

15 - ENGINE - CYLINDER HEAD, VALVETRAIN

CYLINDER HEAD, REMOVING AND INSTALLING

Cylinder head, removing and installing

NOTE:

- Replace cylinder head bolts.
- During assembly, replace self-locking nuts and bolts.
- Always replace bolts that are tightened to torque as well as O-rings and gaskets.
- When installing a replacement cylinder head with camshafts installed, oil contact surfaces between roller rocker levers and cam running surfaces after installing cylinder head.
- Do not remove plastic bases protecting exposed valves until immediately before installing cylinder head.
- When replacing the cylinder head or cylinder head gasket, coolant must be completely replaced.
- Cylinder heads with cracks between the valve seats, or between the valve seat and the spark plug threads, can continue to be used without reducing the service life, as long as the cracks have a width of max. 0.3 mm, or only the first 4 threads of the spark plug threads are cracked.

Cylinder head, component overview

NOTE:

- Right cylinder head is depicted in illustration.

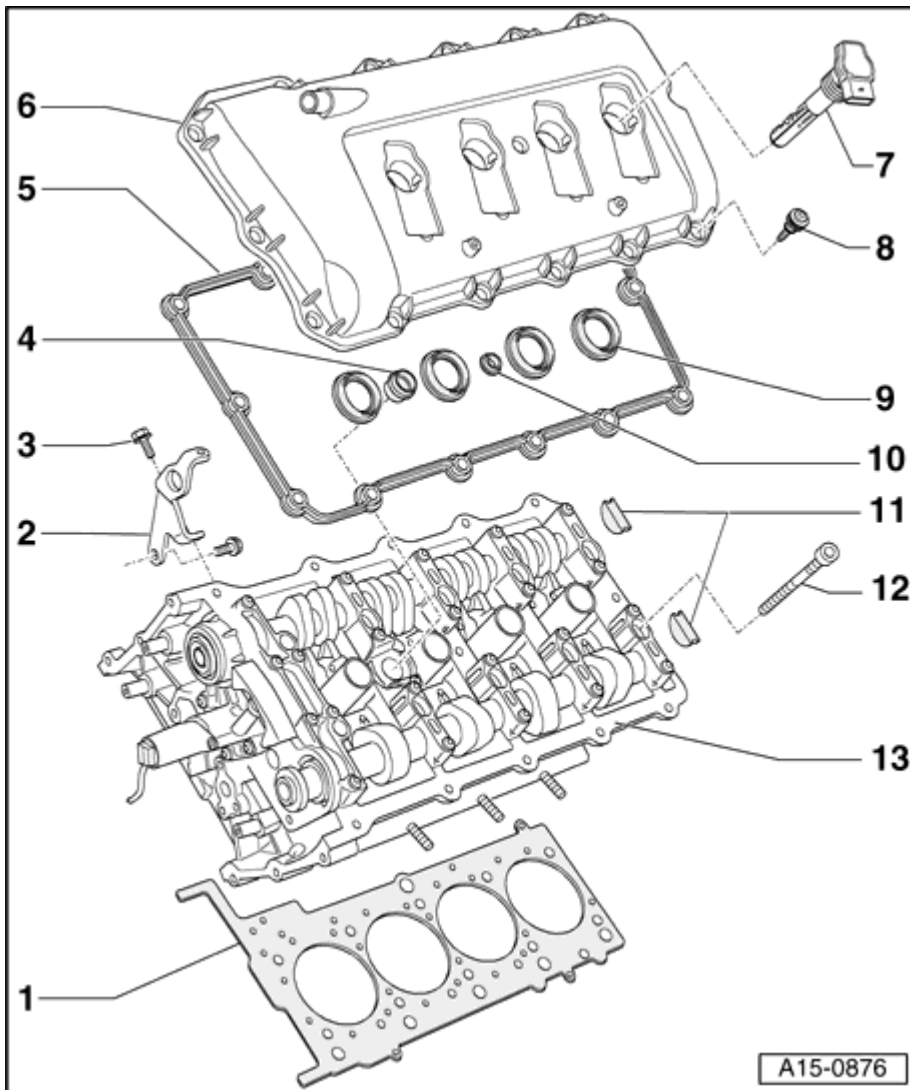


Fig. 305: Cylinder Head, Component Overview
Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - Cylinder head gasket

- Replacing --> **Cylinder head, removing and installing.**
- Installed location: Part Number, points to cylinder head
- After replacing, change engine oil and coolant

2 - Lifting eye

3 - 22 Nm

4 - Gasket

- Replace if damaged or leaking

5 - Cylinder head cover gasket

- Replace if damaged or leaking

6 - Cylinder head cover

- Removing and installing left cylinder head cover --> **Left cylinder head cover, removing and installing**
- Removing and installing right cylinder head cover --> **Right cylinder head cover, removing and installing**

7 - Ignition coil**8 - Special bolt - 10 Nm**

- Replace if damaged or leaking
- Observe sequence for tightening --> **Fig. 317**

9 - Cylinder head cover gaskets

- Replace if damaged or leaking

10 - Cylinder head cover gasket

- Replace if damaged or leaking

11 - Semicircular seal

- Replace if damaged or leaking

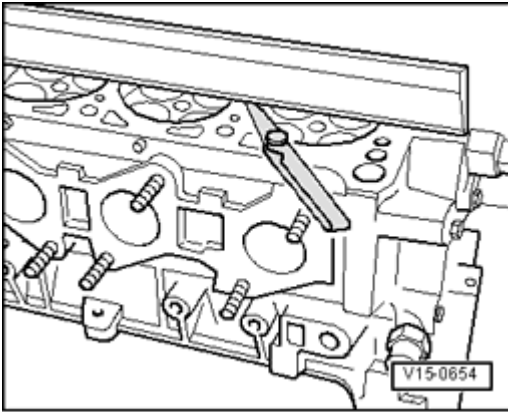
12 - Cylinder head bolt

- Replace
- Observe sequence for loosening --> **Fig. 329**
- Observe sequence for tightening --> **Fig. 333**

13 - Cylinder head

- Removing and installing --> **Cylinder head, removing and installing**
- Check for distortion **Checking cylinder head for distortion**
- Reworking dimension **Reworking dimension, cylinder head**
- After replacing, change engine oil and coolant

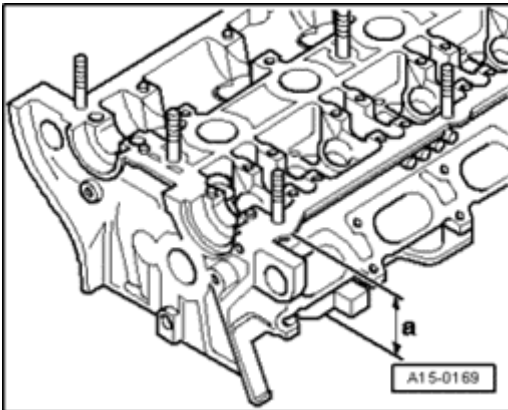
Checking cylinder head for distortion

**Fig. 306: Checking Cylinder Head For Distortion**

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Check cylinder head at multiple points for distortion, using straight edge and feeler gauges.
- Permissible distortion: max. 0.1 mm.

Reworking dimension, cylinder head

**Fig. 307: Reworking Dimension, Cylinder Head**

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Resurfacing cylinder head (face grinding) is only permissible to minimum dimension - **a** -.
- Minimum dimension: - **a** - = 139.25 mm.

Left cylinder head cover, removing and installing

Special tools, testers and auxiliary items required

2006 Audi A6 Quattro

ENGINE 4.2 Liter V8 4V Engine Mechanical, Engine Code(s): BAT, BNK

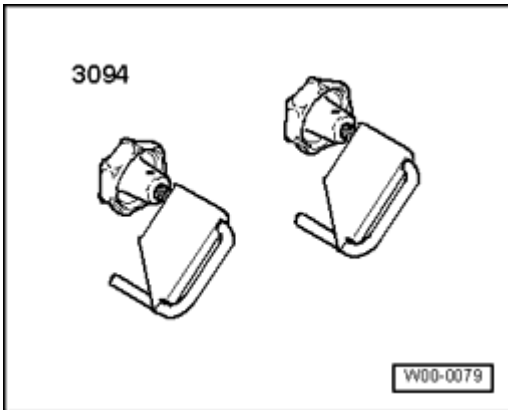


Fig. 308: Identifying Hose Clamps 3094

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Hose Clamps Up to 25 mm dia. 3094

Removing

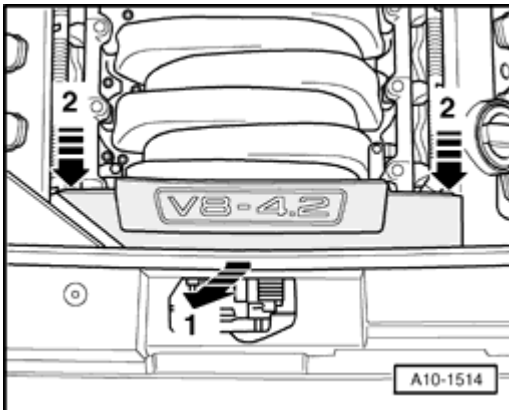


Fig. 309: Removing Front Engine Cover

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove front engine cover - **arrow 1** - and - **arrows 2** -.

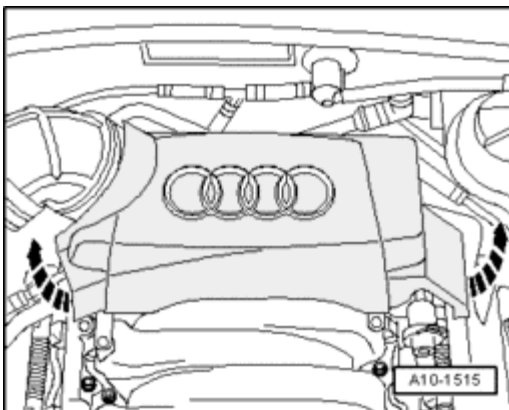


Fig. 310: Removing/Installing Rear Engine Cover

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove rear engine cover - **arrows** -.

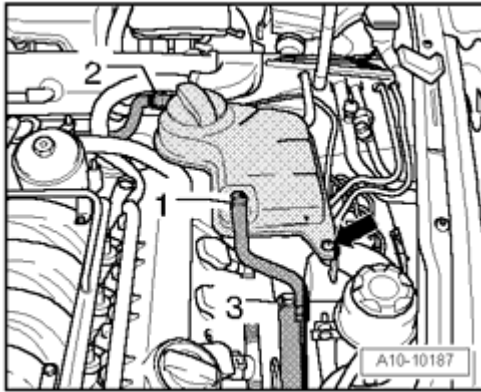


Fig. 311: Removing Coolant Hoses & Coolant Expansion Tank

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Clamp off coolant hose - **2** - using Hose Clamps Up to 25 mm dia. 3094 and disconnect from coolant expansion tank.
- Remove coolant expansion tank - **arrow** -.
- Disconnect electrical wire to Engine Coolant Level (ECL) Warning Switch F66 on bottom of expansion tank and set aside coolant expansion tank with coolant hoses - **1 and 3** - connected.
- If necessary, seal connection using an appropriate plug.

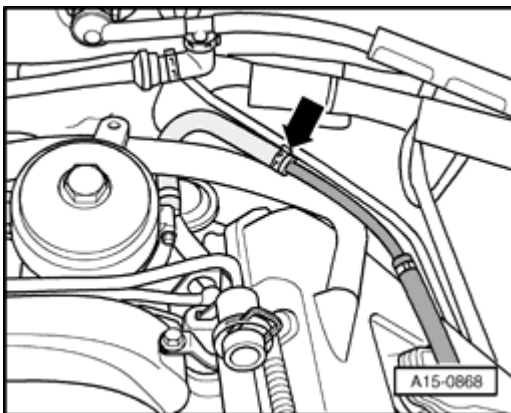


Fig. 312: Disconnecting Vacuum Hose

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose at position indicated by - **arrow** -.

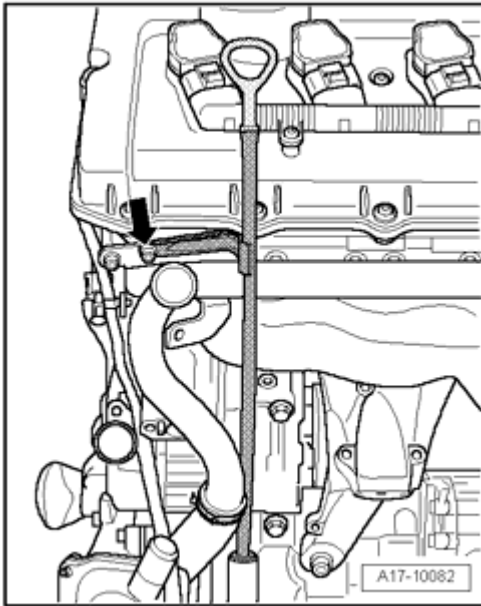


Fig. 313: Removing Guide Pipe For Oil Dipstick At Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolt - **arrow** - at oil dipstick guide tube.

NOTE:

- Guide tube remains inserted in upper part of oil pan.

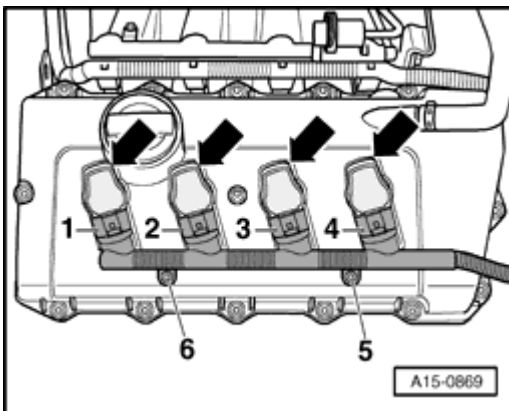


Fig. 314: Removing Bolts On Left Cylinder Head, Disconnecting Electrical Harness Connectors & Removing Ignition Coils
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **5** - and - **6** -.
- Disconnect electrical harness connectors - **1 to 4** -.
- Remove ignition coils - **arrows** -.

NOTE:

-

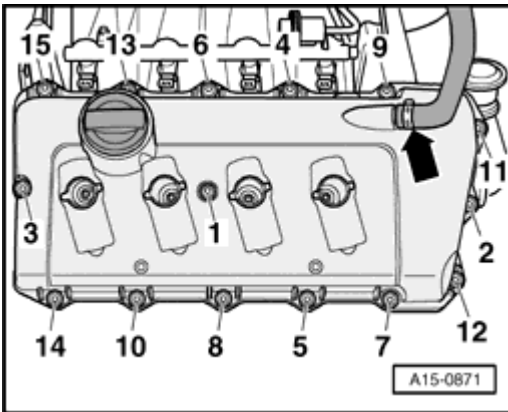


Fig. 315: Disconnecting Hose Of Crankshaft Housing Ventilation & Removing Left Cylinder Head Cover Bolts In Sequence

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect hose of crankshaft housing ventilation - **arrow** -.
- Remove left cylinder head cover bolts in sequence - **15 to 1** -.
- Remove cylinder head cover.

Installing

Installation is in reverse order of removal, note the following:

NOTE:

- Replace cylinder head cover gaskets if damaged.
 - Replace bolts for cylinder head cover if gasket is damaged.
- Clean sealing surfaces, must be free of oil and grease.

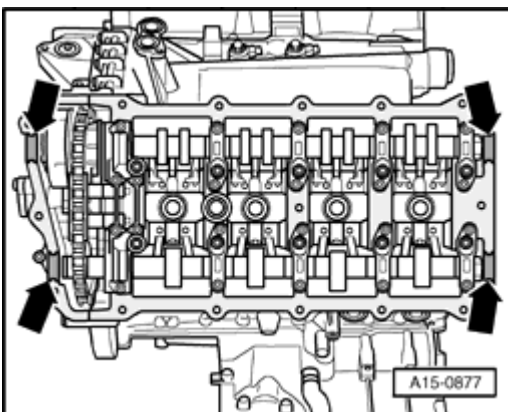


Fig. 316: Coating Semicircular Seals Lightly With Oil And Insert

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Coat semicircular seals - **arrows** - lightly with oil and insert.

2006 Audi A6 Quattro

ENGINE 4.2 Liter V8 4V Engine Mechanical, Engine Code(s): BAT, BNK

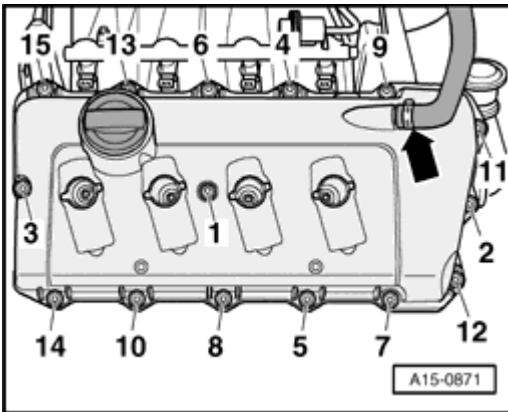


Fig. 317: Tightening Cylinder Head Cover In Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Tighten cylinder head cover in sequence - **1 to 15** -.

Torque specifications

Component	Nm
Cylinder head cover to cylinder head	10
Wiring for ignition coils at cylinder head cover	5 * See note
Oil dip stick guide tube to cylinder head	10

* Insert using locking compound; locking compound .

Right cylinder head cover, removing and installing

Removing

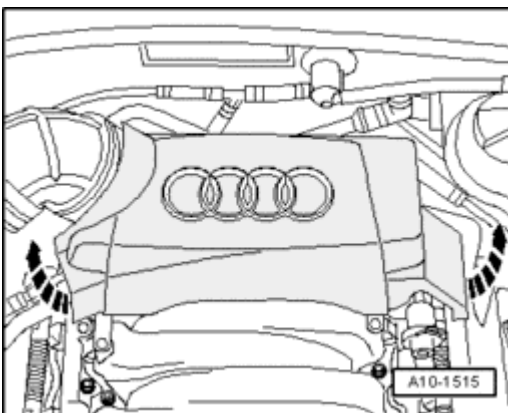


Fig. 318: Removing/Installing Rear Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove rear engine cover - **arrows** -.

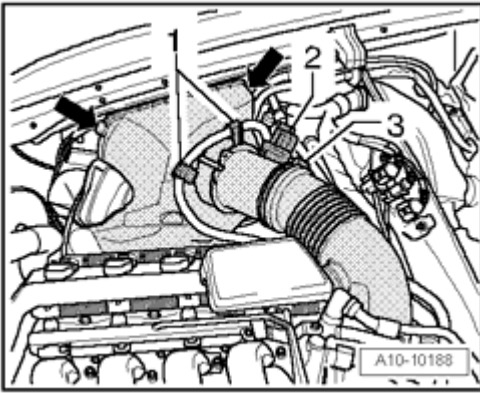


Fig. 319: Disconnecting Mass Air Flow (MAF) Sensor G70 Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Unclip fuel hose - **1** -.
- Disconnect electrical connector - **2** - from mass air flow (MAF) sensor.
- Disconnect mass air flow sensor from intake air duct - **3** -.
- Remove upper part of air filter housing with mass air flow (MAF) sensor - **arrows** -.

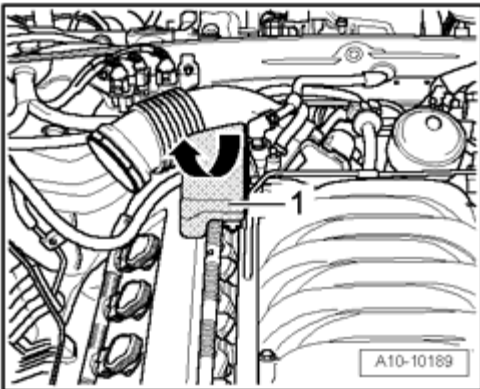


Fig. 320: Removing Resonator
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Pull resonator - **1** - in direction of - **arrow** - upward and unclip it.

CAUTION: Note rules of cleanliness for working on fuel injection system --> Rules of cleanliness for performing work on fuel injection system.

CAUTION: Fuel system is under pressure! Before opening the low pressure section of the fuel injection system, wrap a clean rag around connection and relieve residual pressure by carefully loosening connection.

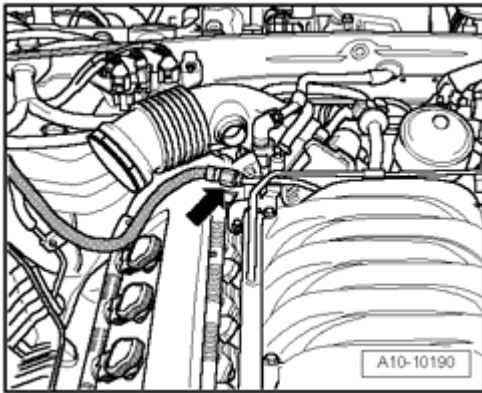


Fig. 321: Disconnecting Fuel Line

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect fuel line - **arrow** -.

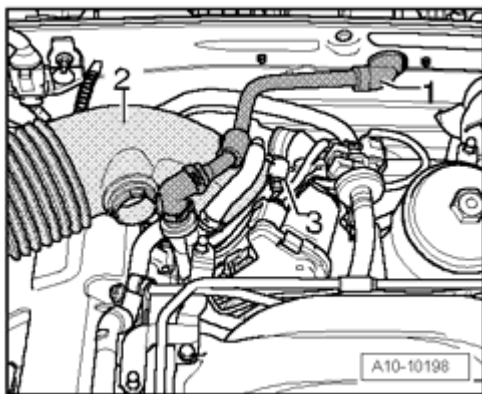


Fig. 322: Identifying Vacuum Hose, Intake Hose & Clamp

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose - **1** - for brake booster at bulkhead.
- Remove intake hose - **2** - , thereby loosening clamp - **3** -.

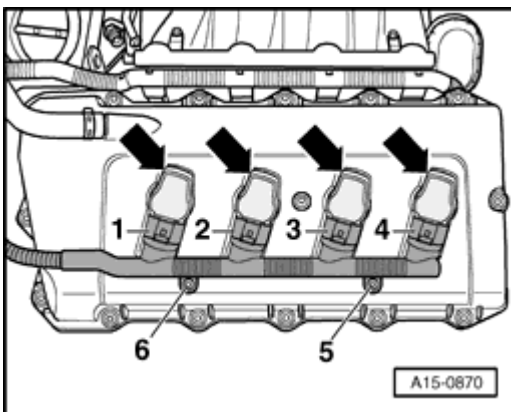


Fig. 323: Removing Bolts On Right Cylinder Head, Disconnecting Electrical Harness Connectors & Removing Ignition Coils

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **5** - and - **6** - on right cylinder head.
- Disconnect electrical harness connectors - **1 to 4** -.
- Remove ignition coils - **arrows** -.

NOTE:

- **Extractor T10094 can be used for removal.**

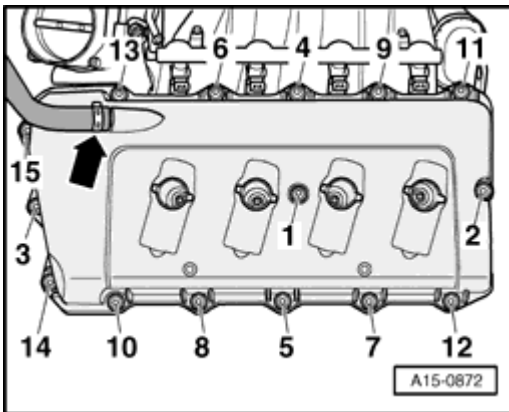


Fig. 324: Disconnecting Hose Of Crankshaft Housing Ventilation & Removing Right Cylinder Head Cover Screws In Sequence

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect hose of crankshaft housing ventilation - **arrow** -.
- Remove right cylinder head cover bolts in sequence - **15 to 1** -.
- Remove cylinder head cover.

Installing

Installation is in reverse order of removal, note the following:

NOTE:

- **Replace cylinder head cover gaskets if damaged.**
- **Replace bolts for cylinder head cover if gasket is damaged.**

- Clean sealing surfaces, must be free of oil and grease.

2006 Audi A6 Quattro

ENGINE 4.2 Liter V8 4V Engine Mechanical, Engine Code(s): BAT, BNK

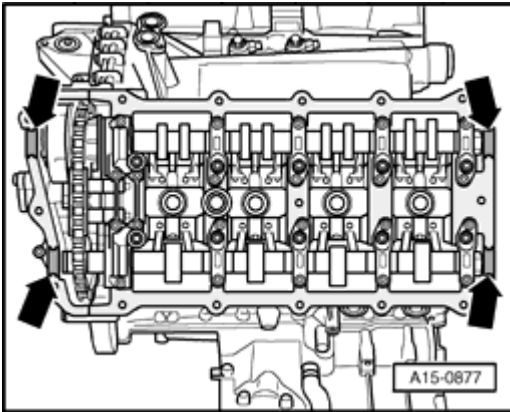


Fig. 325: Coating Semicircular Seals Lightly With Oil And Insert
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Coat semicircular seals - **arrows** - lightly with oil and insert.

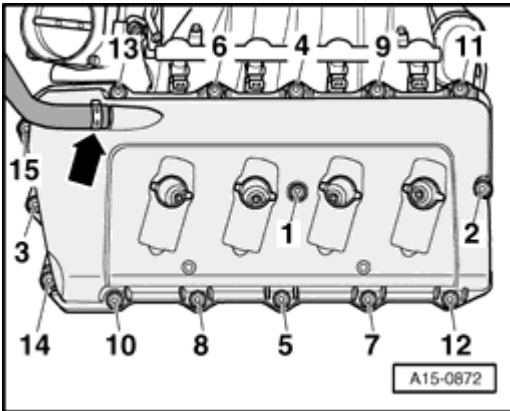


Fig. 326: Disconnecting Hose Of Crankshaft Housing Ventilation & Removing Right Cylinder Head Cover Screws In Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Tighten cylinder head cover in sequence - **1 to 15** -.

Torque specifications

Component	Nm
Cylinder head cover to cylinder head	10
Wiring for ignition coils at cylinder head cover	5 * See note

* Insert using locking compound; locking compound .

Cylinder head, removing and installing

Removing

- Remove engine --> **Engine, removing and installing.**
- Remove camshaft timing chains from camshafts --> **Camshaft timing chains, removing from camshafts.**

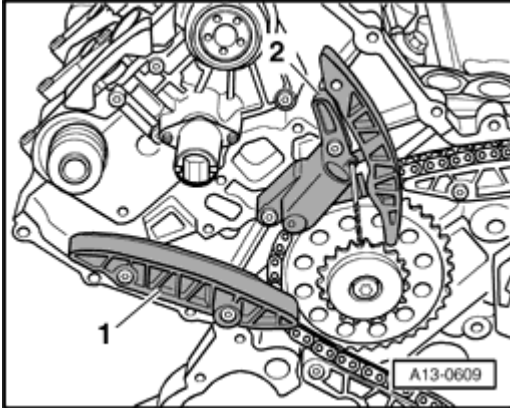


Fig. 327: Removing Glide Track At Left Cylinder Head & Chain Tensioner
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove glide track - 1 - at left cylinder head.
- Remove chain tensioner - 2 -.

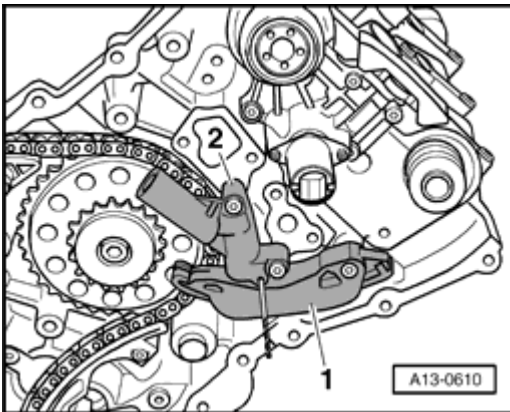


Fig. 328: Removing Glide Track At Right Cylinder Head & Chain Tensioner
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove glide track - 1 - at right cylinder head.
- Remove chain tensioner - 2 -.

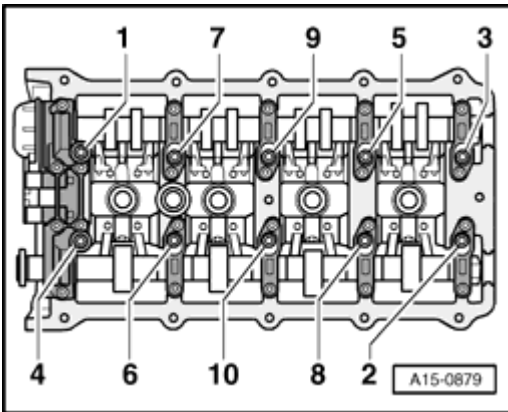


Fig. 329: Loosening Cylinder Head Bolts In Sequence
 Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Follow sequence - **1 to 10** - when loosening cylinder head bolts.
- Remove cylinder head and place it on a soft surface (foam).

Installing

NOTE:

- Replace cylinder head bolts.
- During assembly, replace self-locking nuts and bolts.
- Always replace bolts that are tightened to torque as well as O-rings and gaskets.
- Carefully remove residual sealant from cylinder head and cylinder block. Make sure that no long scrapes or scratches result.
- Carefully remove all grinding and sanding residue.
- There must be no oil or coolant in the blind holes for the cylinder head bolts in the cylinder block.
- When installing a replacement cylinder head with camshafts installed, oil contact surfaces between roller rocker levers and cam running surfaces after installing cylinder head.
- Do not remove plastic bases protecting exposed valves until immediately before installing cylinder head.
- When replacing cylinder head or cylinder head seal, engine oil and coolant must be changed.
- Cylinder heads with cracks between the valve seats, or between the valve seat and the spark plug threads, can continue to be used without reducing the service life, as long as the cracks have a width of max. 0.3 mm, or only the first 4 threads of the spark plug threads are cracked.
- Only unpack new cylinder head gasket immediately prior to installation.
- Handle gasket carefully. Damages to the silicone layer and in areas of recesses may result in leaks.

- Install cylinder head gasket onto guide sleeves. Marking "oben" (top) or part number must face toward cylinder head.
- Secure all hose connections using hose clamps appropriate for the model type .
- After working on the valvetrain and lifters, carefully rotate the crankshaft by hand at least 2 full revolutions before starting to be sure that valves do not strike the pistons.
- All cable ties which are opened or cut open when removing, must be replaced in the same position when installing.

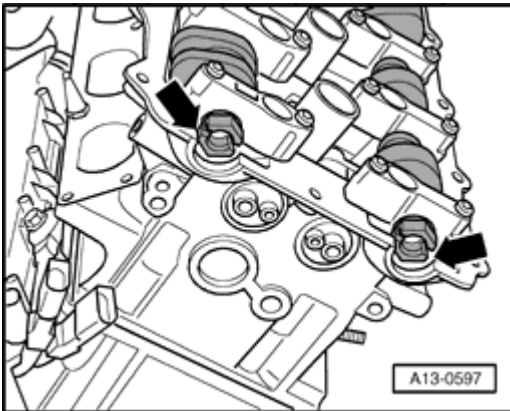


Fig. 330: Identifying Slits At Front In Camshafts Stand Parallel At Same Height With Upper Edge Of Cylinder Head

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Check whether camshafts of both cylinder heads stand in TDC position.
- Slits - **arrows** - at front in camshafts must stand parallel at same height with upper edge of cylinder head.

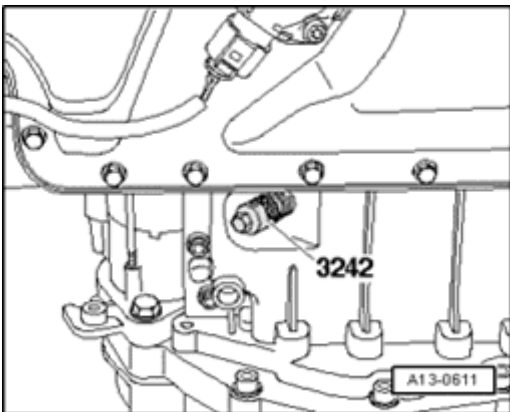


Fig. 331: Removing/Installing Crankshaft Holder 3242 Into Hole

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Crankshaft holder 3242 must be installed.

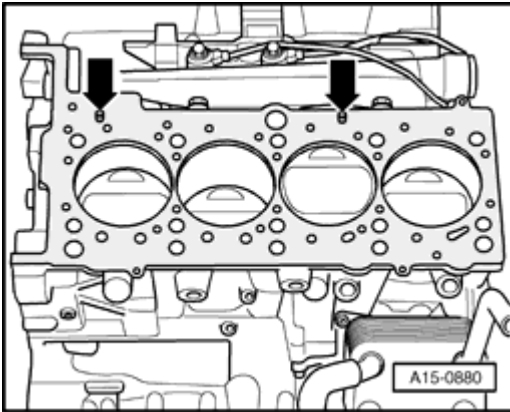


Fig. 332: Setting Cylinder Head Gasket In Place
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Set cylinder head gasket in place.
- Pay close attention to alignment bushings in cylinder block - **arrows** -.
- Pay attention to installation position of cylinder head gasket, marking "oben" (top) or part number must face toward cylinder head.
- Set cylinder head in place.
- Insert new cylinder head bolts and tighten by hand.

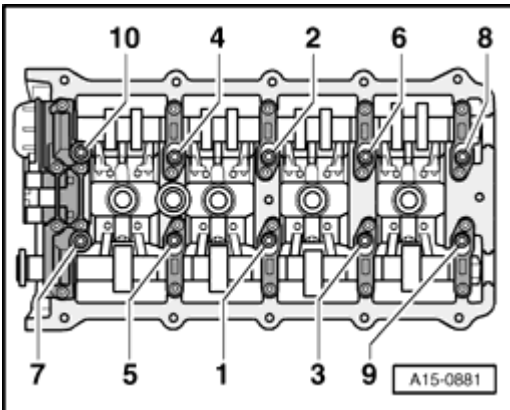


Fig. 333: Tightening Cylinder Head Bolts In 4 Stages In Tightening Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Tighten cylinder head in sequence indicated, in four stages as follows:

Step	Tighten
I	○ Using torque wrench, tighten to 30 Nm.
II	○ Using torque wrench, tighten to 60 Nm.
III	○ With Torx key, 90° (¹ / ₄ turn) additional turn.

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ENGINE 4.2 Liter V8 4V Engine Mechanical, Engine Code(s): BAT, BNK

IV

- With Torx key, 90° ($\frac{1}{4}$ turn) additional turn.

NOTE:

- There is no requirement to retighten the cylinder head bolts after repairs.

Further installation is in reverse order of removal, note the following:

- Install camshaft timing chains **Installing**.
- Install engine --> **Engine, installing**.
- Change engine oil --> **01 - MAINTENANCE**.
- Replace coolant.

Torque specifications

Component	Nm
Chain tensioner to cylinder head	5 + 90° * See note* See note

* 90° corresponds to a 1/4 turn

*Replace bolts.

Compression pressures, checking

Special tools, testers and auxiliary items required

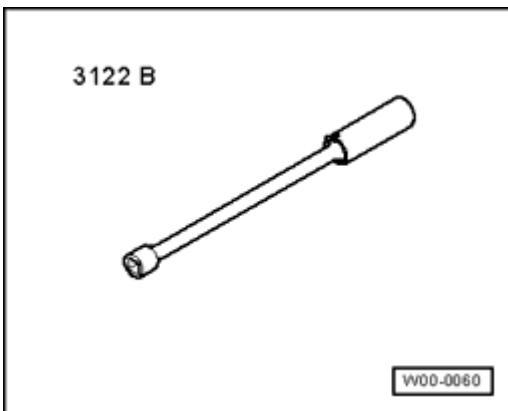


Fig. 334: Spark Plug Removal Tool 3122 B

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Spark plug removal tool 3122 B



Fig. 335: Compression Tester V.A.G 1763

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Compression tester V.A.G 1763

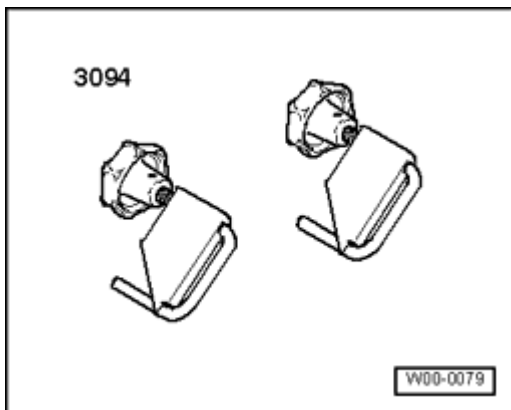


Fig. 336: Identifying Hose Clamps 3094

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Hose Clamps Up to 25 mm dia. 3094

Test conditions

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

Test sequence

- Switch off ignition.

2006 Audi A6 Quattro

ENGINE 4.2 Liter V8 4V Engine Mechanical, Engine Code(s): BAT, BNK

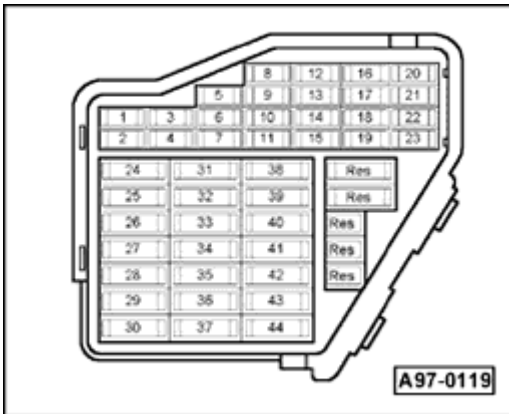


Fig. 337: Main Fuse Case

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove fuse for Fuel Pump (FP) from socket "28".

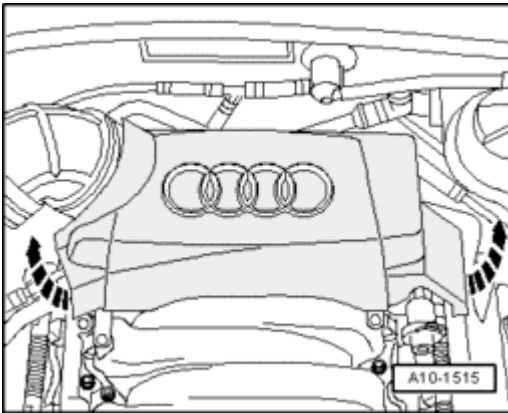


Fig. 338: Removing/Installing Rear Engine Cover

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove rear engine cover - **arrows** -.

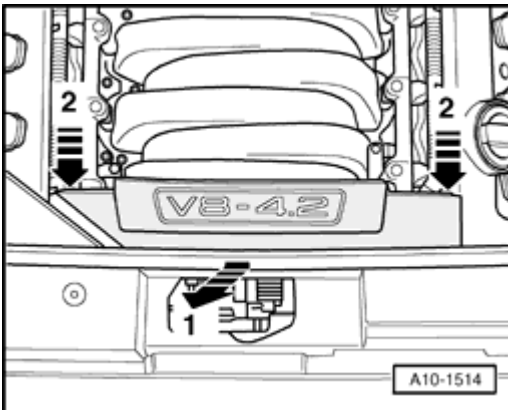


Fig. 339: Removing Front Engine Cover

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove front engine cover - **arrow 1** - and - **arrows 2** -.

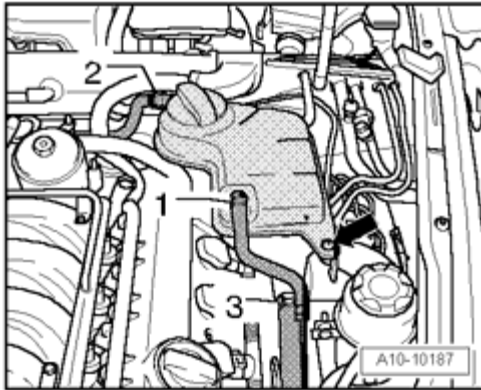


Fig. 340: Removing Coolant Hoses & Coolant Expansion Tank
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Clamp off coolant hose - **2** - using Hose Clamps Up to 25 mm dia. 3094 and disconnect from coolant expansion tank.
- Remove coolant expansion tank - **arrow** -.
- Disconnect electrical wire to Engine Coolant Level (ECL) Warning Switch F66 on bottom of expansion tank and set aside coolant expansion tank with coolant hoses - **1 and 3** - connected.
- If necessary, seal connection using an appropriate plug.

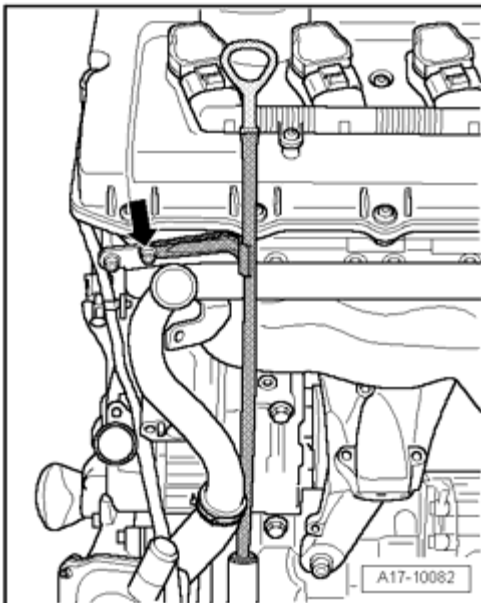


Fig. 341: Removing Guide Pipe For Oil Dipstick At Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolt - **arrow** - at oil dipstick guide tube.

- NOTE:**
- Guide tube remains inserted in upper part of oil pan.

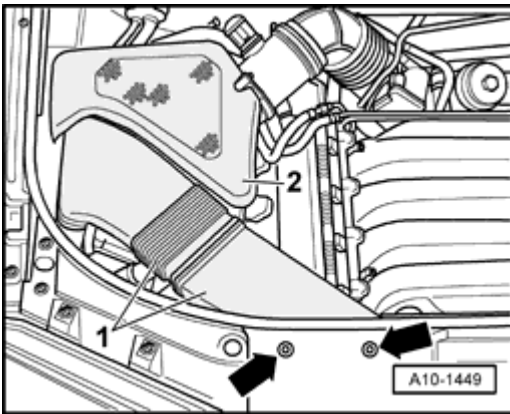


Fig. 342: Identifying Air Filter Cover & Air Duct
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove air filter cover - 2 -.
- Remove air duct - 1 -.

- NOTE:**
- To pull out clips - arrows - , use pry lever 80-200.
 - If necessary, use silicon-free spray lubricant to facilitate removal.

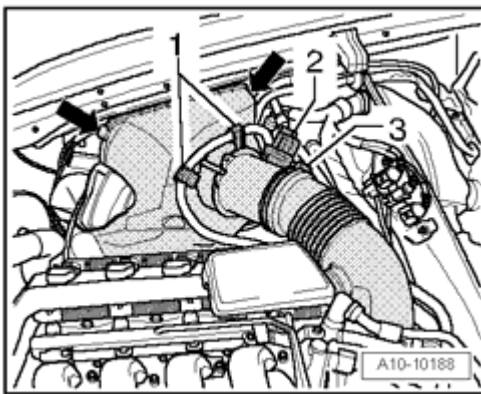


Fig. 343: Disconnecting Mass Air Flow (MAF) Sensor G70 Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Unclip fuel hose - 1 -.
- Disconnect electrical connector - 2 - from mass air flow (MAF) sensor.
- Disconnect mass air flow sensor from intake air duct - 3 -.
- Remove upper part of air filter housing with mass air flow (MAF) sensor - **arrows** -.

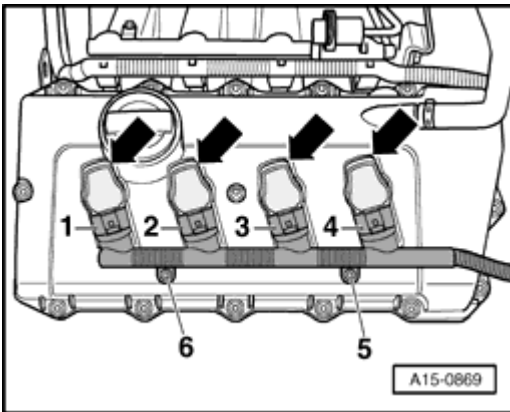


Fig. 344: Removing Bolts On Left Cylinder Head, Disconnecting Electrical Harness Connectors & Removing Ignition Coils

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - 5 - and - 6 - on left cylinder head.
- Disconnect electrical harness connectors - 1 to 4 -.
- Remove ignition coils - **arrows** -.

NOTE:

- **Extractor T10094 can be used for removal.**

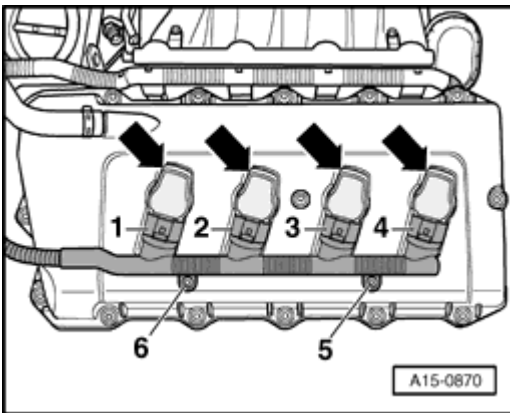


Fig. 345: Removing Bolts On Right Cylinder Head, Disconnecting Electrical Harness Connectors & Removing Ignition Coils

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - 5 - and - 6 - on right cylinder head.
- Disconnect electrical harness connectors - 1 to 4 -.
- Remove ignition coils - **arrows** -.

NOTE:

- **Extractor T10094 can be used for removal.**

- Using spark plug removal tool 3122 B , remove spark plugs.

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- Open throttle valve completely.
- Check compression pressure using compression tester V.A.G 1763.

NOTE: • **Using tester operating instructions.**

- Operate starter until tester shows no further pressure increase.

Compression pressure:

New bar positive pressure	Wear limit bar positive pressure	Difference between cylinders bar positive pressure
10.0 to 14.0	9.0	max. 3.0

Assembly is in reverse order of removal, note the following:

- Install sparks plugs --> **01 - MAINTENANCE** .

The following work step must be performed after engine compression test.

- As a final step, check DTC memory of Engine Control Module (ECM) and erase it , since malfunctions were stored by removing fuse.

Torque specifications

Component	Nm
Wiring for ignition coils at cylinder head cover	5 * See note
Oil dip stick guide tube to cylinder head	10

* Insert using locking compound; locking compound .

INTAKE MANIFOLD, REMOVING AND INSTALLING

Intake manifold, component overview

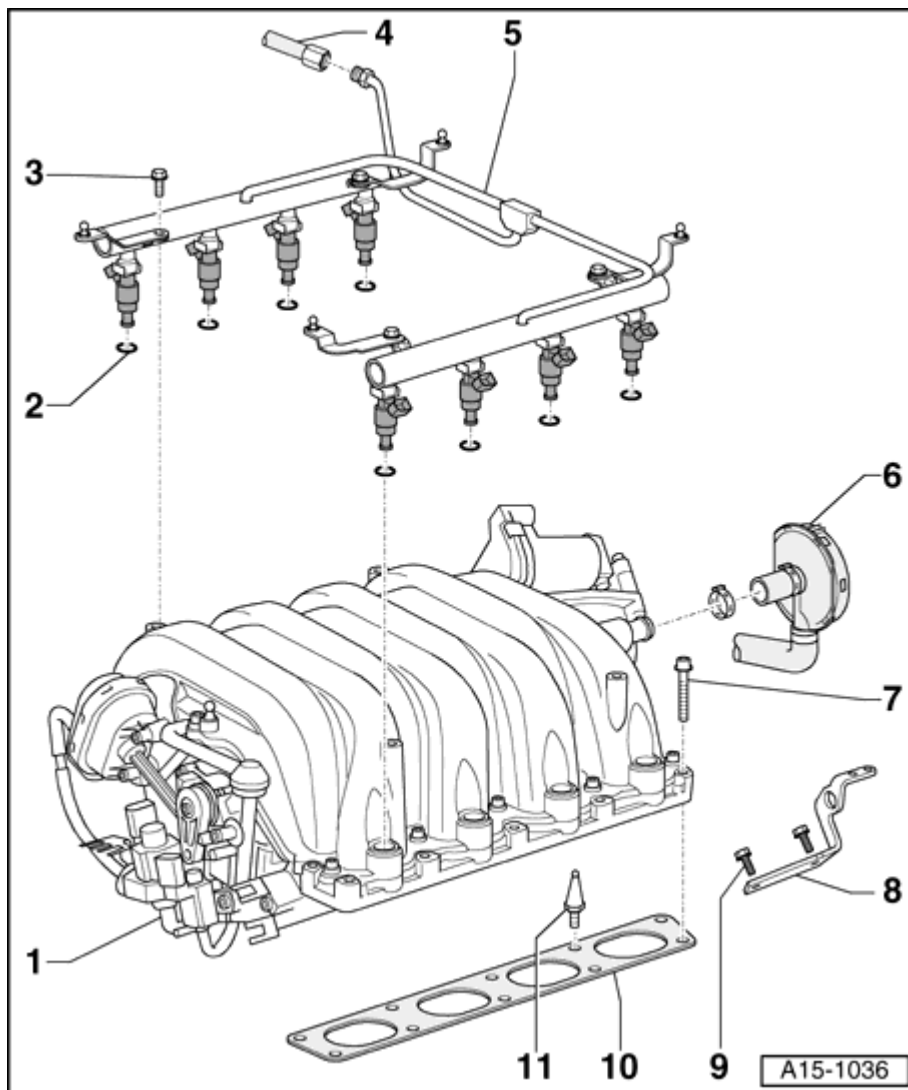


Fig. 346: Intake Manifold, Component Overview

Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - Intake manifold

- Removing and installing --> **Intake manifold, removing and installing**

2 - O-rings

- For fuel injectors
- Replace

3 - 10 Nm

4 - Fuel supply line

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- Tighten union nut to 25 Nm

5 - Fuel rail

6 - Pressure regulator valve

- For crankcase ventilation

7 - 10 Nm

- Fasten diagonally in steps

8 - Lifting eye

9 - 23 Nm

10 - Gasket

- For intake manifold
- Replace

11 - Locking pin - 0.6 Nm

Intake manifold, removing and installing

Removing

NOTE:

- All cable ties which are opened or cut open when removing, must be replaced in the same position when installing.

- Remove engine compartment cover.
- Disconnect vacuum hose - **3** - to brake booster at bulkhead.

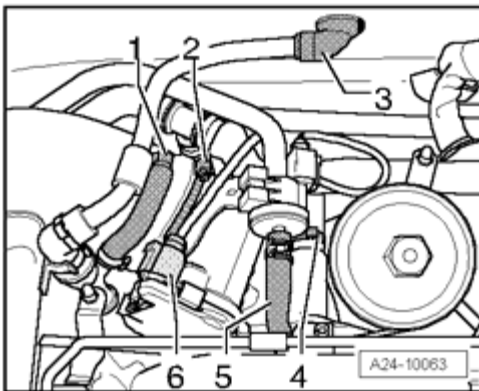


Fig. 347: Disconnecting Throttle Valve Control Module J338 Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose - **1** -.
- Disconnect electrical connection - **6** - at throttle valve control module J338.
- Release hose clamp - **2** - and pull out air duct hose.
- Pull off vacuum hose - **4** - from crankcase breather at intake manifold.
- Disconnect vacuum hose - **5** - from intake manifold.

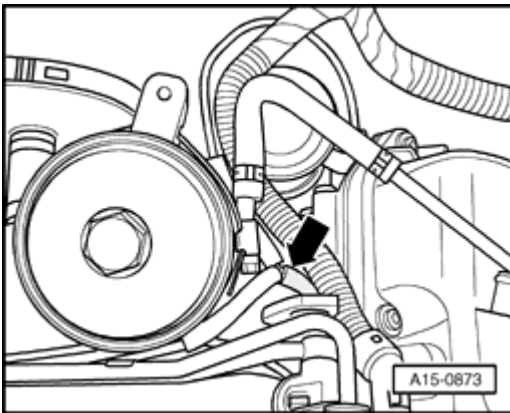


Fig. 348: Disconnecting Vacuum Hose At T-Piece
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose - **arrow** - at T-piece.

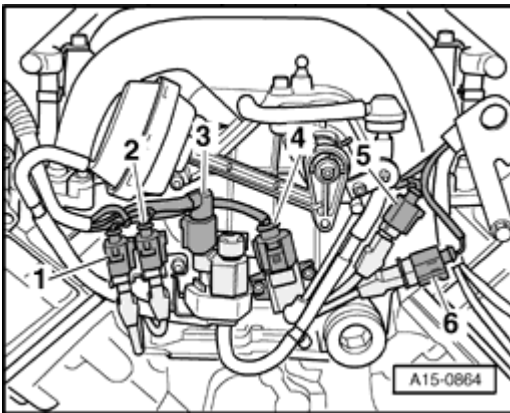


Fig. 349: Remove Electrical Harness Connectors Toward Front From Brackets On Intake Pipe
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove electrical harness connectors - **1 to 4** - toward front from brackets on intake pipe.

NOTE:

- **The electrical connections must not be separated.**

- Pull off connector strips - **2** - and - **3** - at 8 fuel injectors.

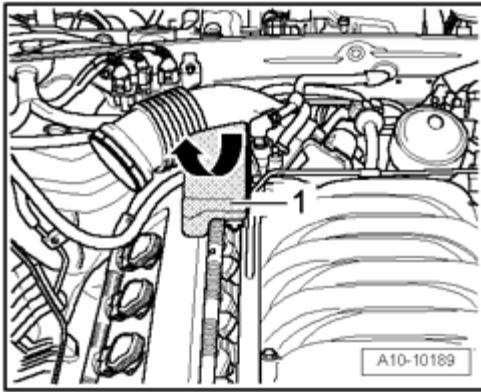


Fig. 350: Removing Resonator

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Pull resonator - **1** - in direction of - **arrow** - upward and unclip it.

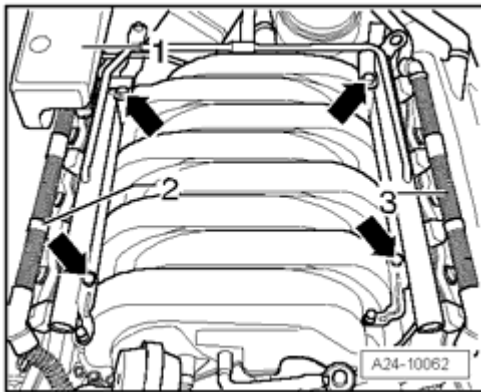


Fig. 351: Pulling Off Connector Strips At Fuel Injectors & Removing Bolts From Fuel Rail

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** - from fuel rail.
- Pull fuel rail with injectors upward uniformly from intake manifold and set aside in engine compartment on a clean cloth.

NOTE:

- **Carefully protect the removed fuel injectors from contamination.**

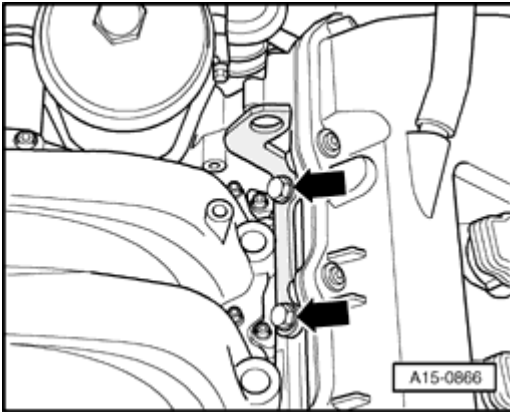


Fig. 352: Removing Left Rear Engine Lifting Eye
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove left rear engine lifting eye - **arrows** -.

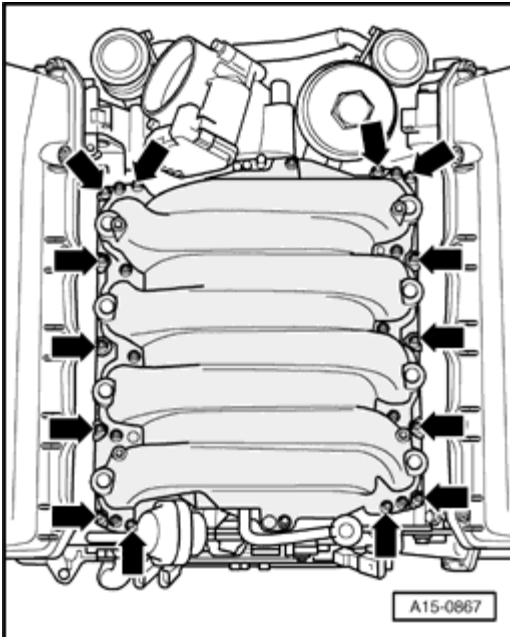


Fig. 353: Removing Intake Manifold Bolts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove intake manifold bolts - **arrows** - and remove it.

NOTE:

- Plug intake ports of the cylinder head with clean rags.

Installing

Installation is in reverse order of removal, note the following:

NOTE:

- Replace gaskets and O-rings.
- During installation, all cable ties must be re-installed at the same location.
- Secure all hose connections using hose clamps appropriate for the model type

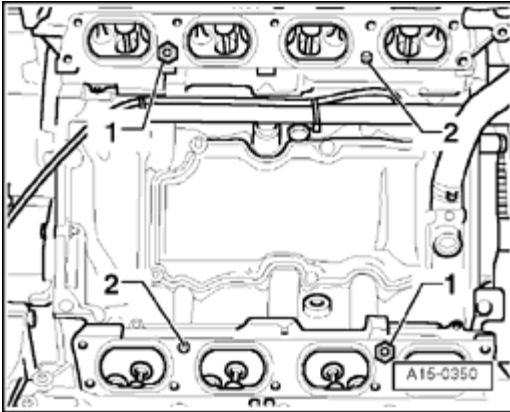


Fig. 354: Replacing Intake Manifold Gaskets, Thereby Removing Locking Bolt
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Replace intake manifold gaskets, thereby removing locking bolt - **1** -.
- Be aware of alignment pins - **2** - when setting intake manifold in place.

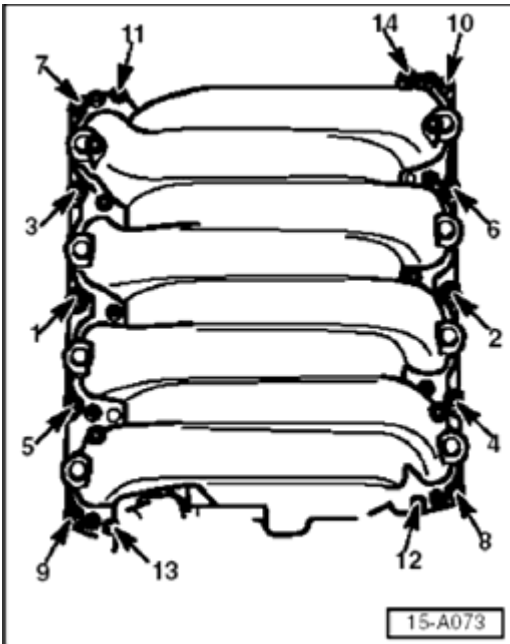


Fig. 355: Tightening Intake Manifold Bolts In Stages And In Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Tighten intake manifold bolts - **arrows** - in stages and in sequence as shown.

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- Reconnect all vacuum lines.
- Make sure electrical connections are securely seated.
- Bleed fuel system --> **24 - FUEL INJECTION SYSTEM**

Torque specifications

Component	Nm
Locking bolt to cylinder head	0.6
Intake manifold to cylinder head	10
Engine lifting eye to cylinder head	22
Fuel rail to intake manifold	10

VALVETRAIN, SERVICING

Valvetrain, servicing

NOTE:

- Cylinder heads with cracks between the valve seats, or between the valve seat and the spark plug threads, can continue to be used without reducing the service life, as long as the cracks have a width of max. 0.3 mm, or only the first 4 threads of the spark plug threads are cracked.
- After installing the camshafts, the engine may not be started for approx. 30 minutes. The hydraulic equalization elements must seat themselves (otherwise the valves will crash into the pistons).
- After working on the valvetrain, carefully rotate engine by hand at least 2 full revolutions to ensure that valves do not strike the pistons when starting.
- Always replace seals, sealing rings and O-rings.

Valvetrain, component overview

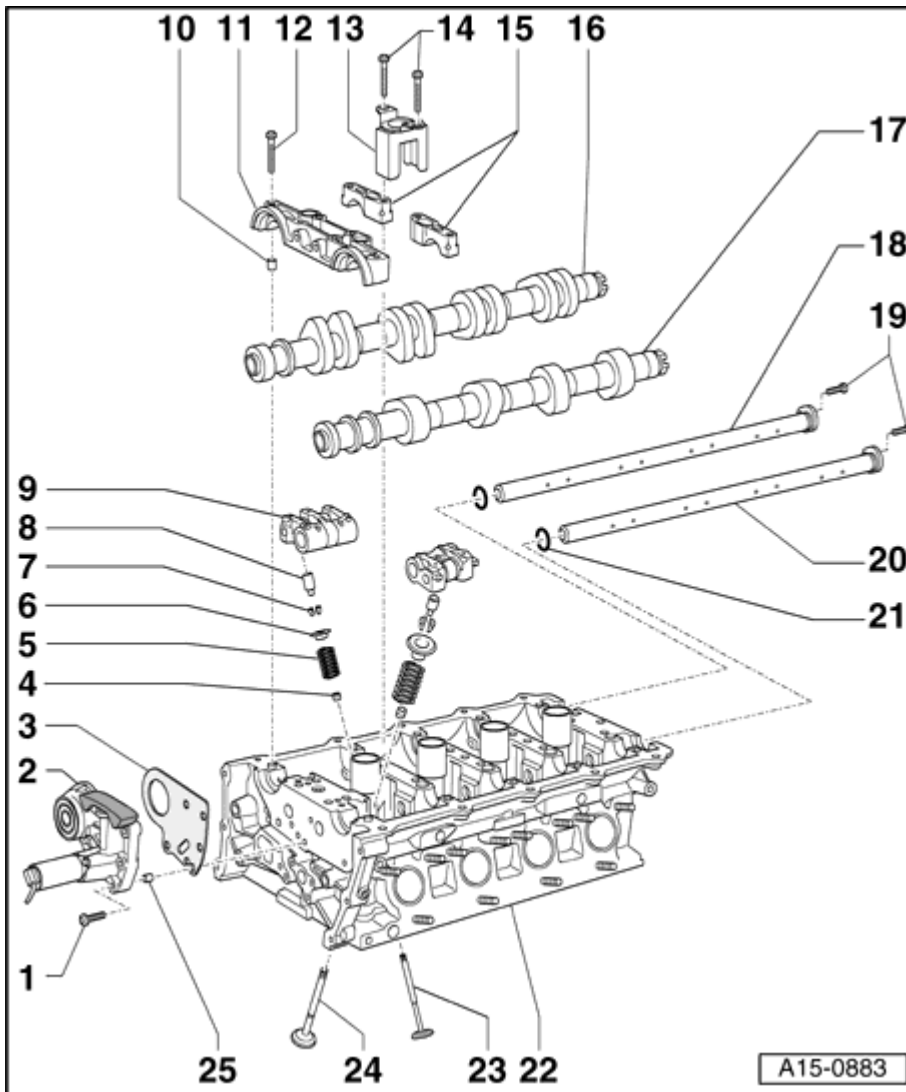


Fig. 356: Valvetrain, Component Overview
 Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - 5 Nm plus an additional $\frac{1}{4}$ turn (90°)

- Replace

2 - Housing for camshaft adjustment solenoid valve

3 - Gasket

- Replace

4 - Valve stem seal

- Replacing --> **Valve stem seals, replacing**

5 - Valve spring

6 - Valve spring plate

7 - Valve keepers

8 - Hydraulic valve lifter

- Pressed into roller rocker lever
- Not removable without being damaged

9 - Roller rocker lever

- Removing and installing --> **Roller rocker lever, removing and installing**

10 - Alignment bushing

- 2 pieces

11 - Double bearing cap

12 - 5 Nm plus an additional $\frac{1}{4}$ turn (90°)

- Replace

13 - Oil deflector

- On cylinder head at right between bearing cap E4 and A4
- On cylinder head at left between bearing cap E2 and A2

14 - 5 Nm plus an additional $\frac{1}{4}$ turn (90°)

- Replace

15 - Bearing cap

- Note installation position and allocation --> **Fig. 360**

16 - Intake camshaft

- Removing and installing --> **Camshafts, removing and installing**
- Checking axial play --> **Camshafts, checking axial clearance**
- Check radial clearance using Plastigage (roller rocker lever removed)
- Radial clearance wear limit: 0.1 mm

- Radial clearance run-out: max. 0.01 mm

17 - Exhaust camshaft

- Removing and installing --> **Camshafts, removing and installing**
- Checking axial play --> **Camshafts, checking axial clearance**
- Check radial clearance using Plastigage (roller rocker lever removed)
- Radial clearance wear limit: 0.1 mm
- Radial clearance run-out: max. 0.01 mm

18 - Shaft for roller rocker lever, intake side

- Removing and installing --> **Roller rocker lever, removing and installing**

19 - 10 Nm

20 - Shaft for roller rocker lever, exhaust side

- Removing and installing --> **Roller rocker lever, removing and installing**

21 - O-ring

- For roller rocker lever shaft
- Replace

22 - Cylinder head

- See note --> **Valvetrain, servicing**
- Check valve guides, grind valve seats --> **Valve guides, checking**
- Rework valve seats --> **Valve seats, reworking**

23 - Intake valve

- Do not rework, only lapping is permitted
- Valve dimensions --> **Valve dimensions**
- Check valve guides, grind valve seats --> **Valve guides, checking**

24 - Exhaust valve

- Do not rework, only lapping is permitted
- Valve dimensions --> **Valve dimensions**
- Check valve guides, grind valve seats --> **Valve guides, checking**

25 - Alignment bushing

- 2 pieces

Camshafts, removing and installing

Removing

NOTE:

- Here, removal and installation at right cylinder head is depicted in the following description.

- Remove engine --> Engine, removing and installing.
- Separate engine/transmission unit --> Engine and transmission, separating.
- Remove camshaft timing chains from camshafts --> Camshaft timing chains, removing from camshafts.

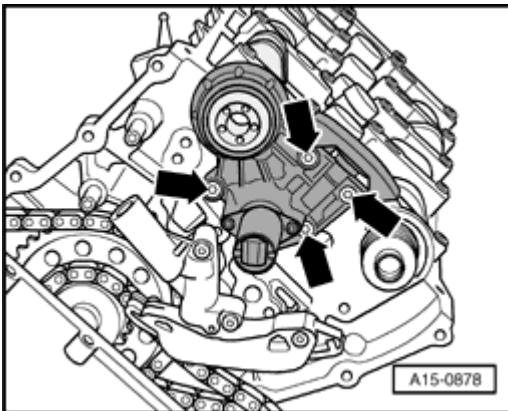


Fig. 357: Removing Housing For Camshaft Adjustment Solenoid Valves
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove housing for camshaft adjustment solenoid valves - **arrows** -.

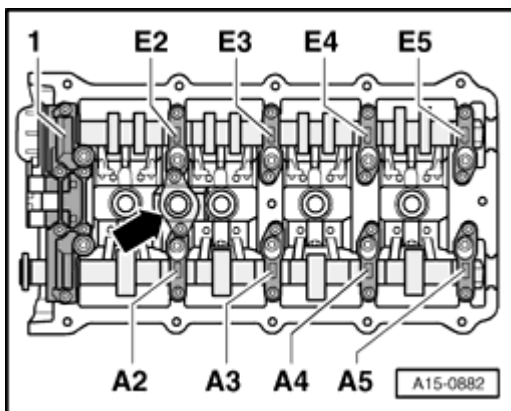


Fig. 358: Removing/Installing Bearing Caps

- Remove bearing caps - **1** - , - **E3** - , - **E5** - , - **A3** - and - **A5** -.
- Remove oil deflector - **arrow** -.
- Loosen and remove bearing caps - **E2** - , - **E4** - , - **A2** - and - **A4** - for intake and exhaust camshafts, alternating and in diagonal sequence.
- Remove intake and exhaust camshaft.

Installing

- Secure crankshaft in TDC position using crankshaft holder 3242

NOTE:

- **Always replace bolts that are tightened to torque as well as O-rings and gaskets.**

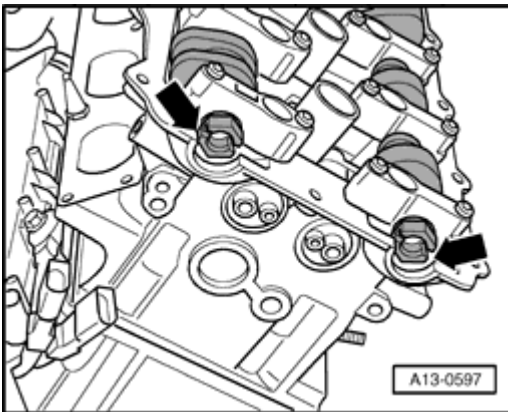


Fig. 359: Identifying Slits At Front In Camshafts Stand Parallel At Same Height With Upper Edge Of Cylinder Head

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install camshafts at TDC position into cylinder head.
- Slits - **arrows** - at front in camshafts must stand parallel at same height with upper edge of cylinder head.

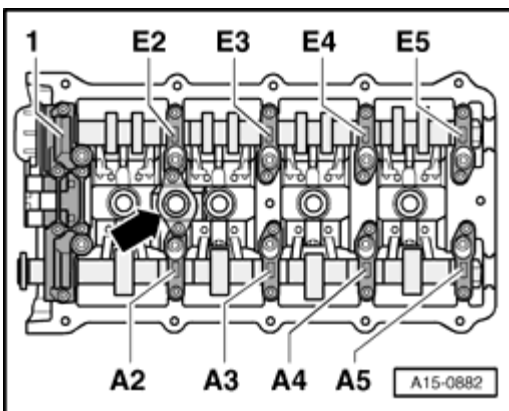


Fig. 360: Removing/Installing Bearing Caps

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Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install bearing caps - **E2** - , - **E4** - , - **A2** - and - **A4** - .
- Install oil deflector - **arrow** - :
- On cylinder head at right between bearing cap - **E4** - and - **A4** - .
- On cylinder head at left between bearing cap - **E2** - and - **A2** - .
- Tighten bearing caps - **E2** - , - **E4** - , - **A2** - and - **A4** - for intake and exhaust camshafts, alternating and in diagonal sequence.
- Tighten remaining bearing caps in diagonal sequence.

NOTE:

- **Note alignment bushing on bearing cap - 1 - .**

Further installation is in reverse order of removal, note the following:

- Install camshaft timing chains **Installing**.
- Install engine --> **Engine, installing**.

Torque specifications

Component	Nm
Bearing cap to cylinder head	5 + 90° * See note* See note
Housing for camshaft adjustment solenoid valve	5 + 90° * See note* See note

* 90° corresponds to a 1/4 turn

* Replace bolts

Camshafts, checking axial clearance

Special tools, testers and auxiliary items required

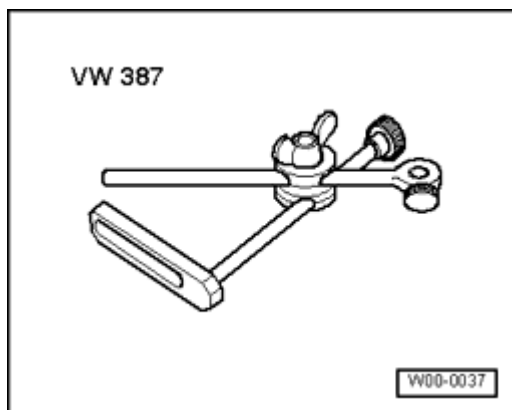


Fig. 361: Dial Gauge Holder VW 387

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Dial gauge holder VW 387
- Dial gauge

Test sequence

- Camshafts removed --> **Camshafts, removing and installing.**
- Roller rocker lever removed --> **Roller rocker lever, removing and installing.**

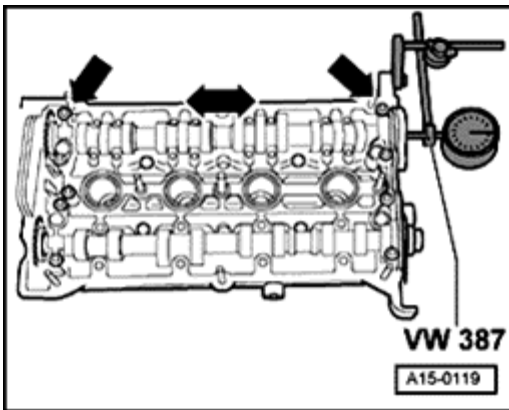


Fig. 362: Inserting Camshafts In Cylinder Head And Tighten With Outer Bearing Caps

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Insert camshafts in cylinder head and tighten with outer bearing caps - **arrows** -.
- Secure dial gauge holder VW 387 to dial gauge on cylinder head:
- Wear limit for intake and exhaust camshaft: max. 0.20 mm.

Roller rocker lever, removing and installing

Removing

- Remove engine --> **Engine, removing and installing.**
- Remove camshafts --> **Camshafts, removing and installing.**
- Mark allocation of roller rocker lever and shafts for roller cam follower for re-installation.

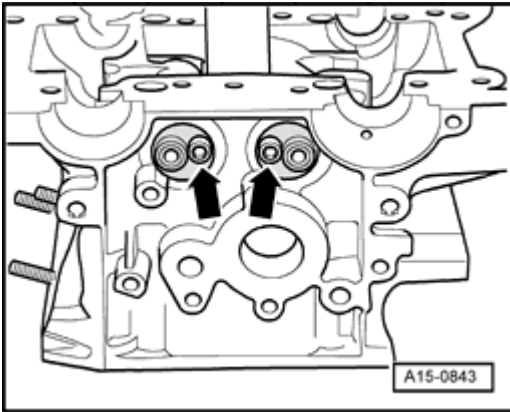


Fig. 363: Removing bolts

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** -.
- Thread a M6-bolt into the hole in shaft for roller rocker lever.
- Remove shaft from cylinder head and remove roller rocker lever.

Installing

Installation is in reverse order of removal, note the following:

NOTE:

- **Replace O-rings.**

- Before installing, oil bearing areas for roller rocker lever.
- Install camshafts --> **Camshafts, removing and installing.**
- Install engine --> **Engine, installing.**

Torque specifications

Component	Nm
Shaft for roller rocker lever to cylinder head	10

Valve stem seals, replacing

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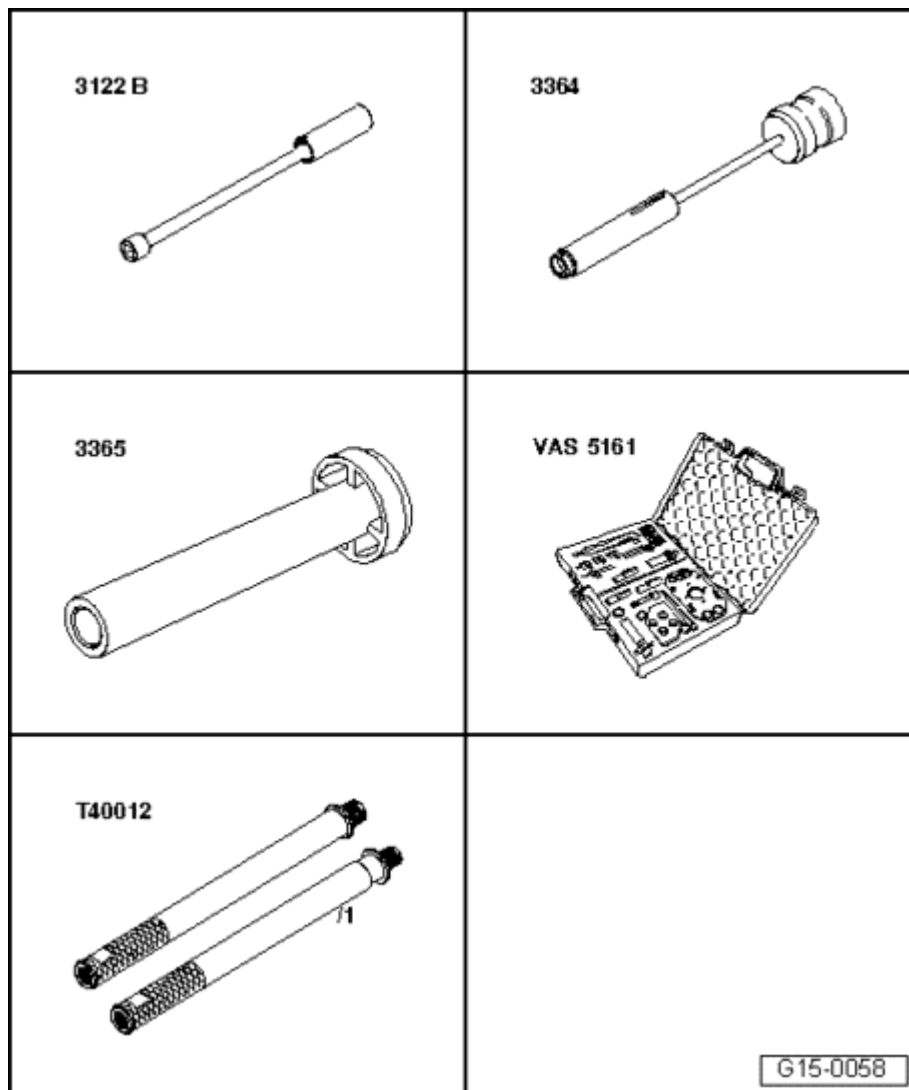


Fig. 364: Identifying Special Tools - Valve Stem Seals, Replacing
Courtesy of VOLKSWAGEN UNITED STATES, INC.

Special tools, testers and auxiliary items required

- Spark plug removal tool 3122 B
- Valve seal removal tool 3364
- Valve stem seal driver 3365
- Valve cotter disassembly and assembly device VAS 5161
- Adapter T40012

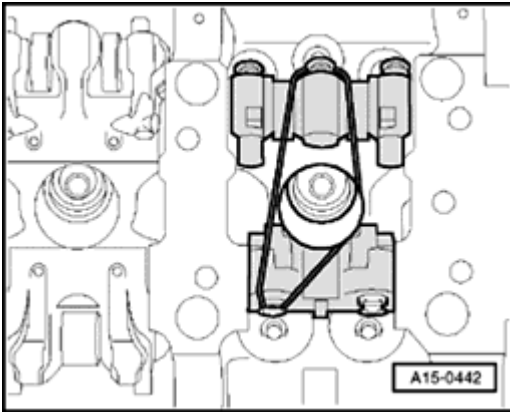


Fig. 365: Turning Roller Rocker Lever Upward And Securing With A Rubber Band
Courtesy of VOLKSWAGEN UNITED STATES, INC.

Work procedure

- Remove engine --> **Engine, removing and installing.**
- Remove camshafts --> **Camshafts, removing and installing.**
- Using spark plug removal tool 3122 B , remove spark plugs.
- Turn roller rocker lever upward and secure it with a rubber band.

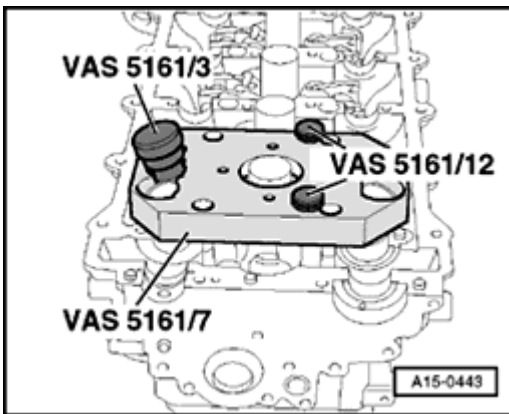


Fig. 366: Placing Guide Plate VAS 5161/7 From Valve Cotter Disassembly, Assembly Device VAS 5161 On Cylinder Head & Securing Guide Plate VAS 5161/7 With Knurled Screws VAS 5161/12
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Place guide plate VAS 5161/7 from VAS 5161 onto cylinder head.
- Secure guide plate VAS 5161/7 with knurled screws VAS 5161/12.

NOTE:

- If guide plate cannot be installed, drill mounting bores to approx. 0.5 mm.

- Insert drift VAS 5161/3 into guide plate and loosen stuck valve keepers using a plastic hammer.

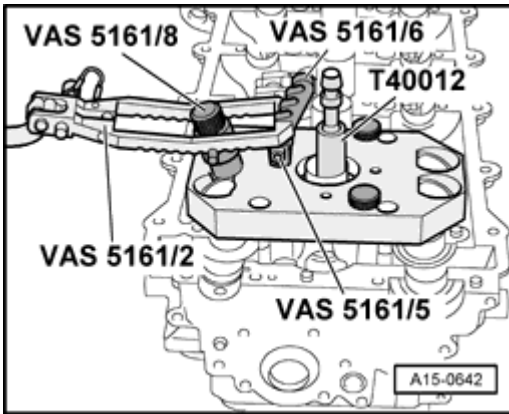


Fig. 367: Installing Engaging Device VAS 5161/6 With Installation Forks VAS 5161/5 Into Guide Plate VAS 5161/7

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install engaging device VAS 5161/6 with VAS 5161/5 into guide plate VAS 5161/7.
- Guide installation cartridge VAS 5161/8 into guide plate VAS 5161/7.
- Install adapter T40012 with gasket by hand into respective spark plug thread and apply constant pressure.
- Minimum pressure: 6 bar positive pressure.
- Engage pressure fork VAS 5161/2 at engaging device VAS 5161/6 and press down installation cartridge.
- At the same time, turn knurled bolt of installation cartridge to the right, until points engage in the valve keepers.
- Lightly move knurled bolt back and forth, causing valve keepers to be pressed apart and be captured in the installation cartridge.
- Release pressure fork.
- Take out installation cartridge.
- Remove guide plate.
- Pressurized air hose remains connected.
- Remove valve spring with valve spring plate.

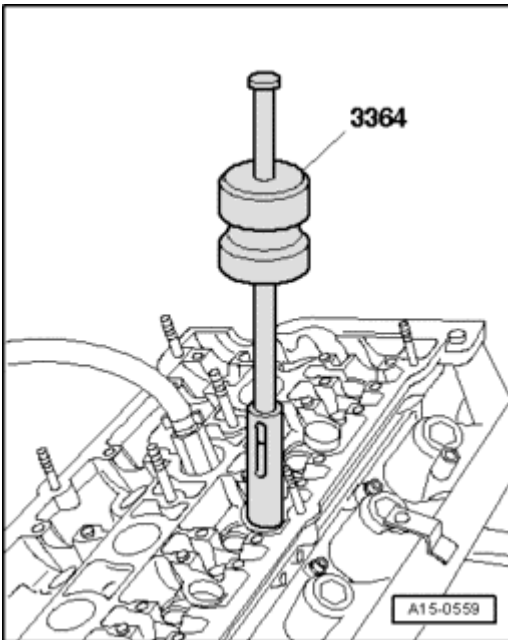


Fig. 368: Pulling Off Valve Stem Seals With Valve Seal Removal Tool 3364
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Pull off valve stem seals with valve seal removal tool 3364.

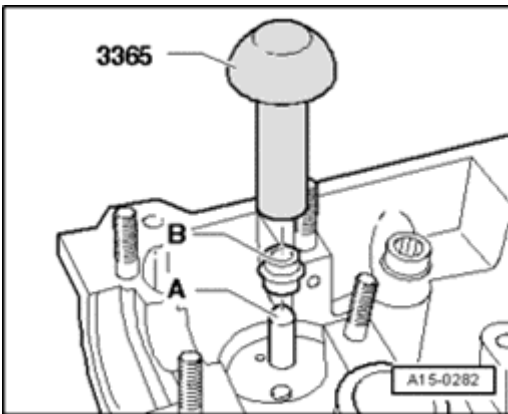


Fig. 369: Identifying Plastic Sleeve, Valve Stem Oil Seal & Valve Stem Seal Driver 3365
Courtesy of VOLKSWAGEN UNITED STATES, INC.

NOTE:

- For pressing on valve stem seals from delivery program, the valve stem seal driver 3365 must be drilled to 10.5 mm dia.
 - A plastic sleeve - A - is supplied with the new valve shaft seals.
-
- Place plastic sleeve - A - on valve stem to prevent damage to new valve stem oil seals - B -.
 - Lightly oil valve stem seal.
 - Push valve stem seal onto plastic sleeve.

- Remove plastic sleeve again.

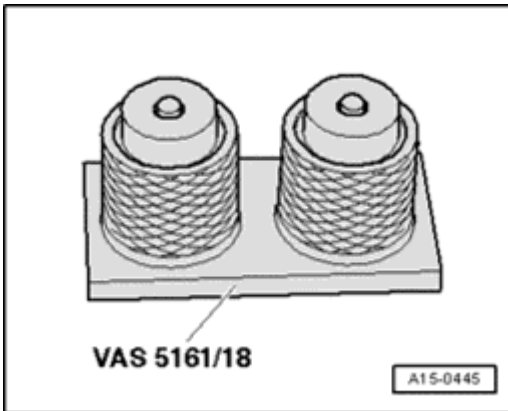


Fig. 370: Identifying Installation Cartridge VAS 5161/8
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- If valve keys were removed from installation cartridge, they must be inserted into insertion device VAS 5161/18 next.

NOTE:

- The large diameter of the valve keepers point upward.

- Insert valve spring and valve spring plate.
- Install Guide Plate VAS 5161/7 onto cylinder head again.

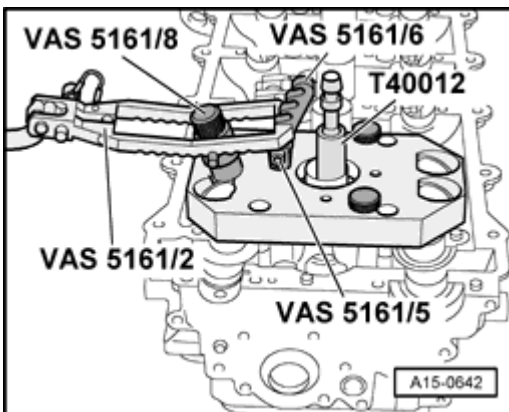


Fig. 371: Installing Engaging Device VAS 5161/6 With Installation Forks VAS 5161/5 Into Guide Plate VAS 5161/7
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Insert installation cartridge VAS 5161/8 into guide plate.
- Press down pressure fork and pull knurled-head screw upward - thereby the valve keepers are inserted.
- Release pressure fork with knurled bolt still pulled.
- Install camshafts --> **Camshafts, removing and installing.**

- Install engine --> **Engine, installing.**

NOTE:

- After installing the camshaft, the engine may not be started for approx. 30 minutes. The hydraulic equalization elements must seat themselves (otherwise the valves will crash into the pistons).
- After working on the valvetrain and lifters, carefully rotate the crankshaft by hand at least 2 full revolutions before starting to be sure that valves do not strike the pistons.

Valve guides, checking

Special tools, testers and auxiliary items required

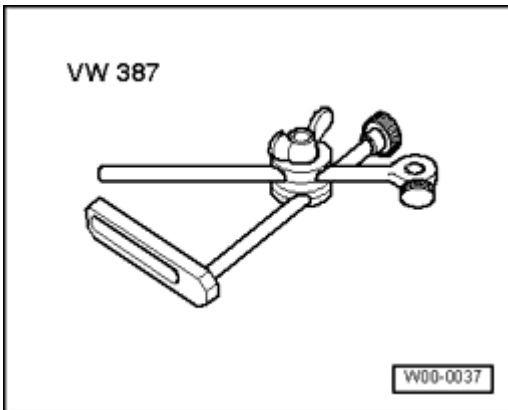


Fig. 372: Dial Gauge Holder VW 387

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Dial gauge holder VW 387
- Dial gauge

Test sequence

- Insert valve into guide. The end of the valve stem must be flush with the guide. Due to the slight difference in stem dimensions, ensure that only an intake valve is used in the intake guide and an exhaust valve in the exhaust guide.

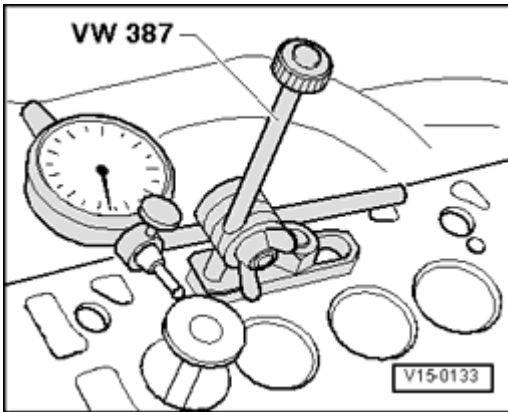


Fig. 373: Identifying Special Tool - VW 387 Installed
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Determine tip clearance.
- Wear limit of intake and exhaust valve guide: 0.80 mm.

NOTE:

- If wear limit is exceeded, re-measure using new valves. If wear limit is still exceeded, replace cylinder head. The valve guides cannot be replaced.
- If the valve is to be replaced as part of a repair, use a new valve for the calculation.

Valves, checking

- Visually check for signs of wear on stem and on seating surface. Replace valve if it shows significant signs of wear.

Valve dimensions

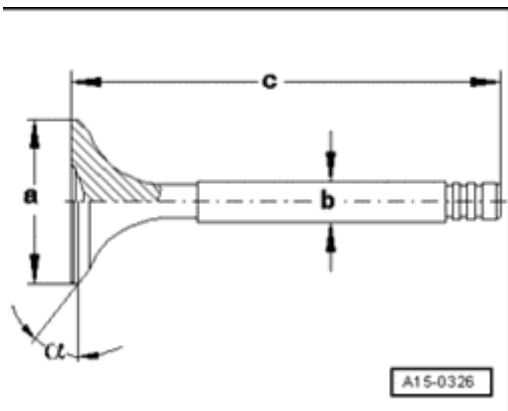


Fig. 374: Valve Dimensions
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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- Valves must not be reworked. Only lapping is permitted.

Dimension	Intake valve	Exhaust valve
a = dia. mm	26.8 to 27.0	29.8 to 30.0
b = dia. mm	5.956 to 5.970	5.936 to 5.950
c = mm	96.39 to 96.59	94.79 to 94.99
a = Angle°	45	45

CAUTION:

- Worn sodium-filled exhaust valves must not be scrapped without first being properly treated.
- Using a metal saw, the valves must be cut into two pieces between the shaft center and valve head. While doing this, do not come into contact with water. At the very most, throw 10 of the prepared valves into a bucket filled with water. Then, move quickly away, because a sudden chemical reaction will occur during which the sodium is burnt away.
- The treated parts may then be discarded through conventional disposal channels.

Valve seats, reworking

NOTE:

- If a perfect contact pattern is not achieved by grinding the valve seats, rework the valve seats.

Special tools, testers and auxiliary items required

- Depth gauge
- Valve seat refacing tool

NOTE:

- When repairing engines with leaking valves, it is not sufficient to rework or replace valve seats and valves. It is particularly important to check valve guides for wear on engines with higher mileage performance --> Valve guides, checking.
- Only reface valve seats enough until a perfect contact pattern is obtained.
- The maximum permissible reworking dimension must be calculated before work is carried out.
- If the reworking dimension is exceeded, the function of the hydraulic lifters can no longer be guaranteed and therefore the cylinder head should be replaced.

Calculating maximum allowable reworking dimension

- Insert valve and press it firmly against the valve seat.

NOTE:

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

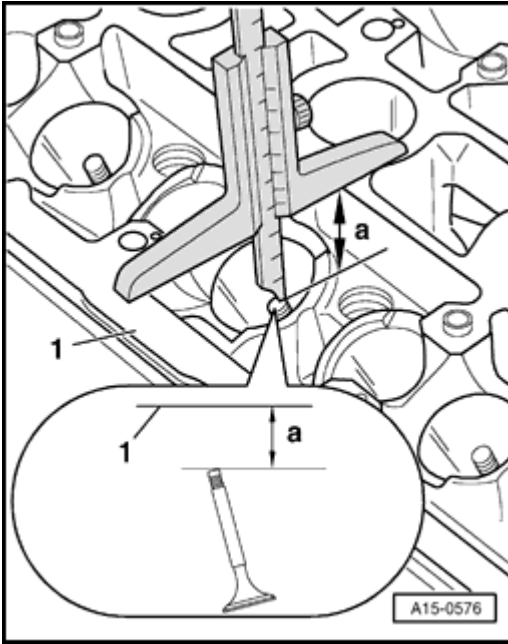


Fig. 375: Measuring Distance Between Valve Stem End (Upper Edge) And Top Surface Of Cylinder Head Using Depth Gauge

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Measure distance - **a** - between end of valve stem and camshaft center axle (camshaft center axle is located at the level of cylinder head upper edge).
- Calculate max. permissible reworking dimension from measured distance and minimum dimension.

Minimum dimensions		
Outer intake valves	Center intake valves	Exhaust valves
39.3 mm	41.0 mm	39.9 mm

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

Example for outer intake valve:		
	Measured distance - a -	39.7 mm
-	Minimum dimension	-39.3 mm
=	Max. perm. rework dimension	= 0.4 mm

NOTE:

- If the maximum permissible reworked dimension is 0 mm or less than 0

mm or less than 0 mm, replace cylinder head.

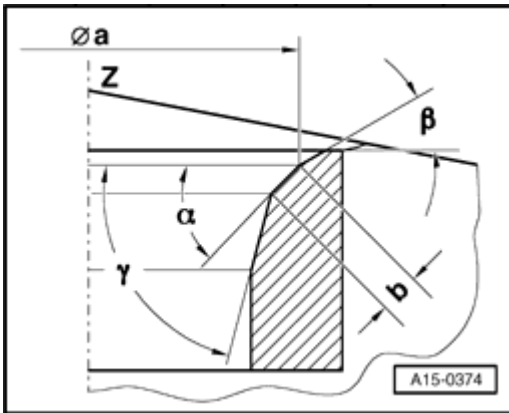


Fig. 376: Refacing Valve Seats Dimension

Courtesy of VOLKSWAGEN UNITED STATES, INC.

Valve seats, reworking

Intake valve seat		
a	=	Dia. 26.6 mm
b	=	Approx. 1.0 mm
Z	=	Cylinder head lower edge
a	=	45° valve seat angle
β	=	30° upper correction angle
g	=	60° lower correction angle

Exhaust valve seat		
a	=	Dia. 26.0 mm
b	=	Approx. 1.0 mm
Z	=	Cylinder head lower edge
a	=	45° valve seat angle
β	=	30° upper correction angle
g	=	60° lower correction angle