Workshop Manual

Audi A8 1994 ➤

6-cylinder engine (5-valve), mechanics									
Engine ID	ACK	ALG	APR	AQD	AMX				

Edition 06.2009

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Technical information should always be available to the foremen and mechanics, because their careful and constant adherence to the instructions is essential to ensure vehicle road-worthiness and safety. In addition, the normal basic safety precautions for working on motor vehicles must, as a matter of course, be observed.

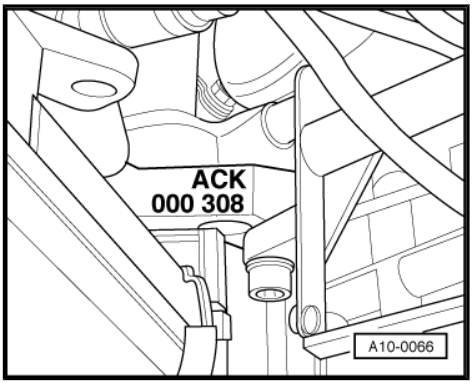
Contents

00 – Technical data

1 Technical data

1.1 Engine number

- The engine number (“engine code letters” and “serial number”) is marked on the right inner side of the cylinder block between cylinder head and power steering pump.
- In addition, a sticker indicating the “engine code letters” and “serial number” is affixed to the air duct.
- The engine code letters are also indicated on the vehicle data sticker.

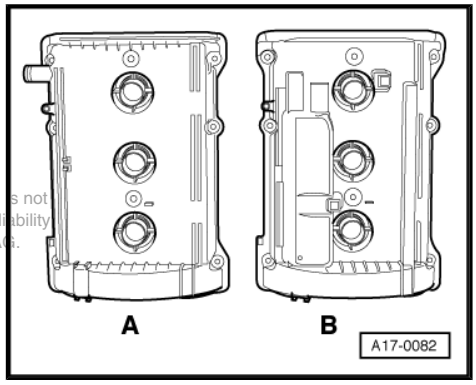


1.2 Distinguishing features of “engine generations II” and “III”

An external distinguishing feature of the “engine generations II” and “III” is the shape of the cylinder head cover:

A - “Engine generation II” (up to approx. 04.1997)

B - “Engine generation III” (as of approx. 04.1997)



Note

“Engine generation I” only applies to 2V engines.

The new features of “engine generation III” as opposed to “engine generation II” are as follows:

- Cylinder block with wider main bearing caps
- Cracked instead of sawn conrods (gradual introduction)
- Chain-driven oil pump beneath crankshaft group
- Modified front sealing flange
- Modified oil routing in cylinder head; originally with oil supply pipes on camshaft bearing caps, subsequently replaced by integrated oil ducts in camshaft bearing caps
- Modified top part of sump with liquid gasket
- Modified crankcase breather
- Modified tensioner and guard for toothed belt

1.3 Engine features

Code letters		ACK	ALG	APR	AQD	AMX
Capacity	l	2.771	2.771	2.771	2.771	2.771
Power	kW at rpm	142/6000	142/6000	142/6000	142/6000	142/6000
Torque	Nm at rpm	280/3200	280/3200	280/3200	280/3200	280/3200
Bore	∅ mm	82.5	82.5	82.5	82.5	82.5

Code letters	ACK	ALG	APR	AQD	AMX
Stroke mm	86.4	86.4	86.4	86.4	86.4
Compression ratio	10.6	10.6	10.6	10.6	10.6
RON min.	98 1)	98 1)	98 1)	98 1)	98 1)
Injection/ignition system	Motronic	Motronic	Motronic	Motronic	Motronic
Electronic throttle	no	no	yes	yes	yes
Knock control	yes	yes	yes	yes	yes
Camshaft timing control	yes	yes	yes	yes	yes
Intake manifold changeover	yes	yes	yes	yes	yes
Secondary air system	no	yes	no	yes	yes

- 1) In exceptional circumstances min. 95 RON, however reduced power

2 Safety precautions

2.1 Working on the cooling system

When working on the cooling system note the following warnings:

WARNING

Hot steam/hot coolant can escape - risk of scalding.

- *The cooling system is under pressure when the engine is hot.*
- *To allow pressure to dissipate, cover filler cap on coolant expansion tank with cloth and open carefully.*

2.2 Using testers and measuring instruments during a road test

Note the following if testers and measuring instruments have to be used during a road test:

WARNING

Accidents can be caused if the driver is distracted by test equipment while road-testing, or if test equipment is not properly secured.

Persons sitting in the front passenger's seat could be injured if the airbag is triggered in an accident.

- *The use of test equipment while driving causes distraction.*
- *There is an increased risk of injury if test equipment is not secured.*
- *Test equipment must always be secured on the rear seat with a strap and operated from the rear seat by a second person.*

2.3 Working on the exhaust system

When working on the exhaust system please note the following:

Caution

Avoid damage to flexible joint.

- *Do not bend flexible joint more than 10°.*
- *Install flexible joint so that it is not under tension.*
- *Take care not to damage wire mesh on flexible joint.*

3 General repair instructions

3.1 Rules for cleanliness when working on fuel supply system, injection system and turbocharger

Even small amounts of dirt can cause malfunctions. For this reason, please observe the following rules when working on the fuel supply system, injection system and turbocharger:

- Carefully clean connection points and the surrounding area with engine cleaner or brake cleaner and dry thoroughly before opening.
- Seal off open pipes/lines and connections immediately with clean plugs, e.g. from engine bung set -VAS 6122- .
- Place parts that have been removed on a clean surface and cover them over. Use only lint-free cloths.
- Carefully cover or seal open components if repairs cannot be carried out immediately.
- Only install clean components; replacement parts should only be unpacked immediately prior to installation. Do not use parts that have not been stored in their packing (e.g. in tool boxes etc.).
- When the system is open, do not work with compressed air and do not move the vehicle.
- Protect unplugged electrical connectors against dirt and moisture and make sure connections are dry when attaching.

3.2 Checking fuel system for leaks

– Allow engine to run for several minutes at moderate rpm.

– Switch off ignition.

– Check complete fuel system for leaks.

– If leaks are found although the connections have been tightened to the correct torque, the relevant component must be renewed.

– Road-test vehicle and accelerate with full throttle at least once.

– Then inspect high-pressure section of fuel system again for leaks.

3.3 Foreign particles in engine

- When performing assembly work on engine, all open passages in the intake and exhaust systems must be sealed with suitable plugs (e.g. from engine bung set -VAS 6122-) to prevent foreign particles from entering the engine.
- In the event of mechanical damage to one of the cylinder banks, the intake and exhaust systems and combustion chambers of the opposite cylinder bank must always be examined for foreign particles to prevent further damage occurring later.

3.4 Contact corrosion!

Contact corrosion can occur if unsuitable fasteners are used (e.g. bolts, nuts, washers, etc.).

For this reason, only fasteners with a special surface coating are used.

Additionally, all rubber and plastic parts and all adhesives are made of non-conductive materials.

Always install new parts if you are not sure whether used parts can be re-fitted ⇒ Electronic parts catalogue .

Note the following:

- We recommend using only genuine replacement parts; these have been tested and are compatible with aluminium.
- We recommend the use of Audi accessories.
- Damage caused by contact corrosion is not covered under warranty.

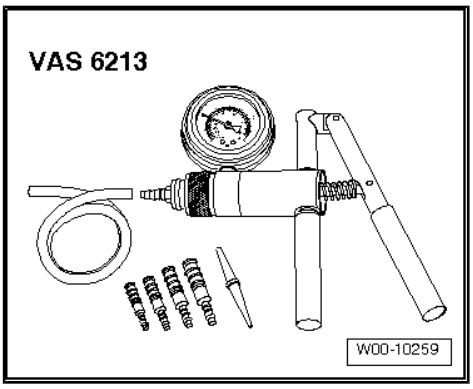
3.5 Routing and attachment of pipes, hoses and wiring

- Mark fuel lines, hydraulic lines, vacuum lines, lines for activated charcoal filter system and electrical wiring etc. before removal so they can be re-installed in the original positions and correctly connected. Make sketches or take photographs if necessary.
- To prevent damaging pipes, hoses and wiring, ensure sufficient clearance from all moving or hot components in engine compartment (little space in engine compartment).

3.6 Checking vacuum system

Special tools and workshop equipment required

- Hand vacuum pump -VAS 6213-



Procedure

– Check all vacuum lines in the complete vacuum system for:

- Cracks
- Traces of animal bites
- Kinked or crushed lines
- Lines porous or leaking

– Check vacuum line to solenoid valve and from solenoid valve to corresponding component.

– If a fault is stored in the fault memory, check the vacuum lines leading to the corresponding component and also check the remaining vacuum lines in the system.

– If it is not possible to build up pressure with the hand vacuum pump -VAS 6213- or if the pressure drops again immediately, check the hand vacuum pump and connecting hoses for leaks.

3.7 Installing radiators, condensers and charge air coolers

Even when the radiator, condenser and charge air cooler are correctly installed, slight impressions may be visible on the fins of these components. This does not mean that the components are damaged. If the fins are only very slightly distorted, this does not justify renewal of the radiator, condenser or charge air cooler.

10 – Removing and installing engine

1 Contact corrosion

- Contact corrosion can occur if use is made of unsuitable connecting elements (bolts, nuts, washers …).
- For this reason, only connecting elements with a special surface coating are fitted. These elements can be recognised from their greenish colour.
- In addition, rubber components, plastic components and adhesives are made of non-conductive material.
- In cases of doubt about suitability for re-use, always fit new components.

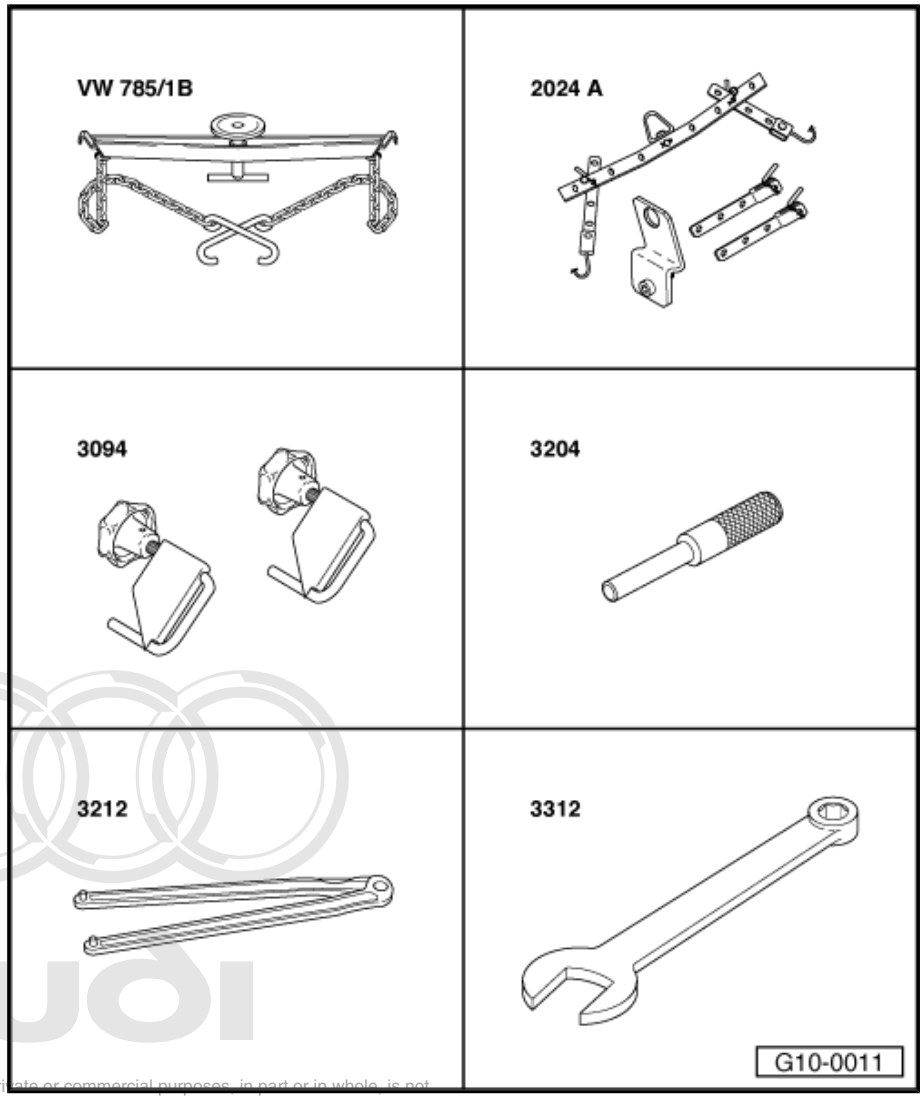
Caution

- *Only use genuine Audi components.*
- *Accessories must have been approved by Audi AG.*
- *Damage caused by contact corrosion is not covered by warranty.*

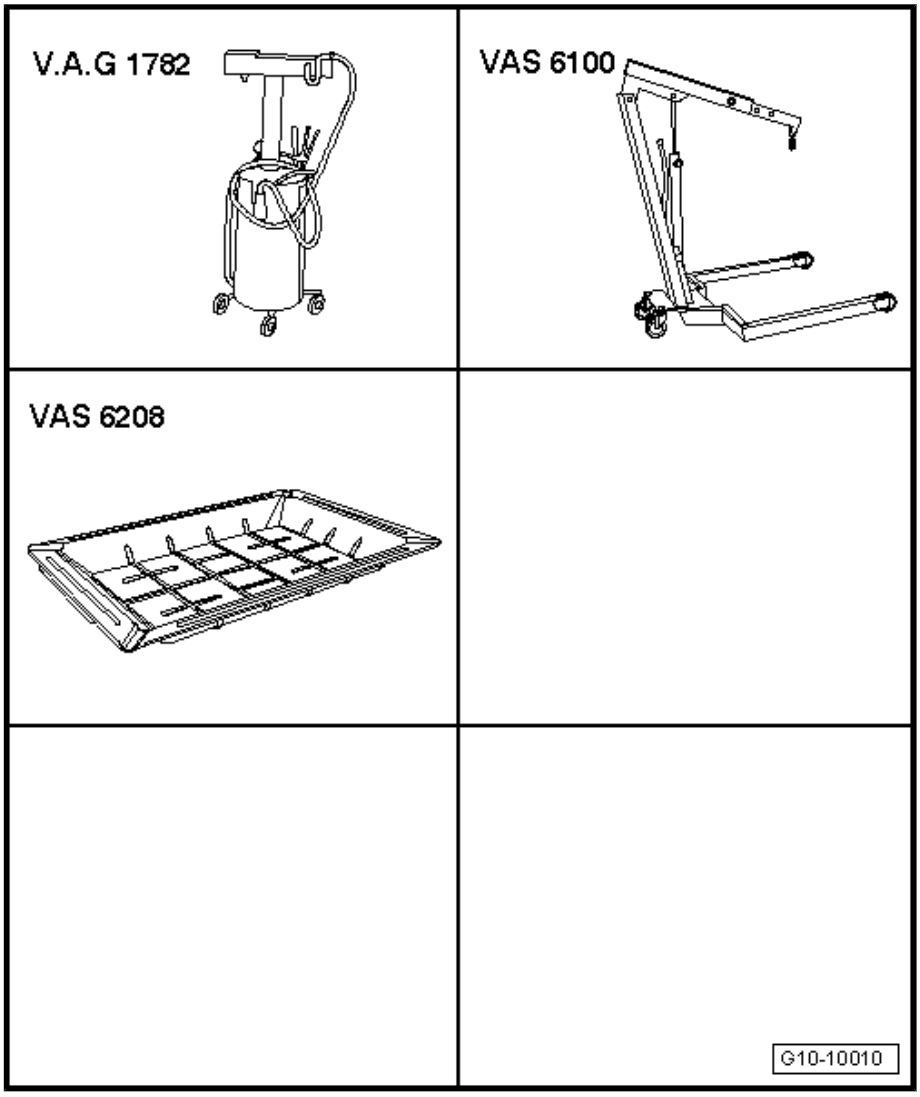
2 Removing and installing engine

Special tools and workshop equipment required

- Holding device -VW 785/1 B- (front-wheel drive vehicles only)
- Lifting tackle -2024 A-
- Hose clamps up to Ø 25 mm -3094-
- Locking pin -3204-
- Pin wrench -3212-
- Open-ended wrench -3312-



- Used oil collector and extractor -V.A.G 1782-
- Workshop crane - VAS 6100-
- Drip tray for workshop cranes -VAS 6208- or -V.A.G 1306-



2.1 Removing engine

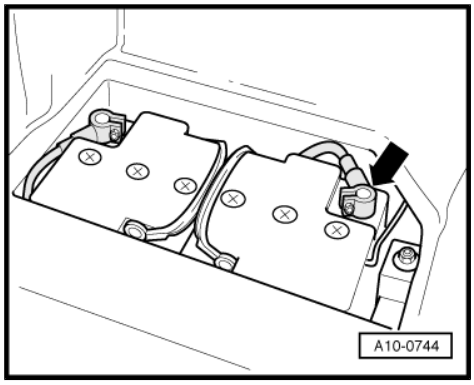
Note

- *The engine is lifted out without the gearbox.*
- *Collect drained coolant in a clean container for disposal or re-use.*
- *Re-attach all cable ties unfastened or severed on removal at the same location on installation.*

Caution

On vehicles with telematics system, activate service mode of telematics control unit before disconnecting battery ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .

– Pay attention to and if necessary establish code for vehicles with encoded radio set/radio navigation system (RNS).
– Detach the side luggage compartment storage area partition and the floor covering secured with a velcro fastener.
– With ignition switched off, disconnect earth strap/cable at negative terminal -arrow- of battery on right of luggage compartment.

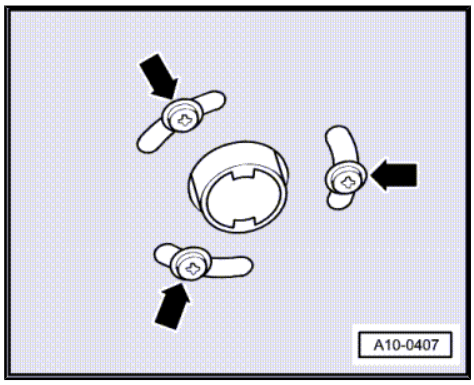


WARNING

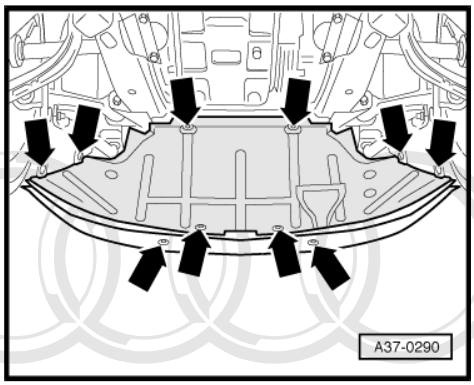
Hot vapour/coolant may escape when opening the expansion tank. Cover the cap with a cloth and open carefully.

– Open cap of coolant expansion tank.

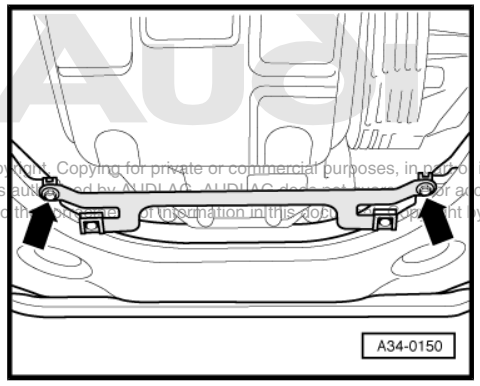
– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



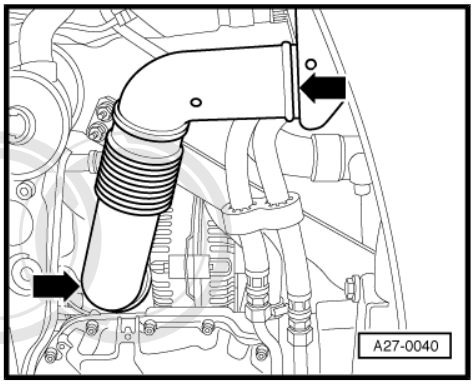
– Detach noise insulation -arrows-.



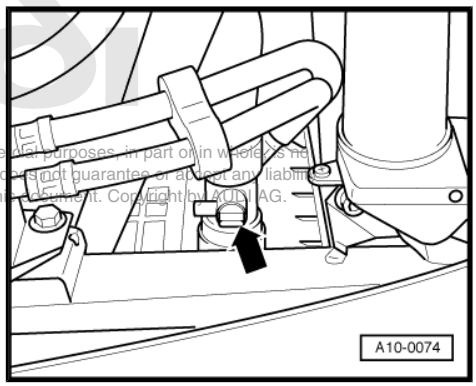
– Unscrew holder for noise insulation -arrows-.



– Unclip alternator air duct -arrows-.



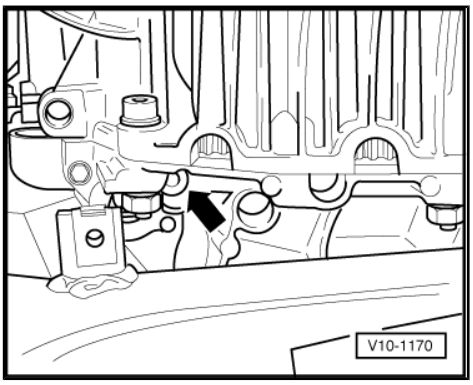
– Place drip tray for workshop cranes -VAS 6208- or -V.A.G 1306- beneath engine.
– Turn drain plug -arrow- on right of radiator anti-clockwise. Attach hose to connection if necessary.



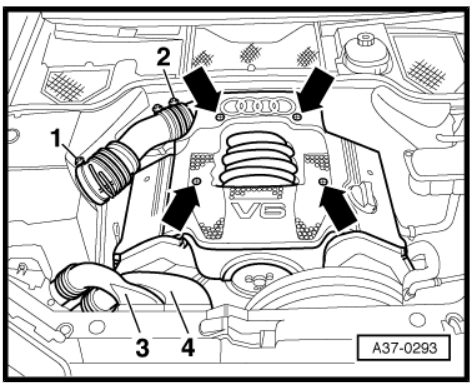
– Additionally open coolant drain plug -arrow- on engine.

Note

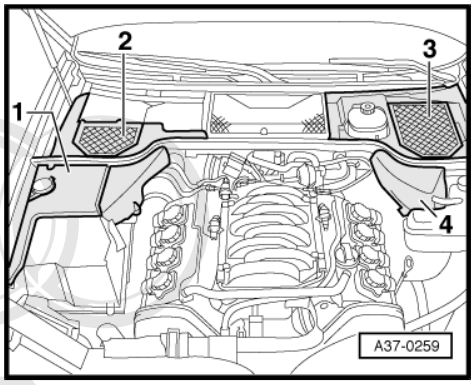
Replace O-ring.



– Unfasten hose clamps -1- and -2- and remove air hose.
– Detach centre engine cover -arrows-.
– Remove air ducts -3- and -4-.



– Remove covers -1-, -2- and -4-.

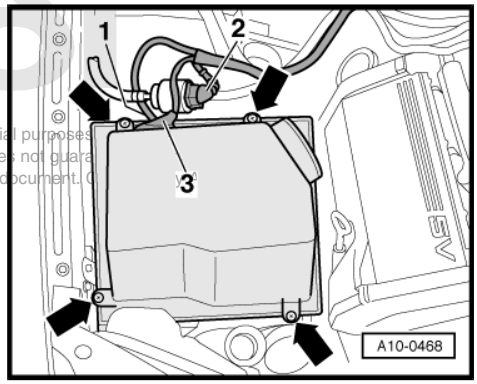


Note

Leave cover -3- in position.

– Screw out bolts -arrows- and detach top part of air cleaner housing.

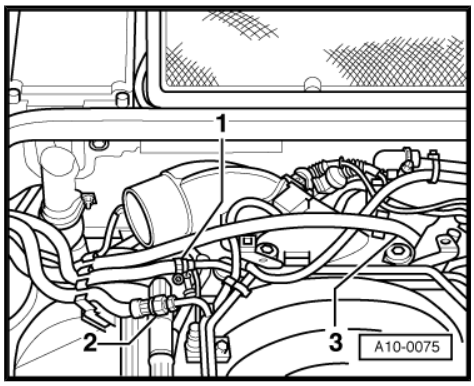
– Unplug connectors -1 … 3- as well as connector at air mass meter and lay bare wires.



Note

Connector for air mass meter is located inside air cleaner housing.

– Disconnect vacuum hose -3- at activated charcoal filter system solenoid valve 1 -N80- .

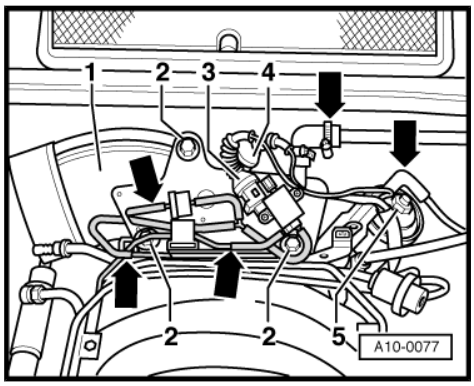


WARNING

The fuel system is pressurised. Before opening the system, wrap a cloth around the connection. Then dissipate pressure by carefully unfastening the connection.

– Disconnect fuel supply pipe -2- and return pipe -1-.

Vehicles with no secondary air system:



– Carefully detach vacuum pipes -arrows-.

– Unplug connectors at variable intake manifold changeover valve -N156- -Item 3- and intake air temperature sender -G42- -Item 4-.

– Screw out bolts -2- of retaining plate for variable intake manifold changeover valve.

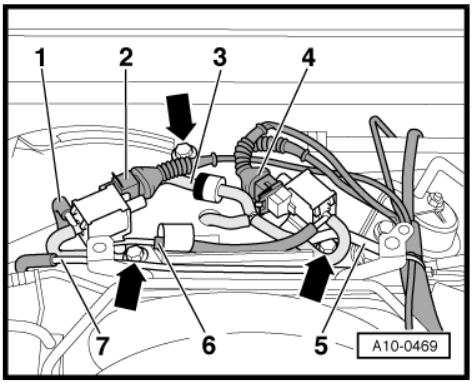
– Detach retaining plate and disconnect hose from air intake connection.

– Screw out bolt of air intake connection -1- and detach intake connection.

– Unscrew nut -5- and set down vacuum unit.

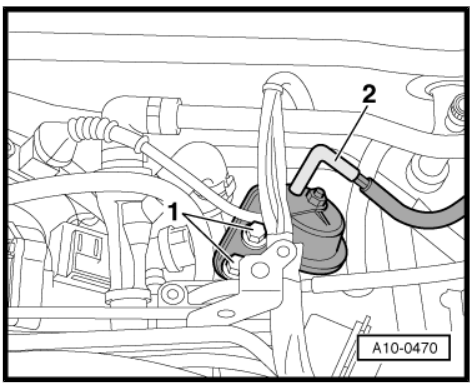
Vehicles with secondary air system:

– Unplug connectors -2- and -4-.
– Carefully disconnect vacuum hoses -1-, -3-, -5-, -6- and -7-.
– Unscrew retaining plate for solenoid valves -arrows-.



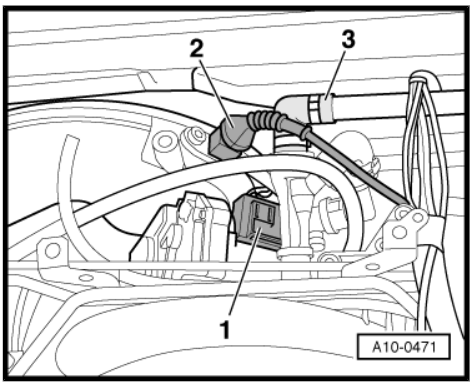
Vehicles with throttle cable:

– Detach vacuum hose -2- at CCS vacuum unit.
– Screw out bolts -1- and set down vacuum unit.



All models:

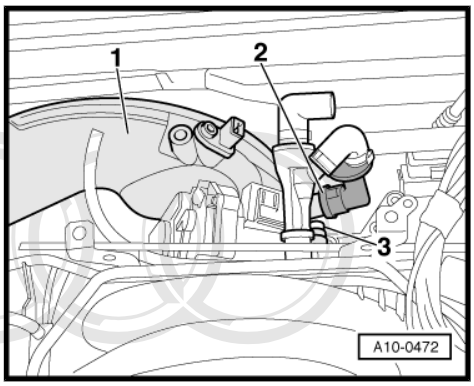
– Unplug connectors -1- and -2-.
– Detach vacuum hose -3- to brake servo.



– Screw out bolt -3- and detach air duct -1- with seal from throttle valve module.
– Detach crankcase breather hose -2-.

Vehicles with throttle cable:

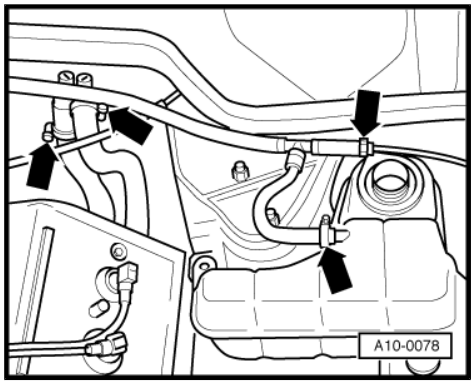
– Disengage CCS operating rod at throttle valve module.
– Disengage throttle cable at throttle valve housing and support bracket (do not remove retainer). Move throttle cable aside.



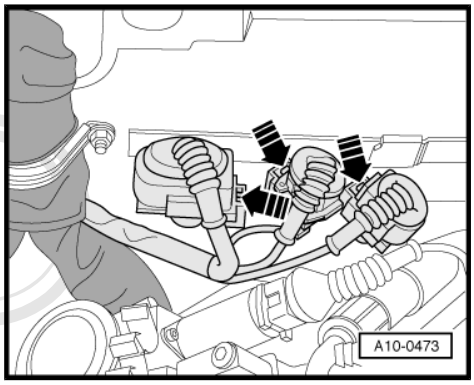
All models:

– Detach coolant hose between coolant pipe and expansion tank at expansion tank and rigid pipe -right arrows-.

– Detach engine/heating coolant hoses at heat exchanger connection -left arrows-.



– Press retainer tab in -direction of arrow- and unclip all connectors at bulkhead from holders.

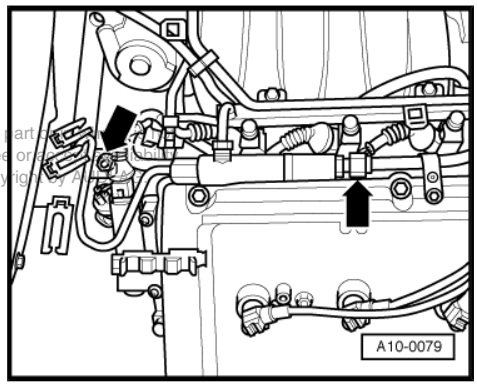


Note

The illustration shows the connectors at the bulkhead on the right.

– Unplug connectors to lambda probes.

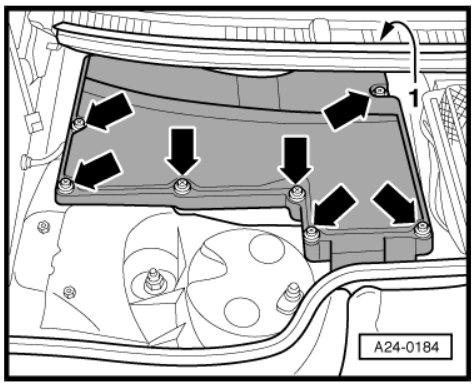
– Unscrew hydraulic pressure pipe for power steering at rear coolant pipe -left arrow- and disconnect pipe on a level with cylinder head on right -right arrow-.



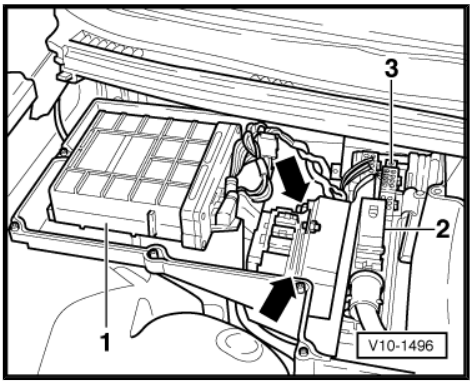
– Prise out cover -1- in scuttle panel trim and slacken off rear cross-head bolt -rear right arrow-.

– Slacken off the remaining cross-head bolts -arrows-.

– Detach cover for electronics box in plenum chamber.



– Unplug multi-pin connectors at engine control unit -1- and gearbox control unit -2- as well as all connectors -3-.



Vehicles with throttle cable:

– Unplug connector at CCS control unit.

– Unscrew CCS control unit with relay and fuse carrier -arrows-.

All models:

– Detach sealing strip between engine compartment and plenum chamber.

– Unscrew wiring harness from bulkhead and take out spacer sleeves.

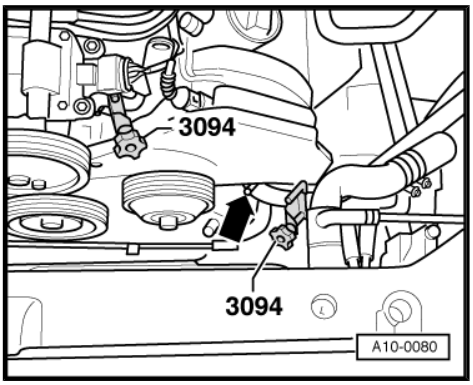
– Lay bare wiring harness and set down complete harness on engine.

– Detach 2 radiator/engine coolant hoses at front of engine.

– Disconnect vacuum pipe to vacuum reservoir at front left of engine.

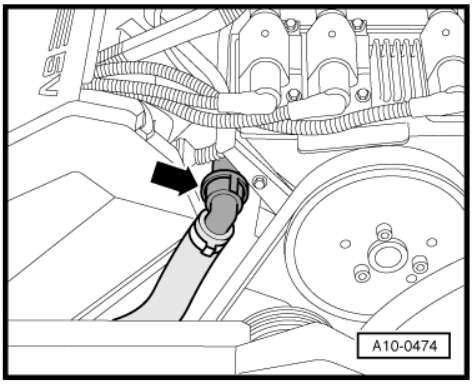
– Use hose clamps -3094- to pinch off both hoses at hydraulic supply pipe for power steering.

– Place a cloth beneath feed pipe under cylinder head on left and unscrew pipe -arrow-.



Vehicles with secondary air system:

– Disconnect hose -arrow- from secondary air connecting pipe.

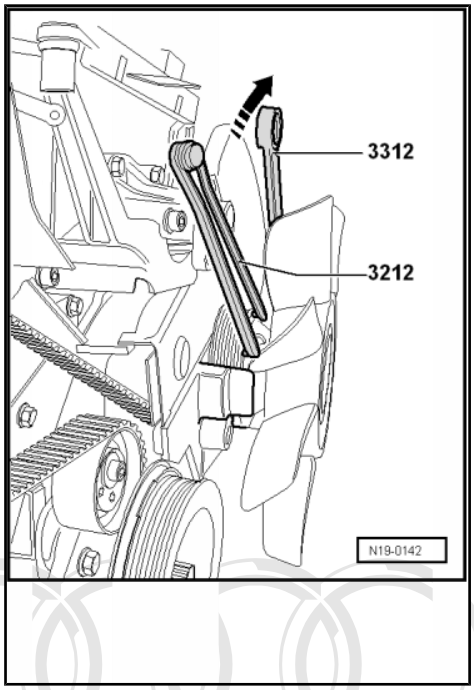


All models:

– Use pin wrench -3212- to support viscous fan pulley and unscrew viscous fan with open-ended wrench -3312- -arrow- (left-hand thread).

– Unscrew radiator cowl for viscous fan.

– Lift out viscous fan with radiator cowl.



Tensioning roller with hexagon head:

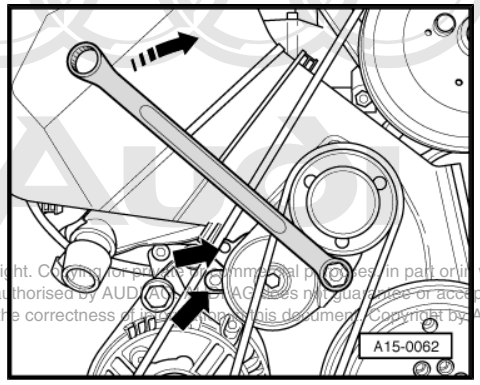
Note

Prior to removal, mark direction of poly V-belt with chalk or a felt-tip pen. Running a used belt in the opposite direction could destroy it.

– Use 17 mm ring spanner to swivel tensioner in -direction of arrow- to slacken off poly V-belt.

– Lock tensioner in position by inserting locking pin -3204- in locating holes -arrows-.

– Detach poly V-belt.



Tensioning roller with hexagon socket:

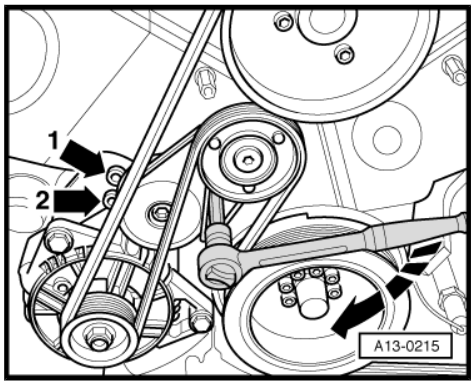
Note

Prior to removal, mark direction of poly V-belt with chalk or a felt-tip pen. Running a used belt in the opposite direction could destroy it.

– Use 10 mm Allen key to swivel tensioner in -direction of arrow- to slacken off poly V-belt.

– Lock tensioner in position by inserting locking pin -3204- in locating holes -arrow 1- and -arrow 2-.

– Detach poly V-belt.

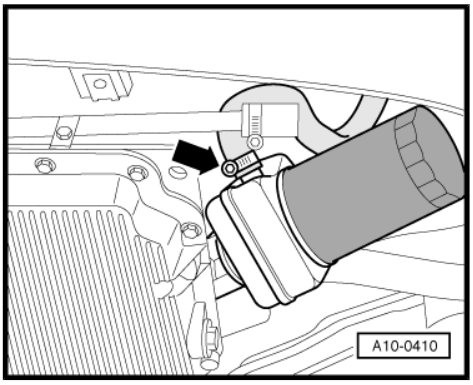


All models:

– Unscrew exhaust manifold/front exhaust pipe nuts which are accessible from above on left and right.

– Screw out engine/gearbox connecting bolts accessible from above. Leave one bolt screwed in hand-tight.

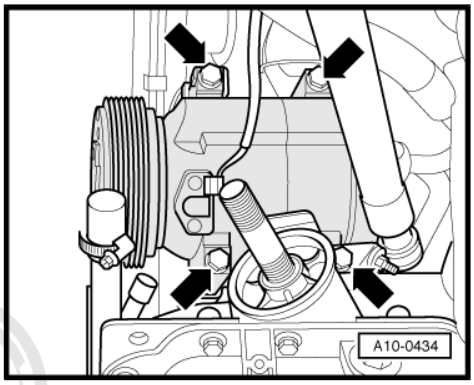
– Place drip tray for workshop cranes -VAS 6208- or -V.A.G 1306- beneath engine.
– Detach coolant hose at bottom of oil cooler -arrow- and allow remaining coolant to drain off.
– Place used oil collector and extractor -V.A.G 1782- beneath engine.
– Remove oil filter.



– Unplug connector to air conditioner compressor magnetic clutch.

WARNING

The air conditioner refrigerant circuit is not to be opened.



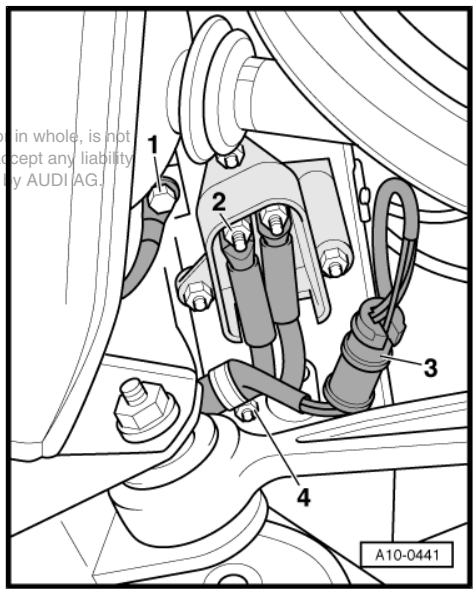
– Unscrew air conditioner compressor from holder -arrows-.
– Suspend air conditioner compressor with pipes connected from longitudinal member.

Note

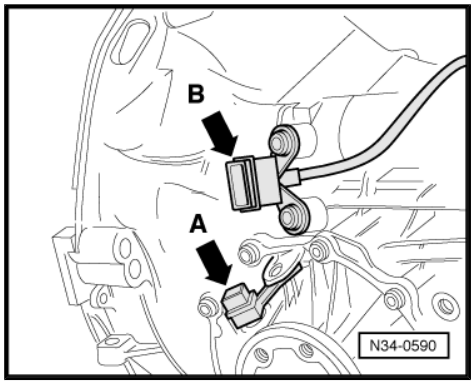
Illustration shows air conditioner compressor with oil cooler removed.

Vehicles with manual gearbox:

– Unclip and unplug connector -3-.
– Unclip cover for wiring connections.
– Unscrew earth strap -1-.
– Unscrew wiring connection -2-.
– Unscrew clamp -4- and lay bare wiring.



– Unplug connector at speedometer sender -G22- -arrow A-.
– Unplug connector at reversing light switch -F4- -arrow B-.

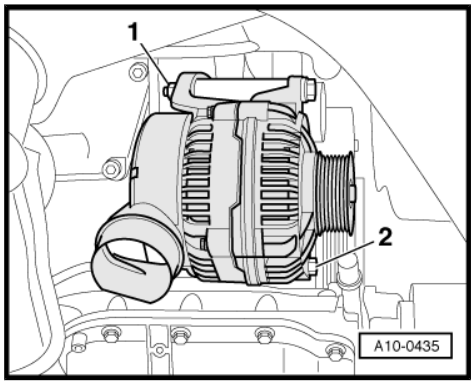


Note

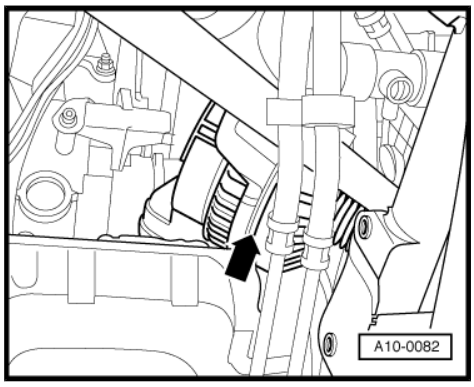
Illustration shows gearbox removed.

Vehicles with automatic gearbox:

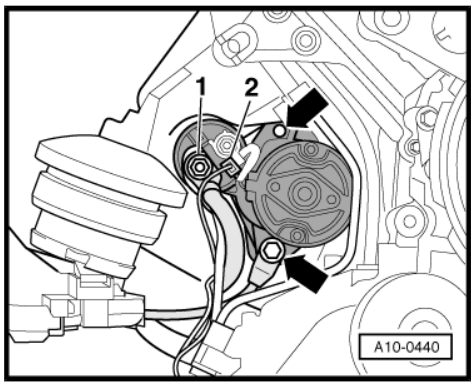
– Disconnect coolant hose in front of alternator.
– Screw out bolt -2-.
– Unfasten nut -1-.
– Swivel alternator aside and unscrew wires.



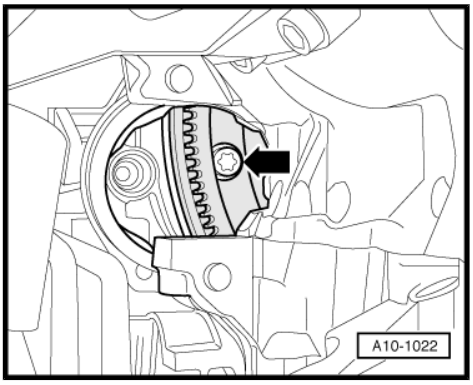
– Set down alternator to front between sump and body brace -arrow-.



– Detach wires -1- and -2- at starter and detach insulator at positive connection of starter.
– Screw out starter securing bolts -arrows- from gearbox side.
– Unscrew clamp on right of top part of sump and lay bare wiring.
– Take out starter downwards through gap between sump and body brace; leave alternator in vehicle.



– Screw out 3 bolts -arrow- of torque converter in opening of removed starter (give crankshaft a further $^{1}/_{3}$ turn in each case).

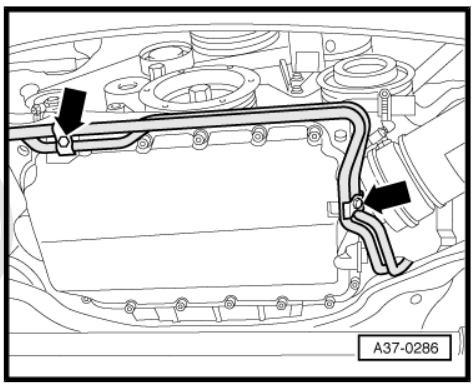


Note

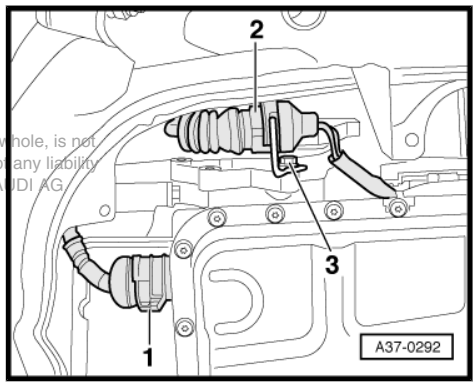
Provide support at central bolt of vibration damper when slackening off torque converter bolts.

– To remove engine, re-attach alternator to holder with a bolt.

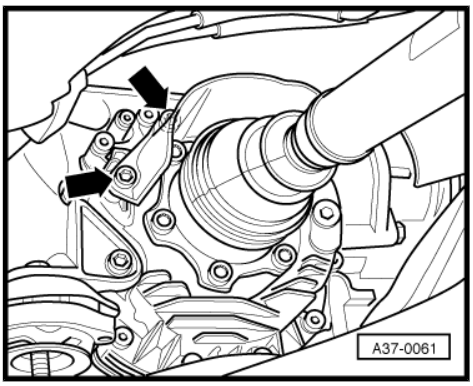
– Unscrew holder for ATF pipes -arrows-.



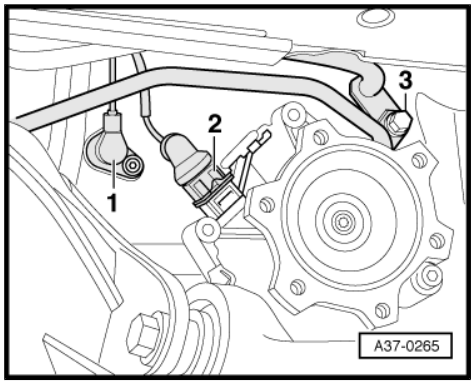
– Swivel locking lever -1- and unplug connector for gearbox.
– Unplug connector -2- at multi-function switch -F125- .



– Unscrew heat shields for left and right drive shafts -arrows-.



– Unscrew engine speed sender -G28- -Item 1- at front left of gearbox.
– Unplug connector -2- at speedometer sender -G22- .
– Screw out bolt -3- and detach ATF pipes from gearbox.



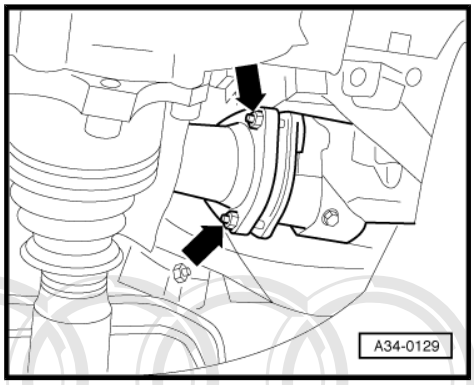
Note

Heed rules for cleanliness when working on automatic gearbox ⇒ Automatic gearbox 01V, front-wheel drive and four-wheel drive; Rep. Gr. 37 .

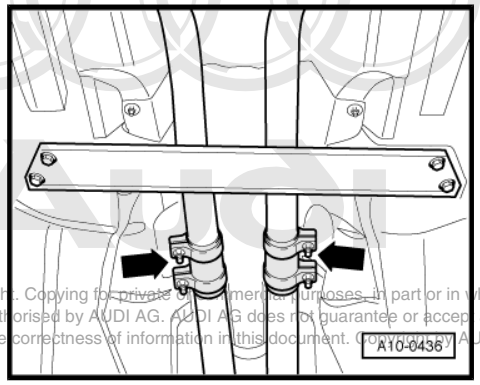
– Lay ATF pipes aside.

All models:

– Unscrew nuts -arrows- accessible from underneath at front exhaust pipes at front right and left.



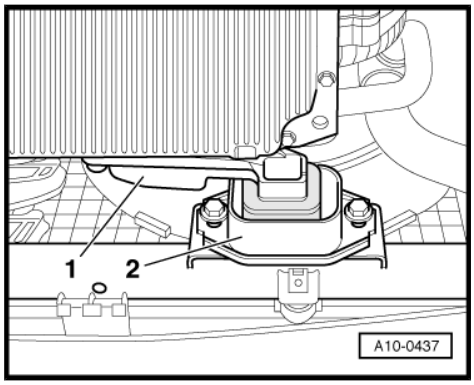
– Unfasten clamps -arrows-.
– Detach front exhaust pipes with catalytic converters and lambda probes.



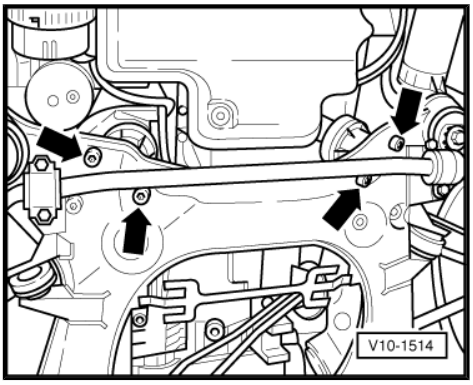
Note

Make sure there is clearance at the connectors for the lambda probes.

– Unscrew torque reaction support -1- and stop for torque reaction support -2-.
– Screw out engine/gearbox connecting bolts accessible from underneath.



– Screw out bottom bolts -arrows- at engine mountings.



Front-wheel drive vehicles:

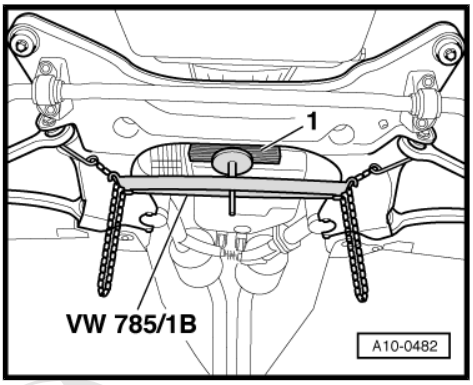
– Engage holding device -VW 785/1 B- at inner bushes of front transverse links.

– Position wooden block -1- on plate of spindle and support gearbox.

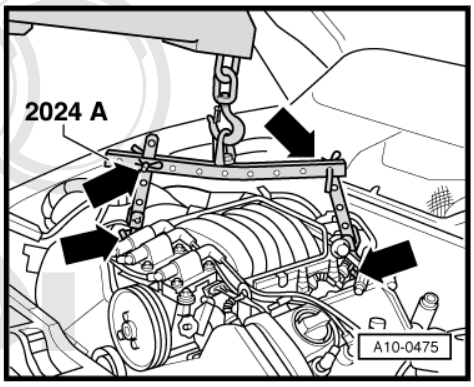
All models:

– Disengage gas-filled struts for bonnet at top.

– Position bonnet upright and secure with suitable tool.



– Engage lifting tackle -2024 A- at engine and workshop crane -VAS 6100- as shown.



Note

To adjust to the centre of gravity of the assembly, the perforated rails of the support hooks must be positioned as shown.

WARNING

The support hooks and locking pins at the lifting tackle must be secured with locking elements -arrows-.

– Screw out the last engine/gearbox connecting bolt.

Note

Check whether all hose and pipe/wiring connections between engine and body have been unfastened.

Vehicles with automatic gearbox:

– Press automatic gearbox off engine. In doing so, press torque converter off drive plate.

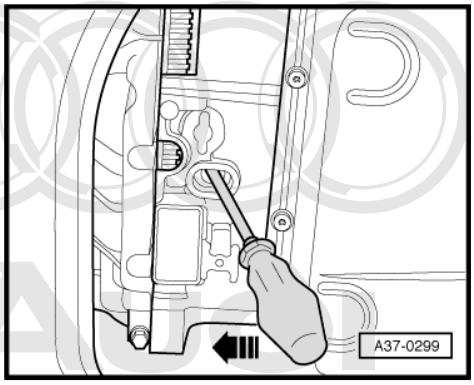
All models:

– Carefully raise engine.

– Detach engine from gearbox and guide it forwards out of engine compartment.

Vehicles with automatic gearbox:

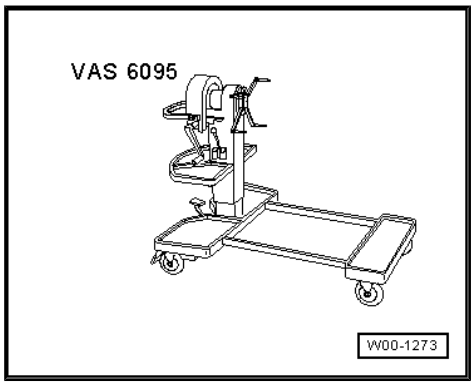
– If necessary, use a piece of wire to secure torque converter in position in gearbox to stop it falling out.



2.2 Attaching engine to repair stand

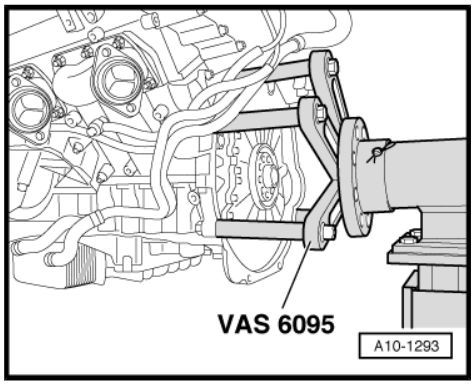
Special tools and workshop equipment required

♦ Engine and gearbox holder -VAS 6095-



Sequence of operations

– Attach engine as shown to engine and gearbox holder -VAS 6095- .



2.3 Installing engine

Install in reverse order, paying attention to the following:

Note

♦ *Replace self-locking nuts and bolts when performing assembly work.*

♦ *Replace bolts tightened by turning through a specified angle, as well as sealing rings and seals.*

♦ *Secure all hose connections with standard clamps ⇒ Parts catalogue .*

♦ *Re-attach all cable ties in the same locations on installation.*

– Check whether dowel sleeves for centring engine/gearbox have been fitted in cylinder block (insert if necessary).

– Position intermediate plate on dowel sleeves.

Vehicles with manual gearbox:

– Clean input shaft splines and hub splines on used clutch plates, remove corrosion and apply an extremely thin layer of clutch plate grease -G 000 100- to the splines. Do not grease guide sleeve.

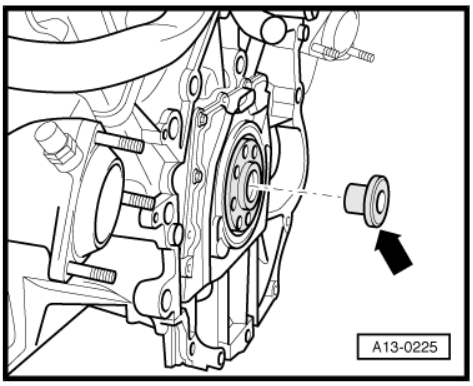
– If applicable, check centring of clutch plate.

– Check clutch release bearing for wear and replace if necessary.

– Engines for vehicles with manual gearbox must be fitted with a needle bearing in the dual-mass flywheel. Install needle bearing if necessary ⇒ page 52 .

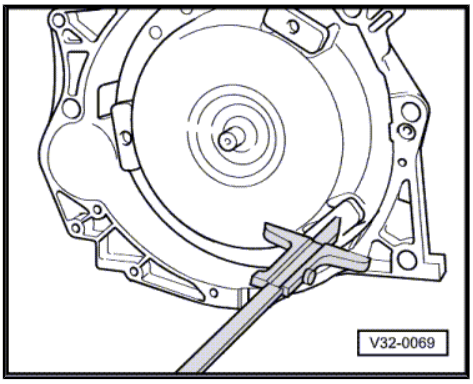
Vehicles with automatic gearbox:

– Before installing a reconditioned engine in a vehicle with automatic gearbox, check whether centring sleeve -arrow- for torque converter has been fitted at rear in crankshaft.



Checking installation dimension of torque converter:

If the converter has been correctly inserted, the distance between the contact surfaces at the bottom at the tapped holes on the converter and the contact surface of the torque converter bell housing at the automatic gearbox is approx. 23 mm.

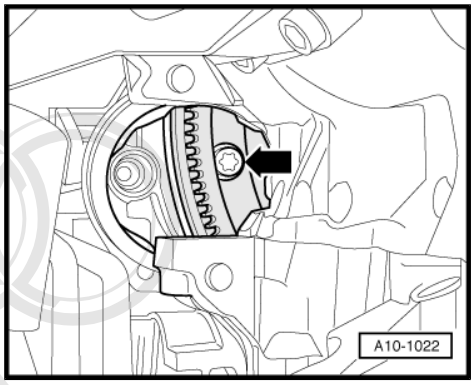


Caution

An incorrectly inserted torque converter will result in destruction of the converter or ATF pump driver on connecting the gearbox to the engine.

– Before assembling engine and gearbox, turn torque converter and drive plate of engine such that one hole or tapped hole is on a level with opening for removed starter -arrow-.

– Use new genuine ribbed bolts for attaching torque converter to drive plate ⇒ Parts catalogue .



Caution

Prior to and whilst tightening bolts at engine/gearbox flange, keep checking whether torque converter can be turned behind drive plate. If not, it must be assumed that converter has not been properly inserted and that driver of ATF pump and thus gearbox will be destroyed on finish-tightening the screw connections.

– Attach ATF pipes to gearbox ⇒ Automatic gearbox 01V, front-wheel drive and four-wheel drive; Rep. Gr. 37 .

– Check ATF level ⇒ Automatic gearbox 01V, front-wheel drive and four-wheel drive; Rep. Gr. 37 .

All models:

– Install air conditioner compressor ⇒ Air conditioning system; Rep. Gr. 87 .

– Allow stop for torque reaction support to drop into position on rubber buffer for torque reaction support and tighten bolts.

– Install front exhaust pipes
⇒ “1.3 Removing and installing left front exhaust pipe with catalytic converter”, page 185 and
⇒ “1.4 Removing and installing right front exhaust pipe with catalytic converter”, page 186 .

– Perform stress-free alignment of exhaust system
⇒ page 193 .

– Fit poly V-belt ⇒ page 31 .

– Replenish coolant ⇒ page 157 .

Note

- *Coolant drained off is only to be re-used if cylinder head or cylinder block has not been replaced.*
- *Never re-use contaminated coolant.*

Vehicles with throttle cable:

– Check throttle cable adjustment ⇒ Fuel supply system - petrol engines; Rep. Gr. 20 .

All models:

– Replenish power steering fluid and bleed steering system ⇒ Running gear, front-wheel drive and four-wheel drive; Rep. Gr. 48 .

– Pour in engine oil and check oil level ⇒ page 151 .

– For electrical connections and routing, refer to ⇒ Current flow diagrams, Electrical fault finding and Fitting locations.

Caution

Never use charger to provide starting assistance, as this could damage the vehicle control units.

Note

- *On re-connecting the battery, remember to activate vehicle equipment (radio/radio navigation system, clock, electric window lifters) in line with owner's manual.*
- *Deactivate service mode of telematics control unit ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .*

– Perform adaption of throttle valve module ⇒ Rep. Gr. 24 .

– As a final step, interrogate and erase engine control unit fault memory, as unplugging the connectors causes faults to be stored ⇒ Vehicle diagnosis, testing and information system VAS 5051.

Tightening torques

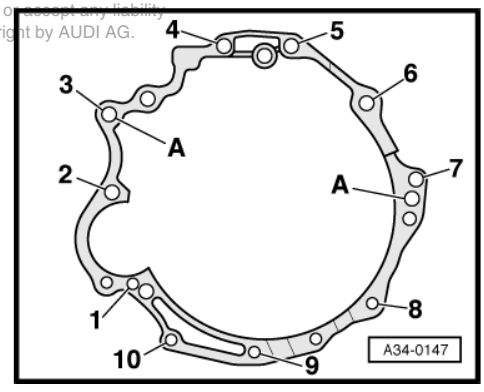
Note

- *Tightening torques only apply to lightly greased, lubricated, phosphate-coated or blackened nuts and bolts.*
- *Additional lubricants such as engine or gear oil are permitted, however not graphite-based lubricants.*
- *Do not use degreased parts.*
- *Tolerance for tightening torques ± 15%*

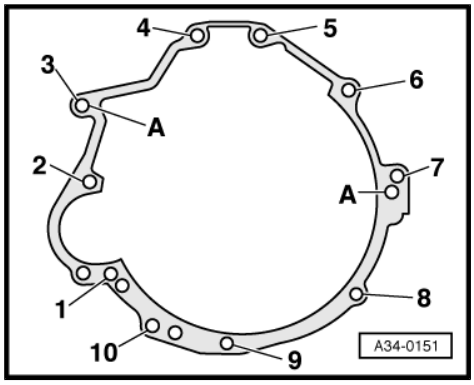
Engine/manual gearbox attachment

Item	Bolt	Nm
1	M10x135	45
2	M12x130	65
3, 4, 5	M12x67	65
6	M12x90 1)	65
7	M12x80	65
8, 9, 10	M10x45	45
A	Dowel sleeves for centring	

• 1) Bolt with washer



Engine/automatic gearbox attachment



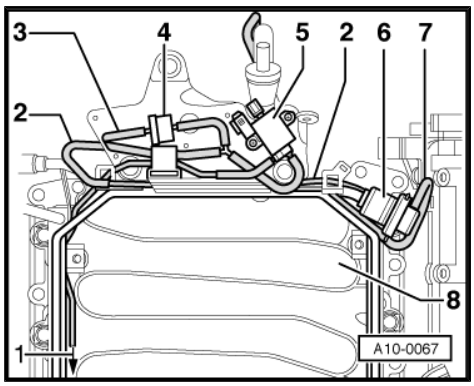
Item	Bolt	Nm
1	M10x80	45
2	M12x110	65
3, 4, 5	M12x67	65
6	M12x90	65
7	M12x80	65
8	M10x60	45
9, 10	M10x45	45
A	Dowel sleeves for centring	

Component		Nm
Bolts/nuts	M6	10
	M8	20
	M10	45
	M12	65
Exceptions:		
Coolant drain plug to cylinder block		20
Fuel pipes to fuel rail/fuel pressure regulator		23
Air duct to intake manifold		10
Power steering pressure pipe to pressure hose		40
Viscous fan to mount using open-ended wrench -3312-		37
Alternator to engine	M8	22
	M10	45
Drive plate to torque converter		85 1)
Engine speed sender to gearbox		10
Stop for torque reaction support to lock carrier		40
Torque reaction support to engine		42
Engine mounting to subframe		25
Heat shield for drive shaft to gearbox		23

- 1) Use new genuine ribbed bolts ⇒ Parts catalogue .

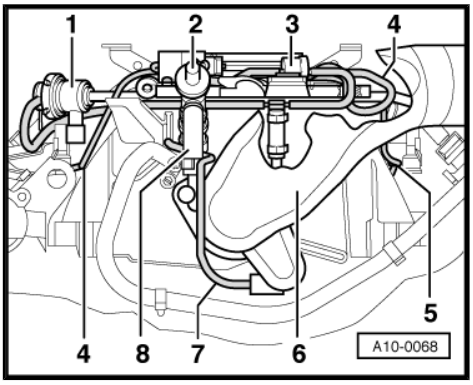
2.4 Vacuum connections

Vehicles with no secondary air system (top view)



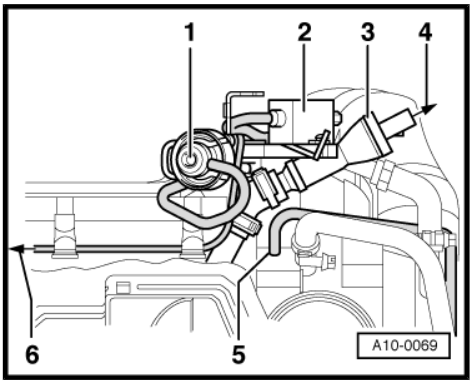
1 - To intake manifold changeover vacuum unit
2 - To vacuum reservoir
3 - To connection at intake manifold
4 - Non-return valve
5 - Variable intake manifold changeover valve -N156-
6 - Fuel pressure regulator to T-piece
7 - To connection at intake manifold
8 - Intake manifold

Back of engine



1 - Fuel pressure regulator
2 - Suction jet pump
3 - Non-return valve
4 - To vacuum reservoir
5 - To intake manifold changeover vacuum unit
6 - Air intake connection
7 - Air intake connection/throttle valve unit connection
8 - Connection between suction jet pump/air intake connection

Side view from left:



1 - Fuel pressure regulator
2 - Variable intake manifold changeover valve -N156-
3 - Suction jet pump
4 - To brake servo
5 - Air intake connection/throttle valve unit connection
6 - To vacuum reservoir

Vehicles with secondary air system

1 - Right combination valve for secondary air

- ❑ At cylinder head on rear right

2 - To activated charcoal filter system solenoid valve 1 -N80-

- ❑ Attached to air cleaner

3 - Throttle valve module -J338-

4 - Secondary air inlet valve -N112-

5 - Non-return valve

6 - Variable intake manifold changeover valve -N156-

7 - To brake servo

8 - Not fitted

9 - Left combination valve for secondary air

- ❑ At cylinder head on rear left

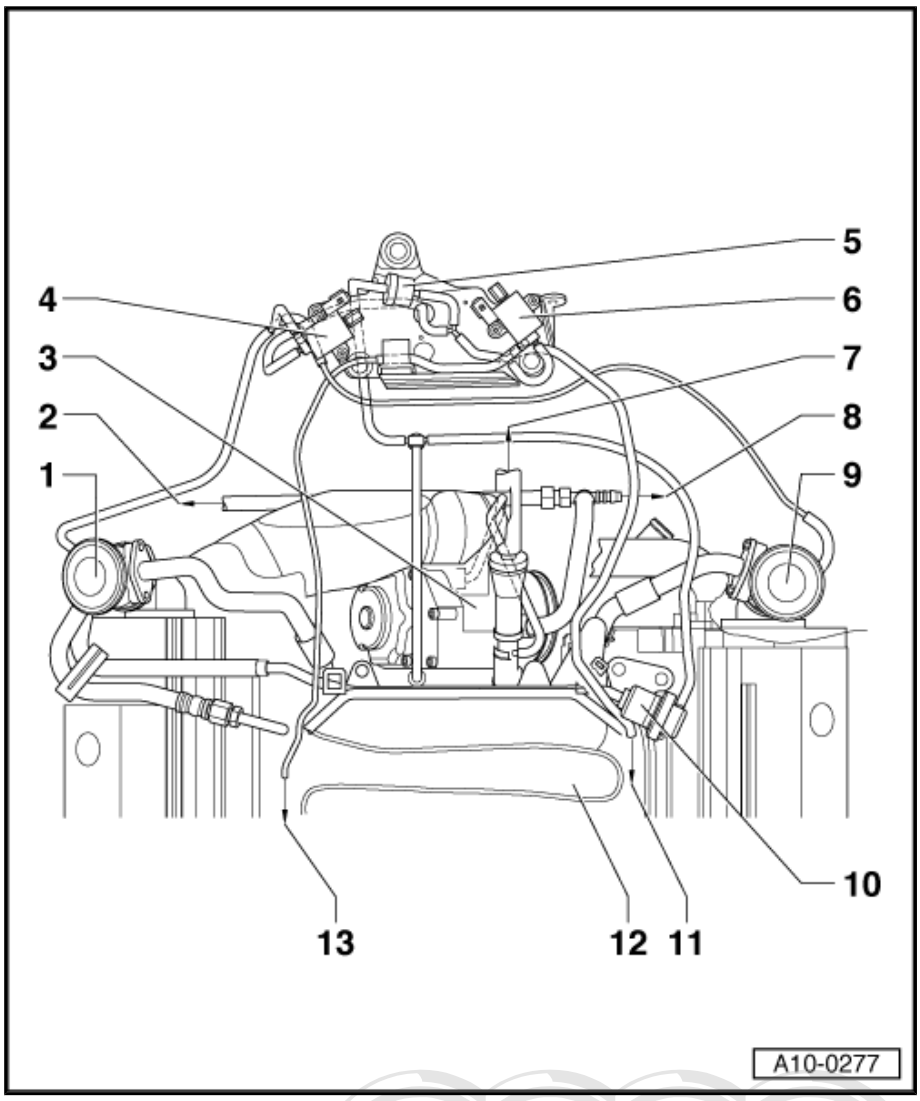
10 - Fuel pressure regulator

11 - To vacuum reservoir

- ❑ Beneath right front wheel housing liner

12 - Intake manifold

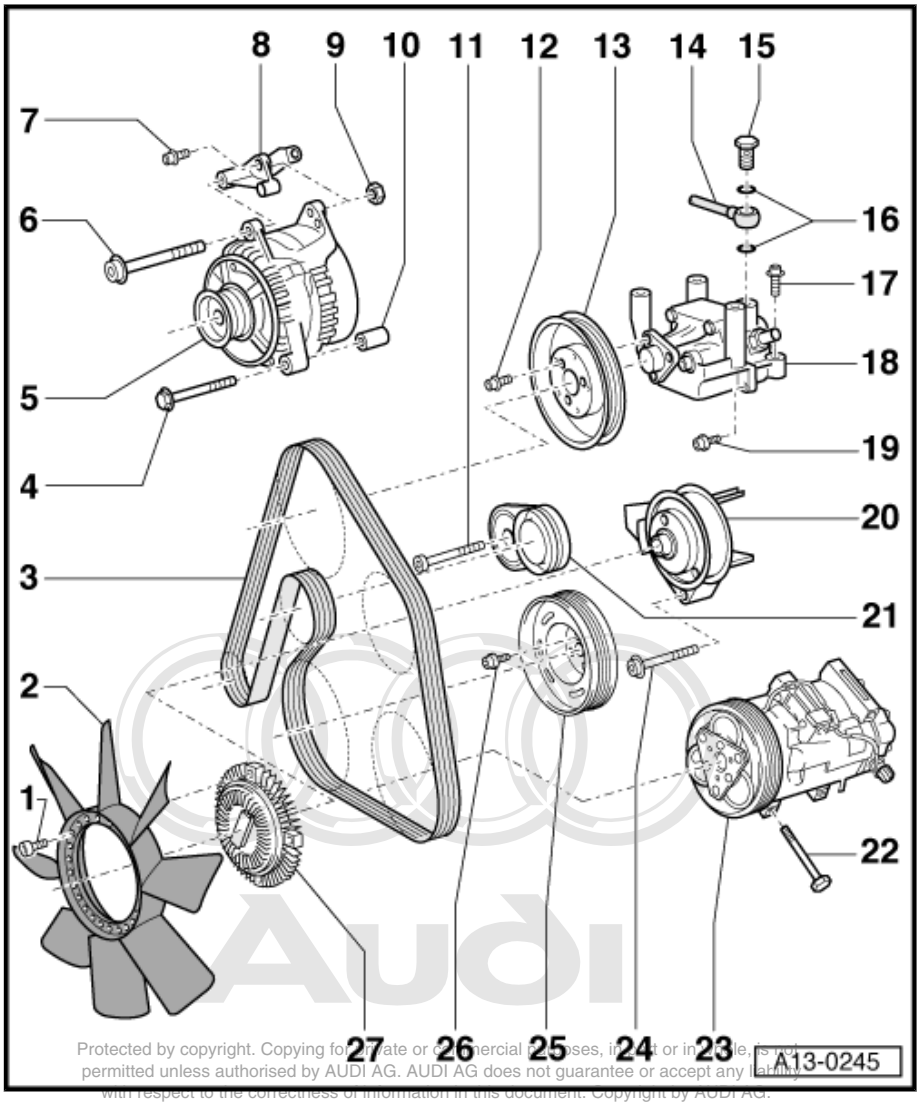
13 - To intake manifold changeover vacuum unit



13 – Crankshaft group

1 Servicing work on pulley end

1.1 Exploded view of poly V-belt drive for power steering pump, alternator, viscous fan and air conditioner



1 - 11 Nm

2 - Viscous fan impeller

- ❑ Removing and installing ⇒ page 173

3 - Poly V-belt

- ❑ Prior to removal, mark direction with chalk or a felt-tip pen. Running a used belt in the opposite direction could destroy it.
- ❑ Removing and installing ⇒ page 30

4 - 22 Nm

5 - Alternator

- ❑ Removing and installing ⇒ Electrical system; Rep. Gr. 27

6 - 45 Nm

7 - 22 Nm

8 - Holder for alternator

9 - 45 Nm

10 - Spacer sleeve

11 - 55 Nm

12 - 22 Nm

13 - Pulley for power steering pump

- ❑ Provide support with pin wrench -3212- on removal and installation

14 - Pressure pipe

- ❑ To power steering

15 - Banjo bolt - 40 Nm

16 - Seal

- ❑ Replace

17 - 22 Nm

18 - Power steering pump with holder

- ❑ Removing and installing ⇒ Running gear, front-wheel drive and four-wheel drive; Rep. Gr. 48

19 - 22 Nm

20 - Pulley for viscous fan

- ❑ With holder
- ❑ Removing and installing ⇒ page 173

21 - Poly V-belt tensioner

22 - 25 Nm

23 - Air conditioner compressor

- ❑ Do not unscrew/disconnect refrigerant pipes
- ❑ After detaching, use a piece of wire for example to attach compressor to longitudinal member. Do not leave hanging from refrigerant pipes.

24 - M6 = 10 Nm; M8 = 22 Nm

25 - Vibration damper

- ❑ Removing and installing ⇒ page 32

26 - 22 Nm

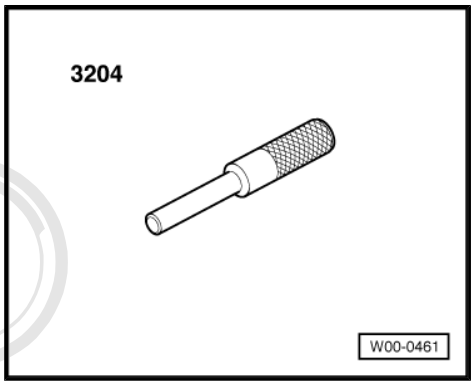
27 - Viscous fan coupling

- ❑ Removing and installing ⇒ page 173

1.2 Removing and installing poly V-belt

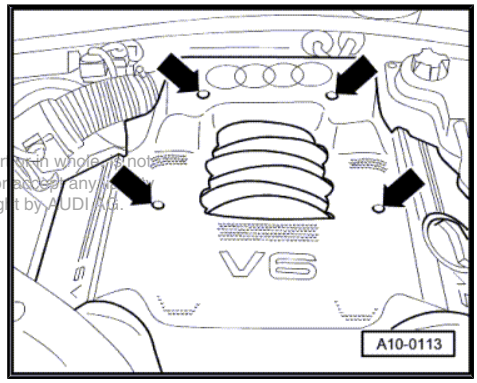
Special tools and workshop equipment required

- ♦ Locking pin -3204-

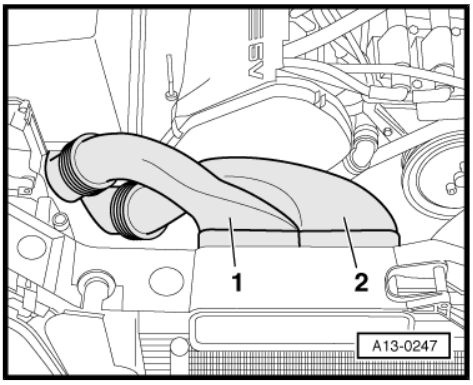


Removing

– Remove engine cover -arrows-.



– Remove air ducts -1- and -2-.

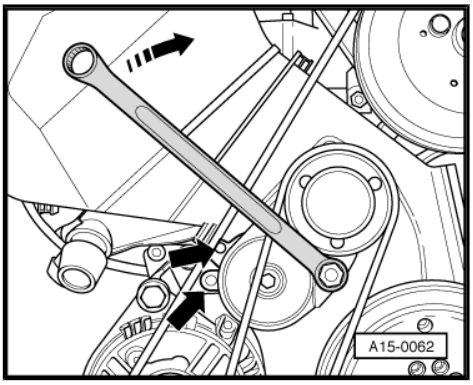


Tensioning roller with hexagon head:

Note

Prior to removal, mark direction of poly V-belt with chalk or a felt-tip pen. Running a used belt in the opposite direction could destroy it.

– Use 17 mm ring spanner to swivel tensioner in -direction of arrow- to slacken off poly V-belt.
– Lock tensioner in position by inserting locking pin -3204- in locating holes -arrows-.
– Guide poly V-belt over viscous fan and detach.

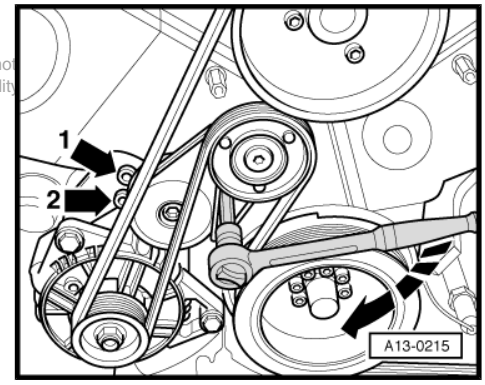


Tensioning roller with hexagon socket:

Note

Prior to removal, mark direction of poly V-belt with chalk or a felt-tip pen. Running a used belt in the opposite direction could destroy it.

– Use 10 mm Allen key to swivel tensioner in -direction of arrow- to slacken off poly V-belt.
– Lock tensioner in position by inserting locking pin -3204- in locating holes -arrow 1- and -arrow 2-.
– Detach poly V-belt.

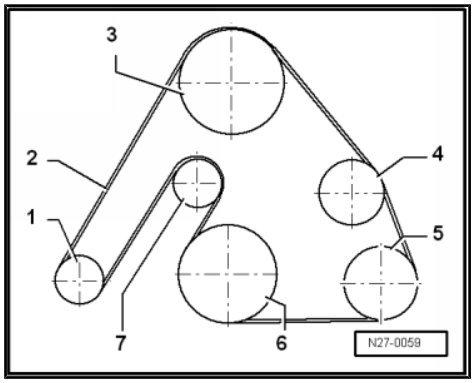


Installing

Install in reverse order, paying attention to the following:

– Start by positioning poly V-belt over crankshaft pulley. As a final step, position belt on tensioning roller.

Belt routing



1 - Alternator
2 - Poly V-belt
3 - Power steering pump
4 - Viscous fan
5 - Air conditioner compressor
6 - Crankshaft
7 - Tensioning roller

Note

Pay attention to correct positioning on pulleys when fitting poly V-belt.

– Start engine and check belt running.

1.3 Removing and installing vibration damper

Removing

- Poly V-belt removed ⇒ page 30

– Unscrew radiator cowl for viscous fan.

– Unscrew vibration damper.

Note

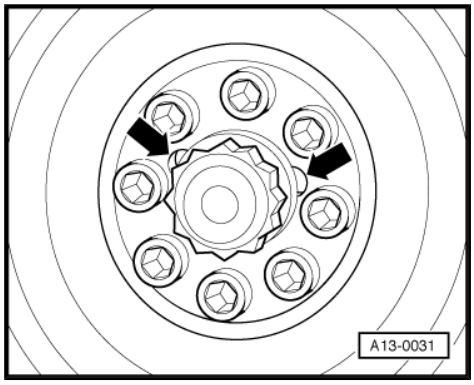
Removing the vibration damper does not involve slackening off the central bolt.

Installing

Install in reverse order, paying attention to the following:

- On installation, make sure notches -arrows- in vibration damper are aligned with locking lugs on toothed belt sprocket.

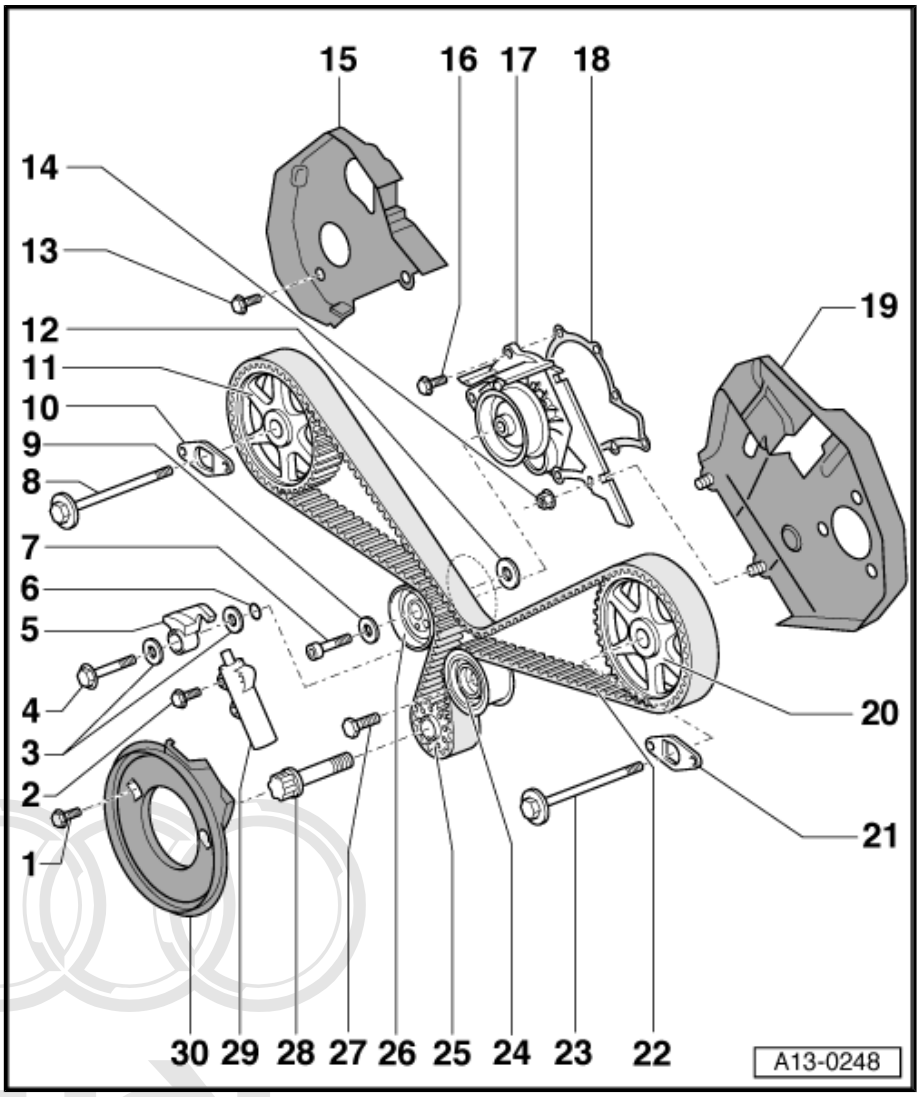
– Fit poly V-belt ⇒ page 31 .



Tightening torque

Component	Nm
Vibration damper to crankshaft	22

1.4 Exploded view of toothed belt drive



1 - 10 Nm

2 - 10 Nm

- ❑ With “engine generation II” apply locking fluid on fitting; locking fluid ⇒ Parts catalogue

3 - Washer

4 - 22 Nm

5 - Tensioning lever with mounting bush

6 - O-ring

- ❑ Replace if damaged
- ❑ Secures ⇒ Item 3 (page 33) , ⇒ Item 4 (page 33) and ⇒ Item 5 (page 33) assembly

7 - 22 Nm

8 - 55 Nm

9 - Washer

10 - Locating plate

- ❑ Labelled side “rear hinten” faces rear

11 - Right camshaft sprocket

- ❑ Removing and installing ⇒ “1.5 Removing and installing toothed belt”, page 35
- ❑ Use puller -T40001- to detach

12 - Spacer

13 - 10 Nm

- ❑ Apply locking fluid on fitting; locking fluid ⇒ Parts catalogue

14 - 10 Nm

15 - Rear right toothed belt guard

16 - 10 Nm

17 - Coolant pump

- ❑ Removing and installing ⇒ page 162

18 - Gasket

- ❑ Replace

19 - Rear left toothed belt guard

20 - Left camshaft sprocket

- ❑ Removing and installing ⇒ “1.5 Removing and installing toothed belt”, page 35
- ❑ Use puller -T40001- to detach

21 - Locating plate

- ❑ Labelled side “rear hinten” faces rear

22 - Toothed belt

- ❑ Prior to removal, mark direction with chalk or a felt-tip pen. Running a used belt in the opposite direction could destroy it.
- ❑ Check for wear
- ❑ Removing ⇒ page 35
- ❑ Installing (adjusting timing) ⇒ page 38

23 - 55 Nm

24 - Idler wheel

25 - Crankshaft toothed belt sprocket

- ❑ There must not be any oil at contact surface between toothed belt sprocket and crankshaft
- ❑ Fitting is only possible in one position

26 - Tensioning roller with mounting bush

27 - 43 Nm

28 - 200 Nm + further 180° ($^1/_2$) turn

- ❑ Replace
- ❑ Not to be additionally lubricated
- ❑ Use locking bolt -3242- for slackening off and tightening
- ❑ Screwing in locking bolt -3242- ⇒ page 42

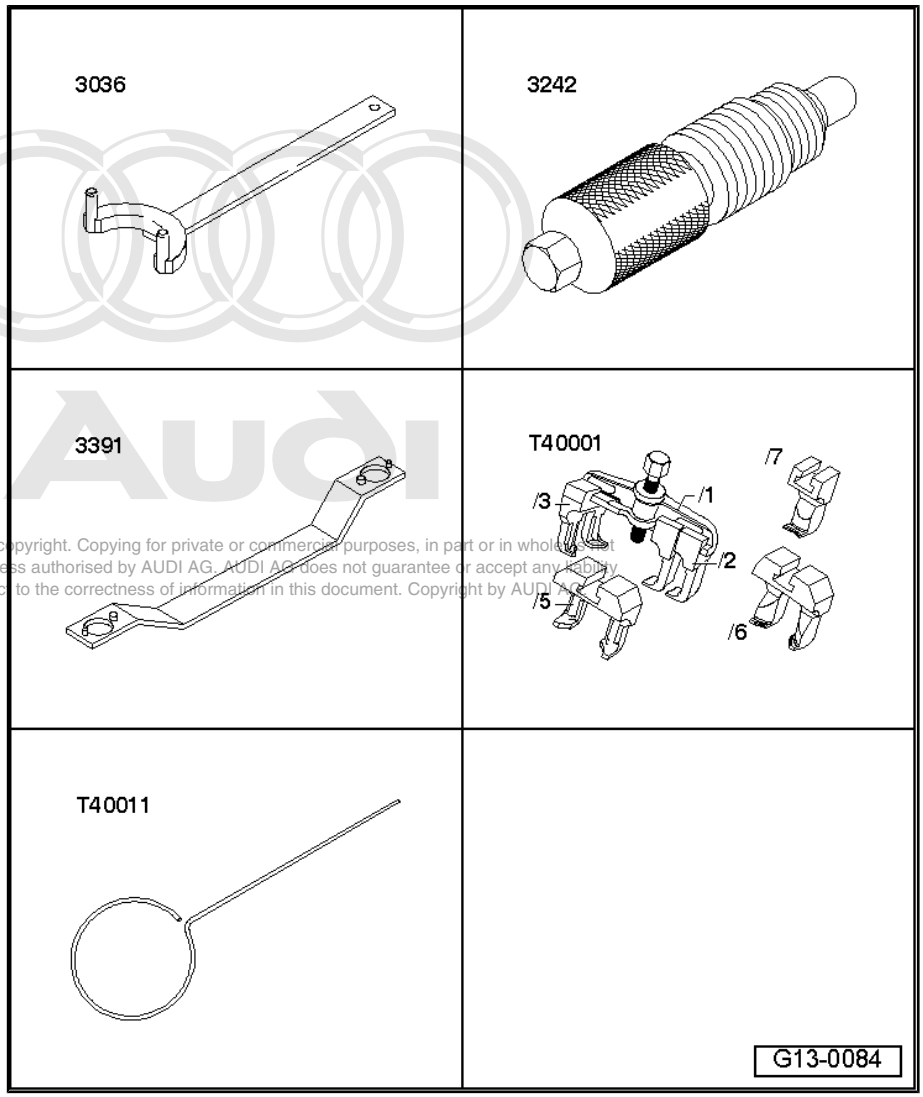
29 - Tensioning element

30 - Lower toothed belt guard

1.5 Removing and installing toothed belt

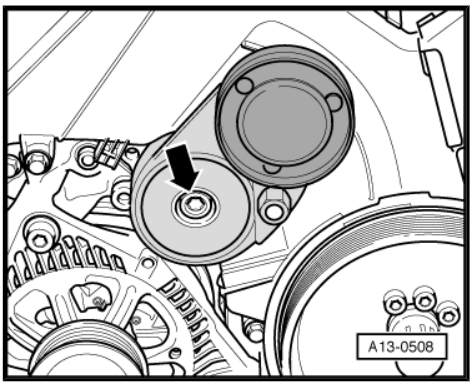
Special tools and workshop equipment required

- Counterhold -3036-
- Locking bolt -3242-
- Camshaft retainer -3391-
- Puller -T40001- with claws -T40001/2-
- Locking pin -T40011-



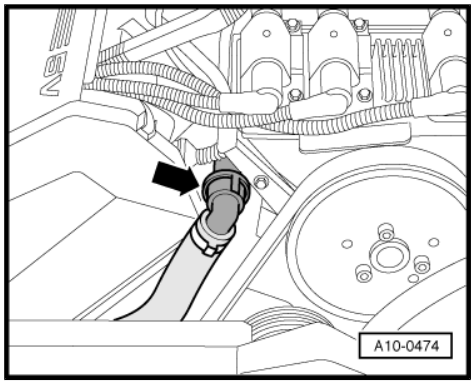
Removing

- Engine in position
- – Remove viscous fan ⇒ page 173 .
- – Unscrew radiator cowl for viscous fan.
- – Remove poly V-belt ⇒ page 30 .
- – Screw out bolt -arrow- and detach poly V-belt tensioner.



Vehicles with secondary air system:

– Disconnect hose -arrow- from secondary air connecting pipe.



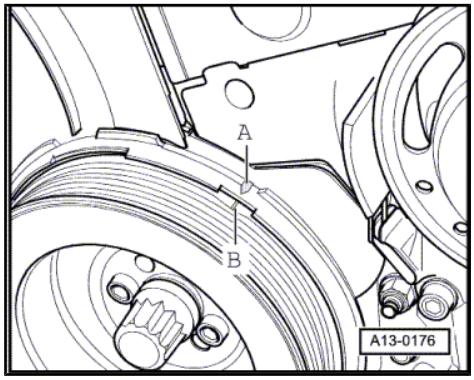
All models:

– Remove toothed belt guard on left and right.

> **Caution**
>
> ***The engine is only to be turned at the crankshaft in the direction of engine rotation (clockwise).***

– Set crankshaft at central bolt of toothed belt sprocket in direction of engine rotation to TDC mark.

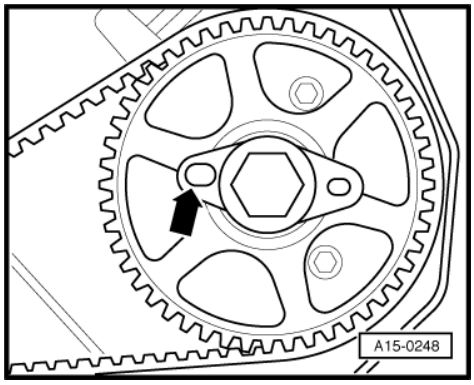
• Notch -B- is opposite mark -A-.



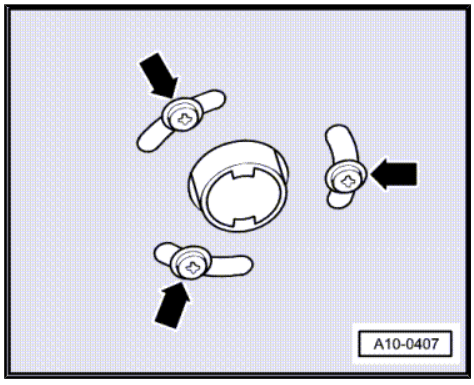
– Check position of camshafts.

• Large holes -arrow- of locating plates at camshaft sprockets must be opposite one another on inside.

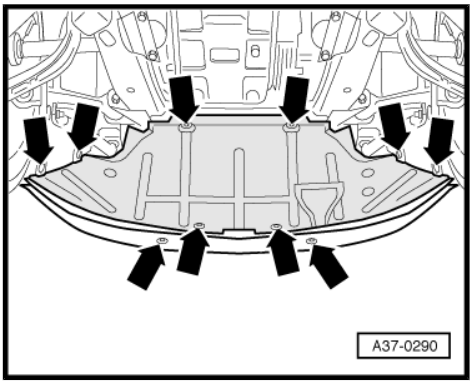
– If not, give crankshaft a further turn.



– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



– Detach noise insulation -arrows-.



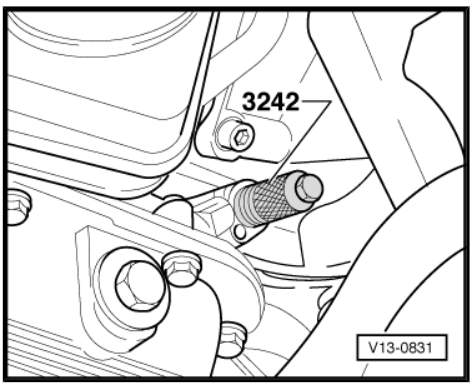
– Unscrew TDC mark sealing plug at cylinder block.

Note

A TDC hole can be felt in the crankshaft exactly behind the sealing plug.

WARNING

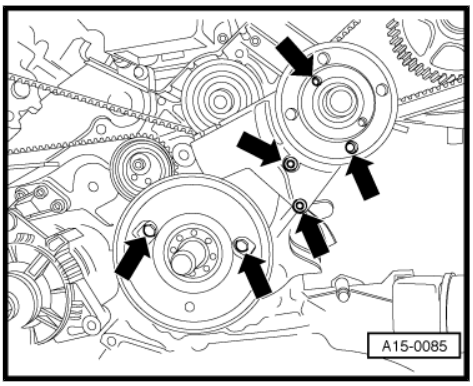
To avoid possible injury, do not turn crankshaft whilst feeling for TDC hole.



– Screw locking bolt -3242- into hole of sealing plug removed and tighten bolt.

– Remove vibration damper ⇒ page 32 .

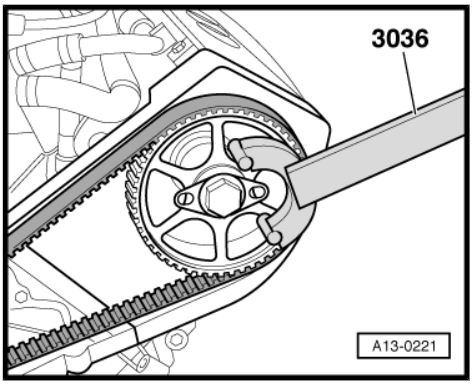
– Unscrew toothed belt guard at bottom and poly V-belt pulley for viscous fan -arrows-.



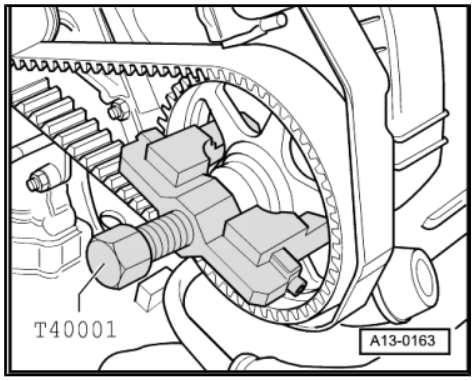
– Whilst providing support with counterhold -3036- , slacken off the bolts of both camshaft sprockets.

Note

Leave the bolts screwed in loosely.



– Use puller -T40001- with claws -T40001/2- to detach camshaft sprockets from taper on left and right.

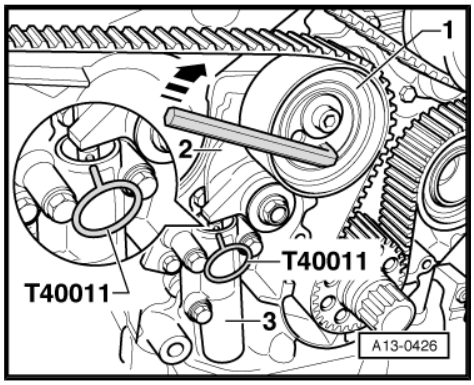


Note

- *Prior to removal, mark direction of toothed belt with chalk or a felt-tip pen. Running a used belt in the opposite direction could destroy it.*
- *The toothed belt tensioning element is oil cushioned and can only be compressed slowly exerting uniform force.*

– Turn toothed belt tensioning roller -1- clockwise with an 8 mm Allen key in -direction of arrow- until tensioning lever -2- has compressed tensioning element -3- to such an extent that plunger can be secured with locking pin -T40011- .

– Detach toothed belt.



Installing (adjusting timing)

- Crankshaft locked in position with locking bolt -3242-
- Camshaft sprockets unfastened

Note

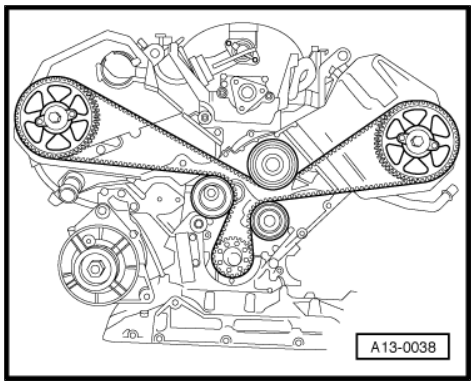
- *When turning the camshaft, none of the crankshaft cylinders should be at TDC, as otherwise the valves/piston crown could be damaged.*
- *The timing is to be adjusted as follows even when performing repairs which only involve detaching the toothed belt from the camshaft sprocket:*

– Fit both camshaft sprockets with locating plates, washers and bolts.

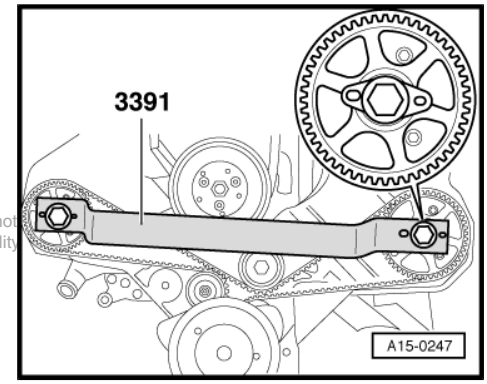
- Installation position of locating plates: labelled side “front/ vorne” faces front or marking “rear/hinten” faces rear.

– Screw on the two camshaft sprockets such that they can still just be turned and do not tilt.

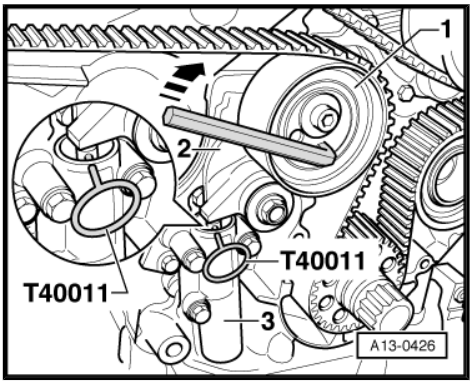
– Position toothed belt as shown on all sprockets and finally on tensioning roller.



– Insert camshaft retainer -3391- in locating plates of both camshafts.



– Use 8 mm Allen key to turn toothed belt tensioning roller -1- clockwise in -direction of arrow- until locking pin -T40011- can be removed.



Prior to initial start-up of engine, pre-tension the tensioning roller as follows:

– Apply torque wrench to hexagon socket of tensioning roller.
– Turn (15 Nm) tensioning roller in tensioning direction to pre-tension the tensioning roller.
– Tighten camshaft sprockets to 30 Nm.
– Remove camshaft retainer -3391- .
– Finish-tighten camshaft sprockets. Provide support with counterhold -3036- when doing so.
– Install vibration damper ⇒ page 32 .
– Remove locking bolt -3242- .
– Screw TDC mark sealing plug with new O-ring into cylinder block.
– Fit poly V-belt ⇒ page 31 .
– Install viscous fan ⇒ page 173 .

Tightening torques

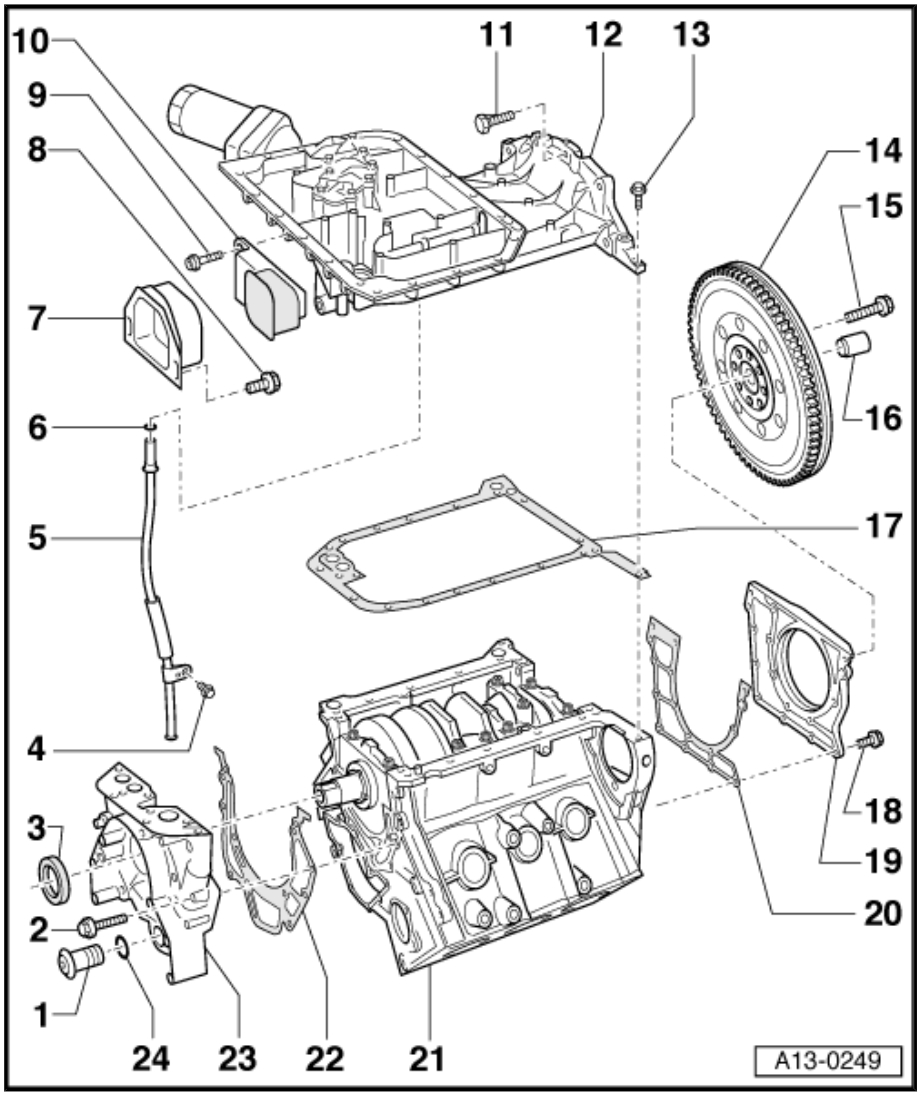
Component		Nm
Camshaft sprocket to camshaft		55
Vibration damper to crankshaft sprocket		22
Poly V-belt tensioner to cylinder block		55
Sealing plug in cylinder block		10
Lower toothed belt guard to cylinder block		10
Holder for viscous fan to cylinder block	M6	10
	M8	22

2 Servicing work on flywheel end

2.1 Exploded view of sealing flange and dual-mass flywheel/drive plate

Note

- *The illustration shows the "engine generation II" version as an example for both engine generations.*
- *Components relating to "engine generation III" are noted separately in the text.*
- *Clutch servicing work ⇒ Rep. Gr. 30*



1 - Spray nozzle valve - 40 Nm

- ❑ "Engine generation II" only

2 - M6 = 10 Nm; M8 = 30 Nm

3 - Crankshaft oil seal

- ❑ Removing and installing ⇒ page 42

4 - 10 Nm

5 - Guide tube for dipstick

6 - O-ring

- ❑ Replace

7 - Stop for torque reaction support

8 - 40 Nm

9 - 42 Nm

10 - Torque reaction support

11 - 45 Nm

12 - Top part of sump

- ❑ Removing ⇒ page 132
- ❑ Installing ⇒ "1.8 Installing top part of sump - engine generation II ", page 140 or ⇒ "1.9 Installing top part of sump - engine generation III ", page 141

13 - M6 = 10 Nm; M7 = 16 Nm; M8 = 20 Nm

14 - Dual-mass flywheel/drive plate

- ❑ Removing and installing dual-mass flywheel ⇒ page 49
- ❑ Removing and installing drive plate ⇒ page 51

15 - Bolt for dual-mass flywheel/drive plate

- ❑ Replace
- ❑ Tightening torque for dual-mass flywheel: 60 Nm + 180° ($^1/_2$) turn further
- ❑ Tightening torque for drive plate (vehicles with automatic gearbox): 60 Nm + 90° ($^1/_4$) turn further.

16 - Needle bearing

- ❑ Manual gearbox only
- ❑ Extracting and driving in ⇒ page 52
- ❑ With automatic gearboxes, a mounting bush is pressed into the crankshaft instead of the needle bearing in the dual-mass flywheel ⇒ page 56

17 - Gasket

- ❑ “Engine generation II” only
- ❑ Replace
- ❑ Must be dry when fitting
- ❑ Additional sealant is not required
- ❑ Replaced in “engine generation III” by liquid gasket ⇒ page 141

18 - 10 Nm

19 - Rear sealing flange with oil seal

- ❑ Removal and installation involve taking out top part of sump ⇒ page 132
- ❑ Lightly lubricate sealing lip of oil seal
- ❑ When fitting, slide guide sleeve from installation kit onto crankshaft

20 - Gasket

- ❑ Replace

21 - Cylinder block

- ❑ Removing and installing crankshaft ⇒ page 54
- ❑ Dismantling and assembling pistons and conrods ⇒ page 60

22 - Gasket

- ❑ Replace

23 - Oil pump for “engine generation II” or front sealing flange for “engine generation III”

- ❑ Removing and installing ⇒ “1.10 Removing and installing oil pump - engine generation II ”, page 142 or ⇒ “2.3 Removing and installing front sealing flange - engine generation III ”, page 44

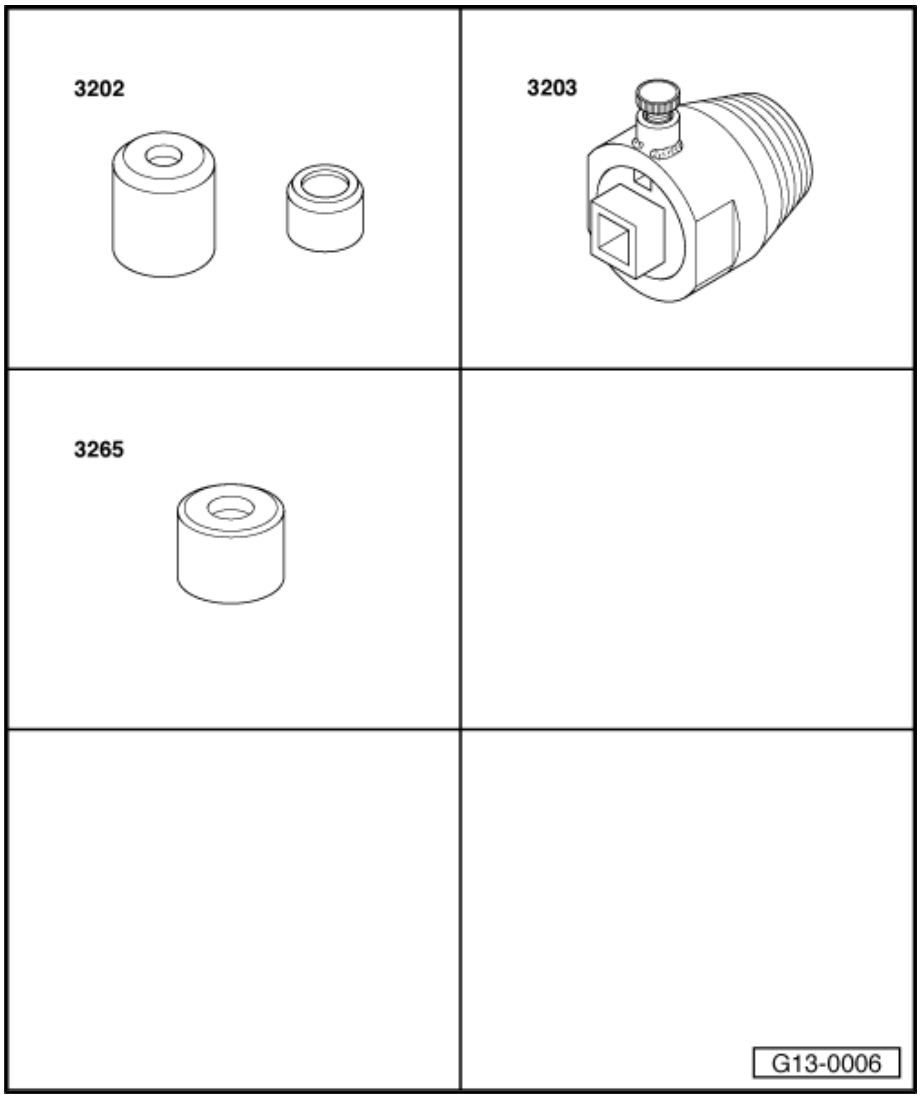
24 - O-ring

- ❑ “Engine generation II” only
- ❑ Replace

2.2 Replacing crankshaft oil seal on pulley end

Special tools and workshop equipment required

- Fitting sleeves -3202/1-
- Oil seal extractor -3203-
- Fitting sleeve -3265-



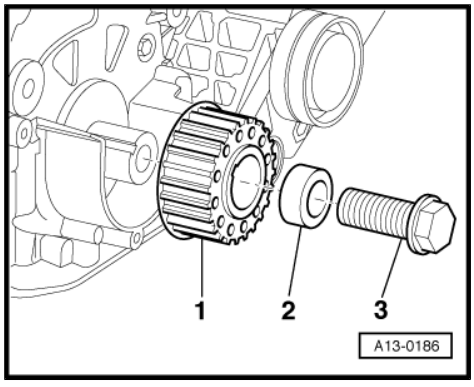
Sequence of operations

- Engine in position

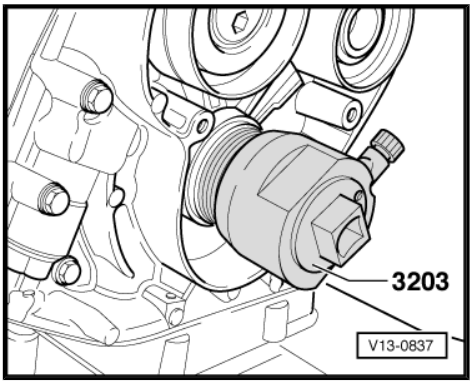
– Remove toothed belt ⇒ page 35 .

– Screw out central bolt -3- for crankshaft toothed belt sprocket -1-.

– Detach spacer -2- and toothed belt sprocket.



– Screw inner part of oil seal extractor -3203- out of outer part by three turns and lock with knurled screw.
– Lubricate threaded end of oil seal extractor, fit in position and screw as far as possible into oil seal whilst exerting firm pressure.
– Slacken off knurled screw and turn inner part towards crankshaft until oil seal has been extracted.
– Clamp flats of oil seal extractor in a vice.
– Use pliers to remove oil seal.

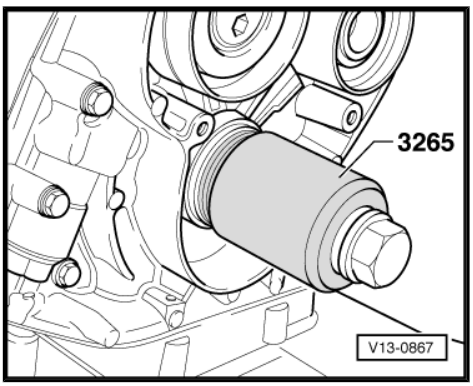


– Clean contact and sealing surfaces.

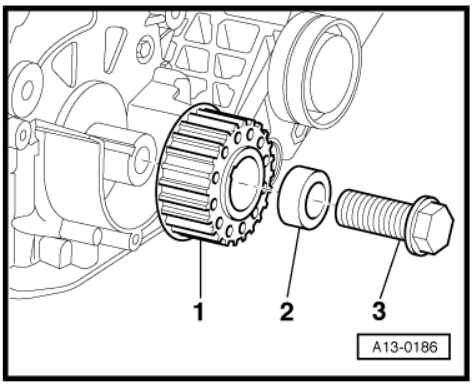
Note

Do not lubricate sealing lip and outer rim of oil seal before pressing in.

– Press on oil seal with fitting sleeves -3202/1- .
– Press in oil seal with fitting sleeve -3265- and central bolt such that it is flush.



– Install crankshaft toothed belt sprocket -1- with spacer -2- with new central bolt -3-.



Note

- *There must not be any oil at contact surface between toothed belt sprocket and crankshaft.*
- *Do not additionally lubricate bolt for crankshaft toothed belt sprocket.*

– Fit toothed belt (adjust timing) ⇒ page 38 .

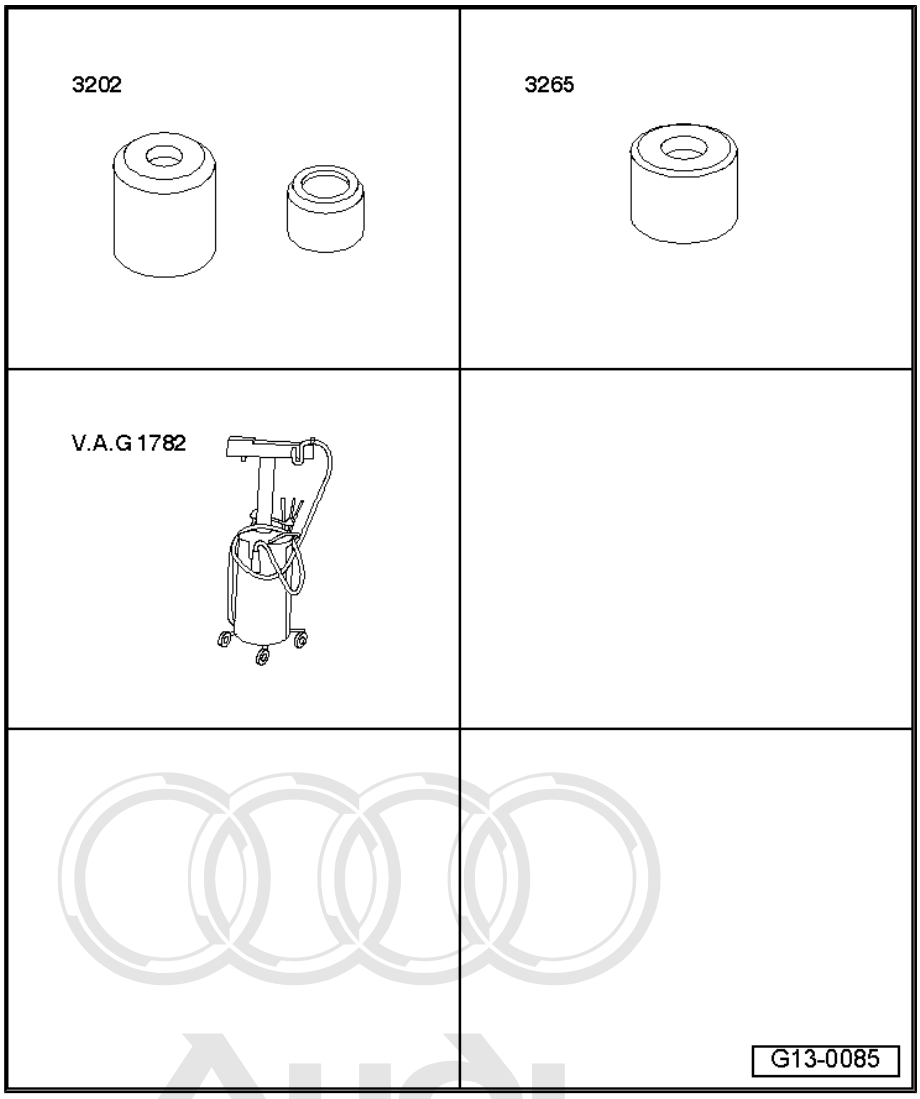
Tightening torque

Component	Nm
Toothed belt sprocket to crankshaft	200 + 180° 1) 2)
• 1) Replace bolt. • 2) 180° corresponds to half a turn.	

2.3 Removing and installing front sealing flange - “engine generation III”

Special tools and workshop equipment required

- Fitting sleeve -3202/1- from fitting sleeves -3202-
- Fitting sleeve -3265-
- Used oil collector and extractor -V.A.G 1782-
- Hand drill with plastic brush attachment
- Safety goggles
- Sealant ⇒ Parts catalogue



Removing

- Engine in position

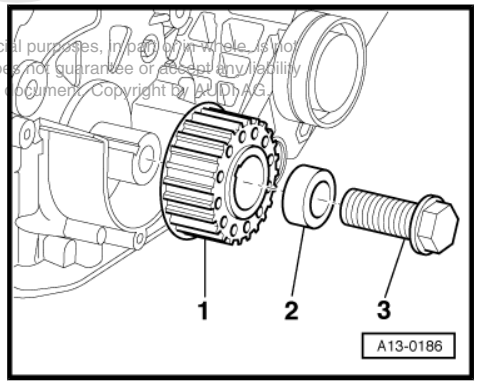
– Remove toothed belt ⇒ page 35 .

– Screw out central bolt -3- for crankshaft toothed belt sprocket -1-.

– Detach spacer -2- and toothed belt sprocket.

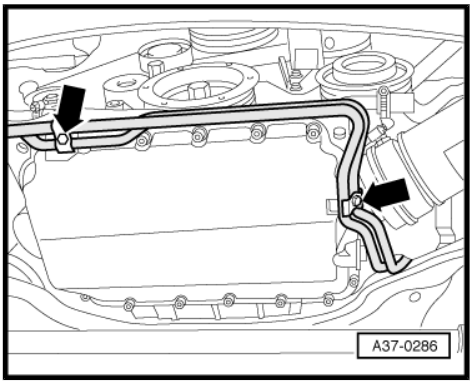
– Place used oil collector and extractor -V.A.G 1782- beneath engine.

– Drain off engine oil.



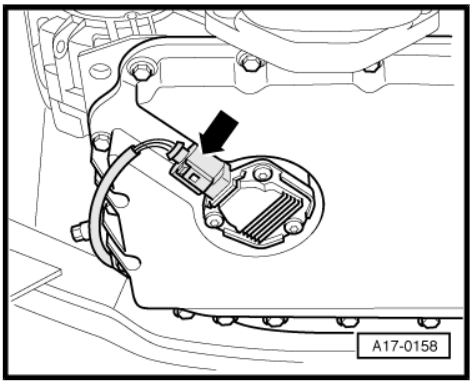
Vehicles with automatic gearbox:

– Unscrew holder for ATF pipes -arrows-.

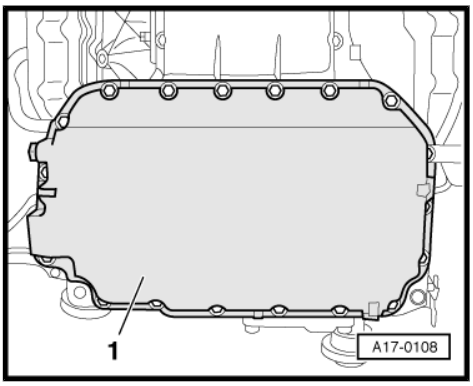


All models:

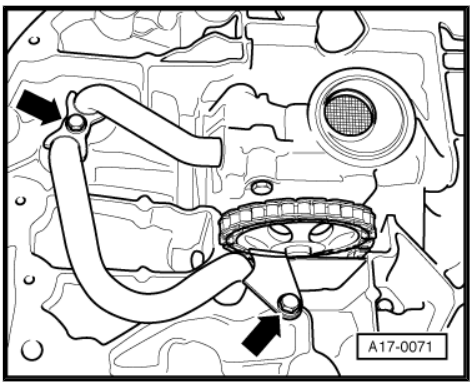
– Unplug connector at oil level/oil temperature sender -G266- -arrow- and lay bare wire.



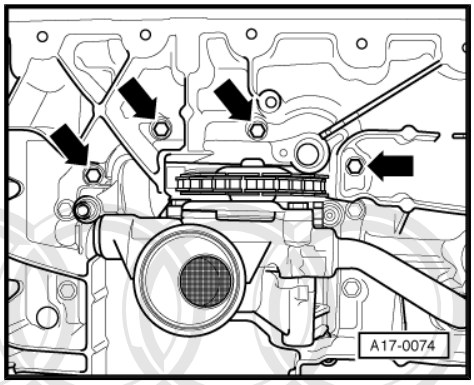
– Unscrew bottom part of sump -1-.



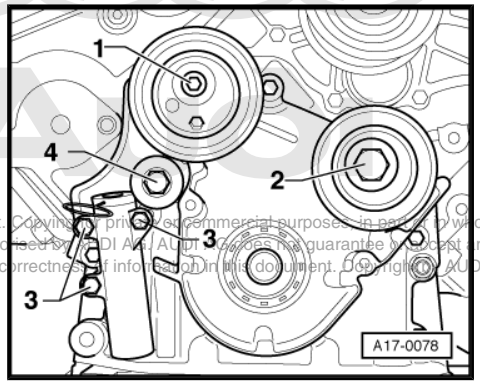
– Unscrew holder of oil feed pipes -arrows- and detach front (long) oil feed pipe.



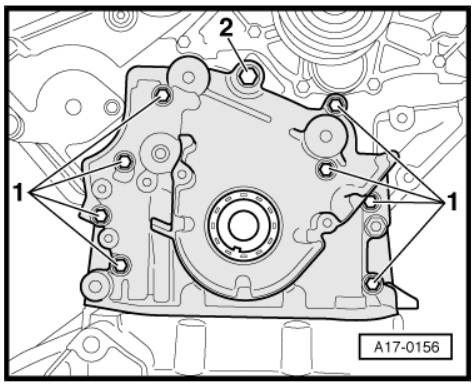
– Screw the 4 bolts -arrows- out of top part of sump.



– Unscrew idler wheel -2-, tensioning roller -1-, tensioning lever -4- and tensioning element -3-.



– Screw out bolts -1- and -2-.
– Detach front sealing flange.
– Drive out oil seal with flange removed.

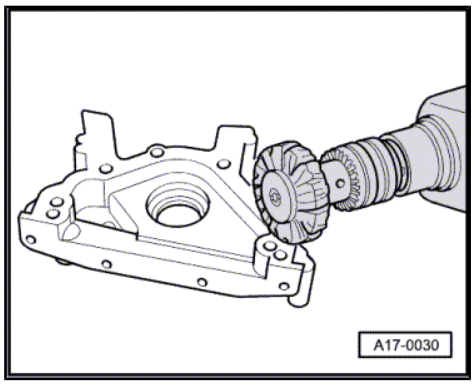


Installing

Install in reverse order, paying attention to the following:

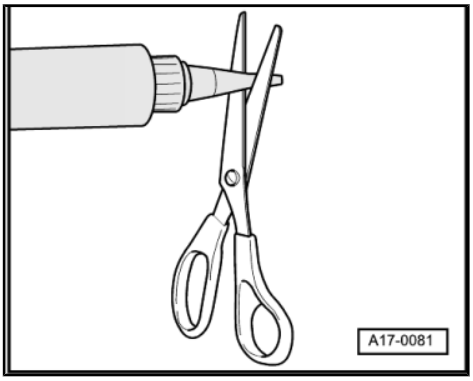
– Use rotating plastic brush for example to remove sealant remnants at sealing flange, as well as bottom and top part of sump.

> **WARNING**
>
> *Wear safety goggles.*

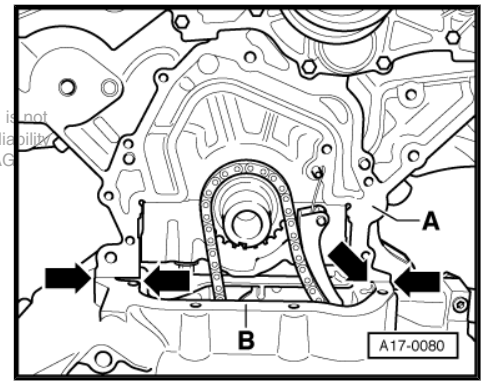


– Clean sealing surfaces; surfaces must be free from oil and grease.

– Cut off tube nozzle at front mark (∅ of nozzle approx. 3 mm).



– Attach gasket to fitted pins at sealing surfaces -A-.



Note

Do not apply sealant to sealing surface -A- of cylinder block.

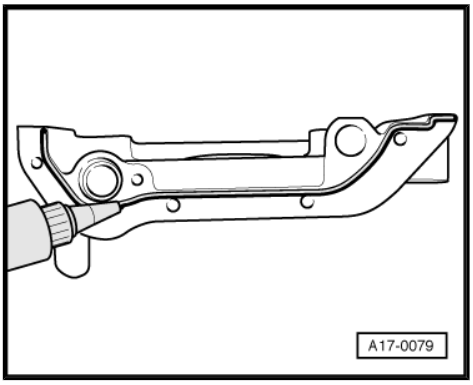
– After fitting gasket, apply a small sealant bead in each case to edges between -left arrows- and -right arrows-.

Note

After applying the silicone sealant, the sealing flange must be fitted within 5 minutes.

– Apply sealant bead as shown to clean sealing surface of sealing flange.

• Thickness of sealant bead: 2 ... 3 mm

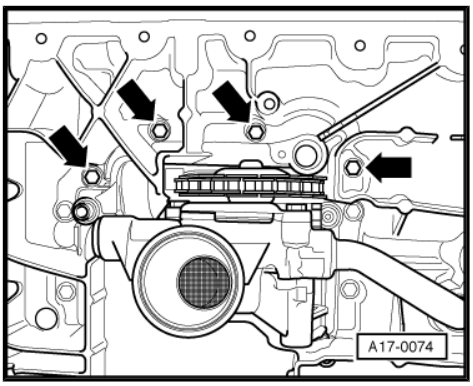


Note

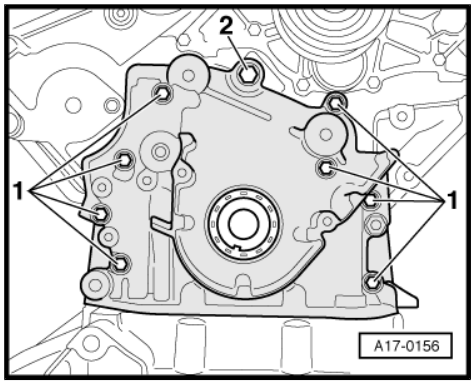
♦ *The sealant bead must not be thicker than 3 mm, as otherwise surplus sealant could ingress into the sump and clog the screen in the oil intake pipe.*

♦ *For fitting sealing flange with oil seal in position, attach fitting sleeves -3202/1- to end of crankshaft.*

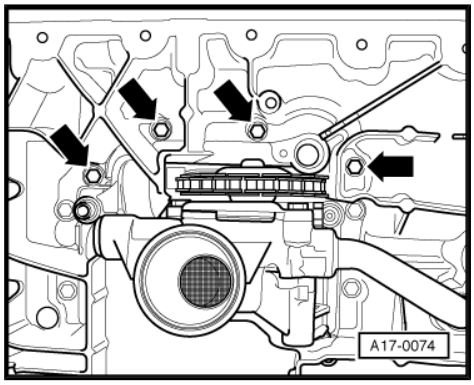
– Hand-tighten the 4 bolts -arrows-.



– Apply locking fluid when fitting bolt -2-; locking fluid ⇒ Parts catalogue .
– Tighten bolts -1- to 10 Nm and bolt -2- to 30 Nm.



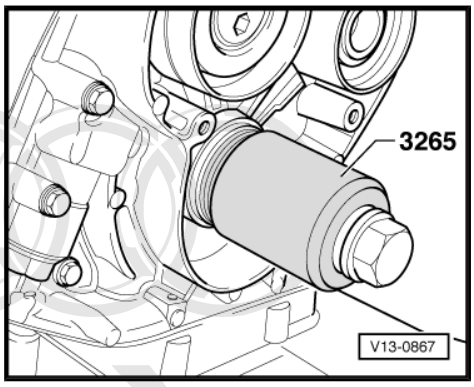
– Finish-tighten the 4 bolts -arrows-.
- M6 = 10 Nm
- M7 = 16 Nm



Note

Do not lubricate sealing lip and outer rim of oil seal before pressing in.

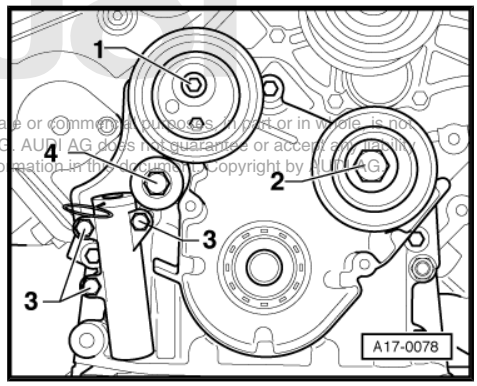
– Press on oil seal with fitting sleeves -3202/1- .
– Press in oil seal with fitting sleeve -3265- and central bolt such that it is flush.



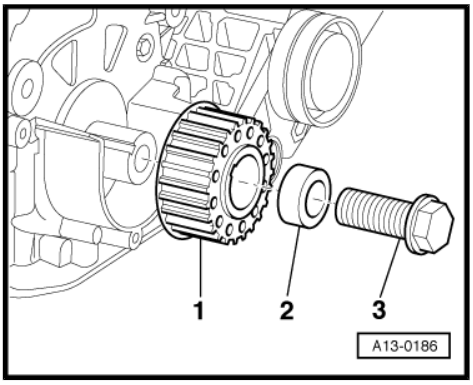
– Install components in the following order:

1. Toothed belt tensioning element -Item 3-
2. Tensioning lever -Item 4-
3. Toothed belt tensioning roller -Item 1-
4. Idler wheel -Item 2-

– Pay attention to spacers beneath tensioning roller and tensioning lever.



– Install crankshaft toothed belt sprocket -1- with spacer -2- with new central bolt -3-.



Note

- *There must not be any oil at contact surface between toothed belt sprocket and crankshaft.*
- *Do not additionally lubricate bolt for crankshaft toothed belt sprocket.*

– Fit toothed belt (adjust timing) ⇒ page 38 .

Tightening torques

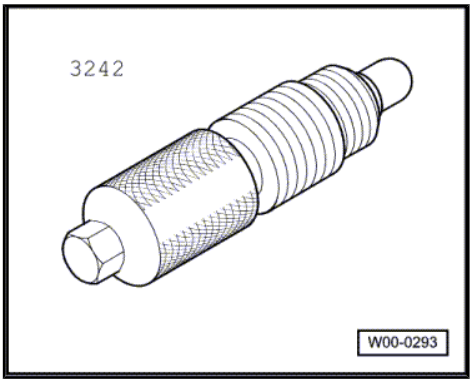
Component		Nm
Front sealing flange to cylinder block	M6	10
	M8	30
Front sealing flange to top part of sump	M6	10
	M7	16
Toothed belt sprocket to crankshaft		200 + 180° 1) 2)
Tensioning element to front sealing flange		10
Tensioning lever to front sealing flange		22
Tensioning roller to front sealing flange		22
Idler wheel to front sealing flange		43

- 1) Replace bolt.
- 2) 180° corresponds to half a turn.

2.4 Removing and installing dual-mass flywheel

Special tools and workshop equipment required

- Locking bolt -3242-



Removing

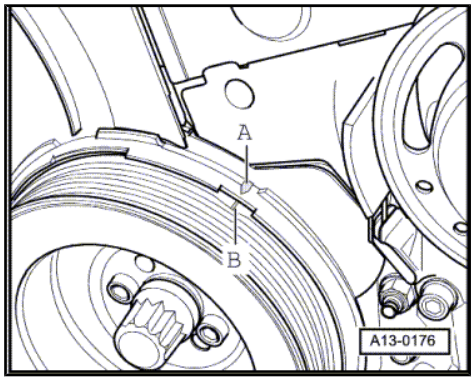
- Gearbox removed

Caution

The engine is only to be turned at the crankshaft in the direction of engine rotation (clockwise).

– Set crankshaft at central bolt of toothed belt sprocket in direction of engine rotation to TDC mark.

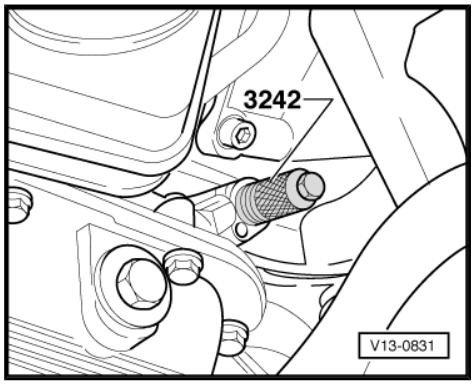
- Notch -B- is opposite mark -A-.



– Unscrew TDC mark sealing plug at cylinder block.

Note

A TDC hole can be felt in the crankshaft exactly behind the sealing plug.



WARNING

To avoid possible injury, do not turn crankshaft whilst feeling for TDC hole.

– Screw locking bolt -3242- into hole of sealing plug removed and tighten bolt.

– Mark dual-mass flywheel with respect to engine.

– Unscrew dual-mass flywheel.

Installing

Install in reverse order, paying attention to the following:

– Replace and tighten bolts.

Note

The needle bearing is located in the dual-mass flywheel and must be pressed in on replacing the dual-mass flywheel ⇒ page 52 .

– Remove locking bolt -3242- .

– Screw TDC mark sealing plug with new O-ring into cylinder block.

Tightening torques

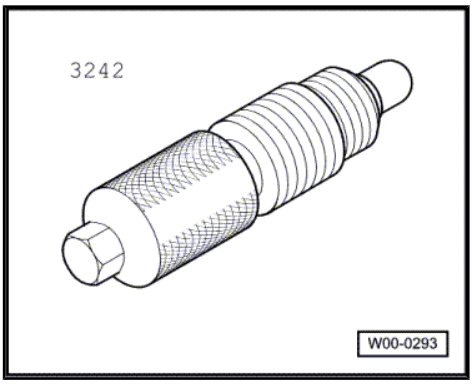
Component	Nm
Dual-mass flywheel to crankshaft	60 + 180° 1) 2)
Sealing plug in cylinder block	10

- 1) Replace bolts.
- 2) 180° corresponds to half a turn.

2.5 Removing and installing drive plate

Special tools and workshop equipment required

- Locking bolt -3242-

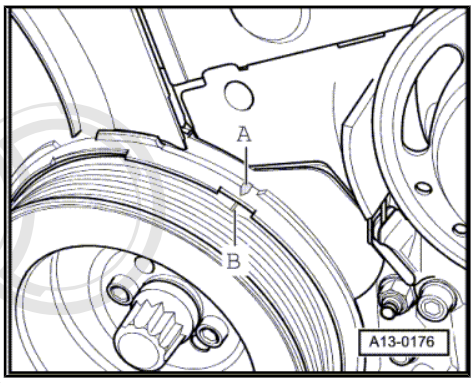


Removing

- Gearbox removed

Caution

The engine is only to be turned at the crankshaft in the direction of engine rotation (clockwise).



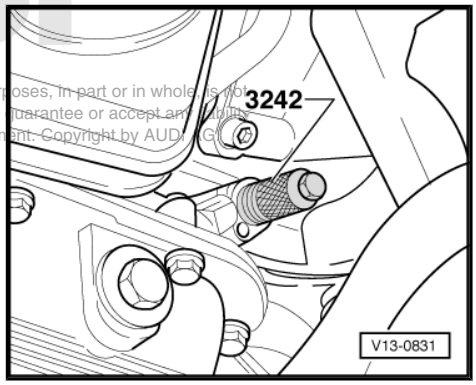
– Set crankshaft at central bolt of toothed belt sprocket in direction of engine rotation to TDC mark.

- Notch -B- is opposite mark -A-.

– Unscrew TDC mark sealing plug at cylinder block.

Note

A TDC hole can be felt in the crankshaft exactly behind the sealing plug.



WARNING

To avoid possible injury, do not turn crankshaft whilst feeling for TDC hole.

– Screw locking bolt -3242- into hole of sealing plug removed and tighten bolt.

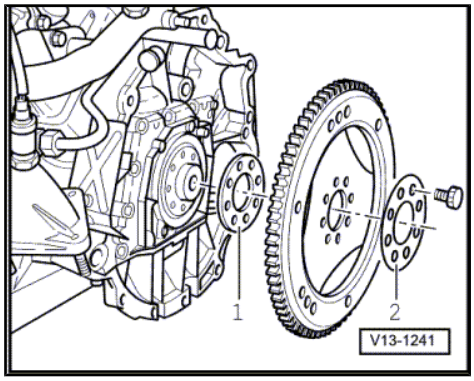
– Mark drive plate with respect to engine.

– Unscrew drive plate.

Installing

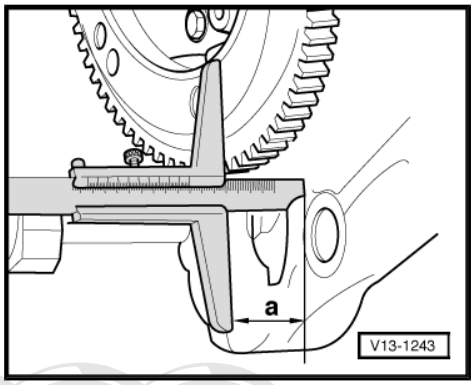
– Fit drive plate in position with packing plate -2- and shim -1- of “3.0 mm” or “4.0 mm” thickness.

– Insert at least 3 old bolts and tighten to 30 Nm.



– Check dimension -a- at 3 locations and calculate mean value.

• Specification for automatic gearbox 01V: 18.1 … 19.7 mm.



If reading does not match specification:

– Remove drive plate again and fit with different shim -1-. Re-tighten bolts to 30 Nm.

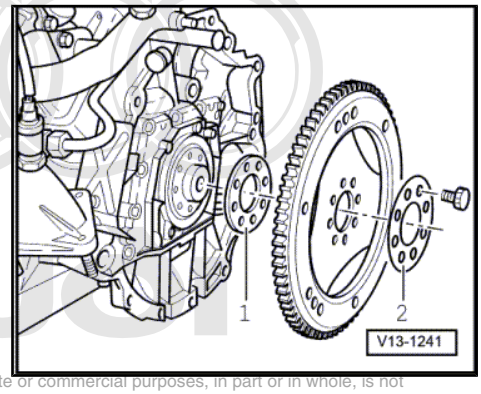
– Repeat measurement procedure.

If reading matches specification:

– Replace and tighten bolts.

– Remove locking bolt -3242- .

– Screw TDC mark sealing plug with new O-ring into cylinder block.



Tightening torques

Component	Nm
Drive plate to crankshaft	60 + 90° 1) 2)
Sealing plug in cylinder block	10

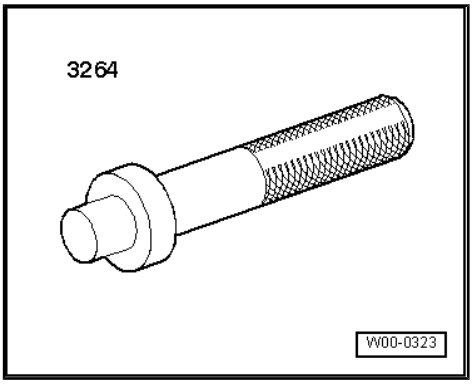
• 1) Replace bolts.

• 2) 90° corresponds to a quarter turn.

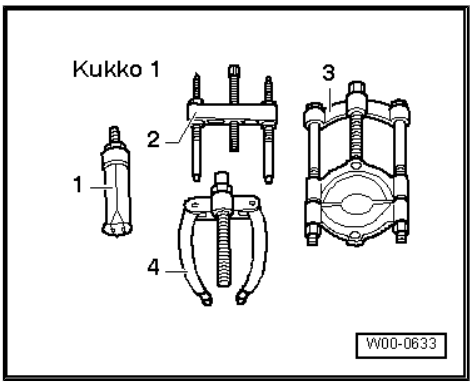
2.6 Extracting needle bearing from dual-mass flywheel and driving in

Special tools and workshop equipment required

♦ Driving-in mandrel -3264-



♦ 1 - Internal puller -Kukko 21/1-

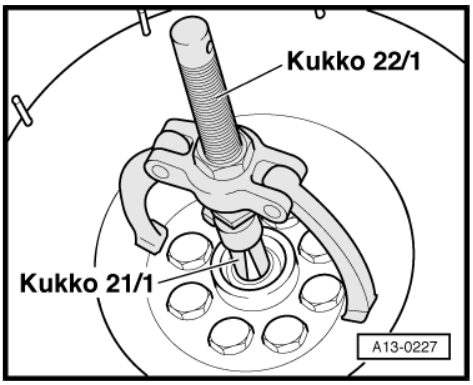


♦ 4 - Support -Kukko 22/1-

Sequence of operations

– Use internal puller -Kukko 21/1- and support -Kukko 22/1- to extract needle bearing.

– Use driving-in mandrel -3264- to drive in needle bearing such that it is flush.

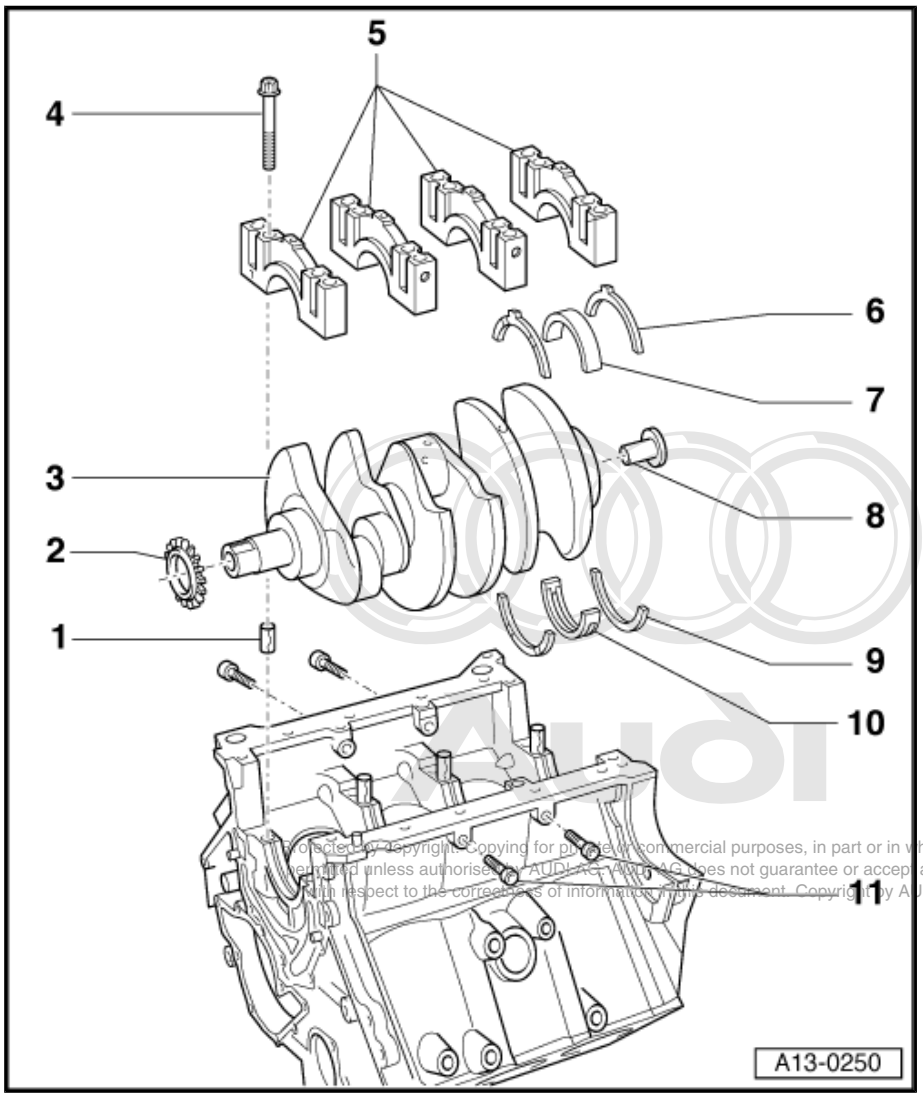


3 Removing and installing crankshaft

3.1 Exploded view of crankshaft

Note

- *The illustration shows the "engine generation III" version as an example for both engine generations.*
- *For performing assembly work, attach engine with engine and gearbox holder -VAS 6095- to repair stand* ⇒ page 22 .



1 - Dowel sleeve
- ❑ Insert in cylinder block

2 - Chain sprocket
- ❑ "Engine generation III" only
- ❑ Removing and installing ⇒ page 58

3 - Crankshaft
- ❑ Measuring axial clearance ⇒ page 57
- ❑ Measuring radial clearance ⇒ page 57
- ❑ Do not turn crankshaft when measuring radial clearance
- ❑ Crankshaft dimensions ⇒ page 56

4 - Bearing cap bolts
- ❑ Replace
- ❑ Tightening sequence ⇒ page 56

5 - Bearing cap
- ❑ Heed identification ⇒ page 55
- ❑ Installing ⇒ page 56

6 - Thrust washer
- ❑ At 4th crankshaft bearing only
- ❑ Oil grooves face outwards
- ❑ Pay attention to retainer
- ❑ Measuring axial clearance of crankshaft ⇒ page 57

7 - Bearing shell for bearing cap
- ❑ No oil groove
- ❑ Do not interchange used bearing shells (mark)
- ❑ Insert new bearing shells for bearing caps with correct colour coding ⇒ page 56

8 - Mounting bush
- ❑ Automatic gearbox only
- ❑ Driving in ⇒ page 56

9 - Thrust washer

- ❑ At 4th crankshaft bearing only
- ❑ Oil grooves face outwards
- ❑ Measuring axial clearance of crankshaft ⇒ page 57

10 - Bearing shell for cylinder block

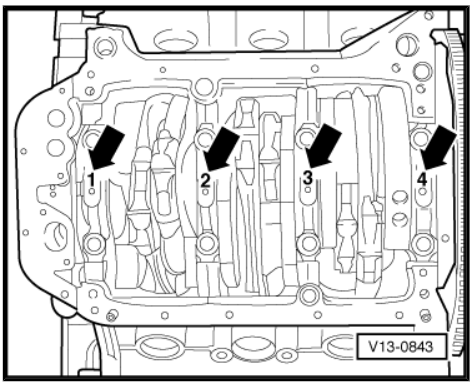
- ❑ With oil groove
- ❑ Do not interchange used bearing shells (mark)
- ❑ Insert new bearing shells for cylinder block with correct colour coding ⇒ page 55

11 - Bearing cap bolts

- ❑ Tightening sequence ⇒ page 56

Identification of crankshaft bearing caps

- ♦ Bearing -1- is located on pulley end.
- ♦ Bearing -4- is located on flywheel end.



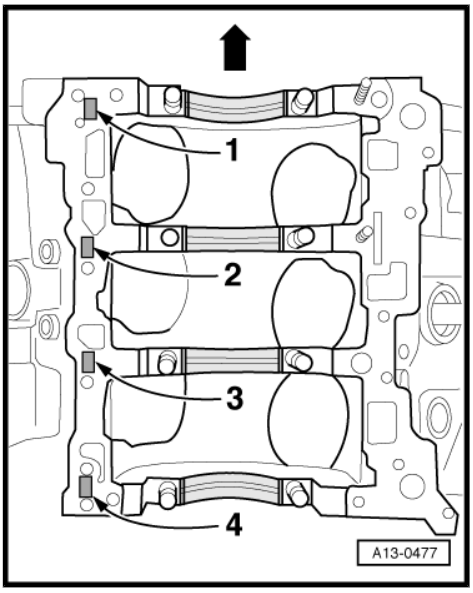
Assignment of crankshaft bearing shells for cylinder block

Note

Arrow faces pulley end.

- ♦ Bearing shells of the correct thickness are assigned to the cylinder block at the factory. Coloured dots at the bearing shell provide an indication of the bearing shell thickness.
- ♦ The assignment of the bearing shells to the cylinder block is indicated by a letter next to the corresponding bearing.

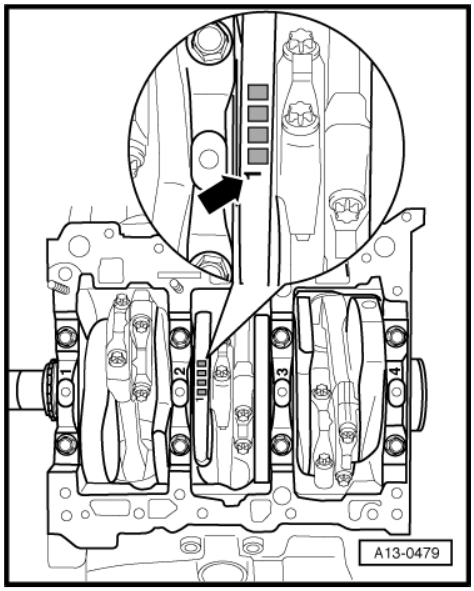
Letter on cylinder block	Colour of bearing
G =	yellow
B =	blue
S =	black



Assignment of crankshaft bearing shells for bearing caps

- Bearing shells of the correct thickness are assigned to the bearing caps at the factory. Coloured dots at the bearing shell provide an indication of the bearing shell thickness.
- The assignment of the bearing shells to the crankshaft is indicated by a series of letters at the crankshaft web. The “1” at the beginning -arrow- designates the colour code for bearing 1.

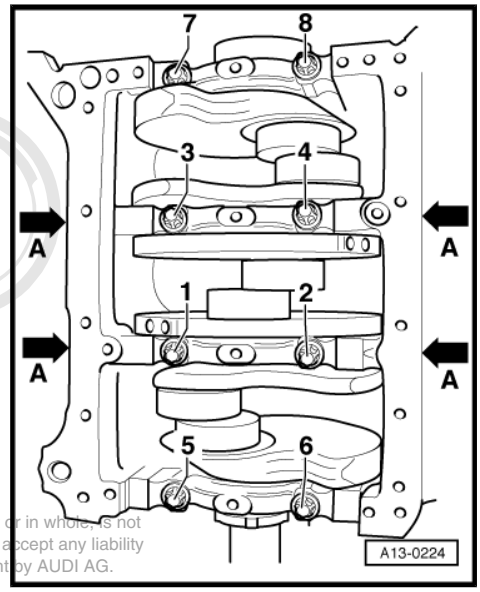
Letter on crankshaft	Colour of bearing
G =	yellow
B =	blue
S =	black



Installing crankshaft bearing caps

– Replace bolts -1 … 8-.
– Insert dowel sleeves in cylinder block.
– Tighten bearing cap bolts in the following sequence:

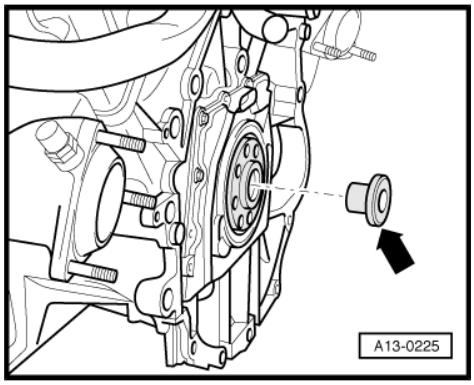
1. Screw in bolts -A- hand-tight.
2. Use torque wrench to tighten bolts -1 … 8- to 60 Nm.
3. Use fixed wrench to give bolts -1 … 8- a further 90° ($^1/_4$) turn.
4. Use torque wrench to tighten bolts -A- to 25 Nm.



Mounting bush for torque converter

Note

Short and reconditioned engines, as well as new and reconditioned crankshafts, are supplied without bush -arrow-. On vehicles with automatic gearbox, the bush must therefore be driven in before fitting the drive plate. Vehicles with manual gearbox must not be fitted with a bush.



3.2 Crankshaft dimensions

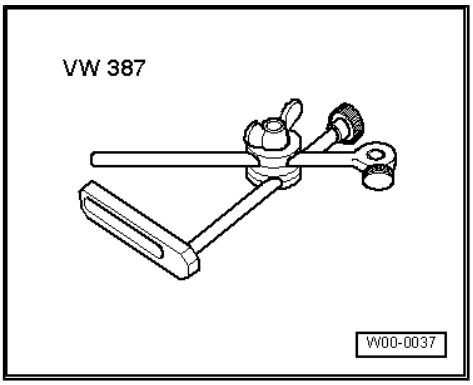
Grinding dimension in mm	Crankshaft bearing journal ∅	Crankshaft conrod journal ∅
Basic dimension	65.00 – 0.022 – 0.042	54.00 – 0.022 – 0.042
Repair stage 1	64.75 – 0.022 – 0.042	53.75 – 0.022 – 0.042

Grinding dimension in mm	Crankshaft bearing journal ∅	Crankshaft conrod journal ∅
Repair stage 2	64.50 – 0.022 – 0.042	53.50 – 0.022 – 0.042
Repair stage 3	64.25 – 0.022 – 0.042	53.25 – 0.022 – 0.042

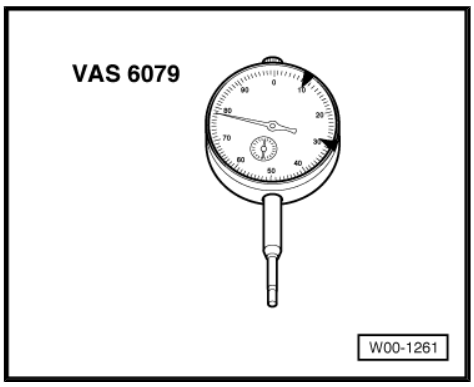
3.3 Measuring crankshaft axial clearance

Special tools and workshop equipment required

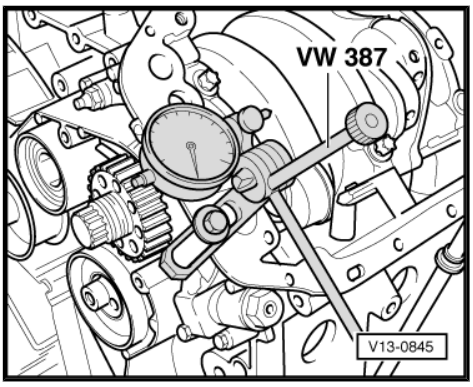
- Universal dial gauge holder -VW 387-



- Dial gauge -VAS 6079-



Sequence of operations



– Screw on dial gauge with universal dial gauge holder -VW 387- at cylinder block and position against crank web.

– Press crankshaft by hand towards dial gauge and set dial gauge to “0”.

– Press crankshaft away from dial gauge and take reading:

- Axial clearance (new): 0.07 ... 0.23 mm.
- Axial clearance: wear limit: 0.25 mm

3.4 Measuring crankshaft radial clearance

Special tools and workshop equipment required

- Plastigage

Sequence of operations

Note

Do not interchange used bearings.

– Remove crankshaft bearing cap and clean bearing cap and journal.

– Place Plastigage thread corresponding to bearing width on journal or in bearing shells.

• Plastigage thread must come to rest in centre of bearing shell.

– Fit crankshaft bearing cap and tighten to 30 Nm. Do not turn crankshaft.

– Remove crankshaft bearing cap again.

– Compare width of Plastigage thread to measurement scale:

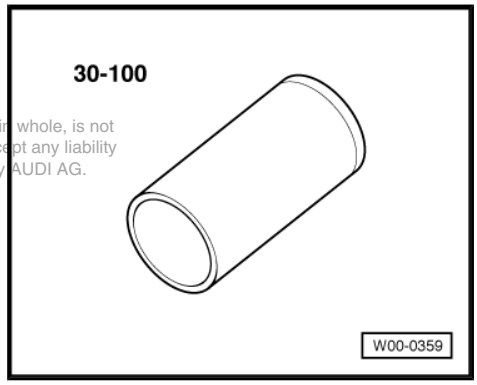
• Radial clearance (new): 0.018 ... 0.045 mm.

• Radial clearance (wear limit): 0.10 mm.

3.5 Removing and installing chain sprocket - “engine generation III”

Special tools and workshop equipment required

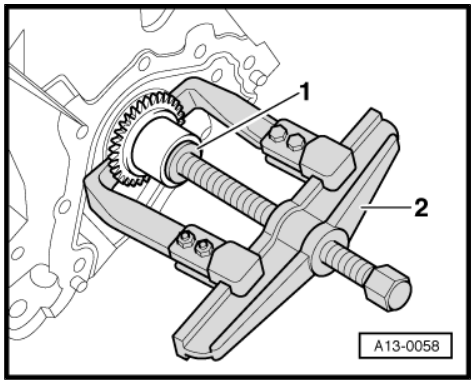
♦ Fitting sleeve -30-100-



Removing

– Remove oil pump chain ⇒ page 147 .

– Use commercially available claw-type puller -2- to detach crankshaft chain sprocket. In doing so, protect end of crankshaft with suitable packing plate -1-.



Installing

Install in reverse order, paying attention to the following:

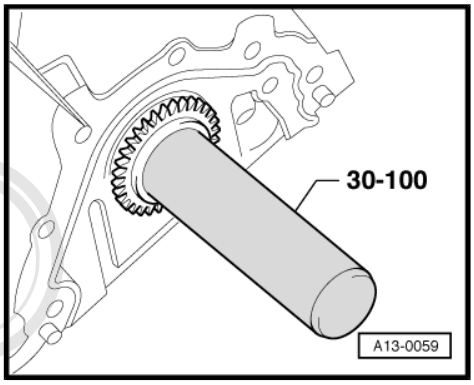
Note

Installation position: lettering on chain sprocket must be visible.

– Heat chain sprocket in stove for approx. 15 minutes to 220 ° C.

WARNING

Wear protective gloves.



– Use pliers to position chain sprocket on end of shaft and press home on crankshaft with fitting sleeve -30-100- .

4 Dismantling and assembling pistons and conrods

4.1 Different conrods and conrod bolts

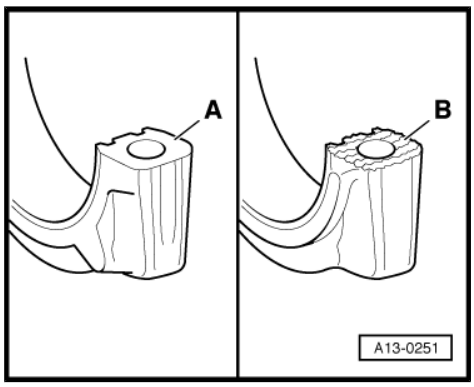
The following new features were gradually introduced with “engine generation III”:

- Cracked instead of sawn conrods as of approx. 10.1997
- Distinguishing features of sawn and cracked conrods:

A - Sawn conrods = smooth parting surface

B - Cracked conrods = rough parting surface

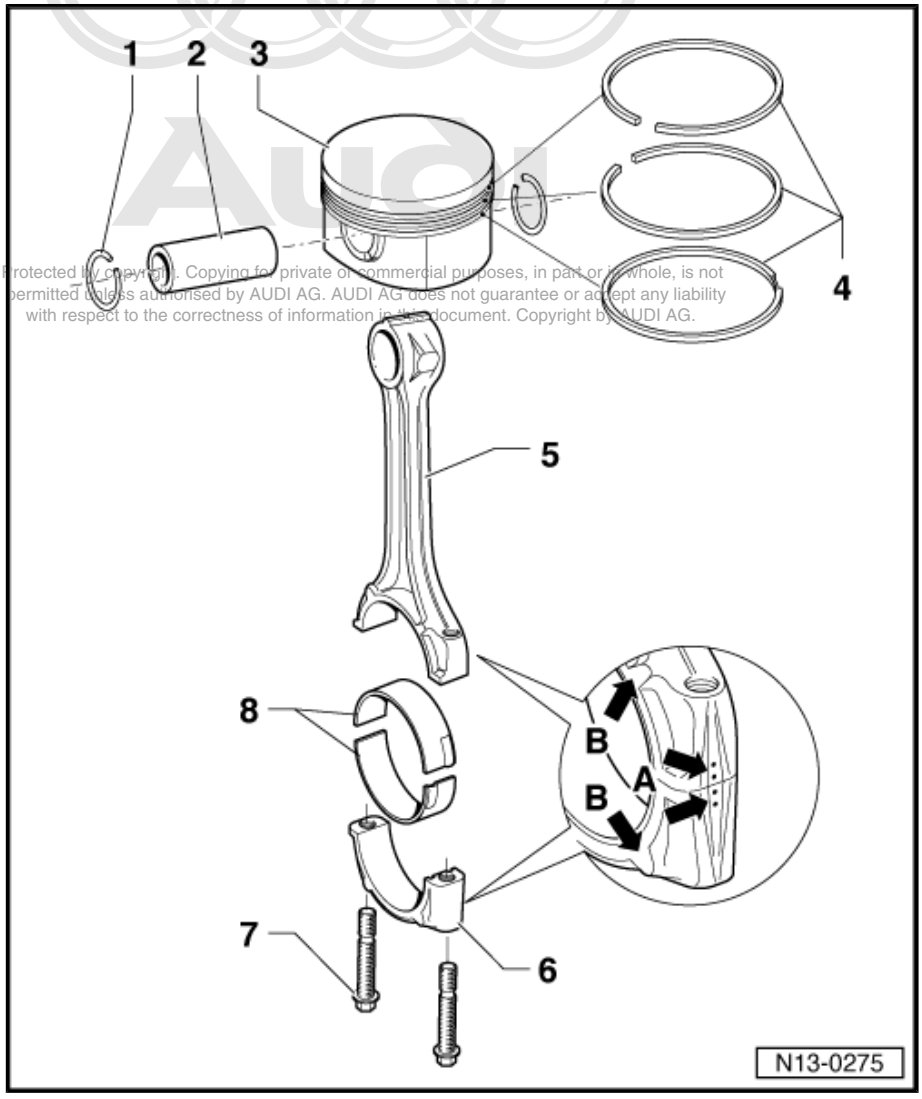
- Gradual introduction of M8.5 conrod bolts instead of M8



4.2 Exploded view of sawn conrods

Note

Oil spray jet for piston cooling ⇒ page 65



1 - Circlip

2 - Piston pin

- ❑ If stiff, heat piston to approx. 60 °C
- ❑ Use mandrel -VW 222 A- for removal and installation

3 - Piston

- ❑ Mark installation position and assignment to cylinder
- ❑ Arrow on piston crown faces pulley end
- ❑ Checking ⇒ page 63
- ❑ Install using piston ring clamp
- ❑ Piston and cylinder dimensions ⇒ page 65
- ❑ Checking cylinder bore ⇒ page 64

4 - Piston rings

- ❑ Offset gap by 120°
- ❑ Use piston ring pliers for removal and installation
- ❑ “TOP” mark must face piston crown
- ❑ Checking ring gap ⇒ page 63
- ❑ Checking side clearance ⇒ page 63

5 - Conrod

- ❑ Only to be replaced as a set
- ❑ Mark assignment to cylinder -A- ⇒ page 64
- ❑ Marks -B- face pulley end with cyl. 1 … 3 and flywheel end with cyl. 4 … 6

6 - Conrod bearing cap

- ❑ Heed installation position

7 - Conrod bolt - 30 Nm + further 90° ($^1/_4$) turn

- ❑ Replace
- ❑ Lubricate thread and resting surface
- ❑ Tighten to 30 Nm for measuring radial clearance but do not give further turn

8 - Bearing shell

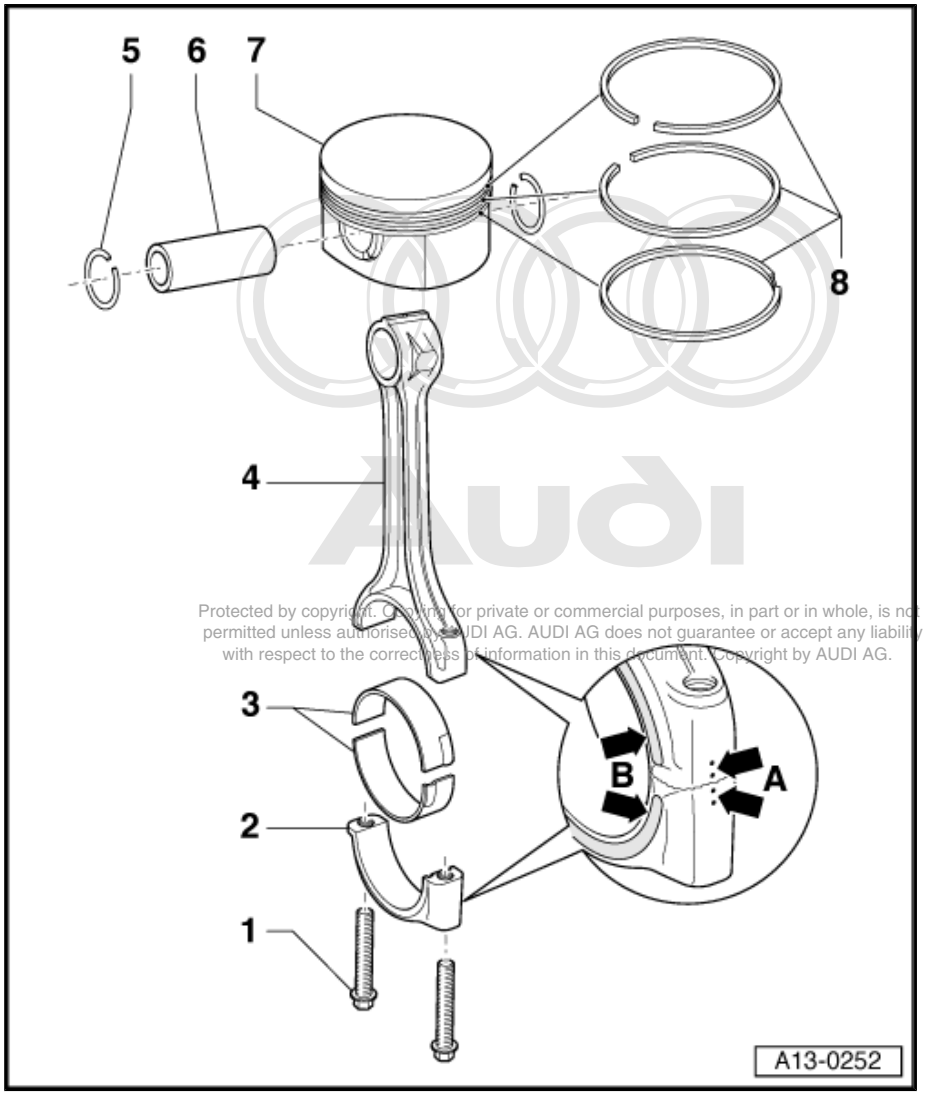
- ❑ Heed installation position
- ❑ Do not interchange used bearing shells (mark)
- ❑ Measuring radial clearance ⇒ page 65

❑ Tighten bolts ⇒ Item 7 (page 61) to 30 Nm for measuring radial clearance but do not give further turn

4.3 Exploded view of cracked conrods

Note

Oil spray jet for piston cooling ⇒ page 65



1 - Conrod bolt M8 = 30 Nm + further 90° (1/4) turn; conrod bolt M8.5 = 40 Nm + further 90° (1/4) turn

Caution

Both M8 and M8.5 conrod bolts are used with cracked conrods.

The use of M8 bolts in M8.5 threads results in serious engine damage.

- ❑ Replace
- ❑ Lubricate thread and resting surface
- ❑ Tighten to 30 Nm for measuring radial clearance but do not give further turn

2 - Conrod bearing cap

- ❑ Note installation position: split contact surfaces on side of conrod must be in alignment -B-

3 - Bearing shell

- ❑ Heed installation position
- ❑ Do not interchange used bearing shells (mark)
- ❑ Measuring radial clearance ⇒ page 65
- ❑ Tighten bolts ⇒ Item 7 (page 61) to 30 Nm for measuring radial clearance but do not give further turn

4 - Conrod

- ❑ Only to be replaced as a set
- ❑ Mark assignment to cylinder -A- ⇒ page 64
- ❑ Note when fitting bearing cap: split contact surfaces on side of conrod must be in alignment -B-
- ❑ Installation position of conrod pairs ⇒ page 65

5 - Circlip

6 - Piston pin

- ❑ If stiff, heat piston to approx. 60 °C
- ❑ Use mandrel -VW 222 A- for removal and installation

7 - Piston

- ❑ Mark installation position and assignment to cylinder
- ❑ Arrow on piston crown faces pulley end
- ❑ Checking ⇒ page 63
- ❑ Install using piston ring clamp
- ❑ Piston and cylinder dimensions ⇒ page 65
- ❑ Checking cylinder bore ⇒ page 64

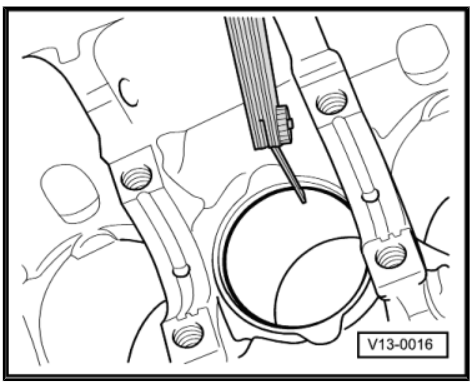
8 - Piston rings

- ❑ Offset gap by 120°
- ❑ Use piston ring pliers for removal and installation
- ❑ “TOP” mark must face piston crown
- ❑ Checking ring gap ⇒ page 63
- ❑ Checking side clearance ⇒ page 63

Checking piston ring gap

– Insert ring at right angles to cylinder wall from above as far as lower cylinder opening, approx. 15 mm from edge of cylinder. Use piston without rings for insertion.

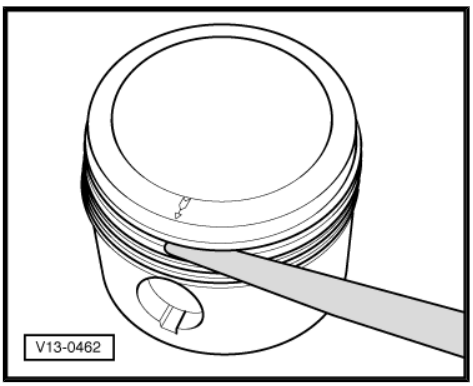
Piston ring Dimensions in mm	As-new	Wear limit
1. Compression ring	0.35 … 0.50	1.0
2. Compression ring	0.50 … 0.70	1.4
Oil scraper ring	0.25 … 0.50	0.8



Checking piston ring side clearance

– Clean ring groove of piston before checking.

Piston ring Dimensions in mm	As-new	Wear limit
Compression rings	0.02 … 0.08	0.10
Oil scraper ring	0.02 … 0.08	0.10

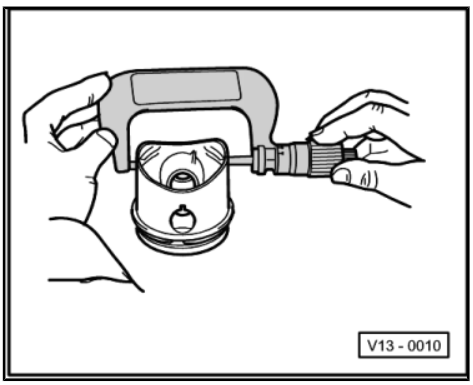


Checking piston

– Measure by placing 75 … 100 mm external micrometer approx. 10 mm from bottom edge, offset by 90° with respect to piston pin axis.

• Maximum deviation from nominal dimension: 0.04 mm.

Rated dimension
⇒ “4.4 Piston and cylinder dimensions”, page 65

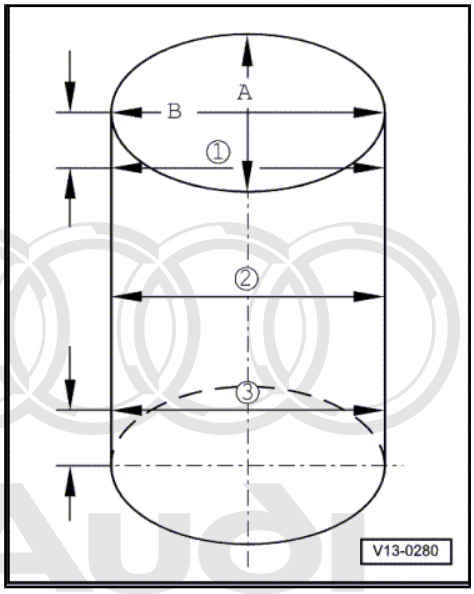


Checking cylinder bore

– Use 50 … 100 mm inside calipers to measure diagonally at 3 locations in transverse direction -A- and in axial direction -B-.

• Maximum deviation from nominal dimension: 0.08 mm.

Rated dimension
⇒ “4.4 Piston and cylinder dimensions”, page 65



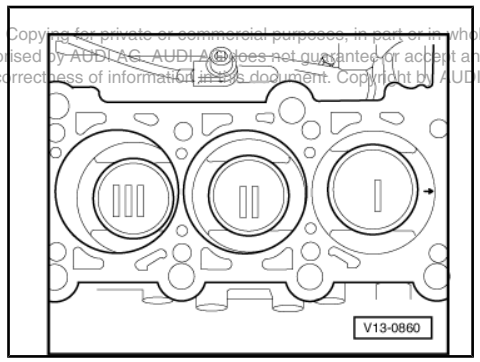
Piston installation position and piston/cylinder assignment

– Use chalk or a waterproof felt-tip pen to mark installation position and assignment to cylinder at piston crown.

Note

Do not use centre punch or scriber, as this would damage the coating of the piston crown.

• Installation position: Arrow on piston crown points to pulley end.



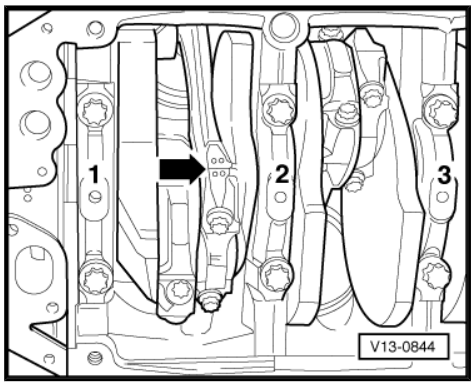
Marking conrods

Note

♦ *Conrods are only to be replaced as a set.*

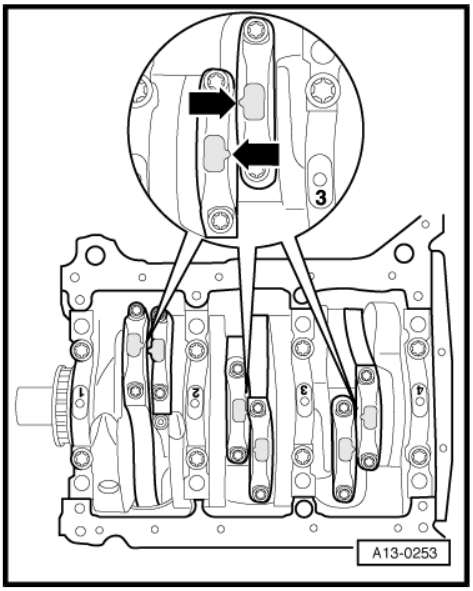
♦ *Do not interchange conrod bearings.*

– Prior to removal, use a coloured pen to mark mutual assignment of conrod and conrod bearing cap -arrow-.



Installation position of conrod pairs with cracked conrods

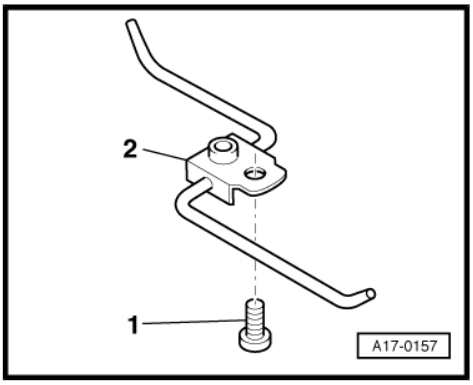
- The cast lugs -arrows- at the ground surfaces of the conrod pairs 1 and 2, 3 and 4, as well as 5 and 6, must face one another.



Oil spray jet for piston cooling

1 - Bolt -10 Nm

2 - Oil spray jet for piston cooling



4.4 Piston and cylinder dimensions

Grinding dimension in mm	Piston ∅ mm	Cylinder bore ∅ mm
Basic dimension	82.485	82.51
Stage I	82.735	82.76
Stage II	82.985	83.01

Note

Only pistons with basic dimension are available as replacement parts.

4.5 Checking radial clearance of conrods

Special tools and workshop equipment required

♦ Plastigage

Test sequence

– Remove conrod bearing caps.

– Clean bearing caps and bearing journals.

– Place Plastigage thread corresponding to bearing width on journal or in bearing shells.

• Plastigage thread must come to rest in centre of bearing shell.

– Fit conrod bearing caps and tighten to 30 Nm. Do not turn crankshaft.
– Remove conrod bearing caps again.
– Compare width of Plastigage thread to measurement scale:
• Radial clearance (new): 0.015 ... 0.062 mm.
• Radial clearance (wear limit): 0.12 mm.
– Replace bolts for conrod bearings.

15 – Cylinder head, valve gear

1 Removing and installing cylinder head

1.1 Different cylinder heads

The new features of “engine generation III” as opposed to “engine generation II” are as follows:

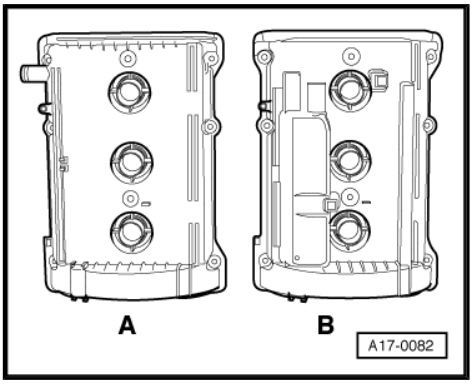
- Modified oil routing in cylinder head; originally with oil supply pipes on camshaft bearing caps, subsequently replaced by integrated oil ducts in camshaft bearing caps

Distinguishing feature

An external distinguishing feature of the “engine generations II” and “III” is the shape of the cylinder head cover:

A - “Engine generation II” (up to approx. 04.1997)

B - “Engine generation III” (as of approx. 04.1997)



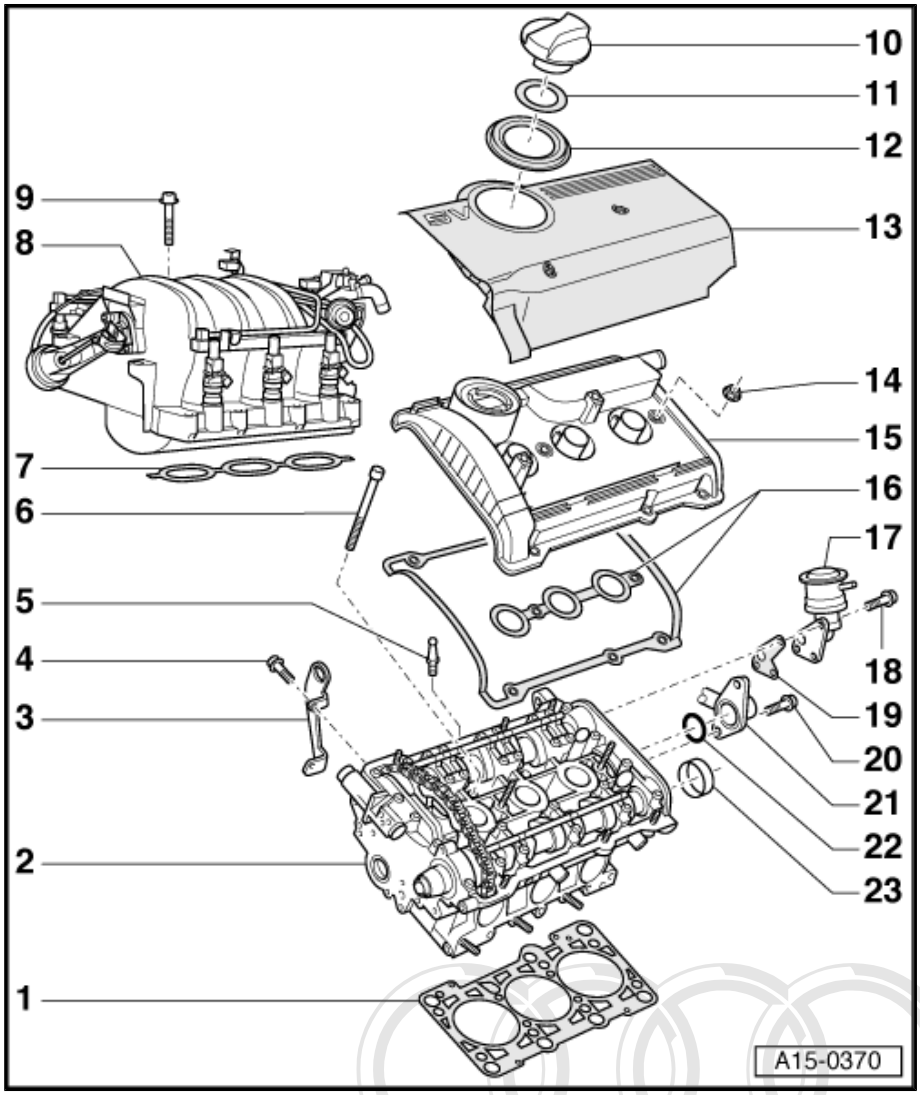
Note

- *“Engine generation II” cylinder heads are only to be fitted on an “engine generation II” cylinder block. A combination of the two versions is not permitted.*
- *“Engine generation III” cylinder heads are only to be fitted on an “engine generation III” cylinder block. A combination of the two versions is not permitted.*
- *“Engine generation III” cylinder heads can be combined regardless of the type of oil routing (with or without oil pipe).*

1.2 Exploded view of cylinder head

Note

The illustration shows the left cylinder head for “engine generation III” with oil pipes.



1 - Cylinder head gasket

- ❑ Replacing ⇒ “1.5 Removing left cylinder head”, page 74 or ⇒ “1.6 Removing right cylinder head”, page 77
- ❑ Installation position: Part No. towards cylinder head
- ❑ Fill with fresh coolant following replacement

2 - Cylinder head

- ❑ Removing: left-side ⇒ page 74 ; right-side ⇒ page 77
- ❑ Checking for torsion ⇒ page 69
- ❑ Reworking dimension ⇒ page 69
- ❑ Driving sealing cap into cylinder head ⇒ page 70
- ❑ Installing ⇒ page 80
- ❑ Fill with fresh coolant following replacement

3 - Lifting eye

4 - 25 Nm

5 - Centring pin for intake manifold

6 - Cylinder head bolt

- ❑ Replace
- ❑ Different bolts ⇒ page 70
- ❑ Heed unfastening sequence ⇒ page 77 or ⇒ page 79
- ❑ Heed tightening sequence ⇒ page 82

7 - Intake manifold gasket

- ❑ Replace

8 - Intake manifold

- ❑ Removing and installing ⇒ page 83

9 - 10 Nm

- ❑ Tighten diagonally and in stages

10 - Sealing cap

11 - Gasket

- ❑ Replace if damaged or leaking

12 - Rubber ring

13 - Cover panel for cylinder head cover

14 - 10 Nm

- ❑ Heed tightening sequence ⇒ page 72 or ⇒ page 74

15 - Cylinder head cover

- ❑ Removing and installing: left-side ⇒ page 70 , right-side ⇒ page 72

16 - Gaskets for cylinder head cover

- ❑ Replace if damaged or leaking
- ❑ Before fitting, apply sealant to transitions ⇒ page 70 ; sealant ⇒ Parts catalogue

17 - Secondary air combination valve

18 - 10 Nm

19 - Gasket

- ❑ Replace

20 - 10 Nm

21 - Rear coolant pipe

22 - O-ring

- ❑ Replace

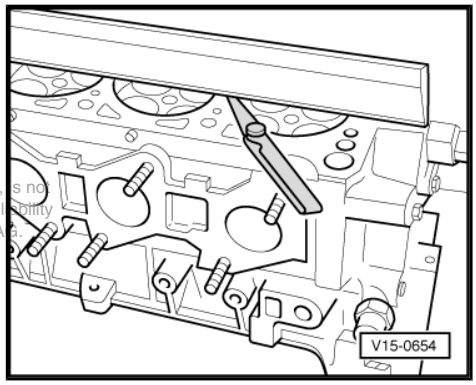
23 - Sealing cap

- ❑ Removing and installing ⇒ page 96

Checking cylinder head for torsion

– Use bevelled straightedge and feeler gauge to check the cylinder head for torsion at several locations.

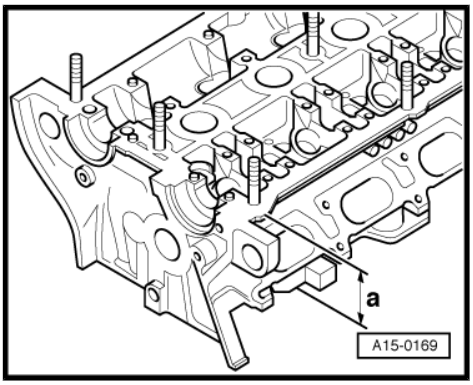
• Maximum permissible distortion: 0.1 mm.



Cylinder head reworking dimension

– Cylinder head reworking (surface grinding) is only permissible down to the minimum dimension -a-.

• Minimum dimension -a- = 139.25 mm

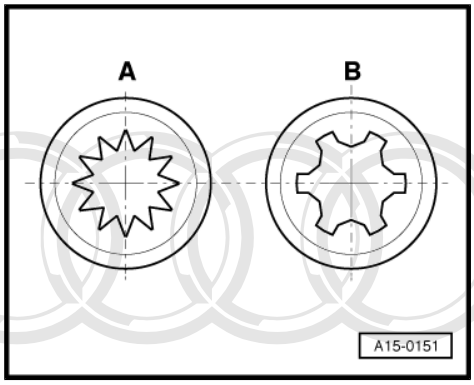


Different cylinder head bolts

The cylinder head bolts have been gradually converted from a multi-point socket to Polydrive. It is necessary to establish the type of head involved before slackening off or tightening the cylinder head bolts:

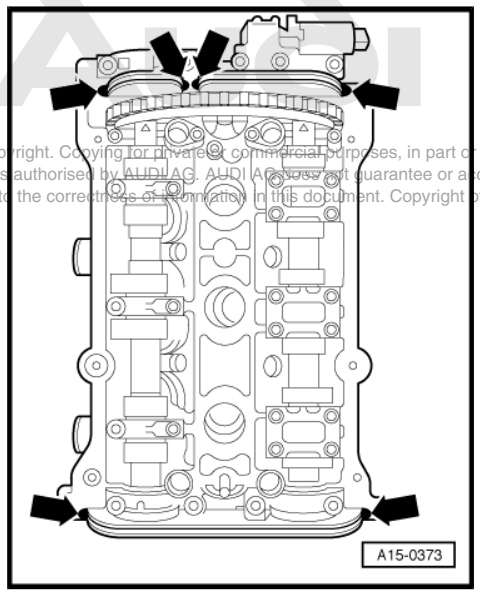
A - Multi-point socket head (use socket -3410-)

B - Polydrive head (use socket -T10070-)



Sealing bearing cap transitions in cylinder head

– Apply a small quantity of sealant to the transitions -arrows- at the upper cylinder head sealing surface; sealant ⇒ Parts catalogue .

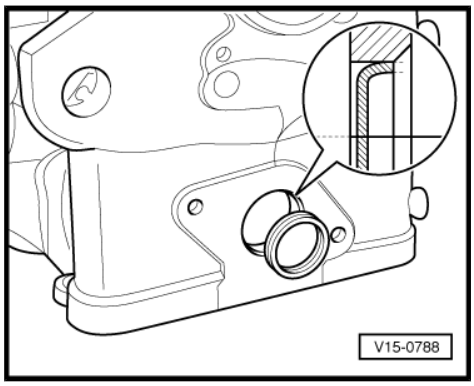


Driving sealing cap into cylinder head

Replacement cylinder heads without camshafts can be used on the left and right and must be provided with a sealing cap on the front side in each case.

– Coat the rim of the sealing cap with sealing paste; sealing paste ⇒ Parts catalogue .

– Use mandrel -VW 295- to drive in sealing cap until outer rim of sealing cap is flush with end of chamfer at cylinder head.



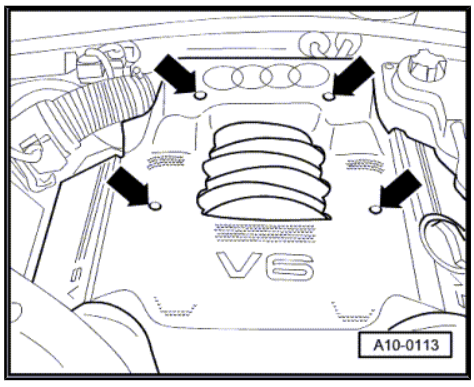
1.3 Removing and installing left cylinder head cover

Note

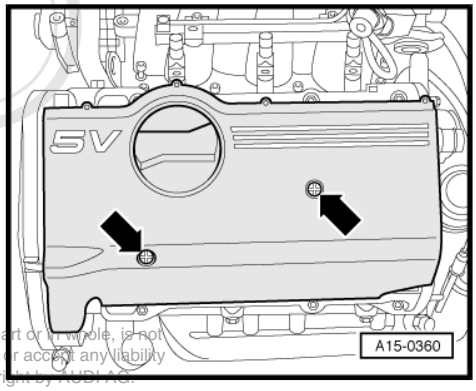
Re-attach all cable ties unfastened or severed on removal at the same location on installation.

Removing

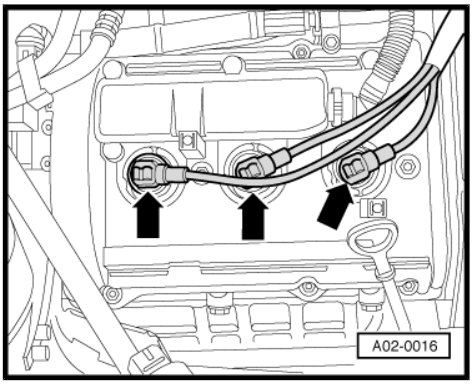
– Remove engine cover -arrows-.



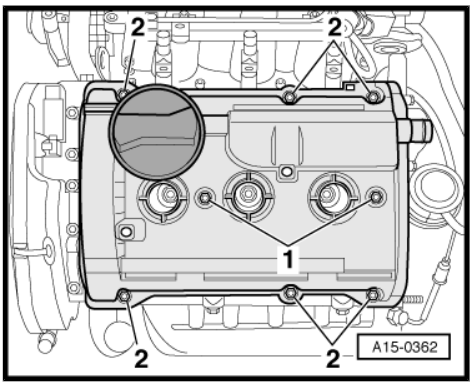
– Remove cover panel for left cylinder head cover -arrows-.



– Unplug spark plug connectors -arrows-.
– Detach crankcase breather hose at cylinder head cover.
– Unfasten cable tie and lay bare wire.



– Unscrew nuts -1- and -2- and detach cylinder head cover.



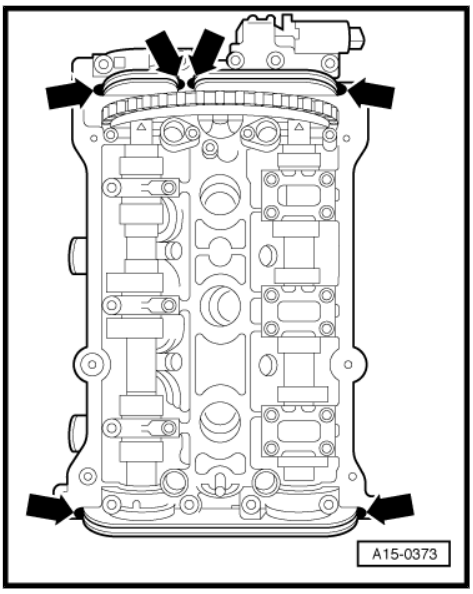
Installing

Install in reverse order, paying attention to the following:

Note

- *Replace gaskets for cylinder head cover if damaged.*
- *Re-attach all cable ties in the same locations on installation.*

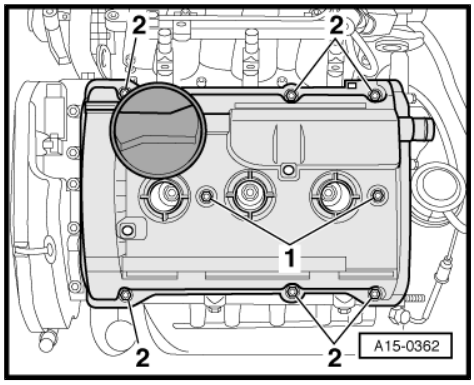
– Apply a small quantity of sealant to the transitions -arrows- at the upper cylinder head sealing surface; sealant ⇒ Parts catalogue .



– Tighten inner nuts -1- for cylinder head cover.
– Then tighten outer nuts -2- diagonally and in stages.

Tightening torque

Component	Nm
Cylinder head cover to cylinder head	10



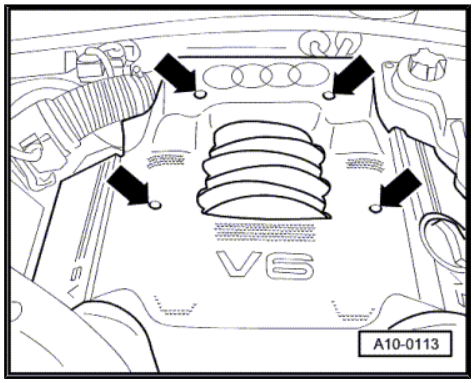
1.4 Removing and installing right cylinder head cover

Note

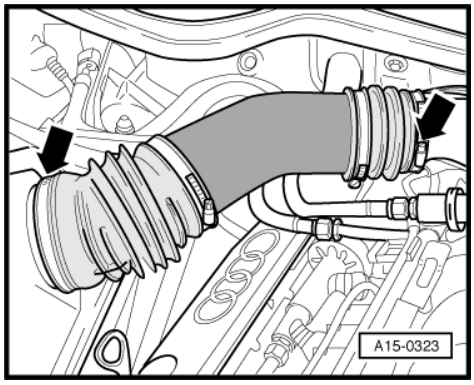
Re-attach all cable ties unfastened or severed on removal at the same location on installation.

Removing

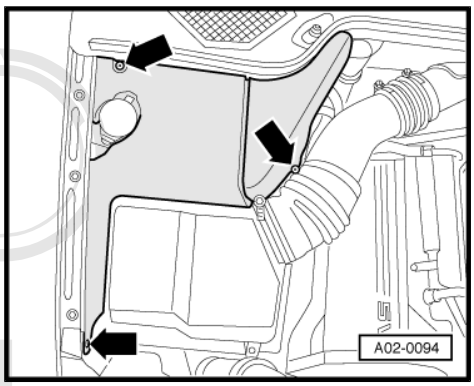
– Remove engine cover -arrows-.



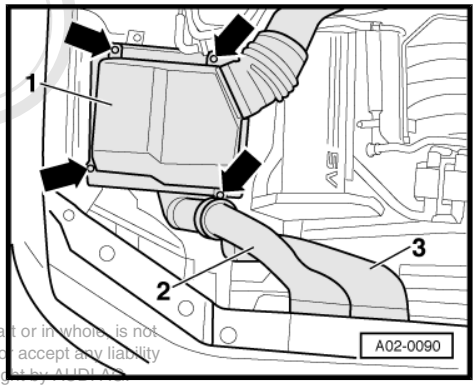
– Remove air hose between air mass meter and intake manifold -arrows-.



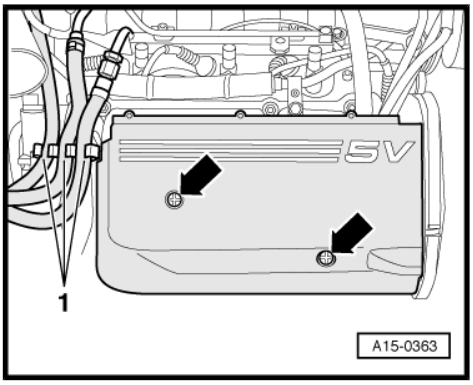
– Remove cover on right in engine compartment -arrows-.



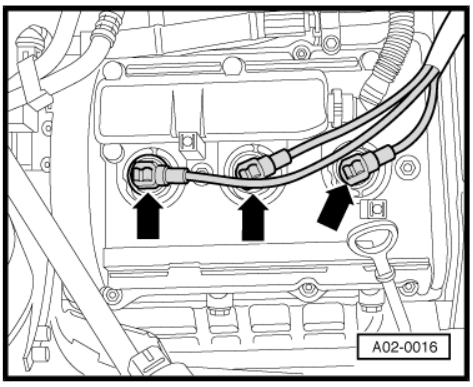
– Remove air ducts -2- and -3-.
– Slacken off bolts -arrows- and lay aside cover -1- of air cleaner housing.



– Disengage 3 hoses -1- from holder at cylinder head cover.
– Remove cover panel for right cylinder head cover -arrows-.
– Unscrew holder for hydraulic pipe from cylinder head cover.



– Unplug spark plug connectors -arrows-.

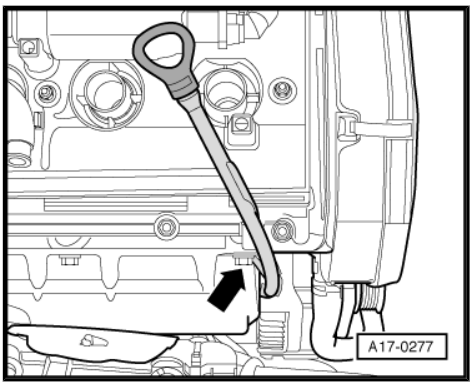


– Unscrew guide tube for dipstick at cylinder head -arrow-.

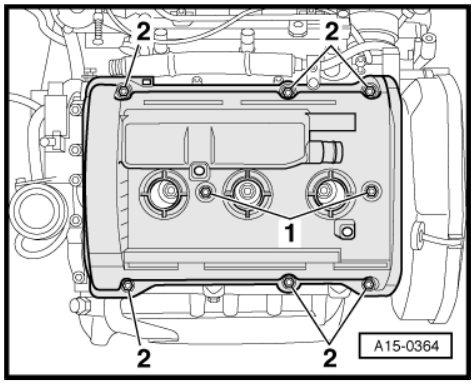
Note

The dipstick guide tube is not to be pulled out upwards, as otherwise the O-ring at the bottom of the guide tube has to be replaced.

– Detach crankcase breather hose at cylinder head cover.
– Unfasten cable tie and lay bare wire.



– Unscrew nuts -1- and -2- and detach cylinder head cover.



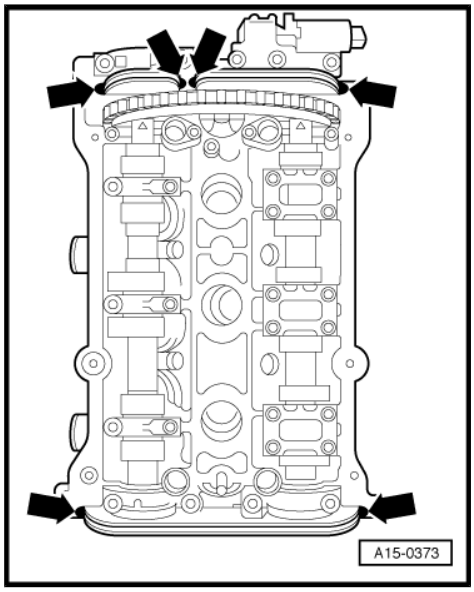
Installing

Install in reverse order, paying attention to the following:

Note

- *Replace gasket for cylinder head cover if damaged.*
- *Re-attach all cable ties in the same locations on installation.*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*

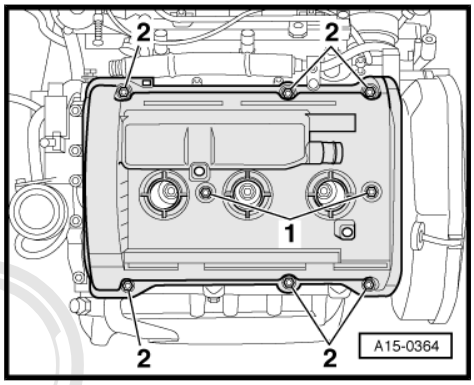
– Apply a small quantity of sealant to the transitions -arrows- at the upper cylinder head sealing surface; sealant ⇒ Parts catalogue .



– Tighten inner nuts -1- for cylinder head cover.
– Then tighten outer nuts -2- diagonally and in stages.

Tightening torques

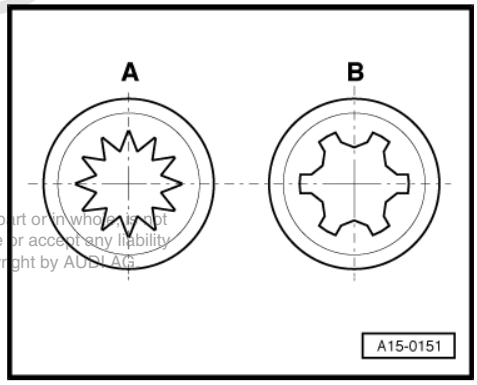
Component	Nm
Cylinder head cover to cylinder head	10
Guide tube for dipstick to cylinder head	22
Holder of power steering pipe to cylinder head	10



1.5 Removing left cylinder head

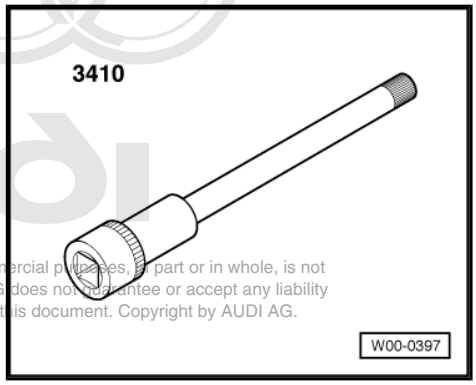
Note

- *The cylinder head bolts have been gradually converted from a multi-point socket to Polydrive. It is necessary to establish the type of head involved before slackening off or tightening the cylinder head bolts:*
- *A - Multi-point socket head (use socket -3410-)*
- *B - Polydrive head (use socket -T10070-)*

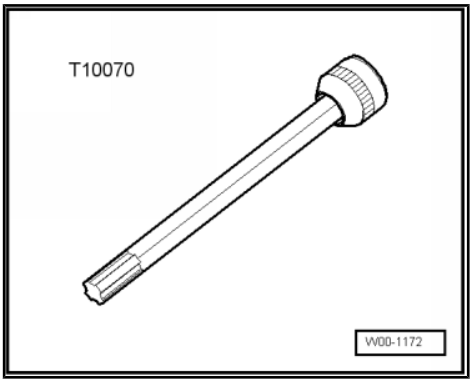


Special tools and workshop equipment required

- Socket -3410-



- Socket -T10070-



Sequence of operations

- Engine in position

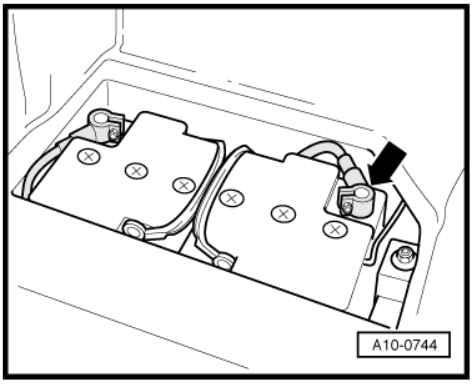
Note

Re-attach all cable ties unfastened or severed on removal at the same location on installation.

Caution

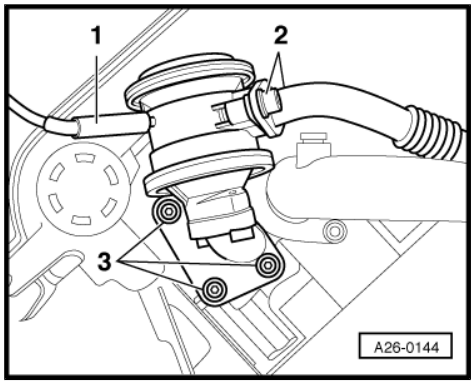
On vehicles with telematics system, activate service mode of telematics control unit before disconnecting battery ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .

– Pay attention to and if necessary establish code for vehicles with encoded radio set/radio navigation system (RNS).
– Detach the side luggage compartment storage area partition and the floor covering secured with a velcro fastener.
– With ignition switched off, disconnect earth strap/cable at negative terminal -arrow- of battery on right of luggage compartment.
– Drain off coolant ⇒ page 155 .
– Remove left front exhaust pipe ⇒ page 188 .



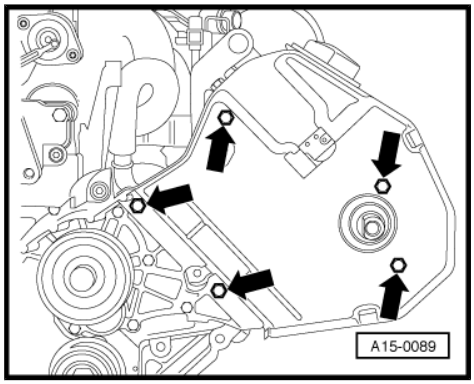
Vehicles with secondary air system:

– Screw out bolts -3- at secondary air combination valve.

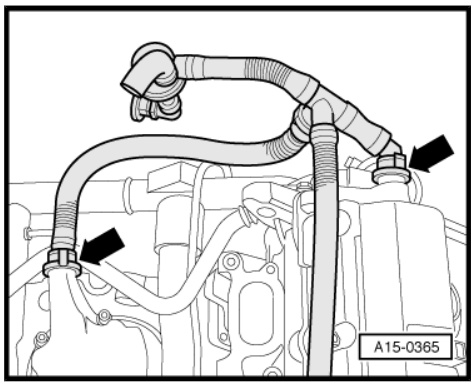


All models:

– Remove toothed belt ⇒ page 35 .
– Detach camshaft sprocket.
– Unscrew toothed belt guard at rear left -arrows-.



– Remove intake manifold ⇒ page 83 .
– Remove crankcase breather hose -arrows-.
– Unplug connectors at Hall sender and camshaft adjustment valve.



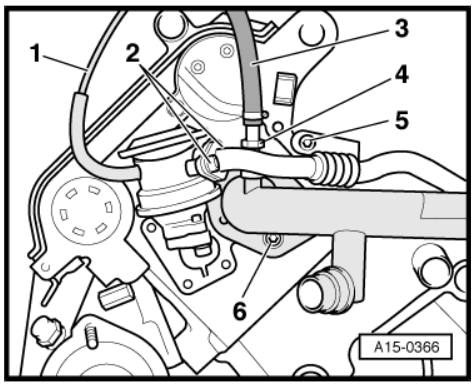
– Detach coolant hose -3-.

Vehicles with secondary air system:

– Detach vacuum hose -1- at combination valve.
– Screw out connection -4-.
– Screw out bolts -2- and detach combination valve.
– Screw out bolt -5-.

All models:

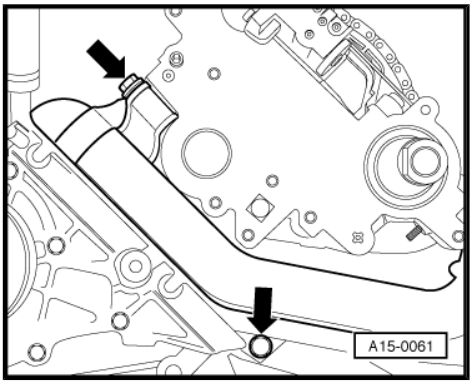
– Screw out the 2 bolts -6- at the rear coolant pipe.



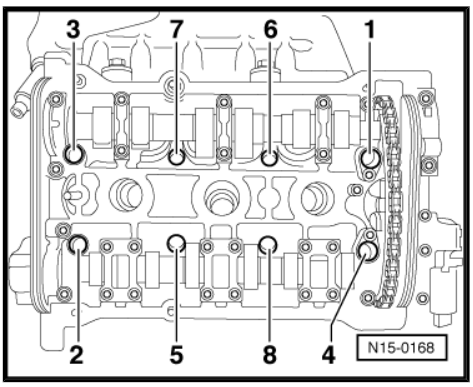
Note

Leave coolant pipe in position.

– Unscrew front coolant pipe at cylinder head -arrows-.



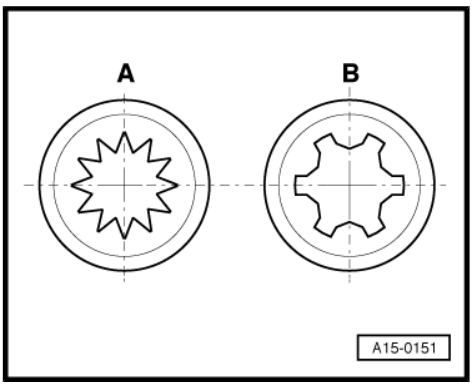
– Remove left cylinder head cover ⇒ page 70 .
– Slacken off cylinder head bolts in sequence -1 ... 8-.
– Screw out cylinder head bolts and carefully detach cylinder head.



1.6 Removing right cylinder head

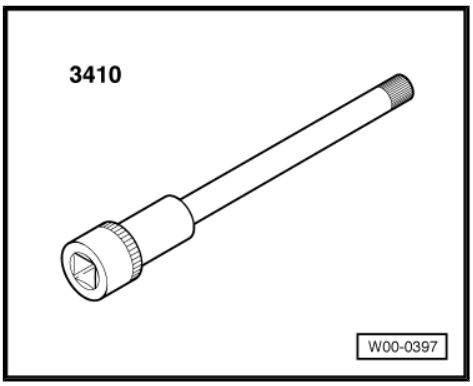
Note

- *The cylinder head bolts have been gradually converted from a multi-point socket to Polydrive. It is necessary to establish the type of head involved before slackening off or tightening the cylinder head bolts:*
- *A - Multi-point socket head (use socket -3410-)*
- *B - Polydrive head (use socket -T10070-)*

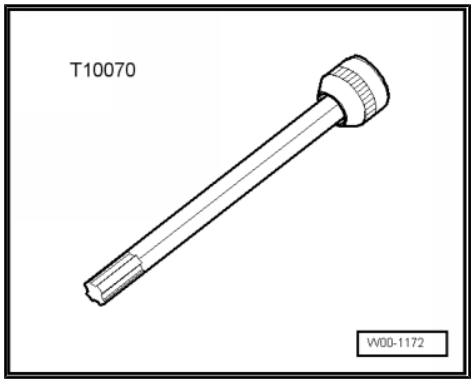


Special tools and workshop equipment required

- Socket -3410-



♦ Socket -T10070-



Sequence of operations

- Engine in position

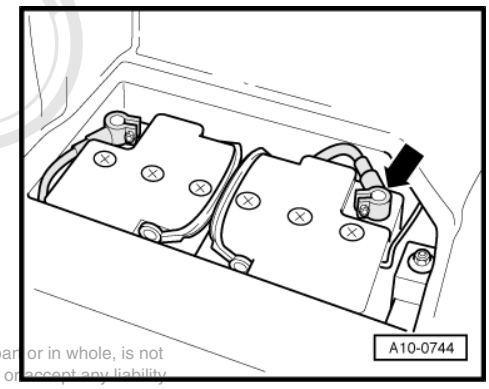
Note

Re-attach all cable ties unfastened or severed on removal at the same location on installation.

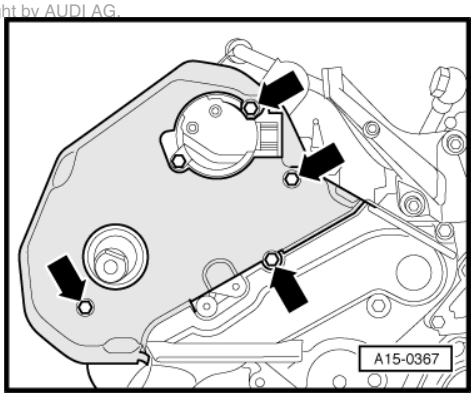
Caution

On vehicles with telematics system, activate service mode of telematics control unit before disconnecting battery ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .

– Pay attention to and if necessary establish code for vehicles with encoded radio set/radio navigation system (RNS).
– Detach the side luggage compartment storage area partition and the floor covering secured with a velcro fastener.
– With ignition switched off, disconnect earth strap/cable at negative terminal -arrow- of battery on right of luggage compartment.
– Drain off coolant ⇒ page 155 .
– Remove right front exhaust pipe ⇒ page 186 .



– Remove toothed belt ⇒ page 35 .
– Detach camshaft sprocket.
– Unscrew toothed belt guard at rear right -arrows-.
– Remove intake manifold ⇒ page 83 .

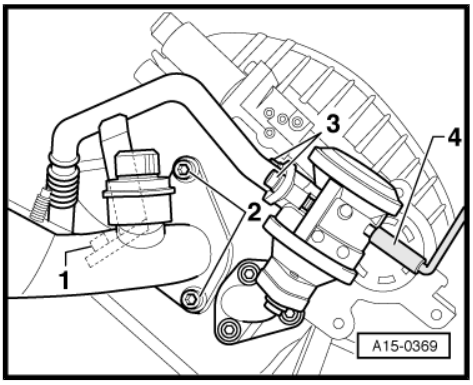


Vehicles with secondary air system:

– Detach vacuum hose -4- at combination valve.
– Screw out bolts -3-.
– Screw out bolt -1- for connecting pipe holder.

All models:

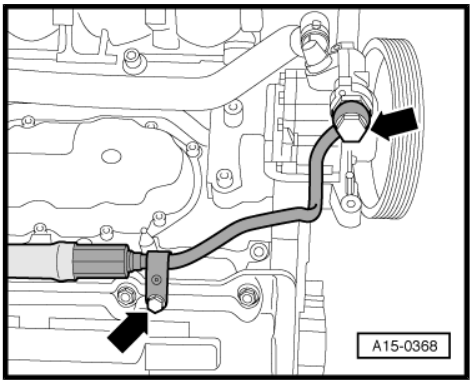
– Screw out coolant pipe bolts -2-.



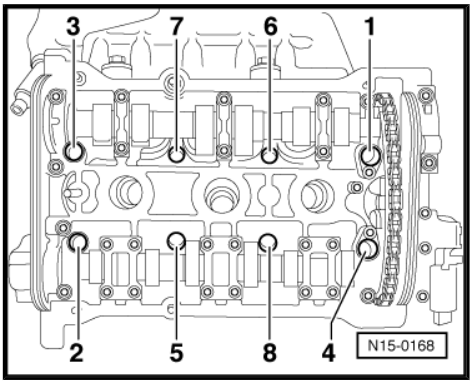
Note

Leave coolant pipe in position.

– Unplug connectors at Hall sender and camshaft adjustment valve.
– Detach power steering pressure pipe at power steering pump and at cylinder head cover -arrows-.



– Remove right cylinder head cover ⇒ page 72 .
– Slacken off cylinder head bolts in sequence -1 ... 8-.
– Screw out cylinder head bolts and carefully detach cylinder head.



1.7 Installing cylinder head

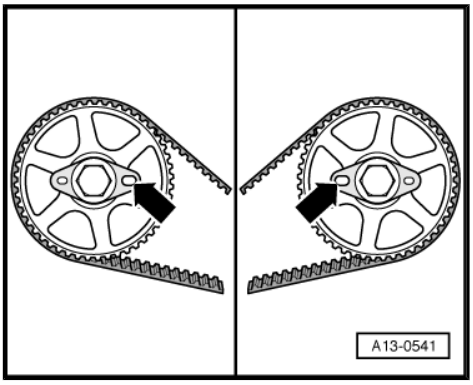
Note

- *Replace cylinder head bolts.*
- *Replace self-locking nuts and bolts when performing assembly work.*
- *Replace bolts tightened by turning through a specified angle, as well as sealing rings and seals.*
- *When performing repairs, carefully remove remnants of gasket from cylinder head and cylinder block. Take care to avoid producing long scoring marks or scratches.*
- *Carefully remove abrasive and grinding residue.*
- *There must not be any oil or coolant in the blind holes for the cylinder head bolts in the cylinder block.*
- *Leave new cylinder head gasket in wrapping until immediately prior to installation.*
- *Treat gasket with extreme care. Damage to silicone layer and in bead area will cause leakage.*
- *Position cylinder head gasket on dowel sleeves. "Top" mark or part number must face cylinder head.*
- *Cylinder heads with cracks between valve seats or between one valve seat ring and spark plug thread can be re-used without shortening service life if cracks are only minor (max. 0.3 mm wide) or if only the first 4 turns of the spark plug thread are cracked.*
- *When installing a reconditioned cylinder head with camshafts fitted, the contact surfaces between bucket tappet and cam surface must be lubricated after fitting the head.*
- *The plastic pads for protection of the open valves are not to be removed until immediately prior to fitting cylinder head.*
- *If a cylinder head is replaced or use is made of a replacement cylinder head without camshafts, a sealing cap must be driven in on the front side of the head in each case* *⇒ page 70*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*
- *Re-attach all cable ties in the same locations on installation.*
- *After working on valve gear, carefully crank engine at least twice by hand to ensure that no valves make contact on starting.*
- *The coolant must be completely replaced on replacing cylinder head or cylinder head gasket.*

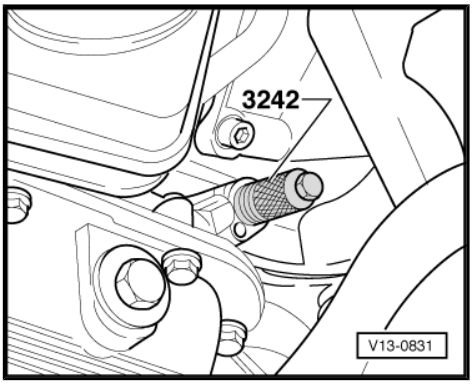
Install in reverse order, paying attention to the following:

– Set crankshaft and camshafts to TDC before fitting cylinder head:

- Large holes -arrows- of locating plates at camshaft sprockets rnust be opposite one another on inside.

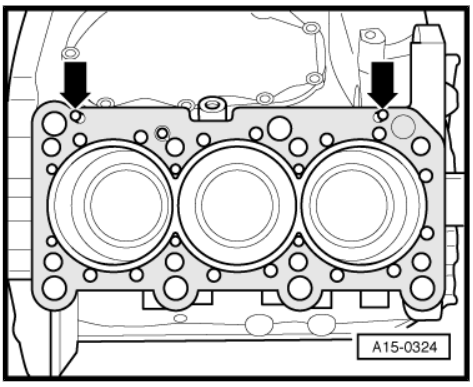


- The locking bolt -3242- must have been screwed in.



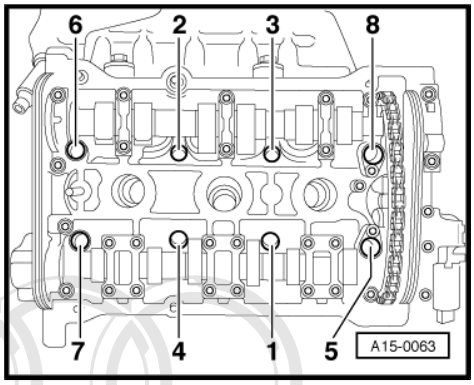
– Fit cylinder head gasket.
- Pay attention to centring pins -arrows- in cylinder block.
- Heed installation position of cylinder head gasket. “Top” mark or part no. must face cylinder head.

– Fit cylinder head.
– Insert and hand-tighten new cylinder head bolts.



– Tighten cylinder head bolts as follows in 3 stages in the sequence indicated:

1. Tighten to 60 Nm with torque wrench.
2. Give further 90° ($^1/_4$) turn with fixed wrench.
3. Give further 90° ($^1/_4$) turn with fixed wrench.



Note

The cylinder head bolts do not have to be re-tightened on completion of repair work.

– Screw in centring pin for intake manifold.
– Install intake manifold ⇒ page 87 .
– Connect vacuum pipes ⇒ page 26 .
– Install cylinder head cover: left-side ⇒ page 71 , right-side ⇒ page 74 .
– Fit toothed belt (adjust timing) ⇒ page 38 .
– Fit poly V-belt ⇒ page 31 .
– Install front exhaust pipe: left-side ⇒ page 185 , right-side ⇒ page 186 .
– Perform stress-free alignment of exhaust system ⇒ page 193 .
– Replace coolant ⇒ page 157 .

Note

- *On re-connecting the battery, remember to activate vehicle equipment (radio/radio navigation system, clock, electric window lifters) in line with owner's manual.*
- *Deactivate service mode of telematics control unit ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .*

– Perform adaption of throttle valve module ⇒ Rep. Gr. 24 .
– Replenish power steering fluid and bleed steering system ⇒ Running gear, front-wheel drive and four-wheel drive; Rep. Gr. 48 .

Tightening torques

Component		Nm
Rear coolant pipe to cylinder head		10
Combination valve to cylinder head		10
Connecting pipe to combination valve		10
Connecting pipe to cylinder head	M6	10
	M8	22
Connection to rear coolant pipe		15
Front coolant pipe to cylinder head	M6	10
	M8	22
Power steering pressure pipe to power steering pump		40
Power steering pressure pipe to cylinder head		10
Guide tube for dipstick to cylinder head		22
Rear toothed belt guard to cylinder head		10 1)

- 1) Apply locking fluid on fitting bolts; locking fluid ⇒ Parts catalogue .

1.8 Removing and installing intake manifold

Note

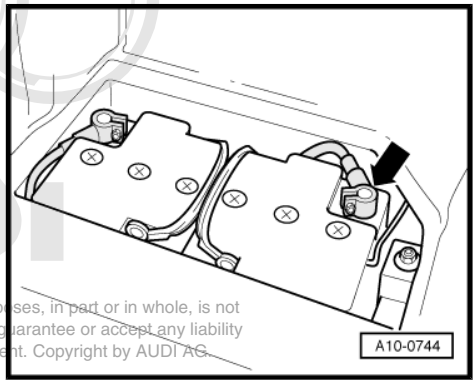
Re-attach all cable ties unfastened or severed on removal at the same location on installation.

Removing

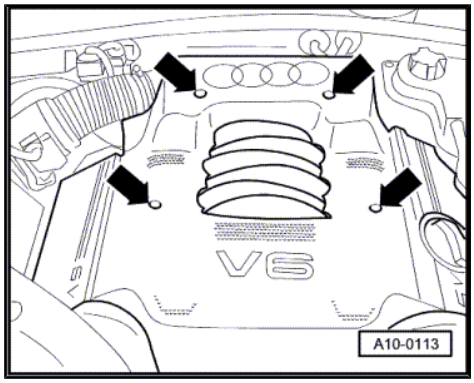
Caution

On vehicles with telematics system, activate service mode of telematics control unit before disconnecting battery ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .

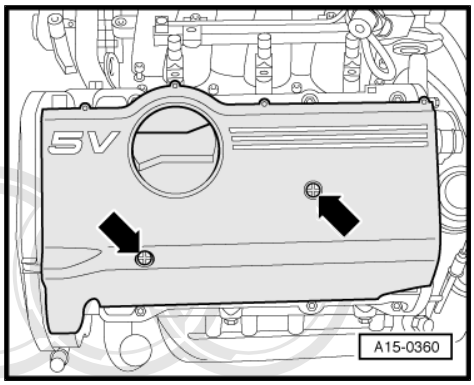
– Pay attention to and if necessary establish code for vehicles with encoded radio set/radio navigation system (RNS).
– Detach the side luggage compartment storage area partition and the floor covering secured with a velcro fastener.
– With ignition switched off, disconnect earth strap/cable at negative terminal -arrow- of battery on right of luggage compartment.
– Drain off coolant at engine ⇒ page 155 .



– Remove engine cover -arrows-.



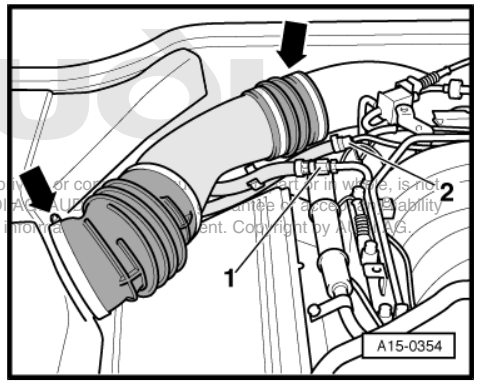
– Remove covers on left and right -arrows-.



– Remove air hose between air mass meter and intake manifold -arrows-.

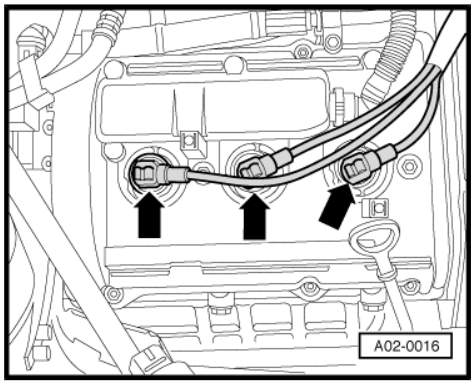
WARNING

The fuel system is pressurised. Before opening the system, wrap a cloth around the connection. Then dissipate pressure by carefully unfastening the connection.

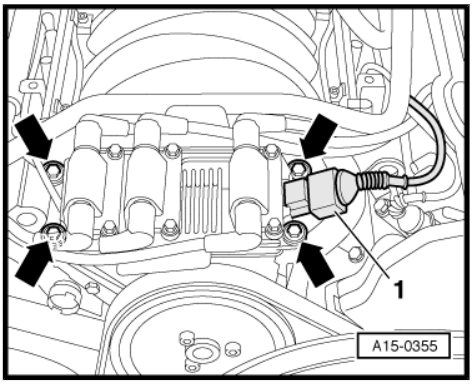


– Disconnect fuel supply pipe -1- and return pipe -2-.

– Unplug all 6 spark plug connectors -arrows-.

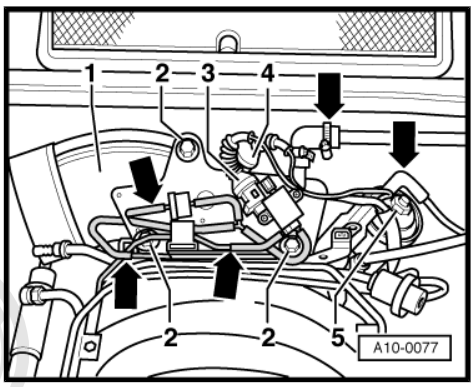


– Unscrew ignition coils -arrows- and detach together with ignition cables.
– Detach crankcase breather hose at right cylinder head cover.



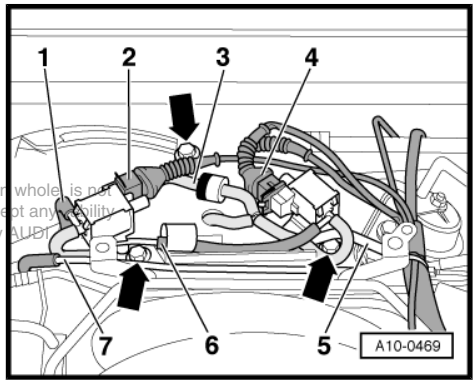
Vehicles with no secondary air system:

– Carefully detach vacuum pipes -arrows-.
– Unplug connectors at variable intake manifold changeover valve -N156- -Item 3- and intake air temperature sender -G42- -Item 4-.
– Screw out bolts -2- of retaining plate for variable intake manifold changeover valve.
– Detach retaining plate and disconnect hose from air intake connection.
– Screw out bolt of air intake connection -1- and detach intake connection.
– Unscrew nut -5- and set down vacuum unit.



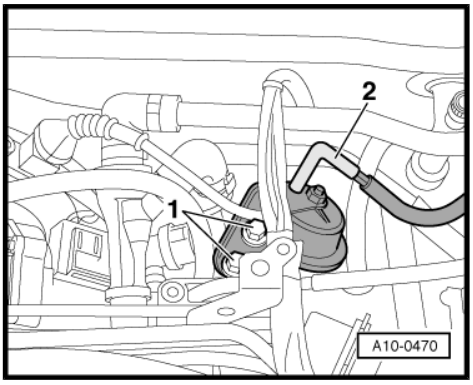
Vehicles with secondary air system:

– Unplug connectors -2- and -4-.
– Carefully disconnect vacuum hoses -1-, -3-, -5-, -6- and -7-.
– Unscrew retaining plate for solenoid valves -arrows-.



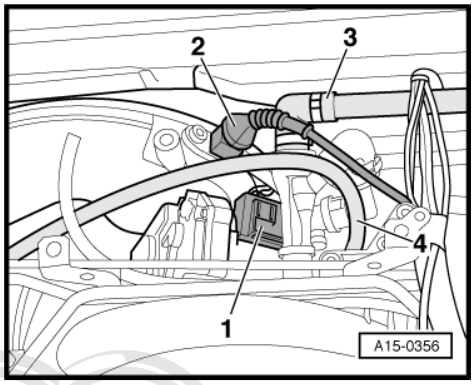
Vehicles with throttle cable:

– Detach vacuum hose -2- at CCS vacuum unit.
– Screw out bolts -1- and set down vacuum unit.



All models:

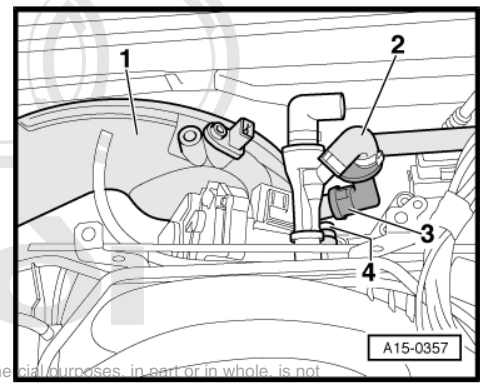
- Unplug connectors -1- and -2-.
- Detach vacuum hose -3- to brake servo.
- Disconnect vacuum hose -4- at activated charcoal filter system solenoid valve 1 -N80- .



- Detach hose -2-.
- Screw out bolt -4- and detach air duct -1- with seal from throttle valve module.
- Detach hose -3- and take out air duct.

Vehicles with throttle cable:

- Disengage CCS operating rod at throttle valve module.
- Disengage throttle cable at throttle valve housing and support bracket (do not remove retainer). Move throttle cable aside.

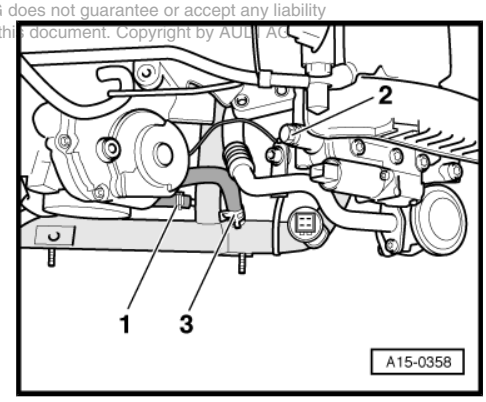


All models:

- Unscrew earth wire -2- at rear from right cylinder head.
- Disconnect coolant hoses -1- and -3- from throttle valve module and rear coolant pipe.
- Unplug connectors at all injectors.
- Lay bare wiring harness and crankcase breather pipe from intake manifold.

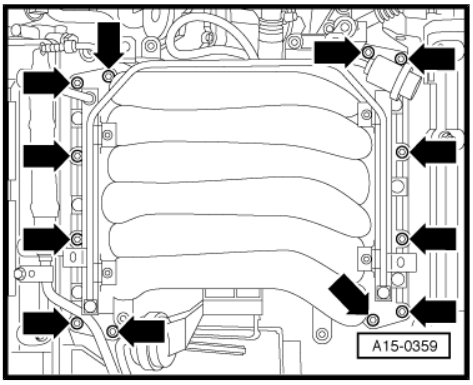
Vehicles with secondary air system:

- Disconnect vacuum hose at secondary air combination valve.



All models:

– Unscrew and take out intake manifold -arrows-.



Note

Use clean cloths to seal intake ducts in cylinder heads.

Installing

Install in reverse order, paying attention to the following:

Note

- *Replace self-locking nuts, gaskets and seals.*
- *Re-attach all cable ties in the same locations on installation.*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*

– Replenish coolant ⇒ page 157 .

Vehicles with throttle cable:

– Check throttle cable adjustment ⇒ Fuel supply system - petrol engines; Rep. Gr. 20 .

All models:

Note

- *On re-connecting the battery, remember to activate vehicle equipment (radio/radio navigation system, clock, electric window lifters) in line with owner's manual.*
- *Deactivate service mode of telematics control unit ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .*

– Perform adaption of throttle valve module ⇒ Rep. Gr. 24 .

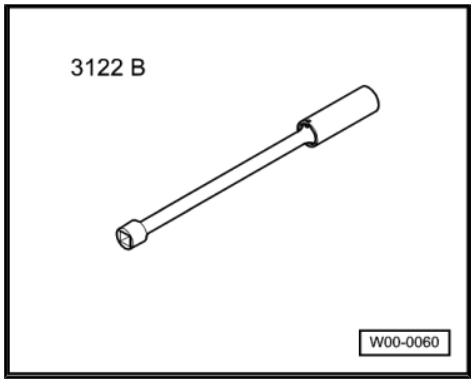
Tightening torques

Component	Nm
Intake manifold to cylinder head	10
Fuel pipes to fuel rail/fuel pressure regulator	23
Air duct to intake manifold	10

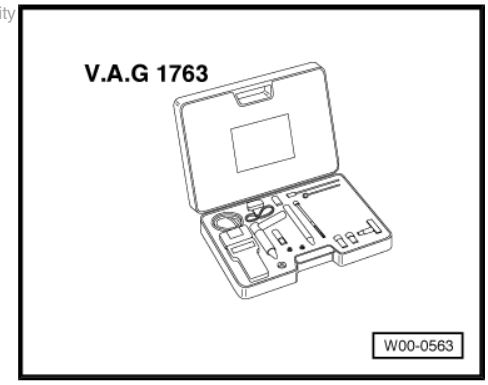
1.9 Checking compression

Special tools and workshop equipment required

♦ Spark plug wrench -3122 B-



♦ Compression tester -V.A.G 1763-

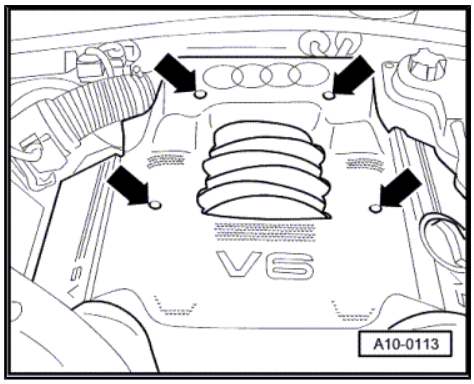


Test conditions

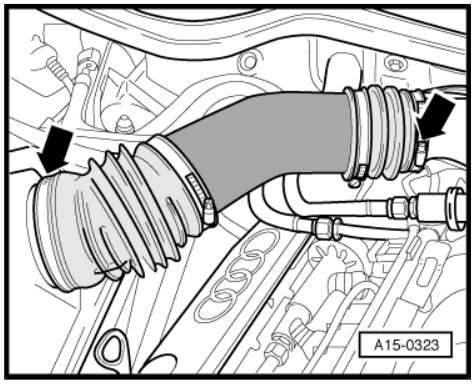
- Engine oil temperature min. 30 °C
- Battery voltage min. 12.5 V

Test sequence

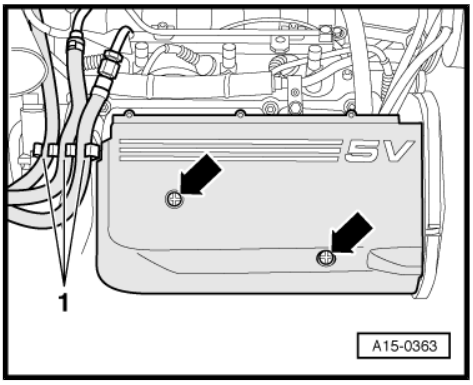
– Remove engine cover -arrows-.



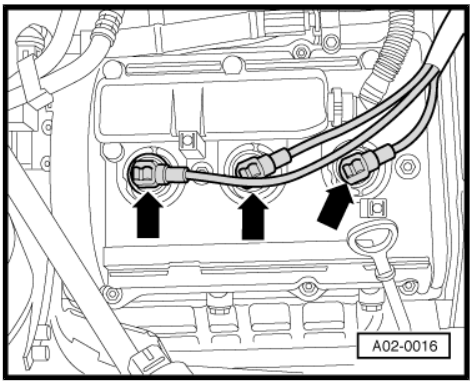
– Remove air hose between air mass meter and intake manifold -arrows-.



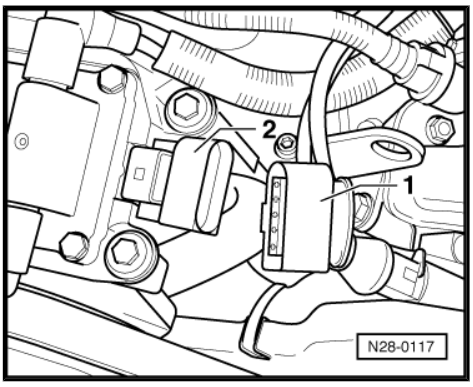
– Remove covers on left and right -arrows-.



– Unplug all 6 spark plug connectors -arrows-.
– Use spark plug wrench -3122 B- to screw out spark plugs.



– Unplug 5-pin connector -1- from output stage of ignition coils -2-.
– Unplug connectors at all injectors.
– Check compression with compression tester -V.A.G 1763- .



Note

For information on how to use tester, refer to ⇒ Operating instructions .

– Have a 2nd mechanic floor the accelerator and at the same time operate the starter until no further pressure increase is indicated by the tester.

Compression values	As-new	Wear limit	Difference between cylinders
bar (gauge)	9.0 … 14.0	7.5	max. 3.0

– Fit spark plugs ⇒ Rep. Gr. 28 .
– As a final step on completion of compression test, interrogate and erase engine control unit fault memory, as unplugging the connectors causes faults to be stored ⇒ Vehicle diagnosis, testing and information system VAS 5051.

2 Servicing valve gear

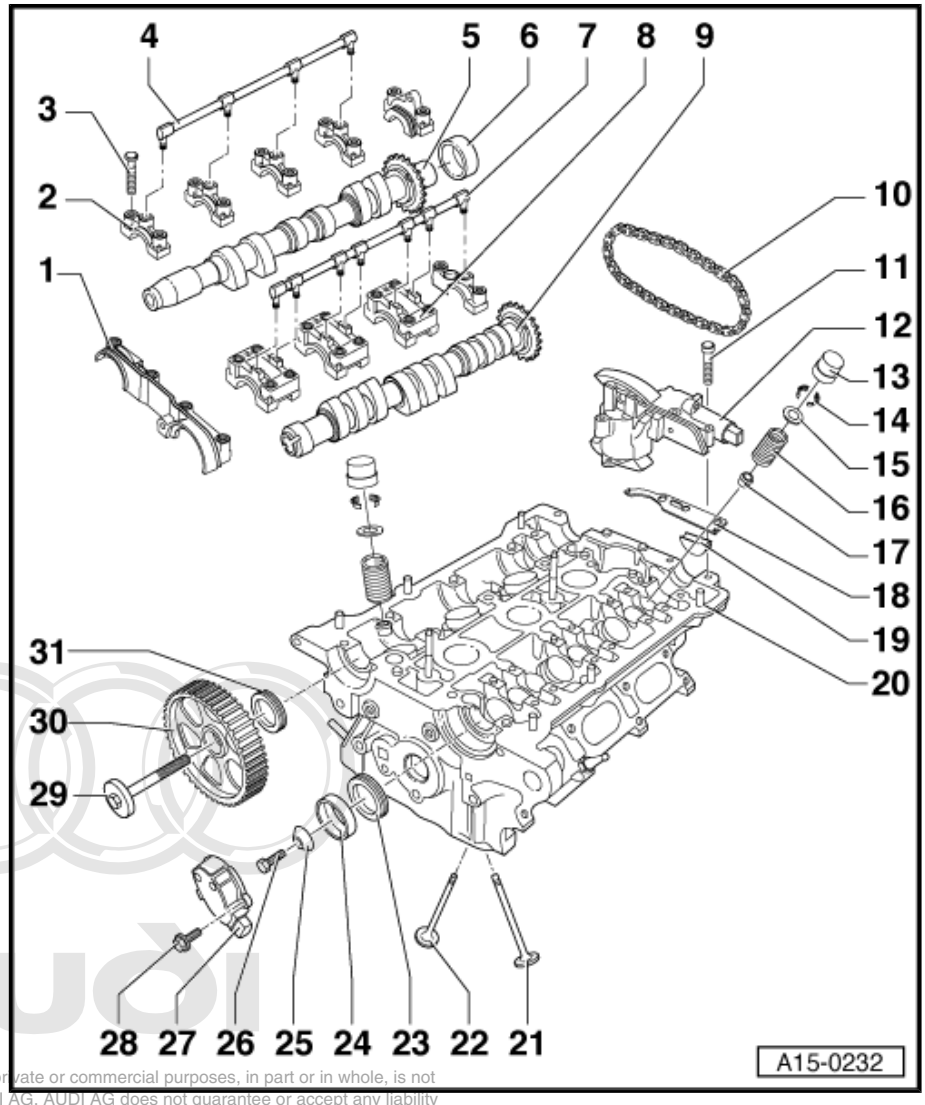
Note

- *Cylinder heads with cracks between valve seats or between one valve seat ring and spark plug thread can be re-used without shortening service life if cracks are only minor (max. 0.3 mm wide) or if only the first 4 turns of the spark plug thread are cracked.*
- *The engine is not to be started for approx. 30 minutes after fitting the camshafts. Hydraulic valve lifters must be allowed to settle (valves would otherwise strike piston).*
- *After working on valve gear, carefully crank engine at least twice by hand to ensure that no valves make contact on starting.*
- *Replace gaskets and seals.*

2.1 Exploded view of valve gear

Note

The illustration shows the right cylinder head for "engine generation III" with oil pipes ⇒ page 67 .



1 - Double bearing cap

- ❑ Prior to installation, coat contact surfaces of bearing caps at front and rear with a small quantity of sealant ⇒ page 93

2 - Exhaust camshaft bearing cap

- ❑ Pay attention to dowel sleeve
- ❑ Heed installation position and assignment ⇒ page 101
- ❑ Prior to installation, apply thin coat of sealant to bearing cap after chain ⇒ page 93

3 - 10 Nm

4 - Exhaust end oil pipe

- ❑ For lubrication of bearing caps
- ❑ Version depends on design status ⇒ page 67
- ❑ Always replace after removing
- ❑ Pay attention to installation position ⇒ page 93

5 - Exhaust camshaft

- ❑ Checking axial clearance ⇒ page 93
- ❑ Removing and installing ⇒ page 100
- ❑ Check radial clearance with Plastigage (bucket tappet removed)
- ❑ Radial clearance: wear limit: 0.1 mm
- ❑ Runout: max. 0.01 mm

6 - Sealing cap

- ❑ Replacing ⇒ page 96
- ❑ Detach bearing cap to remove
- ❑ With bearing cap in position, drive in carefully with fitting sleeve -3202-

7 - Inlet end oil pipe

- ❑ For lubrication of bearing caps
- ❑ Version depends on design status ⇒ page 67
- ❑ Always replace after removing
- ❑ Pay attention to installation position ⇒ page 93

8 - Inlet camshaft bearing cap

- ❑ Heed installation position and assignment ⇒ page 101

9 - Inlet camshaft

- ❑ Checking axial clearance ⇒ page 93
- ❑ Removing and installing ⇒ page 100
- ❑ Check radial clearance with Plastigage (bucket tappet removed)
- ❑ Radial clearance: wear limit: 0.1 mm
- ❑ Runout: max. 0.01 mm

10 - Drive chain

- ❑ Installing ⇒ page 102

11 - 10 Nm

12 - Mechanical camshaft adjuster

- ❑ With inlet camshaft timing adjustment valve 1 -N205-
- ❑ Secure with holder for chain tensioner -3366- before removing ⇒ page 100

13 - Hydraulic bucket tappet (inlet valve)

- ❑ Checking ⇒ page 104
- ❑ Removing and installing ⇒ page 106
- ❑ Do not interchange
- ❑ Set down with contact surface facing downwards
- ❑ Checking camshaft axial clearance prior to installation ⇒ page 93
- ❑ Lubricate contact surface

14 - Valve cotters

15 - Valve spring plate

16 - Valve spring

17 - Valve stem seal

- ❑ Replacing ⇒ page 106

18 - Bonded rubber gasket

- ❑ Replace

19 - Gasket

- ❑ Replace

20 - Cylinder head

- ❑ Heed note ⇒ page 90
- ❑ Checking valve guides, grinding in valve seats ⇒ page 110
- ❑ Reworking valve seats ⇒ page 111

21 - Exhaust valve

- ❑ Not to be reworked, only grinding in is permissible
- ❑ Valve dimensions ⇒ page 110
- ❑ Checking valve guides, grinding in valve seats ⇒ page 110

22 - Inlet valve

- ❑ Not to be reworked, only grinding in is permissible
- ❑ Valve dimensions ⇒ page 110
- ❑ Checking valve guides, grinding in valve seats ⇒ page 110

23 - Seal

- ❑ Heed direction of rotation
- ❑ Replacing ⇒ page 96 or ⇒ page 97

24 - Rotor ring for Hall sender

- ❑ Heed installation position, notch in camshaft

25 - Washer

- ❑ Tapered

26 - 25 Nm

27 - Hall sender

28 - 10 Nm

29 - 55 Nm

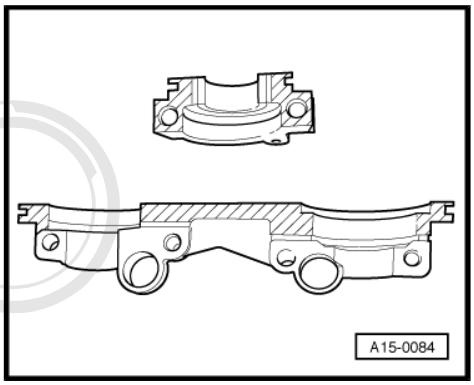
30 - Camshaft sprocket

31 - Seal

- ❑ Heed direction of rotation
- ❑ Replacing ⇒ page 94

Coating bearing cap with sealant

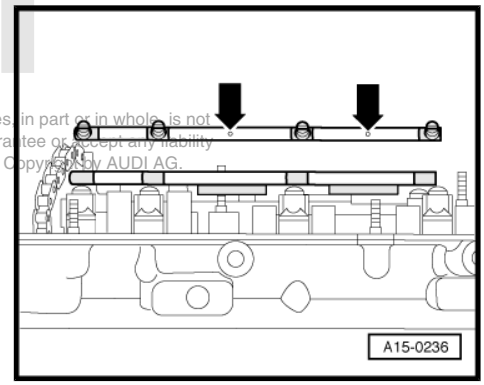
– Coat -hatched areas- of bearing caps at front and rear at inlet camshaft with a small quantity of sealant and fit bearing caps (pay attention to dowel sleeves); sealant ⇒ Parts catalogue .



Installation position of exhaust camshaft oil pipe

If connections are incorrectly positioned as shown here, the holes in the oil pipe are exposed -arrows-.

– For correct installation, turn oil pipe through 180° and slide connections over holes.

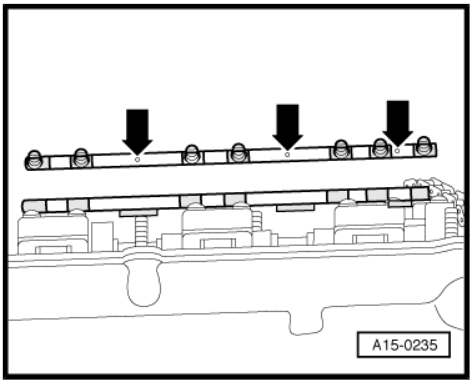


> **Caution**
>
> *The camshaft bearings will not be lubricated if the oil pipes have not been fitted properly.*

Installation position of inlet camshaft oil pipe

If connections are incorrectly positioned as shown here, the holes in the oil pipe are exposed -arrows-.

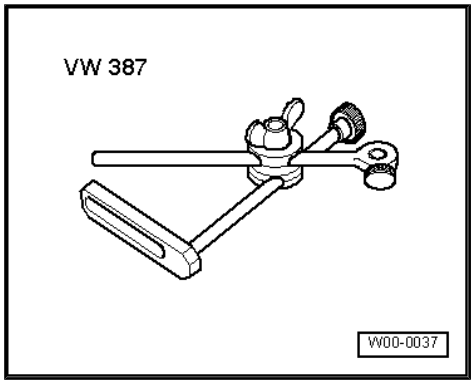
– For correct installation, turn oil pipe through 180° and slide connections over holes.



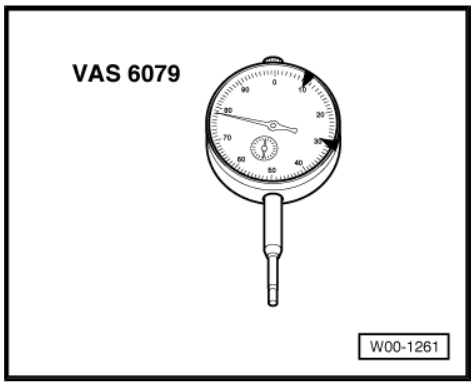
2.2 Checking axial clearance of camshafts

Special tools and workshop equipment required

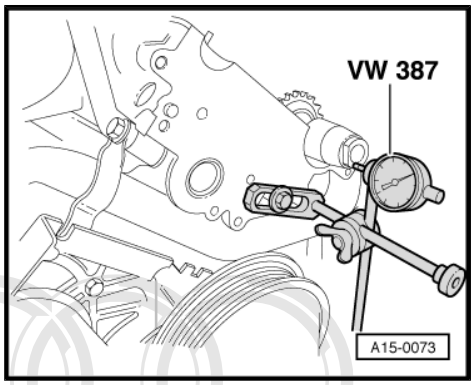
♦ Universal dial gauge holder -VW 387-



♦ Dial gauge -VAS 6079-



Test sequence



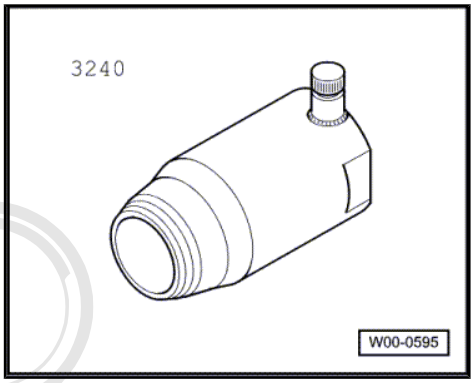
– Remove camshaft ⇒ page 100 .
– Remove bucket tappets.
– Insert camshafts without chain in cylinder head and secure with bearing caps 2 and 4.
– Attach dial gauge -VAS 6079- with universal dial gauge holder -VW 387- to cylinder head.
– Press camshaft by hand towards dial gauge.
– Set dial gauge to “0”.
– Press camshaft off dial gauge.
– Take reading:

• Specification: 0.05 … 0.15 mm.
• Wear limit 0.20 mm

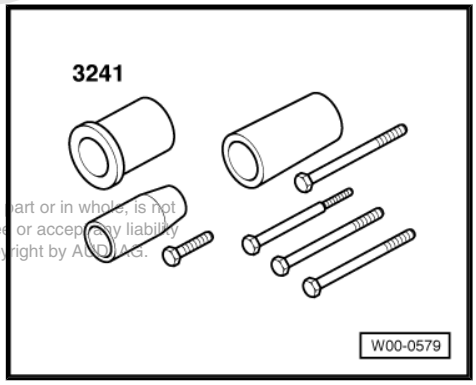
2.3 Replacing oil seals for camshafts

Special tools and workshop equipment required

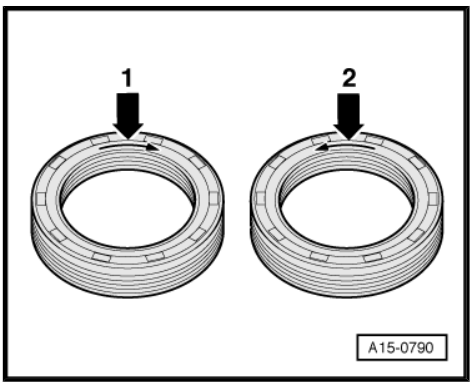
♦ Oil seal extractor -3240-



♦ Fitting sleeves -3241-



Sequence of operations



Note

♦ *PTFE oil seals are assigned to the direction of rotation of the shaft (see arrow mark on seal). Incorrect direction of rotation will cause oil to escape.*

♦ *The direction of rotation of the oil seals at the front of the engine is “clockwise” -arrow 1-. The direction of rotation of the oil seals on the back of the engine is “anti-clockwise” -arrow 2-.*

– Remove toothed belt ⇒ page 35 .

– Detach camshaft sprockets.

Note

In the event of radial shaft seal leakage, replace oil seals at both cylinder heads.

– Position inner part of oil seal extractor -3240- such that it is flush with outer part.

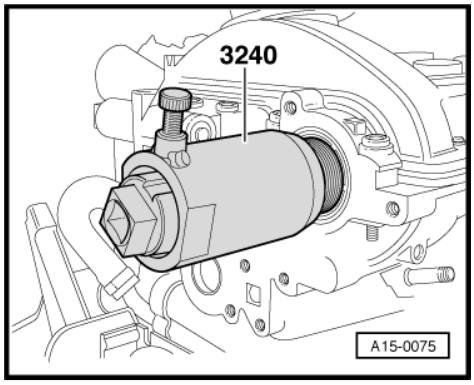
Left cylinder head:

– Screw out inner part of oil seal extractor by 5 turns and lock with knurled screw.

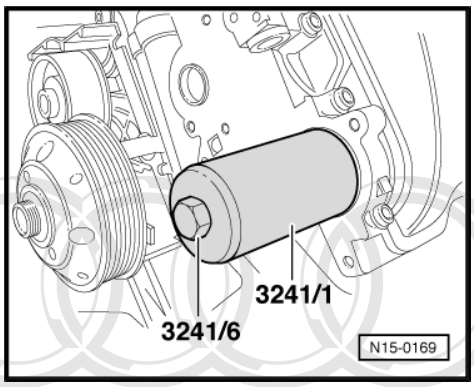
Right cylinder head:

– Screw out inner part of oil seal extractor by 11 turns and lock with knurled screw.

Both sides (continued):



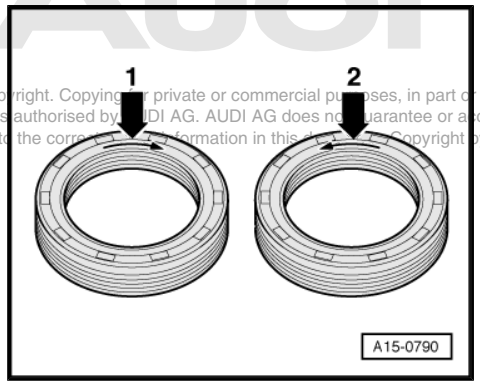
– Lubricate threaded end of oil seal extractor -3240- , fit in position and screw as far as possible into oil seal whilst exerting firm pressure.
– Slacken off knurled screw and turn inner part towards camshaft until oil seal has been extracted.
– Clamp flats of oil seal extractor in a vice.
– Use pliers to remove oil seal.
– Clean contact and sealing surfaces.
– Check direction of rotation of oil seal before fitting.
• “Clockwise” direction of rotation (arrow on oil seal)
– Slide oil seal onto camshaft taper.



– Press in oil seal with fitting sleeve -3241/1- and hexagon bolt -3241/6- such that it is flush.
– Fit toothed belt (adjust timing) ⇒ page 38 .

2.4 Replacing oil seal for Hall sender and sealing cap - left cylinder head

Sequence of operations

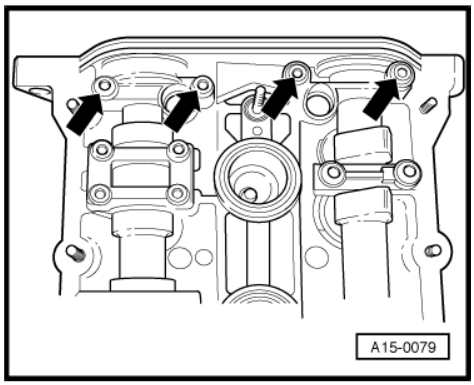


Note

♦ *PTFE oil seals are assigned to the direction of rotation of the shaft (see arrow mark on seal). Incorrect direction of rotation will cause oil to escape.*

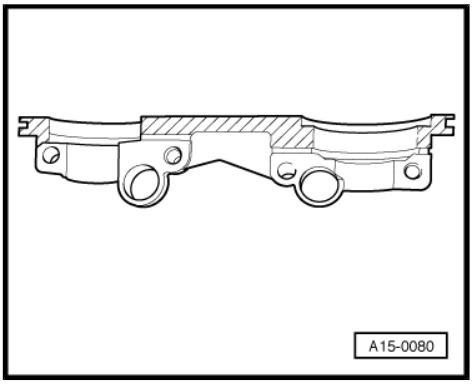
♦ *The direction of rotation of the oil seals at the front of the engine is “clockwise” -arrow 1-. The direction of rotation of the oil seals on the back of the engine is “anti-clockwise” -arrow 2-.*

• Engine in position



– Remove left cylinder head cover ⇒ page 70 .
– Remove Hall sender ⇒ Item 27 (page 93) and Hall sender rotor ring ⇒ Item 24 (page 92) .
– Unscrew double bearing cap -arrows-.
– Take out oil seal and sealing cap.

– Clean contact and sealing surfaces as well as resting surfaces of double bearing cap.
– Coat -hatched area- of double bearing cap with a small quantity of sealant; sealant ⇒ Parts catalogue .
– Check direction of rotation of oil seal before fitting.
• “Anti-clockwise” direction of rotation (arrow on oil seal)
– Fit oil seal in position and install double bearing cap.
– Use assembly lever to press in sealing cap.



Note

If engine has been removed, bearing cap can be left in position when replacing oil seal and sealing cap. Procedure ⇒ page 97 .

– Install Hall sender rotor ring ⇒ Item 24 (page 92) and washer ⇒ Item 25 (page 93) .
– Fit Hall sender ⇒ Item 27 (page 93) .
– Install left cylinder head cover ⇒ page 71 .

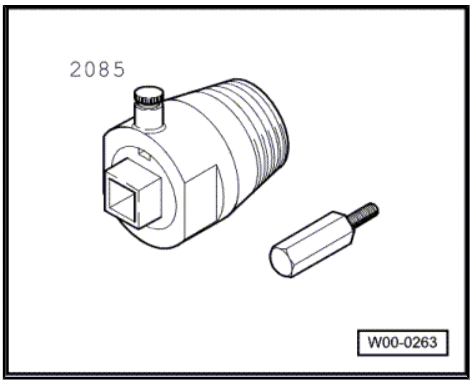
Tightening torques

Component	Nm
Bearing cap to cylinder head	10
Hall sender rotor ring to camshaft	25
Hall sender housing to cylinder head	10

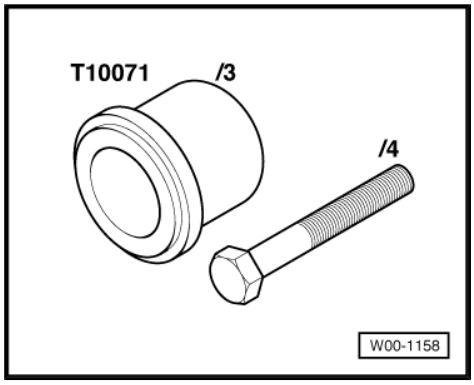
2.5 Replacing oil seal for Hall sender - right cylinder head

Special tools and workshop equipment required

♦ Oil seal extractor -2085-



♦ Assembly tool -T10071-



♦ Bolt M8x50

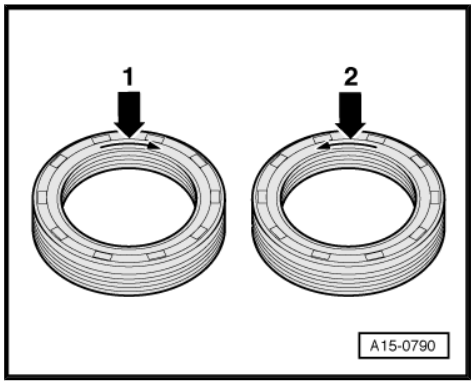
♦ Bolt M8x60

Sequence of operations

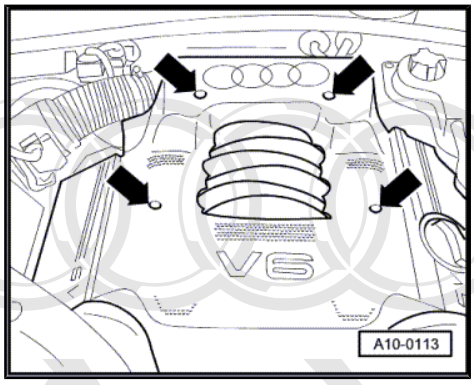
Note

♦ *PTFE oil seals are assigned to the direction of rotation of the shaft (see arrow mark on seal). Incorrect direction of rotation will cause oil to escape.*

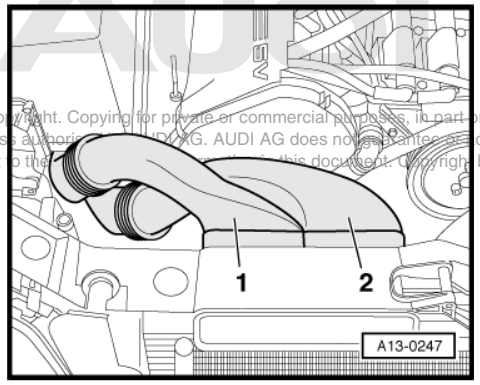
♦ *The direction of rotation of the oil seals at the front of the engine is "clockwise" -arrow 1-. The direction of rotation of the oil seals on the back of the engine is "anti-clockwise" -arrow 2-.*



– Remove engine cover -arrows-.

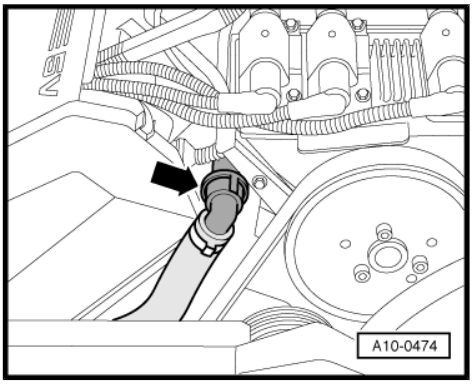


– Remove air ducts -1- and -2-.



Vehicles with secondary air system:

– Disconnect hose -arrow- from secondary air connecting pipe.



All models:

– Remove upper toothed belt guard.

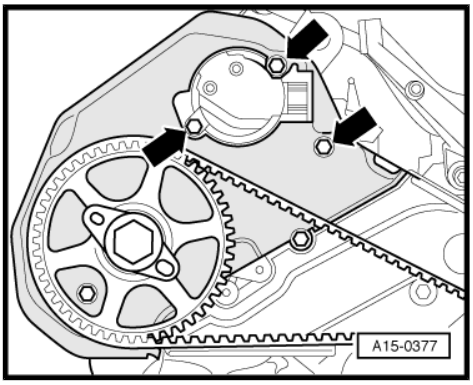
– Unclip centre toothed belt guard.

– Unplug connector at Hall sender.

– Screw out bolts -arrows-.

– Pull toothed belt guard slightly forwards and detach Hall sender.

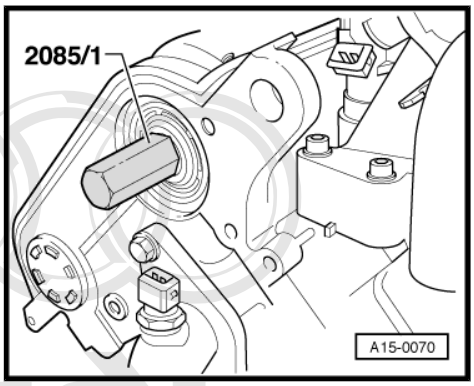
– Remove Hall sender rotor ring ⇒ Item 24 (page 92) and washer ⇒ Item 25 (page 93) .



– Screw in bolt -2085/1- for oil seal extractor -2085- .

– Position inner part of oil seal extractor -2085- such that it is flush with outer part.

– Screw out inner part of oil seal extractor by 3 turns and lock with knurled screw.



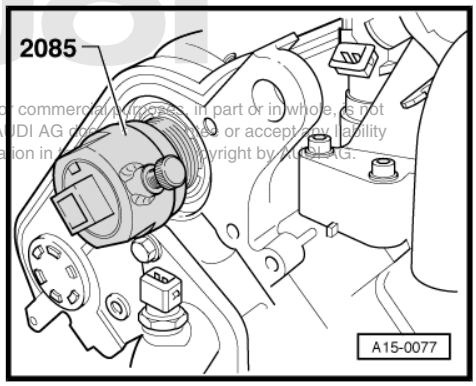
– Lubricate threaded end of oil seal extractor -2085- , fit in position and screw as far as possible into oil seal whilst exerting firm pressure.

– Slacken off knurled screw and turn inner part towards camshaft until oil seal has been extracted.

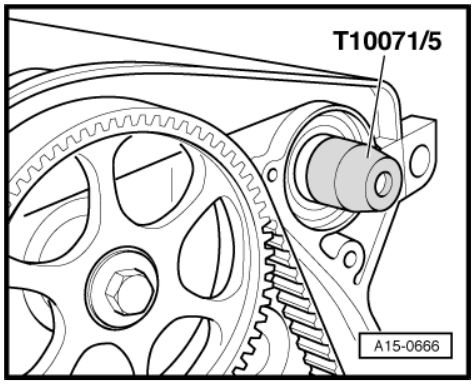
– Clamp flats of oil seal extractor in a vice.

– Use pliers to remove oil seal.

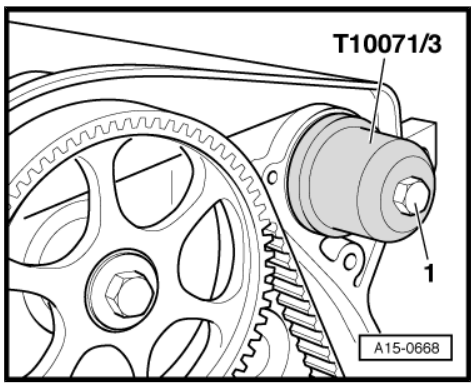
– Screw out bolt -2085/1- for oil seal extractor -2085- .



– Clean contact and sealing surfaces.
– Position guide sleeve -T10071/5- on camshaft journal and fix in position with M8x50 bolt.
– Check direction of rotation of oil seal before fitting.
• “Clockwise” direction of rotation (arrow on oil seal)
– Slide oil seal over guide sleeve onto journal.
– Detach guide sleeve.



– Press home oil seal with thrust sleeve -T10071/3- and M8x60 bolt -Item 1-.
– Install Hall sender rotor ring ⇒ Item 24 (page 92) and washer ⇒ Item 25 (page 93) .
– Fit Hall sender ⇒ Item 27 (page 93) .
– Fit upper toothed belt guard.



Tightening torques

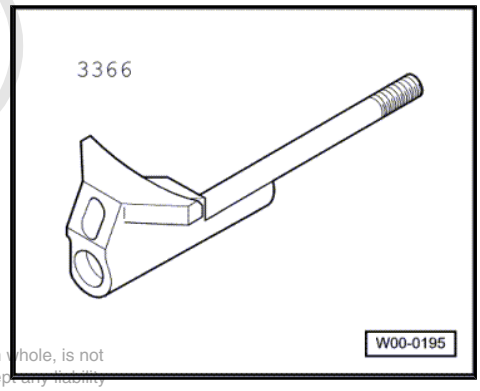
Component	Nm
Hall sender rotor ring to camshaft	25
Hall sender housing to cylinder head	10
Rear toothed belt guard to cylinder head	10 1)

• 1) Apply locking fluid on fitting bolts; locking fluid ⇒ Parts catalogue .

2.6 Removing and installing camshafts and camshaft adjuster

Special tools and workshop equipment required

♦ Holder for chain tensioner -3366-



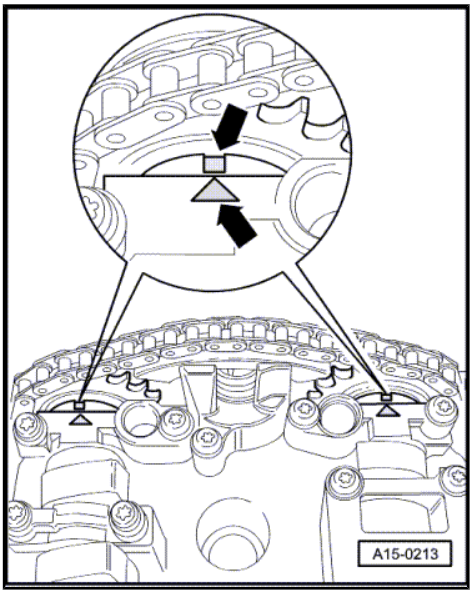
♦ Sealant ⇒ Parts catalogue

Removing

– Remove toothed belt ⇒ page 35 .
– Detach camshaft sprocket.
– Unscrew rear toothed belt guard.
– Remove cylinder head cover ⇒ page 70 or ⇒ page 72 .
– Unplug connector at camshaft adjuster.

– Remove Hall sender ⇒ Item 27 (page 93) and Hall sender rotor ring ⇒ Item 24 (page 92) .

– If applicable, use a screwdriver to carefully prise oil pipes for lubricating camshaft bearings out of camshaft bearings.



Note

Make sure retainers do not break off when prising out.

– Give crankshaft an approx. 45° anti-clockwise turn at toothed belt sprocket bolt so that no pistons are at TDC.

– Check TDC position of camshafts again:

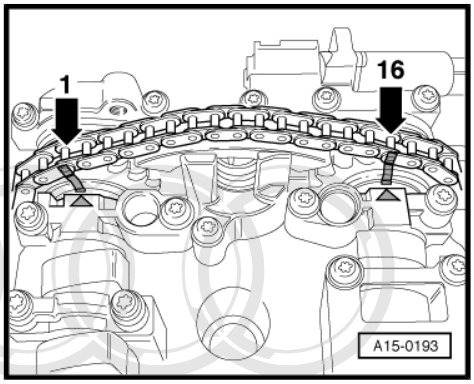
• The two marks at the camshafts must be opposite the two arrows on the bearing caps.

If old drive chain is re-used:

– Clean drive chain and sprockets of camshafts opposite the two arrows on the bearing caps and mark installation position with a coloured dot.

• The distance between the two arrows/coloured marks is 16 drive chain rollers.

• The notch on the exhaust camshaft has a slight inward offset with respect to chain roller -1-.

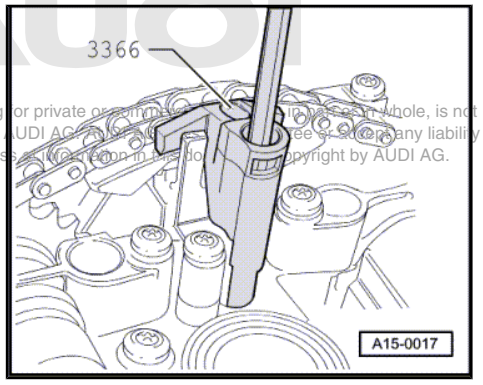


Note

Do not mark chain by way of a centre punch, notch or the like.

Continued:

– Secure camshaft adjuster with holder for chain tensioner -3366- .



Note

Over-tightening the chain tensioner holder could damage the camshaft adjuster.

– Irrespective of the existing designations on the bearing caps, mark sequence and installation position of all bearing caps as illustrated.

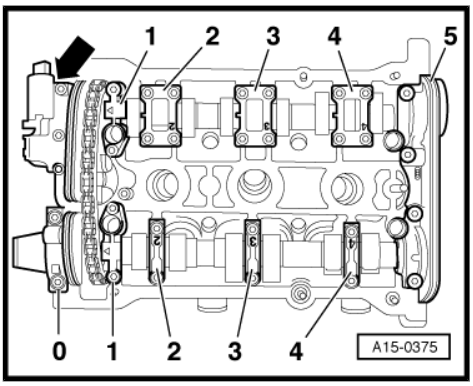
– Screw out bolts of camshaft adjuster -arrow-.

– Unscrew bearing cap -0-.

– Unscrew bearing caps -1-, -3- and -5- and set down in correct sequence on a clean surface.

– Unfasten bearing caps -2- and -4- of inlet and exhaust camshaft alternately and diagonally and remove.

– Lift out both camshafts with camshaft adjuster.

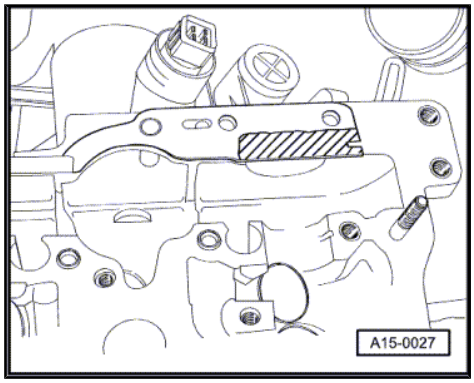


Installing

Install in reverse order, paying attention to the following:

– Replace half-round sealing plug.

– Replace bonded rubber gasket for camshaft adjuster and coat -hatched area- with a small quantity of sealant; sealant ⇒ Parts catalogue .



– Position drive chain as follows on camshaft chain sprockets:

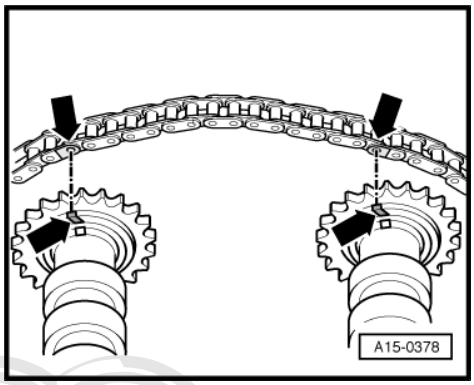
If old drive chain is being used:

• Align coloured marks -arrows-.

If new drive chain is being used:

Caution

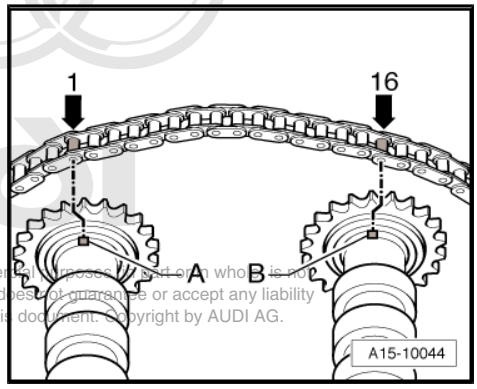
- *The number of rollers stated is only intended as a guide for fitting the chain on the camshafts.*
- *After inserting camshafts (with chain) in cylinder head, make sure arrows on bearing caps and notches at camshafts are opposite one another* *⇒ page 103* *.*



Left cylinder head:

• The distance between the notches -A- and -B- at the camshafts must be 16 drive chain rollers. The illustration shows where the 1st and 16th rollers must be positioned at the sprockets.

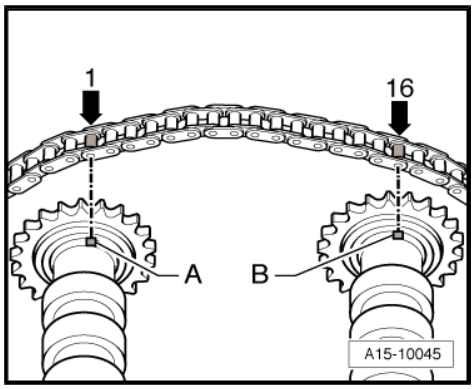
• The chain rollers -1- and -16- have an outward offset with respect to the notches -A- and -B- of $^{1}/_{2}$ tooth width in each case.



Right cylinder head:

• The distance between the notches -A- and -B- at the camshafts must be 16 drive chain rollers. The illustration shows where the 1st and 16th rollers must be positioned at the sprockets.

• The chain rollers -1- and -16- are positioned vertically over the notches -A- and -B-.



All chains (continued):

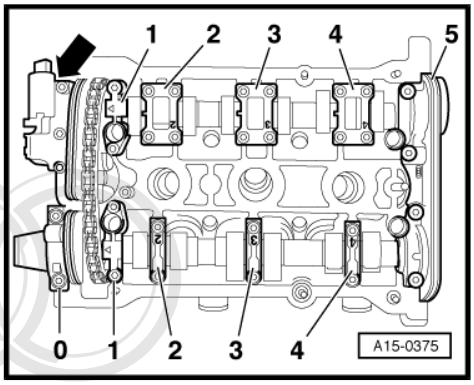
– Insert camshaft adjuster between drive chain (2nd mechanic required).

– Insert camshafts with drive chain and camshaft adjuster in cylinder head.

– Lubricate contact surfaces of camshafts.

• Bearing cap and camshaft adjuster dowel sleeves must be fitted in cylinder head.

– Secure camshaft adjuster -arrow- (pay attention to dowel sleeves).
– Install bearing caps -2- and -4- in line with markings.
– Tighten bearing caps -2- and -4- of inlet and exhaust camshaft alternately and diagonally.
– Install the two bearing caps -1- at the inlet and exhaust camshaft chain sprockets.
– Remove holder for chain tensioner -3366- .

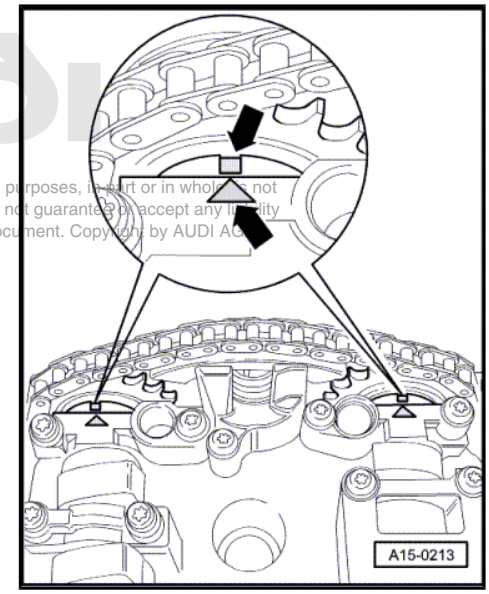


– Check correct setting of camshafts:

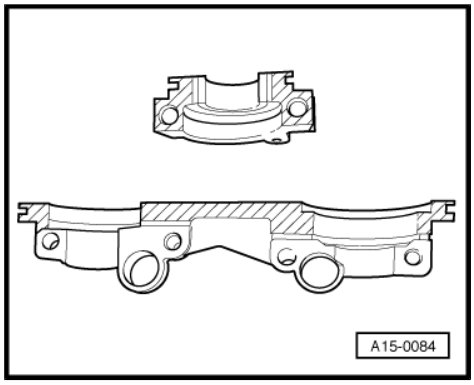
• The two marks at the camshafts must be opposite the two arrows on the bearing caps -arrows-.

Note

If necessary, turn camshaft slightly backwards or forwards so that the two marks coincide.



– Coat -hatched area- of double bearing cap and outer bearing cap next to camshaft adjuster with a small quantity of sealant; sealant ⇒ Parts catalogue .
– Fit bearing cap (pay attention to dowel sleeves).
– Fit the remaining bearing caps (pay attention to dowel sleeves).
– If applicable, replace oil pipes for lubricating camshaft bearings and install ⇒ page 93 and ⇒ page 93
– Replace oil seals for inlet and exhaust camshaft ⇒ page 94 , ⇒ page 96 or ⇒ page 97 .
– Screw on the remaining bearing caps.
– Give crankshaft an approx. 45° clockwise turn at toothed belt sprocket bolt to return it to TDC and secure crankshaft with locking bolt.
– Fit toothed belt (adjust timing) ⇒ page 38 .
– Install cylinder head cover: left-side ⇒ page 71 , right-side ⇒ page 74 .



Note

- *The engine is not to be started for approx. 30 minutes after fitting the camshafts. Hydraulic valve lifters must be allowed to settle (valves would otherwise strike piston).*
- *After working on valve gear, carefully crank engine at least twice by hand to ensure that no valves make contact on starting.*

Tightening torques

Component	Nm
Bearing cap to cylinder head	10
Camshaft adjuster to cylinder head	10
Hall sender rotor ring to camshaft	25
Hall sender housing to cylinder head	10
Rear toothed belt guard to cylinder head/cylinder block	10 1)
• 1) Apply locking fluid on fitting bolts; locking fluid ⇒ Parts catalogue .	

2.7 Checking hydraulic bucket tappets

Special tools and workshop equipment required

- Feeler gauge
- Wooden/plastic wedge

Note

- *Hydraulic bucket tappets cannot be serviced.*
- *Irregular valve noise on starting is normal.*

Sequence of operations

– Start engine and leave it running until coolant temperature is approx. 80 °C.

– Increase engine speed for 2 minutes to approx. 2500 rpm. Perform test drive if applicable.

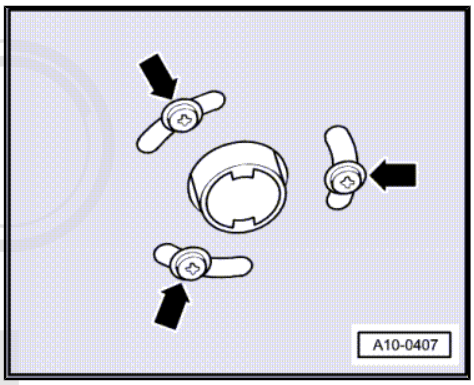
Note

If the irregular valve noise disappears but repeatedly re-occurs when driving short distances, the oil retention valves must be replaced. Fitting location of oil retention valves: beneath cover on intake manifold ⇒ page 148 .

If the hydraulic bucket tappets are still noisy, determine defective tappet as follows:

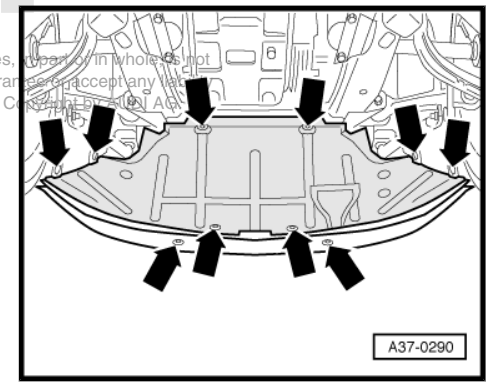
– Remove cylinder head cover ⇒ page 70 or ⇒ page 72 .

– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



– Detach noise insulation -arrows-.

– Turn crankshaft clockwise at central bolt of toothed belt sprocket until cams of cylinder to be tested are facing upwards.

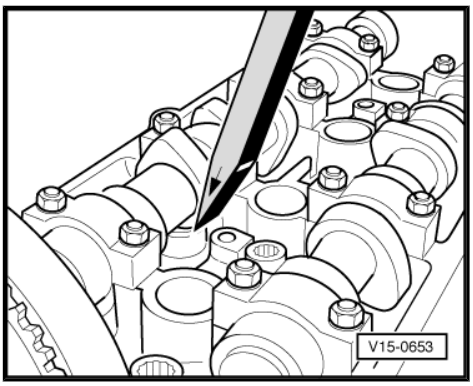


– Determine clearance between cam and bucket tappet.

– Use wooden/plastic wedge to press down bucket tappet.

If a 0.20 mm feeler gauge can be inserted between camshaft and bucket tappet:

– Replace bucket tappet ⇒ “2.6 Removing and installing camshafts and camshaft adjuster”, page 100 .



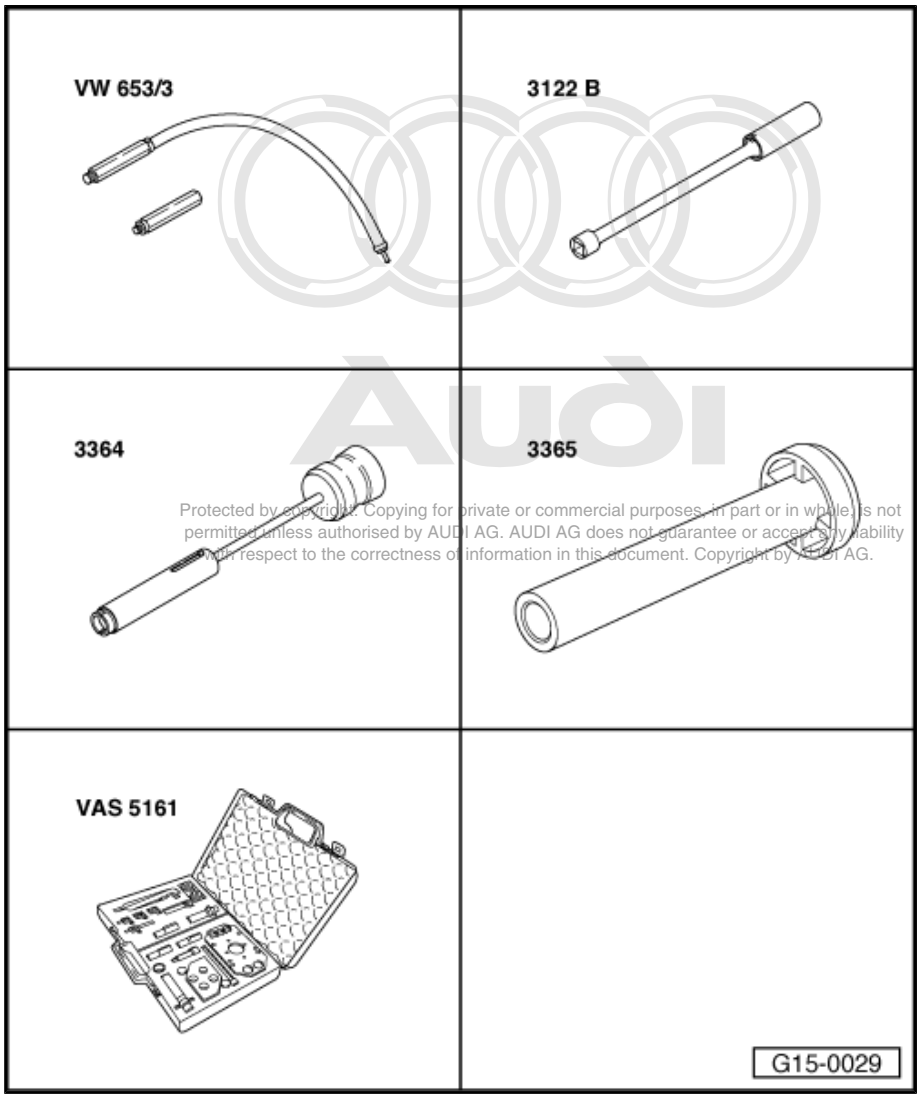
Note

- *The engine is not to be started for approx. 30 minutes after fitting the camshafts. Hydraulic valve lifters must be allowed to settle (valves would otherwise strike piston).*
- *After working on valve gear, carefully crank engine at least twice by hand to ensure that no valves make contact on starting.*

2.8 Replacing valve stem seals

Special tools and workshop equipment required

- Pressure hose -VW 653/3-
- Spark plug wrench -3122 B-
- Puller for valve stem seal -3364-
- Pressing-on tool for valve stem seal -3365-
- Disassembly and assembly tool -VAS 5161-



Sequence of operations

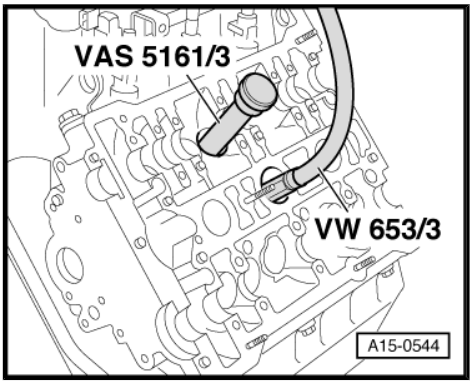
- Cylinder head in position

– Remove camshafts and camshaft adjuster ⇒ page 100 .

Note

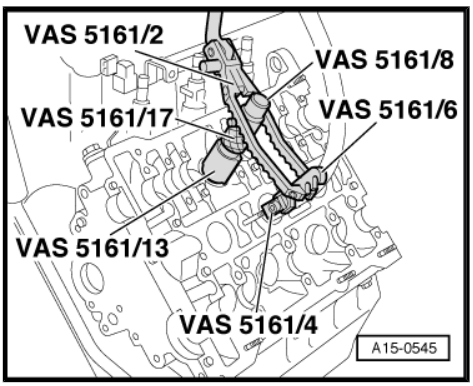
Mark assignment of bucket tappets on back with a waterproof felt-tip pen to prevent interchange.

– Take bucket tappets out of guides and set down with contact surface facing downwards.
– Use spark plug wrench -3122 B- to screw out spark plugs.
– Set piston of corresponding cylinder to “bottom dead centre”.
– Connect pressure hose -VW 653/3- to compressed air supply.
• Air pressure: at least 6 bar
– Insert punch -VAS 5161/3- in bucket tappet guide.
– Use a plastic-headed hammer to release seized valve cotters at all five valves.



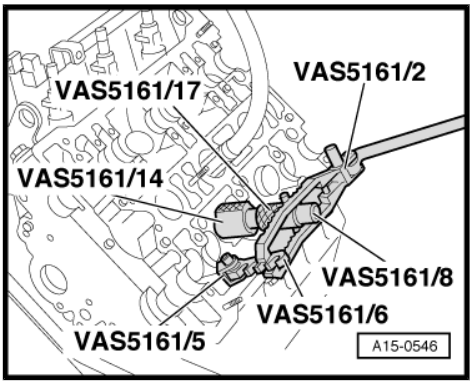
Inlet end:

– Screw snap-in device -VAS 5161/6- with engaging fork -VAS 5161/4- onto stud at cylinder head.
– Slide home guide bushing -VAS 5161/13- in bucket tappet guide at valve to be removed.
• Installation position: knurled surfaces face perpendicular to direction of travel.
– Slip knurled spacer ring -VAS 5161/17- onto assembly cartridge -VAS 5161/8- .
– Slide assembly cartridge into guide bushing.
– Engage pressure fork -VAS 5161/2- at snap-in device -VAS 5161/6- and press assembly cartridge downwards.
– At the same time, turn knurled screw of assembly cartridge to the right until tips engage in valve cotters.
– Move knurled screw back and forth slightly. This causes the valve cotters to be pressed apart and enter into the cartridge.
– Release pressure fork.
– Take out assembly cartridge with spacer ring, guide bushing, valve spring plate and valve spring.



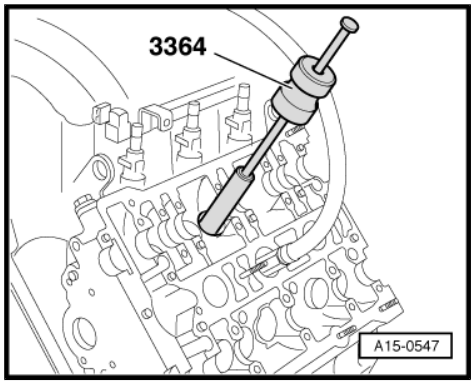
Exhaust end:

– Screw snap-in device -VAS 5161/6- with engaging fork -VAS 5161/5- into tapped hole at cylinder head.
– Slide home guide bushing -VAS 5161/14- in bucket tappet guide at valve to be removed.
• Installation position: knurled surfaces face perpendicular to direction of travel.
– Slip knurled spacer ring -VAS 5161/17- onto assembly cartridge -VAS 5161/8- .
– Slide assembly cartridge into guide bushing.
– Engage pressure fork -VAS 5161/2- at snap-in device -VAS 5161/6- and press assembly cartridge downwards.
– At the same time, turn knurled screw of assembly cartridge to the right until tips engage in valve cotters.
– Move knurled screw back and forth slightly. This causes the valve cotters to be pressed apart and enter into the cartridge.
– Release pressure fork.
– Take out assembly cartridge with spacer ring, guide bushing, valve spring plate and valve spring.



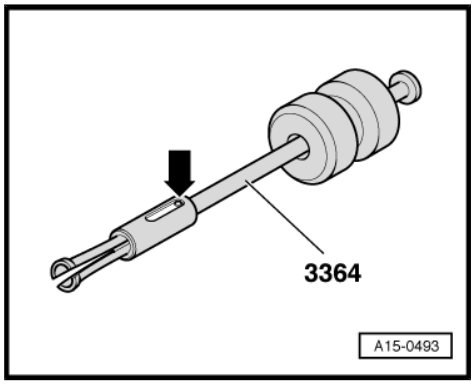
Both sides (continued):

– Detach valve stem seals with valve stem seal puller -3364- .

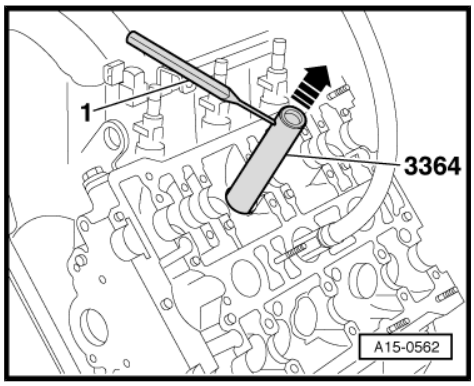


Proceed as follows if puller -3364- cannot be used on account of confined space with certain valve stem seals:

– Use mandrel to drive out spring pin -arrow- at valve stem seal puller -3364- and detach impact-type extractor attachment.



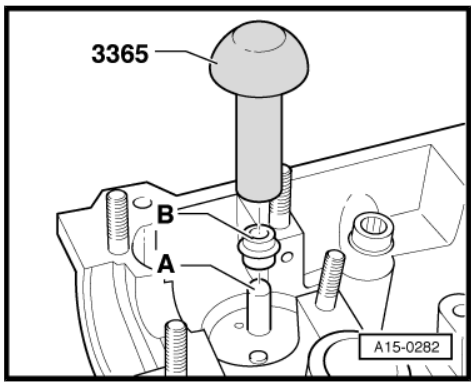
– Position bottom part of puller -3364- at valve stem seal.
– Secure valve stem seal pullers -3364- with a mandrel or pin punch -1- as shown.
– Apply assembly lever to valve stem seal puller -3364- and detach valve stem seal -arrow-.



Note

A plastic sleeve -A- is supplied with new valve stem seals.

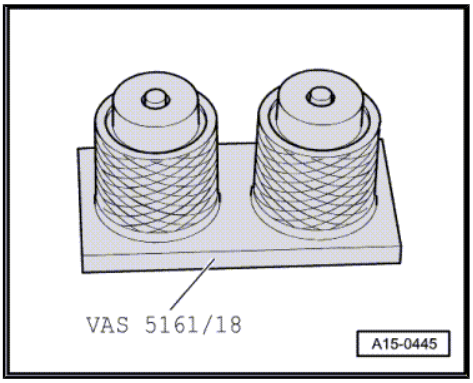
– To avoid damaging new valve stem seals -B-, attach plastic sleeve -A- to valve stem.
– Lightly lubricate sealing lip of valve stem seal.
– Slip valve stem seal onto plastic sleeve.
– Use pressing-on tool -3365- to carefully press valve stem seal onto valve guide.
– Detach plastic sleeve again.



Note

Pay attention to correct positioning in cylinder head on inserting exhaust valve springs as otherwise assembly is not possible.

– If the valve cotters have been removed from the assembly cartridge, they must first be inserted in the insertion device -VAS 5161/18- .



Note

The large diameter of the valve cotters faces upwards.

– Press assembly cartridge -VAS 5161/8- from above onto insertion device to pick up valve cotters.

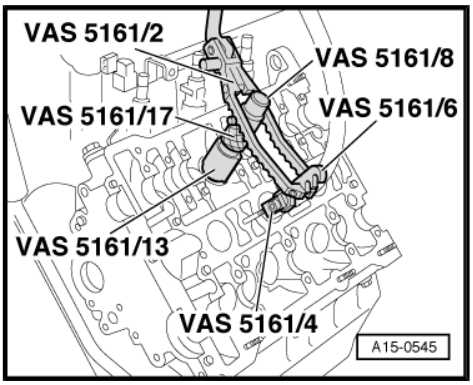
– Re-insert assembly cartridge -VAS 5161/8- in guide busing -VAS 5161/13- or -VAS 5161/14- .

– Press down pressure fork and pull up knurled screw whilst turning to left and right. This inserts the valve cotters.

– Relieve pressure on pressure fork whilst still pulling knurled screw.

– Insert bucket tappets.

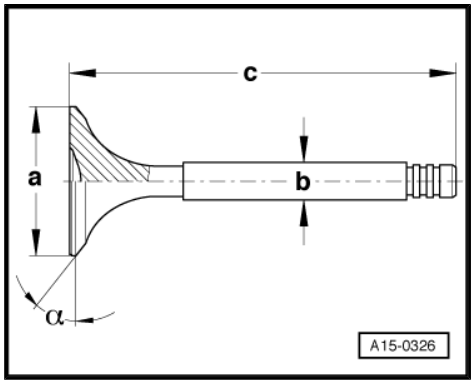
– Install camshafts and camshaft adjuster ⇒ page 100 .



Note

- *The engine is not to be started for approx. 30 minutes after fitting the camshafts. Hydraulic valve lifters must be allowed to settle (valves would otherwise strike piston).*
- *After working on valve gear, carefully crank engine at least twice to ensure that no valves make contact on starting.*

2.9 Valve dimensions



Note

Valves are not to be reworked. Only grinding in is permissible.

Dimension		Inlet valve	Exhaust valve
∅ a	mm	26.80 … 27.00	29.80 … 30.00
∅ b	mm	5.960 … 5.970	5.940 … 5.950
c	mm	104.84 … 105.34	103.64 … 104.14
α	∠°	45	45

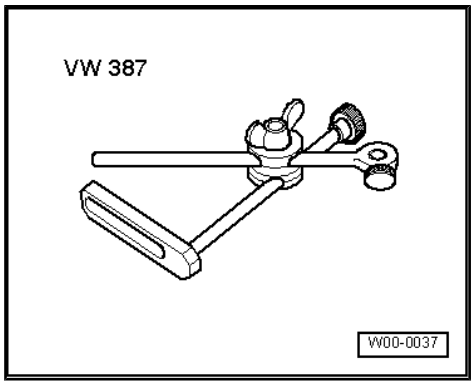
WARNING

- *Worn sodium-filled exhaust valves cannot simply be scrapped.*
- *The valves must be sawn into two sections between centre of stem and valve plate using a metal-cutting saw. They must not come into contact with water when doing so. Throw a maximum of ten valves prepared in this manner into a bucket of water. Then step back, as a sudden chemical reaction occurs involving combustion of the sodium fill.*
- *The parts treated in this manner can then be disposed of together with normal scrap.*

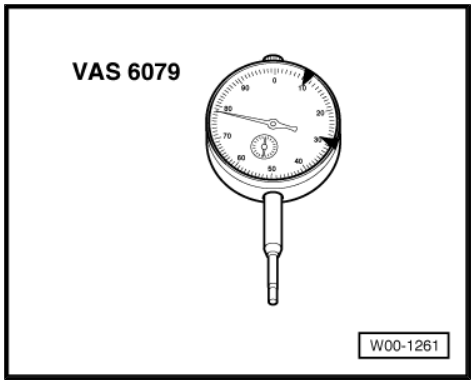
2.10 Checking valve guides

Special tools and workshop equipment required

- Universal dial gauge holder -VW 387-



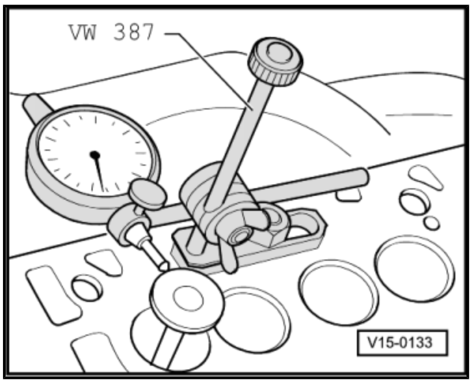
- Dial gauge -VAS 6079-



Sequence of operations

– Insert valve in valve guide.

• End of valve stem must be flush with guide.



Note

On account of differing stem diameters, only use inlet valve in inlet guide and exhaust valve in exhaust guide.

– Determine amount of sideways play.

• Wear limit (sideways play): 0.80 mm.

Note

- *If the wear limit is exceeded, repeat measurement with new valves. Replace cylinder head if the wear limit is still exceeded. The valve guides cannot be replaced.*
- *If valve is replaced in the course of repair work, use new valve for measurement.*

2.11 Reworking valve seats

Rework valve seats if grinding in does not yield proper surface appearance.

Special tools and workshop equipment required

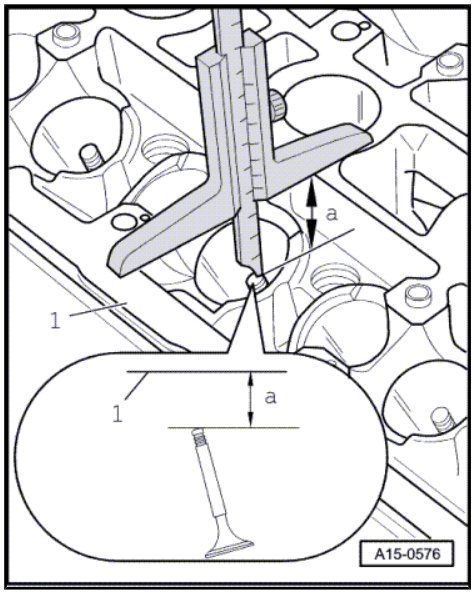
- Depth gauge
- Valve seat machining tool

Note

- *When servicing engines where valves are leaking, it is not sufficient to machine/replace valve seats and valves. Particularly in the case of high-mileage engines, it is necessary to check the valve guides for wear* ⇒ page 110 .
- *Valve seats are only to be reworked to the extent required to yield a proper surface appearance.*
- *Max. perm. reworking dimension is to be calculated before starting work.*
- *If reworking dimension is exceeded, proper hydraulic valve lifter operation can no longer be guaranteed and cylinder head is to be replaced.*

Calculating max. perm. reworking dimension

– Insert valve and press it firmly against valve seat.



Note

If valve is replaced in the course of repair work, use new valve for measurement.

– Use a depth gauge to measure distance -a- between end of valve stem (upper edge) and top surface of cylinder head.

– Calculate max. perm. reworking dimension from measured distance and minimum dimension.

Minimum dimensions		
Inlet valves (outer)	Inlet valve (centre)	Exhaust valves
31.0 mm	32.2 mm	31.9 mm

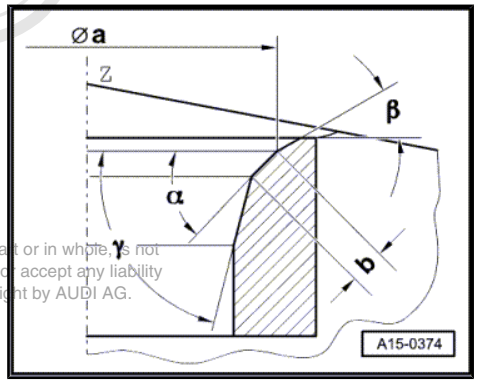
Measured distance minus minimum dimension = max. perm. reworking dimension

Example for inlet valve (outer):	
Measured distance	31.4 mm
– Minimum dimension	– 31.0 mm
= Max. perm. reworking dimension	= 0.4 mm

Note

If the max. perm. reworking dimension is 0 mm or less than 0 mm, repeat measurement with a new valve. If the measurement result is still 0 mm or less than 0 mm, replace cylinder head.

Reworking valve seats



Inlet valve seat:

a - ⌀ 26.2 mm

b - 1.5 … 1.8 mm

Z - Bottom edge of cylinder head

α - 45° valve seat angle

β - 30° correction angle at top

γ - 60° correction angle at bottom

Exhaust valve seat:

a - ⌀ 29.0 mm

b - approx. 1.8 mm

Z - Bottom edge of cylinder head

α - 45° valve seat angle

β - 30° correction angle at top

γ - 60° correction angle at bottom

2.12 Checking valves

– Perform visual inspection for scoring at stem and seat area.

In the event of obvious scoring:

– Replace corresponding valve.

3 Checking camshaft timing control

The inlet camshaft is adjusted as a function of load and engine speed. The camshaft adjustment solenoid valve switches oil pressure to the camshaft adjuster (mechanical adjuster).

3.1 Checking camshaft timing control function

Note

Camshaft timing control is only activated 25 seconds after starting the engine.

Special tools and workshop equipment required

- Vehicle diagnostic, testing and information system -VAS 5051 A-

Test conditions

- Vehicle diagnostic, testing and information system - VAS 5051 A- with diagnostic wire -VAS 5051/1- connected, vehicle self-diagnosis and vehicle system “01 - Engine electronics” selected
- Coolant temperature at least 80 °C
- Vehicles with automatic gearbox: selector lever in position “P” or “N”.

Test sequence

WARNING

- *Always attach the testers and measuring instruments to the rear seat and have them operated from there by a second person.*
- *If testers and measuring instruments were to be operated from the front passenger's seat, the person sitting there could be injured by triggering of the front passenger's airbag in an accident.*

– Start engine and leave it idling.

Vehicles with throttle cable:

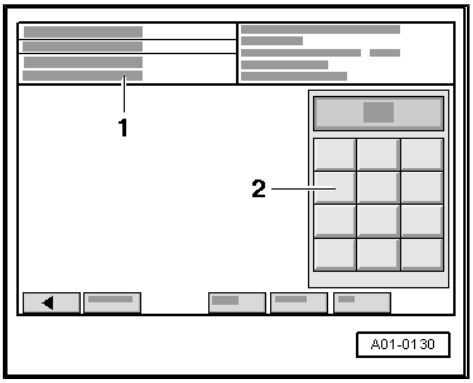
Display on -VAS 5051 A-

– From list -1-, select function “08 - Reading measured value block”.

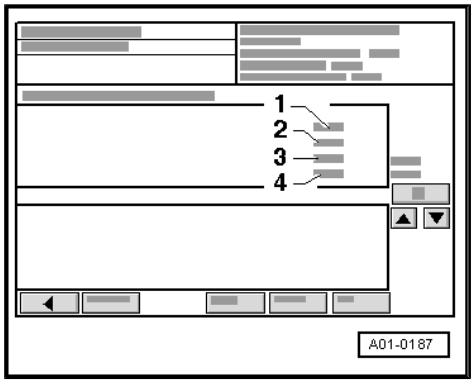
Display on -VAS 5051 A-

1 - Enter display group

– Use keypad -2- to enter “27” for “display group 027” and confirm by touching Q key.



Display on -VAS 5051 A-



Note

Engine idling.

– Check specifications in display zones -1-, -3- and -4-.

Display zones		Explanatory notes
1	---	Camshaft timing control • Specification: 0 (= “Variable valve timing OFF”)
3	... °CA	Variable valve timing bank 1 (cylinder bank right-side) • Specification: –3 ... 6 CA
4	... °CA	Variable valve timing bank 2 (cylinder bank left-side) • Specification: –3 ... 6 CA

– Perform test drive.

– Check specifications in display zones -1-, -3- and -4-.

Display zones		Explanatory notes
1	---	Camshaft timing control • Specification: 1 (= “Variable valve timing ON”)
3	... °CA	Variable valve timing bank 1 (cylinder bank right-side) • Specification: 16 ... 25 CA [1)]
4	... °CA	Variable valve timing bank 2 (cylinder bank left-side) • Specification: 16 ... 25 CA [1)]
• [1)] If, during the test drive, a value of only between 6.0 and 16.0 ° crank angle is displayed, the camshaft adjustment solenoid valve is switching the oil pressure correctly to the mechanical camshaft adjuster, but this is not able to reach its end position (e.g. on account of stiffness).		

– Terminate function “08 - Reading measured value block” by touching ↵ key.

– Touch “06 - End output”.

– Switch off ignition.

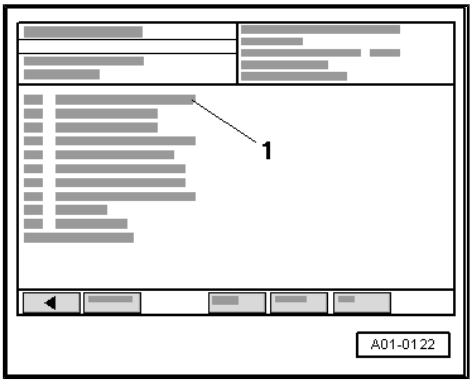
If readings do not match specifications:

– Check camshaft adjustment solenoid valves ⇒ page 119 .

Vehicles with electronic throttle:

Display on -VAS 5051 A-

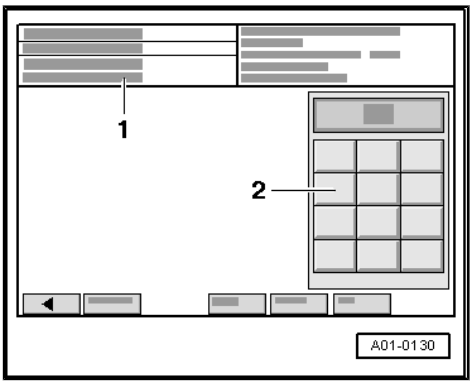
– From list -1-, select function “08 - Reading measured value block”.



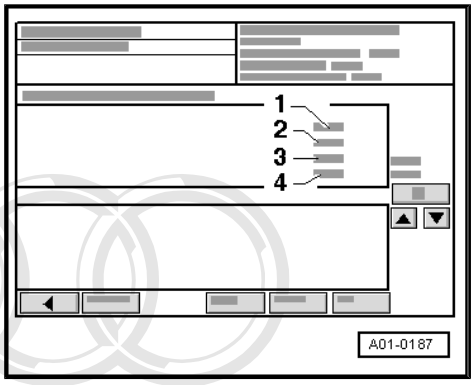
Display on -VAS 5051 A-

1 - Enter display group

– Use keypad -2- to enter “90” for “display group 090” and confirm by touching Q key.



Display on -VAS 5051 A-



Note

Engine idling.

– Check specifications in display zones -2-, -3- and -4-.

Display zones		Explanatory notes
2	---	Camshaft timing control • Specification: “CS-ctrl.OFF”
3	... °CA	Variable valve timing bank 1 (cylinder bank right-side) • Specification: -3 ... 6 CA
4	... °CA	Variable valve timing bank 2 (cylinder bank left-side) • Specification: -3 ... 6 CA

– Perform test drive.

– Check specifications in display zones -2-, -3- and -4-.

Display zones		Explanatory notes
2	---	Camshaft timing control • Specification: “CS-ctrl.ON”
3	... °CA	Variable valve timing bank 1 (cylinder bank right-side) • Specification: 16 ... 25 CA [1)]
4	... °CA	Variable valve timing bank 2 (cylinder bank left-side) • Specification: 16 ... 25 CA [1)]
• [1)] If, during the test drive, a value of only between 6.0 and 16.0 ° crank angle is displayed, the camshaft adjustment solenoid valve is switching the oil pressure correctly to the mechanical camshaft adjuster, but this is not able to reach its end position (e.g. on account of stiffness).		

– Terminate function “08 - Reading measured value block” by touching ⏎ key.

– Touch “06 - End output”.

– Switch off ignition.

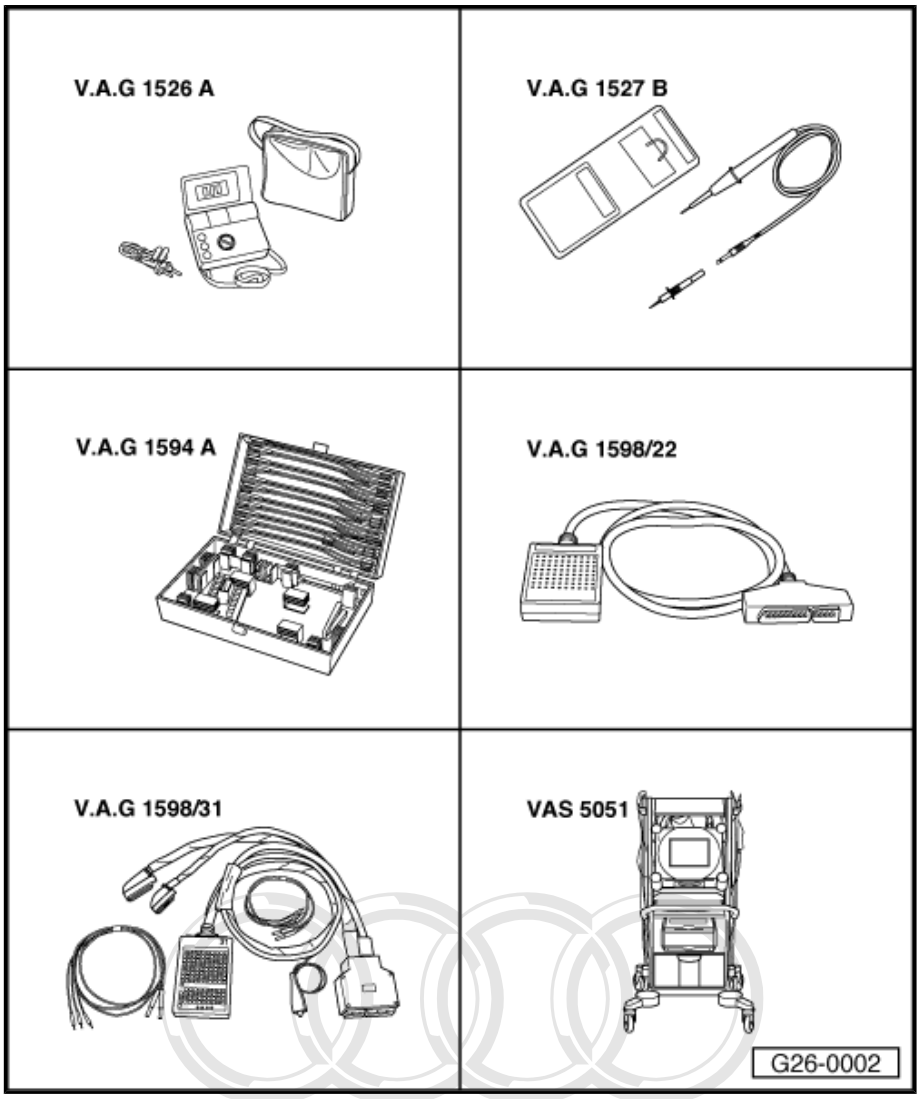
If readings do not match specifications:

– Check camshaft adjustment solenoid valves ⇒ page 119 .

3.2 Checking camshaft adjustment solenoid valves

Special tools and workshop equipment required

- Portable multimeter -V.A.G 1526 A- or -V.A.G 1526 B-
- Voltage tester -V.A.G 1527 B-
- Adapter set -V.A.G 1594 A- or -V.A.G 1594 C-
- Test box -V.A.G 1598/22- (vehicles with throttle cable)
- Test box -V.A.G 1598/31- (vehicles with electronic throttle)
- Vehicle diagnostic, testing and information system -VAS 5051 A- with diagnostic wire -VAS 5051/1-



Test conditions

- Vehicle diagnostic, testing and information system -VAS 5051 A- with diagnostic wire -VAS 5051/1- connected, vehicle self-diagnosis and vehicle system “01 - Engine electronics” selected; when doing this, the ignition must be switched on.
- Vehicles with automatic gearbox: selector lever in position “P” or “N”.

Test sequence

Display on -VAS 5051 A-

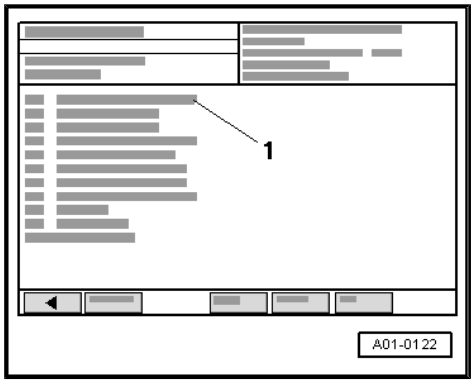
– In list -1- select function “03 - Final control diagnosis”.

– Keep touching [→] key until camshaft adjustment solenoid valves are actuated.

• Camshaft adjustment solenoid valves must click.

– Terminate function “03 - Final control diagnosis” by touching [←] key.

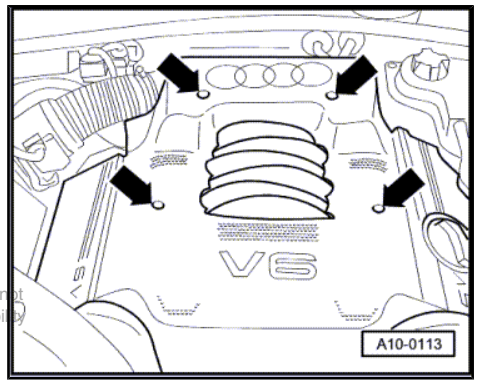
– Switch off ignition.



If one of the valves is not actuated (does not click):

Checking internal resistance

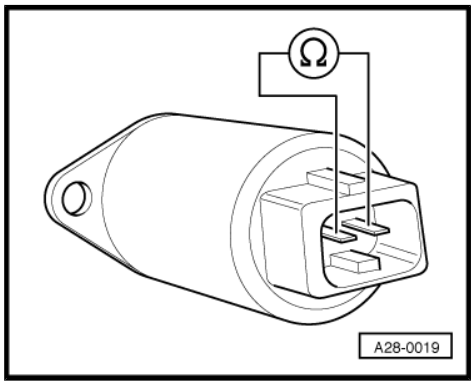
– Remove engine cover -arrows-.



– Unplug corresponding connector at solenoid valve.

– Connect multimeter (resistance measuring range) to valve.

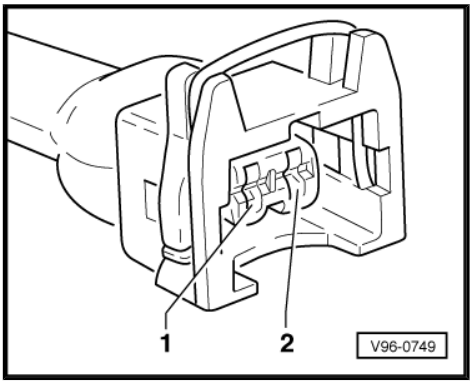
• Specification:



If reading does not match specification:

– Replace solenoid valve.

Checking power supply



- Fuse for camshaft adjustment solenoid valve OK ⇒ Current flow diagrams, Electrical fault finding and Fitting locations
- Fuel pump relay -J17- OK

Note

The camshaft adjustment solenoid valves are supplied with power by way of the fuel pump relay.

– Unplug connector at corresponding solenoid valve.

– Connect up voltage tester -V.A.G 1527 B- between contact -1- and earth.

– Briefly operate starter.

- The LED must light.

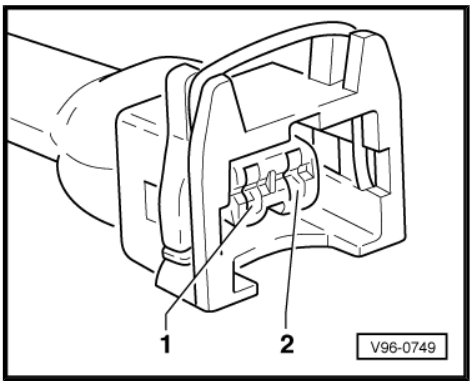
If LED does not light:

– Check wiring from contact 1 of connector via fuse to fuel pump relay for open circuit ⇒ Current flow diagrams, Electrical fault finding and Fitting locations.

– Eliminate open circuit in wiring if necessary.

If LED lights:

Checking actuation



– Connect up voltage tester -V.A.G 1527 B- between contacts -1- (positive) and -2- of connector.

– Repeat function “03 - Final control diagnosis”.

– Keep touching ⌴ key until camshaft adjustment solenoid valves are actuated.

- The LED must flash.

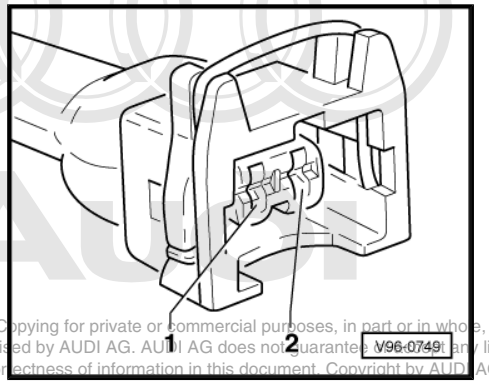
– Terminate function “03 - Final control diagnosis” by touching ⌫ key.

– Switch off ignition.

If the LED does not flash or if it is permanently lit:

– Connect test box -V.A.G 1598/22- or -V.A.G 1598/31- to wiring harness to engine control unit, but do not connect actual engine control unit ⇒ Rep. Gr. 24 .

– Check for open circuit and short to earth/positive in the following wiring from inlet camshaft timing adjustment valve 1 - N205- or inlet camshaft timing adjustment valve 2 -N208- :



Vehicles with throttle cable:

Connector Contact	Test box -V.A.G 1598/22- Socket
-2-	55

Vehicles with electronic throttle:

Connector Contact	Test box -V.A.G 1598/31- Socket
-2-	115

All models:

– Repair wiring if necessary.

If wiring is OK:

– Replace engine control unit ⇒ Rep. Gr. 24 .

If no fault is found:

– Replace mechanical camshaft adjuster
⇒ “2.6 Removing and installing camshafts and camshaft adjuster”, page 100 .

17 – Lubrication

1 Removing and installing lubrication system components

Note

- *If large quantities of metal swarf or abrasion particles are found in the engine oil when performing engine repairs, the oil ducts must be carefully cleaned and the oil cooler additionally replaced so as to prevent further damage.*
- *The oil level must not exceed the max. mark as otherwise the catalytic converter could be damaged.*
- *Oil spray jet for piston cooling ⇒ page 127*

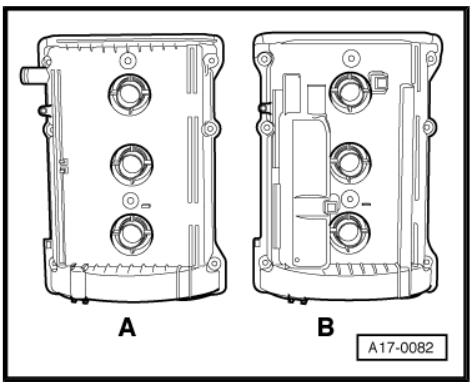
Viscosity classes and oil specifications ⇒ Maintenance ; Booklet 403

Oil capacities ⇒ Maintenance tables

1.1 Different oil circuits

The new features of “engine generation III” as opposed to “engine generation II” are as follows:

- Chain-driven oil pump beneath crankshaft group
- Modified front sealing flange
- Modified oil routing in cylinder head; originally with oil supply pipes on camshaft bearing caps, subsequently replaced by integrated oil ducts in camshaft bearing caps
- Modified top part of sump with liquid gasket



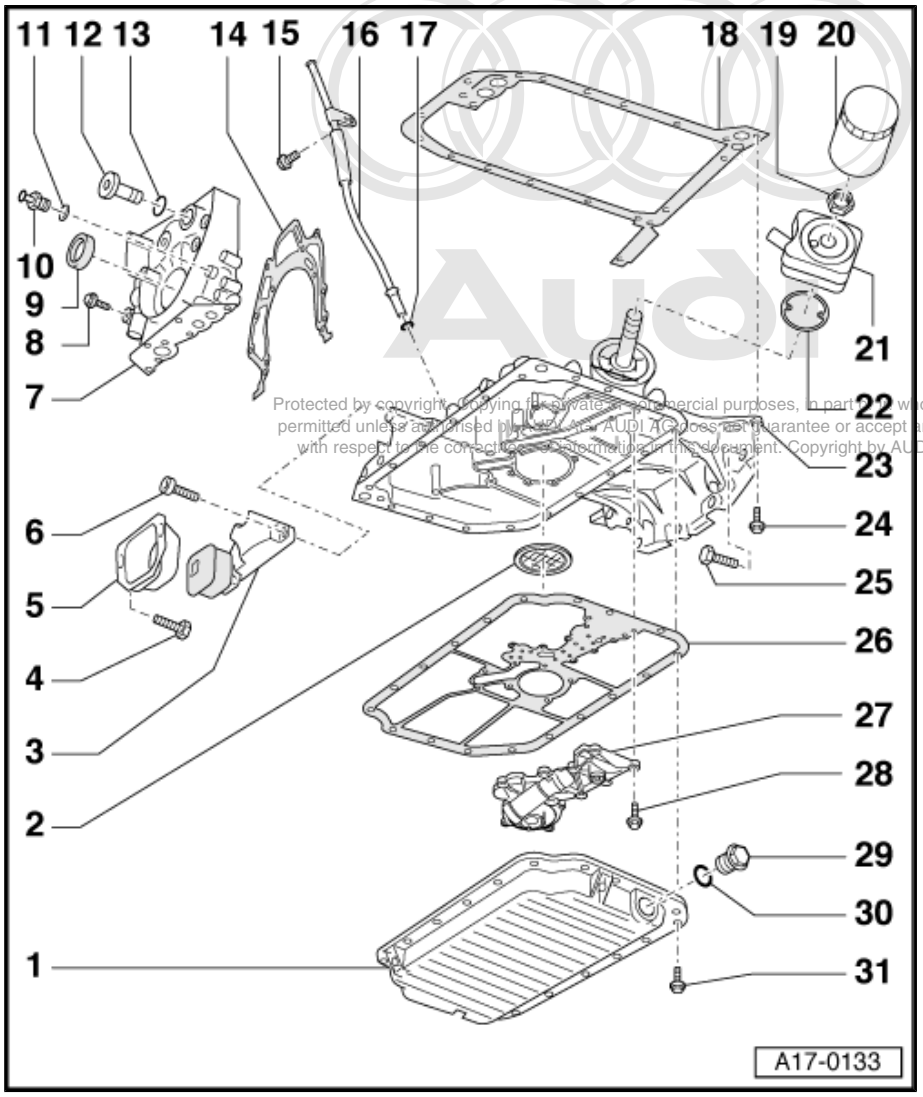
Distinguishing feature

An external distinguishing feature of the “engine generations II” and “III” is the shape of the cylinder head cover:

A - “Engine generation II” (up to approx. 04.1997)

B - “Engine generation III” (as of approx. 04.1997)

1.2 Exploded view of lubrication system “engine generation II”



1 - Bottom part of sump

- ❑ Removing ⇒ page 128
- ❑ Installing ⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129

2 - Oil screen

- ❑ Engages by way of 3 lugs in top part of sump

3 - Torque reaction support

4 - 40 Nm

5 - Stop for torque reaction support

- ❑ Allow stop for torque reaction support to drop into position on rubber buffer for torque reaction support and tighten bolts to 40 Nm

6 - 42 Nm

7 - Oil pump

- ❑ Removing and installing ⇒ page 142

8 - 10 Nm

9 - Oil seal

- ❑ For crankshaft
- ❑ Removing and installing ⇒ page 42

10 - Oil temperature sender - G8-

- ❑ Tighten to 10 Nm

11 - Oil seal

- ❑ Cut open if leaking and replace

12 - Spray nozzle valve - 40 Nm

13 - O-ring

- ❑ Replace

14 - Gasket

- ❑ Replace

15 - 22 Nm

16 - Guide tube for dipstick

17 - O-ring

- ❑ Replace

18 - Gasket

- ❑ Replace
- ❑ Must be dry when fitting
- ❑ Additional sealant is not required

19 - 30 Nm

20 - Oil filter

- ❑ Heed replacement intervals ⇒ Maintenance ; Booklet 403
- ❑ Use oil filter wrench -3417- to unfasten
- ❑ Heed installation instructions on oil filter
- ❑ Tighten to 20 Nm
- ❑ After installing new oil filter, check clearance of hoses from oil cooler with respect to adjacent components and correct position of oil cooler if necessary

21 - Oil cooler

- ❑ Heed note ⇒ page 123

22 - Gasket

- ❑ Replace
- ❑ Engage in lugs at oil cooler

23 - Top part of sump

- ❑ Removing ⇒ page 132
- ❑ Installing ⇒ “1.8 Installing top part of sump - engine generation II ”, page 140

24 - 10 Nm

- ❑ Tighten diagonally and in stages

25 - 45 Nm

26 - Gasket

- ❑ Replace
- ❑ Replacement involves removing ⇒ Item 27 (page 125)

27 - Sealing cap

28 - 10 Nm

29 - Oil drain plug - 30 Nm

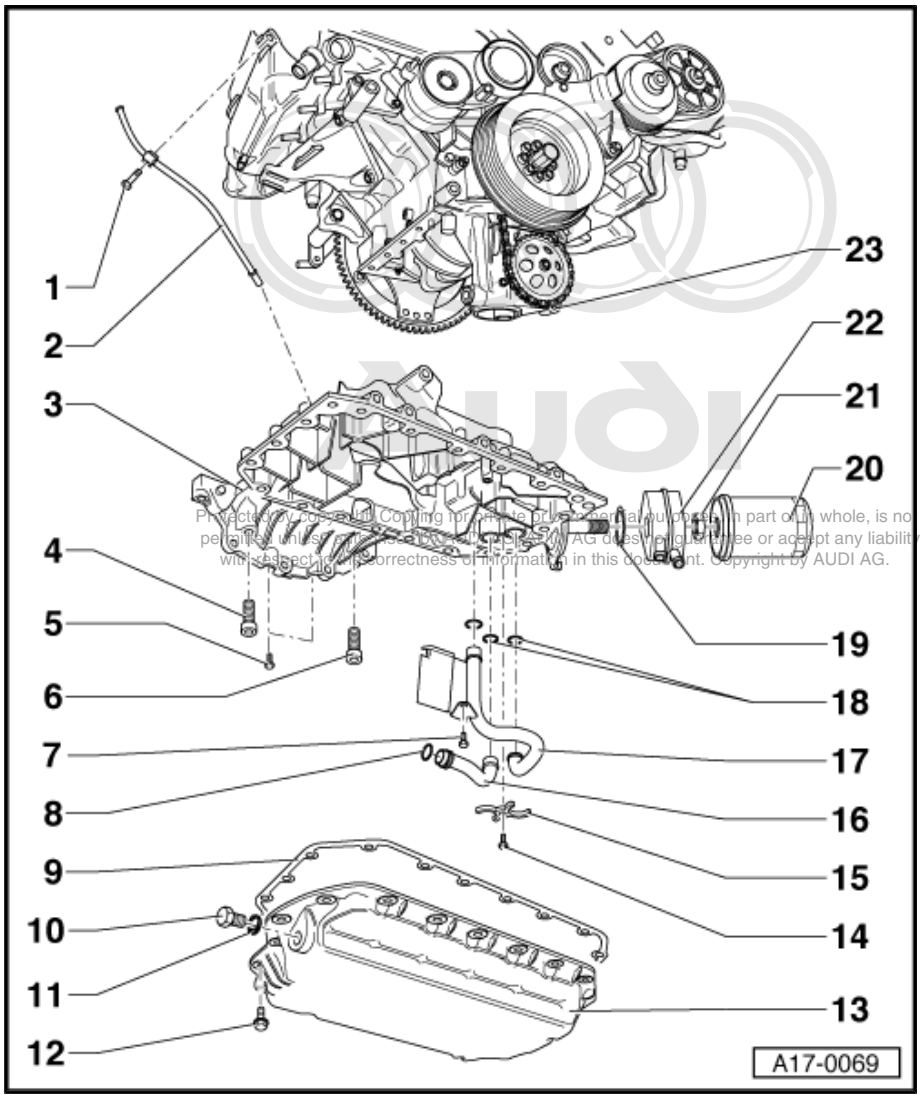
30 - Oil seal

- ❑ Replace

31 - 10 Nm

- ❑ Tighten diagonally and in stages

1.3 Exploded view of lubrication system “engine generation III”



1 - 22 Nm

2 - Guide tube for dipstick

3 - Top part of sump

- ❑ Fitted with liquid gasket
- ❑ Removing ⇒ page 132
- ❑ Installing ⇒ “1.9 Installing top part of sump - engine generation III ”, page 141

4 - M8 = 22 Nm

5 - M6 = 10 Nm; M7 = 16 Nm

6 - M8 = 22 Nm

7 - 10 Nm

8 - O-ring

- ❑ Replace

9 - Gasket

- ❑ Moulded gasket up to approx. 9.98
- ❑ Replacing ⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129
- ❑ Liquid gasket as of approx. 10.98
- ❑ Replacing ⇒ “1.6 Installing bottom part of sump - engines with liquid gasket”, page 130

10 - Oil drain plug - 30 Nm

11 - Gasket

- ❑ Replace

12 - 10 Nm

13 - Bottom part of sump

- ❑ Removing ⇒ page 128
- ❑ Installing ⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129 or ⇒ “1.6 Installing bottom part of sump - engines with liquid gasket”, page 130

14 - 10 Nm

15 - Holder for oil pipes

16 - Oil feed pipe

- ❑ From pump to oil filter

17 - Oil feed pipe

- ❑ From oil filter to engine oil circuit

18 - O-ring

- ❑ Replace

19 - Gasket

- ❑ Replace
- ❑ Engage in lugs at oil cooler

20 - Oil filter

- ❑ Heed replacement intervals ⇒ Maintenance ; Booklet 403
- ❑ Use oil filter wrench -3417- to unfasten
- ❑ Heed installation instructions on oil filter
- ❑ Tighten to 20 Nm
- ❑ After installing new oil filter, check clearance of hoses from oil cooler with respect to adjacent components and correct position of oil cooler if necessary

21 - 30 Nm

22 - Oil cooler

- ❑ Heed note ⇒ page 123

23 - Oil pump

- ❑ Components ⇒ page 127
- ❑ Driven by crankshaft by way of chain
- ❑ Removing and installing ⇒ page 145

Oil pump components

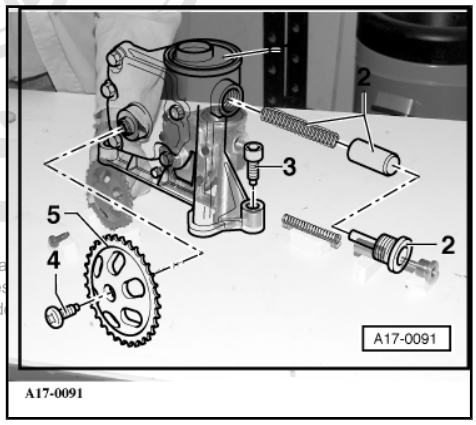
1 - Oil pump (cannot be dismantled)

2 - Pressure control valve - 40 Nm

3 - 22 Nm

4 - 25 Nm

5 - Chain sprocket

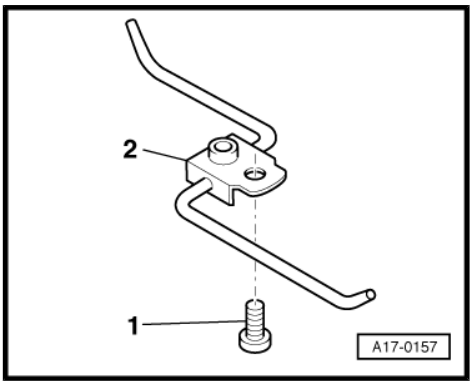


A17-0091

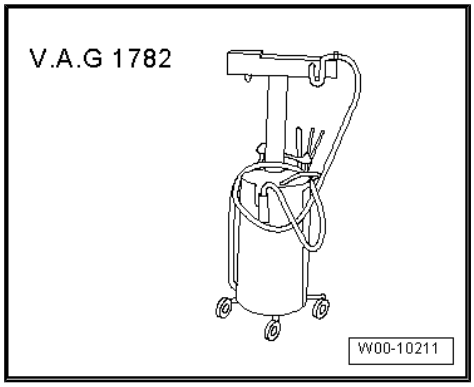
Oil spray jet

1 - Bolt - 10 Nm

2 - Oil spray jet for piston cooling



1.4 Removing bottom part of sump

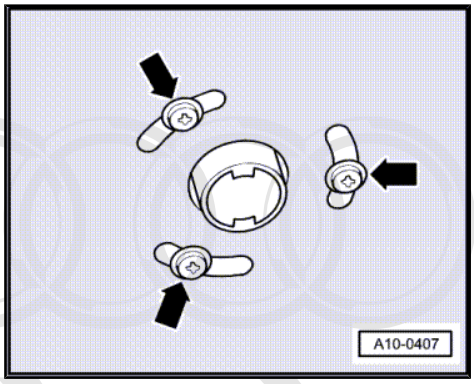


Special tools and workshop equipment required

- Used oil collector and extractor -V.A.G 1782-

Sequence of operations

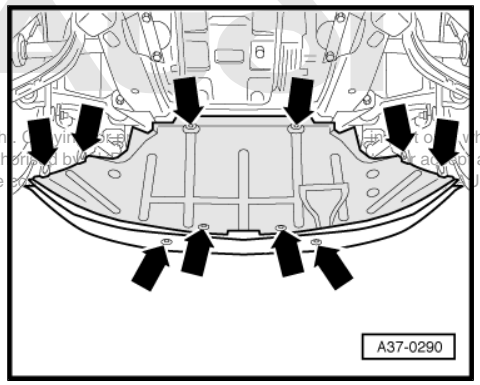
– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



– Detach noise insulation -arrows-.

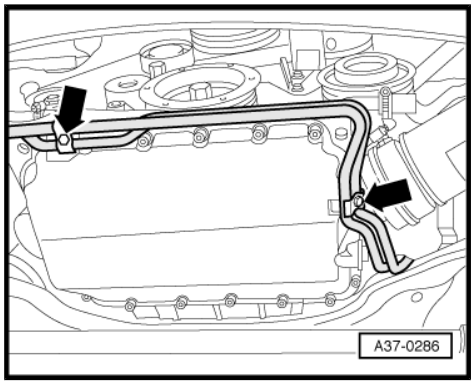
– Place used oil collector and extractor -V.A.G 1782- beneath engine.

– Drain off engine oil.



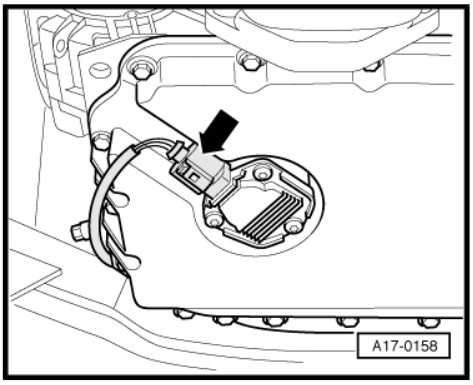
Vehicles with automatic gearbox:

– Unscrew holder for ATF pipes -arrows-.



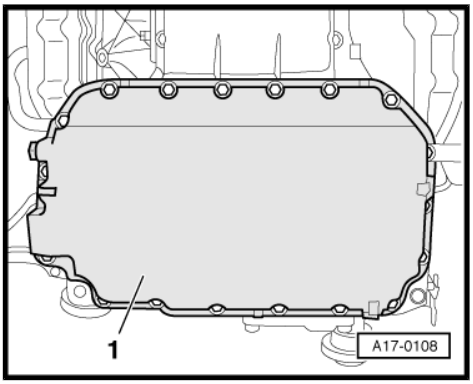
All models:

– Unplug connector at oil level/oil temperature sender -G266- -arrow- and lay bare wire.



– Place engine oil collector beneath engine, as oil escapes again.

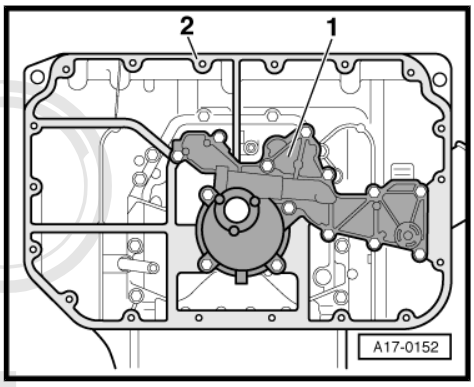
– Unscrew and carefully detach bottom part of sump -1-.



Vehicles with “engine generation II”:

– Unscrew sealing cap -1-.

– Detach gasket -2-.



1.5 Installing bottom part of sump - engines with moulded gasket

Sequence of operations

Install in reverse order, paying attention to the following:

Note

Replace gaskets and seals.

Caution

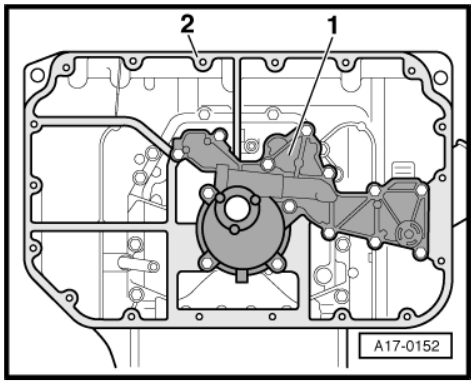
A moulded gasket must be used again on engines on which the bottom part of the sump had been fitted with a moulded gasket.

– Clean sealing surfaces before fitting bottom part of sump.

Vehicles with “engine generation II”:

– Fit gasket -2- for bottom part of sump.

– Screw on sealing cap -1-.



All models:

– Fit bottom part of sump in position and pre-tighten all bolts diagonally to 5 Nm.

– Diagonally tighten bolts for bottom part of sump.

– Pour in engine oil and check oil level ⇒ page 151 .

Tightening torques

Component	Nm
Sealing cap to top part of sump	10
Bottom part of sump to top part	10
Oil drain plug	30

1.6 Installing bottom part of sump - engines with liquid gasket

Special tools and workshop equipment required

- Hand drill with plastic brush attachment
- Safety goggles
- Sealant ⇒ Parts catalogue

Sequence of operations

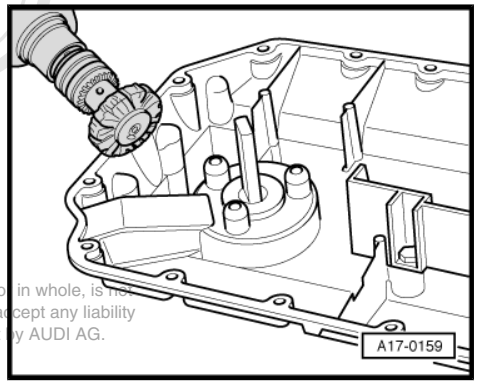
Note

Replace oil seals.

Caution

A liquid gasket must be used again on engines on which the bottom part of the sump had been fitted with a liquid gasket.

– Use rotating plastic brush for example to remove sealant remnants at bottom and top part of sump.

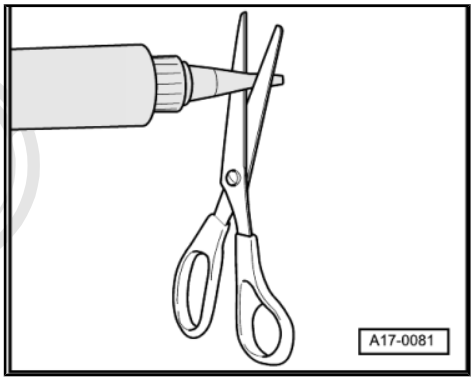


WARNING

Wear safety goggles.

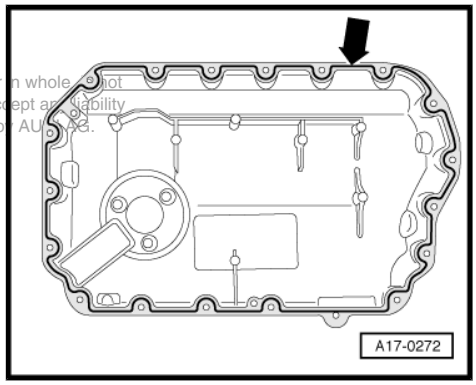
– Clean sealing surfaces; surfaces must be free from oil and grease.

– Cut off tube nozzle at front mark (∅ of nozzle approx. 3 mm).



– Apply sealant bead as shown to clean sealing surface of bottom part of sump.

• The bead of sealant should be approx. 1.5 mm wide -arrow-.



Note

♦ *After applying the sealant, the bottom part of the sump must be fitted within 5 minutes.*

♦ *The sealant bead must not be thicker than specified, as otherwise surplus sealant could ingress into the sump and clog the oil pump screen.*

– Fit bottom part of sump in position and pre-tighten all bolts diagonally to 5 Nm.

– Diagonally tighten bolts for bottom part of sump.

– Pour in engine oil and check oil level ⇒ page 151 .

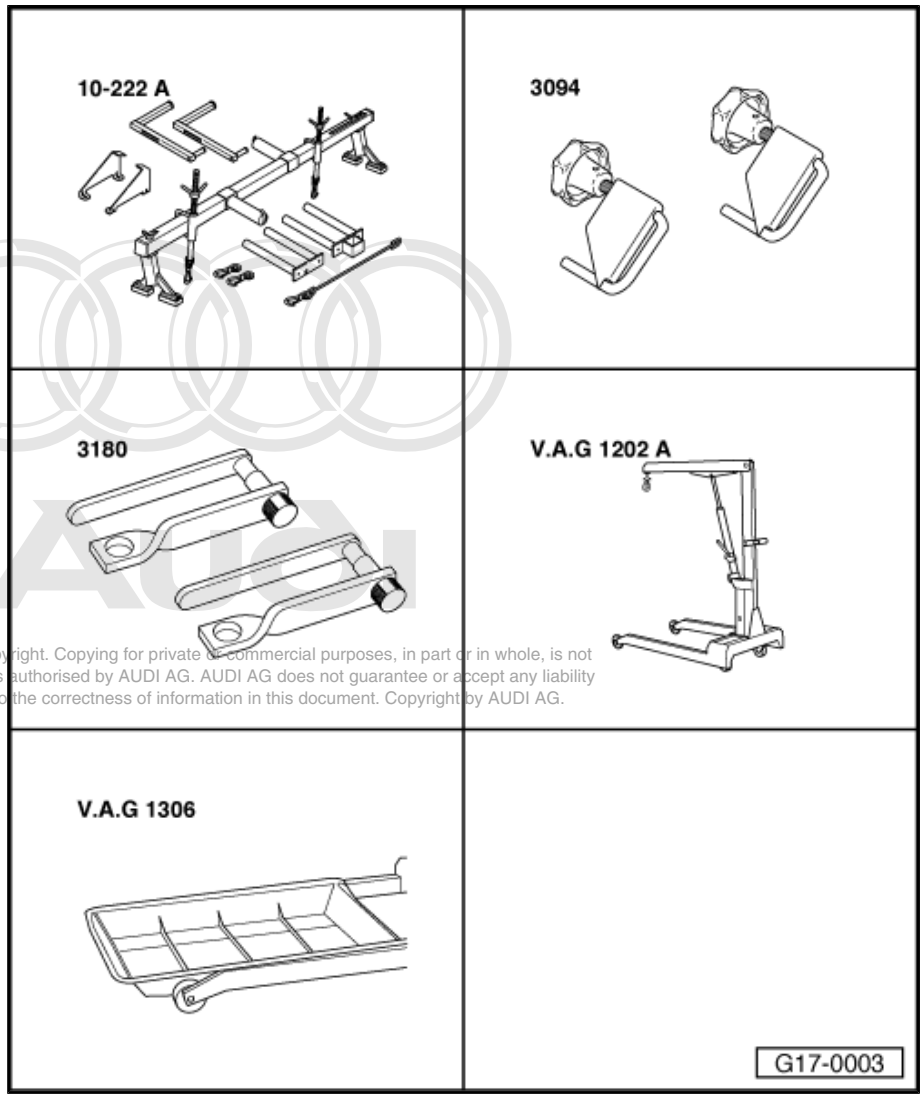
Tightening torques

Component	Nm
Bottom part of sump to top part	10
Oil drain plug	30

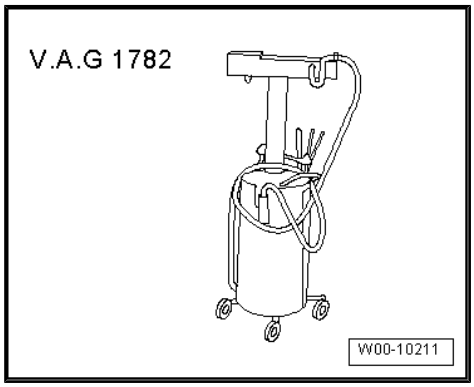
1.7 Removing top part of sump

Special tools and workshop equipment required

- Support bar -10-222 A- and adapter -10-222 A/4-
- Hose clamps up to Ø 25 mm -3094-
- Holder -3180-
- Workshop crane -VAS 6100- or -V.A.G 1202 A-
- Drip tray for workshop cranes -VAS 6208- or -V.A.G 1306-



- Used oil collector and extractor -V.A.G 1782-

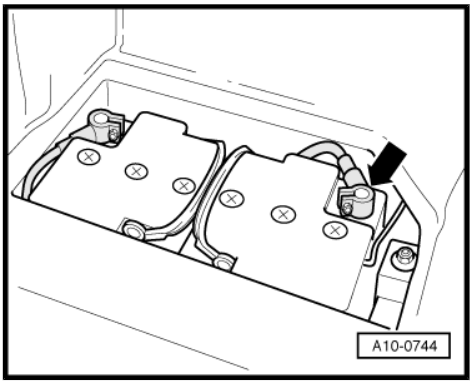


- TORX wrench T45

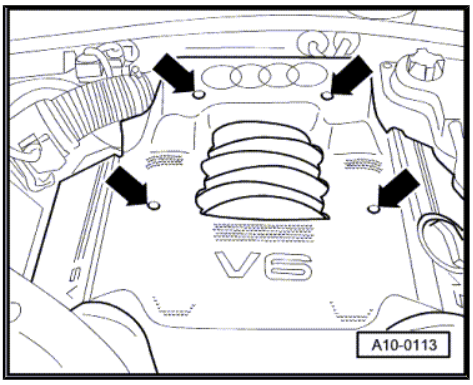
Sequence of operations

Caution

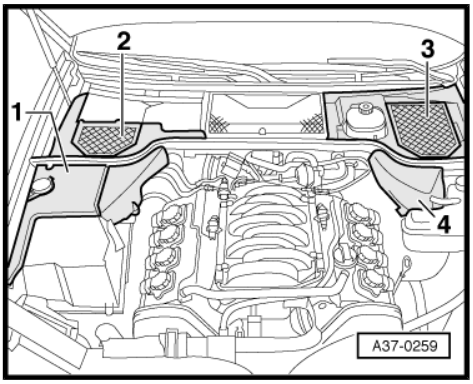
On vehicles with telematics system, activate service mode of telematics control unit before disconnecting battery ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .



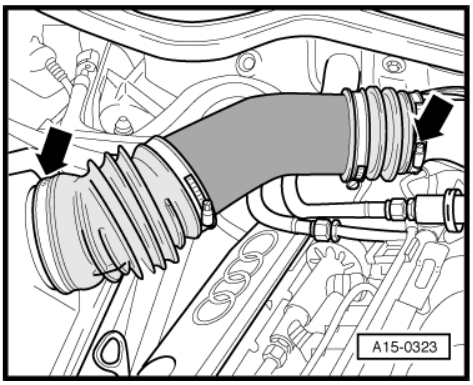
– Pay attention to and if necessary establish code for vehicles with encoded radio set/radio navigation system (RNS).
– Detach the side luggage compartment storage area partition and the floor covering secured with a velcro fastener.
– With ignition switched off, disconnect earth strap/cable at negative terminal -arrow- of battery on right of luggage compartment.
– Remove engine cover -arrows-.



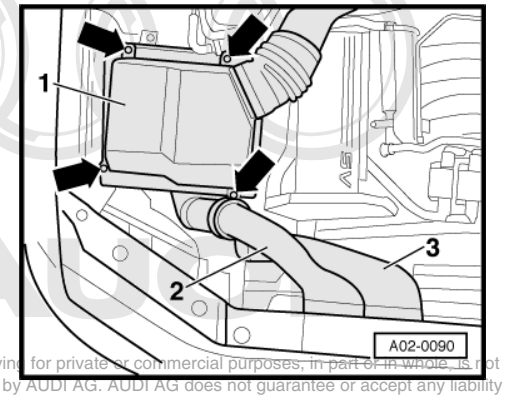
– Remove covers -1 … 4-.



– Remove air hose between air mass meter and intake manifold -arrows-.



– Remove air ducts -2- and -3-.
– Slacken off bolts -arrows- and lay aside cover -1- of air cleaner housing.



Note

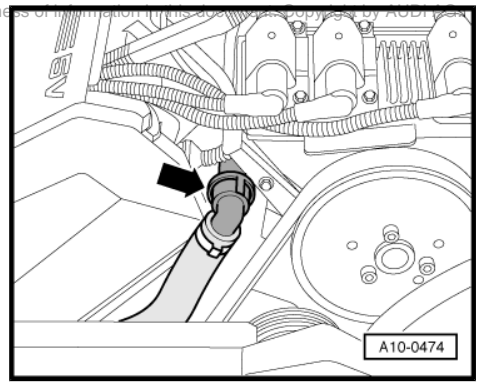
Leave wire for air mass meter connected.

Vehicles with secondary air system:

– Disconnect hose -arrow- from secondary air connecting pipe.

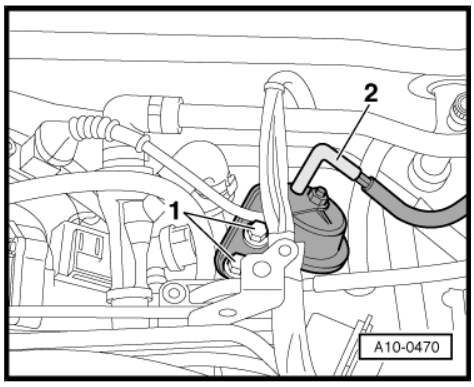
All models:

– Remove bottom part of air cleaner housing.
– Slacken off poly V-belt and detach it from alternator pulley ⇒ page 31 .



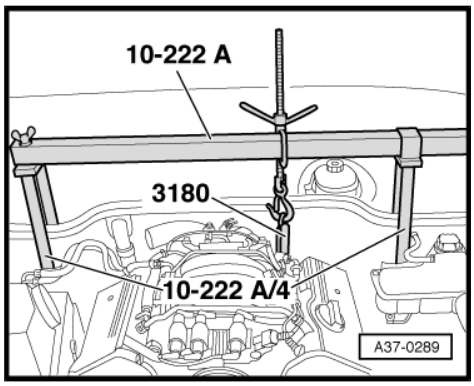
Vehicles with throttle cable:

– Detach vacuum hose -2- at CCS vacuum unit.
– Screw out bolts -1- and set down vacuum unit.

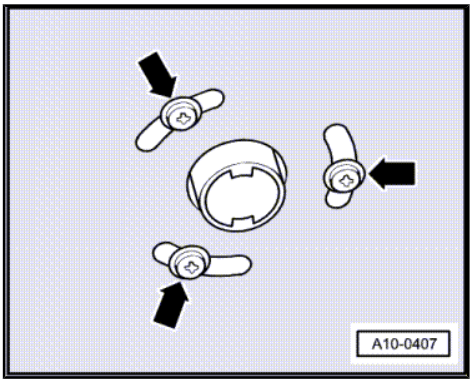


All models:

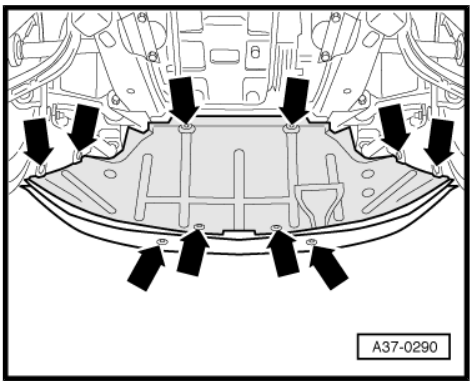
– Position support bar -10-222 A- with adapter -10-222 A/4- on bolts of suspension strut holder and check for stability.
• Spindle is positioned behind support bar.
– Unplug connector of injector at rear left.
– Fit holder -3180- and engage support bar.
– Slightly tighten spindle but do not pre-tension engine.



– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.

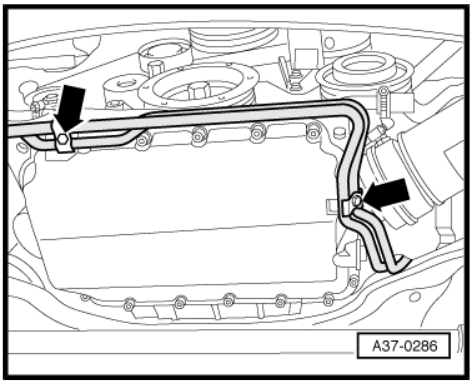


– Detach noise insulation -arrows-.
– Place used oil collector and extractor -V.A.G 1782- beneath engine.
– Drain off engine oil.



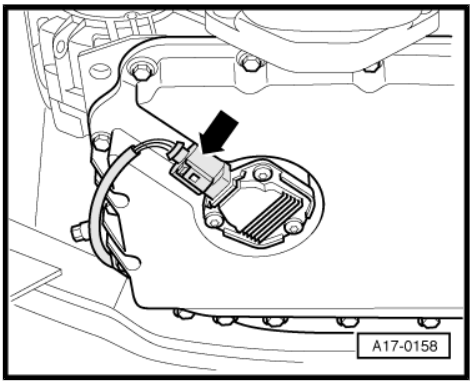
Vehicles with automatic gearbox:

– Unscrew holder for ATF pipes -arrows-.

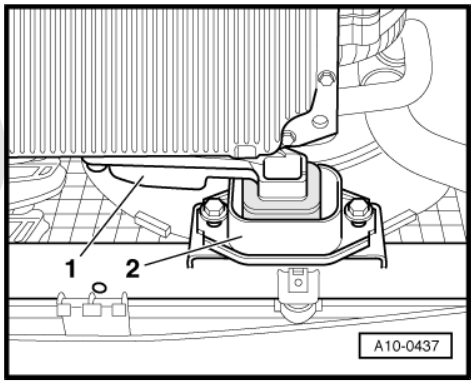


All models:

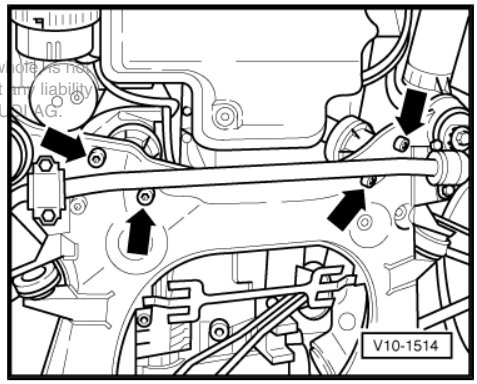
– Unplug connector at oil level/oil temperature sender -G266- -arrow- and lay bare wire.



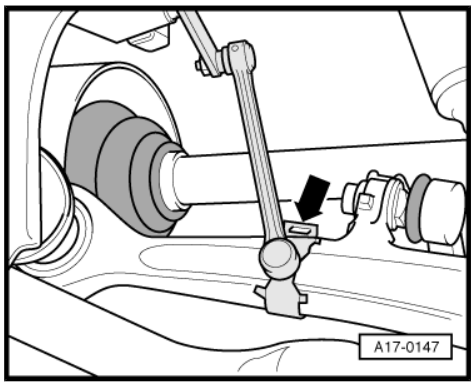
– Unscrew torque reaction support -1- and stop for torque reaction support -2-.



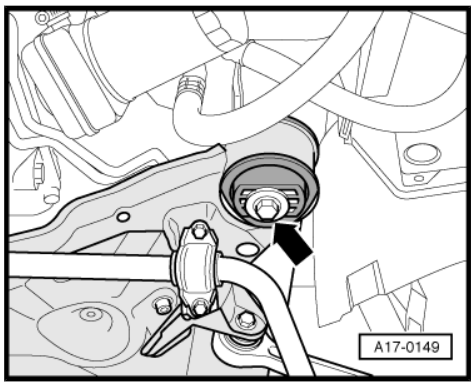
– Screw out bottom bolts -arrows- at engine mountings.



– If applicable unclip operating rod of vehicle level sender at transverse link at bottom -arrow-.



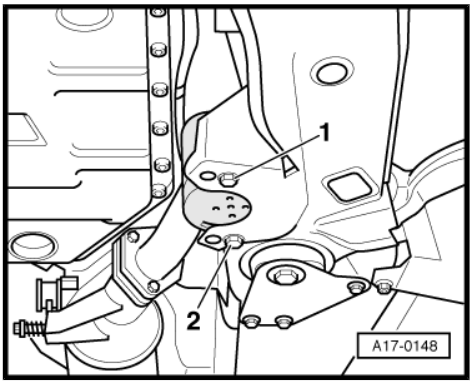
– Support subframe with workshop crane -VAS 6100- .
– Screw out front bolts -arrow- of subframe on left and right.



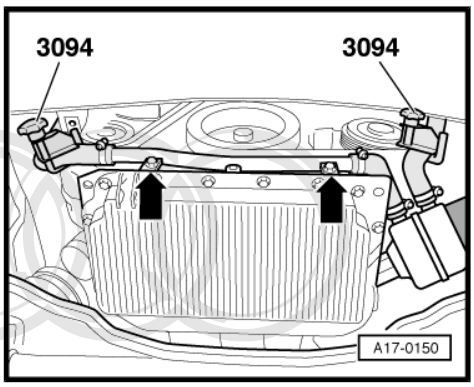
Note

The subframe is only to be unfastened and lowered at the front, as otherwise wheel alignment has to be performed.

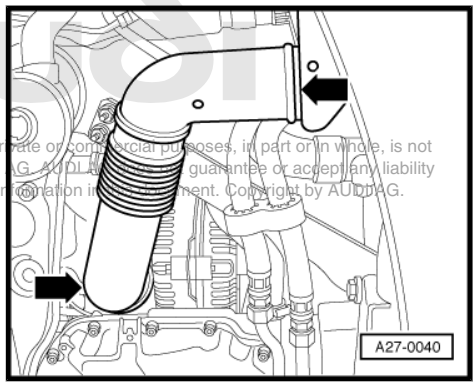
– Slacken off rear bolt -2- at left gearbox mounting by several turns and screw out front bolt -1-.
– Slowly lower subframe with workshop crane -VAS 6100- .
– Move workshop crane out from under the vehicle.



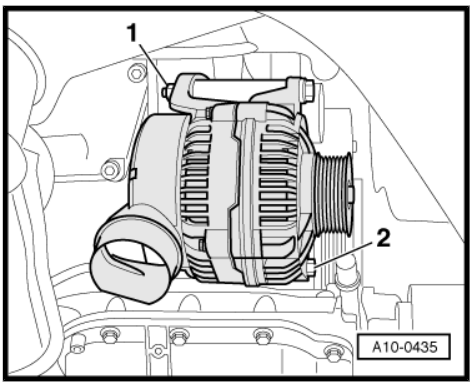
– Use hose clamps -3094- to pinch off both coolant hoses to oil cooler.
– Place drip tray for workshop cranes -VAS 6208- or -V.A.G 1306- beneath engine.
– Unscrew coolant pipe -arrows- and detach it from hoses.
– Place used oil collector and extractor -V.A.G 1782- beneath engine.
– Remove oil filter and oil cooler.
– Unplug connector at oil pressure switch -F1- and lay bare wire.



– Unclip alternator air duct -arrows-.



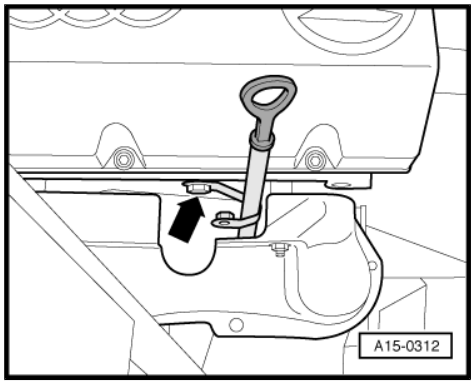
– Screw out bolt -2-.
– Unfasten nut -1-.
– Swivel alternator aside and unscrew wires.
– Unscrew alternator, lift clear and tie in place on body.



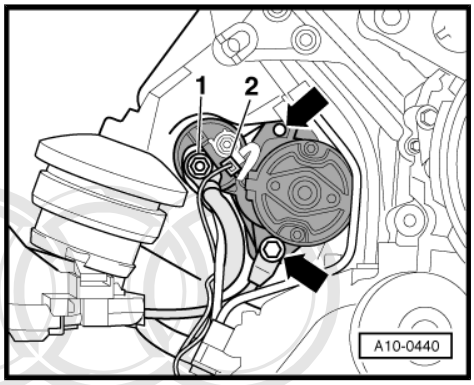
Note

If this is not done, the alternator will drop to the ground on removing top part of sump.

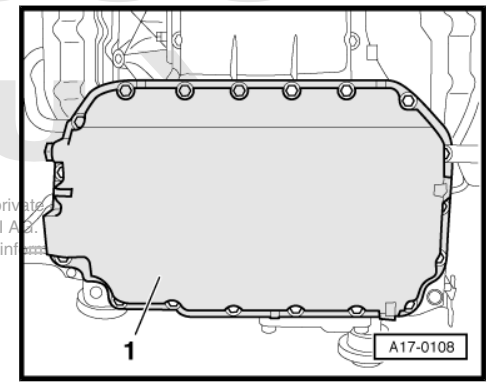
– Unscrew and lift off guide tube for dipstick at cylinder head -arrow-.



– Detach wires -1- and -2- at starter and detach insulator at positive connection of starter.
– Screw out starter securing bolts -arrows- from gearbox side.
– Unscrew clamp on right of top part of sump and lay bare wiring.
– Detach starter.

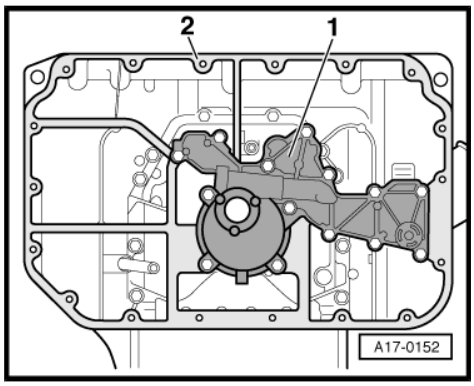


– Unscrew bottom part of sump -1-.



Vehicles with “engine generation II”:

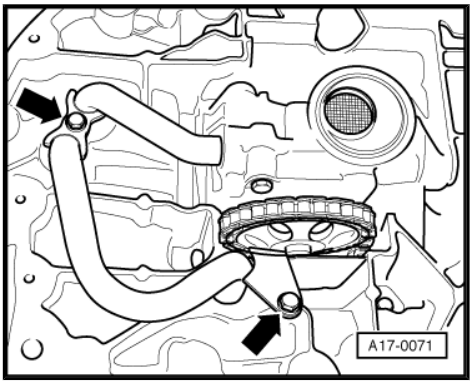
– Unscrew sealing cap -1-.
– Detach gasket -2-.



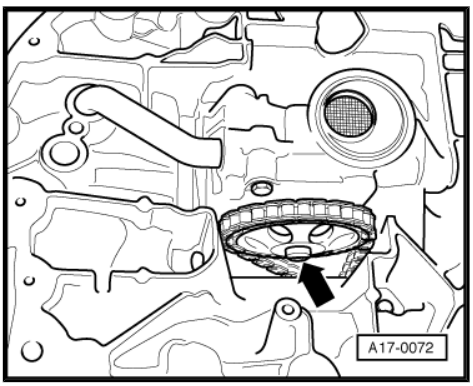
Vehicles with “engine generation III”:

– Place used oil collector and extractor -V.A.G 1782- beneath engine.

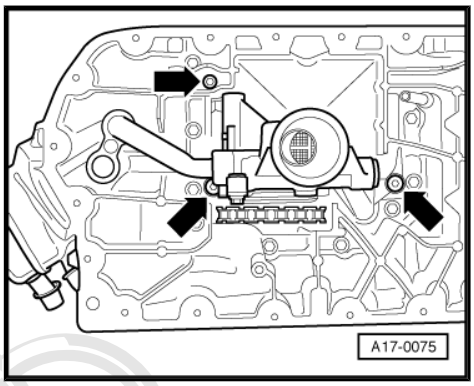
– Unscrew holders -arrows- for oil feed pipes and detach long oil feed pipe downwards.



– Unscrew chain sprocket using TORX wrench T45 -arrow- and detach it from oil pump.



– Remove oil pump together with short oil feed pipe -arrows-.



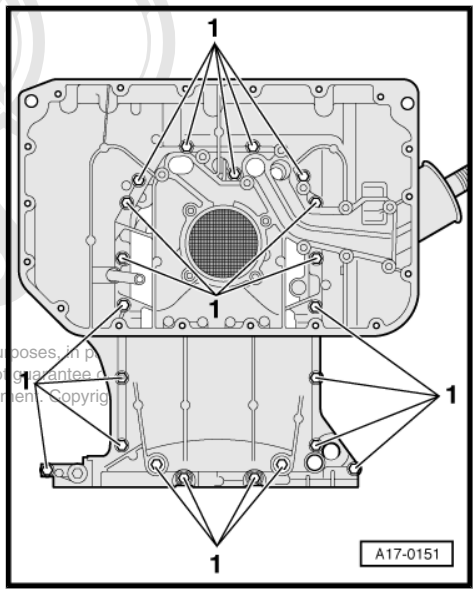
All models:

– Screw out engine/gearbox connecting bolts in area of top part of sump.

– Screw out bolts -1- for top part of sump.

– Press top part of sump off spring pins of cylinder block.

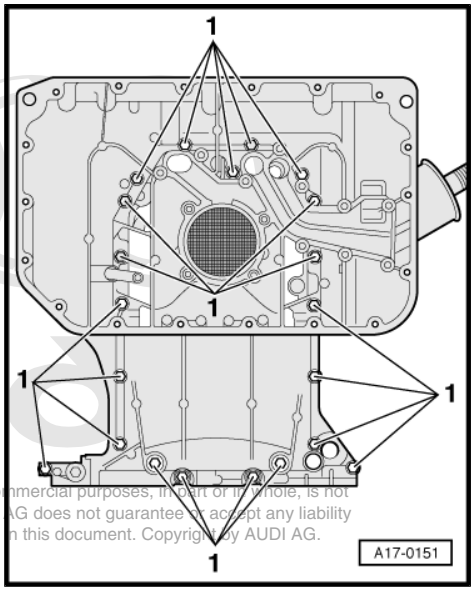
– Detach top part of sump.



1.8 Installing top part of sump - “engine generation II”

Sequence of operations

Install in reverse order, paying attention to the following:



Note

Replace self-locking nuts, gaskets and seals.

- Clean sealing surfaces before fitting top part of sump.
- Fit top part of sump in position and pre-tighten bolts -1- for top part of sump/cylinder block diagonally to 5 Nm.
- Tighten bolts for top part of sump/gearbox.
- Diagonally tighten bolts for top part of sump/cylinder block.
- Install bottom part of sump ⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129 .
- Fit subframe, paying attention to tightening sequence ⇒ Running gear, front-wheel drive and four-wheel drive; Rep. Gr. 40 .
- Allow stop for torque reaction support to drop into position on rubber buffer for torque reaction support and tighten bolts.
- Pour in engine oil and check oil level ⇒ page 151 .
- Replenish coolant ⇒ page 157 .

Note

- *On re-connecting the battery, remember to activate vehicle equipment (radio/radio navigation system, clock, electric window lifters) in line with owner's manual.*
- *Deactivate service mode of telematics control unit ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .*

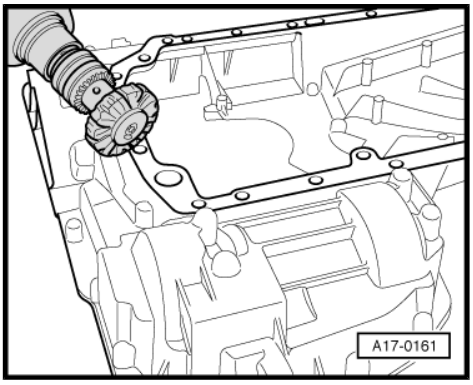
Tightening torques

Component	Nm
Top part of sump to cylinder block	10
Top part of sump to gearbox	45
Oil cooler to top part of sump	30
Engine mounting to subframe	25
Torque reaction support to top part of sump	42
Stop for torque reaction support to body	40
CCS unit to intake manifold	10

1.9 Installing top part of sump - “engine generation III”

Sequence of operations

Install in reverse order, paying attention to the following:



Note

Replace self-locking nuts, gaskets and seals.

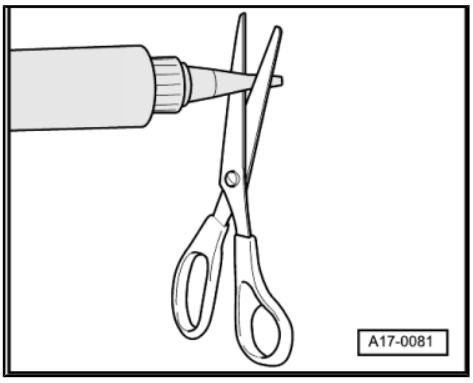
– Use rotating plastic brush for example to remove sealant remnants at top part of sump and cylinder block.

WARNING

Wear safety goggles.

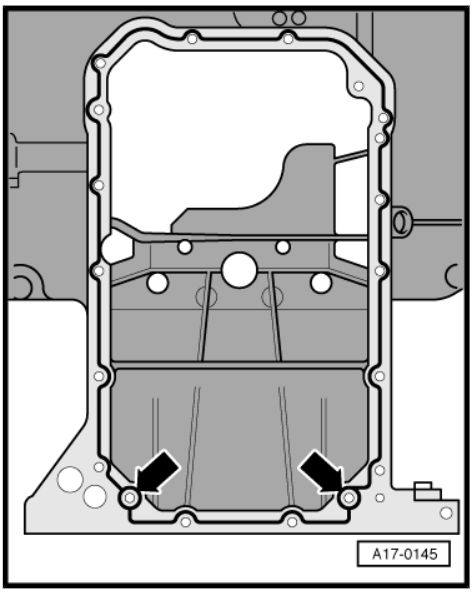
– Clean sealing surfaces; surfaces must be free from oil and grease.

– Cut off tube nozzle at front mark (∅ of nozzle approx. 3 mm).



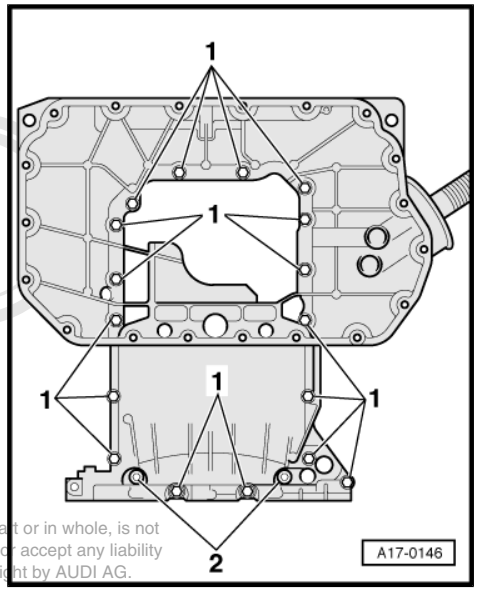
– Apply sealant bead as shown to clean sealing surface of top part of sump.

- Thickness of sealant bead: 2 ... 3 mm



Note

- *After applying the silicone sealant, the top part of the sump must be fitted within 5 minutes.*
- *The sealant bead must not be thicker than 3 mm, as otherwise surplus sealant could ingress into the sump and clog the screen in the oil intake pipe.*
- *Take particular care when applying sealant bead in area of rear sealing flange -arrows-.*



- Fit top part of sump in position (2nd mechanic required) and pre-tighten bolts -1- and -2- for top part of sump/cylinder block diagonally to 5 Nm.
- Tighten bolts for top part of sump/gearbox.
- Diagonally tighten bolts for top part of sump/cylinder block.
- Install oil pump ⇒ page 145 .
- Install bottom part of sump
  ⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129 or
  ⇒ “1.6 Installing bottom part of sump - engines with liquid gasket”, page 130 .
- Fit subframe, paying attention to tightening sequence ⇒ Running gear, front-wheel drive and four-wheel drive; Rep. Gr. 40 .
- Replace O-ring at guide tube for dipstick and insert guide tube in hole in top part of sump.
- Install starter ⇒ Electrical system; Rep. Gr. 27 .
- Install alternator ⇒ Electrical system; Rep. Gr. 27 .
- Fit poly V-belt ⇒ page 31 .
- Allow stop for torque reaction support to drop into position on rubber buffer for torque reaction support and tighten bolts.
- Pour in engine oil and check oil level ⇒ page 151 .
- Replenish coolant ⇒ page 157 .

Note

- *On re-connecting the battery, remember to activate vehicle equipment (radio/radio navigation system, clock, electric window lifters) in line with owner's manual.*
- *Deactivate service mode of telematics control unit ⇒ Radio, telephone, navigation self-diagnosis; Rep. Gr. 01 .*

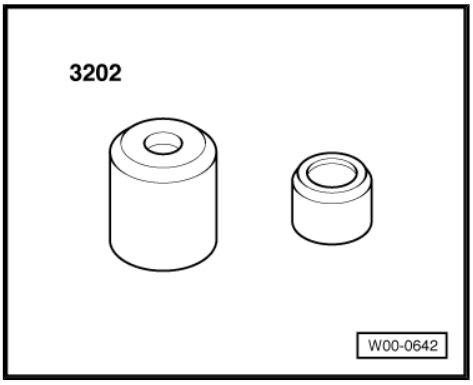
Tightening torques

Component		Nm
Top part of sump to cylinder block	M6	10
	M7	16
	M8	22
Top part of sump to gearbox		45
Oil cooler to top part of sump		30
Engine mounting to subframe		25
Torque reaction support to top part of sump		42
Stop for torque reaction support to body		40
CCS unit to intake manifold		10

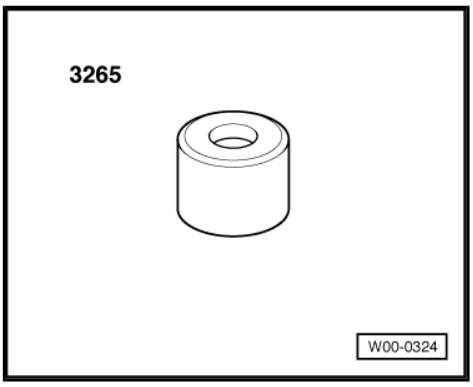
1.10 Removing and installing oil pump - “engine generation II”

Special tools and workshop equipment required

♦ Fitting sleeves -3202/1-

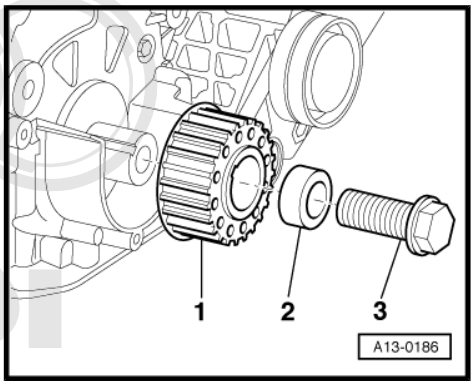


♦ Fitting sleeve -3265-

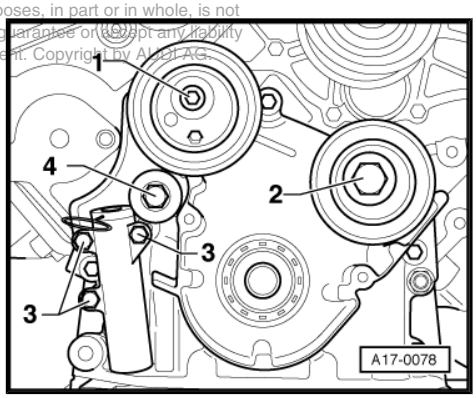


Removing

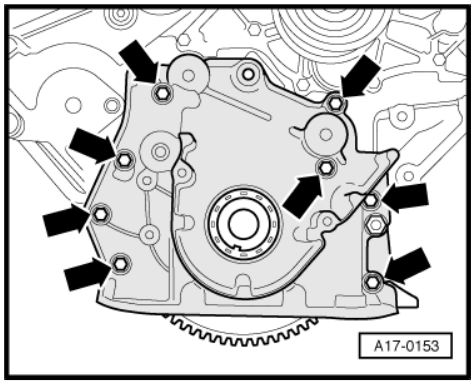
– Remove toothed belt ⇒ page 35 .
– Screw out central bolt -3- for crankshaft toothed belt sprocket -1-.
– Detach spacer -2- and toothed belt sprocket.
– Remove top part of sump ⇒ page 132 .



– Unscrew idler wheel -2-, tensioning roller -1-, tensioning lever -4- and tensioning element -3-.
– Screw out spray nozzle valve ⇒ Item 12 (page 124) .



– Unplug connector at oil temperature sender.
– Screw out bolts -arrows-.
– Detach oil pump at front.
– Drive out oil seal with oil pump removed.



Installing

Install in reverse order, paying attention to the following:

Note

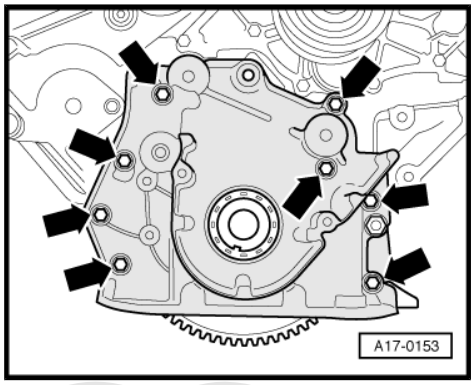
Replace gaskets and seals.

– Clean sealing surfaces before fitting oil pump.
– Position oil pump such that it engages in drivers at crankshaft.

Note

If oil pump is inserted with oil seal fitted, fitting sleeve -3202/1- must be attached to end of crankshaft before installing oil pump.

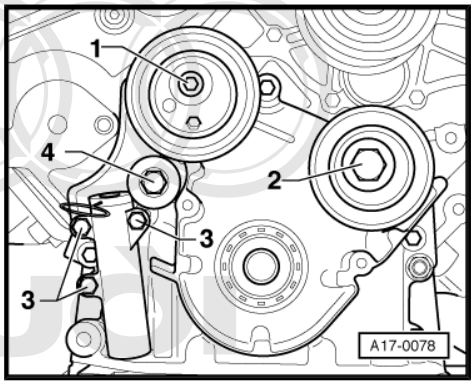
– Tighten bolts -arrows-.



– Install components in stated sequence:

1. Spray nozzle valve ⇒ Item 12 (page 124)
2. Tensioning element for toothed belt -Item 3-, apply locking fluid to bolts on fitting; locking fluid ⇒ Parts catalogue
3. Tensioning lever -Item 4-
4. Toothed belt tensioning roller -Item 1-
5. Idler wheel -Item 2-

– Pay attention to spacers beneath tensioning roller and tensioning lever.

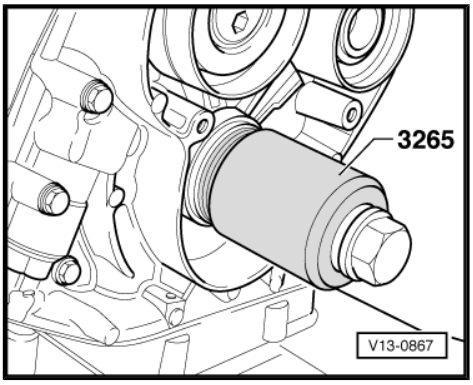


Note

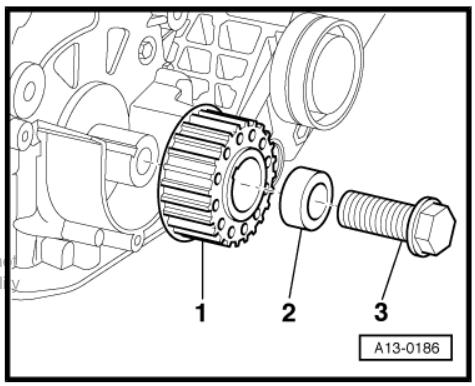
Do not lubricate sealing lip and outer rim of oil seal before pressing in.

– Use fitting sleeve -3202/1- to attach oil seal.

– Press in oil seal with fitting sleeve -3265- and central bolt such that it is flush.



– Install crankshaft toothed belt sprocket -1- with spacer -2- with new central bolt -3-.



Note

- *There must not be any oil at contact surface between toothed belt sprocket and crankshaft.*
- *Do not additionally lubricate bolt for crankshaft toothed belt sprocket.*

– Fit toothed belt (adjust timing) ⇒ page 38 .

– Install top part of sump ⇒ “1.8 Installing top part of sump - engine generation II ”, page 140 .

– Install bottom part of sump ⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129 .

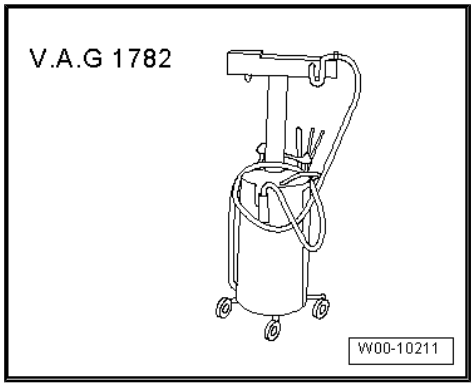
Tightening torques

Component	Nm
Oil pump to cylinder block	10
Toothed belt sprocket to crankshaft	200 + 180° 1)2)
Toothed belt tensioning roller to oil pump	22
Tensioning lever to oil pump	22
Tensioning element to oil pump	10
Idler wheel to oil pump	43
Spray nozzle valve	40
• 1) Replace bolt. • 2) 180° corresponds to half a turn.	

1.11 Removing and installing oil pump - “engine generation III”

Special tools and workshop equipment required

♦ Used oil collector and extractor -V.A.G 1782-



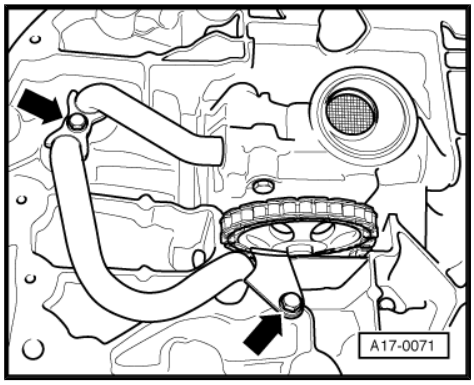
♦ TORX wrench T45

Removing

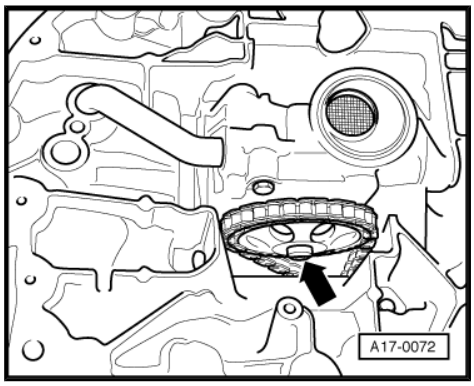
– Remove bottom part of sump ⇒ page 128 .

– Place used oil collector and extractor -V.A.G 1782- beneath engine.

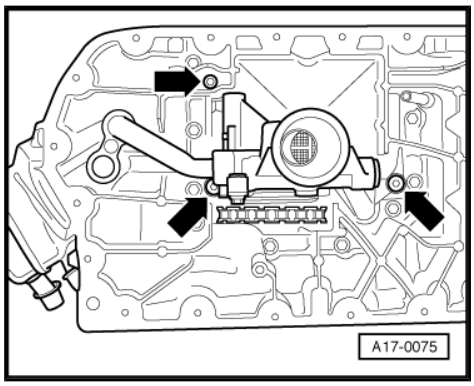
– Unscrew holders -arrows- for oil feed pipes and detach long oil feed pipe downwards.



– Unscrew chain sprocket using TORX wrench T45 -arrow- and detach it from oil pump.



– Remove oil pump together with short oil feed pipe -arrows-.



Installing

Install in reverse order, paying attention to the following:

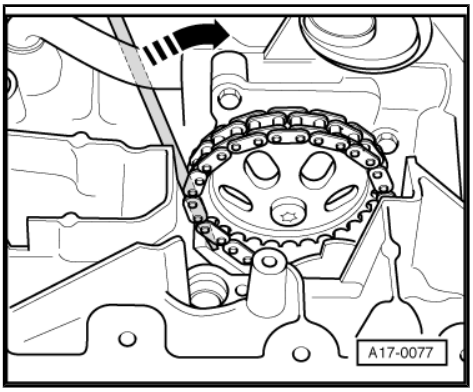
- Chain sprocket can only be fitted in one position on oil pump shaft.

– Install bottom part of sump
⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129 or
⇒ “1.6 Installing bottom part of sump - engines with liquid gasket”, page 130 .

Tightening torques

Component	Nm
Oil pump to cylinder block	22
Chain sprocket to oil pump shaft	25
Holder to top part of sump	10

1.12 Checking chain tensioner - “engine generation III”



– Remove bottom part of sump ⇒ page 128 .
– Insert screwdriver between chain and chain tensioner and apply lever action to chain tensioner.

If no spring tension is found and chain is slack:

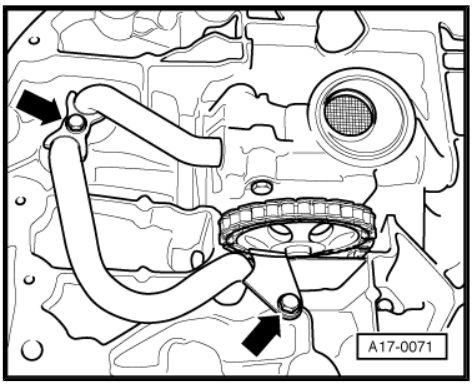
– Replace chain tensioner ⇒ page 147 .

1.13 Removing and installing chain/chain tensioner for oil pump - “engine generation III”

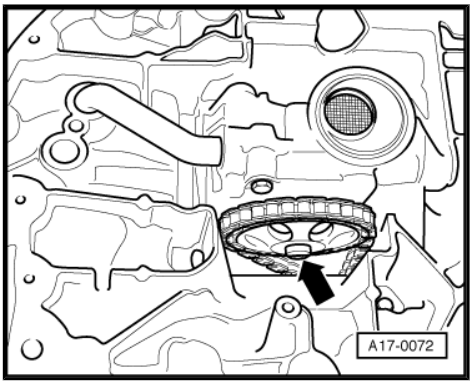
Special tools and workshop equipment required

♦ TORX wrench T45

Removing



– Remove bottom part of sump ⇒ page 128 .
– Remove front sealing flange ⇒ page 44 .
– Place used oil collector and extractor -V.A.G 1782- beneath engine.
– Unscrew holders -arrows- for oil feed pipes and detach long oil feed pipe downwards.



– Unscrew chain sprocket using TORX wrench T45 -arrow- and detach it from oil pump.
– Take chain sprocket out of chain.
– Detach chain tensioner.
– Lift off chain.

Installing

Install in reverse order, paying attention to the following:

• Chain sprocket can only be fitted in one position on oil pump shaft.
– Install bottom part of sump
⇒ “1.5 Installing bottom part of sump - engines with moulded gasket”, page 129 or
⇒ “1.6 Installing bottom part of sump - engines with liquid gasket”, page 130 .
– Install front sealing flange ⇒ page 46 .

Tightening torques

Component	Nm
Oil pump to cylinder block	22
Chain sprocket to oil pump shaft	15
Holder to top part of sump	10

1.14 Replacing oil retention valves

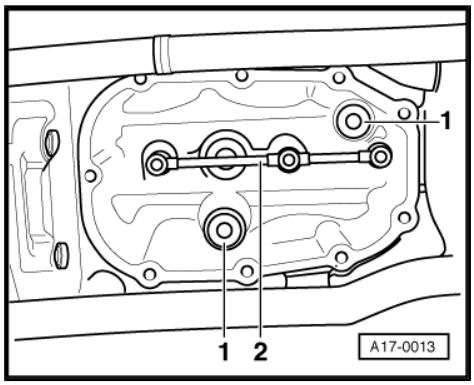
Note

Oil retention valves must be replaced in the event of irregular valve noise which disappears after a lengthy journey and repeatedly re-occurs when driving short distances.

Sequence of operations

– Remove intake manifold ⇒ page 83 .

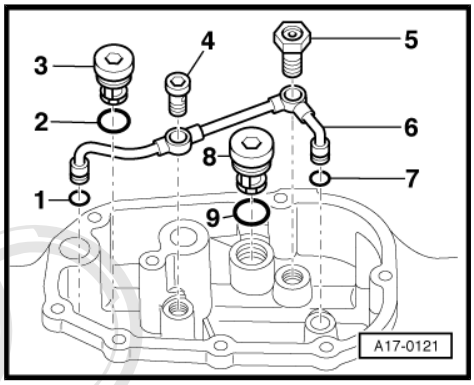
– Unscrew cover beneath intake manifold.



“Engine generation II”

1 - Oil retention valve - 25 Nm

2 - Oil pipe of spray nozzle valve for piston cooling spray nozzles - 15 Nm



“Engine generation III”

1 - O-ring; replace

2 - O-ring; replace

3 - Oil retention valve for left cylinder head - 20 Nm

4 - Banjo bolt - 15 Nm

5 - Spray nozzle valve for piston cooling spray nozzles - 25 Nm

6 - Oil pipe

7 - O-ring; replace

8 - Oil retention valve for right cylinder head - 20 Nm

9 - O-ring; replace

Assemble in reverse order; paying attention to the following:

Note

Replace O-rings.

– Install intake manifold ⇒ page 83 .

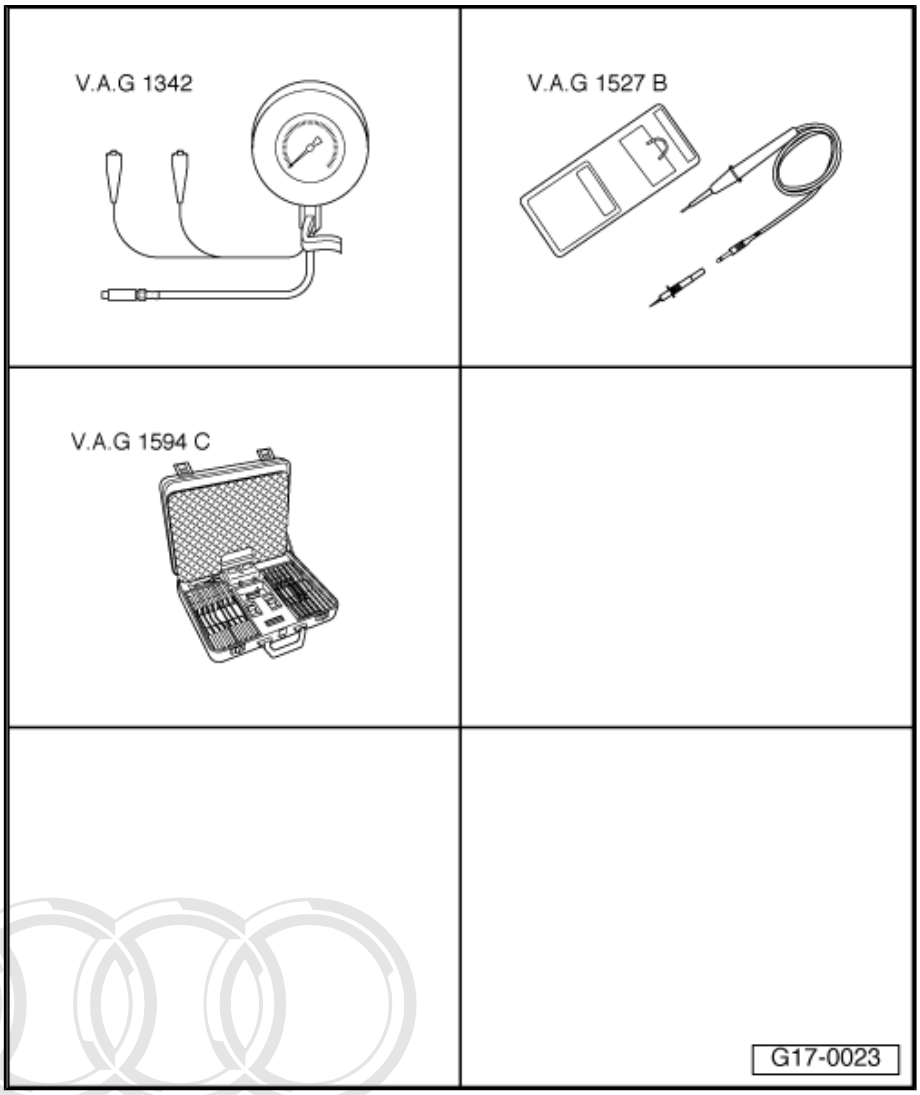
Tightening torque

Component	Nm
Cover to cylinder block	10

1.15 Checking oil pressure and oil pressure switch

Special tools and workshop equipment required

- Oil pressure tester -V.A.G 1342-
- Voltage tester - V.A.G 1527 B-
- Adapter set -V.A.G 1594 C-

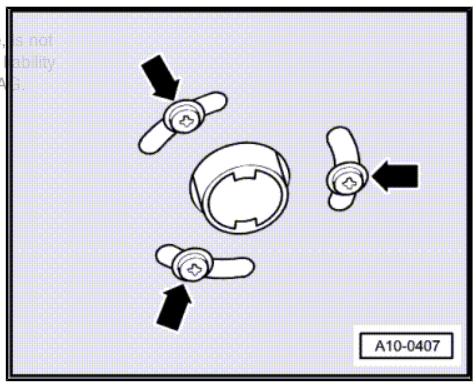


Test conditions

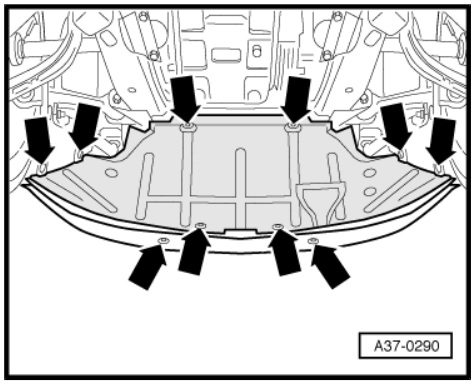
- Oil level OK
- Engine oil temperature approx. 80 °C

Test preparation

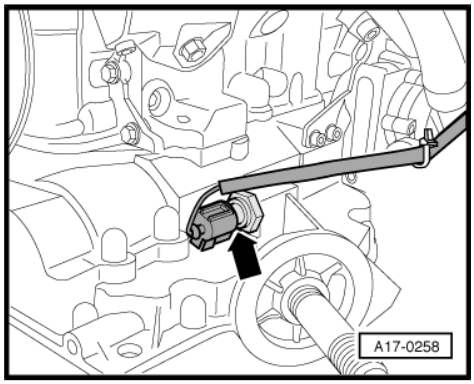
– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.

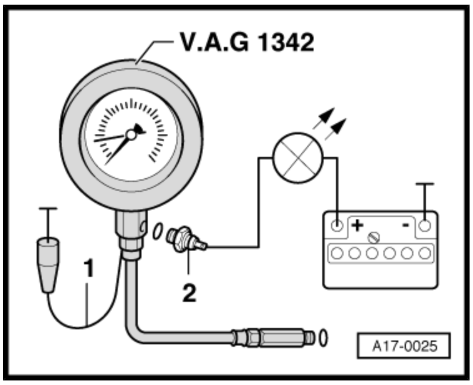


– Detach noise insulation -arrows-.



– Unplug connector at oil pressure switch -arrow-.
– Screw out oil pressure switch.





– Connect oil pressure tester -V.A.G 1342- at hole for oil pressure switch.

– Screw oil pressure switch -2- into oil pressure tester -V.A.G 1342- .

Checking oil pressure switch

– Connect brown wire -1- of oil pressure tester to earth (–).

– Connect voltage tester -V.A.G 1527 B- with test leads from adapter set -V.A.G 1594 C- to oil pressure switch and battery positive (+).

• LED must not light.

If LED lights:

– Replace oil pressure switch.

– Start engine.

Note

Observe tester and LED on starting, as switching point of oil pressure switch may already be exceeded on starting.

Black oil pressure switch:

• LED must light at 1.2 … 1.6 bar.

White oil pressure switch:

• LED must light at 1.6 … 2.0 bar.

All models:

If LED does not light:

– Replace oil pressure switch.

Checking oil pressure

– Start engine.

• Oil pressure at 2000 rpm min. 2.0 bar

The pressure relief valve or oil pump is defective if the specifications are not attained.

– Replace oil pump ⇒ page 142 or ⇒ page 145 .

Assemble in reverse order.

1.16 Engine oil

Viscosity classes and oil specifications

⇒ Maintenance ; Booklet 403

1.17 Checking oil level

Test conditions

• Engine oil temperature min. 60 °C

• Vehicle standing on a flat surface

• Wait a few minutes after switching off engine to allow oil to flow back into sump

Test sequence

– Pull out dipstick, wipe with a clean cloth and re-insert as far as it will go.

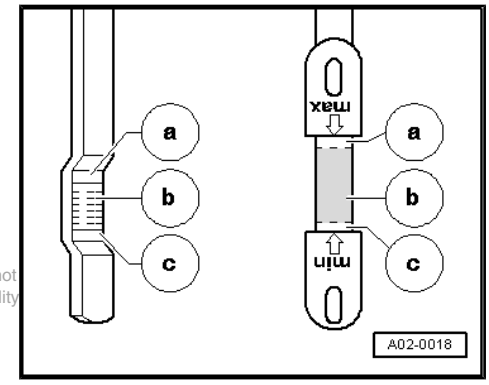
– Then pull out dipstick again and take oil level reading.

Markings on dipstick:

a - Oil is not to be topped up.

b - Oil can be topped up.

c - Oil must be topped up. It is then sufficient for the oil level to be in area -b- (hatched area).



Note

The oil level must not be above mark -a- on the dipstick or below mark -c-.

19 – Cooling

1 Removing and installing cooling system components

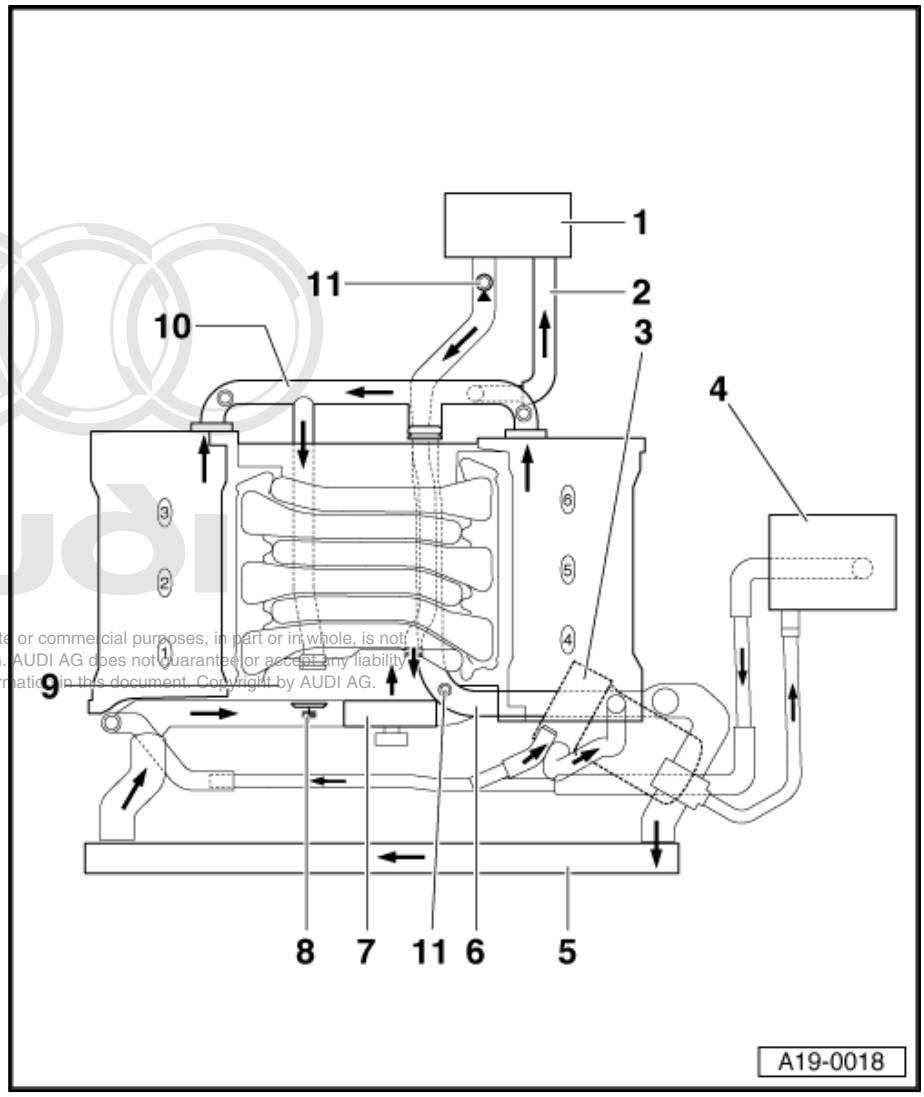
WARNING

Hot vapour/coolant may escape when opening the expansion tank. Cover the cap with a cloth and open carefully.

Note

- *The cooling system is pressurised when the engine is warm. Dissipate pressure if necessary before starting repair work.*
- *Replace gaskets and seals.*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*
- *The arrows on the coolant pipes and the ends of the coolant hoses must coincide.*
- *Removing and installing viscous fan* *⇒ page 173*

1.1 Connection diagram for coolant hoses



1 - Heating system heat exchanger

- ❑ Fill with fresh coolant following replacement

2 - Supply hose

- ❑ To heating system heat exchanger

3 - Oil cooler

4 - Expansion tank

- ❑ With cap
- ❑ Checking pressure relief valve in cap ⇒ page 178

5 - Radiator

- ❑ Removing and installing ⇒ page 174
- ❑ Fill with fresh coolant following replacement

6 - Front coolant pipe

- ❑ Removing and installing ⇒ page 168

7 - Coolant pump

- ❑ Removing and installing ⇒ page 162

8 - Thermostat

- ❑ Removing and installing ⇒ page 164
- ❑ Checking ⇒ page 167
- ❑ Installation position ⇒ page 162

9 - Intake manifold

10 - Rear coolant pipe

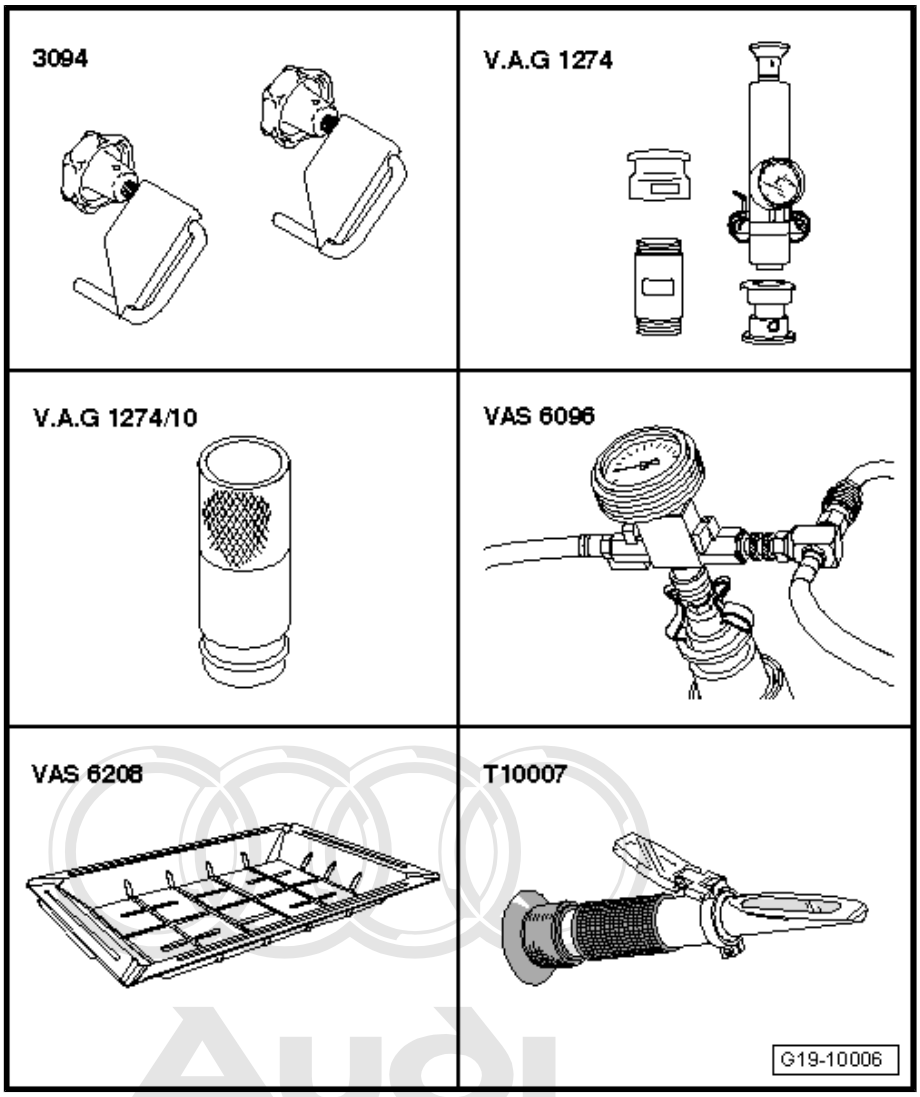
- ❑ Removing and installing ⇒ page 171

11 - Bleed screw

1.2 Draining and replenishing coolant

Special tools and workshop equipment required

- Hose clamps up to Ø 25 mm -3094-
- Cooling system tester -V.A.G 1274/1- from -V.A.G 1274-
- Pipe for cooling system tester -V.A.G 1274/10-
- Cooling system filler unit -VAS 6096-
- Drip tray for workshop cranes -VAS 6208- or -V.A.G 1306-
- Refractometer -T10007-



Draining

Note

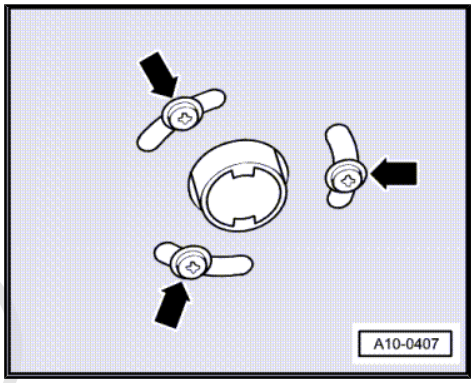
Collect drained coolant in a clean container for disposal or re-use.

WARNING

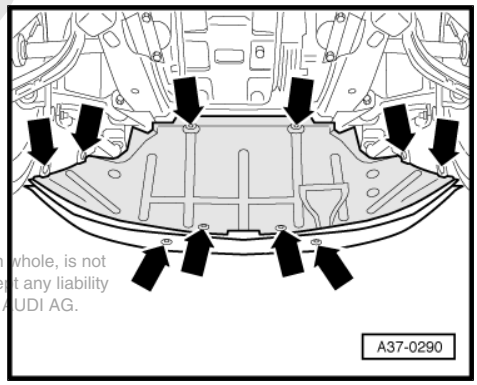
Hot vapour/coolant may escape when opening the expansion tank. Cover the cap with a cloth and open carefully.

– Open cap of coolant expansion tank.

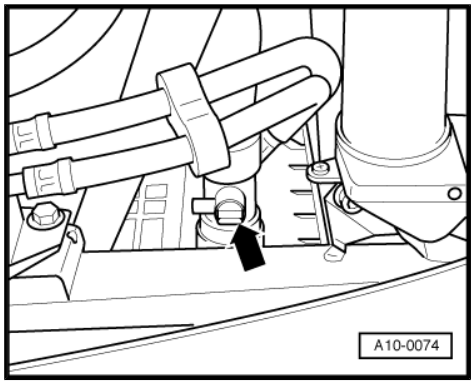
– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



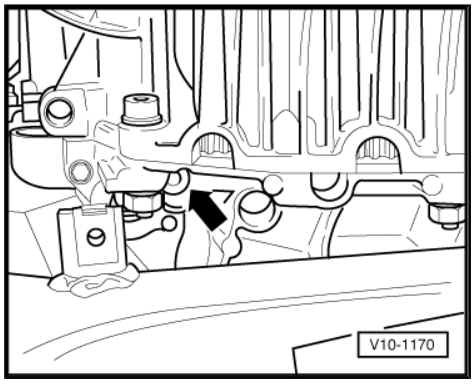
– Detach noise insulation -arrows-.



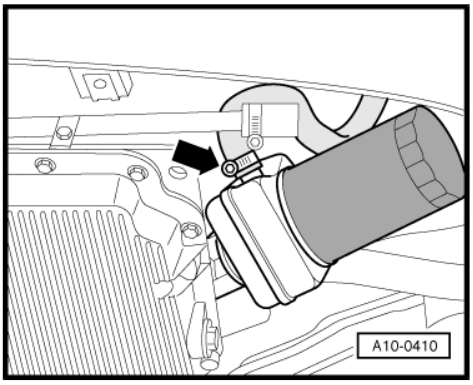
– Place drip tray for workshop cranes -VAS 6208- or -V.A.G 1306- beneath engine.
– Turn drain plug -arrow- on right of radiator anti-clockwise. Attach hose to connection if necessary.



– Additionally open coolant drain plug on engine -arrow-.



– Additionally detach coolant hose at oil cooler -arrow- and drain off remaining coolant.

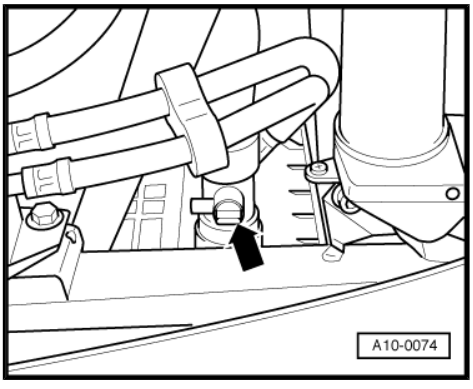


Replenishing

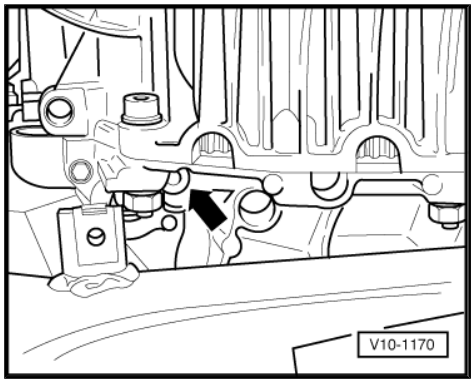
Note

- *The cooling system is filled all year round with a mixture of water and radiator anti-freeze/anti-corrosion agent.*
- *It is important to use only coolant additive Plus -G 012 A8F A1- (also designated as "G12+") "meeting specification TL VW 774 F". Other coolant additives could considerably impair anti-corrosion action in particular. The resultant damage could lead to loss of coolant and consequently to serious engine damage.*
- *The coolant additive "G12+" can be mixed with the additives "G11" and "G12".*
- *"G12+" and coolant additives marked "meeting specification TL VW 774 F" prevent frost and corrosion damage, stop scale forming and at the same time also increase the boiling point. The cooling system must therefore be filled all year round with anti-freeze and anti-corrosion additive.*
- *On account of the higher boiling point, the coolant helps to enhance engine reliability under heavy loads particularly in countries with tropical climates.*
- *Frost protection must be ensured down to approx. –25 °C (in countries with an Arctic climate down to approx. –35 °C).*
- *The coolant concentration must not be reduced by adding water even in warmer seasons and in warmer countries. The anti-freeze ratio must be at least 40 %.*
- *If greater frost protection is required in very cold climates, the amount of "G12+" can be increased, however only up to 60 % (giving frost protection to around -40 °C) as otherwise frost protection decreases again and cooling efficiency is also impaired.*
- *Exclusive use is to be made of clean drinking water for mixing coolant.*
- *If the radiator, heat exchanger, cylinder head, cylinder head gasket or cylinder block has been replaced, do not re-use the old coolant.*
- *Never re-use contaminated coolant.*
- *For checking anti-freeze protection in cooling system, use must be made for coolant additive "G12+" of the refractometer -T10007- .*

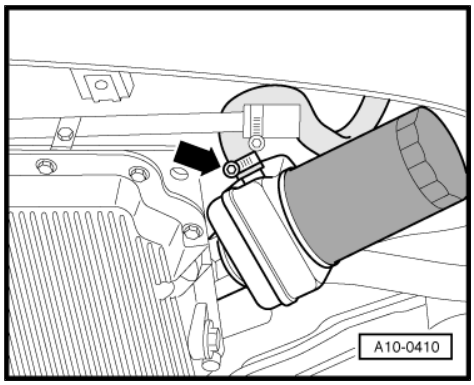
– Close drain plug -arrow- on right of radiator.



– Replace O-ring and tighten drain plug -arrow- to 20 Nm.



– Connect coolant hose to oil cooler -arrow-.



– Fill coolant tank -VAS 6096/1- with at least 12 litres of coolant pre-mixed to the correct ratio:

• “G12+” (40 %) and water (60 %) for frost protection down to -25 °C

• “G12+” (50 %) and water (50 %) for frost protection down to -35 °C

• “G12+” (60 %) and water (40 %) for frost protection down to -40 °C

– Screw adapter for cooling system tester -V.A.G 1274/1- to coolant expansion tank.

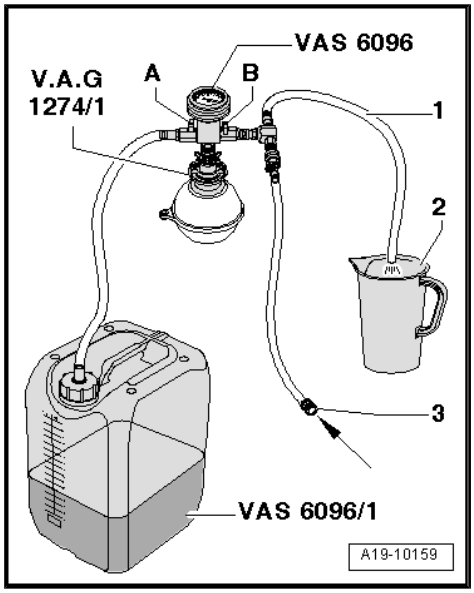
– Attach cooling system filler unit -VAS 6096- to adapter -V.A.G 1274/1- .

– Route exhaust air hose -1- into a small vessel -2- (the exhaust air entrains a small quantity of coolant, which is to be collected).

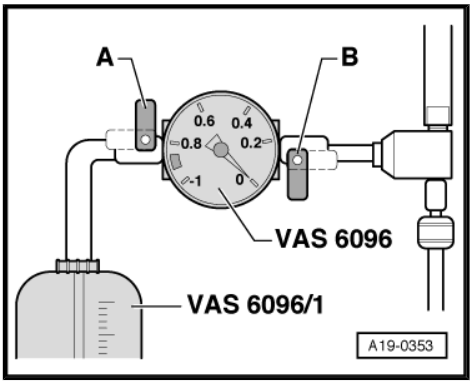
– Close the two valves -A- and -B- by setting lever at right angle to direction of flow.

– Connect hose -3- to compressed air supply.

• Pressure: 6 ... 10 bar.



– Open valve -B- by setting lever to direction of flow.



The vacuum booster generates a vacuum in the cooling system.

- The pointer of the indicating instrument must move into the green zone.

– Additionally open valve -A- briefly by setting lever to direction of flow so that hose of coolant tank -VAS 6096/1- is filled with coolant.

– Close valve -A- again.

– Leave valve -B- open for a further 2 minutes.

- The vacuum booster continues to generate vacuum in the cooling system.
- The pointer of the indicating instrument must remain in the green zone.

– Close valve -B-.

- The pointer of the indicating instrument must stop in the green zone. The vacuum in the cooling system is then sufficient for subsequent filling.

Repeat procedure if pointer is below green zone.

If the vacuum decreases, there is a leak in the cooling system.

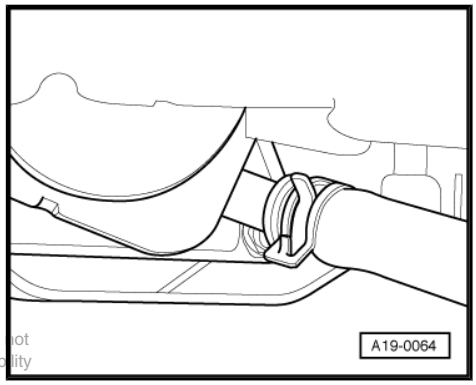
– Detach compressed air hose.

– Open valve -A-.

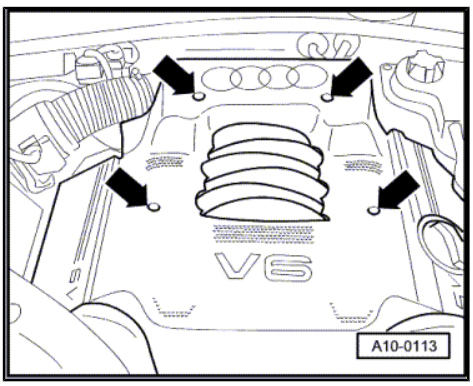
The vacuum in the cooling system causes coolant to be drawn in from the coolant tank -VAS 6096/1- ; the cooling system is filled.

– Detach cooling system filler unit -VAS 6096- from expansion tank.

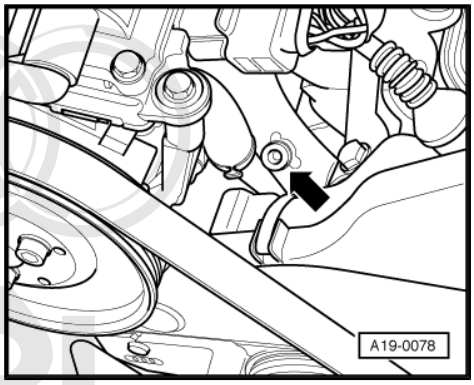
– Attach pipe for cooling system tester -V.A.G 1274/10- to adapter -V.A.G 1274/1- .



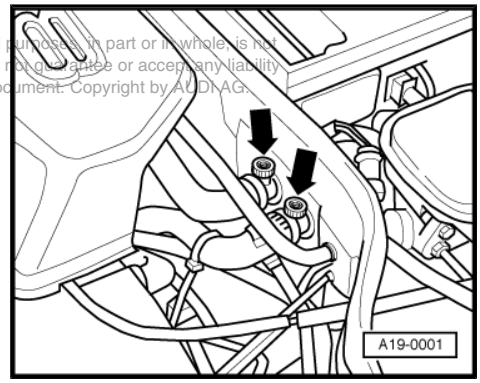
– Remove engine cover -arrows-.



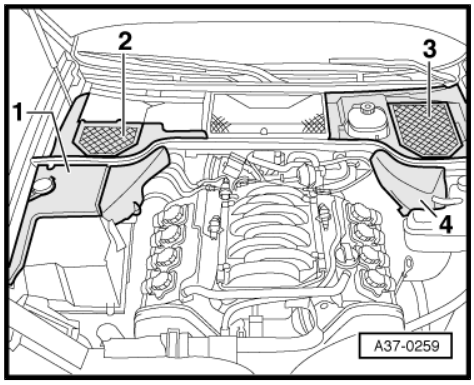
– Open bleed screw -arrow- at front coolant pipe between power steering pump and left cylinder head.
– Pour in coolant until it emerges at bleeder hole.
– Replace O-ring and tighten bleed screw -arrow- to 15 Nm.



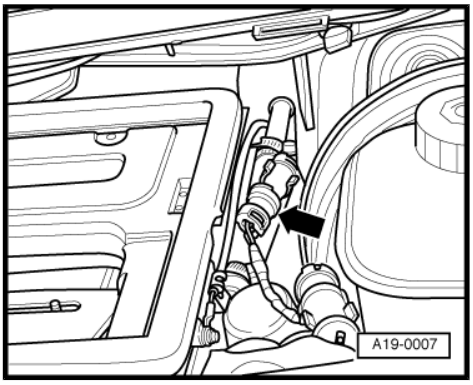
– Open bleed screws -arrows- at heating system heat exchanger supply and return.
– Pour in coolant until it emerges at bleeder holes.
– Close bleed screws.



– Remove cover -3-.



– Unplug connector -arrow- to pump/valve unit.



Note

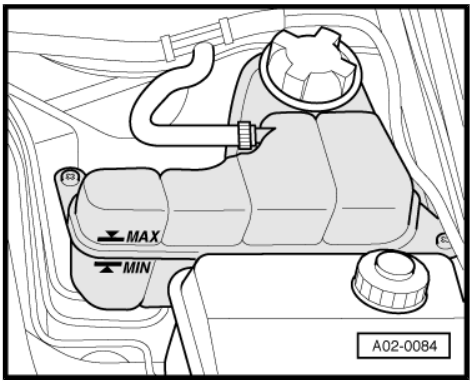
- *The coolant circulation pump -V50- of the pump/valve unit is not to be started up until the coolant circuit has been bled.*
- *Dry-running would destroy the pump/valve unit.*

– Switch the auxiliary heating briefly on and then off again on appropriately equipped vehicles.
– Plug in connector -arrow- at pump/valve unit.
– Screw on expansion tank cap.
– Set heater/air conditioner to “HI” on both sides.
– Start engine and maintain engine speed at approx. 2000 rpm for roughly 3 minutes.
– Switch off engine.

WARNING

Hot vapour/coolant may escape when opening the expansion tank. Cover the cap with a cloth and open carefully.

– Check coolant level and replenish coolant if necessary. Coolant level must be on MAX mark with warm engine and between MIN and MAX marks if engine is cold.
– Check proper filling of cooling system:



- When set to “HI”, the heating system must supply the same temperature on the driver's and front passenger's side.
- The heater/air conditioner pump/valve unit must not make any noise.

– Repeat bleeding procedure if necessary ⇒ page 159 .

Tightening torques

Component	Nm
Drain plug to cylinder block	20
Bleed screw to coolant pipe	15

1.3 Exploded view of coolant pump and thermostat

1 - Thermostat
- ❑ Removing and installing ⇒ page 164
- ❑ Checking ⇒ page 167
- ❑ Installation position ⇒ page 162

2 - Seal
- ❑ Replace

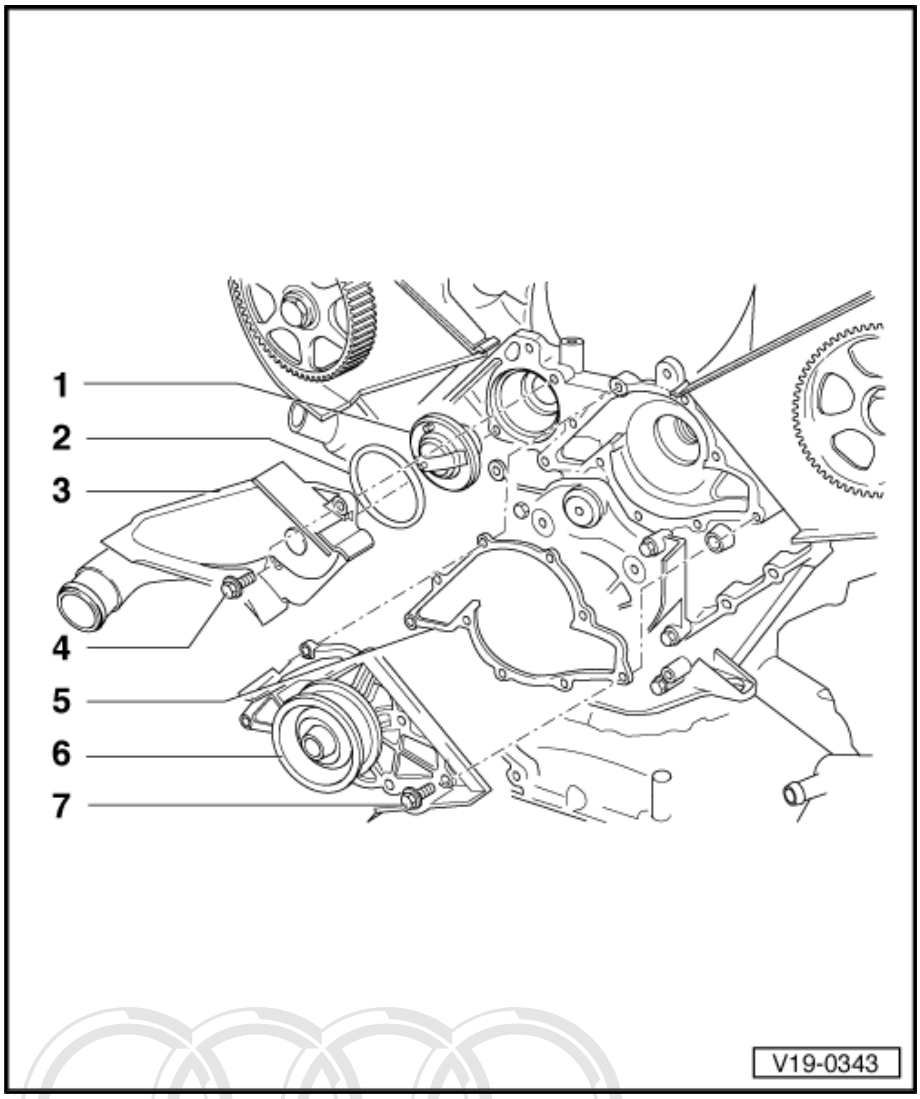
3 - Thermostat housing

4 - 10 Nm

5 - Gasket
- ❑ Replace

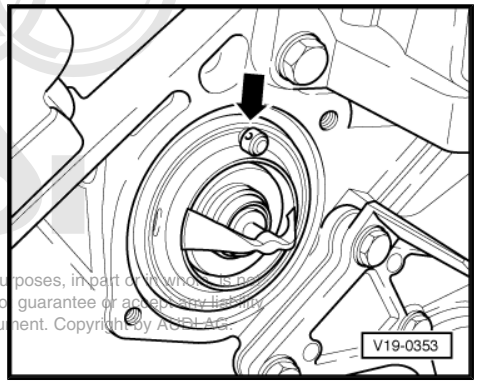
6 - Coolant pump
- ❑ Removing and installing ⇒ page 162

7 - 10 Nm



Installation position of thermostat

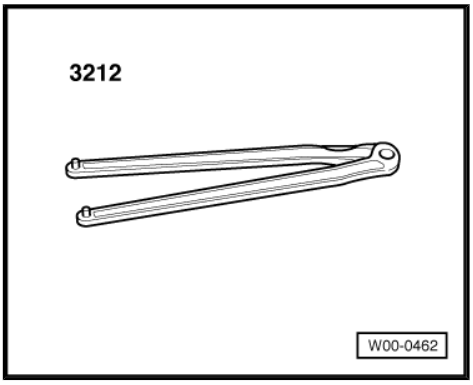
- Vent valve -arrow- facing upwards
- Seal facing housing



1.4 Removing and installing coolant pump

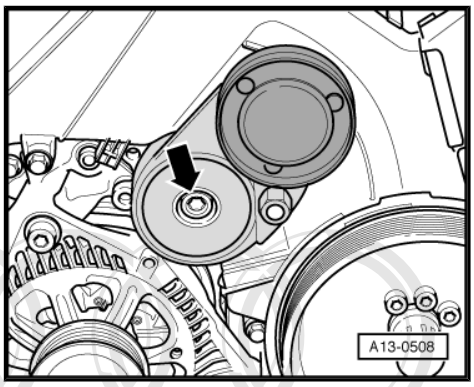
Special tools and workshop equipment required

♦ Pin wrench -3212-

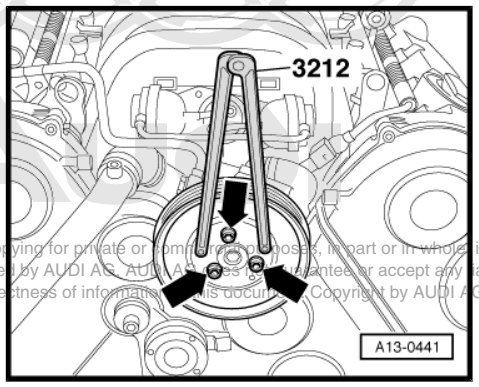


Removing

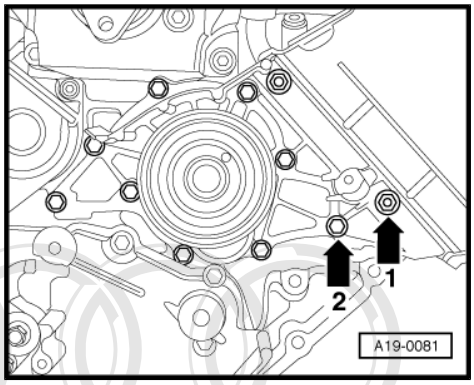
– Drain off coolant ⇒ page 155 .
– Remove poly V-belt ⇒ page 30 .
– Screw out bolt -arrow- and detach poly V-belt tensioner.



– Provide support for power steering pump pulley with pin wrench -3212- and unscrew pulley -arrows-.
– Remove toothed belt ⇒ page 35 .
– Remove toothed belt tensioning roller.



– Unscrew nuts -arrow 1- (2x) for rear toothed belt guard.
– Screw out bolts -arrow 2- (9x) for coolant pump and detach coolant pump.



Installing

Install in reverse order, paying attention to the following:

Note

Replace gaskets and seals.

– On installing toothed belt tensioning roller, pay attention to spacer behind it ⇒ Item 12 (page 33) .
– Fit toothed belt (adjust timing) ⇒ page 38 .
– Replenish coolant ⇒ page 157 .

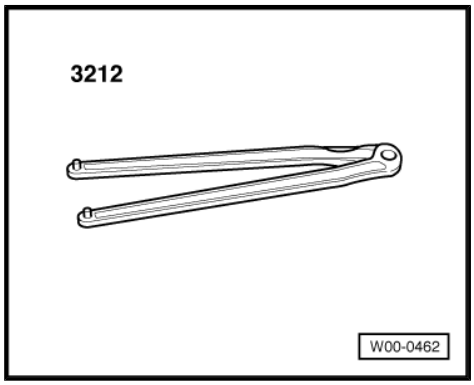
Tightening torques

Component	Nm
Coolant pump to cylinder block	10
Rear toothed belt guard to coolant pump	10
Toothed belt tensioning roller to oil pump/front sealing flange	22

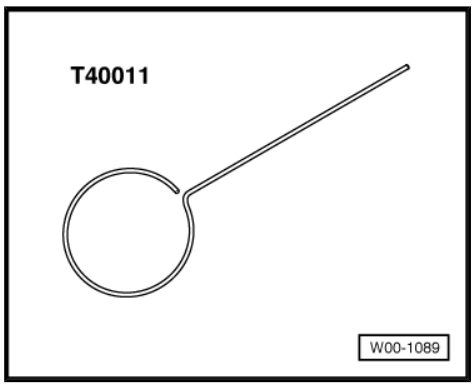
1.5 Removing, installing and checking thermostat

Special tools and workshop equipment required

♦ Pin wrench -3212-

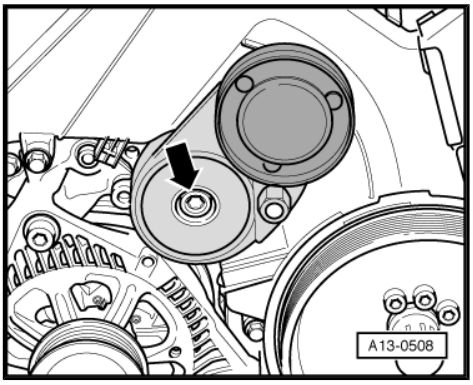


♦ Locking pin -T40011-



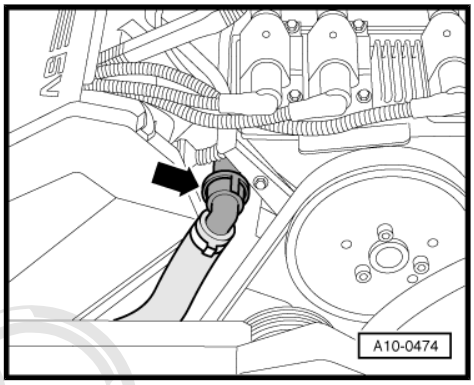
Removing

– Drain off coolant ⇒ page 155 .
– Remove poly V-belt ⇒ page 30 .
– Screw out bolt -arrow- and detach poly V-belt tensioner.



Vehicles with secondary air system:

– Disconnect hose -arrow- from secondary air connecting pipe.

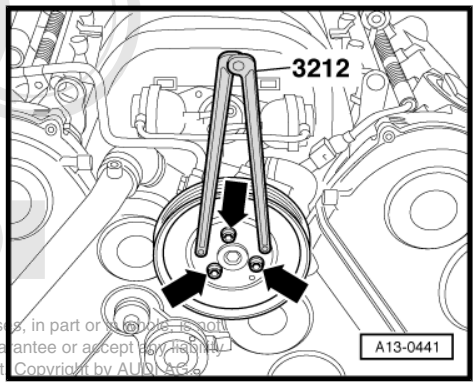


All models:

– Provide support for power steering pump pulley with pin wrench -3212- and unscrew pulley -arrows-.
– Unscrew radiator cowl for viscous fan.
– Remove right toothed belt guard (2 sections).

Vehicles with “engine generation III”:

– Remove vibration damper ⇒ page 32 .
– Remove lower toothed belt guard.



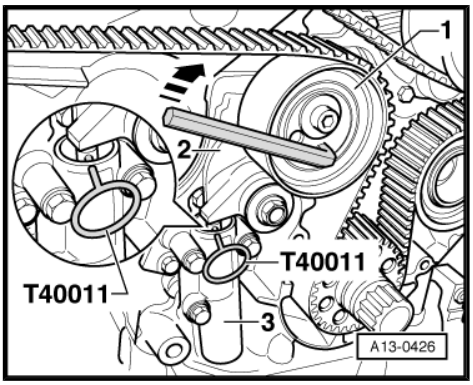
All models:

– Detach coolant hoses at thermostat housing.

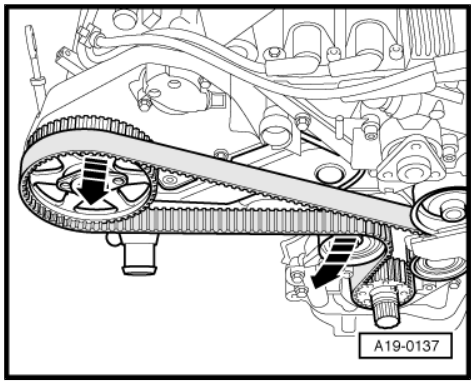
Note

The toothed belt tensioning element is oil cushioned and can only be compressed slowly exerting uniform force.

– Turn toothed belt tensioning roller -1- clockwise with an 8 mm Allen key in -direction of arrow- until tensioning lever -2- has compressed tensioning element -3- to such an extent that plunger can be secured with locking pin -T40011- .
– Insert locking pin -T40011- and release toothed belt tensioning roller.



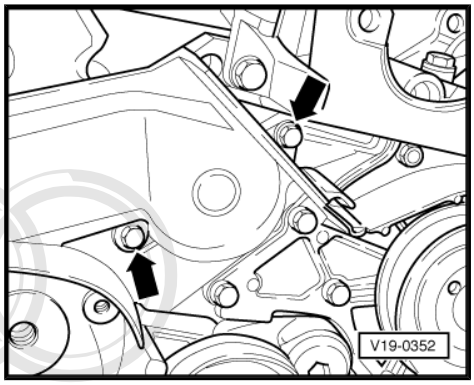
– Pull toothed belt forwards slightly -arrows- on tensioning roller and on right camshaft toothed belt sprocket; do not completely detach.



Caution

If toothed belt has slipped off tensioning roller, timing must be adjusted ⇒ page 38 .

– Detach thermostat housing -arrows-.



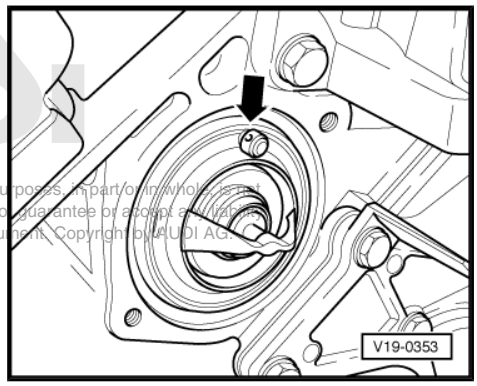
Note

Fig. shows thermostat housing with toothed belt detached.

– Detach O-ring and thermostat.

Installing

Install in reverse order, paying attention to the following:



Note

Replace O-ring.

– Before installing, clean/smooth sealing surface for O-ring.

– Install thermostat.

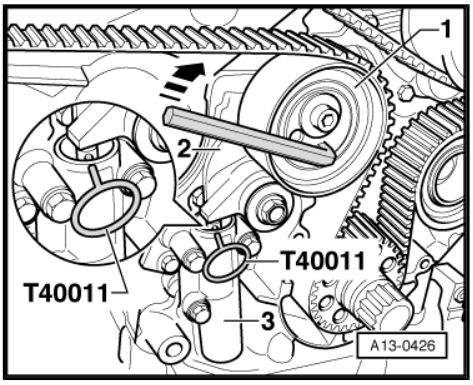
• Installation position: vent valve -arrow- faces upwards and seal faces to housing.

– Install thermostat housing.

Caution

If toothed belt has slipped off tensioning roller, timing must be adjusted ⇒ page 38 . Pay attention to all instructions for removing and installing toothed belt ⇒ page 35 .

– Use 8 mm Allen key to turn toothed belt tensioning roller -1- clockwise in -direction of arrow- until locking pin -T40011- can be removed.



Prior to initial start-up of engine, pre-tension the tensioning roller as follows:

– Apply torque wrench to hexagon socket of tensioning roller.

– Turn (15 Nm) tensioning roller in tensioning direction to pre-tension the tensioning roller.

Vehicles with “engine generation III”:

– Install vibration damper ⇒ page 32 .

All models:

– Fit poly V-belt ⇒ page 31 .

– Replenish coolant ⇒ page 157 .

Tightening torque

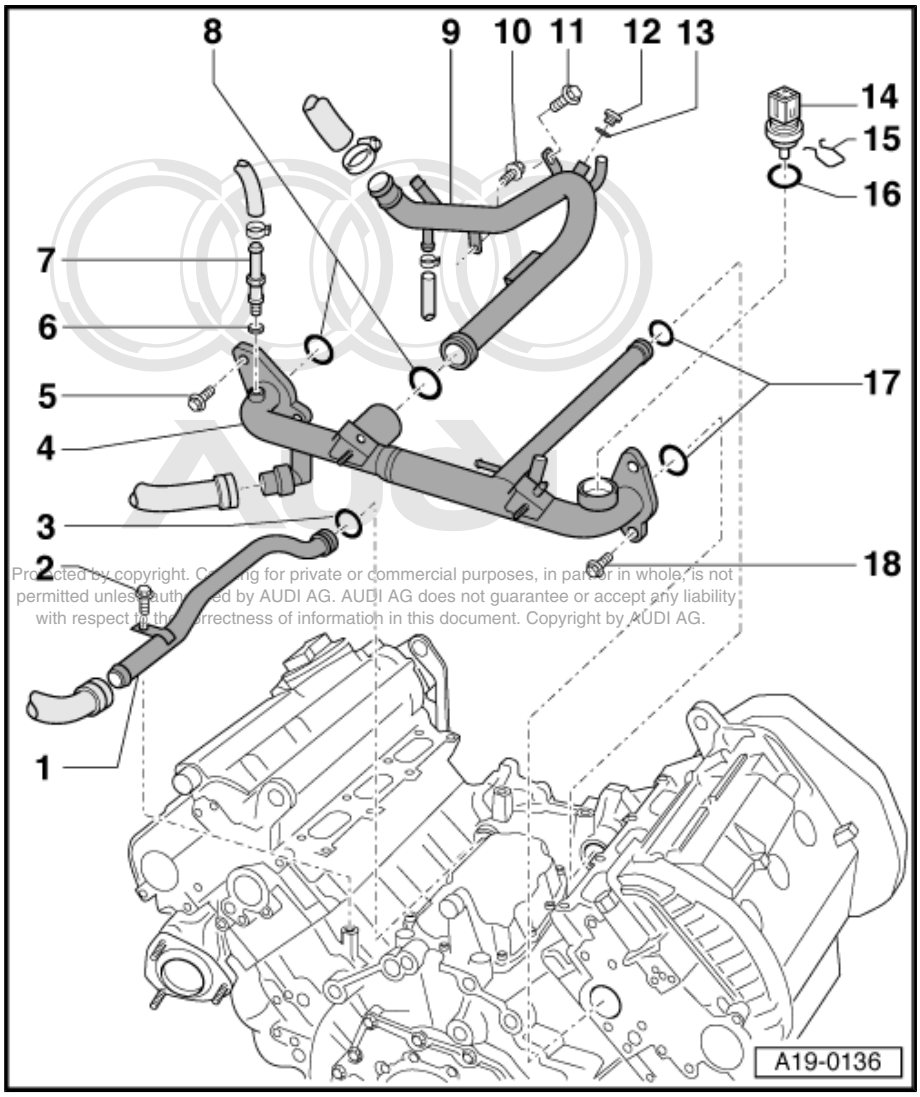
Component	Nm
Thermostat housing to cylinder block	10

Checking thermostat

– Heat thermostat in water bath.

Start of opening	End of opening	Opening stroke
approx. 87 °C	approx. 102 °C 1)	min. 8 mm
• 1) Cannot be checked		

1.6 Exploded view of coolant pipes



1 - Small coolant pipe
- ❑ Removing and installing ⇒ page 170

2 - 10 Nm

3 - O-ring
- ❑ Replace

4 - Rear coolant pipe
- ❑ Removing and installing ⇒ page 171

5 - 10 Nm

6 - Seal
- ❑ Cut open and replace

7 - Connection
- ❑ Tighten to 15 Nm

8 - O-ring
- ❑ Replace

9 - Front coolant pipe
- ❑ Removing and installing ⇒ page 168

10 - 10 Nm

11 - 22 Nm

12 - Bleed screw - 15 Nm

13 - Seal
- ❑ Cut open and replace

14 - Coolant temperature gauge sender -G2- / coolant temperature sender -G62-

15 - Clip

16 - O-ring
- ❑ Replace

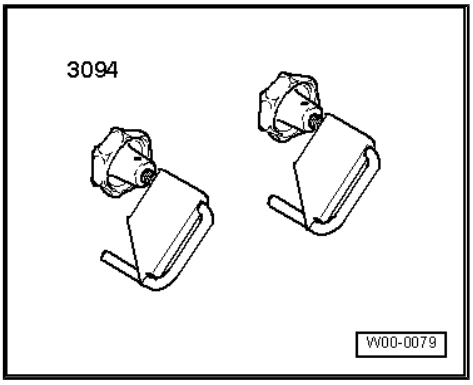
17 - O-ring
- ❑ Replace

18 - 10 Nm

1.7 Removing and installing front coolant pipe

Special tools and workshop equipment required

♦ Hose clamps up to Ø 25 mm -3094-

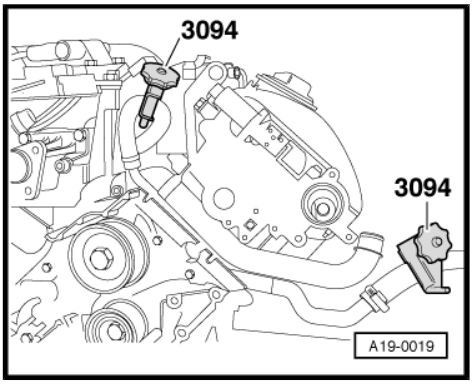


Removing

Note

Re-attach all cable ties unfastened or severed on removal at the same location on installation.

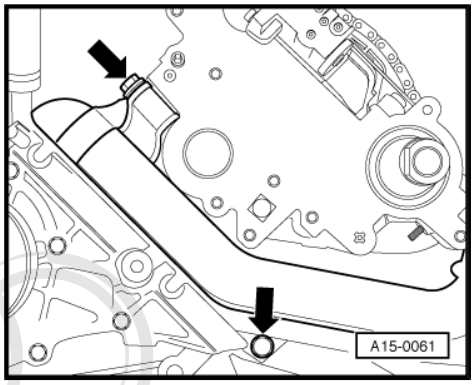
– Drain off coolant at engine ⇒ page 155 .
– Remove intake manifold ⇒ page 83
– Remove coolant pump ⇒ page 162
– Detach camshaft sprocket.
– Unscrew toothed belt guard at rear left.
– Use hose clamps -3094- to pinch off both hoses at hydraulic fluid supply pipe.
– Detach both hydraulic pipes from intermediate pipe.



Note

Place cloth beneath pipes to be detached, as oil escapes.

– Detach coolant hose at front coolant pipe.



– Screw out bolts -arrows-.
– Lay bare wires at coolant pipe.
– Detach coolant pipe to front.

Installing

Install in reverse order, paying attention to the following:

Note

- *Replace O-rings.*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*
- *Re-attach all cable ties in the same locations on installation.*

– Before installing, clean/smooth sealing surface for O-ring.
– Moisten new O-ring with “G12+” and slip onto coolant pipe.
– Slide coolant pipe into hole at rear coolant pipe.
– Install intake manifold ⇒ page 87 .
– Install coolant pump ⇒ page 164 .
– Replenish coolant ⇒ page 157 .
– Replenish power steering fluid and bleed steering system ⇒ Running gear, front-wheel drive and four-wheel drive; Rep. Gr. 48 .

Tightening torques

Component		Nm
Front coolant pipe to cylinder head	M6	10
	M8	20
Holder of power steering pipes to cylinder head		10

1.8 Removing and installing small coolant pipe

Removing

– Remove front coolant pipe ⇒ page 168 .
– Detach coolant hose at rear at small coolant pipe.
– Screw out bolt.
– Detach small coolant pipe to rear.
– Lift off coolant pipe.

Installing

Install in reverse order, paying attention to the following:

Note

- *Replace O-rings.*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*

– Before installing, clean/smooth sealing surface for O-ring.

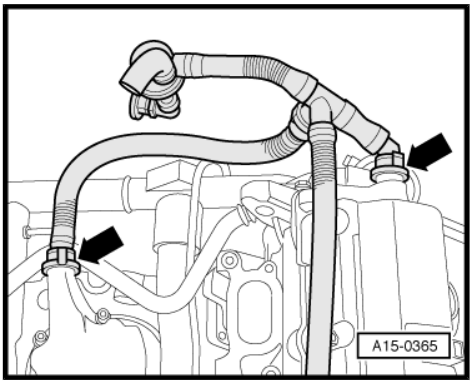
– Moisten new O-ring with “G12+” and slip onto coolant pipe.
– Slide coolant pipe into hole at cylinder block.
– Install front coolant pipe ⇒ page 170 .
– Replenish coolant ⇒ page 157 .

Tightening torque

Component	Nm
Small coolant pipe to cylinder block	10

1.9 Removing and installing rear coolant pipe

Removing



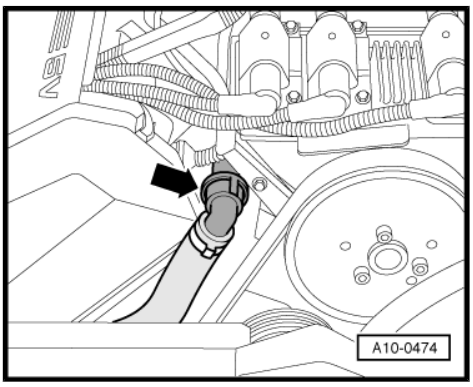
Note

Re-attach all cable ties unfastened or severed on removal at the same location on installation.

– Drain off coolant at engine ⇒ page 155 .
– Remove intake manifold ⇒ page 83 .
– Remove crankcase breather hose -arrows-.
– Unplug connector at coolant temperature gauge sender -G2- / coolant temperature sender -G62- .

Vehicles with secondary air system:

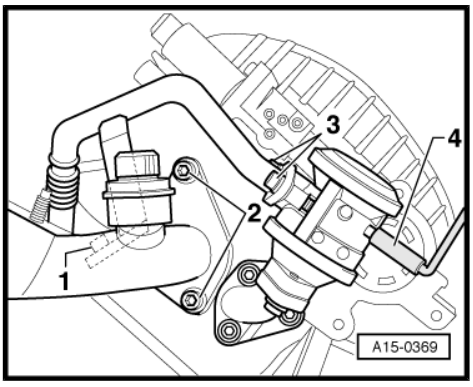
– Disconnect hose -arrow- from secondary air connecting pipe.



– Disconnect vacuum hose -4- at secondary air combination valve.
– Screw out bolts -3-.
– Screw out bolt -1- for connecting pipe holder.
– Screw out bolt at front right connecting pipe.

All models:

– Screw out coolant pipe bolts -2-.



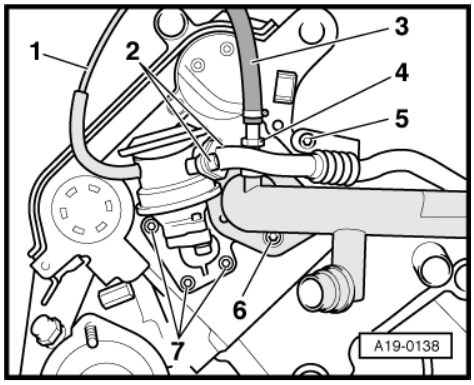
– Detach coolant hose -3-.
– Detach coolant hose to heating system heat exchanger at rear coolant pipe.

Vehicles with secondary air system:

– Disconnect vacuum hose -1- at secondary air combination valve.
– Screw out connection -4-.
– Screw out bolt -5-.
– Screw out bolts -2- and detach secondary air connecting pipe.
– Screw out bolts -7- and detach secondary air combination valve.

All models:

– Lay bare wires at rear coolant pipe.
– Screw out the 2 bolts -6- at the rear coolant pipe and detach coolant pipe.



Installing

Install in reverse order, paying attention to the following:

Note

- *Replace gaskets and O-rings.*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*
- *Re-attach all cable ties in the same locations on installation.*

– Before installing, clean/smooth sealing surface for O-rings.
– Moisten new O-ring with “G12+” and slip onto coolant pipe.
– Install intake manifold ⇒ page 87 .
– Replenish coolant ⇒ page 157 .

Tightening torques

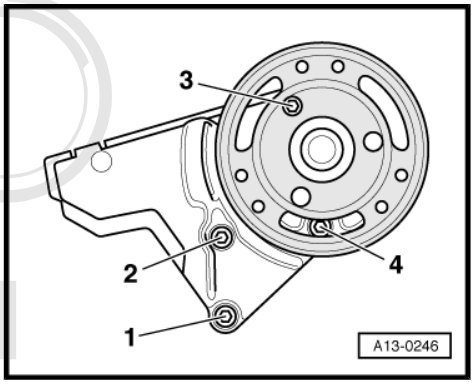
Component		Nm
Rear coolant pipe to cylinder head		10
Combination valve to cylinder head		10
Connecting pipe to combination valve		10
Connecting pipe to cylinder head	M6	10
	M8	22
Connection to rear coolant pipe		15

1.10 Removing and installing pulley for viscous fan

Removing

- Poly V-belt removed ⇒ page 30

– Screw out bolts -1 … 4-.



Note

Bolts -3- and -4- cannot be detached.

Installing

Install in reverse order, paying attention to the following:

– Tighten bolt -3- (5 mm hexagon socket) to 10 Nm.

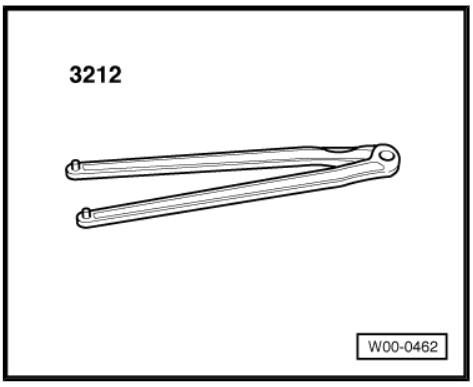
– Tighten bolts -1-, -2- and -4- (6 mm hexagon socket) to 22 Nm.

– Fit poly V-belt ⇒ page 31 .

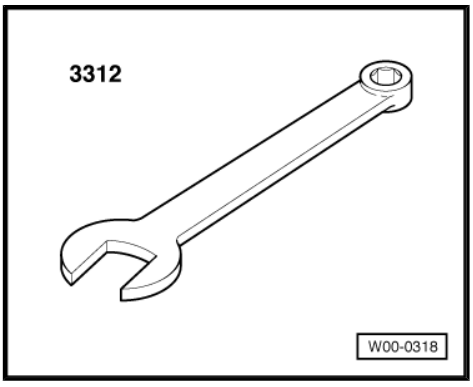
1.11 Removing and installing viscous fan

Special tools and workshop equipment required

♦ Pin wrench -3212-



♦ Open-ended wrench -3312-



Removing

– Use pin wrench -3212- to support viscous fan pulley and unscrew viscous fan with open-ended wrench -3312- -arrow- (left-hand thread).

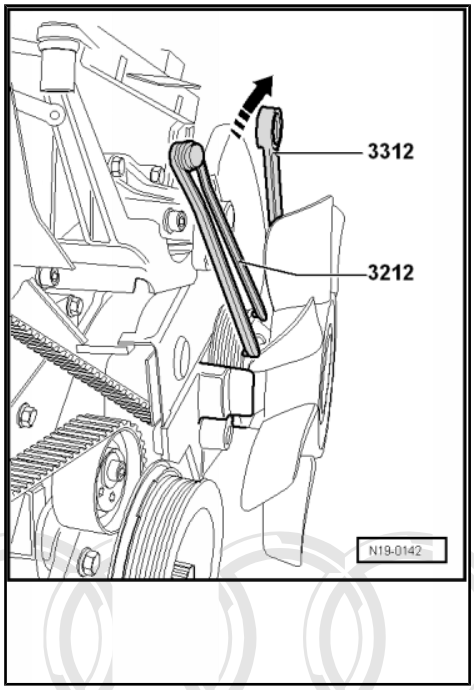
– Lift out viscous fan.

Installing

Install in reverse order.

Tightening torque

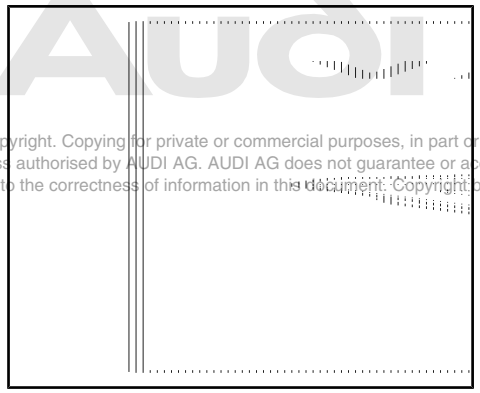
Component	Nm
Viscous fan to mount using open-ended wrench -3312-	37



1.12 Removing and installing radiator

Special tools and workshop equipment required

♦ Drip tray for workshop cranes -VAS 6208- or -V.A.G 1306-



Removing

Note

♦ *Collect drained coolant in a clean container for disposal or reuse.*

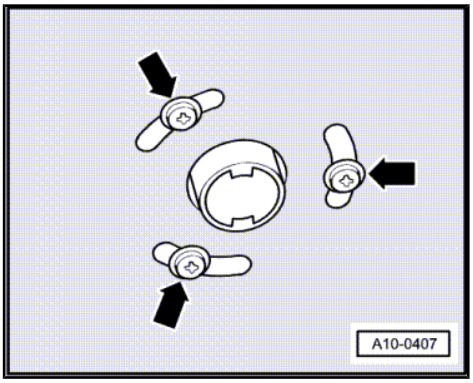
♦ *Coolant must be completely drained off if radiator is replaced.*

WARNING

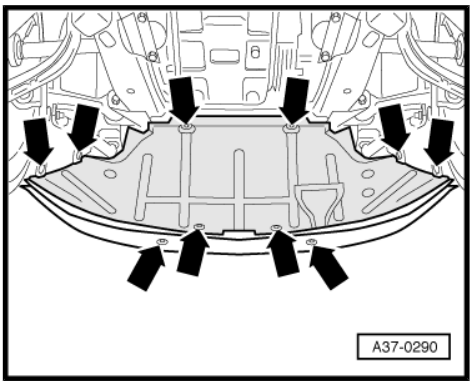
Hot vapour/coolant may escape when opening the expansion tank. Cover the cap with a cloth and open carefully.

– Open cap of coolant expansion tank.

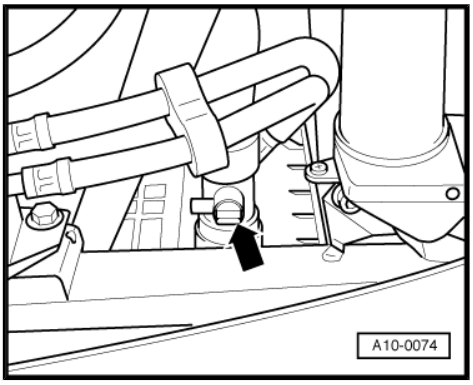
– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



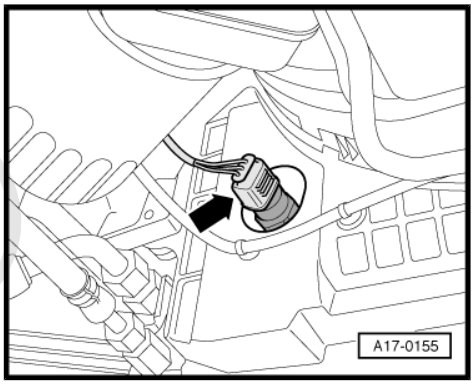
– Detach noise insulation -arrows-.



– Place drip tray for workshop cranes -VAS 6208- or -V.A.G 1306- beneath engine.
– Turn drain plug -arrow- on right of radiator anti-clockwise. Attach hose to connection if necessary.
– Disengage clip at connecting flange and detach coolant hose at bottom of radiator.



– Unplug connector -arrow- at radiator fan thermal switch -F18- / -F54- at bottom left of radiator.
– Remove front bumper ⇒ General body repairs, exterior; Rep. Gr. 63 .



Vehicles with automatic gearbox:

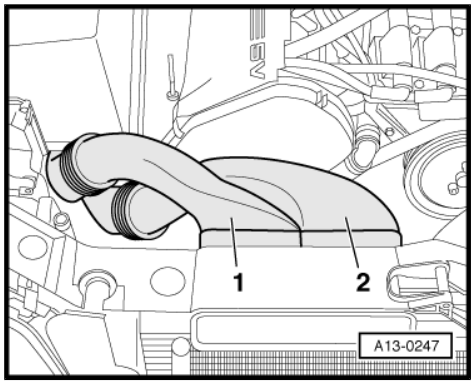
– Remove air ducts -1- and -2-.

– Detach ATF pipes from radiator ⇒ Automatic gearbox 01V, front-wheel drive and four-wheel drive; Rep. Gr. 37 .

All models:

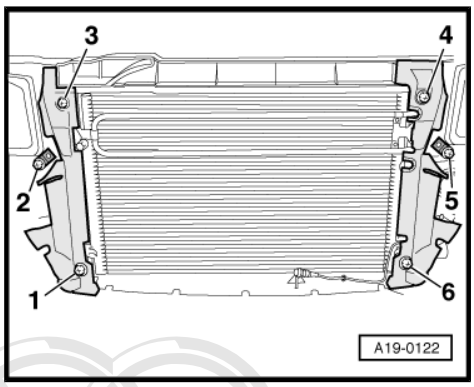
– Detach coolant hose at top of radiator.

– Remove decorative trim beneath headlights ⇒ Electrical system; Rep. Gr. 94 .

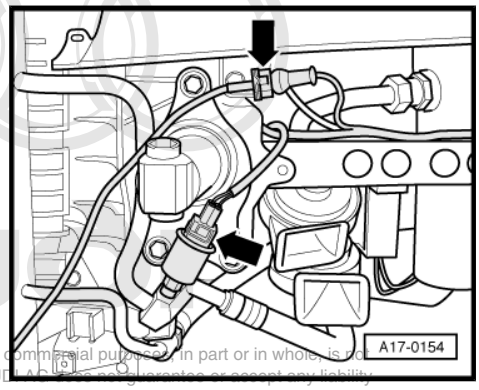


– Unscrew holders -2- and -5- for decorative trim from headlights.

– Remove air ducts -1-, -3-, -4- and -6- at radiator on left and right.



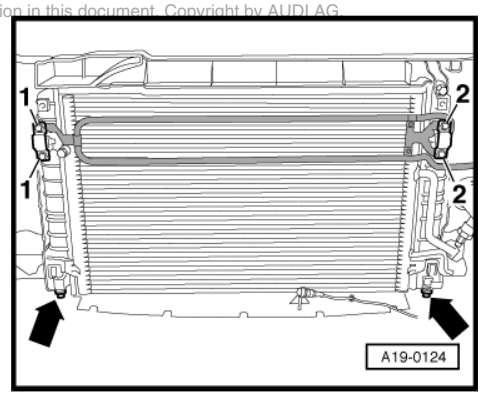
– Unplug connectors -arrows-.



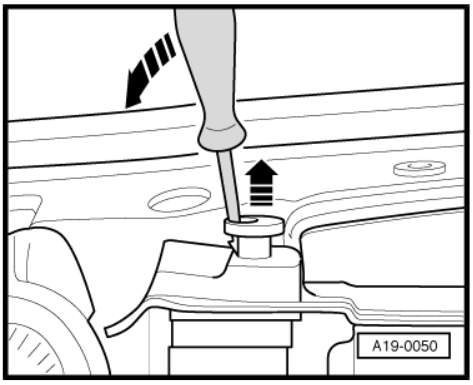
– Screw out bolts -1- and -2-.

– Detach cooling pipe for power steering hydraulic fluid and lay aside with pipes connected.

– Pull condenser upwards out of holders, swivel aside and set down securely.



– Prise off both caps at top of lock carrier.
– Release both retaining pins for radiator and lift off -arrows-.
– Swivel top edge of radiator forwards and lift off radiator.



Installing

Install in reverse order, paying attention to the following:

Note

- *Replace gaskets and seals.*
- *Secure all hose connections with standard clamps ⇒ Parts catalogue .*

Vehicles with automatic gearbox:

– Attach ATF pipes to ATF cooler ⇒ Automatic gearbox 01V, front-wheel drive and four-wheel drive; Rep. Gr. 37 .
– Check ATF level ⇒ Automatic gearbox 01V, front-wheel drive and four-wheel drive; Rep. Gr. 37 .

All models:

– Install front bumper ⇒ General body repairs, exterior; Rep. Gr. 63 .
– Replenish coolant ⇒ page 157 .

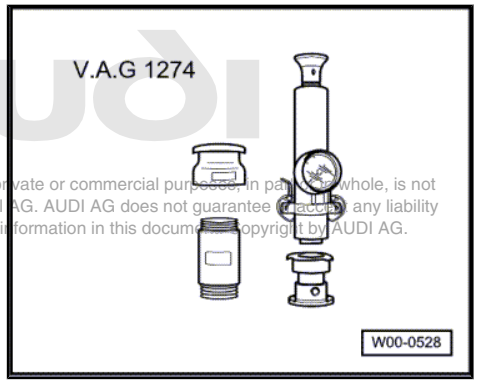
Tightening torque

Component	Nm
Condenser to radiator	10

1.13 Checking cooling system for leaks

Special tools and workshop equipment required

- Cooling system tester -V.A.G 1274- with -V.A.G 1274/1-



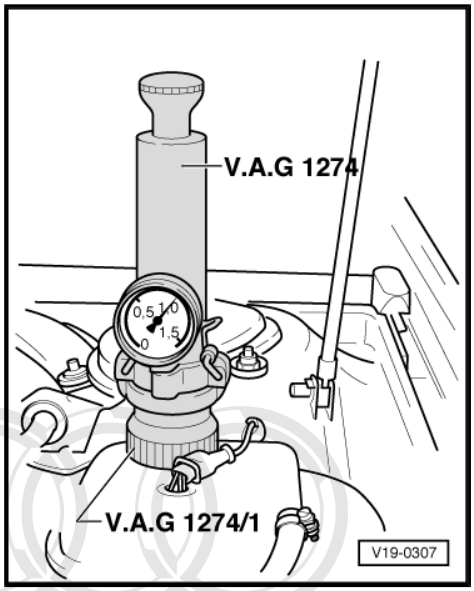
Test condition

- Engine warm

Test sequence

WARNING

Hot vapour/coolant may escape when opening the expansion tank. Cover the cap with a cloth and open carefully.



- Open cap of coolant expansion tank.
- Position cooling system tester -V.A.G 1274- with adapter -V.A.G 1274/1- on expansion tank.
- Use hand pump of cooling system tester to generate a pressure of approx. 1.0 bar.

If pressure decreases:

- Localise leak and eliminate fault.

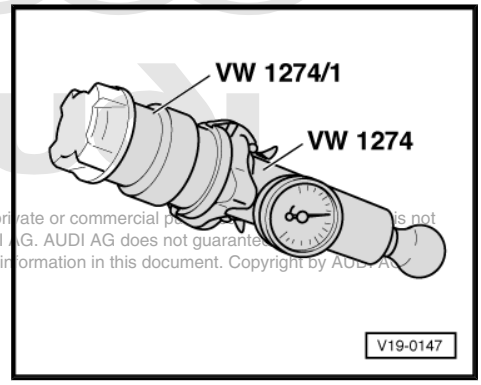
Checking pressure relief valve in cap

- Position cooling system tester -V.A.G 1274- with adapter -V.A.G 1274/1- on cap.
- Use hand pump of cooling system tester to generate pressure.

• Pressure relief valve must open at 1.2 … 1.5 bar.

If pressure relief valve does not open as indicated:

- Replace cap.



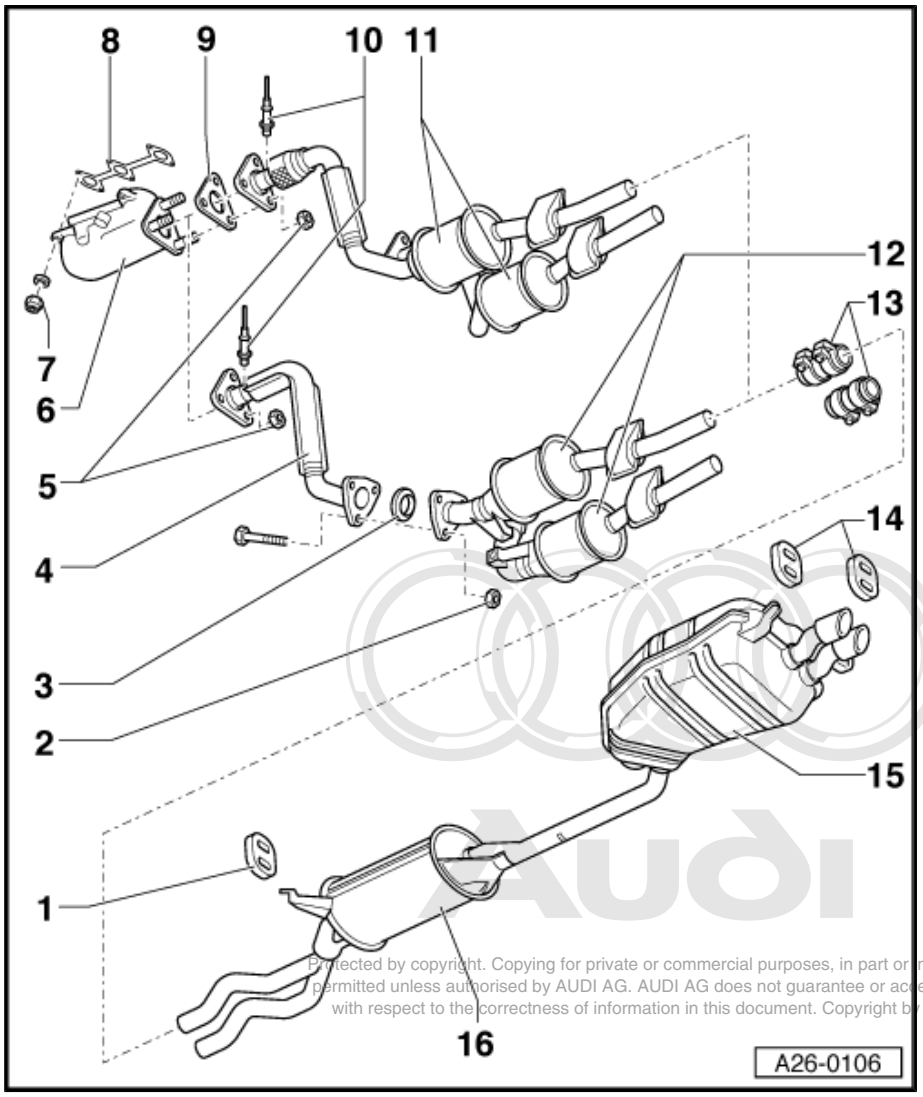
26 – Exhaust system

1 Removing and installing exhaust system components

Note

- *Replace gaskets and self-locking nuts.*
- *On completion of exhaust system installation work, make sure exhaust system is not subject to strain and that there is sufficient clearance from the body. If necessary, unfasten clamps and adjust position of silencers and exhaust pipes to create sufficient clearance from the body and to ensure uniform loading of the mountings.*
- *To avoid damage, decoupling element in front exhaust pipe is not to be kinked by more than 10°.*
- *Mounting components for four-wheel drive vehicles with manual gearbox ⇒ page 183 or with automatic gearbox ⇒ page 183*
- *Removing and installing floor cross member ⇒ page 183*

1.1 Exploded view of exhaust system



1 - Rubber mount

- ❑ Checking pre-tension ⇒ “1.7 Stress-free alignment of exhaust system”, page 193

2 - 25 Nm

3 - Seal

- ❑ Not impact-resistant, take care not to drop

4 - Front exhaust pipe

- ❑ For four-wheel drive vehicles
- ❑ Different version for manual gearbox and automatic gearbox
- ❑ Removing and installing: left-side ⇒ page 185 , right-side ⇒ page 186
- ❑ Stress-free alignment of exhaust system ⇒ page 193

5 - 25 Nm

- ❑ Replace

6 - Exhaust manifold

- ❑ Removing and installing: left-side ⇒ page 188 , right-side ⇒ page 190

7 - 25 Nm

- ❑ Replace

8 - Gasket

- ❑ Replace

9 - Gasket

- ❑ Replace

10 - Lambda probe

- ❑ The threads of new lambda probes are coated with assembly paste, which is not to be allowed to come into contact with the slits in the probe body
- ❑ If the old lambda probe is re-used, grease thread with high-temperature paste; the paste must not be allowed to come into contact with the slits in the probe body; high-temperature paste ⇒ Parts catalogue
- ❑ Removing/installing and checking ⇒ Rep. Gr. 24
- ❑ Tighten to 55 Nm

11 - Front exhaust pipe with catalytic converter

- ❑ For front-wheel drive vehicles
- ❑ Protect against impact and jolts
- ❑ With decoupling element
- ❑ To avoid damage, do not kink decoupling element by more than 10°
- ❑ Removing and installing: left-side ⇒ page 185 , right-side ⇒ page 186
- ❑ Aligning catalytic converters ⇒ page 181

12 - Catalytic converter

- ❑ For four-wheel drive vehicles
- ❑ Protect against impact and jolts
- ❑ Removing and installing left catalytic converter ⇒ page 185
- ❑ Removing and installing right catalytic converter ⇒ page 186
- ❑ Aligning catalytic converters ⇒ page 181

13 - Clamp

- ❑ Installation position of bolt ends ⇒ page 183
- ❑ Before tightening, perform stress-free alignment of exhaust system ⇒ page 193
- ❑ Tighten screw connections evenly to 40 Nm

14 - Rubber mount

- ❑ Checking pre-tension ⇒ “1.7 Stress-free alignment of exhaust system”, page 193

15 - Rear silencer

- ❑ Forms one unit with centre silencer as original equipment; can be replaced separately when performing repair work
- ❑ Cutting point ⇒ page 184
- ❑ Stress-free alignment of exhaust system ⇒ page 193

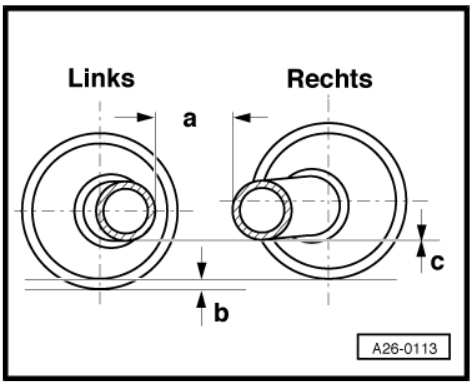
16 - Centre silencer

- ❑ Forms one unit with rear silencer as original equipment; can be replaced separately when performing repair work
- ❑ Cutting point ⇒ page 184
- ❑ Stress-free alignment of exhaust system ⇒ page 193

Aligning catalytic converters

	Front-wheel drive	Four-wheel drive
Pipe spacing -a-	50 mm	96 mm
Height offset of catalytic converters -b-	approx. 5 mm 1) approx. 0 mm 2)	approx. 3 mm
Height offset of pipes -c-	0 … 3 mm	0 … 3 mm

- 1) Vehicles with manual gearbox
- 2) Vehicles with automatic gearbox

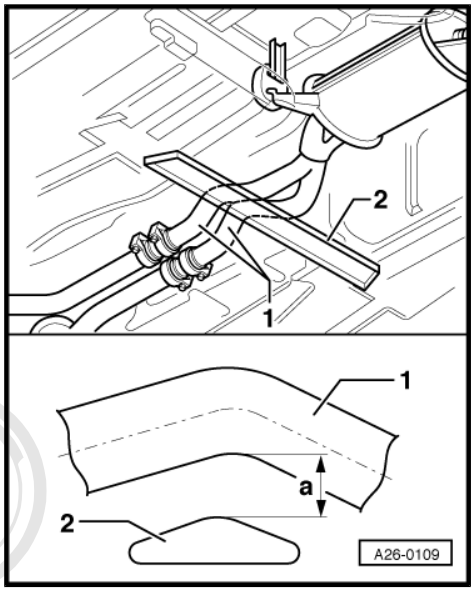


Distance between exhaust pipes and floor cross-member

1 - Exhaust pipes

2 - Floor cross-member

- Dimension -a- = 38 mm



Distance between exhaust pipes and propshaft/body

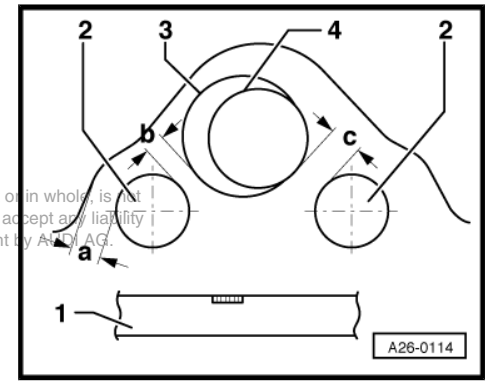
1 - Floor cross-member

2 - Exhaust pipes

3 - Propshaft for manual gearbox

4 - Propshaft for automatic gearbox

- Dimension -a- = 23 mm
- Dimension -b- = 22 mm (manual gearbox)
- Dimension -c- = 32.5 mm (automatic gearbox)



Note

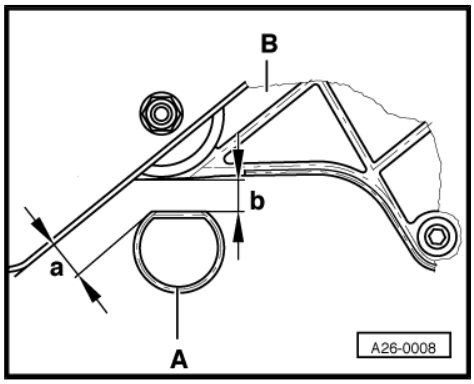
Illustration shows rear view of exhaust system.

Distance of exhaust pipe from rear axle between centre and rear silencer

A - Exhaust pipe

B - Rear axle

- Dimension -a- = 27 mm
- Dimension -b- = 20 mm



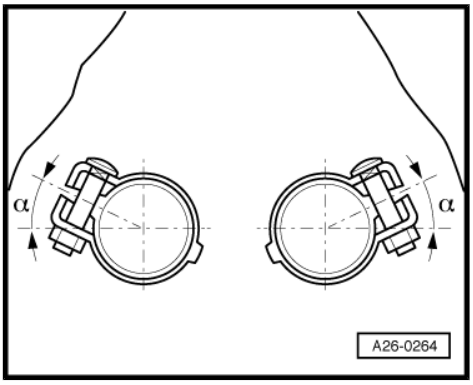
Note

Illustration shows rear view of exhaust pipe.

Installation position of clamp

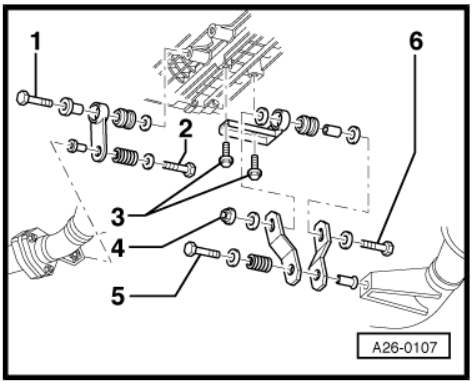
- Angle -α- = 25°

– Uniformly tighten bolted joints of clamp to 40 Nm.



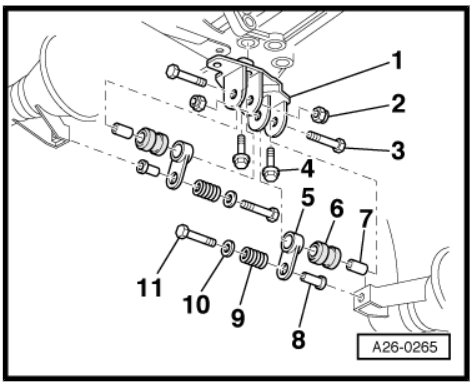
Mounting for four-wheel drive vehicles with manual gearbox

1 - Hexagon bolt M10x50 - 40 Nm
2 - Hexagon bolt M8x48 - 25 Nm
3 - Combi bolt M10x20 - 25 Nm
4 - Locking nut - 25 Nm
5 - Hexagon bolt M8x48 - 25 Nm
6 - Hexagon bolt M8x52 - 25 Nm



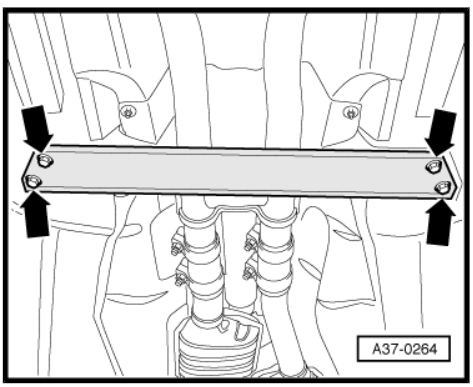
Mounting for four-wheel drive vehicles with automatic gearbox

1 - Holder
2 - Self-locking nut - 25 Nm
3 - Hexagon bolt M8x48 - 25 Nm
4 - Combi bolt M8x20 or M8x40 - 25 Nm
5 - Right link plate
6 - Buffer
7 - Spacer
8 - Spacer sleeve
9 - Pressure spring
10 - Washer
11 - Hexagon bolt M8x48 - 25 Nm



Removing and installing floor cross-member

- Tightening torque: 25 Nm.

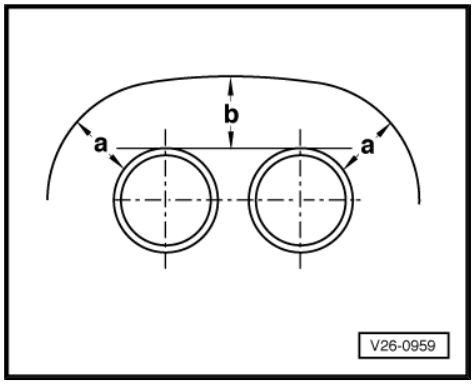


Tailpipe alignment

– Align tailpipes such that distance -a- on left is equal to distance -a- on right.

– At the same time, ensure compliance with distance -b- between opening in bumper and tailpipes at top.

• Dimension -b- = 22.5 mm

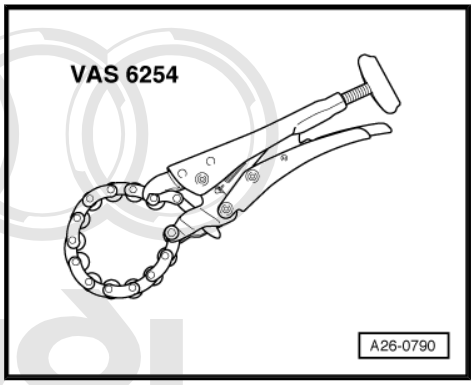


1.2 Separating centre and rear silencer

A cutting point is provided in the connecting pipe for separate replacement of the centre or rear silencer.

Special tools and workshop equipment required

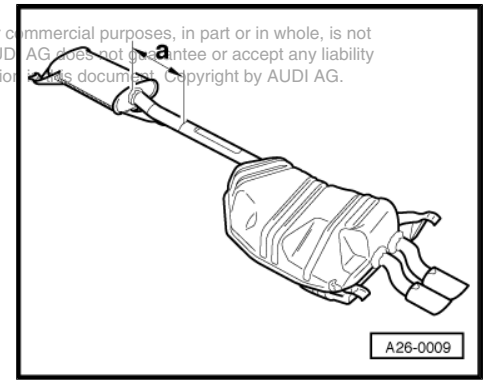
♦ Chain pipe cutter -VAS 6254-



Sequence of operations

– Cut exhaust pipe at right angles at cutting point using chain pipe cutter -VAS 6254- .

• Dimension -a- = 240 mm



Note

The cutting point is additionally marked by an indentation on the periphery of the exhaust pipe.

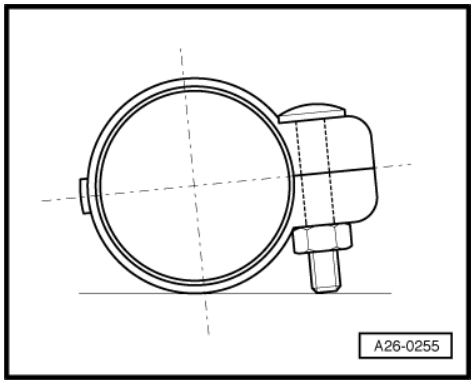
– On installation, centrally align clamp with separating cut.

– Install clamp such that end of bolt does not project beyond lower edge of clamp.

• Screw connection faces to right

– Perform stress-free alignment of exhaust system ⇒ page 193 .

– Uniformly tighten bolted joints of clamp to 40 Nm.



Note

Illustration shows rear view of clamp.

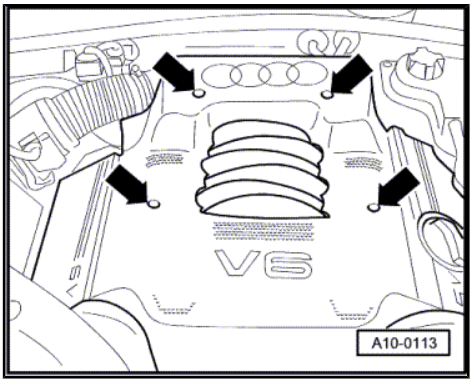
1.3 Removing and installing left front exhaust pipe with catalytic converter

Removing

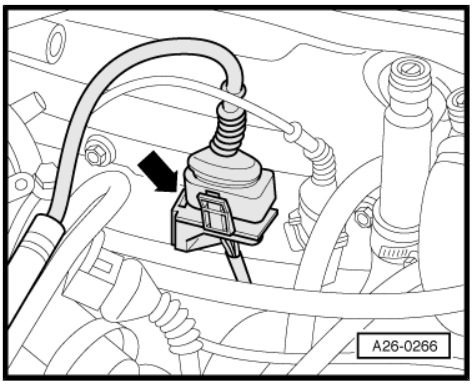
Note

Re-attach all cable ties unfastened or severed on removal at the same location on installation.

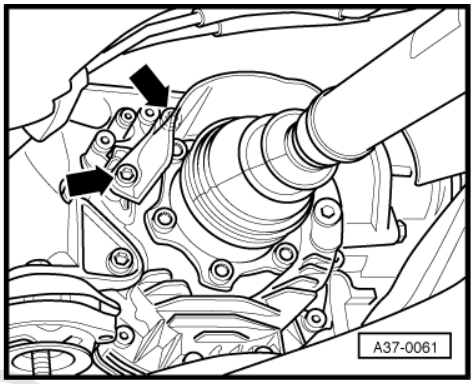
– Remove engine cover -arrows-.



– Unplug connector -arrow- of lambda probe.
– Take bottom part of connector out of holder.
– Route wire to lambda probe downwards.
– Unscrew exhaust manifold/front exhaust pipe nut accessible from above.



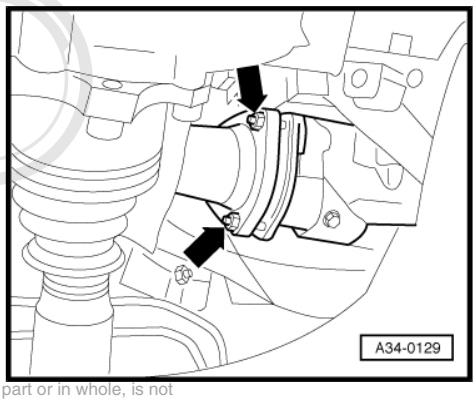
– Remove heat shield for left drive shaft -arrows-.



– Unscrew nuts -arrows- at front exhaust pipe.

Four-wheel drive vehicles:

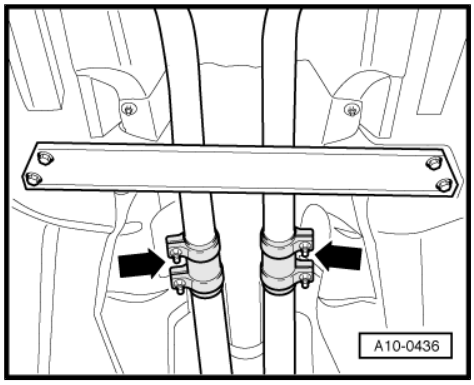
– Disconnect front exhaust pipe and catalytic converter.
– Unscrew mounting ⇒ page 183 or ⇒ page 183



All models:

– Unfasten left clamp -left arrow-.

– Detach left front exhaust pipe with catalytic converter and lambda probe.



Note

- *To avoid damage, decoupling element in front exhaust pipe is not to be kinked by more than 10°.*
- *Make sure there is clearance at the connector for the lambda probe.*

Installing

Install in reverse order, paying attention to the following:

Note

- *Re-attach all cable ties in the same locations on installation.*
- *On installation, the lambda probe wire is always to be re-attached at the same locations to stop the probe wire coming into contact with the exhaust pipe.*
- *Replace gaskets and self-locking nuts.*

– Perform stress-free alignment of exhaust system ⇒ page 193 .

Note

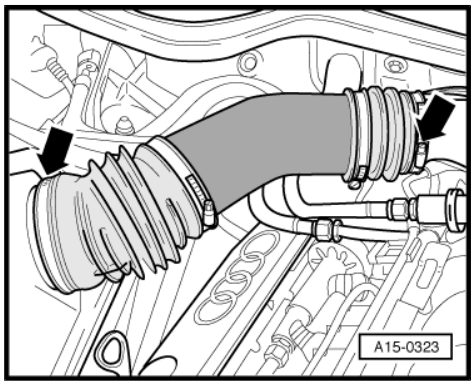
Exhaust system mounting at gearbox on four-wheel drive vehicles ⇒ page 183 or ⇒ page 183

Tightening torques

Component	Nm
Front exhaust pipe to exhaust manifold	25
Front exhaust pipe to catalytic converter	25
Clamp for exhaust pipe	40

1.4 Removing and installing right front exhaust pipe with catalytic converter

Removing

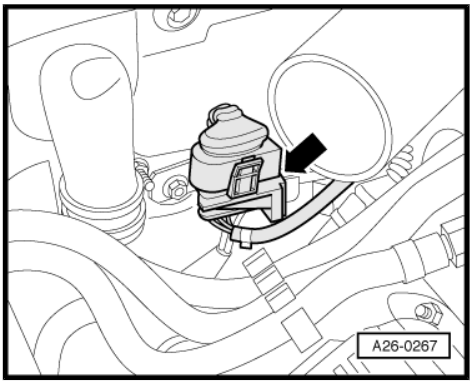


Note

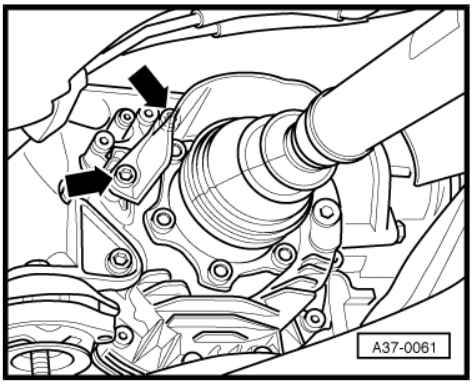
Re-attach all cable ties unfastened or severed on removal at the same location on installation.

– Remove air hose between air mass meter and intake manifold -arrows-.

– Unplug connector -arrow- of lambda probe.
– Take bottom part of connector out of holder.
– Route wire to lambda probe downwards.
– Unscrew exhaust manifold/front exhaust pipe nut accessible from above.



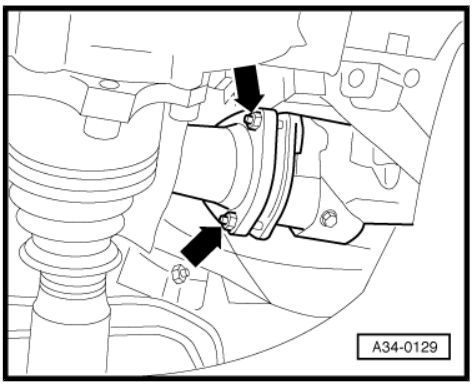
– Remove heat shield for right drive shaft -arrows-.



– Unscrew nuts -arrows- at front exhaust pipe.

Four-wheel drive vehicles:

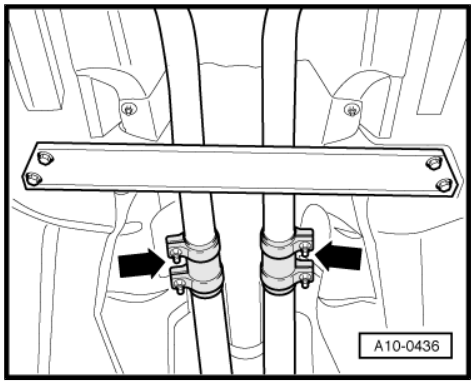
– Unscrew mounting ⇒ page 183 or ⇒ page 183



All models:

– Unfasten right clamp -right arrow-.

– Detach right front exhaust pipe with catalytic converter and lambda probe.



Note

- *To avoid damage, decoupling element in front exhaust pipe is not to be kinked by more than 10°.*
- *Make sure there is clearance at the connector for the lambda probe.*

Installing

Install in reverse order, paying attention to the following:

Note

Replace gaskets and self-locking nuts.

– Perform stress-free alignment of exhaust system ⇒ page 193 .

Note

- *Re-attach all cable ties in the same locations on installation.*
- *On installation, the lambda probe wire is always to be re-attached at the same locations to stop the probe wire coming into contact with the exhaust pipe.*
- *Replace gaskets and self-locking nuts.*

Tightening torques

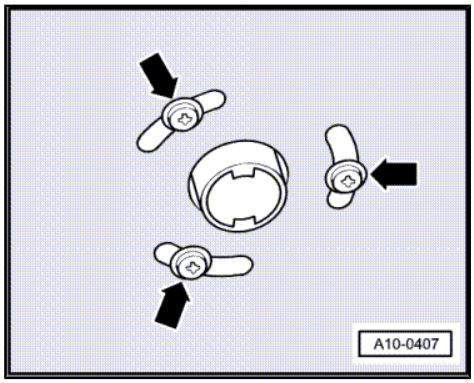
Component	Nm
Front exhaust pipe with catalytic converter to exhaust manifold	25
Clamp for exhaust pipe	40

1.5 Removing and installing left exhaust manifold

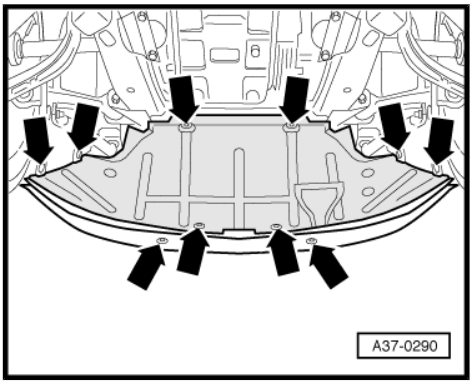
Removing

– Remove left front exhaust pipe ⇒ page 185 .

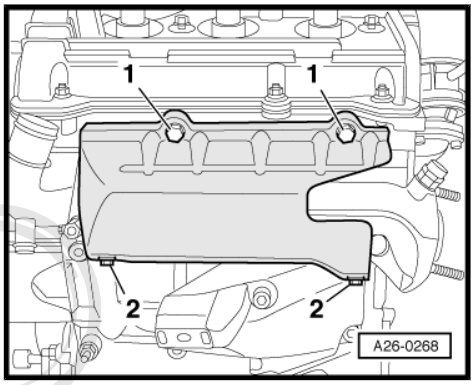
– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



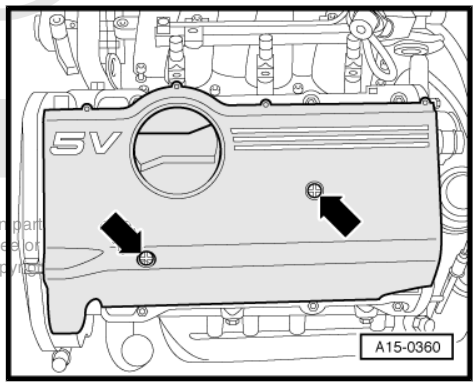
– Detach noise insulation -arrows-.



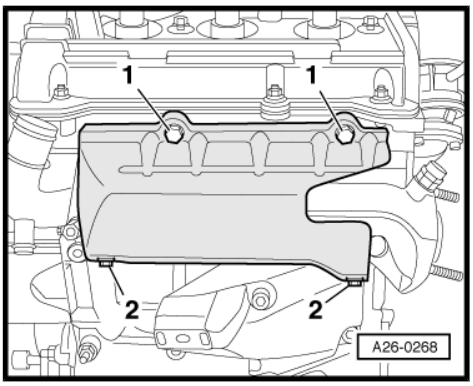
– Unscrew screw connection -2- accessible from underneath at heat shield.



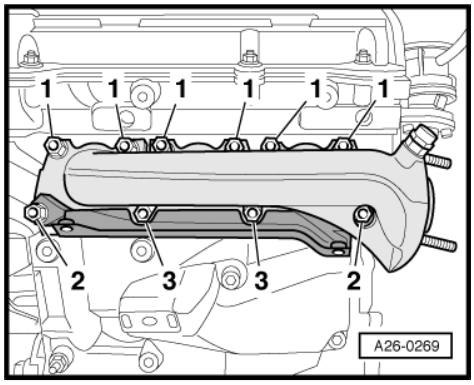
– Remove cover panel for left cylinder head cover -arrows-.
– Unclip coolant hose between heat exchanger and coolant expansion tank from holders.



– Unscrew screw connection -1- accessible from above at heat shield and detach heat shield.



– Unscrew exhaust manifold screw connections -1- accessible from above.



Note

The nuts can also be unscrewed using a 7 mm Allen key.

– Unscrew nuts -2- from underneath and detach heat shield.
– Unscrew nuts -3- and detach exhaust manifold.

Installing

Install in reverse order, paying attention to the following:

Note

Replace gaskets and self-locking nuts.

– Perform stress-free alignment of exhaust system ⇒ page 193 .

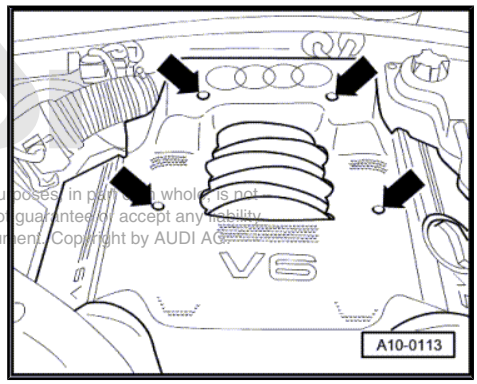
Tightening torques

Component		Nm
Exhaust manifold to cylinder head		25
Heat shield at top for exhaust manifold	M6	10
	M8	25

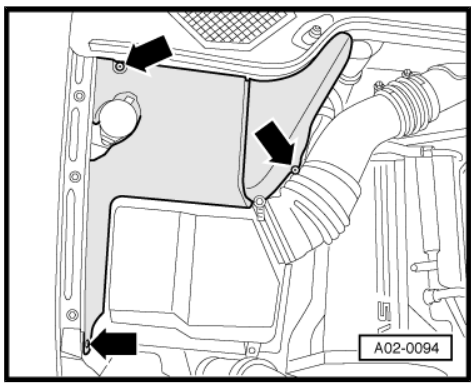
1.6 Removing and installing right exhaust manifold

Removing

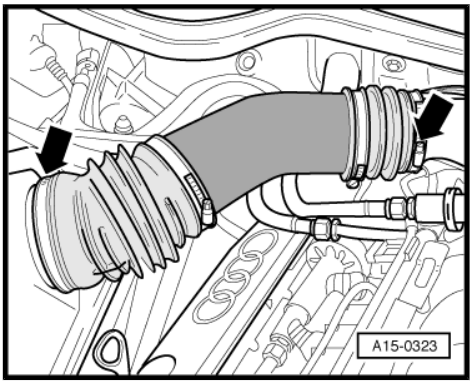
– Remove engine cover -arrows-.



– Remove cover on right in engine compartment -arrows-.



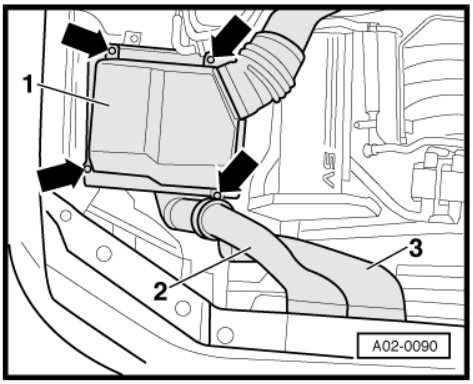
– Remove air hose between air mass meter and intake manifold -arrows-.



– Remove air ducts -2- and -3-.
– Slacken off bolts -arrows- and lay aside cover -1- of air cleaner housing.

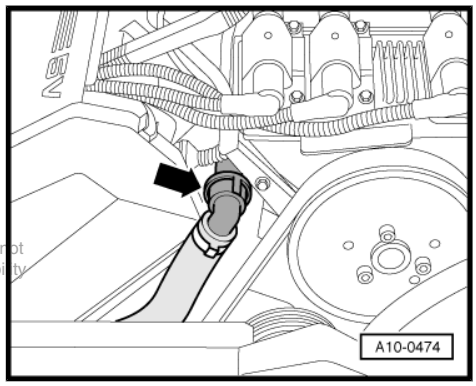
Note

Leave wire for air mass meter connected.



Vehicles with secondary air system:

– Disconnect hose -arrow- from secondary air connecting pipe.

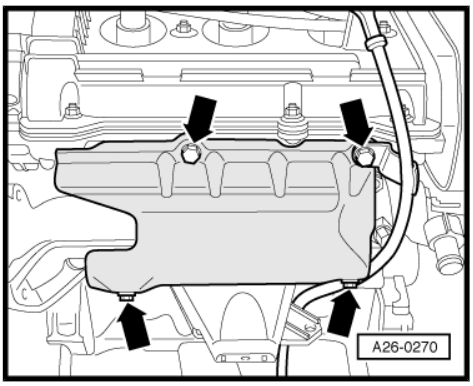


All models:

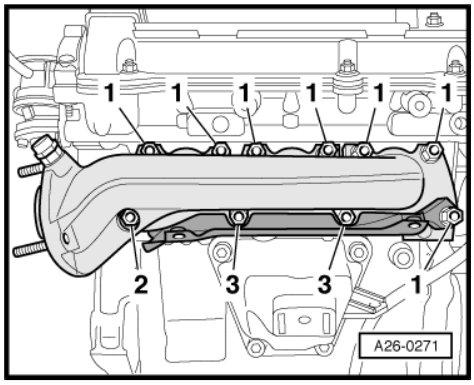
– Remove bottom part of air cleaner housing.
– Unscrew heat shield -arrows-.

Note

The dipstick guide tube is not to be pulled out upwards, as otherwise the O-ring at the bottom of the guide tube has to be replaced.



– Unscrew screw connection -1- accessible from above.

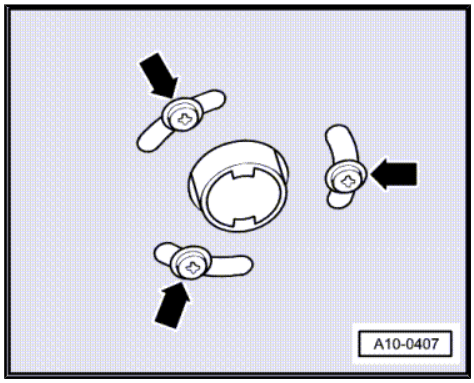


Note

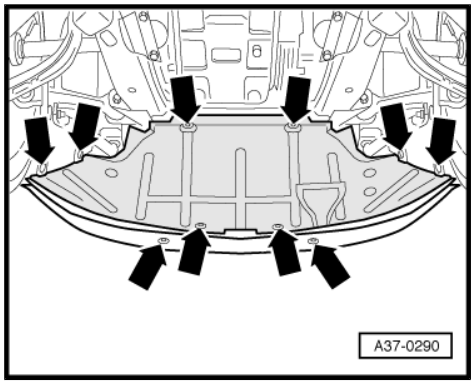
The nuts can also be unscrewed using a 7 mm Allen key.

– Remove right front exhaust pipe ⇒ page 186 .

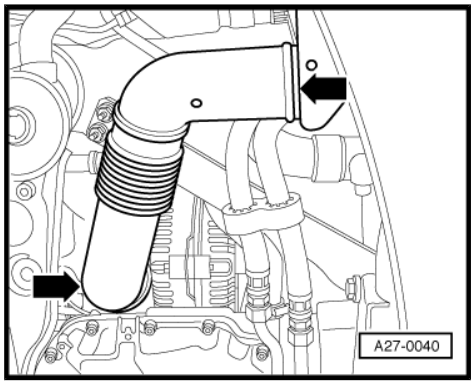
– On vehicles with auxiliary heater, screw out bolts -arrows- for attaching exhaust pipe of auxiliary/supplementary heater to noise insulation.



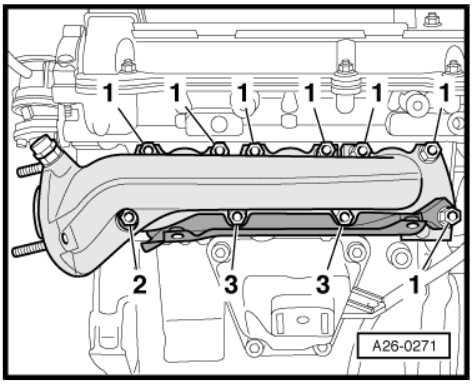
– Detach noise insulation -arrows-.



– Unclip alternator air duct -arrows-.



– Unscrew nut -2- from underneath and detach heat shield.
– Unscrew nuts -3- and detach exhaust manifold.



Installing

Install in reverse order, paying attention to the following:

Note

Replace gaskets and self-locking nuts.

– Perform stress-free alignment of exhaust system ⇒ page 193 .

Tightening torques

Component		Nm
Exhaust manifold to cylinder head		25
Heat shield at top for exhaust manifold	M6	10
	M8	25

1.7 Stress-free alignment of exhaust system

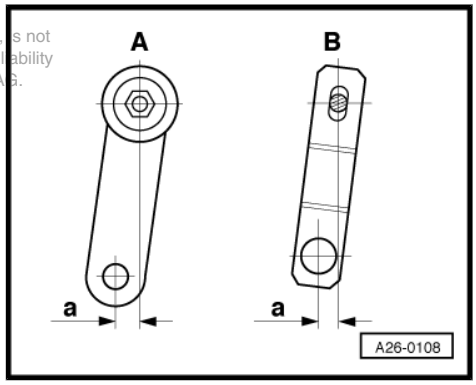
Note

Exhaust system alignment is performed when cold.

Four-wheel drive vehicles with manual gearbox:

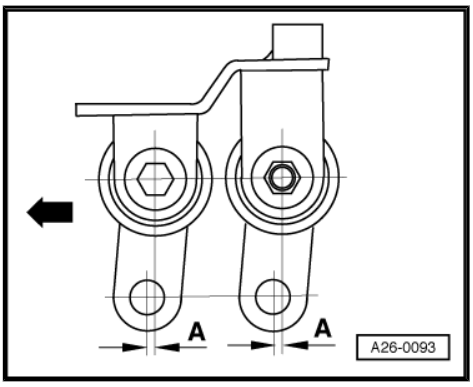
A - Left holder - viewed from left

B - Right holder - viewed from right



- Dimension -a- = 3 mm

Four-wheel drive vehicles with automatic gearbox:



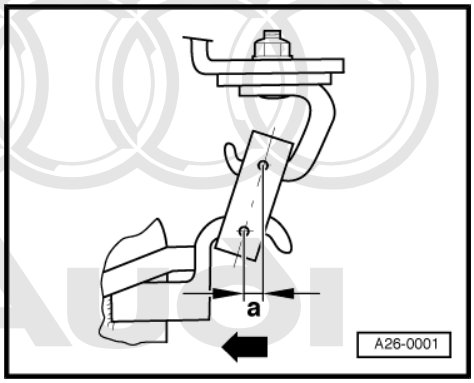
- Dimension -A- = 4.5 mm

Note

-Arrow- points in direction of travel.

Vehicles with no clamp between centre and rear silencer

- Unfasten bolted joints of clamps ⇒ Item 13 (page 181) .
- Press exhaust system forwards -arrow- until pre-tension at rubber mount at rear left at rear silencer is -a- = 10 mm.
- Uniformly tighten bolted joints of clamp to 40 Nm.
- Check installation dimensions ⇒ page 181

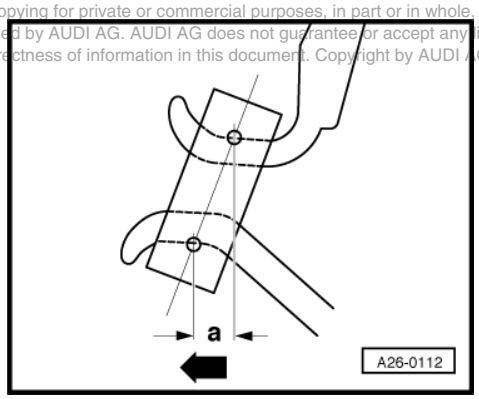


Vehicles with clamp between centre and rear silencer

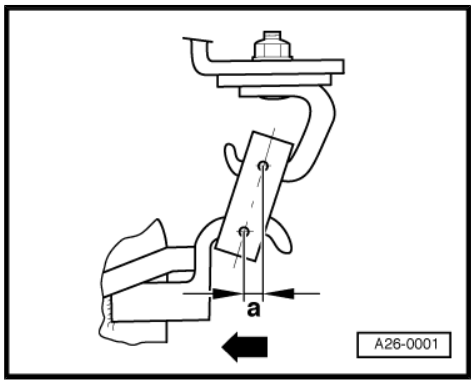
Note

Additional alignment of the front silencer is only required on vehicles with clamp between centre and rear silencer.

- Unfasten bolted joints of front clamp ⇒ Item 13 (page 181) and rear clamp.
- Press exhaust system forwards -arrow- until pre-tension at rubber mount at front left at centre silencer is -a- = 10 mm.
- Uniformly tighten bolted joints of front clamp ⇒ Item 13 (page 181) to 40 Nm.



- Press rear silencer forwards -arrow- until pre-tension at rubber mount at rear left at rear silencer is -a- = 10 mm.
- Uniformly tighten bolted joints of rear clamp to 40 Nm.
- Check installation dimensions ⇒ page 181



1.8 Checking exhaust system for leaks

- Start engine and leave it idling.
- Seal off tailpipes for duration of leak test with a cloth or plug for example.
- Listen at joints between cylinder head/exhaust manifold, exhaust manifold/catalytic converter etc. to check for leaks.
- Eliminate any leaks found.

2 Secondary air system

The secondary air system is designed to achieve more rapid warm-up and thus ensure that the catalytic converter is ready for operation more quickly after cold starting.

2.1 Principle and operation

Principle

On account of over-enrichment of the mixture in the cold starting phase, there is a greater proportion of unburnt hydrocarbons in the exhaust gas. The secondary air injection enhances the post-oxidation in the catalytic converter and thus reduces pollutant emissions. The heat liberated by post-oxidation considerably shortens the start-up time of the catalytic converter, thus greatly improving the exhaust gas quality in the cold running phase.

Operation

- In the cold running phase, the engine control unit actuates the secondary air pump by way of the secondary air pump relay - J299- . Air is routed to the secondary air combination valves.
- In parallel to this, the secondary air inlet valve is actuated and allows vacuum to pass to the secondary air combination valves. The corresponding secondary air combination valve

thus permits the passage of secondary air to the exhaust ducts of the appropriate cylinder head.

1 - Air cleaner housing

2 - Secondary air pump motor -V101-

- ❑ Fitting location ⇒ page 197

3 - Secondary air pump relay -J299-

- ❑ Fitting location ⇒ page 197

4 - Motronic control unit -J220-

5 - Secondary air combination valve

6 - Secondary air inlet valve -N112-

- ❑ Fitting location ⇒ page 196

7 - Non-return valve

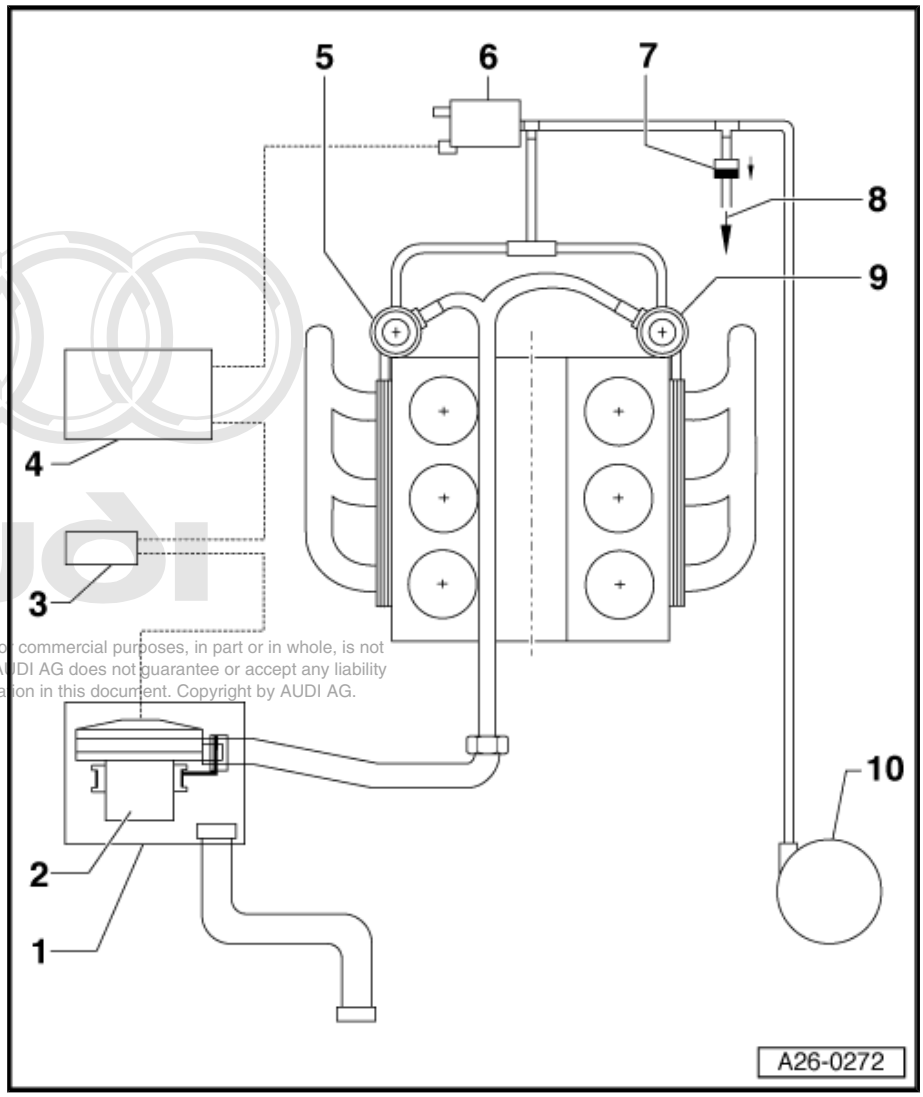
- ❑ Installation position (light side/dark side) as shown in illustration. Arrow indicates direction of flow.

8 - To intake manifold

9 - Secondary air combination valve

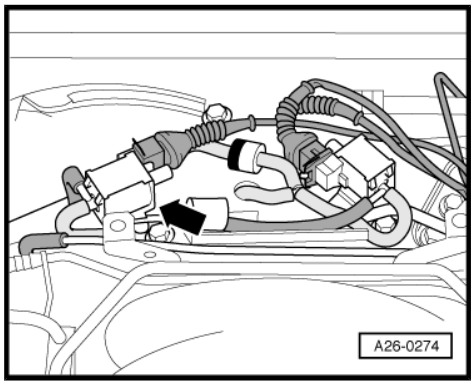
10 - Vacuum reservoir

- ❑ Fitting location: in front left wheel housing beneath liner



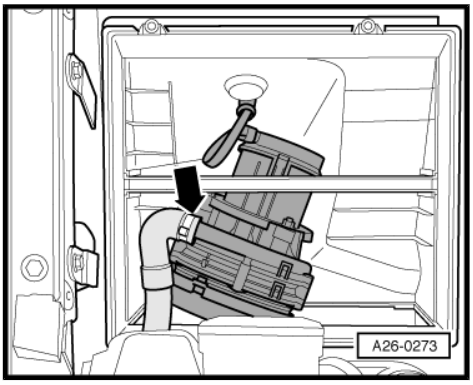
Fitting location of secondary air inlet valve -N112-

- Screwed to retaining plate for solenoid valves on back of engine -arrow-



Fitting location of secondary air pump motor -V101-

- In bottom part of air cleaner housing

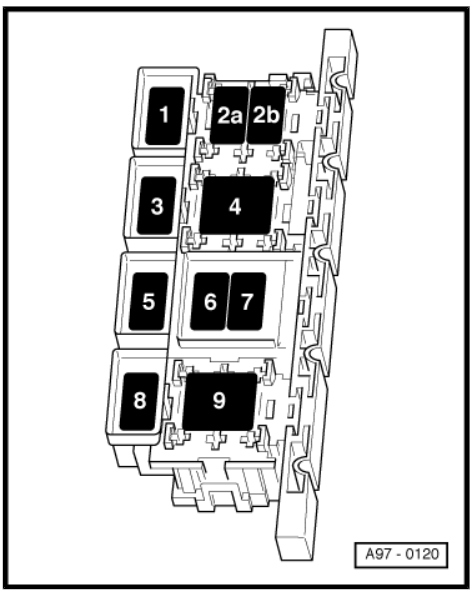


Fitting location of secondary air pump relay -J299-

- In relay and fuse carrier in plenum chamber electronics box, position -4-

Note

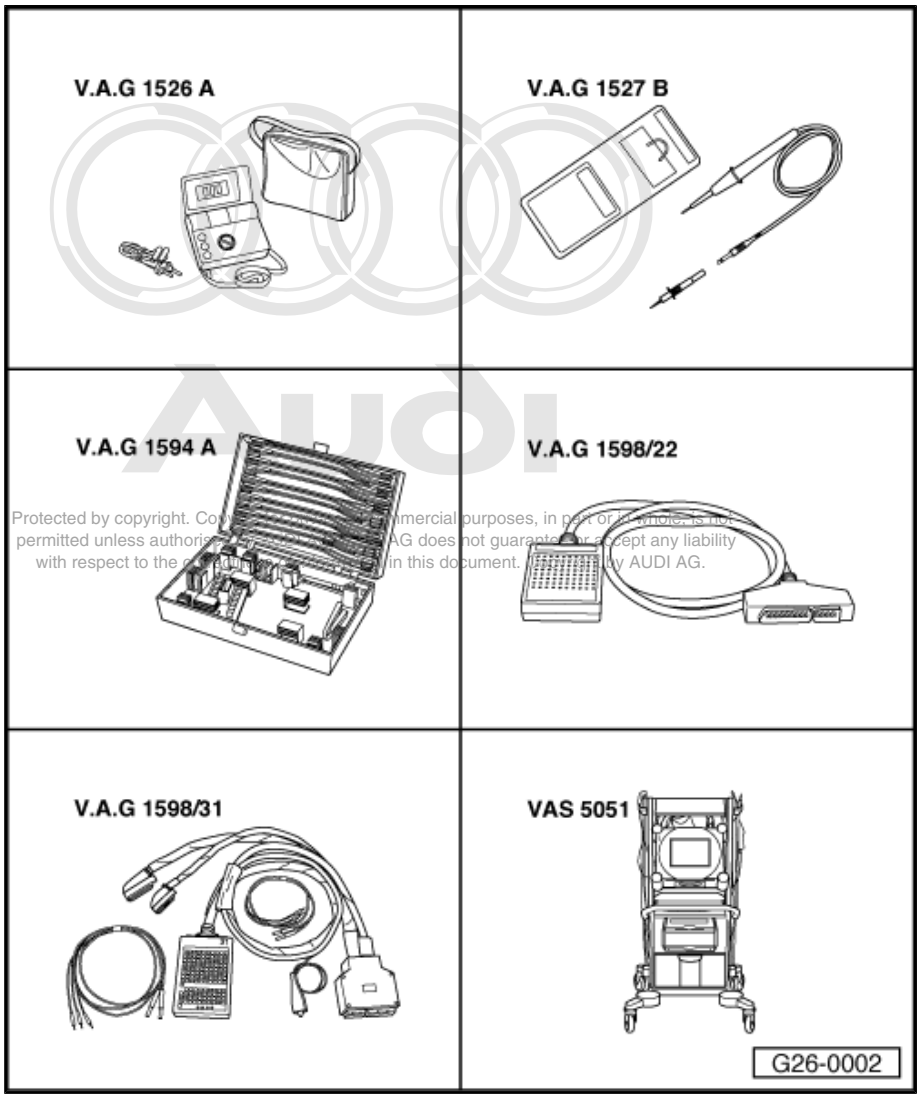
Fitting location of secondary air pump fuse -S130- : in fuse holder on A-pillar (right-side).



2.2 Checking secondary air inlet valve -N112-

Special tools and workshop equipment required

- Portable multimeter -V.A.G 1526 A- or -V.A.G 1526 B-
- Voltage tester -V.A.G 1527 B-
- Adapter set -V.A.G 1594 A- or -V.A.G 1594 C-
- Test box -V.A.G 1598/22- (vehicles with throttle cable)
- Test box -V.A.G 1598/31- (vehicles with electronic throttle)
- Vehicle diagnostic, testing and information system -VAS 5051 A- with diagnostic wire -VAS 5051/1-



Test conditions

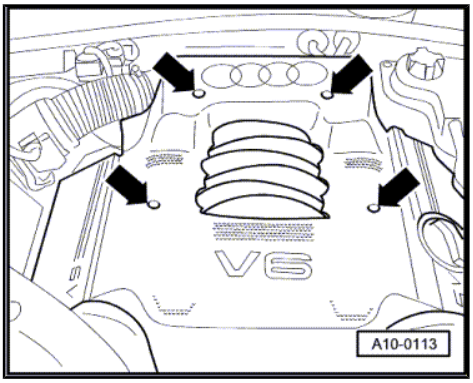
- Vehicle diagnostic, testing and information system -VAS 5051 A- with diagnostic wire -VAS 5051/1- connected, vehicle self-diagnosis and vehicle system “01 - Engine electronics” selected; when doing this, the ignition must be switched on.
- Engine control unit fault memory interrogated

Note

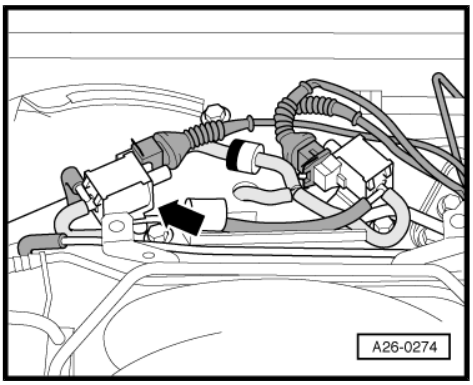
The secondary air inlet valve -N112- and the wiring connections are monitored by the engine control unit.

Test sequence

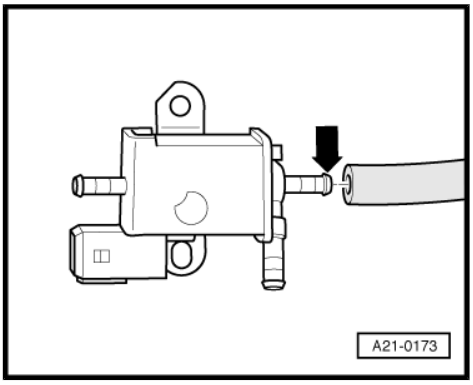
– Remove engine cover -arrows-.



– Detach hoses from secondary air inlet valve -N112- -arrow-; leave connector plugged in.



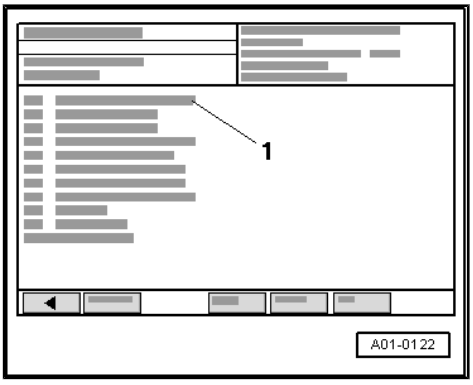
– Connect test hose to valve connection marked with -arrow-.



Display on -VAS 5051 A- :

– In list -1- select function “03 - Final control diagnosis”.

– Keep touching ⇨ key until secondary air inlet valve -N112- is actuated.



- The valve must click and must open and close (can be checked by blowing into test hose).

– Terminate function “03 - Final control diagnosis” by touching ⇦ key and switch off ignition.

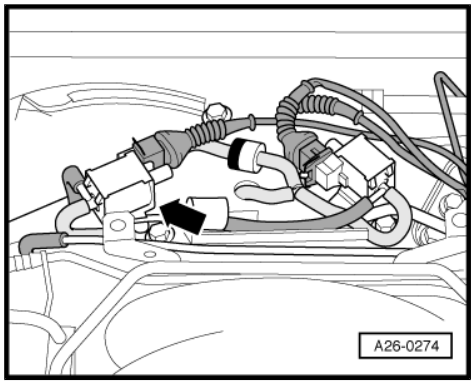
If valve does not open or close properly:

– Replace secondary air inlet valve -N112- .

If valve does not click during final control diagnosis:

Checking internal resistance

– Unplug connector at secondary air inlet valve -N112- -arrow-.



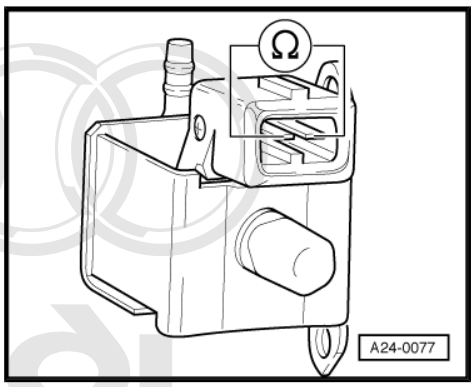
– Connect multimeter (resistance measuring range) to valve.

• Specification: 25 ... 35 Ω.

If reading does not match specification.

– Replace secondary air inlet valve -N112- .

If reading matches specification:



Checking power supply

• Fuse for secondary air inlet valve OK

• Fuel pump relay -J17- OK

Note

The secondary air inlet valve -N112- is supplied with power by way of the fuel pump relay.

– Connect up voltage tester -V.A.G 1527 B- between contact -1- and earth.

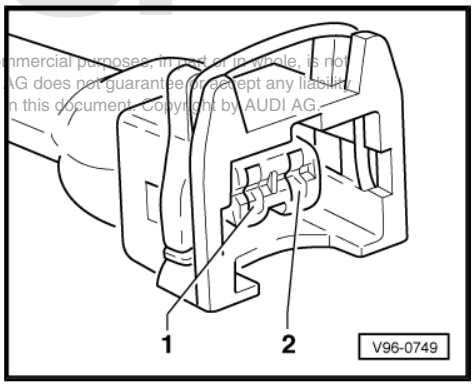
– Briefly operate starter.

• The LED must light.

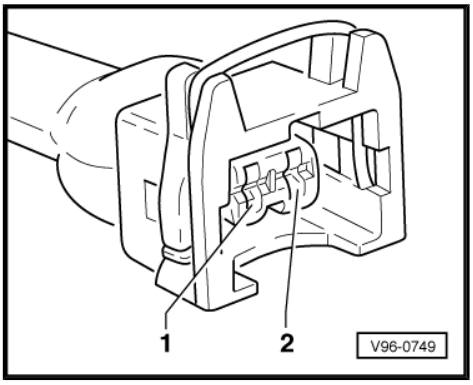
If LED does not light:

– Use current flow diagram to repair wiring from contact -1- of connector via fuse to fuel pump relay.

If LED lights:



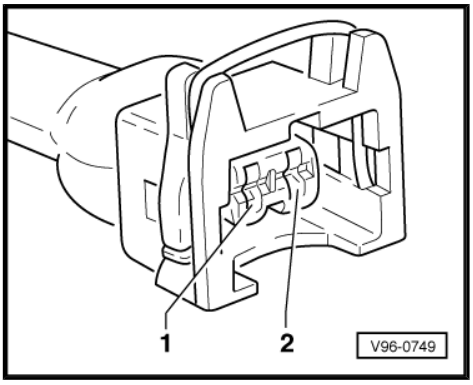
Checking actuation



– Connect up voltage tester -V.A.G 1527 B- between contacts -1- and -2-.
– Repeat function “03 - Final control diagnosis”.
– Keep touching ⇨ key until secondary air inlet valve -N112- is actuated.
• The LED must flash.
– Terminate function “03 - Final control diagnosis” by touching ⇦ key and switch off ignition.

If LED does not flash:

– Connect test box -V.A.G 1598/22- or -V.A.G 1598/31- to wiring harness to engine control unit, but do not connect actual engine control unit ⇒ Rep. Gr. 24 .



– Check for open circuit and short to earth or positive in the following wiring:

Vehicles with throttle cable:

Connector Contact	Test box -V.A.G 1598/22- Socket
-2-	33

Vehicles with electronic throttle:

Connector Contact	Test box -V.A.G 1598/31- Socket
-2-	44

All models:

– Repair wiring if necessary.

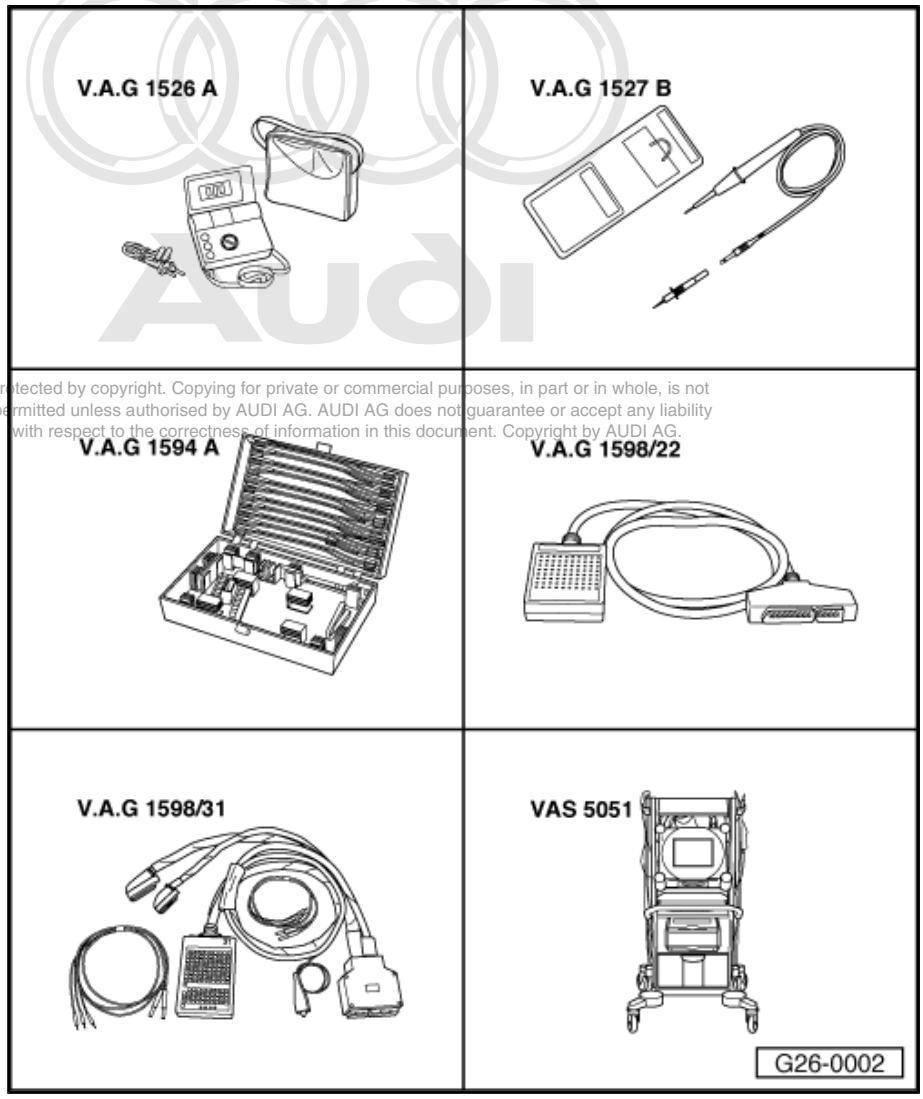
If no fault is found in wiring:

– Replace engine control unit.

2.3 Checking secondary air pump relay -J299- and actuation

Special tools and workshop equipment required

- Portable multimeter -V.A.G 1526 A- or -V.A.G 1526 B-
- Voltage tester -V.A.G 1527 B-
- Adapter set -V.A.G 1594 A- or -V.A.G 1594 C-
- Test box -V.A.G 1598/22- (vehicles with throttle cable)
- Test box -V.A.G 1598/31- (vehicles with electronic throttle)
- Vehicle diagnostic, testing and information system -VAS 5051 A- with diagnostic wire -VAS 5051/1-



Test conditions

- Vehicle diagnostic, testing and information system -VAS 5051 A- with diagnostic wire -VAS 5051/1- connected, vehicle self-diagnosis and vehicle system “01 - Engine electronics” selected; when doing this, the ignition must be switched on.
- Engine control unit fault memory interrogated

Test sequence

Display on -VAS 5051 A-

– In list -1- select function “03 - Final control diagnosis”.

– Keep touching → key until secondary air pump relay -J299- is actuated.

- The secondary air pump relay -J299- , position -4- (in relay and fuse carrier in plenum chamber electronics box) must be energised and the secondary air pump motor -V101- must run intermittently.

– Terminate function “03 - Final control diagnosis” by touching ← key and switch off ignition.

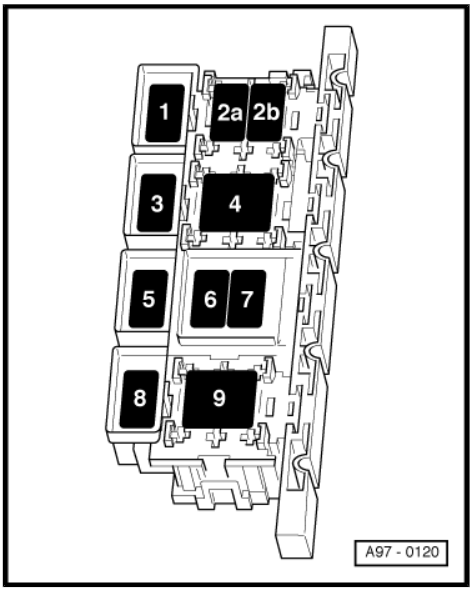
A - If relay is not energised:

– Check power supply of secondary air pump relay -J299- ⇒ page 203 .

– Check actuation of secondary air pump relay -J299- ⇒ page 204 .

B - If relay is energised but secondary air pump motor -V101- does not run:

– Check power supply for secondary air pump motor -V101- ⇒ page 205 .

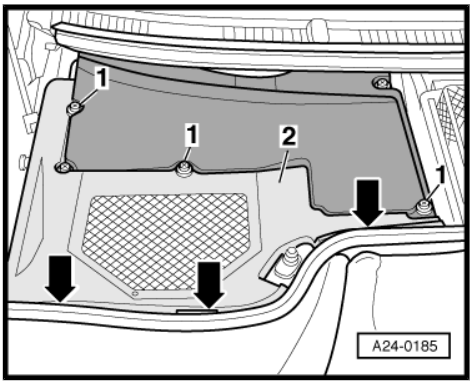


Checking power supply of secondary air pump relay -J299-

– Slacken off cross-head bolts -1- at electronics box in plenum chamber.

– Unclip plenum chamber cover -2- at front at bulkhead -arrows-.

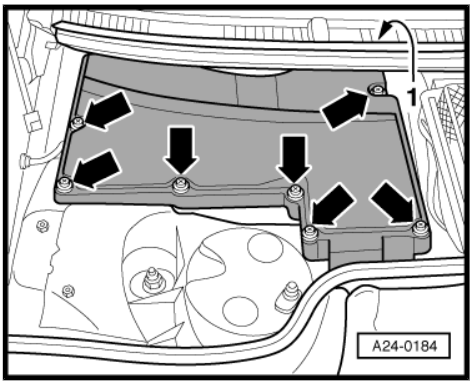
– Detach plenum chamber cover.



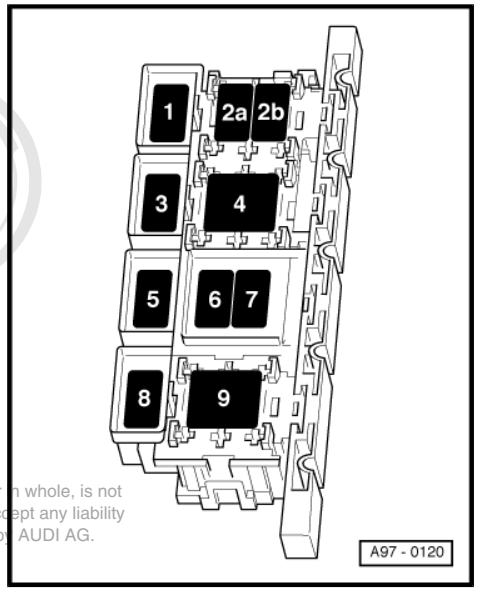
– Prise out cover -1- in scuttle panel trim and slacken off rear cross-head bolt -rear right arrow-.

– Slacken off the remaining cross-head bolts -arrows-.

– Detach cover for electronics box in plenum chamber.

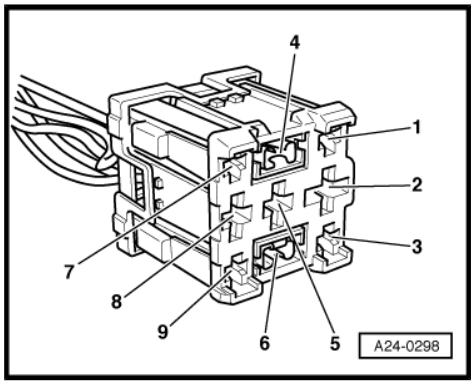


– Detach secondary air pump relay -J299- at position -4-.



– Connect up multimeter (voltage measuring range) between relay socket, contact -8- and earth.

• Specification: approx. battery voltage



If reading does not match specification:

– Check secondary air pump fuse -S130- (60 A) in right A-pillar fuse carrier.

– Check for open circuit in wiring from battery + (terminal 30) via secondary air pump fuse -S130- (in right A-pillar fuse carrier) to secondary air pump relay -J299- (in relay and fuse carrier in plenum chamber electronics box, position 4).

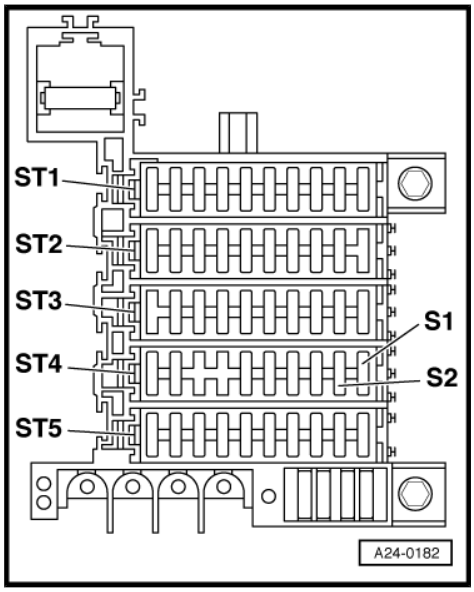
– Connect up multimeter (voltage measuring range) between relay socket, contact 4 and earth.

– Briefly operate starter.

• Specification: approx. battery voltage

If reading does not match specification:

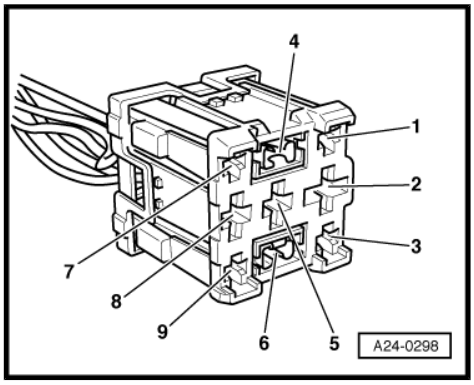
– Use current flow diagram to repair wiring.



Checking actuation of secondary air pump relay -J299-

– Switch off ignition.

– Disconnect secondary air pump relay -J299- .



– Connect up voltage tester -V.A.G 1527 B- between relay socket contact -6- and battery positive.
– Repeat function “03 - Final control diagnosis”.
– Keep touching → key until secondary air pump relay -J299- is actuated.

• The LED must flash.

– Terminate function “03 - Final control diagnosis” by touching ← key and switch off ignition.

If LED does not flash:

– Connect test box -V.A.G 1598/22- or -V.A.G 1598/31- to wiring harness to engine control unit, but do not connect actual engine control unit ⇒ Rep. Gr. 24 .
– Check for open circuit and short to earth or positive in the following wiring:

Vehicles with throttle cable:

Relay socket Contact	Test box -V.A.G 1598/22- Socket
-6-	30

Vehicles with electronic throttle:

Relay socket Contact	Test box -V.A.G 1598/31- Socket
-6-	46

All models:

– Repair wiring if necessary.

If no fault is found in wiring:

– Replace secondary air pump relay -J299- .

Checking power supply for secondary air pump motor -V101-

– Unplug connector at secondary air pump motor -V101- .
– Connect up voltage tester -V.A.G 1527 B- between contacts 1 and 2.
– Repeat function “03 - Final control diagnosis”.
– Keep touching → key until secondary air pump relay -J299- is actuated.

• The LED must flash.

– Terminate function “03 - Final control diagnosis” by touching ← key and switch off ignition.

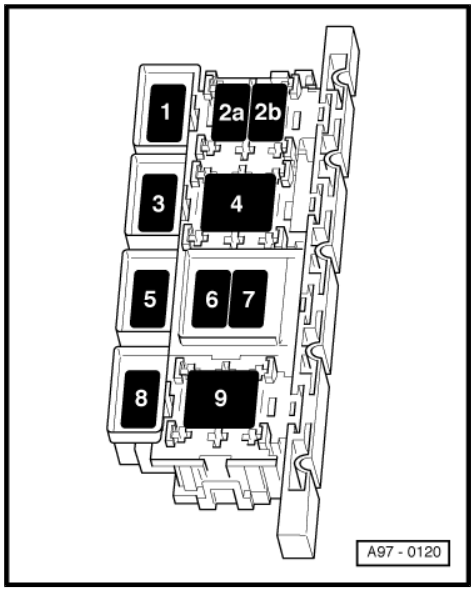
If LED does not flash:

– Use current flow diagram to check for open circuit in wiring between connector at secondary air pump motor -V101- and secondary air pump relay -J299- , position -4- (in relay and fuse carrier in electronics box in plenum chamber).

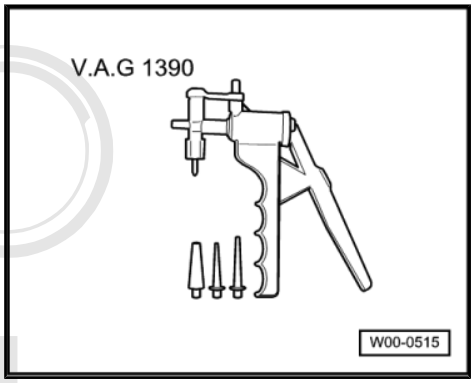
– Use current flow diagram to check for open circuit in wiring between connector at secondary air pump motor -V101- and earth.

If no fault is found:

– Replace secondary air pump motor -V101- .



2.4 Checking secondary air combination valve for proper operation and leakage



Special tools and workshop equipment required

♦ Vacuum hand pump with accessories -V.A.G 1390-

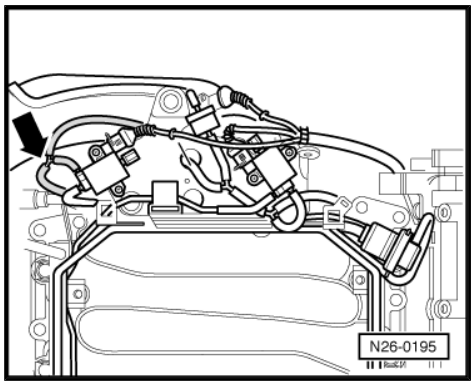
Test conditions

• No leaks in vacuum pipes and hose connections

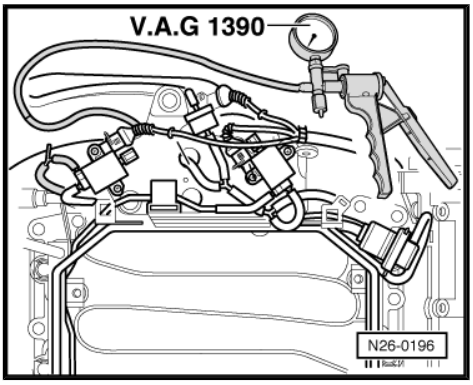
• Vacuum pipes not clogged

Test sequence

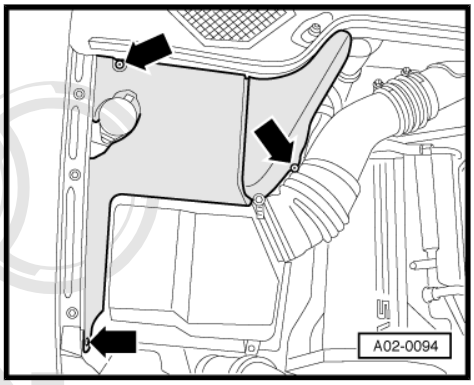
– Disconnect vacuum hose of combination valve to be checked at Y-piece -arrow-.



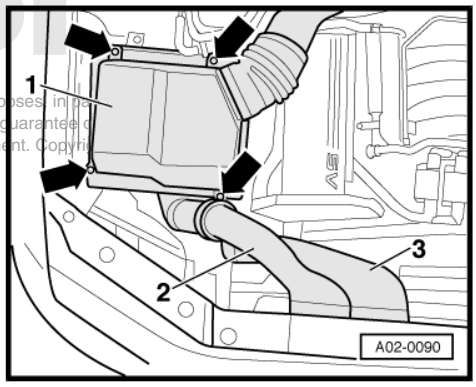
– Connect vacuum hand pump -V.A.G 1390- to vacuum hose of combination valve to be checked.



– Remove cover on right in engine compartment -arrows-.



– Remove air ducts -2- and -3-.
– Slacken off bolts -arrows- and lay aside cover -1- of air cleaner housing.



Note

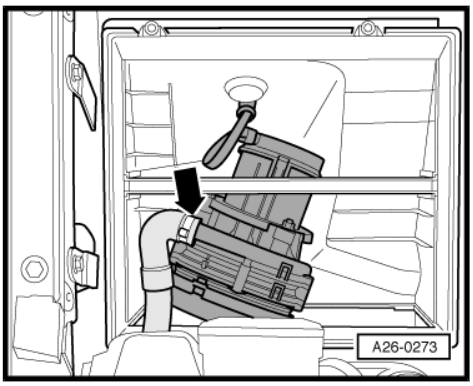
Leave wire for air mass meter connected.

– Detach pressure hose -arrow- at secondary air pump motor and blow gently into it (do not use compressed air).

• Both combination valves must be closed; blowing through must not be possible

– Use vacuum hand pump to generate vacuum.

• The corresponding combination valve must open; blowing through must be possible



If the corresponding combination valve does not open:

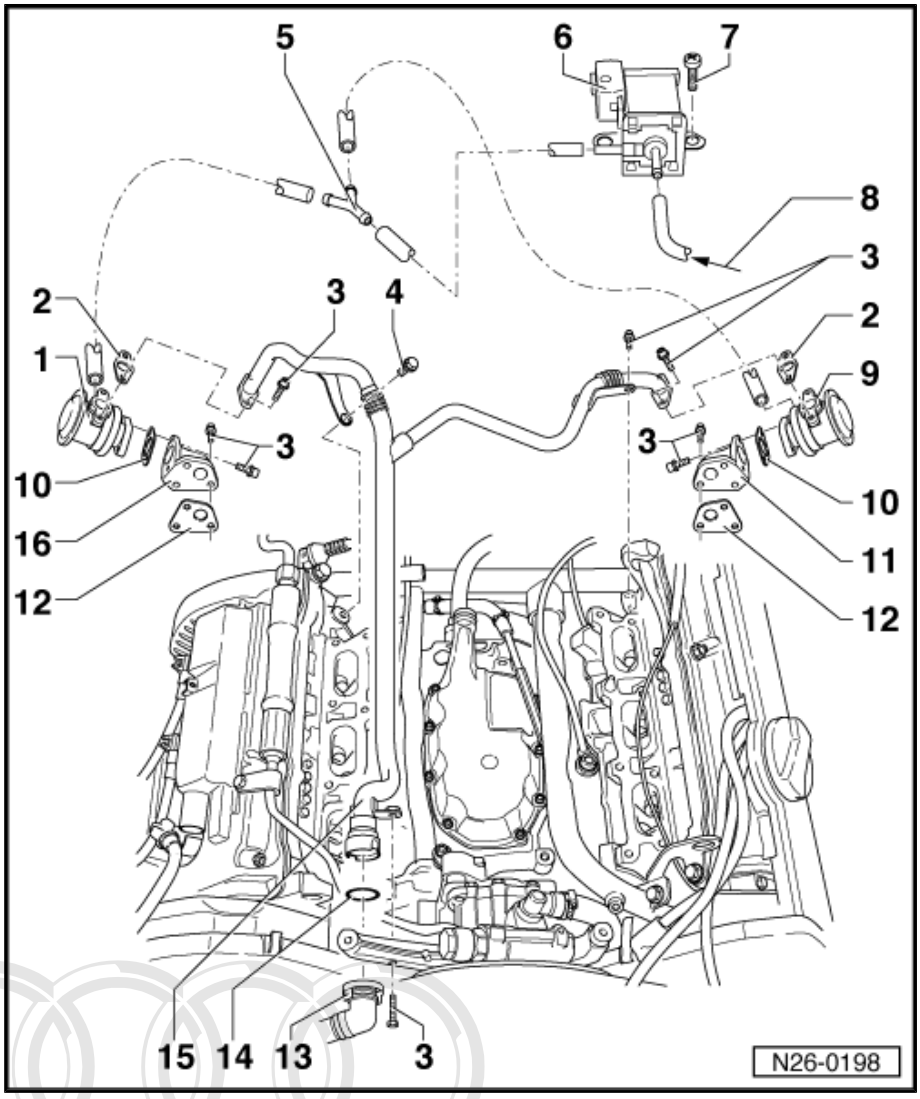
– Renew combination valve: left-side ⇒ page 208 , right-side ⇒ page 209 .

Assemble in reverse order.

2.5 Exploded view of secondary air system components

Note

Further fitting locations ⇒ page 197 and ⇒ page 197



1 - Right combination valve for secondary air

- ❑ Removing and installing ⇒ page 209

2 - Gasket

- ❑ Replace

3 - 10 Nm

4 - 22 Nm

5 - Y-piece

6 - Secondary air inlet valve - N112-

7 - 6 Nm

8 - From vacuum reservoir

- ❑ Fitting location: in front left wheel housing beneath liner

9 - Left combination valve for secondary air

- ❑ Removing and installing ⇒ page 208

10 - Gasket

- ❑ Replace

11 - Connection

12 - Gasket

- ❑ Replace

13 - Pressure hose

- ❑ Ensure proper attachment
- ❑ Squeeze at front to release

14 - O-ring

- ❑ Replace

15 - Connecting pipe

- ❑ To secondary air combination valves
- ❑ Removal and installation involve taking out intake manifold ⇒ page 83

16 - Connection

2.6 Removing and installing left combination valve for secondary air

Removing

– Drain off coolant ⇒ page 155 .

– Remove left front exhaust pipe ⇒ page 188 .

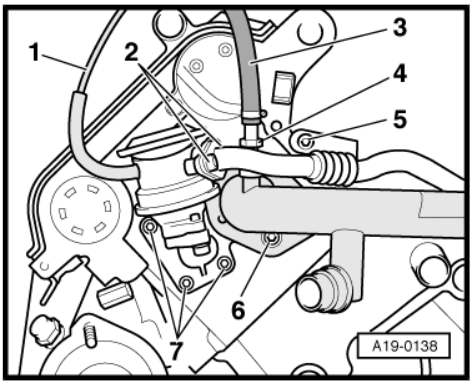
– Screw out bolts -7- accessible from underneath at secondary air combination valve.

– Detach coolant hose -3-.

– Screw out connection -4-.

– Detach vacuum hose -1-.

– Screw out bolts -2- and detach secondary air combination valve.



Installing

Install in reverse order, paying attention to the following:

Note

Replace gaskets and seals.

– Perform stress-free alignment of exhaust system ⇒ page 193 .

– Replenish coolant ⇒ page 157 .

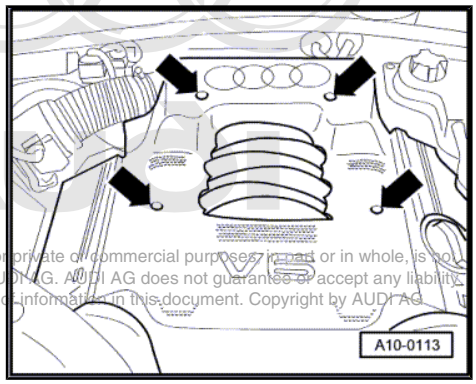
Tightening torques

Component	Nm
Secondary air combination valve to cylinder head	10
Connecting pipe to cylinder head	10
Connection to rear coolant pipe	15

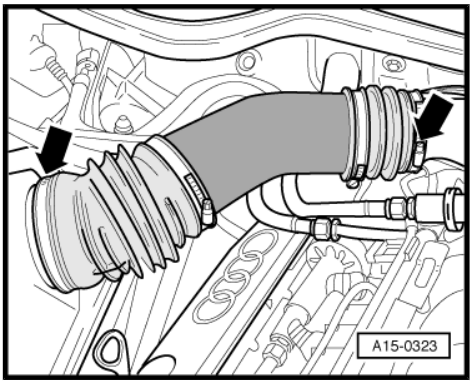
2.7 Removing and installing right combination valve for secondary air

Removing

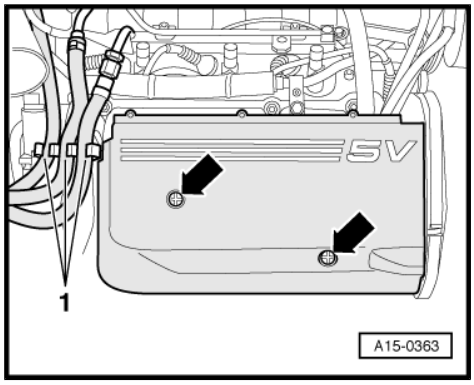
– Remove engine cover -arrows-.



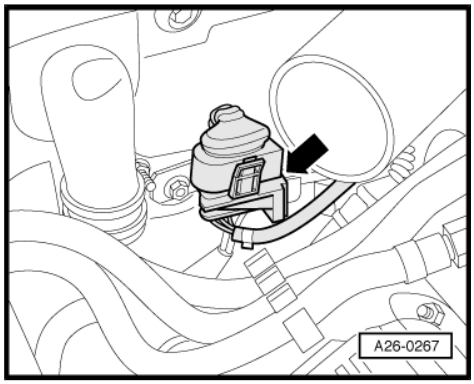
– Remove air hose between air mass meter and intake manifold -arrows-.



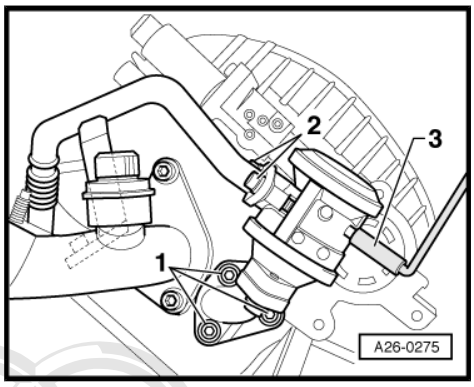
– Remove cover panel for right cylinder head cover -arrows-.



– Press retainer tab in -direction of arrow- and unclip holder for lambda probe connector at bulkhead.



– Detach vacuum hose -3-.
– Screw out bolts -2-.
– Screw out bolts -1- and detach secondary air combination valve.



Installing

Install in reverse order, paying attention to the following:

Note

Replace gaskets.

Tightening torques

Component	Nm
Secondary air combination valve to cylinder head	10
Connecting pipe to cylinder head	10