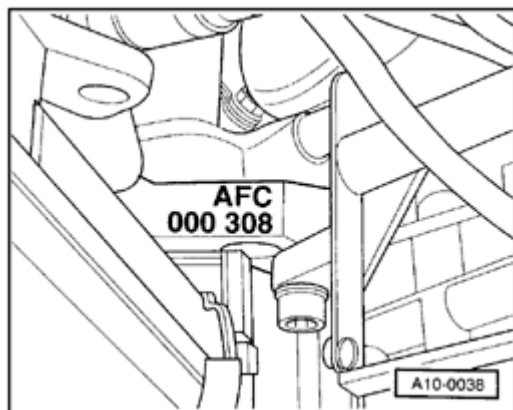


## Technical data

### Engine number



- A** The engine code letters as well as the serial number are stamped on the right hand side of the engine block between the cylinder head and the power steering pump.

In addition, an adhesive label on the drive belt cover lists the engine code and engine number (serial number).

The engine code is also found on the vehicle data plate.

## Engine specifications

| Engine code                                               |             | AFC        |  |
|-----------------------------------------------------------|-------------|------------|--|
| Manufactured                                              | from:to:    | 05.95      |  |
|                                                           |             | -          |  |
| No. of cylinders                                          |             | 6          |  |
| Displacement                                              | liters      | 2.771      |  |
| Output <sup>1)</sup>                                      | kW @ RPM    | 128 @ 5500 |  |
|                                                           | Hp @ RPM    | 174 @ 5500 |  |
| Torque <sup>1)</sup>                                      | Nm @ RPM    | 245 @ 3000 |  |
|                                                           | Ft.lb @ RPM | 180 @ 3000 |  |
| Bore diameter                                             | mm          | 82.5       |  |
| Stroke                                                    | mm          | 86.4       |  |
| Compression ratio                                         |             | 10.0:1     |  |
| Valve timing: at 1 mm valve lift and 0 mm valve clearance |             |            |  |
| Intake opens after TDC                                    |             | 10.50 °    |  |
| Intake closes after BDC                                   |             | 45.45 °    |  |
| Exhaust opens before BDC                                  |             | 37.50 °    |  |
| Exhaust closes before TDC                                 |             | 2.55 °     |  |

|                                                               |         |    |  |
|---------------------------------------------------------------|---------|----|--|
| RON                                                           | minimum | 91 |  |
| 1) Performance with RON 98 super (premium) lead-free gasoline |         |    |  |

00-3

|                                  |  |                                |  |
|----------------------------------|--|--------------------------------|--|
| Fuel injection system            |  | Multiport Fuel Injection (MFI) |  |
| On Board Diagnostic              |  | Yes                            |  |
| Oxygen Sensor (O2S) control      |  | Yes                            |  |
| Knock sensor control             |  | Yes                            |  |
| Three Way Catalytic Converter(s) |  | Yes                            |  |
| Exhaust gas turbocharger         |  | No                             |  |
| Exhaust Gas Recirculation (EGR)  |  | Yes                            |  |

## Engine, removing and installing

### Rules of cleanliness

#### **CAUTION!**

***Whenever carrying out work on the fuel supply and fuel injection systems, carefully observe the following five rules of cleanliness.***

- 1 - Thoroughly clean fuel system line and hose connections and the surrounding area before disconnecting.
- 2 - Place removed components on a clean surface and cover. Use plastic sheeting or paper. Do not use fluffy rags that could leave lint!
- 3 - Carefully cover over or seal any components that have been opened if repairs are not carried out immediately.
- 4 - Install only clean parts:  
  
Do not remove replacement parts from the packaging until immediately before they are to be installed.  
  
Do not use parts that have been stored without packaging (e.g. in toolboxes, etc.).

5 - When the fuel system is opened:

Avoid working with compressed air whenever possible.

Avoid moving the vehicle if possible.

## Safety precautions

### **WARNING!**

*Be sure the ignition is switched OFF, when:*

- ♦ *Disconnecting ignition wires*
- ♦ *Disconnecting fuel injection system wiring*
- ♦ *Connecting or disconnecting test equipment leads*
- ♦ *Disconnecting the battery*
- ♦ *Washing the engine or engine compartment.*

### **CAUTION!**

*BEFORE disconnecting the battery:*

- ♦ *Stop the engine.*
- ♦ *Be sure the ignition is switched OFF (also applies when connecting the battery). Failure to do so may damage the Engine Control Module (ECM).*

- ♦ *Be sure of the proper radio code (for vehicles equipped with coded anti-theft radio).*

## Removing

The engine is removed from the front, after being separated from the transmission.

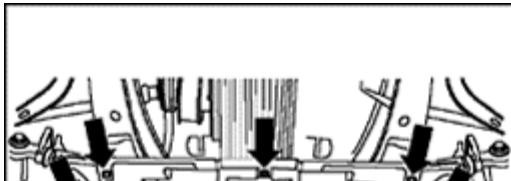
### **CAUTION!**

***Determine correct radio anti-theft coding before disconnecting the battery.***

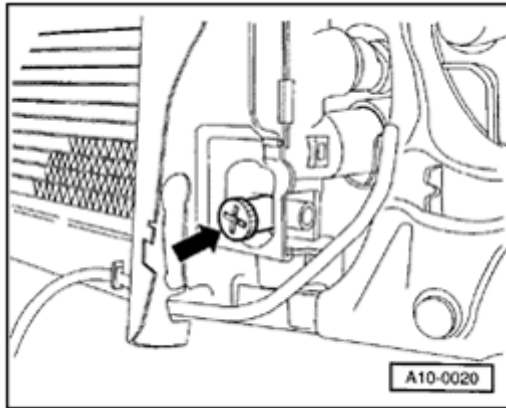
### **Note:**

*All tie wraps that are loosened or removed in order to remove the engine must be replaced or reinstalled in the same place when the engine is installed.*

- Ignition switched off
  - Disconnect battery Ground (GND) strap.
  - Unbolt bumper by unclipping vent grille at left and right and removing from bumper
- ⇒ [Repair Manual, Body Exterior, Repair Group 63](#).
- ⚡ - Remove noise insulation panel.



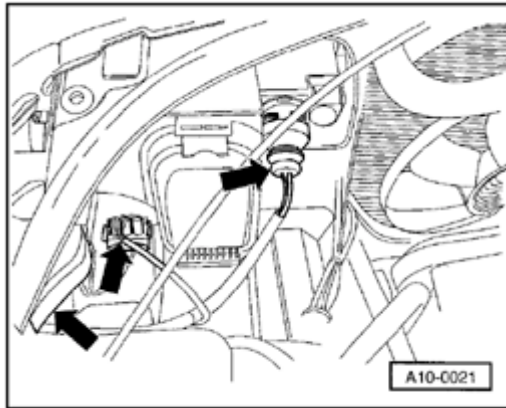
10-4



A

- Unbolt cooling coil for power steering fluid at bottom left of radiator.
- Drain coolant at radiator.
- Remove locking element for connection flange of coolant hose at bottom of radiator; pull off connection flange.

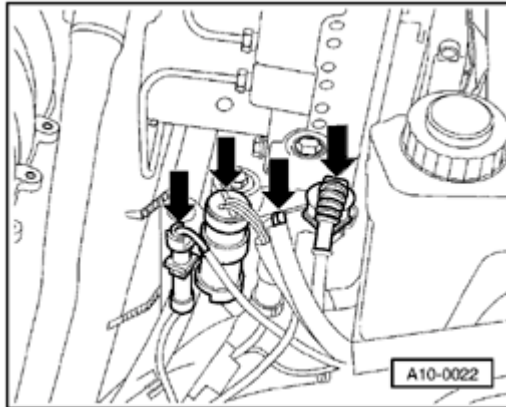
10-5



- Remove intake air duct to air cleaner at air scoop and lift out.

A

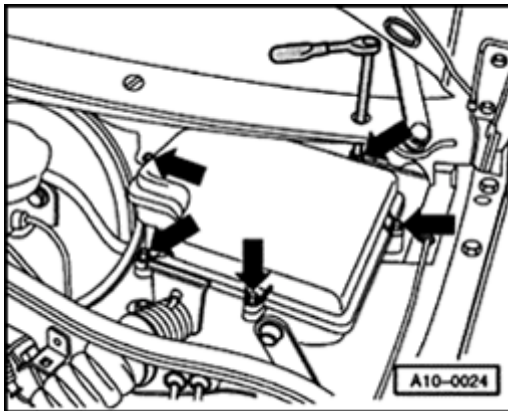
- Disconnect harness connectors for headlights and turn signal lights.
- Disconnect harness connector of engine coolant temperature sensor near bottom coolant hose at left of radiator.



A

- Disconnect four harness connectors at ABS hydraulic unit.
- Disconnect harness connectors for anti-theft warning system at upper left of front end.
- Disconnect coolant hose at top left of engine.
- Unclip and disconnect A/C clutch harness connectors at radiator air guide on lower right.
- Disconnect harness connectors at both horns, let cables hang free.
- Remove air scoop.

- Disconnect harness connectors at Mass Air Flow (MAF) sensor and Idle Air Control (IAC) valve, unbolt hose from plenum chamber and unclip.
- Disconnect hose connection at IAC valve.
- Remove air guide between air cleaner and throttle body.
- Remove air cleaner housing.
- Disconnect fuel supply and return lines.
- Remove coolant expansion tank.



A

- Remove cover for electronics box.
- Unclip engine control module and disconnect harness connectors.
- Disconnect harness connectors at connector station below engine control module.
- Disconnect ground connection and bracket for harness connectors at plenum chamber.
- Disconnect both coolant lines to heater core between plenum chamber and engine.
- Disconnect accelerator pedal cable and let hang free.

- Disconnect both harness connectors at top of transmission.

- Loosen V-belt for hydraulic pump, viscous fan and generator and secure with special tool 3204.
- Use screwdriver to counter-hold belt pulley for viscous fan and unbolt with open-end wrench 3312.

Tightening torque with torque wrench 1331 and open-end wrench 3312 is 37 Nm (27 ft lb); without open-end wrench 3312 tightening torque is 70 Nm (52 ft lb).

**Note:**

*Refer to table for torque wrenches of a different length; length of torque wrench from socket drive to center of handle.*

| Length of torque wrench | Tightening torques |            |
|-------------------------|--------------------|------------|
| 220 mm                  | 33 Nm              | (24 ft lb) |
| 280 mm                  | 37 Nm              | (27 ft lb) |
| 300 mm                  | 39 Nm              | (29 ft lb) |
| 440 mm                  | 45 Nm              | (33 ft lb) |

- Unbolt hydraulic pump from mounting bracket.

**CAUTION!**

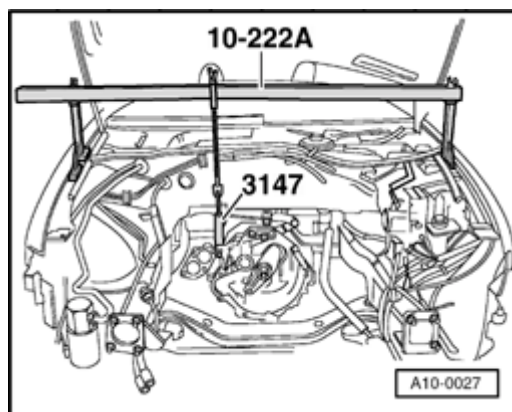
***Hydraulic lines should remain connected.***

- Unscrew bolts and secure A/C compressor to one side with wire.

**CAUTION!**

- ♦ ***Disconnect at mounting points only.***
- ♦ ***DO NOT open the air conditioning refrigerant circuit.***
- ♦ ***Set the A/C compressor aside carefully. Refrigerant lines kink easily.***
- ♦ ***The A/C refrigerant circuit must only be opened by specially trained technicians using the proper tools and equipment.***
- Remove bolts securing exhaust manifold and front exhaust pipe at top.
- Disconnect battery positive (B+) cable from starter at right of engine below exhaust manifold.

- Remove starter, take off insulator at starter positive (B+) connection, unbolt fixture at engine block, disconnect ground wire from engine support.
- Unscrew four engine mounting bolts.

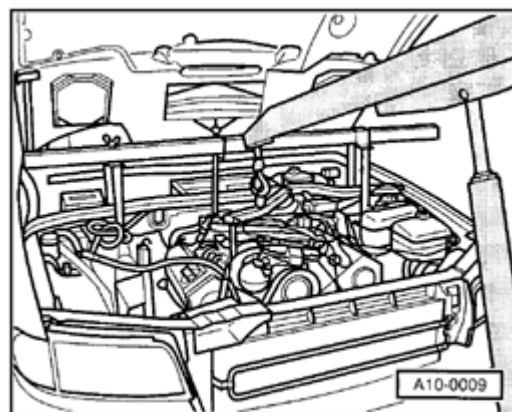


- Support weight of transmission using engine support bridge 10-222A.

A

- Attach engine support adapter 3147 to bolt hole of transmission bell housing.

(Adapter installation shown with engine removed)



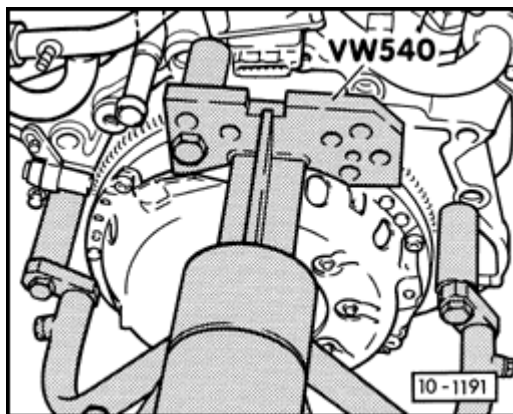
A

- Attach engine sling 2024A to engine and workshop crane 1202A.

**CAUTION!**

**The mounting hooks and pins on the lifting device must be secured with locking pins.**

### Mounting engine cylinder block on assembly stand



A

- Mount engine to stand using holding fixture VW 540 along with VW 540/2.

#### **CAUTION!**

**DO NOT** have the cylinder block mounted to the assembly stand while measuring the cylinder bores (Repair Group 13). The cylinder block is deformed by its own weight under these conditions and such stress will result in false measurements that are not accurate after the tension has been relieved.

## Installing

The engine is installed in the reverse order of removal, with the addition of the following special conditions and steps:

### **WARNING!**

*Do not re-use any fasteners that are worn or deformed in normal use. Many fasteners are designed to be used only once and become unreliable and may fail when used a second time. This includes, but is not limited to, nuts, bolts, washers, self-locking nuts or bolts, circlips and cotter pins. Always follow recommendations given in this publication. Always replace these fasteners with new parts.*

- Check that alignment sleeves for centering engine and transmission are properly installed in cylinder block. Install sleeves if necessary.
- Always install new seals and gaskets.
- Check centering of clutch disc, if necessary.
- Check clutch release bearing for wear and replace if necessary.

- Clean transmission input shaft splines. Lightly lubricate clutch release bearing and transmission input shaft splines with G 000 100 grease. Do not grease guide sleeve for release bearing.
- Install engine mounts free of stress. To do so, align engine by shaking before tightening engine mounts.

---

10-12

- Allow stop of torque support to move down onto rubber block under its own weight; tighten bolts to 45 Nm (33 ft lb).
- Align exhaust system free of stress ⇒ Repair Group 26.
- Adjust accelerator pedal cable ⇒ Repair Group 20.
- Re-fill engine cooling system ⇒ Repair Group 19.
- Drained coolant may only be re-used provided the cylinder block or the cylinder head was not replaced.
- Check oil level before starting engine.
- Short blocks are supplied without bushing in crankshaft. For vehicles with automatic transmission, tap bushing into place before installing drive plate.
- Check reconditioned engines with manual gearbox to determine whether needle bearing is installed in crankshaft; install if necessary.

- Observe tightening torque specifications.

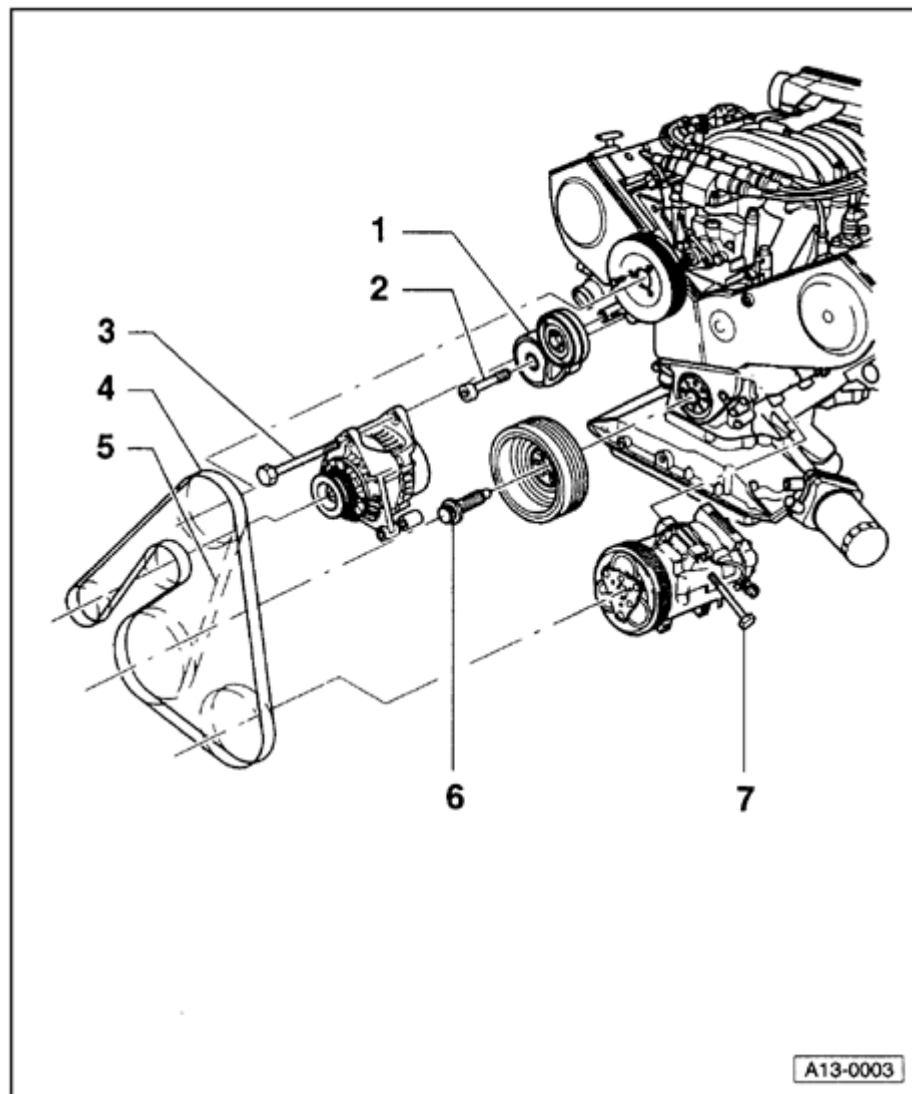
Tightening torques

Notes:

- ◆ *The tightening torques apply only to lightly greased, oiled, plated or specially treated nuts and bolts.*
- ◆ *It is permissible to use additional lubricants such as engine or gear oils, but do not use Molykote and do not use degreased parts.*
- ◆ *Permissible tolerance for tightening torques  $\pm 15\%$ .*

|                          |     |          |               |
|--------------------------|-----|----------|---------------|
| Bolts, nuts              | M6  | 10<br>Nm | (7 ft<br>lb)  |
|                          | M8  | 20<br>Nm | (15 ft<br>lb) |
|                          | M10 | 45<br>Nm | (33 ft<br>lb) |
|                          | M12 | 60<br>Nm | (44 ft<br>lb) |
| Exhaust pipe to manifold | M8  | 25<br>Nm | (18 ft<br>lb) |
| AC compressor to bracket | M8  | 25       | (18 ft        |

|                                 |     | Nm    | lb)        |
|---------------------------------|-----|-------|------------|
| Torque converter to drive plate | M8  | 35 Nm | (26 ft lb) |
| Engine support to engine mount  | M10 | 45 Nm |            |
| Viscous coupling to bracket     | M10 | 45 Nm | (33 ft lb) |
| Hydraulic pump to bracket       | M8  | 25 Nm | (18 ft lb) |
| Generator to mounting bracket   | M8  | 35 Nm | (28 ft lb) |



## Ribbed belt and pulley, assembly

### 1 - Tensioner

- ◆ Loosening ⇒ [page 13-9](#)

### 2 - 55 Nm (41 ft lb)

### 3 - 20 Nm (15 ft lb)

### 4 - Ribbed belt

- ◆ Removing and installing ⇒ [page 13-9](#)

### 5 - Belt routing for vehicles w/o A/C

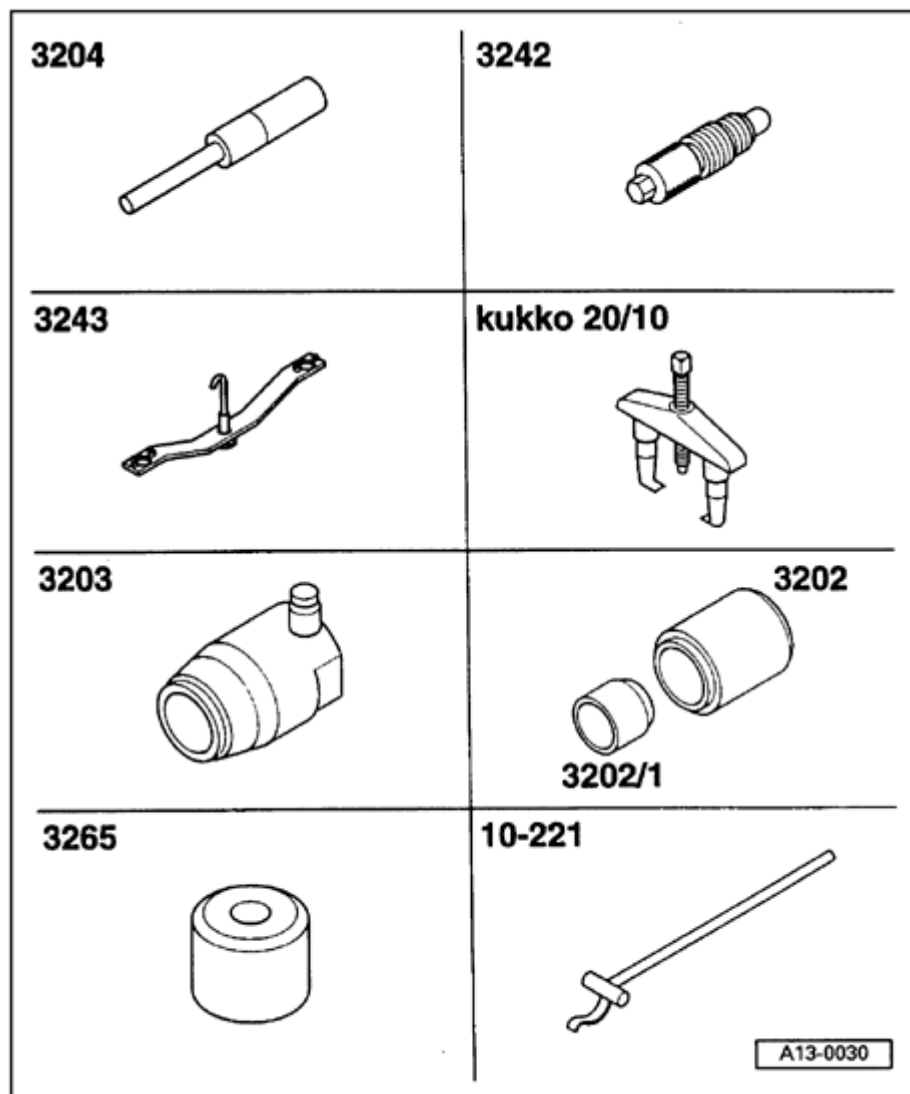
- ◆ Not applicable for USA/Canada

### 6 - Bolt

- ◆ Always replace
- ◆ Oil threads
- ◆ Use only new double hex head (12-pt.) cap screw grade 9.8
- ◆ Tightening torque (bolt oiled): 200 Nm (148 ft lb) plus additional 1/2-turn (180°); two 1/4-turns (90°) are permissible

### 7 - 20 Nm (15 ft lb)

13-1

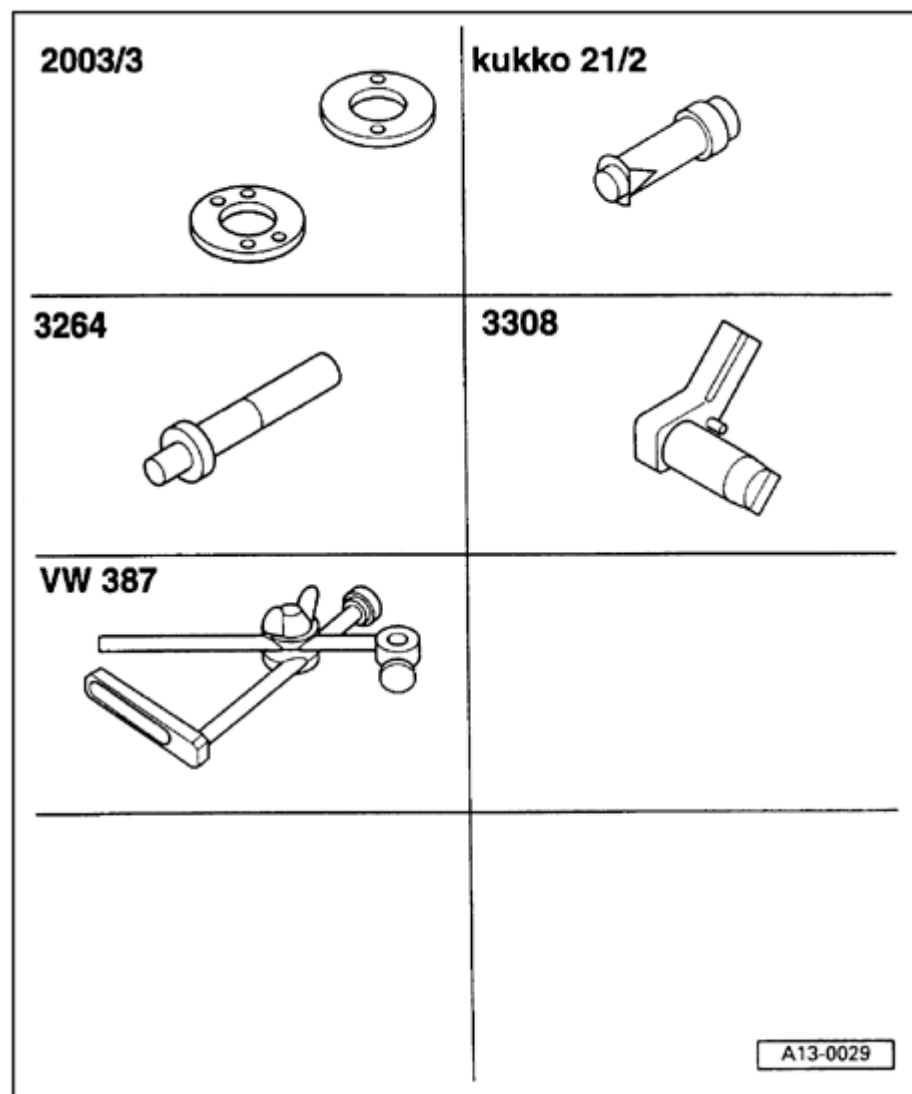


## Special tools

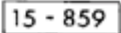
The following special tools and test equipment are required for these operations:

|        |                      |
|--------|----------------------|
| 3204   | Drift                |
| 3242   | Crankshaft holder    |
| 3243   | Camshaft holder tool |
| 20-10  | Kukko 2-arm puller   |
| 3203   | Seal remover         |
| 3202   | Retractor            |
| 3265   | Seal installer       |
| 10-221 | Extractor            |

13-2



- 4
- |        |                                |
|--------|--------------------------------|
| 2003/3 | Seal installer                 |
| 21/2   | Kukko extractor                |
|        | 14.5 - 18.5mm                  |
| 3264   | Adjusting driver               |
| 3308   | RPM sensor<br>adjusting device |
| VW 387 | Dial gauge holder              |



**1 - Bolt**

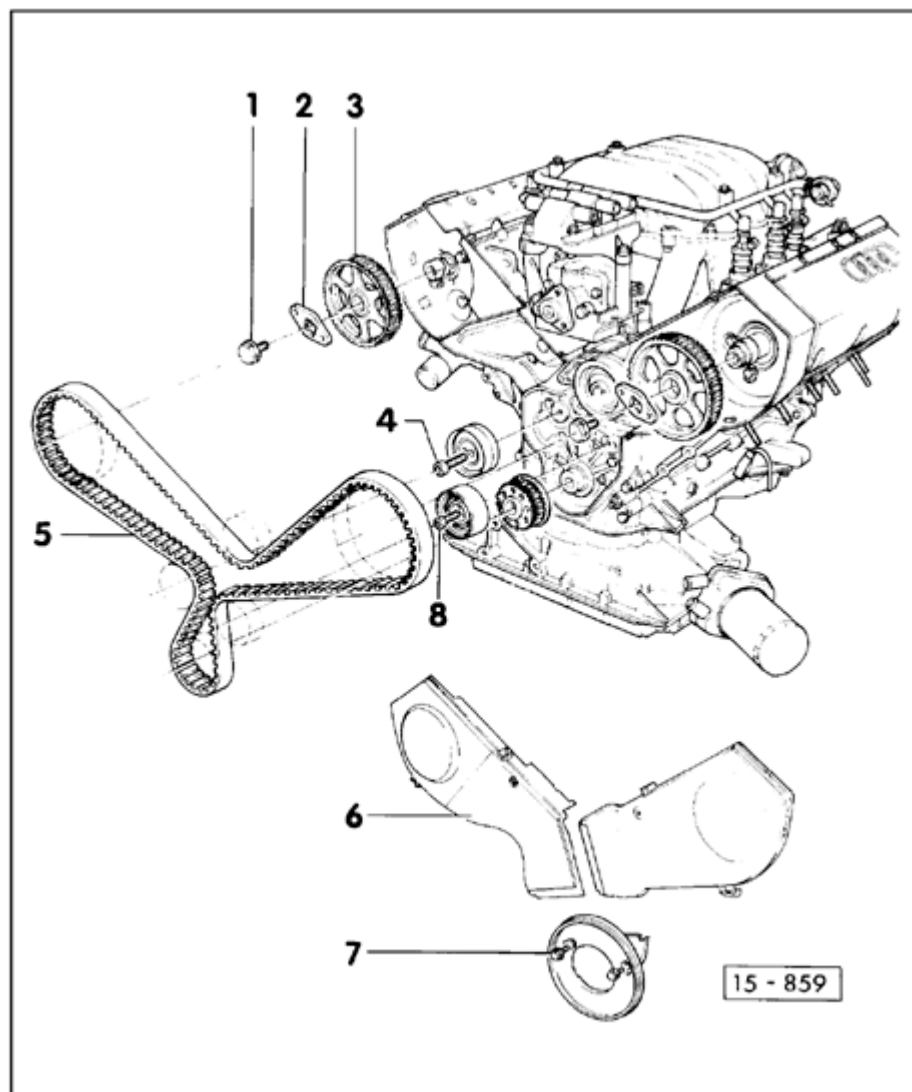
- ## 2 - Locking plate

- ### 3 - Camshaft sprocket

- CAUTION!**

- ◆ **Camshaft holder 3243 must be installed before attaching camshaft sprockets.**
- ◆ **Do not tighten the camshaft sprockets until after toothed belt tension has been adjusted.**

13-5

**4 - Toothed belt tensioner**

◆ 45 Nm (33 ft lb)

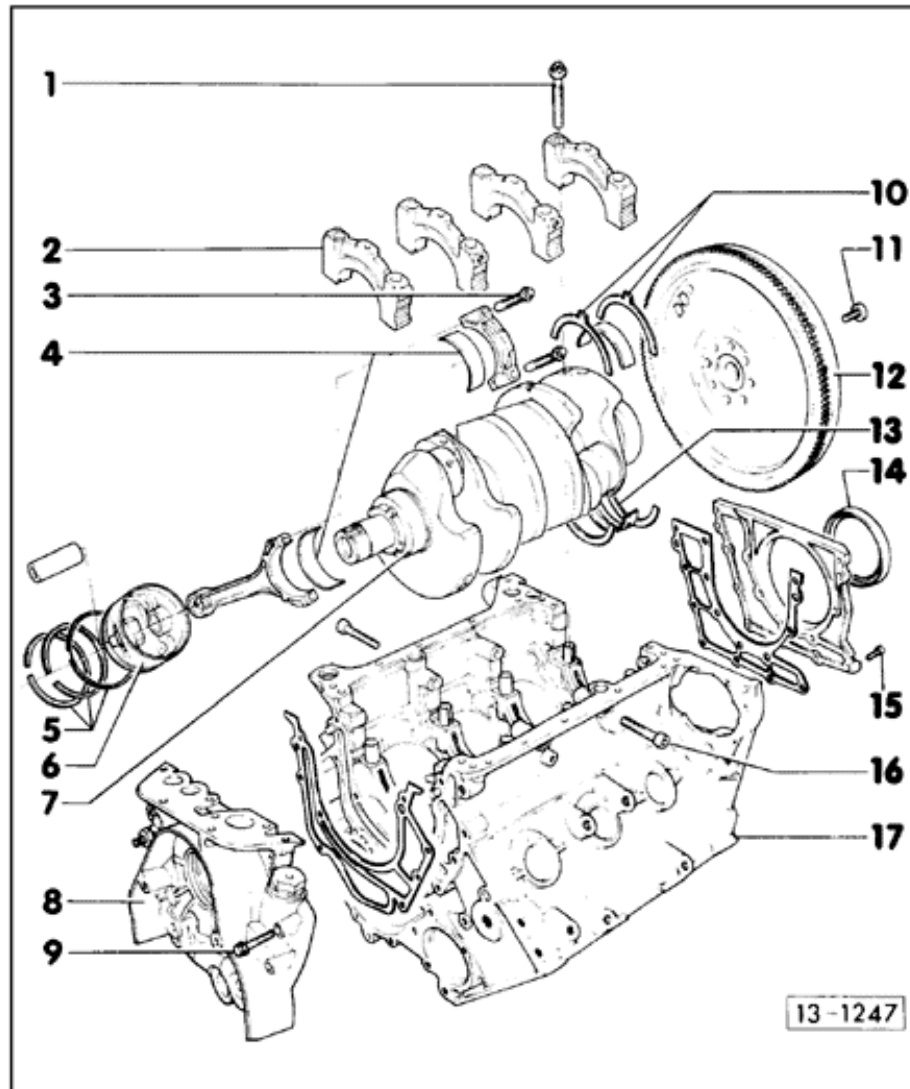
**5 - Toothed belt**

◆ Removing and installing ⇒ [page 13-11](#)

**6 - Toothed belt cover**

7 - 10 Nm (7 ft lb)

8 - 25 Nm (18 ft lb)



## Cylinder block, crankshaft and flywheel, component layout

### Note:

*Always replace gaskets and seals.*

#### 1 - Main bearing cap bolts

- ◆ Always replace
- ◆ Tightening torque: 60 Nm (44 ft lb) plus 1/2-turn (180°)

#### 2 - Main bearing cap

- ◆ ID: "1" on side facing oil pump
- ◆ Always replace bolts
- ◆ Checking bearing clearance ⇒ [page 13-21](#)

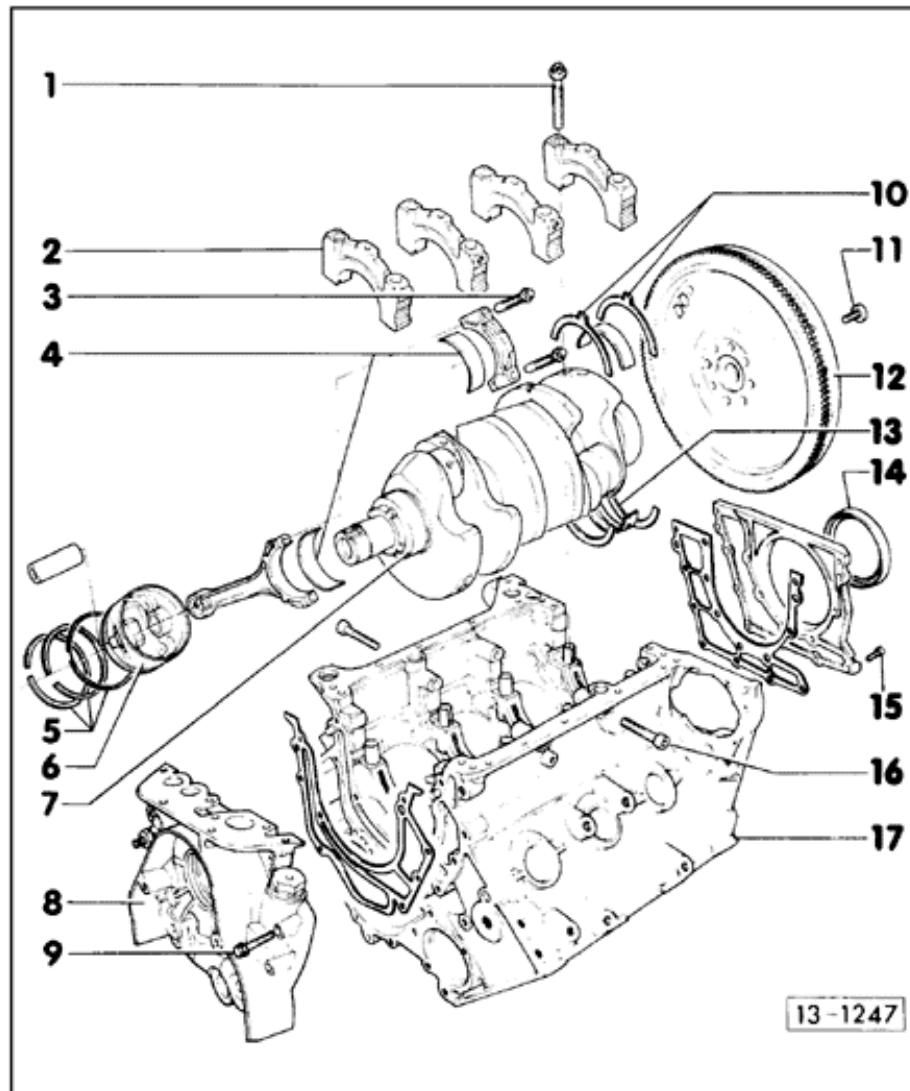
#### 3 - Connecting rod bearing cap bolts

- ◆ Always replace
- ◆ Tightening torque: 30 Nm (22 ft lb) plus 1/4-turn (90°)
- ◆ Tighten to 20 Nm (15 ft lb) for measuring radial clearance, but do NOT tighten further

#### 4 - Connecting rod bearing shells

- ◆ Never interchange used connecting rod bearing shells

- ◆ Checking connecting rods and bearings ⇒  
[page 13-31](#)

**5 - Piston rings**

- ◆ Checking ⇒ [page 13-25](#)

**6 - Piston**

- ◆ Checking ⇒ [page 13-26](#)

**7 - Crankshaft**

- ◆ Checking ⇒ [page 13-21](#)
- ◆ Dimensions ⇒ [page 13-24](#)

**8 - Oil pump**

- ◆ Check drive gear on crankshaft when installing
- ◆ Removing ⇒ Repair Group 17

**9 - 10 Nm (7 ft lb)****10 - Thrust washers**

- ◆ Installed only at 4th crankshaft main bearing
- ◆ Checking crankshaft axial clearance ⇒ [page 13-21](#)

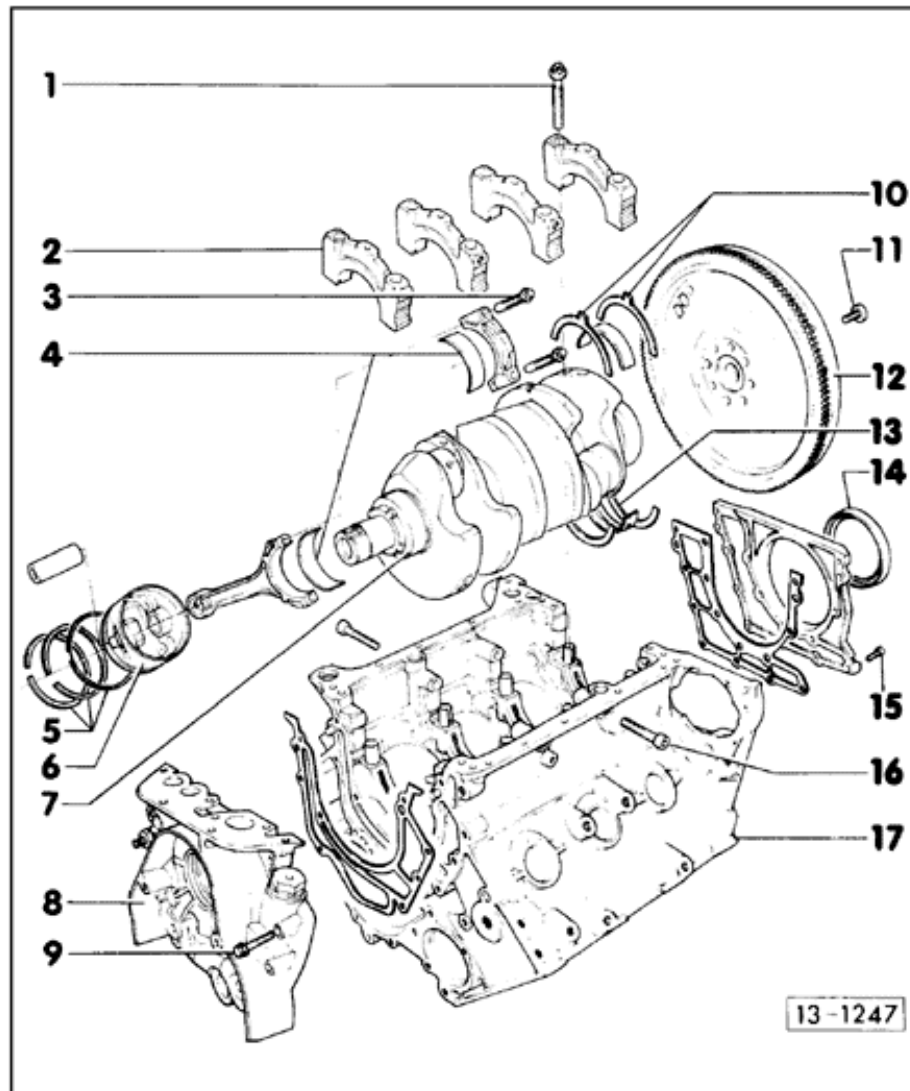
**11 - Bolt**

Automatic trans. (drive plate)

- ◆ Always replace
- ◆ Tightening torque: 60 Nm (44 ft lb) plus 1/4-turn (90°)

Manual trans. (flywheel)

- ◆ Always replace
- ◆ Tightening torque: 40 Nm (30 ft lb) plus  
1/2-turn (180°)

**12 - Dual mass flywheel or drive plate**

- ◆ Removing and installing, installation dimensions ⇒ [page 13-17](#)
- ◆ Removing and installing pilot needle bearing ⇒ [page 13-16](#)
- ◆ Adjusting engine speed (RPM) sensor bracket -G28- ⇒ [page 13-20](#)

**13 - Main bearing shell**

- ◆ Checking radial clearance ⇒ [page 13-21](#)

**14 - Seal**

- ◆ Replacing ⇒ [page 13-14](#)

**15 - 10 Nm (7 ft lb)****16 - 25 Nm (18 ft lb)**

- ◆ Thread bolts in hand-tight before tightening crankshaft main bearing caps

**17 - Cylinder block**

## Ribbed belt, removing and installing

### **CAUTION!**

***Mark the direction of belt travel before removing, using a crayon or marker. Reinstalling a used belt in the opposite direction could damage the belt.***

### Removing

- Remove engine and ribbed-belt guard.
- Loosen ribbed-belt tensioner using 17 mm wrench and secure with locking drift 3204.
- Remove ribbed belt.

### Installing

- Install ribbed belt over the crankshaft belt pulley and guide pulley first, and then push it onto the tensioning pulley.
- Remove locking drift 3204.
- Install engine and ribbed belt guard.



### Routing of ribbed belt drive -D-



D1 - Without air conditioner

D2 - With air conditioner

## Vibration damper, removing and installing

### Removing

Removing ribbed belt ⇒ [page 13-9](#) .

#### **Note:**

*The center bolt does not have to be loosened to remove the vibration damper.*

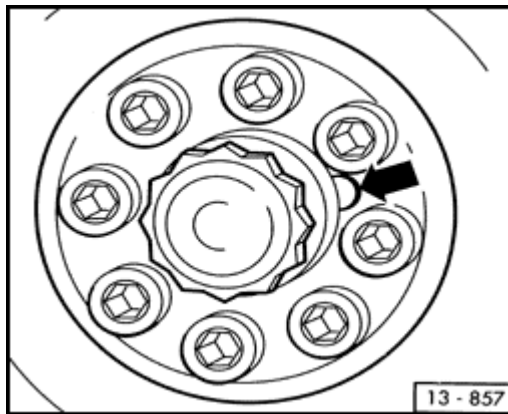
- Remove vibration damper.

### Installing



- When installing, make sure that notch (arrow) in vibration damper is aligned with locking lug on toothed belt sprocket.

Tightening torque: 25 Nm (15 ft lb)



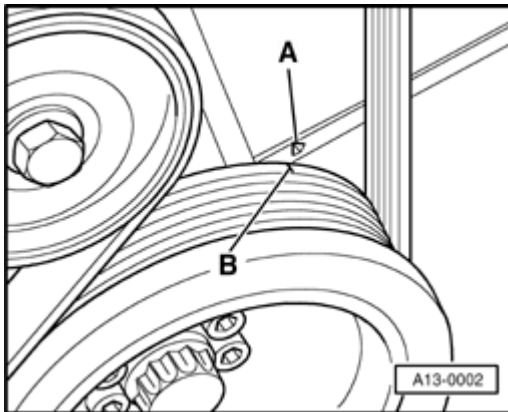
## Toothed belt, removing and installing

### Removing

#### **CAUTION!**

**Mark the direction of belt travel before removing, using a crayon or marker. Reinstalling a used belt in the opposite direction could damage the belt.**

- Remove ribbed belt ⇒ [page 13-9](#) .
- Unclip toothed belt guard on both sides.
- ⚠ - Crank engine by hand to Top Dead Center (TDC) position.
- Check camshaft position. Large holes in camshaft sprocket locking plates must face toward each other. If not, turn crankshaft one more revolution.
- Remove Crankshaft Position (CKP) sensor from left-hand side of cylinder block.
  - The TDC hole in the crankshaft must be aligned with the hole for the removed crankshaft position sensor (check by looking and feeling).
- ⚠ - Thread crankshaft holder 3242 into hole left by crankshaft position sensor, and tighten slightly.
- Remove ribbed-belt tensioner.



- Remove left and right toothed-belt guards.
- Remove vibration damper ⇒ [page 13-10](#) .
- Remove lower toothed-belt guard.
- Loosen toothed-belt tensioning pulley, and remove belt.

### Installing

A

- Loosen right and left camshaft sprockets from tapered ends of camshafts using puller (Kukko 20-10 or equivalent).

#### **Note:**

*The arms of the puller must engage on the rear hub of the sprocket.*

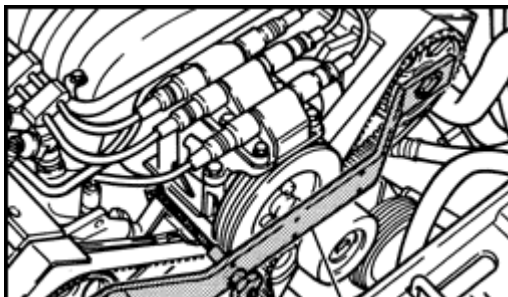
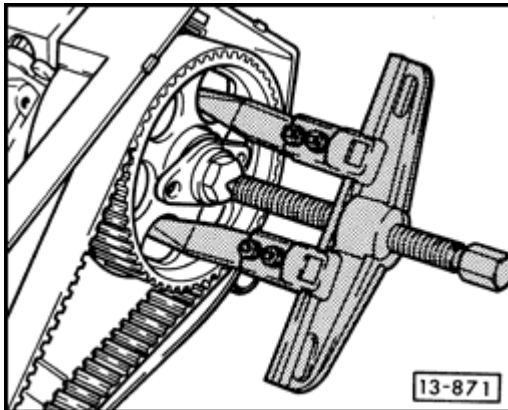
- Install toothed belt over both camshaft sprockets first, then over remaining sprockets, and over tensioning roller last.

A

- Install camshaft holder 3243.

#### **Note:**

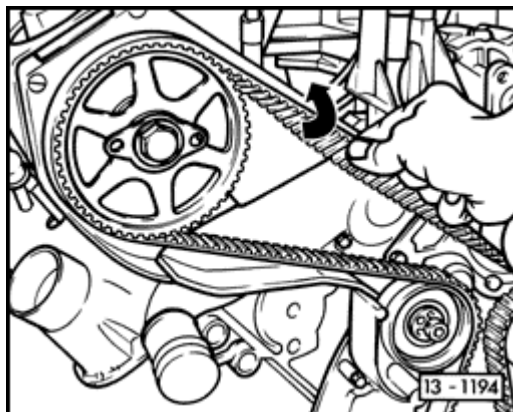
*The camshaft sprockets must be loose enough on the tapered ends of the shafts so that the camshafts can still be turned, but tight enough that the sprockets do not tilt out of alignment.*



- Adjust belt tension ⇒ [page 13-13](#) .

## Toothed belt, adjusting tension

- Adjust toothed belt tension by turning tensioning roller to right and holding using 8 mm hex socket wrench.
- Tighten tensioning roller center bolt with another 8 mm hex socket wrench.



A

- Check toothed belt tension between right camshaft sprocket and coolant pump.

Holding toothed belt half way between camshaft sprocket and coolant pump with thumb and index finger, it must be just possible to twist toothed belt by 90°.

Tightening torque (tensioning roller): 45 Nm (33 ft lb)

Center crankshaft bolt: Always replace, using new double hex head (12-pt.) cap screw grade 9.8

| Component                               | Tightening torque         |
|-----------------------------------------|---------------------------|
| Toothed belt sprocket to camshaft       | 70 (52 ft lb)             |
| Idler roller                            | 25 (18 ft lb)             |
| Toothed belt tensioner                  | 45 (33 ft lb)             |
| Belt cog to crankshaft                  | 25 (18 ft lb)             |
| Center bolt <sup>1)</sup> to crankshaft | 200 (148 ft lb) + 180° 2) |

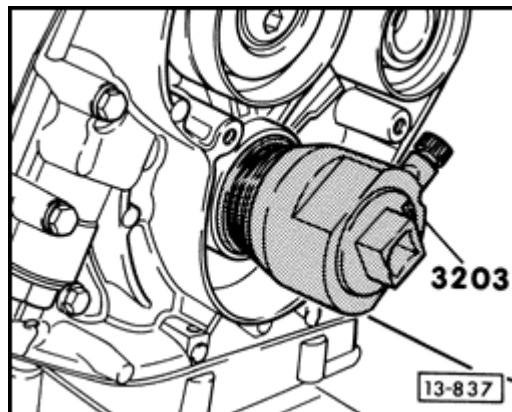
- 1) Always replace the center bolt.
- 2) Two turns of  $90^\circ$  are permissible.

## Crankshaft oil seals, replacing

### Toothed belt end (front)

- Remove toothed belt ⇒ [page 13-11](#) .

- Remove toothed belt sprocket from crankshaft.

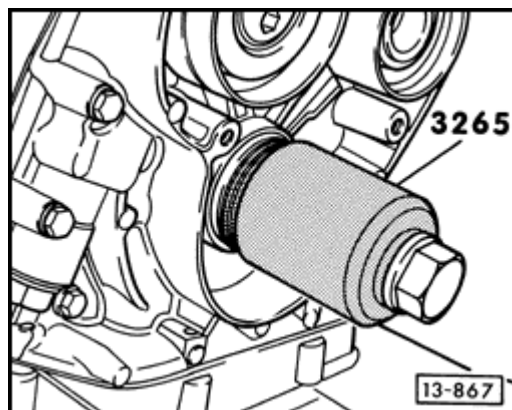


A

- Remove oil seal using seal remover 3203.
- Clean running and sealing surfaces.

#### **Note:**

*Do not oil sealing lip or outer edge of seal before pressing in.*



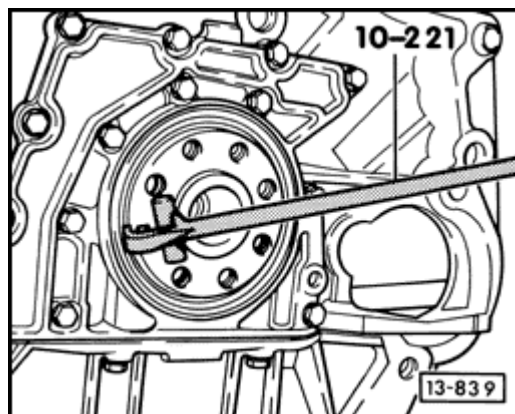
A

- Push oil seal over 3202/1 from retractor 3202.
- Press in oil seal flush with seal installer 3265 and center crankshaft bolt.

**Flywheel/drive plate end (rear)****CAUTION!**

***Always replace the seal with the flange, if available. Drain engine coolant before removing flange (⇒ Repair Group 19). Replace only seal as described below if oil seal with flange is not available.***

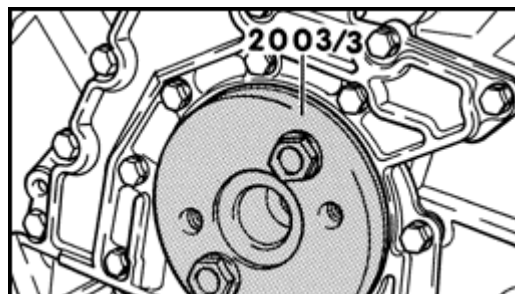
- Remove clutch and flywheel, or drive plate, as necessary.

**A**

- Pry out oil seal with extractor 10-221.
- Clean running and sealing surfaces.

**Note:**

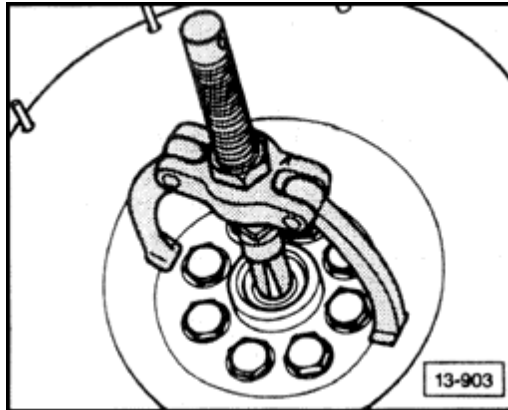
*Do not oil sealing lip or outer edge of seal before pressing in.*

**A**

- Using assembly aid supplied with new oil seal, slide seal onto crankshaft.  
Assembly aid is supplied with oil seal
- Press in oil seal as far as possible using seal installer 2003/3 and flywheel or drive plate mounting screws.

13-16

### Flywheel pilot needle bearing, removing and installing

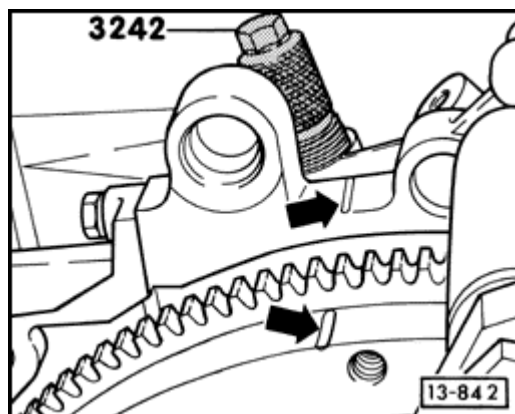


A

- Remove bearing with puller assembly such as Kukko 21/2 and Kukko 22-1, as shown
- Install bearing with drift 3264.

## Dual mass flywheel or drive plate, removing and installing

### Flywheel



- Install crankshaft holder 3242 with crankshaft at Top Dead Center (TDC) position.
- Mark relationship between flywheel and engine cylinder block (arrows).
- Remove flywheel.

### **Note:**

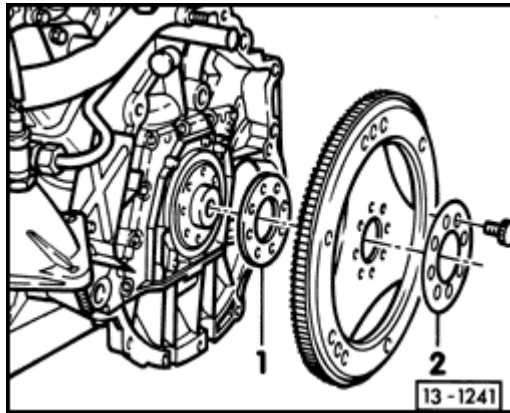
*The needle roller bearing is in the flywheel and must be pressed in when replacing the flywheel.*

### Tightening torque

- ◆ Dual mass flywheel: 40 Nm (30 ft lb) plus 1/2-turn (180°)

### Drive plate

- Hold crankshaft in position using crankshaft holder 3242 ⇒ [page 13-11](#)



A

- Mark bolt hole pattern of drive plate and washers -1- and -2- relative to crankshaft. Mark position of shim in front and shim behind drive plate.

### CAUTION!

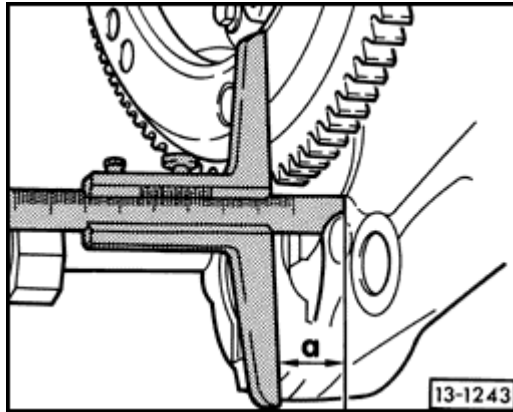
**Part numbers are listed for reference only. Always check with your Parts department for the latest information.**

- Install drive plate with 3.0 mm shim -1- (Part no. 054 105 301) or 4.0 mm shim -1- (Part no. 054 105 202), and spacer -2- (Part no. 035 105 303A).

### Note:

*Short blocks are supplied without a bushing in the crankshaft. For vehicles with automatic transmission, tap the bushing into place before installing the drive plate.*

13-19



A

- Check clearance -a- between drive plate and cylinder block in three places and calculate average value.

Dimension -a-:

- ◆ Transmission 01V: 18.1-19.7 mm (0.713-0.776 in.)
- If necessary, install other shims to achieve correct clearance dimension.

Tightening torque: 60 Nm (44 ft lb) plus 1/4-turn (90°)

**Note:**

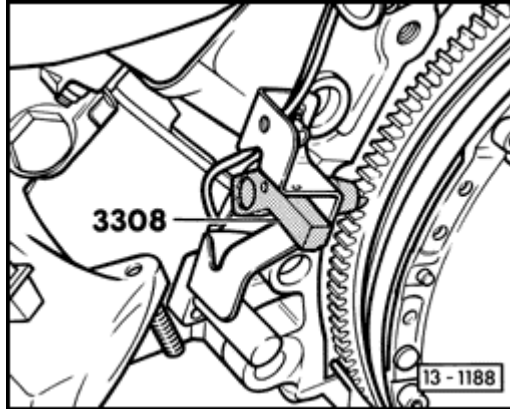
*Before installing the engine, make sure that the engine-to-transmission dowel sleeves are installed in the cylinder block flange.*

## Engine speed (RPM) sensor mounting bracket, adjusting

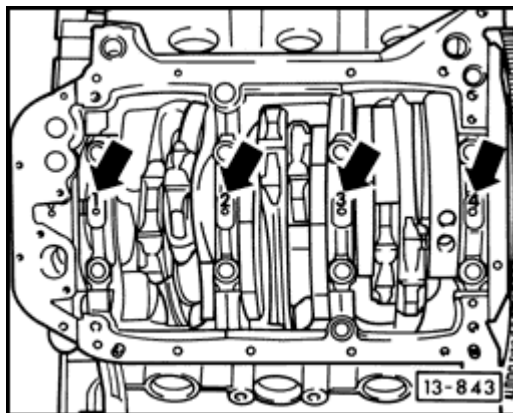
### **Note:**

*The crankshaft must be at TDC and locked in position with crankshaft holder 3242 ⇒ [page 13-11](#).*

- Remove heat shield for RPM sensor, and then remove RPM sensor.
- Loosen bracket.
- A** - Insert adjustment tool 3308 in place of sensor.
  - Adjustment tool must engage in flywheel ring gear.
- Tighten bracket securely.
- Install RPM sensor.



## Crankshaft axial and radial clearance, checking



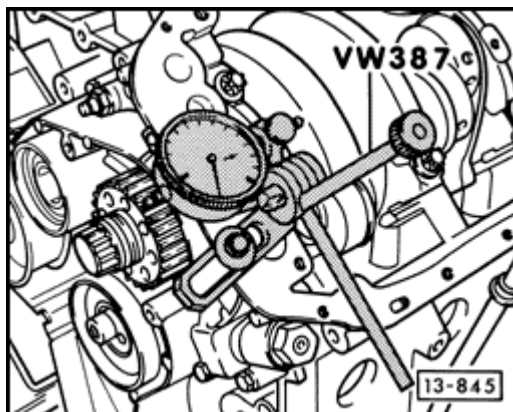
### A Orientation of crankshaft bearing caps

#### **CAUTION!**

**Bearing shells must be reinstalled in their original location and orientation. Always label the bearing shells according to their installed position before removing. NEVER interchange used bearing shells.**

- ◆ Main bearing cap -1- is at the oil pump end (front).
- ◆ Main bearing cap -4- is at the flywheel end (rear).

### Checking axial clearance



- ### A
- Install dial indicator with holder VW 387 on oil pump and set indicator against crankshaft counterweight.
  - Press crankshaft against dial indicator by hand.
  - Set dial gauge to zero.
  - Press crankshaft away from dial indicator and read gauge.

#### Specifications:

- ◆ New: 0.07-0.23 mm (0.0027-0.0091 in.)
- ◆ Wear limit: 0.25 mm (0.0098 in.)

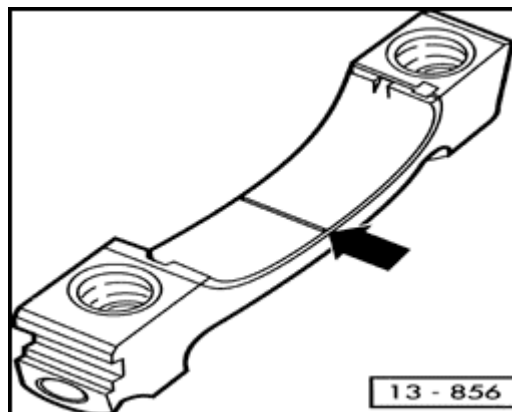
## Checking radial clearance

### Note:

Radial clearance is measured using Plastigage<sup>®</sup>.

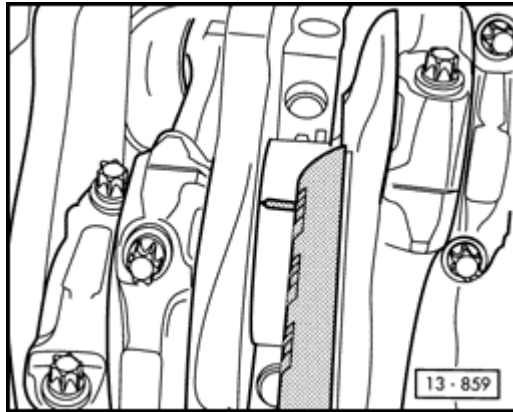
| Plastigage <sup>®</sup> type | Color | Measuring range  |
|------------------------------|-------|------------------|
| PG-1                         | Green | 0.025 - 0.076 mm |
| PR-1                         | Red   | 0.050 - 0.150 mm |

- Remove crankshaft bearing cap.
- Clean bearing shell and crankshaft journal.
- Place Plastigage<sup>®</sup> on crankshaft journal over entire width of bearing, or in bearing shell (arrow).
- Install crankshaft bearing cap with bearing shell and new bolts.
- Tighten to 60 Nm (44 ft lb) plus 1/2-turn 180°.



### CAUTION!

**Do NOT turn the crankshaft or allow it to rotate during the measurement with Plastigage<sup>®</sup> in place.**



- Remove crankshaft bearing cap again.
- Compare width of Plastigage® with measuring scale.

Specifications:

- ◆ New: 0.018-0.045 mm (0.0007-0.0018 in.)
- ◆ Wear limit: 0.10 mm (0.0039 in.)

## Crankshaft dimensions

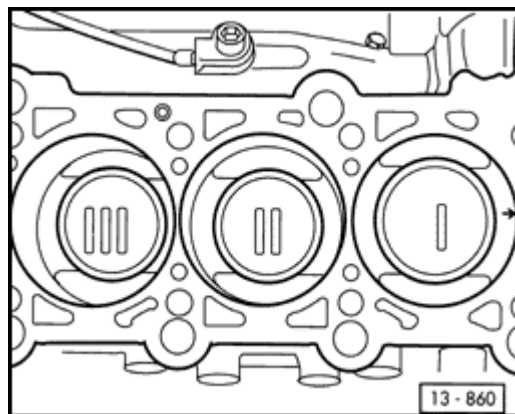
| Reconditioning dimension         | Crankshaft journal diameter - mm (in.) | Connecting rod journal diameter - mm (in.) |
|----------------------------------|----------------------------------------|--------------------------------------------|
| maximum size (from nominal)      | -0.022 (0.00087)                       | -0.022 (0.00087)                           |
| <b>Basic dimension (nominal)</b> | 65.00 (2.559)                          | 54.00 (2.126)                              |
| minimum size (from nominal)      | -0.042 (0.00165)                       | -0.042 (0.00165)                           |
| maximum size (from nominal)      | -0.022 (0.00087)                       | -0.022 (0.00087)                           |
| <b>1st undersize (nominal)</b>   | 64.75 (2.549)                          | 53.75 (2.116)                              |
| minimum size (from nominal)      | -0.042 (0.00165)                       | -0.042 (0.00165)                           |
| maximum size (from nominal)      | -0.022 (0.00087)                       | -0.022 (0.00087)                           |
| <b>2nd undersize (nominal)</b>   | 64.50 (2.539)                          | 53.50 (2.106)                              |
| minimum size (from nominal)      | -0.042 (0.00165)                       | -0.042 (0.00165)                           |
| maximum size (from nominal)      | -0.022 (0.00087)                       | -0.022 (0.00087)                           |
| <b>3rd undersize (nominal)</b>   | 64.25 (2.530)                          | 53.25 (2.096)                              |
| minimum size (from nominal)      | -0.042 (0.00165)                       | -0.042 (0.00165)                           |

## Pistons and piston rings, checking and installing

### Note:

*Before removing the pistons, mark their installation positions clearly on the piston crowns (as shown in illustration 13-860) using a waterproof felt-tipped pen.*

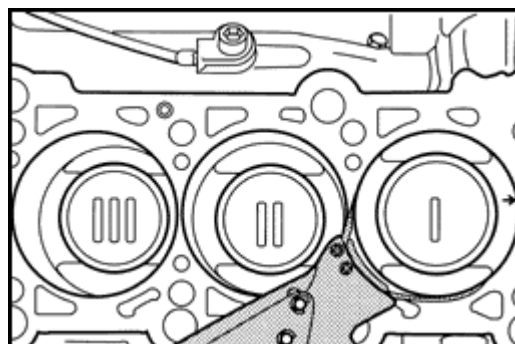
### Piston installed position

**A**

- Arrow marking must point toward oil pump (front).
- Mark position clearly on piston crown with waterproof felt pen.

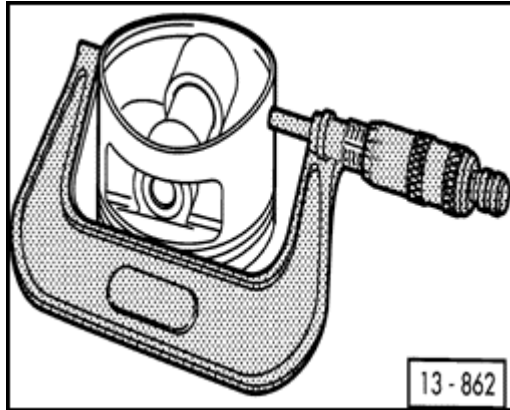
### CAUTION!

**Do NOT scratch or scribe the piston surface. This surface has a coating on it that must not be disturbed.**

**A**

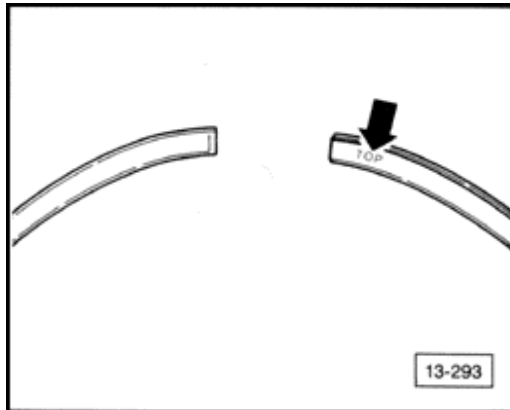
- Install piston using piston ring compressor.

### Checking pistons



- Measure piston approx. 10 mm (0.39 in.) from bottom of skirt, at right angle ( $90^\circ$ ) to piston pin.

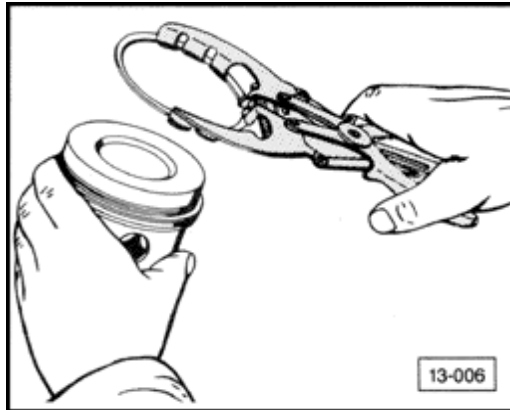
Maximum deviation from nominal dimension: 0.04 mm (0.0016 in.)



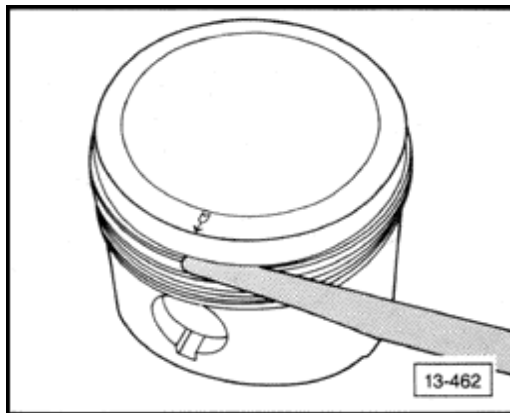
### Checking and installing piston rings

- "TOP" inscription must point toward piston crown
- Inner chamfer on plain ring must point toward piston crown
- Outer chamfer of stepped ring must point toward piston crown

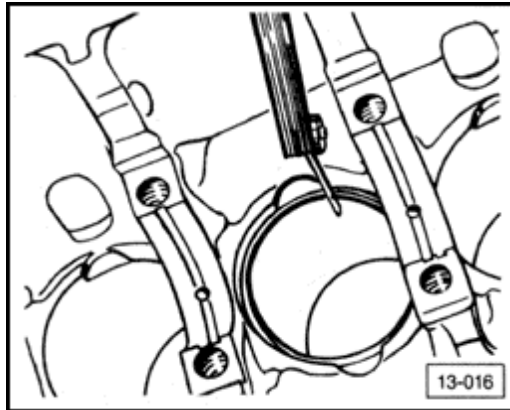
13-27



- A - Remove and install piston rings using ring expander as shown.



- A - Check piston ring clearance in groove.
- ◆ New: 0.02-0.08 mm (0.001-0.003 in.)
  - ◆ Wear limit: 0.10 mm (0.004 in.)



A

- Check piston ring gap.
- Push piston ring into lower end of cylinder at right angle until approx. 15 mm (0.59 in.) from bottom edge.

| Piston ring | End gap                               | Wear limit            |
|-------------|---------------------------------------|-----------------------|
| 1           | 0.35 - 0.50 mm<br>(0.014 - 0.020 in.) | 1.0 mm<br>(0.039 in.) |
| 2           | 0.50 - 0.70 mm<br>(0.020 - 0.028 in.) | 1.4 mm<br>(0.055 in.) |
| 3           | 0.25 - 0.50 mm<br>(0.010 - 0.020 in.) | 0.8 mm<br>(0.032 in.) |

### Checking cylinder bore

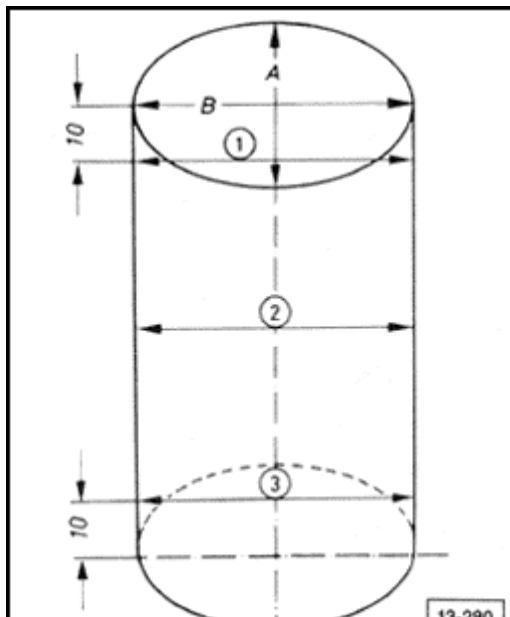
1 - Approx. 10 mm from top

2 - Center

3 - Approx. 10 mm from bottom

A - Across cylinder block (perpendicular to crankshaft)

B - In line with cylinder block (parallel to crankshaft)



A

- Measure diagonally at three points in transverse direction -A- and in longitudinal direction -B-.

- ◆ Use internal dial gauge 50-100 mm (2-4 in.)
- ◆ Maximum deviation from nominal dimension: 0.08 mm (0.0031 in.)

### CAUTION!

**DO NOT have the cylinder block mounted to the assembly stand while measuring the cylinder bores. The block is deformed by its own weight under these conditions and this stress will result in false measurements that are not accurate after the tension has been relieved.**

**Piston and cylinder dimensions**

| <b>Reconditioning dimension</b> | <b>Piston diameter</b>   | <b>Cylinder bore diameter</b> |
|---------------------------------|--------------------------|-------------------------------|
| Basic dimension                 | 82.48 mm<br>(3.2472 in.) | 82.51 mm<br>(3.2484 in.)      |
| 1st oversize                    | 82.74 mm<br>(3.2575 in.) | 82.76 mm<br>(3.2583 in.)      |
| 2nd oversize                    | 82.98 mm<br>(3.2669 in.) | 83.01 mm<br>(3.2681 in.)      |

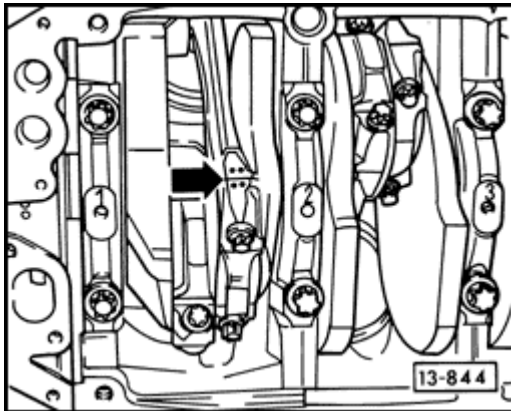
**Note:**

*Only pistons of the "basic dimension" size are available from the Parts Department.*

## Connecting rods and connecting rod bearings, checking

- Replace connecting rods only as a complete set.
- Do not interchange connecting rod bearings.
- Always replace connecting rod bearing cap bolts.

### Checking radial clearance

**A**

- Mark connecting rod bearing caps with light punch marks (arrow) before removing.
- Remove connecting rod bearing caps.
- Clean bearing caps and journals.
- Place Plastigage<sup>®</sup> over entire width of bearing journal or in bearing shell.
- Re-install connecting rod bearing cap and tighten to 20 Nm (15 ft lb) only; do NOT tighten further.

### **CAUTION!**

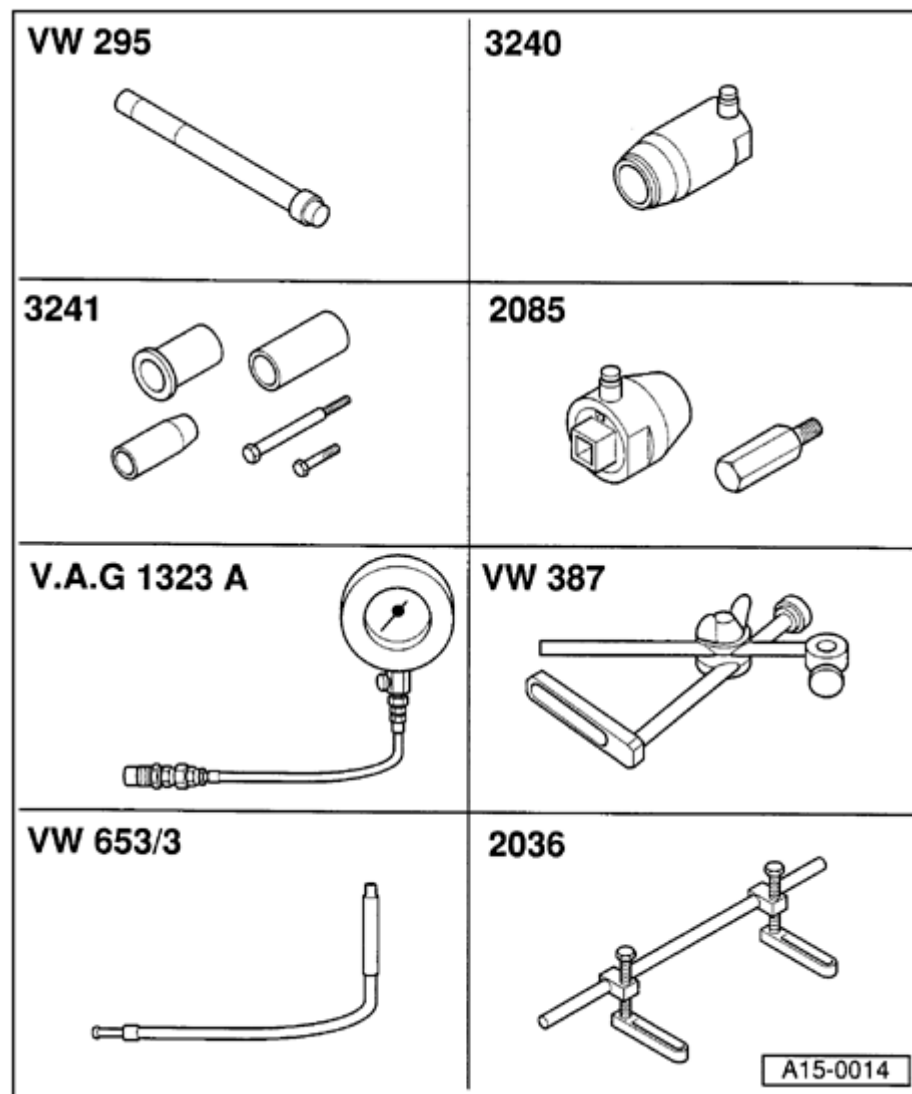
**Do NOT turn the crankshaft or allow it to rotate during the measurement with Plastigage<sup>®</sup> in place.**

- Remove connecting rod bearing caps again.
- Compare width of Plastigage<sup>®</sup> with measuring scale.

Specifications:

- |               |                                            |
|---------------|--------------------------------------------|
| ◆ New:        | 0.015 to 0.062 mm (0.00059 to 0.00244 in.) |
| ◆ Wear limit: | 0.12 mm (0.0047 in.)                       |

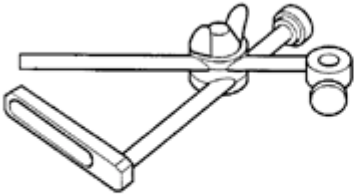
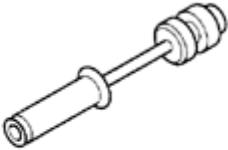
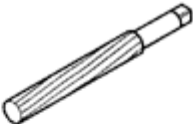
15-1



## Special tools

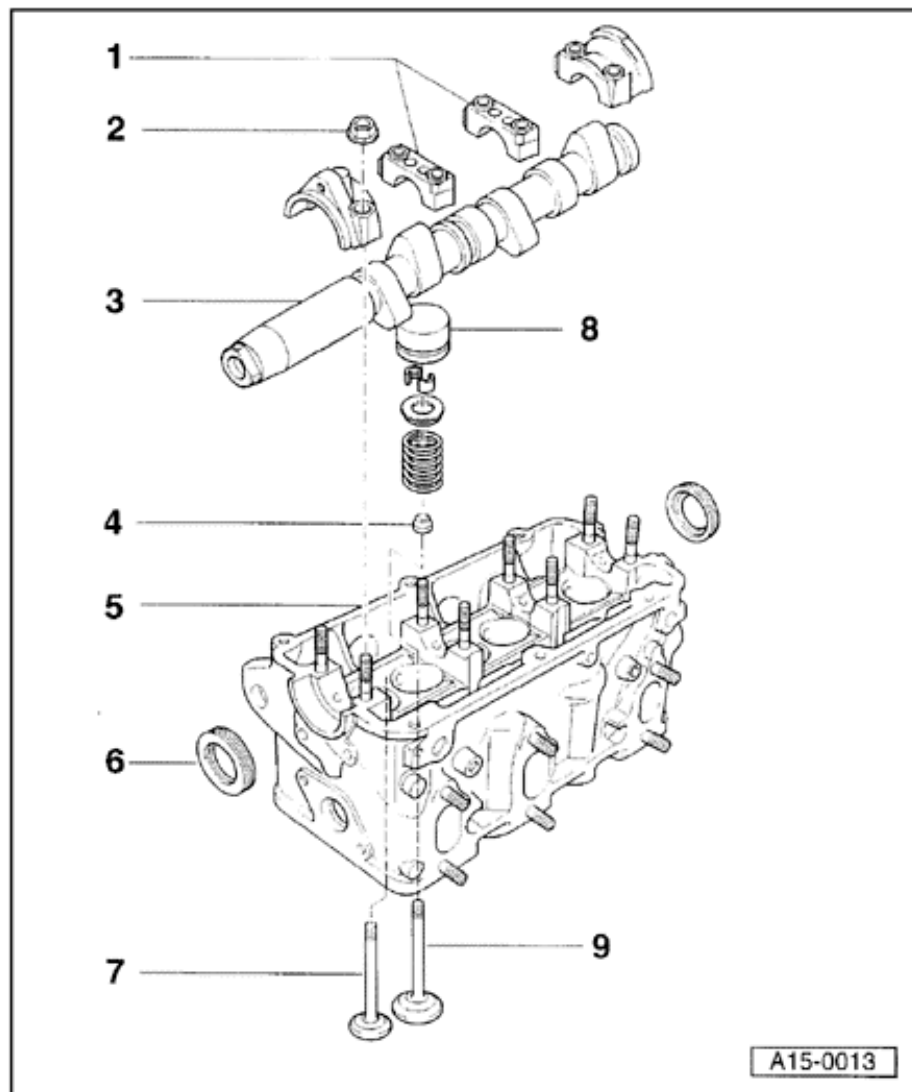
The following special tools and test equipment are required for these operations:

|          |                      |
|----------|----------------------|
| VW 295   | Drift                |
| 3240     | Seal extractor       |
| 3241     | Seal installer       |
| 2085     | Puller               |
| VAG 1381 | Compression recorder |
| VW 387   | Dial gauge holder    |
| VW 653/3 | Pressure hose        |
| 2036     | Adjustable rod       |

|                                                                                                    |                                                                                                    |
|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>VW 387</b><br> | <b>3047 A</b><br> |
| <b>10-206</b><br> | <b>3120</b><br>   |
|                                                                                                    |                                                                                                    |
|                                                                                                    |                                                                                                    |

A15-0015

- 4
- VW 541/1    Lever
  - 3047A       Slide hammer
  - 10-206      Drift
  - 3120         Reamer - 7mm



## Cylinder head and valve drive, servicing

### Component layout

#### **Note:**

*Always replace all seals and gaskets.*

#### **1 - Bearing cap**

- ◆ Installation position ⇒ [page 15-20](#)

#### **2 - 17 Nm (13 ft lb)**

#### **3 - Camshaft**

- ◆ Removing and installing ⇒ [page 15-19](#)
- ◆ Checking axial play ⇒ [page 15-21](#)
- ◆ Maximum runout: 0.01 mm (0.0004 in.)

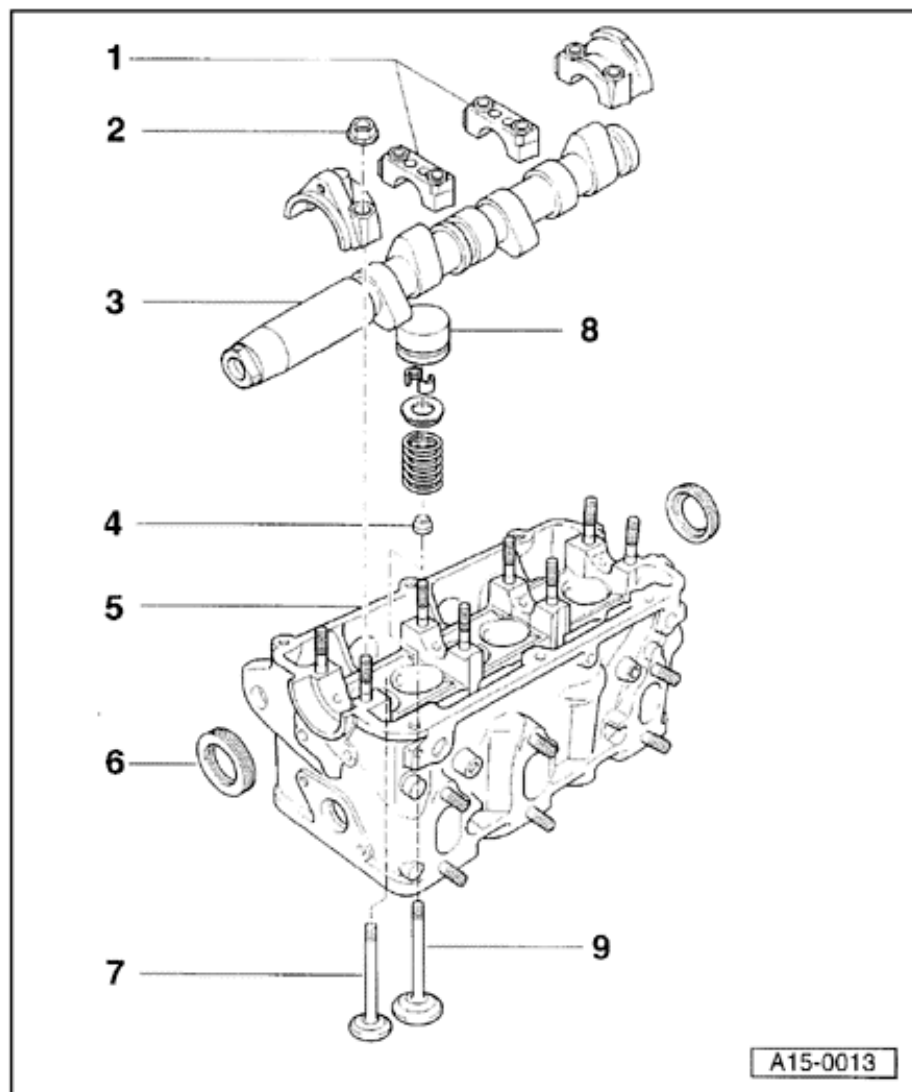
#### **4 - Valve stem seal**

- ◆ Always replace
- ◆ Replacing ⇒ [page 15-24](#)

#### **5 - Cylinder head**

- ◆ Resurfacing ⇒ [page 15-26](#)
- ◆ Refacing valve seats ⇒ [page 15-31](#)

15-4



## 6 - Oil seal

- ◆ Always replace
- ◆ Replacing ⇒ [page 15-10](#)

## 7 - Exhaust valve

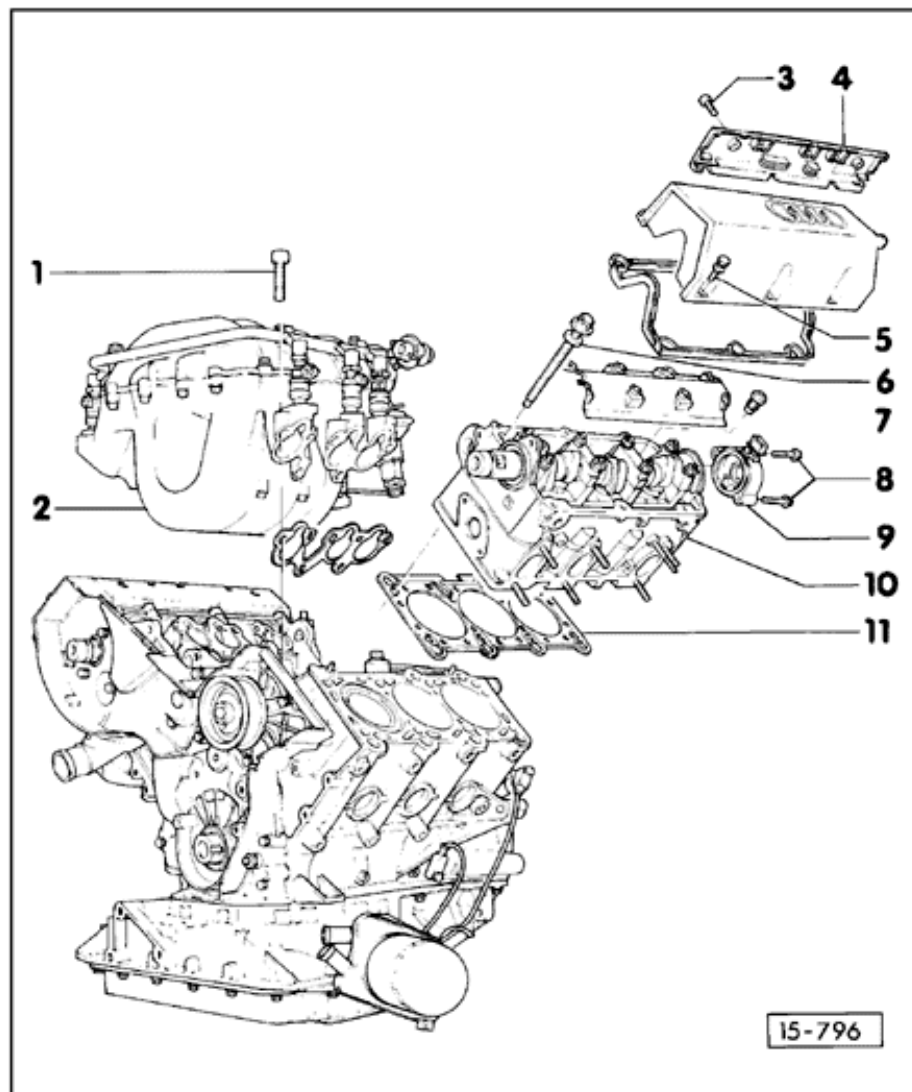
- ◆ Checking ⇒ [page 15-27](#)
- ◆ Checking and replacing valve guides ⇒ [page 15-29](#)

## 8 - Hydraulic valve lifter

- ◆ Oil contact surfaces before installing
- ◆ Store with cam lobe contact surface facing downward
- ◆ Checking ⇒ [page 15-22](#)

## 9 - Intake valve

- ◆ Checking and refacing ⇒ [page 15-27](#)
- ◆ Checking and replacing valve guides ⇒ [page 15-29](#)



## Cylinder head, assembly

Installing cylinder head cover ⇒ [page 15-9](#) .

**1 - 20 Nm (15 ft lb)**

**2 - Intake manifold**

◆ Removing and installing ⇒ [page 15-15](#)

**3 - 10 Nm (7 ft lb)**

**4 - Cover**

**5 - 10 Nm (7 ft lb)**

**6 - Cylinder head bolt**

◆ Always replace

◆ Tightening ⇒ [page 15-17](#)

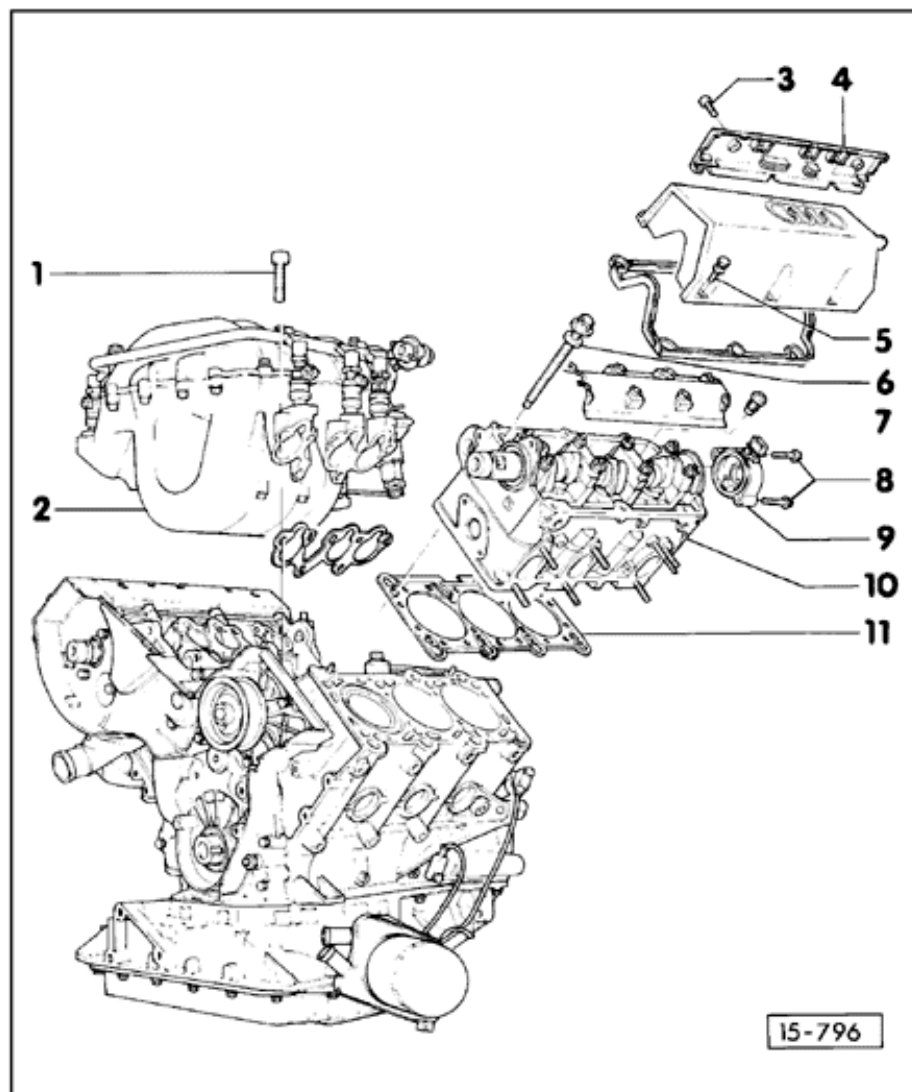
**7 - Pressure relief valve**

◆ Replace if loud valve noises affecting the entire cylinder head bank can be heard

◆ Secure with thread locking compound AMV 197 000 01

◆ Replace valves that have loosened up

◆ 25 Nm (18 ft lb)



**8 - 10 Nm (7 ft lb)**

**9 - Housing for Camshaft Position (CMP) sensor**

**10 - Cylinder head**

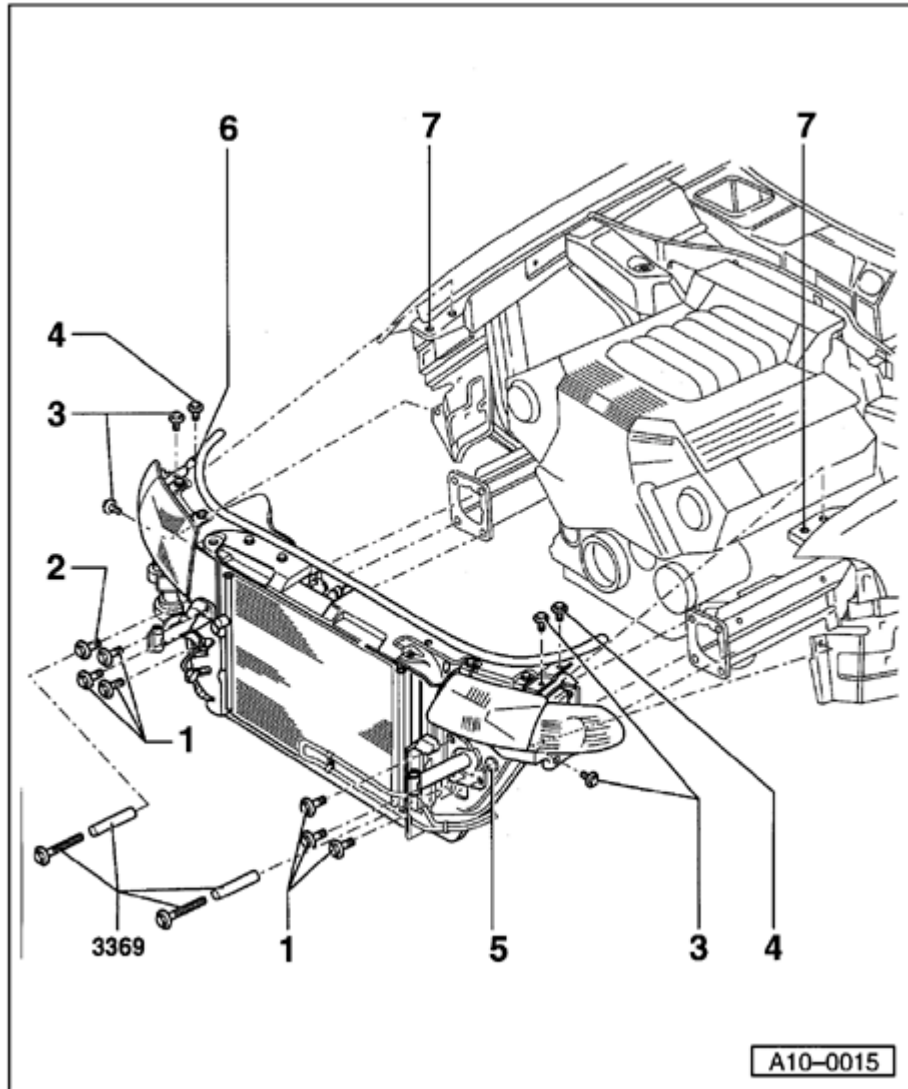
- ◆ Checking for distortion ⇒ [page 15-16](#)
- ◆ Resurfacing dimensions ⇒ [page 15-26](#)

**Note:**

- ◆ The single cylinder head - 10 - listed in the Parts catalog microfiche can be used on either left or right sides and uses a cap to seal the front.
- ◆ Installing cylinder head sealing cap ⇒ [page 15-9](#).

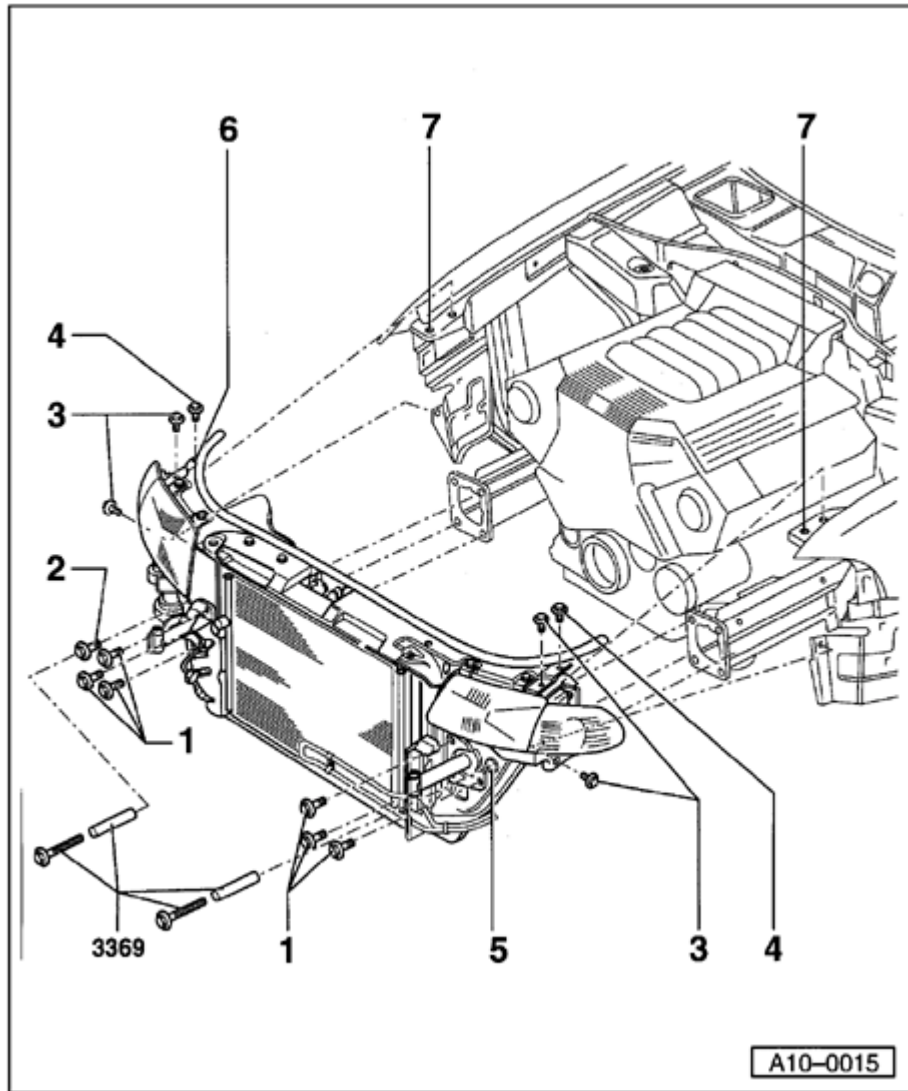
**11 - Cylinder head gasket**

- ◆ Always replace
- ◆ Identification: lettering on gasket must face upward



## Lock carrier, removing for service

- 1 - Bolt (8 x 45)**
  - ◆ 45 Nm (33 in lb)
- 2 - Bolt (8 x 45)**
  - ◆ 45 Nm (33 in lb)
- 3 - Bolt (6 x 20)**
  - ◆ 10 Nm (7 ft lb)
- 4 - Bolt (6 x 20)**
  - ◆ 10 Nm (7 ft lb)
- 5 - Hole for special tool VAG 3369**
- 6 - Alignment hole in front end**
- 7 - Hole in side panel**



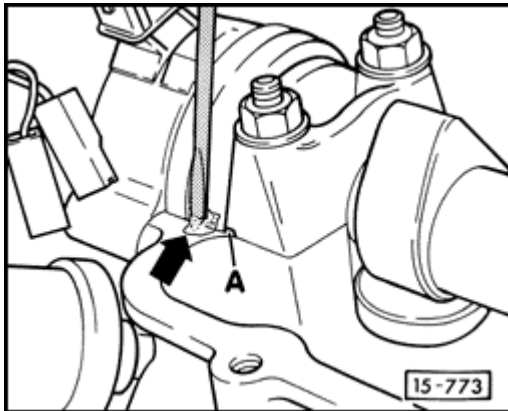
### Removing

- Unbolt air guide at front end, between front end and air cleaner, and remove.
- Remove mounting bolt -2- on right-hand side and thread in VAG 3369.
- Thread VAG 3369 into hole -5- on left-hand side.
- Remove mounting bolts -1- and -3-.
- Remove mounting bolt -4-, pull front end forward and insert mounting bolt -4- through rear alignment hole -6- and side panel alignment hole -7-.

## Cylinder head cover, installing

### CAUTION!

- ♦ *Part numbers are listed for reference only. Always check with your Parts department for the latest information.*
- ♦ *The inside and outside surfaces of the cylinder head cover gasket must be lightly coated with silicone lubricant D 007 000 04 before installation.*

**A**

- Carefully coat four edges on cylinder head sealing surfaces with Silimate, Part No. AMV 174 004 01, using a small screwdriver.
- Silimate must be kept out of oil opening -A-.

### Installing cylinder head sealing cap

Cylinder heads available from the Parts department can be used on either the left and right hand sides and are provided with a sealing cap for use where appropriate.

- Coat edge of sealing cap with sealing paste AMV 188 000 02.

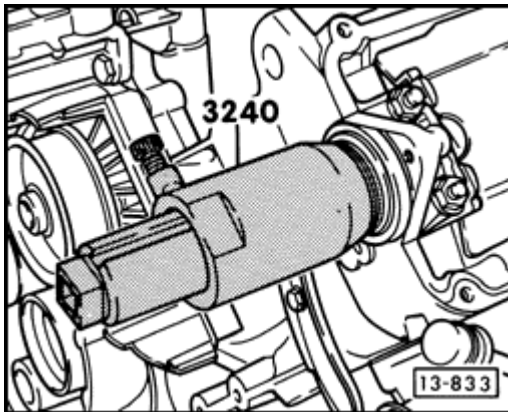
**A**

- Tap sealing cap in using drift VW 295, far enough so that outer edge of sealing cap is flush with chamfer on cylinder head.

## Camshaft oil seals, replacing

### Front

- Remove toothed belt ⇒ [page 13-11](#) .
- Remove cylinder head cover.
- Remove rear toothed-belt guard.



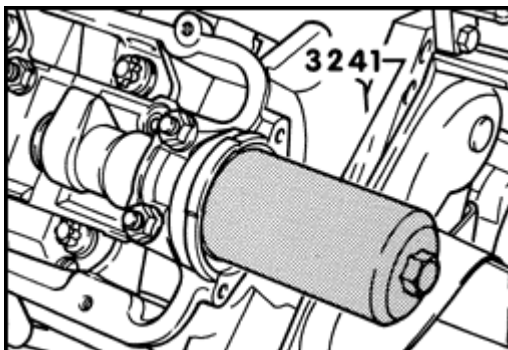
A

- Remove seal with seal extractor 3240.
- Clean bearing and sealing surfaces.

### Note:

*Do not oil sealing lip or outer edge of seal before pressing in.*

### Left front



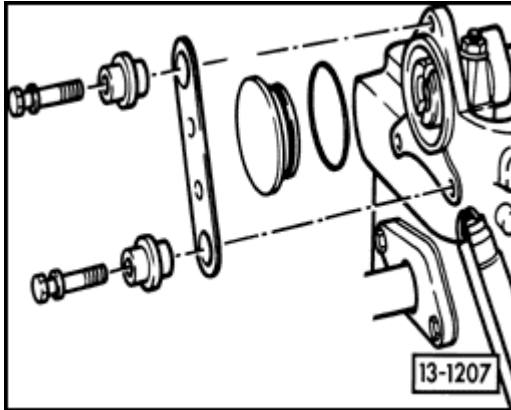
A

- Press seal in as far as possible using seal installer 3241.

### Right front

- Use pulling sleeve on camshaft.
- Press seal in flush using 3241.

15-11

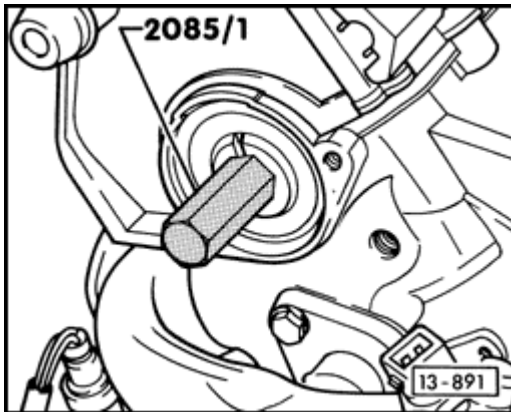
**Right rear**

A

- Remove bolts, spacer plate and attachments.
- Remove cap.
- Replace O-ring.

**Left rear**

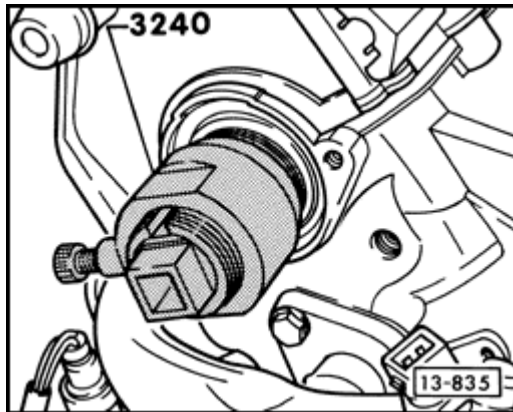
- Remove Camshaft Position (CMP) sensor housing.
- Remove bolt from CMP sensor plate.  
Tightening torque: 20 Nm (15 ft lb)
- Carefully pry out sensor plate using screwdriver.



A

- Thread in bolt for seal extractor 2085/1.

15-12



A

- Use seal extractor 3240 or 2085 and bolt 2085/1 to remove seal.
- Clean bearing and sealing surfaces.

**Note:**

*Do not oil sealing lip or outer edge of seal before pressing in.*

- Use guide sleeve and insertion tool 3241 to press seal in until fully seated.

Tightening torque:

CMP sensor plate: 20 Nm (15 ft lb)

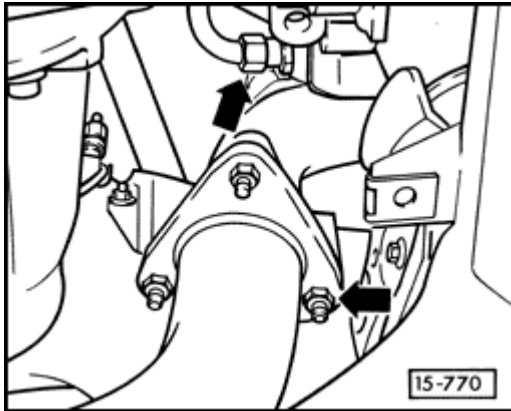
## Cylinder head, removing and installing

### Engine installed

This removal procedure refers to the left cylinder head

### Removing

- Remove ribbed belt ⇒ [page 13-9](#)
- Remove toothed belt ⇒ [page 13-11](#)
- Disconnect exhaust pipe from manifold.
- Disconnect components of EGR system, if applicable.



- Drain engine coolant at drain plug (arrow) using special tool 3247, and at drain plug in bottom of radiator.
- Remove air hose between Mass Air Flow (MAF) sensor and intake manifold.
- Disconnect all spark plug connectors.

- Disconnect all harness connectors on fuel injectors.

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15-14

- Disconnect positive crankcase ventilation connections on left and right cylinder head covers.
- Disconnect fuel supply and return lines.
- Unclip cover on intake air housing.
- Remove both screws under cover.
- Push back and lift intake air housing upward.
- Pull vacuum hose off left side and remove housing.
- Remove left-side cover for fuel injector lines.
- Detach accelerator pedal cable and lay clear.
- Disconnect line from Idle Air Control (IAC) valve at throttle body.
- Disconnect harness connector at IAC valve and throttle position sensor.
- Disconnect vacuum pipe at the cruise control vacuum control actuator.

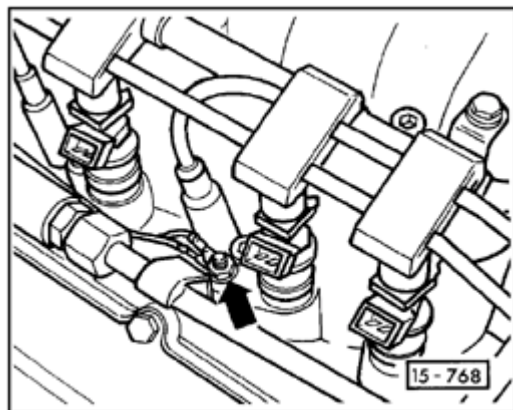


A

- Disconnect harness connector at oil pressure sensor and at oil pressure switch.
- Disconnect harness connector at the Camshaft Position (CMP) sensor housing.
- Disconnect vacuum pipe at intake manifold changeover valve (blue) and also at EGR valve (brown).

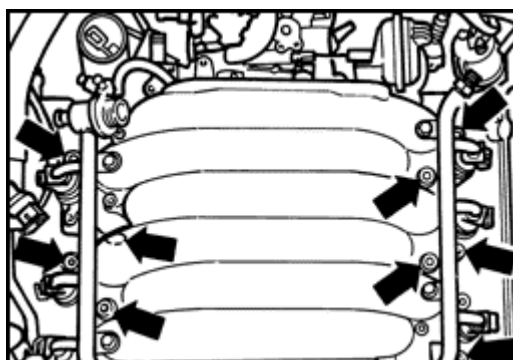
## 15-15

- Disconnect harness connectors for Heated Oxygen Sensors (HO2S) and oxygen sensor heaters at engine compartment bulkhead, and move to one side.
- Disconnect vacuum line to EGR vacuum regulator solenoid valve at throttle body.
- Remove EGR valve from intake manifold.



A

- Remove hydraulic hose bracket and disconnect Ground (GND) wires (arrow) on intake manifold.



A

- Remove bolts (arrows) and remove intake manifold.
- Seal off openings using clean cloth rags.
- Disconnect coolant line at rear of cylinder head.

**Note:**

*The intake manifold has two slanting mounting surfaces to the left and*

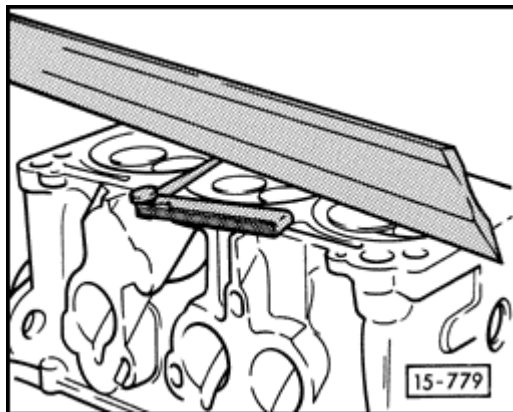
*right cylinder heads. The cylinders heads can be warped by removing the manifold. If only the intake manifold is removed, or if only one cylinder head is removed, then the cylinder head bolts of the head(s) that are not removed must be tightened 1/4-turn (90°).*

- Remove heated oxygen sensors.
- Remove exhaust manifold heat shield.
- Remove cylinder head cover.
- Remove rear toothed-belt guard.
- Disconnect hose from hydraulic reservoir to pump.
- Remove cylinder head.

#### Checking cylinder head distortion

A

- Measure with feeler gauge at several points using straight edge.  
Max. permissible distortion: 0.05 mm (0.0020 in.)



## Installing

- Clean sealing surfaces.
- Install cylinder head gasket.

Lettering on gasket faces toward cylinder head.

- Install cylinder head.

Pay attention to centering pins in cylinder block.

- Install cylinder head bolts and tighten by hand.

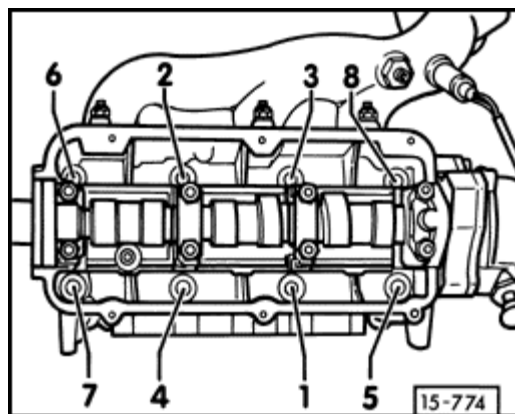
## Tightening

4

- Tighten cylinder head bolts in two stages:
  - ◆ Stage 1 60 Nm (44 ft lb)
  - ◆ Stage 2 additional 1/2-turn (180°)

### Note:

- ◆ For final 1/2-turn, two 1/4-turns (90°) are also permissible if tightening with a fixed wrench.
- ◆ It is not necessary to retighten the cylinder head bolts after repairs, or



*as part of maintenance service.*

## Compression pressure, checking

- Engine warm-oil temperature at least 30 ° C (86 ° F)
- Throttle valve fully open during cranking
- Disconnect harness connectors from ignition coil power output stage and from all six fuel injectors.
- Use compression pressure recorder VAG 1381 together with adapter 1381/5 or equivalent to measure compression.

### **Note:**

*Refer to operating instructions for use of the recorder.*

- Operate starter until tester shows no additional increase in pressure.

## Compression pressures

- ◆ New: 9-14 bar (131-203 psi)
- ◆ Wear limit: 7.5 bar (109 psi)

- ◆ Max. permissible pressure difference between all cylinders: 3 bar (44 psi)

**CAUTION!**

***If the test values are not within the specifications, recheck compression pressure after a test drive.***

## Camshaft, removing and installing

### Removing

- Removing ribbed drive belt ⇒ [page 13-9](#) .
- Remove toothed camshaft drive belt ⇒ [page 13-11](#) .
- Remove cylinder head cover.

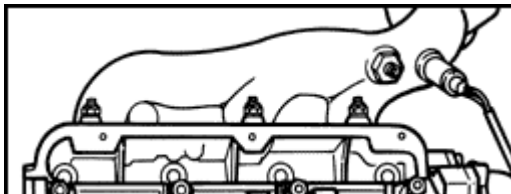
---

Left side:

- Remove housing for camshaft position sensor.

Right side:

- Remove plug/cover on cylinder head.

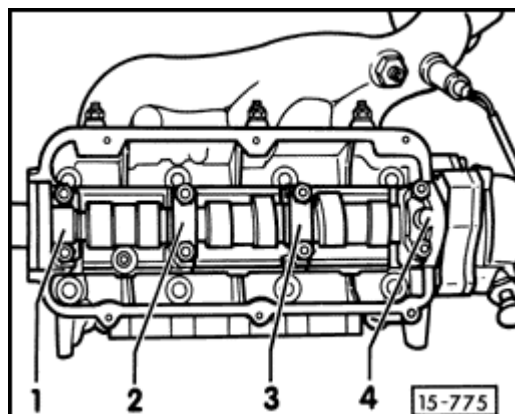


4

- Remove toothed belt camshaft sprocket.
- Remove camshaft bearing caps -2- and -3-.
- Gradually and evenly loosen nuts for bearing caps -1- and -4-, alternating in diagonal sequence.

**CAUTION!**

***DO NOT allow bearing caps to become mixed up. Identify as necessary using a felt marker.***



## Installing

A

- Install bearing caps -1- and -4-.

Gradually and evenly tighten bearing cap nuts, alternating in diagonal sequence.

- Install bearing caps -2- and -3-.

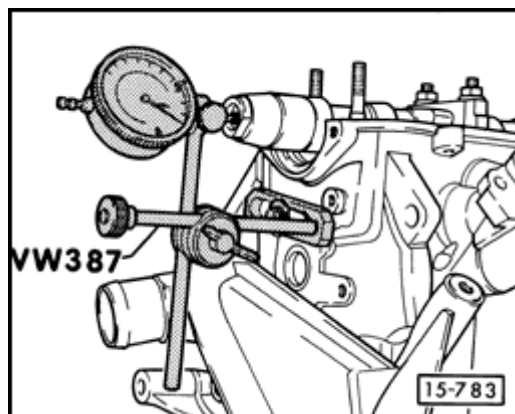
Tightening torque: 17 Nm (15 ft lb)

### CAUTION!

- ♦ *After installing new or re-installing old lifters, and after installing the camshaft(s), the engine must not be started for at least 30 minutes. Otherwise the valves could strike the pistons.*
- ♦ *After working on the valve train and lifters, crank the engine carefully by hand, at least two full revolutions, to make sure that the valves do not strike the pistons.*

## Camshaft axial play, checking

- Housing for camshaft position sensor removed
- Hydraulic lifters removed
- Camshaft bearing caps 2 and 4 removed



A

- Mount dial indicator in holder VW 387 on front end of cylinder head.
- Push camshaft by hand against dial indicator.
- Set dial gauge to zero.
- Push camshaft away from dial indicator.
- Read axial play on gauge.

Specifications:

- ◆ New: 0.04-0.15 mm (0.0016-0.0059 in.)
- ◆ Wear limit: 0.35 mm (0.0138 in.)

## Hydraulic valve lifters, checking

### **Note:**

- ◆ *Irregular valve noise during cranking is normal.*
- ◆ *Do not interchange hydraulic lifters. If necessary mark them when they are being removed.*
- ◆ *Place lifters that have been removed on a clean surface with the contact surface (camshaft end) facing downward.*
- ◆ *Hydraulic lifters cannot be repaired or adjusted. Faulty lifters must be replaced.*
- Start and run engine until warm-until radiator coolant fan has come on at least once.
- Increase engine speed to approx. 2500 RPM for 2 minutes

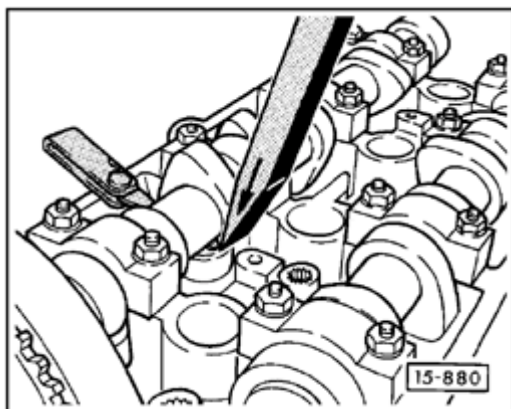
If the irregular valve noise stops and then re-occurs again each time vehicle is used in stop and go traffic:

- Replace the oil check valves ⇒ Repair Group

17.

If the irregular noise does NOT stop, locate faulty hydraulic lifter as follows:

- Remove cylinder head cover.
- Turn crankshaft clockwise until cam lobe for lifter being checked is pointing upward.



- Use a wooden or plastic wedge to press valve lifter down.

A

- If a 0.20 mm (0.008 in.) feeler gauge can be inserted between camshaft and lifter, replace lifter.

**CAUTION!**

- ♦ **After installing new or re-installing old lifters, and after installing the camshaft(s), the engine must not be started for at least 30 minutes. Otherwise the valves could strike the pistons.**
- ♦ **After working on the valve train and lifters, crank the engine carefully by hand, at least two full revolutions, to make sure that the valves do not strike the pistons.**

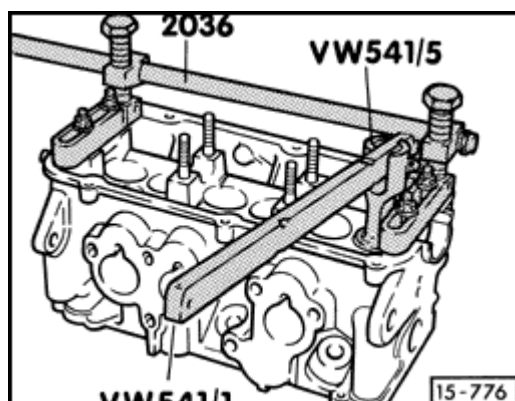
**Note:**

*The illustration is used to show an example of pressing down on the lifter checking the clearance with a feeler gauge-it does not specifically show the 2.8 liter V6 engine.*

## Valve stem oil seals, replacing

### Cylinder head installed

- Remove toothed camshaft drive belt ⇒ [page 13-11](#).
- Remove camshafts and hydraulic lifters.
- Remove spark plugs.
- Rotate crankshaft by hand to set piston of appropriate cylinder to Bottom Dead Center (BDC).
- Thread VW 653/3 hose, US 1106 cylinder leakdown tester or equivalent with seal into spark plug hole by hand and apply a continuous pressure of at least 6 bar (87psi).

**A**

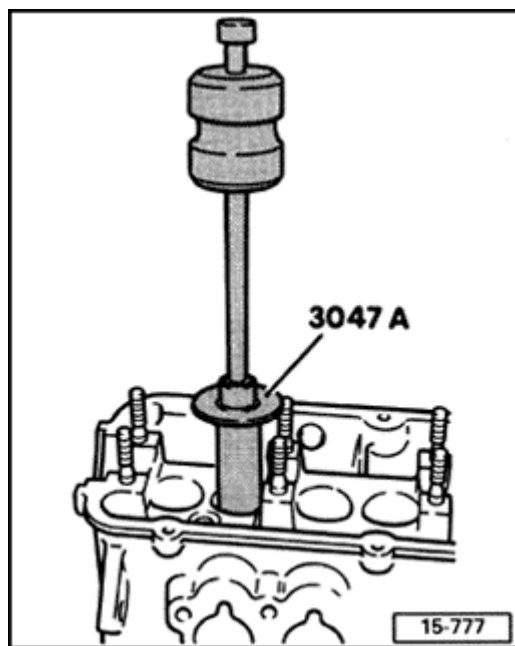
- Install compressor tool 2036 and adjust to height of studs.
- Remove valve spring with valve spring tensioner VW 541/1 and thrust pad VW 541/5 or equivalent.

**Note:**

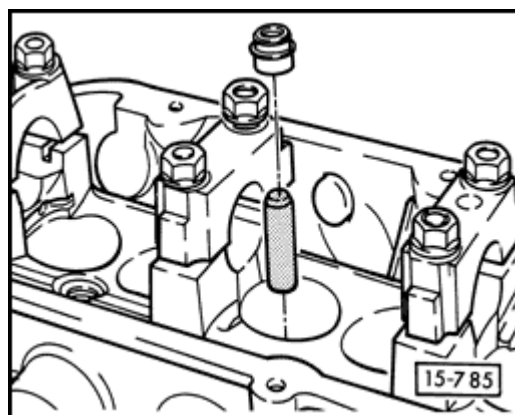
*Tight valve keepers can be loosened by tapping lightly on lever VW 541/1 with a hammer.*

- Remove valve springs.

15-25



- A
- Remove valve stem oil seal with slide hammer 3047 A.
  - Install new valve stem oil seal.



- A
- Fit protective sleeve over valve stem, slide seal carefully onto valve guide.

**Note:**

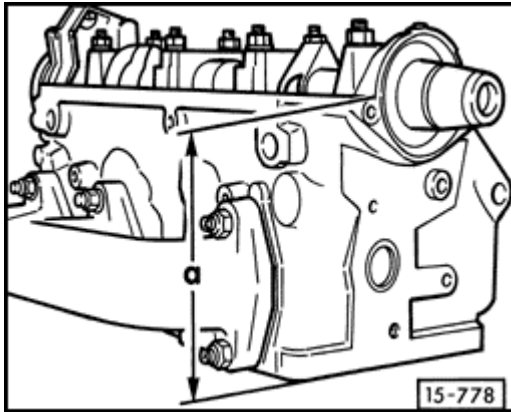
*Always use the enclosed plastic sleeve for installation of valve stem oil seals to protect the seal from being damaged by the valve keeper grooves.*

15-26

### Cylinder head, resurfacing



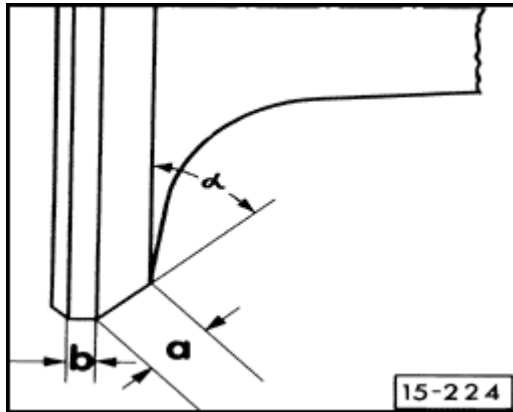
Minimum dimension -a- = 132.75 mm (5.226 in.)



## Intake and exhaust valves, checking and refacing

### Checking

- Inspect visually for scoring on valve stem and valve seat surfaces. If clear signs of wear are present replace valves.



### Refacing intake valve

$\alpha$  -  $45^{\circ}$

a - max 3.5 mm (0.138 in.)

b - min. 0.5 mm (0.020 in.)

### Refacing exhaust valves

#### **WARNING!**

- ♦ *Valves must not be refaced by cutting or grinding.*
- ♦ *Only lapping is permitted.*

***WARNING!***

***Worn sodium-filled exhaust valves must not be scrapped without properly disposing of the sodium.***

- ♦ ***The valves must be cut into two parts with a hacksaw between the center of the valve stem and the valve head. They must not come into contact with water when being cut open.***

***After cutting the valves:***

- ♦ ***Throw the valves, not more than ten at a time, into a bucket filled with water and STAND BACK. A sudden chemical reaction occurs as the sodium comes into contact with the water.***
- ♦ ***Valves that have been processed in this way can then be disposed of in the normal waste.***

## Valve guides, checking and replacing

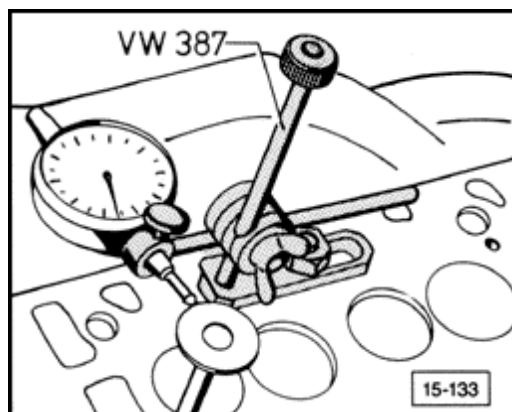
### Checking

When repairing engines with low compression due to leaking valves, it is not sufficient to reface or replace the valve seats and valves. It is also necessary to check the valve guides for wear. This is particularly important when checking engines with high mileage.

- Insert new valve into guide until end of valve stem is flush with end of guide.

### **CAUTION!**

***Due to the difference in valve stem diameters, make sure that only an intake valve is used to check intake valve guides, and that only an exhaust valve is used to check the exhaust valve guides.***



A

- Determine valve rock-amount that valve can move side-to-side.

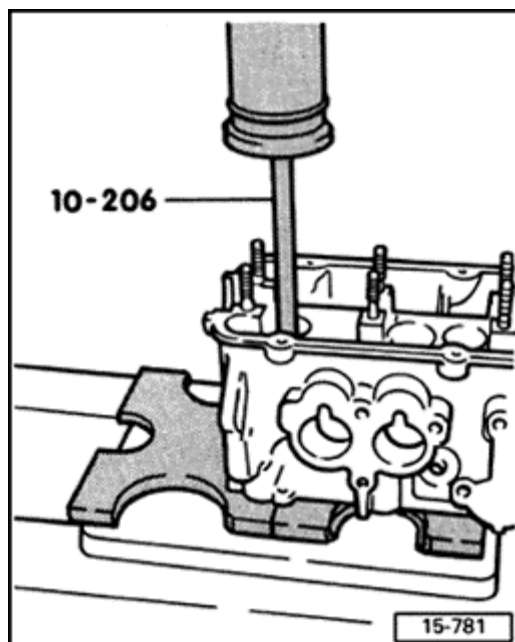
### Wear limit

- ◆ Intake valve guide 1.0 mm (0.039 in.)
- ◆ Exhaust valve guide 1.3 mm (0.051 in.)

## Replacing

### CAUTION!

*Cylinder heads with valve seats that can no longer be refaced, or which have already been machined to the minimum dimension, should no longer be repaired.*



A

- Press out worn valve guides from camshaft side using drift 10-206. (Replacement guides with shoulder must be pressed out from combustion chamber side.)
- Coat new guides with oil and, using drift 3121, press into cold cylinder head from camshaft side until shoulder makes contact.

### CAUTION!

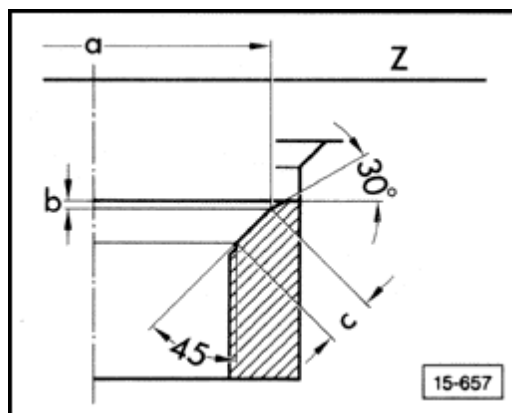
*When the shoulder on the new guide makes contact, the pressing force must not exceed 1.0 ton or the guide shoulder could break off.*

- Use 7mm reamer 3120 to ream new valve guides to size, using plenty of cutting fluid.

## Valve seats, refacing

### Note:

- ♦ Pay attention to the cylinder head minimum dimension when refacing valve seats ⇒ [page 15-32](#)
- ♦ Only reface valve seats enough to produce perfect contact.
- ♦ Before refacing, calculate the maximum permissible refacing dimension. If this dimension is exceeded, correct functioning of hydraulic valve lifters can no longer be guaranteed and the cylinder head must be replaced.



### Intake valve seat

a - Diameter: 39.2 mm (1.543 in.)

b - Max. permissible refacing dimension<sup>1)</sup>

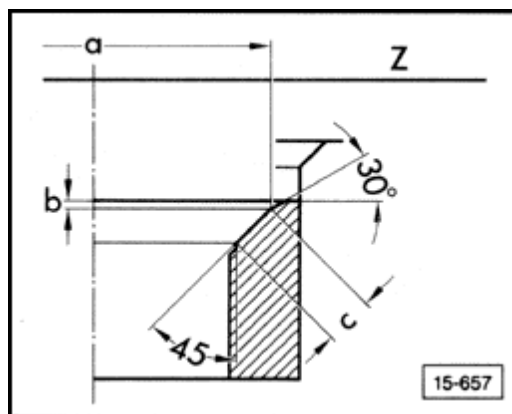
c - Seat width: 2.0 mm (0.079 in.)

30° - Upper correction angle

45° - Valve seat angle

Z - Bottom surface of cylinder head

1) Calculating max. permissible refacing dimensions ⇒ [page 15-32](#)



#### Exhaust valve seat

a - Diameter: 32.4 mm (1.276 in.)

b - Max. permissible refacing dimension<sup>1)</sup>

c - Seat width: 2.4 mm (0.094 in.)

30° - Upper correction angle

45° - Valve seat angle

Z - Bottom surface of cylinder head

<sup>1)</sup> Calculating max. permissible refacing dimensions ⇒ [page 15-32](#)

#### Maximum permissible refacing dimension, calculating

- Insert valve into guide and press firmly against valve seat.



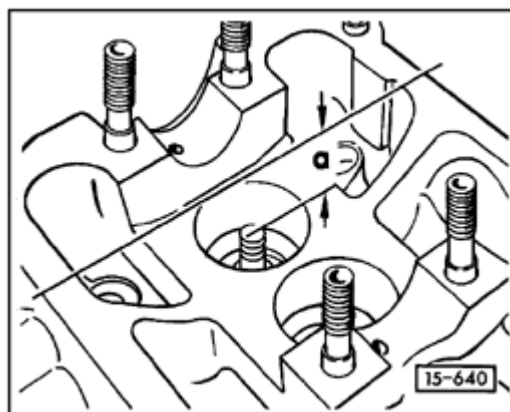
- Measure distance -a- between end of valve stem and top surface of cylinder head.

The maximum permissible refacing dimension is the difference between the actual distance measured at the cylinder head and the specified minimum dimension.

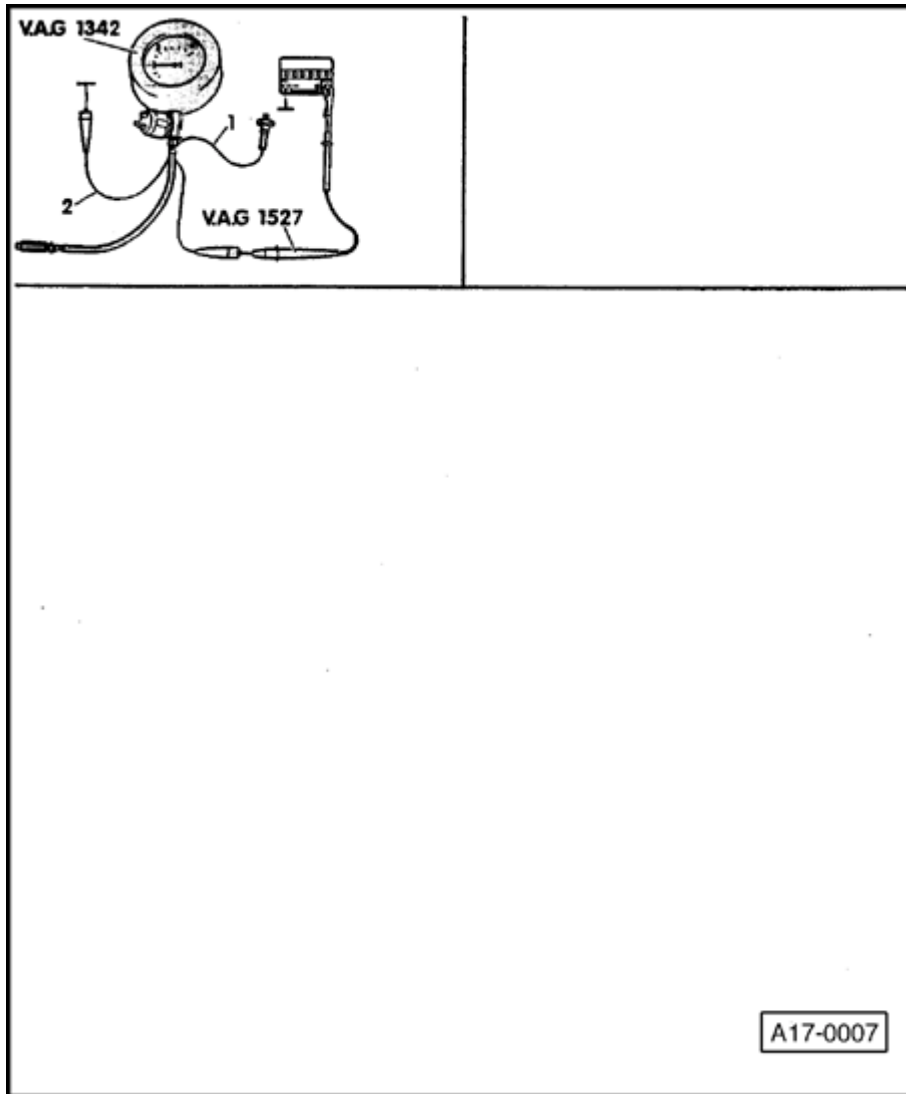
#### Minimum dimensions

◆ At intake valve: 33.8 mm (1.331 in.)

◆ At exhaust valve: 34.1 mm (1.343 in.)



17-1

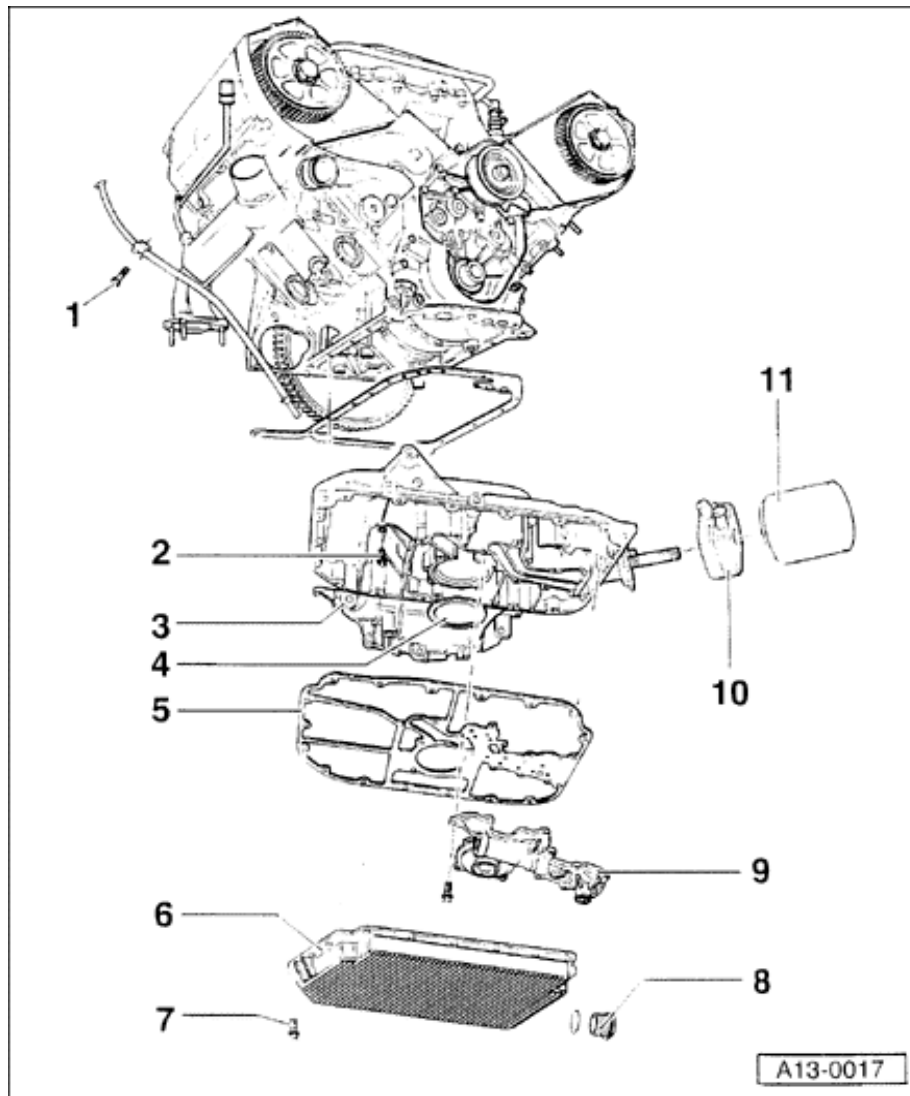


## Lubrication system components, removing and installing

### Special tools

The following special tools and test equipment are required for these operations

|          |                     |
|----------|---------------------|
| VAG 1342 | Oil pressure tester |
| VAG 1527 | Voltage tester      |



## Component layout

### Modified oil circuit

#### **CAUTION!**

**Do NOT overfill with oil past the MAX mark on the oil dipstick. Damage to the three way catalytic converter could result.**

#### **Note:**

- ◆ Always replace gaskets and seals

**1 - 10 Nm (7ft lb)**

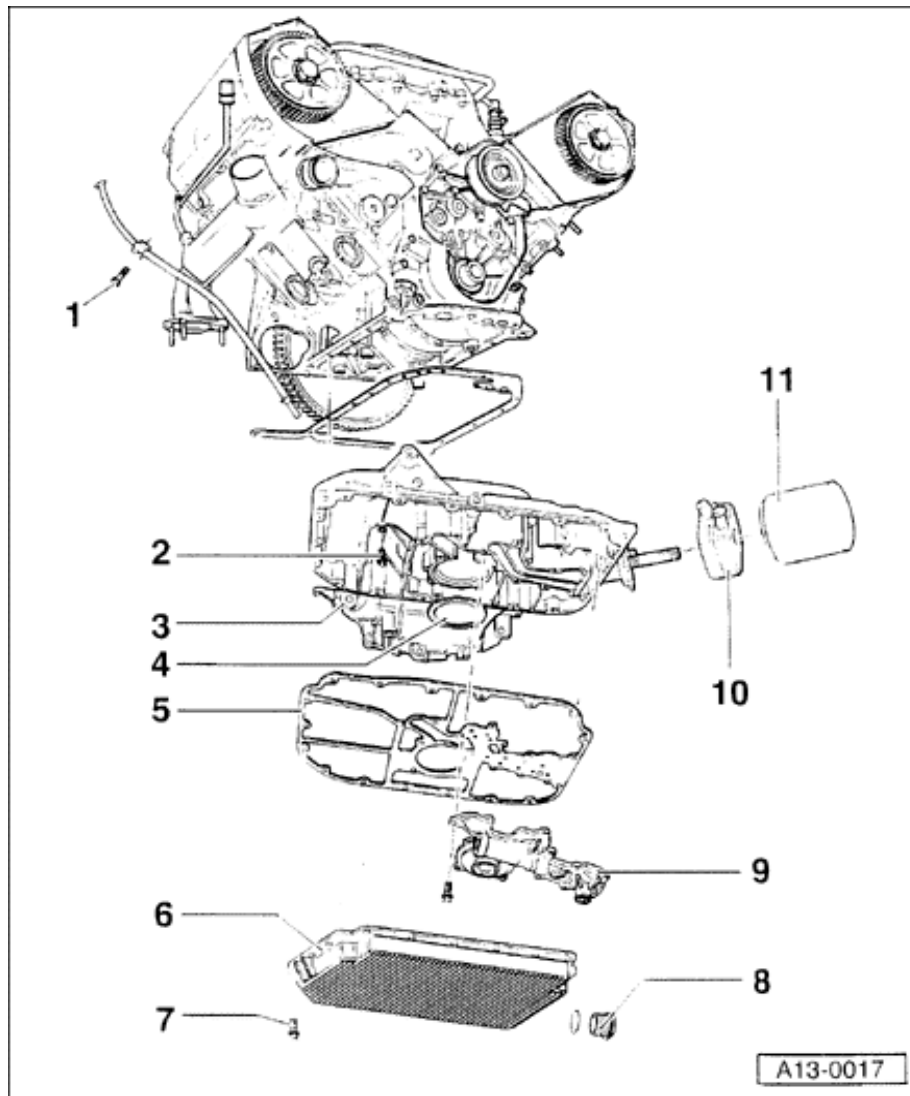
**2 - 10 Nm (7 ft lb)**

**3 - Oil pan, upper**

**4 - Pick-up strainer**

- ◆ Locks into upper oil pan with three lock tabs

**5 - Gasket**



**6 - Oil pan, lower**

**7 - 10 Nm (7 Nm)**

**8 - Oil drain plug**

◆ 40 Nm (30 ft lb)

**9 - Cover**

◆ With integrated 5 bar (72 psi) and 11 bar (159 psi) pressure relief valves

**10 - Oil cooler**

**11 - Oil filter**

◆ NOT interchangeable with older version

◆ Revised lubrication system requires different filter: Part no. 078 115 561 D

## Oil pump, removing

### Note:

*If irregular valvetrain noises occur and disappear after a lengthy drive, but always re-occur on short drives, replace the oil retention valves.*

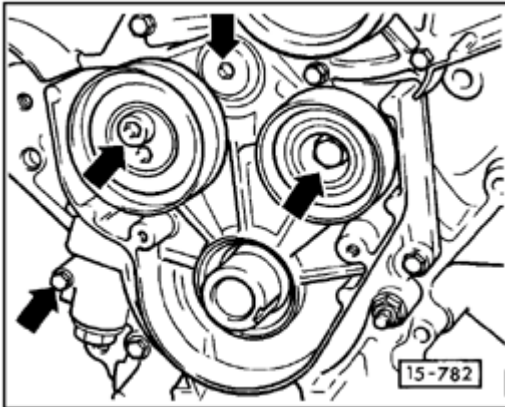
- Remove oil dipstick and drain engine oil.
- Remove upper and lower parts of oil pan.
- Remove toothed belt ⇒ [page 13-11](#) .
- Remove toothed-belt tensioner and guide pulley at oil pump.
- Remove screw plug.
- Remove oil pump.

### Note:

*When installing the oil pump check alignment of oil pump drive*

### Tightening torques

|                |                  |
|----------------|------------------|
| ◆ Oil pump     | 10 Nm (7 ft lb)  |
| ◆ Guide pulley | 20 Nm (15 ft lb) |
|                | 30 Nm (22 ft lb) |



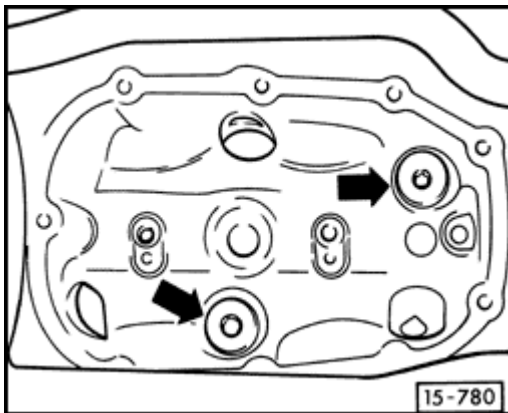
- ◆ Screw plug
- ◆ Toothed belt tensioner 45 Nm (33 ft lb)

## Oil retention valves, replacing

### Note:

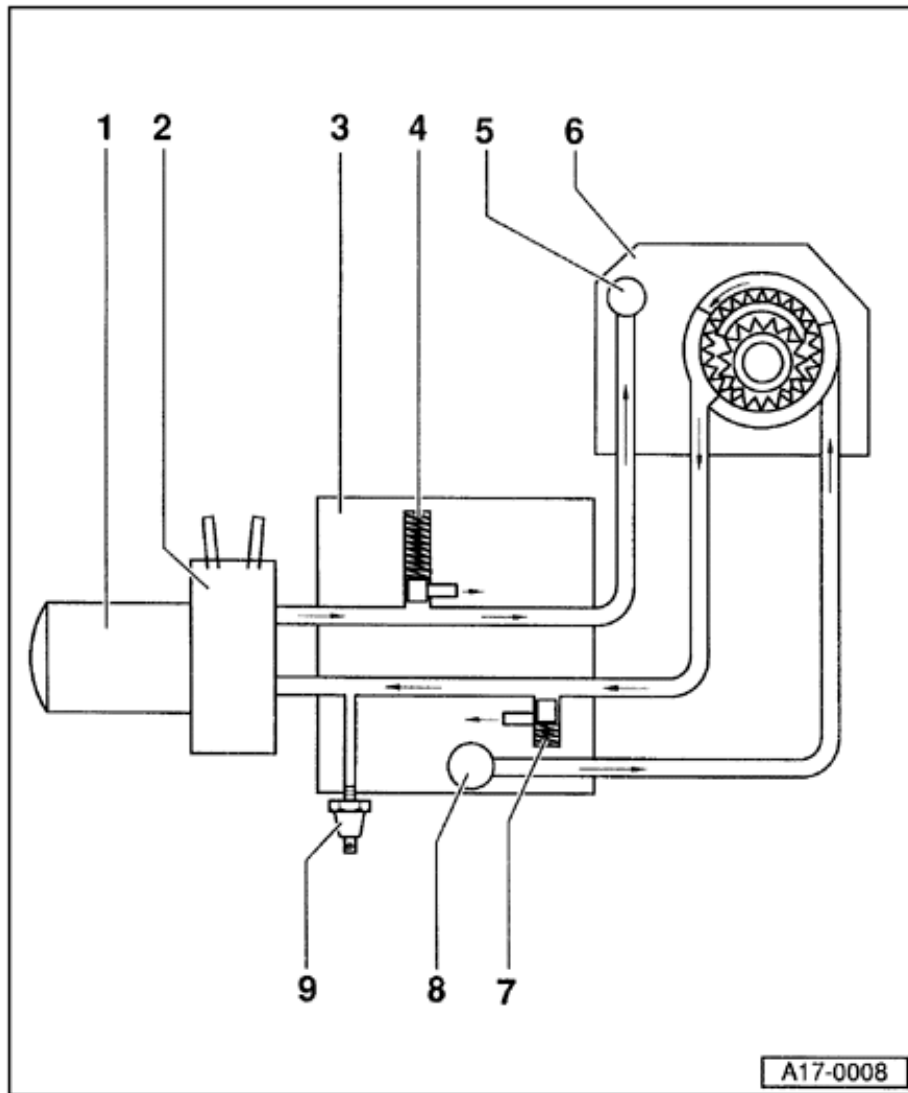
- ◆ *The oil retention valves must be replaced if the valvetrain sounds noisy on short drives, although the noise may go away on longer drives.*
- ◆ *When installing the oil pump, ensure that the driver at the crankshaft engages in the oil pump,*

- Remove intake manifold.
- Remove cover plate beneath intake manifold.
- Replace oil retention valves (arrows).



### Tightening torques

- ◆ Intake manifold      20 Nm    (15 ft lb)
- ◆ Cover                10 Nm    (7 ft lb)
- ◆ Oil retention valves    25 Nm    (18 ft lb)



## Revised oil circulation system

### Note:

- ◆ Modifications compared to previous 2.8 liter V6 (Audi 90, Audi 100).
- ◆ Only the modified components should be installed on this engine.

#### 1 - Oil filter

- ◆ Larger outer dimensions

#### 2 - Oil cooler

- ◆ Larger cross-sectional flow area

#### 3 - Cover for oil pan

- ◆ New

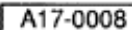
#### 4 - Pressure relief valve

- ◆ New

#### 5 - Oil supply to engine

#### 6 - Oil pump

- ◆ New



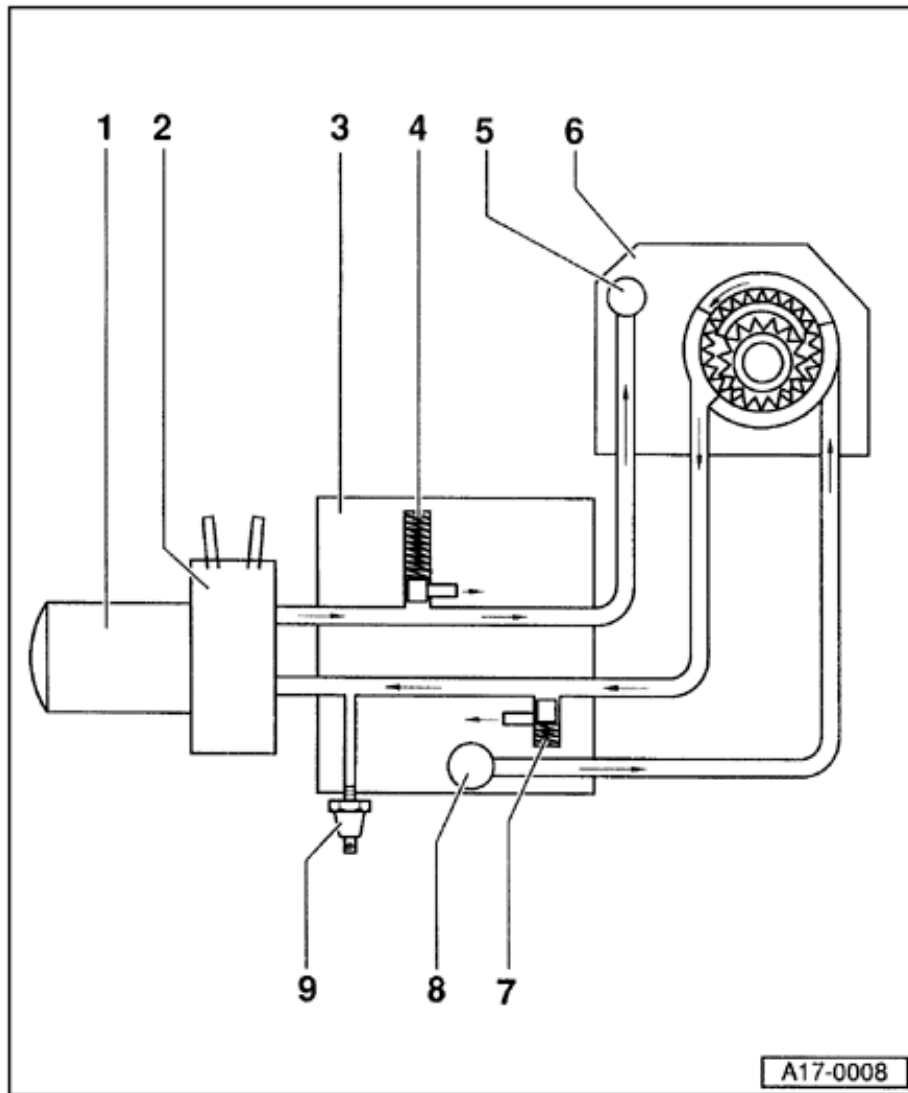
◆ New

◆ New

◆ Color: Brown

- ◆ Checking  $\Rightarrow$  [page 17-9](#)

- ◆ Dynamic oil pressure warning system function ⇒ [page 17-11](#)



## Function of revised oil circulation

### Intake side

Oil is taken in from the oil pump -6- via the oil pick-up pipe -8-.

### Pressure side

Oil pressure comes from the oil pump -6- through the upper part of the oil pan past the pressure relief valve -7-, oil pressure switch -9-, oil cooler -2- and oil filter -1- to the pressure relief valve -4-.

Pressure relief valve -4- controls the oil pressure to the engine.

The pressure relief valve -7- is a safety valve that opens only at high RPM and cold engine temperature.

### Advantages

Oil pressure is controlled from the oil filter and oil cooler, so that the oil pressure available at those locations is supplied via the pressure relief valve -4- or from the oil pump.

## Oil pressure and oil pressure switch, checking

Operational test and servicing the visible and audible oil pressure indicator:

⇒ *Electrical Wiring Diagrams, Troubleshooting & Component Locations binder.*

### Test requirements

- Oil level OK
- Oil pressure warning light -K3- comes on with ignition on
- Auto-Check system indication OK, if applicable.
- Engine oil temperature approx. 80 ° C (176 ° F) and radiator coolant fan must have switched on at least once

### Checking oil pressure switch

- Disconnect harness connector from oil pressure switch.



- Remove oil pressure switch and install into oil pressure tester VAG 1342.
- Connect cable -2- (brown) to Ground (GND).
- Connect cable -1- (blue) to oil pressure switch.
- Connect VAG 1527B voltage tester to cable -1- and battery positive voltage (B+).

---

**17-10**

- Start engine and slowly increase engine speed (RPM).
- At 1.6-2.0 bar (23-29 psi) pressure, the LED must come on

If not:

- Replace 1.8 bar oil switch.

## Operation of dynamic oil pressure warning system, checking

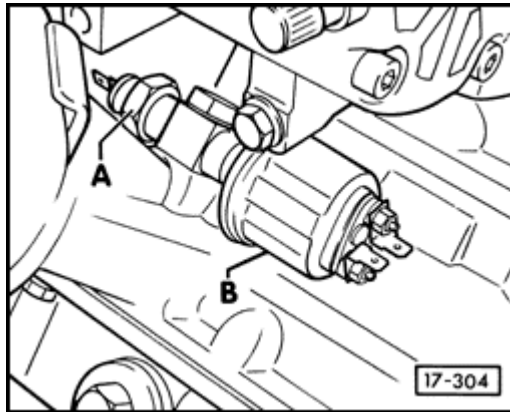
Testing oil pressure warning light:

After ignition is switched on (terminal 15 on) with the engine not running, the oil pressure warning light flashes (not on models with Auto Check System).

Warning criteria:

- ◆ Engine not running; oil pressure switch closed
- ◆ Engine coolant temperature greater than 60 ° C (140 ° F), engine speed greater than 1500 RPM and oil pressure switch open
- ◆ Engine coolant temperature less than 60 ° C (140 ° F), engine speed greater than 300 RPM and oil pressure switch open
- ◆ At an engine speed greater than 5000 rpm, an active oil warning is not cancelled, irrespective of the position of the oil pressure switch
- ◆ If the voltage supply to the control module (terminal 15) is in order and, when the engine is running, the oil pressure switch is open for

longer than 0.5sec. above 1500 RPM, this event is stored. If this condition occurs three times during "terminal 15 on," the warning also becomes or remains active below 1300 RPM.



### Testing oil pressure

A

- Remove oil pressure switch and screw in VAG 1342 oil pressure gauge.  
(The oil pressure sensor shown in the illustration is not installed on the A4)
- Install oil pressure switch into VAG 1342.
- Start engine.

### Oil pressure specifications

- Engine oil temperature at least 80 ° C (176 ° F)
- ◆ At idle: 1.0-2.5 bar (15-36 psi)
- ◆ At 3000 RPM: 3.0-5.0 bar (44-73 psi)

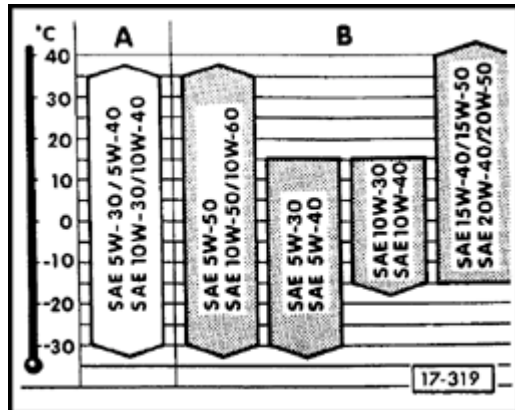
## Engine oil

### Viscosity and specification

The engine is factory-filled with a quality multi-grade oil that can also be used as an all-season oil, except in extremely cold climates.

The oil specifications on these pages must be indicated on the container, either individually or in combination with other specifications.

When topping up and changing the oil use only quality engine oil. Mixing oils when topping up is permissible.



A

Select the viscosity classification according to the illustration. The oil does not need to be changed if the outside temperature only briefly exceeds the specified ranges.

A - Multi-grade high lubricity oils

Specification VW 500 00 <sup>1)</sup>

B - Multi-grade high lubricity oils

Specification VW 501 00 <sup>1)</sup>

A - Multi-grade high lubricity oils, minimum API-SF<sup>2)</sup> or API-SG<sup>2)</sup> specification

<sup>1)</sup> A date not older than 10.91 must be indicated after this VW standard.

<sup>2)</sup> These oils may only be used if in exceptional cases no approved

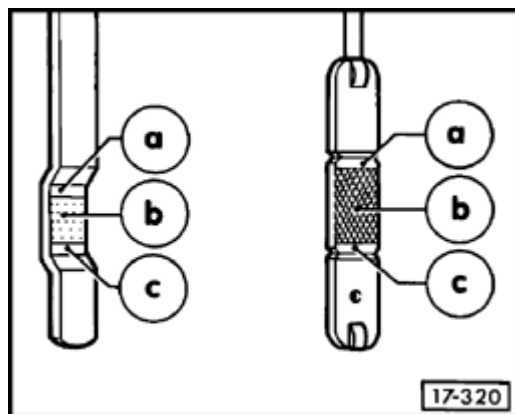
engine oil is available.

### Checking engine oil level

The vehicle must be on a level surface when checking the engine oil level. Wait a few minutes after stopping the engine so the oil can run back into the pan. Then withdraw the oil dipstick, wipe with a clean cloth and insert again as far as possible. Withdraw dipstick again and read engine oil level.

Check engine oil level only with the engine warm:

- Oil temperature greater than 60 °C (140 °F)



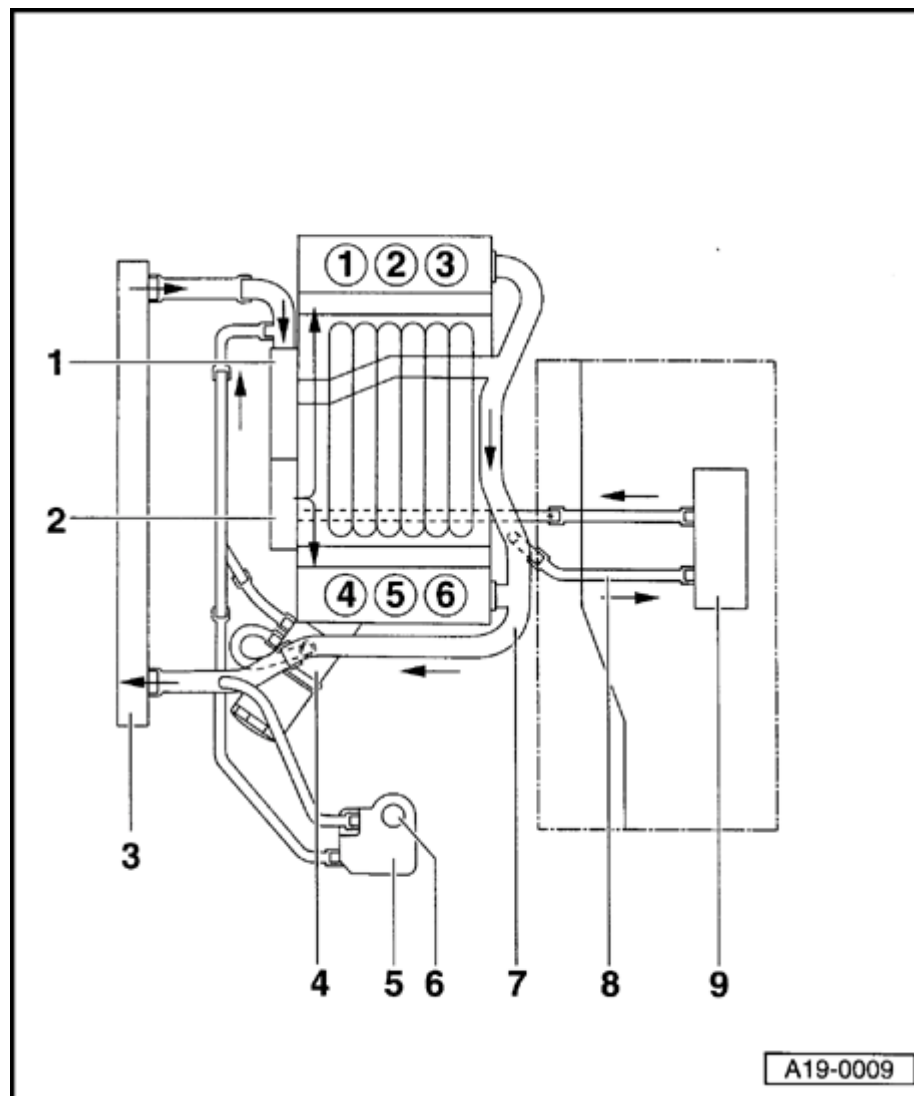
A

Markings on oil dipstick:

- a - Oil MUST NOT be topped up past this point
- b - Oil may be topped up
- c - Oil MUST be topped up. It is sufficient if the oil level, after topping up, is somewhere within range -b- (knurled area)

### CAUTION!

**The oil level must NOT exceed the max. marking on the dipstick.**



## Cooling system components, removing and installing

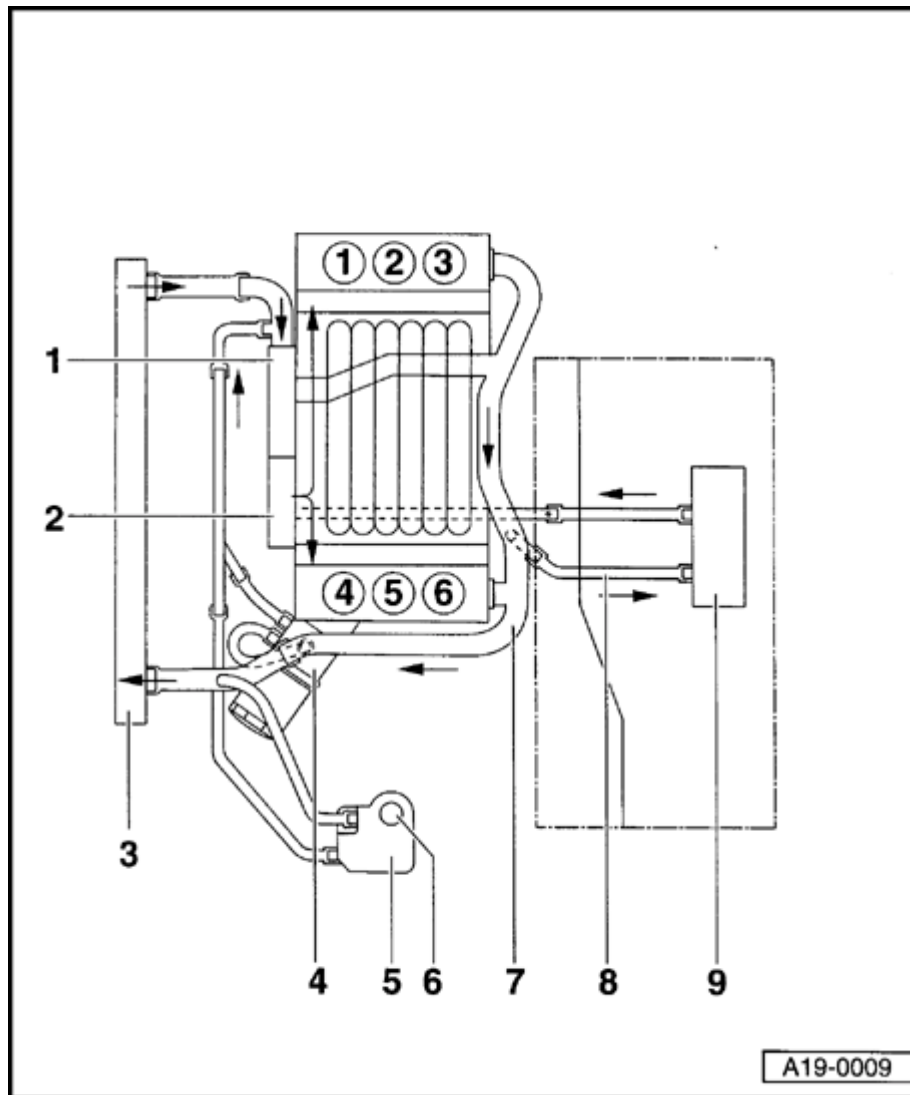
### Note:

- ◆ Always replace gaskets and seals.
- ◆ Draining and filling system with coolant ⇒ [page 19-6](#).
- ◆ Testing cooling system for leaks ⇒ [page 19-11](#).
- ◆ The toothed belt should NOT be removed in order to take out the coolant thermostat.
- ◆ The arrow markings on the coolant lines and the ends of the coolant hoses must align with each other.
- ◆ Tightening torque for coolant pipe hose clamps: 3-3.5Nm (27-31 in lb).

**1 - Thermostat**

**2 - Coolant pump**

**3 - Radiator**



**4 - Oil cooler**

**5 - Expansion tank**

**6 - Pressure cap**

♦ Testing ⇒ [page 19-12](#)

**7 - Coolant line**

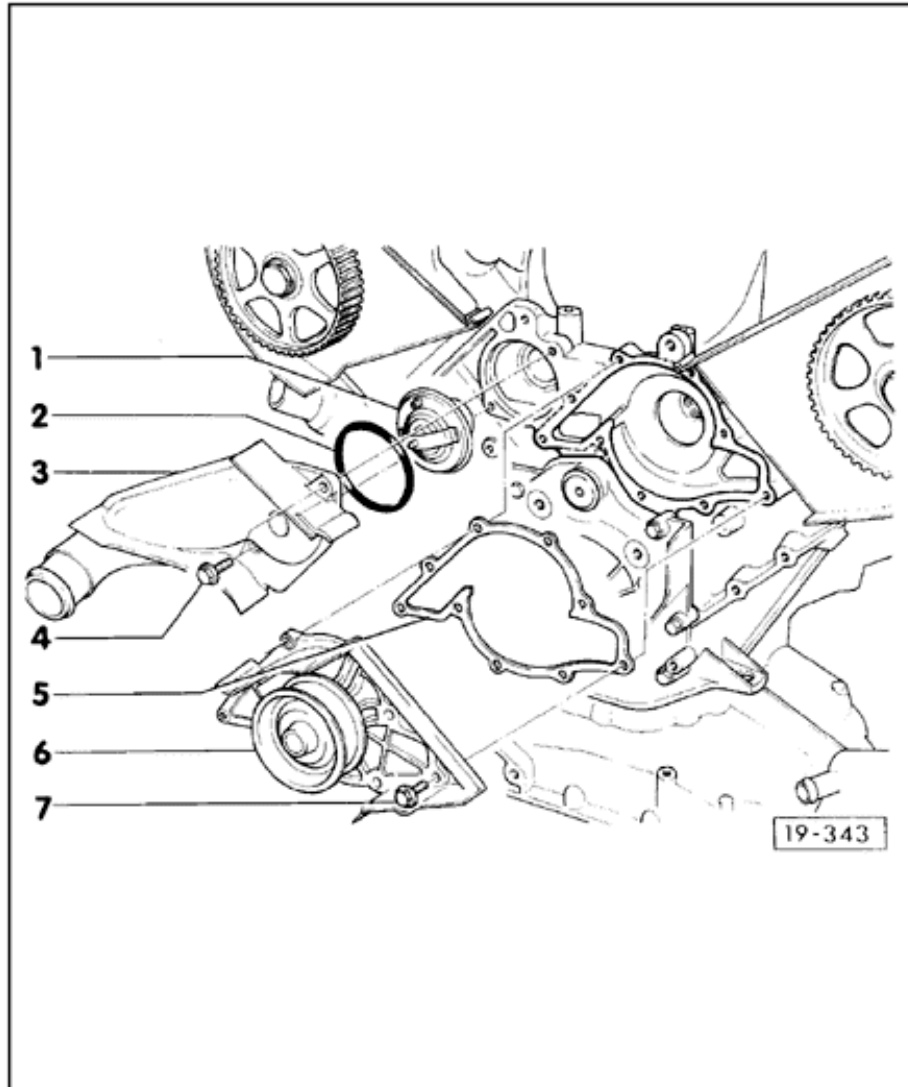
**8 - Feed line**

♦ To heater core

**9 - Heater core**

**10 - Vent bore**

♦ In the return line from heater core



## Cooling system, components

### Note:

- ◆ Always replace gaskets and seals.
- ◆ Draining and filling system with coolant ⇒ [page 19-6](#).
- ◆ Testing cooling system for leaks ⇒ [page 19-11](#).

#### 1 - Thermostat

- ◆ Replacing ⇒ [page 19-4](#)
- ◆ Opening and closing temperatures ⇒ [page 19-4](#)

#### 2 - Seal

- ◆ Always replace

#### 3 - Thermostat housing

#### 4 - 10 Nm (7 ft lb)

#### 5 - Gasket

- ◆ Always replace

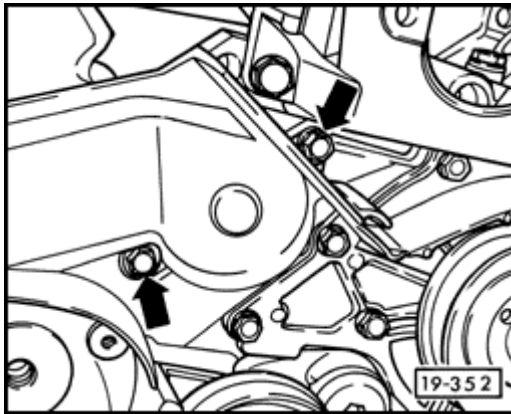
#### 6 - Coolant pump

- ◆ To remove and install, remove ribbed drive belt ( ⇒ [page 13-9](#) ) and toothed belt ( ⇒ [page 13-11](#) )

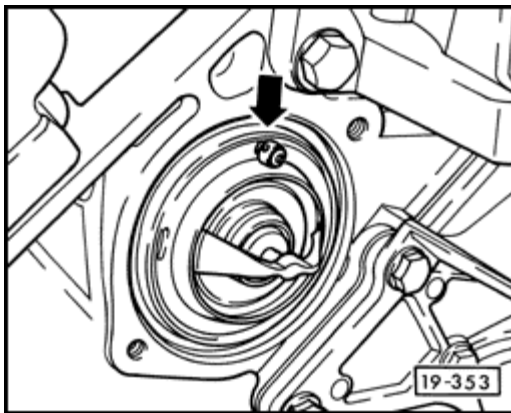
#### 7 - 10 Nm (7 ft lb)

## Thermostat, replacing

- Remove ribbed belt ⇒ [page 13-9](#) .
- Adjusting tension of toothed belt ⇒ [page 13-13](#) .



- Unbolt thermostat housing and pull out from below toothed belt.



Installation position of thermostat. The vent valve must be installed facing up (arrow).

- ◆ Starts to open at approx. 87 ° C (189 ° F)
- ◆ End of opening approx. 102 ° C (216 ° F)
- ◆ Stroke: 8.0 mm (5/16 in.)

### Coolant fan control thermal switch, checking

The coolant fan control thermal switch -F54- is located in the lower left part of the radiator.

| Terminal assignment |                               | Switching temperature               |                          |
|---------------------|-------------------------------|-------------------------------------|--------------------------|
| 3-pin connector     |                               |                                     |                          |
|                     | On                            | Off                                 |                          |
| 1 =                 | 1st stage                     | 92 ° - 97 ° C<br>(198 ° - 207 ° F)  | approx. 84 ° C (183 ° F) |
| 2 =                 | 2nd stage                     | 99 ° - 105 ° C<br>(210 ° - 221 ° F) | approx. 91 ° C (196 ° F) |
| 3 =                 | Battery positive voltage (B+) |                                     |                          |

## Cooling system, draining and filling

### Note:

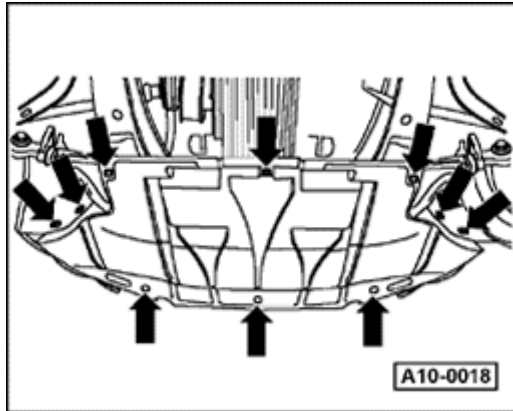
- ◆ *The cooling system is filled year round with a mixture of water and anti-freeze and anti-corrosion agent G 011 A8C.*
- ◆ *G 011 A8C and coolant additives marked with "conforming to TLVW 774 C" prevents freezing, corrosion damage and scale formation, and raises the coolant boiling point. For these reasons the cooling system must always be filled year-round with G 011 A8C anti-freeze and anti-corrosion agent.*
- ◆ *Due to its high boiling point, coolant is an aid to operational efficiency when the engine is operating at full load, particularly in tropical climates.*
- ◆ *Coolant must be drained and replaced if either the radiator, heater core, cylinder head or cylinder head gasket have been replaced.*
- ◆ *Capacity: approx. 8.5 liters (9 qt.)*

### Draining

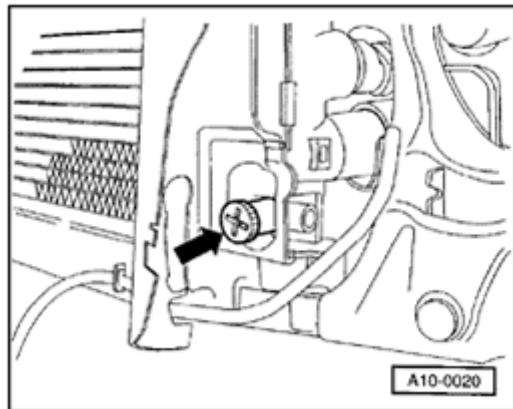
### **WARNING!**

*The cooling system is pressurized when the engine is warm. Wear gloves and other appropriate protection, and slowly and carefully release system pressure, if necessary, before performing repairs.*

19-7



- Open the cap on the coolant expansion tank.
- ↳ - Remove noise insulation panel below engine.



- ↳ - Drain coolant at radiator.
- Remove locking plate for connection flange of coolant hose at bottom of radiator, pull off connection flange.



- Using special tool 3247, drain coolant from engine drain plug (arrow) and at drain plug on bottom left of radiator.

### Filling

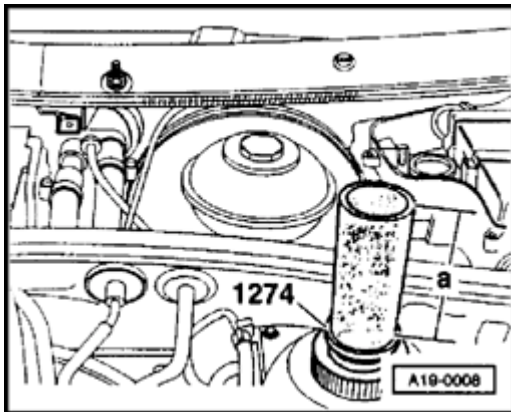
Recommended mixing ratios:

| Anti-freeze protection down to: | Anti-freeze concentration <sup>1)</sup> | G 11 <sup>2)</sup>  | Water <sup>2)</sup> |
|---------------------------------|-----------------------------------------|---------------------|---------------------|
| -25 ° C (-13 ° F)               | 40%                                     | 2.5 liter (2.6 qt.) | 3.5 liter (3.7 qt.) |
| -35 ° C (-31 ° F)               | 50%                                     | 3.0 liter (3.2 qt.) | 3.0 liter (3.2 qt.) |

<sup>1)</sup> Do not exceed an antifreeze concentration of 60%; antifreeze protection and cooling efficiency are reduced if the concentration is higher.

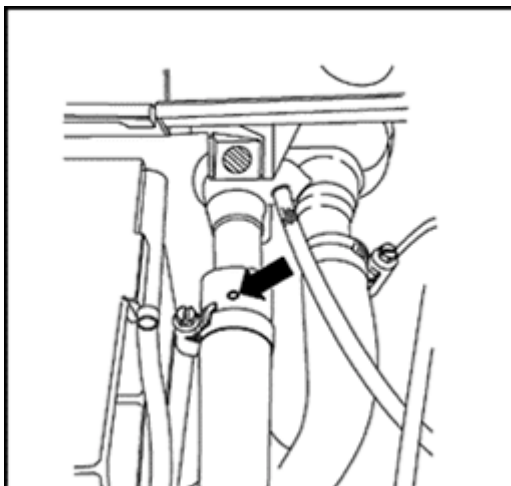
<sup>2)</sup> The quantity of coolant may differ depending on specific equipment installed in the vehicle.

- Close drain plug at engine block and at bottom left of radiator.
- Push on connection flange of coolant hose at bottom of radiator, and install locking element for connection flange.



A

- Unscrew cap on expansion tank, screw on adapter VAG 1274/1, and extend with 42mm diameter and 100 mm long auxiliary hose.



A

- Open hose clamp, pull back coolant hose sufficiently so that vent hole is no longer concealed by connection.
- Open bleed screw at coolant pipe below expansion tank.
- Pour coolant into system until it flows out at bleeder hole, then tighten screw to 15 Nm (11 ft lb).
- Pour in more coolant until it flows out at vent hole, then push on coolant hose and tighten.
- Close cap on expansion tank and set heater controls to hot position.
- Start engine and run at about 2000 RPM for about 3 minutes.

- Continue running engine at idle until radiator becomes hot at the bottom connection.

**WARNING!**

***The cooling system is pressurized when the engine is warm. Wear gloves and other appropriate protection, and slowly and carefully release system pressure, if necessary, before performing repairs.***

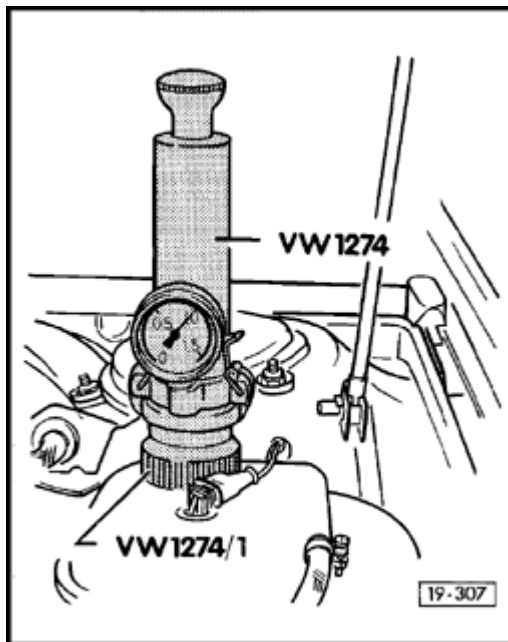
- Check coolant level in expansion tank and top up if necessary.
- Stop engine (switch ignition off).

## Cooling system leaks, checking

### **WARNING!**

*The cooling system is pressurized when the engine is warm. Wear gloves and other appropriate protection, and slowly and carefully release system pressure, if necessary, before performing repairs.*

- Engine must be at operating temperature

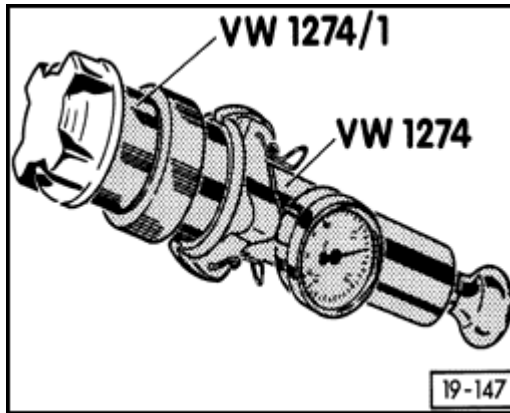


- Connect cooling system tester VW 1274 to expansion tank using adapter VW 1274/1.
- Operate hand pump on tester to create a pressure of approx. 1 bar (15 psi).

If the pressure drops:

- Locate and repair leak in the cooling system.

### Expansion tank cap, pressure testing



- Screw cap onto cooling system tester VW 1274 with adapter VW 1274/1.
- Operate hand pump to build pressure.
- Pressure relief valve must open at 1.2-1.5 bar (17-22 psi).

## Fuel supply system components, removing and installing

### **WARNING!**

**Always be sure to comply with applicable safety precautions when working on the fuel system** ⇒ [page 20-3](#) .

Pay attention to rules of cleanliness ⇒ [page 20-2](#) .

Adjusting accelerator pedal cable ⇒ [page 20-15](#) .

### **Notes:**

- ◆ *Hose connections are secured with clamp-type, screw-type, spring-type clamps.*
- ◆ *Always replace clamp-type with spring-type or screw-type clamps.*

## Rules of cleanliness

### **CAUTION!**

***Whenever carrying out work on the fuel supply and fuel injection systems, carefully observe the following five rules of cleanliness.***

- 1 - Thoroughly clean fuel system line and hose connections and the surrounding area before disconnecting.
- 2 - Place removed components on a clean surface and cover. Use plastic sheeting or paper. Do not use fluffy rags that could leave lint!
- 3 - Carefully cover over or seal any components that have been opened if repairs are not carried out immediately.
- 4 - Install only clean parts:  
  
Do not remove replacement parts from the packaging until immediately before they are to be installed.  
  
Do not use parts that have been stored without packaging (e.g. in toolboxes, etc.).
- 5 - When the fuel system is opened:

Avoid working with compressed air whenever possible.

Avoid moving the vehicle if possible.

## Safety precautions

### **WARNING!**

***When removing and installing the fuel pump or fuel level sensor from a filled or partially filled fuel tank:***

- ♦ ***BEFORE beginning repairs, the suction pipe of an exhaust extraction system must be located near the fuel tank opening so that escaping fuel vapors can be immediately carried away.***
- ♦ ***If no exhaust extraction system is available, a radial fan (motor located outside airflow) with volume of at least 15 m<sup>3</sup>/hr (9 cfm) may be used.***
- ♦ ***Wear fuel-resistant gloves whenever working with open parts of the fuel system.***

***Be sure the ignition is switched OFF, when:***

- ♦ ***Disconnecting fuel injection system wiring***
- ♦ ***Connecting or disconnecting test equipment leads***

***BEFORE cranking the engine at starting RPM***

*(such as for compression testing) disable the ignition and fuel injection systems:*

- ♦ *Disconnect the ignition coil power output stage.*
- ♦ *Disconnect harness connectors from all fuel injectors.*
- ♦ *After the work is completed, erase Diagnostic Trouble Code (DTC) memory.*

**CAUTION!*****BEFORE disconnecting the battery:***

- ♦ ***Stop the engine.***
- ♦ ***Be sure the ignition is switched OFF (also applies when connecting the battery). Failure to do so may damage the Engine Control Module (ECM).***
- ♦ ***Be sure of the proper radio code (for vehicles equipped with coded anti-theft radio).***

***Be sure the battery negative (-) cable is disconnected, when:***

- ♦ ***Working on the electrical system***
- ♦ ***Resistance (spot) welding or electric arc welding anywhere on the vehicle.***

***When connecting and disconnecting electrical test equipment (LED voltage tester, multimeter, etc.):***

- ♦ ***Be sure the ignition is switched OFF.***
- ♦ ***Use correct adapters from the VW 1594***

***connector test kit.***

## Flange and fuel level sensor, removing and installing

- Observe safety measures ⇒ [page 20-3](#)
- Pay attention to rules of cleanliness ⇒ [page 20-2](#) .

### **WARNING!**

***Fire hazard. DO NOT smoke or work near heaters or have anything in the area that can ignite fuel!***

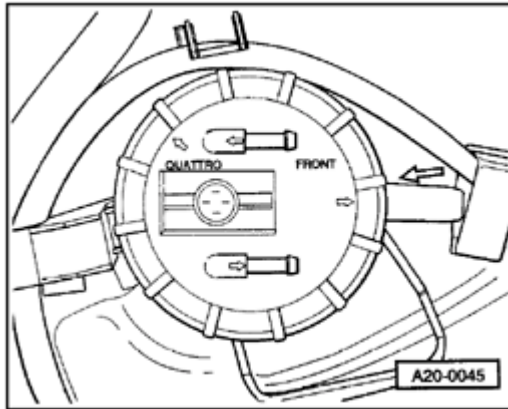
- Switch ignition on.
- Observe fuel gauge.

### **CAUTION!**

- ♦ ***The fuel tank should not be more than 2/3 full. Empty fuel tank, if necessary, using an approved fuel cart.***
- ♦ ***Determine correct radio anti-theft coding before disconnecting the battery.***

## Removing

- Disconnect battery Ground (GND) strap.
- Remove cover for fuel pump module flange (under luggage compartment trim).
- Disconnect harness connector for fuel level sensor and fuel pump.



- Detach blue return line and feed line.
- Use special tool 3217 to loosen sealing ring.
- Carefully pull flange out and detach.
- Unclip fuel level sensor and remove.

### Installing

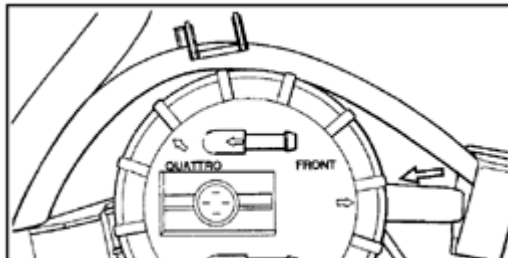
- Installation is in reverse order of removal.

Front-wheel-drive vehicles:

- Fuel level sensor wiring must be routed between return line and fuel tank housing.

All-wheel-drive vehicles:

- Fuel level sensor wiring must be routed between line of fuel transfer pump and fuel tank housing.



- When installing, make sure that arrows are aligned.  
Note different alignment arrows for FRONT-wheel-drive and QUATTRO

## Fuel pump, removing and installing

- Observe safety measures ⇒ [page 20-3](#)
- Pay attention to rules of cleanliness ⇒ [page 20-2](#).

Removing and installing sealing flange and fuel level sensor ⇒ [page 20-5](#)

### **WARNING!**

**Fire hazard. DO NOT smoke or work near heaters or have anything in the area that can ignite fuel!**

### Removing



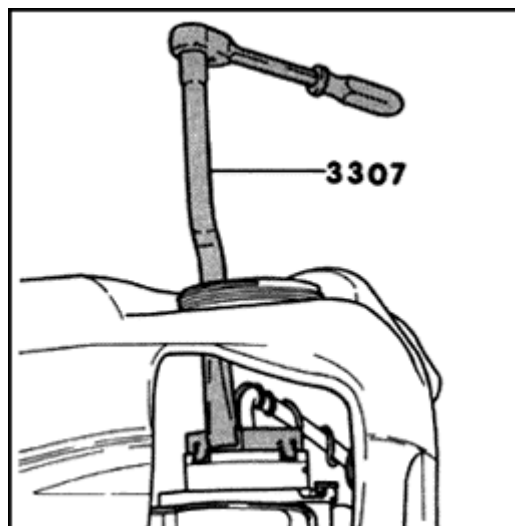
- Insert fuel pump wrench 3307 through fuel tank opening and position at inner part of fuel reservoir housing.
- Turn inner part of reservoir housing about 15° to left as far as stop and remove fuel pump along with inner part of reservoir housing.

### Installing

Installation is in reverse order of removal.

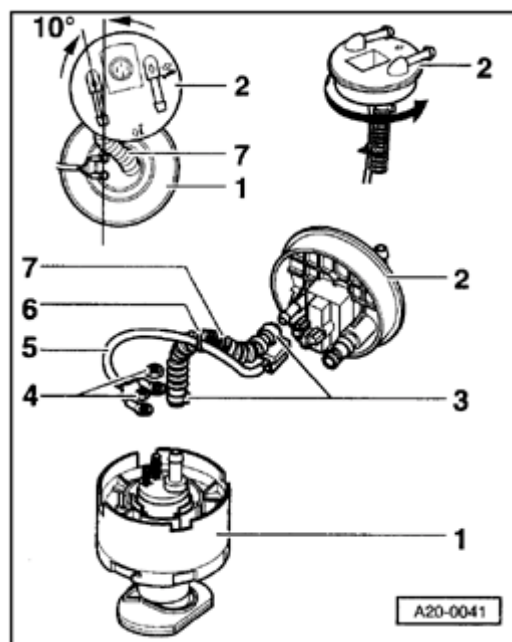
#### **Note:**

- ◆ *Moisten the flange seal with fuel before installing.*



◆ *Flange installation position* ⇒ [page 20-6](#) .

# Front-wheel-drive vehicles



A

- Turn hose -7- and wiring harness -5- into position as shown at upper left of illustration; when installing flange, turn in direction of arrow as shown at upper right of illustration.

- Compress clamp -3- with pliers, VAG 1275.

1 - Reservoir housing

2 - Flange

3 - Clamp

4 - Securing bolt

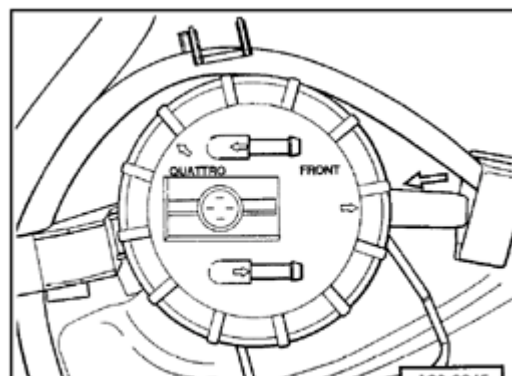
5 - Wiring

6 - Cable strap

7 - Hose

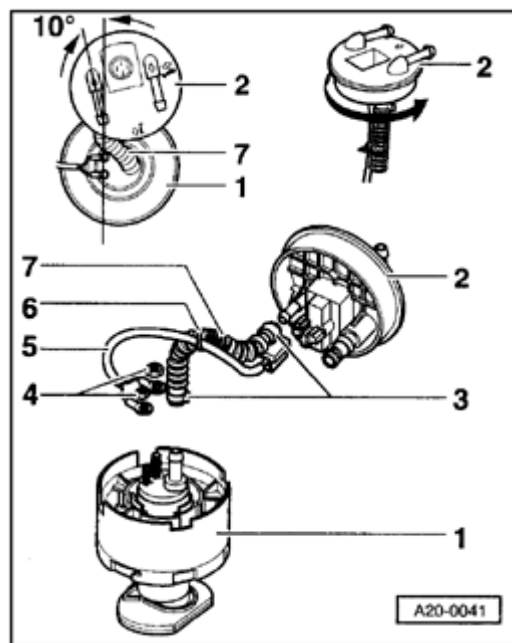
- Install reservoir housing with flange into fuel tank.

- Wiring for fuel level sensor must be routed between return line and fuel tank housing.



A

- Turn flange to left until arrows (FRONT) are aligned.

**All wheel-drive-vehicles**

A

- Turn hose -7- and wiring harness -5- into position as shown in upper left of illustration; when installing flange, turn in direction of arrow as shown at upper right of illustration.

- Compress clamp -3- with pliers VAG 1275.

1 - Reservoir housing

2 - Flange

3 - Clamp

4 - Securing bolt

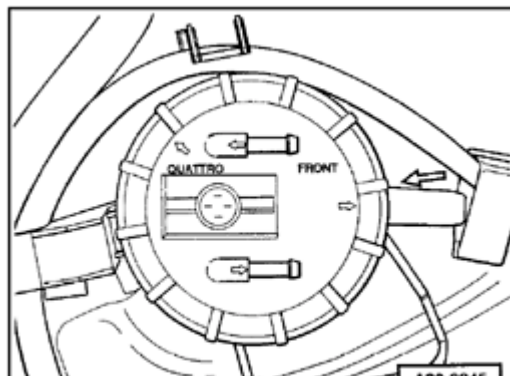
5 - Wiring

6 - Cable strap

7 - Hose

- Install reservoir housing with flange into fuel tank.

- Wiring for fuel level sensor must be routed between fuel transfer pump line and fuel tank housing.



A

- Turn flange to left until arrows (QUATTRO) are aligned.

## Fuel pump, testing

### **WARNING!**

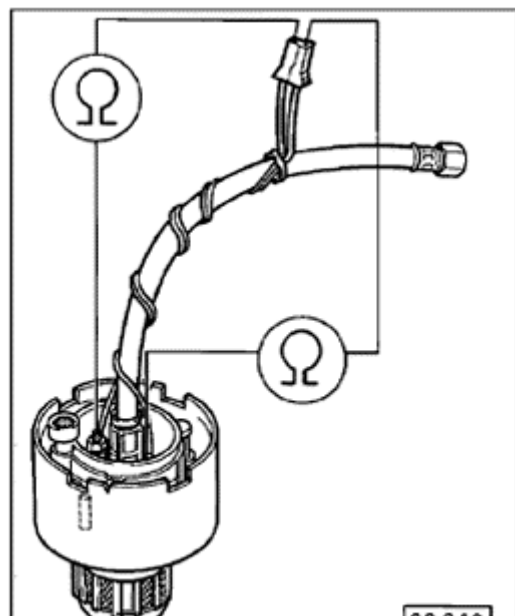
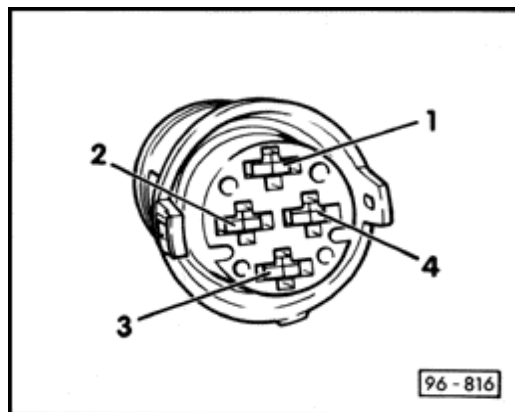
***Fire hazard! DO NOT smoke or work near heaters or have anything in area that can ignite fuel!***

### Checking power supply

- Battery fully charged
  - Fuse 28 OK
  - Test voltage supply to fuse 28 ⇒ Repair Manual, 2.8 Liter V-6 OBD II Fuel Injection and Ignition, Repair Group 24
  - Fuel supply OK
- Switch ignition on.
- Fuel pump must be heard to run briefly.  
(Second person will be required for this if surrounding noise level is too high).

If fuel pump does NOT run:

- Remove cover for fuel pump module (under luggage compartment trim, right rear).
- Disconnect harness connector for fuel pump and fuel level sensor.



- Supply voltage to fuel pump using VAG 1551 scan tool and "Output Diagnostic Test Mode" function 03.

A

- Connect multimeter between connector terminal 1 (green wire) and terminal 4 (brown wire) using adapter cables from VW 1594 connector test kit.

Specified value: approx. battery positive voltage (B+)

- If specified value is obtained, reconnect harness connector.

A

- Using ohmmeter, check for continuity between connector (outside of housing), harness connector and fuel pump.

If wiring is OK:

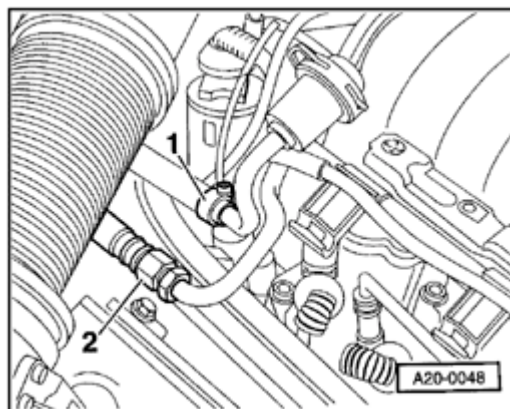
- Replace fuel pump ⇒ [page 20-7](#) .
- Install cover for fuel pump module.

### Checking fuel delivery

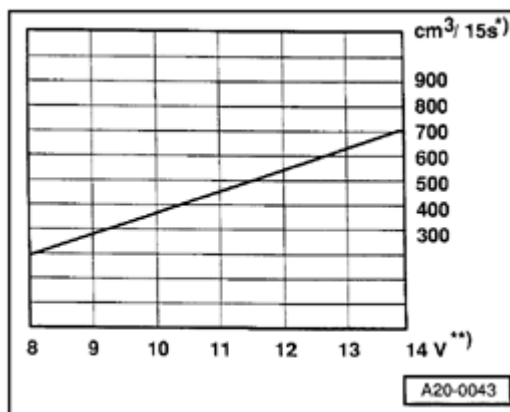
- Fuse 28 OK
- Relay in relay position 6 OK

- Fuel filter OK
- Battery fully charged

20-12



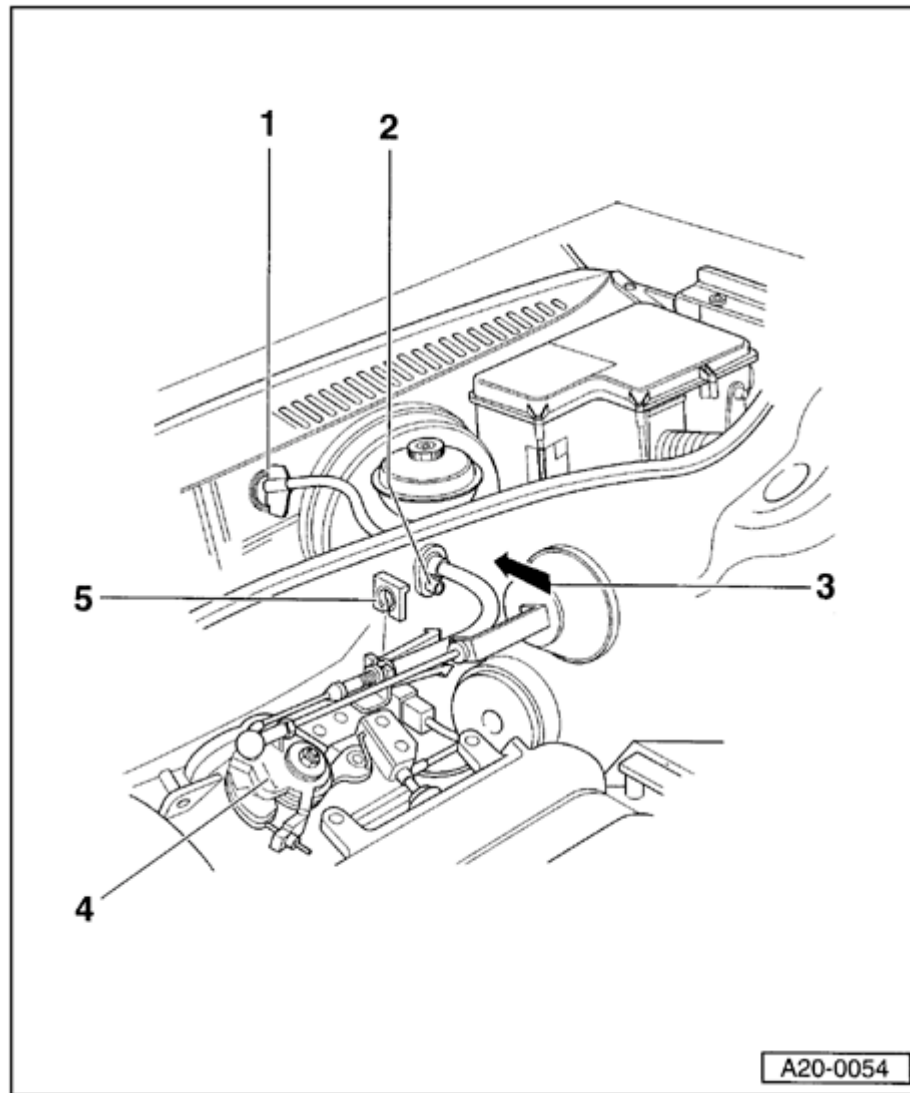
- Disconnect fuel return line -1- at engine compartment bulkhead and hold in measuring container.
- Connect remote control VAG 1348/3A with auxiliary cable VAG 1348/2 to fuse 28, connect positive (+) cable to battery.
- Operate remote control for 15 seconds (hold down button).



- Compare quantity of fuel delivered with specified values for minimum fuel delivery rate in graph, according to actual voltage at fuel pump.
  - \*) - Minimum fuel delivery rate-fuel volume in cm<sup>3</sup> (ml) delivered in 15 seconds
  - \*\*\*) - Voltage (V) at fuel pump with engine stopped, fuel pump running- approx. 2 volts less than battery positive voltage (B+)

### Fuel pump check valve, checking

Testing check valve ⇒ Repair Manual, 2.8 Liter V-6 OBD II Fuel Injection & Ignition, Repair Group 24



### Accelerator pedal cable and linkage, servicing

1 - Cable attachment

2 - 10 Nm (7ft lb)

3 - Cable installation direction

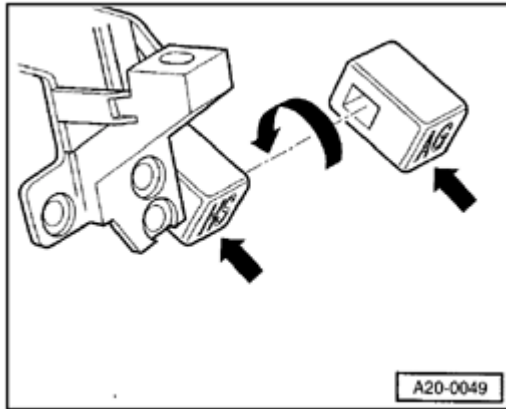
◆ Arrow

4 - Cam

◆ Adjusting ⇒ [page 20-15](#)

5 - Cable securing clip

20-14



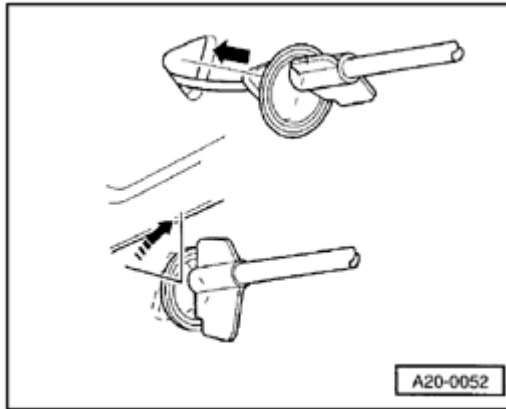
#### ✦ Installation position of stop buffer

Identification:

HS - Manual transmission

AG -Automatic transmission

- Marking -HS- or -AG- must be readable



#### ✦ Attachment of cable sleeve

- Push throttle cable through engine compartment bulkhead.
- Push cable attachment into bulkhead and turn counterclockwise approx. 90°.

## Accelerator pedal cable, adjusting

### **CAUTION!**

- ♦ *The accelerator pedal cable is easily damaged (kinked) and therefore must be handled carefully.*
  - ♦ *A single slight kink can lead to cable failure while the vehicle is being driven.*
  - ♦ *A KINKED CABLE MUST NOT BE INSTALLED.*
  - ♦ *When installing the cable, make sure that it is aligned between its supporting mounts and the attachment points.*
- Pull off cable locking plate at throttle body.
  - Depress accelerator pedal to wide open throttle position.

### **Note:**

*A second person is required for this step.*

Vehicles with manual transmission

- Pull cable sleeve away from cam at throttle body until throttle valve has opened fully, then hold tight in this position.

#### Vehicles with automatic transmission

- Pull cable sleeve back toward wide open throttle position until throttle valve is fully open and kickdown switch is actuated (clicks), then hold tight in this position.

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20-16

- Insert securing clip for cable sleeve.
- Release accelerator pedal.

**Note:**

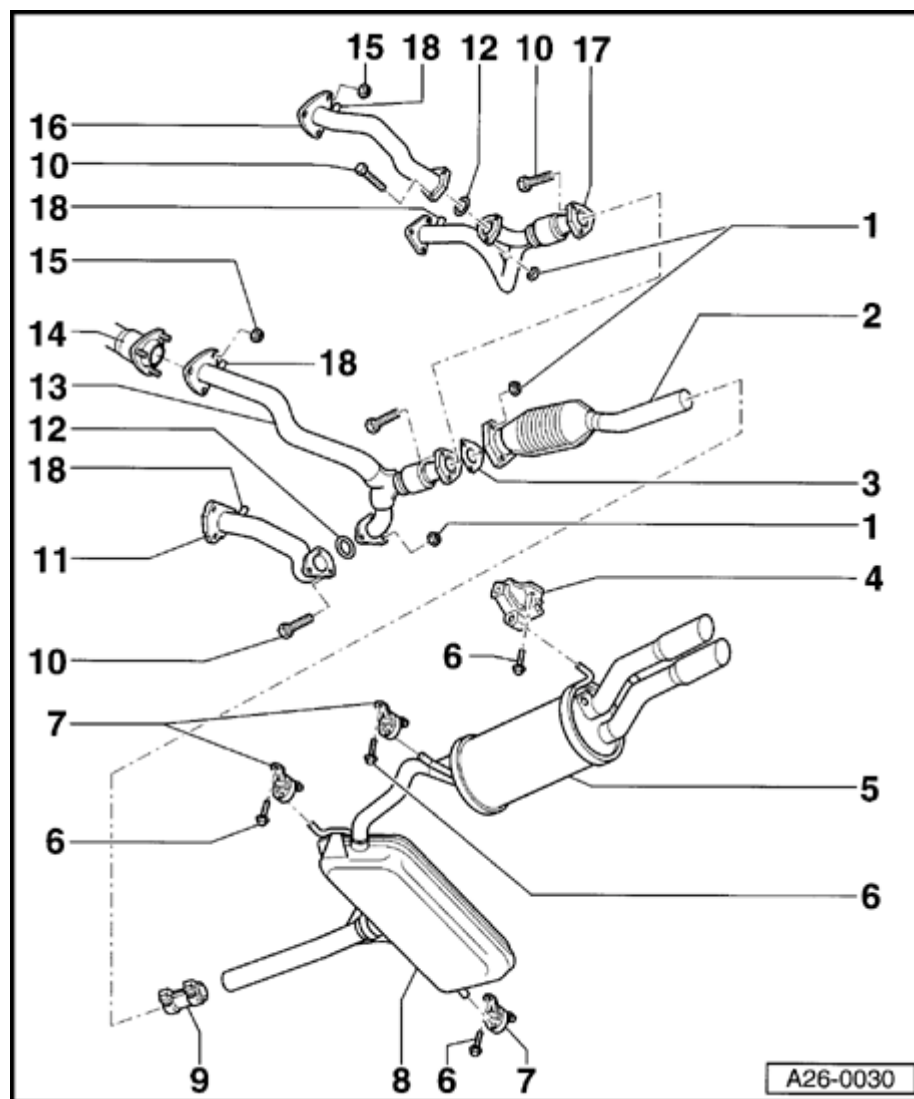
*After adjusting the cable, check idle speed and check the wide open throttle stop at the throttle valve.*

## Exhaust system components, removing and installing

### **Note:**

- ◆ *As a general rule, always install new seals and gaskets and clamping sleeves.*
- ◆ *Always replace self-locking nuts.*
- ◆ *Install retaining rings and bolted connections as specified ⇒ Parts catalog microfiche.*
- ◆ *Make sure that there is adequate clearance between the body and the exhaust system components.*

Instructions for aligning the exhaust system free of stress will be issued in a subsequent Technical Bulletin.



### Front-wheel-drive, engine code AFC

**1 - Locking nut**

◆ 25 Nm (18 ft lb)

**2 - Three Way Catalytic Converter (TWC)**

**3 - Gasket**

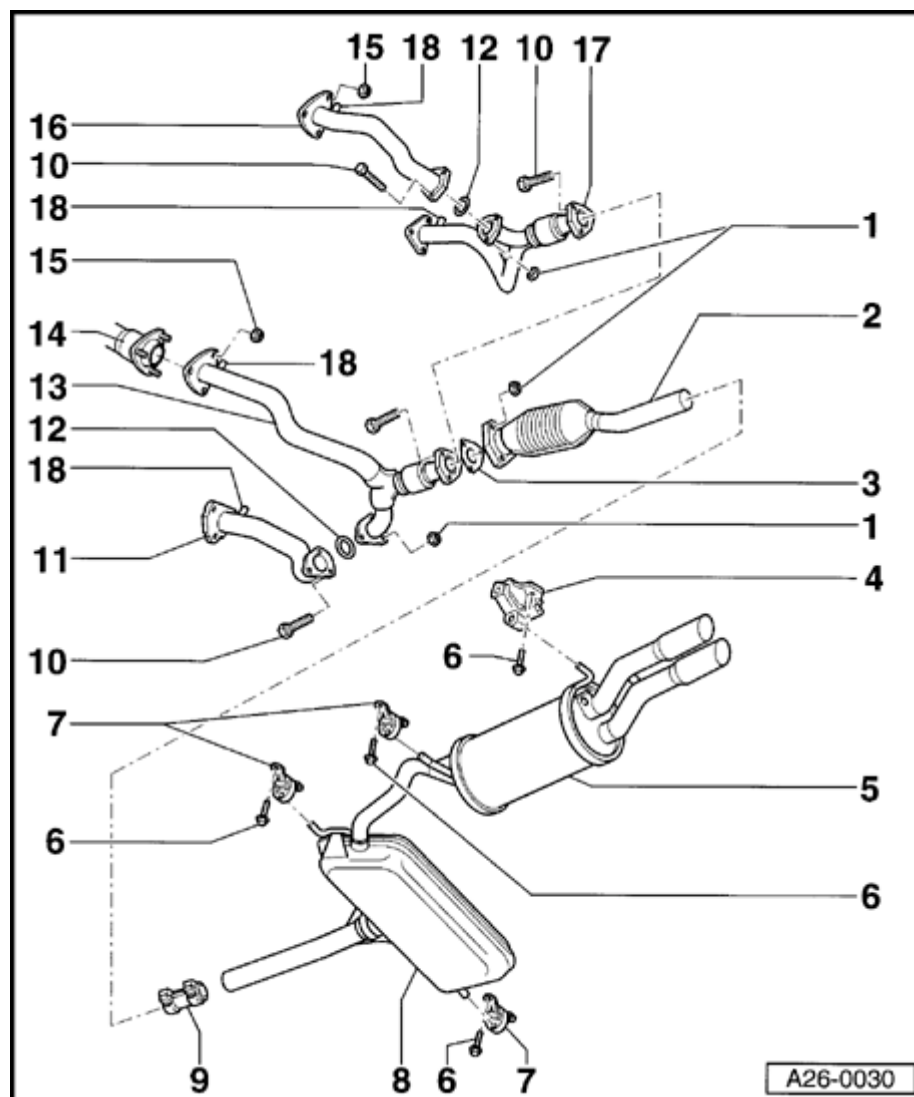
**4 - Retaining ring**

◆ When replacing always use a lubricant and avoid damaging the rubber.

**5 - Rear muffler**

**6 - Hex bolt**

◆ 25 Nm (18 ft lb)



**7 - Retaining ring**

**8 - Center muffler**

**9 - Clamping sleeve**

◆ 40 Nm (30 ft lb)

◆ Tighten evenly

◆ Installed horizontally in vehicle

**10 - Hex bolt**

**11 - Exhaust pipe, right front**

◆ Only for models with automatic transmission

**12 - Seal**

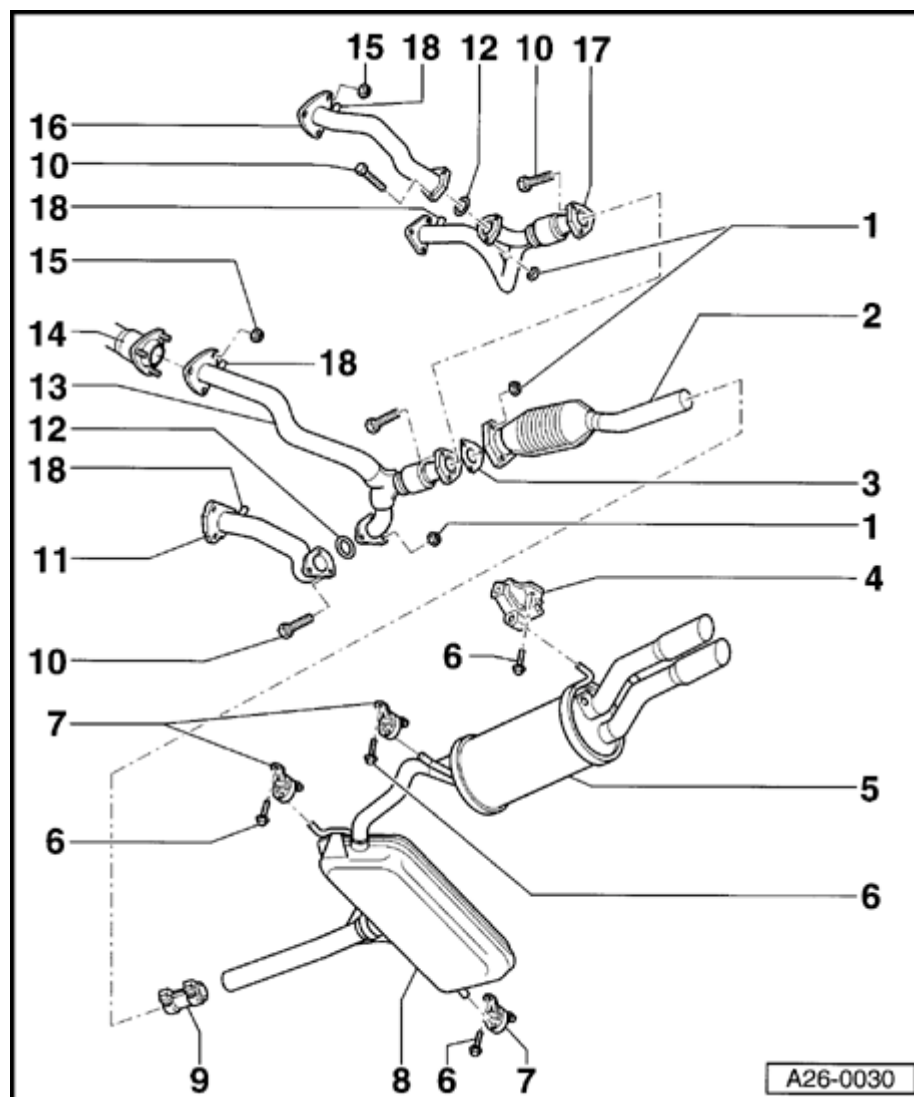
**13 - Exhaust pipe with insulating element, left front**

◆ Only for models with automatic transmission

**Note:**

*Handle the insulating elements with care; protect from shock-like stresses and extreme bending. Maximum deflection 10°.*

26-4



**14 - Exhaust manifold**

**15 - Hex nut**

◆ 30 Nm (22 ft lb)

**16 - Exhaust pipe, left front**

**17 - Exhaust pipe with insulating element, right front**

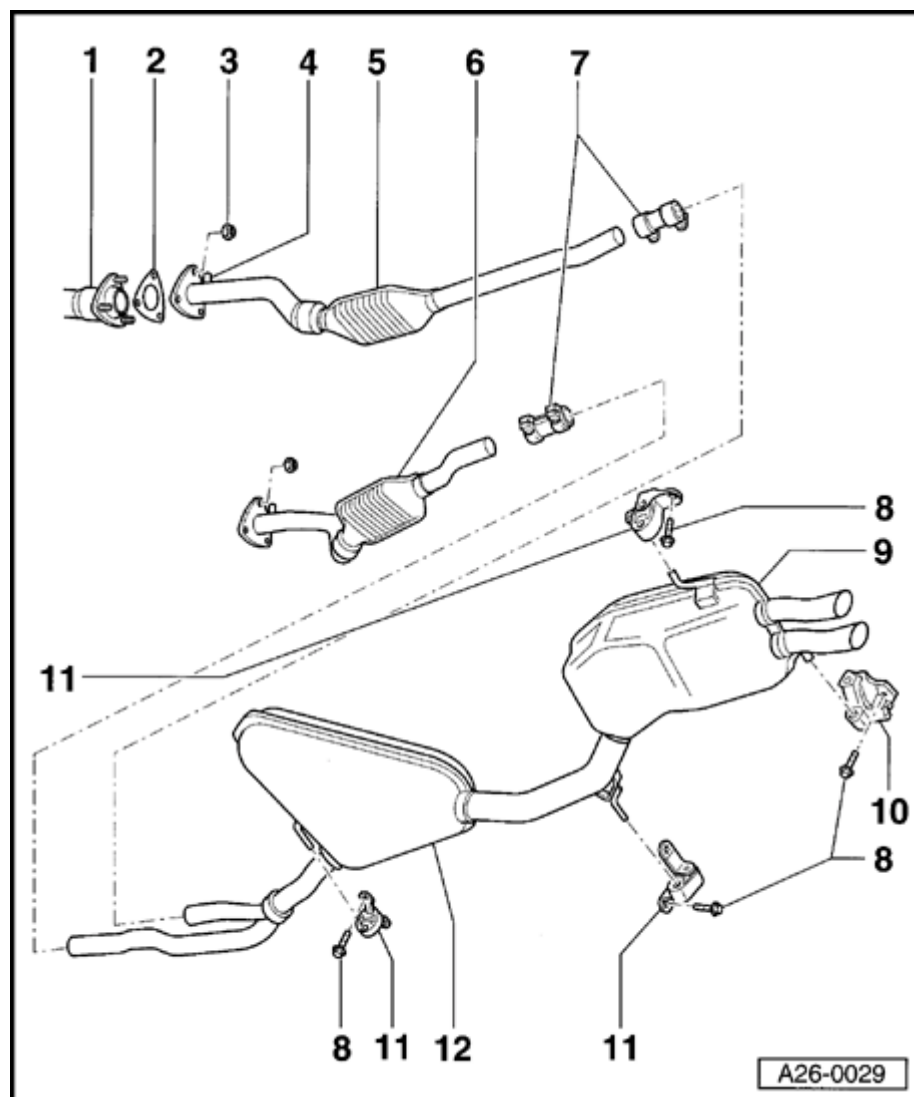
**18 - Heated Oxygen Sensor (HO2S)**

◆ 50 Nm (37 ft lb)

◆ Testing ⇒ Repair Manual, 2.8 Liter V6  
OBD II Fuel Injection & Ignition, Repair  
Group 24

◆ Lubricate threads with G5

◆ G5 must not get into slots on HO2S probe  
body



### All-wheel-drive, engine codes AFC

**1 - Exhaust manifold**

**2 - Gasket**

**3 - Hex nut**

◆ 30 Nm (22 ft lb)

**4 - Heated Oxygen Sensor (HO2S)**

◆ 50 Nm (37 ft lb)

◆ Testing ⇒ Repair Manual, 2.8 Liter V6  
OBD II Fuel Injection & Ignition, Repair  
Group 24

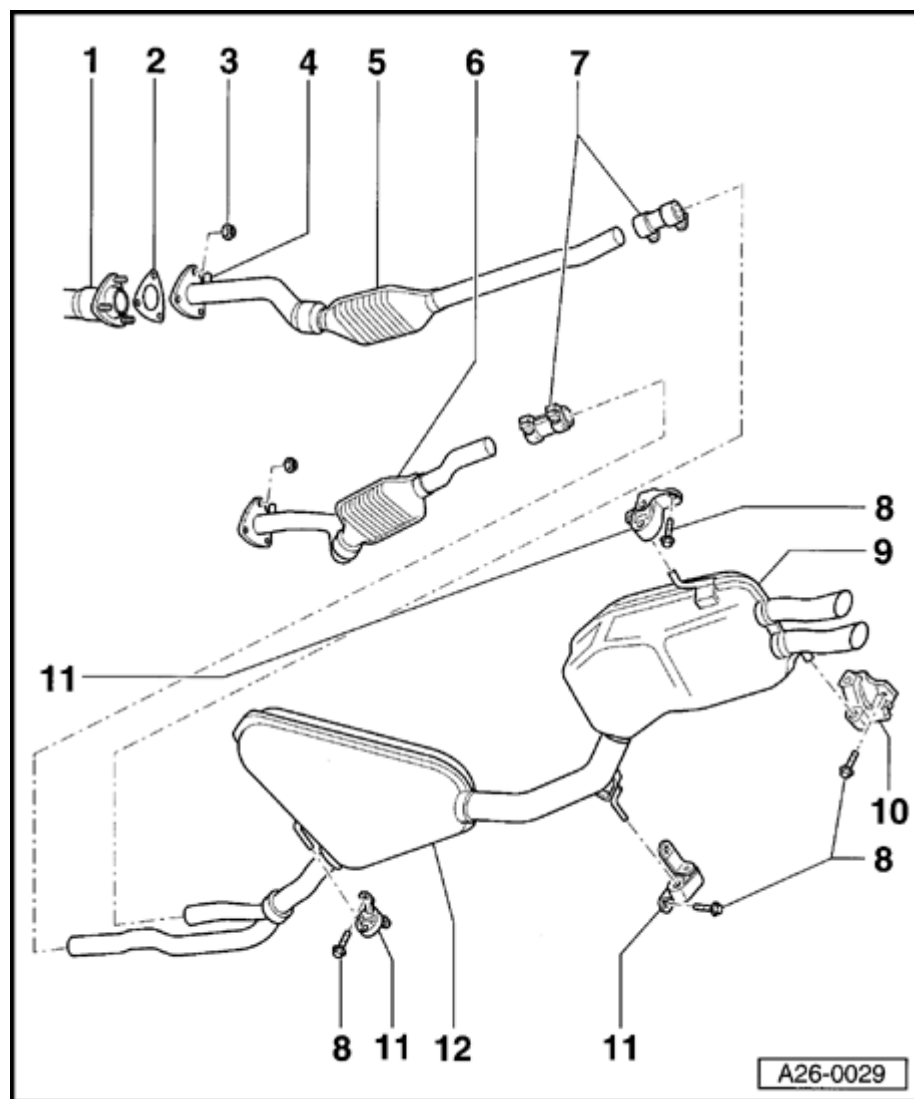
◆ Lubricate threads with G5

◆ G5 must not get into slots on HO2S probe  
body

**5 - Three Way Catalytic Converter (TWC) with  
insulating element, left**

### Note:

*Handle the insulating elements with care; protect  
from shock-like stresses and extreme bending.  
Maximum deflection 10°.*



**6 - Three Way Catalytic Converter (TWC) with insulating element, right**

**7 - Clip**

◆ 40 Nm (30 ft lb)

**8 - Hex bolt**

◆ 25 Nm (18 ft lb)

**9 - Rear muffler**

**10 - Retaining ring**

◆ When replacing always use a lubricant and avoid damaging the rubber.

**11 - Retaining ring**

◆ When replacing always use a lubricant and avoid damaging the rubber.

**12 - Center muffler**

26-7

## Exhaust system, checking for leaks

The exhaust system must be checked for leaks as follows:

- Run engine.
- Seal tail pipes being checked with, for instance, rag or plug.
- Joints: cylinder head/manifold, manifold/front exhaust pipe, etc., check for audible leaks.
- Eliminate any leaks found.