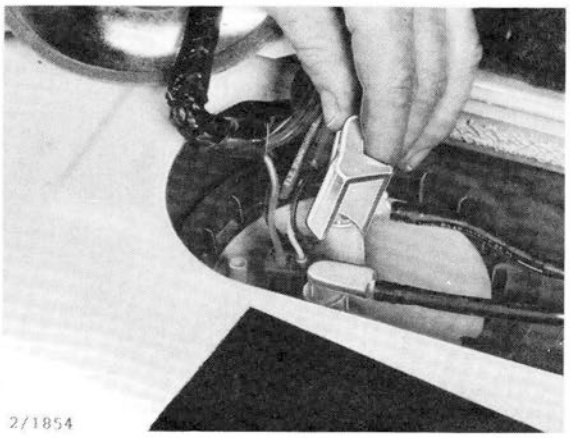

2/1849

Check that the aligning marks are still in line.

Tolerance: 5°.

4 Always fit new 'O' rings inside the fuel line fittings and then connect the fittings to the pump.

5 Plug on the connector and secure the clip.


2/1854

6 Reconnect the battery.

Check that the pump is working properly and that there are no leaks.

7 Refit the cover and floor panel.

8 Refit the metal finisher. **Hatchbacks only:** Fold the backrest back into position.

The procedures for dismantling the pump, and replacing the ejector pump and hoses are the same as before. See Section 2:3 of the 9000 Workshop Service Manual (LH fuel-injection system), subsection 234.

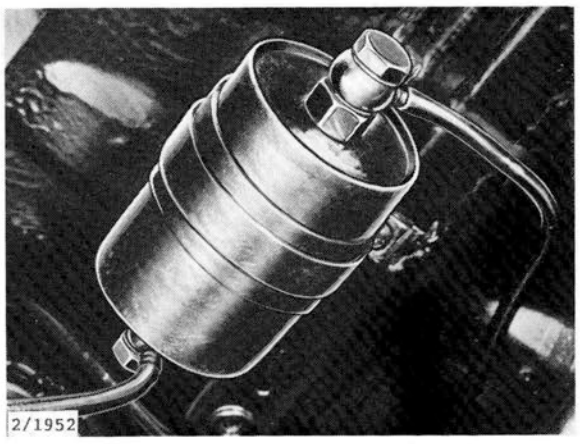
Fuel filter

Object code: 24151

To remove

1 Raise the car and wash the surfaces surrounding the filter connections. Place a suitable receptacle underneath to collect escaping fuel.

2 Slacken the two banjo fittings (using a spanner across the flats to stop the other half turning).

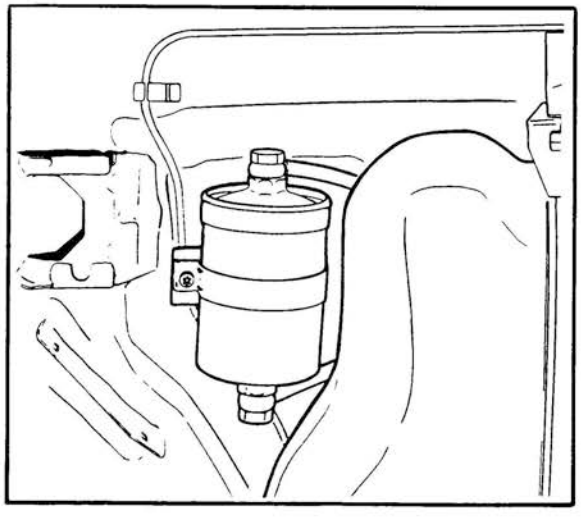


3 Release the strap and disconnect the banjo fittings.

To fit

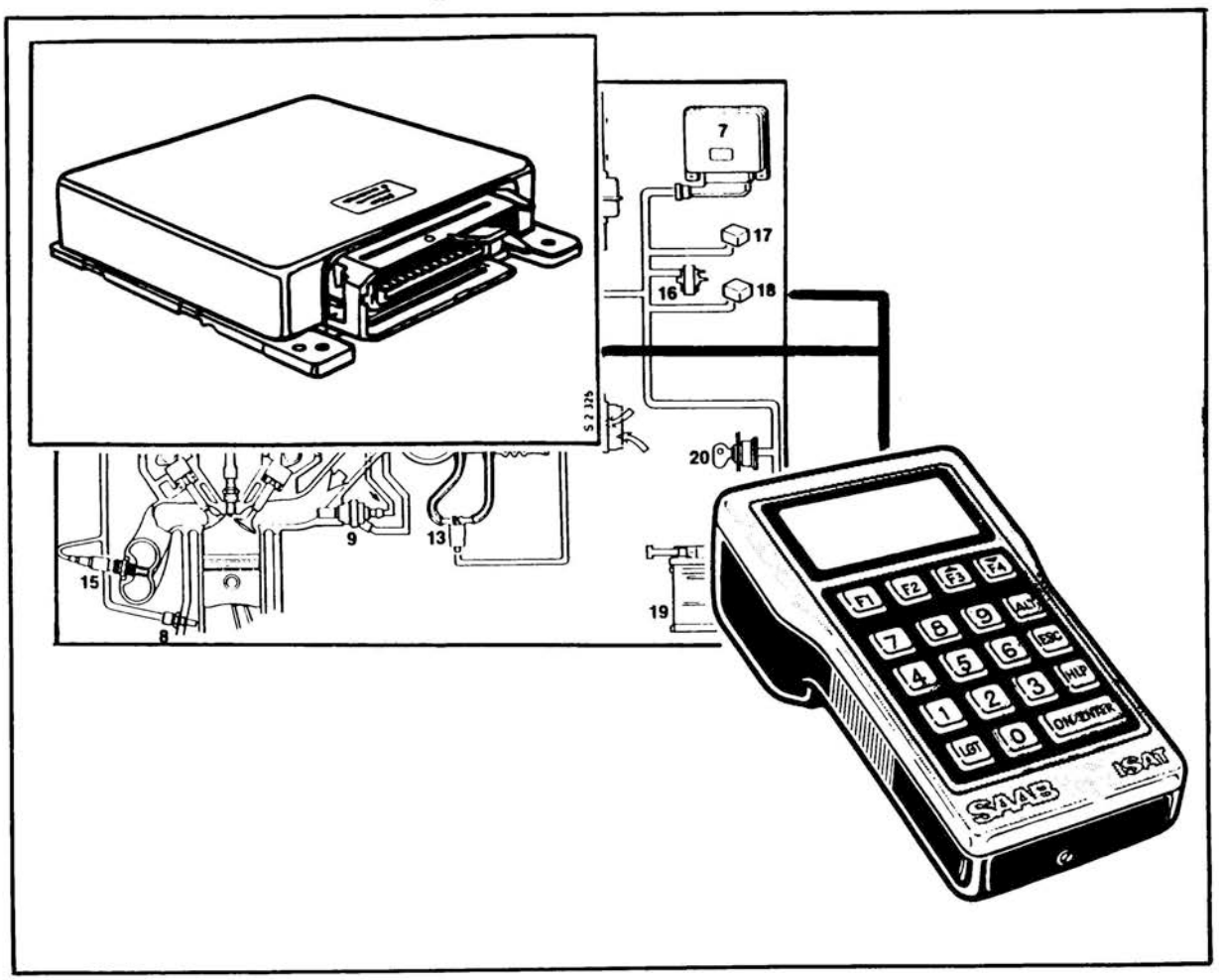
1 Hang the fuel filter loosely in the banjo fittings, making sure that the arrow is pointing in the direction of flow.

2 Fit the strap and tighten the fittings, using a second spanner across the flats to stop the fitting turning.



3 Start the engine and check for leaks.

LH 2.4.1 fuel-injection system, diagnostics



Description

In common with M90 B202 engines with LH 2.4, the B234 engine has enhanced diagnostics. There are now new self-diagnostics blink codes (not previously available for LH 2.4) and it is also possible to use ISAT for fault diagnosis on the system.

The ISAT fault-diagnosis program does not have more fault (error) codes than those included in the self-diagnosis function, although development of the tester will have been completed for M91.

Using ISAT, a number of input command codes can be generated for checking the function and status of different components.

The LH-system tester can also still be used for fault diagnosis.

Self-diagnosis blink codes

(The codes shown here are in addition to those used in LH 2.4.)

Error code	CHECK ENGINE	Malfunction indicated	Action
12243	Off	No signal from road	a) With ECU connector speed sensor plugged in: check the voltage across ECU pin 34 and earth. With one of the front road wheels spinning, the reading should oscillate between 1 and 11 V. If not: Check the green lead between pin 132 on the speed sensor and ECU pin 34. Also check the black lead between the sensor and earthing point 3, and the green/white lead to pin 15 on the ignition switch (20). b) Try a known good road speed sensor. c) Try a known good LH-system ECU.
12245	On	EGR function faulty	a) With ignition in the Drive position (engine off), enter code 555 on ISAT. Check that the modulating valve is operating. If not: Check the yellow/white lead between ECU pin 19 and connector 394, and the white lead between the connector and the modulating valve (390). Also check the green/white lead between the modulating valve and the pin for the green/red lead in the connector to the injectors. b) Try a known good modulating valve. c) Check the yellow/white lead between the thermostatic switch (389) and ECU pin 23, and the black lead between the thermostatic switch and earthing point 201. d) Try a known good thermostatic switch. e) Try a known good LH-system ECU.

Before starting diagnosis work

Caution
Never unplug the connector from the ECU nor disconnect either of the battery leads before the faults stored in the ECU memory have been transferred to ISAT.

Successful fault diagnosis on the LH system requires not only in-depth knowledge of the system on the part of the technician but also access to either the LH-system tester or the ISAT tester.

ISAT makes a valuable contribution to efficient and reliable fault diagnosis

Thanks to the self-diagnostics incorporated in the LH system, which continuously monitors and records the majority of conceivable faults, both permanent and intermittent, using ISAT it is easy to pinpoint a fault, rectify it and then check that the system is functioning properly again.

This integrated self-diagnostics function in the system combined with the capabilities of the ISAT tester make not only for quicker fault-diagnosis work but, above all, much more reliable diagnosis. It is therefore far less likely that a sound component will be replaced, having mistakenly been judged to be faulty, and service costs should benefit considerably as a result.

Is the fault in the LH system?

Many so-called fuel-injection faults can often be traced to other unrelated engine or electrical faults. Before starting any fault-diagnosis work on the LH system, therefore, always check the following first:

- Battery condition
- Engine condition (compression, inlet manifold pressure, etc.)
- Charging system
- Other auxiliary systems
- Electrical connections
- Earthing points

Using ISAT for fault diagnosis

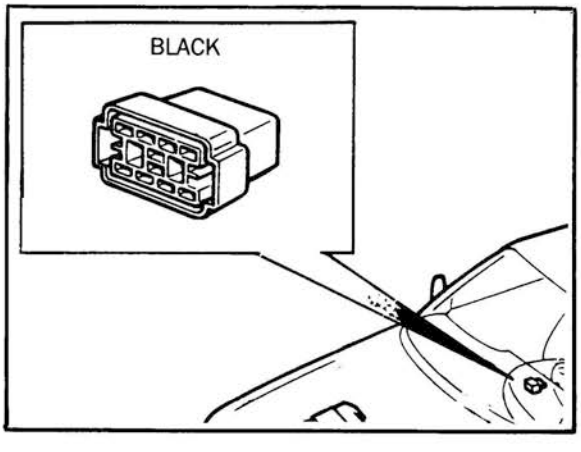
Instructions on the use of ISAT are contained in the special ISAT supplement, Section 1:4 of the Workshop Service Manual.

Fault diagnosis

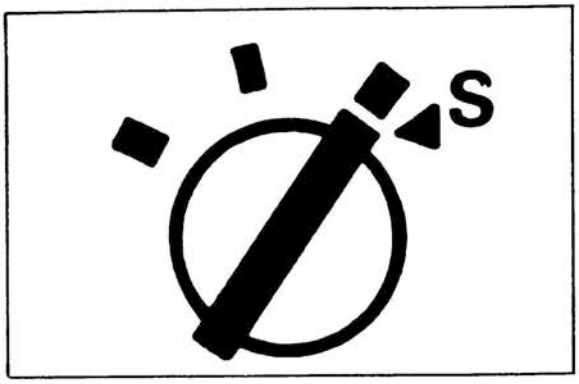
Note the following:

- Never unplug the connector from the ECU nor disconnect either of the battery leads before the faults stored in the ECU memory have been transferred to ISAT.

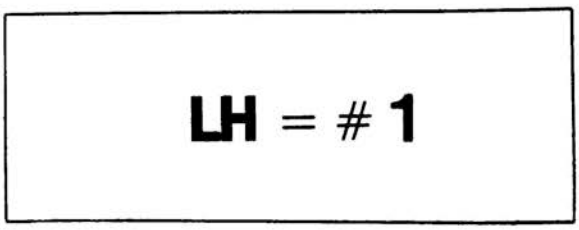
- The diagnostics socket for the engine electronics is a black 10-pin socket, located in the front, underneath the RH seat, and protected by a plastic cover held in place by a quick-release screw.



- Turn the ignition key to the Drive position.



- The identification number for the LH system in ISAT is system no. 1.



- If communication cannot be established between ISAT and the LH-system ECU, check first the leads between ECU pins 12 and 16 and the diagnostics socket (347). Also check the live feed to the diagnostics socket, that the socket has a good earth and that the connector pins are not damaged.

- Once the fault data stored in the LH-system ECU have been transferred to ISAT, the diagnosis work, as such, is finished. The detected faults are now available in the form of 5-digit codes; look up the relevant code in the fault-diagnosis chart (page 240-11) for details of the procedure to be followed.

Connecting test probes to the ECU connector

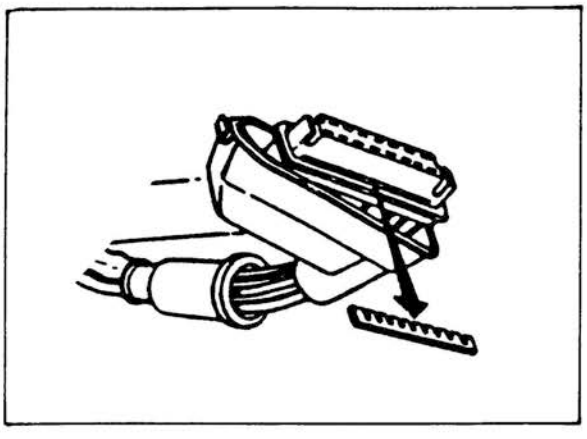
Before starting any fault-diagnosis work on the LH system, you must first gain access to the ECU connector block. Test probes and the like must be connected to the back of the wiring-loom half of the connector.

1 Remove the ECU, located in the space behind the false bulkhead panel.

2 Unplug the connector.

3 Undo the cover and peel back the rubber gaiter.

4 Pull out the rubber seal and lift out the connector block.



5 Plug in the connector.

Checking the wiring

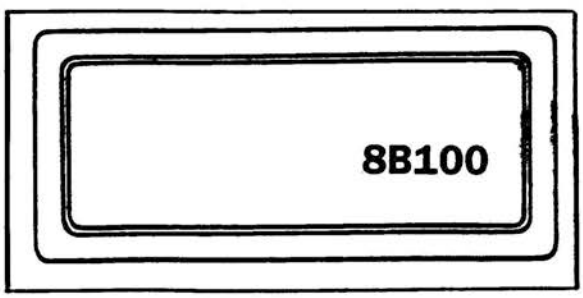
The words, "Check the wiring between xx and yy", are used frequently in the fault-diagnosis charts. Sometimes the wiring may be run through different types of connector and, by implication, these must also be checked for circuit continuity and short circuiting.

Also make a visual check to ensure that there is no damage to wiring or connectors.

Be alert to the possibility of crosstalk or interference from other components.

How ISAT displays the results

When ISAT is used to simulate signals or functions by means of special commands to the ECU, the results appear on the display in the form of a 5-character alphanumeric code.



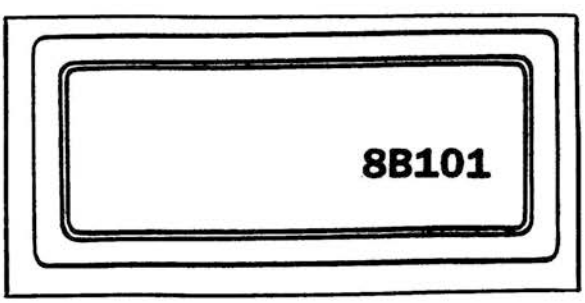
The result for a code entered is displayed in the form of a 5-character alphanumeric code.

Example 1:

To check the position of the throttle butterfly, we enter code 201 via the ISAT keypad.

With the engine idling, the code appearing on the display should be 8B101.

Further details are given under the heading, "ISAT input command codes (LH 2.4, M90)", on page 46.



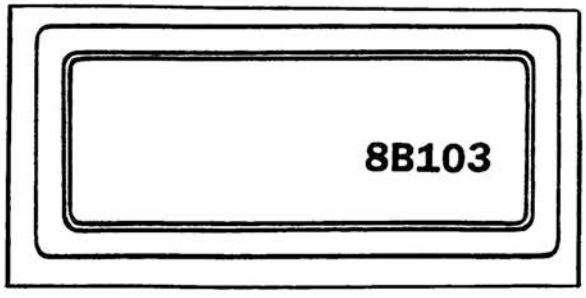
Example 2:

Sometimes we may want to determine whether a signal is high or low. To check the DRIVE signal, enter code 203 via the ISAT keypad.

If the signal has not been activated, 8B000 will appear on the display, indicating that the signal is low.

If the signal has been activated, the voltage should be high and 8B103 should appear on the display.

Further details are given under the heading, "ISAT input command codes (LH 2.4, M90)", on page 240-10.



ISAT error codes

Permanent fault	Intermittent fault	Faulty component/signal
67192	-	ROM (microprocessor chip)
45771	25771	Throttle-position sensor idling contacts not breaking circuit on increase in engine idling speed and load (constantly earthed).
45772	25772	Throttle-position sensor full-load contacts constantly closed.
46261	26261	Temperature sensor signal showing constant value.
46271	26271	Temperature sensor indicating temperature above 160°C (constantly earthed).
46221	26221	Temperature sensor indicating temperature below -90°C (break in circuit).
42291	22291	Voltage at ECU pin 4 not within 10 - 16 V range.
42251	22251	Voltage at ECU pin 4 too low (<1 V).
58121	38121	Air mass meter: no filament burn-off function .
45691	25691	Air mass meter signal faulty (too high or too low).
42491	22491	Prolonged fault in fuel-air mixture (additive idling fault).
42492	22492	Prolonged fault in fuel-air mixture (multiplicative fault in conjunction with driving).
42450	22450	Mixture too lean.
42440	22440	Mixture too rich.
42460	22460	Faulty signal from Lambda sensor.
58321	38321	AIC valve faulty.
44261	24261	Road speed sensor signal faulty.
45723	25723	DRIVE signal faulty.
46391	26391	EGR system malfunction (temperature too high or too low).
58371	38371	Injectors: injection pulses faulty.

ISAT Input command codes

Code	Function	Display
550	Activates AC function (0.2 Hz)	8A550
200	Checks status of AC	8B100 (= activated) 8B000 (= not activated)
201	Checks position of throttle butterfly	8B101 (= idling position) 8B001 (= normal position) 8B301 (= full-load position) 8B103 (= idling + full load)
552	Activates injectors (15 Hz or 1.5 ms opening duration). Fuel pump isolated.	8A552
553	Activates AIC valve (1 Hz)	8A553
554	Activates ELCD valve (1 Hz)	8A554
202	Checks status of ELCD valve	8B002 (= open) 8B102 (= closed)
555	Activates EGR valve (1 Hz) (US-West only)	8A555
203	Checks status of DRIVE signal	8B103 (= activated) 8B000 (= not activated)
205	Checks status of Lambda sensor	8B105 (= lean) 8B305 (= rich) 8B005 (= inoperative)
900	Deletes all error codes and resets all adaptive values to basic settings	11111
930	Resets all adapted values to basic settings	11011
100	Transfers all error codes from the LH-system ECU to ISAT	
207	Ignition pulses	8B107 (= pulses present) 8B007 (= no pulses)
382	ECU identification code (last four digits of Bosch part no.)	(To be entered only when requested by Saab-Scania AB)

ISAT fault-diagnosis chart

Permanent fault	Intermittent fault	Malfunction indicated	Action
67192		ROM fault (ECU faulty)	Try a known good ECU.
45771	25771	Throttle-position sensor (203): idling contacts constantly open	a) Enter code 201 on ISAT. Depress the accelerator slowly to the full-throttle position. The following should now appear on the display: 8B101 ... 8B001 ... 8B301. If 8B001 is displayed continuously, a break in the wiring to the throttle-position sensor is indicated. Go on to steps c) and d). If 8B103 is displayed, the codes are shown in a different position or do not change: Unplug the connector from the throttle-position sensor. 8B001 should now show on the display. If not, go to step c), d) or e) as appropriate. b) If 8B001 is displayed, try a known good throttle-position sensor. c) If 8B101 is shown, check the wiring between pin 2 of the ECU (200) and pin 1 of the throttle-position sensor (203), and the wiring between ECU pin 2 and pin 7 of the EZK-system ECU (176). d) If 8B301 is shown, check the wiring between pin 3 of the ECU (200) and pin 3 of the throttle-position sensor (203) and also terminal TK on the AC relay (156). Also check that terminal TK is not earthed. e) If 8B103 is displayed, check the wiring as detailed in steps c) and d). f) Try a known good LH-system ECU
45772	25772	Throttle-position sensor (203) full-load contacts constantly closed	Same procedure as for 45771/25771 above.
46261	26261	Constant signal from	a) Check the wiring between pin 13 of the ECU (200) temperature sensor (202)and pin 1 on the temperature sensor (202). b) Check the wiring between pin 2 of the temperature sensor and earthing point 201. c) Check that a good earth is obtained at the earthing point. d) Check the temperature sensor. e) Try a known good LH-system ECU.

Permanent fault	Intermittent fault	Malfunction indicated	Action
46271	26271	Temperature sensor (202) indicating temp. above 160°C	Check the resistance of the NTC resistor, and between pin 13 on the ECU and earth. Should be 2280 - 2720 ohm at 20°C or 290 - 356 ohm at 80°C, measured with ECU connector unplugged.
46221	26221	Temperature sensor (202) indicating temp below -90°C	Same procedure as for 46271/26271 above.
42291	22291	Voltage at ECU pin 4 not within 10 - 16 V range	Check the condition of the battery, charging system, earthing points, etc.
42251	22251	Voltage too low at ECU pin 4 (<1 V)	Same procedure as for 42291/22291 above.
58121	38121	No filament burn-off function at air mass meter (205)	a) Check the wiring between pin 8 on the ECU (200) and pin 4 on the air mass meter (205) b) Check the wiring between pin 5 on the air mass meter and pin 87B on the system relay (229) c) Try a known good air mass meter d) Try a known good LH-system ECU
45691	25691	Faulty signal from air mass meter	a) Check for leaks in induction system between induction system between air mass meter and inlet manifold. b) Check air mass meter pin 1 for good earth and pin 5 for live feed. c) Try a known good air mass meter. d) Try a known good LH-system ECU.

Permanent fault	Intermittent fault	Malfunction indicated	Action
42491	22491	Prolonged fault in fuel-air mixture on idling (= additive adaptive error in Lambda system)	a) Check for leaks in induction and fuel systems and the Lambda-sensor preheater function. b) Check the operation of the induction system. c) Try a known good LH-system ECU.
42492	22492	Prolonged fault in fuel-air mixture when driving (= multiplicative adaptive error in Lambda system)	Same procedure as for 42491/22491 above.
42440	22440	Rich mixture	a) Check for loose screws or hose clips and for leaks in hoses or around 'O' rings. b) Check for leaks in the induction system and that it is operating properly. c) Check that voltage is present across the pins on the Lambda-sensor connector. d) Check the fuse for the Lambda-sensor pre-heating. e) Check that the Lambda sensor signal fluctuates between 0 and 1.5 V (sensor warm). f) Replace the Lambda sensor. g) Try a known good LH-system ECU. Test: enter code 205 on ISAT. During the warm-up phase, 8B105 (lean) and 8B305 (rich) should alternate on the display (changing about every 20 seconds).
42450	22450	Lean mixture	Same procedure as for 42440/22440 above.

Permanent fault	Intermittent fault	Malfunction indicated	Action
45723	25723	Faulty DRIVE signal	a) Check fuse 9. b) Check that battery voltage is present in pin 3 of the shift-up switch (239) with the ignition switch in the Drive position. If not: check the wiring between the +54 supply terminal (231) and pin 3 on the shift-up switch. c) Check that the shift-up switch is working. d) Check the wiring between pin 4 on the shift-up switch and pin 30 on the ECU (200) Test: enter code 203 on ISAT. Move the selector lever slowly from P to D. 8B003 shown on the display (P & N positions) should now change to 8B103 (DRIVE position).
46391	26391	EGR function faulty (US-West)	a) With ignition in the Drive position (engine off), enter code 555 on ISAT. Check that the modulating valve is operating. If not: Check the yellow/white lead between ECU pin 19 and connector 394, and the white lead between the connector and the modulating valve (390). Also check the green/white lead between the modulating valve and the pin for the green/red lead in the connector to the injectors. b) Try a known good modulating valve. c) Check the yellow/white lead between the thermostatic switch (389) and ECU pin 23, and the black lead between the thermostatic switch and earthing point 201. d) Try a known good thermostatic switch. e) Try a known good LH-system ECU.
42460	22460	Faulty signal from Lambda sensor (136)	a) Check that the preheaterfunction for the Lambda sensor is working (check for voltage across pins 1 and 2 of connector 59). b) Check the wiring between pin 24 on the ECU (200) and connector 60. c) Check the wiring between pin 5 on the ECU and the screening around the Lambda-sensor lead. d) Run the engine up to normal temperature. Disconnect the lead from the Lambda sensor at connector 60 and measure the signal voltage. This should be 0.5 V (approx.). e) Try a known good Lambda sensor. f) Try a known good LH-system ECU. Test: enter code 205 on ISAT. Run the engine up to normal temperature and check that the display alternates between 8B105 (lean) and 8B305 (rich) within 20 seconds. If 8B005 is displayed, the Lambda sensor is not actuated.

Permanent fault	Intermittent fault	Malfunction indicated	Action
58321	38321	No signal from pin 33 of the AIC valve	a) With the ignition in the Drive position (engine off), enter code 553 on ISAT. The valve should now pulse about once every second. b) Check that battery voltage is available from the +30 supply terminal (230). c) Check the wiring between the +30 supply terminal and pin 30 on the system relay (229). d) Check the wiring between pin 87 on the system relay and pin 1 on the AIC valve (272). e) Check that battery voltage is present across pin 1 on the AIC valve (272) and earth. f) Check the wiring between pin 33 of the ECU and pin 2 of the AIC valve. g) Check the setting and operation of the throttle-position sensor (203). h) Check that the throttle-butterfly is correctly adjusted (as near to closed as possible without binding). i) Try a known good system relay. j) Try a known good AIC valve. k) Fit a knew LH-system ECU.
58371	38371	Faulty injection pulses to injectors (206)	a) With the ignition in the Drive position (engine off), enter code 552 on ISAT. The injectors should now pulsate about 15 times a second. b) Check that battery voltageis present at pin 30 of the system relay (229). c) Check the wiring between pin 87 of the system relay and pin 1 on the injectors (206). d) Check the wiring between pin 18 of the ECU (200) and pin 2 on the injectors. e) Try a known good system relay. f) Try a known good LH-system ECU.

Permanent fault	Intermittent fault	Malfunction indicated	Action
44261	24261	No signal from road speed sensor (US-West)	a) With ECU connector plug on: Check the voltage across ECU pin 34 and earth. When either of the front road wheels is spinning, the value should oscillate between 1 and 11 V. If not: Check the green lead between the speed sensor (123) and ECU pin 34. Check the black lead from the sensor to earthing point 3, and the green/white lead to terminal 15 on the ignition switch (20). b) Try a known good speed sensor. c) Try a known good LH-system ECU.

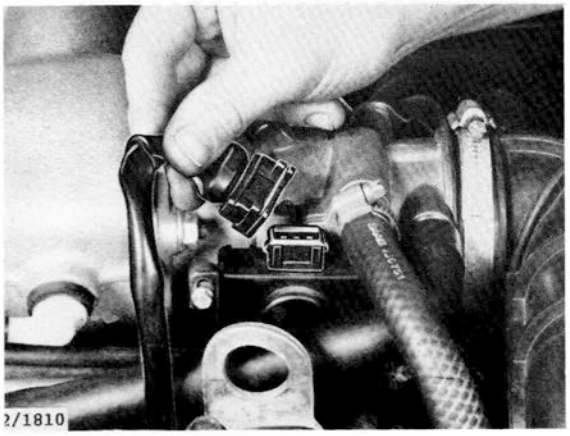
Component replacement

Throttle-position sensor

Object code: 24830

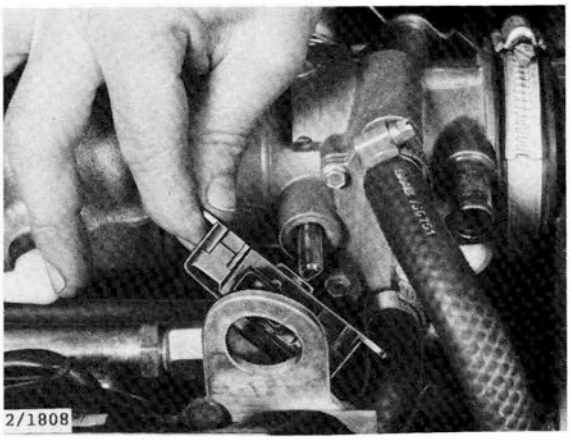
To remove

1 Unplug the electrical connector.



2 Disconnect the large-bore crankcase breather hose from the throttle housing.

3 Undo the screws and remove the throttle-position sensor.



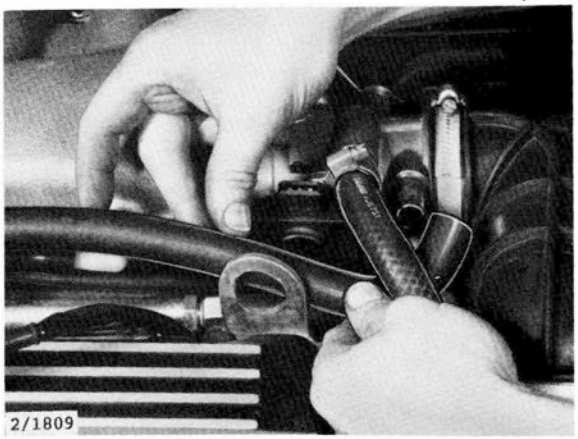
To fit

1 Check the condition of the 'O' ring for the throttle spindle (on the throttle-position sensor).

2 Fit the throttle-position sensor onto the throttle spindle.

3 Fit the screws loosely, adjust the position of the throttle-position sensor and tighten the screws.

4 Reconnect the crankcase breather hose and plug on the electrical connector.



Fuel-pressure regulator

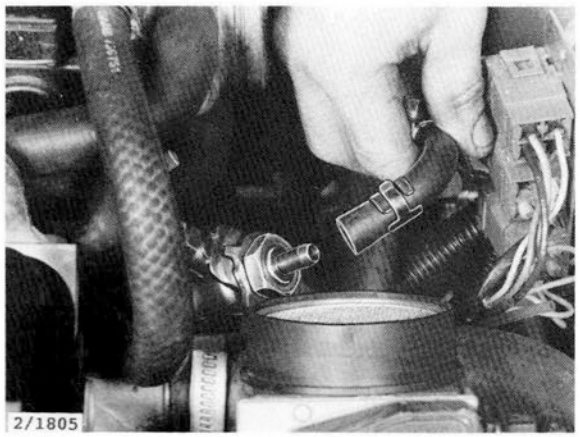
Object code: 24120

To remove

1 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

2 Disconnect the rubber elbow from the throttle housing.

3 Clean the surrounding surfaces and disconnect the fuel return hose.



4 Disconnect the vacuum hose.

5 Disconnect the hose between the fuel-pressure regulator and the fuel-injection rail and remove the nut.

6 Remove the fuel-pressure regulator.

To fit

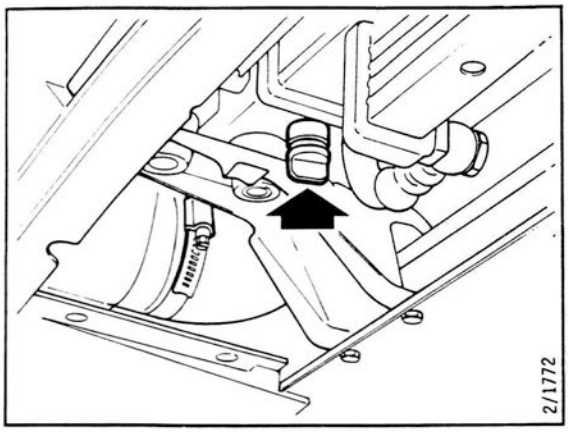
Fit in the reverse order.

Inlet manifold, throttle housing and fuel-injection rail

Object code: 25111 (24610, 24131)

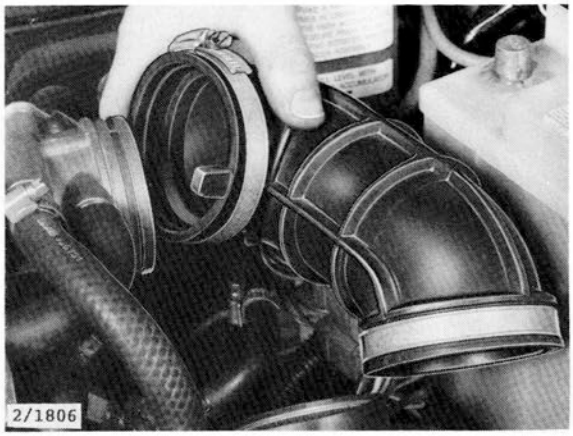
To remove

1 Drain the coolant.

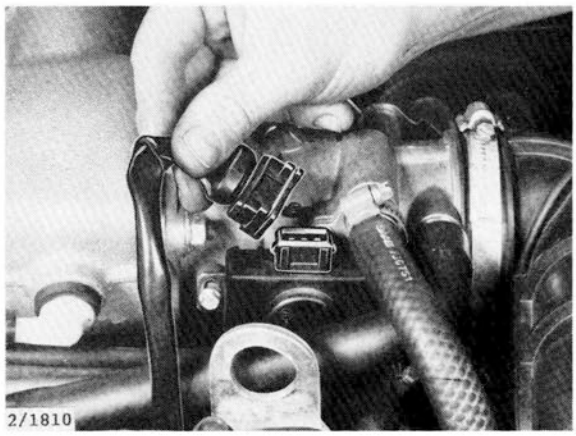


2 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

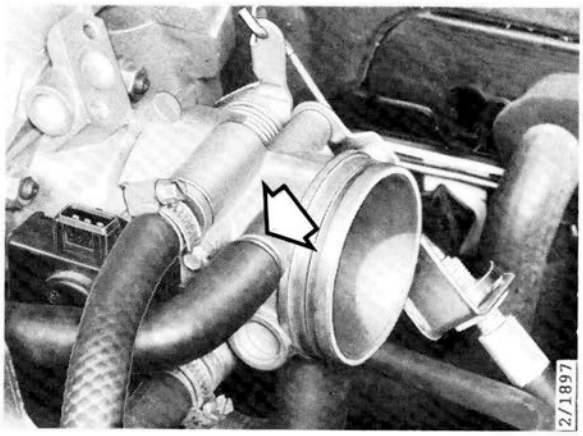
3 Disconnect the rubber elbow from between the throttle housing and air mass meter.



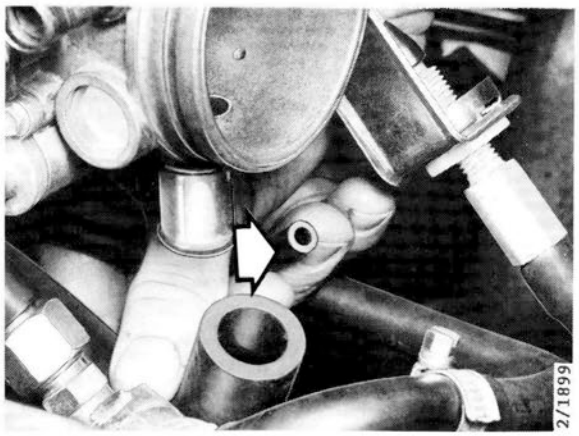
4 Unplug the electrical connector from the throttle-position sensor.



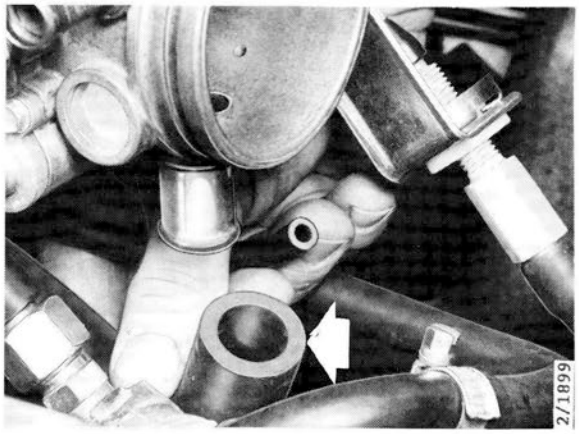
5 Disconnect the crankcase breather hose from the throttle housing.



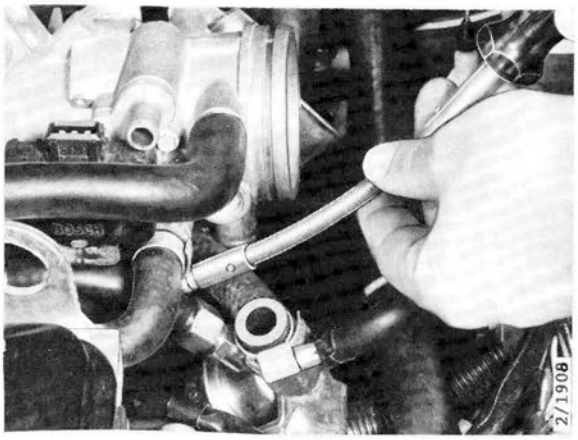
6 Disconnect the cruise control vacuum hose from the throttle housing.



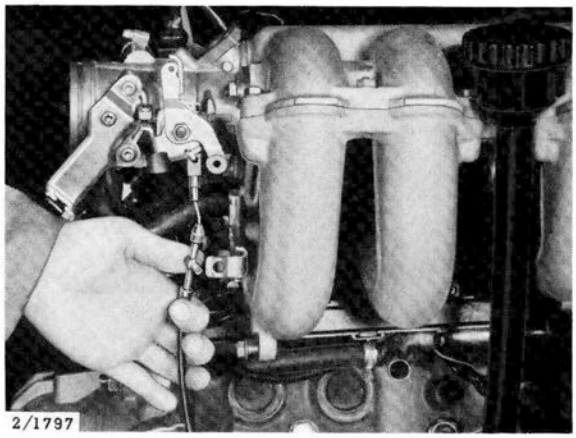
7 Disconnect the AIC-valve hose from the throttle housing.



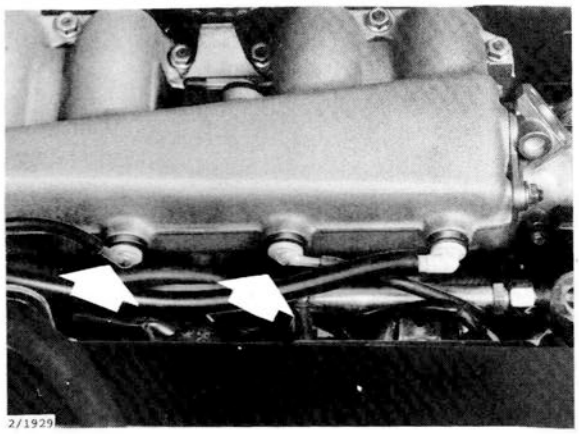
8 Disconnect the throttle-housing preheater hoses.



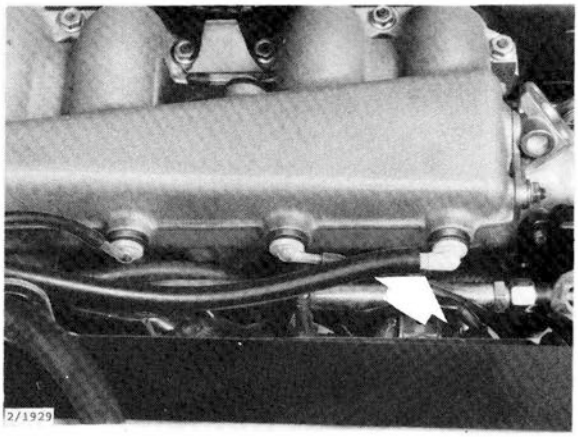
9 Disconnect the throttle cable from the throttle linkage (Automatics: and the kickdown cable).



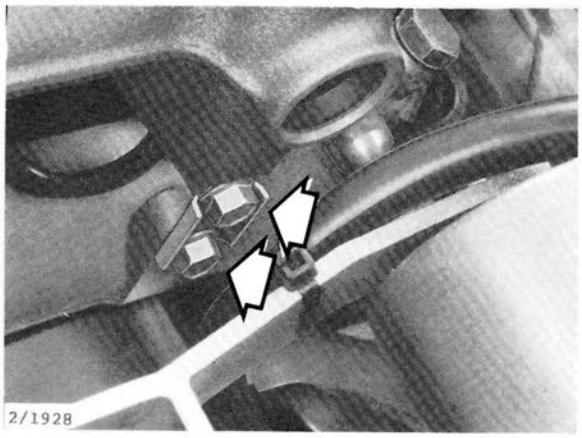
10 Disconnect the fuel-pressure regulator vacuum hose and the small-bore crankcase breather hose from the inlet manifold.



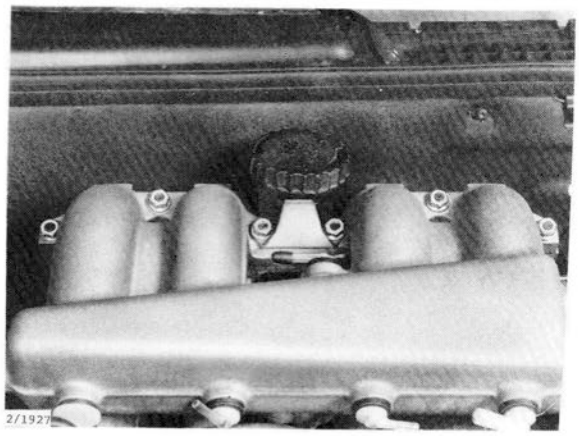
11 Disconnect the vacuum hose for the charcoal canister from the inlet manifold.



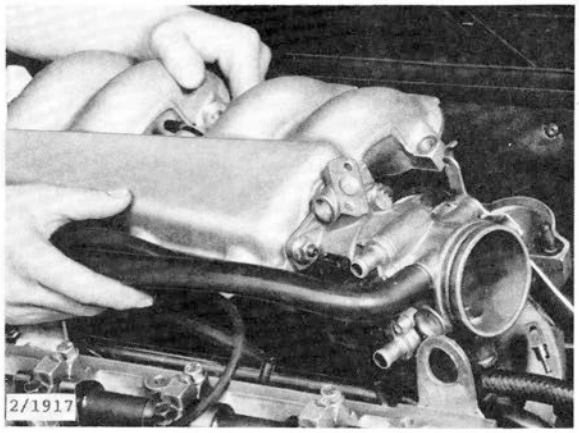
12 Remove the two bolts in the sides of the top of the inlet manifold (slacken off the lower ones).



13 Remove the bracket for the dipstick tube and the remaining bolts in the top of the inlet manifold.

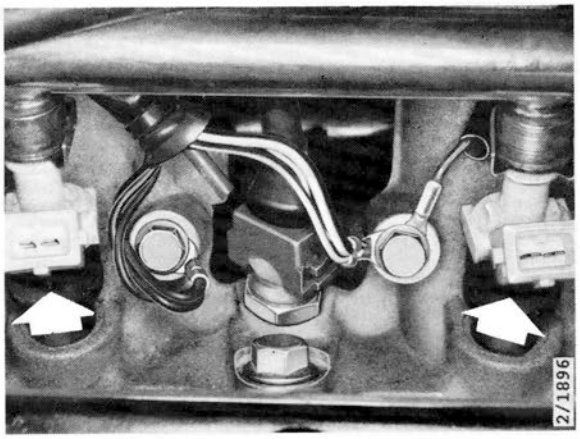


14 Unplug the connector from the AIC valve and lift off the top of the inlet manifold.

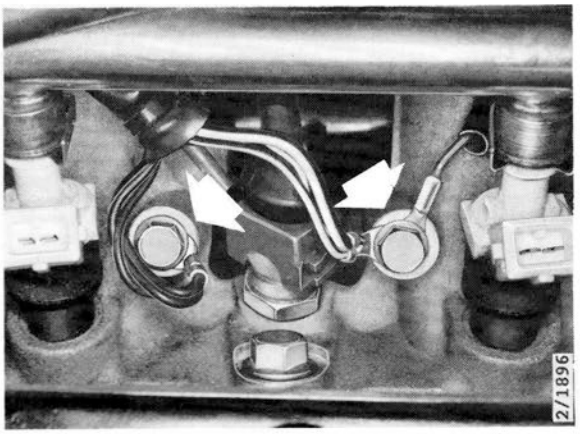


15 Disconnect the electrical leads from the following:

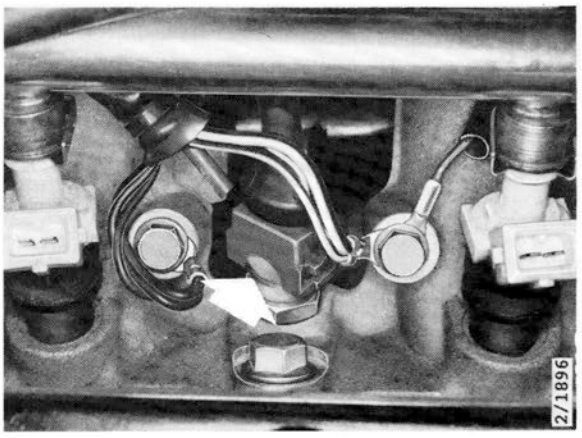
- Injectors (leads are labelled with cylinder number)



- The two earthing points on the inlet manifold (note their positions)



- The temperature sensor



16 Release the wiring loom from the clips under the inlet manifold.

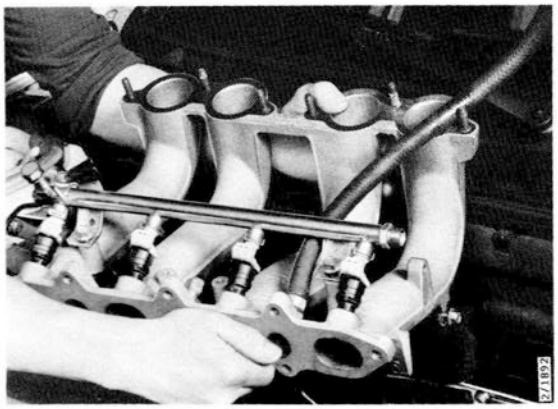
17 Remove the throttle-cable bracket from the inlet manifold.

18 Clean the surrounding surfaces and disconnect the fuel hoses from the fuel-injection rail.

19 Undo the bolts securing the steady bars to the inlet manifold.

20 Remove the remaining bolts in the lower half of the inlet manifold securing it to the cylinder head.

21 Lift off the lower section of the inlet manifold complete with fuel-injection rail.



To fit

Fit new gaskets between the lower section of the inlet manifold and the cylinder head, and between the two sections of the manifold.

Refit in the reverse order.

Throttle housing

Object code: 24610

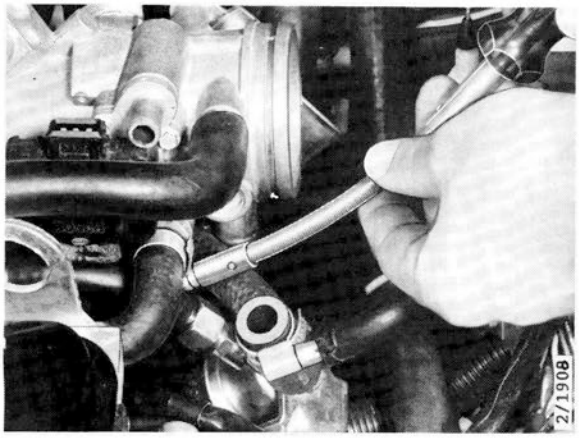
To remove

1 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

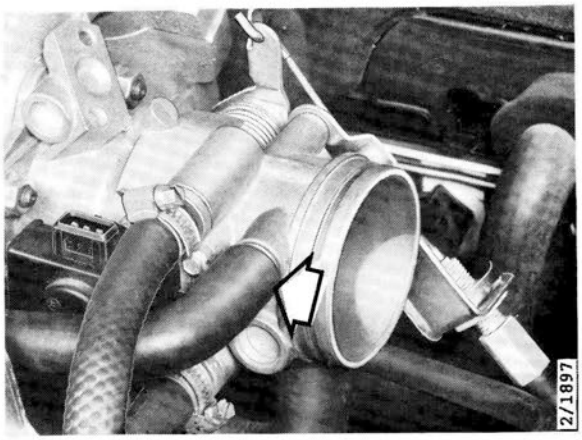
2 Disconnect the rubber elbow from between the throttle housing and the air mass meter.

3 Unplug the connector from the throttle-position sensor.

4 Disconnect the throttle-housing preheater hoses.

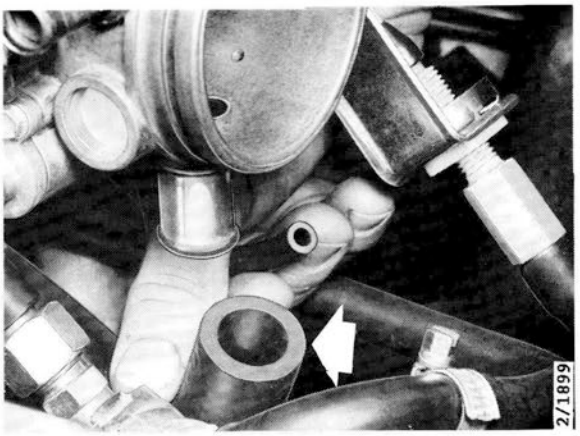


5 Disconnect the crankcase breather hose.

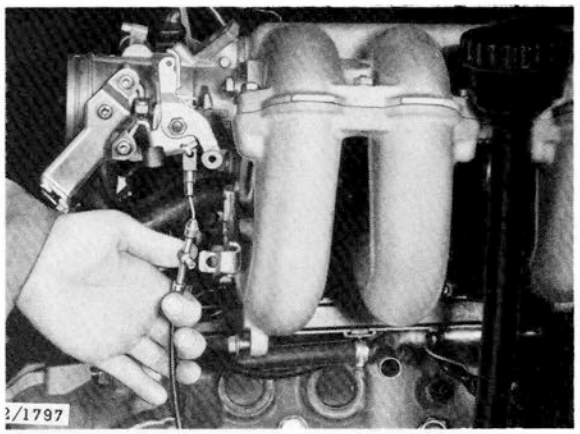


6 Disconnect the cruise control vacuum hose.

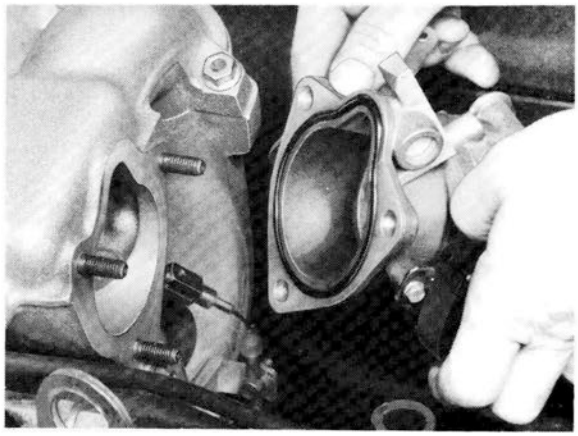
7 Disconnect the AIC-valve hose from the throttle housing.



8 Disconnect the throttle cable from the linkage on the throttle housing (Automatics: and the kickdown cable).



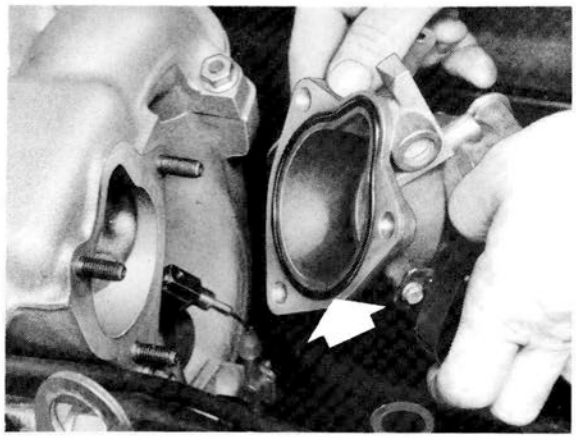
9 Undo the throttle-housing securing screws and lift off the casting.



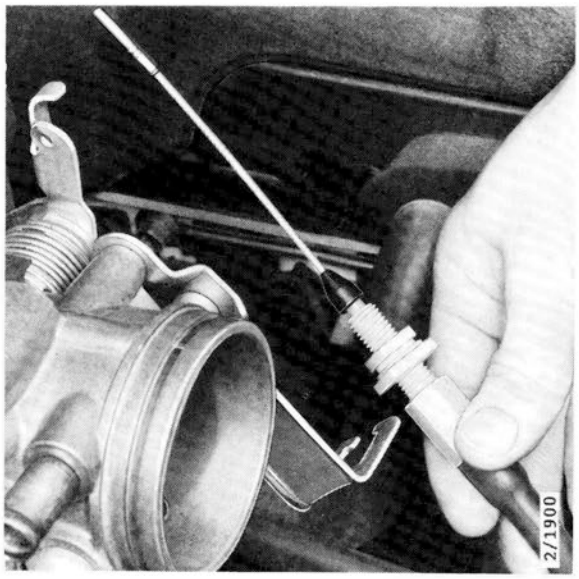
To fit

Note the position of the 'O' ring in the throttle housing.

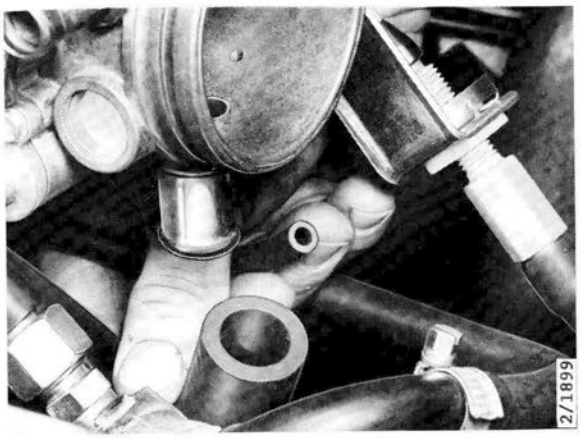
1 Fit a new 'O' ring and then the throttle housing.

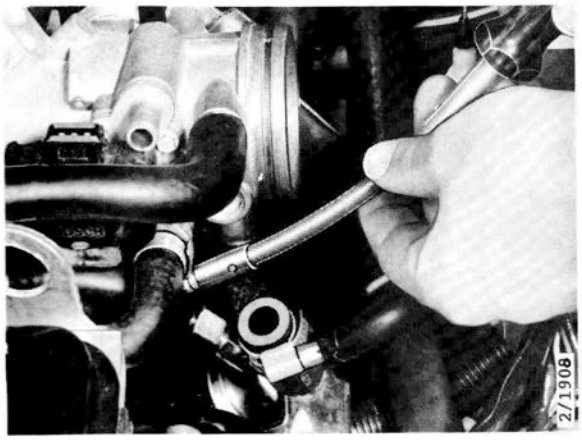


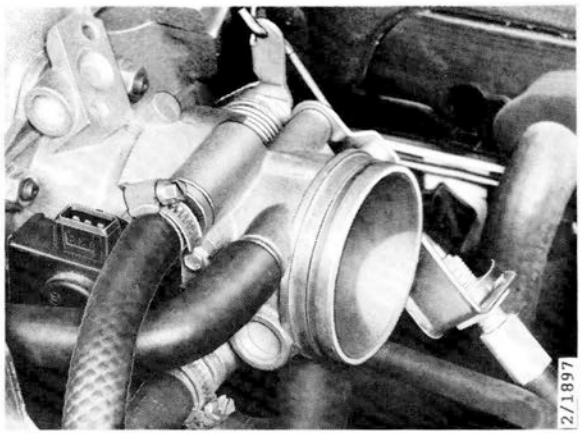
2 Reconnect the throttle cable (Automatics: and the kickdown cable).



3 Reconnect the hoses for the crankcase ventilation, the cruise-control system, the AIC valve and the throttle-housing preheating.





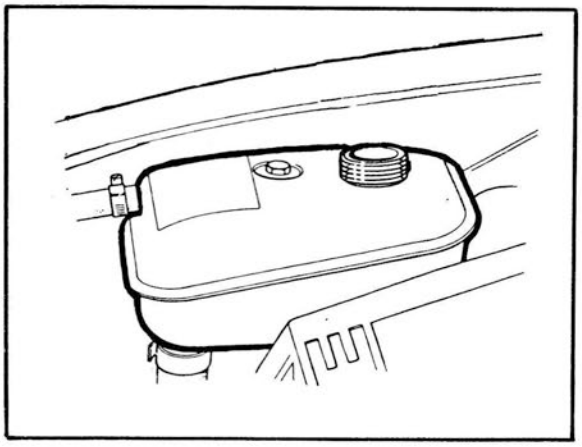


4 Plug on the connector for the throttle-position sensor.

5 Fit the rubber elbow between the throttle housing and the air mass meter.

6 Reconnect the battery.

7 Check the coolant level and top up as necessary.

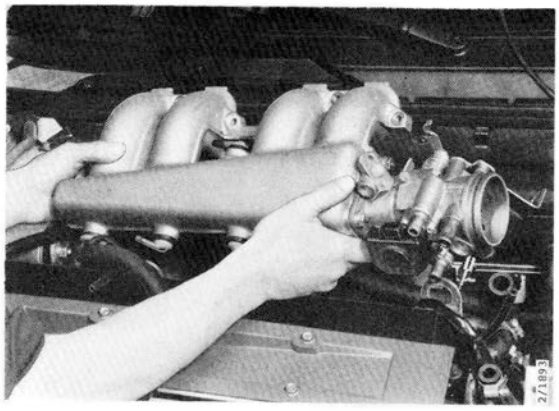


AIC valve

Object code: 24641

To remove

1 Remove the top section of the inlet manifold (as detailed in steps 1 to 14 in the earlier section under the heading, 'Inlet manifold, throttle housing and fuel-injection rail'.



2 Remove the AIC valve and disconnect the hoses.

To fit

Fit in the reverse order.

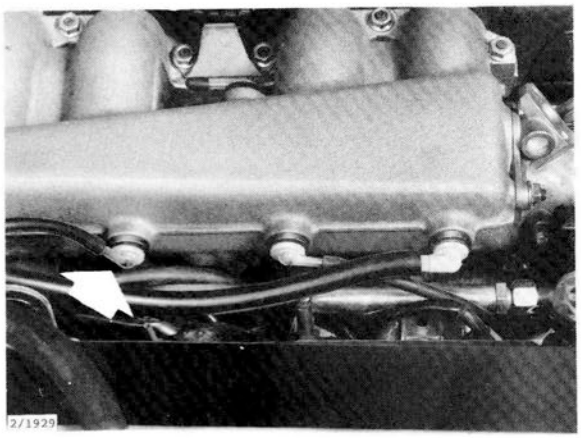
Fuel-injection rail and injectors

Object code: 24131 & 24211

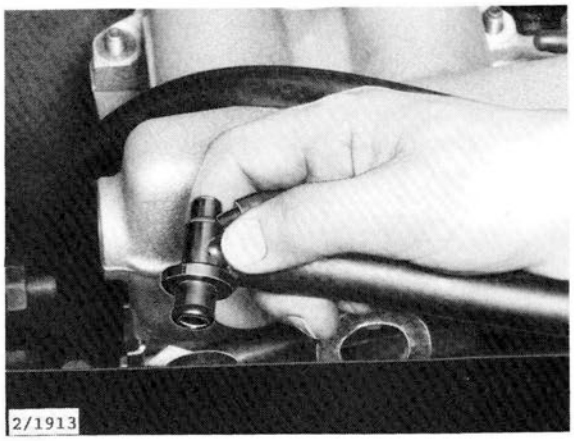
To remove

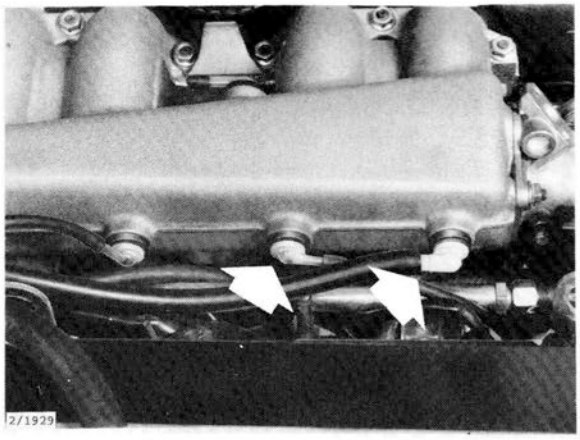
1 Disconnect the following hoses and move them out of the way:

- The small-bore crankcase breather hose from the inlet manifold

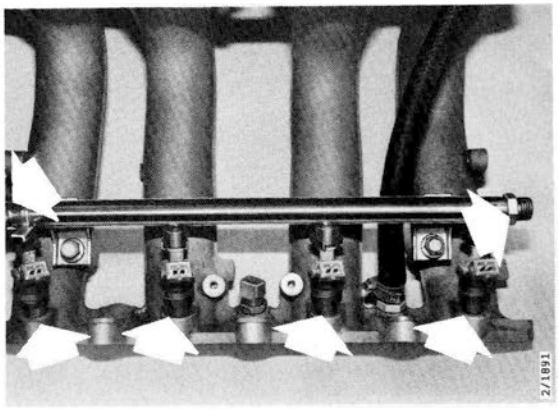


- The large-bore crankcase breather hose from the camshaft cover
- The charcoal-canister hose from the inlet manifold
- The fuel-pressure regulator vacuum hose.





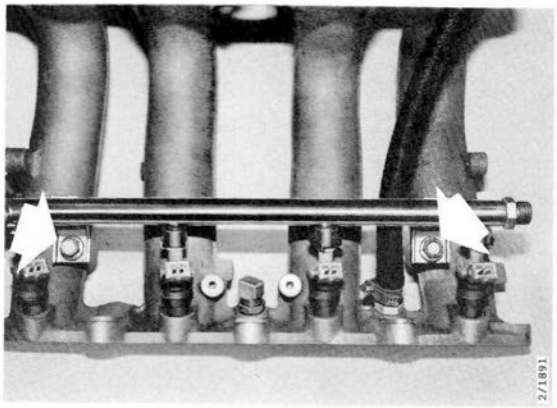
2 Clean the areas around the fuel-line connections and at the injectors.



3 Disconnect the fuel hoses from the fuel-injection rail.

4 Unplug the electrical leads from the injectors.

5 Remove the fuel-injection rail securing screws and lift up the rail complete with injectors.



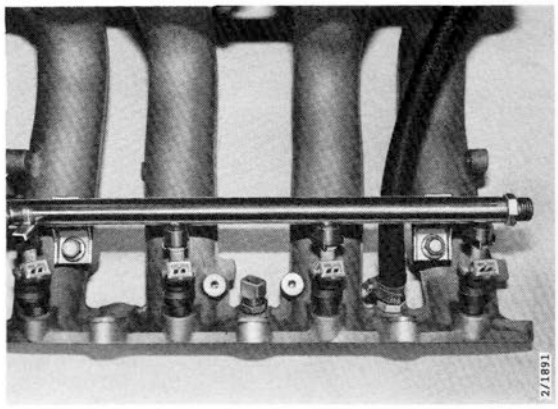
6 Remove the clips and separate the injectors from the rail.

To fit

Prior to fitting, inspect the 'O' rings on the injectors, replacing any that are damaged, and lubricating them to facilitate fitting.

1 Fit the injectors onto the fuel-distribution rail and secure by means of the clips.

2 Fit the injection rail complete with injectors and tighten the securing screws.

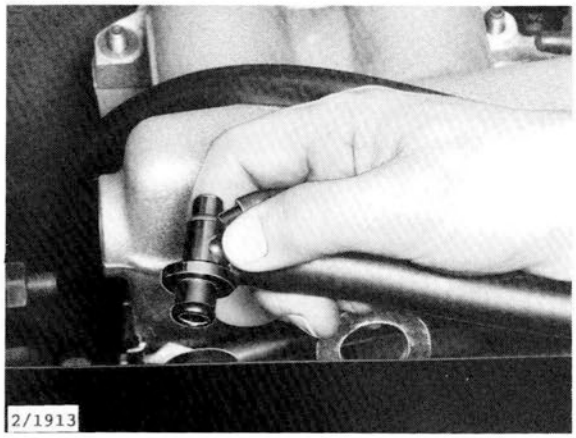


3 Reconnect the fuel hoses.

4 Plug on the electrical leads to the injectors.

5 Reconnect the following hoses:

- The small-bore crankcase breather hose to the inlet manifold
- The large-bore crankcase breather hose to the camshaft cover



- The charcoal-canister hose to the inlet manifold
- The fuel-pressure regulator vacuum hose.

6 Start the engine. Check that all systems are functioning properly and that there are no leaks.

Air mass meter

Object code: 24820

To remove

1 Unplug the connector from the air mass meter.

2 Undo the hose clips and remove the meter.

To fit

Fit in the reverse order.

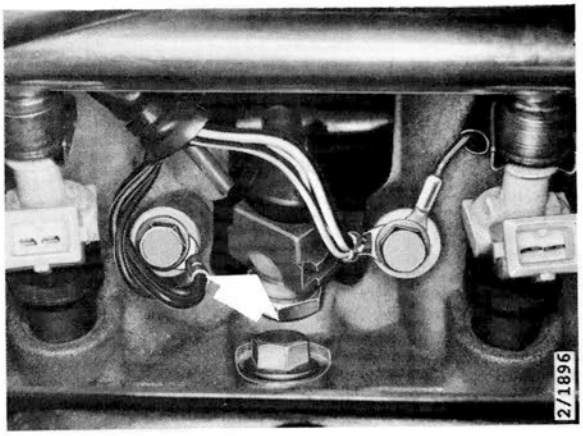
Temperature sensor

Object code: 24831

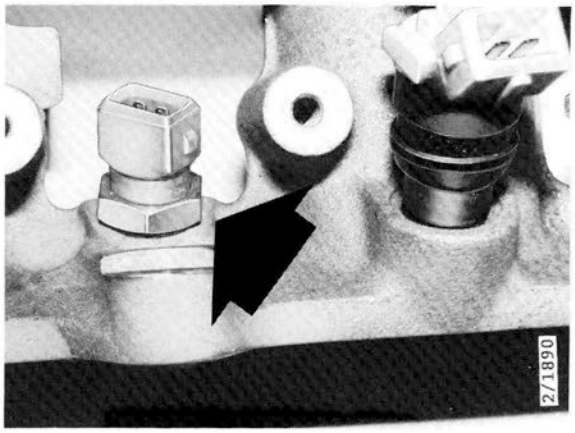
To remove

1 Remove the top section of the inlet manifold (as detailed in steps 1 to 14 in the earlier section under the heading, 'Inlet manifold, throttle housing and fuel-injection rail'.

2 Unplug the connector from the temperature sensor.



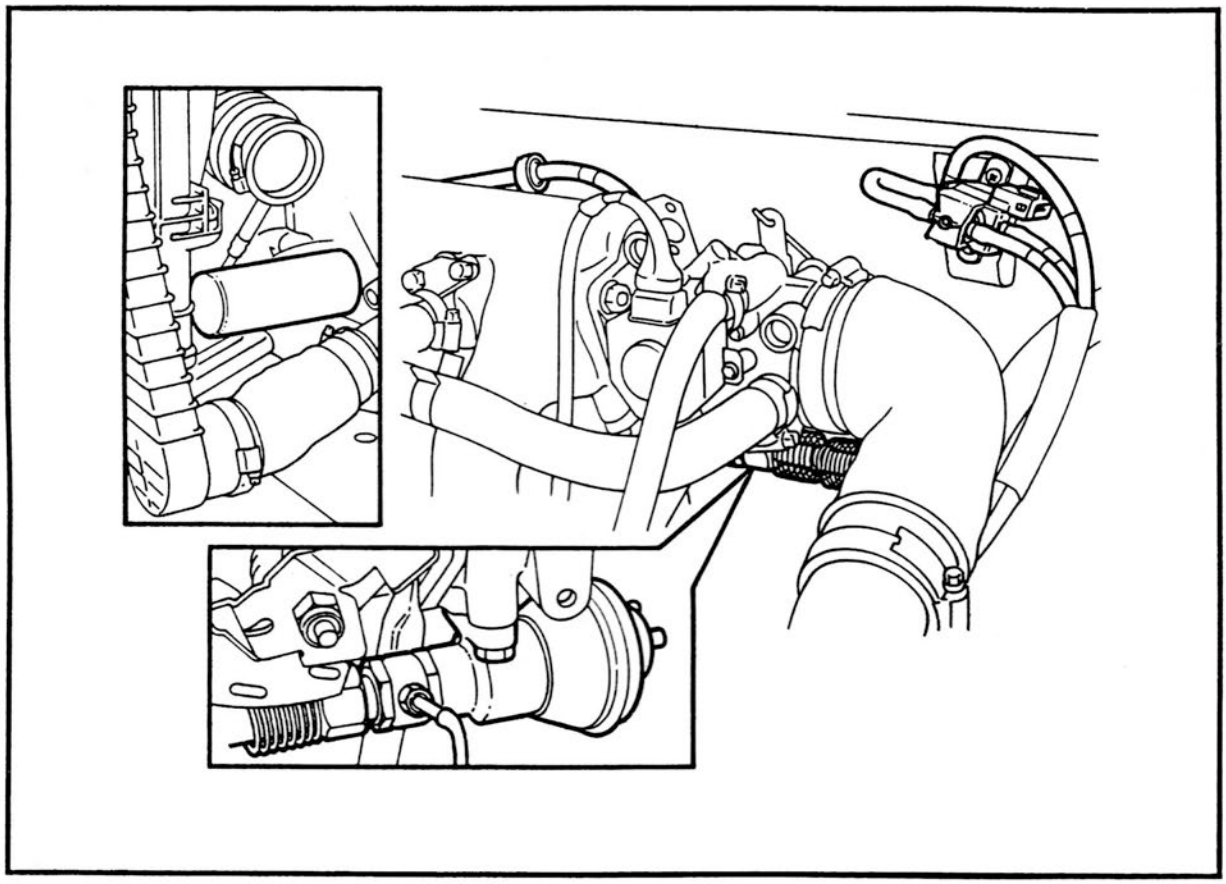
3 Remove the temperature sensor.



To fit

Fit in the reverse order.

Exhaust emission control



Component replacement

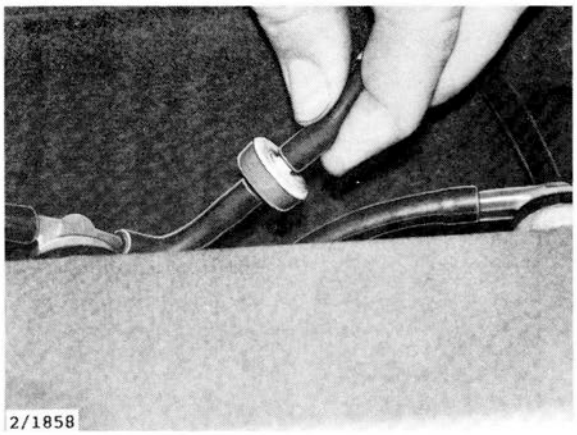
Non-return valve

Object code: 25423

To replace

1 Disconnect the valve from the hose.

2 Fit the new valve, with the arrow pointing towards the vacuum tank.



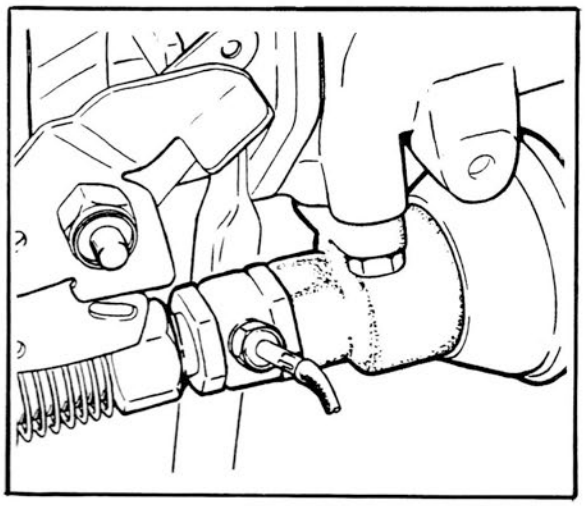
Temperature sensor

Object code 25439

To remove

1 Unplug the connector at the inlet manifold.

2 Remove the temperature sensor from the EGR valve.



To fit

Fit in the reverse order.

Vacuum tank

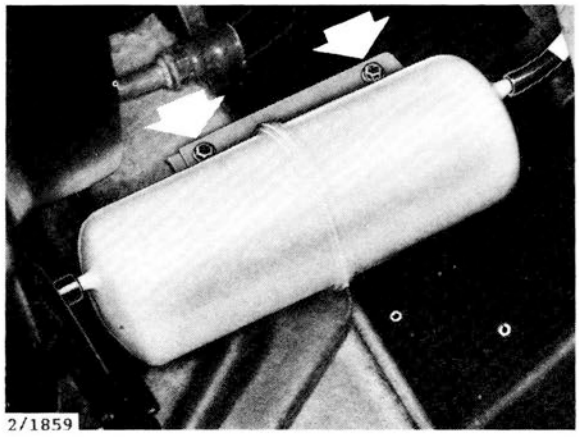
Object code: 25433

To remove

1 Remove the air mass meter and tuck the air hose out of the way.

2 Disconnect the two vacuum hoses from the vacuum tank.

3 Unscrew (two screws) and remove the vacuum tank.



4 Remove the bracket from the tank.

To fit

Fit in the reverse order.

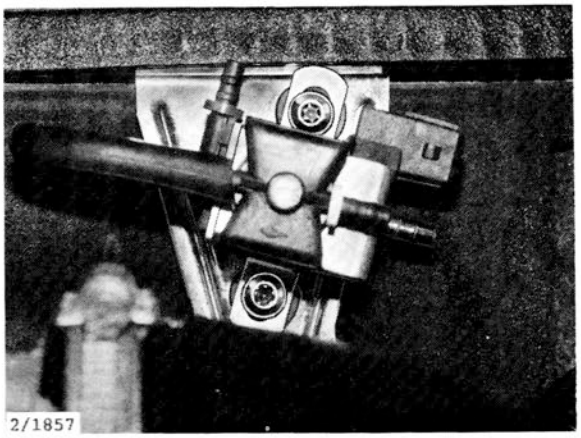
Modulating valve

Object code: 25461

To remove

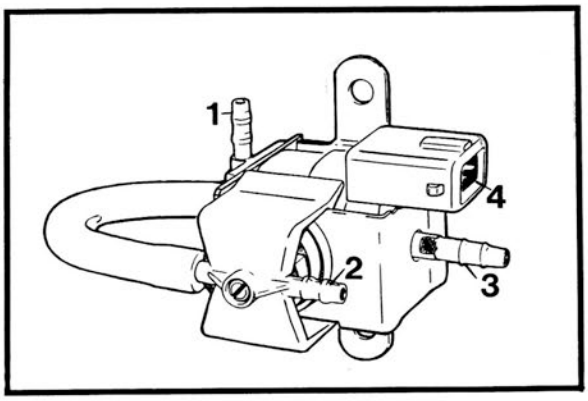
1 Unplug the connector and disconnect the three hose connections.

2 Remove the valve.



To fit

Fit in the reverse order, taking care to ensure that the hoses are fitted to the right connections (as shown).



1 To EGR valve
2 To inlet manifold via vacuum tank
3 To air hose between air mass meter and throttle housing
4 Two-pin connector (signal from LH-system ECU)

Alternator

Object code: 32101

To remove

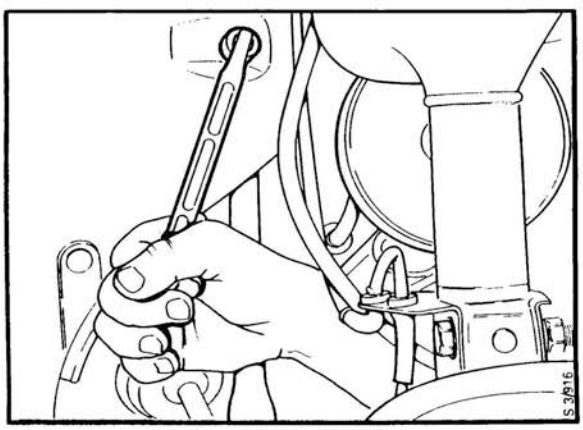
1 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

2 Remove the RH front wheel.

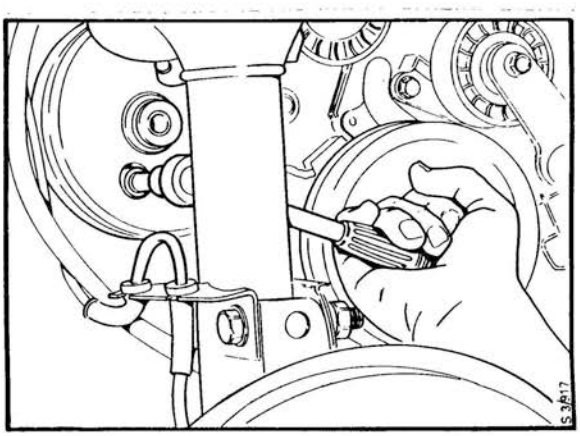
3 Remove the RH wing liner.

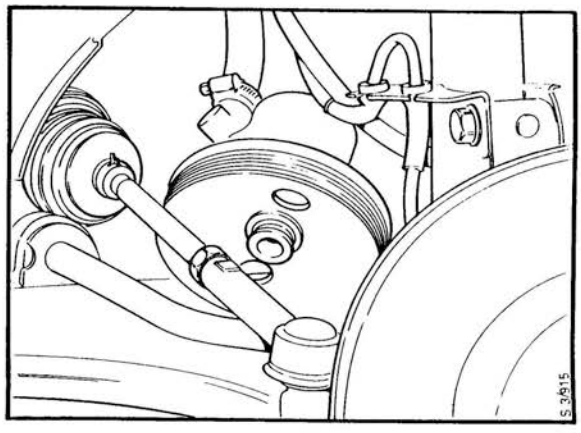
4 Ease the multigroove belt off the pulleys on the alternator and hydraulic pump (see Section 215).

5 Remove the steady bar from between the wheel arch and the subframe (two bolts).

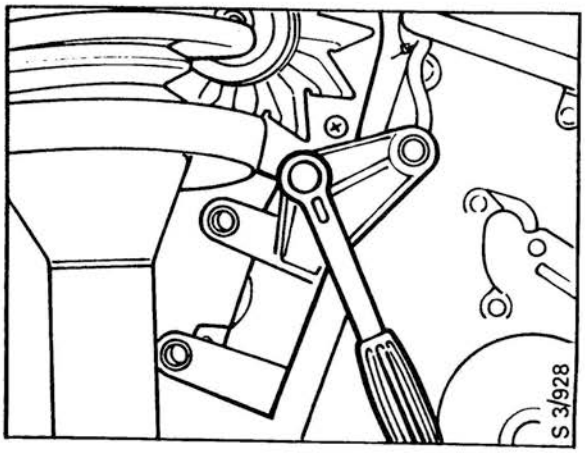


6 Undo the two securing bolts and remove the hydraulic pump by dropping it down and towards the rear of the car.

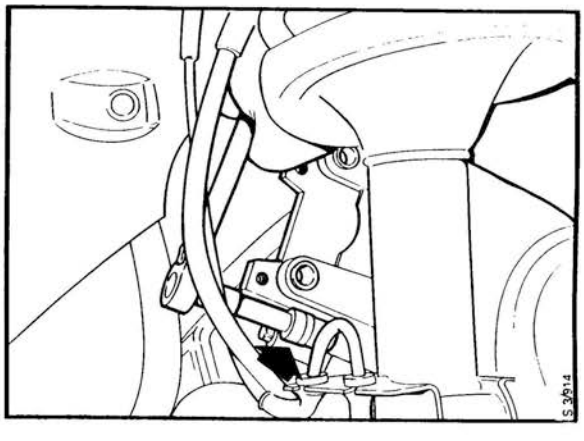




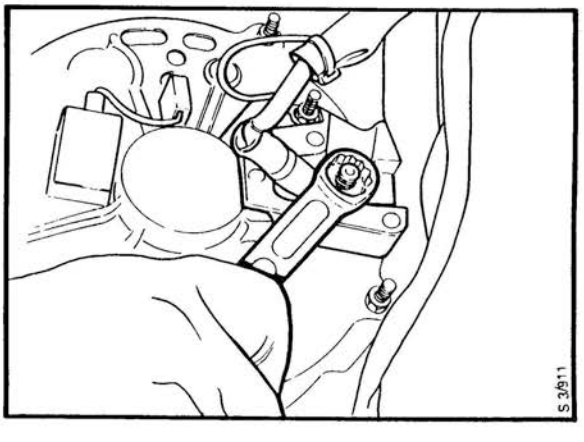
7 Undo the two securing bolts and drop the alternator down and towards the rear of the car.



8 Remove the pump bracket (four bolts).



9 Disconnect the electrical leads from the alternator and remove it by lifting it towards the front of the car.

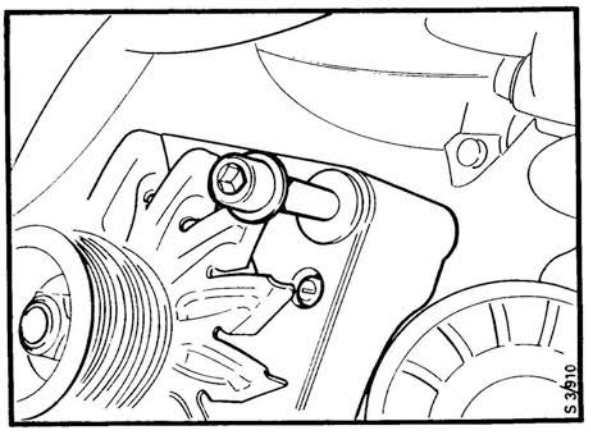


To fit

1 Connect the leads to the alternator and place the alternator in position in the engine bay.

2 Fit the bracket for the hydraulic pump.

3 Fit the top bolt in the alternator, leaving it slack. Align the alternator, secure it to the bracket and tighten the bolts.



4 Fit the hydraulic pump.

5 Fit the steady bar.

6 Fit the belt.

7 Fit the wing liner and wheel.

8 Reconnect the battery.

Starter motor

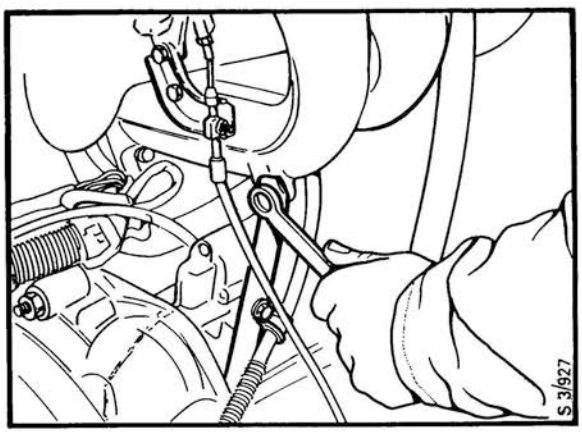
Object code: 33101

To remove

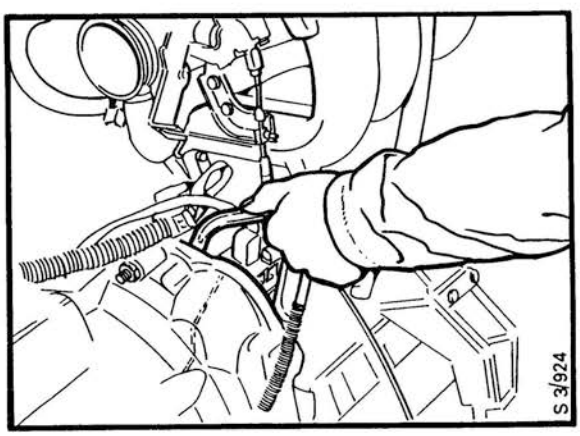
1 Disconnect the negative (-) battery lead and cover the terminal pole on the battery.

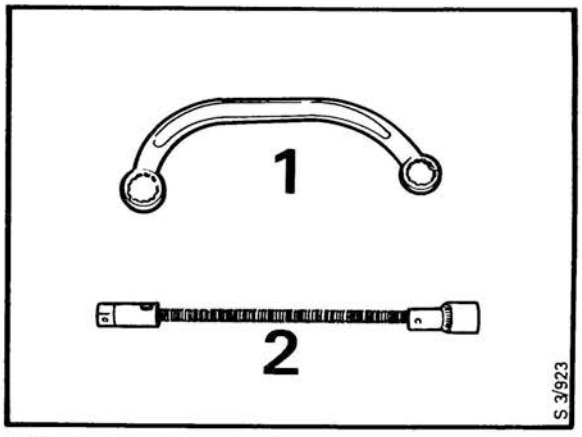
2 Remove the rubber elbow from between the air mass meter and throttle housing.

3 Undo the top bolt in the inlet-manifold steady bar.

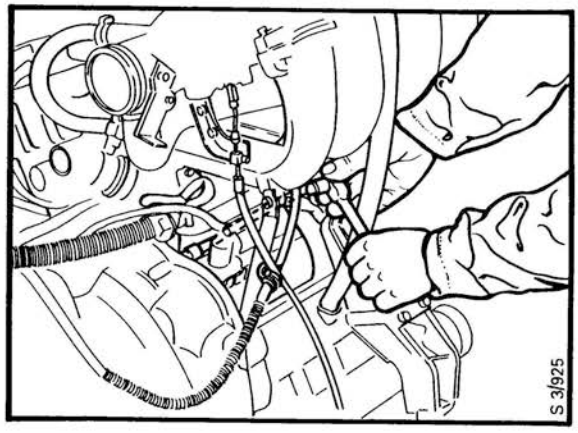


4 Slacken the top securing bolt for the starter motor by means of an obstruction ring wrench and then remove the bolt using a flexible socket extension.

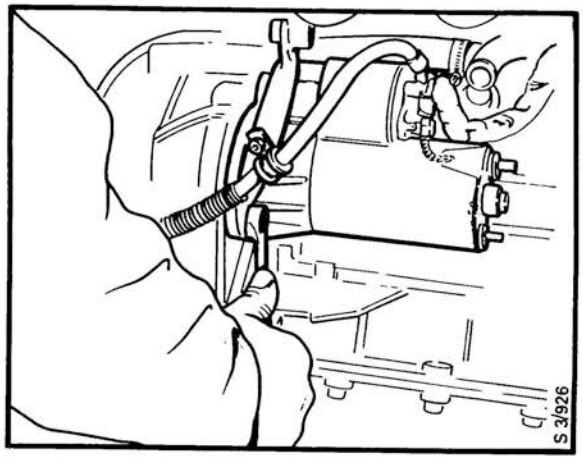




1 Obstruction ring wrench
2 Flexible socket extension



5 Disconnect the electrical leads and remove the lower securing bolt from underneath. Swivel the steady bar out of the way.



6 Remove the starter motor by lifting it towards the rear and up between the inlet manifold and brake master cylinder.

To fit

1 Lift the starter motor into position. Fit the top bolt first, leaving it slack, and then the bottom bolt using a flexible socket extension.

2 Ensure that the starter motor is properly aligned and tighten the top bolt using the obstruction ring wrench.

3 Tighten the bottom bolt (with steady bar) from underneath and reconnect the electrical leads.

4 Tighten the top bolt in the inlet-manifold steady bar.

5 Fit the rubber elbow.

6 Reconnect the battery.

Ignition system

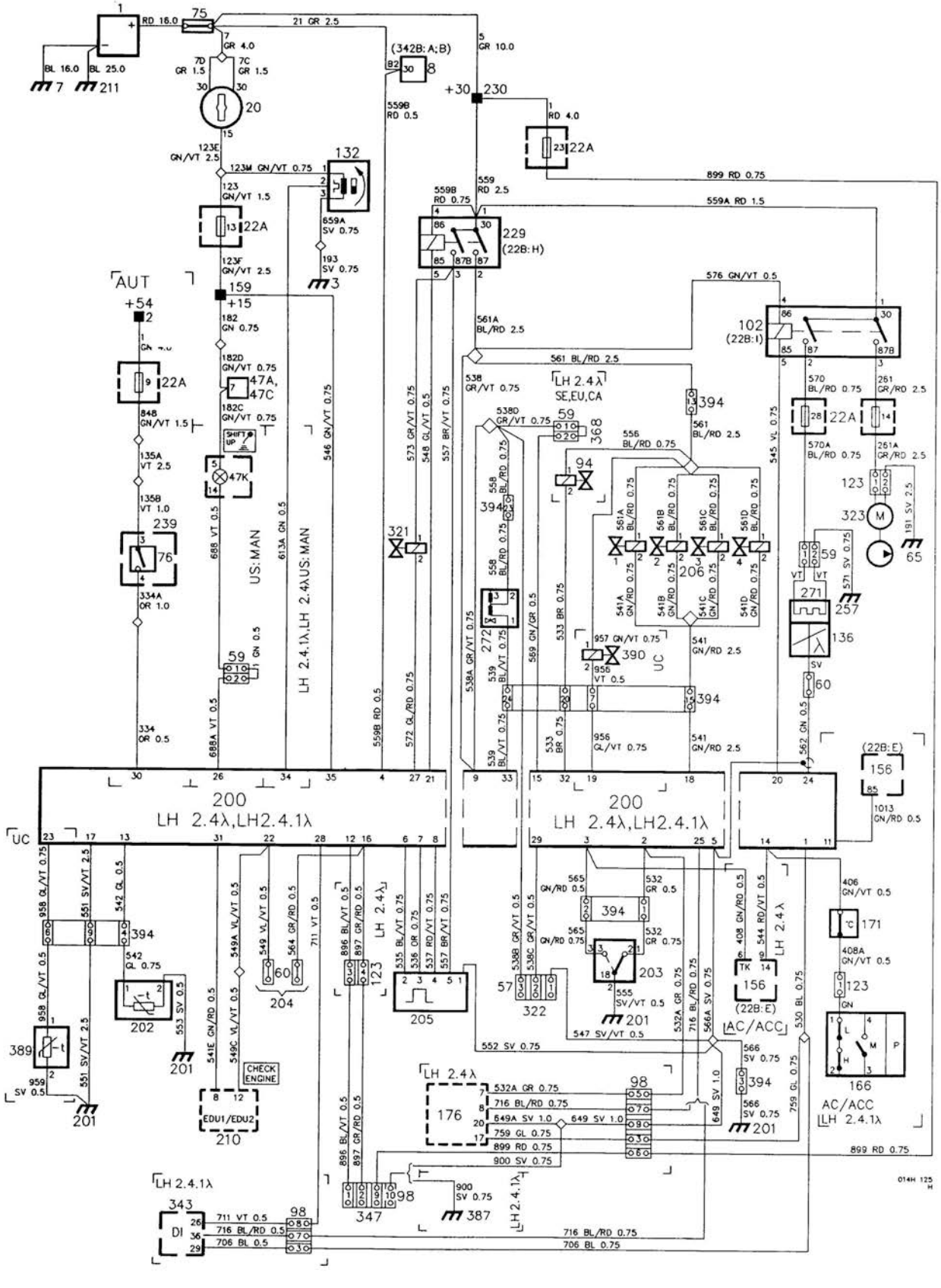
Crankshaft sensor (DI system)

Object code: 34043

To remove

The procedure for removing the crankshaft sensor is identical to that given in Section 2:6 of the Workshop Manual, the only difference being the procedure for removing the multigroove belt. For details of this, see Section 215.

LH 2.4.1 Fuel-injection system

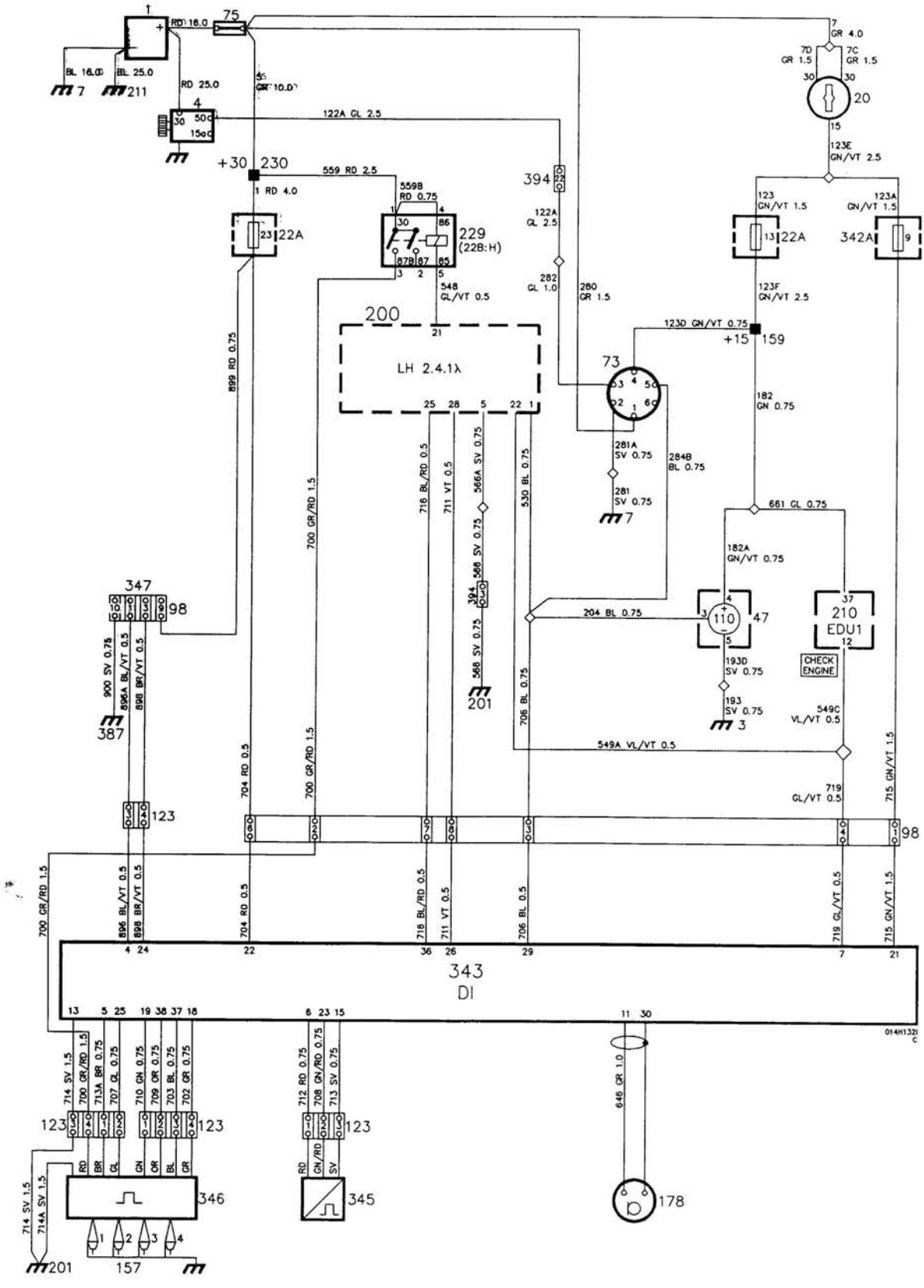


Overview of LH 2.4.1 functions

The LH 2.4.1 fuel-injection system differs from the LH 2.4 system as follows:

- AC cut-in function modified. The cut-in delay and adaptive functions previously performed by the AC relay (156) are now integrated in the LH-system ECU (200).
- Pin 14 of the ECU (200) is now connected direct to anti-frost thermostat 171, and pin 85 of the AC relay to ECU pin 11.
- When the AC system is switched on by means of the switch on the dash, ECU pin 14 is energized via the anti-frost thermostat (171) and relay 166. With due regard to the time-delay and engine-load functions, the ECU determines when to activate the AC function, which it does by grounding pin 85 of the AC relay.
- The cold-start valve has been discontinued. The valve, designed to assist starting at extremely low temperatures, has been made redundant by the introduction of the DI system.
- As before, the road-speed signal is used in the function for shift-up indication. In LH 2.4.1, however, the signal is also used in control of the AIC function, to tell the ECU whether the car is moving or at a standstill. This makes for more-precise control of the AIC-valve setting and improved drivability.

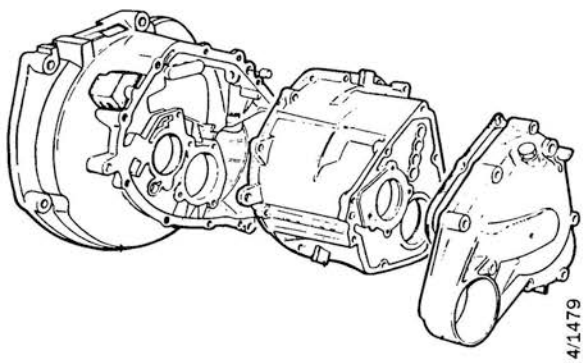
DI system with tachometer and TSI socket



Transmission

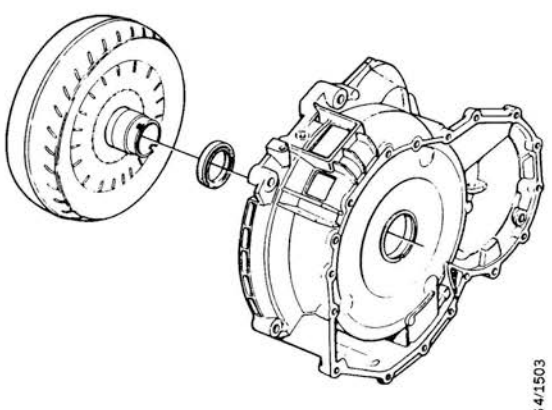
Clutch housing

The manual gearbox has a new clutch housing designed for the B234 engine. This housing can also be fitted to the B202 engine but note that the housing designed for the B202 engine cannot be fitted to the B234.



Torque converter housing (Automatic transmission)

A new torque converter housing, with holes arranged to suit the B234 engine, has been introduced.



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