15 - ENGINE - CYLINDER HEAD, VALVETRAIN

CYLINDER HEAD, REMOVING AND INSTALLING

Cylinder Head, Removing and Installing

--> Cylinder Head, Component Overview

--> Left Cylinder Head Cover, Removing and Installing

--> Right Cylinder Head Cover, Removing and Installing

--> Cylinder Head, Removing and Installing

--> Brake Booster Vacuum Pump, Removing and Installing

--> Compression, Checking

Cylinder Head, Component Overview

Cylinder Head, Component Overview

NOTE:

- **Illustration depicts left cylinder head.**
- **Both cylinder heads can be removed and installed when engine is installed in engine compartment.**

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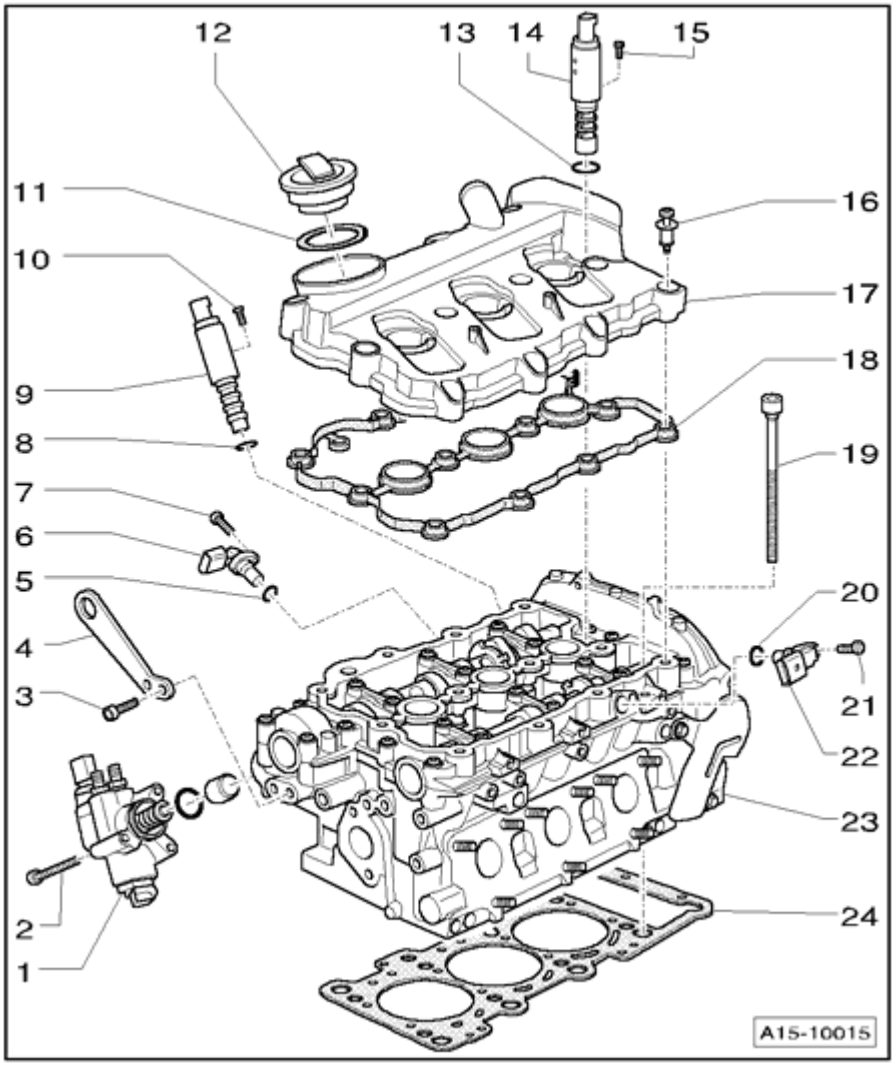

Fig. 361: Cylinder Head, Component Overview
Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - High pressure pump

- Removing and installing --> **24 - FUEL INJECTION SYSTEM**

2 - 9 Nm

3 - 20 Nm

4 - Lifting eye

5 - O-ring

- Replace

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6 - Camshaft position sensor, intake camshaft

- Cylinder bank 1 (right) Camshaft Position (CMP) Sensor G40
- Cylinder bank 2 (left) Camshaft Position (CMP) Sensor 2 G163

7 - 8 Nm plus an additional 90 ($^{1}/_{4}$ turn)

- Replace

8 - O-ring

- Replace

9 - Solenoid valve for camshaft adjustment - intake side

- Cylinder bank 1 (right) Camshaft Adjustment Valve 1 N205
- Cylinder bank 2 (left) Camshaft Adjustment Valve 2 N208

10 - 2.5 Nm

11 - Gasket

- Replace if damaged or leaking

12 - Cap

13 - O-ring

- Replace

14 - Solenoid valve for camshaft adjustment - exhaust side

- Cylinder bank 1 (right) Exhaust camshaft control valve 1 N318
- Cylinder bank 2 (left) Camshaft Adjustment Valve 2 (exhaust) N319

15 - 2.5 Nm

16 - Special bolt - 9 Nm

- Replace if damaged or leaking

17 - Cylinder head cover

18 - Cylinder head cover gasket

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- Replace if damaged or leaking

19 - Cylinder head bolt

- Replace
- Observe sequence for loosening --> *Follow sequence 1 to 8 when loosening cylinder head bolts.* under **Cylinder Head, Removing and Installing**
- Observe sequence for tightening --> *Tighten cylinder head in sequence indicated, in 3 stages as follows:* under **Cylinder Head, Removing and Installing**

20 - O-ring

- Replace

21 - 8 Nm plus an additional 90 ($^{1}/_{4}$ turn)

- Replace

22 - Camshaft position sensor, exhaust camshaft

- Cylinder bank 1 (right) Camshaft Position (CMP) Sensor 3 G300
- Cylinder bank 2 (left) Camshaft Position (CMP) Sensor 4 G301

23 - Cylinder Head

- Removing --> **Cylinder Head, Removing and Installing**
- Check for distortion --> **Checking cylinder head for distortion**
- Reworking dimension --> **Reworking dimension, cylinder head**
- Installing --> **Cylinder Head, Removing and Installing**

- After replacing, change coolant and engine oil

24 - Cylinder head gasket

- Replacing --> **Cylinder Head, Removing and Installing**.
- Installation position: Part Number, points to cylinder head
- After replacing, change coolant and engine oil

Checking cylinder head for distortion

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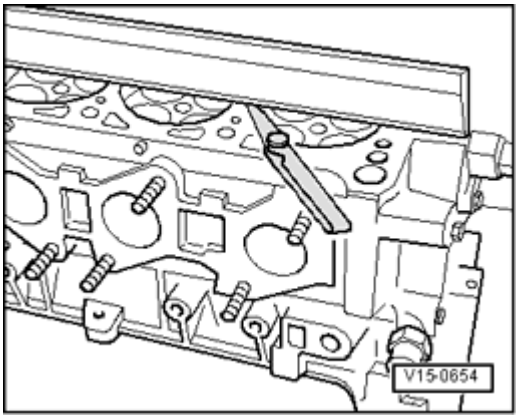

Fig. 362: Checking Cylinder Head For Distortion
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Check cylinder head at multiple points for distortion, using straight edge and feeler gauges.
- Max. distortion: 0.05 mm.

Reworking dimension, cylinder head

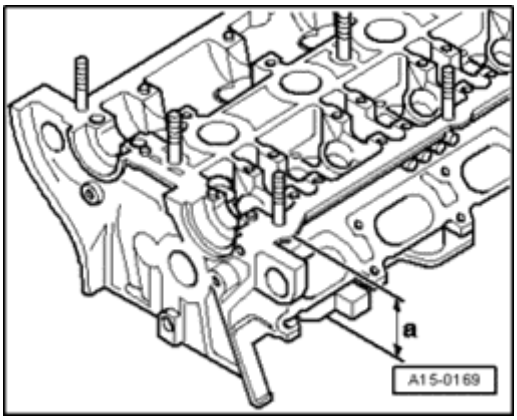

Fig. 363: Reworking Dimension, Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

Resurfacing cylinder head (face grinding) is only permissible to minimum dimension - **a** -.

- Minimum dimension - **a** - = 139.20 mm.

Left Cylinder Head Cover, Removing and Installing

Left Cylinder Head Cover, Removing and Installing

Special tools, testers and auxiliary items required

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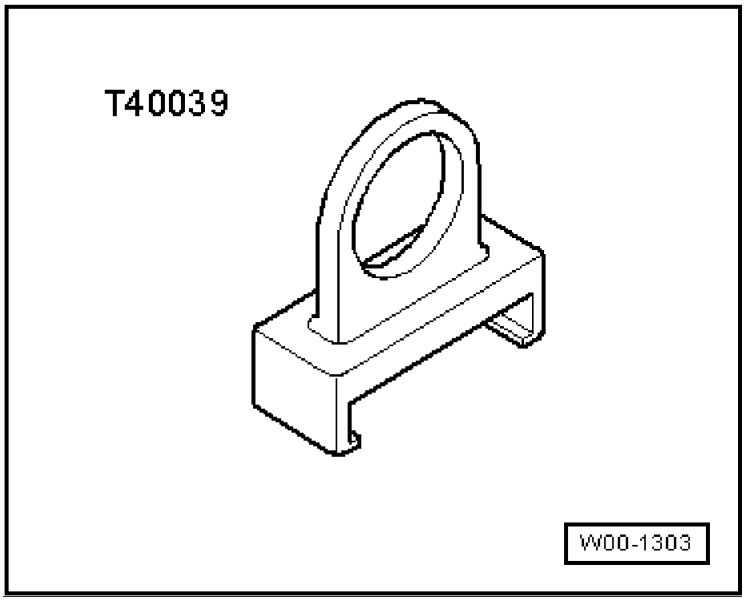

Fig. 364: Ignition Coil Puller T40039
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Ignition Coil Puller T40039

Removing

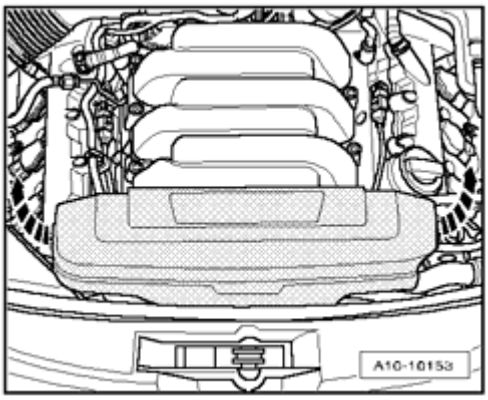

Fig. 365: Identifying Front Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove front engine cover - **arrows** -.

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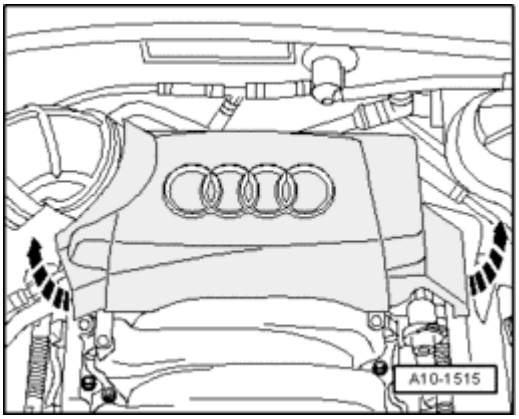

Fig. 366: Removing Rear Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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

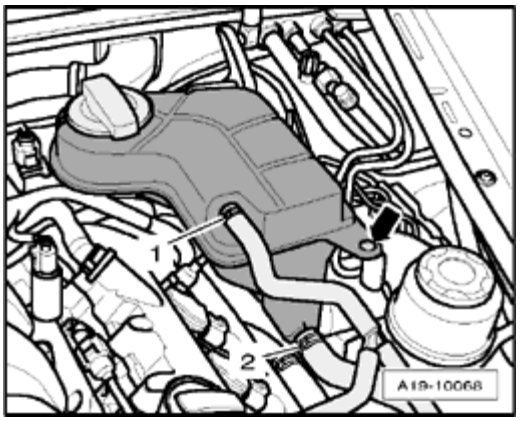

Fig. 367: Removing Coolant Hoses At Coolant Expansion Tank
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove coolant expansion tank - **arrow** -.
- Disconnect electrical connection from Engine Coolant Level (ECL) Warning Switch F66 at bottom of coolant reservoir and set aside coolant reservoir with coolant hoses - **1** - and - **2** - connected.

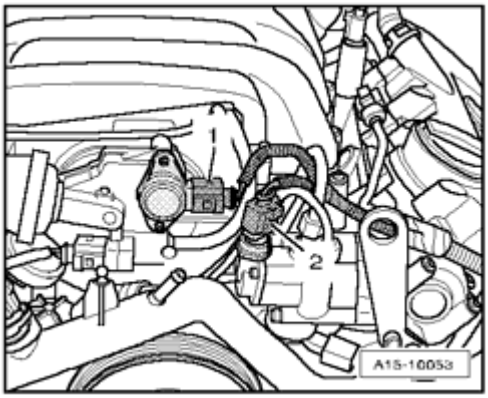

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Fig. 368: Disconnecting Electrical Harness Connectors
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical harness connectors.

1. Change-over valve for intake manifold flap N239
2. Intake Manifold Tuning (IMT) Valve Position Sensor G513

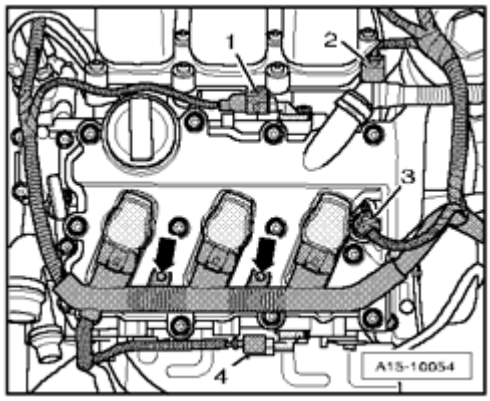

Fig. 369: Remove Bolts & Disconnecting Electrical Harness Connectors At Ignition Coils
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical harness connectors.

1. Camshaft position (CMP) sensor 2 G163
2. Camshaft Adjustment Valve 2 N208
3. Camshaft Adjustment Valve 2 (exhaust) N319
4. Camshaft position (CMP) sensor 4 G301

- Remove bolts - **arrows** - and disconnect electrical connections at the ignition coils.
- Set electrical wiring harness aside.

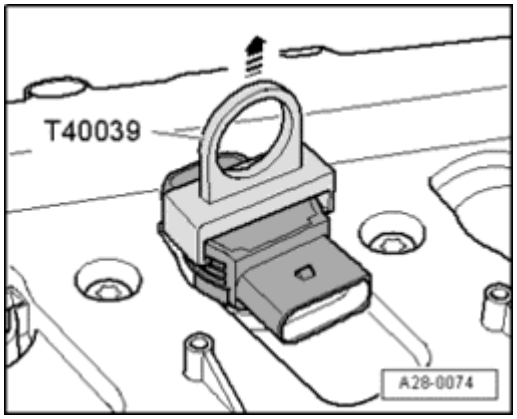

Fig. 370: Removing Ignition Coils Using Ignition Coil Puller T40039

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Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove ignition coils using ignition coil puller T40039.

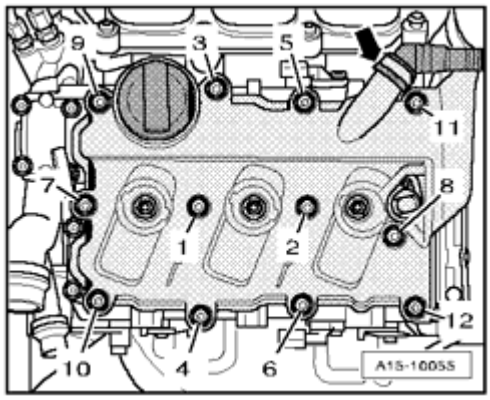

Fig. 371: Removing Left Cylinder Head Cover Bolts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove left cylinder head cover bolts in sequence - **12 to 1** -.

NOTE:

- **Disregard - arrow -.**

CAUTION: Crankcase ventilation must not be removed.

- Lay aside removed cylinder head cover with connected crankcase ventilation hose.

Installing

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

NOTE:

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

- Clean sealing surfaces so they are completely free of any oil or grease.
- Tighten cylinder head cover in sequence - **1 to 12** -.

Tightening specifications

Component	Nm
Cylinder head cover to cylinder head	9

Right Cylinder Head Cover, Removing and Installing

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Right Cylinder Head Cover, Removing and Installing

Special tools, testers and auxiliary items required

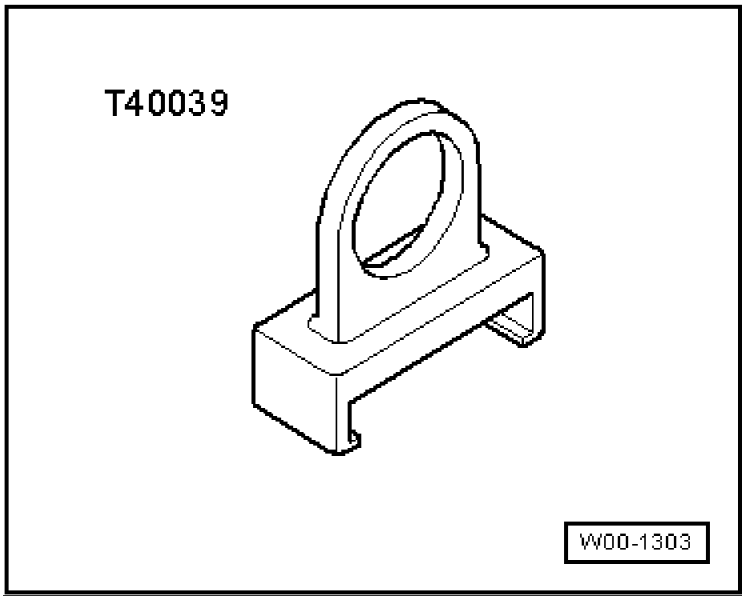

Fig. 372: Ignition Coil Puller T40039
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Ignition Coil Puller T40039

Removing

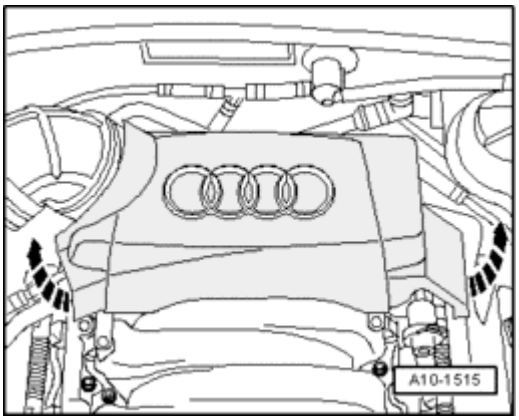

Fig. 373: Removing Rear Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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

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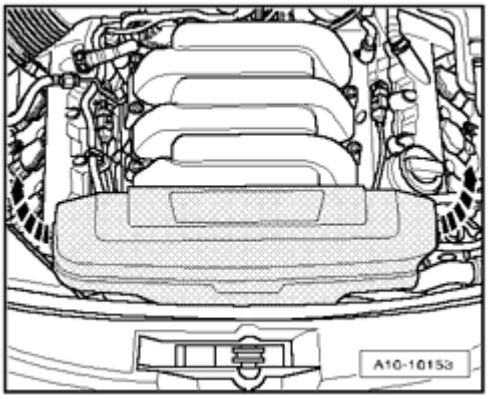

Fig. 374: Identifying Front Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove front engine cover - **arrows** -.

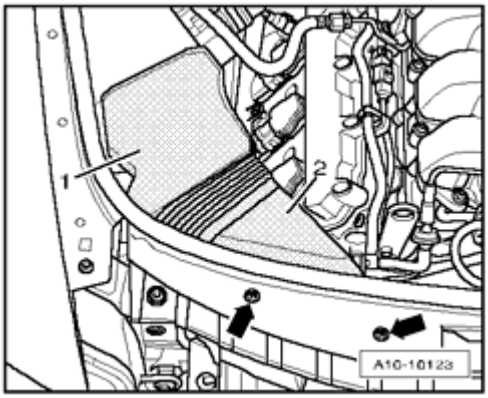

Fig. 375: Removing Air Duct Screws & Air Ducts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** -.
- Remove air duct - **1** - and - **2** -.

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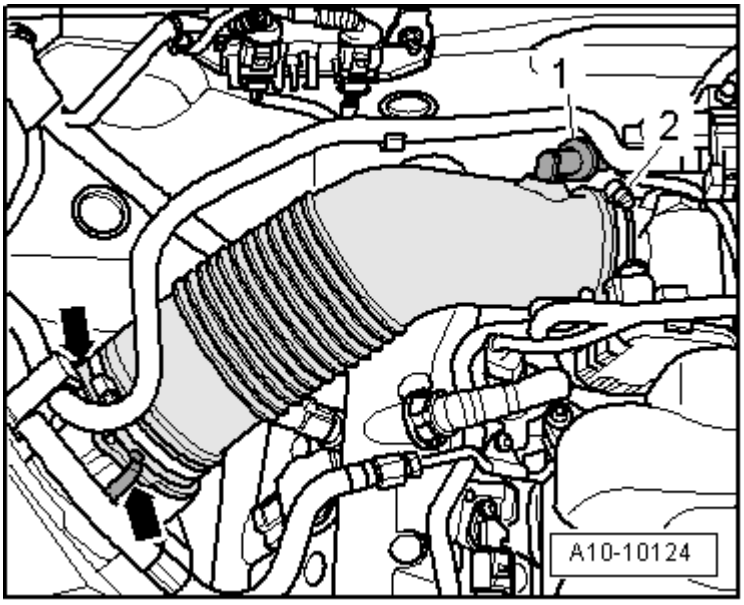

Fig. 376: Disconnecting Check Valve From Connection At Air Duct Hose & Removing Air Duct Hose
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect check valve - **1** - from air duct hose.
- Remove air duct hose, thereby loosening the hose clamp - **2** - and opening the clips - **arrows** -.

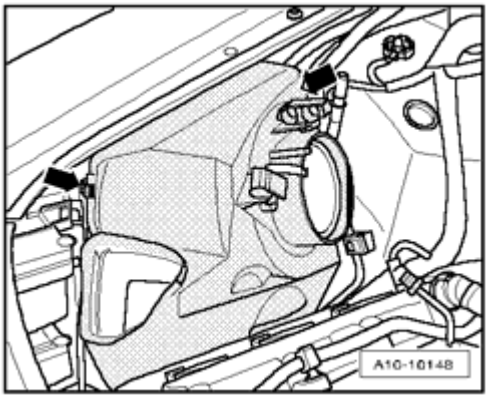

Fig. 377: Opening Clips And Removing Upper Part Of Air Filter Housing
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Open clips - **arrows** - and remove upper part of air filter housing.

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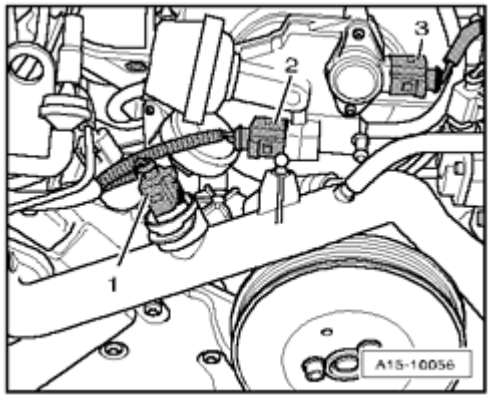

Fig. 378: Disconnecting Electrical Harness Connectors
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical harness connectors.

1. Engine Coolant Temperature (ECT) Sensor G62
2. Change-over valve for intake manifold flap N239

NOTE:

- **Ignore - 3 -.**

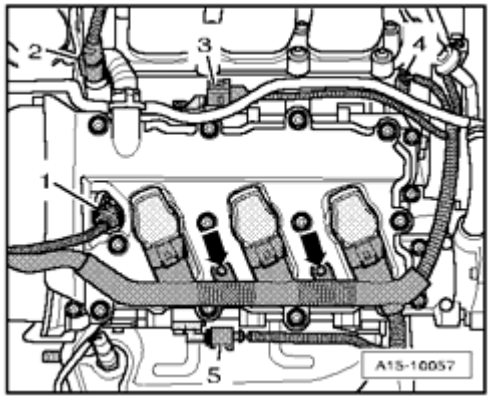

Fig. 379: Disconnecting Electrical Harness Connectors
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical harness connectors.

1 - Camshaft Adjustment Valve 1 (exhaust) N318

3 - Camshaft Position (CMP) sensor G40

4 - Intake Manifold Runner Position Sensor G336

5 - Camshaft position (CMP) sensor 3 G300

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NOTE:

- **Ignore - 2 -.**

- Remove bolts - **arrows** - and separate electrical connections at the ignition coils.
- Set electrical wiring harness aside.

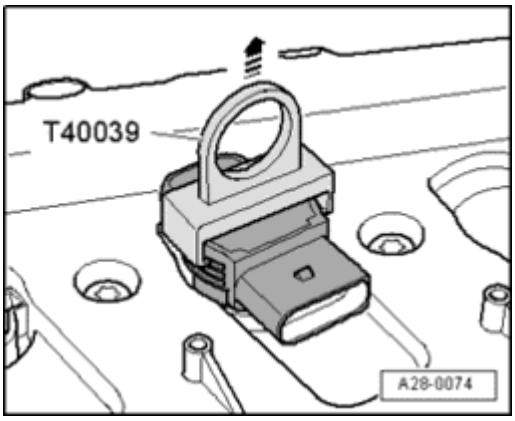

Fig. 380: Removing Ignition Coils Using Ignition Coil Puller T40039
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove ignition coils using ignition coil puller T40039.

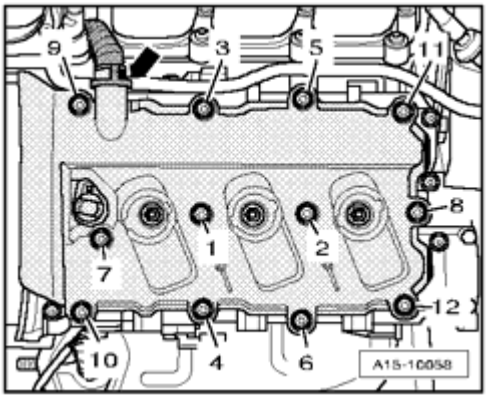

Fig. 381: Removing Crankshaft Housing Ventilation Hose & Right Cylinder Head Cover Bolts In Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove right cylinder head cover bolts in sequence - **12 to 1** -.

NOTE:

- **Disregard - arrow -.**

CAUTION: Crankcase ventilation must not be removed.

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- Lay aside removed cylinder head cover with connected crankcase ventilation hose.

Installing

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

NOTE:

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

- Clean sealing surfaces so they are completely free of any oil or grease.
- Tighten cylinder head cover in sequence - **1 to 12** -.

Tightening Specifications

Component	Nm
Cylinder head cover to cylinder head	9
Hose clamps 9 mm wide	3

Cylinder Head, Removing and Installing

Cylinder Head, Removing and Installing

Special tools, testers and auxiliary items required

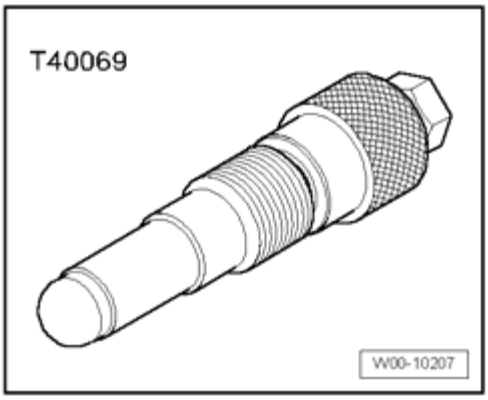

Fig. 382: Locking Pin T40069
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Locking pin T40069

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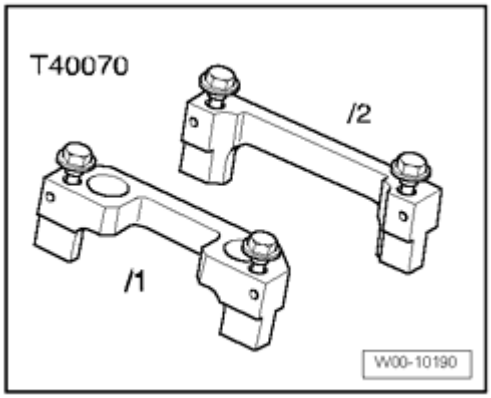

Fig. 383: Camshaft Locator T40070
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Camshaft locator T40070

Removing

- Engine installed.

NOTE:

- **The following removal and installation procedure is for the left cylinder head. The procedure for the other side is identical.**

CAUTION: Fuel system is under high pressure! Before opening high pressure components of the fuel injection system, pressure must be relieved to residual pressure --> Before Opening High Pressure Fuel Injection System. Then wrap a clean rag around the connection and relieve residual pressure by carefully loosening the connection.

- Drain coolant --> **Cooling System, Draining and Filling**.
- Remove front exhaust pipe: Left --> **Left Front Exhaust Pipe with Catalytic Converter, Removing and Installing** , right --> **Right Exhaust Pipe with Catalytic Converter, Removing and Installing** .
- Remove ribbed belt --> **Ribbed Belt, Removing and Installing**
- Remove front coolant pipe --> **Front Coolant Line, Removing and Installing**.
- Remove power steering pump --> **48 - STEERING** .

NOTE:

- **To remove the right cylinder head, the vacuum pump for brake booster must be removed --> Brake Booster Vacuum Pump, Removing and Installing.**

- Remove upper part of intake manifold --> **24 - FUEL INJECTION SYSTEM** .
- Remove intake manifold lower part --> **24 - FUEL INJECTION SYSTEM** .

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- Disconnect electrical harness connectors at fuel injectors.
- Remove oil filter housing --> **Oil Filter Housing, Removing and Installing** .

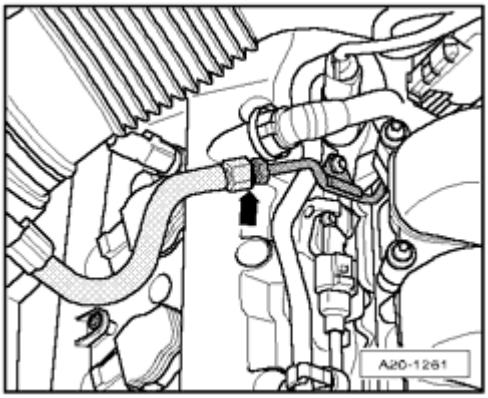

Fig. 384: Separating Fuel Line
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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

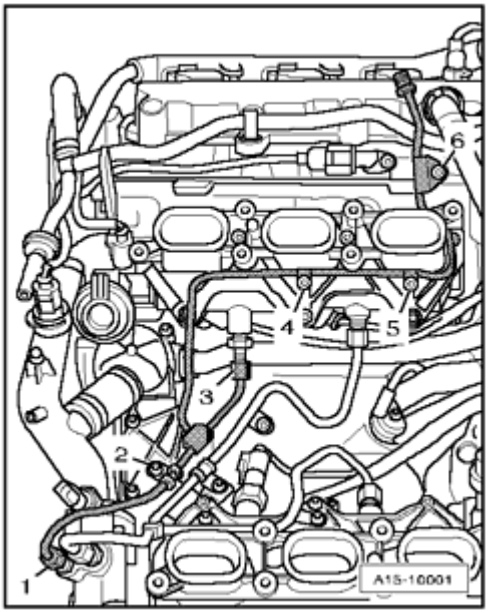

Fig. 385: Removing Low Pressure Line, Thereby Removing Bolts And Union Nuts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove low pressure line, thereby removing bolts and union nuts - **1 through 6** -.

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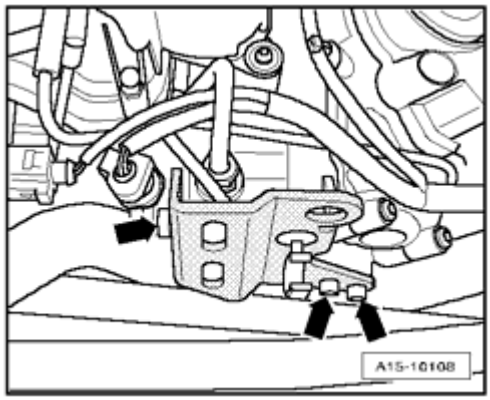

Fig. 386: Removing Large Lifting Eye
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- If equipped, unbolt large lifting eye - **arrows** -.

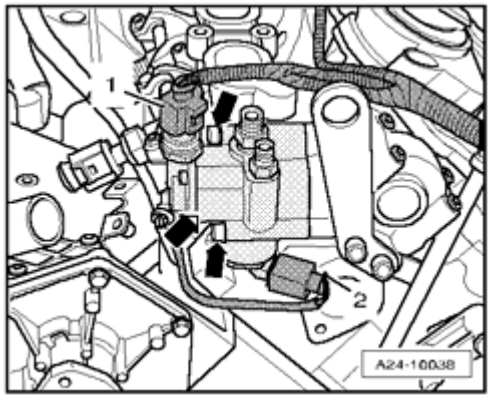

Fig. 387: Disconnecting Electrical Connectors & Removing High Pressure Pump From Left Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical connectors - **1** - and - **2** -.
- If necessary, remove high pressure pump from left cylinder head - **arrows** -.

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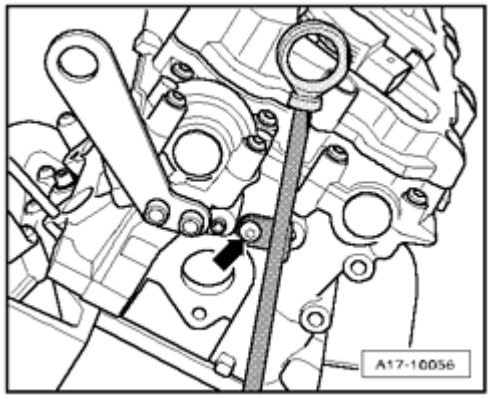

Fig. 388: Removing Bolt And Pulling Oil Dipstick Guide Tube Upward And Out
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolt - **arrow** - and pull oil dipstick guide tube upward and out.
- Remove cylinder head cover.
- Remove left and right timing chain covers --> **Timing Chain Covers, Removing and Installing** .
- Remove camshaft timing chains from camshafts --> **Timing Chains, Removing from Camshafts and Chain Tensioner, Removing and Installing** .

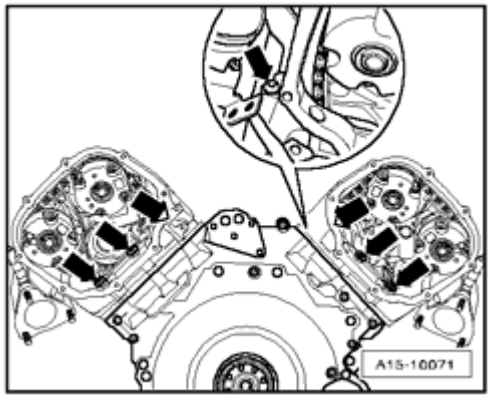

Fig. 389: Removing Bolts At Rear Of Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** - at rear of cylinder head.

- Left cylinder head: 3 bolts.
- Right cylinder head: 4 bolts.

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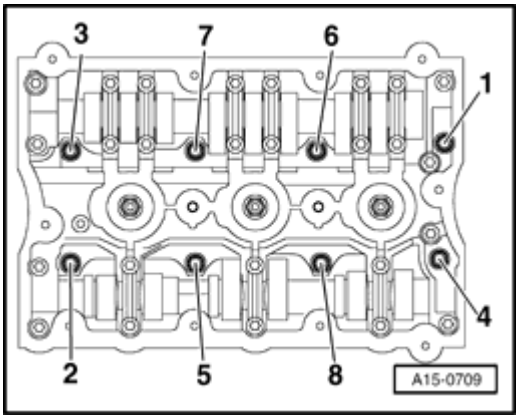

Fig. 390: Identifying Cylinder Head Bolts Loosening Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Follow sequence - **1 to 8** - when loosening cylinder head bolts.
- Carefully remove cylinder head.

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.**
- **Checking cylinder head for distortion --> Checking cylinder head for distortion.**
- **Only unpack new cylinder head gasket immediately prior to installation.**
- **Handle gasket carefully. Damage in silicon layer and recessed area lead to leakage.**
- **Install cylinder head gasket onto guide sleeves. Marking "oben" (top) or part number must face toward cylinder head.**
- **After installing a replacement cylinder head with camshafts installed, oil contact surfaces between roller cam followers and cam lubricating surfaces after installing cylinder head.**
- **Do not remove plastic bases protecting freed up valves until immediately before installing cylinder head.**
- **When replacing cylinder head or cylinder head seal, coolant and engine oil must be changed.**

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- **Secure all hose connections with hose clamps appropriate for the model .**
- **During installation, all cable ties must be re-installed at the same location.**
- **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.**

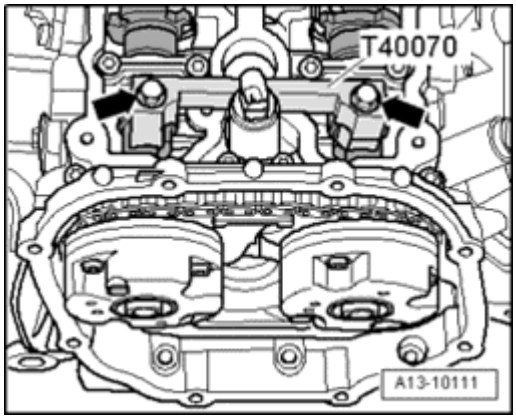

Fig. 391: Mounting Camshaft Locating Tool T40070 To Both Cylinder Heads And Tightening Bolts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Before installing cylinder head, set crankshaft and camshafts to TDC setting, mounting camshaft locating tool T40070 on both cylinder heads and tightening to 20 Nm.

- The camshaft locating tool T40070 is correctly positioned when the holes for the cylinder head bolts remain free.

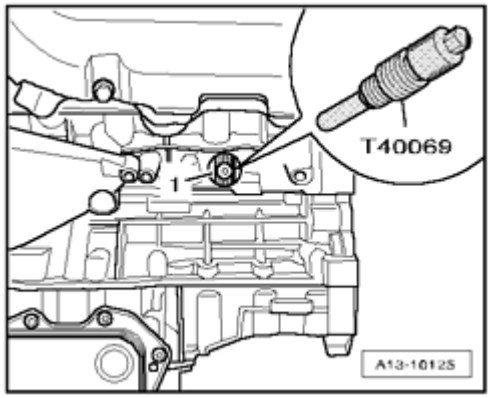

Fig. 392: Installing Crankshaft Holder T40069 Into Hole
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Crankshaft holder T40069 must be screwed into the crankshaft.

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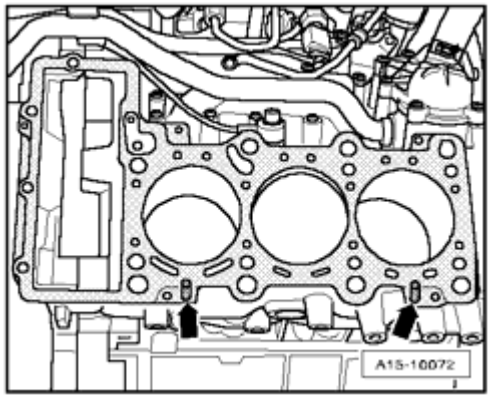

Fig. 393: Paying Close Attention To Centering Pins In Cylinder Block
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Position cylinder head gasket.

- Pay close attention to centering pins - **arrows** - in cylinder block.
- Pay attention to installation position of cylinder head gasket, marking "oben" (top) or part number must face toward cylinder head.

- Install cylinder head.

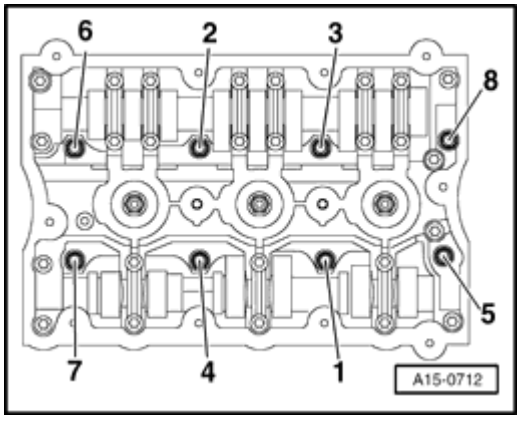

Fig. 394: Tightening Cylinder Head Bolts In Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Insert new cylinder head bolts and tighten by hand.
- Tighten cylinder head in sequence indicated, in 3 stages as follows:
- Using torque wrench, tighten to 40 Nm.
- With Torx key, 90 ($^{1}/_{4}$ turn) additional turn.
- With Torx key, 90 ($^{1}/_{4}$ turn) additional turn.

NOTE:

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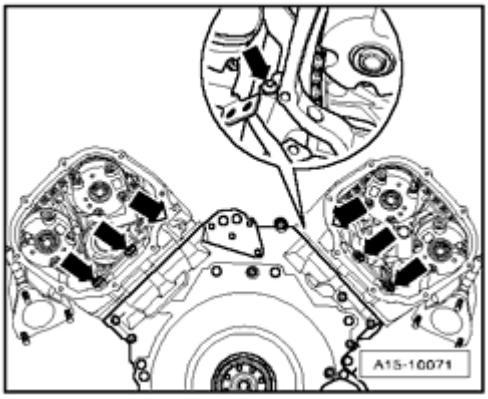

Fig. 395: Removing Bolts At Rear Of Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Tighten bolts - **arrows** - to 9 Nm.
  - Left cylinder head: 3 bolts.
  - Right cylinder head: 4 bolts.

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

- Install camshaft timing chains --> **Timing Chains, Removing from Camshafts and Chain Tensioner, Removing and Installing** .
- Install left and right timing chain covers --> **Timing Chain Covers, Removing and Installing** .
- Install cylinder head cover.
- Install high pressure pump --> **24 - FUEL INJECTION SYSTEM** .
- Install oil filter housing --> **Oil Filter Housing, Removing and Installing** .
- Install intake manifold lower-part with high and low-pressure lines --> **24 - FUEL INJECTION SYSTEM** .
- Install intake manifold upper-part --> **24 - FUEL INJECTION SYSTEM** .
- Install vacuum pump for brake booster --> **Brake Booster Vacuum Pump, Removing and Installing**.
- Install power steering pump --> **48 - STEERING** .
- Install front coolant pipe --> **Front Coolant Line, Removing and Installing**.
- Install ribbed belt --> **Ribbed Belt, Removing and Installing** .
- Install front exhaust pipe with catalytic converter: Left --> **Left Front Exhaust Pipe with Catalytic Converter, Removing and Installing** ; right --> **Right Exhaust Pipe with Catalytic Converter, Removing and Installing** .
- Align exhaust system --> **Exhaust System, Installing**.
- Replace engine oil --> **01 - MAINTENANCE** .
- Replace coolant --> **Cooling System, Draining and Filling**.
- Fill power-steering system oil and bleed steering system --> **48 - STEERING** .

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Component	Nm
Oil dip stick guide tube to cylinder head	9
Fuel hose to fuel line	22

Brake Booster Vacuum Pump, Removing and Installing

Brake Booster Vacuum Pump, Removing and Installing

Removing

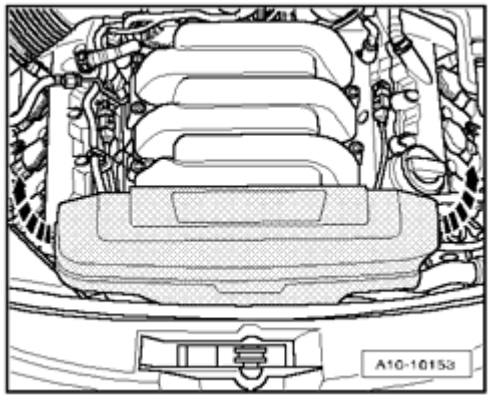

Fig. 396: Identifying Front Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove front engine cover - **arrows** -.

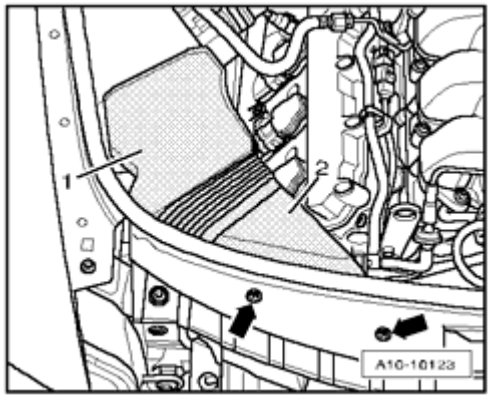

Fig. 397: Removing Air Duct Screws & Air Ducts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** -.
- Remove air duct - **1** - and - **2** -.

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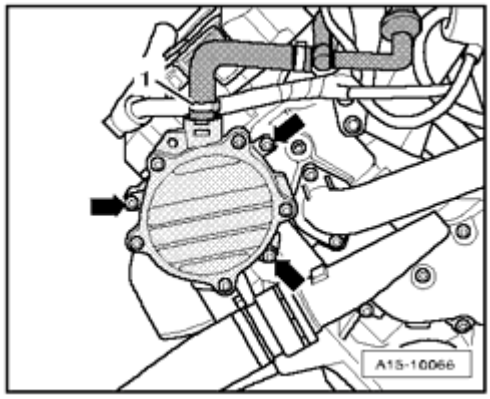

Fig. 398: Disconnecting Vacuum Hose At Vacuum Pump
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose - **1** - at vacuum pump.
- Remove bolts - **arrows** - and remove vacuum pump.

Installing

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

NOTE:

- **Replace O-rings.**
- **Secure all hose connections with hose clamps appropriate for the model .**

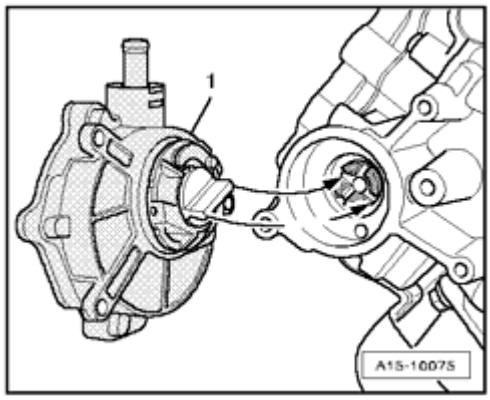

Fig. 399: Positioning Vacuum Pump Coupling So That It Engages Symmetrical Groove Of Camshaft When Installing Vacuum Pump
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Position vacuum pump coupling - **1** - so that it engages the symmetrical groove of the camshaft - **arrows** - when installing vacuum pump.

Tightening specifications

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Component	Nm
Vacuum pump to cylinder head	9

Compression, Checking

Compression, Checking

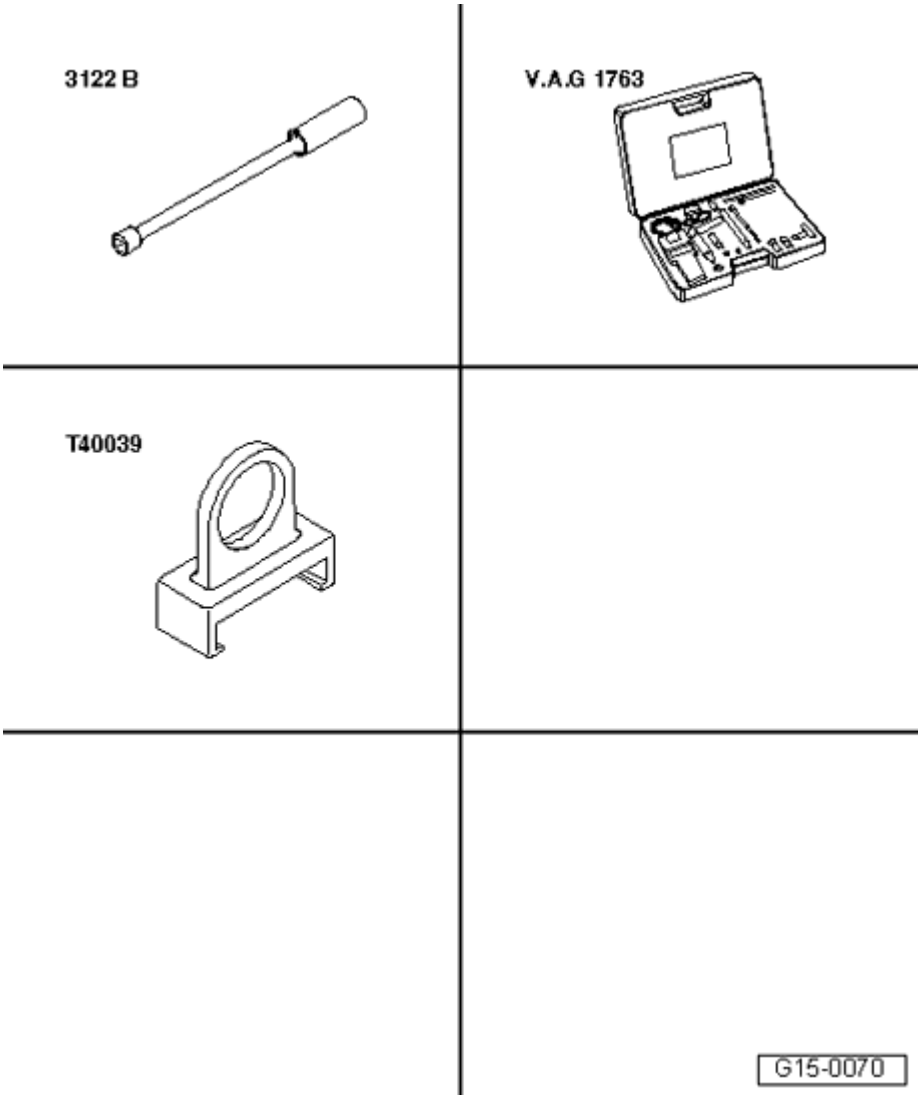

Fig. 400: Identifying Special Tools - Compression, Checking
Courtesy of VOLKSWAGEN UNITED STATES, INC.

Special tools, testers and auxiliary items required

- Spark plug removal tool 3122 B
- Compression tester V.A.G 1763
- Ignition Coil Puller T40039

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Procedure

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

- Switch off ignition.

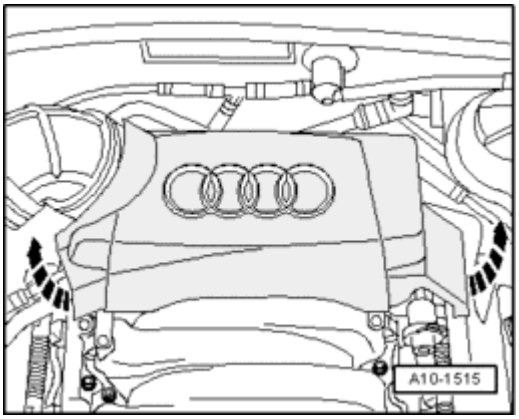

Fig. 401: Removing Rear Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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

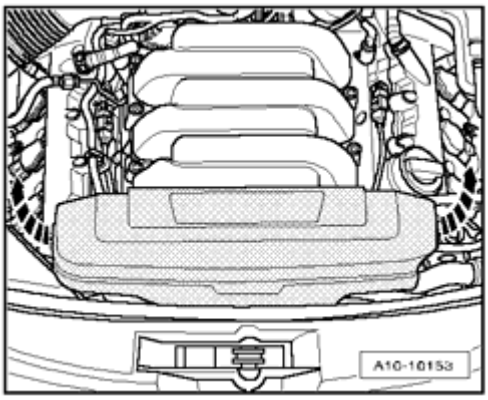

Fig. 402: Identifying Front Engine Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove front engine cover - **arrows** -.

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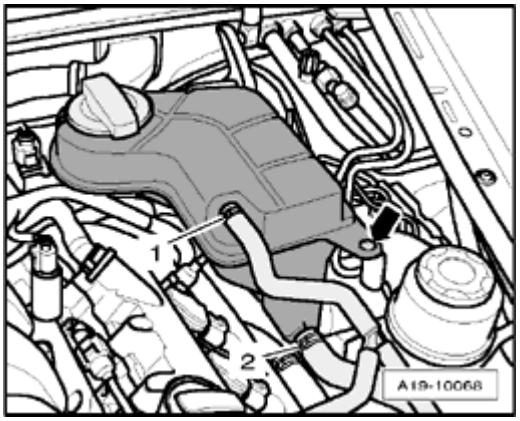

Fig. 403: Removing Coolant Hoses At Coolant Expansion Tank
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove coolant expansion tank - **arrow** -.
- Disconnect electrical connection from Engine Coolant Level (ECL) Warning Switch F66 at bottom of coolant reservoir and set aside coolant reservoir with coolant hoses - **1** - and - **2** - connected.

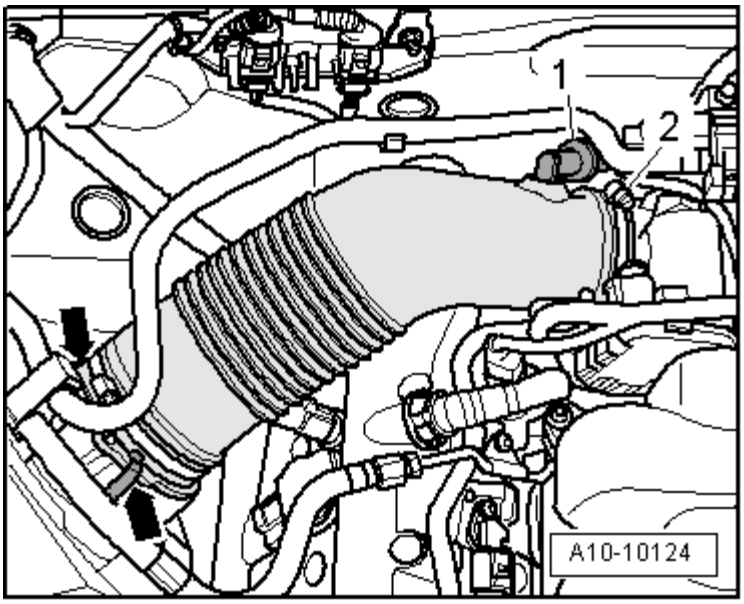

Fig. 404: Disconnecting Check Valve From Connection At Air Duct Hose & Removing Air Duct Hose
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect check valve - **1** - from connection at air duct hose.
- Remove air duct hose, thereby loosening the hose clamp - **2** - and opening clips - **arrows** -.

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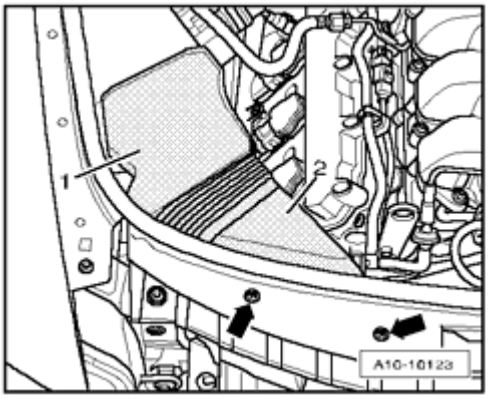

Fig. 405: Removing Air Duct Screws & Air Ducts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** -.
- Remove air duct - **1** - and - **2** -.

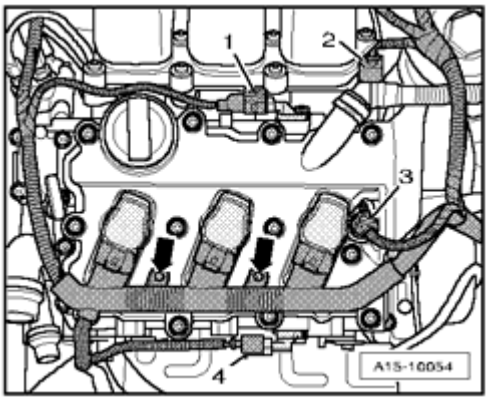

Fig. 406: Remove Bolts & Disconnecting Electrical Harness Connectors At Ignition Coils
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** - and separate the electrical connections at the ignition coils of left cylinder head.

NOTE:

- **Ignore - 1 to 4 -.**

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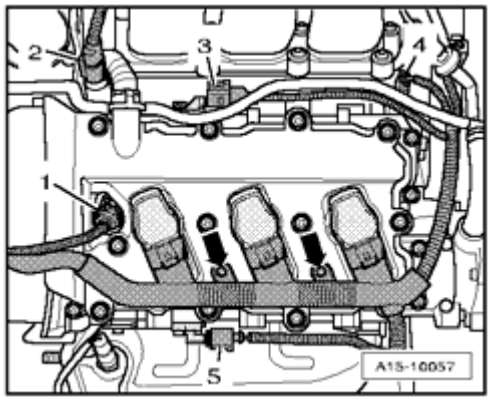

Fig. 407: Disconnecting Electrical Harness Connectors
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** - and disconnect electrical connections at the ignition coils of right cylinder head.

NOTE:

- **Ignore items - 1 to 5 -.**

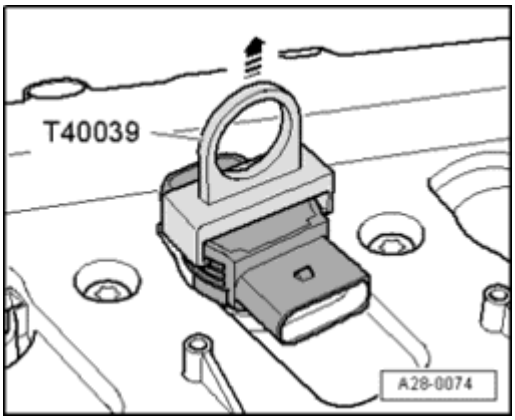

Fig. 408: Removing Ignition Coils Using Ignition Coil Puller T40039
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove ignition coils using ignition coil puller T40039.

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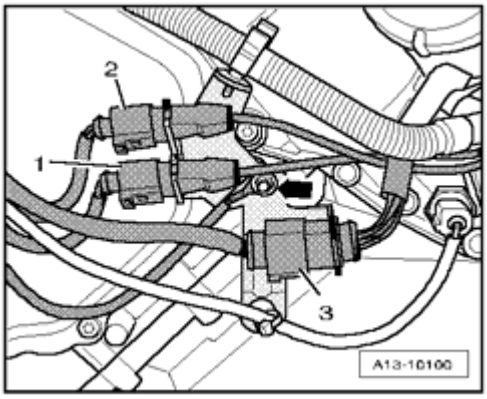

Fig. 409: Disconnecting Electrical Harness Connectors
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- On rear of left cylinder head, disconnect electrical harness connector - **3** - for fuel injectors.

NOTE:

- **Ignore - 1 - , - 2 - and - arrow -.**

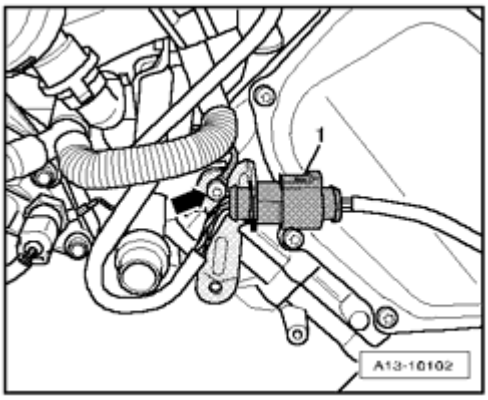

Fig. 410: Disconnecting Electrical Connector & Removing Bolt & Retainer For Connection
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- On rear of right cylinder head, disconnect electrical harness connector - **1** - for fuel injectors.

NOTE:

- **Disregard - arrow -.**

- Using spark plug removal tool 3122 B , remove spark plugs.
- Check compression using compression tester V.A.G 1763.

NOTE:

- **Using tester --> operating instructions.**

- Have a second technician press accelerator pedal completely and at the same time operate starter long enough until pressure increase no longer appears on tester.

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Compression pressure	Bar pressure
New	11.0 to 14.0
Wear limit	10.0
Difference between cylinders	max. 3.0

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

- Install spark plugs --> **01 - MAINTENANCE** .
- Finally, check DTC memory and, if necessary, erase it. After DTC memory is erased, a readiness code must be generated for the engine control module using operating mode "Guided Fault-Finding".

Tightening specifications

Component	Nm
Hose clamps 9 mm wide	3

VALVETRAIN, SERVICING

Valvetrain, Servicing

--> **Valvetrain, Component Overview**

--> **Camshafts, Checking Axial Clearance**

--> **Camshafts, Removing and Installing**

--> **Valve Stem Seals, Cylinder Head Installed, Replacing**

--> **Valve Stem Seals, Cylinder Head Removed, Replacing**

--> **Hydraulic Adjusting Elements, Checking**

--> **Valve Dimensions**

--> **Valves, Checking**

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 approximately 30 minutes. The hydraulic adjusting elements must seat themselves (otherwise the valves will seat themselves on the pistons).**
- **After working on the valvetrain, carefully rotate engine by hand at least 2**

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full revolutions to ensure that valves do not strike the pistons when starting.

- **Left cylinder head is shown in Fig. 411.**

Valvetrain, Component Overview

Valvetrain, Component Overview

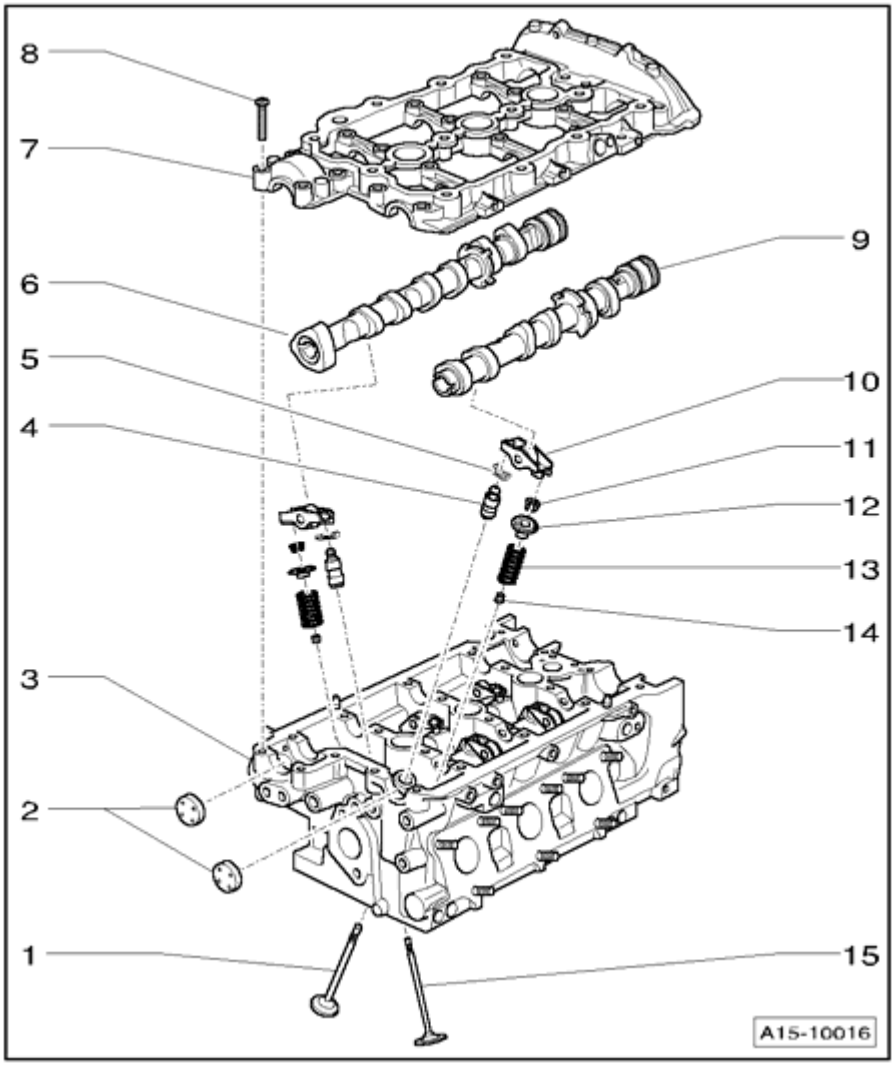

Fig. 411: Valvetrain, Component Overview
Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - Exhaust valve

- Different versions
- Do not rework, only lapping is permitted

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- Valve dimensions --> **Valve Dimensions**
- Check valve guides --> **Valve Guides, Checking**

2 - Sealing plug

- Install with sealant; sealant

3 - Cylinder Head

- Check valve guides --> **Valve Guides, Checking**

4 - Hydraulic adjusting element

- Checking --> **Hydraulic Adjusting Elements, Checking**
- Do not interchange
- Lubricate contact surface

5 - Securing clip

- Check for secure seat

6 - Intake camshaft

- Checking axial play --> **Camshafts, Checking Axial Clearance**
- Removing and installing --> **Camshafts, Removing and Installing**
- Check radial clearance using Plastigage (roller rocker lever removed)
- Radial clearance at bearing-dia. 24 mm: 0.024 to 0.066 mm
- Radial clearance at bearing-dia. 36 mm: 0.032 to 0.078 mm
- Run-out: max. 0.04 mm

7 - Bearing bracket

- With integrated camshaft bearings
- Removing and installing --> **Camshafts, Removing and Installing**

8 - 8 Nm plus an additional 90 ($^{1}/_{4}$ turn)

- Replace

9 - Exhaust camshaft

- Checking axial play --> **Camshafts, Checking Axial Clearance**

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- Removing and installing --> **Camshafts, Removing and Installing**
- Check radial clearance using Plastigage (roller rocker lever removed)
- Radial clearance at bearing-dia. 24 mm: 0.024 to 0.066 mm
- Radial clearance at bearing-dia. 36 mm: 0.032 to 0.078 mm
- Run-out: max. 0.04 mm

10 - Roller rocker lever

- Do not interchange
- Check roller for easy movement
- Lubricate contact surface

11 - Valve keys

12 - Valve spring plate

13 - Valve spring

- Installation position: The tight spring coils face toward cylinder head

14 - Valve stem seal

- Replacing, Cylinder Head Installed --> **Valve Stem Seals, Cylinder Head Installed, Replacing**
- Replacing, Cylinder Head Removed --> **Valve Stem Seals, Cylinder Head Removed, Replacing**

15 - Intake valve

- Do not rework, only lapping is permitted
- Mark installed position for re-installation
- Valve dimensions --> **Valve Dimensions**
- Check valve guides --> **Valve Guides, Checking**

Camshafts, Checking Axial Clearance

Camshafts, Checking Axial Clearance

Special tools, testers and auxiliary items required

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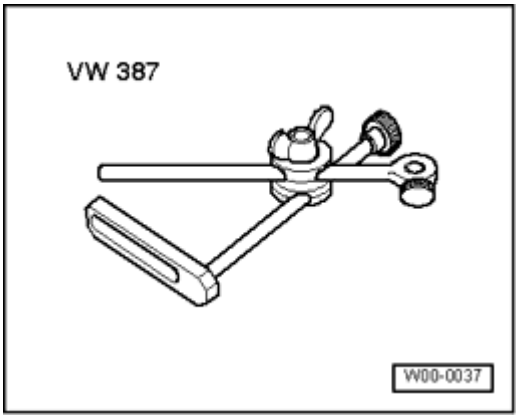

Fig. 412: Dial Gauge Holder VW 387
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Dial gauge holder VW 387
- Dial gauge VAS 6080

Procedure

- Perform measurement with roller rocker levers and hydraulic adjusting elements removed.

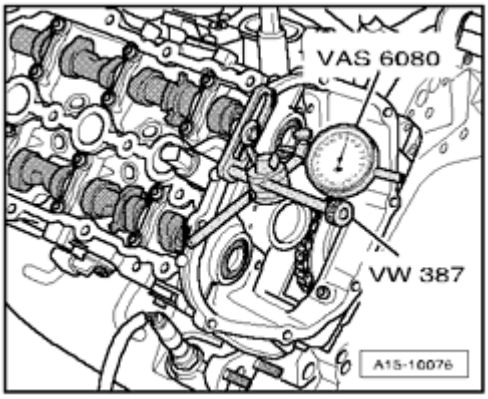

Fig. 413: Securing Dial Gauge Holder VW 387 To Dial Gauge VAS 6080 On Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Secure dial gauge holder VW 387 to dial gauge VAS 6080 on cylinder head.
- Determine axial clearance.

- Axial clearance: 0.100 to 0.191 mm.

Camshafts, Removing and Installing

Camshafts, Removing and Installing

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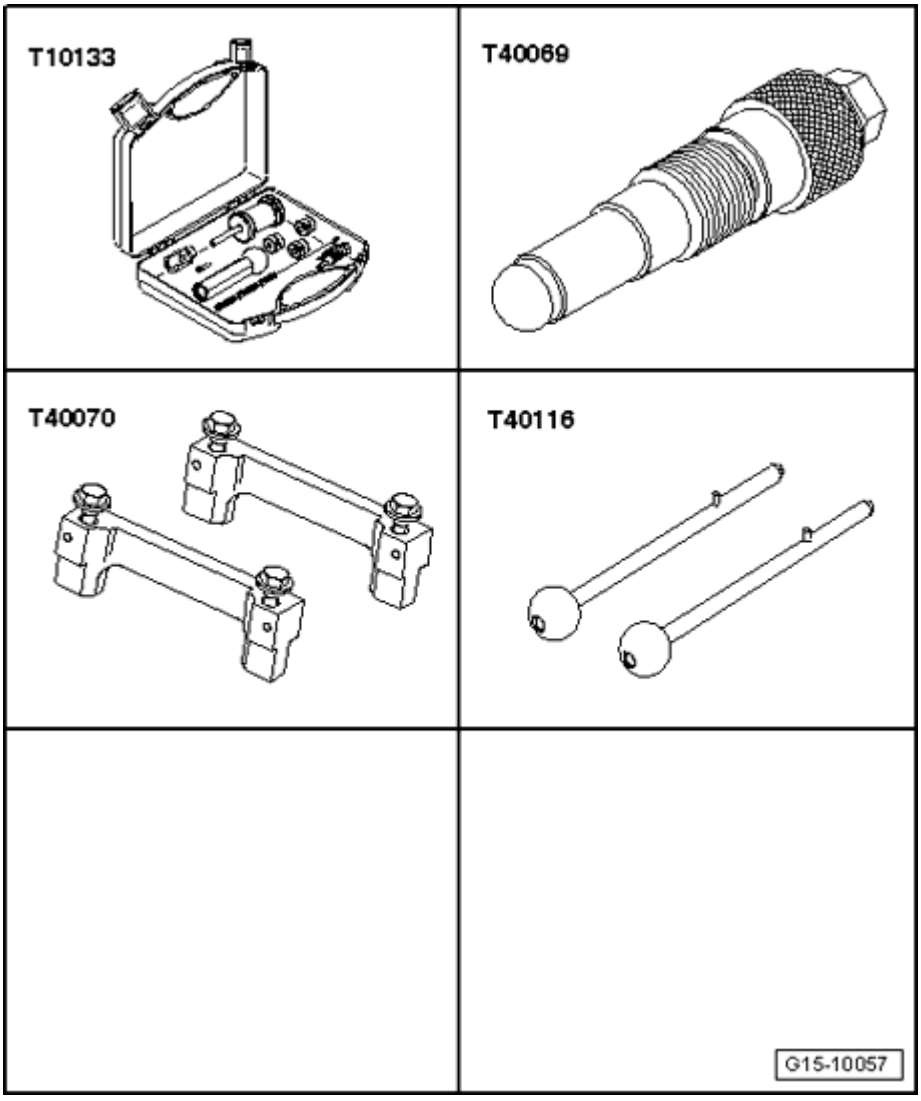

Fig. 414: Identifying Special Tools - Camshafts, Removing And Installing
Courtesy of VOLKSWAGEN UNITED STATES, INC.

Special tools, testers and auxiliary items required

- Impact puller T10133/3 from the tool set T10133
- Locking pin T40069
- Camshaft locator T40070 (qty. 2)
- Securing pins 1 set = qty. 2 T40116

- Hand drill with plastic brush attachment
- Protective glasses
- Sealant

Removing

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- Remove cylinder head cover.
- Remove left and right timing chain covers --> **Timing Chain Covers, Removing and Installing** .
- Remove camshaft timing chains from camshafts --> **Timing Chains, Removing from Camshafts and Chain Tensioner, Removing and Installing** .
- To remove right camshafts, the vacuum pump for brake booster must be removed --> **Brake Booster Vacuum Pump, Removing and Installing**.

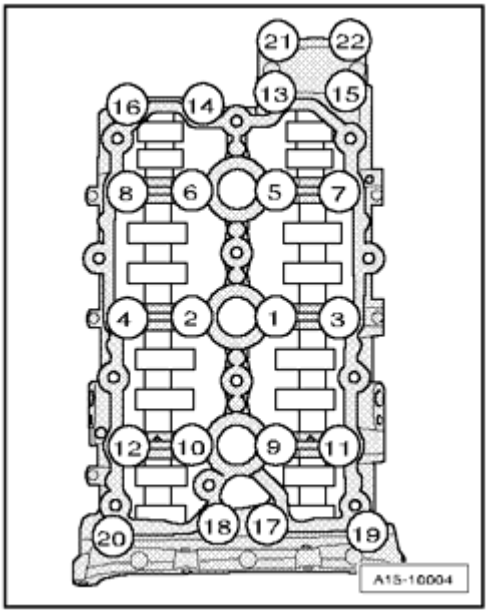

Fig. 415: Loosening/Tightening Guide Frame Bolts In Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Loosen guide frame bolts in sequence - **22 to 1** -.

NOTE:

- **Bearing bracket of left cylinder head is displayed in illustration.**

- Carefully remove guide frame.
- Mark camshafts and remove.

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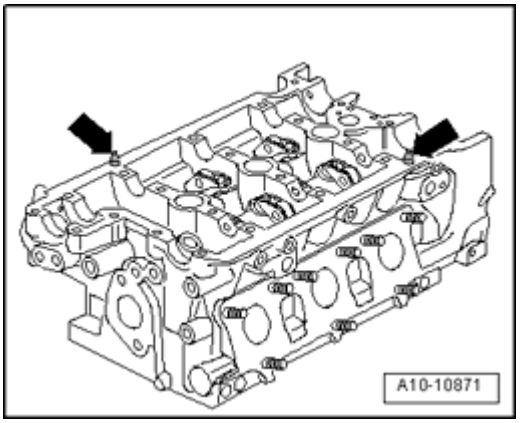

Fig. 416: Identifying Alignment Pins
Courtesy of VOLKSWAGEN UNITED STATES, INC.

NOTE:

- **Since the securing pins T40116 cannot be used during installation, the alignment pins - arrows - on an engine with alignment pins must be driven out with a cotter pin driver.**

Installing

NOTE:

- **Always replace gaskets and seals.**

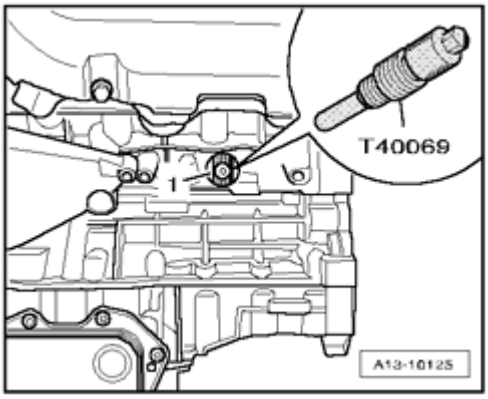

Fig. 417: Installing Crankshaft Holder T40069 Into Hole
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Secure crankshaft - **1** - using crankshaft holder T40069.

CAUTION: Wear safety glasses.

  - Using rotating plastic brush, remove any remaining sealant from cylinder head and guide frame.

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CAUTION: Make sure that no sealant residue enters the cylinder head and bearings.

- Clean sealing surfaces, they must be free of oil and grease.
- Oil journal surfaces of camshafts.
- Place guide frame onto a soft surface on the workbench.

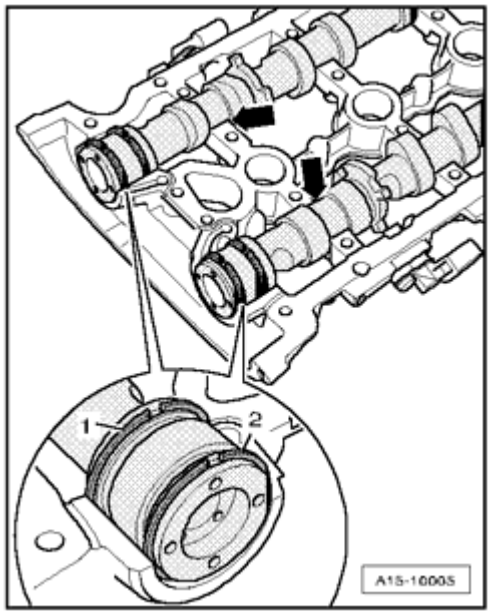

Fig. 418: Setting Camshafts Into Guide Frame
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Set camshafts into guide frame.

- The placement of the camshafts must be exactly within the axial bearings - **arrows** - of the guide frame.
- The ends of the piston rings - **1** - and - **2** - must face upward or downward, and must never face sideways.

- Turn over the guide frame with installed camshafts, thereby holding the camshafts tight within the guide frame.

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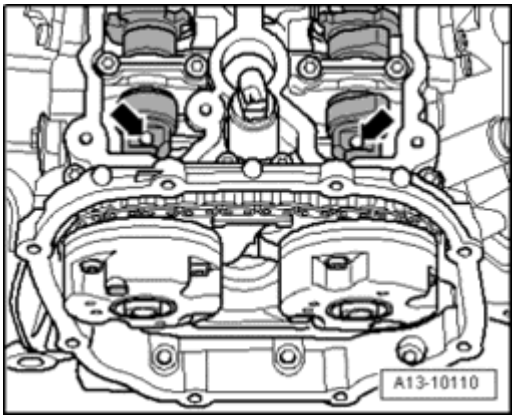

Fig. 419: Identifying Threaded Holes In Camshafts Must Face Upward
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Rotate camshafts until threaded holes - **arrows** - point upward.
- Check whether camshafts still lie exactly in axial bearings of guide frame.

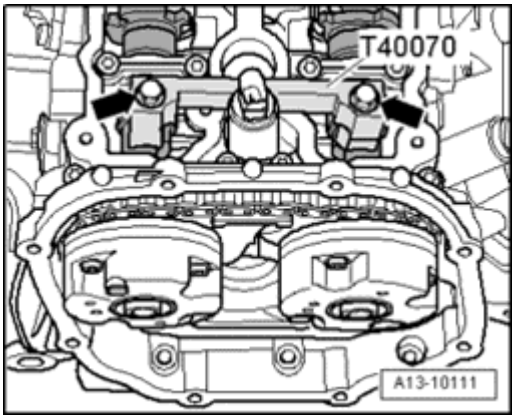

Fig. 420: Mounting Camshaft Locating Tool T40070 To Both Cylinder Heads And Tightening Bolts
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Mount camshaft locating tool T40070 as shown in the illustration and tighten the bolts - **arrows** - to 20 Nm.

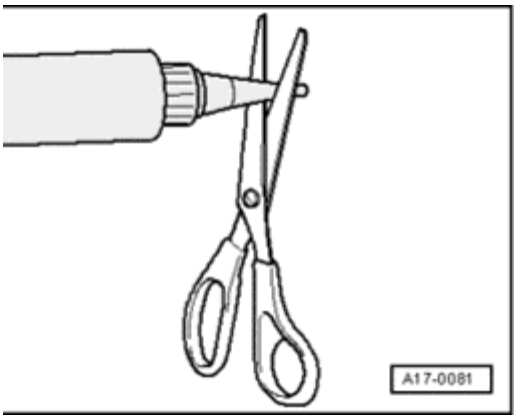

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Fig. 421: Cutting Tube Nozzle At Front Marking
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Cut tube nozzle at front marking (diameter of nozzle approximately 1 mm).
- Turn around guide frame again.

Vehicles through approximately 08.2004:

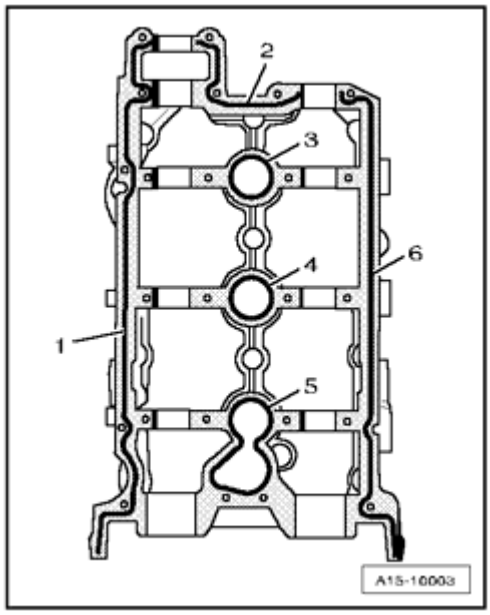

Fig. 422: Applying Sealant Beads On Clean Sealing Surfaces Of Guide Frame
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Apply sealant beads - **1 through 6** - on clean sealing surfaces of guide frame as shown in illustration.

- The grooves of sealing surface must be completely filled with sealant.
- Sealant beads must be 1.5 to 2.0 mm above the sealing surface.

NOTE:

- **Sealant beads must be applied according to exact specifications, otherwise excess sealant could get into the camshaft bearings.**

Vehicles from approximately 08:2004:

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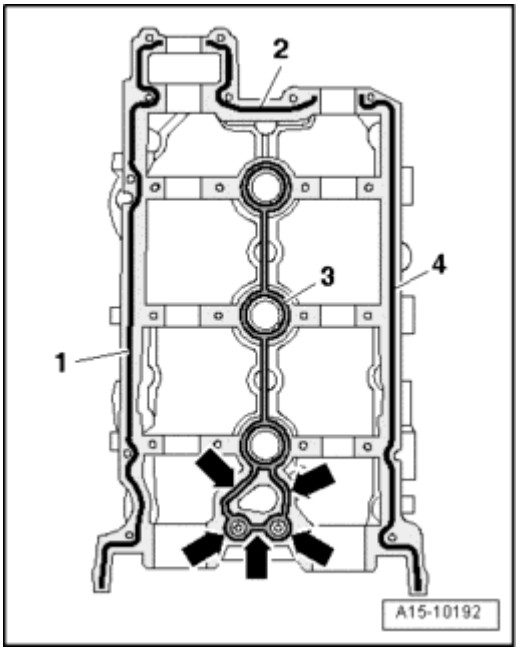

Fig. 423: Applying Small Quantity Of Sealant In Seal Groove In Area Of Camshaft Adjuster Solenoid Valve Opening
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Apply a small quantity of sealant in the seal groove - **3** - in the area of the camshaft adjuster solenoid valve opening - **arrows** -.
- Press seal into guide frame and wipe off escaping sealant on seal and guide frame.
- Apply sealant beads - **1** - , - **2** - and - **4** - on clean sealing surfaces of guide frame as shown in illustration.

- Thickness of sealant bead: 1.0 mm.

NOTE:

- **Sealant beads must be applied according to exact specifications, otherwise excess sealant could get into the camshaft bearings.**

All:

NOTE:

- **Because the sealant begins hardening immediately, guide frame must be promptly positioned and tightened.**

- Place guide frame on cylinder head.

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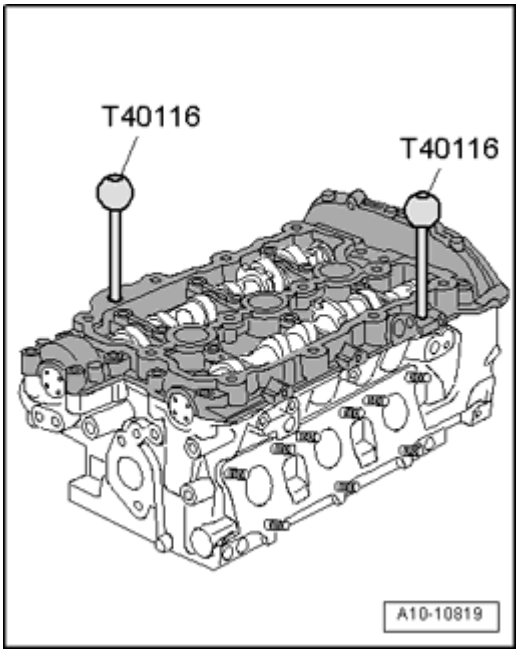

Fig. 424: Inserting locating pins T40116 in guide frame and cylinder head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Insert locating pins T40116 in guide frame and cylinder head.

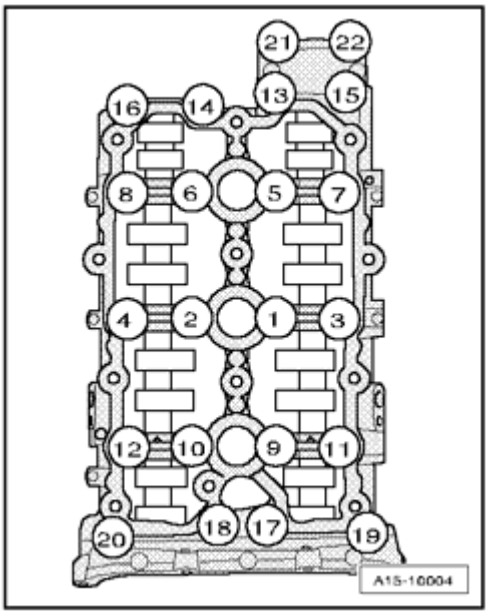

Fig. 425: Loosening/Tightening Guide Frame Bolts In Sequence
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Attach guide frame on cylinder head immediately.
- Hand-tighten guide frame bolts equally, in sequence - **1 to 22** -.

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- The guide frame must be in contact with the entire contact surface of the cylinder head.

- Fasten guide frame bolts in sequence - **22 to 1** - until they stop.

NOTE:

- **Bearing bracket of left cylinder head is displayed in illustration.**
- **After installing guide frame, sealant must dry for approximately 30 minutes.**

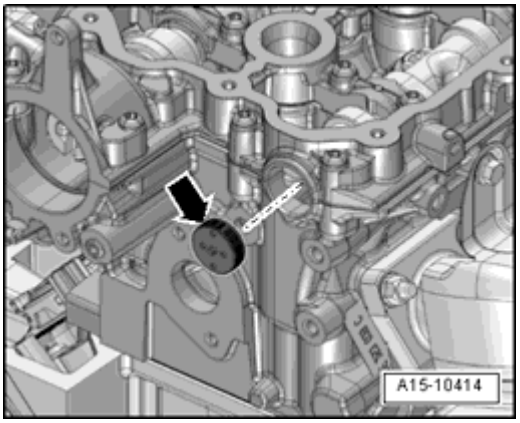

Fig. 426: Identifying Sealing Plug
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Clean sealing plug hole in the cylinder head. It must be free of oil and grease.
- Coat outer circumference of the sealing plug - **arrow** - with sealant; sealant
- Drive in sealing plugs until they are flush.

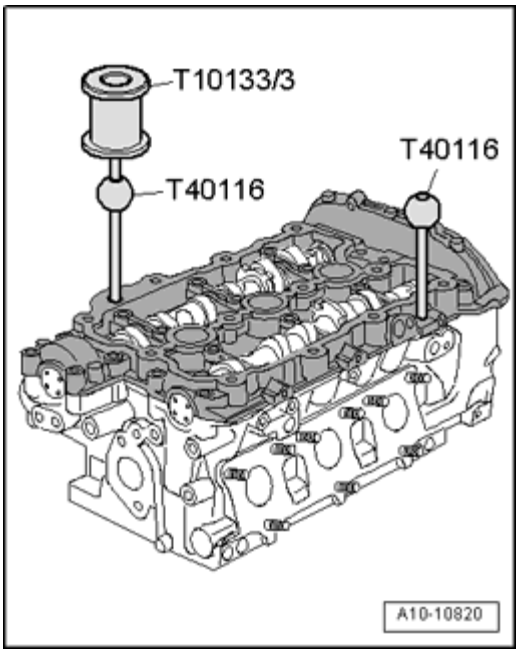

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Fig. 427: Removing Locating Pins T40116 With Impact Puller T10133/3
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove locating pins T40116 with impact puller T10133/3.

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

NOTE:

- **After installing the camshafts, the engine may not be started for approximately 30 minutes. The hydraulic adjusting elements must seat themselves (otherwise the valves will seat themselves on 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.**

- Install vacuum pump for brake booster --> **Brake Booster Vacuum Pump, Removing and Installing**.
- Install camshaft timing chains --> **Timing Chains, Removing from Camshafts and Chain Tensioner, Removing and Installing** .
- Install left and right timing chain covers --> **Timing Chain Covers, Removing and Installing** .
- Install cylinder head cover.

Tightening specifications

Component	Nm
Bearing bracket to cylinder head	8 + 90° 1)2)
1) Replace bolts. 2) 90° corresponds to a quarter turn.	

Valve Stem Seals, Cylinder Head Installed, Replacing

Valve Stem Seals, Cylinder Head Installed, Replacing

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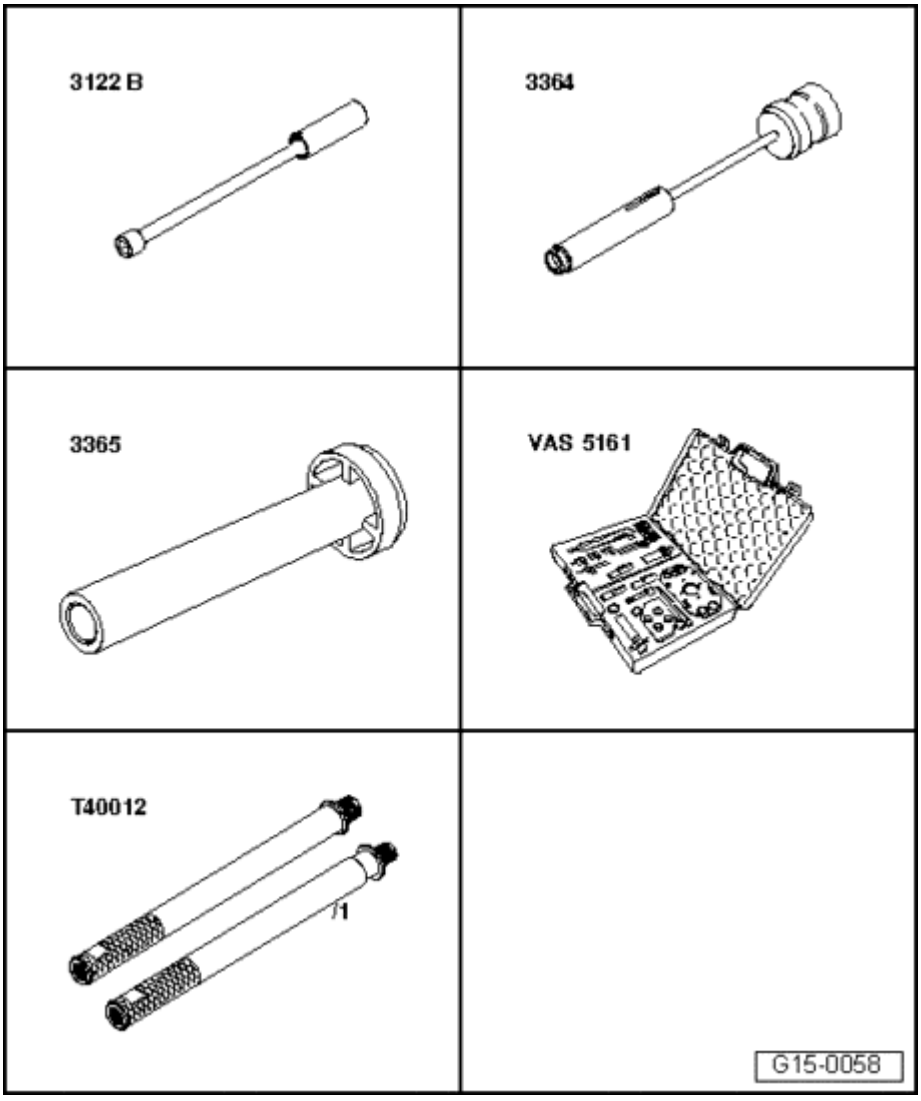

Fig. 428: Identifying Special Tools - Valve Stem Seals, Cylinder Head Installed, Replacing
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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 with guide plate VAS 5161/19 A
- Adapter T40012

Procedure

- Remove camshafts --> **Camshafts, Removing and Installing**.

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- Mark the positioning of the roller rocker lever and hydraulic adjusting elements for re-installation.
- Remove roller rocker lever together with the hydraulic adjusting elements and place them on a clean surface.
- Using spark plug removal tool 3122 B , remove spark plugs.

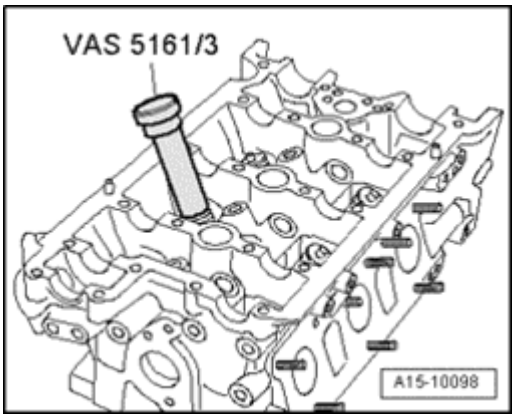

Fig. 429: Placing Drift VAS 5161/3 On Valve Spring Plate And Loosening Stuck Valve Keepers Using Plastic Hammer
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Place drift VAS 5161/3 on valve spring plate and loosen stuck valve keepers using a plastic hammer.

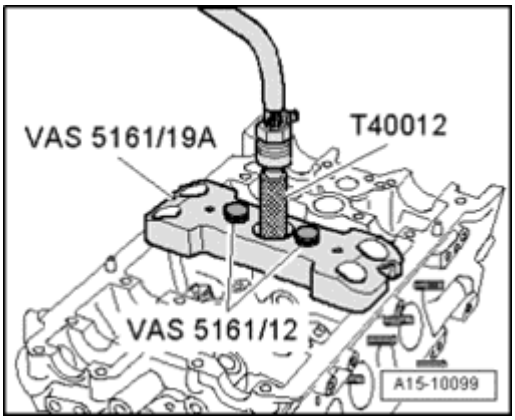

Fig. 430: Placing Guide Plate VAS 5161/19 A From Valve Cotter Disassembly And Assembly Device VAS 5161 On Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Place guide plate VAS 5161/19 A from valve cotter disassembly and assembly device VAS 5161 on cylinder head.
- Secure guide plate with knurled screws VAS 5161/12.
- Install adapter T40012 with gasket by hand into respective spark plug thread and apply constant pressure.

- Minimum pressure: 6 bar positive pressure.

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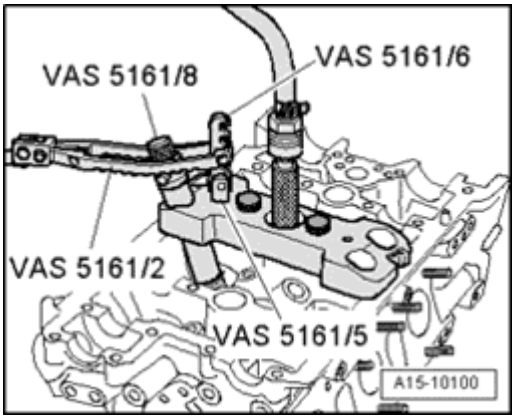

Fig. 431: Installing Engaging Device VAS 5161/6 With Installation Fork VAS 5161/5 Into Guide Plate
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install engaging device VAS 5161/6 with installation fork VAS 5161/5 into guide plate.
- Push installation cartridge VAS 5161/8 into guide plate.
- Hook in pressure fork VAS 5161/2 at engaging device and press down installation cartridge.
- At the same time, turn knurled bolt of installation cartridge to the right, until the points engage in the valve keepers.

- Lightly move knurled bolt back and forth, causing the valve keepers to be pressed apart and be captured in the installation cartridge.
- Release pressure fork.
- Take out installation cartridge.
- Unfasten guide plate and turn it aside.

- Pressurized air hose remains connected.

- Remove valve spring with valve spring plate.

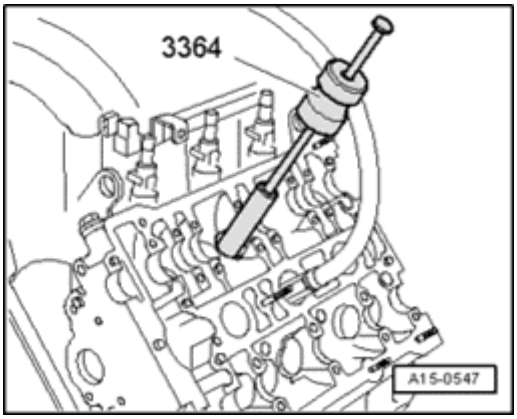

Fig. 432: Removing Valve Stem Oil Seals Using Valve Seal Removal Tool 3364
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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- Remove valve stem oil seals using Valve Seal Removal Tool 3364.

If Valve Seal Removal Tool 3364 cannot be used, on several valve stem seals due to restricted clearance, proceed as follows:

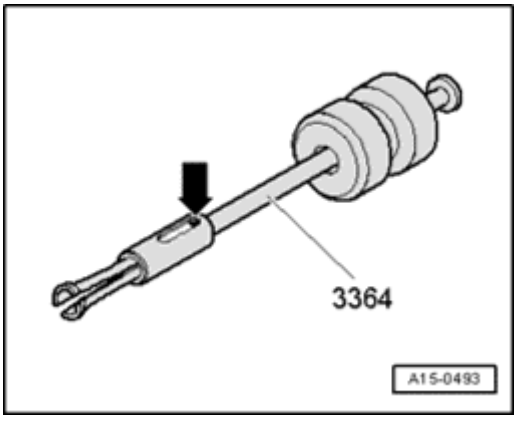

Fig. 433: Identifying Valve Seal Removal Tool 3364
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Using a drift, drive out the roll pin - **arrow** - at Valve Seal Removal Tool 3364 and remove the impact puller attachment.
- Place lower part of the Valve Seal Removal Tool 3364 on the valve stem seal.

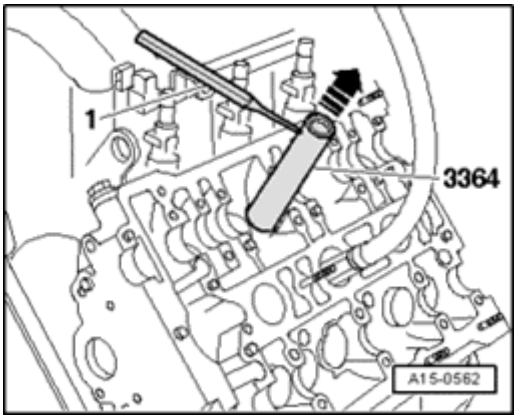

Fig. 434: Securing Valve Seal Removal Tool 3364 With Drift Or Cotter Pin Driver
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Secure Valve Seal Removal Tool 3364 with a drift or cotter pin driver - **1** - , as shown in the illustration.
- Place the valve lever on Valve Seal Removal Tool 3364 and pull off the valve stem seal - **arrow** -.

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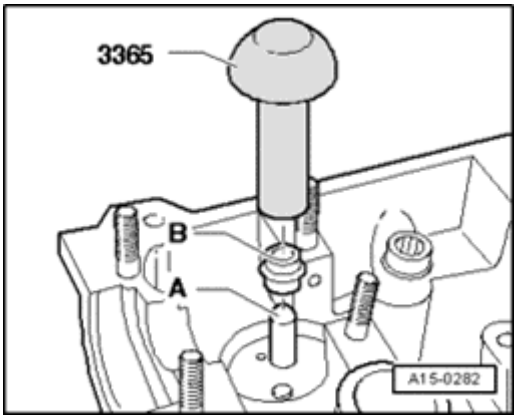

Fig. 435: Identifying Plastic Sleeve, Valve Stem Oil Seal & Valve Stem Seal Driver 3365
Courtesy of VOLKSWAGEN UNITED STATES, INC.

NOTE:

- **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 seals - **B** -.
- Lightly coat sealing lips of valve stem seal with oil.
- Push valve stem seal onto plastic sleeve.
- Carefully press valve stem oil seal onto valve guide using Valve Stem Seal Driver 3365.

- Remove plastic sleeve again.

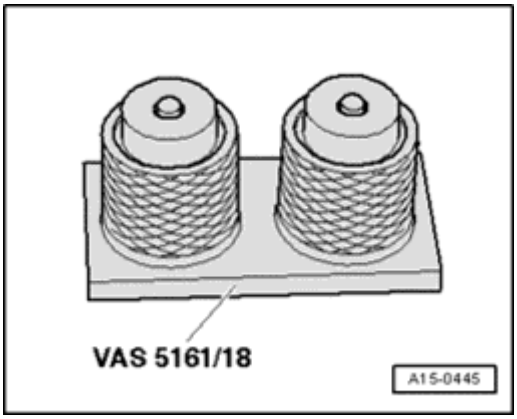

Fig. 436: Identifying Installation Cartridge VAS 5161/8
Courtesy of VOLKSWAGEN UNITED STATES, INC.

If the valve keepers were removed from the installation cartridge, they must then be inserted into the valve keeper insertion device VAS 5161/18.

- The large diameter of the valve keepers point upward.

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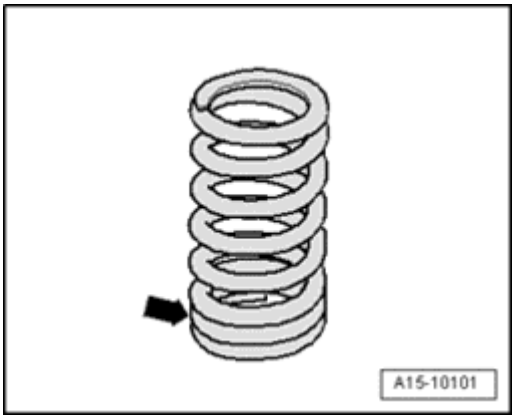

Fig. 437: Identifying Tight Spring Coils Face Toward Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install valve spring and valve spring plate.

- The tight spring coils - **arrow** - face toward cylinder head.

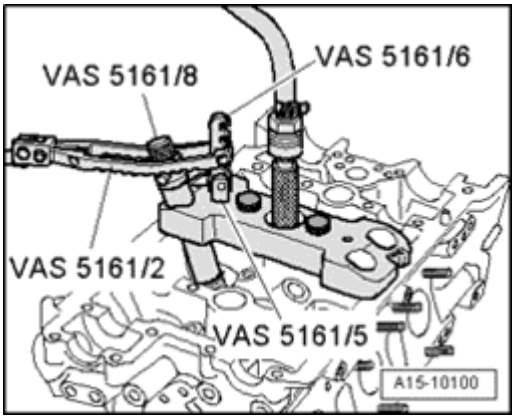

Fig. 438: Installing Engaging Device VAS 5161/6 With Installation Fork VAS 5161/5 Into Guide Plate
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install guide plate onto cylinder head again.
- Insert installation cartridge into guide plate.
- Press the pressure fork down and pull the knurled bolt upward while turning it left and right to insert the valve keepers.
- Release pressure fork with the knurled bolt still pulled.

- Make sure all the roller rocker levers seat properly on the valve stem ends and are clipped onto the respective hydraulic adjusting elements.
- Install camshafts --> **Camshafts, Removing and Installing**.
- Install spark plugs --> **01 - MAINTENANCE** .

NOTE:

- **After installing the camshafts, the engine may not be started for**

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approximately 30 minutes. The hydraulic adjusting elements must seat themselves (otherwise the valves will seat themselves on 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 Stem Seals, Cylinder Head Removed, Replacing

Valve Stem Seals, Cylinder Head Removed, Replacing

Special tools, testers and auxiliary items required

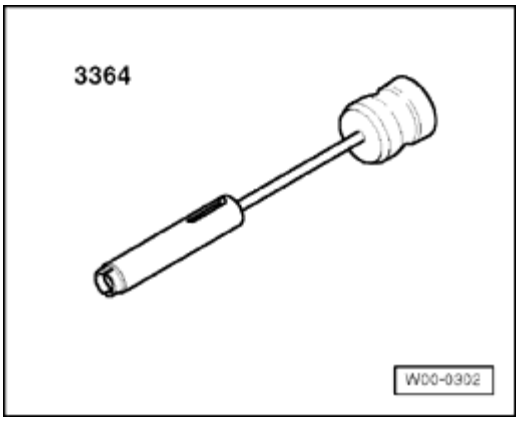

Fig. 439: Valve Seal Removal Tool 3364
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Valve Seal Removal Tool 3364

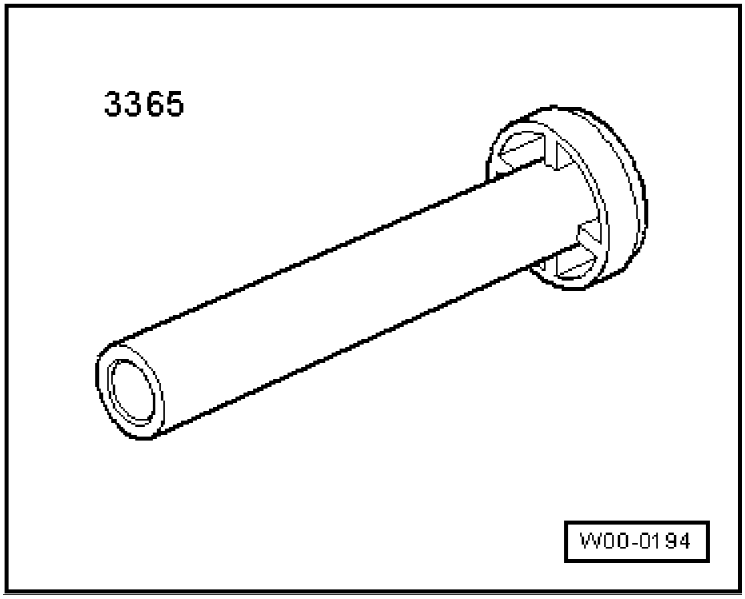

Fig. 440: Identifying Valve Stem Seal Driver 3365

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Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Valve stem seal driver 3365

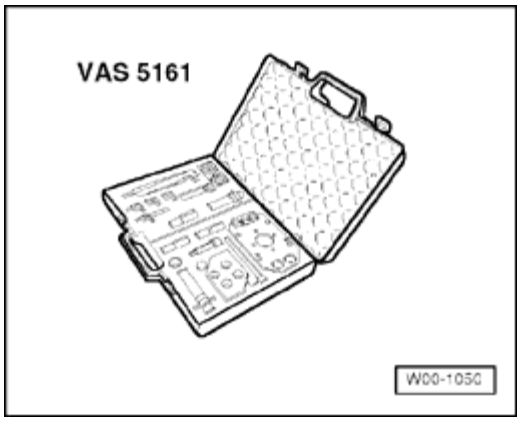

Fig. 441: Valve Cotter Disassembly/Assembly Device VAS 5161
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Valve cotter disassembly and assembly device VAS 5161

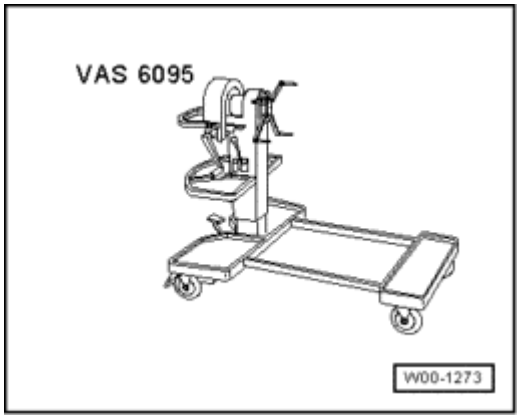

Fig. 442: Special Tool - Engine/Transmission Holder VAS 6095
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Engine and transmission holder VAS 6095
- Tensioning element VAS 6419

Procedure

- Remove camshafts --> **Camshafts, Removing and Installing**.

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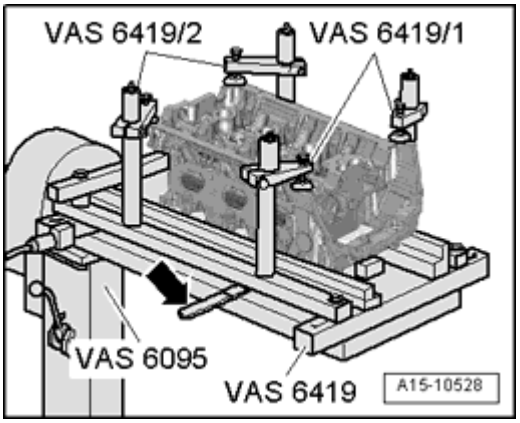

Fig. 443: Tensioning Cylinder Head On Tensioning Element VAS 6419
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Insert tensioning element VAS 6419 in the engine and transmission holder VAS 6095.
- Tension the cylinder head on the tensioning element VAS 6419 as shown in the illustration.
- Connect the tensioning element VAS 6419 to compressed air.
- Slide the air cushion with the lever - **arrow** - under the cylinder onto the valve stem seal that will be removed.

- Let enough compressed air flow into the air cushion until it contacts the valve plate.

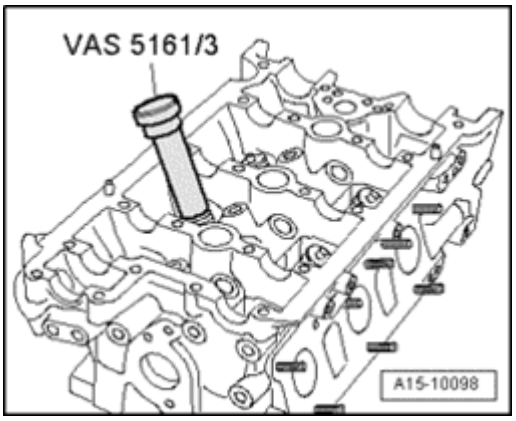

Fig. 444: Placing Drift VAS 5161/3 On Valve Spring Plate And Loosening Stuck Valve Keepers Using Plastic Hammer
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Place drift VAS 5161/3 on valve spring plate and loosen stuck valve keepers using a plastic hammer.

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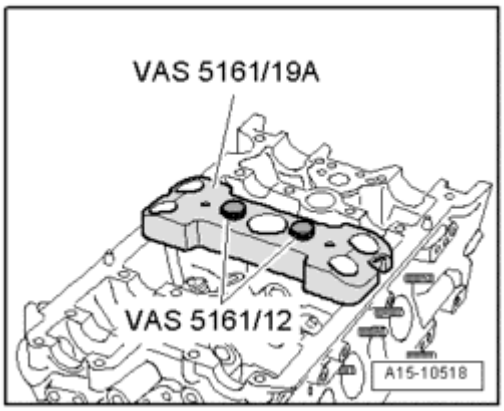

Fig. 445: Placing Guide Plate VAS 5161/19 A From Valve Cotter Disassembly/Assembly Device VAS 5161 On Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Place guide plate VAS 5161/19 A from valve cotter disassembly and assembly device VAS 5161 on cylinder head.
- Secure guide plate with knurled screws VAS 5161/12.

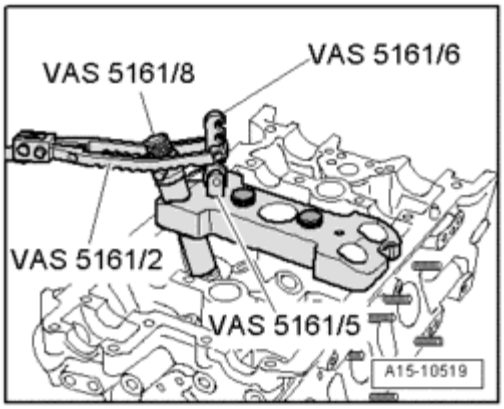

Fig. 446: Installing Engaging Device VAS 5161/6 With Installation Fork VAS 5161/5 Into Guide Plate
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install engaging device VAS 5161/6 with installation fork VAS 5161/5 into guide plate.
- Push installation cartridge VAS 5161/8 into guide plate.
- Hook in pressure fork VAS 5161/2 at engaging device and press down installation cartridge.
- At the same time, turn knurled bolt of installation cartridge to the right, until the points engage in the valve keepers.

- Lightly move knurled bolt back and forth, causing the valve keepers to be pressed apart and be captured in the installation cartridge.
- Release pressure fork.
- Take out installation cartridge.

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- Remove valve spring with valve spring plate.

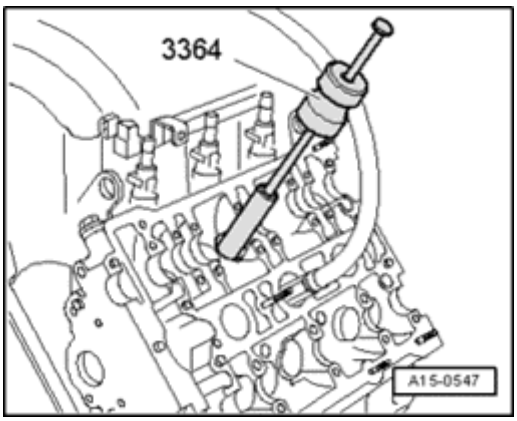

Fig. 447: Removing Valve Stem Oil Seals Using Valve Seal Removal Tool 3364
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Pull off valve stem oil seals using Valve Seal Removal Tool 3364.

NOTE:

- **A plastic sleeve - A - is supplied with the new valve shaft seals.**

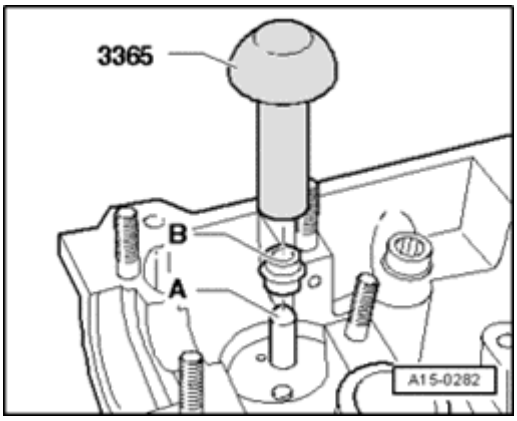

Fig. 448: Identifying Plastic Sleeve, Valve Stem Oil Seal & Valve Stem Seal Driver 3365
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Place plastic sleeve - **A** - on valve stem to prevent damage to new valve stem seals - **B** -.
- Lightly coat sealing lips of valve stem seal with oil.
- Push valve stem seal onto plastic sleeve.
- Carefully press valve stem oil seal onto valve guide using Valve Stem Seal Driver 3365.

- Remove plastic sleeve again.

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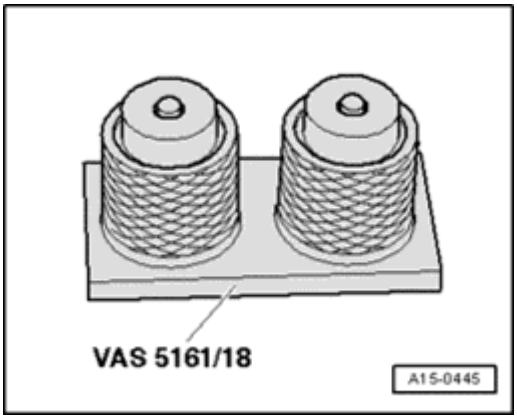

Fig. 449: Identifying Installation Cartridge VAS 5161/8
Courtesy of VOLKSWAGEN UNITED STATES, INC.

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

- The large diameter of the valve keepers point upward.

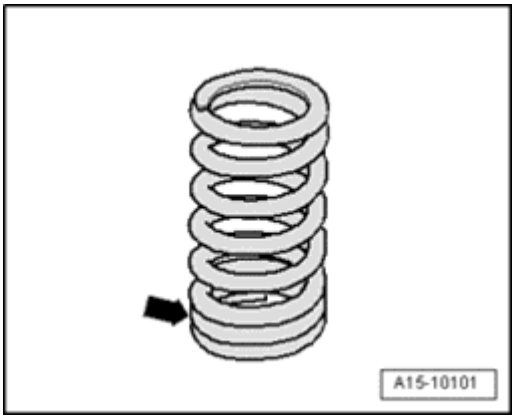

Fig. 450: Identifying Tight Spring Coils Face Toward Cylinder Head
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install valve spring and valve spring plate.
- The tight spring coils - **arrow** - face toward cylinder head.

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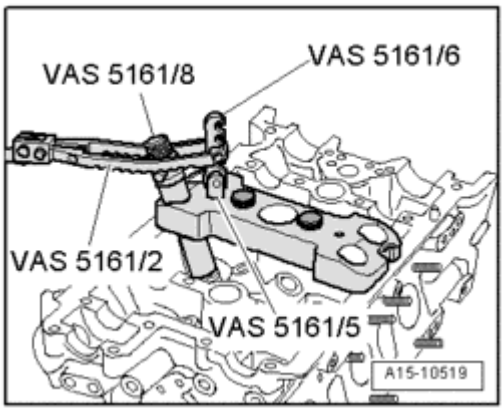

Fig. 451: Installing Engaging Device VAS 5161/6 With Installation Fork VAS 5161/5 Into Guide Plate
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Install guide plate onto cylinder head again.
- Insert installation cartridge into guide plate.
- Press pressure fork down and pull the knurled bolt upward while turning it left and right to insert the valve keepers.
- Release pressure fork with the knurled bolt still pulled.
- Make sure all the roller rocker levers seat properly on the valve stem ends and are clipped onto the respective hydraulic adjusting elements.
- Install camshafts --> **Camshafts, Removing and Installing**.

Hydraulic Adjusting Elements, Checking

Hydraulic Adjusting Elements, Checking

Special tools, testers and auxiliary items required

- Feeler gauge

NOTE:

- **The hydraulic adjusting elements cannot be repaired.**
- **Irregular valve noises are normal while starting the engine.**

Procedure

- Start the engine and let it run until the radiator fan has switched on once.
- Increase engine speed for about 2 minutes to approximately 2500 RPM, perform road test if necessary.

If the hydraulic adjusting elements are still loud, determine which element is faulty:

- Remove cylinder head cover.
- Rotate crankshaft until lobes on the adjusting element to be checked face upward:

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- Vehicles with manual transmission: With 4th gear engaged and ignition switched off, slide forward.
- Vehicles with Multitronic transmission or automatic transmission 09L: Rotate crankshaft clockwise at ribbed belt pulley center bolt.

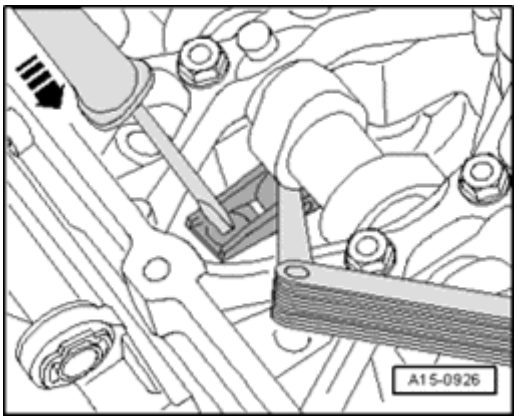

Fig. 452: Checking Play Between Cam Lobes And Roller Rocker Lever
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Check play between cam lobes and roller rocker lever.
- Press roller rocker lever down with screwdriver - **arrow** -.

If a 0.20 mm feeler gauge can be inserted between camshaft and roller rocker lever:

- Replace hydraulic adjuster --> **Camshafts, Removing and Installing**.

NOTE:

- **After installing the camshafts, the engine may not be started for approximately 30 minutes. The hydraulic adjusting elements must seat themselves (otherwise the valves will seat themselves on 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 Dimensions

Valve Dimensions

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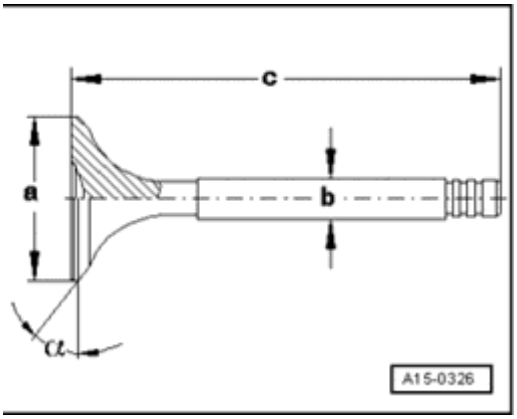

Fig. 453: Valve Dimensions
Courtesy of VOLKSWAGEN UNITED STATES, INC.

NOTE:

- **Intake and exhaust valves must not be refaced by grinding. Only lapping is permitted.**

Dimension		Intake valve	Exhaust valve
Dia. a	mm	33.85 ± 0.310	28.0 ± 0.1
Dia. b	mm	5.98 ± 0.01	5.96 ± 0.01
c	mm	104.0 ± 0.2	101.9 ± 0.2
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 Guides, Checking

Valve Guides, Checking

Special tools, testers and auxiliary items required

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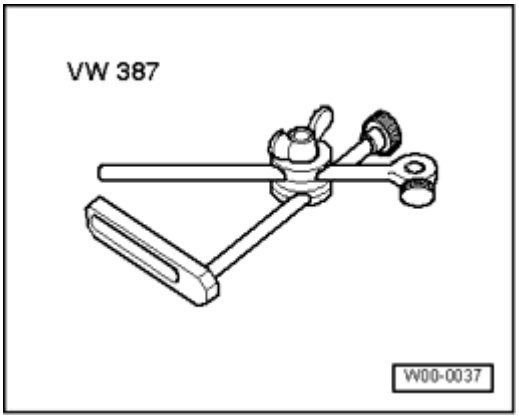

Fig. 454: Dial Gauge Holder VW 387
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Dial gauge holder VW 387

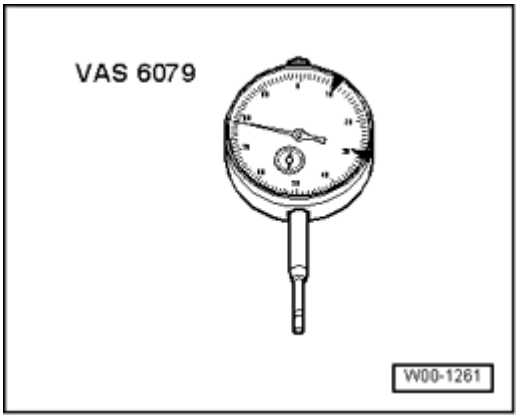

Fig. 455: Dial Gauge VAS 6079
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Dial gauge VAS 6079

Procedure

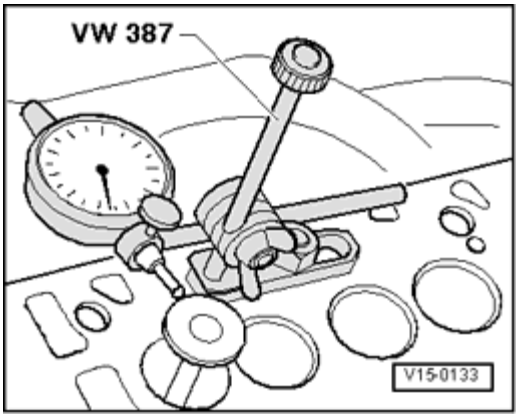

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Fig. 456: Identifying Special Tool - VW 387 Installed
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Insert valve into valve 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.
- Valve stem tip must seal with valve guide.
- Determine tilt clearance.
- Wear limit: 0.8 mm.

NOTE:

- **If the valve is to be replaced as part of a repair, use a new valve for the calculation.**
- **If wear limit is exceeded, re-measure using new valves. If wear limit is still exceeded, replace cylinder head.**

Valves, Checking

Valves, Checking

- Perform a visual check for signs of wear at stem and at seating surface.

If significant wear is discovered:

- Replace respective valve.

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