

**Repair Manual**  
**Golf, GTI, Jetta, Cabrio 1993 ►**

Engine codes: AAZ, 1Z, AHU

**1.9 Liter Turbo-Diesel**  
**General, Engine**

Edition 05.97

W42 011 294 103B

**1.9 Liter Turbo-Diesel General, Engine**

When filing a new Technical Bulletin enter the Bulletin No. in the adjacent column. When using the Repair Manual you can then see at a glance whether Bulletins have been published for that particular Repair Group. In addition, safety precautions must be observed when working on motor vehicles

Repair Group	Technical Bulletins					
<b>00</b> General, Technical data						
<b>10</b> Engine—Assembly						
<b>13</b> Engine—Crankshaft, Cylinder block						
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# Volkswagen

## Repair Manual

### Golf, GTI, Jetta, Cabrio

#### 1993 ►

This repair manual contains information published for use in the repair and servicing of the 1993 and later Volkswagen Golf, GTI, Jetta and Cabrio models imported into the USA and Canada.

**CAUTION!**

Before attempting any work on a Volkswagen sold in the USA or Canada, first determine whether the service or repair procedure you wish to use is applicable to USA or Canada models. The use of procedures and specifications that are not intended for use in connection with USA or Canada Volkswagen models may endanger the safety of persons servicing the vehicle or be detrimental to the safe operation of the vehicle.

Part numbers mentioned in these procedures are for reference only. Always check with your authorized Volkswagen dealer to verify part numbers.

**Note:**

This booklet supersedes the Golf, GTI, Jetta, Cabrio Repair Manual booklet *1.9 Liter Turbo-Diesel General, Engine*, 07.96 edition (W42 011 294 103A).

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## Introduction

This Repair Manual booklet covers 1.9 liter Turbo-Diesel general information, Repair Group 00, and engine mechanical components and systems, Repair Groups 10, 13, 15, 17, 19, 20, 21 and 26. This revised edition supersedes the Golf, GTI, Jetta, Cabrio Repair Manual booklet *General, Engine*, 07.96 edition (W42 011 294 103A).

The 1.9 liter Turbo-diesel Direct Injection (TDI) Diesel engine (engine code AHU) was first introduced in A3 vehicles in the USA and Canada during m.y. 1997.

### ***Important!***

The contents of this manual have been and will continue to be updated by Technical Bulletins. This manual has been updated to include information from Technical Bulletins available at the time of printing that specifically cover changes or additions to repair procedures and specifications, but Technical Bulletins covering other important information, and those that have been created since the printing of this manual, are not included. Before using this manual, be sure to look up the latest Technical Bulletins.

# Please read these **WARNINGS** and **CAUTIONS** before proceeding with maintenance and repair work.

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, we suggest you leave such repairs to an authorized Volkswagen retailer or other qualified shop. We especially urge you to consult an authorized Volkswagen retailer before beginning repairs on any vehicle that may still be covered wholly or in part by any of the extensive warranties issued by Volkswagen.
- Volkswagen is constantly improving its vehicles and sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, part numbers listed in this manual are for reference only. Always check with your authorized Volkswagen retailer parts department for the latest information.
- Never work under a lifted vehicle unless it is solidly supported on stands designed for the purpose. Do not support a vehicle on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a vehicle that is supported solely by a jack. Never work under the vehicle while the engine is running.
- If you are going to work under a vehicle on the ground, make sure that the ground is level. Block the wheels to keep the vehicle from rolling. Disconnect the battery negative terminal (ground strap) to prevent others from starting the vehicle while you are under it.
- Never run the engine unless the work area is well ventilated. Carbon monoxide (CO) kills.
- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.
- Illuminate the work area adequately but safely. Use a portable safety light for working inside or under the vehicle. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.
- Finger rings should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.
- Disconnect the battery negative terminal (ground strap) whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.
- Any time the battery has been disconnected on an automatic transmission vehicle, it will be necessary to reestablish Transmission Control Module (TCM) basic settings using the VAG 1551 Scan Tool (ST).
- For vehicles equipped with an anti-theft radio, be sure of the correct radio activation code before disconnecting the battery or removing the radio. If the wrong code is entered when power is restored, the radio may lock up and become inoperable, even if the correct code is used in a later attempt.
- Do not attempt to work on your vehicle if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medicine or any other substance that may impair you or keep you from being fully alert.
- Always observe good workshop practices. Wear goggles when you operate machine tools or work with battery acid. Wear goggles, gloves and other protective clothing whenever the job requires working with harmful substances.
- Do not re-use any fasteners that are worn or deformed in normal use. Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.
- Friction materials such as brake pads and clutch discs may contain asbestos fibers. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing asbestos fibers and asbestos dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

# Please read these **WARNINGS** and **CAUTIONS** before proceeding with maintenance and repair work.

- Catch draining fuel, oil or brake fluid in suitable containers. Do not use empty food or beverage containers that might *mislead someone* into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.
- Keep sparks, lighted matches, and open flame away from the top of the battery. If escaping hydrogen gas is ignited, it will ignite gas trapped in the cells and cause the battery to explode.
- The air-conditioning (A/C) system is filled with a chemical refrigerant that is hazardous. The A/C system should be serviced only by trained automotive service technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.
- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.
- Some of the vehicles covered by this manual are equipped with a supplemental restraint system (SRS), that automatically deploys an airbag in the event of a frontal impact. The airbag is operated by an explosive device. Handled improperly or without adequate safeguards, it can be accidentally activated and cause serious personal injury. To guard against personal injury or airbag system failure, only trained Volkswagen Service technicians should test, disassemble or service the airbag system.
- Never use a test light to conduct electrical tests of the airbag system. The system must only be tested by trained Volkswagen Service technicians using the VAG 1551 Scan Tool (ST) or an approved equivalent. The airbag unit must never be electrically tested while it is not installed in the vehicle.
- When driving or riding in an airbag-equipped vehicle, never hold test equipment in your hands or lap while the vehicle is in motion. Objects between you and the airbag can increase the risk of injury in an accident.
- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly, do not attempt shortcuts. Use tools that are appropriate to the work and use only replacement parts meeting Volkswagen specifications. Makeshift tools, parts and procedures will not make good repairs.
- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque listed.
- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond, or lake. Consult local ordinances that govern the disposal of wastes.
- Before doing any electrical welding on vehicles equipped with anti-lock brakes (ABS), disconnect the battery negative terminal (ground strap) and the ABS control module connector.
- When boost-charging the battery, first remove the fuses for the Engine Control Module (ECM), the Transmission Control Module (TCM), the ABS control module, and the trip computer. In cases where one or more of these components is not separately fused, disconnect the control module connector(s).
- Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.
- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.

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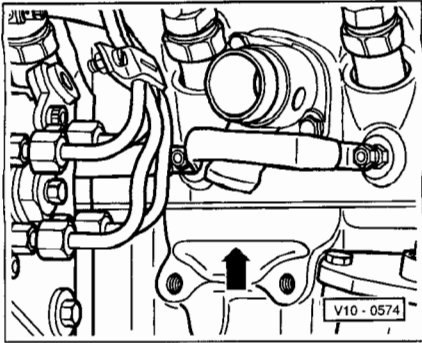
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## Technical data

### Engine number, location



◀ The engine numbers ("engine code" and "serial number") are located on the front of the cylinder block between the Diesel injection pump and the exhaust (arrow).

There is also a sticker on the toothed belt guard showing the "engine code" and "serial number".

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

00-1

## Engine data

Engine code		AAZ	1Z	AHU
Start of production		10.91 ▶	08.96 ▶	—
Displacement	liters	1.9	1.9	1.9
Output	kW @ RPM	55 @ 4200	66 @ 4000	66 @ 4000
	SAE bhp @ RPM	75 @ 4200	90 @ 4000	90 @ 4000
Torque	Nm @ RPM	150 @ 2400–3400	202 @ 1900	202 @ 1900
	Ft lb @ RPM	111 @ 2400–3400	149 @ 1900	149 @ 1900
Bore diameter	mm (in.)	79.5 (3.13)	79.5 (3.13)	79.5 (3.13)
Stroke	mm (in.)	95.5 (3.76)	95.5 (3.76)	95.5 (3.76)
Compression ratio		22.5 : 1	19.5 : 1	19.5 : 1
CN	minimum	45	45	45
Firing order		1–3–4–2	1–3–4–2	1–3–4–2
Turbocharger		YES	YES	YES
Oxidation Catalytic Converter		YES	YES	YES
Exhaust Gas Recirculation		YES	YES	YES
Charge Air Cooler		NO	YES	YES

00-2

## Engine, removing and installing

### **WARNING!**

- ◆ *Do not re-use any fasteners that are worn or deformed in normal use.*
- ◆ *Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.*

### **CAUTION!**

*Before disconnecting the battery, determine the correct coding for the anti-theft radio.*

### **Special tools, testers and auxiliary items**

- ◆ VAG1921 spring clip pliers
- ◆ 2024A engine sling
- ◆ G 000 100 grease (vehicles with manual transmission)
- ◆ VAG1331 torque wrench, 5 to 50 Nm range
- ◆ VAG1332 torque wrench, 40 to 200 Nm range
- ◆ Cable ties

10-1

### **Removing**

- Switch ignition off.
- Disconnect battery Ground (GND) strap.

### **Notes:**

- ◆ *Remove engine and transmission (as an assembly) in a forward direction.*
- ◆ *When re-installing the engine, replace or re-install all cable ties (in original position) which were loosened or cut during engine removal.*
- Remove air cleaner housing complete with intake hoses.
- Loosen power steering reservoir hose clamp.
- Disconnect power steering hydraulic lines from engine carrier and transmission.
- Disconnect power steering pump with bracket and move to one side.
- ⇒ Repair Manual, *Suspension, Wheel, Brakes, Steering*, Repair Group 48

### **CAUTION!**

**DO NOT disconnect power steering hoses ⇒ also Repair Manual, "Suspension, Wheels, Brakes, Steering", Repair Group 48.**

- Drain engine coolant ⇒ page 19-10.

10-2

### Engine code AAZ

- Disconnect accelerator pedal cable at injection pump lever, remove mounting clip on support bracket and release cable.
- Disconnect cold start accelerator cable.

### Engine codes 1Z, AHU

- Remove connecting line between charge air cooler and intake manifold pressure line.

### All engines

- Disconnect fuel supply and return lines from fuel pump.
- Disconnect all wiring harness connectors and other electrical connections from engine as required.
- Remove lock carrier with attachments.  
⇒ Repair Manual, *Body—Interior, Body—Exterior*, Repair Group 50
- Remove coolant fan and shroud.

10-3

### Vehicles with A/C

#### **CAUTION!**

- ◆ **Disconnect A/C refrigerant line brackets and support points only.**
- ◆ **DO NOT open the air conditioning refrigerant circuit.**
- ◆ **Avoid damage from bending. Refrigerant lines kink easily.**

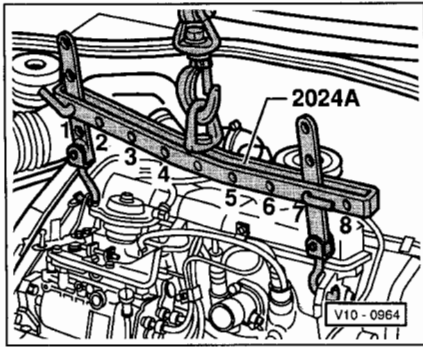
- Observe additional information and removal instructions ⇒ page 10-19.

### Vehicles with manual transmission

Depending on engine type:

- Disconnect clutch cable (engine code AAZ).
- Remove hydraulic clutch slave cylinder (engine codes 1Z, AHU).  
⇒ Repair Manual, *Manual Transmission 02A*, Repair Group 30

10-4



#### All vehicles

- Disconnect shift linkage from transmission.
- Disconnect drive axles from transmission drive flanges.
- Disconnect exhaust from turbocharger.
- ◀ - Attach engine sling 2024A as follows and lift slightly using workshop crane (remove slack).
  - ◆ Pulley end: 2nd hole in hook at position 1
  - ◆ Flywheel end: 2nd hole in hook at position 7

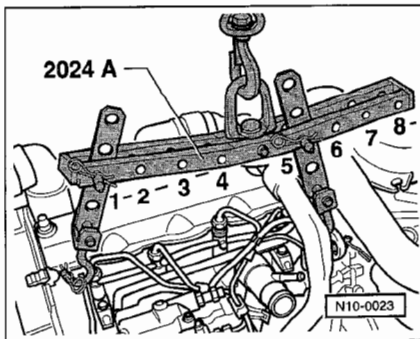
#### **CAUTION!**

**Secure all 2024A engine sling hooks and locating pins using lock pins.**

#### **Notes:**

- ◆ The end of the cross bar marked with installation positions 1-4 points toward drive belt.
- ◆ Holes in the hooks are counted from the hook end.

10-5



#### Vehicles with automatic transmission

- ◀ - Attach engine sling 2024A as follows and lift slightly using workshop crane (remove slack).
  - ◆ Pulley end: 2nd hole in hook at position 1
  - ◆ Flywheel end: 2nd hole in hook at position 5

#### **CAUTION!**

**Secure all 2024A engine sling hooks and locating pins using lock pins.**

#### **Notes:**

- ◆ The end of the cross bar marked with installation positions 1-4 points toward drive belt.
- ◆ Holes in the hooks are counted from the hook end.

10-6

### All vehicles

- Remove front engine mount as an assembly.
- Lift engine/transmission assembly out toward front.

#### **CAUTION!**

**When lifting engine/transmission assembly, carefully guide the assembly out to avoid damage to body.**

#### **Note:**

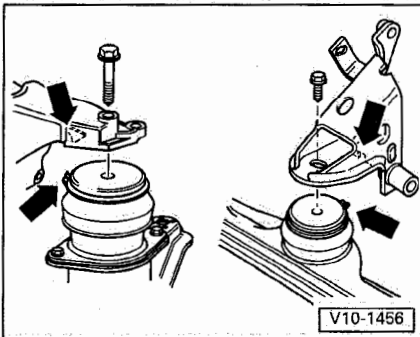
When working on the engine, secure the block to an engine stand using the VW540 holding fixture.

#### **Installing**

Engine installation is the reverse of removal. When installing, note the following:

- Check clutch release bearing for wear, replace if necessary.
- Lightly grease clutch release bearing, release bearing guide sleeve and splines on input shaft using G 000 100 grease.
- Make sure alignment dowels for centering engine to transmission are installed in cylinder block; install if necessary.
- When lowering engine/transmission assembly, make sure that there is sufficient clearance between engine/transmission and drive shafts.

10-7



#### **Engine code AAZ**

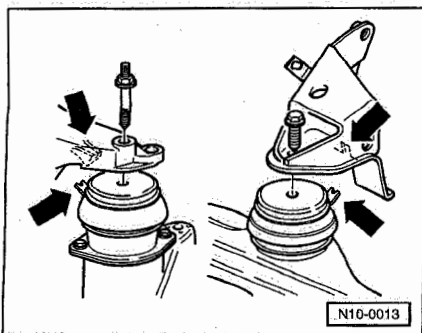
- First tighten right rear engine mount, then left rear engine mount.
- ▲ When installing the engine mounts, the recesses on the right rear engine mount bracket and front engine mount must engage in the guide pins of the bonded rubber mounts (arrows).
- Loosen front engine mount on carrier, align stress-free by rocking engine/transmission assembly and then re-tighten.

#### **CAUTION!**

- ◆ Do not interchange the hollow banjo bolts for the fuel supply and return line fittings.
- ◆ The return line has a smaller diameter bore and has an "OUT" marking on the bolt head.

#### **Engine codes 1Z, AHU**

- ▲ - When installing engine mounts, make sure that recesses on front and rear engine mount brackets locate on engine mount lugs (arrows).
- Align engine mounts so that they are free of stress by rocking power train.
- Install hydraulic clutch slave cylinder.
- ⇒ Repair Manual, *Manual Transmission 02A*, Repair Group 30



10-8

### **All engines**

- Install shift linkage to transmission.
- Install power steering pump.  
⇒ Repair Manual, *Suspension, Wheel, Brakes, Steering*, Repair Group 48
- Install lock carrier with attachments.  
⇒ Repair Manual, *Body—Interior, Body—Exterior*, Repair Group 50
- Install A/C compressor.  
⇒ Repair Manual, *Heating & Air Conditioning*, Repair Group 87

10-9

### **Engines with ribbed belt without tensioner**

- Install ribbed belt ⇒ page 13-13.
- Fill cooling system with coolant ⇒ page 19-10.
- Connect harness connectors.
- Check headlight alignment and adjust as necessary.  
⇒ Repair Manual, *Maintenance*
- Adjust shift linkage (if necessary) ⇒ Repair Manual.  
⇒ Repair Manual, *Manual Transmission*, Repair Group 34

### **Engine code AAZ**

- Adjust Cold Start Accelerator (CSA) cable ⇒ page 20-12.
- Adjust accelerator cable ⇒ page 20-9.

10-10

## Tightening torques

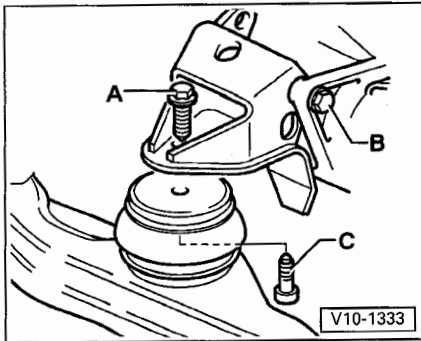
Mounting point		Tightening torque
Engine to transmission	M10	60 Nm (44 ft lb)
	M12	80 Nm (59 ft lb)
Drive shafts to drive flanges		45 Nm (33 ft lb)
Front exhaust pipe to manifold		25 Nm (18 ft lb)
Engine carrier mount to body		80 Nm (59 ft lb)

10-11

## Engine and transmission mounts, tightening torques

### Engine code AAZ

(Bolts lubricated)

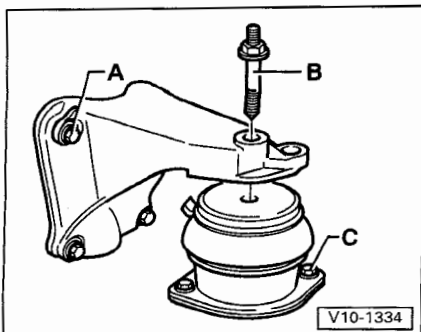


#### ◀ Front engine/transmission mount

A - 50 Nm (37 ft lb)

B - 55 Nm (41 ft lb)

C - 50 Nm (37 ft lb)



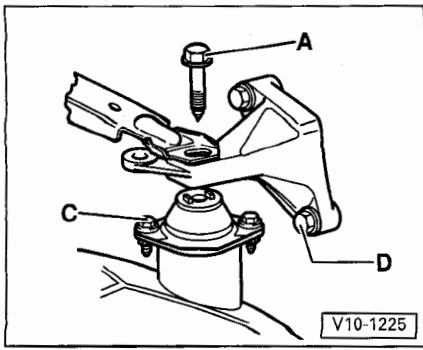
#### ◀ Right rear engine mount

A - 25 Nm (18 ft lb)

B - 50 Nm (37 ft lb)

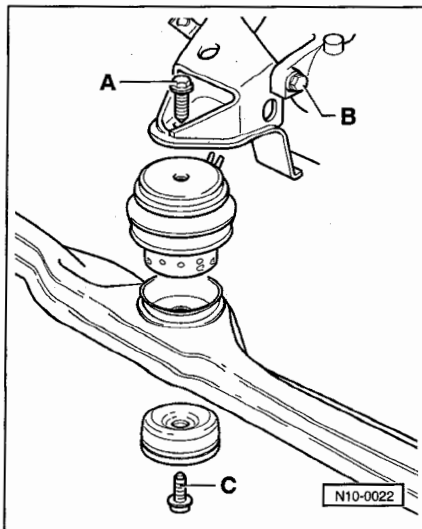
C - 25 Nm (18 ft lb)

10-12



- ◀ Left rear engine/transmission mount
- A - 50 Nm (37 ft lb)
- C - 25 Nm (18 ft lb)
- D - 25 Nm (18 ft lb)

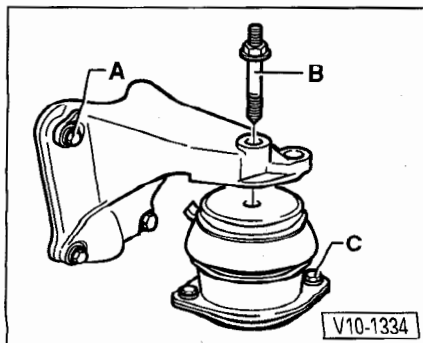
10-13



**Engine codes 1Z, AHU**

(Bolts lubricated)

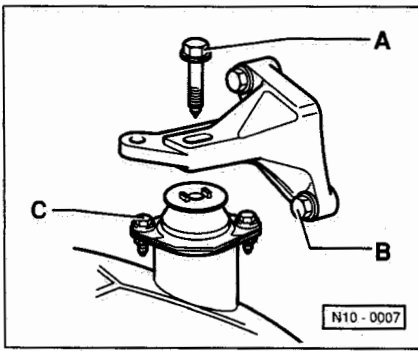
- ◀ Front engine mount
- A - 60 Nm (44 ft lb)
- B - 60 Nm (44 ft lb)
- C - 55 Nm (41 ft lb)



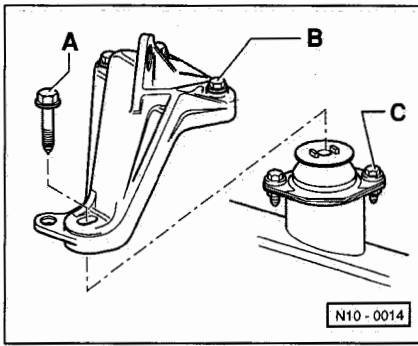
- ◀ Right rear engine mount
- A - 60 Nm (44 ft lb)
- B - 60 Nm (44 ft lb)
- C - 25 Nm (18 ft lb)

10-14





- ◀ Left rear engine mount—Manual transmission
  - A - 60 Nm (44 ft lb)
  - B - 30 Nm (22 ft lb)
  - C - 25 Nm (18 ft lb)



- ◀ Left rear engine mount—Automatic transmission
  - A - 60 Nm (44 ft lb)
  - B - 30 Nm (22 ft lb)
  - C - 25 Nm (18 ft lb)

10-15

### Engine and transmission, aligning

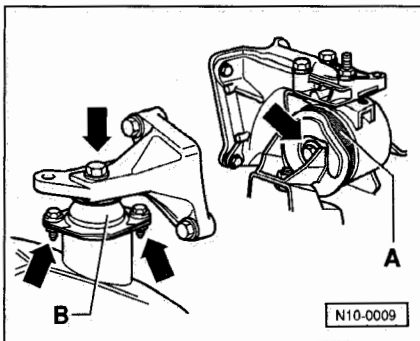
Alignment is only necessary when the engine and transmission have been removed, and in addition sub-frame and engine mounts have been loosened.

#### Special tools, testers and auxiliary items

- ◆ VAG1331 torque wrench, 5 to 50 Nm range
- ◆ VAG1332 torque wrench, 40 to 200 Nm range

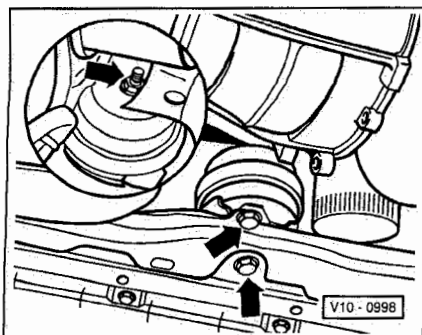
#### Engine code AAZ

- ◀ - Loosen engine mount center bolt -A-
- Loosen transmission mount -B- (on transmission and sub-frame).

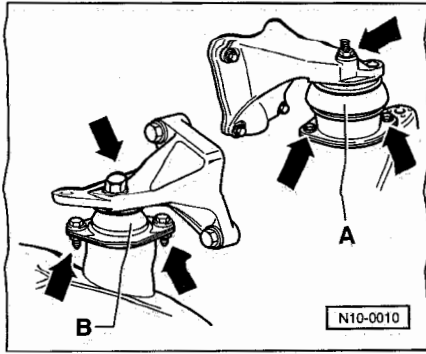


- ◀ - Loosen front engine mount on engine carrier and bracket.
- Align assembly free of stress by rocking power train.
- Tighten bolts again in same sequence.

Tightening torques ⇒ page 10-12

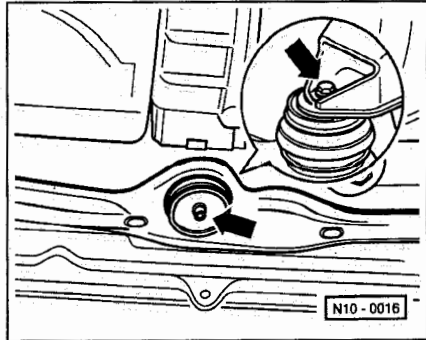


10-16



**Engine codes 1Z, AHU**

- ◀ - Loosen engine mount -A- (engine carrier mount) on sub-frame and bracket.
- Loosen transmission mount -B- on transmission and sub-frame.



- ◀ - Loosen front engine mount (on engine carrier and bracket).
  - Align assembly free of stress by rocking power train.
  - Tighten bolts again in same sequence.
- Tightening torques ⇒ page 10-12

10-17

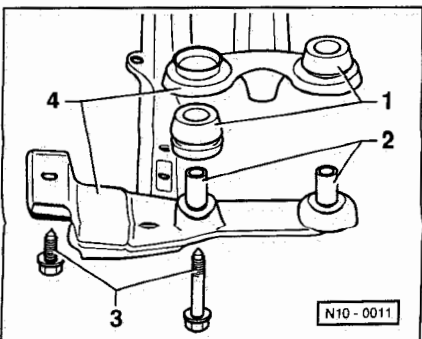
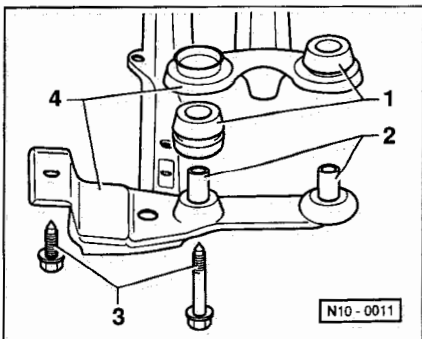
**Engine carrier rubber mounts, replacing**

**Special tools, testers and auxiliary items**

- ◆ 10-222A engine support bridge
- ◆ 10-222A/1 bracket for engine

**Work sequence**

- Assemble 10-222A engine support bridge using bracket 10-222A/1.
- Connect support bridge to lifting eye on left side of cylinder head and remove slack in lifting apparatus.
- Remove engine carrier.
- ◀ - Pry spacer bracket -2- out from engine mount.
- Press out rubber bushing from mount -1-.
- ◀ Note installed position of rubber bushing in mount -1-.
- Install new rubber bushing.
- Press engine spacer bracket into rubber bushing.
- Install engine mount -4- and tighten mounting bolts -3-.
- Tightening torque: 80 Nm (59 ft lb)



10-18

## Vehicles with A/C, additional information and removal instructions

### **CAUTION!**

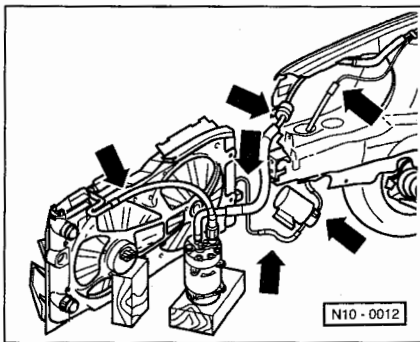
- ◆ **Disconnect A/C refrigerant line brackets and support points only.**
- ◆ **DO NOT open the air conditioning refrigerant circuit.**
- ◆ **Avoid damage from bending. Refrigerant lines kink easily.**

### **Note:**

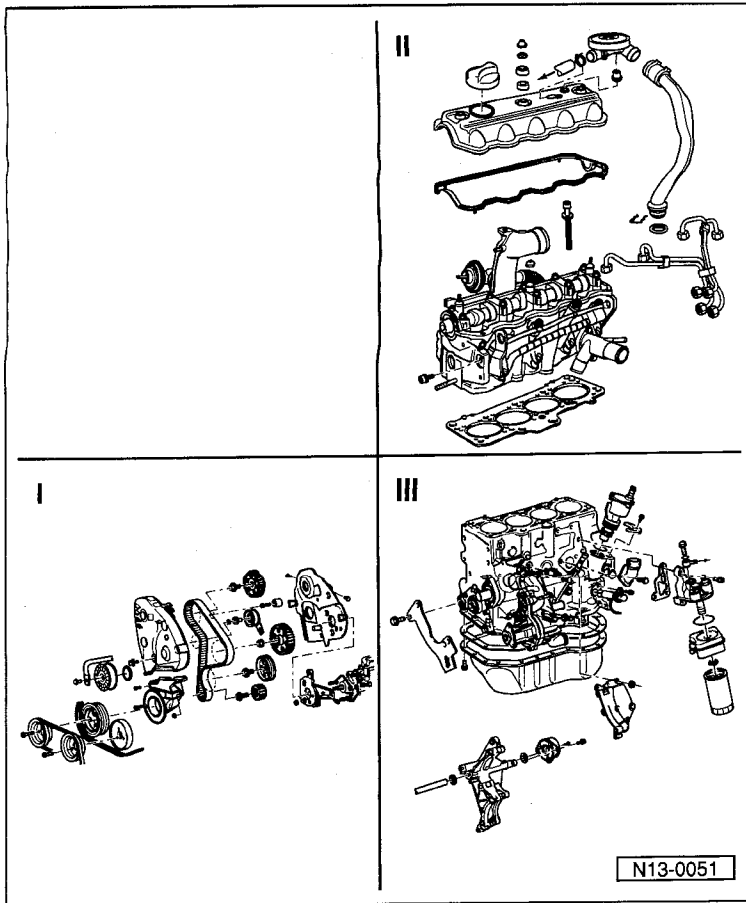
To prevent condenser and refrigerant line damage, make sure that the A/C lines and hoses are not stretched, kinked or bent.

To remove and install the engine without opening the refrigerant circuit:

- Unbolt A/C fluid reservoir and allow to hang free.
- Remove retaining clamp(s) from refrigerant lines.
- Remove ribbed belt ⇒ page 13-13.
- Remove hood lock carrier assembly ⇒ Repair Manual, *Body—Interior, Body—Exterior*, Repair Group 50.
- Remove A/C compressor bracket ⇒ Repair Manual, *Heating & Air Conditioning*, Repair Group 87.
- ◀ - Remove A/C compressor and lay to side with hood lock carrier in a way that refrigerant lines (arrows) are not stressed.



## Engine, disassembling and assembling



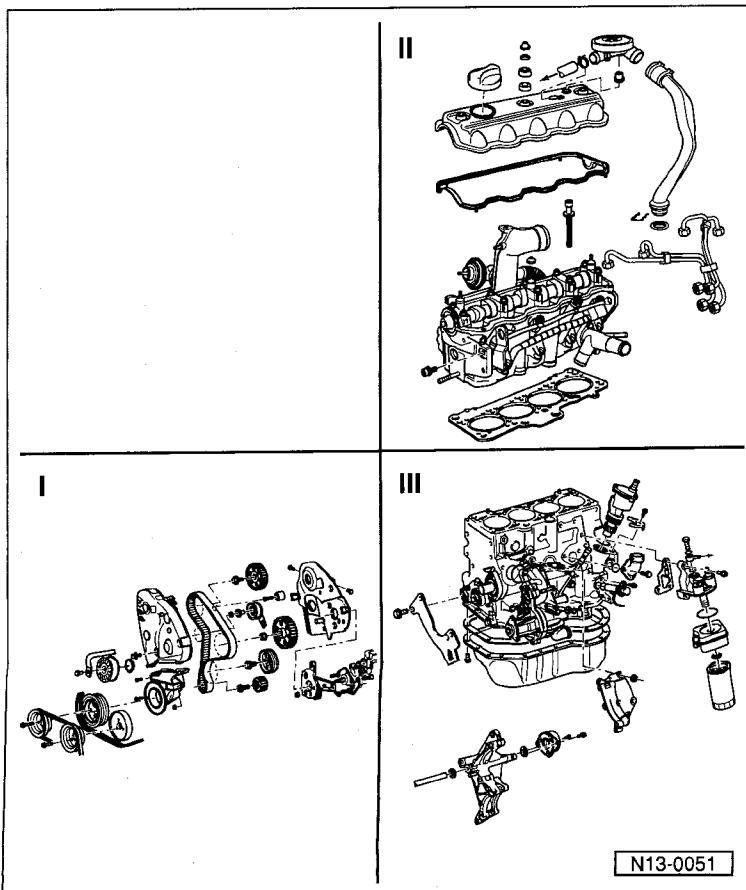
### WARNING!

- ◆ Do not re-use fasteners that are worn or deformed in normal use.
- ◆ Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.

### CAUTION!

- ◆ If metal shavings or quantities of small metal particles are found in the engine oil, from crankshaft and connecting rod bearing wear, thoroughly clean the oil passages to help prevent further damage.
- ◆ The oil cooler cannot be sufficiently cleaned, and must be replaced.

13-1



### Section I

⇒ Page 13-3

### Section II

⇒ Page 13-7

### Section III

⇒ Page 13-9

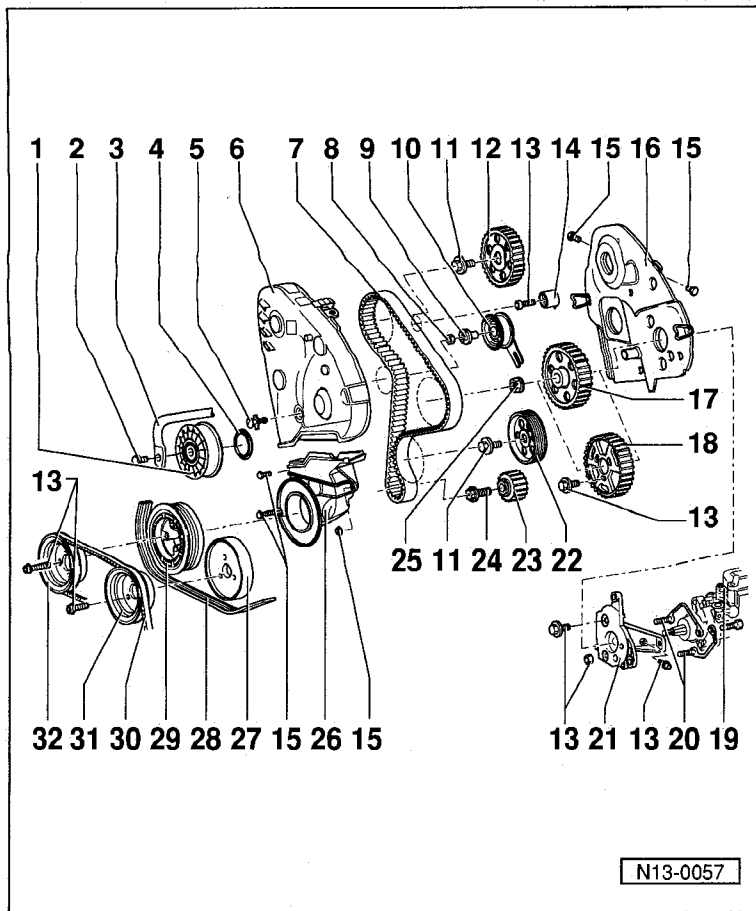
### Notes:

- ◆ Faulty fuel injectors can cause severe engine knock and resulting bearing damage.
- ◆ To check for faulty fuel injectors, run the engine at idle and loosen one injector line fitting at a time. If the knocking stops after loosening a line, the corresponding fuel injector to that line is malfunctioning.

### Servicing fuel injectors:

- ◆ Engine code AAZ ⇒ Repair Manual, 1.9 Liter Diesel Fuel Injection & Ignition, Repair Group 23.
- ◆ Engine codes 1Z, AHU ⇒ Repair Manual, 1.9 Liter TDI OB2 II, Direct Fuel Injection & Glow Plug System, Repair Group 23.

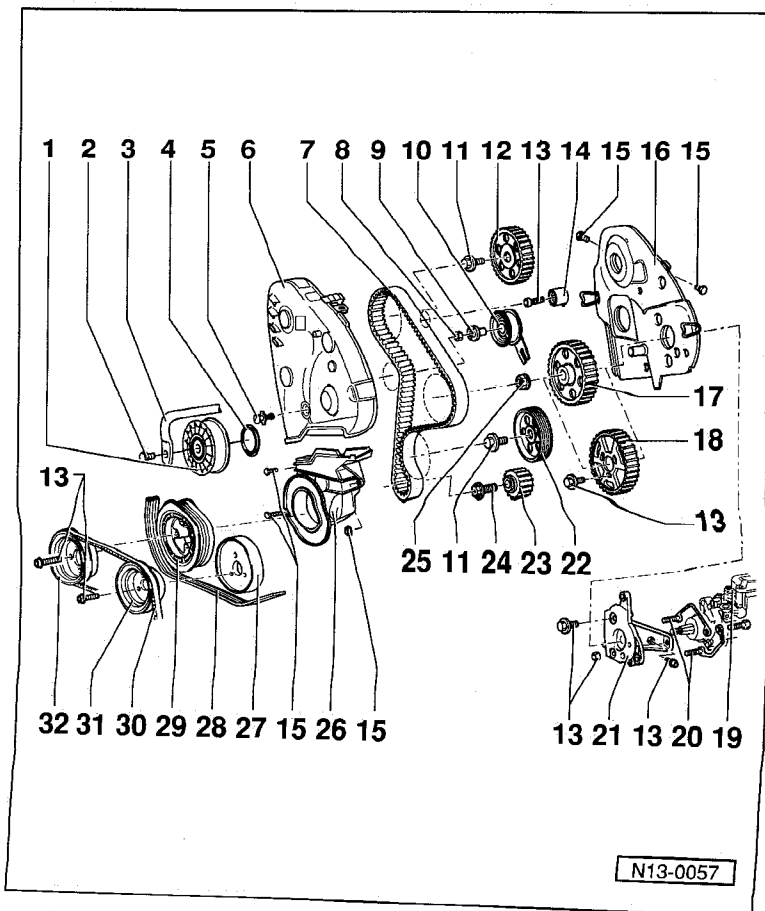
13-2



## Section I

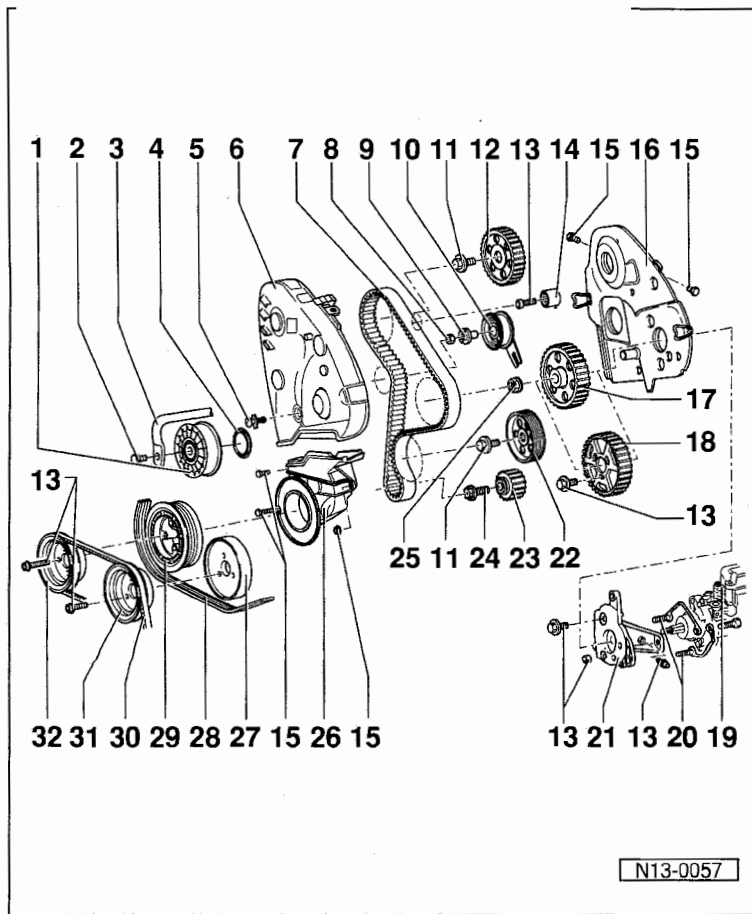
- 1 - Tensioning roller
- 2 - 20 Nm (15 ft lb)
- 3 - Tensioning lever
- 4 - Dust cap
- 5 - Expansion clip
- 6 - Toothed belt guard, upper
- 7 - Toothed belt
  - ◆ Mark running direction before removing
  - ◆ Inspect for wear
  - ◆ Do not bend or kink
  - ◆ Removing and installing ⇒ page 13-17
- 8 - Nut
  - Manual tensioning roller:
    - ◆ 45 Nm (33 ft lb)
  - Semi-automatic tensioning roller:
    - ◆ 20 Nm (15 ft lb)
    - ◆ First requires basic setting ⇒ page 13-24
- 9 - Cam
  - ◆ For tensioning roller -10-

13-3



- 10 - Tensioning roller
  - ◆ Semi-automatic tension roller (engine codes 1Z, AHU) shown
  - ◆ Tensioning requires basic setting ⇒ page 13-24
- 11 - 45 Nm (33 ft lb)
- 12 - Camshaft sprocket
  - ◆ Loosen from tapered end of camshaft by tapping with hammer on punch inserted through hole in rear drive belt guard
- 13 - 25 Nm (18 ft lb)
- 14 - Idler pulley
  - ◆ For engine codes 1Z, AHU
- 15 - 10 Nm (7 ft lb)
- 16 - Toothed belt guard, rear
- 17 - Injection pump sprocket
  - ◆ Removing ⇒ page 13-28
- 18 - Not applicable

13-4



### 19 - Injection pump

Removing and installing:

- ◆ Engine code AAZ ⇒ Repair Manual, 1.9 Liter Diesel Fuel Injection & Ignition, Repair Group 23
- ◆ Engine codes 1Z, AHU ⇒ Repair Manual, 1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System, Repair Group 23.

### 20 - Bracket

- ◆ Engine codes 1Z, AHU

### 21 - Console

### 22 - Intermediate shaft sprocket

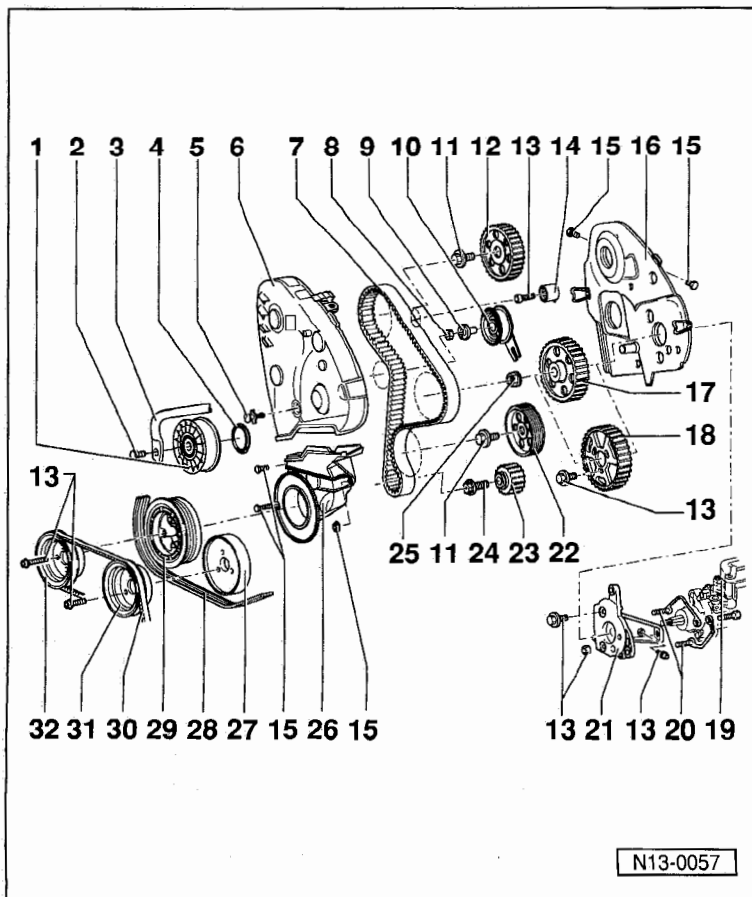
### 23 - Crankshaft sprocket

- ◆ For toothed belt

### 24 - 90 Nm (66 ft lb) + 1/4-turn (90°)

- ◆ Always replace
- ◆ Loosen and tighten using 3099 spur belt spreading tool
- ◆ Lubricate thread and collar
- ◆ Additional 1/4-turn can be performed in more than 1 increment, if necessary

13-5



### 25 - Nut

- Engine code AAZ
- ◆ 45 Nm (33 ft lb)
- Engine codes 1Z, AHU
- ◆ 55 Nm (41 ft lb)

### 26 - Toothed belt guard, lower

### 27 - Belt pulley

- ◆ For engine coolant pump
- ◆ Ribbed belt version

### 28 - Ribbed belt

- ◆ Mark running direction before removing
- ◆ Removing and installing ⇒ page 13-13

### 29 - Belt-pulley/vibration damper

- ◆ Can only be installed in one position

### 30 - V-belt

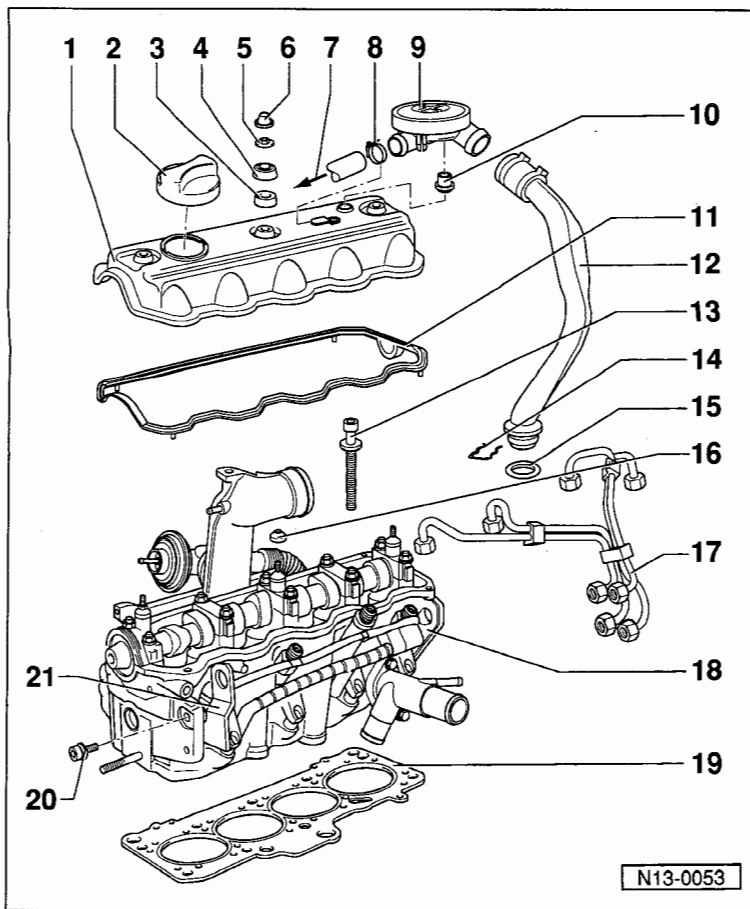
- ◆ Adjusting ⇒ Repair Manual, Suspension, Wheel, Brakes, Steering, Repair Group 48

### 31 - Pulley

- ◆ For engine coolant pump
- ◆ V-belt version shown

### 32 - Pulley

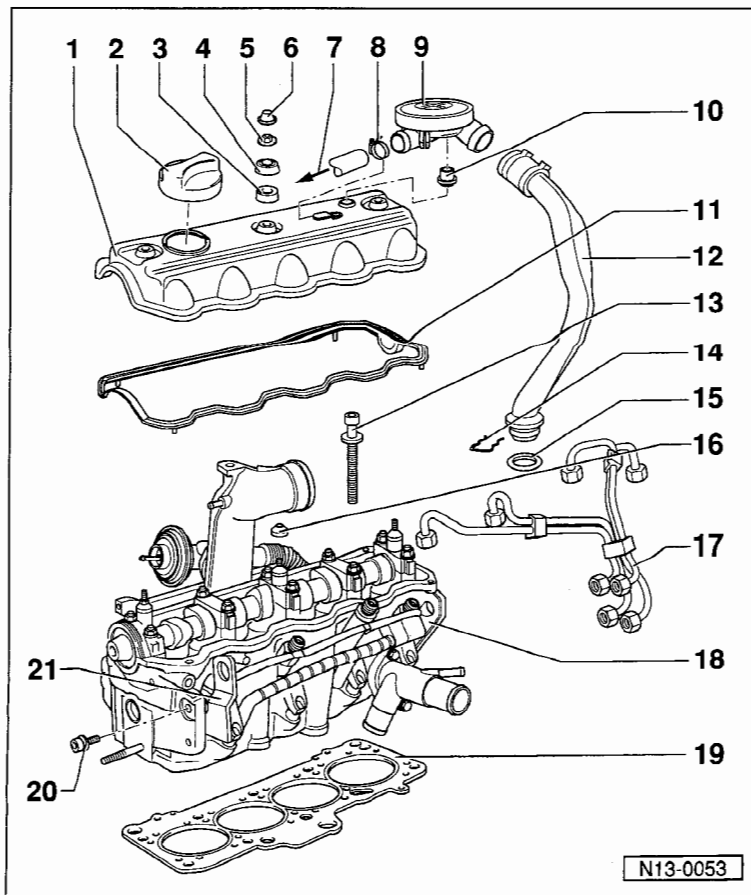
13-6



## Section II

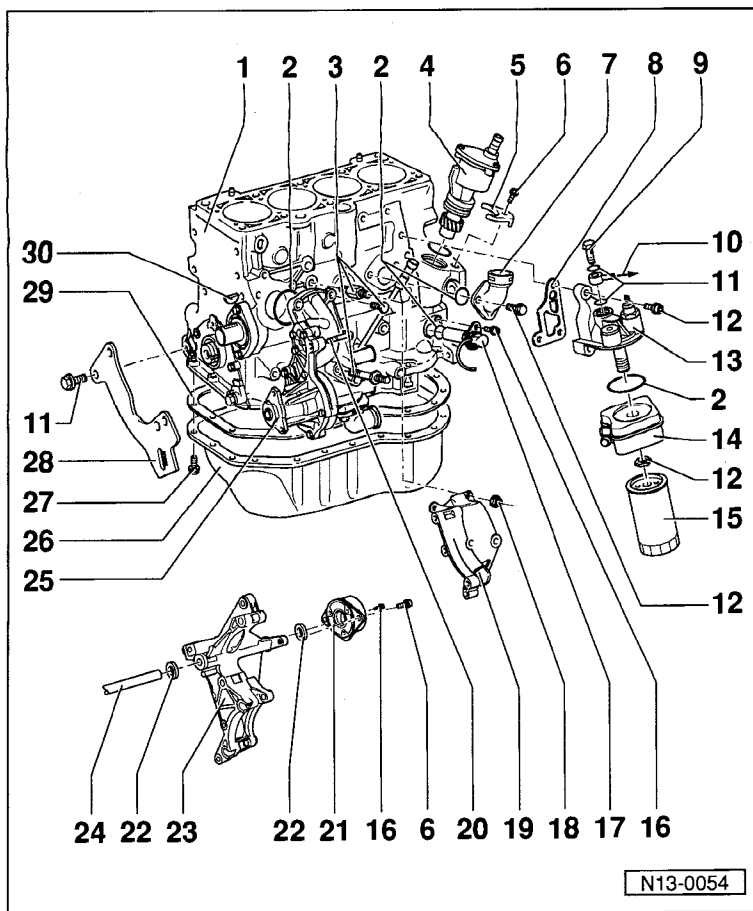
- 1 - Cylinder head cover
- 2 - Cap
  - ◆ Replace seal, if damaged
- 3 - Upper sealing washer
- 4 - Cup washer
- 5 - 10 Nm (7 ft lb)
- 6 - Cap
- 7 - To intake hose
- 8 - Retaining clip
- 9 - Positive Crankcase Ventilation (PCV) valve
  - ◆ For crankcase ventilation
- 10 - Gasket
  - ◆ Replace if damaged
- 11 - Cylinder head cover gasket
  - ◆ Replace if damaged
- 12 - Crankcase breather
- 13 - Cylinder head bolt
  - ◆ Note sequence when loosening and tightening ⇒ page 15-9

13-7



- 14 - Mounting clip
- 15 - O-ring
  - ◆ Always replace
- 16 - Cone seal, lower
- 17 - Fuel injector lines
  - ◆ Tighten to 25 Nm (18 ft lb)
  - ◆ Remove using 3035 injector line wrench
  - ◆ Always remove fuel line cluster as an assembly
  - ◆ Do not bend or alter shape
- 18 - Cylinder head
  - ◆ Removing and installing ⇒ page 15-3
  - ◆ If replaced, also completely replace engine coolant
- 19 - Cylinder head gasket
  - ◆ Always replace
  - ◆ Note marking ⇒ page 13-48
  - ◆ If replaced, also completely replace engine coolant
- 20 - 20 Nm (15 ft lb)
- 21 - Lifting eye

13-8



### Section III

#### 1 - Cylinder block

- ◆ Removing and installing sealing flange and flywheel/drive plate ⇒ page 13-29
- ◆ Removing and installing crankshaft ⇒ page 13-35
- ◆ Disassembling and assembling pistons and connecting rods ⇒ page 13-40

#### 2 - O-ring

- ◆ Replace if damaged

#### 3 - 20 Nm (15 ft lb) + 1/4-turn (90°)

- ◆ Always replace

#### 4 - Vacuum pump

#### 5 - Yoke clamp

#### 6 - 20 Nm (15 ft lb)

#### 7 - Flange connection

- ◆ For crankcase breather

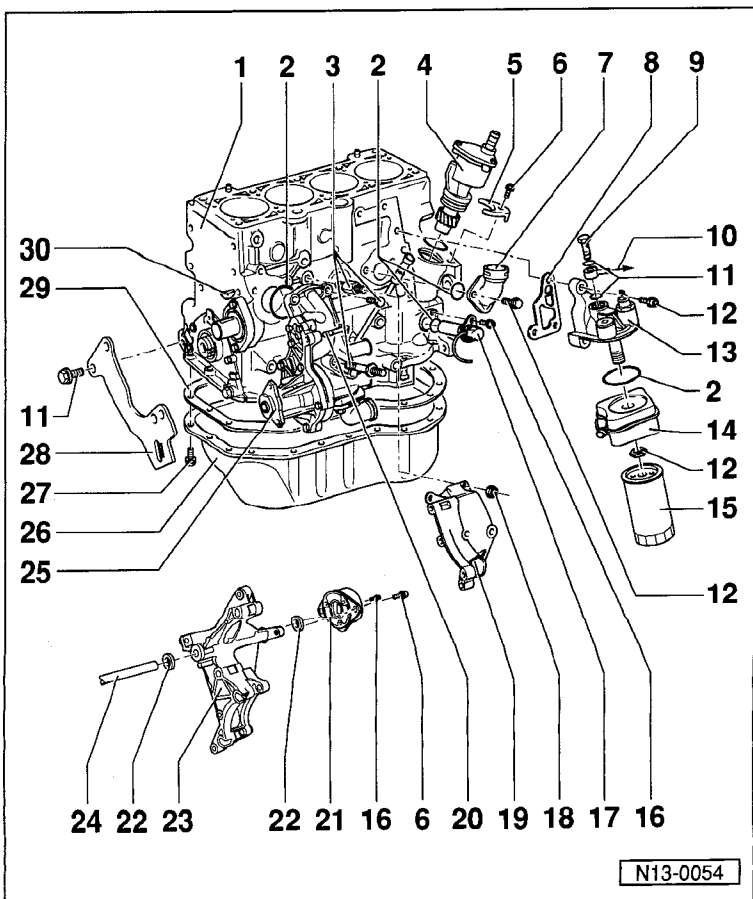
#### 8 - Gasket

- ◆ Always replace

#### 9 - Banjo bolt

- ◆ 25 Nm (18 ft lb)

13-9



#### 10 - To turbocharger

#### 11 - Sealing ring

- ◆ Always replace

#### 12 - 25 Nm (18 ft lb)

#### 13 - Oil filter bracket

#### 14 - Oil cooler

- ◆ Coat contact area to flange, outside seal, with AMV 188 100 02
- ◆ Check for adequate clearance to adjacent components
- ◆ See *CAUTION!* ⇒ page 13-1

#### 15 - Oil filter

- ◆ Use strap wrench to loosen
- ◆ Tighten by hand
- ◆ Note instructions on filter when installing

#### 16 - 10 Nm (7 ft lb)

#### 17 - Engine speed (RPM) sensor

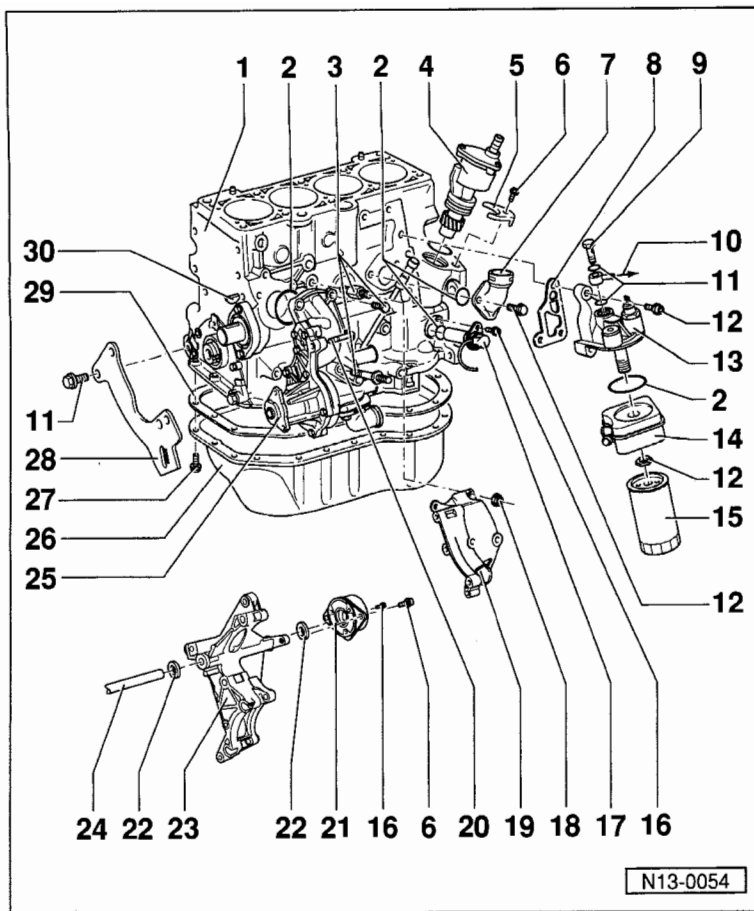
#### 18 - 30 Nm (22 ft lb)

#### 19 - Bracket

- ◆ For ribbed belt without tensioner

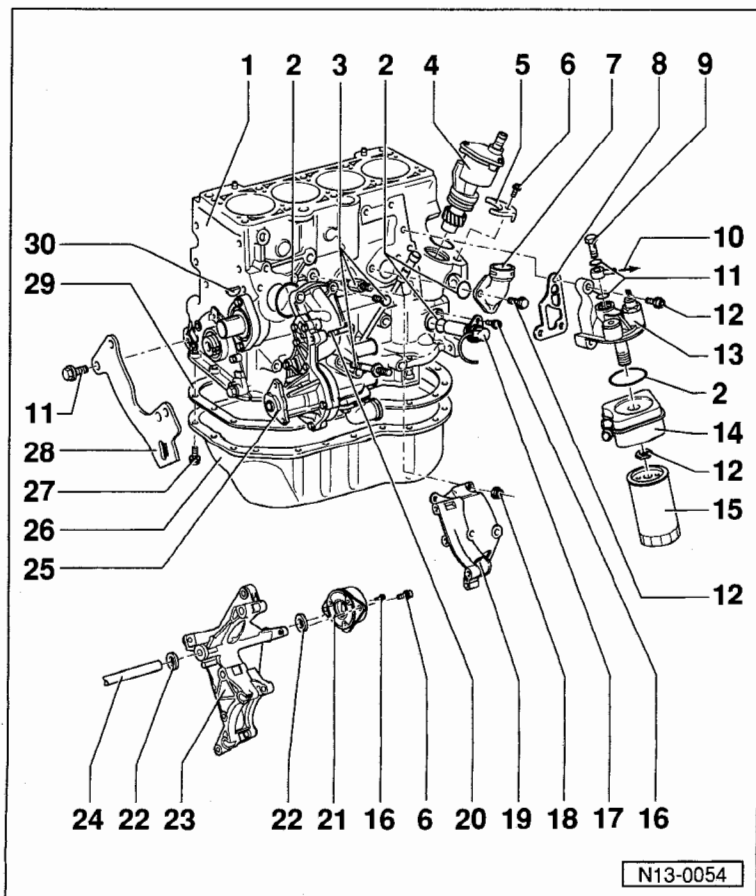
13-10





- 20 - Hammer-head bolt**
- 21 - Tensioning element**
- 22 - Sealing ring**
  - ◆ Replace if damaged
- 23 - Bracket**
  - ◆ For ribbed belt with tensioner
- 24 - Tensioning lever**
- 25 - Engine coolant pump**
  - ◆ Disassembling and assembling  
⇒ page 19-8
- 26 - Oil pan**
  - ◆ Clean sealing surface before installing
- 27 - 20 Nm (15 ft lb)**
  - ◆ Remove and install both rear bolts on transmission end using 3185 swivel wrench
- 28 - Bracket**
  - ◆ For power steering pump

13-11



- 29 - Oil pan gasket**
  - ◆ Always replace
  - ◆ Engine code AAZ with baffle plate: replace if seal is damaged
  - ◆ Before installing gasket, coat oil pan flange/cylinder block flange with "D2"
- 30 - Woodruff key**
  - ◆ Check for tight fit

13-12

## Ribbed belt, removing and installing

### Belt drive without tensioner

Belt drive with tensioner ⇒ page 13-15

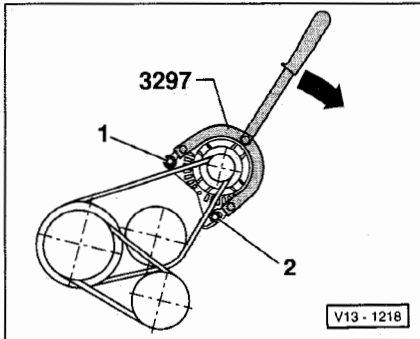
### Special tools, testers and auxiliary items

- ◆ 3297 lever

#### Note:

Before removing the ribbed belt, mark the running direction. When installing the belt, make sure it is correctly seated in the pulley.

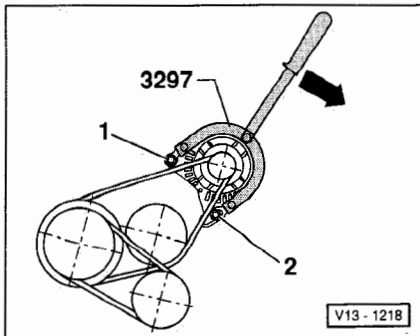
#### Removing



- ◀ - Loosen generator mounting bolts -1- and -2- at least one turn.
- Press down on generator using 3297 lever and remove ribbed belt from generator pulley.
- Remove power steering pump V-belt.  
⇒ Repair Manual, *Suspension, Wheel, Brakes, Steering*, Repair Group 48
- Remove ribbed belt.

13-13

#### Installing



- Place ribbed belt on crankshaft pulley/vibration damper and coolant pump pulley.
- Install power steering pump V-belt.  
⇒ Repair Manual, *Suspension, Wheel, Brakes, Steering*, Repair Group 48
- Push generator down onto stop at least 3 times using 3297 lever, to make sure that it moves freely.
- ◀ - Push down on generator using 3297 and install ribbed belt.

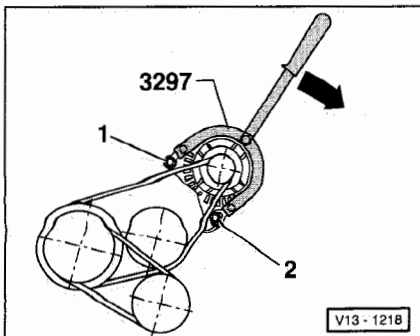
#### Note:

If the engine has not yet been installed, continue with this sequence AFTER the engine has been installed.

- Idle engine for at least 10 seconds with generator loose.

#### Note:

When tightening the generator bolts, observe tightening sequence, do not use generator for support and do not touch the ribbed belt.



- Tighten mounting bolt -2- to 25 Nm (18 ft lb).
- ◀ - Tighten mounting bolt -1- to 25 Nm (18 ft lb).

13-14

## Belt drive with tensioner

### Special tools, testers and auxiliary items

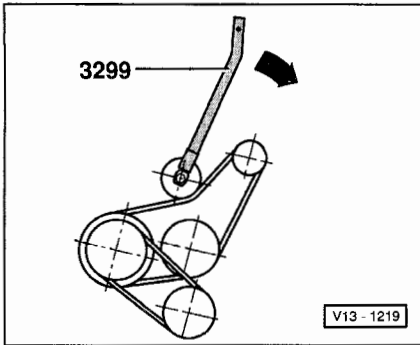
3299 ribbed belt install. tool.

### Removing

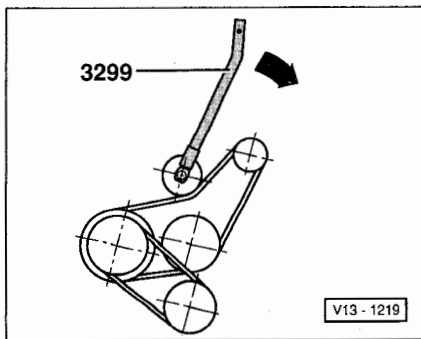
- ◀ - Lift tensioning roller using tool 3299 and remove ribbed belt from generator pulley.
- Remove power steering pump V-belt.  
⇒ Repair Manual, *Suspension, Wheel, Brakes, Steering*, Repair Group 48
- Remove ribbed belt.

### Installing

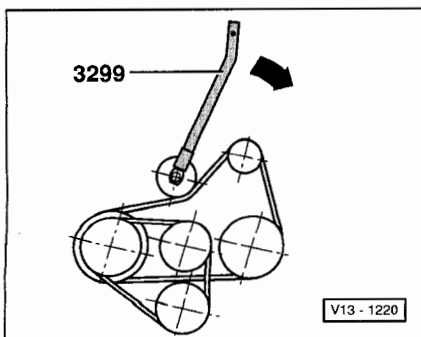
- Place ribbed belt on crankshaft pulley/vibration damper.
- Install power steering pump V-belt.  
⇒ Repair Manual, *Suspension, Wheel, Brakes, Steering*, Repair Group 48
- Lift tensioning roller using tool 3299 and install ribbed belt.



13-15



- ◀ **Without A/C compressor**



- ◀ **With A/C compressor**

13-16

## Toothed belt, removing and installing (engine code AAZ 09.94 ►)

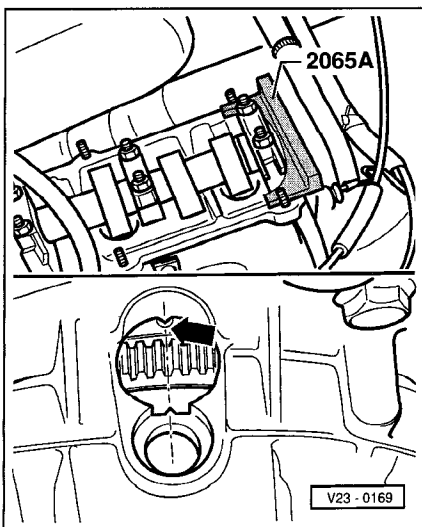
### Special tools, testers and auxiliary items

- ◆ 3297 lever (for ribbed belt without tensioning roller)
- ◆ 3299 ribbed belt install. tool (for ribbed belt with tensioning roller)
- ◆ 2065A setting bar
- ◆ 2064 lock pin
- ◆ Pin wrench (e.g. Matra V159)
- ◆ VAG1331 torque wrench, 5 to 50 Nm range
- ◆ VW210 gauge belt tensioner (for engines without semi-automatic tensioning roller)

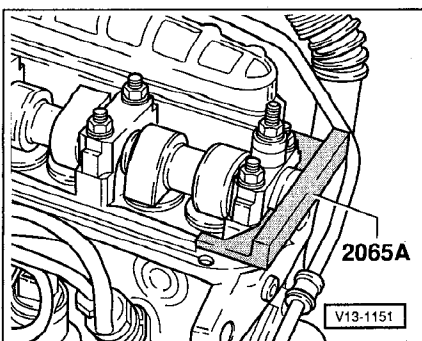
### Removing

- Removing ribbed belt,  
⇒ page 13-13
- If installed, remove ribbed belt tensioning roller.
- Remove upper toothed belt guard and cylinder head cover.

13-17

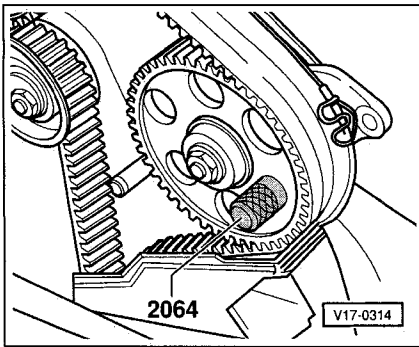


- ◀ - Turn crankshaft to TDC for number 1 cylinder (arrow).



- Lock camshaft using 2065A setting bar.
- ◀ - Center 2065A setting bar by turning camshaft so that one side of setting bar contacts cylinder head.
- Measure gap between other end of setting bar and cylinder head using feeler gauge.
- Divide that measurement in half and place feeler gauge corresponding to half measurement between setting bar and cylinder head.

13-18



- Turn camshaft until setting bar contacts feeler gauge, then place 2nd feeler gauge (of same 1/2 measurement) on opposite side between setting bar and cylinder head.

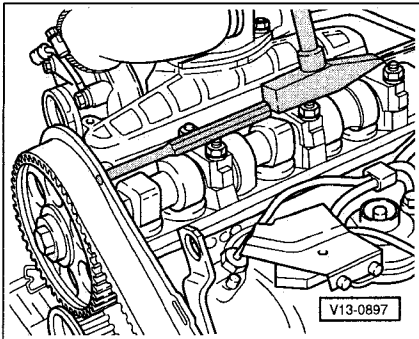
- ◀ - Lock injection pump sprocket using pin.
- Loosen tensioner.
- Remove vibration damper and belt pulley.
- Remove lower toothed belt guard.
- Mark toothed belt running direction.

#### Engines with semi-automatic tensioning roller

- Remove idler pulley.
- Remove toothed belt.

#### Installing

- Make sure TDC mark on flywheel and reference mark are aligned.
- ◀ - Loosen camshaft sprocket mounting bolt 1/2 turn. Release camshaft sprocket from camshaft taper by very carefully tapping with hammer on soft drift inserted through hole of rear toothed belt guard or by GENTLY hitting sprocket squarely on sprocket teeth using synthetic face hammer.



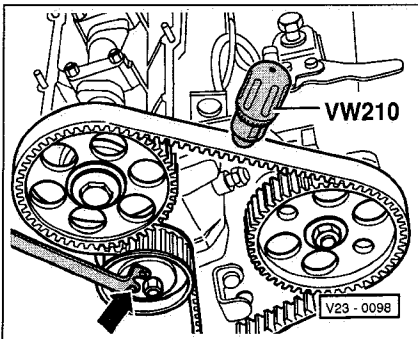
13-19

#### Engines without semi-automatic tensioning roller

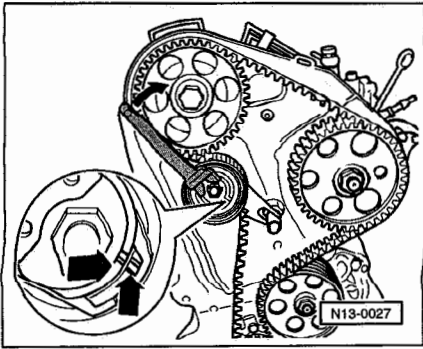
- ◀ - Install toothed belt (note running direction) and remove pin from fuel injection pump sprocket.
- Tension toothed belt by turning tensioner to right (arrow) using pin wrench, e.g. Matra V159.

Scale value: 12 to 13; measured between camshaft sprocket and diesel injection pump sprocket

- Tighten lock nut on tensioner.
- Tightening torque: 45 Nm (33 ft lb)
- Tighten camshaft sprocket mounting bolt.
- Tightening torque: 45 Nm (33 ft lb)
- Remove setting bar.
- Turn crankshaft two rotations in engine running direction and check toothed belt tension again.



13-20



### Engines with semi-automatic tensioning roller

- Install toothed belt (note running direction) and remove pin from fuel injection pump sprocket.
- Install idler pulley and tighten.

Tightening torque: 25 Nm (18 ft lb)

- ◀ - Turn tensioning roller to right using pin wrench (e.g. Matra V159) until notch aligns with raised portion (arrows).

- Tighten lock nut on tensioning roller.

Tightening torque: 20 Nm (15 ft lb)

- Check again to make sure TDC mark on flywheel and reference mark are aligned.

- Tighten camshaft sprocket mounting bolt.

Tightening torque: 45 Nm (33 ft lb)

- Remove setting bar.

### All engines

- Install toothed belt guard, vibration damper, belt pulley, and cylinder head cover.

- Install ribbed belt ⇒ page 13-13.

- Check fuel delivery (via adjusting screw) ⇒ Repair Manual, 1.9 Liter Diesel Fuel Injection & Ignition, Repair Group 23

13-21

## Toothed belt, removing and installing (engine codes AAZ ▶ 10.94, 1Z, AHU)

### Special tools

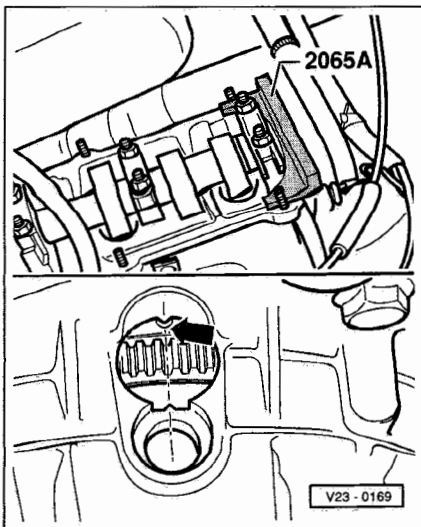
- ♦ 2065A setting bar
- ♦ 3359 locating pin (engine code AAZ)
- ♦ 2064 lock pin (engine codes 1Z, AHU)
- ♦ Matra V159 pin wrench or equivalent; e.g. Hazet 2587, US4493

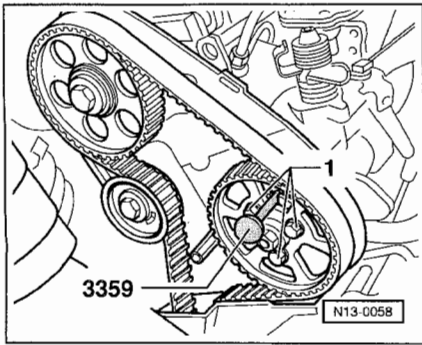
### Removing

- Remove ribbed belt ⇒ page 13-13.
- Remove ribbed belt tensioning roller (if installed).
- Remove upper toothed belt guard and valve cover.
- ◀ - Set crankshaft to TDC for cylinder 1 and lock camshaft using 2065A setting bar.

Center the 2065A setting bar as follows:

- Turn locked camshaft, with setting bar in place, until one end of setting bar touches cylinder head.
- Measure gap at other end of setting bar using feeler gauge.



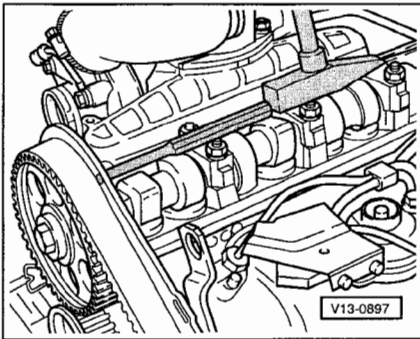


- Select feeler gauge that is one half of measured gap, and temporarily install between setting bar and cylinder head.

**Notes:**

- ◆ Illustration shows engine code AAZ (3 mounting bolts)
- ◆ Engine codes 1Z, AHU uses a center mounting bolt.
- Turn camshaft so that setting bar is resting against feeler gauge then insert second feeler gauge of same thickness at other end between setting bar and cylinder head.
- ◀ - Lock injection pump sprocket using lock pin.
  - ◆ Engine code AAZ: 3359 rig pin
  - ◆ Engine codes 1Z, AHU: 2064 lock pin
- Loosen injection pump sprocket mounting bolts -1- (AAZ) or center bolt (1Z, AHU).
- Loosen tensioner roller.
- Remove vibration damper and belt pulley.
- Remove lower toothed belt guard.
- Clearly identify toothed belt running direction using felt marker.
- Remove toothed belt.

13-23



**Installing belt and adjusting tension (basic setting)**

- Make sure that TDC marks on flywheel and references align.
- Loosen camshaft sprocket mounting bolt(s) 1/2-turn.
- ◀ - Loosen from tapered end of camshaft by very carefully tapping with hammer on soft drift inserted through hole of rear toothed belt guard or by GENTLY hitting sprocket squarely on sprocket teeth using synthetic face hammer.
- Place belt onto toothed belt sprocket/crankshaft, intermediate shaft sprocket, injection pump sprocket and tension roller.

Note running direction of belt.

- Place camshaft sprocket together with toothed belt and tighten mounting bolts.

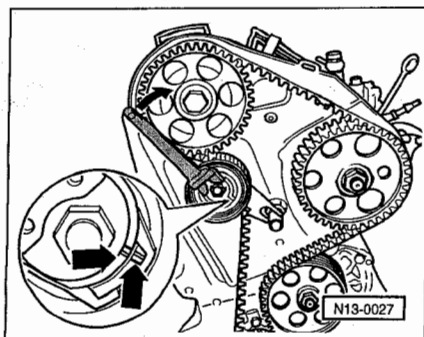
Camshaft sprocket can still be turned.

**Note:**

Illustration shows engine code 1Z; engine code AAZ is similar.

- ◀ - Turn tensioner roller to right using Matra V159 pin wrench (or equivalent) until notch and lifting arrow are across from one another.
- Tighten tensioner roller clamp nut.

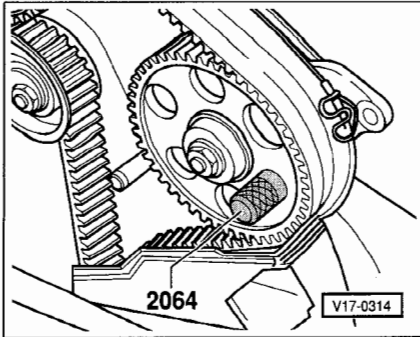
Tightening torque: 20 Nm (15 ft lb)



13-24

- Make sure that TDC marks on flywheel and reference are still in alignment.
- Tighten camshaft sprocket mounting bolt.  
Tightening torque: 45 Nm (33 ft lb)
- Tighten injection pump sprocket mounting bolt(s).  
Tightening torque: 25 Nm (18 ft lb)
- Remove setting bar.
- Remove pin.
- Turn crankshaft twice in direction of rotation and place again at TDC for cylinder 1.

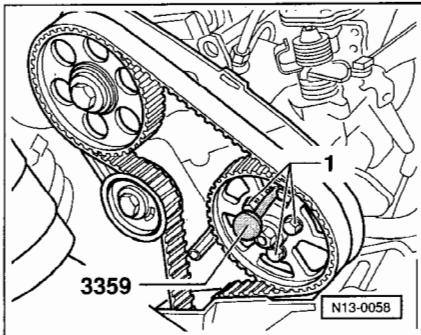
**Engine codes 1Z, AHU**



- ◀ - Make sure injection pump sprocket can be locked using 2064 lock pin.

13-25

**Engine code AAZ**



- ◀ - Check whether injection pump sprocket can be locked using 3359 rig pin.

**All engines**

If injection pump sprocket cannot be locked:

- Loosen injection pump sprocket mounting bolt(s).
- Turn injection pump until locating pin fits.
- Tighten injection pump sprocket mounting bolt(s).  
Tightening torque: 25 Nm (18 ft lb)
- Remove locating pin.
- Install belt guard, vibration damper, pulley and valve cover.
- Install ribbed belt ⇒ page 13-13.

13-26



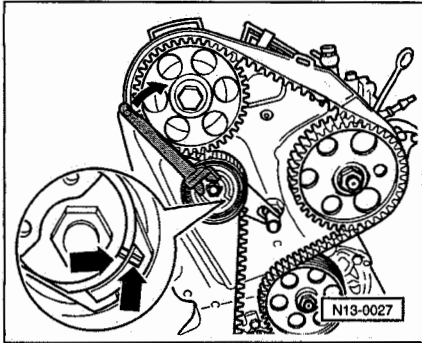
## Semi-automatic toothed belt tensioning roller, checking

### Test conditions

- Toothed belt installed and tensioned

### Test sequence

- ◀ – Tension toothed belt using firm thumb pressure.
- Notched and raised portion (arrows) must move apart.
- Release thumb pressure on toothed belt.
- The tensioning roller must move back to its initial position. (Notched and raised portions align again)

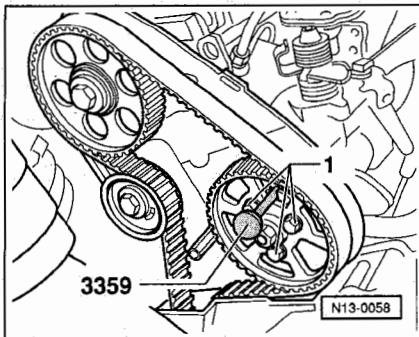


13-27

## Injection pump sprocket, removing

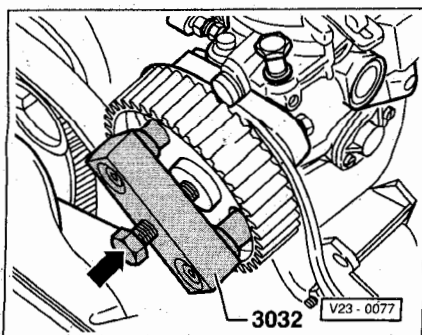
### Engine code AAZ

- ◀ – Remove 3 injection pump sprocket mounting bolts -1- (with belt loosened).

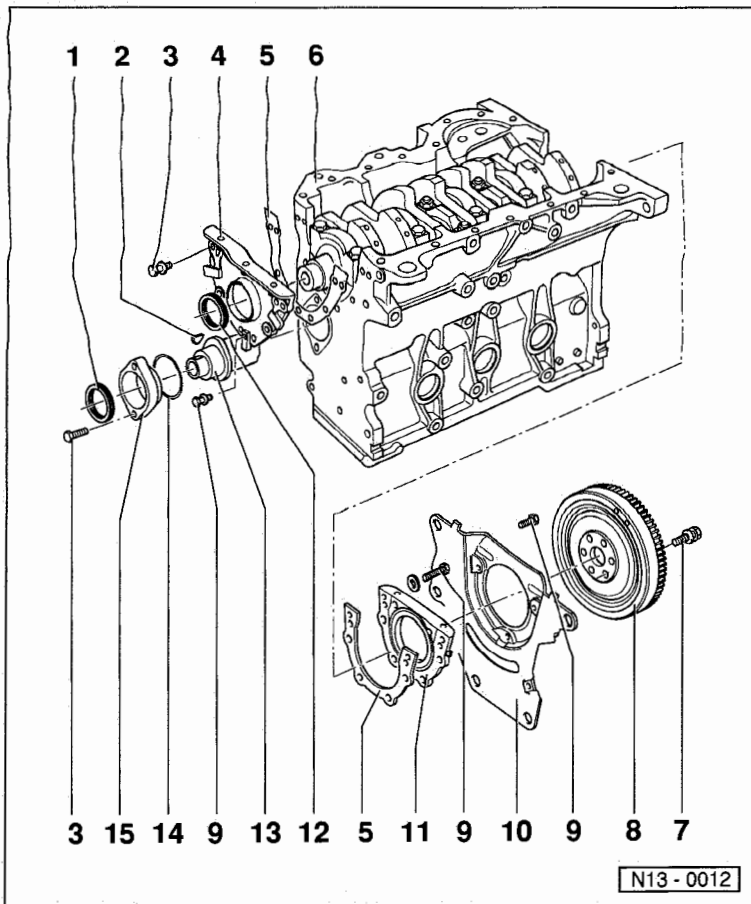


### Engine codes 1Z, AHU

- Remove injection pump sprocket mounting nut.
- ◀ – Loosen puller arms and raise up.
- Locate puller arms through holes in injection pump sprocket and tighten.
- Using puller, place injection pump sprocket under tension.
- Release injection pump sprocket from injection pump taper by tapping on puller spindle (arrow). Hold onto sprocket to prevent it from dropping.



13-28



## Flywheel and drive plate sealing flange, removing and installing

### Note:

For repairs to the clutch ⇒ *Repair Manual, Manual Transmission, Repair Group 30*

#### 1 - Oil seal

- ◆ Remove to remove sealing flange
- ◆ Install using 10-203 oil seal driver
- ◆ Use engine oil to lightly oil sealing lip, do not use grease

#### 2 - Woodruff key

- ◆ Make sure fit is tight

#### 3 - 25 Nm (18 ft lb)

#### 4 - Sealing flange

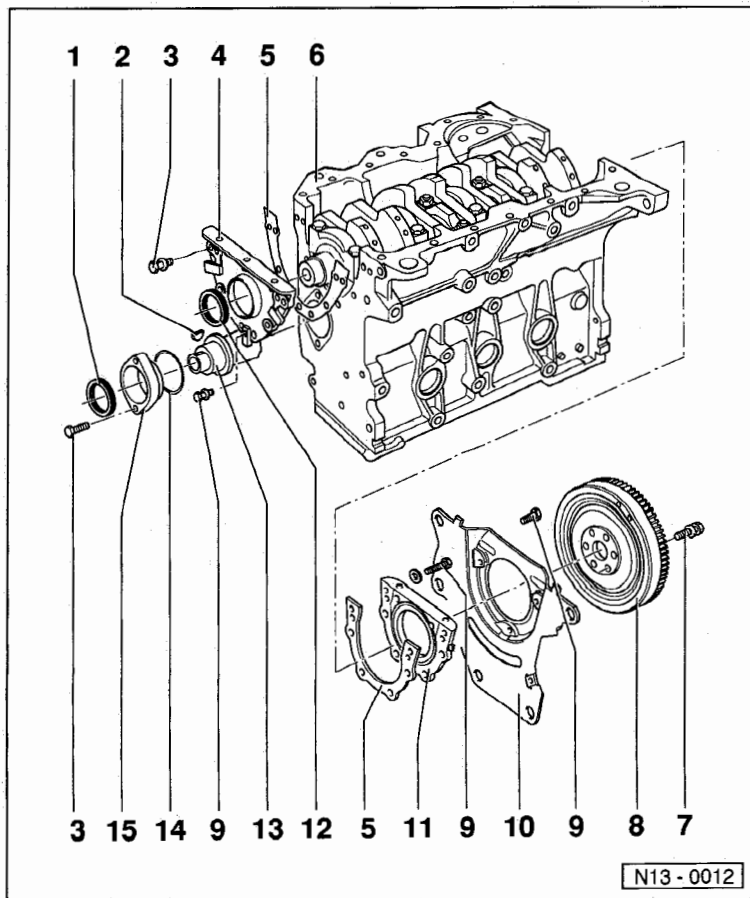
#### 5 - Gasket

- ◆ Always replace

#### 6 - Cylinder block

- ◆ Crankshaft, removing and installing ⇒ page 13-35
- ◆ Pistons and connecting rods, dismantling and assembling ⇒ page 13-40

13-29



#### 7 - 60 Nm (44 ft lb) + 1/4-turn (90°)

- ◆ Always replace

#### 8 - Flywheel/drive plate

- ◆ To remove and install flywheel, counter-hold using 3067 fly-wheel retainer
- ◆ Drive plate, removing and installing ⇒ page 13-33

#### 9 - 10 Nm (7 ft lb)

#### 10 - Intermediate plate

- ◆ Must be located on dowels
- ◆ Do not damage/bend when assembling

#### 11 - Sealing flange with oil seal

- ◆ Only replace complete
- ◆ Use engine oil to lightly oil sealing lip, do not use grease

#### 12 - Oil seal

- ◆ Replacing ⇒ page 13-31

#### 13 - Intermediate shaft

#### 14 - O-ring

- ◆ Replace if damaged

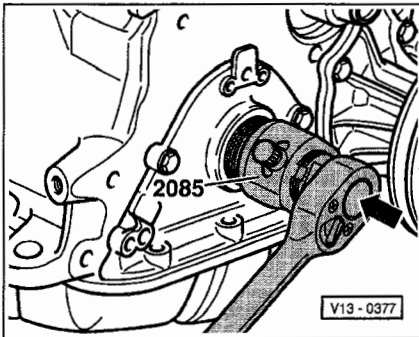
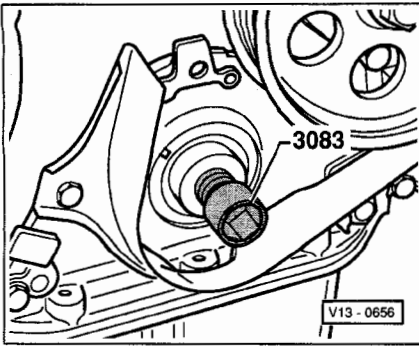
#### 15 - Sealing flange for intermediate shaft

13-30

## Crankshaft oil seal (pulley end), replacing

### Removing

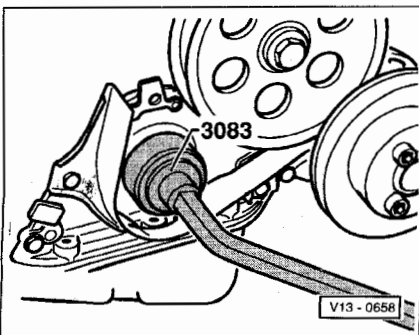
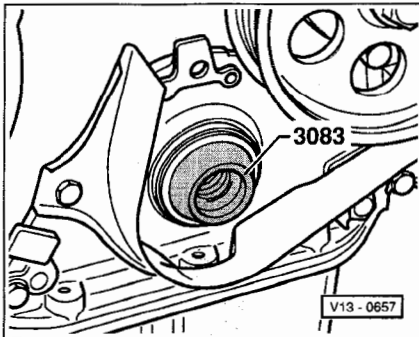
- Remove ribbed belt ⇒ page 13-13.
- Remove toothed belt.
  - ◆ Engine code 1Z ⇒ page 13-17
  - ◆ Engine code AHU ⇒ page 13-22
- Remove crankshaft sprocket by counter-holding sprocket using 3099.
- ▲ - To guide seal puller, screw bolt from 3083 arbor into crankshaft as far as it will go.
- Unscrew inner part of 2085 seal puller two turns (approx. 3 mm) out of outer part, then lock using knurled screw.
- ▲ - Lubricate threaded head of oil seal puller, place it in position and while exerting firm pressure, screw into oil seal as far as possible.
- Loosen knurled screw and rotate inner section against crankshaft until oil seal is pulled out.



13-31

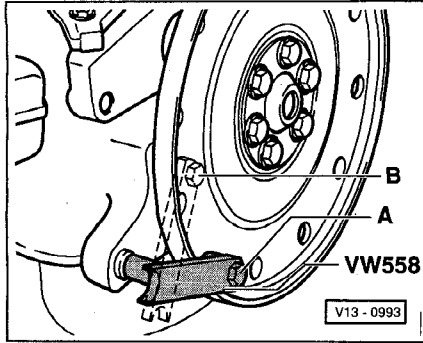
### Installing

- Use engine oil to lightly oil lip of seal (do not use grease!)
- ▲ - Place guide sleeve from 3083 arbor onto crankshaft journal.
- Slide oil seal over guide sleeve.
- ▲ - Press in oil seal up to stop using sleeve from 3083.
- Install and tension toothed belt.
  - ◆ Engine code 1Z ⇒ page 13-17
  - ◆ Engine code AHU ⇒ page 13-22



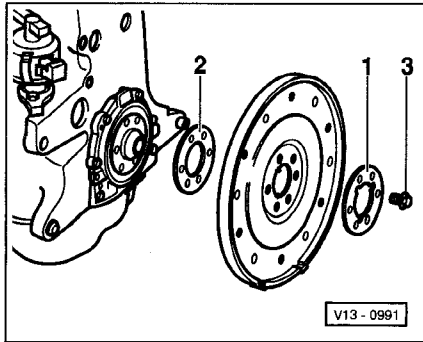
13-32

## Drive plate, removing and installing



### Loosening and tightening drive plate

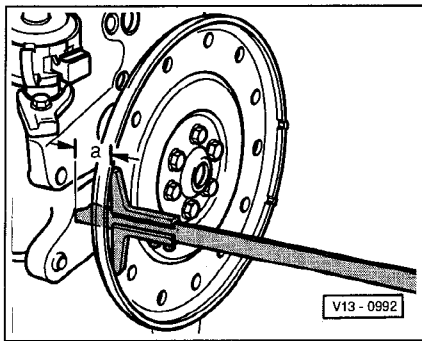
- ◆ Position -A-: Loosening
- ◆ Position -B-: Tightening
- Attach VW558 flywheel lock adapter to drive plate using M8x45 hex bolt.
- Place two M10 nuts between counter-hold tool and drive plate.



### Installing drive plate

- ▲ - Align drive plate and backing plate -1- using recesses.
  - install new bolts -3- and tighten.
- Tightening torque: 30 Nm (22 ft lb)

13-33



- ▲ - Check dimension -a- at three points and calculate average.
- Must be 19.5–21.1 mm (0.768–0.831 in.)

If dimension -a- is OK:

- Fully tighten bolts -3- to 60 Nm (44 ft lb) and then turn an additional 1/4-turn (90°).

The additional 1/4-turn can be accomplished in several stages.

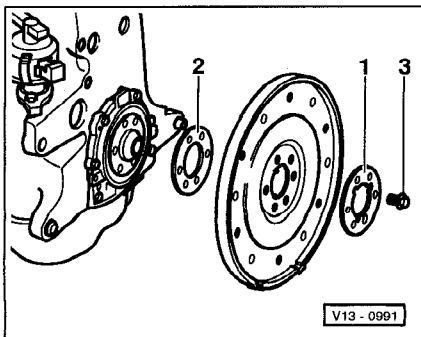
If dimension -a- is not as specified:

- ▲ - Remove drive plate, install shim -2- and tighten bolts -3-.
- Tightening torque: 30 Nm (22 ft lb)

If dimension -a- is OK:

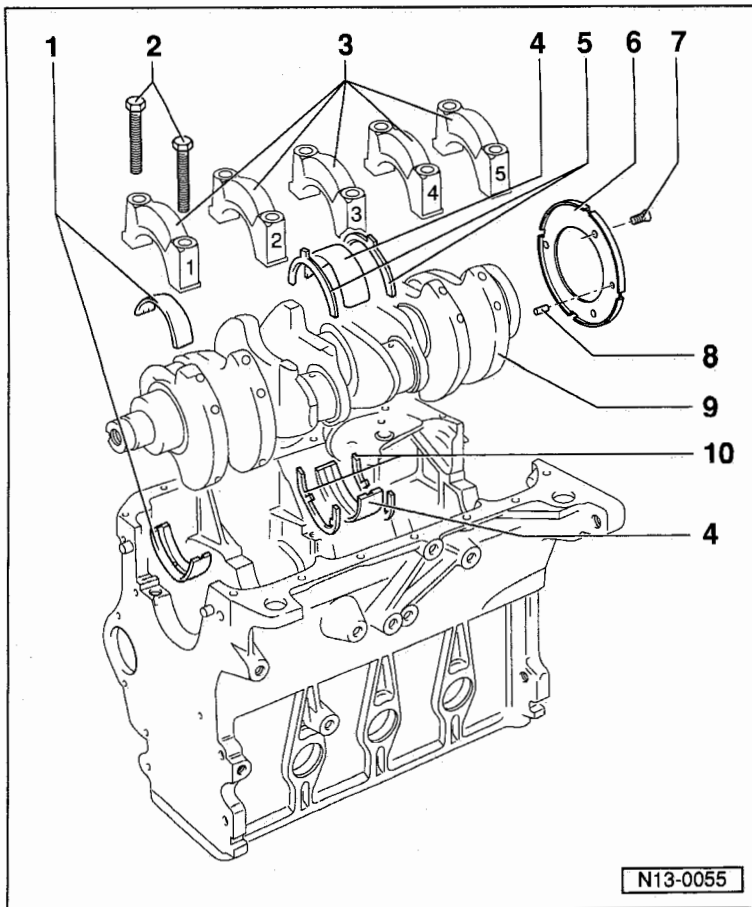
- Tighten bolts -3- to 60 Nm (44 ft lb) and then turn an additional 1/4-turn (90°).

The additional 1/4-turn can be accomplished in several stages.



13-34

## Crankshaft, removing and installing



### 1 - Bearing caps 1, 2, 4 and 5

- ◆ For bearing caps without oil groove
- ◆ For cylinder block with oil groove
- ◆ Do not interchange used bearing shells (mark as such)

### 2 - 65 Nm (48 ft lb) + 1/4-turn (90°)

- ◆ Always replace
- ◆ To measure radial clearance tighten to 65 Nm (48 ft lb) but not further

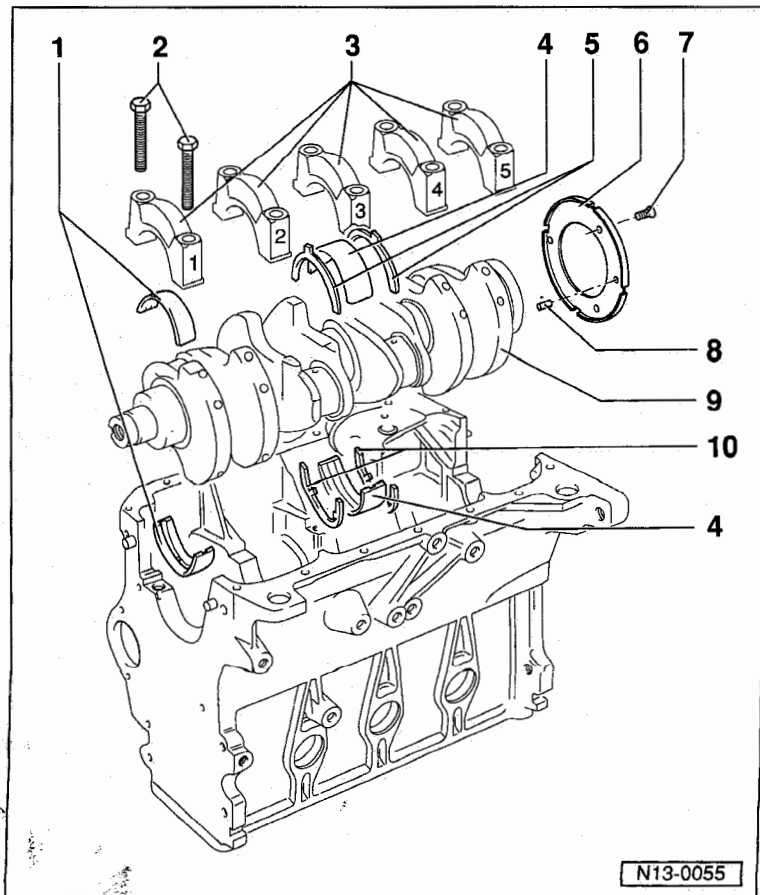
### 3 - Bearing cap

- ◆ Bearing cap 1: pulley end
- ◆ Bearing cap 3 with recesses for thrust washers
- ◆ Bearing shell retaining lugs cylinder block/bearing cap must be on same side

### 4 - Bearing shell 3

- ◆ For bearing cap without oil groove
- ◆ For cylinder block with oil groove

13-35



### 5 - Thrust washer

- ◆ For bearing cap -3-
- ◆ Note arrangement

### 6 - Sensor wheel

- ◆ Engine codes 1Z, AHU
- ◆ For engine speed sensor

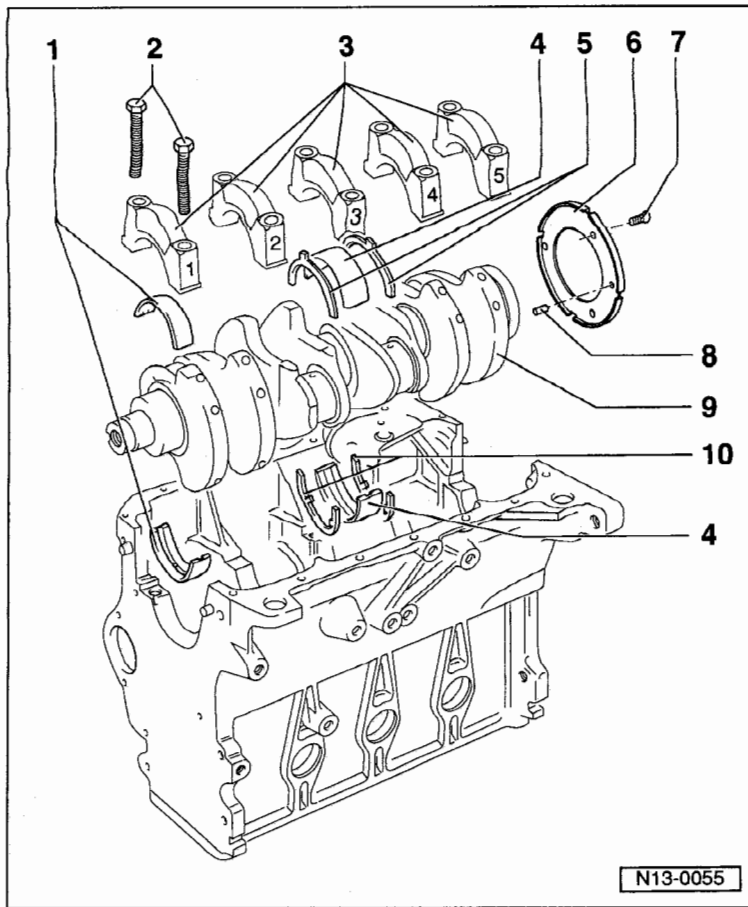
### 7 - 10 Nm (7 ft lb) plus 1/4-turn (90°)

- ◆ Always replace

### 8 - Dowel pin

- ◆ Engine codes 1Z, AHU
- ◆ Checking projection from crankshaft ⇒ Fig. 1

13-36



**9 - Crankshaft**

Axial clearance:

- ◆ New: 0.07 to 0.17 mm (0.0028–0.0067 in.)
- ◆ Wear limit: 0.37 mm (0.0146 in.)

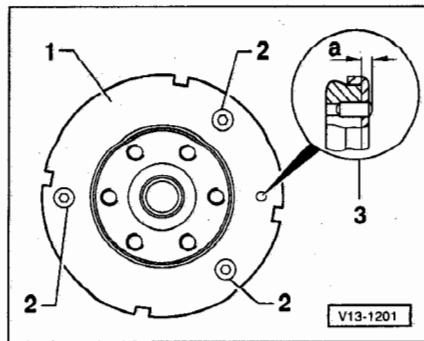
Radial clearance:

- ◆ Check using Plastigage®
- ◆ New: 0.03 to 0.08 mm (0.0012–0.0031 in.)
- ◆ Wear limit: 0.17 mm (0.0067 in.)
- ◆ Do not allow crankshaft to rotate while measuring radial clearance
- ◆ Crankshaft dimensions ⇒ page 13-39

**10 - Thrust washer**

- ◆ For engine block, bearing 3

13-37



◀ **Fig. 1 Checking crankshaft dowl pin projection**

Dowl pin projection -3- from crankshaft:

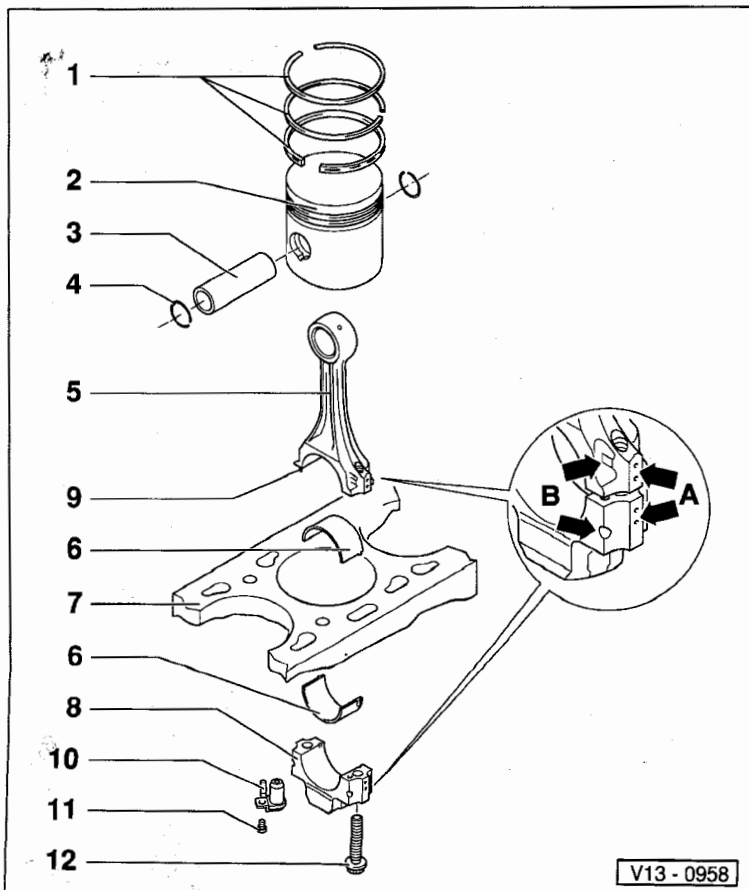
Dimension -a- = 2.5–3.0 mm (0.098–0.118 in.)

13-38

## 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)
Basic dimension (nominal)	54.00 (2.1260)	47.80 (1.8819)
minimum size (from nominal)	-0.042 (0.00165)	-0.042 (0.00165)
maximum size (from nominal)	-0.022 (0.00087)	-0.022 (0.00087)
1st undersize (nominal)	53.75 (2.1161)	47.55 (1.8720)
minimum size (from nominal)	-0.042 (0.00165)	-0.042 (0.00165)
maximum size (from nominal)	-0.022 (0.00087)	-0.022 (0.00087)
2nd undersize (nominal)	53.50 (2.1063)	47.30 (1.8622)
minimum size (from nominal)	-0.042 (0.00165)	-0.042 (0.00165)
maximum size (from nominal)	-0.022 (0.00087)	-0.022 (0.00087)
3rd undersize (nominal)	53.25 (2.0965)	47.05 (1.8524)
minimum size (from nominal)	-0.042 (0.00165)	-0.042 (0.00165)

13-39



## Pistons and connecting rods, disassembling and assembling

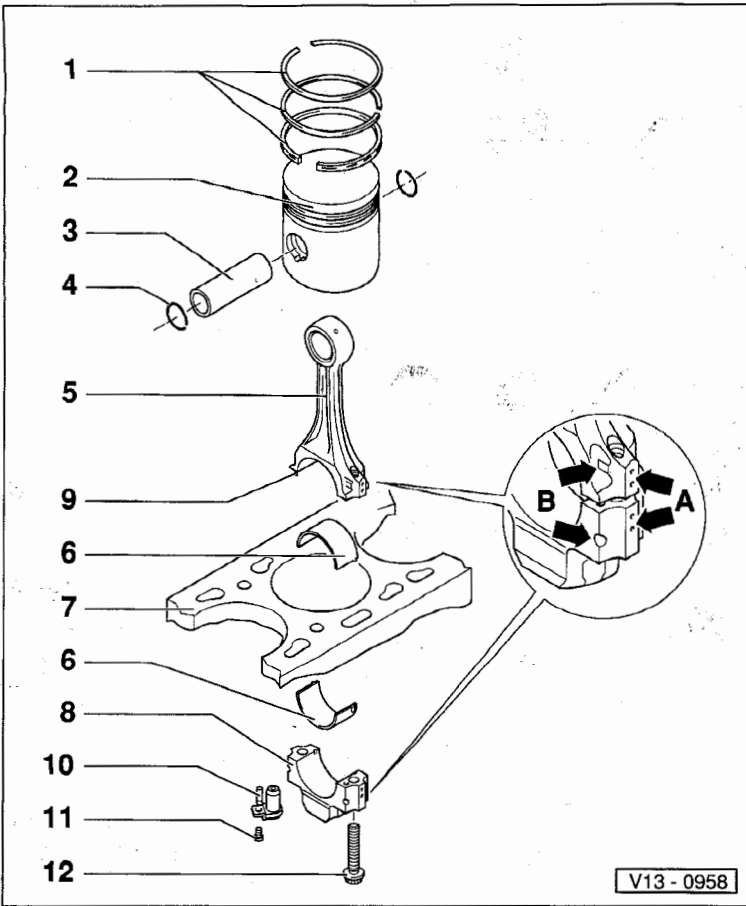
### 1 - Piston ring

- ◆ Offset ring gaps by 120°
- ◆ Remove and install using piston ring pliers
- ◆ "OBEN" points toward piston crown
- ◆ Checking ring gap ⇒ Fig. 1
- ◆ Checking ring to groove clearance ⇒ Fig. 2

### 2 - Piston

- ◆ Engine codes 1Z, AHU: with combustion chamber
- ◆ Mark installed position and cylinder number; engine codes 1Z, AHU ⇒ Fig. 4
- ◆ Arrow on piston crown points toward pulley end
- ◆ Install using piston ring clamp
- ◆ If there are cracks on piston skirt, replace piston
- ◆ Piston position at TDC, checking ⇒ page 13-47

13-40



V13 - 0958

### 3 - Piston pin

- ◆ If difficult to remove, heat piston to 60° C (140° F)
- ◆ Remove and install using VW222a pilot drift

### 4 - Circlip

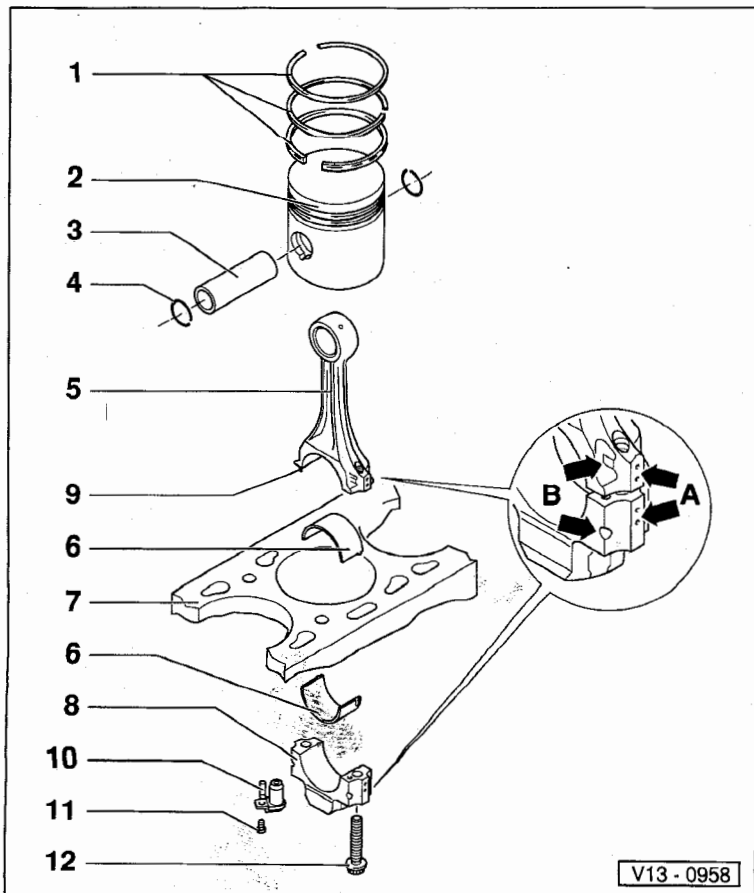
### 5 - Connecting rod

- ◆ Only replace as a set
- ◆ Mark cylinder number (arrows -A-)
- ◆ Installation position: marking (arrow -B-) faces pulley end

### 6 - Bearing shell

- ◆ Note installed-position
- ◆ Do not interchange used bearing shells
- ◆ Make sure that retaining lugs fit tightly in recesses
- ◆ Axial clearance, wear limit: 0.37 mm (0.0146 in.)
- ◆ Check radial clearance using Plastigage®, wear limit: 0.08 mm (0.0031 in.)
- ◆ Do not rotate crankshaft when checking radial clearance

13-41



V13 - 0958

### 7 - Cylinder block

- ◆ Checking cylinder bore diameter ⇒ Fig. 3
- ◆ Piston and cylinder dimensions ⇒ page 13-49

### 8 - Connecting rod bearing cap

- ◆ Note installation position

### 9 - Locating pin

- ◆ The fitted pin must seat securely in connecting rod, not in bearing cap

### 10 - Oil spray jet

- ◆ For piston cooling

### 11 - 10 Nm (7 ft lb)

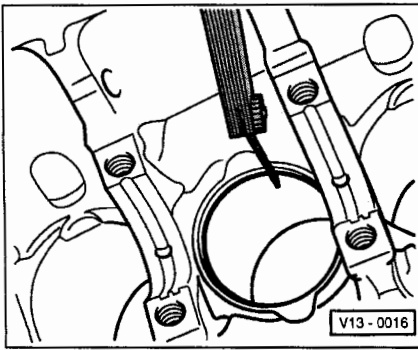
- ◆ Install using AMV 188 100 02

### 12 - Connecting rod bolt

- ◆ Always replace
- ◆ 30 Nm (22 ft lb) + 1/4-turn (90°)
- ◆ Oil threads and contact surfaces
- ◆ Use old bolts to measure radial clearance

13-42



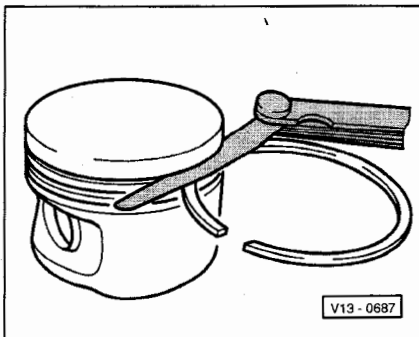


◀ **Fig. 1 Checking piston ring gap**

- Insert ring into cylinder from above. Push down squarely on piston ring until it is approx. 15 mm (5/8 in.) from bottom of cylinder

Piston ring	Ring gap — mm (in.)		
	New	Wear limit (AAZ)	Wear limit (1Z, AHU)
Top compression ring	0.20-0.40 (0.0078-0.0157)	1.2 (0.0472)	1.0 (0.0394)
2nd compression ring	0.20-0.40 (0.0078-0.0157)	0.6 (0.0236)	1.0 (0.0394)
Oil scraper ring	0.25-0.50 (0.0098-0.0197)	1.2 (0.0472)	1.0 (0.0394)

13-43

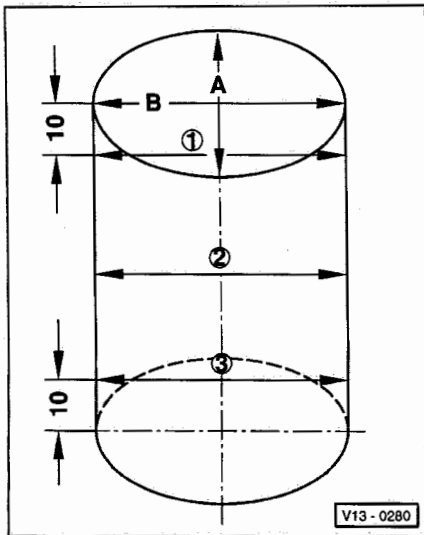


◀ **Fig. 2 Checking ring to groove clearance**

- Clean piston ring groove before checking.

Piston ring	Side clearance — mm (in.)	
	New	Wear limit
Top compression ring	AAZ	0.09-0.12 (0.0035-0.0047)
	1Z, AHU	0.06-0.12 (0.0024-0.0047)
2nd compression ring		0.05-0.08 (0.0020-0.0031)
Oil scraper ring		0.03-0.06 (0.0012-0.0024)

13-44



◀ Fig. 3 Checking cylinder bore diameter

**Special tools, testers and auxiliary items**

Internal dial gauge 50 to 100 mm.

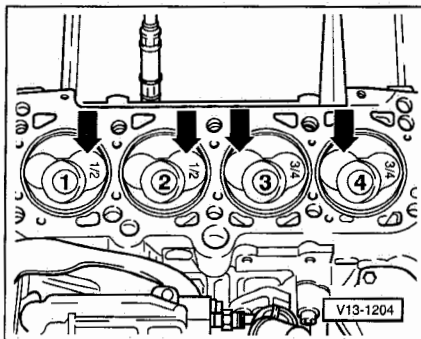
**Checking**

- Measure bore at 3 positions in both lateral (arrow -A-) and longitudinal (arrow -B-) directions, as illustrated.

Deviation from nominal dimension: 0.10 mm (0.0039 in.) maximum

**CAUTION!**

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



◀ Fig. 4 Piston installation and cylinder orientation

Pistons cylinders 1 and 2:

- ◆ Larger intake valve chamber toward flywheel (arrows)

Pistons cylinders 3 and 4:

- ◆ Larger intake valve chamber toward pulleys (arrows)

**Note:**

*Piston orientation is indicated by a colored mark on the piston crown.*

- ◆ Pistons for cylinders 1 and 2: marked 1/2
- ◆ Pistons for cylinders 3 and 4: marked 3/4

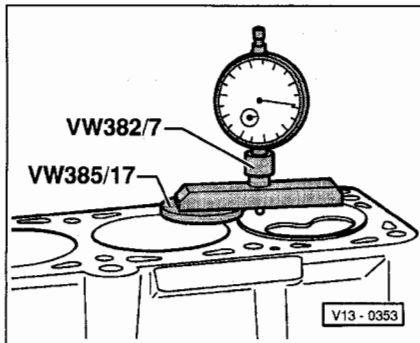
## Piston position at TDC, checking

### Special tools, testers and auxiliary items

- ◆ VW382/7 measuring bar
- ◆ VW385/17 magnetic plate 50mm dia.

### Test sequence

- ◀ Piston position at TDC must be measured whenever new pistons or a short block is installed. Depending on piston position at TDC, install correct gasket using the following table:



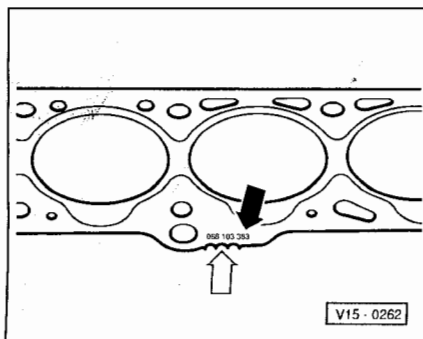
### Engine code AAZ

Piston height above cylinder block (TDC)	Cylinder head gasket notches/holes
0.66–0.86 mm (0.0260–0.0339 in.)	1
0.87–0.90 mm (0.0343–0.0354 in.)	2
0.91–1.02 mm (0.0358–0.0402 in.)	3

13-47

### Engine codes 1Z, AHU

Piston height above cylinder block (TDC)	Cylinder head gasket notches/holes
0.91–1.00 mm (0.0358–0.0394 in.)	1
1.01–1.10 mm (0.0398–0.0433 in.)	2
1.11–1.20 mm (0.0437–0.0472 in.)	3



### ◀ Cylinder head gasket identification

- ◆ Part number: black arrow
- ◆ Holes/notches: white arrow

### Note:

If differing results are obtained when measuring piston position at TDC, use the largest measurement to select the correct gasket.

13-48

## Piston and cylinder dimensions

### Engine code AAZ

Reconditioning dimension	Piston diameter mm (in.)	Cylinder bore diameter mm (in.)
Basic dimension	79.48 (3.1291)	79.51 (3.1303)
1st oversize	79.73 (3.1390)	79.76 (3.1402)
2nd oversize	79.98 (3.1488)	80.01 (3.1500)

### Engine codes 1Z, AHU

Reconditioning dimension	Piston diameter mm (in.)	Cylinder bore diameter mm (in.)
Basic dimension	79.48 (3.1287)	79.51 (3.1303)
1st oversize	79.72 (3.1385)	79.76 (3.1402)
2nd oversize	79.98 (3.1484)	80.01 (3.1500)

## Cylinder head, removing and replacing

### **WARNING!**

- ◆ *Do not re-use any fasteners that are worn or deformed in normal use.*
- ◆ *Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.*

### **Notes:**

- ◆ *The cylinder head can be removed and installed without removing the engine from the vehicle.*
- ◆ *When replacing the cylinder head, the engine coolant must be completely replaced.*
- ◆ *Checking compression ⇒ page 15-12.*
- ◆ *When installing a replacement cylinder head complete with camshaft, the contact surfaces between the hydraulic valve lifters and the cam lobes must be lubricated after installing the cylinder head.*
- ◆ *The plastic liners supplied on replacement cylinder heads for protection of open valves must not be removed until just before installing the cylinder head.*

15-1

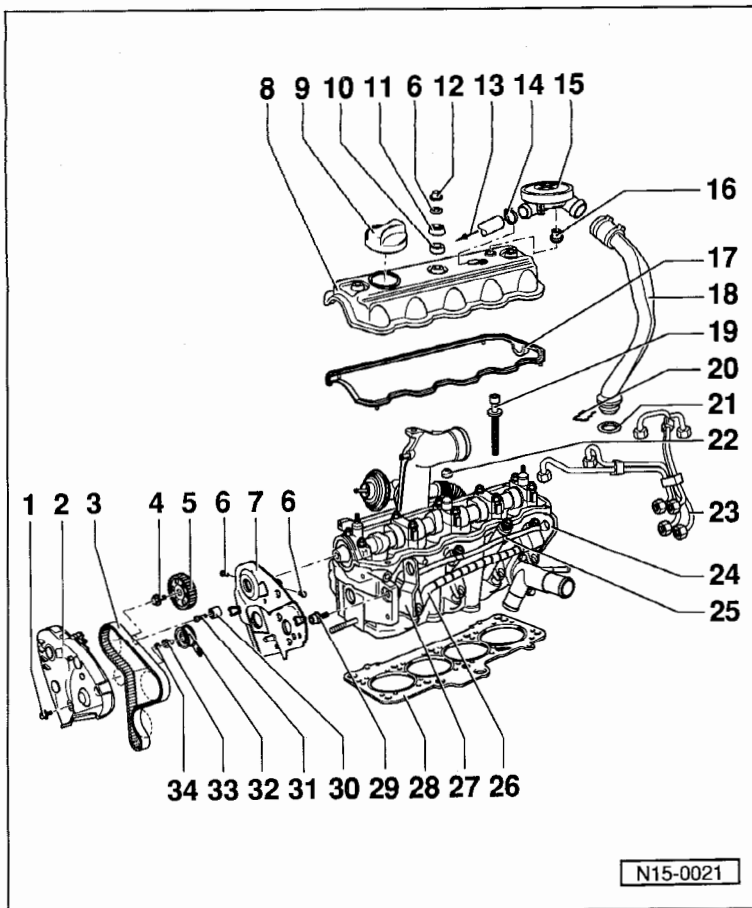
### **Metal cylinder head gasket**

- ◆ *From 11.93 ► all 1.9 liter Diesel engines are equipped with a new metal cylinder head gasket with silicone coating.*
- ◆ *When making repairs it is no longer necessary to tighten the cylinder head bolts by an additional 1/4-turn (90°) with the engine warm.*
- ◆ *The four-step procedure for tightening the cylinder head bolts during assembly has not changed.*
- ◆ *When installing a new metal cylinder head gasket, follow all precautions ⇒ Notes page 15-9.*

### **Note:**

*The new metal cylinder head gasket can be installed on all 1.9 liter Diesel engines manufactured before 11.93.*

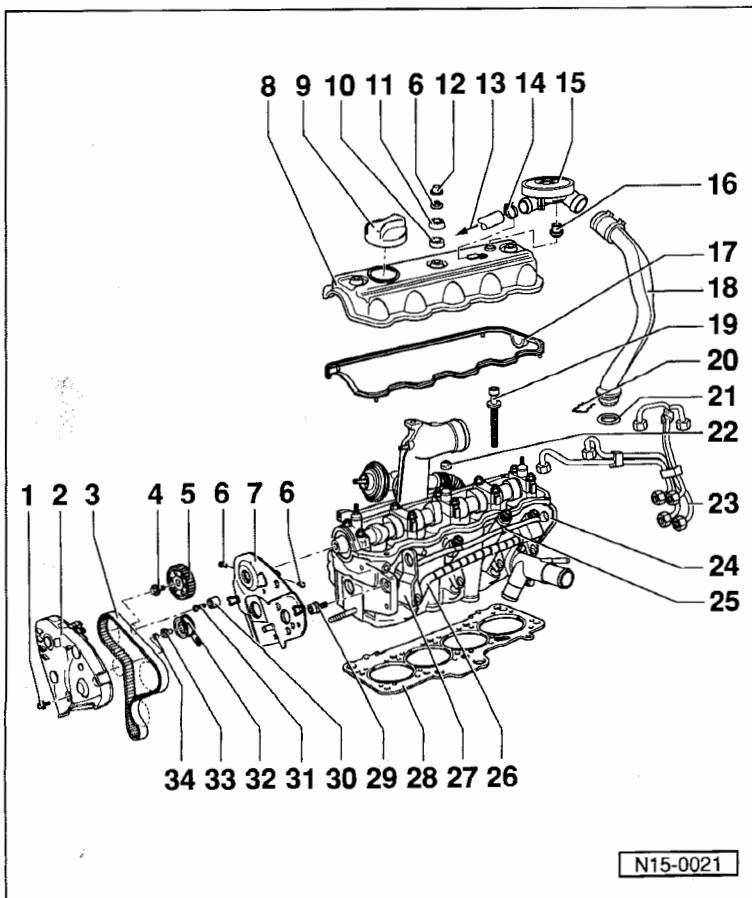
15-2



## Cylinder head, disassembling and assembling

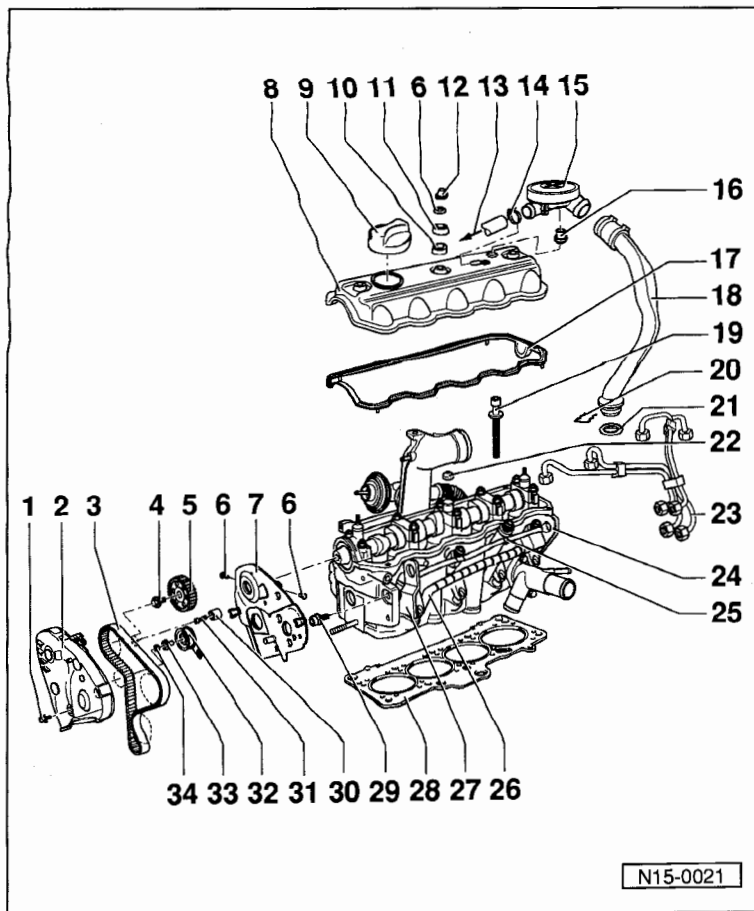
- 1 - Expanding clip
- 2 - Toothed belt guard, upper
- 3 - Toothed belt
  - ◆ Mark running direction before removing
  - ◆ Check for wear
  - ◆ Do not kink
 Removing and installing:
  - ◆ Engine code 1Z ⇒ page 13-17
  - ◆ Engine code AHU ⇒ page 13-22
- 4 - 45 Nm (33 ft lb)
- 5 - Camshaft sprocket
  - ◆ Drive off camshaft taper using hammer and drift through toothed belt guard opening
- 6 - 10 Nm (7 ft lb)
- 7 - Toothed belt guard, rear
- 8 - Cylinder head cover
- 9 - Cap
  - ◆ Replace seal if damaged

15-3



- 10 - Upper sealing washer
  - ◆ Replace if damaged
- 11 - Cup washer
- 12 - Cap
- 13 - To intake hose
- 14 - Retaining clip
- 15 - Positive Crankcase Ventilation (PCV) valve
  - ◆ For crankcase breather
- 16 - Gasket
  - ◆ Replace if damaged
- 17 - Cylinder head cover gasket
  - ◆ Replace if damaged
  - ◆ Insert projections into holes on cylinder head
- 18 - Crankcase breather
- 19 - Cylinder head bolt
  - ◆ Always replace
  - ◆ Follow instructions for loosening and tightening in proper sequence ⇒ page 15-9
- 20 - Mounting clip

15-4



**21 - O-ring**

- ◆ Always replace

**22 - Lower sealing cone**

**23 - Injector lines**

- ◆ 25 Nm (18 ft lb)
- ◆ Remove using 3035 injector line wrench
- ◆ Always remove fuel lines as an assembly
- ◆ Do not bend or alter shape

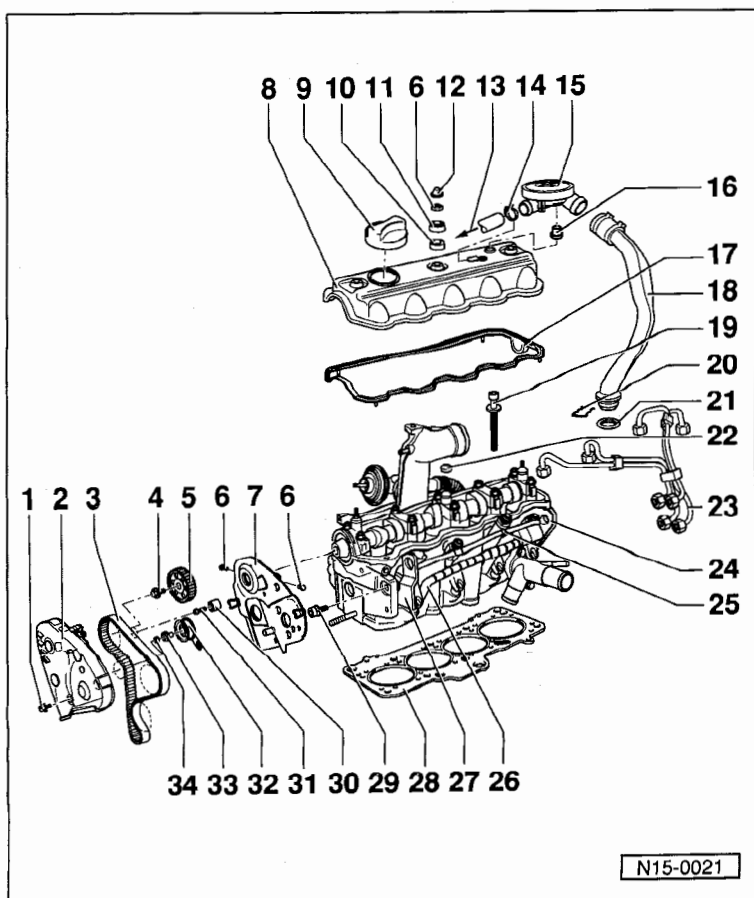
**24 - Cylinder head**

- ◆ Check for distortion ⇒ Fig. 1
- ◆ Installing ⇒ page 15-9
- ◆ After replacing, engine coolant must be completely replaced

**25 - Fuel injector**

Removing and installing:

- ◆ Engine code AAZ ⇒ Repair Manual, 1.9 Liter Diesel Fuel Injection & Ignition, Repair Group 23
- ◆ Engine codes 1Z, AHU ⇒ Repair Manual, 1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System, Repair Group 23



**26 - Glow plug**

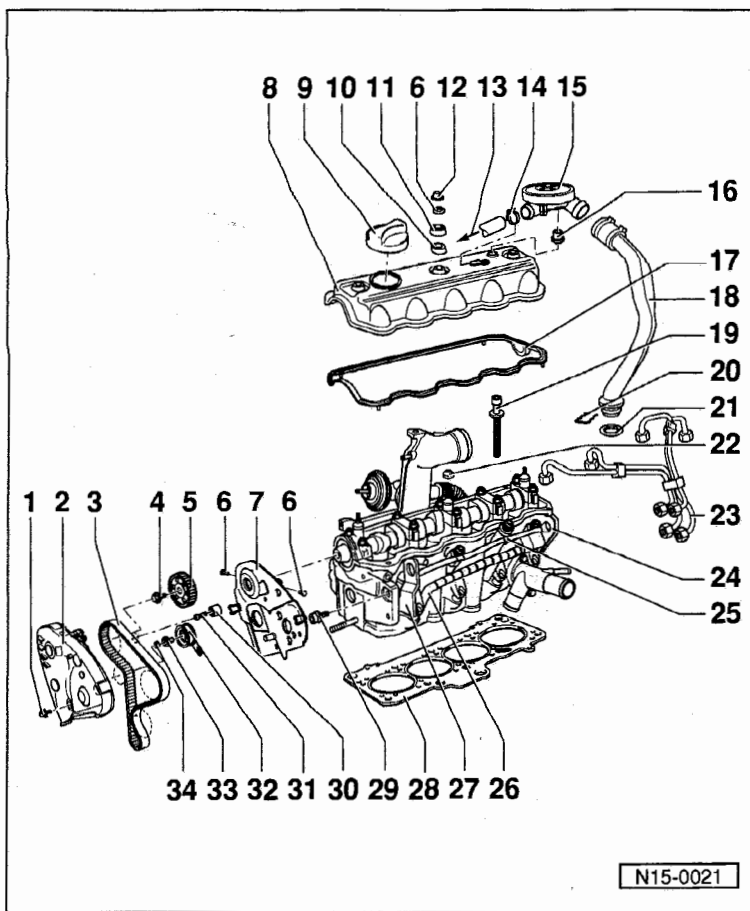
Engine code AAZ:

- ◆ Tightening torque: 25 Nm (18 ft lb)
  - ◆ Checking ⇒ Repair Manual, 1.9 Liter Diesel Fuel Injection & Ignition, Repair Group 28
- Engine codes 1Z, AHU:
- ◆ Tightening torque: 15 Nm (11 ft lb)
  - ◆ Checking ⇒ Repair Manual, 1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System, Repair Group 28

**27 - Lifting eye**

**28 - Cylinder head gasket**

- ◆ Always replace
- ◆ New metal gasket from 11.93 ⇒ page 15-2
- ◆ Note marking ⇒ Fig. 2
- ◆ After replacing, engine coolant must be completely replaced



29 - 20 Nm (15 ft lb)

30 - Idler roller

◆ Engine codes 1Z, AHU

31 - 25 Nm (18 ft lb)

32 - Semi-automatic toothed belt tensioning roller

◆ Engine codes 1Z, AHU: checking ⇒ page 13-27

33 - Eccentric

◆ Engine codes 1Z, AHU

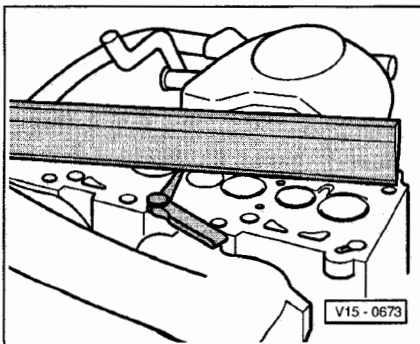
◆ For semi-automatic toothed belt tensioning roller

34 - Tightening torque

◆ Engine code AAZ: 45 Nm (33 ft lb)

◆ Engine codes 1Z, AHU: 20 Nm (15 ft lb)

15-7

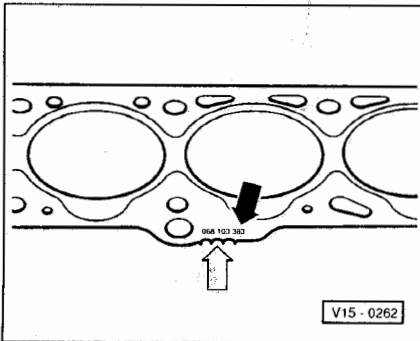


◀ Fig. 1 Checking cylinder head distortion

Maximum permissible distortion: 0.1 mm (0.0039 in.)

**CAUTION!**

**Resurfacing Diesel engine cylinder heads is not permissible.**



◀ Fig. 2 Cylinder head gasket identification

◆ Part number (black arrow)

◆ Holes/notches (white arrow)

Different thickness cylinder head gaskets are available. The correct thickness depends on the amount of piston protrusion.

Measuring piston protrusion ⇒ page 13-47.

When only replacing the cylinder head gasket, install a new gasket with the same identification.

**Note:**

New metal gasket, 11.93 ▶ ⇒ page 15-2.

15-8



## Cylinder head, installing

### Special tools, testers and auxiliary items

- ◆ VAG1332 torque wrench 40 to 200 Nm
- ◆ 3070 guide pins

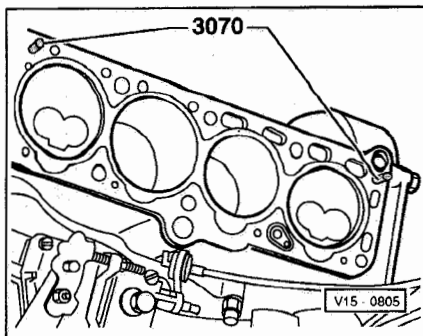
#### CAUTION!

**Always replace cylinder head bolts.**

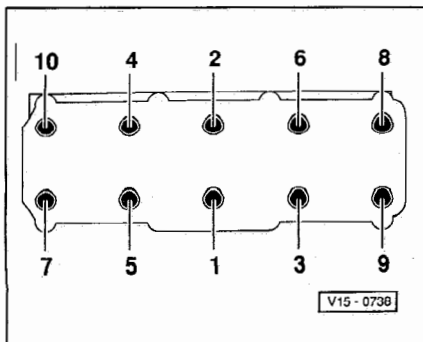
#### Notes:

- ◆ During repairs, carefully remove seal/gasket fragments from cylinder head and cylinder block. Make sure that no longitudinal grooves or scratches are created. When using abrasive paper do not use a grade coarser than 100. Carefully remove any abrasive debris.
- ◆ Remove new cylinder head gasket from packaging, just before installing.
- ◆ Handle gasket extremely carefully. Damaging the silicone layer or the indented area can cause leakage.
- ◆ New metal cylinder head gaskets can be installed on 1.9 liter Diesel engines manufactured before 11.93 ⇒ page 15-2.
- Turn crankshaft to TDC mark before installing cylinder head.
- Turn crankshaft against engine direction of rotation until all pistons are approximately equally placed below TDC.
- Install cylinder head gasket.

15-9



- ◀ - To center gasket, screw guide pins from 3070 into outer threaded holes on intake side.
- Install cylinder head, thread in 8 remaining cylinder head bolts and tighten by hand.
- Remove guide pins using removal tool from 3070 and install cylinder head bolts.



- ◀ - Tighten cylinder head bolts in four stage sequence as shown. (Loosen in reverse order):
  1. Tighten initially using a torque wrench.
    - ◆ Stage I: 40 Nm (30 ft lb)
    - ◆ Stage II: 60 Nm (44 ft lb)
  2. Turn further using a hand wrench.
    - ◆ Stage III: additional 1/4-turn (90°)
    - ◆ Stage IV: additional 1/4-turn (90°)

#### Note:

It is NOT necessary to re-torque cylinder head bolts after the first 1,000 km (600 mi).

15-10

### Installation with older style head gasket ONLY

- Tighten according to above four stage sequence.
- After final assembly, run engine until completely warm—oil temperature at least 50°C (122°F)—and tighten bolts additional 1/4-turn (90°).
  - ◆ Do not loosen bolts first
  - ◆ Follow tightening sequence
  - ◆ Tighten each bolt in one step, without interruption
  - ◆ It is NOT necessary to re-torque cylinder head bolts after the first 1,000 km (600 mi).

### All vehicles

- After tightening cylinder head, rotate camshaft so cam for no. 1 cyl. points evenly upward.
- Rotate crankshaft, in running direction of engine to TDC before installing toothed belt.

15-11

## Cylinder compression, checking

### Compression, checking (engine code AAZ)

#### Special tools, testers and auxiliary items

- ◆ US1110 compression tester-Diesel engine
- ◆ VAG1381/2A adapter
- ◆ 3035 injector line wrench

#### Test conditions

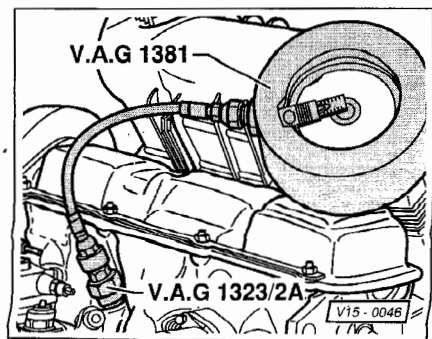
- Engine oil temperature 30°C (86°F) minimum

#### Test sequence

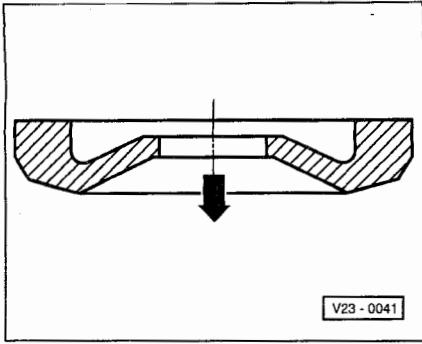
- Disconnect wiring from engine stop on injection pump, insulate and lay to one side.
- Remove injection lines using 3035 injector line wrench.
- Remove all fuel injectors and all heat shields.
- ◀ - Thread VAG1323/2A adapter in place of fuel injectors. Insert old heat shield between adapter and cylinder head.
- Hand thread US1110 into compression tester adapter.

#### Note:

For compression tester usage, see manufacturers operating instructions.



15-12



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

Compression pressures:

- ◆ New: 34 bar (493 psi)
- ◆ Wear limit: 26 bar (377 psi)

Permissible difference between all cylinders: 5 bar (73 psi)

**Note:**

*Always replace the heat shield seals fitted between the cylinder head and the fuel injectors.*

- ◀ Heat shield installed position, (arrow) points to cylinder head.

Tightening torques:

- ◆ Fuel injector lines: 25 Nm (18 ft lb)
- ◆ Fuel injectors: 70 Nm (52 ft lb)

15-13

## Compression, checking (engine codes 1Z, AHU)

### Special tools, testers and auxiliary items

- ◆ US1110 compression tester-Diesel engine
- ◆ VAG1381/12 adapter
- ◆ 3220 hinged socket

### Test conditions

- Engine oil temperature 30°C (86°F) minimum

### Test sequence

- Disconnect fuel cut-off valve on Diesel injection pump.
- Disconnect harness connector for quantity adjuster on Diesel injection pump.
- Remove all glow plugs using 3220 hinged socket.
- Install VAG1323/12 adapter in place of glow plugs.
- Check compression using US1110 compression tester.

**Note:**

*For compression tester usage, see manufacturers operating instructions.*

15-14

- Operate starter until tester shows no further pressure increase.

Compression pressures:

- ◆ New: 25 to 31 bar (363–450 psi)
- ◆ Wear limit: 19 bar (276 psi)

Permissible difference between all cylinders: 5 bar (73 psi)

- Install glow plugs using 3220 hinged socket.

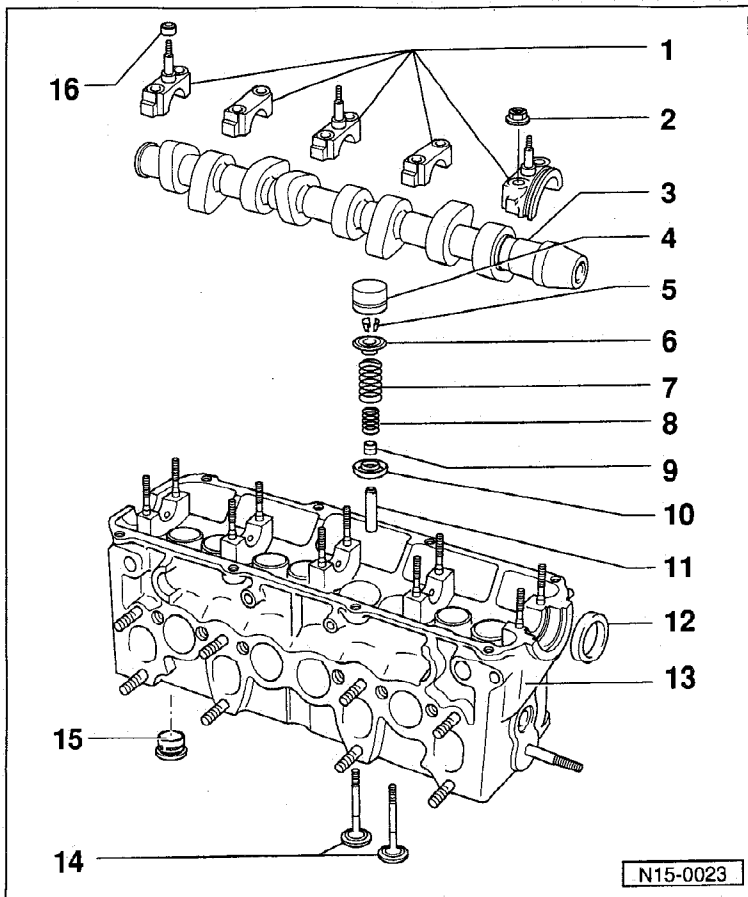
Tightening torque: 15 Nm (11 ft lb)

- Check DTC memory.
- ⇒ Engine codes 1Z, AHU, Repair Manual, 1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System, Repair Group 01

**Note:**

A Diagnostic Trouble Code (DTC) will be generated as a result of disconnecting injection pump harness connector. Check and erase DTC memory to clear the DTC.

15-15



## Valve train, servicing

**Note:**

Cylinder heads with cracks between the valve seats may be used without reducing engine life, provided the cracks are small and not more than 0.5 mm (0.020 in.) wide.

**1 - Bearing caps**

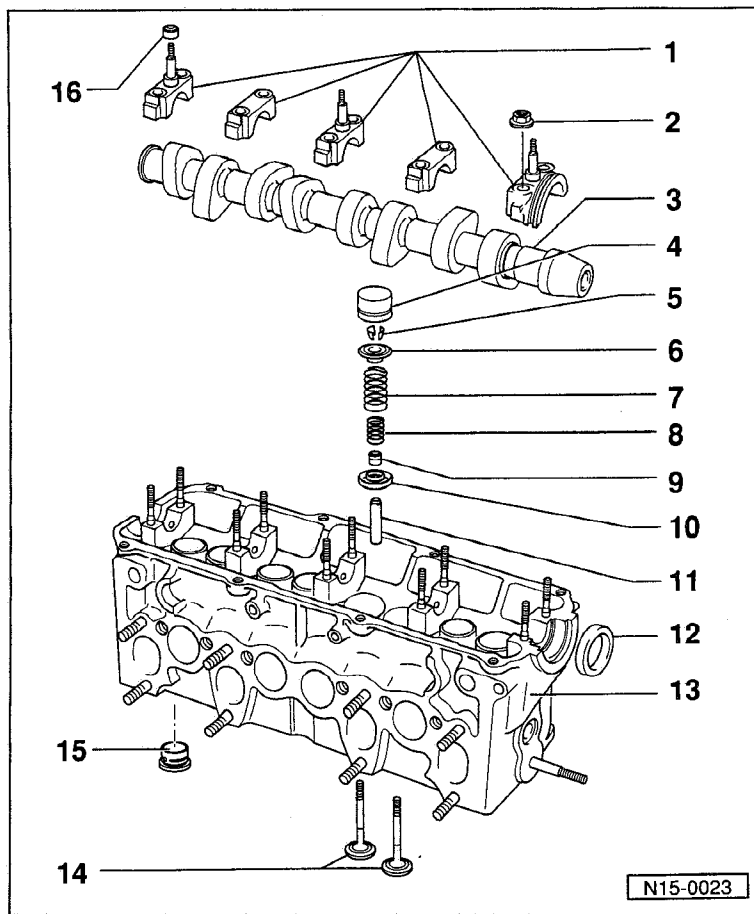
- ◆ Installation position ⇒ Fig. 2
- ◆ Installation sequence ⇒ page 15-31, camshaft, removing and installing

**2 - 20 Nm (15 ft lb)**

**3 - Camshaft**

- ◆ Checking axial clearance ⇒ Fig. 1
- ◆ Removing and installing ⇒ page 15-31
- ◆ Check radial clearance, with Plastigage®.
- ◆ Wear limit: 0.11 mm (0.0043 in.)
- ◆ Run-out: max. 0.01 mm (0.0004 in.)
- ◆ Identification and valve timing ⇒ Fig. 4

15-16



#### 4 - Hydraulic lifter

- ◆ Do not interchange
- ◆ Has hydraulic valve clearance compensation
- ◆ Checking ⇒ page 15-33
- ◆ Store with cam contact surface facing downward
- ◆ Check camshaft axial clearance before installing ⇒ Fig 1
- ◆ Oil contact surfaces before assembling

#### 5 - Valve keepers

#### 6 - Valve spring seat, upper

#### 7 - Valve spring, outer

- ◆ Removing and installing ⇒ page 15-29
- ◆ Cylinder head removed, use 2037 valve spring compressor

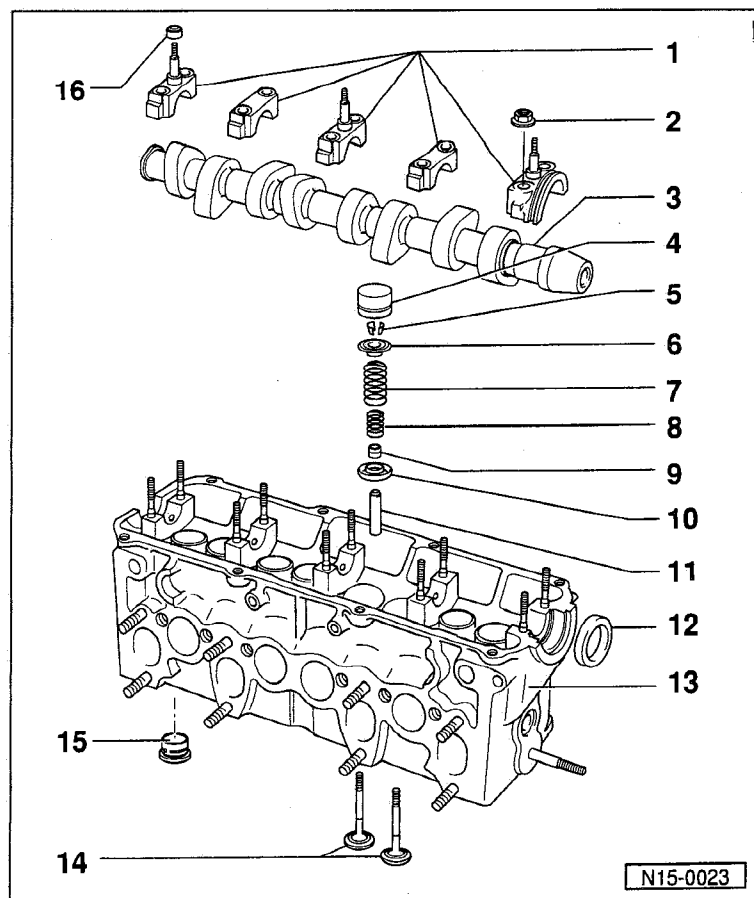
#### 8 - Valve spring, inner

- ◆ Removing and installing ⇒ page 15-29
- ◆ Cylinder head removed, use 2037 valve spring compressor

#### 9 - Valve stem seal

- ◆ Replacing ⇒ page 15-29

15-17



#### 10 - Valve spring seat, lower

- ◆ Remove and install using 3047A slide hammer

#### 11 - Valve guide

- ◆ Checking ⇒ page 15-26
- ◆ Replacing ⇒ page 15-27
- ◆ Replacement part has collar

#### 12 - Oil seal

- ◆ Use engine oil to lightly oil sealing lip, do not use grease
- ◆ To remove and install, remove bearing cap

Toothed belt, removing and installing

- ◆ Engine code 1Z ⇒ page 13-17
- ◆ Engine code AHU ⇒ page 13-22

#### 13 - Cylinder head

- ◆ See Note ⇒ page 15-16
- ◆ Valve seats, refacing ⇒ page 15-22

#### 14 - Valves

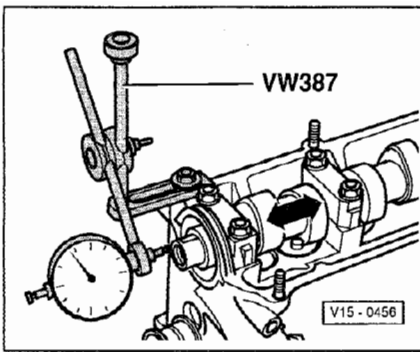
- ◆ Valve dimensions ⇒ Fig. 3

#### 15 - Swirl chamber

- ◆ Replace if damaged
- ◆ Replacing ⇒ page 15-35

#### 16 - Lower sealing cone

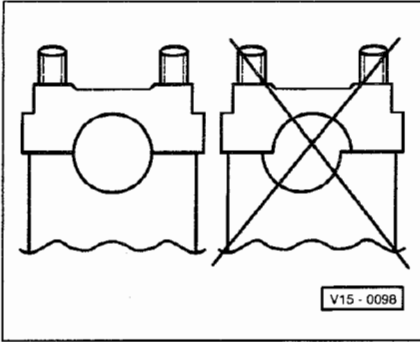
15-18



◀ **Fig. 1 Checking camshaft axial clearance**

Wear limit: max. 0.15 mm (0.0059 in.)

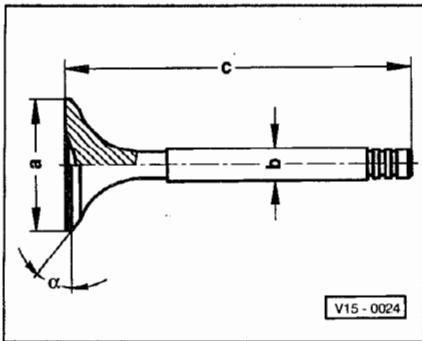
- Check with hydraulic lifters removed and with first and last bearing caps fitted.



◀ **Fig. 2 Installation position of camshaft bearing caps**

- Note offset before installing camshaft, install bearing caps to best determine camshaft installation position.

15-19



◀ **Fig. 3 Valve dimensions**

**WARNING!**

*Valves must NOT be refaced by grinding. Only lapping by hand is permitted.*

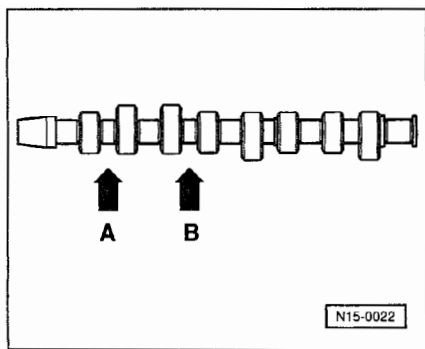
**Engine code AAZ**

Dimension		Intake valve	Exhaust valve
-a-	mm (in.)	36.0 (1.417)	31.0 (1.220)
-b-	mm (in.)	7.97 (0.3138)	7.95 (0.3130)
-c-	mm (in.)	95.0 (3.740)	95.0 (3.740)
α	∠°	45°	45°

**Engine codes 1Z, AHU**

Dimension		Intake valve	Exhaust valve
-a-	mm (in.)	35.95 (1.415)	31.45 (1.238)
-b-	mm (in.)	7.97 (0.3138)	7.95 (0.3138)
-c-	mm (in.)	96.85 (3.813)	96.85 (3.813)
α	∠°	45	45

15-20



◀ Fig. 4 Camshaft identification, valve timing

**Identification**

- ◆ Cam base diameter: 38 mm
- ◆ Identification: stamped numbers and letters between intake and exhaust cams

Engine codes	1Z, AHU	AAZ
No. 1 cylinder (arrow -A-)	W	W
No. 2 cylinder (arrow -B-)	028 F	028 D

**Valve timing at 1 mm valve lift**

Engine codes	1Z, AHU	AAZ
Intake opens after TDC	16°	6°
Intake closes after BDC	25°	20°
Exhaust opens before BDC	28°	25.5°
Exhaust closes after TDC	19°	6.5°

15-21

**Valve seats, refacing**

**Special tools, testers and auxiliary items**

- ◆ Depth gauge
- ◆ Valve seat refacing tool

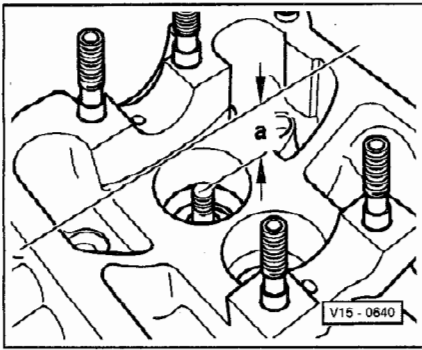
**CAUTION!**

- ◆ *When refacing valve seats, remove only enough material to produce the correct seat contact pattern. The maximum permissible refacing dimension must be calculated before refacing.*
- ◆ *If the maximum refacing dimension is exceeded, the hydraulic lifters will not function properly and the cylinder head must be replaced.*

**Note:**

*When repairing engines with leaking valves, it is not always sufficient to just replace valves and/or reface valve seats. It is also necessary to check valve guides for wear. This is particularly important on high mileage engines.*

15-22



### Maximum permissible refacing dimension, calculating

- Insert valve and press firmly against seat.

**Note:**

*If the valve is to be replaced as part of a repair, use the new valve for the calculation.*

- ◀ - Measure distance -a- between end of valve stem and upper edge of cylinder head.
- Calculate maximum permissible refacing dimension from measured distance -a- and minimum dimension.

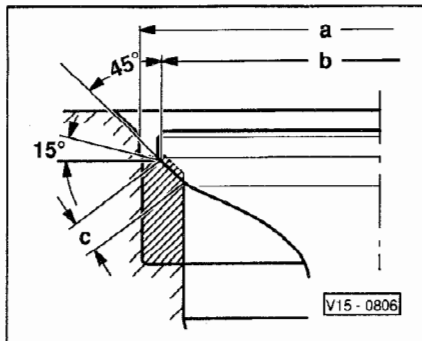
Minimum dimension:

- ♦ Intake valve 35.8 mm (1.409 in.)
- ♦ Exhaust valve 36.1 mm (1.421 in.)

Measured distance minus minimum dimension equals maximum permissible refacing dimension.

**Example (intake valve)**

Measured distance -a-	36.5 mm	(1.437 in.)
- Minimum dimension	35.8 mm	(1.409 in.)
= Maximum refacing dimension	0.7 mm	(0.028 in.)



### Engine code AAZ

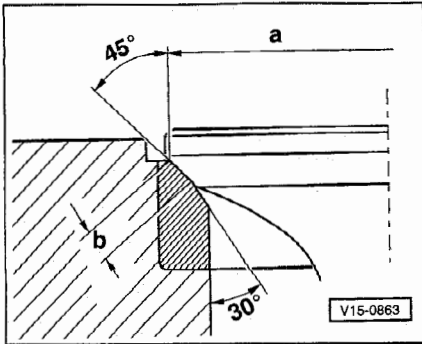
◀ **Refacing intake and exhaust valve seats**

Dimension		Intake valve seats	Exhaust valve seats
∅ a	mm (in.)	37.20 <sup>1)</sup>	33.20 <sup>1)</sup>
∅ b	mm (in.)	34.80	30.40
c	mm (in.)	2.70	2.05
45°	∠°	Valve seat angle	
15°	∠°	Correction angle	

<sup>1)</sup> Max. external diameter of correction cutter



## Engine codes 1Z, AHU

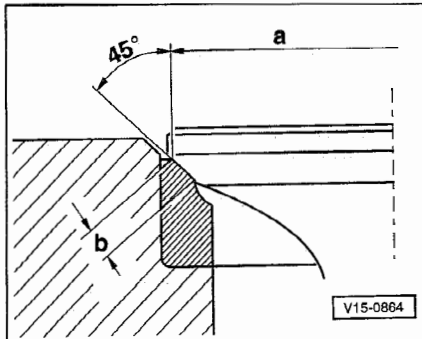


### ◀ Refacing intake valve seat

- a- = 35.7 mm (1.406 in.) diameter
- b- = 1.6 mm (0.063 in.)
- 45° = Valve seat angle

#### **Note:**

The 30° valve seat chamfer is necessary to ensure that intake channel flow characteristics are maintained.



### ◀ Refacing exhaust valve seat

- a- = 31.4 mm (1.236 in.) diameter
- b- = 2.7 mm (0.106 in.)
- 45° = Valve seat angle

15-25

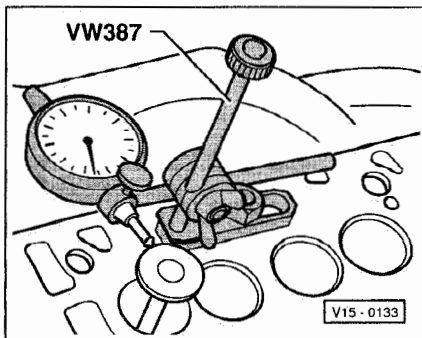
## Valve guides, checking

### Special tools, testers and auxiliary items

- ♦ VW387 dial gauge holder
- ♦ Dial gauge

### Test sequence

- Check using new valve
- ◀ - Insert 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.

- Rock valve from side to side and note total travel on dial indicator.

### Wear limit

Intake and exhaust: 1.3 mm (0.051 in.)

15-26

## Valve guides, replacing

### Special tools, testers and auxiliary items

- ◆ 10-206 drift
- ◆ 10-215 hand reamer and cutting fluid

### Removing

- Clean and check cylinder head. Do not replace valve guides in cylinder heads in which valve seats can no longer be re-faced, or in cylinder heads which have been machined to minimum dimension.
- Press out worn production valve guides using 10-206 drift from camshaft side.

#### **Note:**

*If pressing out replacement valve guides (with shoulder), press out from the combustion chamber side.*

15-27

### Installing

- Coat new guides with oil and press in using 10-206 drift from camshaft side (cylinder head cold) until shoulder of new guide just contacts head.

#### **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.***

- Ream guides out using 10-215 hand reamer using plenty of cutting fluid.
- Reface valve seats ⇒ page 15-22.

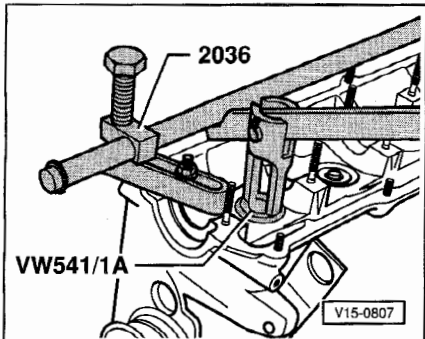
15-28

## Valve stem seals, replacing

(With cylinder head installed)

### Special tools, testers and auxiliary items

- ◆ 3047A slide hammer
- ◆ 2036 adjustable rod
- ◆ VW541/1A lever with VW541/5 or US4481 valve spring retainer
- ◆ 10-204 or US5042 driver



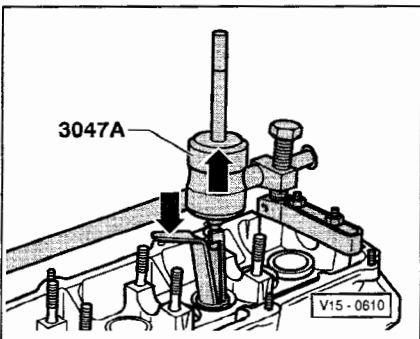
### Removing

- Remove camshaft ⇒ page 15-31.
- Remove hydraulic lifters (do not interchange) and store with cam contact surface facing downward.
- Bring piston of respective cylinder to TDC.
- ◀ - Fit 2036 adjustable rod and adjust mountings to height of studs.
- Remove valve springs using VW541/1A lever and VW541/5 (or US5042) valve spring retainer.

### Note:

The valves are supported by the piston crown.

15-29



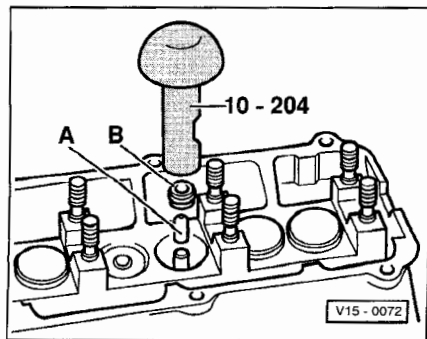
- ◀ - Remove valve stem seals using 3047A slide hammer.

### CAUTION!

To prevent damaging the valve stem oil seals, always use the plastic fitting sleeve.

### Installing

- ◀ - Slide plastic sleeve -A- on end of valve stem.
- Oil valve stem seal -B-.
- Place seal in 10-204 (or US5042) driver and push carefully onto valve guide.



15-30

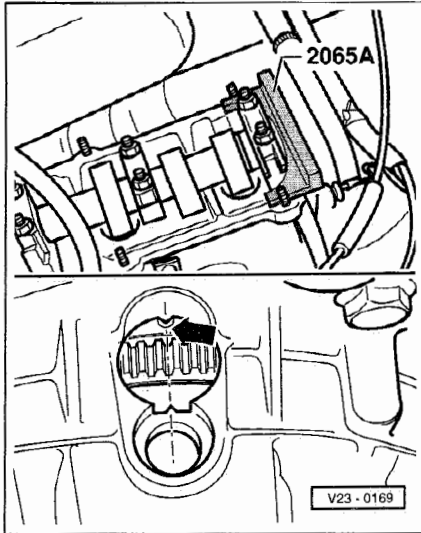
## Camshaft, removing and installing

### Special tools, testers and auxiliary items

VAG1331 torque wrench, 5 to 50 Nm

### Removing

- Remove upper toothed belt guard and cylinder head cover.
- ◀ - Turn crankshaft to TDC for cyl. 1 (arrow).
- Loosen tensioner.
- Remove toothed drive belt ⇒ page 13-17.
- Loosen camshaft sprocket securing bolt 1/2 turn. Release camshaft sprocket from camshaft taper by tapping with hammer (using drift through rear toothed belt guard opening).
- Remove camshaft sprocket.
- First remove bearing caps 5, 1 and 3. Loosen nuts for bearing caps 2 and 4 gradually and evenly, alternating in diagonal pattern.

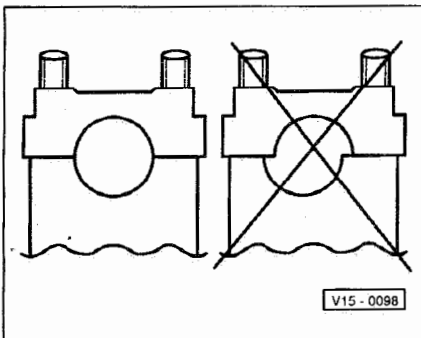


15-31

### Installing

#### Notes:

- ♦ *Cylinder no. 1 cam lobes must point upward when installing.*
- ◀ ♦ *Before installing bearing caps note offset. Fit bearing caps to determine installed position before installing camshaft.*
- Oil camshaft contact surfaces.
- Tighten bearing caps gradually and evenly, alternating in diagonal pattern.
- Install and tighten bearing caps 2 and 4.  
Tightening torque: 20 Nm (15 ft lb)
- Install and tighten bearing caps 5, 1 and 3.  
Tightening torque: 20 Nm (15 ft lb)
  - If bearing cap 5 is difficult to install, locate cap by tapping lightly on end of camshaft.
- Install camshaft sprocket.
- Install and tension toothed belt ⇒ page 13-17.



#### **CAUTION!**

***After installing new valve lifters, do not start the engine for approx. 30 minutes (to allow the new lifters to bleed down to proper height). Otherwise valves may strike the pistons.***

15-32

## Hydraulic lifters, checking

### **CAUTION!**

**After installing new valve lifters, DO NOT start the engine for approx. 30 minutes. This is to allow the new lifters to bleed down to proper height. Otherwise valves may strike the pistons.**

### Special tools, testers and auxiliary items

- ◆ Feeler gauge
- ◆ Wood or plastic wedge

### Notes:

- ◆ *Replace malfunctioning lifters only as complete units (they cannot be adjusted or repaired).*
- ◆ *Irregular valve noises during engine start-up are normal.*

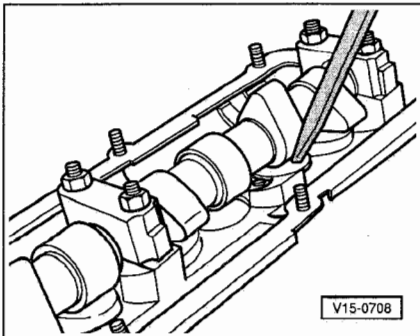
### Test sequence

- Start engine and run until radiator coolant fan has switched on at least once.
- Increase engine speed to about 2500 RPM for 2 minutes.

If the hydraulic lifters are still noisy, locate malfunctioning lifter(s) as follows:

- Remove cylinder head cover.

15-33



- Rotate crankshaft clockwise, until cam lobe of lifter to be checked is pointing upward.

- Measure clearance between cam lobe and lifter.

If clearance exceeds 0.1 mm (0.004 in.):

- Replace lifter.

If clearance is less than 0.1 mm (0.004 in.) or zero.

- Proceed with checking as follows.

- ▶ - Press lifter down using wooden or plastic wedge. If free travel in excess of 1 mm (0.040 in.) is felt before lifter contacts valve, replace lifter.

15-34

## Swirl chambers, replacing

- ◆ Swirl chambers are supplied as replacement parts for the 1.9 liter Diesel engine
- ◆ When installing a metal cylinder head gasket on an engine that previously used a plastic gasket (⇒ page 15-2), the swirl chambers should also be replaced

### Special tools, testers and auxiliary items

- ◆ VW382/7 measuring bar
- ◆ VW385/17 magnetic plate 50 mm dia.

### Replacing

- Cylinder head removed
- Remove all fuel injectors.

Engine code AAZ

⇒ 1.9 Liter Diesel Fuel Injection & Ignition, Repair Group 23

Engine codes 1Z, AHU

⇒ 1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System, Repair Group 23

- Remove glow plugs.

Engine codes 1Z, AHU: use 3220 hinged socket

15-35

- Drive swirl chamber out of cylinder head using suitable drift inserted through fuel injector opening.

#### **CAUTION!**

**Protect threads in fuel injector opening from damage.**

- Clean swirl chamber contact surface in cylinder head to remove combustion deposits.
- Place new swirl chamber in position and drive in using soft-faced hammer.

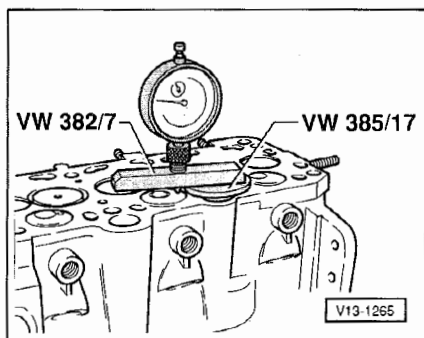
Installation position is determined by groove and guide tabs

- Measure projection of swirl chamber.

Specified value: 0.07 mm (0.0028 in.) maximum

If swirl chamber projects more than specified value:

- Replace cylinder head.



15-36

## Lubrication system, general information

### CAUTION!

- ◆ If large amounts of metal shavings or small metal particles are found in the engine oil, caused by wear of crankshaft and connecting rod bearings, thoroughly clean the oil passages to remove contaminants and help prevent later damage.
- ◆ The oil cooler cannot be sufficiently cleaned, and must be replaced.

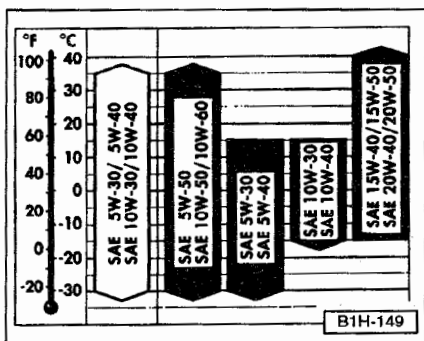
Oil pressure, checking ⇒ page 17-8

### Oil capacity

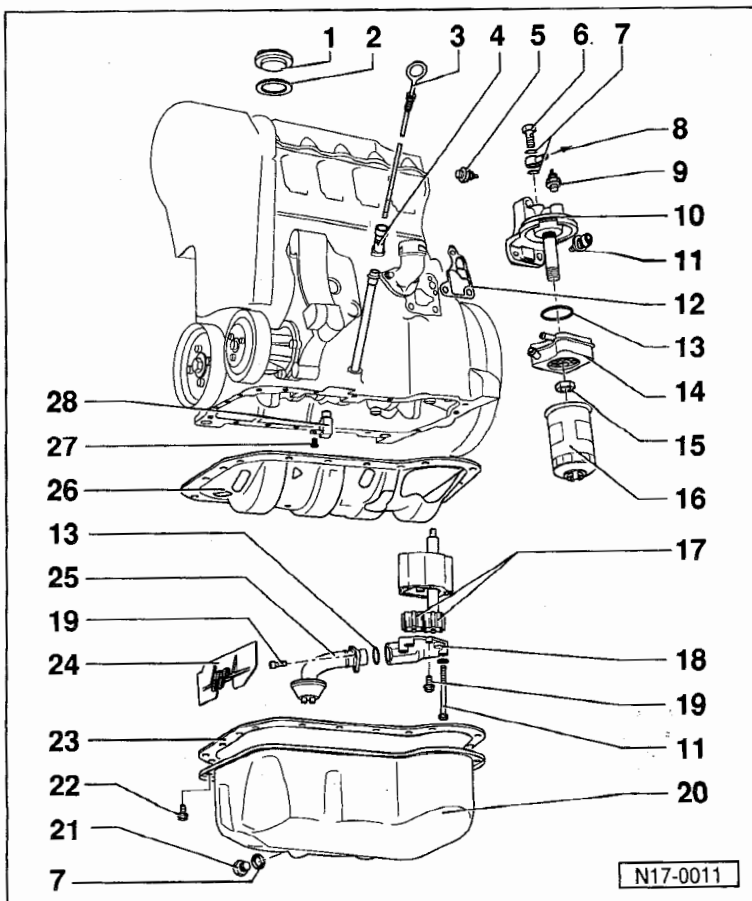
- ◆ Without oil filter: 4.0 liters (4.2 qt.)
- ◆ With oil filter: 4.5 liters (4.7 qt.)

### Engine oil, specifications

- ◆ Only use multi-grade or single-grade oils conforming to API-CD
- ◆ Choose the proper viscosity by considering the ambient temperatures and environment in which the vehicle is operated



17-1



## Lubrication system, component layout

### WARNING!

- ◆ Do not re-use fasteners that are worn or deformed in normal use.
- ◆ Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.

### CAUTION!

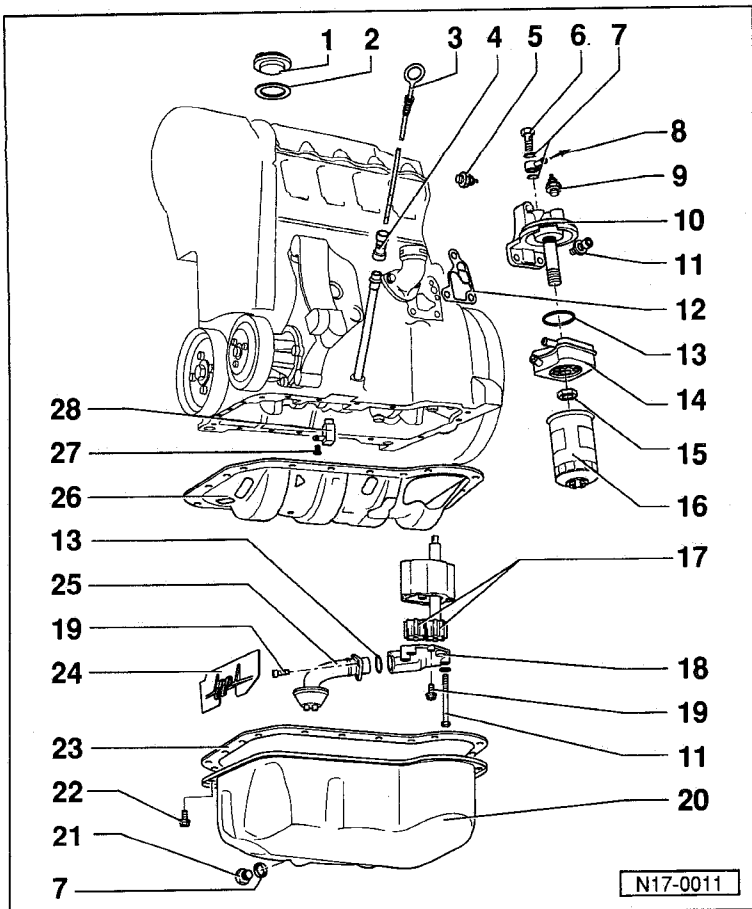
Part numbers are listed here for reference only. Always check with your Parts department for the latest information.

1 - Cap

2 - Gasket

- ◆ Replace if damaged

17-2



### 3 - Oil dipstick

- ◆ Oil level must not be above MAX mark.
- ◆ Area above shaded zone up to MAX mark: Do not top up engine oil!
- ◆ Oil level in shaded zone: Engine oil can be topped up.
- ◆ Area from MIN mark up to shaded zone: Top up engine oil

### 4 - Guide

- ◆ Remove to suck oil out

### 5 - 0.3 bar oil pressure switch -F22-

- ◆ 0.3 bar (4.4 psi)
- ◆ Color: Blue
- ◆ Checking ⇒ page 17-8
- ◆ 25 Nm (18 ft lb)
- ◆ If sealing ring is leaking, cut open and replace

### 6 - Banjo bolt

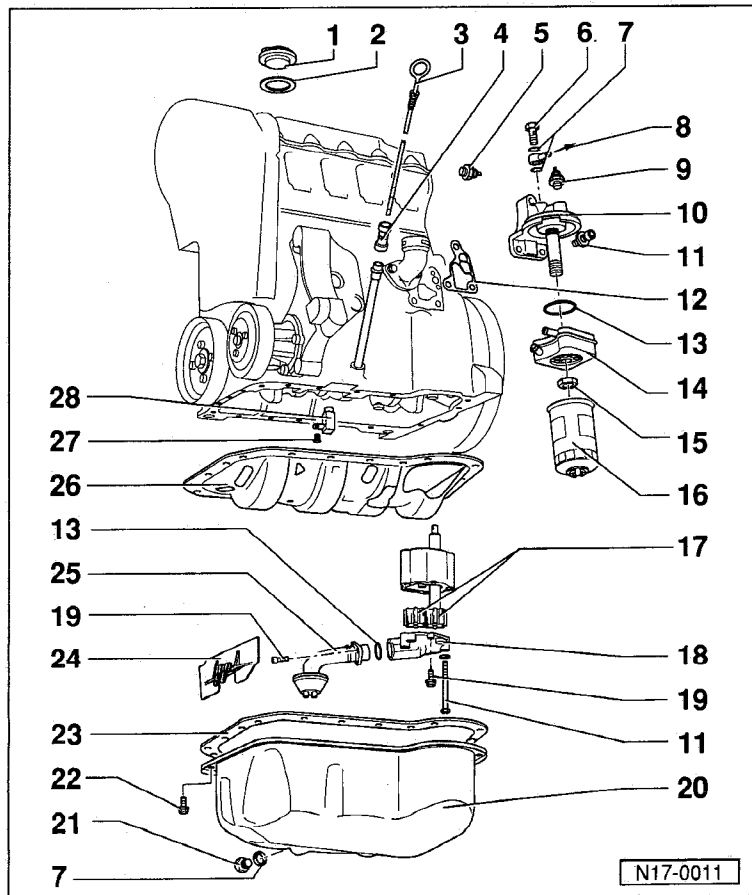
- ◆ 25 Nm (18 ft lb)

### 7 - Oil seal

- ◆ Always replace

### 8 - To charge air cooler

17-3



### 9 - Oil pressure switch -F1-

- ◆ Color: Grey
- ◆ Checking ⇒ page 17-8
- ◆ 25 Nm (18 ft lb)
- ◆ If sealing ring is leaking, cut open and replace

### 10 - Oil filter bracket

### 11 - Mounting bolt

- ◆ 25 Nm (18 ft lb)

### 12 - Gasket

- ◆ Always replace

### 13 - O-ring

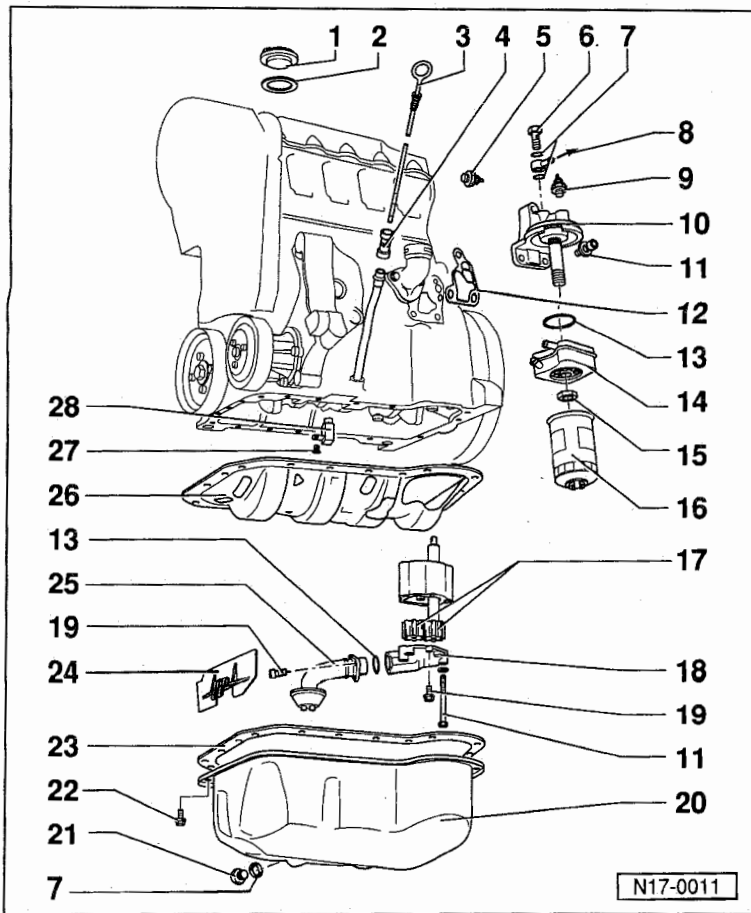
- ◆ Always replace

### 14 - Oil cooler

- ◆ Coat oil filter bracket contact surfaces outside of seal with AMV 188 100.02
- ◆ Make sure that there is adequate clearance to surrounding components
- ◆ If metal shavings or particles are found in engine oil, oil cooler must be replaced ⇒ CAUTION!, page 17-1

17-4





15 - 25 Nm (18 ft lb)

**16 - Oil filter**

- ◆ Loosen with filter wrench
- ◆ Tighten by hand
- ◆ Note installation instructions on filter

**17 - Oil pump gears**

- ◆ Checking backlash ⇒ Fig. 1
- ◆ Checking axial play ⇒ Fig. 2
- ◆ Gear width: 36 mm (1.42 in.)

**18 - Oil pump cover with pressure relief valve**

- ◆ Opening pressure: 5.7–6.7 bar (82.65–97.15 psi)

19 - 10 Nm (7 ft lb)

**20 - Oil pan**

- ◆ Clean mating surfaces before assembly

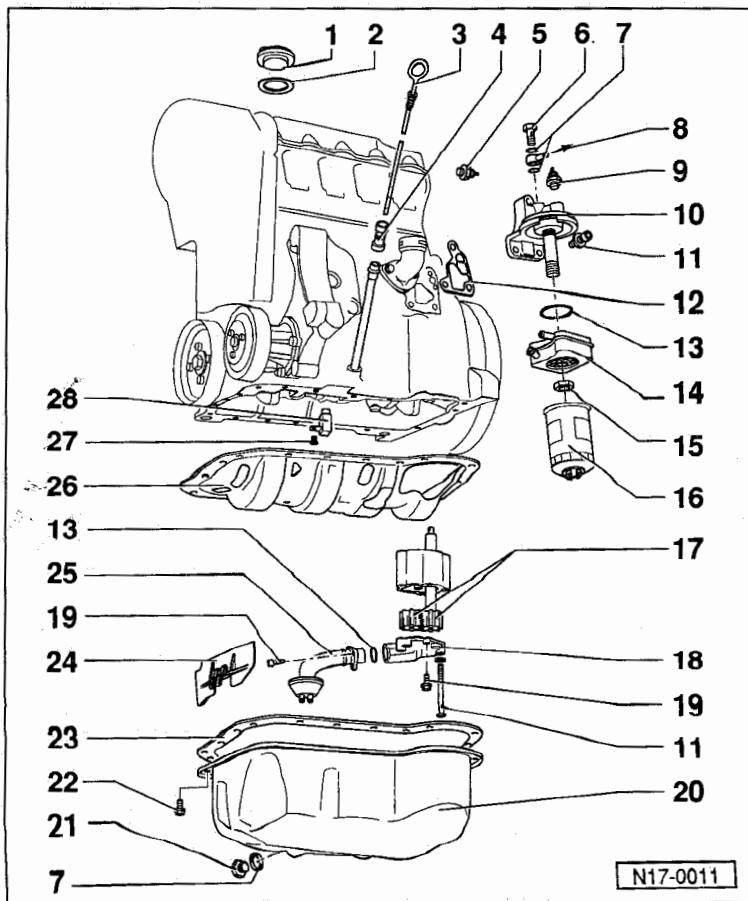
**21 - Oil drain plug**

- ◆ 30 Nm (22 ft lb)

**22 - 20 Nm (15 ft lb)**

- ◆ Remove and install rear bolts to transmission using 3185 or equivalent 10 mm swivel/extension

17-5



**23 - Gasket**

- ◆ Engine codes 1Z, AHU
- ◆ Always replace
- ◆ Before installing gasket coat oil pan/engine block flange with D2 sealant

**24 - Baffle**

**25 - Oil pick-up**

- ◆ Clean strainer

**26 - Baffle plate**

- ◆ Engine code AAZ
- ◆ With seal
- ◆ Replace seal if damaged

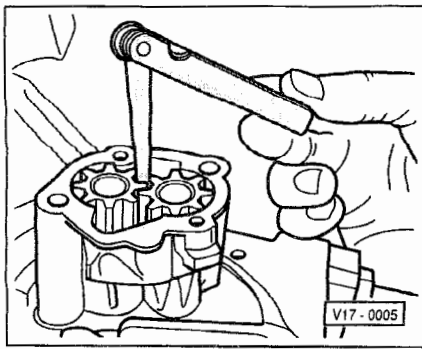
**27 - 10 Nm (7 ft lb)**

- ◆ Install with AMV 188 100.02

**28 - Oil spray nozzle**

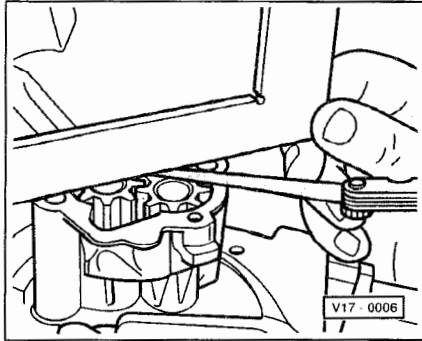
- ◆ For piston cooling

17-6



◀ **Fig. 1 Checking oil pump gear backlash**

- ◆ New: 0.05 mm (0.0020 in.)
- ◆ Wear limit: 0.20 mm (0.0079 in.)



◀ **Fig. 2 Checking oil pump gear axial play**

Wear limit: 0.15 mm (0.0059 in.)

17-7

## Oil pressure and oil pressure switch, checking

### Dynamic oil pressure warning system

#### Note:

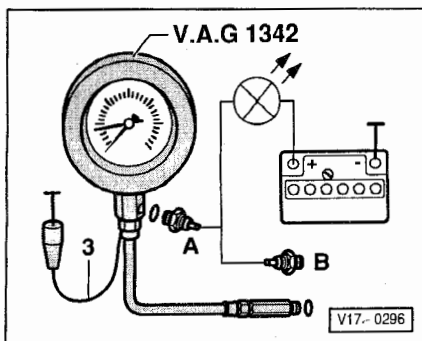
For functional testing and repair of the optical (warning light) and acoustic (warning buzzer) oil pressure warning systems → "Electrical Wiring Diagrams, Troubleshooting & Component Locations" binder.

#### Special tools, testers and auxiliary items

- ◆ VAG1342 oil pressure gauge
- ◆ VAG1527B voltage tester
- ◆ VW1594 connector test kit

#### Test sequence

- ◀ – Remove 0.3 bar oil pressure switch -F22- (blue insulation) and install in VAG1342 oil pressure gauge.
- Connect line from VAG1342 oil pressure gauge in place of 0.3 bar oil pressure switch -F22-.
- Connect brown wire from oil pressure gauge to Ground.
- Connect VAG1527B voltage tester to battery positive voltage (B+) and 0.3 bar oil pressure switch -A- (installed in oil pressure gauge) using adapters from VW1594 connector test kit.



17-8

- Voltage tester LED must light up
- Start engine and increase RPM slowly to 0.15–0.45 bar (2.2–6.5 psi).

- Voltage tester LED must go out

If NO:

- Replace 0.3 bar oil pressure switch -F22-.
- Connect VAG1527B voltage tester to 0.9 bar oil pressure switch -F1- (grey insulation) on oil filter mounting bracket -B-. Increase RPM slowly to 0.75-1.05 bar (10.9-15.2 psi)

- LED must light up

If NO:

- Replace oil pressure switch -F1-.
- Increase engine speed further and check engine oil pressure:
  - ◆ At 2000 RPM and 80°C (176°F) oil temperature, oil pressure must be min. 2.0 bar (29 psi)
  - ◆ At higher RPM, oil pressure must not exceed 7.0 bar (101 psi).

If NO:

- Replace oil pump cover with pressure relief valve.

## Cooling system components, servicing

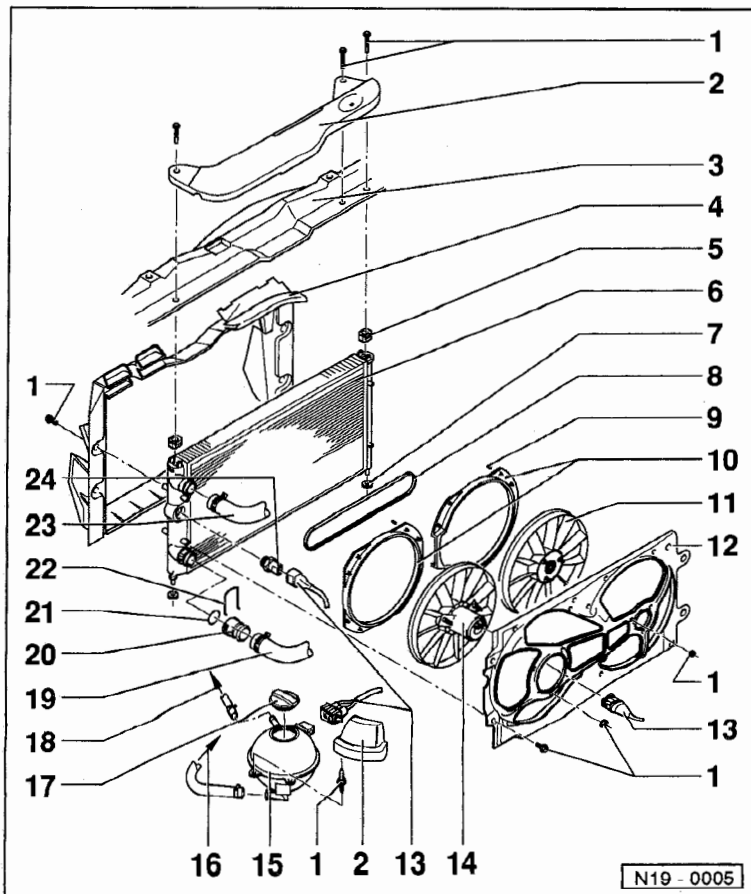
### WARNING!

- ◆ *The cooling system is pressurized when the engine is warm. When opening the expansion tank, wear gloves and other appropriate protection, cover the cap with a cloth and open carefully to relieve system pressure slowly.*
- ◆ *Do not re-use any fasteners that are worn or deformed in normal use.*
- ◆ *Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.*

### Notes:

- ◆ *Hoses are secured with spring-type clips. In cases of repair only use spring-type clips for replacements.*
- ◆ *VAG1921 pliers are recommended for installing spring-type hose clamps.*
- ◆ Engine coolant, draining and filling ⇒ page 19-10
- ◆ Coolant mixture ratios ⇒ page 19-10
- ◆ Cooling system leak-testing, use VAG1274 cooling system tester and VAG1274/3 adapter

19-1



### Cooling system components, body side

1 - 10 Nm (7 ft lb)

2 - Cover

3 - Lock carrier

4 - Air intake elbow

5 - Bracket

6 - Radiator

◆ Removing and installing ⇒ page 19-14

◆ After replacing, completely replace engine coolant

7 - Rubber washer

8 - V-belt

9 - Expandable pin

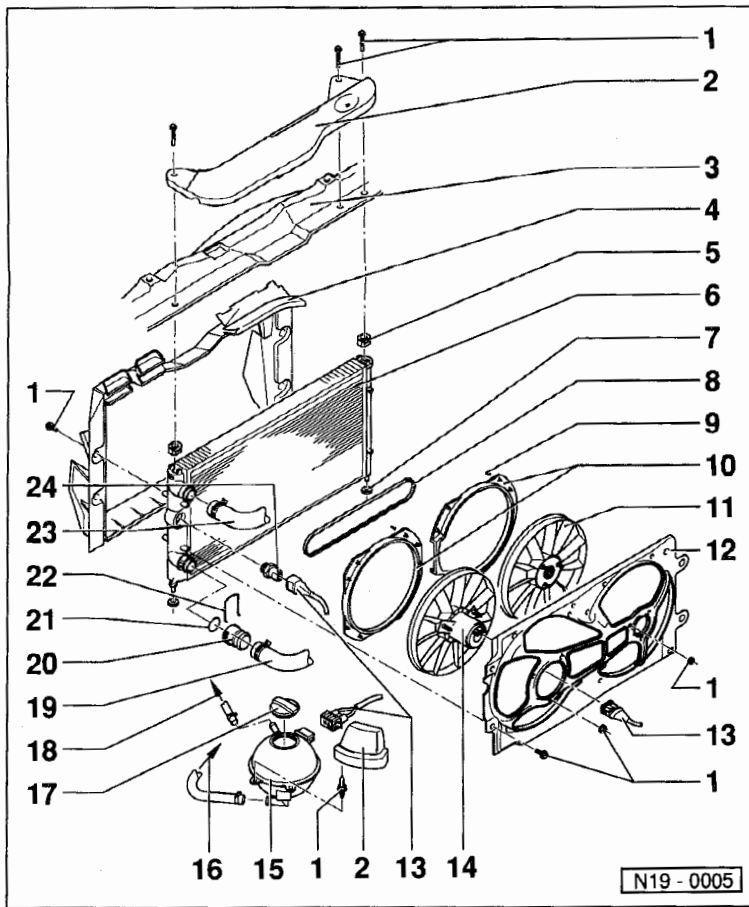
10 - Guide ring

◆ Note installed position

◆ Secured to lock carrier -3- with clips

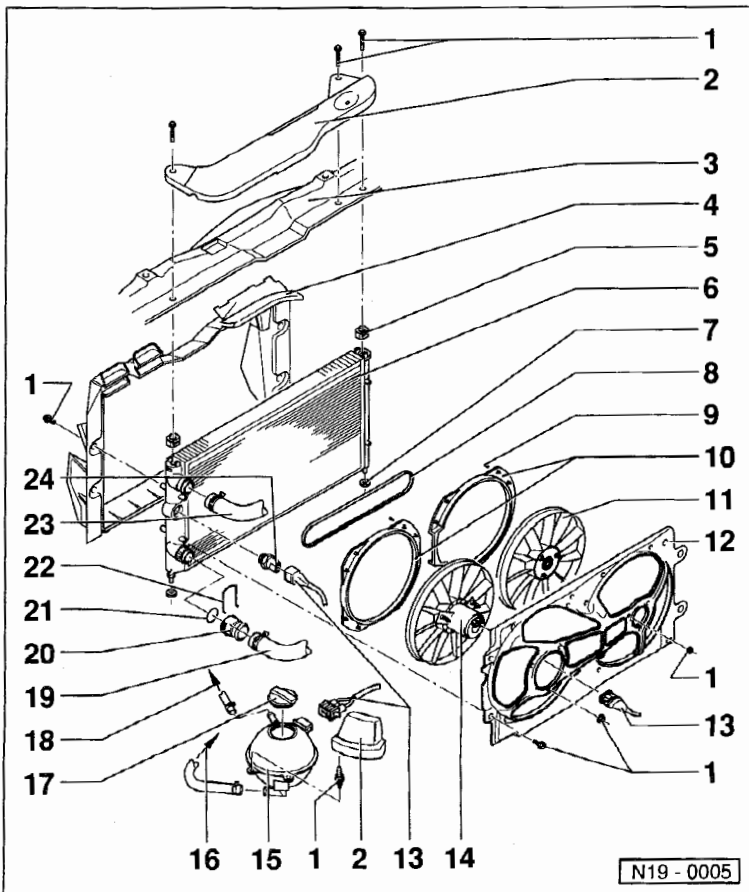
◆ Removing and installing ⇒ page 19-14

19-2



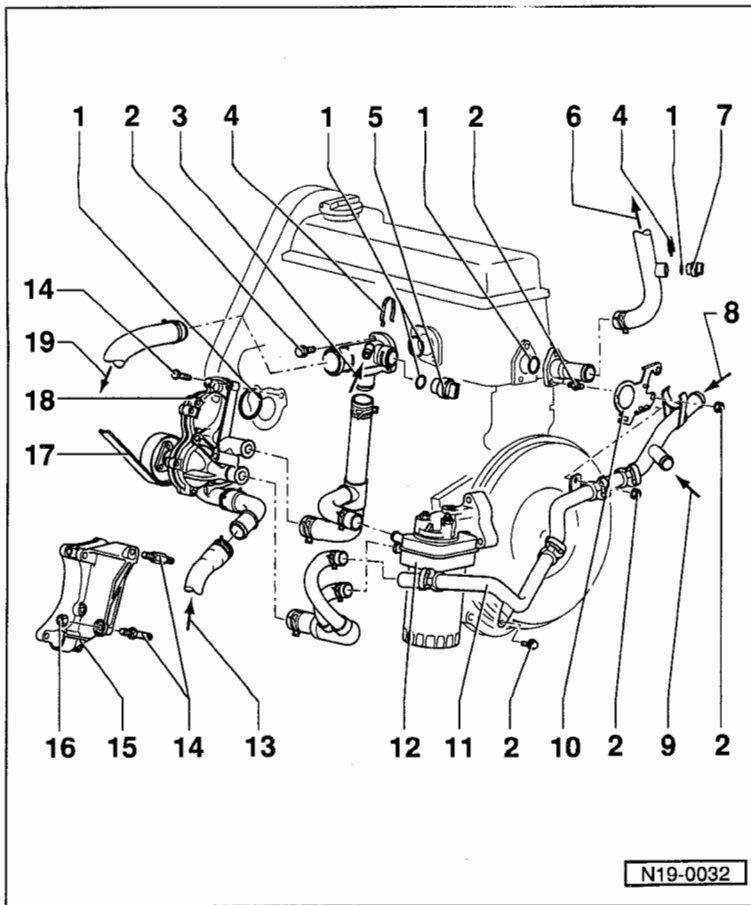
- 11 - Additional fan
- 12 - Fan ring
- 13 - Connector
- 14 - Coolant fan
  - ◆ Removing and installing ⇒ page 19-14
- 15 - Expansion tank
- 16 - To coolant line
  - ◆ ⇒ page 19-6, item 9
- 17 - Cap
  - ◆ Check using cooling system tester VAG1274 and 1274/4
  - ◆ Test pressure: 1.3–1.5 bar (20–23 psi)
- 18 - To connection
  - ◆ ⇒ page 19-5, item 3
- 19 - Lower coolant hose
  - ◆ To engine coolant pump ⇒ page 19-7, item 18
- 20 - Connection
- 21 - O-ring
  - ◆ Always replace

19-3



- 22 - Retaining clip
  - 23 - Upper coolant hose
    - ◆ To connection ⇒ page 19-7, item 19
  - 24 - Coolant Fan Control (FC) thermal switch -F18-
    - ◆ 35 Nm (26 ft lb)
    - ◆ For electric fan
    - ◆ Only with optional extras: third speed coolant Fan Control (FC) thermal switch -F165- ⇒ page 19-5, item 7
- Switching temperatures
- Stage 1:
- ◆ On: 92–97° C (198–207° F)
  - ◆ Off: 84 to 91° C (183–196° F)
- Stage 2:
- ◆ On: 99–105° C (210–221° F)
  - ◆ Off: 91–98° C (196–208° F)

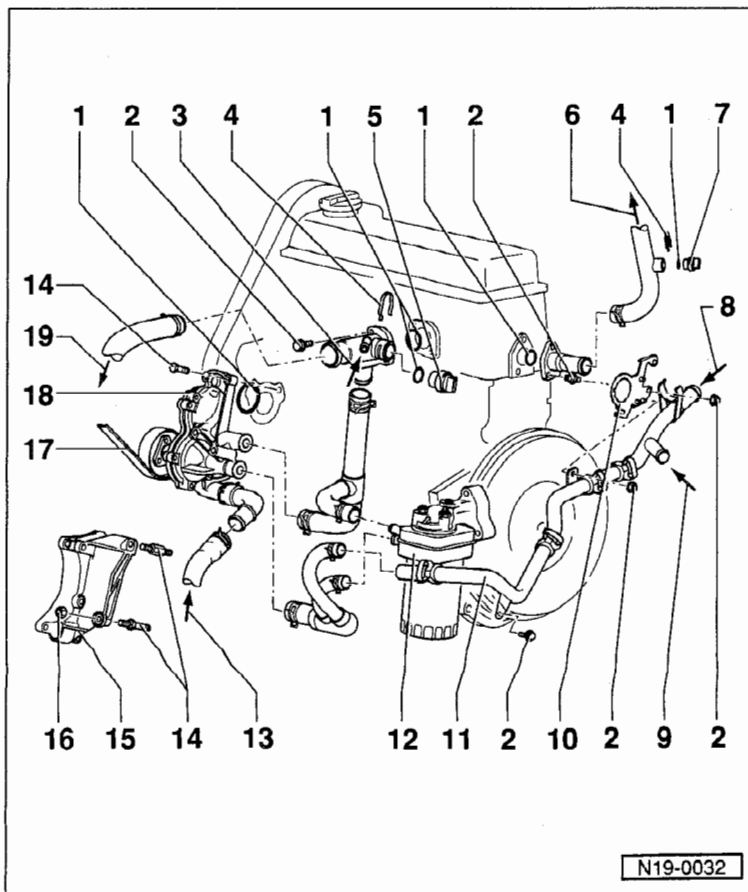
19-4



## Cooling system components, engine side

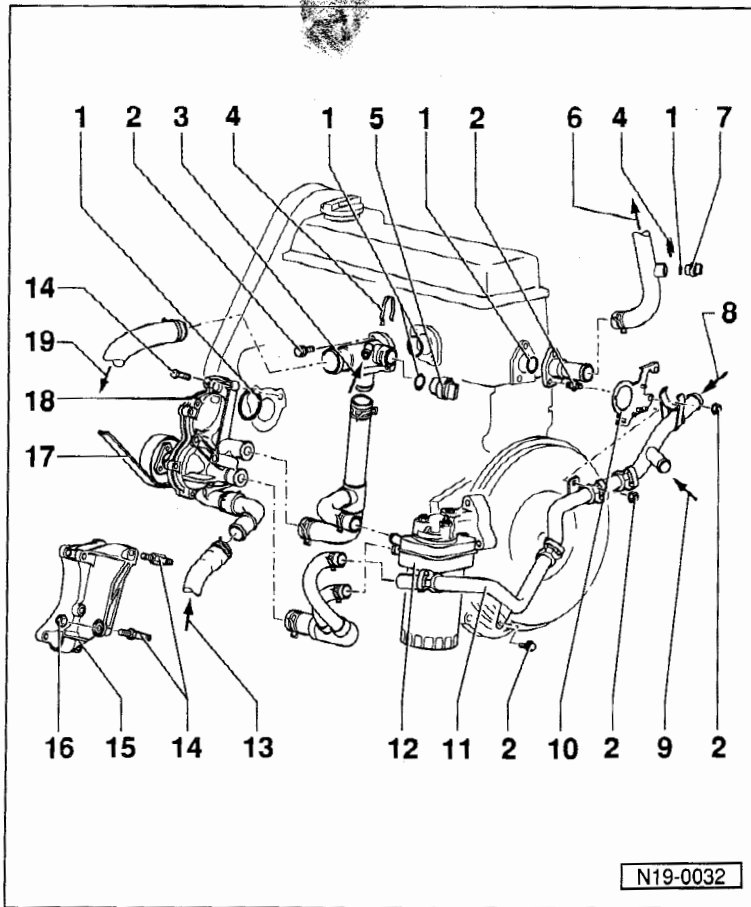
- 1 - O-ring**
  - ◆ Always replace
- 2 - 10 Nm (7 ft lb)**
- 3 - From expansion tank**
  - ◆ Item 18 ⇒ page 19-4
- 4 - Retaining clip**
- 5 - Engine Coolant Temperature (ECT) sensor -G62- or sensor for engine temperature -G27-**
  - ◆ With Engine Coolant Temperature (ECT) sensor -G2-
- 6 - Coolant hose**
  - ◆ Engine code AHU: to EGR cooler
  - ◆ Engine codes AAZ, 1Z: to heater core
- 7 - Not applicable for USA/Canada**

19-5



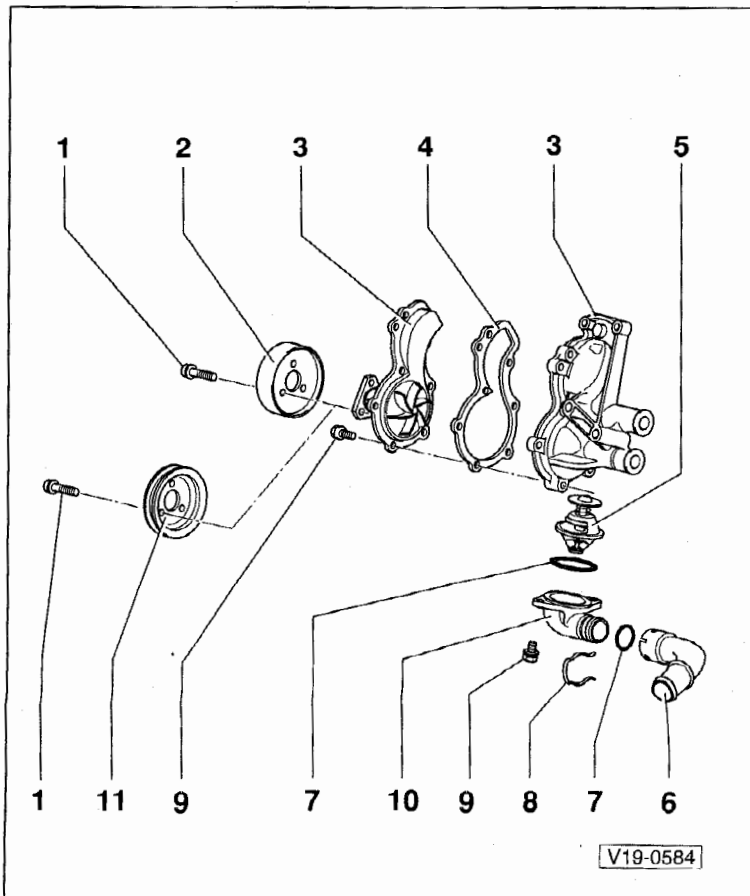
- 8 - From heater core**
- 9 - To expansion tank**
  - ◆ Item 16 ⇒ page 19-3
- 10 - Bracket**
- 11 - Coolant line**
- 12 - Oil cooler**
  - ◆ Removing and installing ⇒ page 17-2
- 13 - From bottom of radiator**
  - ◆ ⇒ page 19-3, item 19
- 14 - 20 Nm (15 ft lb) + 1/4 turn (90°)**
  - ◆ Always replace
- 15 - Bracket**
  - ◆ For ribbed belts without tensioner
- 16 - 30 Nm (22 ft lb)**
- 17 - V-belt/ribbed belt**
  - ◆ Removing and installing ribbed belt ⇒ page 13-13
  - ◆ Adjusting V-belt tension ⇒ Repair Manual, *Suspension Wheels, Brakes, Steering, Repair Group 48*

19-6



- 18 - Engine coolant pump**
  - ◆ Disassembling and assembling
  - ⇒ page 19-8
- 19 - To top of radiator**
  - ◆ ⇒ page 19-4, item 23

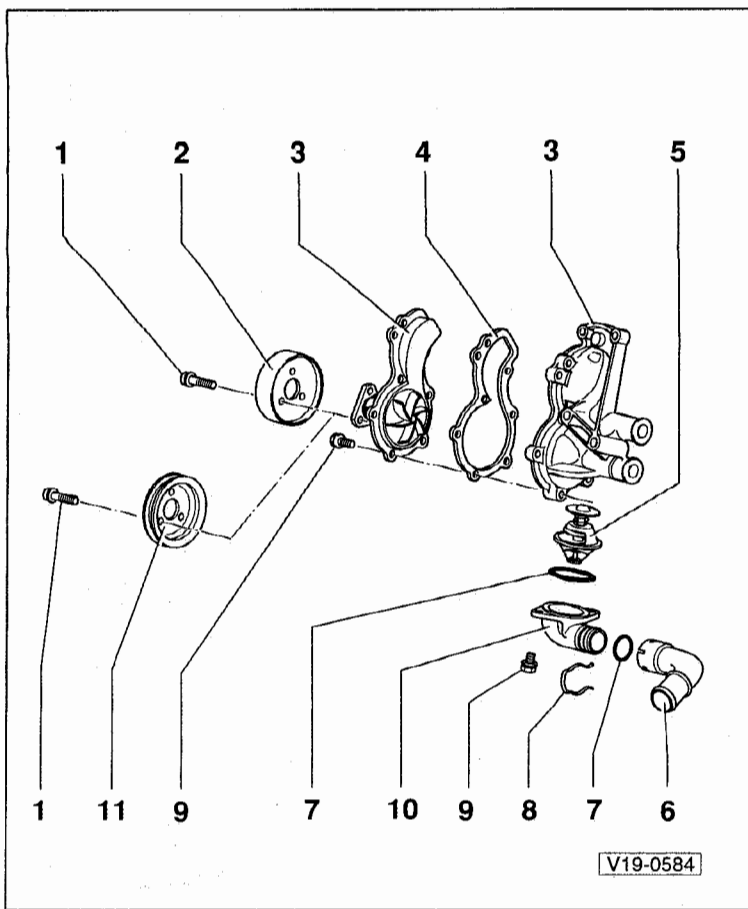
19-7



**Engine coolant pump, disassembling and assembling**

- 1 - 25 Nm (18 ft lb)**
- 2 - Pulley**
  - ◆ Ribbed belt version
- 3 - Engine coolant pump**
  - ◆ Check shaft for ease of movement
- 4 - Gasket**
  - ◆ Always replace
- 5 - Coolant thermostat**
  - ◆ Checking: heat thermostat in boiling water
  - ◆ Opening starts approx. 85° C (185° F)
  - ◆ Fully open approx. 105° C (221° F)
  - ◆ Opening lift: 7 mm (0.27 in.) minimum
- 6 - Elbow connection**
- 7 - O-ring**
  - ◆ Always replace

19-8



8 - Retaining clip

9 - 10 Nm (7 ft lb)

10 - Thermostat housing

11 - Pulley  
 ♦ V-belt version

19-9

### Cooling system, draining and filling

- ♦ Anti-freeze and coolant additives marked "In accordance with TL VW774 B" prevent freezing, corrosion damage, scale formation and raises the coolant's boiling point.
- ♦ The high boiling point of the coolant mixture helps improve engine efficiency when operating at full load, particularly in tropical climates.
- ♦ The cooling system is filled for use year-round with a mixture of water and "G11" anti-freeze coolant additive.
- ♦ If the engine coolant radiator, heater core, cylinder head or cylinder head gasket are replaced, completely replace engine coolant. Do not re-use old coolant.
- ♦ Dispose of used coolant properly.

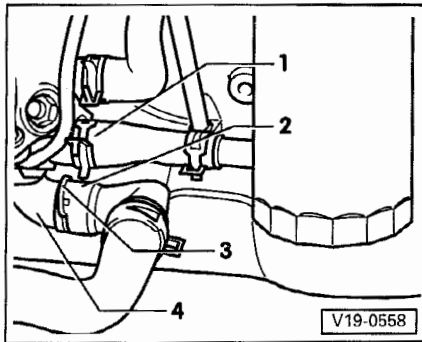
**WARNING!**

*The cooling system is pressurized when the engine is warm. When opening the expansion tank, wear gloves and other appropriate protection, cover the cap with a cloth and open carefully to relieve system pressure slowly.*



**CAUTION!**

- ◆ A new "G12" coolant additive, recognized by its red color, has been introduced during m.y. 1997, replacing the "G11" used previously.
- ◆ The "G11" and "G12" coolant additives are **NOT** interchangeable, and must **NEVER** be mixed. Use only water or "G12" coolant additive G 012 A8D A1 to top up cooling systems filled with "G12."
- ◆ Contamination of "G12" with other coolants can be identified by discoloration (brown, purple, etc.), and foamy deposits in the radiator or expansion tank. If contaminated, the system must be drained and flushed immediately.
- ◆ "G12" (Part No. G 012 A8D A1) may also be used in older vehicles, but only if the cooling system is drained and flushed as described below.
- ◆ Part numbers listed are for reference only. Always check with the Parts department for the latest information.



**Draining**

- Remove cap from coolant expansion tank.
- ◀ - Remove retaining clip -3- and separate connection -2- from thermostat housing -4-.
- Remove coolant hose -1- or remove thermostat housing -4-.

19-11

**Flushing procedure**

- Engine at normal operating temperature (heater valve open where applicable)
- Coolant drained
- Apply compressed air to expansion tank to help blow out remaining coolant.
- Close cooling system, fill with distilled water, then run engine for minimum of 2 minutes.
- Drain cooling system and apply compressed air to expansion tank to help blow out remaining water.
- Close cooling system and fill with appropriate mixture of "G12" coolant additive and distilled water ⇒ page 19-13.
- Test drive vehicle and top off coolant level if necessary.

**CAUTION!**

- ◆ **Never reuse old coolant.**
- ◆ **Dispose of old coolant properly.**
- ◆ **Coolant G 012 A8D A1 may only be used in older vehicles after the original coolant is drained and the cooling system flushed as described above otherwise engine damage can result.**
- ◆ **Part numbers listed are for reference only. Always check with the Parts department for the latest information.**

19-12

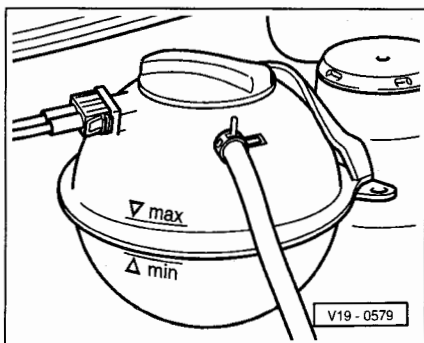
## Filling

Recommended mixture ratios:

Protection down to	Coolant additive <sup>2)</sup>	Water <sup>2)</sup>
-25°C (-13°F)	2.6 liters(2.7 qt.)	3.9 liters(4.1 qt.)
-35°C (-36°F)	3.25 liters(3.4 qt.)	3.25 liters(3.4 qt.)

1) Percentage of anti-freeze must not exceed 60%: otherwise freeze protection and cooling efficiency will decrease.

2) Total coolant quantity may vary depending on vehicle equipment.



- Press down on top of radiator hose.
- ◀ - Slowly fill with coolant up to "max" mark on expansion tank (filling time approx. 5 minutes).
- Start engine and run at approx. 1500 RPM for 2 minutes max. while filling coolant up to over-flow hole on expansion tank.
- Re-install cap on expansion tank and run engine until radiator coolant fan has switched on.
- Check engine coolant level and top-off, if necessary.
- When engine is at normal operating temperature, coolant level must be on "max" mark
- When engine is cold, coolant level must be between "min" and "max" marks

19-13

## Radiator and coolant fan, removing and installing

### Special tools, testers and auxiliary items

VAG1921 pliers for spring type clips.

### Removing

#### Note:

Vehicles with A/C, observe additional information and removal work ⇒ page 19-15.

- Drain coolant ⇒ page 19-10.
- Remove radiator coolant hoses.
- Disconnect harness connectors from thermoswitch and radiator coolant fan.
- Remove radiator mounting bolts.
- Remove lock carrier with attachments.  
⇒ Repair Manual, *Body—Exterior*, *Body—Interior*, Repair Group 50
- Lift out radiator, coolant fan and air guide housing.

### Installing

Installation is in the reverse order of removal procedure. When installing, note the following:

19-14

Filling with coolant ⇒ page 19-10

Electrical connections and routing

⇒ Repair Manual, *Electrical Equipment*, Repair Group 97

- Check headlight alignment and adjust if necessary.
- ⇒ Repair Manual, *Maintenance*

**Additional removal information for vehicles with A/C**

**CAUTION!**

- ♦ **Disconnect A/C refrigerant line brackets and support points only.**
- ♦ **DO NOT open the air conditioning refrigerant circuit.**
- ♦ **Avoid damage from bending. Refrigerant lines kink easily.**

- Remove air cleaner assembly.
- Remove A/C fluid reservoir and allow to hang free.
- Remove retaining clamp(s) from refrigerant lines.
- Remove A/C condenser from radiator and pull forward as far as possible.
- Lift out radiator and fan assembly.
- Secure A/C condenser to body so that refrigerant lines/hoses are not stressed.

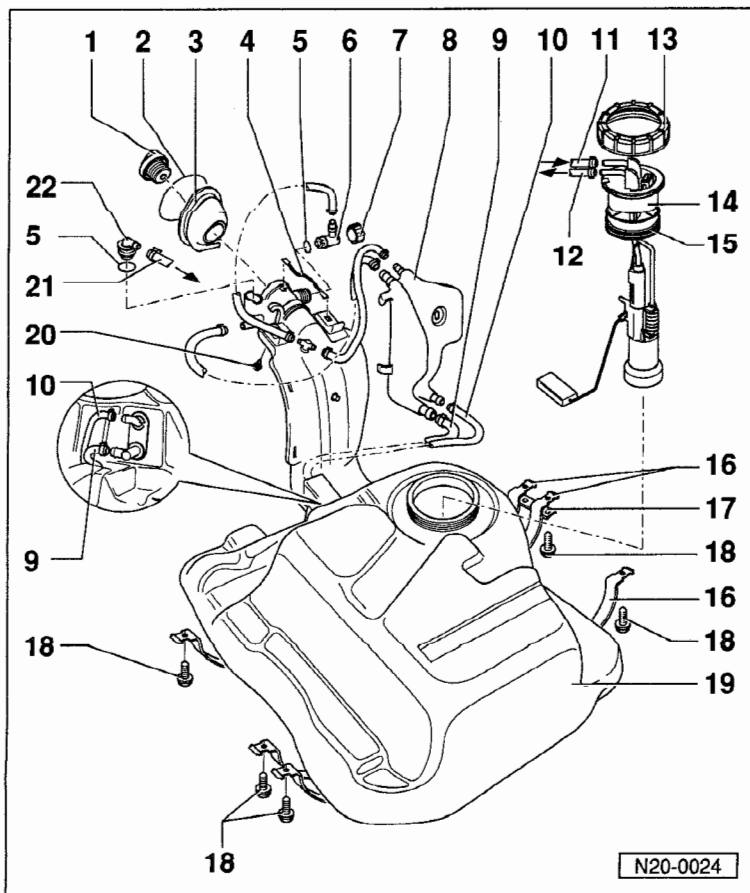
## Fuel supply system components, removing and installing

- ◆ Checking fuel system for leaks
- ◆ Removing and installing fuel filter and draining water, engine code AAZ:  
⇒ Repair Manual, *1.9 Liter Diesel Fuel Injection & Ignition*, Repair Group 23
- ◆ Removing and installing fuel filter and draining water, engine codes 1Z, AHU:  
⇒ Repair Manual, *1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System*, Repair Group 23
- ◆ Observe safety precautions ⇒ page 20-6
- ◆ Observe rules of cleanliness ⇒ page 20-8
- ◆ Accelerator pedal linkage, servicing (AAZ) ⇒ page 20-9
- ◆ Cold Start Accelerator (CSA) cable, overview (AAZ) ⇒ page 20-11

### Notes:

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

20-1



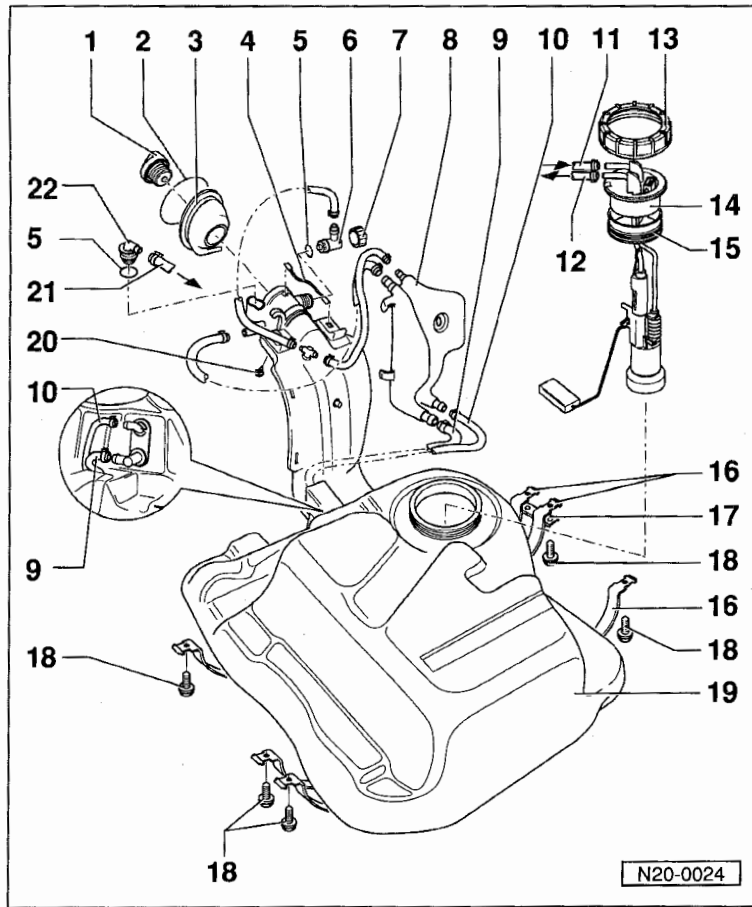
## Fuel tank components, removing and installing

### WARNING!

- ◆ *Do not re-use fasteners that are worn or deformed in normal use.*
- ◆ *Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.*
- ◆ *DO NOT smoke or work near heaters or other fire hazards when working on fuel system.*

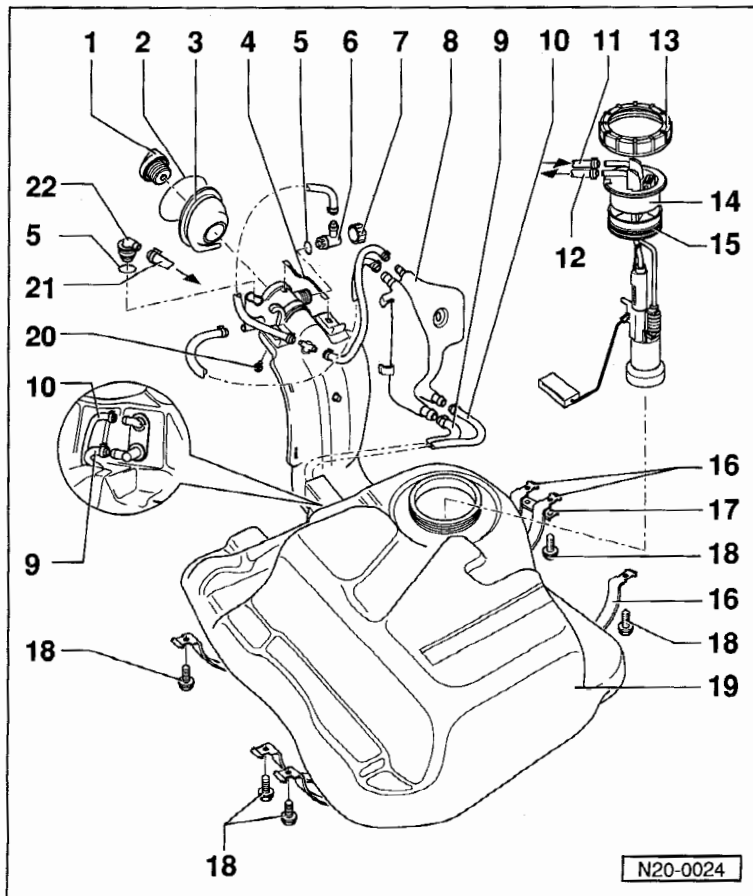
- 1 - Fuel filler cap  
◆ Replace seal if damaged
- 2 - Retaining ring
- 3 - Fuel filler splash shield
- 4 - Ground (GND) connection

20-2



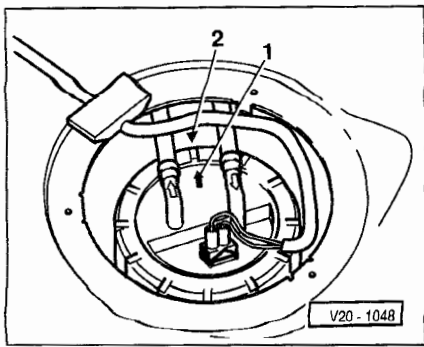
- 5 - O-ring
  - ◆ Replace if damaged
- 6 - Vent valve
  - ◆ Checking ⇒ Fig. 2
- 7 - Union nut
- 8 - Overflow tank
- 9 - Vent pipe
  - ◆ Filling vent
- 10 - Vent pipe
  - ◆ Operating vent
- 11 - Fuel return line
  - ◆ Blue
- 12 - Fuel supply line
  - ◆ Black
- 13 - Union nut
  - ◆ Remove and install using 3218 wrench
- 14 - Sender for fuel gauge -G-
  - ◆ Note installed position on fuel tank ⇒ Fig. 1
  - ◆ Sender along with fuel strainer telescopes into upper section

20-3



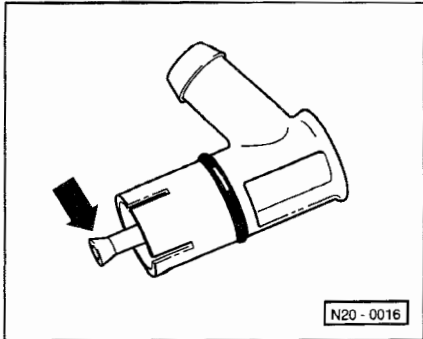
- 15 - Sealing ring
  - ◆ Replace if damaged
  - ◆ Coat with fuel when installing
- 16 - Mounting straps
  - ◆ Note different lengths
- 17 - Bracket
  - ◆ To secure mounting straps
- 18 - 25 Nm (18 ft lb)
- 19 - Fuel tank
  - ◆ Support using VAG383A engine and transmission jack, when removing
- 20 - 10 Nm (7 ft lb)
- 21 - Vent pipe
  - ◆ To fuel filler splash shield -3-
- 22 - Gravity valve
  - ◆ To remove valve, unclip and pull upward out of filler neck
  - ◆ Check valve for flow
  - ◆ Valve vertical: open
  - ◆ Valve tilted 45°: closed

20-4



◀ Fig. 1 Installed position of sender for fuel gauge -G-

- Mark on sensor -1- must be aligned with mark -2- on fuel tank.



◀ Fig. 2 Checking vent valve

- ♦ Lever in rest position: closed
- ♦ Lever pushed in direction of arrow: open

20-5

## Safety precautions when working on the fuel supply system

### **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.*

*Make 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.*

20-6

**CAUTION!**

**BEFORE disconnecting the battery:**

- ◆ **Stop the engine.**
- ◆ **Make sure the ignition is switched OFF (also applies when connecting the battery). Failure to do so may damage the Engine Control Module (ECM).**
- ◆ **Before disconnecting the battery, determine the correct coding for the anti-theft radio.**

**Make 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.):**

- ◆ **Make sure the ignition is switched OFF.**
- ◆ **Use correct adapters from the VW1594 connector test kit.**

20-7

## Rules of cleanliness

**CAUTION!**

**Whenever working on fuel supply and fuel injection systems, carefully observe the following six 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.).

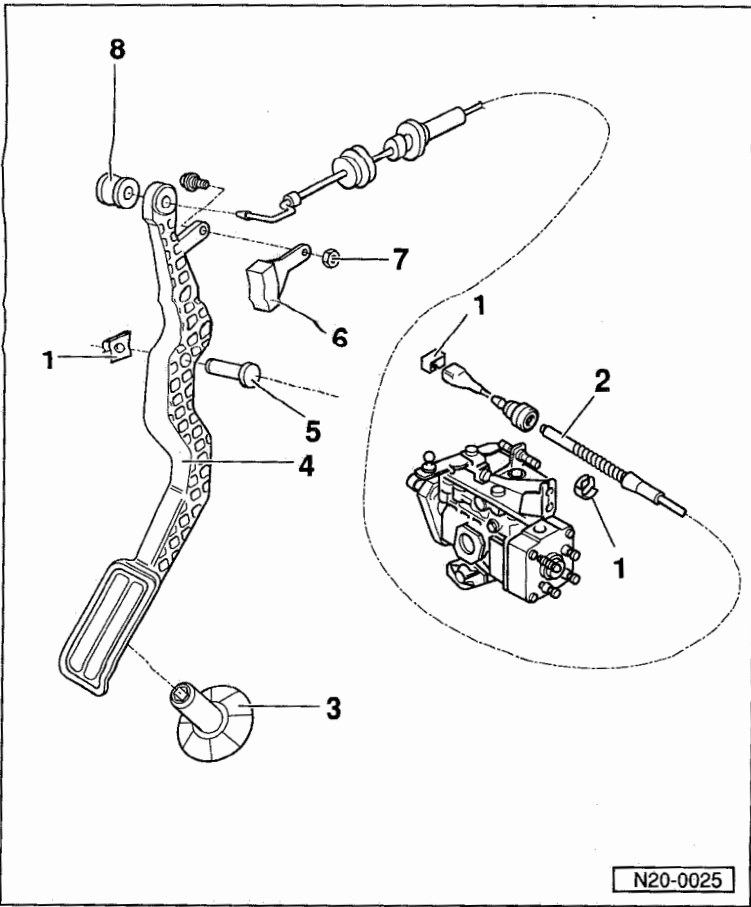
5 - When the fuel system is opened:

Avoid working with compressed air whenever possible. Avoid moving the vehicle if possible.

6 - Make sure that no Diesel fuel runs onto coolant hoses.

Affected hoses must be cleaned immediately. Contaminated hoses must be replaced.

20-8



N20-0025

## Accelerator pedal linkage, servicing

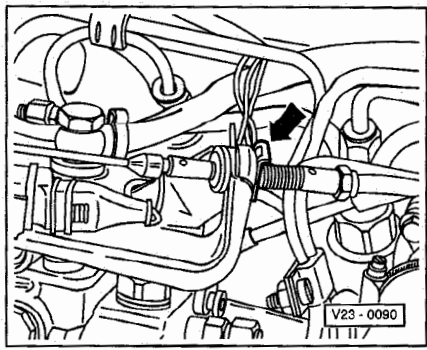
Engine code AAZ

Engine codes 1Z, AHU accelerator linkage:

⇒ Repair Manual, 1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System, Repair Group 23

- 1 - Retaining clip
- 2 - Accelerator cable
  - ◆ Adjust by moving position of securing clip (retainer) on outer cable grooves ⇒ Fig. 1
- 3 - Accelerator pedal stop
- 4 - Accelerator pedal
- 5 - Pivot pin
- 6 - Balance weight
- 7 - 10 Nm (7 ft lb)
- 8 - Rubber bushing

20-9



V23-0080

◀ Fig. 1 Adjusting accelerator cable

Adjust cable with the accelerator pedal in the Wide Open Throttle (WOT) position by moving the securing clip (arrow) on the outer cable grooves.

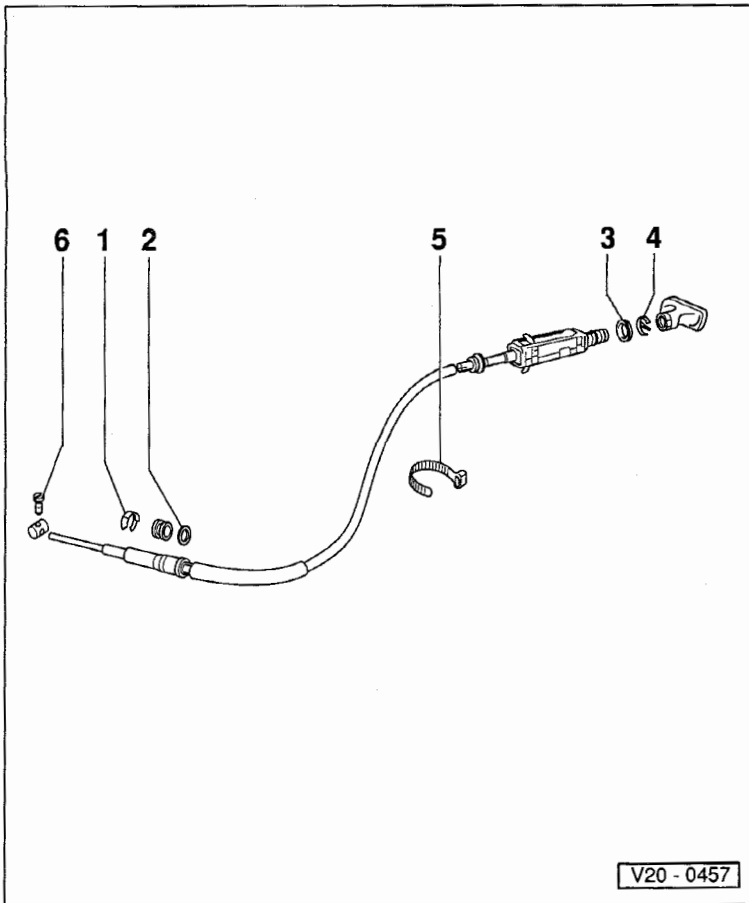
The accelerator pedal is properly adjusted when the injection pump lever just contacts stop and is not stressed.



## Cold Start Accelerator (CSA) cable, overview

Engine code AAZ

- 1 - Securing clip
- 2 - Washer
- 3 - Nut
- 4 - Securing clip
- 5 - Tie wrap
  - ◆ In engine compartment
- 6 - Locking screw
  - ◆ Adjusting ⇒ page 20-12

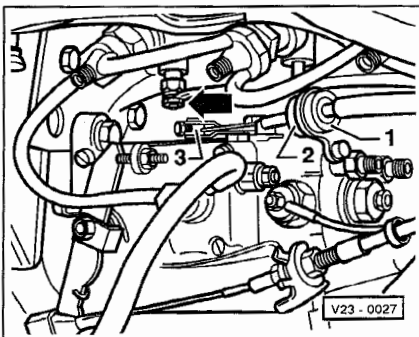


20-11

## Cold Start Accelerator (CSA) cable, adjusting

Engine code AAZ

- ◀ – Slide washer -1- on CSA cable and secure cable using clip -2-.
- Move operating lever to 0 position (direction of arrow).
- Pull inner cable tight and clamp to pin -3- using locking screw.



20-12

## Turbocharger system components, servicing

Engine codes: AAZ, 1Z, AHU

◆ Observe rules of cleanliness  
⇒ page 21-10

◆ Turbocharger hoses and lines, connecting  
⇒ page 21-11

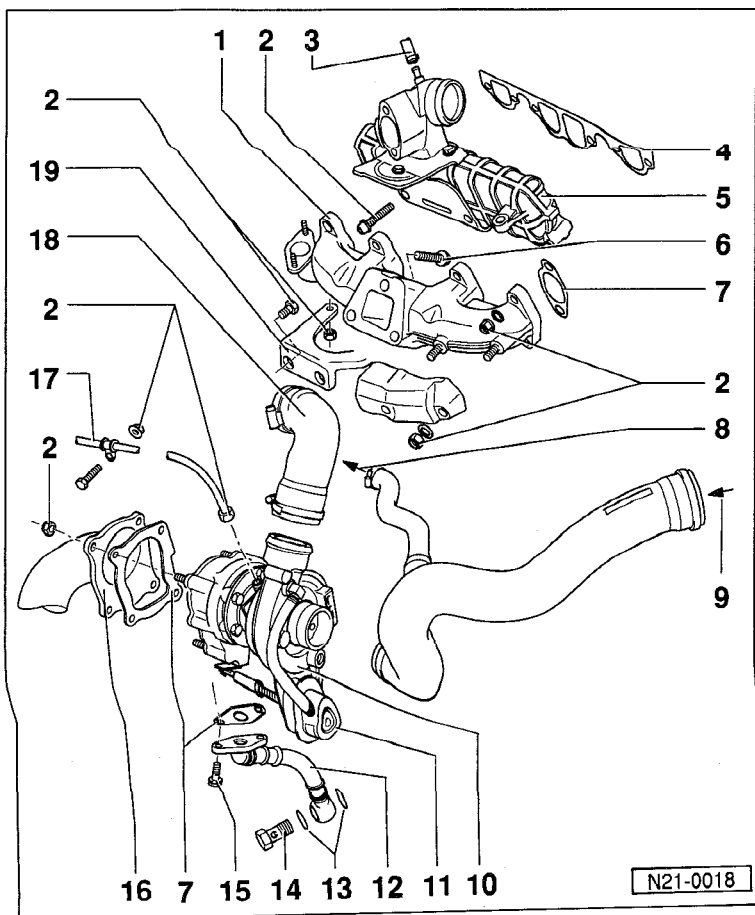
### WARNING!

- ◆ Do not re-use any fasteners that are worn or deformed in normal use.
- ◆ Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.

### Notes:

- ◆ All hose connections are secured with clips.
- ◆ Charge air system must be free of leaks.
- ◆ Always replace self-locking nuts.

21-1



## Turbocharger system components, removing and installing (engine code AAZ)

### Notes:

- ◆ Boost pressure control is switched off during part throttle operation by EGR part throttle switch -F166- and two-way valve for EGR -N161-
- ◆ Checking and adjusting part throttle switch ⇒ page 26-23
- ◆ Checking two-way valve ⇒ page 26-20

1 - Exhaust manifold

2 - 25 Nm (18 ft lb)

3 - Hose

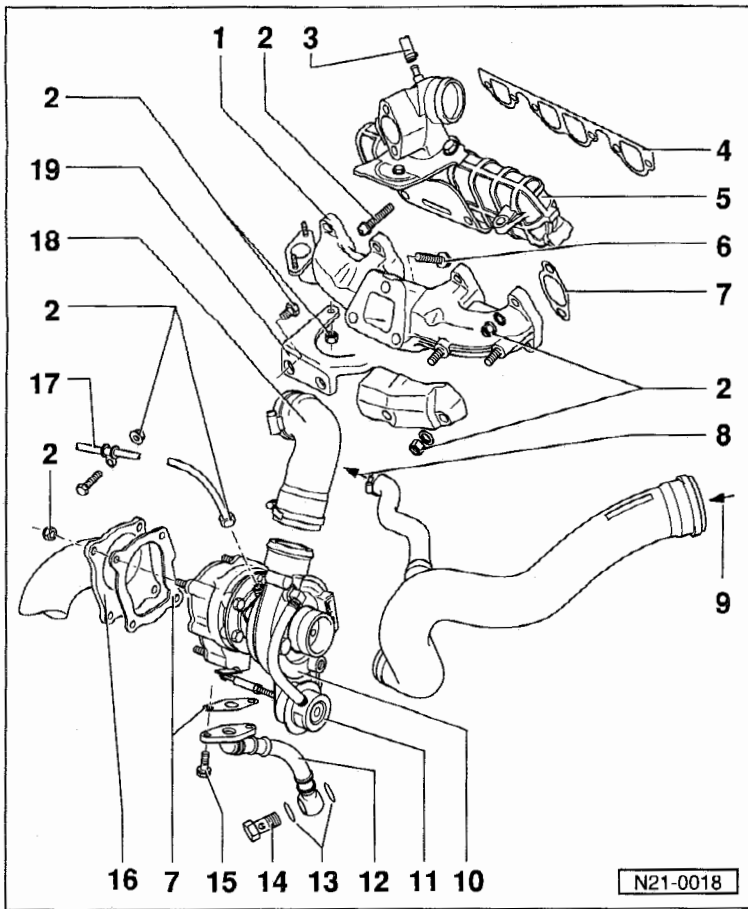
- ◆ To Diesel injection pump

4 - Gasket

- ◆ Always replace
- ◆ Coating (beading) faces intake manifold

5 - Intake manifold

21-2



**6 - 45 Nm (33 ft lb)**  
 ♦ Always replace  
 ♦ Coat threads and bolt head sealing surfaces with high temperature (2000° F) anti-seize compound

**7 - Gasket**  
 ♦ Always replace  
 ♦ Note installation position

**8 - To Positive Crankcase Ventilation (PCV) valve**

**9 - From Air Cleaner**

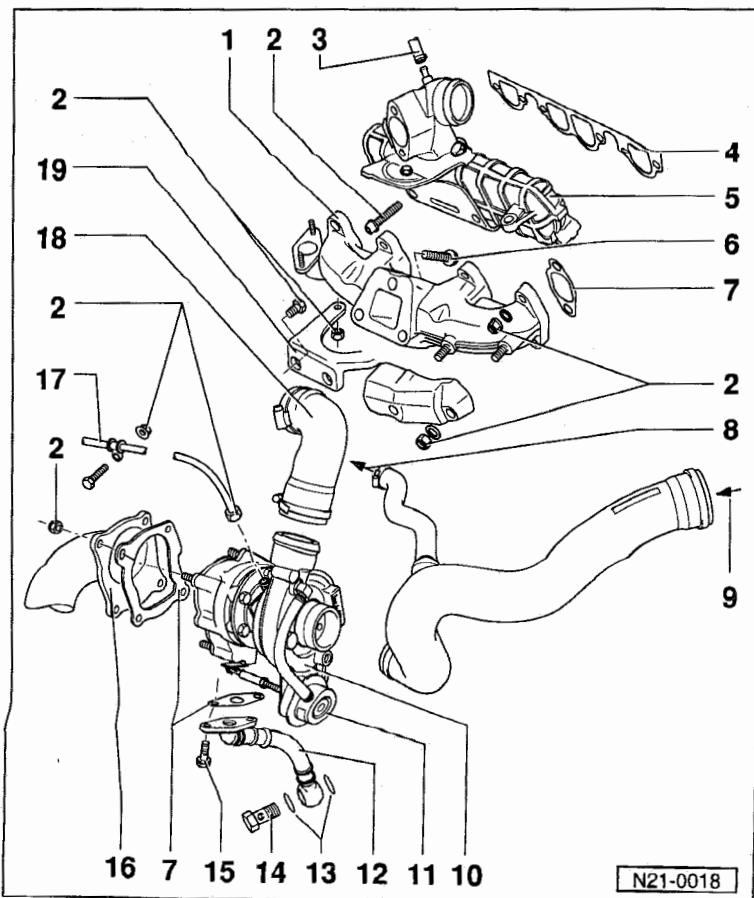
**10 - Turbocharger**  
 ♦ Removing and installing ⇒ page 21-12  
 ♦ Boost pressure, checking ⇒ page 21-18

**11 - Turbocharger wastegate**  
 ♦ Integral part of turbocharger cannot be replaced separately  
 ♦ Hoses and lines, connecting ⇒ page 21-11

**12 - Oil return line**  
 ♦ To cylinder block

**13 - Sealing rings**  
 ♦ Always replace

21-3



**14 - Banjo bolt**  
 ♦ 30 Nm (22 ft lb)

**15 - 30 Nm (22 ft lb)**

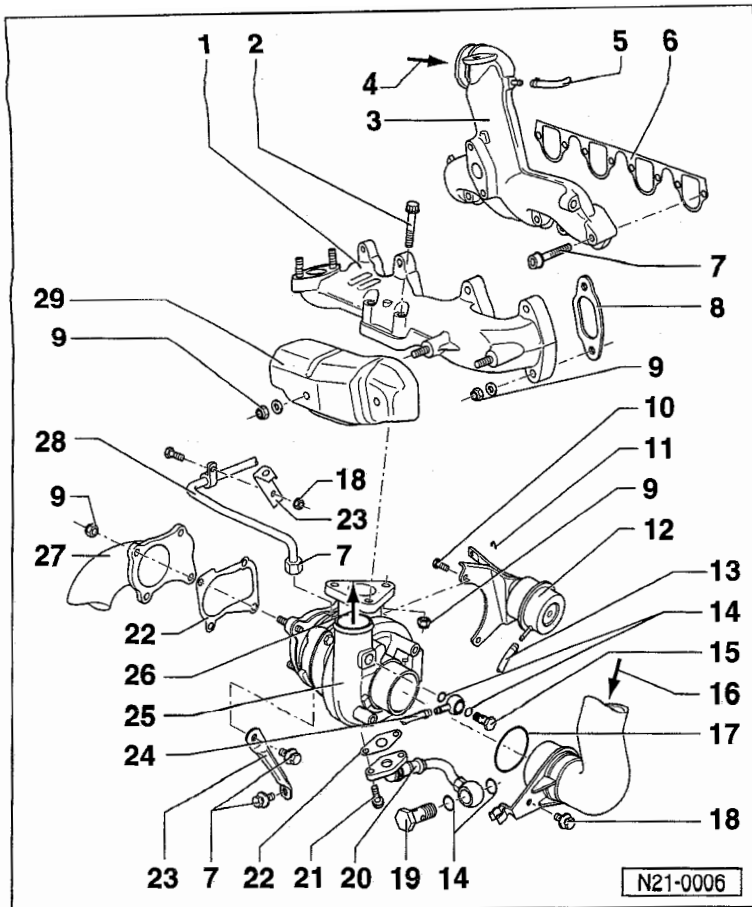
**16 - Front exhaust pipe**

**17 - Oil supply line**  
 ♦ From oil filter bracket ⇒ page 17-4

**18 - Intake air hose**

**19 - Mounting bracket**  
 ♦ Between exhaust pipe and exhaust manifold

21-4



## Turbocharger system components, removing and installing (engine codes 1Z, AHU)

1 - Exhaust manifold

2 - 35 Nm (26 ft lb)

- ◆ Always replace
- ◆ Coat threads and bolt head sealing surfaces with high temperature (2000° F) anti-seize compound

3 - Intake manifold

4 - From charge air cooler

5 - Hose

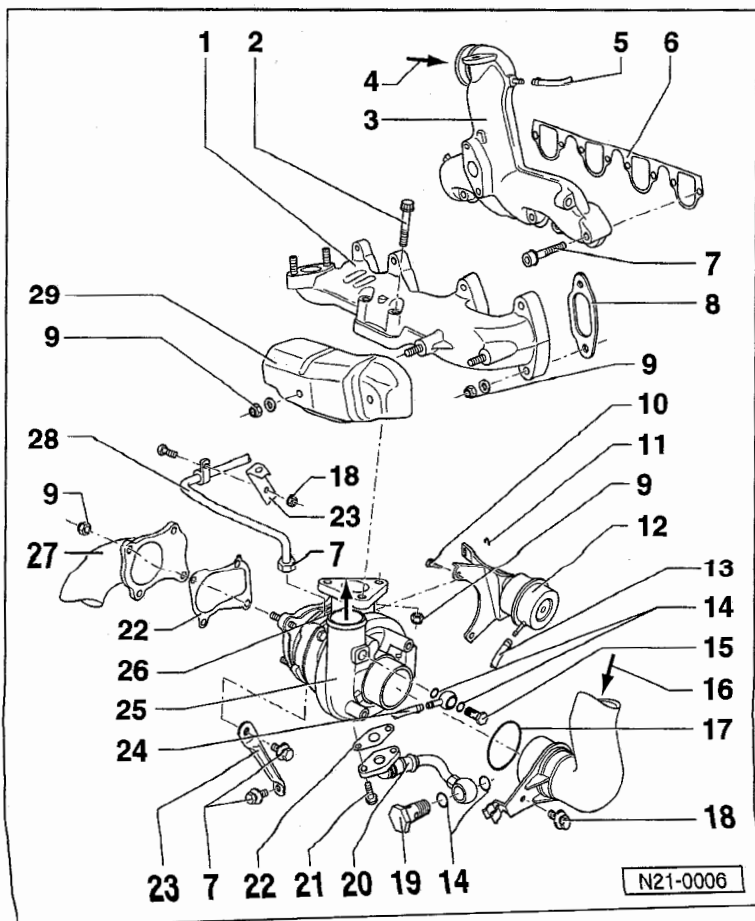
- ◆ Black
- ◆ To Diesel Direct Fuel Injection (DFI) Engine Control Module (ECM) -J248-

6 - Gasket

- ◆ Always replace
- ◆ Coating (beading) faces intake manifold

7 - 25 Nm (18 ft lb)

21-5



8 - Gasket

- ◆ Note installation position

9 - 25 Nm (18 ft lb)

10 - 10 Nm (7 ft lb)

- ◆ Install using D6

11 - Circlip

12 - Turbocharger wastegate

- ◆ Checking ⇒ page 21-24
- ◆ Removing and installing ⇒ page 21-25

13 - Hose

- ◆ Blue
- ◆ To wastegate bypass regulator valve -N75-
- ◆ Connecting ⇒ page 21-11

14 - Oil seal

- ◆ Always replace

15 - Banjo bolt

- ◆ 15 Nm (11 ft lb)

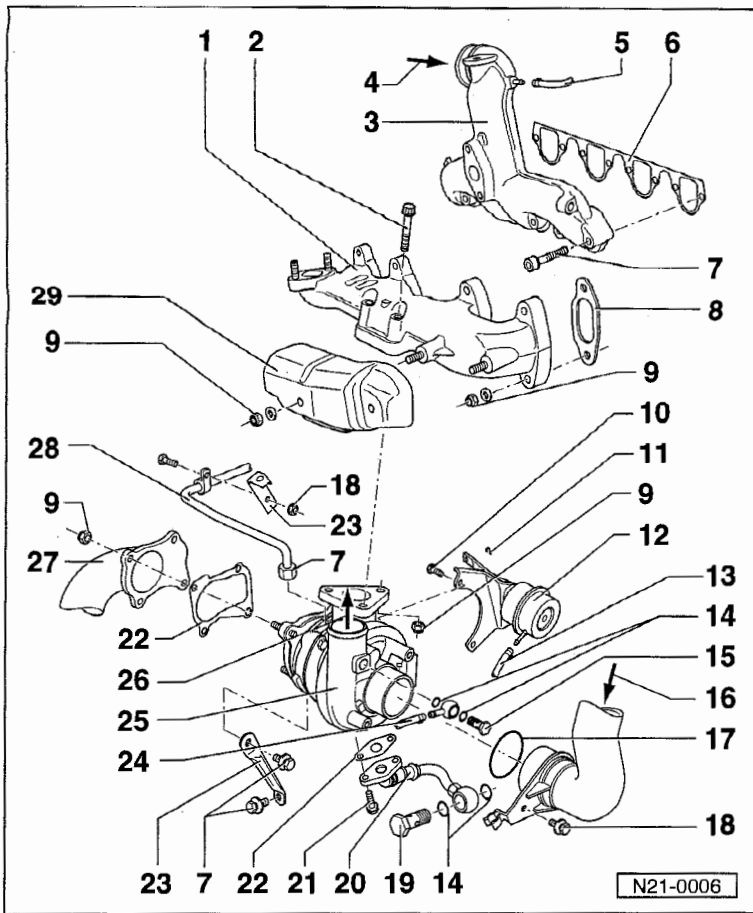
16 - From air cleaner

17 - O-ring

- ◆ Replace if damaged

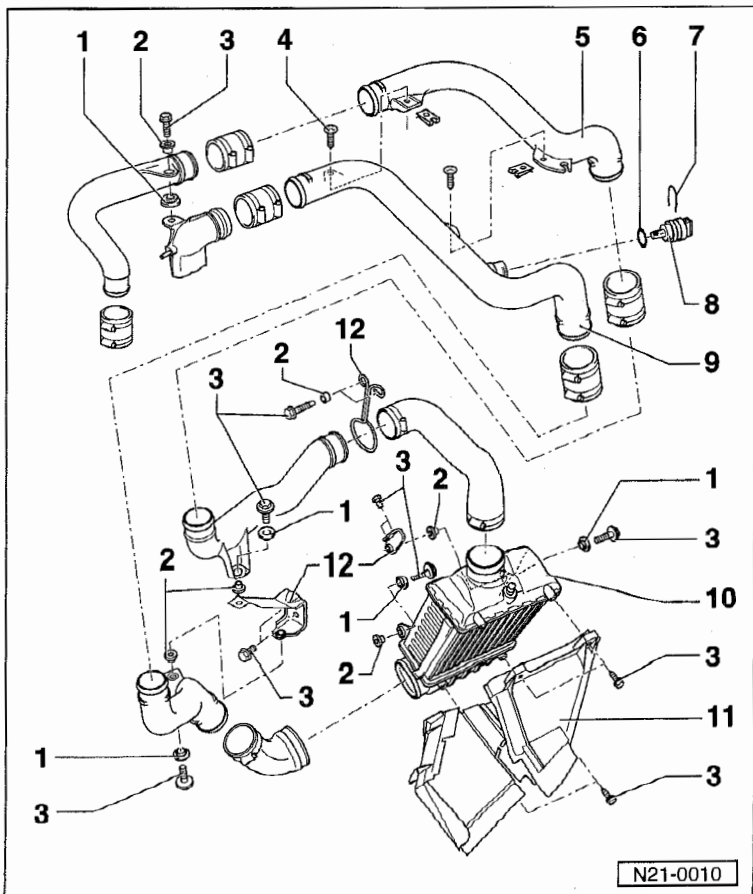
18 - 10 Nm (7 ft lb)

21-6



- 19 - Banjo bolt  
♦ 30 Nm (22 ft lb)
- 20 - Oil return line  
♦ To cylinder block
- 21 - 30 Nm (22 ft lb)
- 22 - Gasket  
♦ Always replace
- 23 - Retainer
- 24 - Hose  
♦ Red  
♦ To wastegate bypass regulator valve -N75-  
♦ Connecting ⇒ page 21-11
- 25 - Turbocharger  
♦ Removing and installing ⇒ page 21-14  
♦ Boost pressure, checking ⇒ page 21-20
- 26 - To charge air cooler
- 27 - Front exhaust pipe
- 28 - Oil supply line  
♦ From oil filter bracket
- 29 - Heat shield

21-7



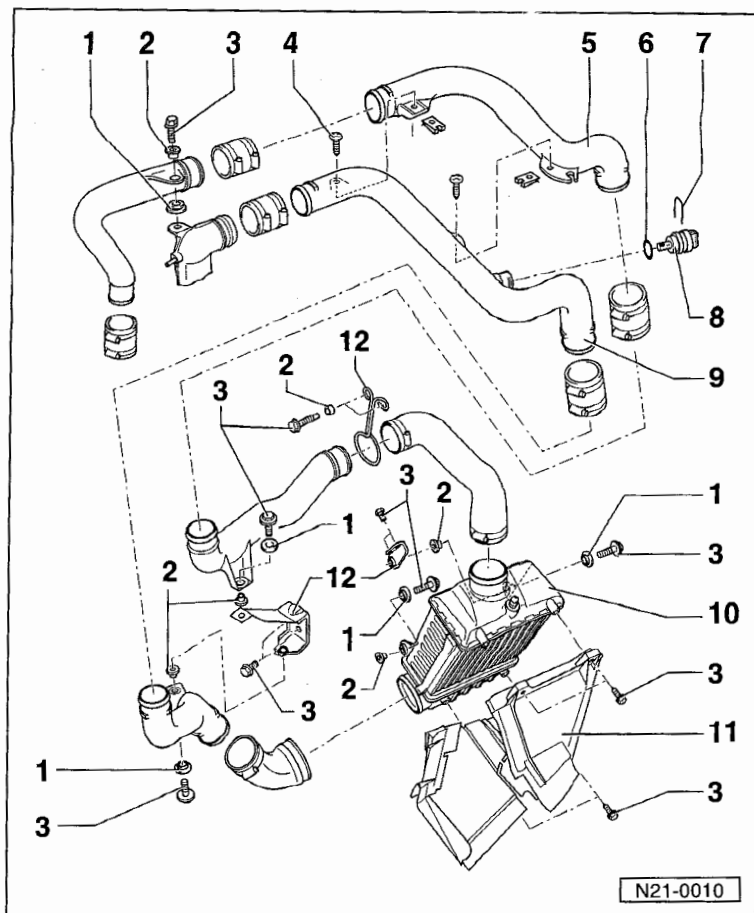
### Turbocharger cooling system components, removing and installing (engine codes 1Z, AHU)

**Notes:**

- ♦ All hose connections secured by clips.
- ♦ Charge air system must be free of leaks.

- 1 - Rubber mounting
- 2 - Spacer
- 3 - 10 Nm (7 ft lb)
- 4 - 10 Nm (7 ft lb)
- 5 - Connecting pipe  
♦ Between charge air cooler and turbocharger
- 6 - O-ring  
♦ Replace if damaged
- 7 - Retaining clip
- 8 - Intake Air Temperature (IAT) sensor -G72-

21-8



9 - Connecting pipe  
 ♦ Between charge air cooler and intake manifold

10 - Charge air cooler

11 - Air ducting

12 - Retainers

21-9

### Rules of cleanliness

**CAUTION!**

*Whenever working on turbocharger systems, carefully observe the following 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.).

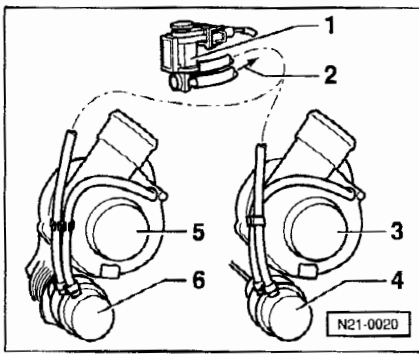
5 - When the fuel system is opened:

Avoid working with compressed air whenever possible. Avoid moving the vehicle if possible.

6 - Make sure that Diesel fuel does not run onto coolant hoses.

Affected hoses must be cleaned immediately. Contaminated hoses must be replaced.

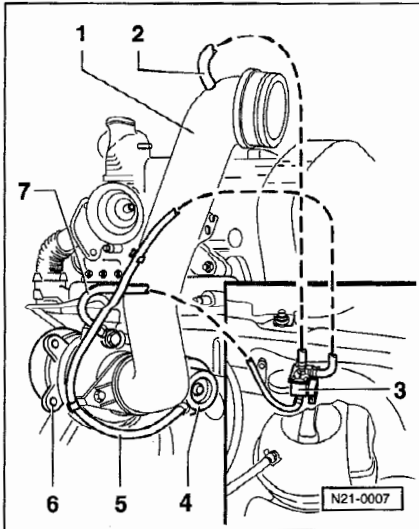
21-10



## Turbocharger hoses and lines, connecting

### Engine code AAZ

- ◀ 1 - Two-way valve
- 2 - To vacuum pump
- 3 - Turbocharger (KKK)
- 4 - Wastegate
- 5 - Turbocharger (Garrett)
- 6 - Wastegate



### Engine codes 1Z, AHU

- ◀ 1 - Intake air hose
- 2 - Hose, black
- 3 - Wastegate bypass regulator valve -N75-
- 4 - Wastegate
- 5 - Hose, blue
- 6 - Turbocharger
- 7 - Hose, red

21-11

## Turbocharger, removing and installing (engine code AAZ)

Engine codes 1Z, AHU, turbocharger removing and installing.  
⇒ page 21-14

### Special tools, testers and auxiliary items

- ◆ 3205 swivel wrench
- ◆ VAG1331 torque wrench, 5 to 50 Nm
- ◆ High temperature (2000° F) anti-seize compound

### Removing

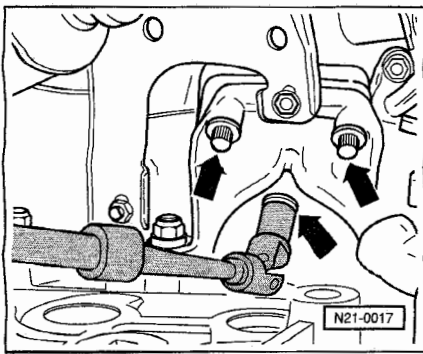
- Switch ignition off.

#### **CAUTION!**

***Before disconnecting the battery, determine the correct coding for the anti-theft radio.***

- Disconnect battery Ground strap.
- Remove hoses between intake manifold to turbocharger and turbocharger to air cleaner.
- Disconnect oil supply line from turbocharger and mounting clip from intake manifold.
- Disconnect oil return line at turbocharger.

21-12



- Disconnect exhaust pipe from turbocharger and exhaust manifold support.

- ◀ - Remove 3 mounting bolts (arrows) between turbocharger and exhaust manifold (using either box wrench or 3205 swivel wrench).

### Installing

When installing observe the following:

- Install turbocharger and tighten exhaust pipe mounting nuts so that turbocharger can still be moved slightly.
- Install 3 mounting bolts and tighten fully, then tighten exhaust pipe nuts.
- Before attaching oil supply line, fill turbocharger connections with engine oil.

### CAUTION!

**After installing the turbocharger, let engine idle for approx. 1 minute. DO NOT rev-up the engine at first! (This ensures that the turbocharger is properly lubricated.)**

21-13

## Turbocharger, removing and installing (engine codes 1Z, AHU)

Engine code AAZ, turbocharger removing and installing  
⇒ page 21-12

### Special tools, testers and auxiliary items

- ◆ VAG1331 torque wrench, 5 to 50 Nm
- ◆ High temperature (2000° F) anti-seize compound

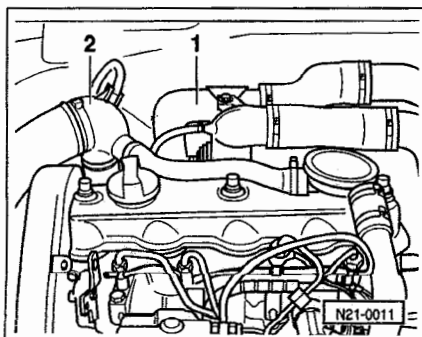
### Removing

- Switch ignition off.
- Disconnect battery Ground strap.

### CAUTION!

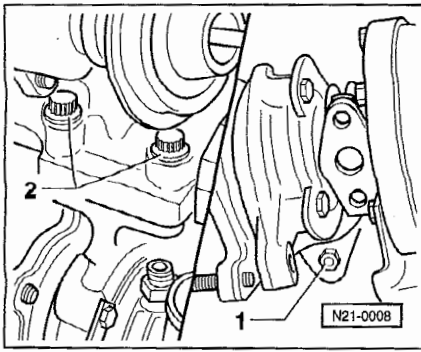
**Before disconnecting the battery, determine the correct coding for the anti-theft radio.**

- ◀ - Remove hoses between intake manifold to turbocharger -1- and turbocharger to air cleaner -2-.
- Remove red hose (or remove banjo bolt) for wastegate bypass regulator valve -N75- on turbocharger.
- Disconnect exhaust pipe from turbocharger.



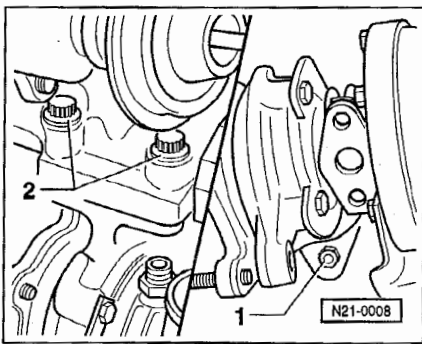
21-14





- Disconnect oil supply line from turbocharger and mounting clip from intake manifold.
- Remove turbocharger to engine support.
- Disconnect oil return line at turbocharger.
- ◀ - Remove nut -1- from below and bolts -2- from above.
- Lift turbocharger out and upward.
- Disconnect blue hose from wastegate.

21-15



**Installing (engine codes 1Z, AHU)**

- Install blue wastegate hose on turbocharger and secure with clamp.
- ◀ - Grease threads of mounting bolts -2- and head contacting surfaces with high temperature (2000° F) anti-seize compound.
- Install turbocharger on exhaust manifold and tighten mounting bolts -2- finger-tight.
- Install mounting nut -1- and tighten.  
Tightening torque: 20 Nm (15 ft lb)
- Tighten mounting bolts -2-.  
Tightening torque: 35 Nm (26 ft lb)
- Install turbocharger to cylinder head support.  
Tightening torque: 25 Nm (18 ft lb)
- Install oil return pipe with new seal and tighten.  
Tightening torque: 30 Nm (22 ft lb)
- Install front exhaust pipe with new gasket onto flange and tighten.  
Tightening torque: 25 Nm (18 ft lb).
- Fill turbocharger with engine oil via oil supply connection.

- Install oil supply line.

Tightening torque: 25 Nm (18 ft lb)

- Tighten oil supply line support to: 10 Nm (7 ft lb).

- Install red hose for wastegate bypass regulator valve -N75- on turbocharger and secure with clamp (or banjo bolt with new seal) and tighten.

Tightening torque: 15 Nm (11 ft lb)

- Install O-ring onto intake pipe, then install pipe to turbocharger and tighten.

Tightening torque: 10 Nm (7 ft lb)

- Install pressure line.

**CAUTION!**

*After installing the turbocharger, let engine idle for approx. 1 minute. DO NOT rev-up the engine at first! (This ensures that the turbocharger is properly lubricated.)*

**Turbocharger, checking (engine code AAZ)**

**Special tools, testers and auxiliary items**

- ◆ VAG1397A turbocharger tester

**Checking conditions**

The turbocharger and wastegate are an assembly. A faulty turbocharger must be replaced because it is not possible to repair using workshop equipment.

Requirements for proper turbocharger operation and achieving specified boost pressure:

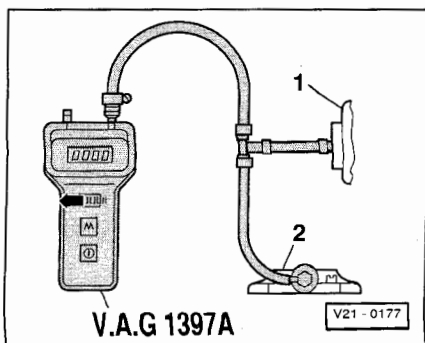
- No leaks from intake and exhaust systems
- Wastegate control line is not blocked, loose or leaking
- No engine or fuel injection mechanical malfunctions, e.g. start of injection, fuel injectors and compression pressure
- Engine oil temperature 80°C (176°F) minimum

**Test sequence**

- Measure boost pressure under full load, while driving on road.

Test duration per measurement: 10 seconds maximum

- Disconnect hose (at one end) running between intake manifold -1- and Diesel injection pump -2-.



- Using tee, connect VAG1397A turbocharger tester.

**Notes:**

- ◆ To operate the VAG1397A turbocharger tester see manufacturers operating instructions.
- ◆ If boost pressure is being measured while driving, a second person must be used to read and operate the turbocharger tester.
- ◆ Make sure that the pressure hose is not trapped between the hood and the body.

- Measure boost pressure at wide open throttle.

While driving on an open road:

- ◆ In 2nd gear (manual) or with transmission range selector lever in position 1 (automatic)
- ◆ While simultaneously applying brakes to maintain approx. 37 MPH (60 kph).

Specification: 0.60 to 0.83 bar (relative pressure)

If specification not obtained:

- Replace turbocharger.

If the boost pressure is too high and if the wastegate control line is not blocked, loose or leaking:

- Replace turbocharger (wastegate is faulty and unit can only be replaced as an assembly).

21-19

## **Turbocharger, checking (engine codes 1Z, AHU)**

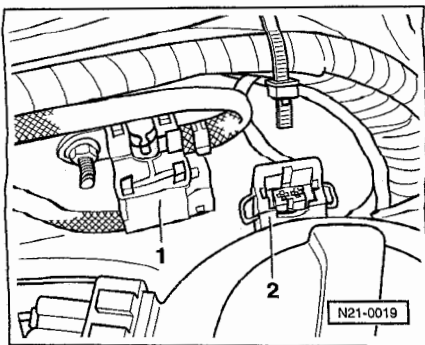
### **Special tools, testers and auxiliary items**

- ◆ VAG1397A turbocharger tester

### **Checking conditions**

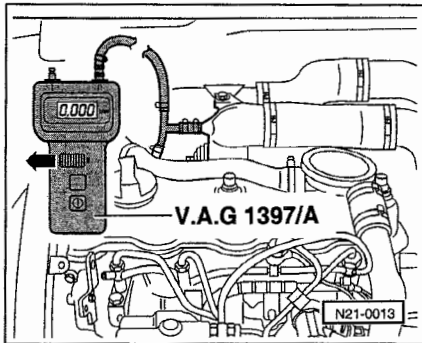
- No malfunctions stored in Diagnostic Trouble Code (DTC) memory  
⇒ Engine codes 1Z, AHU: *1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System*, Repair Group 01
- Perform output Diagnostic Test Mode (DTM)  
⇒ Engine codes 1Z, AHU: *1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System*, Repair Group 01
- No leaks from intake and exhaust systems
- Wastegate control line is not blocked, loose or leaking
- No engine or fuel injection mechanical malfunctions, e.g. start of injection, fuel injectors and compression pressure
- Engine oil temperature 80°C (176°F) minimum
- ◆ Measure boost pressure under full load, while driving on open road.
- ◆ Duration of test per measurement: 10 seconds maximum

21-20



- ◀ - Disconnect harness connector -2- from wastegate bypass regulator valve -1- (-N75-).

Reconnect -N75- after check.



- ◀ - Disconnect connecting hose running between intake manifold and Diesel Direct Fuel Injection (DFI) Engine Control Module (ECM) -J248-.
- Using tee, connect VAG1397A turbocharger tester and select measuring range II.

**Notes:**

- ◆ To operate the VAG1397A turbocharger tester see manufacturers operating instructions.
- ◆ Make sure that all of the hoses are connected so there is no possibility of leakage.
- ◆ If boost is being measured while driving, a second person must be used to read and operate turbocharger tester.
- ◆ Make sure that the pressure hose is not trapped between the hood and the body.

21-21

- Measure boost pressure at wide open throttle.

While driving on an open road:

- ◆ In 2nd gear (manual) or with transmission range selector lever in position 1 (automatic)
- ◆ Under acceleration at wide open throttle while watching the tachometer

**Note:**

*Do not apply the brakes while taking boost measurements (unless of course it becomes necessary). The engine control module responds to braking by reducing fuel quantity; which can lead to incorrect boost measurements.*

- Press "M" button (memory) on VAG1397A turbocharger tester when engine speed falls between 3500 and 4000 RPM, then read out boost values.

Specification: 0.50 to 0.65 bar (relative pressure)

If specified boost pressure NOT obtained:

- Check wastegate bypass regulator valve and replace if necessary.
- Repeat boost pressure check.

If specified boost pressure still NOT obtained:

- Replace turbocharger.

21-22

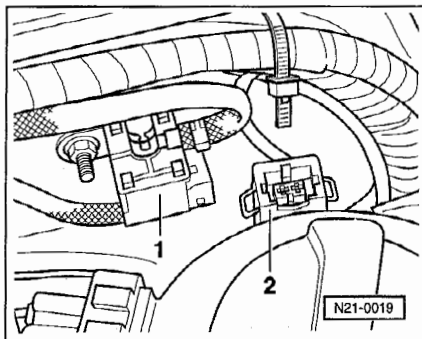
If boost pressure is exceeded:

- Check wastegate bypass regulator valve -N75-.

Flow between turbocharger and valve to wastegate should not be blocked when connector is disconnected.

- Make sure that turbocharger wastegate valve is securely mounted on turbocharger.
- Check wastegate and operating rod, replace if necessary.
- Check wastegate shaft mounting in turbocharger for ease of movement. If corroded together; replace turbocharger.

21-23



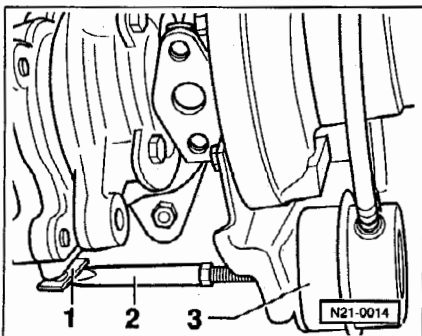
### Wastegate, checking (engine codes 1Z, AHU)

#### Check conditions

- Engine oil temperature: 80° C (176° F) minimum

#### Test sequence

- ◀ - Disconnect harness connector -2- from wastegate bypass regulator valve -1- (-N75-).



- ◀ - Start engine and raise to maximum speed briefly by operating throttle.
- Wastegate operating rod -2- must move

If operating rod does not move:

- Check wastegate lever -1- for ease of movement, if corroded together; replace turbocharger.

If the operating rod does not move, even though the lever is free to move:

- Replace wastegate -3-.

21-24

## Wastegate, removing and installing (engine codes 1Z, AHU)

### Special tools, testers and auxiliary items

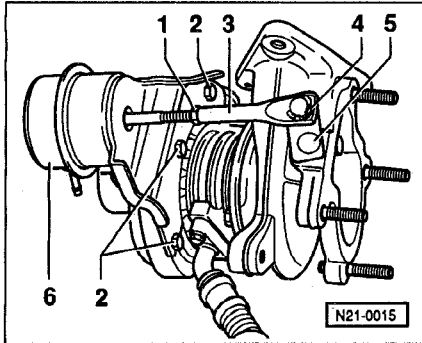
VAG1331 torque wrench 5 to 50 Nm

### Removing

- Remove turbocharger.  
⇒ page 21-14
- ◀ - Unclip mounting clip -4-.
- Remove mounting bolts -2-.
- Remove wastegate -6-.

### Installing

- Install wastegate -6- on turbocharger and tighten.  
Tightening torque: 10 Nm (7 ft lb)
- Install mounting bolts -2- using D6.
- Loosen lock nut -1- and operating rod -3-.
- Swing wastegate lever -5- toward turbocharger to stop, and hold.



21-25

- Adjust length of rod -3- so that rod eye will install easily on lever pin -5- (lever lies against stop with no play).
- Shorten operating rod 8 full turns from this position.
- Tighten lock nut -1-.
- Attach operating rod onto lever and install mounting clip -4-.
- Re-install turbocharger.  
⇒ page 21-14

21-26

## Exhaust system components, servicing

### Front exhaust pipe and Oxidation Catalytic converter (OC)

- ◆ Engine code AAZ ⇒ page 26-2
- ◆ Engine codes 1Z and AHU ⇒ page 26-3

### Mufflers and attachments

- ◆ Engine code AAZ ⇒ page 26-5
- ◆ Engine codes 1Z and AHU ⇒ page 26-9

Removing and installing exhaust manifold ⇒ page 21-2 (engine code AAZ) or page 21-5 (engine codes 1Z, AHU).

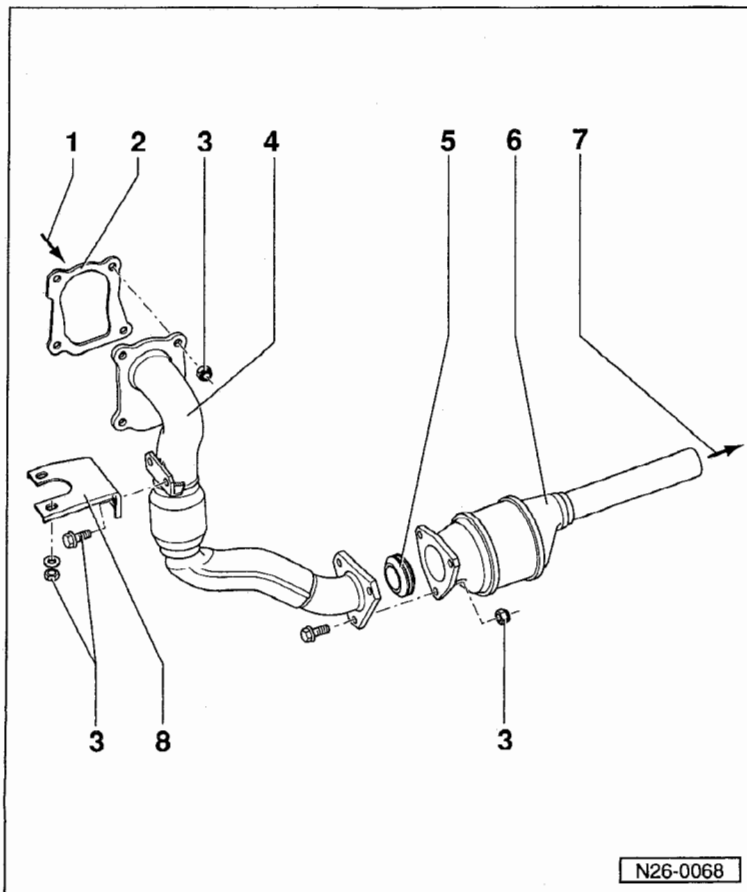
#### **WARNING!**

*Do not re-use any fasteners that are worn or deformed in normal use. Some fasteners are designed to be used only once, and are unreliable and may fail if used a second time. This includes, but is not limited to, nuts, bolts, washers, circlips and cotter pins. Always follow the recommendations in this manual—replace these fasteners with new parts where indicated, and any other time it is deemed necessary by inspection.*

#### **Note:**

*After exhaust system repairs, make sure that the system is mounted without stress or preload, and that there is sufficient clearance between the system and the body. If necessary, loosen clamps and align mufflers and pipes to obtain sufficient clearance to body and balanced loads at hangers.*

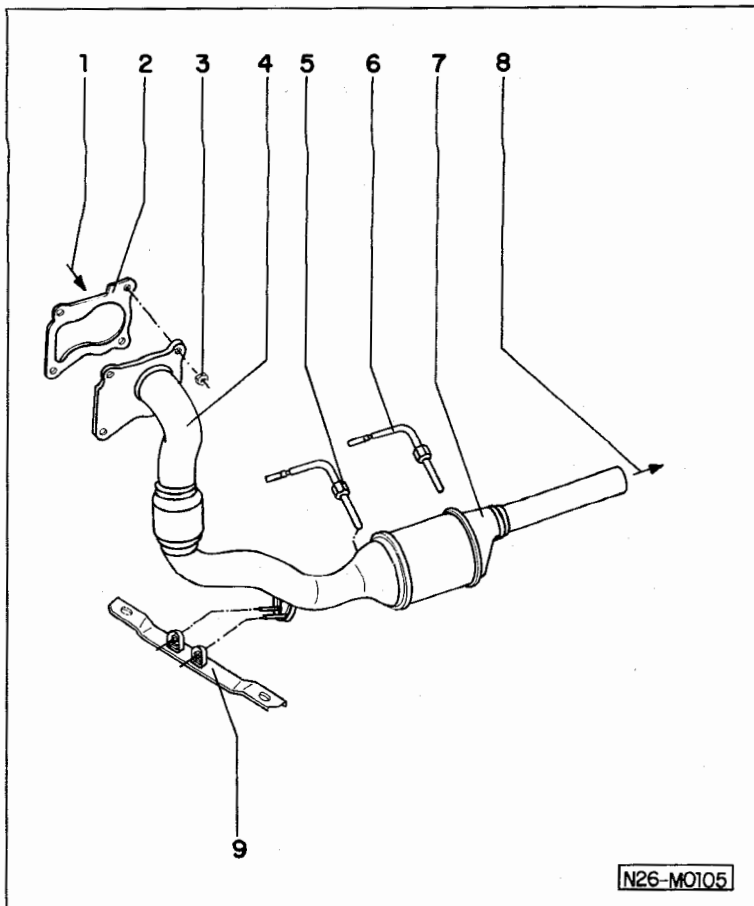
26-1



### Front exhaust pipe and oxidation catalytic converter, component layout (engine code AAZ)

- 1 - From turbocharger
- 2 - Gasket
  - ◆ Always replace
- 3 - 25 Nm (18 ft lb)
- 4 - Front exhaust pipe
- 5 - Sealing ring
  - ◆ Replace if damaged
- 6 - Oxidation Catalytic converter (OC)
- 7 - To intermediate pipe
  - ◆ ⇒ page 26-5, item 8
- 8 - Retainer
  - ◆ Between exhaust pipe and exhaust manifold

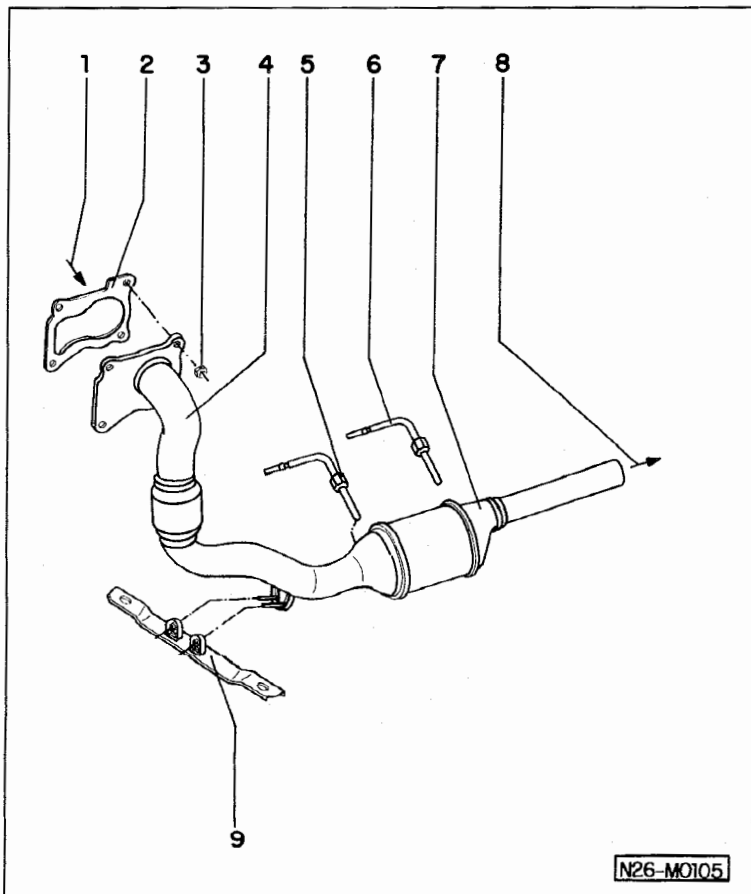
26-2



**Front exhaust pipe and oxidation catalytic converter, component layout (engine codes 1Z, AHU)**

- 1 - From turbocharger
- 2 - Flange gasket
  - ◆ Always replace
- 3 - 25 Nm (18 ft lb)
- 4 - Exhaust pipe, front
- 5 - Temperature sensor I for catalyst -G20-
  - ◆ Engine code 1Z only
  - ◆ 30 Nm (22 ft lb)

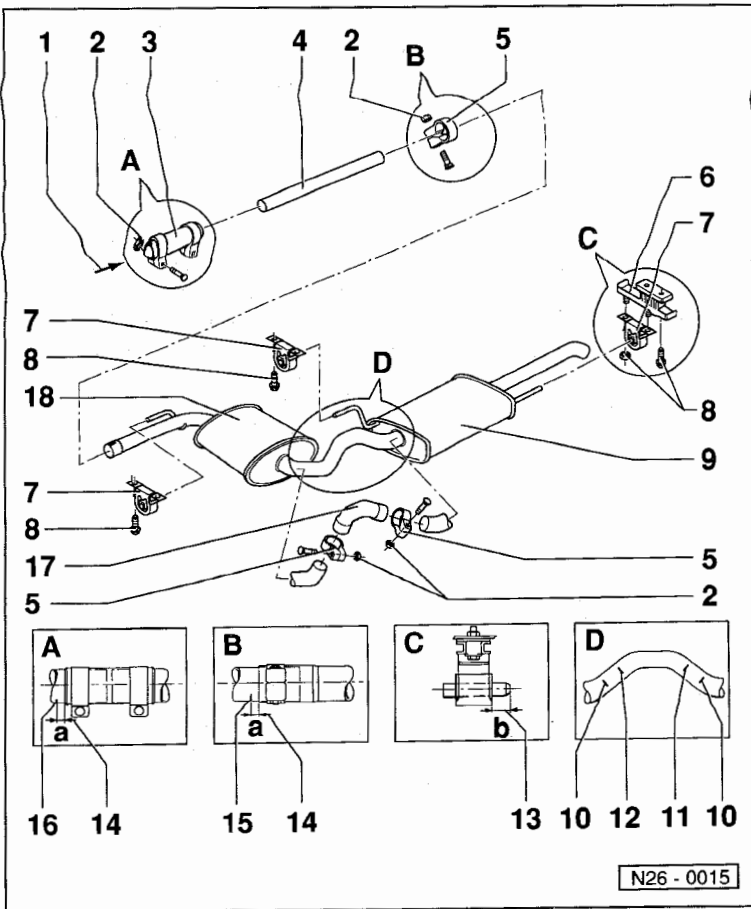
26-3



- 6 - Temperature sensor II for catalyst -G132-
  - ◆ Engine code 1Z only
  - ◆ 30 Nm (22 ft lb)
- 7 - Oxidation Catalytic converter (OC)
- 8 - To intermediate tube
- 9 - Mounting bracket

26-4





## Mufflers and attachments, removing and installing (engine code AAZ)

### Note:

Align exhaust system lengthwise to  
maintain dimensions -a- and -b-.

1 - From oxidation catalytic  
converter

2 - 40 Nm (30 ft lb)

3 - Double clamp

4 - Intermediate pipe

5 - Clamp

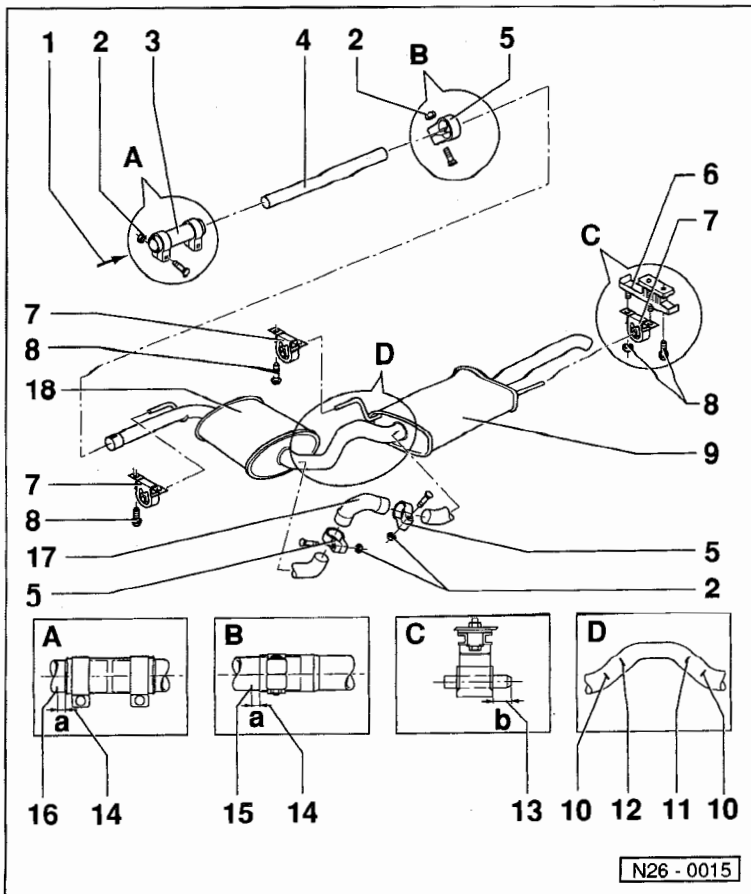
6 - Console

7 - Mount

8 - 25 Nm (18 ft lb)

9 - Rear muffler

26-5



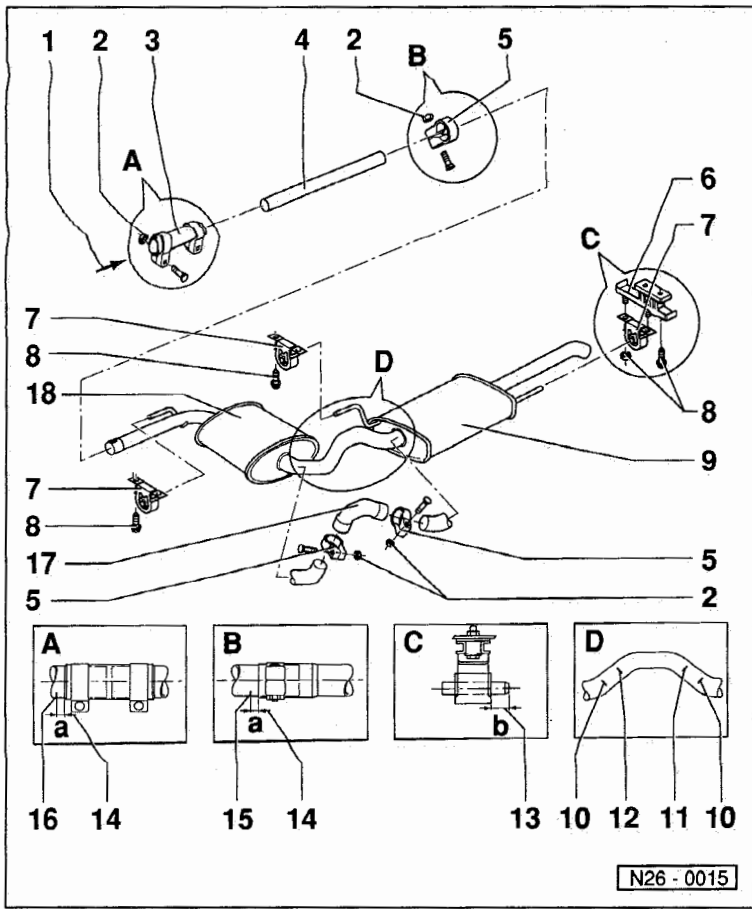
### 10 - Markings

- ◆ For clamp
- ◆ 3 places on circumference
- ◆ Clamp to marking (dimension -a- of item -14-) ⇒ page 26-7

### 11 - Separating point

- ◆ Allows replacement of center muffler only instead of replacing center/rear muffler as an assembly
- ◆ Marks appear 3 times on circumference of connecting pipe
- ◆ Center and rear mufflers are one-piece welded assembly in production. For repairs, center and rear mufflers are supplied individually and repair connecting pipe with two clamps is supplied
- ◆ Cut through connecting pipe using body saw square to separation point

26-6



**12 - Separating point**

- ◆ Allows replacement of rear muffler only instead of center/rear muffler as an assembly
- ◆ Marks appear 3 times on circumference of connecting pipe
- ◆ Center and rear mufflers are one-piece welded assembly in production. For repairs, center and rear mufflers are supplied individually and repair connecting pipe with two clamps is supplied
- ◆ Cut through connecting pipe using body saw square to separation point

**13 - Dimension -b-**

- ◆ Approx. 10 mm (0.4 in.)

**14 - Dimension -a-**

- ◆ Approx. 5 mm (0.2 in.)

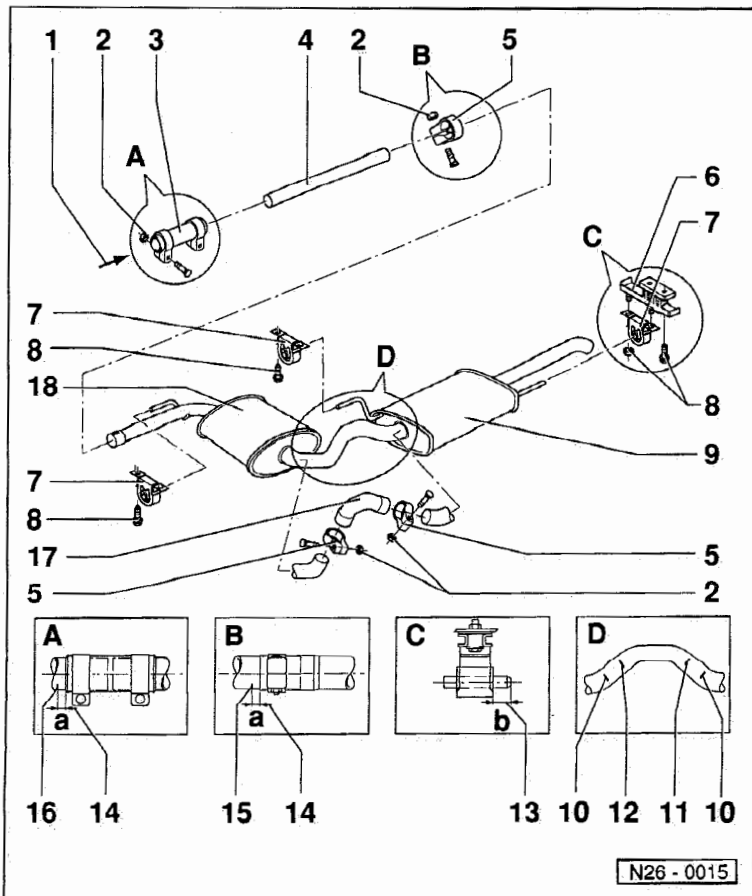
**15 - Marking**

- ◆ 3 places on circumference

**16 - Marking**

- ◆ 3 places on circumference
- ◆ S: Manual transmission
- ◆ A: Automatic transmission

26-7

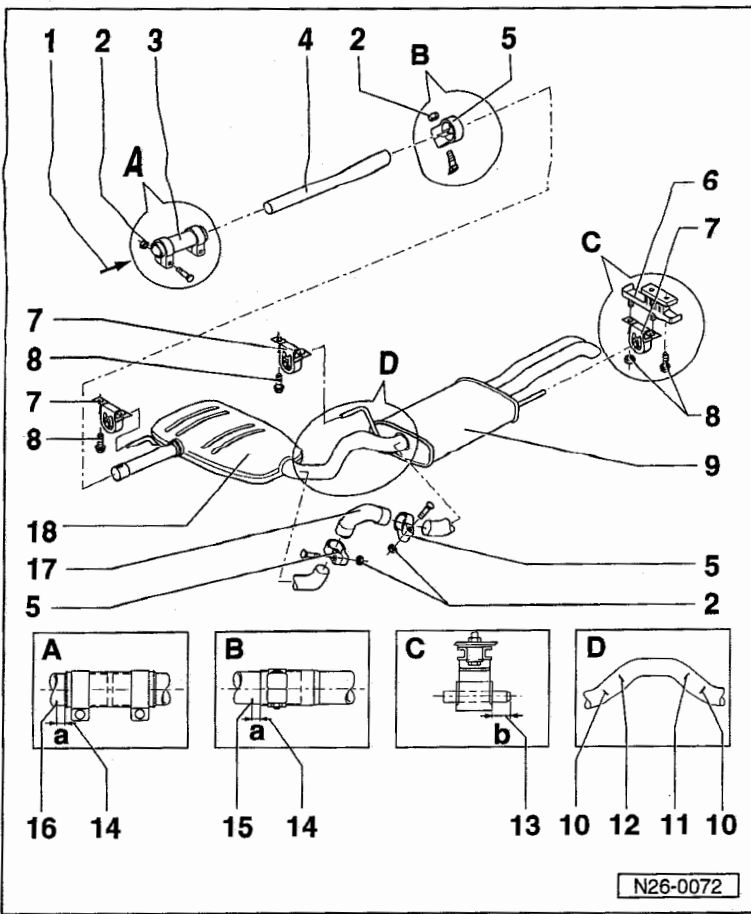


**17 - Repair connecting pipe**

- ◆ Repair piece for use when replacing single muffler

**18 - Center muffler**

26-8

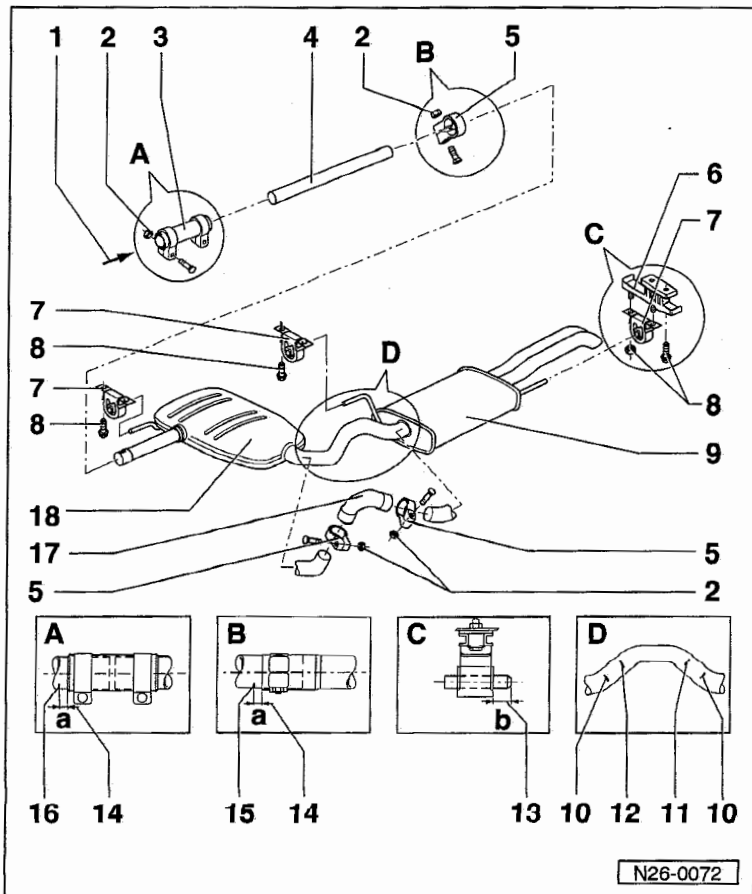


### Mufflers and attachments, removing and installing (engine codes 1Z, AHU)

**Note:**

Align exhaust system lengthwise to maintain dimensions -a- and -b-.

- 1 - From oxidation catalytic converter
- 2 - 40 Nm (30 ft lb)
- 3 - Double clamp
- 4 - Intermediate pipe
- 5 - Clamp
- 6 - Console
- 7 - Mount
- 8 - 25 Nm (18 ft lb)
- 9 - Rear muffler

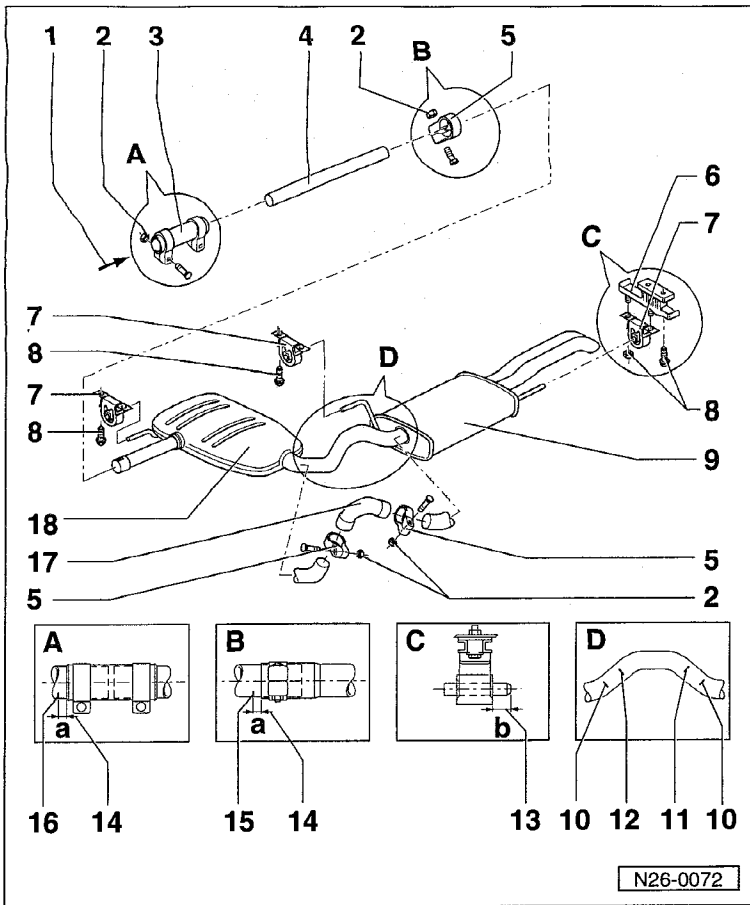


**10 - Marking**

- ◆ For clamp
- ◆ 3 places on circumference
- ◆ Clamp to marking (dimension -a- of item -14-) ⇒ page 26-11

**11 - Separating point**

- ◆ Allows replacement of center muffler only instead of replacing center/rear muffler as an assembly
- ◆ Marks appear 3 times on circumference of connecting pipe
- ◆ Center and rear mufflers are one-piece welded assembly in production. For repairs, center and rear mufflers are supplied individually and repair connecting pipe with two clamps is supplied
- ◆ Cut through connecting pipe using body saw square to separation point



**12 - Separating point**

- ◆ Allows replacement of rear muffler only instead of center/rear muffler assembly
- ◆ Marks appear 3 times on circumference of connecting pipe
- ◆ Center and rear mufflers are one-piece welded assembly in production. For repairs, center and rear mufflers are supplied individually and repair connecting pipe with two clamps is supplied

**13 - Dimension -b-**

- ◆ Approx. 10 mm (0.4 in.)

**14 - Dimension -a-**

- ◆ Approx. 5 mm (0.2 in.)

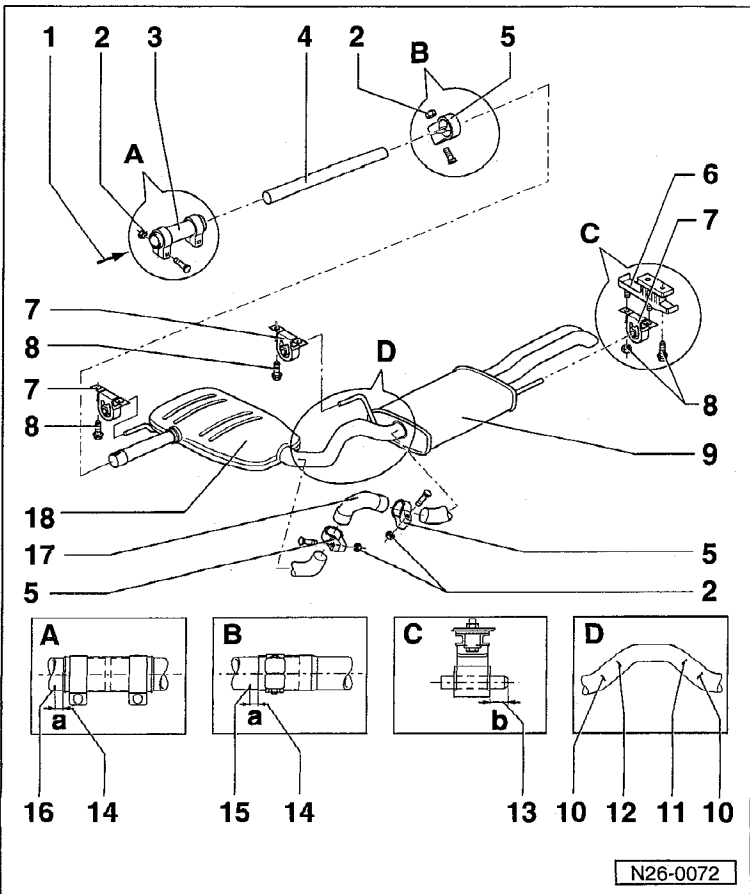
**15 - Marking**

- ◆ 3 places on circumference

**16 - Marking**

- ◆ 3 places on circumference
- ◆ S: Manual transmission
- ◆ A: Automatic transmission

26-11



**17 - Connecting pipe**

- ◆ Repair piece for use when replacing single muffler

**18 - Center muffler**

26-12

## Exhaust Gas Recirculation (EGR) system, servicing (engine code AAZ)

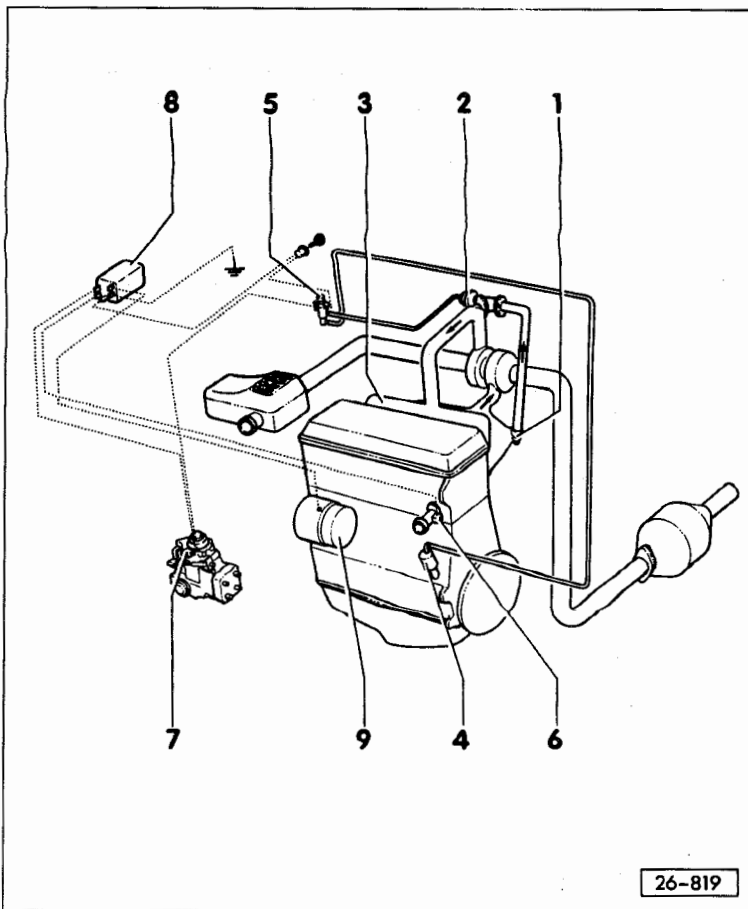
### EGR system, overview

Exhaust gas is removed from the exhaust manifold -1- and enters the intake manifold -3- via the EGR vacuum regulator solenoid valve -2-.

Actuation is by vacuum from vacuum pump -4- while control is provided by the automatic glow time control module -J179- (item -8-) via the two-way valve for EGR -N161- (item -5-).

When engine is cold, under full load, certain RPM ranges and at altitudes above 3300 feet, the EGR is switched off as follows:

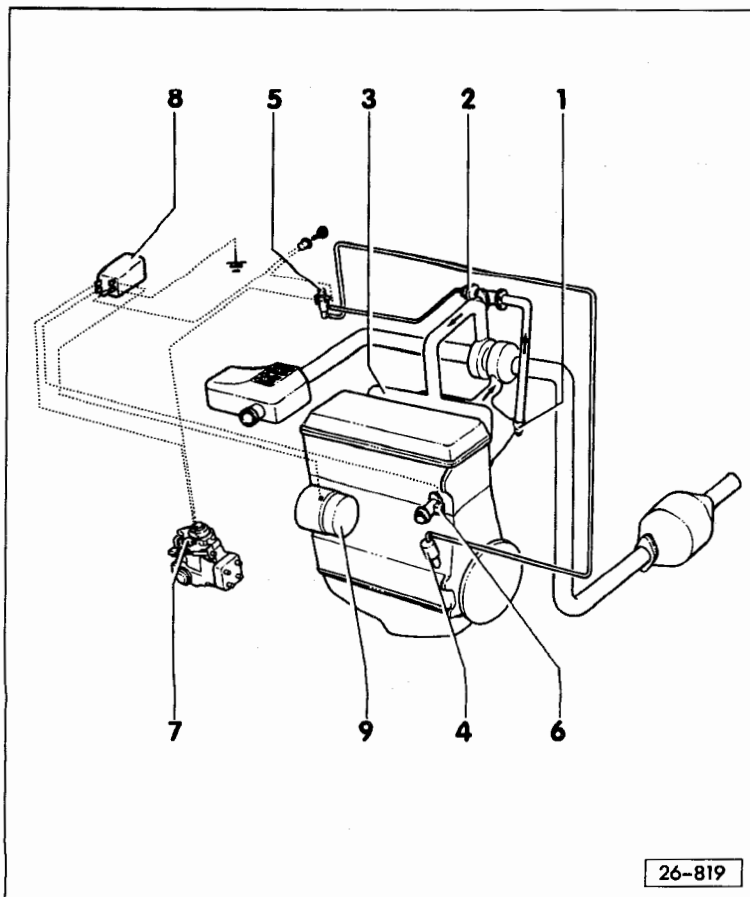
- ◆ At temperatures below +50° C (122°F) and engine is cold, EGR is switched off via sensor for engine temperature -G27- (item -6-).
- ◆ The EGR part throttle switch -F166- (item -7-) for EGR (on injection pump) ensures that exhaust gas is only recirculated during part throttle operation.



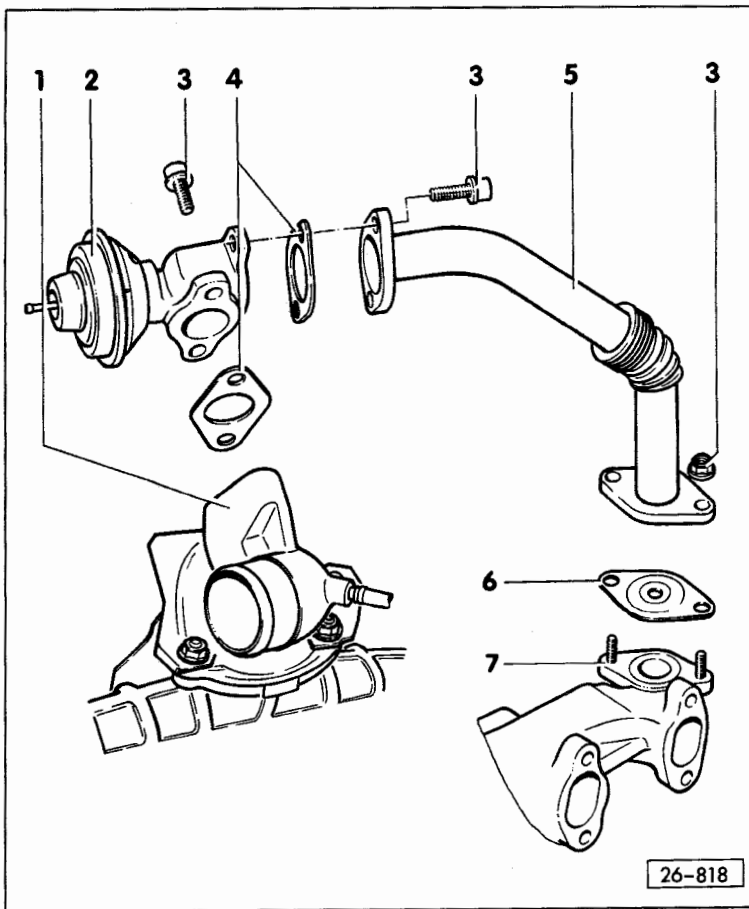
26-13

- ◆ Engine speed limiting is affected by automatic glow time control module -J179- (item -8-) and Generator terminal "W" (item -9-). When engine speed exceeds 1200 RPM, EGR is interrupted for 2 seconds. When engine speed exceeds 3200 RPM, EGR is switched off.

- ◆ At altitudes over approx. 3300 feet, EGR is switched off by altitude correction features in automatic glow time control module -8-.



26-14



## EGR system components, removing and installing

Engine code AAZ

1 - Intake manifold

2 - EGR valve

- ◆ Flow diagram ⇒ page 26-13
- ◆ Checking ⇒ page 26-19

3 - 25 Nm (18 ft lb)

4 - Gasket

- ◆ Always replace

5 - Connecting pipe

6 - Gasket

- ◆ Always replace
- ◆ Restriction hole 9 mm diameter

7 - Exhaust manifold

26-15

## EGR system, checking

Engine code AAZ

Special tools, testers and auxiliary items

- ◆ VAG1527B voltage tester
- ◆ VW1594 connector test kit
- ◆ Wiring diagram

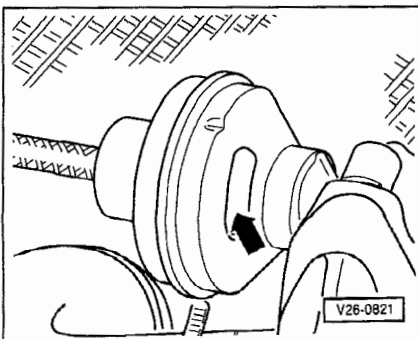
Test conditions

- Engine oil temperature 50° C (122° F) minimum

Checking function

- Start engine and let idle.
  - ◆ EGR valve diaphragm rod is pulled toward vacuum hose connector.
  - ◆ Diaphragm rod visible through opening (arrow) means exhaust gas is being supplied.
- Slowly increase engine speed, when engine speed exceeds 1200 RPM, EGR is interrupted for 2 seconds.

Diaphragm rod moves toward intake manifold for 2 seconds then moves back toward vacuum connection



26-16

- Continue to raise engine speed until part throttle switch closes.

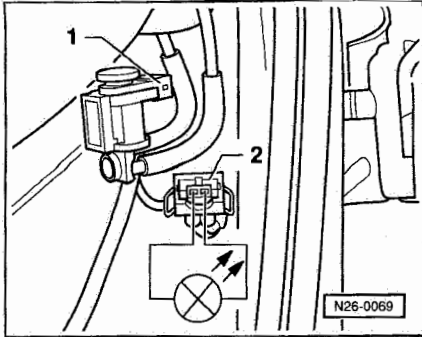
Diaphragm rod moves back toward intake manifold means EGR is interrupted.

If EGR does not work as described:

- Check activation as follows.

#### **Checking activation**

- Switch ignition off.
- ◀ - Disconnect 2-pin harness connector -2- from two-way valve for EGR -N161- (item -1-).
- Connect VAG1527B voltage tester using jumper cables from VW1594 connector test kit to connector terminals.
- Start engine and let idle.
- LED must light up
- Slowly increase engine speed.
- LED must go out for 2 seconds and then light up again
- Continue to increase engine speed until EGR part throttle switch closes.
- LED must go out



26-17

If control is OK:

- Check EGR two-way valve.  
⇒ page 26-20
- Check EGR valve.  
⇒ page 26-19

If control is NOT OK:

- Check engine coolant temperature sensor.  
⇒ page 26-21
- Check EGR part throttle switch.  
⇒ page 26-23

If no malfunction is detected for engine temperature sensor or for EGR part throttle switch:

- Check wiring using *Electrical Wiring Diagrams, Troubleshooting & Component Locations* binder, or replace automatic glow time control module -J179-, if necessary.

26-18

## EGR valve, checking

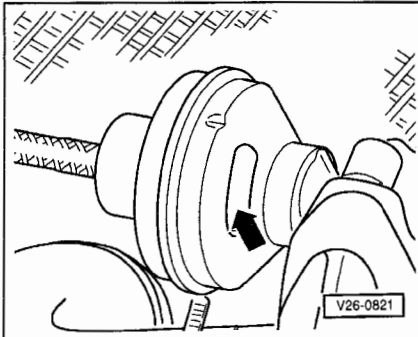
Engine code AAZ

### Special tools, testers and auxiliary items

- ◆ US8026 hand vacuum pump

### Test sequence

- Disconnect vacuum hose from exhaust gas recirculation valve.
- Connect US8026 hand vacuum pump to EGR valve.
- ◀ - Operate hand pump.
- The diaphragm rod must move toward vacuum connection. Observe membrane rod through opening (arrow)
- Disconnect US8026 hand vacuum pump from EGR valve.
- Valve must clearly be heard to close (diaphragm rod moves toward intake manifold)



26-19

## EGR two-way valve, checking

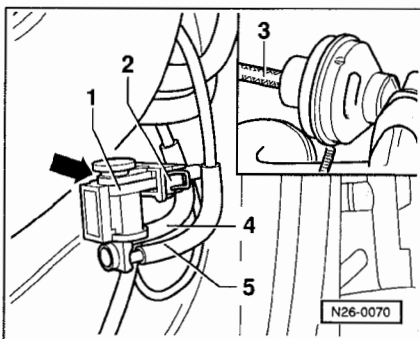
Engine code AAZ

### Test conditions

- Engine oil temperature 50° C (122° F) minimum

### Test sequence

- Switch ignition on.
- ◀ - Disconnect vacuum hose -5- from EGR two-way valve -N161- (item -1-).
- Disconnect vacuum hose -3- from EGR two-way valve and blow into hose.
- The EGR two way valve must allow air to pass to vacuum pump connection (flow not blocked)
- Disconnect 2-pin harness connector -2- from EGR two-way valve -1-.
- Blow again into vacuum hose -3-.
- The vacuum connection to vacuum pump must be closed and outlet to outside (arrow) open



26-20



## Engine coolant temperature sensor, checking

Engine code AAZ

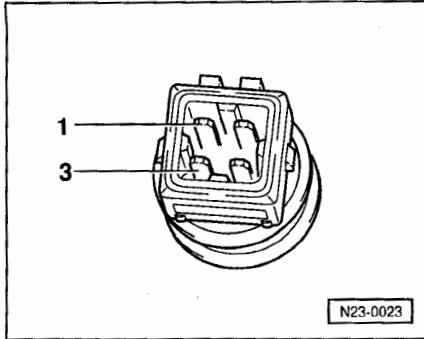
### Special tools, testers and auxiliary items

- ◆ Fluke 83 multimeter (or equivalent)
- ◆ VW1594 connector test kit

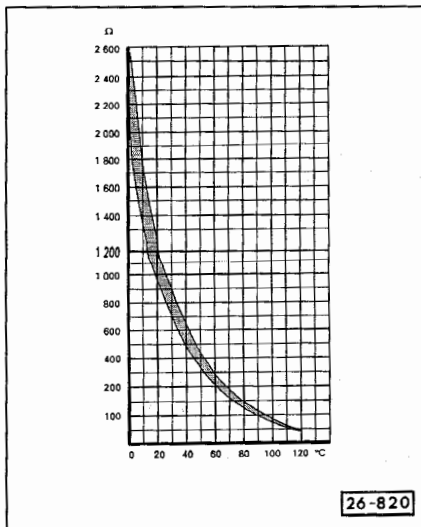
### Test sequence

– Remove harness connector from sensor for engine temperature -G27- ⇒ page 19-5, item 5.

- ◀ – Measure resistance between engine temperature sensor terminals -1- and -3- using multimeter.



26-21



- ◀ – Compare reading with specifications (see illustration).

If specification not obtained:

- Release coolant system pressure and replace engine temperature sensor.

26-22

## EGR part throttle switch, checking and adjusting

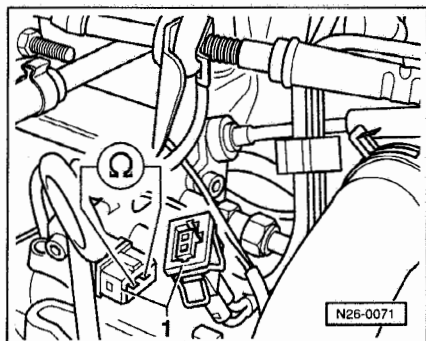
Engine code AAZ

### Special tools, testers and auxiliary items

- ◆ Fluke 83 multimeter (or equivalent)
- ◆ VW1594 connector test kit
- ◆ 12 mm hex drive and glow plug or equivalent spacer

### Test sequence

- ◀ – Disconnect 2-pin harness connector -1- from EGR part throttle switch -F166-.
- Measure resistance between EGR part throttle switch terminals using multimeter.
  - ◆ Switch open (pump lever on idle speed stop):  $\infty \Omega$
  - ◆ Switch closed (pump lever toward WOT):  $0 \Omega$



26-23

### Adjusting

#### Notes:

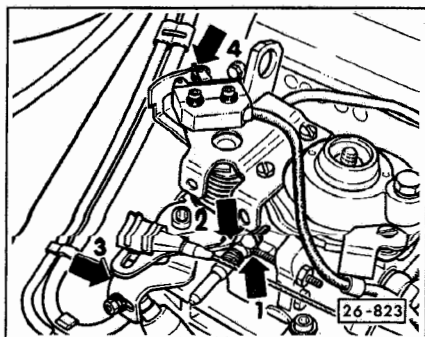
The EGR part throttle switch, switch points are set by the manufacturer on a test stand and must not be altered.

Adjust new switches as follows:

- ◀ – Operate injection pump lever and clamp 12 mm hex drive of glow plug between stop (arrow -1-) and lower edge of operating lever (arrow -2-).
- Press operating lever securely against glow plug (arrow -3-). In this position, adjust EGR part throttle switch by sliding unit in elongated holes until switch point (switch clicks) is just behind highest point on curved plate (arrow -4-).

#### Note:

The upper EGR part throttle switch cover is shown removed to make the illustrated switch point more clear.



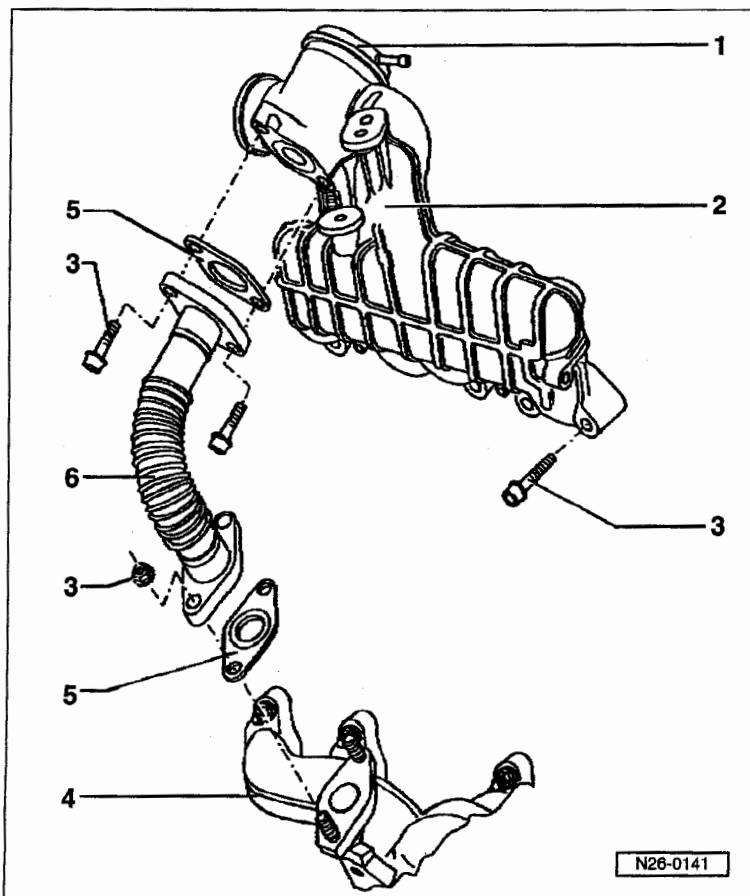
26-24

## Exhaust Gas Recirculation (EGR) system, servicing (engine code 1Z)

### Notes:

- ◆ Functional control of Exhaust Gas Recirculation (EGR) system is performed by Diesel Direct Fuel Injection (DFI) Engine Control Module (ECM) -J248- via the EGR vacuum regulator solenoid valve -N18-.
- ◆ Check EGR vacuum regulator solenoid valve -N18- using Output Diagnostic Test Mode (DTM).
- ◆ The cone shaped plunger in the mechanical EGR valve enables various cross sectional openings at different plunger heights.
- ◆ Every conceivable valve position is possible via pulsed control.
- ◆ Always replace self-locking nuts.

26-25



### EGR system components, removing and installing

#### Engine code 1Z

- 1 - EGR valve**
  - ◆ Part of intake manifold assembly, cannot be individually replaced
  - ◆ Checking ⇒ page 26-27
- 2 - Intake manifold**
  - ◆ With integral EGR valve
- 3 - 25 Nm (18 ft lb)**
- 4 - Exhaust manifold**
- 5 - Gasket**
  - ◆ Always replace
- 6 - Connecting pipe**

26-26

## EGR valve, checking

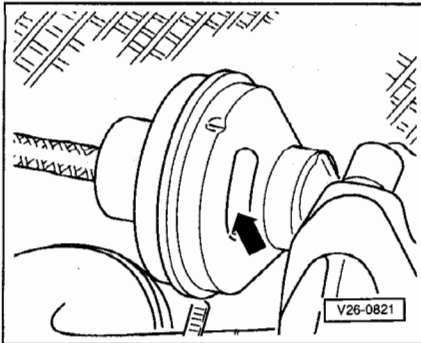
Engine code 1Z

Special tools, testers and auxiliary items

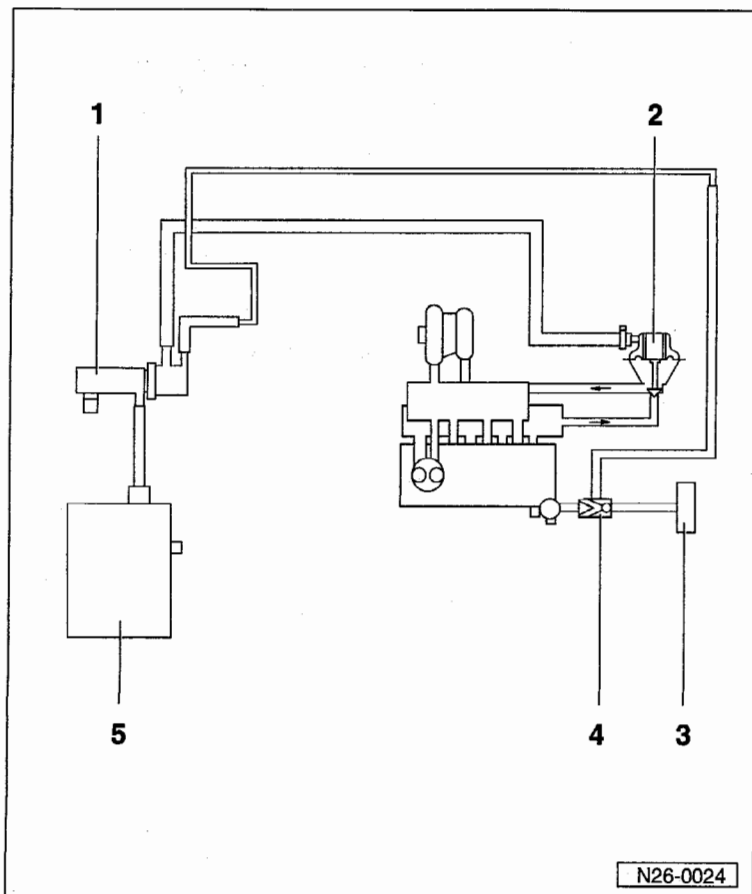
- ◆ US8026 Hand vacuum pump

Test sequence

- Disconnect vacuum hose from EGR valve.
- Connect US8026 hand vacuum pump to EGR valve.
- ▶ - Operate vacuum pump.
- The diaphragm rod must move toward vacuum connection. Observe diaphragm rod via opening (arrow)
- Disconnect US8026 hand vacuum pump from EGR valve.
- Valve must audibly close (diaphragm rod moves toward intake manifold)



26-27



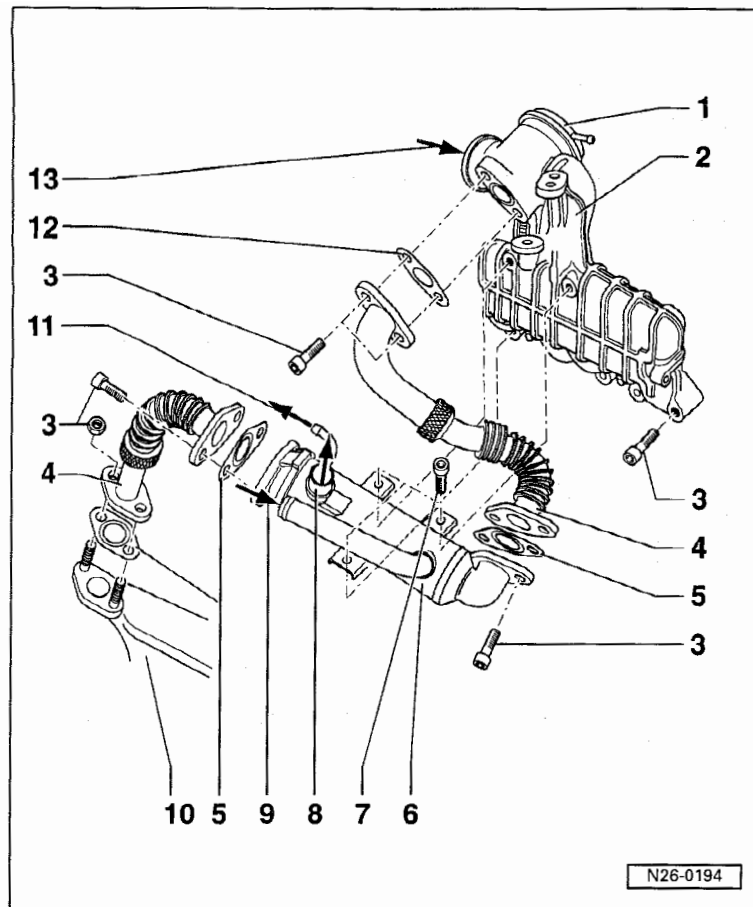
## Vacuum hose, connections

Engine code 1Z

- 1 - EGR vacuum regulator solenoid valve -N18-
- 2 - EGR valve
- 3 - Brake servo
- 4 - Check-valve
- 5 - Air Cleaner (ACL)

26-28

## Exhaust Gas Recirculation (EGR) system, servicing (engine code AHU)



### 1 - EGR valve

- ◆ Checking ⇒ page 26-31
- ◆ Checking triggering ⇒ Repair Manual, 1.9 Liter TDI OBD II, Direct Fuel Injection & Glow Plug System, Repair Group 01

### 2 - Intake manifold

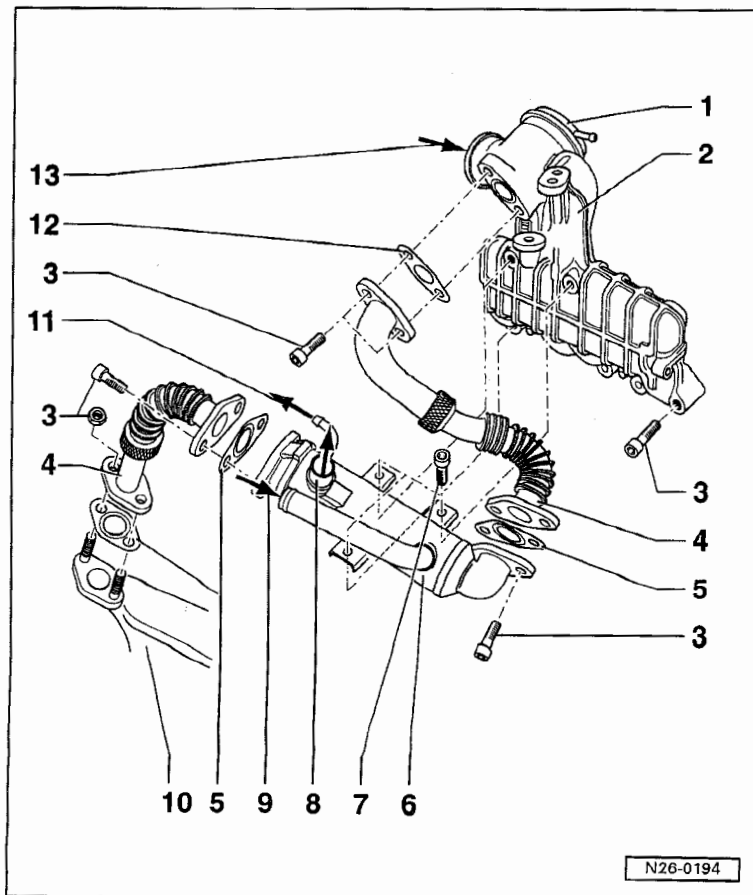
3 - 25 Nm (18 ft lb)

### 4 - Connecting pipe

### Note:

When installing, tighten all bolts finger tight (parts free to move slightly) then tighten free of stress.

26-29



### 5 - Gasket

- ◆ Always replace

### 6 - EGR cooler

7 - 10 Nm (7 ft lb)

### 8 - To heater core

### 9 - From cylinder head

### 10 - Exhaust manifold

### 11 - To overflow reservoir

### 12 - Flange gasket

- ◆ Always replace

### 13 - From charge air cooler

26-30

## EGR valve, checking

Engine code AHU

### Special tools, testers and auxiliary items

- ◆ US8026 Hand vacuum pump

### Test sequence

- Remove connecting pipe between intake pipe and charge air cooler.
- Disconnect vacuum hose from EGR valve (in intake manifold).
- Connect US8026 hand vacuum pump to EGR valve.
- ◀ - Operate vacuum pump.
- The valve plate must lift from valve seat (observe membrane cam via intake opening).
- Disconnect US8026 hand vacuum pump from EGR valve.
- Valve must audibly close (valve plate must position itself again on valve seat)

