VOLVO

# Service Manual

## Design

## Function

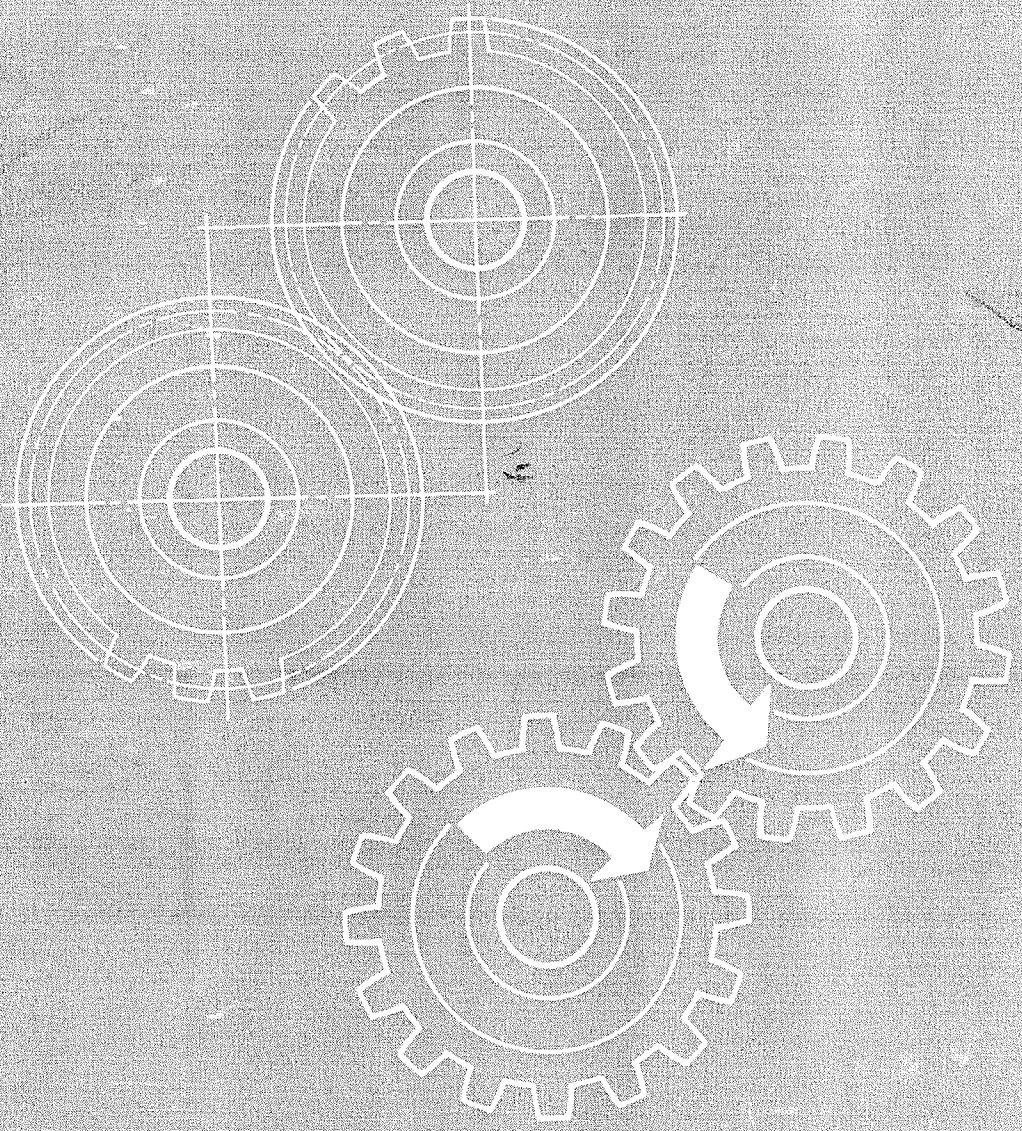
Section 2

Engine B234F

740, 1988-19 . . .

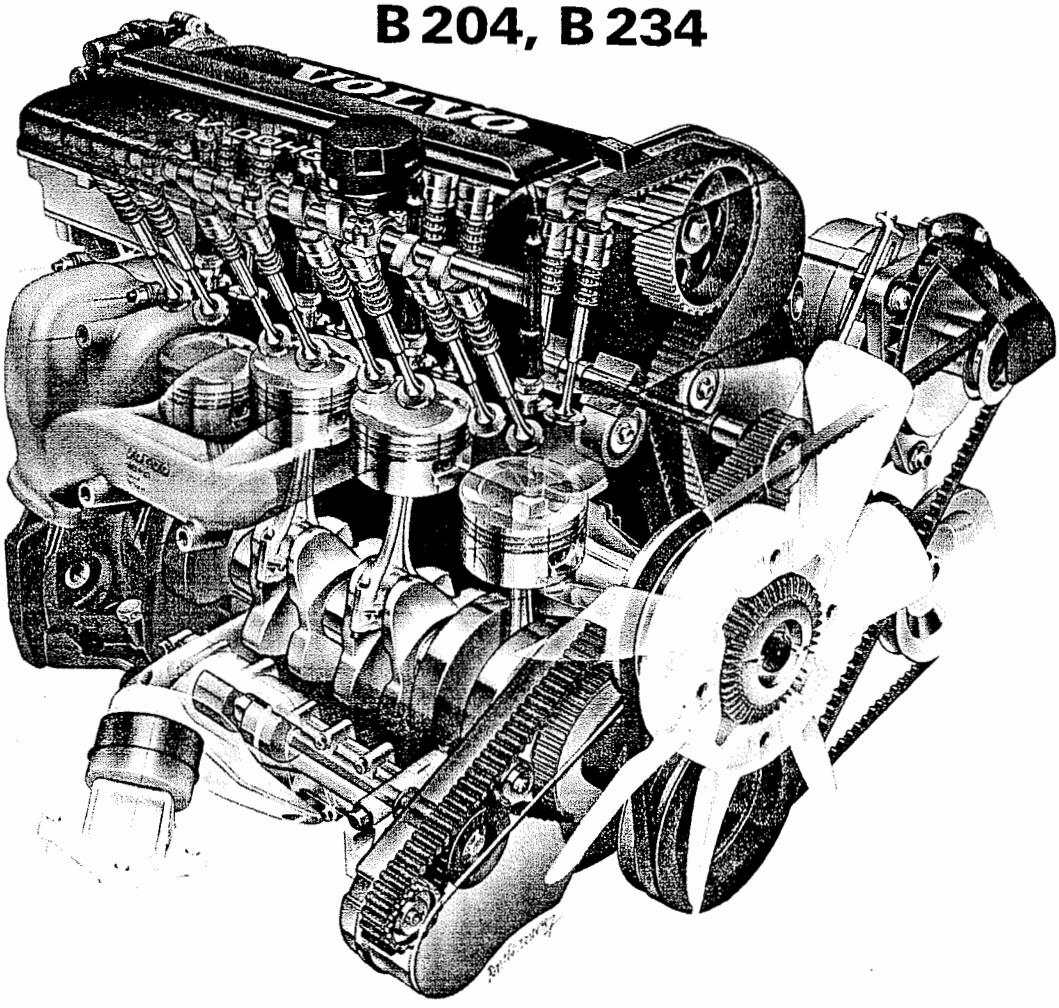
TP 31304/2 09.88





Volvo Car Corporation

# B 204, B 234






**Key to designations**

**B 234 F**

**F** = Fuel-injected with catalytic converter
**E** = Fuel-injected
**4** = No. of valves per cylinder
**23** = Cubic capacity (displacement)
**B** = Petrol (gasoline)

**B 234** = Basic engine
**B 204** = **B 234** with smaller bore

**This manual deals with the following engine types:**

| Type | Model year |
|---|---|
| B 204 E | 1989– |
| B 234 F | 1988– |

Volvos are sold in versions adapted for different markets. These adaptations depend on many factors including legal, taxation and market requirements.

This manual may therefore show illustrations and text which do not apply to cars in your country.

Volvo owners planning to export their car(s) to another country should investigate the applicable safety and exhaust emission requirements. In some cases it may be impossible to comply with these requirements.

**Order No.: TP 31311/1**

# Contents

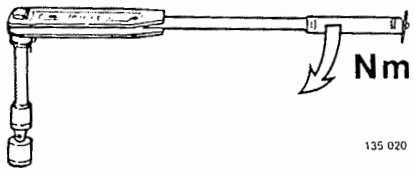


**See page 255 for Index**



**Part number: TP 31311/1**

# Important information




## Tightening torques

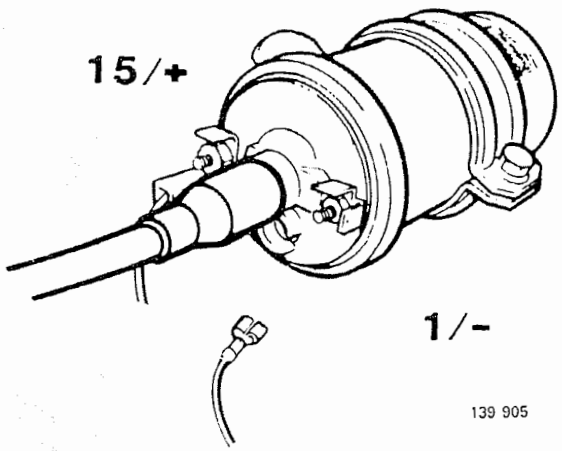
The torques specified in this manual are shown in one of two ways:

1. Values which **must** be applied with a torque wrench are indicated in bold print, thus: Tighten to **40 Nm** (29 ft.lb).
2. Recommended values which **need not** be applied with a torque wrench are shown in ordinary print, thus: Tighten to 40 Nm (29 ft.lb).


## Ignition system

**Warning!** The ignition system operates at **high power,** with **dangerous** voltages in both the low-tension and high-tension circuits.

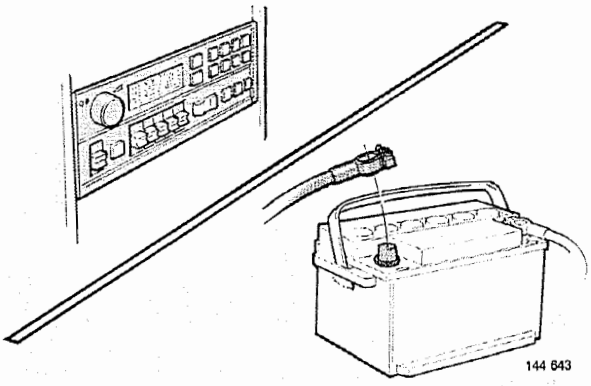
Dangerous voltage levels occur **in all parts of the ignition system**, including connectors and similar fittings.




## Compression testing

**Disconnect** the lead from **terminal 1** on the ignition coil to prevent flashover to the electrical system wiring.

**Disconnect** the injector connectors to avoid flooding the engine, diluting the engine oil etc.




## Battery

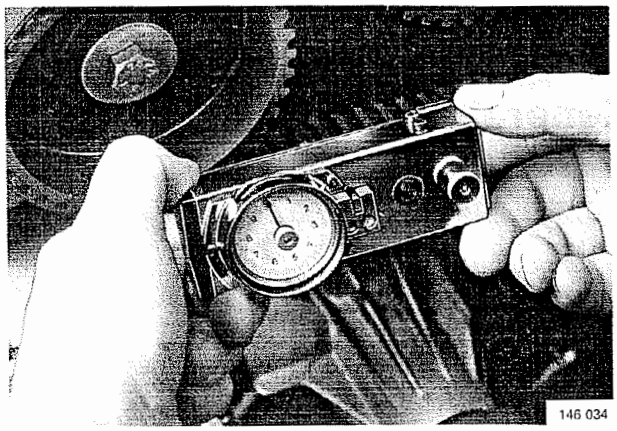
**Do not disconnect** the battery leads while the engine is running.

**Disconnect** the battery leads when boost charging.

**Do not use** a supply higher than **15 A/16 V** when jump starting the engine.

### Radios with microprocessors

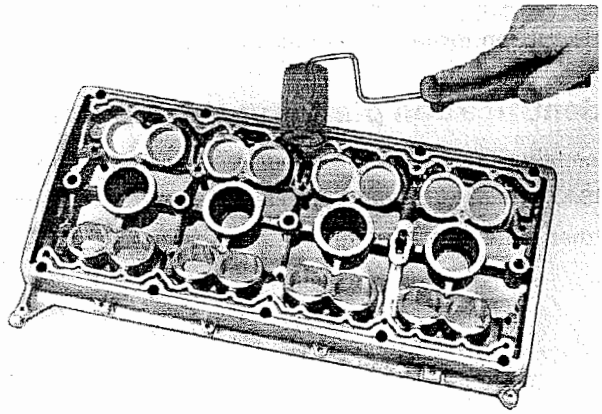
To avoid damage to the microprocessor, the **radio must be switched off** before disconnecting the battery earth lead.


146 034

## Timing and balance shaft belts

It is essential that the timing and camshaft belts be tensioned **exactly** to the values stated in the specifications. (See page 11.)

Belt tension gauge **998 8500** must be used for this purpose.

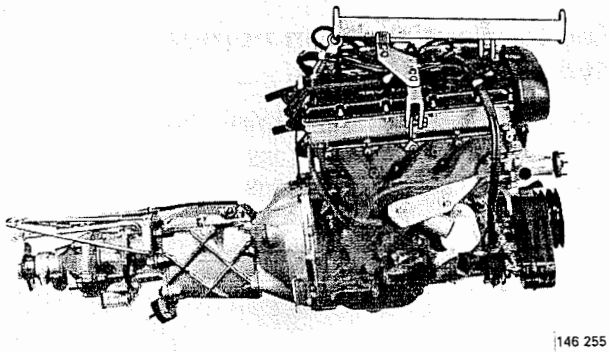

144 981

## Liquid sealing compound

The joint between the camshaft carrier and cylinder head on the B 204 E and B 234 F engines is sealed with a liquid sealing compound (liquid gasket).

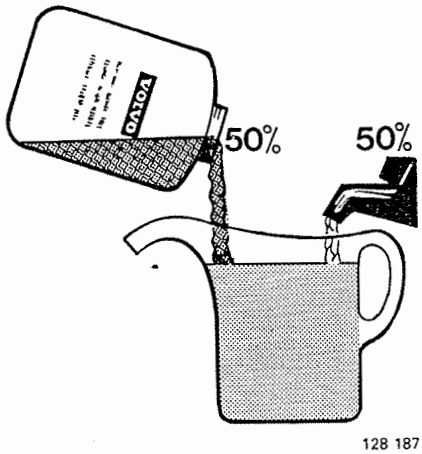
It is essential that the joint faces be **thoroughly cleaned** and that all traces of oil be removed before applying the compound.

The compound is applied with a short-haired roller.


146 255

## Suspended engine

**Caution!** Before carrying out work on a suspended engine, ensure that the lifting equipment is **securely attached and is in perfect condition.**



128 187

## Coolant

Genuine Volvo coolant diluted with **clean** water in proportions of **50/50** is the only coolant which can be guaranteed by Volvo. This mixture prevents corrosion and freezing damage.

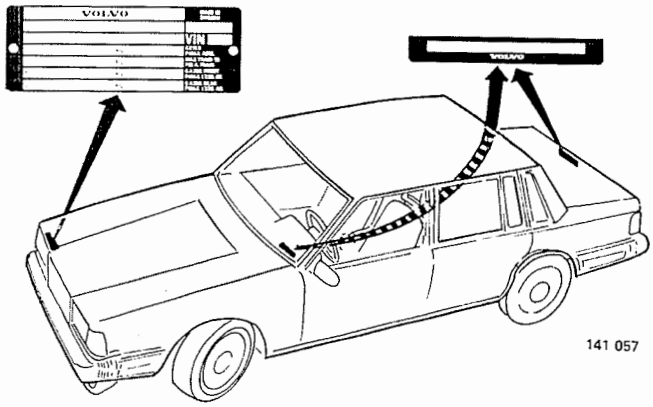
**Type C** coolant (blue-green) must not be mixed with any other type.

The coolant must be changed **every second year** to ensure continued protection against corrosion.

Use only **type C** coolant as a replacement.

# Specifications

## Group 20 General




## PLATES AND LABELS

### Product plate

Located over right-hand headlamp.

Information includes identification number (type designation).

### Identification plate (type designation)

**Scandinavia:** Located on upper rear member in boot.

**USA, Canada:** Located at top left of instrument panel.

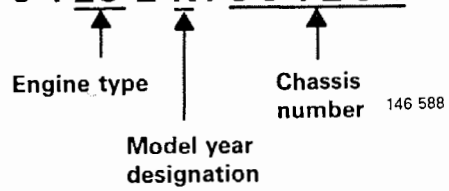
**Other markets:** No plate.

**USA/Canada**

YV1DX894XK1000000

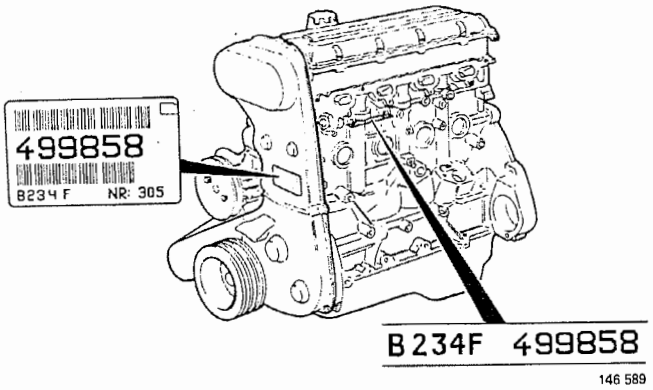
**Other**

YV1704292K1001234




### Key to identification number (type designation)

| Engine type | Model year designation |
|---|---|
| 29 = B 204 E | J = 1988 |
| 89 = B 234 F | K = 1989 |

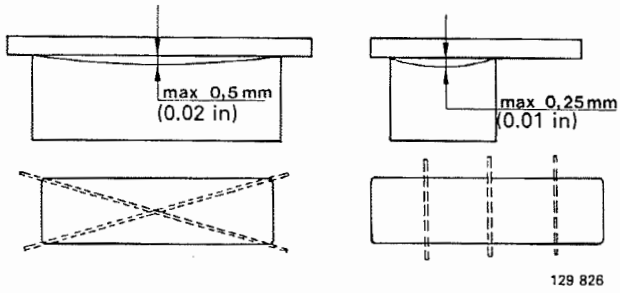



### Engine serial and part numbers

Punched on left-hand side of cylinder block.

The transmission (timing) cover also carries a label specifying the engine type, part number and serial number.

# Group 21 Engine



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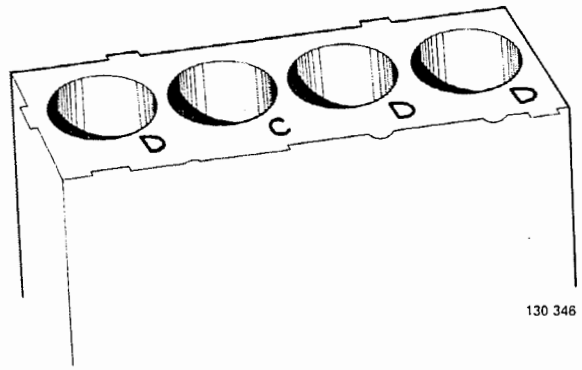
## CYLINDER HEAD

### Max. distortion

Max. distortion without machining:
Longitudinal ..... **0.50 mm** (0.02 in)
Lateral ..... **0.25 mm** (0.01 in)

The cylinder head must be replaced if the distortion exceeds **1.0 mm** (0.04 in) along the length or **0.50 mm** (0.02 in) across the width.

Height of cylinder head
as new ..... **103.50±0.5 mm** (4.07±0.04 in)
Minimum height after
machining ..... **102.5 mm** (4.035 in)



130 346

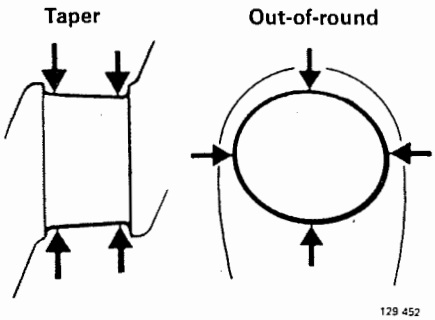
## CYLINDER BLOCK

### Bores

| Standard | B 204 | B 234 |
|---|---|---|
| Bore marked C ..... | **88.90 mm** (3.5000 in) | **96.00** (3.7795 in) |
| Bore marked D ..... | **88.91 mm** (3.5004 in) | **96.01 mm** (3.7799 in) |
| Bore marked E ..... | **88.92 mm** (3.5008 in) | **96.02 mm** (3.7803 in) |
| Bore marked G ..... | **88.94 mm** (3.5016 in) | **96.04 mm** (3.7811 in) |

### Oversize

| | | |
|---|---|---|
| Oversize 1 ..... | **89.29 mm** (3.5154 in) | **96.30 mm** (3.7913 in) |
| Oversize 2 ..... | **89.67 mm** (3.5303 in) | **96.60 mm** (3.8031 in) |



129 452

## CRANKSHAFT ASSEMBLY

### Crankshaft journals

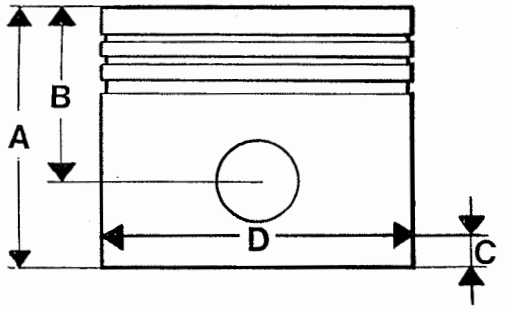
Max. out-of-round ..... **0.01 mm** (0.0003 in)
Max. taper ..... **0.01 mm** (0.0003 in)

Diameter, standard ..... **49.00 mm** (1.9646 in)
undersize 1 ..... **48.75 mm** (1.9193 in)
undersize 2 ..... **45.50 mm** (1.7913 in)
Bearing seat width . **25.00±1.1 mm** (0.9834±0.0433 in)

# PISTONS

## Piston diameter

| Engine type | Dimensions, mm (in) | | |
|---|---|---|---|
| | A | B | C |
| B 204 | 67.1 (2.64) | 39.1 (1.54) | 13.4 (0.53) |
| B 234 | 68.7 (2.70) | 39.9 (1.57) | 11.0 (0.43) |




137 551

A = Total height of piston
B = Height from gudgeon pin centre to crown
C = Piston diameter to be measured at right-angles to gudgeon pin hole, at distance C from edge of skirt
D = Piston diameter

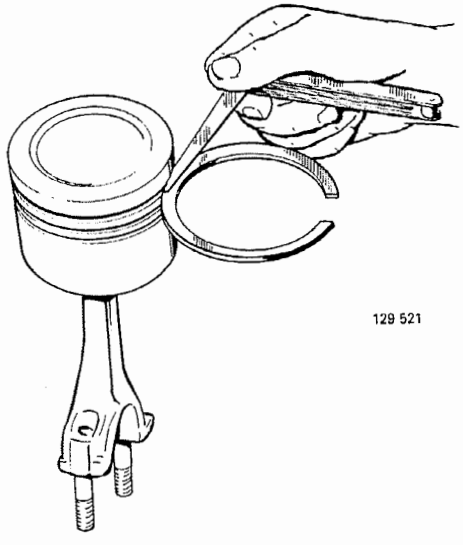
**Piston diameter (D)**

| **Standard** | **B 204** | **B 234** |
|---|---|---|
| Pistons marked C..... | **88.88 mm** $^{+0.01}_{0}$ | **95.98 mm** $^{+0.01}_{0}$ |
| | (3.4992 in $^{+0.0004}_{0)}$ | (3.7787 in $^{+0.0004}_{0)}$ |
| Pistons marked D ..... | **88.89 mm** $^{+0.01}_{0}$ | **95.99 mm** $^{+0.01}_{0}$ |
| | (3.4996 in $^{+0.0004}_{0)}$ | (3.7791 in $^{+0.0004}_{0)}$ |
| Pistons marked E..... | **88.90 mm** $^{+0.01}_{0}$ | **96.00 mm** $^{+0.01}_{0}$ |
| | (3.5000 in $^{+0.0004}_{0)}$ | (3.7795 in $^{+0.0004}_{0)}$ |
| Pistons marked G ..... | **88.91 mm** $^{+0.01}_{0}$ | **96.02 mm** $^{+0.01}_{0}$ |
| | (3.5004 in $^{+0.0004}_{0)}$ | (3.7803 in $^{+0.0004}_{0)}$ |
| **Oversize** | | |
| Oversize 1..... | **89.27 mm** $^{+0.01}_{0}$ | **96.28 mm** $^{+0.01}_{0}$ |
| | (3.5146 in $^{+0.0004}_{0)}$ | (3.7906 in $^{+0.0004}_{0)}$ |
| Oversize 2..... | **89.65 mm** $^{+0.01}_{0}$ | **96.58 mm** $^{+0.01}_{0}$ |
| | (3.5295 in $^{+0.0004}_{0)}$ | (3.8024 in $^{+0.0004}_{0)}$ |

## Piston weight

B 204 ..... **460±7 g** (16.2±0.25 oz)
B 234 ..... **530±7 g** (18.7±0.25 oz)

Max. difference in weight between pistons in same engine:..... **14 g** (0.5 oz)



129 521

## Piston clearance

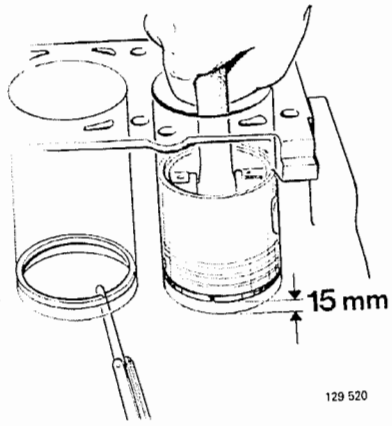
B 204, B 234..... **0.010–0.030 mm** (0.0004–0.0012 in)

## Piston rings, side clearance

**Upper compression ring**
B 204 ..... **0.040–0.072 mm** (0.0016–0.0028 in)
B 234 ..... **0.060–0.092 mm** (0.0024–0.0036 in)

**Lower compression ring**
B 204 ..... **0.030–0.062 mm** (0.0012–0.0024 in)
B 234 ..... **0.040–0.072 mm** (0.0016–0.0028 in)

**Oil scraper ring**
B 204 ..... **0.020–0.055 mm** (0.0008–0.0022 in)
B 234 ..... **0.030–0.065 mm** (0.0012–0.0026 in)



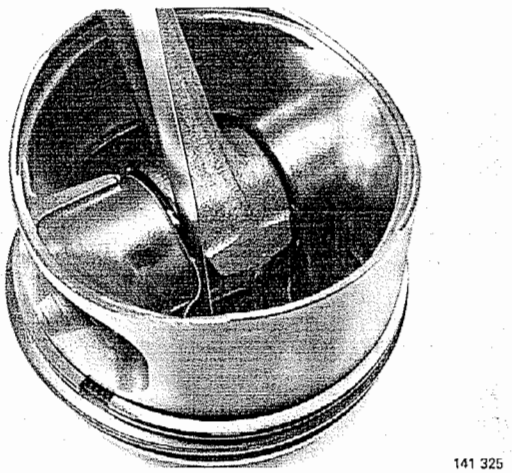
129 520

## Piston ring gap

Piston ring gap is measured with crown of inverted piston 15 mm(0.6 in) from bottom of cylinder.

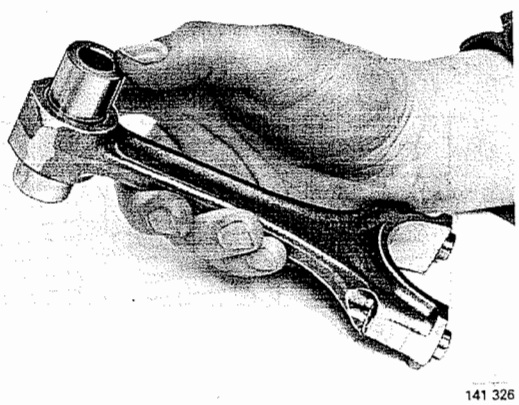
**Upper and lower compression rings**
B 204..... **0.30–0.50 mm** (0.012–0.020 in)
B 234..... **0.30–0.55 mm** (0.012–0.022 in)

**Oil scraper ring**
B 204..... **0.25–0.50 mm** (0.010–0.020 in)
B 234..... **0.30–0.60 mm** (0.012–0.024 in)


141 325

## Piston/connecting rod, side clearance

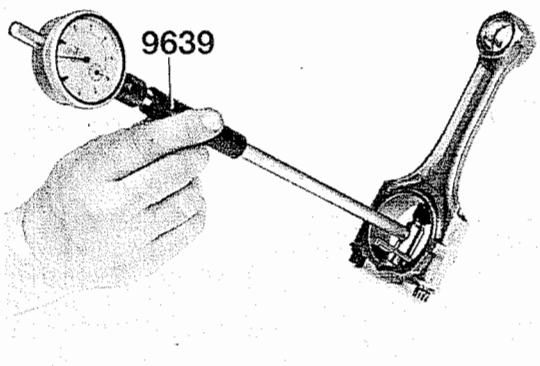
B 204, B 234 ..... **0.15–0.45 mm** (0.006–0.018 in)


141 326

## Gudgeon pin, fit in con rod

The gudgeon pin should slide through the hole without noticeable play when pressed gently with the thumb.

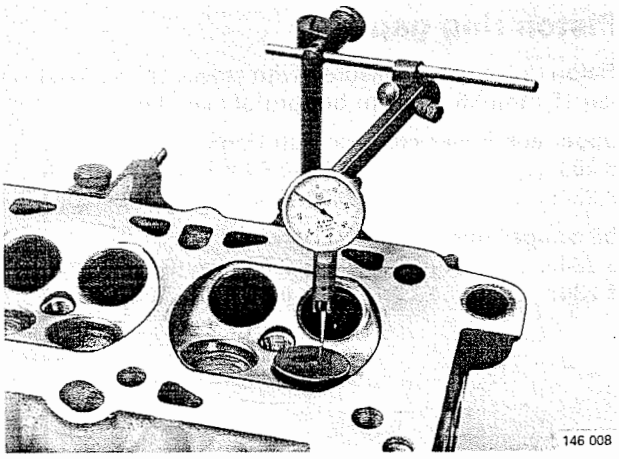
**B 204, B 234**
Gudgeon pin diameter ..... **23.0 mm** (0.9055 in)



146 414

## Connecting rods, big end bearing seat

Bearing seat diameter ..... **52.0 mm** (2.047 in)
Max. out-of-round..... **0.03 mm** (0.0012 in)


146 008

# VALVE ASSEMBLIES

## Valve guides

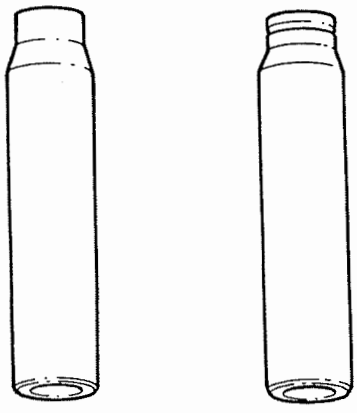
Lift valve **approx. 2–3 mm** (1/10 in) clear of seat when checking guides.

Clearance between new components:

Intake ..... **0.03–0.06 mm** (0.0012–0.0024 in)
Exhaust ..... **0.04–0.07 mm** (0.0016–0.0028 in)

**Max. clearance, used components:**

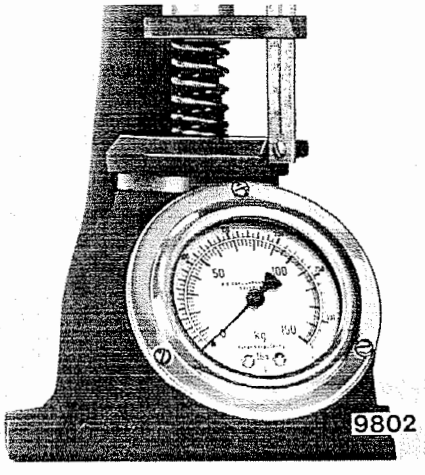
Intake/exhaust ..... **0.15 mm** (0.0059 in)


144 930

## Marking and dimensions of valve guides

Guide, P/N ..... **1 378 960–7**
**Standard:** Outside dia. ..... **12.0 mm** (0.4724 in)
No. of grooves: ..... **0**

Guide, P/N ..... **1 378 958–1**
**Oversize:** Outside dia. ..... **12.1 mm** (0.4764 in)
No. of grooves: ..... **1**

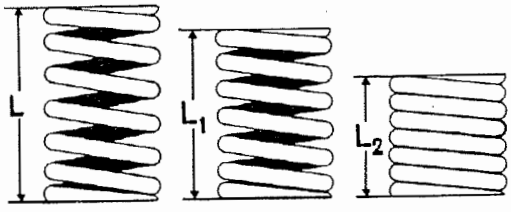


146 009

## Valve springs

Outside dia. ..... **26.2 mm** (1.0315 in)
Inside dia. ..... **18.1 mm** (0.7126 in)

| **Length, mm (in)** | **Load, N (lb)** |
|---|---|
| L: 43.0 (1.69) | 0 (0) |
| L1: 37.0 (1.46) | 232±20 (52±4.5) |
| L2: 26.5 (1.04) | 640±40 (144±9) |

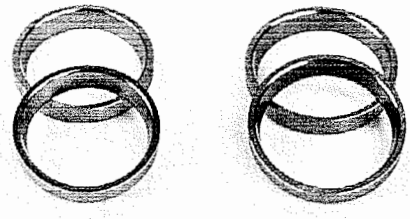


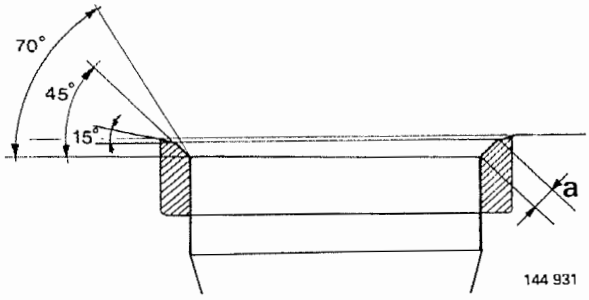
129 453

## Valve seats

Since the seats are not marked, the dimensions must be measured.

| **Valve seat diameter** | **Intake** | **Exhaust** |
|---|---|---|
| **B 234** | | |
| Standard ..... | **36.14 mm** (1.4228 in) | **33.14 mm** (1.3047 in) |
| Oversize ..... | **36.64 mm** (1.4425 in) | **33.64 mm** (1.3244 in) |
| **B 204** | | |
| Standard ..... | **34.14 mm** (1.3441. in) | **31.14 mm** (1.2260 in) |
| Oversize ..... | **34.64 mm** (1.3638 in) | **31.64 mm** (1.2457 in) |


146 027

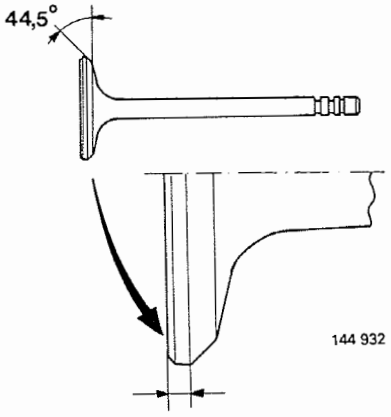



## Valve seats, machining

**Machine valve seats to following angles:**

Seating face, intake/exhaust ..... **45°**
Relief angle, upper ..... **15°**
Relief angle, lower ..... **70°**

**Valve seat width (a)**
Intake..... **1.3–1.9 mm** (0.051–0.075 in)
Exhaust..... **1.7–2.3 mm** (0.067–0.091 in)



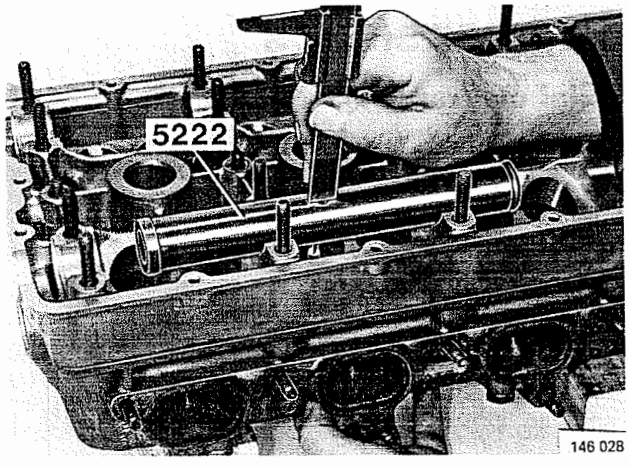

## Valves, machining

**Machine-grind intake valves to following angles:**

Seating face..... **44.5°**

Edge width, new valve..... **1.5 mm** (0.059 in)
Min. edge width after grinding ..... **1.2 mm** (0.047 in)

**Caution!** Exhaust valves are stellite-coated and must be ground only with grinding paste (carborundum).



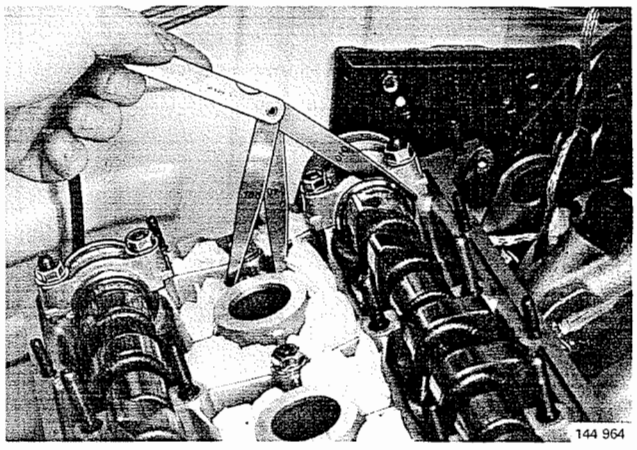

## Valve stems

Valve stem height... **49.4±0.4 mm** (1.9449±0.0157 in)

Max. machining allowance..... **0.4 mm** (0.0157 in)

Length, new valve:
Intake..... **122.45±0.2 mm** (4.8209±0.0079 in)
Exhaust..... **122.25±0.2 mm** (4.8130±0.0079 in)

**N.B. Correct valve stem height** is essential to satisfactory operation of hydraulic tappets.


144 964

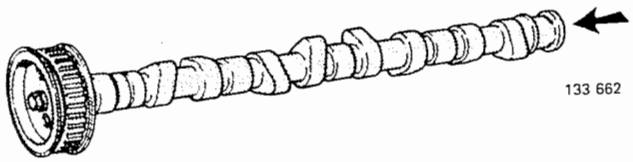
# CAMSHAFTS

## Axial clearance

Place camshafts in bearing seats.

Replace rear bearing caps and tighten nuts.

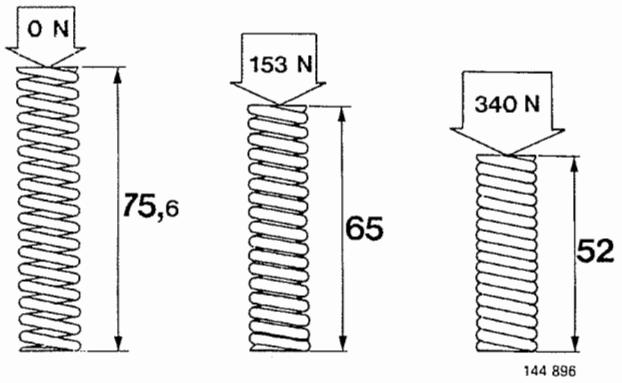
Axial clearance ..... **0.05–0.40 mm** (0.0020–0.0157 in)


133 662

## Marking, lift height

The camshafts are marked at the rear.

| Camshaft profile | Marking |
|---|---|
| Intake | U1 |
| Exhaust | U |

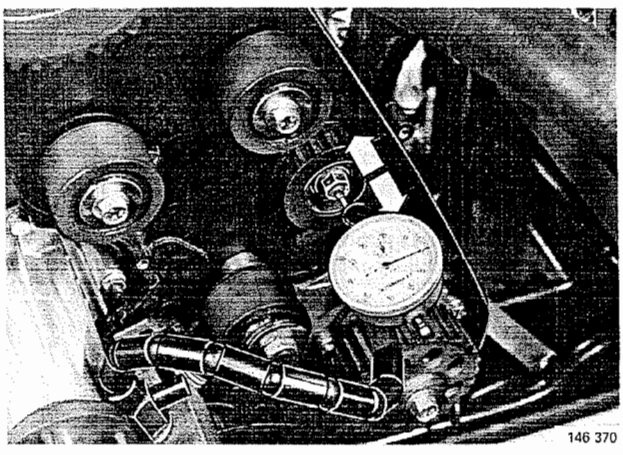


144 896

## Timing belt, tensioning spring

Inside diameter ..... **10.5 mm** $^{+0.5}_{0}$
(0.4134 in $^{+0.0197}_{0}$)

| Length, mm (in) | Load, N (lb) |
|---|---|
| 75.6 (2.98) | 0 (0) |
| 65.0 (2.56) | 153 (34.5) |
| 52.0 (2.05) | 340 (76.5) |


146 370

# BALANCE SHAFTS

## Axial clearance

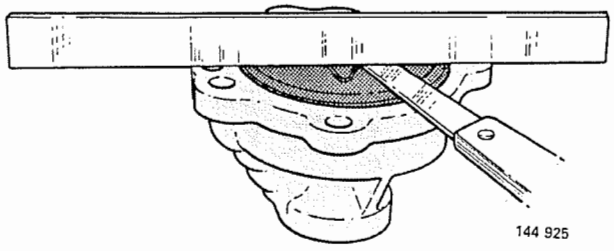
Axial clearance ..... **0.06–0.19 mm** (0.0024–0.0075 in)

## Belt tension – table of values

| | Timing belt | | | Balance shaft belt | |
|---|---|---|---|---|---|
| Coolant temp. | Check measurement, limiting values* | Existing belt | New belt | Existing belt | New belt |
| 20°C (68°F) | < 2,5<br>> 3,5 | 3,2±0,3 | 3,8±0,3 | 3,4±0,2 | 3,8±0,2 |
| 40°C (104°F) | < 3,2<br>> 4,2 | 3,9±0,3 | 4,4±0,3 | 3,9±0,2 | 4,3±0,2 |
| 87°C (187°F) | < 4,6<br>> 5,3 | 5,1±0,2 | 5,5±0,2 | 4,6±0,2 | 4,9±0,2 |

*Check to be carried out **10 000 km**(6 250 miles) (USA: 5 000 miles) after belt replacement

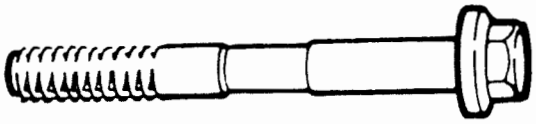
< = less than
> = greater than




# OIL PUMP

## Axial clearance of rotors

Axial clearance of inner and outer rotors in pump housing:
Specified clearance . **0.05–0.10 mm** (0.0020–0,0040 in)
(Measured with pump dry)



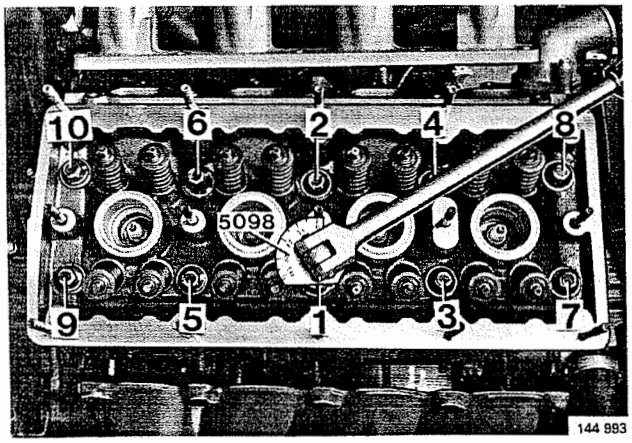
134 266

# TIGHTENING TORQUES

Specified torque values refer to oiled nuts and bolts. Degreased (washed) components must be oiled prior to assembly.

Any bolt showing signs of elongation must be replaced. This will be indicated clearly by thinning of the mid-section.
Bolts should be reused not more than **5** times.

Replace bolts if in any doubt regarding above.




144 993

## Cylinder head

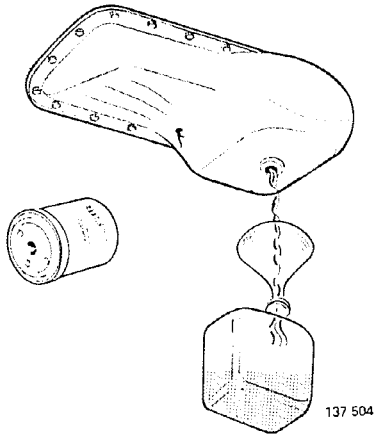
Insert and tighten bolts in three stages in specified order (see illustration):

1 = **20±2 Nm** (15±1.5 ft.lb)
2 = **40±5 Nm** (30±4 ft.lb)
3 = Tighten through **115°**±10°

| Component | Nm | (ft.lb) |
|---|---|---|
| Crankshaft,* stage 1 | **20** | (15) |
| stage 2 ... tighten through | **90°** | |
| Flywheel (use new bolts) | **70** | (52) |
| Spark plugs (do not oil) | **25**(±5) | (18±4) |
| Camshaft drive pulleys | **50** | (37) |
| Timing belt idler pulleys | **25** | (18) |
| Timing belt tensioner | **50** | (37) |
| Camshaft bearing caps | **20** | (15) |
| Balance shaft drive pulleys | **50** | (37) |
| Balance shaft belt tensioner | **40** | (30) |
| Camshaft carrier (central bolted joint) | **20** | (15) |
| Oil pump | **10** | ( 7) |
| Oil pump pulley, stage 1 | **20** | (15) |
| stage 2 ... tighten through | **60°** | |
| Crankshaft, pulley centre bolt, stage 1 | **60** | (44) |
| stage 2 ... tighten through | **60°** | |

* Original bolts may be used if length does not exceed 55.5 mm (2.19 in)

# Group 22 Lubrication system


137 504

## Engine oil

Capacity, excl. oil filter..... **3.5 l** (3.7 US qt)
incl. oil filter..... **4.0 l** (4.2 US qt)

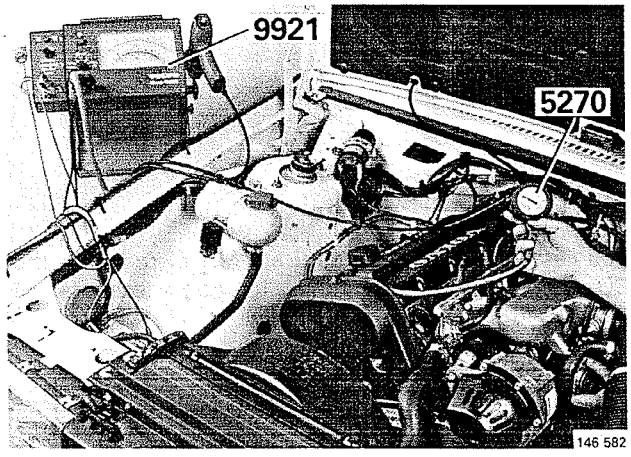
When replacing filter only:
Top up with 0.5 l (0.5 US qt).

### GRADE OF OIL

As per API-Service..... min. **SF***
As per CCMC..... class **G2/G3**

* Oils designated SF/CC and SF/CD fulfil this requirement.

Volvo does not recommend the use of additives, since these may have an adverse effect on engine life.



146 582

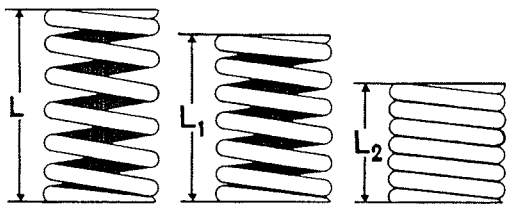
### OIL PRESSURE (min)

15 r/s (900 r/min)..... **0.10 MPa** (14.5 lb/in²)
33 r/s (2000 r/min)..... **0.25 MPa** (36 lb/in²)
50 r/s (3000 r/min)..... **0.50 MPa** (72.5 lb/in²

Max. oil pressure (relief valve setting)..... **0.80 MPa** (116 lb/in²)

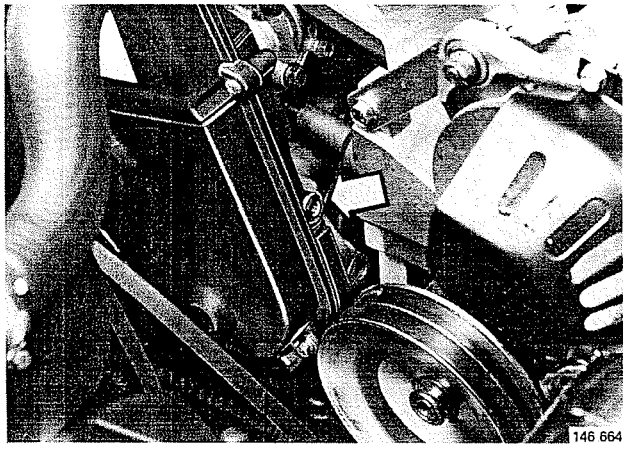
(1 MPa = 145 lb/in²)

**Relief valve spring** (length at different loads):



129 453

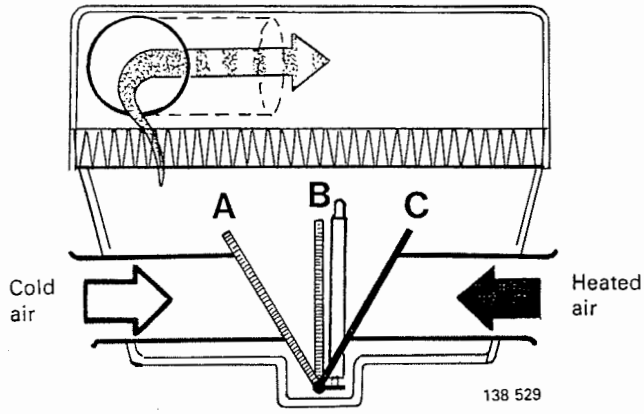
| **Load, N** (lb) | **Length, mm** (in) |
|---|---|
| 0 | **47.6** (1.87) |
| 44±4 (10±0.9) | 32.0 (1.26) |
| 61±6 (14±1.4) | 26.0 (1.02) |


146 664

## Relief valve

Tightening torque..... **40±4 Nm** (29.5±3 ft.lb)

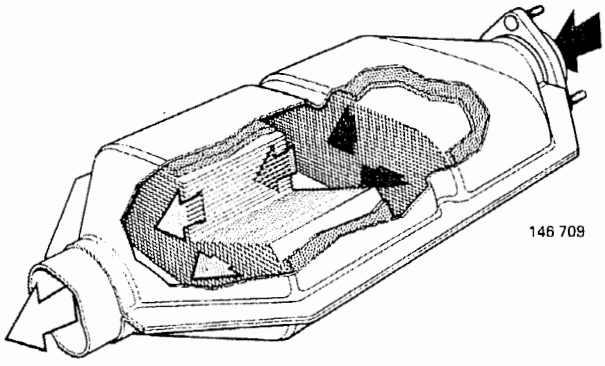
# Group 25 Intake and exhaust system




## Air cleaner

**Damper setting at different outside temperatures:**

A = < +5°C (41°F) (heated air only)
B = approx. +10°C (50°F)
C = +15°C (59°F) (cold air only)



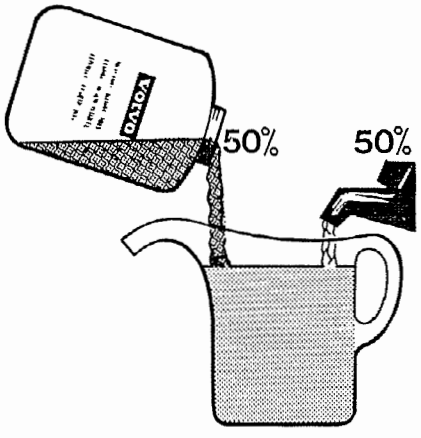

## Catalytic converter

The catalytic converter has the effect of reducing the CO content on reaching ignition temperature (450°C/840°F).

### Tightening of flange bolts

The catalytic converter mounting flange bolts must be pulled up after the first 1 000–2 000 km (625–1 250 miles) of driving.

# Group 26 Cooling system



128 187

## Coolant – composition – warranty

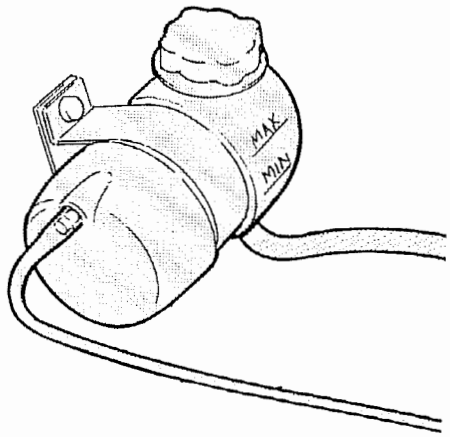
Genuine Volvo coolant diluted with clean water in proportions of 50/50 is the only coolant guaranteed by Volvo to prevent corrosion and freezing damage.

Type C (blue-green) coolant may not be mixed with any other type.

The coolant must be changed every second year to ensure protection against corrosion.

Only type C coolant should be used as a replacement.

Capacity, manual gearbox ..... **9.5 l** (10 US qt)
Capacity, automatic gearbox ..... **9.3 l** (9.8 US qt)



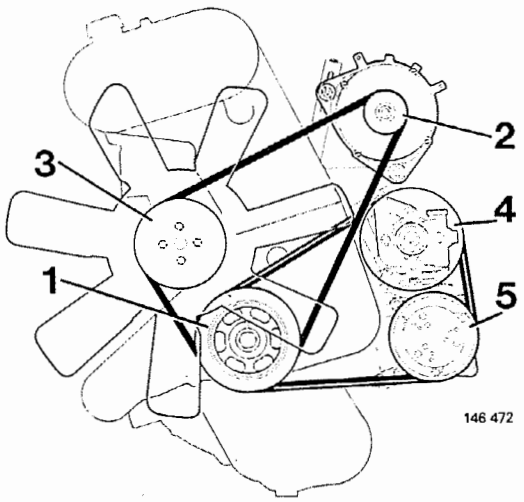
146 779

## Expansion tank

The relief valve in the cover opens at:
overpressure ..... **150 kPa** (22 lb/in²)
underpressure ..... **7 kPa** (1 lb/in²)

## Thermostat

Marking ..... **87**
Opening commences at ..... **86–88°C** (187–190°F)
Full opening at ..... **97°C** (207°F)



146 472

## Auxiliary drive belts

On cars with AC, the compressor and servo pump are driven by twin drive belts.

1. Crankshaft pulleys
2. Alternator
3. Radiator fan
4. Servo pump
5. AC compressor

Alternator ..... **HC 47*1288*1**
Servo pump ..... **HC 50*1063*1**
AC compressor/servo pump ..... **HC 50*1188*2**

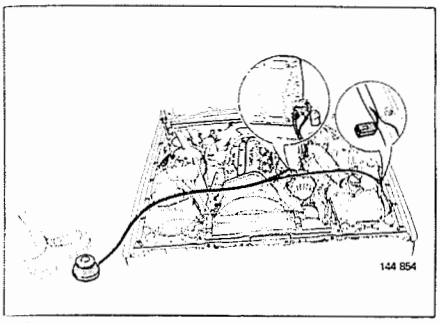
# Special tools

| 115 | Description – use |
|---|---|
| 8263-2 | **Starter switch:** for turning engine |
| 8280-6 | **Milling tool:** for machining valve seats |
| 8281-4 | **Piston ring compressor:** for fitting pistons in block |
| 8540-3 | **L155 extension sleeve:** for compression tester |

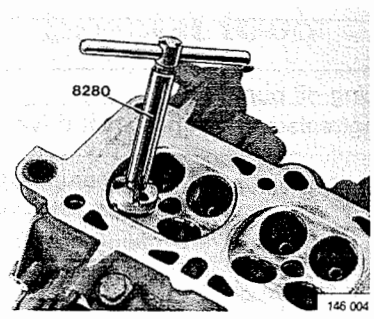
| 998 | Description – use |
|---|---|
| 5424-2 | **Piston ring holder:** for removing/refitting piston rings |
| 5496-0 | **Pressure tester:** for pressure testing cooling system |
| 6045-5 | **Mira** valve seat milling tool |
| 6052-0 | **Valve clamp:** for removing/refitting valve collets |
| 8500-6 | **Belt tension gauge:** for checking tension of timing/balance shaft belts |

| 999 | Description – use |
|---|---|
| 1426-0 | **Drift:** for fitting clutch release bearing |
| 1801-3 | **Standard handle:** for attachment to drifts |
| 2413-6 | **Counterhold:** for replacement of con rod bushings |
| 2520-8 | **Stand:** for fixtures |
| 2810-3 | **Lifting yoke:** used when removing and installing engine |
| 2903-6 | **Filter wrench:** for removing oil filter |
| 4090-3 | **Extractor:** for removing clutch release bearing |
| 5006-5 | **Lifting yoke:** for lifting engine |
| 5021-4 | **Press tool:** for removing/replacing camshaft |
| 5025-5 | **Assembly tool:** for fitting camshaft seal |
| 5033-9 | **Lifting bars:** for lifting engine |
| 5035-4 | **Attachment:** for lifting engine |
| 5039-6 | **Counterhold:** for removing/replacing oil pump rotors |
| 5098-2 | **Protractor:** for tightening cylinder head bolts to specified angle |
| 5111-3 | **Centering tool:** for centering clutch plate |
| 5112-1 | **Gear sector:** for locking flywheel |
| 5115-4 | **Lifting hook:** for lifting engine |
| 5185-7 | **Lifting hook:** for lifting engine |
| 5186-5 | **Lifting hook:** for lifting engine |
| 5199-8 | **Counterhold:** for removing/replacing camshaft pulley |
| 5219-4 | **Valve guide retainer:** for removing/replacing valve guide seals |
| 5222-8 | **Gauge:** for measuring valve stem length |
| 5244-2 | **15 mm socket:** for removing/replacing universal joint bolts |
| 5267-3 | **Lifting lug:** for removing/installing engine |
| 5270-7 | **Oil pressure gauge** |
| 5276-4 | **Drift:** for fitting crankshaft rear oil seal |
| 5283-0 | **Drift:** for fitting crankshaft front oil seal |
| 5284-8 | **Counterhold:** for removing/replacing vibration damper |
| 5297-0 | **Fixture:** for holding engine in stand 2520 |
| 5309-3 | **Drift:** for replacing con rod bushings |

| 999 | Description – use |
|---|---|
| **5361-9** | **Assembly tool:** for replacing oil pump seal |
| **5362-2** | **Counterhold:** for removing/replacing balance shaft drive pulley |
| **5363-0** | **Fixture:** for removing/replacing valve guides |
| **5364-8** | **Drift:** for removing/replacing valve guides |
| **5365-5** | **Drift:** for removing/replacing valve guides |
| **5366-3** | **Drift:** for removing/replacing valve guides |
| **5367-1** | **Reamer:** for reaming valve guides internally |
| **5368-9** | **Drift:** for fitting intake valve seats |
| **5369-7** | **Drift:** for fitting exhaust valve seats |
| **5373-9** | **Reamer:** for oversize valve guides |
| **5376-2** | **Extractor:** for removing balance shaft housing |
| **5377-0** | **Drift:** for fitting intake valve seats |
| **5378-8** | **Drift:** for fitting exhaust valve seats |
| **5379-6** | **Drift:** for fitting valve stem seals |
| **5871-2** | **Lifting lug:** for removing/installing engine |
| **5872-0** | **Guide:** spacer for 5284 |
| **5972-8** | **Fixture:** for removing/installing gearbox |
| **5996-7** | **Assembly tool:** for fitting balance shaft seals |
| **9639-9** | **Dial gauge:** for internal measurements |
| **9678-7** | **Honing tool:** dia. 60–105 mm |
| 9689-4 | Compression tester: for petrol engines |
| **9701-7** | **Micrometer:** 0–25 mm |
| **9702-5** | **Micrometer:** 25–500 mm |
| **9704-1** | **Micrometer:** 75–100 mm |
| **9802-3** | **Spring tester:** for measuring spring load/length |
| **9921-1** | **Volvo Monotester** |




115 **8281**

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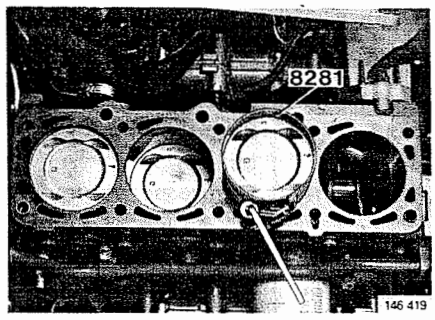


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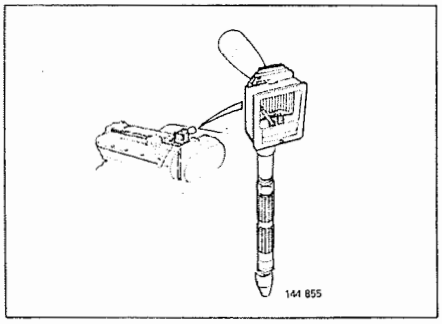


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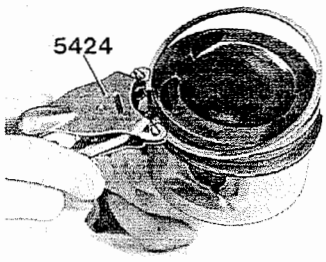


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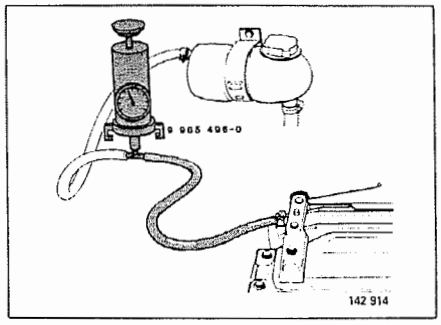


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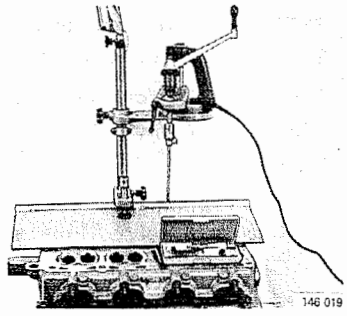


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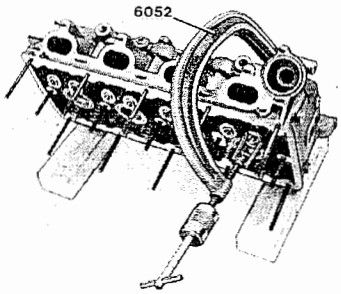


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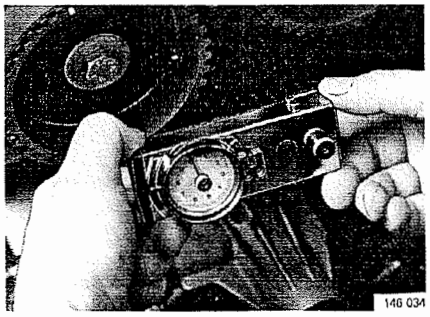
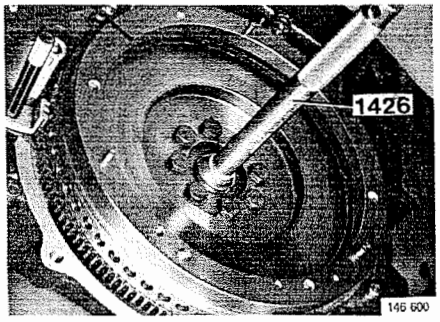



998 **8500**

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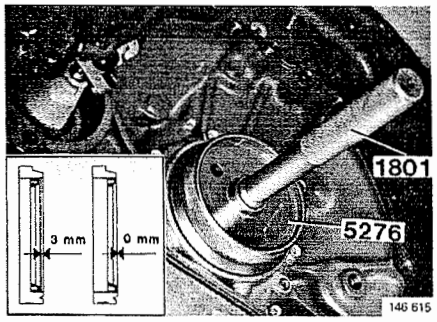


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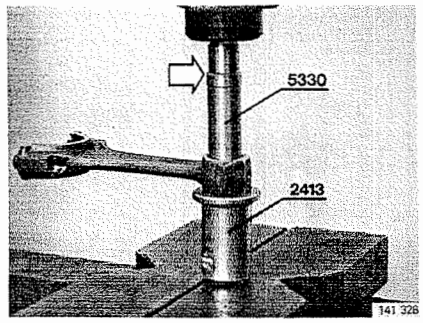
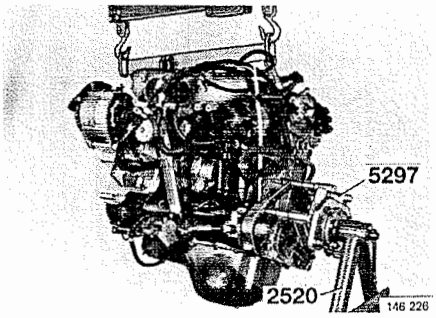
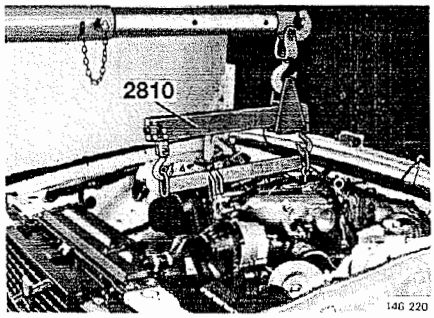



999 **2413**

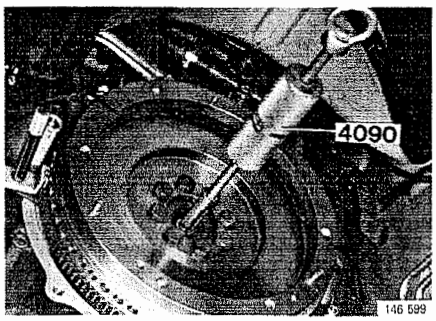



999 **2520**




999 **2810**


999 **2903**

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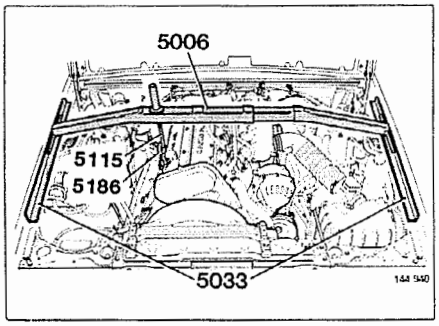


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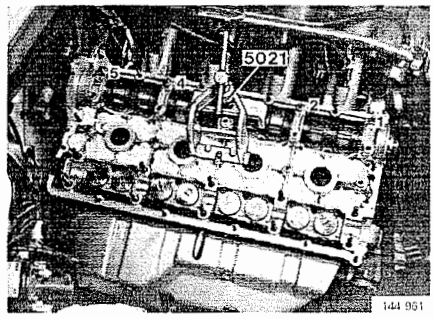


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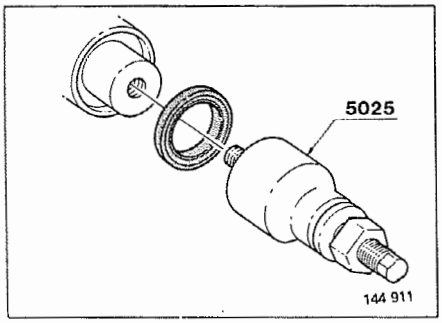


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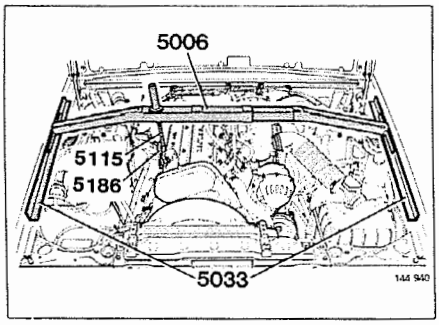


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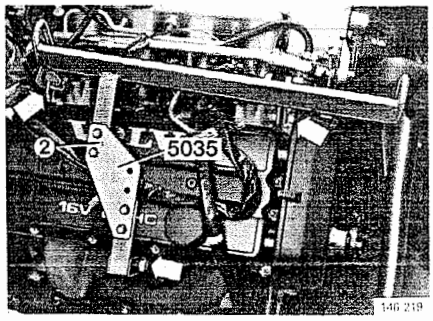


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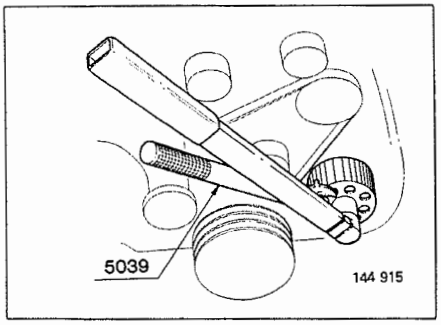


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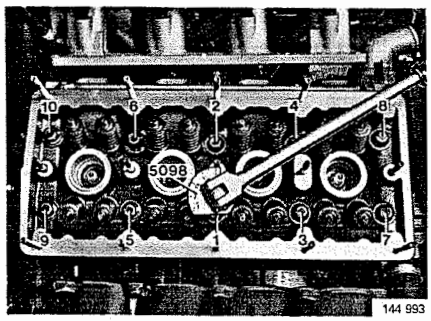
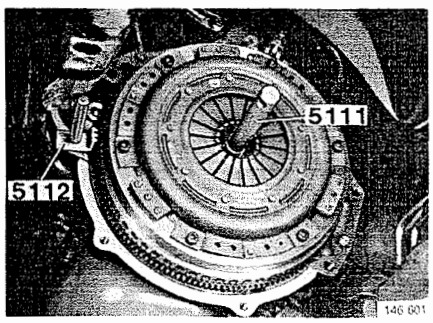



999 **5098**

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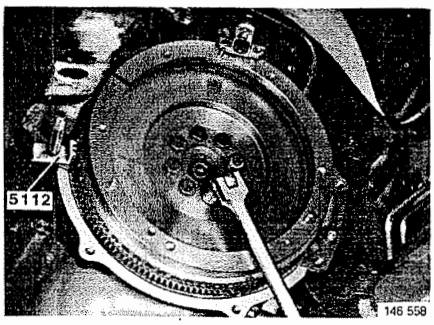


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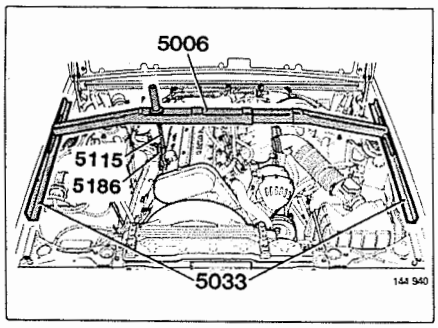


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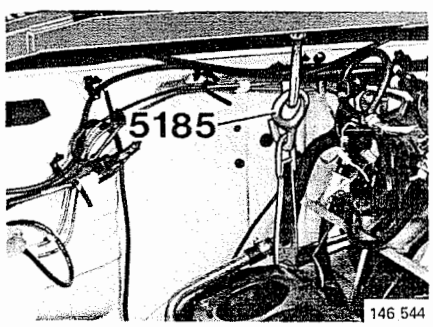


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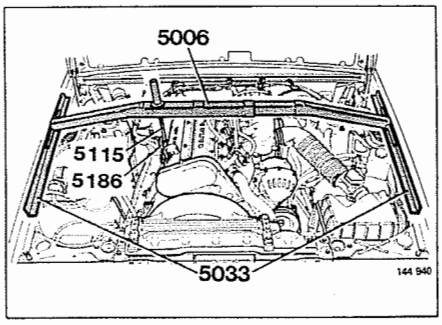


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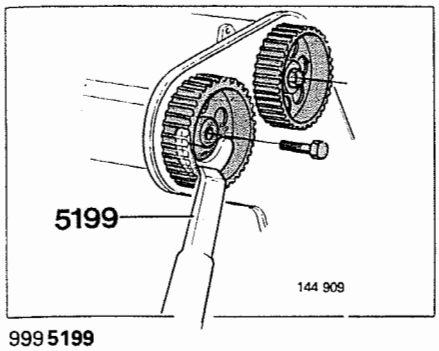


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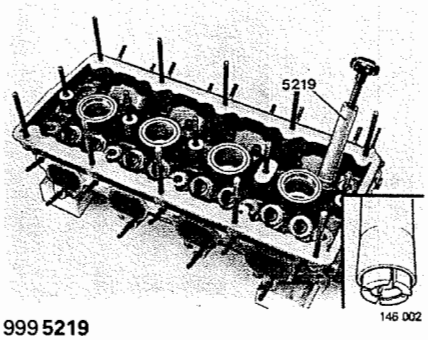


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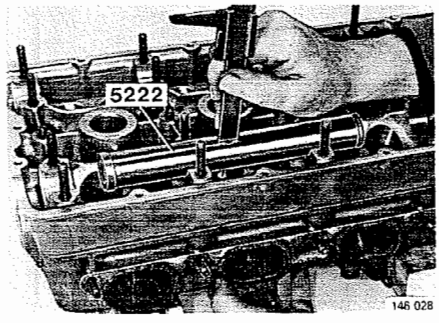


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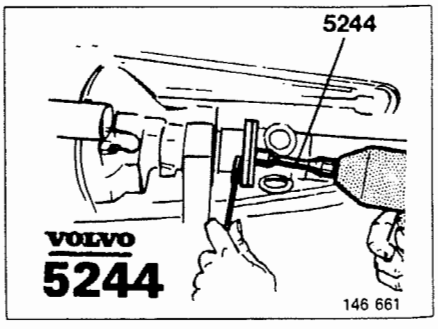


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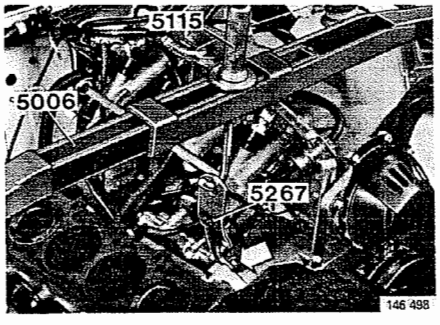


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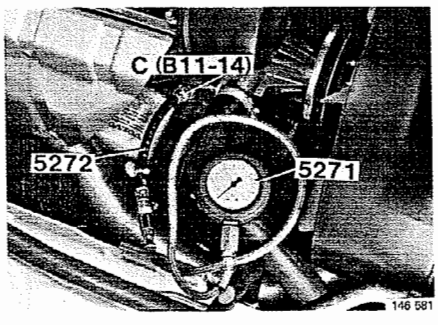


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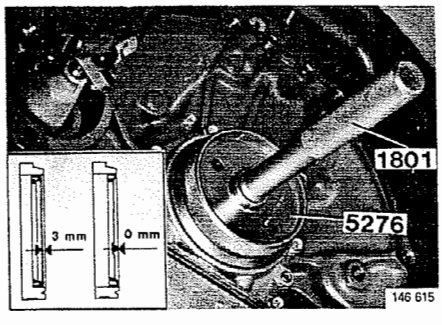


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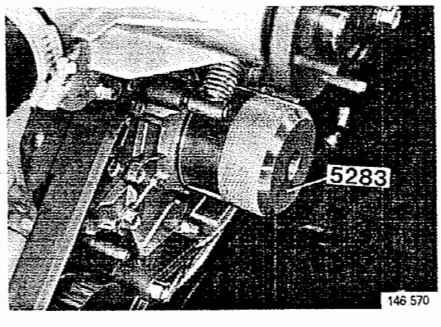


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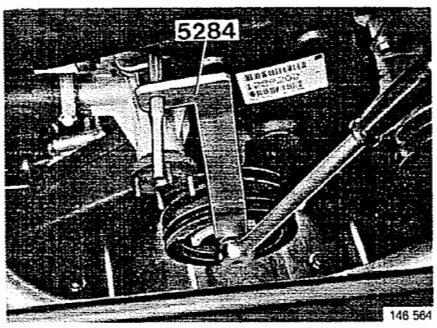


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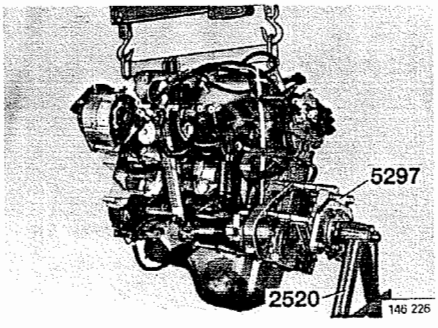


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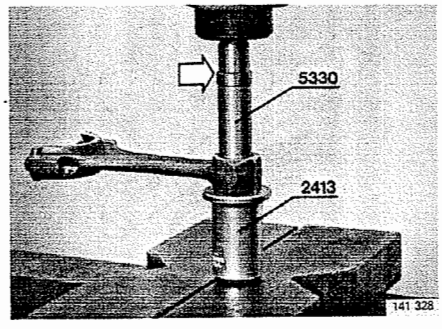


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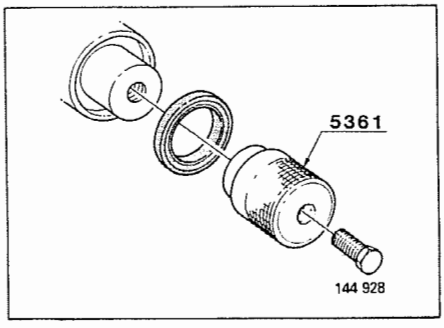


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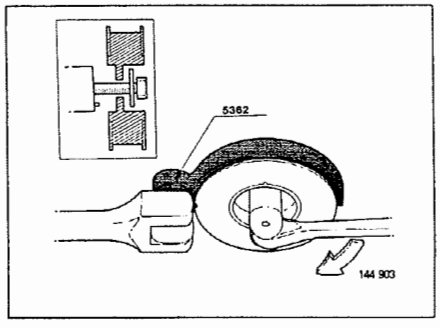


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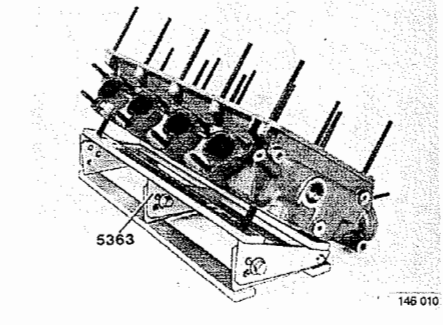


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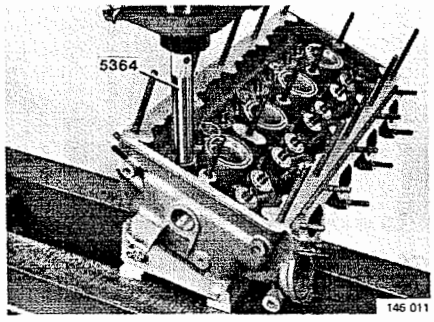


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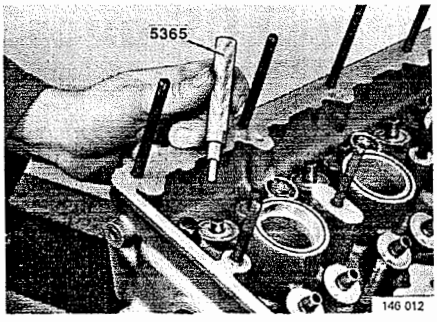


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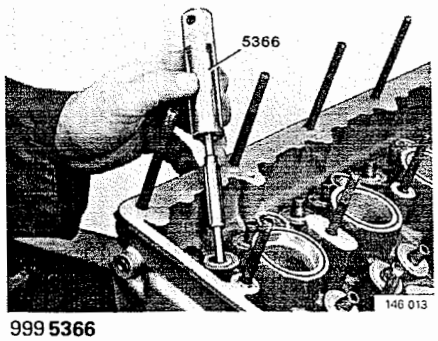


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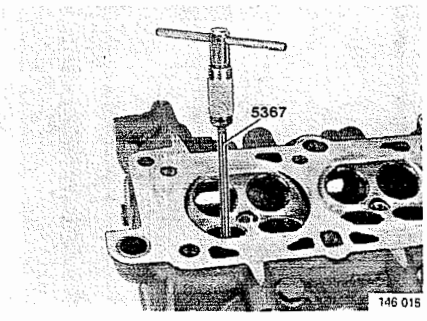


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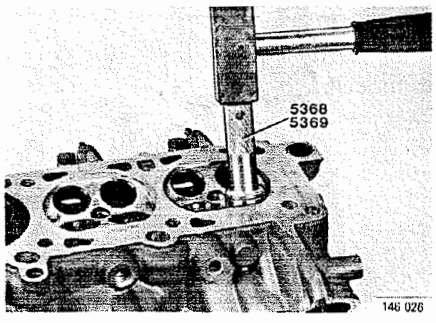
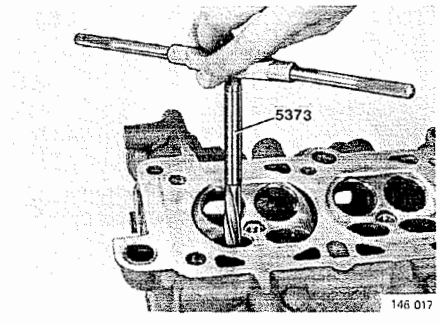



999 **5368, 5369**

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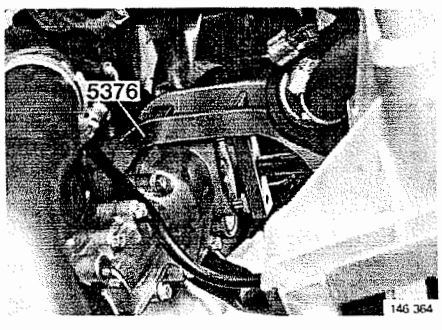


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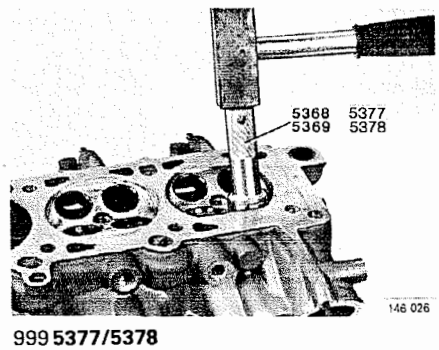
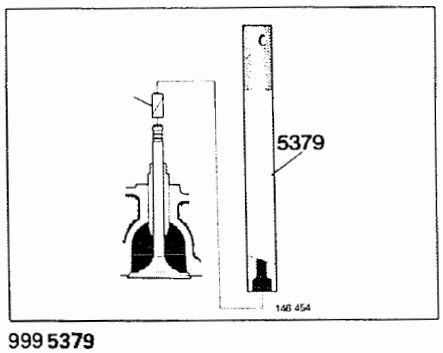



999 **5377/5378**

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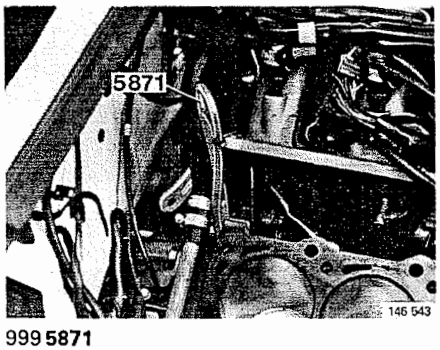


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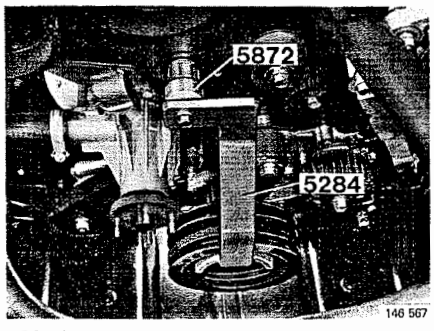


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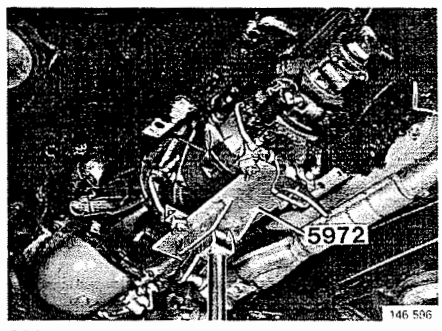


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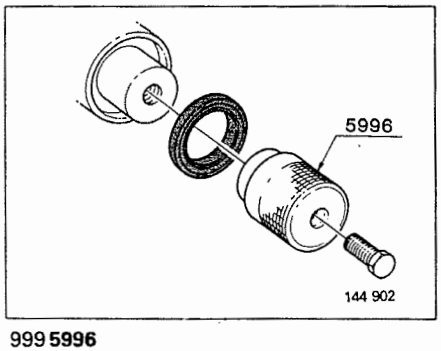


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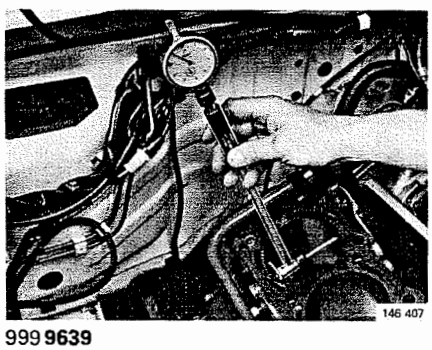


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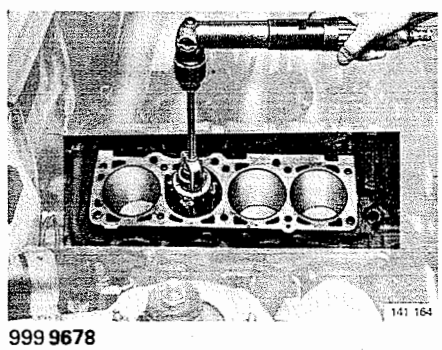


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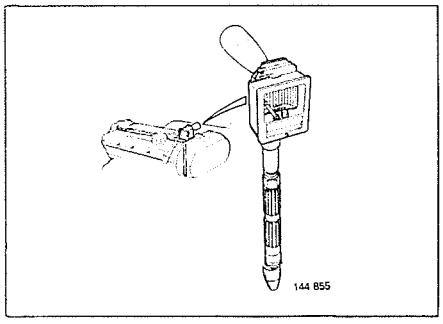


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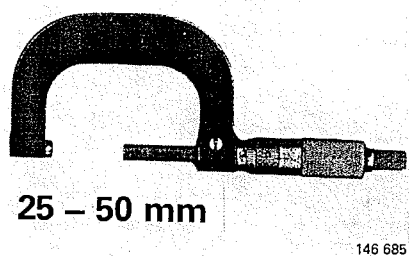


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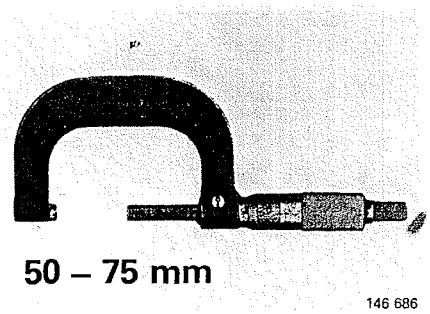


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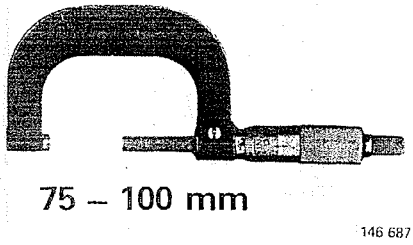


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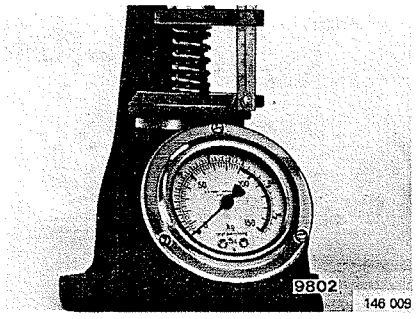


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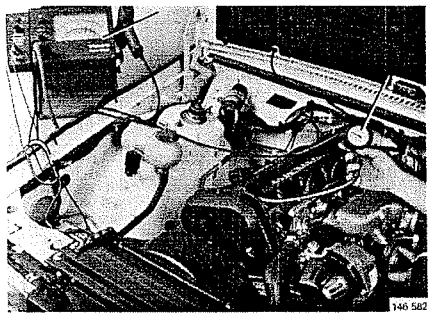
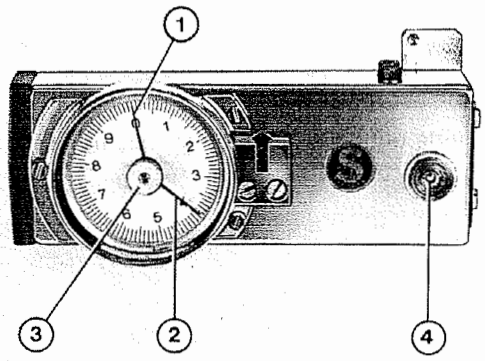



999 **9921**

# Group 20 General

## Belt tension gauge – use and calibration

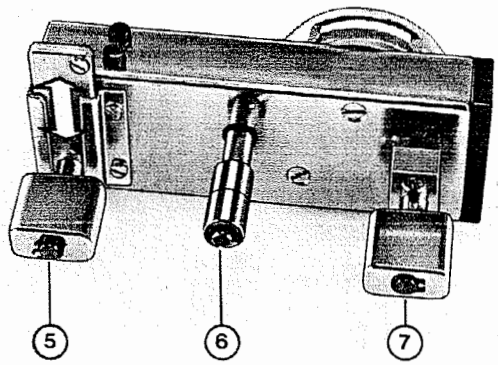
It is essential that the belts be **correctly tensioned** to ensure maximum reliability and long life. Gauge **998 8500** must be used to adjust the tension to the correct value.




146 032

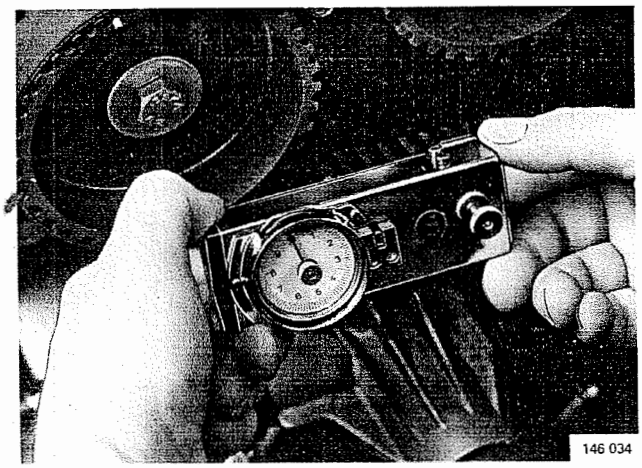
**Components of gauge**

1. Indicator
2. Indication marker
3. Marker adjuster
4. Movable guide latch




146 033

5. Movable guide
6. Sensing roller
7. Fixed guide



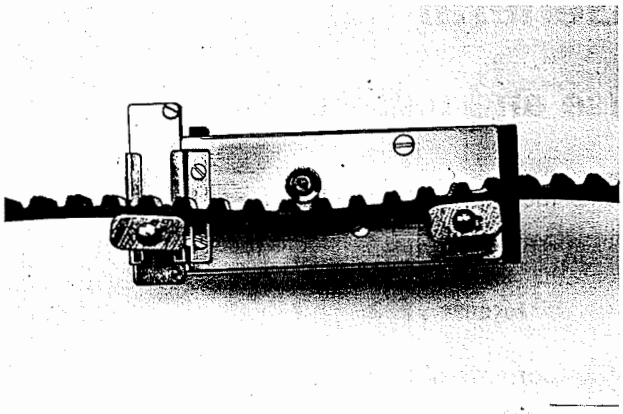
146 034

**Measurement**

**Check that gauge is zeroed**

Turn dial to zero indicator.

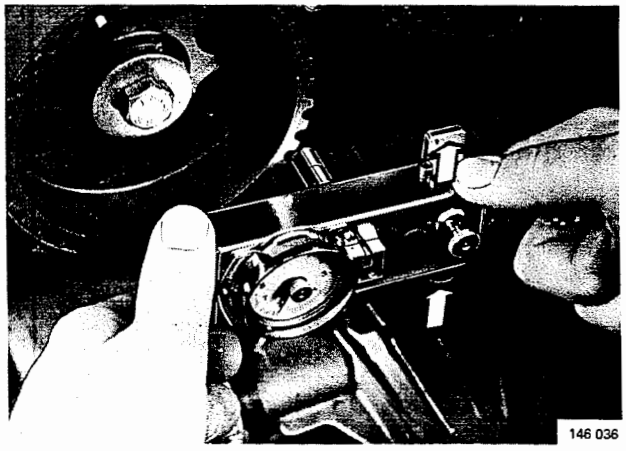
Release movable guide.



146 035

**Place gauge on belt**

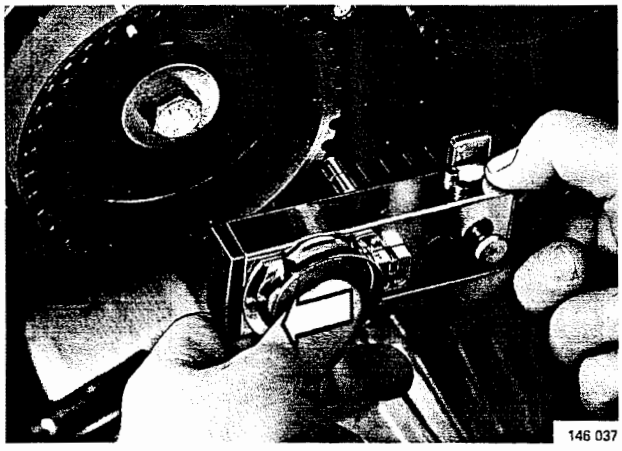
Position sensing roller between two teeth.



146 036

**Raise movable guide**

Raise guide until it locks in upper position.

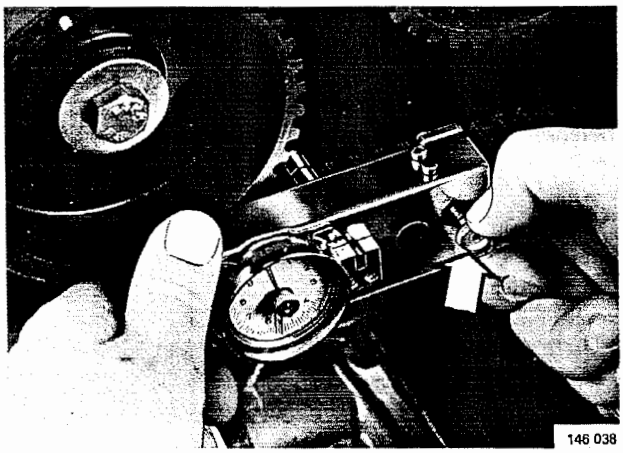


146 037

**Hold gauge in neutral position against belt**

Hold gauge without pressing upwards or downwards.

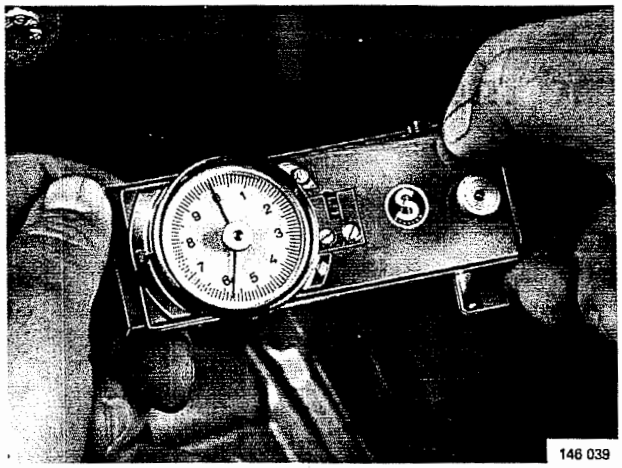
Set indication marker to coincide with indicator.



146 038

**Release movable guide**

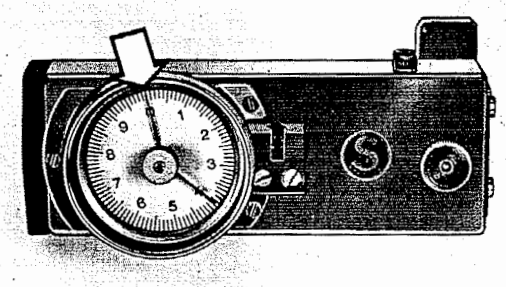
Pull out movable guide latch.


146 039

**Remove gauge from belt and read indicated value**

## Calibration

**Gauge must be calibrated**
- after **prolonged** use (approx. 100 measurements),
- following exposure to **minor** shocks.


146 040

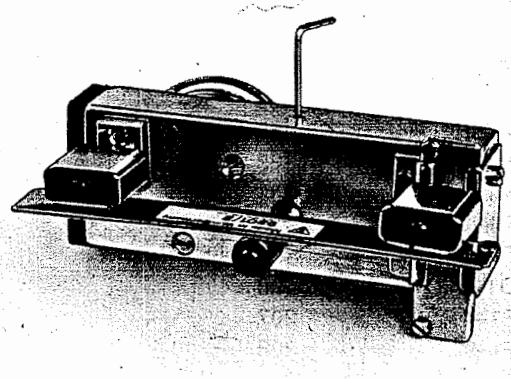
## Check that gauge is zeroed

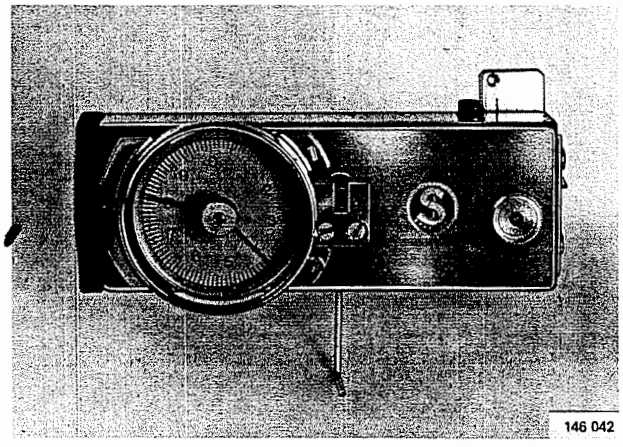
Turn dial until indicator reads zero.

## Place calibration plate in position

Position plate with projections in contact with guides.

Press movable guide upwards until locked in upper position.


146 041


146 042

## Calibration value

Gauge should now read **4.0** units.

**If value is incorrect:** Adjust using 1.5 mm Allen key inserted in hole 1 in bottom of gauge.

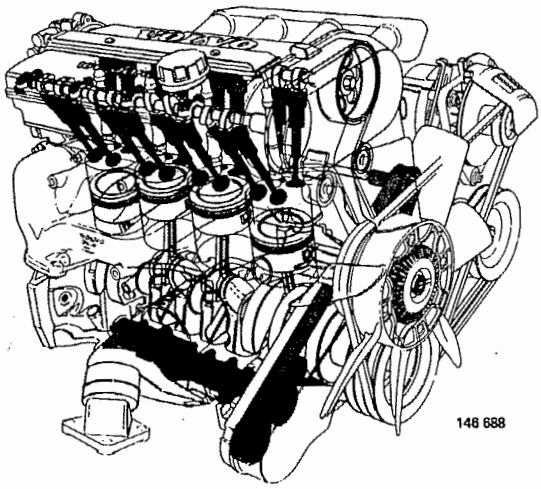
**Caution!** Adjustment must be limited to within ± 1 unit of the calibration value. If error is greater, return instrument to **Volvo Parts** for repair.

# Group 21 Engine and mountings

## Contents

# Design/function

# Engine

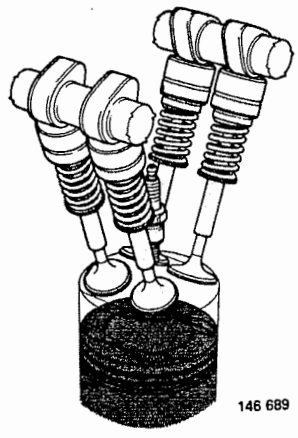



**Features common to B 204 and B 234 engines:**

- In-line, 4-cylinder, liquid-cooled engine
- Inclined 20° to right for installation purposes
- Cast iron cylinder block with cylinders bored directly in block
- Cast light-alloy pistons
- Forged steel connecting rods and crankshaft
- Light-alloy cylinder head
- Cross-flow configuration i.e. intake and exhaust passages located on opposite sides of combustion chambers
- Twin overhead camshafts
- Four valves per cylinder
- Two externally-mounted balance shafts
- Camshafts, balance shafts and oil pump driven by toothed belts

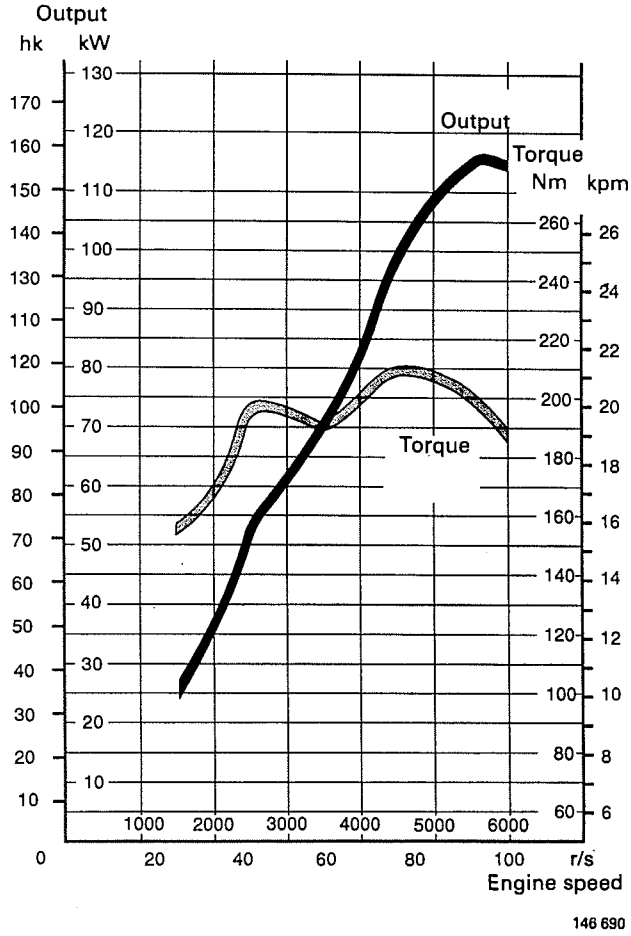
**Differences between basic B 204 engine and B 234:**

- Cubic capacity (2.0 litre)
- Pistons (smaller diameter)
- Valves (smaller diameter)
- Balance shafts (lower moment of inertia)




**Four valves per cylinder**

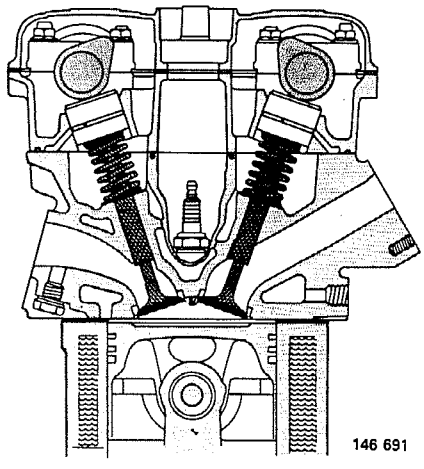
The introduction of four valves per cylinder improves engine 'breathing'. Gas flow conditions in the cylinders are improved, producing more complete combustion of the fuel/air mixture and improving the efficiency of the engine.




### Output and torque diagram for 1988 B 234 F engine

As the curves show, maximum output is achieved at **5800 r/min** while maximum torque is developed at **4450 r/min.**

Overrun protection operates at 6200 r/min. (Maximum speed varies somewhat depending on market and model variant.)



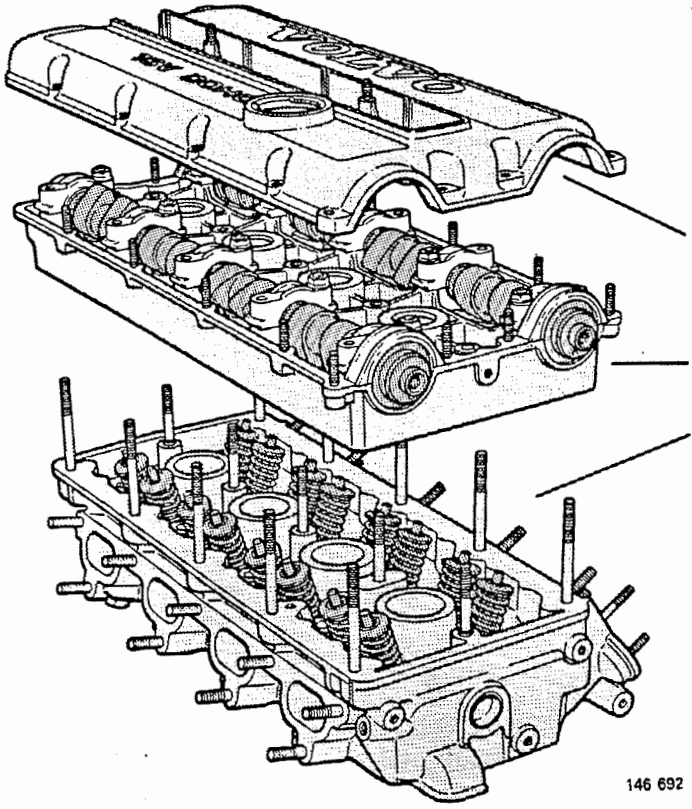

### Twin overhead camshafts

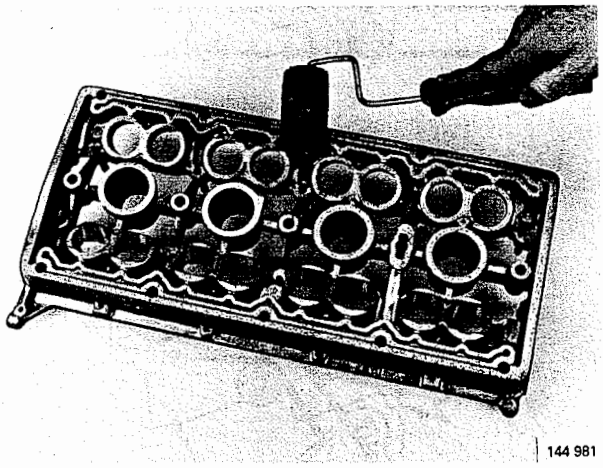
The valves are operated by twin overhead camshafts through hydraulic tappets. The oil-filled tappets are self-adjusting.

Since the valve guides are inclined at an angle of 19° to the vertical, the use of a special tool is recommended when replacing the components.

## Valve cover gaskets

The valve cover is provided with two types of gasket, one for sealing the spark plug wells and the other the outer perimeter of the joint.



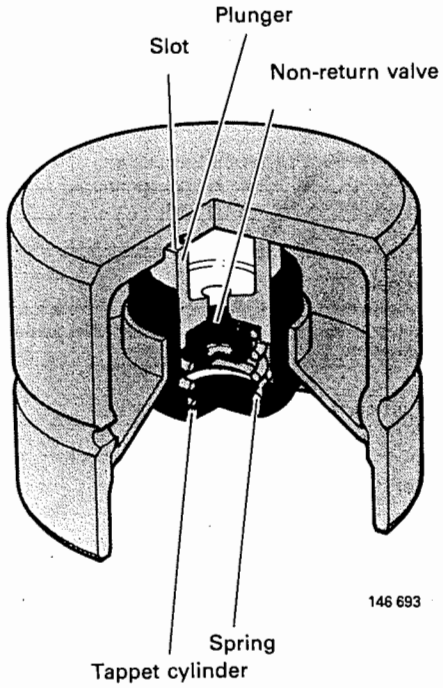




The joint between the camshaft carrier and cylinder head is sealed in two ways:

- The spark plug wells are sealed using four O-rings and a liquid sealing compound (liquid gasket).
- A **liquid sealing compound** is used to seal the flat mating surfaces between the components.

It is essential that the surfaces be thoroughly **cleaned** and that all traces of oil be removed before applying new sealing compound.

The compound is applied with a short-haired roller.

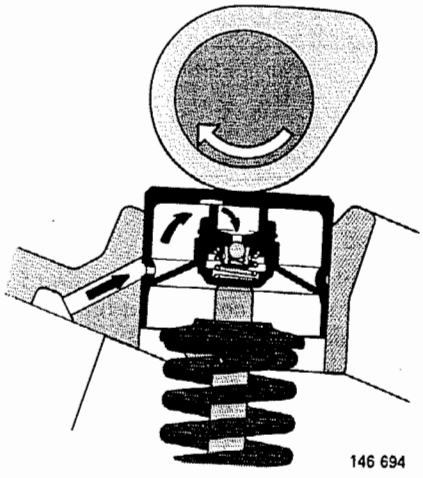



## Hydraulic tappets

The valves are operated by twin overhead camshafts through hydraulic tappets. The oil-filled tappets are self-adjusting.

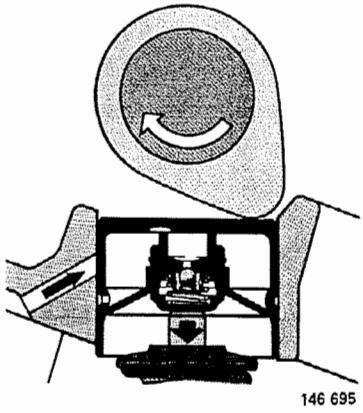
Each tappet is held in contact with the camshaft by a spring in the tappet cylinder. The spring force is lower than that of the valve spring to ensure that the valve is free to expand linearly.

A non-return valve prevents the escape of oil when the camshaft is operating the tappet and when the oil pressure in the tappet cylinder is higher than the engine oil pressure.



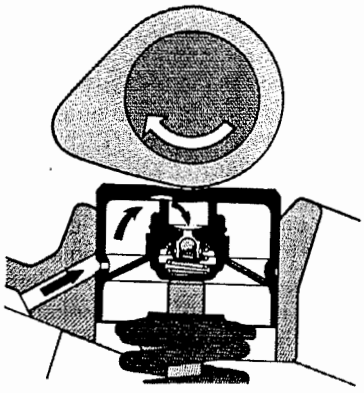

### Tappet in contact with base circle of cam

Oil from the camshaft carrier is forced into the tappet through a groove and a series of holes in the side, entering the plunger through a slot in the top. Since the engine oil pressure is higher than that in the tappet cylinder when the tappet is not operated by the cam, the oil flows through the non-return valve into the tappet cylinder.




### Tappet operated by cam

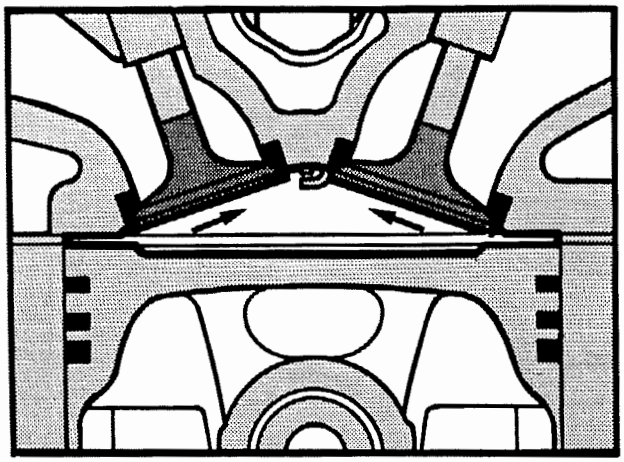
The oil pressure in the tappet cylinder now exceeds the engine oil pressure, closing the non-return valve and effectively making the assembly a solid component.



146 696

**Tappet resumes contact with base circle of cam**

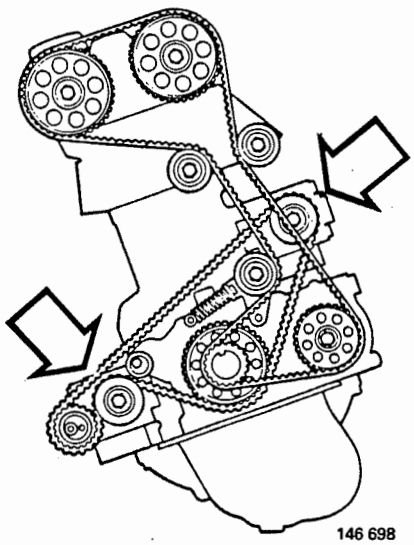
The engine oil pressure again exceeds that in the tappet cylinder, opening the non-return valve and admitting oil to maintain the tappet in contact with the cam.



146 697

### Combustion chamber

The 'pent-roof' combustion chamber features squish zones which force the fuel/air mixture towards the centre of the chamber as the piston approaches top dead centre (TDC) on the compression stroke – a feature which promotes excellent mixing as the fuel approaches the spark plug. The resultant short combustion path promotes rapid combustion, reducing the risk of self-ignition (or knock) and enabling a high compression ratio to be used. This, in turn, yields high performance at low fuel consumption.



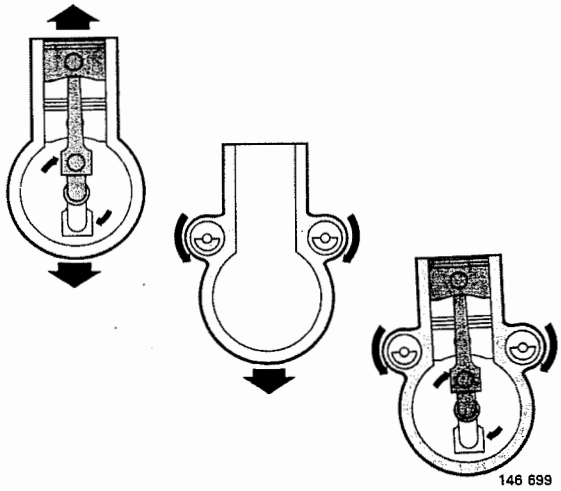
146 698

## Balance shafts

The vibrations caused by the reciprocating movement of the pistons are counterbalanced by two counter-rotating balance shafts running at twice the engine speed.

Each of the two externally-mounted balance shaft housings is split. Made of die-cast aluminium, the housings are located at different heights on the block. The block casting is provided with bosses which are milled out to provide a press fit for the housings. Securely located, the housings are then bolted in position. The right-hand housing also supports the drive belt tensioner.

The joint between the housing halves is sealed with a liquid sealing compound in the same manner as that between the camshaft carrier and cylinder head.


146 699

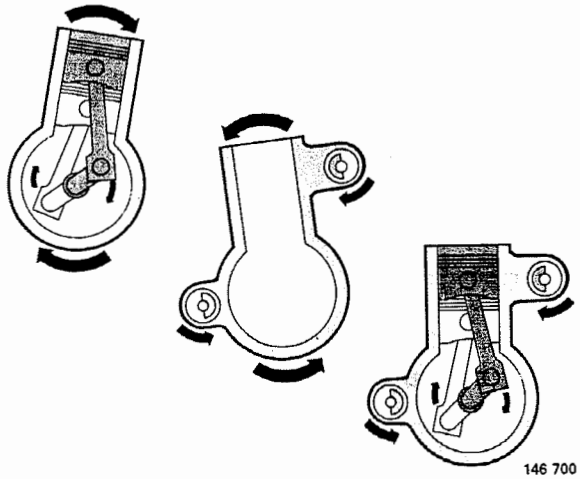
### Equalization of upward and downward forces

In a 4-cylinder engine, vibrations are caused by the reciprocating action of the pistons as they move upwards and downwards in pairs. The two outermost pistons (1 and 4) are at top dead centre (TDC) when the inside pair (2 and 3) are at bottom dead centre (BDC), and vice versa. However, since the forces developed by each pair of pistons differ, they do not cancel each other completely. (The force due to a piston and crankshaft is greater at TDC than at BDC since, in the latter position, the mass of that portion of the crankshaft above the centre line is partly counterbalanced by that below.)

The purpose of the balance shafts is to increase the force developed by the piston pair reversing at BDC, thereby equalizing that due to the pair at TDC.

Since two piston reversals occur during each revolution of the crankshaft, the balance shafts rotate at twice the speed of the engine. The balance weights mounted on the shafts reach their lowermost position each time one of the piston pairs reverses at BDC.

As a result, the force developed by this particular pair is increased, equalizing that of the pair at TDC and producing smoother running.

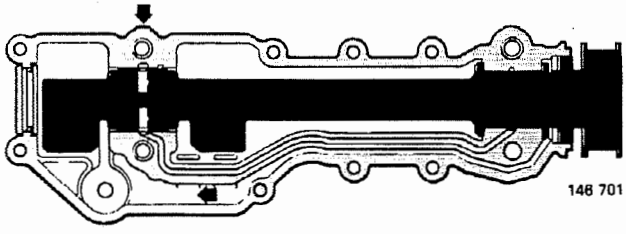

146 700

### Equalization of lateral forces

The lateral forces produced by the action of the pistons at TDC and BDC cause the engine to pivot about an axis located approximately at the mid-point of the block.

The balance shafts are located at different heights on the block to counteract the resultant moment. The forces due to the balance weights combine to exert a moment which opposes that produced by the pistons.

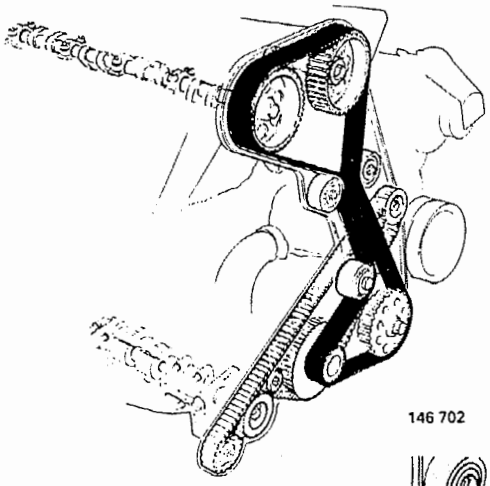
Cancelling the moments produces smoother running in this respect also.


146 701

### Lubrication of balance shaft

Pressurized oil is supplied to the rear balance shaft bearings, each of which is an extra heavy-duty shell type. The rear section of the shaft is subject to the highest stresses since the balance weights are located at that end.

The front bearing is machined in the housing and is lubricated from the rear bearing through a channel formed by matching grooves formed in the two halves. The oil is discharged through an outlet in the bottom half of the housing.

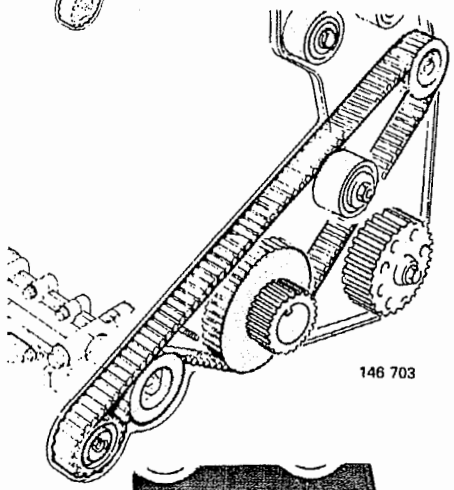

146 702

## Camshaft and balance shaft drives

### Camshaft drive

The camshaft drive consists of a conventional single-toothed belt which drives both camshafts and the oil pump.

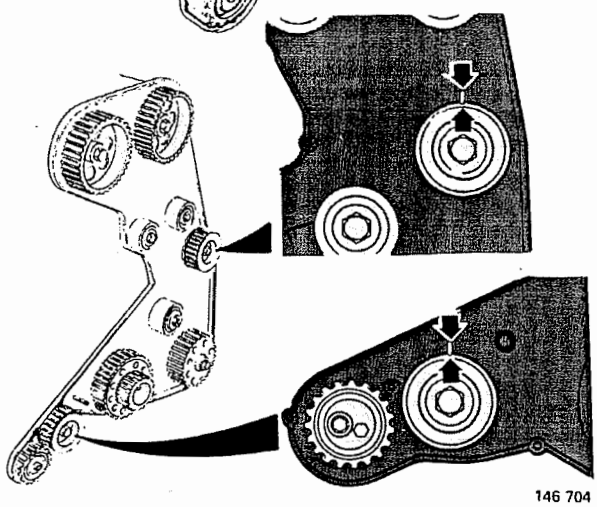
The belt tension is controlled by a spring-loaded tensioner, while alignment is maintained by two idler pulleys.


146 703

### Balance shaft drive

Rotating in opposite directions, the two balance shafts are driven from the crankshaft by a double-toothed belt.

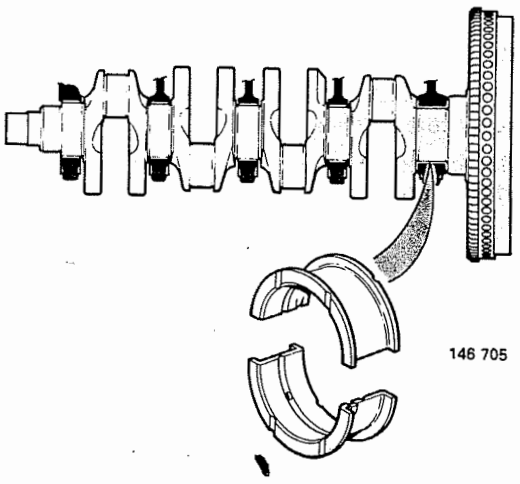
The left-hand shaft is driven by the inside teeth and the right-hand shaft by the outside teeth.


146 704

### Tensioning of balance shaft belt

A tensioner mounted eccentrically on the housing below the right-hand balance shaft is used to control the belt tension, the alignment of which is maintained by an idler. Since tensioning of the balance shaft belt must be carried out with the greatest accuracy, the instructions in the workshop manual must be followed exactly.

Overtensioning of the belt may damage the balance shaft housings, while insufficient tension may cause misalignment.


146 705

## Crankshaft

The crankshaft main bearings are 63 mm in diameter. The 35.5 mm wide thrust bearing (rear main bearing) is of the flanged shell type with a bearing surface of 2x360°. The big-end bearings on the **connecting rods** are of the low-friction type, while the gudgeon pins are located in a high position in the pistons – a feature which minimizes friction and vibration, although imposing greater demands in terms of cooling and lubrication. The engine is fitted with a 'heavy' **flywheel** weighing 12.7 kg (28 lb).

# A. Compression testing

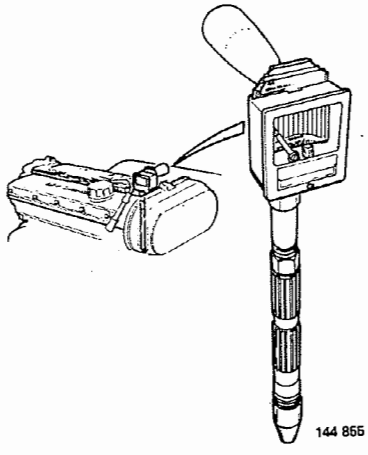
*Special tools: 9689, 115 8263, 115 8540*

143 094

## Ignition system

**Warning!** The ignition system operates at **high power,** with **dangerous** voltages in both the low-tension and high-tension circuits.

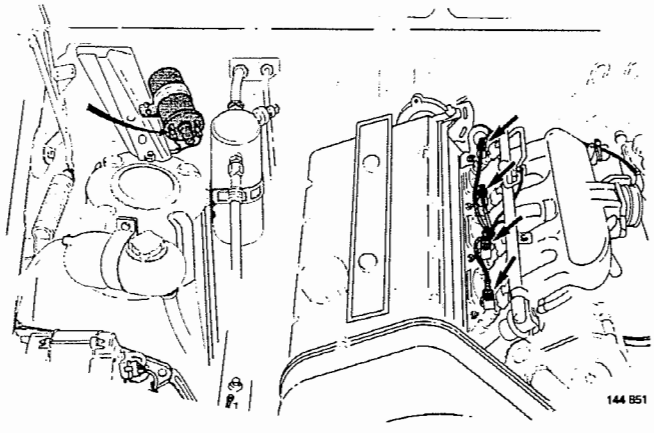
Dangerous voltage levels occur **in all parts of the ignition system,** including connectors and similar fittings.


144 855

### Measure compression at full throttle with engine hot

Normal value ..... **0.9-1.1 MPa** (131-160 lb/in²)

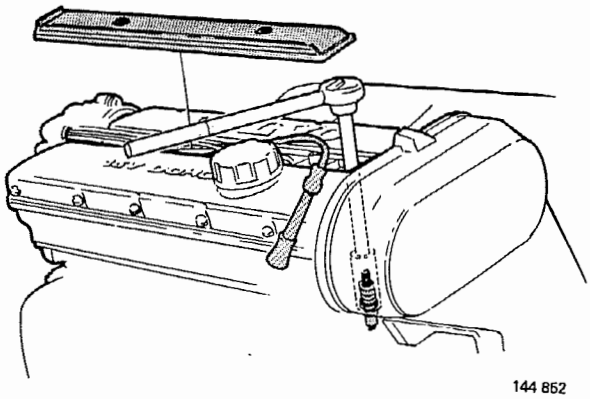
**N.B.** Above value applies when engine is hot, throttle is fully open and engine is turned at 4.2-5.0 r/s (250-300 r/min) using starter motor.


144 851

*A1*

### Disconnect:

- lead from terminal 1 on ignition coil (to prevent flashover to electrical system wiring)
- injector connectors (to prevent flooding of engine and dilution of engine oil)



144 852

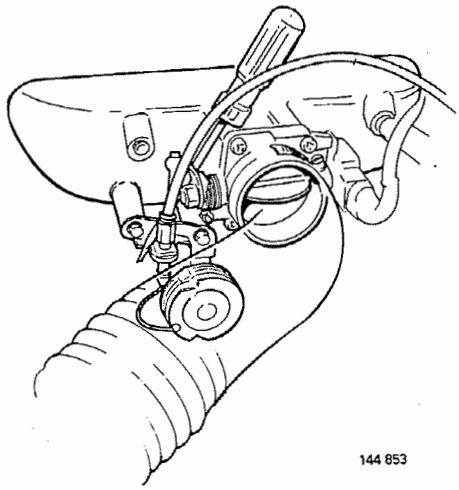
*A2*

**Remove:**

- ignition lead cover plate
- ignition leads from plugs
- plugs from cylinder head

Clean spark plug wells as required before removing plugs. Check condition of plugs.

**N.B.** Always grip ignition leads by **caps** when removing to avoid damage to leads.

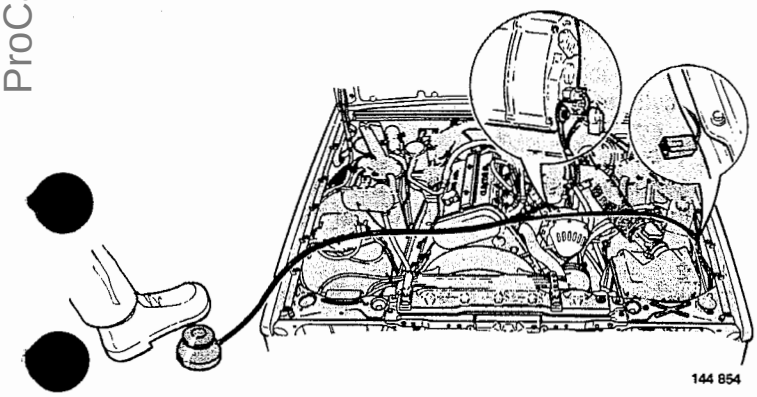


144 853

*A3*

**Lock throttle in fully open position**

Use tool such as screwdriver for this purpose.



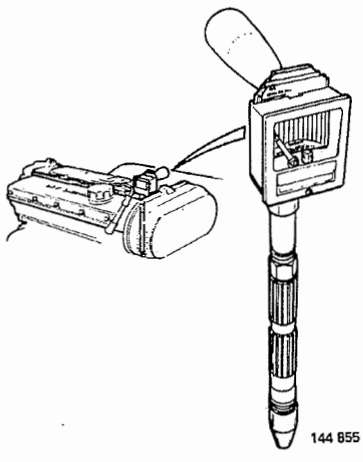
144 854

*A4*

**Connect starter switch**

Use special tool **115 8263-4.**

Connect switch in series with alternator (+) and service point on left-hand wheel housing.



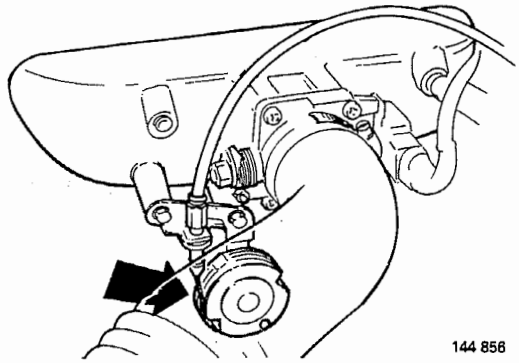
144 855

*A5*

**Measure compression**

Use compression tester **9689** and extension sleeve **115 8540.**

Measure compression in all cylinders.

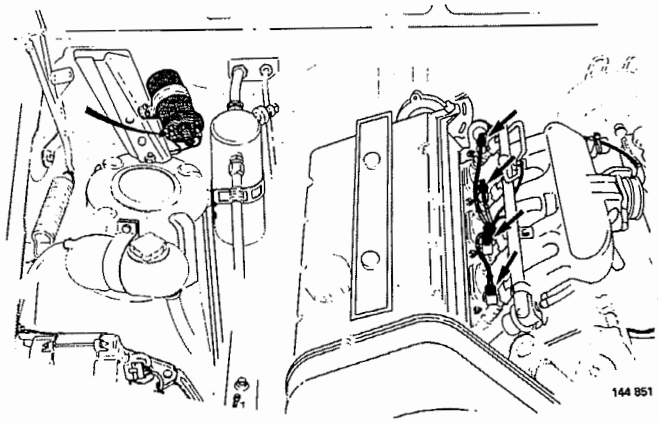



*A6*

**Disconnect/remove:**

- starter switch
- throttle 'lock'

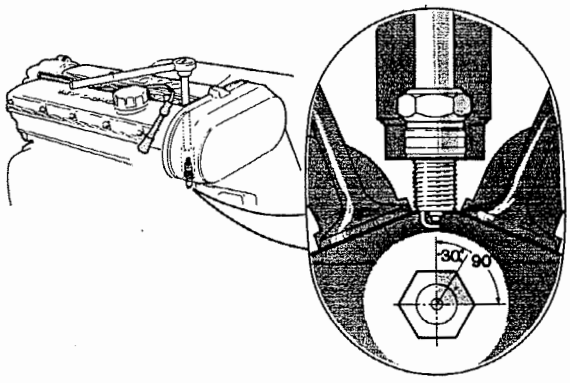
Check that throttle cable is seated in pulley groove.




*A7*

**Reconnect:**

- injector connectors
- lead to terminal 1 on ignition coil



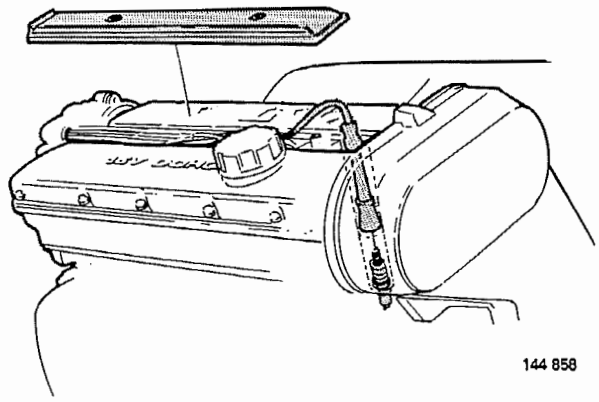

*A8*

**Install spark plugs**

Screw in each plug until sealing ring is in firm contact with cylinder head.

Alt. 1
Tighten new plugs through further **90°**.
Tighten used plugs through further **30°**.

Alt. 2
Tightening torque **25±5 Nm** (18.5±4 ft.lb)




*A9*

**Install:**

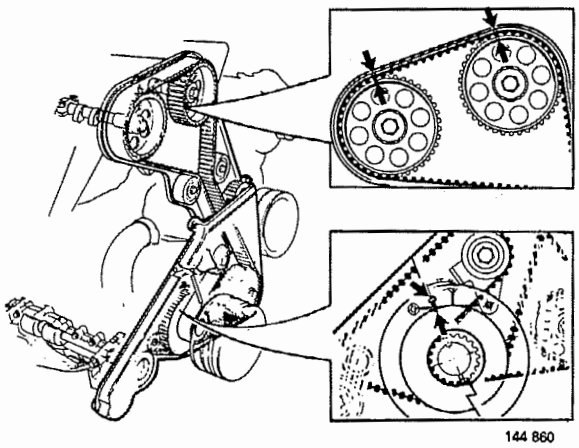
- ignition leads (in correct firing order)
- ignition lead cover plat

# B. Timing belt, checking/adjustment

*Special tool: 998 8500*

To be carried out **10000 km** (6250 miles) (USA: 5000 miles) following belt replacement.
Procedure to be carried out with engine warm to touch (approx. **40°C/104°F).**

**Caution!** See table in specifications if checking/adjustment is carried out at **other** engine temperature.


144 860

## Checking

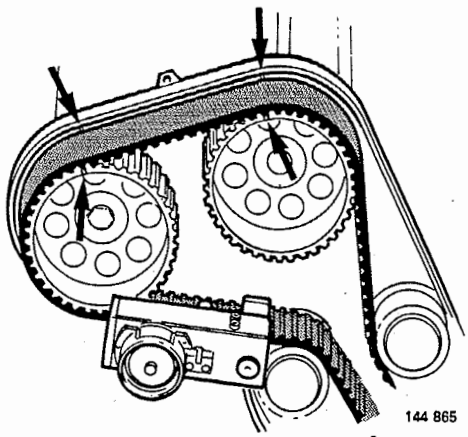
*B1*

**Turn engine to TDC in No. 1 cylinder**

Remove upper transmission cover (1).

Check that markings on camshaft pulleys are opposite markings on transmission mounting plate.

Check that marking on crankshaft is opposite TDC marking.


144 865

*B2*

**Check belt tension**

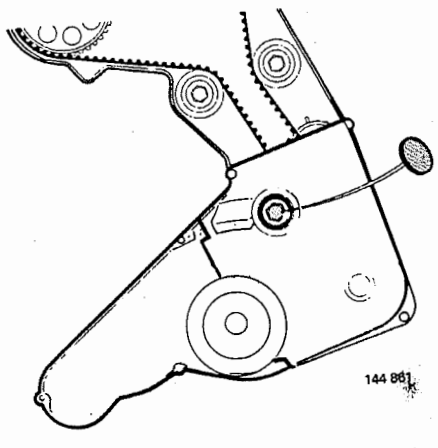
Position gauge **998 8500** between exhaust camshaft pulley and tensioner.

Read gauge.

If belt tension is correct, reading should be between 3.2 and 4.2 units.

If tension is correct, install transmission cover (1).

If tension is incorrect, belt **must** be adjusted as described in operations **B3-B10.**


144 861

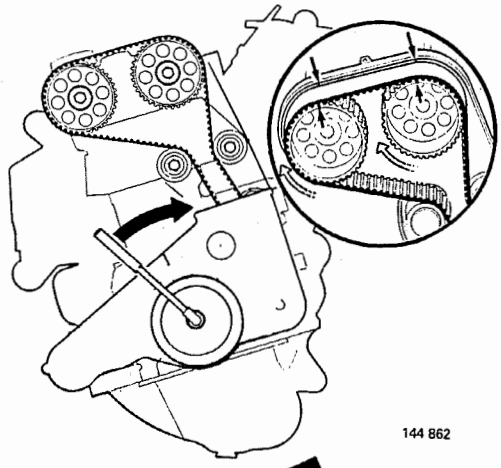
## Adjustment

*B3*

**Slacken tensioner locknut**

Remove protective rubber cap in transmission cover.

Slacken locknut.

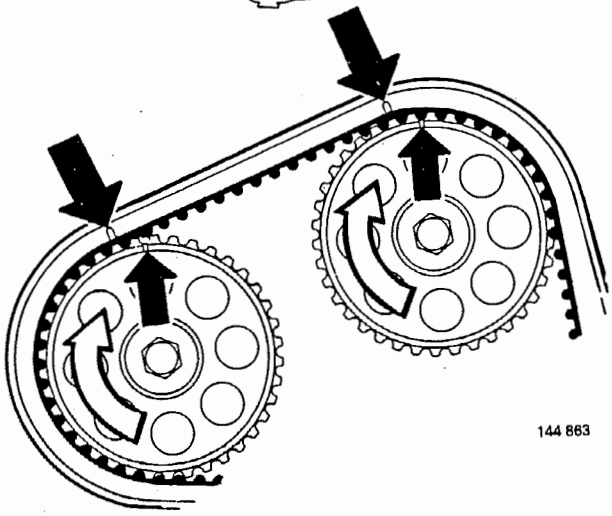



*B4*

**Turn crankshaft clockwise through one revolution**

Camshaft pulley markings should again coincide with markings on transmission mounting plate.

**N.B.** Engine must **not** be rotated counterclockwise during belt tensioning procedure.

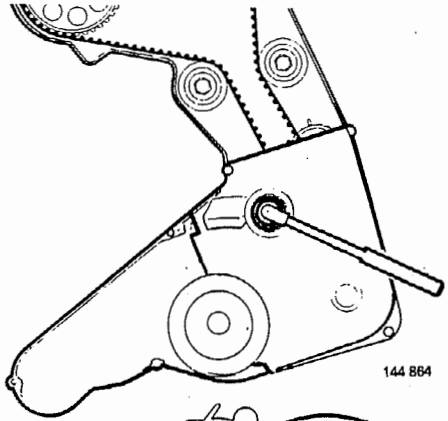



*B5*

**Turn engine further clockwise**

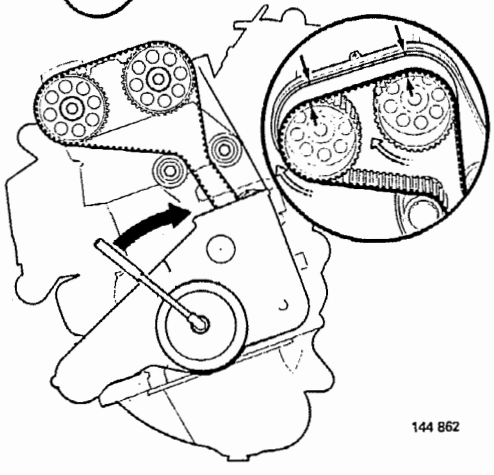
Turn engine until camshaft pulley markings are **1 ½ teeth** past markings on transmission mounting plate.

**N.B.** Rotate crankshaft **smoothly.**




*B6*

**Tighten tensioner locknut**

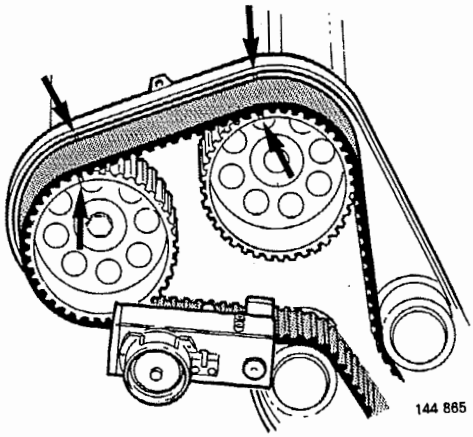



*B7*

**Turn crankshaft clockwise to complete one revolution**

Turn crankshaft to return to TDC.

Check that **all markings coincide.**


144 865

*B8*

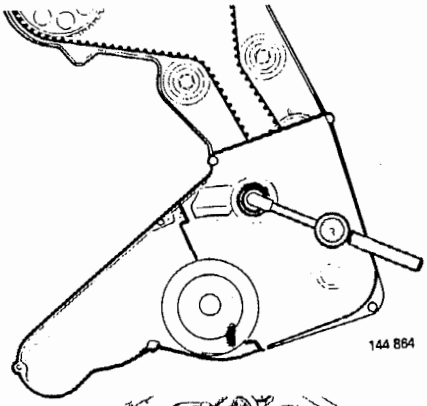
### Recheck belt tension

Position gauge **998 8500** between exhaust camshaft pulley and idler pulley.

Read gauge.

Belt tension should now agree with specified value of **3.9±0.3** units.

**N.B.** If reading is still **outside** correct range, adjust as described in operation **B11.**


144 864

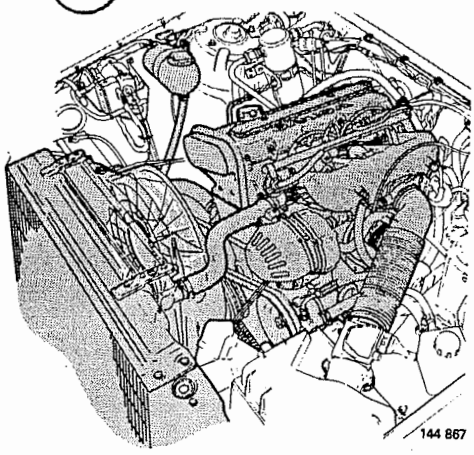
*B9*

### Tighten tensioner locknut

Tighten to **50 Nm** (37 ft.lb)

### Install:

- protective rubber cap over tensioner locknut
- upper transmission cover (1)

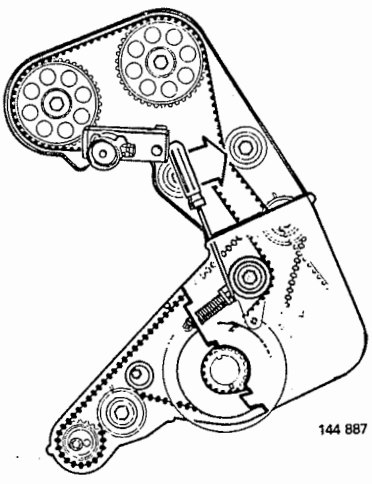

144 867

*B10*

### Check operation

Test run engine.

---


144 887

*B11*

### Tension timing belt

Slacken tensioner locknut.

Position gauge in measuring zone.

Insert screwdriver between tensioner pulley and end of spring carrier pin.

**If belt tension is too low:**
Move pulley to adjust reading to 4.4±0.3 units.

**If belt tension is too high:**
Adjust to obtain reading of 3.4±0.3 units.

Tighten tensioner locknut.

Recheck belt tension as per operations **B7-B8.**

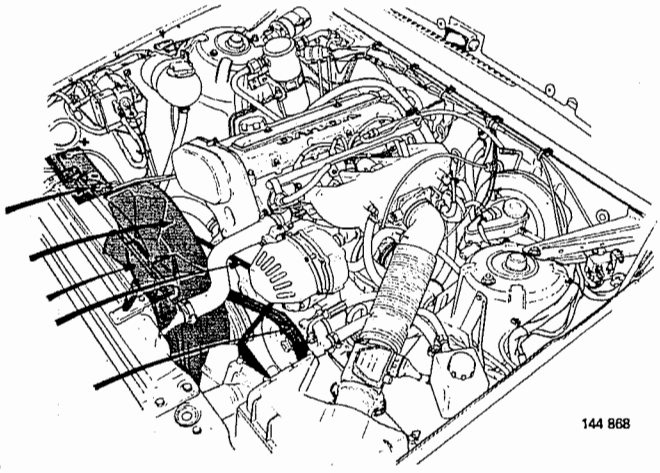
Complete adjustment as per **B9-B10.**

---

# C. Timing/balance shaft belts, replacement

*Special tool: 998 8500*

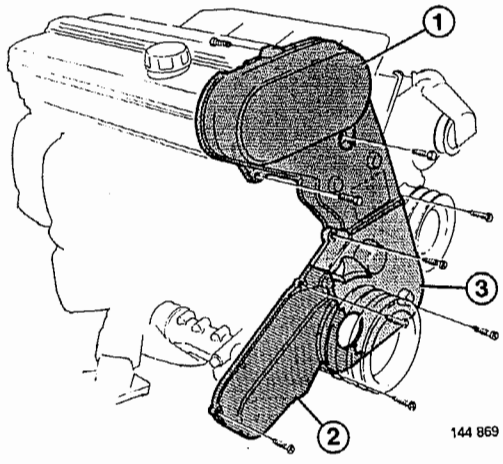
**Important**
See table in specifications in belt replacement is carried out at engine temperature **other** than that specified.


144 868

*C1*

**Remove:**

- battery (–) lead
- alternator drive belt
- radiator fan and pulley
- fan shroud
- servo pump and (if fitted) AC compressor drive belts

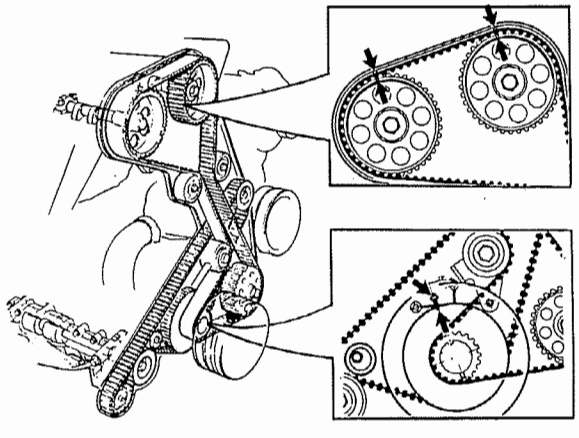


144 869

*C2*

**Remove all three transmission covers**

Remove all bolts.
Remove covers, starting with topmost (1).


144 870

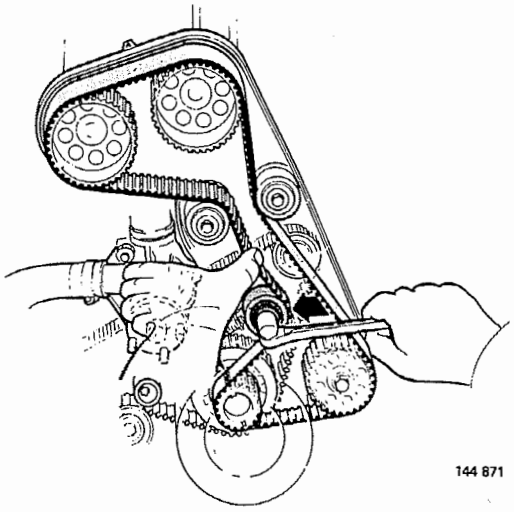
*C3*

**Turn engine until camshaft/crankshaft markings coincide**

Turn engine to TDC in No. 1 cylinder.

Check that markings on camshaft pulleys coincide with those on transmission mounting plate.

Check that marking on belt guide plate on crankshaft is opposite TDC marking on cylinder block.


144 871

## Removal of timing belt

*C4*

**Remove timing belt**

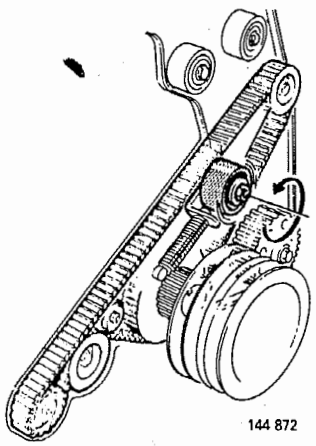
Slacken tensioner locknut.

Compress tensioner spring.

Tighten tensioner locknut.

Remove belt.

**Caution!** Crankshaft and camshafts must **not** be rotated while timing belt is slack or has been removed.

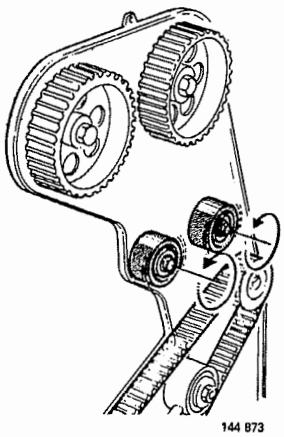

144 872

*C5*

**Check tensioner**

Spin tensioner pulley and listen for bearing noise.

Check that pulley surface in contact with belt is clean and smooth.


144 873

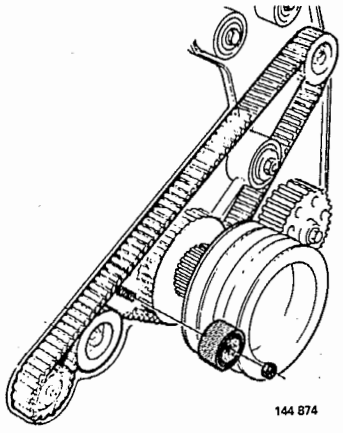
*C6*

**Check timing belt idler pulleys**

Spin pulleys and listen for bearing noise.

Check that pulley surfaces in contact with belt are clean and smooth.

Check pulley mountings. Torque: 25 Nm (18.5 ft.lb).

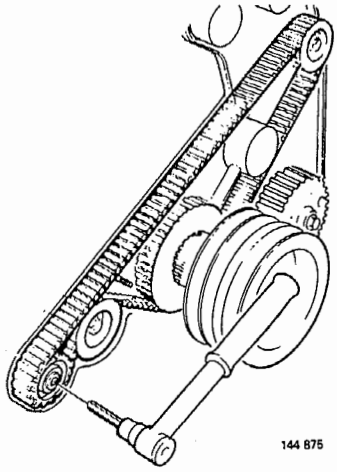



## Removal of balance shaft belt

*C7*

**Remove balance shaft belt idler pulley**

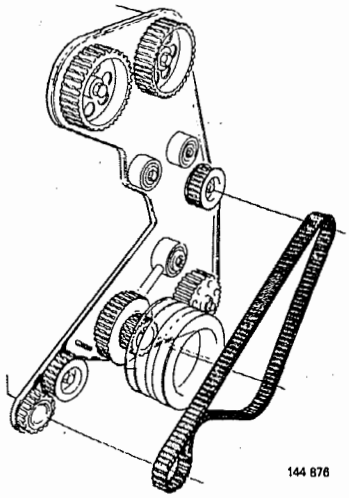
Check pulley surface and bearing for faults.




*C8*

**Slacken belt tensioner**

Slacken locknut.



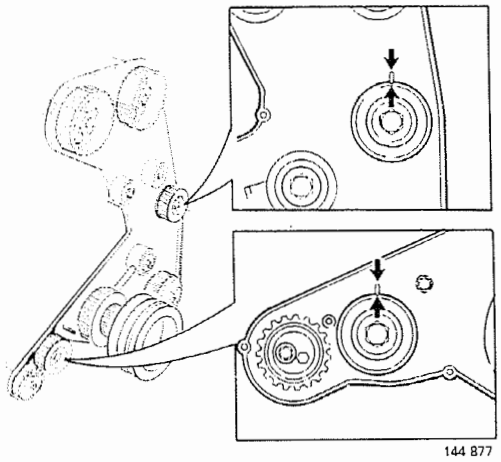

*C9*

**Remove balance shaft belt**

Slide belt off drive pulleys and tensioner.

Work belt out under crankshaft pulley assembly.

Check tensioner bearing and inspect for oil leakage from shaft seals.



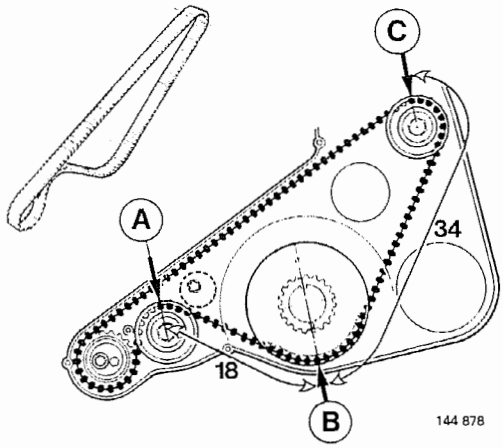

C10

**Check balance shaft and crankshaft markings**

Check that balance shaft markings coincide with markings on transmission mounting plate.

Check that crankshaft marking is opposite TDC marking on cylinder block.

## Installation of balance shaft belt

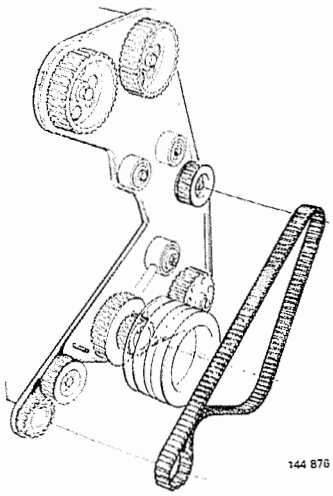



C11

**Balance shaft belt markings (3)**

A. RH balance shaft (yellow dot).
B. Lower marking on crankshaft (blue dot).
C. LH balance shaft (yellow dot).

A-B = 18 teeth
B-C = 34 teeth




C12

**Install balance shaft belt**

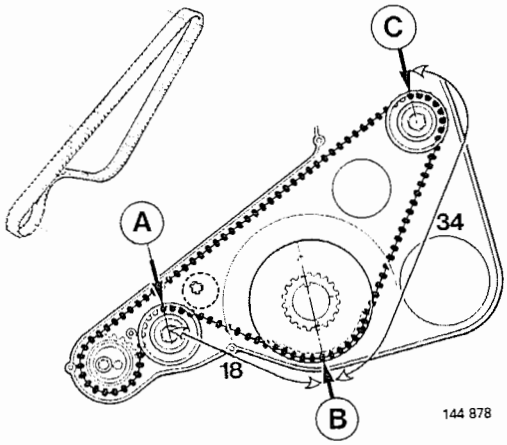
**Carefully** work belt in **under** crankshaft pulley assembly.

Ensure that blue dot (marking B) is opposite **bottom** (TDC) marking on belt guide plate (at bottom of crankshaft).

Fit belt **around** left-hand (upper) balance shaft with marking C opposite marking on pulley.

Fit belt **on** right-hand (lower) balance shaft with marking A opposite marking on pulley.

Fit belt **around** tensioner.



144 878

*C13*

### Check balance shaft and crankshaft markings

Check that markings are still aligned.

*C14*

### Tighten tensioner

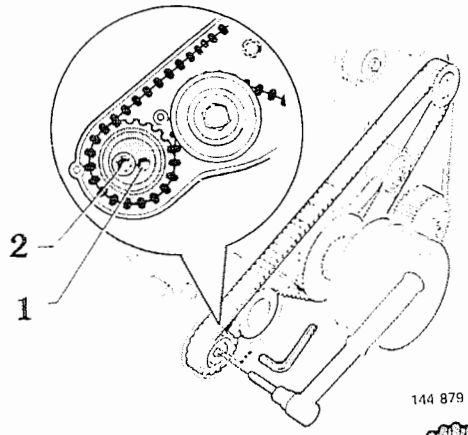
Tension belt using Allen key inserted in adjusting hole (1) in tensioner.

Turn crankshaft **carefully** through a few degrees on either side of the TDC position to ensure that belt engages properly in pulleys.

Return crankshaft to TDC position.

Adjusting hole in tensioner must be **immediately below** '3 o'clock' when tightening locking bolt.

Tighten locking bolt (2) to **40 Nm** (29.5 ft.lb). Use Allen key inserted in adjusting hole (1) as **counterhold**.



144 879

*C15*

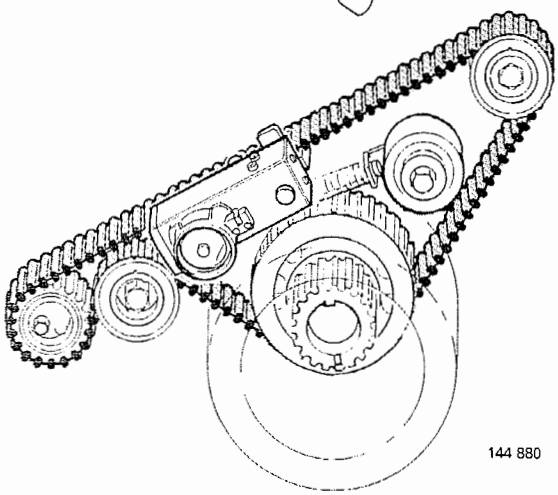
### Check belt tension

Use gauge **998 8500.**

Position gauge immediately above location of dismantled idler.

Belt tension **must** be within **1-4** unit range.

**N.B.** If belt tension is outside above range, slacken tensioner and repeat operation C14.


144 880

## Installation of timing belt

*C16*

### Install timing belt

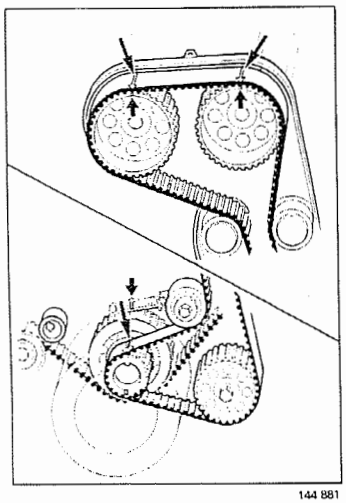
Align double-line marking on belt with **top** marking on belt guide plate (at top of crankshaft).

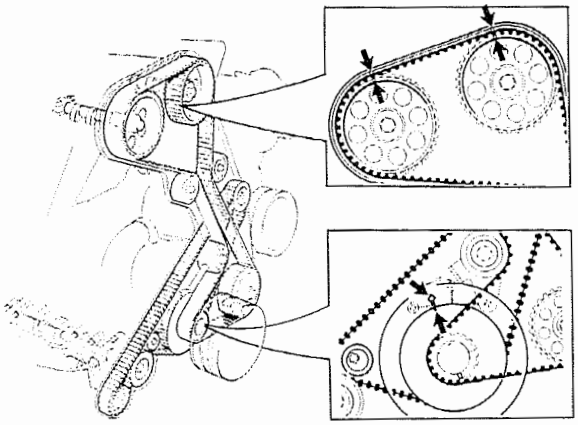
**N.B.** Arrows on belt should point towards front (i.e. away from engine).

Stretch belt around crankshaft pulley and place **over** tensioner and **right-hand** idler.

Place belt on camshaft pulleys. Both single-line markings should coincide with pulley markings.

Place belt **around** oil pump drive pulley and press belt onto **left-hand** idler.


144 881

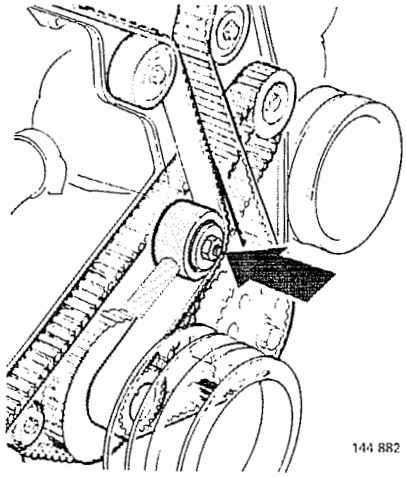


144 870

C17

### Check markings

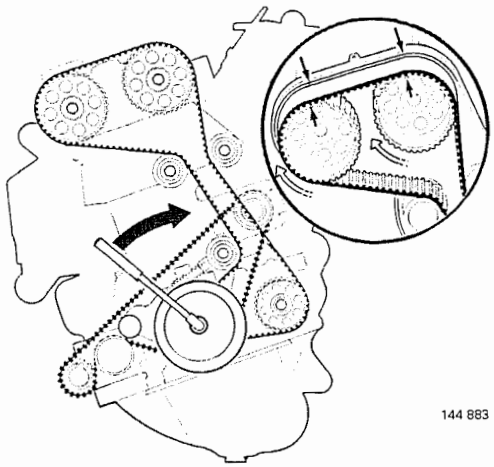
Check that **all** markings are aligned and that engine is turned to TDC in No. 1 cylinder.



144 882

C18

### Slacken tensioner locknut



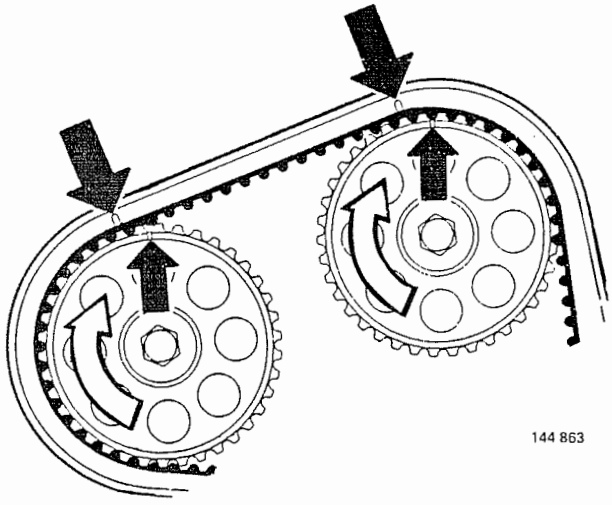
144 883

C19

### Turn crankshaft clockwise

Crankshaft pulleys should rotate one turn until **pulley markings** again coincide with those on transmission mounting plate.

**N.B.** Engine must **not** be rotated counterclockwise while belt is being tensioned.



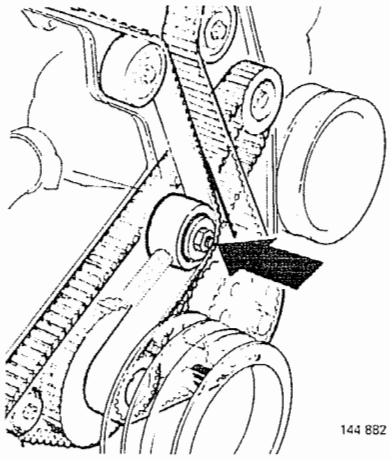
144 863

C20

### Turn crankshaft further clockwise

Turn crankshaft further clockwise until pulley markings are **1 ½ teeth** past markings on housing.

**N.B.** Rotate crankshaft **smoothly.**


144 882

*C21*

**Tighten tensioner locknut**

*C22*

**Check/adjust balance shaft belt tension**

Use gauge **998 8500.** Measure tension above location of dismantled idler.

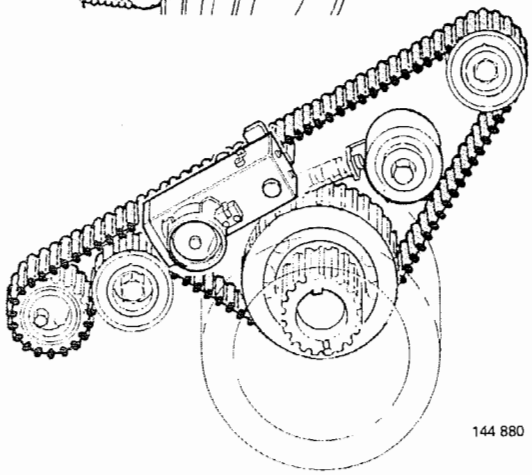
Belt tension should be **3.8±0.2** units at **20°C** (68°F).

**If belt tension is too low:** Correct by adjusting tensioner **clockwise.**

**N.B.** Tensioner may be adjusted **clockwise** only. Only small adjustments are required.

**If belt tension is too high:** Repeat operations **C14-C15.**

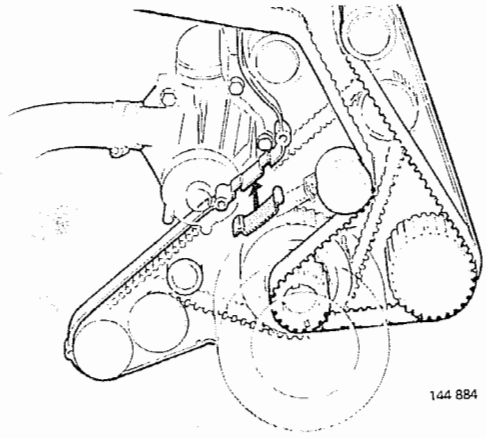
Turn crankshaft through one revolution and recheck/adjust belt tension.


144 880

*C23*

**Install:**

- guide (i.e. ensure that guide is in position)
- middle transmission cover (3)
- fan shroud
- heater hose tie
- radiator fan and pulley
- all auxiliary drive belts
- battery (–) lead


144 884

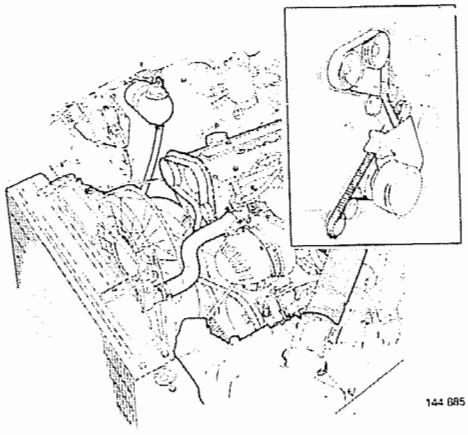
*C24*

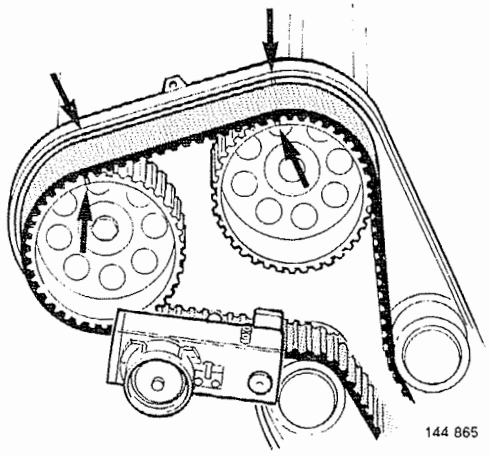
**Check operation**

Run engine until thermostat opens.

Stop engine.

**Caution!** Remember that transmission covers (1) and (2) have **not been replaced at this point.**


144 685




## Check/adjust timing belt tension after thermostat has opened

*C25*

### Check belt tension

Use gauge **998 8500.**

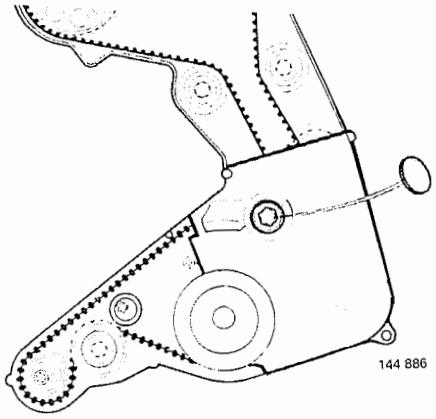
Rotate crankshaft to bring engine to TDC position in No. 1 cylinder.

Position gauge between exhaust camshaft pulley and idler.

Read gauge.

Belt tension **must** be within the **5.5±0.2** unit range.

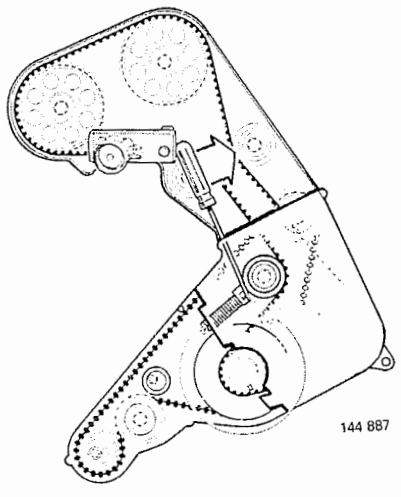
**N.B.** If belt tension is **correct**, proceed to operation **C30**. If reading is **outside** above range, carry out operations **C27-C29.**




*C26*

### Slacken tensioner locknut

Remove protective rubber cap over locknut.




*C27*

### Tension timing belt

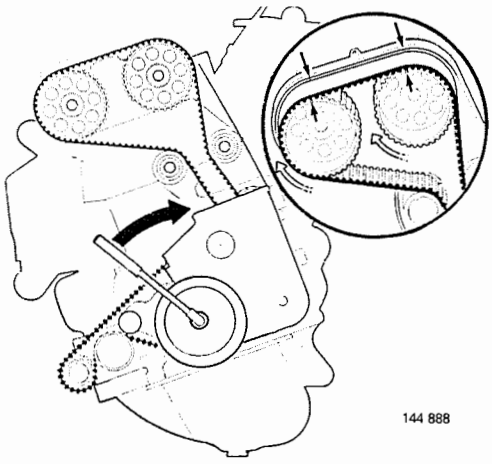
Position gauge in measuring zone.

Insert screwdriver between tensioner pulley and spring carrier pin.

**If belt tension is too low:**
Move roller to adjust belt tension to **6.0±0.2** units.

**If belt tension is too high:**
Adjust to obtain reading of **5.0±0.2** units.

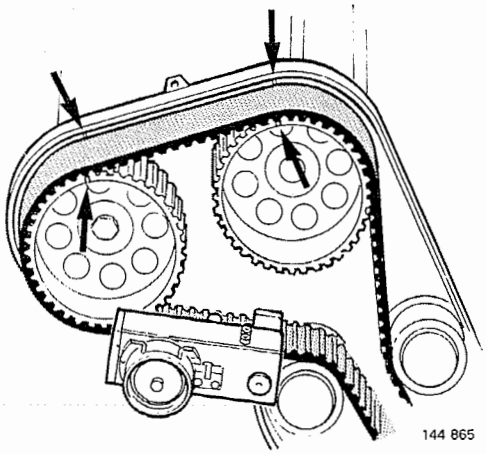
Tighten tensioner locknut.




*C28*

**Turn crankshaft clockwise**

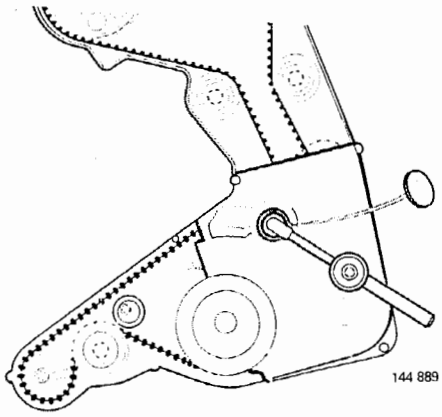
Turn crankshaft to rotate camshaft pulleys through one revolution.




*C29*

**Measure belt tension**

Belt tension should now agree with specified value of **5.5±0.2** units.

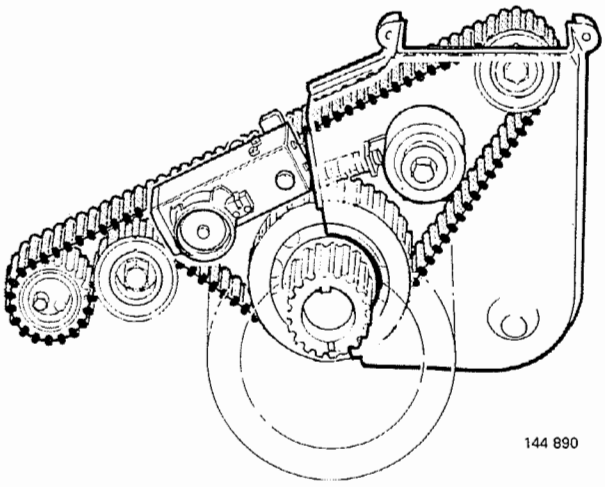



*C30*

**Tighten tensioner locknut**

Tighten to **50 Nm** (37 ft.lb).

Replace protective cap over locknut.




## Check/adjust balance shaft belt tension after opening of thermostat

*C31*

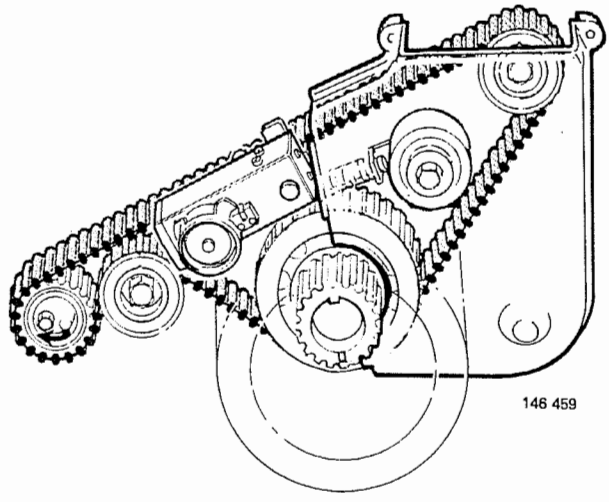
### Check belt tension

Use gauge **998 8500.**

Position gauge above location of dismantled idler.

Belt tension **must** be within the **4.9±0.2** unit range.

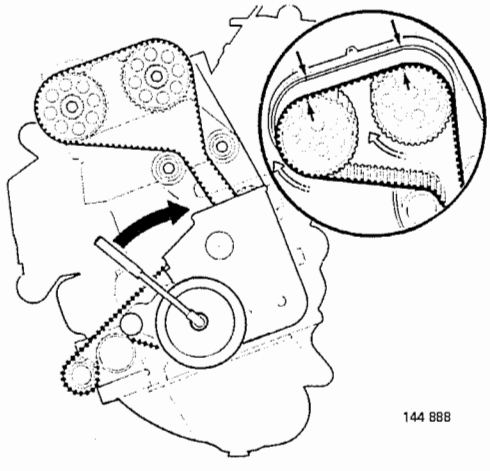
**N.B.** If belt tension is **correct**, proceed to operations **C35-C37.**
If belt tension is too **low**, carry out operations **C32-C34.**
If belt tension is too **high**, repeat operations **C14-C15** and continue with operations **C32-C34.**




*C32*

### Turn tensioner clockwise and read indication on gauge

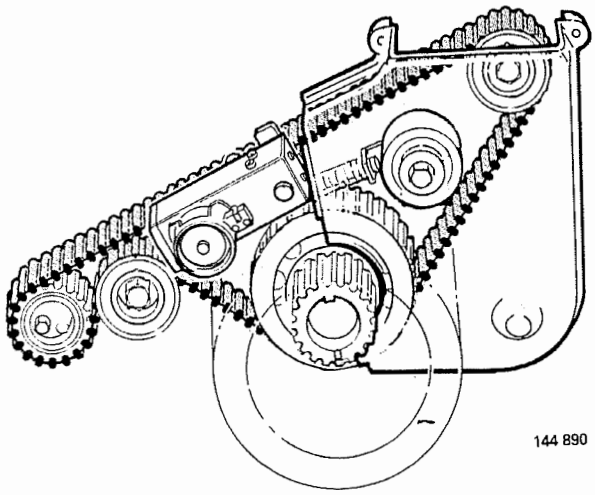
**N.B.** Tensioner may be turned **clockwise** only. Only small movements are necessary.




*C33*

### Turn crankshaft clockwise

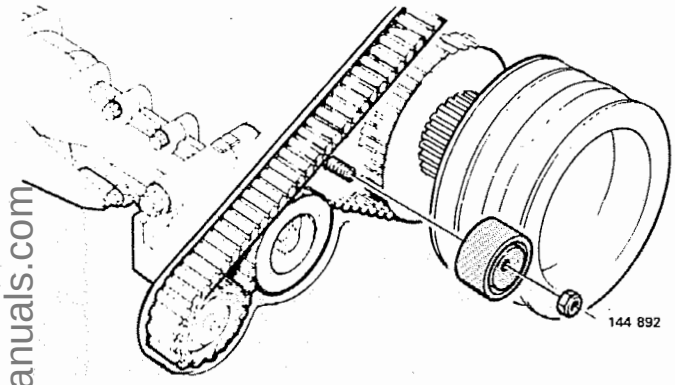
Turn crankshaft clockwise through one revolution.




C34

**Check belt tension**

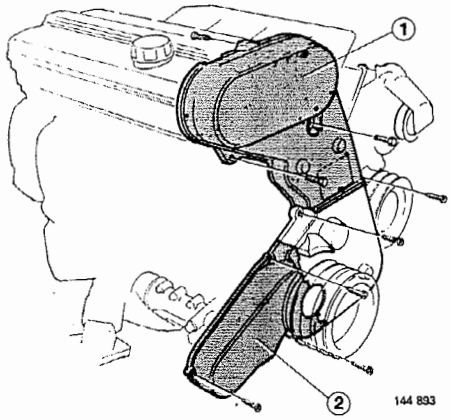
Belt tension should now agree with specified value of **4.9±0.2** units.




C35

**Install idler**

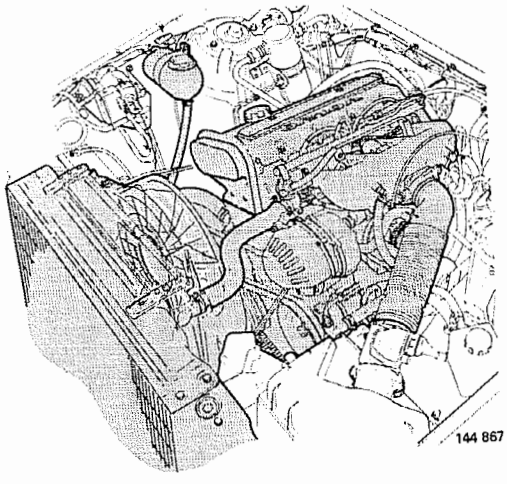
Remount idler in position.




C36

**Install:**

- lower transmission cover (2)
- upper transmission cover (1)



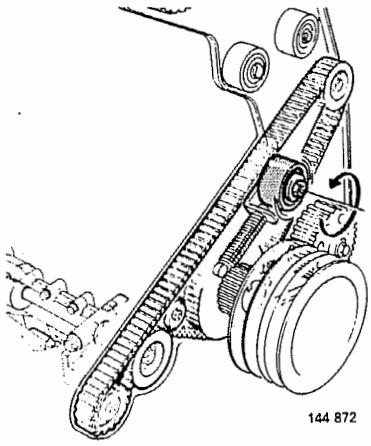

C37

**Check operation**

Test run engine.

# D. Timing belt tensioner, inspection/replacement

*Special tool: 9802*


144 872

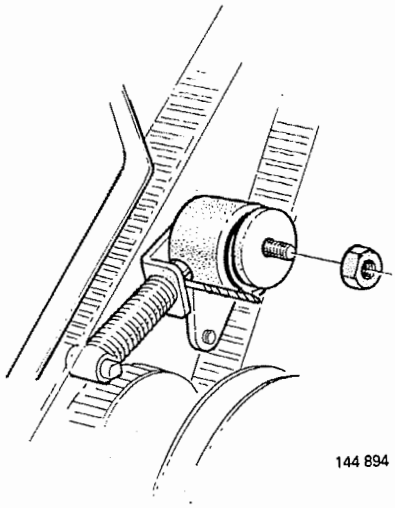
Remove timing belt as described in operations **C1-C4**.

*D1*

**Check tensioner**

Spin pulley and listen for noise. Check manually for bearing play.

Check that pulley surface in contact with belt is clean and smooth.


144 894

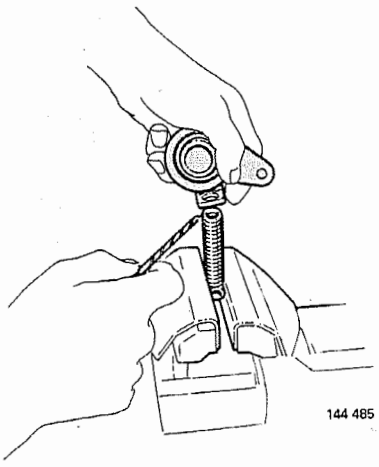
*D2*

**Remove tensioner**

Compress tensioner spring and lock with 3 mm drill bit.

**Remove:**

- tensioner locknut
- pulley (pull straight off)


144 485

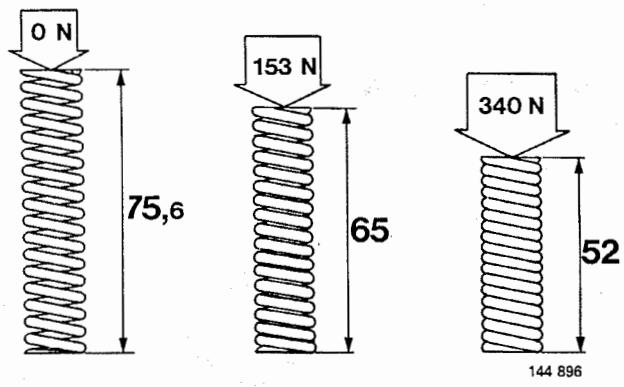
*D3*

**Dismantle tensioner**

Clamp tensioner between soft jaws in vice.

Compress spring by hand and remove drill bit.

Release spring **slowly**. Separate pulley bracket and spring carrier pin.




*D4*

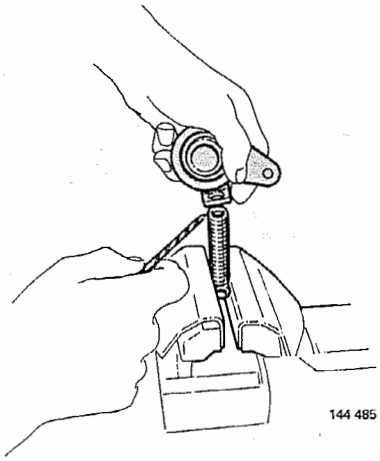
**Check tensioner spring**

Check spring using tool **9802.**

Inside diameter:..... **10.5 mm** $^{+0.5}_{0}$

(0.41 in $^{+0.02}_{0}$)

| Length, mm (in) | Load, N (lb) |
|---|---|
| 75.6 (2.98) | 0 (0) |
| 65.0 (2.56) | 153 (34.5) |
| 52.0 (2.05) | 340 (77.5) |

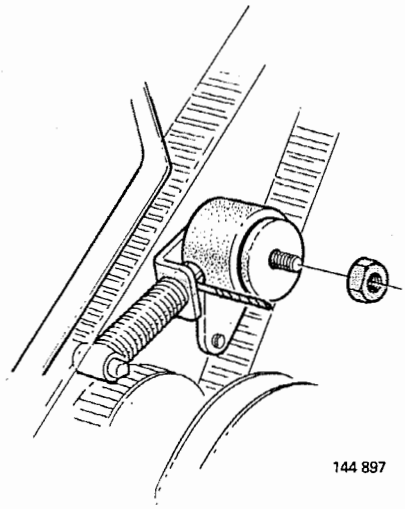



*D5*

**Reassemble tensioner**

Clamp spring carrier pin and spring between soft jaws in vice.

Compress spring by hand and hold in position with 3 mm drill bit.




*D6*

**Install tensioner**

Mount tensioner on cylinder block.

Tighten tensioner locknut.

Remove drill bit.

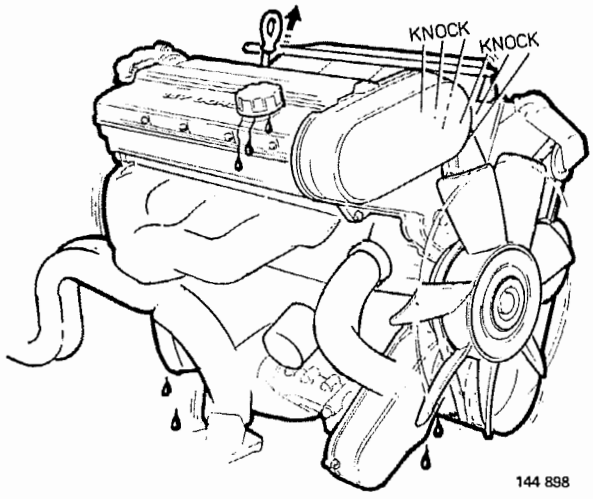
Replace timing belt as described in operations **C16-21**, **C23-30** and **C36-37**.

**N.B. See table** of tension values in specifications (page11) if replacing existing timing/balance shaft belts.

# E. Balance shaft seals, replacement

*Special tools: 5362, 5996*

*E1*



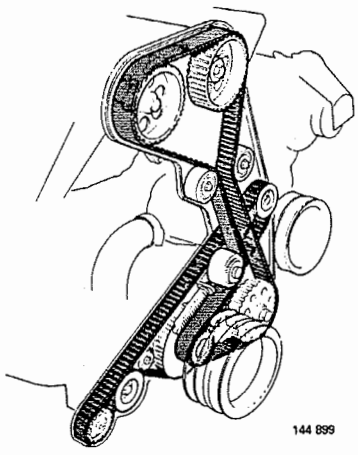

**Check that flame trap is not blocked**

Flame trap blockage restricts crankcase ventilation and increases crankcase pressure.

Symptoms of flame trap blockage:

- Oil dipstick tends to lift in tube.
- Oil leakage from cylinder block seals.
- Seals do not always require renewal if leakage is due to this cause. Overhaul flame trap, clean engine and reinspect for seal leakage.
- Engine knocks.

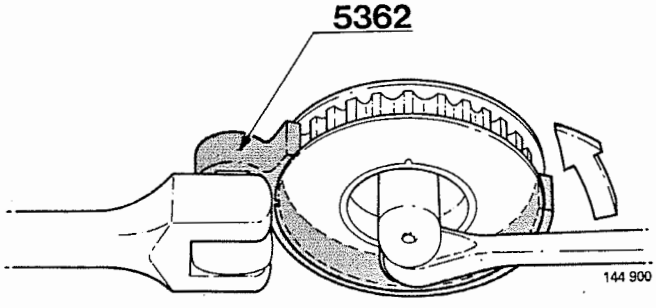
*E2*




**Remove:**

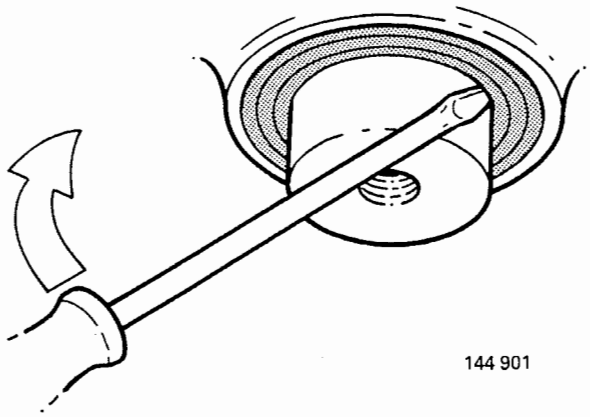
- timing and balance shaft belts as described in operations **C1-C10**.

*E3*




**Remove balance shaft pulley**

Use counterhold **5362**.


144 901

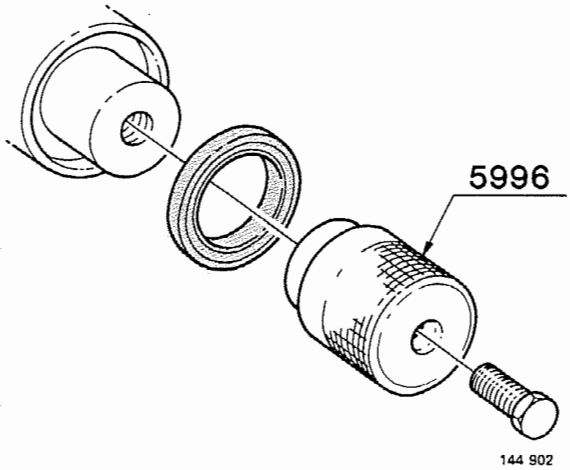
*E4*

**Remove seal**

Prise out seal **carefully** with screwdriver, taking care to avoid damaging seating faces on shaft and housing.

Place paper or waste underneath to soak up leakage oil.

Clean seating in housing and check shaft end for grooving, indicating wear.



144 902

*E5*

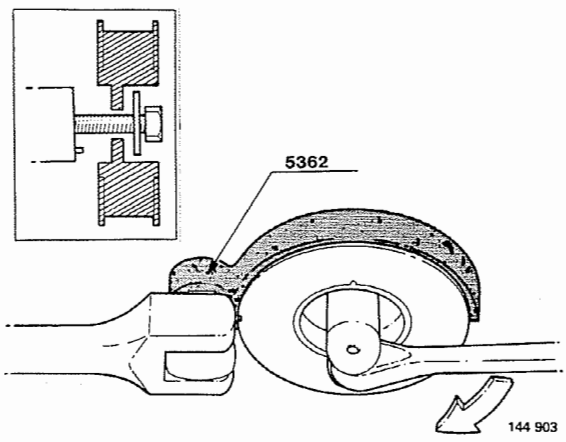
**Fit new seal**

Use assembly tool **5996**.

Grease seal.

Press seal into shaft housing. Press in lightly with tool **5996** and use centre bolt together with tool to press home fully.

**N.B.** Face of seal should normally be flush with chamfered edge in housing. However, if shaft end shows signs of wear, seal may be located approx. 2 mm further in.



144 903

*E6*

**Install balance shaft pulley**

Use counterhold **5362**.

Tighten centre bolt to **50 Nm** (37 ft.lb).

**N.B.** Slot in pulley should engage guide pin on shaft.
**Shallower** side of pulley should face inwards.

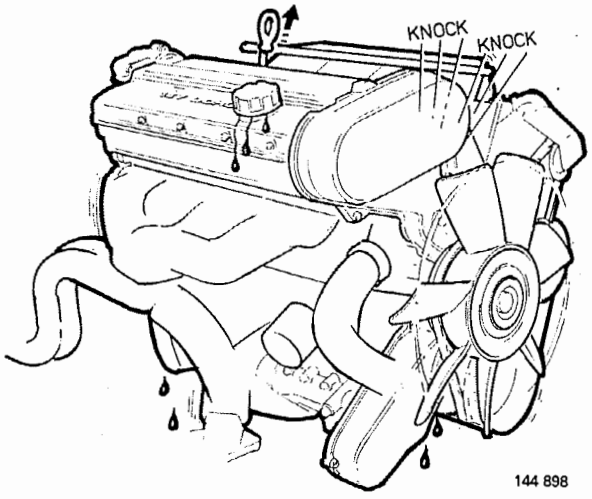
Replace timing and balance shaft belts as described in operations **C12-37**.

**N.B. See table** of tension values in specifications (page 11) if replacing existing timing/balance shaft belts.

# F. Camshaft seals, replacement

*Special tools: 5025, 5199*

On later versions of engines, seals may be replaced without removing transmission mounting plate.



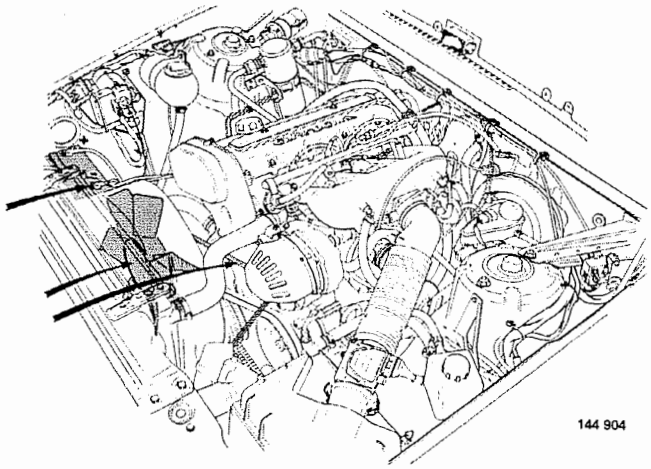

*F1*

**Check that flame trap is not blocked**

Flame trap blockage restricts crankcase ventilation and increases crankcase pressure.

Symptoms of flame trap blockage:

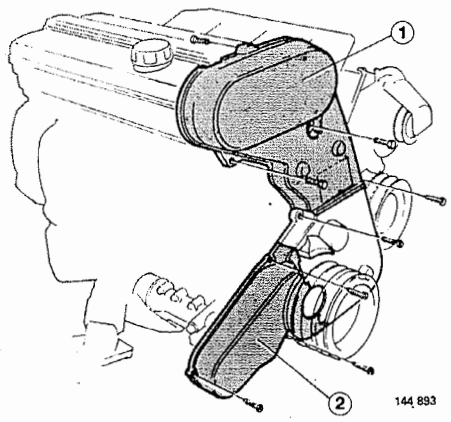
- Oil dipstick tends to lift in tube.
- Oil leakage from cylinder block seals.
- Seals do not always require renewal if leakage is due to this cause. Overhaul flame trap, clean engine and reinspect for seal leakage.
- Engine knocks.




*F2*

**Remove:**

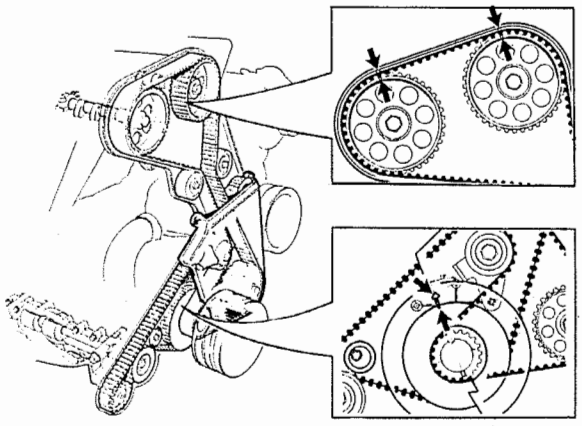
- battery earth lead
- alternator drive belt
- radiator fan and pulley




*F3*

**Remove transmission covers (1) and (2)**

Remove upper (1) and lower (2) transmission covers.

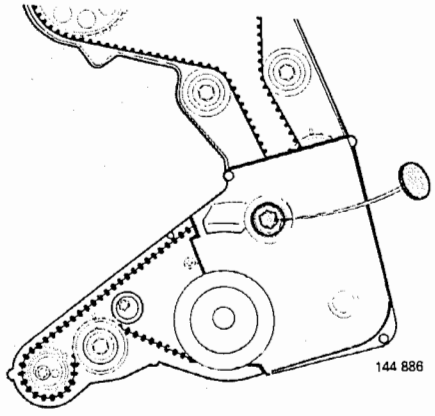

144 905

*F4*

**Align camshaft/crankshaft markings**

Turn engine to TDC position in No. 1 cylinder.

Check that markings on camshaft pulleys are aligned with those on transmission mounting plate.

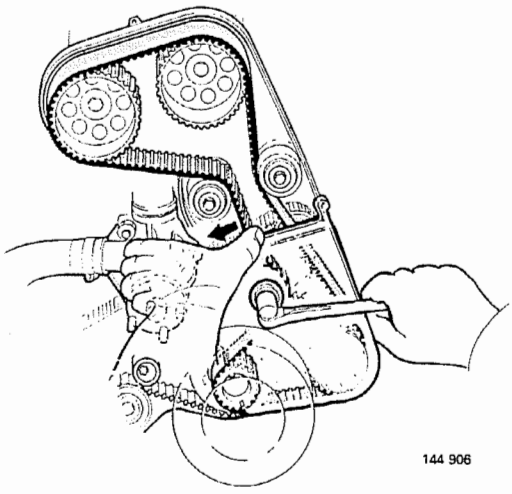

144 886

*F5*

**Slacken tensioner locknut**

Remove protective rubber cap over tensioner locknut.

Slacken locknut.


144 906

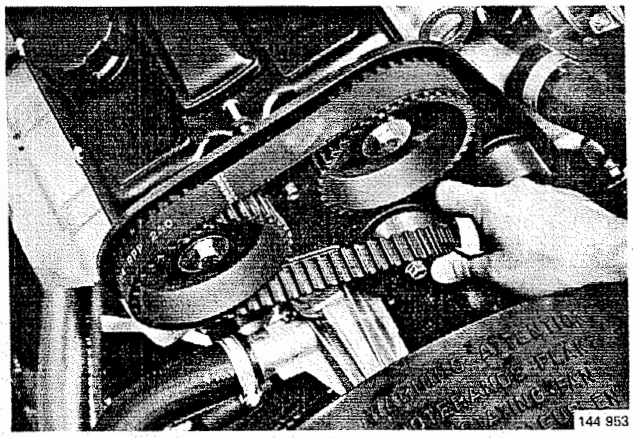
*F6*

**Compress tensioner spring**

Compress tensioner spring.

Press timing belt outwards between right-hand idler and tensioner.

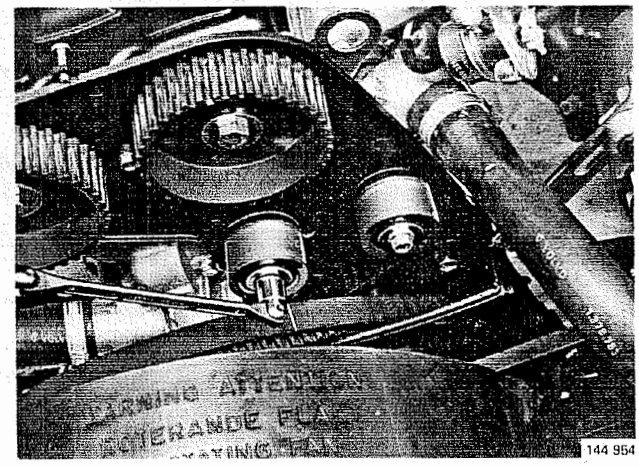
Tighten tensioner locknut.


144 953

*F7*

**Remove timing belt from crankshaft pulleys**

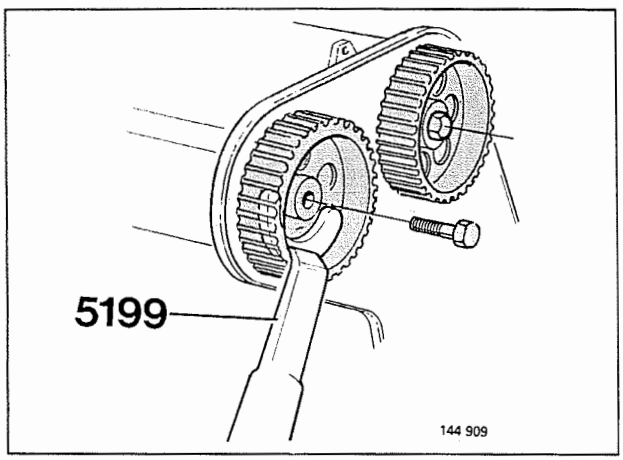
**Caution!** Crankshaft and camshaft **must not** be rotated while timing belt is slack or has been removed.


144 954

*F8*

**Remove timing belt idlers**

Check pulley surfaces and bearings.

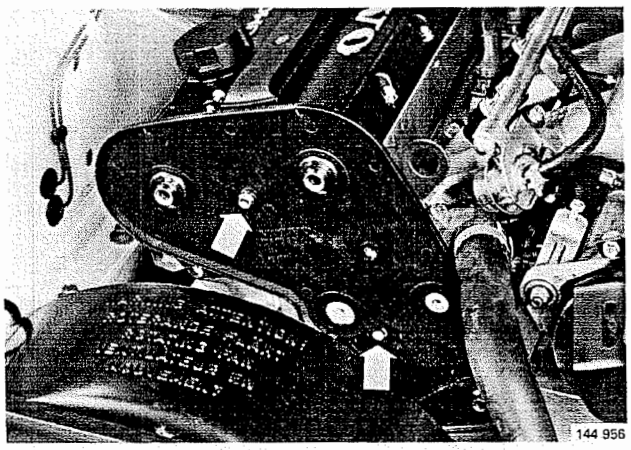


144 909

*F9*

**Remove camshaft drive pulleys**

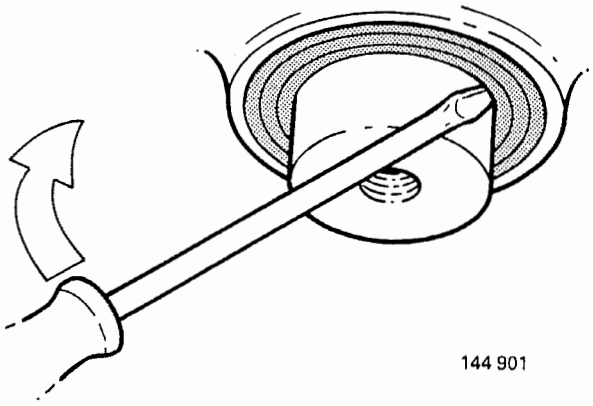
Use counterhold **5199**.


144 956

*F10*

**Remove upper section of transmission mounting plate**

Remove bolts between camshafts and under right-hand idler.



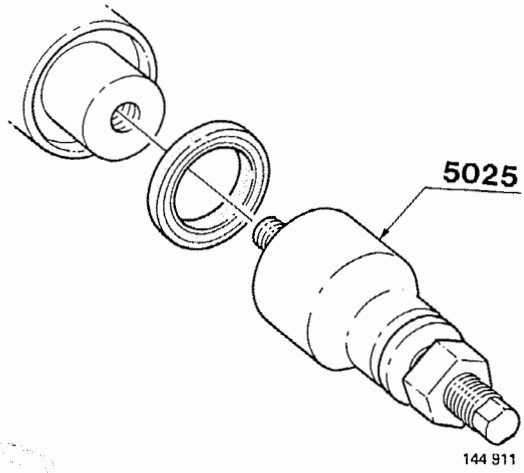
144 901

*F11*

**Remove seal**

Prise out seal **carefully** using a screwdriver, taking care to avoid damaging shaft ends and seating surfaces in camshaft carrier.

Clean seats in camshaft carrier and check shafts for grooving, indicating wear.




144 911

*F12*

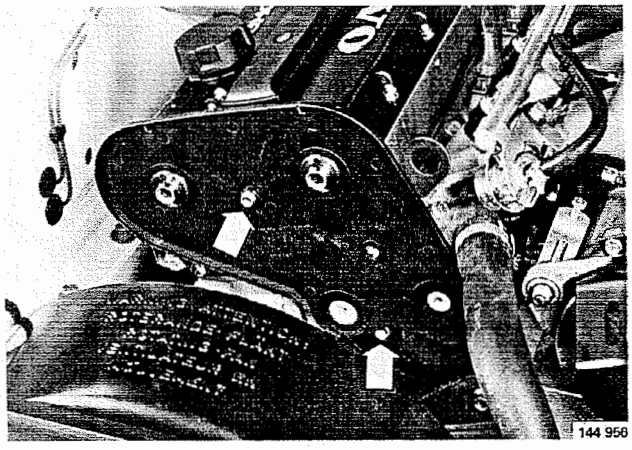
**Fit new seals**

Use assembly tool **5025**.

Grease seals.

Press in seals.

**N.B.** Camshafts must **not** be allowed to rotate when fitting seals. Face of seal should normally be flush with chamfered edge in camshaft carrier. However, if shaft end shows signs of wear, seal may be located approx. 2 mm further in.



144 956

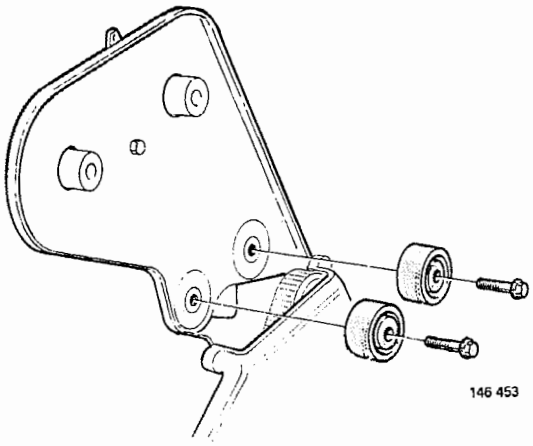
*F13*

**Replace upper section of transmission mounting plate**

Adjust plate so that camshafts are centred in holes.

Replace bolts between camshafts and under right-hand idler.

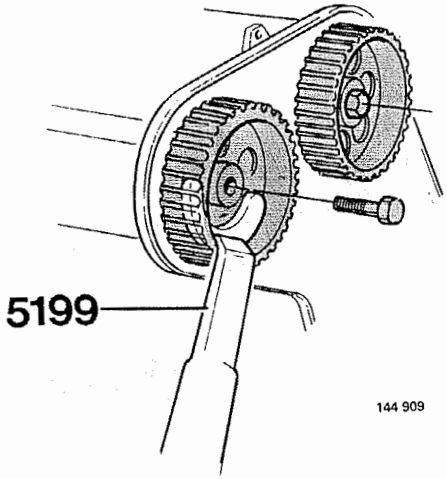
F14




### Replace idlers

Tighten to **25 Nm** (18.5 ft.lb).

F15



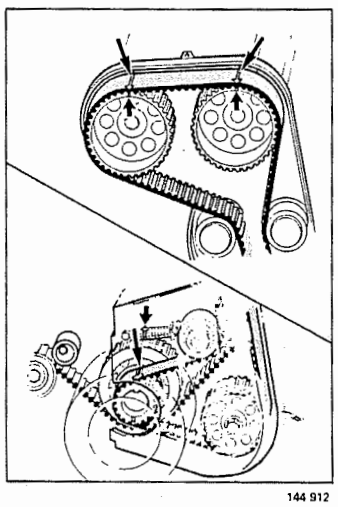

### Install camshaft drive pulleys

Use counterhold **5199**.

Replace centre bolts and tighten to **50 Nm** (37 ft.lb.).

**N.B.** Camshafts must **not** be allowed to rotate when replacing the centre bolts.

F16

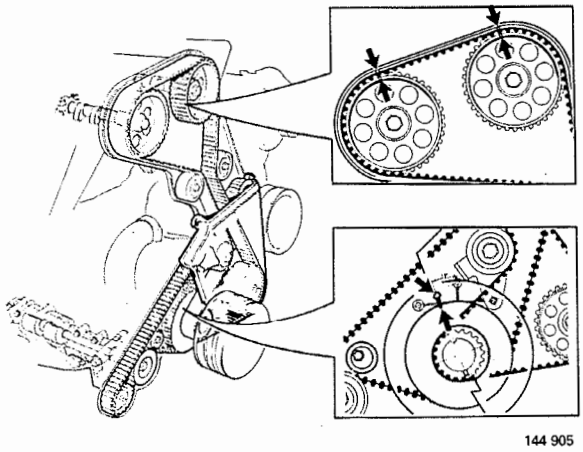



### Replace timing belt

Position belt so that double-line marking coincides with **top** marking on belt guide plate (at top of crankshaft).

Place belt on camshaft pulleys, ensuring that single-line markings coincide with pulley markings.

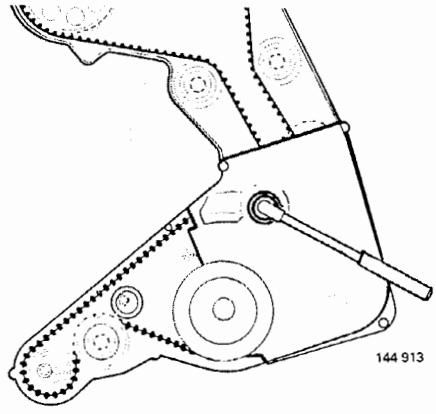
Place belt in position over **right-hand** and then over **left-hand** idler.


144 905

*F17*

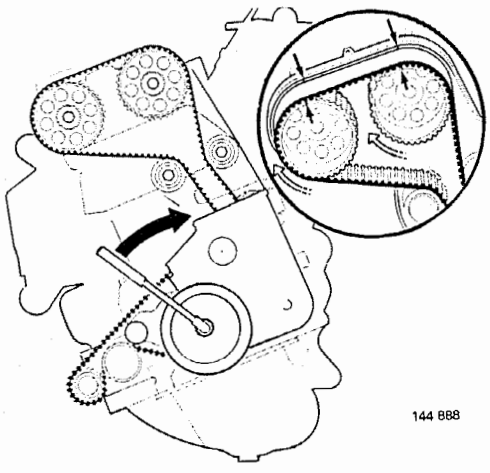
### Check markings

Check that **all** markings coincide and that the engine is turned to TDC in No. 1 cylinder.


144 913

*F18*

### Slacken tensioner locknut


144 888

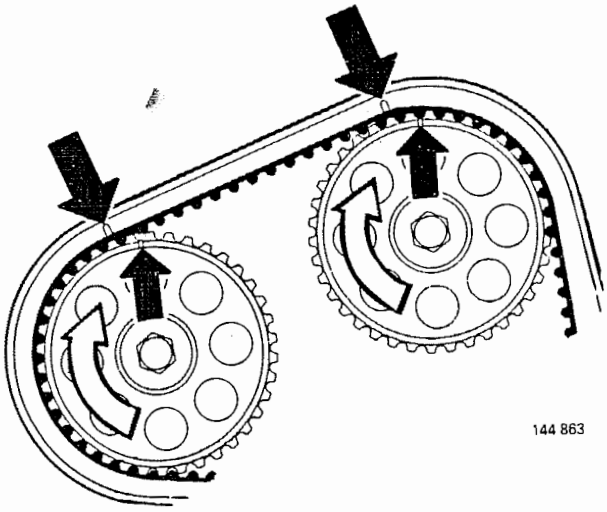
*F19*

### Turn crankshaft clockwise

Crankshaft pulleys should rotate one turn until **pulley markings** again coincide with those on transmission mounting plate.

**N.B.** Engine must **not** be rotated counterclockwise while belt is being tensioned.

F20

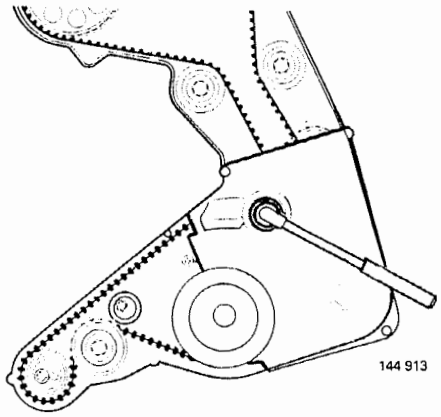



**Turn crankshaft further clockwise**

Turn crankshaft further clockwise until pulley markings are **1½ teeth** past markings on housing.

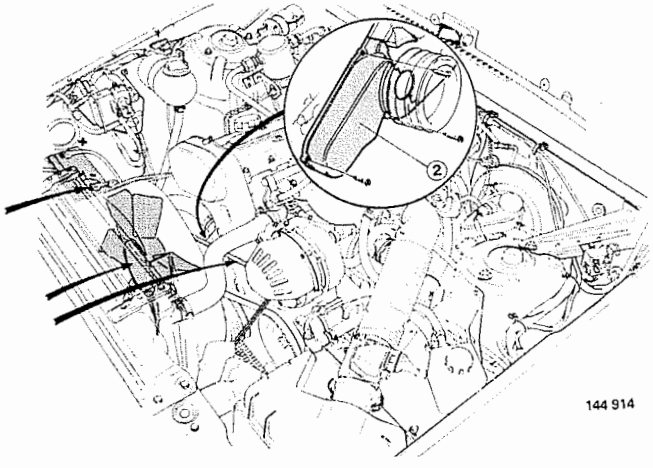
**N.B.** Rotate crankshaft **smoothly**.

F21




**Tighten tensioner locknut**

F22



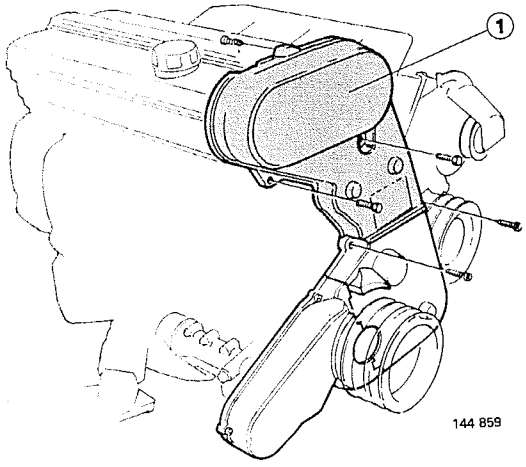

**Install:**

- lower transmission cover (2)
- radiator fan and pulley
- alternator drive belt
- battery earth lead

Continue with operations **C24-25**.

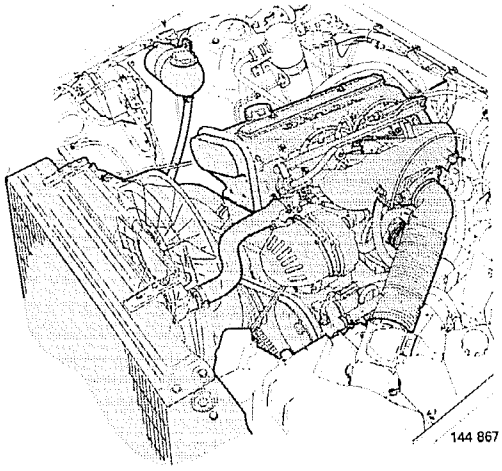
**N.B.** See table of belt tensioning values in specifications (page 11) if refitting original timing belt.

*F23*




**Install upper transmission cover (1)**

*F24*

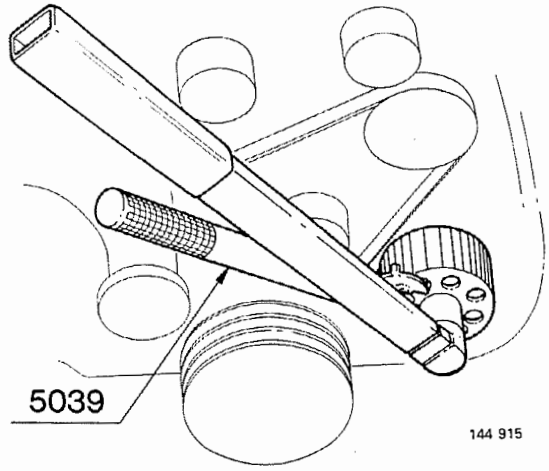



**Check operation**

Test run engine.

# G. Oil pump seal, replacement

*Special tools: 5039, 5361*



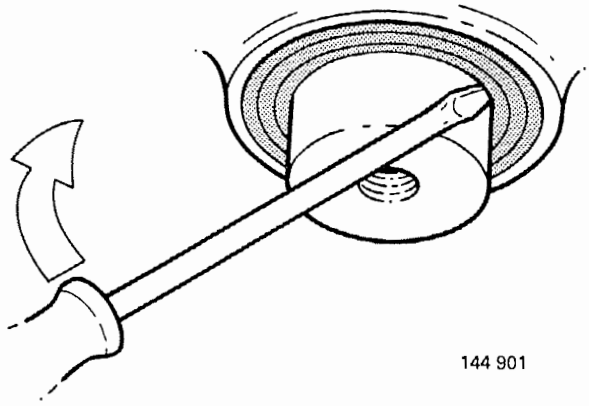
144 915

Remove timing belt as described in operations **C1–4**.

*G1*

**Remove oil pump drive pulley**

Use counterhold **5039**.


144 901

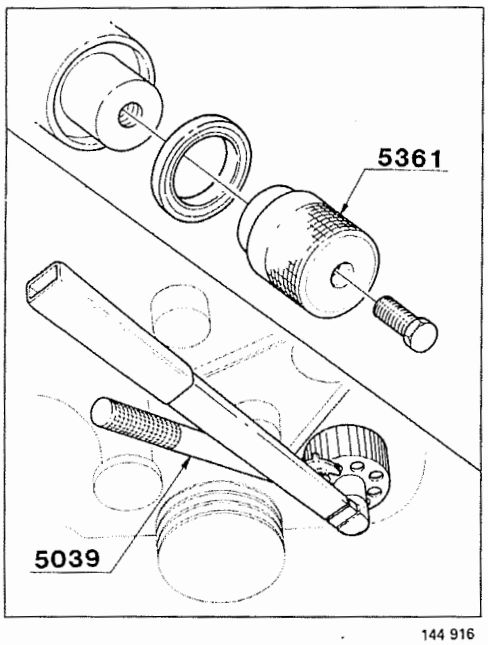
*G2*

**Remove seal**

Clean area around drive shaft and seal.

Prise out seal **carefully** using a screwdriver, taking care to avoid damaging shaft end and housing.

Clean seat in housing and check shaft for signs of wear.



144 916

*G3*

**Fit new seal**

Use assembly tool **5361**.

**N.B.** Face of seal should normally be flush with chamfered edge in housing. However, if shaft end shows signs of wear, seal may be located approx. 2 mm further in.

*G4*

**Install drive pulley**

Use counterhold **5039**.

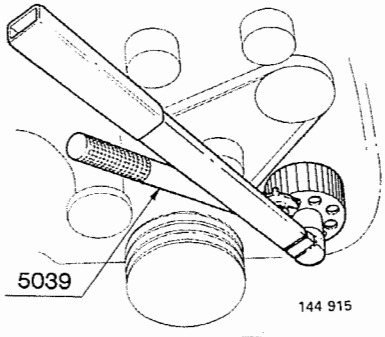
Rotate pulley to align locating chamfer. Tighten centre bolt to **20 Nm** (15 ft.lb) and through a further **60°**.

Install timing belt as described in operations **C16–21**, **C23–30** and **C36–37**.

**N.B.** See table of belt tensioning values in specifications (page 11) if refitting original timing belt.

# H. Oil pump, replacement

*Special tool: 5039*



144 915

Remove timing belt as described in operations **C1–4.**

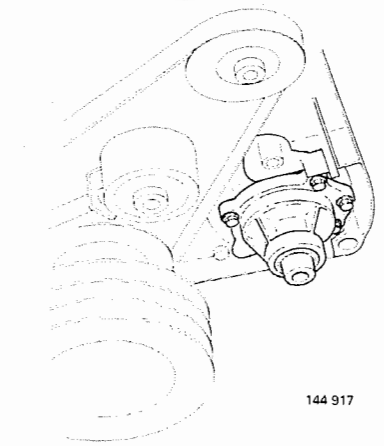
*H1*

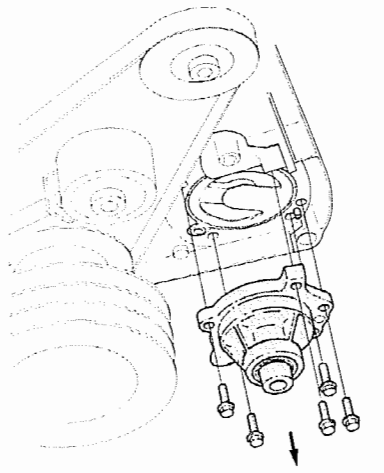
**Remove oil pump drive pulley**

Use counterhold **5039.**

*H2*

**Clean area in vicinity of pump joint**


144 917


144 918

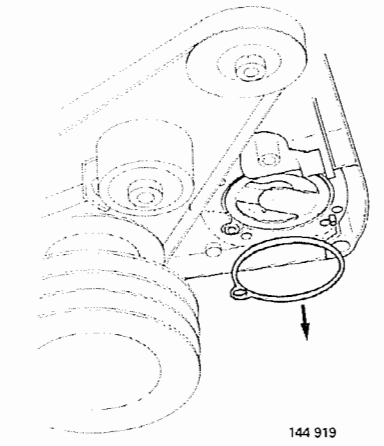
*H3*

**Remove oil pump**

Remove pump mounting bolts. .

Place paper or container on engine splashguard to collect leakage oil.

Remove pump.


144 919

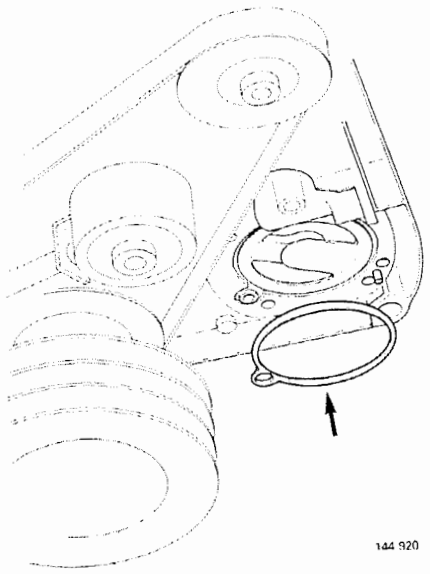
*H4*

**Remove seal**

Remove seal from seating groove in cylinder block.

Clean joint face and groove.

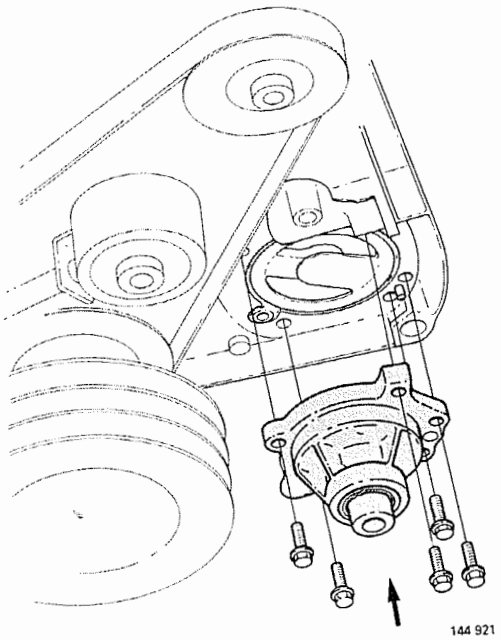
Check rear contact faces of rotors.


144 920

H5

### Fit new seal

Seat seal in groove.


144 921

H6

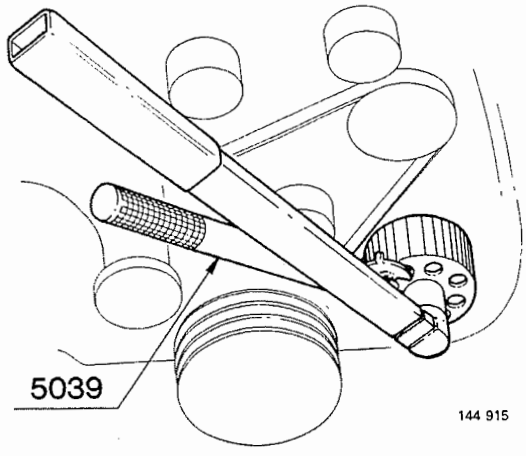
### Install oil pump

Lubricate rotors generously.

Position pump on cylinder block.

Tighten mounting bolts to **10 Nm** (7.5 ft.lb.).

**N.B. Take care not to turn pump** so that rotor shaft falls out of position in housing.



144 915

H7

### Install drive pulley

Use counterhold **5039.**

Rotate pulley to align locating chamfer.

Tighten centre bolt to **20 Nm** (15 ft.lb) and through a further **60°.**

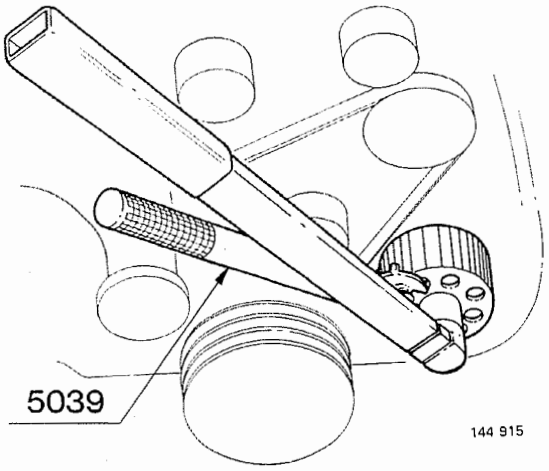
Clean and remove paper/oil container.

Install timing belt as described in operations **C16–21, C23–30** and **C36–37.**

**N.B.**See table of belt tensioning values in specifications (page 11) if refitting original timing belt.

# I. Oil pump, inspection

*Special tools: 5039, 5361*



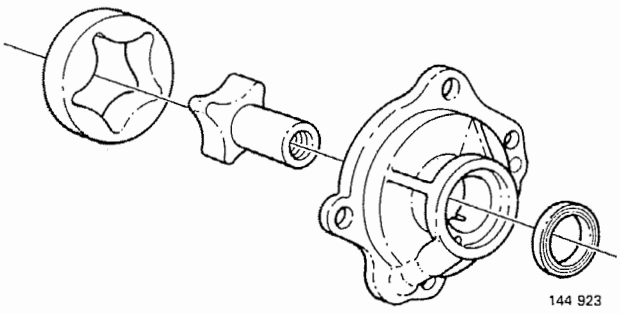

Remove timing belt as described in operations **C1–4**.

Remove oil pump as described in operations **H1–4**.

*I1*

**Remove rotors and shaft seal from oil pump housing**

Mark outer rotor with felt pen to ensure same direction of rotation on reassembly.

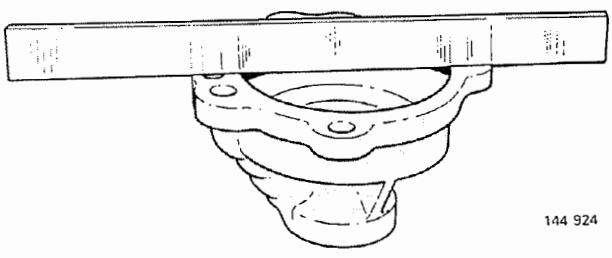



*I2*

**Clean and inspect components**

Inspect pump housing, rotors and rotor mating faces for visible signs of wear.

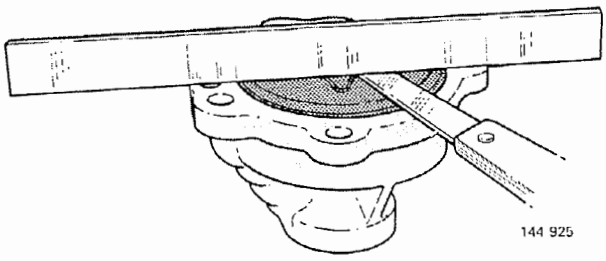
**N.B.** Note marking of outer rotor.




*I3*

**Check pump housing joint for distortion**

Use steel rule/sliding calipers.

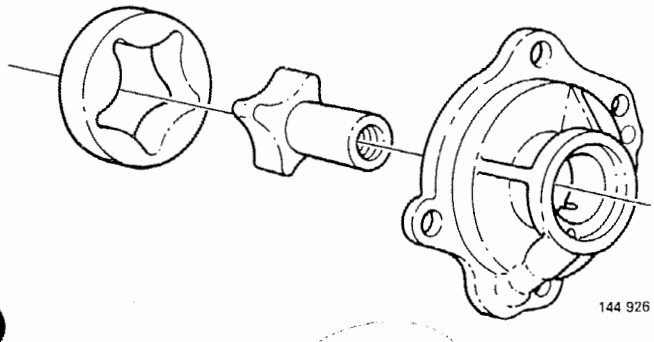



*14*

**Check axial clearance of rotors**

Check axial clearance of outer and inner rotors in pump housing.

Correct clearance: **0.05–0.10 mm** (0.0020–0.0040 in) (with pump dry).

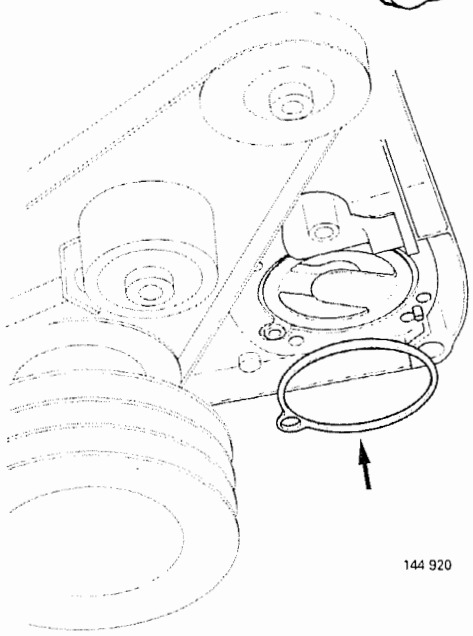



*15*

**Lubricate rotors and inside of pump housing**

Remove rotors. Apply generous lubrication to rotors and inside of pump housing.

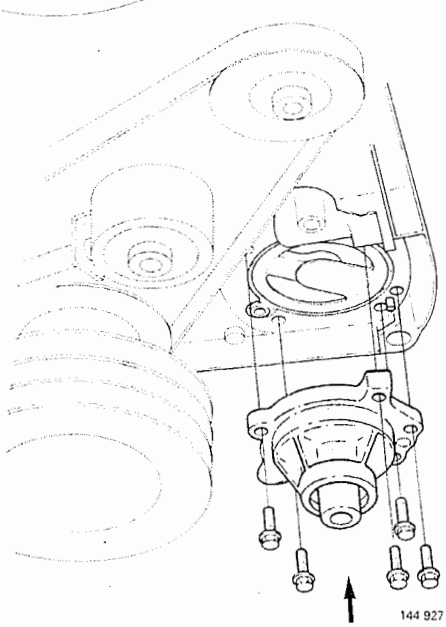
Replace rotors in housing.




*16*

**Fit new seal**

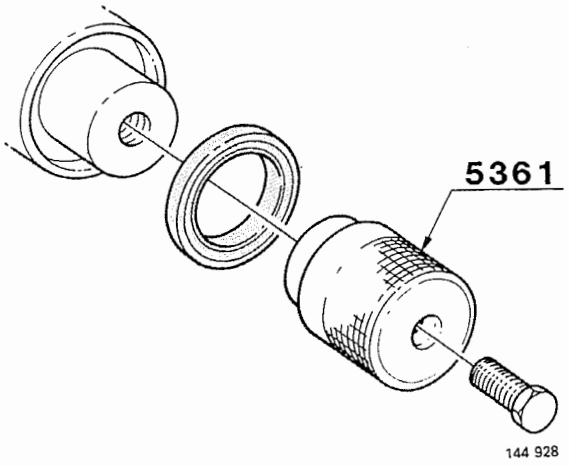
Seat seal in groove.




*17*

**Replace oil pump**

Tighten mounting bolts to **10 Nm** (7.5 ft.lb).

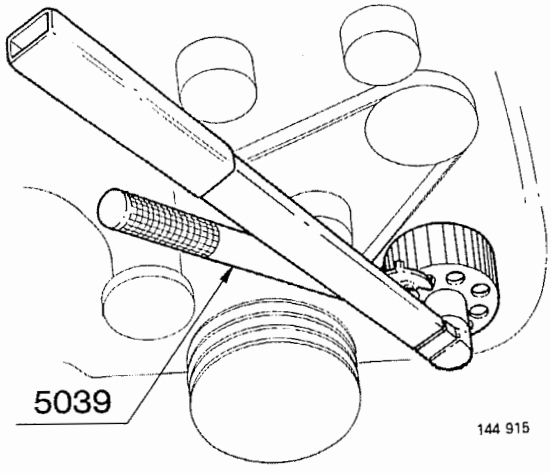



*I8*

### Fit new seal

Use assembly tool **5361.**

**N.B.** Face of seal should normally be in line with chamfered edge in housing. However, if shaft end shows signs of wear, seal may be located approx. 2 mm further in.




*I9*

### Replace drive pulley

Use counterhold **5039.**

Rotate pulley to align locating chamfer.

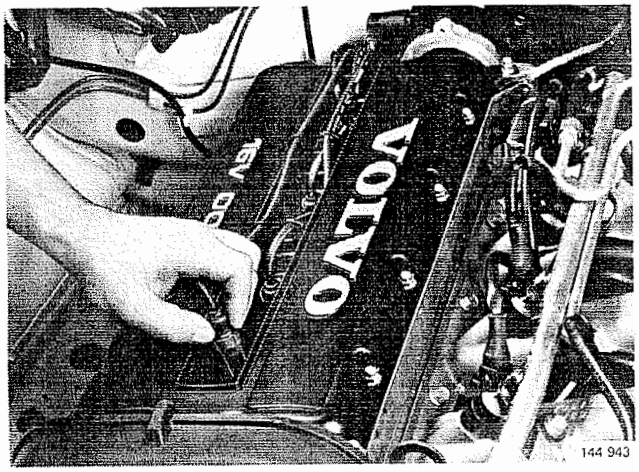
Tighten centre bolt to **20 Nm** (15 ft.lb) and through a further **60°.**

Clean and remove paper/oil container.

Replace timing belt as described in operations **C16–21, C23–30** and **C36–37.**

**N.B.** See table of belt tensioning values in specifications (page 11) if refitting original timing belt.

# J. Valve cover gaskets, replacement



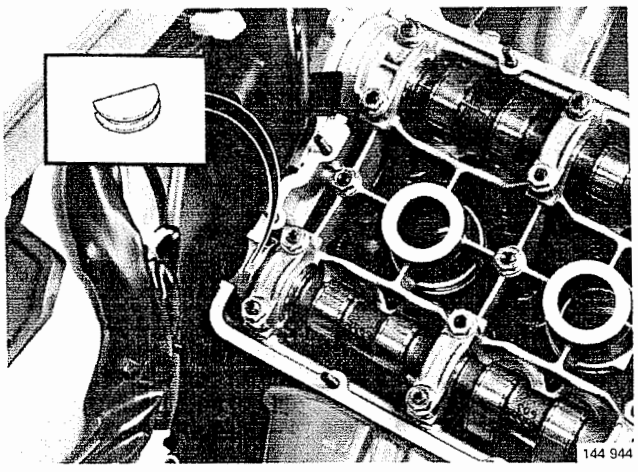
144 943

*J1*

**Remove/disconnect:**

- ignition lead cover plate
- ignition leads from plugs

**N.B.** Always grip ignition leads by **caps** when removing to avoid damage to leads.

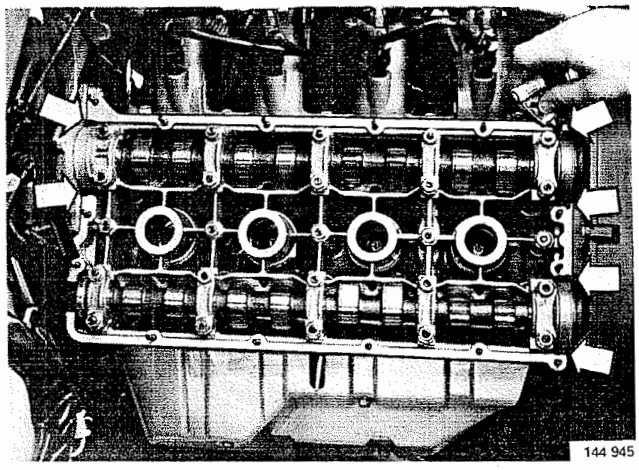

144 944

*J2*

**Remove valve cover and gaskets**

Remove remains of gaskets and clean joint faces.

Inspect rubber seal at rear of exhaust valve camshaft.


144 945

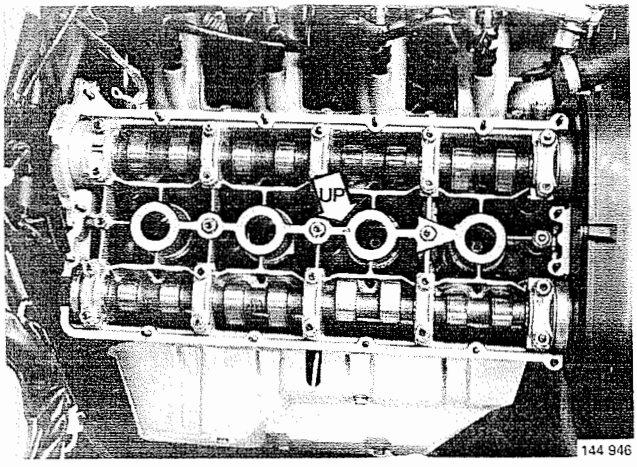
*J3*

**Apply sealer at front and rear camshaft bearing caps**

Use silicone sealer.

Apply bead of sealer to angle between cap and joint face.

*J4*




**Install new gaskets and replace valve cover**

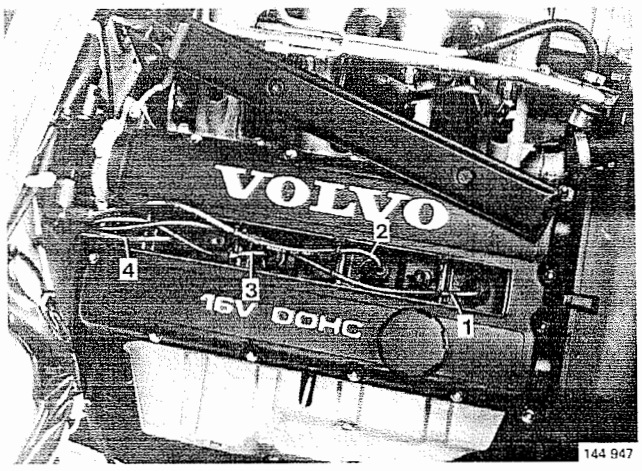
Position spark plug well gasket with arrow pointing to No. 1 cylinder and marking facing upwards.

Shape outer gasket to fit camshaft bearing caps.

Place gasket in position and replace valve cover.

**N.B.** Remember to connect earth lead to distributor.

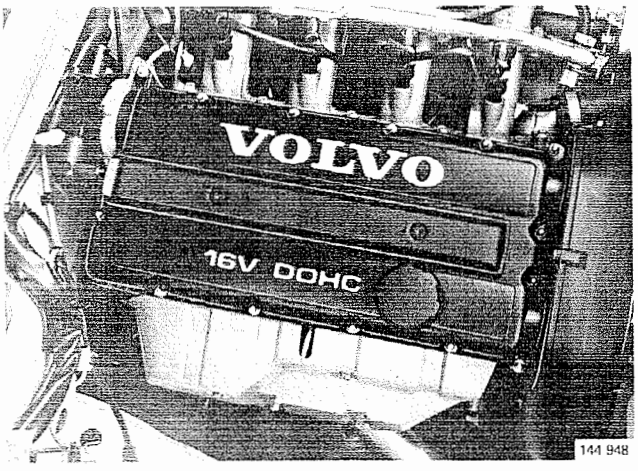
*J5*




**Install:**

- ignition leads (in correct firing order)
- ignition lead cover plate

*J6*

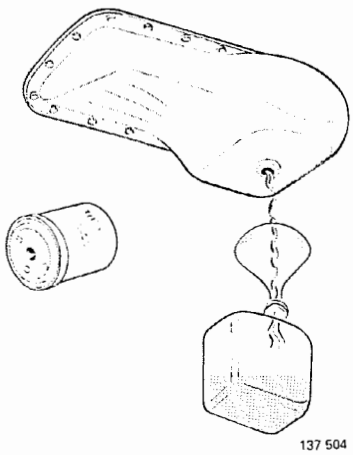



**Check operation**

Check operation/sealing.

# K. Camshafts and tappets, replacement

*Special tools: 5021, 5199*


137 504

### Replacement of camshafts due to wear

**It is imperative that engine be flushed clean before installing new components.**

In most cases, damage to tappets and camshafts is due to engine oil contamination.

### Flush engine

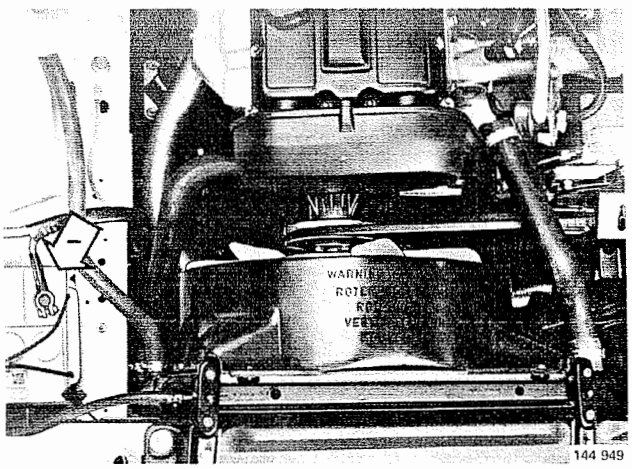
Change oil and filter.

Run engine for approx. 10 minutes.

Drain oil and remove filter.

Install camshafts.

Fit new filter and fill engine with fresh oil of correct grade.


144 949

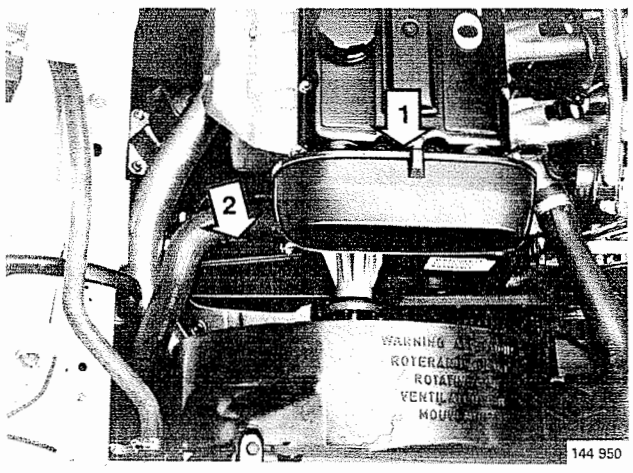
## Removal of camshafts

**N.B.** Procedure describes removal of all tappets. To ensure sealing function of liquid sealing compound between camshaft carrier and cylinder head, tappets should be exposed only on one side at a time.

*K1*

### Remove/disconnect:

- battery earth lead
- alternator drive belt
- radiator fan and pulley

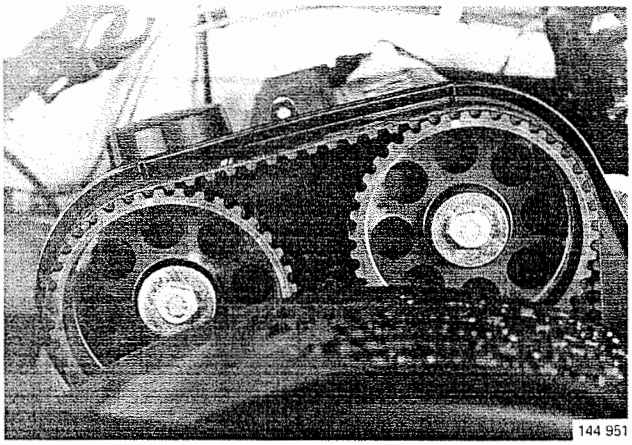


144 950

*K2*

### Remove transmission covers (1) and (2)

Remove upper (1) and lower (2) transmission covers.

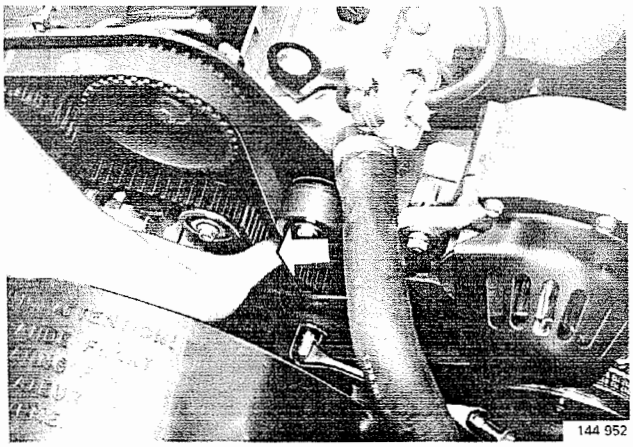

144 951

*K3*

**Align camshaft/crankshaft markings**

Turn engine to TDC position in No. 1 cylinder.

Check that markings on camshaft pulleys are aligned with those on transmission mounting plate.


144 952

*K4*

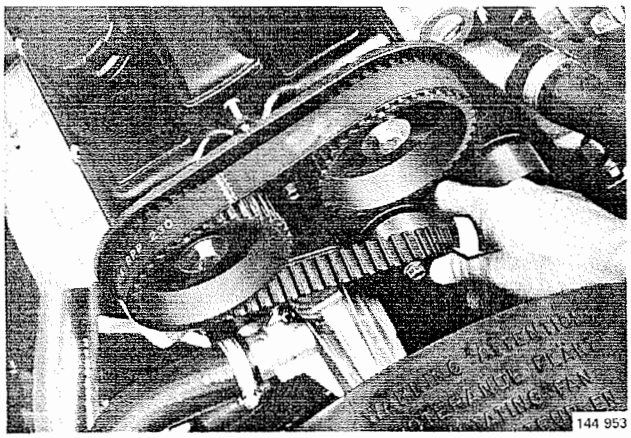
**Slacken tensioner locknut**

Remove protective rubber cap over locknut.

Slacken locknut.

Compress tensioner spring.

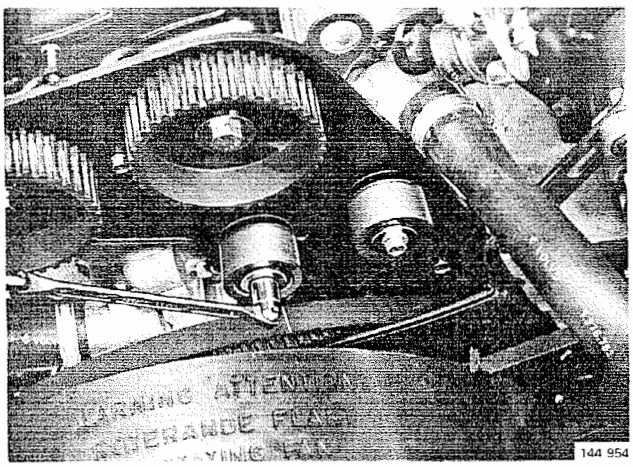
Tighten locknut.


144 953

*K5*

**Remove timing belt from crankshaft pulleys**

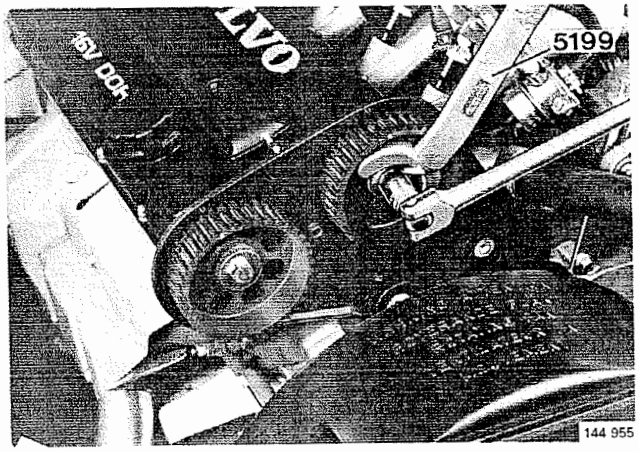
Caution! Crankshaft and camshafts must **not** be rotated while timing belt is slack or has been removed.


144 954

*K6*

**Remove timing belt idlers**

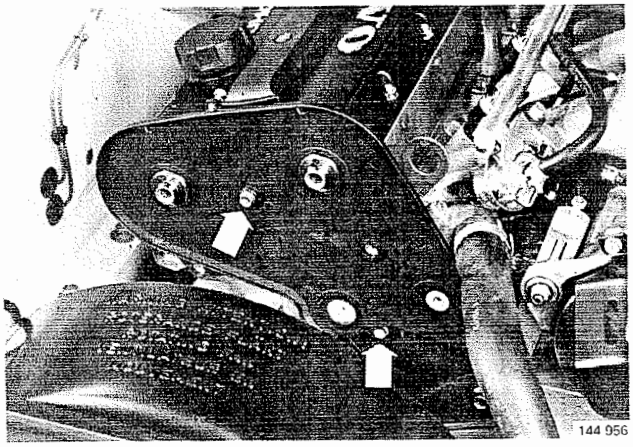
Check pulley surfaces and bearings.




K7

**Remove camshaft drive pulleys**

Use counterhold **5199.**

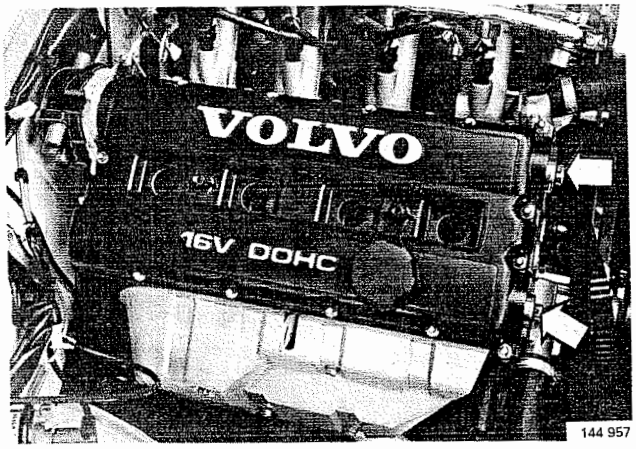



K8

**Remove:**

- upper section of transmission mounting plate
- ignition lead cover plate
- ignition leads at plugs and distributor cap
- ignition coil high-tension lead at distributor cap

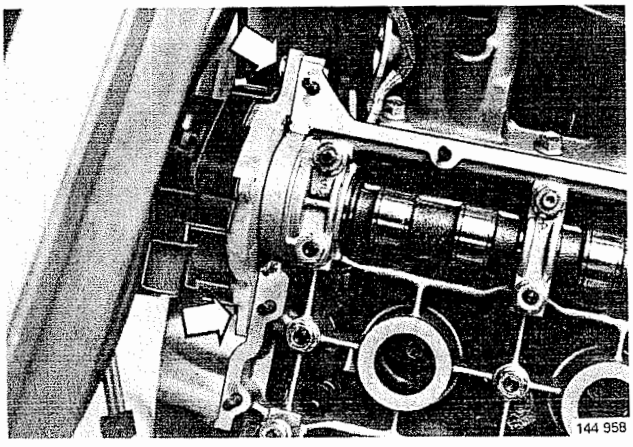
**N.B.** Always grip ignition leads by **caps** when removing to avoid damage to leads.




K9

**Remove valve cover and gaskets**

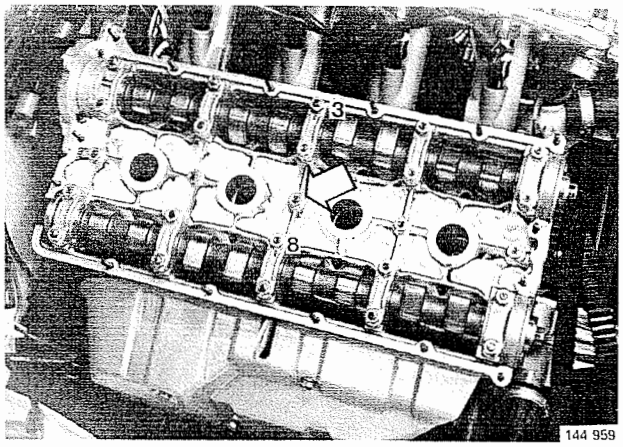
Remove gasket remains and clean joint faces.




K10

**Detach distributor housing from camshaft carrier**

**N.B.** Remove ignition lead clip beside left-hand bolt.



144 959

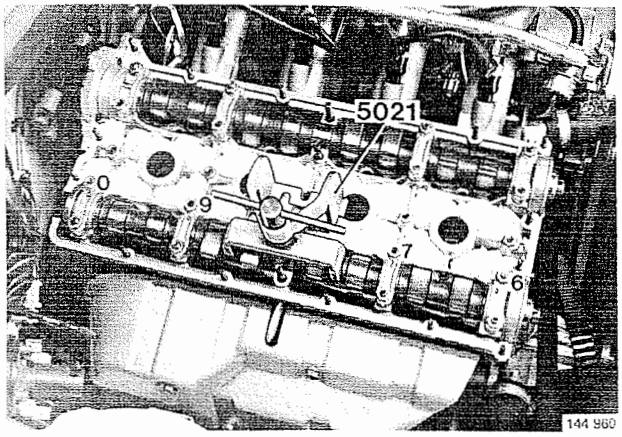
*K11*

**Remove camshaft centre bearing caps**

Plug openings in camshaft carrier (around spark plug wells) with paper.

Remove camshaft centre bearing caps (No. 3 on intake side, No. 8 on exhaust side). Mark caps as required.

Remove third nut in central bolted joint.



144 960

*K12*

**Remove exhaust side camshaft**

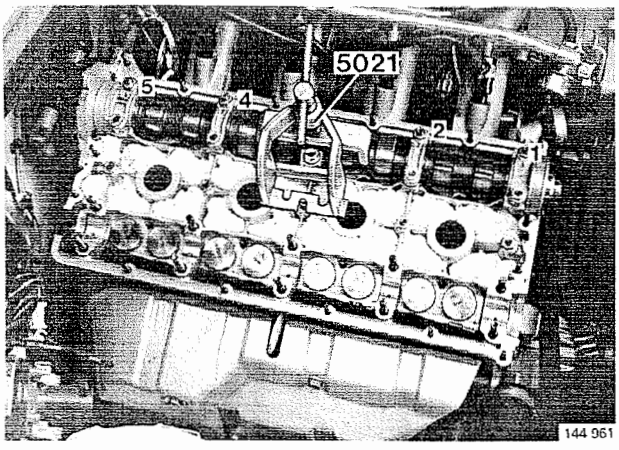
Use press tool **5021**. Place tool in No. 8 bearing cap position.

Clamp press tool on camshaft.

Remove remaining bearing cap nuts and caps (6, 7, 9 and 10).

Inspect bearing surfaces for signs of wear.

Remove press tool 5021 and lift out camshaft.



144 961

*K13*

**Remove intake side camshaft**

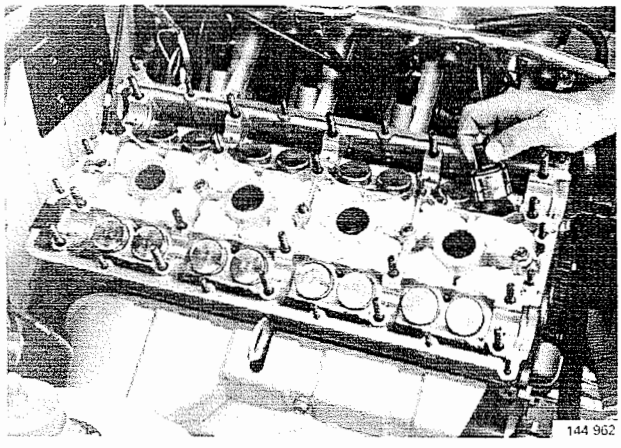
Use press tool **5021**. Place tool in No. 3 bearing cap position.

Clamp press tool on camshaft.

Remove remaining bearing cap nuts and caps (1, 2, 3 and 5).

Inspect bearing surfaces for signs of wear.

Remove press tool 5021 and lift out camshaft together with distributor.


144 962

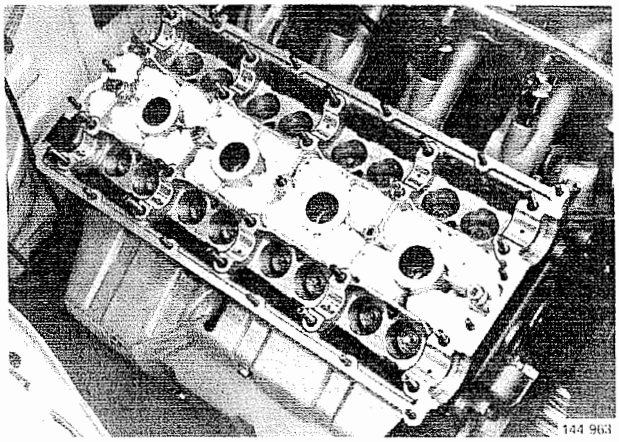
*K14*

**Remove tappets from camshaft carrier**

Magnet or suction cup may be used to facilitate tappet removal.

Inspect tappets for signs of wear.

**N.B.** Store tappets upside down to prevent drainage of oil. Ensure tappets are placed in order – they must not be interchanged.

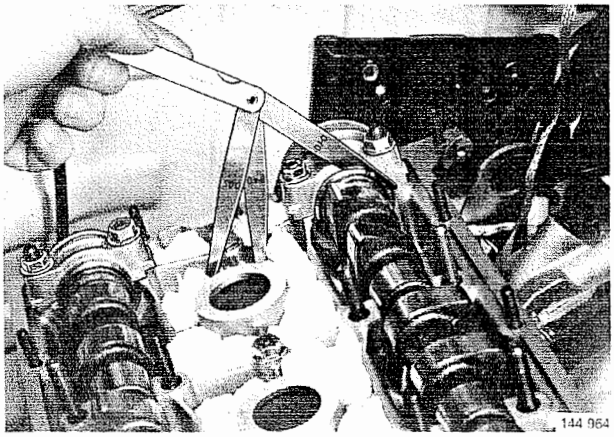

144 963

*K15*

**Clean/inspect camshaft carrier**

Clean and inspect camshaft bearings and tappet bores for signs of wear.

Camshaft axial clearance


144 964

## Camshaft axial clearance

*K16*

**Check camshaft axial clearance**

Place camshafts in position.

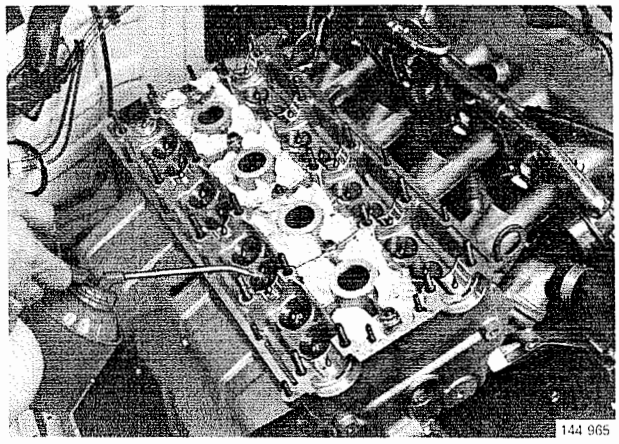
Install rear bearing caps and tighten nuts.

Axial clearance ..... **0.05–0.40 mm** (0.0020–0.0157 in)

Measure clearance with feeler gauges.

Install new rear bearing cap if clearance is excessive.

Remove bearing caps and camshafts.

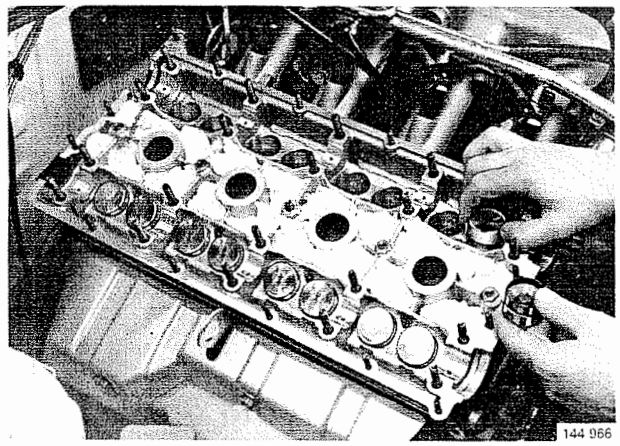

144 965

## Camshaft installation

*K17*

**Oil components**

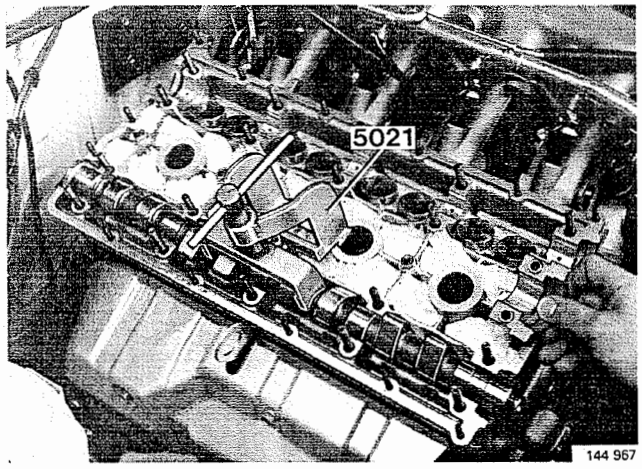
Oil bearings and sliding surfaces on camshaft carrier, bearing caps, camshafts and tappets.


144 966

*K18*

**Insert tappets**

Tappets **must** be replaced in original order.




*K19*

**Install exhaust side camshaft**

Place camshaft in camshaft carrier with pulley guide pin facing upwards.

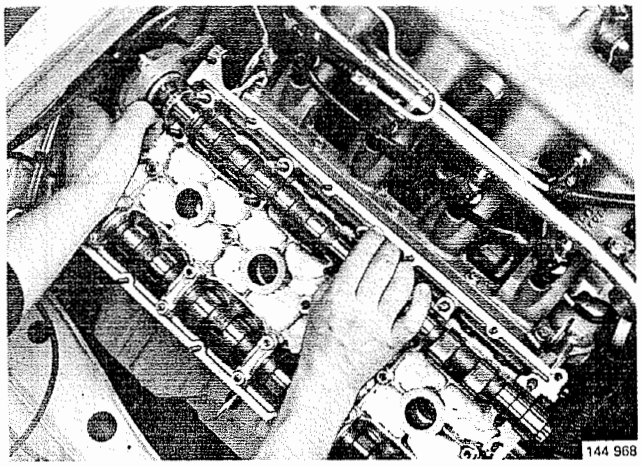
Press camshaft into place with press tool **5021** (using rear bearing cap as guide).

Install bearing caps in original order.

Apply liquid sealing compound to joint face between camshaft carrier and front bearing cap (No. 6).

Install bearing cap nuts in stages.

Remove press tool 5021 and install centre bearing cap (8).




*K20*

**Install intake side camshaft**

Place camshaft in camshaft carrier with pulley guide pin facing upwards.

**N.B.** Turn distributor shaft to align driver with markings on distributor housing.

Fit housing and rotor shaft with **new** O-rings.

Press camshaft into position with press tool **5021** (using rear bearing cap as guide).

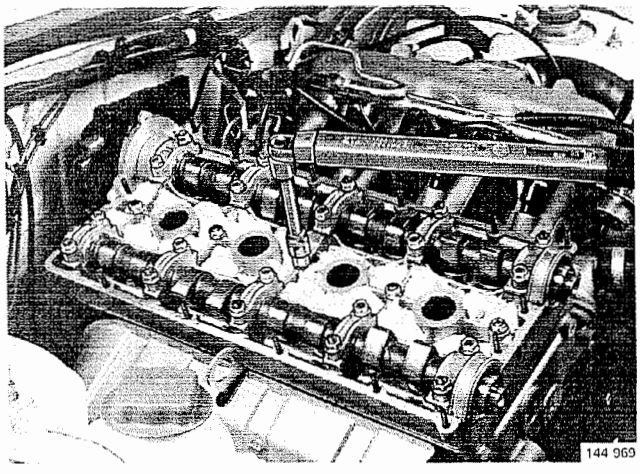
Install bearing caps in original order.

Apply liquid sealing compound to joint faces between camshaft carrier and front and rear bearing caps (Nos. 1 and 5).

Install bearing cap nuts in stages.

Remove press tool 5021 and install centre bearing cap (8).

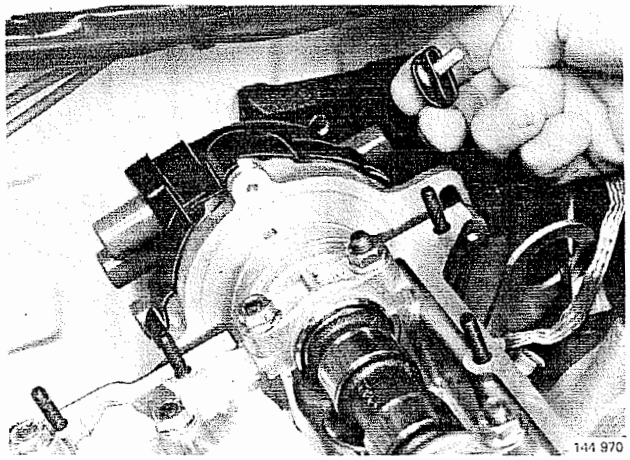
Install camshaft carrier centre nut.




*K21*

**Tighten bearing cap nuts and centre nut**

Tighten to **20 Nm** (15 ft.lb).


144 970

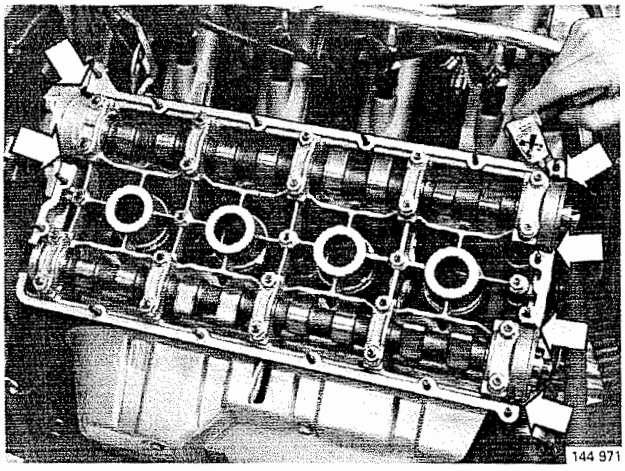
K22

**Refit distributor**

Reconnect high-tension lead between distributor cap and ignition coil.

Remove paper in camshaft carrier openings.

**N.B.** Replace ignition lead clip beside left-hand bolt.

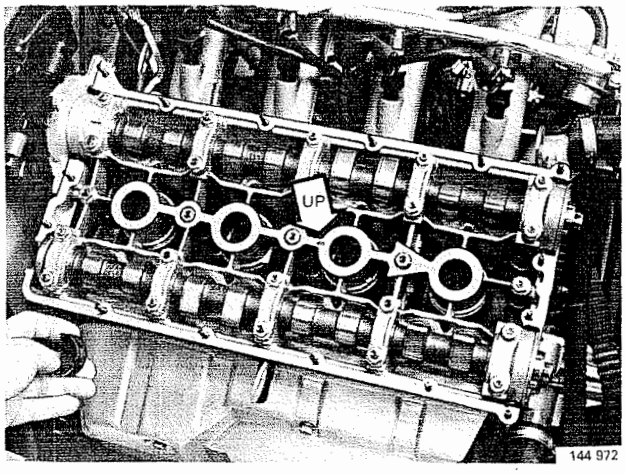

144 971

K23

**Seal front and rear camshaft bearing caps**

Use silicone sealer.

Apply bead of sealer to angle between cap and joint face.



144 972

K24

**Install new gaskets and replace valve cover**

Inspect rubber seal behind camshaft **on exhaust side.**

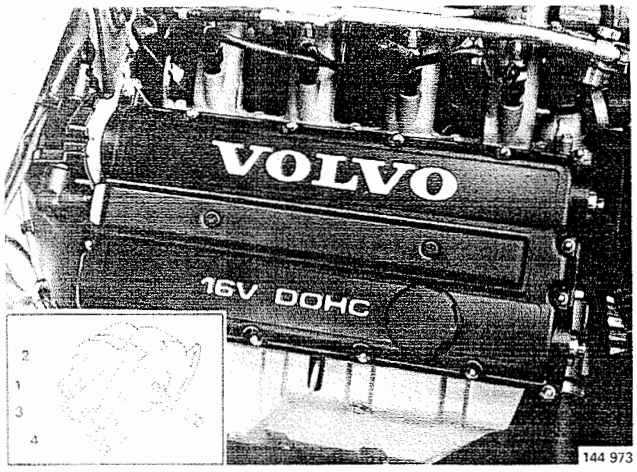
Position spark plug well gasket with arrow pointing to No. 1 cylinder and marking facing upwards.

Shape outer gasket to fit camshaft bearing caps.

Place gasket in position and replace valve cover.

**N.B.** Remember to connect earth lead to distributor.

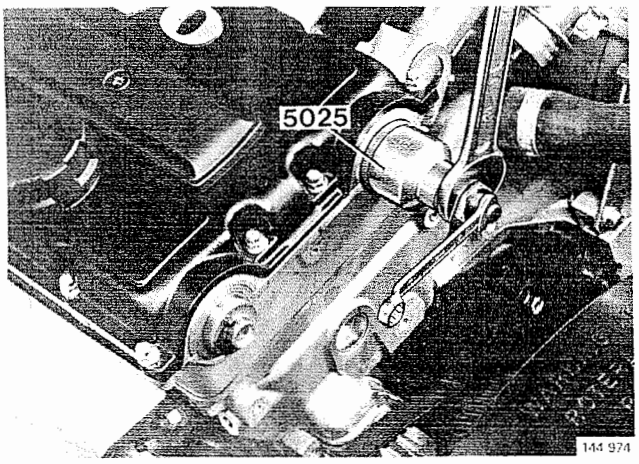
*K25*




**Install:**

– ignition leads (in correct firing order)
– ignition lead cover plate

*K26*




**Fit camshaft front oil seals**

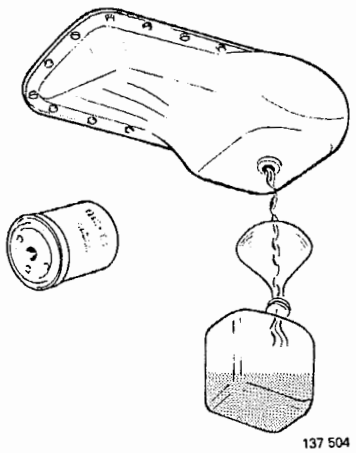
Fit seals as described in operations **F12–24.**

**N.B.** Install new oil filter and fill engine with fresh oil of correct grade.

**Caution!** Some noise may be heard from tappets when engine is first started. However, this will disappear as tappets are filled with oil.

Engine **must not** be run at speed higher than **3000 r/min** while tappet noise is present.

# L. Hydraulic tappets, inspection


137 504

**If noise is heard from tappets:**

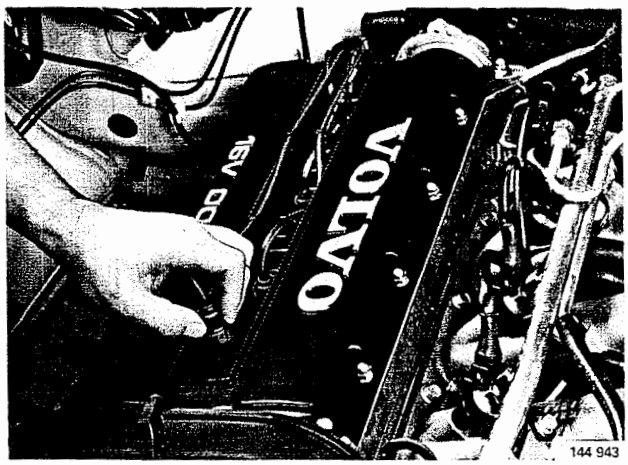
Check tappets for 'spongy' feeling. No play is permissible between camshafts and tappets.

**Flush engine**

Change engine oil and filter.
Run engine for approx. 10 minutes.
Drain oil and remove filter.
Fit new filter and fill engine with fresh oil of correct grade.

Immediately prior to above, run engine at **2000-3000 r/min** for approx. **15 min** at correct oil level and pressure.

**N.B.** Engine **must not** be run at speed higher than **3000 r/min** if noise is heard from any of tappets.



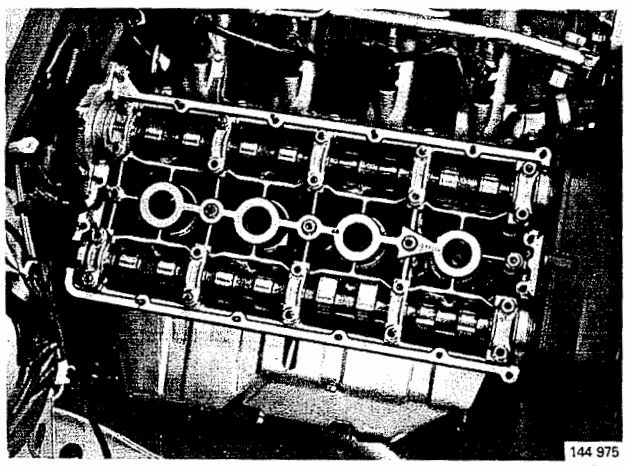
144 943

*L1*

**Remove:**

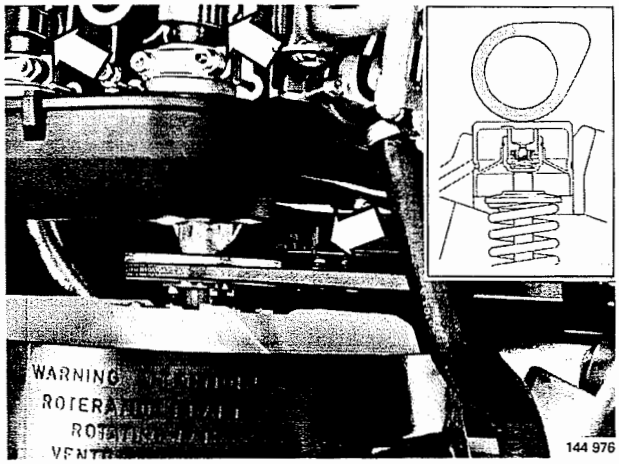
- ignition lead cover plate
- ignition leads from plugs

**N.B.** Always grip ignition leads by **caps** when removing to avoid damage to leads.


144 975

*L2*

**Remove valve cover**

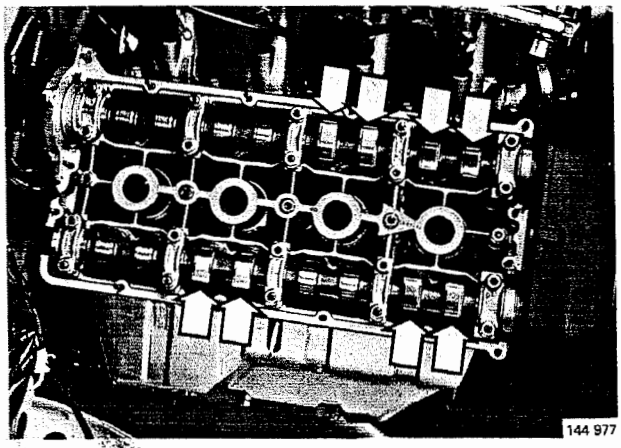



*L3*

**Turn engine to TDC (ignition) in No. 1 cylinder**

Cam pairs on intake/exhaust sides of No. 1 cylinder should be facing away from tappets.

N.B. Check is carried out with tappet in contact with **base circle** of cam (i.e. cam profile must not be in contact with tappet).



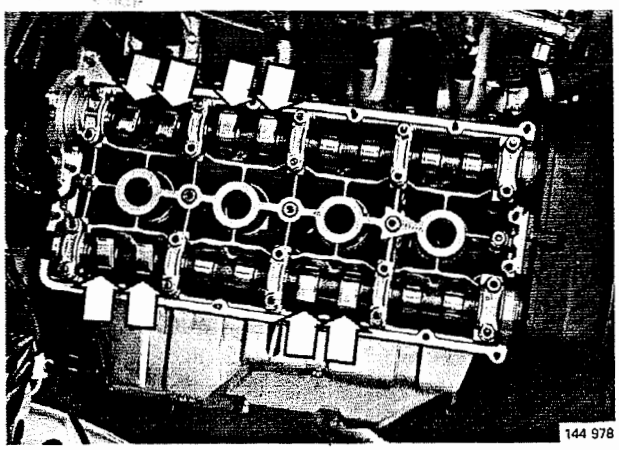

*L4*

**Check tappets**

Depress tappets firmly with thumb or brass rod.

Check following tappets:

No. 1 cylinder intake/exhaust
No. 2 cylinder intake
No. 3 cylinder exhaust

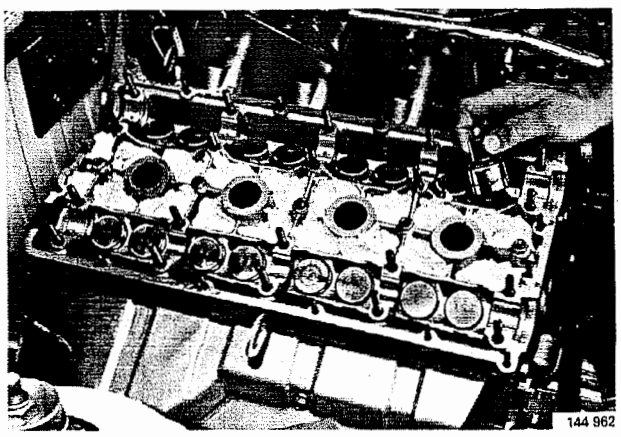



*L3*

**Turn engine to TDC (ignition) in No. 4 cylinder**

Check following tappets:

No. 2 cylinder exhaust
No. 3 cylinder intake
No. 4 cylinder intake/exhaust




*L6*

**Replace any tappet which feels spongy**

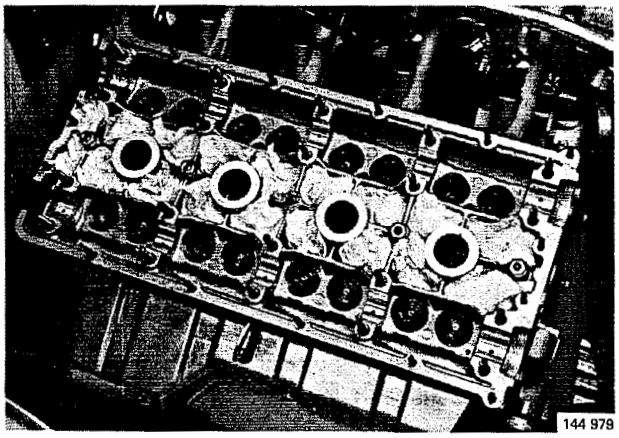
Tappet replacement:

Remove as described in operations **K1-8** and **K10-15.**
Replace as described in operations **K17-26.**

**If tappets are in satisfactory condition:**

See operations **J3-6.**

# M. Camshaft carrier/cylinder head joint, resealing


144 979

Remove camshafts as described in operations **K1-14**.

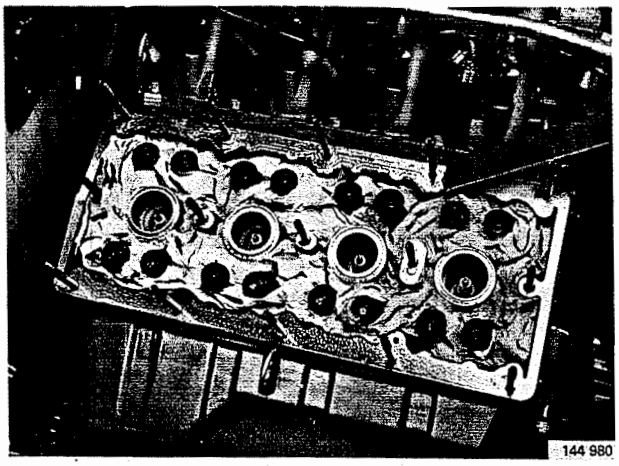
*M1*

**Separate camshaft carrier from cylinder head**

Remove four remaining nuts from central bolted joint.

Detach carrier from head. Tap carrier **carefully** with plastic mallet if component is stuck to head.

Remove O-rings around spark plug wells.


144 980

*M2*

**Clean camshaft carrier/bearing seats and cylinder head**

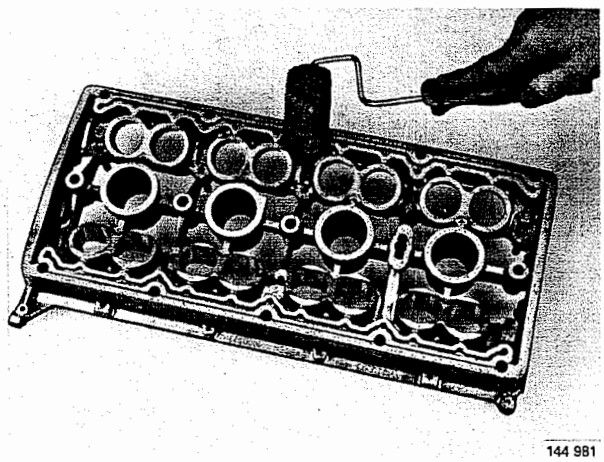
Plug openings in cylinder head with paper.

Dissolve remains of sealing compound with solvent.

**Carefully** scrape joint surfaces clean with plastic putty knife or similar implement.

Blow camshaft carrier **completely** clean with compressed air.

Wipe surfaces with degreasing agent.


144 981

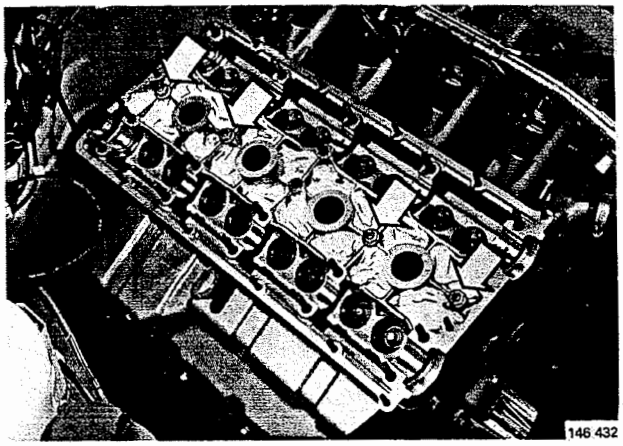
*M3*

**Apply liquid sealing compound**

Apply compound to joint between camshaft carrier and cylinder head, and to bearing cap joint faces (1, 5 and 6).

Apply compound with a short-haired roller.

**N.B.** Remove excess compound from oilways prior to reassembly.



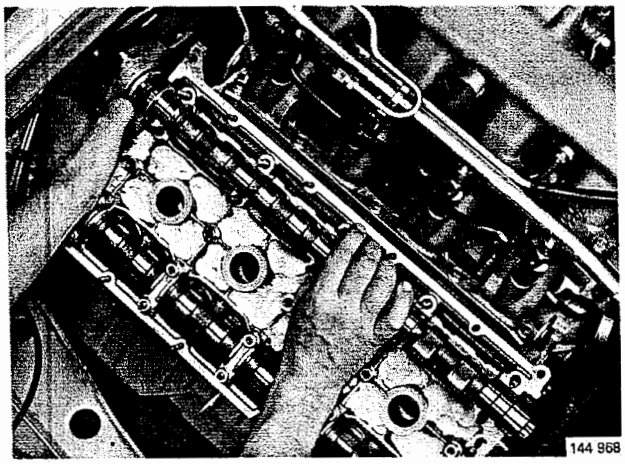

*M4*

**Install camshaft carrier**

Fit new O-rings in grooves around spark plug wells.

Position camshaft carrier on cylinder head and replace nuts 1, 2, 4 and 5 in central bolted joint.

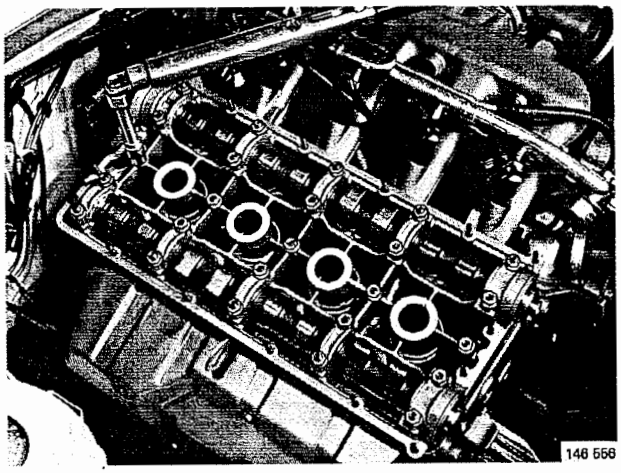
Plug openings around spark plug wells with paper.




*M5*

**Insert tappets and install camshafts as described in operations K17-20**

(Liquid sealing compound has already been applied to camshaft bearing caps.)




*M6*

**Tighten five nuts on camshaft carrier and all bearing caps**

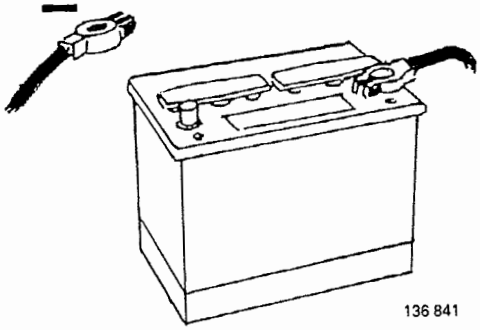
Tighten five nuts in central bolted joint and on all bearing caps.

Tighten to **20 Nm** (15 ft.lb).

Carry out operations **K22-26** and **F12-24**.

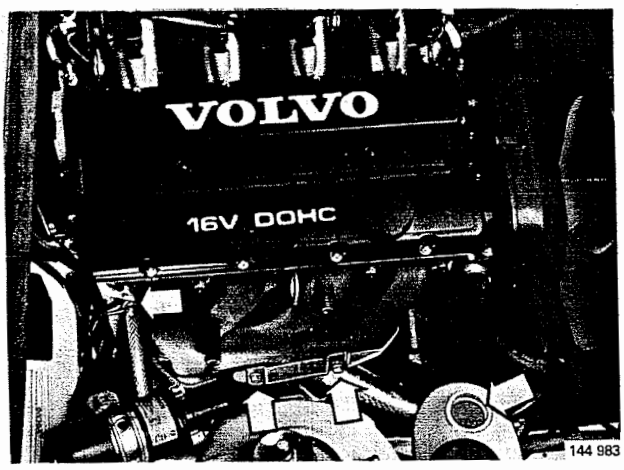
# N. Cylinder head gasket, replacement

*Special tool: 5098*


136 841

*N1*

**Disconnect battery earth lead**



144 983

*N2*

**Drain coolant**

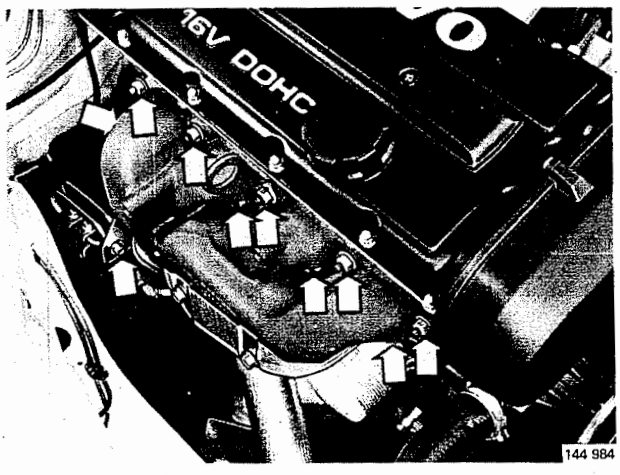
Remove heat shield over exhaust manifold.

(Only the two bottom bolts on the plate need be removed.)

Remove expansion tank cap.

Drain coolant through cock on right-hand side of cylinder block. Fit tube to cock to facilitate collection of coolant.

Remove tube and **close** drain cock on completion of drainage.



144 984

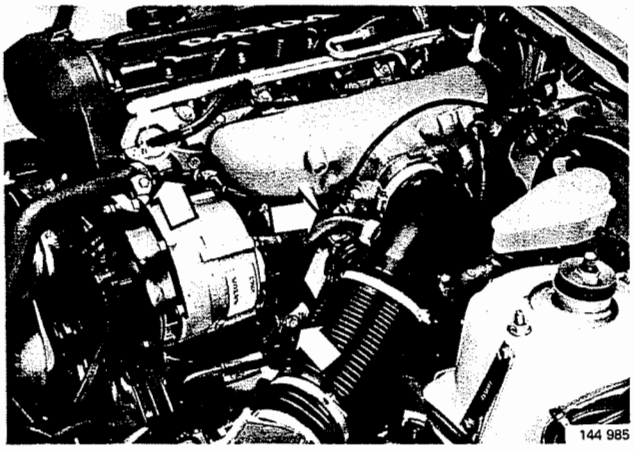
*N3*

**Strip right-hand side of cylinder head**

Unbolt exhaust pipe from bracket.

Remove manifold nuts.

Detach manifold from cylinder block.


144 985

*N4*

**Strip left-hand side of cylinder head**

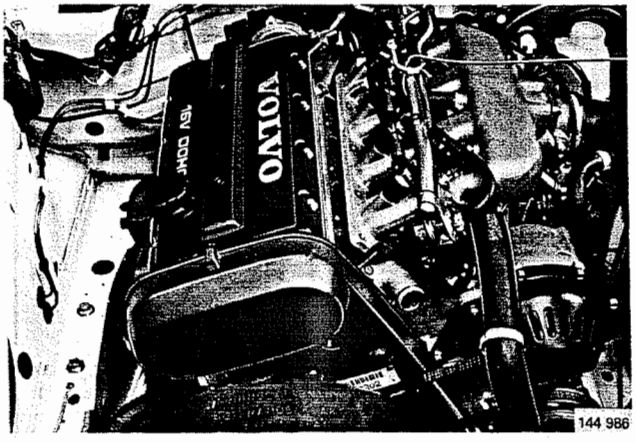
Remove support under intake manifold. Remove bottom bolt in cylinder block.

Detach and tie up manifold in suitable manner.

Disconnect temperature sensor connectors.

Disconnect heating hose under No. 3 and 4 cylinder intake branches.

Disconnect upper coolant hose at thermostat.

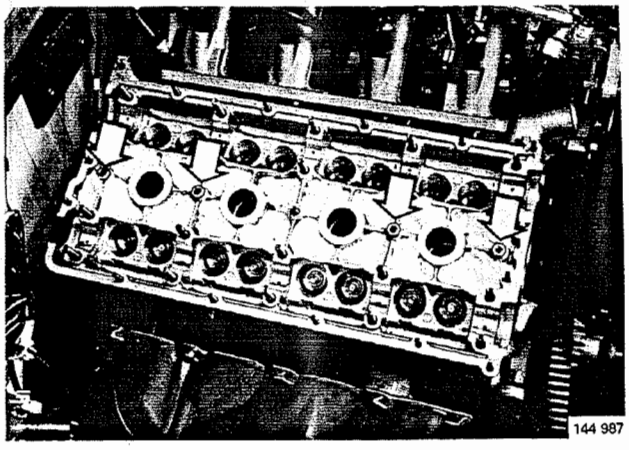


144 986

*N5*

**Strip front and top of cylinder head**

Carry out operations **K1-14.**


144 987

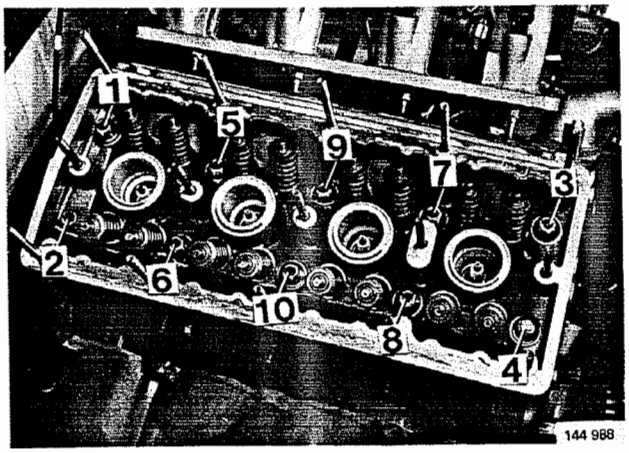
*N6*

**Separate camshaft carrier from cylinder head**

Remove four remaining nuts from central bolted joint.

Detach carrier from head. Tap carrier **carefully** with plastic mallet if component is stuck to head.

Remove O-rings around spark plug wells.



144 988

*N7*

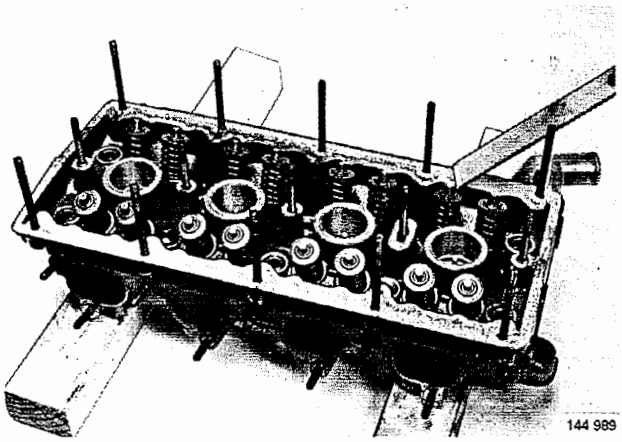
**Remove cylinder head**

Wipe remaining oil from cylinder head.

Undo bolts in order shown, commencing at rear of engine.

Remove cylinder head and gasket.

**Caution!** Cylinder head is made of aluminium. Place on pair of clean wooden blocks or similar supports to avoid scoring.

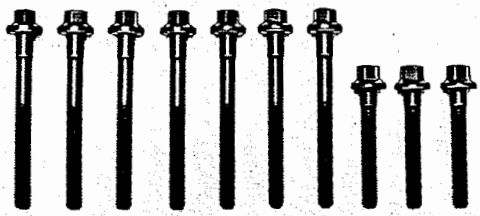

144 989

*N8*

**Clean and inspect all cylinder head joint faces**

See operation **M2** regarding cleaning of camshaft carrier and removal of sealing compound.

Clean and inspect cylinder block joint faces.


144 990

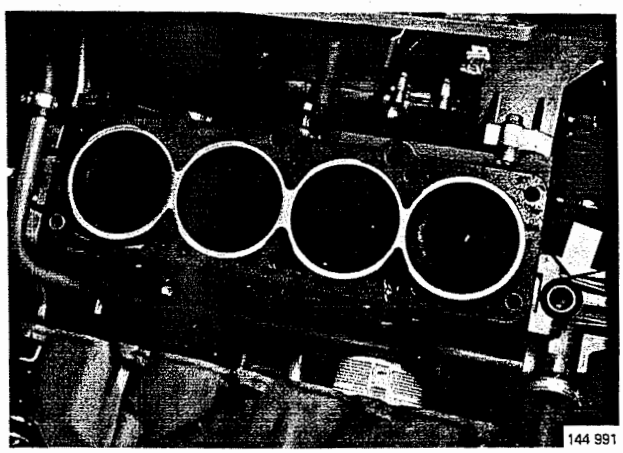
*N9*

**Clean and inspect cylinder head bolts**

Bolts should be replaced if any evidence of elongation is observed. (This will be indicated by thinning of mid-section.)

Bolts should be used no more than **5 times.**

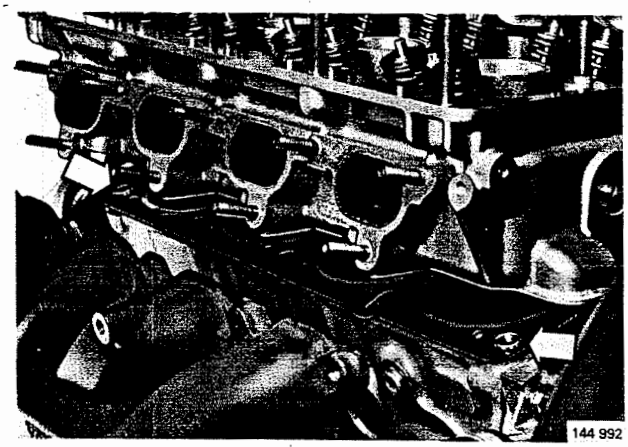
Replace bolts if in any doubt regarding above.


144 991

*N10*

**Fit:**

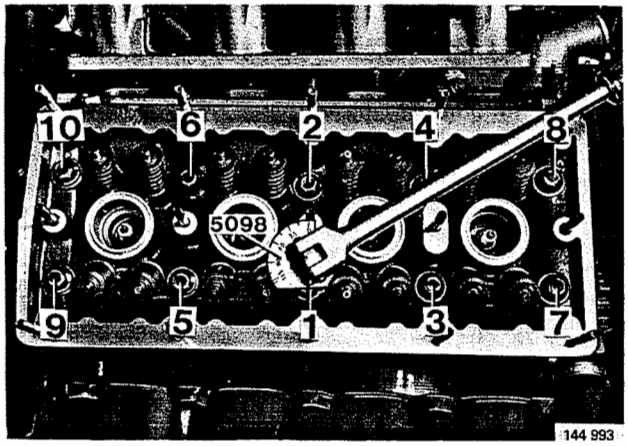
- new cylinder head gasket
- new O-ring seal for water pump


144 992

*N11*

**Place cylinder head in position**

Lower head carefully into position over guides, taking care to **avoid damaging** gasket.




*N12*

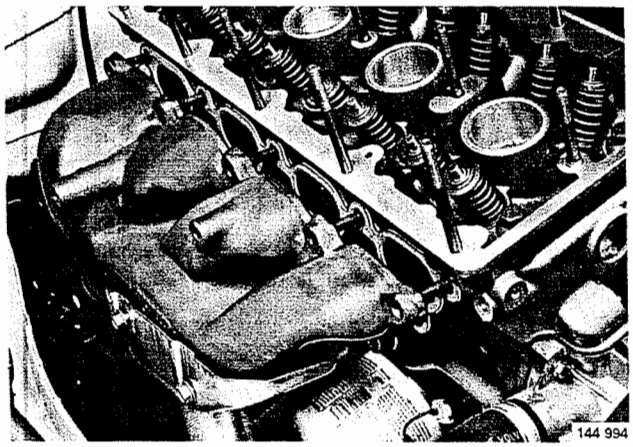
**Tighten cylinder head bolts**

Use protractor **5098.**

Oil bolts.

Insert and tighten bolts in three stages, in order shown.

1 = **20±2 Nm** (15±1.5 ft.lb)
2 = **40±5 Nm** (30±4 ft.lb)
3 = Tighten through further **115°±10°.**




*N13*

**Install exhaust manifold**

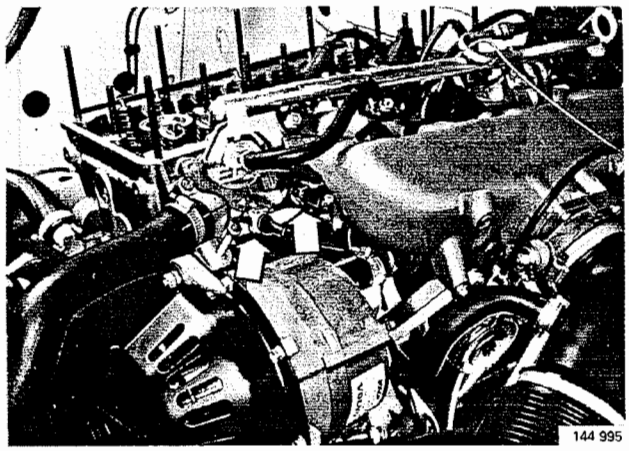
Use **new** gasket.

Place manifold in position. Replace and install nuts.

Bolt lifting lug in position between No. 2 and 3 exhaust branches.

Reattach front exhaust pipe to bracket.

Install bottom heat shield.

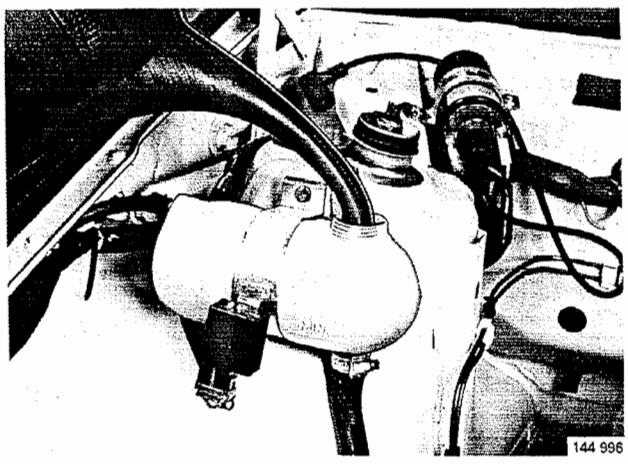



*N14*

**Reconnect:**

- temperature sensor connectors
- heating hose under No. 3 and 4 cylinder intake branches
- upper coolant hose to thermostat.

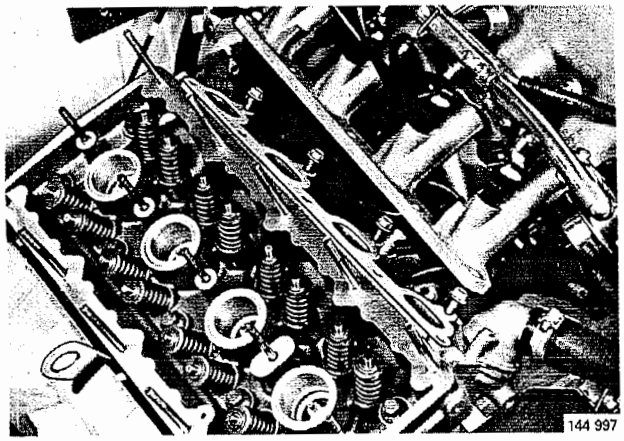
**Caution!** Note marking on hose. Clearance between hose and alternator drive belt **must be at least 25 mm** (1 in).




*N15*

**Fill cooling system**

Check system for leaks.


144 997

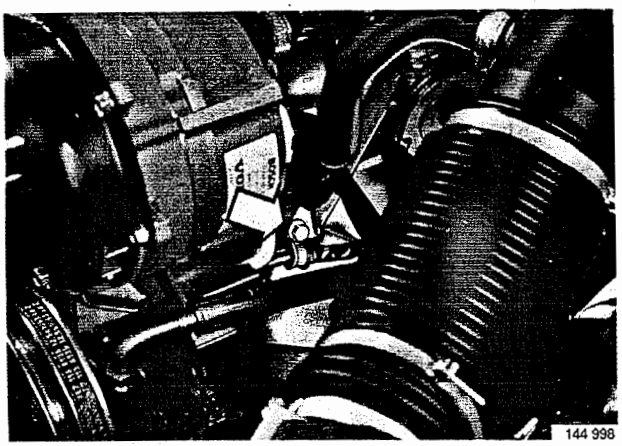
*N16*

**Install intake manifold**

Use **new** gasket.

Screw in bottom bolts a few turns.

Place intake manifold and lifting lugs in position. Tighten manifold from centre outwards.

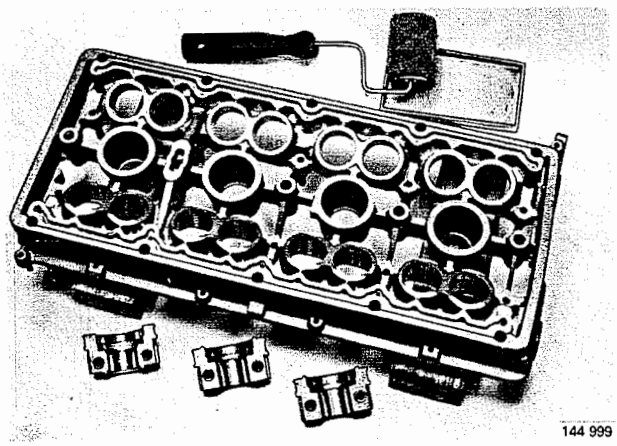

144 998

*N17*

**Reattach support under intake manifold**

Install cable clip.

Check connections on and underneath manifold.


144 999

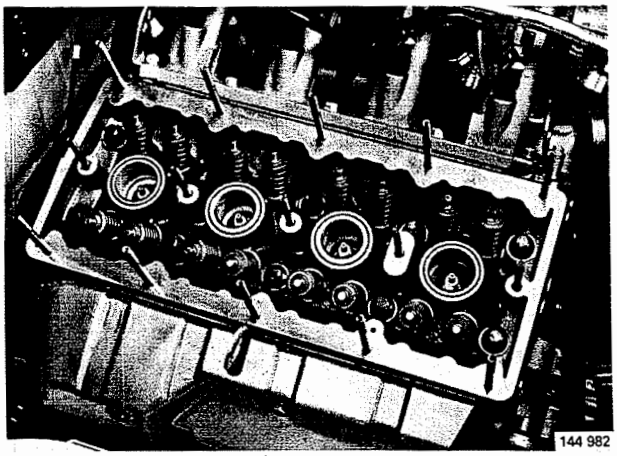
*N18*

**Apply liquid sealing compound**

Apply compound to joint between camshaft carrier and cylinder head, and to bearing cap joint faces (1, 5 and 6).

Apply compound with a short-haired roller.

**N.B.** Remove excess compound from oilways prior to reassembly.

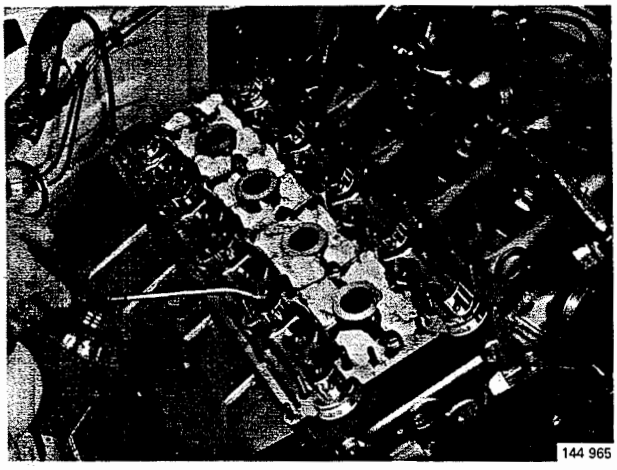

144 982

*N19*

**Install camshaft carrier**

Fit new O-rings in grooves around spark plug wells.

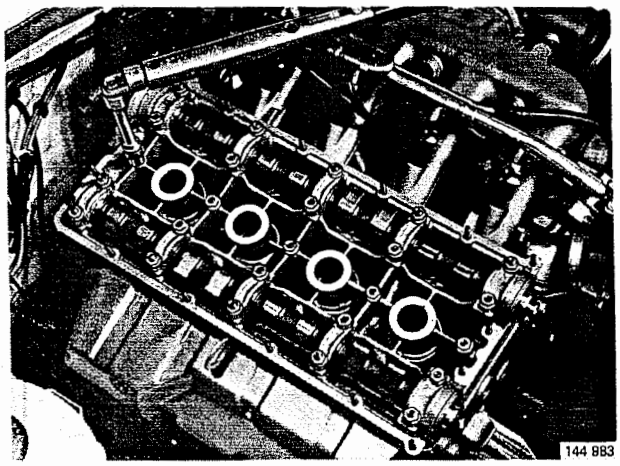
Position carrier on cylinder head and replace nuts 1, 2, 4 and 5 in central bolted joint.




*N20*

**Insert tappets and install camshafts as described in operations K17-20**

(Liquid sealing compound has already been applied to camshaft bearing caps.)




*N21*

**Tighten five nuts on camshaft carrier and all bearing caps**

Tighten five nuts in central bolted joint and on all bearing caps.

Tighten to **20 Nm** (15 ft.lb).

Carry out operations **K22-26** and **F12-24.**

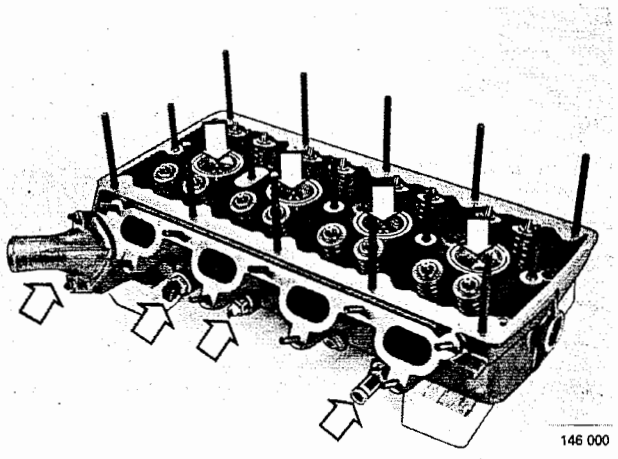
# O. Cylinder head, dismantling/inspection

*Special tools: 5219, 9802, 998 6052, 115 8280*

**Remove cylinder head as described in operations N1-7**

**Caution!** Cylinder head is made of aluminium. Place on pair of clean wooden blocks or similar supports to avoid scoring.

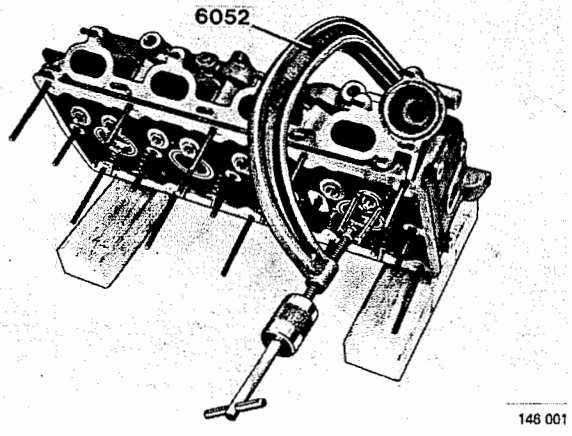
## Stripping


146 000

*O1*

**Remove:**

- spark plugs
- temperature sensors and pipe branches
- thermostat housing and thermostat



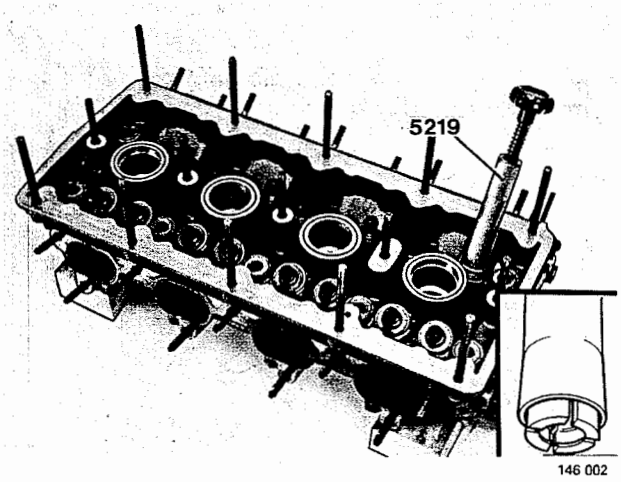
146 001

*O2*

**Remove:**

- valve collets, using clamp **998 6052**
- upper spring collars
- valve springs
- valves

**N.B.** Ensure that **position** of every part removed is **identified.** Parts must not be interchanged.

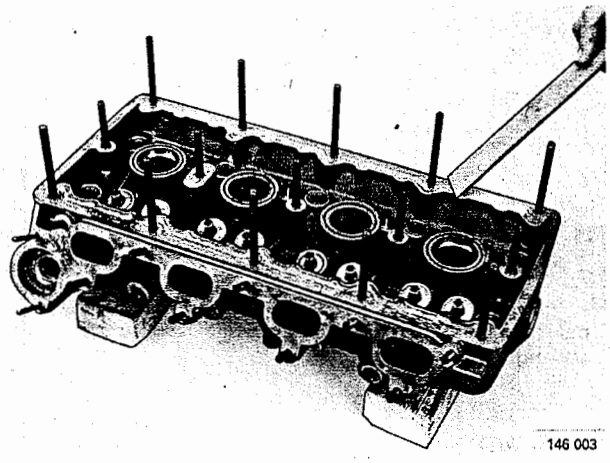


146 002

*O3*

**Remove:**

- valve stem seals, using tool **5219**
- lower spring collars




## Cleaning and inspection

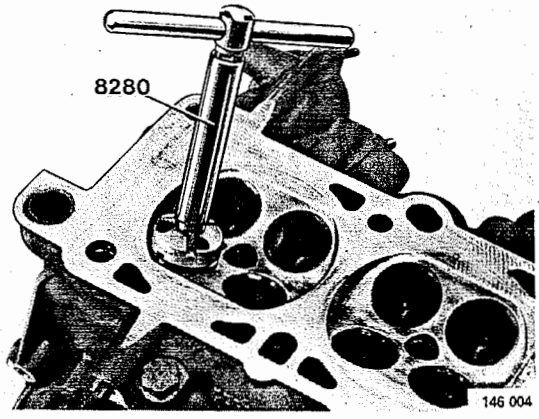
*O4*

**Clean:**

– joint faces

Remove all traces of liquid sealing compound as described in operation **M2.**

*O5*




**Clean:**

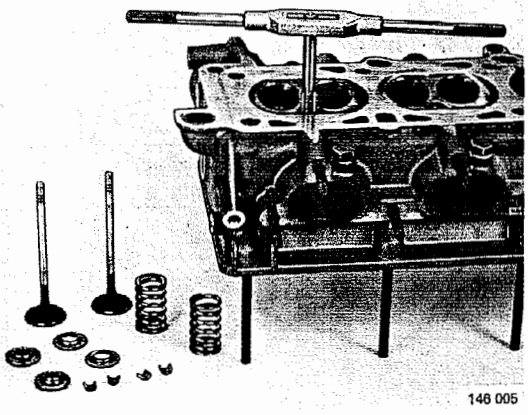
– combustion chambers
– intake/exhaust passages
– valve seats

Clean all valve seats.

Use tool **115 8280** with 7 mm dia. spindle and 45° cutter.

**N.B.** Ensure that tool is clear of combustion chamber walls.

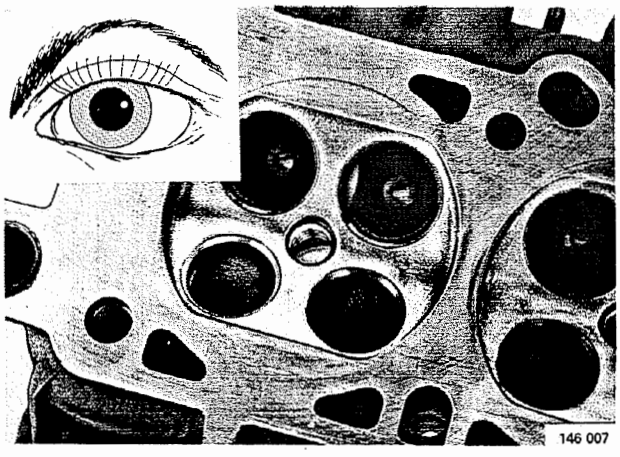
*O6*




**Clean:**

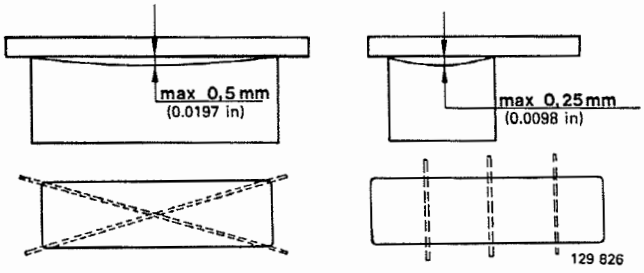
– spark plug mating threads
– valves
– valve springs and spring collars

*O7*




**Inspect cylinder head and dismantled components**

Inspect head and components visually for signs of wear or damage.




*O8*

## Measure cylinder head distortion

Use steel rule and feeler gauges.

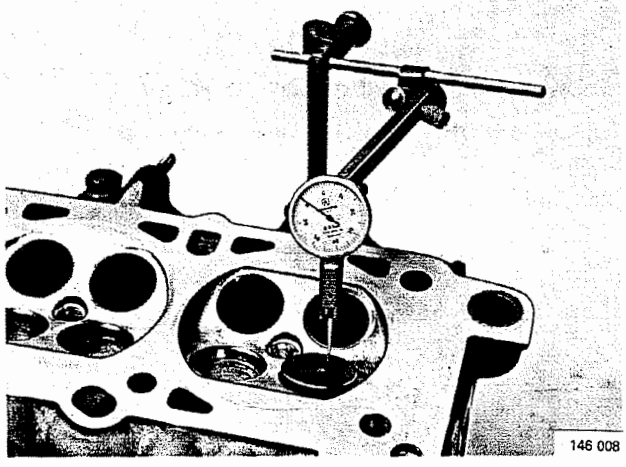
Max. distortion without machining:

Longitudinal ..... **0.50 mm** (0.0197 in)
Lateral..... **0.25 mm** (0.0098 in)

Cylinder head must be replaced if distortion exceeds **1.0 mm** (0.0394 in) along length or **0.50 mm** (0.0197in) across width.

Height of cylinder head as new ..... **103.50±0.5 mm** (4.0780±0.0197 in)

Minimum height after machining ..... **102.5 mm** (4.0354 in)




*O9*

## Measure valve guide wear

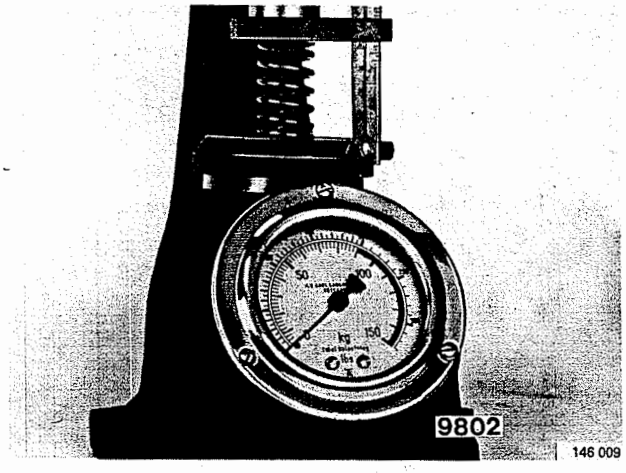
Use magnetic stand and dial gauge.

Lift valve **approx. 2–3 mm** (1/10 in) clear of seat when checking guide.

**Clearance between new components:**

Intake ..... **0.03–0.06 mm** (0.0012–0.0024 in)
Exhaust ..... **0.04–0.07 mm** (0.0016–0.0028 in)

**Max. clearance, used components:**
Intake/exhaust ..... **0.15 mm** (0.0059 in)




*O10*

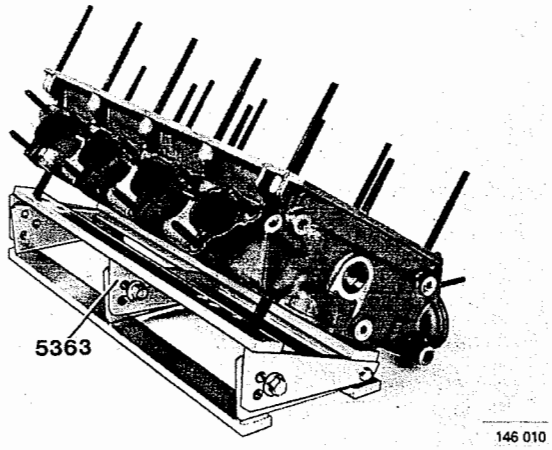
## Measure valve springs

Use spring tester **9802.**
Outside dia..... **26.2 mm** (1.0315 in)
Inside dia. ..... **18.1 mm** (0.7126 in)

| Length, mm (in) | Load, N (lb) |
|---|---|
| L: 43.0 (1.69) | 0 (0) |
| L1: 37.0 (1.46) | 232±20 (52±4.5) |
| L2: 26.5 (1.04) | 640±40 (144±9) |

# P. Cylinder head, overhaul

*Special tools: 5222, 5363, 5364, 5365, 5366, 5367, 5368, 5369, 5373, 5377, 5378, 998 6045*



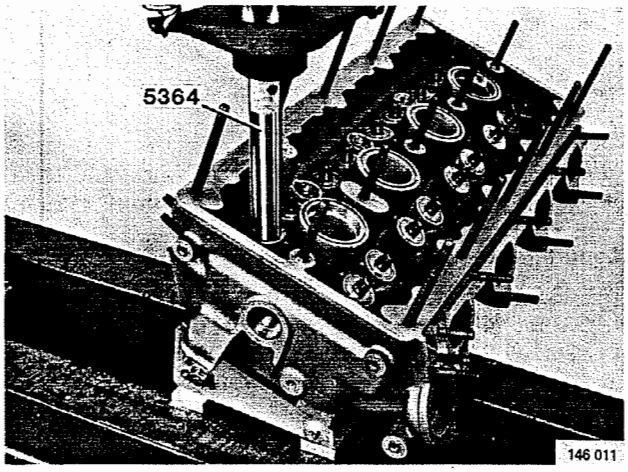

## Replacement of valve guides

*P1*

**Mount cylinder head on fixture 5363**

Adjust angle of inclination. Use locating holes No. 2 in fixture supports.

Clamp head to fixture. Use locating holes No. 2 on face.

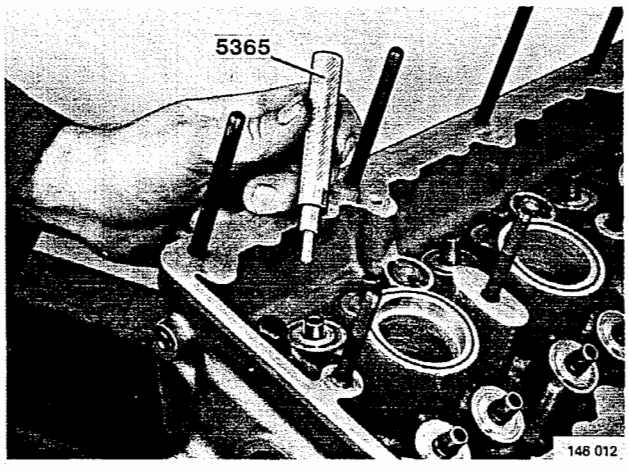



## Press out guides to be replaced. (Procedure is carried out in three stages)

*P2*

**1. Free guide using drift 5364**

Press **slowly** until drift bears against valve spring seat.

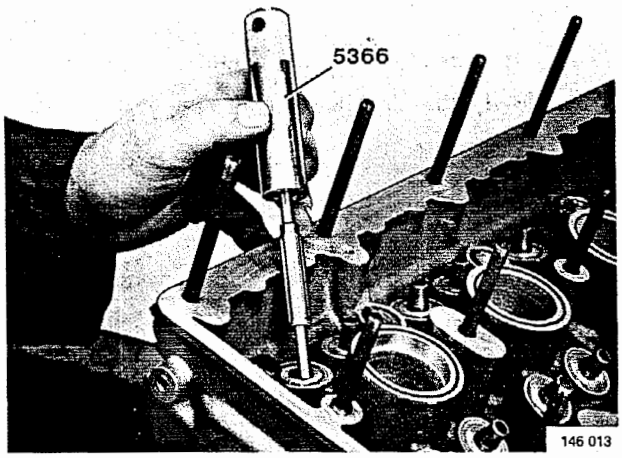



*P3*

**2. Press out further using drift 5365**

Press **slowly** until drift bears against valve spring seat.

Inspect upper section of guide bore.




*P4*

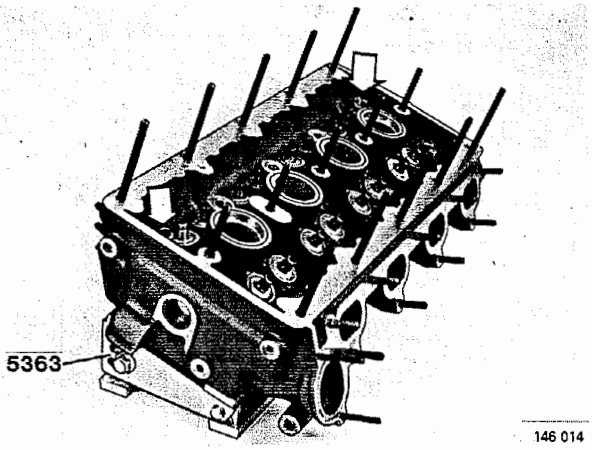
**3. Place new valve guide on drift 5366 and press home**

Press guide **slowly** into head until drift bears against valve spring seat.

Top of guide should project by ..... **15±0.2 mm** (0.5906±0.0079 in)

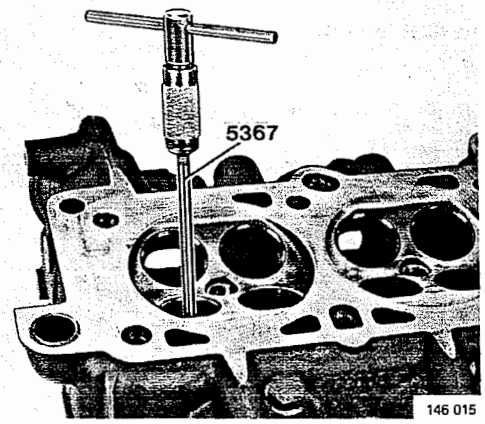
(Height is set by tool.)

**Important!** Press force must be at least **9000 N** (2025 lb). If force is lower, guide must be removed and bore reamed out for fitting oversized guide.




*P5*

**Remove cylinder head from fixture 5363**




*P6*

**Ream valve guides internally**

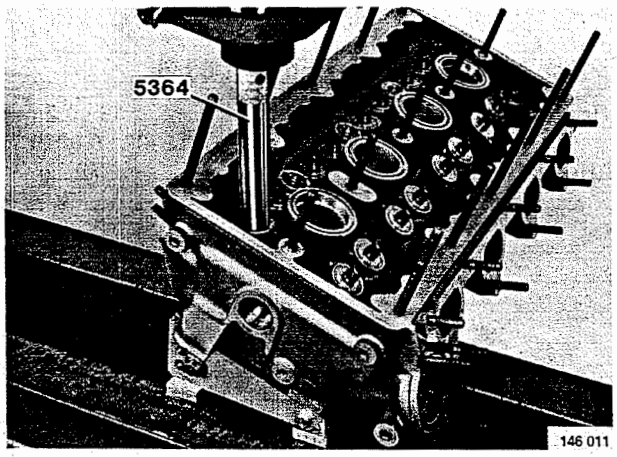
Use reamer **5367.**

Ream from combustion chamber side.

**N.B.** Valve and seat **must** be ground in following installation of new guide.

## Installing oversized valve guides

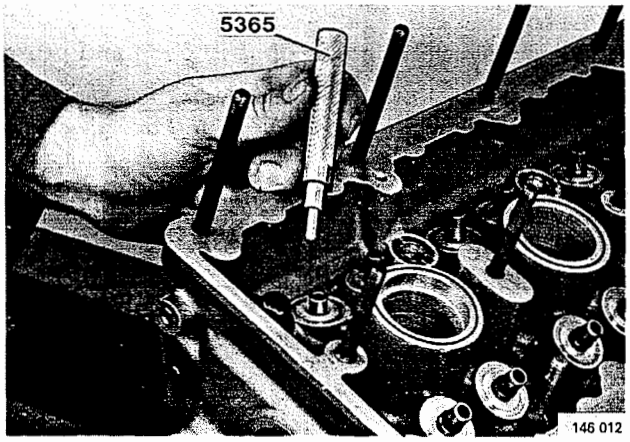
**Important!** Oversized guides must be fitted if press force is less than **9000 N** (2025 lb) or if guide bores in cylinder head are damaged.




*P7*

**Press out guide using drift 5364**

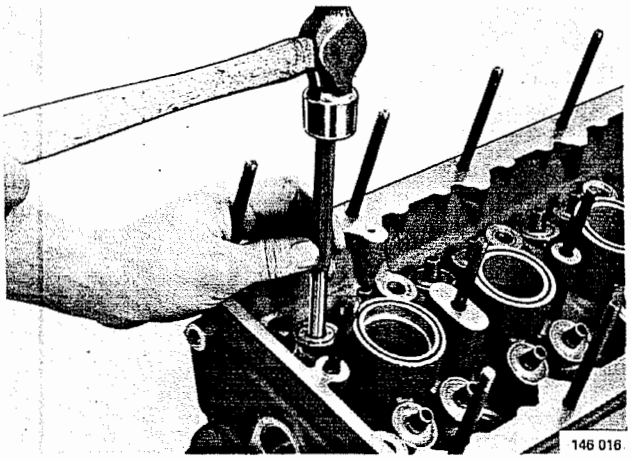
Press **slowly** until drift bears against valve spring seat.




*P8*

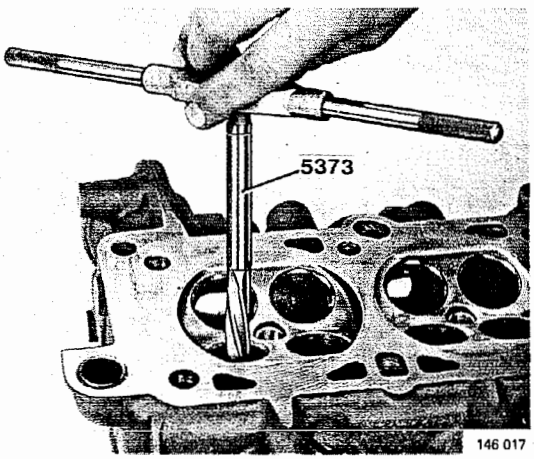
**Press out further using drift 5365**

Press **slowly** until drift bears against valve spring seat.




*P9*

**Tap out guide using drift**

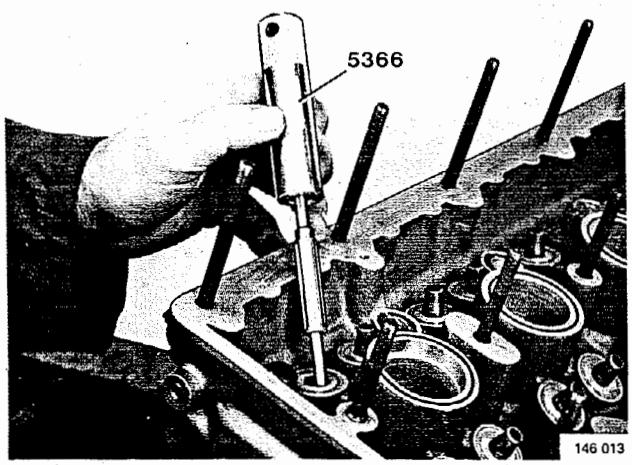



*P10*

**Ream out guide bore**

Use reamer **5373.**

Ream from combustion chamber side.



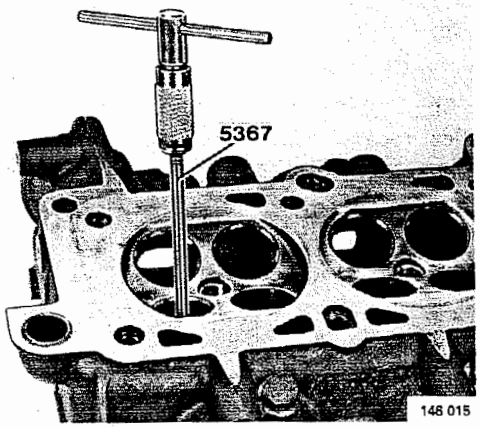

*P11*

**Press in new guide using drift 5366**

Top of guide should project by ..... **15±0.2 mm**
(0.5906±0.0079 in)

(Height is set by tool)

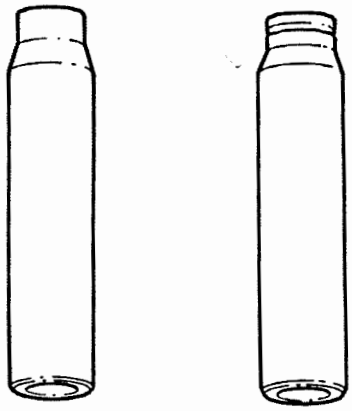
P12




**Ream valve guides internally**

Use reamer **5367**.
Ream from combustion chamber side.

P13




**Marking and dimensions of valve guides**

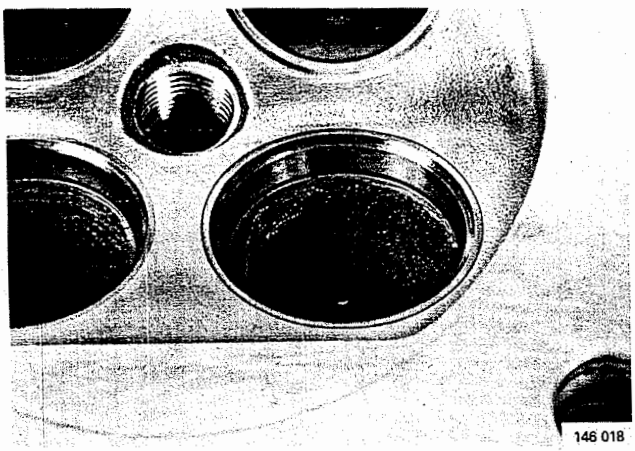
Guide P/N ..... **1 378 960-7**
**Standard:** Outside dia. ..... **12.0 mm** (0.4724 in)
No. of grooves: ..... **0**

Guide P/N ..... **1 378 958-1**
**Oversize:** Outside dia. ..... **12.1 mm** (0.4764 in)
No. of grooves: ..... **1**

## Replacement of valve seats

**Important!** Valve guide **must always** be replaced **before** replacing seat.

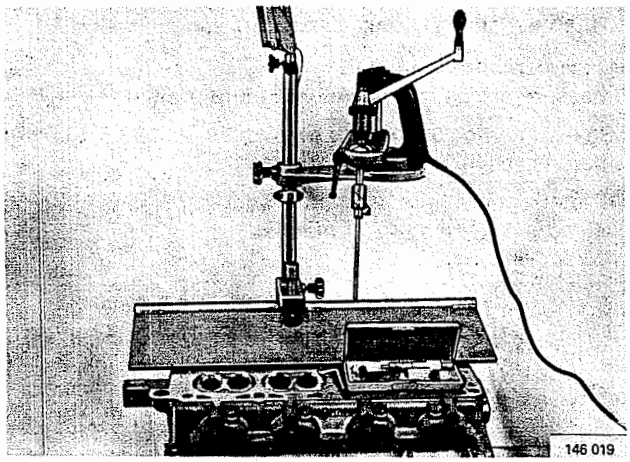
P14




**Clean valve seat**

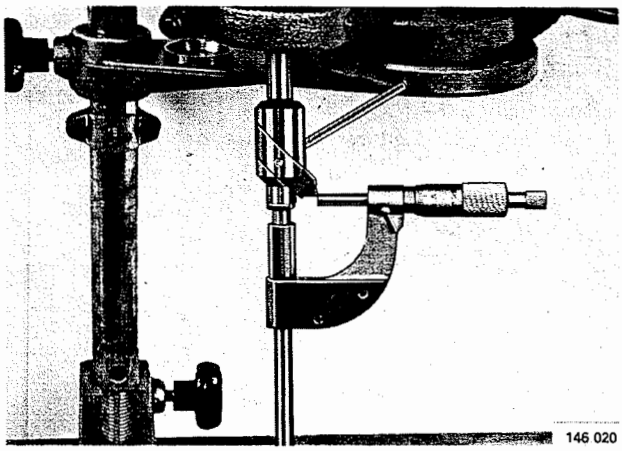
Ensure that edge of seat is clearly visible.

P15




**Remove valve seat**

Use seat miller such as Mira P/N **998 6045-5.**

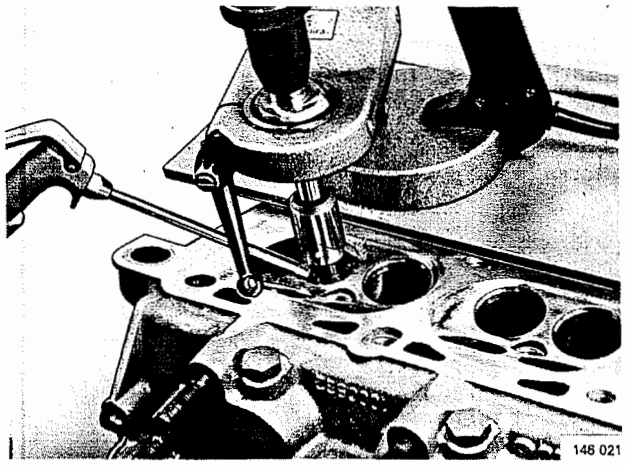

146 020

*P16*

### Set milling cutter

Adjust cutter diameter to slightly less than **standard diameter** of **seat recess** in cylinder head.

| Seat recess diameter | Intake | Exhaust |
|---|---|---|
| **B 234** ..... mm | **35.9**$^{0}_{-0.05}$ (1.4144 in$^{0}_{-0.0020}$) | **32.9**$^{0}_{-0.05}$ (1.2953 in$^{0}_{-0.0020}$) |
| **B 204** ..... mm | **33.9**$^{0}_{-0.05}$ (1.3346 in$^{0}_{-0.0020}$) | **30.9**$^{0}_{-0.05}$ (1.2165 in$^{0}_{-0.0020}$) |


146 021

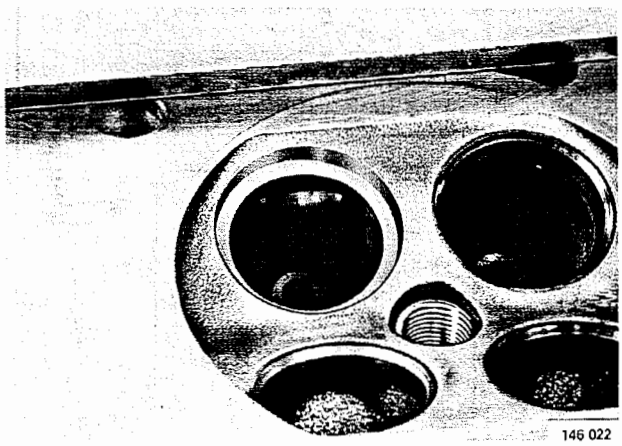
*P17*

### Mill out valve seat

Blow clean with compressed air and inspect work continuously.

Remove remains of seat.

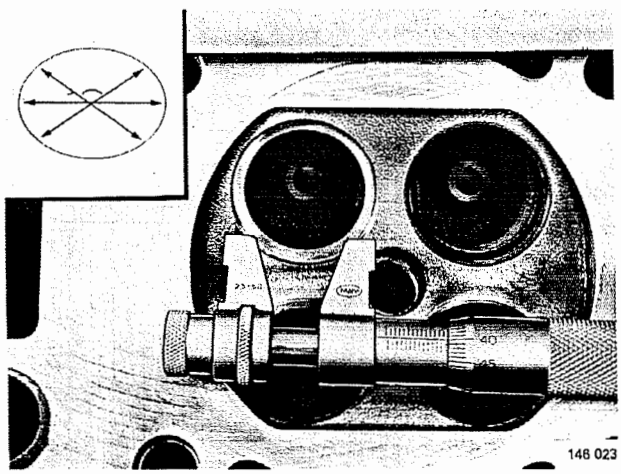
Seat will become loose just before max. milling depth is reached.


146 022

*P18*

### Check valve seat recess

If damaged, recess must be machined for oversized valve seat.


146 023

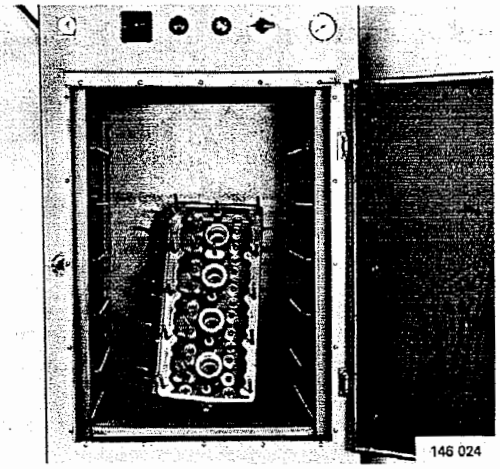
*P19*

### Measure seat recess diameter

Use internal micrometer.
Measure diameter all around circumference.

Seat should be **0.10-0.14 mm** (0.0039–0.0055 in) **larger** than recess in cylinder head.

If interference fit is less than above, recess must be milled out to take oversized seat.

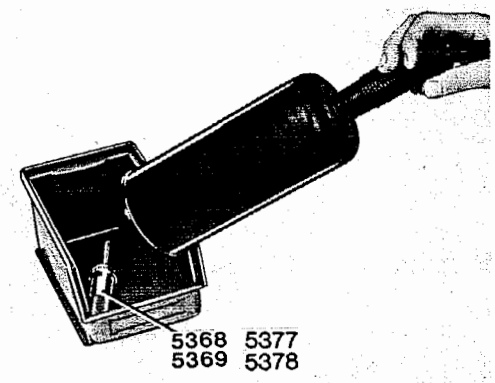

146 024

*P20*

## Heat cylinder head

Heat head in oven at approx. 100°C (212°F).

**N.B.** Use heavy protective gloves when handling **hot cylinder head.**



146 025

*P21*

## Cool valve seat

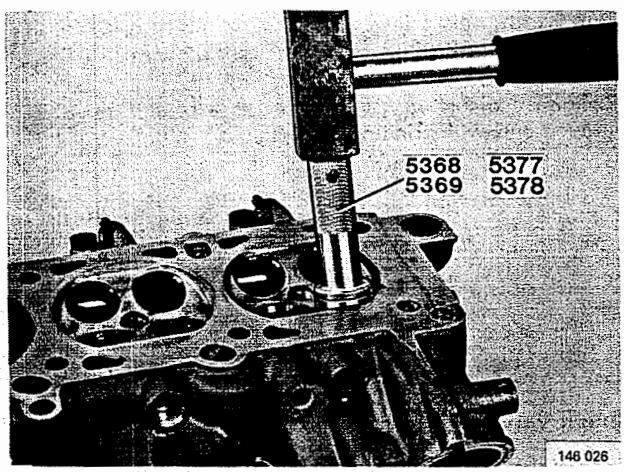
Place seat on appropriate drift:

B 234: Intake **5368** Exhaust **5369**
B 204: Intake **5377** Exhaust **5378**

Cool seat using dry ice or similar medium.

Use grease to hold seat to drift **5369.**

**N.B.** Use heavy protective gloves when handling **chilled assembly tool.**



146 026

*P22*

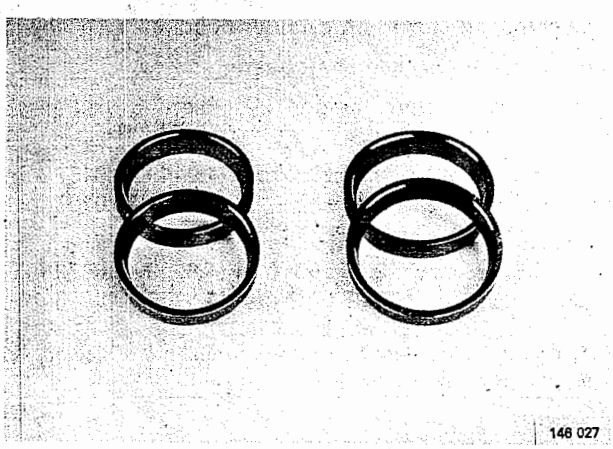
## Insert valve seat in cylinder head

Operation **must be carried out quickly** to maintain maximum possible temperature difference between components.

Check that recess in cylinder head is clean.

Use hammer to tap seat fully home in recess.

**Important!** After replacing valve seat:
Seat face **must be milled.**
Seat and valve must be inspected and ground in as required.


146 027

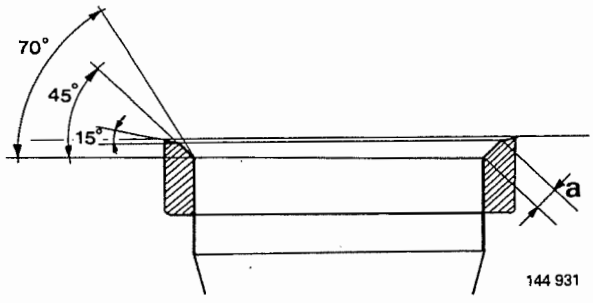
*P23*

## Valve seat dimensions

Since seats are not marked, dimensions must be measured.

| Valve seat diameter | Intake | Exhaust |
|---|---|---|
| **B 234** | | |
| Standard . . . **mm** | **36.14**$^{0}_{-0.016}$ (1.4228 in$^{0}_{-0.0006}$) | **33.14**$^{0}_{-0.016}$ (1.3047 in$^{0}_{-0.0006}$) |
| Oversize . . . . **mm** | **36.64**$^{0}_{-0.016}$ (1.4425 in$^{0}_{-0.0006}$) | **33.64**$^{0}_{-0.016}$ (1.3244 in$^{0}_{-0.0006}$) |
| **B 204** | | |
| Standard . . . **mm** | **34.14**$^{0}_{-0.016}$ (1.3441 in$^{0}_{-0.0006}$) | **31.14**$^{0}_{-0.016}$ (1.2260 in$^{0}_{-0.0006}$) |
| Oversize . . . . **mm** | **34.64**$^{0}_{-0.016}$ (1.3638 in$^{0}_{-0.0006}$) | **31.64**$^{0}_{-0.016}$ (1.2457 in$^{0}_{-0.0006}$) |

## Valve seats, machining



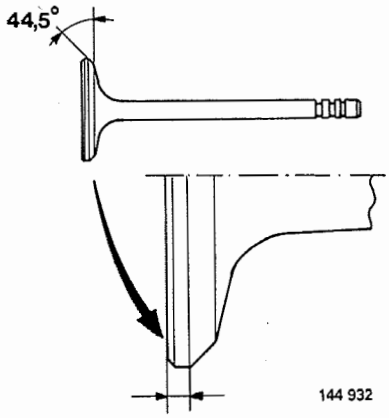

*P24*

**Machine valve seats to following angles:**

Seating face, intake/exhaust ..... **45°**
Relief angle, upper ..... **15°**
Relief angle, lower ..... **70°**

**Valve seat width (a)**
Intake..... **1.3–1.9 mm** (0.051–0.075 in)
Exhaust..... **1.7–2.3 mm** (0.067–0.091 in)

**N.B.** Check that milling cutter is clear of combustion chamber walls.




## Machining of valves

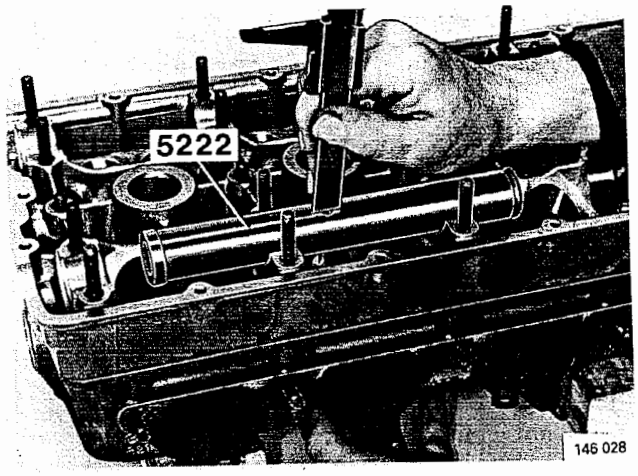
*P25*

**Machine-grind intake valves as follows:**

Seating face angle..... **44.5°**

Edge width, new valve..... **1.5 mm** (0.059 in)
Min. edge width after grinding ..... **1.2 mm** (0.047 in)

**Caution!** Exhaust valves are stellite-coated and must be ground only with grinding paste.




*P26*

**Check valve stem height**

Use gauge **5222** and sliding callipers.

Place camshaft carrier on cylinder head.

Place gauge across camshaft bearing seats.

Measure valve stem height by inserting callipers through hole in gauge.

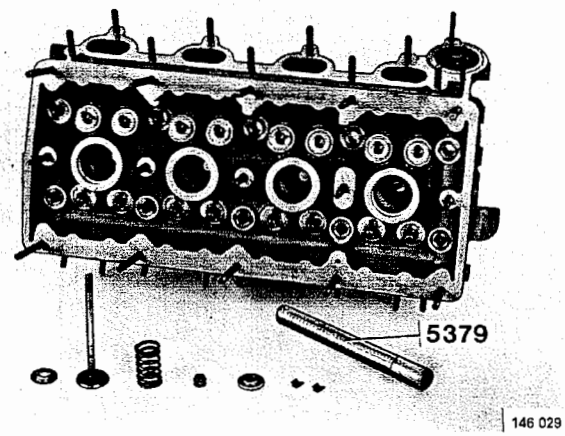
Valve stem height... **49.4±0.4 mm** (1.9449±0.0157 in)
Max. machining allowance..... **0.4 mm** (0.0157 in)

Length, new valve:
Intake..... **122.45±0.2 mm** (4.8209±0.0079 in)
Exhaust..... **122.25±0.2 mm** (4.8130±0.0079 in)

**N.B. Correct valve stem height** is essential to satisfactory operation of hydraulic tappets.

# Q. Cylinder head, reassembly

*Special tools: 5379, 998 6052*




## Installation of valves

Check that cylinder head and other components are clean.

*Q1*

**Install:**

- lower valve spring collars
- valves (in correct positions), oiling valve stems and guides
- intake and exhaust valve stem seals

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Always use protective sleeve included in gasket set.

Place sleeve over valve stem.

Push down seal onto stem.

Remove protective sleeve.

Press home seal using assembly tool **5379**.

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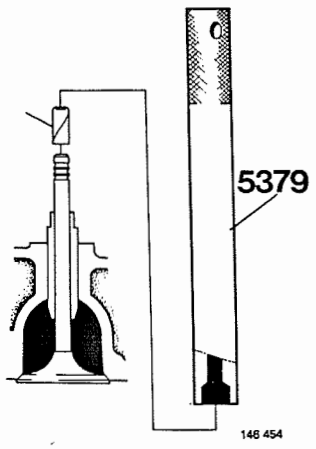
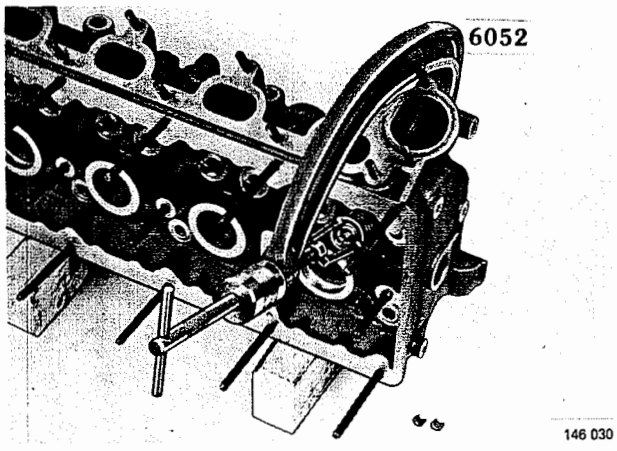
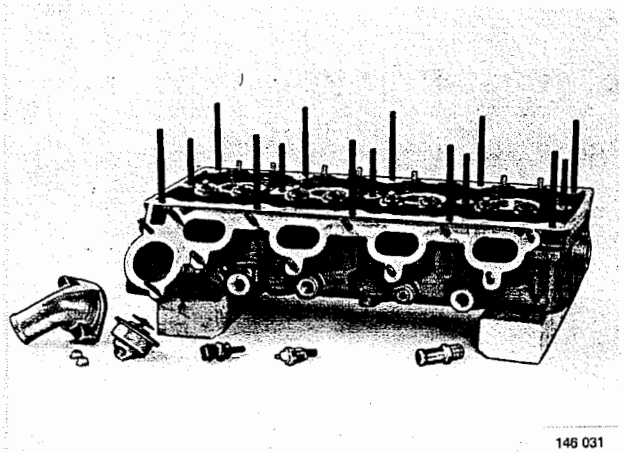



*Q2*

**Install:**

- valve spring and upper spring collar, using clamp **998 6052**
- collets

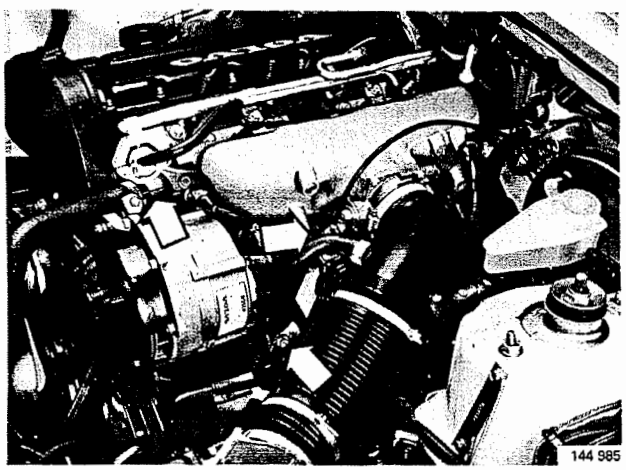


146 031

*Q3*

**Install:**

- thermostat and thermostat housing
- temperature sensors and pipe branch
- spark plugs (after balance shaft and timing belts have been fitted)



144 985

*Q4*

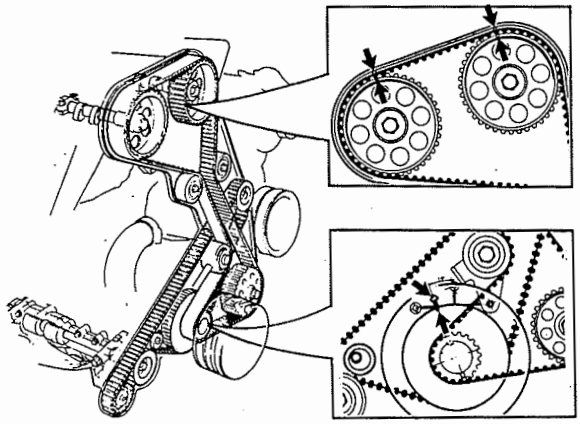
**Install cylinder head**

Install cylinder head as described in operations **N9-21.**

# R. Balance shaft housing, replacement/overhaul

*Special tools: 5006, 5033, 5115, 5186, 5362, 5376*





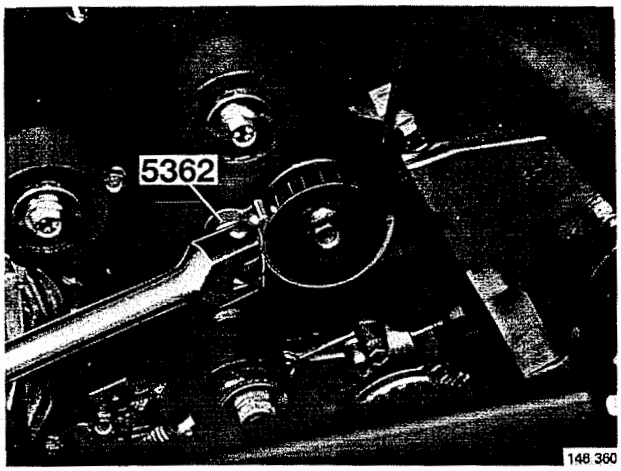
144 870

## Replacement of complete left-hand housing

*R1*

**Remove timing and balance shaft belts**

See operations **C1–9.**

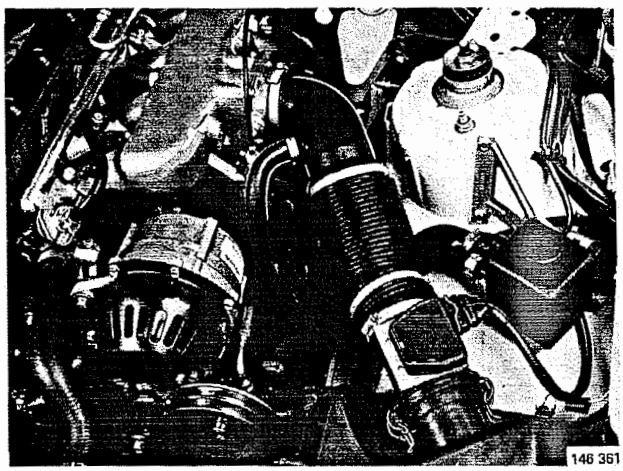



148 360

*R2*

**Remove balance shaft pulley**

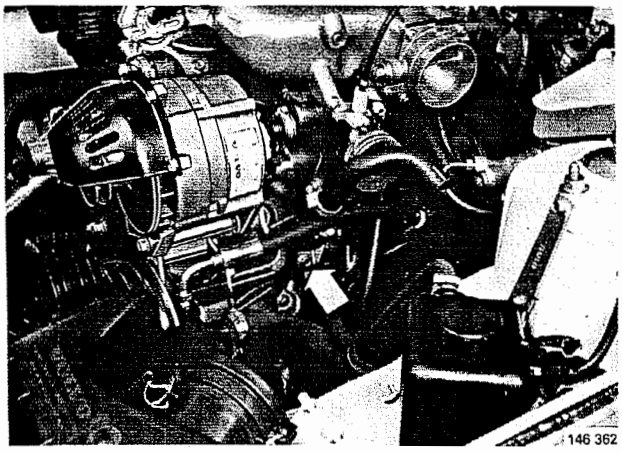
Use counterhold **5362.**



146 361

*R3*

**Remove air mass meter and inlet hose**



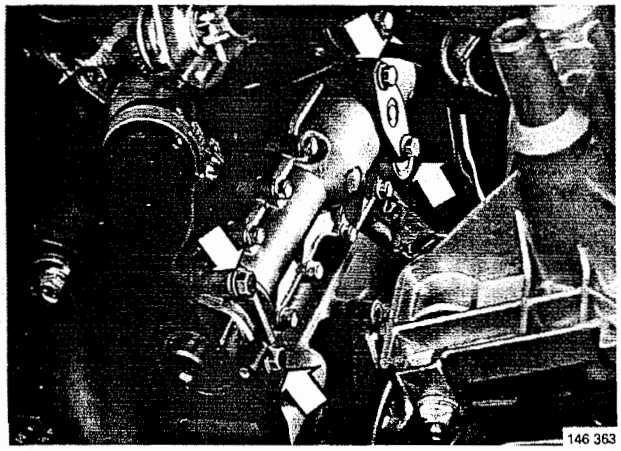

*R4*

**Unbolt alternator and servo pump bracket**

Undo bracket under intake manifold.

Tie bracket and assembly to wheel housing.

**N.B.** Protect wheel housing from scratches.

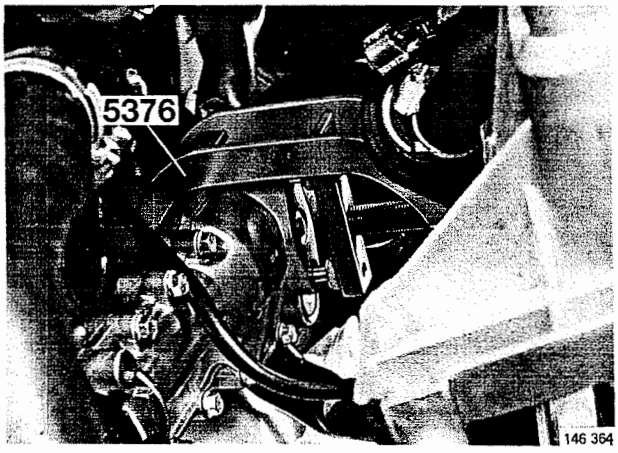



*R5*

**Remove:**

– bolts securing balance shaft housing to cylinder block.

Place container underneath joint (or place paper on front crossmember) to collect oil spillage from housing.




*R6*

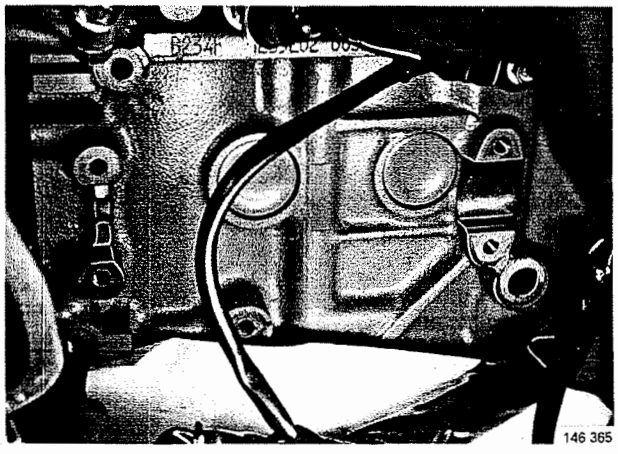
**Remove balance shaft housing**

Use extractor **5376.**

Position tool over rear mounting point.

Separate housing from cylinder block carefully. Use tool (e.g. 5196) simultaneously to prise loose **front mounting** to assist in removing housing.

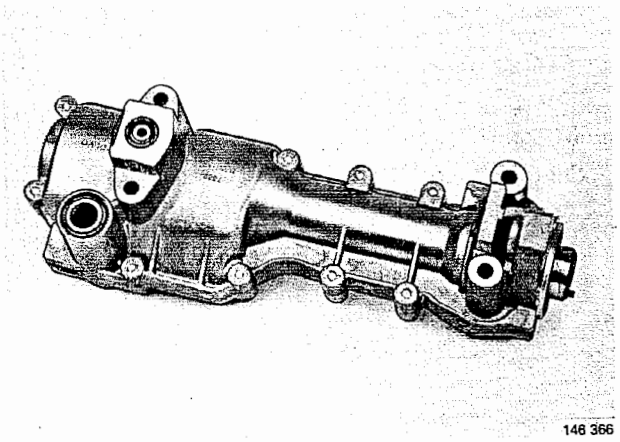
**Caution!** If housing is to be reused, it must be removed **evenly** from front and rear mountings.




*R7*

**Clean mounting points**

Clean joint faces on cylinder block.



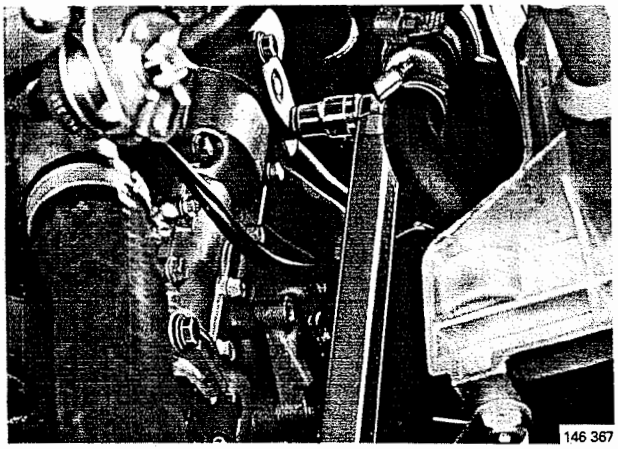
146 366

*R8*

### Place O-rings in position

Place O-rings in grooves around housing oilways.

Fix O-rings in position by packing grooves with grease and lubricate housing joint faces with thin coating of grease.



146 367

*R9*

### Install balance shaft housing

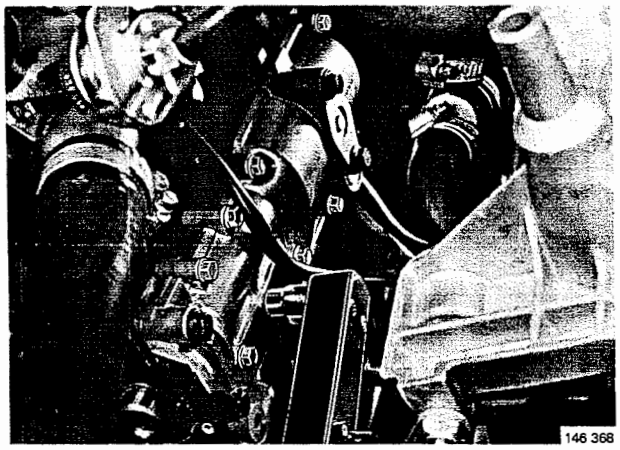
Ensure housing is replaced evenly on front and rear mountings. Max. permissible deviation between mounting faces with reference to block is **1 mm** (0.04 in).

Tighten bolts **alternately** in **diagonal** pattern. Tighten each bolt by**max.** ½ turn at a time.

Tighten bolts to **20 Nm** (15 ft.lb).

Slacken and retighten to **10 Nm** (7.5 ft.lb) and through a further **90°**.

**N.B.** Check that shaft **does not seize** in housing during tightening procedure.

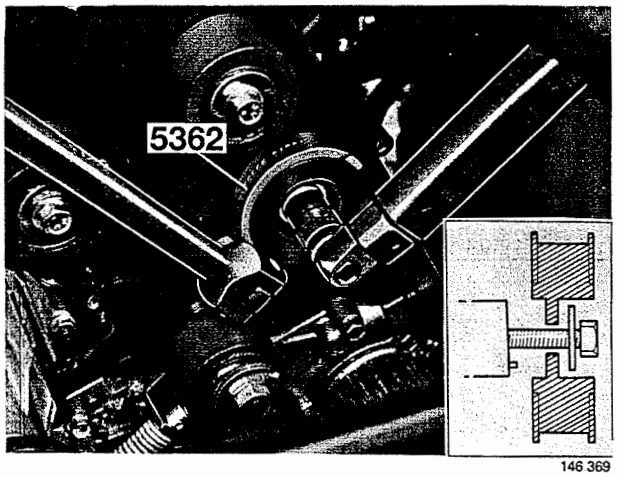


146 368

*R10*

### Tighten bolted joint between housing halves

Tighten to **8 Nm** (6 ft.lb).




146 369

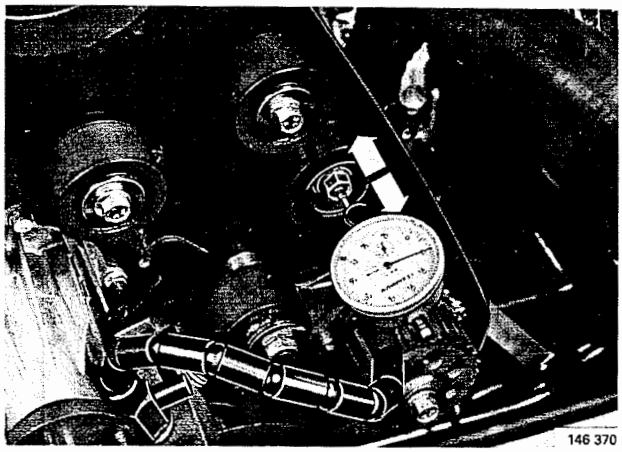
*R11*

### Install drive pulley

Use counterhold **5362.**

**N.B.** Slot in pulley hub must be aligned with guide pin on shaft end. **Shallower** side of pulley must face inwards.

Tighten centre bolt to **50 Nm** (37 ft.lb). Use tool **5362** as counterhold.

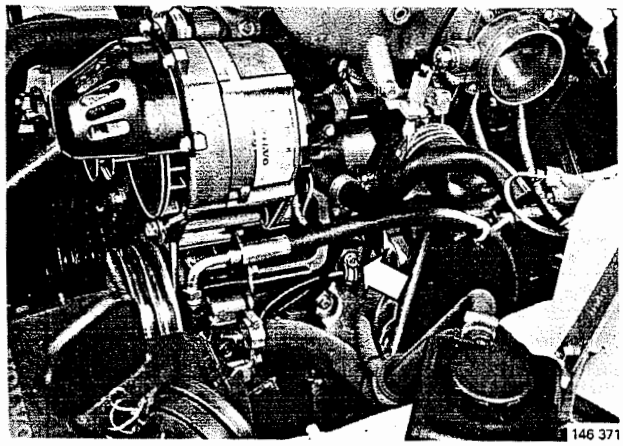

146 370

*R12*

**Check axial clearance of balance shaft**

Measure clearance using dial gauge mounted on magnetic stand.

Axial clearance ..... **0.06–0.19 mm** (0.0024–0.0075 in)


146 371

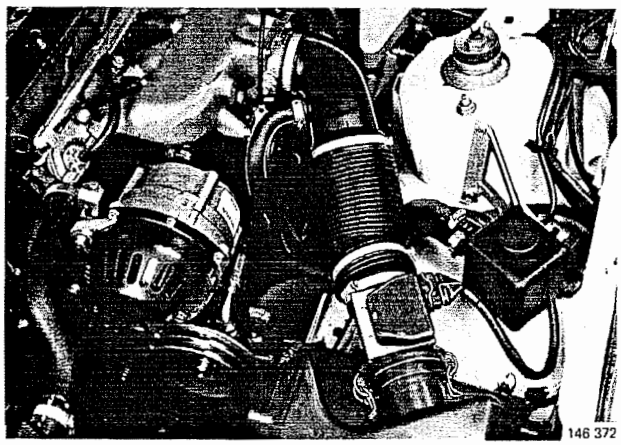
*R13*

**Install alternator and servo pump bracket**

Check alternator and servo pump connections.

Reattach support under intake manifold.

**N.B. Remember** to attach cable tie (clamp) to bottom bolt on support.

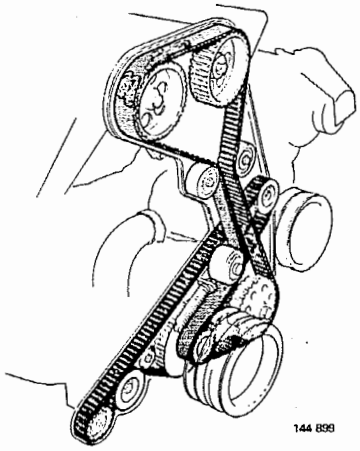

146 372

*R14*

**Install:**

– air mass meter with air inlet hose and connections

**N.B.** Lower engine if unit has been raised to provide access to right-hand balance shaft housing.

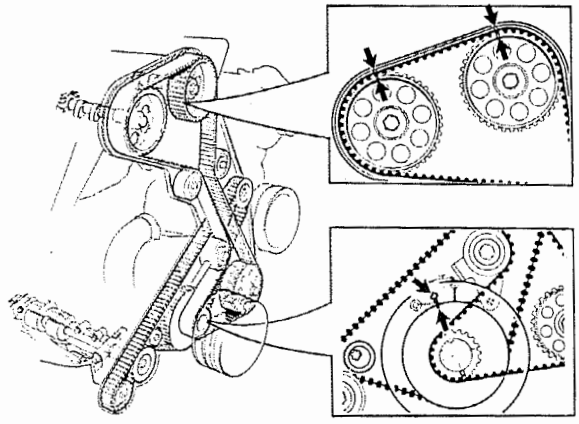

144 899

*R15*

**Install timing/balance shaft belts**

See operations **C12–37.**

**N.B. See table** of tension values in specifications (page 11) if replacing existing timing/balance shaft belts.



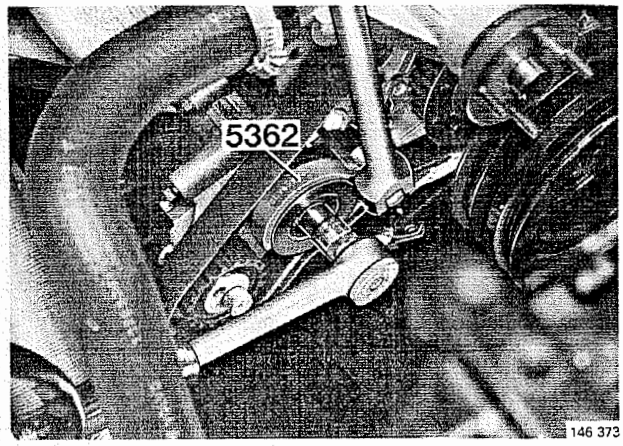
144 870

## Replacement of complete right-hand housing

*R16*

**Remove timing/balance shaft belts**

See operations **C1–9**.

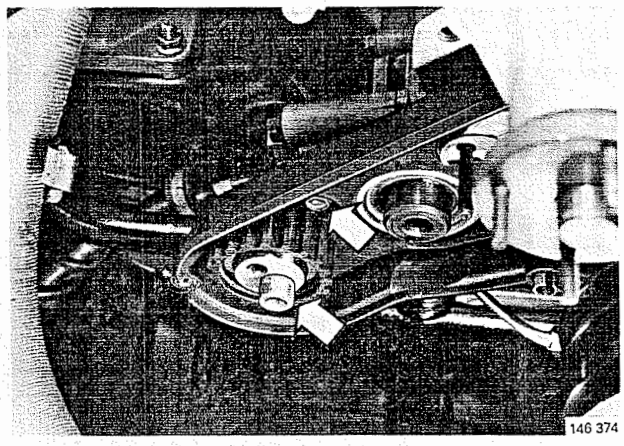



146 373

*R17*

**Remove drive pulley**

Use counterhold **5362**.

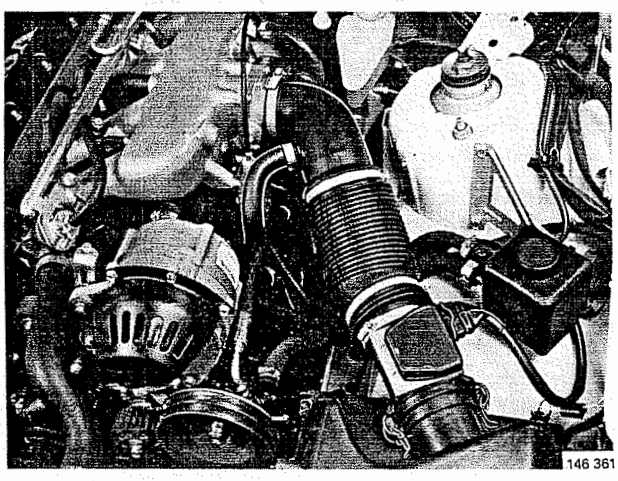


146 374

*R18*

**Remove:**

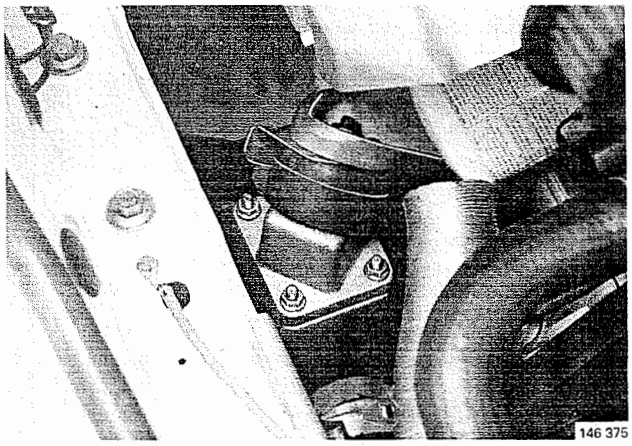
- balance shaft belt tensioner
- bolt between rear section of transmission mounting plate and balance shaft housing



146 361

*R19*

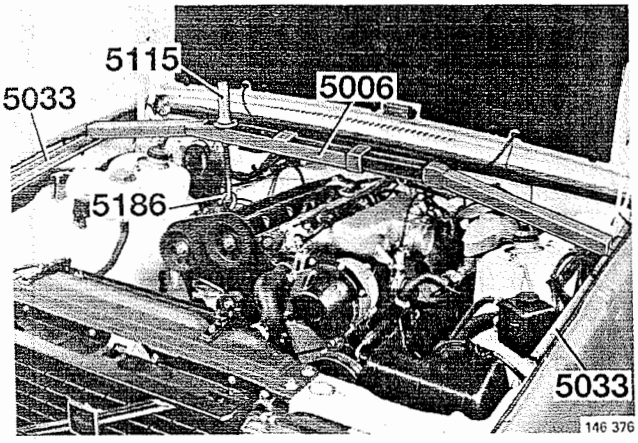
**Remove air mass meter and air inlet hose**




*R20*

**Remove:**

- air preheating hose from bottom heat shield under exhaust manifold
- nuts securing right-hand engine mounting to member

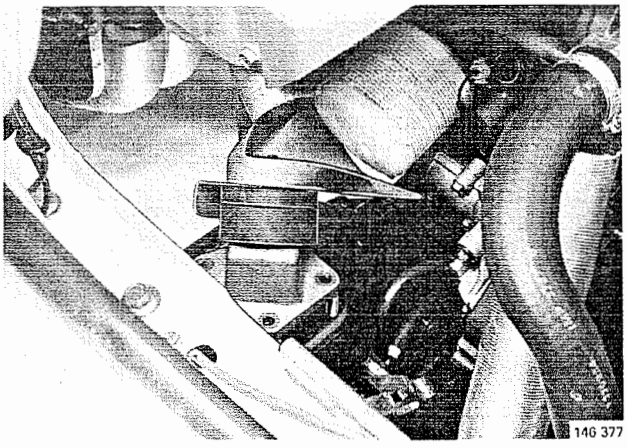



*R21*

**Lift engine using right-hand lifting lug**

Use lifting yoke **5006,** two support bars **5003,** and lifting hooks **5115**and **5186.**

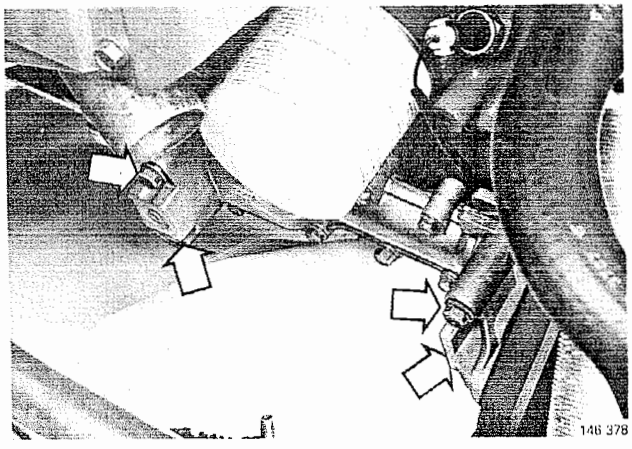
**N.B.** Check clearance between master cylinder and intake manifold.




*R22*

**Remove engine mounting**

Remove complete mounting (including insulating pad and lower mounting plate) from block.

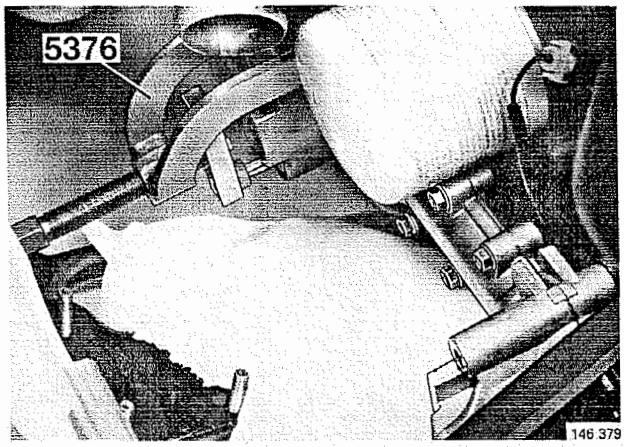



*R23*

**Remove:**

- bolts attaching balance shaft housing to cylinder block.

Place container underneath joint (or place paper on front crossmember) to collect oil spillage from housing.




R24

### Remove balance shaft housing

Use extractor **5376.**

Position tool over rear mounting point.

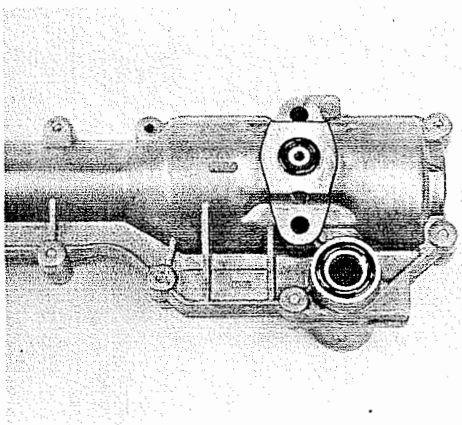
Separate housing from cylinder block carefully. Use tool (e.g. 5196) simultaneously to prise loose **front mounting** to assist in removing housing.

**Caution!** If housing is to be reused, it must be removed **evenly** from front and rear mountings.


R25

### Clean mounting points

Clean joint faces on cylinder block.

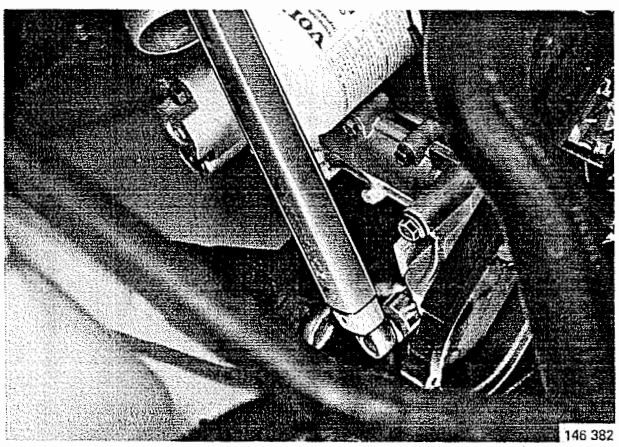



R26

### Place O-rings in position

Place O-rings in grooves around housing oilways.

Fix O-rings in position by packing grooves with grease and lubricate housing joint faces with thin coating of grease.




R27

### Install balance shaft housing

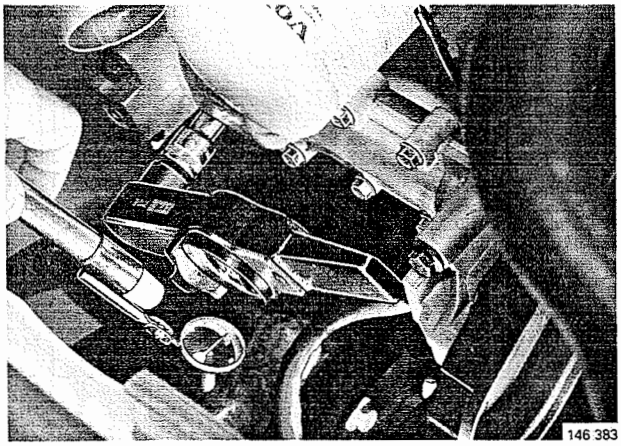
Ensure housing is aligned evenly on front and rear mountings. Max. permissible deviation between mounting faces with reference to block is **1 mm** (0.04 in).

Tighten bolts **alternately** in **diagonal** pattern. Tighten each bolt by **max.** ½ turn at a time.

Tighten bolts to **20 Nm** (15 ft.lb).

Slacken and retighten to **10 Nm** (7.5 ft.lb) and through a further **90°.**

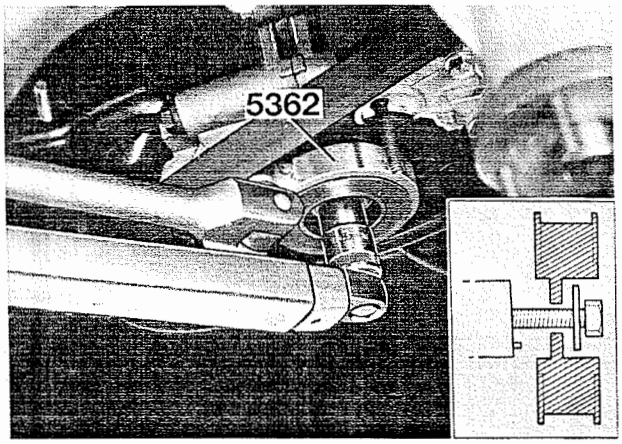
**N.B.** Check that shaft **does not seize** in housing during tightening procedure.


146 383

*R28*

**Tighten bolted joint between housing halves**

Tighten to **8 Nm** (6 ft.lb).



146 384

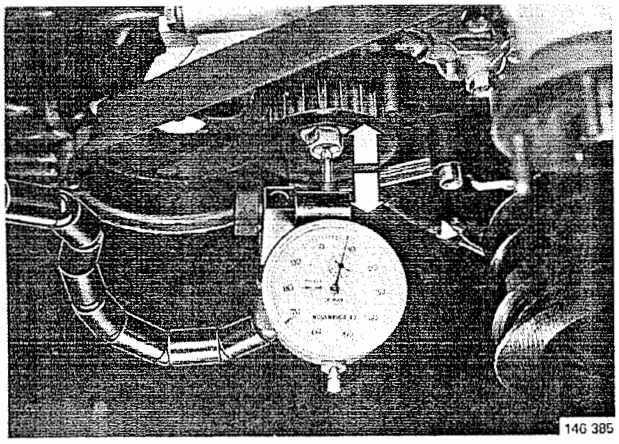
*R29*

**Install drive pulley**

Use counterhold **5362.**

**N.B.** Slot in pulley hub must be aligned with guide pin on shaft end. **Shallower** side of pulley must face inwards.

Tighten centre bolt to **50 Nm** (37 ft.lb). Use tool **5362** as counterhold.

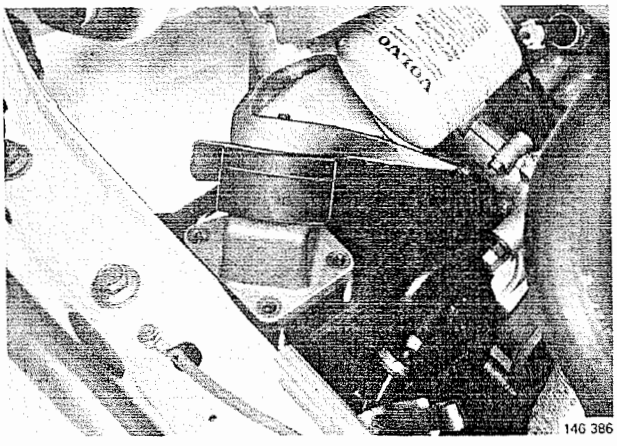

146 385

*R30*

**Check axial clearance of balance shaft**

Measure clearance using dial gauge mounted on magnetic stand.

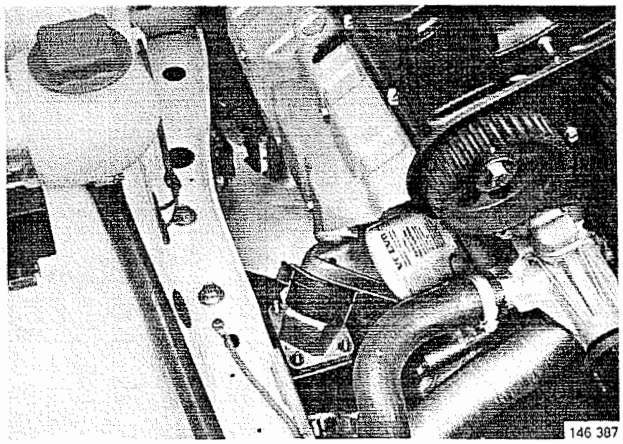
Axial clearance ..... **0.06–0.19 mm** (0.0024–0.0075 in)


146 386

*R31*

**Install engine mounting**

Install mounting complete with insulating pad and lower mounting plate.

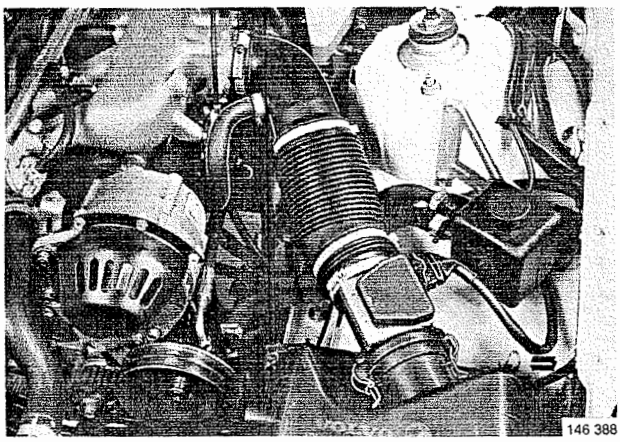

146 387

*R32*

**Lower engine into position on front crossmember**

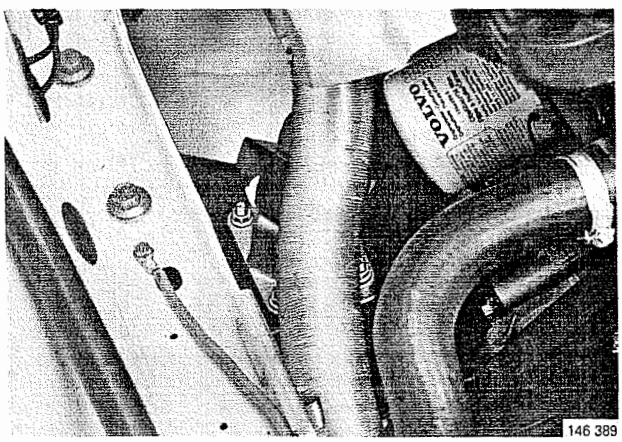
Use studs on member to guide lower engine mounting plate into position.

Remove lifting attachments.


146 388

*R33*

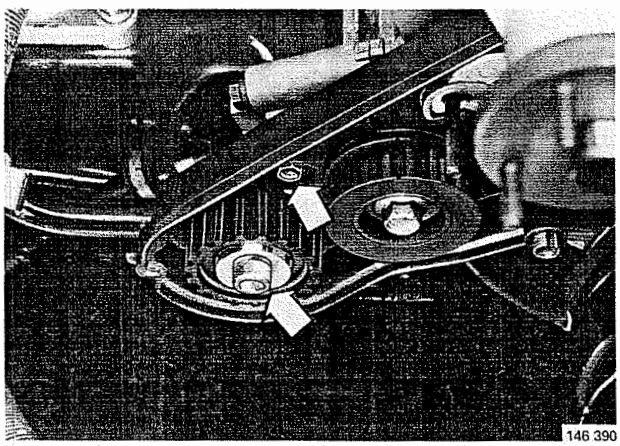
**Install air mass meter with air inlet hose and connections**


146 389

*R34*

**Retighten:**

- engine mounting
- air preheating hose

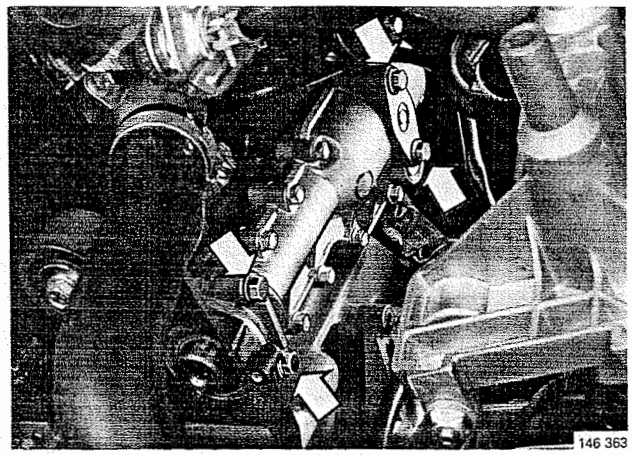

146 390

*R35*

**Install:**

- bolt in rear section of transmission mounting plate
- belt tensioner, tightening bolt so that pulley is movable when belt is placed in position
- timing/balance shaft belts as described in operations **C12–37**.

**N.B.** See table of tension values in specifications (page 11) if replacing existing timing/balance shaft belts.


146 363

## Balance shaft housing, reconditioning

### Remove balance shaft housing

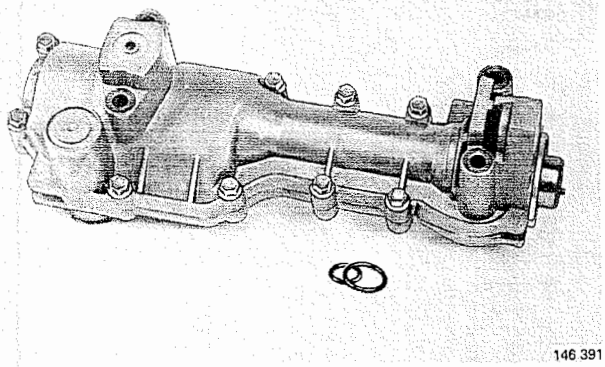
Remove **left-hand** housing as described in operations **R1–7.**

**Remove right-hand** housing as described in operations **R16–25.**

## Balance shaft housing, dismantling

*R36*

### Remove bolts in housing joint

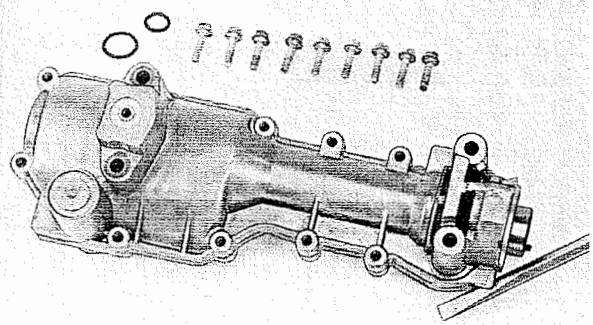

146 391

*R37*

### Separate housing halves

Prise housing halves apart using heavy screwdriver inserted between projections at four points around joint.

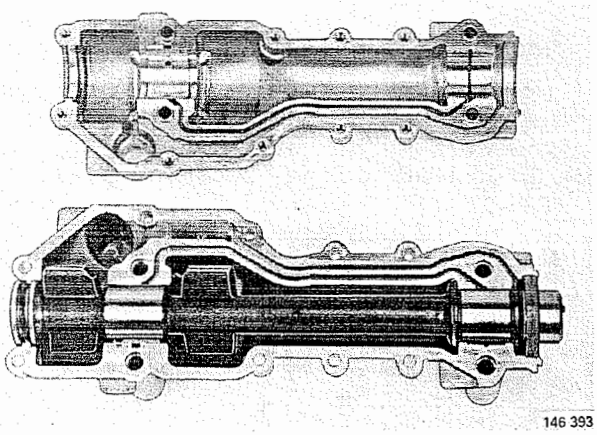
**N.B.** Prise **carefully** at each point in turn, ensuring that deviation in parallelism between joint faces does not exceed **1 mm** (0.0040 in).

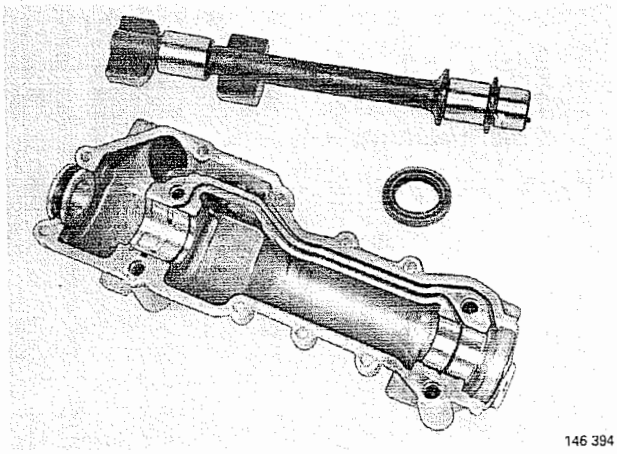

146 392

*R38*

### Lift out balance shaft

Remove front sealing ring from shaft.

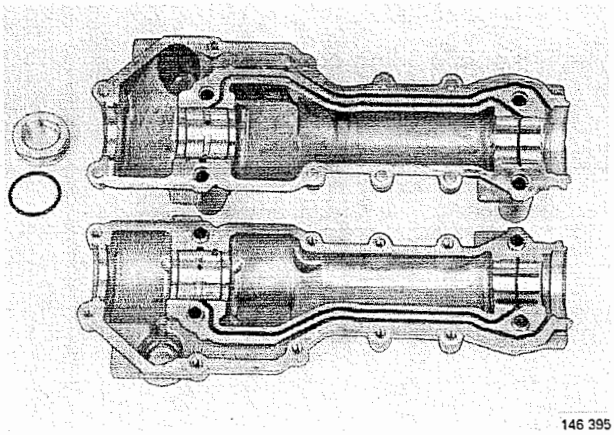

146 393


146 394

*R39*

**Remove sealing plate**

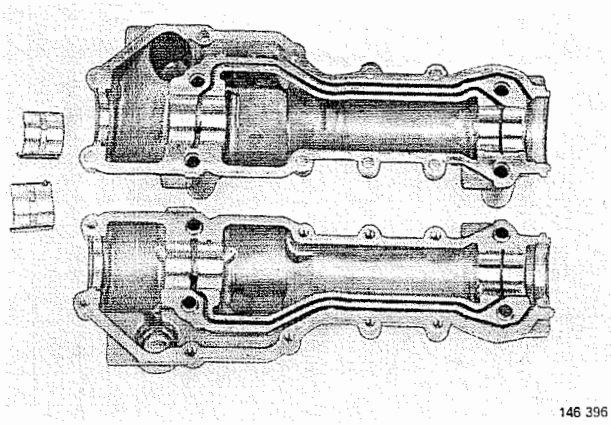
Remove O-ring from groove in sealing plate.


146 395

*R40*

**Remove bearing shells**

Remove rear bearing shells from housing halves.


146 396

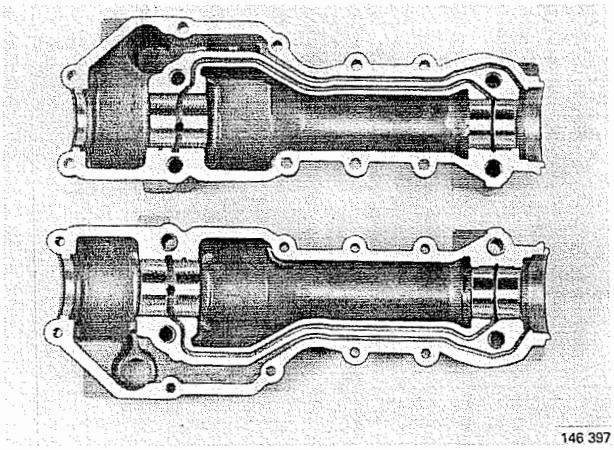
*R41*

**Clean housing and other components**

Use solvent to remove remains of liquid sealing compound.

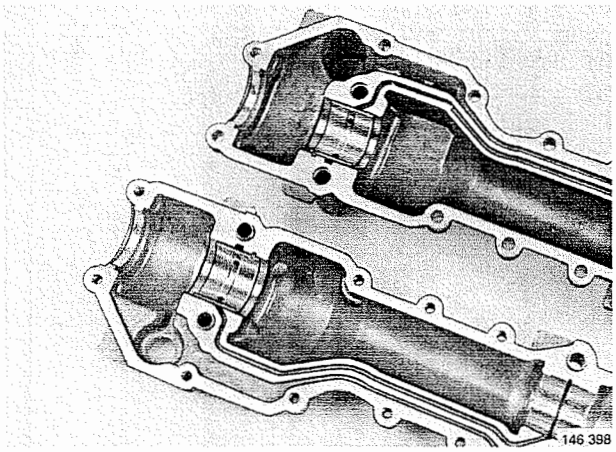
Carefully scrape surfaces clean using plastic putty knife.

Wipe components with degreasing agent and blow clean thoroughly with compressed air.


146 397

*R42*

**Inspect joint and bearing surfaces**

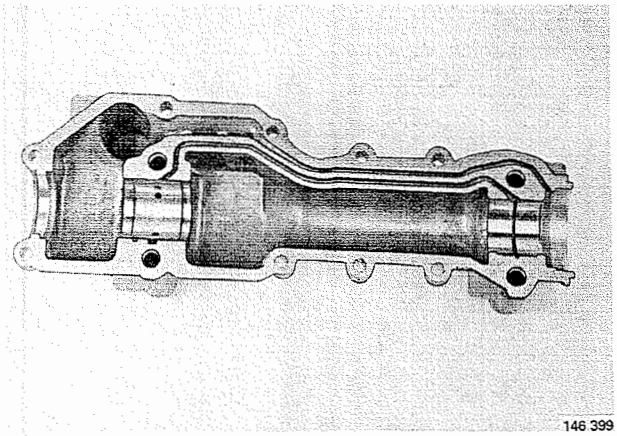

146 398

## Balance shaft housing, assembly

*R43*

**Install rear bearing shells**

Position shells flush with joint surfaces.

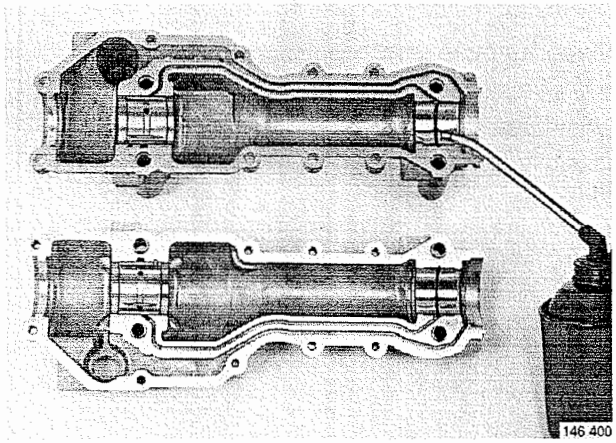

146 399

*R44*

**Apply liquid sealing compound**

Apply compound to housing half not fitted with guide sleeves.

**N.B.** Excess sealing compound **must** be removed from oil-ways and bearing surfaces prior to assembly.

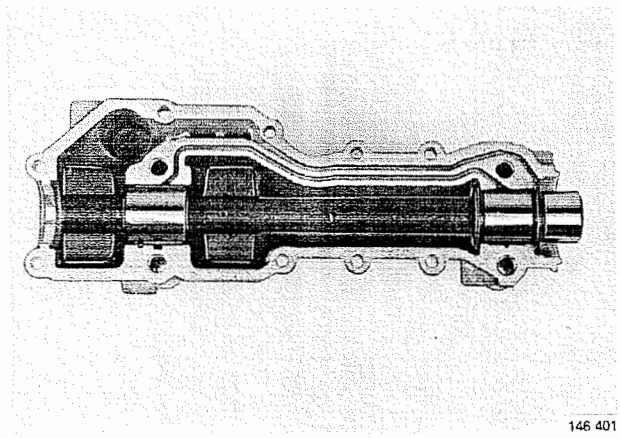

146 400

*R45*

**Lubricate balance shaft bearings**

Oil bearing shells in both housing halves.

**N.B.** Lubricant must **not** be allowed to come in contact with liquid sealing compound or joint faces.

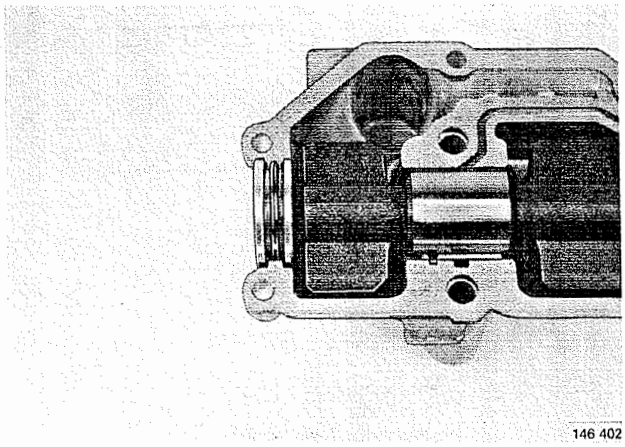

146 401

*R46*

**Place balance shaft in position**

Place shaft in housing half to which liquid sealing compound has been applied.

*R47*



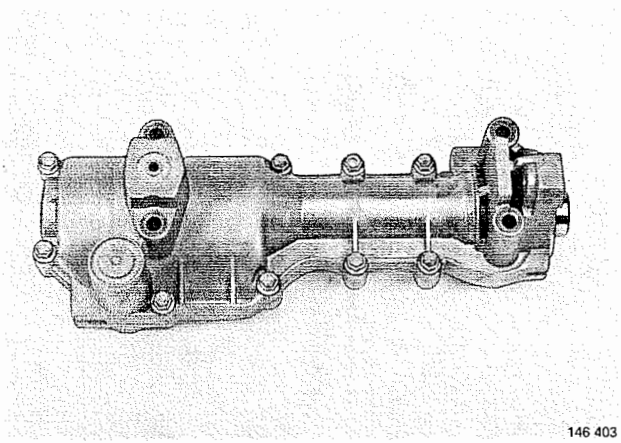
146 402

### Install rear sealing plate

Fit **new** O-ring in groove in sealing plate.

Position seal in housing half with balance shaft.

*R48*



146 403

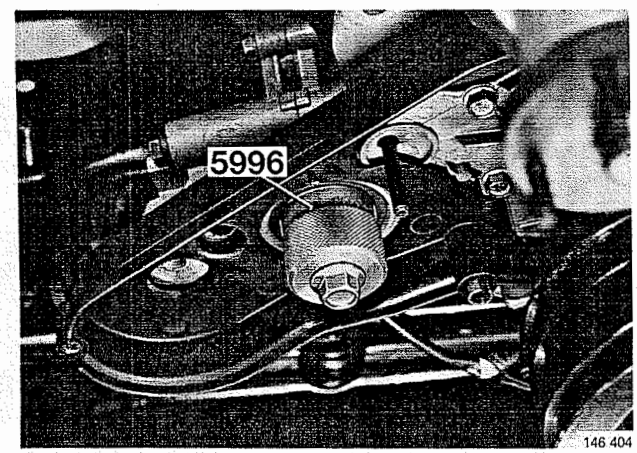
### Reassemble balance shaft housing

Tighten bolted joint all around to ensure halves are pulled together evenly.

Tighten to **5 Nm** (3.7 ft.lb).

Ensure that shaft does not seize in housing.

*R49*




146 404

### Install balance shaft housing

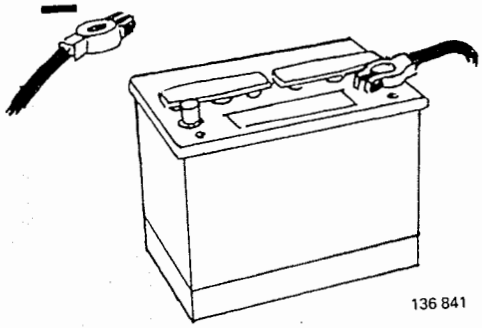
Install **left-hand** housing as described in operations **R8–15.**

**Install right-hand** housing as described in operations **R26–35.**

**N.B.** Balance shaft front seal is replaced as described in **E6** when housing has been tightened in position as per operation **R11** or **R27.**

# S. Engine mountings, replacement

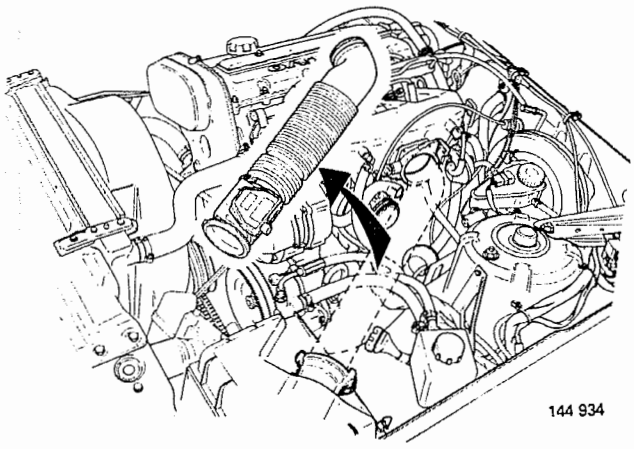
*Special tools: 5006, 5033, 5115, 5186*




## Left-hand side

*S1*

**Disconnect battery earth lead**

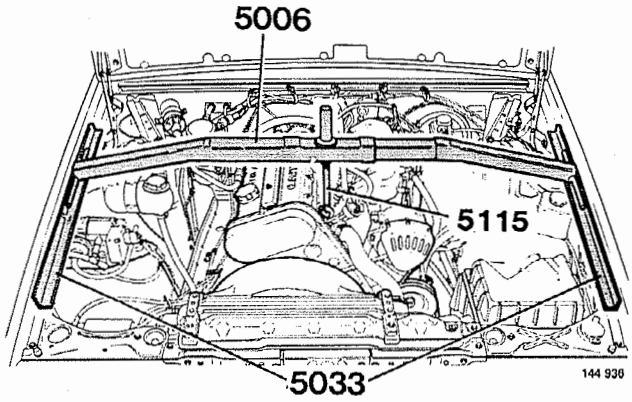



*S2*

**Remove:**

- air mass meter and air inlet hose
- engine mounting bottom nut

**N.B.** Undo bottom nut from underneath on cars equipped with an AC compressor. Remove front splashguard.



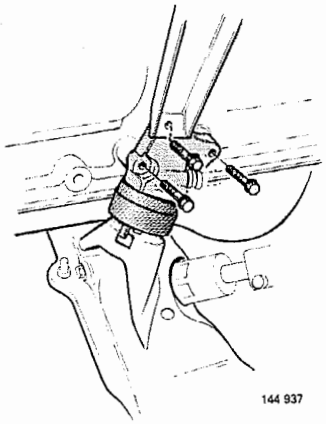

*S3*

**Raise engine using left front lifting lug**

Use lifting yoke **5006**, two support bars **5033** and lifting hook **5115**.

**N.B.** Ensure that fan blades are **not** damaged by contact with shroud.

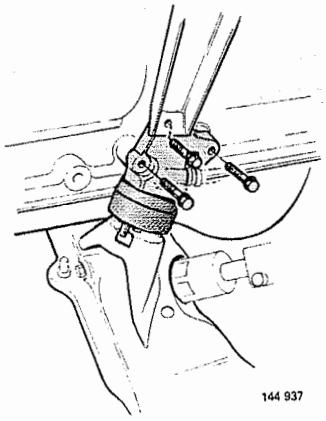
S4




**Remove:**

- three bolts securing mounting to cylinder block
- mounting complete with insulating block

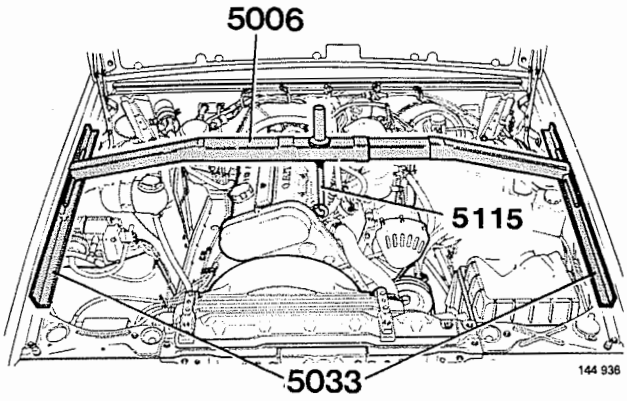
S5




**Install:**

- mounting with new insulating block
- cable clip and support at top bolt

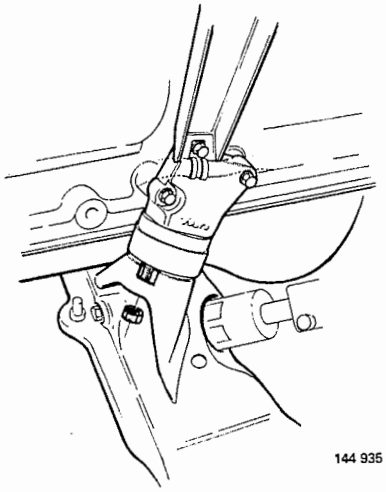
S6




**Lower engine into position and remove lifting attachments**

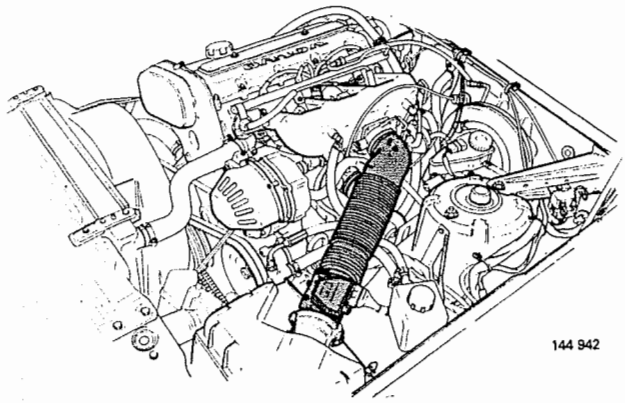
Guide bottom bolt of mounting into bracket.

S7



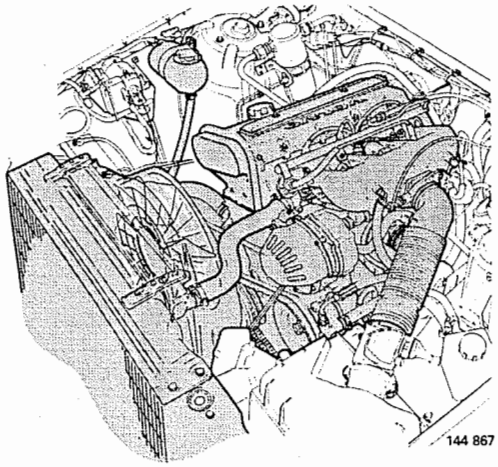

**Install engine mounting bottom nut**

N.B. Tighten nut from underneath on cars equipped with an AC compressor. Install front splashguard.




*S8*

**Install air mass meter with air inlet hose and connections**

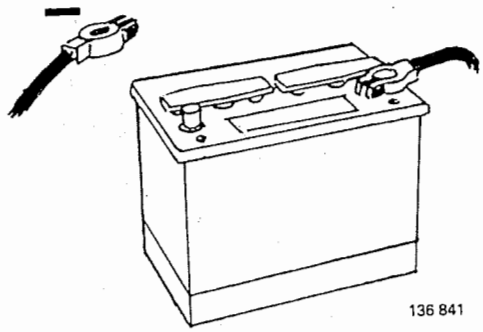



*S9*

**Check operation**

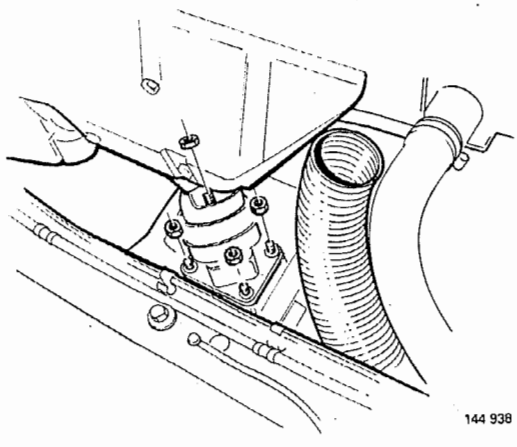
Test run engine.

## Right-hand side




*S10*

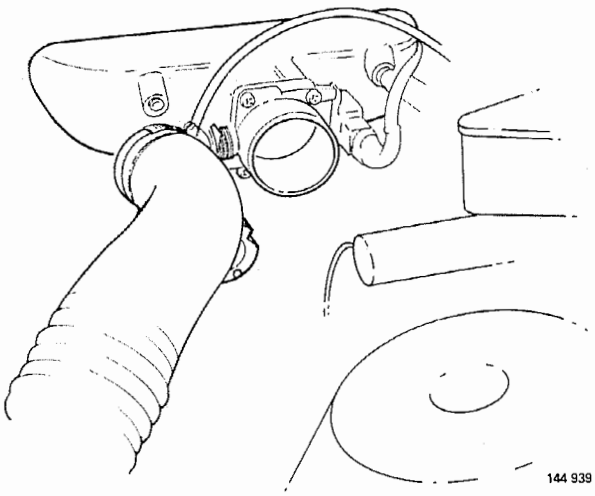
**Disconnect battery earth lead**




*S11*

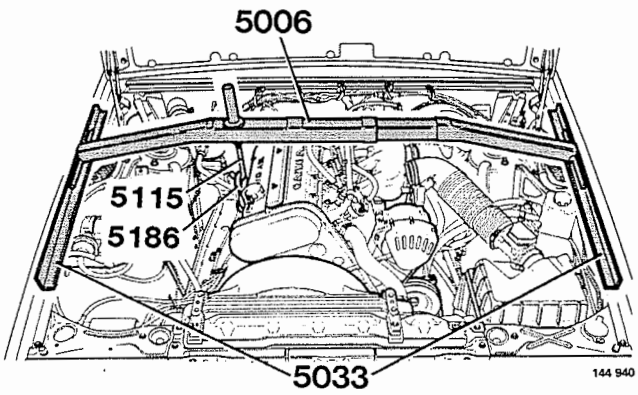
**Disconnect/remove:**

- air preheating hose from bottom heat shield
- four nuts securing bottom mounting plate


144 939

*S12*

**Disconnect air inlet hose from throttle housing**



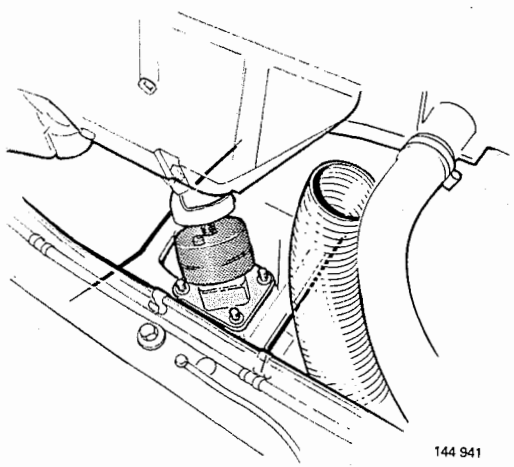
144 940

*S13*

**Raise engine using right front lifting lug**

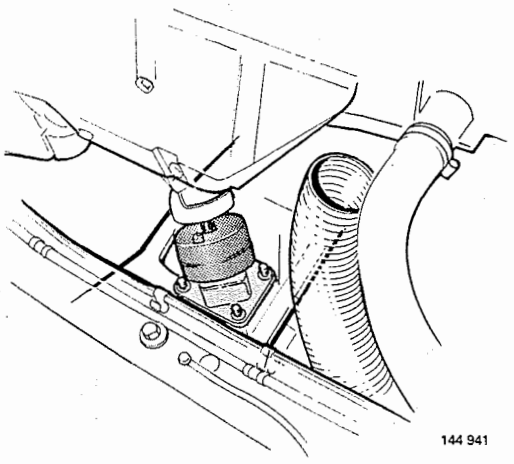
Use lifting yoke **5006,** two support bars **5033, and lifting hooks 5115** and **5186.**

**N.B.** Check clearance between master cylinder and inlet manifold, and between fan blades and shroud.


144 941

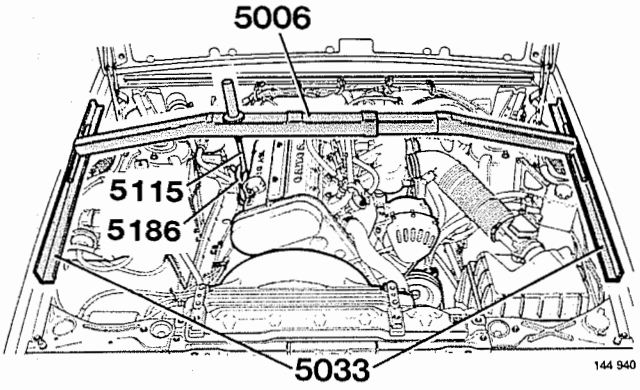
*S14*

**Remove engine mounting and bottom mounting plate**


144 941

*S15*

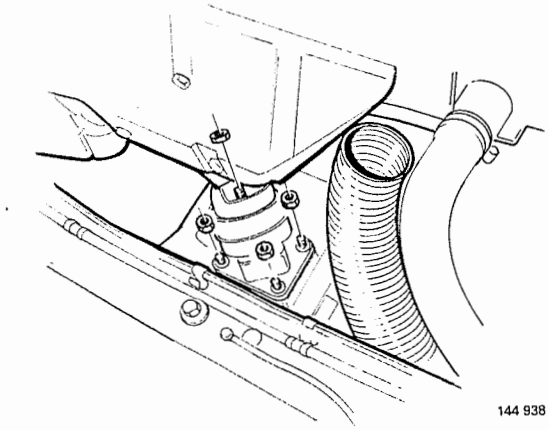
**Install new engine mounting and bottom mounting plate**




*S16*

**Lower engine into position and remove lifting attachments**

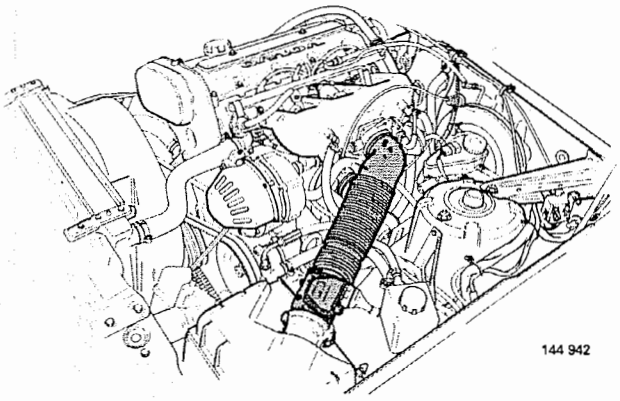
Guide upper mounting plate and mounting into position.




*S17*

**Install/reconnect:**

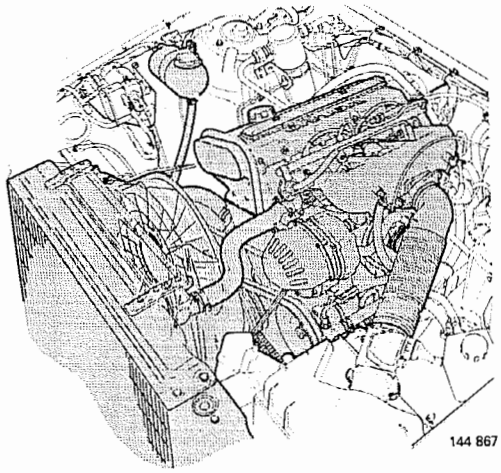
- four nuts securing engine mounting and bottom mounting plate
- air preheating hose to bottom heat shield




*S18*

**Reconnect air inlet hose to throttle housing**

Check other connections to air inlet hose.




*S19*

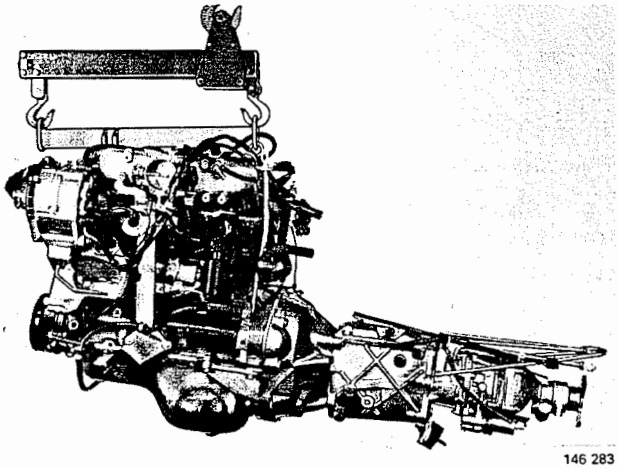
**Check operation**

Reconnect battery earth lead.

Test run engine.

# T. Engine, removal

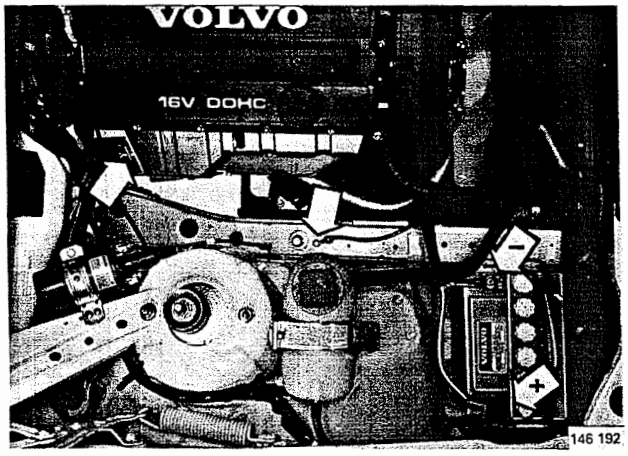
*Special tools: 2810, 5006, 5033, 5035, 5115, 5186, 5244*


146 283

### Procedure for cars with manual gearboxes

Removal of automatic gearbox is described in procedure AD.

**Caution!** Since operations **T29-30** are carried out with engine freely suspended, ensure that lifting equipment is **securely attached** and in **perfect condition.**

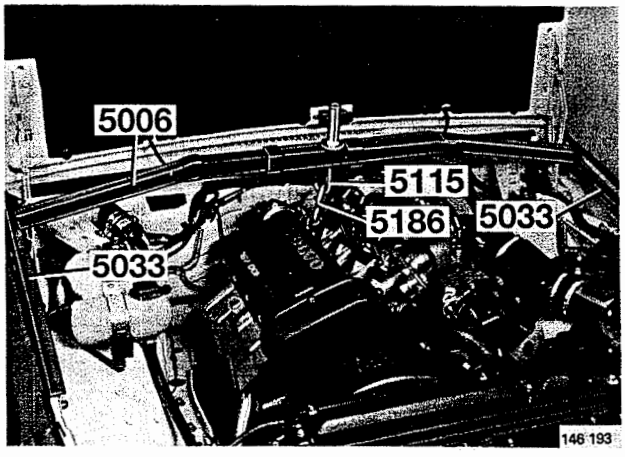


146 192

*T1*

### Disconnect battery leads

Disconnect
- earth (negative) lead
- leads connected to terminal lug of battery positive lead
- battery positive lead
- earth lead connection to top of side member
- bolted connection to exhaust manifold front bracket



146 193

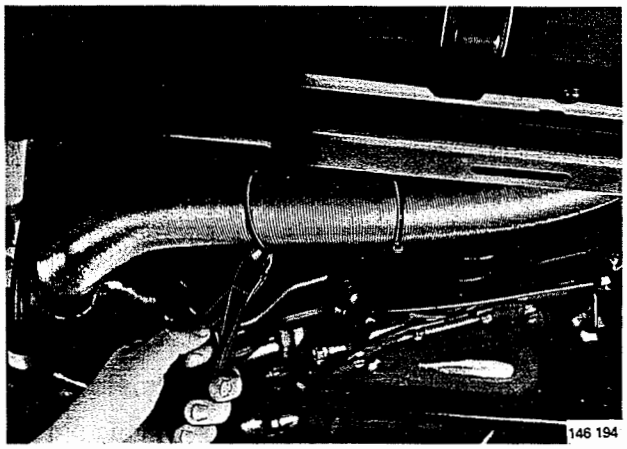
*T2*

### Support engine at rear

Use two support bars **5033,** lifting yoke **5006,** and lifting hooks **5115**and **5186.**

**Raise engine using rear left lifting lug.**

**Cut cable tie and position wiring clear of lifting lug.**

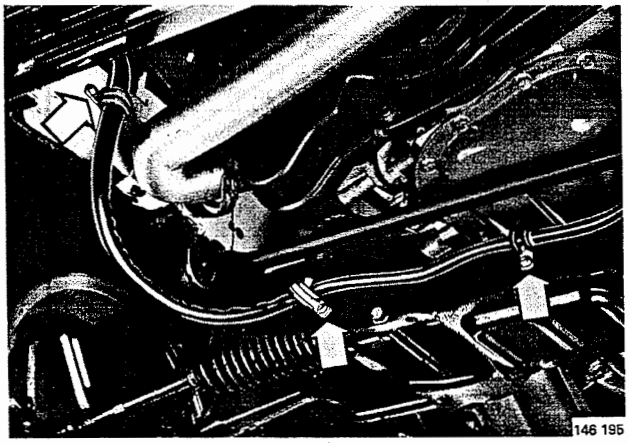

146 194

*T3*

**Drain engine oil**

**Remove splashguard under engine**

Cut air preheating hose ties.

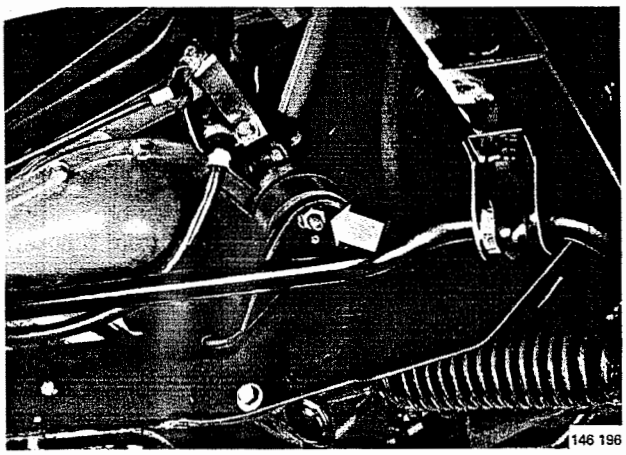

146 195

*T4*

**Release battery leads from body**

Undo clips on front crossmember and right-hand side member.

Work wiring free of anti-roll bar.

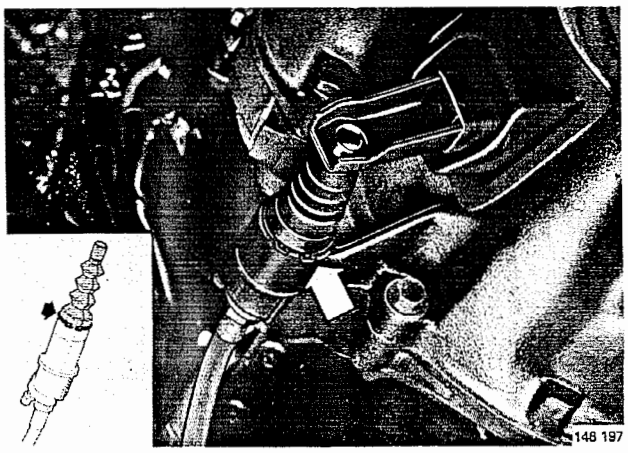

146 196

*T5*

**Release front left-hand engine mounting**

Undo bottom nut.

**N.B.** On cars equipped with AC: Remove AC compressor from mounting bracket.


148 197

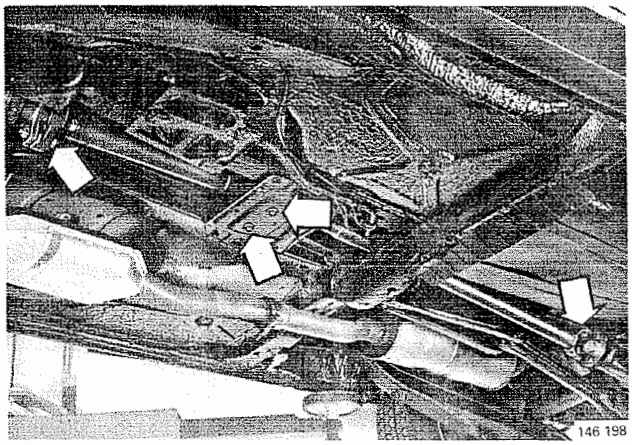
*T6*

**Remove clutch slave cylinder**

Remove cylinder circlip.

Withdraw cylinder carefully from location in housing.

**N.B.** Rubber boot retains plunger in cylinder. Secure boot with circlip.


146 198

*T7*

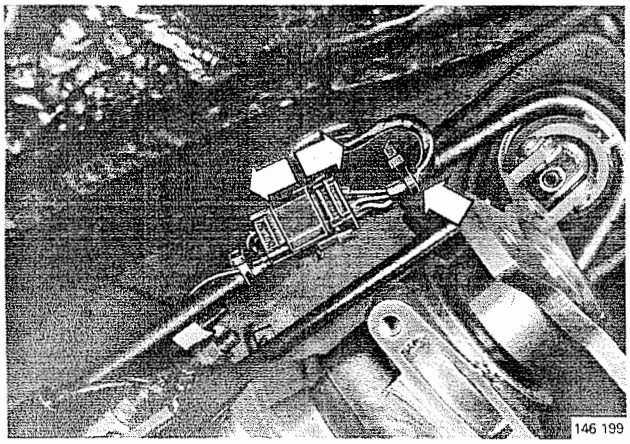
**Remove propeller shaft**

Use socket **5244.**

Separate front and rear universal joints.

Unbolt centre support bearing from member.

Withdraw propeller shaft backwards.

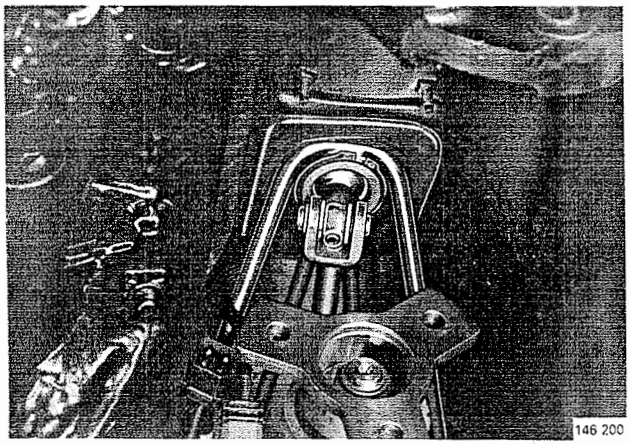

146 199

*T8*

**Free gearbox wiring**

Cut **rear** tie at gear lever mounting.

Separate wiring connectors.


146 200

*T9*

**Release gear lever**

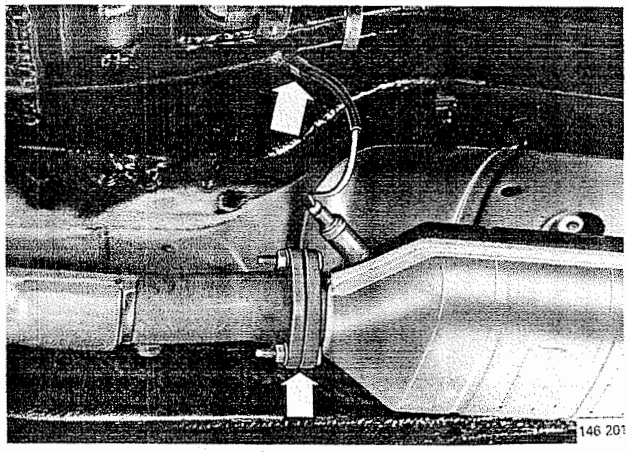
Undo lever locking bolt.

Remove pivot pin between lever and gear selector rod.

Remove circlip from lever sleeve under mounting.

Push up lever.

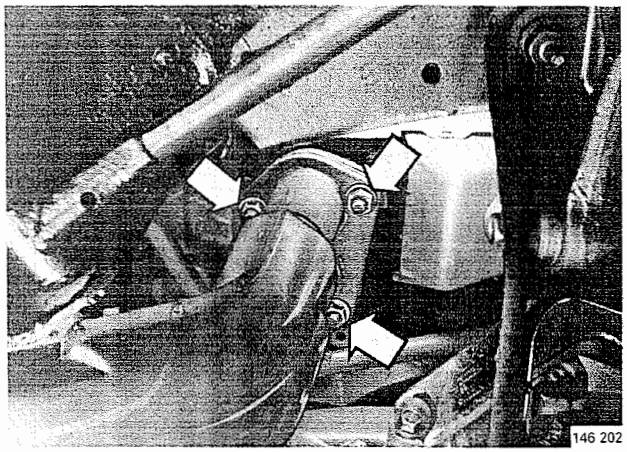
Remove bearing bushings and O-ring.


146 201

*T10*

**Undo bolted joint at front of catalytic converter**

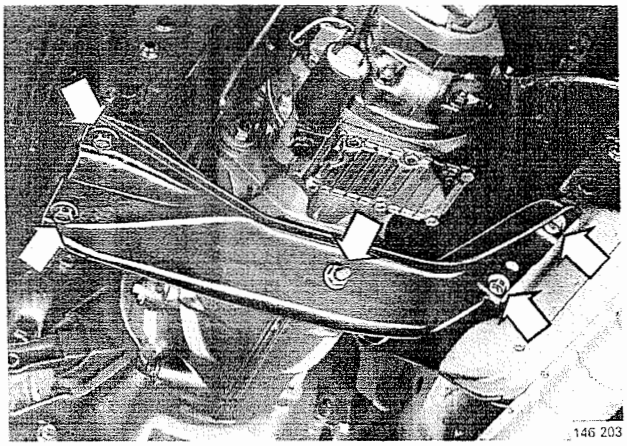
Release oxygen sensor lead from rear clip.




*T11*

**Remove front exhaust pipe**

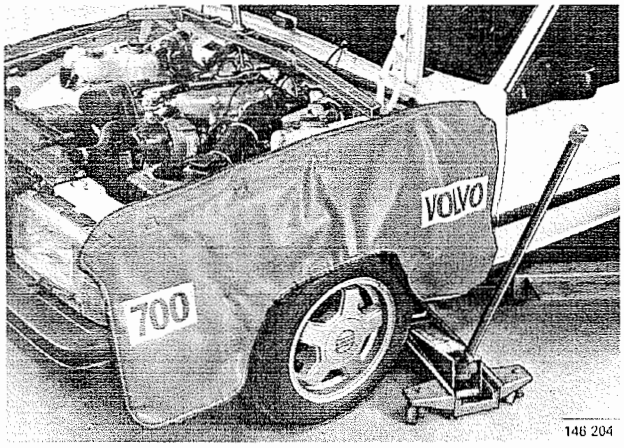
Remove nuts in bolted joint with exhaust manifold.




*T12*

**Remove gearbox support member**

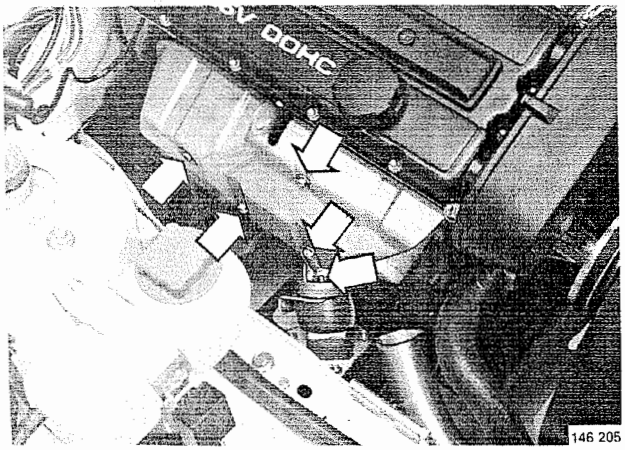
Remove gearbox bump stop nut and bolts attaching member to side members.




*T13*

**Support gearbox on jack**

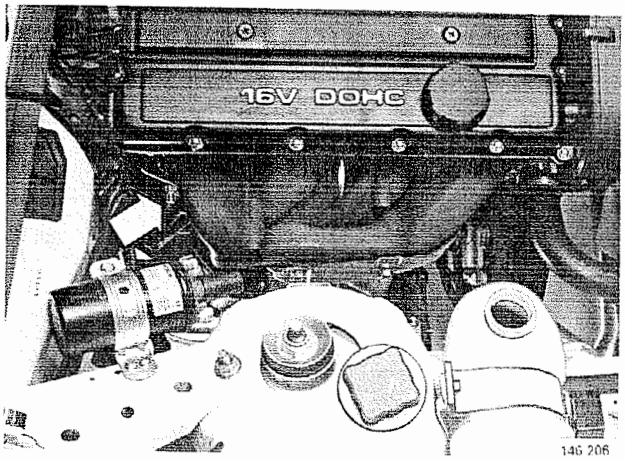
Remove lifting attachments (5006, 5033, 5115 and 5186).




*T14*

**Remove:**

- top heat shield from exhaust manifold
- air preheating hose from bottom heat shield
- top nut on right-hand engine mounting



146 206

T15

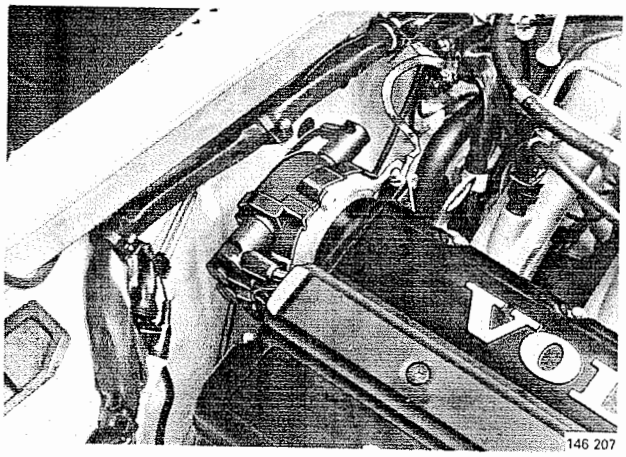
**Drain coolant**

Remove expansion tank cap.

Drain coolant through cock on right-hand side of cylinder block.

Fit tube to cock to facilitate collection of coolant.

Remove tube and **close** drain cock on completion of drainage.


146 207

T16

**Remove distributor cap**

Remove high-tension supply lead from cap.

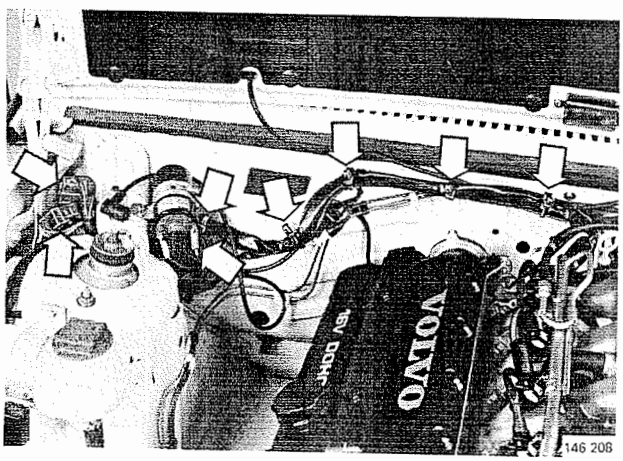
Remove ignition leads from cap.

Undo cap retaining screws (three).

Remove cap and distributor rotor.

Disconnect braided earth lead from engine.

**N.B.** Always grip ignition leads by **caps** when removing to avoid damage to leads.



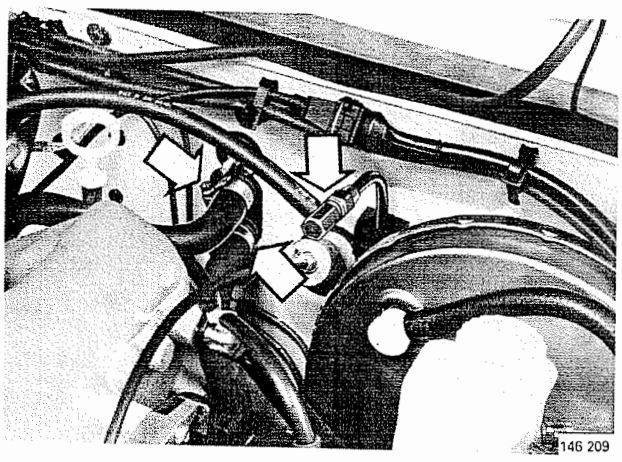
146 208

T17

**Release wiring harness at rear of engine**

Open cable clips on bulkhead.

Separate wiring connectors at right-hand suspension strut housing and disconnect lead to terminal **1** on ignition coil.


146 209

T18

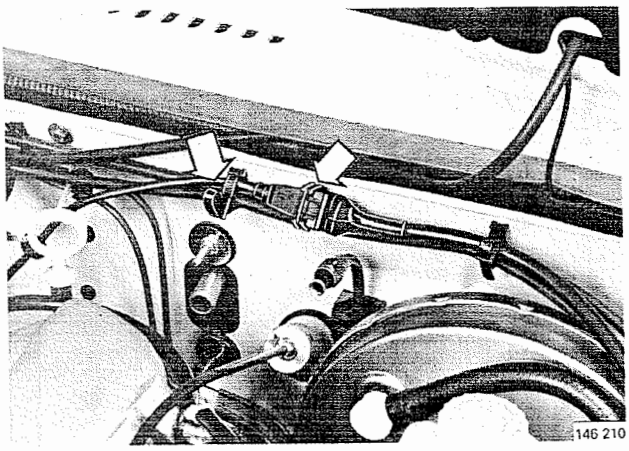
**Undo hose connections at left-hand side of bulkhead**

Disconnect heater hoses from pipe branches on bulkhead.

Open union between hose and pipe on fuel line.

Soak up fuel spillage with paper.

**N.B.** Seal open ends to prevent entry of dirt into fuel line.

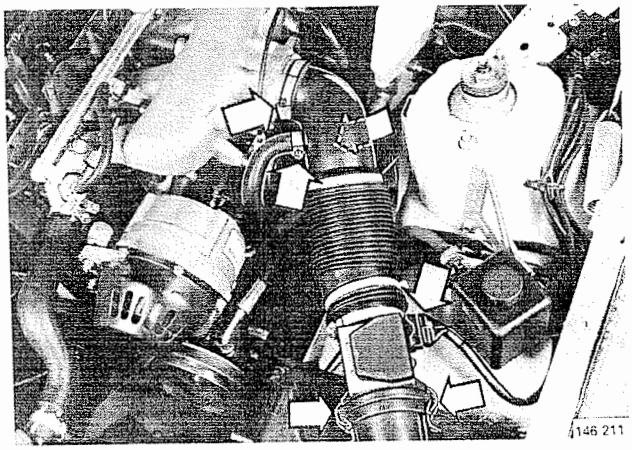



*T19*

**Disconnect speed pick-up lead**

Open cable clip on bulkhead.

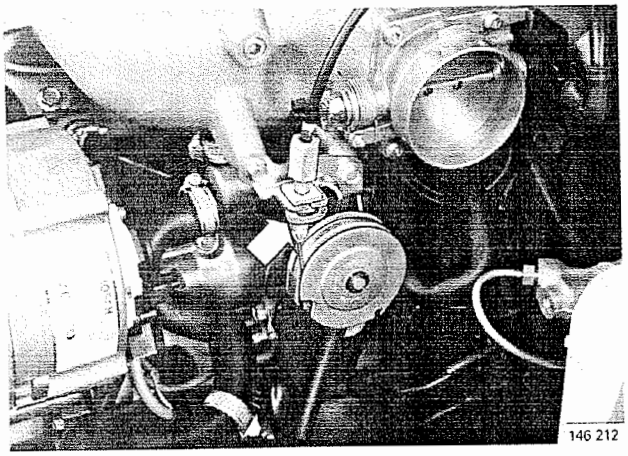
Open connector.




*T20*

**Remove air mass meter and air inlet hose**

Disconnect air mass meter wiring and hoses connected to inlet hose.

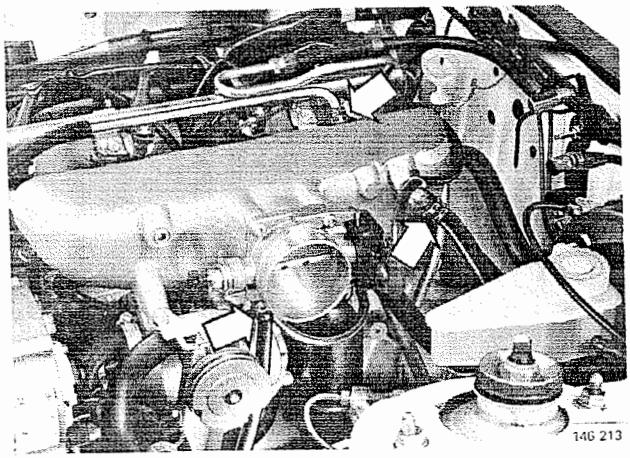



*T21*

**Release throttle cable from pulley**

Release locking clip on cable tensioner.

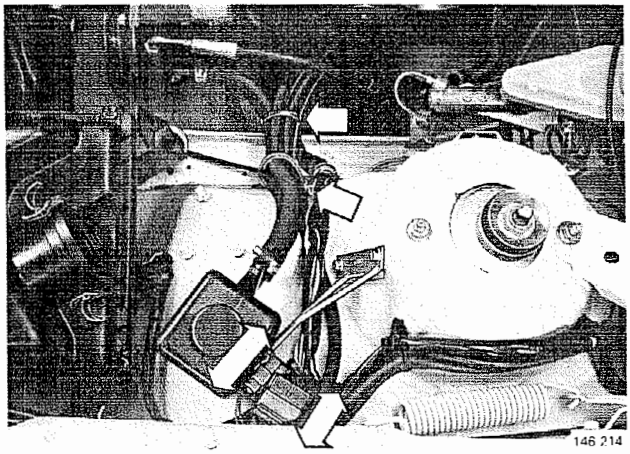
Unhook cable from pulley.




*T22*

**Remove:**

- brake servo vacuum hose from branch on intake manifold
- EVAP valve hose from branch on bottom of intake manifold
- return line from fuel distribution pipe


146 214

*T23*

**Release engine wiring harness on left-hand side**

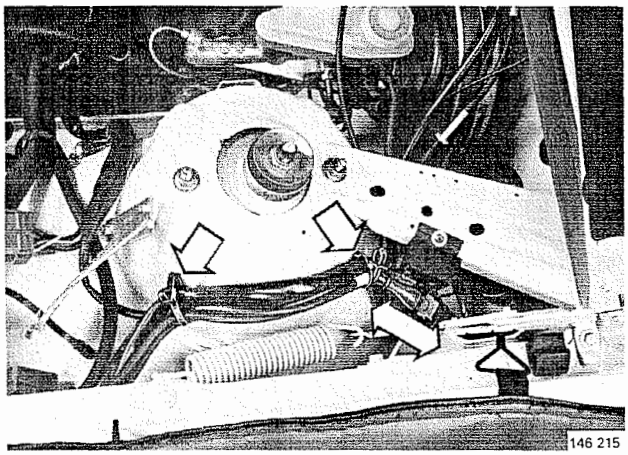
Cut steering servo hose and wiring harness ties.

Undo cable clip at left-hand wheel housing.

Unhook servo reservoir from mounting bracket.

Open cable clip at connectors.

Separate wiring connectors at servo reservoir.


146 215

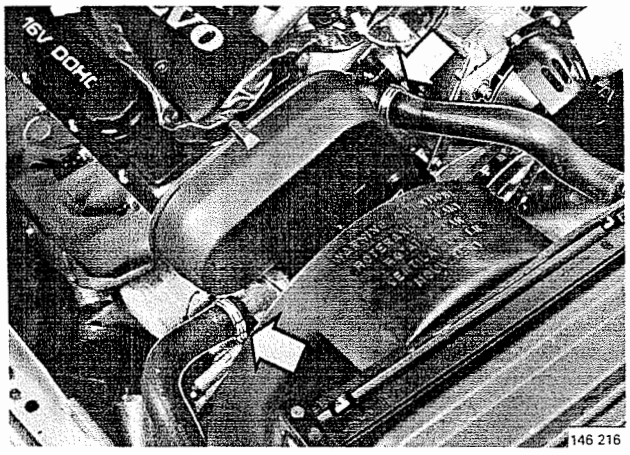
*T24*

**Disconnect knock sensor lead**

Open cable clips on left-hand suspension strut housing.

Separate connectors at diagnostic unit.

Work wiring free of servo hoses.



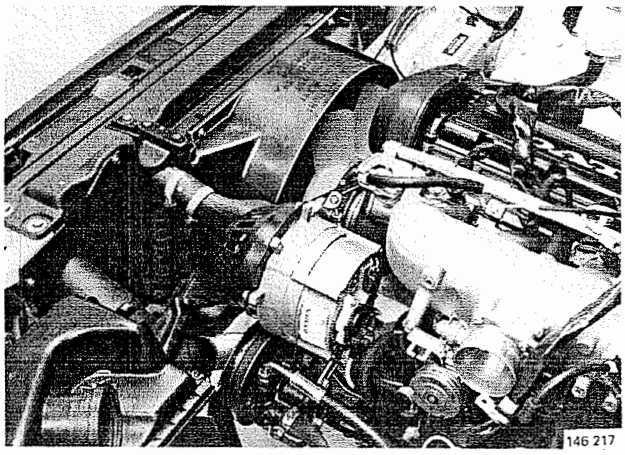
146 216

*T25*

**Remove coolant hoses**

Disconnect upper coolant hose at thermostat housing.

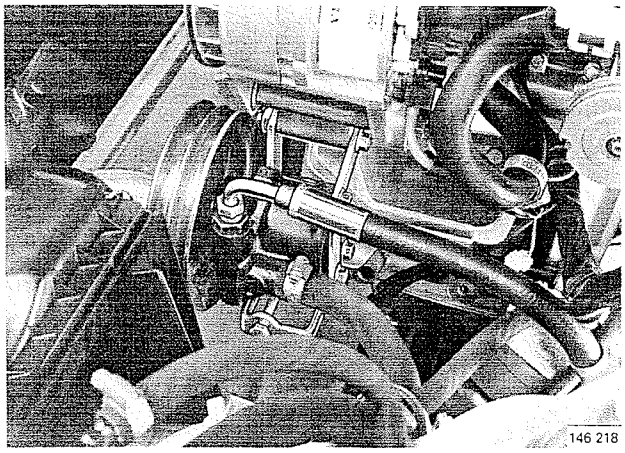
Disconnect lower coolant hose at water pump.


146 217

*T26*

**Remove:**

- alternator, servo pump and (if fitted) AC compressor drive belts
- radiator fan and drive pulley
- fan shroud


146 218

T27

### Remove servo pump

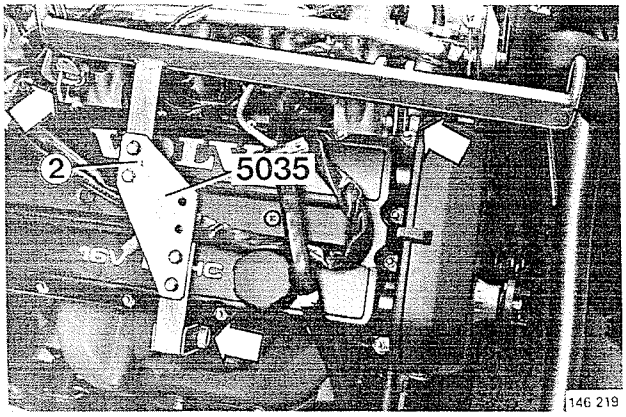
Remove pump from mounting bracket.

Place pump on left-hand wheel housing.

Use paper or other material to protect wheel housing from scratches.

On cars with AC: Tie compressor out of way.

**N.B. Do not** undo AC or servo unit hose connections.



146 219

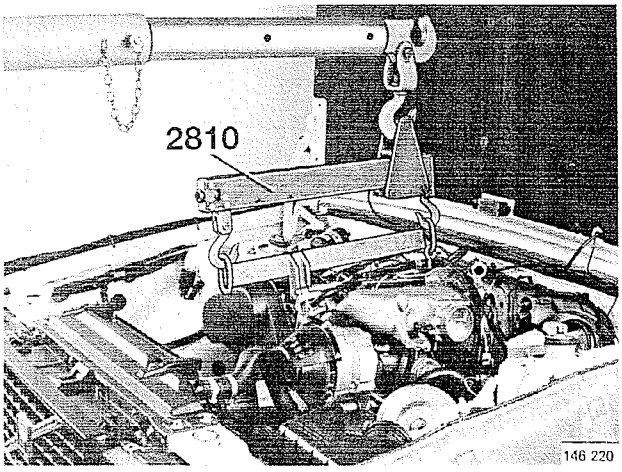
T28

### Attach lifting gear

Use bracket **5035** with side arm bolted to hole configuration No. 2.

Attach tool first to front left lifting lug, hook fast at rear and finally attach to side lifting lug.

**N.B.** Position wiring harnesses so as to **avoid damage** when lifting.



146 220

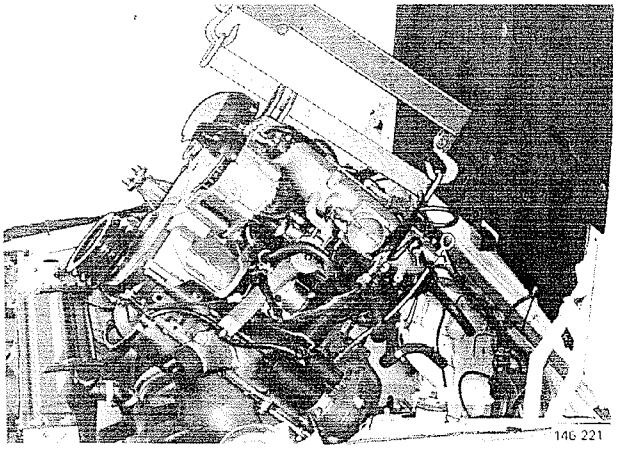
T29

### Lift engine

Use lifting tool **2810.**

Adjust lifting yoke to ensure engine is balanced.

Remove jack under gearbox.


146 221

T30

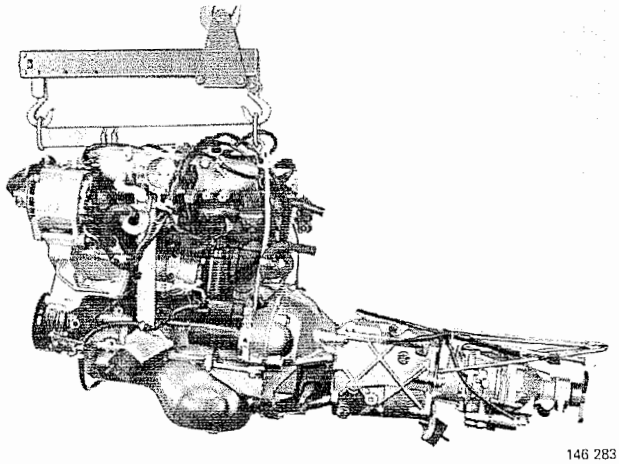
### Lift out engine and gearbox

Adjust angle of lift throughout operation.

**N.B. Carefully** check that drive unit is free of radiator, body and extra equipment (if any).

# U. Engine replacement, transfer of components

*Special tools: 2520, 2820, 5035, 5111, 5112, 5927*



146 283

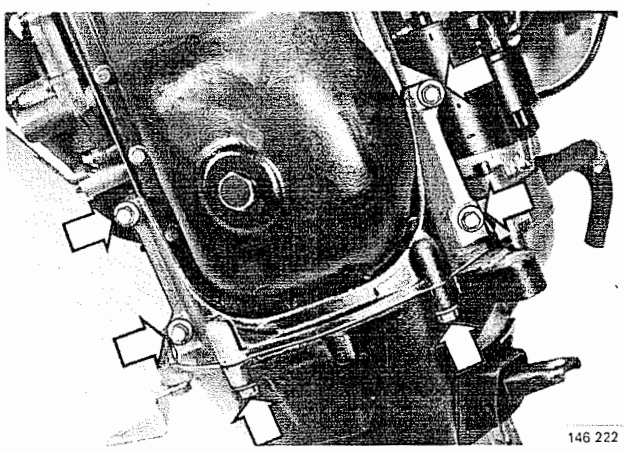
The following procedure assumes that the engine has been removed as described in operations **T1-30.**

**Procedure applies to cars with manual gearboxes**

Removal of automatic gearbox is described in procedure AD.

Caution! Since operations **U1–4** and **U30–34** are carried out with engine freely suspended, ensure that lifting equipment is **securely attached** and in **perfect condition.**

## Stripping of engine

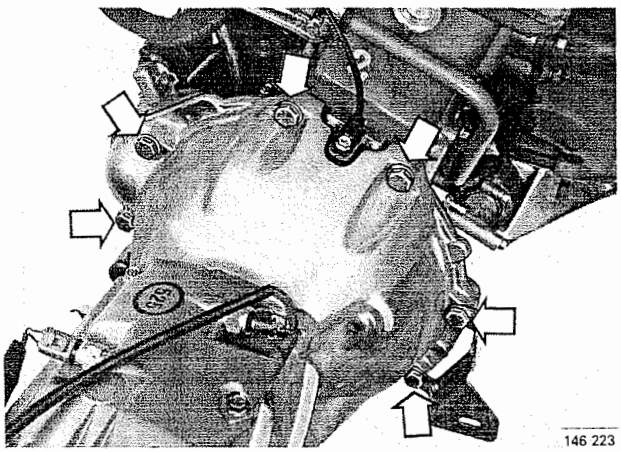


146 222

*U1*

**Remove reinforcing bracket**

Unbolt bracket between engine and gearbox.



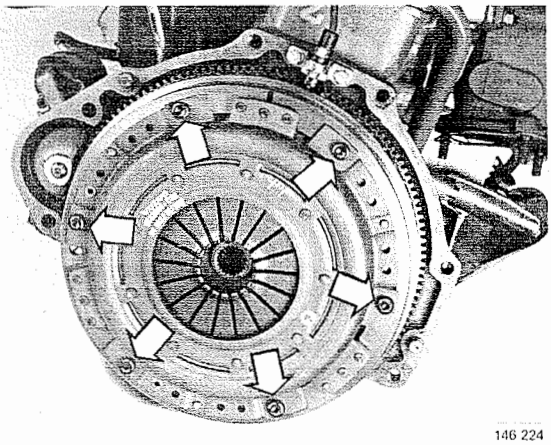
146 223

*U2*

**Remove gearbox**

Detach gearbox from engine by separating flywheel housing from cylinder block.

Inspect clutch release bearing and seal on input shaft.



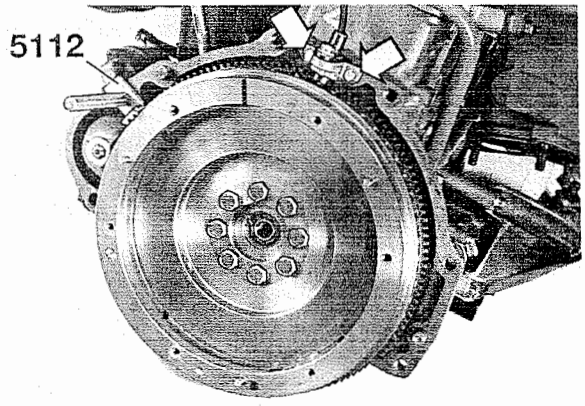
146 224

U3

**Remove pressure plate and clutch plate**

Use gear sector **5112.** Undo pressure plate joint evenly all round.

Inspect clutch components.




146 225

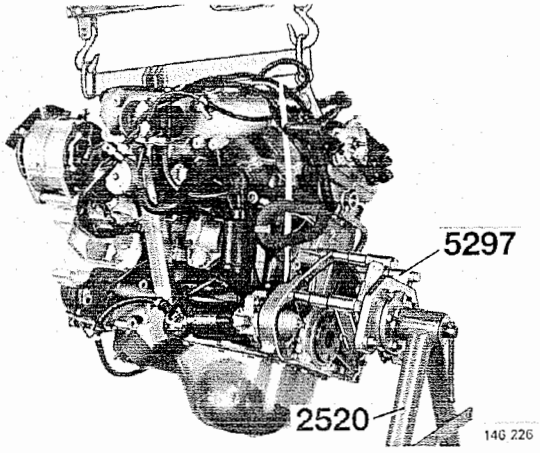
U4

**Remove speed pick-up and flywheel**

Use gear sector **5112.**

Remove flywheel.

**N.B.** Speed pick-up must be removed before flywheel.



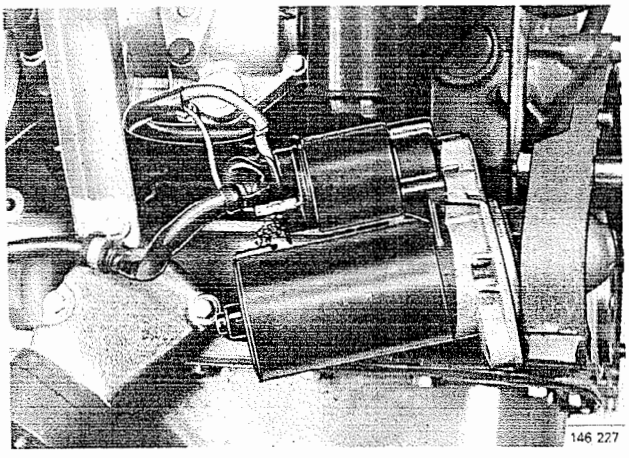

146 226

U5

**Mount engine in stand**

Use stand **2520** and fixture **5297.**

Remove lifting tool **2810** and bracket **5035.**

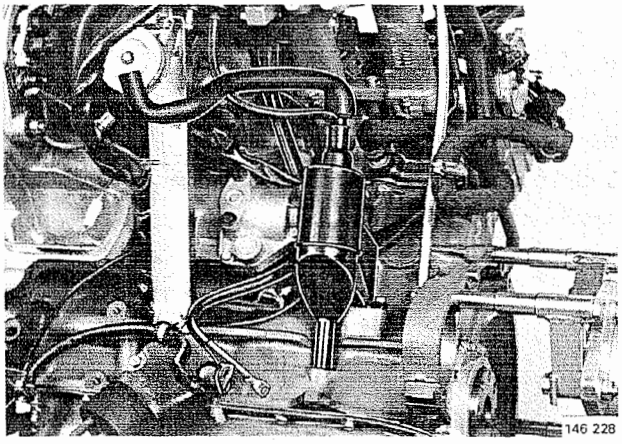


146 227

U6

**Remove starter motor**

Disconnect starter motor leads.

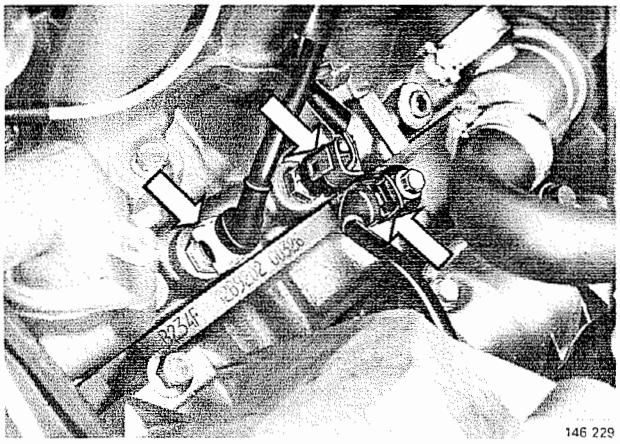

146 228

*U7*

**Remove oil trap**

Disconnect oil trap hoses.

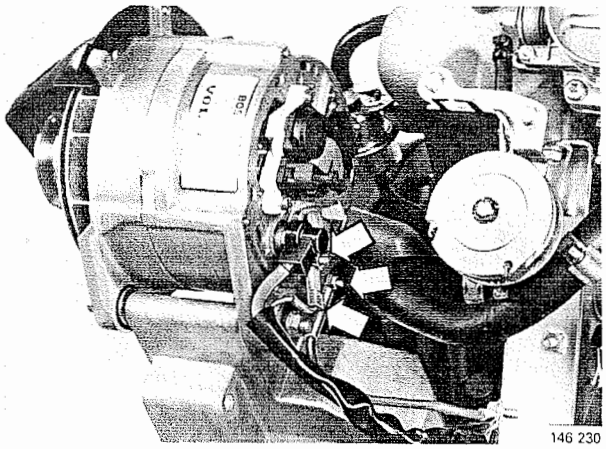
Remove trap and withdraw wiring harness between balance shaft housing and trap.


146 229

*U8*

**Disconnect:**

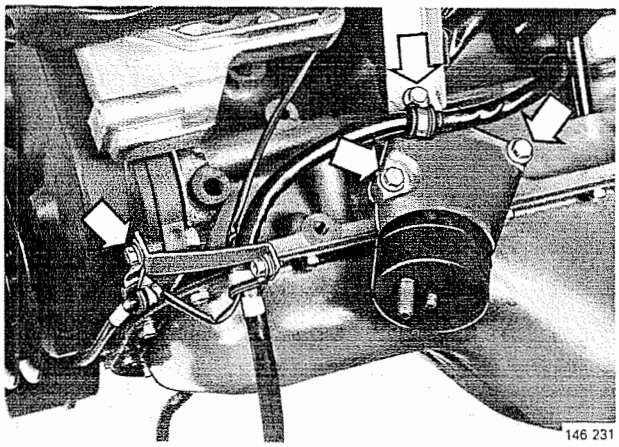
- knock sensor
- temperature sensors under intake manifold.


146 230

*U9*

**Disconnect alternator leads**

Remove protective cap over terminal B+.

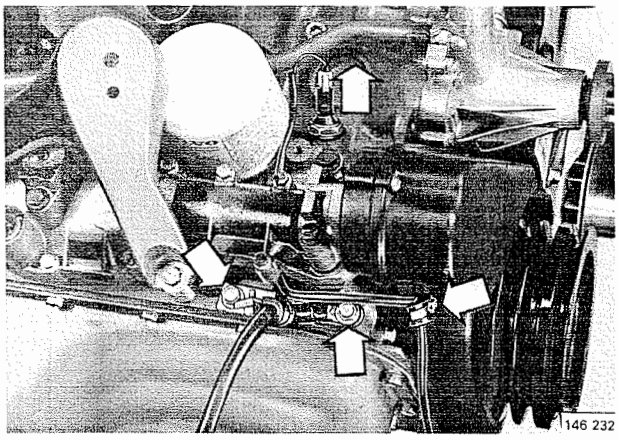

146 231

*U10*

**Remove cable clip at left-hand engine mounting**

Remove engine mounting.

Remove wiring harness bracket on transmission cover.



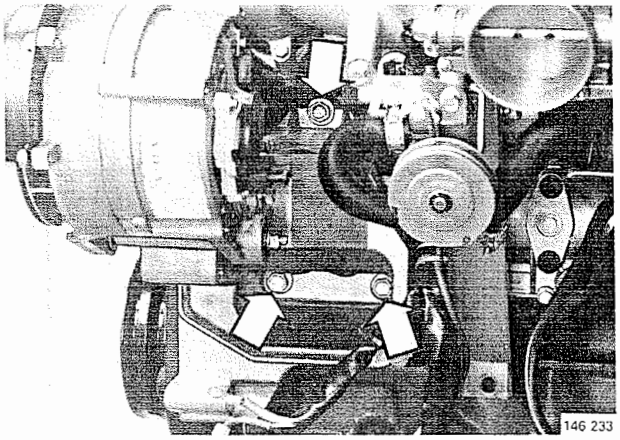

*U11*

**Release wiring harness on right-hand side**

Remove bracket under right-hand balance shaft and disconnect earth lead at cylinder block.

Remove oil pressure switch connector.

Undo cable clip at bottom front of transmission cover.

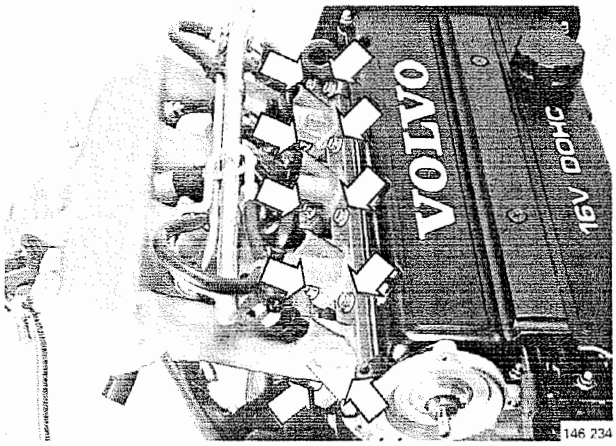



*U12*

**Remove alternator**

Remove auxiliary mounting bracket from cylinder block.

On cars equipped with AC: Remove compressor mounting bracket.

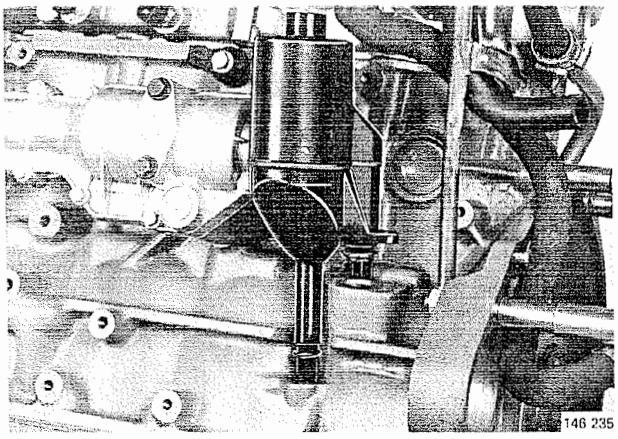



*U13*

**Remove intake manifold**

Remove bolts securing manifold to cylinder head.

Remove complete manifold and engine wiring harness.

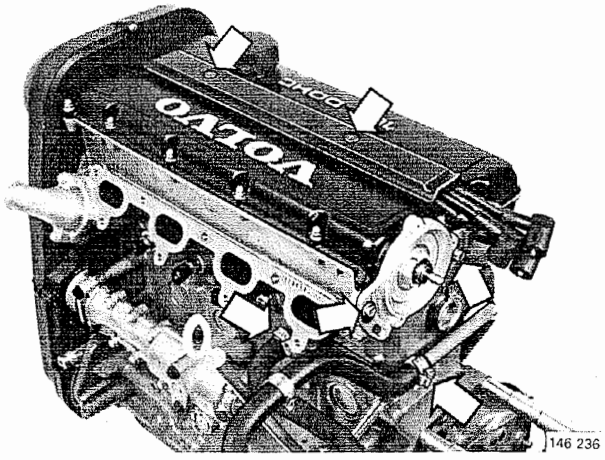



*U14*

**Remove oil trap**

Remove O-rings between oil trap and cylinder block.

*U15*

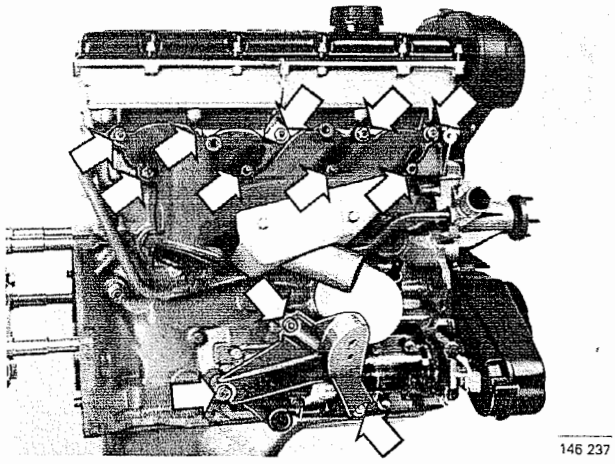


146 236

**Remove:**

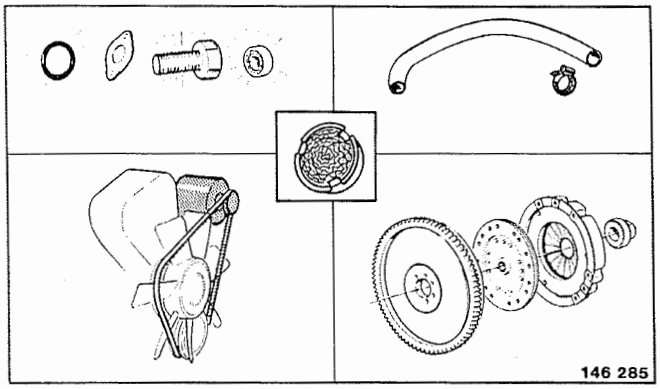
- distributor housing
- heater hoses
- ignition lead cover plate
- ignition leads

*U16*


146 237

**Remove:**

- exhaust manifold and lower heat shield
- right-hand engine mounting


146 285

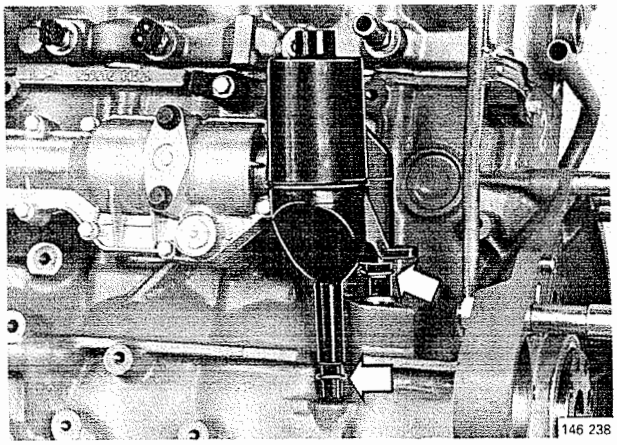
## Remounting components on replacement engine

**Use:**

- new gaskets and seals
- new flywheel bolts
- new **flame trap**

**Inspect and renew as required:**

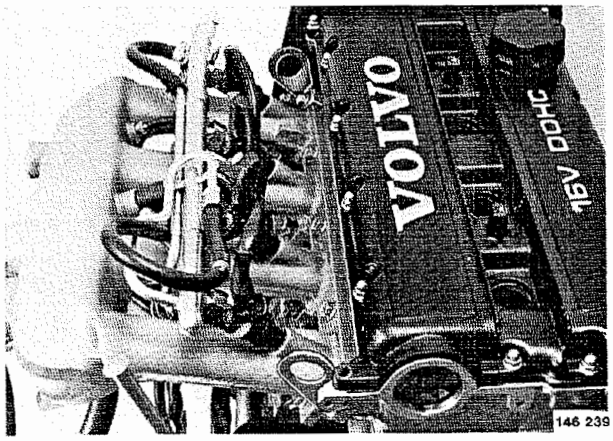
- hoses and clips
- auxiliary drive belts
- clutch components


146 238

*U17*

**Install oil trap in cylinder block**

Use **new** O-rings.



146 239

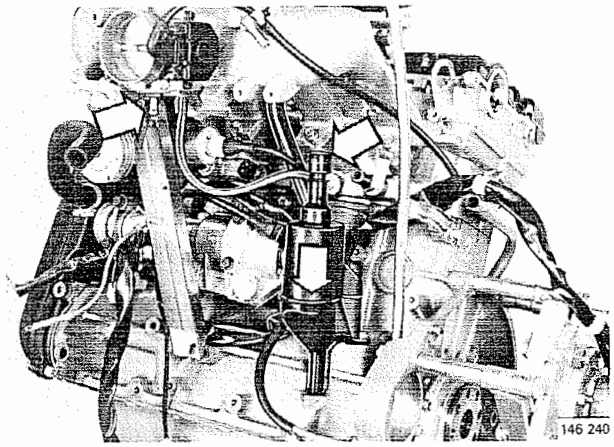
*U18*

**Install intake manifold assembly and wiring harness**

Use **new** gasket at joint with cylinder head.

Tighten bottom bolts a few turns.

Fit intake manifold and lifting lugs. Tighten mounting bolts from centre outwards.


146 240

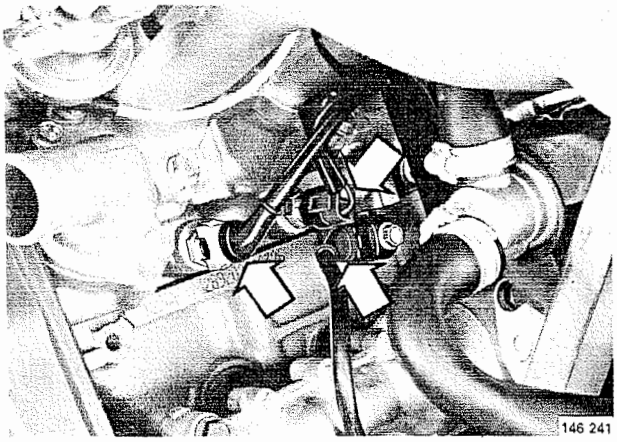
*U19*

**Mount oil trap**

Position engine wiring harness between oil trap and balance shaft housing.

Insert oil trap and tighten in position.

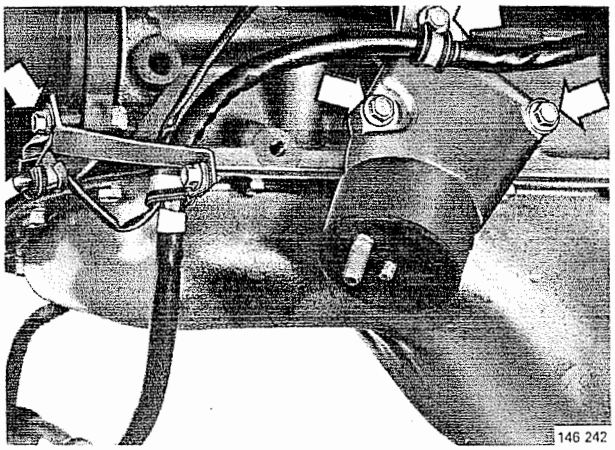
Install flame trap and hoses, and connect to branch on bottom of intake manifold.




*U20*

**Reconnect connectors under intake manifold**

Connect knock sensor and temperature sensors.

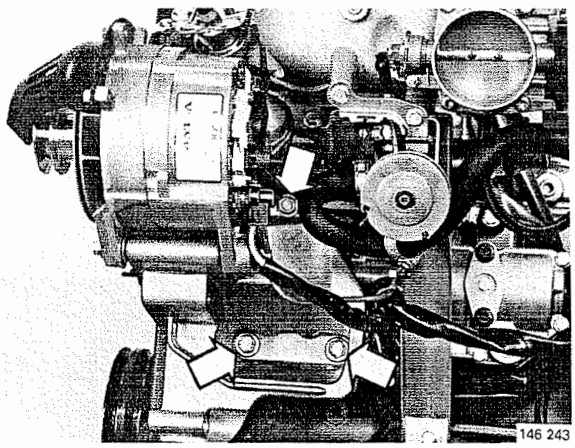



*U21*

**Install left-hand engine mounting**

Reattach cable clip at upper bolt of engine mounting/ intake manifold support.

Install wiring harness bracket and cable clip on transmission cover.



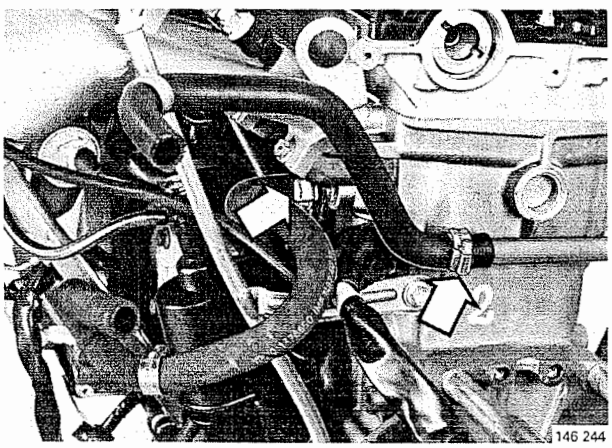

*U22*

**Install alternator and auxiliary mounting bracket**

Reconnect alternator leads.

Replace protective cap over terminal B+.

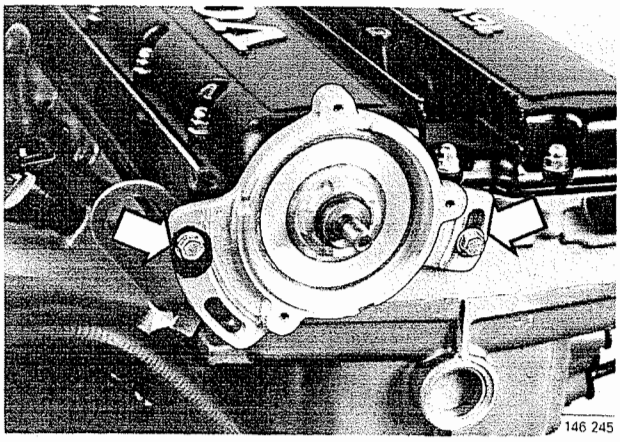
On cars equipped with AC: Install compressor mounting bracket.




*U23*

**Reconnect heater hoses**

Connect heater hoses to cylinder head and to distribution manifold from water pump.

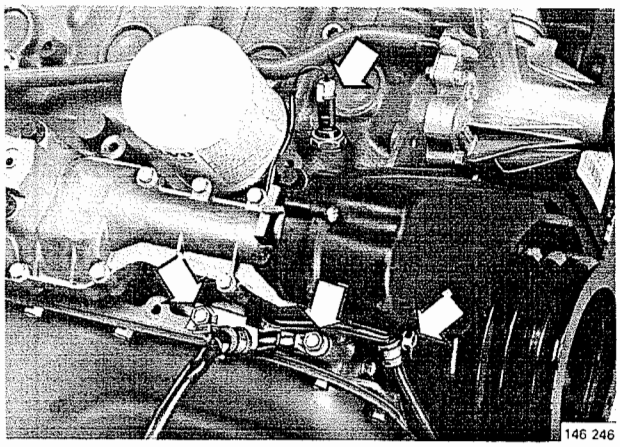



*U24*

**Install distributor housing**

Use **new** O-rings in housing and on rotor shaft.

**N.B.** Install ignition lead clip beside left-hand mounting bolt.

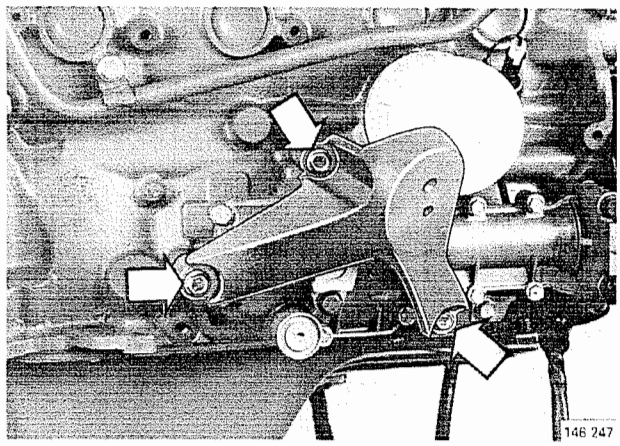



*U25*

**Install wiring harness bracket under right-hand balance shaft**

Connect earth lead to cylinder block and reconnect oil pressure switch.

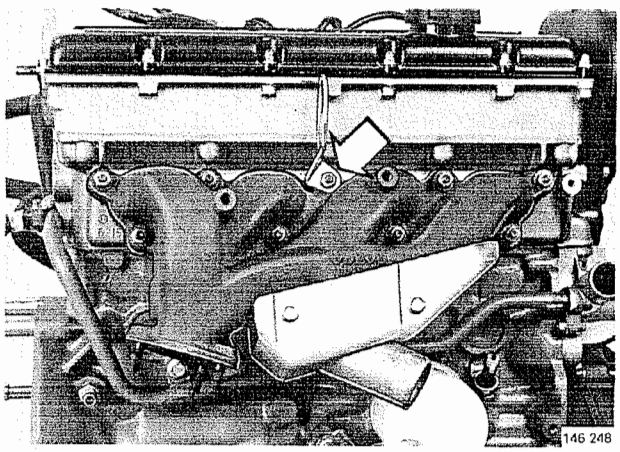
Install pressure switch cable clip at front of transmission cover.




*U26*

**Install right-hand engine mounting**

Reattach upper bracket to cylinder block.

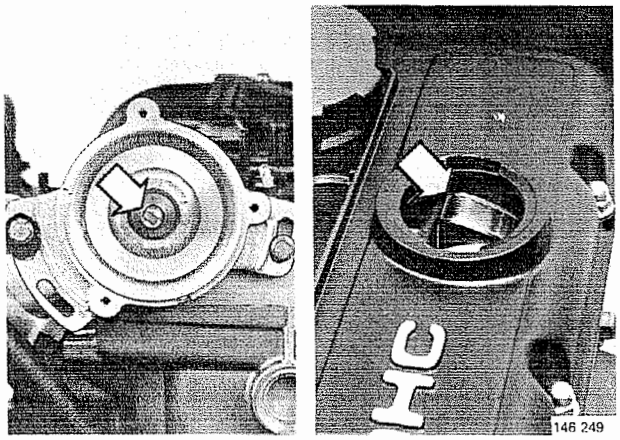



*U27*

**Install exhaust manifold and bottom heat shield**

Use **new** gasket in joint with cylinder head.

Attach lifting lug to centre stud.



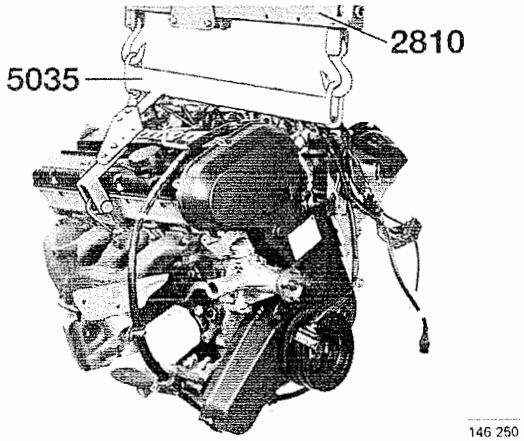
146 249

*U28*

**Turn crankshaft to TDC (ignition) in No. 1 cylinder**

Align crankshaft pulley (vibration damper) marking with 0 mark on transmission cover.

Check that slot in distributor rotor shaft is at '10 o'clock' or that No. 1 cylinder exhaust cams are pointing upwards at approx. 60° to engine centre line.



146 250

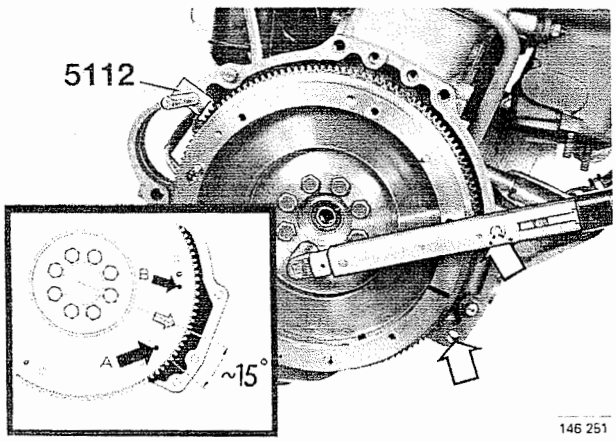
*U29*

**Lift engine from stand**

Use attachment **5035** and lifting yoke **2810.**

Position engine wiring harness to **avoid** risk of damage.

**Caution!** Since operations and **U30–34** are carried out with engine freely suspended, ensure that lifting equipment is **securely attached** and in **perfect condition.**



146 251

*U30*

**Install flywheel**

Use gear sector **5112.**

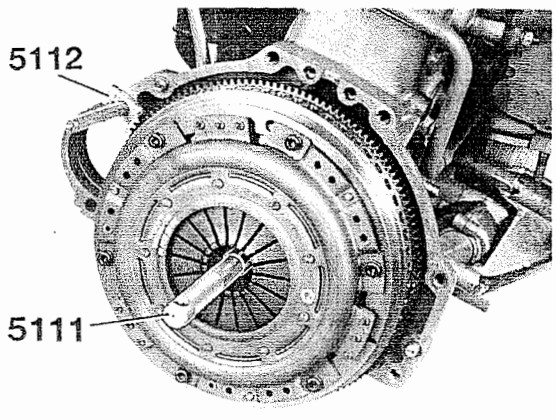
At TDC, mark on flywheel should be positioned between the two lower bolt holes on right-hand side of cylinder block.

**Caution!** If flywheel is not marked, new position is indicated by pins **A** and **B** at rear.

Pins **A** and **B** are located respectively approx. 15° on either side of marking position.

Use **new** bolts and **thread locking compound.**

**Tighten to 70 Nm** (52 ft.lb).



146 252

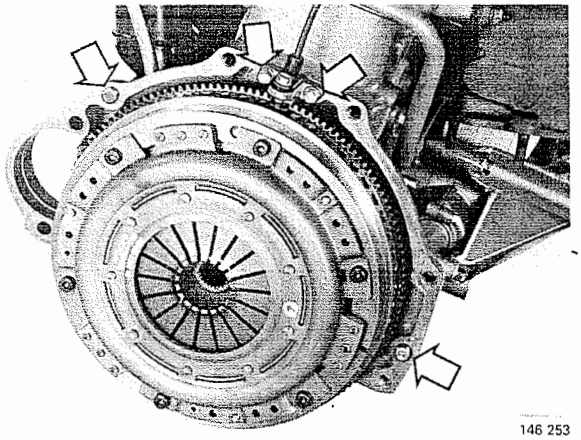
*U31*

**Install clutch plate and pressure plate**

Use centering tool **5111** and gear sector **5112.**

Tighten pressure plate in stages. Work around circumference tightening diagonally-opposite bolts alternately.

Remove centering tool and gear sector.



146 253

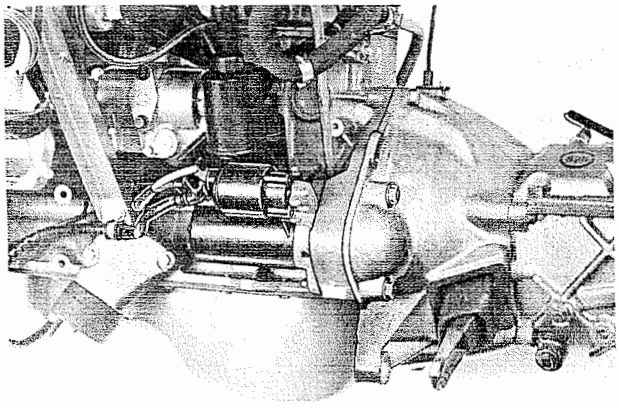
*U32*

**Install speed pick-up**

Use thread locking compound.

Tighten to 5 Nm (3.5 ft.lb).

Check that cylinder block guide pins are in position.



146 254

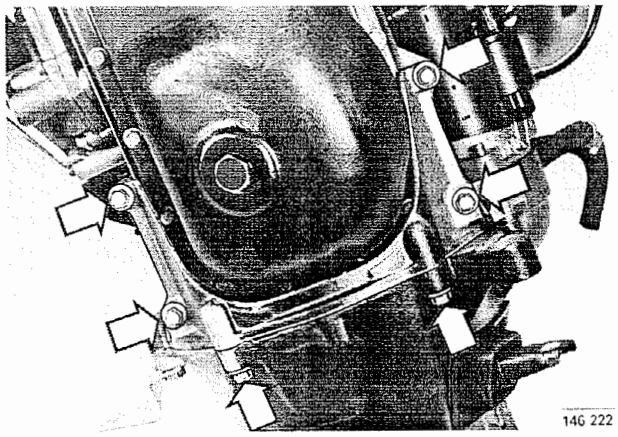
*U33*

**Install gearbox and starter motor**

Lubricate input shaft splines with thin coating of grease.

Reconnect starter motor leads.

**N.B. Remember** to install exhaust manifold front mounting bracket.



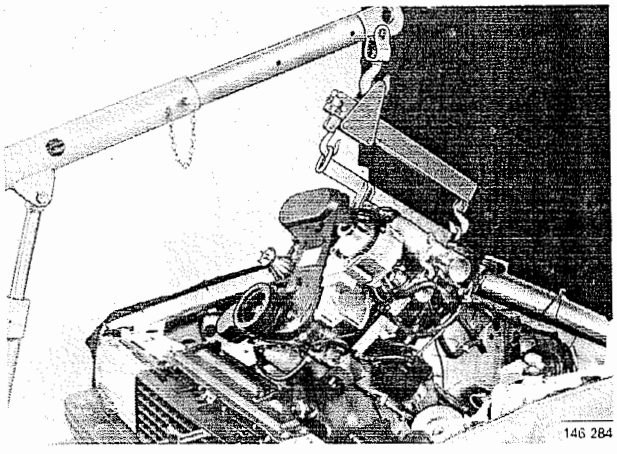
146 222

*U34*

**Install reinforcing bracket**

Tighten bracket in stages.

Attach bracket first to flywheel housing and then to cylinder block.



146 284

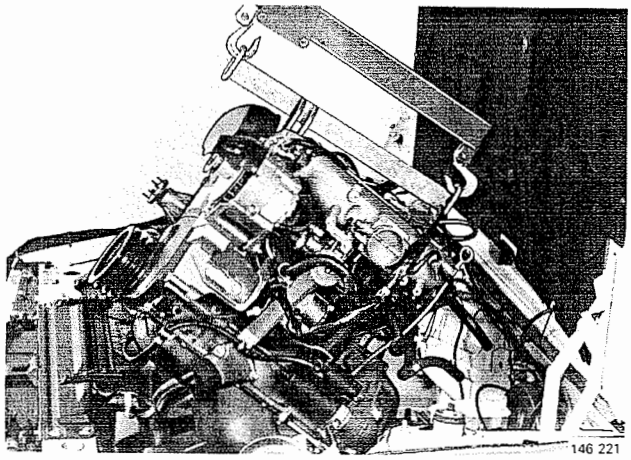
*U35*

**Install engine in car**

Installation is carried out as described in operations **V1-31.**

# V. Engine, installation

*Special tools: 2810, 5006, 5033, 5035, 5115, 5186, 5244*

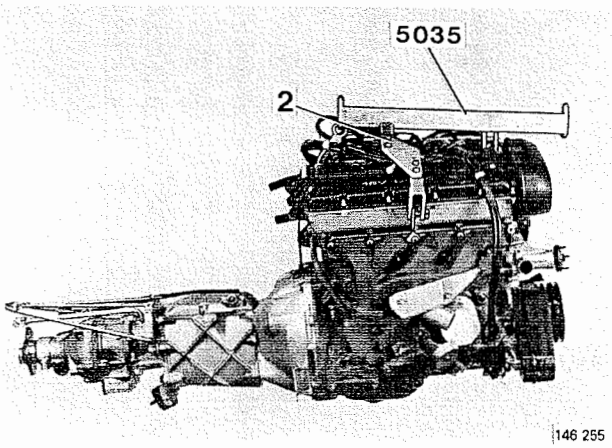



**Procedure applies to cars with manual gearboxes**

Removal of automatic gearbox is described in procedure AD.

**Caution!** Since procedure is carried out with engine freely suspended, ensure that lifting equipment is **securely attached** and in **perfect condition.**





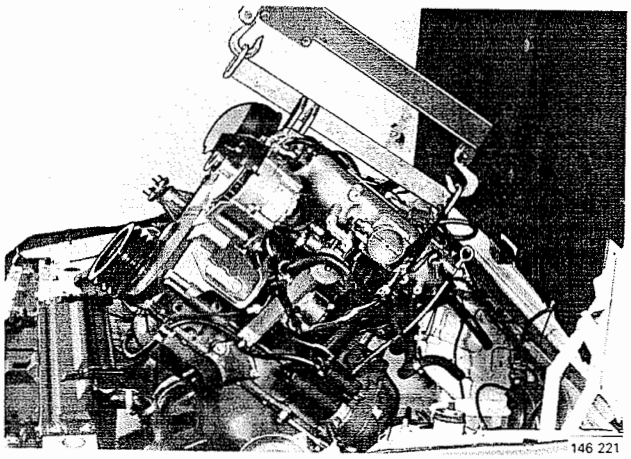

*V1*

**Attach lifting equipment**

Use attachment **5035** with side arm bolted to hole configuration No. 2.

Attach tool first to front left lifting lug, hook in position at rear and finally attach to side lifting lug.

**N.B.** Position wiring harnesses so as to **avoid damage** when lifting.




*V2*

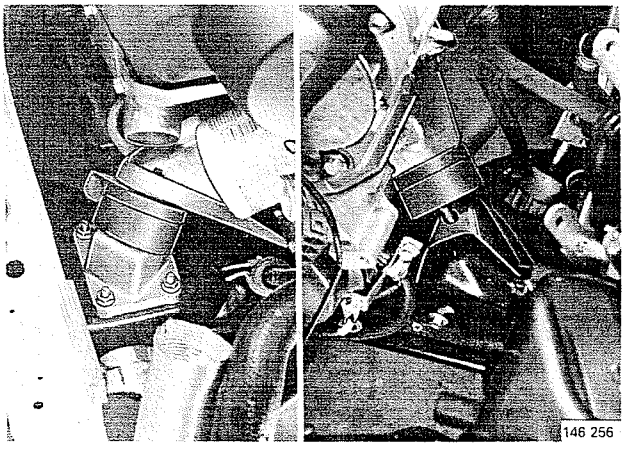
**Lower engine and gearbox into position**

Use lifting tool **2810.**

Adjust lifting yoke to ensure engine is balanced.

Adjust angle of lift throughout operation.

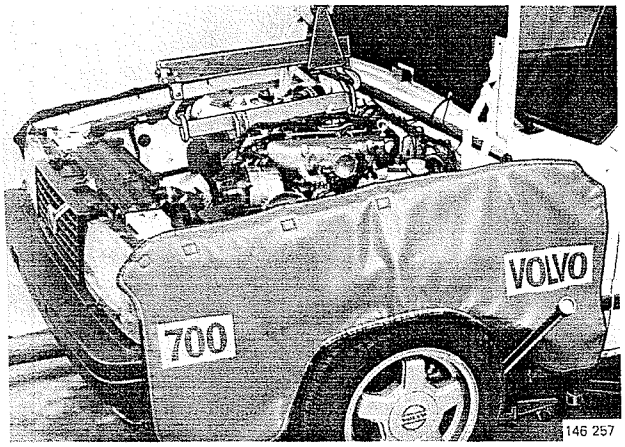
**N.B. Carefully** check that drive unit is free of radiator, body and extra equipment (if any).




*V3*

**Guide front engine mountings into position**

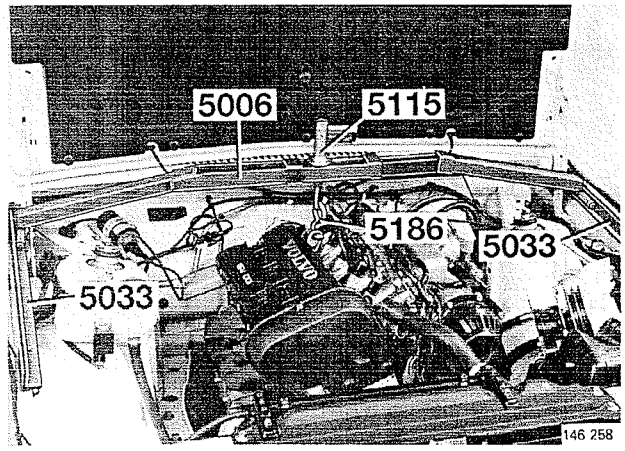
Guide mountings into brackets on front crossmember.




*V4*

**Support gearbox on jack**

Remove lifting yoke **2810** and attachment **5035**.



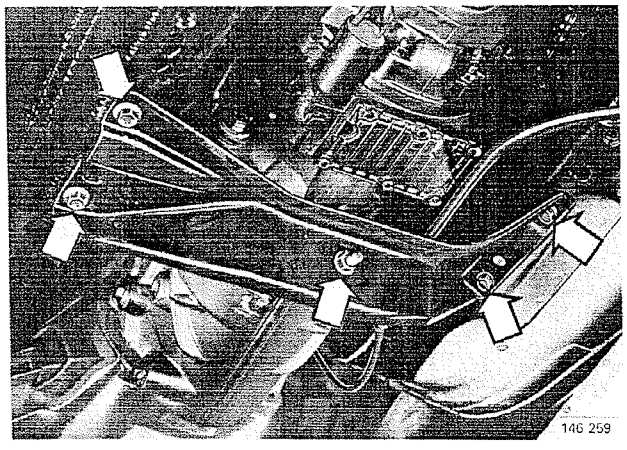

*V5*

**Raise rear of engine slightly**

Use two support bars **5033**, lifting yoke **5006**, lifting hooks **5115** and**5186**.

Lift engine using rear left lifting lug.

Remove jack under gearbox.

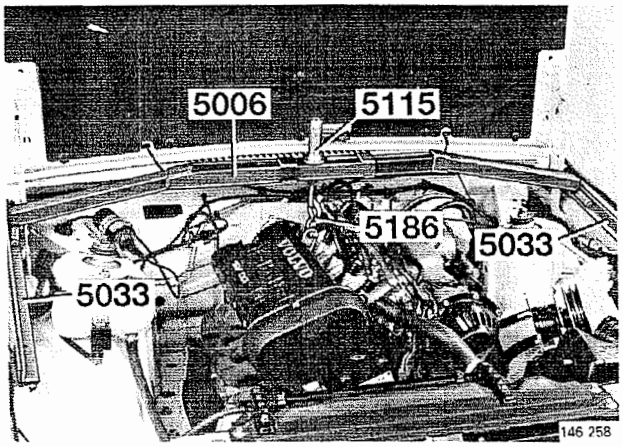



*V6*

**Replace gearbox support member**

Tighten bolts securing member to side members. Tighten bump stop nut.

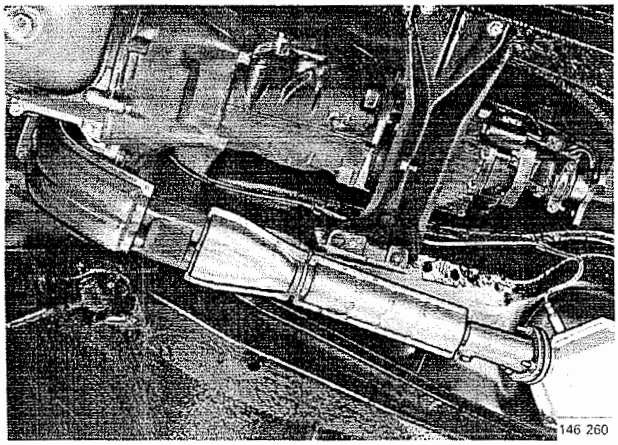
Ensure that oxygen sensor lead is positioned above member.




*V7*

**Remove lifting attachments**

Remove items 5006, 5033, 5115 and 5186.



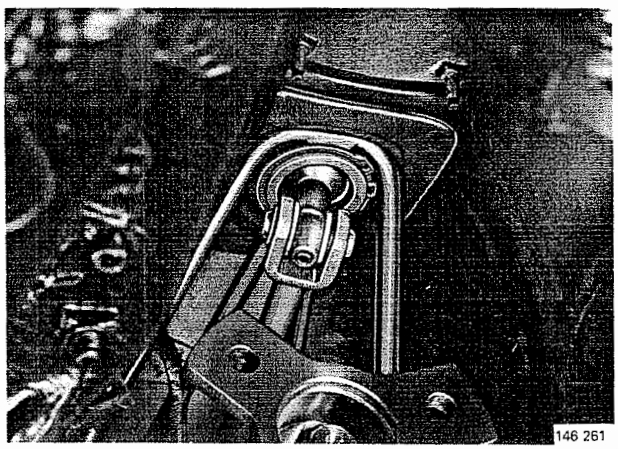

*V8*

**Install front exhaust pipe**

Use **new** gasket in joint between pipe and exhaust manifold.

Secure pipe to exhaust manifold and to flanged joint at front of catalytic converter.

Secure **oxygen sensor** lead in clip.



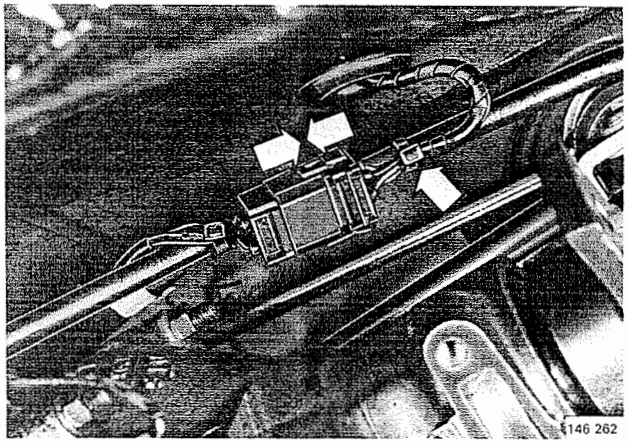

*V9*

**Install gear lever**

Insert gear lever sleeve in mounting.

**Install:**

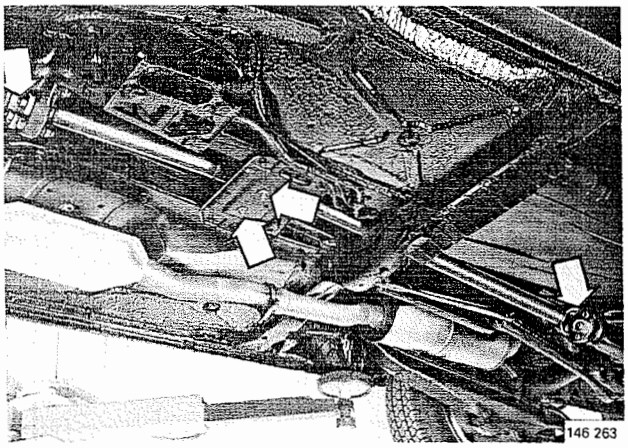
- bearing bushings and O-ring on gear selector rod; install circlip on rod
- selector rod/gear lever pivot pin; tighten set screw
- circlip on gear lever sleeve; pull selector rod downwards when fitting circlip




*V10*

**Reconnect gearbox wiring**

Reconnect wiring connectors and replace cable tie.



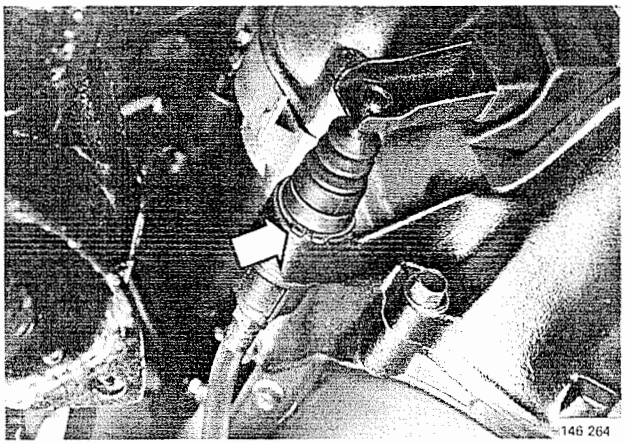

*V11*

**Install propeller shaft**

Use socket **5244.**

Tighten front and rear universal joints.

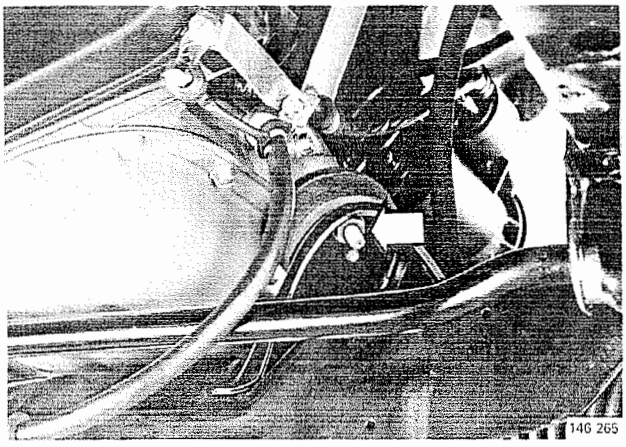
Reattach intermediate bearing to member.




*V12*

**Install clutch slave cylinder**

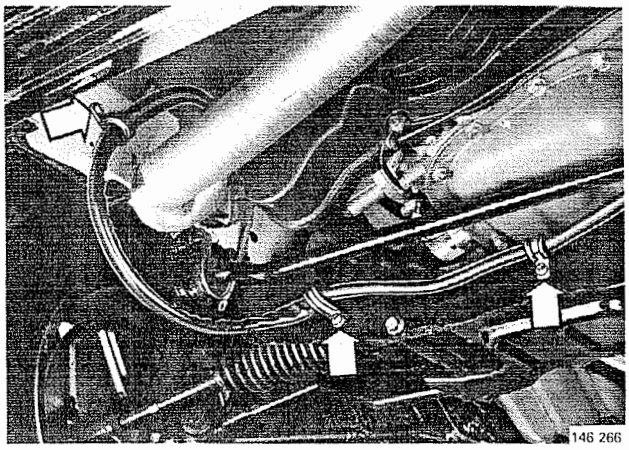
Secure cylinder with circlip.




*V13*

**Tighten left-hand engine mounting**

On cars equipped with AC: Replace compressor.


146 266

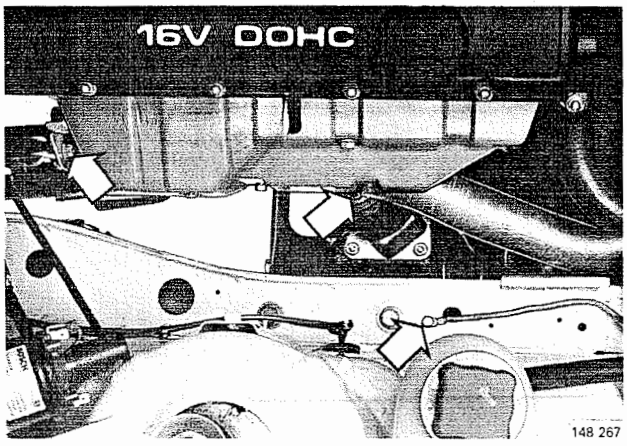
*V14*

**Reconnect battery leads**

Run wiring between anti-roll bar support and front crossmember.

Install cable clips on crossmember and right-hand side member.

Install splashguard under engine.

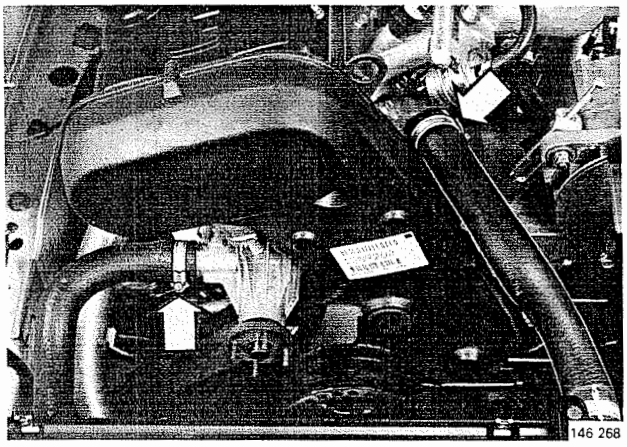


148 267

*V15*

**Install/reconnect:**

- earth lead to top of right-hand side member
- right-hand engine mounting nut
- upper heat shield
- air preheating hose on lower heat shield
- exhaust manifold front mounting bolt

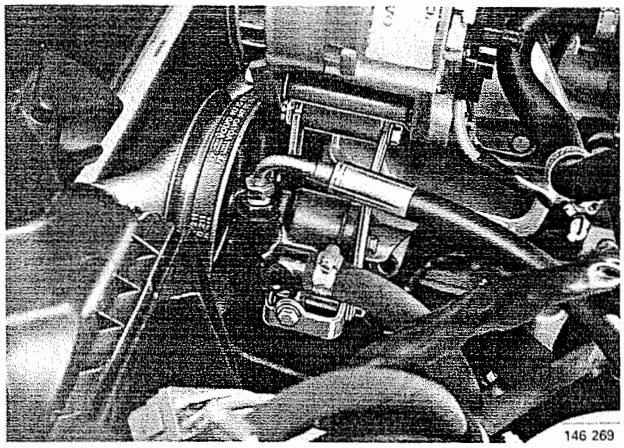

146 268

*V16*

**Reconnect:**

- bottom coolant hose to coolant pump
- upper coolant hose to thermostat

**Important!** Note marking on upper hose. Clearance between hose and alternator belt **must** be **at least 25 mm** (1 in).


146 269

*V17*

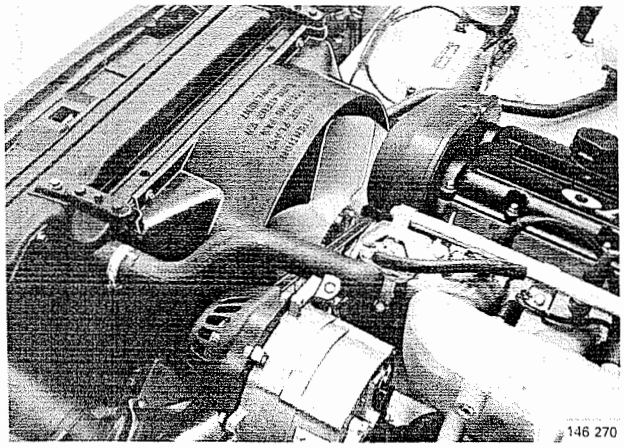
**Install servo pump**

Mount pump on auxiliary equipment bracket.

Refit belt and adjust tension.

Tighten pump housing.

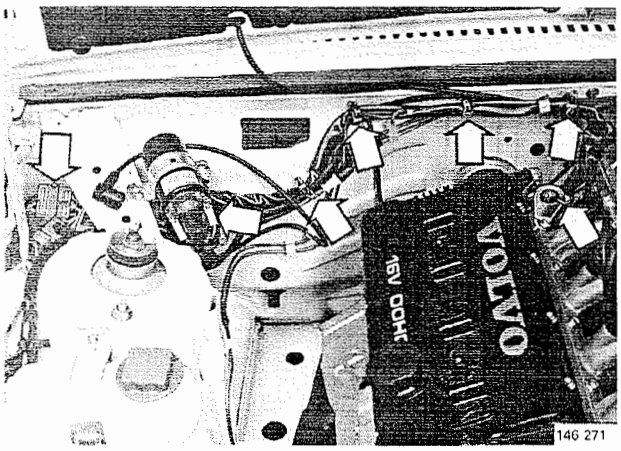
On cars equipped with AC: Refit twin drive belts.


146 270

*V18*

**Install:**

- cable ties under fan shroud
- fan shroud
- air preheating hose; tighten ties
- belt pulley and fan
- alternator drive belt; adjust belt tension and tighten alternator



146 271

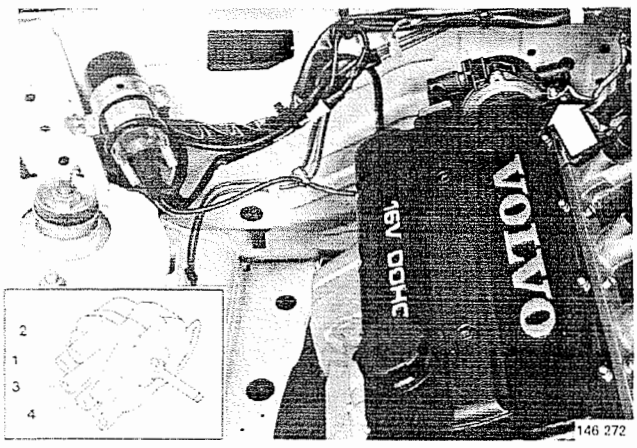
*V19*

**Reconnect rear wiring harness**

Secure wiring in cable clips on bulkhead.

Reconnect connectors behind right-hand suspension strut tower and reconnect lead to terminal 1 on ignition coil.

Use cable tie to secure lead to rear left lifting lug.

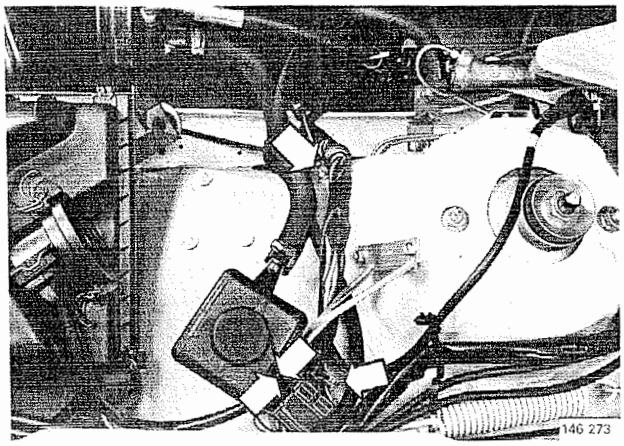


146 272

*V20*

**Install/reconnect:**

- distributor rotor
- distributor cap
- high-tension lead between ignition coil and distributor cap
- ignition leads in correct firing order
- ignition lead cover plate
- braided earth lead to distributor




*V21*

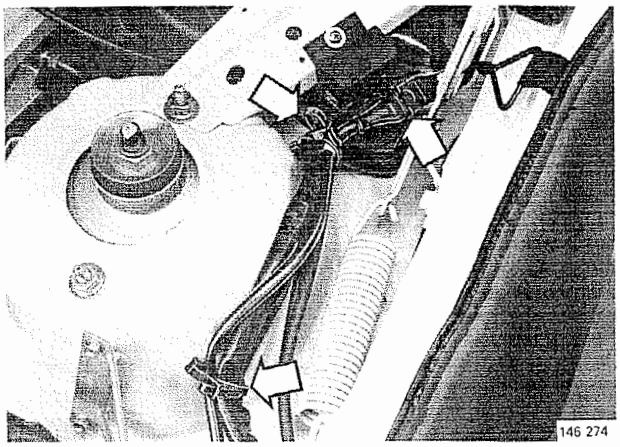
**Reconnect left-hand wiring harness**

Attach cable clips to wheel housing.

Reconnect connectors at suspension strut tower.

Secure wiring in cable clips.

Install servo reservoir.

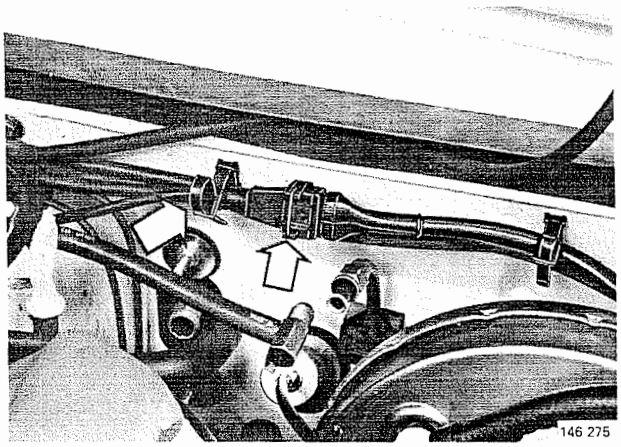



*V22*

**Reconnect knock sensor lead**

Reconnect connector at diagnostic unit.

Secure cable in clips around suspension strut tower.

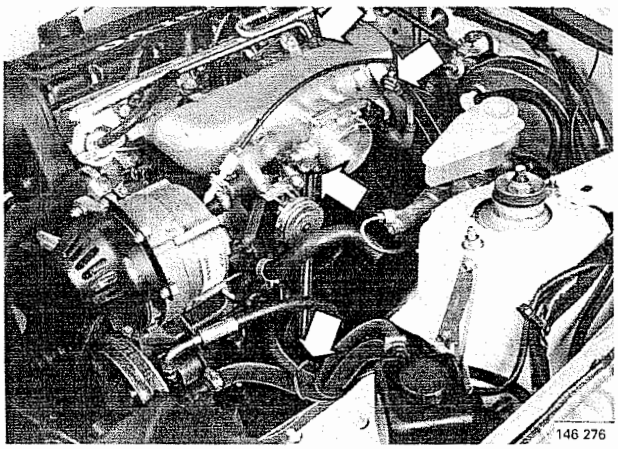



*V23*

**Reconnect speed pick-up lead**

Reconnect connectors on bulkhead.

Secure lead in clip on bulkhead.

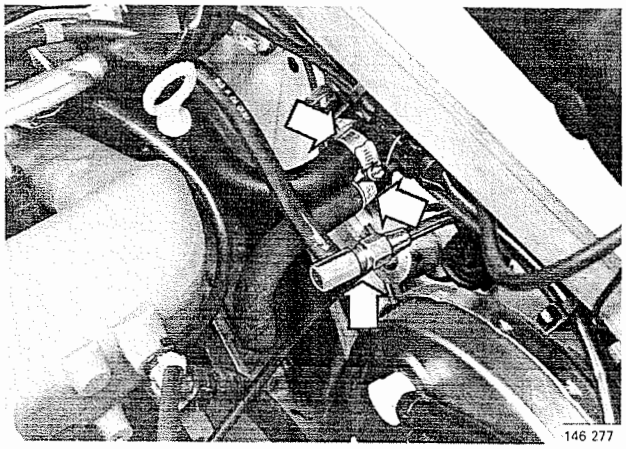



*V24*

**Reconnect:**

- brake servo vacuum hose to branch on intake manifold
- EVAP valve hose to branch on intake manifold
- return line to fuel distribution pipe

Secure servo hoses and wiring harness with cable tie.

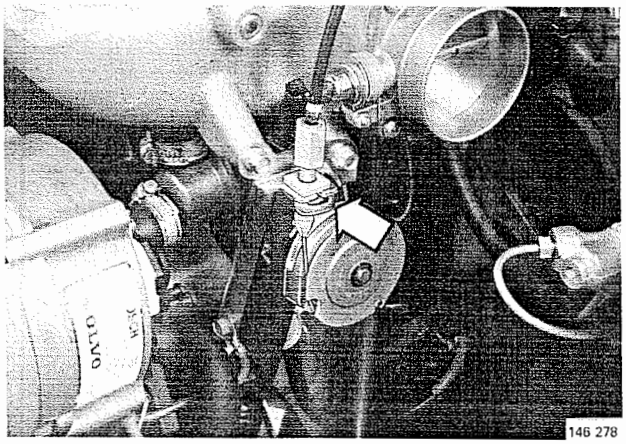

146 277

*V25*

**Reconnect hoses to left-hand side of bulkhead**

Reattach heater hoses to branches on bulkhead.

Reconnect union between pipe and hose on fuel line.


146 278

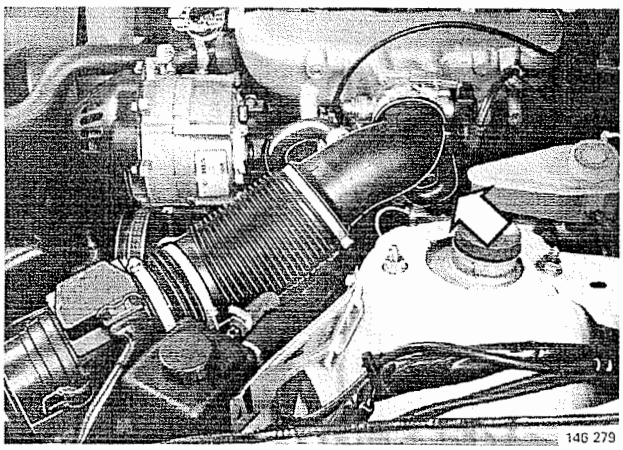
*V26*

**Reattach throttle cable to pulley**

Hook cable onto pulley.

Attach clip to cable tensioner.

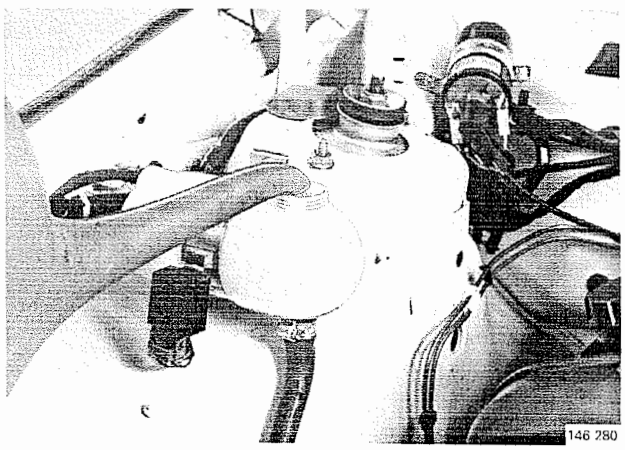
Check stop functions and throttle switch operation.


146 279

*V27*

**Install air mass meter, complete with air inlet hose and connections**

**N.B.** Connect hose from oil trap under inlet hose.


146 280

*V28*

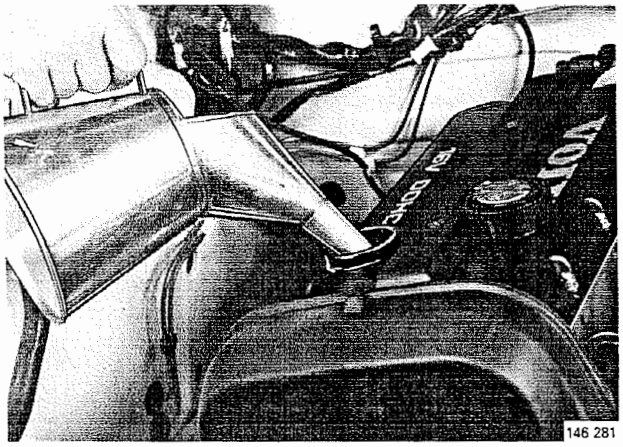
**Fill engine with coolant**

Use genuine **type C** Volvo coolant.

Approx. capacity..... **9 l** (9.5 US qt)

Set heater control in car to max. heat.

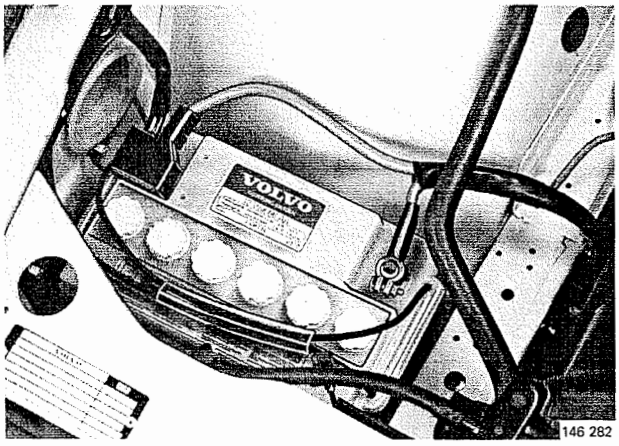
Check system for leaks.




*V29*

### Fill engine with engine oil

Capacity excl. filter ..... **3.5 l** (3.7 US qt)
incl. filter ..... **4.0 l** (4.2 US qt)



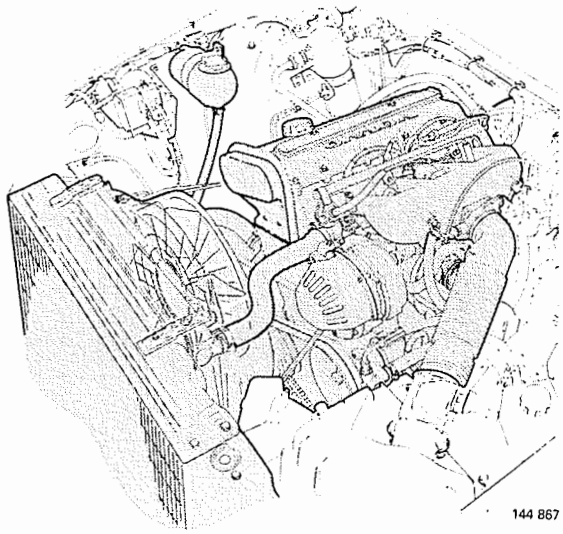

*V30*

### Reconnect battery leads

Reconnect positive lead, and lead between right-hand wheel housing and positive terminal.

Install protective cap on positive terminal.

Reconnect earth lead.




*V31*

### Check operation

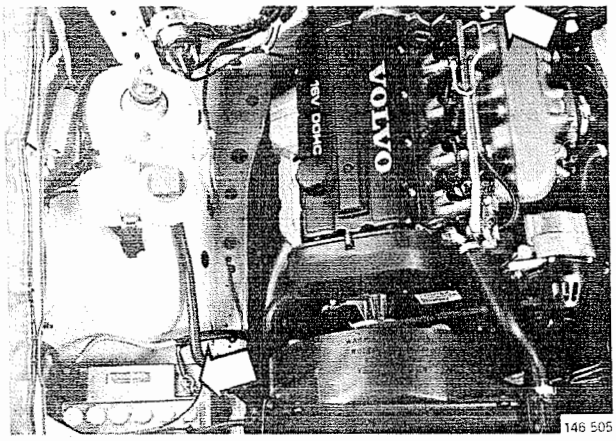
Start and run engine until thermostat opens.

Check and top up oil and coolant levels as required.

**Important!** Some noise may be heard from tappets when replacement engine is started for the first time. This will disappear as tappets are filled with oil.

# W. Oil sump, gasket replacement

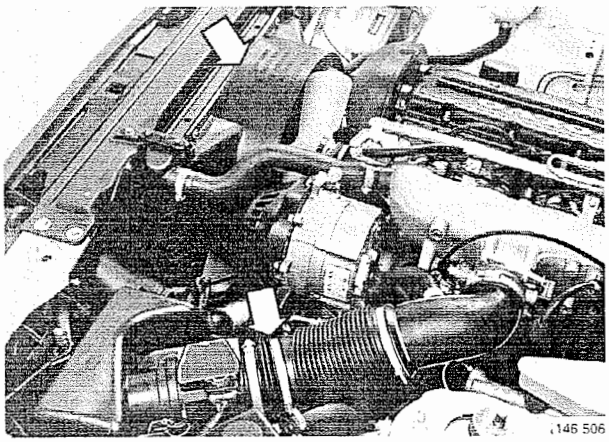
*Special tools: 5006, 5003, 5115*




*W1*

**Disconnect/remove:**

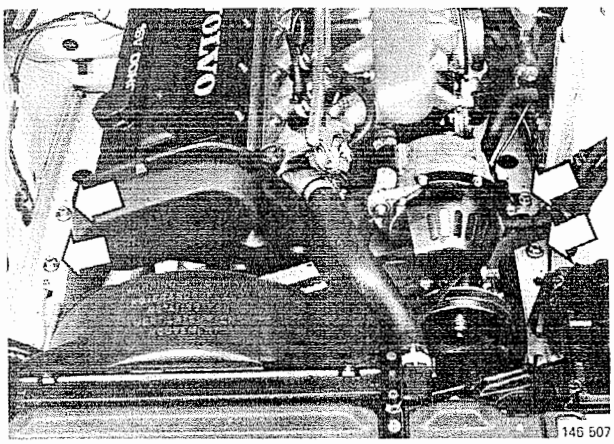
- battery earth lead
- oil dipstick




*W2*

**Remove air mass meter and air inlet hose**

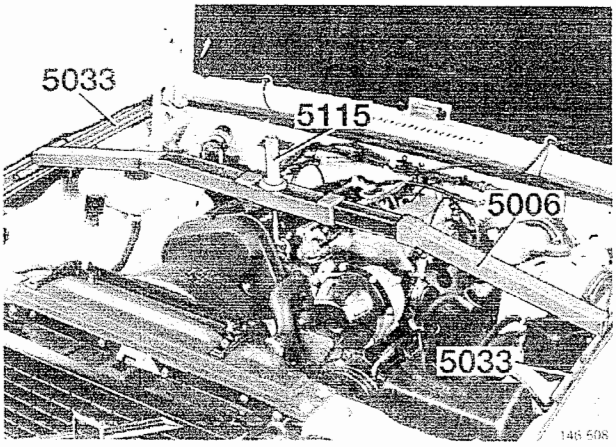
Loosen fan shroud.




*W3*

**Remove front crossmember bolts**

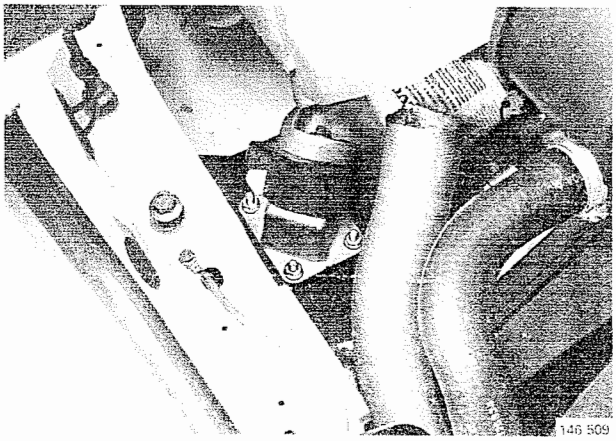
Remove bolts at both ends of crossmember.




*W4*

**Relieve weight on engine mountings by lifting at front**

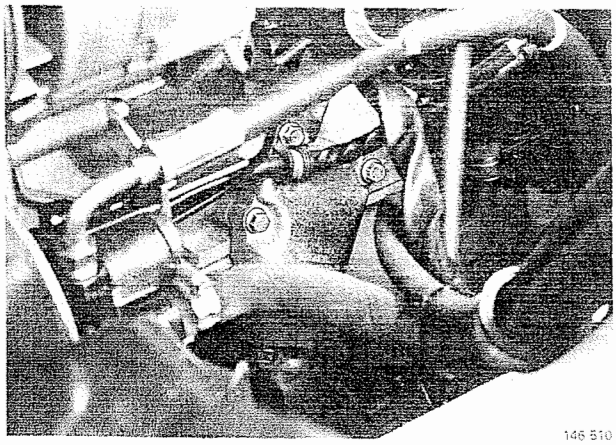
Use lifting yoke **5006**, two support bars **5033** and lifting hook **5115**.




*W5*

**Undo right-hand engine mounting**

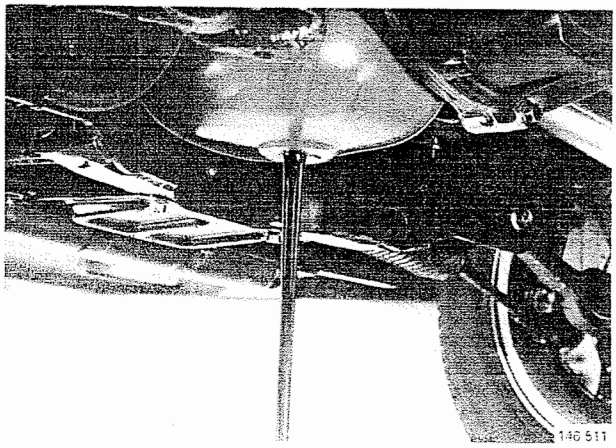
Unbolt bottom mounting plate from front crossmember.




*W6*

**Undo left-hand engine mounting**

Unbolt upper mounting plate from cylinder block.

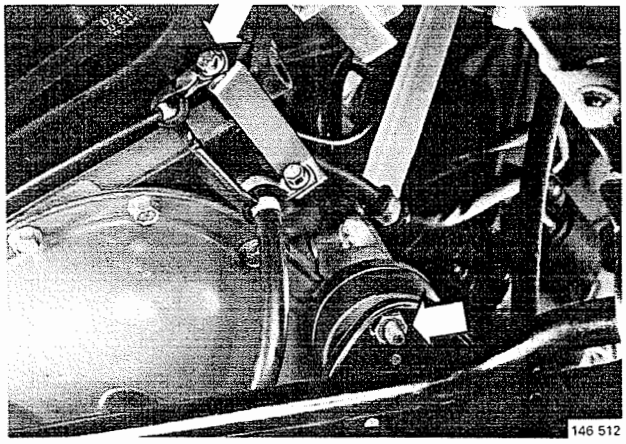



*W7*

**Drain engine oil**

Replace plug on completion of drainage, using **new** seal.

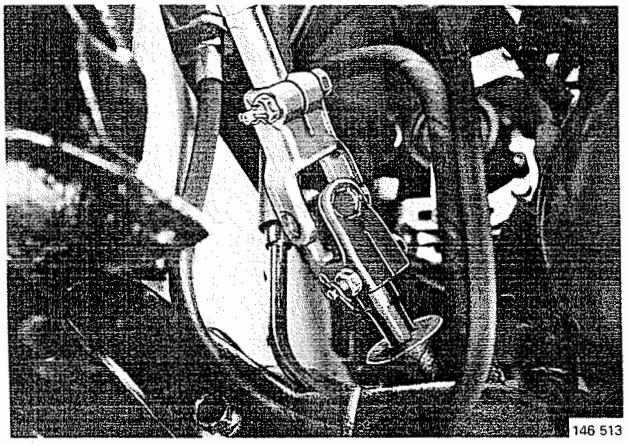
Tighten to **60 Nm** (44 ft.lb).




*W8*

**Remove:**

- splashguard under engine
- bottom nut from left-hand engine mounting
- wiring harness bracket from transmission cover



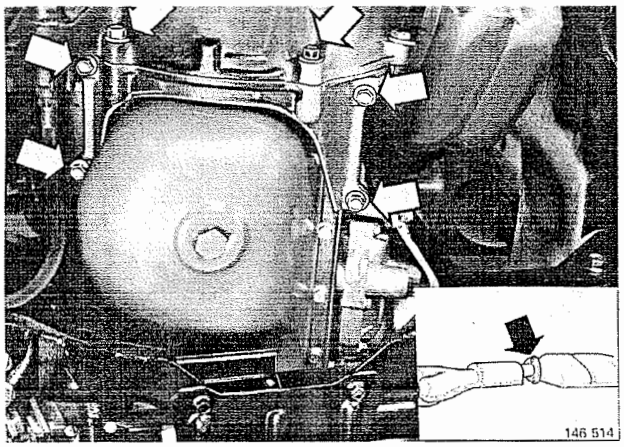

*W9*

**Separate steering shaft from steering gear**

Remove lower clamping bolt and loosen upper bolt.

Mark position of splined joint.

Slide driver up steering shaft.

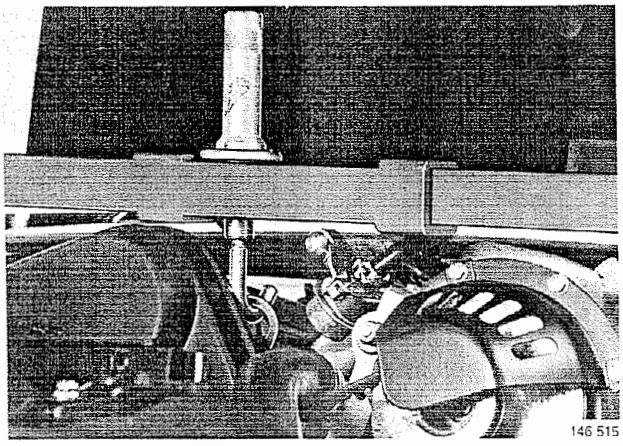



*W10*

**Remove:**

- bump stop on front crossmember
- reinforcing bracket between engine and gearbox

Undo bolted joint at front of catalytic converter.

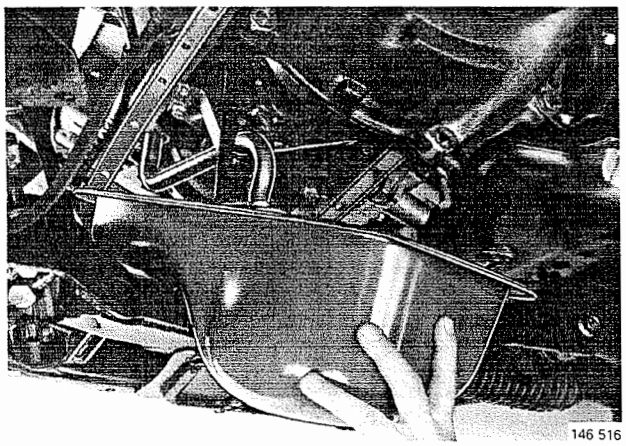



*W11*

**Raise engine**

Check **clearance** to lifting tool 5006 and bulkhead. Ensure that wiring and hoses are not **strained.**

Remove left-hand engine mounting.


146 516

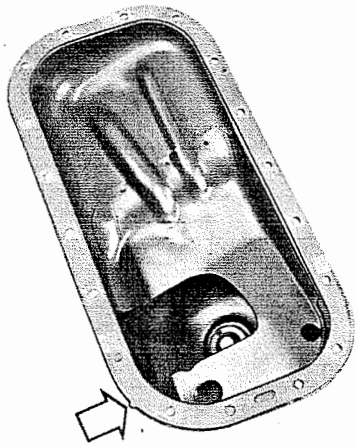
*W12*

**Remove oil sump**

Remove all sump mounting bolts.

Lift off, turn and remove sump.

Remove gasket and clean joint faces.


146 517

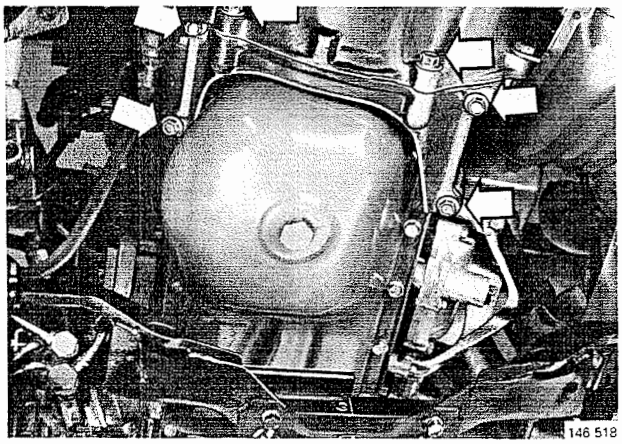
*W13*

**Install oil sump**

Fit **new** gasket.

Position gasket with tab on starter motor side. Turn and lift sump into position.

Install all fasteners: Tighten to 11 Nm (8 ft.lb).


146 518

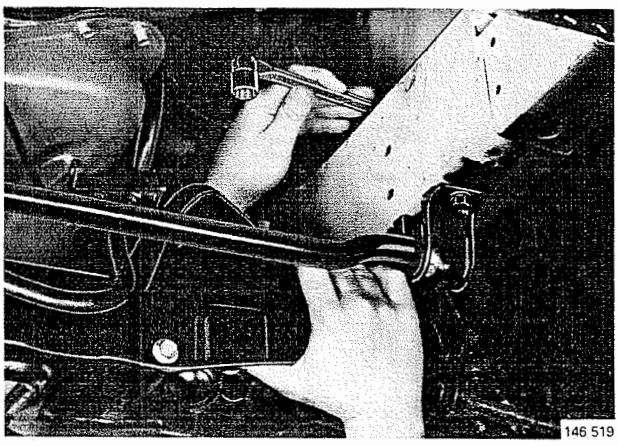
*W14*

**Install reinforcing bracket**

Tighten bracket in stages.

Attach bracket first to flywheel housing and then to cylinder block.

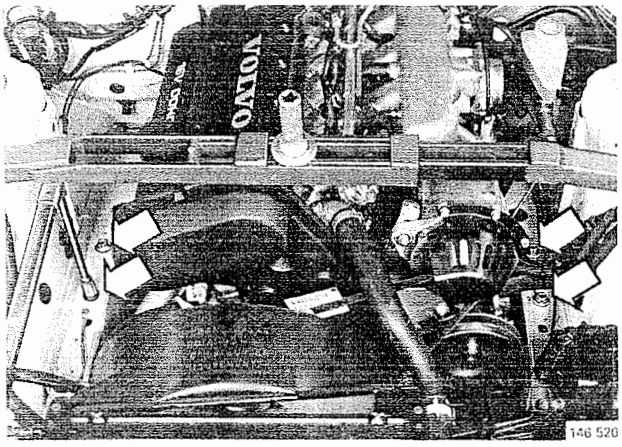
Install bump stop on front crossmember.


146 519

*W15*

**Reattach front crossmember**

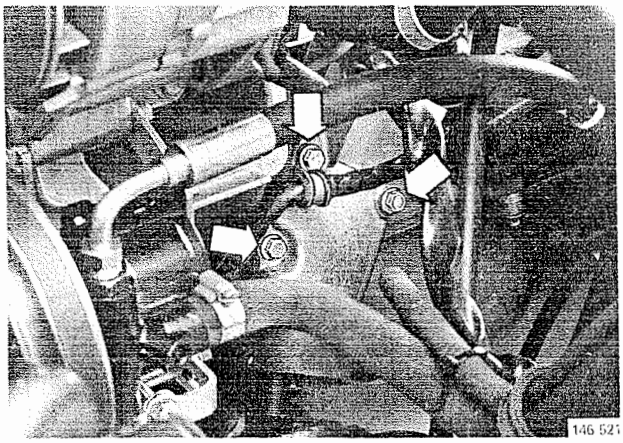
Lift member into position against side members and insert bolts (tightening a few turns).




*W16*

**Tighten front crossmember**

Tighten to **95 Nm** (70 ft.lb).

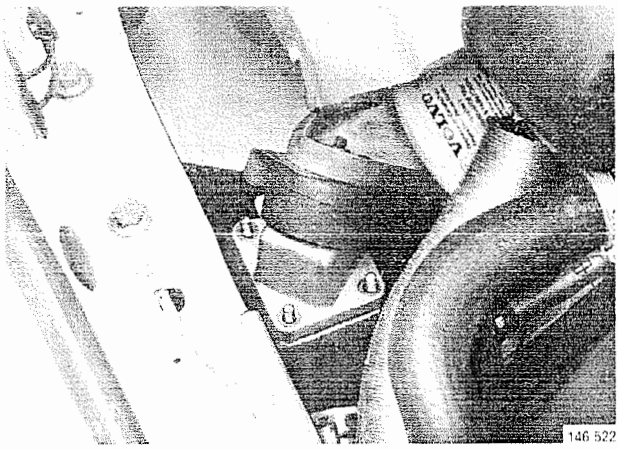



*W17*

**Install left-hand engine mounting**

Secure mounting plate to cylinder block.

**N.B.** Remember to replace cable clip on upper bolt.

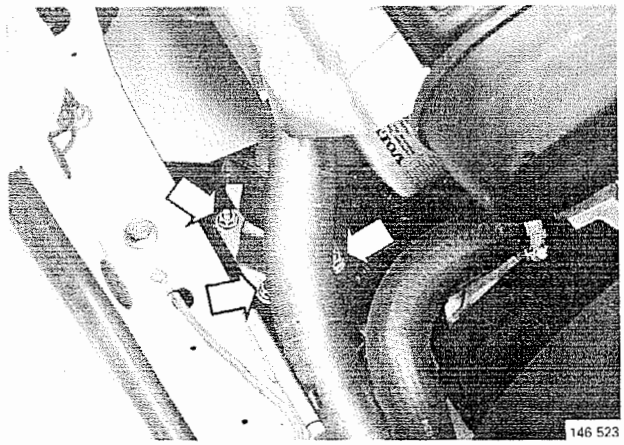



*W18*

**Lower engine into position**

Guide engine mountings into position.

Remove lifting attachments.

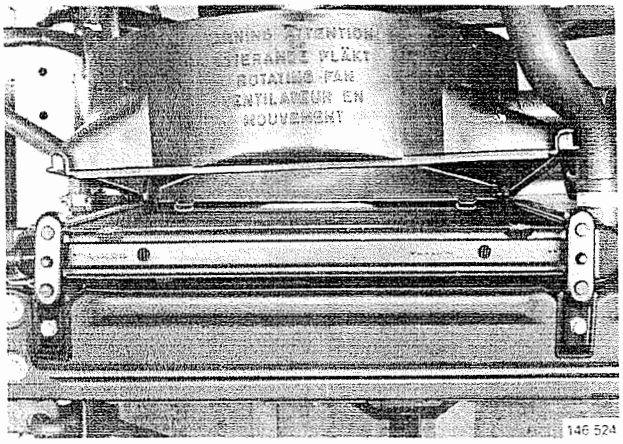



*W19*

**Tighten right-hand engine mounting**

Secure mounting plate to front crossmember.

Check connection of air preheating hose.

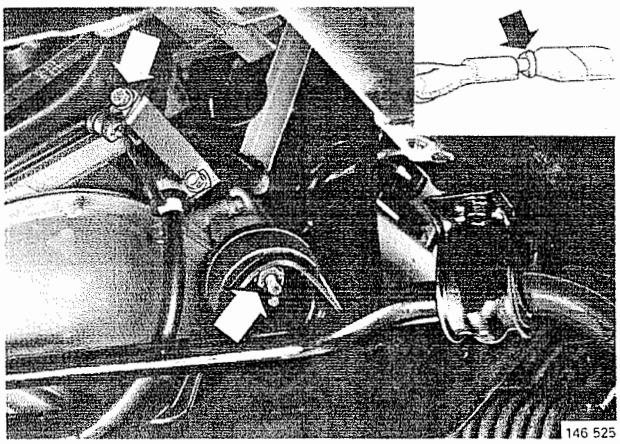


146 524

W20

**Tighten fan shroud**

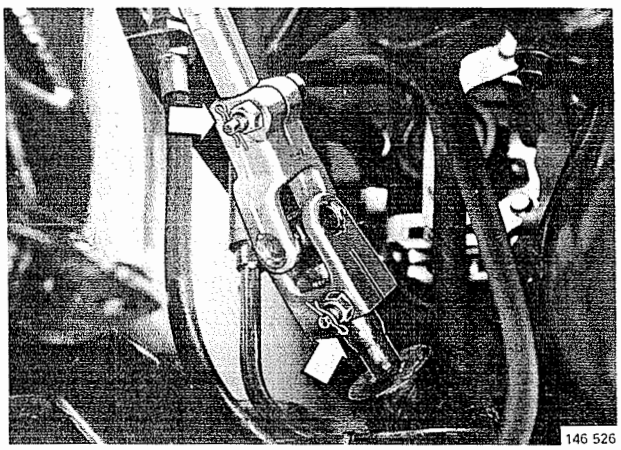
Adjust position of bottom bracket and tighten shroud to radiator.


146 525

W21

**Tighten:**

- left-hand engine mounting
- wiring harness bracket on transmission cover
- splashguard under engine
- bolted joint at front of catalytic converter


146 526

W22

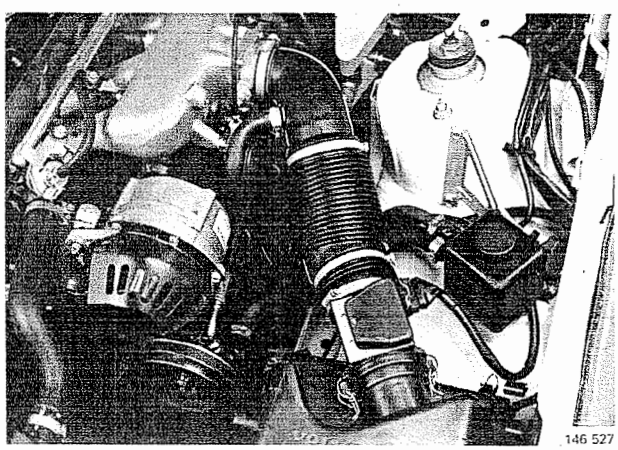
**Reassemble steering shaft and steering gear**

Assemble splined joint as indicated by markings.

Insert and tighten bottom bolt. Tighten to **21 Nm** (15.5 ft.lb).

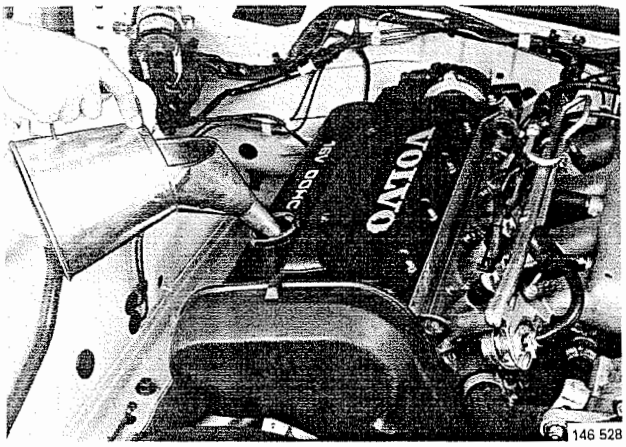
Tighten upper bolt. Tighten to **21 Nm** (15.5 ft.lb).

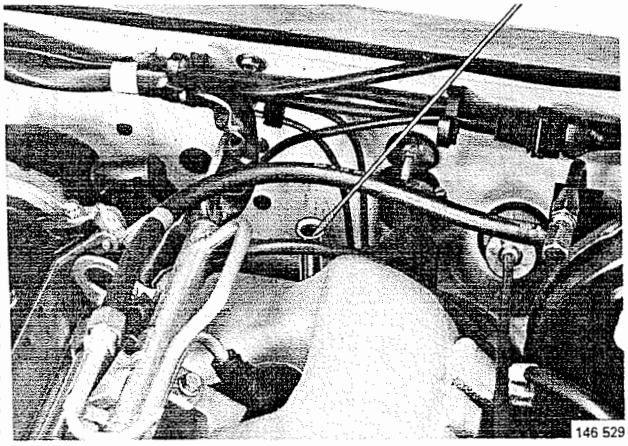
Install spring clips.


146 527

W23

**Install air mass meter with air inlet hose and connections**




*W24*

**Fill engine with oil**

Capacity excl. filter ..... **3.5 l** (3.7 US qt)
incl. filter ..... **4.0 l** (4.2 US qt)

*W25*

**Check operation**

Reconnect battery earth lead.

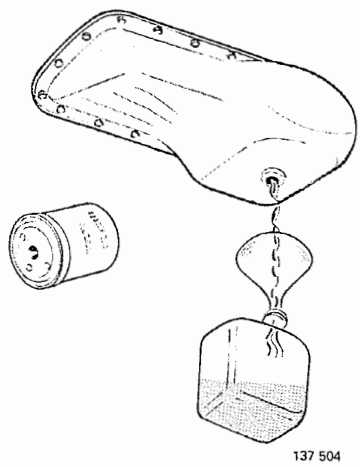
Check oil level.

Start engine.

Check operation and inspect for leaks.

# X. Crankshaft assembly, dismantling

*Special tools: 5006, 5021, 5033, 5115, 5199, 5267*


137 504

**When pistons, piston rings or bearings have been renewed due to wear:**

**It is imperative that engine be flushed clean before installing new components.**

In most cases, damage to tappets and camshafts is due to engine oil contamination.

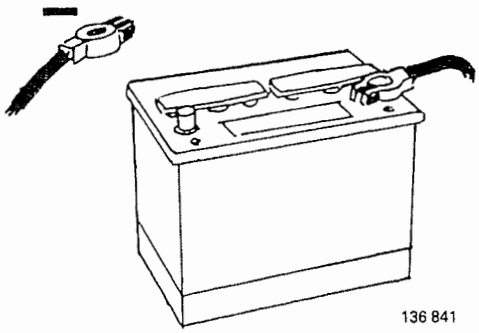
### Flush engine

Change engine oil and filter.

Run engine for approx. 10 minutes.

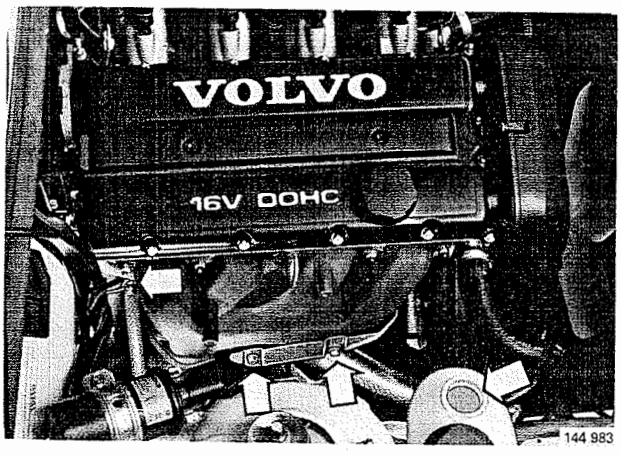
Drain oil and remove filter.

Fit new filter and fill engine with fresh oil of correct grade (on completion of procedure).


136 841

*X1*

**Disconnect battery earth lead**



144 983

*X2*

### Drain coolant

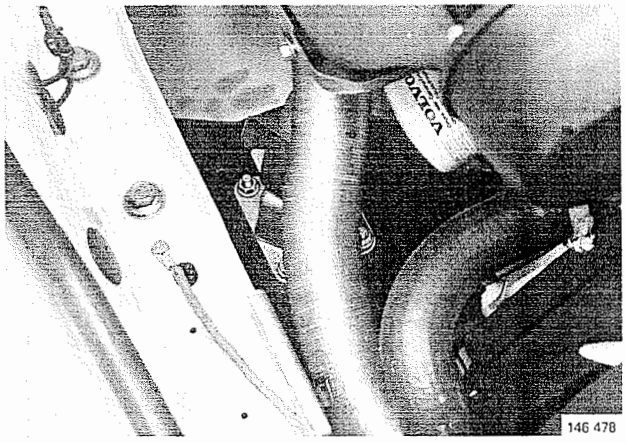
Remove heat shield over exhaust manifold.

(Only the two bottom bolts on the plate need be removed.)

Remove expansion tank cap.

Drain coolant through cock on right-hand side of cylinder block. Fit tube to cock to facilitate collection of coolant.

Remove tube and **close** drain cock on completion of drainage.

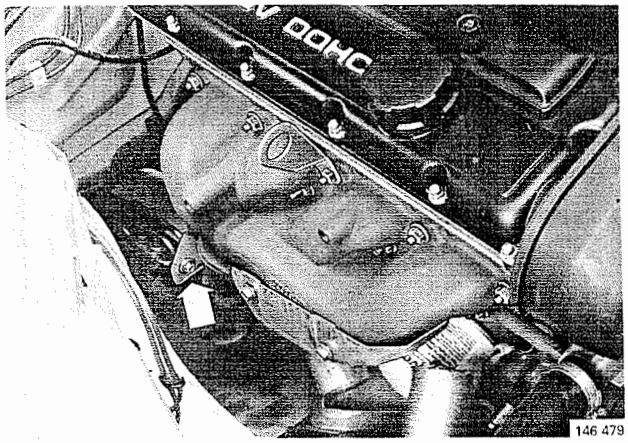



*X3*

**Undo right-hand engine mounting**

Disconnect air preheating hose from heat shield.

Unbolt bottom mounting plate at front crossmember.



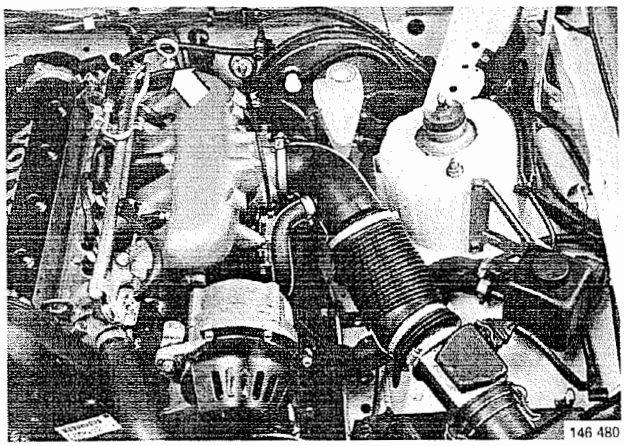

*X4*

**Strip right-hand side of cylinder head**

Unbolt exhaust pipe from bracket.

Remove nuts holding manifold.

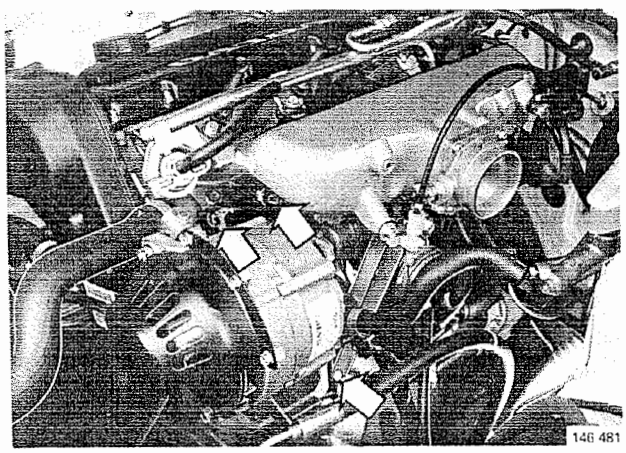
Detach manifold from cylinder block.




*X5*

**Remove:**

- air mass meter and air inlet hose
- oil dipstick




*X6*

**Strip left-hand side of cylinder head**

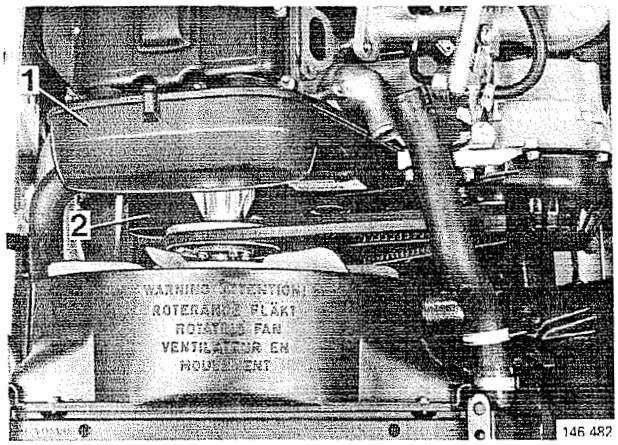
Remove support under intake manifold. Remove bottom bolt in cylinder block.

Detach and tie up manifold in suitable manner.

Disconnect temperature sensor connectors.

Disconnect heating hose under No. 3 and 4 cylinder intake branches.

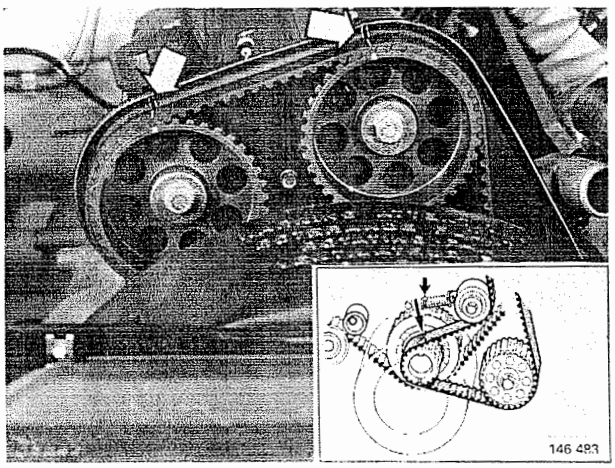
Disconnect upper coolant hose at thermostat.




*X7*

**Remove:**

- alternator drive belt
- radiator fan and pulley
- upper (1) and lower (2) transmission covers

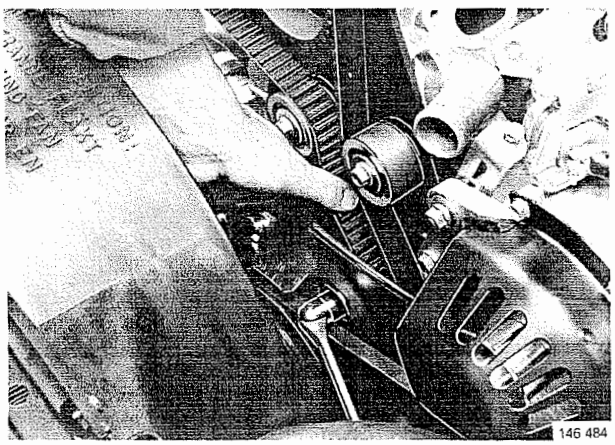



*X8*

**Align camshaft/crankshaft markings**

Turn engine to TDC position in No. 1 cylinder.

Check that markings on camshaft pulleys are aligned with those on transmission mounting plate.




*X9*

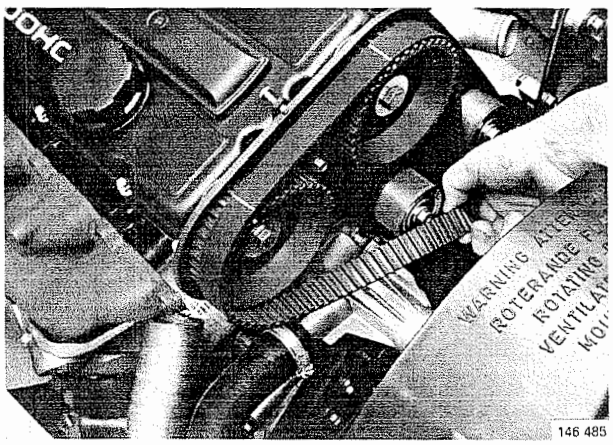
**Slacken tensioner locknut**

Remove protective rubber cap over tensioner.

Slacken locknut.

Compress tensioner spring.

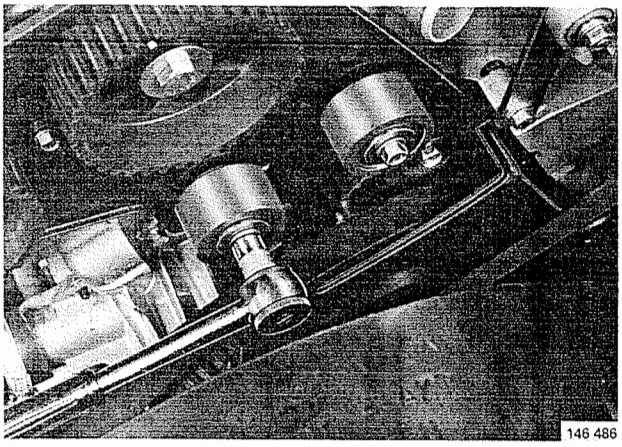
Tighten tensioner locknut.




*X10*

**Remove timing belt from crankshaft pulleys**

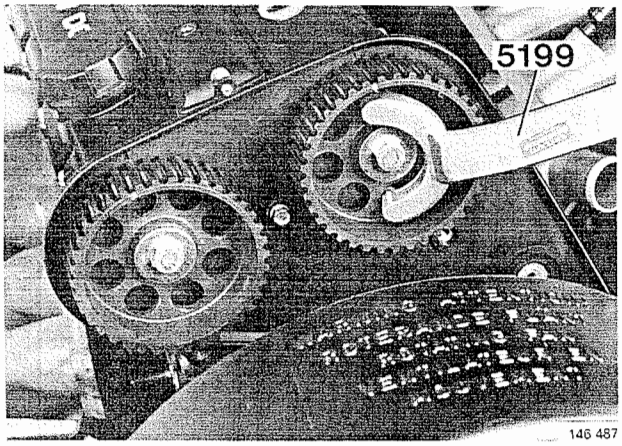
**Caution!** Crankshaft and camshafts must **not** be rotated while timing belt is slack or has been removed.




*X11*

**Remove timing belt idlers**

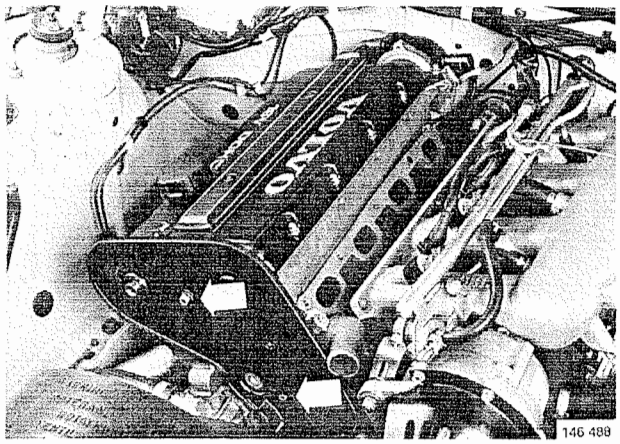
Check roller surfaces and bearings.




*X12*

**Remove camshaft pulleys**

Use counterhold **5199.**

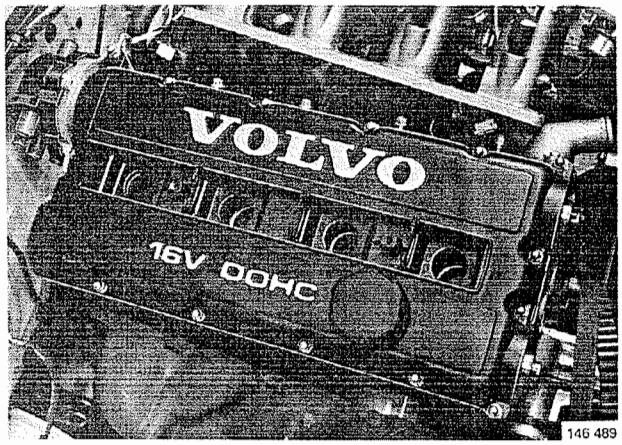



*X13*

**Remove/disconnect:**

- upper section of transmission mounting plate
- ignition lead cover plate
- ignition leads at plugs and distributor cap
- high-tension lead at distributor cap

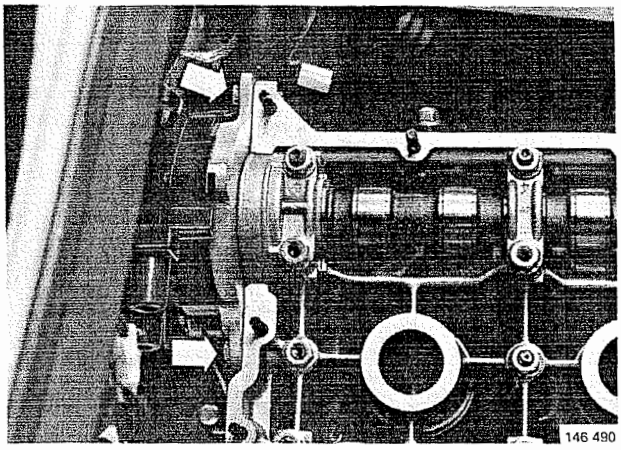
**N.B.** Always grip ignition leads by **caps** when removing to avoid damage to leads.




*X14*

**Remove valve cover and gaskets**

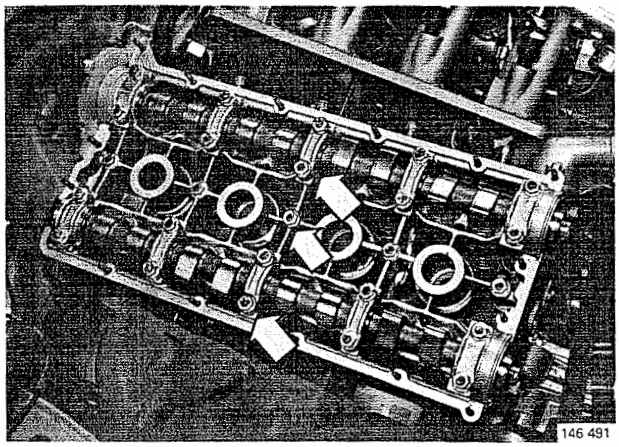
Remove remains of gaskets and clean joint faces.


146 490

*X15*

**Detach distributor housing from crankshaft carrier**

**N.B.** Remove ignition lead clip beside left-hand bolt.


146 491

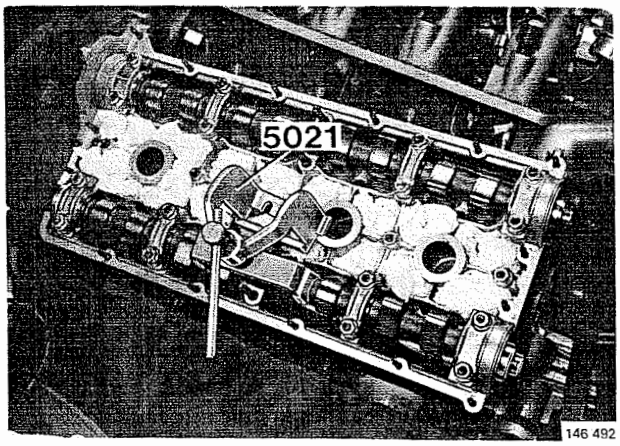
*X16*

**Remove camshaft centre bearing caps**

Plug openings in camshaft carrier (around spark plug wells) with paper.

Remove camshaft centre bearing caps (No. 3 on intake side, No. 8 on exhaust side). Mark caps as required.

Remove third nut in central bolted joint between bearing caps.



146 492

*X17*

**Remove exhaust side camshaft**

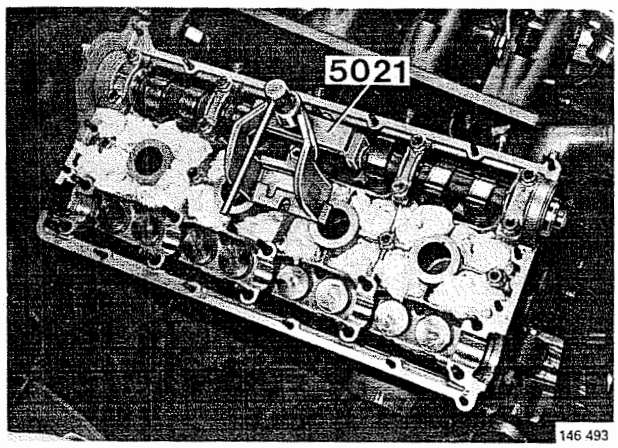
Use press tool **5021**. Place tool in No. 8 bearing cap position.

Clamp press tool on camshaft.

Remove remaining bearing cap nuts and caps (6, 7, 9 and 10).

Inspect bearing surfaces for signs of wear.

Remove press tool 5021 and lift out camshaft.



146 493

*X18*

**Remove intake side camshaft**

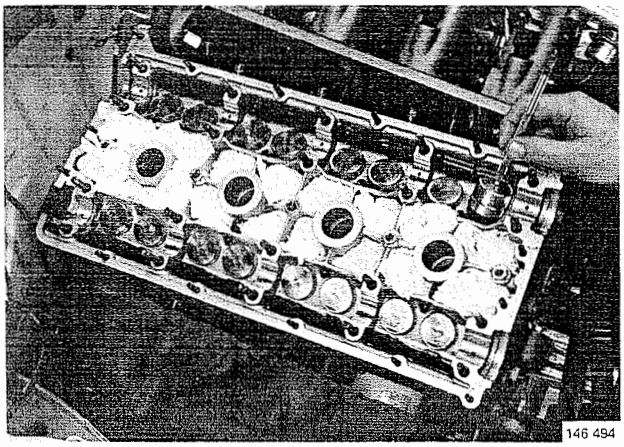
Use press tool **5021**. Place tool in No. 3 bearing cap position.

Clamp press tool on camshaft.

Remove remaining bearing cap nuts and caps (1, 2, 4 and 5).

Inspect bearing surfaces for signs of wear.

Remove press tool 5021 and lift out camshaft together with distributor.



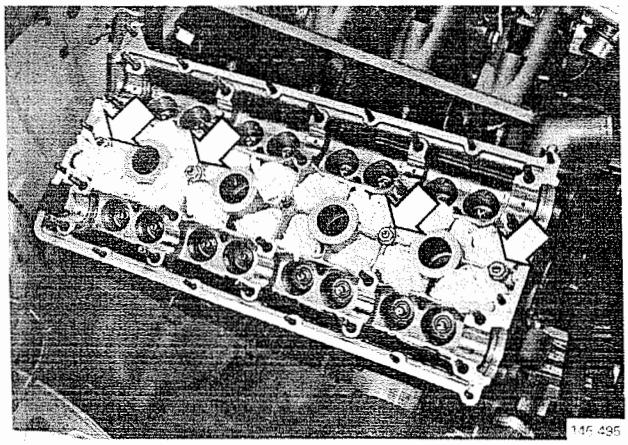

*X19*

**Remove tappets from camshaft carrier**

Magnet or suction cup may be used to facilitate tappet removal.

Inspect tappets for signs of wear.

**N.B.** Store tappets upside down to prevent drainage of oil. Ensure tappets are placed in order – they must not be interchanged.



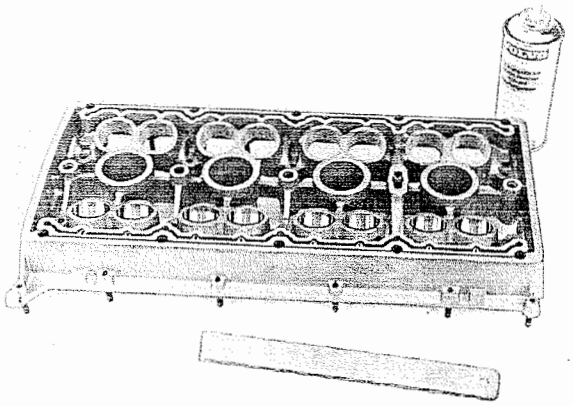

*X20*

**Separate camshaft carrier from cylinder head**

Remove four remaining nuts from central bolted joint.

Detach carrier from head. Tap carrier **carefully** with plastic mallet if component is stuck to head.

Remove O-rings around spark plug wells.

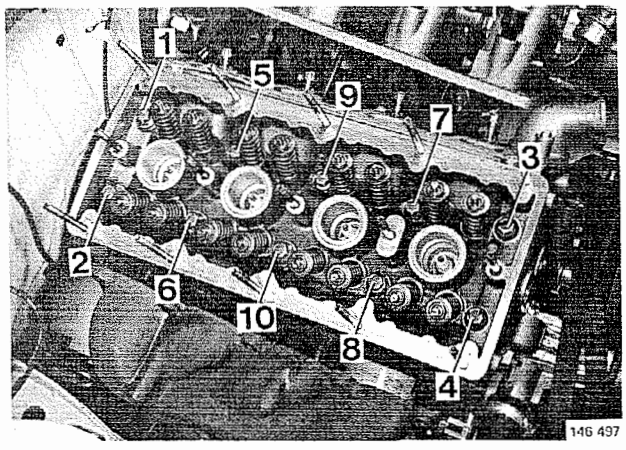



*X21*

**Clean/inspect camshaft carrier**

Clean carrier and inspect camshaft bearing and tappet bores for signs of wear or damage.

(Check axial clearance of camshafts as described in operation **K16.**)




*X22*

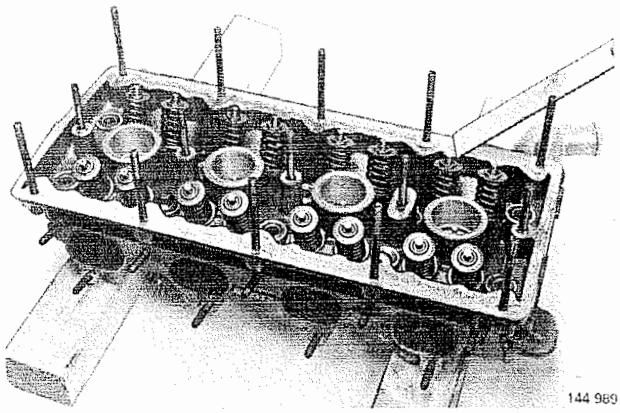
**Remove cylinder head**

Wipe remaining oil from cylinder head.

Undo bolts in order shown, commencing at rear of engine.

Remove cylinder head and gasket.

**Caution!** Cylinder head is made of aluminium. Place on pair of clean wooden blocks or similar supports to avoid scoring.

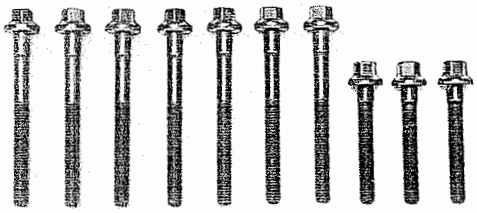

144 989

X23

**Clean and inspect all cylinder head joint faces**

See operation **M2** regarding cleaning of camshaft carrier and removal of sealing compound.

Clean and inspect cylinder block joint faces.


144 990

X24

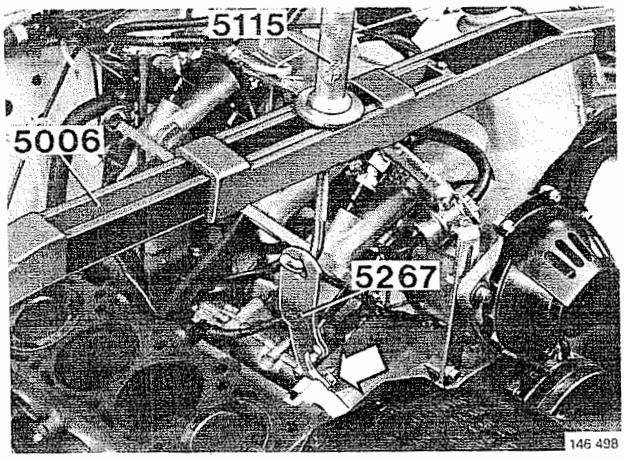
**Clean and inspect cylinder head bolts**

Bolts should be replaced if any evidence of elongation is observed.

(This will be indicated by thinning of mid-section.)

Bolts should be used no more than **5 times.**

**Replace bolts if in any doubt regarding above.**



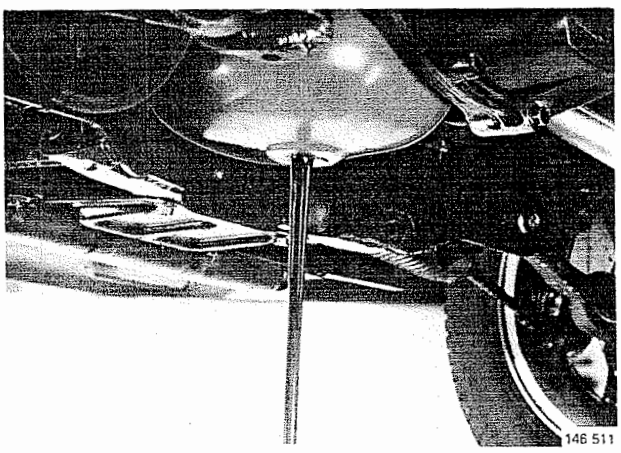
146 498

X25

**Relieve load on engine mountings**

Use lifting yoke **5006,** two support bars **5033,** lifting hook **5115** and lifting lug **5267.**

Attach lifting lug 5267 to upper mounting bolt of alternator bracket.

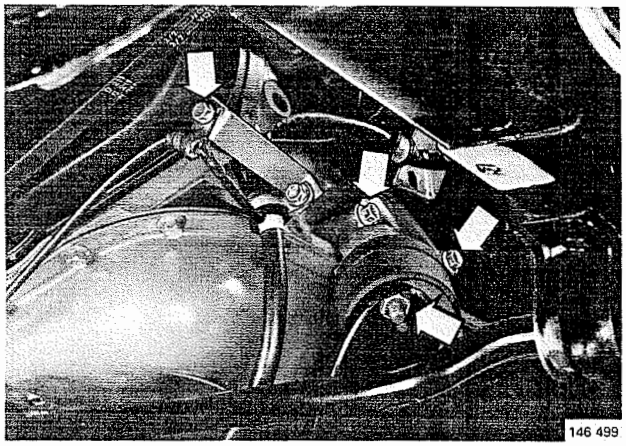

146 511

X26

**Drain engine oil**

Install plug on completion of drainage, using **new** seal.

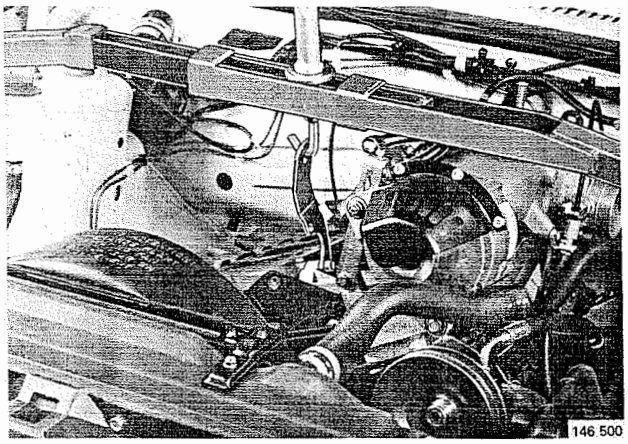
Tighten to **60 Nm** (44 ft.lb).




*X27*

**Remove:**

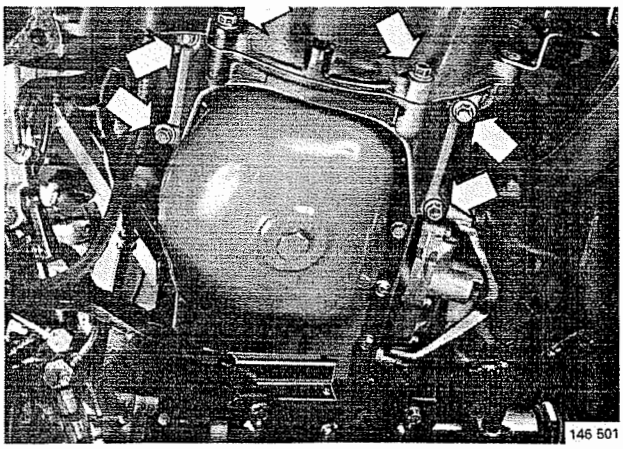
- splashguard under engine
- wiring harness bracket and cable clip on left-hand side of transmission casing
- left-hand engine mounting; remove nut under mounting and bolts attaching mounting to block




*X28*

**Raise engine**

**N.B.** Ensure that wiring and hoses are not strained. Check clearance between drive unit and other equipment.

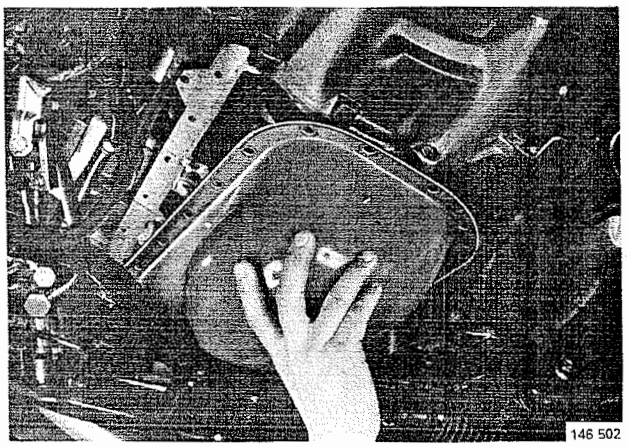



*X29*

**Remove reinforcing bracket**

Remove bracket between cylinder block and flywheel housing.

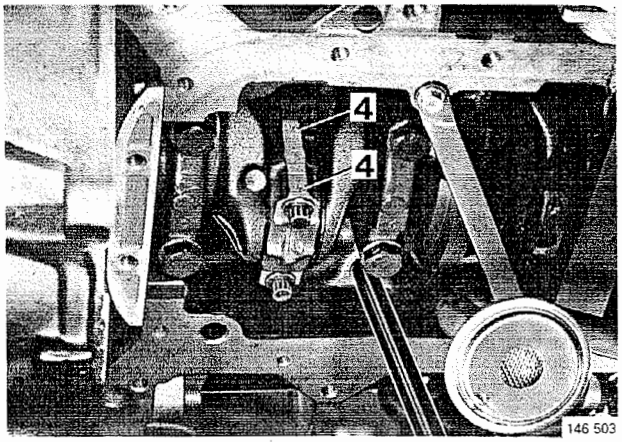
Remove bump stop on front crossmember.




*X30*

**Remove oil sump**

Lower sump and draw straight backwards.

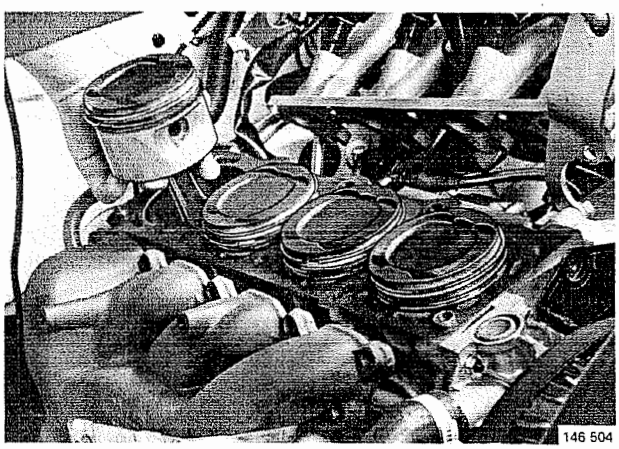



*X31*

**Remove crankshaft bearing caps**

Check markings on bearing caps and crankshaft.

Mark as required.




*X32*

**Remove pistons from cylinder block**

Polish bores to remove shoulders caused by piston reversal.

Press out pistons **carefully** from underneath (until ring friction is released).

Lift out pistons and connecting rods.

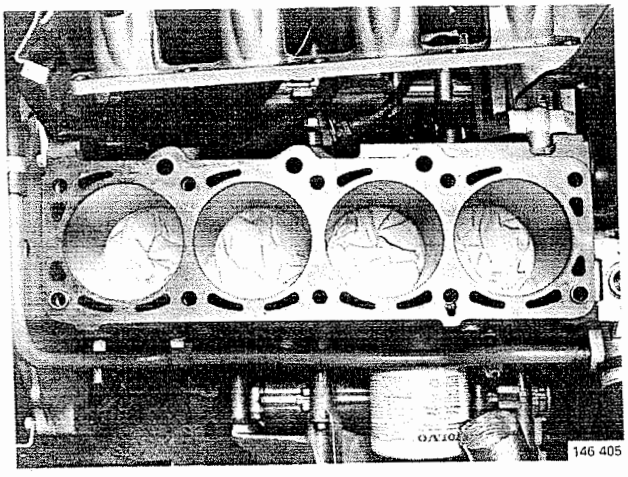
**N.B.** Press connecting rods with brass or wooden implement to **avoid damage** to bearing and contact surfaces.

# Y. Crankshaft assembly, inspection/cleaning

*Special tools: 9639, 9678, 9701, 9702, 9704, 998 6052*



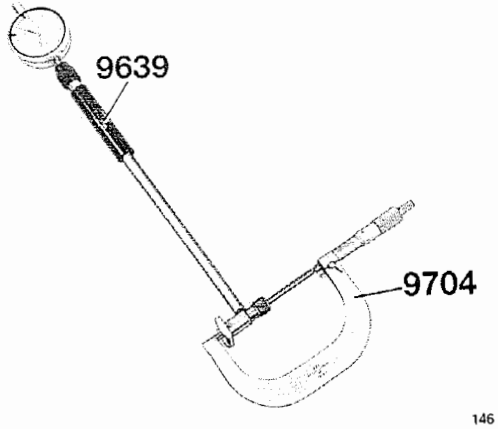
## Cylinder bores and crankshaft


146 405

*Y1*

**Wipe cylinder bores clean**

Cover crankshaft with paper to **prevent dirt** from entering oilways.



146 406

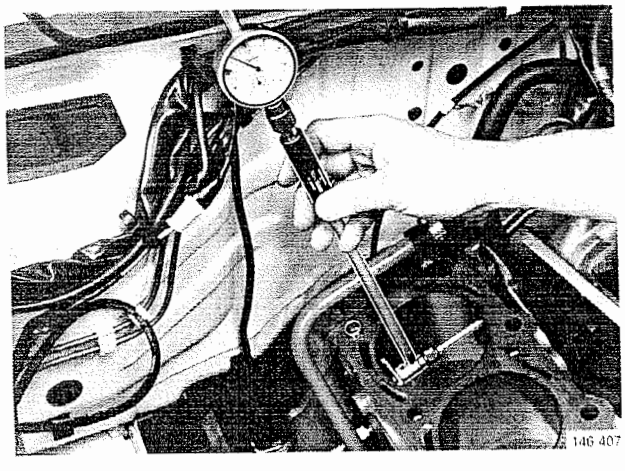
*Y2*

**Measure cylinder bores**

Use inside dial gauge **9639** (50-100 mm), micrometer **9704** (75-100 mm) and a micrometer stand.

Set micrometer to bore diameter plus **max.** tolerance as marked on cylinder block.

Calibrate dial gauge using micrometer.


146 407

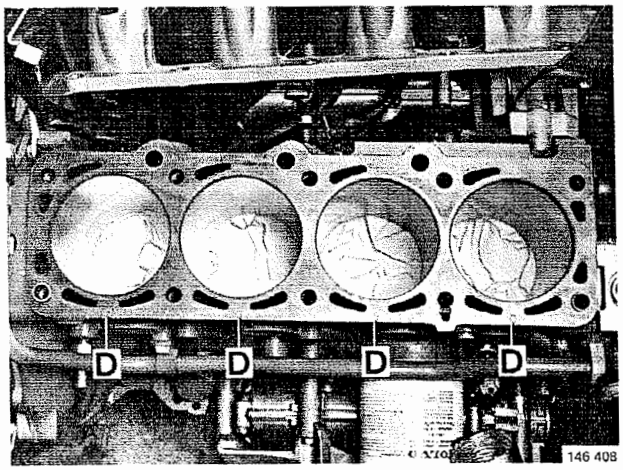
*Y3*

**Measure wear**

Check for **maximum wear** at right-angles to centre line of engine immediately below TDC.

Check for **minimum wear** in direction of centre line at BDC.

Remove engine and gearbox from car if measurements indicate that rebore is necessary. (See operations **AA1-25.**)




Y5

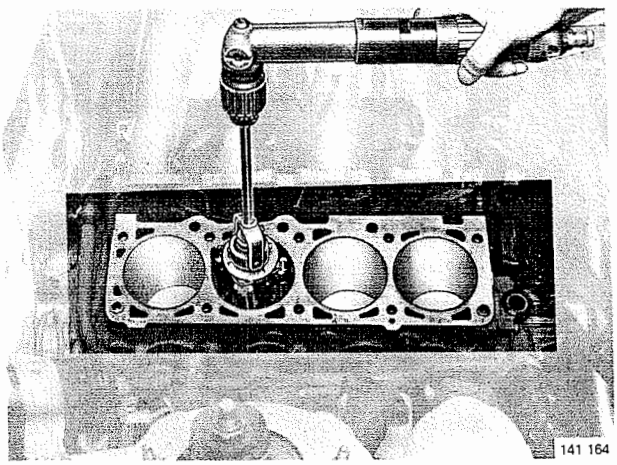
In the event of excessive piston clearance in cylinders marked C, D or E:

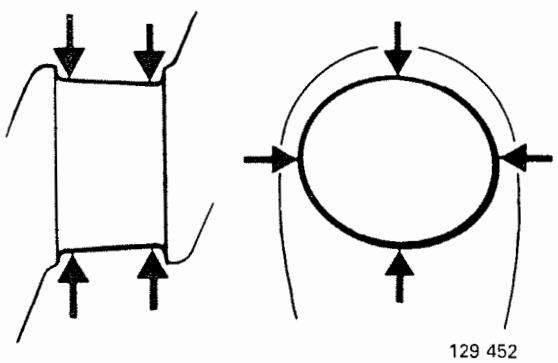
Hone bore to next largest oversize.

Use honing tool **9678.**

**Clean bore thoroughly after honing.**

**N.B.** Turn crankshaft to ensure that honing tool is clear of crank throws.




Y4

### Classification

Each cylinder is identified by a classification marking (C, D, E or G) punched in the block.

Oversized bores may be designated OS1 or OS2 as appropriate. This designation must be added after reboring.

### Cylinder bore diameters

| Standard | B 204 | B 234 |
|---|---|---|
| Bore marked C . | **88.90 mm** $^{+0.01}_{0}$ | **96.00 mm** $^{+0.01}_{0}$ |
| | (3.5000 in $^{+0.0004}_{0}$) | (3.7795 in $^{+0.0004}_{0}$) |
| Bore marked D . | **88.91 mm** $^{+0.01}_{0}$ | **96.01 mm** $^{+0.01}_{0}$ |
| | (3.5004 in $^{+0.0004}_{0}$) | (3.7799 in $^{+0.0004}_{0}$) |
| Bore marked E.. | **88.92 mm** $^{+0.01}_{0}$ | **96.02 mm** $^{+0.01}_{0}$ |
| | (3.5008 in $^{+0.0004}_{0}$) | (3.7803 in $^{+0.0004}_{0}$) |
| Bore marked G . | **88.94 mm** $^{+0.01}_{0}$ | **96.04 mm** $^{+0.01}_{0}$ |
| | (3.5016 in $^{+0.0004}_{0}$) | (3.7811 in $^{+0.0004}_{0}$) |

### Oversize

| | | |
|---|---|---|
| Oversize 1..... | **89.29 mm** (3.5154 in) | **96.30 mm** (3.7913 in) |
| Oversize 2..... | **89.67 mm** (3.5303 in) | **96.60 mm** (3.8031 in) |

Reboring should be carried out when wear reaches 0.01 mm (0.0039 in).

Y6

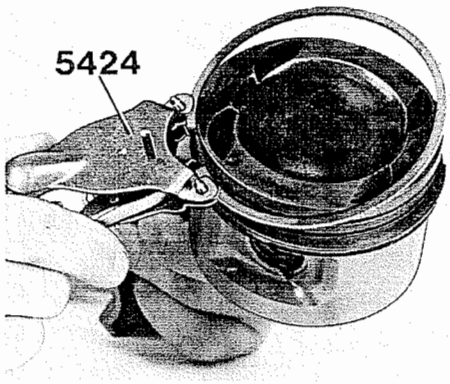
### Measure crankshaft

Use micrometer **9701.**Measure out-of-round and taper of crank pins. Use micrometer and measure at several points around circumference and along length.

### Crank pins

| | | |
|---|---|---|
| Max. out-of-round..... | **0.01 mm** (0.0003 in) | |
| Max. taper..... | **0.01 mm** (0.0003 in) | |
| Diameter, standaard ..... | **49.00 mm** | $^{+0.005}_{-0.016}$ |
| | (1.9646 in | $^{+0.0002}_{-0.0006}$) |
| undersize 1..... | **48.75 mm** | $^{+0.005}_{-0.016}$ |
| | (1.9193 in | $^{+0.0002}_{-0.0006}$) |
| undersize 2..... | **45.50 mm** | $^{+0.005}_{-0.016}$ |
| | (1.7913 in | $^{-0.0002}_{-0.0006}$) |
| Bearing seat width ..... | **25,00±1.1 mm** (0.9834±0.0433 in) | |

## Pistons and connecting rods



146 409

*Y7*

### Clean and inspect pistons

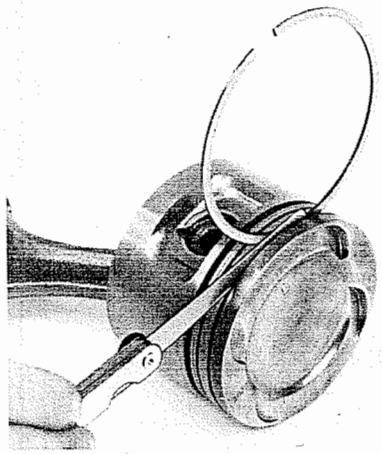
Use piston ring pliers **998 5424.**

Remove piston rings.

Remove all carbon deposits. Clean piston ring grooves by scraping with a special scraping tool or part of an old ring ground to suit.

Inspect pistons for:

- damage
- wear
- cracking


146 410

*Y8*

### Check piston ring side play

Use **new** rings.

#### Upper compression ring

B 204..... **0.040–0.072 mm** (0.0016–0.0028 in)
B 234 ..... **0.060–0.092 mm** (0.0024–0.0036 in)

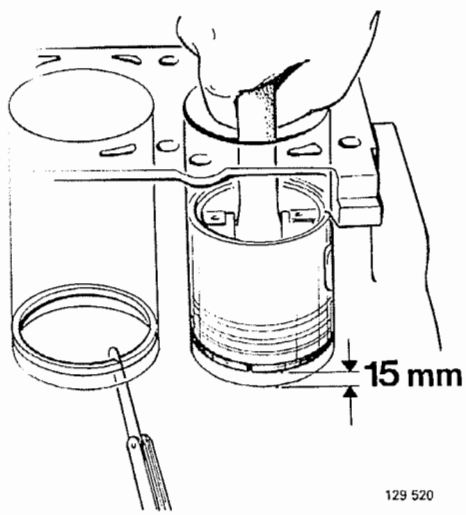
#### Lower compression ring

B 204 ..... **0.030–0.062 mm** (0.0012–0.0024 in)
B 234 ..... **0.040–0.072 mm** (0.0016–0.0028 in)

#### Oil scraper ring

B 204 ..... **0.020–0.055 mm** (0.0008–0.0022 in)
B 234 ..... **0.030-0.065 mm** (0.0012-0.0026 in)

| Replace piston if play is excessive. |
|---|



129 520

*Y9*

### Measure piston ring gap

Use feeler gauges.

Place ring in cylinder bore and use inverted piston to locate it in correct position for measurement.

Piston ring gap is measured with crown of inverted piston **15 mm**(0.6 in) from bottom of cylinder.

#### Upper and lower compression rings

B 204..... **0.30-0.50 mm** (0.012-0.020 in)
B 234..... **0.30-0.55 mm** (0.012-0.022 in)

#### Oil scraper ring

B 204..... **0.25-0.50 mm** (0.010-0.020 in)
B 234..... **0.30-0.60 mm** (0.012-0.024 in)

Y10

### Measure piston diameter

Use micrometer **9704** and feeler gauges.

A = Total height of piston
B = Height from gudgeon pin centre to crown
C = Piston diameter to be measured at right-angles to gudgeon pin hole, at distance C from edge of skirt

D = Piston diameter

| Enginetype | Dimensions, mm (in) | | |
|---|---|---|---|
| | A | B | C |
| B 204 | 67.1 (2.64) | 39.1 (1.54) | 13.4 (0.53) |
| B 234 | 68.7 (2.70) | 39.9 (1.57) | 11.0 (0.43) |

Piston diameter (D)

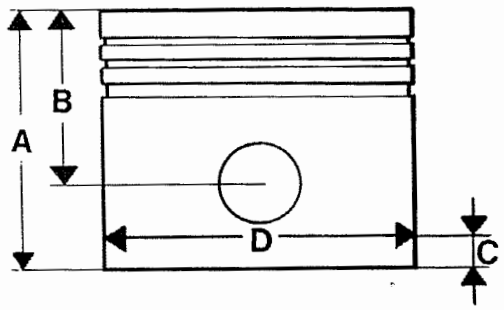
| **Standard** | **B 204** | **B 234** |
|---|---|---|
| Pistons marked C* ..... | **88.88 mm** $^{+0.01}_{0}$ | **95.98 mm** $^{+0.01}_{0}$ |
| | (3.4992 in $^{+0.0004}_{0}$) | (3.7787 in $^{+0.0004}_{0}$) |
| Pistons marked D ..... | **88.89 mm** $^{+0.01}_{0}$ | **95.99 mm** $^{+0.01}_{0}$ |
| | (3.4996 in $^{+0.0004}_{0}$) | (3.7791 in $^{+0.0004}_{0}$) |
| Pistons marked E*..... | **88.90 mm** $^{+0.01}_{0}$ | **96.00 mm** $^{+0.01}_{0}$ |
| | (3.5000 in $^{+0.0004}_{0}$) | (3.7795 in $^{+0.0004}_{0}$) |
| Pistons marked G* ..... | **88.91 mm** $^{+0.01}_{0}$ | **96.02 mm** $^{+0.01}_{0}$ |
| | (3.5004 in $^{+0.0004}_{0}$) | (3.7803 in $^{+0.0004}_{0}$) |

* Production only (non-stocked)

**Oversize**

| | | |
|---|---|---|
| Oversize 1..... | **89.27 mm** $^{+0.01}_{0}$ | **96.28 mm** $^{+0.01}_{0}$ |
| | (3.5146 in $^{+0.0004}_{0}$) | (3.7906 in $^{+0.0004}_{0}$) |
| Oversize 2..... | **89.65 mm** $^{+0.01}_{0}$ | **96.58 mm** $^{+0.01}_{0}$ |
| | (3.5295 in $^{+0.0004}_{0}$) | (3.8024 in $^{+0.0004}_{0}$) |

Max. difference in weight between pistons in same engine..... **14 g** (0.5 oz)

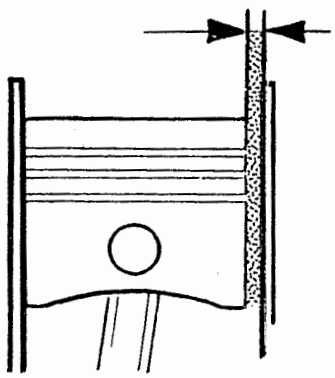



137 551 *Y12*

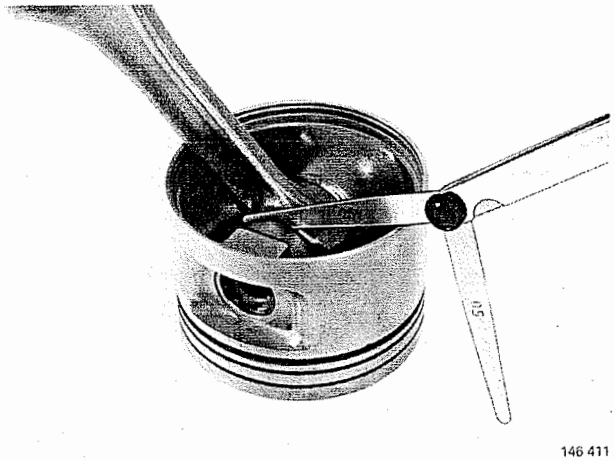
### Check con rod/piston side clearance

Use feeler gauges.

Specified con rod/piston axial clearance for B 234, B 204 ..... **0.15-0.45 mm** (0.0059-0.0177 in)



131 370

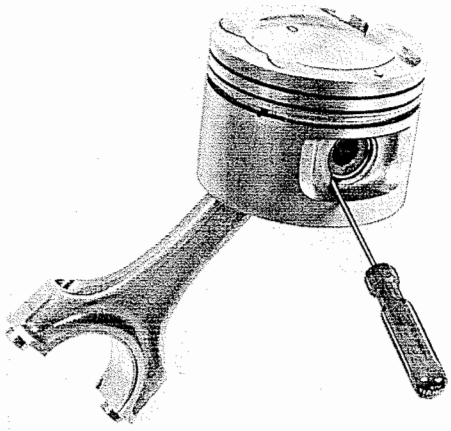


146 411

*Y11*

### Calculate piston clearance

| Example: | Min. | Max. |
|---|---|---|
| Cylinder bore, measured diameter .... | 96.02 mm (3.7803 in) | 96.03 mm (3.7807 in) |
| Less piston diameter as measured..... | –96.01 mm (3.7799 in) | –96.00 mm (3.7795 in) |
| Piston clearance ..... | 0.010 mm (0.0004 in) | 0.030 mm (0.0012 in) |
| Specified piston clearance for B 234, B 204..... | 0.010 mm (0.0004 in) | 0.030 mm (0.0012 in) |



146 412

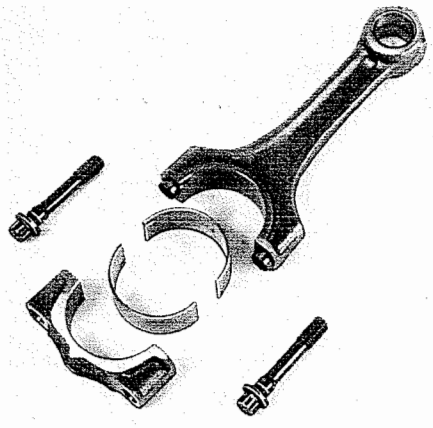
*Y13*

### Separate con rods and pistons

Before separating, check that each piston and con rod is marked. Mark as required.

**Carefully** prise out locking circlip with a screwdriver.

Press out gudgeon pin by hand.



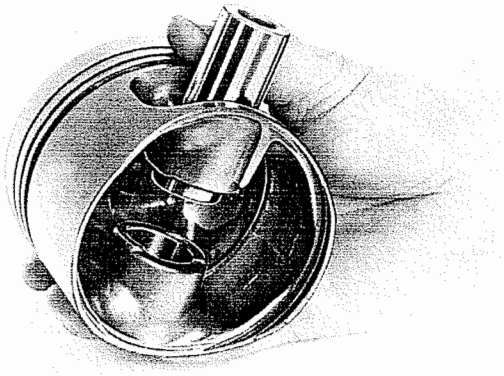
146 413

*Y14*

### Clean and inspect con rods, bearing caps and bolts

Check for:

- damage
- wear
- cracks



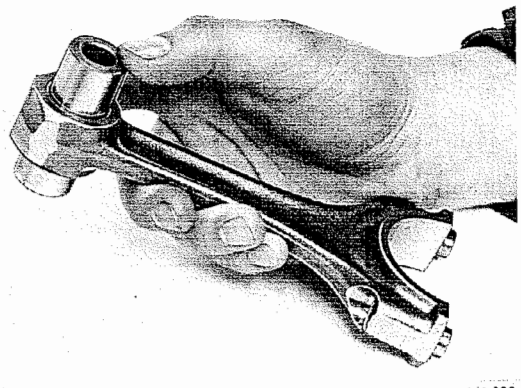
141 327

*Y15*

### Check fit of gudgeon pins in pistons

No play is permissible. Gudgeon pin should slide through hole without play when pressed gently with thumb.

| Replace piston if play is present. |
|---|



141 326

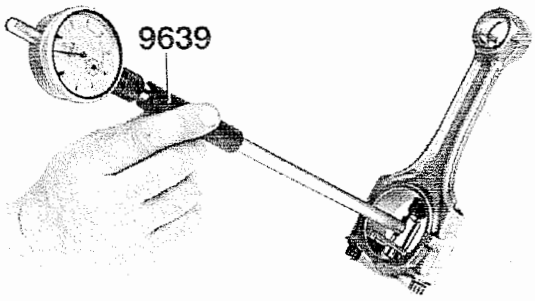
*Y16*

### Check fit of gudgeon pins in con rods

Gudgeon pin should slide through hole without noticeable play when pressed gently with thumb.

If play is excessive, measure gudgeon pin and fit new con rod bushing, if necessary. Use micrometer **9701**.

Specified gudgeon pin diameter for
B 204, B 234.... **23.00 mm** $^{0}_{-0.006}$ (0.9055 in $^{0}_{-0.0002}$)



146 414

*Y17*

### Check big end bearing seats

Inspect bearing shells visually.

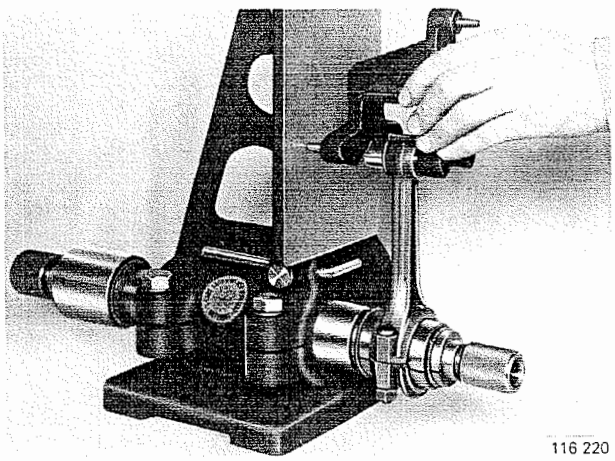
If in doubt, measure out-of-round.

Use inside micrometer **9639.**

**Tighten bearing cap on con rod as indicated by markings.**

Bearing seat diameter ..... **52.00 mm** $^{+0.01}_{0}$ (2.9472 in $^{+0.0004}_{0)}$

Max. permissible out-of-round.... **0.03 mm** (0.0012 in)


116 220

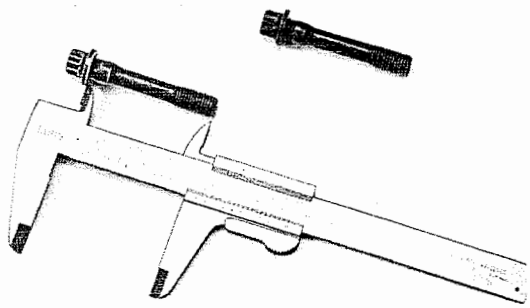
*Y18*

### Check con rod in alignment gauge

Check for straightness and twisting.

**Important!** Ensure that clamping surface of fork is round and free of burrs.

Release and tighten expander at big end between each alignment check.


146 415

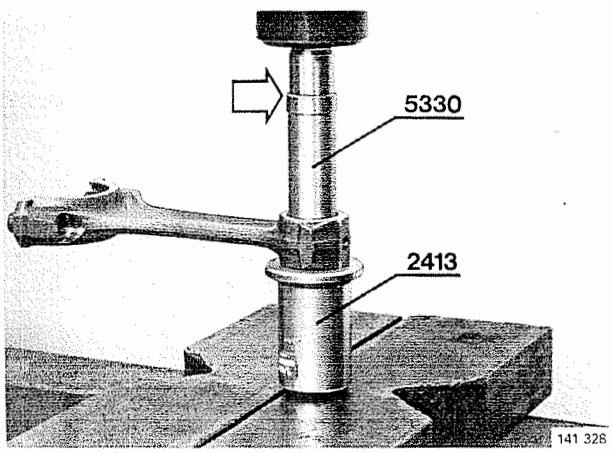
*Y19*

### Check length of con rod bearing bolts

Use sliding callipers.

Max. length ..... **55 mm** (2.1654 in)

## Con rod bushing replacement



141 328

*Y20*

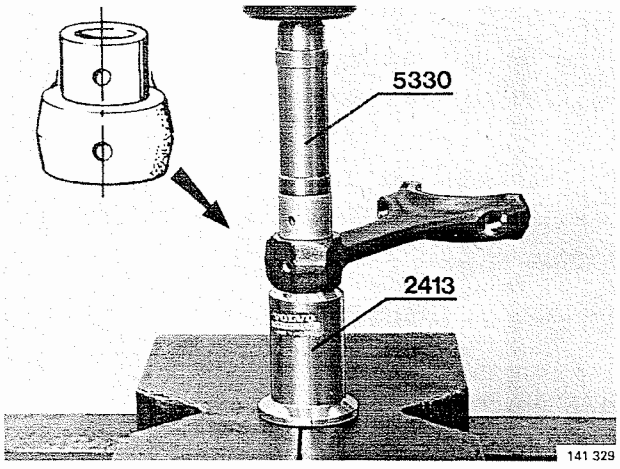
### Replacing con rod bushing

### Press out bushing

Use drift **5309.**

Position drift correctly with short end downwards.

Use **2413** as counterhold.




*Y21*

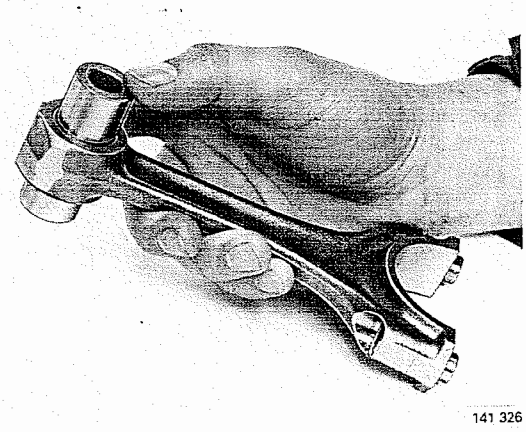
**Press in new bushing**

Use drift **5309**.

Position drift correctly with long end downwards.

Press drift down fully.

**Important!** Ensure that hole in bushing is aligned with oil-way in con rod.




*Y22*

**Check fit of gudgeon pin in new bushing**

Gudgeon pin should slide through hole without noticeable play when pressed gently with thumb.

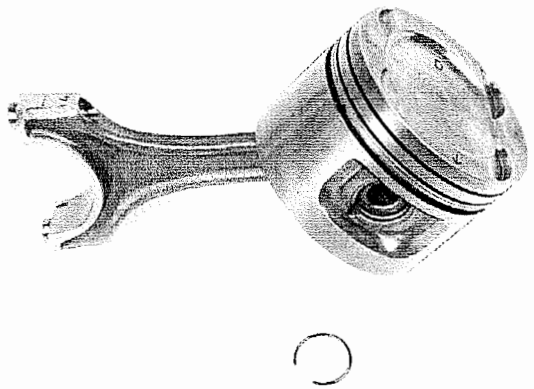
Adjust bushing as required.

# Z. Crankshaft assembly, reassembly

*Special tools: 5006, 5021, 5025, 5033, 5098, 5115, 5199, 5267, 115 8221, 998 5424, 998 8500*



## Pistons, con rods



146 416

*Z1*

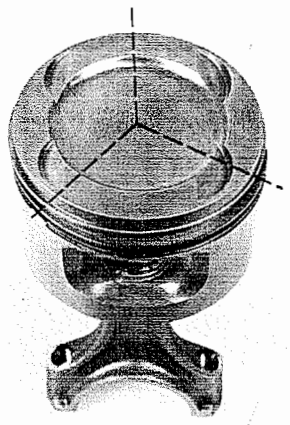
### Assemble piston and con rod

Arrow on piston crown must point towards front of engine.

Numerical designation on con rod must face towards right-hand side of block (oil filter side).

Ensure that con rods and pistons are assembled in matched pairs.

**N.B.** Fit gudgeon pin circlip, ensuring that circlip is fully seated in groove.



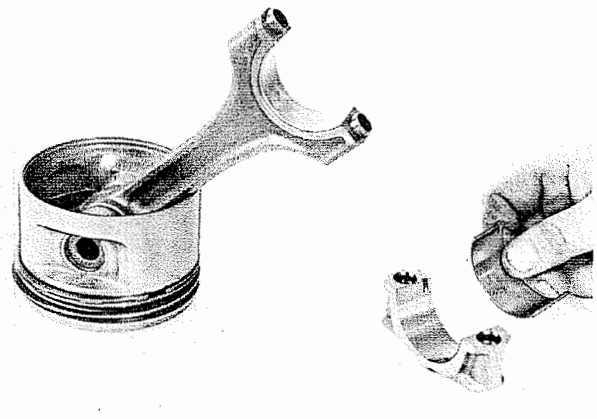
146 417

*Z2*

### Install piston rings

Use piston ring pliers **998 5424**.

Turn rings so that gaps are positioned approx. 120° apart.



146 418

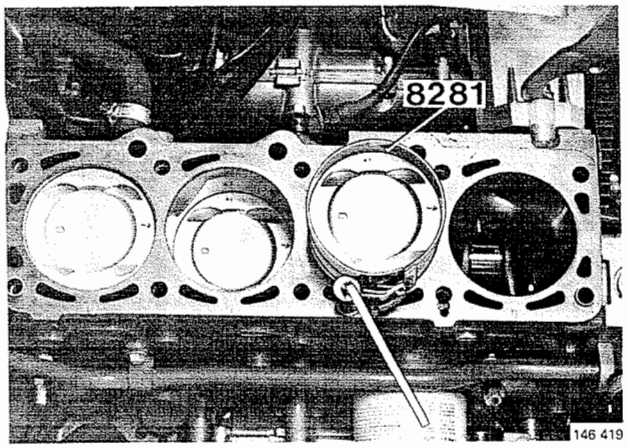
*Z3*

### Place bearing shells in con rod big end and bearing cap

Wipe bearing seats clean.

Place shells in position in con rod and bearing cap.

Oil cylinder bore, piston and bearing shells.




Z4

### Fit piston in bore

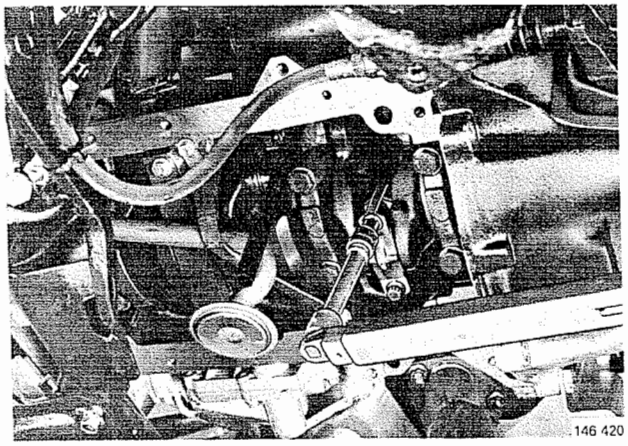
Use piston ring compressor **115 8281**.

When fitting piston, turn crankshaft so that corresponding crankshaft throw is pointing straight downwards.

Insert piston in bore.

Push down piston (using implement such as hammer handle).

**N.B.** Arrow on piston crown **must** point towards front.




Z5

### Install bearing cap

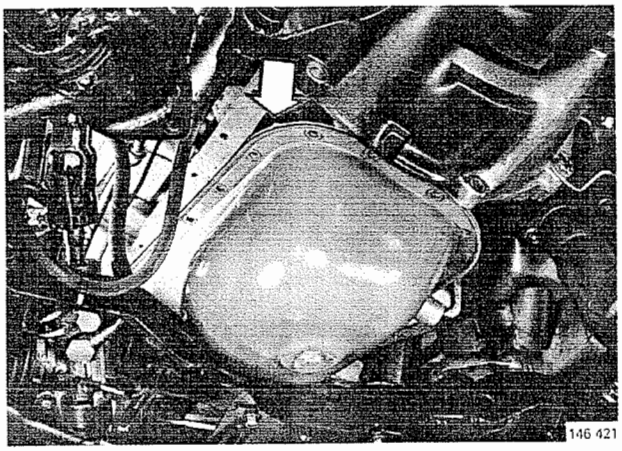
Ensure that bearing shell remains in position.

Check markings. Markings on con rod must agree with those on bearing cap.

Oil bolts.

Tighten bolts in two stages:

1. **20 Nm** (15 ft.lb)
2. Tighten through further **90°**




Z6

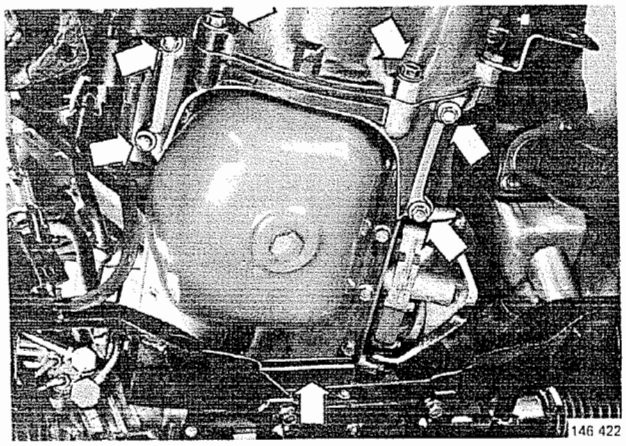
### Install oil sump

Clean inside of sump as required.

Use **new** sump gasket. Ensure that tab on gasket is pointing towards engine mounting.

Tighten sump in position.

Tighten bolts to 11 Nm (8 ft.lb).



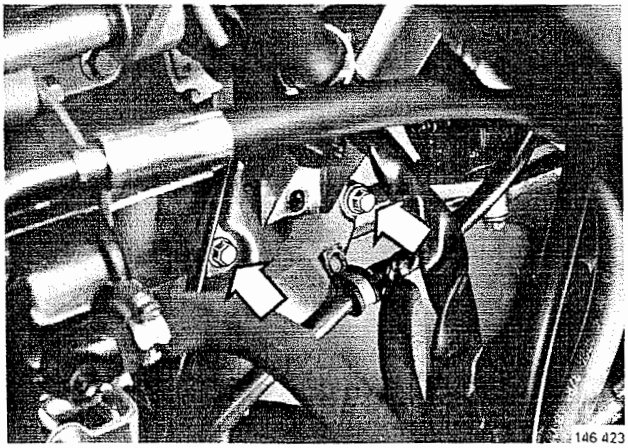

Z7

### Install reinforcing bracket

Tighten bracket in stages.

Secure bracket first to flywheel housing and then to cylinder block.

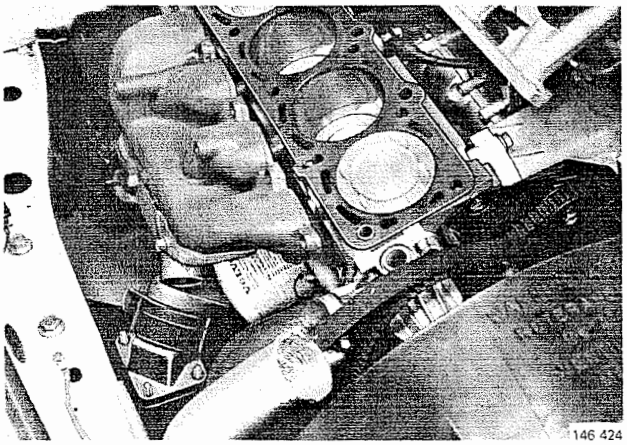
Install bump stop on front crossmember.


146 423

Z8

**Install left-hand engine mounting**

Tighten **two** lower bolts in cylinder block.

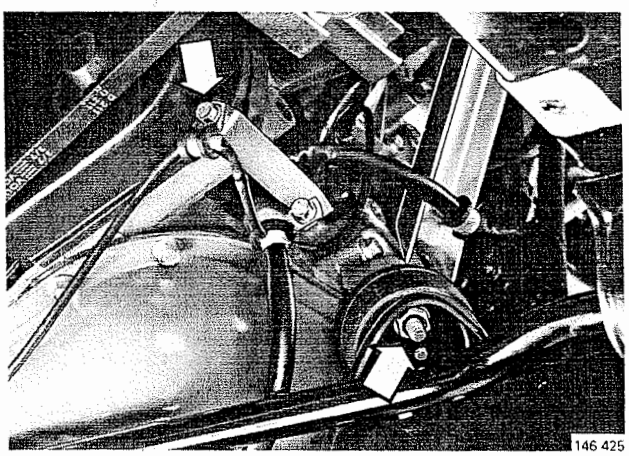

146 424

Z9

**Lower engine**

Guide engine mountings into position.

Remove lifting gear (5006, 2 × 5033, 5115, 5267).

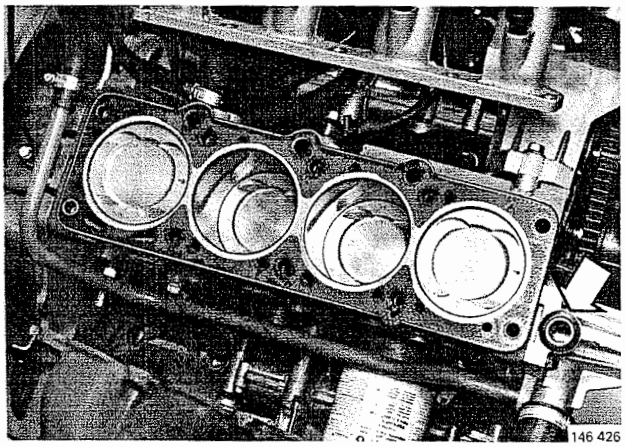

146 425

Z10

**Tighten left-hand engine mounting**

Install bottom nut.

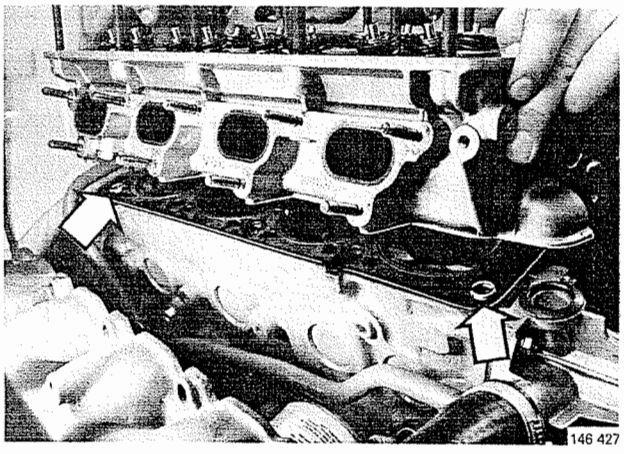
Reattach wiring harness bracket and cable clip on transmission casing.


146 426

Z11

**Install:**

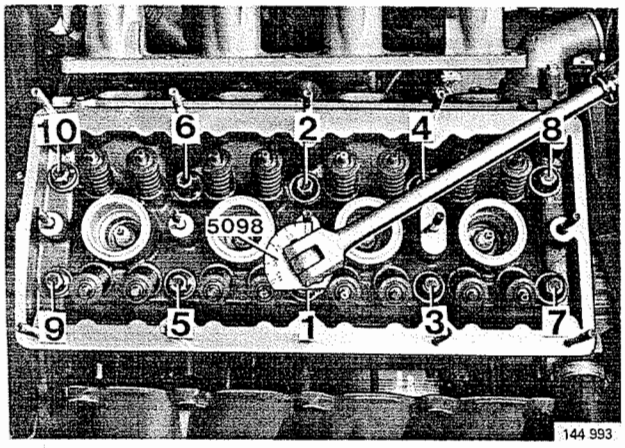
- **new** cylinder head gasket
- **new** water pump O-ring




*Z12*

**Place cylinder head in position**

**Carefully** lower head over guides, taking care to avoid damage to gasket.




*Z13*

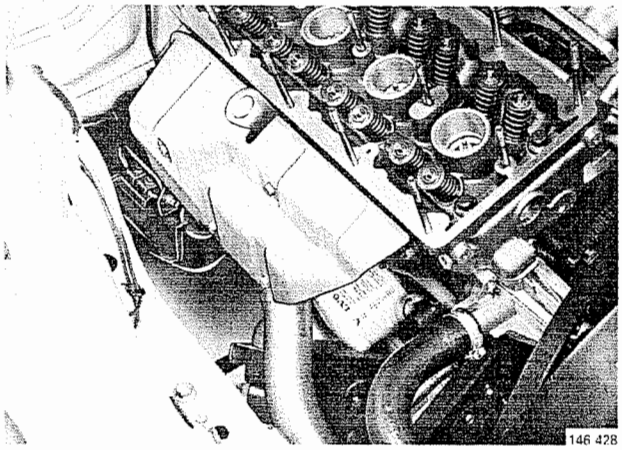
**Tighten cylinder head bolts**

Use protractor **5098**.

Oil bolts.

Insert and tighten bolts in three stages in order illustrated.

1. **20±2 Nm** (15±1.5 ft.lb)
2. **40±5 Nm** (29.5±3.5 ft.lb)
3. Tighten through further **115°** (±10°)




*Z14*

**Install exhaust manifold**

Use **new** gasket.

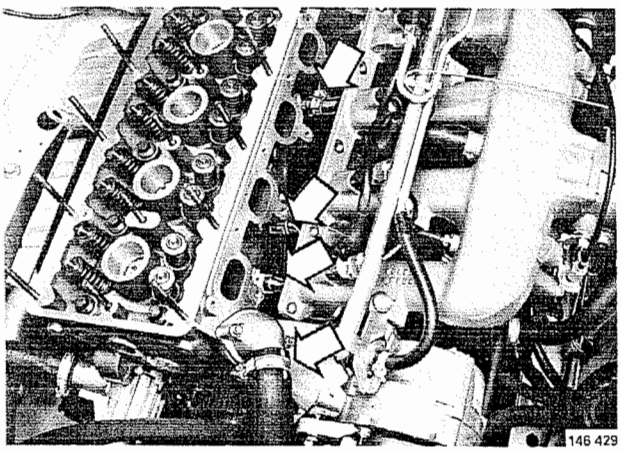
Install manifold.

Attach lifting lug between No. 2 and 3 exhaust branches.

Connect front exhaust pipe to bracket.

Secure right-hand engine mounting to front crossmember.

Install heat shield.

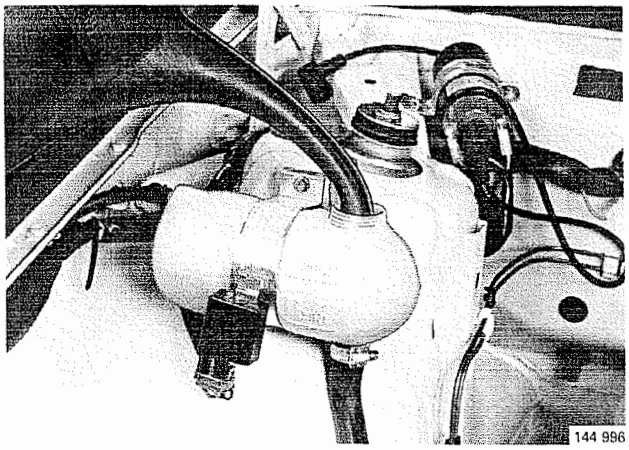



*Z15*

**Reconnect:**

- temperature sensor connectors
- heater hose under No. 3 and 4 intake branches
- upper coolant hose to thermostat housing.

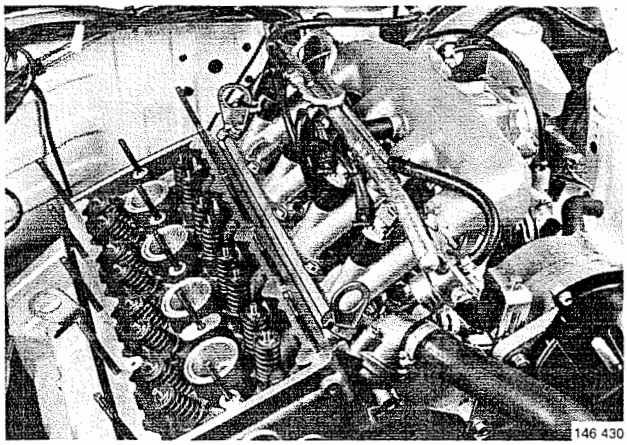
**Important!** Note marking on upper hose. Clearance between hose and alternator belt **must** be **at least 25 mm** (1 in).




*Z16*

**Fill engine with coolant**

Inspect for leaks.



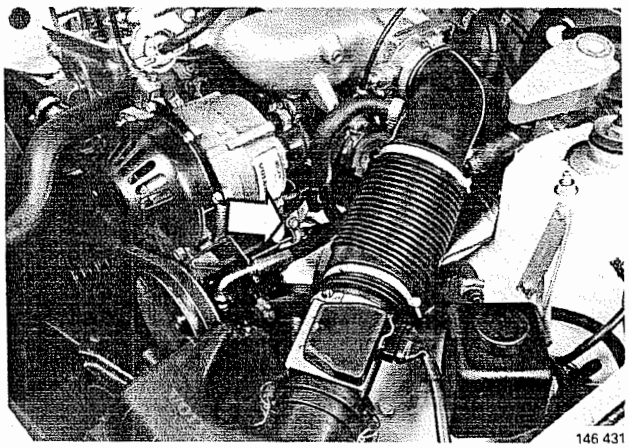

*Z17*

**Install intake manifold**

Use **new** gasket.

Screw in bottom bolts a few turns.

Place manifold and lifting lugs in position. Tighten manifold from centre outwards.



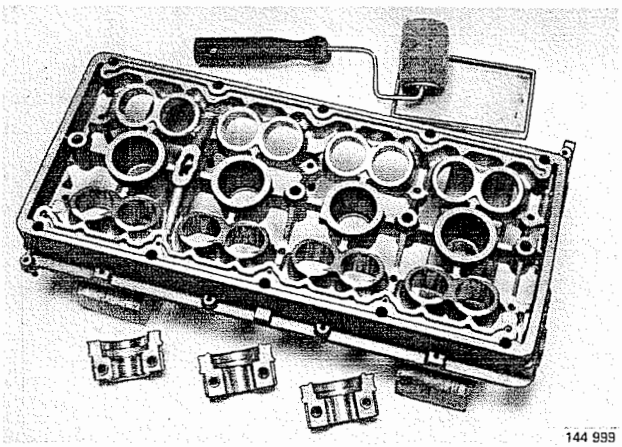

*Z18*

**Reattach support under intake manifold**

Install cable clip.

Secure support to engine mounting.

Install air mass meter complete with air inlet hose and connections.



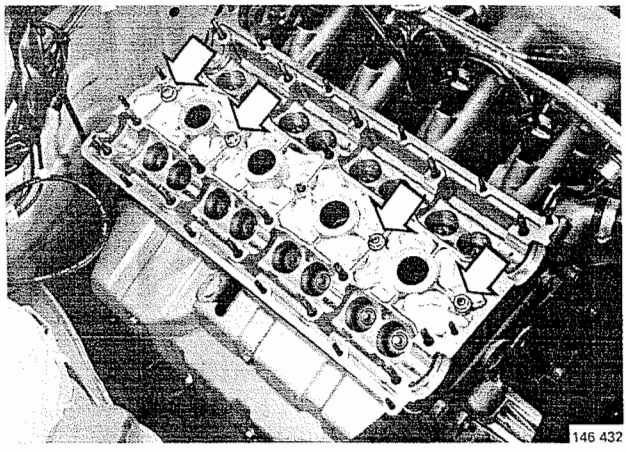

*Z19*

**Apply liquid sealing compound**

Apply compound to joint between camshaft carrier and cylinder head, and to bearing cap joint faces (1, 5 and 6).

Apply compound with a short-haired roller.

**N.B.** Remove excess compound from oilways prior to reassembly.



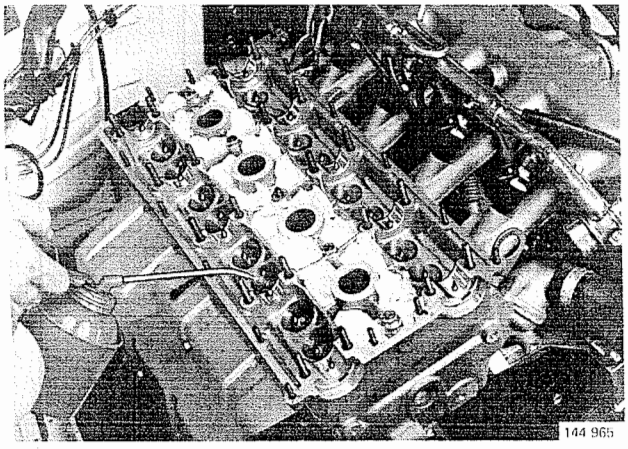

*Z20*

**Install camshaft carrier**

Fit new O-rings in grooves around spark plug wells.

Position carrier on cylinder head and install nuts 1, 2, 4 and 5 in central bolted joint.

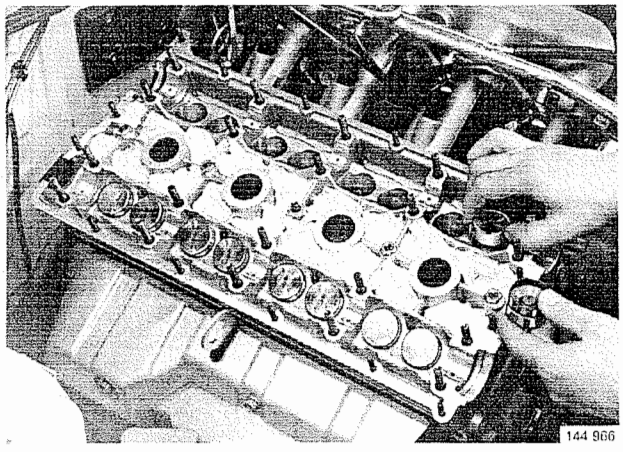
Plug openings around spark plug wells with paper.




*Z21*

**Oil**

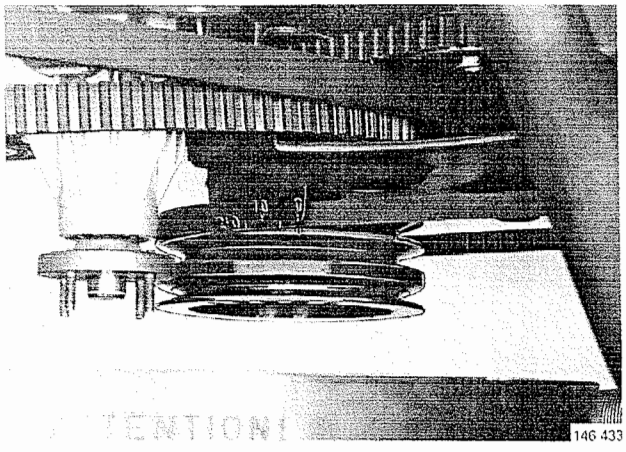
Oil bearings and sliding surfaces on camshaft carrier, bearing caps, camshafts and tappets.




*Z22*

**Insert tappets**

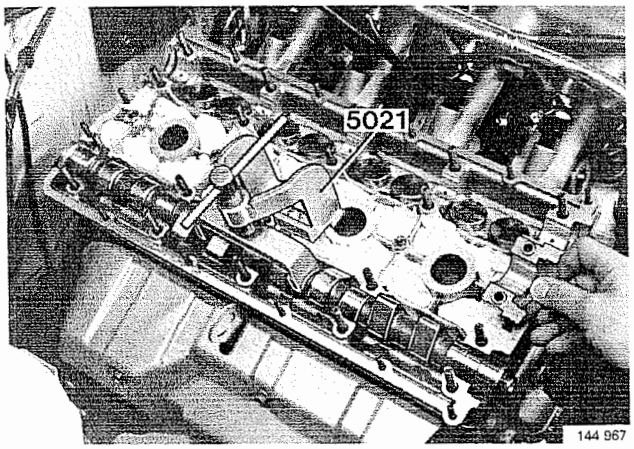
Tappets **must** be replaced in original order.




*Z23*

**Turn engine to TDC in No. 1 cylinder**

Check that TDC markings on vibration damper are aligned with zero marking on transmission cover.




*Z24*

### Install exhaust side camshaft

Place camshaft in camshaft carrier with guide pin for pulley facing upwards.

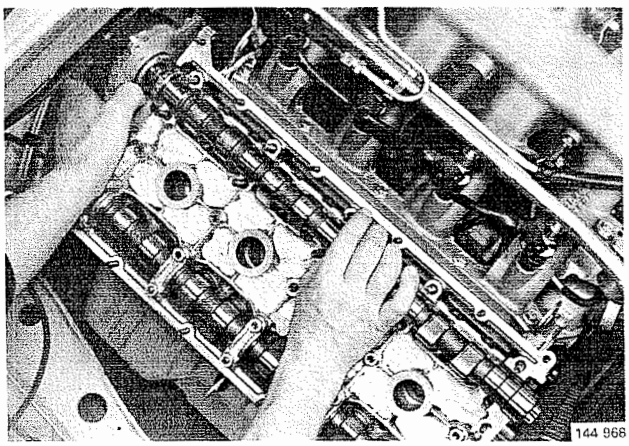
Press down camshaft with press tool **5021** (using rear bearing cap as guide).

Install bearing caps in original order.

Apply liquid sealing compound to joint face between camshaft carrier and front bearing cap (No. 6).

Install bearing cap nuts in stages.

Remove press tool 5021 and replace centre bearing cap (8).




*Z25*

### Install intake side camshaft

Place camshaft in camshaft carrier with guide pin for pulley facing upwards.

**N.B.** Turn distributor shaft to align driver with markings on the housing.

Fit housing and rotor spindle with **new** O-rings.

Press down camshaft with press tool **5021** (using rear bearing cap as guide).

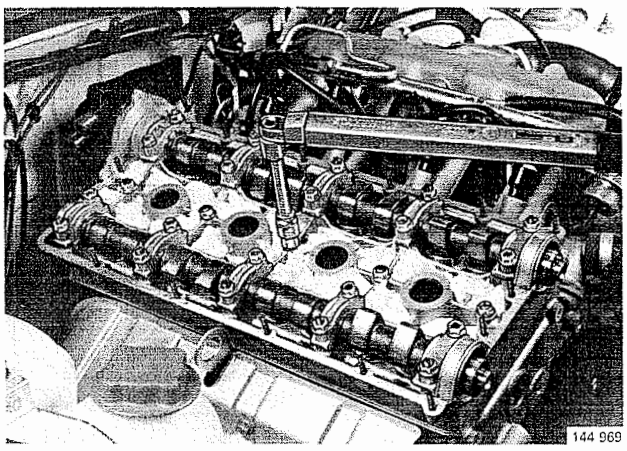
Install bearing caps in original order.

Apply liquid sealing compound to joint faces between camshaft carrier and front and rear bearing caps (Nos. 1 and 5).

Install bearing cap nuts in stages.

Remove press tool 5021 and replace centre bearing cap (8).

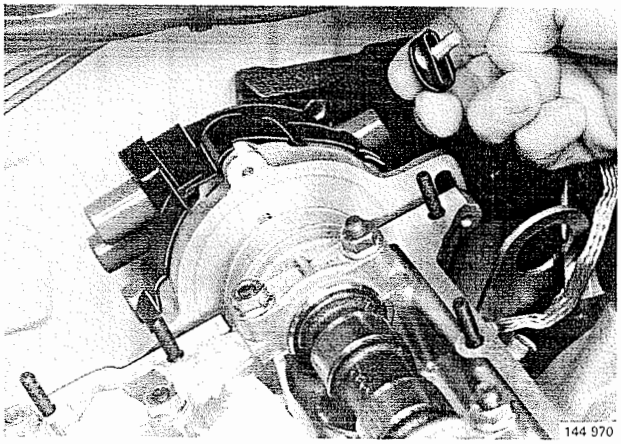
Install camshaft carrier centre nut.




*Z26*

### Tighten bearing cap nuts and centre nut

Tighten to **20 Nm** (15 ft.lb).



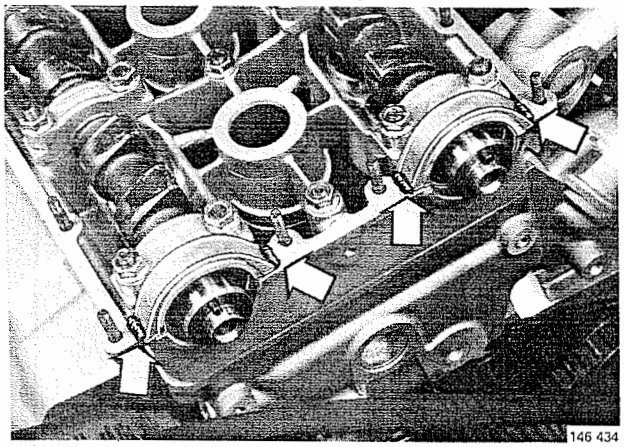

*Z27*

**Remount distributor**

Replace high-tension lead between distributor cap and ignition coil.

Remove paper in camshaft carrier openings.

**N.B.** Replace ignition lead clip beside left-hand bolt.

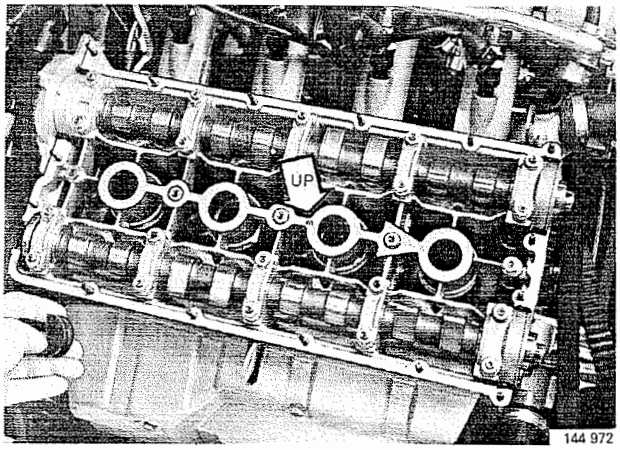



*Z28*

**Apply sealer at front and rear camshaft bearing caps**

Use silicone sealer.

Apply bead of sealer to angle between cap and joint face.




*Z29*

**Install new gaskets and replace valve cover**

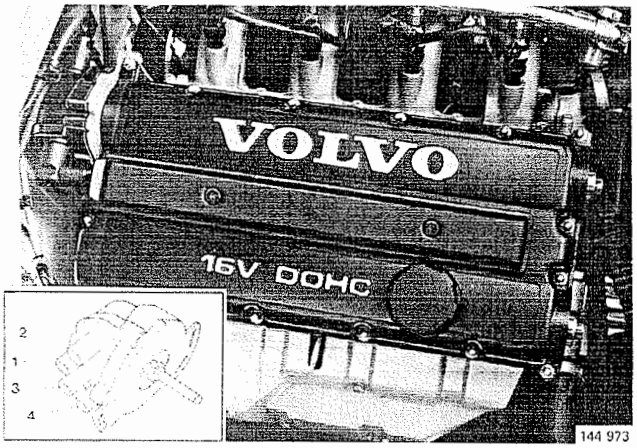
Inspect rubber seal behind camshaft **on exhaust side**.

Position spark plug well gasket with arrow pointing to No. 1 cylinder and markings facing upwards.

Shape outer gasket to fit camshaft bearing caps.

Place gasket in position and replace valve cover.

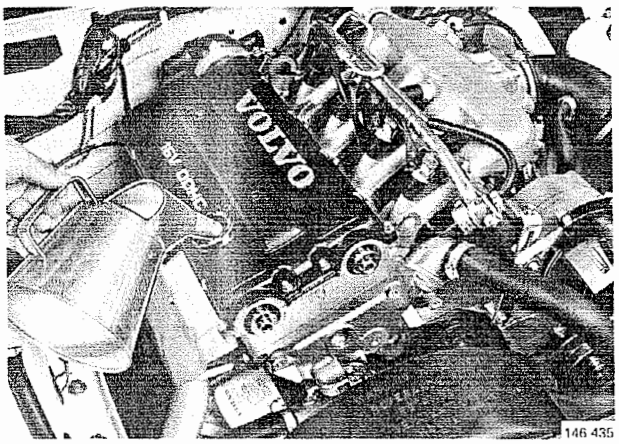
**N.B.** Remember to connect earth lead to distributor.




*Z30*

**Install:**

- ignition leads (in correct firing order)
- ignition lead cover plate



146 435

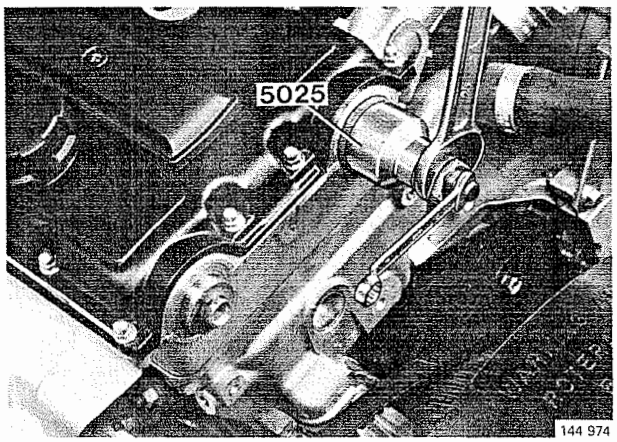
*Z31*

**Fill engine with oil**

Use **new** oil filter.

Capacity, incl. filter ..... **4.0 l** (4.2 US qt)

Insert dipstick and check oil level.



144 974

*Z32*

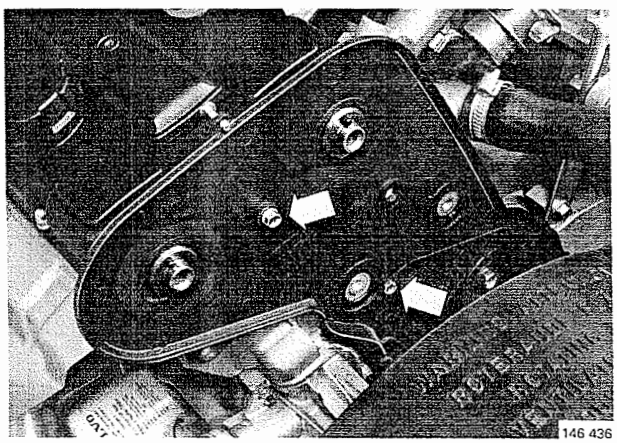
**Fit camshaft front oil seals**

Use assembly tool **5025**.

Grease seals.

Press seals home.

**N.B.** Camshafts must **not** be rotated while fitting seals.

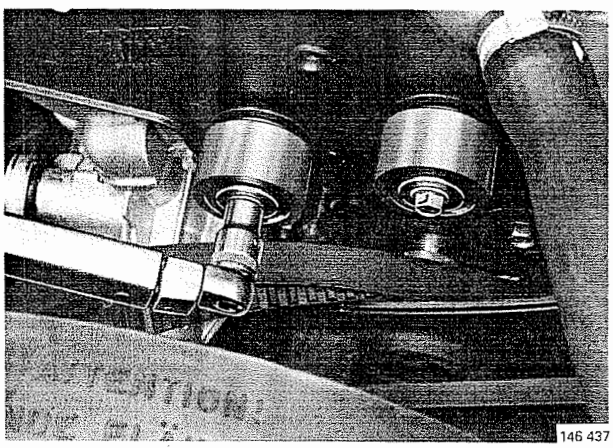

146 436

*Z33*

**Install transmission mounting plate**

Adjust position of plate to avoid contact with camshafts.

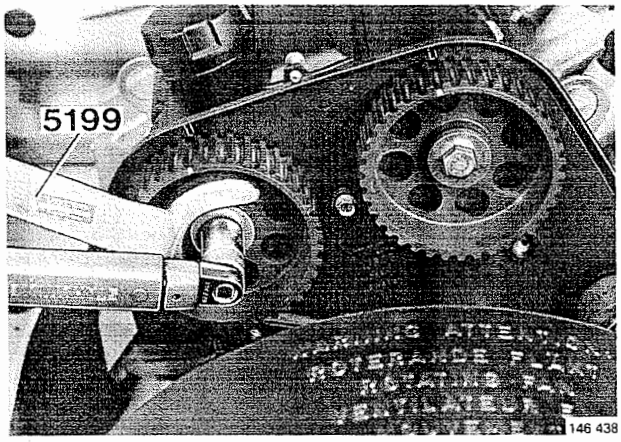
Insert bolts between camshafts and under right-hand idler.


146 437

*Z34*

**Install idlers**

Tighten to **25 Nm** (18.5 ft.lb).



146 438

*Z35*

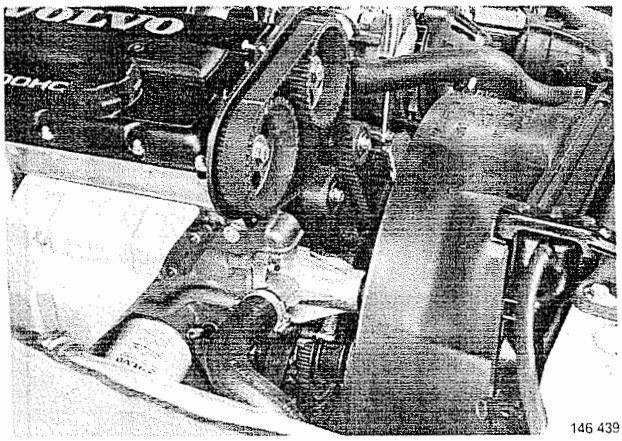
### Install camshaft drive pulleys

Use counterhold **5199**.

Insert centre bolts and tighten to **50 Nm** (37 ft.lb.).

Check that pulley markings are aligned with markings on transmission mounting plate.

**N.B. Camshafts must not** be allowed to rotate when replacing the centre bolts.



146 439

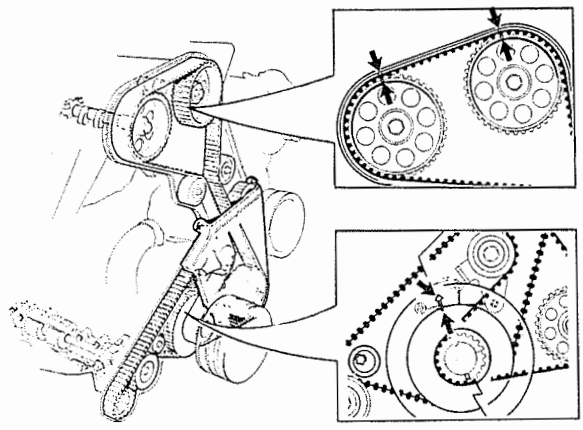
*Z36*

### Install timing belt

Position belt so that double-line marking coincides with **top** marking on belt guide plate (at top of crankshaft).

Place belt on camshaft pulleys, ensuring that single-line markings coincide with pulley markings.

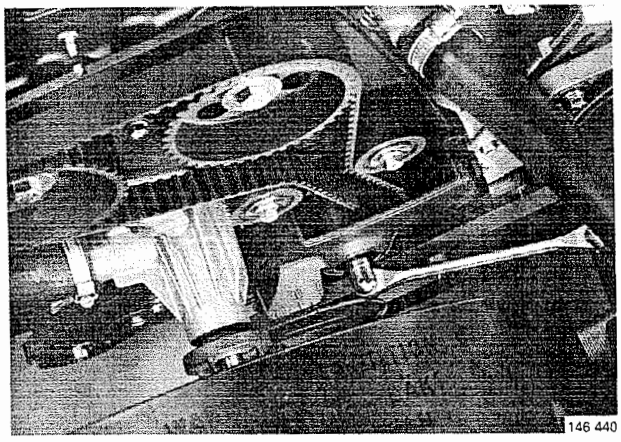
Place belt in position over **right-hand** and then over **left-hand** idler.


144 905

*Z37*

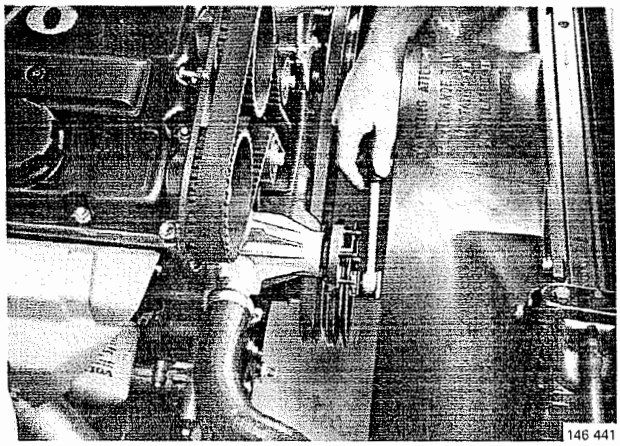
### Check markings

Check that **all** markings coincide and that the engine is turned to TDC in No. 1 cylinder.


146 440

*Z38*

### Slacken tensioner locknut

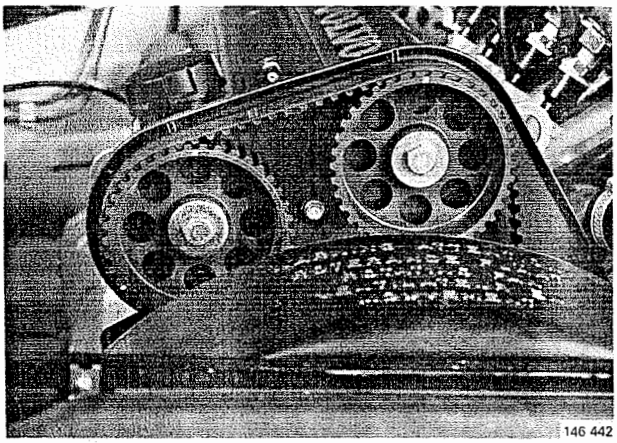

146 441

*Z39*

**Turn crankshaft clockwise**

Crankshaft pulleys should rotate one turn until markings again coincide with those on the transmission mounting plate.

**N.B.** Engine must **not** be rotated counterclockwise while belt is being tensioned.

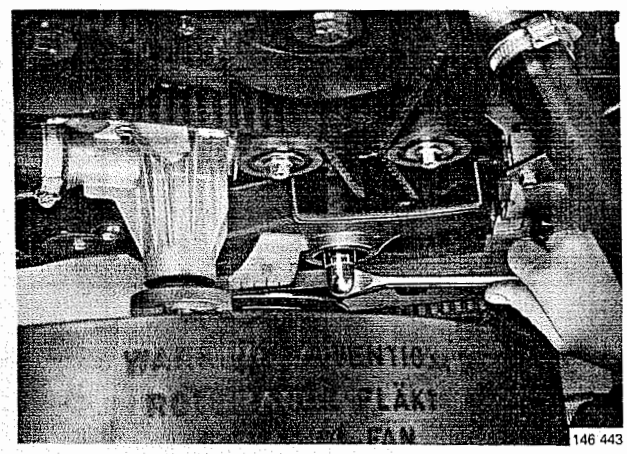

146 442

*Z40*

**Turn crankshaft further clockwise**

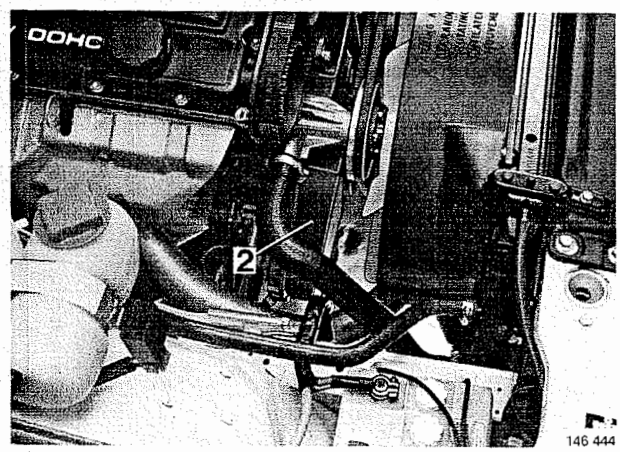
Continue to turn crankshaft until pulley markings are **1½ teeth** past markings on housing.

**N.B.** Rotate crankshaft **smoothly**.


146 443

*Z41*

**Tighten tensioner locknut**

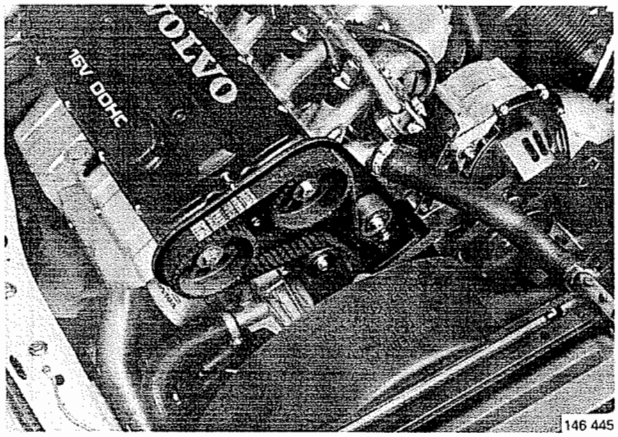


146 444

*Z42*

**Install:**

- lower transmission cover (2)
- radiator fan and pulley
- alternator drive belt
- battery earth lead



146 445

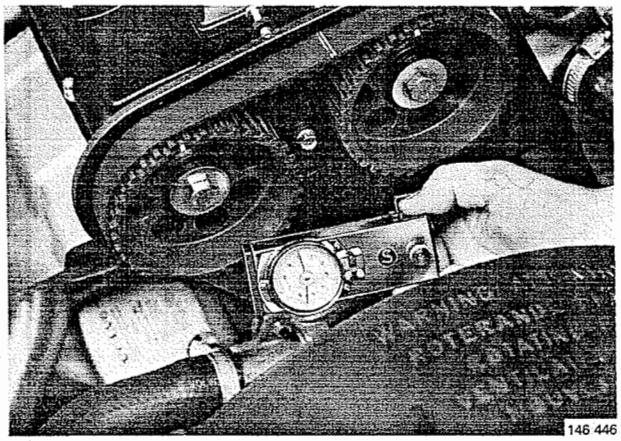
*Z43*

### Check operation

Run engine until thermostat opens.

Stop engine.

**Caution!** Remember that transmission cover (1) is **not** replaced at this point.


146 446

*Z44*

### Check belt tension

Use gauge **998 8500**.

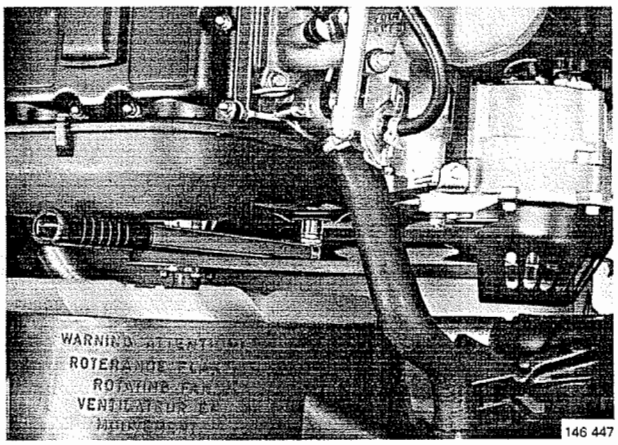
Rotate crankshaft to bring engine to TDC position in No. 1 cylinder.

Position gauge between exhaust camshaft pulley and idler.

Read gauge.

Belt tension **must** be within **5.1±0.2** unit range (5.5±0.2 units for new belt).

**If** reading is **outside** above range, carry out operations **C26–C30**.


146 447

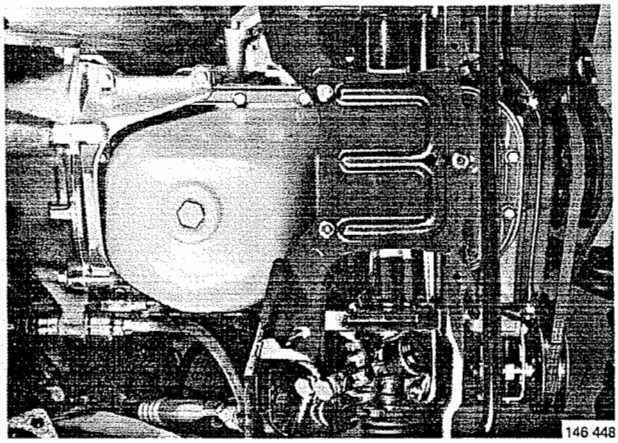
*Z45*

### Tighten tensioner locknut

Tighten to **50 Nm** (37 ft.lb).

Install protective cap over locknut.

Install upper transmission cover (1).


146 448

*Z46*

### Check operation

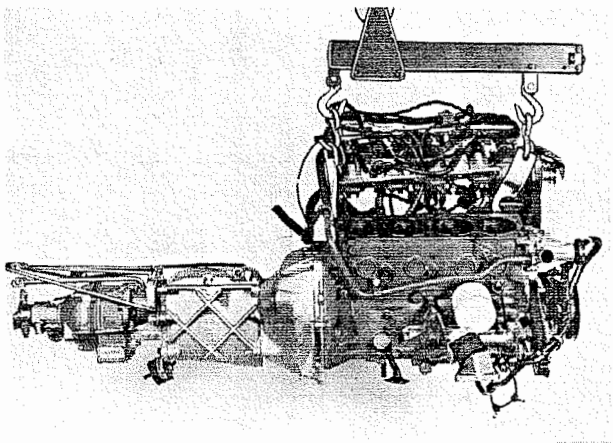
Test run engine.

Inspect for oil and coolant leaks.

Install splashguard under engine.

# AA. Stripped engine, removal

*Special tools: 2810, 5006, 5033, 5115, 5185, 5186, 5871*



146 530

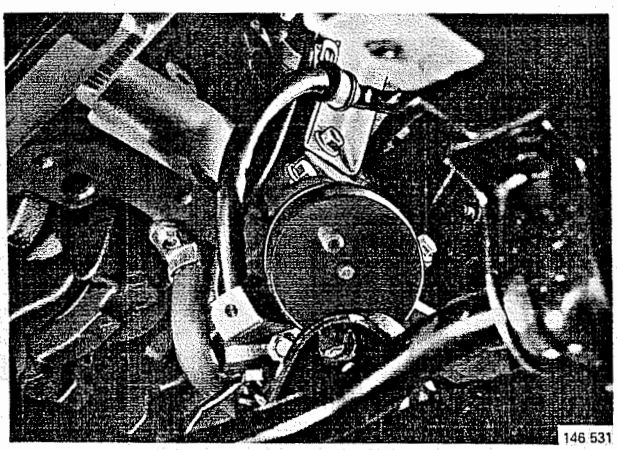
**Assuming bores, crankshaft etc. have been found to be in need of overhaul:**

Remove engine complete with gearbox.

Following procedure applies to engines with manual gearboxes.

Automatic gearboxes are removed as described in procedure **AD.**

**Caution!** Since operations **AA24–25** are carried out with engine freely suspended, ensure that lifting equipment is **securely attached** and in **perfect condition.**

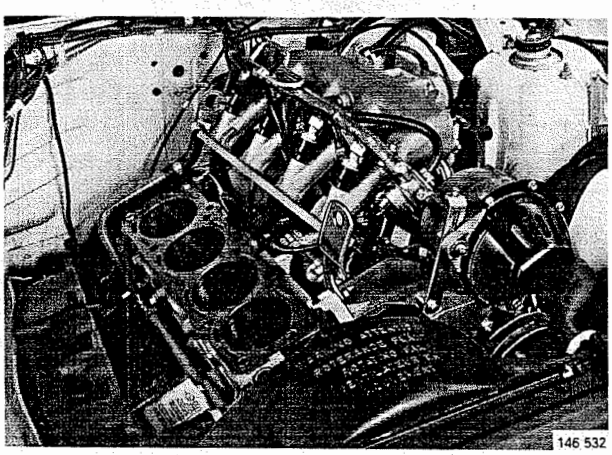


146 531

*AA1*

**Install left-hand engine mounting and support under intake manifold**

Tighten components to cylinder block.



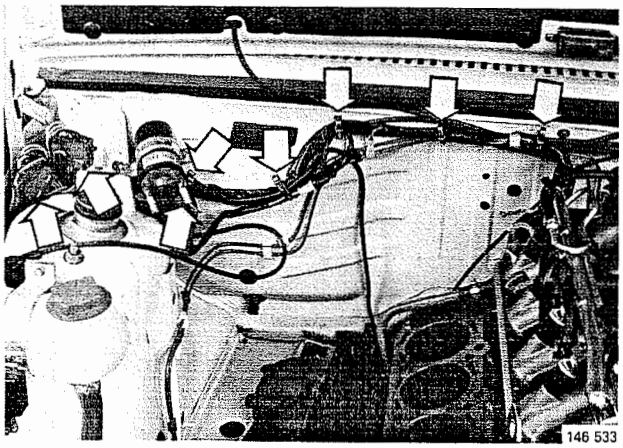
146 532

*AA2*

**Remove lifting attachments**

Lower engine onto engine mountings.

Remove hook 5115 and lifting yoke 5006.

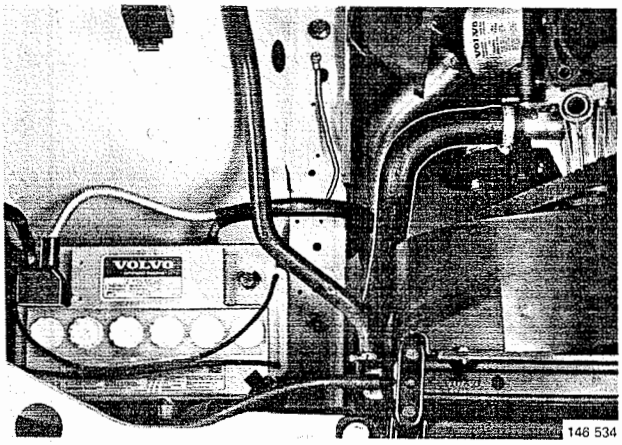

146 533

*AA3*

**Release wiring harness at rear of engine**

Open cable clips on bulkhead.

Separate connectors at right-hand suspension strut tower and disconnect lead to terminal 1 on ignition coil.

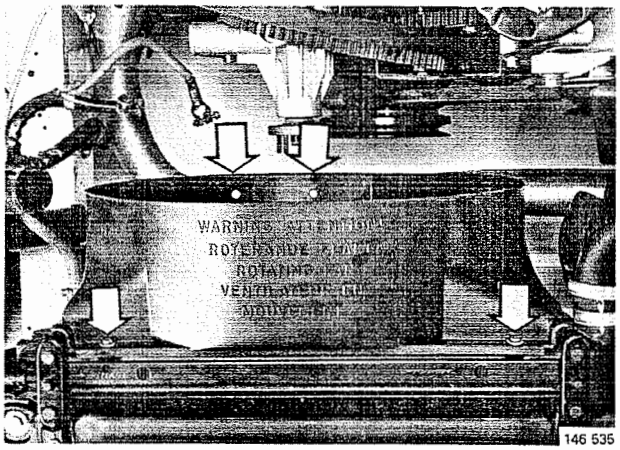


146 534

*AA4*

**Disconnect:**

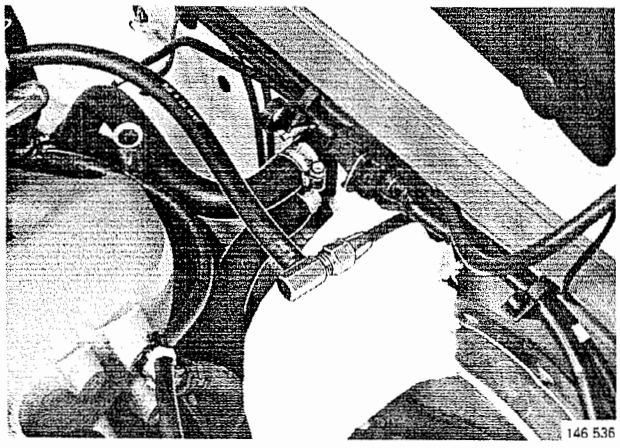
- leads connected to terminal lug of battery positive lead
- battery positive lead
- earth lead connection to top of side member
- lower coolant hose from water pump


146 535

*AA5*

**Remove fan shroud**

Cut tie around air preheating hose.


146 536

*AA6*

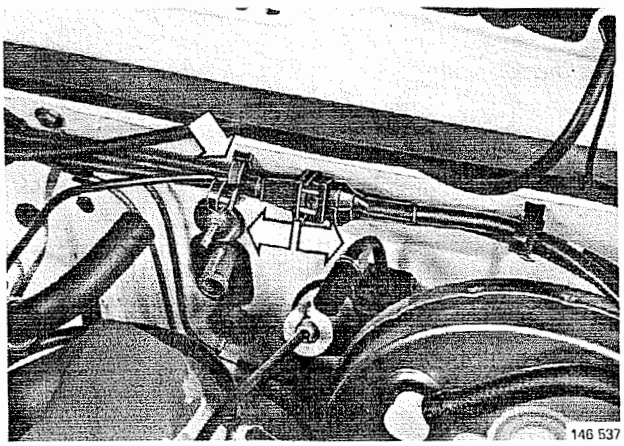
**Undo hose connections at left-hand side of bulkhead**

Disconnect heater hoses from pipe branches on bulkhead.

Open union between hose and pipe on fuel line.

Soak up fuel spillage with paper.

**N.B. Seal open ends to prevent entry of dirt into fuel line.**

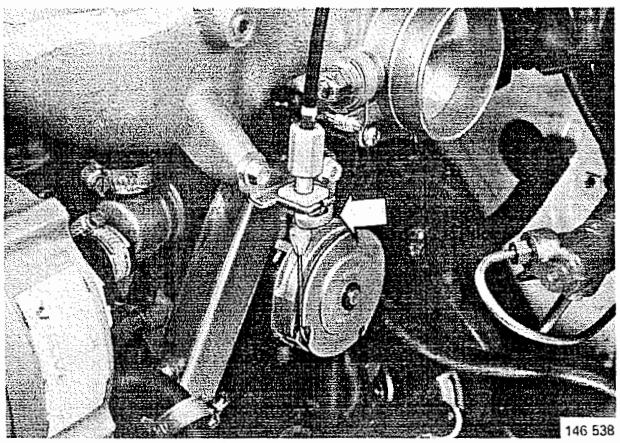

146 537

*AA7*

**Disconnect speed pick-up lead**

Open cable clip on bulkhead.

Open connector.

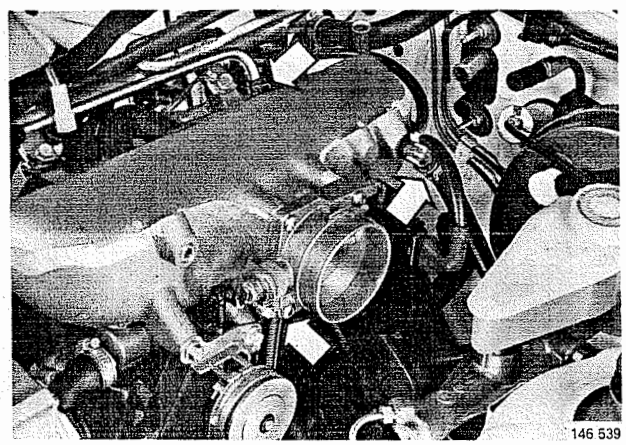

146 538

*AA8*

**Release throttle cable from pulley**

Release locking clip on cable tensioner.

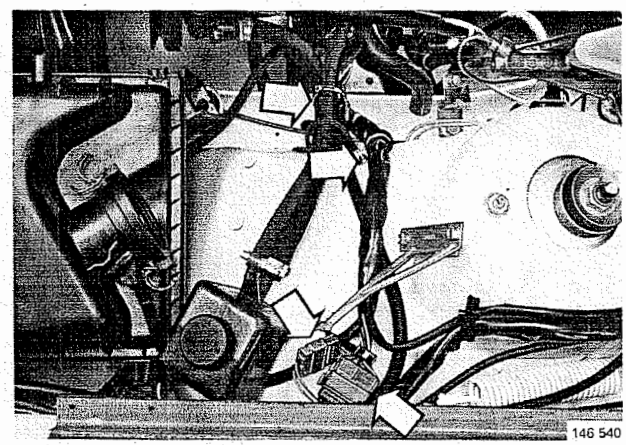
Unhook cable from pulley.


146 539

*AA9*

**Remove:**

- brake servo vacuum hose from branch on intake manifold
- EVAP valve hose from branch on bottom of intake manifold
- return line from fuel distribution pipe


146 540

*AA10*

**Free engine wiring harness on left-hand side**

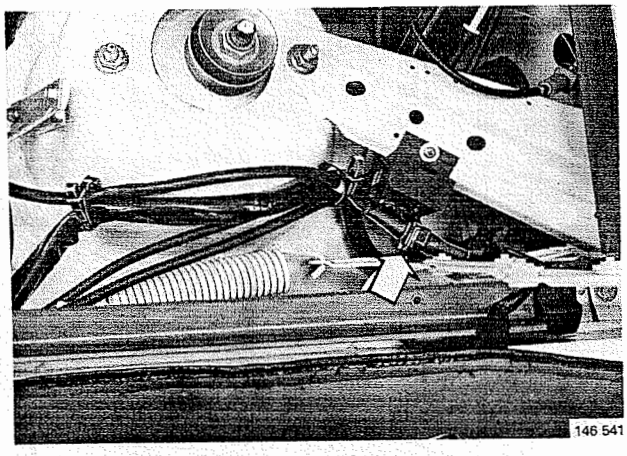
Cut steering servo hose and wiring harness ties.

Undo cable clip at left-hand wheel housing.

Unhook servo reservoir from mounting bracket.

Open cable clip at connectors.

Separate wiring connectors at servo reservoir.



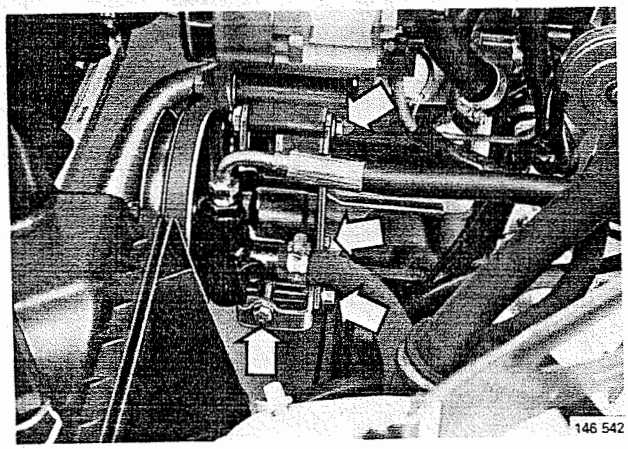

*AA11*

**Disconnect knock sensor lead**

Open cable clips on left-hand suspension strut housing.

Separate connectors at diagnostic unit.

Work wiring free of servo hoses.




*AA12*

**Remove servo pump**

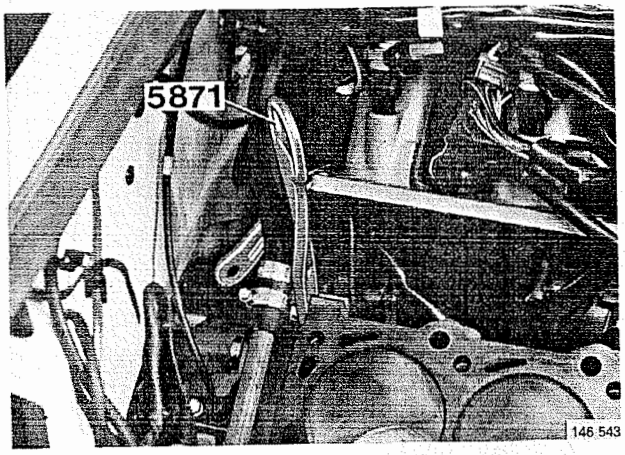
Remove drive belt.

Remove pump from mounting bracket.

Place pump on left-hand wheel housing.

Use paper or other material to protect wheel housing from scratches.

**N.B.** Do **not** open any hose connections.



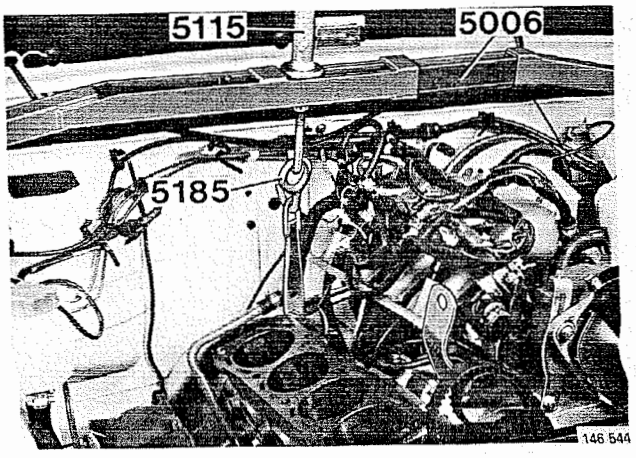

*AA13*

**Attach lifting lug 5871 to rear of cylinder block**

Remove dipstick tube support.

Remove flat washer on bolt.

Tighten lifting lug.

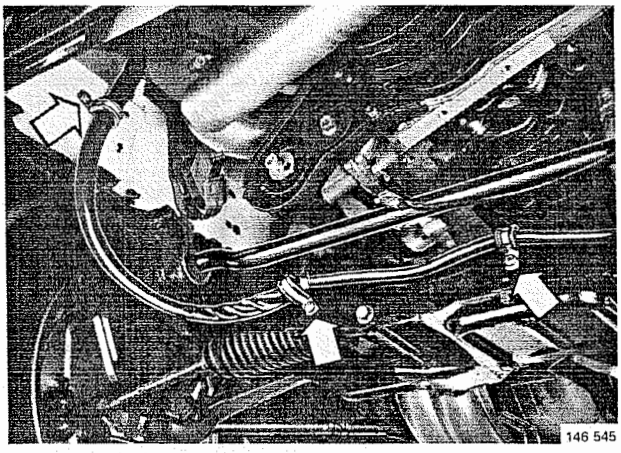



*AA14*

**Support engine at rear**

Use two support bars **5033**, lifting yoke **5006**, and lifting hooks **5115** and **5186**.

Lift engine using rear lifting lug **5871**.


146 545

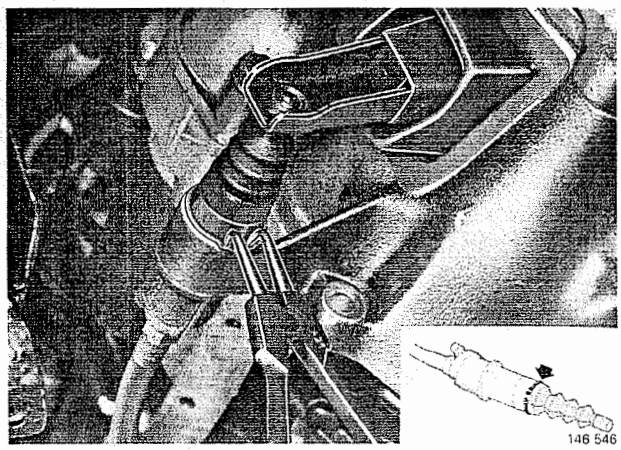
*AA15*

**Disconnect battery leads from body**

Undo clips on front crossmember and right-hand side member.

Work wiring free of anti-roll bar.

**N.B.** On cars equipped with AC: Unbolt AC compressor from mounting bracket.


146 546

## Manual gearbox

(See procedure AD for removal of automatic gearbox)

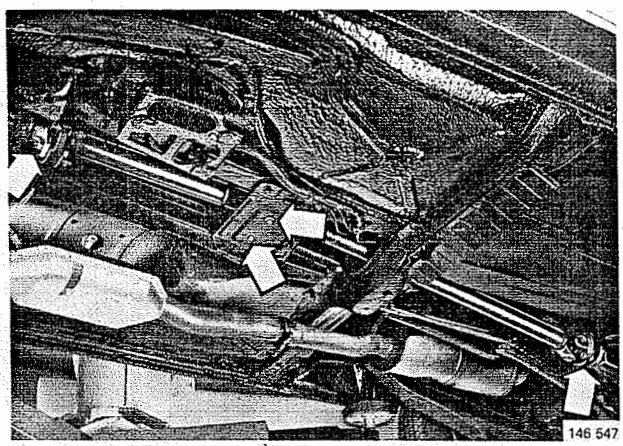
*AA16*

**Remove clutch slave cylinder**

Remove cylinder circlip.

Withdraw cylinder carefully from location in housing.

**N.B.** Rubber boot retains plunger in cylinder. Secure boot with circlip.


146 547

*AA17*

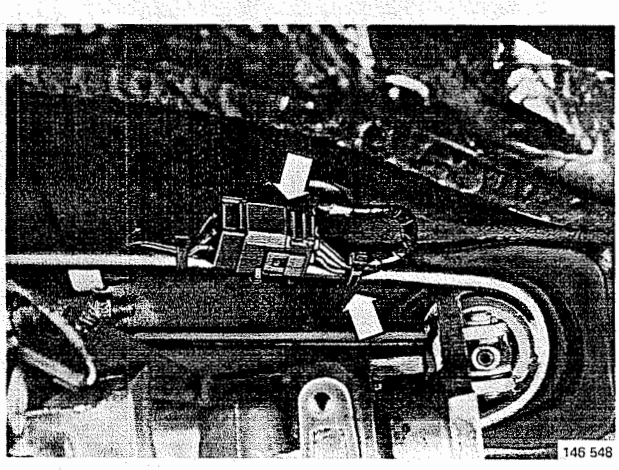
**Remove propeller shaft**

Use socket **5244**.

Separate front and rear universal joints.

Unbolt intermediate bearing from member.

Withdraw propeller shaft backwards.

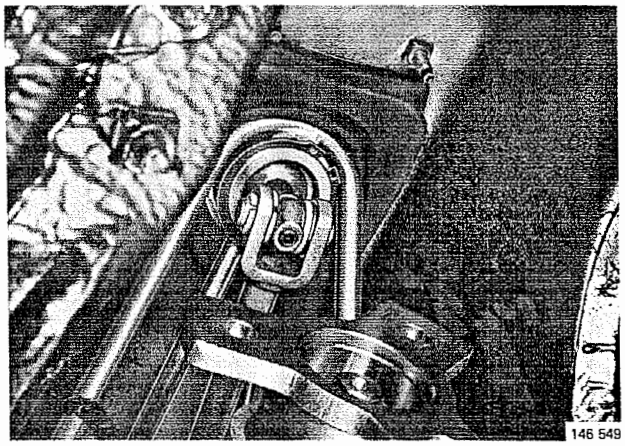

146 548

*AA18*

**Free gearbox wiring**

Cut **rear** tie at gear lever mounting.

Separate wiring connectors.


146 549

*AA19*

**Release gear lever**

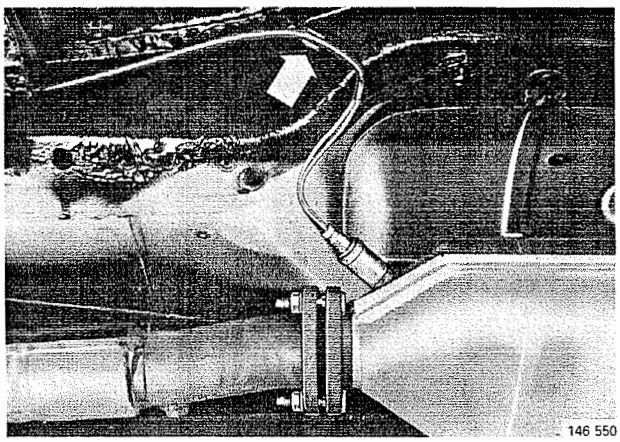
Undo lever locking bolt.

Remove pivot pin between lever and gear selector rod.

Remove circlip from lever sleeve under mounting.

Push up lever.

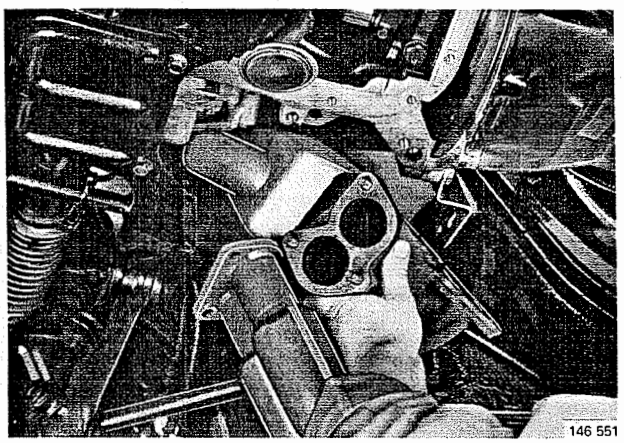
Remove bearing bushings and O-ring.


146 550

*AA20*

**Undo bolted joint at front of catalytic converter**

Release oxygen sensor lead from rear clip.

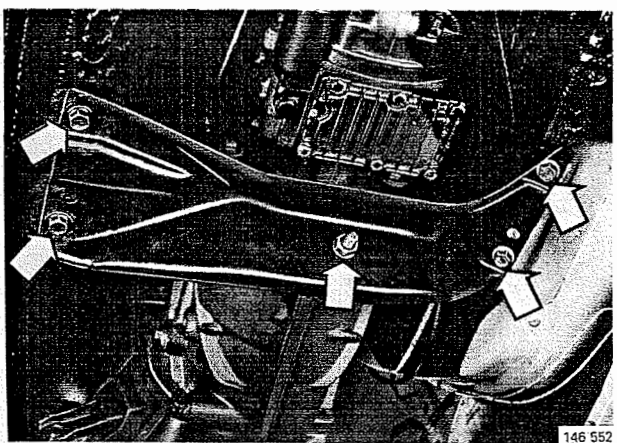

146 551

*AA21*

**Remove front exhaust pipe**

Remove nuts in flanged joint with exhaust manifold.

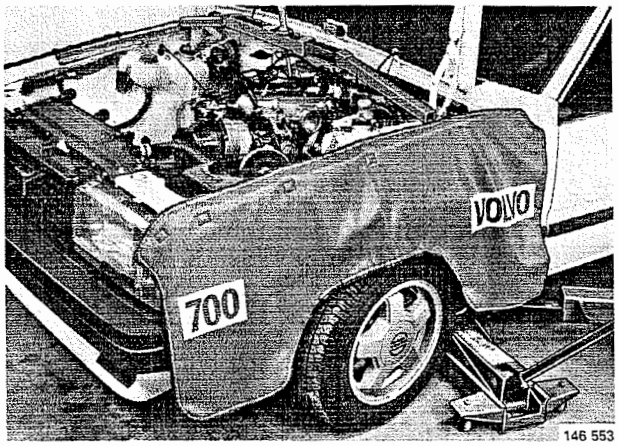
Remove manifold.


146 552

*AA22*

**Remove gearbox support member**

Remove gearbox bump stop nut and bolts attaching member to side members.



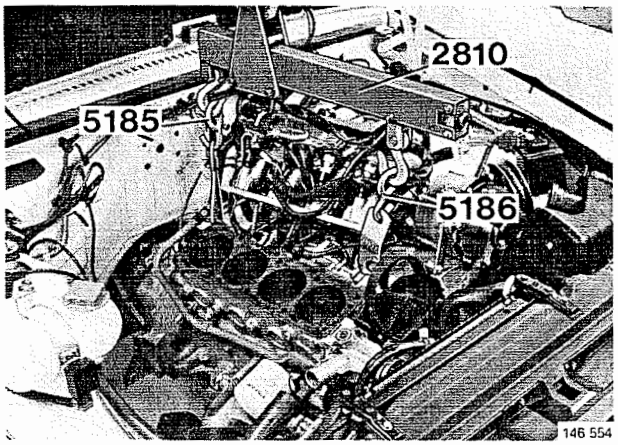
146 553

*AA23*

**Support gearbox on jack**

Remove lifting attachments (5006, 5033, 5115 and 5185).

On cars equipped with AC: Tie aside compressor.



146 554

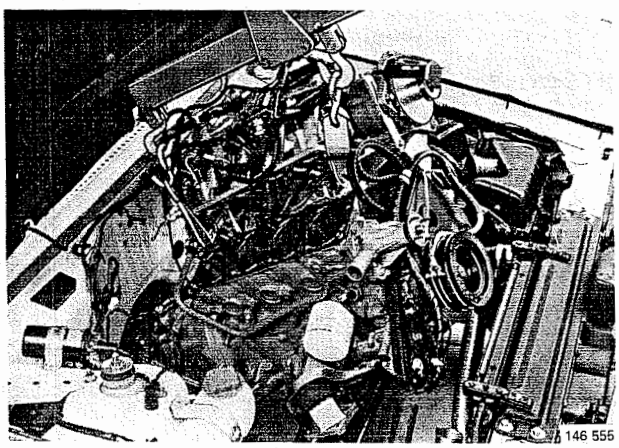
*AA24*

**Lift engine**

Use lifting tool **2810**, and lifting hooks **5185 and 5186**.

Adjust lifting yoke to ensure engine is balanced.

Remove jack under gearbox.


146 555

*AA25*

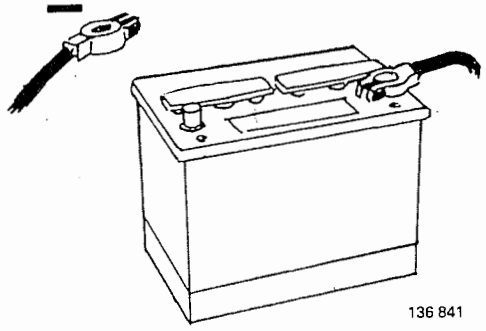
**Lift out engine and gearbox**

Adjust angle of lift throughout operation.

**N.B. Carefully** check that drive unit is free of radiator, body and extra equipment (if any).

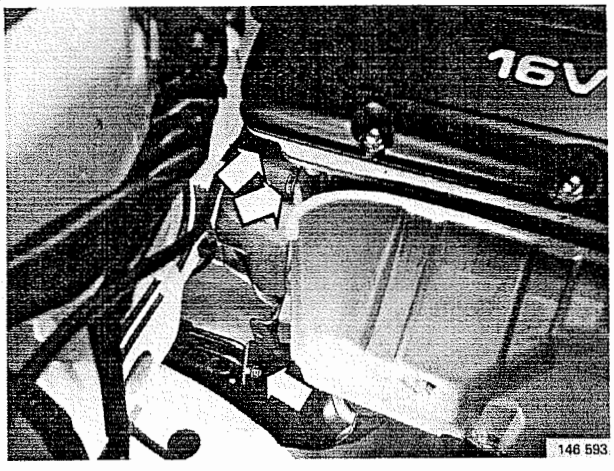
# AB. Crankshaft main bearings, replacement

*Special tools: 1426, 4090, 5006, 5033, 5111, 5112, 5115, 5186, 5244, 5972*




*AB1*

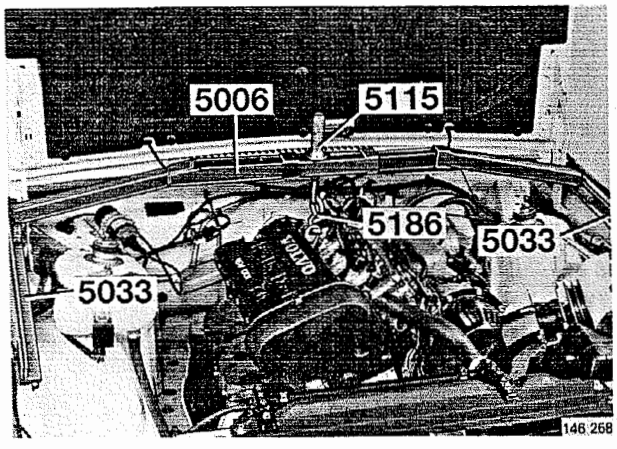
**Disconnect battery earth lead**




*AB2*

**Unbolt front exhaust pipe from bracket**

Remove upper bolts between flywheel housing and cylinder block.



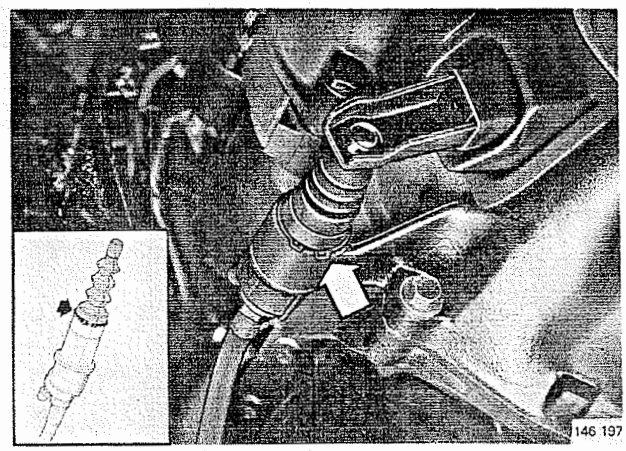

*AB3*

**Relieve weight on gearbox rear mounting**

Use support bars **5033**, lifting yoke **5006**, and lifting hooks **5115** and **5186**.

Raise unit using rear left-hand lifting lug.

Take care to **avoid damage** to wiring harness.



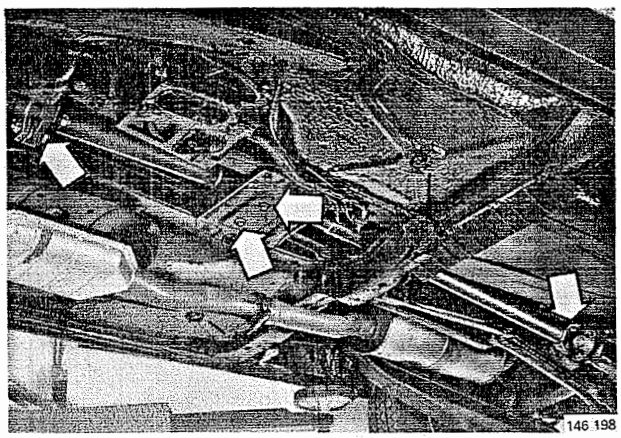

*AB4*

**Remove clutch slave cylinder**

Remove cylinder circlip.

Withdraw cylinder carefully from location in housing.

**N.B.** Rubber boot retains plunger in cylinder. Secure boot with circlip.




*AB5*

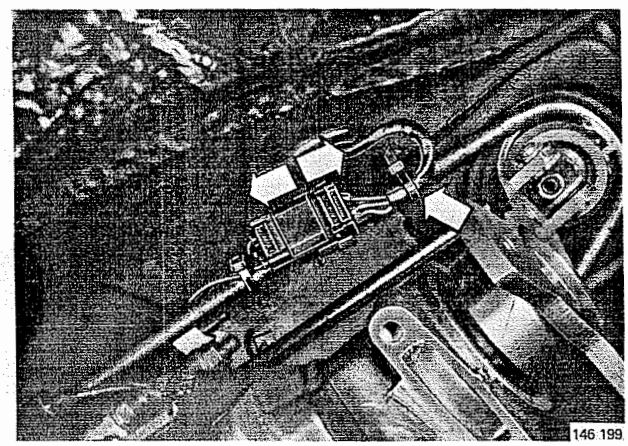
**Remove propeller shaft**

Use socket **5244**.

Separate front and rear universal joints.

Unbolt intermediate bearing from member.

Withdraw propeller shaft backwards.

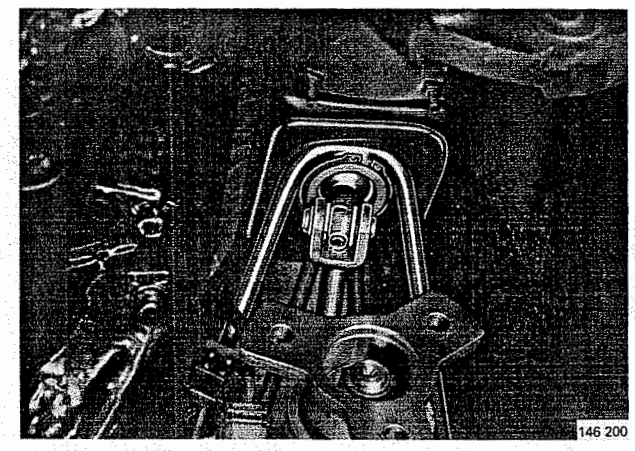



*AB6*

**Free gearbox wiring**

Cut **rear** tie at gear lever mounting.

Separate wiring connectors.




*AB7*

**Release gear lever**

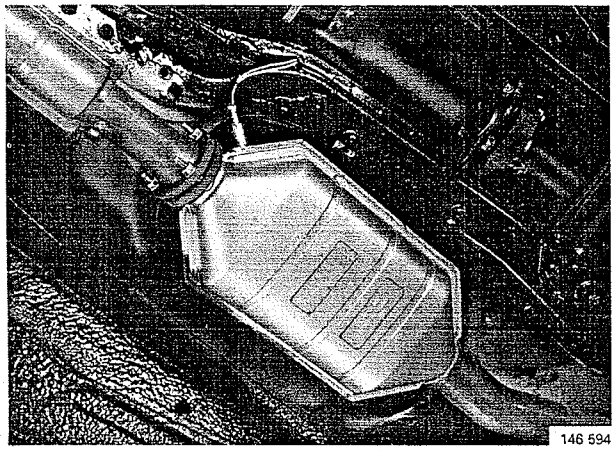
Undo lever locking bolt.

Remove pivot pin between lever and gear selector rod.

Remove circlip from lever sleeve under mounting.

Push up lever.

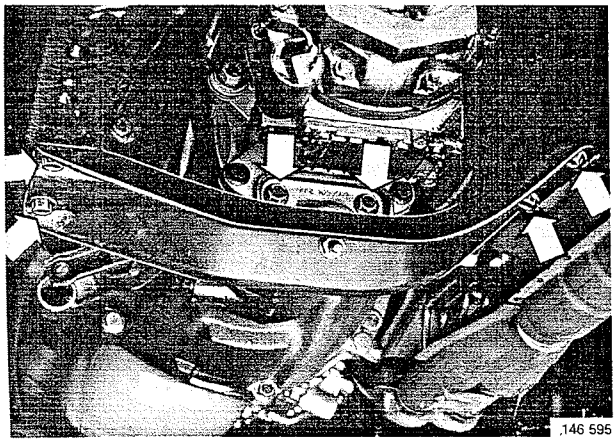
Remove bearing bushings and O-ring.


146 594

*AB8*

**Undo bolted joint at front of catalytic converter**

Release oxygen sensor lead from rear clip.

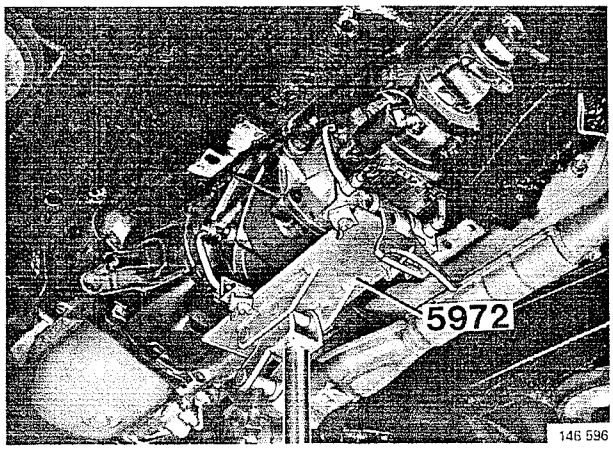

146 595

*AB9*

**Remove gearbox support member and bracket**

Unbolt bracket.

Unbolt gearbox support member from side members.



146 596

*AB10*

**Remove gearbox**

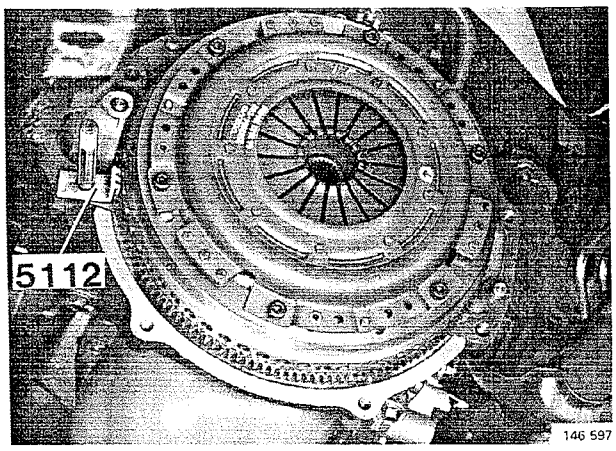
Undo remaining bolts in flywheel housing.

Place fixture **5972** under gearbox.

Separate flywheel housing from cylinder block and turn gearbox clockwise in fixture.

Draw gearbox backwards to separate input shaft completely from clutch plate.

Lower gearbox.



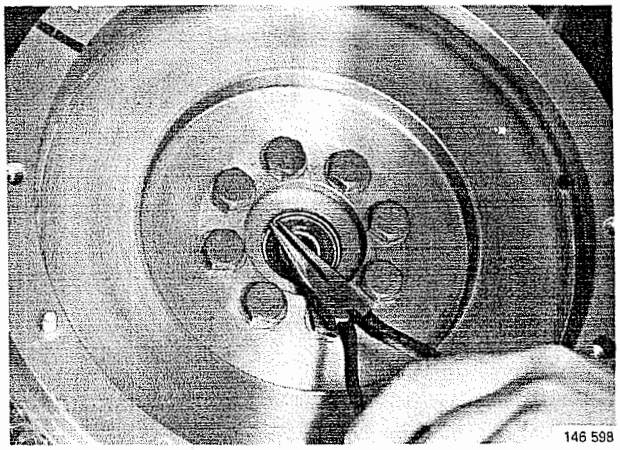
146 597

*AB11*

**Remove pressure plate and clutch plate**

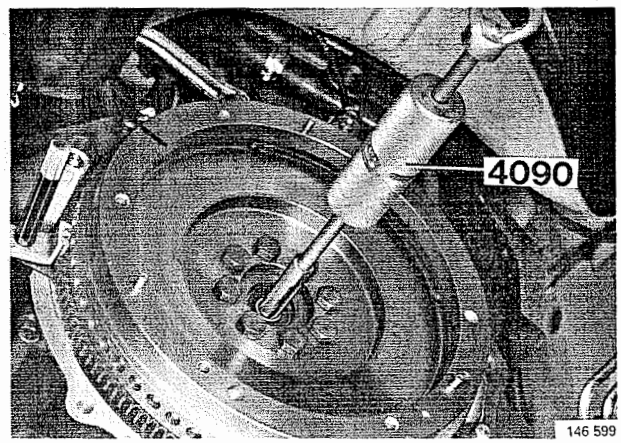
Use gear sector **5112**.

Undo pressure plate joint evenly all round.


146 598

*AB12*

**Remove clutch release bearing circlip**

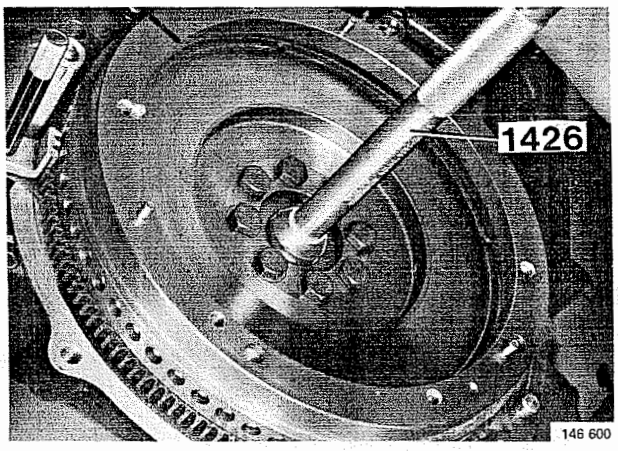


146 599

*AB13*

**Withdraw clutch release bearing from crankshaft**

Use extractor **4090.**

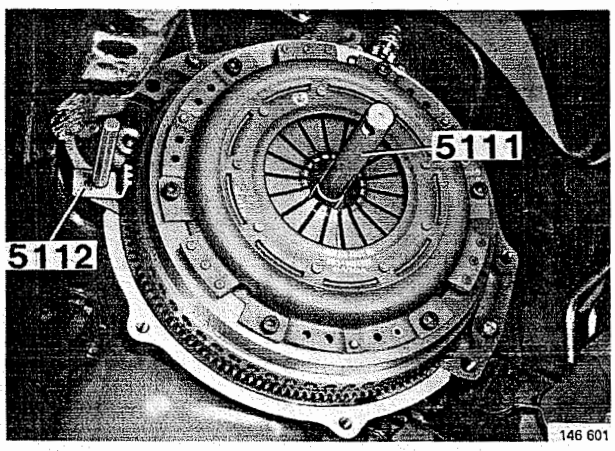


146 600

*AB14*

**Install:**

– new clutch release bearing using drift **1426**
– circlip



146 601

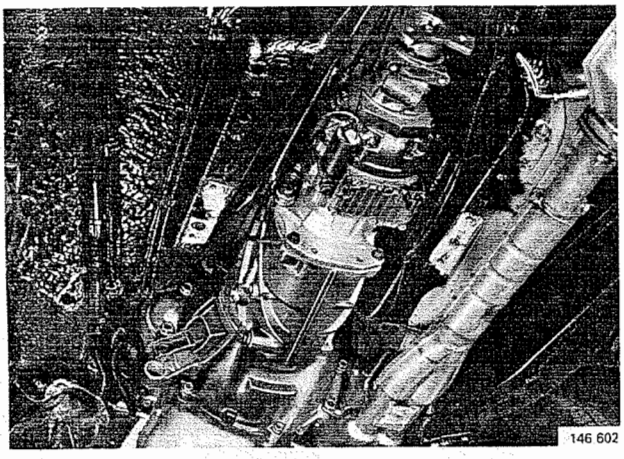
*AB15*

**Refit clutch plate and pressure plate**

Use centering tool **5111** and gear sector **5112.**

Tighten pressure plate in stages. Work around circumference tightening diagonally-opposite bolts alternately.

Remove centering tool and gear sector.


146 602

*AB16*

**Install gearbox**

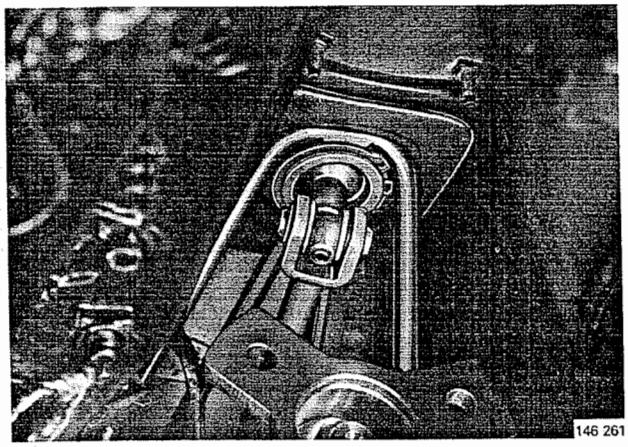
Use fixture **5972.**

Align input shaft, insert and turn gearbox into position.

Tighten gearbox in position.

Remove fixture.

(Tighten two uppermost bolts from engine compartment. See operation AB24.)


146 261

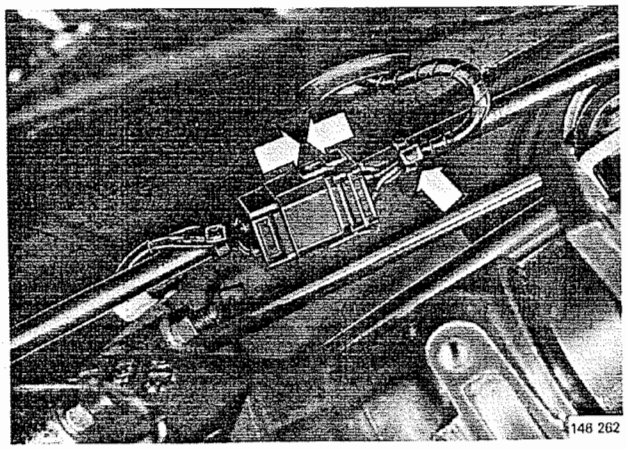
*AB17*

**Install gear lever**

Insert gear lever sleeve in mounting.

**Install:**

- bearing bushings and O-ring on gear selector rod; replace selector circlip
- gear selector/lever pivot pin; tighten set screw
- circlip on gear lever sleeve; pull selector rod downwards when fitting circlip

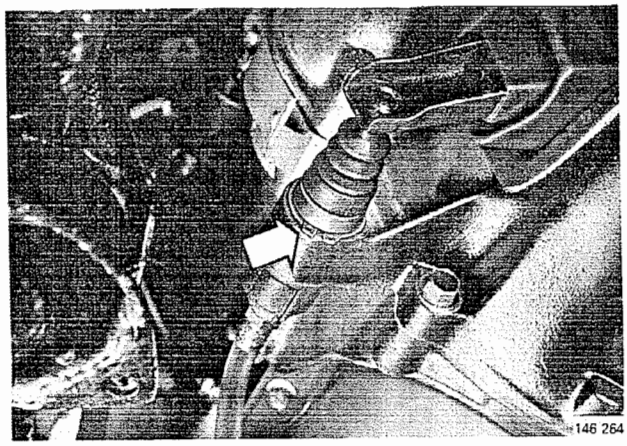

146 262

*AB18*

**Reconnect gearbox wiring**

Reconnect wiring connectors.

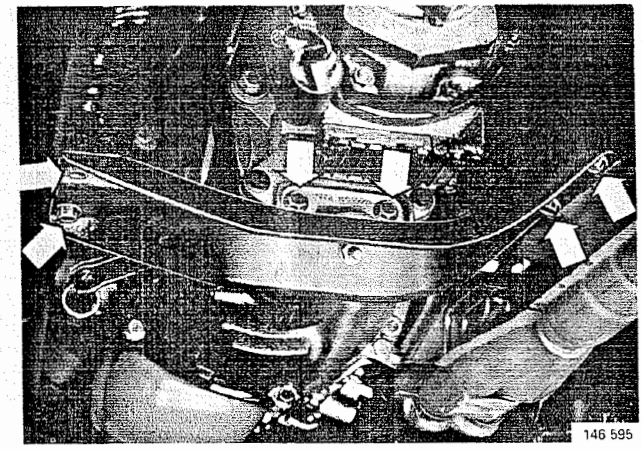
Install cable tie.


146 264

*AB19*

**Install clutch slave cylinder**

Secure cylinder with circlip.


146 595

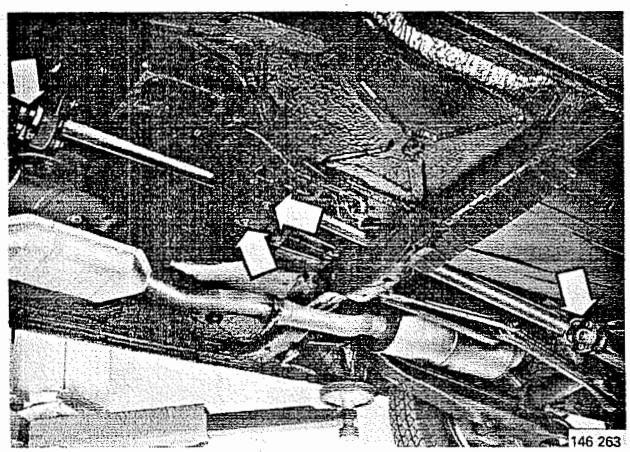
*AB20*

**Install gearbox support member and reinstate rear mounting**

Rebolt rear mounting to gearbox.

Rebolt support member to side members.

Ensure that oxygen sensor lead is above support member.


146 263

*AB21*

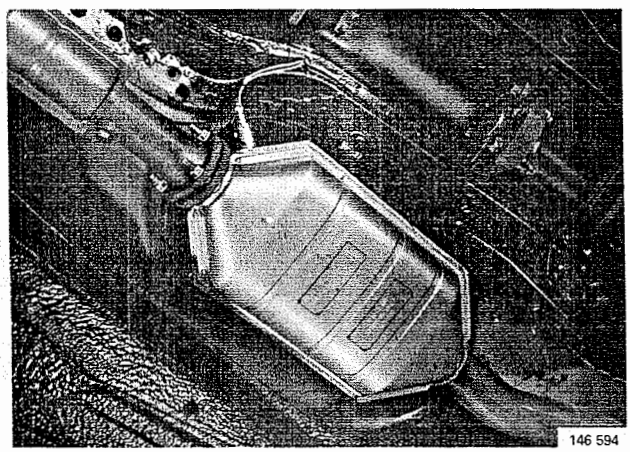
**Install propeller shaft**

Reassemble front universal joint at gearbox.

Reassemble rear universal joint at differential.

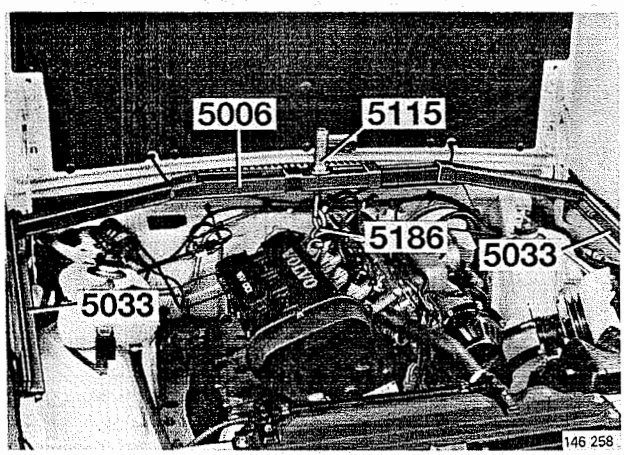
Use socket **5244**.

Reattach intermediate bearing to member.


146 594

*AB22*

**Remake bolted joint at front of catalytic converter**

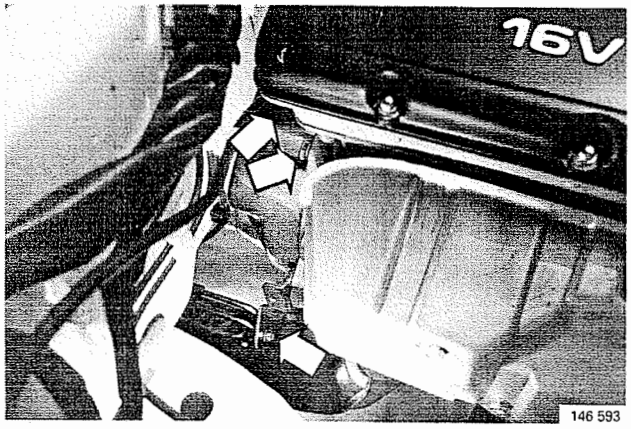


146 258

*AB23*

**Remove lifting attachments**

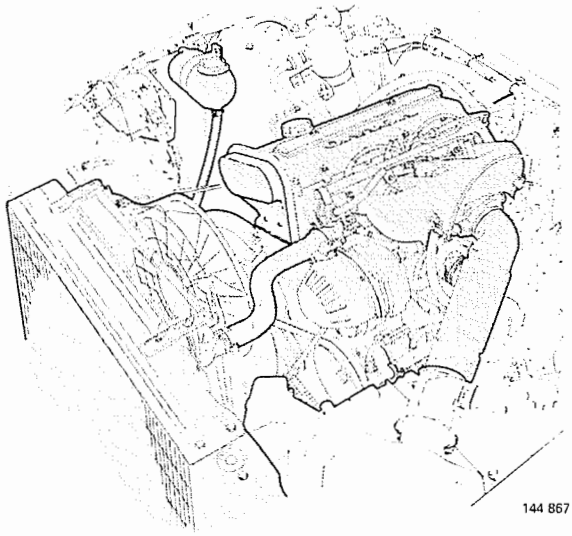
Remove tools 5006, 5033, 5115 and 5186.




AB24

**Tighten two uppermost bolts in flywheel housing**

Reattach front exhaust pipe to bracket.



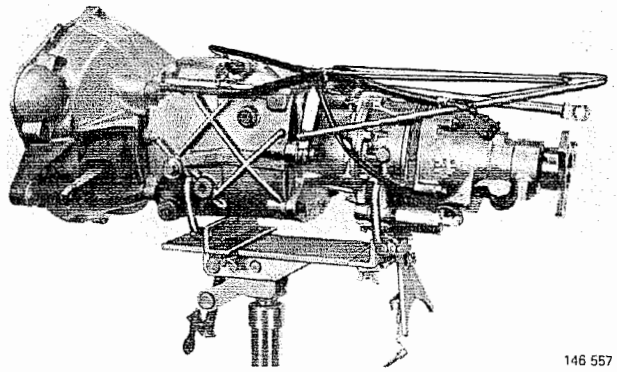

AB25

**Check operation**

Replace battery earth lead.

# AC. Ring gear, replacement

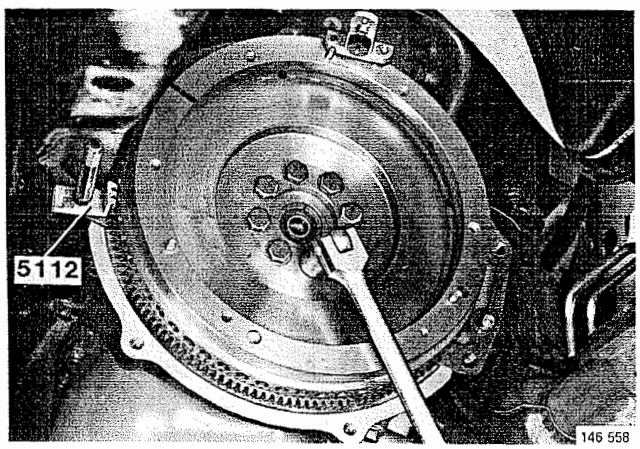
*Special tools: 5111, 5112*


146 557

**Ring gear replacement applies only to cars with manual gearboxes**

Strip gearbox to expose flywheel as described in operations **AB1–11**.

On cars with **automatic gearboxes**, carrier plate is replaced complete with ring gear. (See procedure **AD. Crankshaft rear seal, replacement**.)



146 558

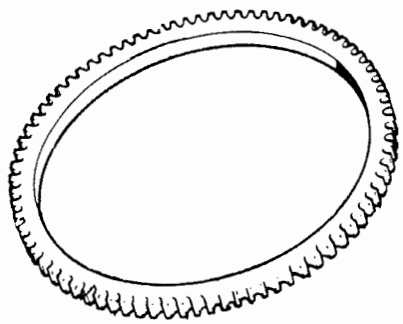
*AC1*

**Remove speed pick-up and unbolt flywheel**

Use gear sector **5112**.

Remove flywheel.

**N.B.** Remove speed pick-up **before** flywheel.


146 562

**+230 C°**
**(450 F°)**

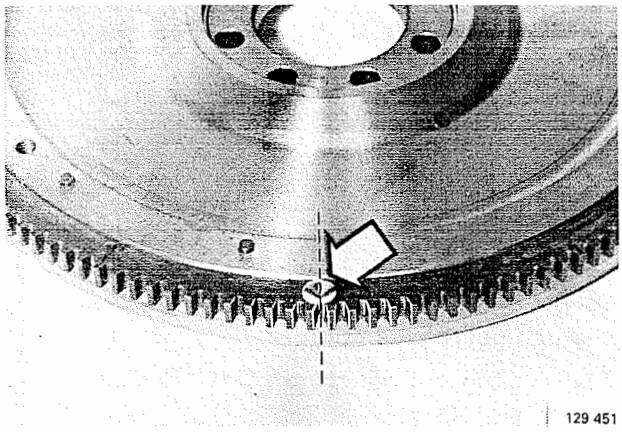
*AC2*

**Heat new ring gear to +230°C (450°F)**

Heat component in oven or using torch flame.

If using oven, commence procedure by heating component.

If using torch flame, heat component immediately prior to fitting.


129 451

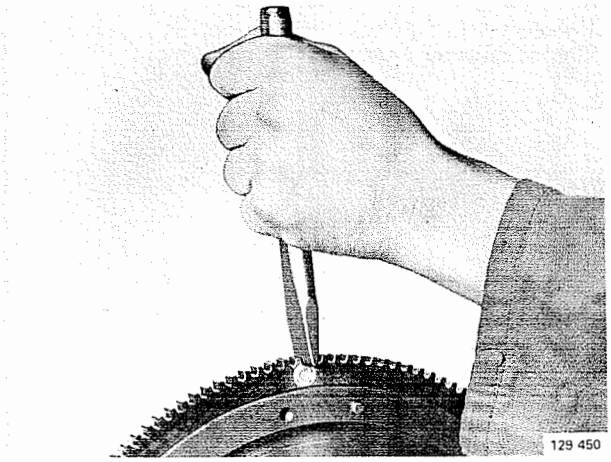
*AC3*

**Drill hole between two teeth**

Use **10 mm** drill.

Drill hole to depth of approx. 9 mm (3/8").

**Caution!** Avoid penetrating flywheel, otherwise out-of-balance may result.


129 450

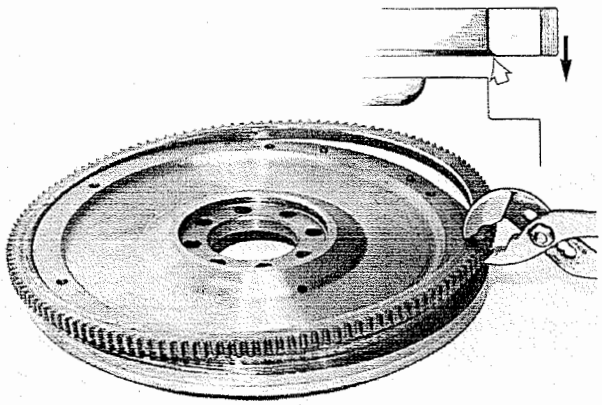
*AC4*

**Remove ring gear**

Clamp flywheel in vice between soft jaws.

Prise ring gear loose with screwdriver. If necessary, split component at drilled hole.

Clean mating surface on flywheel.


129 449

*AC5*

**Fit new ring gear**

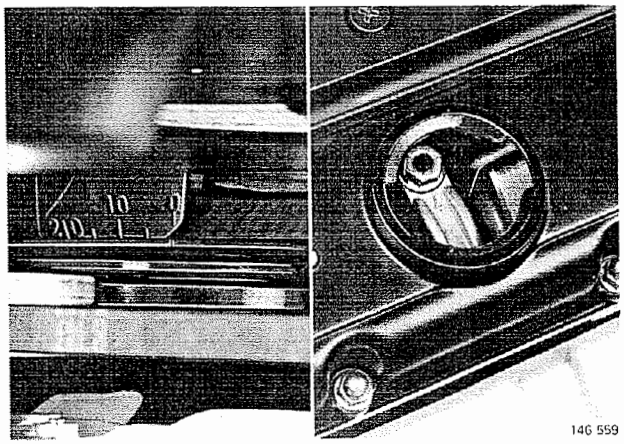
Check temperature with solder (40% tin and 60% lead). Solder melts at 220–230°C (430–450°F).

Place gear in position.

Tap gear fully home as required using brass drift.

Allow gear to cool.

**Important!** Bevelled edge must face flywheel.

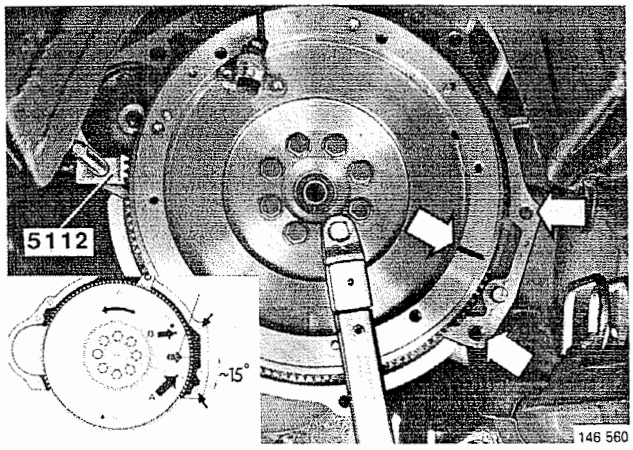

146 559

*AC6*

**Turn crankshaft to TDC (ignition) in No. 1 cylinder**

Align crankshaft pulley (vibration damper) marking with 0 mark on transmission cover.

Check that No. 1 cylinder cams on exhaust camshaft are pointing upwards at approx. 60° to centre line of engine.




*AC7*

**Replace flywheel**

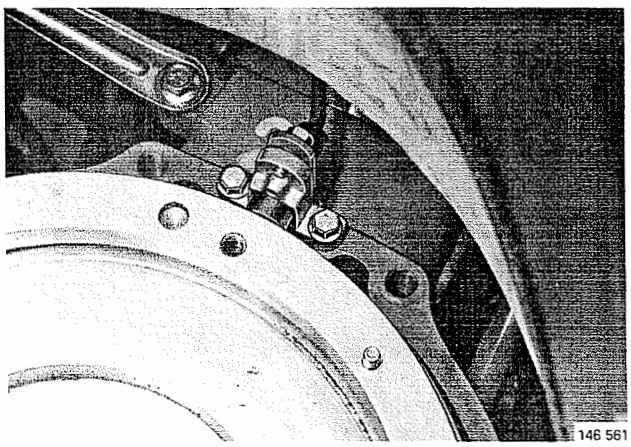
Use gear sector **5112**.

At **TDC, mark on** flywheel should be positioned between **the two lower** bolt holes on right-hand side of cylinder block.

> **Caution!** If flywheel is not marked, new position is indicated by pins **A** and **B** at rear.
>
> Pins **A** and **B** are located respectively approx. 15° on either side of marking position.

Use **new** bolts and **thread locking compound**.

Tighten to **70 Nm** (52 ft.lb).

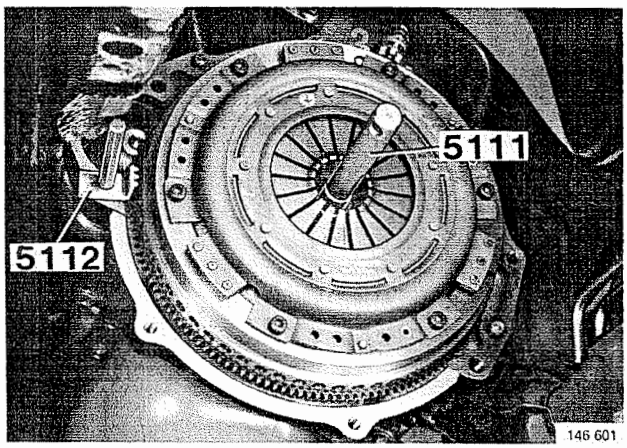



*AC8*

**Install speed pick-up**

Use thread locking compound.

Tighten to 5 Nm (3.5 ft.lb).




*AC9*

**Refit clutch plate and pressure plate**

Use centering tool **5111** and gear sector **5112**.

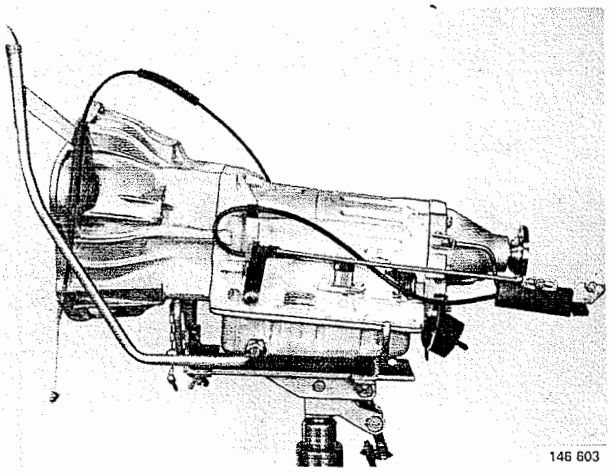
Tighten pressure plate in stages. Work around circumference tightening diagonally-opposite bolts alternately.

Remove centering tool and gear sector.

Install gearbox and propeller shaft as described in operations **AB16–26**.

# AD. Crankshaft rear seal, replacement

*Special tools: 1801, 5006, 5033, 5111, 5112, 5115, 5186, 5244, 5276, 5972*


146 603

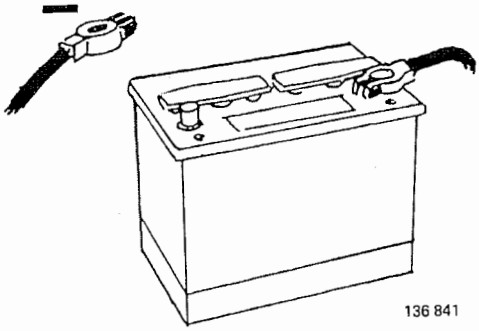
**Procedure applies to cars equipped with automatic gearboxes**

**Manual gearbox:**

Remove gearbox as described in operations **AB1-11**.

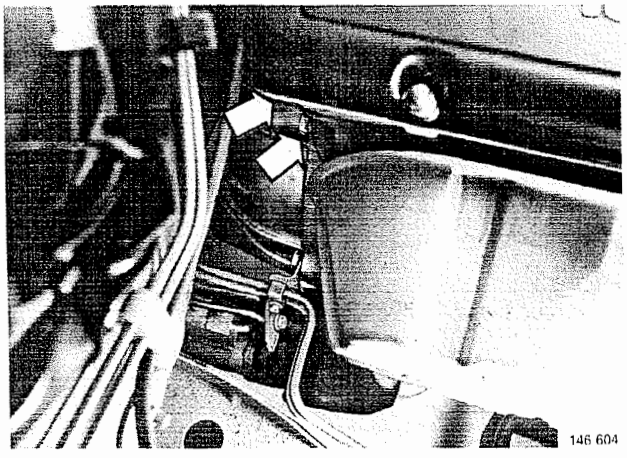
## Automatic gearbox

*AD1*


136 841

**Disconnect battery earth lead**

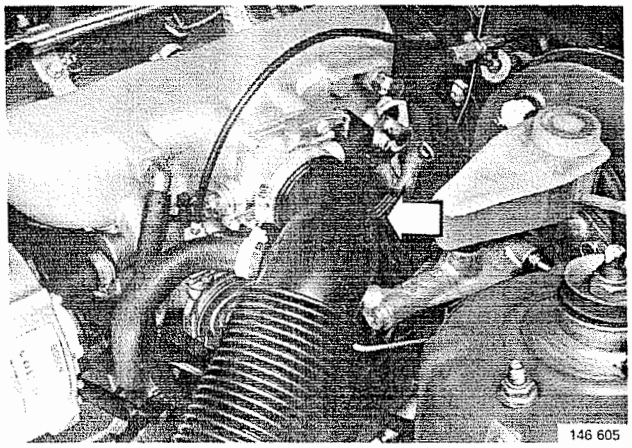
*AD2*


146 604

**Remove bolts securing front exhaust pipe to bracket**

Remove upper mounting bolts in torque converter housing.

Remove retaining clip for oil cooler lines.

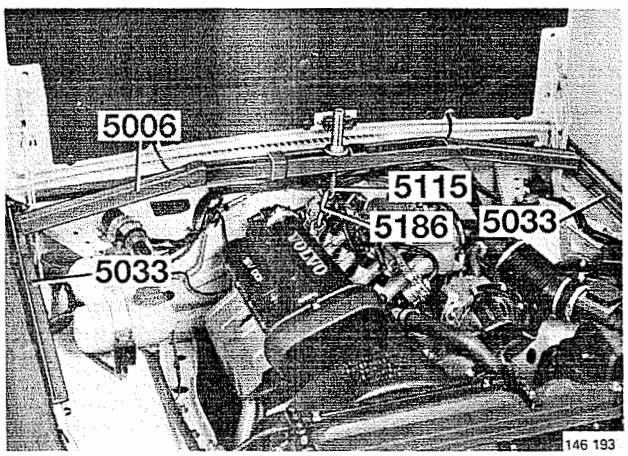

146 605

AD3

**Release kickdown cable**

Remove transmission oil dipstick.

**N.B.** Cover open end of dipstick tube.



146 193

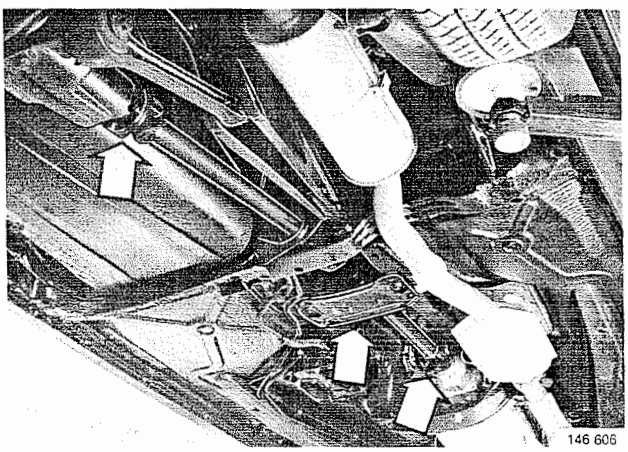
AD4

**Relieve weight on gearbox rear mounting**

Use support bars **5033**, lifting yoke **5006**, and lifting hooks **5115** and **5186**.

Raise unit using rear left-hand lifting lug.

Take care to avoid damage to wiring harness.


146 606

AD5

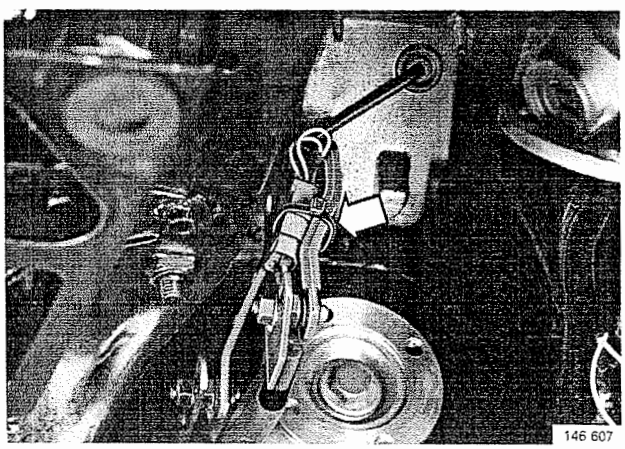
**Remove propeller shaft**

Use socket **5244**.

Separate front and rear universal joints.

Unbolt intermediate bearing from member.

Withdraw propeller shaft backwards.

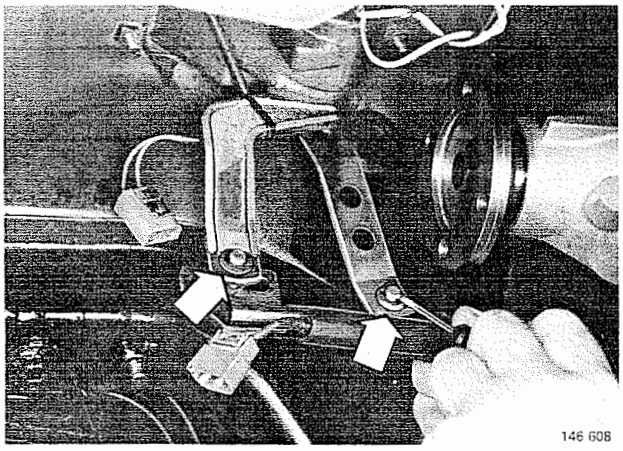

146 607

AD6

**Free gearbox wiring**

Cut lower cable tie at lever mounting.

Separate wiring connectors.

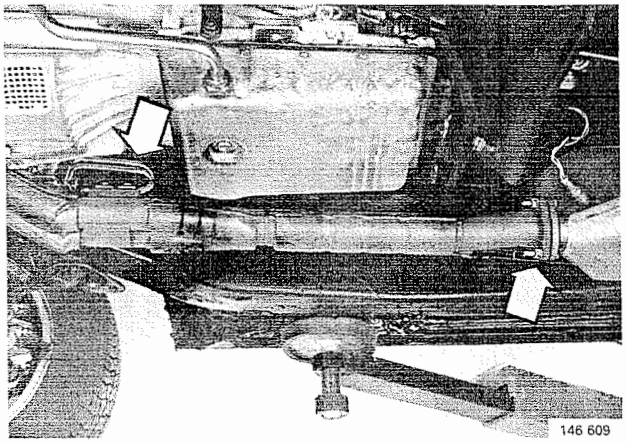



*AD7*

**Release gear selector lever**

Remove clips from pivoted joints between selector lever and selector rod/reaction arm.

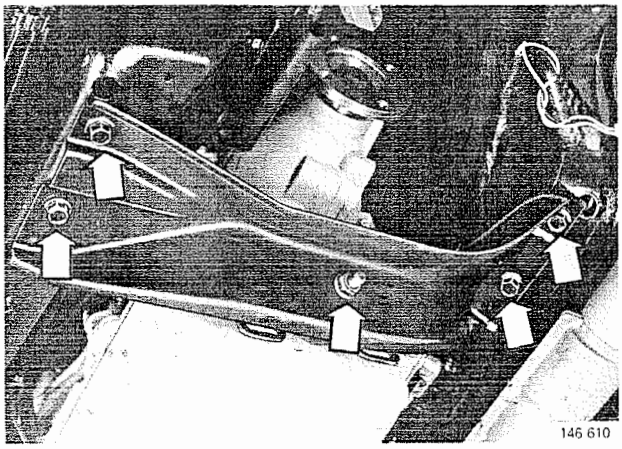
Withdraw selector rod and reaction arm from mounting.




*AD8*

**Undo bolted joint at front of catalytic converter**

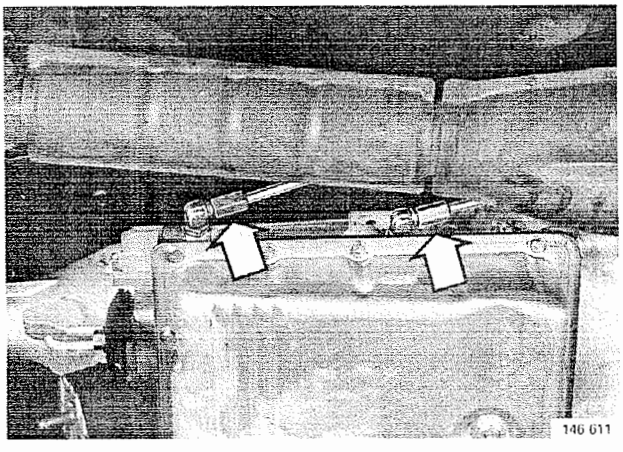
Remove front exhaust pipe bracket.




*AD9*

**Remove gearbox support member**

Separate member from gearbox bump stop and side members.

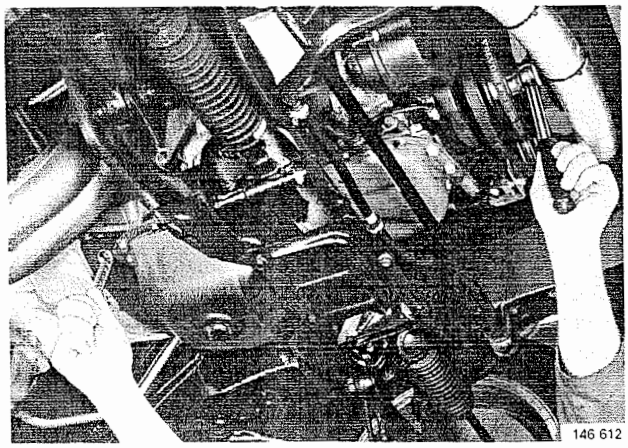



*AD10*

**Disconnect transmission oil lines at gearbox**

Collect leakage oil in container or mop up with paper.

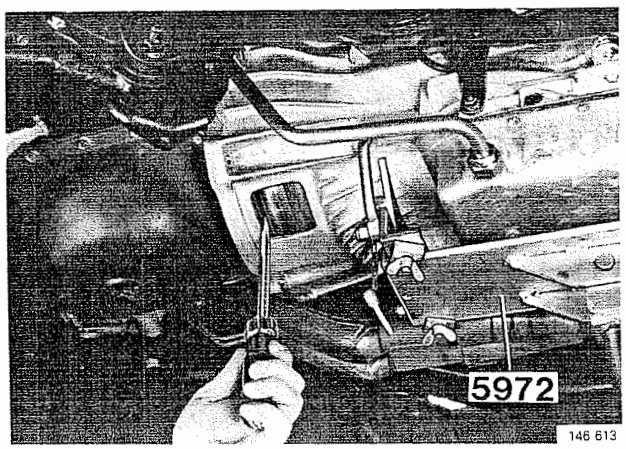
Plug connections.


146 612

AD11

**Remove:**

- splashguard under engine
- reinforcing bracket between engine and gearbox
- bolts securing torque converter to carrier plate
- ventilation grille over torque converter



146 613

AD12

**Remove gearbox**

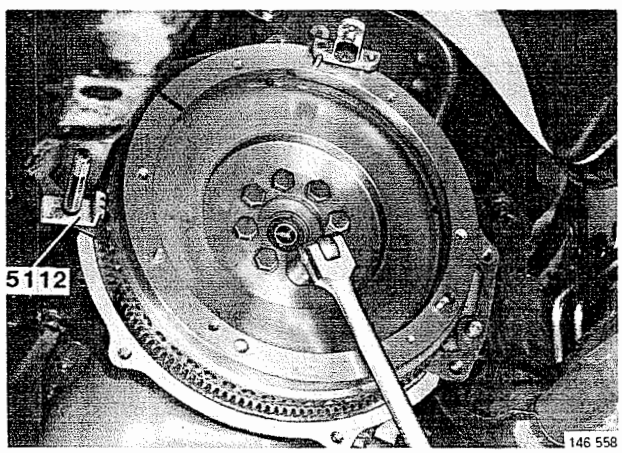
Place fixture **5972** under gearbox.

Remove remaining bolts in torque converter housing.

**Carefully** prise torque converter free of carrier plate.

Lower gearbox, inclining unit backwards very slightly to prevent torque converter slipping off shaft.

**N.B.** Position fixture **5972** with fork at front under gearbox.



146 558

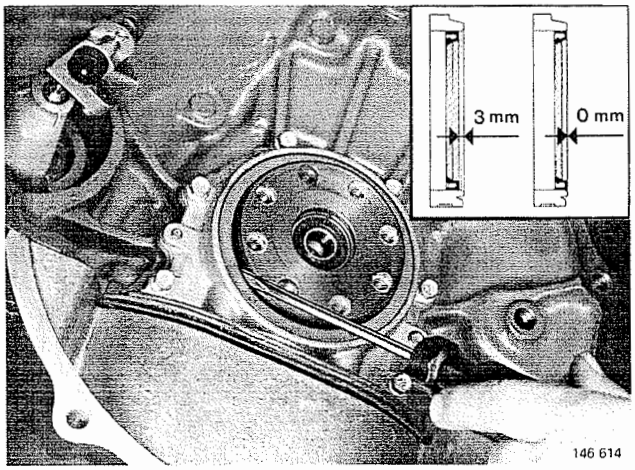
AD13

**Remove speed pick-up and unbolt flywheel/ carrier plate**

Use gear sector **5112**.

Remove flywheel/carrier plate.

**N.B.** Speed pick-up must be removed **before** flywheel/ carrier plate.




*AD14*

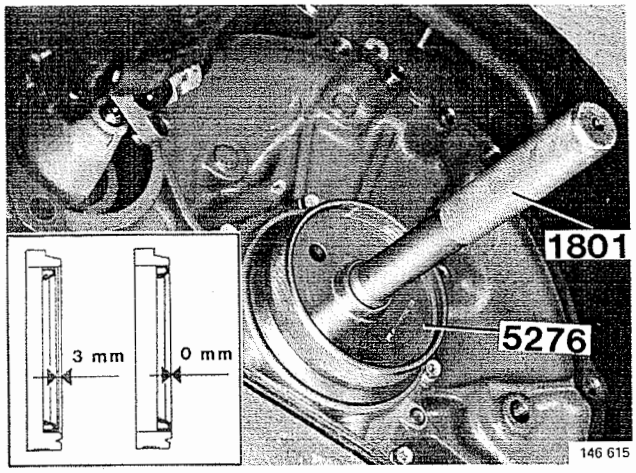
**Remove crankshaft seal**

Prise out seal **carefully** with screwdriver.

Take care to avoid damaging sealing faces on shaft and seating flange.

Clean seat in flange and inspect shaft for grooving, indicating wear.

**Important!** Note position of seal in relation to seating flange.




*AD15*

**Press seal into rear seating flange**

Assemble standard handle **1801** and assembly tool **5276**.

Oil mating surfaces between flange and seal, and between lips of seal.

Place seal on drift.

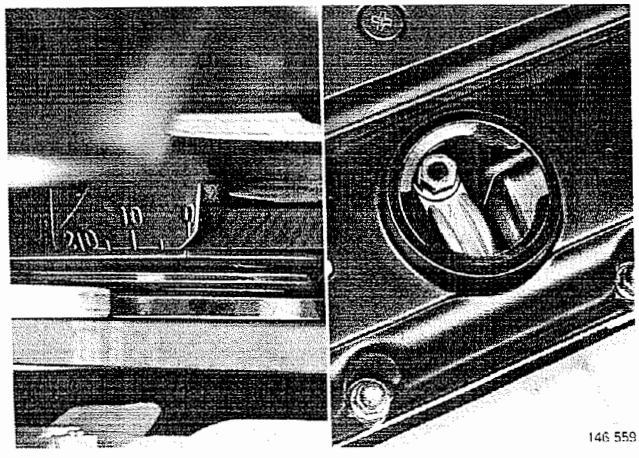
Locate seal further in than before if wear mark is present on crankshaft.

Remove **one** spacer from drift if original seal was flush with flange.

Remove **two** spacers from drift if original seal was located 3 mm inside flange.

Leave both spacers in position if crankshaft is undamaged.

Tap in seal until drift meets crankshaft.

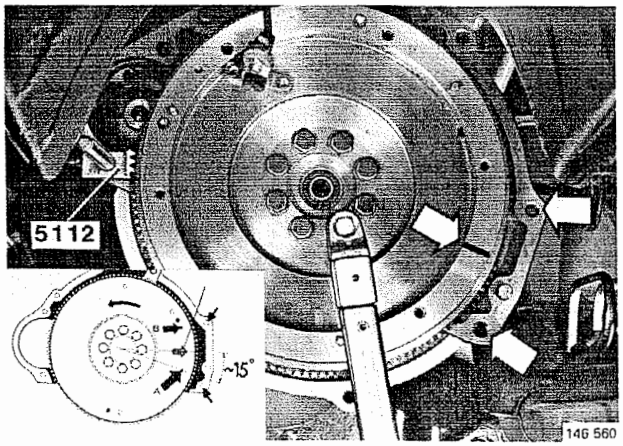



*AD16*

**Turn crankshaft to TDC (ignition) in No. 1 cylinder**

Align vibration damper marking with 0 mark on transmission cover.

Check that No. 1 cylinder cams on exhaust camshaft are pointing upwards at approx. 60° to centre line of engine.




*AD17*

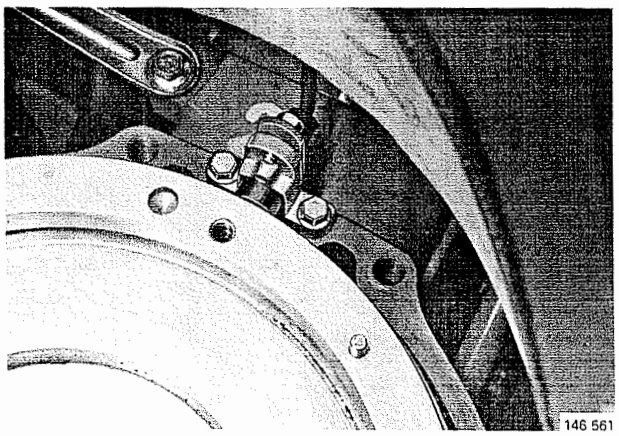
### Replace flywheel/carrier plate

Use gear sector **5112.**
At TDC, mark on flywheel/carrier plate should be positioned between the two lower bolt holes on right-hand side of cylinder block.

> **Caution!** If flywheel is not marked, new position is indicated by pins **A** and **B** at rear.
>
> Pins **A** and **B** are located respectively approx. 15° on either side of marking position.

Use **new** bolts and **thread locking compound.**
Tighten to **70 Nm** (52 ft.lb).

**Automatic gearbox:** Note location of support plates. Outer plate must be installed with edge facing outwards.




*AD18*

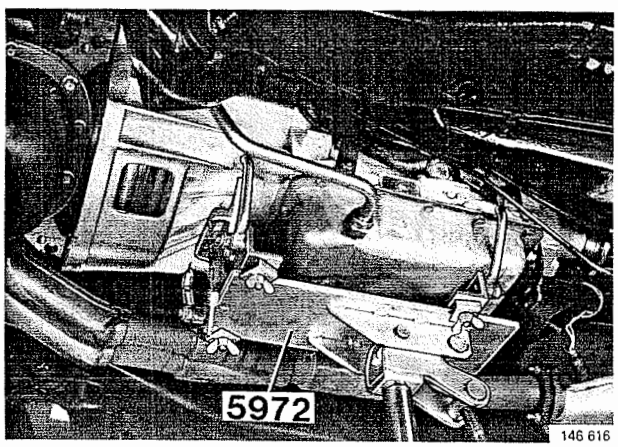
### Install speed pick-up

Use thread locking compound.

Tighten to 5 Nm (3.5 ft.lb).

### Cars equipped with manual gearboxes:

Install clutch and gearbox as described in operations **AB15–26.**




*AD19*

### Install gearbox

Use fixture **5972.**

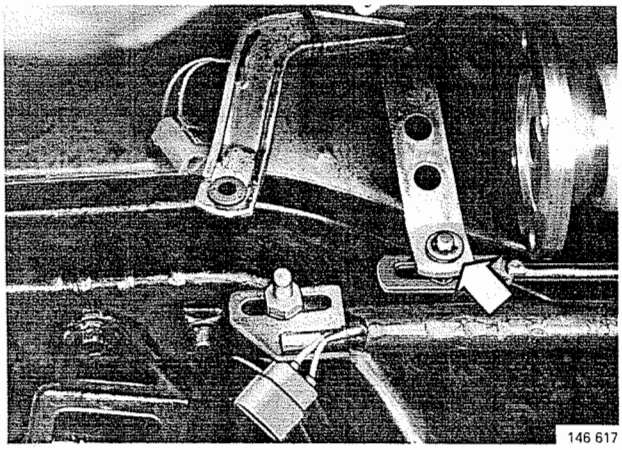
Lift gearbox, tilting unit slightly backwards.

Align torque converter with carrier plate.

Tighten gearbox in position.

Reattach front exhaust pipe bracket to torque converter housing.

Remove fixture 5972.



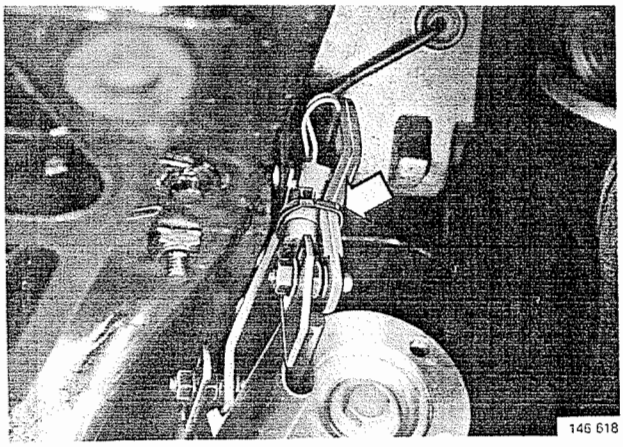

*AD20*

**Reconnect gear selector lever**

Reattach selector rod and reaction arm to lever mounting.

Install locking clips.

**N.B.** Fit selector rod with flat washer.

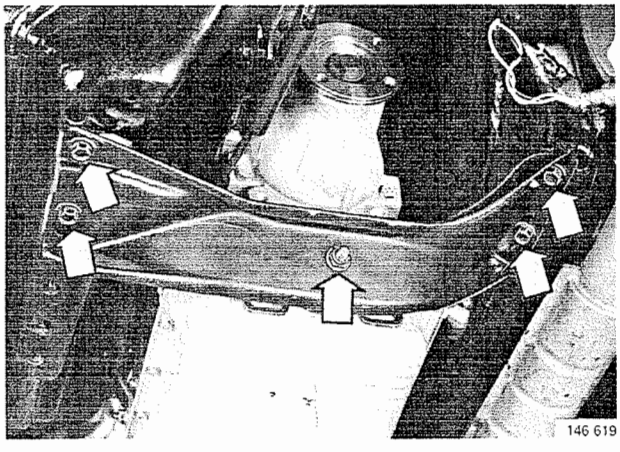



*AD21*

**Reconnect gearbox wiring**

Reconnect wiring connectors.

Install cable tie at gear selector mounting.

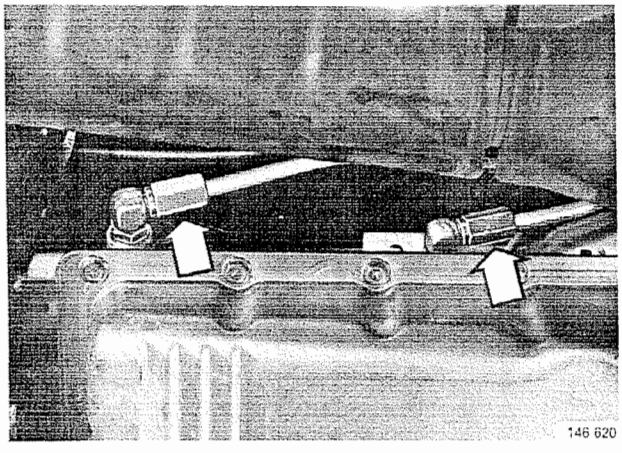



*AD22*

**Install gearbox support member**

Rebolt support member to side members.

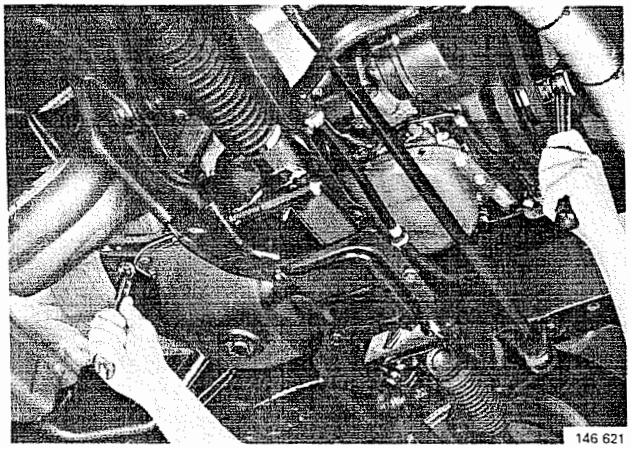
Tighten bump stop. (Ensure that oxygen sensor lead is above member.)




*AD23*

**Reconnect transmission oil lines**

Reconnect and tighten unions on gearbox.


146 621

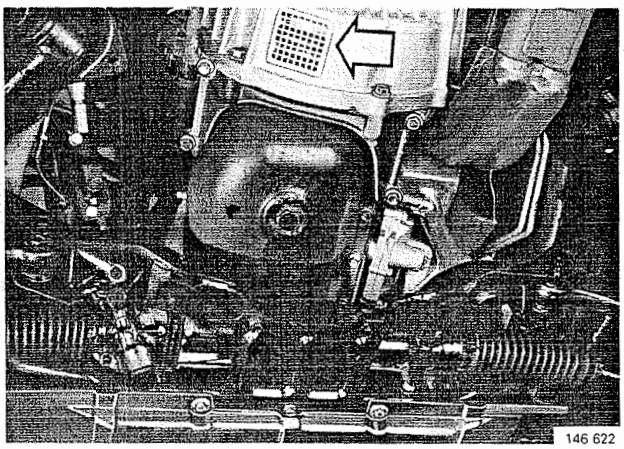
*AD24*

**Tighten torque converter on carrier plate**

Finger-tighten all bolts.

Tighten bolts alternately.

Tightening torque 45 Nm (33 ft.lb).


146 622

*AD25*

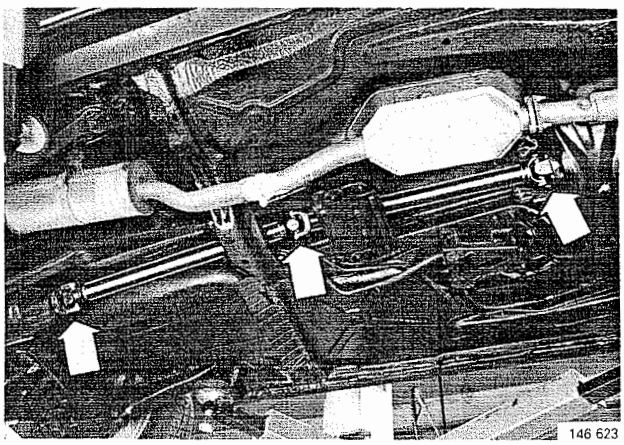
**Install reinforcing bracket**

Tighten bracket in stages.

Attach bracket first to torque converter housing and then to cylinder block.

Install ventilation grille.

Install splashguard under engine.


146 623

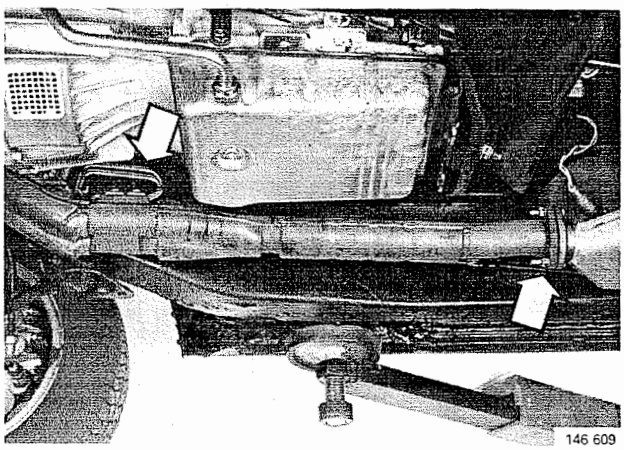
*AD26*

**Install propeller shaft**

Use socket **5244**.

Tighten front and rear universal joints.

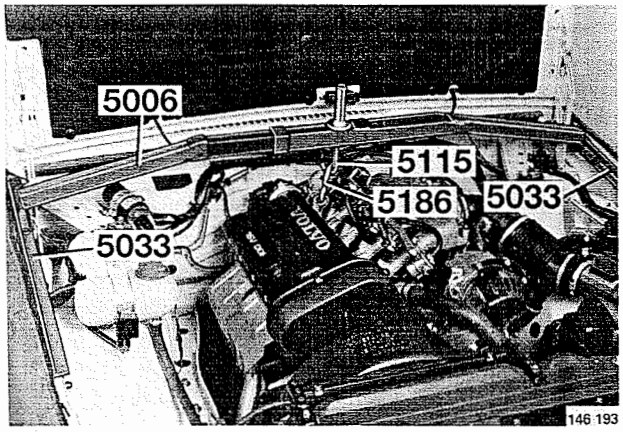
Rebolt intermediate bearing to member.


146 609

*AD27*

**Retighten bolted joint in front of catalytic converter**

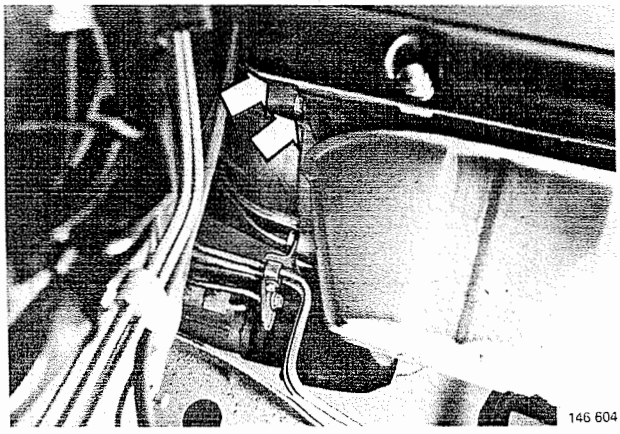
Install front exhaust pipe bracket.




*AD28*

**Remove lifting attachments**

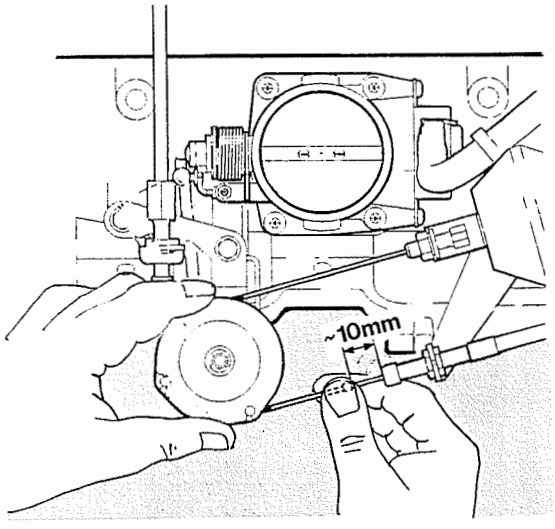
Remove tools 5006, 5033, 5115 and 5186.




*AD29*

**Tighten two uppermost bolts on torque converter housing**

Reattach front exhaust pipe to bracket.



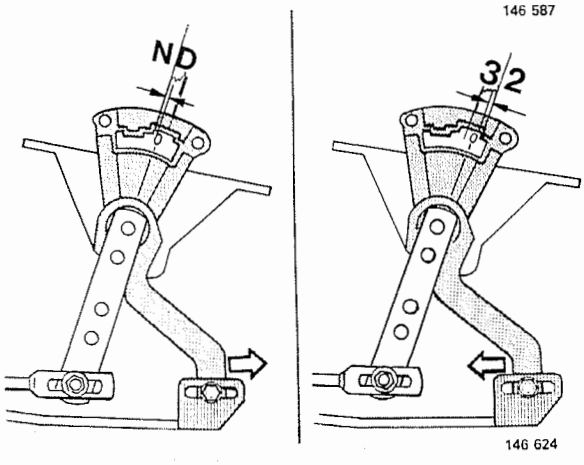

*AD30*

**Connect kickdown cable to throttle pulley**

Check cable adjustment.

Replace transmission oil dipstick.

**N.B.** See procedure **AS** for checking/adjustment of kick-down cable.




*AD31*

**Check operation**

Reconnect battery earth lead.

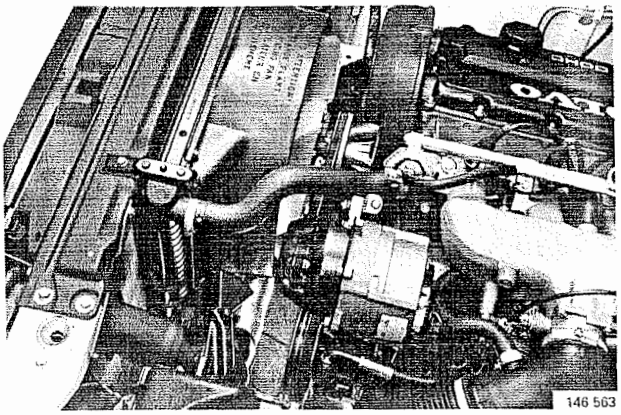
Check gear selector play in **D** and **N** positions.

Play should be the same or somewhat less than in positions 1 and 2.

Check transmission oil level.

# AE. Crankshaft pulley (vibration damper), replacement

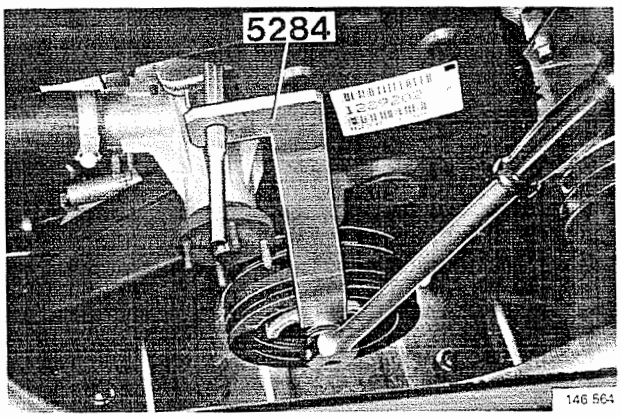
*Special tool: 5284*


146 563

*AE1*

**Remove:**

- battery earth lead
- alternator drive belt
- radiator fan and pulley
- fan shroud
- servo pump and (if fitted) AC compressor drive belts



146 564

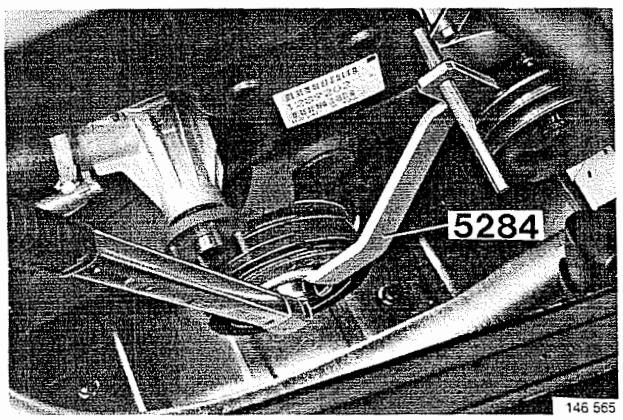
*AE2*

**Remove crankshaft pulley (vibration damper) from crankshaft**

Lock pulley using counterhold **5284**.

Secure counterhold using implement such as drift placed against cylinder head over coolant pump.

**N.B.** Counterhold **5284** must **not** be locked against pump throat.



146 565

*AE3*

**Replace pulley on crankshaft**

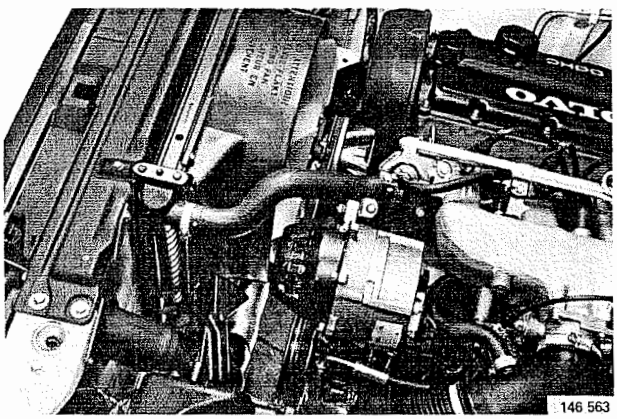
Use counterhold **5284**.

Check that slot in damper engages projection on timing belt pulley.

Secure counterhold using implement such as drift placed against auxiliary mounting bracket.

Tighten crankshaft bolt in two stages:

1. Tighten to **60 Nm** (44 ft.lb).
2. Tighten through further **60°**.


146 563

*AE4*

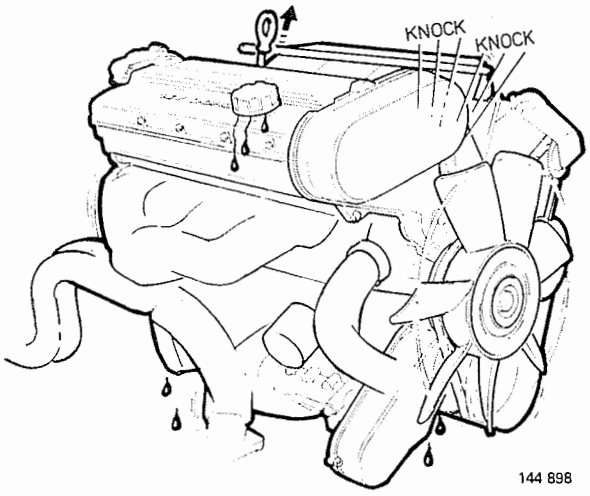
**Install:**

- fan shroud
- radiator fan and pulley
- all drive belts
- battery earth lead

Start engine and check operation.

# AF. Crankshaft front seal, replacement

*Special tools: 5283, 5284, 5872*



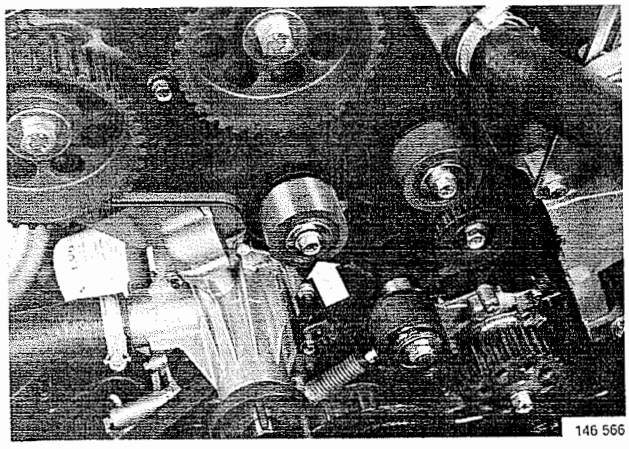
144 898

**Check that flame trap is not blocked**

Flame trap blockage restricts crankcase ventilation and increases crankcase pressure.

Symptoms of flame trap blockage:

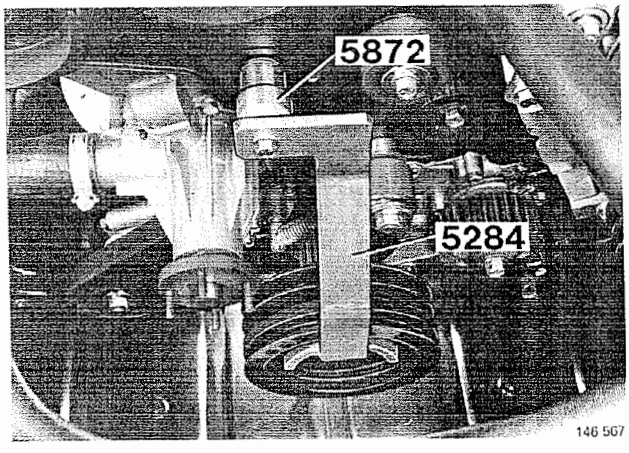
- Oil dipstick tends to lift in tube.
- Oil leakage from cylinder block seals.
- Seals do not always require renewal if leakage is due to this cause. Overhaul flame trap, clean engine and reinspect for seal leakage.
- Engine knocks.


146 566

Remove timing/balance shaft belts as described in operations **C1–9**.

*AF1*

**Remove timing belt right-hand idler**



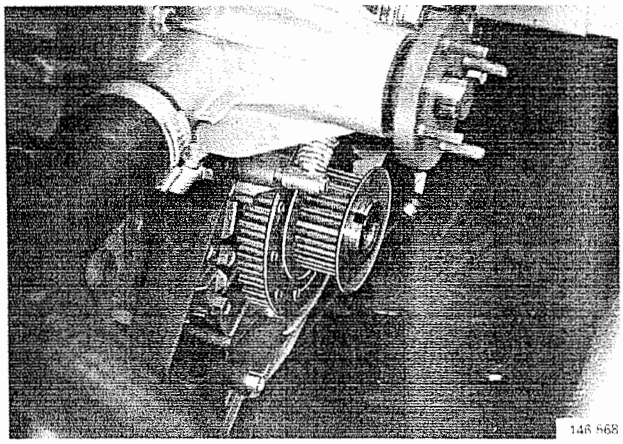
146 567

*AF2*

**Remove crankshaft pulley (vibration damper)**

Use counterhold **5284** and guide **5872**.

Mount counterhold using M8 × 80 mm flanged bolt, using guide as spacer between counterhold and cylinder head, in right-hand idler bolt hole.

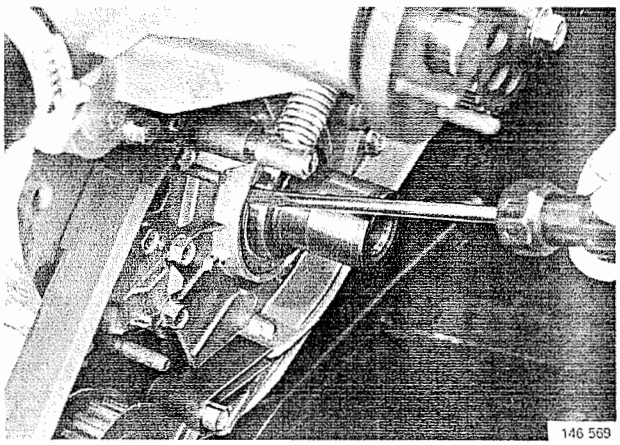



*AF3*

**Remove timing/balance shaft drive pulleys**

Remove timing belt outer guide, pulley and inner guide.

Remove balance shaft pulley.

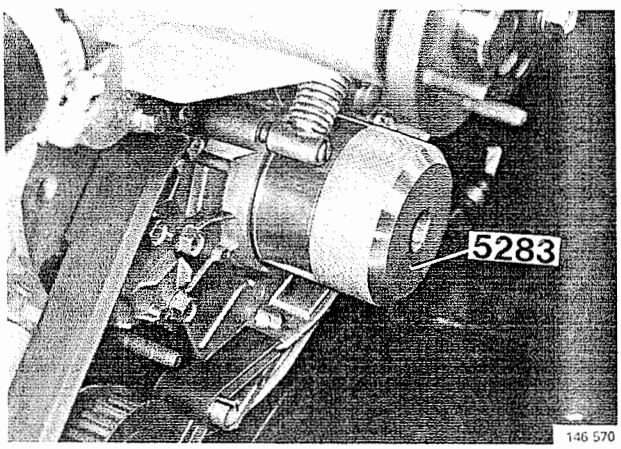



*AF4*

**Remove seal**

Prise out seal **carefully** using screwdriver, taking care to avoid damaging sealing faces on shaft and in seating flange.

Clean crankshaft end and seating flange. Inspect shaft for signs of wear.




*AF5*

**Fit new seal**

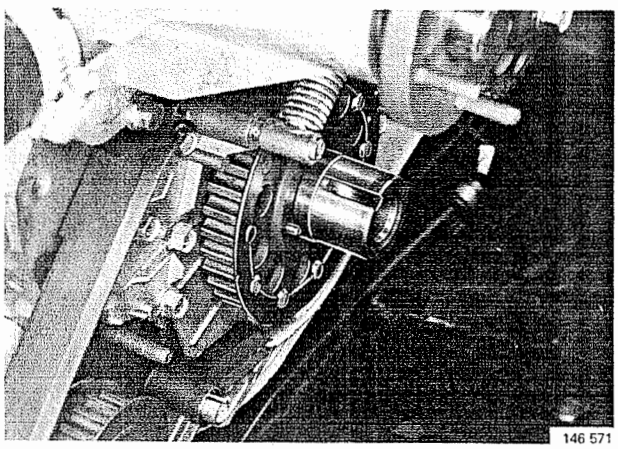
Use tool **5283**.

Grease seal.

Place seal on tool.

Tap seal home into seating flange.

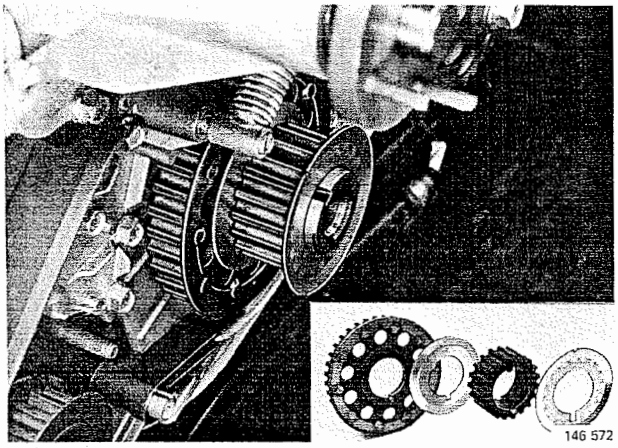
**N.B.** Face of seal should normally be flush with chamfered edge in housing. However, if shaft end shows signs of wear, seal may be located approx. 3 mm further in.




*AF6*

**Install balance shaft drive pulley**

**N.B.** Guide must face outwards.


146 572

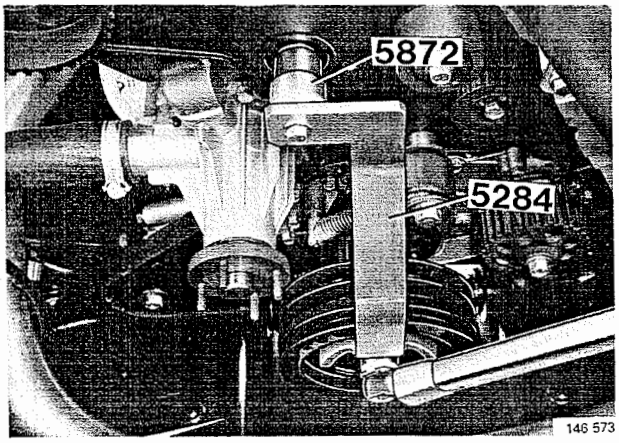
*AF7*

**Install timing belt pulley and guides**

**Install:**

- inner guide
- drive pulley
- outer guide

**N.B.** Slot in pulley must face cylinder block and must engage guide pin on balance shaft drive pulley.



146 573

*AF8*

**Install crankshaft pulley (vibration damper)**

Use counterhold **5284** and guide **5872**.

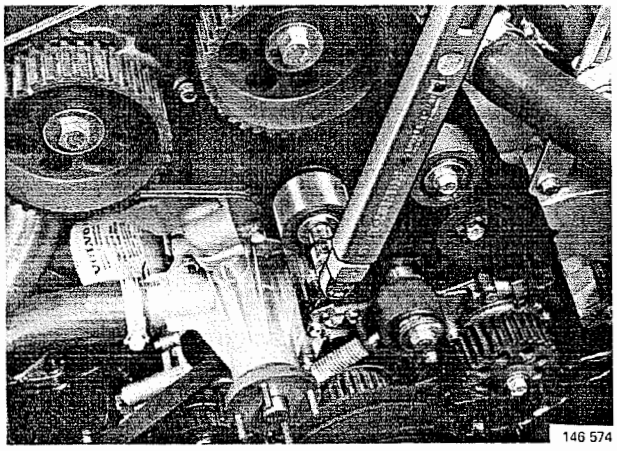
Check that slot in damper engages projection on timing belt pulley.

Mount counterhold using M8 × 80 mm flanged bolt, using guide as spacer between counterhold and cylinder head, in right-hand idler bolt hole.

Tighten crankshaft bolt in two stages:

1. Tighten to **60 Nm** (44 ft.lb).
2. Tighten through further **60°**.

Turn crankshaft to TDC in No. 1 cylinder.


146 574

*AF9*

**Install right-hand idler**

Tighten to **25 Nm** (18.5 ft.lb).

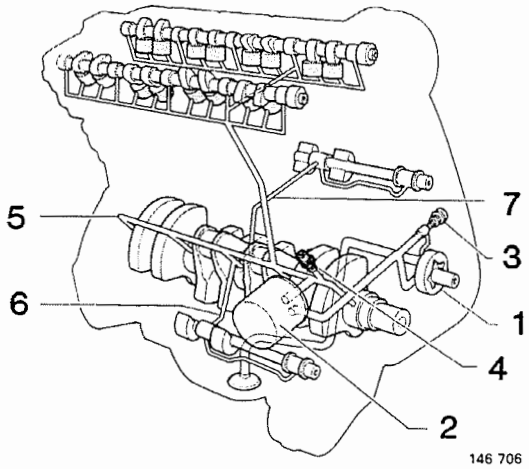
Install timing/balance shaft belts as described in operations **C10-37**.

**N.B. See table** of tension values in specifications (page 11) if replacing existing timing/balance shaft belts.

# Group 22 Lubrication system

## Contents

# Lubrication system
# Design/function




## Oil supply

Driven by the timing belt, the **oil pump** (1) draws oil through a strainer in the sump.

The **oil filter** (2) (to which the oil flows through a passage at the front of the cylinder block) is mounted on the opposite side to the pump. The filter is of the conventional type.

The **oil pressure regulator** (3) limits the pressure in the system to 0.86 MPa (122 psi).

Located in the passage downstream of the filter, the **oil pressure switch** (4) operates the low oil pressure warning lamp.

The **crankshaft** (5) is lubricated in conventional manner through passages cast and drilled in the block, and oilways in the shaft itself.

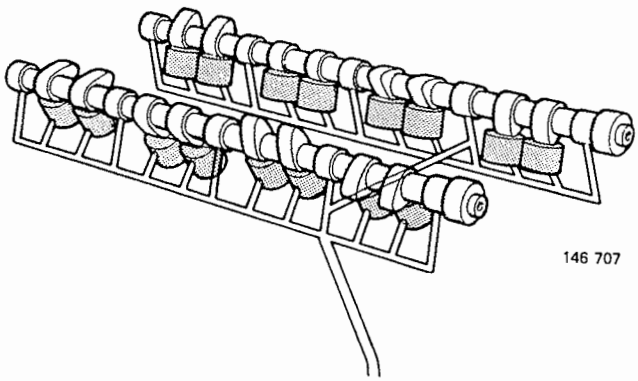
The **pistons and cylinder walls** are lubricated by oil mist and by splash lubrication from the crankshaft.

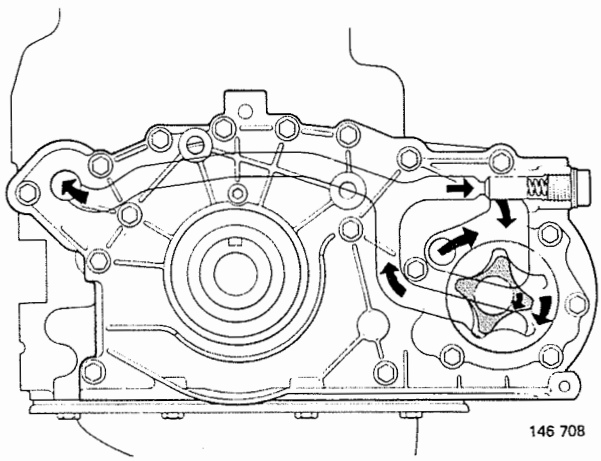
Lubrication for the **right-hand balance shaft** (6) is supplied through a passage formed in the right-hand side of the block.

The **left-hand balance shaft** (7) is lubricated from the third main crankshaft bearing through a milled slot.

The **camshafts** and **hydraulic tappets** are supplied with lubricating oil under pressure through a channel adjacent to the second cylinder head bolt on the right-hand side. Within the head, the channel is integral with the bolt for half of its length, following which the oil is conveyed through a drilled passage to the gallery on the right-hand side of the camshaft carrier.

The left-hand gallery, which supplies the camshaft and tappets on that side, is supplied with pressurized oil through a passage connecting it with the right-hand gallery.



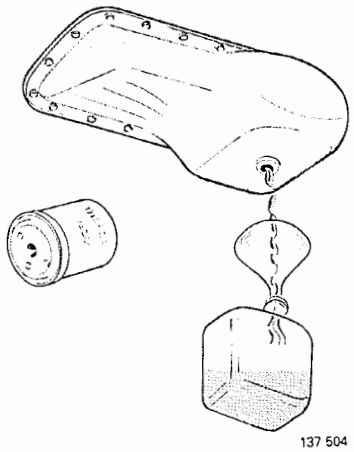

## Oil pump.

A higher oil flow is required to supply the new components – balance shafts, second camshaft and hydraulic tappets – particularly when the engine is hot.

The new pump is an Eaton type – essentially an internal gear pump consisting of a 4-lobed rotor running inside a 5-lobed ring. The pumping action is achieved by the continuous increase and decrease in volume which occurs as the elements rotate. Although the capacity is comparable to that of earlier gear pumps, it is higher at low speeds and when the oil is hot (120°C/250°F). The capacity at an engine speed of 4000 r/min is approximately 360 l/min (95 US gpm).

# AG. Oil and oil filter, changing

*Special tool: 2903*


137 504

### Changing engine oil

Always use oil of the correct grade:

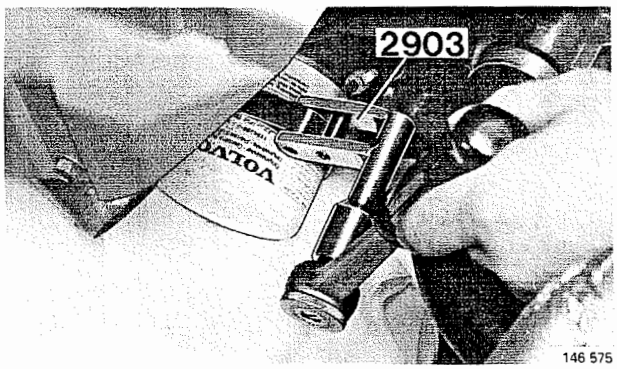
As per API-Service..... min. **SF***
As per CCMC..... class **G2/G3**

*Oils designated SF/CC and SF/CD fulfil this requirement.

Ensure engine is hot before draining oil.

Use **new** sump plug seal.
Torque 60 Nm (44 ft.lb).

Capacity, excl. oil filter..... **3.5 l** (3.7 US qt)
incl. oil filter..... **4.0 l** (4.2 US qt)



146 575

## Oil filter, replacement

*AG1*

### Remove oil filter

Use tool **2903**.

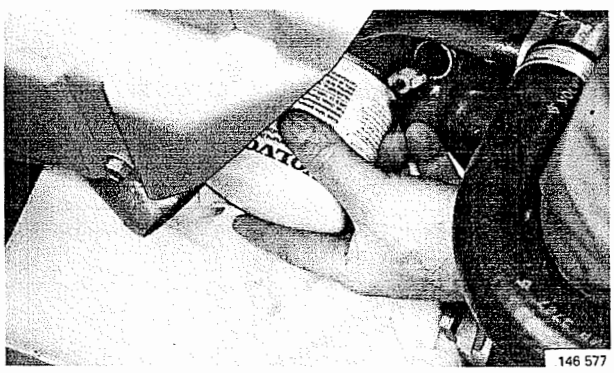
Remove filter from engine compartment side. Use paper or waste to mop up oil spillage.


146 576

*AG2*

### Install new oil filter

Coat face of seal with oil.


146 577

*AG3*

### Tighten oil filter

Screw home filter by hand until seal makes firm contact. Tighten a further ½–¾ turn.

Fill engine with oil.

Start engine.

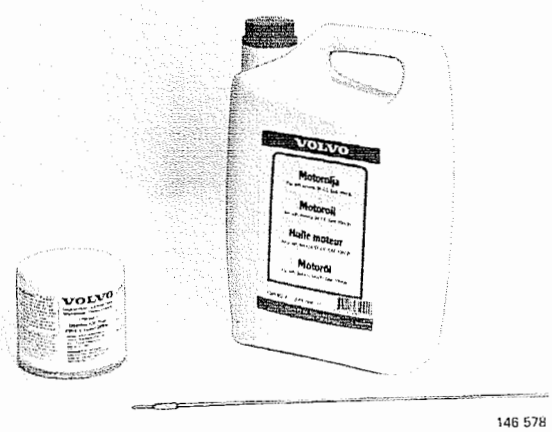
Inspect filter for leakage.

When replacing filter only:

Top up engine with **0.5 l** (0.5 US qt) of oil.

# AH. Oil pressure, checking

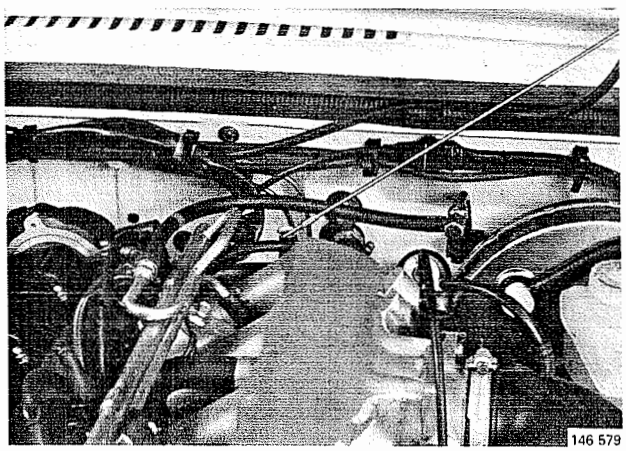
*Special tool: 5270*



146 578

**Check oil pressure with engine hot and oil at correct level**

Engine oil must be of recommended grade and type. Genuine Volvo oil filter must be fitted.


146 579

*AH1*

**Check engine oil level**

Top up as required.

If grade/type of oil and filter condition **cannot** be ascertained, replace filter and change oil.

146 580

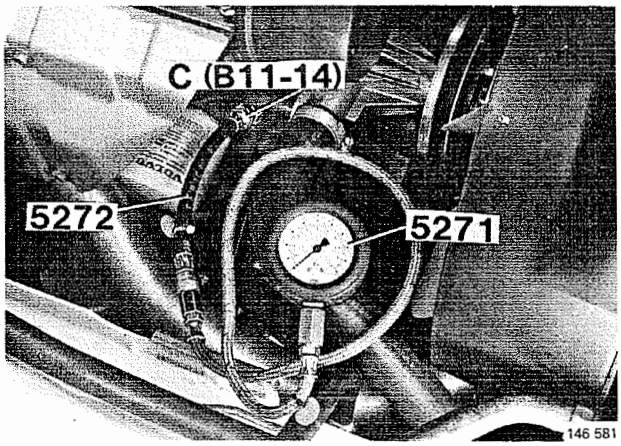
*AH2*

**Check oil pressure switch**

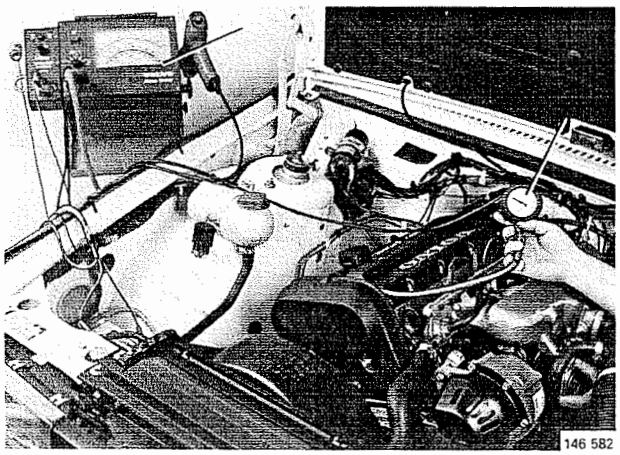
If pressure indication is absent:
- check switch lead and connector
- check switch type and function; fit new switch if necessary
- check for faulty lead between switch and warning lamp

**N.B.** Use **new** gasket between switch and cylinder block when switch is finally reinstalled.

*AH3*



146 581


146 582

**Check oil pressure**

Use instrument kit **5270.**

*Connect adapter C (B11-14), tube* **5272** and instrument **5271** to pressure switch tapping on cylinder block.

Connect rev counter.

Start engine and read oil pressure at different speeds.

**N.B.** Use **new** gasket between switch and cylinder block when switch is finally reinstalled.

Minimum oil pressure

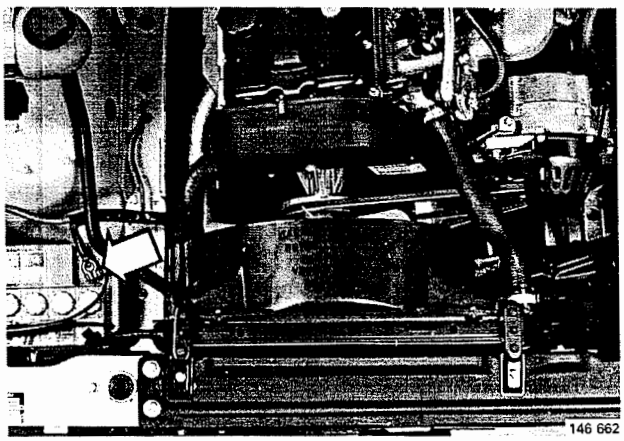
15 r/s (900 r/min) ..... **0.10 MPa**
33 r/s (2000 r/min) ..... **0.25 MPa**
50 r/s (3000 r/min) ..... **0.50 MPa**

Maximum oil pressure (with relief valve open): ..... **0.80 MPa**

**If readings are not satisfactory:**

Check oil pressure regulator as described in operations **AI1-7.**

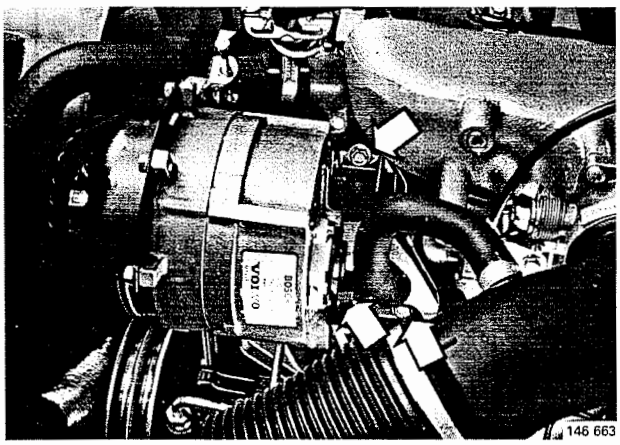
# AI. Oil pressure regulator, checking


146 662

*AI1*

**Remove:**

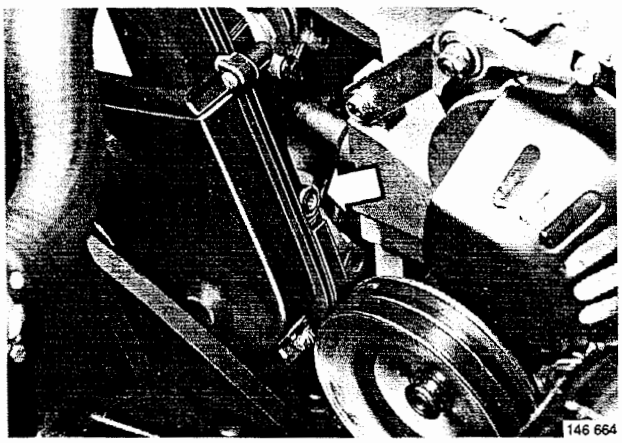
- battery earth lead
- alternator drive belt
- servo pump and (if fitted) AC compressor drive belts


146 663

*AI2*

**Detach alternator bracket from cylinder block**

Tie up bracket out of way..


146 664

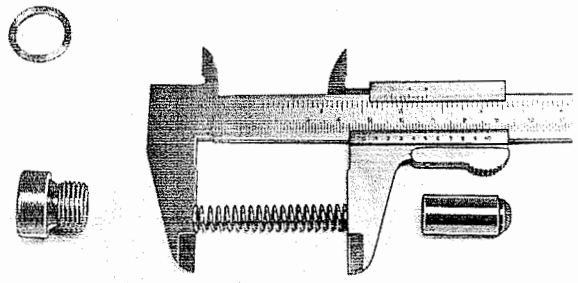
*AI3*

**Remove relief valve**

Remove plug over spring.

Remove spring and plunger.

AI4



146 665

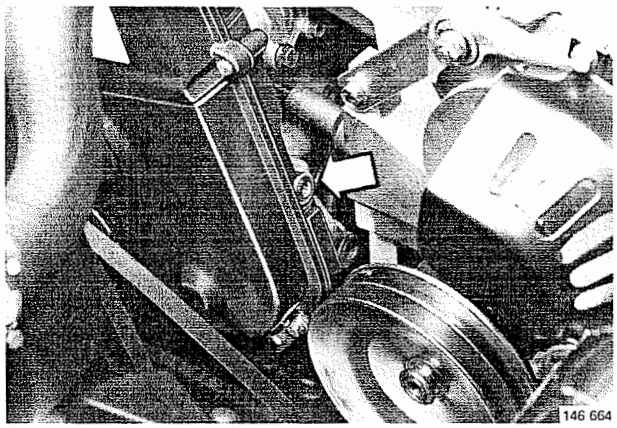
**Clean and inspect components**

Check plunger for wear.

Measure spring length:

Length, unloaded..... **47.6 mm** (1.87 in)
(44±4 N/10±0.9 lb ..... 32.0 mm/1.25 in)
(61±6 N/14±1.4 lb ..... 26.0 mm/1.02 in)

AI5



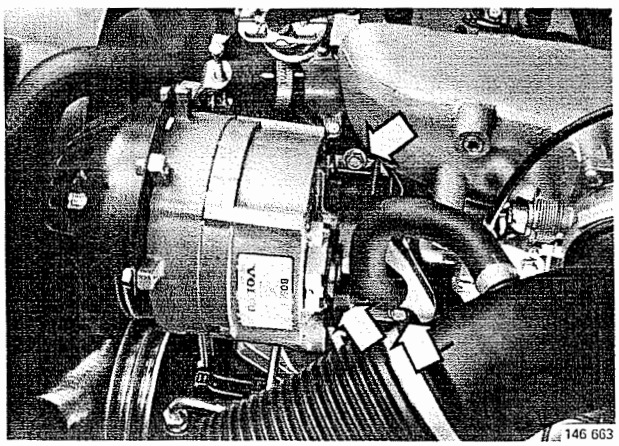
146 664

**Install relief valve**

Fit **new** sealing washer.

Tighten to **40±4 Nm** (29.5±3 ft.lb).

AI6

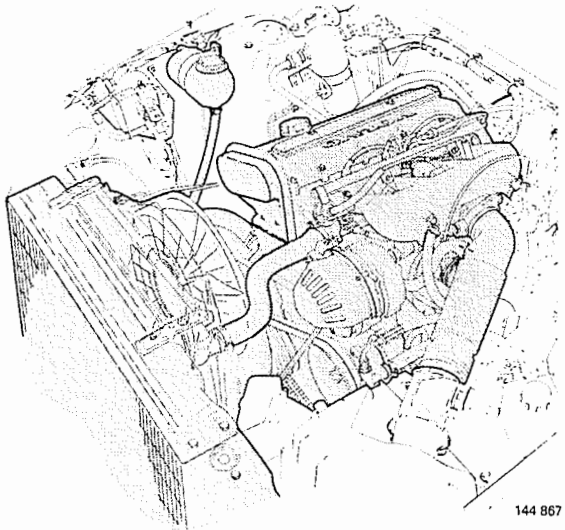


146 663

**Install:**

- alternator bracket
- all drive belts
- battery earth lead

AI7



144 867

**Check operation/inspect for leaks**

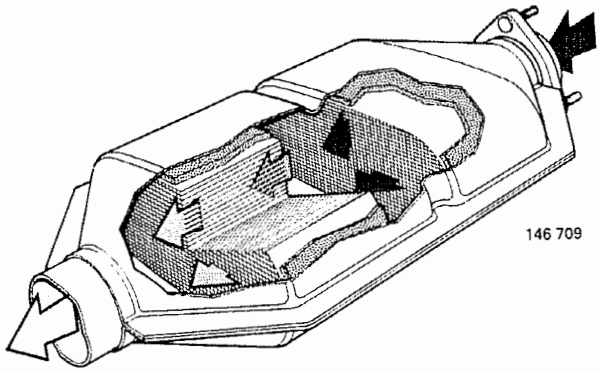
Test run engine.

See procedures **H, I** and **J** for details of other work on lubrication system.

# Group 25 Intake and exhaust systems

## Contents

# Design/function




### Catalytic converter

The three-way catalytic converter is used to purify the exhaust gases of unburnt residues of
- carbon monoxide (CO)
- hydrocarbons (HC)
- nitrous oxides (NOx)

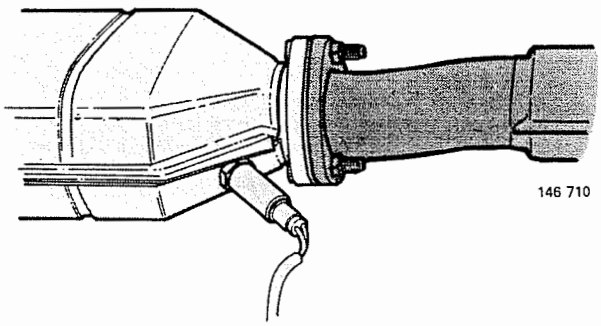
by chemical reaction i.e. combustion with unburnt oxygen.

The unit converts 90-95% of these noxious substances into innocuous

water ($H_2O$)
carbon dioxide ($CO_2$)
nitrogen ($N_2$)

The active surface area of the unit is 32 000 $m^2$ and the noble metal content is 4 g of platinum/rhodium.

**N.B.** Any trace of lead in the fuel will quickly damage the catalytic converter beyond repair.

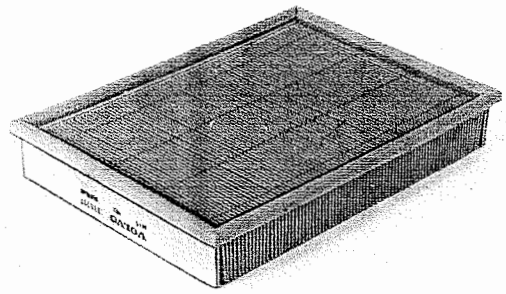



### Oxygen sensor (Lambdasond®)

The ideal air/fuel ratio is usually given as 14.7 kg of air to 1 kg of fuel. The oxygen sensor is used to measure the oxygen content of the exhaust gases as a means of achieving these conditions.

Since the device functions only above a certain temperature, it is heated electrically to ensure that the specified value is reached quickly and maintained more efficiently. Current is supplied to the heating element when the system relay operates.

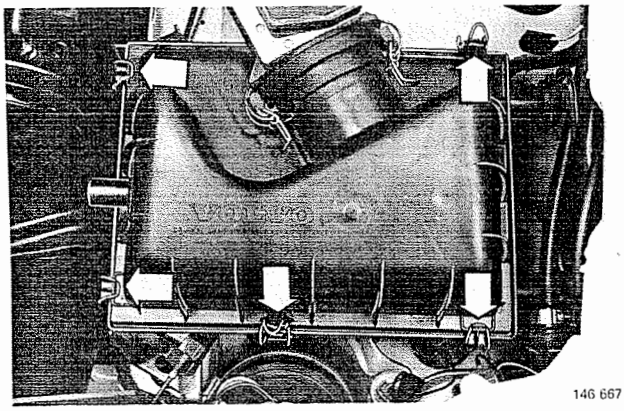
# AJ. Air cleaner, replacement



146 666

**Air cleaner is normally replaced every 40 000 km** (25 000 miles)

Cleaner should be replaced at shorter intervals if car is frequently driven on unsurfaced roads or under abnormally dusty conditions.

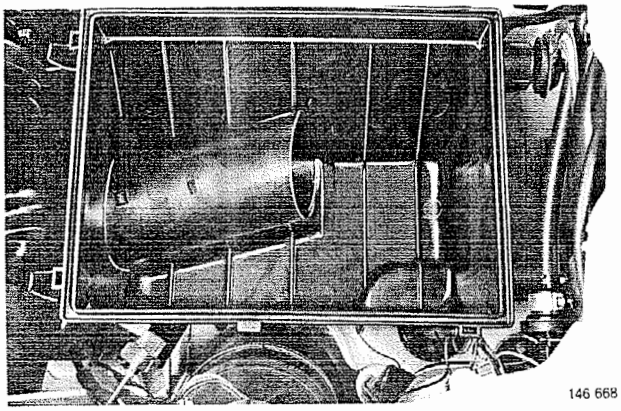


146 667

*AJ1*

**Remove air cleaner cover**

Release catches.



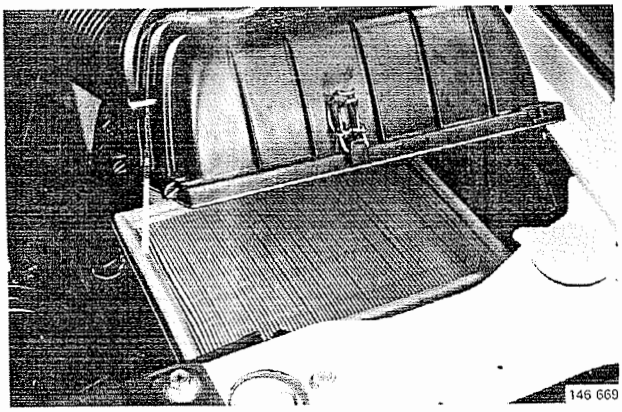
146 668

*AJ2*

**Replace cleaner element**

Inspect inside of cleaner housing.

Clean as required.



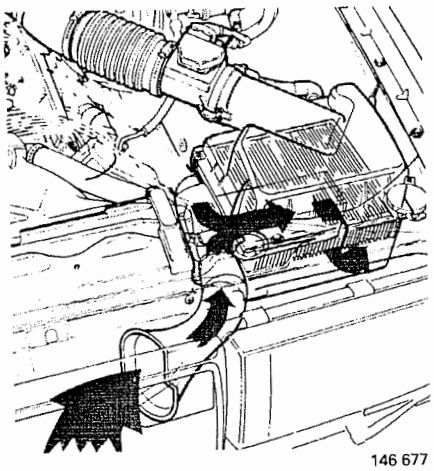
146 669

*AJ3*

**Reassemble air cleaner**

Ensure that sealing flange is correctly seated.

# AK. Intake air preheating function, checking

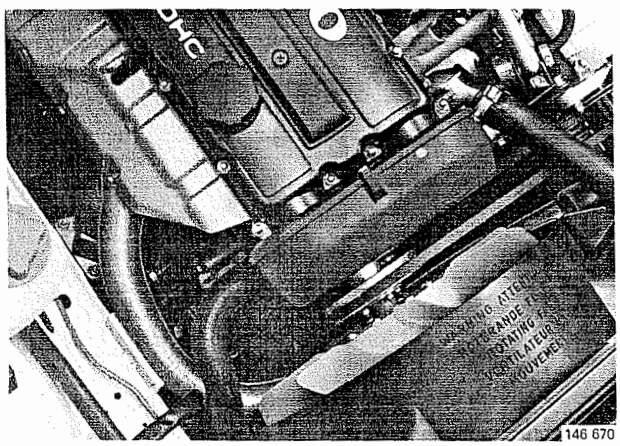

146 677

The preheating function consists essentially of a thermostatically controlled damper housed in the air cleaner.

The thermostat senses the temperature of the intake air and alters the position of the damper to vary the proportions of hot and cold air entering the cleaner. This enables the intake air temperature to be maintained at a constant value, irrespective of the outside temperature.

Proceed as follows if any of the following problems are encountered:

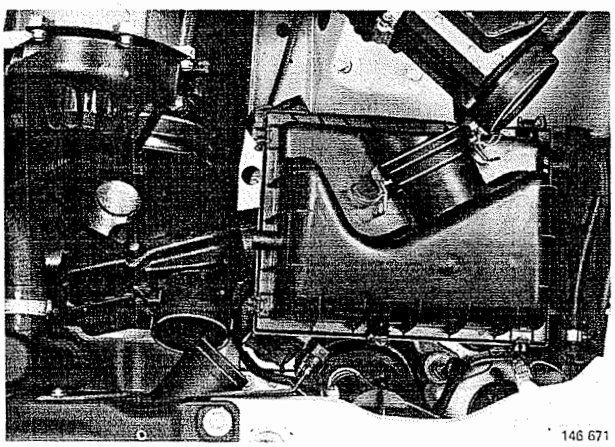
- juddering
- loss of power
- high fuel consumption


146 670

*AK1*

**Check attachment and sealing of:**

- heat shield
- preheating hose
- air cleaner housing


146 671

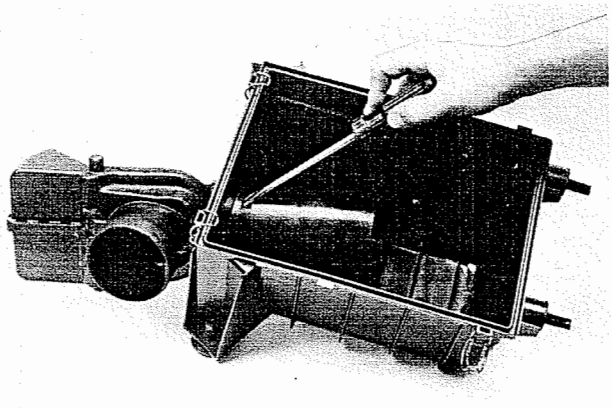
## Damper operation, checking

*AK2*

**Remove air cleaner housing**

Undo air duct connections.

Remove housing carefully from mountings.



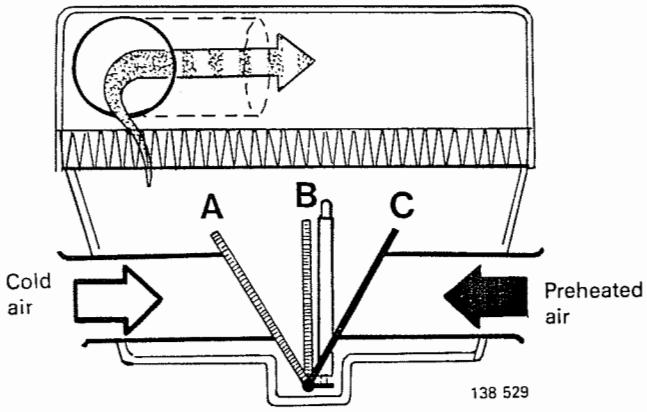
146 672

*AK3*

**Remove damper housing from air cleaner**

Remove cover and cleaner element.

Depress damper housing catches and withdraw housing.




138 529

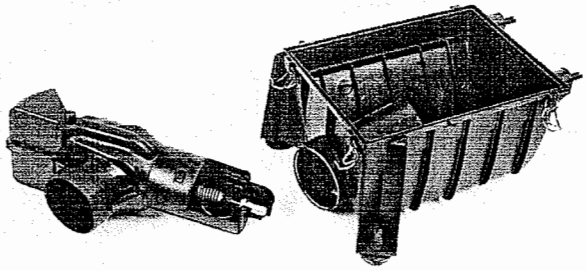
*AK4*

**Check operation of preheating components:**

- bushings and mountings
- spring
- thermostat (for example, with cooling spray)

Damper position at different outside temperatures:

**A** = <+5°C/41°F (preheated air only)
**B** = approx. 10°C/50°F
**C** = +15°C/59°F (cold air only)



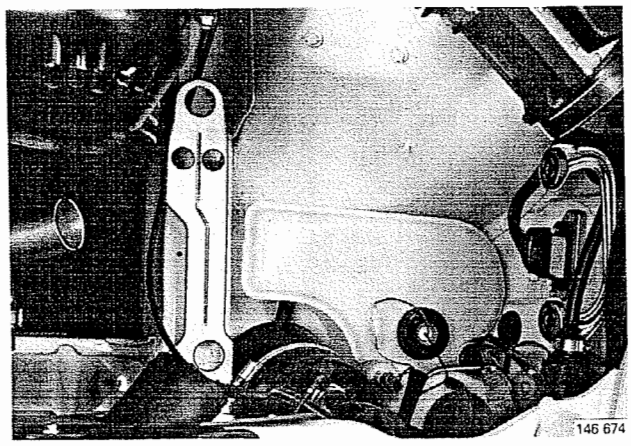
146 673

*AK5*

**Reassemble air cleaner**

**Install:**

- damper housing
- cleaner element
- cover



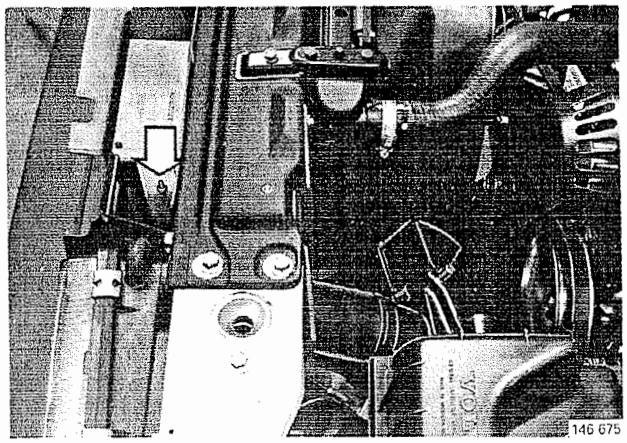
146 674

*AK6*

**Install air cleaner in car**

Place unit on mountings.

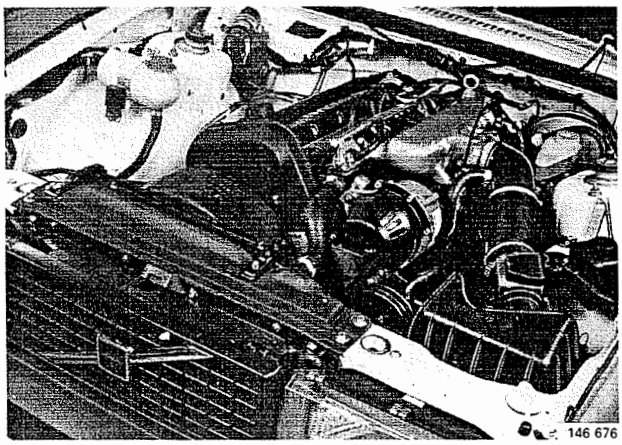
Reconnect all air ducts.




*AK7*

**Check attachment of front intake**

If required, remove grille and tighten intake mountings.

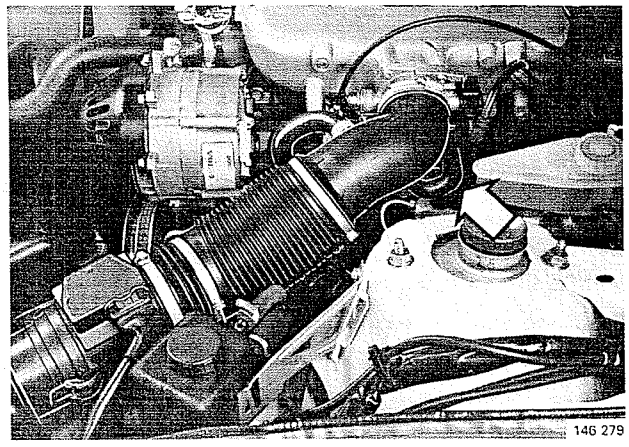



*AK8*

**Check operation**

Start and test run engine.

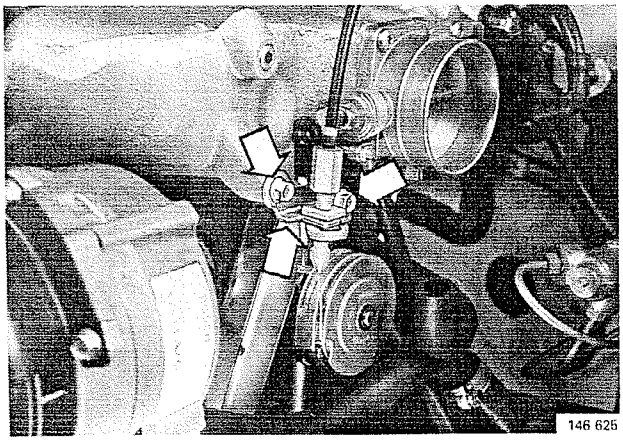
# AL. Intake manifold, replacement




*AL1*

**Remove air mass meter and air inlet hose**

Undo connector at air mass meter and hose connections to oil trap and idling (air control) valve.

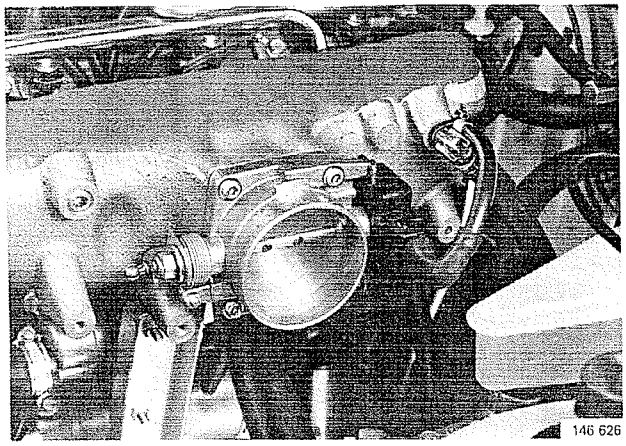



*AL2*

**Detach throttle pulley from intake manifold**

Detach pulley link rod from throttle lever.

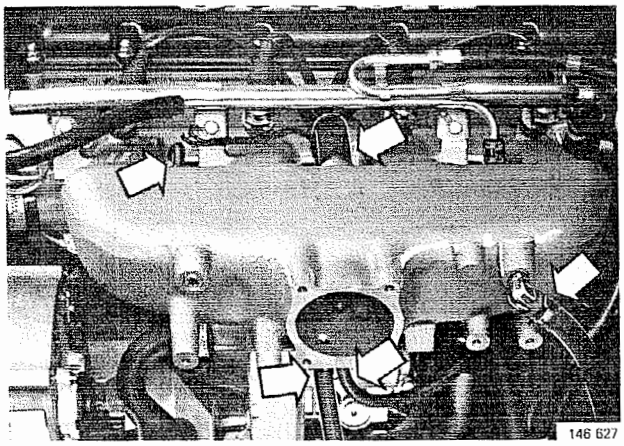
Loosen bolt securing intake manifold support to engine mounting.




*AL3*

**Separate throttle housing from intake manifold**

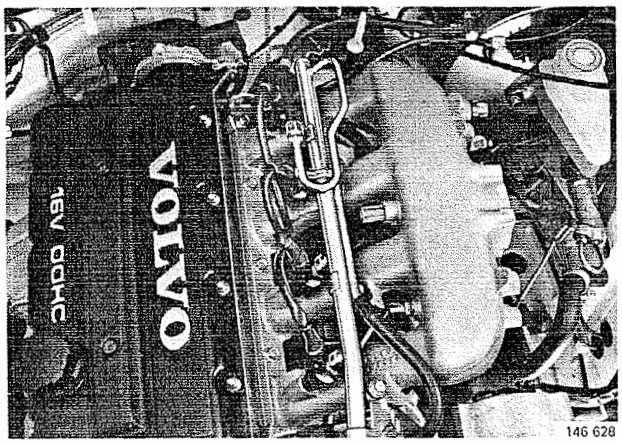
Cut cable tie holding throttle switch wiring to vacuum servo hose connection.


146 627

*AL4*

**Disconnect following hoses/lines from intake manifold:**

- vacuum servo
- EVAP valve (F engines only)
- oil trap
- fuel pressure regulator
- idling (air control) valve
- vacuum tank (applies only to cars equipped with CU/CU + AC heater)



146 628

*AL5*

**Remove fuel distribution pipe and injectors**

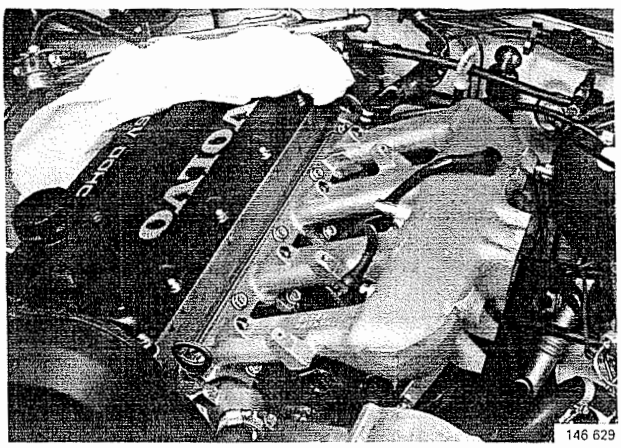
Disconnect fuel return line at distribution pipe.

Mop up fuel spillage with paper.

Disconnect injector connectors.

Carefully withdraw distribution pipe/injector assembly.

**N.B.** Protect injectors from entry of dirt.

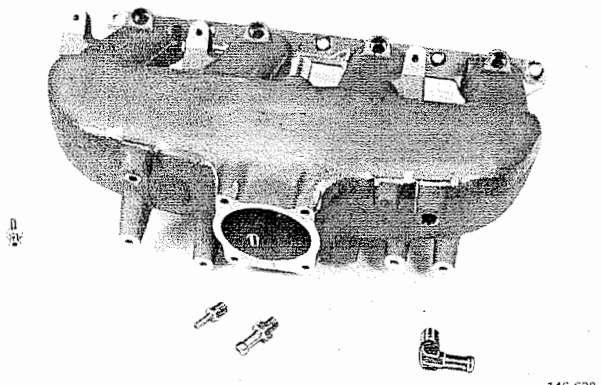


146 629

*AL6*

**Remove intake manifold from cylinder head**

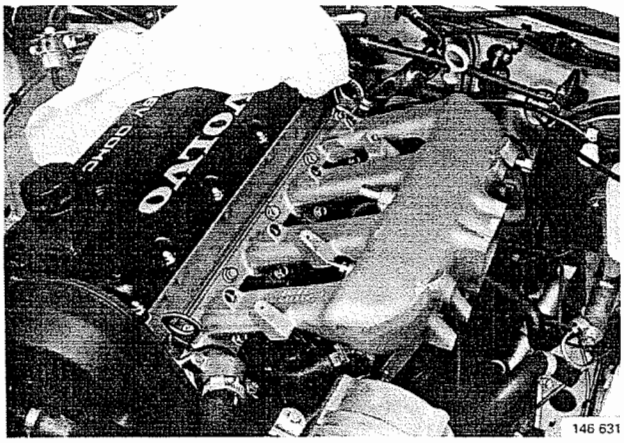
Remove gasket between manifold and cylinder head, and clean joint as required.


146 630

*AL7*

**Transfer hose nipples and plugs (if any) to new manifold:**

- vacuum servo
- EVAP valve (F engines only)
- oil trap
- fuel pressure regulator
- idling (air control) valve
- vacuum tank (applies only to cars equipped with CU/CU + AC heater)



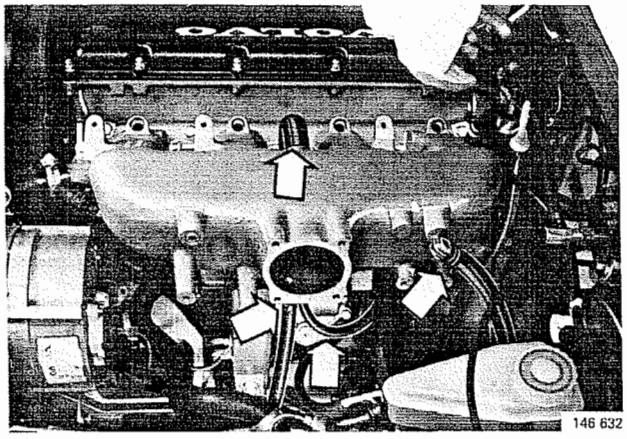
146 631

*AL8*

**Install and tighten new intake manifold in position**

Use **new** gasket.

Tighten bolts from centre outwards.

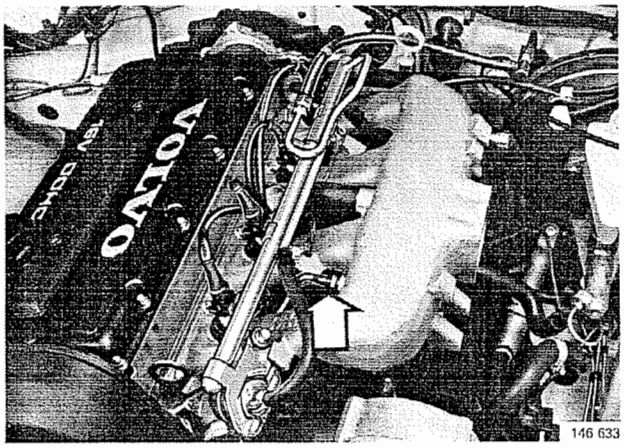


146 632

*AL9*

**Reconnect following hoses/lines:**

- vacuum servo
- EVAP valve (F engines only)
- oil trap
- idling (air control) valve
- vacuum tank (applies only to cars equipped with CU/CU + AC heater)



146 633

*AL10*

**Install fuel distribution pipe and injectors**

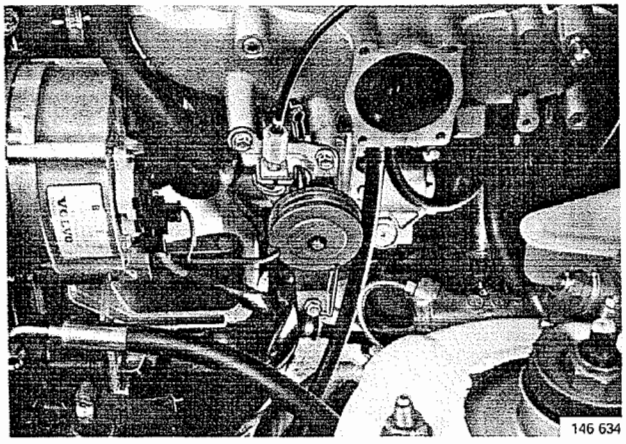
Inspect injector O-rings. Lubricate O-rings with water-free vaseline.

Position injector wiring between No. 2 and No. 3 cylinder connections.

Reconnect injector connectors.

Attach and tighten fuel distribution pipe and earth leads to intake manifold.

Reconnect fuel pressure regulator line to intake manifold.

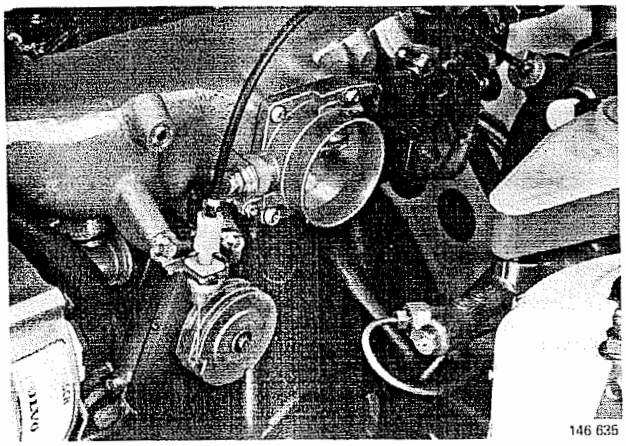

146 634

*AL11*

**Install throttle pulley**

Position pushrod under upper mounting points.

Tighten support under manifold and at engine mounting.


146 635

*AL12*

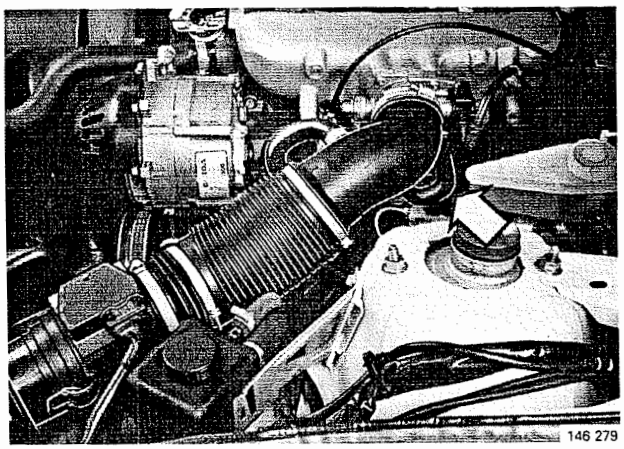
**Install throttle housing**

Use **new** gasket.

Reattach pulley pushrod to throttle lever.

Check operation of throttle switches and stops.

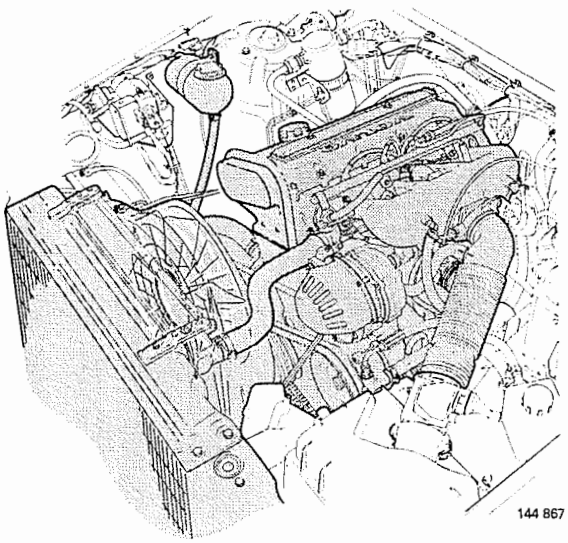
Secure wiring using cable tie attached to vacuum servo hose nipple.


146 279

*AL13*

**Install air mass meter and air inlet hose**

Reconnect air meter connector, oil trap hose and idling (air control) valve hose.

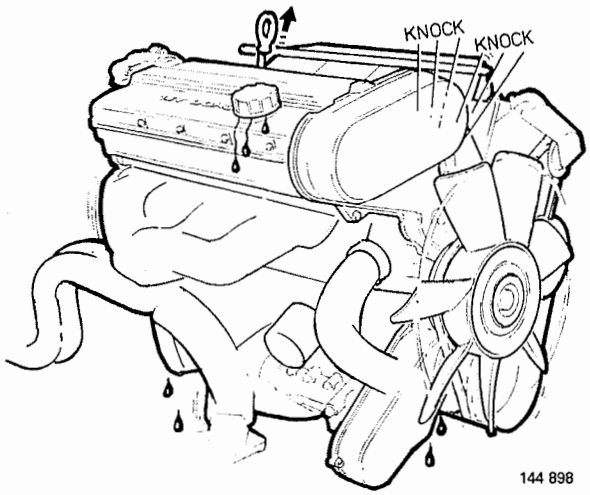

144 867

*AL14*

**Check operation**

Test run engine.

# AM. Crankcase ventilation, checking/overhaul



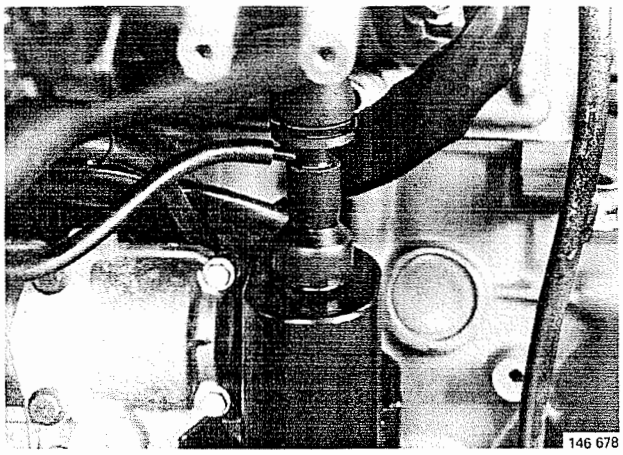
144 898

### Blocked flame trap/ventilation system

Blockage of the flame trap may be caused by:
- excessive interval between engine oil changes
- use of inferior grade engine oil
- excessive interval between flame trap services

Flame trap blockage restricts crankcase ventilation and increases crankcase pressure.

Symptoms of flame trap blockage:
- Oil dipstick tends to lift in tube.
- Oil leakage from cylinder block seals. Seals do not always require renewal if leakage is due to this cause. Overhaul flame trap, clean engine and reinspect for seal leakage.
- Engine knocks.


146 678

## Flame trap, inspection

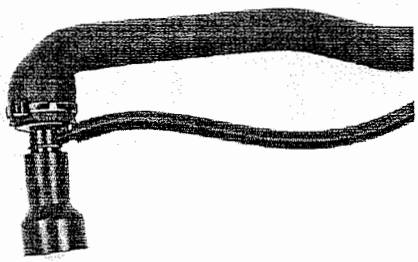
*AM1*

### Remove oil trap T-piece

Disconnect hoses from intake manifold and air inlet hose.

Disconnect bottom T-piece hose from oil trap.

*AM2*

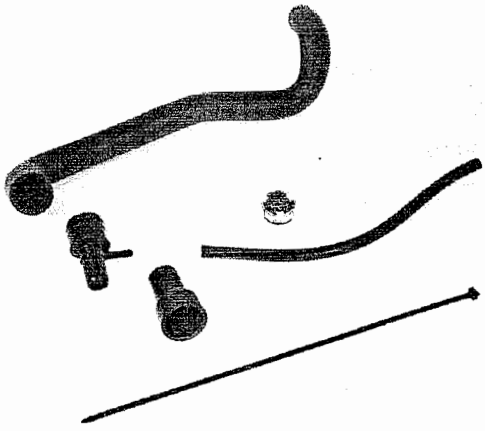

146 679

### Inspect flame trap

Disconnect hoses from T-piece.

Cut tie around top T-piece hose.

Remove flame trap from T-piece.



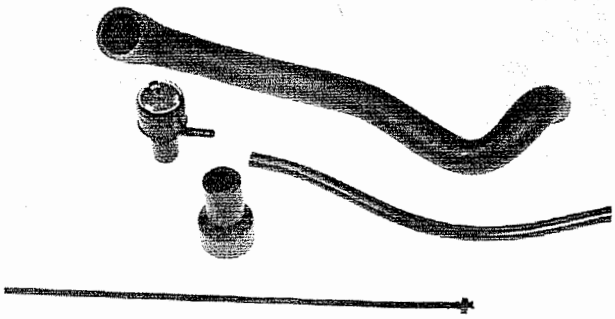
146 680

*AM3*

**Blow hoses and flame trap clean**

Replace flame trap if blocked.

Check hose connection under intake manifold.



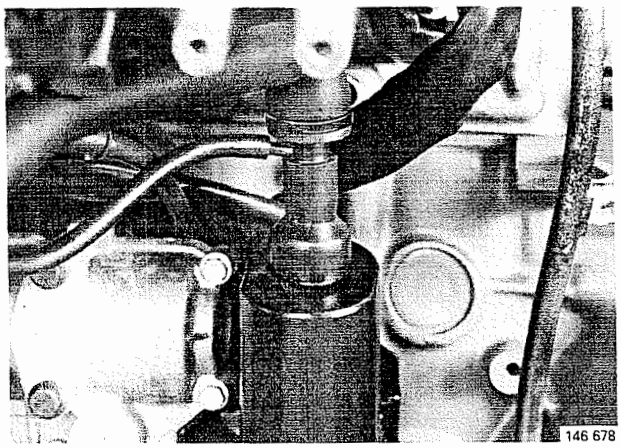
146 681

*AM4*

**Install/reconnect:**

- flame trap in T-piece
- hoses to T-piece
- tie around upper hose
- T-piece and hoses in oil trap

Connect hoses to intake manifold.



146 678

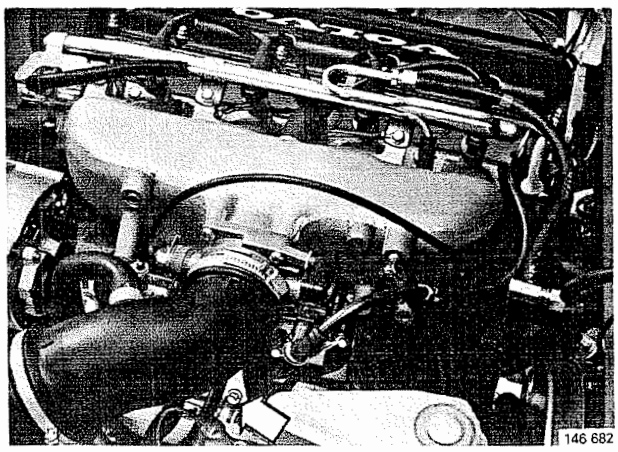
## Oil trap seals, replacement

*AM5*

**Detach T-piece from oil trap**

Disconnect hoses from intake manifold and oil trap.

Remove oil trap from cylinder block.



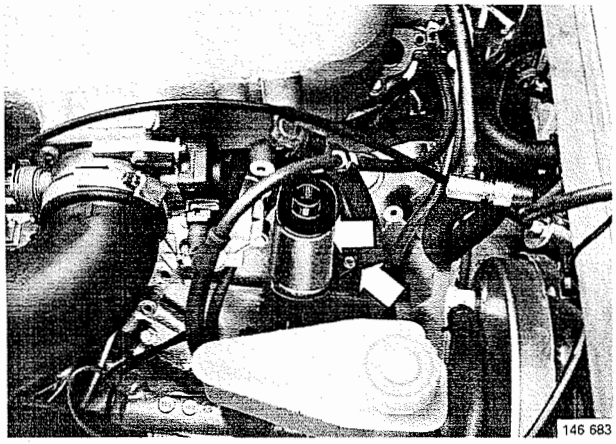
146 682

*AM6*

**Remove intake manifold**

Undo support at left-hand engine mounting.

Separate manifold from cylinder head.


146 683

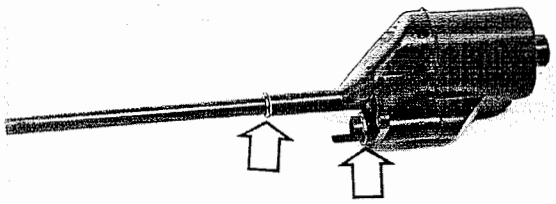
*AM7*

**Remove oil trap**

Lift trap out of cylinder block.

Lift intake manifold when oil trap has been removed.

**N.B.** Ensure that seals do **not** fall into crankcase.

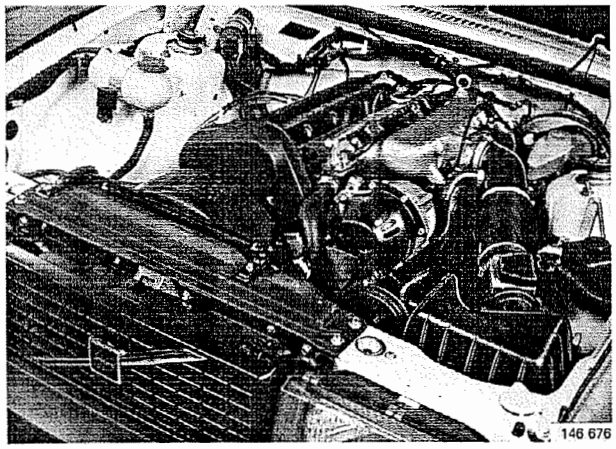

146 684

*AM8*

**Install/reconnect:**

- O-rings on oil trap (use **new** rings)
- oil trap in cylinder block
- gasket between intake manifold and cylinder head (use **new** gasket)
- intake manifold and support
- T-piece and hoses to oil trap

Reconnect hoses to intake manifold.


146 676

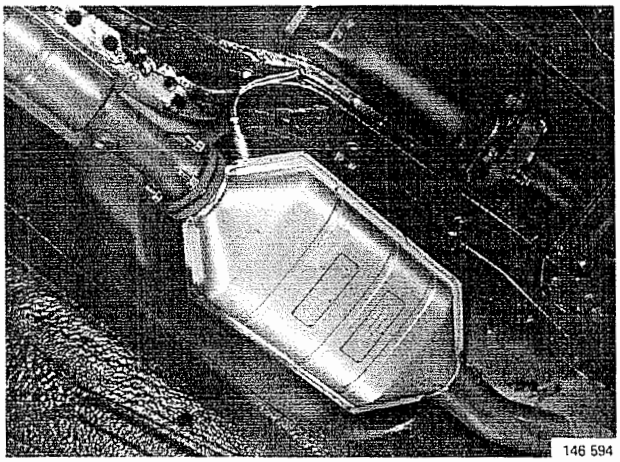
*AM9*

**Check operation**

Start engine.

Inspect for leakage.

# AN. Exhaust system, inspection/overhaul

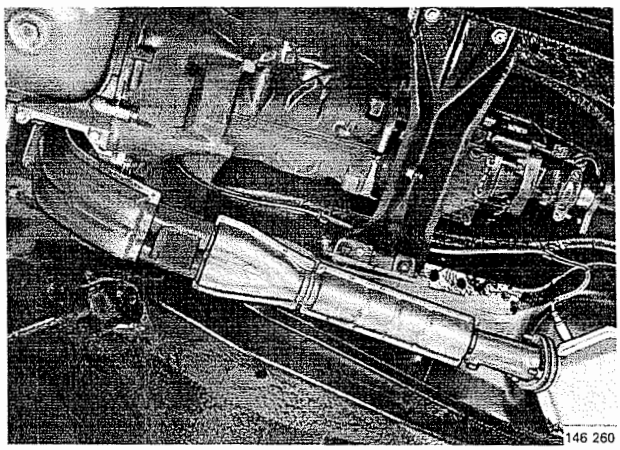

146 594

### Sealing

The system must not only be well sealed, but must also be assembled from components made to manufacturer's specifications, to ensure optimum engine performance and guarantee the cleaning efficiency of the catalytic converter.*

New gaskets **must** be used when fitting components.

* Engines supplied to certain markets (E engines) may not be fitted with catalytic converters.


146 260

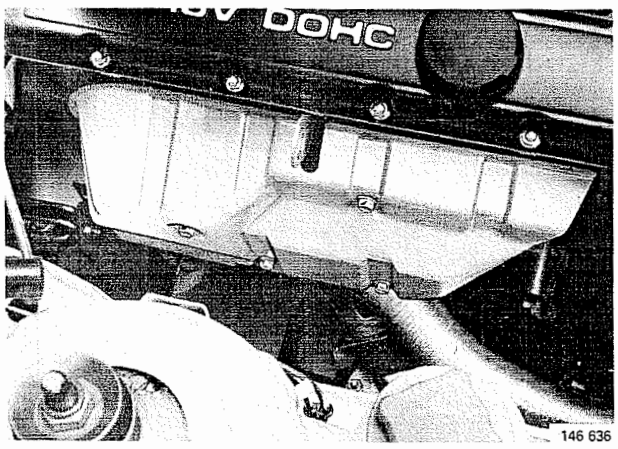
## Exhaust manifold, replacement

*AN1*

### Release front exhaust pipe

Remove nuts in joint with manifold.

Undo joint between catalytic converter and front silencer.



146 636

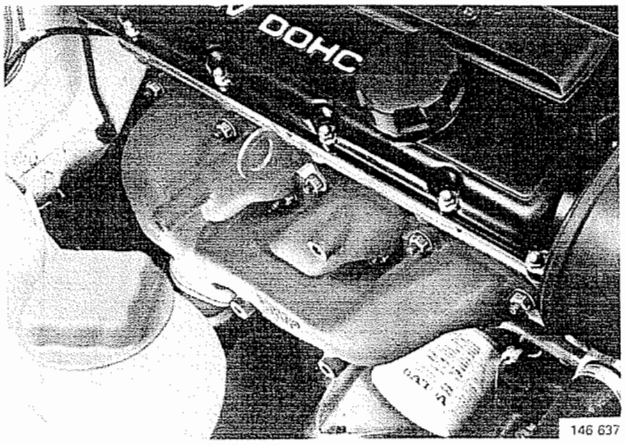
*AN2*

### Remove heat shields

Disconnect air preheating hose.

Remove top and bottom heat shields.

Disconnect front exhaust pipe from bracket on flywheel housing.

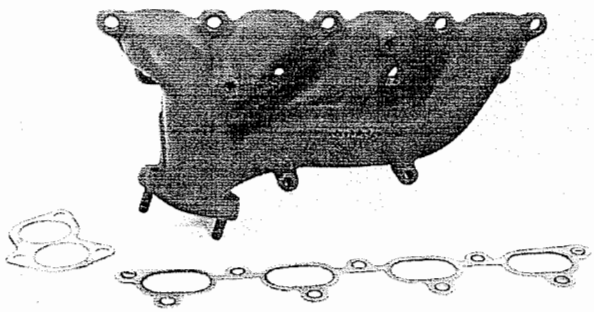


146 637

*AN3*

**Remove exhaust manifold and gasket**

Inspect faces of joints with cylinder head and front exhaust pipe.


146 638

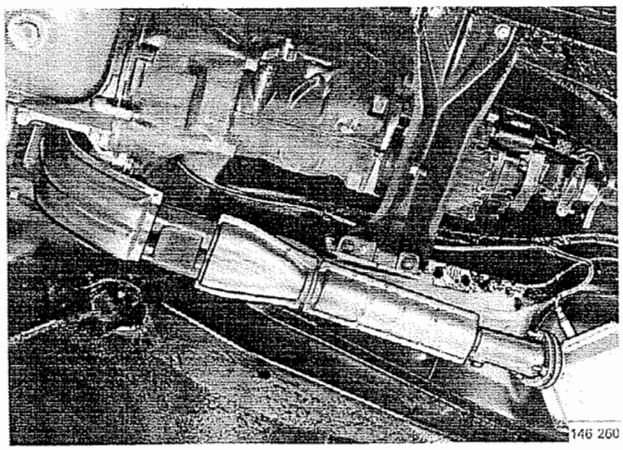
*AN4*

**Install exhaust manifold**

Use **new** gasket.

Tighten manifold on cylinder head.

Attach lifting lug to upper row of bolts between No. 2 and No. 3 exhaust branches.


146 260

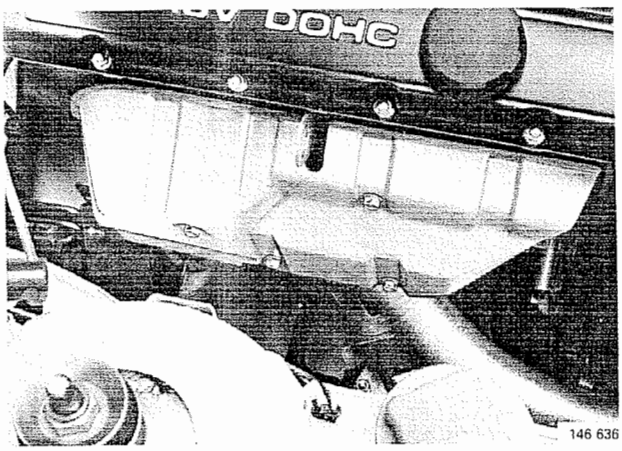
*AN5*

**Install front exhaust pipe**

Use **new** gasket.

Tighten joint with manifold.

Tighten joint at front of catalytic converter/silencer.



146 636

*AN6*

**Install heat shields**

Tighten exhaust pipe to bracket on flywheel housing.

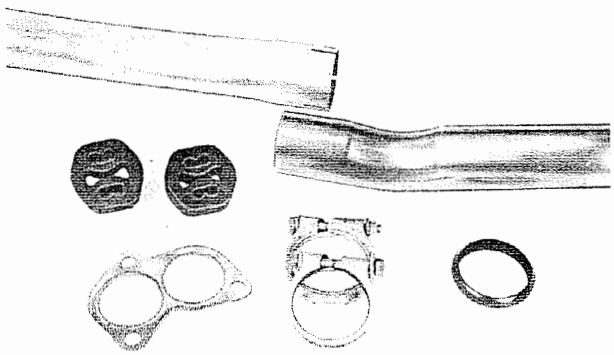
Reconnect air preheating hose.

**Check operation**

Start engine.

Check system for leaks.

# Exhaust pipe, replacement



146 639

## General

Use **new** gaskets.

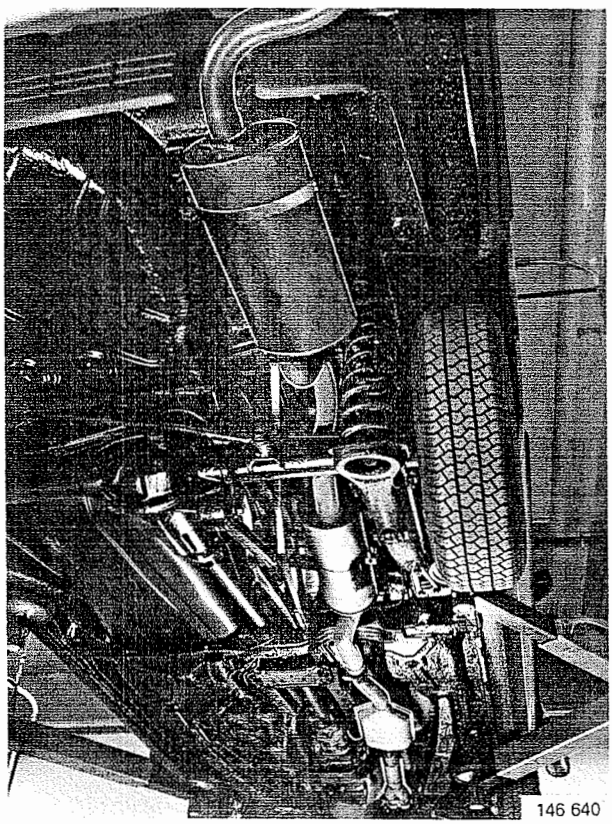
Replace conical steel ring in clamped joint on front exhaust pipe only if damaged.

Inspect rubber mountings and replace if necessary.

Pipe sections should overlap by approx. 40 mm (1 1/2 in).

Clearance between exhaust system and body should not be less than 20 mm (3/4 in).

**N.B.** Ensure that oxygen sensor wiring is protected against strain when replacing exhaust systems on cars with catalytic converters.



146 640

*AN7*

## Installation of complete system

Follow procedure below to avoid stresses in system:

Install front pipe and tighten bolted joint with manifold.

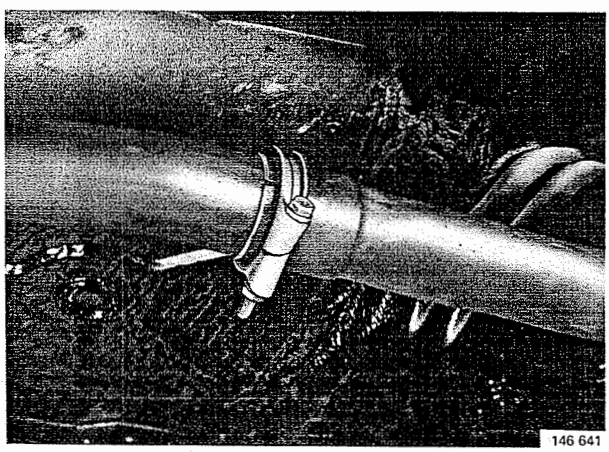
Insert and tighten mounting bolts in front pipe bracket.

Offer up and align other components.

Tighten pipe/silencer clamps.

Tighten nuts at front pipe pivot point.

Check clearance between system and body. Adjust as required.



146 641

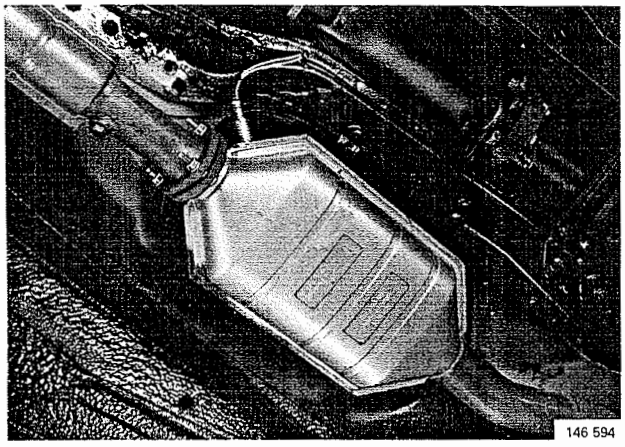
*AN8*

## Check operation

Start engine.

Check system for leaks.

## Catalytic converter

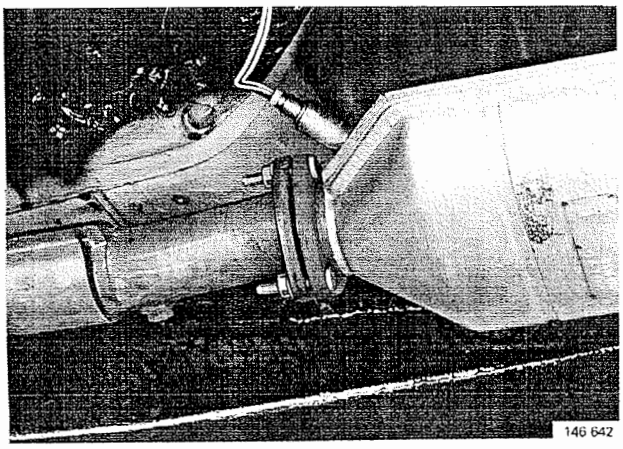

146 594

### General

Different catalytic converters are used depending on engine type, model year and market.

Each converter provided with a plate stating the part number and other details.

The unit is also marked with an arrow to indicate the direction of flow.

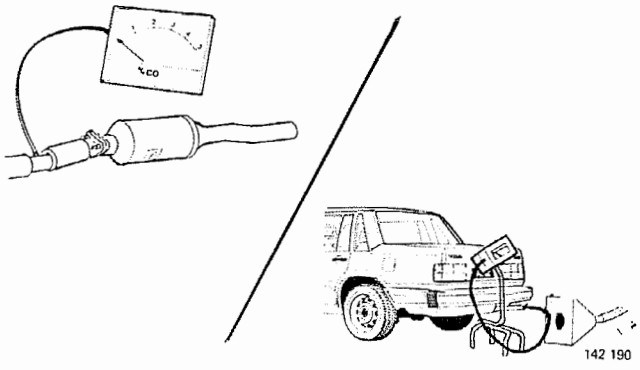

146 642

*AN9*

### Connection to front exhaust pipe

Catalytic converter flange is fitted with fixed bolts.

Bolts may be replaced with separate bolts in the event of damage.


142 190

*AN10*

### Check catalytic converter

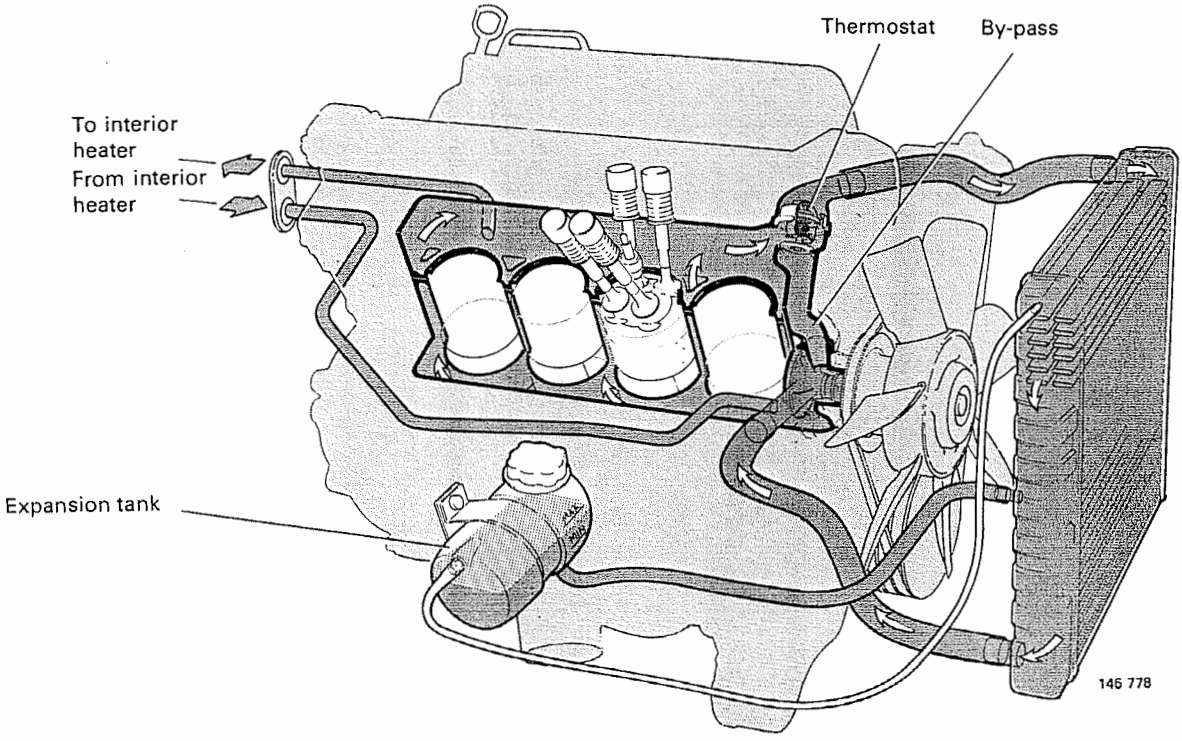
Converter efficiency may be checked by measuring and comparing CO content before and after unit.

Converter reduces CO content on reaching ignition temperature (450°C/840°F).

# Group 26 Cooling system

# Design/function

## Cooling system




The liquid-cooled engine is equipped with a closed cooling system.

The system consists of an inner and an outer circuit, the latter including the radiator and expansion tank. Other parts of the system and of the car heating system are considered part of the inner circuit.

The outer circuit is isolated when the engine temperature is below the thermostat opening temperature. Under these conditions, coolant is returned to the pump inlet through a by-pass in the cylinder head.

The system is filled (either when empty or when topping up) through the expansion tank.

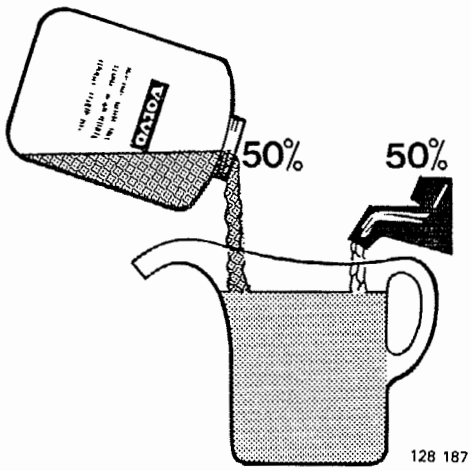
Genuine Volvo coolant diluted with **clean** water in proportions of **50/50** is the only coolant guaranteed by Volvo to prevent corrosion and freezing damage.

**Type C** (blue-green) coolant may not be mixed with any other type.

The coolant must be replaced **every second year** to ensure protection against corrosion.

# AO. Cooling system, checking/overhaul

*Special tools: 998-5496*




### Coolant

Since some engine components are made of aluminium, the coolant must contain an active corrosion inhibitor to prevent corrosion damage.

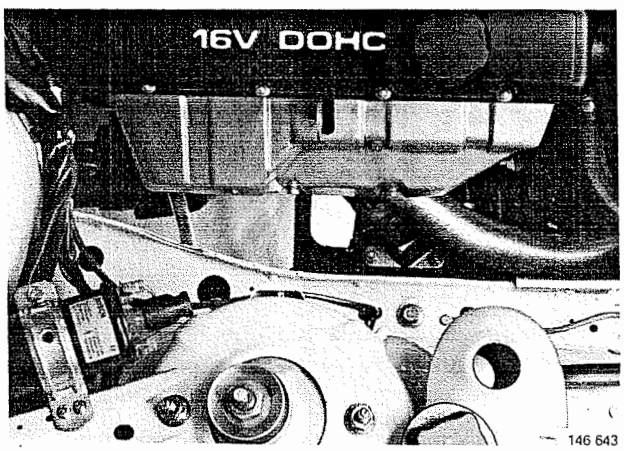
Genuine Volvo coolant diluted with **clean** water in proportions of **50/50** is the only coolant guaranteed by Volvo to prevent corrosion and freezing damage.

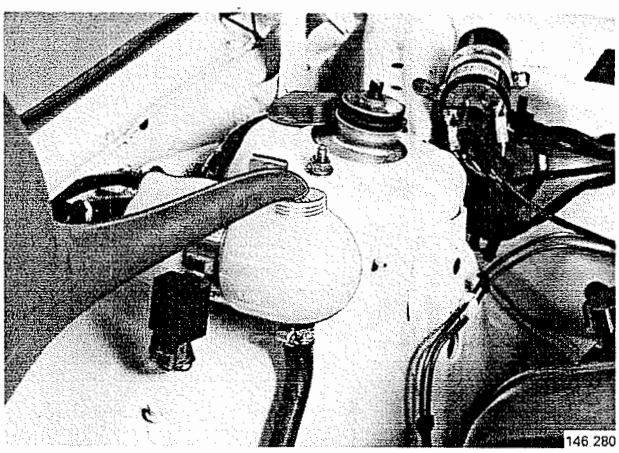
**Type C** (blue-green) coolant may not be mixed with any other type.

The coolant must be replaced **every second year** to ensure protection against corrosion.

Only **type C** coolant should be used as a replacement.

Capacity, **manual gearbox**.....**9.5 l** (10 US qt)
**automatic gearbox**.....**9.3 l** (9.8 US qt)




## Coolant, changing

*AO1*

### Drain coolant

Set heater control to max. heat.

Remove expansion tank cap.

Open cock on right-hand side of cylinder block. Fit hose to cock to collect coolant.

Disconnect bottom radiator hose.

Close drain cock and replace radiator hose.

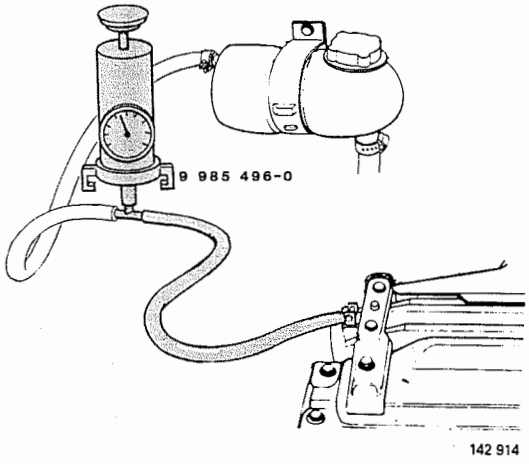
*AO2*

### Fill system with coolant

Fill system through expansion tank.

Run engine up to temperature and top up as required.

Inspect system for leaks.



142 914

## Checking system for leaks

*AO3*

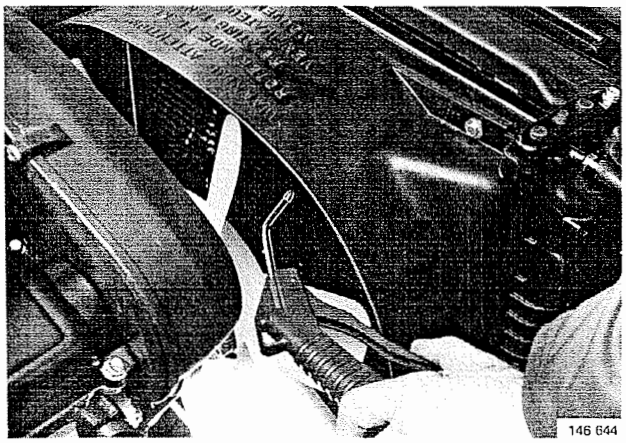
### Pressure test cooling system

Use pressure tester **998 5496**.

Connect tester to T-piece on vent line between expansion tank and radiator.

Increase pressure and check opening pressure and tightness of filler cap:

- correct pressure is **150 kPa** (22 lb/in)
- pressure in system should be steady


146 644

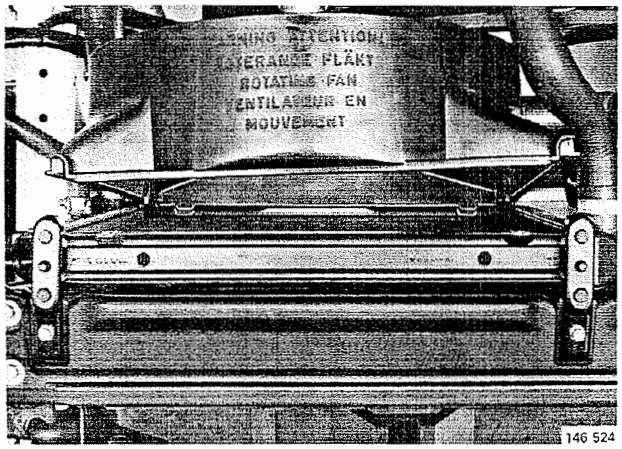
## Radiator, cleaning/checking operation

*AO4*

### Cleaning of radiator

Clean off insects and other dirt by flushing from the rear with water and blowing clean with compressed air.

**N.B. Excessive** pressure will damage cooling fins.


146 524

*AO5*

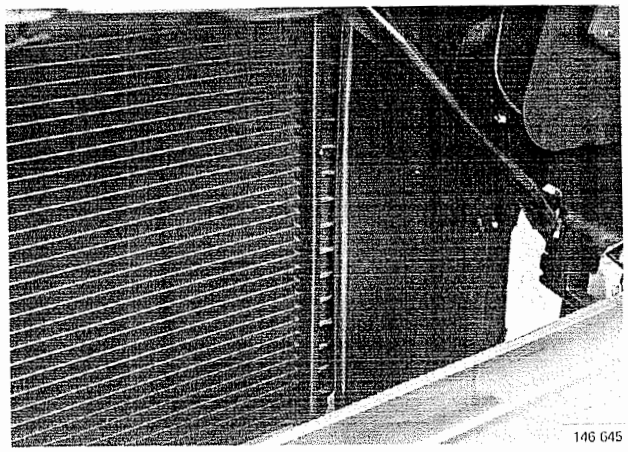
### Inspection of radiator

Run engine up to working temperature. Continue running for another few minutes.

Stop engine.

Remove top section of fan shroud from radiator.

Feel radiator with hand. Presence of cold areas indicates that unit is partially blocked.


146 645

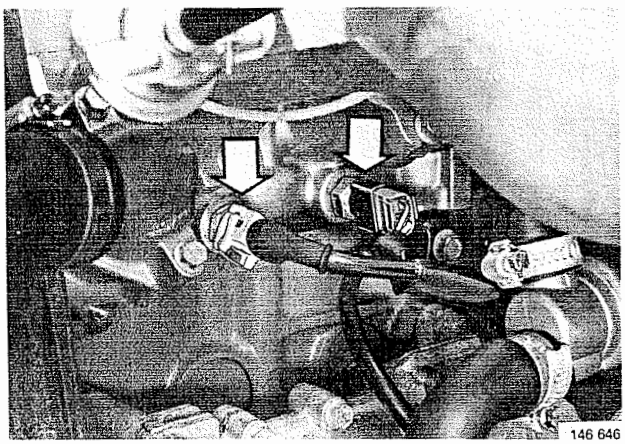
AO6

### Checking/adjustment of radiator position

Radiator must be fitted tight against front panel, otherwise air leakage may occur at sides.

Adjust position of air baffles as required.

## Coolant temperature sensors


146 646

AO7

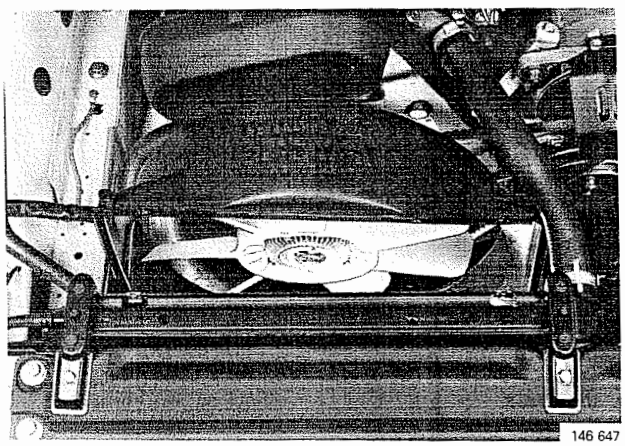
### Location of sensors

Sensors are located on left-hand side of cylinder head under intake manifold.

Front sensor supplies signal to ignition and fuel injection systems.

Rear sensor is connected to temperature gauge.

## Radiator fan


146 647

AO8

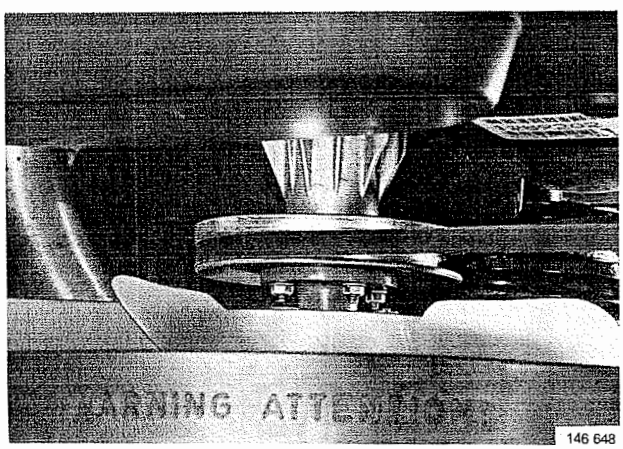
### Fan blades, replacement

Remove top section of fan shroud.

Remove blades from clutch housing.

### Install:

- new fan blades
- fan shroud


146 648

AO9

### Fan replacement

Slacken alternator drive belt.

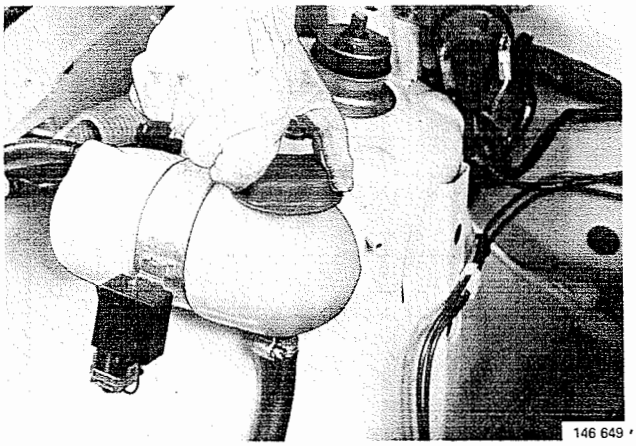
Withdraw fan from driver on water pump.

### Replace fan

Adjust alternator belt tension.

# AP. Coolant pump, inspection/replacement

*Special tool: 998 5496*




## Coolant pump, inspection

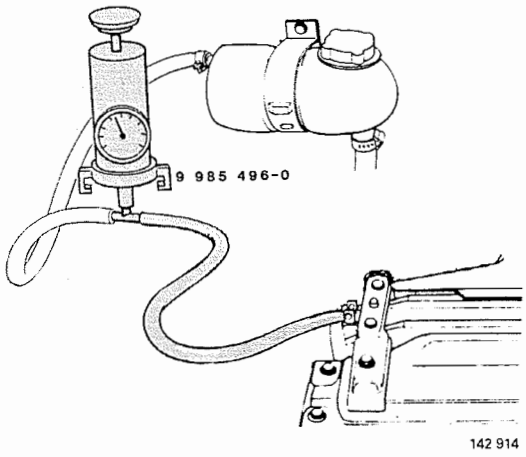
*AP1*

**Run engine until hot**

Continue running until thermostat opens.

Stop engine.

**N.B.** Lower pressure in cooling system. Open expansion tank cap **carefully!** Retighten cap when pressure has been reduced.



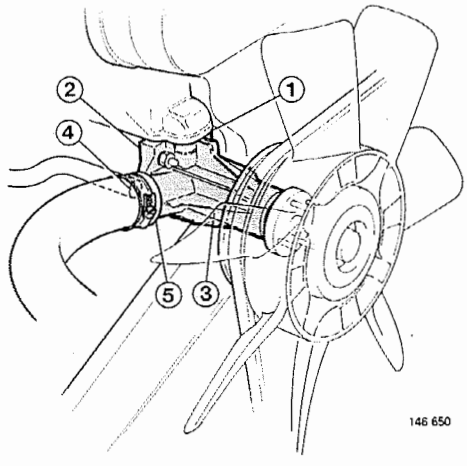

*AP2*

**Pressure test cooling system**

Use pressure tester **998 5496**. Fit T-piece in vent line between radiator and expansion tank.

Increase pressure to **150 kPa**.

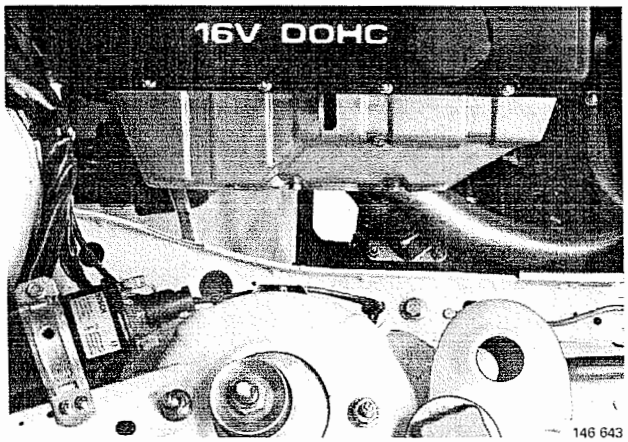
Pressure must not drop significantly in 3 minutes.




*AP3*

**Proceed as follows in case of leakage: (Numbers refer to locations indicated on illustration)**

1. Replace all gaskets.
2. Replace all gaskets.
3. Replace complete pump.
4. Replace all gaskets.
5. Overhaul hose connection:
   - clean off corrosion, if any
   - replace hose clip, if necessary
   - replace hose, if necessary



146 643

# Coolant pump, replacement

*AP4*

**Drain coolant**

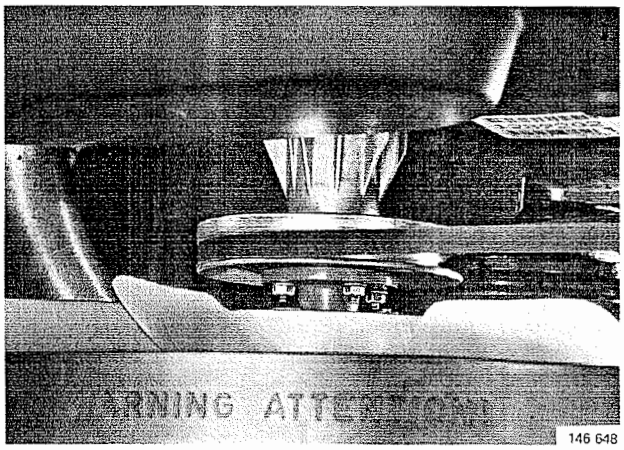
Set heater control to max. heat.

Remove expansion tank cap.

Open cock on right-hand side of cylinder block. Fit hose to cock to collect coolant.

Disconnect bottom radiator hose.

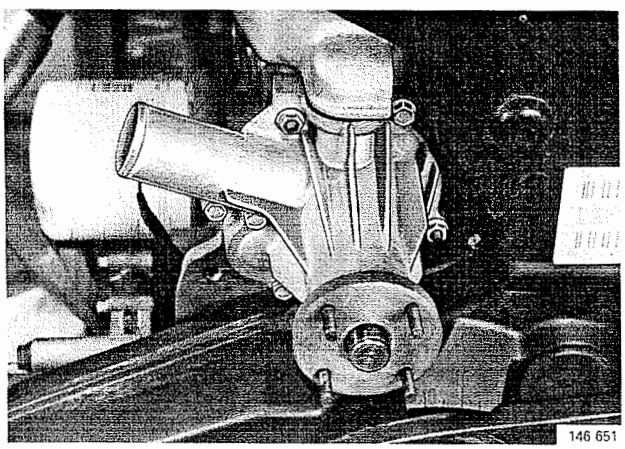
Close drain cock and replace hose.


146 648

*AP5*

**Remove:**

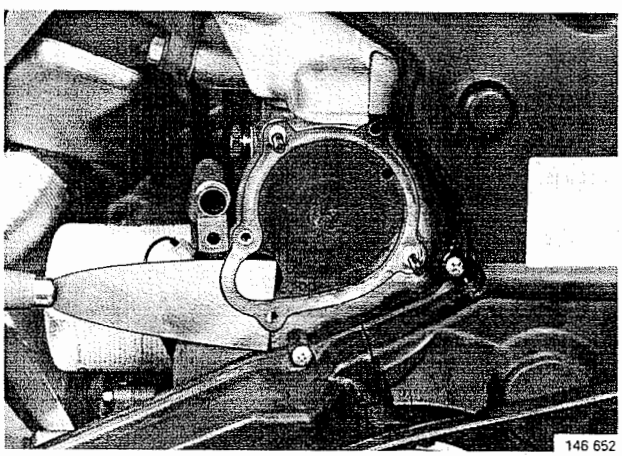
- alternator drive belt
- radiator fan and pulley


146 651

*AP6*

**Remove coolant pump**

Remove all bolts, washers and nuts.

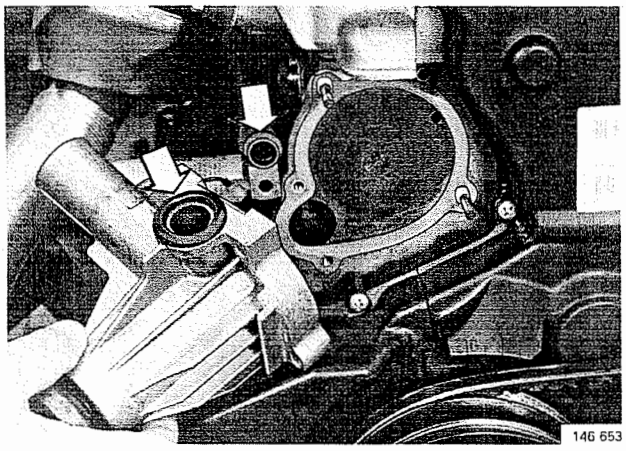

146 652

*AP7*

**Clean joint faces and mating surfaces**

Scrape all gasket remains from cylinder block.

Clean mating surface of rubber seal with cylinder head.


146 653

*AP8*

**Replace coolant pump**

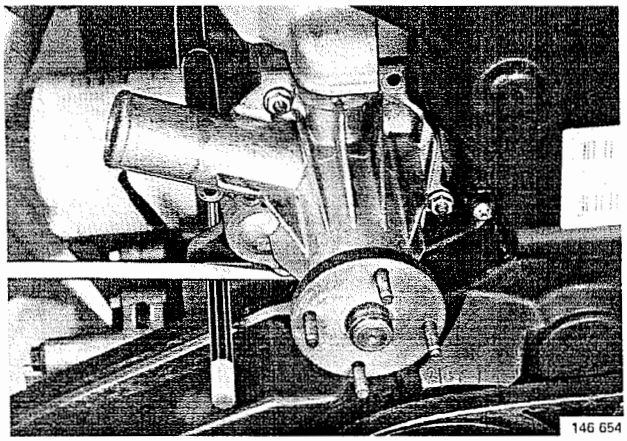
Use **new** gaskets between pump housing and cylinder block, cylinder head and return pipe.

Place O-ring on return pipe and gasket on block.

Ensure that O-ring is located in groove in pump housing.

Tighten both mounting nuts.

Tighten nuts sufficiently to eliminate play while permitting adjustment of pump position.


146 654

*AP9*

**Press pump upwards against cylinder head**

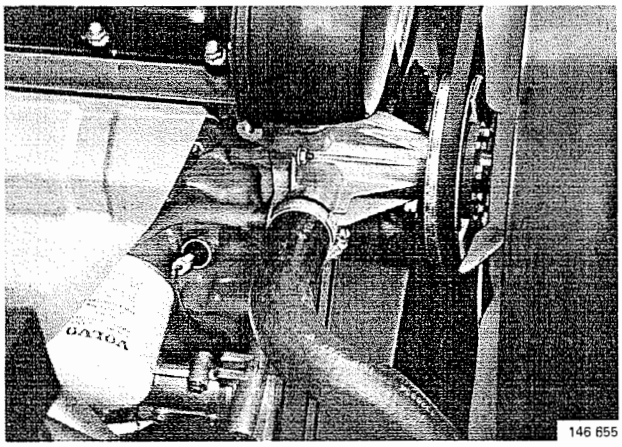
Place drift in bolt hole in cylinder block under pump housing.

Use screwdriver to press pump housing upwards against cylinder head.

Replace remaining washers and bolts.

Tighten pump housing.

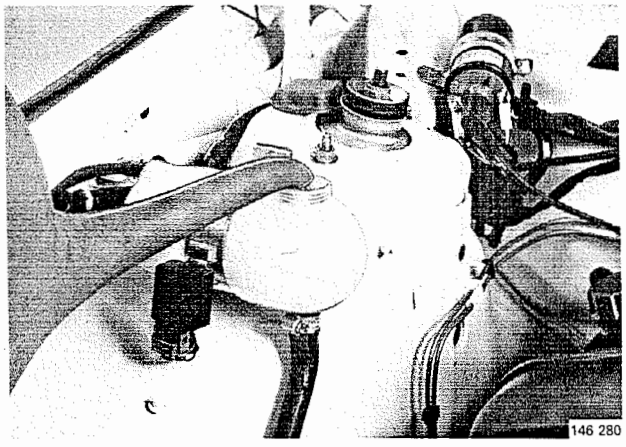
Reconnect return pipe.


146 655

*AP10*

**Install:**

- bottom radiator hose
- radiator fan and pulley
- alternator drive belt


146 280

*AP11*

**Fill system with coolant**

Fill system through expansion tank.

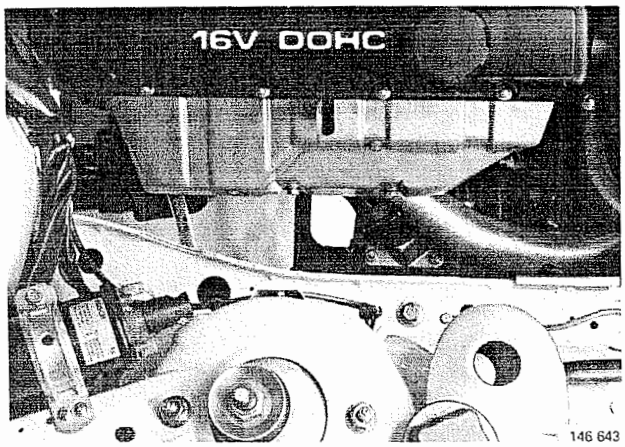
Run engine up to temperature and top up as required.

Inspect system for leaks.

# AQ. Thermostat, checking/replacement



## Thermostat replacement



146 643

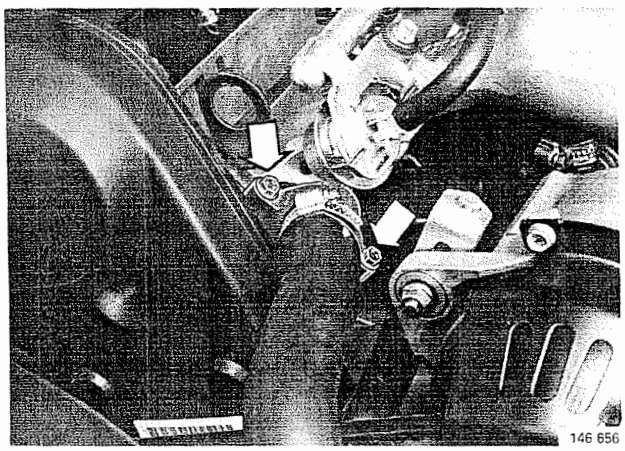
*AQ1*

**Drain off approx. 2 litres (2 US qt) of coolant**

Remove expansion tank cap.

Open cock on right-hand side of cylinder block. Fit hose to cock to collect coolant.

Close drain cock.

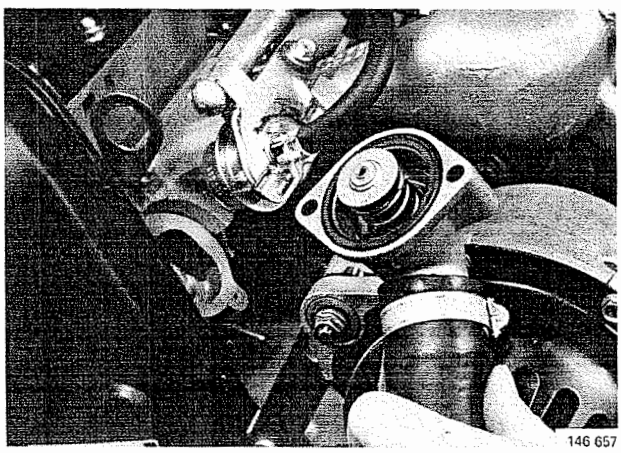

146 656

*AQ2*

**Undo thermostat housing**

Remove thermostat and gasket.

Clean joint surfaces on cylinder head and thermostat housing.


146 657

*AQ3*

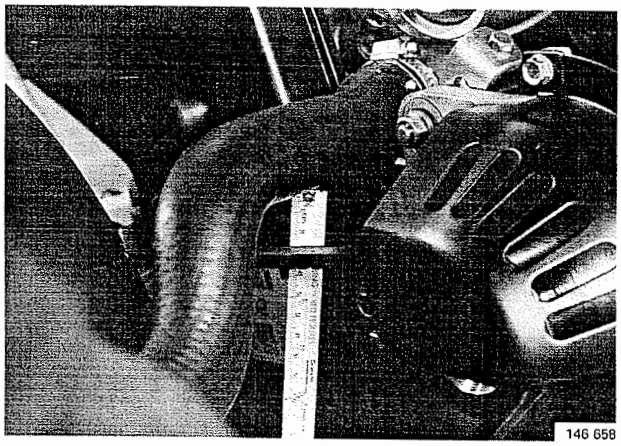
**Install new thermostat**

Use **new** gasket.

Place gasket on thermostat.

Place thermostat in housing.

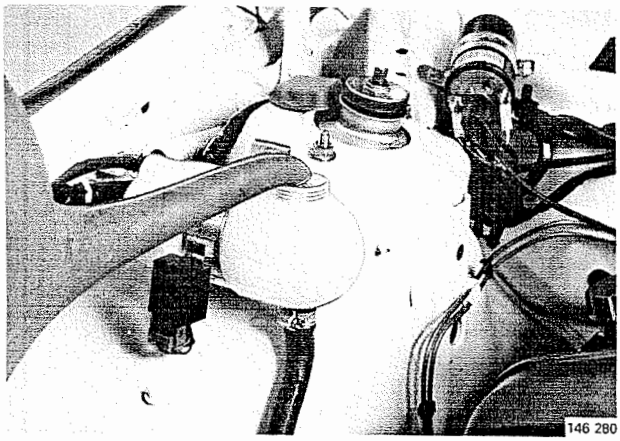
Replace and tighten housing.


146 658

*AQ4*

**Check upper radiator hose**

Clearance between alternator drive belt and hose must **not** be less than **25 mm** (1 in).


146 280

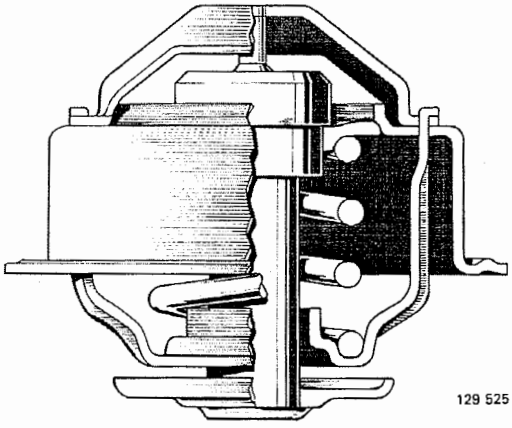
*AQ5*

**Fill system with coolant**

Fill system through expansion tank.

Run engine until thermostat opens and top up as required.

Inspect system for leaks.


129 525

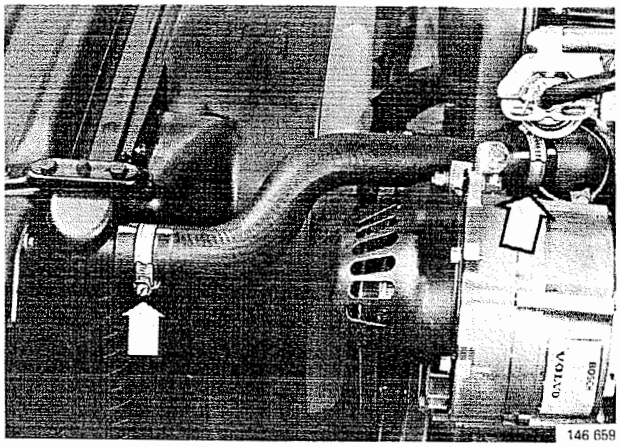
## Checking thermostat

*AQ6*

**Check opening function**

Thermostat may be tested in hot water. Maximum opening must be reached within **2 minutes** in water at operating temperature.

| Marking | Opening commences at | Fully open at |
|---|---|---|
| 87 | 86–88°C (187–190°F) | 97°C (207°F) |


146 659

## Top radiator hose, position marking

*AQ7*

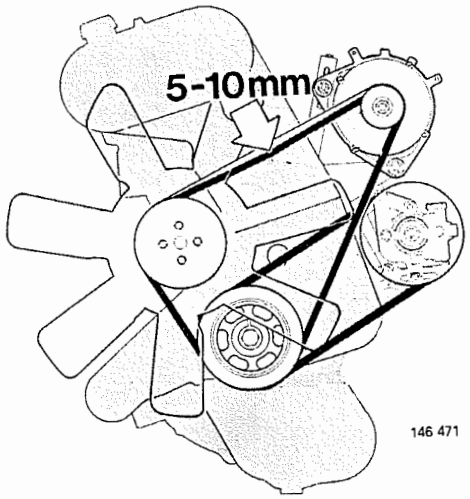
**Top radiator hose, replacement**

Position front marking (radiator end) facing straight upwards.

Position rear marking (thermostat end) opposite joint on thermostat housing.

Check that clearance between normally adjusted alternator drive belt and hose is at least **25 mm** (1 in).

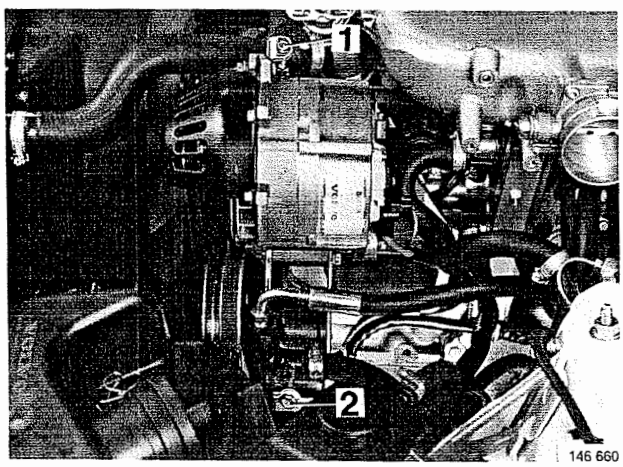
# AR. Auxiliary drive belts




### General

When correctly tensioned, free movement of belt between pulleys should be **5–10 mm** (3/16–3/8 in).

**N.B.** Replace **both** belts when renewing parts on engines with twin drive belts.



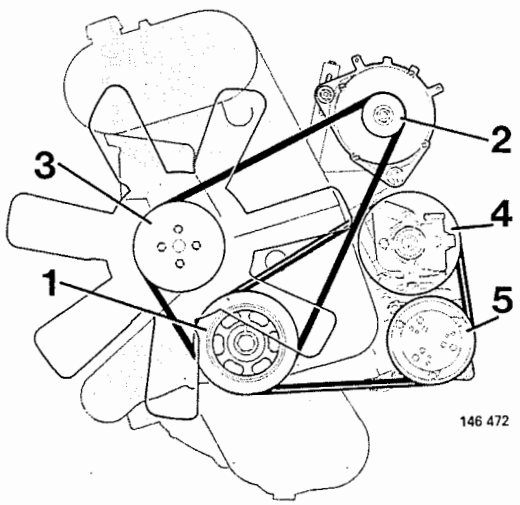

*AR1*

### Adjust belt tension

Loosen auxiliary mounting bolts.

Tension belts by operating adjusters **1** (alternator) and **2** (servopump/AC compressor).

Tighten mounting bolts.




*AR2*

### Cars equipped with AC are fitted with twin compressor and servo pump drive belts

1. Crankshaft pulley
2. Alternator
3. Radiator fan
4. Servo pump
5. AC compressor

# Group 27 Engine controls

## Contents

# Cruise control

## Design/function

**Warning!** Cruise control must **not** be used on wet or slippery road surfaces, or in dense traffic.


146 747

In the system, a regulator is used to control a vacuum pump in response to signals from the speedometer and from a control lever. The pump, in turn, operates a vacuum servo connected to the throttle pulley by a cable.

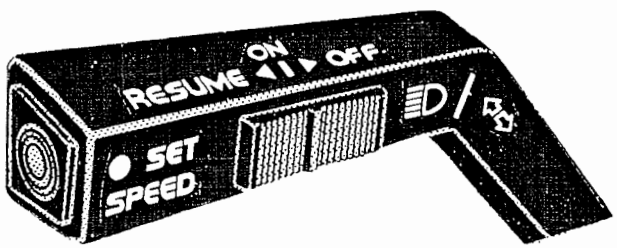
The system maintains the speed of the car constant by continuously adjusting the vacuum in the servo in response to variations in speed.

### Speed adjustment

Set switch to **ON**.

Accelerate to required speed (at least 40 km/h/25 mph).

Press **SET SPEED** button in the end of the direction indicator stalk. Release button and remove foot from accelerator.




146 748

### To reduce set speed

Set switch to **OFF**. When car has slowed to required speed, reset switch to **ON** and operate **SET SPEED** button.

### To increase set speed

Accelerate to required speed and press **SET SPEED** button. Car will now maintain the higher speed.

### Temporary speed increase

Operate accelerator in usual manner.

Car will return to previous speed setting when pedal is released.


146 747

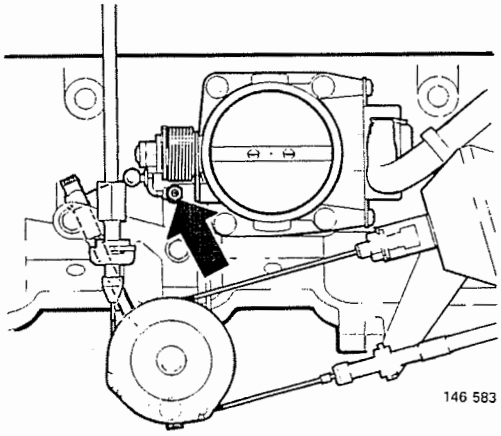
### Disengagement of system

Press brake or clutch pedal lightly or set switch to **OFF**.

### Return to set speed

After braking, the car will return to the previous speed setting if the switch is held in the **RESUME** position for a brief instant.

# AS. Throttle/kickdown cable, inspection/adjustment




*AS1*

**Basic adjustment of throttle**

Disconnect air inlet hose from throttle housing.

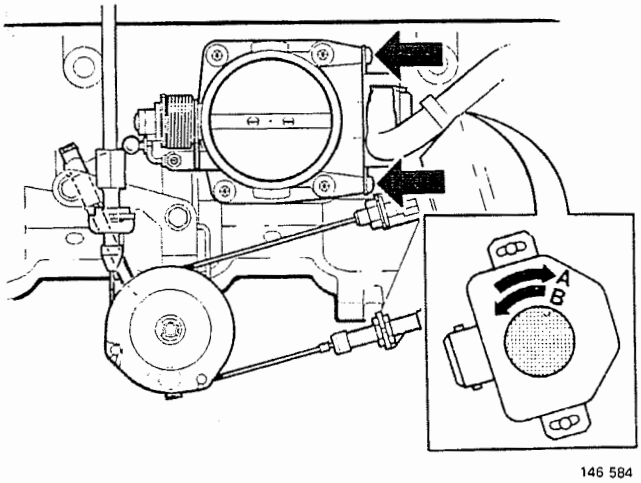
Remove throttle pulley link rod.

Undo adjuster locknut.

Screw out adjuster until throttle is fully closed. If throttle does **not** close, remove throttle switch.

Screw in adjuster until it is just in contact with throttle lever. Screw in a further ~~turn~~. half turn

Lock adjuster with locknut. Ensure that adjuster does not move during this procedure.



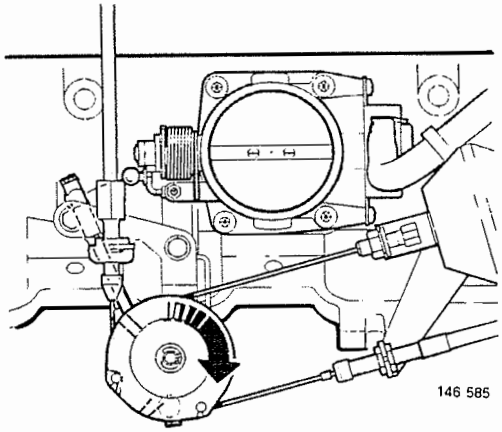

*AS2*

**Check throttle switch setting**

Open throttle slightly and listen to switch. Switch should emit a click (indicating opening of idling contacts) as soon as throttle opens.

**Adjust as follows:**

- undo mounting screws
- turn switch slightly clockwise
- turn switch anticlockwise until click is heard
- tighten screws
- check setting




*AS3*

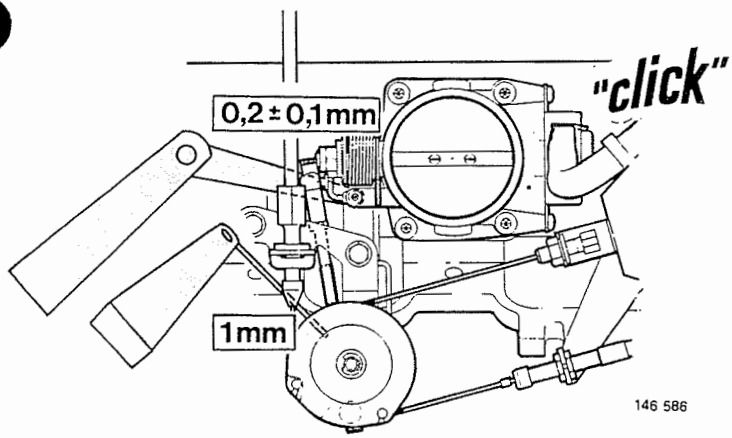
### Inspect/adjust throttle pulley and cable

Pulley should turn easily without sticking.

Cable should be taut in idling position without preventing pulley from bearing against idling stop.

Adjust as required.

Press **accelerator** to floor and check that pulley rotates to meet full-load stop.




*AS4*

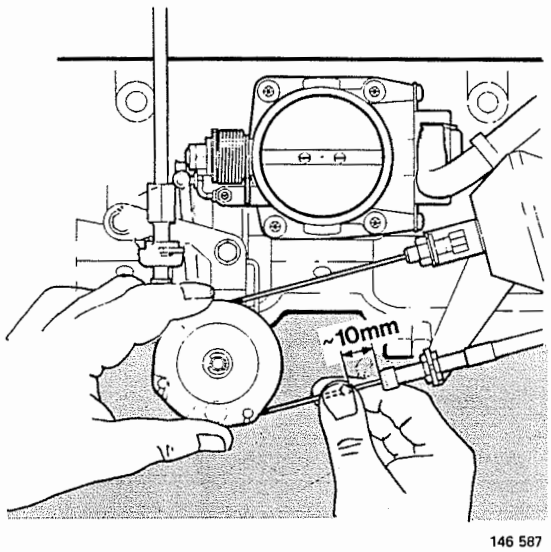
### Connect and inspect/adjust link rod

Insert **1 mm** (0.04 in) feeler gauge between projection on throttle pulley and idling stop.

Clearance between throttle lever and adjuster should now be **0.2±0.1 mm** (0.008±0.004 in).

Adjust link rod as required.

Check throttle switch. Switch **must** open immediately when link rod lifts.




*AS5*

### Kickdown cable, inspection/adjustment

Check that cable:

- is seated in groove in pulley
- is taut in idling position without exerting pull on pulley
- moves easily in sleeve

Pull cable out approx. 10 mm (3/8 in) and release suddenly. Metallic click should be heard from kickdown cam (in gearbox) as it returns to idle position.

Cable over-taut: No clicking sound.

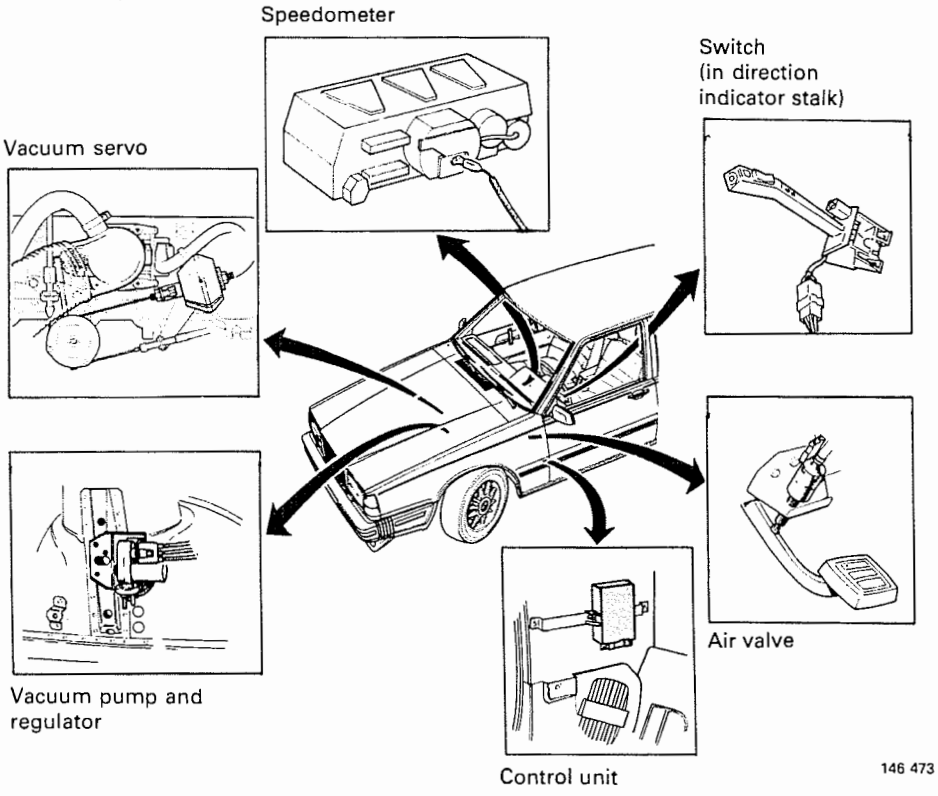
Cable slack: No kickdown action.

Correct by adjusting cable tensioner.

**N.B.** Throttle pulley must return to stop as described in AS3.

# AT. Cruise control, location of components

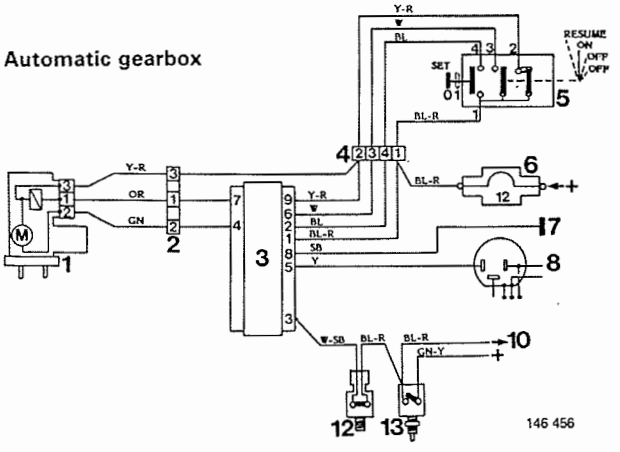
*AT1*



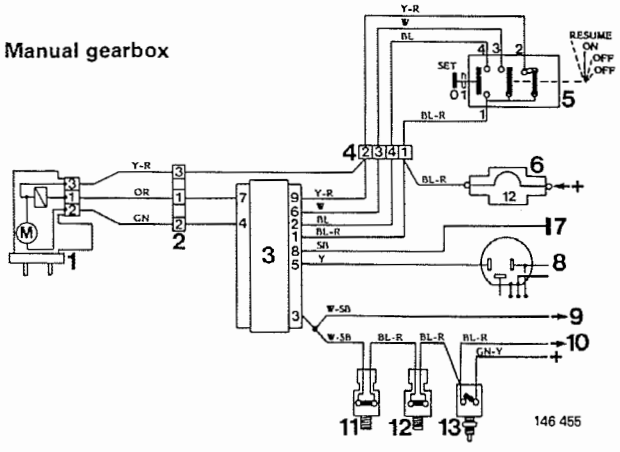

*AT2*

## Cruise control, wiring diagram

**Automatic gearbox**




**Manual gearbox**



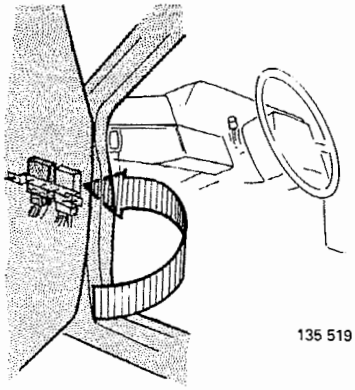

### Components

1 Vacuum pump and regulator
2 11-pole connector at right-hand A-post (located in black box containing three connectors)
3 Control unit
4 Connector
5 Switch (in direction indicator stalk)
6 From busbar +15 (in central electrical unit), across fuse No. 12
7 Earth terminal (in central electrical unit)
8 Speedometer
9 To gear change relay (manual gearbox only)
10 To brake lights
11 Clutch pedal air valve
12 Brake pedal air valve
13 Brake light switch

### Colour codes

R = red
Y = yellow
BL = blue
GN = green
W = white
OR = orange
SB = black

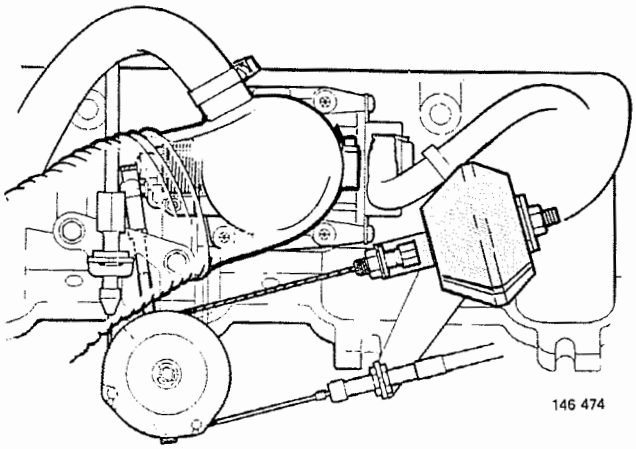
# Cruise control, checking/fault tracing


135 519

*AT3*

**Important!** Cruise control function will not operate if speedometer is out of order.

Control unit should be replaced only if remainder of system is fault-free. Replacement of unit without rectifying other system faults will result in damage to new unit.


146 474

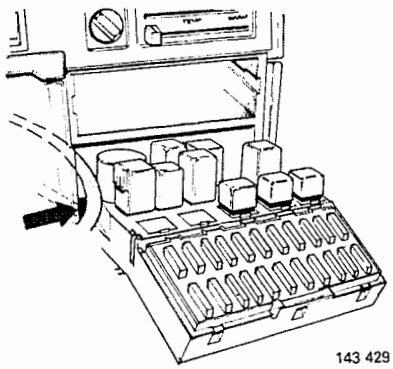
*AT4*

## Inspect/adjust throttle and cruise control cables

Both cables should be taut in idling position without altering position of pulley. Pulley should bear against idling stop.

Adjust cables as required.

Press **accelerator** to floor and check that pulley moves to full-load stop.

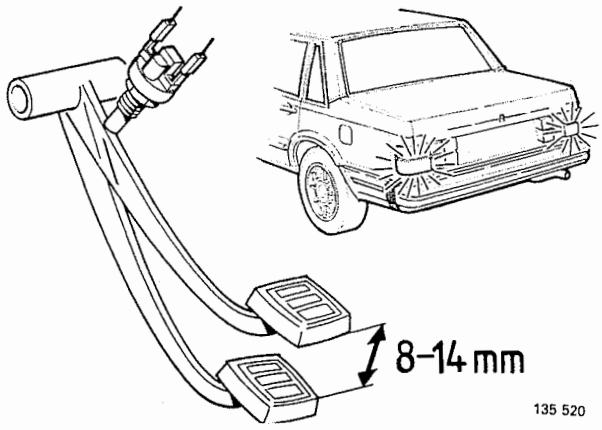

143 429

*AT5*

## Check fuses No. 4 and 12

### Check wiring and vacuum hoses

Hoses must be correctly connected and must not be crimped or damaged. Connections must be correctly made.



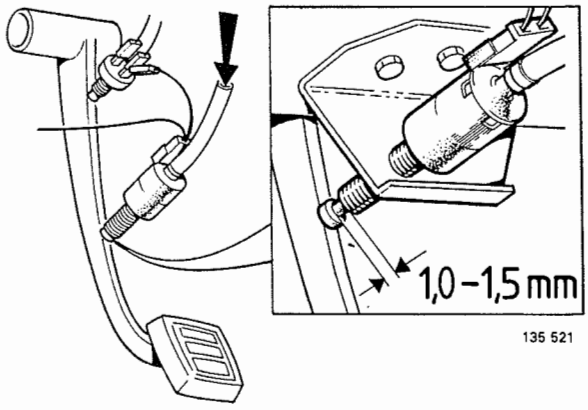
135 520

*AT6*

## Check that brake lights are operating and that switch is correctly adjusted

Control unit is connected to earth across brake lights. Unit will not operate if both brake light bulbs are faulty.

Brake lights should operate before brakes engage when pedal is depressed by **8–14 mm** (¼–½ in). Adjust as required.



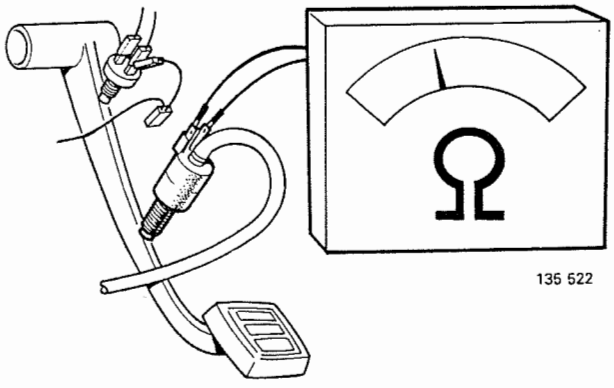

*AT7*

**Check that brake pedal air valve is correctly adjusted and is not leaking**
**(Repeat check for clutch pedal valve on manuals)**

Valve must close, without leaking, when pedal is released, and must open when pedal is operated.

Check each valve by connecting and blowing into a tube.

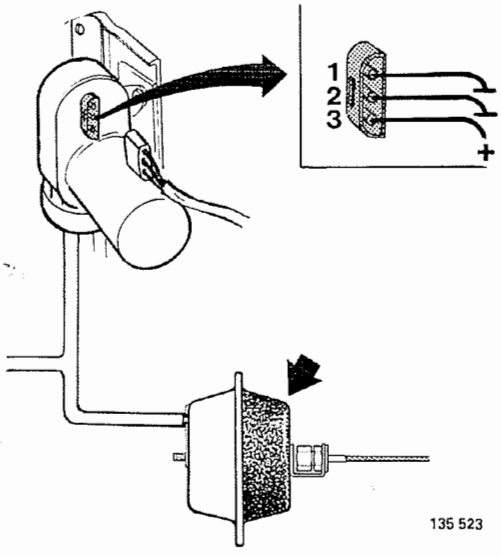
Adjust as required.




*AT8*

**Check that air valve switches are operating correctly**

Connect ohmmeter across switch terminals. Resistance must be low (circuit closed) when pedal is released and infinite (open circuit) when pedal is operated.




*AT9*

**Check vacuum pump and regulator; check system for leaks**

Three separate leads are required for checking purposes.

Remove vacuum pump connector.

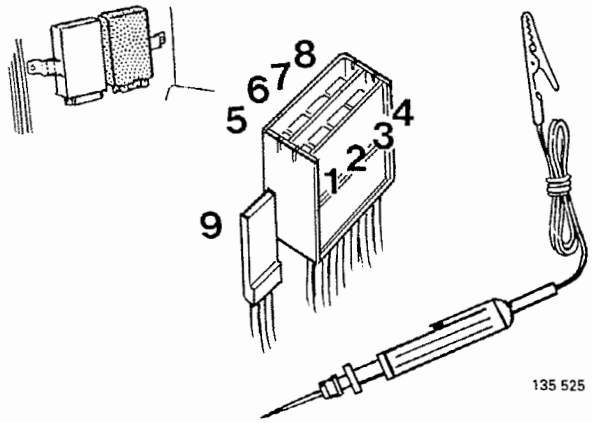
Connect one lead between 12 V power source and pump terminal 3. Connect remaining two leads between earth and pump terminals 1 and 2. Pump should start and vacuum servo should pull cable to bottom limit. Disconnect earth lead from terminal 2. Pump should stop and vacuum servo should remain in actuated position. Absence of servo movement when pump is operated indicates leakage in system or pump fault.

Disconnect earth lead from terminal 1. Vacuum servo should return to original position. Failure to do so indicates pump fault.

Disconnect supply lead.

Replace vacuum pump connector.

*AT10*




### Check wiring

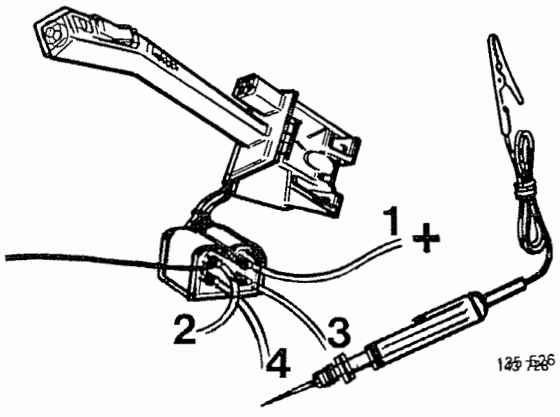
Switch off ignition and disconnect control unit.

Test connector pins using test lamp as described below.

(Also see wiring diagram.)

| Test procedure | Fault symptom | Cause/action |
|---|---|---|
| • Ignition off<br>• Switch on<br>Connect test lamp across earth and terminals 1 to 9 in turn<br>Lamp **must not light** when connected to any of terminals | Lamp lights at certain terminal(s) | – Faulty wiring connection<br>– Flashover |
| • Ignition off<br>• Switch on<br>Connect test lamp across earth and terminals 1 to 9 in turn<br><br>Lamp **should light** when connected to terminals 1, 9 and 4 | Lamp does not light when connected to terminal 1 | – Check fuse No. 2<br>– Wiring open-circuit |
| | Lamp does not light when connected to terminal 9 | – Check switch<br>– Wiring open-circuit |
| | Lamp does not light when connected to terminal 4 | – Vacuum pump not connected<br>– Wiring open-circuit |
| • Ignition off<br>• Switch on<br>Connect test lamp across earth and terminals 1 and 8 in turn<br>Lamp **should light** | Lamp does not light | – Faulty earth connection |
| • Ignition off<br>• Switch on<br>Connect test lamp across earth and terminals 1 and 9 in turn<br>Lamp **should light when pedals are released and go out when pedals are operated** | Lamp does not light when pedals are released | – Wiring open-circuit<br>– Brake light switch not connected |
| | Lamp does not go out when pedals are operated | – Check control switch<br>– Wiring open-circuit |
| • Ignition off<br>• Switch on<br>• Press SET SPEED button<br>Connect test lamp across earth and terminal 2.<br>Press SET SPEED button.<br>Lamp **should light** | Lamp does not light | – Check control switch<br>– Wiring open-circuit |

| Test procedure | Fault symptom | Cause/action |
|---|---|---|
| • Ignition off<br>• Switch on<br>Connect test lamp across earth and terminal 6.<br>Set switch to RESUME position.<br>Lamp **should light** | Lamp does not light | – Check control switch (see AT11)<br>– Wiring open-circuit |
| • Ignition off<br>• Switch on<br>Connect lead across earth and terminal 7.<br>Vacuum pump in engine compartment should emit **click.**<br>Connect second lead across earth and terminal 4.<br>**Vacuum pump should start** | Click not heard and pump does not start | – Wiring open-circuit |




*AT11*

### Check cruise control switch

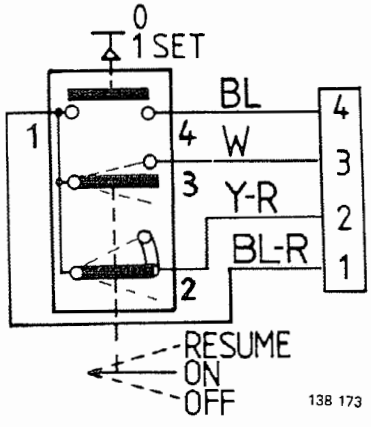
Open connector at switch.

Connect lead between 12 V power supply and terminal 1.

Connect test lamp across earth and terminals 2 to 4 in turn.

Lamp should light as indicated in table below. Replace switch if faulty.

| Terminal | Switch position and test lamp function | | | |
|---|---|---|---|---|
| | **OFF** | **ON** | **ON SET SPEED depressed** | **RESUME** |
| **2** | not lit | **lit** | **lit** | **lit** |
| **3** | not lit | not lit | not lit | **lit** |
| **4** | not lit | not lit | **lit** | not lit |



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**TP 31311/1**
3000.12.88
Printed in U.S.A.

Printed in U.S.A., Western Publishing Co., 1988