

100/S4 1992 ▶, A6/S6 1995 ▶ 2.8L V6 General, Engine

Repair Manual

100/S4/A6/S6

1992 ▶

Engine codes: AAH, AFC

2.8 Liter V6

General, Engine

Edition 06.95

W42 013 195 101

Technical Service Communications



List of Repair Manual Repair Groups

1992 ►

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.

Part No. W42 013 195 101

Audi

Repair Manual

100/S4/A6/S6

1992 ►

This repair manual contains information published for use in the repair and servicing of the 1992 and later Audi 100, A6, S4 and S6 models imported into the USA and Canada.

CAUTION!

Before attempting any work on an Audi 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 Canadian Audi 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 Audi retailer to verify part numbers.

Note:

This booklet supersedes the microfiche Repair Manual, *100/S4/A6/S6 From 1992* (Oct. 1, 1994): Fiche 1 of 19 (W42-544-192-F3), Repair Groups 00, 10, 13, 15, 17, 19, 20, 21 and 26.

Printed in the United States of America

©1995 AUDI OF AMERICA, INC.

All rights reserved. Information contained in this manual is based on the latest information available at the time of printing. The right is reserved to make changes at any time without notice. No part of this manual may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publisher.

Introduction

This repair manual booklet covers general information, Repair Group 00, and the 2.8 Liter V6 engine (engine codes AAH and AFC), Repair Groups 00, 10, 13, 15, 17, 19, 20, 21 and 26.

It supersedes these Repair Groups in the Oct. 1, 1994 microfiche Repair Manual, *100/S4/A6/S6 From 1992*, Fiche 1 of 19 (W42-544-192-F3).

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 on OTIS, paper or microfiche.

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 Audi retailer or other qualified shop. We especially urge you to consult an authorized Audi retailer before beginning repairs on any vehicle that may still be covered wholly or in part by any of the extensive warranties issued by Audi.
- Audi 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 Audi 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. Many fasteners are designed to be used only once and become unreliable and may fail when used a second time. This includes, but is not limited to, nuts, bolts, washers, self-locking nuts or bolts, circlips, cotter pins. Always follow recommendations made in this publication. Always replace these fasteners with new parts.
- 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.

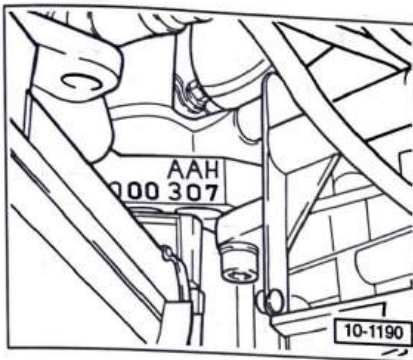
Index

00	General, Technical data	
	Technical data	Page
	- Engine code	00-1
	- Engine modifications	00-1
	- Engine specifications	00-2
		00-3
10	Engine—Removing and installing	Page
	Engine, removing and installing	
	- Installing	10-1
	- Removing	10-15
	- Rules of cleanliness	10-3
	- Safety precautions	10-1
	- Tightening torques	10-2
		10-17
13	Engine—Crankshaft, Cylinder block	Page
	Cylinder block, crankshaft and flywheel, component layout	13-4
	- Connecting rods and connecting rod bearings, checking	13-35
	- Crankshaft axial and radial clearance, checking	13-25
	- Crankshaft dimensions	13-28
	- Crankshaft oil seals, replacing	13-19
	- Crankshaft pilot needle bearing, removing and installing	13-21
	- Dual mass flywheel or drive plate, removing and installing	13-23
	- Engine speed (RPM) sensor mounting bracket, adjusting	13-22
	- Pistons and piston rings, checking and installing	13-29
	- Vibration damper, removing and installing	13-15
	Ribbed belt and pulley, assembly	13-1
	- Ribbed belt, removing and installing	13-7
	- Ribbed belt drive, checking and adjusting	13-9
	- Ribbed belt drive, troubleshooting	13-10
	Toothed drive belt and pulley, assembly	13-3
	- Toothed belt, removing and installing	13-16
15	Engine—Cylinder head, Valve gear	Page
	Cylinder head and valve drive	15-1
	- Component layout, engine code AAH up to 8.94	15-1
	- Component layout, engine code AAH from 8.94	15-3
	- Component layout, engine code AFC	15-3
	Cylinder head, assembly	15-5
	- Camshaft, removing, installing and checking	15-17
	- Camshaft oil seals, replacing	15-8
	- Compression pressure, checking	15-16
	- Cylinder head, removing and installing	15-11
	- Cylinder head, resurfacing	15-23
	- Cylinder head cover, installing	15-7
	- Hydraulic valve lifters, checking	15-19
	- Intake and exhaust valves, checking and refacing	15-24
	- Maximum permissible refacing dimension, calculating	15-28
	- Valve guides, checking and replacing	15-25
	- Valve seats, refacing	15-27
	- Valve stem seals, replacing	15-21
17	Engine—Lubrication system	Page
	Engine oil	17-16
	Lubrication system	17-1
	- Component layout, engine code AAH up to 8.94	17-1
	- Component layout, engine code AAH from 8.94	17-3
	- Component layout, engine code AFC	17-3
	- Oil pressure, oil pressure switch and oil pressure sensor, checking	17-11
	- Oil pump, removing	17-9
	- Oil retention valves, replacing	17-10
	- Revised oil circulation, engine code AAH from 8.94 and engine code AFC	17-5

19	Engine—Cooling system	Page
	Cooling system, components	19-1
	- Coolant Fan Control (FC) thermal switch, checking	19-6
	- Coolant pipes, layout	19-3
	- Cooling system, draining and filling	19-9
	- Cooling system leaks, checking	19-7
	- Expansion tank cap, pressure testing	19-8
	- Thermostat, replacing	19-5
20	Fuel supply	Page
	Fuel supply system, components	20-1
	- Accelerator Pedal (AP) cable and linkage, repairing	20-24
	- Accelerator Pedal (AP) cable, adjusting	20-25
	- Evaporative Emissions (EVAP) system, component layout	20-23
	- Fuel level sensor, removing and installing	20-10
	- Fuel Pump (FP), removing and installing	20-12
	- Fuel Pump (FP), assembly	20-15
	- Fuel Pump (FP), checking	20-16
	- Fuel pump check valve, checking	20-21
	- Fuel system, checking for leaks	20-8
	- Rules of cleanliness	20-7
	- Safety precautions	20-5
26	Exhaust system	Page
	Exhaust system, checking for leaks	26-37
	Exhaust system components, engine code AAH up to 8.94, removing and installing	26-1
	- All-wheel-drive vehicles	26-10
	- Exhaust system, aligning	26-22
	- Front-wheel-drive vehicles with manual transmission	26-2
	- Front-wheel-drive vehicles with automatic transmission 097	26-2
	- Front-wheel-drive vehicles with automatic transmission 01K	26-7
	Exhaust system components, engine code AAH from 8.94, removing and installing	26-30
	- All-wheel-drive vehicles	26-33
	- Front-wheel-drive vehicles	26-31
	Exhaust system components, engine code AFC, removing and installing	26-30
	- All-wheel-drive vehicles	26-33
	- Front-wheel-drive vehicles	26-31

Technical data

Engine code



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

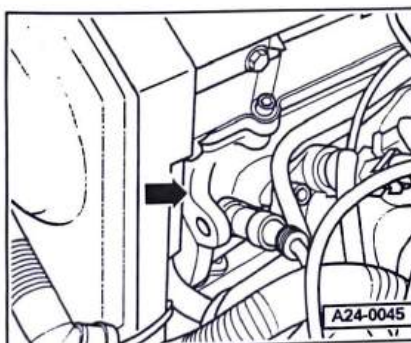
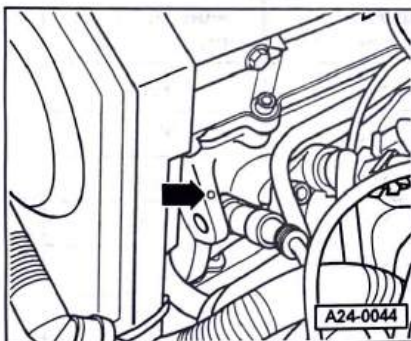
In addition, an adhesive label on the drive belt cover lists the engine code and engine number (serial number).

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

00-1

Engine modifications

Engines produced from approx. 8.94 have a lighter valvetrain, a modified lubrication system, as well as various other modifications. These engines are identified by a punch mark (arrow) on the lifting eye at the front of the left-side cylinder head or...



... by a recess in the lifting eye (arrow).

00-2

Engine specifications

Engine code		AAH	AAH/AFC	AFC
Manufactured	from: to:	11.91 approx. 8.94	approx. 8.94	5.95
No. of cylinders		6	6	6
Displacement	liters	2.771	2.771	2.771
Output	kW @ RPM Hp @ RPM	128 @ 5500 ¹⁾ 174 @ 5500 ¹⁾	128 @ 5500 ¹⁾ 174 @ 5500 ¹⁾	128 @ 5500 ¹⁾ 174 @ 5500 ¹⁾
Torque	Nm @ RPM Ft-lb @ RPM	250 @ 3000 ¹⁾ 184 @ 3000 ¹⁾	250 @ 3000 ¹⁾ 184 @ 3000 ¹⁾	245 @ 3000 ¹⁾ 180 @ 3000 ¹⁾
Bore diameter	mm	82.5	82.5	82.5
Stroke	mm	86.4	86.4	86.4
Compression ratio		10.3:1	10.3:1	10.0:1
Valve timing: at 1 mm valve lift and 0 mm valve clearance				
Intake opens after TDC		4°	10.50°	10.50°
Intake closes after BDC		42°	45.45°	45.45°
Exhaust opens before BDC		42°	37.50°	37.50°
Exhaust closes before TDC		2°	2.55°	2.55°
RON	minimum	95	95	91

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

00-3

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

Note:

Vehicle is specially tuned for: low emissions.

Engine specifications

Engine code		AAH	AAH/AFC	AFC
Manufactured	from: to:	11.91 approx. 8.94	approx. 8.94	5.95
No. of cylinders		6	6	6
Displacement	liters	2.771	2.771	2.771
Output	kW @ RPM Hp @ RPM	128 @ 5500 ¹⁾ 174 @ 5500 ¹⁾	128 @ 5500 ¹⁾ 174 @ 5500 ¹⁾	128 @ 5500 ¹⁾ 174 @ 5500 ¹⁾
Torque	Nm @ RPM Ft-lb @ RPM	250 @ 3000 ¹⁾ 184 @ 3000 ¹⁾	250 @ 3000 ¹⁾ 184 @ 3000 ¹⁾	245 @ 3000 ¹⁾ 180 @ 3000 ¹⁾
Bore diameter	mm	82.5	82.5	82.5
Stroke	mm	86.4	86.4	86.4
Compression ratio		10.3:1	10.3:1	10.0:1
Valve timing: at 1 mm valve lift and 0 mm valve clearance				
Intake opens after TDC		4°	10.50°	10.50°
Intake closes after BDC		42°	45.45°	45.45°
Exhaust opens before BDC		42°	37.50°	37.50°
Exhaust closes before TDC		2°	2.55°	2.55°
RON	minimum	95	95	91

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

00-3

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

Note:

Vehicle is specially tuned for: low emissions.

00-4

Engine, removing and installing

Rules of cleanliness

CAUTION!

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

1 - Thoroughly clean fuel system line and hose connections and the surrounding area before disconnecting.

2 - Place removed components on a clean surface and cover. Use plastic sheeting or paper. Do not use fluffy rags that could leave lint!

3 - Carefully cover over or seal any components that have been opened if repairs are not carried out immediately.

4 - Install only clean parts:

Do not remove replacement parts from the packaging until immediately before they are to be installed.

Do not use parts that have been stored without packaging (e.g. in toolboxes, etc.).

5 - When the fuel system is opened:

Avoid working with compressed air whenever possible.

Avoid moving the vehicle if possible.

10-1

Safety precautions

WARNING!

Be sure the ignition is switched OFF, when:

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

CAUTION!

BEFORE disconnecting the battery:

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

Removing

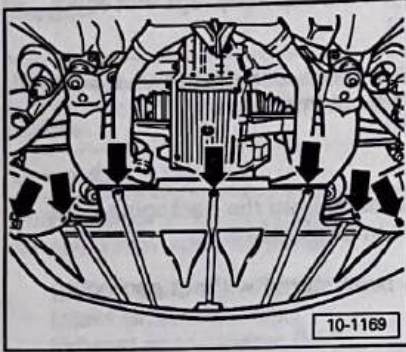
- The engine must be removed from above, after being separated from the transmission.

Note:

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

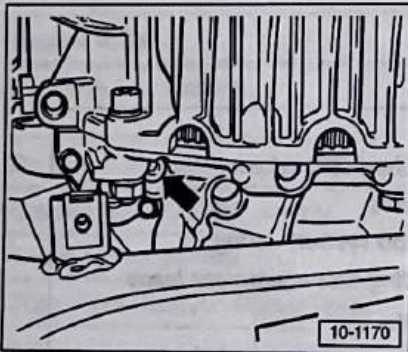
CAUTION!

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

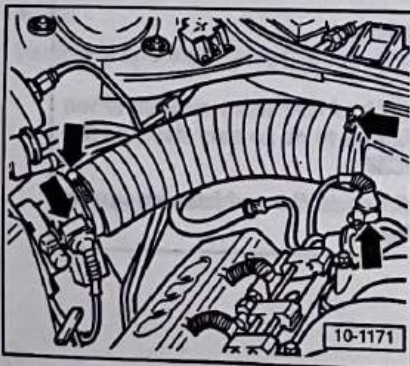


- ◀ - Disconnect battery Ground (GND) strap.
The battery is located below the rear seat bench.
- Remove noise insulation panel (7 fasteners).
- Disconnect bracket for noise insulation panel on engine mount.

10-3



- ◀ - Drain engine coolant at drain plug (arrow) using special tool 3247 or equivalent.
- Drain radiator using drain plug at bottom right of radiator.

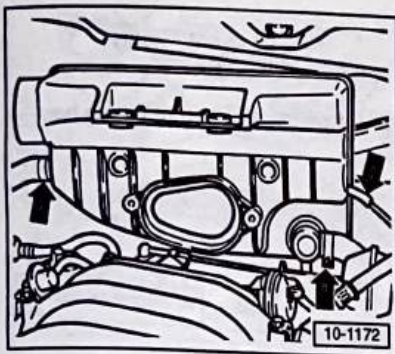


- ◀ - Remove intake air dust between Mass Air Flow (MAF) sensor and intake manifold.
- Disconnect harness connectors from MAF sensor and Idle Air Control (IAC) valve.
- Remove intake air preheating hose.
- Remove EVAP canister purge regulator valve on MAF sensor.
- Unclip air cleaner housing and remove with MAF sensor.

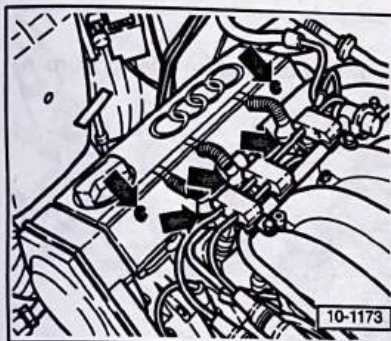
Note:

All illustrations are shown with covering removed.

10-4

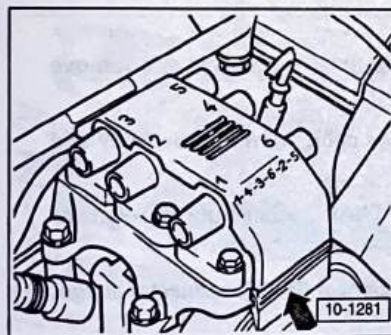


- ◀ - Remove cover on intake air housing, remove both screws, push back and lift housing.
- Remove both positive crankcase ventilation breather hoses, disconnect vacuum hose and remove intake air housing.
- Remove coolant hose between radiator and top of engine.

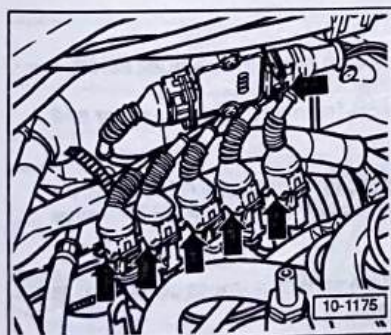


- ◀ - Remove both covers for fuel injection lines on left and right sides.
- Disconnect fuel injector harness connectors and place aside at rear together with the covers.

10-5

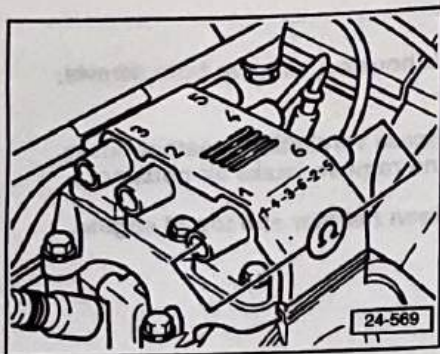


- ◀ - Remove ignition coil cover (arrow).
- Mark which ignition wires go to which spark plugs.
- Disconnect wires from ignition coil.

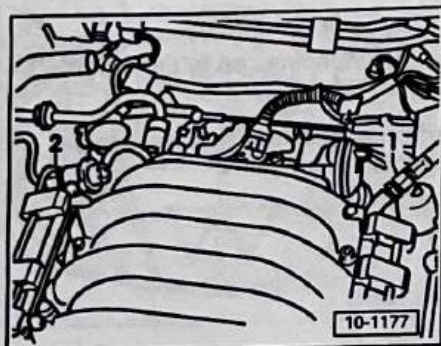


- ◀ - Disconnect harness connectors (arrows) attached to bracket on engine compartment bulkhead near plenum chamber.
- Cut tie-wraps and disconnect wires as necessary.

10-6

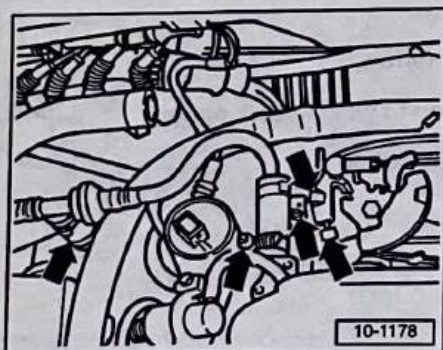


- ◀ - Remove ignition coils with ignition coil holder.
- Pull ignition coil wires forward (toward fan) and out from beneath intake manifold.

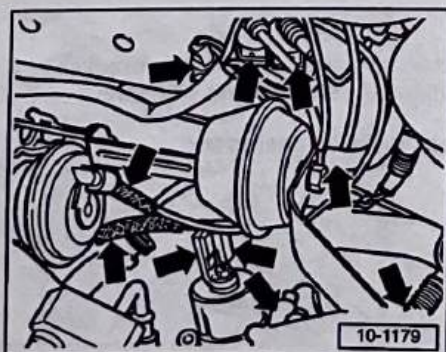


- ◀ - Disconnect fuel supply line -1- and fuel return line -2- from fuel rail.

10-7

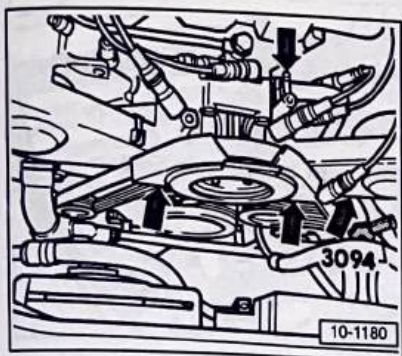


- ◀ - Disconnect vacuum hose on intake manifold and remove vacuum pump (if installed).
- Disconnect accelerator pedal cable from throttle body and move to one side.
- Disconnect hose between EVAP canister purge regulator valve and throttle body.
- Disconnect Heated Oxygen Sensor (HO2S) connector at right and uncover wires.

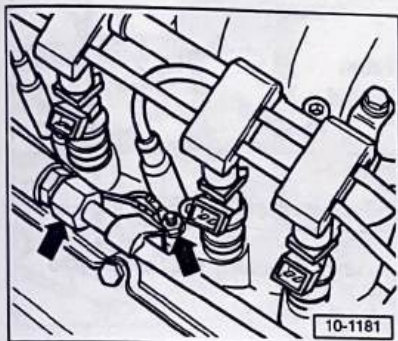


- ◀ - Disconnect harness connector on plenum chamber at left.
- Disconnect harness connectors from oil pressure sensor and oil pressure switch.
- Disconnect harness connectors for cruise control system, intake manifold change-over valve (blue) and EGR valve (brown).
- Disconnect crankshaft position sensor harness connector at rear of left-side cylinder head.
- Disconnect harness connector from throttle position sensor.

10-8

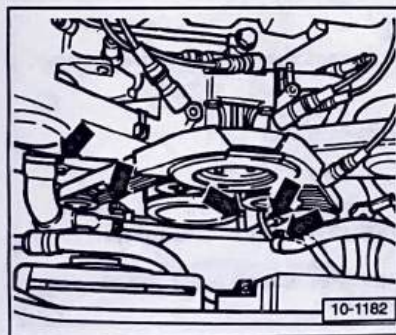


- ◀ - Clamp off engine coolant hose using tool 3094, Snap-On YA 2850, or equivalent special hose clamp. Pull off hose at pump and holder at bottom, uncover.
- Remove cover for ribbed belt.

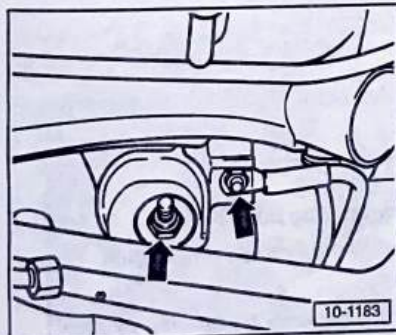


- ◀ - Disconnect pressure line from power steering pump (left arrow).
- Use rag to absorb any oil spills.

10-9

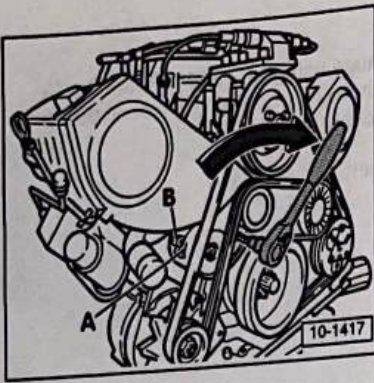


- ◀ - Remove coolant hose on right side, together with coolant line.
- Remove nut from engine support.

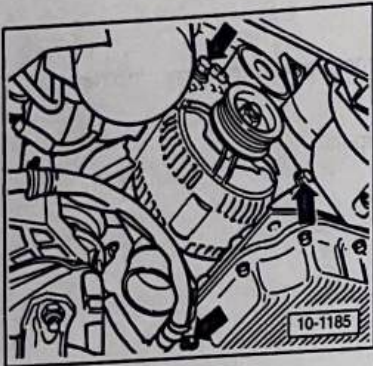


- ◀ - Disconnect GND strap from right side engine support (right arrow).
- Remove nut from engine support (left arrow).

10-10



- ◀ - Relieve tension on ribbed belt, using drift 3204 to secure belt.
- Remove ribbed belt.
- Disconnect both heater hoses from engine at left rear.



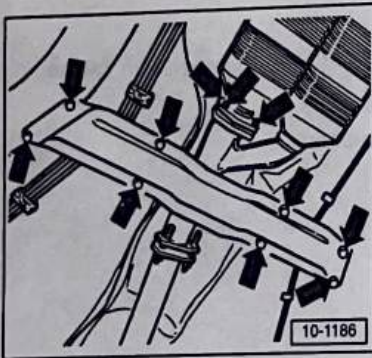
- ◀ - Remove air guide for generator.
- Remove clamp on oil pan.

CAUTION!

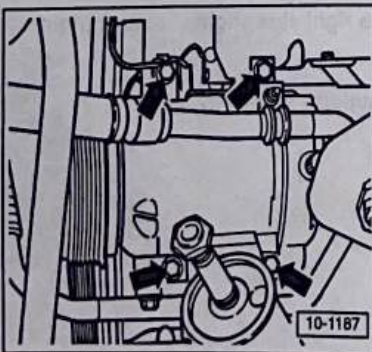
Make sure battery has been disconnected.

- Remove generator (wires remain connected) and tie-up off to one side.

10-11



- Unbolt starter and pull out toward rear (wires remain connected).
- Tie-up starter to engine at one side.
- ◀ - Remove crossmember.
- Disconnect and remove three way catalytic converters.
- Remove clamp for A/C compressor line on cross member at front.
- Remove oil filter.
- Loosen and remove oil cooler from under oil filter.

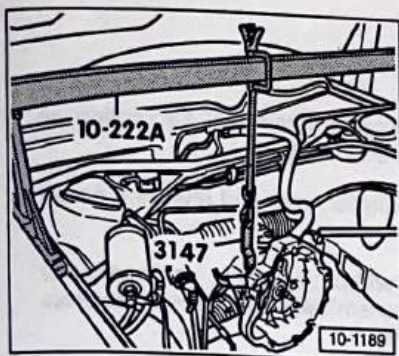


- ◀ - Unscrew bolts and secure A/C compressor to one side with wire.

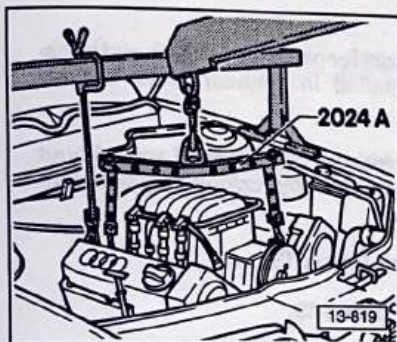
CAUTION!

- ♦ ***Disconnect brackets and mounting points only.***
- ♦ ***DO NOT open the air conditioning refrigerant circuit.***
- ♦ ***Refrigerant lines kink easily.***
- ♦ ***The A/C refrigerant circuit must only be opened by specially trained technicians using the proper tools and equipment.***

10-12



- ◀ - Unbolt engine/transmission flange at bottom and top.
 - Support weight of transmission using engine support bridge 10-222A and hook 3147.
- (Shown with engine removed)



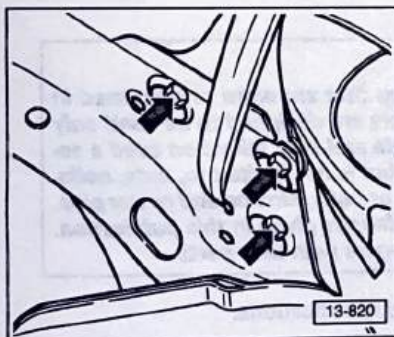
- ◀ - Attach engine sling 2024A at right-rear and left-front of engine, and secure.

Note:

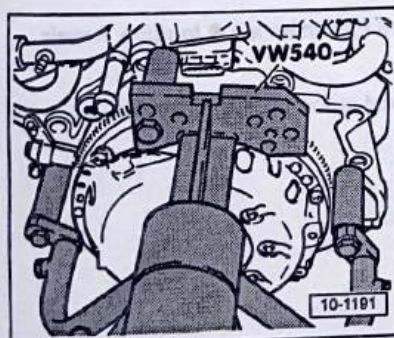
In order to balance the engine's center of gravity, the rail holes of the engine sling must be arranged as illustrated.

- Attach workshop crane to engine sling.

10-13



- Lift engine slightly.
- ◀ - Remove front engine support from side member (arrows) (partially loosen applicable inner fender liner).
- Carefully lift engine while turning 10-222A until clear of right mount.
- Carefully pull engine forward until it is completely clear.
- Lift out starter after engine has been separated from transmission.
- Lift engine up and out.



Mounting engine cylinder block on assembly stand

- ◀ - Mount engine to stand using engine holder VW 540 along with VW 540/1A.

CAUTION!

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

10-14

Installing

Engine is installed in reverse order of removal, also noting the following special conditions and steps:

- Check clutch release bearing for wear and replace if necessary.
- Short blocks are supplied without sleeve in crankshaft. For vehicles with automatic transmission, tap sleeve into place before installing drive plate.
- Lightly lubricate clutch release bearing and transmission input shaft splines with G 000 100 grease. Do not grease guide sleeve for release bearing.
- Check that alignment sleeves for centering engine and transmission are properly installed in cylinder block. Install sleeves if necessary.
- Install engine on mounts without any pre-load and without tension. Ensure proper alignment by rocking engine before tightening engine mounts.
- Adjust ribbed belt ⇒ Repair Group 13.
- Fill with coolant ⇒ Repair Group 19.

10-15

WARNING!

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

- Observe tightening torque specifications.
- Align exhaust system without tension ⇒ Repair Group 26.
- Connect harness connectors on engine compartment bulkhead.
- ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition, Repair Group 24
- Check oil level in engine and automatic transmission.

10-16

Tightening torques

Engine to transmission

M8	25 Nm	(18 ft lb)
M10	45 Nm	(33 ft lb)

Torque converter to drive plate 35 Nm (22 ft lb)

Left engine support to side member 45 Nm (33 ft lb)

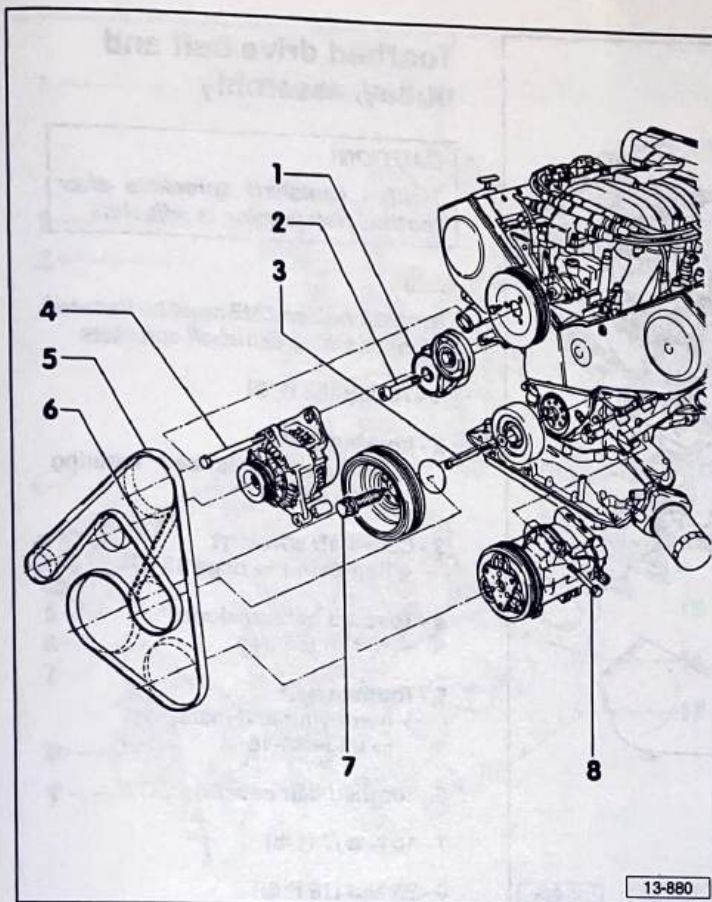
Right engine support 45 Nm (33 ft lb)

Generator (GEN) to mounting bracket

M8	25 Nm	(18 ft lb)
M10	45 Nm	(33 ft lb)

Three way catalytic converter to exhaust manifold 25 Nm (18 ft lb)

A/C compressor to mounting bracket 25 Nm (18 ft lb)



Ribbed belt and pulley, assembly

Note:

- ♦ There are two different types of ribbed belt, identified in this manual as versions A and B.
- ♦ Ribbed belt versions, identifying ⇒ page 13-12.
- ♦ Illustration shows only version B.

1 - Tensioner

- ♦ Loosening ⇒ page 13-7

2 - 55 Nm (41 ft lb)

3 - 20 Nm (15 ft lb)

4 - 20 Nm (15 ft lb)

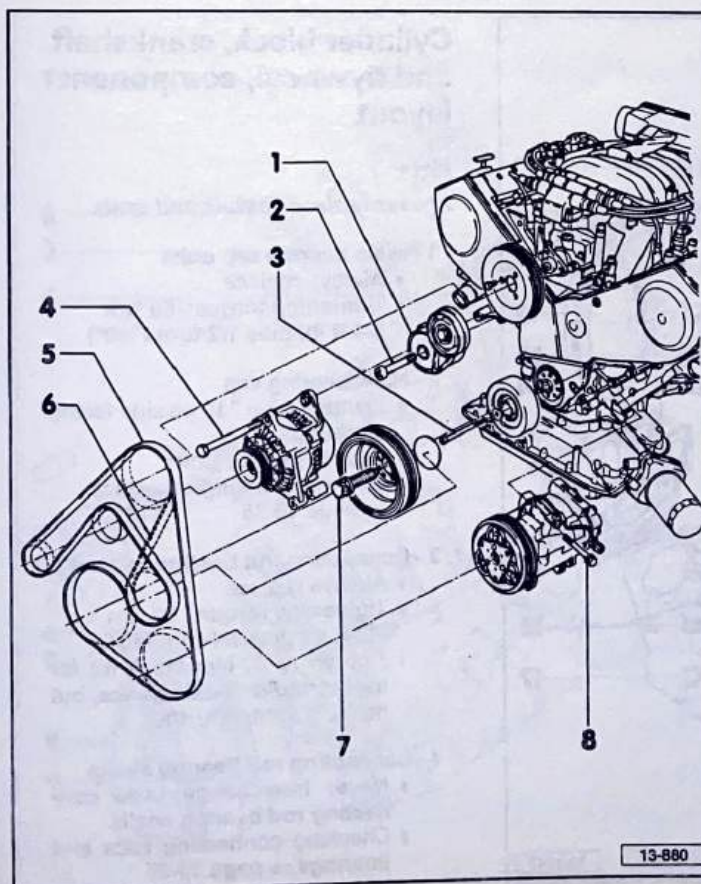
5 - Ribbed belt

- ♦ Removing and installing ⇒ page 13-7
- ♦ Checking pulley alignment ⇒ page 13-9

6 - Belt routing w/o A/C

- ♦ Not applicable to vehicles for USA and Canada

13-1

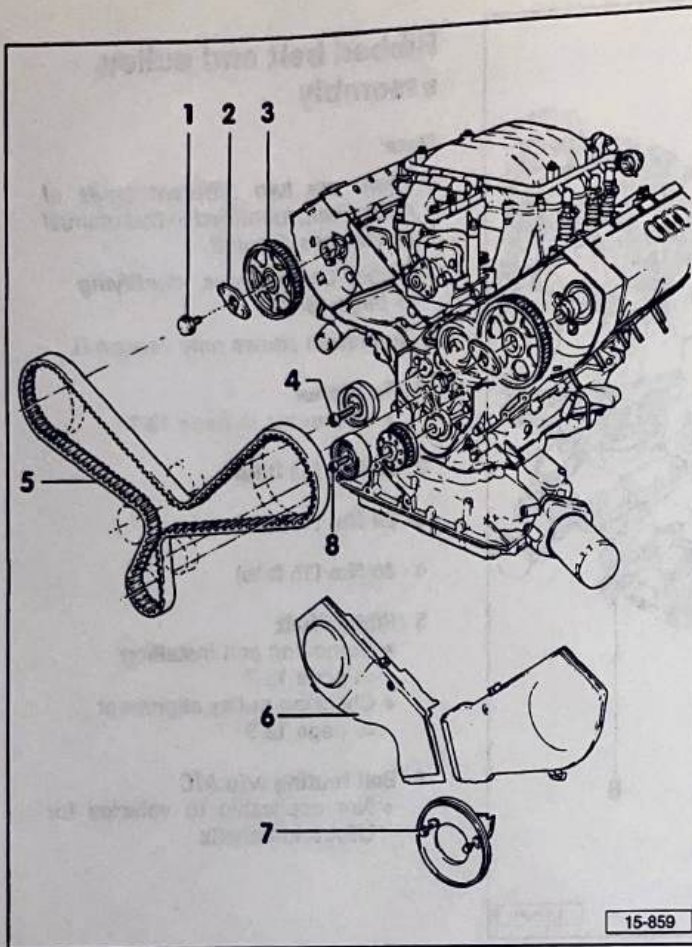


7 - Bolt

- ♦ Always replace
- ♦ Use only new double hex head (12-pt.) cap screw grade 9.8
- ♦ Tightening torque (bolt oiled): 200 Nm (148 ft lb) plus 1/2-turn (180°); two 1/4-turns (90°) turns are permissible
- ♦ Without wrench 2079
- ♦ Install with crankshaft tool 3242 ⇒ page 13-16.

8 - 20 Nm (15 ft lb)

13-2



Toothed drive belt and pulley, assembly

CAUTION!

Tighten camshaft sprockets after toothed belt tension is adjusted.

Note:

Camshaft holder 3243 must be installed before attaching camshaft sprockets.

1 - 70 Nm (52 ft lb)

2 - Locking plate

- ♦ Side with inscribed lettering faces camshaft

3 - Camshaft sprocket

- ♦ Removing ⇒ page 13-17

4 - Toothed belt tensioner

- ♦ 45 Nm (55 ft lb)

5 - Toothed belt

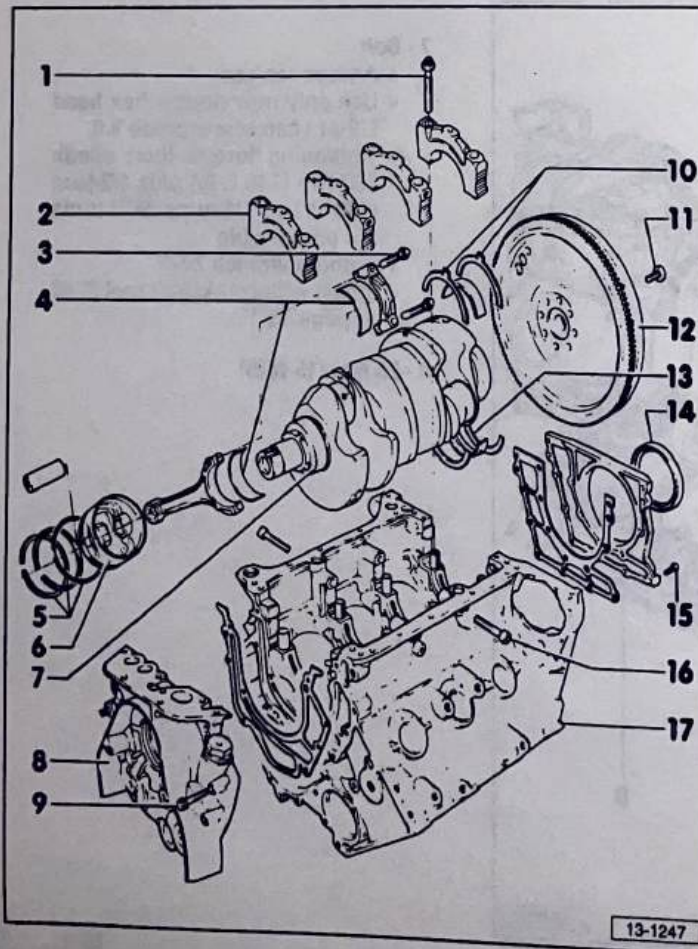
- ♦ Removing and installing ⇒ page 13-16

6 - Toothed belt cover

7 - 10 Nm (7 ft lb)

8 - 25 Nm (18 ft lb)

13-3



Cylinder block, crankshaft and flywheel, component layout

Note:

Always replace gaskets and seals.

1 - Main bearing cap bolts

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

2 - Main bearing cap

- ♦ Identification "1" on side facing oil pump
- ♦ Always replace bolts
- ♦ Checking bearing clearance ⇒ page 13-25

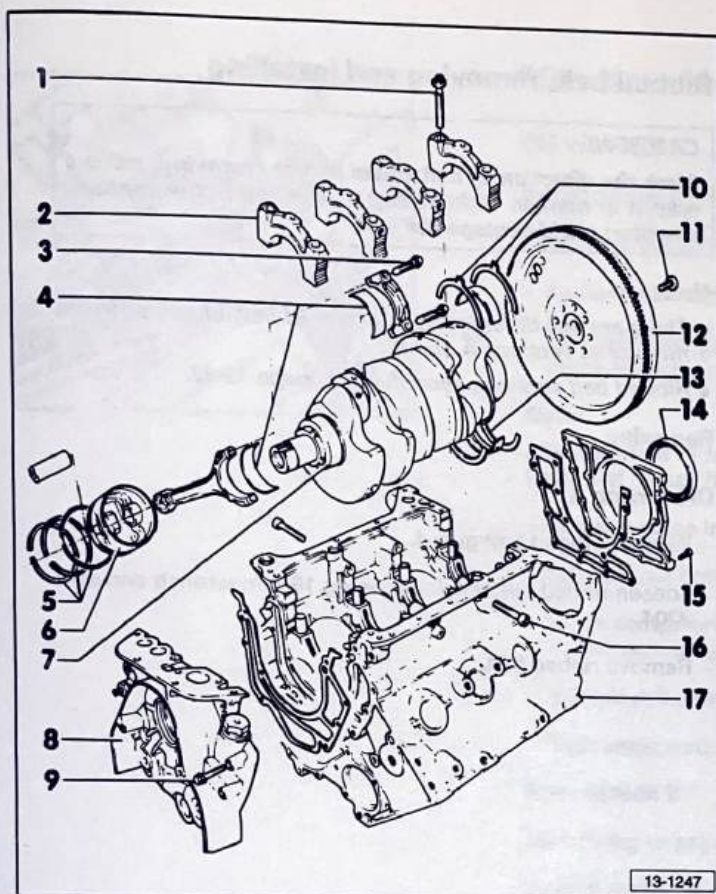
3 - Connecting rod bearing cap bolts

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

4 - Connecting rod bearing shells

- ♦ Never interchange used connecting rod bearing shells
- ♦ Checking connecting rods and bearings ⇒ page 13-35

13-4



5 - Piston rings
♦ Checking ⇒ page 13-29

6 - Piston
♦ Checking ⇒ page 13-30

7 - Crankshaft
♦ Checking ⇒ page 13-25
♦ Dimensions ⇒ page 13-28

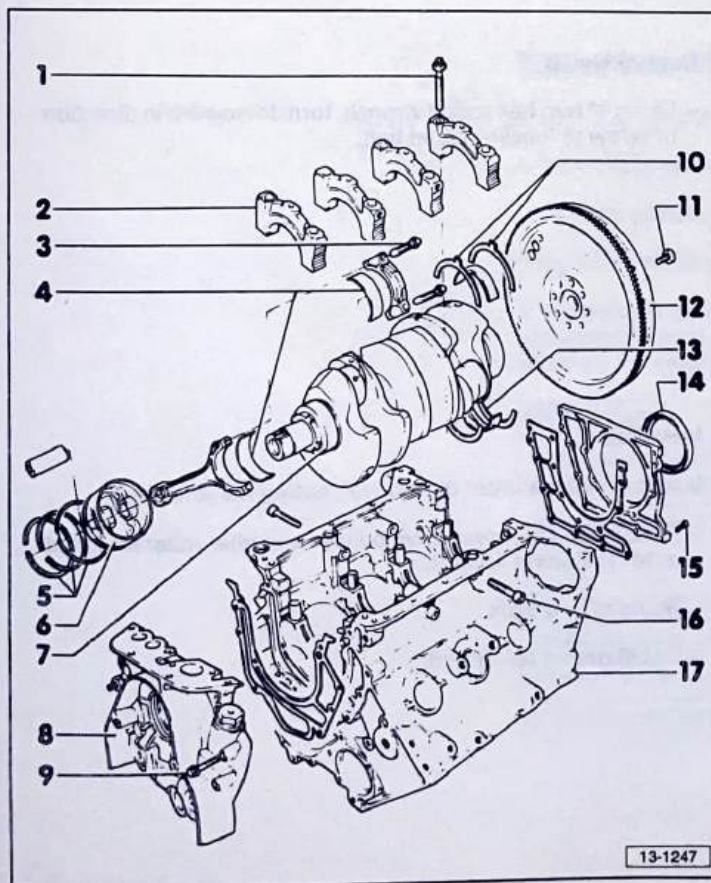
8 - Oil pump
♦ Check drive gear on crankshaft when installing
♦ Removing ⇒ Repair Group 17

9 - 10 Nm (7 ft lb)

10 - Thrust washers
♦ Installed only at 4th crankshaft main bearing
♦ Checking crankshaft axial clearance ⇒ page 13-25

11 - Bolt
♦ For dual mass flywheel (manual transmission)
♦ Always replace
♦ Tightening torque: 40 Nm (30 ft lb) plus 1/2-turn (180°)

13-5



12 - Dual mass flywheel or drive plate
♦ Removing and installing, installation dimensions ⇒ page 13-23
♦ Removing and installing pilot needle bearing ⇒ page 13-21
♦ Adjusting engine speed (RPM) sensor -G28- ⇒ page 13-22

13 - Main bearing shells
♦ Checking radial clearance ⇒ page 13-25

14 - Seal
♦ Replacing ⇒ page 13-19

15 - 10 Nm (7 ft lb)

16 - 25 Nm (18 ft lb)
♦ Thread bolts in hand-tight before tightening crankshaft main bearing caps

17 - Cylinder block

13-6

Ribbed belt, removing and installing

CAUTION!

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

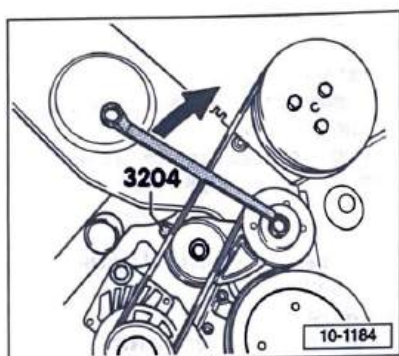
Note:

- ♦ There are two different types of ribbed belt, identified in this manual as versions A and B.
- ♦ Ribbed belt versions, identifying ⇒ page 13-12.

Removing

Old version A

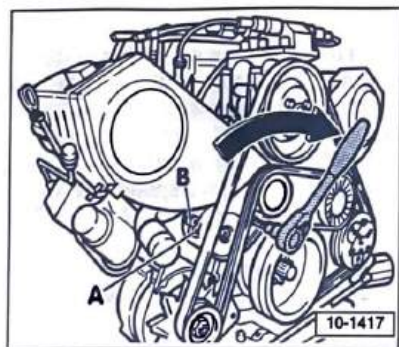
- Remove ribbed belt guard.
- ◀ - Loosen ribbed belt tensioner using 15 mm wrench and drift 3204.
- Remove ribbed belt.



13-7

New version B

- ◀ - Using 10 mm hex socket wrench, turn downward in direction of arrow to loosen ribbed belt.

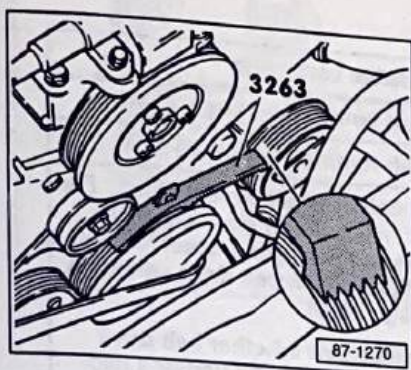


Installing

Install in reverse order of removal, noting the following:

- Place ribbed belt over drive pulleys and idler roller first, and onto tensioning roller last.
- Remove drift 3204.
- Install ribbed belt guard.

13-8



Ribbed belt drive, checking and adjusting

Old version A

Identifying ⇒ page 13-12

- Remove ribbed belt ⇒ page 13-7.
- Remove idler roller.
- ◀ - Fit alignment gauge 3263 to vibration damper pulley and press against grooves of A/C compressor pulley.

Note:

Misalignment of more than 0.4 mm (0.016 in.) will cause belt wear and noise. If misalignment exceeds 0.4 mm (0.016 in.):

- Remove noise insulation panel from underneath.
- Loosen four bolts of A/C compressor.
- Move compressor so that the alignment gauge can be positioned against grooves of compressor pulley.
- Tighten A/C compressor mounting bolts.

Tightening torque: 20 Nm (15 ft lb)

New version B

Identifying ⇒ page 13-12

Alignment of the A/C drive belt pulley is not required.

13-9

Ribbed belt drive, troubleshooting

Proceed as follows if ribbed belt drive noise is noted:

- Reproduce cause for complaint in shop.
- Remove ribbed belt and run engine without belt.

If the noise is still present, it is not caused by the ribbed belt.

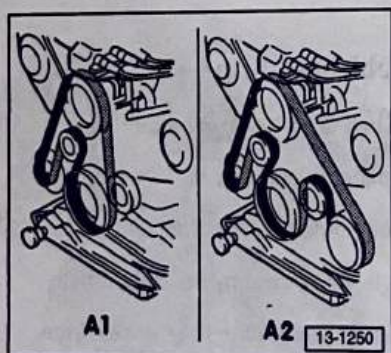
If the noise is no longer present, determine the cause of the noise according to the table of malfunctions on page 13-11, and repair as necessary.

Malfunction	Possible cause(s)		
Knocking noise when starting or switching off engine	1	2	
Knocking noise during acceleration	1	2	
Whistling noise at idle	3	4	5
Whistling noise up to 2000 RPM	3	4	5
Whistling noise above 2000 RPM	7		
Strong friction on pulley	3		
Belt damaged by foreign object	8		

Table of possible belt drive malfunctions

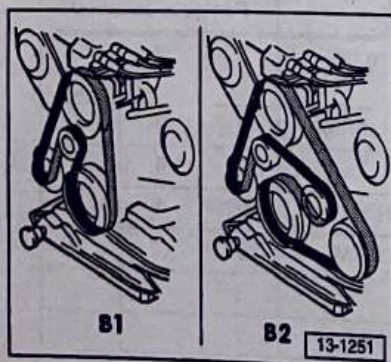
Possible malfunctions	Possible correction
1 Incorrect ribbed belt tensioner	- Correct ribbed belt tensioner ⇒ page 13-14
2 Incorrect ribbed belt routing	- Correct ribbed belt routing ⇒ page 13-12
3 Pulley mis-alignment A/C compressor pulley	- Carry out optical belt drive alignment check. For mis-alignment of belt drive version A, replace pulley, power steering pump or bracket for idler roller. Possible change from belt drive version A to version B ⇒ page 13-14. - It is essential to determine whether belt drive version A or version B is a single unit or a two-part crankshaft pulley and vibration damper. Identification ⇒ page 13-13
4 Incorrect ribbed belt	- Install correct ribbed belt ⇒ page 13-14
5 Ribbed belt (version B) not correctly positioned on pulley	- Position ribbed belt correctly on pulley ⇒ page 13-12
6 Incorrect idler roller installed	- Install correct idler roller ⇒ page 13-14
7 Whistling noises above 2000 RPM not caused by ribbed belt	- Start engine without ribbed belt and isolate whistling noise.
8 Ribbed belt damaged by loose end of the hose clamp in vicinity of generator	- Loosen and rotate hose clamp on coolant hose and secure.

13-11



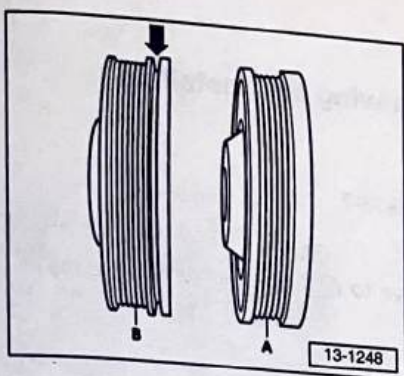
◀ Ribbed belt drive version A

- ♦ A₁ — not applicable to vehicles for USA and Canada
- ♦ A₂ — vehicles with A/C



◀ Ribbed belt drive version B

- ♦ B₁ — not applicable to vehicles for USA and Canada
- ♦ B₂ — vehicles with A/C



Belt drive pulley identification

- A - Crankshaft pulley for ribbed belt drive version A
- B - Crankshaft pulley for ribbed belt drive version B

13-13

Replacement parts, ribbed belt drive A and/or B

CAUTION!

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

Description	Belt drive version A		Belt drive version B	
Toothed belt (timing belt)	078 105 263		078 105 263 B.	
Idler roller	078 903 341 B		078 903 341 J	
Toothed belt cover	078 109 127		078 105 127 A	
Ribbed belt crankshaft pulley	—		078 195 255 D	
Vibration damper	078 105 251 C		078 903 251 F	
Bolts for vibration damper	N 014 739 1	M8 x 16	N 014 710 7	M8 x 20
Ribbed belt:				
♦ With A/C	078 903 137 C	21.36 x 2280 mm	078 903 137 K	21.36 x 2260 mm
Belt tensioner:				
♦ Automatic with A/C	078 903 133 H		078 903 133 M	
♦ Manual with A/C	078 903 133 H		078 903 133 P	

13-14

Vibration damper, removing and installing

Removing

- Remove ribbed belt ⇒ page 13-7.

Note:

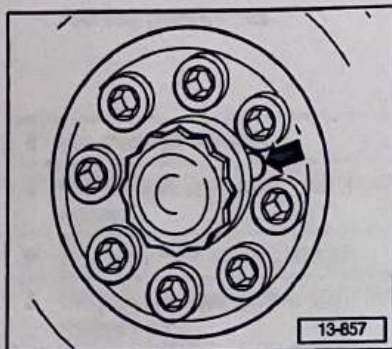
The center bolt does not have to be loosened to remove the vibration damper.

- Remove vibration damper.

Installing

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

Tightening torque: 20 Nm (15 ft lb)



13-15

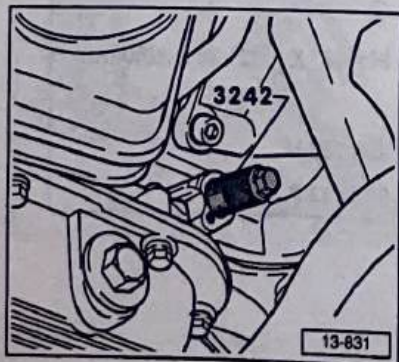
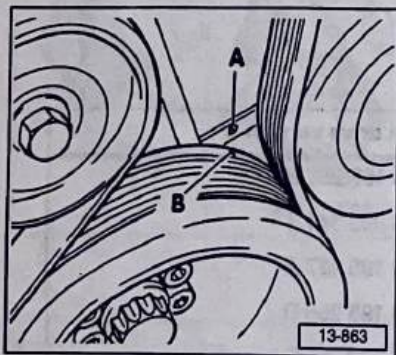
Toothed belt, removing and installing

Removing

CAUTION!

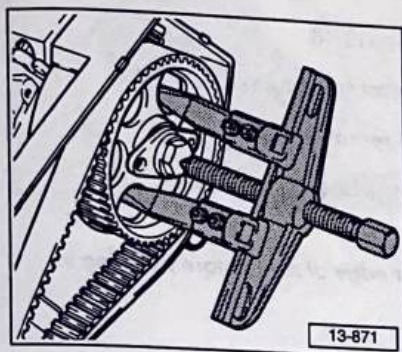
Mark the direction of belt travel before removing, using a crayon or marker. Reinstalling a used belt in the opposite direction could damage the belt.

- Remove ribbed belt ⇒ page 13-7.
- Unclip toothed belt guard on both sides.
- ◀ - Crank engine by hand to Top Dead Center (TDC) position.
- Check camshaft position. Large holes in camshaft sprocket locking plates must face toward each other. If not, turn crankshaft one more revolution.
- Remove Crankshaft Position (CKP) sensor from left-hand side of cylinder block.
- The TDC hole in the crankshaft must be positioned behind the hole of the removed CKP sensor (visible and/or tangible).
- ◀ - Screw crankshaft holder 3242 into hole left by CKP sensor, and tighten slightly.
- Remove ribbed belt tensioner.
- Remove left and right toothed belt guard.



13-16

- Remove vibration damper ⇒ page 13-15.
- Remove lower toothed belt guard.



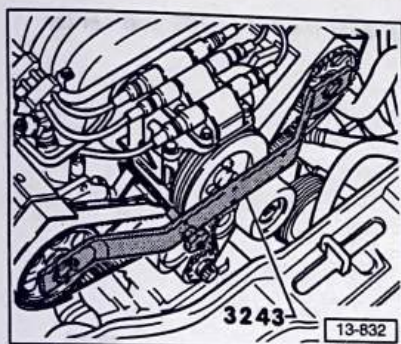
Installing

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

Note:

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

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

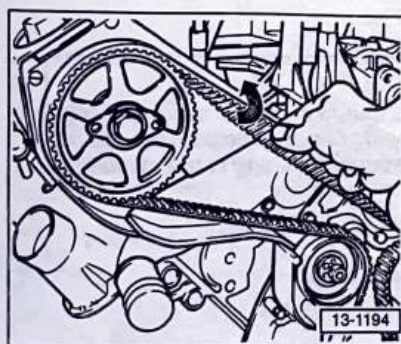


- ◀ - Install camshaft holder 3243.

Note:

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

13-17



Adjusting toothed belt tension

- Adjust toothed belt tension by turning tensioning roller with 8 mm hex socket wrench.
- Tighten tensioning roller center bolt with another 8 mm hex socket wrench.
- Check toothed belt tension between right camshaft sprocket and coolant pump.
- ◀ - Check belt tension.

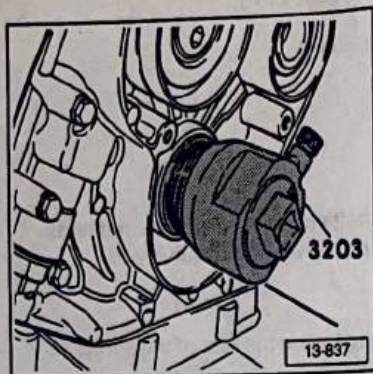
Holding toothed belt half way between camshaft sprocket and coolant pump with thumb and index finger, it must just be possible to twist toothed belt by 90°.

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

Center crankshaft bolt:

- ♦ Always replace
- ♦ Use only new double hex head (12-pt.) cap screw grade 9.8
- ♦ Tightening torque (bolt oiled): 200 Nm (148 ft lb) plus additional 1/2-turn (180°)

Crankshaft oil seals, replacing

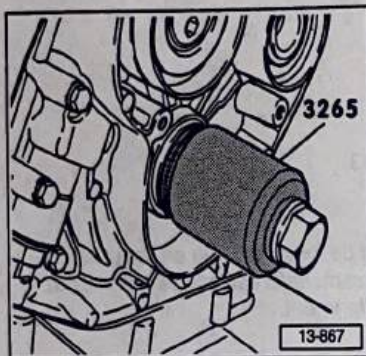


Toothed belt side (front)

- Remove toothed belt ⇒ page 13-16.
- Remove toothed belt sprocket from crankshaft.
- ◀ - Remove oil seal using seal remover 3203.
- Clean running and sealing surfaces.

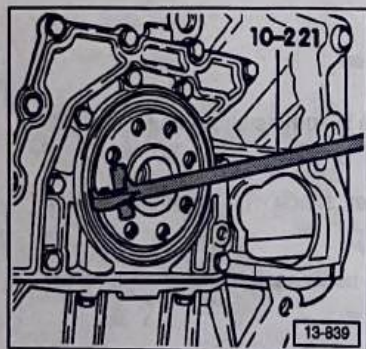
Note:

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



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

13-19

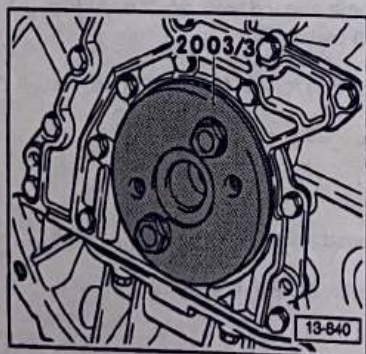


Flywheel side (rear)

CAUTION!

Replacing the seal with the flange is recommended. Drain engine coolant before removing flange. Replace just seal as described below only if oil seal with flange is not available.

- Remove clutch and flywheel, or drive plate.
- ◀ - Pry out oil seal with extractor 10-221.



- Clean running and sealing surfaces.

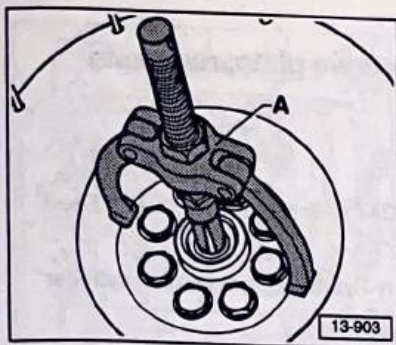
Note:

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

- ◀ - Using installation aid supplied with new oil seal, slide seal onto crankshaft.

Assembly tool is supplied with oil seal

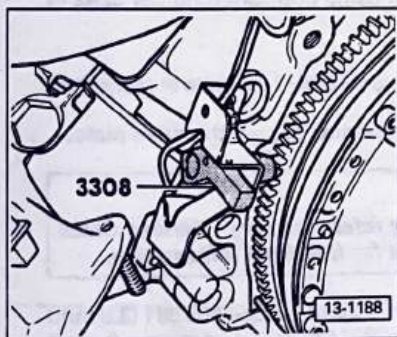
- Press in oil seal as far as possible using seal installer 2003/3 and flywheel or drive plate mounting screws.



Crankshaft pilot needle bearing, removing and installing

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

13-21



Engine speed (RPM) sensor mounting bracket, adjusting

Note:

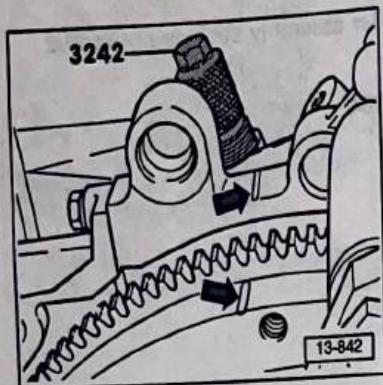
Place crankshaft at TDC position with crankshaft holder 3242.

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

13-22

Dual mass flywheel or drive plate, removing and installing

Flywheel



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

Note:

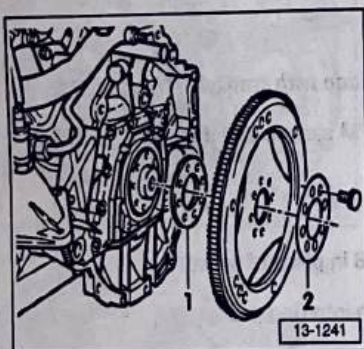
The needle roller bearing is in the flywheel and must be pressed in when replacing the flywheel.

Tightening torque

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

13-23

Drive plate



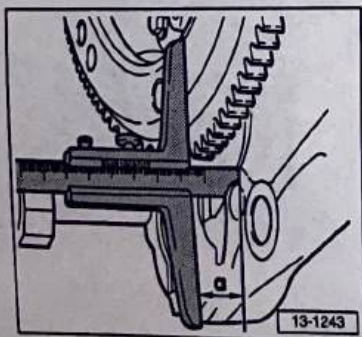
- ◀ - Hold crankshaft in position using crankshaft holder 3242 → page 13-16

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

CAUTION!

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

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

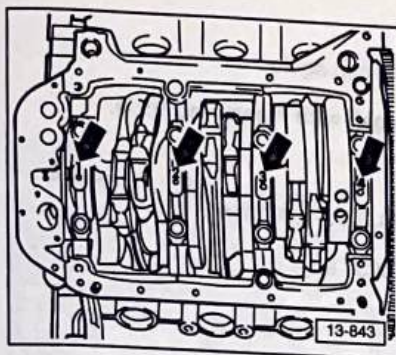


- ◀ - Check clearance -a- between drive plate and cylinder block in three places and calculate average value.

Dimension -a-:

- ♦ Transmission 097: 21.3–22.9 mm (0.839–0.902 in.)
- ♦ Transmissions 01K/01F: 18.1–19.7 mm (0.713–0.776 in.)
- If necessary install other shims to achieve correct dimension.
- ♦ Tightening torque: 60 Nm (44 ft lb) plus 1/4-turn (90°)

13-24



Crankshaft axial and radial clearance, checking

Orientation of crankshaft bearing caps

CAUTION!

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

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

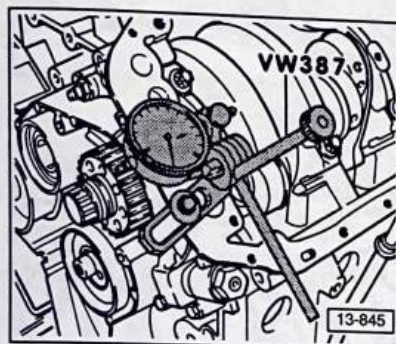
Checking axial clearance

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

Specifications:

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

13-25

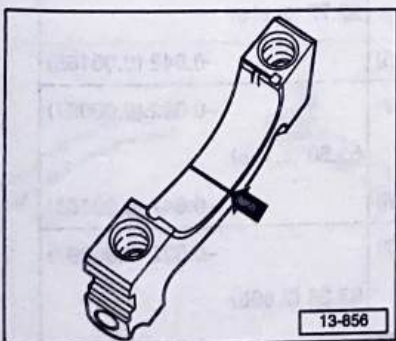


Checking radial clearance

Note:

Radial clearance is measured using Plastigage®.

Plastigage® type	Color	Measuring range
PG-1	Green	0.025 – 0.076 mm
PR-1	Red	0.050 – 0.150 mm

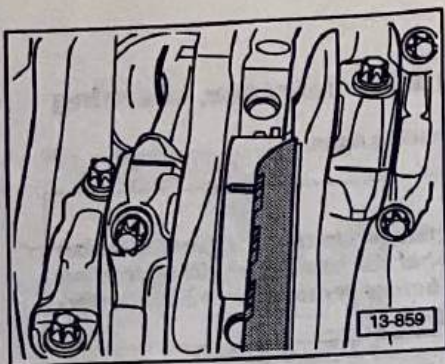


- Remove crankshaft bearing cap.
- Clean bearing shell and crankshaft journal.
- Place Plastigage® on crankshaft journal over entire width of bearing, or in bearing shell (arrow).
- Install crankshaft bearing cap with bearing shell and new bolts.
- Tighten to 60 Nm (44 ft lb) plus 1/2-turn 180°.

CAUTION!

Do NOT turn the crankshaft or allow it to rotate during the measurement with Plastigage® in place.

13-26



- Remove crankshaft bearing cap again.
 - ◀ - Compare width of Plastigage® with measuring scale.
- Specifications:
- ♦ New: 0.018–0.045 mm (0.0007–0.0018 in.)
 - ♦ Wear limit: 0.10 mm (0.0039 in.)

13-27

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)	65.00 (2.559)	54.00 (2.126)
minimum size (from nominal)	–0.042 (0.00165)	–0.042 (0.00165)
maximum size (from nominal)	–0.022 (0.00087)	–0.022 (0.00087)
1st undersize (nominal)	64.75 (2.549)	53.75 (2.116)
minimum size (from nominal)	–0.042 (0.00165)	–0.042 (0.00165)
maximum size (from nominal)	–0.022 (0.00087)	–0.022 (0.00087)
2nd undersize (nominal)	64.50 (2.539)	53.50 (2.106)
minimum size (from nominal)	–0.042 (0.00165)	–0.042 (0.00165)
maximum size (from nominal)	–0.022 (0.00087)	–0.022 (0.00087)
3rd undersize (nominal)	64.25 (2.530)	53.25 (2.096)
minimum size (from nominal)	–0.042 (0.00165)	–0.042 (0.00165)

13-28

Pistons and piston rings, checking and installing

Note:

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

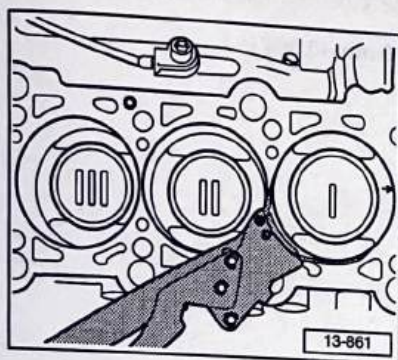
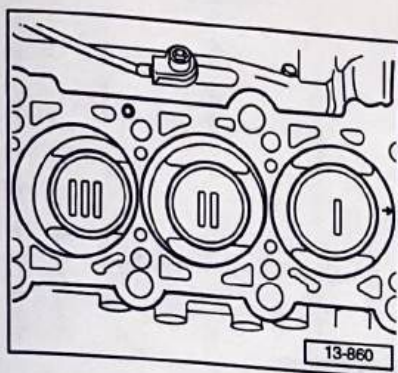
Piston installed position

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

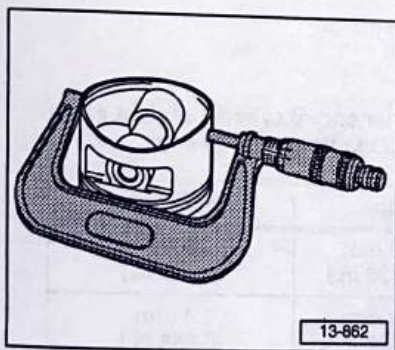
CAUTION!

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

- ▶ Install piston using piston ring compressor.



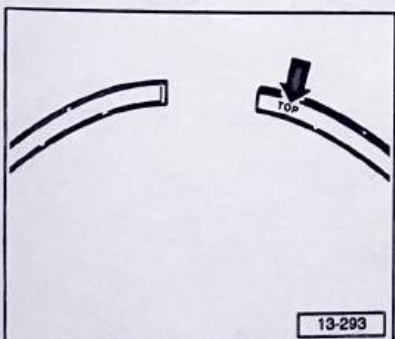
13-29



Checking pistons

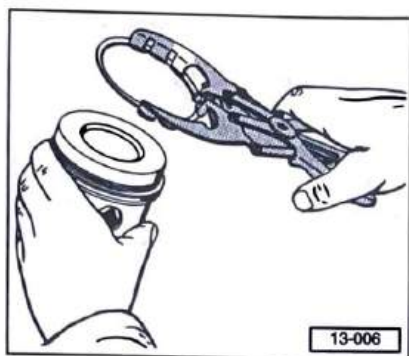
- ▶ Measure piston approx. 10 mm (0.39 in.) from bottom of skirt, at right angle (90°) to piston pin.

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

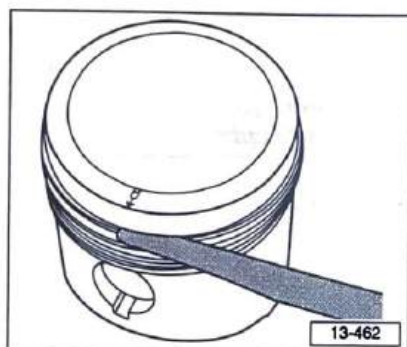


Checking and installing piston rings

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

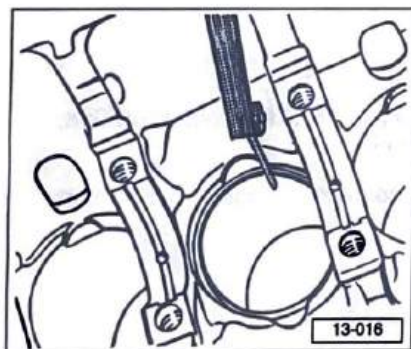


- ◀ - Remove and install piston rings using ring expander as shown.



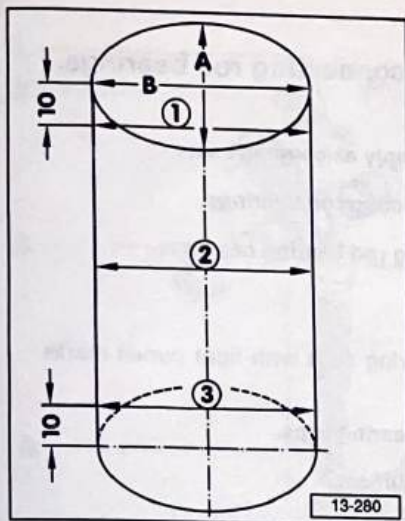
- ◀ - Check piston ring clearance in groove.
 - ♦ New: 0.02–0.08 mm (0.001–0.003 in.)
 - ♦ Wear limit: 0.10 mm (0.004 in.)

13-31



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

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



Checking cylinder bore

◀ - Measure bores in two directions, and at three different depths.

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

1 - Approx. 10 mm from top

2 - Center

3 - Approx. 10 mm from bottom

A - Across cylinder block (perpendicular to crankshaft)

B - In line (parallel to crankshaft)

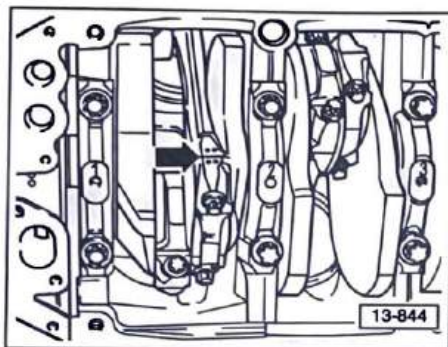
CAUTION!

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

13-33

Piston and cylinder dimensions

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



Connecting rods and connecting rod bearings, checking

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

Checking radial clearance

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

CAUTION!

Do NOT turn the crankshaft or allow it to rotate during the measurement with Plastigage® in place.

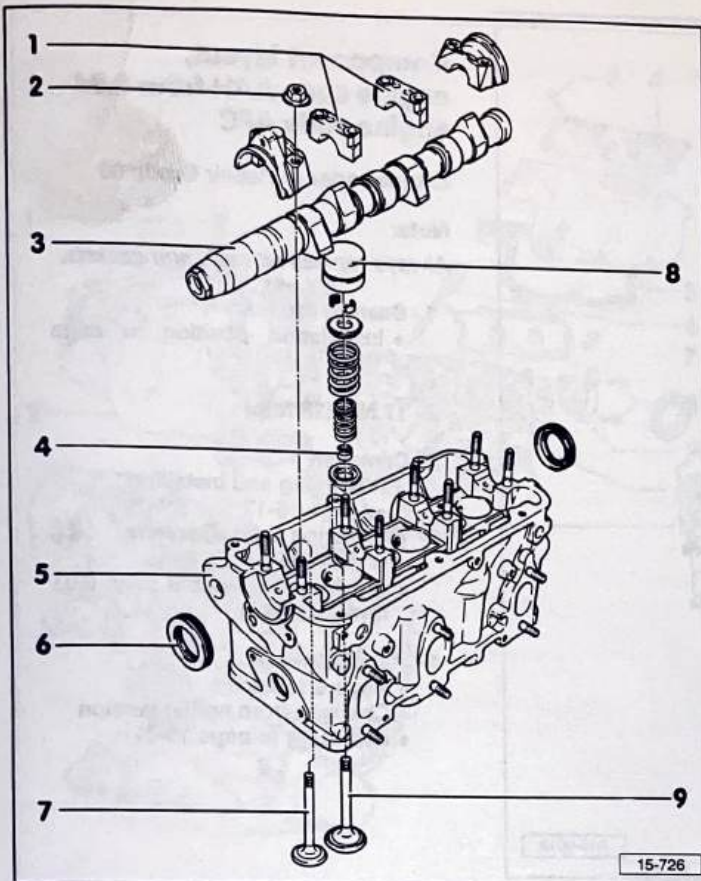
13-35

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

Specifications:

- ♦ New: 0.062 mm (0.0024 in.)
- ♦ Wear limit: 0.12 mm (0.0047 in.)

13-36



Cylinder head and valve drive

Component layout, engine code AAH up to 8.94

Engine codes ⇒ Repair Group 00

Note:

- ♦ Valve guides, checking ⇒ page 15-25
- ♦ Always replace all seals and gaskets

1 - Bearing cap

- ♦ Installation position ⇒ page 15-18

2 - 17 Nm (13 ft lb)

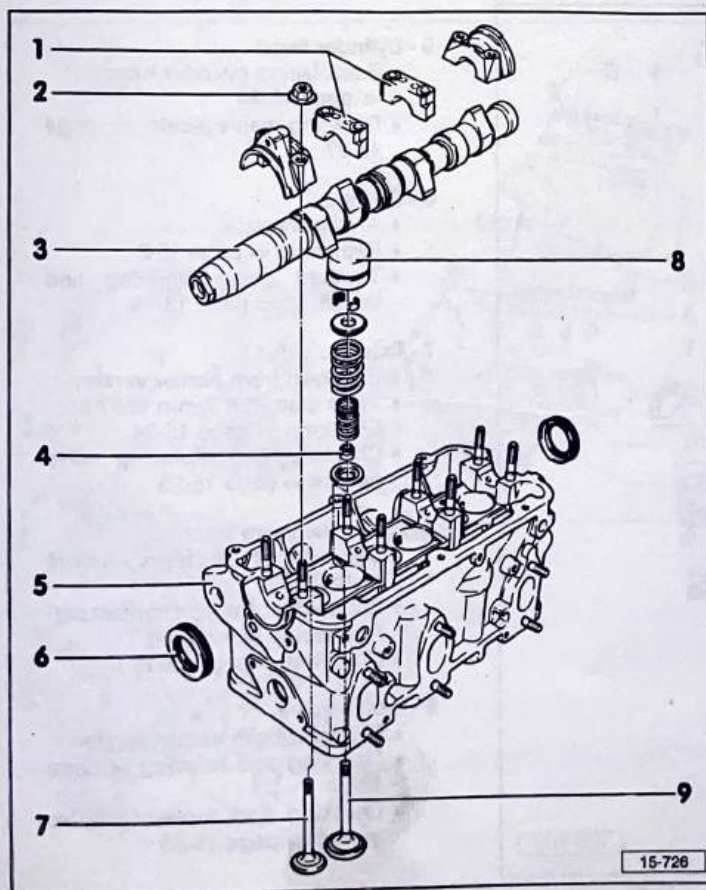
3 - Camshaft

- ♦ Removing and installing ⇒ page 15-17
- ♦ Checking axial clearance ⇒ page 15-17
- ♦ Maximum allowable axial clearance: 0.01 mm (0.0004 in.)

4 - Valve stem seal

- ♦ Always replace
- ♦ Replacing ⇒ page 15-21

15-1



5 - Cylinder head

- ♦ Resurfacing cylinder head ⇒ page 15-23
- ♦ Refacing valve seats ⇒ page 15-27

6 - Oil seals

- ♦ Always replace
- ♦ Replacing ⇒ page 15-8
- ♦ Toothed belt, removing and installing ⇒ page 13-16

7 - Exhaust valve

- ♦ Checking ⇒ page 15-24

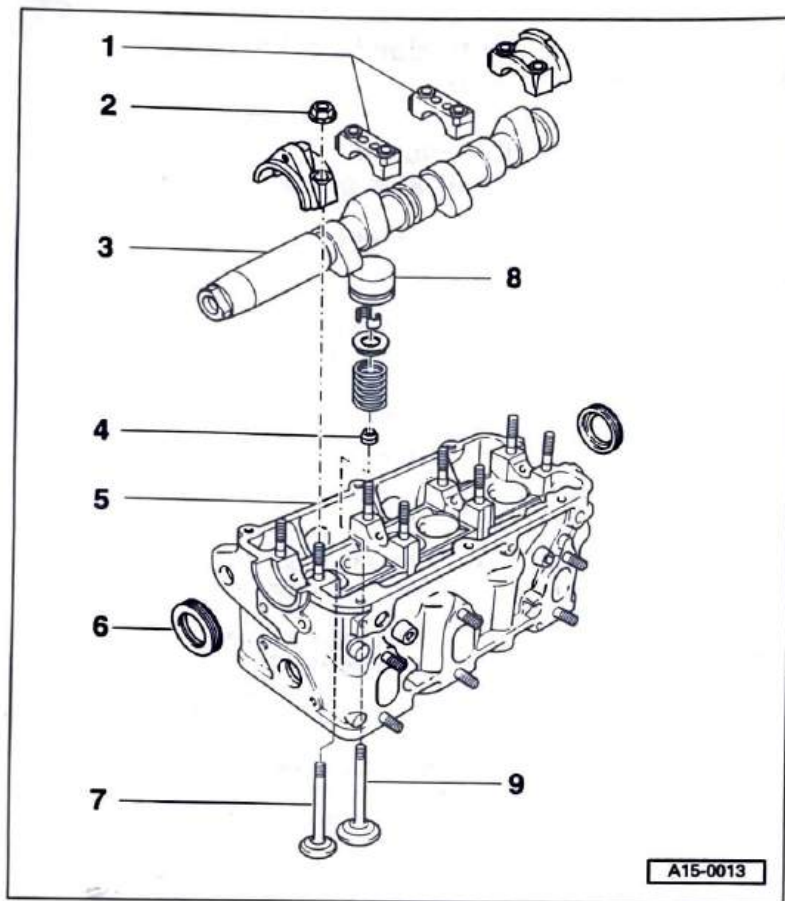
8 - Hydraulic valve lifter

- ♦ Checking ⇒ page 15-19
- ♦ Oil contact surfaces before installing
- ♦ Store with cam lobe contact surface facing downward

9 - Intake valve

- ♦ Checking ⇒ page 15-24

15-2



Component layout, engine code AAH from 8.94 engine code AFC

Engine codes ⇒ Repair Group 00

Note:

Always replace all seals and gaskets.

1 - Bearing cap

- ♦ Installation position ⇒ page 15-18

2 - 17 Nm (13 ft lb)

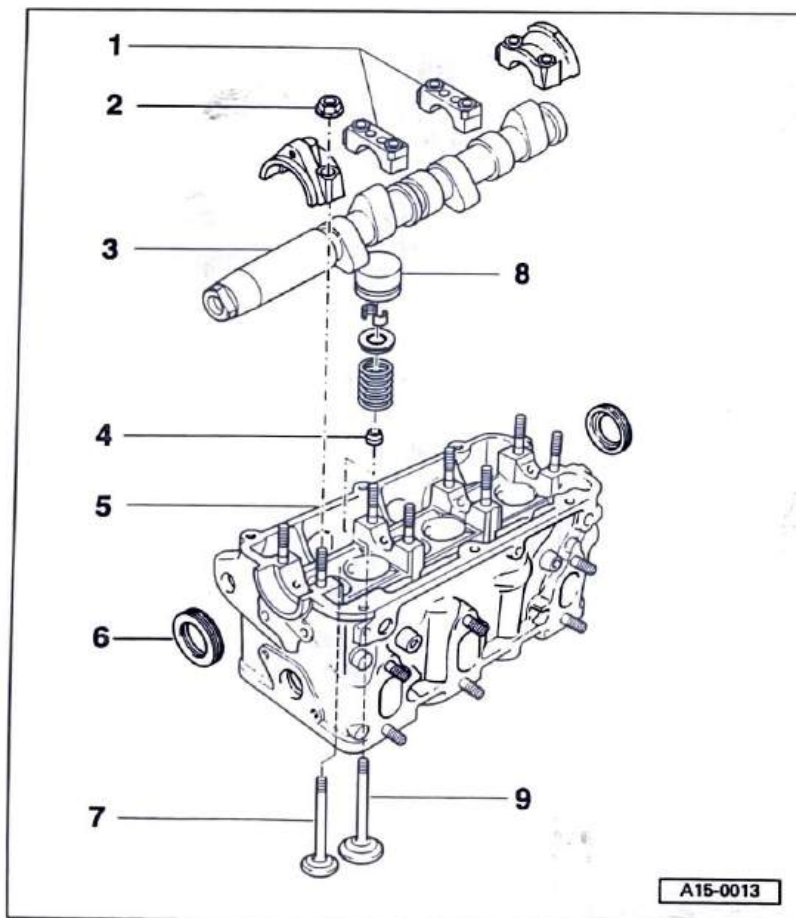
3 - Camshaft

- ♦ Removing and installing ⇒ page 15-17
- ♦ Checking axial clearance ⇒ page 15-17
- ♦ Maximum allowable play: 0.01 mm (0.0004 in.)

4 - Valve stem seal

- ♦ Always replace
- ♦ Changed from earlier version
- ♦ Replacing ⇒ page 15-21

15-3



5 - Cylinder head

- ♦ Resurfacing cylinder head ⇒ page 15-23
- ♦ Refacing valve seats ⇒ page 15-27

6 - Oil seal

- ♦ Always replace
- ♦ Replacing ⇒ page 15-8
- ♦ Toothed belt, removing and installing ⇒ page 13-16

7 - Exhaust valve

- ♦ Changed from earlier version
- ♦ Stem diameter 7 mm (0.27 in.)
- ♦ Checking ⇒ page 15-24
- ♦ Checking and replacing valve guides ⇒ page 15-25

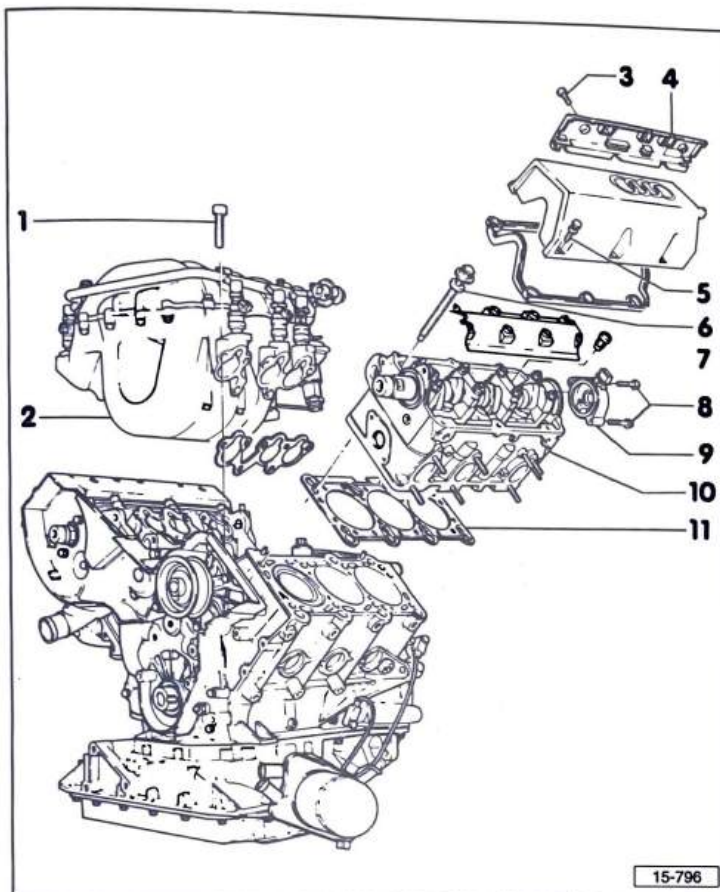
8 - Hydraulic valve lifter

- ♦ Oil contact surfaces before installing
- ♦ Store with cam lobe contact surface facing downward
- ♦ Checking ⇒ page 15-19

9 - Intake valve

- ♦ Changed from earlier version
- ♦ Checking and refacing ⇒ page 15-24
- ♦ Checking and replacing valve guides ⇒ page 15-25

15-4



Cylinder head, assembly

Installing cylinder head cover ⇒ page 15-7.

1 - 20 Nm (15 ft lb)

2 - Intake manifold

- ♦ Removing and installing
⇒ page 15-14, illus. no. 15-771

3 - 10 Nm (7 ft lb)

4 - Cover

5 - 10 Nm (7 ft lb)

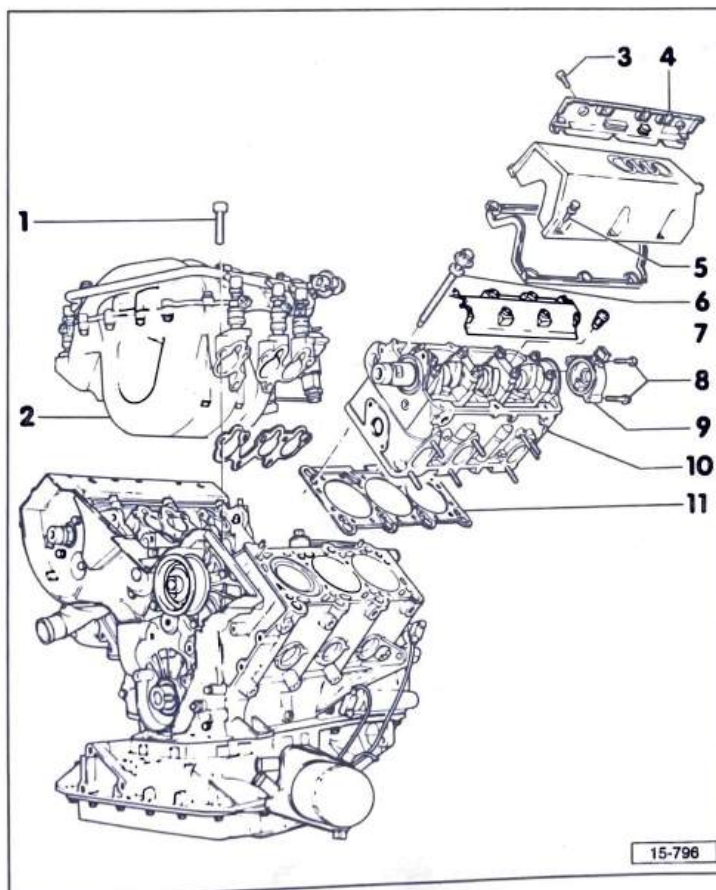
6 - Cylinder head bolt

- ♦ Always replace
- ♦ Tightening ⇒ page 15-15

7 - Pressure relief valve

- ♦ Replace if loud valve noises affecting the entire cylinder head bank can be heard
- ♦ Secure with thread locking compound AMV 197 000 01
- ♦ Replace valves which have loosened up
- ♦ 25 Nm (18 ft lb)

15-5



8 - 10 Nm (7 ft lb)

9 - Camshaft Position (CMP) sensor housing

10 - Cylinder head

- ♦ Checking for distortion
⇒ page 15-15
- ♦ Resurfacing dimensions
⇒ page 15-23

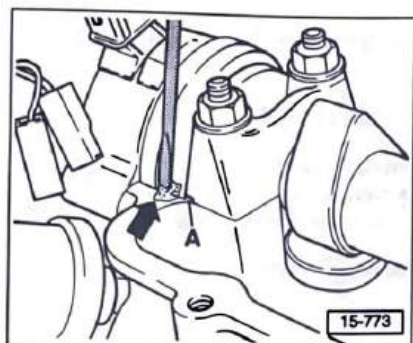
11 - Cylinder head gasket

- ♦ Always replace
- ♦ Identification: lettering on gasket must face upwards

Note:

- ♦ The single cylinder head -10- listed in the Parts catalog microfiche can be used on either left or right sides and uses a cap to seal at the front.
- ♦ Installing cylinder head sealing cap ⇒ page 15-7.

15-6

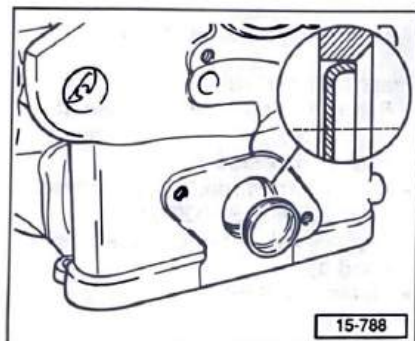


Cylinder head cover, installing

CAUTION!

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

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

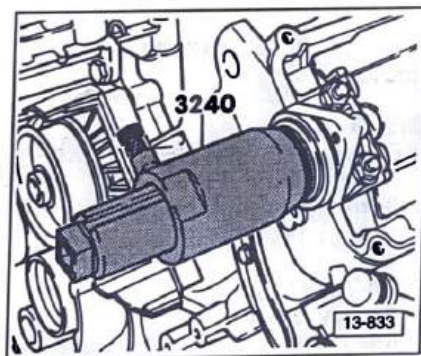


Installing cylinder head sealing cap

Cylinder heads available from the Parts department can be used on either the left and right hand sides and are fitted with a sealing cap in the appropriate front end.

- Coat edge of sealing cap with sealing paste AMV 188 000 02.
- ◀ – Tap sealing cap in using drift VW 295, far enough so that outer edge of sealing cap is flush with chamfer on cylinder head.

15-7



Camshaft oil seals, replacing

Cylinder head, left and right front

- Remove toothed belt ⇒ Repair Group 13.
- Remove cylinder head cover.
- Remove rear toothed belt guard.
- ◀ – Remove seal with seal extractor 3240.
- Clean bearing and sealing surfaces.

Note:

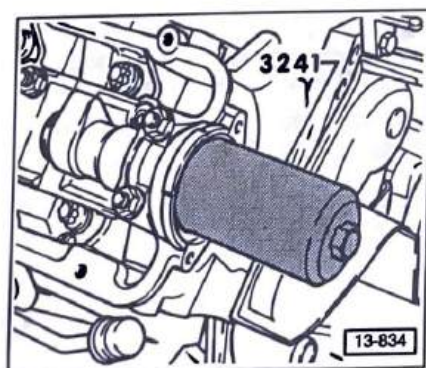
Do not oil sealing lip or outer edge of seal before pressing in.

Left front

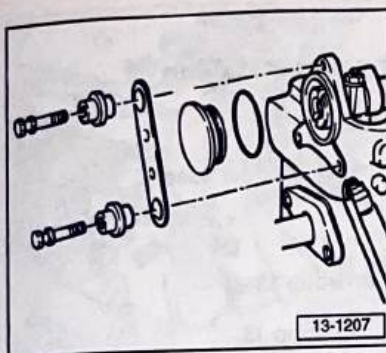
- ◀ – Press seal in as far as possible using seal installer 3241.

Right front

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



15-8



Cylinder head, right rear

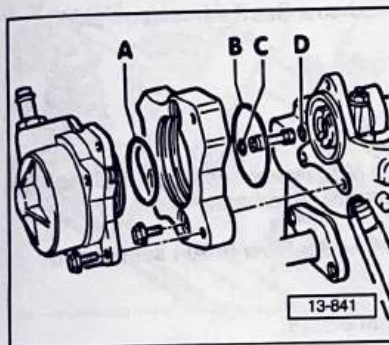
Vehicles without vacuum pump

- ◀ - Remove bolts, as well as spacer and cap locking device.
- Remove cap.
- Replace toroidal sealing ring.

Vehicles with vacuum pump

CAUTION!

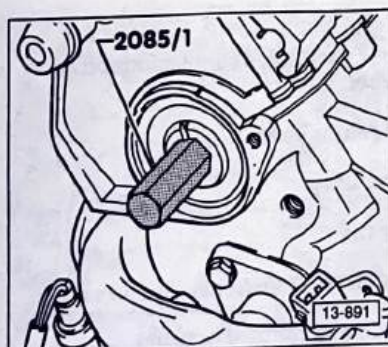
All vehicles fitted with a vacuum pump must be converted. See the repair manual booklet for the appropriate fuel injection & ignition system, Repair Group 24.



- ◀ - Remove vacuum pump or end cover.
- Remove transfer flange.
- Pull piston out of camshaft.
- Replace O-rings -A-, -B-, -C- and -D-.
- Reinstall piston, transfer flange and vacuum pump.

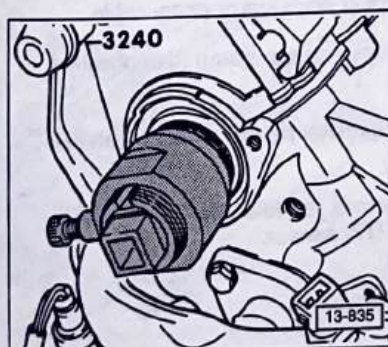
Tightening torque: 10 Nm (7 ft lb)

15-9



Cylinder head, left rear

- Remove Camshaft Position (CMP) sensor housing.
- Remove bolt from CMP sensor plate.
- Pry out sensor plate using screwdriver.
- ◀ - Screw in counter holder for seal extractor 2085/1.



- ◀ - Remove seal using extractor 3240 or 2085, and remove bolt 2085/1.
- Clean bearing and sealing surfaces.

Note:

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

- Using insertion tool and sleeve 3241 press seal in fully.

Tightening torque:

- ♦ CMP sensor plate: 20 Nm (15 ft lb)

Cylinder head, removing and installing

(Engine installed)

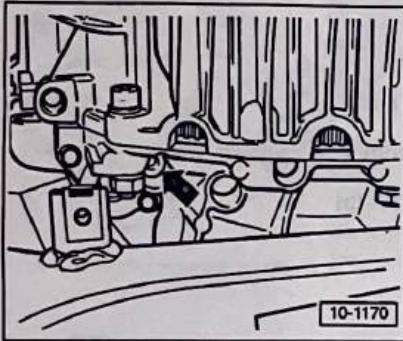
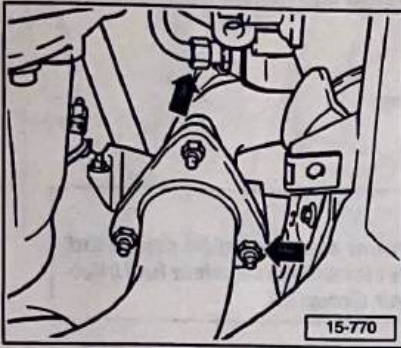
Removal procedures refer to the left cylinder head

Removing

- Remove ribbed belt ⇒ Repair Group 13
- Remove toothed belt ⇒ Repair Group 13

(Vibration damper remains installed)

- Disconnect exhaust pipe from manifold.
- ◀ - Disconnect exhaust hose to Exhaust Gas Recirculation (EGR) valve at manifold.

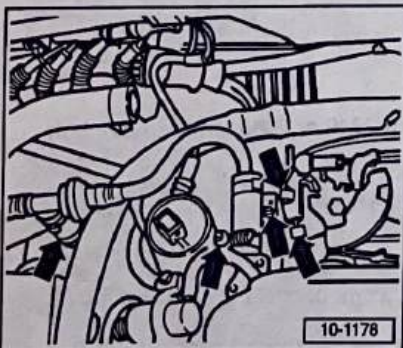


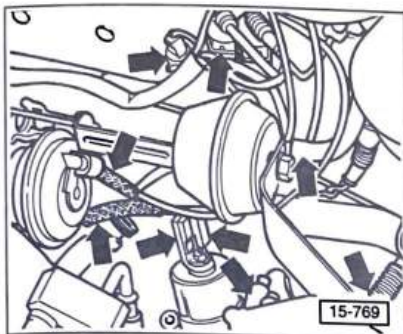
- ◀ - Drain engine coolant at drain plug (arrow) using special tool 3247, and at drain plug in bottom of radiator.
- Remove air hose between Mass Air Flow (MAF) sensor and intake manifold.
- Disconnect all spark plug connectors.
- Disconnect all harness connectors on fuel injectors.

15-11

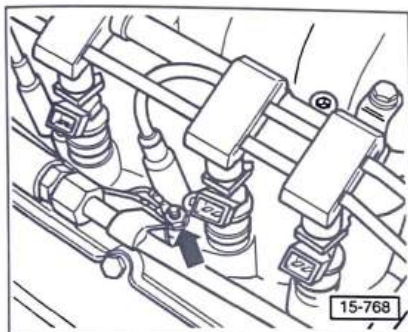
- Disconnect positive crankcase ventilation connections on left and right cylinder head covers.
- Disconnect fuel supply and return lines.
- Unclip cover on intake air housing.
- Remove both screws under cover.
- Push back and lift intake air housing upwards.
- Pull vacuum hose off left side and remove housing.
- Remove left hand cover for fuel injector lines.

- ◀ - Unclip, disconnect and uncover accelerator pedal cable.
- Disconnect vacuum hose from vacuum pump (if applicable) and intake manifold.
- Disconnect hose from EVAP canister purge regulator valve to throttle body.
- Disconnect harness connectors for Idle Air Control (IAC) valve and Throttle Position (TP) sensor.



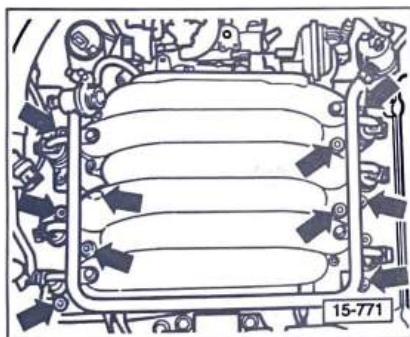


- ◀ - Disconnect vacuum hose on cruise control vacuum control actuator.
- Disconnect harness connectors for oil pressure sensor, oil pressure switch and camshaft position sensor.
- Disconnect vacuum hose on intake manifold changeover valve (blue) as well as from the EGR valve (brown).
- Disconnect harness connectors for Heated Oxygen Sensors (H02S) at fire wall and move to one side.
- Remove EGR valve from intake manifold.



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

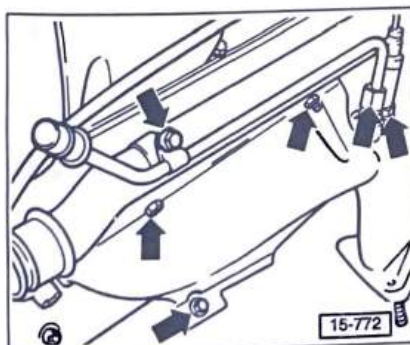
15-13



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

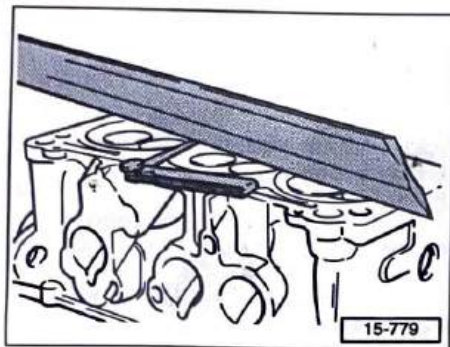
Note:

After loosening the intake manifold mounting bolts, all cylinder head bolts must be tightened 1/4-turn (90°).



- ◀ - Remove CO tap tube.
- Remove oxygen sensor.
- Remove exhaust manifold heat shield.
- Remove cylinder head cover.
- Remove rear toothed belt guard.
- Disconnect hose from hydraulic reservoir to pump.
- Remove cylinder head.

15-14



Checking cylinder head distortion

- Measure at several points with straight edge.

Max. permissible distortion: 0.05 mm (0.0020 in.)

Installing

- Clean sealing surfaces.
- Install cylinder head gasket.
- Lettering on gasket must face toward cylinder head
- Install cylinder head.
- Check centering pins in cylinder block.
- Install cylinder head bolts and tighten by hand.

Tightening sequence:

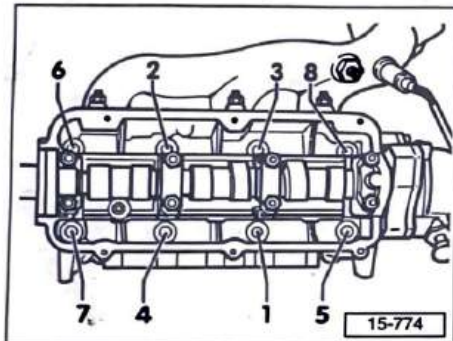
- Tighten cylinder head bolts in two stages:

- ♦ Stage 1 60 Nm (44 ft lb)
- ♦ Stage 2 additional 1/2-turn (180°)

Note:

- ♦ For final 1/2-turn, two 1/4-turns (90°) are also permissible.
- ♦ It is not necessary to retighten the cylinder head bolts after repairs or as part of the maintenance service.

15-15



Compression pressure, checking

- Engine warm—oil temperature at least 30°C (86° F)
- Throttle valve fully open during cranking
- Disconnect both harness connectors from ignition power output stage.
- Use compression pressure recorder VAG 1381 together with adapter 1381/5 or equivalent to measure compression.
- Operate starter until tester shows no further pressure increase.

Compression pressures

- ♦ New: 9–14 bar (131–203 psi)
- ♦ Wear limit: 7.5 bar (109 psi)
- ♦ Max. permissible pressure difference between all cylinders: 3 bar (44 psi)

CAUTION!

If the test values are not within the specifications described above, recheck compression pressure after the test drive.

Camshaft, removing, installing and checking

Removing

- Removing ribbed drive belt and toothed camshaft drive belt
⇒ Repair Group 13.
- Remove cylinder head cover.
- Left side: remove housing for camshaft position sensor.
- Right side: remove vacuum pump if applicable.
- Remove toothed belt camshaft sprocket.
- ◀ - Remove camshaft bearing caps -2- and -3-.
- Gradually and evenly loosen nuts for bearing caps -1- and -4- alternating in diagonal sequence.

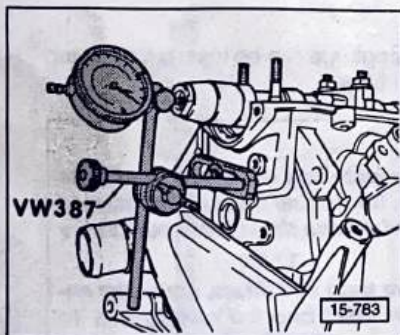
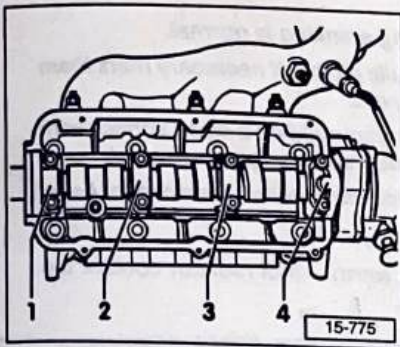
CAUTION!

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

Camshaft axial play, checking

- Housing for camshaft position sensor housing removed, if applicable
- Hydraulic lifters removed
- Camshaft bearing caps 2 and 4 removed.

15-17



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

Specifications:

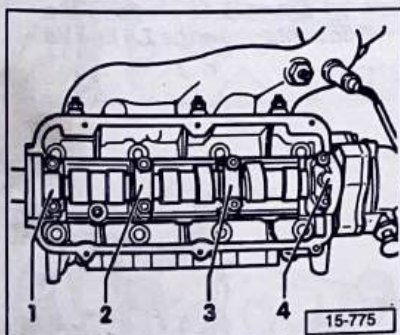
- ♦ New: 0.04–0.15 mm (0.0016–0.0059 in.)
- ♦ Wear limit: 0.35 mm (0.0138 in.)

Installing

- ◀ - Gradually and evenly tighten bearing caps -1- and -4- alternating in diagonal sequence.

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

Tightening torque: 20 Nm (15 ft lb)



Hydraulic valve lifters, checking

Note:

- ♦ Irregular valve noise during cranking is normal.
- ♦ Do not interchange hydraulic lifters. If necessary mark them when they are being removed.
- ♦ Place lifters that have been removed on a clean surface with the contact surface (camshaft end) facing downward.
- ♦ Faulty lifters must be replaced (hydraulic lifters cannot be repaired).

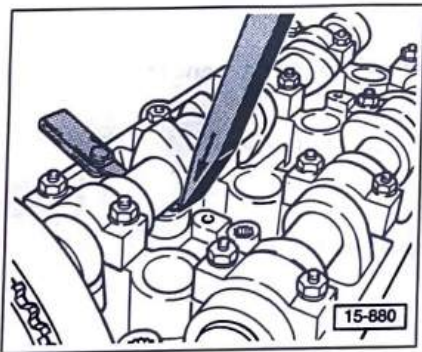
- Start and run engine until warm—until radiator coolant fan has come on at least once.
- Increase engine speed to approx. 2500 RPM for 2 minutes

If the irregular valve noise stops and then re-occurs again each time vehicle is used in stop and go traffic, replace the oil check valves ⇒ Repair Group 17.

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

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

15-19



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

CAUTION!

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

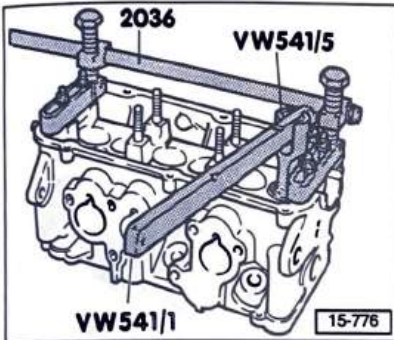
Note:

The illustration is used to show an example of checking the clearance with a feeler gauge—it does not show the 2.8 liter V6 engine.

Valve stem seals, replacing

(Cylinder head installed)

- Remove toothed belt ⇒ Repair Group 13.
- Remove camshafts and hydraulic lifters.
- Remove spark plugs.
- Rotate crankshaft by hand to set piston of appropriate cylinder to Bottom Dead Center (BDC).
- Screw compressed air hose US 1106 or equivalent with seal into spark plug threads by hand and apply a continuous pressure of at least 6 bar (87psi).



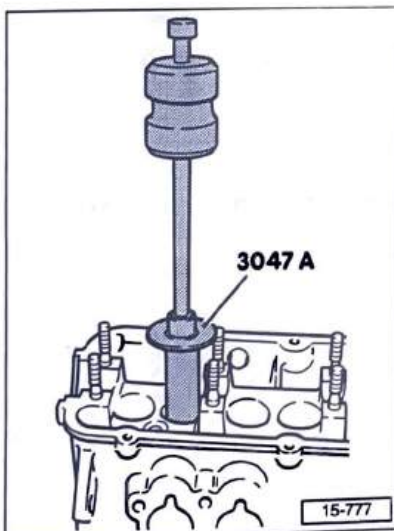
- ◀ – Install compressor tool 2036 and adjust to height of studs.
- Remove valve spring with valve spring tensioner VW 541/1 and thrust pad VW 541/5 or equivalent.

Note:

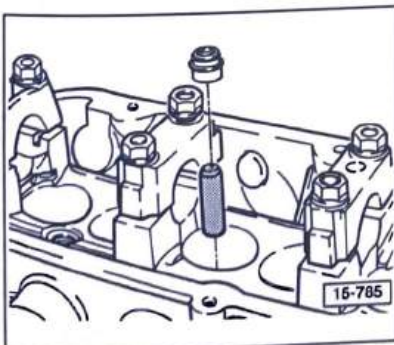
Tight valve keepers can be loosened by tapping lightly on lever VW 541/1 with a hammer.

- Remove valve springs.

15-21



- ◀ – Remove valve stem oil seal with slide hammer 3047 A.



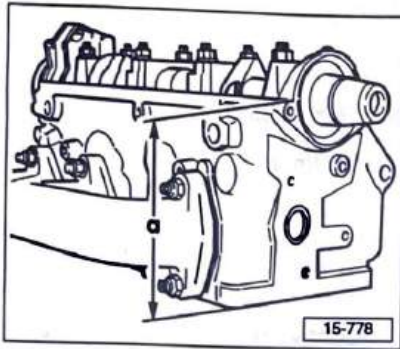
- Install new valve stem oil seal.

- ◀ – Fit plastic sleeve onto seal and slide carefully onto valve.

Note:

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

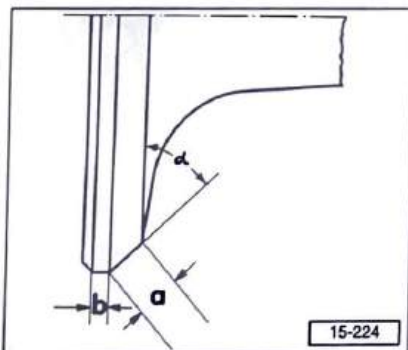
15-22



Cylinder head, resurfacing

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

15-23



Intake and exhaust valves, checking and refacing

Checking

- Inspect visually for traces of scoring on valve stem and valve seat surfaces. Replace valves in case of scored surfaces.

◀ Refacing intake valve

$\alpha - 45^\circ$

a - max 3.5 mm (0.138 in.)

b - min. 0.5 mm (0.020 in.)

Refacing exhaust valves

CAUTION!

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

15-24

Valve guides, checking and replacing

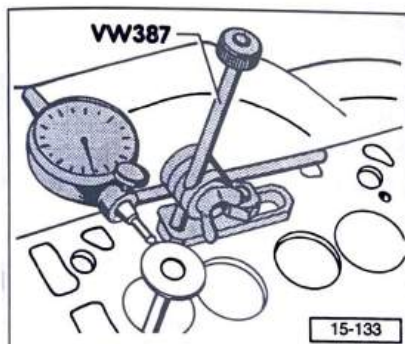
Checking

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

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

CAUTION!

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



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

Wear limit

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

15-25

Replacing

CAUTION!

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

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

CAUTION!

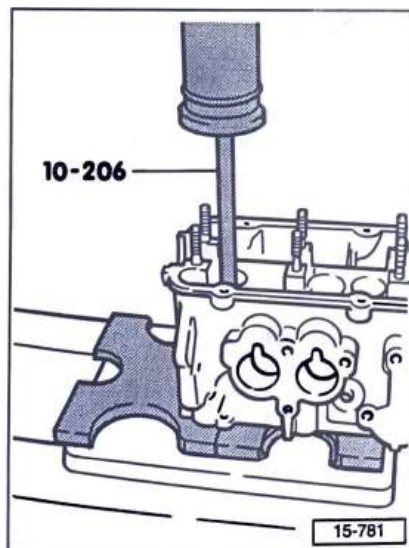
When the shoulder on the new guide makes contact, the pressing force must not exceed 1.0 ton or the guide shoulder could break off.

- Ream new valve guides to size with appropriate size hand reamer, using plenty of diluted soluble oil cutting fluid.

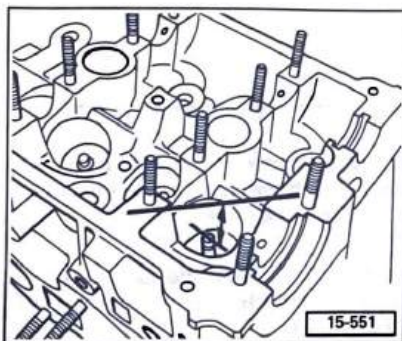
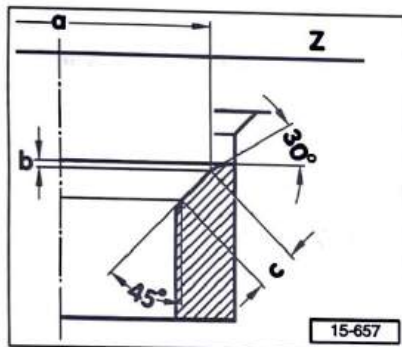
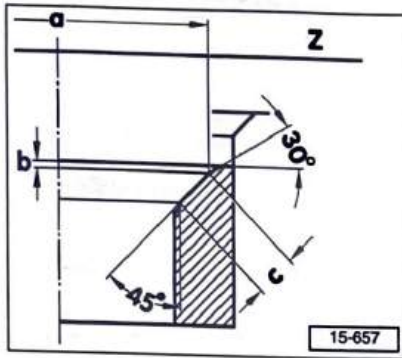
- ♦ 7mm hand reamer 3120
- ♦ 8mm hand reamer 10-215

Note:

Reface valve seats after replacing valve guides. Observe minimum dimensions.



15-26



Valve seats, refacing

Note:

- ♦ Only reface valve seats enough to produce perfect contact.
- ♦ Before refacing, calculate the maximum permissible refacing dimension. If this dimension is exceeded, correct functioning of hydraulic valve lifters can no longer be guaranteed and the cylinder head must be replaced.

Exhaust valve seat

- a - Diameter: 32.4 mm (1.276 in.)
- b - Max. permissible refacing dimension¹⁾
- c - Seat width: 2.4 mm (0.094 in.)
- 30° - Upper correction angle
- 45° - Valve seat angle
- Z - Lower surface of cylinder head

Intake valve seat

- a - Diameter: 39.2 mm (1.543 in.)
- b - Max. permissible refacing dimension¹⁾
- c - Seat width: 2.0 mm (0.079 in.)
- 30° - Upper correction angle
- 45° - Valve seat angle
- Z - Lower surface of cylinder head
- ¹⁾ Calculating max. permissible refacing dimensions
⇒ page 15-28

15-27

Maximum permissible refacing dimension, calculating

- ◀ The maximum permissible refacing dimension is the difference between the actual distance measured at the cylinder head (arrow) and the specified minimum dimension.

Note:

The illustration is used to show an example of the minimum dimension—it does not show the 2.8 liter V6 engine.

- Insert valve and press tightly against valve seat
- Measure distance between center of valve stem and upper surface of cylinder head.

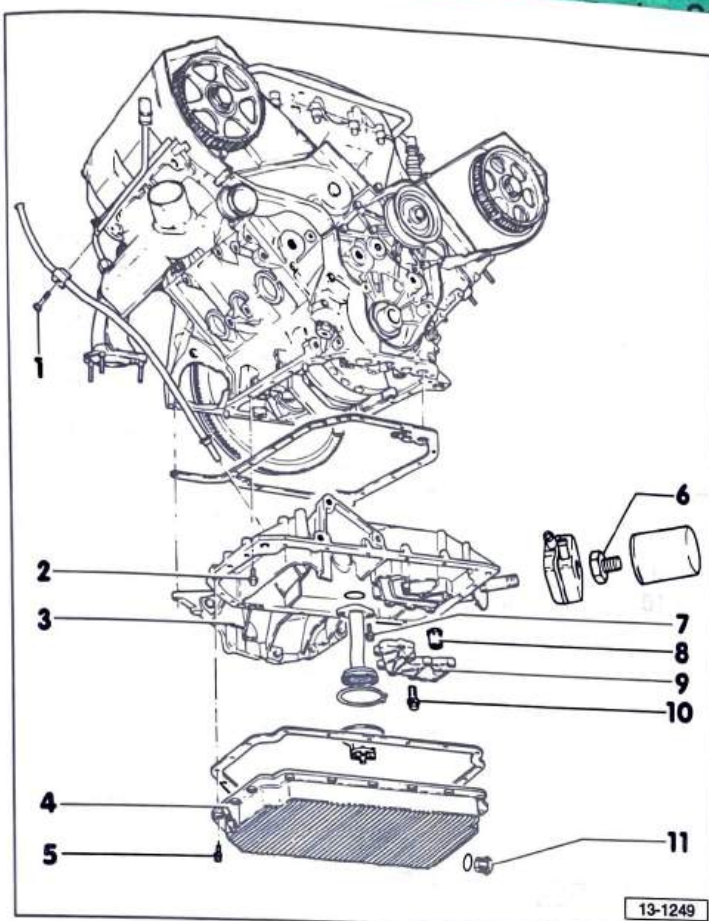
Minimum dimensions

- ♦ At intake valve: 33.8 mm (1.331 in.)
- ♦ At exhaust valve: 34.1 mm (1.343 in.)

Example

Measured distance	34.8 mm
– Minimum dimension (specified)	34.1 mm
= Max. permissible refacing dimension ¹⁾	0.7 mm

¹⁾ Refacing intake and exhaust valves ⇒ page 15-24



Lubrication system

Component layout, engine code AAH up to 8.94

Engine codes ⇒ Repair Group 00.

Revised lubrication system from 8.94
 ⇒ page 17-3.

CAUTION!

- ♦ Do NOT overfill with oil past the MAX mark on the oil dipstick. Damage to the three way catalytic converter could result.
- ♦ Oil filters for earlier and later version lubrication systems are NOT interchangeable.

Note:

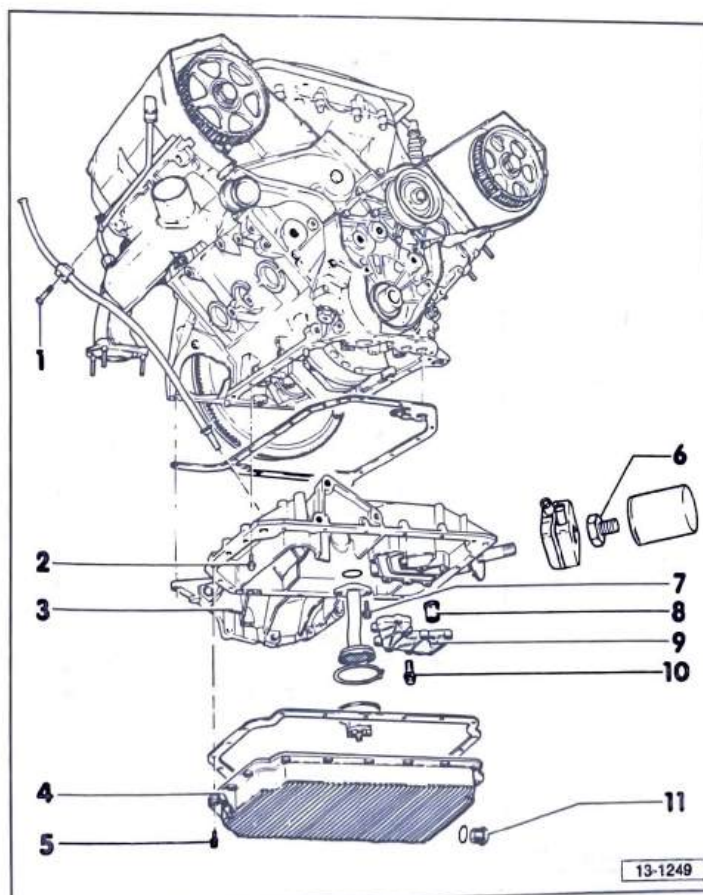
- ♦ Always replace gaskets and seals.
- ♦ Replacing crankshaft oil seals ⇒ Repair Group 13.

1 - 10 Nm (7 ft lb)

2 - 10 Nm (7 ft lb)

3 - Oil pan, upper

17-1



4 - Oil pan, lower

5 - 10 Nm (7 Nm)

6 - 30 Nm (22 ft lb)

7 - 10 Nm (7 ft lb)

8 - Oil pressure relief valve

- ♦ Opening pressure: 16 bar (232 psi)

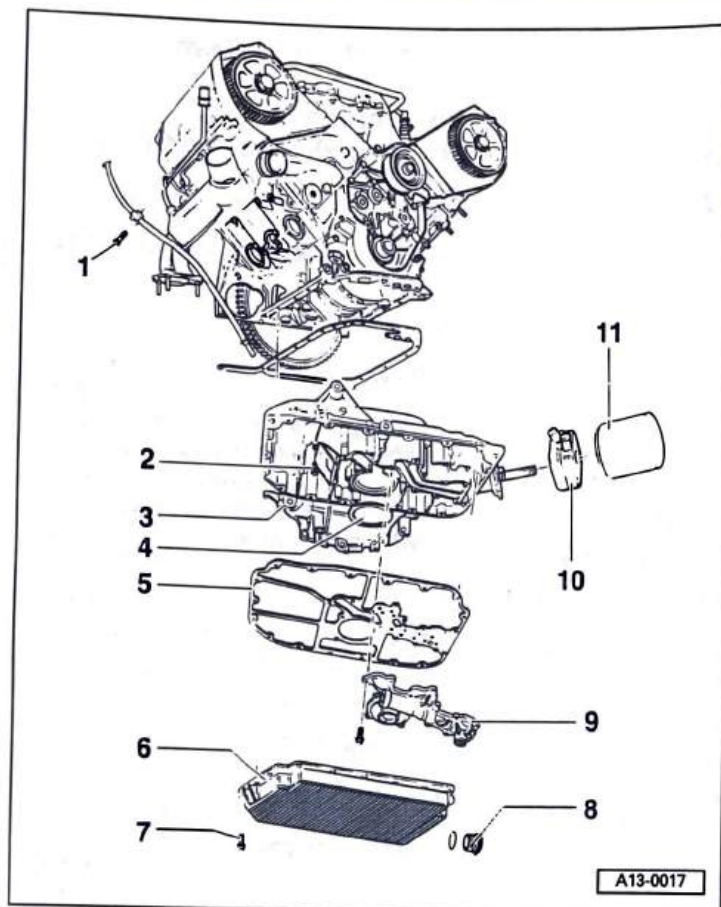
- ♦ Cannot be checked with normal workshop equipment

9 - Cover plate

10 - 10 Nm (7 ft lb)

11 - 40 Nm (30 ft lb)

17-2



Component layout, engine code AAH from 8.94, engine code AFC

CAUTION!

- ♦ Do NOT overfill with oil past the MAX mark on the oil dipstick. Damage to the three way catalytic converter could result.
- ♦ Oil filters for earlier and later version lubrication systems are NOT interchangeable.

Note:

- ♦ Always replace gaskets and seals
- ♦ Replacing crankshaft oil seals ⇒ Repair Group 13.

1 - 10 Nm (7ft lb)

2 - 10 Nm (7 ft lb)

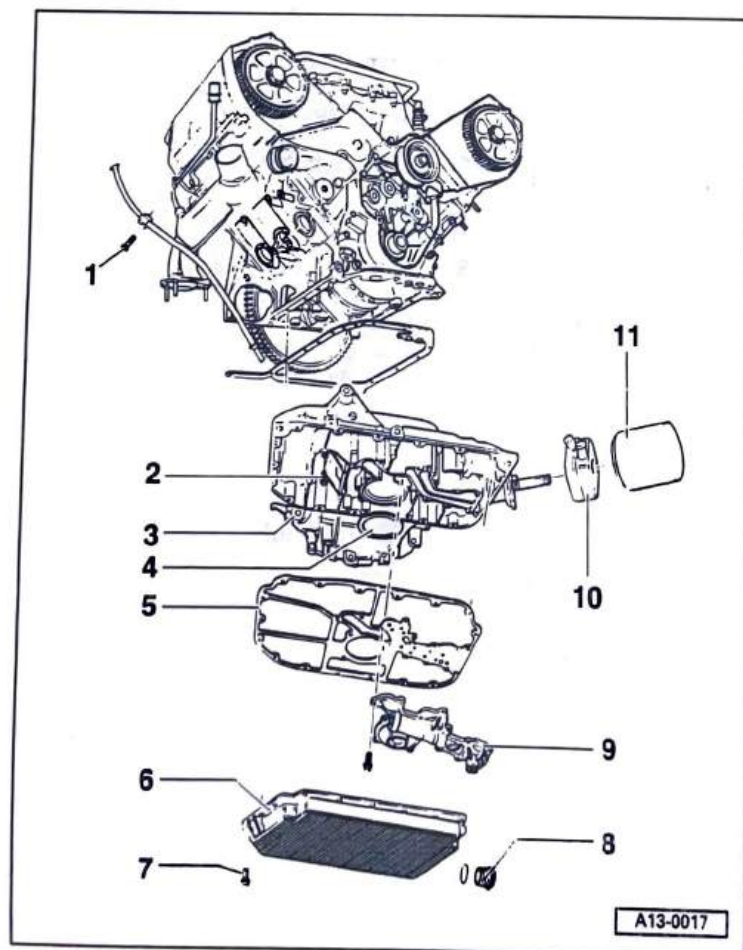
3 - Oil pan, upper

4 - Pick-up strainer

- ♦ Locks into upper oil pan with three lock tabs

5 - Seal

17-3



6 - Oil pan, lower

7 - 10 Nm (7 Nm)

8 - Drain plug
♦ 40 Nm (30 ft lb)

9 - Cover

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

10 - Oil cooler

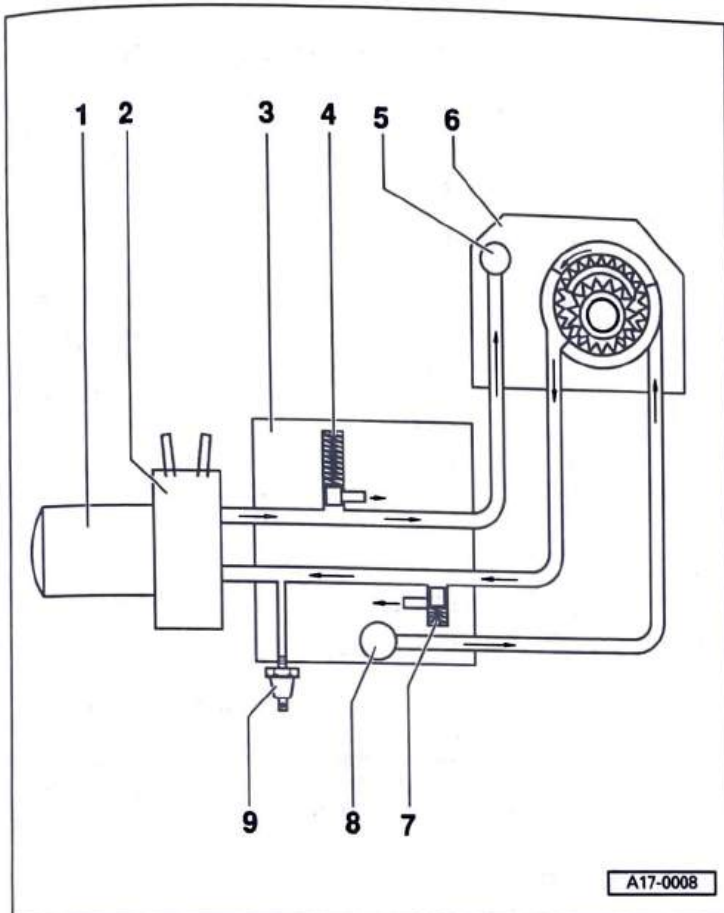
11 - Oil filter

- ♦ NOT interchangeable with older version
- ♦ Revised lubrication system requires different filter: Part no. 078 115 561 D

CAUTION!

Part numbers are for reference only. Always check with your Audi Parts department for the most up-to-date information.

17-4



Revised oil circulation, engine code AAH from 8.94, engine code AFC

Note:

- ♦ Revised components should only be installed on this engine.
- ♦ The later lubrication system with revised oil circulation can be identified by the missing oil pressure relief valve plug on the oil pump.

1 - Oil filter

- ♦ Larger outer measurement
- ♦ Not interchangeable with older version

2 - Oil cooler

- ♦ Larger cross-sectional flow area

3 - Cover for oil pan

- ♦ New

4 - Pressure relief valve

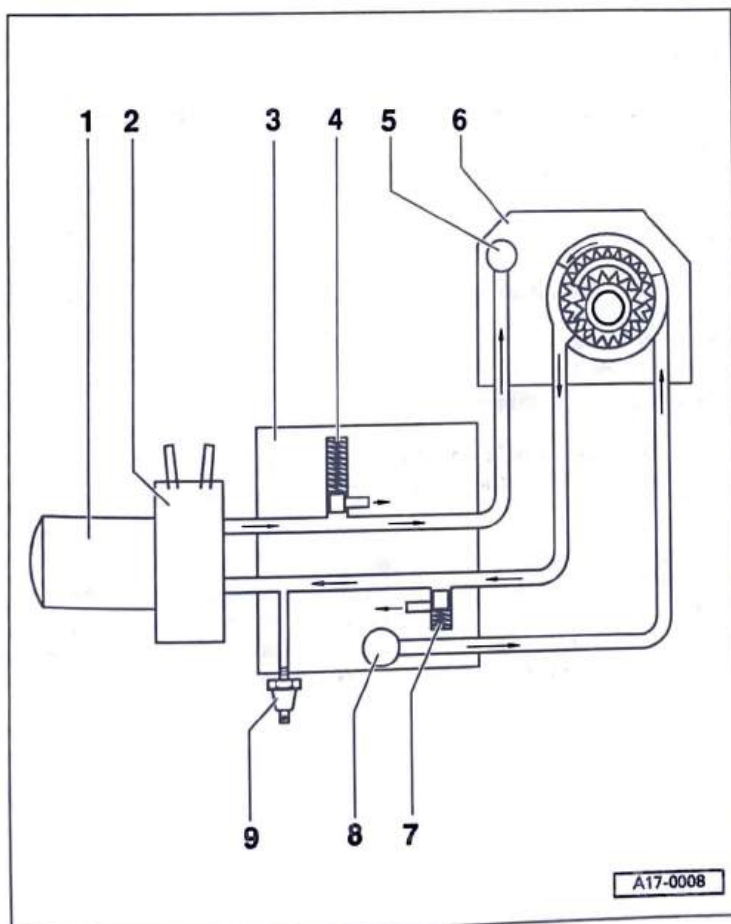
- ♦ New

5 - Oil supply to engine

6 - Oil pump

- ♦ New

17-5



7 - Pressure relief valve 11 bar

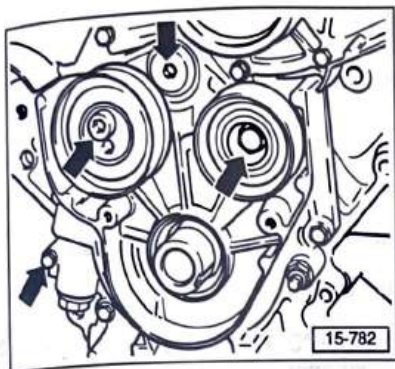
- ♦ New

8 - Oil pick-up pipe

9 - Oil pressure switch 1.8 bar

- ♦ Color: Brown
- ♦ Function ⇒ page 17-7
- ♦ Checking ⇒ page 17-11

17-6



Oil pump, removing

- Remove oil dipstick.
- Drain engine oil.
- Remove upper and lower parts of oil pan.
- Remove toothed belt ⇒ Repair Group 13
- ◀ - Remove toothed belt tensioner.
- Remove locking bolt.
- Remove oil pump.

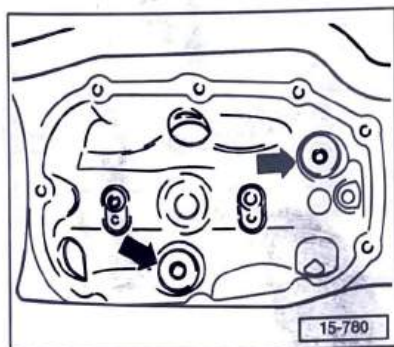
Note:

When installing the oil pump check alignment of oil pump drive

Tightening torques

♦ Oil pump	10 Nm	(7 ft lb)
♦ Locking bolt	30 Nm	(22 ft lb)
♦ Toothed belt tensioner	45 Nm	(33 ft lb)

17-9



Oil retention valves, replacing

Note:

The oil retention valves must be replaced if the valvetrain sounds noisy on short drives, although the noise may go away on longer drives.

- Remove intake manifold.
- Remove cover plate beneath intake manifold.
- ◀ - Replace oil retention valves.

Tightening torques

♦ Intake manifold	20 Nm	(15 ft lb)
♦ Cover	10 Nm	(7 ft lb)

17-10

Oil pressure, oil pressure switch and oil pressure sensor, checking

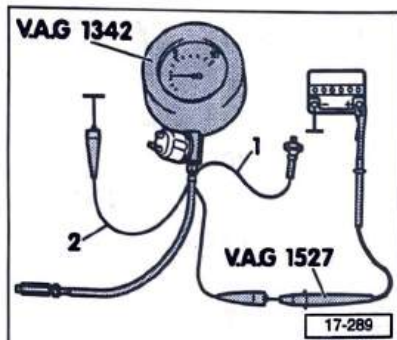
(Optical and acoustic oil pressure indication)

Test requirements

- Oil level OK
- Oil pressure warning light -K3- lights when ignition turned on
- Auto-Check system indicates OK
- Engine oil temperature approx. 80°C (176°F) and radiator fan must have switched on at least once

Checking oil pressure switch and oil pressure sensor electrical functions

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



17-11

- Start engine and check sensors and switches at the relevant engine speed.

Switch	Function / pressure specification
0.3 bar oil pressure switch integral with oil pressure sensor (connection WK)	Switch opens at 0.15–0.45 bar (2.2–6.5 psi)
0.9 bar oil pressure switch (grey insulation)	Switch closes at 0.7–2.7 bar (10–39 psi)
2.5 bar oil pressure switch (red insulation)	Switch closes at 2.3–2.7 bar (33–39 psi)

Checking 0–3 bar oil pressure sensor with 0.3 bar oil pressure switch (0–3/0.3 bar sensor)

Oil pressure	Resistance – ohms (Ω)
0	5–13 Ω
1 bar (14 psi)	65–73 Ω
2 bar (29 psi)	124–134 Ω
3 bar (43 psi)	154–214 Ω

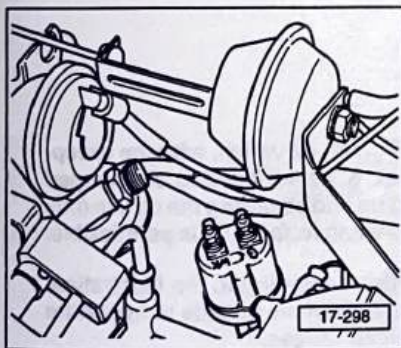
17-12

Checking 0–5 bar oil pressure sensor (with 0.3 bar oil pressure switch)

Oil pressure	Resistance – ohms (Ω)
0	5–13 Ω
1 bar (14 psi)	44–52 Ω
2 bar (29 psi)	78–86 Ω
3 bar (43 psi)	111–121 Ω
5 bar (72 psi)	154–214 Ω

- If the cables to the oil pressure sensor are installed incorrectly, the Auto-Check-System will display the engine oil pressure warning symbol (oil can).

17-13



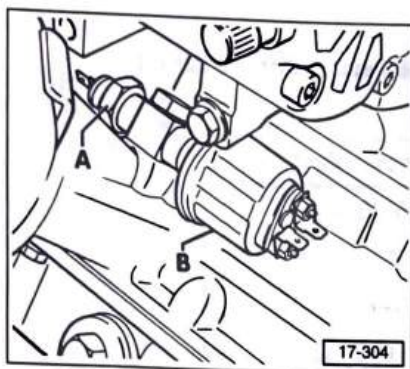
Checking oil pressure on engines with oil pressure switch, oil pressure sensor on cylinder head

- ♦ Engine oil temperature at least 80°C (176°F)
- Remove oil pressure sensor and install into VAG 1342 oil pressure tester.
- Install oil pressure switch into tester.
- Start engine.
 - ♦ Oil pressure at idle: 1.0–2.5 bar (14–37psi)
 - ♦ Oil pressure at 3000 RPM: 2.7–2.9 bar (39–42 psi)

Note:

- ♦ With the pressure relief valve in each cylinder head ($\Rightarrow$ page 15-5) a lower oil pressure is registered in the cylinder head than is actually controlled by the oil pressure control valve.
- ♦ Oil pressure sensor/switch: 0–3/0.3 bar
- ♦ Oil pressure indication: 0–5 bar

17-14



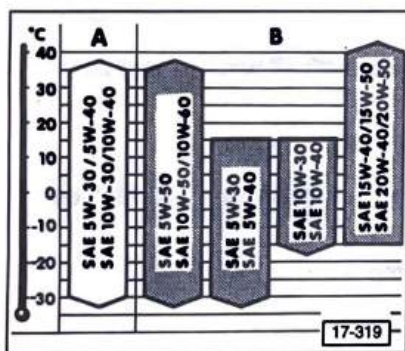
Checking oil pressure on engines with oil pressure sensor in upper oil pan

- Engine oil temperature at least 80°C (176°F)
- ▲ – Remove oil pressure sensor and install into VAG 1342 oil pressure tester.
- Install oil pressure switch into tester.
- Start engine.
 - ♦ Oil pressure at idle: 1.0–2.5 bar (14.5–36 psi)
 - ♦ Oil pressure at 3000 RPM: 3.0–5.0 bar (44–73 psi)

Note:

- ♦ *If oil pressure is excessive (oil pressure relief valve jamming or incorrectly installed), the hydraulic valve lifters will be subjected to excessive pressure. The engine will cut out shortly after starting and, when attempting to restart, the starter motor will rotate the engine noticeably faster due to lack of compression.*
- ♦ Oil pressure sensor/switch: 0–5/0.3 bar
- ♦ Oil pressure indication 0–5 bar

17-15



Engine oil

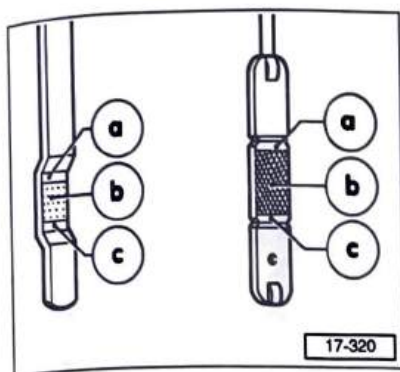
Viscosity and specification

The engine is filled with multi-grade oil which, with the exception of extremely cold climates, does not need to be changed due to climate. When topping up and changing the oil use only quality engine oil. Mixing oils when topping up is permissible.

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

- A - Light oils
Specification VW 500 00
- B - Multi-grade oils
Specification VW 501 00

17-16



Engine oil level, checking

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

Check engine oil level only with engine oil warm:

- Over 60°C (140°F)

◀ Markings on oil dipstick:

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

Oil system capacity with oil filter: 5.0 ltr (5.3 qt.).

Cooling system, components

Note:

- ♦ Always replace seals and gaskets.
- ♦ Check thermal switch for proper function, see appropriate wiring diagram.
- ♦ It is not necessary to remove the ribbed belt to remove the thermostat
- ♦ Arrows on ends of hoses must be aligned with arrows on coolant pipes.
- ♦ Tightening torque for coolant pipe hose clamps: 3–3.5 Nm (27–31 in lb).
- ♦ An oil cooler, located between the oil filter and the oil filter bracket, is connected to the coolant circuit.

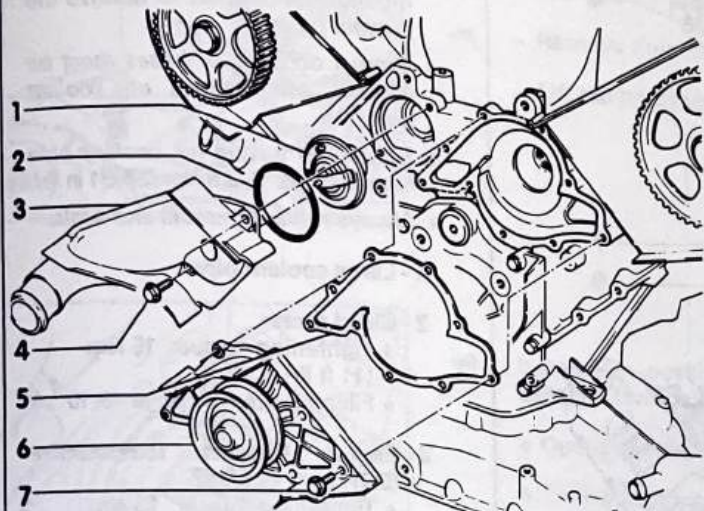
1 - Thermostat

- ♦ Replacing ⇒ page 19-5
- ♦ Start of opening ⇒ page 19-5

2 - Seal

- ♦ Always replace

3 - Thermostat housing



19-343

19-1

4 - 10 Nm (7 ft lb)

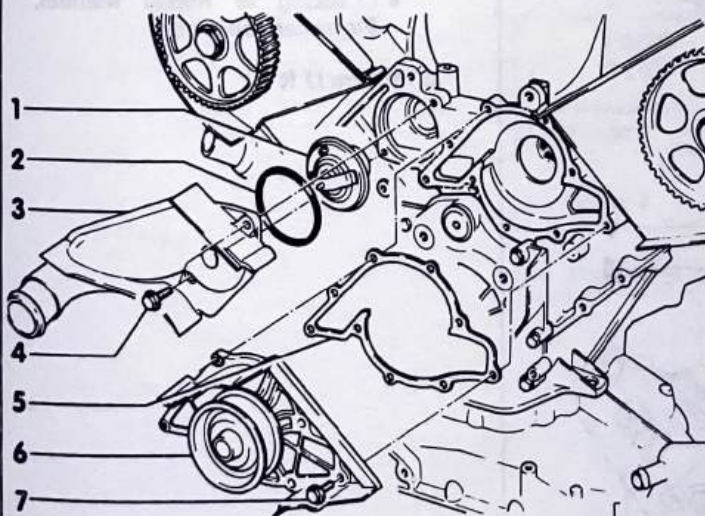
5 - Gasket

- ♦ Always replace

6 - Coolant pump

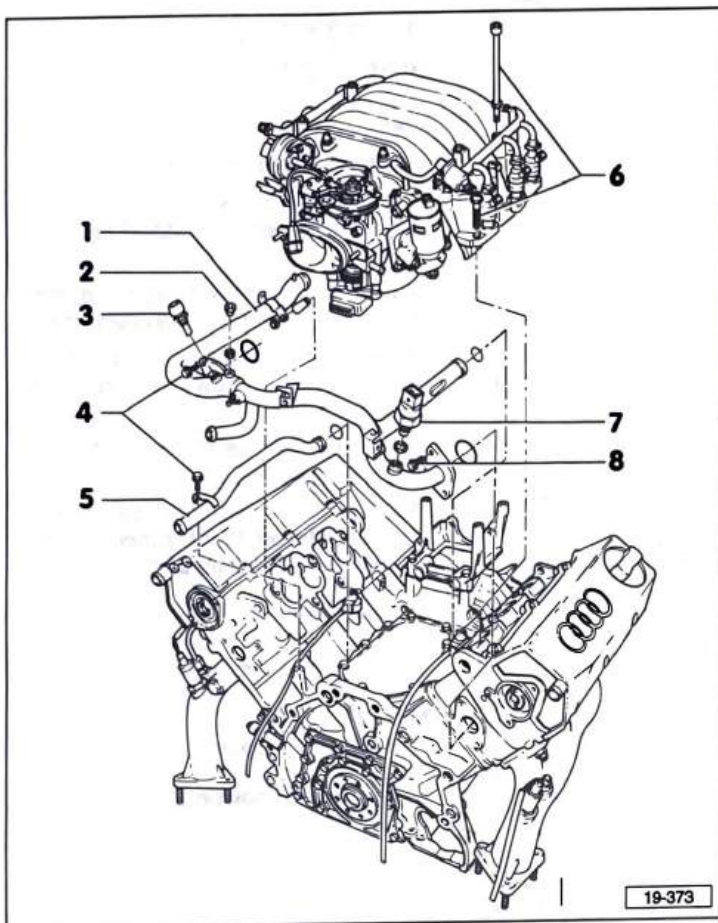
- ♦ To remove and install, remove ribbed drive belt and toothed belt ⇒ Repair Group 13

7 - 10 Nm (7 ft lb)



19-343

19-2



Coolant pipes, layout

Note:

- ♦ The intake manifold must be removed first in order to remove the coolant pipes.
- ♦ Arrows on ends of hoses must be aligned with arrows on coolant pipes.
- ♦ Tightening torque for coolant pipe hose clamps: 3–3.5 Nm (27–31 in lb).
- ♦ Always replace gaskets and seals.

1 - Large coolant pipe

2 - Bleed screw

- ♦ Tightening torque: 15 Nm (11 ft lb)
- ♦ Filling system ⇒ page 19-10

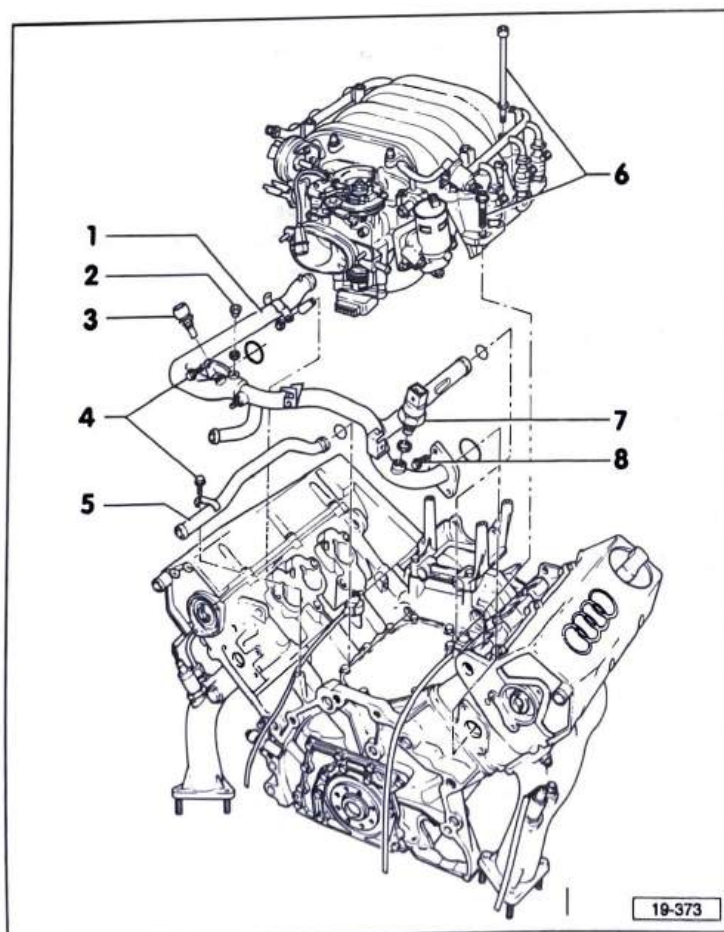
3 - Engine Coolant Temperature (ECT) G62-

- ♦ Tightening torque: 15 Nm (11 ft lb)
- ♦ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition, Repair Group 01

4 - 10 Nm (7 ft lb)

5 - Small coolant pipe

19-3



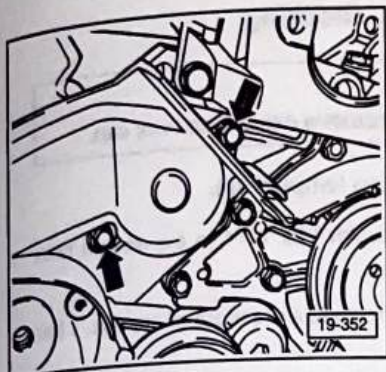
6 - 20 Nm (15 ft lb)

7 - Electronic Engine Coolant Temperature (ECT) thermal switch F76-

- ♦ Checking ⇒ Repair Manual, Electrical Equipment

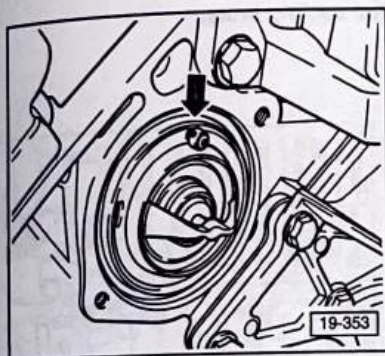
8 - 10 Nm (7 ft lb)

19-4



Thermostat, replacing

- Remove ribbed belt ⇒ Repair Group 13
- Drain coolant into suitable container if it is to be reused.
- ◀ - Remove thermostat housing from under toothed belt cover.
- Lift out housing.



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

- ♦ Opens approx. 87°C (189°F)
- ♦ Closes approx. 102°C (216°F)
- ♦ Stroke: minimum 8.0 mm (5/16 in.)

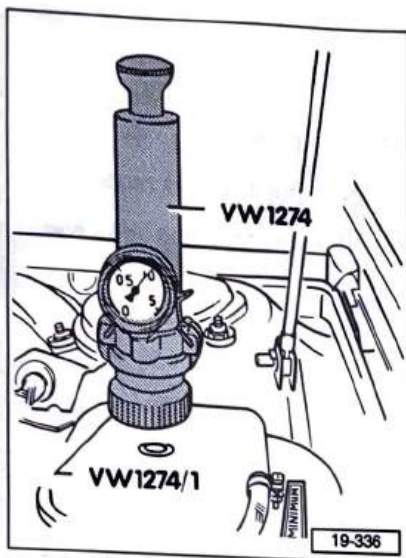
19-5

Coolant Fan Control (FC) thermal switch, checking

The coolant fan control thermal switch -F54- is located in the radiator at the bottom left.

Switch 3-pole	Switching temperature	
	On	Off
1 = Stage 1	92 – 97°C (198 – 207°F)	approx. 84°C (183°F)
2 = Stage 2	99 – 105°C (210 – 221°F)	approx. 91°C (196°F)
3 = Positive (B+)		

19-6



Cooling system leaks, checking

CAUTION!

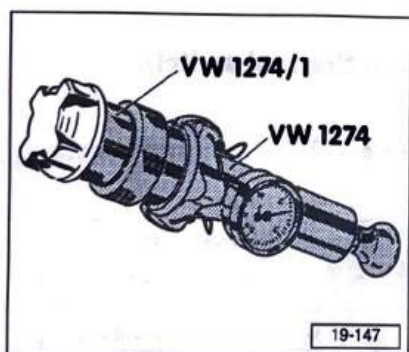
If coolant is hot, carefully remove expansion tank cap.

- Engine must be at operating temperature.
- ◀ - Connect cooling system tester VW 1274 to expansion tank using adapter VW 1274/1.
- Operate the hand pump to create a pressure of approx. 1 bar (15 psi).

If the pressure drops quickly:

- Locate and repair leak in the cooling system.

19-7



Expansion tank cap, pressure testing

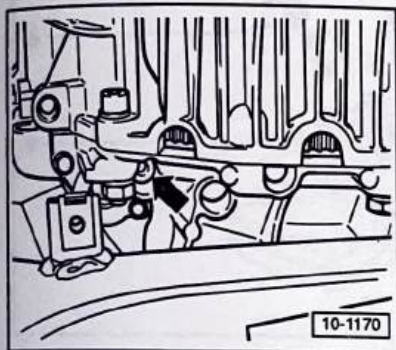
- ◀ - Screw cap onto cooling system tester VW 1274 with adapter VW 1274/1.
- Operate hand pump.
- Pressure relief valve must open at 1.2–1.5 bar (17–22 psi).

19-8

Cooling system, draining and filling

Note:

- ♦ Prominent designations for coolant additives are G 011 A8B or C. There are coolant additives that correspond to the TLVW, but are not released by VW/Audi. Only coolant additives with the designation G 011 A8B or C can be used.
- ♦ The cooling system is filled year round with a mixture of water and G 011 A8B anti-freeze.
- ♦ G 011 A8B prevents freezing, corrosion damage and scale formation and raises the coolant boiling point. For these reasons the cooling system should be filled with G 011 A8B anti-freeze and anti-corrosion additive all the year round.
- ♦ Due to its high boiling point, coolant is an aid to operational efficiency when the engine is operating at full load, particularly in tropical climates.
- ♦ Coolant must be drained and replaced if either the engine or one of the cylinder heads has been replaced, or if the coolant has become contaminated.



Draining

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

Tightening torque: 20 Nm (15 ft lb)

- Remove cap from expansion tank.

19-9

Filling

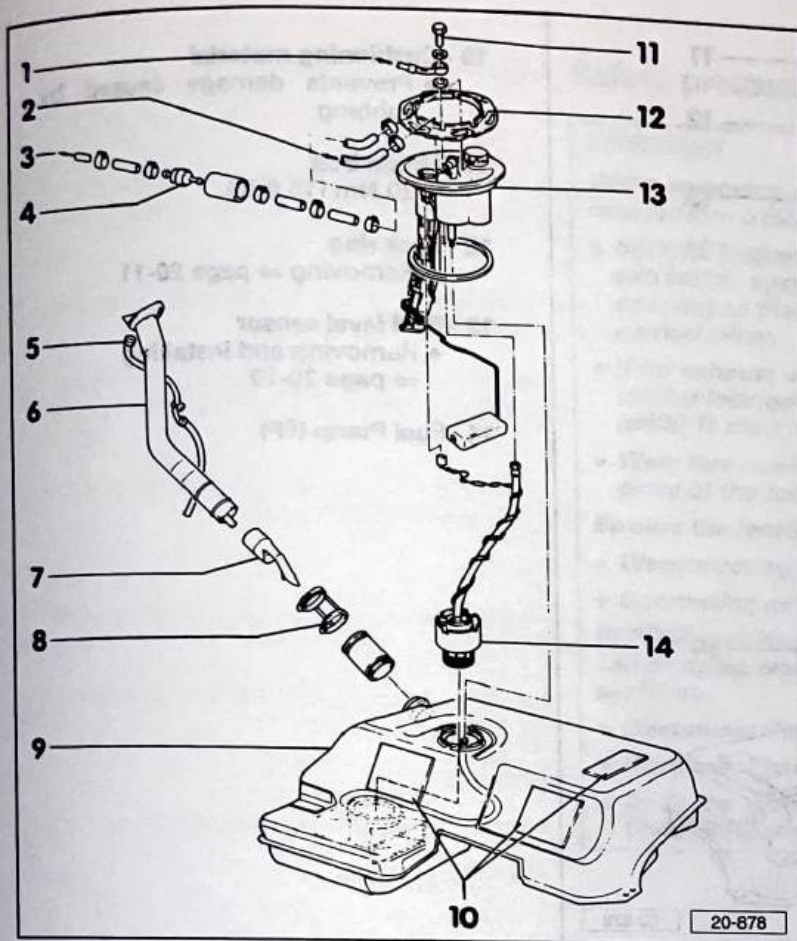
Recommended mixing ratios for 8 liter (8.4 qt.) capacity:

Frost protection	G 011 A8B or C	Water
-25°C (-13°F)	3.2 liter (3.4 qt.)	4.8 liter (5.1 qt.)
-35°C (-31°F) ¹⁾	4.0 liter (4.2 qt.)	4.0 liter (4.2 qt.)

¹⁾ For cold climates

- Back off each of two bleed screw approx. 2 turns.
 - ♦ In coolant hose to heater core, right, next to brake booster
 - ♦ Bleed screw in large coolant pipe, next to engine coolant temperature sensor ⇒ page 19-3
- Pour coolant into expansion tank.
- Check bleed screws and close when coolant starts to run out.
- Fill expansion tank until level reaches top edge.
- Install cap on expansion tank.
- Run engine at idle until coolant fan has switched on once.
- Increase engine speed to 2000 RPM for approx. 30 seconds.
- Stop engine (switch ignition off).
- Check coolant level in expansion tank and top up to MAX mark if necessary.

19-10



Fuel supply system, components

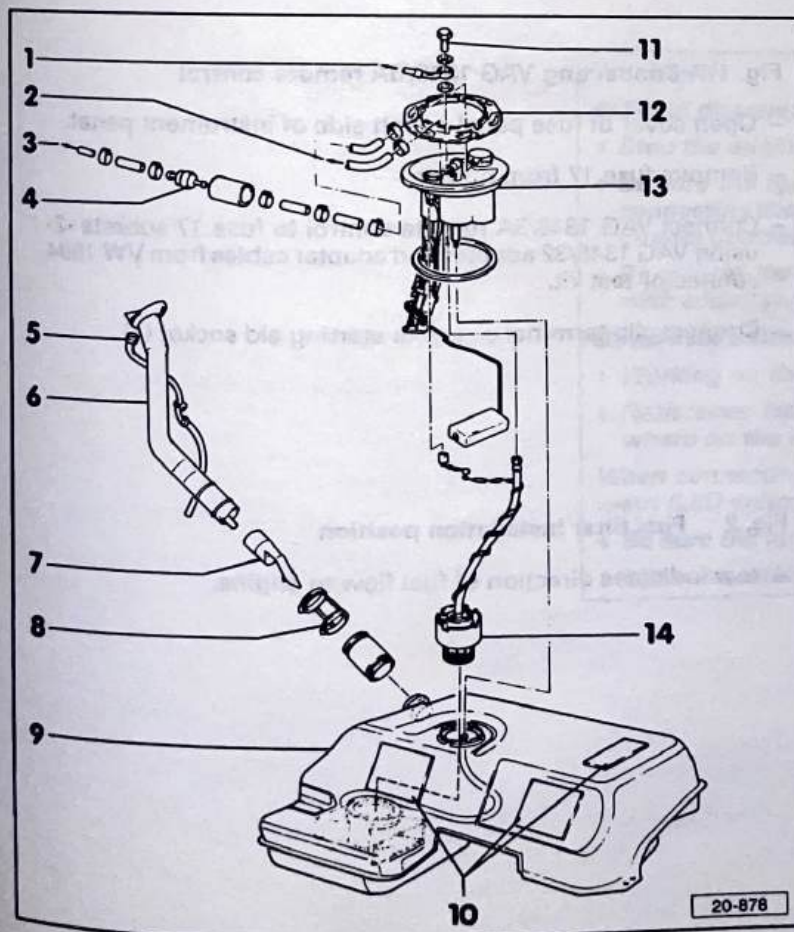
WARNING!

Always be sure to comply with applicable safety precautions when working on the fuel system.

Note:

- ♦ Always replace gaskets, seals and hose clamps when working on the fuel system.
- ♦ Hose connections are secured either with screw-type or spring-type hose clamps.
- ♦ Connect remote control ⇒ Fig. 1.
- ♦ Checking fuel pump relay ⇒ Repair Manual, Fuel Injection & Ignition, for the applicable engine management system.
- ♦ When removing or installing the fuel pump module, make sure that the wiring harness is not damaged.
- ♦ Observe rules of cleanliness ⇒ page 20-7.

20-1



1 - Fuel supply line

- ♦ To fuel tank
- ♦ Installation position of fuel filter ⇒ Fig. 2

2 - Fuel return line

3 - Breather line

- ♦ To Evaporative Emission (EVAP) canister

4 - Breather/vent valve

- ♦ 0.02–0.3 bar (0.3–4.4 psi) pressure
- ♦ Prevents fuel from reaching EVAP canister when filling fuel tank
- ♦ Checking ⇒ page 20-8

5 - Overflow hose

6 - Filler pipe

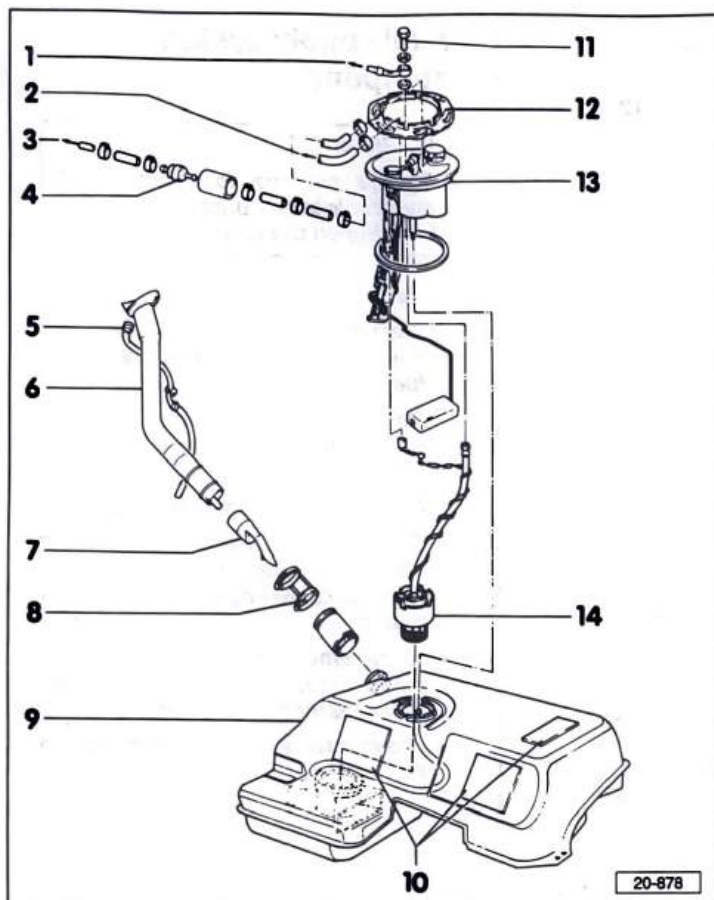
7 - Check valve

8 - Double clip

9 - Fuel tank

- ♦ Checking for leaks ⇒ page 20-8

20-2



- 10 - Cushioning material**
♦ Prevents damage caused by rubbing
- 11 - Union bolt**
♦ 20 Nm (15 ft lb)
- 12 - Lock ring**
♦ Removing ⇒ page 20-11
- 13 - Fuel level sensor**
♦ Removing and installing
⇒ page 20-10
- 14 - Fuel Pump (FP)**

20-3

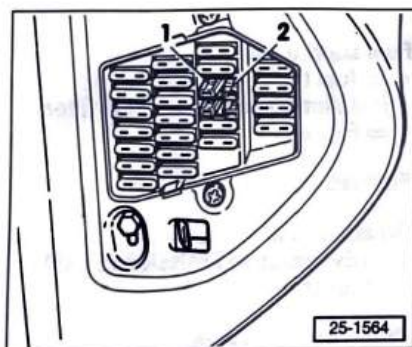


Fig. 1 Connecting VAG 1348/3A remote control

- Open cover of fuse panel on left side of instrument panel.
- ◀ - Remove fuse 17 from holder.
- Connect VAG 1348/3A remote control to fuse 17 sockets -2- using VAG 1348/32 adapter and adapter cables from VW 1594 connector test kit.
- Connect clip terminal clamp to starting aid socket (+).

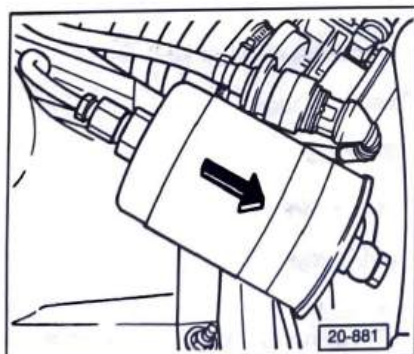


Fig. 2 Fuel filter installation position

Arrow indicates direction of fuel flow to engine.

20-4

Safety precautions

WARNING!

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

- ♦ **BEFORE** beginning repairs, the suction pipe of an exhaust extraction system must be located near the fuel tank opening so that escaping fuel vapors can be immediately carried away.
- ♦ If no exhaust extraction system is available, a radial fan (motor located outside airflow) with volume of at least 15 m³/hr (9 cfm) may be used.
- ♦ Wear fuel-resistant gloves whenever working with open parts of the fuel system.

Be sure the ignition is switched OFF, when:

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

BEFORE cranking the engine at starting RPM (such as for compression testing) disable the ignition and fuel injection systems:

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

20-5

CAUTION!

BEFORE disconnecting the battery:

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

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

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

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

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

Rules of cleanliness

CAUTION!

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

1 - Thoroughly clean fuel system line and hose connections and the surrounding area before disconnecting.

2 - Place removed components on a clean surface and cover. Use plastic sheeting or paper. Do not use fluffy rags that could leave lint!

3 - Carefully cover over or seal any components that have been opened if repairs are not carried out immediately.

4 - Install only clean parts:

Do not remove replacement parts from the packaging until immediately before they are to be installed.

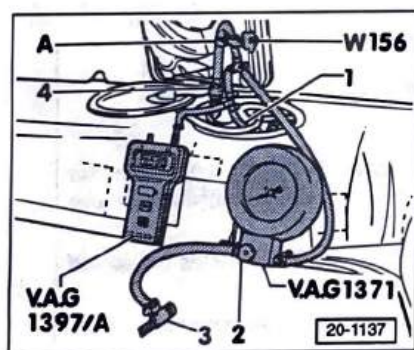
Do not use parts that have been stored without packaging (e.g. in toolboxes, etc.).

5 - When the fuel system is opened:

Avoid working with compressed air whenever possible.

Avoid moving the vehicle if possible.

20-7



Fuel system, checking for leaks

- ◀ - Disconnect vent valve -A- (to EVAP canister) from fuel pump module.
- Connect VAG 1371 fuel system tester and VAG 1397A turbo-charger tester (connection 2, relative pressure), and connect clamp W156, as shown in illustration.
- Tighten clamp.
- Open control valve -2- until indicated pressure reading no longer increases.
- Close control valve -2-.

Opening pressure for fuel tank cap: 0.3–0.4 bar (5.0–5.8 psi)

- Pressure must not fall below 0.28 bar (4 psi) after 30 minutes

If pressure drops below specified value:

- Check fuel tank for leaks.

- Check and if necessary replace:
 - ♦ Fuel tank sealing cap
 - ♦ Fuel level sensor O-ring
 - ♦ Fuel level sensor
 - ♦ Fuel level sensor
 - ♦ Filler pipe
 - ♦ Double clamp together with hose pipe
 - ♦ Fuel tank
- Open clamp W156.

Pressure drops up to 0.02 bar

If pressure drops below 0.017 bar (0.25 psi):

- Check fuel tank for leaks.
- Check and if necessary replace:
 - ♦ Hose pipes and clamps
 - ♦ Pressure retaining valve (check-valve)

CAUTION!

After carrying out checks with VAG 1371 fuel system tester, the tire pressure must be checked.

20-9

Fuel level sensor, removing and installing

- Observe safety measures ⇒ page 20-5

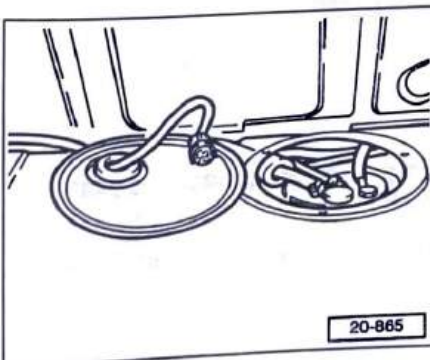
WARNING!

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

- Switch ignition on.
- Observe fuel gauge.

CAUTION!

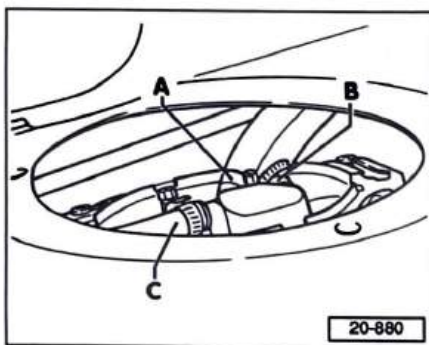
The fuel tank should not be more than 2/3 full. Empty fuel tank, if necessary, using an approved fuel cart.



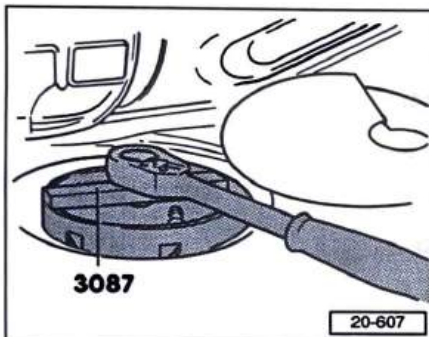
Removing

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

20-10



- ◀ - Loosen fuel supply line -A-, fuel return line -B-, and breather line -C-, then carefully disconnect lines.
- Note installation position of fuel level sensor (angle).



- ◀ - Loosen and remove lock ring with wrench 3087, and remove fuel level sensor from fuel tank.

Note:

While removing and installing the fuel level sensor, use care to ensure that the wiring harness is not damaged.

- Remove fuel supply and return lines from inside of sensor housing.
- Disconnect fuel pump electrical connection.

Installing

- Re-install all components in reverse order of removal.
- Install fuel level sensor in original position.

20-11

Fuel Pump (FP), removing and installing

- Observe safety measures ⇒ page 20-5

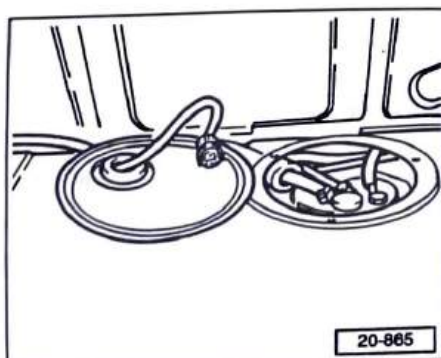
WARNING!

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

- Switch ignition on.
- Observe fuel gauge.

CAUTION!

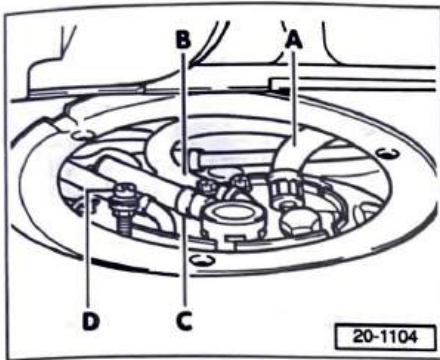
The fuel tank should not be more than 2/3 full. Empty fuel tank, if necessary, using an approved fuel cart.



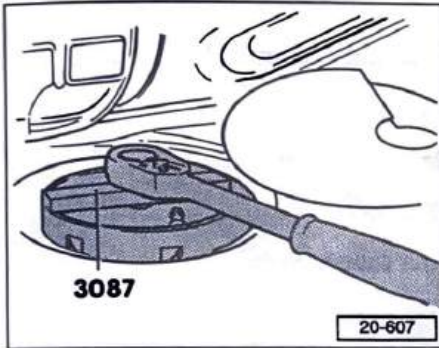
Removing

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

20-12



- Loosen fuel supply line -A-, fuel return line -B-, and breather line -C-, then carefully disconnect lines.
- Note installation position of fuel level sensor (angle).



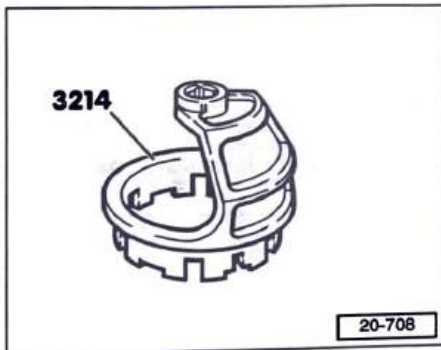
- Loosen and remove lock ring with wrench 3087, and remove fuel level sensor from fuel tank.

Note:

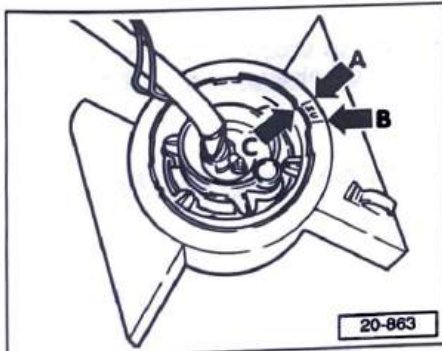
While removing and installing the fuel level sensor, use care to ensure that the wiring harness is not damaged.

- Remove fuel supply and return lines from inside of sensor housing.
- Disconnect fuel pump electrical connection.

20-13



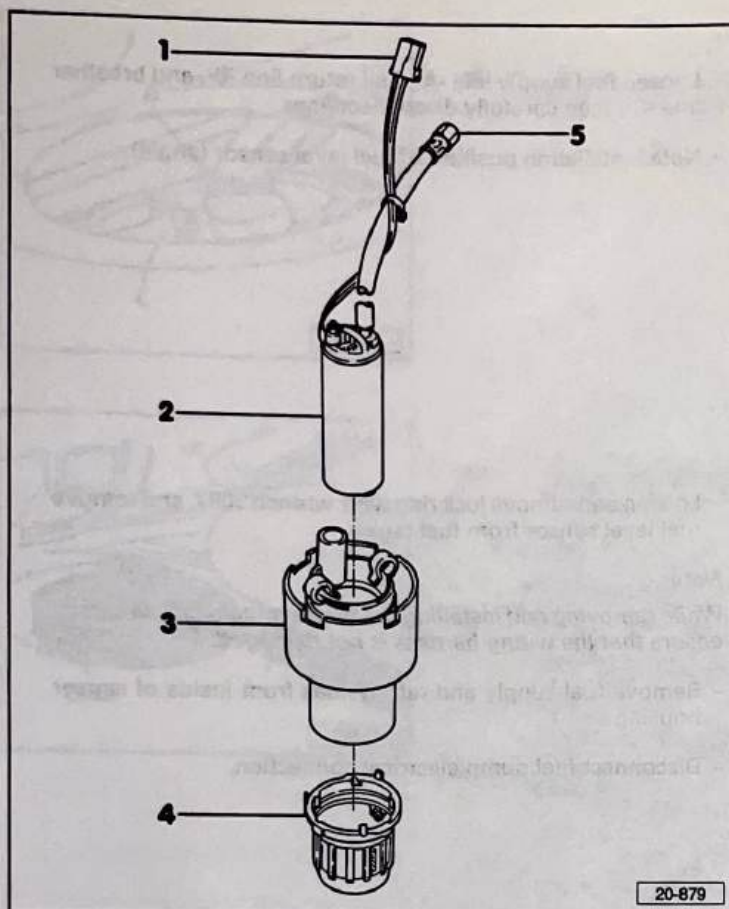
- Mount pump removal tool 3214 to fuel pump in baffle housing and turn pump approx. 15 mm (0.59 in.) in counterclockwise direction.
- Pull out fuel pump upward.



Installing

- Install in reverse order of removal.
- Install fuel pump as follows:
 - Insert fuel pump in baffle housing so that notch (arrow -C-) aligns with marking (arrow -A-).
 - Mount pump removal tool 3214 to fuel pump.
 - Turn fuel pump clockwise until notch is aligned with next marking (arrow -B-)—fuel pump engages.
- Install fuel level sensor in original position.

20-14



Fuel Pump (FP), assembly

WARNING!

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

Note:

Fuel pump baffle housing is available in two versions:

- ◆ Housing connected to filter screen with bayonet fitting
- ◆ Housing welded to filter screen

1 - Fuel pump electrical connection

2 - Fuel pump

3 - Baffle housing

4 - Filter screen

5 - Fuel supply hose

20-15

Fuel Pump (FP), checking

WARNING!

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

Checking power supply

- Fuse 17 OK
- Fuel filter in perfect condition
- Battery fully charged (at least 12 volts)
- Switch ignition on.
- Fuel pump must be heard to run. (A second person will be required for this if the surrounding noise level is too high).

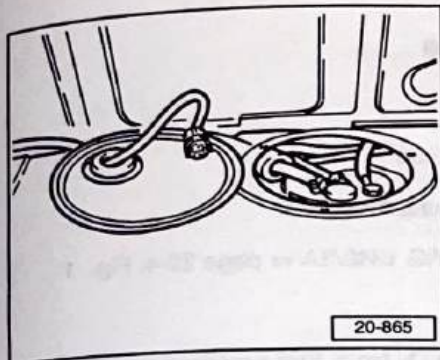
If fuel pump does NOT run:

- Connect remote control VAG 1348/3A ⇒ page 20-4, Fig. 1
- Operate remote control.

If fuel pump runs:

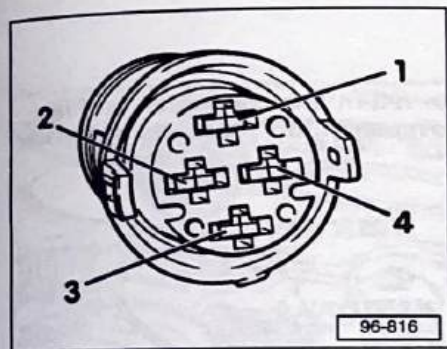
- Check Fuel Pump (FP) relay.
- ⇒ Repair Manual, *Fuel Injection & Ignition*, Repair Group 01, for the applicable engine management system.

20-16



If fuel pump does NOT run:

- ◀ - Remove cover for fuel pump module (under luggage compartment floor).
- Disconnect harness connector for fuel pump and fuel level sensor.
- Switch multimeter (Fluke 83 or equivalent) to volts range.



- ◀ - Connect multimeter between connector terminal 1 (green/yellow wire) and terminal 4 (brown wire) using adapter cables from VW 1594 connector test kit.
 - Operate remote control.
- Specified value: approx. battery positive voltage (B+)

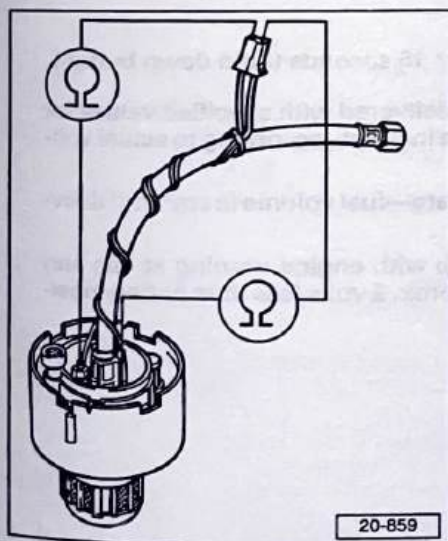
If specified value is NOT obtained:

- Find and eliminate break in wiring using wiring diagram.

If specified value is obtained:

- Remove fuel level sensor ⇒ page 20-10.

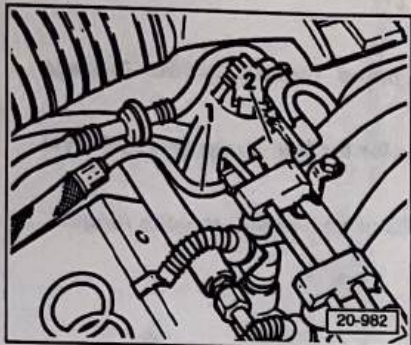
20-17



- ◀ - Check wires from sensor connector to fuel pump for continuity using multimeter and jumper wires, and eliminate break in wiring, if necessary.

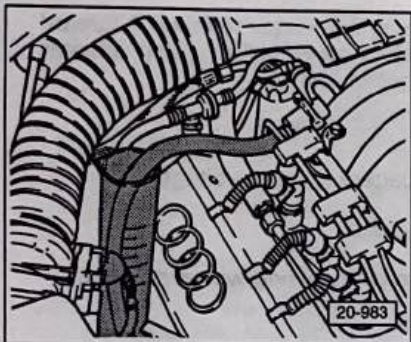
If wiring is OK:

- Replace fuel pump ⇒ page 20-12.



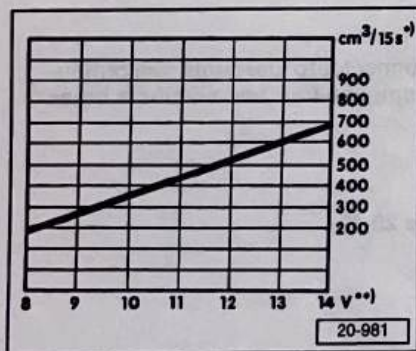
Fuel pump delivery, checking

- Voltage supply OK
- Fuel filter in perfect condition
- Battery fully charged (at least 12 volts).
- Connect remote control VAG 1348/3A ⇒ page 20-4, Fig. 1
- Remove fuel filler cap.
- ◀ - Disconnect fuel return line -1- from fuel pressure regulator.



- ◀ - Temporarily attach hose to return line connection on fuel pressure regulator (-2- above) and route other end of hose into measuring glass.

20-19



- Operate remote control for 15 seconds (hold down button).
- ◀ - Compare quantity of fuel delivered with specified values for minimum fuel delivery rate in graph, according to actual voltage at fuel pump.
- * - Minimum fuel delivery rate—fuel volume in cm^3 (ml) delivered in 15 seconds
- ** - Voltage (V) at fuel pump with engine running at idle and fuel pump running—approx. 2 volts less than battery positive voltage (B+)

Fuel pump check valve, checking

WARNING!

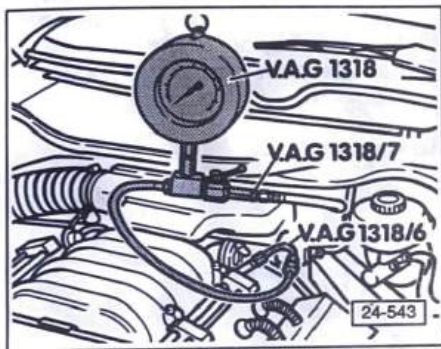
Fire hazard! DO NOT smoke or work near heaters or have anything in area that can ignite fuel!

Test requirements

- Fuse 17 OK
- Fuel filter OK
- Battery fully charged (at least 12 volts)
- Fuel pump delivery rate OK (testing ⇒ page 20-19)
 - Connect remote control ⇒ page 20-4.
- Connect pressure gauge VAG 1318 between fuel supply line and fuel rail.
- Pressure tester valve must be in “open” position
 - Operate remote control switch for approx. 30 seconds.
 - Move lever on pressure tester to “closed” position.

CAUTION!

The lever on the pressure tester must remain in the closed position during the test.



20-21

- Briefly operate remote control switch until max. pressure of 5.5 bar (80 psi) is indicated.
- Observe pressure drop on gauge.

Specification:

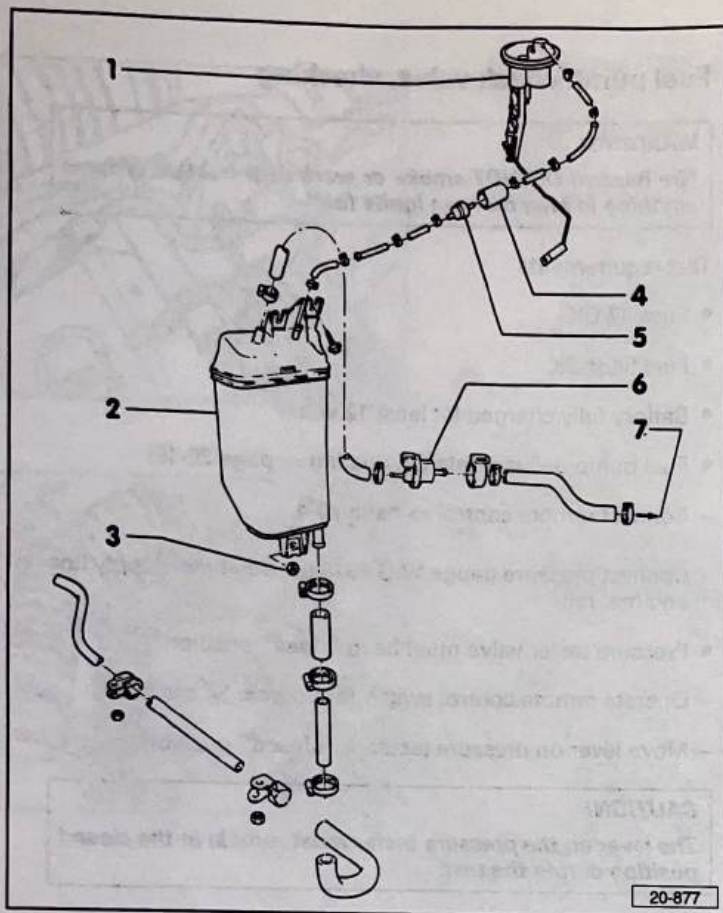
- ♦ After 10 minutes, max. pressure drop is 0.5 bar (7 psi)

If pressure drops below specified value:

- Check pressure tester connections for leaks.
- Check all fuel line connections for tightness and leakage.

If no leaks are present, fuel pump check valve is defective.

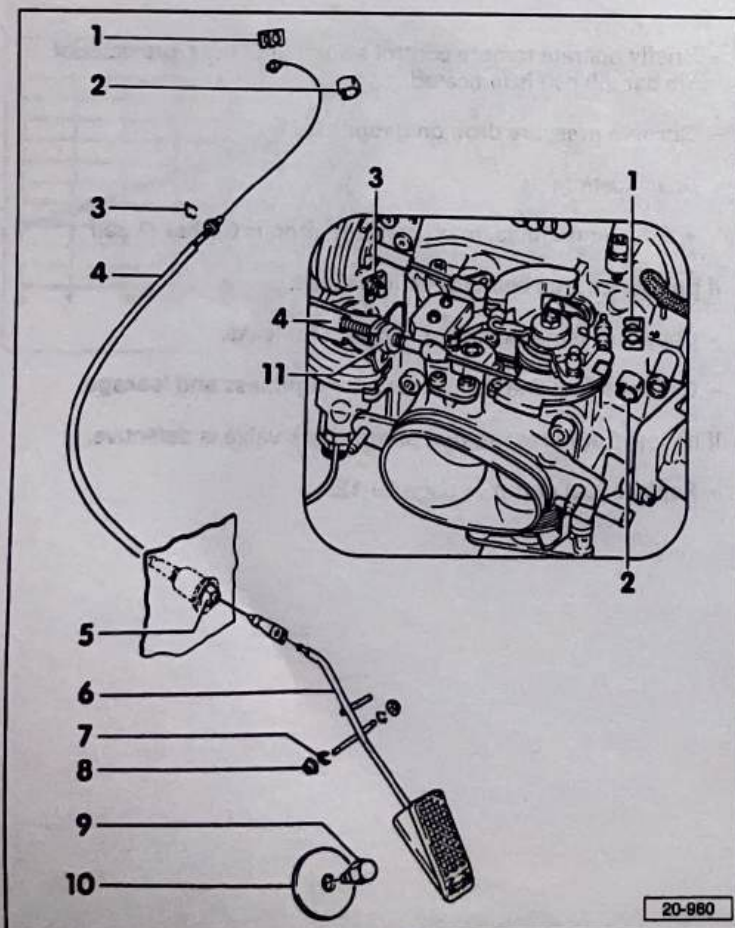
- Replace fuel pump ⇒ page 20-12.



Evaporative Emissions (EVAP) system, component layout

- 1 - Fuel level sensor
- 2 - EVAP canister
- 3 - 10 Nm (7 ft lb)
- 4 - Support hose
- 5 - Breather vent valve
- 6 - EVAP canister purge regulator valve
 - ♦ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for the appropriate engine management system), Repair Group 24
- 7 - To throttle body

20-23



Accelerator Pedal (AP) cable and linkage, repairing

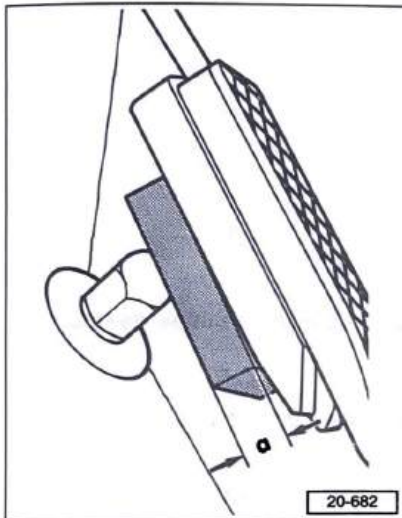
- 1 - Clamp
- 2 - Securing clip
 - ♦ Always replace
- 3 - Securing clip for cable length adjustment
- 4 - Accelerator Pedal (AP) cable
 - ♦ Adjusting ⇒ page 20-25
- 5 - Square mounting
- 6 - Accelerator pedal
- 7 - Securing clip
- 8 - Bearing sleeve
- 9 - Accelerator pedal stop bolt
- 10 - Washer
- 11 - Accelerator cable adjustment grommet

20-24

Accelerator Pedal (AP) cable, adjusting

CAUTION!

- ♦ *The accelerator pedal cable is easily kinked and must therefore be handled carefully when installing.*
- ♦ *A single slight kink can lead to cable failure while the vehicle is being driven.*
- ♦ **ACCELERATOR PEDAL CABLES WHICH ARE KINKED SHOULD BE DISCARDED.**



When installing an accelerator pedal cable, make sure that it is aligned properly between the support bracket and throttle valve lever.

The accelerator pedal cable is fixed to the accelerator pedal and the fast idle cam. Longitudinal adjustment (length) of the accelerator pedal cable sleeve is not determined by the securing clip.

Vehicles with manual transmission

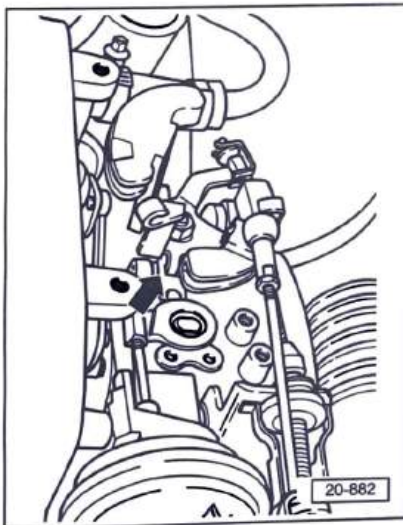
- Depress accelerator pedal to wide open throttle position.

Vehicles with automatic transmission

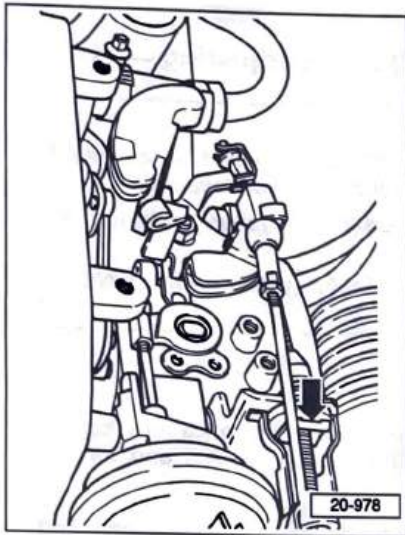
- ◀ - Insert spacer between accelerator pedal and stop, and secure in place.

Dimension -a-: 9 mm (0.35 in.)

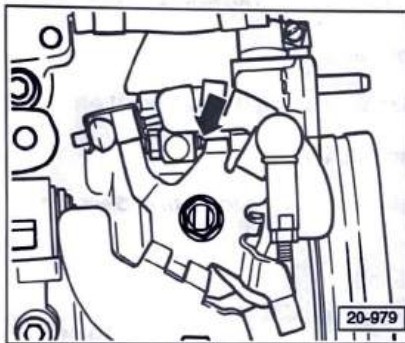
20-25



- ◀ - Pull accelerator pedal cable sleeve back until throttle valve lever contacts wide open throttle stop (arrow).



- Insert the securing clip (arrow) behind support bracket, to lock accelerator pedal cable sleeve in place.



Checking

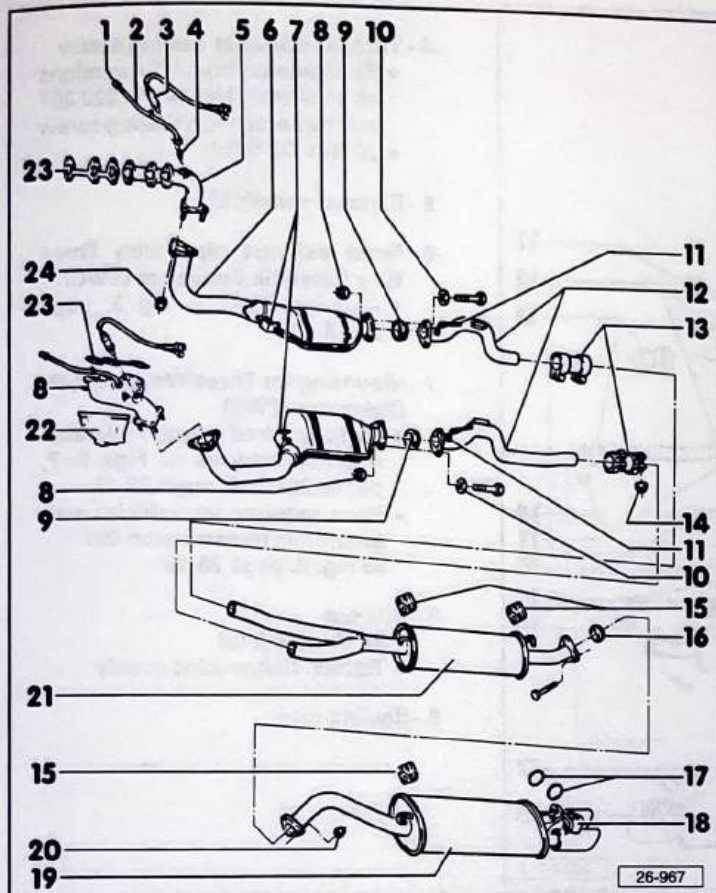
- Depress accelerator pedal pedal.

- Throttle valve lever must contact wide open throttle stop.

Accelerator pedal released:

- ◀ • Throttle valve lever must contact closed throttle position stop (arrow).

If NOT, repeat cable adjustment until checking conditions described above are met.



Exhaust system components, engine code AAH up to 8.94, removing and installing

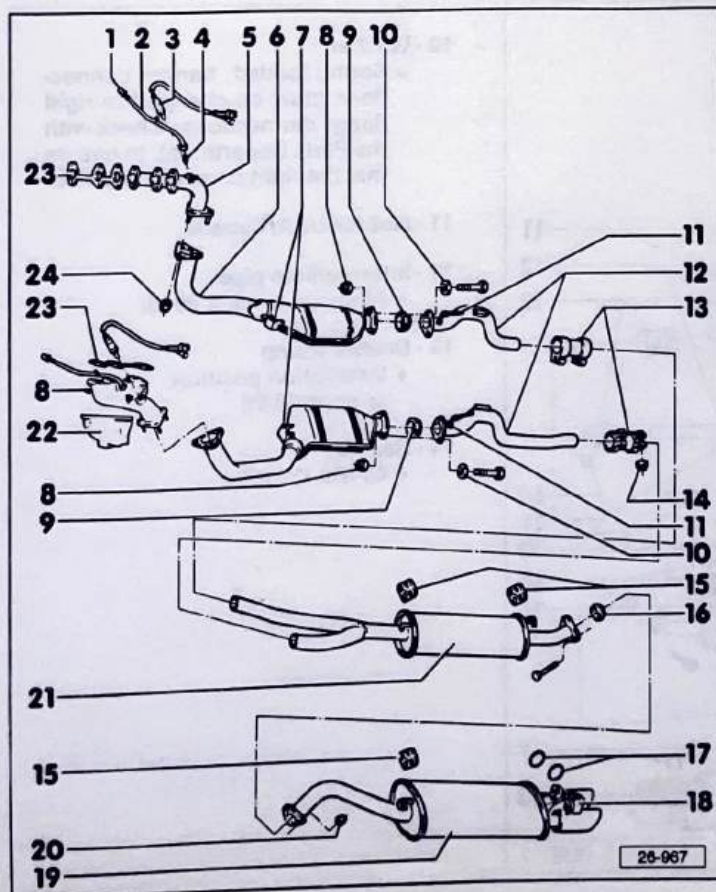
- ♦ Front-wheel-drive vehicles with manual transmission ⇒ page 26-2
- ♦ Front-wheel-drive vehicles with automatic trans. 097 ⇒ page 26-2
- ♦ Front-wheel-drive vehicles with automatic trans. 01K ⇒ page 26-7
- ♦ All-wheel-drive vehicles ⇒ page 26-10

Vehicles from 8.94 ⇒ page 26-30

Note:

- ♦ Always replace all self-locking nuts, seals, and gaskets
- ♦ Distribute exhaust system weight evenly.
- ♦ Align exhaust system free of any preload or tension ⇒ page 26-22
- ♦ Checking the exhaust system for leaks ⇒ page 26-37
- ♦ Align exhaust system flange connections ⇒ Fig. 4, page 26-14

26-1



Front-wheel-drive vehicles with manual transmission or automatic transmission 097

Engine code AAH up to 8.94

1 - CO tap tube cap

- ♦ Deleted from USA versions as of chassis No. 4A PN 022 307

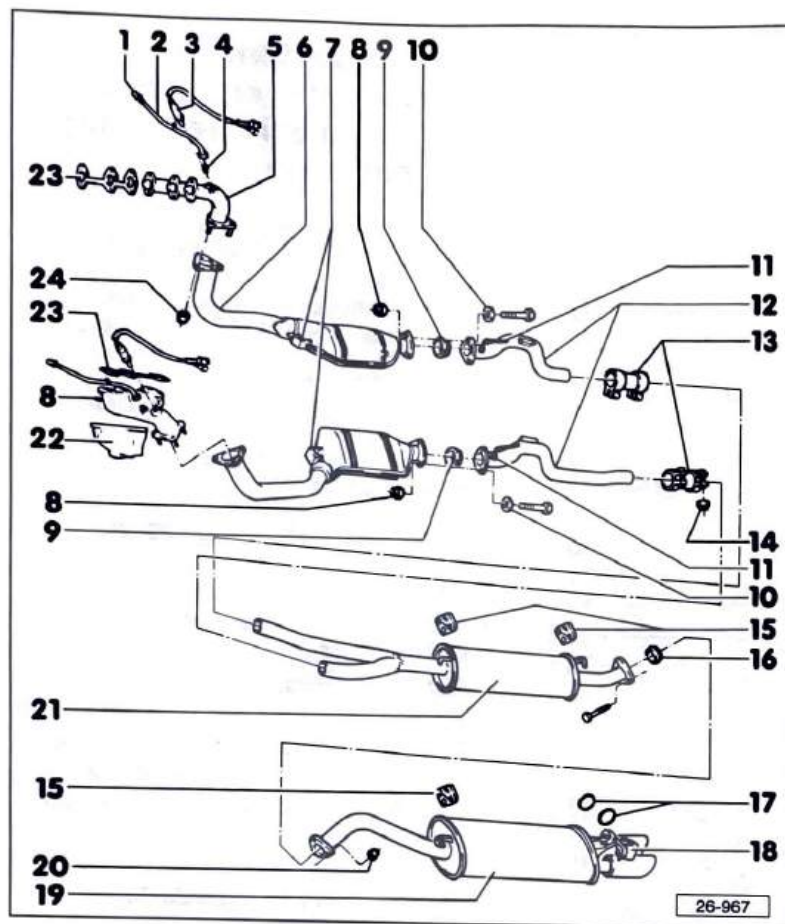
2 - CO tap tube

- ♦ 20 Nm (15 ft lb)
- ♦ Deleted from USA versions as of chassis No. 4A PN 022 307

3 - Heated Oxygen Sensor (HO2S)

- ♦ 50 Nm (37 ft lb)
- ♦ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for applicable engine management system), Repair Group 24
- ♦ When installing sensor, lubricate threads with G5, but do not allow G5 to enter slotted part of sensor body

26-2



- 4 - Threaded stud or sealing screw**
 ♦ Stud deleted from USA versions as of chassis No. 4A PN 022 307 and replaced with sealing screw
 ♦ 30 Nm (22 ft lb)

5 - Exhaust manifold

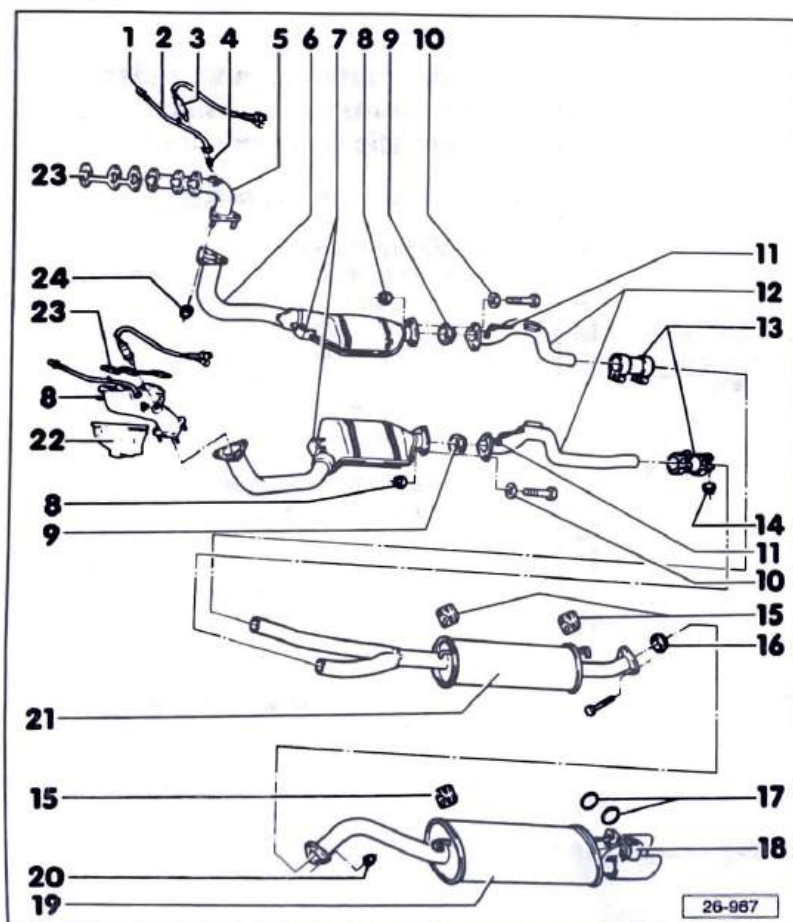
- 6 - Front exhaust pipe with Three Way Catalytic Converter (TWC)**
 ♦ Aligning TWC ⇒ Fig. 3, page 26-14

- 7 - Mounting for Three Way Catalytic Converter (TWC)**
 ♦ Parts required for manual transmission vehicles ⇒ Figs. 5-7, pages 26-15 through 26-17
 ♦ Parts required for vehicles with automatic transmission 097 ⇒ Fig. 8, page 26-18

- 8 - Hex nut**
 ♦ 25 Nm (18 ft lb)
 ♦ Tighten flange joint evenly

9 - Sealing ring

26-3



- 10 - Washer**
 ♦ Spring-loaded flange connections must be changed to rigid flange connections. Check with the Parts Department, to ensure that the right parts are installed.

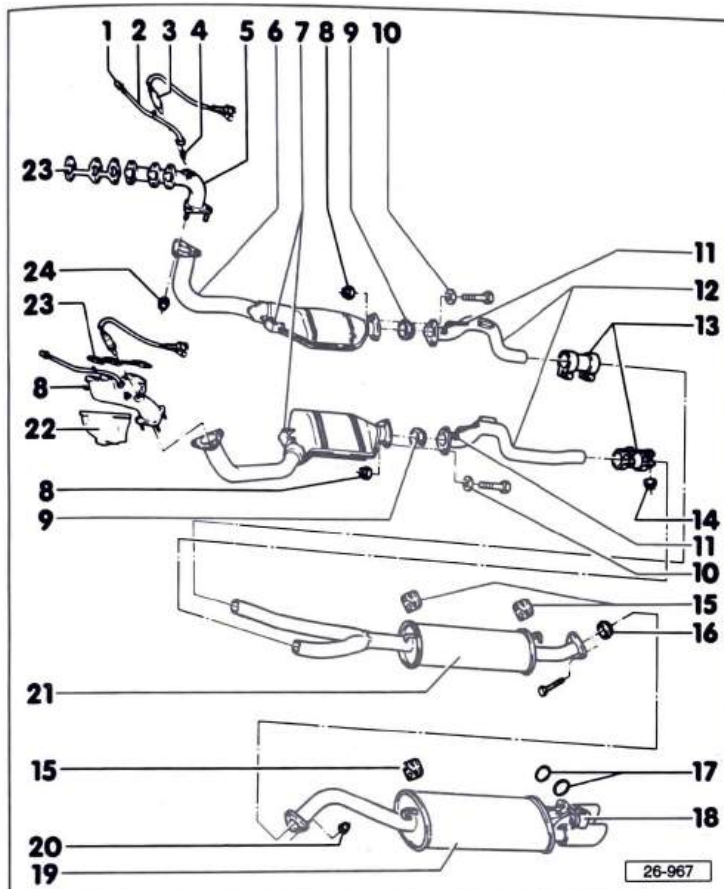
11 - Not for USA/Canada

- 12 - Intermediate pipe**
 ♦ Aligning ⇒ page 26-28

- 13 - Double clamp**
 ♦ Installation position ⇒ page 26-26

- 14 - Hex nut**
 ♦ 40 Nm (30 ft lb)

26-4



15 - Support loop

16 - Sealing ring

17 - Retaining ring

18 - Balance weight

- ♦ For vehicles with automatic transmission 097
- ♦ Installation position ⇒ Fig. 2, page 26-13

19 - Rear muffler

- ♦ Align tail pipes ⇒ page 26-24

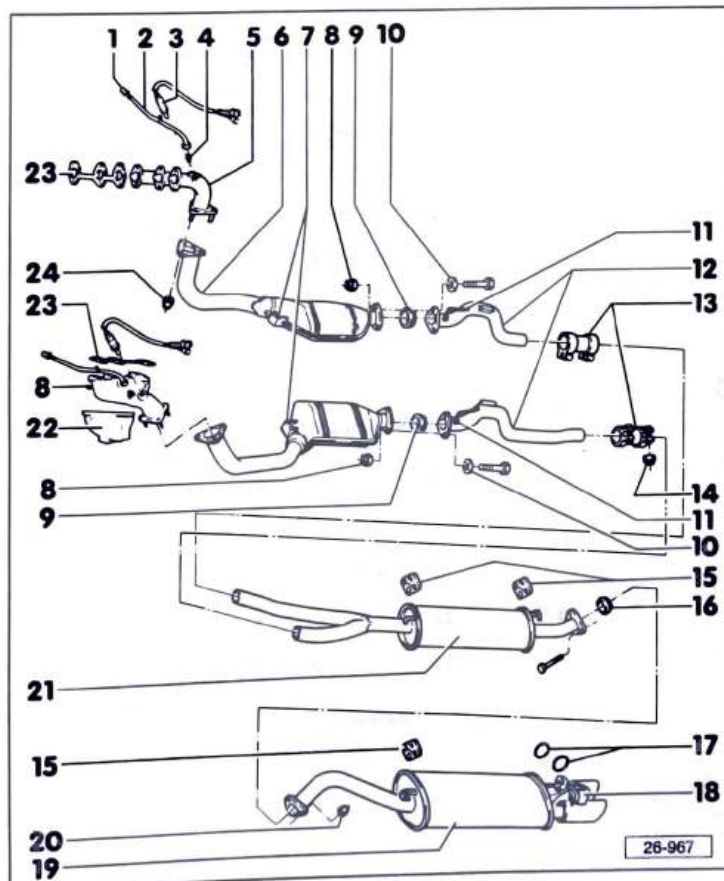
20 - Hex nut

- ♦ 25 Nm (18 ft lb)
- ♦ Installation position for flange connection ⇒ page 26-25

21 - Center muffler

- ♦ Adjust alignment of exhaust system ⇒ page 26-23

26-5



22 - Heat shield

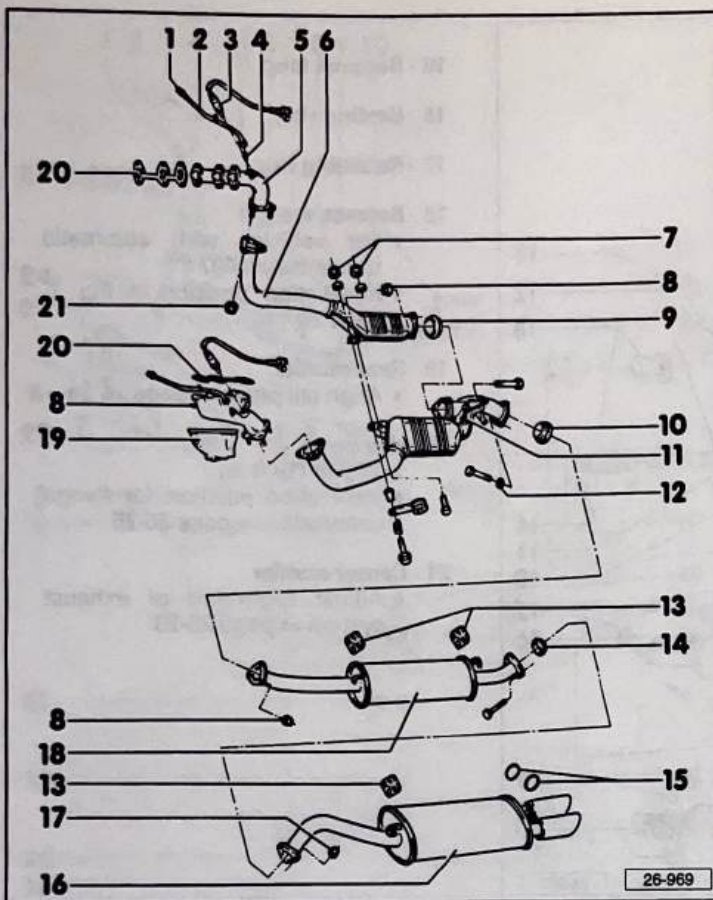
- ♦ Tighten connections at cylinder head (hex nuts) to 9 Nm (80 in lb)
- ♦ Tighten connections to upper/lower heat shield (hex bolts) to 5 Nm (44 in lb)

23 - Exhaust manifold gasket

24 - Hex nut

- ♦ 30 Nm (22 ft lb)
- ♦ Note tightening method ⇒ Fig. 11, page 26-21

26-6

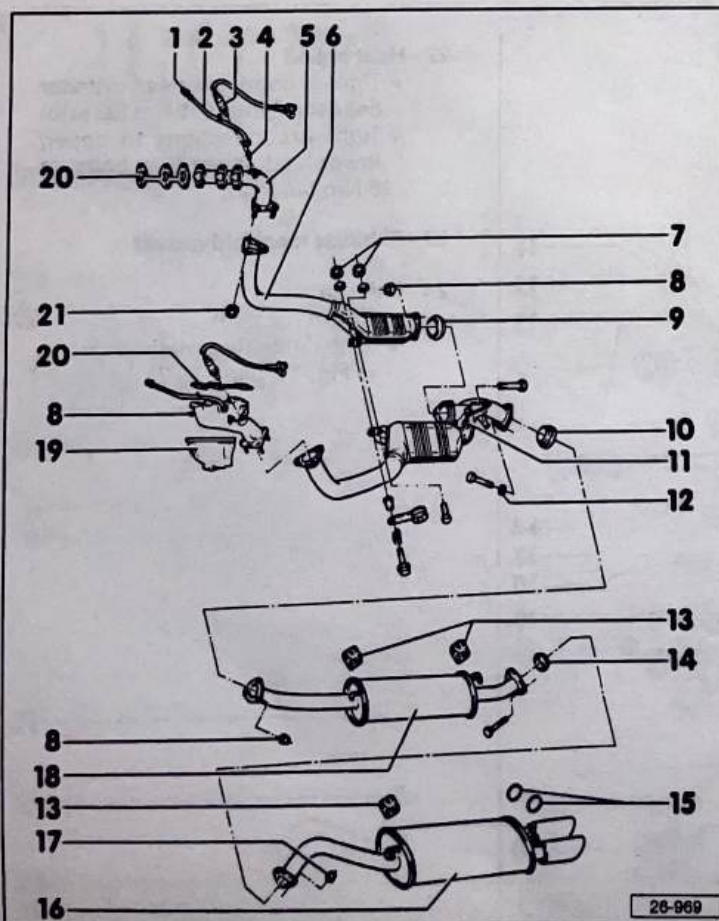


Front-wheel-drive vehicles with automatic transmission 01K

Engine code AAH up to 8.94

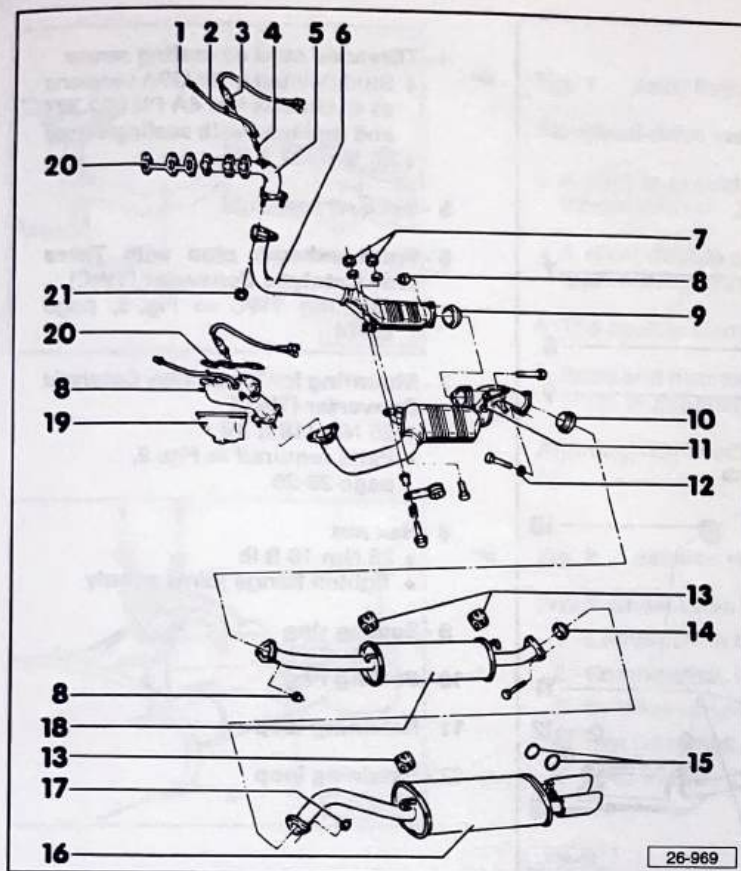
- 1 - CO tap tube cap
 - ♦ Deleted from USA versions as of chassis No. 4A PN 022 307
- 2 - CO tab tube
 - ♦ 20 Nm (15 ft lb)
 - ♦ Deleted from USA versions as of chassis No. 4A PN 022 307
- 3 - Heated Oxygen Sensor (HO2S)
 - ♦ 50 Nm (37 ft lb)
 - ♦ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for applicable engine management system), Repair Group 24
 - ♦ When installing sensor, lubricate threads with G5, but do not allow G5 to enter slotted part of sensor body
- 4 - Threaded stud or sealing screw
 - ♦ Stud deleted from USA versions as of chassis No. 4A PN 022 307 and replaced with sealing screw
 - ♦ 30 Nm (22 ft lb)

26-7



- 5 - Exhaust manifold
- 6 - Front exhaust pipe with Three Way Catalytic Converter (TWC)
 - ♦ Aligning TWC ⇒ Fig. 3, page 26-14
- 7 - Mounting for Three Way Catalytic Converter (TWC)
 - ♦ 25 Nm (18 ft lb)
 - ♦ Parts required ⇒ Fig. 9, page 26-20
- 8 - Hex nut
- 9 - Sealing ring
- 10 - Sealing ring
- 11 - Not for USA/Canada
- 12 - Washer
- 13 - Retaining ring
- 14 - Sealing ring
- 15 - Support loop

26-8



16 - Rear muffler

- ♦ Aligning tail pipes ⇒ page 26-24

17 - Hex nut

- ♦ 25 Nm (18 ft lb)
- ♦ Installation position for flange connection ⇒ page 26-25

18 - Center muffler

19 - Heat shield

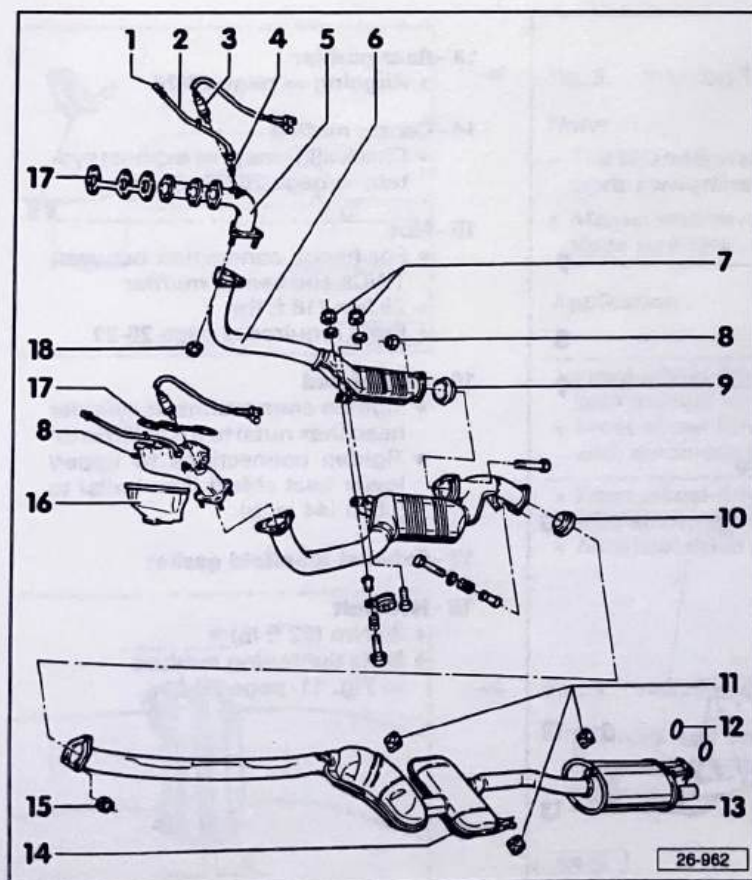
- ♦ Tighten connections at cylinder head (hex nuts) to 9Nm (80 in lb)
- ♦ Tighten connections to upper/lower heat shield (hex bolts) to 5 Nm (44 in lb)

20 - Exhaust manifold gasket

21 - Hex bolt

- ♦ 30 Nm (22 ft lb)
- ♦ Note tightening method ⇒ Fig. 11, page 26-21

26-9



All-wheel-drive vehicles

Engine code AAH up to 8.94

The illustration shows the exhaust system for manual transmission vehicles. Variations for automatic transmission vehicles are also described.

Note:

Joint to allow repair between center and rear silencers ⇒ Fig. 1, page 26-13.

1 - CO tap tube cap

- ♦ Deleted from USA versions as of chassis No. 4A PN 022 307

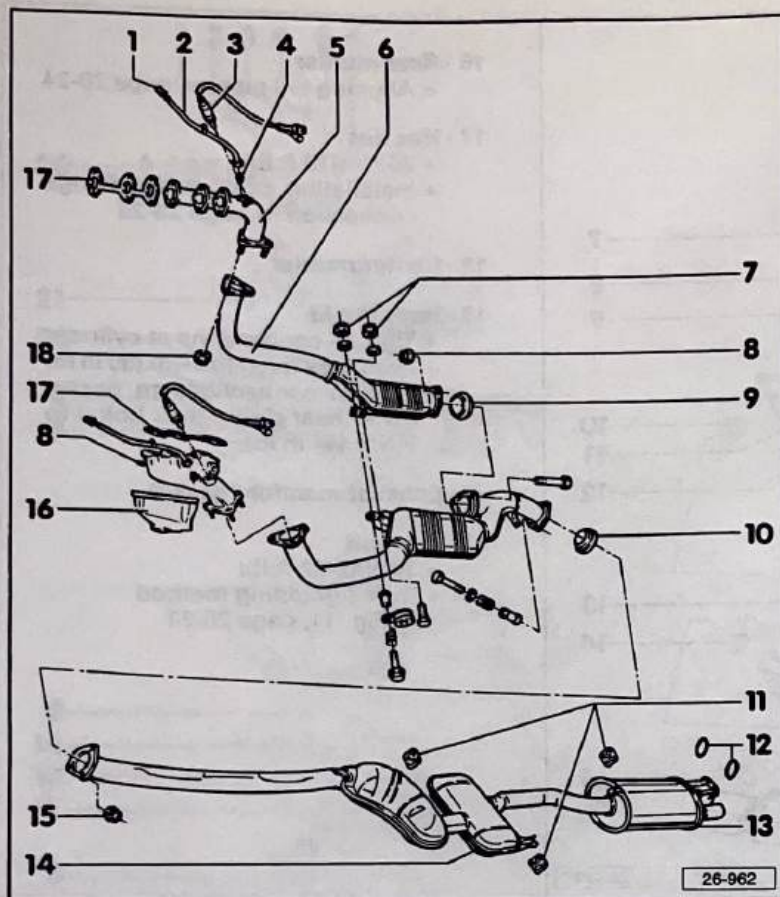
2 - CO tap tube

- ♦ 20 Nm (15 ft lb)
- ♦ Deleted from USA versions as of chassis No. 4A PN 022 307

3 - Heated Oxygen Sensor (HO2S)

- ♦ 50 Nm (37 ft lb)
- ♦ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for applicable engine management system), Repair Group 24
- ♦ When installing sensor, lubricate threads with G5, but do not allow G5 to enter slotted part of sensor body

26-10



- 4 - Threaded stud or sealing screw**
 ♦ Stud deleted from USA versions as of chassis No. 4A PN 022 307 and replaced with sealing screw
 ♦ 30 Nm (22 ft lb)

5 - Exhaust manifold

- 6 - Front exhaust pipe with Three Way Catalytic Converter (TWC)**
 ♦ Aligning TWC ⇒ Fig. 3, page 26-14

- 7 - Mounting for Three Way Catalytic Converter (TWC)**
 ♦ 25 Nm (18 ft lb)
 ♦ Parts required ⇒ Fig. 9, page 26-20

- 8 - Hex nut**
 ♦ 25 Nm 18 ft lb
 ♦ Tighten flange joints evenly

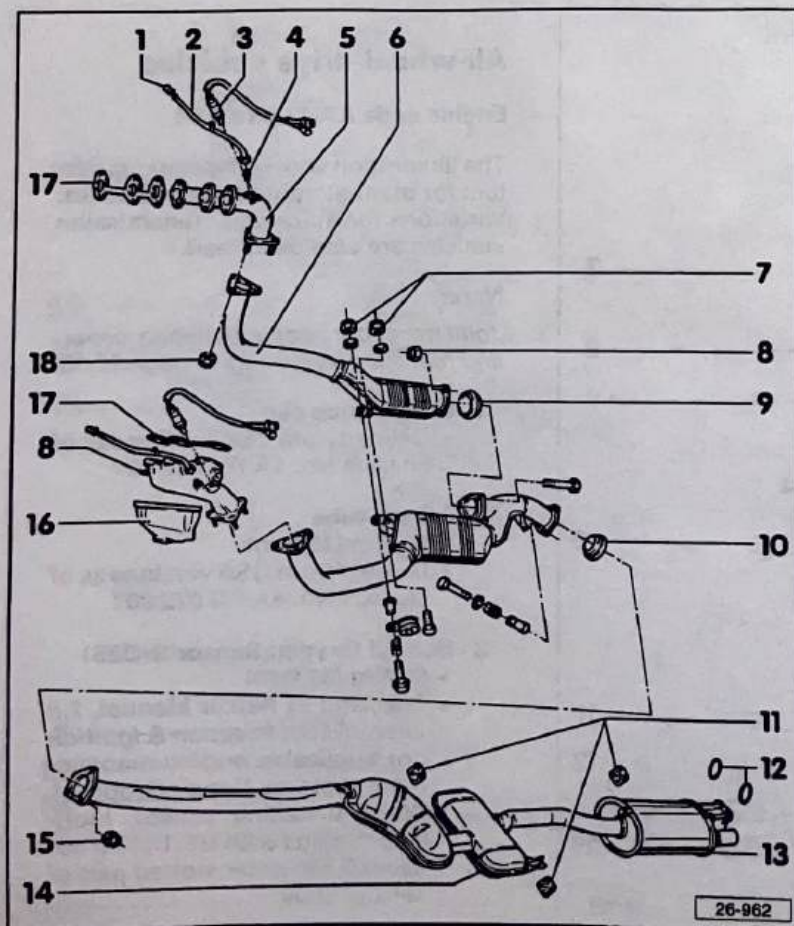
9 - Sealing ring

10 - Sealing ring

11 - Retaining loop

12 - Retaining loop

26-11



- 13 - Rear muffler**
 ♦ Aligning ⇒ page 26-24

- 14 - Center muffler**
 ♦ Check alignment of exhaust system ⇒ page 26-23

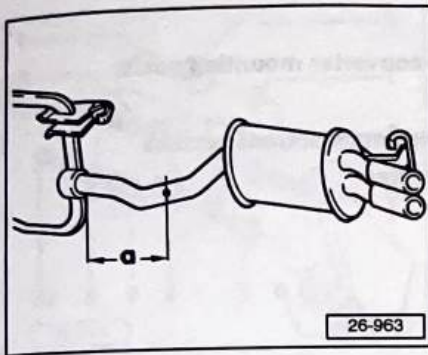
- 15 - Nut**
 ♦ For flange connection between TWCs and center muffler
 ♦ 25 Nm (18 ft lb)
 ♦ Parts required ⇒ page 26-29

- 16 - Heat shield**
 ♦ Tighten connections at cylinder head (hex nuts) to 9 Nm (80 in lb)
 ♦ Tighten connections to upper/lower heat shield (hex bolts) to 5 Nm (44 in lb)

17 - Exhaust manifold gasket

- 18 - Hex bolt**
 ♦ 30 Nm (22 ft lb)
 ♦ Note tightening method ⇒ Fig. 11, page 26-21

26-12

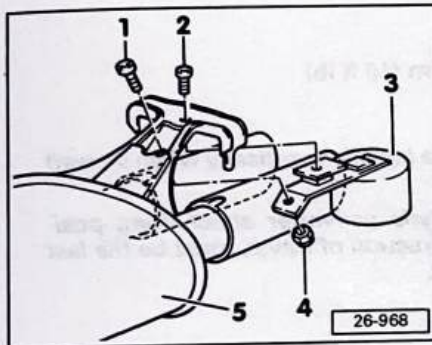


◀ Fig. 1 Joint between center and rear mufflers

All-wheel-drive vehicles

- ♦ A joint is provided for separating center and rear mufflers; dimension -a-: 220 mm (approx. 8.5 in.)
- ♦ A short double clamp is provided to connect the center and rear muffler in case of repair.
- The double clamp must be installed horizontally.
- Bolts and nuts for double clamp must point to right and side-ways to exhaust pipe.

Aligning rear muffler ⇒ page 26-24

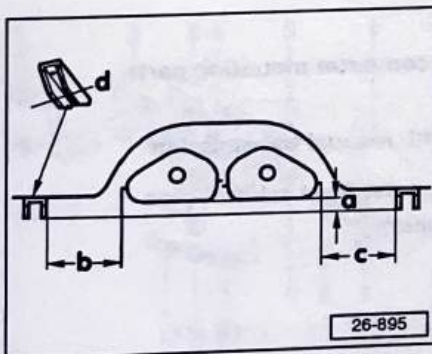


◀ Fig. 2 Balance weight installation position

Front-wheel-drive vehicles with automatic transmission 097

- 1 - Combination bolt
- 2 - Combination bolt: torque to 25 Nm (18 ft lb)
- 3 - Balance weight
- 4 - Hex head nut: torque to 25 Nm (18 ft lb)
- 5 - Rear muffler

26-13

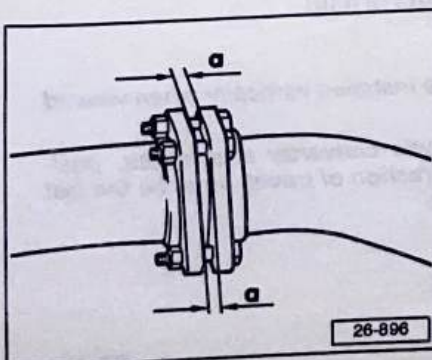


◀ Fig. 3 Aligning Three Way Catalytic Converter (TWC)

Note:

- ♦ The illustration shows the exhaust system and three way catalytic converters from the rear.
- ♦ Measurements must be carried out at the centerline -d- of the three way catalytic converter impact protector.

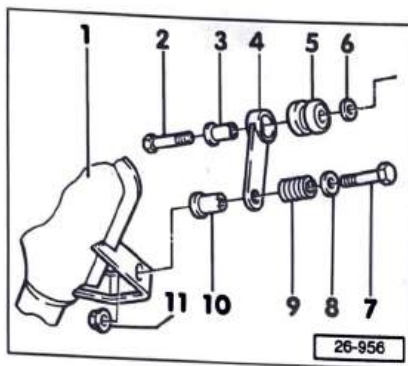
Application	Dimensions	
	mm	in.
♦ Front-wheel-drive vehicles with manual transmission	-a- 8 - 12	0.31 - 0.47
♦ Front-wheel-drive vehicles with automatic trans. 097	-b- 174 - 179	6.85 - 7.05
	-c- 163 - 168	6.42 - 6.61
♦ Front-wheel-drive vehicles with automatic trans. 01K	-a- 8 - 12	0.31 - 0.47
♦ All-wheel-drive vehicles	-b- 182 - 185	7.16 - 7.28
	-c- 179 - 184	7.05 - 7.24



◀ Fig. 4 Aligning exhaust system flange connections

- The nuts and bolts of the exhaust system flanges must be tightened to maintain equal spacing -a- between flange connections.

26-14



◀ **Fig. 5 Three way catalytic converter mounting parts, left-hand side**

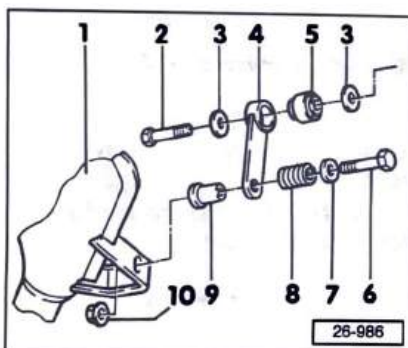
Front-wheel-drive vehicles with manual transmission

- 1 - Three way catalytic converter
 - 2 - Hex head bolt
 - 3 - Distance sleeve
 - 4 - Mounting bracket
 - 5 - Rubber bush
 - 6 - Washer
 - 7 - Hex bolt
 - 8 - Washer
 - 9 - Pressure spring
 - 10 - Distance sleeve
 - 11 - Hex nut
- Tightening torque: 25 Nm (18 ft lb)

Note:

- ♦ *Mounting brackets must be installed vertically when viewed in the direction of travel.*
- ♦ *Bolts for three way catalytic converter attachment, positioned transverse to the direction of travel, must be the last to be tightened stress-free.*

26-15



◀ **Fig. 6 Three way catalytic converter mounting parts, left-hand side**

Front-wheel-drive vehicles with manual transmission

USA version with 57 mm diameter front exhaust pipe

- 1 - Three way catalytic converter
 - 2 - Hex bolt
 - 3 - Washer
 - 4 - Mounting bracket
 - 5 - Rubber bush
 - 6 - Hex bolt
 - 7 - Washer
 - 8 - Pressure ring
 - 9 - Distance sleeve
 - 10 - Hex nut
- Tightening torque: 25 Nm (18 ft lb)

Note:

- ♦ *Mounting brackets must be installed vertically when viewed in the direction of travel.*
- ♦ *Bolts for three way catalytic converter attachment, positioned transverse to the direction of travel, must be the last to be tightened stress-free.*

26-16

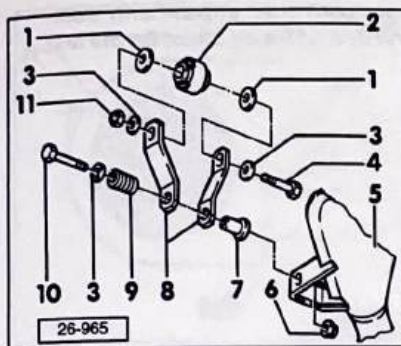


Fig. 7 Three way catalytic converter mounting parts, right hand side

Front-wheel-drive vehicles with manual transmission

- 1 - Washer
- 2 - Rubber bush (installation position ⇒ Fig. 10, page 26-21)
- 3 - Washer
- 4 - Hex bolt
- 5 - Three way catalytic converter
- 6 - Hex nut
Tightening torque: 25 Nm (18 ft lb)
- 7 - Distance sleeve
- 8 - Lever
- 9 - Pressure spring
- 10 - Hex bolt
- 11 - Hex nut
Tightening torque: 25 Nm (18 ft lb)

Note:

- ♦ Mounting brackets must be installed vertically when viewed in the direction of travel.
- ♦ Bolts for three way catalytic converter attachment, positioned transverse to the direction of travel, must be the last to be tightened stress-free.

26-17

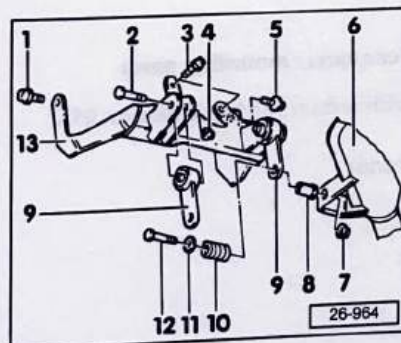


Fig. 8 Three way catalytic converter mounting parts

Front-wheel-drive vehicles with automatic transmission 097

- 1 - Combination bolt
Tightening torque: 40 Nm (30 ft lb)
- 2 - Hex bolt
- 3 - Combination bolt
Tightening torque: 40 Nm (30 ft lb)
- 4 - Hex bolt
Tightening torque: 40 Nm (30 ft lb)
- 5 - Combination bolt
Tightening torque: 40 Nm (30 ft lb)
- 6 - Three way catalytic converter, right side
- 7 - Hex nut
Tightening torque: 25 Nm (18 ft lb)
- 8 - Distance sleeve
- 9 - Lever
- 10 - Pressure spring
- 11 - Washer
- 12 - Hex bolt
- 13 - Bracket

Note:

- ♦ Mounting brackets must be installed vertically when viewed in the direction of travel.

26-18

- ♦ Bolts for three way catalytic converter attachment, positioned transverse to the direction of travel, must be the last to be tightened stress-free.

26-19

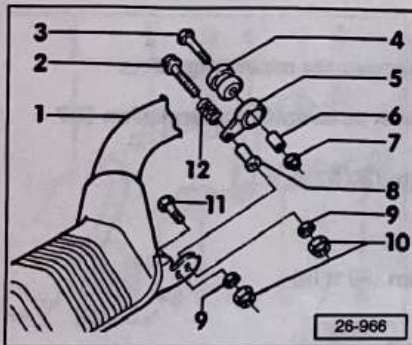


Fig. 9 Three way catalytic converter mounting parts

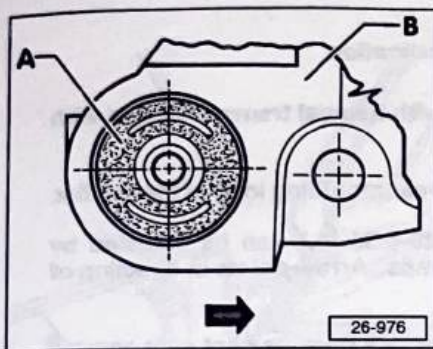
Front-wheel-drive vehicles with automatic transmission 01K vehicles

- 1 - Three way catalytic converter
- 2 - Hex bolt
- 3 - Combi bolt
- 4 - Hex bolt
- 5 - Rubber bush
- 6 - Spreader tube
- 7 - Hex nut
- Tightening torque: 25 Nm (18 ft lb)
- 8 - Distance sleeve
- 9 - Washer
- 10 - Hex nut
- Tightening torque: 25 Nm (18 ft lb)
- 11 - Hex bolt
- 12 - Pressure spring

Note:

- ♦ Mounting brackets must be installed vertically when viewed in the direction of travel.
- ♦ Bolts for three way catalytic converter attachment, positioned transverse to the direction of travel, must be the last to be tightened stress-free.

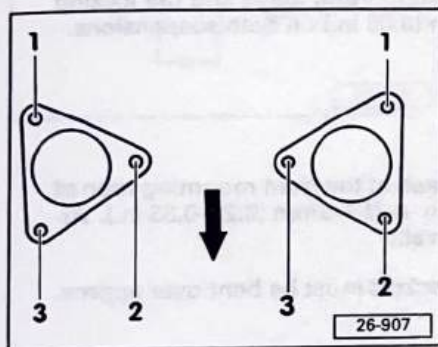
26-20



◀ Fig. 10 Rubber bushing installation position

- Rubber bushing -A- must be pressed in flush with transmission support -B-.

Arrow points in direction of travel.



◀ Fig. 11 Tightening front exhaust pipes

- ♦ Front exhaust pipe flanges are illustrated from below.
- ♦ Arrow points in direction of travel.
- Tightening of the two front exhaust pipes and three way catalytic converters at the exhaust manifold must be done evenly as shown in the illustration.

Tightening torque: 30 Nm (22 ft lb)

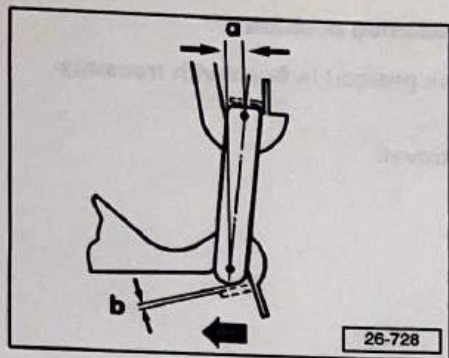
26-21

Exhaust system, aligning

In order to avoid noise and stresses on the exhaust system, it must be aligned free of tension as follows:

Note:

- ♦ A prerequisite for tension-free alignment of the exhaust system is correct alignment and tightening of the three way catalytic converter ⇒ Fig. 3, pages 26-14 and Fig. 11, page 26-21. Special attention must be given to ensure that the three way catalytic converter mounting is carried out free of tension as shown in the illustrations. All other bolted connections must be loosened for this process.
- ♦ The exhaust system is aligned when cold.
- ♦ The following procedure must be carried out in the specified sequence.
- ♦ The dimensions listed in the illustrations are examples only.

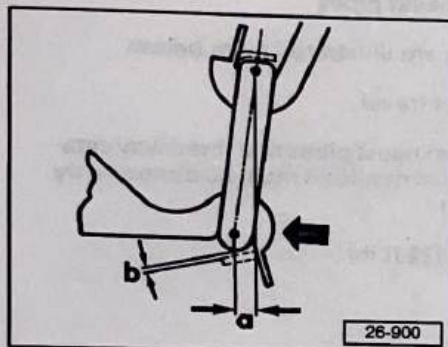


Adjusting exhaust system inclination

Front-wheel-drive vehicles with manual transmission or with automatic transmission 097

Inclination is adjusted at the rear mounting loop of the muffler.

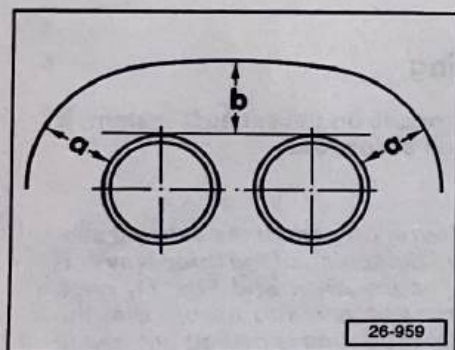
- ◀ Dimension -a-, 7-9 mm (0.28-0.35 in.), can be adjusted by movement in the double clamps. Arrow points in direction of travel.
- The locking tabs on the brackets must be bent over approx. 90° after installation.
- The distance -b- between supporting loops and the locking tabs must be at least 2 mm (0.08 in.) on both suspensions.



All-wheel-drive vehicles

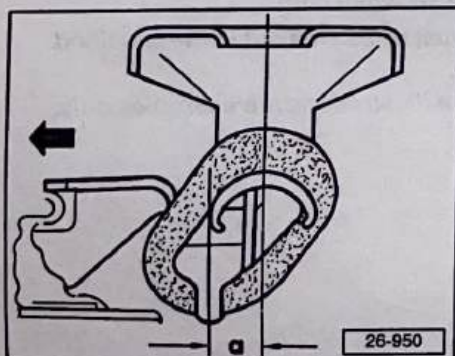
- ◀ The inclination must be checked at the front mounting loop of the center muffler. Dimension -a- is 7-9mm (0.28-0.35 in.). Arrow points in direction of travel.
- The locking tabs on the brackets must be bent over approx. 90° after installation.
- The distance -b- between supporting loops and the locking tabs must be at least 2 mm (0.08 in.) on both suspensions.

26-23



Aligning tail pipes

- ◀ • Distance -a- must be equal on right and left sides.
- Distance -b- to top of bumper recess is approx. 38 mm (1.5 in.).



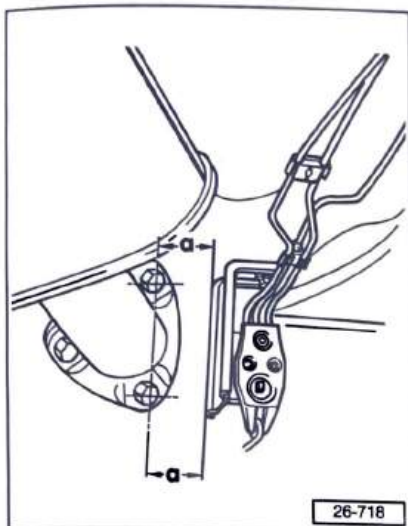
Aligning rear muffler after repairs

All-wheel-drive vehicles

The illustration shows the left suspension of the rear muffler.

- ◀ Offset -a-, 12-14 mm (0.47-0.55 in.) can be adjusted by movement in the short double clamp between the center and rear mufflers. Arrow points in direction of travel.

26-24



Installation position of flange connections

Front-wheel-drive vehicles

The illustration shows the flange connection of the center/rear muffler against the direction of travel.

- ▶ • Flange connections must be aligned as shown
- Distance -a- must be the same on top and at the bottom

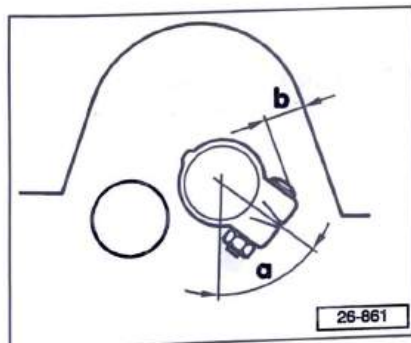
26-25

Installation position of double clamps

Front-wheel-drive vehicles with manual transmission or with automatic transmission 097

Note:

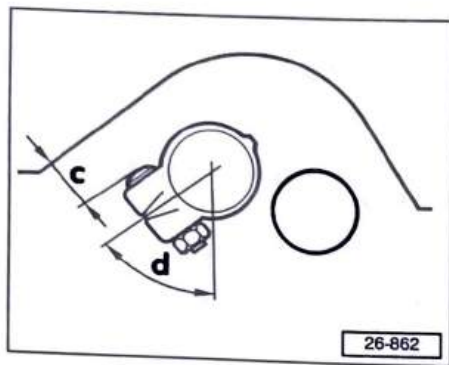
- ♦ Tighten double clamps only after alignment of the intermediate pipes.
- ♦ After the bolts have been loosened, the double clamps must be replaced.
- ♦ The double clamps are illustrated from the rear in the direction of travel.



Right side

- ▶ • The bolts of the double clamp must be positioned as shown
- ♦ Angle -a-: 60°
- ♦ Dimension -b-: 25 mm (approx. 1.0 in.)

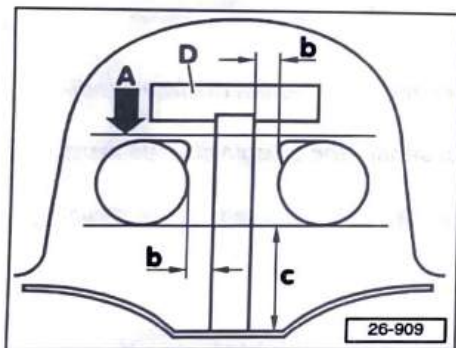
26-26



Left side

- The bolts of the double clamp must be positioned as shown
- ♦ Dimension -c-: 25 mm (approx. 1.0 in.)
- ♦ Angle -d-: 40°

26-27



Aligning intermediate pipes

Front-wheel-drive vehicles with manual transmission or with automatic transmission 097

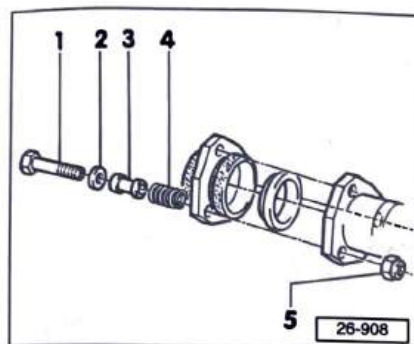
- The measuring angles for the intermediate pipes must be horizontal to each other (arrow -A-).
- The bottoming stop -D- must not be damaged. The exhaust system must not make contact with the bottoming stop.
- ♦ Dimension -b-: 15 mm (0.59 in.)
- ♦ Dimension -c-: 70 mm (2.76 in.)

The bolts on the TWC/intermediate pipe flange connection are tightened only after the doubled clamps have been aligned, bolts installed and tightened.

26-28

Connecting TWC and center silencer

All-wheel-drive vehicles



Arrangement of parts:

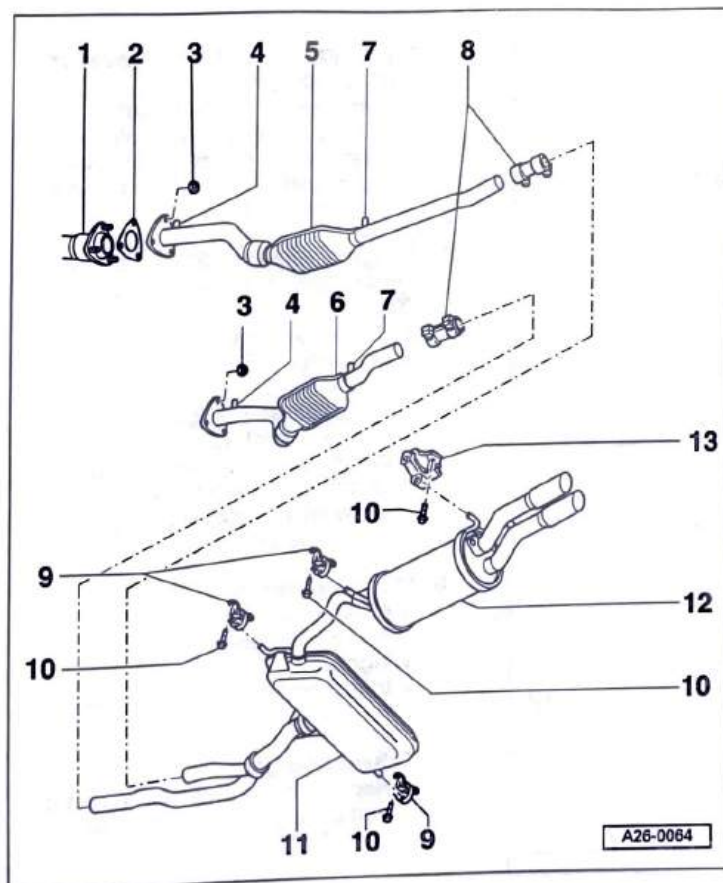
- 1 - Head bolt
- 2 - Washer
- 3 - Spacer tube
- 4 - Pressure spring
- 5 - Hex nut

Tightening torque: 25 Nm (18 ft lb)

Note:

- ♦ On vehicles with automatic transmission the spring-loaded flange connection can be modified into a rigid flange connection.
- ♦ For Installation sequence see illustration for vehicles with front-wheel-drive and automatic transmission ⇒ page 26-7. Be sure correct parts are installed.

26-29



Exhaust system components, engine code AAH from 8.94 and engine code AFC, removing and installing

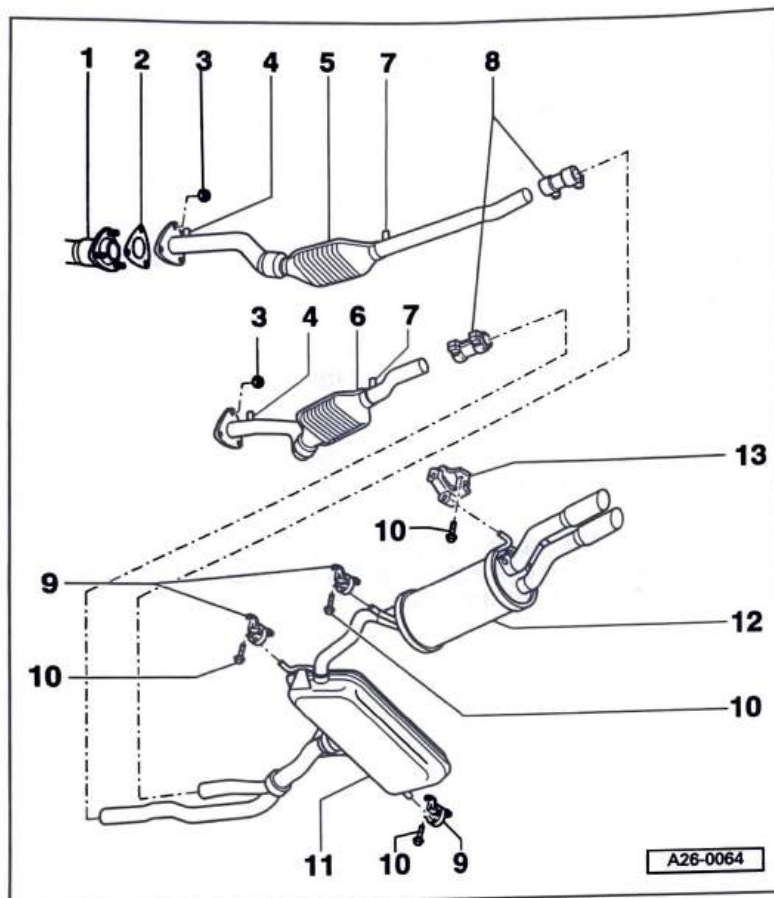
♦ Front-wheel-drive vehicles
⇒ page 26-31

♦ All-wheel-drive vehicles
⇒ page 26-33

Note:

- ♦ Always replace all self-locking nuts, seals and clamping sleeves.
- ♦ Install the necessary exhaust hangers and threaded fasteners according to the parts catalog microfiche.
- ♦ Make sure that there is sufficient clearance between the exhaust system and the body.
- ♦ Align exhaust system free of preload or tension.
- ♦ Check the exhaust system for leaks
⇒ page 26-37

26-30



Front-wheel-drive vehicles

1 - Exhaust manifold

2 - Gasket

- ◆ Always replace

3 - Self-locking nut

- ◆ 30 Nm (22 ft lb)
- ◆ Always replace

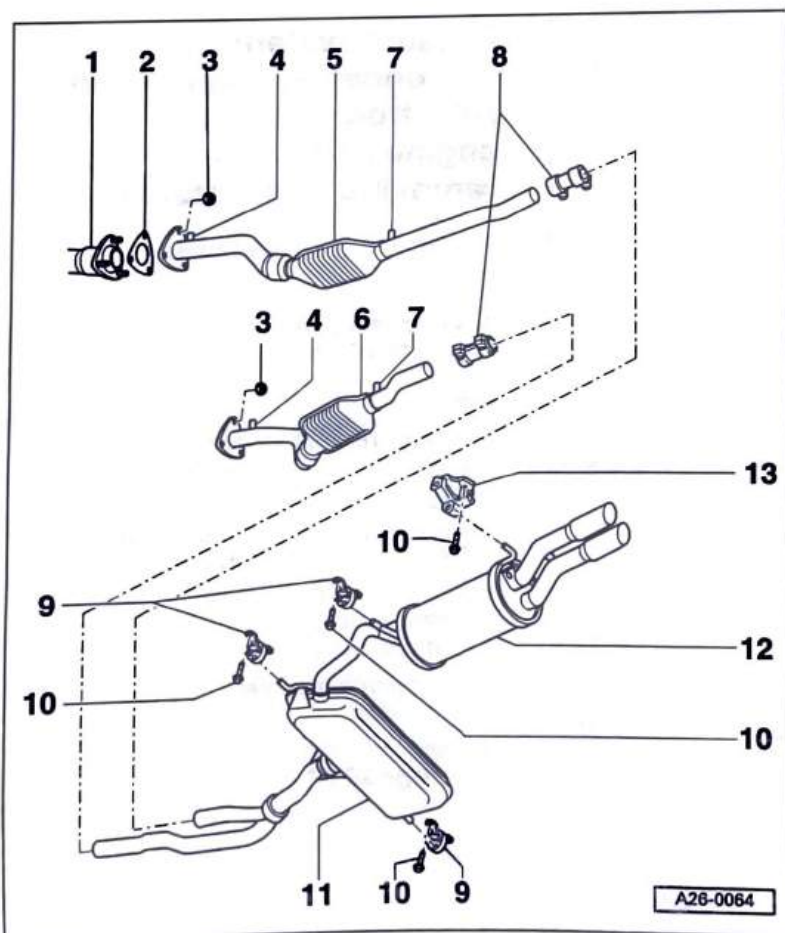
4 - Heated Oxygen Sensor (HO2S)

- ◆ 50 Nm (37 ft lb)
- ◆ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for applicable engine management system), Repair Group 24
- ◆ When installing sensor, lubricate threads with G5, but do not allow G5 to enter slotted part of sensor body

5 - Three Way Catalytic Converter (TWC), left side

- ◆ With uncoupling element
- ◆ Handle uncoupling element carefully; protect from shock loads and large misalignment (maximum 10°)

26-31



6 - Three Way Catalytic Converter (TWC), right side

- ◆ With uncoupling element
- ◆ Handle uncoupling element carefully; protect from shock loads and large misalignment (maximum 10°)

7 - Oxygen Sensor (O2S) behind Three Way Catalytic Converter (TWC)

- ◆ 50 Nm (37 ft lb)
- ◆ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for applicable engine management system), Repair Group 24
- ◆ When installing sensor, lubricate threads with G5, but do not allow G5 to enter slotted part of sensor body

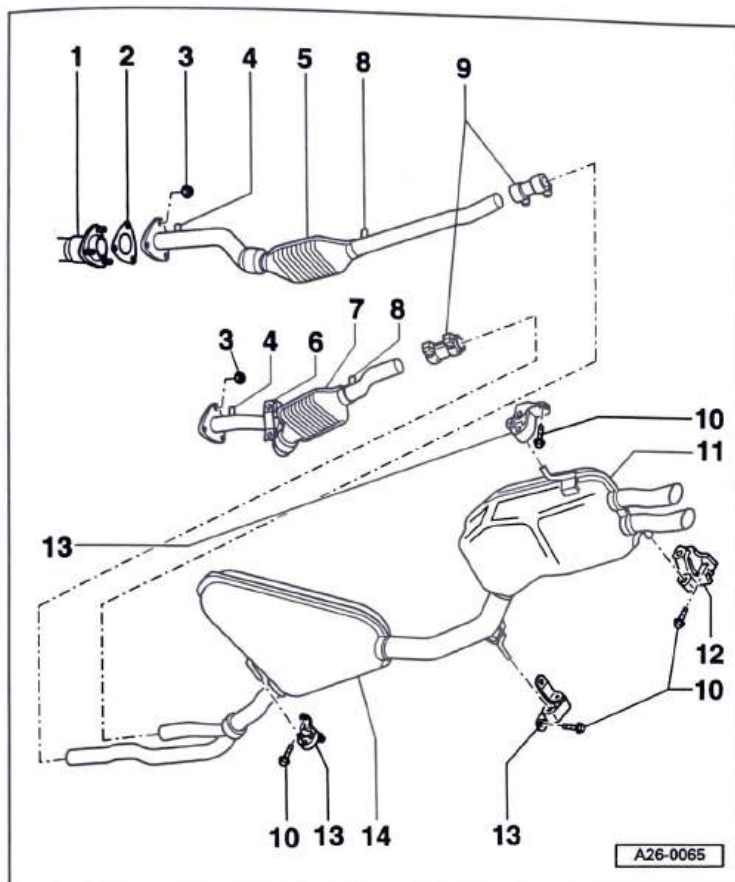
8 - Clamping sleeve

- ◆ 40 Nm (30 ft lb)
- ◆ Always replace
- ◆ Tighten evenly
- ◆ Install in horizontal position in vehicle

9 - Exhaust hanger

- ◆ Replacing: always use lubricant and prevent damage to rubber

26-32



All-wheel-drive vehicles

1 - Exhaust manifold

2 - Gasket

- ♦ Always replace

3 - Self-locking nut

- ♦ 30 Nm (22 ft lb)
- ♦ Always replace

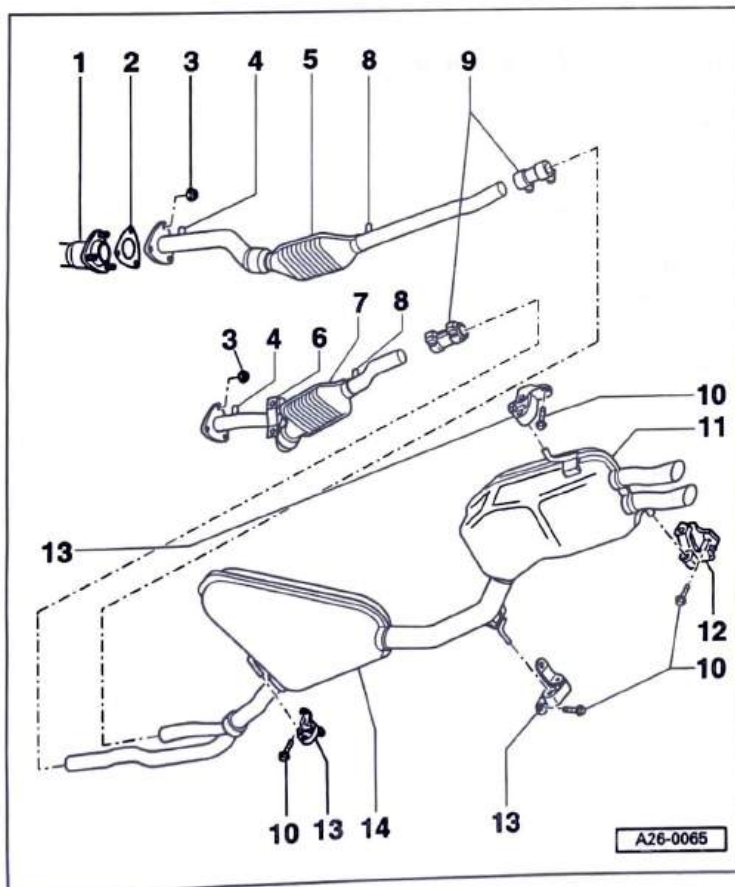
4 - Heated Oxygen Sensor (HO2S)

- ♦ 50 Nm (37 ft lb)
- ♦ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for applicable engine management system), Repair Group 24
- ♦ When installing sensor, lubricate threads with G5, but do not allow G5 to enter slotted part of sensor body

5 - Three Way Catalytic Converter (TWC), left side

- ♦ With uncoupling element
- ♦ Handle uncoupling element carefully; protect from shock loads and large misalignment (maximum 10°)

26-33



6 - Bracket

- ♦ Only for vehicles with manual transmission 01A
- ♦ Mounting parts ⇒ Fig. 1

7 - Three Way Catalytic Converter (TWC), right side

- ♦ With uncoupling element
- ♦ Handle uncoupling element carefully; protect from shock loads and large misalignment (maximum 10°)

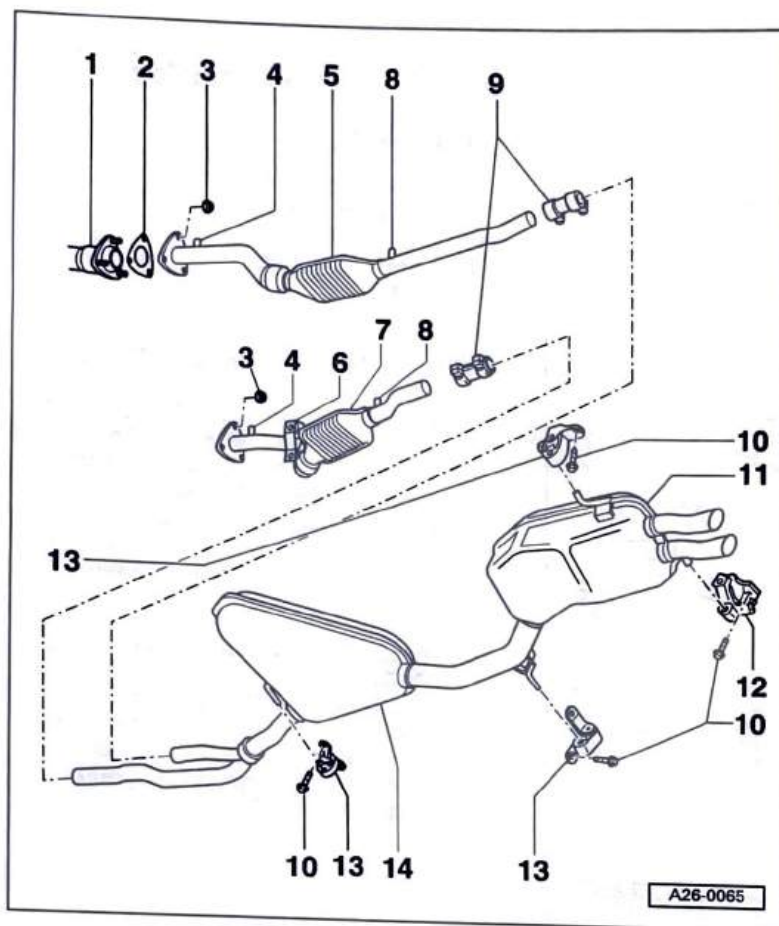
8 - Oxygen Sensor (O2S) behind Three Way Catalytic Converter (TWC)

- ♦ 50 Nm (37 ft lb)
- ♦ Checking ⇒ Repair Manual, 2.8 Liter V6 Fuel Injection & Ignition (for applicable engine management system), Repair Group 24
- ♦ When installing sensor, lubricate threads with G5, but do not allow G5 to enter slotted part of sensor body

9 - Clamping sleeve

- ♦ 40 Nm (30 ft lb)
- ♦ Always replace
- ♦ Tighten evenly
- ♦ Install in horizontal position in vehicle

26-34



10 - Hex bolt
♦ 25 Nm (18 ft lb)

11 - Rear muffler

12 - Exhaust hanger
♦ Replacing: always use lubricant and prevent damage to rubber

13 - Exhaust hanger
♦ Replacing: always use lubricant and prevent damage to rubber

14 - Center muffler

26-35

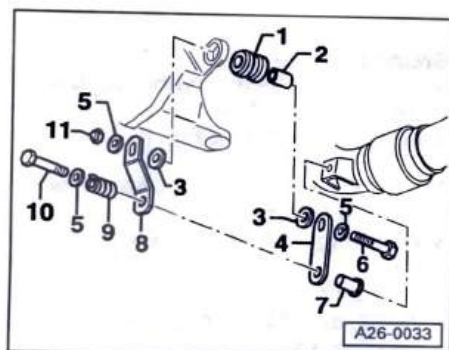


Fig. 1 Individual mounting parts

1 - Buffer

2 - Spacer

3 - Washer

4 - Bracket, right

5 - Washer

6 - Hex bolt

Tightening torque: 25 Nm (18 ft lb)

7 - Spacer

8 - Bracket, left

9 - Compression spring

10 - Hex bolt

11 - Self-locking nut

Tightening torque: 25 Nm (18 ft lb)

26-36

Exhaust system, checking for leaks

The exhaust system must be checked for leaks as follows:

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

**100/S4 1992 ►, A6/S6 1995 ► 2.8L V6 General, Engine
W42 013 195 101 (Engine Code AAH, AFC)**