Workshop Manual
Audi TT 2007 ➢

6-cylinder injection engine (3.2 ltr. 4-valve), mechanics									
Engine ID	BUB	CBR A							

Edition 03.2009

List of Workshop Manual Repair GroupsList of Workshop Manual Repair GroupsList of Workshop Manual Repair Groups

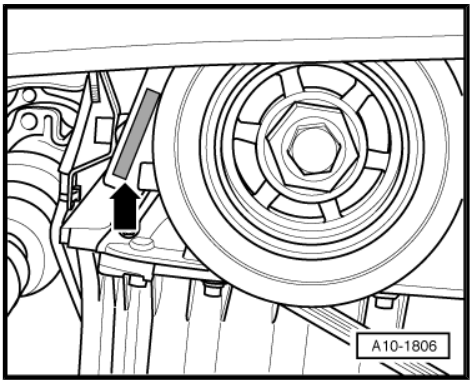
Repair Group

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 Engine number



- The engine number (“engine code” and “serial number”) can be found at the front next to the poly V-belt pulley on the crankshaft -arrow-.
- There is also a sticker on the cylinder head cover showing the “engine code” and “serial number”.
- Starting with the letter “C”, the engine codes consist of 4 letters.
- The first 3 characters of the engine code stand for the engine capacity and the mechanical construction and design. They are stamped on the cylinder block, together with the serial number.
- The 4th character indicates the power output and torque of the engine, and is determined by the engine control unit.

Note

- *The engine code is additionally marked at the engine lifting eye (right-side).*
- *The 3-character engine code also appears on the vehicle data sticker.*
- *The 4-character engine code can be found on the type plate (in versions for some countries only) and on the vehicle data sticker and the engine control unit.*
- *Fitting locations of the type plate (certain countries only) and the vehicle data sticker ⇒ Maintenance ; Booklet 810 .*

2 Engine data

Code letters		BUB	CBRA
Capacity	ltr.	3.189	3.189
Power output	kW at rpm	184/6300	184/6300
Torque	Nm at rpm	320/2500 … 3000	320/2500 … 3000
Bore	∅ in mm	84	84
Stroke	mm	95.9	95.9
Compression ratio		10.85	10.85
RON	not less than	98 1)	98 1)
Injection/ignition system		Motronic	Motronic
Firing order		1-5-3-6-2-4	1-5-3-6-2-4
Emission standards		EU4	LEV2
Exhaust gas recirculation		no	no
Turbocharging/supercharging		no	no
Lambda control		4 probes	4 probes
Variable valve timing		yes	yes
Intake manifold change-over		yes	yes
Secondary air system		yes	yes
Valves per cylinder		4	4

- 1) Unleaded premium RON 95 can also be used, but results in reduced power

3 Safety precautions

When working on the fuel system note the following warnings:

> **WARNING**
>
> *The fuel system operates at extremely high pressure. This can cause injury.*
>
> - *The fuel pressure in the high-pressure section of the injection system must be reduced to a residual pressure prior to opening the system.*
> - *Wrap a clean cloth around the connection and carefully loosen the connection to allow the residual pressure to dissipate.*

– Procedure before opening high-pressure section of injection system ⇒ page 4 .

> **WARNING**
>
> *Escaping fuel can cause a fire risk.*
>
> - *The power supply for the fuel pump control unit -J538- must be disconnected before opening the fuel system, as the fuel system pressurisation pump -G6- will be activated briefly when the driver's door is opened with the battery still connected.*

> **Caution**
>
> *To prevent damage to the electronic components when disconnecting the battery:*
>
> - *Observe notes on procedure for disconnecting the battery.*
> - *Always switch off the ignition before disconnecting the battery.*

– Disconnect battery ⇒ Rep. Gr. 27 .

3.1 Observe the following to prevent injuries to persons and damage to the injection and ignition system:

Observe the following to prevent injuries to persons and damage to the injection and ignition system:

- Do not touch or disconnect ignition coils with output stages when the engine is running or being turned at starter speed.
- Always switch off the ignition before connecting or disconnecting electrical wiring for the injection or ignition system or tester cables.
- If you want to crank the engine at starting speed without actually starting it (e.g. compression test), first unplug the connectors from the ignition coils and the injectors. After completing the work, interrogate and erase the fault memory.
- Always switch off ignition before washing engine.

- Faults are stored in engine control unit if electrical connectors have been unplugged:

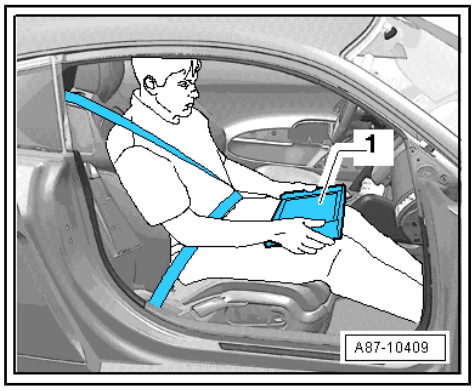
– Connect vehicle diagnostic, testing and information system - VAS 5051B- .

– Start “Guided Functions” mode.

– Generate readiness code in engine control unit.

3.2 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.

Injuries can also be caused if the passenger's airbag is triggered in a collision.

- *The use of test equipment while driving causes distraction.*
- *There is an increased risk of injury if test equipment is not secured.*

TT Coupé:

Test equipment must always be secured on the rear seat with a strap and operated from the rear seat by a second person.

TT Roadster:

- *Move the passenger's seat back as far as it will go.*
- *Use only vehicle diagnosis and service information system -VAS 5052- or diagnosis system -VAS 5053- .*
- *The test equipment -1- must rest flat on the passenger's thighs (as shown in illustration) and must be operated by the passenger.*

3.3 Working on the cooling system

When working on the cooling system note the following:

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.*

3.4 Procedure before opening high-pressure section of injection system

- The injection system consists of a high-pressure section (maximum approx. 120 bar) and a low-pressure section (approx. 6 bar).

- Before removing a component in the high-pressure section of the injection system, the fuel pressure in the high-pressure section must be reduced to a residual pressure of approx. 6 bar; follow the procedure outlined below.

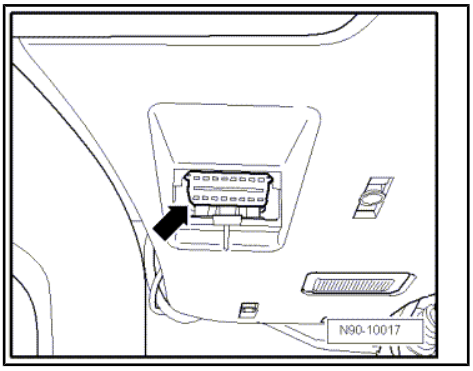
Special tools and workshop equipment required

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

Procedure

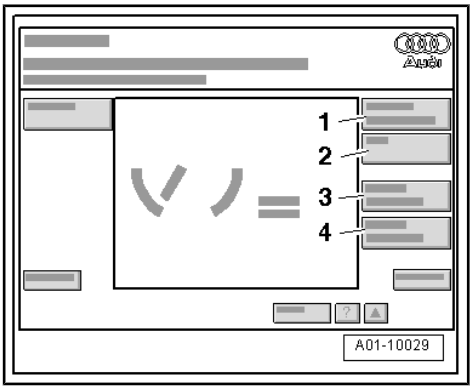
– With ignition switched off, connect vehicle diagnostic, testing and information system -VAS 5051B- with diagnosis lead to diagnosis connection.

– Start the engine and run at idling speed.



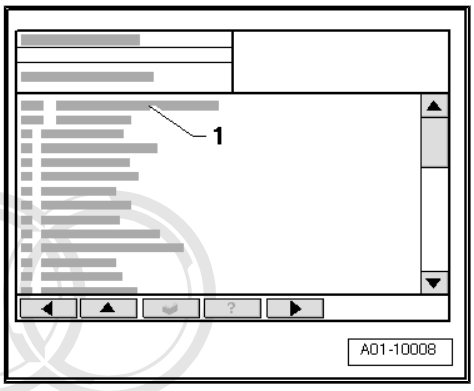
Display on -VAS 5051B- :

– Select `Vehicle self-diagnosis` from the list -item 1-.



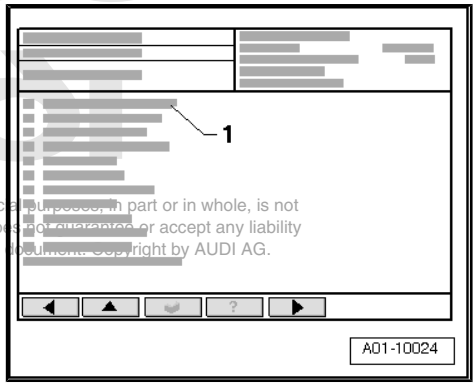
Display on -VAS 5051B- :

– From menu -1-, select vehicle system “Engine electronics” and press → key to continue.



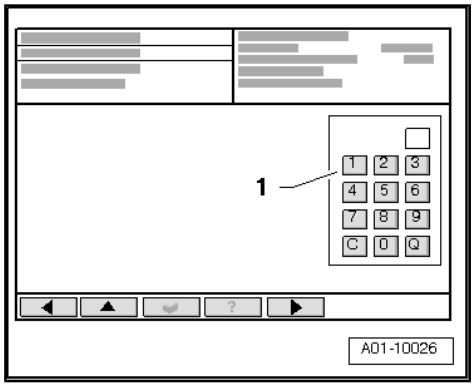
Display on -VAS 5051B- :

– From menu -1-, select function “Measured values” and press → key to continue.



Display on -VAS 5051B- :

– Press keys 1 4 0 on keypad -1- to select “Display group 140” and confirm entry by pressing Q key.

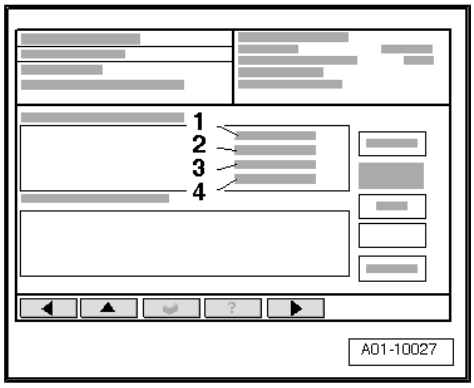


Display on -VAS 5051B- :

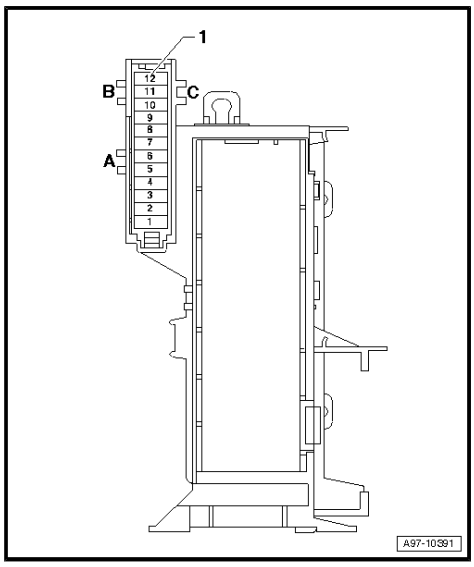
– Check display indicating fuel pressure in fuel rail in display zone -3-.

• With engine idling the figure displayed will be 35 ... 45 bar. The display shows the actual pressure in the fuel rail which is being generated by the high-pressure pump.

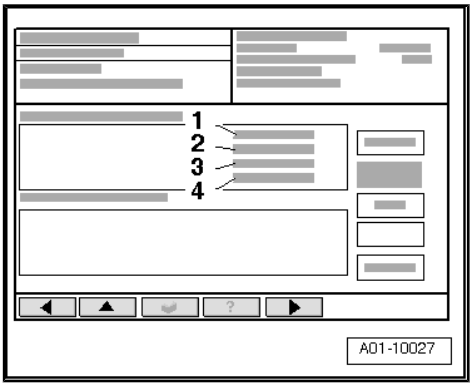
– Remove luggage compartment side trim (right-side) ⇒ Rep. Gr. 70 .



– Remove fuse 6 in fuse holder F -SF6- for fuel pump control unit -J538- in fuse holder in luggage compartment (right-side).



Display on -VAS 5051B- :



– With engine still running, check display zone -3- for fuel pressure in fuel system:

• The fuel pressure will decrease very quickly because the mechanical high-pressure pump is no longer being supplied with fuel from the fuel tank by the electric fuel pump.

– Switch off ignition as soon as fuel pressure has dropped to just below 8 bar.

Note

Fuel pressure must not fall below 6 bar, otherwise the engine will stall (this could damage the catalytic converter).

The fuel rail is still filled with fuel, however it is no longer under high pressure.

WARNING

There is a risk of injury: avoid skin contact with fuel.

- ***Wear safety goggles and protective clothing when opening the fuel system.***
- ***Before opening the high-pressure section of the fuel system, place a clean cloth around the connection to catch escaping fuel.***

– Disconnect a fuel line connection without delay.

Note

The pressure will increase again due to the effect of residual heat if the high-pressure system is not opened immediately.

Additional steps required

– Re-fit fuse 6 in fuse holder F -SF6- .

– With ignition switched off, connect vehicle diagnostic, testing and information system -VAS 5051B- .

– Start “Guided Functions” mode.

– Generate readiness code in engine control unit ⇒ Vehicle diagnosis, testing and information system VAS 5051.

4 General repair instructions

4.1 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.

4.2 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.

4.3 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 to prevent further damage occurring later.

4.4 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.

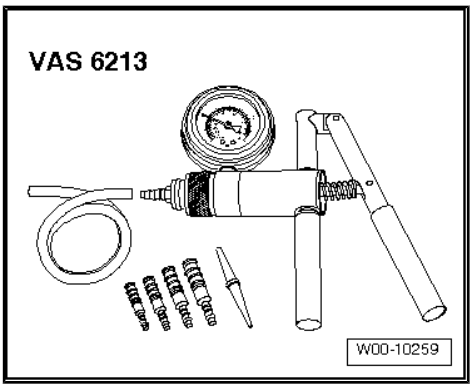
4.5 Routing and attachment of pipes, hoses and wiring

- 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).

4.6 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 hand vacuum pump -VAS 6213- or if the pressure drops again immediately, check hand vacuum pump and connecting hoses for leaks.

4.7 Installing radiators, condensers and charge air coolers

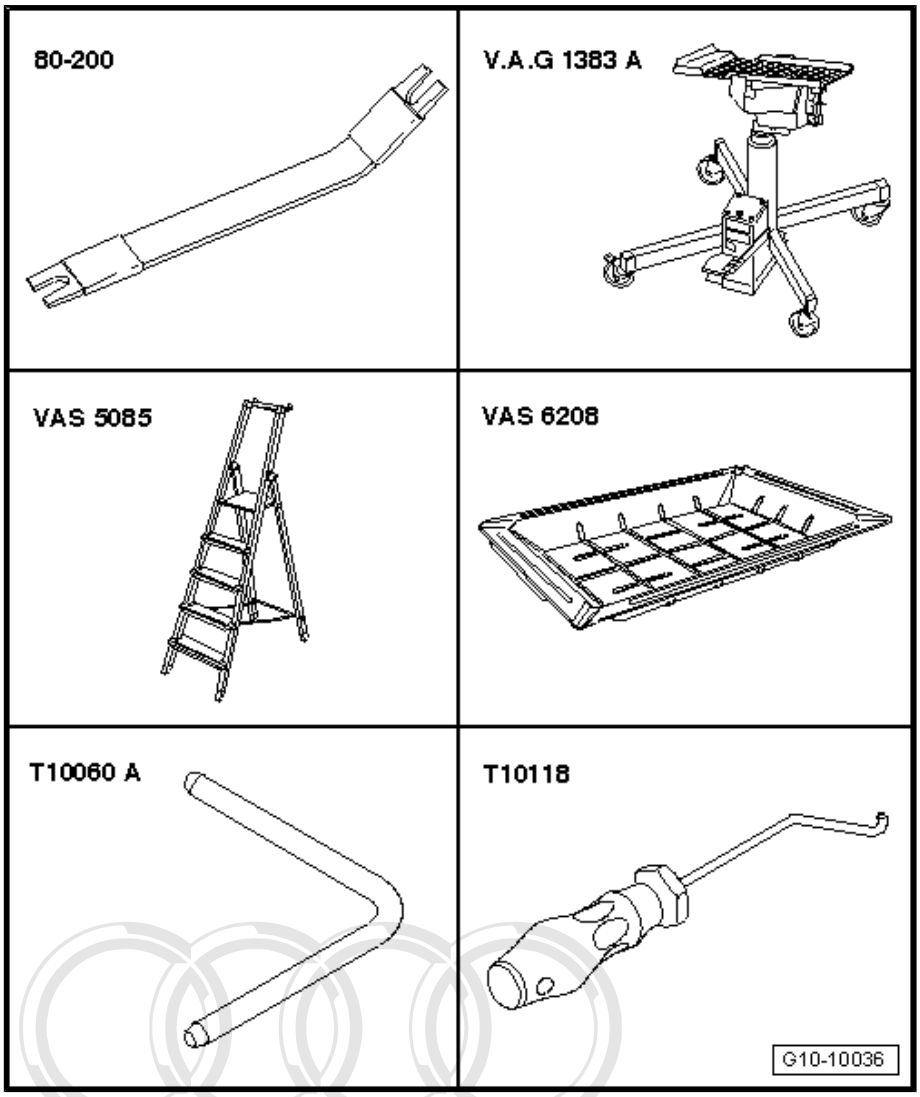
Even when the radiator, condenser and charge air cooler are correctly installed, slight impressions may be visible on the fins of these components. This does not mean that the components are damaged. If the fins are only very slightly distorted, this does not justify renewal of the radiator, condenser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

10 – Removing and installing engine

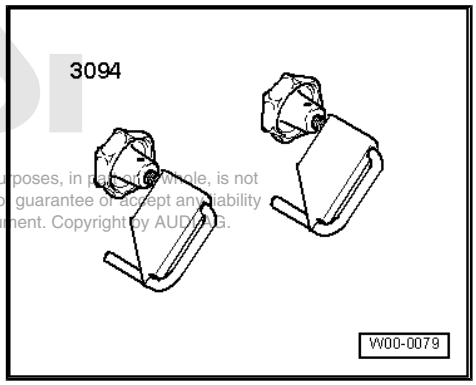
1 Removing engine

Special tools and workshop equipment required

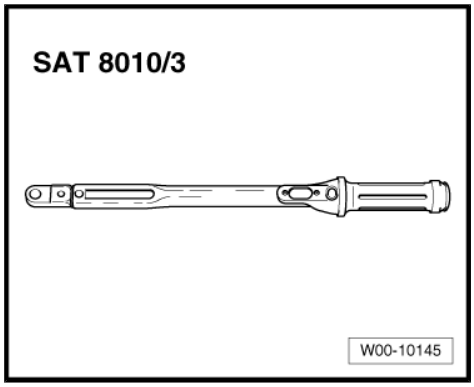
- Removal lever -80 - 200-
- Engine and gearbox jack -V.A.G 1383 A-
- Stepladder -VAS 5085-
- Drip tray for workshop hoist -VAS 6208-
- Locking pin -T10060 A-
- Assembly tool -T10118-



- Hose clamps for hoses up to 25 mm -3094-



- Engine support -T40074-



- Nut M12 (1x)
- Bolts M10 (2x)

Procedure

Note

- *The engine is removed from underneath together with the gearbox.*
- *Fit cable ties in the original positions when installing.*
- *Collect drained coolant in a clean container for re-use or disposal.*

Caution

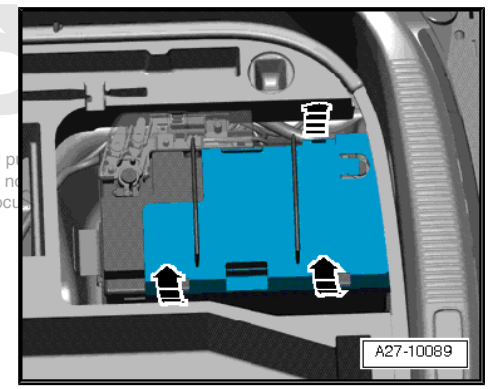
To prevent damage to the electronic components when disconnecting the battery:

- ***Observe notes on procedure for disconnecting the battery.***

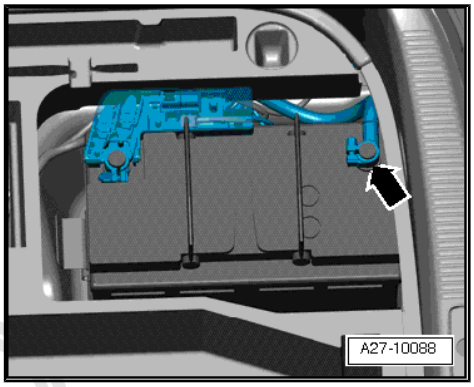
– Take out luggage compartment floor covering.

– Remove rear cross panel trim if cover for negative terminal of battery is located under rear cross panel trim ⇒ Rep. Gr. 70 .

– Release retaining clips -arrows- and detach cover for negative terminal.



– Slacken nut a few turns and disconnect battery clamp on earth cable -arrow- from battery terminal.



WARNING

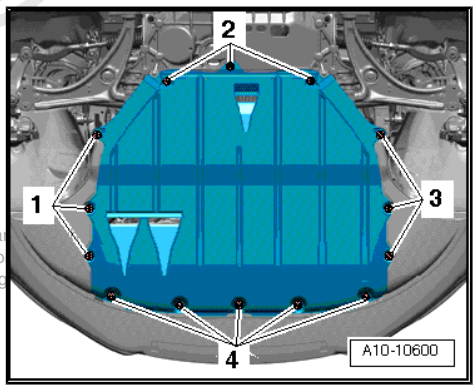
Hot steam/hot coolant can escape - risk of scalding.

- *The cooling system is under pressure when the engine is hot.*
- *Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.*

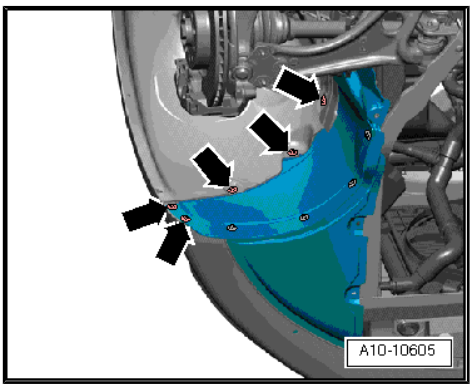
– Open filler cap on expansion tank.

– Remove both front wheels.

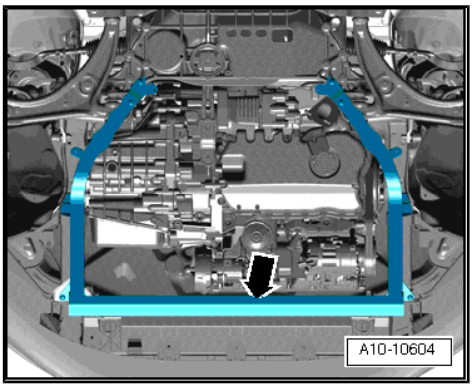
– Release fasteners -1 ... 4- and remove centre noise insulation.



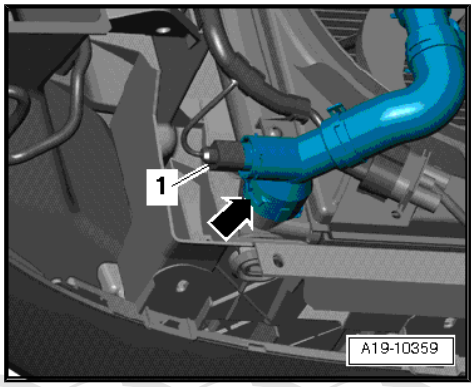
– Remove noise insulation on left and right sides -arrows-.



– Remove noise insulation frame -arrow-.



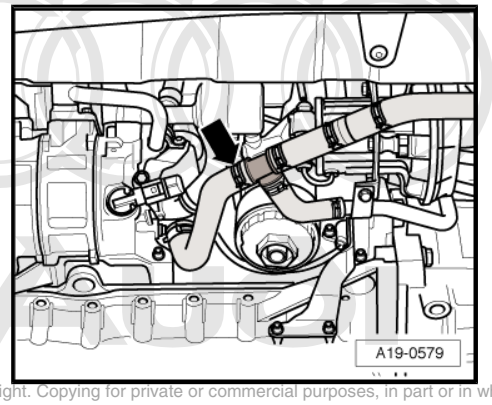
– Unplug electrical connector -1- at radiator outlet coolant temperature sender -G83- .
– Place drip tray for workshop hoist -VAS 6208- beneath engine.
– Disconnect bottom coolant hose from radiator -arrow- and drain off coolant.



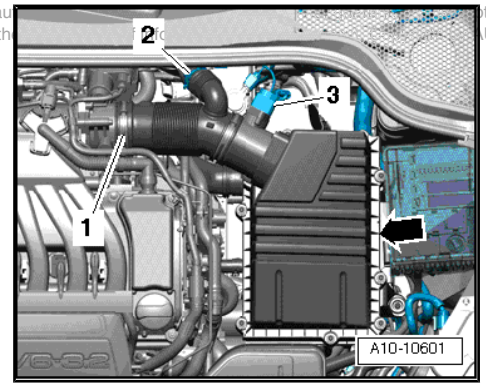
– Disconnect bottom coolant hose leading to continued coolant circulation pump -V51- -arrow- and drain off coolant.

Note

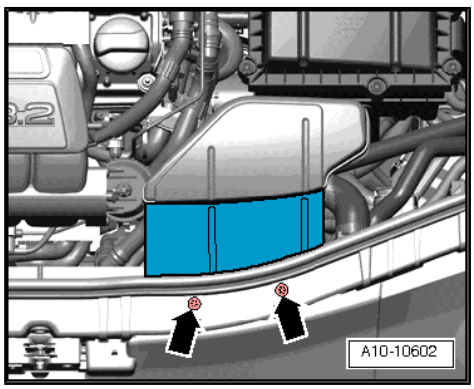
Illustration shows coolant hose on vehicle with direct shift gearbox.



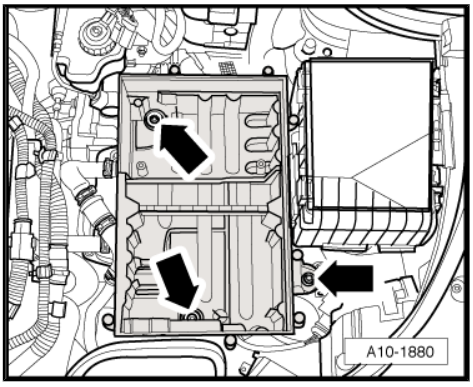
– Detach resonance pipe -2- from air intake hose.
– Disconnect air intake hose -1- from throttle valve module -J338- .
– Detach electrical connector -3- for air mass meter -G70- .
– Unscrew top section of air cleaner housing -arrow- and remove air filter element.



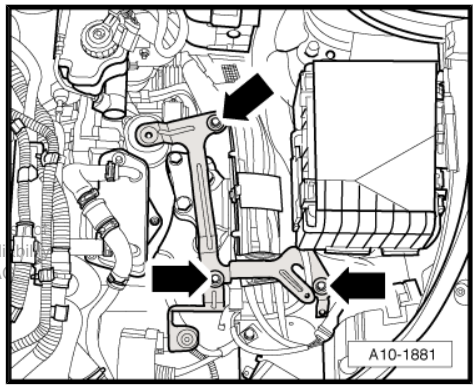
– Unscrew bolts -arrows- and remove air duct.



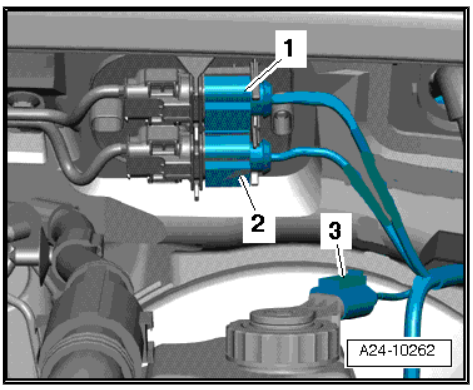
– Remove bottom section of air cleaner housing -arrows-.



– Unbolt bracket for air cleaner housing -arrows-.



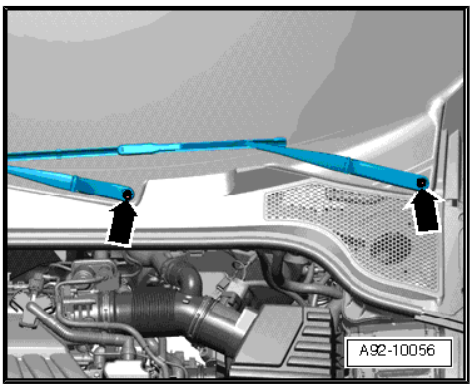
– Unplug electrical connector -1- for Lambda probe 2 -G108- and electrical connector -2- for Lambda probe -G39- .
– Unplug electrical connector -3- for brake fluid level warning contact -F34- .
– Move electrical wiring to Lambda probes clear.



– Pry off caps on windscreen wiper arms with a screwdriver.
– Loosen nuts -arrows- several turns.
– Release wiper arms one by one by tilting them slightly on the wiper shafts.
– Remove nuts and detach windscreen wiper arms.

Note

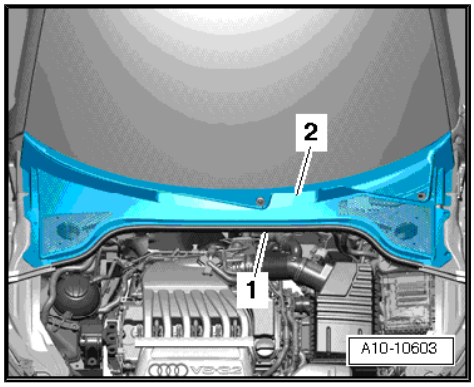
Use puller (commercially available) to remove wiper arm if necessary.



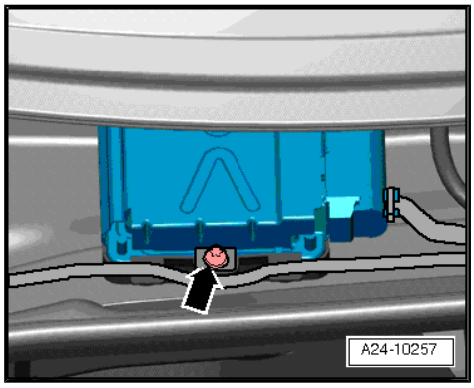
– Pull off rubber seal -1-

– Detach plenum chamber cover -2- by pulling it carefully off retainer at windscreen.

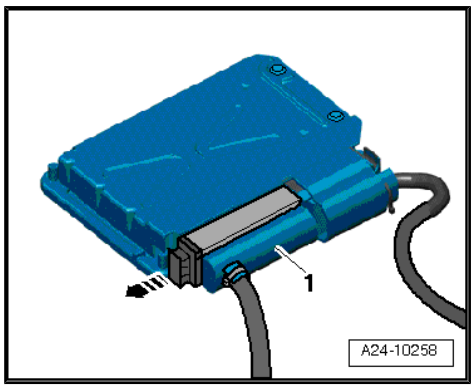
– Detach engine wiring harness (rear) at plenum chamber partition panel.



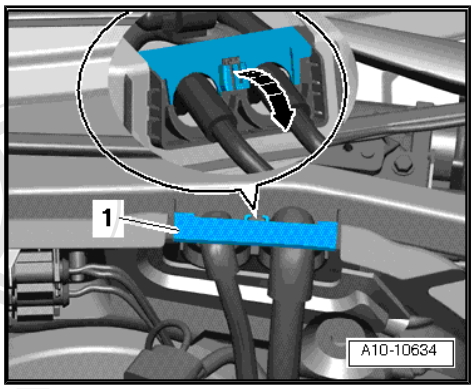
– Unscrew bolt -arrow- and detach engine control unit from retainer.



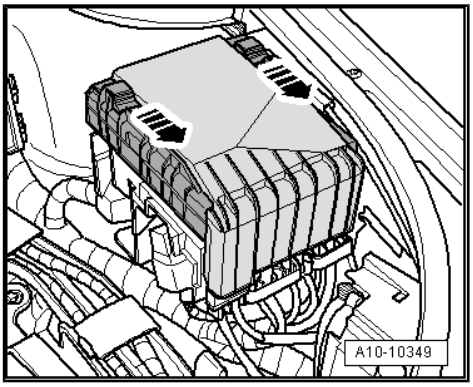
– Unplug electrical connector -arrow- for body wiring harness -1-.



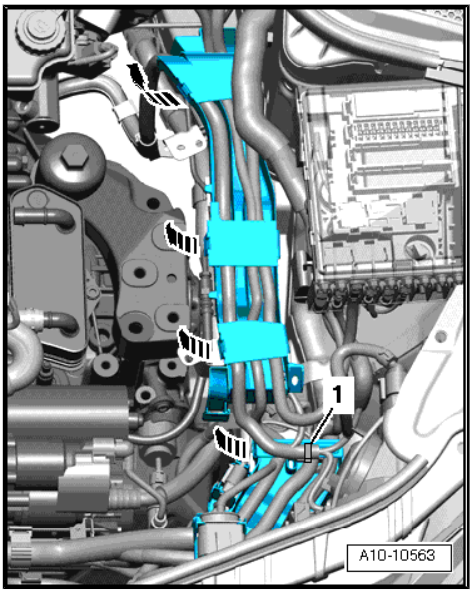
– Release wiring protector -1- for engine wiring harness -arrow- and lift off.



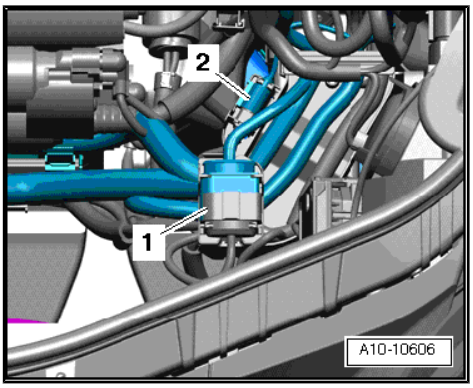
– Slide the two clips in the direction of the -arrows- and remove cover from electronics box in engine compartment.



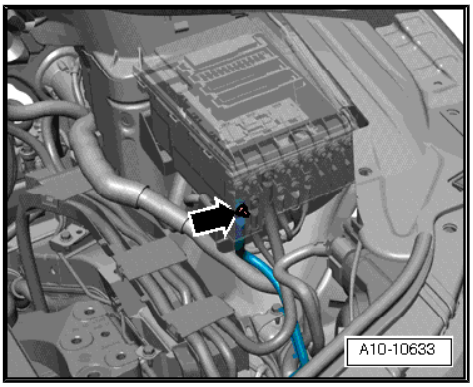
– Open wiring duct brackets -arrows-.
– Cut open cable tie -1-.



– Unclip electrical connector -1- from bracket and unplug.
– Open wiring duct bracket located underneath.
– Unclip wiring harness for engine control unit from wiring duct.
– Place engine wiring harness with engine control unit on top of engine.
– Secure engine control unit to prevent it falling.
– Unclip electrical connector -2- from bracket and unplug.

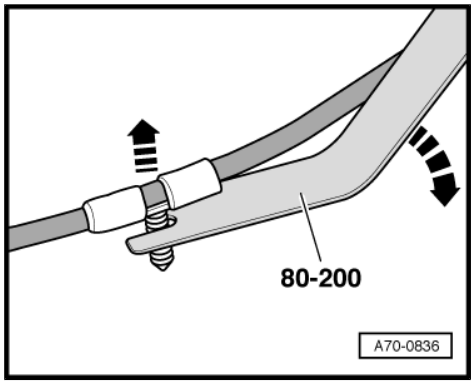


– Unscrew terminal 30 wire from electronics box in engine compartment -arrow- and move it clear.



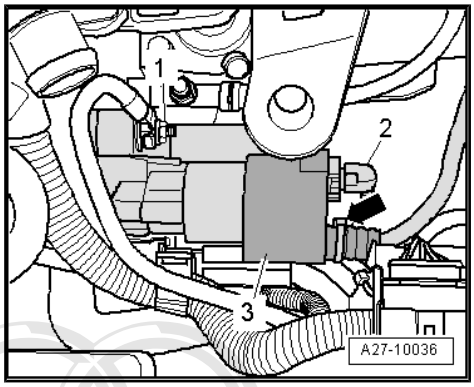
Note

Use removal lever -80 - 200- to lever out the wiring clips.

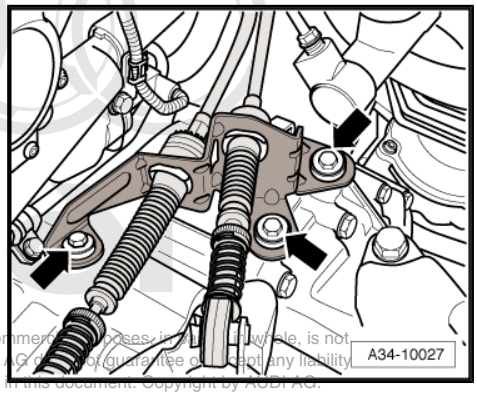


Vehicles with manual gearbox:

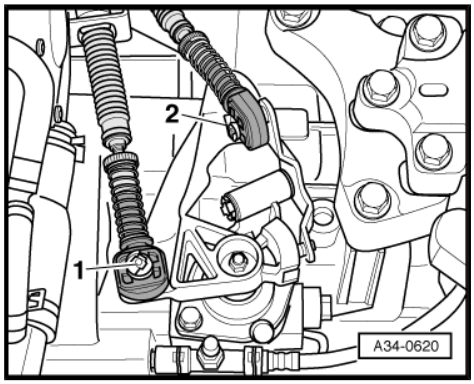
- Cut open cable tie -arrow- for protective cover -3-.
- Unplug electrical connector -2-.
- Push back protective cover and unscrew B+ cable at starter solenoid switch
- Unscrew earth wire -1-.
- Remove top starter bolt.



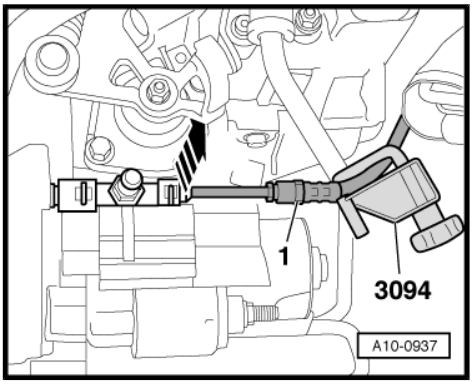
- Detach cable support bracket from gearbox -arrows-.



- Unclip circlip -1- from gear selector cable and circlip -2- from gate selector cable.
- Pull selector cable end-pieces with selector cables off selector shaft lever and relay lever.
- Tie selector cables with cable support bracket to one side.



– Clamp off pressure hose to clutch slave cylinder using a hose clamp -3094- .
– Pull securing clip upwards -arrow- and detach pipe/hose assembly -1- from bleeder connection on clutch slave cylinder.



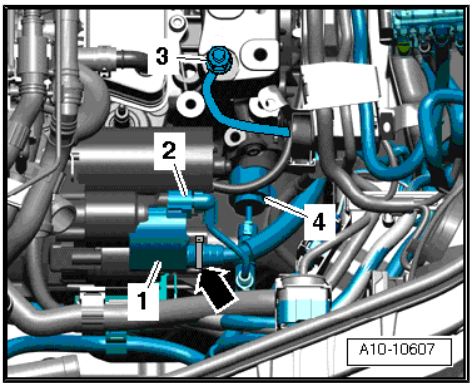
Caution

Risk of contamination by escaping brake fluid.

- *Do not operate clutch pedal after detaching pipe/hose assembly from bleeder connection on clutch slave cylinder.*

Vehicles with direct shift gearbox:

– Cut open cable tie -arrow- for protective cover -1-.
– Unplug electrical connector -2-.
– Push back protective cover and unscrew B+ cable at starter solenoid switch
– Unscrew earth wire -3-.



Caution

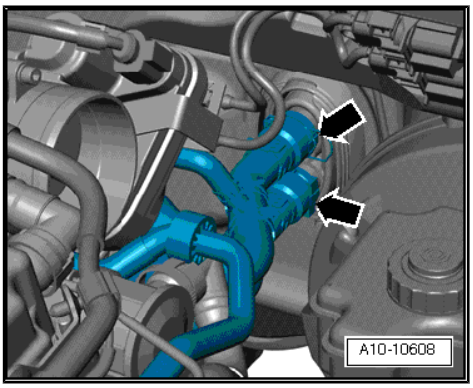
Risk of damage to control unit (mechatronic unit) by static discharge.

- *Do NOT touch connector contacts in gearbox connector with your hands.*

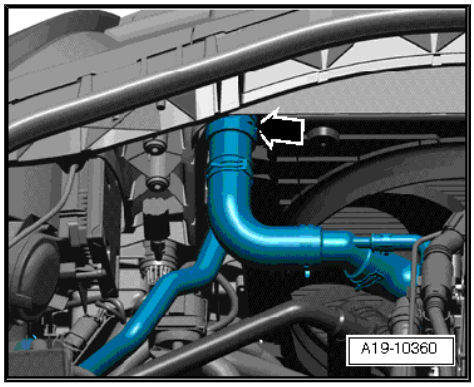
– Touch vehicle earth with bare hands to discharge any static charge.
– Turn retainer catch anti-clockwise and unplug electrical connector -4- at gearbox.

All vehicles (continued):

– Disconnect coolant hoses going to heat exchanger at bulkhead -arrows-.



– Detach coolant hose at top left of radiator -arrow-.

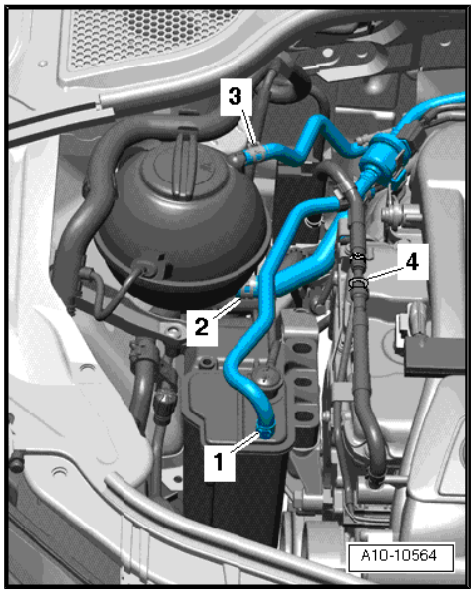


– On rest-of-world vehicles detach vacuum line -1- from activated charcoal filter in engine compartment and move clear.

WARNING

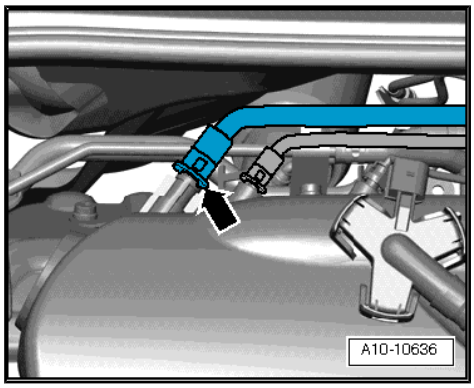
Risk of injury - fuel system operates under high pressure.

- ***To reduce the pressure in the fuel system, wrap a clean cloth around the connection and carefully loosen the connection.***



– Disconnect fuel supply hose -4- by pulling release ring.
– Move fuel supply hose clear.
– Detach coolant hoses -2- and -3-.

– Detach vacuum hose going to brake servo -arrow-.



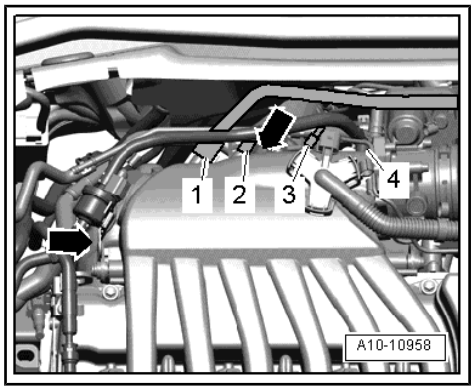
Vehicles with engine code letters CBRA:

– Detach vacuum hoses from intake manifold and move clear.

2 - To fuel system diagnostic pump -V144-

4 - To activated charcoal filter solenoid valve 1 -N80-

– Detach activated charcoal filter solenoid valve 1 -N80- from bracket and move it clear to the side.

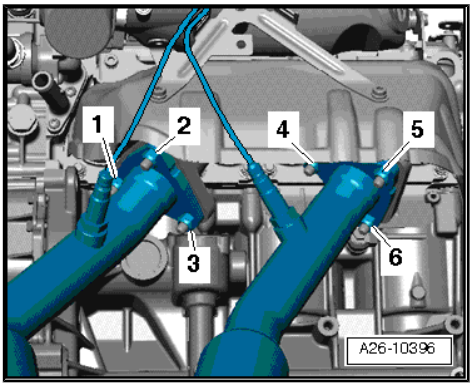


Note

Items -1, 3- and -arrows- can be disregarded.

All vehicles (continued):

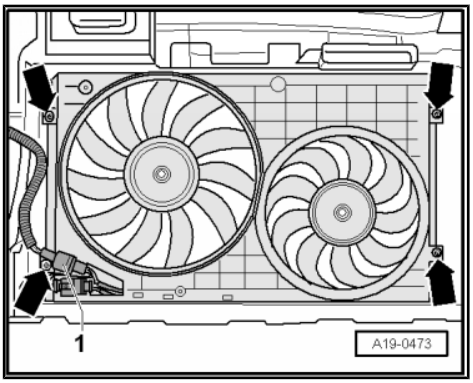
– Unscrew nuts -1- and -2- (accessible from above) securing front exhaust pipe to exhaust manifold.



Note

Nuts -3 ... 6- are removed at a later stage.

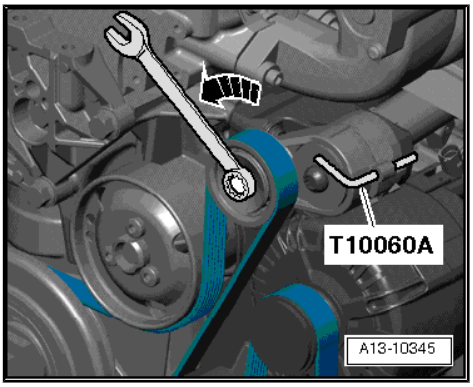
– Remove top bolts -upper arrows- for radiator cowl.



Caution

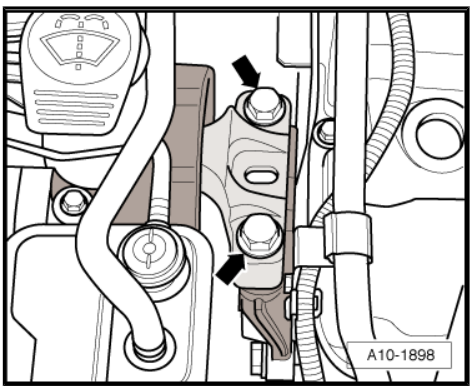
If a used belt runs in the opposite direction when it is refitted, this can cause breakage.

- ***Before removing, mark direction of rotation of poly V-belt with chalk or felt-tipped pen for re-installation.***

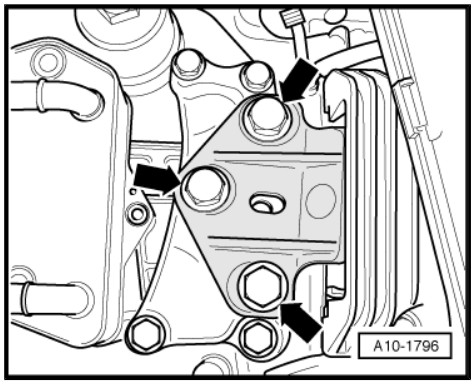


– To slacken poly V-belt turn tensioner in direction of -arrow-.
– Lock tensioner with locking pin -T10060 A-
– Take off poly V-belt.

– Loosen bolts of assembly mounting at engine -arrows- approx. 2 turns.



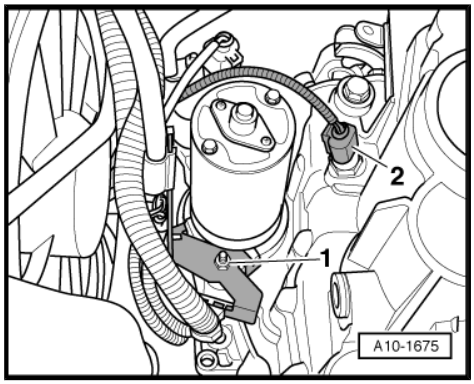
– Loosen bolts of assembly mounting at engine -arrows- approx. 2 turns.



Vehicles with manual gearbox:

– Unplug electrical connector -2- at reversing light switch -F4- .

– Remove nut -1- and remove bracket with wiring from bottom starter bolt.

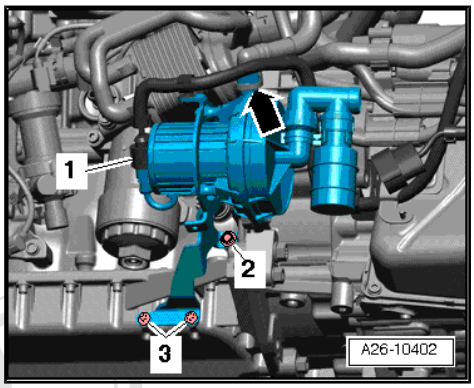


All vehicles (continued):

– Detach electrical connector -1- at secondary air pump motor -V101- and move wire clear.

Note

Disregard items marked -2, 3 and arrow-.

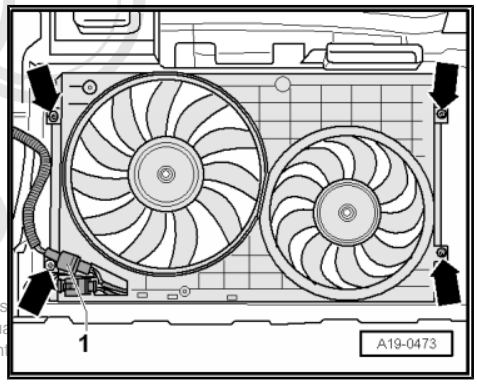


– Move coolant hose at bottom of radiator cowl clear.

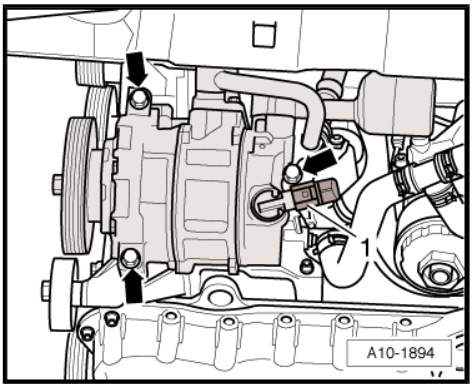
– Detach electrical connectors -1- for radiator fans at bottom of radiator cowl.

– Remove bolts -bottom arrows- at bottom of radiator cowl.

– Remove radiator cowl with both radiator fans from below.



– Unplug electrical connector -1- for magnetic clutch on air conditioner compressor.



WARNING

Risk of injury caused by refrigerant.

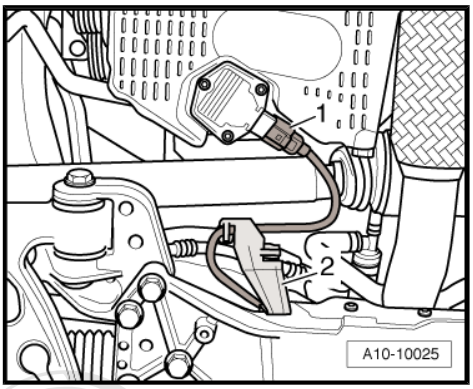
- *The air conditioner refrigerant circuit must not be opened.*

– Remove bolts -arrows- for air conditioner compressor.

– Tie up air conditioner compressor together with refrigerant hoses at front of longitudinal member (refrigerant hoses remain connected).

– Unplug electrical connector -1- at oil level and oil temperature sender -G266- .

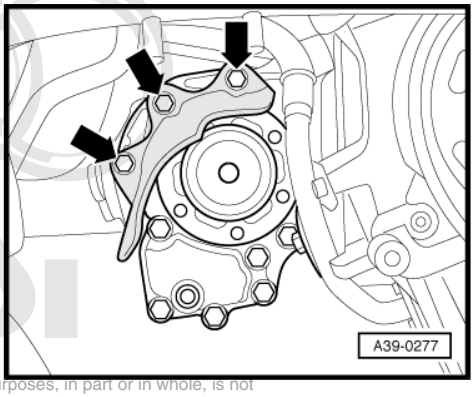
– Unclip bracket -2- for wire to oil level and oil temperature sender -G266- from subframe.



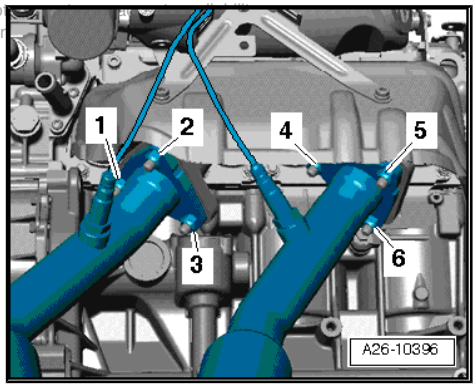
– Unbolt heat shield for drive shaft (right-side) from bevel box -arrows-.

– Remove drive shaft (right-side) ⇒ Rep. Gr. 40 .

– Detach drive shaft (left-side) from flange shaft of gearbox.



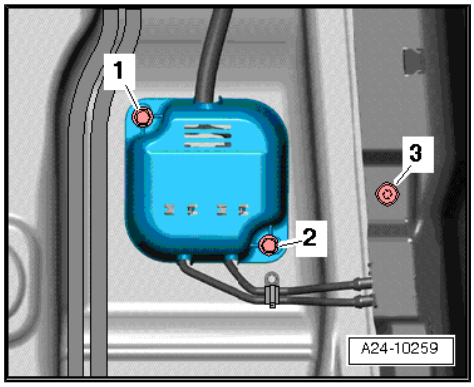
– Unscrew nuts -3 ... 6- securing front exhaust pipe to exhaust manifold.



Note

Nuts -1 and 2- have been removed at an earlier stage.

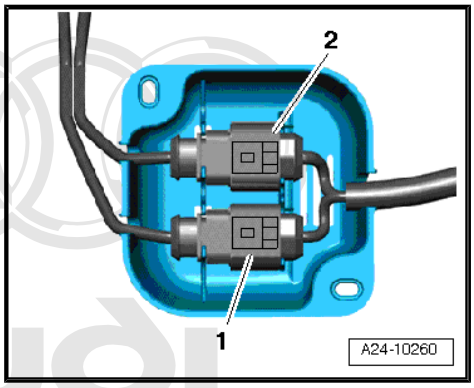
– Remove nuts -1- and -2- on underside of vehicle.
– Detach cover from bracket for electrical connectors for Lambda probes.
– Remove bolt -3- and move electrical wiring to Lambda probes clear.



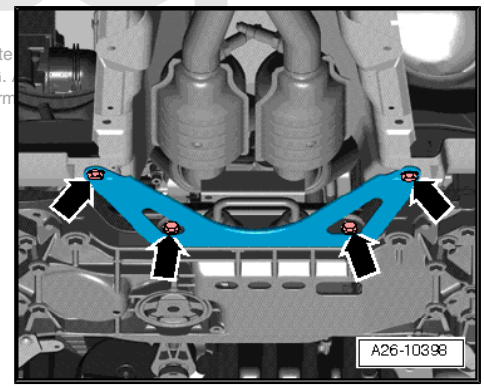
– Detach electrical connectors from bracket and unplug.

1 - For Lambda probe after catalytic converter -G130-

2 - For Lambda probe 2 -G131- (after catalytic converter)



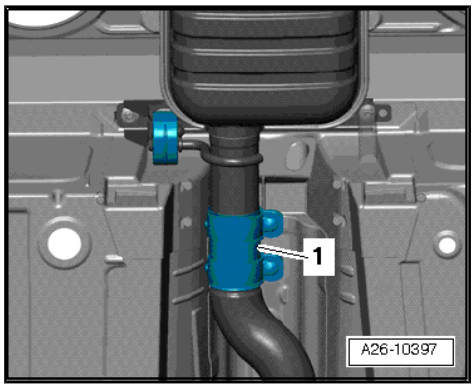
– Unbolt bracket for exhaust system -arrows-.



Caution

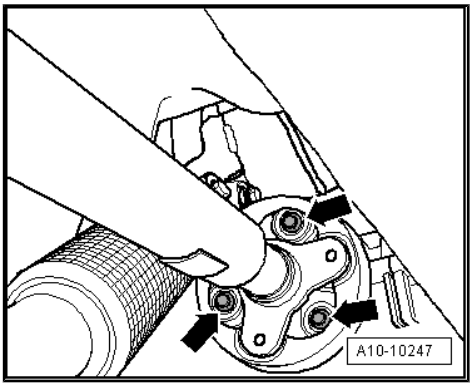
Avoid damage to flexible joints.

- *Do not bend flexible joints in front exhaust pipe more than 10°.*



– Disconnect exhaust system at clamp -1-.
– Detach front exhaust pipes with catalytic converters and front silencer.

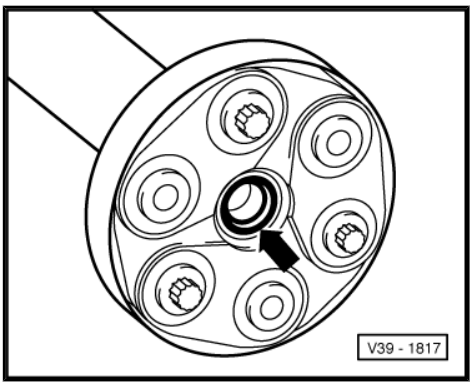
– Mark position of flexible coupling and flange for bevel box in relation to each other for re-installation.
– Unbolt flexible coupling for propshaft at bevel box -arrows- (counterhold using a suitable lever at the triangular flange).



Caution

Make sure not to damage the seal -arrow- in the propshaft flange.

- *Push the propshaft horizontally to the rear and towards the right side of vehicle as far as possible.*

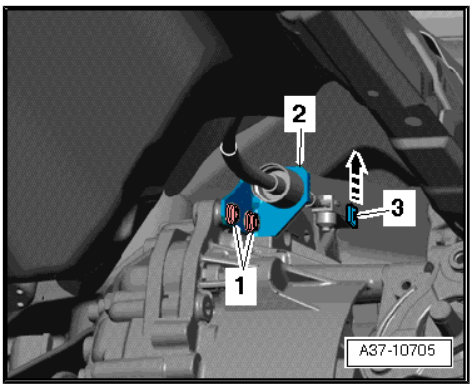


Vehicles with direct shift gearbox:

– Remove bolts -1- for support bracket.
– Pull off securing clip -3- -arrow- and remove selector lever cable from gearbox.

Note

Disregard item -2-.



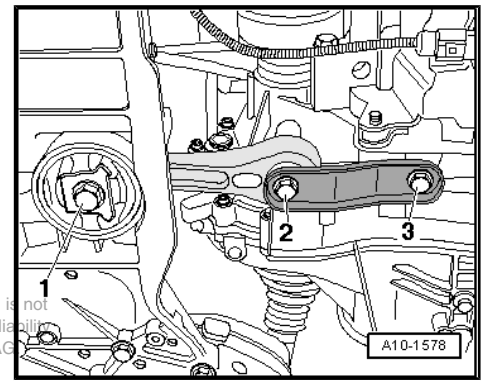
All vehicles (continued):

Caution

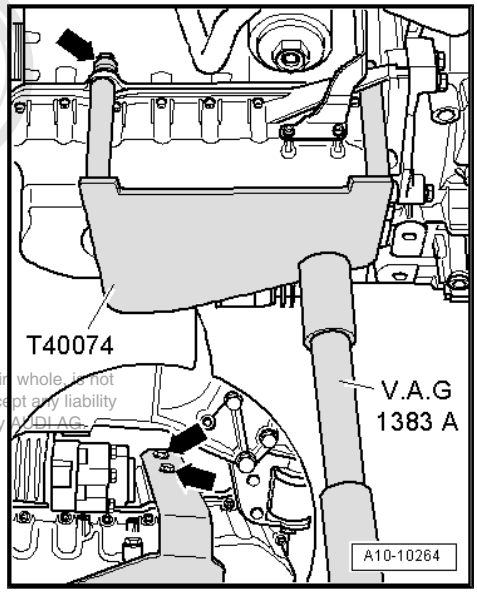
Make sure not to damage the seal in the propshaft flange.

- *When removing the bolts for the pendulum support/subframe, the engine/gearbox assembly swings slightly forward.*

– Remove bolts -1, 2, 3- and remove pendulum support.



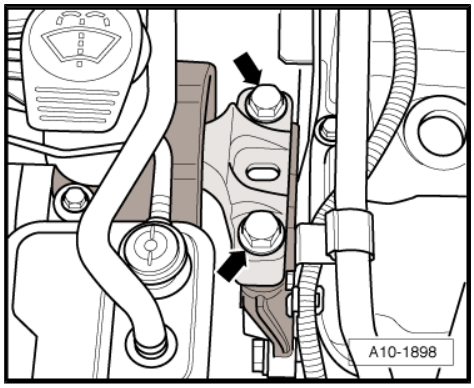
– Bolt engine support -T40074- with M12 nut (1x) and M10 bolts (2x) -arrows- to cylinder block (tightening torque: approx. 20 Nm).
– Insert engine and gearbox jack -V.A.G 1383 A- in engine support -T40074- and raise engine/gearbox assembly slightly.



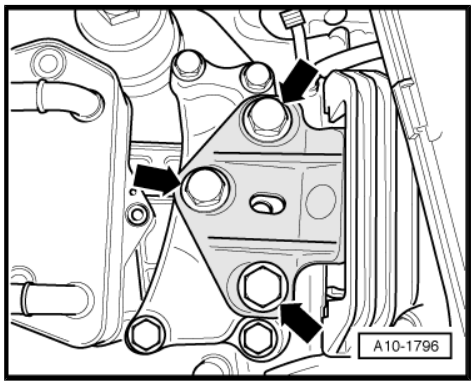
Note

To unscrew bolts for assembly mounting use stepladder -VAS 5085- .

– Remove bolts of assembly mounting at engine -arrows-.



– Remove bolts of assembly mounting at gearbox -arrows-.



Note

- *Check that all hoses, pipes and wiring connections between engine, gearbox and body have been detached.*
- *Carefully guide engine/gearbox assembly when lowering to avoid damage.*

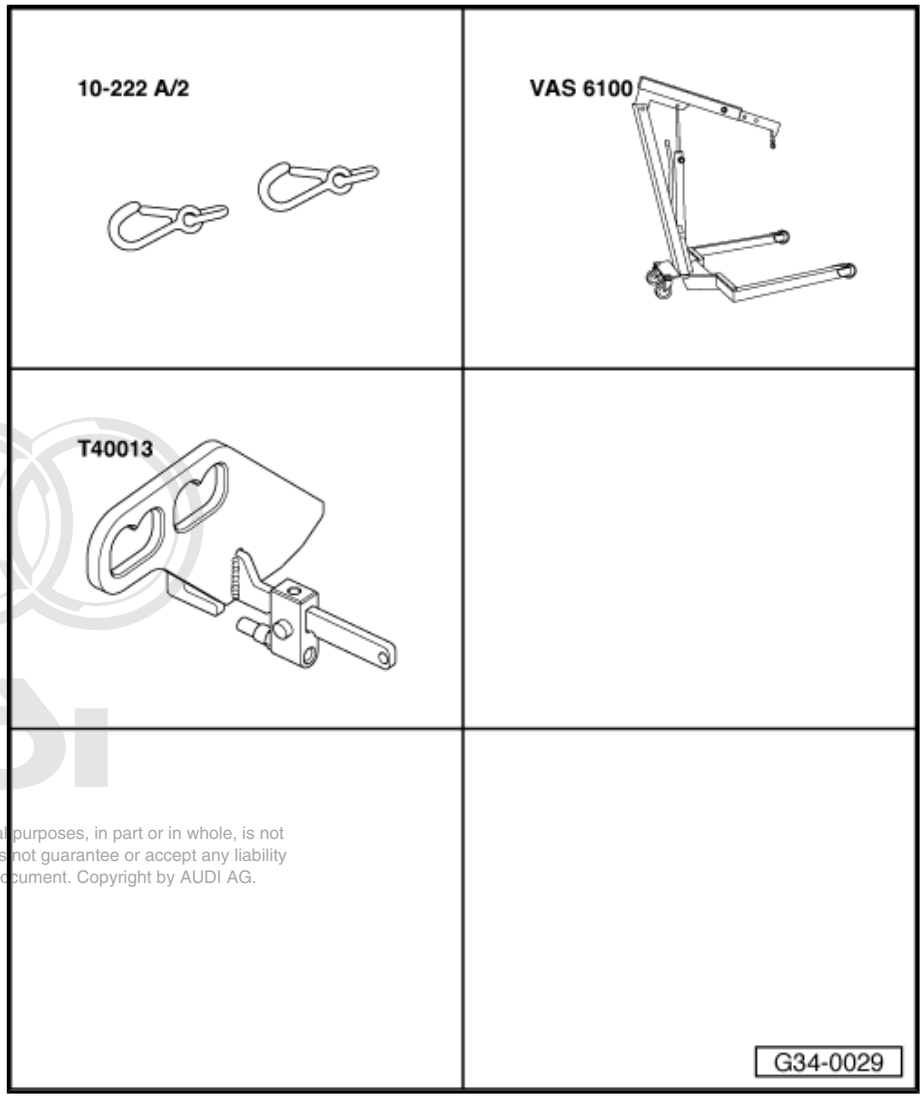
– Pull engine/gearbox assembly as far forward as possible, and lower gradually.

2 Separating engine and gearbox

2.1 Separating engine from manual gearbox

Special tools and workshop equipment required

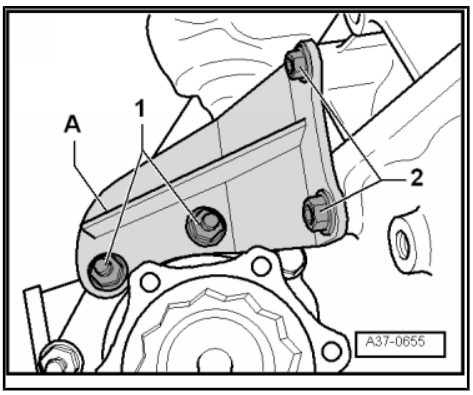
- Hooks -10 - 222 A /2-
- Workshop hoist - VAS 6100-
- Lifting tackle -T40013-



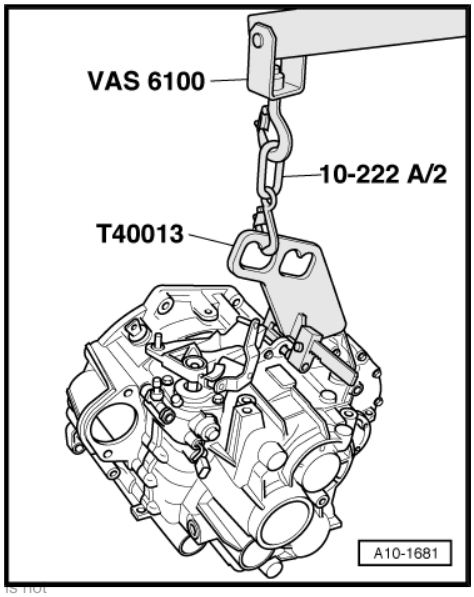
Procedure

- Engine/gearbox assembly removed and attached to engine support.

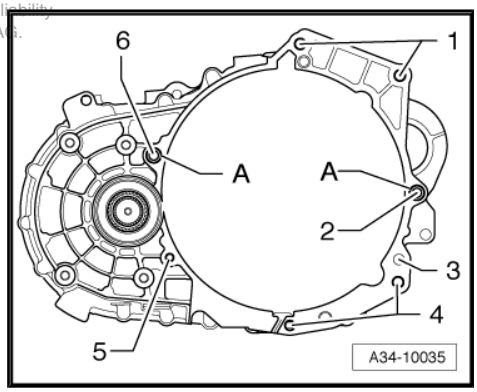
– Unscrew bolts -1- and -2- and remove bracket -A- for bevel box.



– Attach lifting tackle -T40013- to gearbox and close lock.
– Attach workshop hoist -VAS 6100- with hooks -10 - 222 A /2- to the lifting tackle.



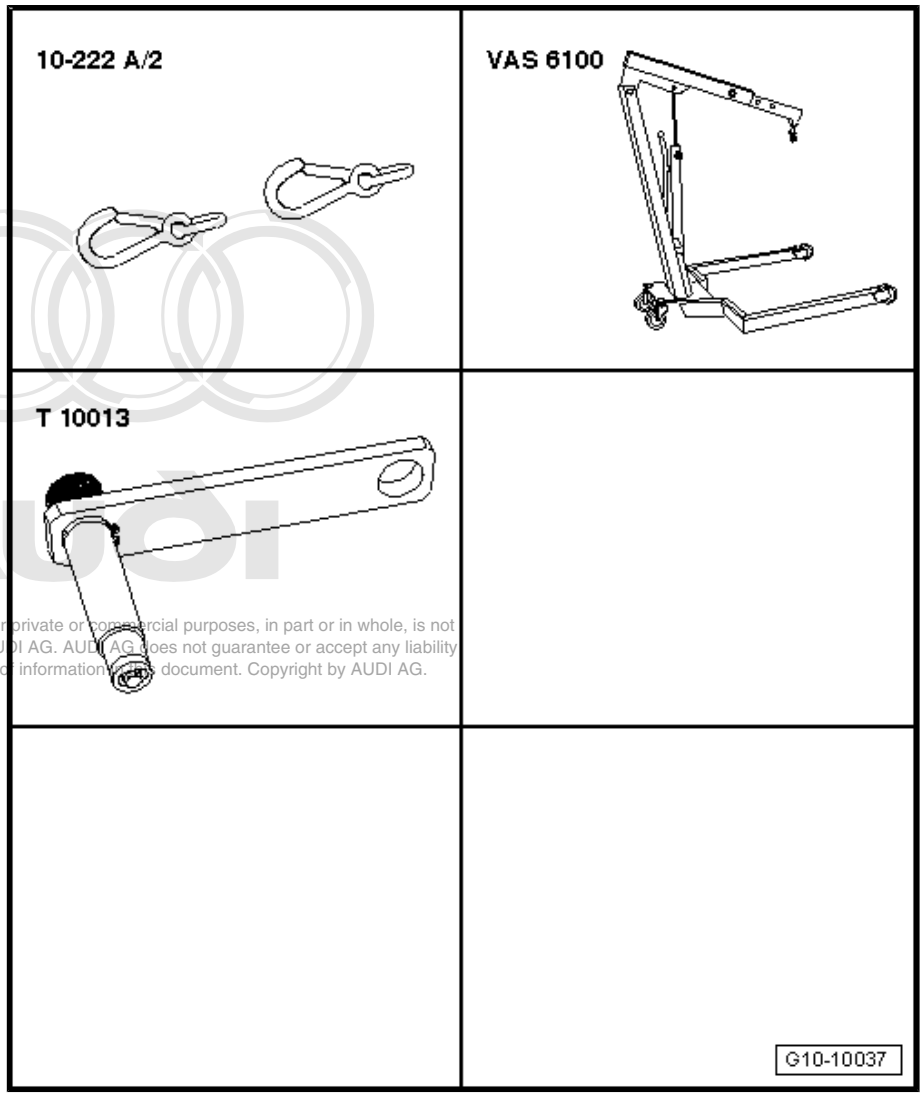
– Remove bolts -1 ... 6- on engine/gearbox flange.
– Detach gearbox from engine.



2.2 Separating engine from direct shift gearbox

Special tools and workshop equipment required

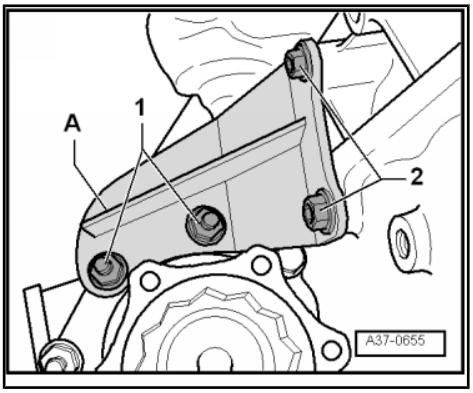
- Hooks -10 - 222 A /2-
- Workshop hoist - VAS 6100-
- Retainer -T10013-
- Bolt M8x40 with nut and washer (25 mm outer diameter)



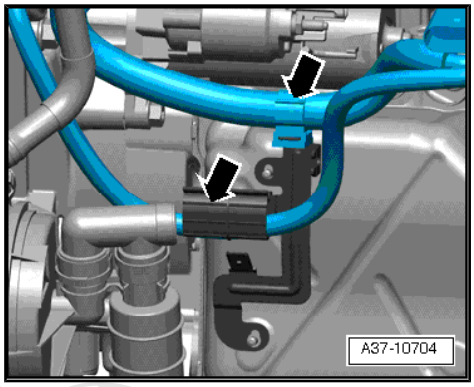
Procedure

- Engine/gearbox assembly removed and attached to engine support.

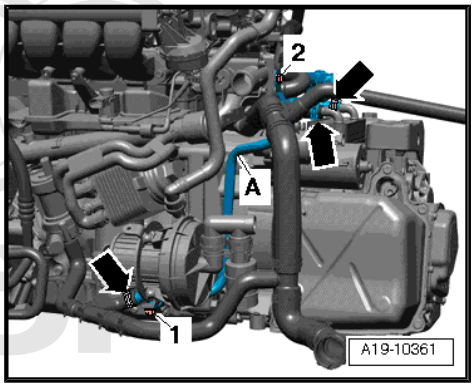
– Unscrew bolts -1- and -2- and remove bracket -A- for bevel box.



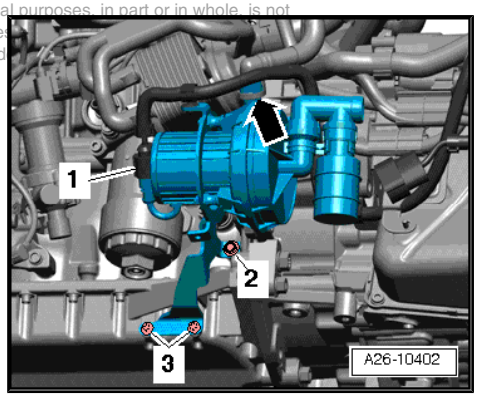
– Move electrical wiring clear -arrows-.



– Detach coolant hoses from gear oil cooler and from coolant pipe going to gear oil cooler -arrows-.
– Remove bolts -1- and -2- and take off coolant pipe -A-.



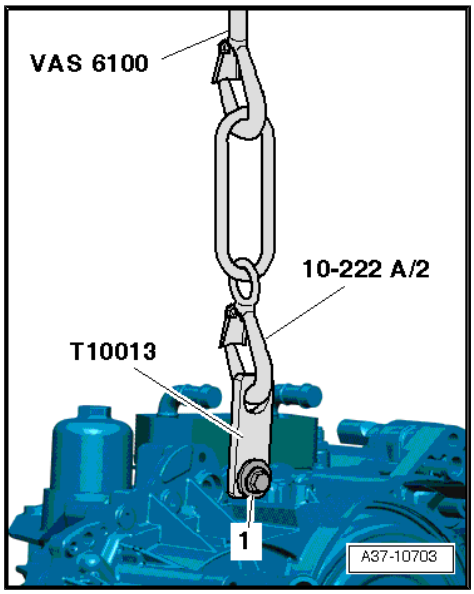
– Disconnect air hose -arrow-.
– Remove bolts -3-.
– Loosen bolt -2- and remove secondary air pump with bracket.



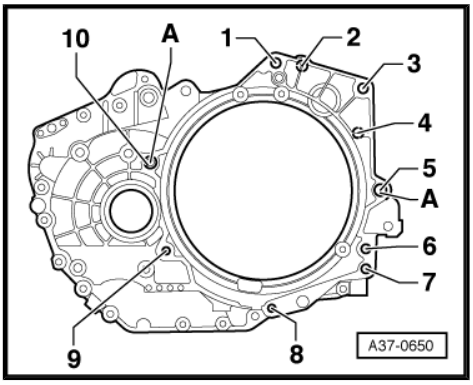
Note

Disregard item -1-.

– Remove threaded pin from retainer -T10013- (to do so, release circlip).
– Secure retainer -T10013- to gearbox lifting eye using bolt M8x40 with nut and washer (25 mm outer diameter).
– Attach workshop hoist -VAS 6100- with hook -10 - 222 A /2- to retainer -T10013- .



– Remove bolts -1, 3, 5, 6, 7, 8, 9, 10- securing gearbox to engine.



Note

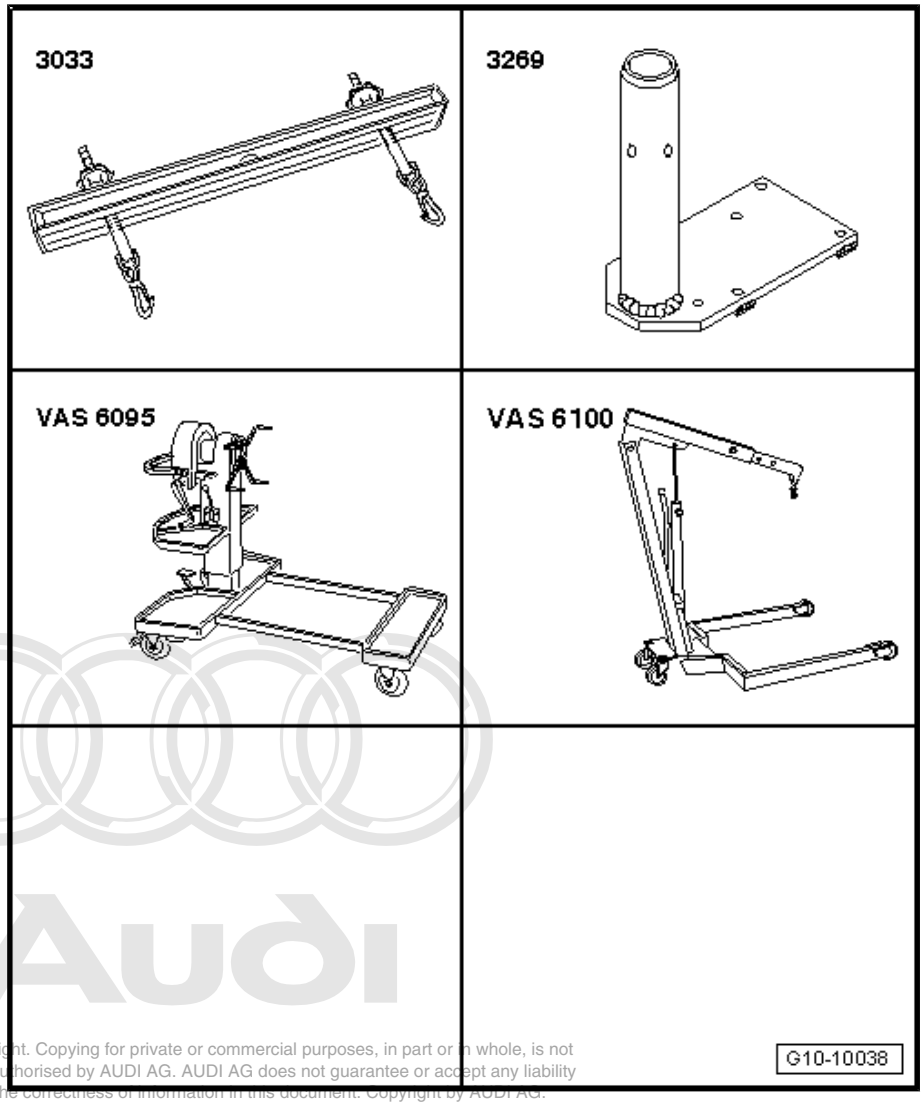
Disregard items marked -2, 4 and A-.

– Detach gearbox from engine.

3 Securing engine to engine and gearbox support

Special tools and workshop equipment required

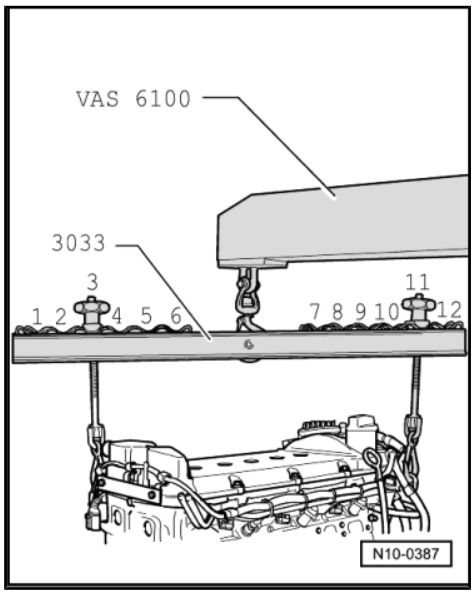
- Lifting tackle -3033-
- Engine bracket -3269-
- Engine and gearbox support -VAS 6095-
- Workshop hoist - VAS 6100-



Procedure

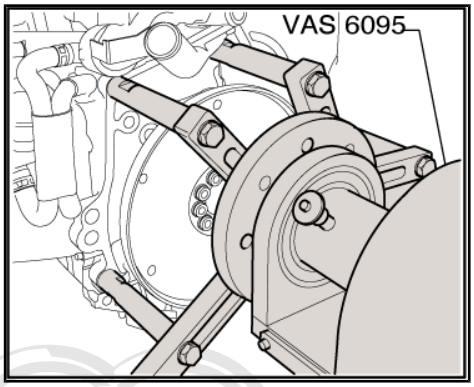
– Attach lifting tackle -3033- to engine and workshop hoist -VAS 6100- as shown in illustration.

– Lift engine off engine support -T40074- using workshop hoist -VAS 6100- .



Securing engine at gearbox end

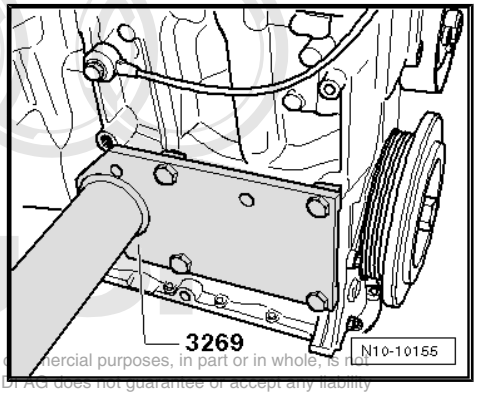
– Secure engine and gearbox support -VAS 6095- to gearbox end of cylinder block as shown in illustration.



Securing engine at side

– Secure engine bracket -3269- to side of cylinder block as shown in illustration.

– Secure engine to engine and gearbox support -VAS 6095- using engine bracket -3269- .



4 Installing engine

Tightening torques

Note

- *Tightening torques apply only to lightly greased, oiled, phosphated or black-finished nuts and bolts.*
- *Additional lubricants such as engine or gearbox oil may be used, but do not use lubricants containing graphite.*
- *Do not use degreased parts.*
- *Tolerance for tightening torques ± 15%.*

Tightening torques ⇒ page 39

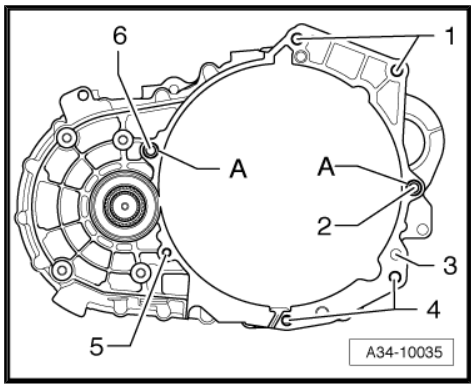
Further tightening torques

Component		Nm
Bolts/nuts	M6	10
	M7	15
	M8	22
	M10	40
	M12	65
Except for the following:		
Earth cable		22

Securing manual gearbox to engine

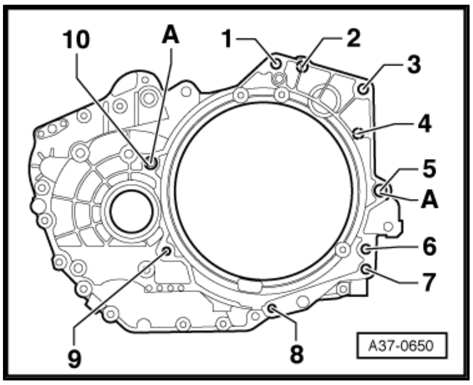
Item	Bolt	Nm
1 [1], 3	M12x55	80
2 [2]	M12x65	80
4, 5 [2]	M10x50	40
6 [2]	M12x80	80
A	Dowel sleeves for centralising	

- [1] Bolt with M8 stud
- [2] Screwed into gearbox from engine side.



Securing direct shift gearbox to engine

Item	Bolt	Nm
1, 3, 6	M12x55	80
5	M12x65	80
7, 8	M10x50	40
9	M10x45	40
10	M12x70	80
A	Dowel sleeves for centralising	



Note

Disregard items marked -2 and 4-.

Procedure

Installation is carried out in the reverse order; note the following:

Note

- ♦ *Renew self-locking nuts and bolts.*
- ♦ *Renew bolts which are tightened to a specified angle as well as oil seals and gaskets.*
- ♦ *Secure all hose connections with the correct type of hose clips (same as original equipment) ⇒ Electronic parts catalogue .*
- ♦ *Fit cable ties in the original positions when installing.*

– If not already fitted, install dowel sleeves for centring engine and gearbox in cylinder block.

Vehicles with manual gearbox:

– Remove needle bearing in crankshaft if fitted ⇒ page 57 .

– Renew clutch release bearing if worn ⇒ Rep. Gr. 30 .

– Lubricate splines of gearbox input shaft lightly with grease for clutch plate splines ⇒ Electronic parts catalogue .

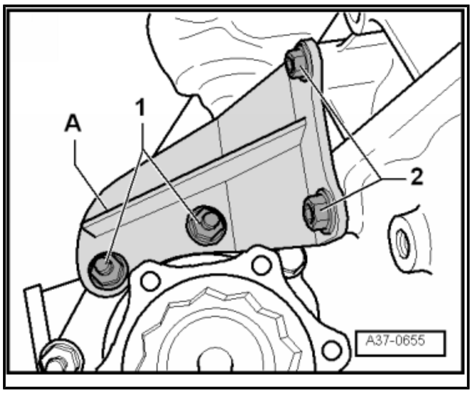
– Make sure that clutch plate is properly centred.

Vehicles with direct shift gearbox:

– Install needle bearing if not fitted in crankshaft ⇒ page 57 .

All vehicles (continued):

– Secure gearbox to engine.



– Secure bracket -A- for bevel box ⇒ Rear final drive 02D/0AV; Rep. Gr. 39 .

Vehicles with direct shift gearbox:

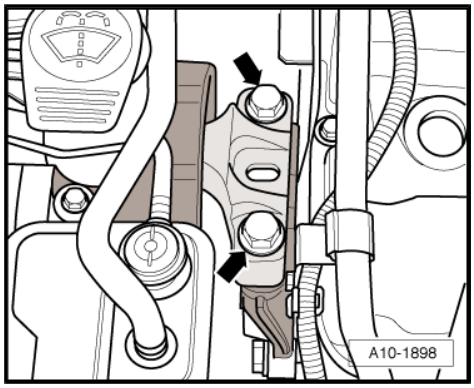
– Install secondary air pump ⇒ page 194 .

– Install coolant pipe going to gear oil cooler ⇒ page 164 .

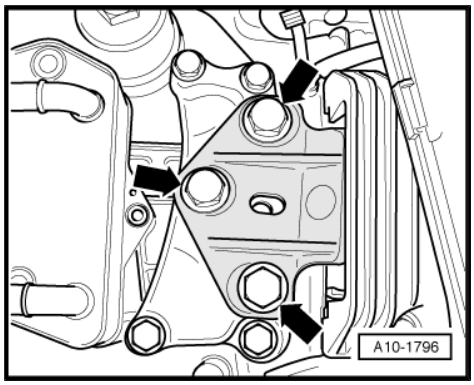
All vehicles (continued):

– Guide engine/gearbox assembly into body.

– Tighten bolts securing engine mounting to engine support -arrows- initially hand-tight.



– Tighten bolts securing gearbox mounting to gearbox support -arrows- initially hand-tight.



Note

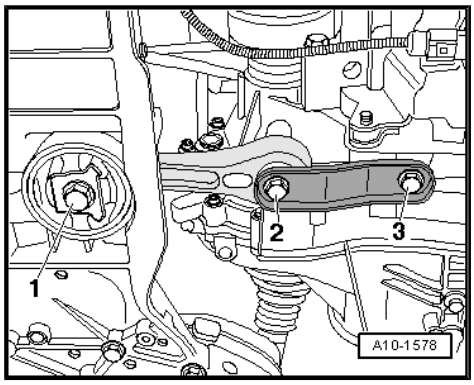
The bolts are tightened to final torque only after adjusting the assembly mountings ⇒ page 39 .

– Remove engine support -T40074- from engine.

– Bolt pendulum support to gearbox ⇒ page 39 .

Vehicles with direct shift gearbox:

– Install selector lever cable ⇒ Rep. Gr. 34 .

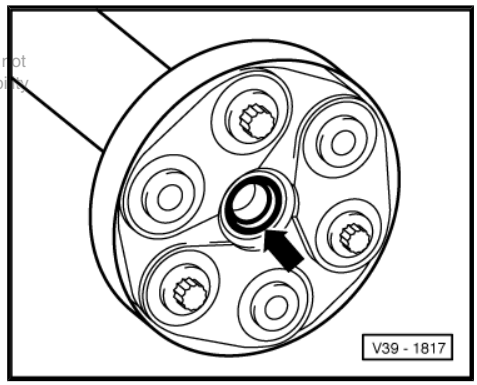


All vehicles (continued):

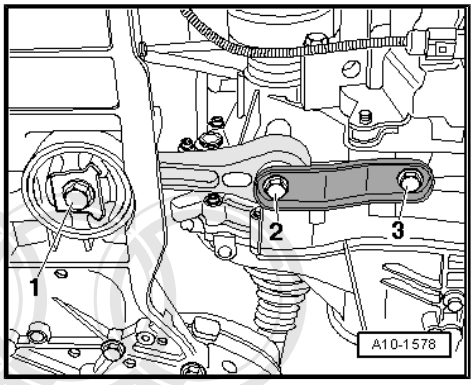
Caution

Make sure not to damage the seal -arrow- in the propshaft flange.

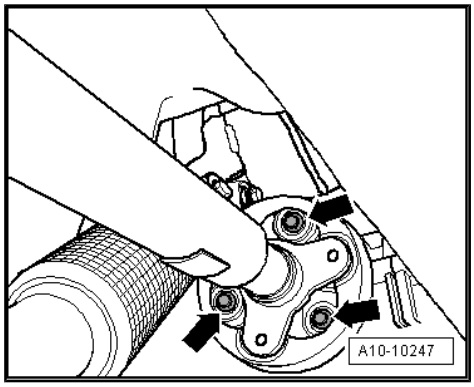
- ***Push engine/gearbox assembly towards bulkhead, guiding pin on bevel box flange carefully into propshaft flange.***



– Bolt pendulum support to subframe ⇒ page 39 .



– Secure propshaft with flexible coupling to bevel box -arrows- ⇒ Rear final drive 02D/0AV; Rep. Gr. 39 .



Remaining installation steps are carried out in reverse sequence; note the following:

– Install front exhaust pipe ⇒ page 177 .
– Install exhaust system and align free of stress ⇒ page 179 .
– Install drive shafts ⇒ Rep. Gr. 40 .
– Install heat shield for drive shaft ⇒ Rep. Gr. 39 .
– Attach electrical connector to starter ⇒ Rep. Gr. 27 .

Vehicles with manual gearbox:

– Installing and adjusting selector mechanism ⇒ Rep. Gr. 34 .

Caution

Risk of contamination by escaping brake fluid.

- ***Do not operate clutch pedal before attaching pipe/hose assembly to bleeder connection on clutch slave cylinder.***

– Connect pipe/hose assembly to bleeder connection on clutch slave cylinder and bleed clutch system ⇒ Rep. Gr. 30 .

All vehicles (continued):

– Install air conditioner compressor ⇒ Rep. Gr. 87 .
– Install radiator cowl ⇒ page 172 .
– Install poly V-belt ⇒ page 48 .
– Adjust assembly mountings ⇒ page 39 .
– Install wiper arms ⇒ Rep. Gr. 92 .
– Electrical connections and routing ⇒ Current flow diagrams, Electrical fault finding and Fitting locations.
– Observe notes on procedure for connecting the battery ⇒ Rep. Gr. 27 .
– Check oil level ⇒ page 141 .

Caution

Risk of damage to control units because of excessive voltage.

- ***Never use battery charging equipment for boost starting.***

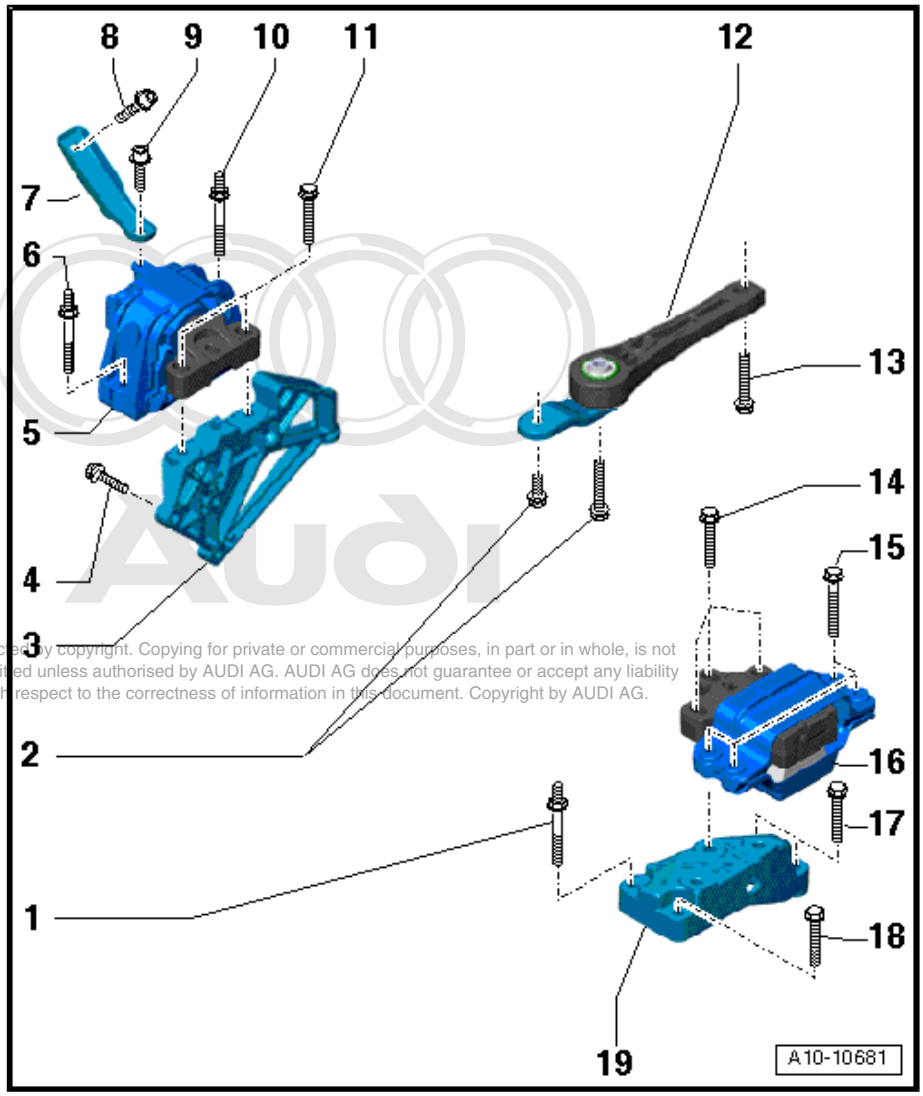
– Fill up with coolant ⇒ page 147 .

Note

- *Do not use drained coolant again if:*
- *the cylinder head or cylinder block have been renewed.*
- *the coolant is contaminated or dirty.*

5 Assembly mountings

5.1 Assembly mountings - exploded view



1 - Bolt
- ❑ Gearbox support to gearbox
- ❑ Tightening torque ⇒ Rep. Gr. 34

2 - Bolts
- ❑ Pendulum support to gearbox
- ❑ Renew
- ❑ 40 Nm + 90° (1/4 turn further)

3 - Engine support

4 - Bolt
- ❑ Engine support to engine
- ❑ 45 Nm

5 - Engine mounting
- ❑ With support arm

6 - Bolt
- ❑ Engine mounting to body
- ❑ Renew
- ❑ 40 Nm + 90° (1/4 turn further)

7 - Connecting bracket

8 - Bolt
- ❑ Connecting bracket to engine mounting
- ❑ Renew
- ❑ 20 Nm + 90° (1/4 turn further)

9 - Bolt
- ❑ Connecting bracket to body
- ❑ Renew
- ❑ 20 Nm + 90° (1/4 turn further)

10 - Bolt
- ❑ Engine mounting to body
- ❑ Renew
- ❑ 40 Nm + 90° (1/4 turn further)

11 - Bolts
- ❑ Engine mounting to engine support
- ❑ Renew
- ❑ 60 Nm + 90° (1/4 turn further)

12 - Pendulum support

13 - Bolt

- ❑ Pendulum support to subframe
- ❑ Renew
- ❑ 100 Nm + 90° ($^1/_4$ turn further)

14 - Bolt

- ❑ Gearbox mounting to gearbox support
- ❑ Tightening torque ⇒ Rep. Gr. 34

15 - Bolt

- ❑ Gearbox mounting to body
- ❑ Tightening torque ⇒ Rep. Gr. 34

16 - Gearbox mounting

- ❑ With support arm
- ❑ Illustration shows version for direct shift gearbox

17 - Bolt

- ❑ Gearbox support to gearbox
- ❑ Tightening torque ⇒ Rep. Gr. 34

18 - Bolt

- ❑ Gearbox support to gearbox
- ❑ Tightening torque ⇒ Rep. Gr. 34

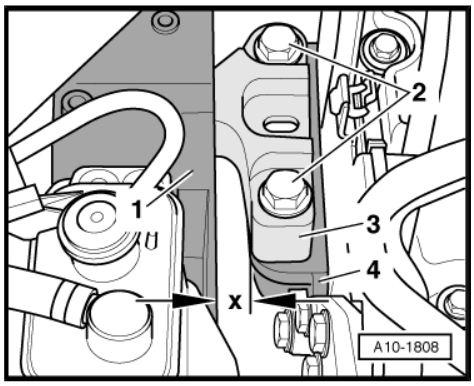
19 - Gearbox support

5.2 Checking adjustment of assembly mountings (engine/gearbox mountings)

Procedure

– Check distances at mounting (right-side) for engine and gearbox:

- The two bolt heads -2- must be parallel with edge of support arm -3- for engine mounting.
- There must be a distance of -x- = 16 mm between engine mounting -1- and engine support -4-.



Note

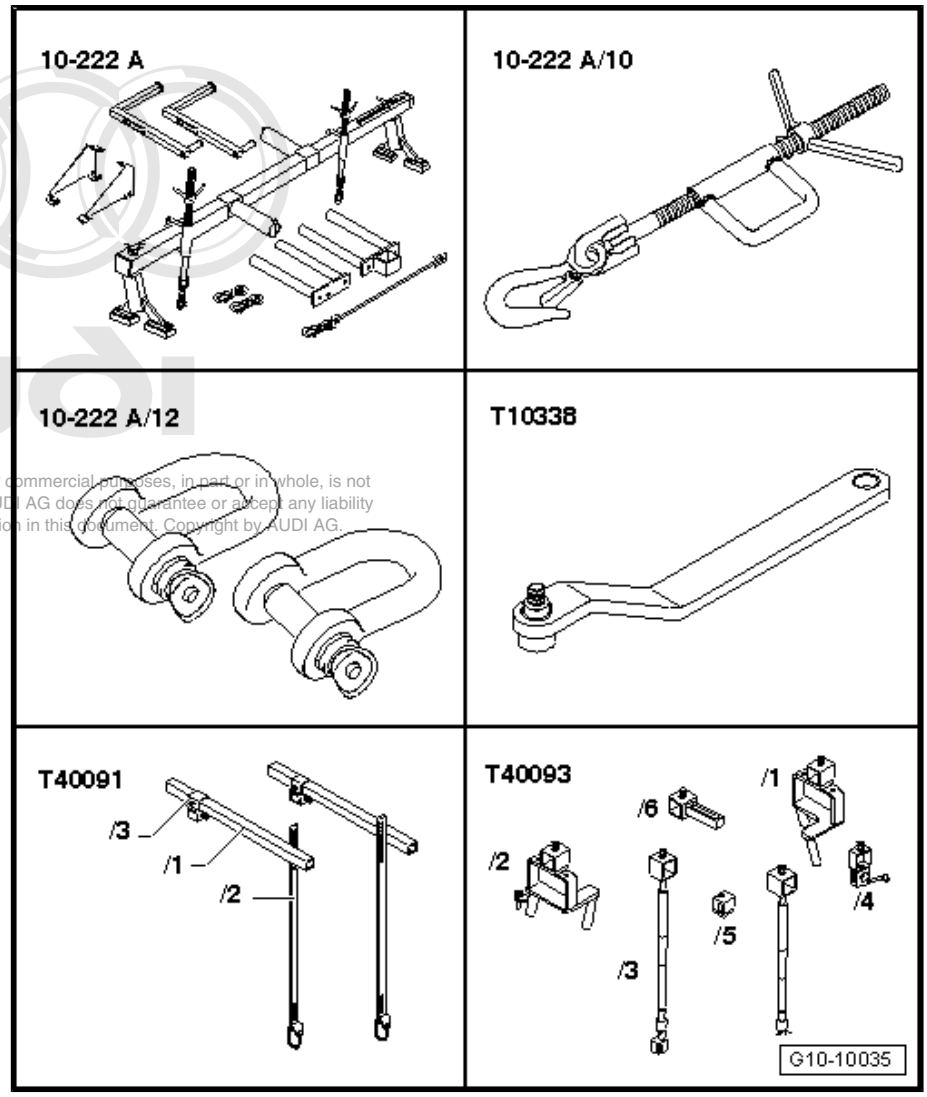
Distance -x- = 16 mm can also be checked with a metal rod of suitable size, or similar.

– If the distance measured is too large or small, the assembly mountings must be adjusted ⇒ page 41 .

5.3 Adjusting assembly mountings

Special tools and workshop equipment required

- Support bracket -10 - 222 A-
- Hook -10 - 222 A /10-
- Shackle -10 - 222 A /12-
- Bracket -T10338-
- Engine support bracket (basic set) -T40091-
- Engine support bracket (supplementary set) - T40093- with -T40093/3-2- and -T40093/3-3-

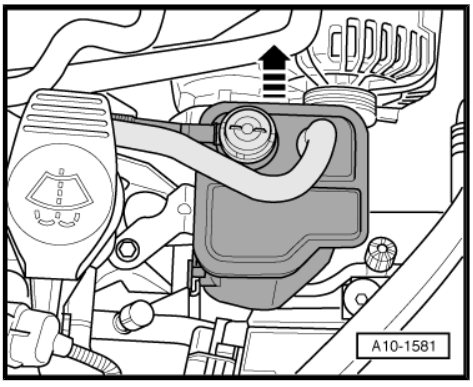


Adjusting

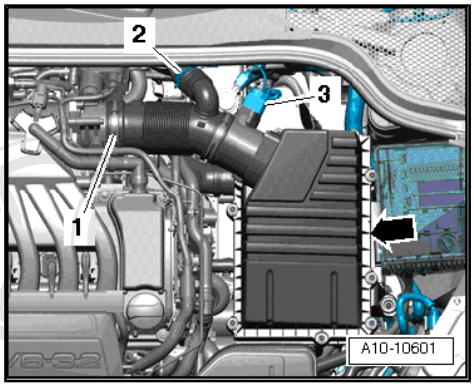
- Tightening torques ⇒ page 39

– On rest-of-world vehicles pull activated charcoal filter with hoses attached upwards out of bracket -arrow- in engine compartment and place to one side.

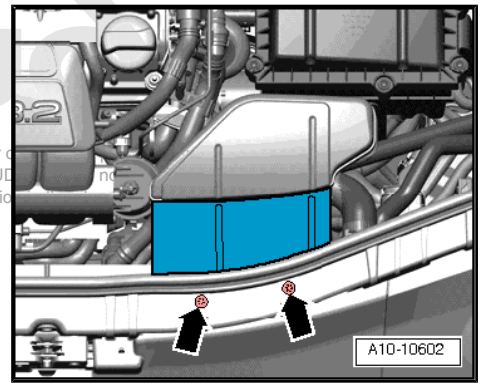
– Remove bracket for activated charcoal filter.



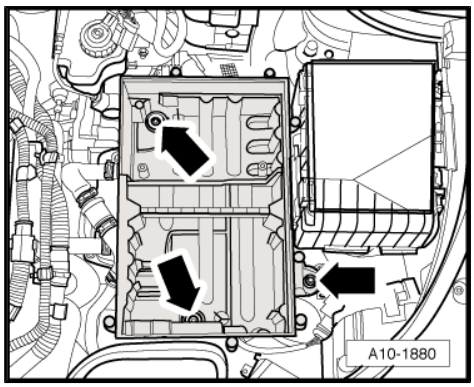
– Detach resonance pipe -2- from air intake hose.
– Disconnect air intake hose -1- from throttle valve module -J338- .
– Detach electrical connector -3- for air mass meter -G70- .
– Unscrew top section of air cleaner housing -arrow- and remove air filter element.



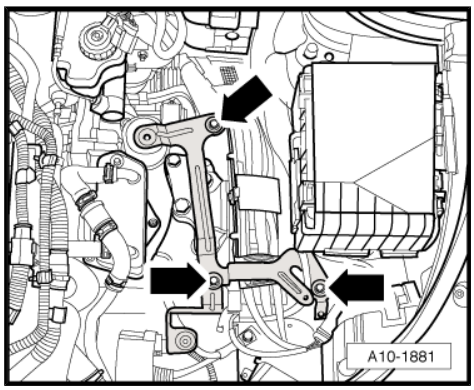
– Unscrew bolts -arrows- and remove air duct.



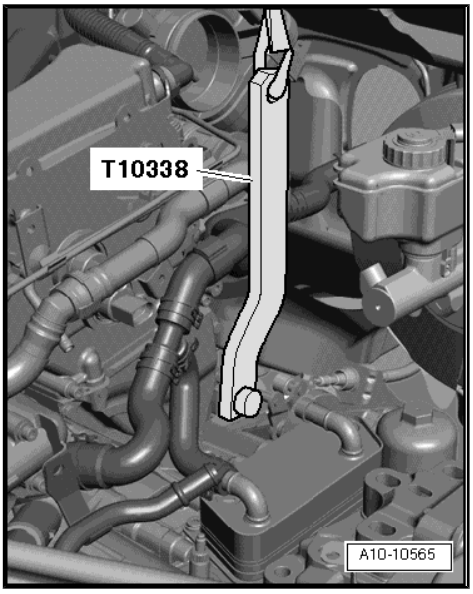
– Remove bottom section of air cleaner housing -arrows-.



– Unbolt bracket for air cleaner housing -arrows-.



– Secure bracket -T10338- to tapped hole at rear left of engine.



– Position support bracket -10 - 222 A- on top of body flanges using the following tools:

♦ 2x Rack -10 - 222 A /1-

♦ Hook -10 - 222 A /10- (spindle faces rear)

♦ Spindle -10 - 222 A /11- (spindle faces front)

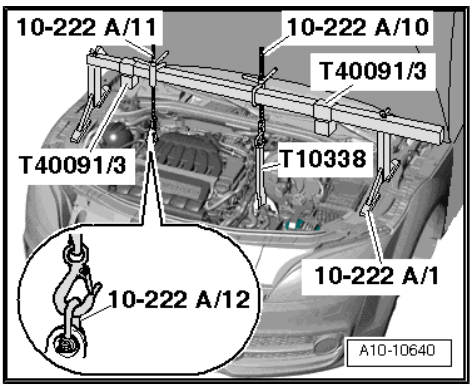
♦ Shackle -10 - 222 A /12-

♦ Connecting piece (2x) -T40091/3-

– Hook spindle -10 - 222 A /11- with shackle -10 - 222 A /12- onto right-side engine lifting eye.

– Engage hook -10 - 222 A /10- in bracket -T10338- .

– Tighten spindles slightly to take up weight of engine/gearbox assembly.

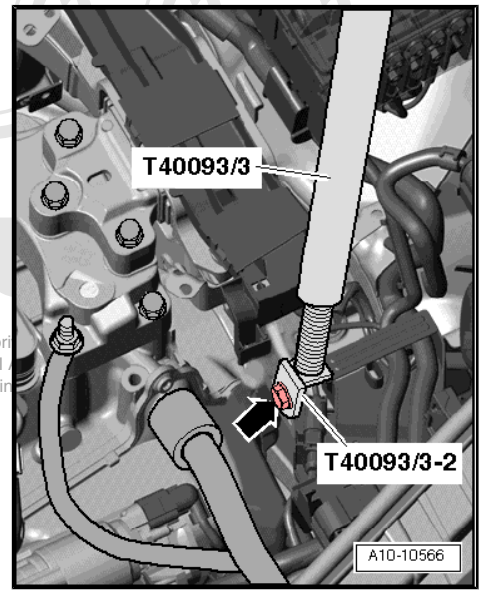


– Fit adapter -T40093/3-2- (left-side) and -T40093/3-3- (right-side) to supports -T40093/3- .

– Unbolt earth wire from longitudinal member (left-side).

– Remove connecting bolt for front section of longitudinal member on left and right.

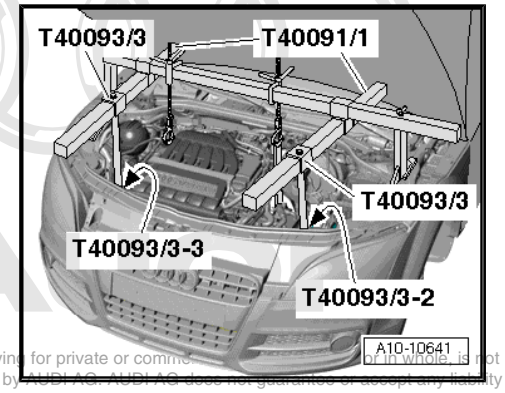
– Secure adapters to longitudinal members using one M8x30 bolt on each side -arrow-.



Note

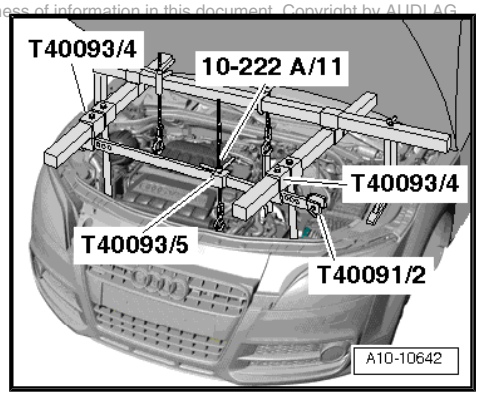
The illustration shows the left side of the vehicle.

– Insert square-section pipes -T40091/1- in connecting pieces -T40091/3- and supports -T40093/3- as shown in illustration.



– Slide connecting pieces -T40093/4- onto square-section pipes.

– Push support -T40091/2- with sliding support -T40093/5- into the two connecting pieces -T40093/4- .



WARNING

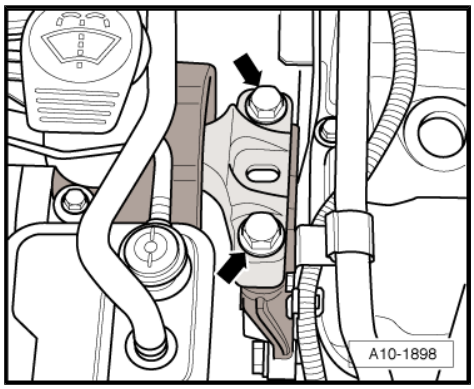
Accident risk from loose components of support bracket.

- ***Secure support -T40091/2- with pins and split pins of connecting pieces -T40093/4- .***
- ***Secure connecting pieces and supports with clamping bolts.***

– Fit spindle -10 - 222 A /11- onto sliding support and onto engine lifting eye.

– Take up weight of engine/gearbox assembly by evenly tightening three spindles.

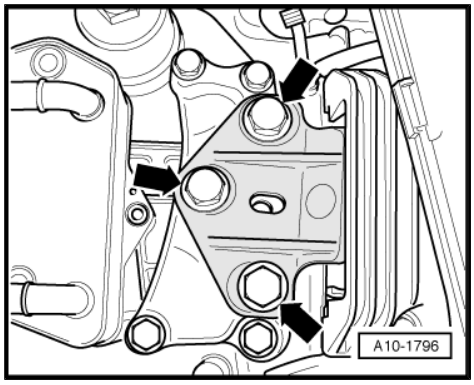
– Remove bolts of assembly mounting at engine -arrows-.



– Remove bolts of assembly mounting at gearbox -arrows-.

– Renew each of the 5 bolts in turn (if not already done when installing engine) and hand-tighten.

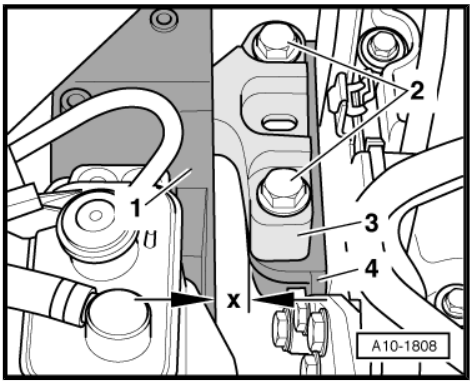
– Slacken bolts on left and right-hand support arms by about two turns each.



– Using a tyre iron, adjust engine/gearbox assembly between engine mounting -1- and engine support -4- until the specifications listed below are obtained:

• The two bolt heads -2- must be parallel with the edge of the support arm -3-.

• There must be a distance of -x- = 16 mm between engine mounting -1- and engine support -4-.



Note

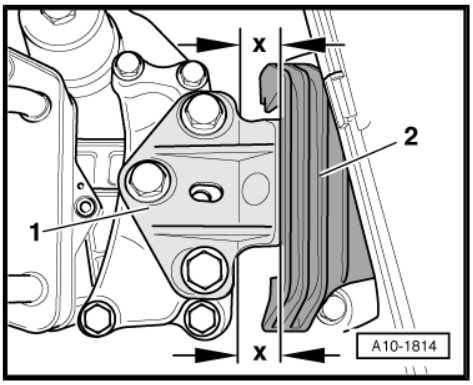
Distance -x- = 16 mm can also be checked with a metal rod of suitable size, or similar.

– Tighten bolts of assembly mounting at gearbox.

– Ensure that the edges of the support arm (on the gearbox assembly mounting) -1- and gearbox mounting -2- are parallel.

• Dimension -x- must be identical on both sides of mounting.

– Tighten bolts for assembly mounting.



Remaining installation steps are carried out in reverse sequence; note the following:

– Tighten bolts for front section of longitudinal member ⇒ Rep. Gr. 50 .

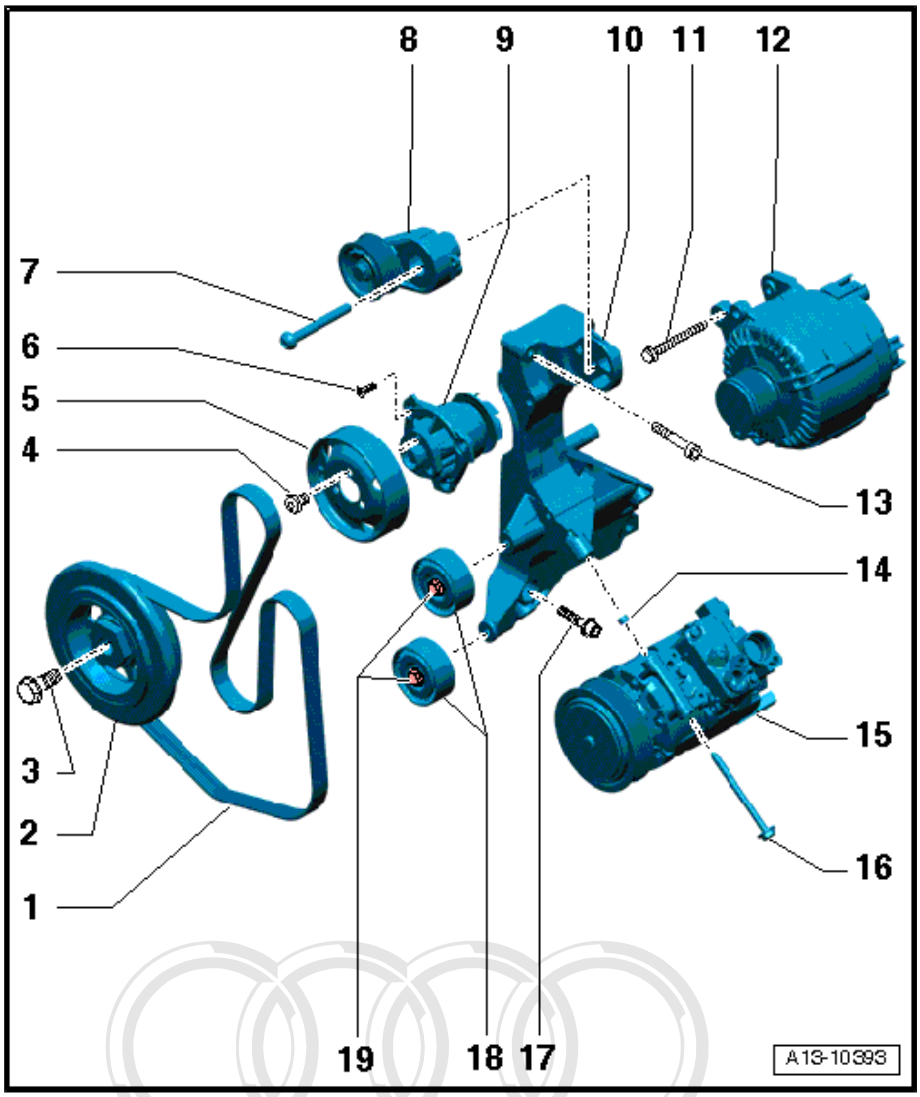
– Install air cleaner housing ⇒ Rep. Gr. 24 .

– Install air filter element ⇒ Rep. Gr. 24 .

13 – Crankshaft group

1 Cylinder block (pulley end)

1.1 Poly V-belt drive - exploded view



1 - Poly V-belt

- ❑ Check for wear
- ❑ Do not kink

> **Caution**
> *If a used belt runs in the opposite direction when it is refitted, this can cause breakage.*
> *Before removing, mark direction of rotation of poly V-belt with chalk or felt-tipped pen for re-installation.*

- ❑ Removing and installing ⇒ page 48
- ❑ When installing, make sure it is properly seated on pulleys.

2 - Vibration damper

- ❑ With poly V-belt pulley
- ❑ Removing and installing ⇒ page 51

3 - Bolt

- ❑ Renew
- ❑ 100 Nm + turn 180° further
- ❑ Use counterhold tool -T10069- when loosening and tightening

4 - Bolt

- ❑ 20 Nm

5 - Poly V-belt pulley for coolant pump

6 - Bolt

- ❑ 8 Nm

7 - Bolt

- ❑ 50 Nm

8 - Tensioner for poly V-belt

- ❑ Pivot with open-end spanner to slacken poly V-belt
- ❑ Lock in position with locking pin -T10060 A-
- ❑ Removing and installing ⇒ page 49

9 - Coolant pump

- ❑ Removing and installing ⇒ page 153

10 - Bracket for ancillaries

- ❑ Removing and installing ⇒ page 50

11 - Bolt

- ❑ 23 Nm

12 - Alternator

- ❑ Removing and installing ⇒ Rep. Gr. 27

13 - Bolt

- ❑ 3 x
- ❑ Tightening torque and tightening sequence ⇒ page 47

14 - Dowel sleeve for air conditioner compressor

15 - Air conditioner compressor

- ❑ Do not unscrew or disconnect refrigerant hoses or pipes.
- ❑ Removing and installing ⇒ Rep. Gr. 87

16 - Bolt

- ❑ 25 Nm

17 - Fitted bolt

- ❑ 2x
- ❑ Tightening torque and tightening sequence ⇒ page 47

18 - Idler rollers

19 - Bolt

- ❑ 40 Nm

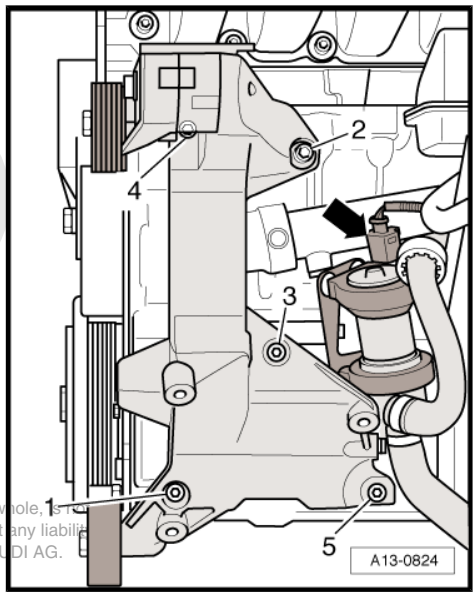
Bracket for ancillaries - tightening torque and tightening sequence

– Tighten bolts in the sequence -1 ... 5- in 2 stages as follows:

1. Tighten bolts hand tight.
2. Tighten bolts to 23 Nm.

Note

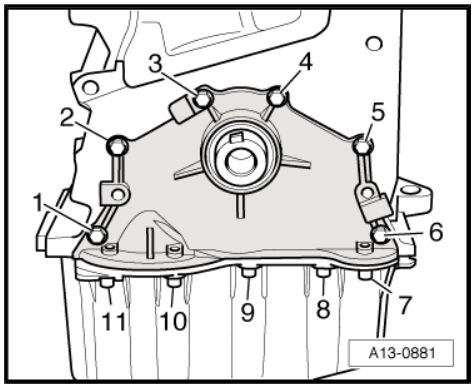
Bolts -1- and -2- are fitted bolts.



Sealing flange - tightening torque and tightening sequence

– Tighten bolts in 3 stages as follows:

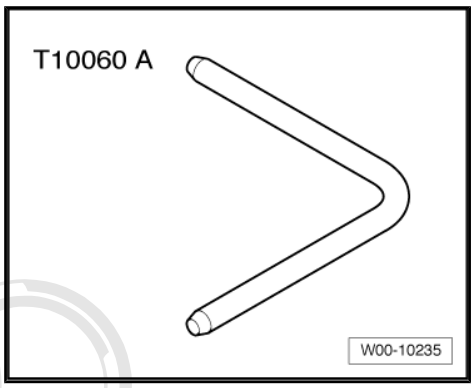
1. Screw in bolts -1 ... 11- hand-tight.
2. Tighten bolts -1 ... 6- in diagonal sequence and in stages to 10 Nm.
3. Tighten bolts -7 ... 11- to 10 Nm.



1.2 Removing and installing poly V-belt

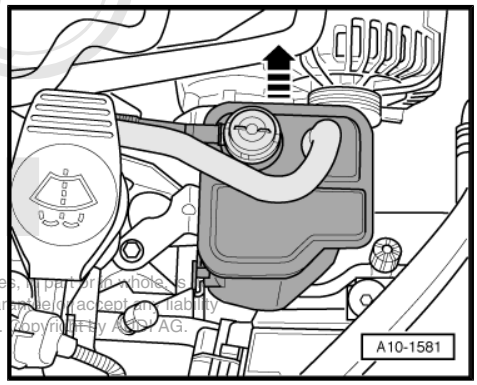
Special tools and workshop equipment required

♦ Locking pin -T10060 A-



Removing

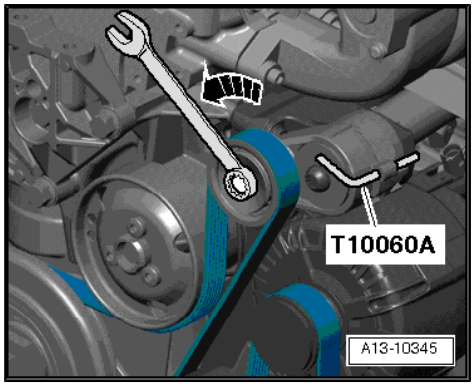
– On rest-of-world vehicles pull activated charcoal filter upwards out of bracket -arrow- in engine compartment and place to one side with hoses attached.



Caution

If a used belt runs in the opposite direction when it is refitted, this can cause breakage.

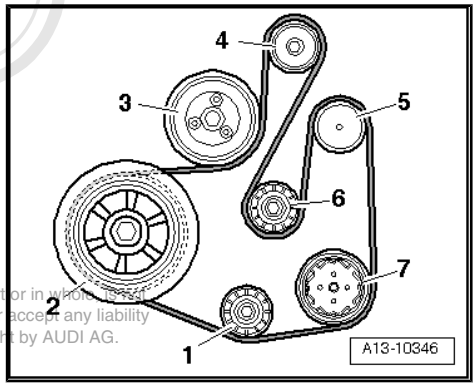
♦ *Before removing, mark direction of rotation of poly V-belt with chalk or felt-tipped pen for re-installation.*



– To slacken poly V-belt turn tensioner in direction of -arrow-.
– Lock tensioner with locking pin -T10060 A-
– Take off poly V-belt.

Installing

Installation is carried out in the reverse order; note the following:

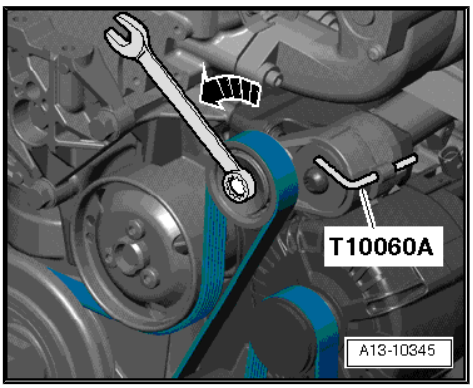


Note

Tighten alternator and A/C compressor mountings before fitting poly-V-belt.

– Fit poly V-belt as follows:

1 - Idler roller
2 - Vibration damper
3 - Coolant pump
4 - Tensioning roller
5 - Alternator
6 - Idler roller
7 - Air conditioner compressor



– Hold tensioner with ring spanner and remove locking pin - T10060 A- .
– Release tensioner.
– Check that poly V-belt is properly seated.
– Start engine and check that poly V-belt runs properly.

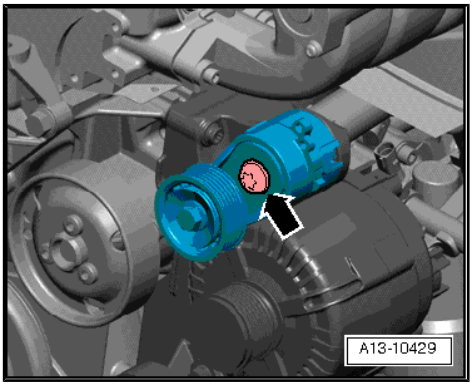
1.3 Removing and installing tensioner for poly V-belt

Removing

– Remove poly V-belt ⇒ page 48 .

Note

Do not lock tensioner.



– Remove bolt -arrow- and take off tensioner for poly-V-belt.

Installing

• Tightening torque ⇒ page 46 .

Installation is carried out in the reverse order; note the following:

– Install poly V-belt ⇒ page 48 .

1.4 Removing and installing bracket for ancillaries

Removing

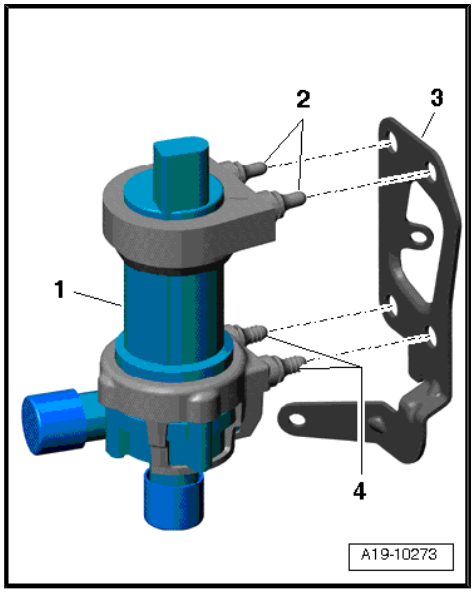
– Remove poly V-belt ⇒ page 48 .

– Remove alternator ⇒ Rep. Gr. 27 .

– Detach air conditioner compressor from engine ⇒ Rep. Gr. 87 and tie up on body with refrigerant lines connected.

– Spray rubber lugs -2 and 4- on flexible retainer for continued coolant circulation pump -V51- -item 1- with silicone-free lubricant.

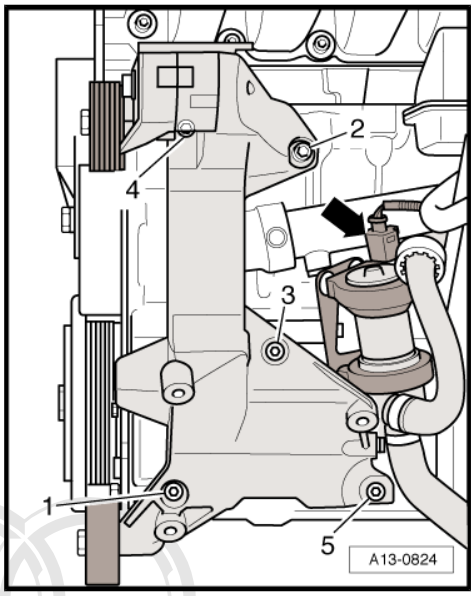
– Disengage rubber lugs from bracket -3- for continued coolant circulation pump -V51- .



Note

Continued coolant circulation pump -V51- remains on engine with coolant hoses connected.

– Remove bolts -1 ... 5- and detach bracket for ancillaries.



Note

Disregard -arrow-.

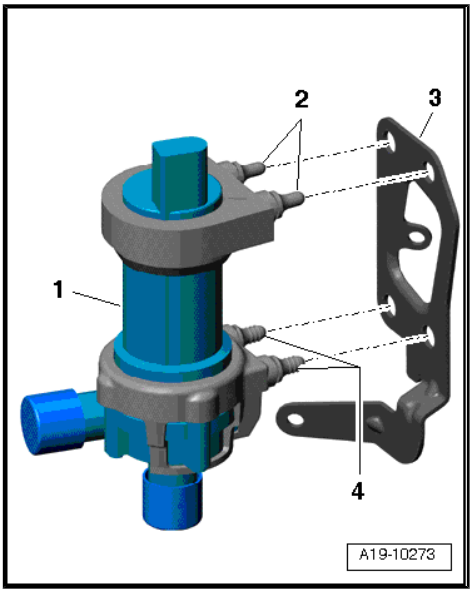
Installing

• Tightening torque ⇒ page 46 .

Installation is carried out in the reverse order; note the following:

– Tighten bolts for bracket for ancillaries ⇒ page 47 .

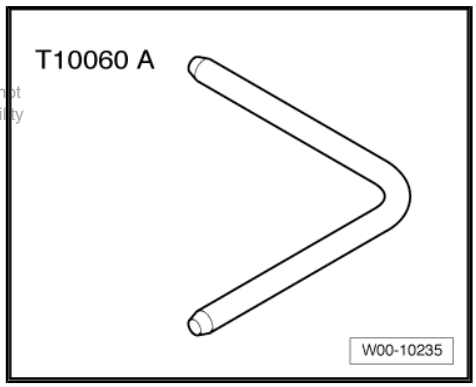
– Engage lugs -2- and -4- on flexible retainer for continued coolant circulation pump -V51- in bracket -3-.
– Install air conditioner compressor ⇒ Rep. Gr. 87 .
– Install alternator ⇒ Rep. Gr. 27 .
– Install poly V-belt ⇒ page 48 .



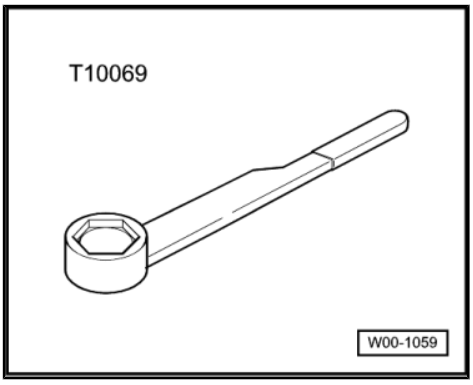
1.5 Removing and installing vibration damper

Special tools and workshop equipment required

♦ Locking pin -T10060 A-



♦ Counterhold tool -T10069-

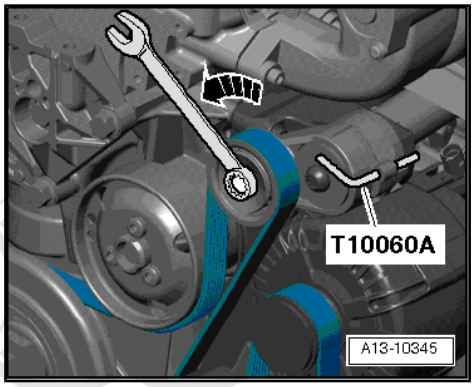


Removing

Caution

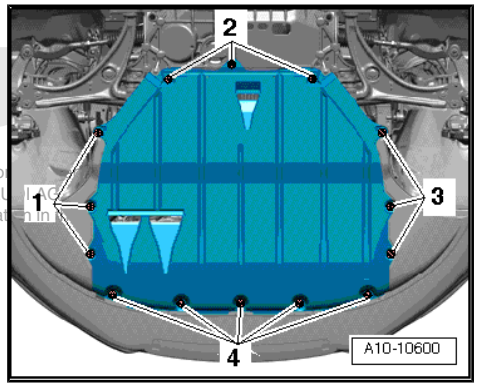
If a used belt runs in the opposite direction when it is refitted, this can cause breakage.

- *Before removing, mark direction of rotation of poly V-belt with chalk or felt-tipped pen for re-installation.*

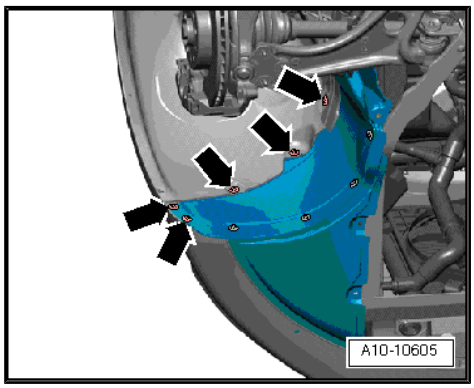


– To slacken poly V-belt turn tensioner in direction of -arrow-.
– Lock tensioner with locking pin -T10060 A-

– Release fasteners -1 ... 4- and remove centre noise insulation.



– Remove noise insulation on left and right sides -arrows-.
– Remove poly V-belt from pulley on vibration damper.



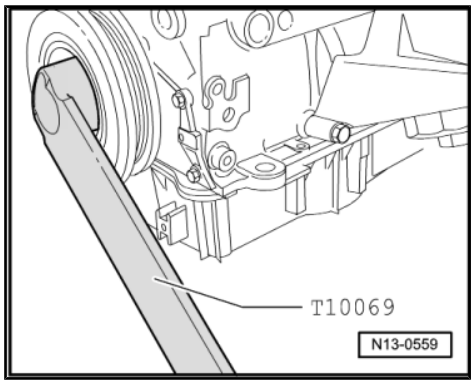
– Remove bolt for vibration damper using counterhold tool -T10069- .

Installing

- Tightening torque ⇒ page 46 .

Installation is carried out in the reverse order; note the following:

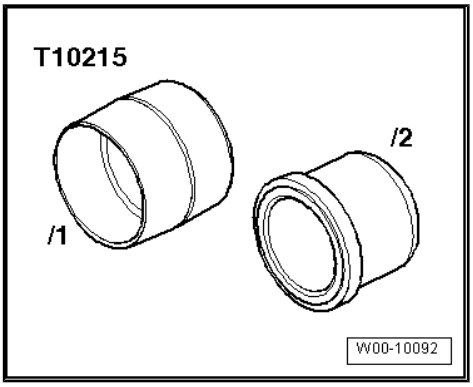
– Install poly V-belt ⇒ page 48 .



1.6 Removing and installing sealing flange

Special tools and workshop equipment required

♦ Assembly tool -T10215-



♦ Electric drill with plastic brush

♦ Safety goggles

♦ Sealant ⇒ Electronic parts catalogue

Removing

– Remove vibration damper ⇒ page 51 .

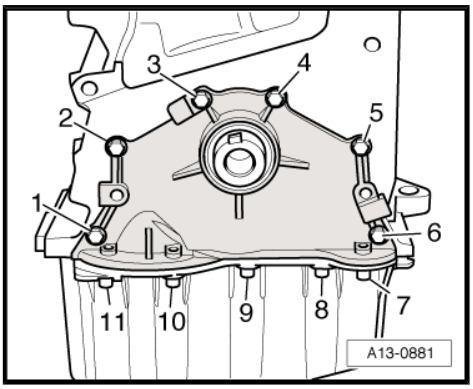
– Remove bolts -1 ... 11-.

– Carefully lever off sealing flange.

Installing

• Tightening torque ⇒ page 48 .

Installation is carried out in the reverse order; note the following:



Caution

Make sure sealant residue does not enter lubrication system.

♦ ***Place a clean cloth over the exposed section of the sump.***

– Carefully remove sealant residue on cylinder block and sump.

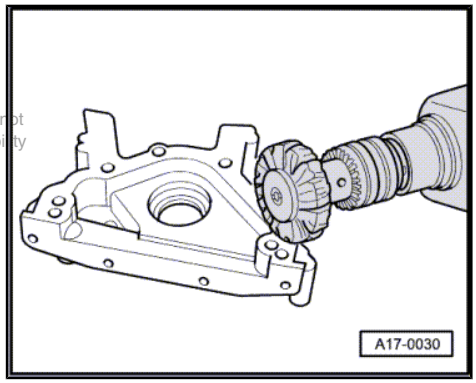
WARNING

Protect eyes against injuries.

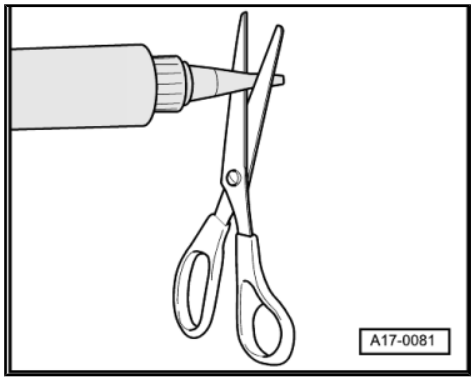
♦ ***Wear safety goggles.***

– Remove sealant residue on sealing flange using rotating plastic brush or similar.

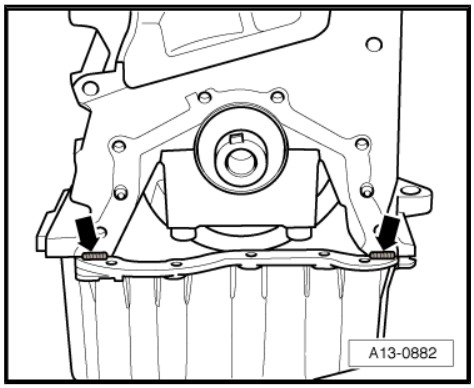
– Clean sealing surfaces; they must be free of oil and grease.



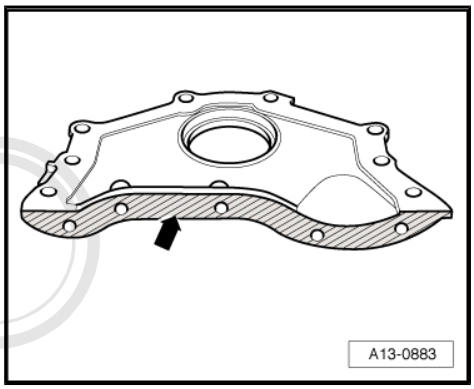
– Cut off nozzle of tube at front marking (diameter of nozzle approx. 2 mm).



– Apply a thin bead of sealant at the edge of the joint between the cylinder block and the sump -arrows-.

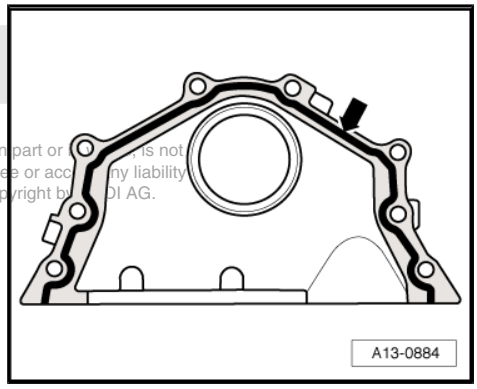


– Apply a thin coat of sealant to bottom sealing surface -shaded- on sealing flange.



– Apply bead of sealant -arrow- onto clean sealing surface of sealing flange as shown in illustration.

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



Caution

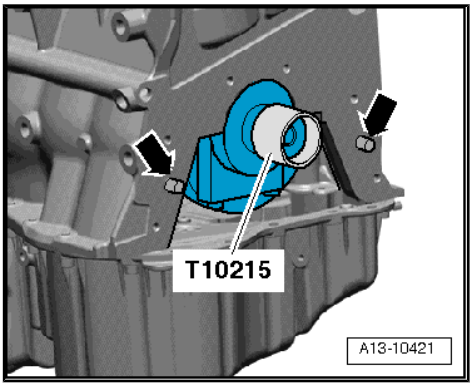
Make sure oil strainer is not clogged by excess sealant.

- *The bead of sealant must not be thicker than specified.*

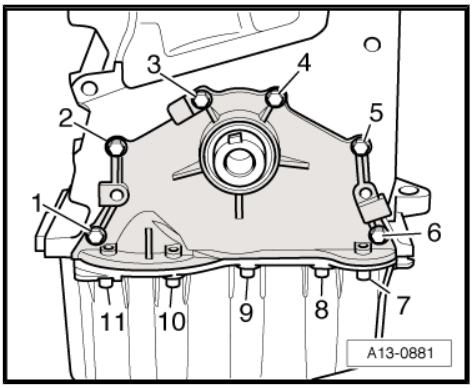
Note

Fit sealing flange within 5 minutes after applying sealant.

– Carefully push sealing flange over assembly tool -T10215- onto dowel pins -arrows- on cylinder block.



– Install sealing flange ⇒ page 48 .
– Install vibration damper ⇒ page 51 .
– Install poly V-belt ⇒ page 48 .



2 Cylinder block (gearbox end)

Note

When performing assembly work, secure engine to engine and gearbox support ⇒ page 32 .

2.1 Dual-mass flywheel - exploded view of components

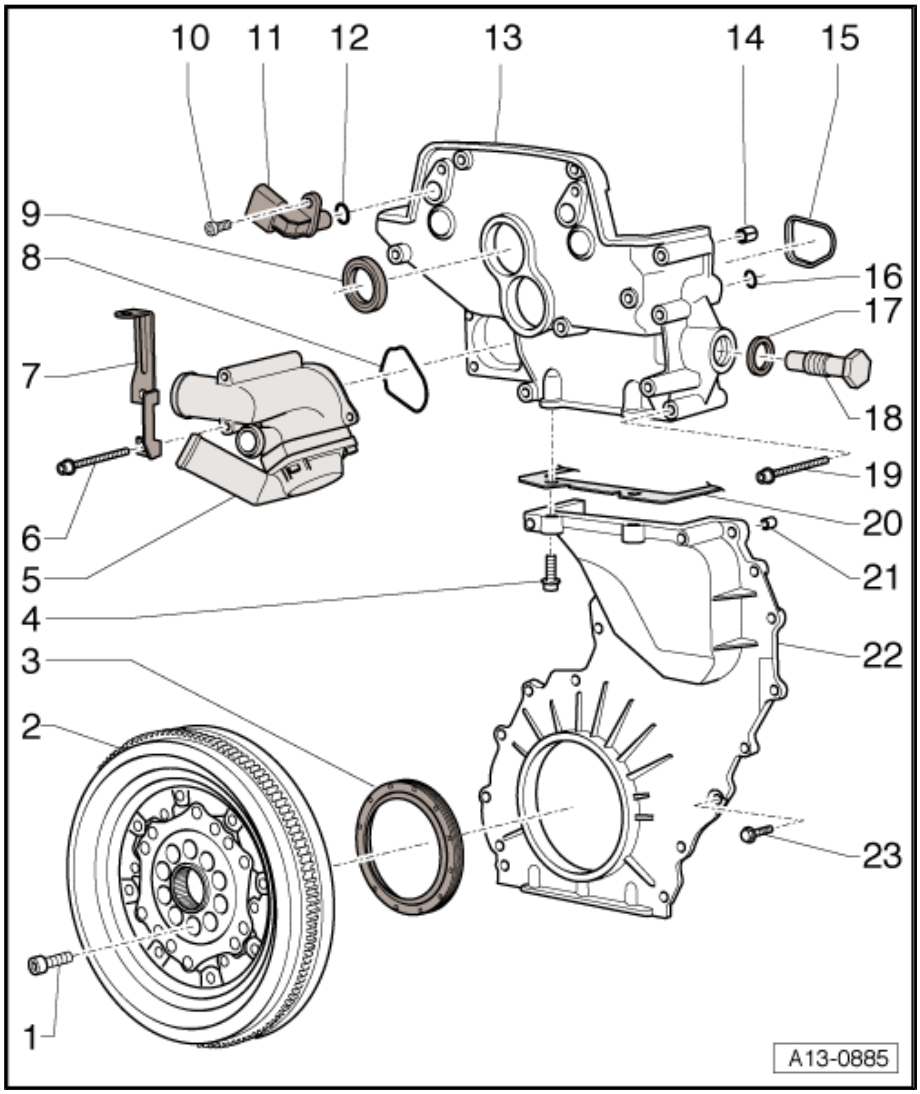
Note

-Items 4 ... 23- ⇒ page 80 .

1 - Bolt
- ❑ Renew
- ❑ 60 Nm + 90° (1/4 turn further)

2 - Dual-mass flywheel
- ❑ Removing and installing ⇒ page 56

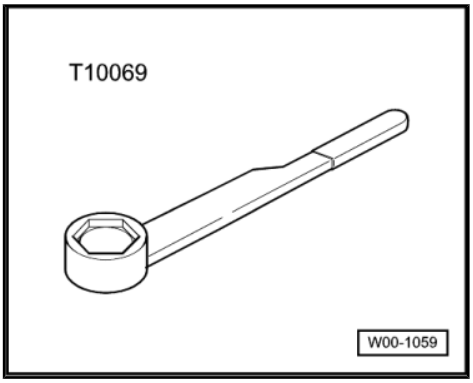
3 - Oil seal
- ❑ Renewing ⇒ page 59



2.2 Removing and installing dual-mass flywheel

Special tools and workshop equipment required

♦ Counterhold tool -T10069-



Removing

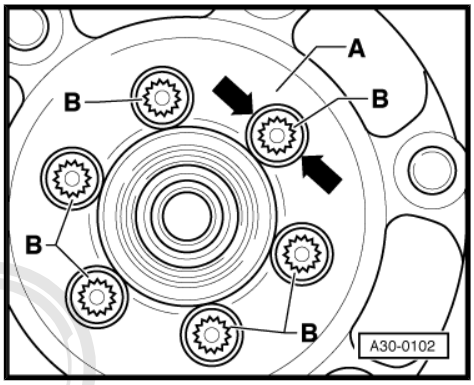
- Gearbox removed.

– Mark position of dual-mass flywheel on crankshaft for re-installation.

Caution

Make sure dual-mass flywheel is not damaged.

- *Remove bolts -B- using normal hand tools (do not use pneumatic wrench or impact driver, etc.).*
- *When removing the bolts, make sure that the bolt heads do not come into contact with the dual-mass flywheel.*
- *Rotate the dual-mass flywheel -A- so that the bolts -B- align centrally with the holes -arrows-.*

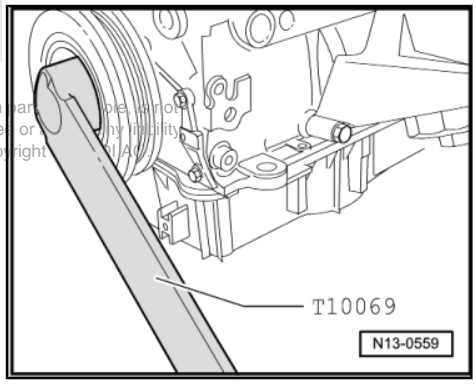


– Counterhold by applying counterhold tool -T10069- to bolt for vibration damper and remove dual-mass flywheel.

Installing

- Tightening torque ⇒ page 56.

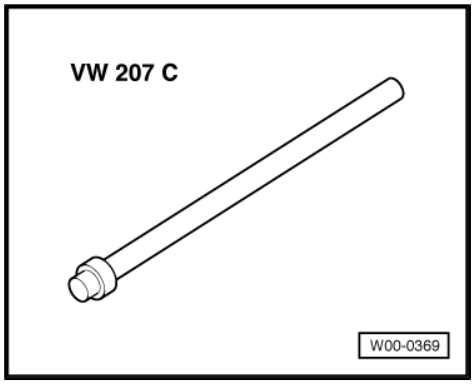
Install in reverse order.



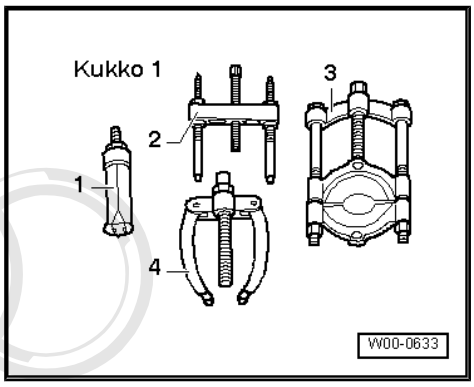
2.3 Extracting and driving in needle bearing for crankshaft

Special tools and workshop equipment required

♦ Drift -VW 207 C- or centring mandrel -3176-



♦ -1- internal puller Kukko 21/1



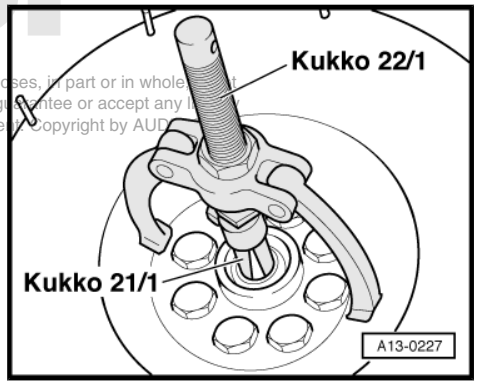
♦ -4- Counter-support Kukko 22/1

♦ Depth gauge

Removing

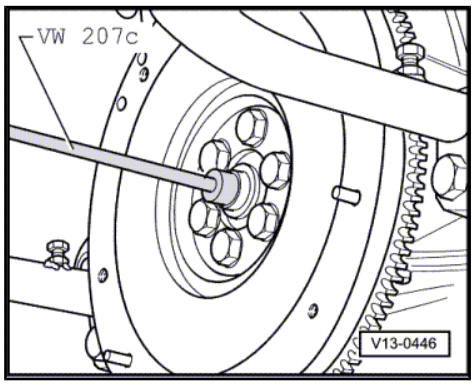
• Gearbox removed.

– Remove needle bearing using internal puller Kukko 21/1 and counter-support Kukko 22/1.



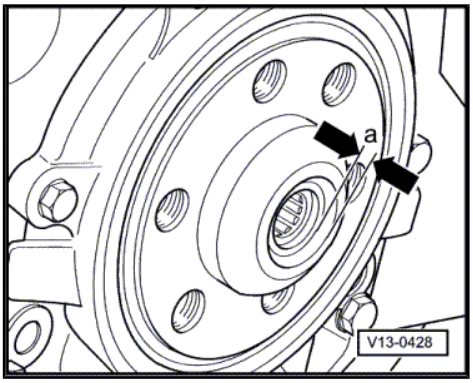
Installing

– Drive in needle bearing with drift -VW 207 C- or centring mandrel -3176- .



Installation position for needle bearing:

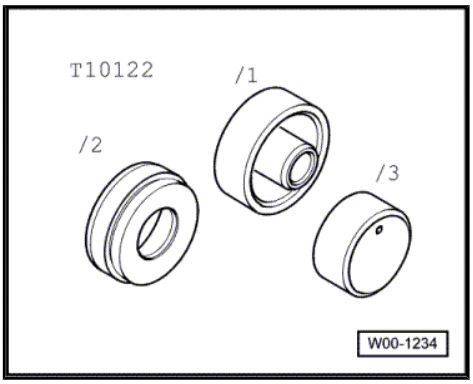
- The inscription on needle bearing must be visible when installed.
- Dimension -a- = 2.0 mm.



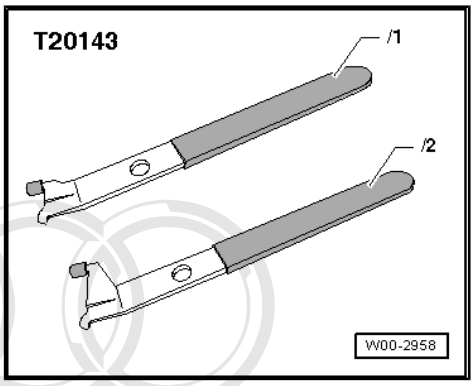
2.4 Renewing crankshaft oil seal

Special tools and workshop equipment required

♦ Fitting tool -T10122-



♦ Extractor tool -T20143-



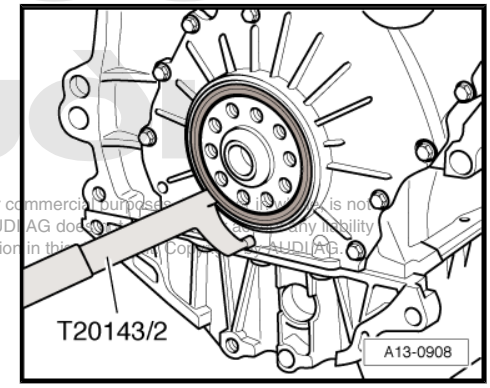
Procedure

- Gearbox removed.

– Remove dual-mass flywheel ⇒ page 56 .

– Pry out oil seal using extractor tool -T20143/2- .

– Clean contact surface and sealing surface.



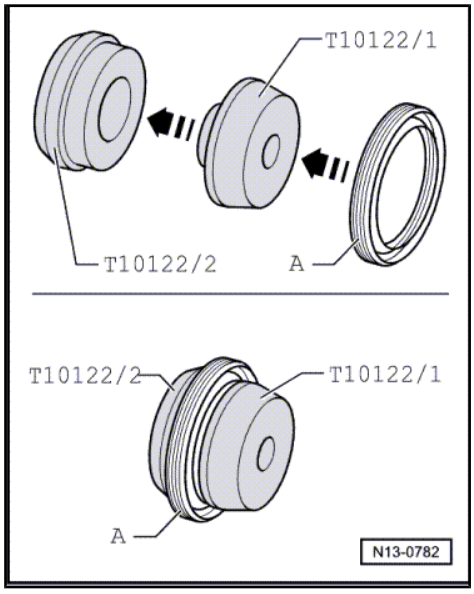
Note

Do not lubricate the oil seal before pressing in.

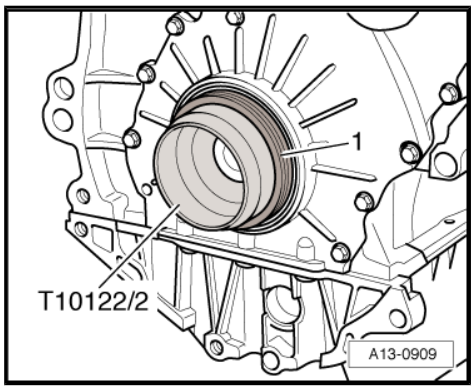
– Slide new oil seal -A- over the fitting sleeve -T10122/1- onto the guide sleeve -T10122/2- .

• Fitting position: closed side faces fitting sleeve.

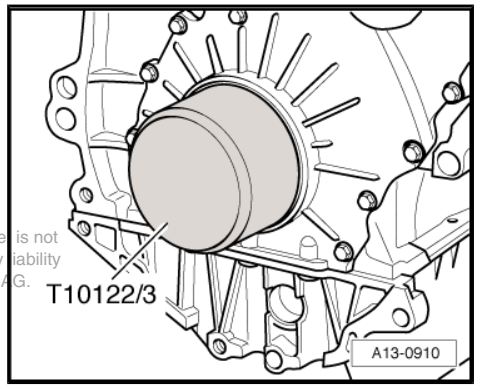
– Detach fitting sleeve from guide sleeve.



– Fit guide sleeve -T10122/2- with oil seal onto crankshaft.



– Press in oil seal uniformly until flush all round using thrust piece -T10122/3- .



Remaining installation steps are carried out in reverse sequence; note the following:

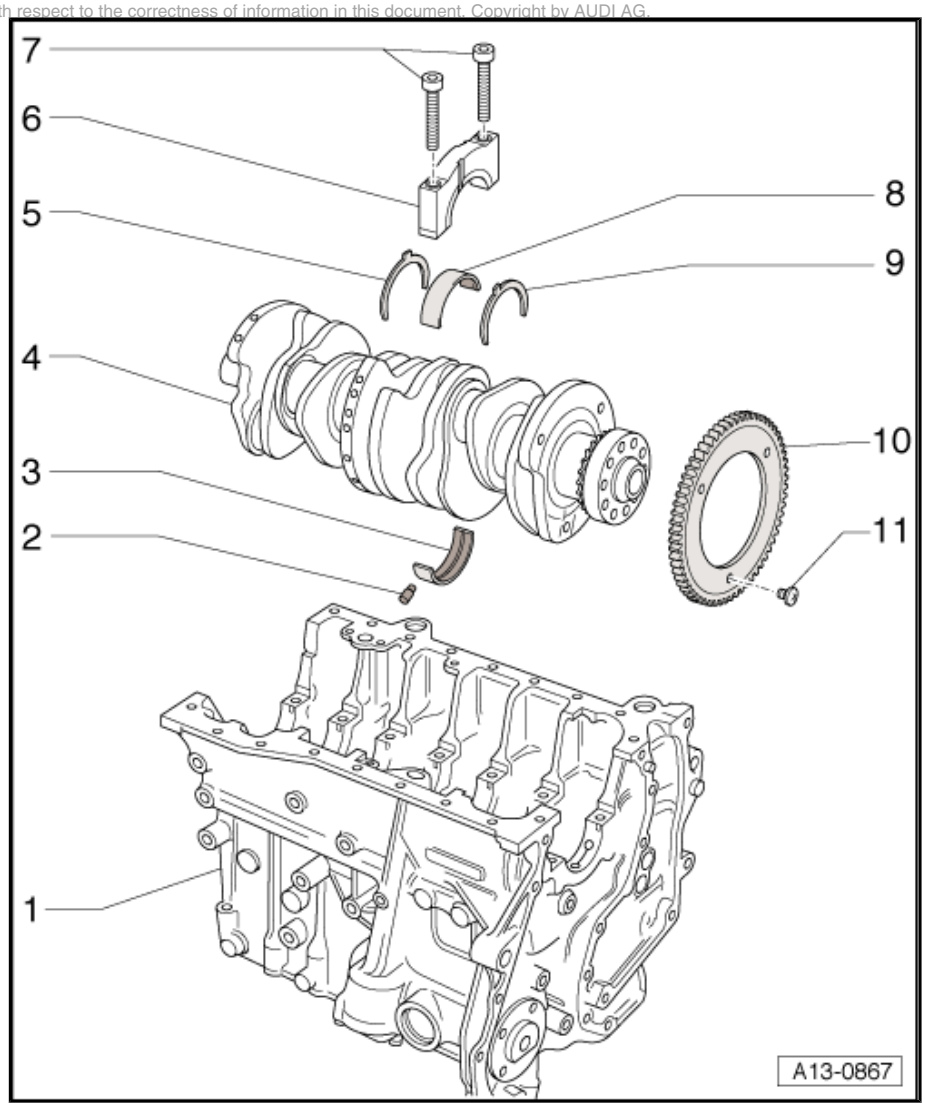
– Install dual-mass flywheel ⇒ page 56 .

3 Crankshaft

Note

- *When performing assembly work, secure engine to engine and gearbox support ⇒ page 32 .*
- *If large quantities of metal shavings or abrasion are found when performing engine repairs, this may be an indication of damage to the crankshaft or conrod bearings. To prevent further damage, the following steps are required after completion of repair work: clean the oil galleries carefully and renew the oil spray jets, oil cooler and oil filter.*

3.1 Crankshaft - exploded view



1 - Cylinder block

- ❑ Checking cylinder bore ⇒ page 67
- ❑ Piston and cylinder dimensions ⇒ page 68

2 - Oil spray jet (for cooling of pistons)

- ❑ For crankshaft bearings 2 ... 7
- ❑ Opening pressure: 2.0 bar
- ❑ Removing and installing ⇒ page 130

3 - Bearing shell

- ❑ For cylinder block, with oil supply drilling
- ❑ Mark used bearing shells
- ❑ Only supplied as a replacement part with “yellow” marking

4 - Crankshaft

- ❑ After removing, place it down so that the sender wheel -item 10- is not damaged and the crankshaft does not rest on the sender wheel
- ❑ Measuring axial clearance ⇒ page 63
- ❑ Measuring radial clearance ⇒ page 64
- ❑ Crankshaft dimensions ⇒ page 63
- ❑ Chain sprocket is an integral part of crankshaft

5 - Thrust washer

- ❑ For bearing No. 5
- ❑ Note location
- ❑ Oil groove points towards crankshaft

6 - Bearing cap

- ❑ Bearing cap 1: Pulley end
- ❑ Bearing cap 5 with recesses for thrust washers
- ❑ Retaining lugs on bearing shells in cylinder block and bearing cap must be on the same side

7 - Bolt

- ❑ Renew
- ❑ 30 Nm + 180° ($^1/_2$ turn further)
- ❑ When measuring radial clearance, tighten used bolt to 30 Nm but not further

8 - Bearing shell

- ❑ For bearing cap, without drilling
- ❑ Mark used bearing shells
- ❑ Only supplied as a replacement part with “yellow” marking

9 - Thrust washer

- ❑ For bearing No. 5
- ❑ Note location
- ❑ Oil groove points towards crankshaft

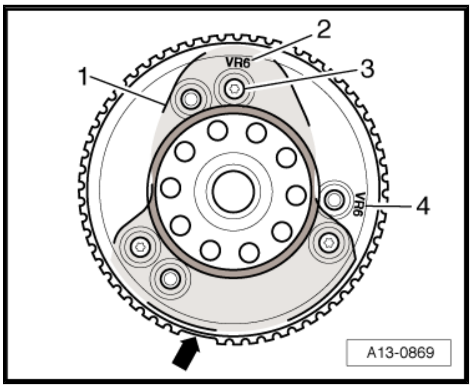
10 - Sender wheel

- ❑ For engine speed sender -G28-
- ❑ Renew
- ❑ Installing ⇒ page 63

11 - Bolt

- ❑ Renew
- ❑ Renew sender wheel if bolts have been unscrewed
- ❑ Tightening torque and tightening sequence ⇒ page 63

Installing sender wheel for engine speed sender -G28-



Note

Renew bolts and sender wheel if sender wheel bolts have been unscrewed.

– Clean contact surface between crankshaft and sender wheel; it must be free of oil and grease.

– Thinly coat contact surface between crankshaft and sender wheel with locking fluid; for locking fluid refer to ⇒ Electronic parts catalogue .

Installation position:

- The marking "VR6" -item 2- must be positioned at the bore of the bolt -3- which goes into the crankshaft conrod journal (outline of crankshaft ⇒ dotted line -1-).

- The gap -arrow- in the starter gear ring is positioned opposite the "VR6" marking.

Note

Ignore the second "VR6" marking -item 4-.

– Tighten sender wheel bolts in three stages as follows:

1. Tighten bolts hand tight.
2. Tighten bolt -3- to 10 Nm and turn 90° ($^1/_4$ further).
3. Tighten the two remaining bolts to 10 Nm and turn 90° ($^1/_4$ turn) further.

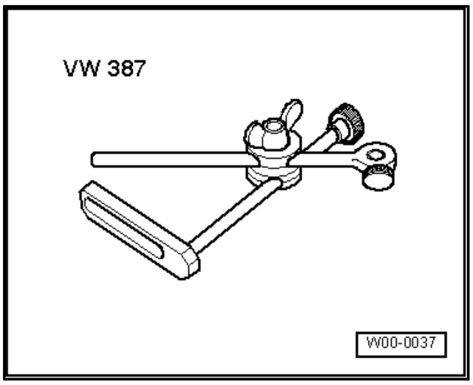
3.2 Crankshaft dimensions

Honing dimension (in mm)	Crankshaft main bearing journal diameter	Conrod bearing journal diameter
Basic dimension [1]	59.958 … 59.978	53.958 … 53.978
• [1] Machining is not permitted.		

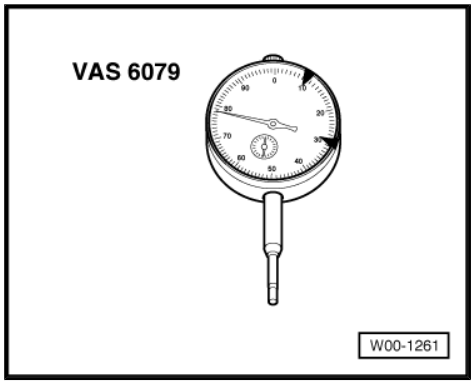
3.3 Measuring axial clearance of crankshaft

Special tools and workshop equipment required

♦ Universal dial gauge bracket -VW 387-



♦ Dial gauge -VAS 6079-



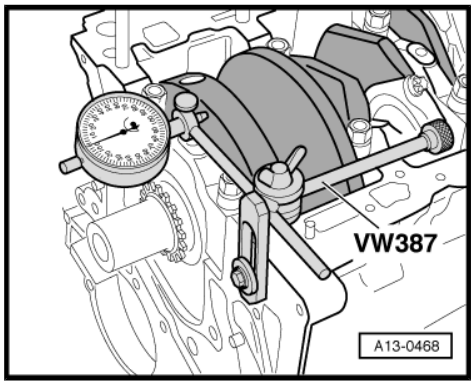
Procedure

– Bolt dial gauge -VAS 6079- with dial gauge bracket -VW 387- onto cylinder block and set it against crank web.

– Press crankshaft against dial gauge by hand.

– Set dial gauge to “0”.

– Push crankshaft away from dial gauge and read off value.



Axial clearance:

- New: 0.07 ... 0.23 mm.
- Wear limit: 0.30 mm.

3.4 Measuring radial clearance of crankshaft

Special tools and workshop equipment required

♦ Plastigage

Procedure

Note

♦ *Do not interchange used bearings.*

♦ *Bearing shells worn down to the nickel layer must be renewed.*

– Remove bearing cap.

– Clean bearing cap and bearing journal.

– Place a length of Plastigage corresponding to the width of the bearing on the bearing journal or bearing shell.

- The Plastigage must be positioned in the centre of the bearing shell.

– Fit bearing cap and tighten bolts to 30 Nm without rotating crankshaft.

– Remove bearing cap again.

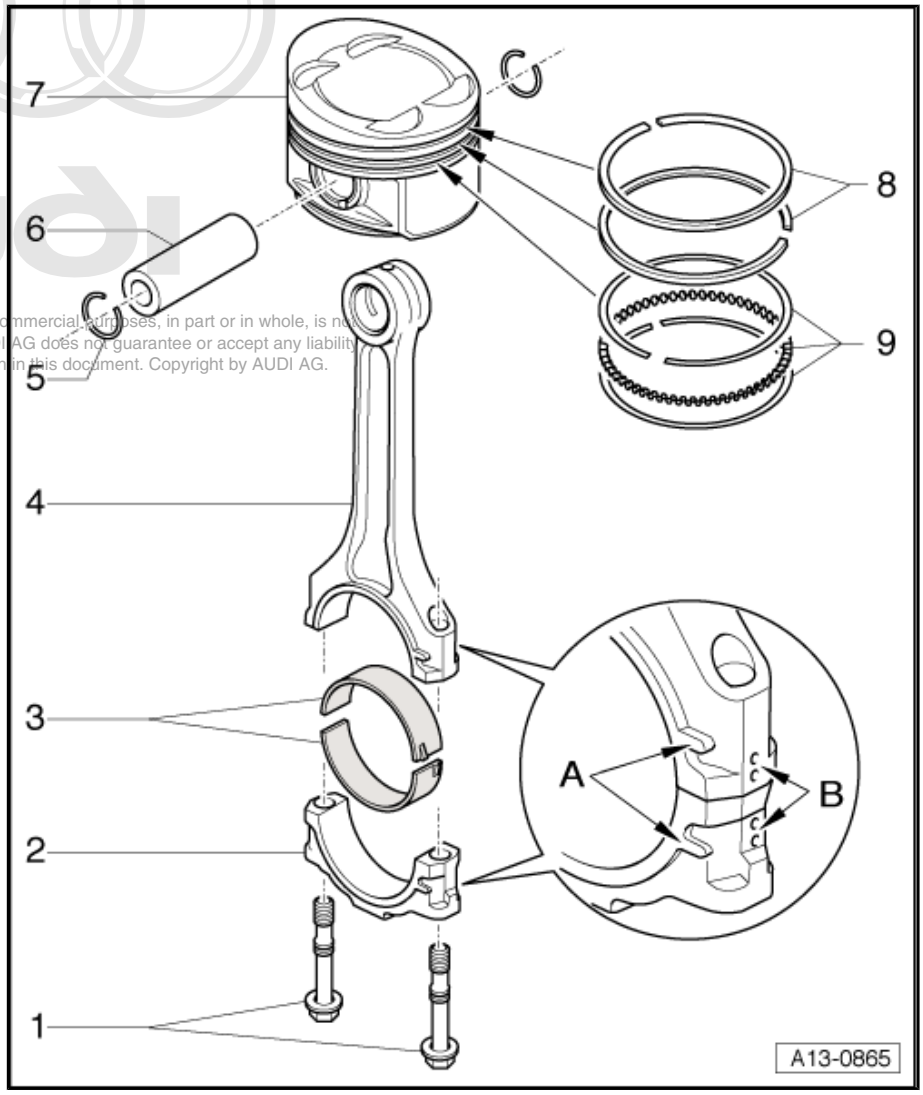
– Compare width of Plastigage with measurement scale.

Radial clearance:

- New: 0.02 ... 0.06 mm.
- Wear limit: 0.10 mm

4 Pistons and conrods

4.1 Pistons and conrods - exploded view



1 - Bolt

- ❑ Renew
- ❑ Lubricate threads and contact surface
- ❑ 30 Nm + 90° (1/4 turn further)
- ❑ When measuring radial clearance, tighten used bolt to 30 Nm but not further

2 - Conrod bearing cap

- ❑ Mark cylinder number -B-
- ❑ Installation position: Markings -A- must be on same side

3 - Bearing shells

- ❑ Mark used bearing shells
- ❑ The lugs on the bearing shells must fit tightly in the recesses
- ❑ Installation position: lugs of both bearing shells must be on same side of conrod
- ❑ Measuring axial clearance ⇒ page 68
- ❑ Measuring radial clearance ⇒ page 68
- ❑ As replacement parts, the upper bearing shell is supplied with colour-coding “yellow”, the lower bearing shell with colour-coding “red”.

4 - Conrod

- ❑ With oil drilling for piston pin lubrication
- ❑ Only renew as a complete set
- ❑ Mark cylinder number -B-
- ❑ Installation position: markings -A- must be on same side as lower side of piston crown (lower side of piston crown faces towards centre of cylinder block)

5 - Circlip

6 - Piston pin

- ❑ If difficult to move, heat piston to approx. 60 °C
- ❑ Remove and install using drift -VW 222 A-

7 - Piston

- ❑ Checking ⇒ page 67
- ❑ Mark installation position to conrod and cylinder allocation

- ❑ Lower side of piston crown points towards centre of cylinder block
- ❑ Piston and cylinder dimensions ⇒ page 68
- ❑ Install with funnel -T10147- ⇒ page 67 .

8 - Piston rings

- ❑ Compression rings
- ❑ Offset gaps by 120°
- ❑ Use piston ring pliers to remove and install
- ❑ “TOP” must face towards piston crown
- ❑ Checking ring gap ⇒ page 66
- ❑ Checking ring-to-groove clearance ⇒ page 66

9 - Piston ring

- ❑ Oil scraper ring
- ❑ 3 parts
- ❑ Offset gap of top steel element of piston ring by 120° to next compression ring
- ❑ Offset gaps of individual parts of oil scraper ring

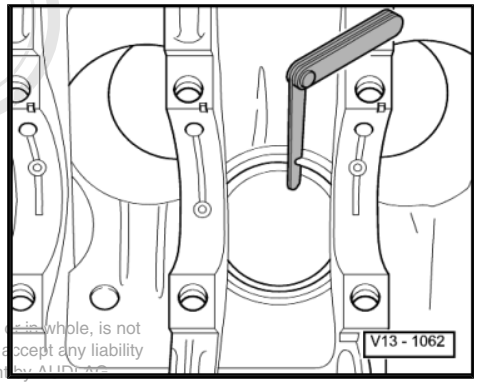
Checking piston ring gap

– Insert piston ring from above as follows and use a piston without piston rings to push down ring into bottom cylinder opening.

• At right angle to cylinder wall.

• Up to approx. 15 mm from bottom of cylinder.

– Check gap using feeler gauge.

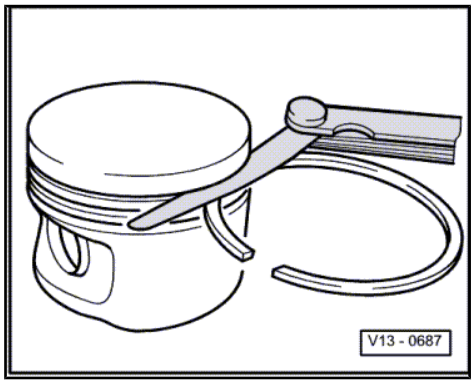


Piston ring Dimensions in mm	New	Wear limit
Compression ring	0.20 … 0.40	1.00
Tapered stepped ring	0.20 … 0.40	1.00
Oil scraper ring	0.25 … 0.50	1.00

Checking ring-to-groove clearance

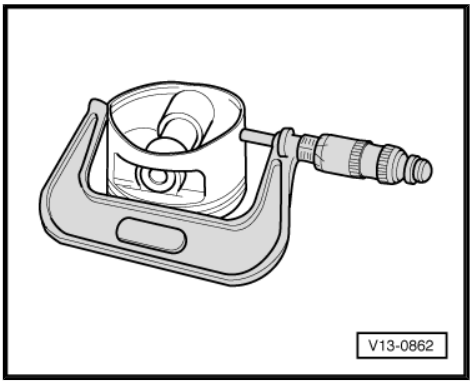
– Clean annular groove of piston.

– Check gap using feeler gauge.



Piston ring Dimensions in mm	New	Wear limit
Compression ring	0.04 … 0.09	0.15
Tapered stepped ring	0.03 … 0.06	0.15
Oil scraper ring	0.02 … 0.06	0.15

Checking piston



– Measure as follows using micrometer, 75 … 100 mm:

• Approx. 6 mm from the bottom of piston skirt.

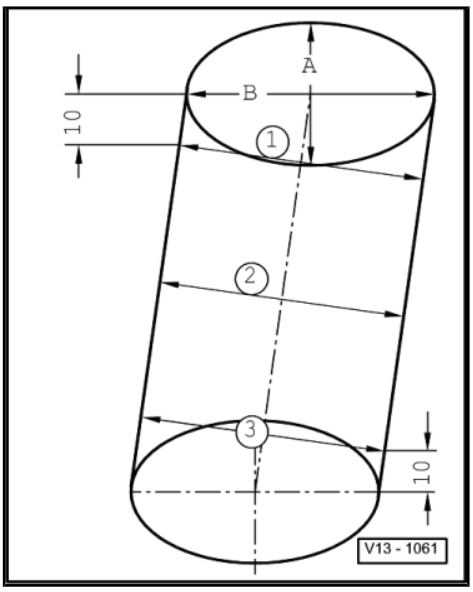
• At 90° to piston pin axis.

Maximum deviation from nominal dimension:

• 0.04 mm (maximum)

Nominal dimension
⇒ “4.2 Piston and cylinder dimensions”, page 68 .

Checking cylinder bore



– Measure as follows using cylinder gauge, 50 … 100 mm:

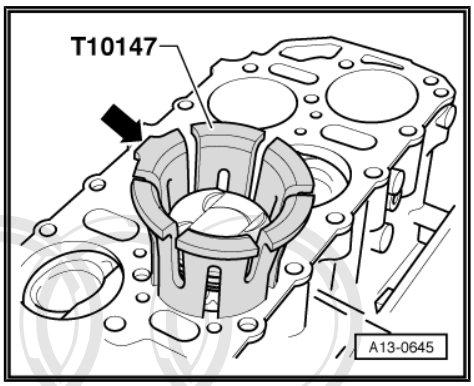
• At 3 positions in both lateral direction -A- and longitudinal direction -B-.

Maximum deviation from nominal dimension:

• 0.08 mm (maximum)

Nominal dimension
⇒ “4.2 Piston and cylinder dimensions”, page 68 .

Install piston with funnel -T10147- .



Note

If a new funnel -T10147- is used to install the pistons, first pass piston (with oiled piston rings) twice through the funnel and remove any resulting swarf. Then install piston with piston rings.

– Lubricate funnel and push piston in by hand.

• The flat side of the piston crown must face the projection on the fitting tool -arrow-.

– Hold upper part of tool (with piston inserted) and press piston in with both thumbs.

– Push piston in until it protrudes approx. 15 mm from the lower edge of the fitting tool.

– Place piston in appropriate cylinder bore.

• Projection on funnel -arrow- must face centre of cylinder block.

– Hold fitting tool firmly against cylinder block and push in the piston.

4.2 Piston and cylinder dimensions

Honing dimension (in mm)	Diameter of piston	Diameter of cylinder bore
Basic dimension	83.965	84.010

4.3 Measuring axial clearance of conrods

Special tools and workshop equipment required

- ♦ Feeler gauge

Procedure

– Check gap using feeler gauge.

Axial clearance:

- New: 0.05 ... 0.31 mm.
- Wear limit: 0.40 mm

4.4 Measuring radial clearance of conrods

– Remove bearing cap.

– Clean bearing cap and bearing journal.

– Place a length of Plastigage corresponding to the width of the bearing on the bearing journal or bearing shell.

- The Plastigage must be positioned in the centre of the bearing shell.

– Fit bearing cap and tighten bolts to 30 Nm without rotating crankshaft.

– Remove bearing cap again.

– Compare width of Plastigage with measurement scale.

Radial clearance:

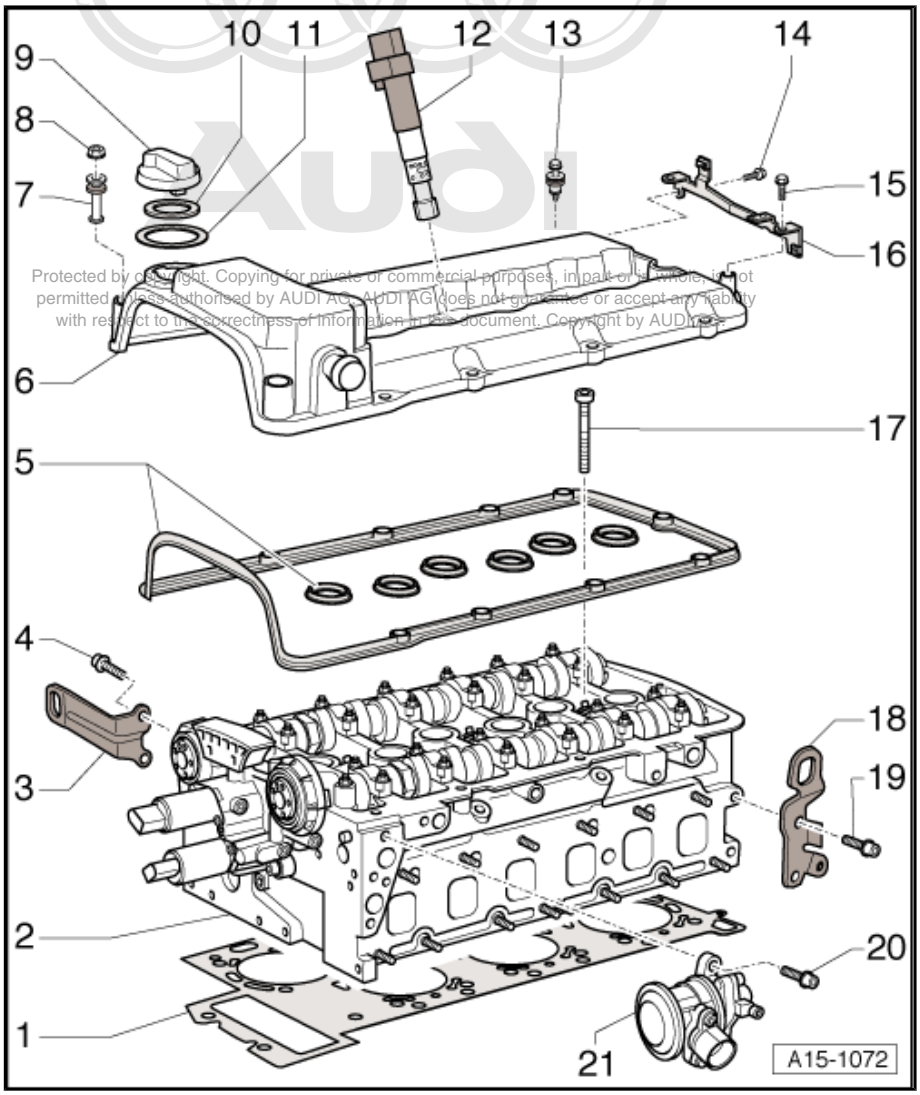
- New: 0.02 ... 0.07 mm.
- Wear limit: 0.10 mm

– Renew conrod bolts.

15 – Cylinder head, valve gear

1 Cylinder head

1.1 Cylinder head and cylinder head cover - exploded view



1 - Cylinder head gasket
- ❑ Renew
- ❑ If renewed, change engine oil and coolant

2 - Cylinder head
- ❑ Removing and installing ⇒ page 72
- ❑ Checking for distortion ⇒ page 71
- ❑ If renewed, change engine oil and coolant

3 - Lifting eye

4 - Bolt
- ❑ 23 Nm

5 - Gaskets for cylinder head cover
- ❑ Renew if damaged

6 - Cylinder head cover
- ❑ Removing and installing ⇒ page 71

7 - Spacer sleeve
- ❑ With seal
- ❑ Renew seal if damaged

8 - Nut
- ❑ 10 Nm

9 - Filler cap

10 - Seal for filler cap
- ❑ Renew if damaged

11 - Washer
- ❑ Renew if damaged

12 - Ignition coil
- ❑ Remove with puller -T10095 A-

13 - Bolt
- ❑ With spacer sleeve and seal
- ❑ Renew seal if damaged
- ❑ Tightening torque and tightening sequence ⇒ page 70

14 - Bolt
- ❑ 10 Nm

15 - Bolt
- ❑ 10 Nm

16 - Bracket

- ❑ For fuel line

17 - Bolt

- ❑ Renew
- ❑ Note correct sequence when loosening ⇒ page 70
- ❑ Tightening torque and tightening sequence ⇒ page 71

18 - Lifting eye

19 - Bolt

- ❑ 23 Nm

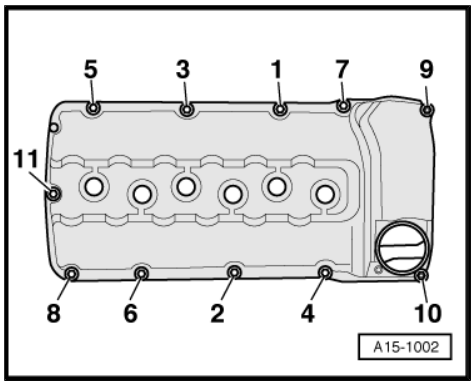
20 - Bolt

21 - Combination valve for secondary air system

- ❑ Version and fitting location ⇒ page 184

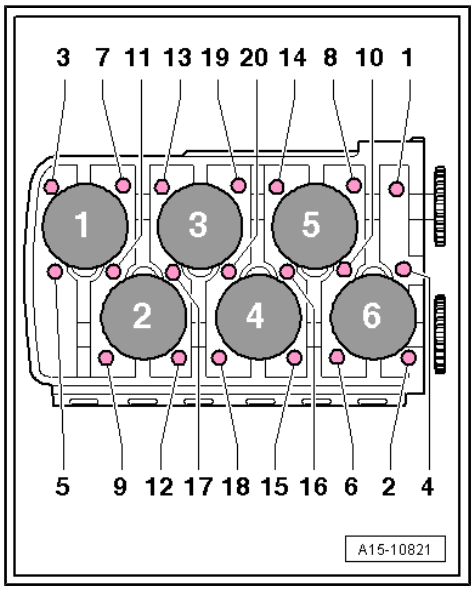
Cylinder head cover - tightening torque and tightening sequence

– Tighten bolts in the sequence -1 ... 11- to 10 Nm.



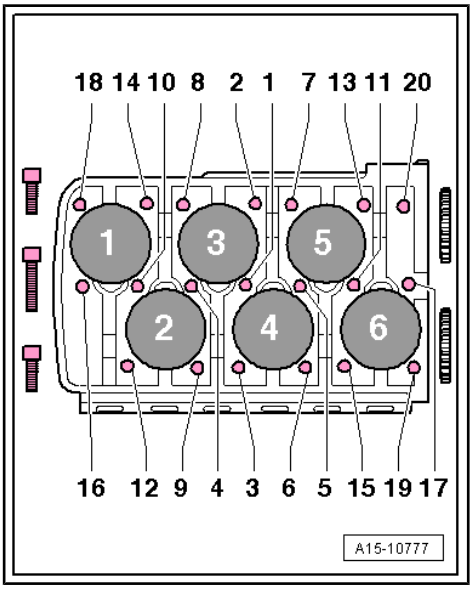
Slackening cylinder head bolts

– Loosen bolts in the sequence -1 ... 20-.



Cylinder head - tightening torque and tightening sequence

– Tighten bolts in the sequence -1 ... 20- in 4 stages as follows:



Note

The long cylinder head bolts are inserted in the middle bores in cylinder head.

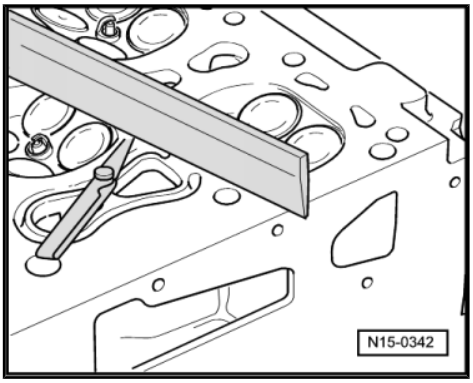
1. Tighten bolts hand tight.
2. Pre-tighten bolts to 30 Nm.
3. Tighten bolts to 50 Nm.
4. Turn bolts 180° ($^1/_2$ turn) further.

Checking cylinder head for distortion

– Measure at several points with straightedge and feeler gauge.

Permissible distortion:

- 0.05 mm (maximum)



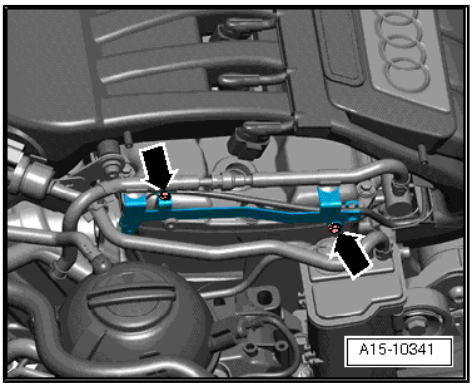
1.2 Removing and installing cylinder head cover

Removing

– Remove intake manifold ⇒ Rep. Gr. 24 .

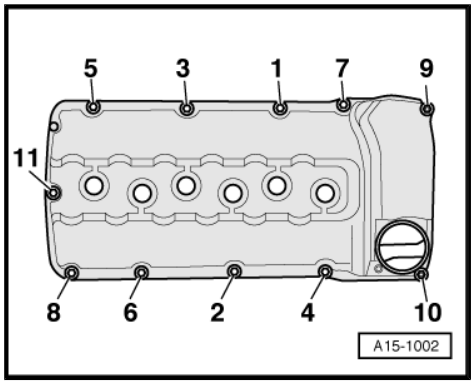
– Unscrew bolts -arrows- and move bracket for fuel line to one side.

– Remove bracket for electrical wiring from timing chain cover (top).



– Slacken cylinder head cover bolts in the sequence -11 ... 1-.

– Remove bolts and take off cylinder head cover.



Installing

• Tightening torques ⇒ page 69 , ⇒ page 70

Installation is carried out in the reverse order; note the following:

Note

Renew gaskets and bolts for cylinder head cover if damaged.

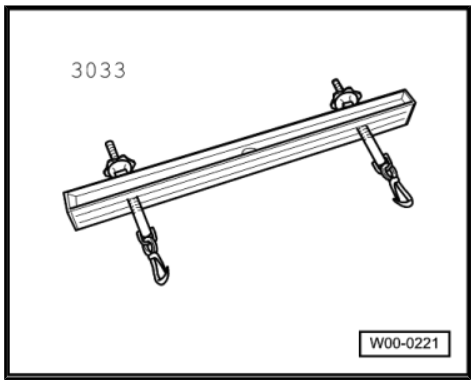
– Tighten cylinder head cover bolts ⇒ page 70 .

– Install intake manifold ⇒ Rep. Gr. 24 .

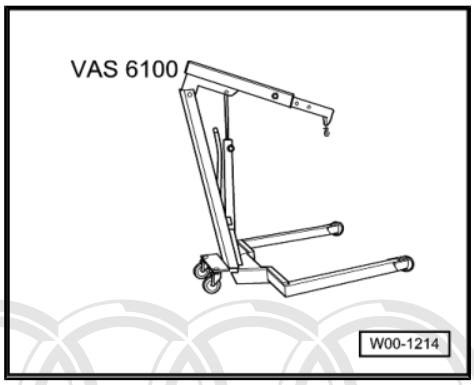
1.3 Removing and installing cylinder head

Special tools and workshop equipment required

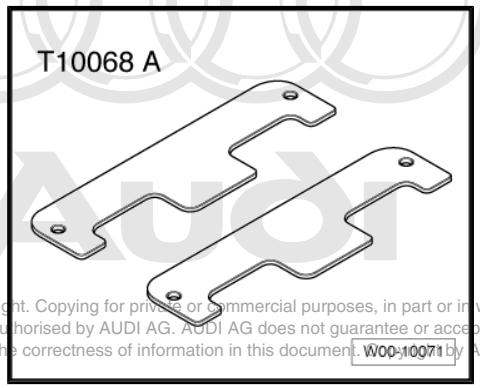
♦ Lifting tackle -3033-



♦ Workshop hoist -VAS 6100-



♦ Camshaft bar -T10068 A-



Removing

- Engine in vehicle.

Note

Fit cable ties in the original positions when installing.

– Drain coolant ⇒ page 145 .

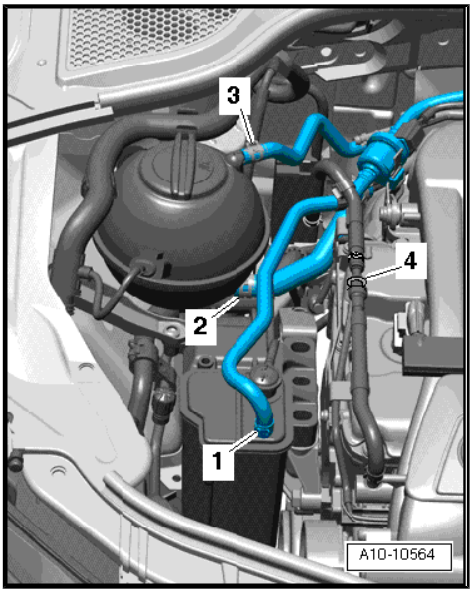
– Remove intake manifold ⇒ Rep. Gr. 24 .

– On rest-of-world vehicles pull activated charcoal filter -1- upwards out of bracket in engine compartment and place to one side with hoses attached.

WARNING

Risk of injury - fuel system operates under high pressure.

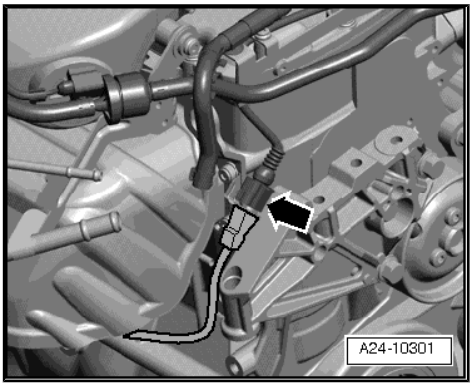
- ***To reduce the pressure in the fuel system, wrap a clean cloth around the connection and carefully loosen the connection.***



– Disconnect fuel supply hose -4- by pulling release ring.

– Detach coolant hoses -2 and 3-.

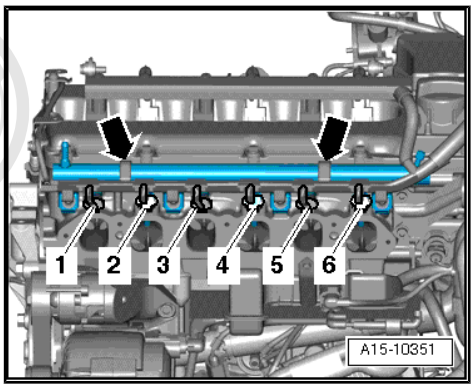
– Unplug electrical connector -arrow- for knock sensor 1 -G61- and move wiring clear.



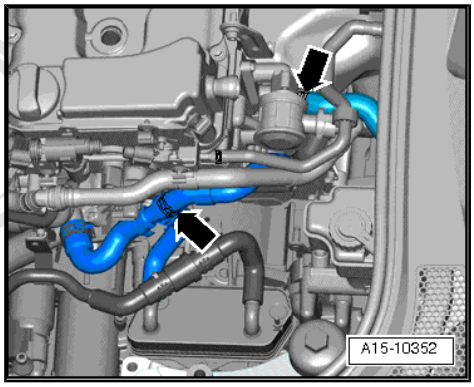
– Remove cylinder head cover ⇒ page 71 .

– Unplug electrical connectors -1 ... 6- at injectors.

– Unclip wiring guide from fuel rail -arrows-.



– Detach coolant hoses -arrows-.



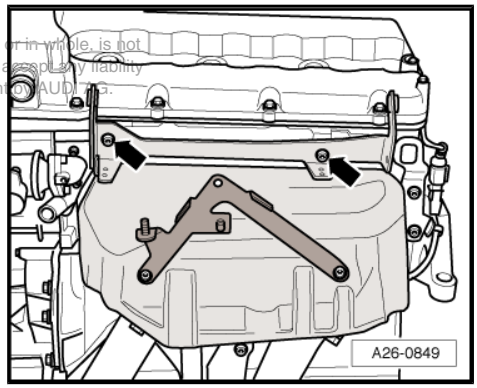
Note

Illustration shows coolant hoses on vehicle with direct shift gearbox.

– Remove thermostat housing ⇒ page 158 .

– Remove timing chain from camshafts ⇒ page 85 .

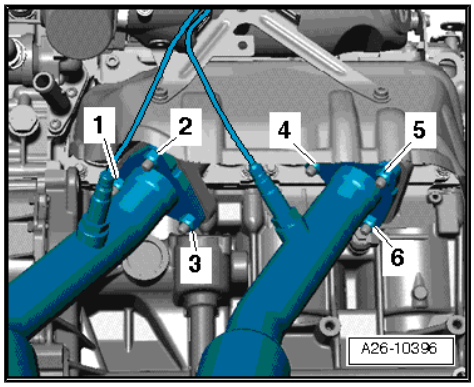
– Remove heat shield above exhaust manifold -arrows-.



Caution

Avoid damage to flexible joints.

- ***Do not bend flexible joints in front exhaust pipe more than 10°.***

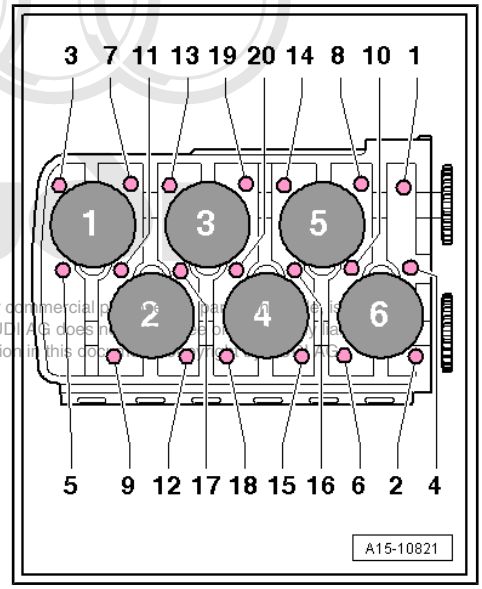


– Remove nuts -1 ... 6- and push back front exhaust pipe slightly from exhaust manifolds.

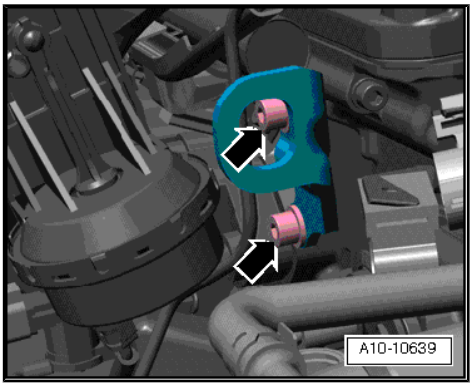
Note

Lambda probes remain installed.

– Slacken cylinder head bolts in the sequence -1 ... 20- and remove.



– Secure engine lifting eye (front left) again -arrows-.

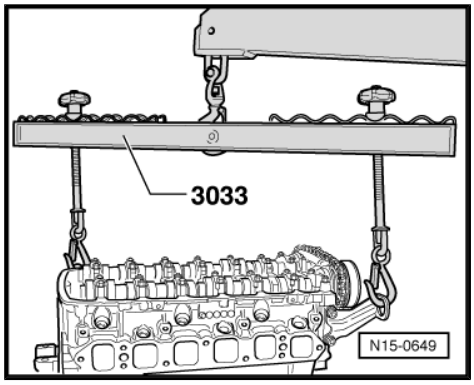


Note

The engine lifting eye (left-side) was removed when removing intake manifold.

– Engage lifting tackle -3033- as follows:

- Pulley end: position “3”.
- Gearbox end: position “10”.



Note

The positions marked “1 ... 12” on the lifting tackle -3033- face towards gearbox end.

– Carefully lift off cylinder head.

Caution

The cylinder bores and pistons must be protected from dirt.

- *Place clean cloths in cylinders.*

Installing

- Tightening torque ⇒ page 71 .

Caution

Avoid damage to sealing surfaces.

- *Carefully remove sealant residue from cylinder head and cylinder block.*
- *Ensure that no long scores or scratches are made on the surfaces.*

Avoid damage to cylinder block.

- *No oil or coolant must be allowed to remain in the blind holes for the cylinder head bolts in the cylinder block.*

Ensure that cylinder head gasket seals properly:

- *Carefully remove any remaining emery and abrasive material.*
- *Do not remove new cylinder head gasket from packaging until it is ready to be fitted.*
- *Handle the cylinder head gasket very carefully to prevent damage to the silicone coating or the indented area of the gasket.*

Avoid damage to open valves.

- *When installing an exchange cylinder head, the plastic protectors fitted to protect the open valves should not be removed until the cylinder head is ready to be fitted.*

Avoid damage to valves and piston crowns after working on valve gear.

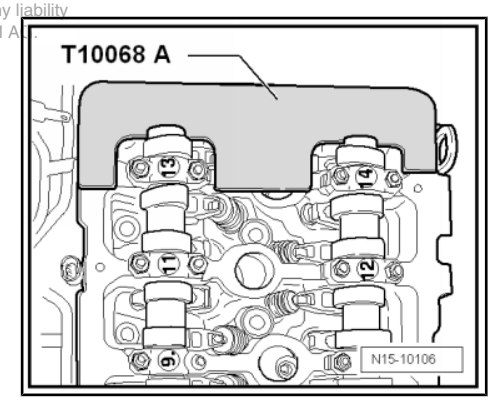
- *Turn the engine carefully at least 2 rotations to ensure that none of the valves make contact when the starter is operated.*

Note

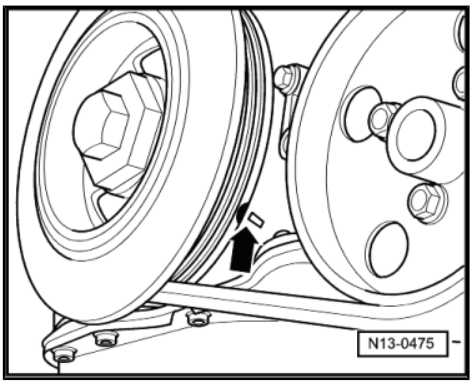
- *Renew the bolts tightened with specified tightening angle.*
- *Renew seals, gaskets and self-locking nuts.*
- *When installing an exchange cylinder head, the contact surfaces between the hydraulic compensation elements, roller rocker fingers and cams must be oiled before installing the cylinder head cover.*
- *Secure all hose connections with the correct type of hose clips (same as original equipment) ⇒ Electronic parts catalogue .*

– Set camshafts to “TDC” before fitting cylinder head.

• You should be able to insert the camshaft bar -T10068 A- in the slots in both camshafts.



– Check again that crankshaft is positioned at “TDC” -arrow-.



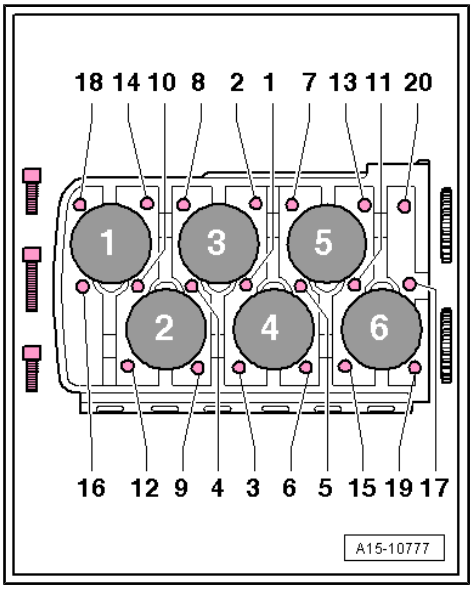
– Place cylinder head gasket in position.

• Note position of centring pins in cylinder block.

• Check installation position of cylinder head gasket; the Part No. should be legible from inlet side.

– Fit cylinder head.

– Insert and hand-tighten cylinder head bolts.



Note

The long cylinder head bolts are inserted in the middle bores in cylinder head.

– Tighten cylinder head bolts ⇒ page 71 .

Note

Cylinder head bolts do not have to be torqued down again later after repair work.

– Install exhaust manifold ⇒ page 181 .

– Install camshaft timing chain ⇒ page 89 .

– Install cylinder head cover ⇒ page 71 .

– Install intake manifold ⇒ Rep. Gr. 24 .

– Observe notes on procedure for connecting the battery ⇒ Rep. Gr. 27 .

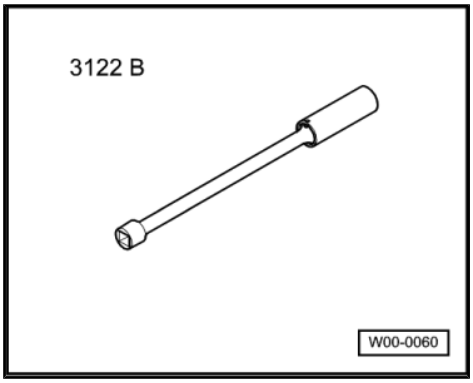
– Change engine oil ⇒ Maintenance ; Booklet 810 .

– Fill cooling system with fresh coolant ⇒ page 145 .

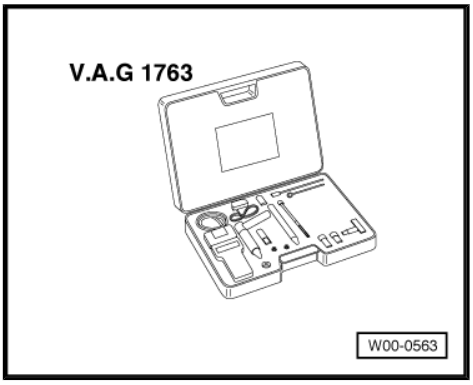
1.4 Checking compression

Special tools and workshop equipment required

♦ Spark plug socket and extension -3122 B-



♦ Compression tester -V.A.G 1763-



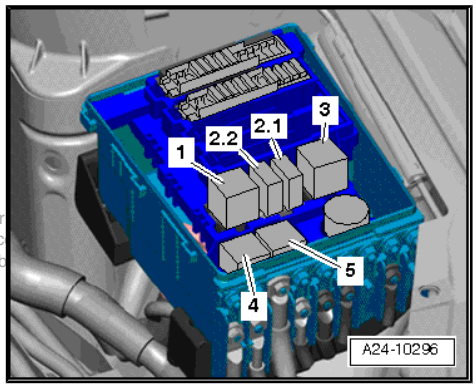
Procedure

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

– Switch off ignition.

– Slide the two clips in the direction of the -arrows- and remove cover from electronics box in engine compartment.

– Detach electric fuel pump 2 relay -J49- -item 2.1- and fuel pump relay -J17- -item 5-.



– Remove ignition coils ⇒ Rep. Gr. 28 .

– Remove spark plugs with spark plug socket and extension -3122 B- .

– Check compression pressure with compression tester -V.A.G 1763- (see ⇒ operating instructions for details of how to use tester).

– Have a 2nd mechanic press down the accelerator pedal completely and at the same time operate the starter until the pressure on the tester display no longer increases.

– Repeat procedure on each cylinder.

Compression pressure	bar
When new	10.0 … 13.0
Wear limit	7.0
Maximum difference between cylinders	3.0

Installation is carried out in the reverse order; note the following:

– Install spark plugs ⇒ Maintenance ; Booklet 810 .

– Install ignition coils ⇒ Rep. Gr. 28 .

The engine control unit will store faults when relays are unplugged.

– Connect vehicle diagnostic, testing and information system -VAS 5051B- .

– Start “Guided Functions” mode.

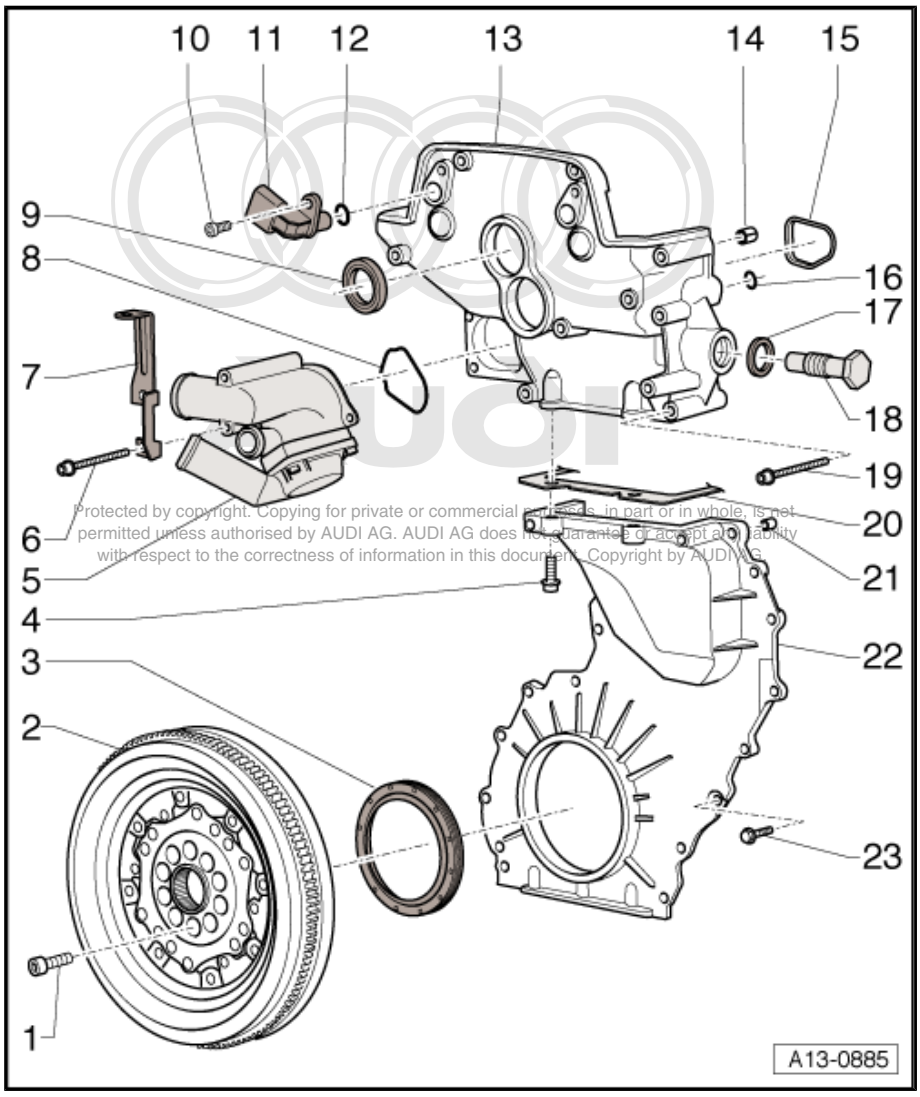
– Generate readiness code in engine control unit.

2 Chain drive

2.1 Timing chain covers - exploded view

Note

-Items 1 ... 3- *⇒ page 56* *.*



4 - Bolt
- ❑ Tightening torque ⇒ page 81

5 - Thermostat housing
- ❑ Removing and installing ⇒ page 158

6 - Bolt
- ❑ 10 Nm

7 - Bracket
- ❑ Version fitted in vehicle may differ from illustration

8 - Gasket
- ❑ Renew

9 - Oil seal
- ❑ 2x
- ❑ For inlet camshaft control valve 1 -N205- and exhaust camshaft control valve 1 -N318-
- ❑ Renew if damaged or leaking
- ❑ Renewing ⇒ page 81

10 - Bolt
- ❑ 10 Nm

11 - Hall sender
- ❑ 2x
- ❑ Mark electrical connector before disconnecting

12 - O-ring
- ❑ 2x
- ❑ Renew

13 - Timing chain cover (top)
- ❑ Coat sealing surfaces with sealant when installing ⇒ page 93

14 - Dowel sleeve
- ❑ 2x

15 - Gasket
- ❑ Renew

16 - O-ring
- ❑ Renew

17 - Seal

- ❑ Renew if damaged or leaking

18 - Chain tensioner for camshaft timing chain

- ❑ Tightening torque ⇒ page 83

19 - Bolt

- ❑ Tightening torque and tightening sequence ⇒ page 81

20 - Cylinder head gasket

- ❑ Clean bores and fill with sealant ⇒ page 93

21 - Dowel pin

22 - Timing chain cover (bottom)

- ❑ Coat sealing surfaces with sealant when installing; for sealant refer to ⇒ Electronic parts catalogue

23 - Bolt

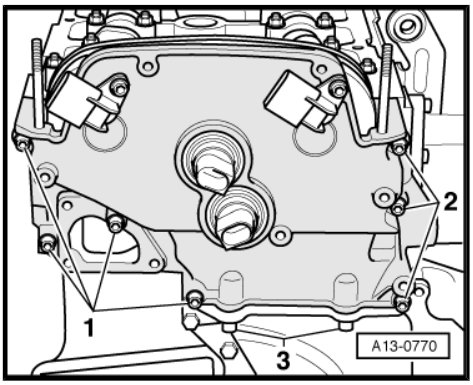
- ❑ 10 Nm
- ❑ Tighten in stages and in diagonal sequence

Timing chain cover (top) - tightening torque and tightening sequence

1 - Tighten bolts -1 - and -2- initially to 5 Nm.

2 - Tighten bolts -3- to 23 Nm.

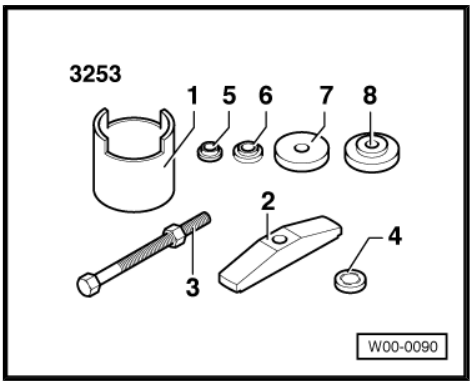
3 - Tighten bolts -1- and -2- to 10 Nm.



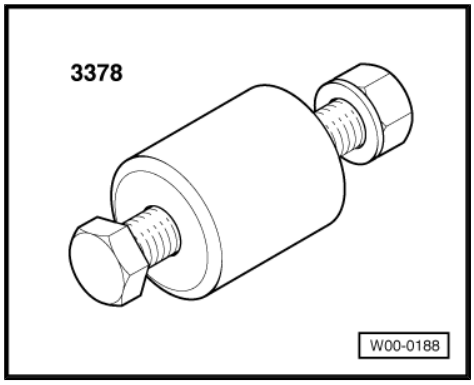
2.2 Renewing oil seals in timing chain cover (top)

Special tools and workshop equipment required

- ♦ Assembly tool -3253-

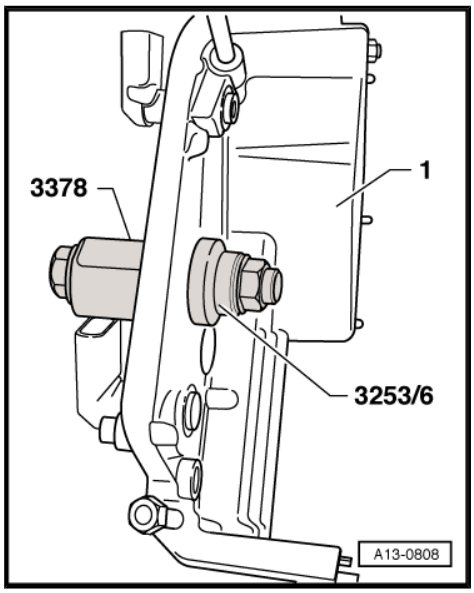


♦ Fitting sleeve -3378-

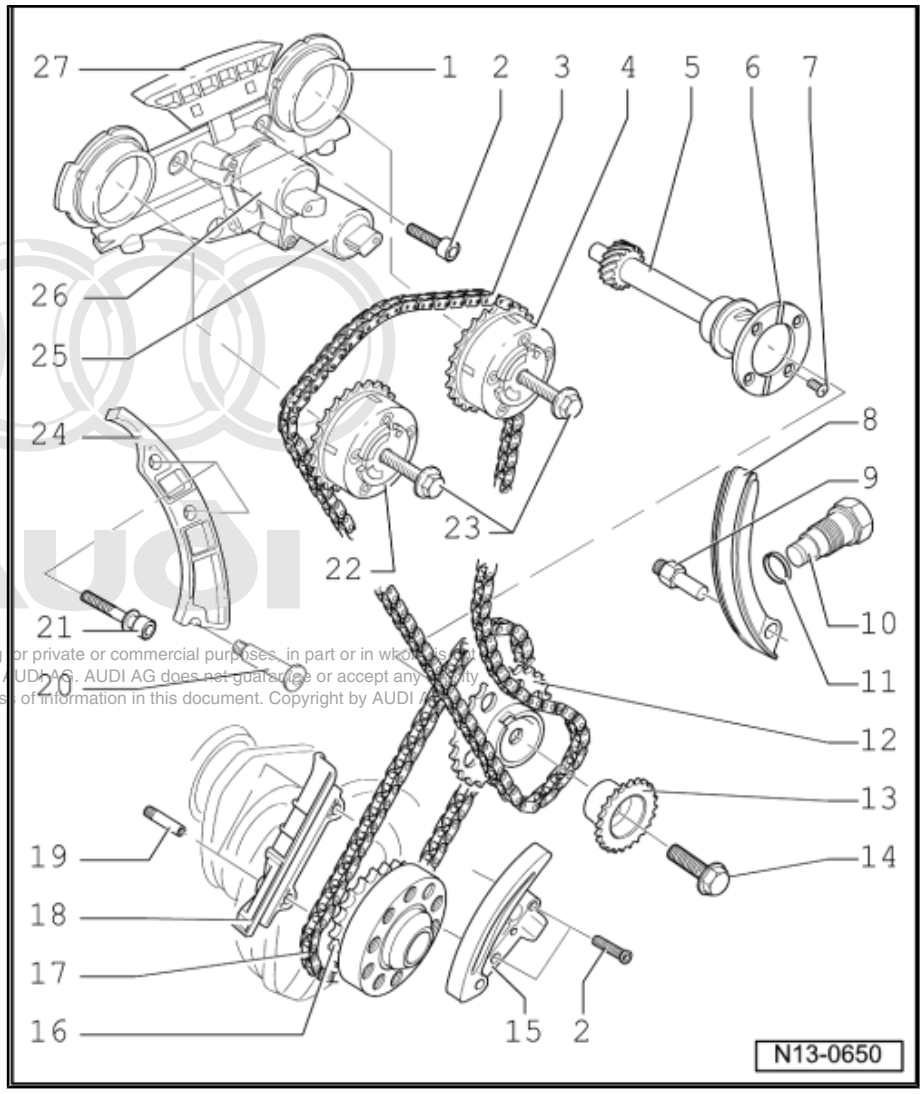


Procedure

– Remove timing chain cover (top) and detach timing chain from camshafts ⇒ page 85 .
– Use drift to drive oil seals out of timing chain cover (top)
– Use fitting sleeve -3378- to fit oil seal in timing chain cover (top) -1-.
– Press oil seal in flush with fitting sleeve from -3253/6- .
– Install camshaft timing chain ⇒ page 89 .



2.3 Timing chain - exploded view of components



1 - Valve timing housing

- ❑ Removing and installing ⇒ “3.4 Removing and installing camshafts”, page 110
- ❑ Dismantling and assembling ⇒ page 108
- ❑ Check filter for dirt ⇒ page 108
- ❑ Lightly coat contact surfaces of oil seals before installing

2 - Bolt

- ❑ Renew
- ❑ 8 Nm

3 - Camshaft timing chain

- ❑ Before removing, mark running direction in colour ⇒ page 85
- ❑ Removing from camshafts ⇒ page 85
- ❑ Removing and installing ⇒ page 94

4 - Camshaft adjuster - exhaust

- ❑ Identification: “32A”
- ❑ Removing and installing ⇒ “2.4 Detaching and re-fitting timing chain on camshafts”, page 85

5 - Intermediate shaft

6 - Thrust washer

7 - Bolt

- ❑ Apply locking fluid when installing; refer to ⇒ Electronic parts catalogue
- ❑ 8 Nm

8 - Tensioning rail for timing chain

- ❑ To remove and install it is first necessary to remove both timing chain covers (top and bottom)

9 - Pivot pin

10 - Chain tensioner for camshaft timing chain

- ❑ Removing and installing ⇒ “2.4 Detaching and re-fitting timing chain on camshafts”, page 85
- ❑ 40 Nm

11 - Oil seal

- ❑ Renew if damaged or leaking

12 - Sprocket for drive chain for valve gear

- ❑ Removing and installing ⇒ “2.5 Removing and installing camshaft timing chain and drive chain for valve gear”, page 94

13 - Sprocket for camshaft timing chain

- ❑ Removing and installing ⇒ “2.5 Removing and installing camshaft timing chain and drive chain for valve gear”, page 94

14 - Bolt

- ❑ To loosen and tighten use counterhold tool -T10069- to counterhold vibration damper.
- ❑ Renew
- ❑ 60 Nm + 90° (1/4 turn further)

15 - Chain tensioner with tensioning rail

- ❑ For drive chain
- ❑ Before installing, release locking spline in chain tensioner with a small screwdriver and press tensioning rail against chain tensioner

16 - Drive chain sprocket

- ❑ Integral part of crankshaft

17 - Drive chain for valve gear

- ❑ Before removing, mark running direction in colour ⇒ page 85
- ❑ Removing and installing ⇒ page 94

18 - Guide rail for drive chain for valve gear

- ❑ Removing and installing
⇒ “2.5 Removing and installing camshaft timing chain and drive chain for valve gear”, page 94

19 - Pin

- ❑ For guide rail
- ❑ 10 Nm

20 - Pivot pin

- ❑ 18 Nm

21 - Bolt

- ❑ 23 Nm

22 - Camshaft adjuster - inlet

- ❑ Identification: “24E”
- ❑ Removing and installing ⇒ “2.4 Detaching and re-fitting timing chain on camshafts”, page 85

23 - Bolt

- ❑ To loosen and tighten, counterhold with open-end spanner on hexagon flats of camshaft ⇒ page 85
- ❑ Renew
- ❑ Contact surface of sender wheel at bolt head must be dry when installing.
- ❑ 60 Nm + 90° (1/4 turn further)

24 - Guide rail for camshaft timing chain

- ❑ Removing and installing ⇒ “2.4 Detaching and re-fitting timing chain on camshafts”, page 85

25 - Inlet camshaft control valve 1 -N205-

- ❑ For inlet camshaft
- ❑ Mark electrical connector before disconnecting

26 - Exhaust camshaft control valve 1 -N318-

- ❑ For exhaust camshaft
- ❑ Mark electrical connector before disconnecting

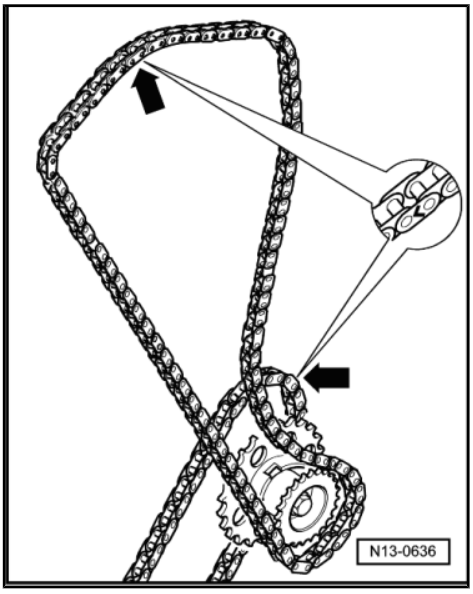
27 - Guide rail for camshaft timing chain

- ❑ Clipped onto valve timing housing

Marking rotation direction of timing chains

– Mark rotation direction of timing chains with coloured arrows for re-installation -arrows-.

> **Caution**
>
> *Avoid damage to timing chains.*
>
> ♦ *Do not mark chains by means of centre punch, notch or the like.*

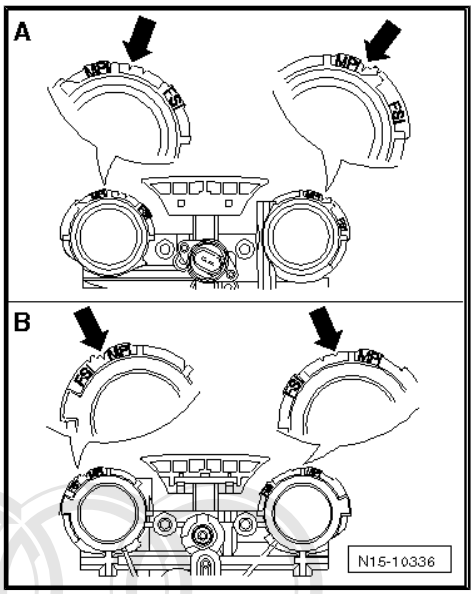


Markings on valve timing housing on MPI engines

-A- Illustration shows flywheel end

-B- Illustration shows vibration damper end

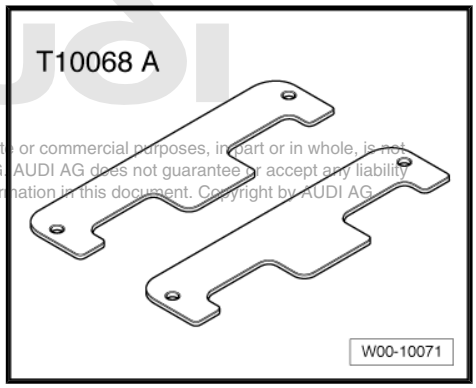
Notches -arrows- serve as reference points for markings on camshaft adjusters.



2.4 Detaching and re-fitting timing chain on camshafts

Special tools and workshop equipment required

♦ Camshaft bar -T10068 A-



♦ Sealant ⇒ Electronic parts catalogue

Detaching camshaft timing chain

- Engine in vehicle.

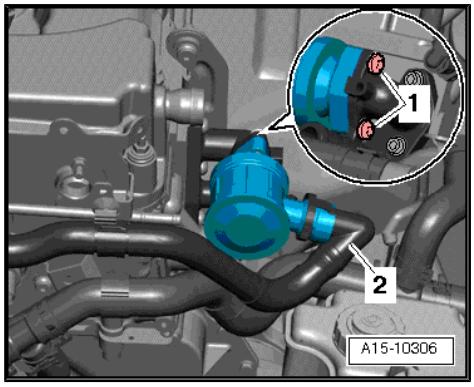
– Drain coolant ⇒ page 145 .

– Remove intake manifold ⇒ Rep. Gr. 24 .

– Remove thermostat housing ⇒ page 158 .

Vehicles with engine code letters BUB:

– Disconnect hose -2- from combination valve for secondary air system.

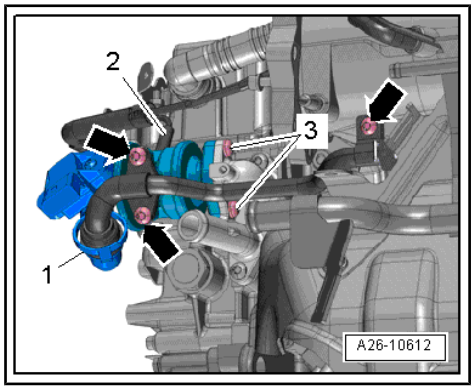


Note

Disregard item -1-.

Vehicles with engine code letters CBRA:

– Disconnect hose -1- and vacuum hose -2- from combination valve for secondary air system (left-side).



Note

Disregard items marked -3- and -arrows-.

All vehicles (continued):

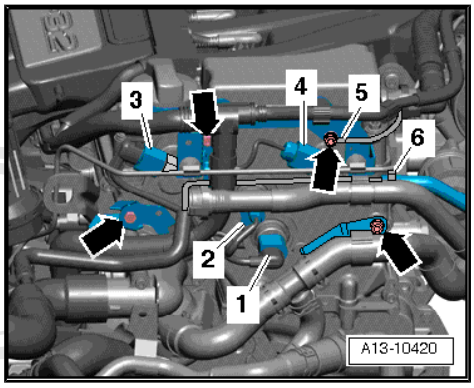
– Mark electrical connectors and unplug:

1 - Exhaust camshaft control valve 1 -N318-

2 - Inlet camshaft control valve 1 -N205-

3 - Hall sender -G40-

4 - Hall sender 2 -G163-



– Unscrew earth wire -5-.

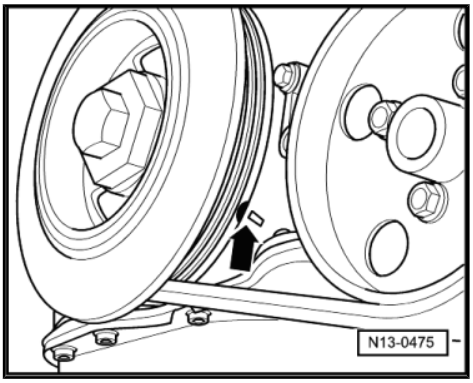
– Disconnect coolant hose -6-.

– Remove bracket for electrical wiring -arrows-.

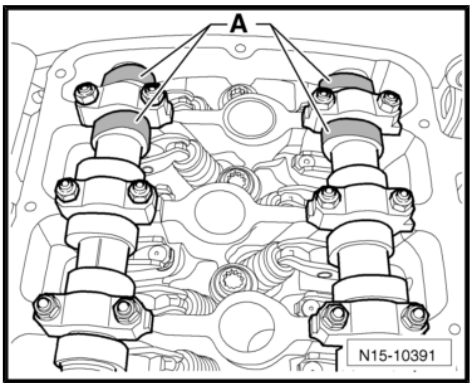
– Place bracket with electrical wiring to front.

– Remove cylinder head cover ⇒ page 71 .

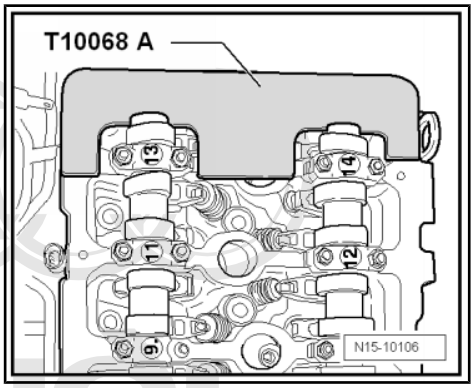
– Turn crankshaft in direction of engine rotation via bolt for vibration damper until marking is at “TDC” -arrow-.



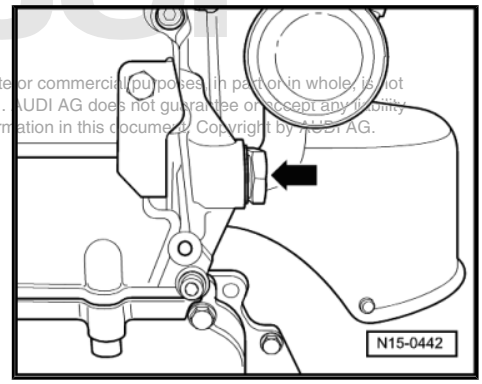
– Cams -A- of cylinder 1 must face each other.



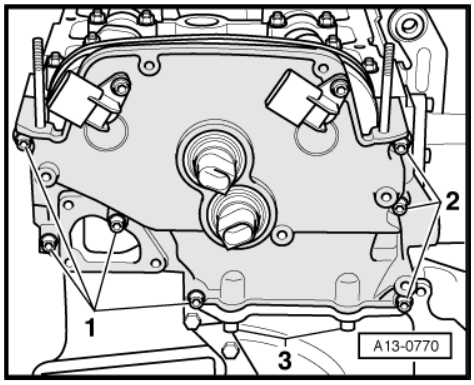
– At the same time insert camshaft bar -T10068 A- in the slots on both camshafts; if necessary, turn the crankshaft 1 rotation further.



– Remove chain tensioner -arrow- for camshaft timing chain.



– Remove bolts -1, 2, 3-.



Caution

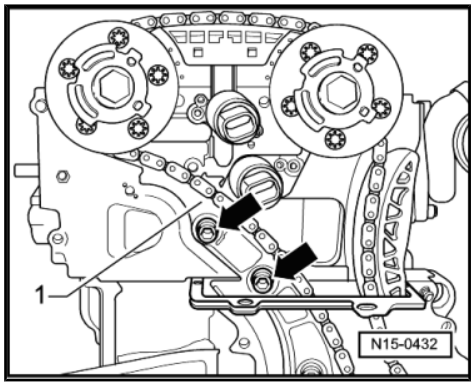
Avoid damage to cylinder head gasket.

- *Pull timing chain cover (top) off cylinder head horizontally.*

– Unscrew bolts -arrows- and remove guide rail -1-.

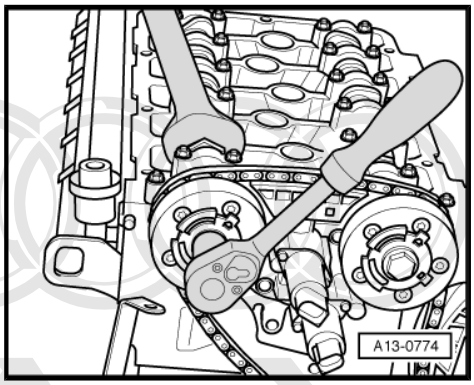
– Remove camshaft bar -T10068 A- .

• The camshaft bar -T10068 A- must not be in place when loosening and tightening the securing bolts for the camshaft adjusters.



– Remove bolt at camshaft adjuster (inlet side); counterhold with open-end spanner on hexagon flats of camshaft.

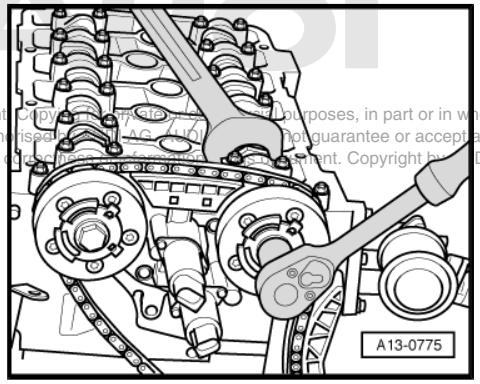
– Remove camshaft adjuster (inlet side).



– Remove bolt at camshaft adjuster (exhaust side); counterhold with open-end spanner on hexagon flats of camshaft.

– Remove camshaft adjuster (exhaust side).

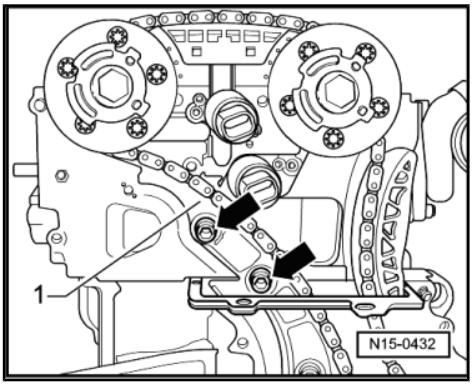
– Place camshaft timing chain over camshaft control valves.



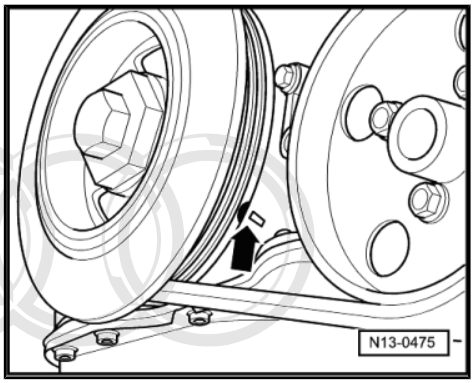
Installing (adjusting valve timing)

- Tightening torques ⇒ page 80 , ⇒ page 81 and ⇒ page 83 .

– Install guide rail -1- and tighten bolts -arrows-.

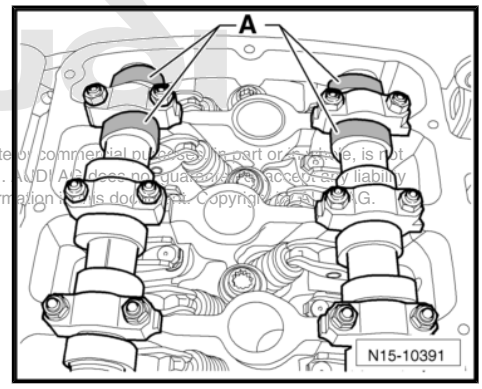


– Check again that crankshaft is positioned at “TDC” -arrow-.

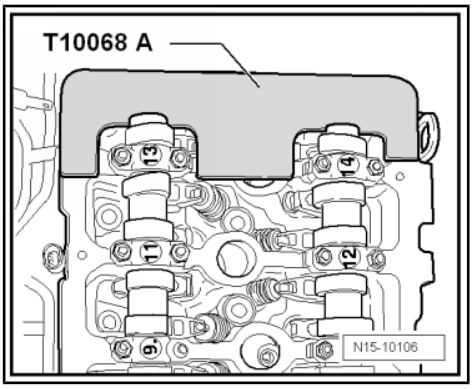


– Check TDC position of camshafts:

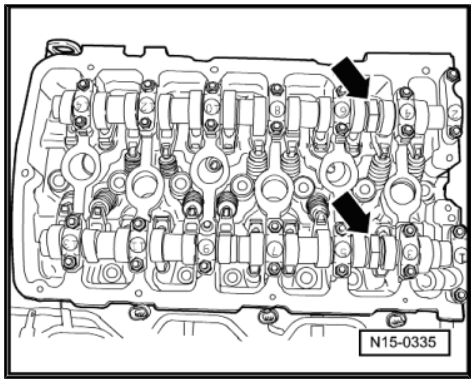
- Cams -A- of cylinder 1 must face each other.



- You should be able to insert the camshaft bar -T10068 A- in the slots in both camshafts.



– If necessary, turn camshafts at hexagon flats -arrows- to correct position using a 32 mm open-end spanner.

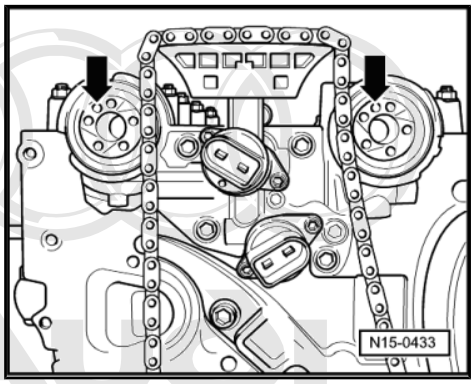


Caution

Avoid damage to valves and piston crowns.

- *The crankshaft must not be at "TDC" at any cylinder when the camshafts are turned.*

– If necessary, turn camshafts at hexagon flats -arrows- to correct position using a open-end spanner.



Note

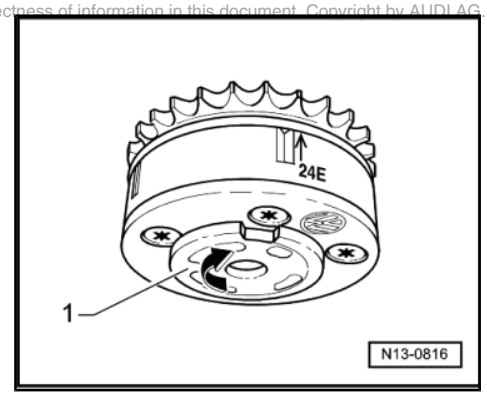
The two camshaft adjusters (marking 24E on inlet side and 32A on exhaust side) can only be secured to camshaft mounting in one position -arrows- (due to a dowel pin fitted).

Special tools and workshop equipment required

-

– First install camshaft adjuster (inlet side):

– Turn sender wheel -1- clockwise -arrow- in camshaft adjuster as far as the stop.

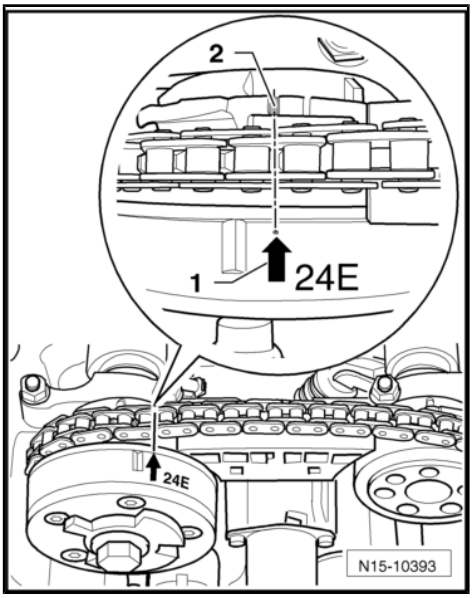


– Tighten the camshaft adjuster (inlet side) in this position to the inlet camshaft finger-tight.

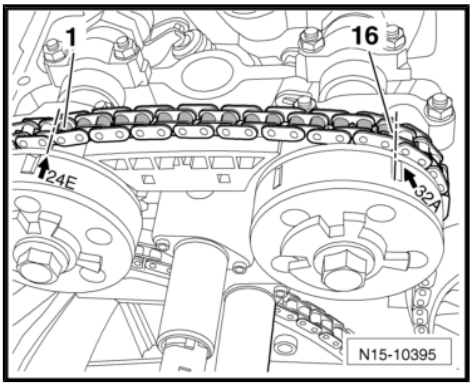
• Contact surface of sender wheel at bolt head must be dry when installing.

• The marking “24E” -item 1- and the tooth just behind it must align with the notch -2- in the valve timing housing. Markings on valve timing housing ⇒ page 85

– Lay the camshaft timing chain in this position tautly onto the chain sprocket of camshaft adjuster (inlet side).



– Now count exactly 16 rollers on timing chain to the right starting at gear aligning with marking “24E”. Mark this roller with coloured pen.

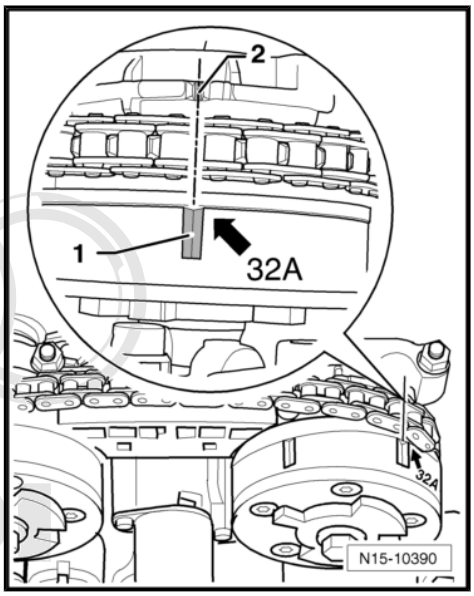


Note

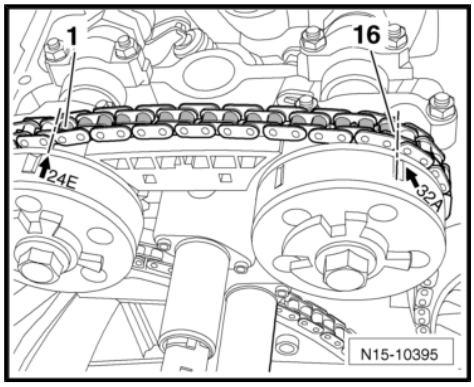
The camshaft adjuster (exhaust side) is locked in “rest position”, so the sender wheel cannot be turned out of position when adjusting the valve timing. If the camshaft adjuster is not locked in “rest position”, turn adjuster by hand in both directions until it engages. If this is not possible, renew camshaft adjuster.

– Fit camshaft adjuster (exhaust side) “32A” into camshaft roller chain with gear tooth at marking -1-, so that there are exactly the 16 counted rollers between marking “24E” and “32A” and the markings -1- and -2- align.

– It must be easily possible to attach camshaft adjuster (exhaust side) to camshaft (exhaust side) and to tighten it hand-tight.

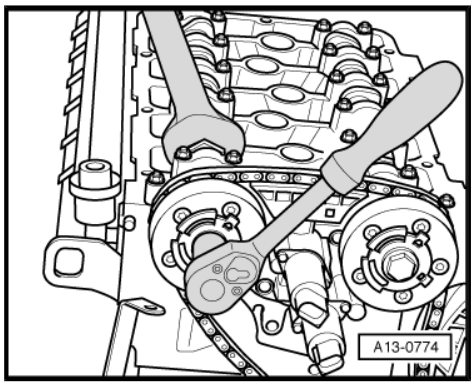


– Check again that both camshaft adjusters are positioned correctly.

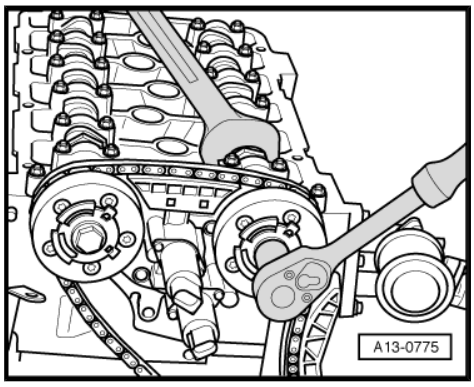


– Remove camshaft bar -T10068 A- .

– Tighten bolt at camshaft adjuster (inlet side); counterhold with open-end spanner on hexagon flats of camshaft.



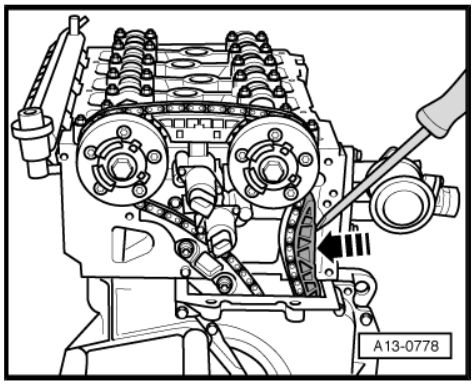
– Tighten bolt at camshaft adjuster (exhaust side); counterhold with open-end spanner on hexagon flats of camshaft.



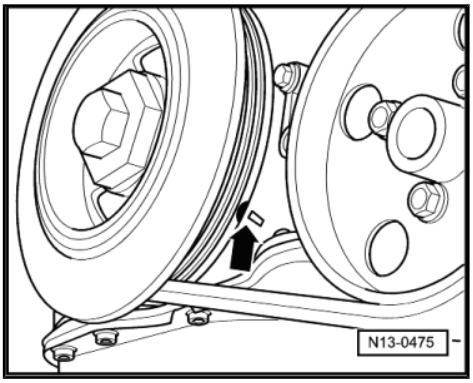
Caution

Prevent timing chain from slipping.

- *When turning the crankshaft, it is necessary to press the tensioning rail firmly against the camshaft timing chain manually (to replace function of chain tensioner) -arrow-.*

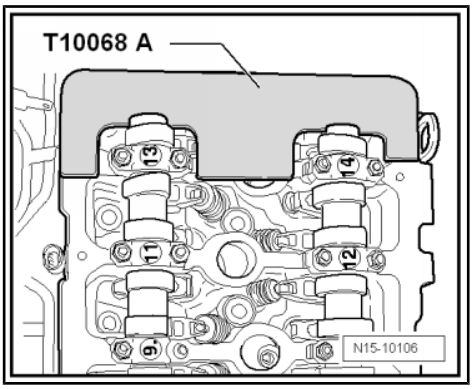


– Turn crankshaft via the bolt for vibration damper 2 rotations in the normal direction of rotation until the marking is at “TDC” -arrow-.



• You should then be able to insert the camshaft bar -T10068 A- in the slots in both camshafts.

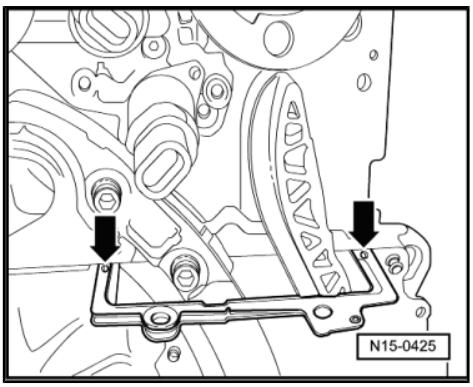
– If the camshaft bar cannot be inserted, adjust valve timing again.



– Clean old sealant from the 3 mm bores -arrows- in the cylinder head gasket.

Note

With the cylinder head installed the holes in the cylinder head gasket are only half visible.



– Fill 3 mm bores in cylinder head gasket with sealant.

– Renew oil seals in timing chain cover (top) ⇒ page 81 .

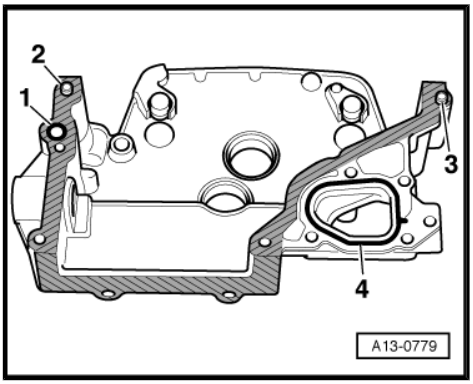
– Clean sealing surfaces; they must be free of oil and grease.

– Check that dowel sleeves -2- and -3- are fitted in timing chain cover (top).

– Insert a new oil seal -1- and a new seal -4-.

– Thinly coat clean surfaces -hatched area- on timing chain cover (top) with sealant.

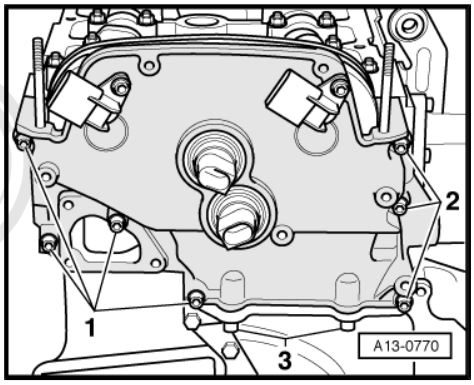
– Also apply a thin coat of sealant to the surface beneath the cylinder head gasket (do not kink gasket).



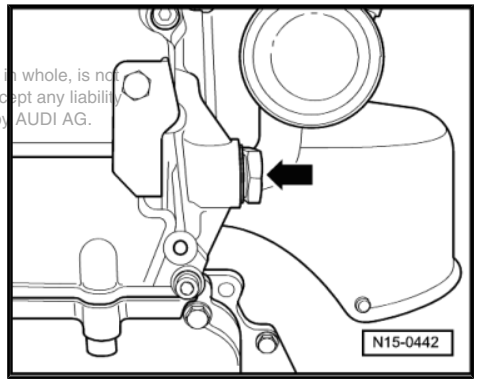
Note

Fit timing chain cover (top) within 5 minutes after applying sealant.

– Fit timing chain cover (top) and tighten bolts ⇒ page 81 .



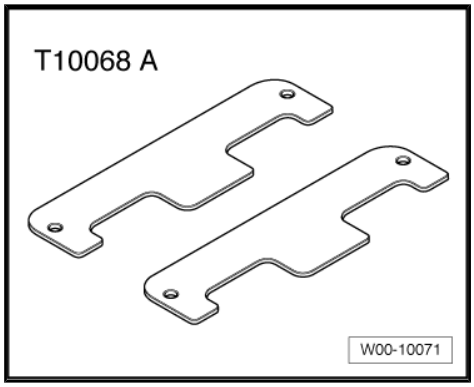
– Secure chain tensioner -arrow- for camshaft timing chain.
– Turn crankshaft at bolt for vibration damper 2 rotations in normal direction of rotation until marking is at “TDC”.
– Checking valve timing again.
– Install cylinder head cover ⇒ page 71 .
– Install intake manifold ⇒ Rep. Gr. 24 .
– Install thermostat housing ⇒ page 158 .



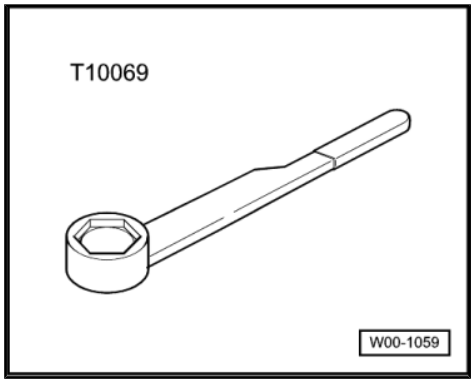
2.5 Removing and installing camshaft timing chain and drive chain for valve gear

Special tools and workshop equipment required

♦ Camshaft bar -T10068 A-



♦ Counterhold tool -T10069-



♦ Sealant ⇒ Electronic parts catalogue

Removing

– Remove engine ⇒ page 11 .

– Separate engine and gearbox: vehicles with manual gearbox ⇒ page 27 , vehicles with direct shift gearbox ⇒ page 29 .

– Remove dual-mass flywheel ⇒ page 56 .

– Remove intake manifold ⇒ Rep. Gr. 24 .

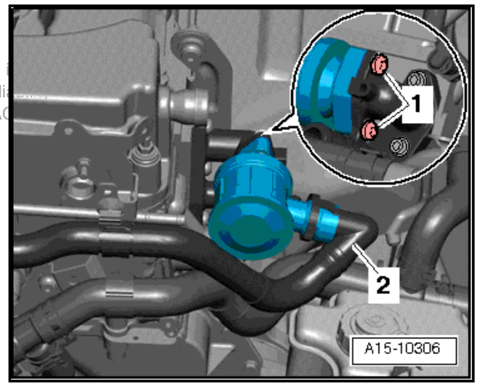
– Remove thermostat housing ⇒ page 158 .

Vehicles with engine code letters BUB:

– Disconnect hose -2- from combination valve for secondary air system.

Note

Disregard item -1-.

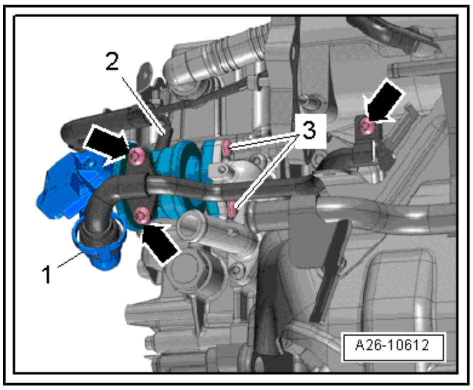


Vehicles with engine code letters CBRA:

– Disconnect hose -1- and vacuum hose -2- from combination valve for secondary air system (left-side).

Note

Disregard items marked -3- and -arrows-.



All vehicles (continued):

– Mark electrical connectors and unplug:

1 - Exhaust camshaft control valve 1 -N318-

2 - Inlet camshaft control valve 1 -N205-

3 - Hall sender -G40-

4 - Hall sender 2 -G163-

– Unscrew earth wire -5-.

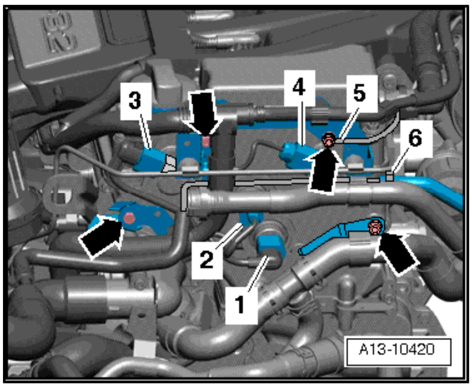
– Disconnect coolant hose -6-.

– Remove bracket for electrical wiring -arrows-.

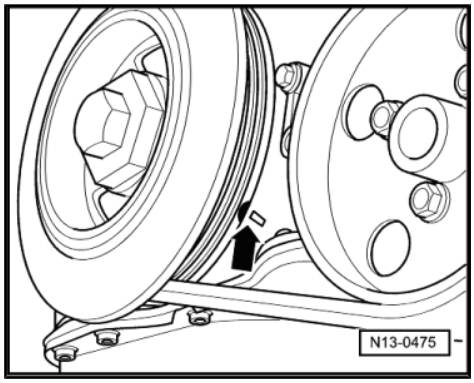
– Place bracket with electrical wiring to front.

– Remove cylinder head cover ⇒ page 71 .

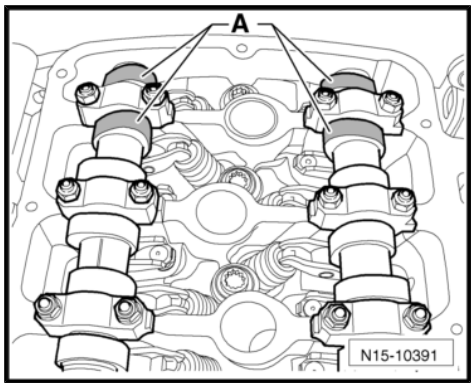
– Remove sump ⇒ page 131 .



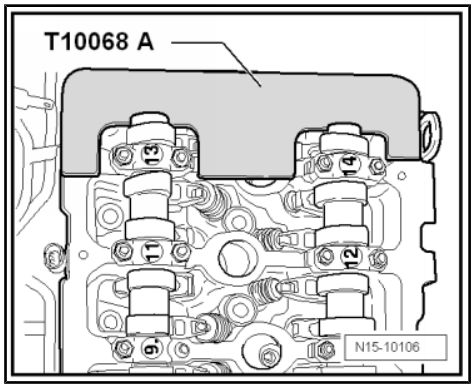
– Turn crankshaft in direction of engine rotation via bolt for vibration damper until marking is at “TDC” -arrow-.



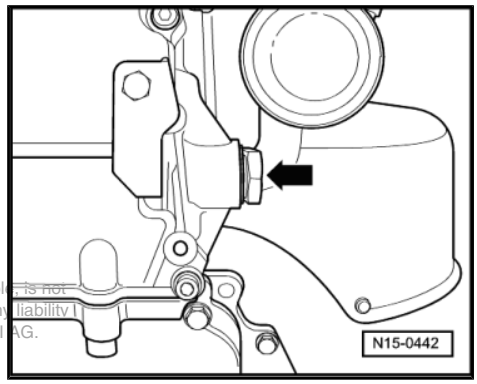
– Cams -A- of cylinder 1 must face each other.



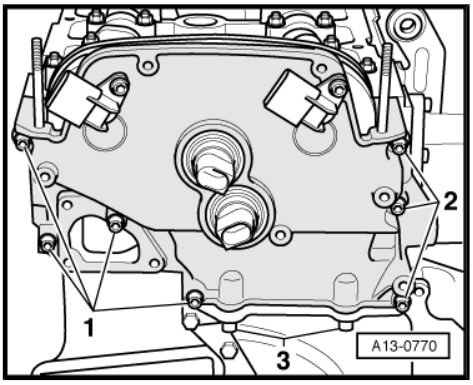
– At the same time insert camshaft bar -T10068 A- in the slots on both camshafts; if necessary, turn the crankshaft 1 rotation further.



– Remove chain tensioner -arrow- for camshaft timing chain.

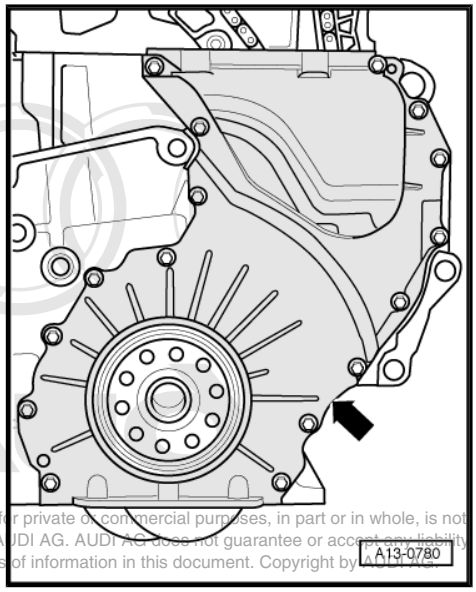


– Remove bolts -1, 2, 3-.



> **Caution**
>
> *Avoid damage to cylinder head gasket.*
>
> - *Pull timing chain cover (top) off cylinder head horizontally.*

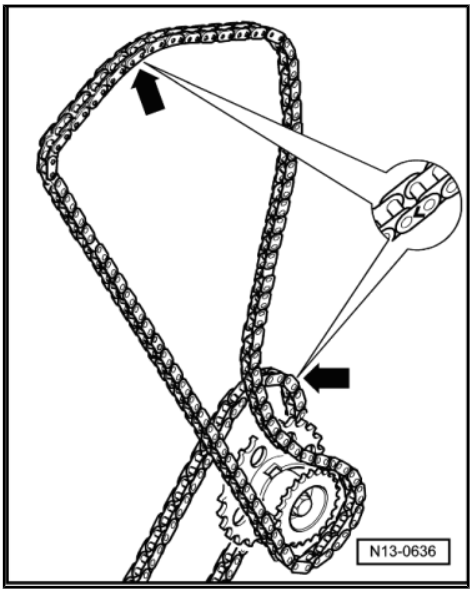
– Remove bolts for for timing chain cover (bottom) -arrow-.



> **Caution**
>
> *Avoid damage to cylinder head gasket.*
>
> - *Pull timing chain cover (bottom) off cylinder block horizontally.*

– Press crankshaft oil seal out of timing chain cover (bottom).

– Mark rotation direction of timing chains with coloured arrows for re-installation -arrows-.

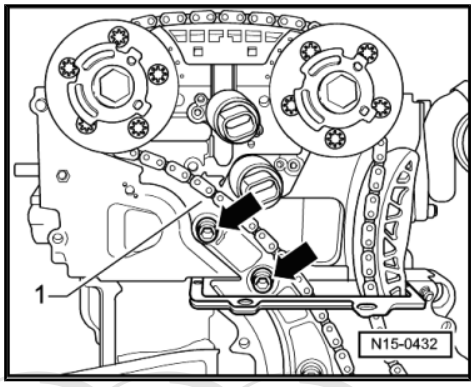


> **Caution**
>
> *Avoid damage to timing chains.*
>
> - *Do not mark chains by means of centre punch, notch or the like.*

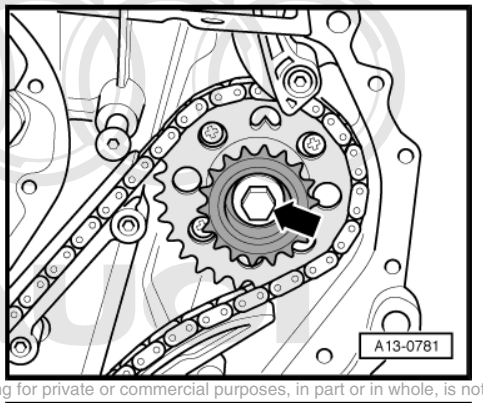
– Unscrew bolts -arrows- and remove guide rail -1-.

– Remove camshaft timing chain from chain sprocket for intermediate shaft.

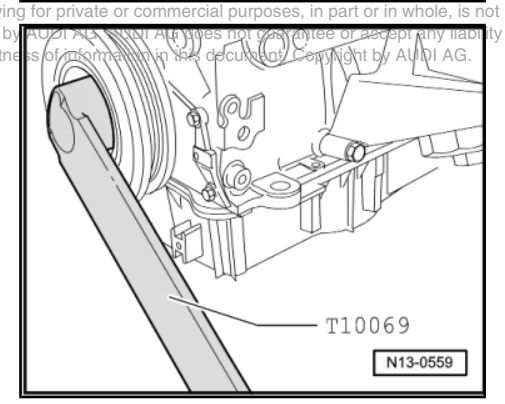
– Pull out camshaft timing chain carefully from behind the projection on the cylinder head gasket.



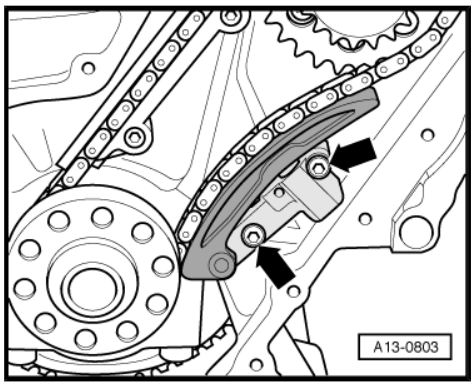
– Slacken off bolt -arrow- for chain sprockets approx. 1 turn.



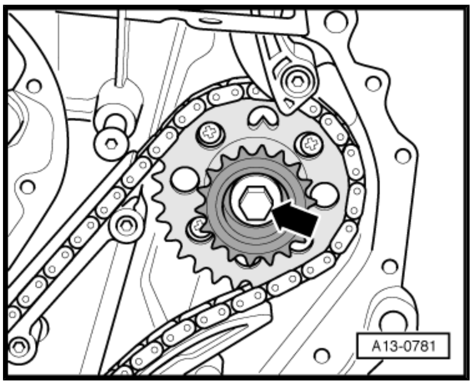
– Use counterhold tool -T10069- to counterhold bolt for vibration damper.



– Unscrew chain tensioner for drive chain for valve gear -arrows-.



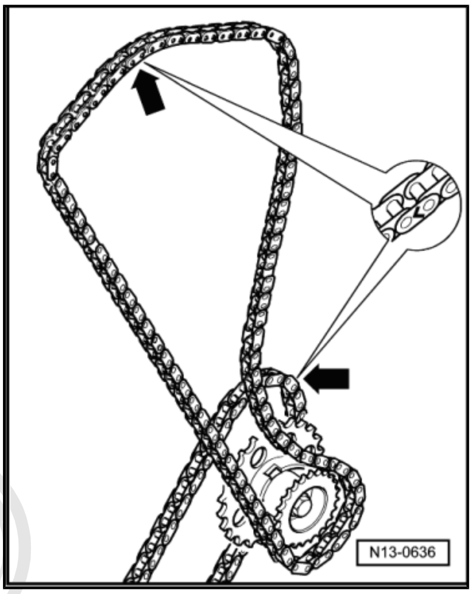
– Unscrew bolt -arrow- and remove drive chain together with chain sprockets from intermediate shaft.



Installing

- Tightening torques ⇒ page 80 , ⇒ page 83 .

– Note the marking for rotation direction -lower arrow- when re-installing a used drive chain for valve gear.



– Install drive chain together with large sprocket on intermediate shaft.

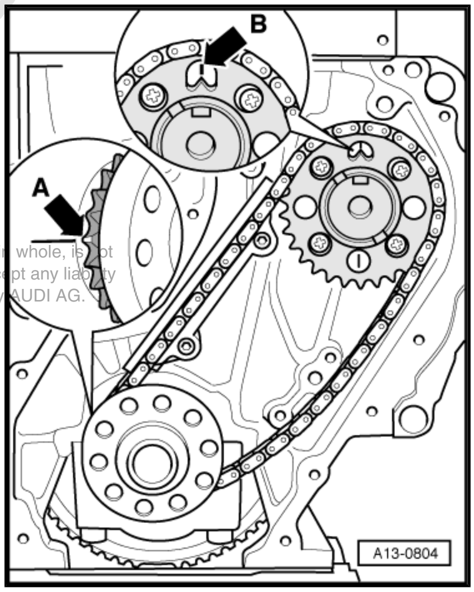
- Can only be installed in one position.

– Turn intermediate shaft slightly if large sprocket cannot be fitted.

– Check whether the crankshaft is still positioned at “TDC”:

- The ground-down tooth of the drive chain sprocket must align with the main bearing joint -arrow A-.

- The notch on the sprocket for intermediate shaft must align with the groove -arrow B- on the thrust washer for intermediate shaft.

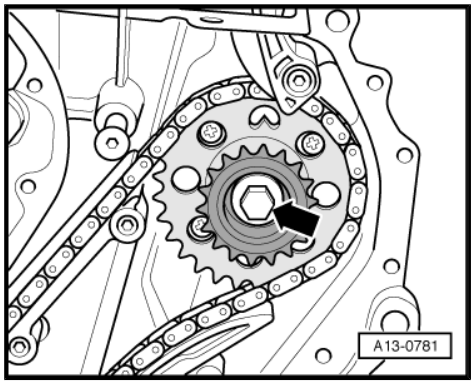


– Fit small sprocket to intermediate shaft.

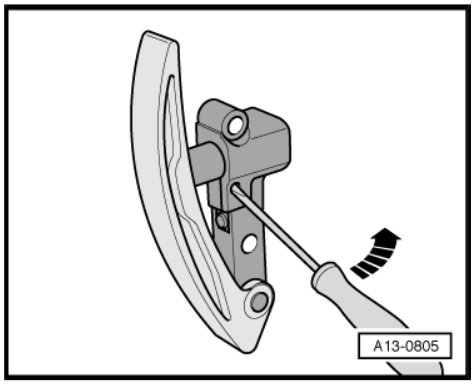
• Can only be installed in one position.

– Renew bolt for chain sprockets of intermediate shaft.

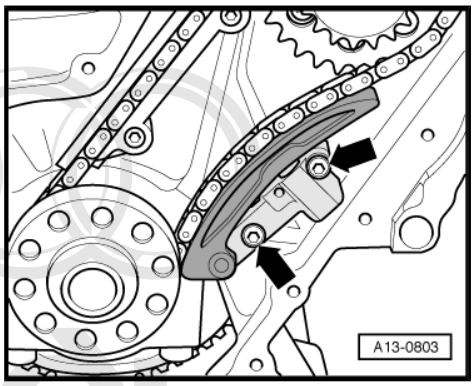
– Hand-tighten bolt -arrow- for chain sprockets.



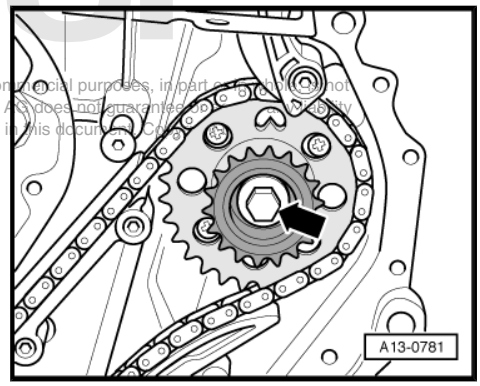
– Release locking spline in chain tensioner with a small screwdriver -arrow-.



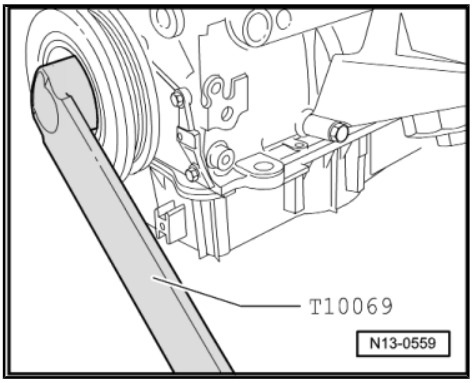
– Press tensioning rail against chain tensioner and secure chain tensioner in this position -arrows-.



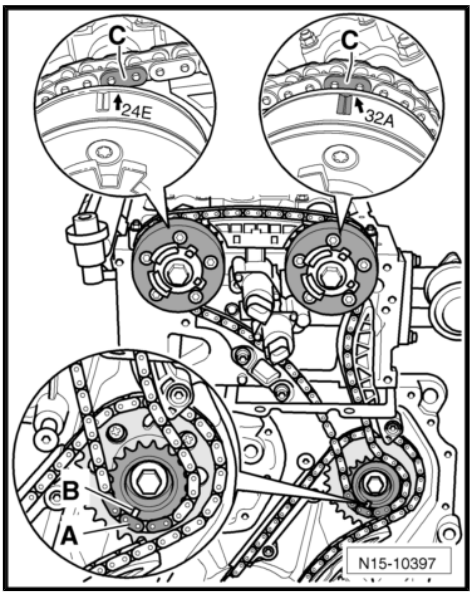
– Tighten bolt for chain sprockets -arrow-.



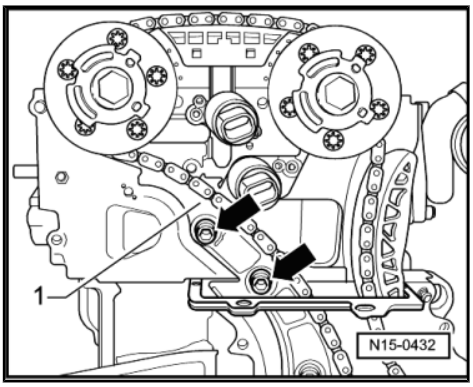
– Use counterhold tool -T10069- to counterhold bolt for vibration damper.



– Fit timing chain onto camshaft adjusters. Make sure that the two individual copper-coloured chain links -C- align with markings on camshaft adjuster. In some cases the camshaft adjuster (inlet side) must be turned slightly.
– Fit timing chain onto small chain sprocket. The marking -B- must align with the copper-coloured chain link in the middle -A-.



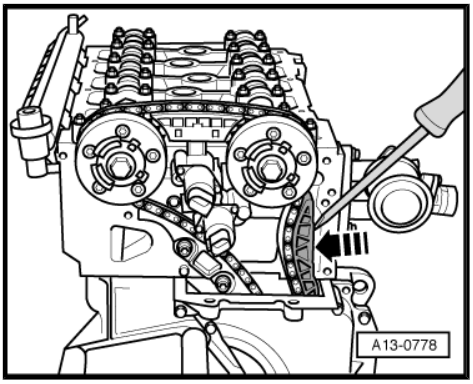
– Install guide rail -1- and tighten bolts -arrows-.
– Remove camshaft bar -T10068 A- .



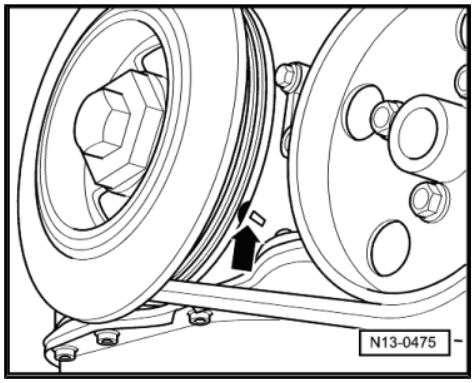
Caution

Prevent timing chain from slipping.

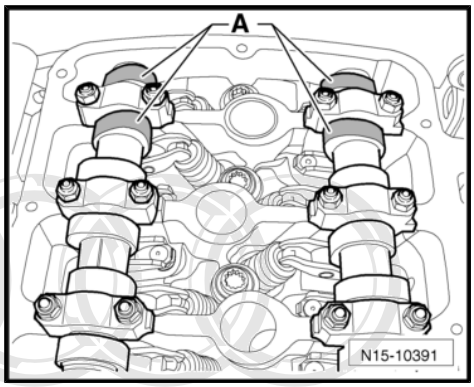
- *When turning the crankshaft, it is necessary to press the tensioning rail firmly against the camshaft timing chain manually (to replace function of chain tensioner) -arrow-.*



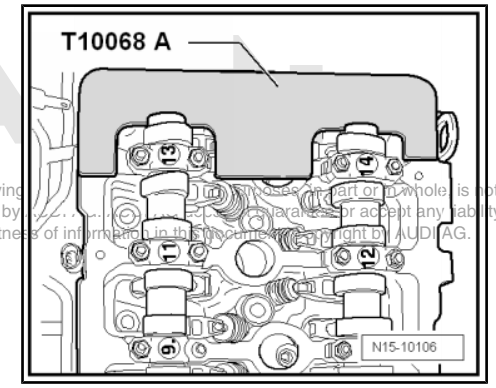
– Turn crankshaft via the bolt for vibration damper 2 rotations in the normal direction of rotation until the marking is at “TDC” -arrow-.



– Cams -A- of cylinder 1 must face each other.



– You should then be able to insert the camshaft bar -T10068 A- in the slots in both camshafts.



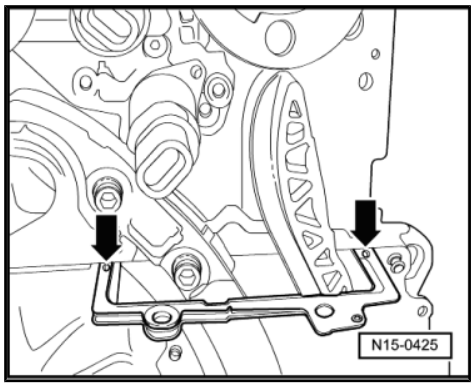
Note

The marked chain links will now be in an undefined position.

If the camshaft bar cannot be inserted:

– Repeat adjustment of valve timing.

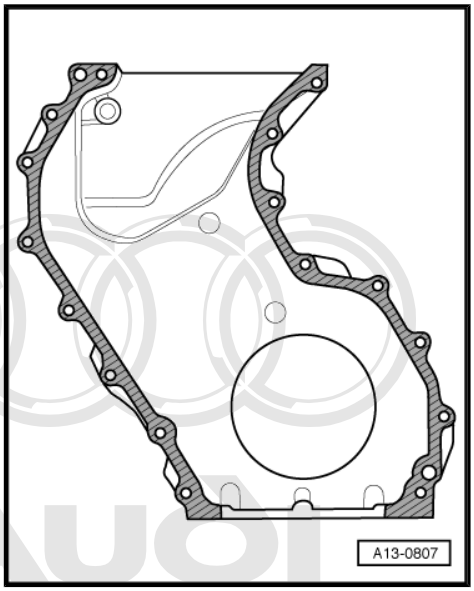
– Clean old sealant from 3 mm bores -arrows- in cylinder head gasket.



Note

With the cylinder head installed the holes in the cylinder head gasket are only half visible.

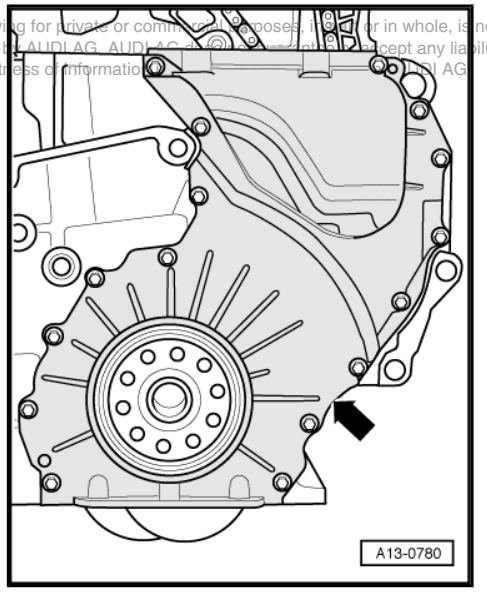
– Check that dowel pins for timing chain cover (bottom) are fitted in cylinder block.
– Thinly coat clean surfaces -hatched area- of timing chain cover (bottom) with sealant.



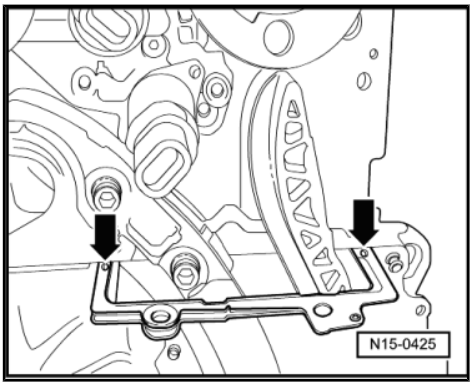
Note

Fit timing chain cover (bottom) within 5 minutes after applying sealant.

– Tighten bolts for timing chain cover (bottom) -arrow-.



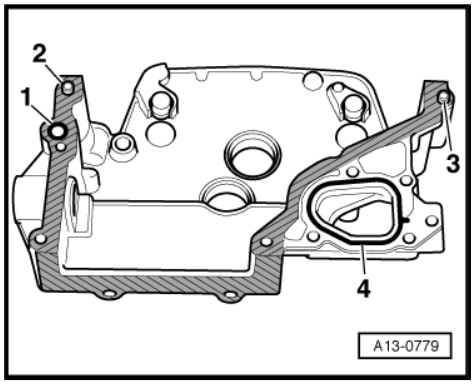
– Fill 3 mm bores -arrows- in cylinder head gasket with sealant.



Note

With the cylinder head installed the holes in the cylinder head gasket are only half visible.

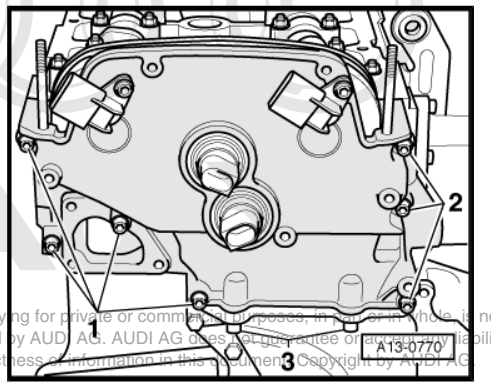
– Renew oil seals in timing chain cover (top) ⇒ page 81 .
– Check that dowel sleeves -2- and -3- are fitted in timing chain cover (top).
– Insert a new oil seal -1- and a new seal -4-.
– Thinly coat clean surfaces -hatched area- of timing chain cover (top) with sealant.
– Also apply a thin coat of sealant to the surface beneath the cylinder head gasket (do not kink gasket).



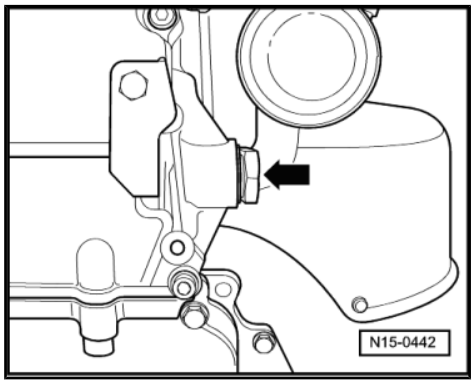
Note

Fit timing chain cover (top) within 5 minutes after applying sealant.

– Fit timing chain cover (top) and tighten bolts ⇒ page 81 .



– Secure chain tensioner -arrow- for camshaft timing chain.
– Turn crankshaft at bolt for vibration damper 2 rotations in normal direction of rotation until marking is at “TDC”.
– Checking valve timing again.
– Install crankshaft oil seal ⇒ page 59 .
– Install cylinder head cover ⇒ page 71 .
– Install intake manifold ⇒ Rep. Gr. 24 .
– Install thermostat housing ⇒ page 158 .
– Install sump ⇒ page 132 .
– Install dual-mass flywheel ⇒ page 56 .
– Install engine ⇒ page 34 .
– Fill with engine oil and check oil level ⇒ page 141 .



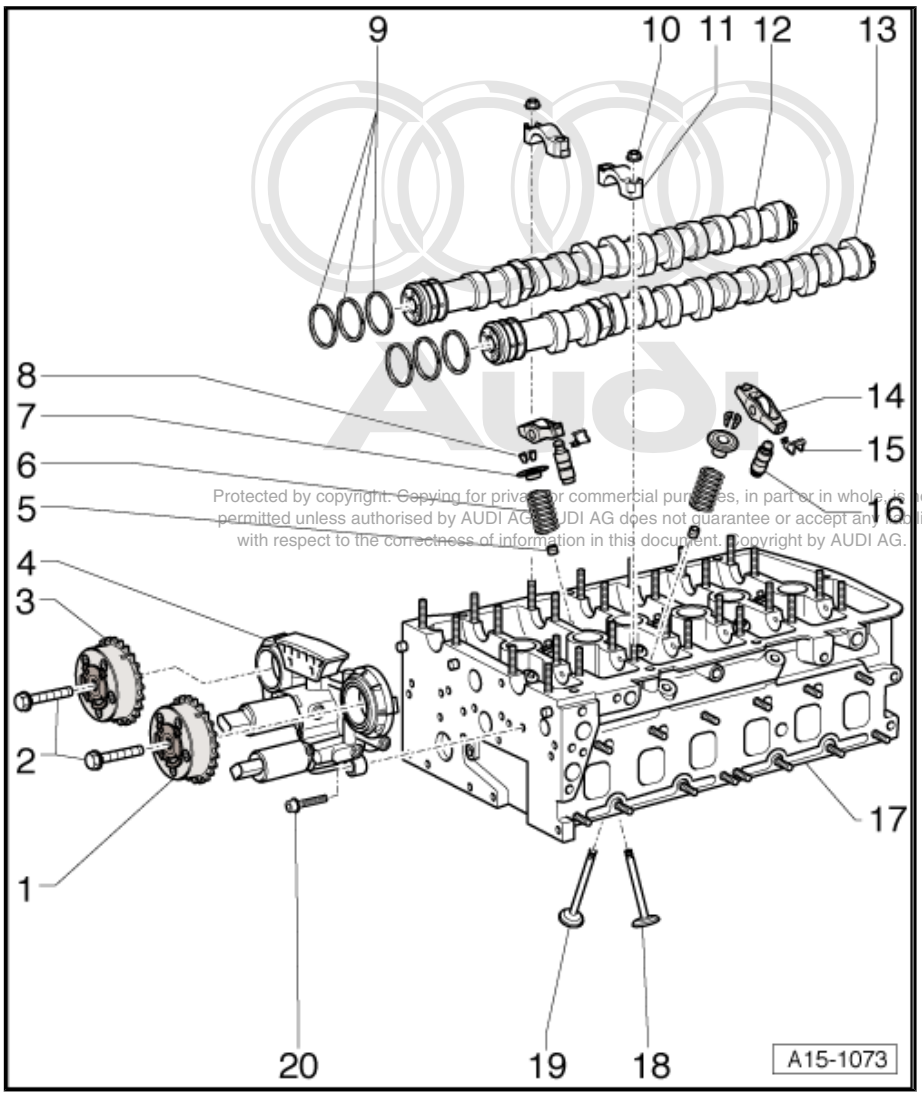
3 Valve gear

Caution

Avoid damage to valves and piston crowns after working on valve gear.

- *The hydraulic tappets have to settle; wait for approx. 30 minutes after installing camshafts before starting engine.*
- *Turn the engine carefully at least 2 rotations to ensure that none of the valves make contact when the starter is operated.*

3.1 Valve gear - exploded view



1 - Camshaft adjuster - exhaust

- ❑ Identification: “32A”
- ❑ Removing and installing ⇒ “2.4 Detaching and refitting timing chain on camshafts”, page 85

2 - Bolt

- ❑ To remove and install, counterhold with open-end spanner on hexagon flats of camshaft ⇒ page 85
- ❑ Renew
- ❑ Tightening torque ⇒ Item 23 (page 84)

3 - Camshaft adjuster - inlet

- ❑ Identification: “24E”
- ❑ Removing and installing ⇒ “2.4 Detaching and refitting timing chain on camshafts”, page 85

4 - Valve timing housing

- ❑ Removing and installing ⇒ “3.4 Removing and installing camshafts”, page 110
- ❑ Check filter of valve timing housing for dirt before installing ⇒ page 108
- ❑ When installing, lightly oil contact surfaces of oil seals
- ❑ Dismantling and assembling ⇒ page 108

5 - Valve stem oil seal

- ❑ Renewing ⇒ page 114

6 - Valve spring

- ❑ Installation position: large ∅ points downwards

7 - Valve spring plate

8 - Valve cotters

9 - Rectangular section seals

- ❑ 3x for each camshaft
- ❑ Renew all if leak detected
- ❑ Do not stretch rectangular section seals too much when fitting
- ❑ Offset gaps by 120°
- ❑ When installing valve timing housing -item 4- lightly oil contact surfaces of rectangular section seals

10 - Nut

- ❑ Tightening torque and tightening sequence ⇒ page 108

11 - Bearing cap

- ❑ Installation position ⇒ page 107
- ❑ Installation sequence ⇒ page 107

12 - Inlet camshaft

- ❑ Identification ⇒ page 107
- ❑ Removing and installing ⇒ page 110
- ❑ Measuring axial clearance ⇒ page 108
- ❑ Measuring radial clearance ⇒ page 109
- ❑ Runout: max. 0.01 mm

13 - Exhaust camshaft

- ❑ Identification ⇒ page 107
- ❑ Removing and installing ⇒ page 110
- ❑ Measuring axial clearance ⇒ page 108
- ❑ Measuring radial clearance ⇒ page 109
- ❑ Runout: max. 0.01 mm

14 - Roller rocker finger

- ❑ Do not interchange
- ❑ Check roller bearing
- ❑ Before installing, check camshaft axial clearance ⇒ page 108
- ❑ Lubricate contact surface
- ❑ Assembly: attach to hydraulic compensation element using securing clip -item 15-

15 - Securing clip

- ❑ Check for firm attachment

16 - Hydraulic valve compensation element

- ❑ Do not interchange
- ❑ Before installing, check camshaft axial clearance ⇒ page 108
- ❑ Lubricate contact surface

17 - Cylinder head

- ❑ Checking valve guides ⇒ page 126
- ❑ Machining valve seats ⇒ page 124

18 - Inlet valve

- ❑ Must not be machined; only grinding-in is permissible
- ❑ Valve dimensions ⇒ page 123
- ❑ Checking valve guides ⇒ page 126
- ❑ Machining valve seats ⇒ page 124

19 - Exhaust valve

- ❑ Must not be machined; only grinding-in is permissible

- ❑ Valve dimensions ⇒ page 123
- ❑ Checking valve guides ⇒ page 126
- ❑ Machining valve seats ⇒ page 124

20 - Bolt

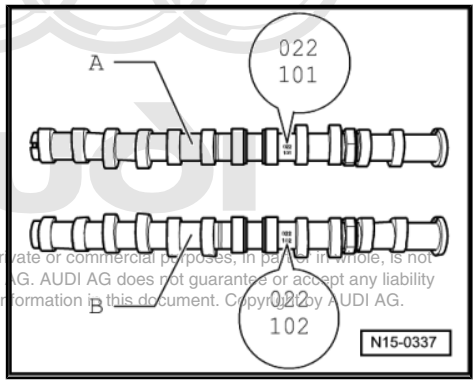
- ❑ 8 Nm

Camshaft identification

The camshaft identification is located between the cam pairs for cylinder No. 4 and 5.

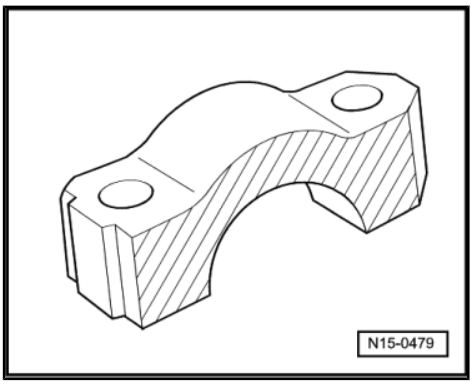
A - Exhaust camshaft; identification 022 - index 101

B - Inlet camshaft; identification 022 - index 102



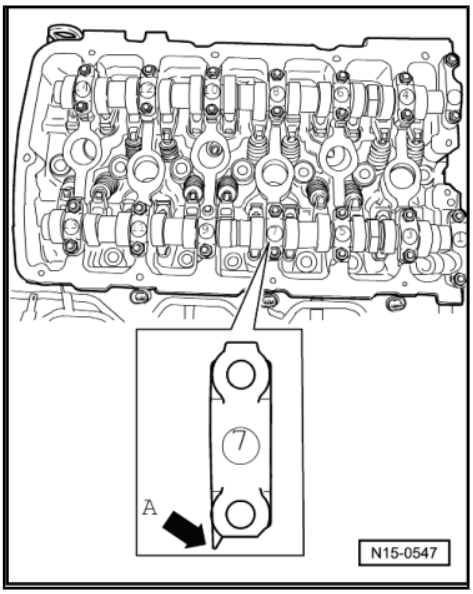
Coat contact surface of bearing caps 7 and 8 with lubricating paste

– Lightly coat contact surface -hatched area- of bearing caps 7 and 8 with lubricating paste; for lubricating paste refer to ⇒ Electronic parts catalogue .

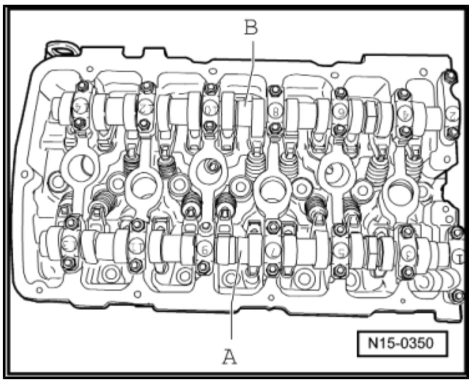


Installation position of bearing caps for camshafts

- The pointed section of the bearing caps -arrow A- for inlet and exhaust camshafts faces outwards.



Camshafts - tightening torque and tightening sequence



– Tighten nuts on inlet camshaft -A- in five stages as follows:

1 - Tighten nuts for bearing caps 5 and 9 alternately and diagonally until bearing caps make contact.

2 - Tighten nuts for bearing caps 5 and 9 to 5 Nm and turn 45° ($^1/_8$ turn) further.

3 - Tighten nuts for bearing caps 1 and 13 to 5 Nm and turn 45° ($^1/_8$ turn) further.

4 - Tighten nuts for bearing cap 7 to 5 Nm and turn 45° ($^1/_8$ turn) further.

5 - Tighten nuts for bearing caps 3 and 11 to 5 Nm and turn 45° ($^1/_8$ turn) further.

– Tighten nuts on exhaust camshaft -B- in five stages as follows:

1 - Tighten nuts for bearing caps 6 and 10 alternately and diagonally until bearing caps make contact.

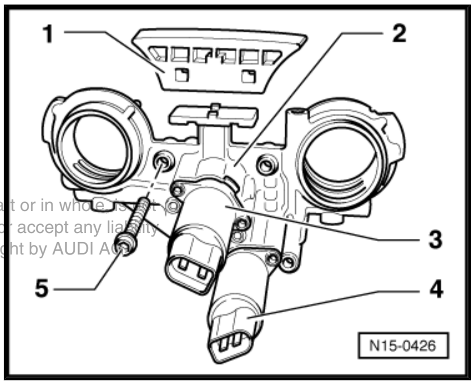
2 - Tighten nuts for bearing caps 6 and 10 to 5 Nm and turn 45° ($^1/_8$ turn) further.

3 - Tighten nuts for bearing caps 2 and 14 to 5 Nm and turn 45° ($^1/_8$ turn) further.

4 - Tighten nuts for bearing cap 8 to 5 Nm and turn 45° ($^1/_8$ turn) further.

5 - Tighten nuts for bearing caps 4 and 12 to 5 Nm and turn 45° ($^1/_8$ turn) further.

Dismantling and assembling valve timing housing



1 - Guide rail; clipped onto valve timing housing

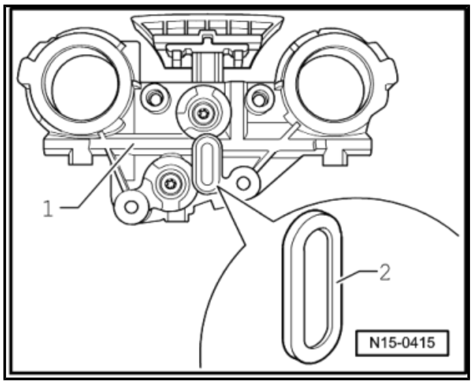
2 - Valve timing housing

3 - Inlet camshaft control valve 1 -N205-

4 - Exhaust camshaft control valve 1 -N318-

5 - Bolt

Cleaning filter of valve timing housing

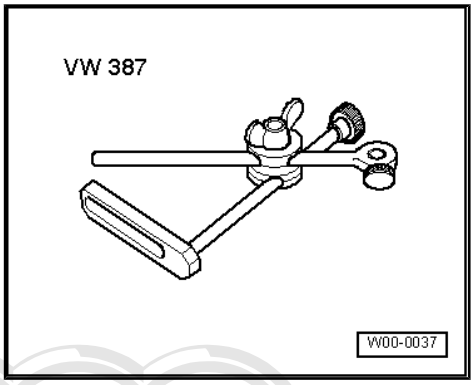


– Unclip the filter -2- on the back of valve timing housing -1- and clean off any dirt.

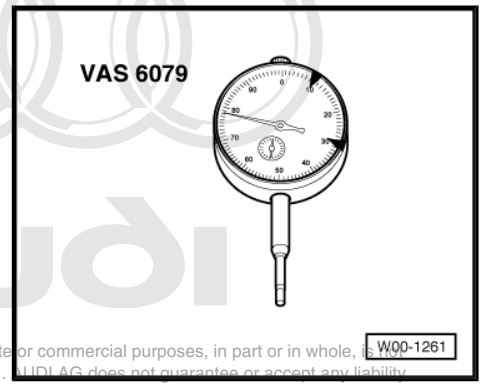
3.2 Measuring axial clearance of camshafts

Special tools and workshop equipment required

♦ Universal dial gauge bracket -VW 387-



♦ Dial gauge -VAS 6079-

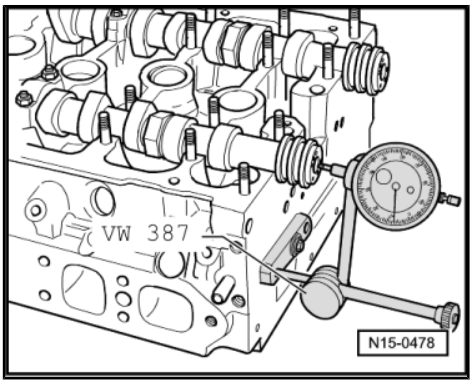


Procedure

– Remove roller rocker fingers and hydraulic compensation elements
⇒ “3.4 Removing and installing camshafts”, page 110 .

• Axial bearing cap for appropriate camshaft remains attached.

– Attach dial gauge bracket -VW 387- with dial gauge -VAS 6079- to cylinder head.



Axial clearance:

• Wear limit: 0.1 mm

3.3 Measuring radial clearance of camshafts

Procedure

– Remove camshafts ⇒ page 110 .

– Clean bearing cap and bearing journal.

– Remove roller rocker fingers
⇒ “3.4 Removing and installing camshafts”, page 110 .

– Place a length of Plastigage corresponding to the width of the bearing on the bearing journal or bearing shell to be measured.

• The Plastigage must be positioned in the centre of the bearing.

– Fit bearing cap and tighten to 5 Nm without rotating camshaft
⇒ page 108 .

– Remove bearing cap again.

– Compare width of Plastigage with measurement scale.

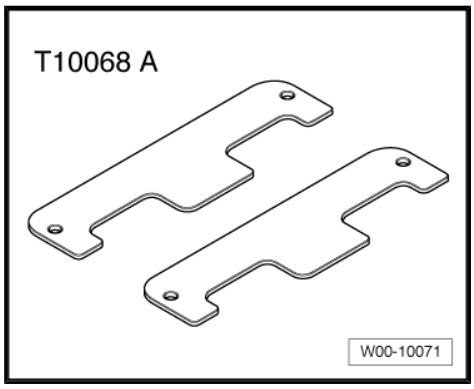
Radial clearance:

- Wear limit: 0.1 mm

3.4 Removing and installing camshafts

Special tools and workshop equipment required

♦ Camshaft bar -T10068 A-



♦ Lubricating paste ⇒ Electronic parts catalogue

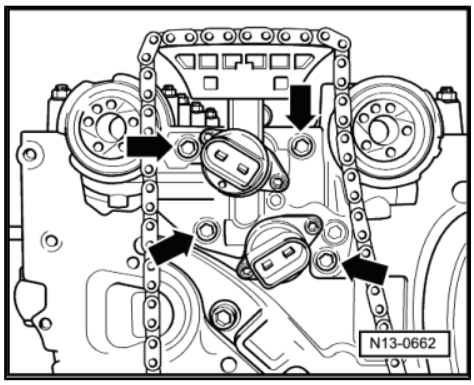
Removing

Note

Fit cable ties in the original positions when installing.

– Remove timing chain from camshafts ⇒ page 85 .

– Unbolt valve timing housing -arrows- and detach carefully from the oil seals for the camshafts.



– Remove inlet camshaft -A- as follows:

1 - Unbolt bearing caps 1 and 13.

2 - Unbolt bearing caps 3 and 11.

3 - Unbolt bearing cap 7.

4 - Loosen bearing caps 5 and 9 alternately in a diagonal sequence and remove.

– Remove exhaust camshaft -A- as follows:

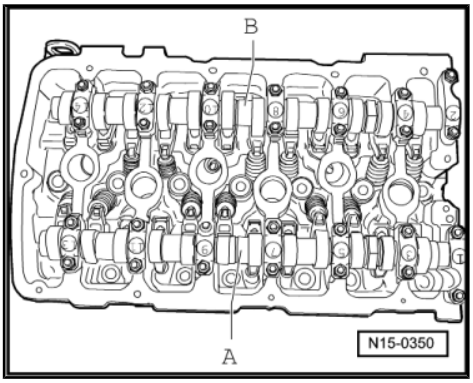
1 - Unbolt bearing caps 2 and 14.

2 - Unbolt bearing caps 4 and 12.

3 - Unbolt bearing cap 8.

4 - Loosen bearing caps 6 and 10 alternately in a diagonal sequence and remove.

– Carefully take out the camshafts and place them on a clean surface.



Installing

- Tightening torques ⇒ page 105 , ⇒ page 108 .

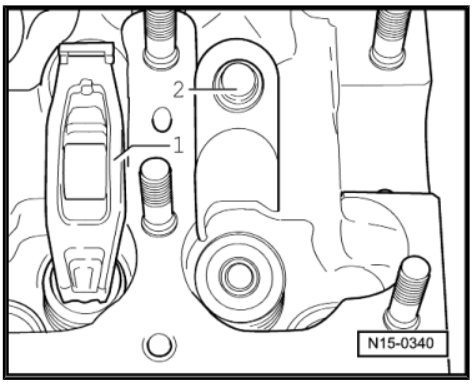
Caution

Avoid damage to valves and piston crowns.

- ***The crankshaft must not be at "TDC" at any cylinder when the camshafts are turned.***

– Fit hydraulic compensation elements in cylinder head.

– Fit roller rocker fingers -1- onto ends of valve stems and clip onto hydraulic compensation elements -2-.

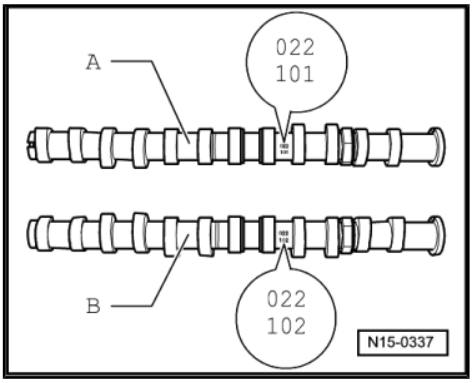


– Oil running surfaces of both camshafts.

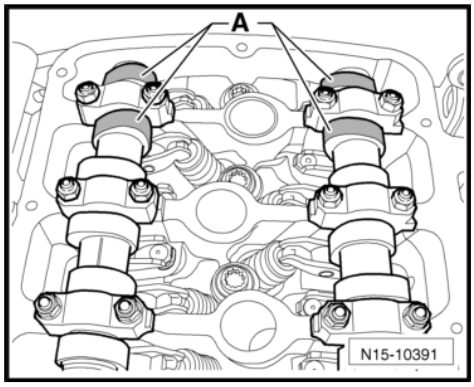
– The camshaft identification is located between the cam pairs for cylinder No. 4 and 5:

A - Exhaust camshaft; identification 022 - index 101

B - Inlet camshaft; identification 022 - index 102

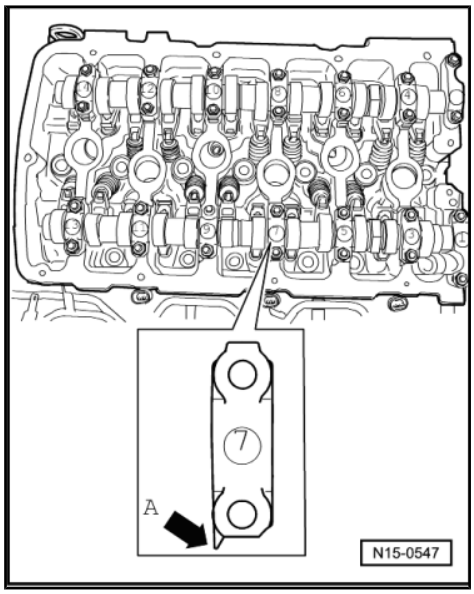


– Position camshafts in cylinder head so that cams -A- of cylinder 1 face each other.

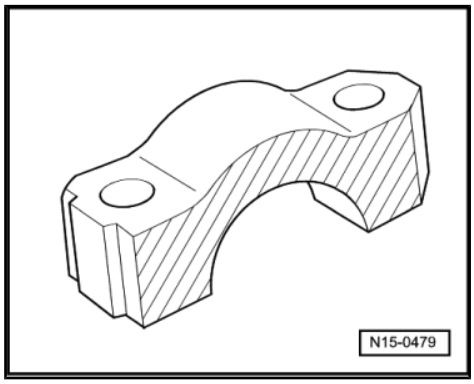


– Installation position of bearing caps:

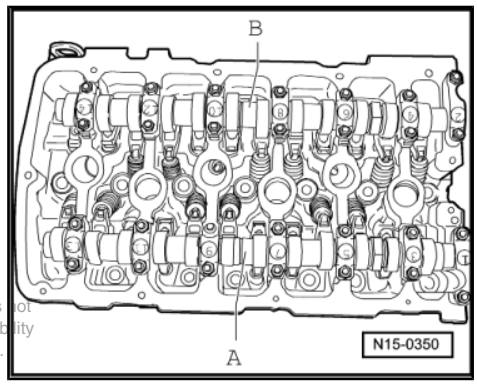
- The pointed section -arrow A- of the bearing caps for inlet and exhaust camshafts faces outwards.
- The identification markings for the bearing caps are legible from the inlet side.



– Lightly coat contact surface -hatched area- of bearing caps 7 and 8 with lubricating paste

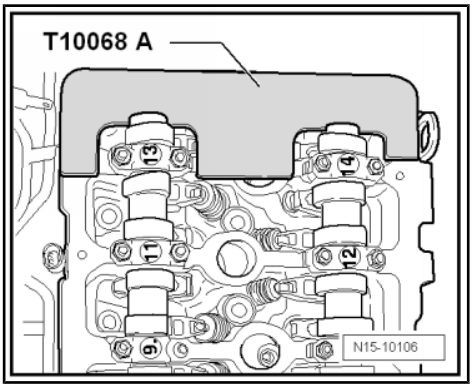


– Tighten camshaft bearing caps ⇒ page 108 .

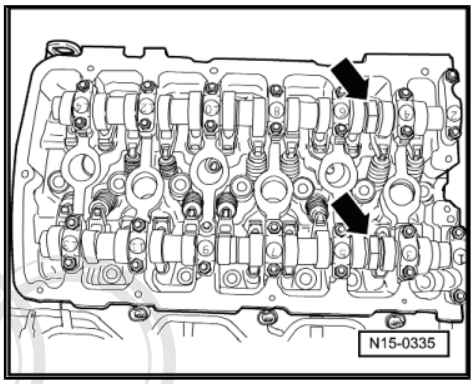


– Set camshafts to “TDC”.

• You should be able to insert the camshaft bar -T10068 A- in the slots in both camshafts.



– If necessary, turn camshafts at hexagon flats -arrows- to correct position using a 32 mm open-end spanner.



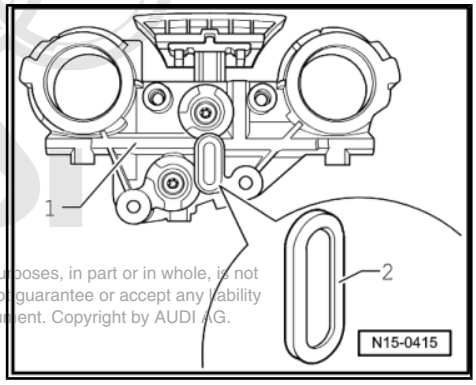
Note

The crankshaft must not be at TDC at any cylinder when the camshafts are turned. Otherwise, there is a risk of damage to valves and piston crowns.

– Unclip filter -2- on the back of valve timing housing -1- and clean off any dirt.

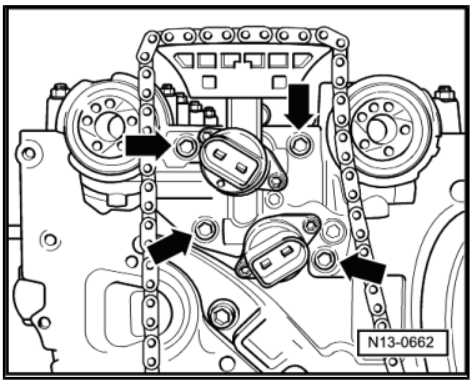
– Lightly oil the contact surfaces for the camshaft oil seals in the valve timing housing.

– Lightly oil contact surfaces of oil seals on the camshafts and carefully push the valve timing housing over the camshaft oil seals.



– Secure valve timing housing -arrows-.

– Install camshaft timing chain (adjust valve timing) ⇒ page 89 .



Caution

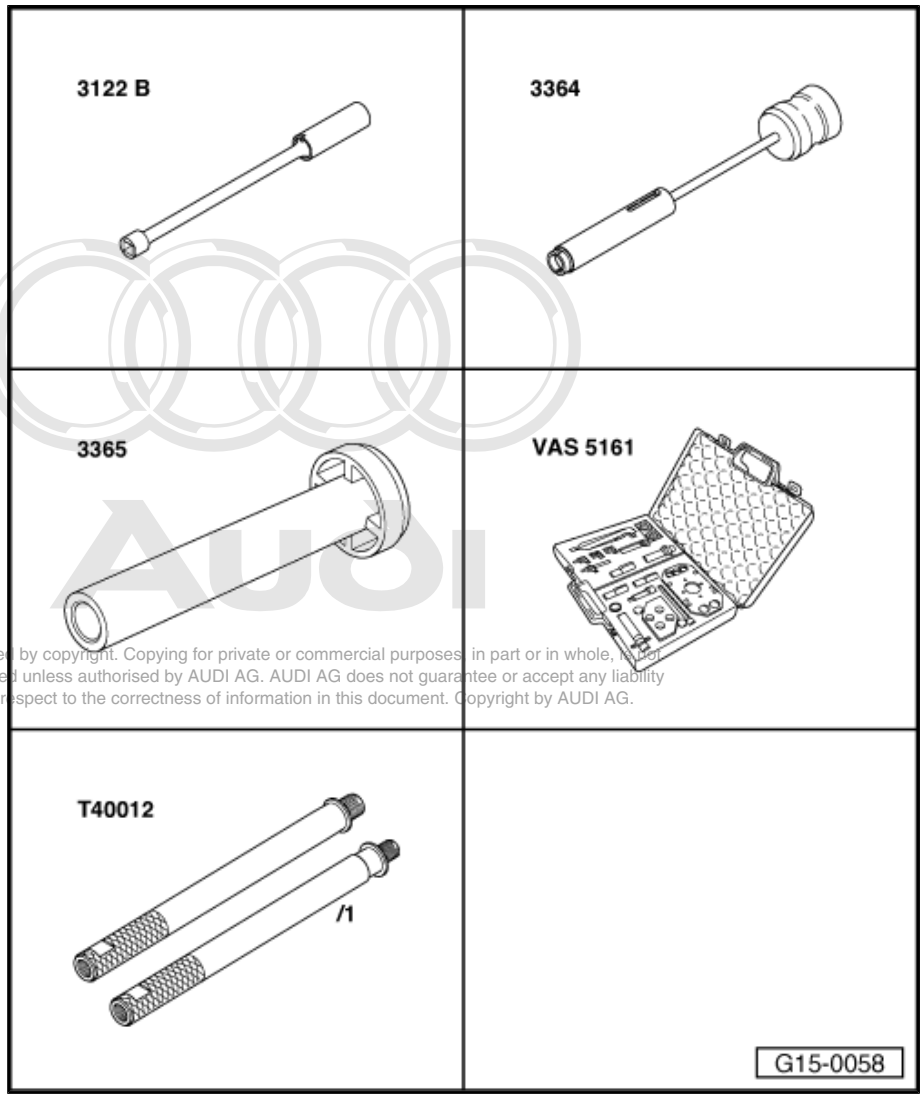
Avoid damage to valves and piston crowns after working on valve gear.

- ***The hydraulic tappets have to settle; wait for approx. 30 minutes after installing camshafts before starting engine.***
- ***Turn the engine carefully at least 2 rotations to ensure that none of the valves make contact when the starter is operated.***

3.5 Renewing valve stem oil seals with cylinder head installed

Special tools and workshop equipment required

- Spark plug socket and extension -3122 B-
- Valve stem seal puller -3364-
- Valve stem seal fitting tool -3365-
- Removal / installing device for valve cotters -VAS 5161- with guide plate -VAS 5161/25-
- Adapter -T40012-



Procedure

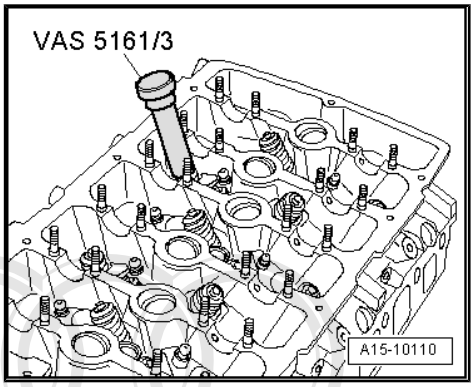
- Engine removed

– Remove camshafts ⇒ page 110 .

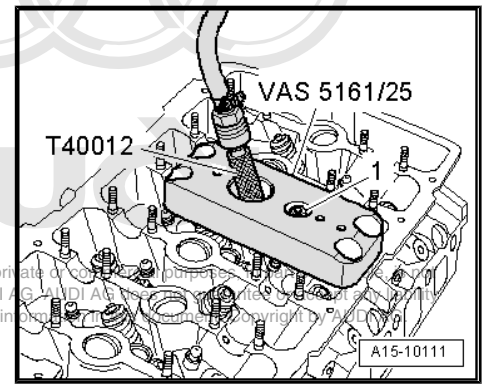
– Remove ignition coils ⇒ Rep. Gr. 28 .

– Remove spark plugs with spark plug socket and extension -3122 B- .

– Apply drift -VAS 5161/3- to valve spring plate.
– Use plastic-headed hammer to release sticking valve cotters.

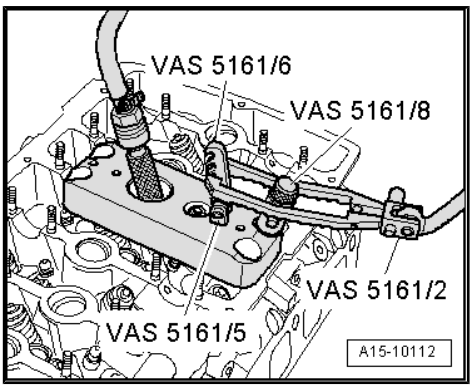


– Fit guide plate -VAS 5161/25- from removal / installing device for valve cotters -VAS 5161- on cylinder head.
– Secure guide plate with nut -1- to cylinder head.
– Screw adapter -T40012- with seal hand-tight into the corresponding spark plug thread.
– Connect hose to compressed air.
• Air pressure: at least 6 bar

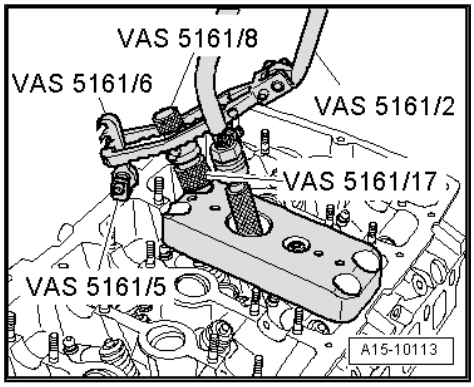


Rear row of valves:

– Screw snap-in device -VAS 5161/6- with engaging fork -VAS 5161/5- into guide plate.
– Insert assembly cartridge -VAS 5161/8- in guide plate.
– Attach pressure fork -VAS 5161/2- to snap-in device and push assembly cartridge down.
– At the same time, turn knurled screw of assembly cartridge clockwise until tips engage in valve cotters.
– Move knurled screw back and forth slightly.
• The valve cotters are forced apart and are taken up by the cartridge.
– Release pressure fork.
– Take out assembly cartridge.
– Detach guide plate and turn to one side.
• The compressed air hose remains connected.
– Detach valve spring with valve spring plate.



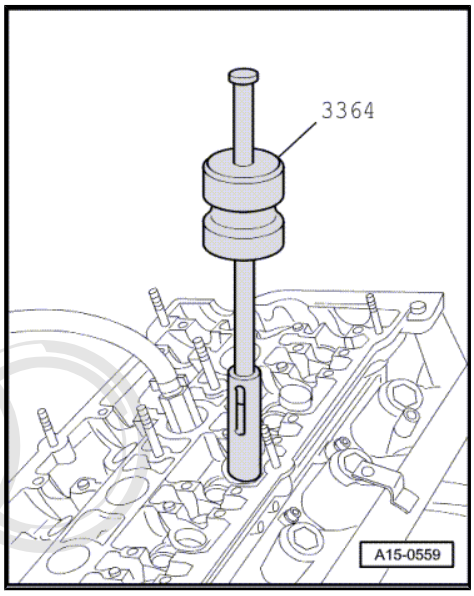
Front row of valves:



– Screw snap-in device -VAS 5161/6- with engaging fork -VAS 5161/5- onto cylinder head.
– Slide knurled spacer ring -VAS 5161/17- onto assembly cartridge -VAS 5161/8- .
– Insert assembly cartridge in guide plate.
– Attach pressure fork -VAS 5161/2- to snap-in device and push assembly cartridge down.
– At the same time, turn knurled screw of assembly cartridge clockwise until tips engage in valve cotters.
– Move knurled screw back and forth slightly.
• The valve cotters are forced apart and are taken up by the cartridge.
– Release pressure fork.
– Take out assembly cartridge.
– Detach guide plate and turn to one side.
• The compressed air hose remains connected.
– Detach valve spring with valve spring plate.

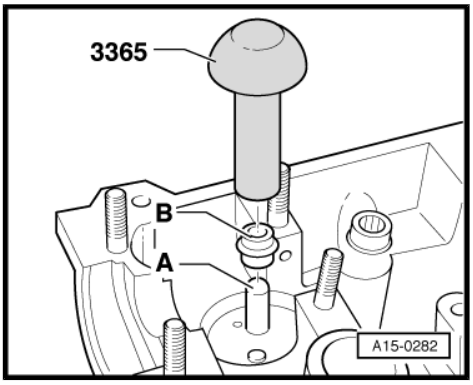
Continuation for both rows of valves:

– Pull off valve stem oil seal with valve stem seal puller -3364- .



Note

- *To press on the green-coloured valve stem seals (as currently supplied), the valve stem oil seal fitting tool -3365- must be drilled out to ∅ 10.5 mm.*
- *Mark the drilled-out fitting tool so it can be used again later.*



Caution

Make sure valve stem oil seals are not damaged when installing.

- ***New valve stem oil seals -B- are supplied with plastic sleeve; fit plastic sleeve -A- onto valve stem.***

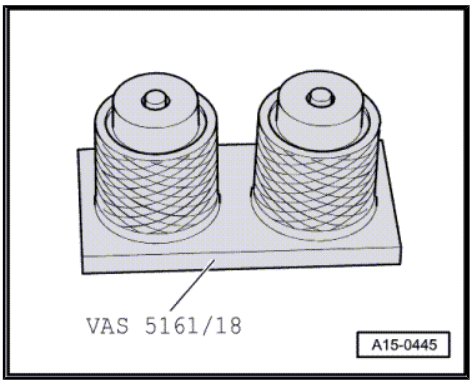
– Lightly oil sealing lip of valve stem oil seal.

– Slide valve stem oil seal onto plastic sleeve.

– Carefully press valve stem oil seal onto valve guide using valve stem seal fitting tool -3365- .

– Take off plastic sleeve.

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

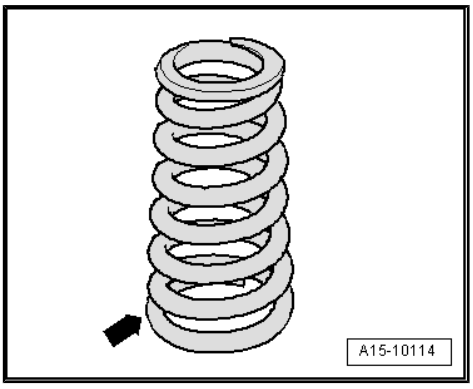


• Larger diameter of valve cotters faces upwards.

– Press assembly cartridge onto insertion device from above and take up valve cotters.

– Insert valve spring and valve spring plate.

• Installation position: the larger diameter -arrow- of the valve spring faces the cylinder head.



Rear row of valves:

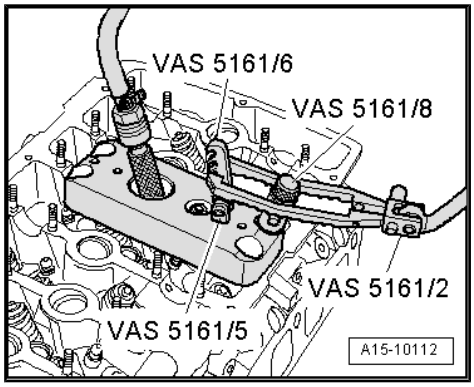
– Secure guide plate back onto cylinder head as shown in illustration.

– Insert assembly cartridge in guide plate.

– Press down pressure fork and pull knurled screw upwards while turning screw in both directions.

• The valve cotters are thus inserted.

– Release the pressure fork with knurled screw still in pulled position.



Front row of valves:

– Insert assembly cartridge with knurled spacer ring in guide plate.

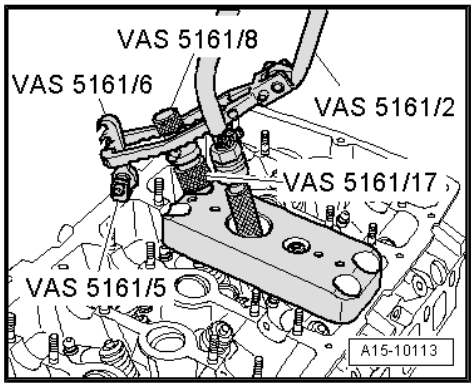
– Press down pressure fork and pull knurled screw upwards while turning screw in both directions.

• The valve cotters are thus inserted.

– Release the pressure fork with knurled screw still in pulled position.

– Install camshafts ⇒ page 110 .

– Install spark plugs ⇒ Maintenance ; Booklet 810 .



Caution

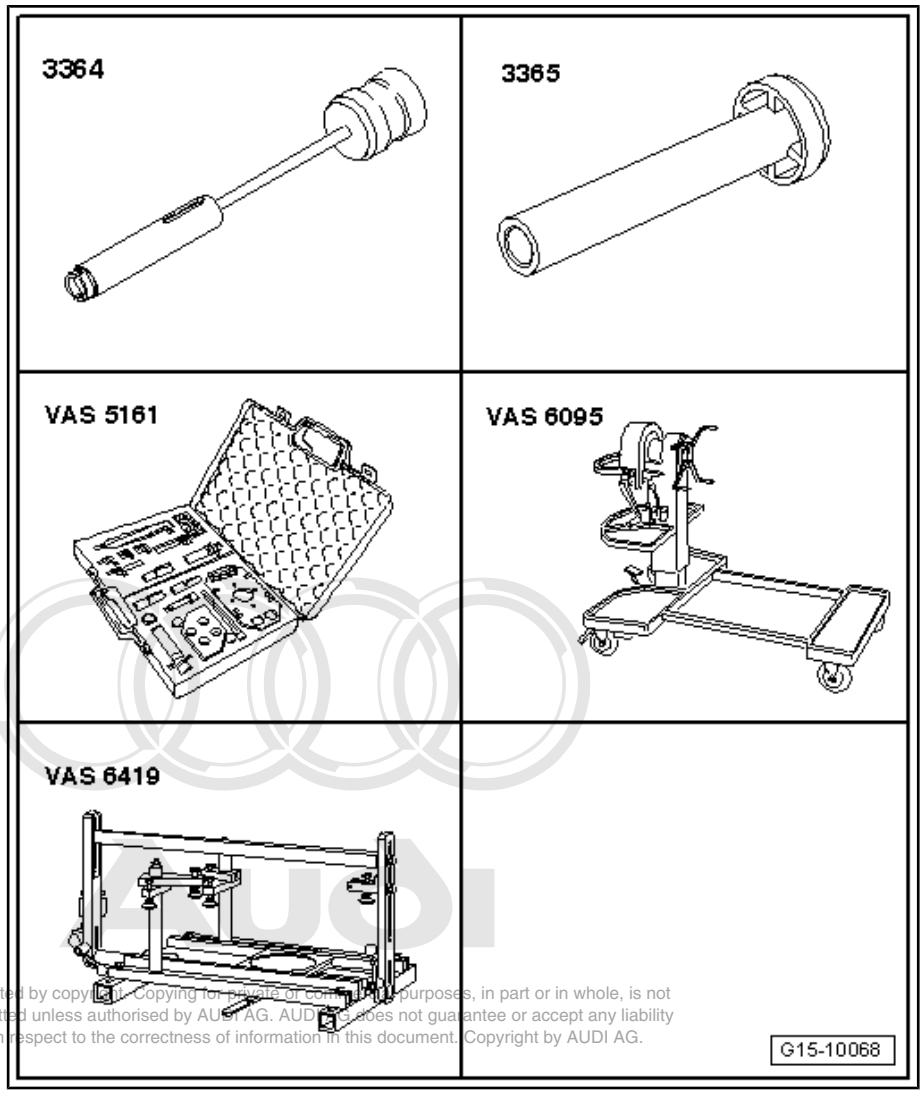
Avoid damage to valves and piston crowns after working on valve gear.

- *The hydraulic tappets have to settle; wait for approx. 30 minutes after installing camshafts before starting engine.*
- *Turn the engine carefully at least 2 rotations to ensure that none of the valves make contact when the starter is operated.*

3.6 Renewing valve stem oil seals with cylinder head removed

Special tools and workshop equipment required

- Valve stem seal puller -3364-
- Valve stem seal fitting tool -3365-
- Removal / installing device for valve cotters -VAS 5161- with guide plate -VAS 5161/25-
- Engine and gearbox support -VAS 6095-
- Cylinder head tensioning device -VAS 6419-



Special tools and workshop equipment required

-

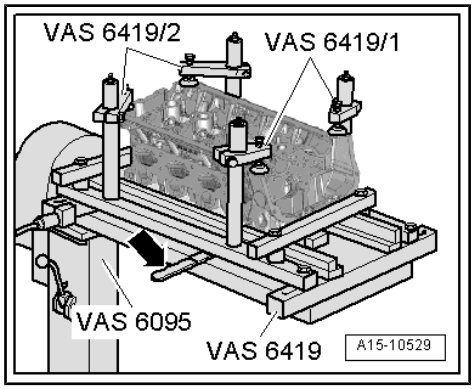
Procedure

– Remove camshafts ⇒ page 110 .

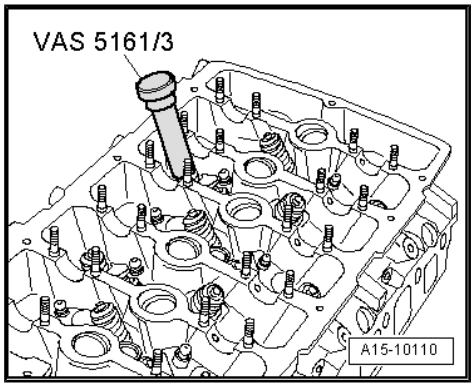
– Mark original positions of roller rocker fingers and hydraulic compensation elements for reinstallation.

– Remove roller rocker fingers together with hydraulic compensation elements and put down on a clean surface.

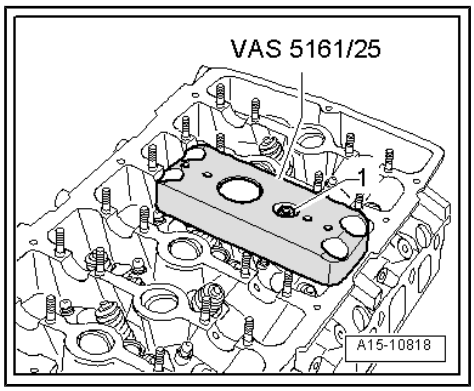
– Attach tensioning device -VAS 6419- to engine and gearbox support -VAS 6095- .
– Secure cylinder head in tensioning device -VAS 6419- as illustrated.
– Connect compressed air line to tensioning device -VAS 6419- .
– Using lever -arrow-, slide air pad under combustion chamber where valve stem oil seals are to be removed.
– Apply just enough compressed air to bring air pad into contact with valve heads.



– Apply drift -VAS 5161/3- to valve spring plate and knock valve cotters loose using a plastic hammer.

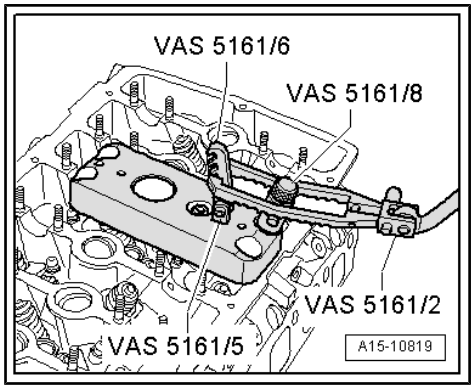


– Fit guide plate -VAS 5161/25- from removal / installing device for valve cotters -VAS 5161- on cylinder head.
– Secure guide plate with one nut -1-.

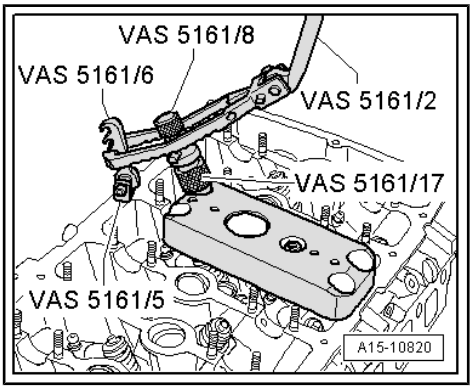


Procedure for rear row of valves:

– Screw snap-in device -VAS 5161/6- with engaging fork -VAS 5161/5- into guide plate.
– Insert assembly cartridge -VAS 5161/8- into guide plate.
– Attach pressure fork -VAS 5161/2- to snap-in device and push assembly cartridge down.
– At the same time, turn knurled screw of assembly cartridge clockwise until tips engage in valve cotters.
– Move knurled screw back and forth slightly; the valve cotters are thus forced apart and taken up by the assembly cartridge.
– Release the pressure fork.
– Remove assembly cartridge.
– Detach guide plate and turn to one side.
– Remove valve spring with valve spring plate.

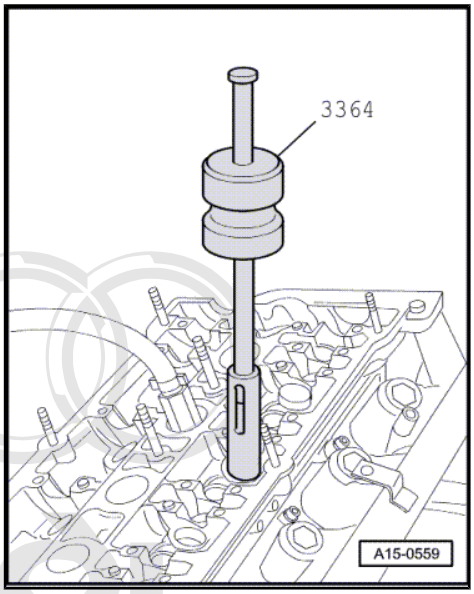


Procedure for front row of valves:



- Screw snap-in device -VAS 5161/6- with engaging fork -VAS 5161/5- onto cylinder head.
- Slide knurled spacer ring -VAS 5161/17- onto assembly cartridge -VAS 5161/8- .
- Insert assembly cartridge into guide plate.
- Attach pressure fork -VAS 5161/2- to snap-in device and push assembly cartridge down.
- At the same time, turn knurled screw of assembly cartridge clockwise until tips engage in valve cotters.
- Move knurled screw back and forth slightly; the valve cotters are thus forced apart and taken up by the assembly cartridge.
- Release the pressure fork.
- Remove assembly cartridge.
- Detach guide plate and turn to one side.
- Remove valve spring with valve spring plate.

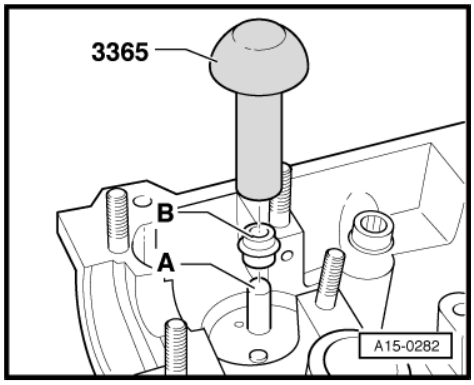
Continuation for both rows of valves:



- Remove valve stem oil seals using the valve stem seal puller -3364- .

Note

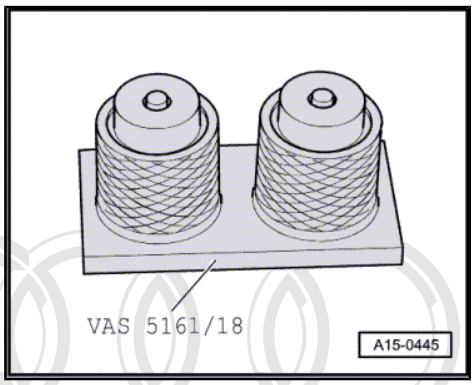
- *To press on the green-coloured valve stem seals (as currently supplied), the valve stem oil seal fitting tool -3365- must be drilled out to ∅ 10.5 mm.*
- *Mark the drilled-out fitting tool so it can be used again later.*
- *A plastic sleeve -A- is included with the new valve stem oil seals.*



– Fit plastic sleeve -A- onto the valve stem to prevent damage to the new valve stem oil seal -B-.
– Lightly lubricate sealing lip of valve stem oil seal.
– Slip valve stem oil seal over plastic sleeve.
– Carefully press the valve stem oil seal onto valve guide using fitting tool -3365- .
– Remove plastic sleeve.

If valve cotters have been removed from assembly cartridge, they need to be put into insertion device -VAS 5161/18- first.

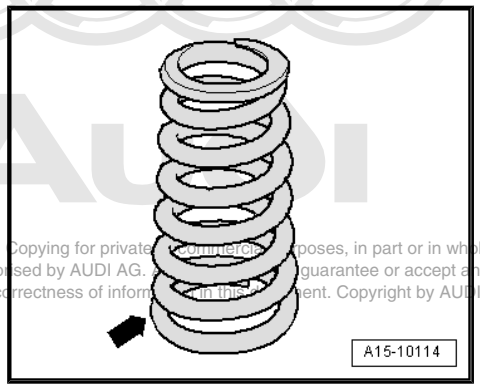
- Larger diameter of valve cotters faces upwards.



– Install valve spring and valve spring plate.

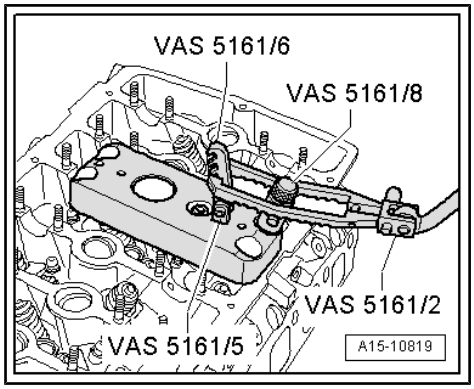
Position of valve spring:

- The larger diameter -arrow- faces the cylinder head.

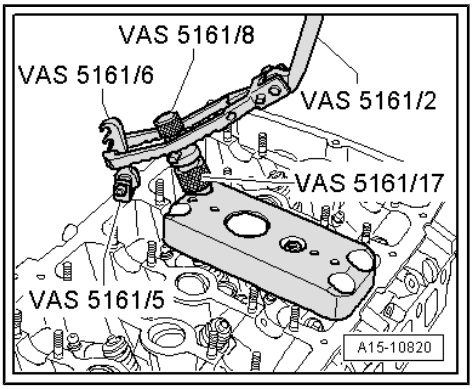


Procedure for rear row of valves:

– Bolt guide plate onto cylinder head again, as shown in the illustration.
– Insert assembly cartridge into guide plate.
– Push pressure fork down and pull knurled screw upwards, while turning screw in both directions – this will insert the valve cotters.
– Release the pressure fork with knurled screw still in pulled position.



Procedure for front row of valves:



- Insert assembly cartridge with knurled spacer ring into guide plate.
- Push pressure fork down and pull knurled screw upwards, while turning screw in both directions – this will insert the valve cotters.
- Release the pressure fork with knurled screw still in pulled position.
- Install camshafts ⇒ page 110 .
- Install spark plugs ⇒ Maintenance ; Booklet 808 .

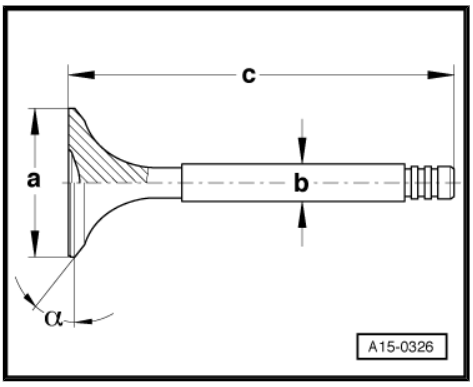
Note

- *After installing camshafts, wait for approx. 30 minutes before starting engine. Hydraulic valve compensation elements have to settle (otherwise valves will strike pistons).*
- *After working on the valve gear, turn the engine carefully at least 2 rotations to ensure that none of the valves make contact when the starter is operated.*

3.7 Valve dimensions

Note

Inlet and exhaust valves must not be machined. Only grinding-in is permitted.



Dimension		Inlet valve		Exhaust valve	
		short version	long version	short version	long version
∅ a	mm	31.00	31.00	27.00	27.00
∅ b	mm	5.96	5.96	5.94	5.94
c	mm	102.20	136.10	102.50	136.40
α	∠°	45	45	45	45

WARNING

Care must be taken when disposing of old sodium-cooled exhaust valves - risk of injury.

- ***The valves must be sawn in two with a metal saw between the centre of the stem and valve head. When doing so, the valves must not come into contact with water.***
- ***Then throw a maximum of ten valves into a bucket of water and step away immediately.***
- ***A sudden chemical reaction will occur upon contact with water in which the sodium filling burns.***
- ***After performing these steps the valves can be disposed of in the normal way.***

3.8 Machining valve seats

If a good seating pattern cannot be obtained by grinding the valve seats (lapping), they must be refaced (machined).

Note

- *When servicing engines with leaking valves, it is not sufficient to machine (reface) the valve seats and renew the valves. The valve guides must also be checked for wear. This is particularly important on high-mileage engines* ⇒ page 126 .
- *Valve seats should only be machined to the extent required to give a proper seating pattern.*
- *Calculate the maximum permissible machining dimension before machining valve seats.*

Special tools and workshop equipment required

- Depth gauge
- Valve seat machining tool

Calculating maximum permissible machining dimension

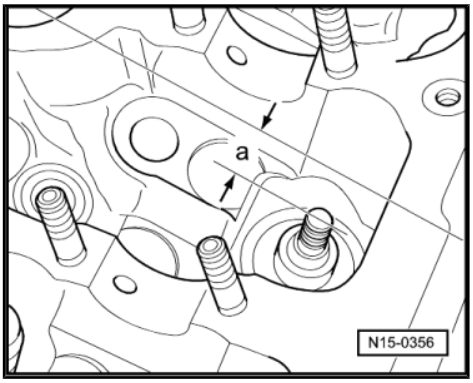
Note

If the valve has to be renewed as part of a repair, use a new valve for the measurement.

– Insert valve and press firmly against valve seat.

– Measure distance -a- between end of valve stem and upper cylinder head surface with a depth gauge.
– Calculate maximum permissible machining dimension from measured distance and minimum dimension.

  Measured distance minus minimum dimension = max. permissible machining dimension.



Minimum dimension for inlet valve		Minimum dimension for exhaust valve	
short version	**long version**	**short version**	**long version**
31.8 mm	10.2 mm	31.8 mm	10.2 mm

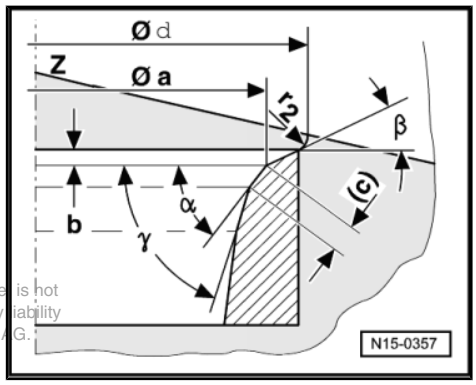
Example for long inlet valve:	
Measured distance	10.6 mm
Minimum dimension	– 10.2 mm
Maximum permissible machining dimension	= 0.4 mm

– If the calculated maximum permissible machining dimension is 0 mm or less than 0 mm, repeat the measurement with a new valve.
– If the maximum permissible machining dimension is then still 0 mm or less than 0 mm, renew cylinder head.

Note

If the machining dimension is below specification, the proper functioning of the hydraulic valve clearance compensation cannot be ensured.

Machining inlet valve seat



a - ∅ 30.6 mm

b - Maximum permissible machining dimension ⇒ page 124

c - 0.9 … 1.5 mm

d - Maximum ∅ 35.0 mm

r2 - Radius 2.0 mm

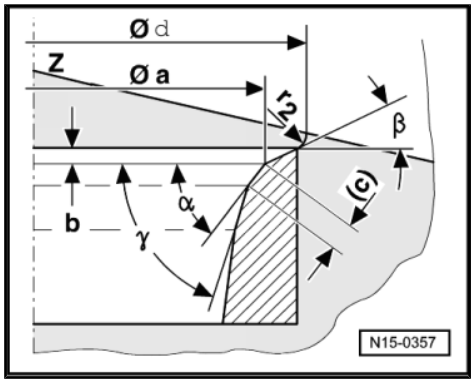
Z - Bottom surface of cylinder head

α - 45° valve seat angle

β - 30° upper correction angle

γ - 60° lower correction angle

Machining exhaust valve seat



a - ∅ 26.7 mm

b - Maximum permissible machining dimension ⇒ page 124

c - 1.2 … 1.7 mm

d - Maximum ∅ 29.0 mm

r2 - Radius 2.0 mm

Z - Bottom surface of cylinder head

α - 45° valve seat angle

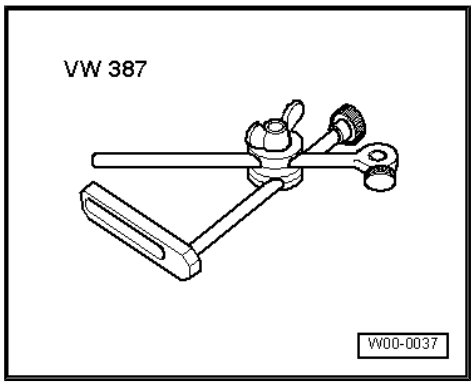
β - 30° upper correction angle

γ - 60° lower correction angle

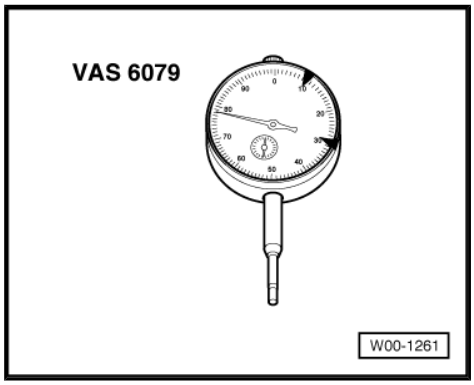
3.9 Checking valve guides

Special tools and workshop equipment required

- Universal dial gauge bracket -VW 387-



- Dial gauge -VAS 6079-



Procedure

Note

- *If the valve has to be renewed as part of a repair, use a new valve for the measurement.*
- *Only insert inlet valve into inlet guide and exhaust valve into exhaust guide, as the stem diameters are different.*

– Insert valve into guide.

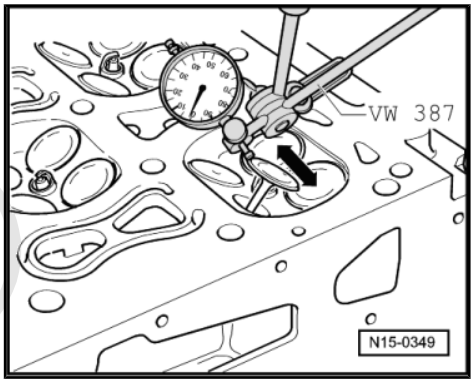
• End of valve stem must be flush with valve guide.

– Determine amount of sideways play.

• Wear limit: 0.8 mm

– If the wear limit is exceeded, repeat the measurement with new valves.

– Renew cylinder head if wear limit is still exceeded.



Note

Valve guides cannot be renewed.

3.10 Checking valves

– Visually inspect for scoring on valve stems and valve seat surfaces.

– Renew valve if scoring is clearly visible.

17 – Lubrication

1 Oil pump and sump

Note

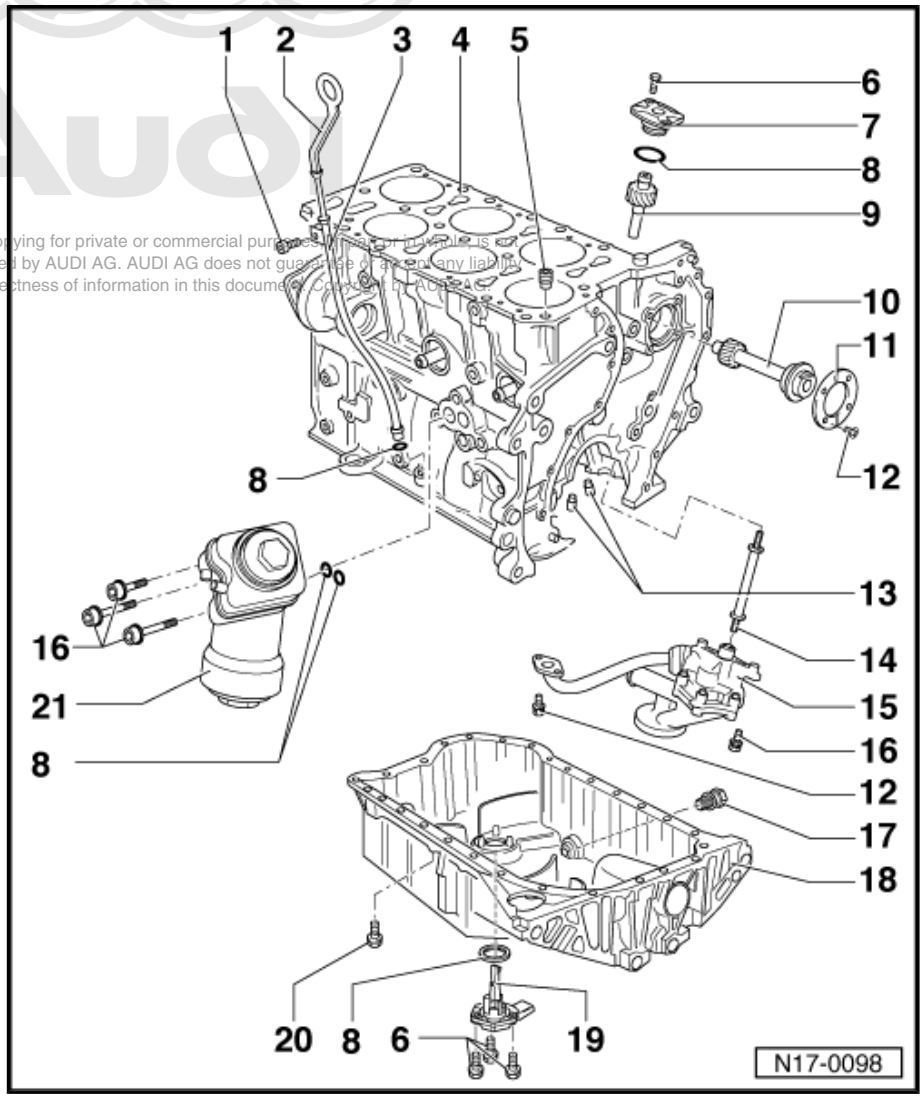
- *If large quantities of metal shavings or abrasion are found when performing engine repairs, this is an indication of damage to the crankshaft or conrod bearings. To prevent further damage, the following steps are required after completion of repair work: clean the oil galleries carefully and renew the oil spray jets, oil cooler and oil filter.*
- *Refer to ⇒ Maintenance tables for engine oil capacity, viscosity grades and oil specifications.*

Caution

Risk of damage to catalytic converter.

- ***The oil level must not be above the "max" mark on the dipstick.***

1.1 Oil pump and sump - exploded view



1 - Bolt

- ❑ Secured to intake manifold
- ❑ 5 Nm

2 - Oil dipstick

3 - Guide tube for oil dipstick

4 - Cylinder block

5 - Oil return valve

- ❑ Removing and installing ⇒ page 130
- ❑ Note installation position

6 - Bolt

- ❑ 8 Nm

7 - Cover for oil pump drive

8 - O-ring

- ❑ Renew
- ❑ Lubricate before installing

9 - Oil pump drive

10 - Intermediate shaft

11 - Thrust washer

12 - Bolt

- ❑ Apply locking fluid when installing; refer to ⇒ Electronic parts catalogue
- ❑ 10 Nm

13 - Oil spray jet (for cooling of pistons)

- ❑ For crankshaft bearings 2 ... 7
- ❑ Opening pressure: 2.0 bar
- ❑ Removing and installing ⇒ page 130

14 - Input shaft for oil pump drive

15 - Oil pump

- ❑ Dismantling and assembling ⇒ page 134
- ❑ Coat oil pressure pipe at cylinder block and at oil pump housing with sealant; for sealant refer to ⇒ Electronic parts catalogue

16 - Bolt

- ❑ 23 Nm

17 - Oil drain plug

- ❑ 30 Nm

18 - Sump

- ❑ Removing and installing ⇒ page 131
- ❑ Tightening torque and tightening sequence ⇒ page 130

19 - Oil level and oil temperature sender -G266-

- ❑ Removing and installing ⇒ page 131

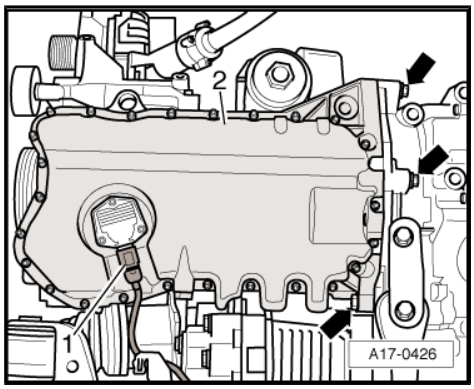
20 - Bolt

- ❑ Tightening torque and tightening sequence ⇒ page 130

21 - Oil filter housing

- ❑ Exploded view ⇒ page 136
- ❑ Removing and installing ⇒ page 137

Sump - tightening torque and tightening sequence



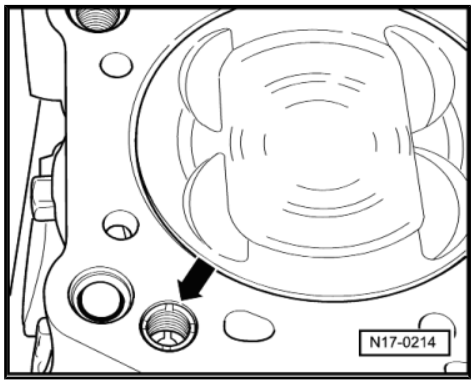
– Tighten bolts in 3 stages as follows:

1. Tighten bolts securing sump to cylinder block in diagonal sequence initially to 5 Nm.
2. Tighten bolts securing sump to gearbox -arrows- ⇒ page 34 .
3. Tighten bolts securing sump to cylinder block in diagonal sequence to 12 Nm.

Note

Disregard item -1-.

Removing and installing oil return valve



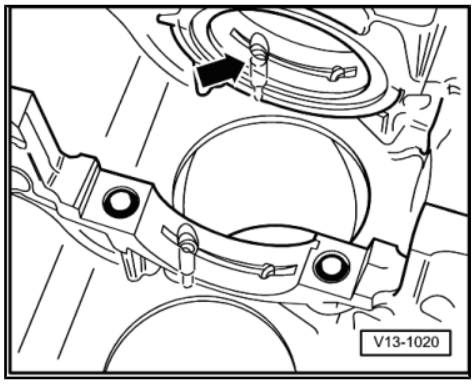
Removing:

– Screw in bolt M8x1.5 approx. 4 turns into valve -arrow-.
– Pull out valve.

Installing:

– Lubricate O-ring with oil.
– Press valve into oil passage by hand.

Removing and installing oil spray jet



Note

Oil spray jets are installed in crankshaft main bearings 2 ... 7.

Removing:

– Use drift with ∅ 4 mm to press out oil spray jet towards crankshaft bearing.

Installing:

– Use drift with ∅ 6 mm to press in oil spray jet -arrow- by hand.

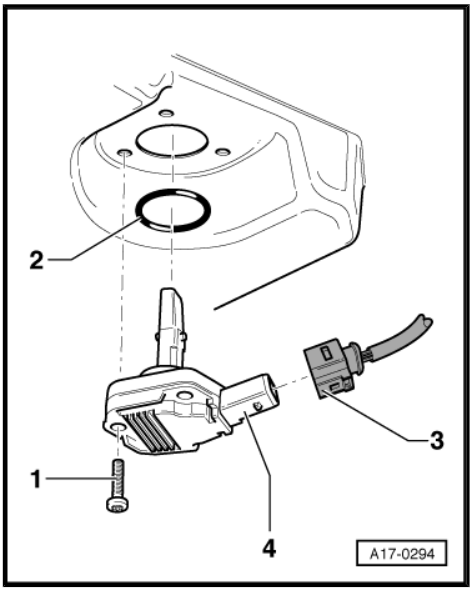
Removing and installing oil level and oil temperature sender - G266-

1 - Bolt, 10 Nm (self-locking); renew

2 - Seal; renew

3 - Electrical connector

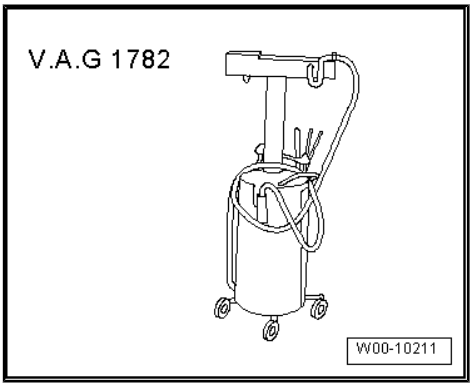
4 - Oil level and oil temperature sender -G266-



1.2 Removing and installing sump

Special tools and workshop equipment required

♦ Used oil collection and extraction unit -V.A.G 1782-



♦ Electric drill with plastic brush

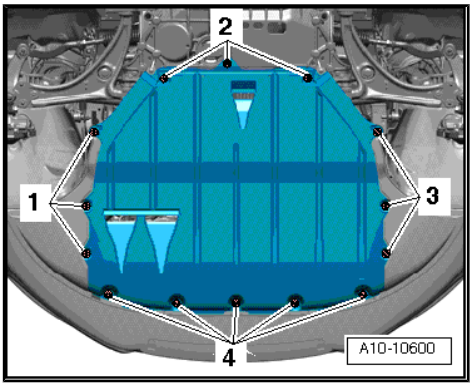
♦ Safety goggles

♦ Sealant ⇒ Electronic parts catalogue

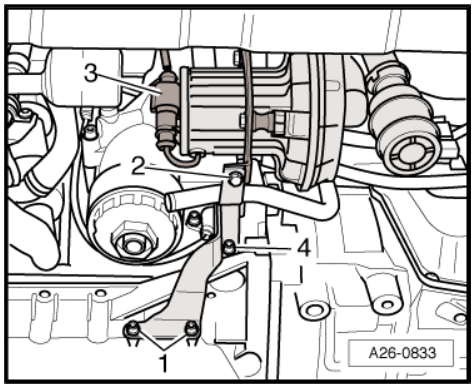
Removing

– Release fasteners -1 ... 4- and remove centre noise insulation.

– Place used oil collection and extraction unit -V.A.G 1782- beneath engine and drain off engine oil.



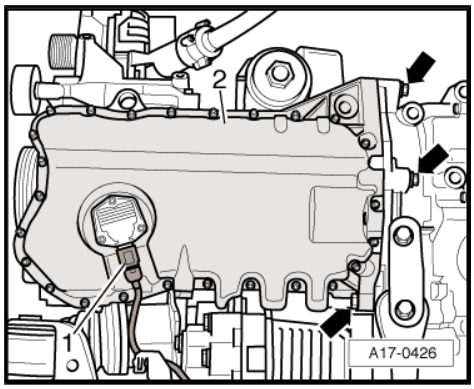
– Remove bolts -1 and 2-.
– Loosen bolt -4- and move secondary air pump with bracket clear to the front.



Note

Disregard item -3-.

– Unplug electrical connector -1- at oil level and oil temperature sender -G266- .
– Remove bolts securing sump to gearbox -arrows-.
– Unscrew bolts for sump -2- in diagonal sequence and remove.
– Take off sump: if necessary loosen it by striking lightly with a rubber hammer.



Installing

• Tightening torques ⇒ page 129 , ⇒ page 130 .

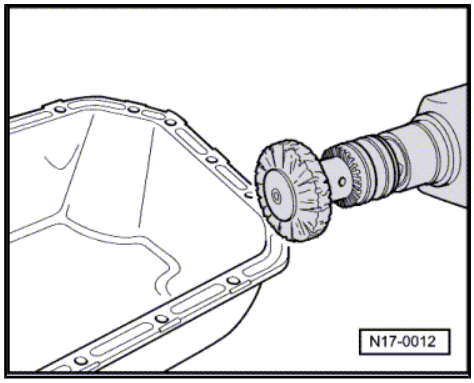
Installation is carried out in the reverse order; note the following:

– Carefully remove any remaining sealant from cylinder block.

WARNING

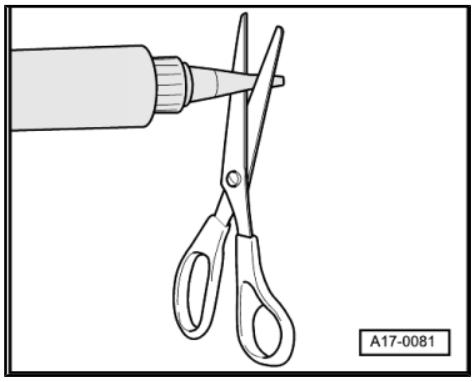
Protect eyes against injuries.

- ***Wear safety goggles.***



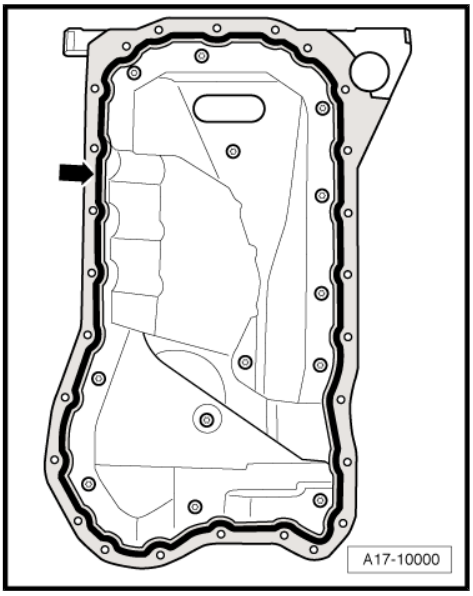
– Remove remaining sealant from sump (with rotating plastic brush or similar).
– Clean sealing surfaces; they must be free of oil and grease.

– Cut off nozzle of tube at front marking (∅ of nozzle approx. 1.5 mm).



– Apply sealant -arrow- onto clean sealing surface of sump as shown in illustration.

- Width of sealant bead: 2 mm.



Caution

Make sure oil strainer is not clogged by excess sealant.

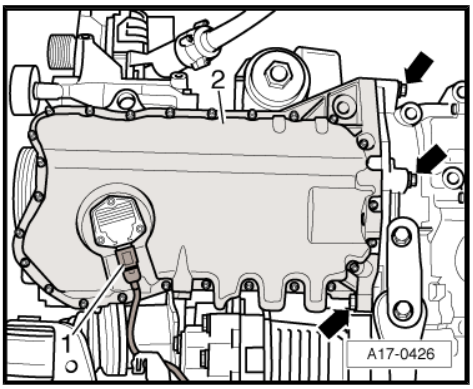
- ***The bead of sealant must not be thicker than specified.***

Note

- *Take extra care when applying sealant in the area around the timing chain cover (bottom).*
- *Fit sump within 5 minutes after applying sealant.*

– Tighten bolts securing sump -2- ⇒ page 130 .

– Connect electrical connector -1- for oil level and oil temperature sender -G266- .



Caution

Take care to avoid leakage at sump.

- ***After fitting sump assembly, the sealant must dry for approx. 30 minutes. Then (and only then) fill the engine with engine oil.***

– Fill with engine oil and check oil level ⇒ page 141 .

1.3 Oil pump - exploded view

1 - Input shaft for oil pump drive

2 - Oil pump housing

3 - Bolt

- ❑ 23 Nm

4 - Gears

- ❑ Measuring backlash ⇒ page 134
- ❑ Checking axial clearance ⇒ page 135

5 - Oil pump cover

- ❑ With pressure relief valve
- ❑ Opening pressure of pressure relief valve: 5.3 ... 5.7 bar
- ❑ Clean strainer if dirty

6 - Bolt

- ❑ Apply locking fluid when installing; refer to ⇒ Electronic parts catalogue
- ❑ 8 Nm

7 - Oil pressure pipe

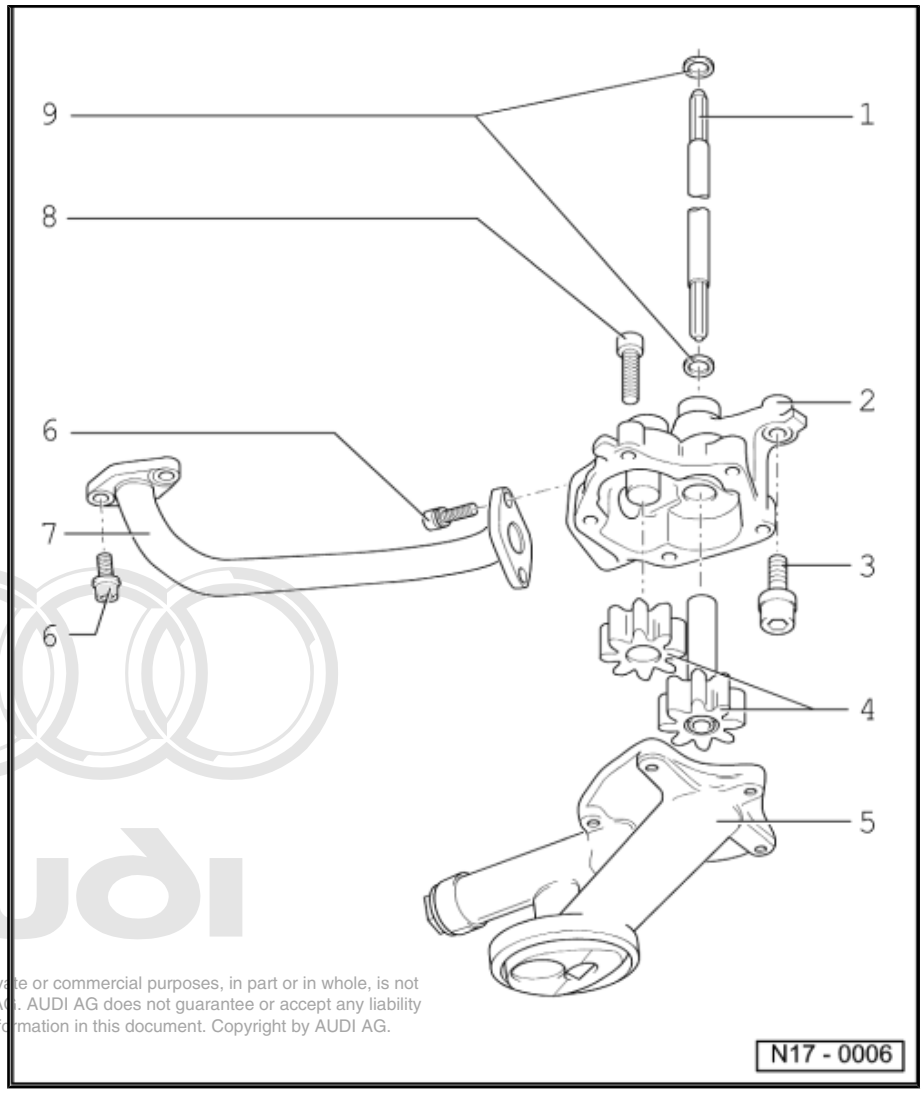
- ❑ Apply sealing paste at cylinder block and at oil pump housing; for sealing paste refer to ⇒ Electronic parts catalogue

8 - Bolt

- ❑ 10 Nm

9 - Seal

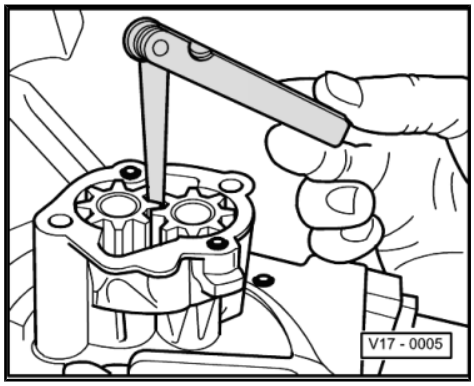
- ❑ Renew if damaged



Measuring backlash

– Check gap using feeler gauge.

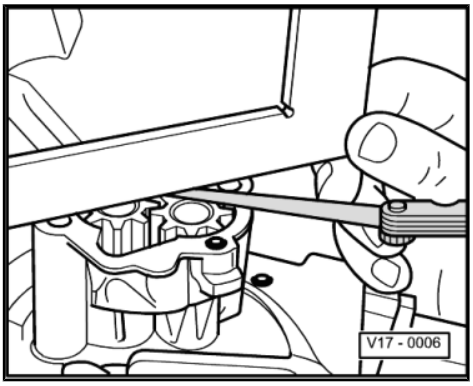
• Wear limit: 0.20 mm



Checking axial clearance

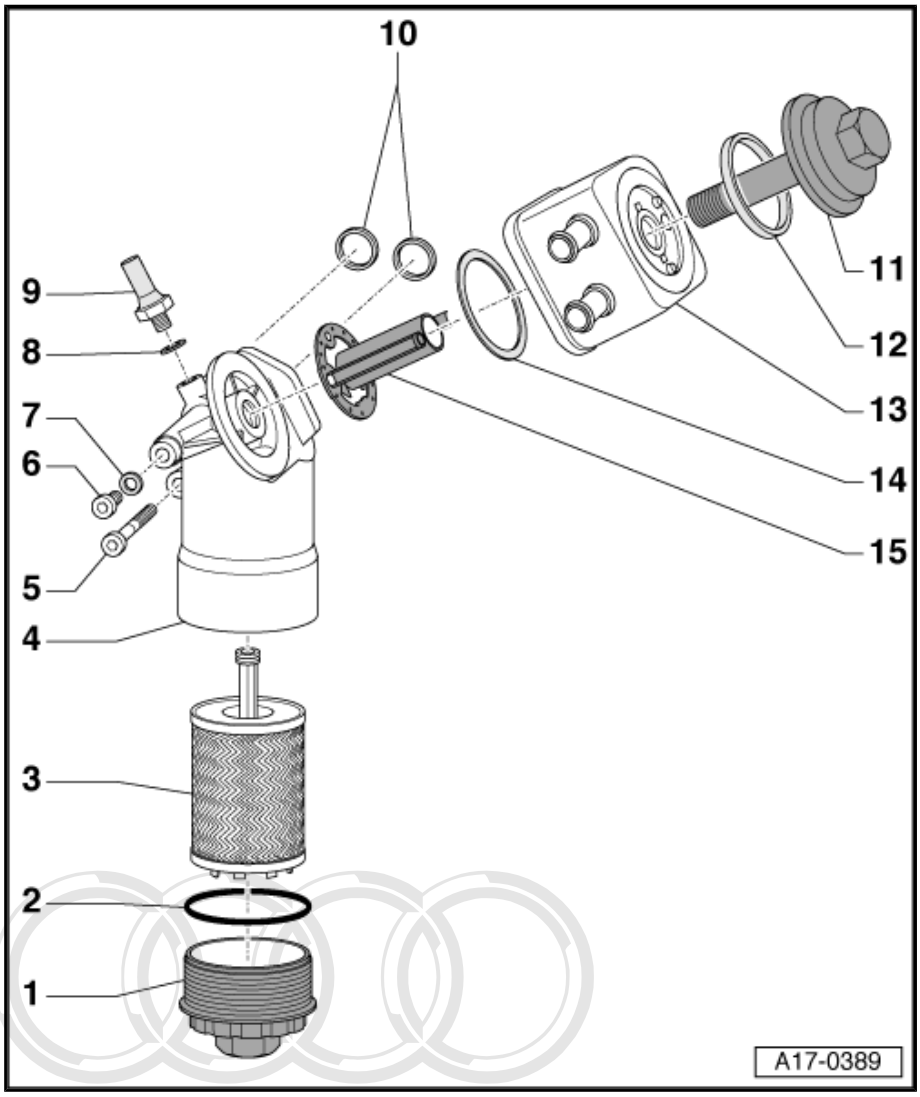
– Check clearance using feeler gauge and straightedge.

• Wear limit: 0.10 mm



2 Oil cooler and oil filter housing

2.1 Oil cooler, oil filter housing - exploded view



1 - Sealing cap
- ❑ 25 Nm

2 - O-ring
- ❑ Renew

3 - Oil filter element
- ❑ Removing and installing ⇒ Maintenance ; Booklet 810

4 - Oil filter housing
- ❑ With oil retention valve

5 - Bolt
- ❑ 23 Nm

6 - Screw plug
- ❑ 15 Nm

7 - Seal
- ❑ If seal is leaking, cut open and renew

8 - Seal
- ❑ If seal is leaking, cut open and renew

9 - Oil pressure switch -F1-
- ❑ Black insulation
- ❑ Opening/closing pressure 1.4 bar
- ❑ Checking ⇒ page 140
- ❑ Removing and installing ⇒ page 139
- ❑ 25 Nm

10 - Seals
- ❑ Renew

11 - Sealing cap
- ❑ 25 Nm

12 - Seal
- ❑ Renew
- ❑ Lubricate before installing

13 - Oil cooler
- ❑ Ensure clearance from adjacent components
- ❑ Diagram of coolant hose connections ⇒ page 144
- ❑ See note if making repairs on engine ⇒ page 128

14 - Seal
- ❑ Installation position ⇒ page 137
- ❑ Lubricate before installing
- ❑ Clamp onto oil cooler together with plastic element -item 15-

15 - Plastic element

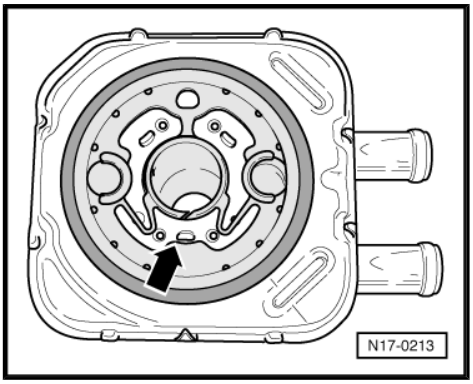
- ❑ Insert into oil cooler together with seal -item 14-
- ❑ Installation position ⇒ page 137

Installation position of seal and plastic element in oil cooler

– Coat seal with oil and insert in oil cooler.

– Insert plastic element into oil cooler.

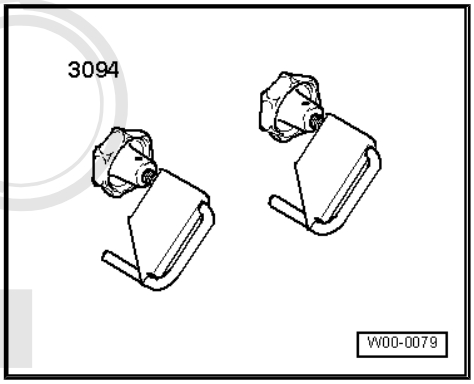
• The side of the plastic element without the support must align with the lug -arrow- of oil cooler.



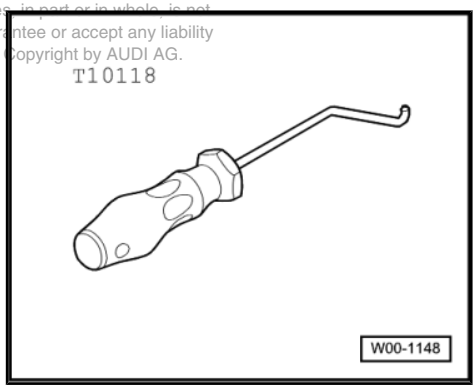
2.2 Removing and installing oil filter housing

Special tools and workshop equipment required

♦ Hose clamps for hoses up to 25 mm -3094-



♦ Assembly tool -T10118-



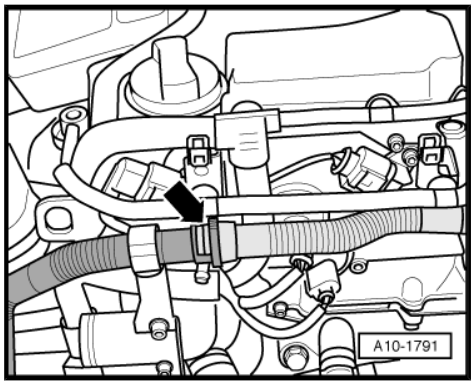
Removing

WARNING

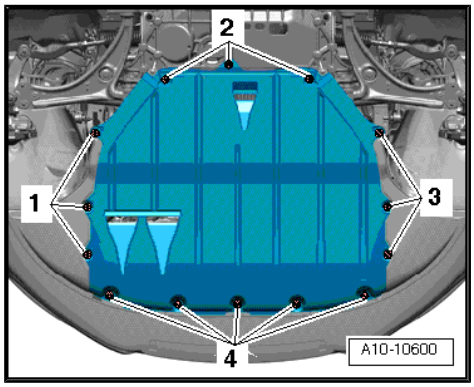
Hot steam/hot coolant can escape - risk of scalding.

- ♦ *The cooling system is under pressure when the engine is hot.*
- ♦ *Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.*

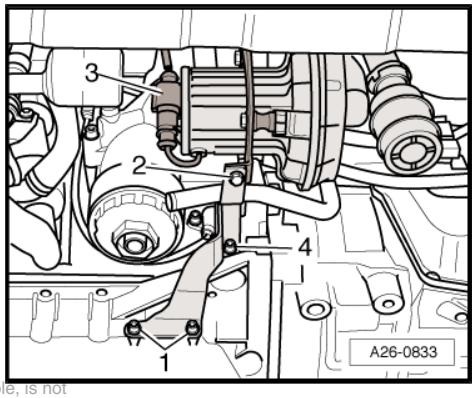
– Open filler cap on expansion tank.
– Detach hose for secondary air system -arrow-.



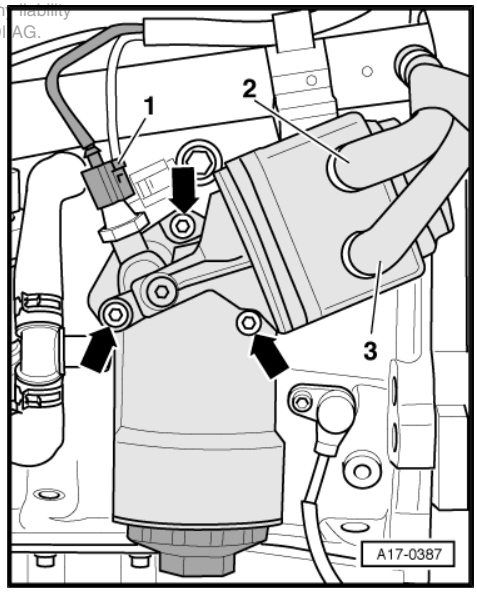
– Release fasteners -1 ... 4- and remove centre noise insulation.



– Move coolant hose at bottom of radiator cowl clear.
– Detach electrical connector -3- at secondary air pump motor -V101- and move wire clear.
– Unscrew bracket -2- for coolant pipe going to gearbox oil cooler on vehicles with direct shift gearbox.
– Remove bolts -1-.
– Loosen bolt -4- and remove secondary air pump with bracket.



– Use hose clamps -3094- to clamp off coolant hoses -2 and 3-.
– Unplug electrical connector -1- at oil pressure switch -F1- using assembly tool -T10118- .
– Detach coolant hoses -2 and 3- from oil filter housing.
– Unscrew bolts -arrows- and remove oil filter housing.



Installing

• Tightening torque ⇒ page 136 .

Installation is carried out in the reverse order; note the following:

Note

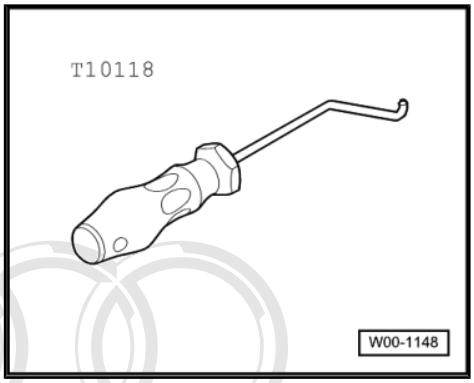
Renew seal.

– Fill up with coolant ⇒ page 147 .

2.3 Removing and installing oil pressure switch -F1-

Special tools and workshop equipment required

- Assembly tool -T10118-

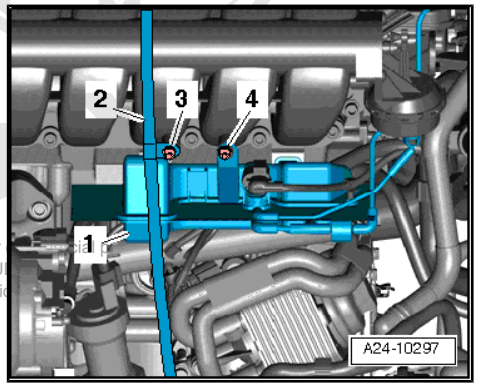


Removing

– Remove poly V-belt ⇒ page 48 .

– Pull out oil dipstick.

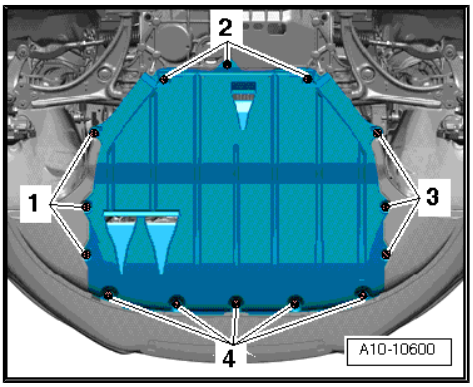
– Unscrew bolt -3- and pull out guide tube for oil dipstick -2- and move clear to one side.



Note

Disregard -items 1 and 4-.

– Release fasteners -1 ... 4- and remove centre noise insulation.

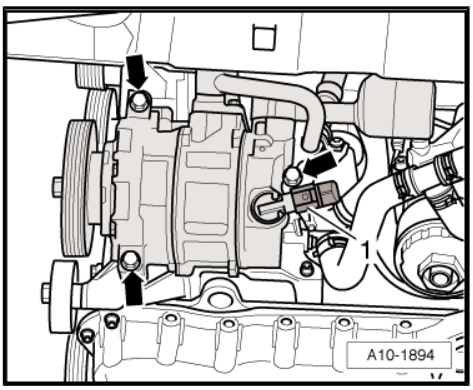


– Unplug electrical connector -1- for magnetic clutch at AC compressor and move electrical wiring clear.

WARNING

Risk of injury caused by refrigerant.

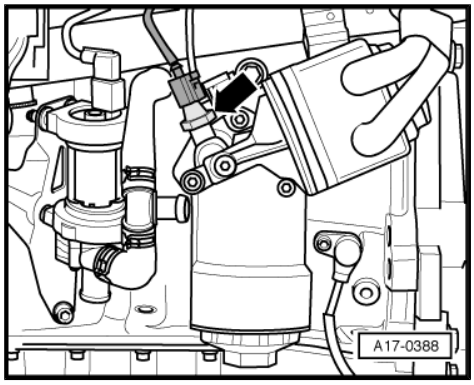
- ***The air conditioner refrigerant circuit must not be opened.***



– Remove bolts -arrows-.

– Tie up air conditioner compressor together with refrigerant hoses at front of noise insulation frame (refrigerant hoses remain connected).

– Unplug electrical connector -arrow- at oil pressure switch -F1- using assembly tool -T10118- .
– Remove oil pressure switch -F1- .



Installing

- Tightening torque ⇒ page 136 .

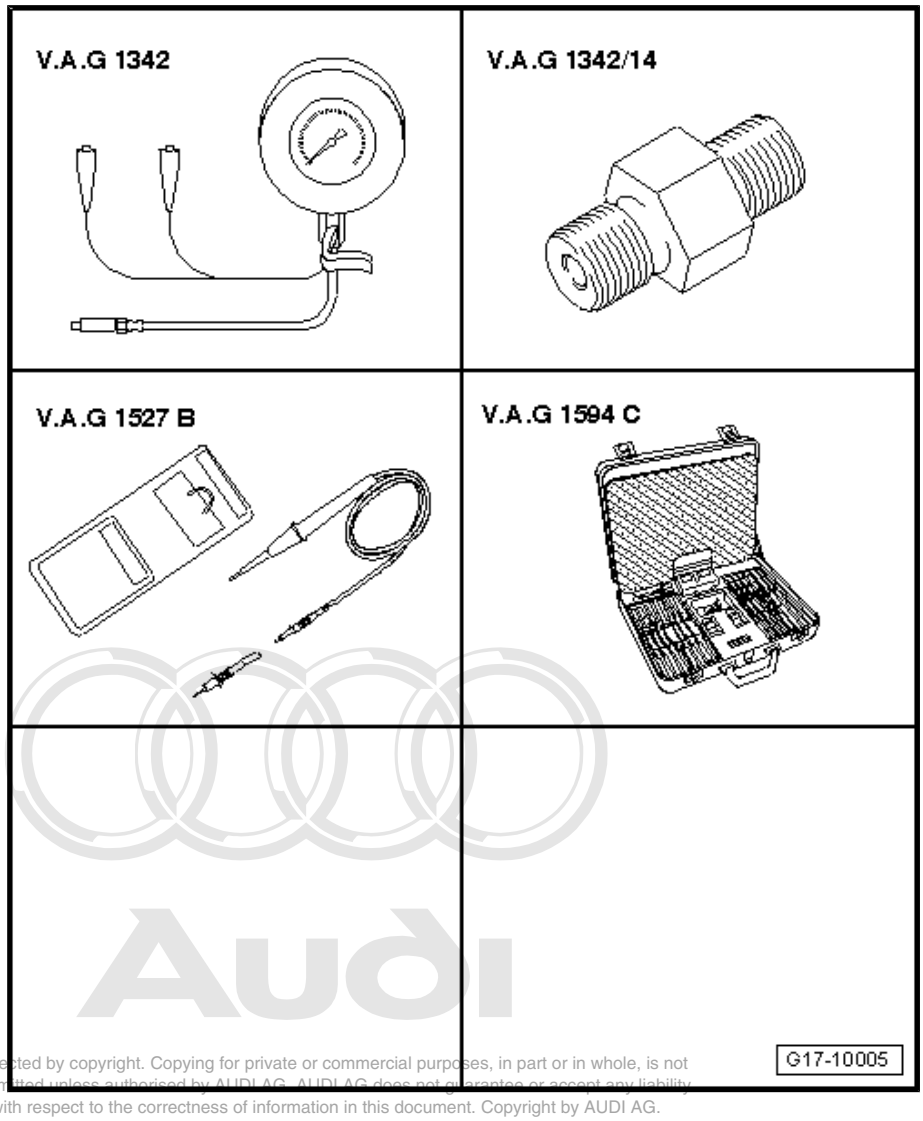
Installation is carried out in the reverse order; note the following:

– Install air conditioner compressor ⇒ Rep. Gr. 87 .
– Install poly V-belt ⇒ page 48 .

2.4 Checking oil pressure and oil pressure switch -F1-

Special tools and workshop equipment required

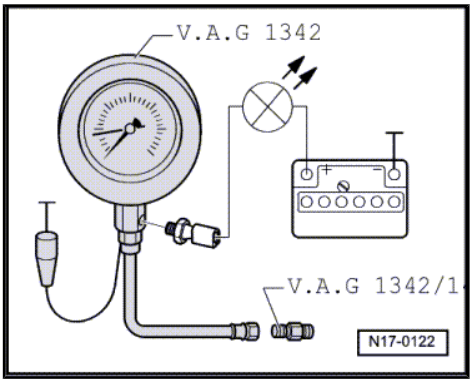
- Oil pressure tester -V.A.G 1342-
- Adapter -V.A.G 1342/14-
- Voltage tester -V.A.G 1527B-
- Auxiliary measuring set -V.A.G 1594C-



Procedure

- Oil level OK
- Engine oil temperature approx. 80 °C
- The message “OK” must light up in the driver information display.

– Remove oil pressure switch ⇒ page 139 .



– Connect oil pressure tester -V.A.G 1342- with adapter -V.A.G 1342/14- to bore for oil pressure switch.
– Screw oil pressure switch into oil pressure tester -V.A.G 1342- .
– Install guide tube for oil dipstick and insert oil dipstick.
– Install air conditioner compressor ⇒ Rep. Gr. 87 .
– Install poly V-belt ⇒ page 48 .

Checking oil pressure switch

– Connect brown wire of oil pressure tester to earth “–”.
– Connect voltage tester -V.A.G 1527B- with adapter leads from auxiliary measuring set -V.A.G 1594C- to oil pressure switch and battery positive (“+”).
• LED should not light up.
– Renew oil pressure switch if LED lights up when engine is not running.
– Start engine.

Note

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

• LED should light up at 1.2 ... 1.6 bar.
– Renew oil pressure switch if LED does not light up.

Checking oil pressure

– Start engine.
• Minimum oil pressure at 1500 rpm: 1.7 bar.
• Minimum oil pressure at 2000 rpm: 2.5 bar.

Assembling

– Install oil pressure switch ⇒ page 139 .

2.5 Engine oil

Refer to ⇒ Maintenance tables for engine oil capacity, viscosity grades and oil specifications.

2.6 Checking oil level

Procedure

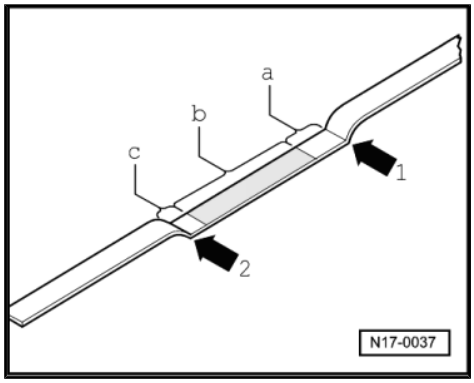
• Engine oil temperature min. 60 °C.
• Vehicle must be level (horizontal).
• Wait a few minutes after switching off the engine to allow the oil to flow back into the sump.
– Pull out oil dipstick.
– Wipe dipstick off with a clean cloth and insert it again as far as it will go.
– Pull out the dipstick again and read off the oil level.

Markings on oil dipstick:

a - Do not top up oil.

b - Oil may be topped up.

c - Oil must be topped up.



Note

The oil level must not be above the “max” marking -arrow 1- and not below the “min” marking -arrow 2-.

19 – Cooling

1 Cooling system

WARNING

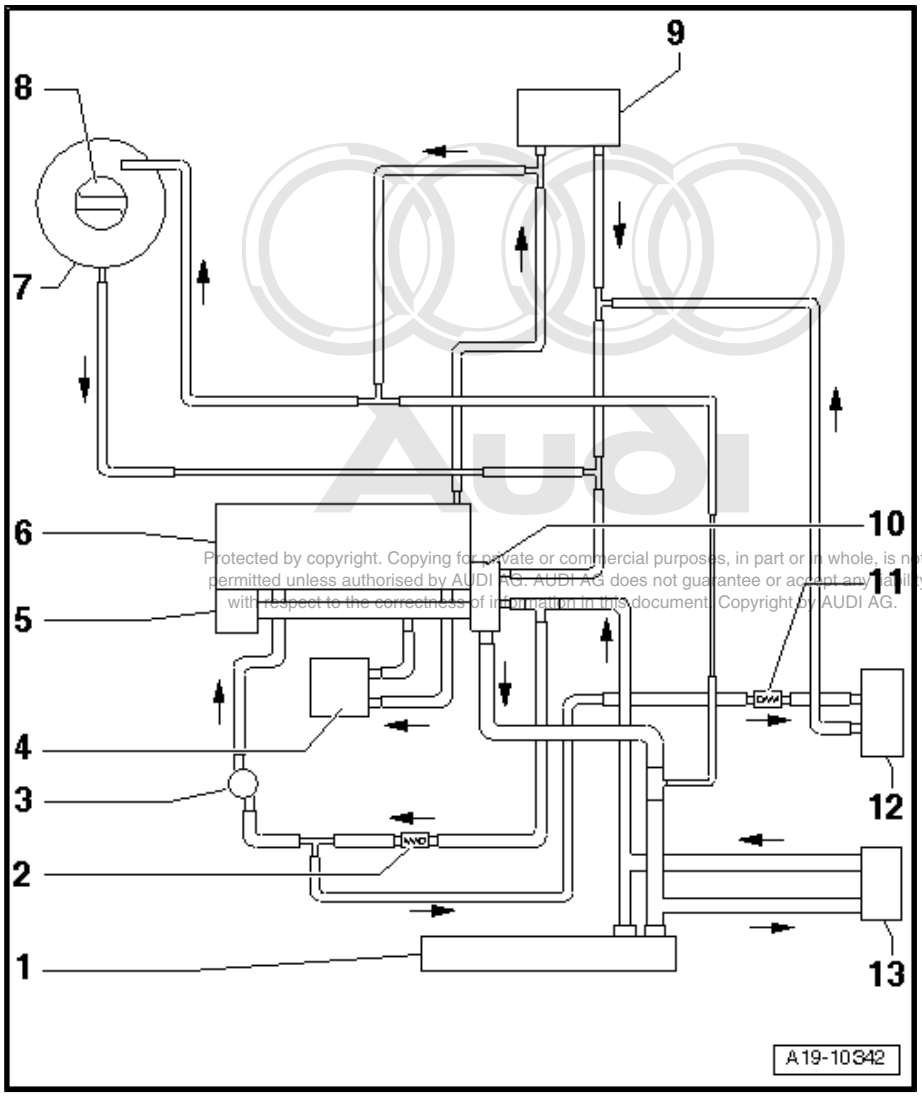
Hot steam/hot coolant can escape - risk of scalding.

- *The cooling system is under pressure when the engine is hot.*
- *Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.*

Note

- *Secure all hose connections with the correct type of hose clips (same as original equipment) ⇒ Electronic parts catalogue .*
- *The arrow markings on coolant pipes and on ends of hoses must align when installing.*

1.1 Diagram of coolant hose connections



1 - Radiator

- ❑ Removing and installing ⇒ page 168
- ❑ If renewed, refill system with fresh coolant

2 - Non-return valve

3 - Continued coolant circulation pump -V51-

- ❑ Removing and installing ⇒ page 156

4 - Oil cooler

- ❑ If renewed, refill system with fresh coolant

5 - Coolant pump

- ❑ Removing and installing ⇒ page 153

6 - Cylinder head and cylinder block

- ❑ If renewed, refill system with fresh coolant

7 - Coolant expansion tank

8 - Filler cap for expansion tank

- ❑ With pressure relief valve
- ❑ Checking pressure relief valve ⇒ page 172

9 - Heat exchanger for heater

- ❑ If renewed, refill system with fresh coolant

10 - Thermostat

- ❑ Removing and installing together with connection ⇒ page 160
- ❑ Checking ⇒ page 161

11 - Non-return valve

- ❑ Only on vehicles with direct shift gearbox

12 - Gearbox oil cooler

- ❑ If renewed, refill system with fresh coolant

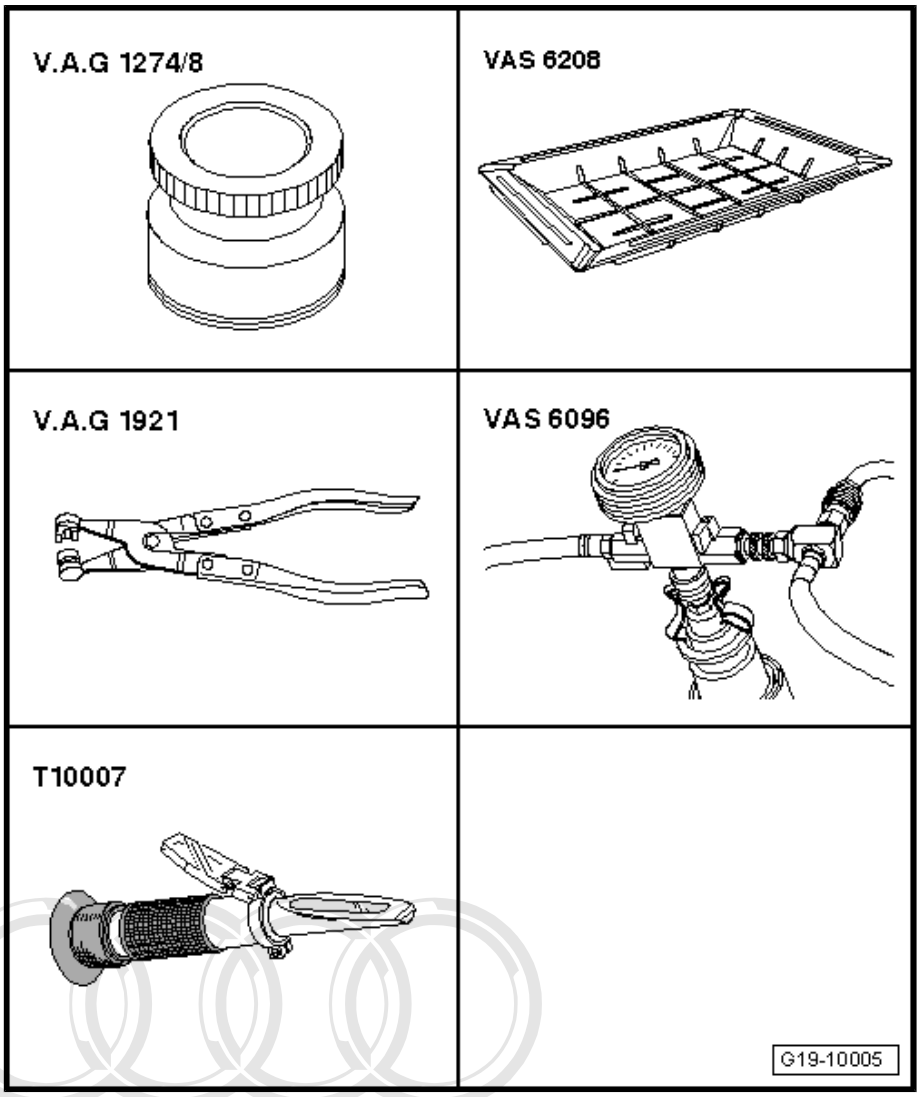
13 - Auxiliary radiator

- ❑ Depending on equipment

1.2 Draining and filling cooling system

Special tools and workshop equipment required

- Adapter for cooling system tester -V.A.G 1274/8-
- Drip tray for workshop hoist -VAS 6208-
- Hose clip pliers - V.A.G 1921-
- Cooling system charge unit -VAS 6096-
- Refractometer -T10007-



Draining

Note

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

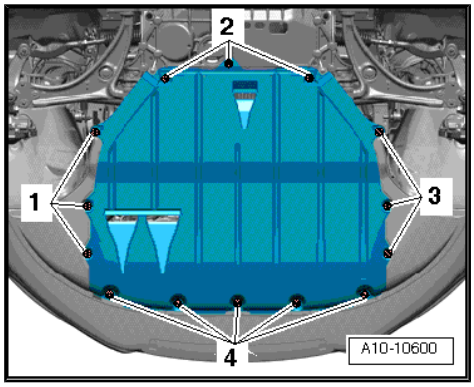
WARNING

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

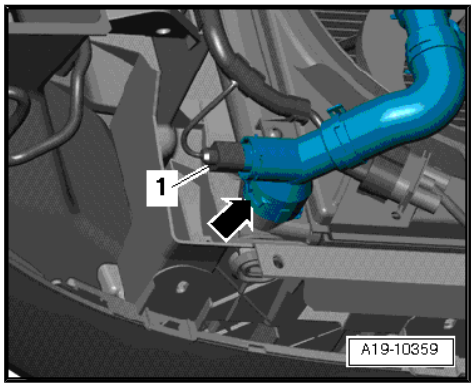
- ***The cooling system is under pressure when the engine is hot.***
- ***Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.***

– Open filler cap on expansion tank.

– Release fasteners -1 ... 4- and remove centre noise insulation.



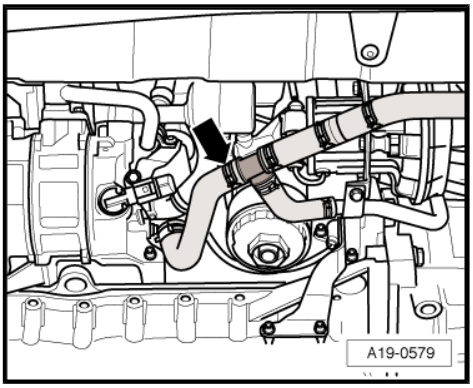
– Place drip tray for workshop hoist -VAS 6208- beneath engine.
– Disconnect bottom coolant hose from radiator -arrow- and drain off coolant.



Note

Disregard item -1-.

– Disconnect bottom coolant hose leading to continued coolant circulation pump -V51- -arrow- and drain off coolant.



Note

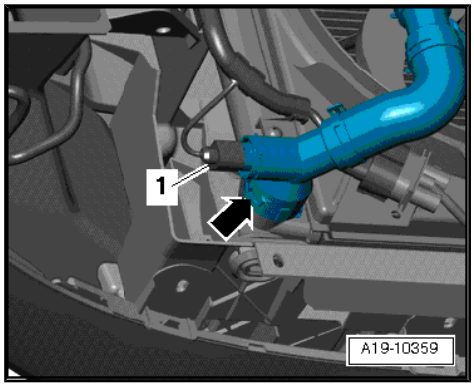
Illustration shows coolant hose on vehicle with direct shift gearbox.

Filling

Note

- *The cooling system is filled all year round with a mixture of water and radiator antifreeze/anti-corrosion agent.*
- *Use only the radiator antifreeze/anti-corrosion agent approved for this engine ⇒ Electronic parts catalogue . Other coolant additives could seriously impair in particular the anticorrosion properties. The resulting damage could lead to loss of coolant and consequently to serious engine damage.*
- *The specified radiator antifreeze/anti-corrosion agent prevents frost and corrosion damage and stops scaling. Such additives also raise the boiling point of the coolant. For these reasons the cooling system must be filled all year round with the correct antifreeze and anticorrosion additive.*
- *Because of its high boiling point, the coolant improves engine reliability under heavy loads, particularly in countries with tropical climates.*
- *Frost protection is required down to about –25 °C (in countries with arctic climate: down to about –35 °C).*
- *The coolant concentration must not be reduced by adding water even in warmer seasons and in warmer countries. The coolant concentration must be at least 40 %.*
- *If greater frost protection is required in very cold climates, the concentration of radiator antifreeze/anti-corrosion agent can be increased, but only up to 60% (this gives frost protection to about –40 °C). If the concentration exceeds 60%, frost protection decreases again and cooling efficiency is also impaired.*
- *Use only clean tap water for mixing coolant.*
- *If radiator, heat exchanger, cylinder head, cylinder head gasket or cylinder block have been renewed, do not re-use old coolant.*
- *Contaminated or dirty coolant must not be used again.*
- *For checking anti-freeze protection in cooling system, use refractometer -T10007- .*

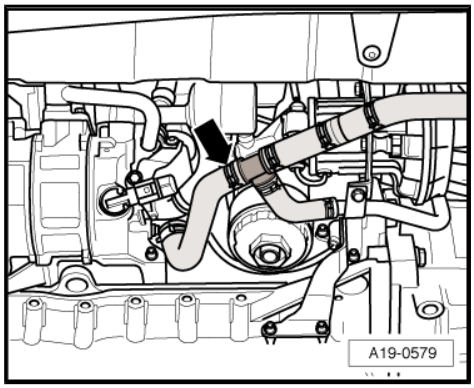
– Connect bottom coolant hose to radiator -arrow-.



Note

Disregard item -1-.

– Connect the coolant hose to the continued circulation coolant pump -V51- -arrow-.



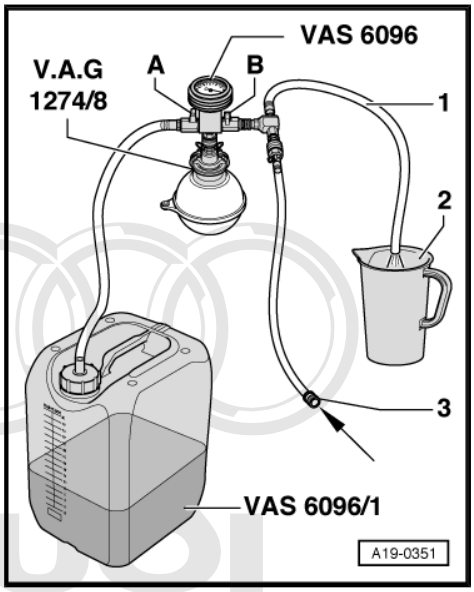
Note

Illustration shows coolant hose on vehicle with direct shift gearbox.

– Fill reservoir of -VAS 6096- with at least 10 litres of premixed coolant (according to recommended ratio):

• “G12+” (40 %) and water (60 %) for frost protection to -25 °C
• “G12+” (50 %) and water (50 %) for frost protection to -35 °C
• “G12+” (60 %) and water (40 %) for frost protection to –40 °C

– Fit adapter for cooling system tester -V.A.G 1274/8- onto coolant expansion tank.
– Attach cooling system charge unit -VAS 6096- to adapter -V.A.G 1274/8- .
– Run vent hose -1- into a small container -2-.



Note

The vented air draws along a small amount of coolant, which should be collected.

– Close both valves -A- and -B- (turn lever at right angles to direction of flow).
– Connect hose -3- to compressed air.

• Pressure: 6 ... 10 bar.

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

• The suction jet pump generates a partial vacuum in the cooling system; the needle on the gauge should move into the green zone.

– Also briefly open valve -A- (turn lever in direction of flow) so that hose on reservoir of -VAS 6096- can fill with coolant.

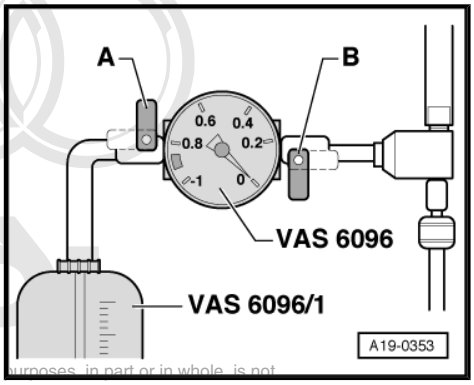
– Close valve -A- again.

– Leave valve -B- open for another 2 minutes.

• The suction jet pump continues to generate a partial vacuum in the cooling system; the needle on the gauge should remain in the green zone.

– Close valve -B-.

• The needle on the gauge should stop in the green zone. The vacuum level in the cooling system is then sufficient for subsequent filling.



Note

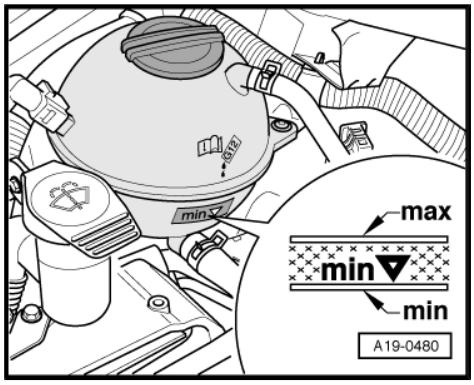
♦ *If the needle does not reach the green zone, repeat the process.*

♦ *Check cooling system for leaks if the vacuum is not maintained.*

– Detach compressed air hose.

– Open valve -A-.

• The vacuum in the cooling system causes the coolant to be drawn out of the reservoir of -VAS 6096- ; the cooling system is then filled.



– Check coolant level.
– Top up coolant to “max” mark.
– Start engine and run for 2 minutes (maximum) at approx. 1500 rpm.
– Top up coolant to overflow hole on expansion tank with engine running.
– Close filler cap on coolant expansion tank.
– Start engine and run until radiator fan cuts in.

WARNING

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

- *The cooling system is under pressure when the engine is hot.*
- *Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.*

– Check coolant level.
• When the engine is at normal operating temperature, coolant level must be at “max” mark, when engine is cold it must be between “min” and “max” marks.
– Top up with coolant again if necessary.
– Switch off engine.

2 Coolant pump, thermostat, coolant pipes

WARNING

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

- *The cooling system is under pressure when the engine is hot.*
- *Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.*

2.1 Thermostat housing - exploded view

1 - O-rings
- ❑ Renew

2 - Retaining clips

3 - Thermostat housing
- ❑ Removing and installing ⇒ page 158

4 - Bracket
- ❑ Version fitted in vehicle may differ from illustration

5 - Bolts
- ❑ 10 Nm

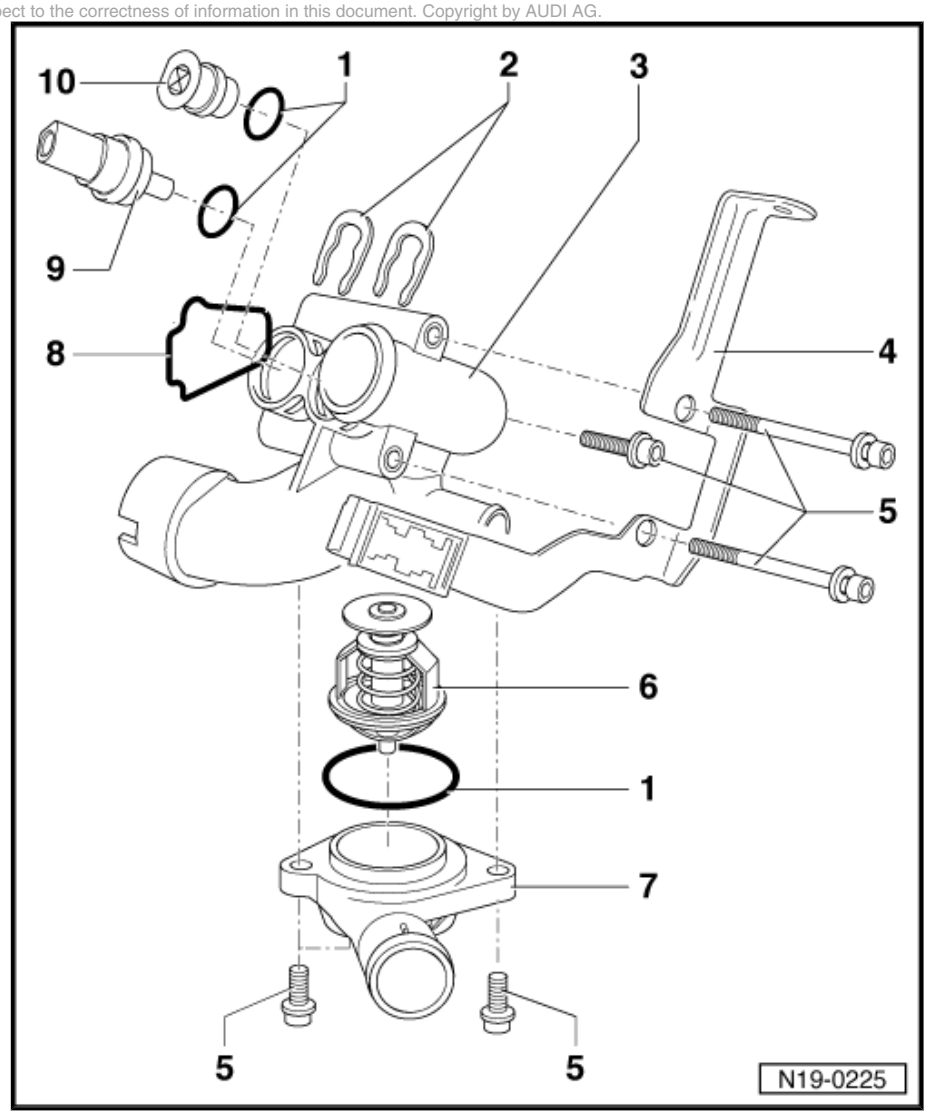
6 - Thermostat
- ❑ Removing and installing together with connection -item 7- ⇒ page 160
- ❑ Checking ⇒ page 161

7 - Connection
- ❑ Removing and installing ⇒ page 160

8 - Gasket
- ❑ Renew

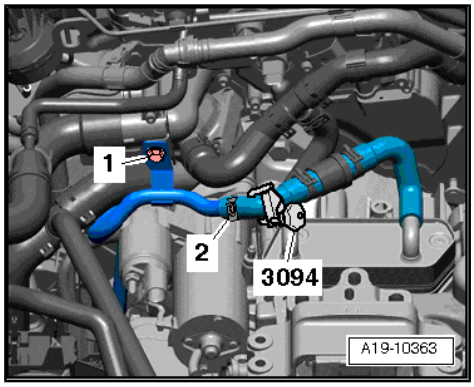
9 - Coolant temperature sender -G62-
- ❑ Removing and installing ⇒ page 161

10 - Sealing plug



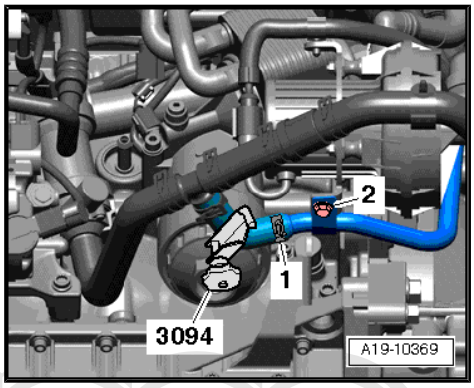
Coolant pipe leading to gear oil cooler - tightening torque

– Tighten bolt -1- to 10 Nm.



Coolant pipe leading to gear oil cooler - tightening torque

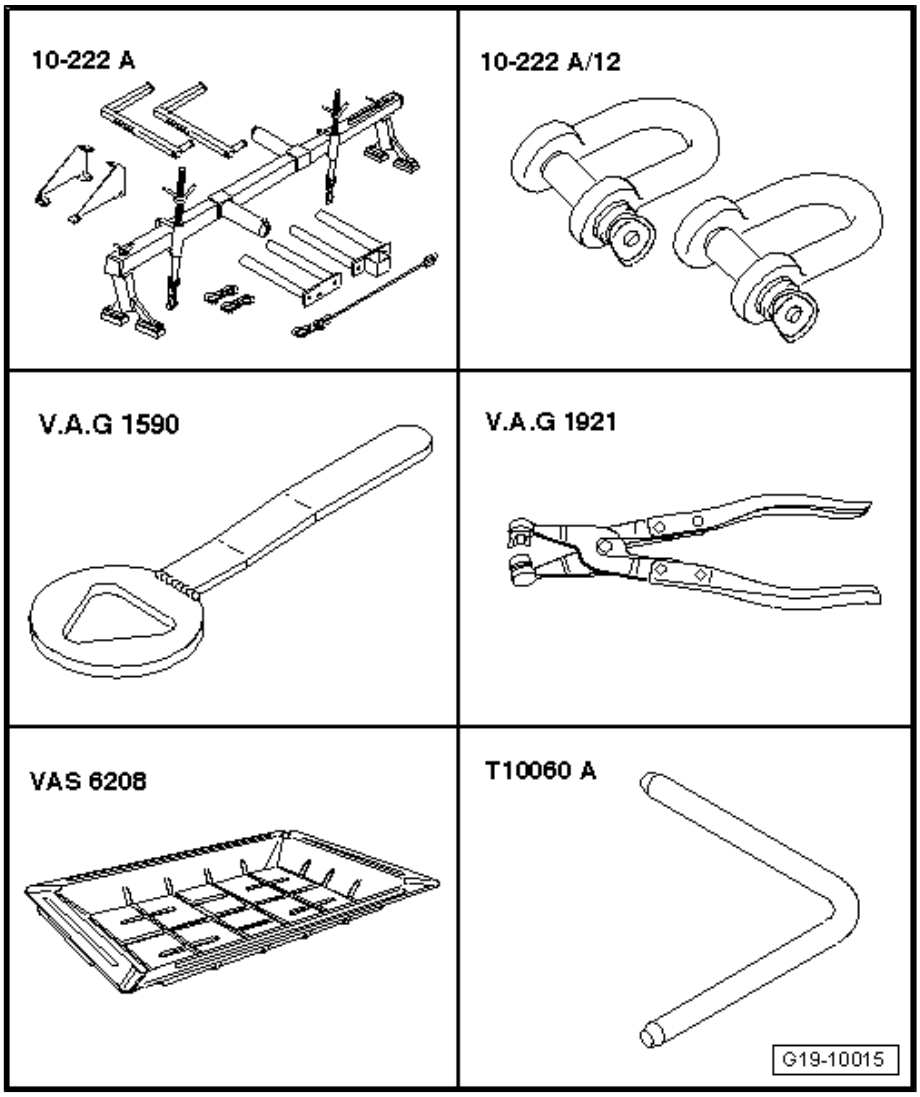
– Tighten bolt -1- to 10 Nm.



2.2 Removing and installing coolant pump

Special tools and workshop equipment required

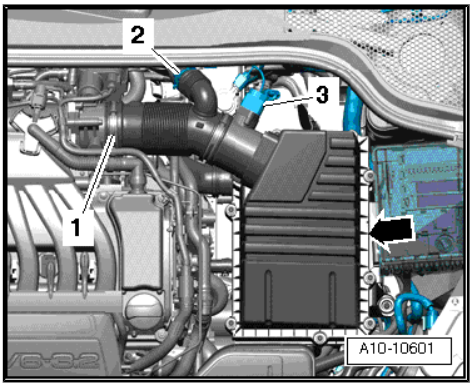
- Support bracket -10 - 222 A-
- Shackle -10 - 222 A /12-
- Water pump wrench - V.A.G 1590-
- Hose clip pliers - V.A.G 1921-
- Drip tray for workshop hoist -VAS 6208-
- Locking pin -T10060 A-
- Bolt M8x40



Removing

– Remove poly V-belt ⇒ page 48 .

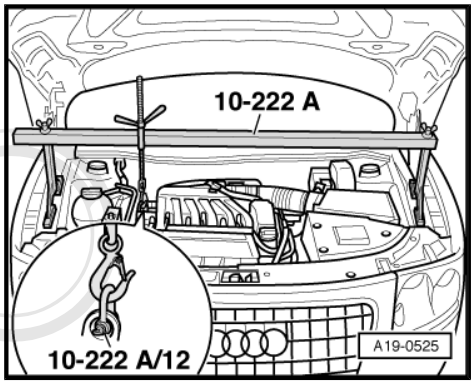
– Disconnect air intake hose -1- from throttle valve module - J338- .



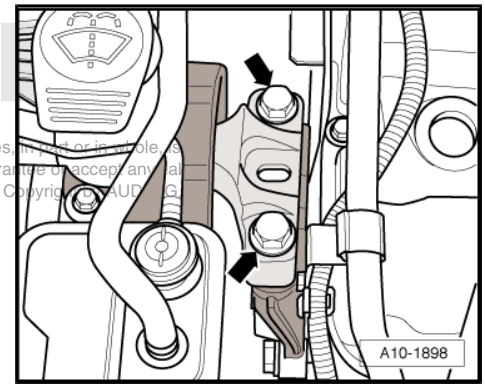
Note

Disregard items marked -2 and 3-.

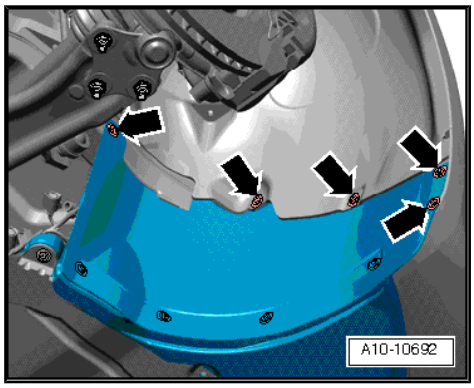
– Secure shackle -10 - 222 A /12- to engine lifting eye (rear right).
– Set up support bracket -10 - 222 A- on top edges of body flanges.
• The spindle is located at rear.
– Engage hook on spindle in shackle.
– Apply light tension to spindle.



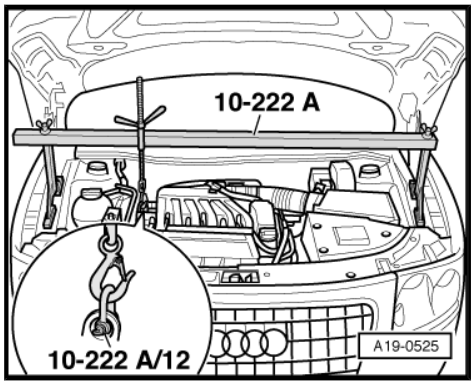
– Remove bolts -arrows- of assembly mounting (left-side) at engine.
– Drain coolant ⇒ page 145 .



– Remove noise insulation (right-side) -arrows-.

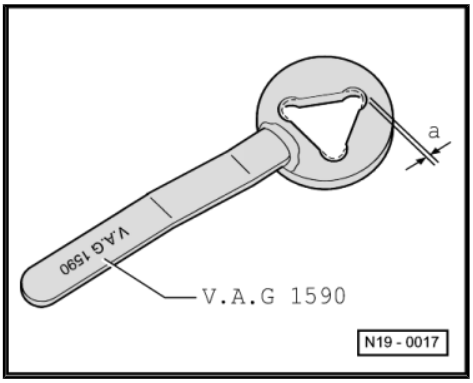


– Lower engine via spindle approx. 60 mm.



– If water pump spanner -V.A.G 1590- has not been filed down previously, file down the 3 round corners on the water pump spanner -V.A.G 1590- to dimension -a-.

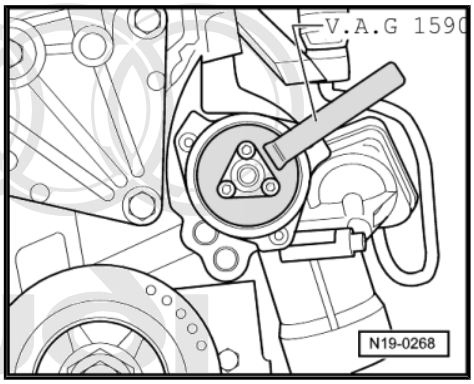
• Dimension -a- = 1 mm.



– Remove poly-V-belt pulley (use water pump spanner -V.A.G 1590- to hold poly V-belt pulley in position).

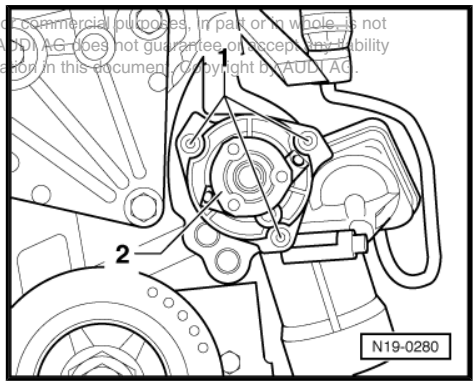
Note

If the engine has been removed, the coolant pump bolts are accessible through the holes in the pulley. In this case it is not necessary to remove the poly V-belt pulley.



– Remove bolts -1- for coolant pump -2-.

– Pivot coolant pump out towards the front.



Installing

• Tightening torques ⇒ page 46

Installation is carried out in the reverse order; note the following:

Note

Renew O-ring.

– Clean and smoothen sealing surface for O-ring.

– Lubricate O-ring with coolant additive “G12+”.

– Fit coolant pump -2-.

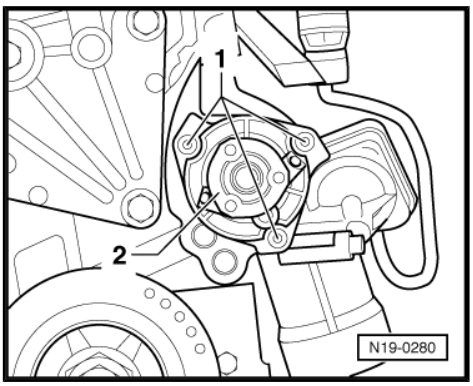
– Tighten coolant pump bolts -1-.

– Install poly-V-belt pulley.

– Install poly V-belt ⇒ page 48 .

– Adjust assembly mountings ⇒ page 39 .

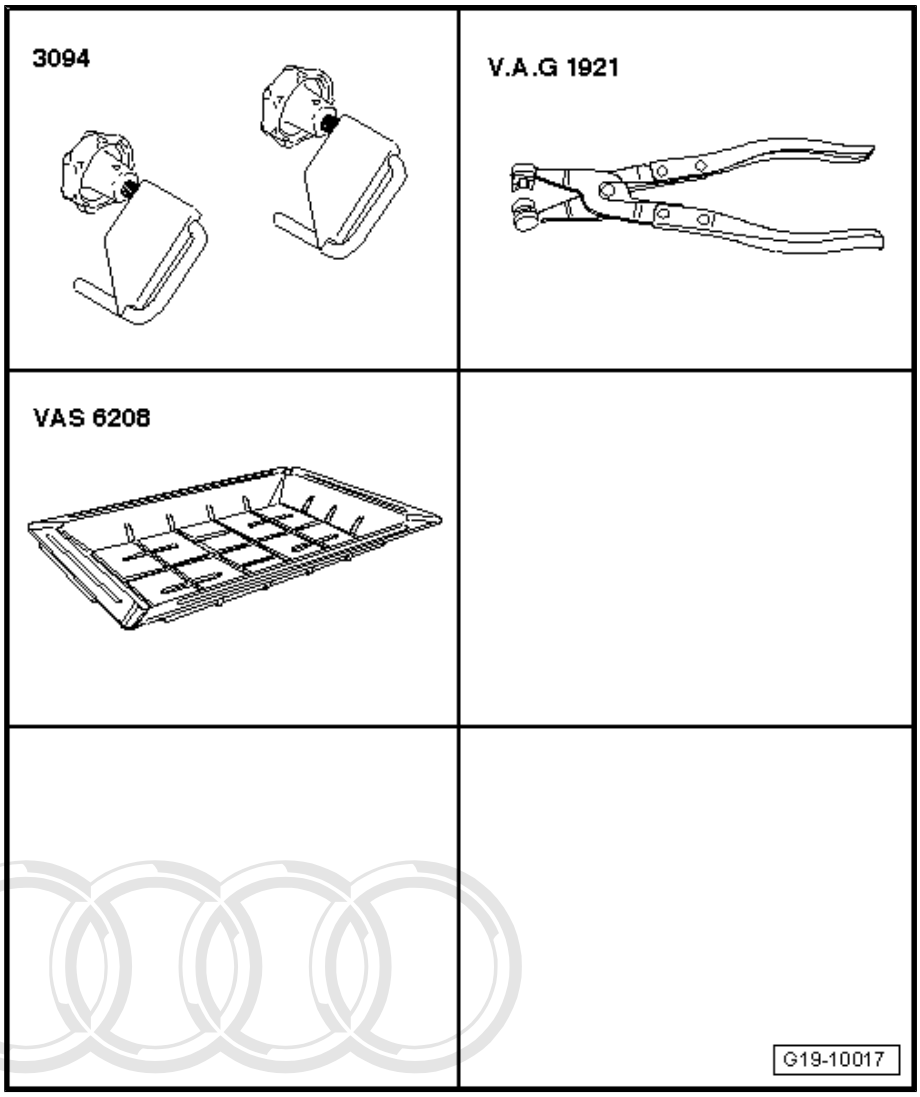
– Fill up with coolant ⇒ page 147 .



2.3 Removing and installing continued coolant circulation pump -V51-

Special tools and workshop equipment required

- Hose clamps for hoses up to 25 mm -3094-
- Hose clip pliers - V.A.G 1921-
- Drip tray for workshop hoist -VAS 6208-



Removing

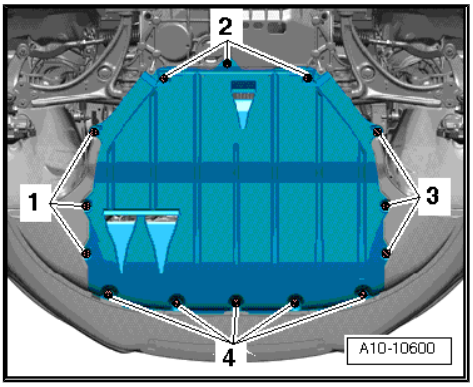
WARNING

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

- ***The cooling system is under pressure when the engine is hot.***
- ***Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.***

– Open filler cap on expansion tank.
– Remove poly V-belt ⇒ page 48 .

– Release fasteners -1 ... 4- and remove centre noise insulation.

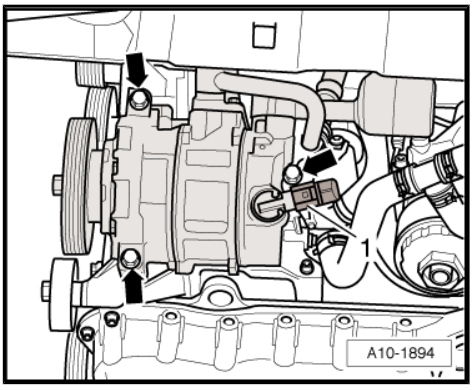


– Unplug electrical connector -1- for magnetic clutch on air conditioner compressor.

WARNING

Risk of injury caused by refrigerant.

- *The air conditioner refrigerant circuit must not be opened.*



– Remove bolts -arrows- for air conditioner compressor.

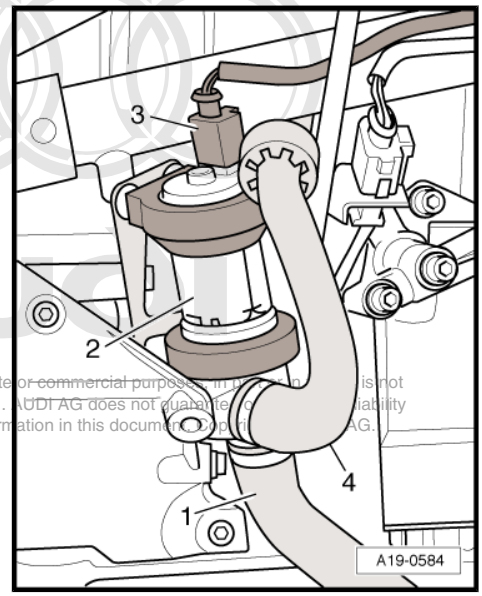
– Tie up air conditioner compressor together with refrigerant hoses at front of noise insulation frame (refrigerant hoses remain connected).

– Unplug electrical connector -3- at continued circulation coolant pump -V51- -item 2-.

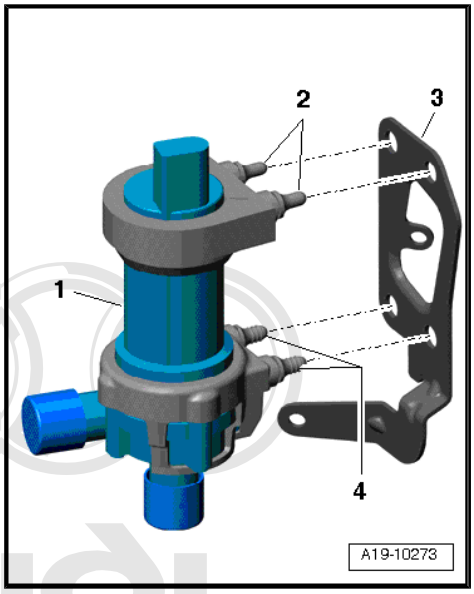
– Place drip tray for workshop hoist -VAS 6208- beneath engine.

– Use hose clamps -3094- to clamp off coolant hoses -1- and -4-.

– Disconnect coolant hoses from continued coolant circulation pump -V51- .



– Spray lugs -2- and -4- on flexible bracket for continued coolant circulation pump -V51- -item 1- with silicone-free lubricant.
– Disengage rubber lugs from bracket -3- for continued coolant circulation pump -V51- .



Installing

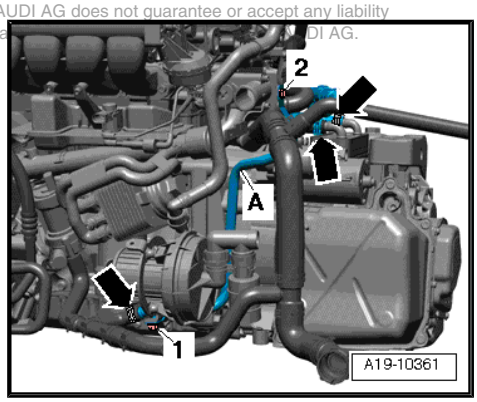
Installation is carried out in the reverse order; note the following:

– Install air conditioner compressor ⇒ Rep. Gr. 87 .
– Install poly V-belt ⇒ page 48 .
– Fill up with coolant ⇒ page 147 .

2.4 Removing and installing thermostat housing

Removing

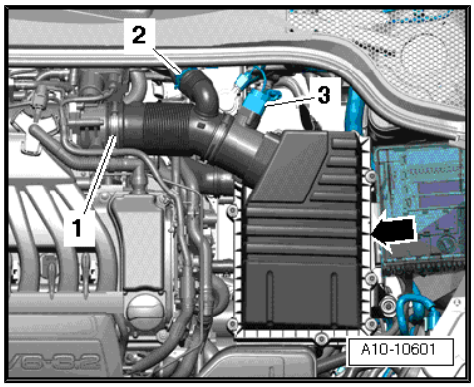
– Drain coolant ⇒ page 145 .
– Remove bolt -1- for coolant pipe -A-.



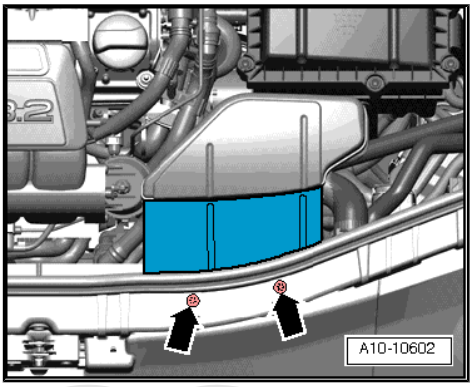
Note

Disregard items marked -2 and arrows-.

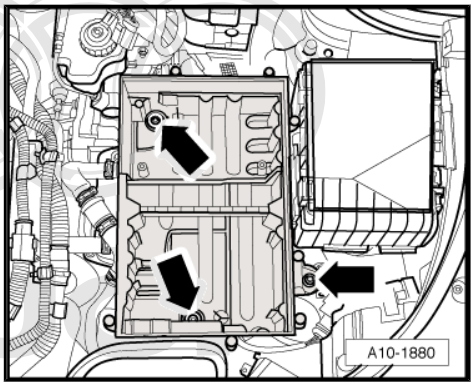
– Detach resonance pipe -2- from air intake hose.
– Disconnect air intake hose -1- from throttle valve module -J338- .
– Detach electrical connector -3- for air mass meter -G70- .
– Unscrew top section of air cleaner housing -arrow- and remove air filter element.



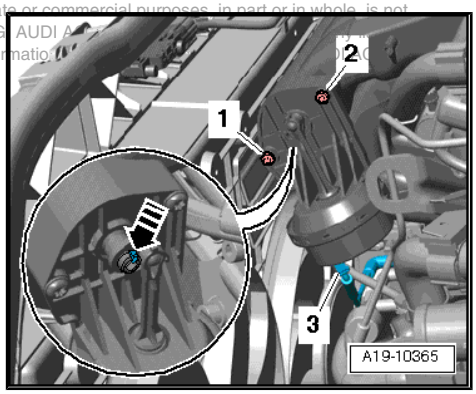
– Unscrew bolts -arrows- and remove air duct.



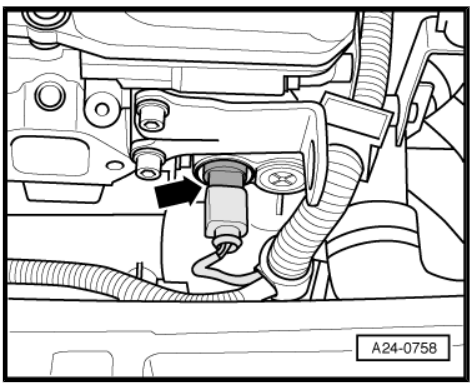
– Remove bottom section of air cleaner housing -arrows-.



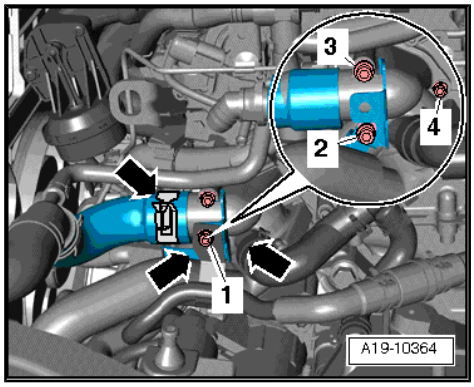
– Release and detach relay lever -arrow-.
– Remove bolts -1- and -2-.
– Detach vacuum unit for intake manifold flaps from intake manifold and move clear to one side (vacuum hose -3- remains connected).



– Unplug electrical connector -arrow- at coolant temperature sender -G62- .



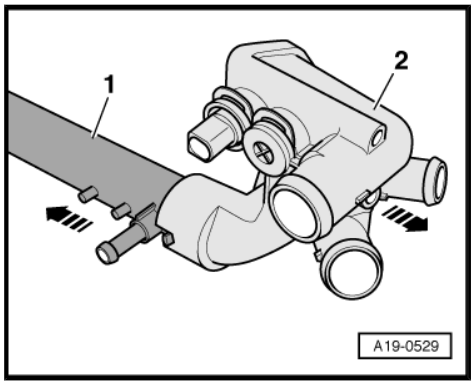
– Detach coolant hoses -arrows-.
– Unscrew bolt -1- and pull coolant pipe to the left.
– Remove bolts -2, 3, 4-.



Caution

Take care to avoid pulling out coolant pipe unintentionally.

- *Use lever to press coolant pipe -1- towards coolant pump -left arrow- when detaching thermostat housing -2- -right arrow-.*



Installing

- Tightening torques ⇒ page 151

Installation is carried out in the reverse order; note the following:

Note

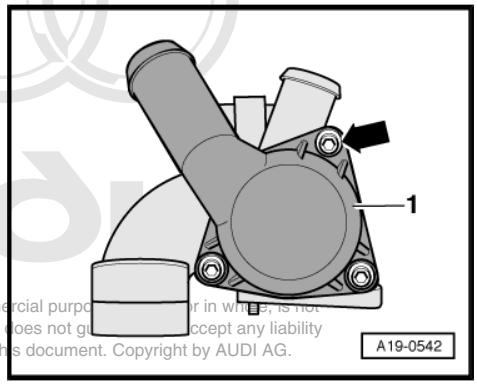
Renew seals and gaskets.

– Install vacuum unit for intake manifold flaps ⇒ Rep. Gr. 24 .
– Install air cleaner housing ⇒ Rep. Gr. 24 .
– Install air filter element ⇒ Rep. Gr. 24 .
– Fill up with coolant ⇒ page 147 .

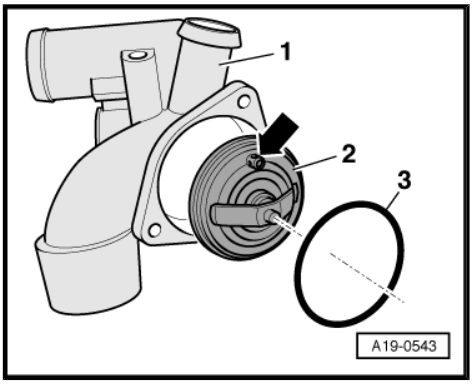
2.5 Removing and installing hose connection with thermostat

Removing

– Drain coolant ⇒ page 145 .
– Remove thermostat housing ⇒ page 158 .
– Unscrew bolts -arrows- and remove connection -1-.



– Remove O-ring -3- with thermostat -2- from thermostat housing -1-.



Installing

• Tightening torques ⇒ page 151

Installation is carried out in the reverse order; note the following:

Note

Renew seals and O-ring.

– Clean sealing surface for O-ring.
– Fit thermostat -2-.
• Installation position: Vent valve -arrow- faces upwards.
– Coat new O-ring -3- with coolant “G12+”.
– Secure connection to thermostat housing.
– Install thermostat housing -1- ⇒ page 158 .
– Fill up with coolant ⇒ page 147 .

2.6 Checking thermostat

– Heat removed thermostat in water bath.

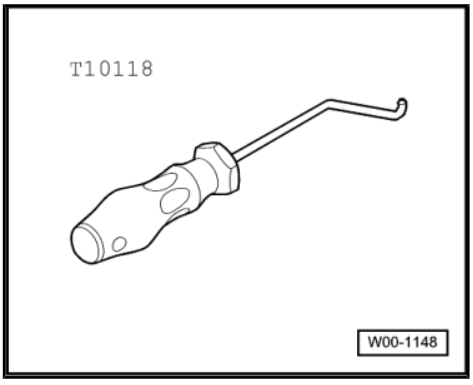
Starts to open	Fully open	Opening travel
approx. 80 °C	approx. 105 °C [1]	at least 7 mm

• [1] Cannot be tested.

2.7 Removing and installing coolant temperature sender -G62-

Special tools and workshop equipment required

♦ Assembly tool -T10118-



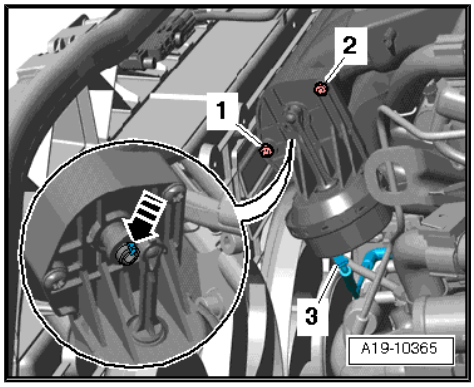
Removing

- Engine cold.

– Release and detach relay lever -arrow-.

– Remove bolts -1- and -2-.

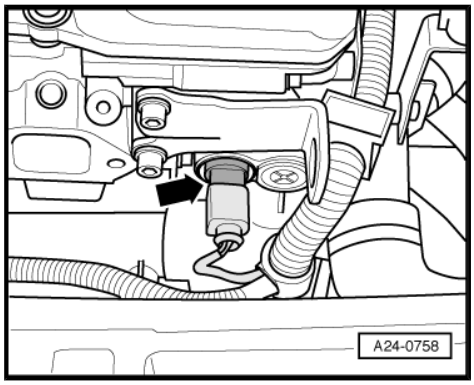
– Detach vacuum unit for intake manifold flaps from intake manifold and move clear to one side (vacuum hose -3- remains connected).



– Unplug electrical connector -arrow- at coolant temperature sender -G62- using assembly tool -T10118- .

– Pull retaining clip for coolant temperature sender -G62- upwards.

– Remove coolant temperature sender -G62- out of thermostat housing.



Installing

Installation is carried out in the reverse order; note the following:

Note

- *Fit new O-ring.*
- *Insert new coolant temperature sender -G62- immediately in thermostat housing to avoid loss of coolant.*

– Install vacuum unit for intake manifold flaps ⇒ Rep. Gr. 24 .

– Check coolant level ⇒ page 147 .

2.8 Removing and installing coolant pipe

Removing

– Drain coolant ⇒ page 145 .

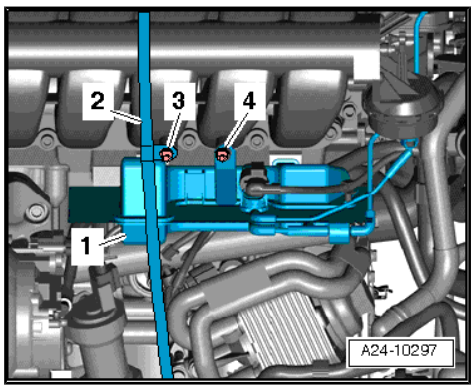
– Remove thermostat housing ⇒ page 158 .

– Pull out oil dipstick.

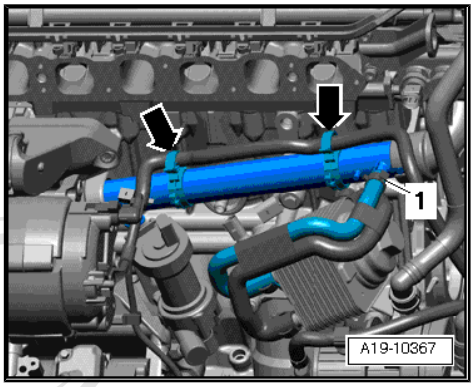
– Unscrew bolt -3- and pull out guide tube for oil dipstick -2- and move clear to one side.

– Remove bolt -4- and detach vacuum reservoir -1- from intake manifold.

– Move vacuum reservoir clear to one side (with pipes/hoses connected).



– Unclip bracket -arrows- for wiring harness (left and right) from coolant pipe.
– Detach coolant hose -1- going to oil cooler from coolant pipe.
– Pull coolant pipe out of cylinder block.



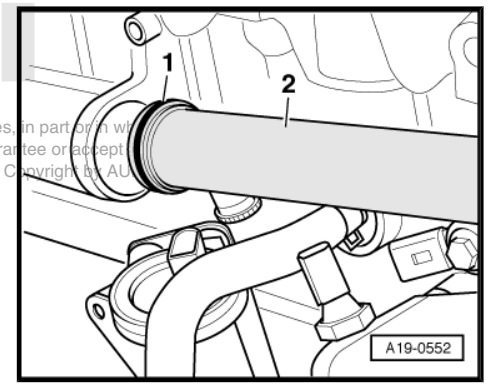
Installing

Installation is carried out in the reverse order; note the following:

Note

Fit new O-rings.

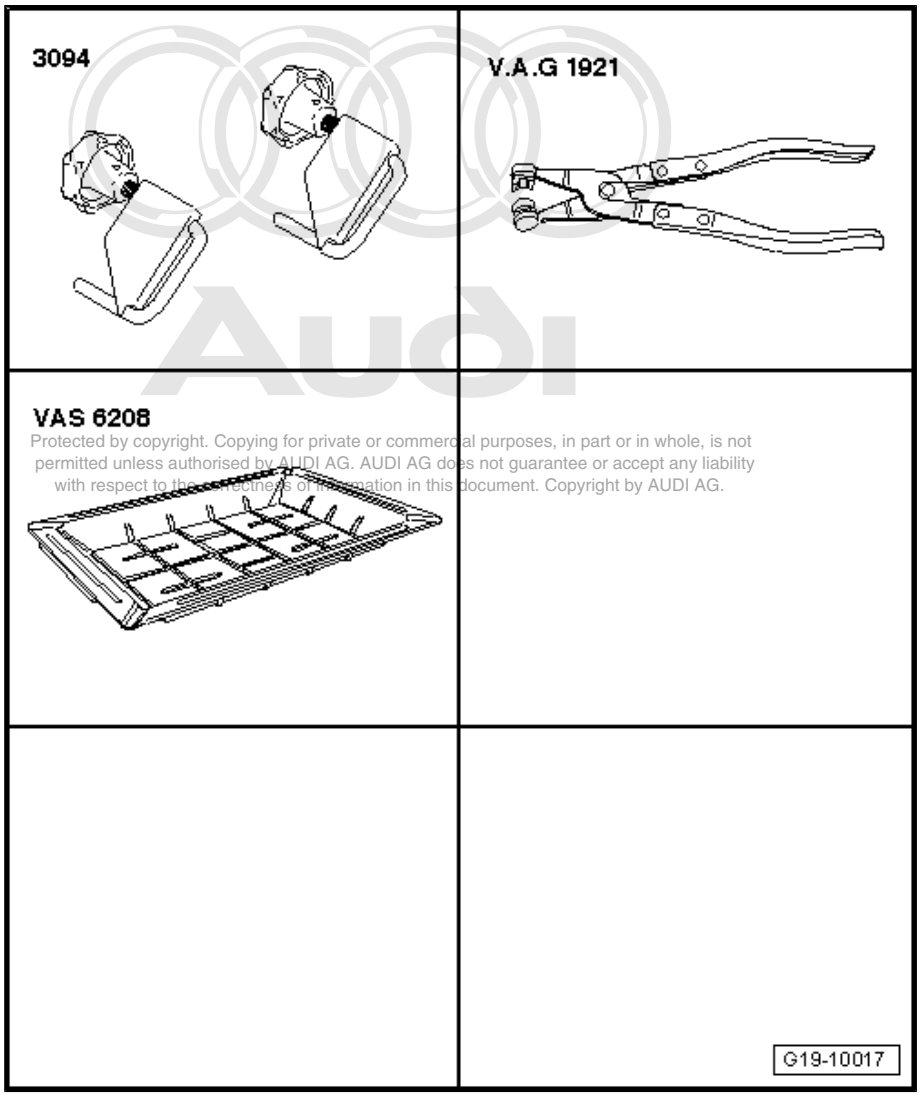
– Clean and smoothen sealing surface for O-ring in cylinder block.
– Lubricate new O-ring -1- with “G 12+” and push onto coolant pipe -2-.
– Slide coolant pipe into bore in cylinder block.
– Install thermostat housing ⇒ page 158 .
– Fill up with coolant ⇒ page 147 .



2.9 Removing and installing coolant pipe going to gear oil cooler

Special tools and workshop equipment required

- Hose clamps for hoses up to 25 mm -3094-
- Hose clip pliers - V.A.G 1921-
- Drip tray for workshop hoist -VAS 6208-



Removing

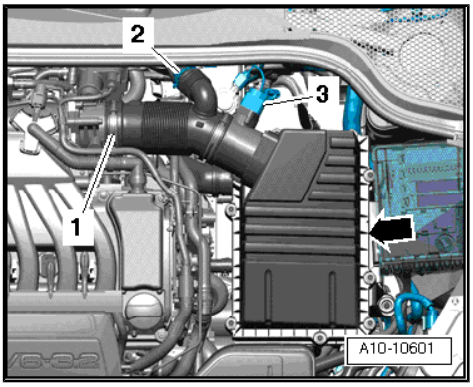
WARNING

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

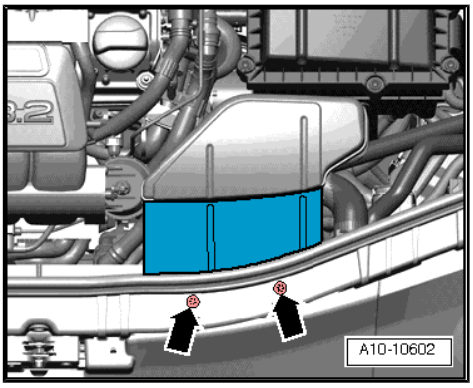
- *The cooling system is under pressure when the engine is hot.*
- *Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.*

– Open filler cap on expansion tank.

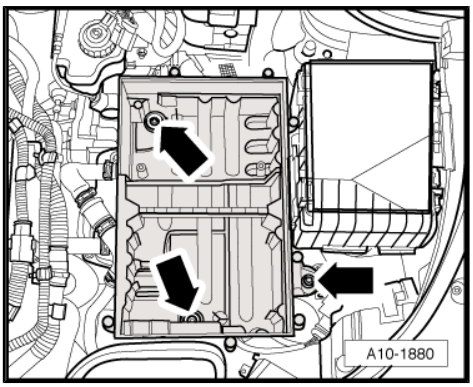
– Detach resonance pipe -2- from air intake hose.
– Disconnect air intake hose -1- from throttle valve module -J338- .
– Detach electrical connector -3- for air mass meter -G70- .
– Unscrew top section of air cleaner housing -arrow- and remove air filter element.



– Unscrew bolts -arrows- and remove air duct.



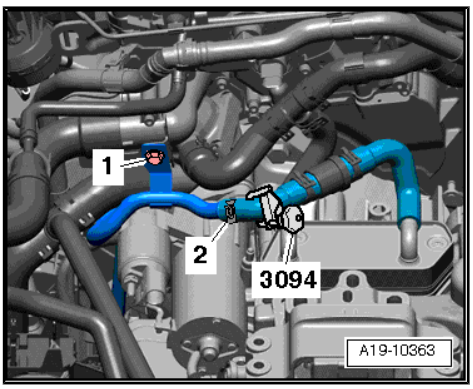
– Remove bottom section of air cleaner housing -arrows-.



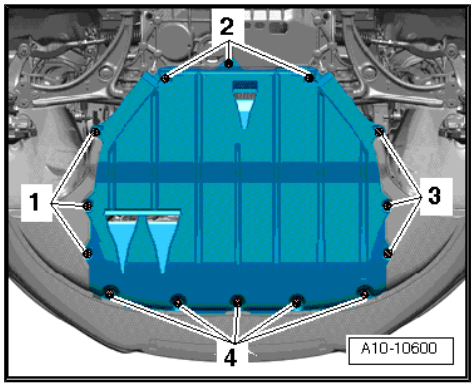
– Use hose clamp -3094- to clamp off coolant hose at coolant pipe going to gear oil cooler.

Note

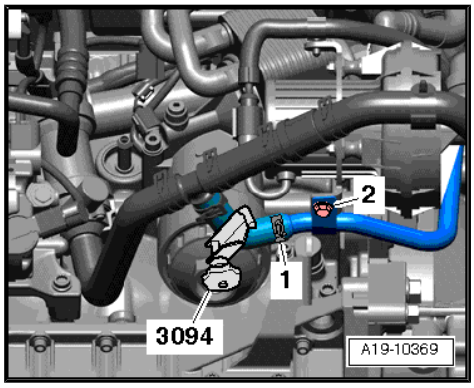
Disregard items marked -1 and 2-.



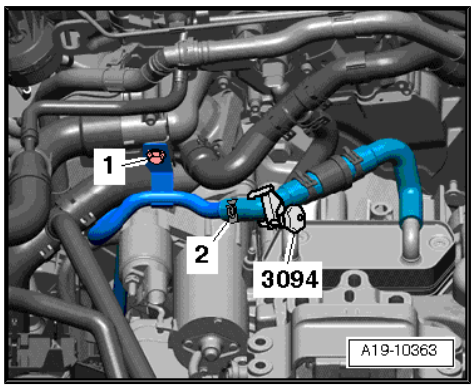
– Release fasteners -1 ... 4- and remove centre noise insulation.



– Place drip tray for workshop hoist -VAS 6208- beneath engine.
– Detach coolant hose -1- from coolant pipe going to gear oil cooler.
– Remove bolt -2-.



– Detach coolant hose -2- from coolant pipe going to gear oil cooler.
– Remove bolt -1-.
– Remove coolant pipe going to gear oil cooler upwards (turn coolant pipe anti-clockwise).



Installing

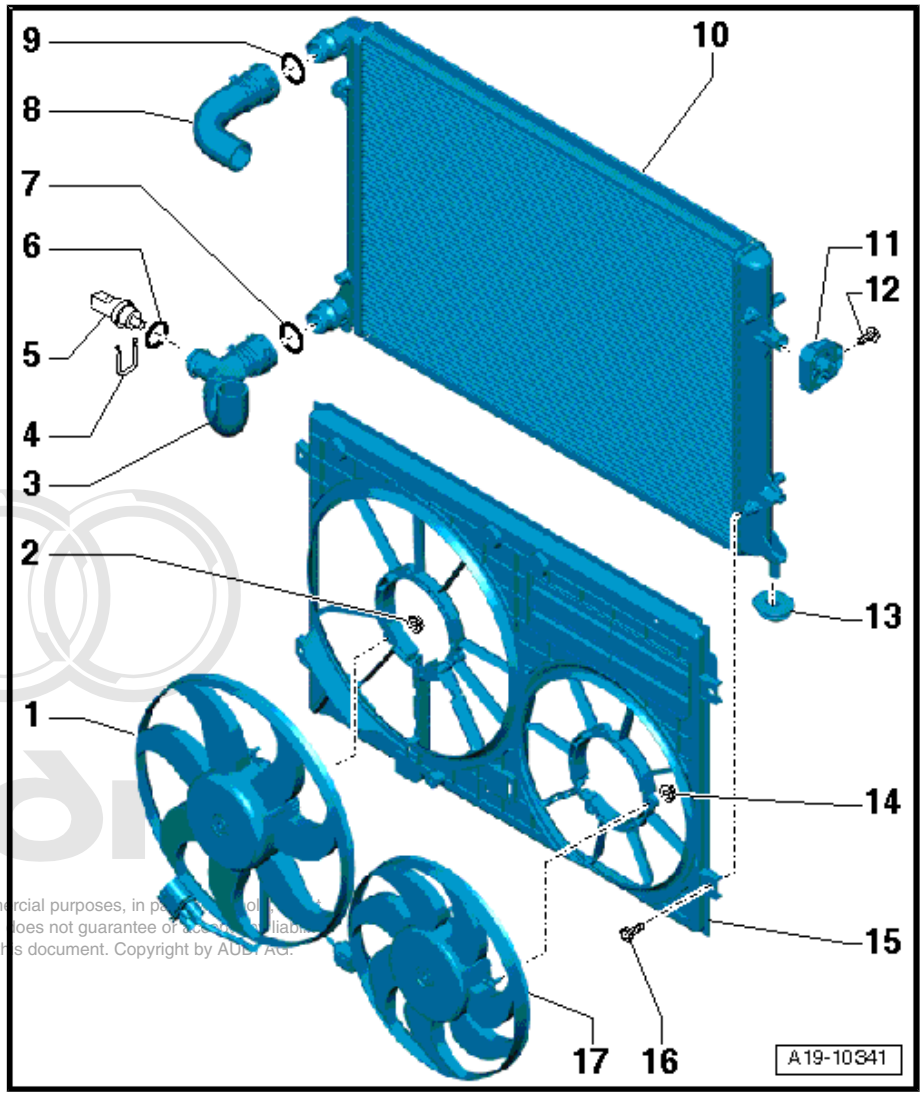
• Tightening torques ⇒ page 151

Installation is carried out in the reverse order; note the following:

– Install air cleaner housing ⇒ Rep. Gr. 24 .
– Install air filter element ⇒ Rep. Gr. 24 .
– Fill up with coolant ⇒ page 147 .

3 Radiator and radiator fans

3.1 Radiator and radiator fans - exploded view



1 - Radiator fan -V7-
- ❑ Removing and installing ⇒ page 174

2 - Nut
- ❑ 10 Nm

3 - Coolant hose (bottom)
- ❑ To connection for thermostat

4 - Retaining clip

5 - Radiator fan thermal switch -F18-
- ❑ 35 Nm

6 - O-ring
- ❑ Renew

7 - O-ring
- ❑ Renew if damaged

8 - Coolant hose (top)
- ❑ To connection at cylinder head

9 - O-ring
- ❑ Renew if damaged

10 - Radiator
- ❑ Removing and installing ⇒ page 168
- ❑ If renewed, change coolant in entire system

11 - Bracket
- ❑ For radiator

12 - Bolt
- ❑ 5 Nm

13 - Rubber bush

14 - Nut
- ❑ 10 Nm

15 - Radiator cowl
- ❑ Removing and installing ⇒ page 172

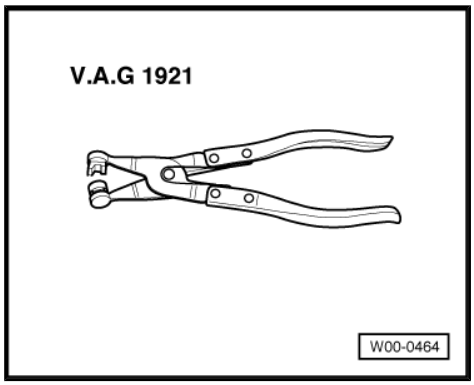
16 - Bolt
- ❑ 5 Nm

17 - Radiator fan 2 -V177-
- ❑ Removing and installing ⇒ page 174

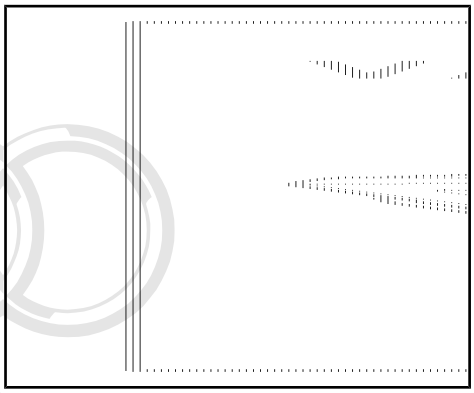
3.2 Removing and installing radiator

Special tools and workshop equipment required

- Hose clip pliers -V.A.G 1921-



- Drip tray for workshop hoist -VAS 6208-



Removing

Note

Even when the radiator and condenser 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 or the condenser.

WARNING

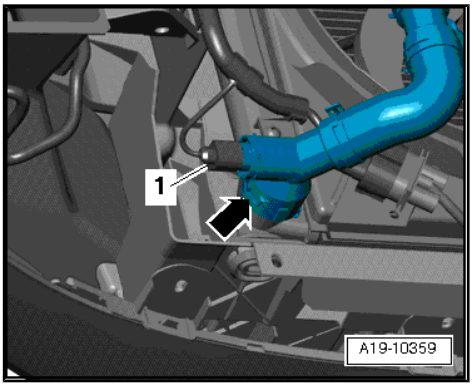
Hot steam/hot coolant can escape - risk of scalding.

- ***The cooling system is under pressure when the engine is hot.***
- ***Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.***

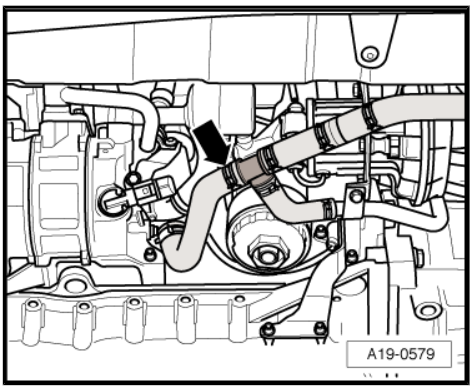
– Open filler cap on expansion tank.

– Remove radiator cowl ⇒ page 172 .

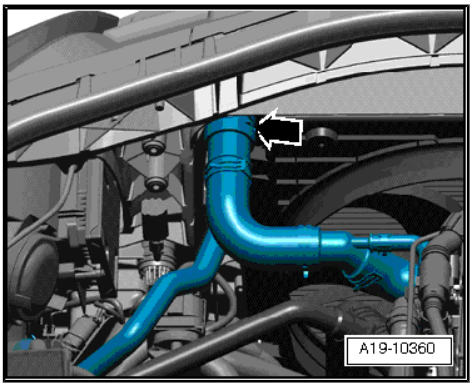
– Unplug electrical connector -1- at radiator outlet coolant temperature sender -G83- .
– Place drip tray for workshop hoist -VAS 6208- beneath engine.
– Disconnect bottom coolant hose from radiator -arrow- and drain off coolant.



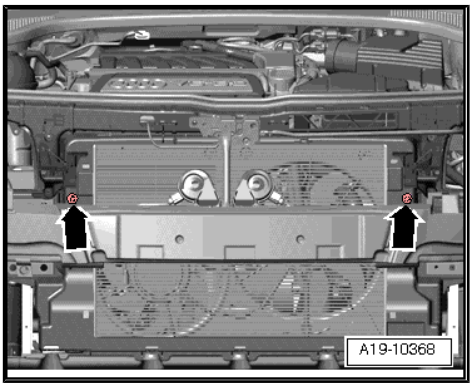
– Disconnect bottom coolant hose leading to continued coolant circulation pump -V51- -arrow- and drain off coolant.
– Remove bumper cover (front) ⇒ Rep. Gr. 63 .



– Pull out retaining clip and disconnect top coolant hose -arrow- from radiator.



– Release air ducts (left and right) and push to one side in order to remove bolts -arrows-.
– Swivel top edge of radiator slightly to rear.
– Lift radiator out of bottom mounting points.
– Push radiator towards engine.
– Support radiator from below to prevent radiator from dropping.



WARNING

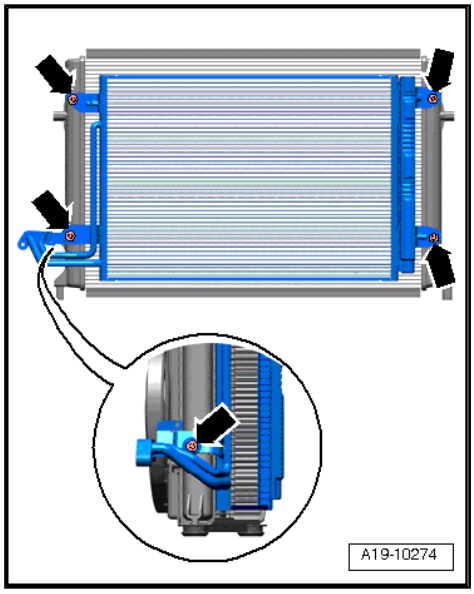
Risk of injury caused by refrigerant.

- *The air conditioner refrigerant circuit must not be opened.*

Caution

Make sure that condenser and refrigerant pipes and hoses are not damaged.

- *Do NOT stretch, kink or bend refrigerant lines and hoses.*



– Remove bolts -arrows-.
– Disconnect condenser from radiator.
– Move condenser to front and place in lock carrier, then secure with cable ties to prevent from dropping.
– Take out radiator downwards

Installing

• Tightening torques ⇒ page 167

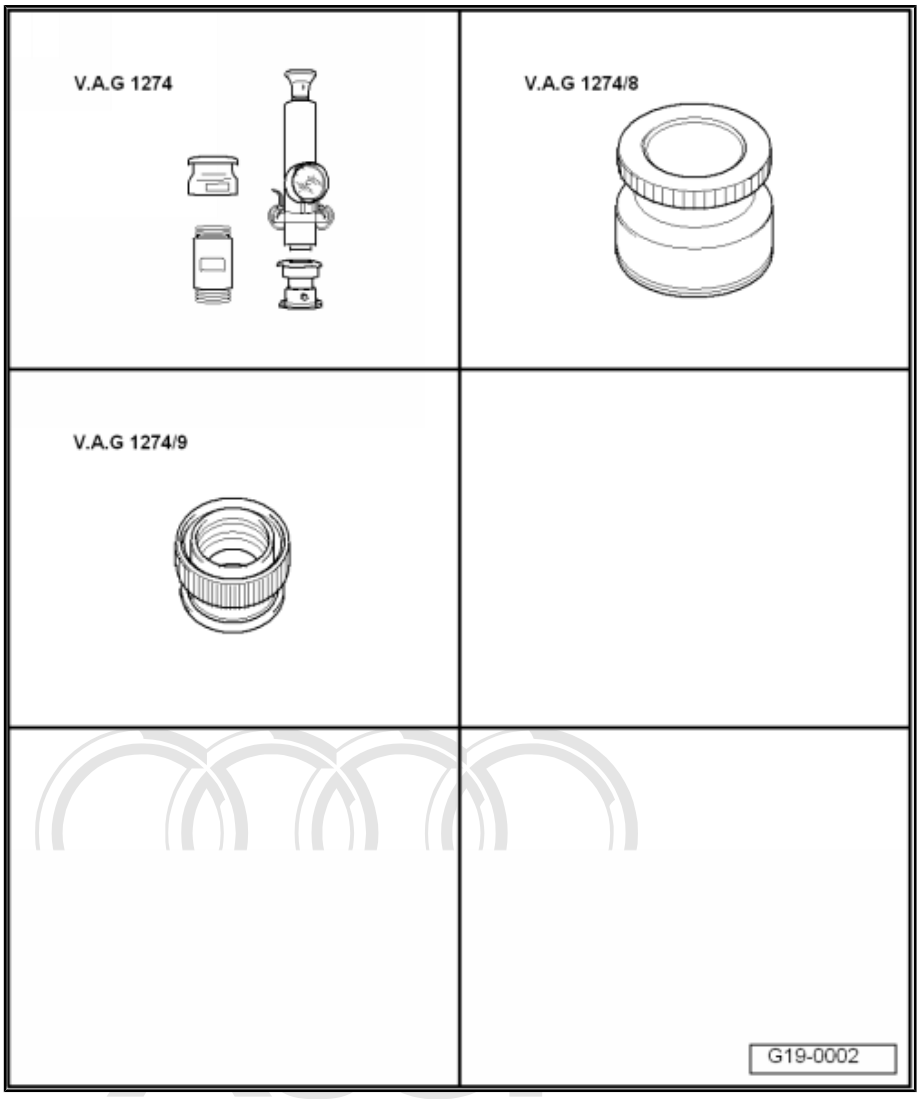
Installation is carried out in the reverse order; note the following:

– Install radiator cowl ⇒ page 172 .
– Install condenser ⇒ Rep. Gr. 87 .
– Install bumper cover (front) ⇒ Rep. Gr. 63 .
– Fill up with coolant ⇒ page 147 .

3.3 Checking cooling system for leaks

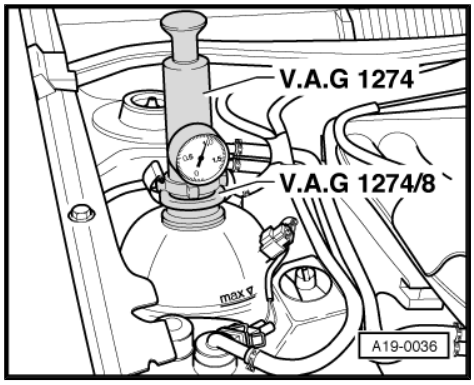
Special tools and workshop equipment required

- Cooling system tester - V.A.G 1274 A-
- Adapter for cooling system tester -V.A.G 1274/8-
- Adapter for cooling system tester -V.A.G 1274/9-



Procedure

- Engine must be warm.



WARNING

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

- *The cooling system is under pressure when the engine is hot.*
- *Cover filler cap on expansion tank with a cloth and open carefully to dissipate pressure.*

– Open filler cap on expansion tank.

– Fit cooling system tester -V.A.G 1274 A- with adapter -V.A.G 1274/8- onto coolant expansion tank.

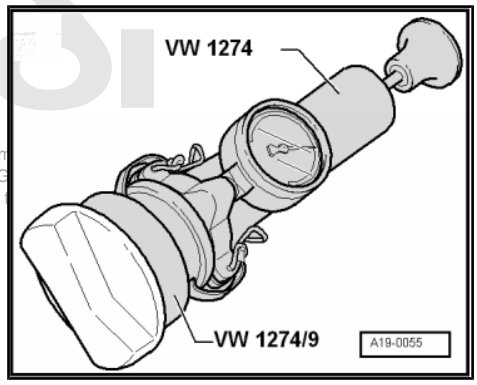
– Using hand pump on cooling system tester, build up a pressure of approx. 1.0 bar.

– If this pressure is not maintained, locate and rectify leaks.

Checking pressure relief valve in filler cap

– Fit cooling system tester -V.A.G 1274 A- with adapter -V.A.G 1274/9- onto filler cap.

– Build up pressure with hand pump on cooling system tester.



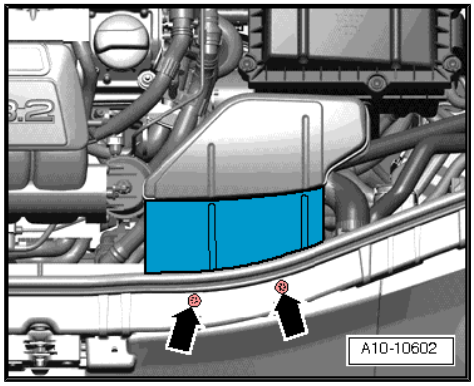
- The pressure relief valve should open at a pressure of 1.4 ... 1.6 bar.

– Renew filler cap if pressure relief valve does not open as described.

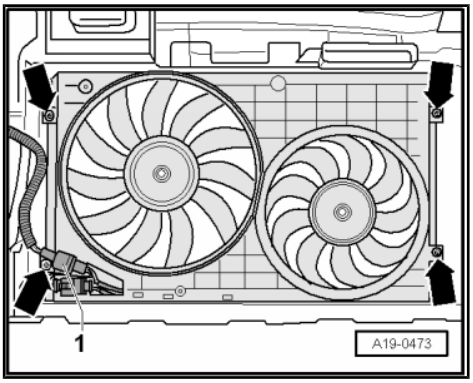
3.4 Removing and installing radiator cowl

Removing

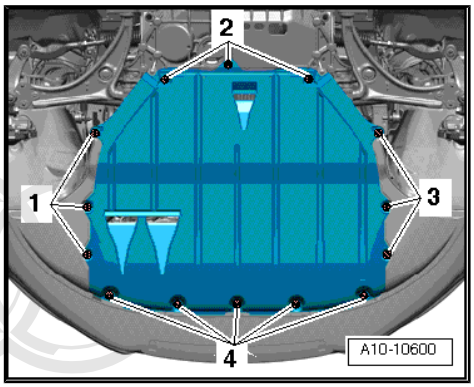
– Unscrew bolts -arrows- and remove air duct.



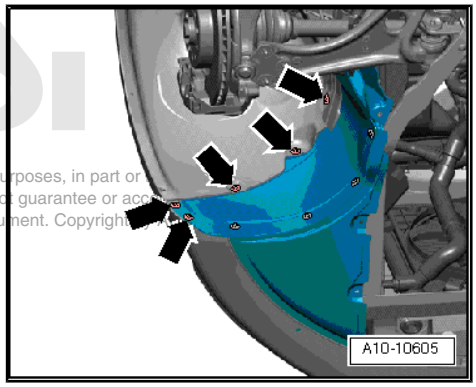
– Remove top bolts -upper arrows- for radiator cowl.



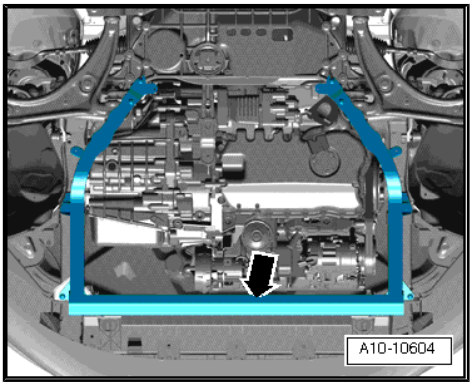
– Release fasteners -1 ... 4- and remove centre noise insulation.



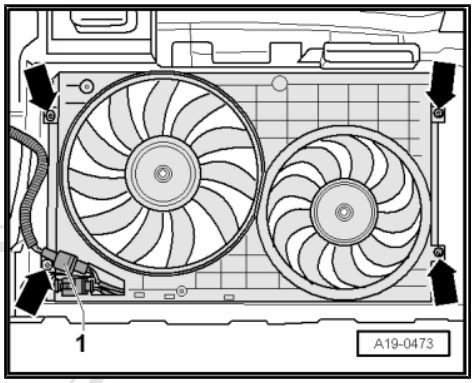
– Remove noise insulation on left and right sides -arrows-.



– Remove noise insulation frame -arrow-.



– Detach electrical connectors -1- for radiator fans at bottom of radiator cowl.
– Remove bolts -bottom arrows- at bottom of radiator cowl.
– Remove radiator cowl with both radiator fans from below.



Installing

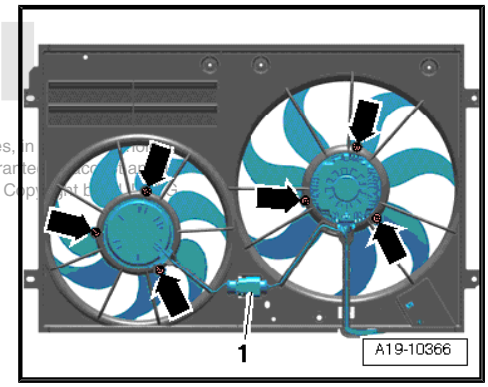
• Tightening torque ⇒ page 167 .

Install in reverse order.

3.5 Removing and installing radiator fan - V7- and radiator fan 2 -V177-

Removing

– Remove radiator cowl ⇒ page 172 .
– Unplug electrical connector -1-.
– Move electrical wiring clear.
– Unscrew nuts -arrows- and remove radiator fans.



Installing

• Tightening torque ⇒ page 167 .

Installation is carried out in the reverse order; note the following:

– Install radiator cowl ⇒ page 172 .

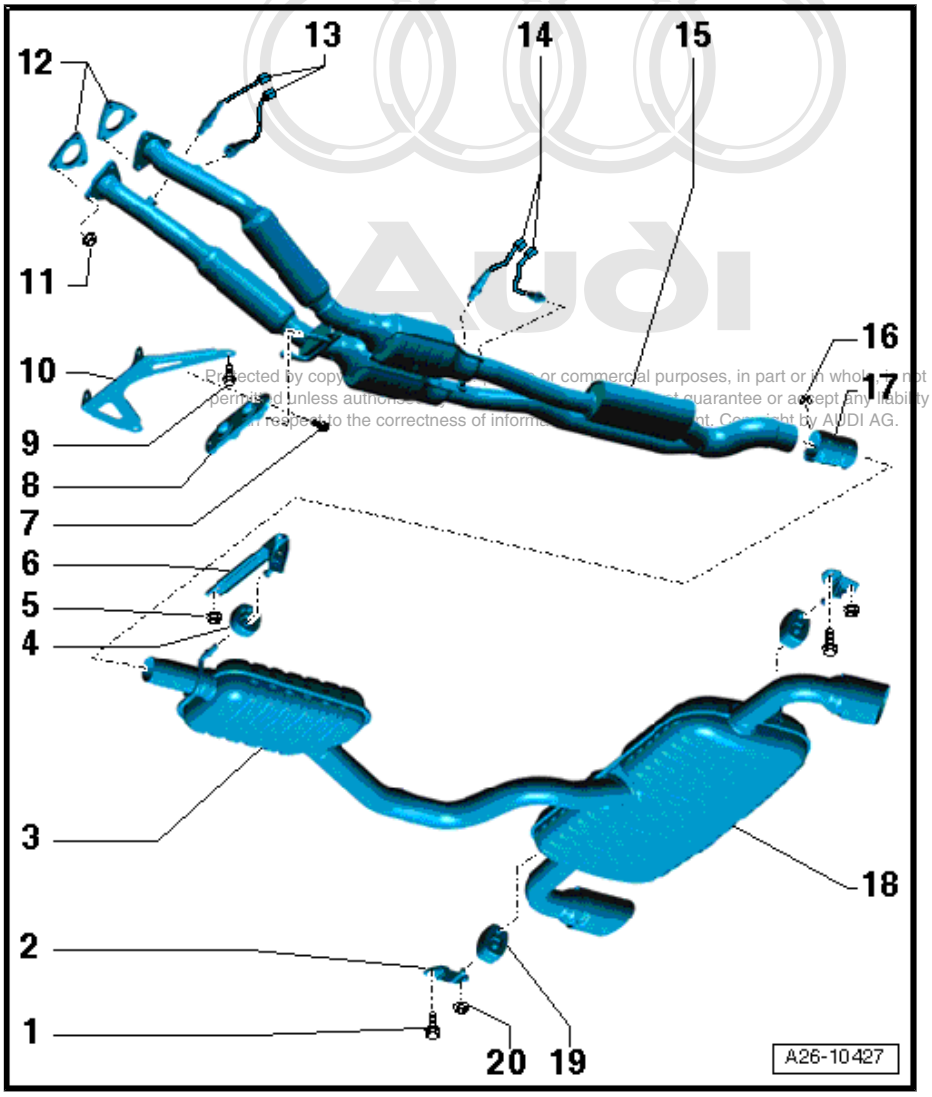
26 – Exhaust system

1 Silencers

Note

Use screwdriver to unfasten and tighten lock washers for heat shields. Tightening torque: 2 Nm

1.1 Silencers - exploded view



1 - Bolt
- ❑ 23 Nm

2 - Bracket for exhaust system

3 - Centre silencer
- ❑ Combined with rear silencer
- ❑ Align exhaust system so it is free of stress ⇒ page 179

4 - Rubber mounting
- ❑ Renew if damaged

5 - Nut
- ❑ 23 Nm

6 - Bracket for exhaust system

7 - Bolt
- ❑ 23 Nm

8 - Mounting
- ❑ Renew if damaged

9 - Bolt
- ❑ 23 Nm

10 - Tunnel brace

11 - Nut
- ❑ Renew
- ❑ 40 Nm

12 - Gaskets
- ❑ Renew

13 - Lambda probes before catalytic converter
- ❑ The threads on the new Lambda probes are coated with a special assembly paste.
- ❑ If re-installing old Lambda probe, coat thread with high-temperature paste: Refer to ⇒ Electronic parts catalogue for high-temperature paste
- ❑ The assembly paste/high-temperature paste must not get into the slots on the probe body.
- ❑ Removing and installing ⇒ Rep. Gr. 24

14 - Lambda probes after catalytic converter
- ❑ The threads on the new Lambda probes are coated with a special assembly paste.
- ❑ If re-installing old Lambda probe, coat thread with high-temperature paste: Refer to ⇒ Electronic parts catalogue for high-temperature paste

- ❑ The assembly paste/high-temperature paste must not get into the slots on the probe body.
- ❑ Removing and installing ⇒ Rep. Gr. 24

15 - Front exhaust pipe with catalytic converters and front silencer

> **Caution**
> *Avoid damage to flexible joints.*
> *Do not bend flexible joints in front exhaust pipe more than 10°.*

- ❑ Install flexible joint so that it is not under tension.
- ❑ Take care not to damage wire mesh on flexible joint.
- ❑ Protect catalytic converter from damage by knocks and impact
- ❑ Removing and installing ⇒ page 177
- ❑ Do not remove protective packaging from replacement part until you are ready to fit the flexible joint
- ❑ Align exhaust system so it is free of stress ⇒ page 179

16 - Nut

- ❑ 23 Nm

17 - Clamp

- ❑ Align exhaust system so it is free of stress before tightening clamp ⇒ page 179
- ❑ Installation position ⇒ page 176
- ❑ Tighten bolt connections evenly

18 - Rear silencer

- ❑ Combined with centre silencer
- ❑ Align exhaust system so it is free of stress ⇒ page 179

19 - Rubber mounting

- ❑ Renew if damaged

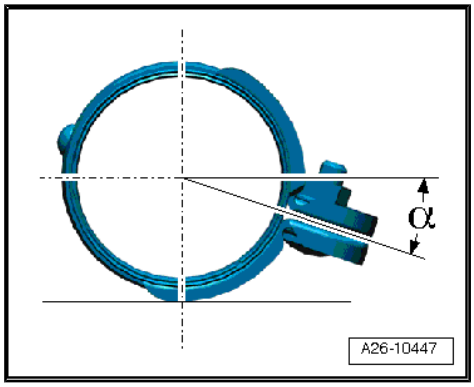
20 - Nut

- ❑ 23 Nm

Installation position of clamp

– Fit the clamp at the angle shown.

- Bolt connections face to right.
- Nuts face upwards.
- α = approx. 20°.



1.2 Removing and installing front exhaust pipe with catalytic converter and front silencer

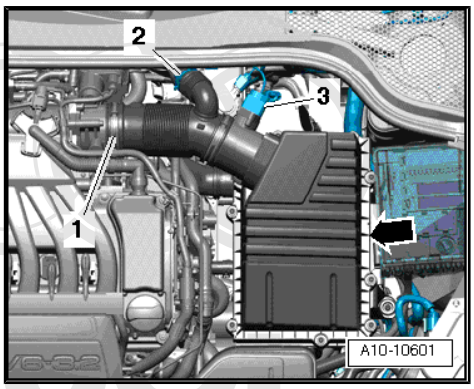
Removing

– Detach resonance pipe -2- from air intake hose.

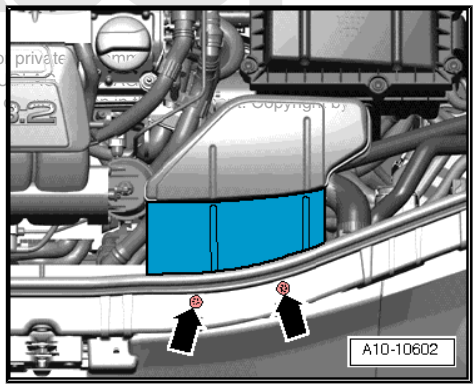
– Disconnect air intake hose -1- from throttle valve module -J338- .

– Detach electrical connector -3- for air mass meter -G70- .

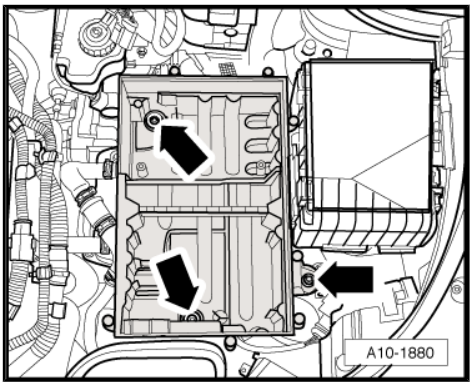
– Unscrew top section of air cleaner housing -arrow- and remove air filter element.



– Unscrew bolts -arrows- and remove air duct.



– Remove bottom section of air cleaner housing -arrows-.



– Detach electrical connectors from bracket and unplug.

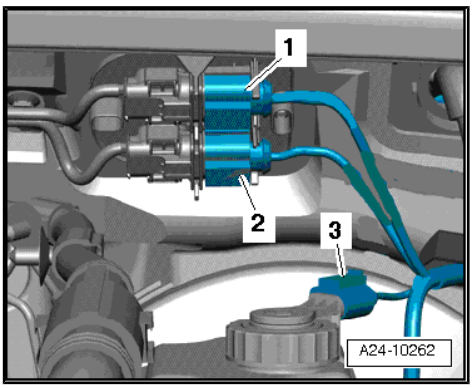
– Move electrical wiring clear.

1 - For Lambda probe 2 -G108-

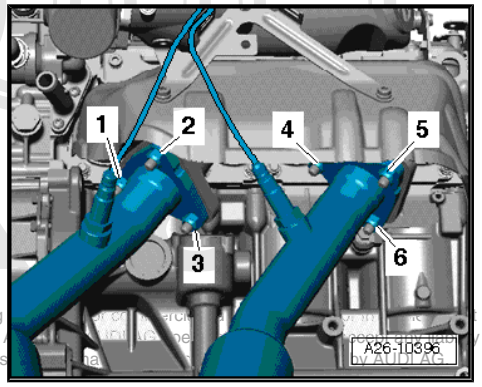
2 - For Lambda probe -G39-

Note

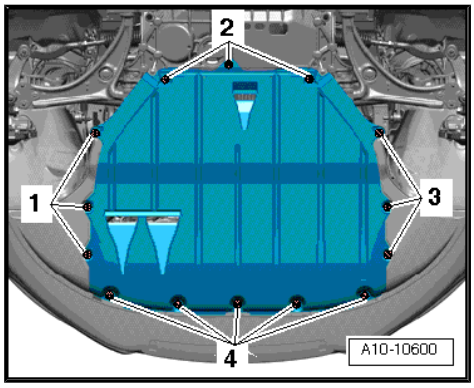
Disregard item -3-.



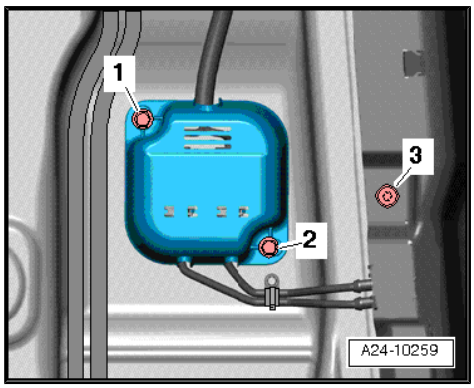
– Unscrew nuts (accessible from above) securing front exhaust pipe to exhaust manifold.



– Release fasteners -1 ... 4- and remove centre noise insulation.



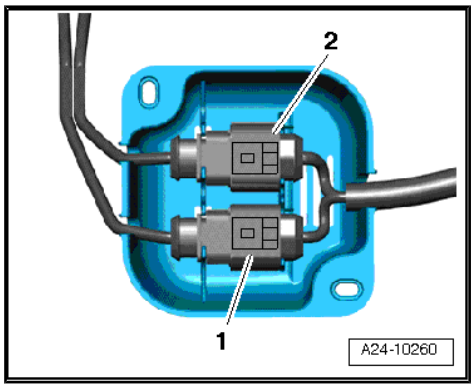
– Remove nuts -1- and -2- on underside of vehicle.
– Detach cover from bracket for electrical connectors for Lambda probes.
– Remove bolt -3- and move electrical wiring to Lambda probes clear.



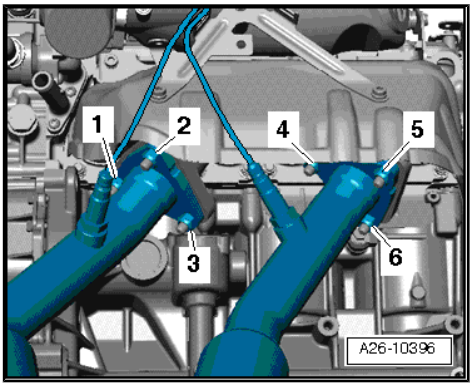
– Detach electrical connectors from bracket and unplug.

1 - For Lambda probe after catalytic converter -G130-

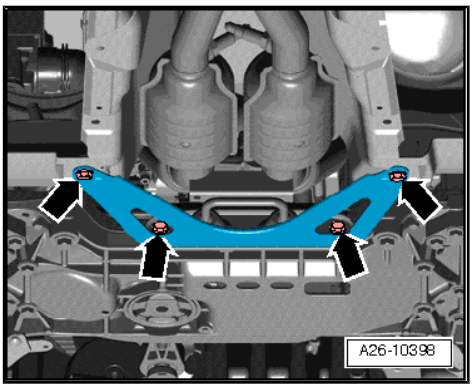
2 - For Lambda probe 2 -G131- (after catalytic converter)



– Unscrew nuts (accessible from below) securing front exhaust pipe to exhaust manifold.



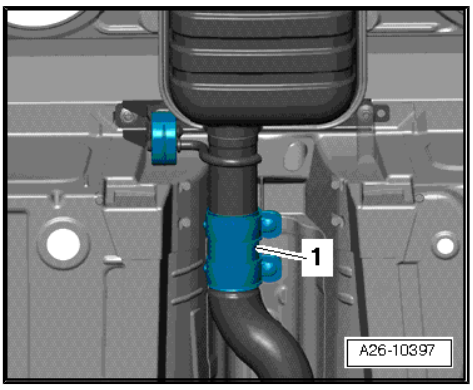
– Unbolt bracket for exhaust system and tunnel brace -arrows-.



Caution

Avoid damage to flexible joints.

- *Do not bend flexible joints in front exhaust pipe more than 10°.*



– Disconnect exhaust system at clamp -1-.

– Detach front exhaust pipes with catalytic converters and front silencer.

Installing

- Tightening torques ⇒ page 175

Installation is carried out in the reverse order; note the following.

Note

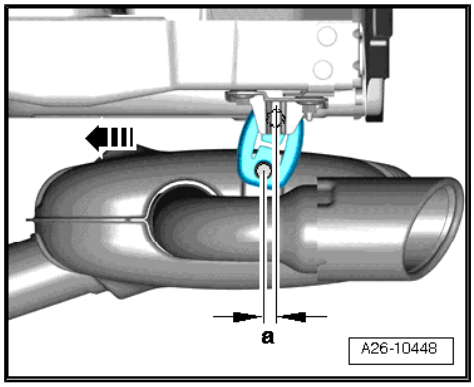
Renew seals, gaskets and self-locking nuts.

– Align the exhaust system so it is free of stress ⇒ page 179 .

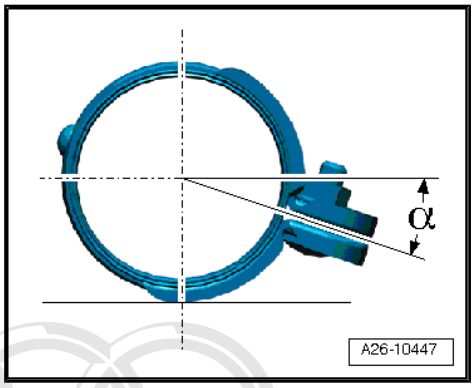
1.3 Stress-free alignment of exhaust system

- The exhaust system must be aligned when it is cool.

– Loosen bolt connections for clamp ⇒ Item 17 (page 176) .
– Push rear silencer towards front of vehicle -arrow- so that rubber mounting (left-side) on rear silencer is preloaded by -a- = 11 ... 13 mm.

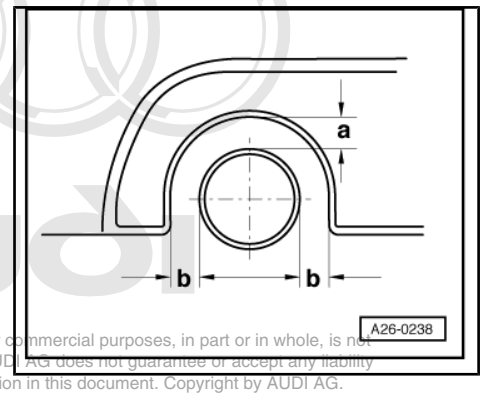


– Fit the clamp at the angle shown.
• Bolt connections face to right.
• Nuts face upwards.
• α = approx. 20°.
• Tightening torque ⇒ page 175 .



1.4 Aligning tailpipes

– Adjust the rear silencer so that there is an even distance between the bumper cut-outs and the tailpipes.
• Dimension -a- = approx. 18.5 mm.
• Distance -b- = -b-.
– Unfasten rear silencer mounting to align tailpipes.
• Tightening torque ⇒ page 175 .



1.5 Checking exhaust system for leaks

– Start the engine and run at idling speed.
– Plug tailpipes during leak test (e.g. with cloth or plug).
– Listen for noise at connection points (exhaust manifold/cylinder head, front exhaust pipe/exhaust manifold, etc.) to locate any leaks.
– Rectify any leaks that are found.

2 Exhaust manifold

2.1 Exhaust manifold - exploded view

1 - Nut
- ❑ Renew
- ❑ 23 Nm

2 - Exhaust manifold
- ❑ Removing and installing ⇒ page 181

3 - Gasket
- ❑ Renew

4 - Gasket
- ❑ With heat shield
- ❑ Renew

5 - Heat shield

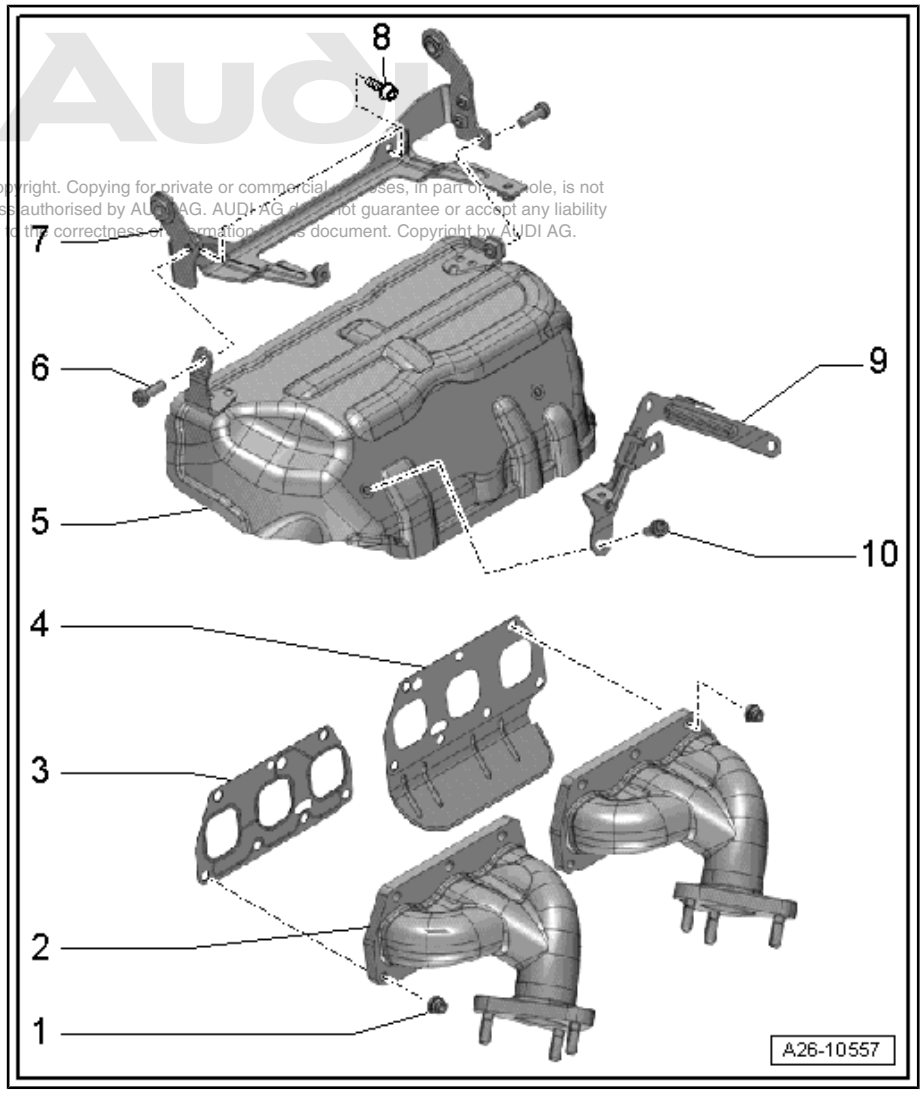
6 - Bolt
- ❑ 10 Nm

7 - Bracket
- ❑ Riveted to heat shield (depending on version)

8 - Bolt
- ❑ 20 Nm

9 - Bracket

10 - Bolt
- ❑ 10 Nm



2.2 Removing and installing exhaust manifold

Removing

Note

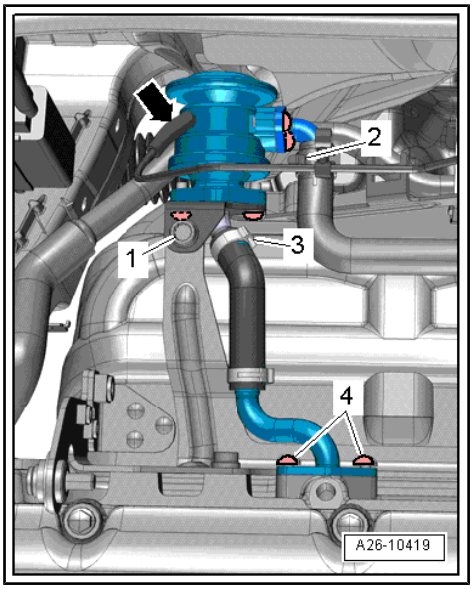
Fit cable ties in the original positions when installing.

– Remove intake manifold ⇒ Rep. Gr. 24 .

Vehicles with engine code letters CBRA:

– Disconnect vacuum hose -arrow-.

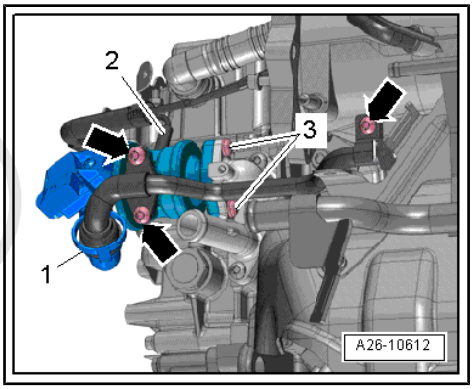
– Remove bolts -1- and -4-.



Note

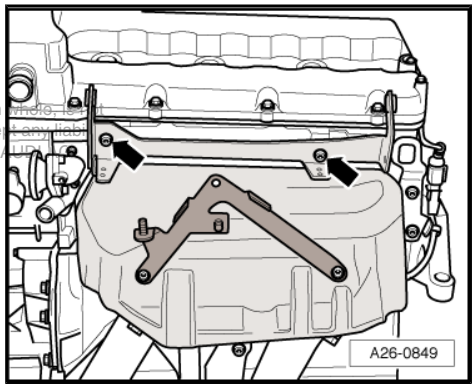
Disregard -items 2 and 3-.

– Remove bolts -arrows- and move pipe to one side with combination valve for secondary air system (right-side) attached.



All vehicles (continued):

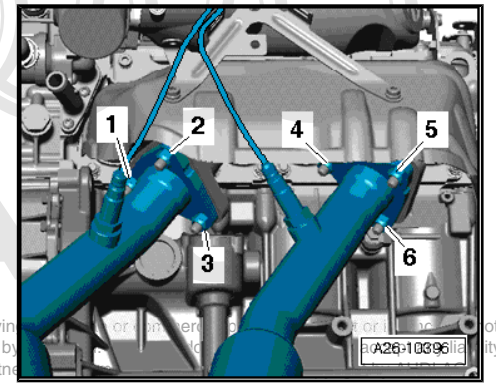
– Remove heat shield above exhaust manifold -arrows-.



Caution

Avoid damage to flexible joints.

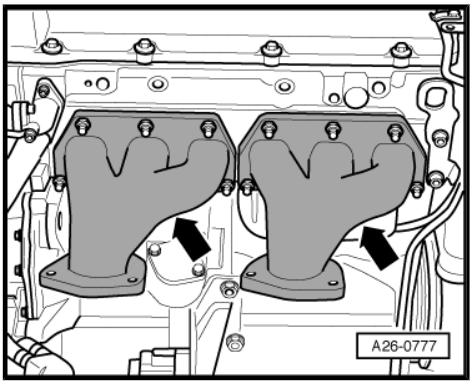
- *Do not bend flexible joints in front exhaust pipe more than 10°.*



– Remove nuts -1 ... 6- and push back front exhaust pipe slightly from exhaust manifolds.

Note

Lambda probes can remain fitted.



– Unscrew the 7 nuts -arrows- on both exhaust manifolds and remove together with washers.
– Pull off exhaust manifold to rear.

Installing

- Tightening torques ⇒ page 181

Installation is carried out in the reverse order; note the following:

Note

Renew seals, gaskets and self-locking nuts.

– Install front exhaust pipe ⇒ page 177 .
– Install intake manifold ⇒ Rep. Gr. 24 .

3 Secondary air system

3.1 Principle and function

Principle

Because of the over-enrichment of the mixture in the cold start phase, the proportion of unburned hydrocarbons in the exhaust gas is higher. The secondary air system improves the afterburning (oxidation) process in the catalytic converter, and thus reduces toxic emissions. The heat generated by oxidisation accelerates the light off of the catalytic converter and significantly improves exhaust gas quality during warm-up.

Function

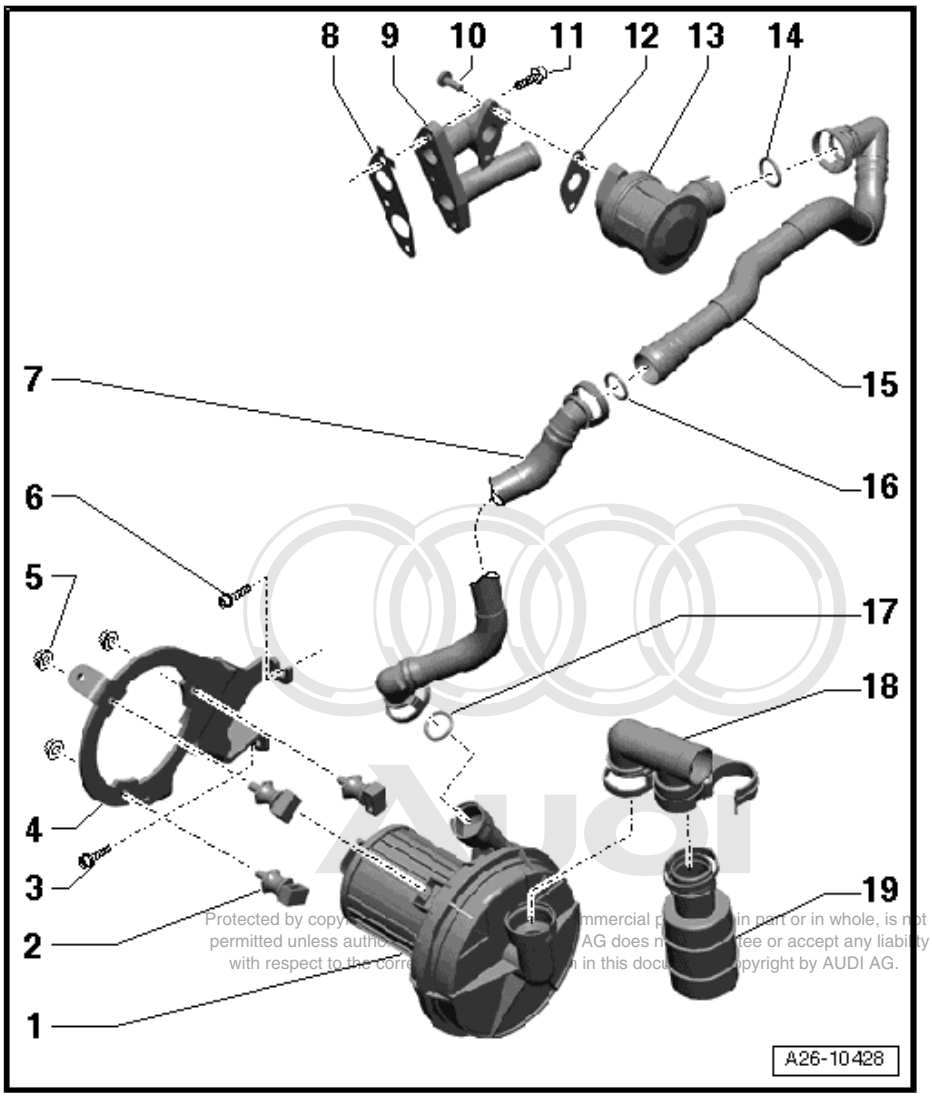
In the warm-up phase, the engine control unit activates the secondary air pump via the secondary air pump relay. The stream of air from the secondary air pump opens the combination valve for secondary air and permits air to flow into the exhaust system upstream of the catalytic converter.

3.2 Secondary air system - exploded view

Note

- *Fitting location for secondary air pump relay -J299-* ⇒ page 188
- *Fitting location for secondary air pump fuse* ⇒ page 188 .

Vehicles with engine code letters BUB



1 - Secondary air pump motor -V101-

- ❑ Removing and installing ⇒ page 194

2 - Rubber mounting

3 - Bolt

- ❑ 9 Nm

4 - Bracket

- ❑ For secondary air pump motor -V101-

5 - Nut

- ❑ 9 Nm

6 - Bolt

- ❑ 9 Nm

7 - Hose

- ❑ Check for firm attachment

8 - Gasket

- ❑ Renew

9 - Connection

- ❑ For coolant and combination valve for secondary air system

10 - Bolt

- ❑ 9 Nm

11 - Bolt

- ❑ 9 Nm

12 - Gasket

- ❑ Renew

13 - Combination valve for secondary air system

- ❑ Checking ⇒ page 189
- ❑ Removing and installing ⇒ page 189

14 - O-ring

- ❑ Renew if damaged

15 - Hose

- ❑ Check for firm attachment

16 - O-ring

- ❑ Renew if damaged

17 - O-ring

- ❑ Renew if damaged

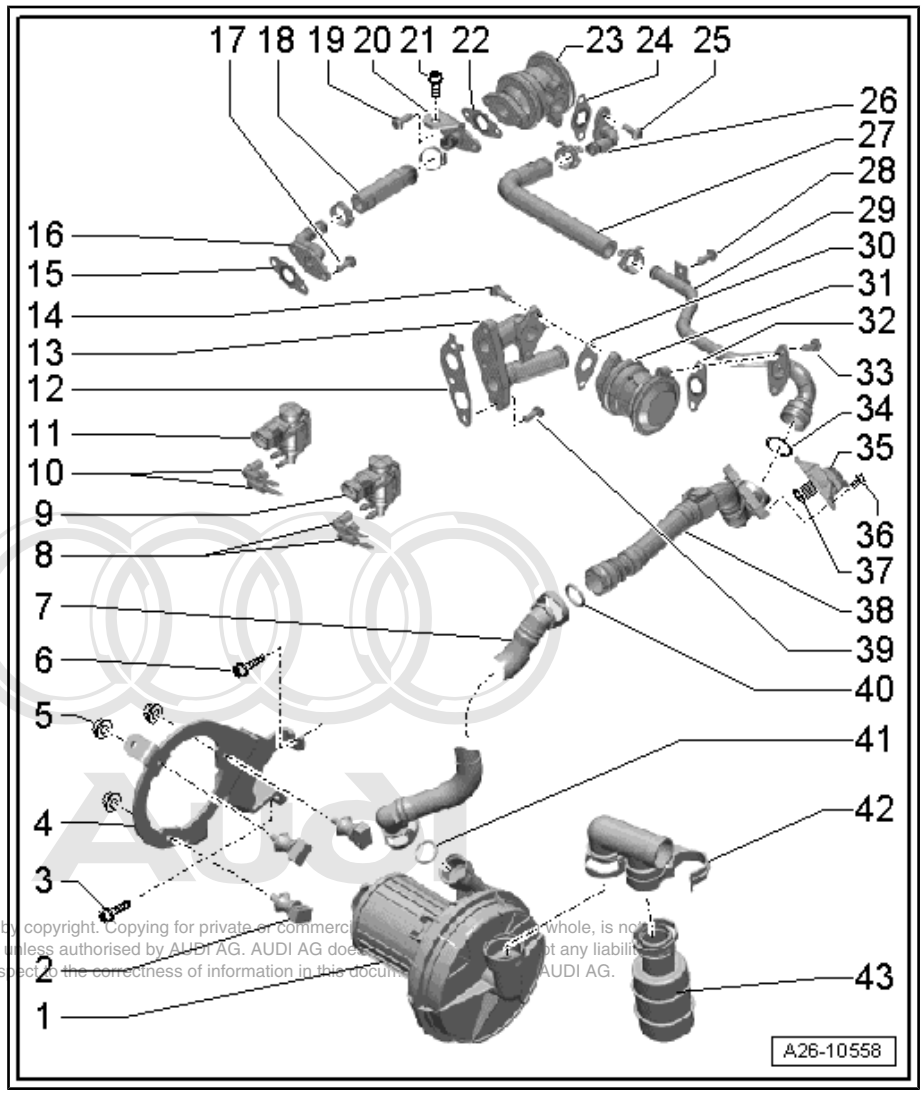
18 - Connecting piece

- ❑ To air cleaner

19 - Air cleaner

- ❑ Clean if dirty

Vehicles with engine code letters CBRA



1 - Secondary air pump motor -V101-

- ❑ Removing and installing ⇒ page 194

2 - Rubber mounting

3 - Bolt

- ❑ 9 Nm

4 - Bracket

- ❑ For secondary air pump motor -V101-

5 - Nut

- ❑ 9 Nm

6 - Bolt

- ❑ 9 Nm

7 - Hose

- ❑ Check for firm attachment

8 - Vacuum hoses

9 - Secondary air inlet valve 2 -N320-

- ❑ Fitting location ⇒ page 188

10 - Vacuum hoses

11 - Secondary air inlet valve -N112-

- ❑ Fitting location ⇒ page 188

12 - Gasket

- ❑ Renew

13 - Connection

- ❑ For coolant and combination valve for secondary air system (left-side)

14 - Bolt

- ❑ 9 Nm

15 - Gasket

- ❑ Renew

16 - Connection

- ❑ For combination valve for secondary air system (right-side)

17 - Bolt

- ❑ 9 Nm

18 - Hose

- ❑ Check for firm attachment

19 - Bolt

- ❑ 9 Nm

20 - Connection

- ❑ For combination valve for secondary air system (right-side)

21 - Bolt
- ❑ 9 Nm

22 - Gasket
- ❑ Renew

23 - Combination valve for secondary air system (right-side)
- ❑ Checking ⇒ page 189
- ❑ Removing and installing ⇒ page 193

24 - Gasket
- ❑ Renew

25 - Bolt
- ❑ 9 Nm

26 - Elbow
- ❑ For combination valve for secondary air system (right-side)

27 - Hose
- ❑ Check for firm attachment

28 - Bolt
- ❑ 9 Nm

29 - Pipe

30 - Gasket
- ❑ Renew

31 - Combination valve for secondary air (left-side)
- ❑ Checking ⇒ page 189
- ❑ Removing and installing ⇒ page 192

32 - Gasket
- ❑ Renew

33 - Bolt
- ❑ 9 Nm

34 - O-ring
- ❑ Renew if damaged

35 - Sender 1 for secondary air pressure -G609-
- ❑ Removing and installing ⇒ page 195

36 - Bolt
- ❑ 3.5 Nm

37 - O-ring
- ❑ Renew

38 - Pipe

39 - Bolt
- ❑ 9 Nm

40 - O-ring
- ❑ Renew if damaged

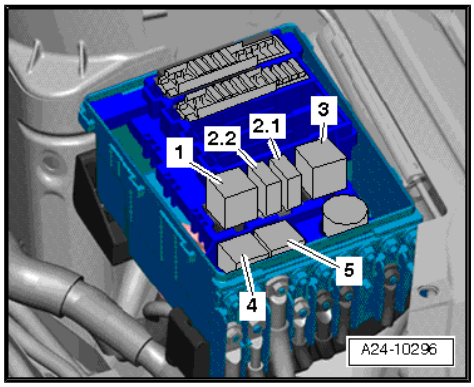
41 - O-ring
- ❑ Renew if damaged

42 - Connecting piece
- ❑ To air cleaner

43 - Air cleaner

❑ Clean if dirty

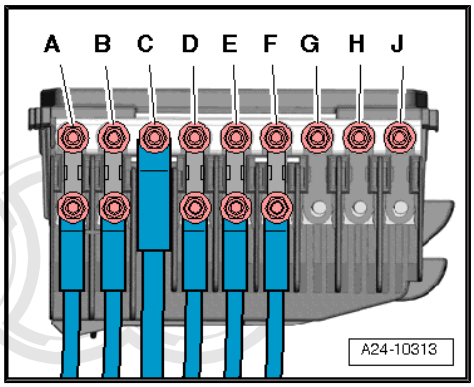
Fitting location of secondary air pump relay -J299-



♦ In electronics box in engine compartment.

3 - Secondary air pump relay -J299-

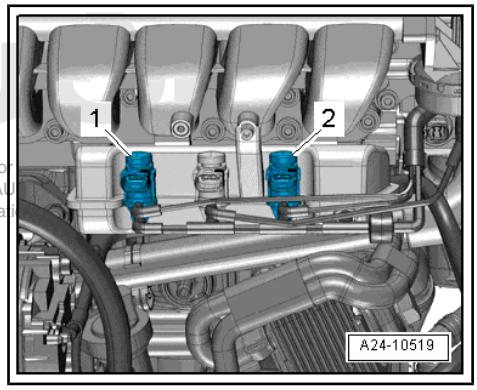
Fitting location of fuse for secondary air pump motor -V101-



♦ In electronics box in engine compartment.

F - 40 A fuse for secondary air pump motor -V101-

Fitting location of secondary air inlet valve(s)

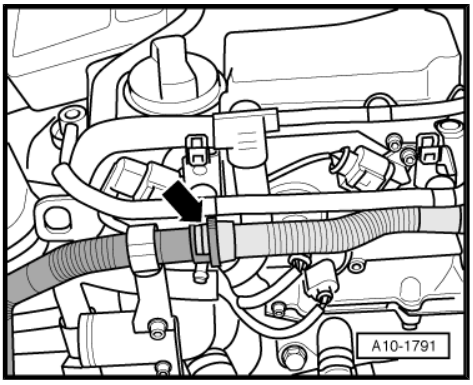


♦ At vacuum reservoir on front of intake manifold

1 - Secondary air inlet valve -N112-

2 - Secondary air inlet valve 2 -N320- - only with engine code CBRA

3.3 Checking combination valve for secondary air system for proper operation and leakage - engine code BUB



Procedure

- Vacuum hoses and hose connections do not leak.
- Vacuum hoses are not clogged.

– Disconnect hose -arrow- and attach test hose to hose leading to combination valve for secondary air system.

– Blow lightly into test hose with your mouth (do not use compressed air).

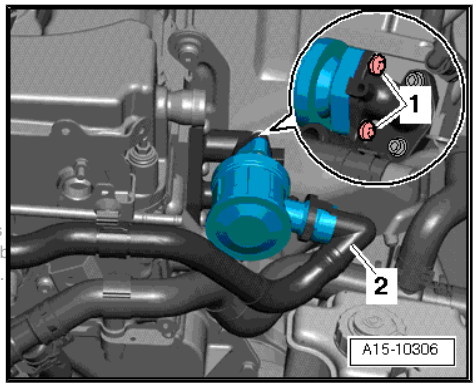
- The combination valve for secondary air system should be closed; it should not be possible to blow through the hose.

– Blow into test hose with your mouth using more pressure (do not use compressed air).

- The combination valve for secondary air system should open; it should now be possible to blow through the hose.

– Renew combination valve for secondary air if you cannot determine the switching point ⇒ page 189 .

3.4 Removing and installing combination valve for secondary air system - engine code BUB



Removing

– Remove throttle valve module -J338- ⇒ Rep. Gr. 24 .

– Disconnect hose -2- from combination valve for secondary air system.

– Unscrew bolts -1- and detach combination valve for secondary air system.

Installing

- Tightening torque ⇒ page 184 .

Installation is carried out in the reverse order; note the following:

Note

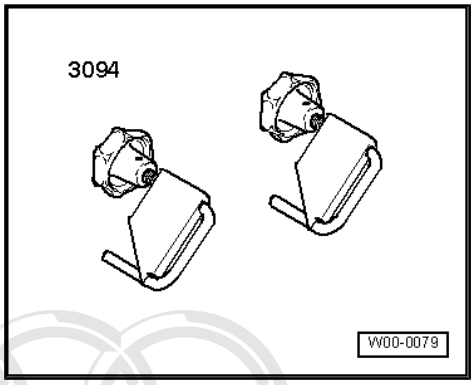
Renew seals and/or gaskets.

– Install throttle valve module -J338- ⇒ Rep. Gr. 24 .

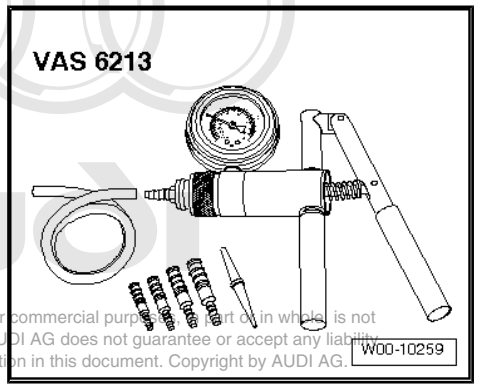
3.5 Checking combination valves for secondary air system for proper operation and leakage - engine code CBRA

Special tools and workshop equipment required

♦ Hose clamps, up to Ø 25 mm -3094- for combination valve for secondary air system (left-side)



♦ Hand vacuum pump -VAS 6213-

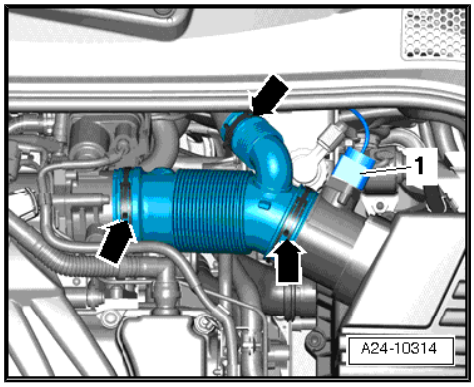


Procedure

- Vacuum hoses and hose connections do not leak.
- Vacuum hoses are not clogged.

Combination valve for secondary air system (left-side):

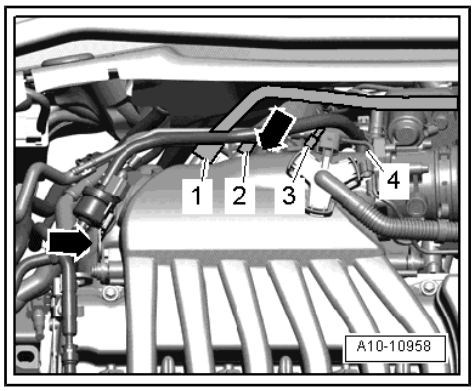
– Disconnect air pipe -arrows-.



Note

Disregard item -1-.

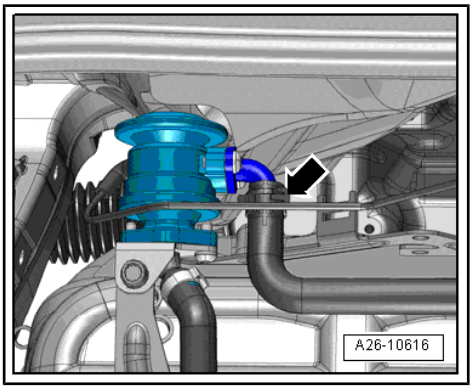
– Disconnect vacuum hoses -1, 2, 4- at rear of intake manifold.
– Unbolt hose bracket from intake manifold -arrows- and move clear to rear, with hoses attached.



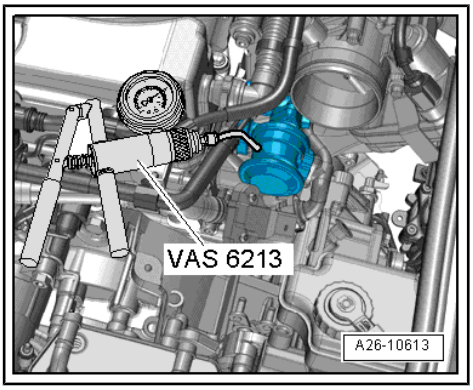
Note

Disregard item -3-.

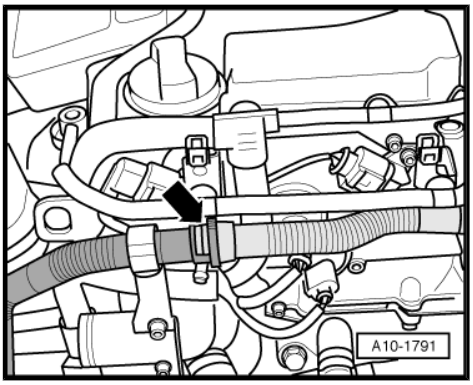
– Disconnect secondary air hose -arrow-, move hose clear towards the top and clamp off using hose clamp -3094- .



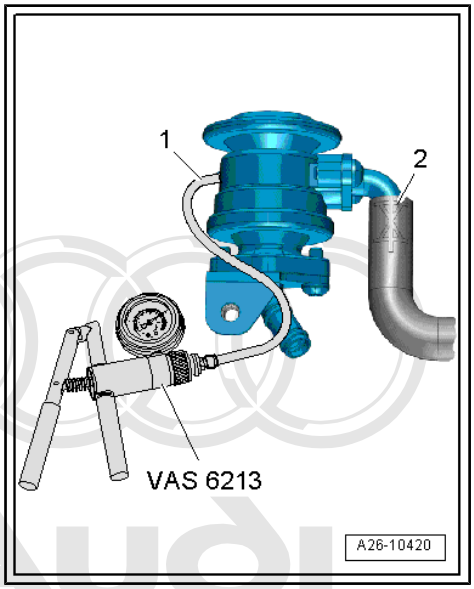
– Disconnect vacuum hose from combination valve for secondary air system (left-side).
– Connect hand-operated vacuum pump -VAS 6213- to vacuum connection on combination valve for secondary air system.



– Disconnect secondary air hose at the position marked with an -arrow-.
– Blow lightly into secondary air hose with your mouth (do not use compressed air).
• The combination valve for secondary air system should be closed; it should not be possible to blow through the hose.
– Operate hand-operated vacuum pump to produce a vacuum.
• The combination valve for secondary air system should open; it should now be possible to blow through the hose.
– Renew combination valve for secondary air system (left-side) if valve does not react as described ⇒ page 192 .



Combination valve for secondary air system (right-side):



– Remove combination valve for secondary air (right-side) ⇒ page 193 .
– Connect hand-operated vacuum pump -VAS 6213- to vacuum connection -1- on combination valve (right-side) for secondary air system.
– Connect a suitable test hose -2- onto combination valve for secondary air system.
– Blow lightly into test hose with your mouth (do not use compressed air).
• The combination valve for secondary air system should be closed; it should not be possible to blow through the hose.
– Operate hand-operated vacuum pump to produce a vacuum.
• The combination valve for secondary air system should open; it should now be possible to blow through the hose.
– Renew combination valve for secondary air system (right-side) if valve does not react as described ⇒ page 193 .

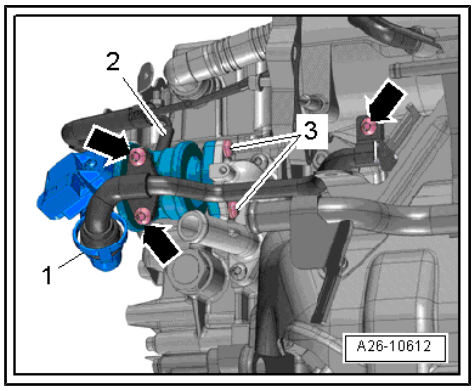
Assembling

Installation is carried out in the reverse order; note the following:

– Install combination valve for secondary air (right-side) ⇒ page 193 .

3.6 Removing and installing combination valve for secondary air system (left-side) - engine code CBRA

Removing



– Remove throttle valve module -J338- ⇒ Rep. Gr. 24 .
– Disconnect hose -1- from combination valve for secondary air system.
– Disconnect vacuum hose -2-.
– Remove bolts -arrows- and move secondary air pipe to one side.
– Remove bolts -3- and detach combination valve (left-side) for secondary air system.

Note

For illustration purposes, the installation position is shown from the rear and with the engine removed.

Installing

• Tightening torques ⇒ page 184

Installation is carried out in the reverse order; note the following:

Note

Renew seals and/or gaskets.

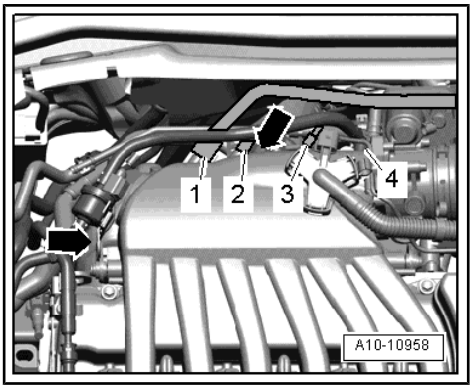
– Install throttle valve module -J338- ⇒ Rep. Gr. 24 .

3.7 Removing and installing combination valve for secondary air system (right-side) - engine code CBRA

Removing

– Disconnect vacuum hoses -1, 2, 4- at rear of intake manifold and move hoses clear.

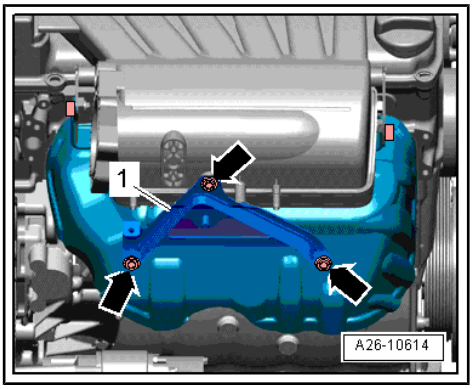
– Unbolt hose bracket from intake manifold -arrows- and move clear to rear, with hoses attached.



Note

Disregard item -3-.

– Remove bolts -arrows- and detach bracket -1- for heat shield.

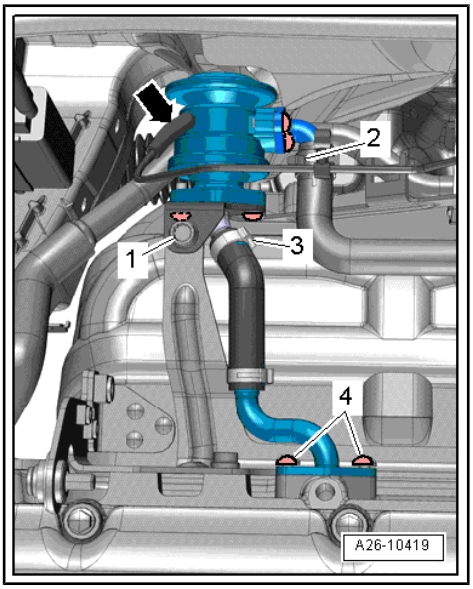


Note

For illustration purposes, the installation position is shown from the rear and with the engine removed.

– Disconnect vacuum hose -arrow-.

– Remove bolt -1- and detach combination valve for secondary air system (right-side) from secondary air hoses -2- and -3-.



Note

Disregard item -4-.

Installing

• Tightening torque ⇒ page 184 .

Installation is carried out in the reverse order; note the following:

Note

♦ *Renew seals and/or gaskets.*

♦ *Secure all hose connections with the correct type of hose clips (same as original equipment) ⇒ Electronic parts catalogue .*

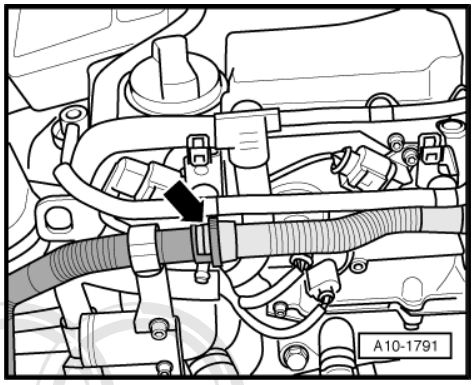
– Install bracket for heat shield ⇒ page 181 .

3.8 Removing and installing secondary air pump

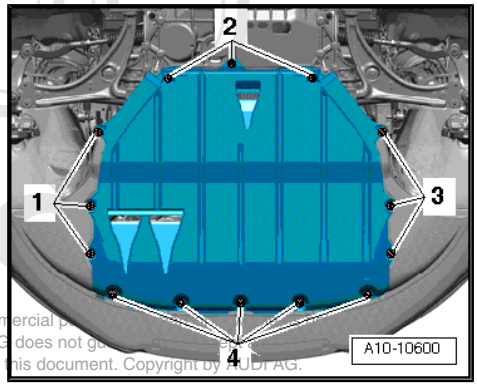
Removing

– Disconnect air hose -arrow-.

– Move hose going to secondary air pump clear.



– Release fasteners -1 ... 4- and remove centre noise insulation.

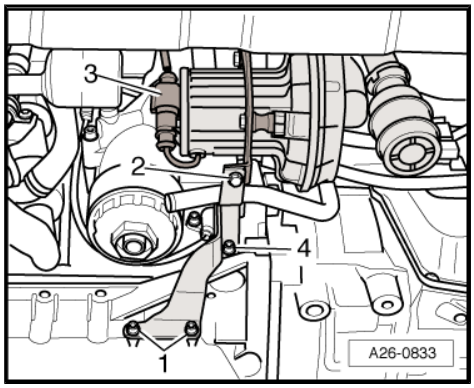


– Detach electrical connector -3- at secondary air pump motor - V101- and move wire clear.

– On vehicles with direct shift gearbox: Remove bolt -2- securing bracket for coolant pipe going to gearbox oil cooler.

– Remove bolts -1-.

– Loosen bolt -4- and remove secondary air pump with bracket.

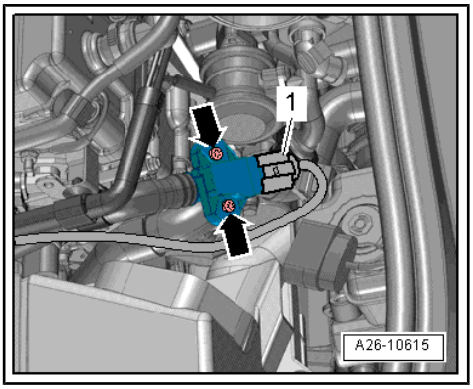


Installing

• Tightening torque ⇒ page 184 .

Install in reverse order.

3.9 Removing and installing sender 1 for secondary air pressure -G609- - engine code CBRA



Removing

– Unplug electrical connector -1-.

– Remove bolts -arrows- and detach sender 1 for secondary air pressure -G609- .

Installing

• Tightening torque ⇒ page 184 .

Installation is carried out in the reverse order; note the following:

Note

Fit new O-ring.