ENGINE

3.6 Liter - Crankshaft, Cylinder Block - Engine Code(s): BHK

13 CRANKSHAFT, CYLINDER BLOCK

GENERAL INFORMATION

CRANKSHAFT

NOTE: The crankshaft bearing shells must be reallocated if the crankshaft or cylinder block is replaced. Refer to CRANKSHAFT BEARING SHELLS, ALLOCATING.

Before removing the crankshaft, prepare for appropriate storage, so that the sensor wheel does not make contact or become damaged.

The engine is to be secured to the engine and transmission holder VAS 6095 when performing assembly work.

CRANKSHAFT BEARING SHELLS, ALLOCATING

The main bearing shells are allocated to the cylinder block and crankshaft with the correct thickness at the factory. Colored dots serve to identify the bearing thicknesses.

If the cylinder block or crankshaft are being replaced, then the bearing shells must be allocated.

The bearing shell for the cylinder block (upper bearing shell) is always marked in yellow.

Using the letters on the cylinder block and crankshaft, determine the correct color identification for the bearing shell in the bearing cap (lower bearing shell).

The first letter is for bearing cap one, the second for bearing cap two, etc.

Cylinder Block Identification:

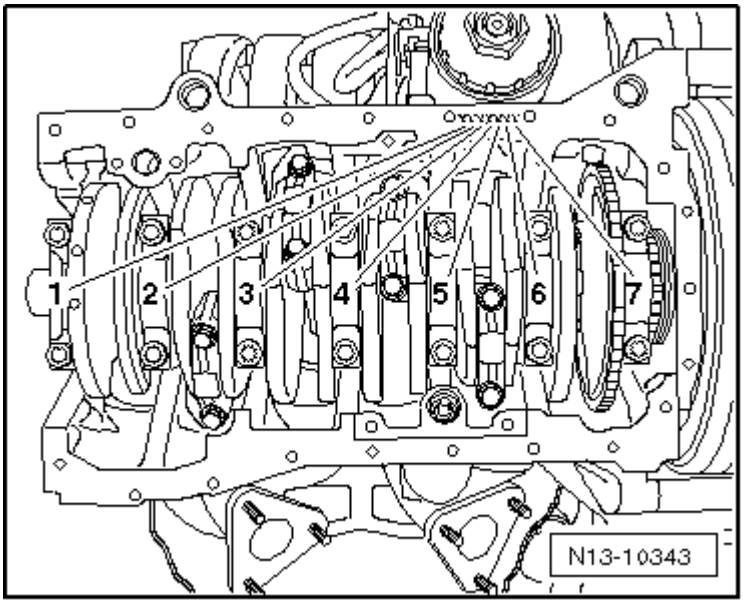

Fig. 1: Cylinder Block Identification
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

The letters are located on the oil pan sealing surface.

Crankshaft Identification:

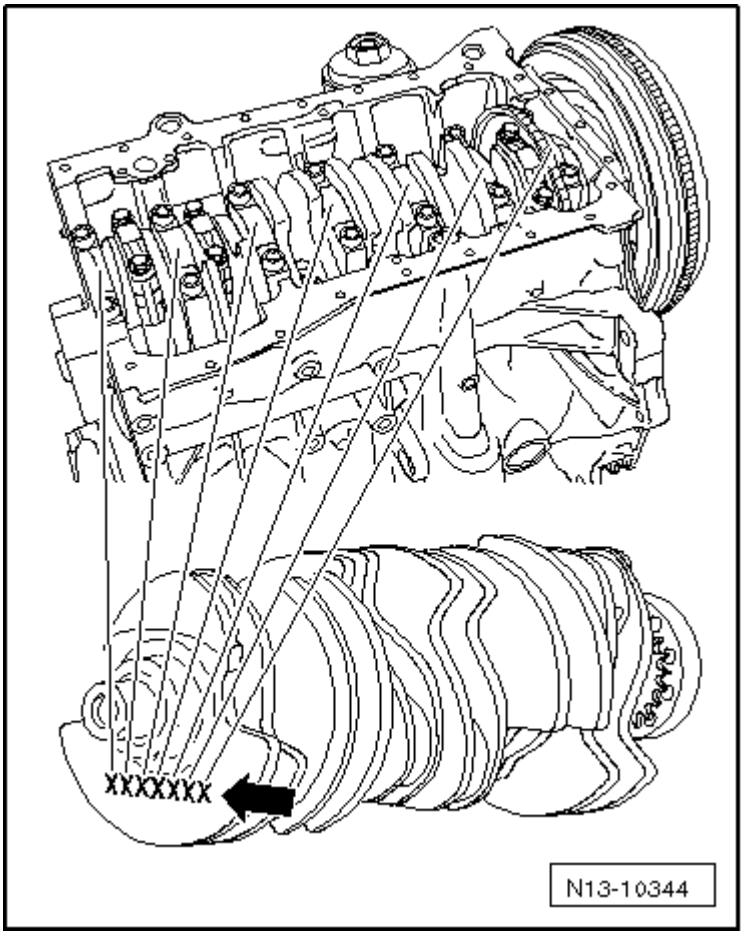

Fig. 2: Crankshaft Identification
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

The letters are located on the outer crankshaft counterweight for cylinder 1.

-- Note the letters and then match it to the color identification in the table.

Letter on Cylinder Block	Letter on Crankshaft Counterweight	Bearing Shell Color Identification for Bearing Cap	Bearing Shell Color Identification for Cylinder Block
A, B, C, D, E	R	red	yellow
A, B, C, D, E	G	red	yellow
A, B, C, D, E	B	yellow	yellow
A, B, C, D, E	V	blue	yellow
G, H, I	R	red	yellow
G, H, I	G	red	yellow
G, H, I	B	yellow	yellow
G, H, I	V	blue	yellow
K, L, M	R	red	yellow
K, L, M	G	yellow	yellow

K, L, M	B	blue	yellow
K, L, M	V	purple	yellow

Example:

Bearing Cap	1	2	3	4	5	6	7
Letter on cylinder block	G	H	H	H	G	E	G
Letter on the crankshaft counterweight	G	B	B	V	B	B	G
Bearing shell color identification for bearing cap	red	yellow	yellow	blue	yellow	yellow	red

DESCRIPTION AND OPERATION

ENGINE OVERVIEW

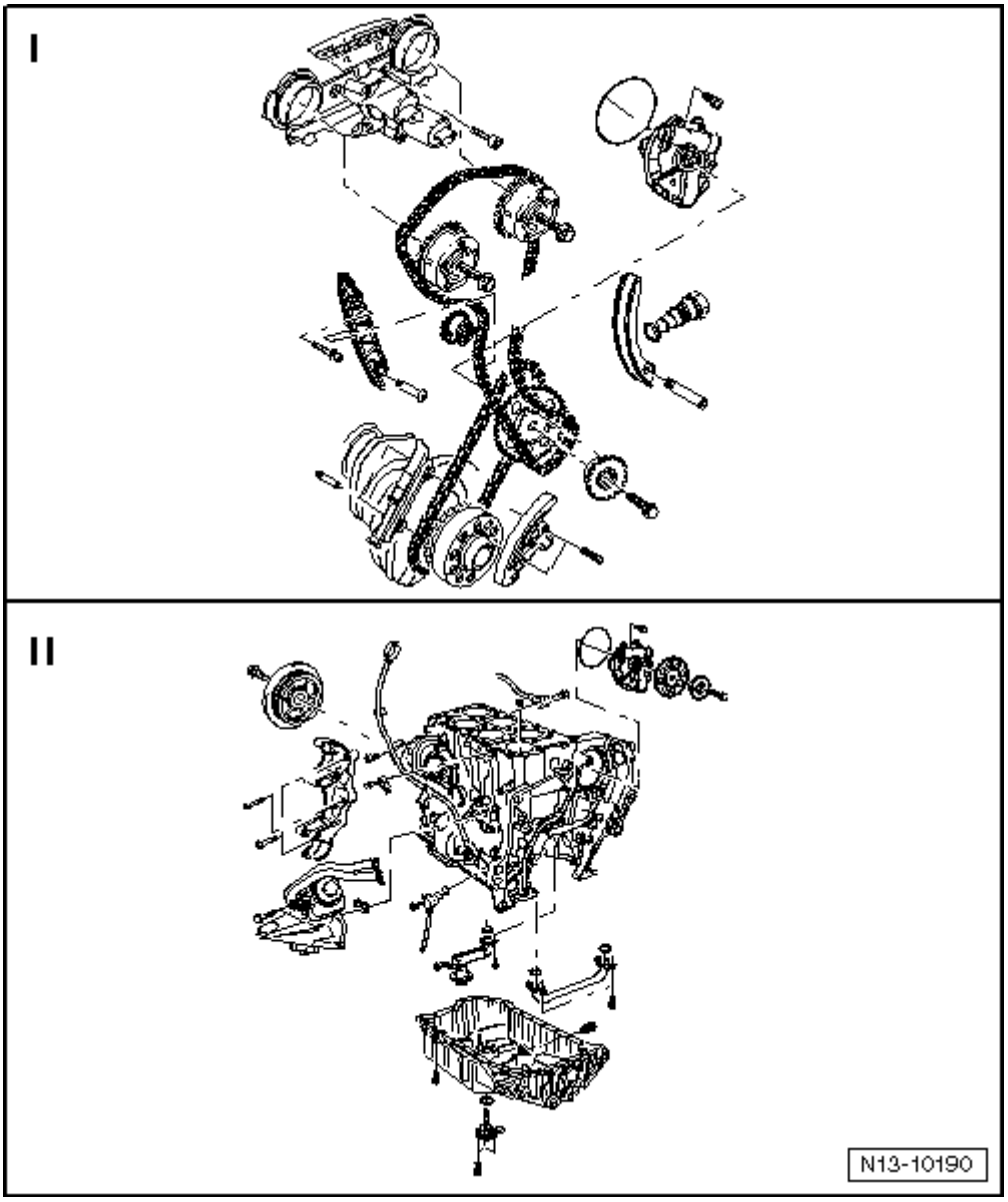

Fig. 3: Engine, Disassembling And Assembling Overview
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: **The engine is to be secured to the engine and transmission holder VAS 6095 when performing assembly work.**

If large quantities of metal particles or abraded material are detected during engine repairs, it may be an indication of a damaged crankshaft or rod bearings. To prevent further damage, perform the following steps after the repair:

Carefully clean the oil passages.

Replace the oil check valve (if installed).

Replace the oil injection jets.

Replace the oil cooler.

Replace the oil filter.

CHAIN DRIVE

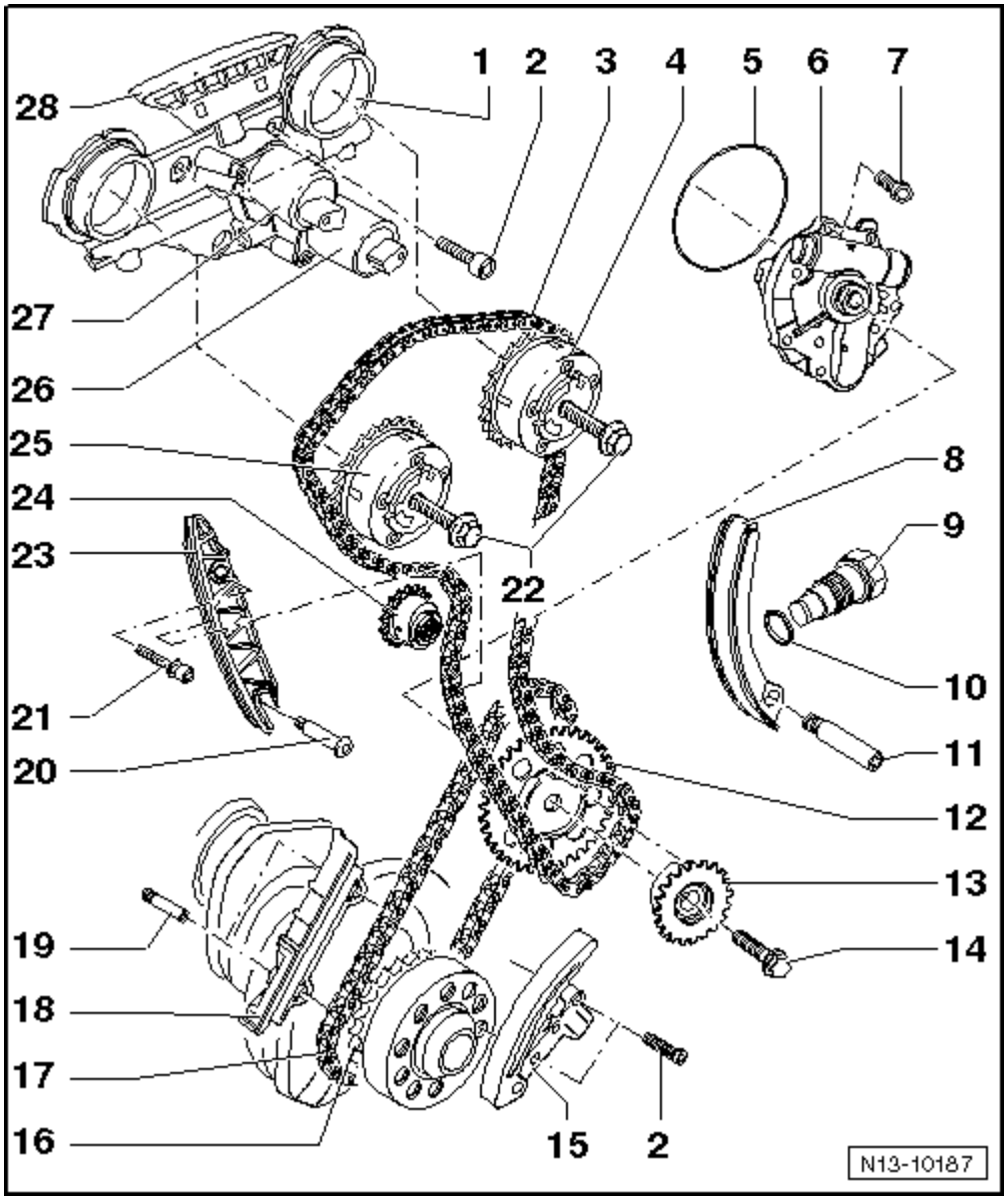

Fig. 4: Engine, Disassembling And Assembling Part I
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Control Housing
    - Lubricate the contact surface of the seals before installing.

- Removing and installing, refer to **CAMSHAFTS** .
- Assembly overview, refer to **CONTROL HOUSING OVERVIEW** .
- Check the control housing strainer for contamination before installation. Refer to **CONTROL HOUSING OVERVIEW** .

2. Bolt
   - 8 Nm + an additional 90° (1/4) turn.
   - Install the control housing bolts using locking compound D 000 600 A2.
3. Timing Chain, Camshaft
   - Mark the direction of rotation before removing (installed position). Refer to **TIMING CHAINS AND ADJUSTERS**.
   - Camshaft adjustor with timing chain for camshaft drive, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING** .
4. Exhaust Camshaft Adjuster
   - Identification: 32A
   - Camshaft adjustor with timing chain for camshaft drive, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING** .
5. Seal
   - Replace
6. Oil Pump
   - Removing and installing, refer to **OIL PUMP** .
7. Bolt
   - 8 Nm
   - Install using locking compound D 000 600 A2.
8. Tensioning Rail
   - For the timing chain -item 3-.
9. Chain Tensioner
   - 50 Nm
   - For the timing chain -item 3-.
   - Only rotate the engine with the chain tensioner installed.
10. Seal
    - Replace if damaged or leaking.
11. Pivot Pin
    - 10 Nm
    - For the tensioning rail -item 8-.
12. Sprocket
    - For the timing chain -item 17-.
    - Camshaft adjustor with timing chain for camshaft drive,, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING** .
13. Sprocket

- For the timing chain -item 3-.
- Camshaft adjustor with timing chain for camshaft drive, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING**

14. Bolt
    - 60 Nm + 90° (1/4) additional turn.
    - Replace
    - Only use bolts with a strength category of 10.9.
15. Chain Tensioner with Tensioning Rail
    - For the timing chain -item 17-.
    - Before installation, release the locking device in the chain tensioner using a small screwdriver and press the tensioning plate against the chain tensioner.
    - Only rotate the engine with the chain tensioner installed.
16. Drive Sprocket
    - Integral part of the crankshaft.
    - Milled tooth aligned with crankshaft main bearing cap joint = cylinder 1 Top Dead Center (TDC). Refer to **OIL PUMP DRIVE TIMING CHAIN, INSTALLING** .
17. Timing Chain
    - For the oil pump drive.
    - Mark the direction of rotation before removing (installed position). Refer to **TIMING CHAINS AND ADJUSTERS**.
    - Install, refer to **OIL PUMP DRIVE TIMING CHAIN, INSTALLING** .
18. Guide Rail
    - For the timing chain -item 17-.
    - Together with the timing chain, installing. Refer to **OIL PUMP DRIVE TIMING CHAIN, INSTALLING** .
19. Locating Pin without Collar
    - 10 Nm
    - For the guide rail -item 18-.
20. Pivot Pin
    - 10 Nm
21. Bolt
    - 23 Nm
22. Bolt
    - 60 Nm + 90° (1/4) additional turn.
    - Replace
    - The contact surfaces of the adjuster wheel and bolt head must be dry when installing.
    - When removing and installing, counter hold the camshaft using a 27 mm open end wrench. Refer to **CAMSHAFTS** .
23. Guide Rail

- For the timing chain -item 3-.

24. High Pressure Pump Drive Pinion
    - With the needle bearing lying inside.
    - Lubricate the needle bearing before installing.
25. Intake Camshaft Adjuster
    - Identification: 24E
    - Camshaft adjustor with timing chain for camshaft drive, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING** .
26. Camshaft Adjustment Valve 1 (Exhaust) -N318-
    - For the exhaust camshaft.
    - Mark the connector belonging to the component before disconnecting.
27. Camshaft Adjustment Valve 1 -N205-
    - For the intake camshaft.
    - Mark the connector belonging to the component before disconnecting.
28. Guide Rail
    - For the timing chain -item 3-
    - Clipped into the control housing.

Marking the Timing Chain

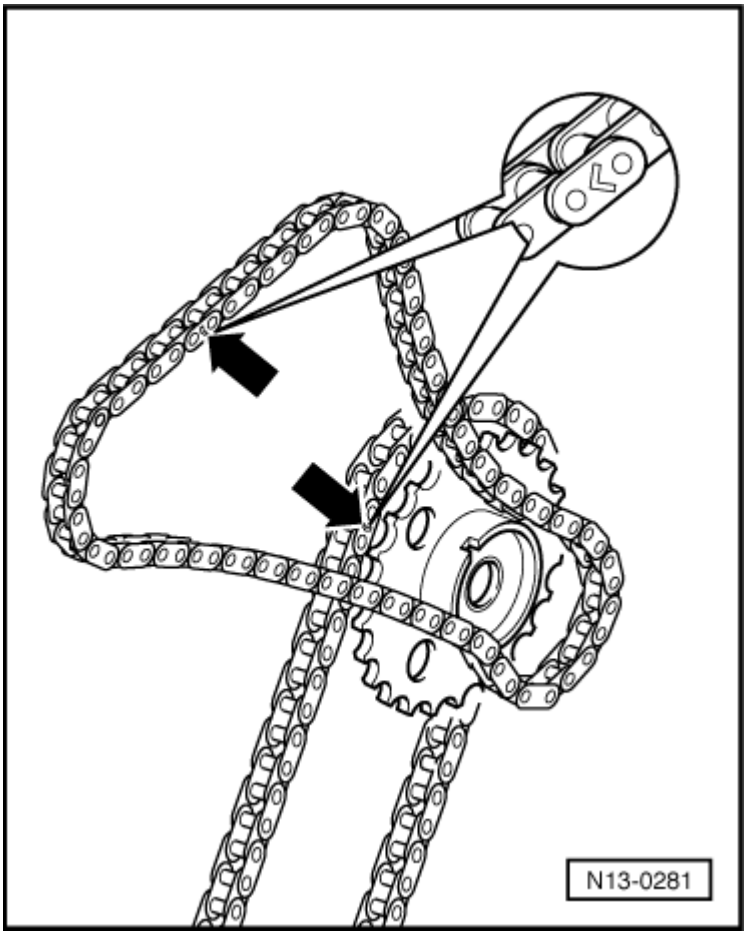

Fig. 5: Identifying Marks On Roller Chains
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Mark the timing chains before removing (for example, using paint, arrow pointing in the direction of rotation).

NOTE: DO NOT mark the chain using a center punch or similar means!

CYLINDER BLOCK AND COMPONENTS

Engine mount and bracket, removing and installing. Refer to **ENGINE MOUNT AND BRACKET**.

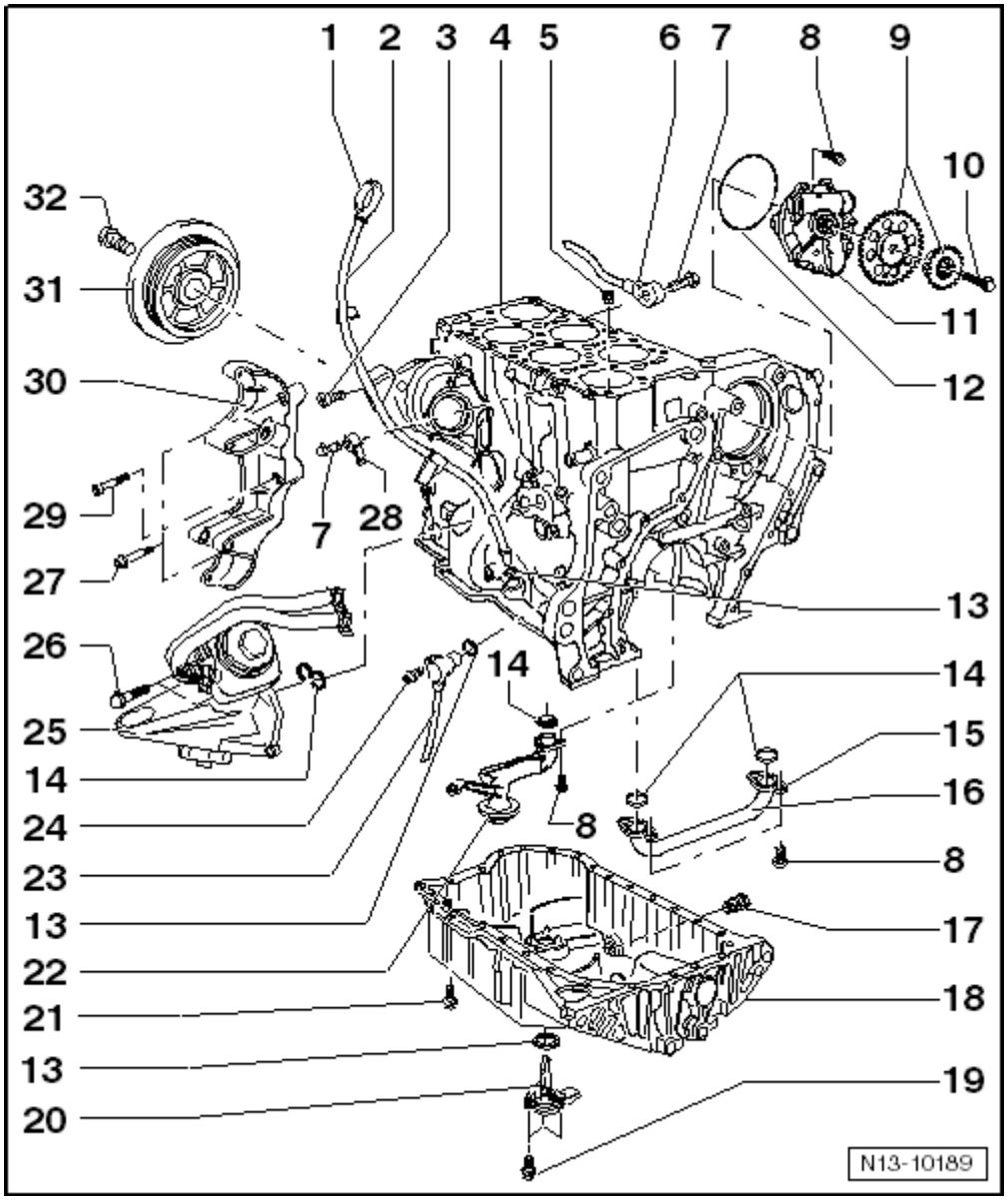

Fig. 6: Engine, Disassembling And Assembling Part II
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Oil Dipstick
   - Oil level must not be above the Max. mark!
   - Mark, refer to **ENGINE OIL** .
2. Oil Dipstick Guide Tube
   - Secured to the intake manifold by a bolt.
3. Bolt
   - 6 Nm
   - To the intake manifold, for the guide tube.
4. Cylinder Block

- Sealing flange and drive plate overview. Refer to **SEALING FLANGES AND DRIVE PLATE OVERVIEW**.
- Crankshaft overview. Refer to **CRANKSHAFT OVERVIEW**.
- Piston and connecting rod overview. Refer to **PISTONS AND CONNECTING ROD OVERVIEW**.

5. Oil Check Valve
   - Only installed on vehicles through 11.06.
   - Pay attention to the installed position.
   - Clean if badly contaminated.
   - See note in **ENGINE OVERVIEW**.
   - Removing and installing, refer to **OIL PAN, PUMP AND FILTER HOUSING OVERVIEW** .
6. Knock Sensor (KS) 1 -G61-
   - Installed location: between cylinders 1 and 3.
7. Bolt
   - 20 Nm
   - Tightening specification affects the function of the KS.
8. Bolt
   - 8 Nm
   - Replace
9. Sprocket
   - For the oil pump.
   - Camshaft adjustor with timing chain for camshaft drive, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING** .
10. Bolt
    - 60 Nm + 90° (1/4) additional turn.
    - Replace
    - Only use bolts with a strength category of 10.9.
11. Oil Pump
    - Removing and installing, refer to **OIL PUMP** .
12. Seal
    - Replace
    - Lubricate before installing.
13. O-ring
    - Replace
14. Gasket
    - Replace
15. Flange
    - Note the installed position.

16. Oil Pressure Line
17. Oil Drain Plug
    - 30 Nm
    - Replace
    - With a permanent seal
18. Oil Pan
    - Removing and installing, refer to **OIL PAN** .
19. Bolt
    - 10 Nm
20. Oil Level Thermal Sensor -G266-
21. Bolt
    - 12 Nm
22. Oil Intake Pipe
    - For the oil pump.
23. Engine Speed (RPM) Sensor -G28-
24. Bolt
    - 10 Nm
25. Oil Filter Housing/Left Engine Mount Bracket
    - Overview, refer to **OIL FILTER HOUSING OVERVIEW** .
    - Coolant hose connection diagram. Refer to **COOLANT HOSE CONNECTION DIAGRAM** .
    - Engine mount and bracket, removing and installing. Refer to **ENGINE MOUNT AND BRACKET**.
26. Bolt
    - 23 Nm
27. Bolt
    - **25 Nm**
28. Knock Sensor (KS) 2 -G66-
    - Installed location: between cylinders 4 and 6.
29. Bolt
    - 25 Nm
    - Used for alignment.
30. Accessory Bracket
    - For the generator, Air/Conditioning (A/C) Compressor, and power steering pump.
31. Vibration Damper
    - Removing and installing the ribbed belt. Refer to **RIBBED BELT**.
32. Bolt
    - 100 Nm + 180° (1/2) additional turn
    - Loosening and tightening, refer to **CYLINDER BLOCK, VIBRATION DAMPER AND**

LUBRICATION COMPONENTS.

Loosening and Tightening the Vibration Damper Bolt

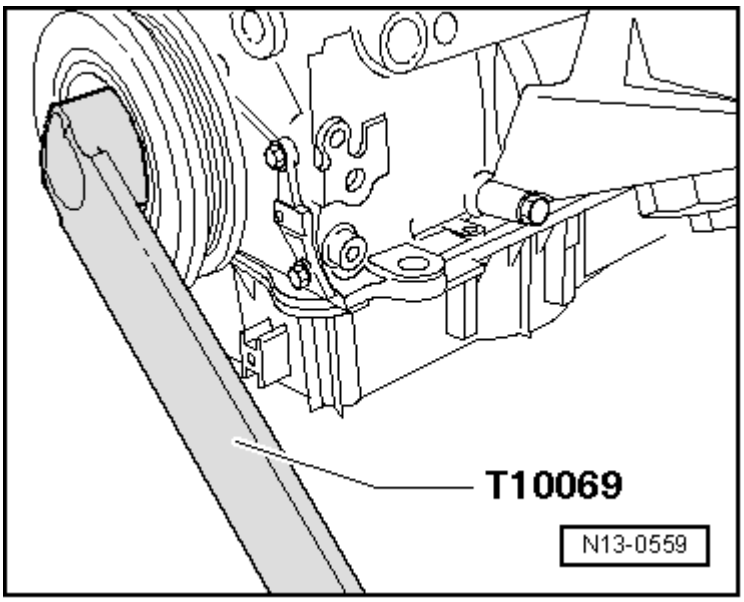

Fig. 7: Counter-Holder T10069 To Hold Vibration Damper
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

CAUTION: Check the rubber isolator between the inner and outer rings of the vibration damper for cracks and flaking. If rubber isolator damage is identified, the vibration damper must be replaced.

-- Lock the vibration damper using the T10069 when loosening or tightening the bolt.

-- Clean the threads in the crankshaft using a M18 x 1.5 tap.

-- Replace the vibration damper bolt.

-- Tighten the bolt using the V.A.G 1601.

Tightening specification: 100 Nm + 180° (1/2) additional turn.

NOTE: The additional turning may be performed in several stages.

SEALING FLANGES AND DRIVE PLATE OVERVIEW

NOTE: Secure the engine to the engine and transmission holder VAS 6095 when working on the engine.

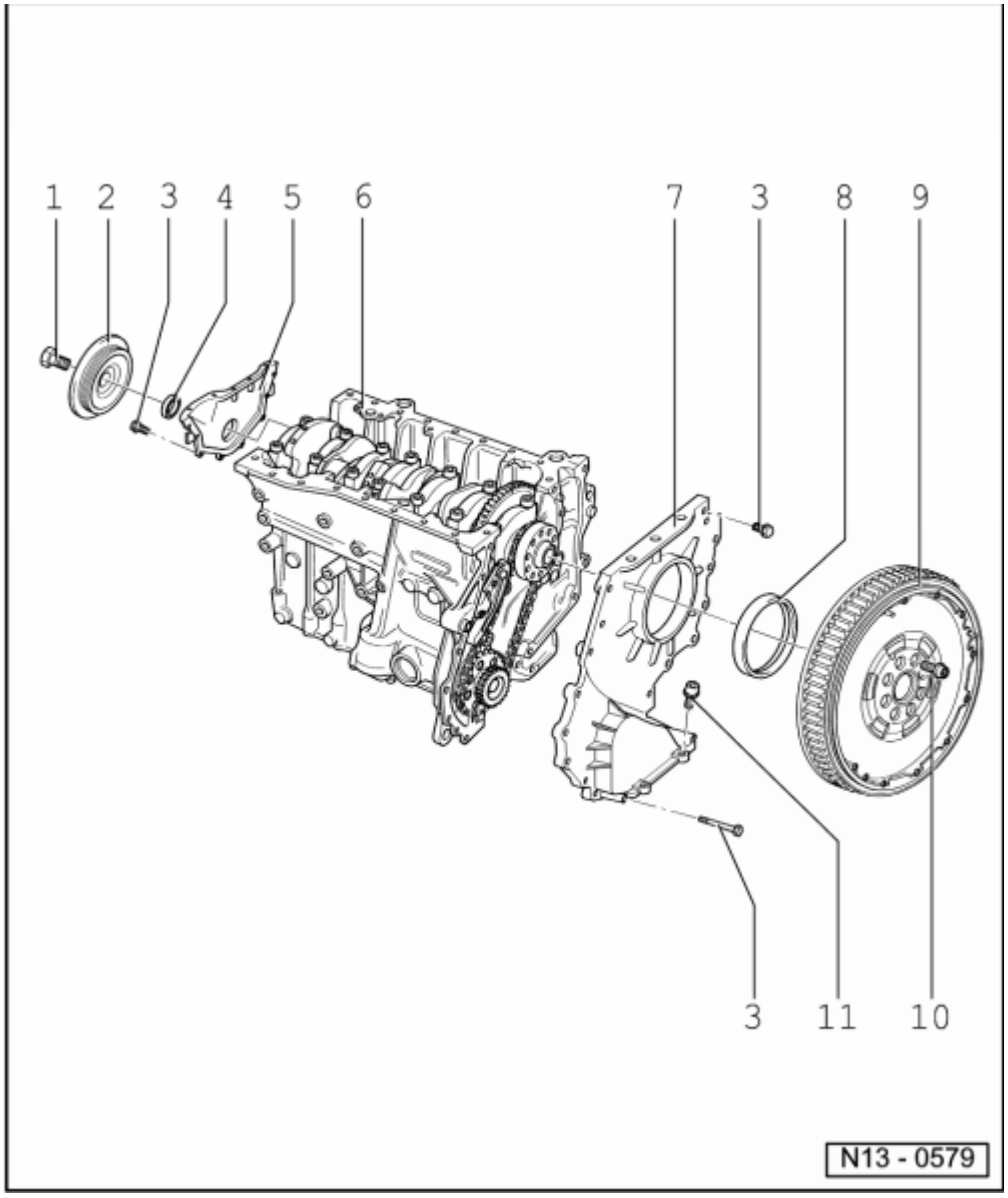

Fig. 8: Exploded View Of Sealing Flanges And Dual-Mass Flywheel
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Bolt
   - 100 Nm + 180° (1/2) additional turn
   - Loosening and tightening, refer to **CYLINDER BLOCK, VIBRATION DAMPER AND LUBRICATION COMPONENTS**.
2. Vibration Damper
   - To remove and install, lock using the counter-holder tool T10069. Refer to **CYLINDER BLOCK, VIBRATION DAMPER AND LUBRICATION COMPONENTS**.
3. Bolt
   - 10 Nm

4. Seal
   - Integrated into the sealing flange -item 5-, cannot be replaced separately. Refer to **SEALING FLANGE, VIBRATION DAMPER SIDE**.
5. Sealing Flange
   - Replacing, refer to **SEALING FLANGE, VIBRATION DAMPER SIDE**.
   - Apply sealant D 176 501 A1 to the sealing surfaces.
6. Cylinder Block
   - Crankshaft overview. Refer to **CRANKSHAFT OVERVIEW**.
   - Piston and connecting rod overview. Refer to **PISTONS AND CONNECTING ROD OVERVIEW**.
7. Sealing Flange
   - **Removing and installing** , refer to **SEALING FLANGE, TRANSMISSION SIDE**.
8. Seal
   - Remove using the pulling hook T20143/2.
   - Polytetrafluoroethylene (PTFE) version of oil seal.
   - Do not oil or grease the sealing lip of the oil seal.
   - Before installing, remove any remaining oil from the crankshaft with a clean cloth.
   - Installing, refer to **SEAL, TRANSMISSION SIDE**.
9. Drive Plate
   - Removing and installing, refer to **DRIVE PLATE**.
10. Bolt
    - 60 Nm + 90° (1/4) additional turn.
    - Replace
    - To loosen or tighten, use the counter hold tool T10044 (with 5 mm spacers), or the counter-holder tool T10069.
11. Bolt
    - 23 Nm

TIMING CHAIN COVERS OVERVIEW

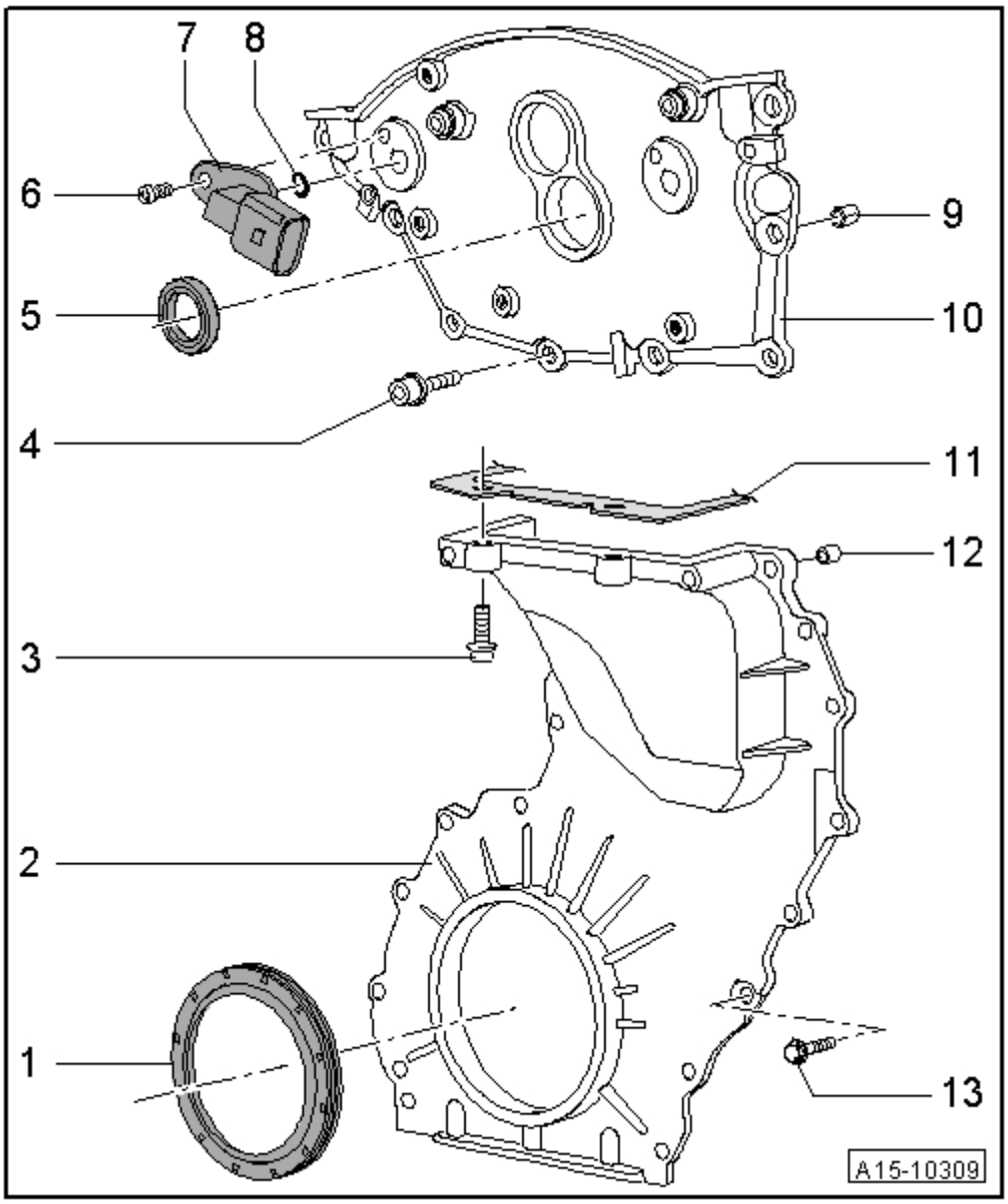

Fig. 9: Identifying Timing Chain Cover And Sealing Flange
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Seal
   - For the crankshaft.
   - Replacing, refer to **SEAL, TRANSMISSION SIDE**.
2. Sealing Flange
   - Transmission side.
   - Removing and installing, refer to **SEALING FLANGE, TRANSMISSION SIDE**.
3. Bolt
   - 23 Nm
4. Bolt

- 8 Nm
- Tighten in a diagonal sequence and in steps.

5. Seal
   - Quantity: 2
   - For the camshaft adjustment valve 1 -N205- and camshaft adjustment valve 1 (exhaust) -N318-.
   - Replace if there is leakage or damage. Refer to **CAMSHAFT TIMING CHAIN COVER SEALS, INSTALLING** .
6. Bolt
   - 10 Nm
7. Camshaft Position (CMP) Sensor
   - CMP sensor -G40- and CMP sensor 2 -G163-.
8. O-ring
   - Quantity: 2
   - Replace
9. Alignment Pins
   - Quantity: 2
10. Timing Chain Cover
    - The version for vehicles without the mechanical vacuum pump is shown.
    - Version for vehicles with a mechanical vacuum pump, refer to **MECHANICAL VACUUM PUMP OVERVIEW** .
    - Can be replaced only when the engine is removed.
11. Cylinder Head Gasket
    - Clean the holes and fill with sealant, refer to **SEALING FLANGE, TRANSMISSION SIDE**.
12. Alignment Pins
13. Bolt
    - 10 Nm

CRANKSHAFT OVERVIEW

NOTE:

- **The crankshaft bearing shells must be reallocated if the crankshaft or cylinder block is replaced. Refer to CRANKSHAFT BEARING SHELLS, ALLOCATING**
- **Before removing the crankshaft, prepare for appropriate storage, so that the sensor wheel -item 6- does not make contact or become damaged.**
- **The engine is to be secured to the engine and transmission holder VAS 6095- when performing assembly work.**

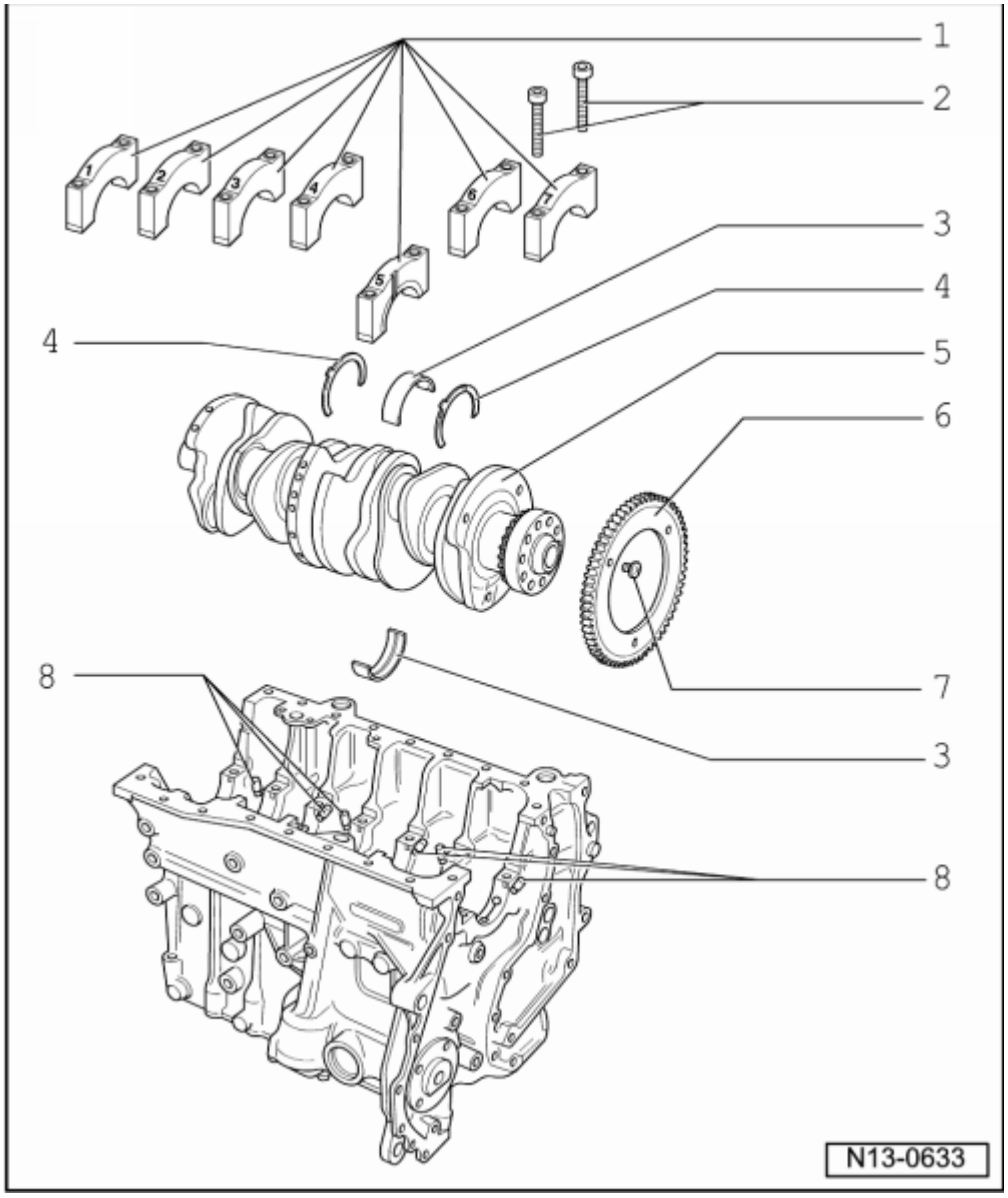

Fig. 10: Crankshaft, Assembly Overview
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Bearing Cap
   - Bearing cap 1: vibration damper side.
   - Bearing cap 5: with notches for the thrust washers.
   - Retaining tabs on bearing shells and cylinder block/bearing caps must align above one another.
2. Bolt
   - 30 Nm + 180° (1/2) additional turn.
   - Replace
   - Two additional 90° turns is permitted.
3. Bearing Shell, 1 through 7

- For bearing caps without a oil groove.
- For cylinder block with a oil groove.
- Do not interchange used bearing shells (mark them).
- Crankshaft bearing shell, allocating. Refer to **CRANKSHAFT BEARING SHELLS, ALLOCATING**.

4. Thrust Washer
   - For bearing cap 5.
   - Observe the locating point.
5. Crankshaft
   - If replacing the crankshaft, allocate the crankshaft bearing shells, refer to **CRANKSHAFT BEARING SHELLS, ALLOCATING**.
   - Before removing, observe the note in **CRANKSHAFT**.
   - Axial play new: 0.07 to 0.23 mm, wear limit: 0.30 mm
   - Check radial clearance using Plastigage, new: 0.02 to 00.06 mm, wear limit: 0.10 mm
   - Do not turn the crankshaft when measuring the radial play.
   - Crankshaft dimensions: crankshaft bearing: 59.958 to 59.978 mm; connecting rod bearing: 53.958 to 53.978 mm
   - It is not permissible to rework the crankshaft.
6. Sensor Wheel
   - For the engine speed (RPM) sensor -G28-.
   - Replace
   - Installing, refer to **CRANKSHAFT SENSOR WHEEL, INSTALLING**.
7. Screw
   - 10 Nm + 90° (1/4) additional turn
   - Replace
8. Oil Spray Jet
   - For the crankshaft bearings 2 through 7.
   - For piston cooling.
   - Opening pressure: 2.0 bar
   - Removing and installing, refer to **OIL PAN, PUMP AND FILTER HOUSING OVERVIEW** .
   - See note in **LUBRICATION SYSTEM** .

PISTONS AND CONNECTING ROD OVERVIEW

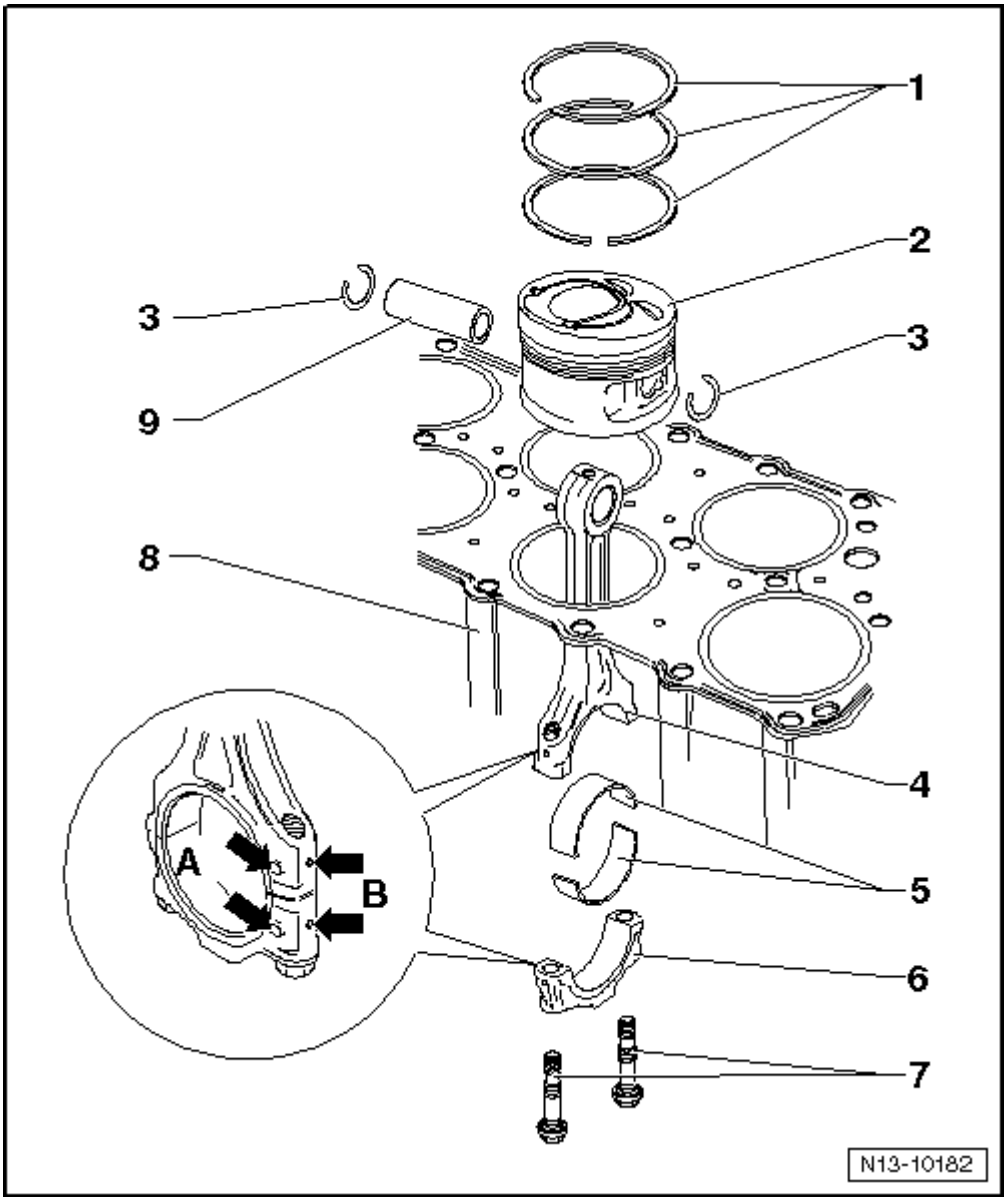

Fig. 11: Piston And Connecting Rod Assembly Overview
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Piston Rings
   - Offset gaps by 120°
   - Use piston ring pliers for removal and installation.
   - "TOP" faces toward the piston crown.
   - Checking ring gap, refer to **PISTON RING GAP, CHECKING**.
   - Checking piston ring groove clearance, refer to **PISTON RING GROOVE CLEARANCE, CHECKING**.
2. Piston
   - Checking, refer to **PISTON, CHECKING**.

- Mark the installed location to the connecting rod and affiliation to cylinder.
- The two deep valve recesses in the piston head point toward the center of the cylinder block.
- Installing, refer to **PISTON, INSTALLING**.

3. Lock Ring
   - Make sure it is secure.
4. Connecting Rod
   - Only replace as a set.
   - Affiliation to the cylinder mark -B-.
   - Installed position: the marks -A- must align.
5. Bearing Shell
   - Note the installed position.
   - Do not interchange used bearing shells.
   - Bearing shell retaining tabs must be firmly seated in the notches.
   - Axial play new: 0.05 to 0.31 mm, wear limit: 0.40 mm
   - Check radial clearance using Plastigage, new: 0.02 to 0.07 mm, wear limit: 0.10 mm Do not turn the crankshaft when checking the radial clearance.
6. Connecting Rod Bearing Cap
   - Affiliation to the cylinder mark -B-.
   - Installed position: the marks -A- must align.
7. Bolt
   - 30 Nm + 90° (1/4) additional turn
   - Replace
   - Lubricate the threads and contact surface.
   - Tighten to 30 Nm to measure the radial play, do not tighten further.
8. Cylinder Block
   - Checking cylinder bore, refer to **CYLINDER BORE, CHECKING**.
   - Crankshaft overview, refer to **CRANKSHAFT**.
   - Piston and cylinder dimensions, refer to **PISTON AND CYLINDER DIMENSIONS**.
9. Piston Pin
   - If difficult to move, heat piston to 60 °C (140 °F)
   - Remove and install using a pilot drift VW 222A.

SPECIFICATIONS

PISTON AND CYLINDER DIMENSIONS

Honing Dimension		Piston Diameter	Cylinder Bore Diameter
Basic dimension	mm	88.945	89.010

FASTENER TIGHTENING SPECIFICATIONS

Component	Fastener Size	Nm
Accessory Bracket to Cylinder Block Bolt	-	25
Camshaft Adjuster to Camshaft Bolt [1, 4]	-	60 + 90°
Camshaft Position Sensor to Timing Chain Cover Bolt	-	10
Chain Tensioner to Cylinder Block	-	50
Chain Tensioner with Tensioning Rail to Cylinder Block Bolt	-	8 + 90°
Connecting Rod Bearing Cap to Connecting Rod Bolt (1)	-	40 + 90°
Control Housing to Cylinder Head Bolt (2)	-	8 + 90°
Cover to Cylinder Head Bolt (2)	-	8
Crankshaft Bearing Cap to Cylinder Block Bolt (1)	-	30 + 180°
Drive Plate to Crankshaft Bolt (1)	-	60 + 90°
Crankshaft Sensor Wheel to Crankshaft Screw (1)	-	10 + 90°
Engine Mount Bracket to Cylinder Block Bolt	-	40
Engine Mount Bracket to Engine Mount Nut	-	75
Engine Speed Sensor to Cylinder Block Bolt	-	10
Engine Mount to Engine Carrier Bolt	-	60
Guide Rail to Cylinder Head Bolt	-	23
Guide Rail Locating Pin without Collar to Cylinder Block	-	10
Guide Rail Pivot Pin to Cylinder Block	-	10
Knock Sensor to Cylinder Block Bolt (5)	-	20
Oil Dipstick Guide Tube to Intake Manifold Bolt	-	6
Oil Drain Plug to Oil Pan (1)	-	30
Oil Filter Housing/Engine Mount Bracket to Cylinder Block Bolt	-	23
Oil Intake Pipe to Cylinder Block Bolt (1)	-	8
Oil Level Thermal Sensor to Oil Pan Bolt	-	10
Oil Pan to Cylinder Block Bolt	-	12
Oil Pressure Line to Cylinder Block Bolt (1)	-	8
Oil Pump to Cylinder Block Bolt (2)	-	8
Sprocket to Oil Pump Bolt [1, 3]	-	60 + 90°
Tensioning Rail Pivot Pin to Cylinder Block	-	10
Timing Chain Cover to Cylinder Head Bolt (6)	-	8
Vibration Damper to Crankshaft Bolt	-	100 + 180°

(1) Always replace

(2) Install using locking compound D 000 600 A2

(3) Only use bolts with a strength category of 10.9

The contact surfaces of the adjuster wheel and bolt head must be dry when installing

(4)

(5) Tightening specification affects the function of the knock sensor

(6) Tighten in a diagonal sequence and in steps

Sealing Flange (Transmission Side) Bolt Tightening Sequence and Specification

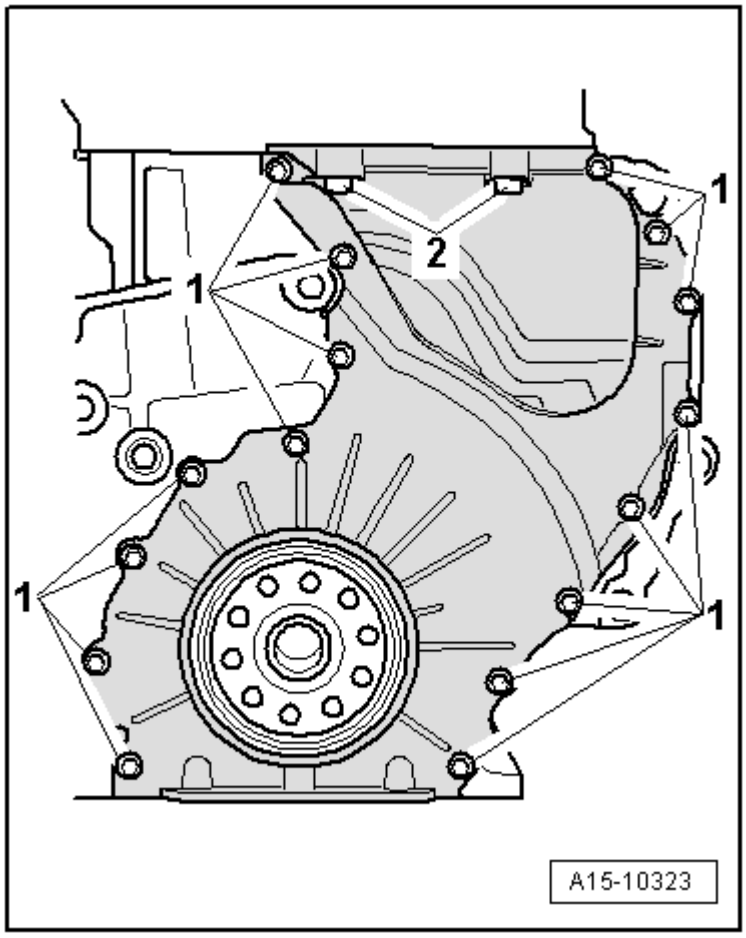

Fig. 12: Identifying Sealing Flange Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Tighten the sealing flange bolts in stages as follows:

-- Tighten the bolts -1- to **5 Nm** .

-- Tighten the bolts -2- to **23 Nm** .

-- Tighten the bolts -1- to **10 Nm** .

DIAGNOSIS AND TESTING

PISTON RING GAP, CHECKING

Special tools and workshop equipment required

- Feeler Gauge

Test Sequence:

-- Push the ring squarely from above down to approximately 15 mm from the bottom end of the cylinder. To do this use a piston without rings.

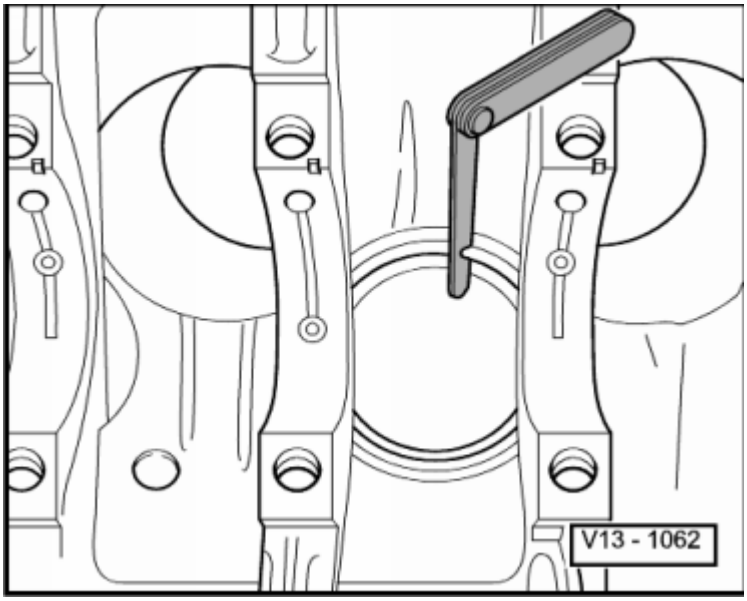

Fig. 13: Checking Piston Ring Gap
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Piston Ring		Gap	
		New	Wear limit
Compression ring	mm	0.20 to 0.40	1.0
Tapered ring	mm	0.20 to 0.40	1.0
Oil scraping ring	mm	0.25 to 0.50	1.0

PISTON RING GROOVE CLEARANCE, CHECKING

Special tools and workshop equipment required

- Feeler Gauge

Clean the ring groove before checking.

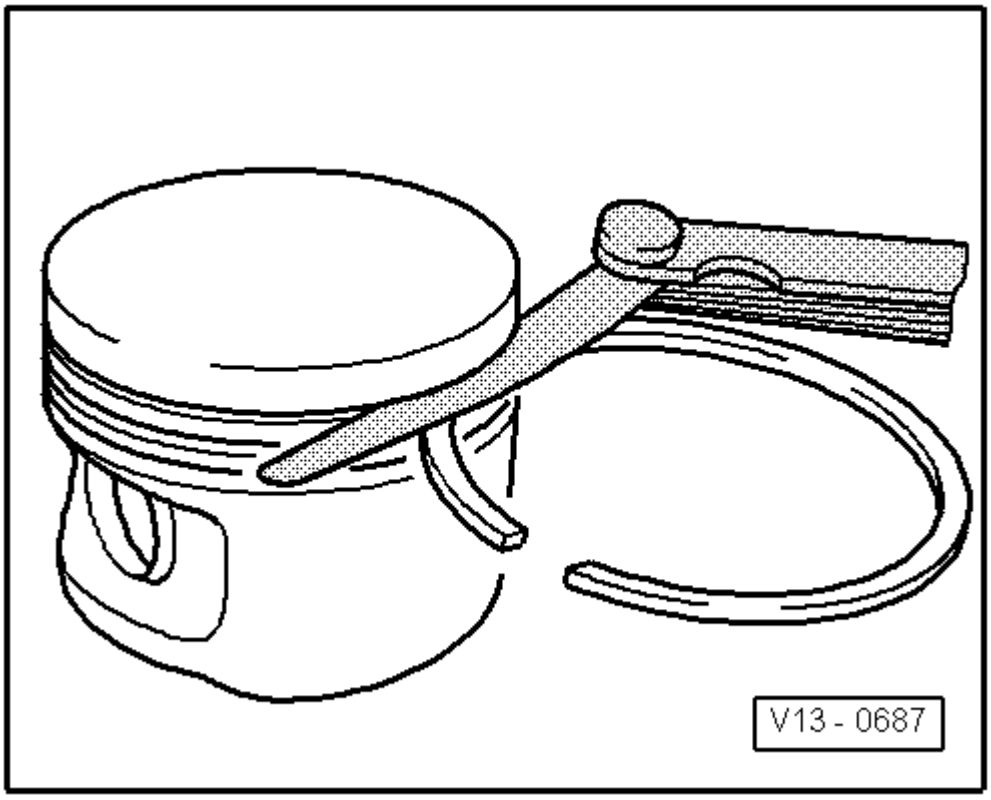

Fig. 14: Checking Piston Ring Gap
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Piston Ring		Ring to Groove Clearance	
		New	Wear limit
Compression ring	mm	0.04 to 0.09	0.15
Tapered ring	mm	0.03 to 0.06	0.15
Oil scraping ring	mm	0.02 to 0.06	0.15

PISTON, CHECKING

Special tools and workshop equipment required

- Micrometer 75-100 mm VAS 6071

Take the measurement approximately 6 mm from the lower edge of the piston skirt and offset 90° to the piston axis.

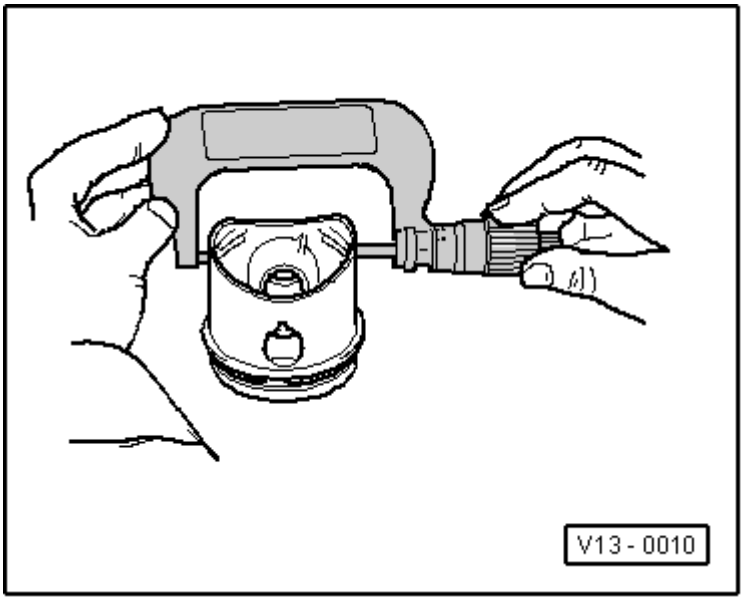

Fig. 15: Checking Piston
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Deviation from nominal dimension: Max. 0.04 mm

CYLINDER BORE, CHECKING

Special tools and workshop equipment required

- Cylinder Gauge VAS 6078

Test Sequence:

- Measure diagonally at 3 positions, transversely -A- and longitudinally -B-.

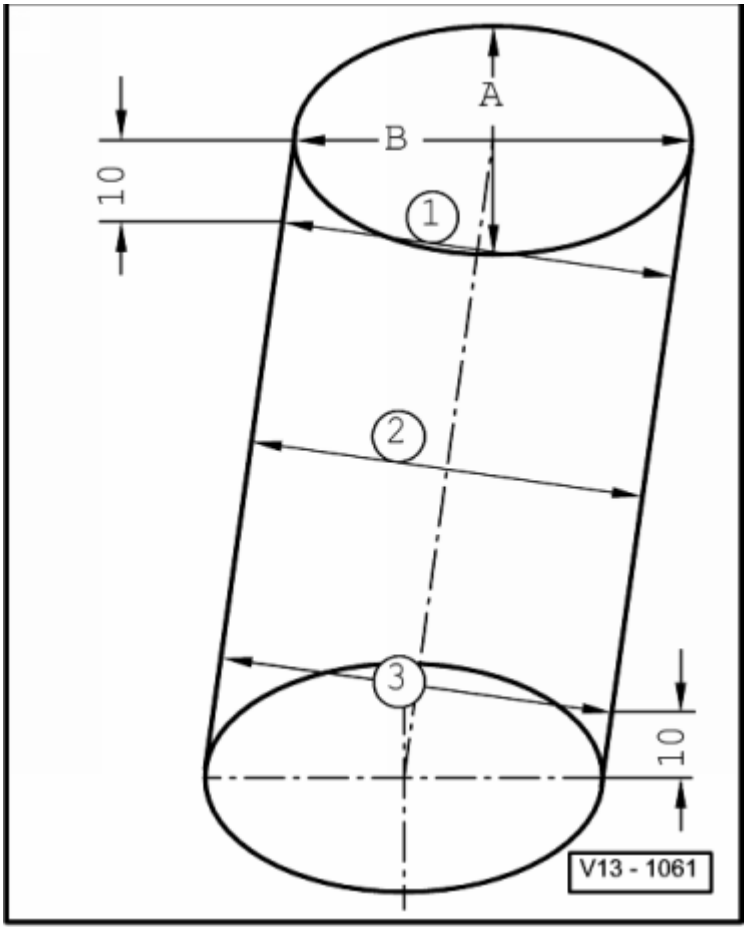

Fig. 16: Checking Cylinder Bore
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Deviation from nominal dimension: Max. 0.08 mm

NOTE: The cylinder bore must not be measured if the cylinder block is secured to the engine and transmission holder VAS 6095- or else the results may be incorrect.

REMOVAL AND INSTALLATION

RIBBED BELT

Special tools and workshop equipment required

- M8 x 50 Bolt

Removing

-- Mark the rotation direction on the ribbed belt.

-- Rotate the tensioner in the -direction of the arrow- using a suitable wrench.

-- Install an M8 x 50 bolt into the threaded hole -A-, thereby securing the belt tensioner.

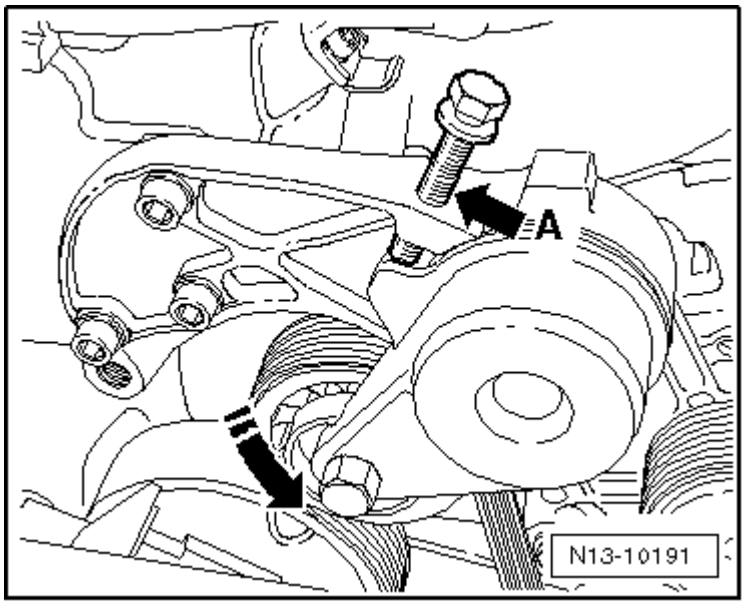

Fig. 17: Identifying M8x50 Bolt In Threaded Hole
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Only screw in the bolt so far until the ribbed belt can be removed, otherwise the housing for the tensioner can be damaged.

-- Remove the ribbed belt.

Installing

NOTE: Ensure, before installing the ribbed belt, that all ancillaries (generator, Air Conditioning (A/C) compressor, power steering pump) are secured.

Check that idler pulley turns easily.

Note the previously marked rotation direction, if reinstalling the used belt and be sure that it is seated correctly on the pulleys.

-- Route the ribbed belt and remove the M8 bolt from the belt tensioner.

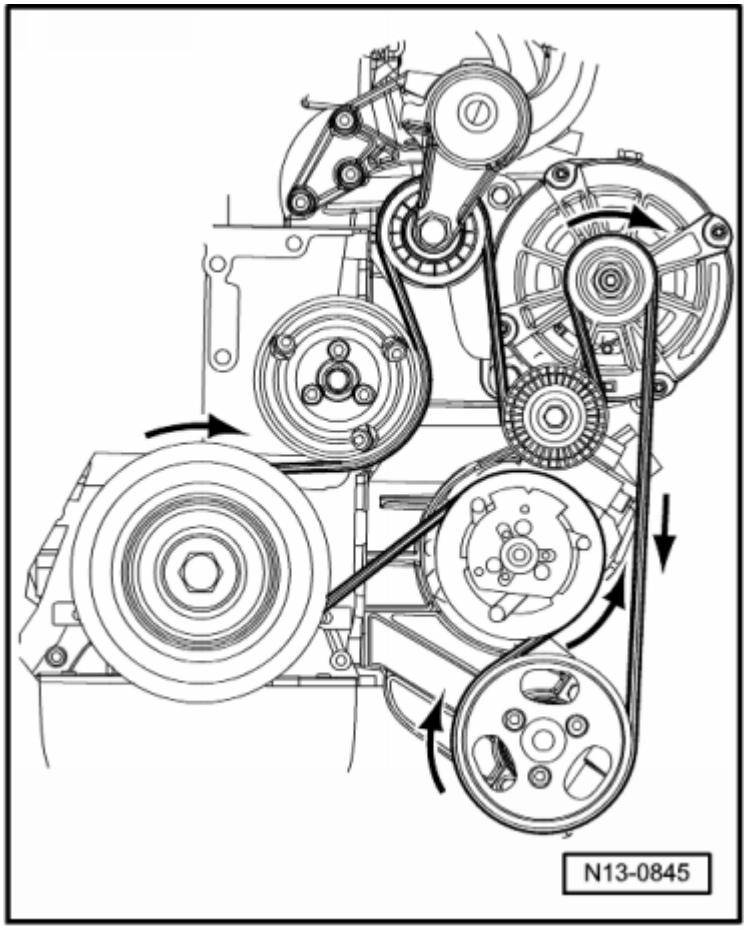

Fig. 18: Identifying Ribbed Belt Routing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

When finished, always perform the following work:

-- Start the engine and check the belt running.

ENGINE MOUNT AND BRACKET

Special tools and workshop equipment required

- Shackle 10 - 222A/12
- Adapter 10 - 222A/16
- Adapter 10 - 222A/19
- Engine Support Bridge 10 - 222A

Removing

-- Completely remove the air filter housing with the Mass Airflow (MAF) sensor. Refer to **AIR FILTER HOUSING OVERVIEW** .

-- Remove the right and left side engine mount bracket to engine mount nuts -2-.

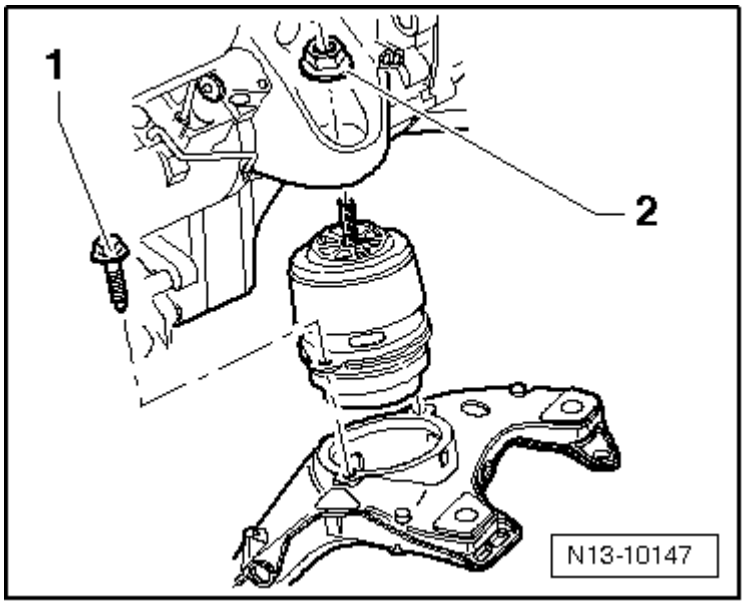

Fig. 19: Identifying Nuts On Engine Mount At Left And Right Engine Supports
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the 10 - 222A/16 onto the 10 - 222A with the high side of the threaded spindle guide facing upward as shown in the illustration.

-- Place the 10 - 222A/19 on the left and right ends of the 10 - 222A. Install the 10 - 222 A onto the longitudinal members.

-- Support the engine with two 10 - 222A/12 and the 10 - 222 A/16, pretension the engine slightly.

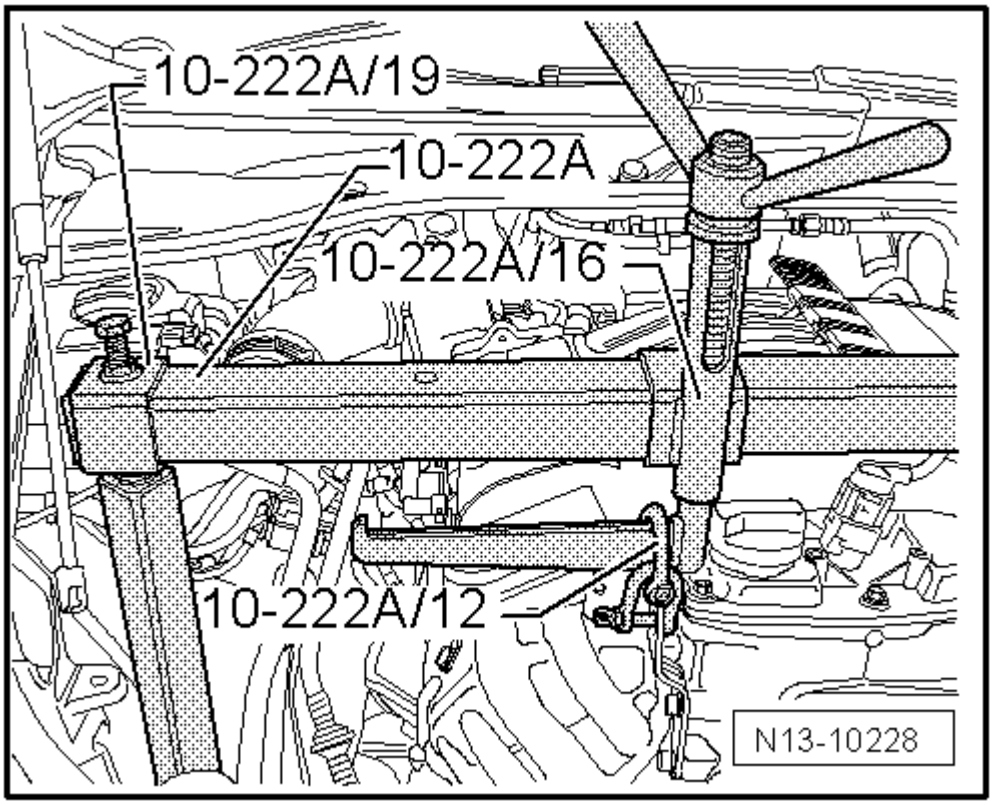

Fig. 20: Engaging Engine With Two Shackles 10 - 222 A/12 At Adapter 10 - 222 A/16 And Pretensioning Engine Slightly
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the left and right engine mount to engine carrier bolts -1-.

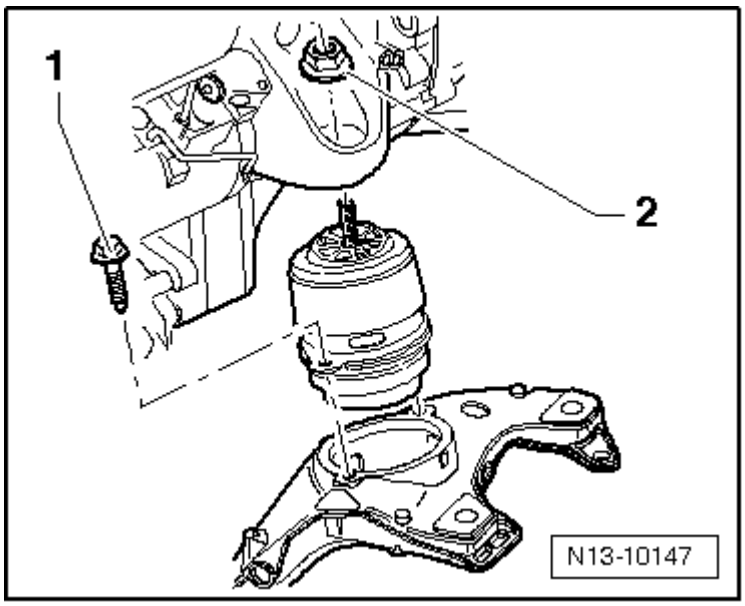

Fig. 21: Identifying Nuts On Engine Mount At Left And Right Engine Supports

Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Be aware of the available clearance between the cylinder head and the bulkhead.

-- Carefully lift the engine using the 10 - 222 A/16.

-- To remove the engine mount bracket from the cylinder block, the bracket must be unbolted from the block on the left or right so that the engine can be raised up enough.

Installing

Installation is performed in reverse order of removal.

-- When installing, make sure the alignment pin of the engine mount is correctly positioned in the engine mount bracket.

-- First install all bolts by hand, and then tighten them all to specifications.

Tightening specification for the bolt -1- : **60 Nm** .

Tightening specification for the nut -2- : **75 Nm** .

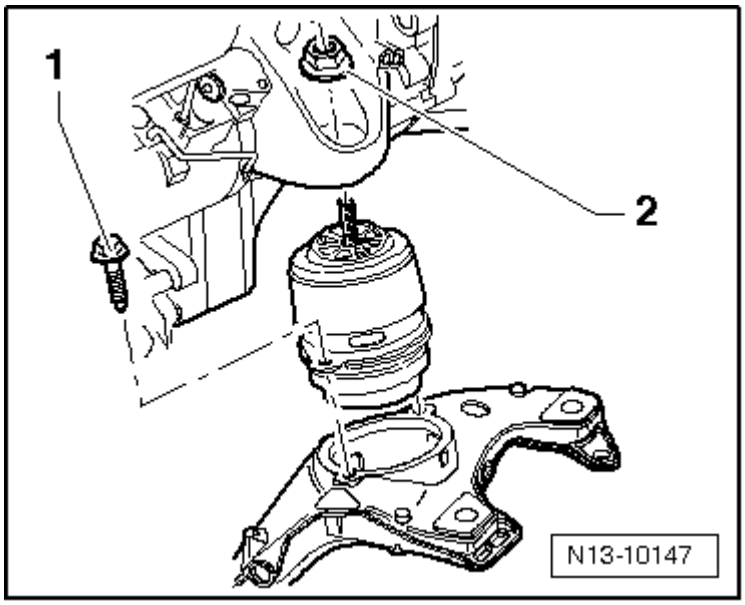

Fig. 22: Identifying Nuts On Engine Mount At Left And Right Engine Supports
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Tightening specification for the oil filter housing/engine mount bracket bolts to the cylinder block, left side: **23 Nm**

Tightening specification for the engine mount bracket bolts to the cylinder block, right side: **40 Nm**

SEALING FLANGE, VIBRATION DAMPER SIDE

Special tools and workshop equipment required

- Counter-Holder Tool T10069
- Assembly Tool T10215
- Torque Wrench V.A.G 1601
- Torque Wrench (40-200 Nm) V.A.G 1332

Removing

NOTE: To remove the sealing flange, the engine must be removed. Refer to REMOVING .

-- Remove the ribbed belt. Refer to **RIBBED BELT**.

-- For repair work, the engine should be secured to the VAS 6095. Refer to **SECURING TO ENGINE AND TRANSMISSION HOLDER** .

-- Remove the vibration damper. To do so, lock the vibration damper using the T10069.

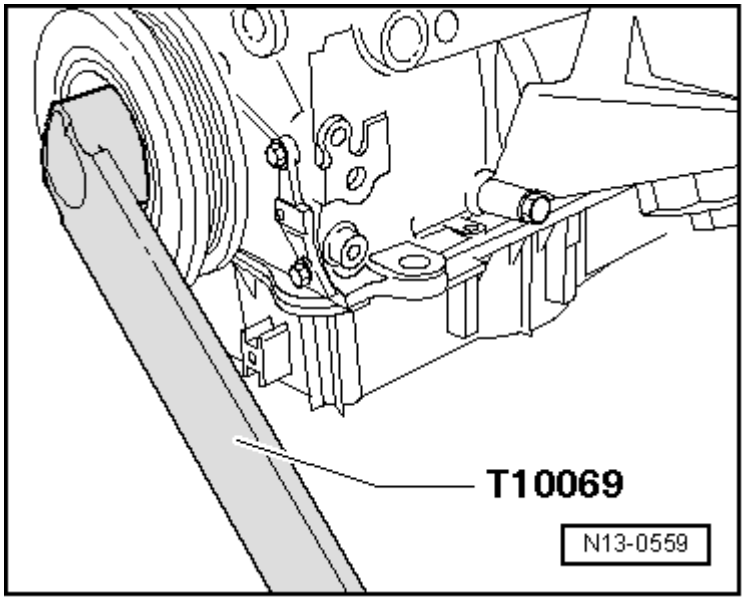

Fig. 23: Counter-Holder T10069 To Hold Vibration Damper
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the oil pan. Refer to **OIL PAN** .

-- Remove the sealing flange bolts and flange.

-- Remove the sealant residue from the sealing surfaces.

Installing

-- Before installing, remove any remaining oil from the end of the crankshaft with a clean cloth.

-- Cut the tube nozzle at the front mark (nozzle diameter approximately 3 mm).

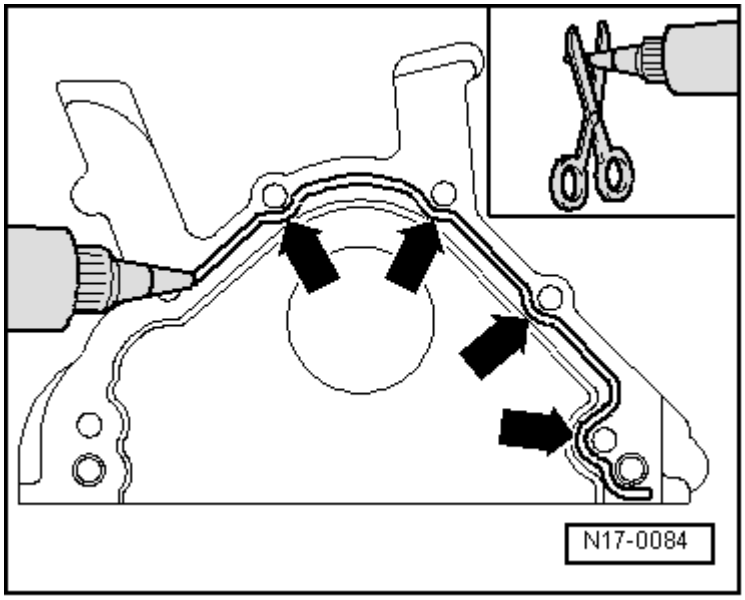

Fig. 24: Applying Silicone Sealing Compound
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Apply a bead of sealant, approximately 2 to 3 mm as shown -arrows- onto the clean sealing surface of the sealing flange.

NOTE: Cover the seal with a clean cloth before applying the sealant bead.

The sealant bead must not be thicker than 2 to 3 mm or the excess sealant could get into the oil pan and clog the oil intake pipe strainer.

Note the expiration date of the sealant.

The sealing flange must be installed within 5 minutes after application of the sealant.

-- Install the T10215/1 -1- on the crankshaft -3-.

-- Slide the sealing flange with the seal -2- carefully over the T10215/1.

-- Install the sealing flange bolts.

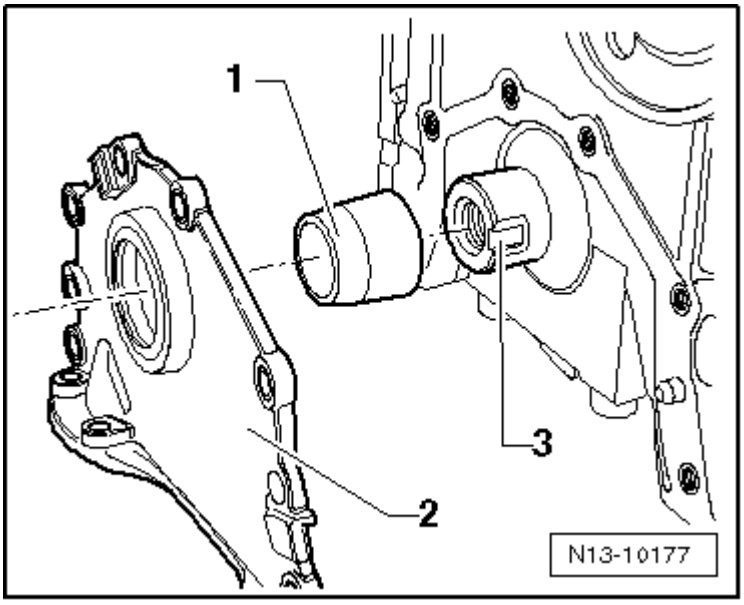

Fig. 25: Identifying Guide Sleeve T10215/1, Crankshaft Pin & Sealing Ring
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the oil pan. Refer to **OIL PAN** .

-- Install the vibration damper. Refer to **CYLINDER BLOCK, VIBRATION DAMPER AND LUBRICATION COMPONENTS**.

-- Install the ribbed belt. Refer to **RIBBED BELT**.

DRIVE PLATE

Special tools and workshop equipment required

- Counter-Holder Tool T10069
- Torque Wrench (40-200 Nm) V.A.G 1332

Removing

-- Removing the engine. Refer to **REMOVING** .

-- Lock the vibration damper using the T10069.

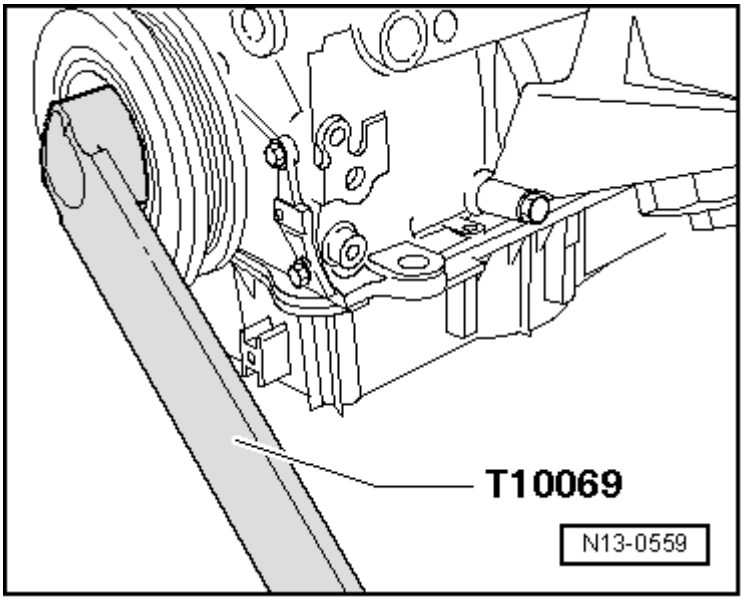

Fig. 26: Counter-Holder T10069 To Hold Vibration Damper
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Loosen the drive plate bolts diagonally and remove them.

-- Remove the drive plate.

Installing

-- Install the drive plate onto the crankshaft.

-- Insert at least 3 old drive plate bolts and tighten them to 30 Nm.

-- Measure dimension -a- using a depth gauge: specified value: 21 to 23 mm.

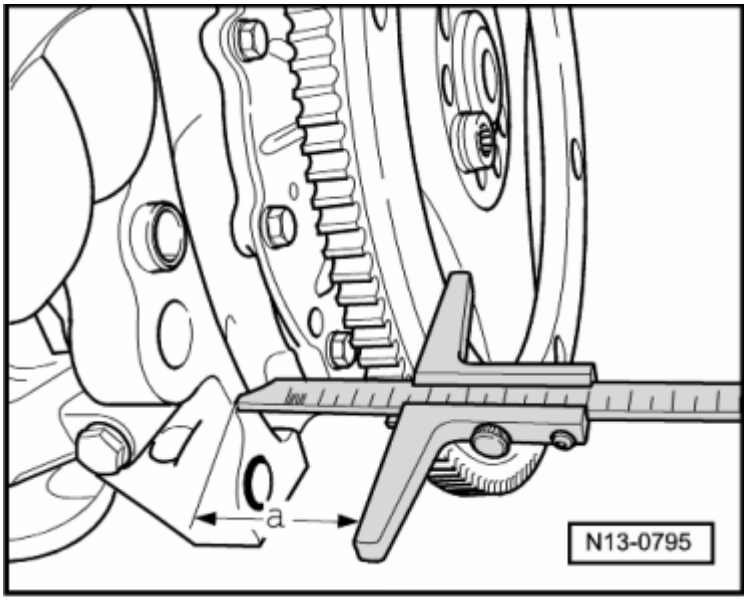

Fig. 27: Measuring Dimension Using Depth Gauge
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

If the specified value is not reached:

-- Remove the drive plate again and install the appropriate shim -1-.

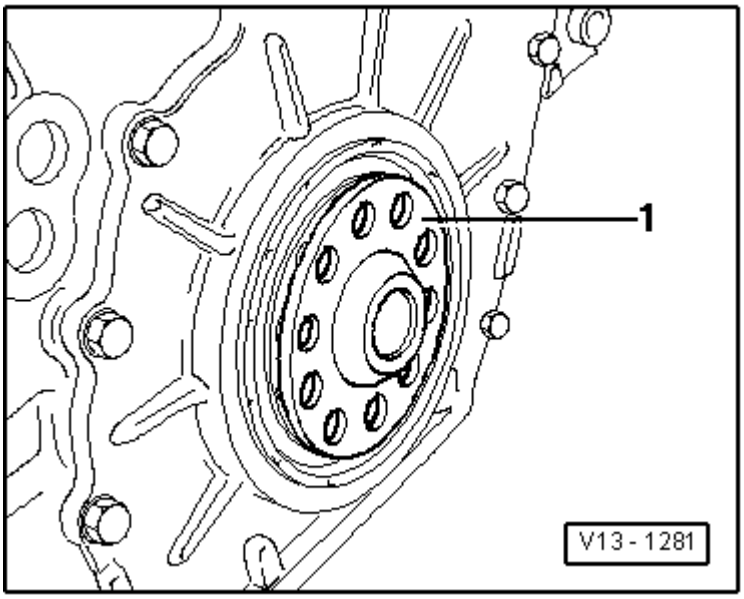

Fig. 28: Identifying Appropriate Shim
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Only one shim of the appropriate thickness may be used.

If the specified value is obtained:

-- Install new drive plate bolts and tighten them by hand.

-- Tighten the bolts to 60 Nm + 90° (1/4) additional turn.

-- Install the engine. Refer to **INSTALLING** .

SEALING FLANGE SEAL, TRANSMISSION SIDE

Special tools and workshop equipment required

- Assembly Tool T10122
- Pulling Hook T20143

Removing

-- Remove the drive plate. Refer to **DRIVE PLATE**.

-- Secure the engine to the VAS 6095. Refer to **SECURING TO ENGINE AND TRANSMISSION HOLDER** .

-- Place the pulling hook T20143/2- behind the sealing lip of the seal as shown in the illustration.

-- Support the T20143/2 on the sealing flange and pry out the seal in the -direction of the arrow-.

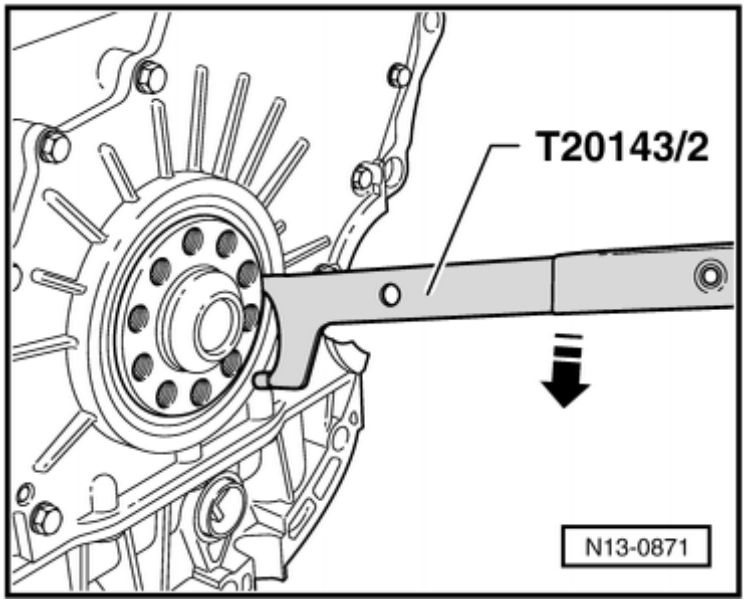

Fig. 29: Identifying Removal Hook T20143/2 Placed Behind Sealing Lip Of Oil Seal
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Installing

-- Pull the seal -A- with its outside over the sleeve T10122/1 of the assembly tool T10122 onto the assembly

tool T10122/2.

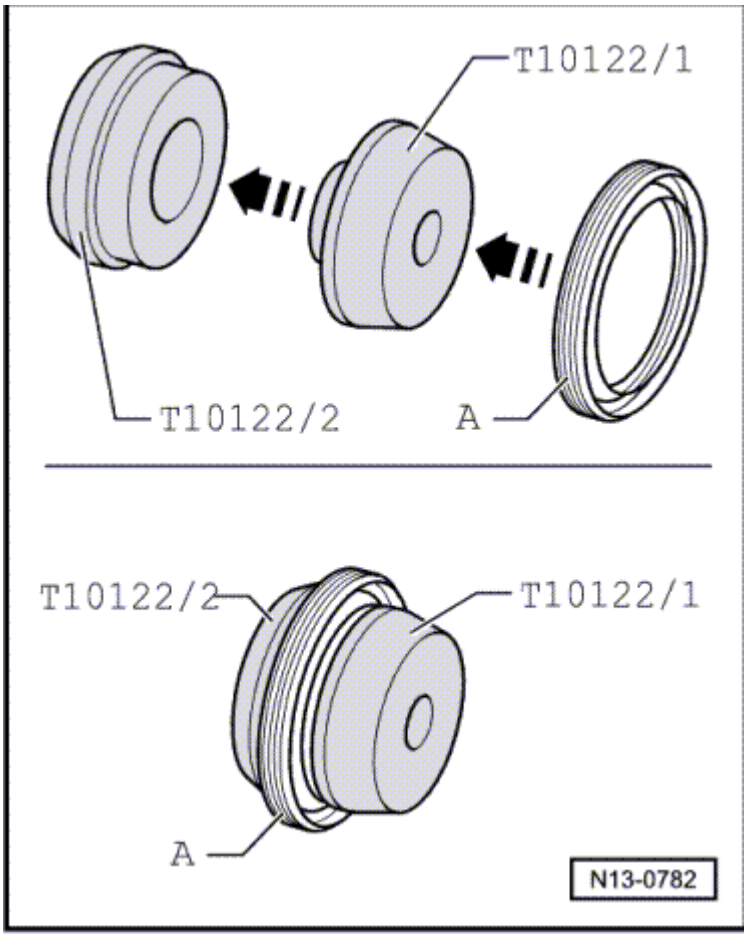

Fig. 30: Identifying Seal, Sleeve T10122/1 And Assembly Tool T10122/2
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Separate both assembly sleeves.

-- Then, place the assembly tool T10122/2 with the dry seal onto the crankshaft.

-- Now, drive the seal into the sealing flange until it is seated using the assembly tool T10122/3.

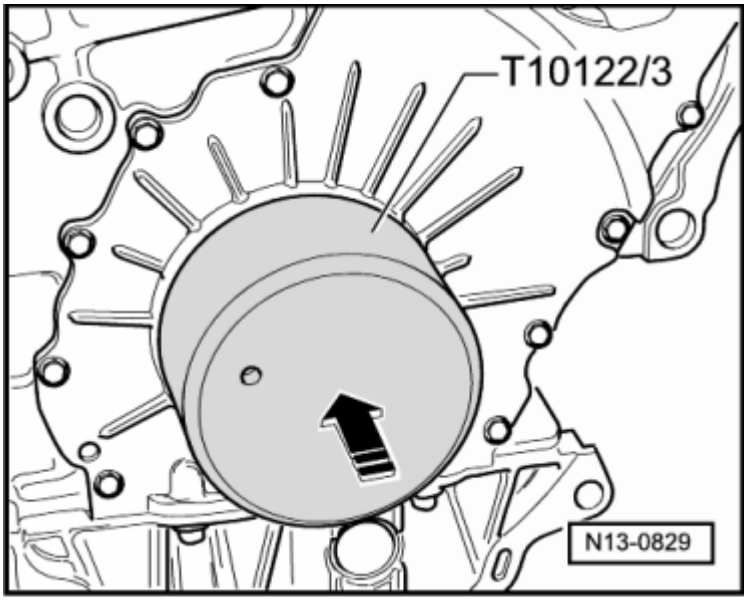

Fig. 31: Driving Seal Into Sealing Flange Until Stop Using Thrust Piece T10122/3
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the drive plate. Refer to **DRIVE PLATE**.

SEALING FLANGE, TRANSMISSION SIDE

Special tools and workshop equipment required

- Hand Drill with Plastic Brush Attachment
- Protective Eyewear
- Sealant D 176 501 A1

Removing

- Removing the engine. Refer to **REMOVING**

- Separate the engine and transmission.

- Secure the engine to the engine and transmission holder VAS 6095. Refer to **SECURING TO ENGINE AND TRANSMISSION HOLDER**

-- Remove the drive plate. Refer to **DRIVE PLATE**.

-- Remove the oil pan. Refer to **OIL PAN** .

-- Remove the sealing flange bolts -1 and 2-.

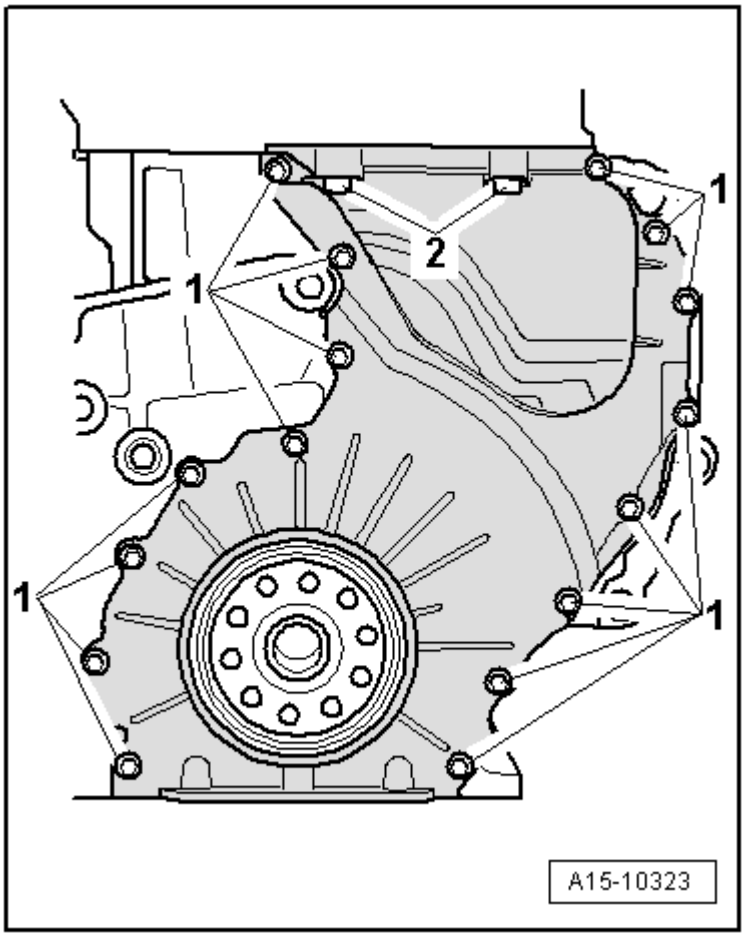

Fig. 32: Identifying Sealing Flange Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

CAUTION: The cylinder head gasket could be damaged. The cylinder head gasket can kink if it is bent too much. A kinked cylinder head gasket must be replaced.

-- Remove the sealing flange from the cylinder block horizontally.

-- Press the crankshaft seal out of the lower timing chain cover.

Installing

- Tightening specifications, refer to **TIMING CHAIN COVER AND SEALING FLANGE OVERVIEW**.

CAUTION: Risk of contaminating lubrication system with sealant residue. Carefully cove the exposed parts of the engine prevent any sealant residue from falling in.

-- Using a rotating plastic brush, remove the remaining sealant from the sealing flange and cylinder block. Wear safety glasses.

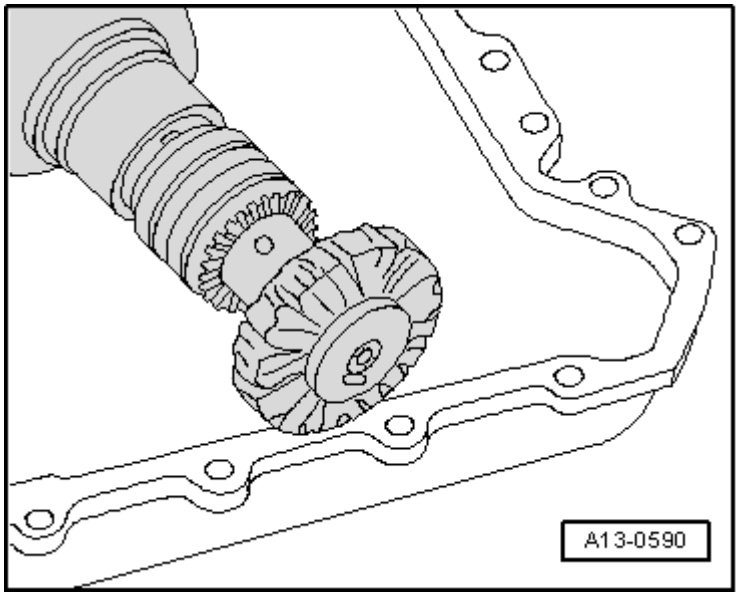

Fig. 33: Identifying Rotating Plastic Brush To Remove Sealant Residue From Sealing Flange, Cylinder Block And Upper Part Of Oil Pan
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

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

-- Clean the holes -arrow- in the cylinder head gasket of old sealant.

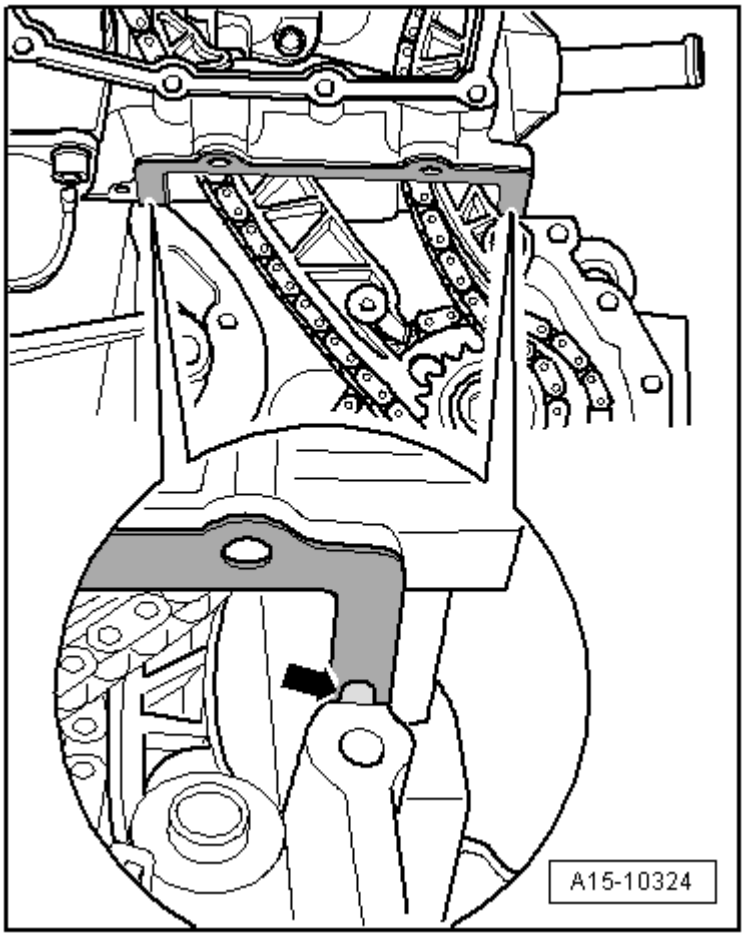

Fig. 34: Cleaning Holes -Arrow- In Cylinder Head Gasket Of Old Sealant
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

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

CAUTION: The cylinder head gasket could be damaged. The cylinder head gasket can kink if it is bent too much. A kinked cylinder head gasket must be replaced.

-- Bend the end of the cylinder head gasket down slightly -arrows- until the upper sealing surface on the cylinder head gasket and cylinder head can be cleaned.

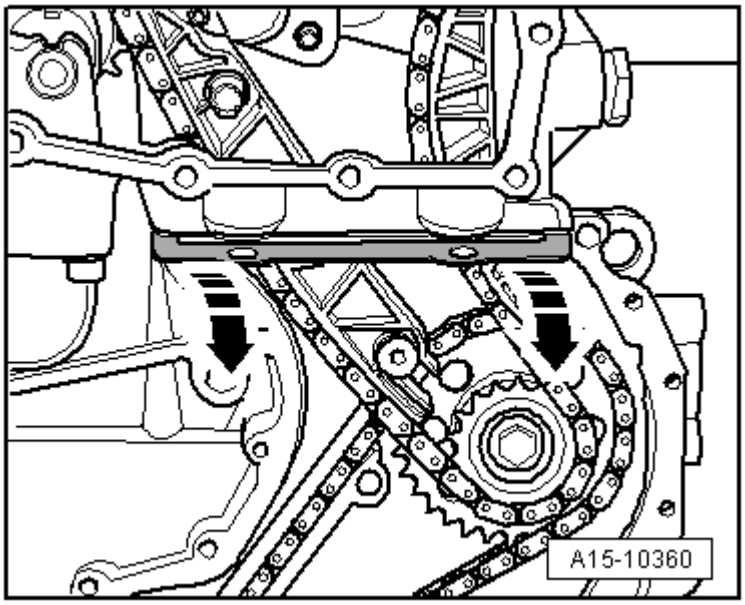

Fig. 35: Bending End Of Cylinder Head Gasket Down Slightly
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Clean the top and bottom of the cylinder head gasket, it must be free of oil and grease.

-- Cut the tube nozzle at the front mark (nozzle diameter approximately 2 mm).

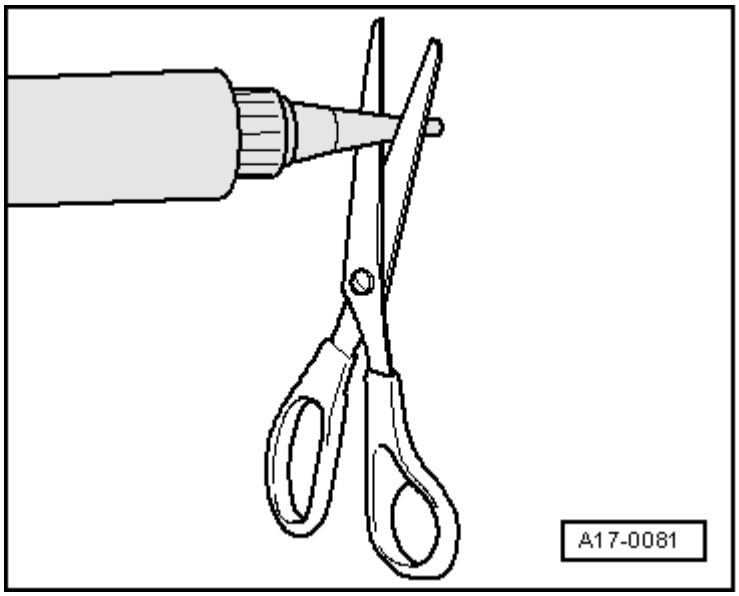

Fig. 36: Cut Tube Nozzle At Front Marking (Nozzle Diameter Approx. 3 Mm)
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Lightly apply sealant to the top and bottom cylinder head gasket sealing surfaces by bending the gasket down slightly again -arrows-.

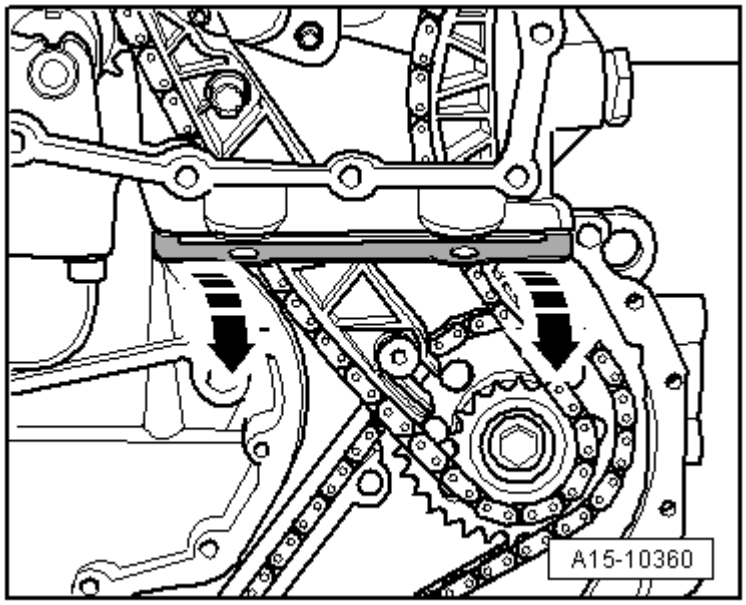

Fig. 37: Bending End Of Cylinder Head Gasket Down Slightly
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- To apply the sealant between the cylinder head and gasket surfaces, use a flat object, for example, a feeler gauge.

-- Place a thin bead of sealant -arrows- from below in both corners between the cylinder head gasket and cylinder block so that cylinder head gasket holes are filled.

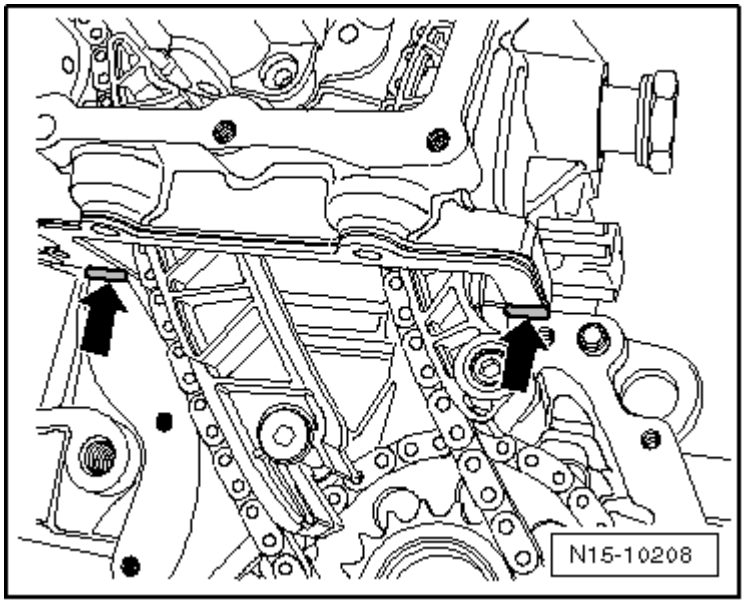

Fig. 38: Identifying Sealant Locations For Corners Of Cylinder Block/Cylinder Head
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Make sure the sealing flange alignment bushings are installed in the cylinder block.

-- Apply sealant D 176 501 A1 onto the sealing flange as shown.

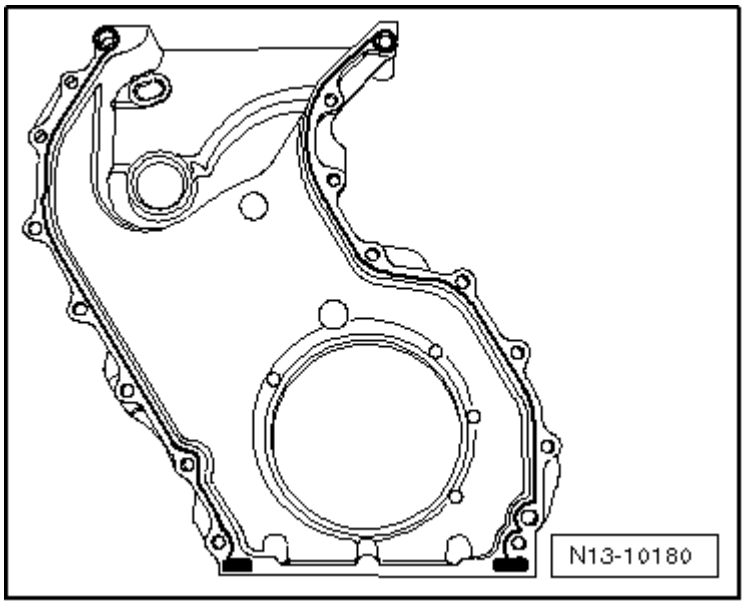

Fig. 39: Applying Sealant On Clean Sealing Surfaces Of Sealing Flange
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The sealing flange must be installed within 5 minutes of applying the sealant.

-- Tighten the bolts in 3 passes as follows:

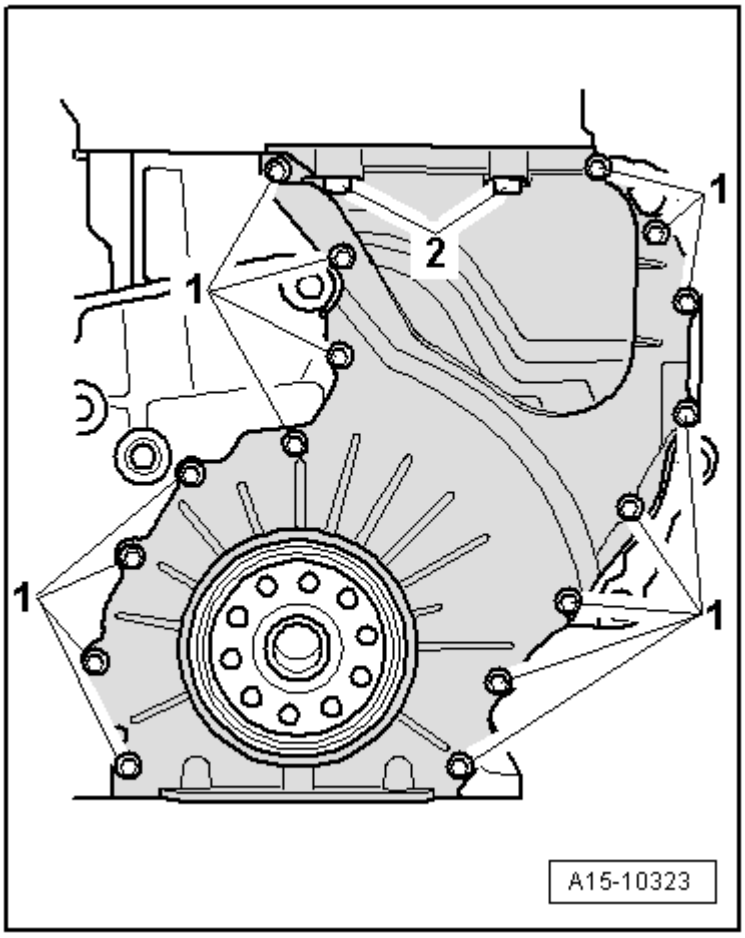

Fig. 40: Identifying Sealing Flange Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

A - Tighten the bolts -1- to 5 Nm.

B - Tighten the bolts -2- to 23 Nm.

C - Tighten the bolts -1- to 10 Nm.

The rest of the installation is performed in reverse order of removal, noting the following:

-- Install the crankshaft seal. Refer to **SEAL, TRANSMISSION SIDE**.

-- Install the oil pan. Refer to **OIL PAN** .

-- Install the drive plate. Refer to **DRIVE PLATE**.

CRANKSHAFT SENSOR WHEEL, INSTALLING

Special tools and workshop equipment required

- Torque Wrench (5-50 Nm) V.A.G 1331
- Locking Compound D154 100 A1

Procedure

Make sure the crankshaft and sensor wheel contact surfaces are free of oil and grease.

NOTE: The sensor wheel may only be installed once, since the attachment points - arrows- of the countersunk screws -1- in the sensor wheel -2- are so severely deformed after installing the second time that the screw heads make contact on the crankshaft -3- and the sensor wheel lies loosely under the screws.

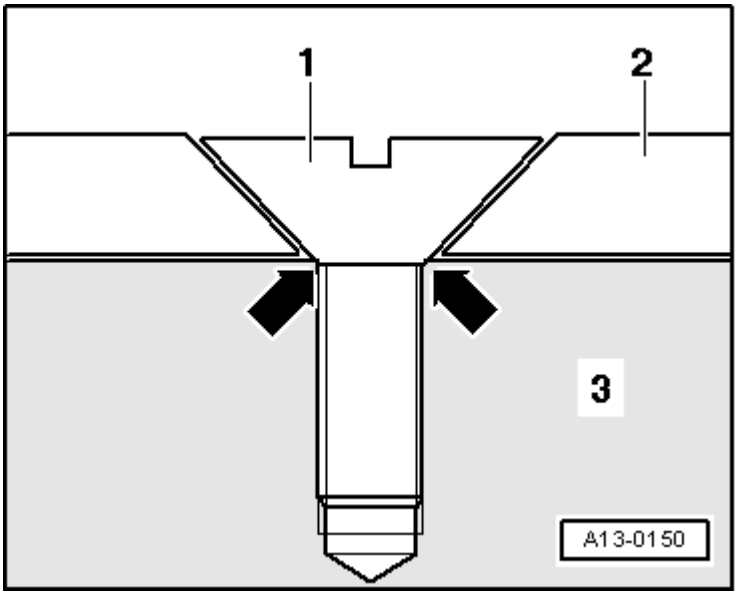

Fig. 41: Identifying Attachment Points, Countersunk Screws, Crankshaft & Sensor Wheel
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Apply a thin coat of locking compound D154 100 A1 to the contact surfaces of the crankshaft and sensor wheel for additional security.

-- When installing, make sure that the mark -VR6- -arrow- aligns with the single threaded hole.

-- Install the new bolts lightly by hand.

-- Tighten the bolt -1- to 10 Nm + 90° (1/4) additional turn.

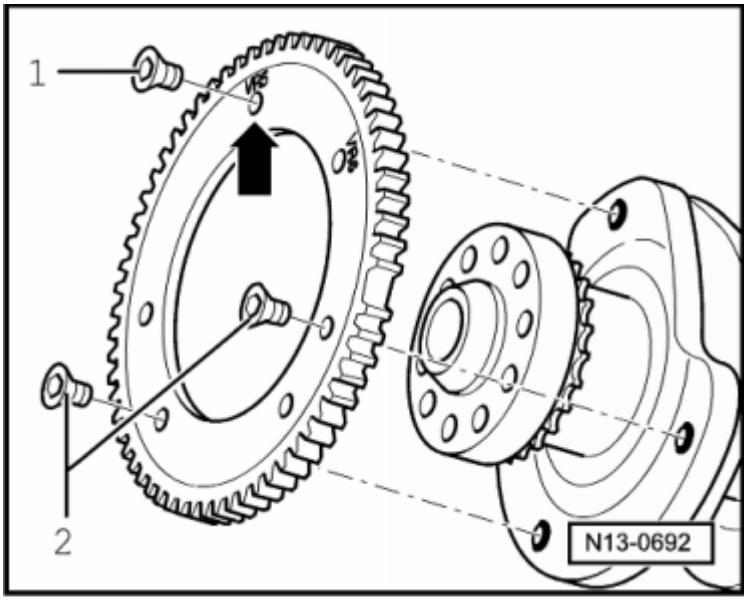

Fig. 42: Identifying VR6 And Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Tighten the bolts -2- to 10 Nm + 90° (1/4) additional turn.

PISTON, INSTALLING

Special tools and workshop equipment required

- Funnel for Piston Installation T10333

NOTE: The T10333 with a piston installed, is placed on the cylinder block so that the straight side of the T10333 -arrow- faces toward the center of the cylinder block.

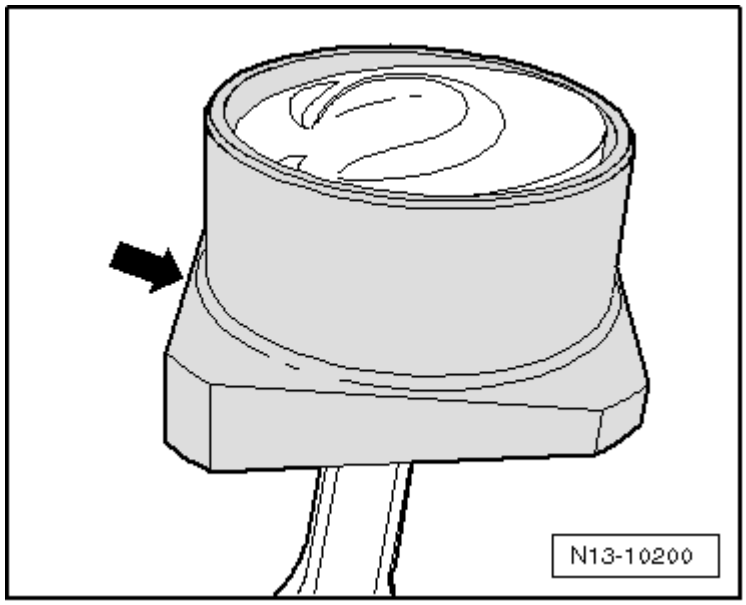

Fig. 43: Identifying Piston Installation Tool
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Procedure

-- Before installing the piston, remove the alignment sleeve -arrow- from the cylinder block.

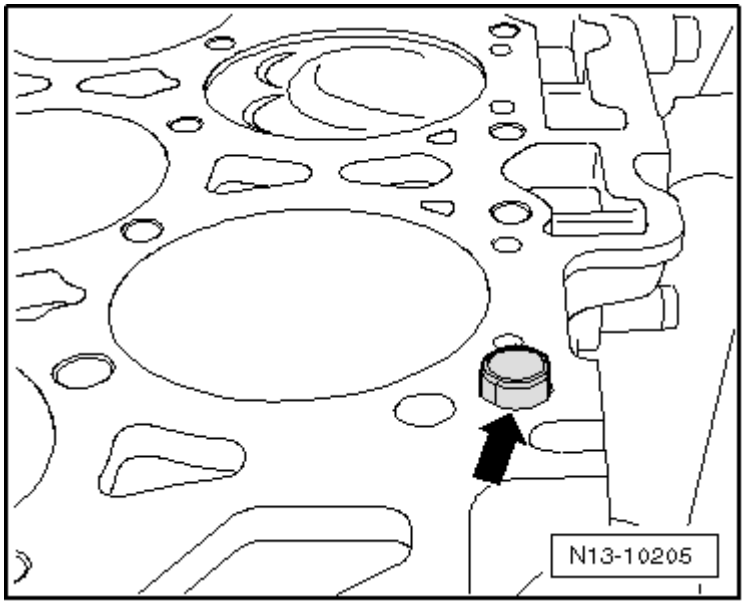

Fig. 44: Identifying Alignment Bushing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- The pistons for cylinders 1, 3 and 5 must be installed so that the deep valve recesses -1- point toward the center of the cylinder block and the arrows -3- point toward the vibration damper.

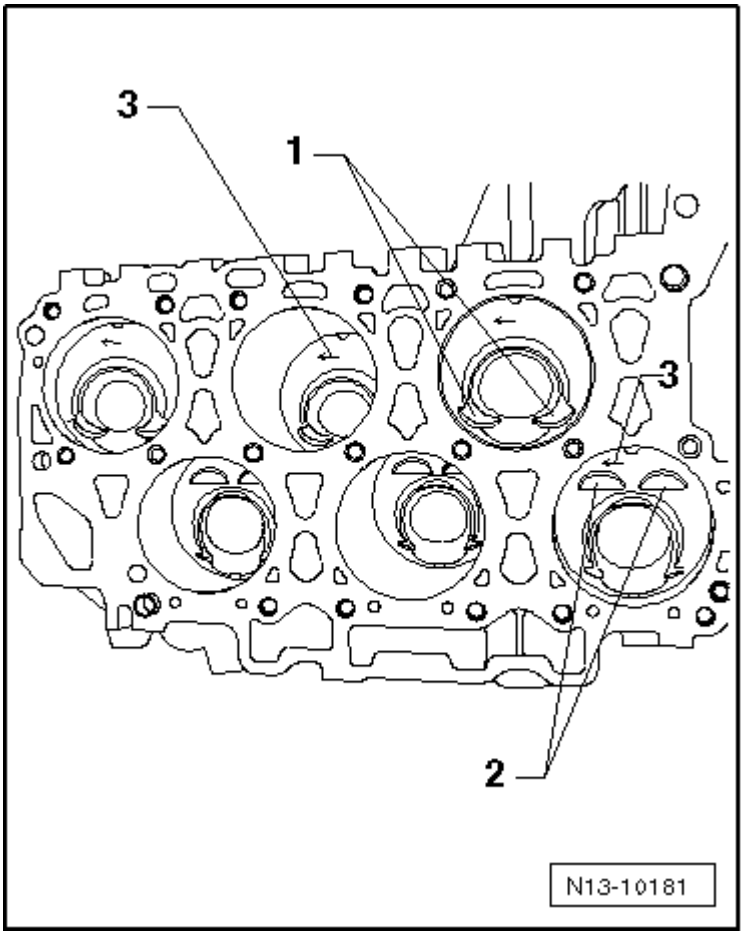

Fig. 45: Identifying Pistons Cylinders Positions
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- The pistons for cylinders 2, 4 and 6 must be installed so that the deep valve recesses -2- point toward the center of the cylinder block and the arrows -3- point toward the vibration damper.

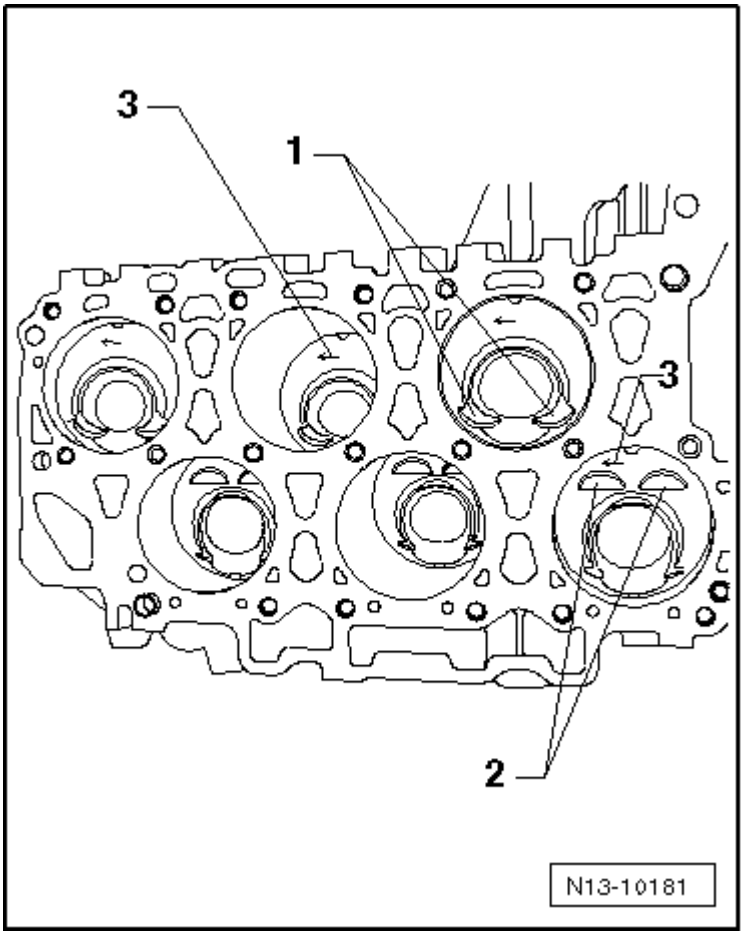

Fig. 46: Identifying Pistons Cylinders Positions
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Slide the correct piston for each cylinder into the T10333 from above until the short side of the piston -arrow- extends approximately 15 mm out of the lower edge of the T10333.

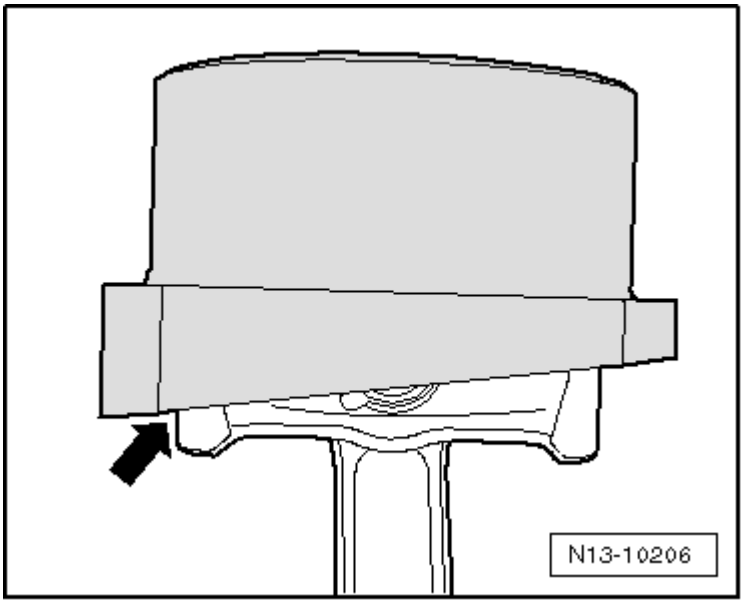

Fig. 47: Sliding Correct Piston For Each Cylinder From Above Into Piston Installation Tool
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Now place the piston and T10333 into the appropriate cylinder bore. The high side of the T10333 -arrow- must face toward the center of the cylinder block.

-- Place the T10333 securely on the cylinder block and slide the piston completely into the cylinder bore.

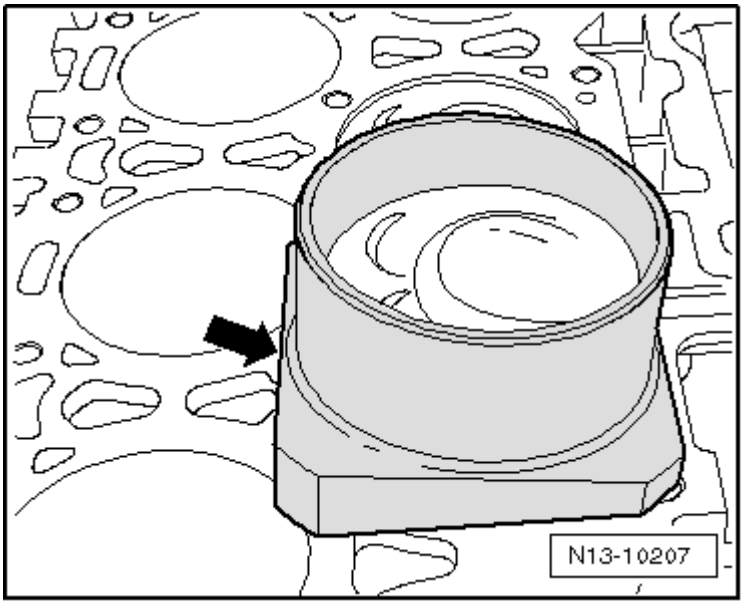

Fig. 48: Placing Funnel Securely On Cylinder Block And Slide Piston Completely Into Cylinder Bore
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- After the piston has been installed, install the alignment sleeve -arrow- back into the cylinder block.

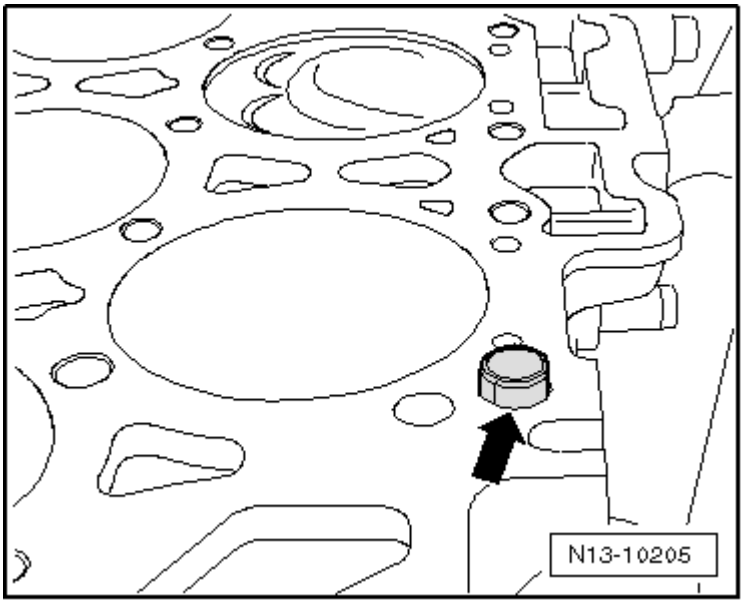

Fig. 49: Identifying Alignment Bushing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

SPECIAL TOOLS

Special tools and workshop equipment required

- Micrometer 75-100 mm VAS 6071
- Cylinder Gauge VAS 6078
- Shackle 10 - 222A/12
- Adapter 10 - 222A/16
- Adapter 10 - 222A/19
- Engine Support Bridge 10 - 222A

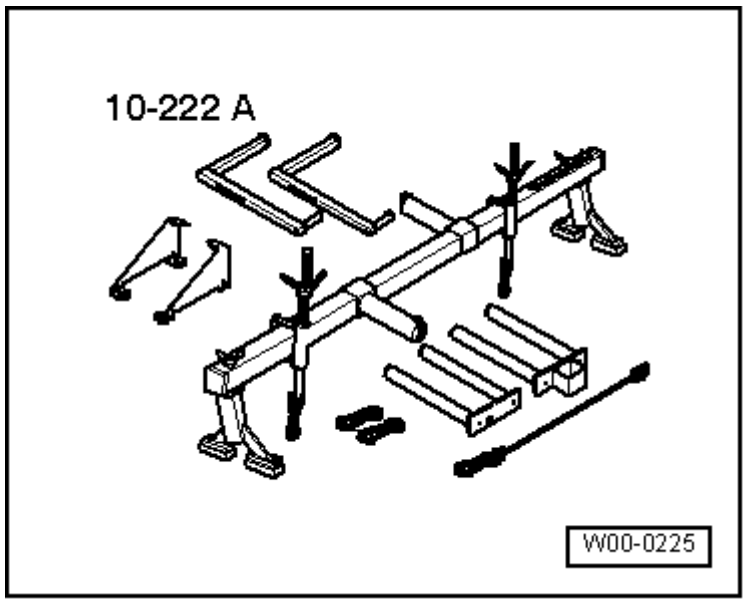

Fig. 50: Engine Support Bridge 10 - 222 A
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Assembly Tool T10122

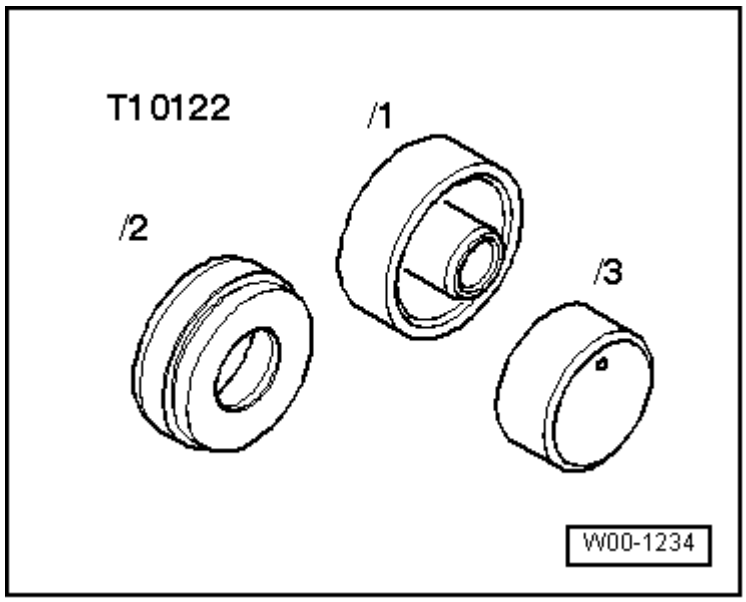

Fig. 51: Identifying Installation Tool T10122
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Pulling Hook T20143

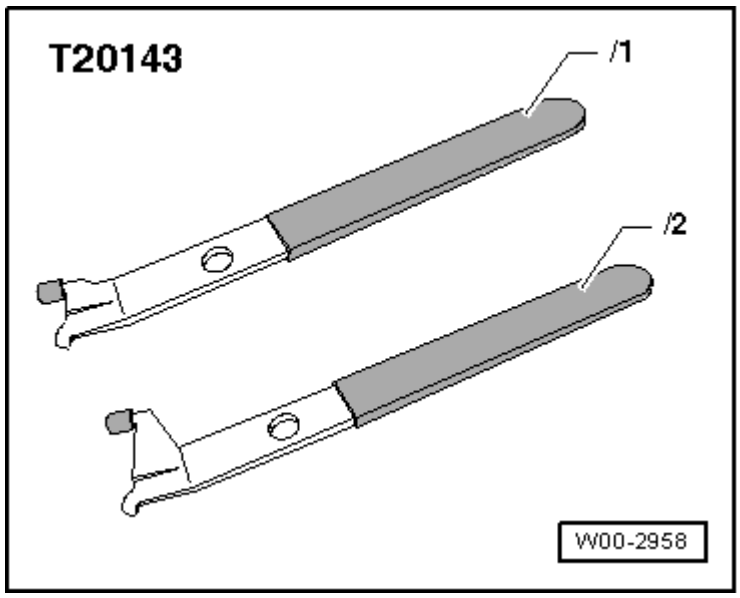

Fig. 52: Extractor Hook T20143
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Torque Wrench (5-50 Nm) V.A.G 1331

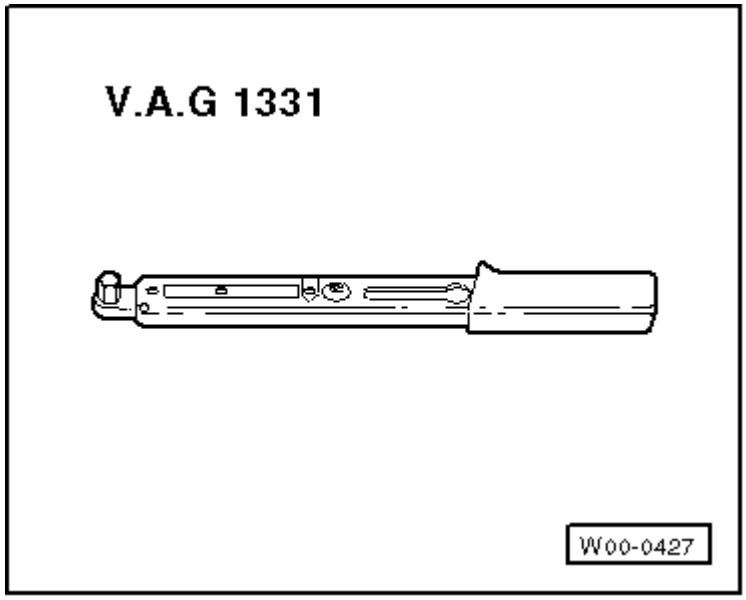

Fig. 53: Identifying Torque Wrench (5 To 50 Nm) V.A.G 1331
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Funnel for Piston Installation T10333

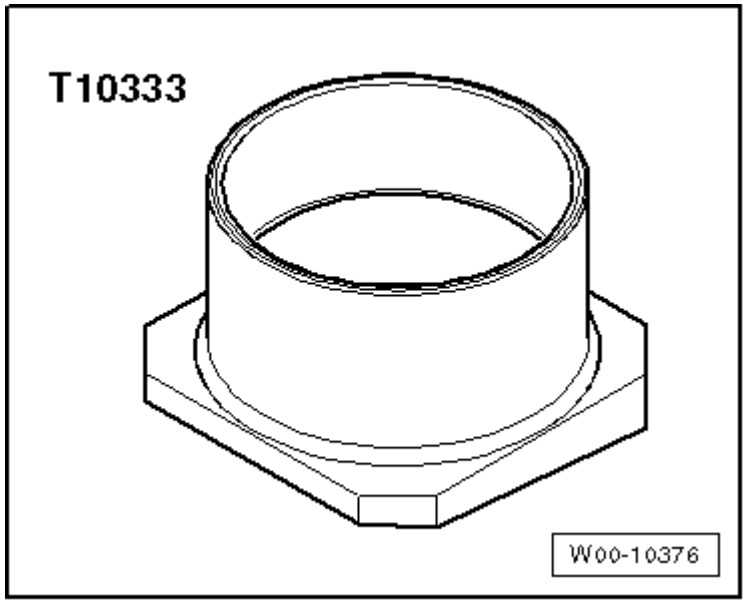

Fig. 54: Identifying Funnel T10333
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

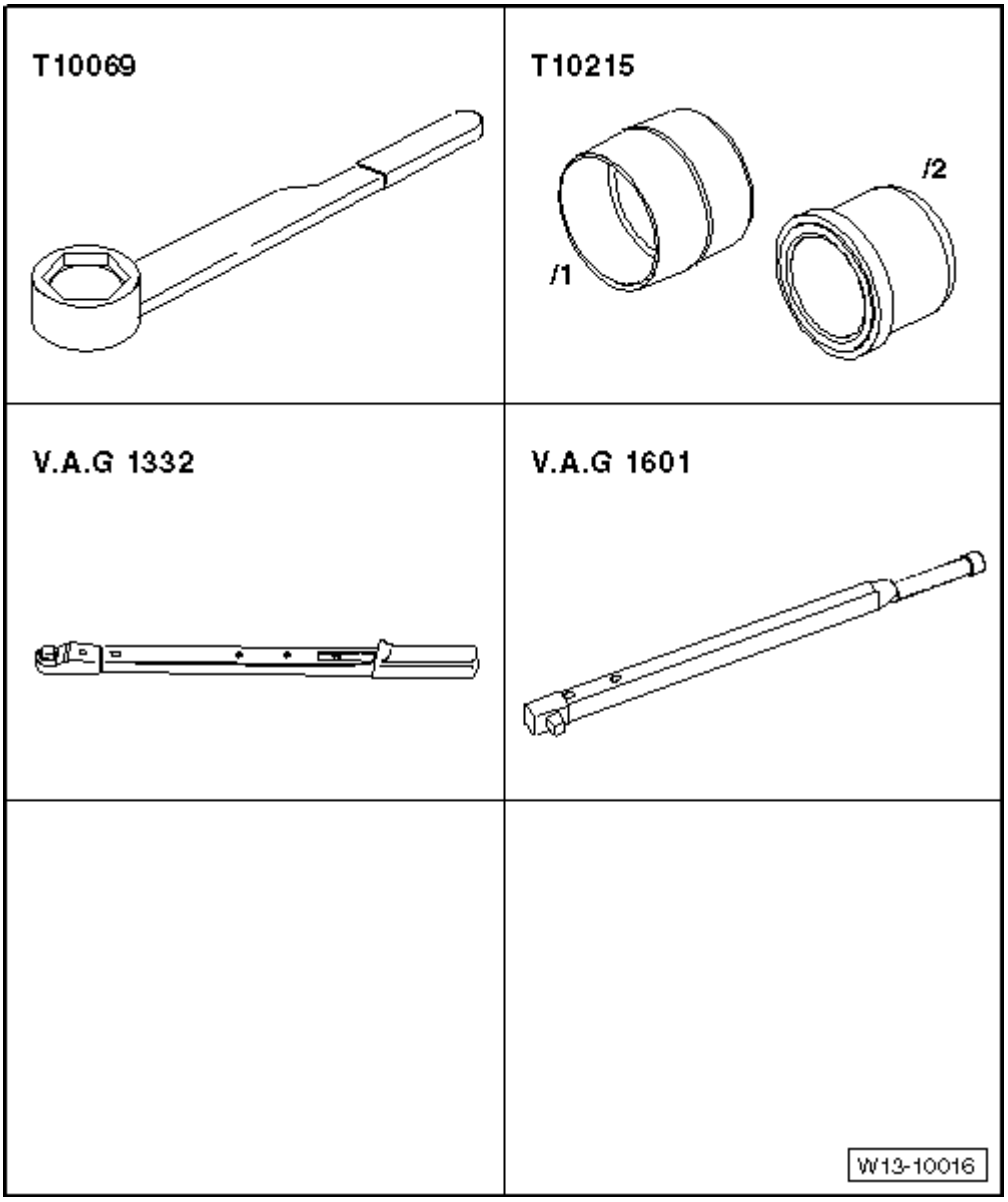

Fig. 55: Identifying Special Tools - Sealing Flange For Crankshaft (Harmonic Balancer Side), Replacing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Special tools and workshop equipment required

- Counter-Holder Tool T10069
- Assembly Tool T10215
- Torque Wrench V.A.G 1601
- Torque Wrench (40-200 Nm) V.A.G 1332

ENGINE

3.6 Liter - Cylinder Head, Valvetrain - Engine Code(s): BHK

15 CYLINDER HEAD, VALVETRAIN

GENERAL INFORMATION

CYLINDER HEAD

NOTE: **To remove the cylinder head the engine must first be removed. Refer to REMOVING .**

When installing a replacement cylinder head, all of the contact surfaces between the supports, roller rocker levers and cam running surfaces on the camshaft must be lubricated before installing the cylinder head cover.

The plastic protectors installed to protect the open valves must only be removed immediately before installing the cylinder head.

When replacing the cylinder head or cylinder head gasket, the coolant must be completely replaced.

CAMSHAFT IDENTIFICATION

Identification is located between cam lobes for cylinders 4 and 5 of the respective camshaft.

Camshaft	Identification
A - exhaust camshaft	03H 101 Index
B - intake camshaft	03H 102 Index

DESCRIPTION AND OPERATION

CYLINDER HEAD OVERVIEW

NOTE: **To remove the cylinder head the engine must first be removed. Refer to REMOVING .**

When installing a replacement cylinder head, all of the contact surfaces between the supports, roller rocker levers and cam running surfaces on the camshaft must be lubricated before installing the cylinder head cover.

The plastic protectors installed to protect the open valves must only be removed immediately before installing the cylinder head.

When replacing the cylinder head or cylinder head gasket, the coolant must be

completely replaced.

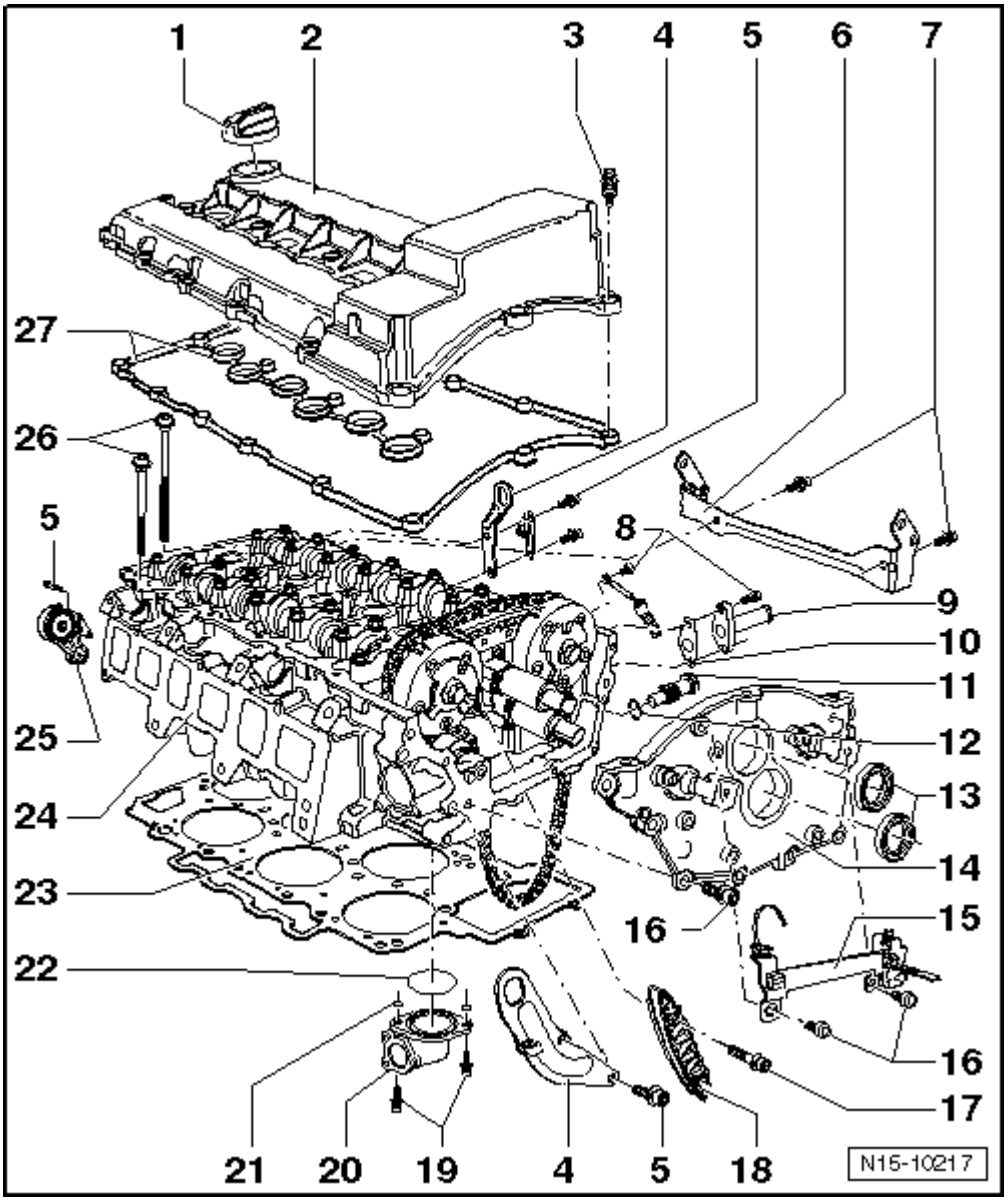

Fig. 1: Cylinder Head, Assembly Overview
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Cap
   - Replace the seal if damaged.
2. Cylinder Head Cover
3. Bolt
   - 10 Nm
   - With a spacer sleeve and seal.
   - Replace the seal if damaged.

4. Lifting Eye
    - With the knock sensor connector retaining plate.
5. Bolt
    - 23 Nm
6. Intake Manifold Support
7. Bolt
    - 23 Nm
8. Bolt
    - 10 Nm
9. Connecting Piece
10. Gasket
    - Replace
    - Note the installed position.
11. Chain Tensioner
    - 50 Nm
    - For the camshaft timing chain.
    - Only rotate the engine with the chain tensioner installed.
12. Seal
    - Replace
13. Seal
    - For the camshaft adjustment valve 1 -N205- and camshaft adjustment valve 1 (exhaust) -N318-.
    - Replace if damaged or leaking.
    - Installing, refer to **CAMSHAFT TIMING CHAIN COVER SEALS, INSTALLING**.
14. Timing Chain Cover
    - Can be removed and installed with the engine installed.
    - Apply sealant D 176 501 A1 to the sealing surfaces.
15. Bracket
16. Bolt
    - 8 Nm
17. Bolt
    - 23 Nm
18. Guide Rail
    - For the camshaft timing chain.
19. Bolt
    - 23 Nm
    - Install using locking fluid D 000 600 A2.
20. Connecting Piece
    - Bolted to the front of the cylinder head.

21. O-ring
    - Replace
22. Seal
    - Replace
23. Cylinder Head Gasket
    - Metal
    - Replace
    - Replacing the cylinder head gasket, refer to **CYLINDER HEAD**.
    - After replacing, replace the entire amount of coolant.
24. Cylinder Head
    - Check for distortion, refer to **CYLINDER HEAD OVERVIEW**.
    - Removing and installing, refer to **CYLINDER HEAD**.
    - After replacing, replace the entire amount of coolant.
25. Belt Tensioner
    - For the ribbed belt.
    - Removing and installing the ribbed belt. Refer to **RIBBED BELT** .
26. Bolt
    - Replace
    - Before installing, apply locking compound D 197 300 A2 to the bolts, refer to **CYLINDER HEAD**
    - Observe the installation instructions and sequence for loosening and tightening. Refer to **CYLINDER HEAD**.
27. Cylinder Head Cover Seal
    - Replace if damaged or leaking.
    - Note the installed position.

Checking Cylinder Head for Distortion

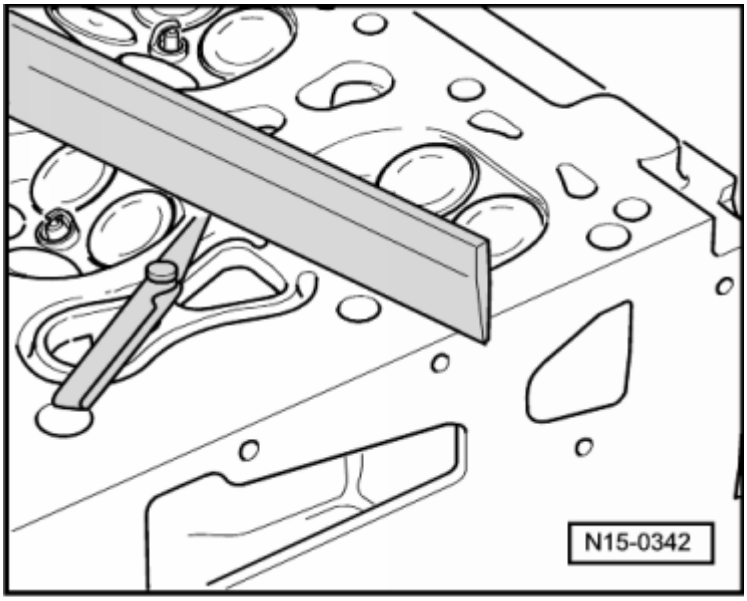

Fig. 2: Checking Cylinder Head For Distortion
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Special tools and workshop equipment required

- Straight Edge 500 mm VAS 6075
- Feeler Gauge

Max. permissible distortion: 0.05 mm

MECHANICAL VACUUM PUMP OVERVIEW

NOTE: A mechanical vacuum pump is installed from 11.06.

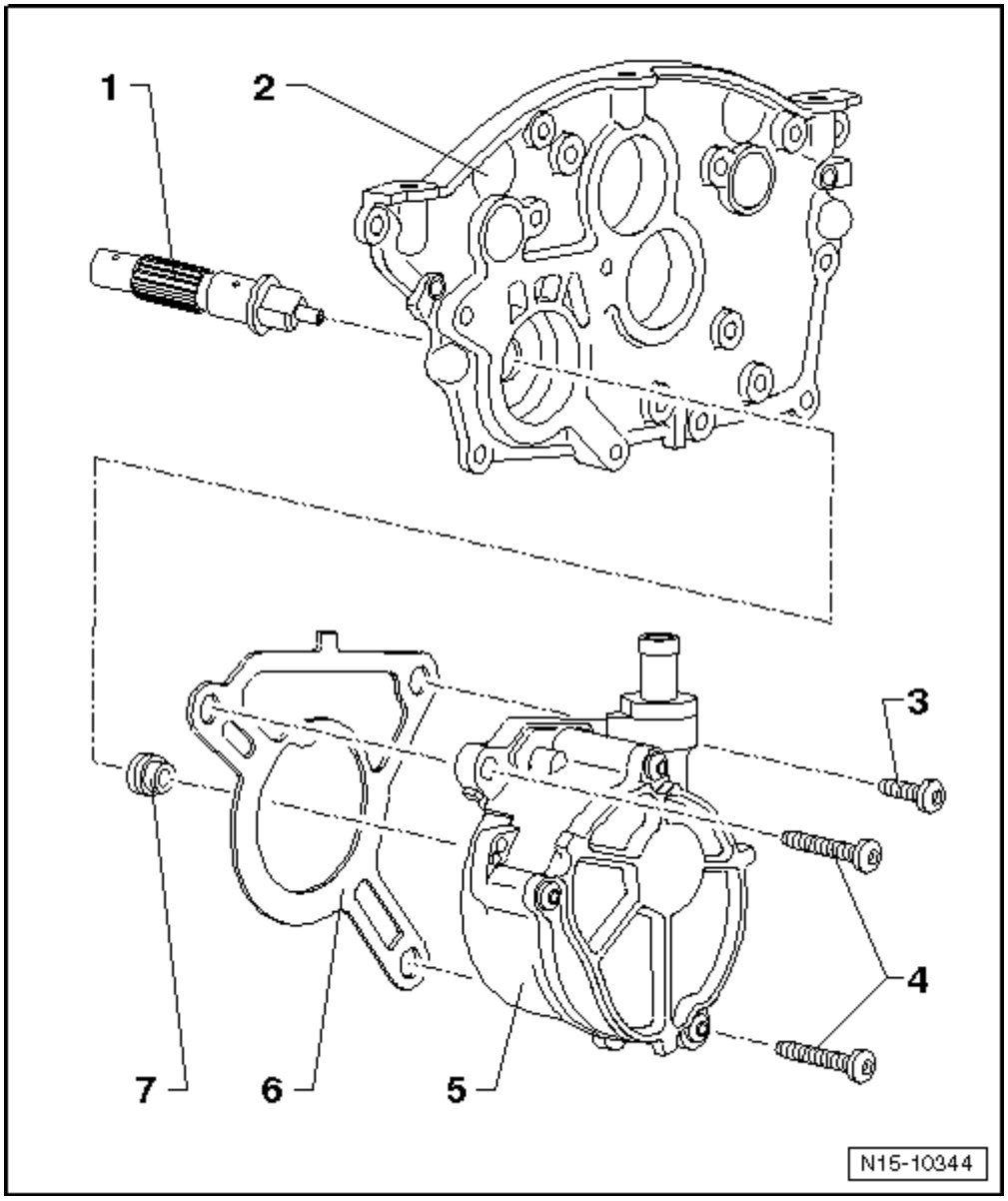

Fig. 3: Mechanical Vacuum Pump, Assembly Overview
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Driveshaft
    - The splines only fit into the drive pinion in one position.
    - Can be replaced only when the engine is removed.
2. Cover
    - Can be replaced only when the engine is removed.
3. Bolt
    - 8 Nm
    - Short
4. Bolt

- 8 Nm
- Long

5. Vacuum Pump
   - Removing and installing, refer to **MECHANICAL VACUUM PUMP**.
6. Gasket
   - Replace
7. Seal
   - Introduction of a non-detachable seal as a running change, identifying feature, refer to **MECHANICAL VACUUM PUMP**.
   - Note the installed position, refer to **MECHANICAL VACUUM PUMP**.

VALVETRAIN OVERVIEW

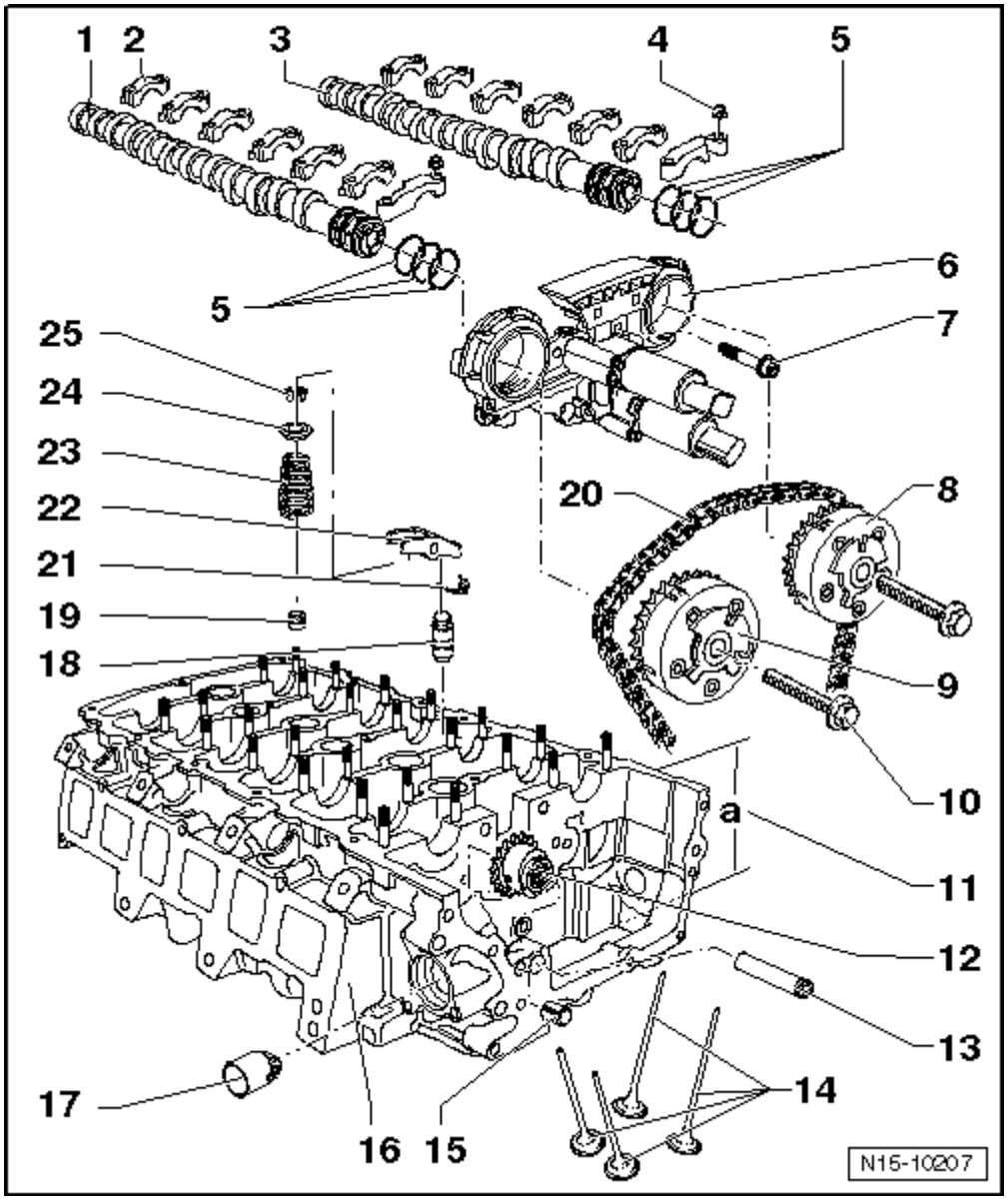

Fig. 4: Valvetrain, Assembly Overview
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Intake Camshaft
   - Check radial clearance with Plastigage, wear limit: 0.1 mm
   - Runout: maximum 0.01 mm
   - Checking axial play, refer to **CAMSHAFT AXIAL PLAY, CHECKING**.
   - Identification, refer to **CAMSHAFT IDENTIFICATION**.
   - Removing and installing, refer to **CAMSHAFTS**.
2. Camshaft Bearing Cap
   - Installed position, refer to **CAMSHAFTS**.
   - Installation sequence, refer to **CAMSHAFTS**.

3. Exhaust Camshaft
   - Check radial clearance with Plastigage, wear limit: 0.1 mm
   - Runout: maximum 0.01 mm
   - Checking axial play, refer to **CAMSHAFT AXIAL PLAY, CHECKING**.
   - Identification, refer to **CAMSHAFT IDENTIFICATION**.
   - Removing and installing, refer to **CAMSHAFTS**.
4. Nut
   - 5 Nm + 45° (1/8) additional turn.
5. Seal
   - If one seal is leaking, replace all of them.
   - Lubricate the contact surfaces of the seal when installing the control housing.
   - Do not spread the seals excessively when installing.
6. Control Housing
   - Lubricate the contact surface of the seals before installing.
   - Camshaft adjustment valves, removing and installing. Refer to **CAMSHAFT ADJUSTER VALVES**.
   - Marks for valve timing, refer to **VEHICLES THROUGH 11.08**.
   - Overview, refer to **CONTROL HOUSING OVERVIEW**.
   - Check control housing strainer for contamination before installation. Refer to **CONTROL HOUSING OVERVIEW**.
   - Removing and installing, refer to **CAMSHAFTS**.
7. Bolt
   - 8 Nm
   - Install using locking fluid D 000 600 A2.
8. Exhaust Camshaft Adjuster
   - Identification: 32A
   - Rotate the engine only with the camshaft adjuster and chain installed.
   - Camshaft adjustor with timing chain, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING**.
9. Intake Camshaft Adjuster
   - Identification: 24E
   - Rotate the engine only with the camshaft adjuster and chain installed.
   - Camshaft adjustor with timing chain, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING**.
10. Bolt
    - 60 Nm + 90° (1/4) additional turn
    - Replace
    - Contact surface of the adjuster wheel and bolt head must be dry when installing.

- When removing and installing, counter hold the camshaft using a 27 mm open end wrench. Refer to **CAMSHAFTS**.

11. Cylinder Head Height
    - Minimum height: a = 139.9 mm
12. Drive Pinion for the High Pressure Pump
    - Vehicles without a vacuum pump.

      With needle bearing lying inside.

      Lubricate the needle bearing before installing.

13. Bearing Shaft (without Input Shaft)
    - Vehicles without a vacuum pump

      Ring groove in the bearing shaft faces forward

    - Vehicles with a vacuum pump

      The input shaft only fits into the drive pinion in one position.

14. Valves
    - Do not regrind, only lapping is permitted.
    - Valve dimensions, refer to **VALVE DIMENSIONS**.
15. Alignment Bushing
16. Cylinder Head
    - Check for distortion, refer to **CYLINDER HEAD OVERVIEW**.
    - Removing and installing, refer to **CYLINDER HEAD**.
    - Refacing valve seats, refer to **VALVE SEAT, REFACING**.
    - After replacing, replace the entire amount of coolant.
17. Pump Plunger
    - Note the installed position.
18. Support Element
    - Before installing, check the camshaft axial play. Refer to **CAMSHAFT AXIAL PLAY, CHECKING**.
    - Do not interchange
    - With hydraulic valve clearance compensation.
19. Valve Stem Seal
    - Replacing, refer to **VALVE STEM SEALS**.
20. Timing Chain
    - Mark the direction of rotation before removing (installed position). Refer to **TIMING CHAINS AND ADJUSTERS** .

- Camshaft adjustor with timing chain, installing. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING**.

21. Securing Clip
    - Check clip for secure seating.
22. Roller Rocker Lever
    - Before installing, check camshaft axial play. Refer to **CAMSHAFT AXIAL PLAY, CHECKING**.
    - Do not interchange.
    - Check the roller for ease of movement.
    - Lubricate the contact surface.
    - Use the securing clip to clip onto the support element when installing.
23. Valve Spring
    - Note the installed position.
    - Removing and installing, refer to **VALVE STEM SEALS**.
24. Valve Spring Plate
25. Valve Retainers

CONTROL HOUSING OVERVIEW

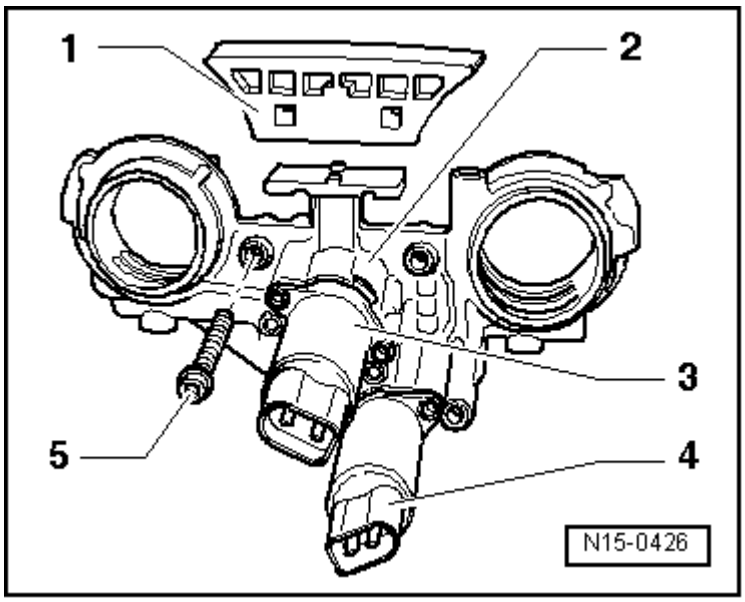

Fig. 5: Control Housing, Assembly Overview
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

1. Guide Rail
    - Clipped onto the control housing.
2. Control Housing
3. Camshaft Adjustment Valve 1 -N205-

- Removing and installing, refer to **CAMSHAFT ADJUSTER VALVES**.

4. Camshaft Adjustment Valve 1 (Exhaust) -N318-
   - Removing and installing, refer to **CAMSHAFT ADJUSTER VALVES**.
5. Bolt
   - 8 Nm
   - Install using locking fluid D 000 600 A2.

Checking Control Housing Strainer for Contaminants

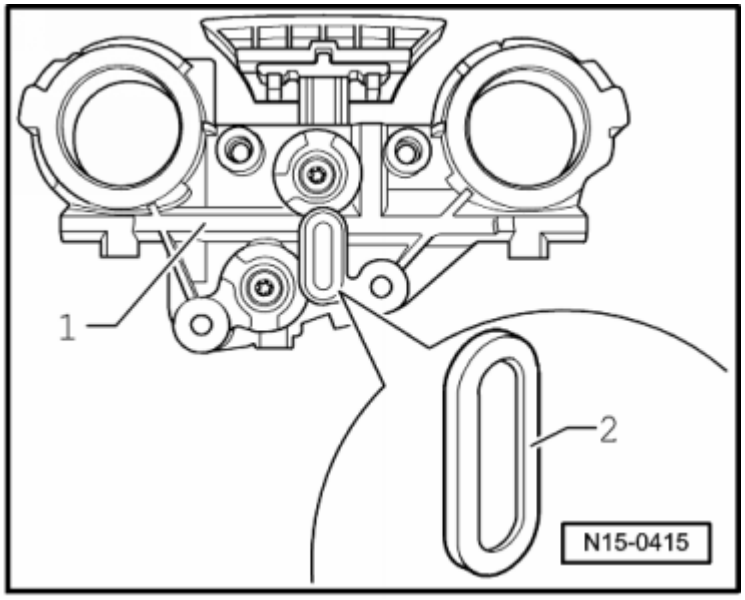

Fig. 6: Backside Of Control Housing & Screen
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Unclip the strainer -2- from the rear side of the control housing -1- and remove any possible contamination.

VALVE SEAT, REFACING

Special tools and workshop equipment required

- Depth Gauge
- Valve Seat Refacing Tool

Procedure

NOTE: When repairing engines with leaking valves, it is not sufficient to reface or replace valve seats and valves. It is also necessary to check the valve guides for wear. This is particularly important on high mileage engines. Refer to VALVE GUIDE, CHECKING.

Only reface valve seats enough until a perfect contact pattern is obtained. The

maximum permissible refacing dimension must be calculated before work is carried out. If the refacing dimension is exceeded, the function of the hydraulic lifters can no longer be guaranteed and therefore the cylinder head should be replaced.

-- Remove the camshafts. Refer to **CAMSHAFTS**.

Maximum permitted refacing dimension is calculated as follows:

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

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

-- Measure the distance -a- between the end of the valve stem and upper edge of the cylinder head.

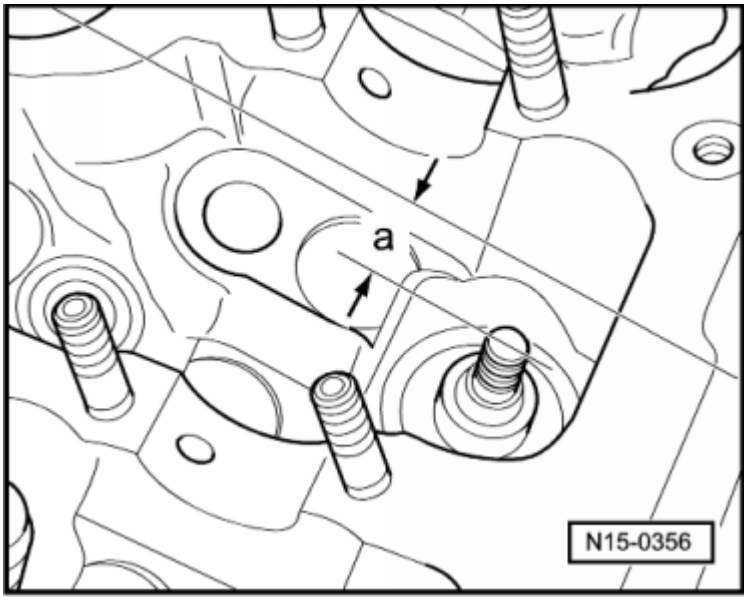

Fig. 7: Identifying Distance Between End Of Valve Stem And Upper Edge Of Cylinder Head
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Calculate the Max. permissible refacing dimension from the measured distance -a- and minimum dimension.

Minimum Dimensions

Short intake valve	mm	31.8
Long intake valve	mm	10.2
Short exhaust valve	mm	31.8
Long exhaust valve	mm	10.2

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

Example:

-	Measured distance Minimum dimension	10.6 mm 10.2 mm
=	Max. permissible refacing dimension 1	0.4 mm

Refacing Intake Valve Seat

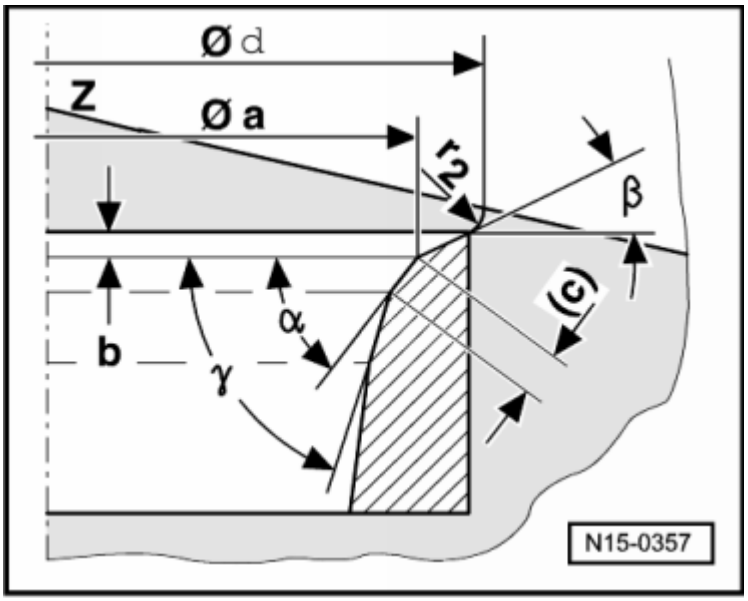

Fig. 8: Identifying Angles And Dimensions To Rework Exhaust Valve Seat
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

a	= diameter 32.8 mm
b	= Maximum permissible refacing dimension 1
c	= 0.9 to 1.5 mm
d	= Max. diameter

r_2	38.0 mm = Radius 2.0 mm
Z	= Cylinder head lower edge
a	= 45° valve seat angle
ß	= 30° upper correction angle
gamma	= 60° lower correction angle

Refacing Exhaust Valve Seat

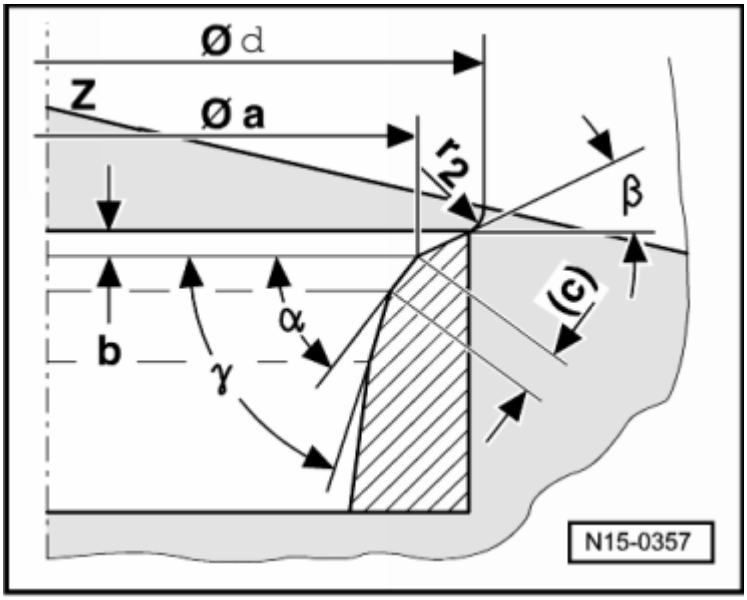

Fig. 9: Identifying Angles And Dimensions To Rework Exhaust Valve Seat
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

a	= diameter 29.8 mm
b	= Maximum permissible refacing dimension (1)
c	= 1.2 to 1.7 mm
d	= Max. diameter 35.0 mm
r_2	= Radius 2.0 mm
Z	= Cylinder head lower edge

a	= 45° valve seat angle
ß	= 30° upper correction angle
gamma	= 60° lower correction angle

(1) Calculating maximum permissible refacing dimension. Refer to **VALVE SEAT, REFACING**.

SPECIFICATIONS

VALVE DIMENSIONS

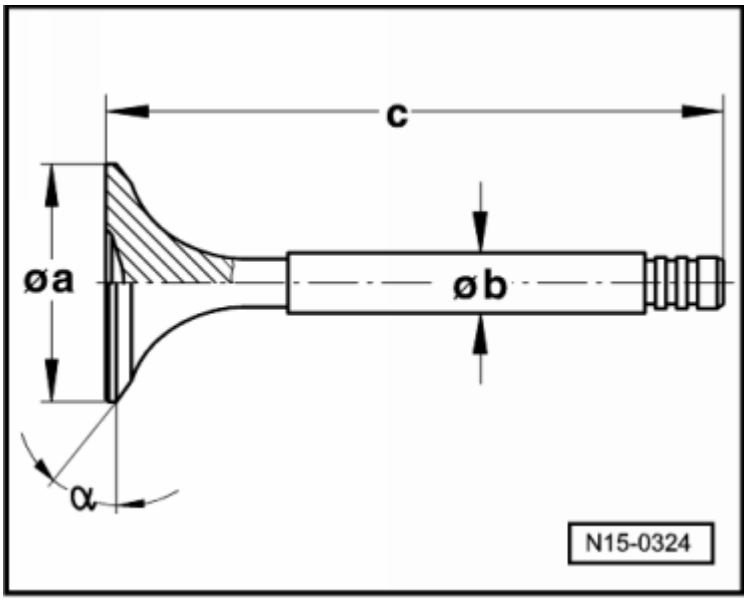

Fig. 10: Identifying Valve Dimensions
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Valves must not be ground. Only lapping is permitted.

Intake Valves

Dimension		Short Valve	Long Valve
Diameter a	mm	33.20	33.20
Diameter b	mm	5.98	5.98
c	mm	102.46	136.36
a	Angle°	44° 40'	44° 40'

Exhaust Valves

Dimension		Short Valve	Long Valve
Diameter a	mm	30.20	30.20
Diameter b	mm	5.97	5.97
c	mm	102.20	136.20

a	Angle°	44° 40'	44° 40'

FASTENER TIGHTENING SPECIFICATIONS

Component	Fastener Size	Nm
Belt Tensioner to Cylinder Head Bolt	-	23
Bracket to Timing Chain Cover Bolt	-	8
Camshaft Adjuster to Camshaft Bolt (1)	-	60 + 90°
Camshaft Adjuster Valve to Control Housing Bolt	-	3.8
Chain Tensioner to Cylinder Block	-	50
Chain Tensioner with Tensioning Rail to Cylinder Block Bolt	-	8
Connecting Piece to Cylinder Block Bolt	-	10
Connecting Piece to Cylinder Head Bolt (2)	-	23
Control Housing to Cylinder Head Bolt (2)	-	8
Guide Rail to Cylinder Head Bolt	-	23
Intake Manifold to Cylinder Head Bolt	-	8
Intake Manifold Support to Cylinder Block Bolt	-	23
Intake Manifold Support to Intake Manifold Bolt	-	20
Lifting Eye to Cylinder Block Bolt	-	23
Oil Dipstick Guide Tube to Intake Manifold Bolt	-	6
Spark Plug	-	20
Sprocket to Oil Pump Shaft Bolt (1)	-	60 + 90°
Timing Chain Cover to Cylinder Head Bolt	-	8
Vacuum Pump to Timing Chain Cover Bolt	-	8

(1) Always replace

(2) Install using locking fluid D 000 600 A2

Cylinder Head Cover Bolt Tightening Sequence and Specification

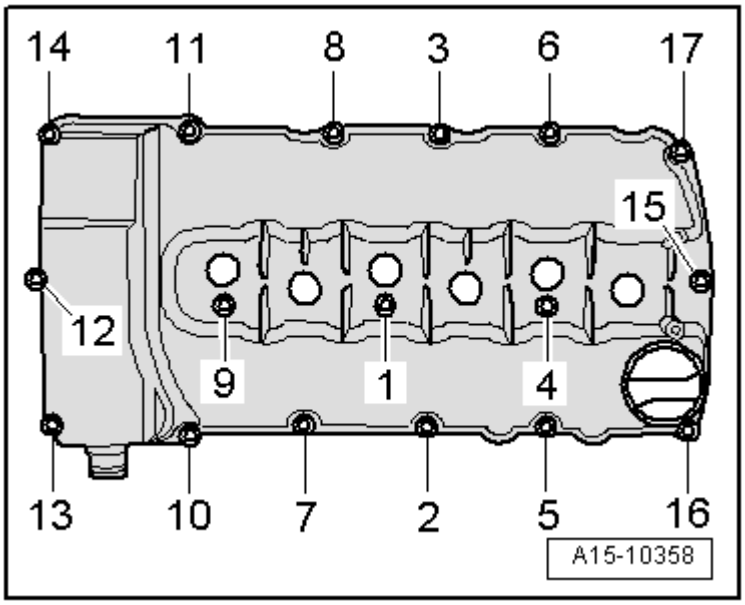

Fig. 11: Cylinder Head Cover Bolt Tightening Sequence
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Tighten the cylinder head cover bolts in sequence -1 through 17- to 10 Nm.

Cylinder Head Bolt Tightening Sequence and Specification

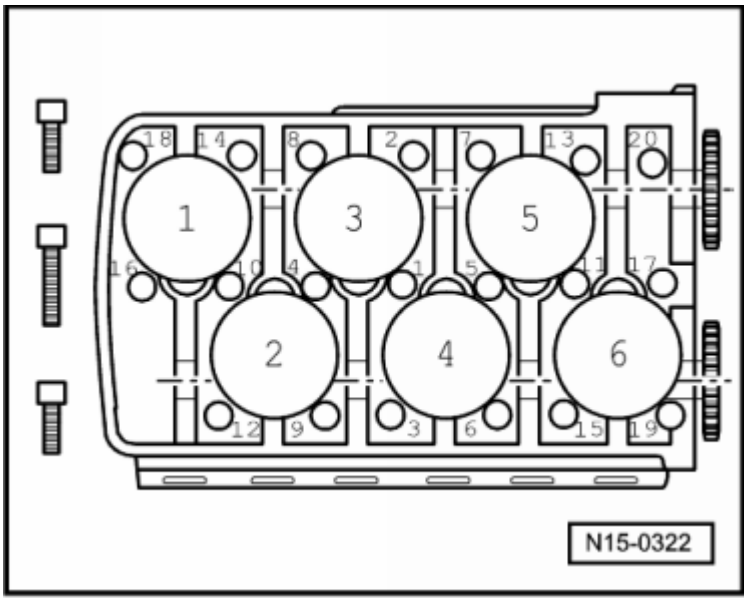

Fig. 12: Cylinder Head Tightening Sequence
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Tighten the cylinder head bolts -1 through 20- in the sequence shown, starting from the inside and working toward the outside, as follows:

-- Tighten all the bolts to 15 Nm.

-- Tighten all the bolts to 30 Nm.

-- Tighten all the bolts and additional 180° (1/2) turn.

Camshaft Bearing Cap Bolt Tightening Sequence and Specification

A - Intake Camshaft

-- Install and tighten the bearing caps 5 and 9 alternating in a diagonal sequence to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 1 and 13 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 7 and 13 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 3 and 11 and tighten to 5 Nm + 45° (1/8) additional turn.

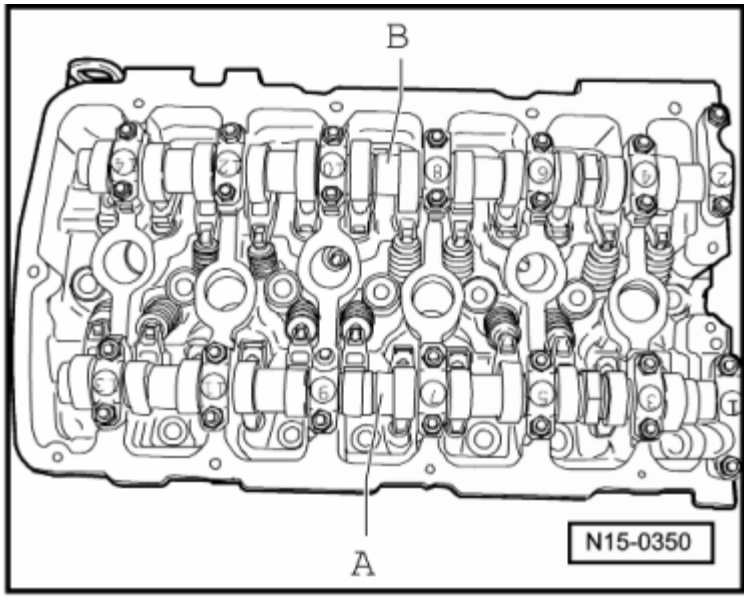

Fig. 13: Identifying Intake Camshaft And Exhaust Camshaft
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

B - Exhaust Camshaft

-- Install and tighten the bearing caps 6 and 10 alternating in a diagonal sequence to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 2 and 14 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 8 and 13 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 4 and 12 and tighten to 5 Nm + 45° (1/8) additional turn.

DIAGNOSIS AND TESTING

VALVE TIMING, CHECKING

VEHICLES THROUGH 11.08

Special tools and workshop equipment required

- Camshaft Bar T10068 A

Sequence

-- Remove the noise insulation. Refer to **Description and Operation** .

-- Remove the intake manifold, refer to one of the following:

With a one piece intake manifold, refer to **INTAKE MANIFOLD** .

With a two piece intake manifold, refer to **UPPER INTAKE MANIFOLD** .

-- Remove the cylinder head cover. Refer to **CYLINDER HEAD COVER**.

-- Rotate the crankshaft at the vibration damper bolt in engine rotation direction to the Top Dead Center (TDC) cylinder 1 mark -arrow-.

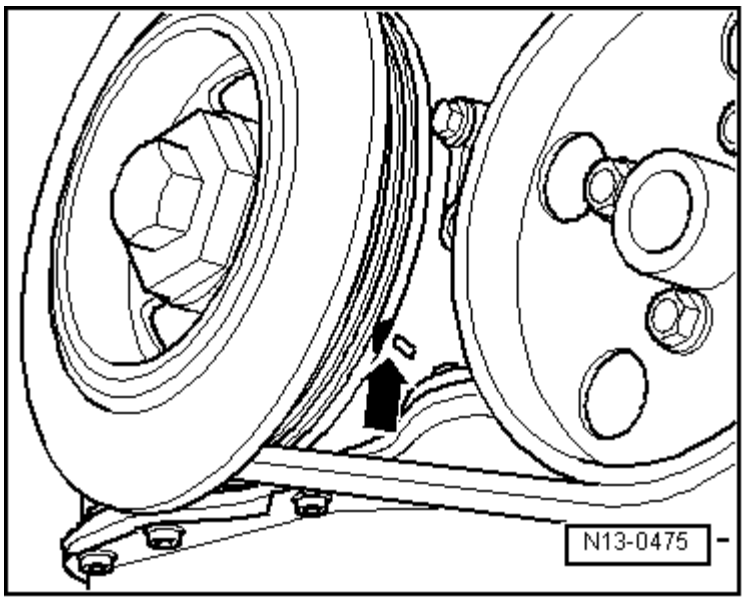

Fig. 14: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

the camshaft lobes -A- for cylinder 1 must face each other.

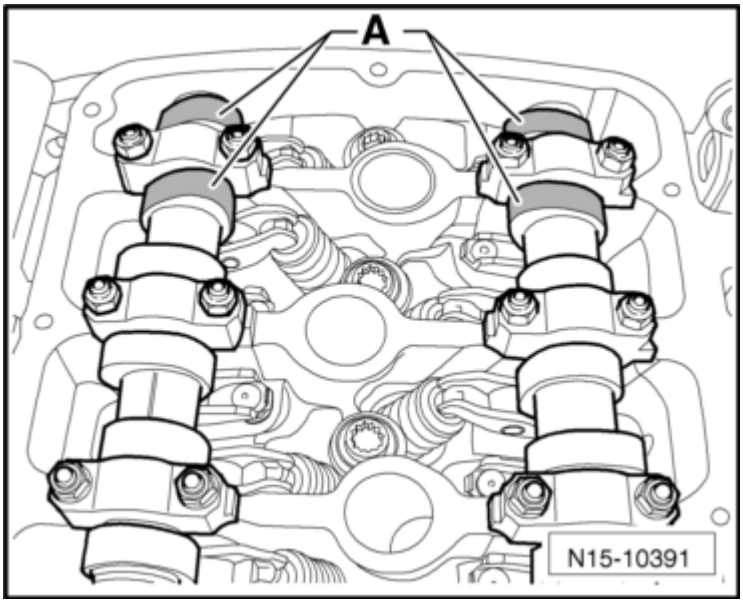

Fig. 15: Camshaft Lobes For Cylinder Facing Each Other
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the T10068 A into both camshaft grooves.

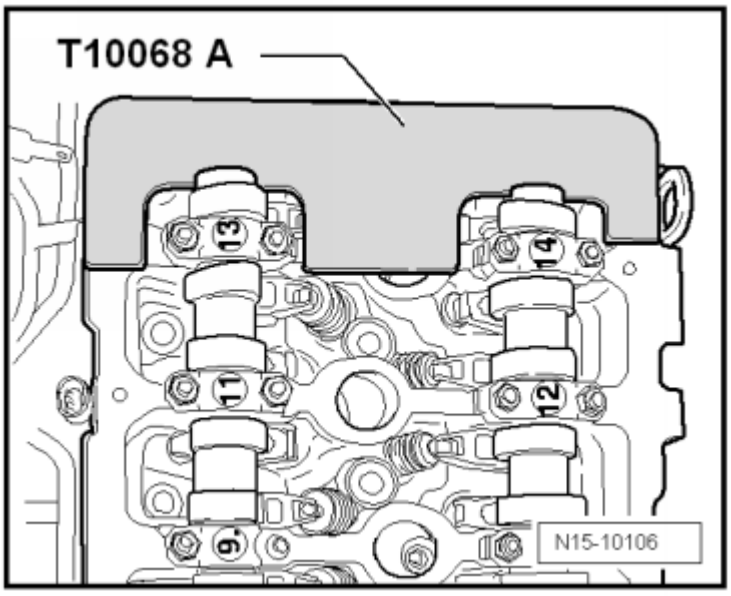

Fig. 16: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Due to the camshaft adjuster function, the camshaft grooves may not be perfectly horizontal. Therefore, if necessary, rotate the camshaft back and forth slightly using an open end wrench on the camshaft recesses -arrows- in order to install the T10068 A.

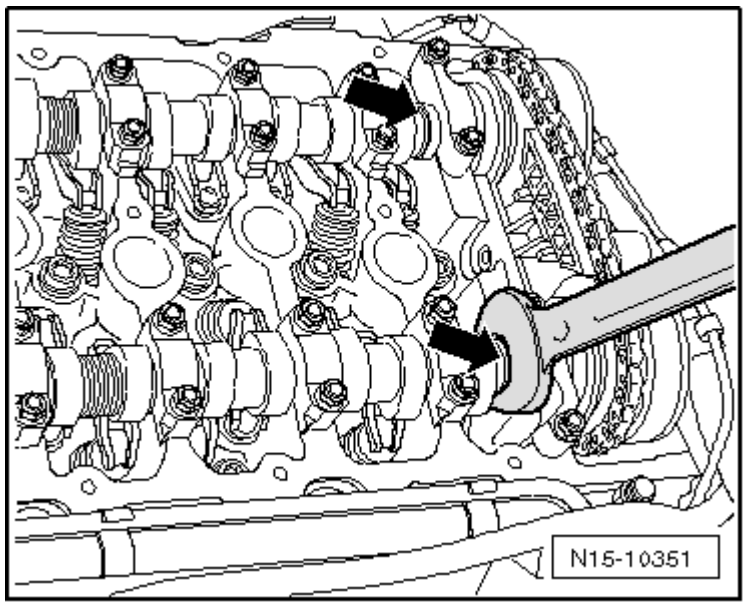

Fig. 17: Counter-Holding At Camshaft Using Wrench
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Verify the installation mark of the camshaft adjuster with the marks on the control housing:

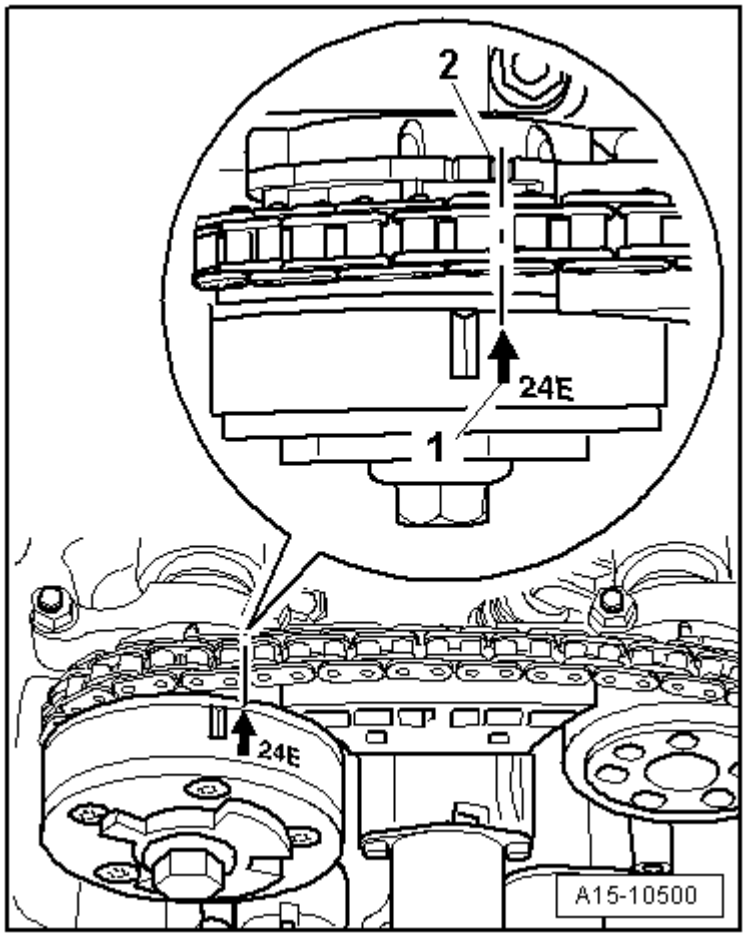

Fig. 18: Verifying Installation Marks Of Intake Camshaft Adjuster With Marks On Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- The "arrow" -item 1- on the intake camshaft adjuster must align with the notch -2- on the far right of the control housing. Marks on control housing, refer to **VEHICLES THROUGH 11.08**.
- The mark -1- on the exhaust camshaft adjuster which the "arrow" points to must align with the notch -2- on the far right of the control housing. Marks on control housing, refer to **VEHICLES THROUGH 11.08**.

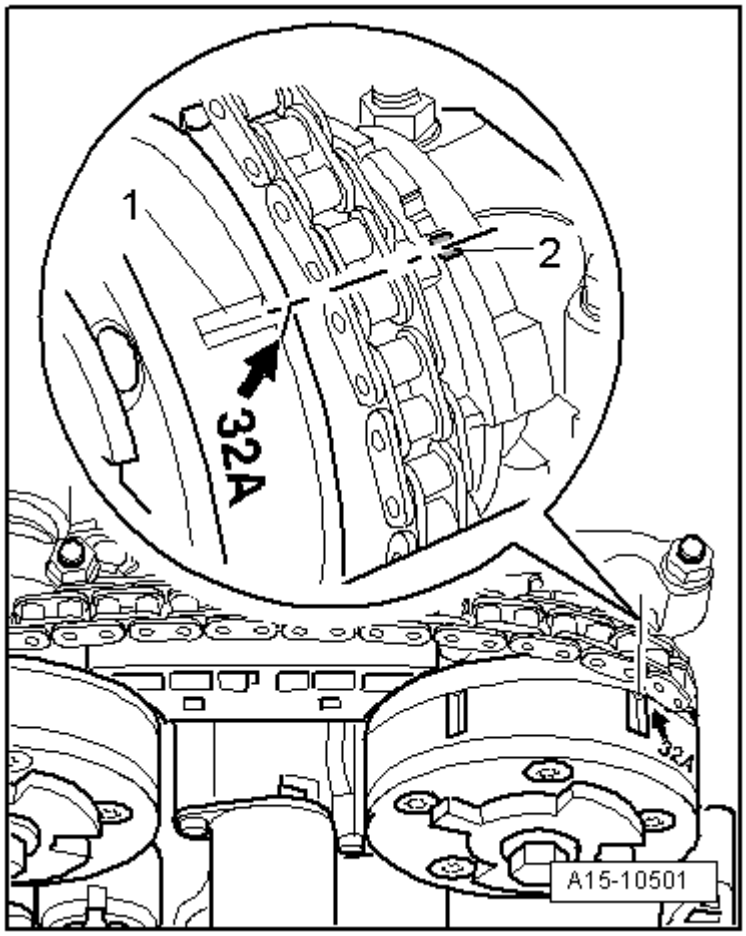

Fig. 19: Verifying Installation Marks Of Exhaust Camshaft Adjuster With Marks On Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: A small offset between the mark -1- and notch -2- is permitted.

-- The distance between the marks on the camshaft adjuster must be exactly 16 rollers of the timing chain.

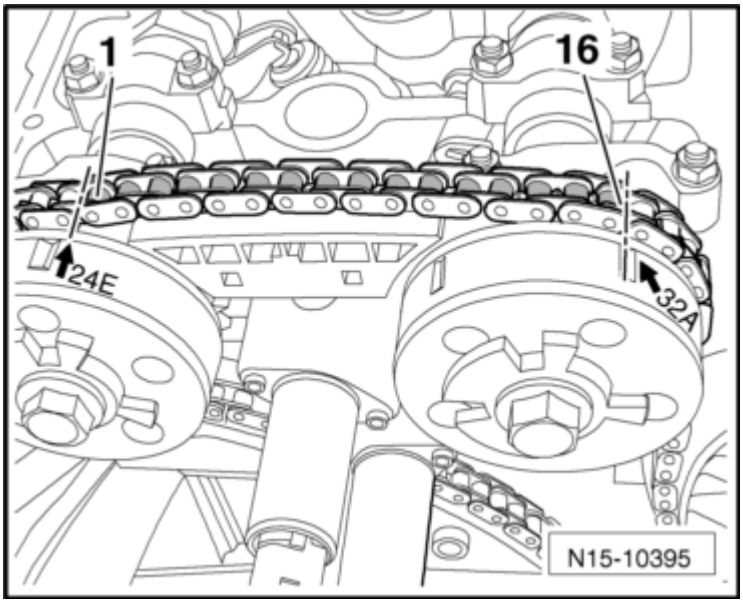

Fig. 20: Identifying Small Offset Between Mark And Notch
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

If the marks do not match:

-- Adjust the valve timing. Refer to **OIL PUMP DRIVE TIMING CHAIN, INSTALLING**.

If the marks match:

-- Install the cylinder head cover. Refer to **CYLINDER HEAD COVER**.

-- Install the intake manifold, refer to one of the following:

With a one piece intake manifold, refer to **INTAKE MANIFOLD** .

With a two piece intake manifold, refer to **UPPER INTAKE MANIFOLD** .

Marks on Control Housing

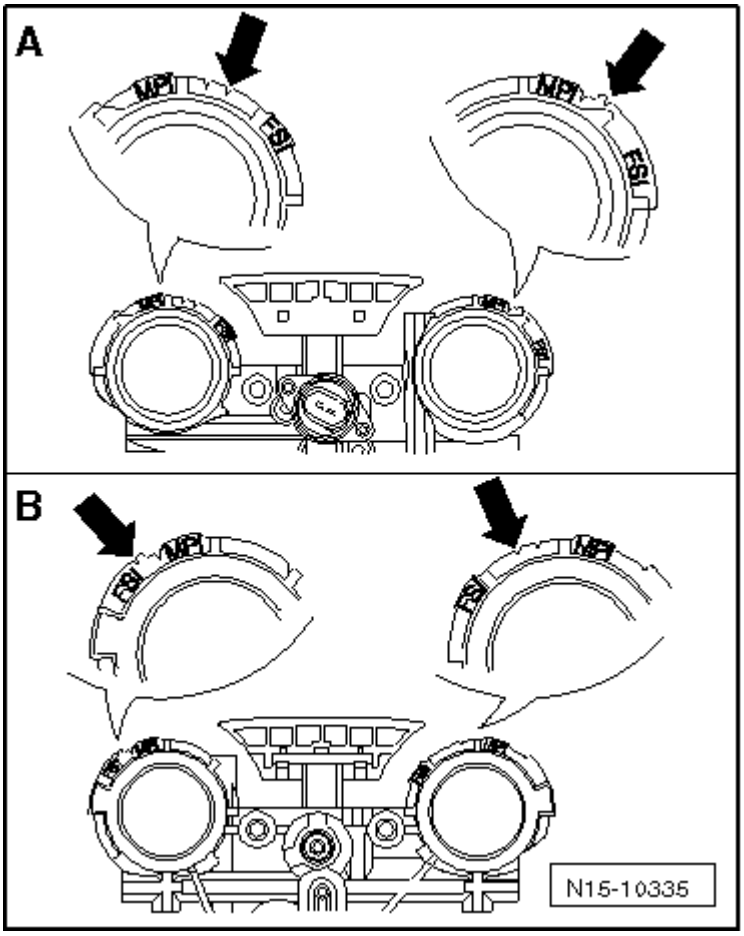

Fig. 21: Markings On Control Housing With FSI Engines
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-A- Flywheel, side view

-B- Vibration damper, side view

Notches -arrows- are reference points for the mark on the camshaft adjusters.

VEHICLES FROM 12.08

Special tools and workshop equipment required

- Camshaft Bar T10068 A

Sequence

-- Remove the noise insulation. Refer to **Description and Operation** .

-- Remove the upper intake manifold. Refer to **UPPER INTAKE MANIFOLD** .

-- Remove the cylinder head cover. Refer to **CYLINDER HEAD COVER**.

-- Rotate the crankshaft at the vibration damper bolt in engine rotation direction to the Top Dead Center (TDC) cylinder 1 mark -arrow-.

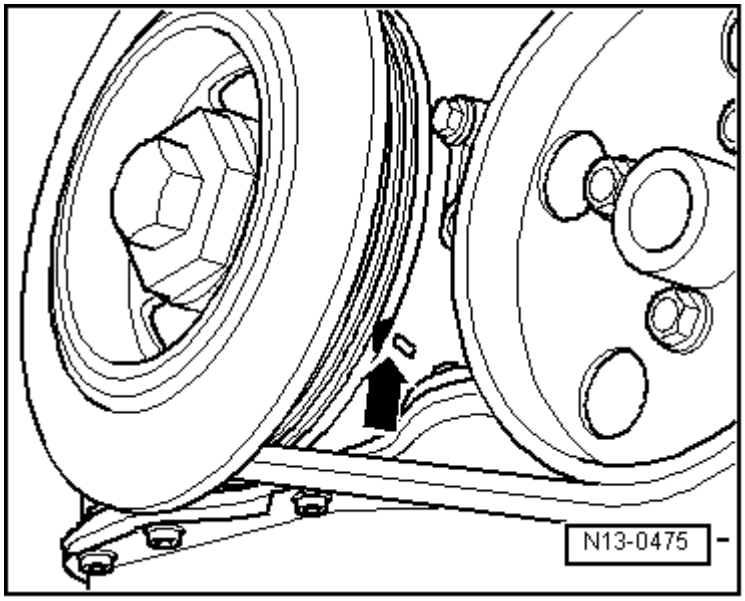

Fig. 22: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

The camshaft lobes -A- for cylinder 1 must face each other.

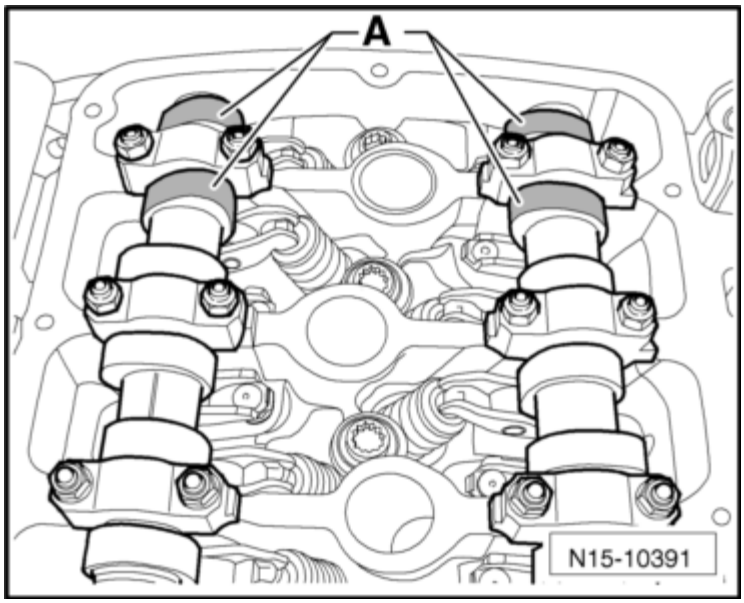

Fig. 23: Camshaft Lobes For Cylinder Facing Each Other
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the T10068 A into both camshaft grooves.

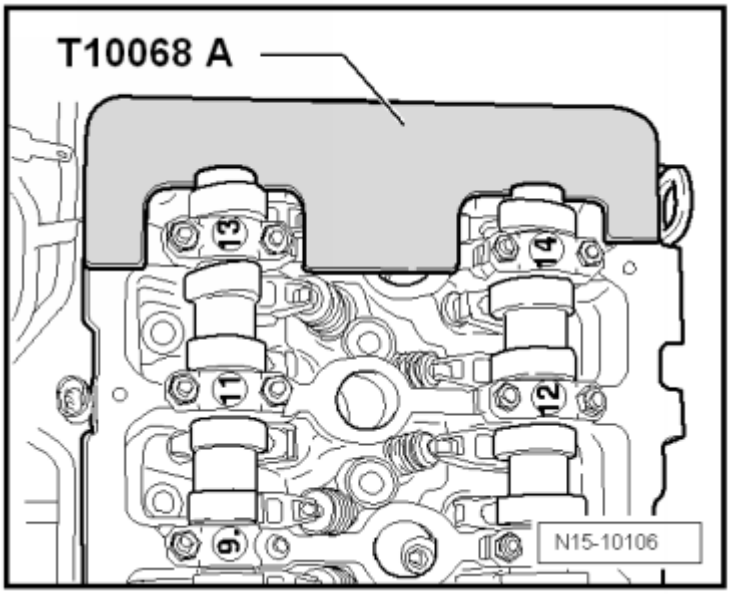

Fig. 24: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Due to the camshaft adjuster function, the camshaft grooves may not be perfectly horizontal. Therefore, if necessary, rotate the camshaft back and forth slightly using an open end wrench on the recesses -arrows- in order to install the T10068 A.

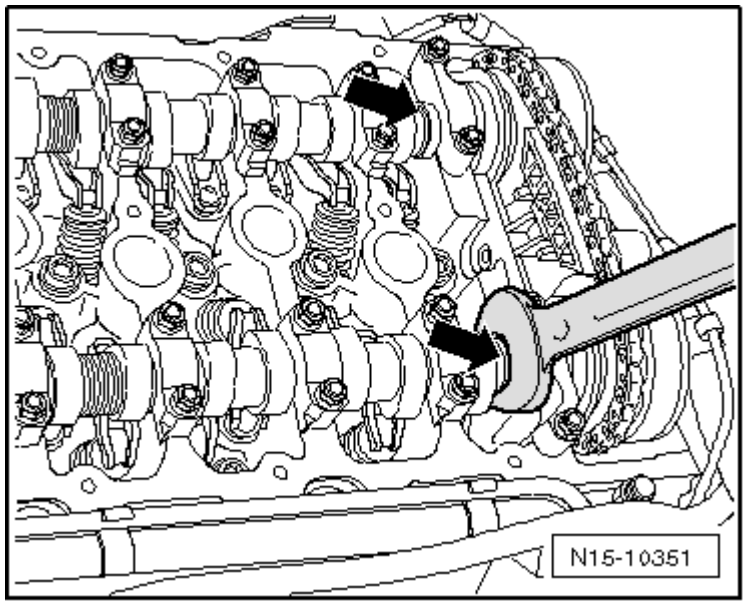

Fig. 25: Counter-Holding At Camshaft Using Wrench
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Verify the installation marks of the camshaft adjuster with the marks on the control housing:

- The arrows on the camshaft adjusters must line up with the notches on the right side of the control housing. Marks on control housing, refer to **VEHICLES FROM 12.08**.

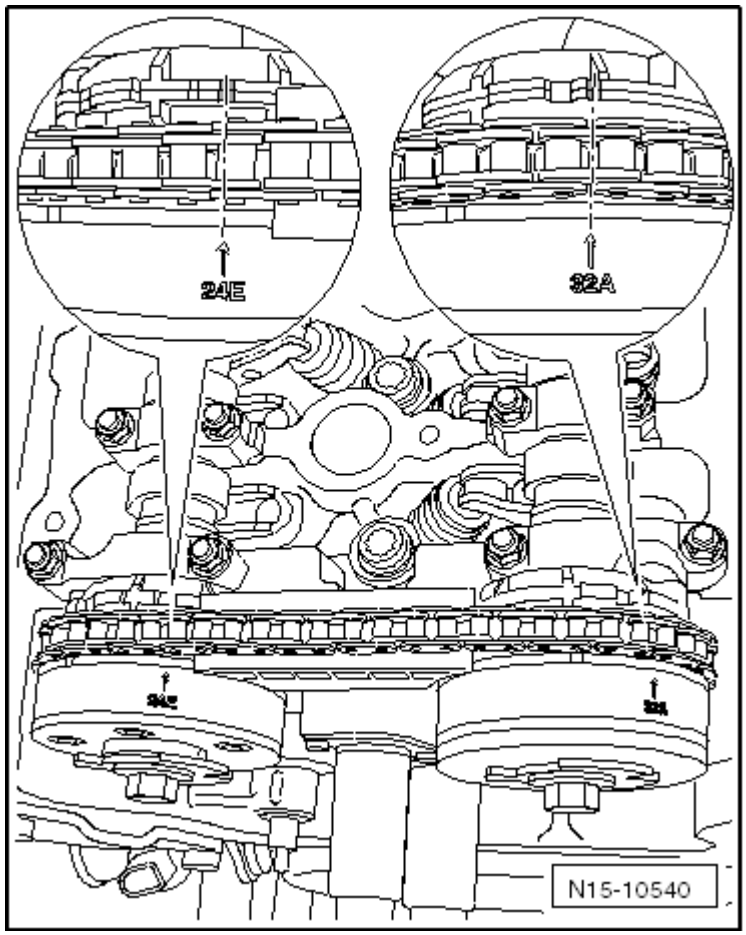

Fig. 26: Verifying Installation Marks Of Camshaft Adjuster With Marks On Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: A slight offset between the 32A mark and the notch is permitted.

Do not pay attention to the position of the copper colored chain links.

-- The distance between the marks on the camshaft adjuster must be exactly 16 rollers of the timing chain.

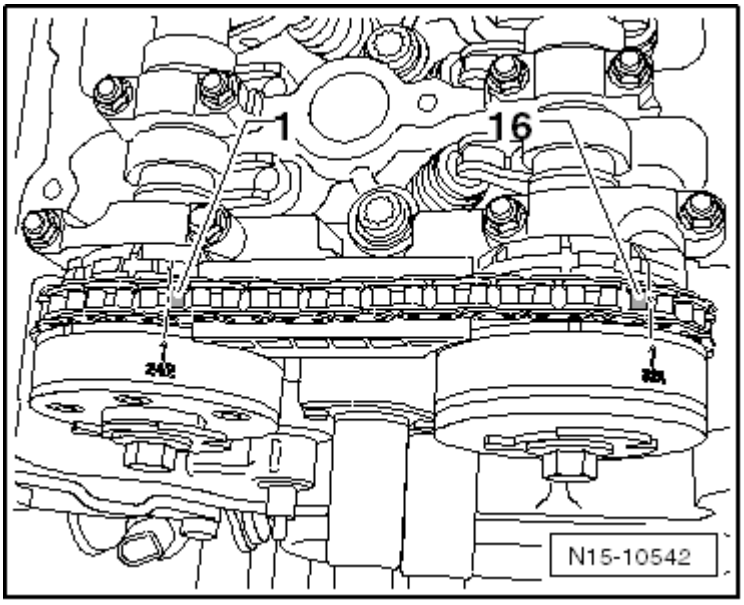

Fig. 27: Distance Between Marks On Camshaft Adjuster
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

If the marks do not match:

-- Adjust the valve timing. Refer to **OIL PUMP DRIVE TIMING CHAIN, INSTALLING**.

If the marks match:

-- Install the cylinder head cover. Refer to **CYLINDER HEAD COVER**.

-- Install the upper intake manifold. Refer to **UPPER INTAKE MANIFOLD** .

Marks on Control Housing

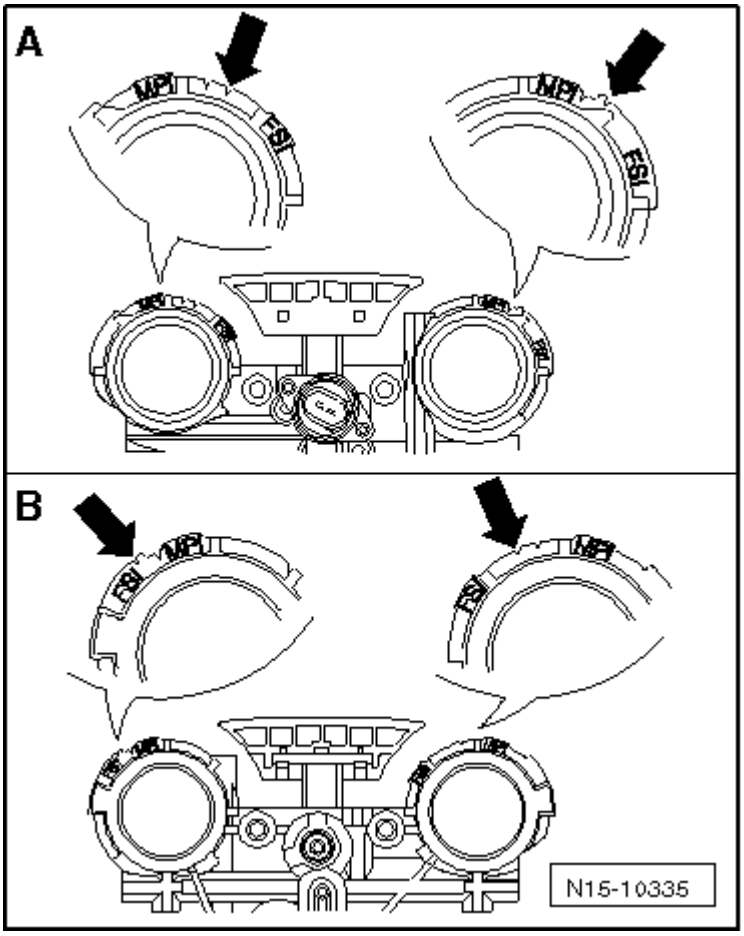

Fig. 28: Markings On Control Housing With FSI Engines
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-A- Flywheel, side view

-B- Vibration damper, side view

Notches -arrows- are reference points for mark on camshaft adjusters.

COMPRESSION, CHECKING

Special tools and workshop equipment required

- Spark Plug Removal Tool 3122 B
- Puller for Ignition Coil T10095 A
- Assembly Tool T10118
- Torque Wrench (5-50 Nm) V.A.G 1331
- Compression Tester V.A.G 1763

Conditions

- Engine oil temperature at least 30 °C (86 °F)
- The battery voltage must be at least 11.5 volts.
- All electrical components such as for example, lights and rear window heater, must be turned off.
- If vehicle is equipped with an Air Conditioning (A/C) system, it must be turned off.
- Selector lever must be in the "P" or "N" position.

Test Sequence

-- Remove the fuel pump fuse from the fuse holder. Refer to SYSTEM WIRING DIAGRAM.

Voltage supply to the fuel pump is interrupted when the fuse is removed.

-- Using the T10118 on the locking button -arrow- and carefully pull the connector up.

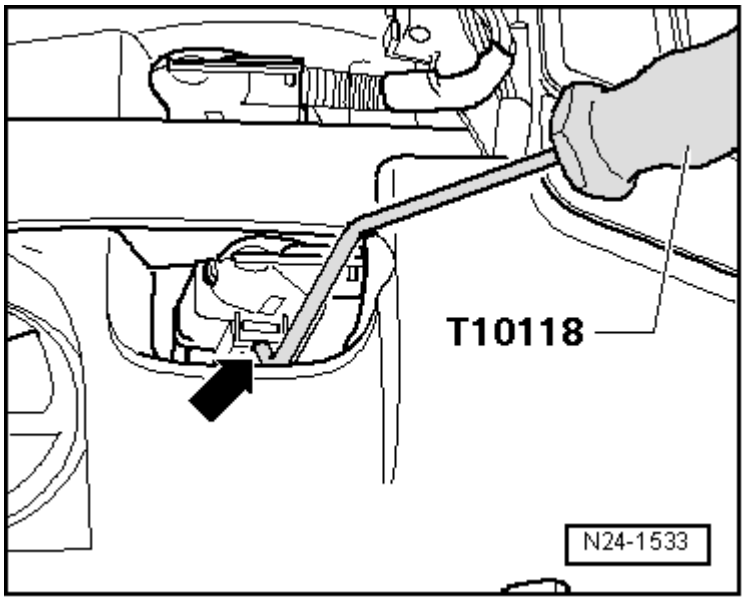

Fig. 29: Disconnecting Electrical Harness Connectors To Ignition Coils
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Slide on the T10095 A from the straight side of the connector in the -direction of the arrow- and pull out the ignition coil with power output stage.

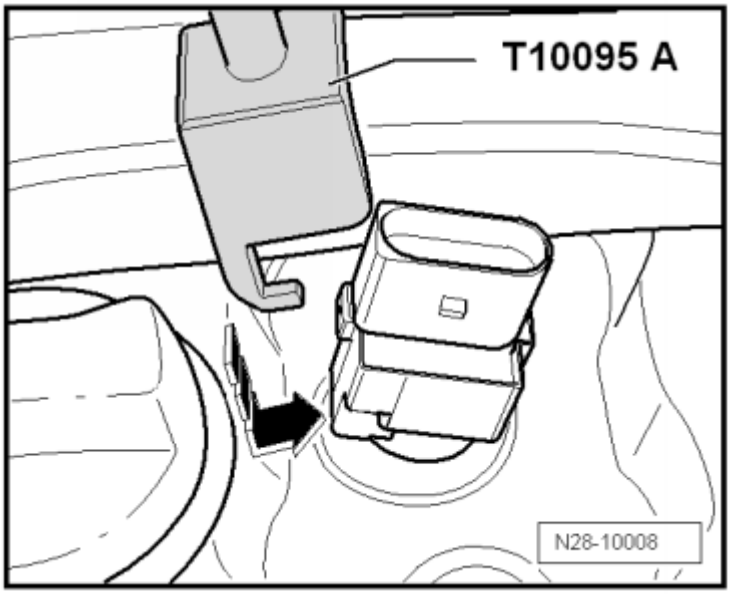

Fig. 30: Identifying Ignition Coil Removal
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the spark plugs using the 3122 B.

-- Check the compression pressure using the V.A.G 1763.

NOTE: Using the V.A.G 1763, refer to the operating instructions.

-- Let a second mechanic operate the starter until a pressure increase is no longer indicated on the tester.

Compression Pressure:

Engine Code	New Bar Positive Pressure	Wear Limit Bar Positive Pressure	Difference Between Cylinders Bar Positive Pressure
BHK	11.0 to 13.0	8.0	Max. 3.0

-- Install the spark plugs using the 3122 B and tighten them to 20 Nm.

-- Install ignition coils with power output stage.

-- To install, insert the ignition coil with power output stage into the appropriate spark plug hole so the straight connector sides fit with each other -arrows-.

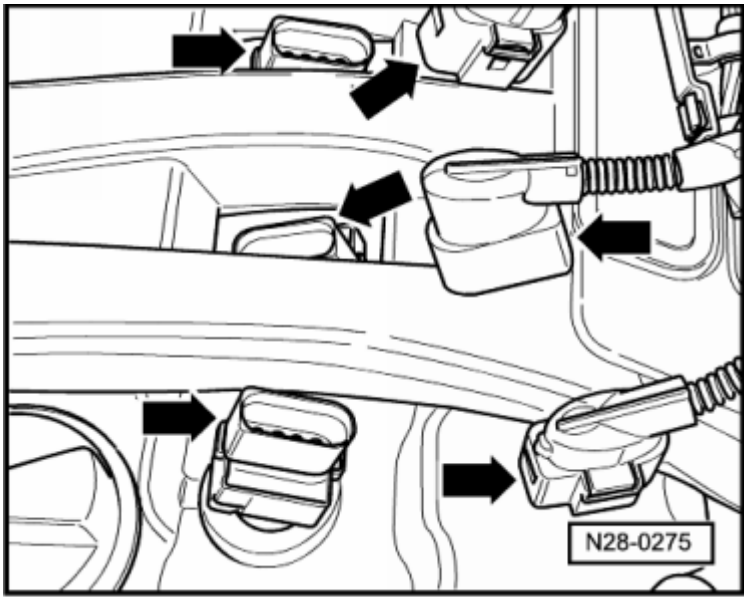

Fig. 31: Identifying Ignition Coil With Power Output Stage
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

After the test is completed:

-- Connect the vehicle diagnostic tester.

-- Perform the vehicle system test, refer to "Guided Fault Finding" in the vehicle diagnostic tester.

-- End the vehicle system test, this will automatically erase Diagnostic Trouble Code (DTC) entries which occurred during the assembly.

-- Generate a readiness code in conjunction with a road test.

Observe the safety precautions that apply to road tests.

-- Then perform the vehicle system test again and repair any occurring malfunctions if necessary.

CAMSHAFT AXIAL PLAY, CHECKING

Special tools and workshop equipment required

- Dial Gauge Holder VW 387
- Dial Gauge

Sequence

Perform the measurement with the support elements and roller rocker levers removed.

The center camshaft bearing cap of the respective camshaft is installed.

Wear limit: maximum 0.40 mm

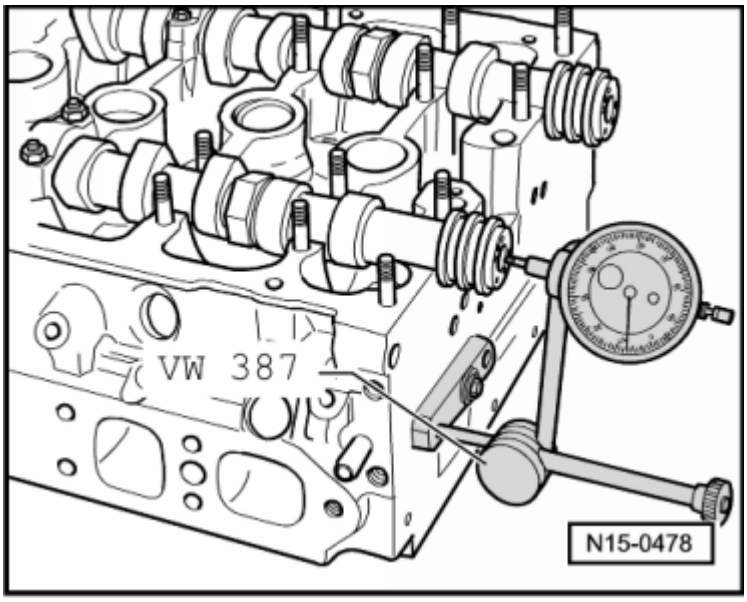

Fig. 32: Checking Camshafts Axial Clearance
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

VALVE GUIDE, CHECKING

Special tools and workshop equipment required

- Dial Gauge Holder VW 387
- Dial Gauge

Sequence

-- Insert a new 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.

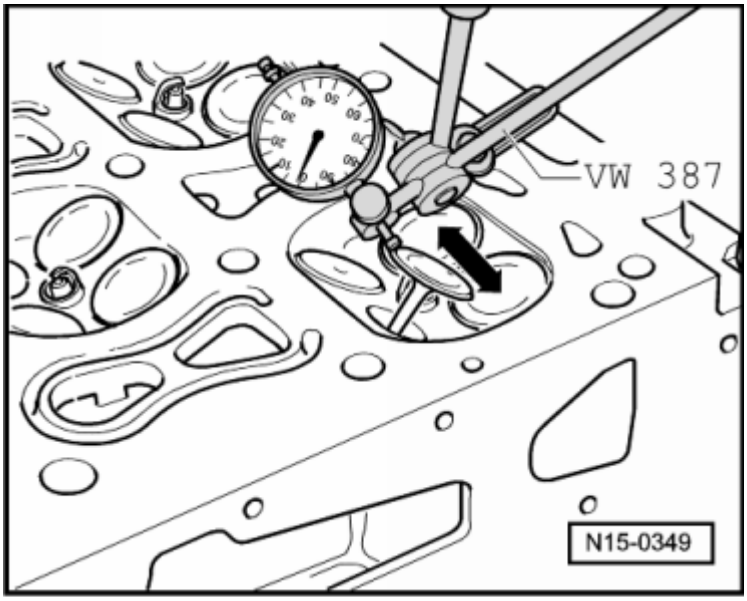

Fig. 33: Checking Valve Guides
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Determine the tilt clearance. Wear limit: 0.8 mm.

If tilt clearance is exceeded:

-- Replace the cylinder head.

REMOVAL AND INSTALLATION

CYLINDER HEAD COVER

Special tools and workshop equipment required

- Spring Type Clip Pliers VAS 5024 A
- Torque Wrench (5-50 Nm) V.A.G 1331
- Assembly Tool T10118
- Puller for Ignition Coil T10095 A

Removing

NOTE: To perform the procedure, the ground cable must be disconnected from the battery. If a coded radio is installed, obtain the anti-theft code beforehand.

-- With the ignition turned off, disconnect the battery ground cable.

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

-- Bring the lock carrier into the service position. Refer to **Description and Operation** .

-- Remove the ignition coils with power output stage. Refer to **IGNITION COILS WITH POWER OUTPUT STAGES** .

-- Remove the intake manifold, refer to one of the following:

With a one piece intake manifold, refer to **INTAKE MANIFOLD**

With a two piece intake manifold, refer to **UPPER INTAKE MANIFOLD**

NOTE: Seal the intake passages in the intake manifold and in cylinder head with clean cloths.

-- Disconnect all other electrical wires from the cylinder head cover and set them to the side.

-- Loosen the cylinder head cover bolts starting from the inside and working toward the outside -17 through 1-.

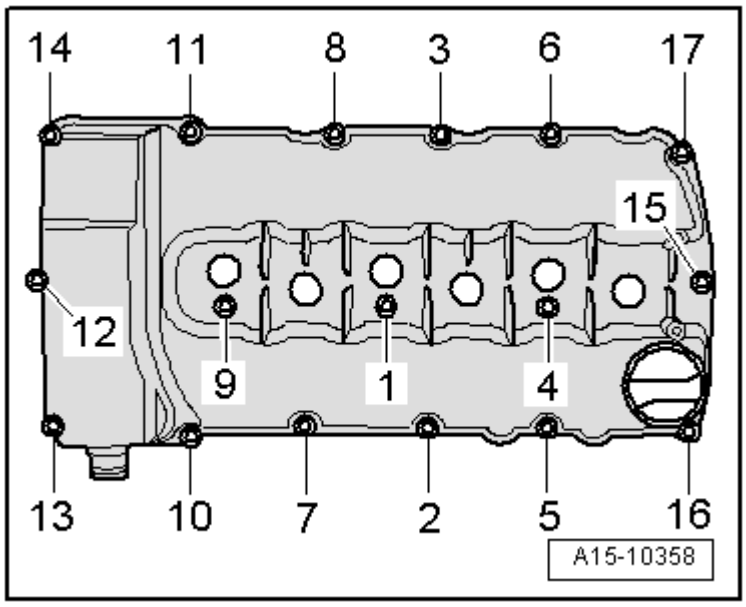

Fig. 34: Cylinder Head Cover Bolt Tightening Sequence
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the bolts and remove the cylinder head cover.

Installing

-- Apply sealant D 454 300 A2 at the locations -arrows- on the cover.

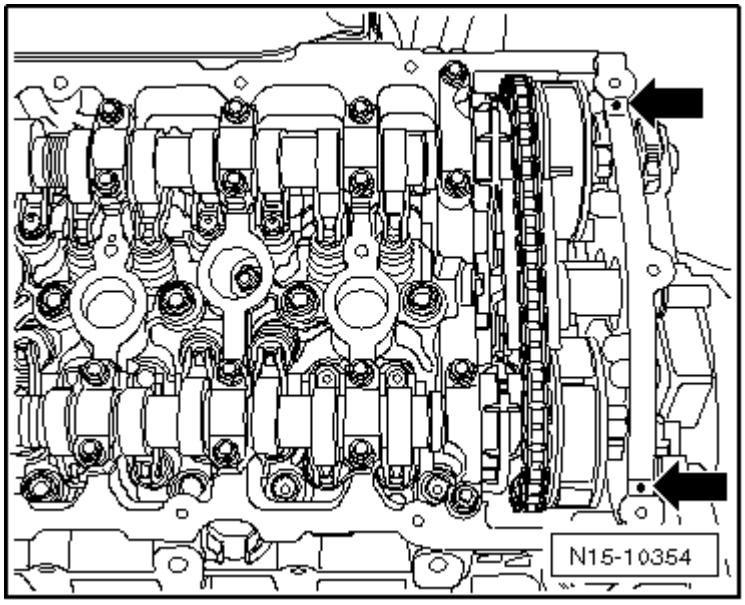

Fig. 35: Identifying Areas For Applying Sealant
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the cylinder head cover and tighten the bolts uniformly, starting from the inside and working toward the outside -1 through 17-.

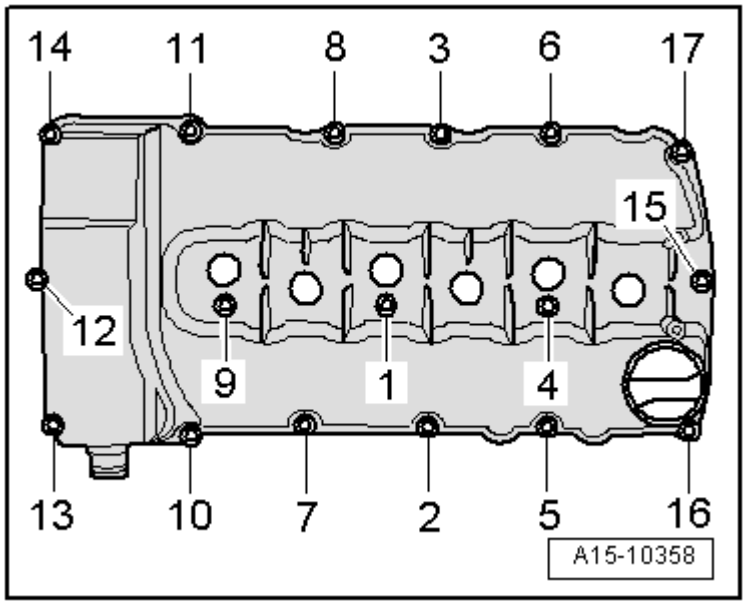

Fig. 36: Cylinder Head Cover Bolt Tightening Sequence
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

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

NOTE: Replace the cylinder head cover if it is damaged or if there are leaks.

First install the intake manifold to the cylinder head. Then tighten both bolts for the intake manifold support.

Ensure the fuel hoses are securely seated.

-- Fill the cooling system, if necessary. Refer to **DRAINING AND FILLING** .

Tightening Specifications

Bolted Connections	Tightening Specifications
Cylinder head cover to cylinder head	10 Nm
Intake manifold to cylinder head	8 Nm
Intake manifold to support	20 Nm
Oil dipstick guide tube to intake manifold	8Nm

CYLINDER HEAD

NOTE: The cylinder head can only be removed with the engine removed. Refer to REMOVING .

Special tools and workshop equipment required

- Camshaft Bar T10068 A
- Drip Tray V.A.G 1306
- Torque Wrench (5-50 Nm) V.A.G 1331
- Torque Wrench (40-200 Nm) V.A.G 1332
- Spring Type Clip Pliers VAS 5024 A
- Puller for Ignition Coil T10095 A
- Hose Clip Pliers VAS 6362
- Sealant D 176 501 A1
- Sealant D 197 300 A2

Requirements

- The engine must be removed.

Removing

CAUTION: When doing any repair work, especially in the engine compartment, pay attention to the following due to clearance issues:

- **Route lines of all types (for example, fuel, hydraulic, Evaporative Emission (EVAP), coolant, refrigerant, brake fluid and vacuum) and**

electrical wiring so that the original path is followed.

- **Ensure sufficient clearance to all moving or hot components.**

NOTE: **All cable ties which are opened or cut off when removing, must be replaced in the same position when installing.**

When the engine is installed in the engine compartment some components cannot be removed or can only be removed with great difficulty. Therefore determine which components are faulty before removing the engine.

To prevent damage to the removed components, use the V.A.G 1698 for storage.

-- Remove the intake manifold, refer to one of the following:

With a one piece intake manifold, refer to **INTAKE MANIFOLD** .

With a two piece intake manifold, refer to **UPPER INTAKE MANIFOLD** .

-- Pull out the high pressure pump plunger -item 17- **VALVETRAIN OVERVIEW**.

-- Remove the heat shield and the intake manifold support from the cylinder head.

Observe the rules for cleanliness. Refer to **CLEAN WORKING CONDITIONS** .

-- Disconnect the connectors from the Camshaft Position (CMP) sensor -G40- -1- and CMP sensor 2 -G163- -2- .

-- Disconnect the connectors from the camshaft adjustment valve 1 -N205- -3- and camshaft adjustment valve 1 (exhaust) -N318- -4-.

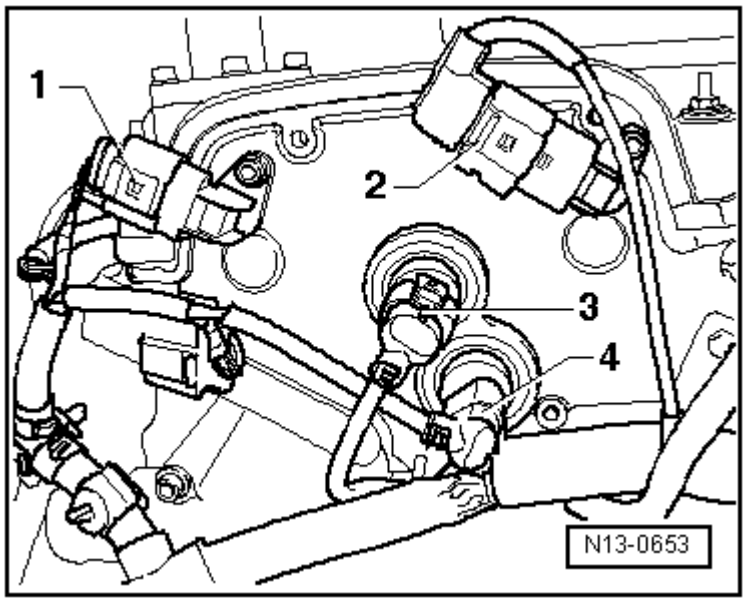

Fig. 37: Identifying CMP Sensor G40, CMP Sensor 2 G163 And Connectors
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Disconnect all remaining electrical wires required from cylinder head and set aside.

-- Remove the bracket from the cover.

-- Remove the vacuum pump, if present. Refer to **MECHANICAL VACUUM PUMP**.

-- Remove the 3 bolts -1 through 3- for the coolant connecting piece.

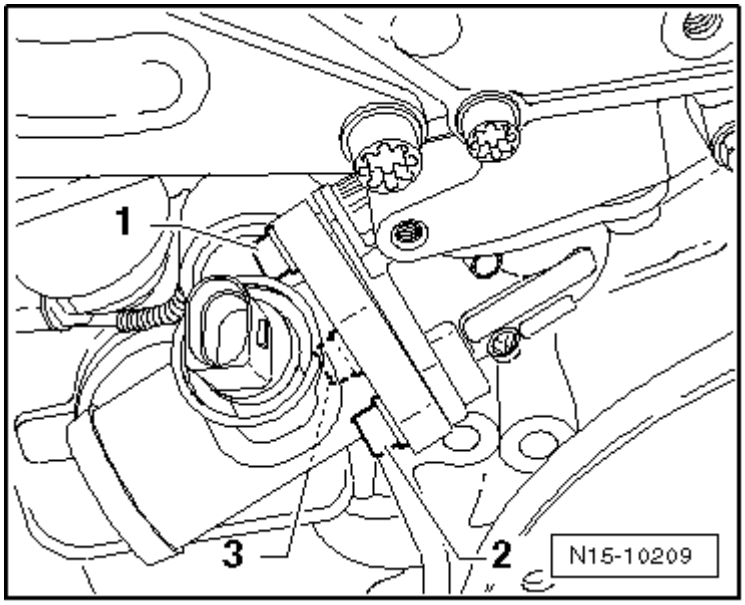

Fig. 38: Removing Three Mounting Bolts On Coolant Connection
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the cylinder head cover.

-- Rotate the crankshaft at the vibration damper bolt in engine rotation direction to the Top Dead Center (TDC) cylinder 1 mark -arrow-.

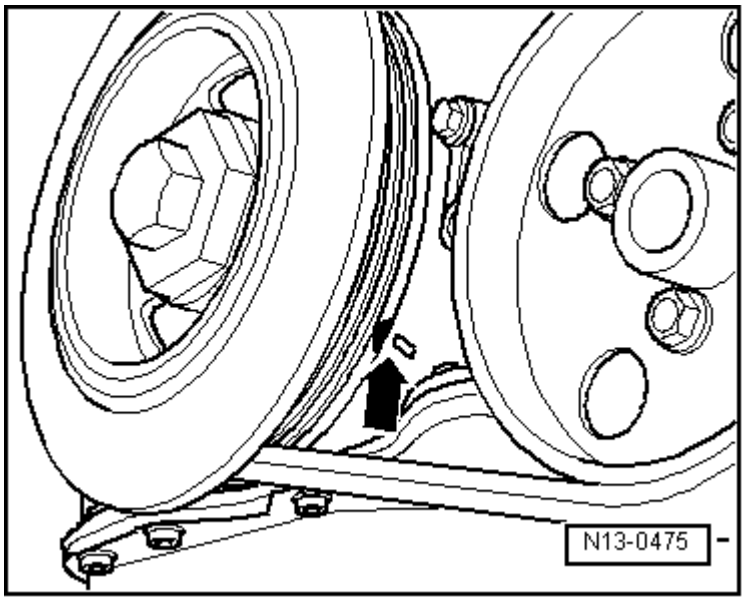

Fig. 39: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

The camshaft lobes -A- for cylinder 1 must face each other.

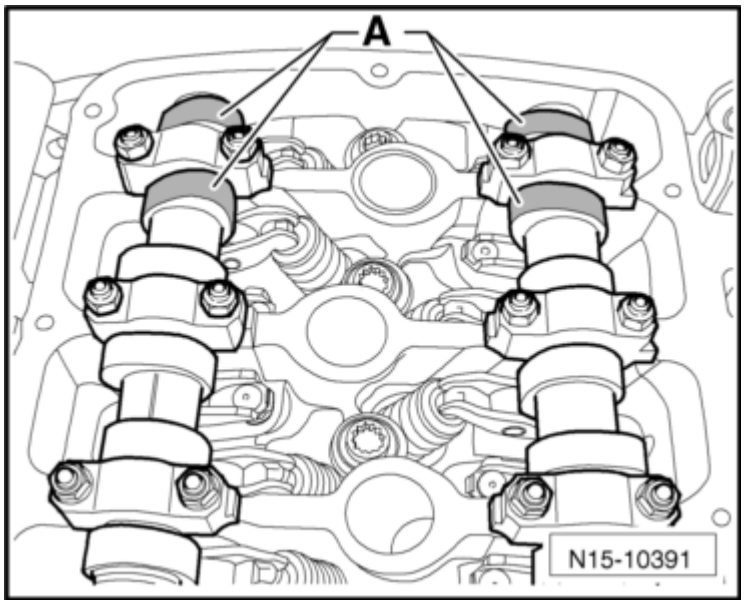

Fig. 40: Camshaft Lobes For Cylinder Facing Each Other
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the chain tensioner -arrow-.

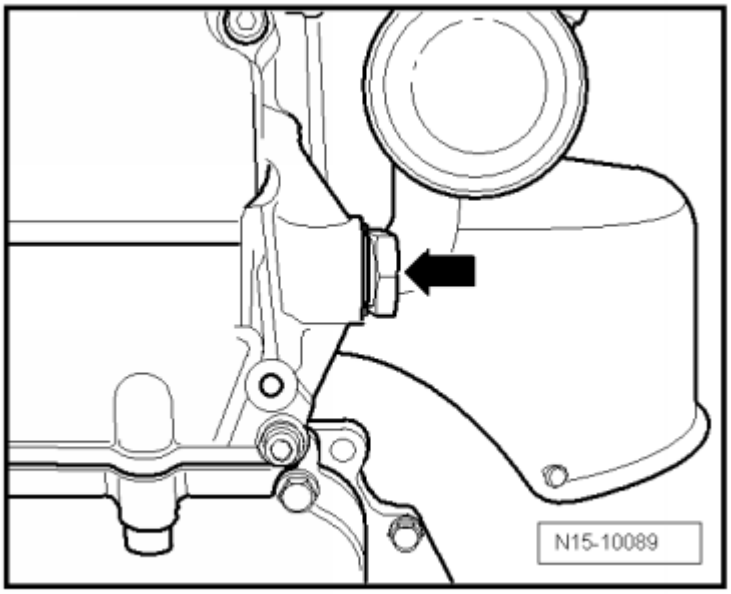

Fig. 41: Chain Tensioner Bolt Camshaft Roller Chain
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove both sealing flange bolts -1- first and then remove the other timing chain cover bolts -arrows- from the cover.

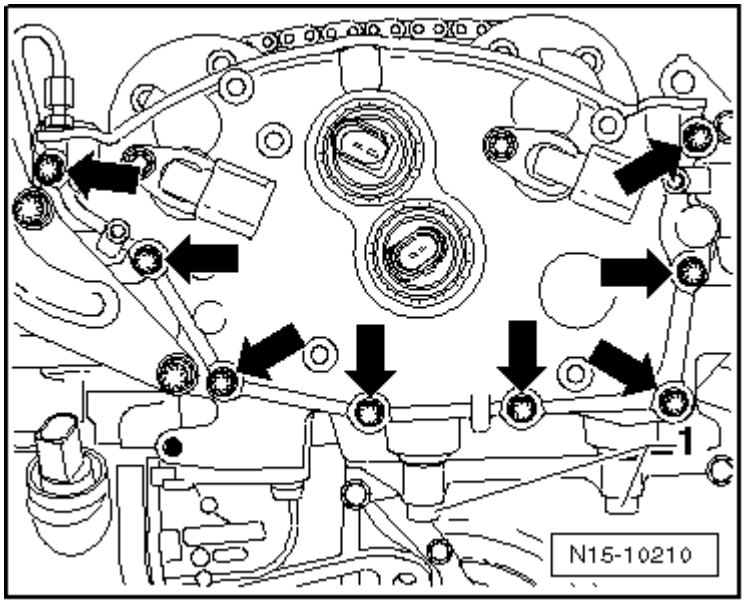

Fig. 42: Identifying Mounting Bolts For Sealing Flange And Cover Piece
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Counter hold the camshaft using a 27 mm open end wrench on the camshaft recesses -arrow-. The T10068 A must not be installed when tightening or loosening the camshaft adjuster bolt.

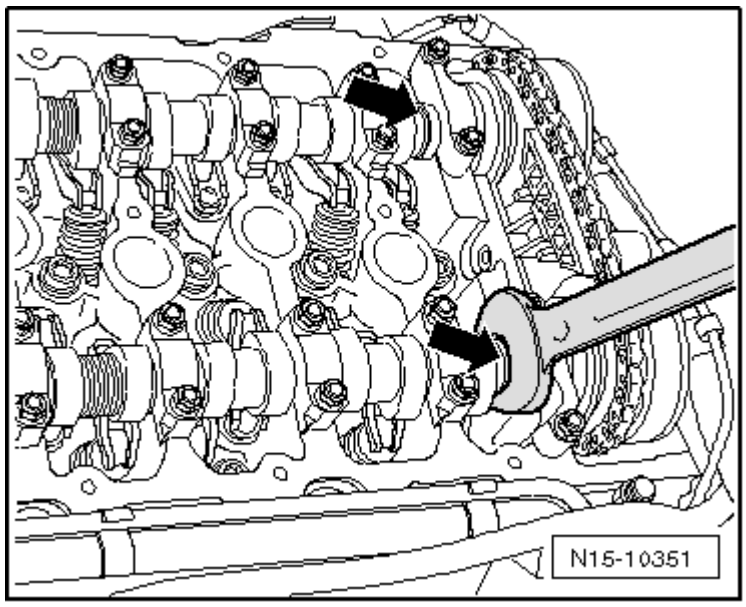

Fig. 43: Counter-Holding At Camshaft Using Wrench
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Loosen the camshaft adjuster bolts -1 and 2- and then remove the guide rail bolt -3-.

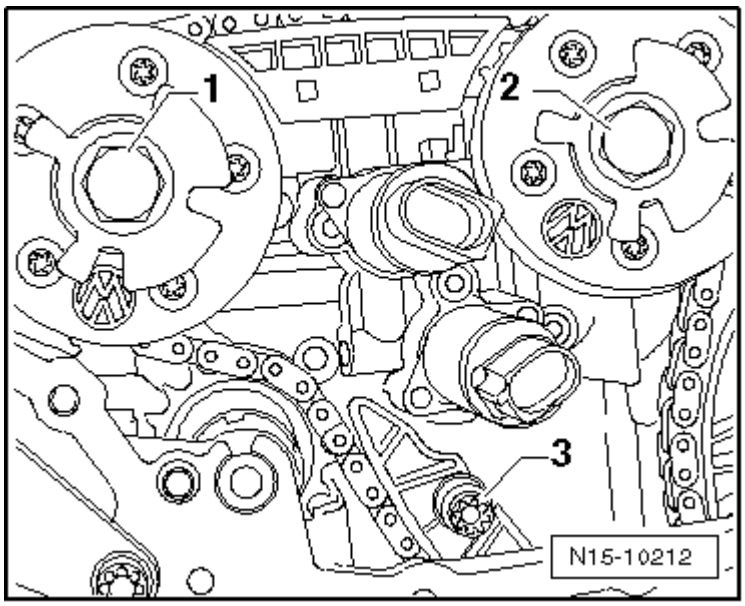

Fig. 44: Camshaft Adjuster Mounting Bolts And Bolts Of Glide Track
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the camshaft adjuster bolts and adjusters.

-- Using a screwdriver at the cylinder head -1-, pry the bearing shaft -3- forward slightly and pull it out in the -direction of arrow-.

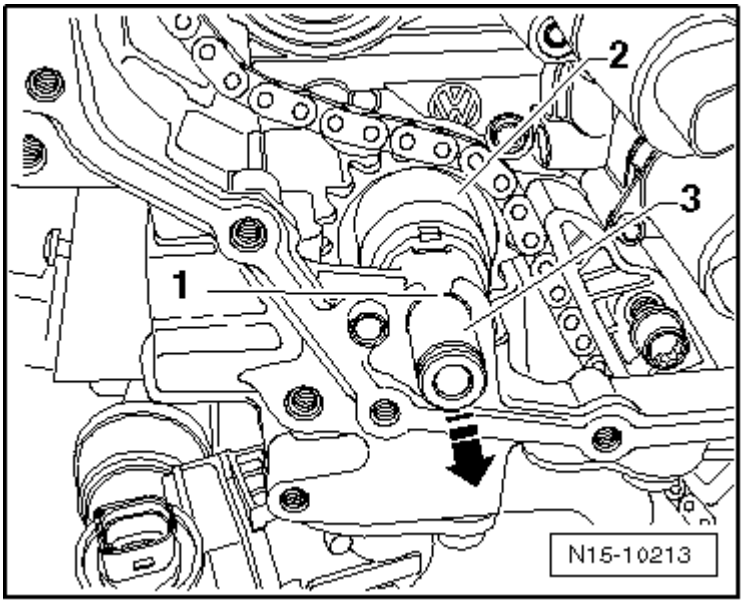

Fig. 45: Identifying Cylinder Head, Bearing Shaft & High Pressure Pump
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the drive pinion for the high pressure pump -2-.

-- Loosen and remove the cylinder head bolts in the sequence specified starting from the outside working toward the inside.

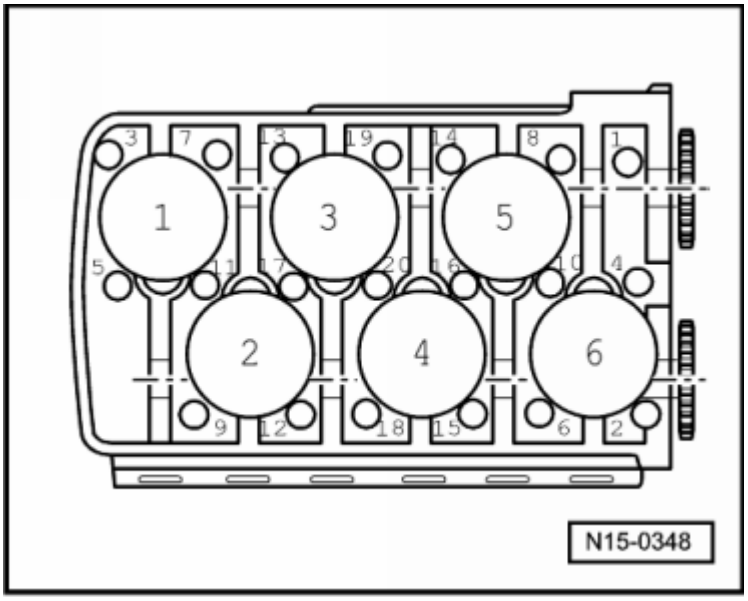

Fig. 46: Cylinder Head Bolts Removal Sequence
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the 4 control housing bolts -1- and remove the control housing -2- in the -direction of the arrow- from the camshafts.

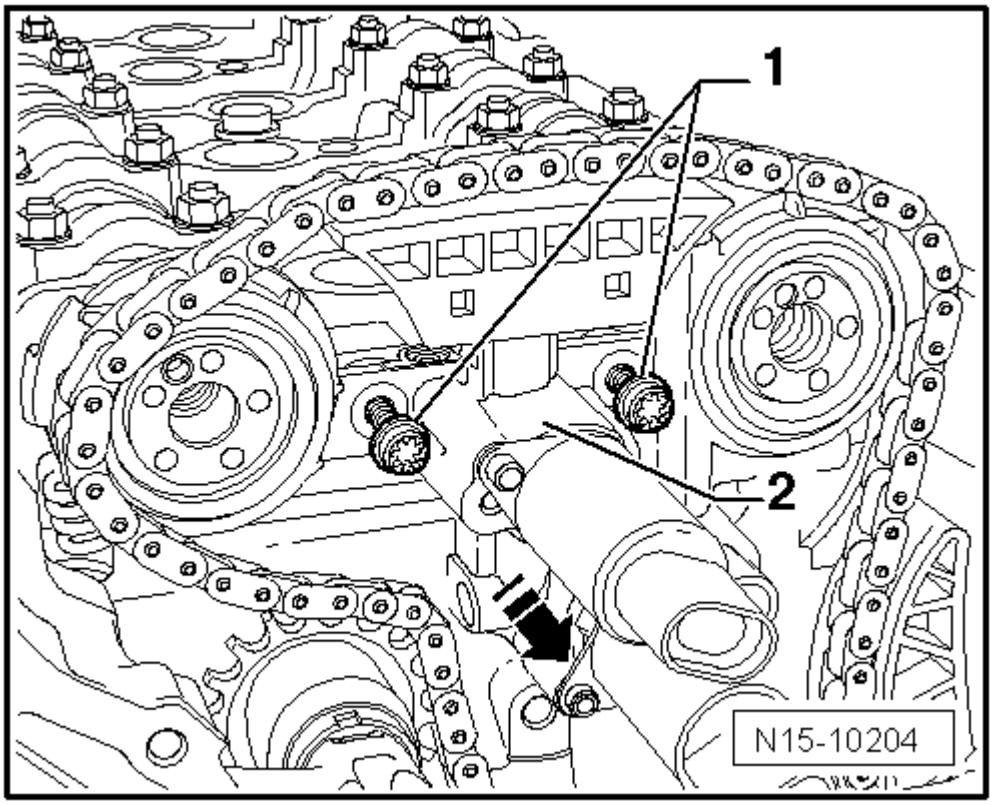

Fig. 47: Control Housing Mounting Bolts And Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Cover the camshafts -arrows- with clean paper strips and wrap the ends with adhesive tape.

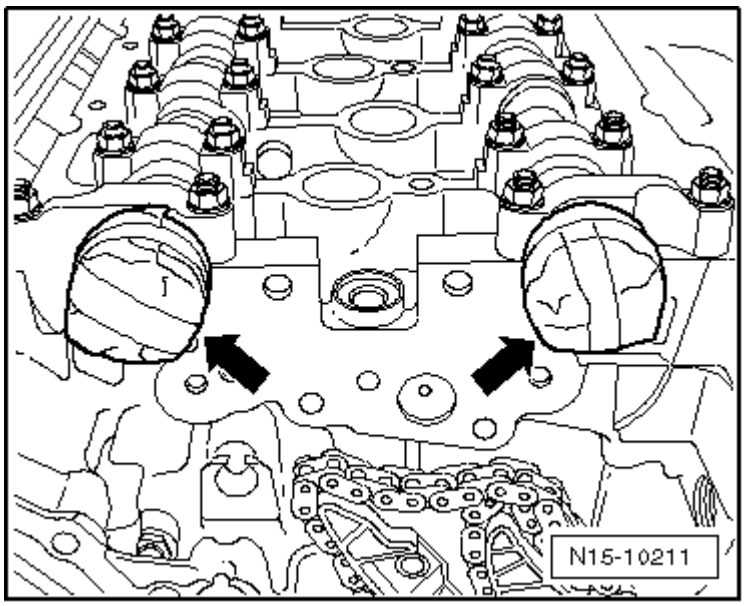

Fig. 48: Covering Camshafts With Clean Paper Strips And Wrapping Ends With Adhesive Tape
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the 3033 as shown and carefully lift off the cylinder head using the VAS 6100 or V.A.G 1202 A:

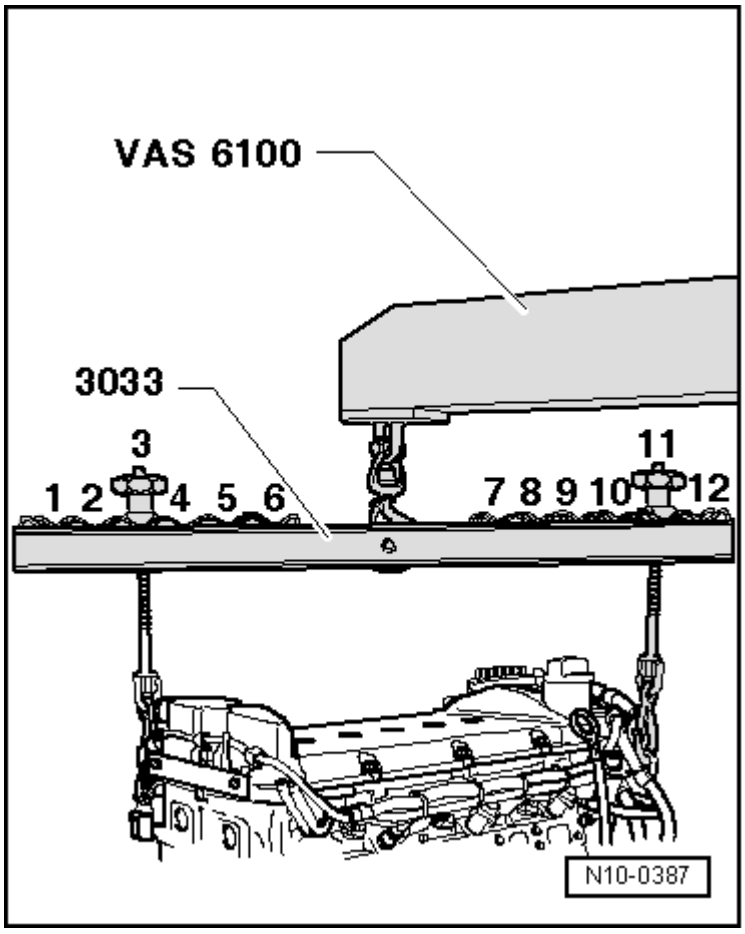

Fig. 49: Hooking Engine Sling 3033 Onto Engine And Onto Workshop Crane VAS 6100
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Vibration damper side: position 3

Flywheel side: Position 11

NOTE: The 3033 items marked 1 through 12 face toward the flywheel side.

Threaded spindles are set in length according to necessity.

-- Carefully lift the cylinder head off.

-- Insert clean cloths into the cylinders so that no dirt or abrasive powder can get between cylinder wall and piston.

-- Do not allow dirt or abrasive powder to get into coolant either.

-- Carefully clean the cylinder head and cylinder block sealing surfaces. Avoid introducing scratches or scoring

(do not use sandpaper with grit below "100").

-- Clean all threaded bores for the cylinder head bolts.

-- Check the cylinder head for warping, refer to **CYLINDER HEAD OVERVIEW**.

Installing

-- Carefully remove any metal particles, emery remains and the cloths.

If the piston for cylinder 1 is not at TDC:

-- Rotate the crankshaft at the vibration damper bolt in engine rotation direction to the TDC cylinder 1 mark -arrow-. Have a second technician guide the camshaft timing chain by hand when doing this.

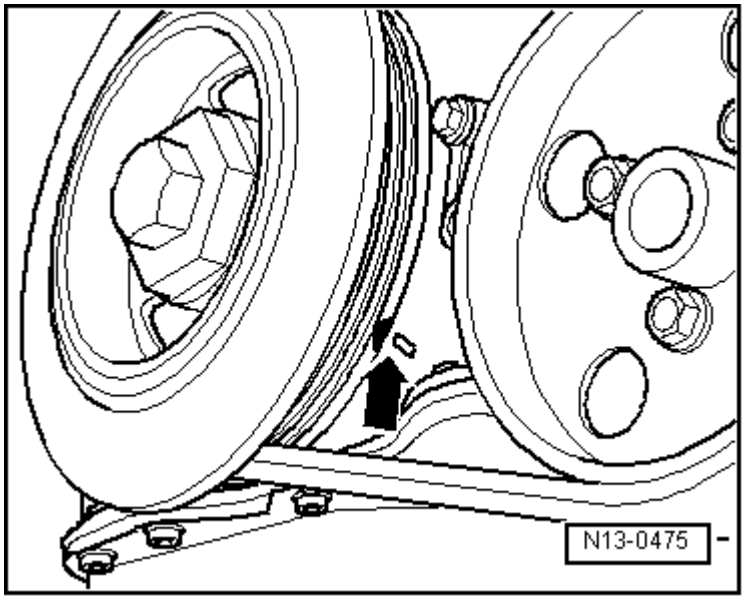

Fig. 50: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Make sure that alignment bushings are inserted in bores 12 and 20 in the cylinder block.

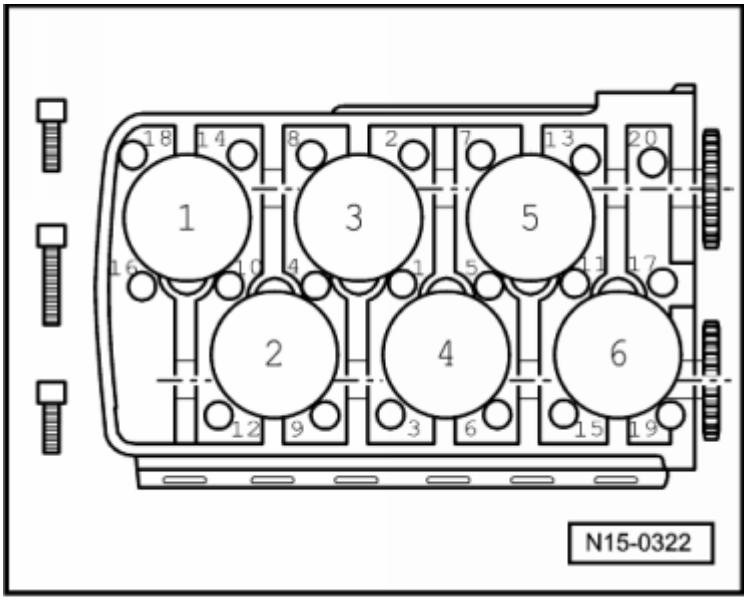

Fig. 51: Cylinder Head Tightening Sequence
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Place a 2 mm thick bead of sealant D 176 501 A1 as shown -arrows- onto the partition of the cylinder block/sealing flange.

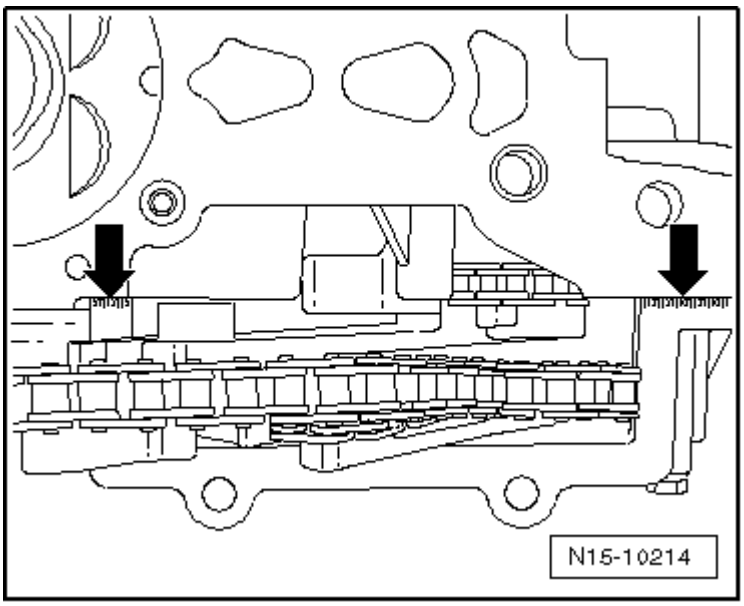

Fig. 52: Identifying Sealant Location For Cylinder Block/Sealing Flange
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Only remove the new cylinder head gasket from its packaging immediately before installing.

Handle the new gasket with extreme care. Damaging will lead to leaks.

-- Immediately place the new cylinder head gasket on. The text (part number) must be visible.

-- Fill both 3 mm holes with some sealant D 176 501 A1.

-- Position the camshafts in the cylinder head to TDC for cylinder 1.

The camshaft lobes -A- for cylinder 1 must face each other.

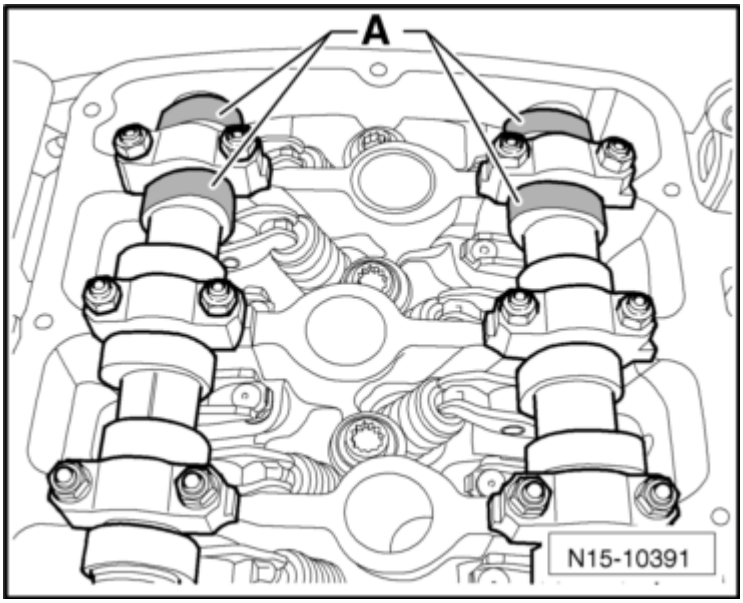

Fig. 53: Camshaft Lobes For Cylinder Facing Each Other
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- It must be possible to install the T10068 A into both camshaft grooves.

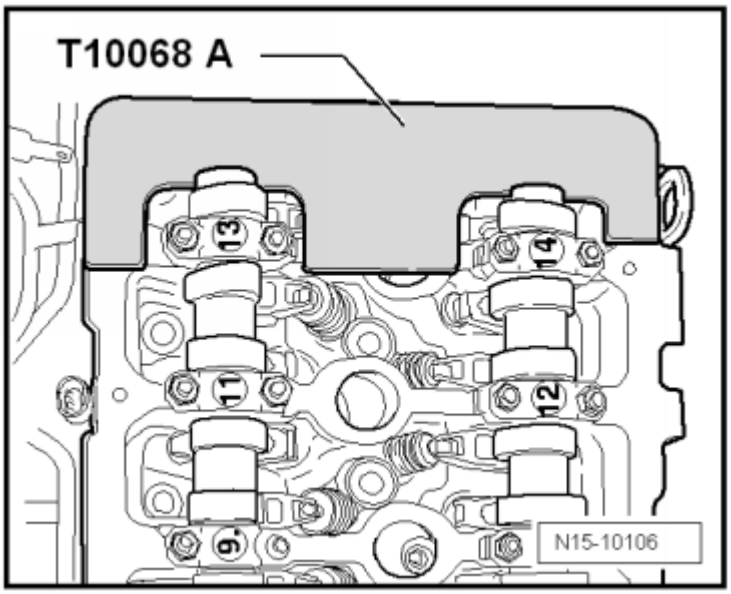

Fig. 54: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves

Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the cylinder head.

-- Apply locking compound D 197 300 A2 to each cylinder head bolt and the head contact surface -arrow- and install the bolts.

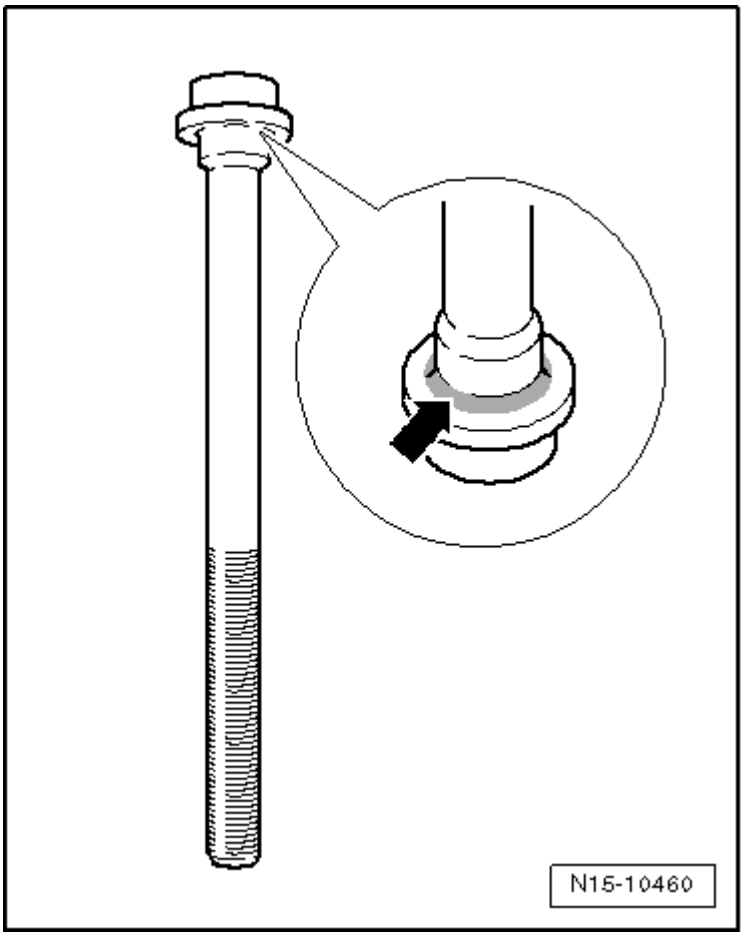

Fig. 55: Applying Liquid Locking Fluid To Cylinder Head Bolt
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The locking compound D 197 300 A2 works as a fine seal over the cylinder head bolt.

The longer cylinder head bolts must be installed in the middle holes of the cylinder head.

-- Tighten the cylinder head bolts in the sequence specified, starting from the inside and working toward the outside, as follows:

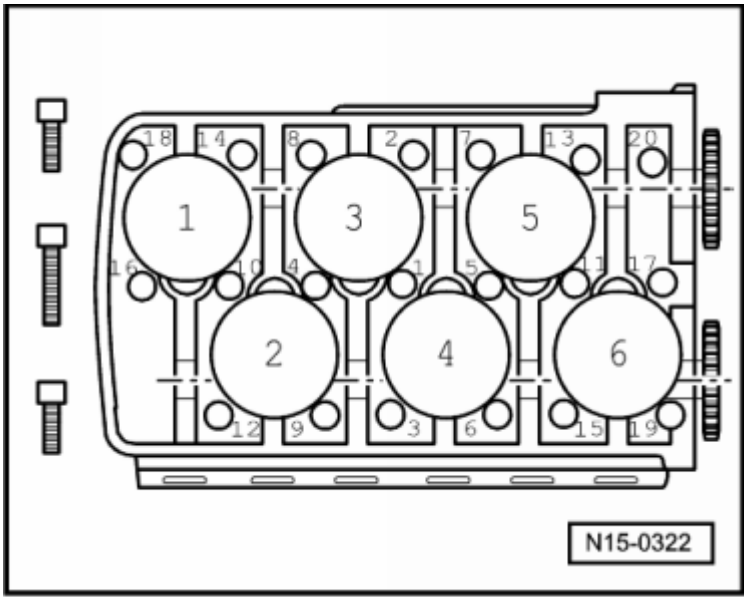

Fig. 56: Cylinder Head Tightening Sequence
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Tighten all the bolts to 15 Nm.

-- Tighten all the bolts to 30 Nm.

-- Tighten all bolts an additional 180° (1/2) turn.

The rest of the installation is basically a reverse of the removal sequence.

-- Install the camshaft adjustors with timing chain. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING**.

-- Install the cylinder head cover.

-- Install the intake manifold, refer to one of the following:

With a one piece intake manifold, refer to **INTAKE MANIFOLD** .

With a two piece intake manifold, refer to **UPPER INTAKE MANIFOLD** .

NOTE: There is no requirement to tighten the cylinder head bolts after repairs.

CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING

VEHICLES THROUGH 11.08

Special tools and workshop equipment required

- Camshaft Bar T10068 A

- Counter-Holder Tool T10069
- Torque Wrench (5-50 Nm) V.A.G 1331
- Torque Wrench (40-200 Nm) V.A.G 1332
- Adjustment Tool T10332 (for vehicles without mechanical vacuum pump)
- Adjustment Tool T10363 (for vehicles with mechanical vacuum pump)
- Sealant D 176 501 A1

-- Rotate the crankshaft at the vibration damper bolt in engine rotation direction to the Top Dead Center (TDC) cylinder 1 mark -arrow-.

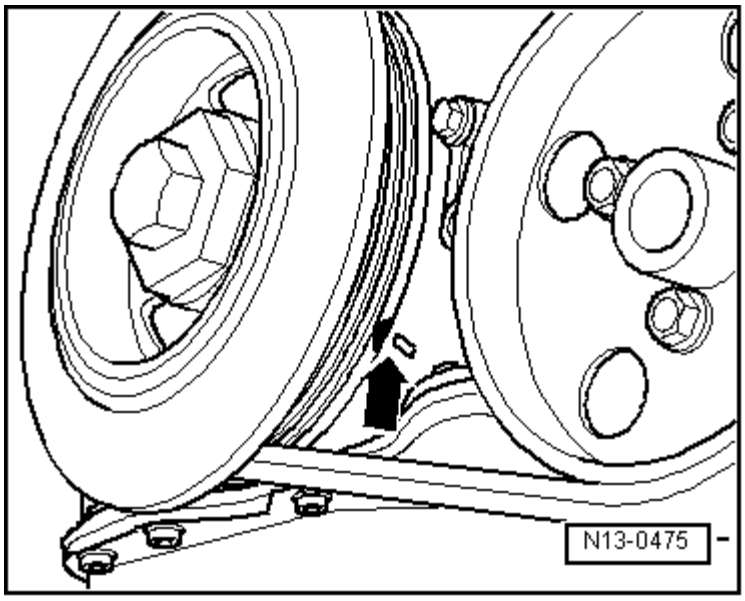

Fig. 57: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Position the camshafts in cylinder head to Top Dead Center (TDC) cylinder 1.

The camshaft lobes -A- for cylinder 1 must face each other.

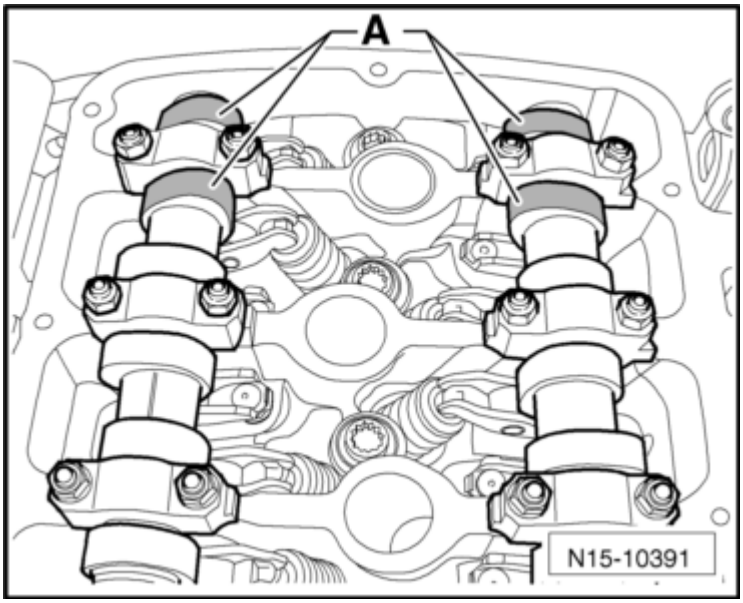

Fig. 58: Camshaft Lobes For Cylinder Facing Each Other
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the T10068 A into both camshaft grooves. If necessary, rotate the camshaft back and forth slightly using an open end wrench on the camshaft recesses.

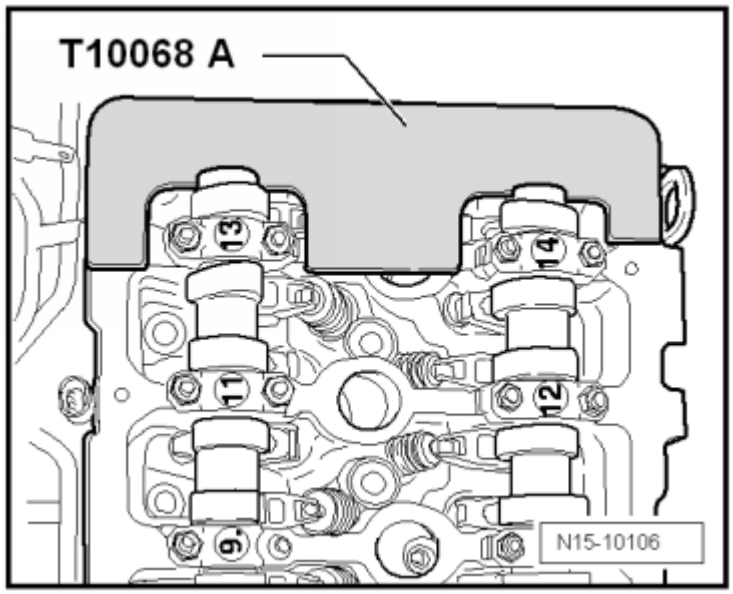

Fig. 59: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Without a Mechanical Vacuum Pump

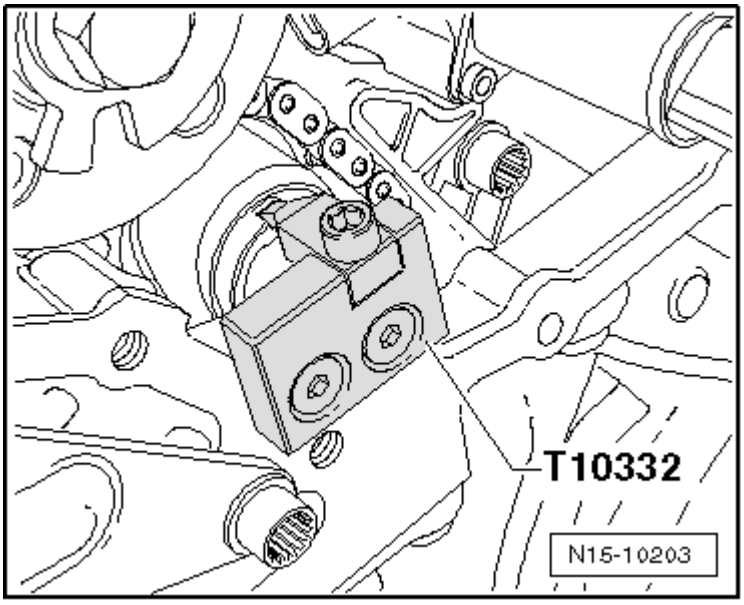

Fig. 60: Securing Position Of Drive Pinion For High Pressure Pump Using Adjustment Tool T10332
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Secure the position of the high pressure pump drive pinion using the T10332.

With a Mechanical Vacuum Pump

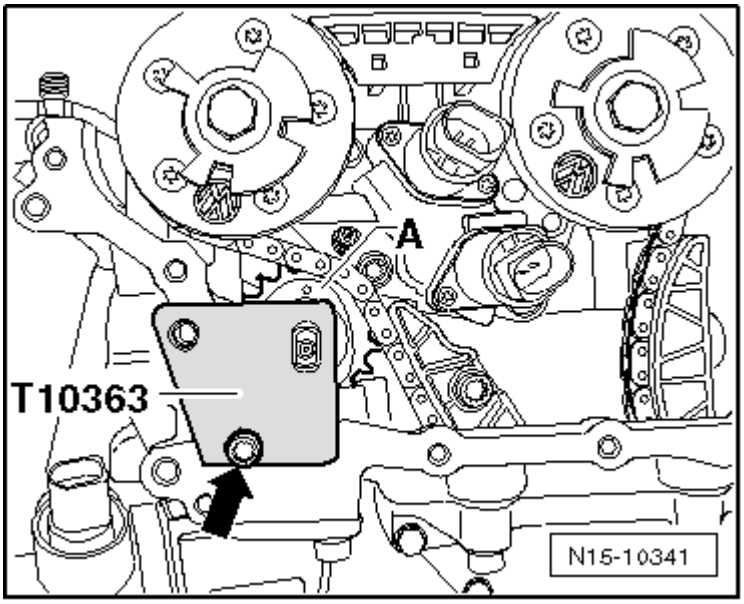

Fig. 61: Securing Position Of Drive Pinion For High Pressure Pump Using Adjustment Tool T10363
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Secure the position of the high pressure pump drive pinion using T10363. The mark -A- on the high pressure drive pinion must be at the top.

Continuation for All

First, install the camshaft adjuster for the intake camshaft as follows:

NOTE: The camshaft adjusters can be attached to the camshaft in only one position. This is due to the alignment pin -arrows-.

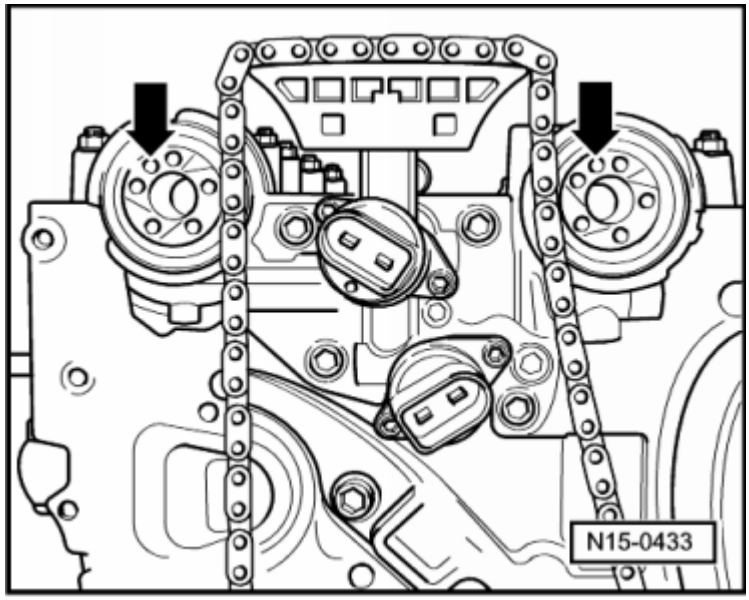

Fig. 62: Camshaft Timing Adjusters Positioned On Camshaft Mountings
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Check the crankshaft TDC position.

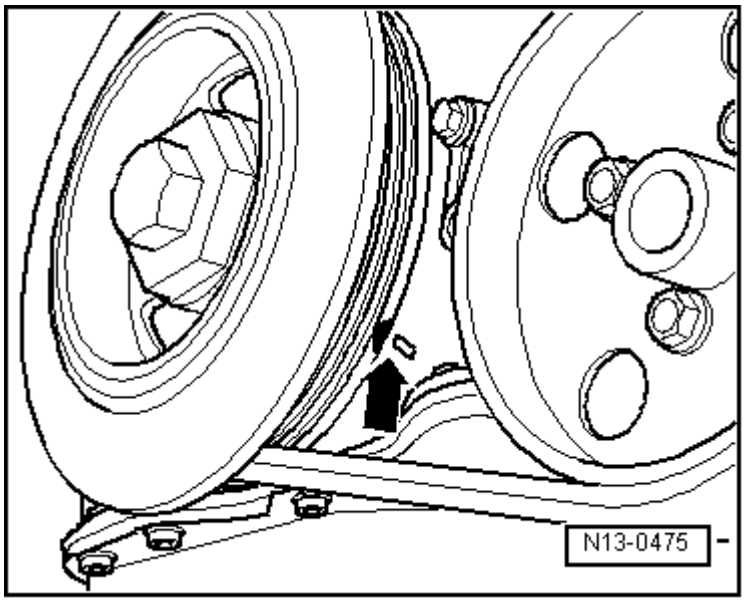

Fig. 63: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Turn the wheel -1- all the way to the right on the adjuster, which was previously removed. Hold the adjuster

in this position.

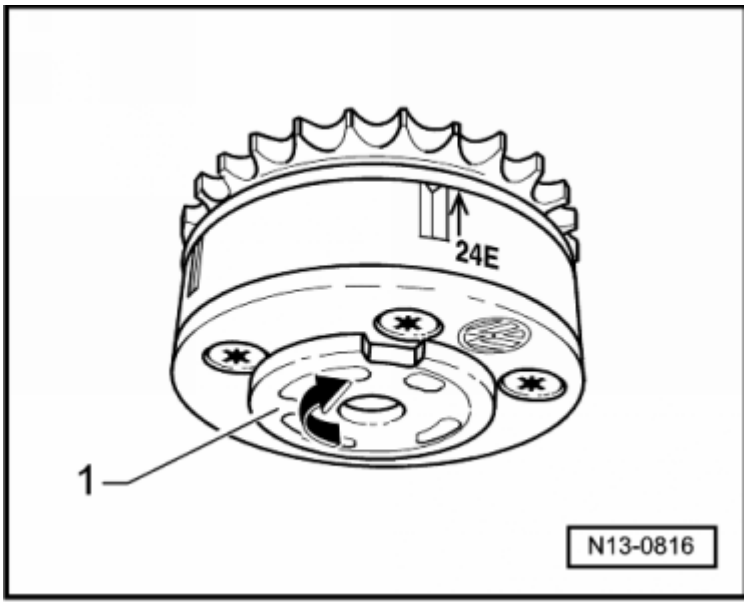

Fig. 64: Identifying Sensor Wheel Turned To The Right At Intake Camshaft Adjuster
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: If the intake camshaft adjuster is attached to the camshaft, the adjuster must be rotated left accordingly with the sprocket and then the camshaft timing chain must be routed.

-- Place the intake camshaft adjuster with the timing chain in place onto the camshaft. Note the following:

- The timing chain for the high pressure pump drive pinion must not hang through.
- It must be easy to install the camshaft adjuster with the timing chain taut so the bolt can then be tighten by hand.
- The arrow -1- on the camshaft adjuster >>24E<< must align with the right notch -2- of the control housing. Marks on control housing, refer to **VEHICLES THROUGH 11.08**.

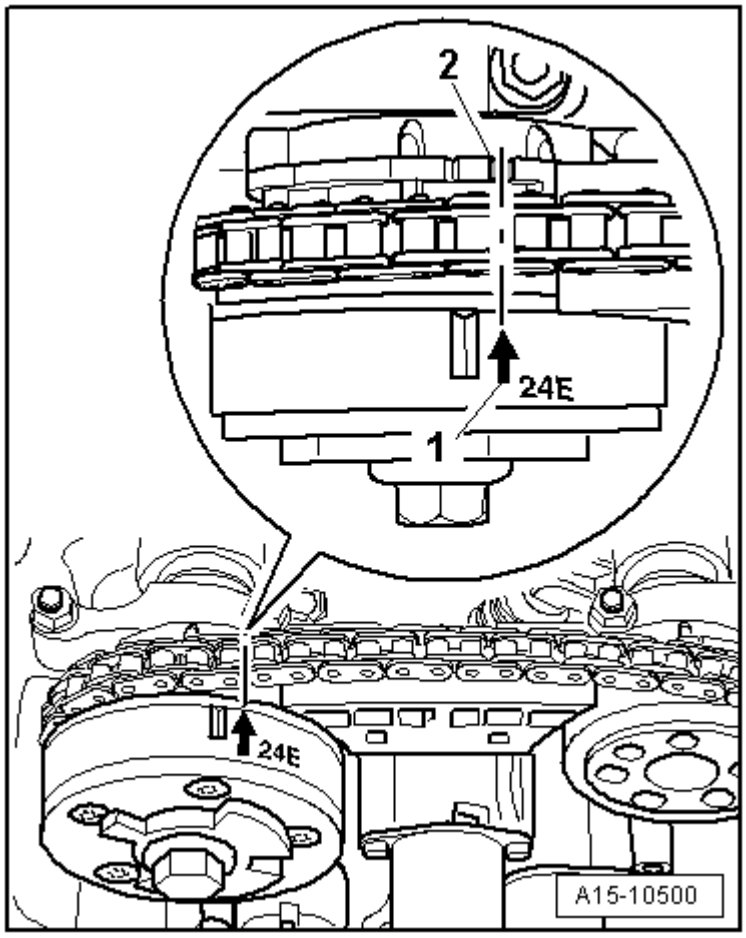

Fig. 65: Verifying Installation Marks Of Intake Camshaft Adjuster With Marks On Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Count exactly 16 rollers on the timing chain to the right from tooth with the arrow -1- aligning with notch -2-. Mark this roller with a colored mark.

NOTE: The Exhaust camshaft adjuster is locked in the rest position. Therefore the wheel cannot be rotated when adjusting the valve timing. If the locking mechanism in its rest position is not engaged (locked) turn the adjuster in both directions by hand until it locks. If that is not possible, replaced the camshaft adjuster.

-- Install the exhaust camshaft adjuster >>32A<< into the timing chain. The previously counted 16 rollers must lie between the arrow marks 24E and 32A.

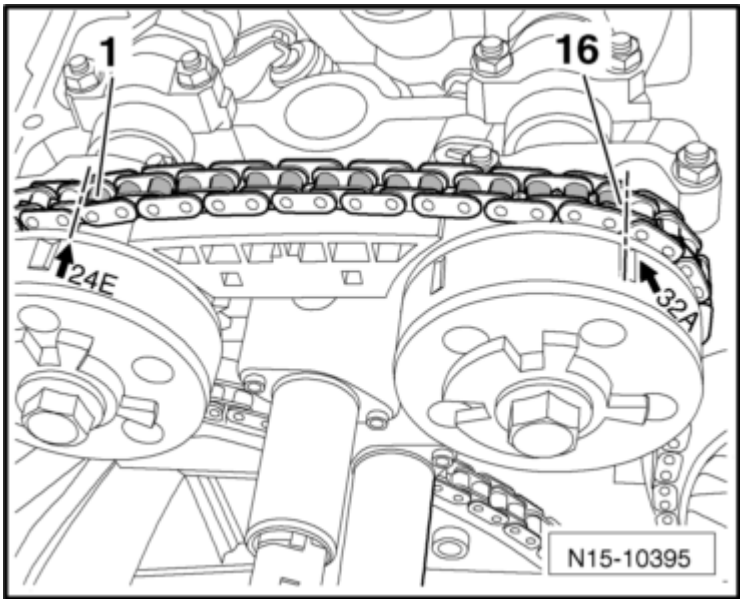

Fig. 66: Identifying Small Offset Between Mark And Notch
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Place the camshaft adjuster >>32A<< with the timing chain installed on the exhaust camshaft. Note the following:

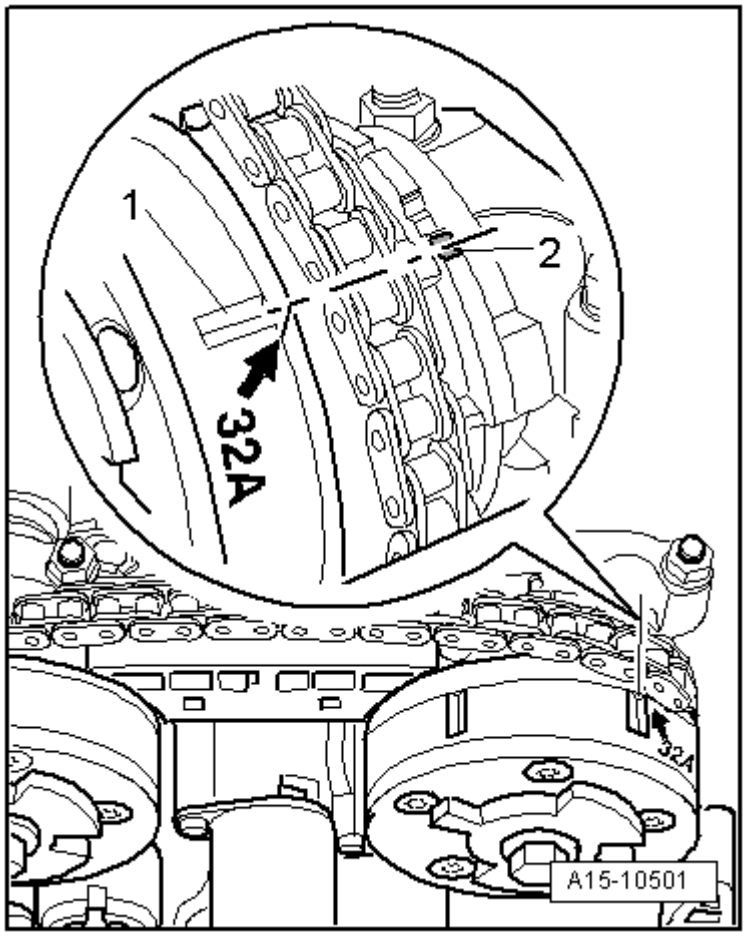

Fig. 67: Verifying Installation Marks Of Exhaust Camshaft Adjuster With Marks On Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- The mark -1- on the camshaft adjuster which the arrow points to must align with the notch -2- at the far right on the control housing. Marks on the control housing. Refer to **VEHICLES THROUGH 11.08**.
- Exhaust camshaft adjuster must be able to be installed easily onto the exhaust camshaft and the bolt be tightened by hand.

NOTE: A small offset between the mark -1- and notch -2- is permitted.

-- Remove the T10332 or the T10363 from the bearing shaft.

-- Remove the T10068 A.

-- Install the chain tensioner and tighten it to 50 Nm.

-- Rotate the crankshaft 2 revolutions in engine rotation direction and check the valve timing. Refer to **VALVE TIMING, CHECKING**.

If the marks match:

-- Secure the respective camshaft to be tightened using a 27 mm open end wrench on the camshaft recess -arrow-.

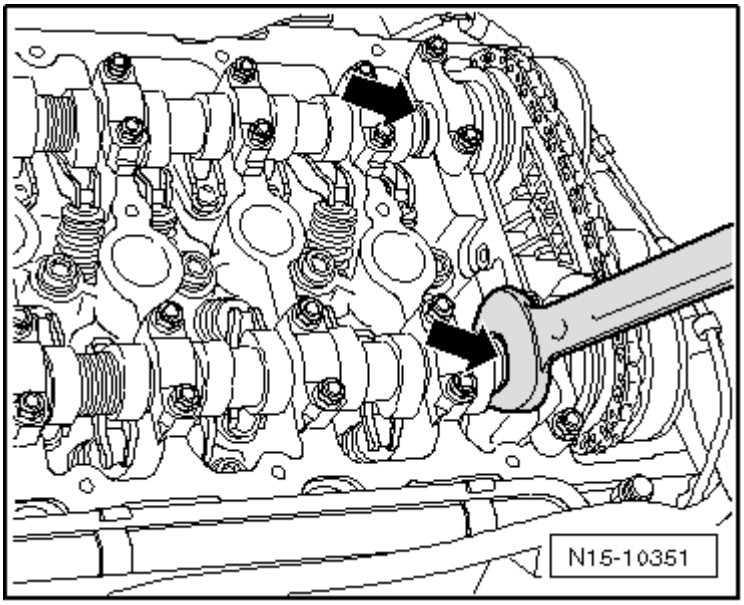

Fig. 68: Counter-Holding At Camshaft Using Wrench
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The T10068 A must not be installed during this process.

Be aware that all sprocket bolts must be replaced.

-- Tighten the new bolts for the intake and exhaust camshaft adjusters to 60 Nm + 90° (1/4) additional turn.

Install the sealing flange. Refer to **SEALING FLANGE, TRANSMISSION SIDE** .

Further installation is performed in reverse order.

VEHICLES FROM 12.08

Special tools and workshop equipment required

- Camshaft Bar T10068 A
- Counter-Holder Tool T10069
- Torque Wrench (5-50 Nm) V.A.G 1331
- Torque Wrench (40-200 Nm) V.A.G 1332
- Adjustment Tool T10332 (without mechanical vacuum pump)
- Adjustment Tool T10363 (with mechanical vacuum pump)
- Sealant D 176 501 A1

-- Rotate the crankshaft at the vibration damper bolt in engine rotation direction to the Top Dead Center (TDC)

cylinder 1 mark -arrow-.

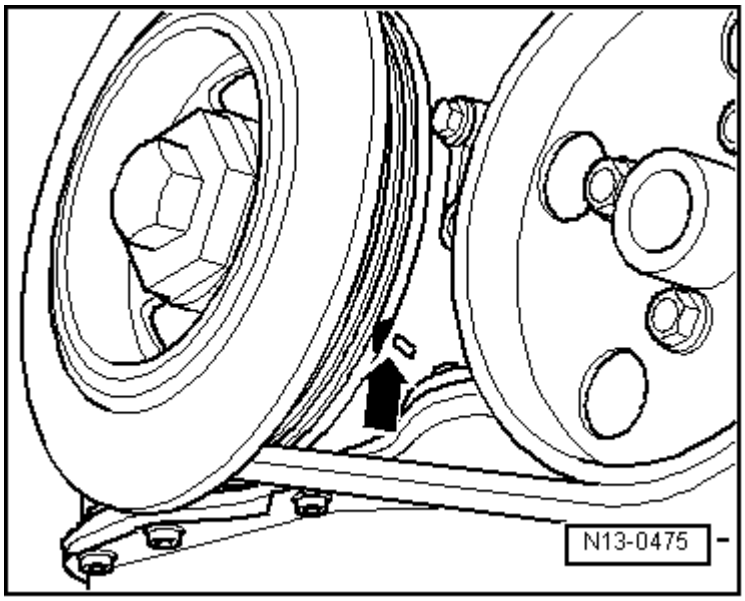

Fig. 69: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Position the camshafts in the cylinder head to Top Dead Center (TDC) cylinder 1.

The camshaft lobes -A- for cylinder 1 must face each other.

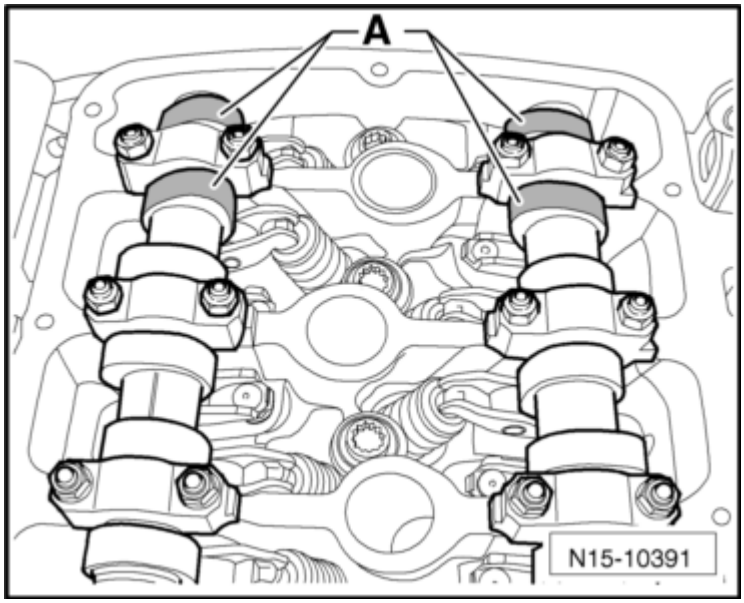

Fig. 70: Camshaft Lobes For Cylinder Facing Each Other
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the T10068 A into both camshaft grooves. If necessary, rotate the camshaft back and forth slightly using an open end wrench on the camshaft recesses.

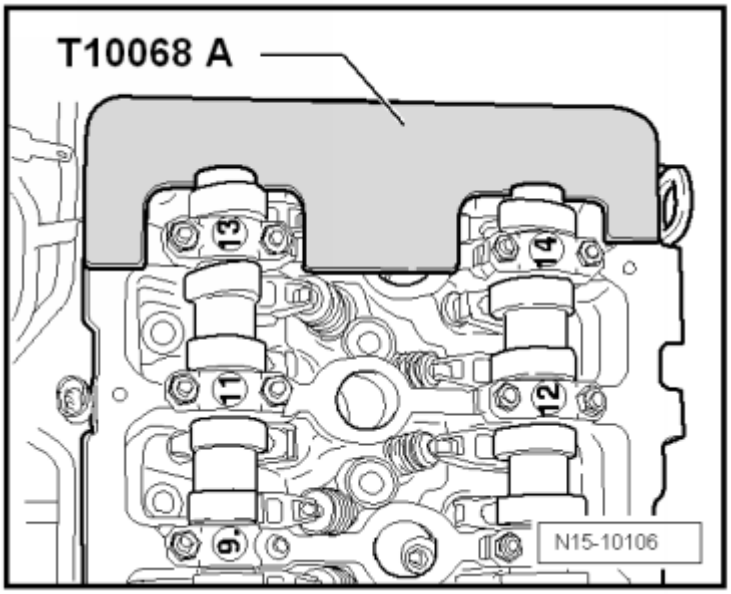

Fig. 71: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Secure the position of the high pressure pump drive pinion using the T10363. The mark -A- on the high pressure drive pinion must be at the top.

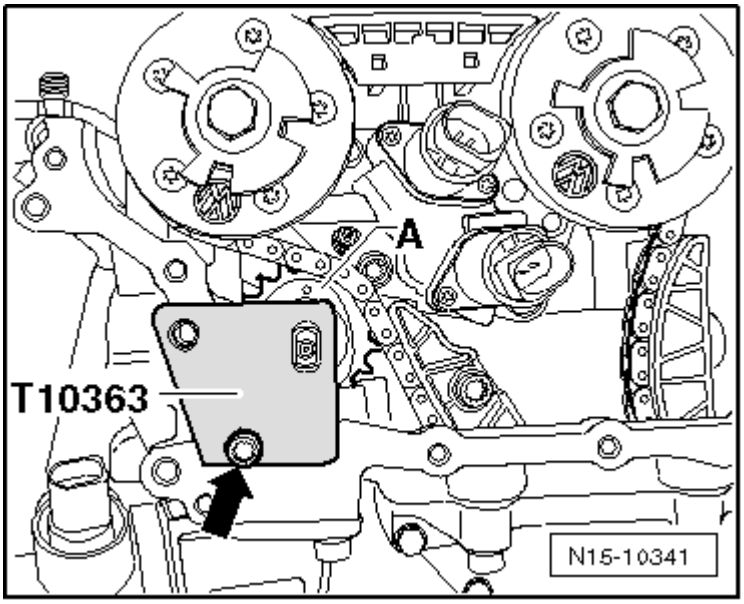

Fig. 72: Securing Position Of Drive Pinion For High Pressure Pump Using Adjustment Tool T10363
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

First, install the camshaft adjuster for the intake camshaft as follows:

NOTE: The camshaft adjusters can be attached to the camshafts in only one position. This is due to the alignment pin -arrows-.

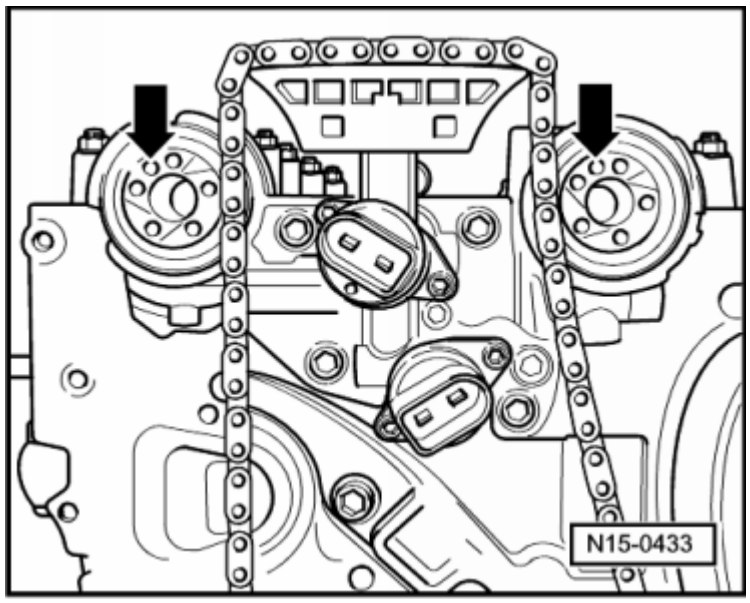

Fig. 73: Camshaft Timing Adjusters Positioned On Camshaft Mountings
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Place the intake camshaft adjuster with the timing chain in place on the camshaft. Note the following:

- The timing chain for the high pressure pump drive pinion must not hang through.
- It must be easy to install the camshaft adjuster with the timing chain taut so the bolt can then be tighten by hand.
- The arrow -1- on camshaft adjuster >>24E<< must align with the right notch -2- of the control housing. Marks on control housing, refer to **VEHICLES THROUGH 11.08**.

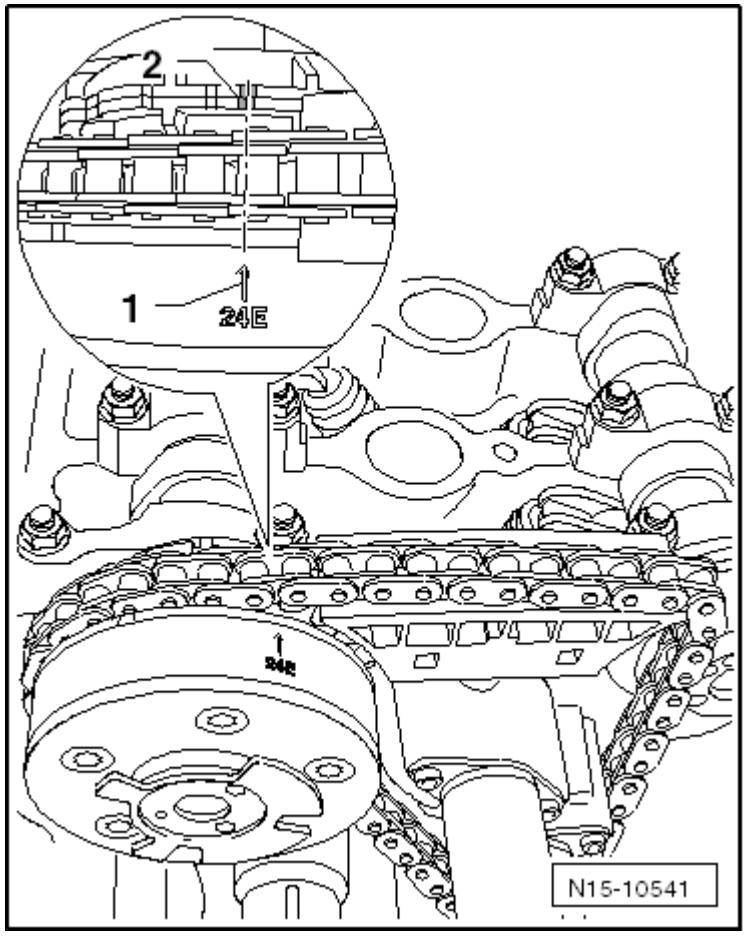

Fig. 74: Identifying Camshaft Adjuster Align With Right Notch Of Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Count exactly 16 rollers to the right on the timing chain from the tooth with the arrow -1- aligning with the notch -2-. Mark this roller with a colored mark.

NOTE: The camshaft adjusters are locked in their rest position. Therefore the wheel cannot be rotated when adjusting the valve timing. If the locking mechanism in its rest position is not engaged (locked) turn the adjuster in both directions by hand until it locks. If that is not possible, replaced the camshaft adjuster.

-- Install the exhaust camshaft adjuster >>32A<< into the timing chain. The previously counted 16 rollers must lie between the arrow marks 24E and 32A.

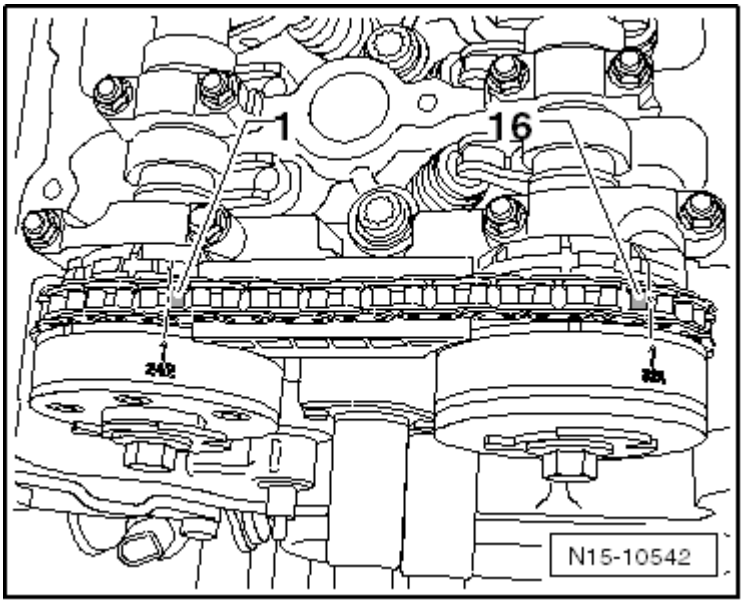

Fig. 75: Distance Between Marks On Camshaft Adjuster
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Place the camshaft adjuster >>32A<< with the timing chain installed to the exhaust camshaft. Note the following:

- The arrow -1- on the camshaft adjuster >>32A<< must align with the notch -2- on the right side of the control housing. Marks on control housing. Refer to **VEHICLES THROUGH 11.08**.

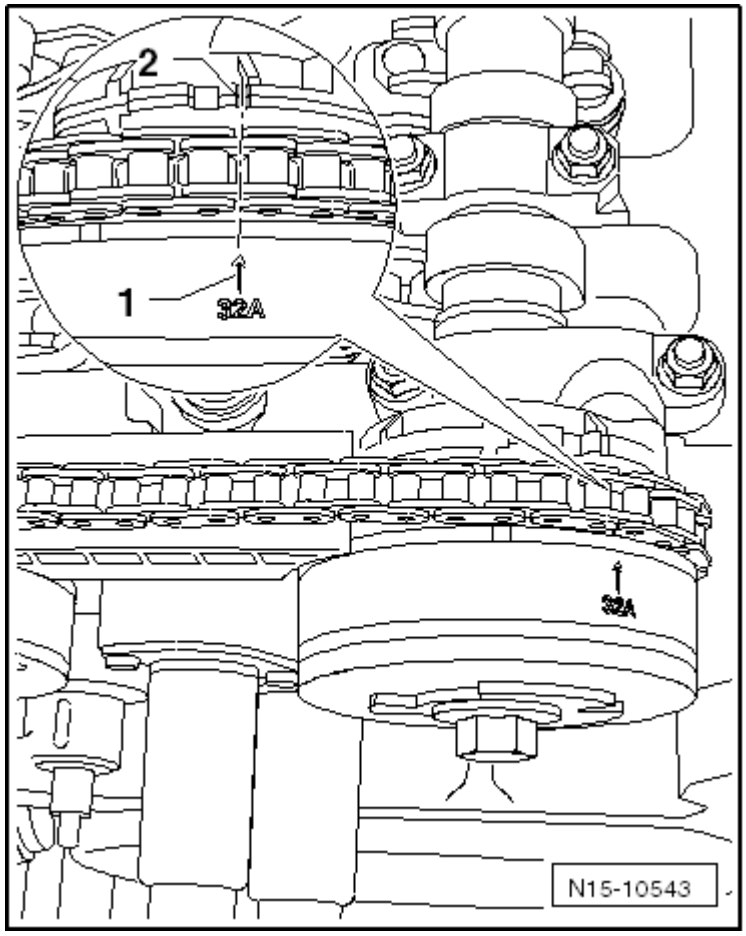

Fig. 76: Identifying Arrow On Camshaft Adjuster Aligns With Notch On Right Side Of Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- The exhaust camshaft adjuster must be able to be installed easily on the exhaust camshaft and the bolt be tightened by hand.

NOTE: A slight offset between the 32A mark and the notch is permitted.

-- Remove the T10363 out of bearing shaft.

-- Remove the T10068 A.

-- Install the chain tensioner and tighten it to 50 Nm.

-- Rotate the crankshaft 2 revolutions in engine rotation direction and check the valve timing.

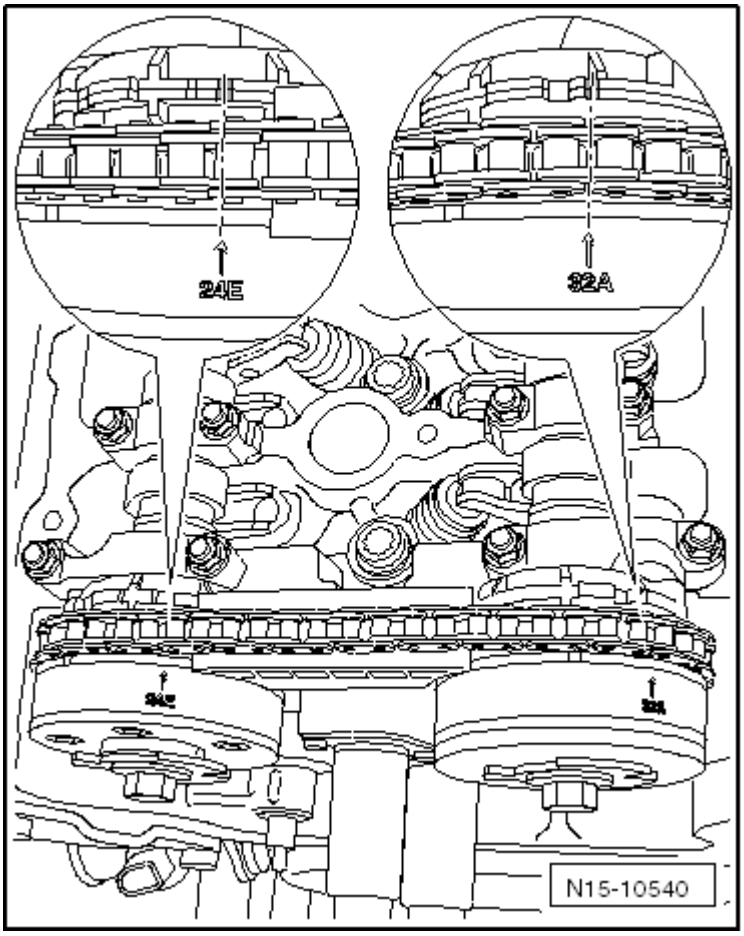

Fig. 77: Verifying Installation Marks Of Camshaft Adjuster With Marks On Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

If the marks match:

-- Secure the respective camshaft to be tightened using a 27 mm open end wrench on the camshaft recess -arrow-.

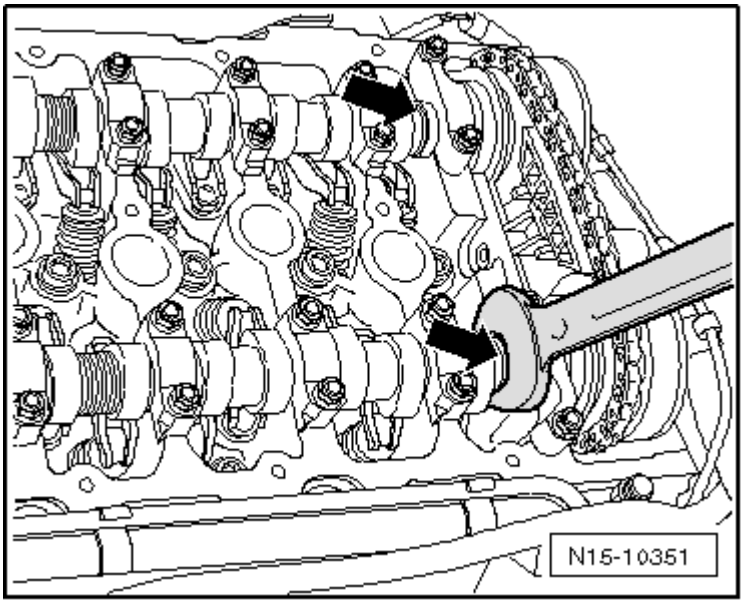

Fig. 78: Counter-Holding At Camshaft Using Wrench
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The T10068 A must not be installed during this process.

Be aware that all sprocket bolts must be replaced.

-- Tighten the new bolts for the intake and exhaust camshaft adjusters to 60 Nm + 90° (1/4) additional turn.

Install the sealing flange. Refer to **SEALING FLANGE, TRANSMISSION SIDE** .

Further installation is performed in reverse order.

OIL PUMP DRIVE TIMING CHAIN, INSTALLING

NOTE: Procedure is only possible when the engine is removed from the engine compartment!

Special tools and workshop equipment required

- Camshaft Bar T10068 A
- Counter-Holder Tool T10069
- Torque Wrench (5-50 Nm) V.A.G 1331
- Torque Wrench (40-200 Nm) V.A.G 1332
- Adjustment Tool T10332 (without mechanical vacuum pump)
- Adjustment Tool T10363 (with mechanical vacuum pump)
- Sealant D 176 501 A1

Requirements

- Engine is removed
- Drive plate is removed
- Oil pan is removed
- Sealing flange is removed
- Cylinder head cover is removed

CAUTION: When doing any repair work, especially in the engine compartment, pay attention to the following due to clearance issues:

- **Route all lines and wires in their original locations.**
- **Make sure the wires have enough clearance to all moving or hot components.**

NOTE: The procedure is described with the engine removed. The adjustments required depend on how far the engine has been disassembled. The oil pan is removed and must only be installed after installing the sealing flange.

Install the timing chain and the chain tensioner with tensioning rail for the oil pump drive:

-- Set the crankshaft to Top Dead Center (TDC) cylinder 1. To do so, the milled tooth on the crankshaft drive sprocket -arrow- must align with the crankshaft bearing cap joint.

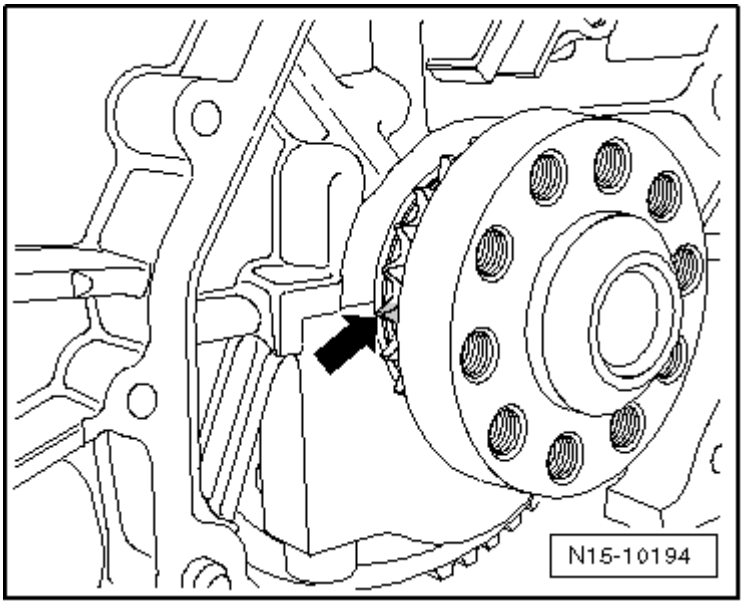

Fig. 79: Identifying Crankshaft Set To TDC Cylinder 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install both locating pins without collars for the guide rail and tighten them to 10 Nm. Place the guide tail on the pins.

-- Set the oil pump shaft -1- with the flat side -arrow- horizontal to the mark -2- on the oil pump.

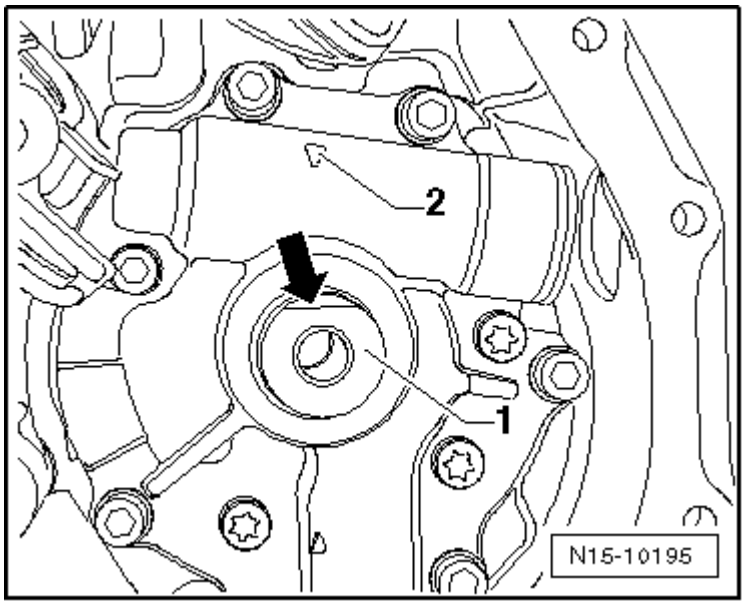

Fig. 80: Setting Oil Pump Shaft With Flat Side Horizontal To Marking On Oil Pump
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Note the direction of rotation of a used timing chain, refer to TIMING CHAINS AND ADJUSTERS .

-- Install the timing chain into the guide rail and mount it onto the crankshaft drive sprocket.

-- Install the large sprocket into the timing chain so that the tab on the sprocket aligns with the mark on the cylinder block -B-.

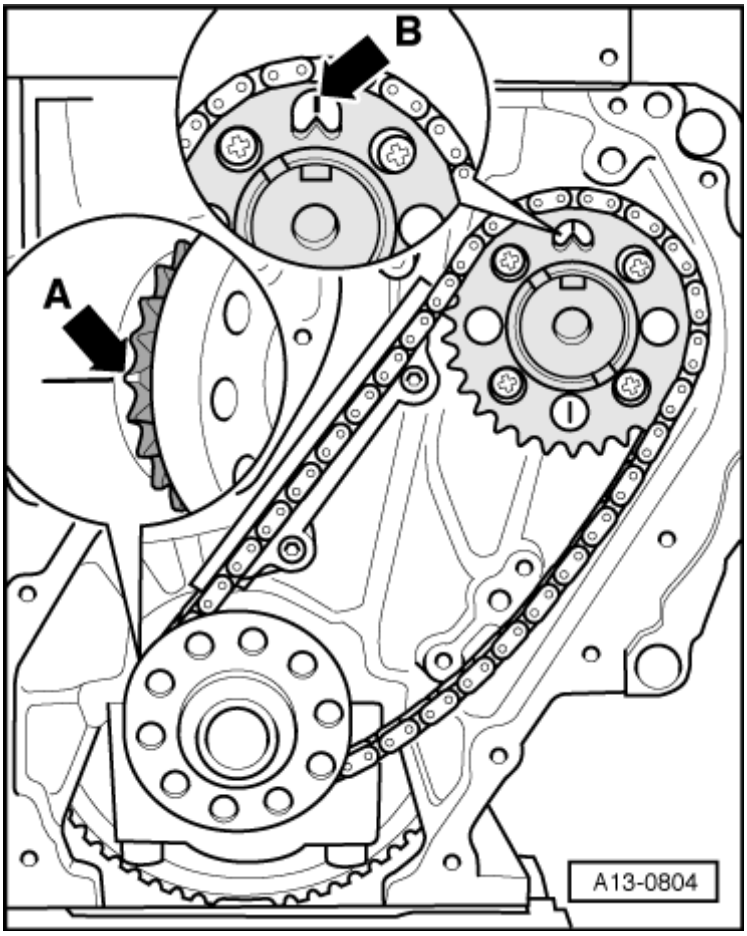

Fig. 81: Identifying Large Sprocket Installed Into Timing Chain With Tab Aligned To Mark On Cylinder Block
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the large sprocket onto the oil pump shaft.

During installation make sure that the timing chain runs completely straight in the guide rail from the crankshaft to the oil pump shaft.

- The milled crankshaft drive sprocket tooth must align with the crankshaft bearing cap joint -arrow A-.
- The tab on the large sprocket must align with the mark -arrow B- behind it.

-- If the large sprocket cannot be installed, rotate the oil pump slightly.

-- Install the chain tensioner with tensioning rail.

-- Release the locking splines of the chain tensioner -A- using a small screwdriver and press the tensioning rail against the chain tensioner.

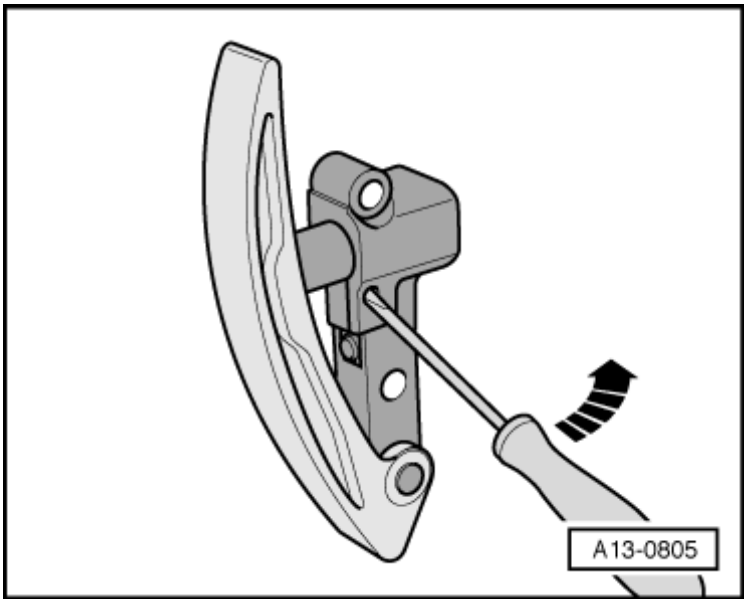

Fig. 82: Identifying Small Screwdriver To Release Locking Splines Of Chain Tensioner
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the chain tensioner in this position and tighten the bolts -arrow- to 8 Nm.

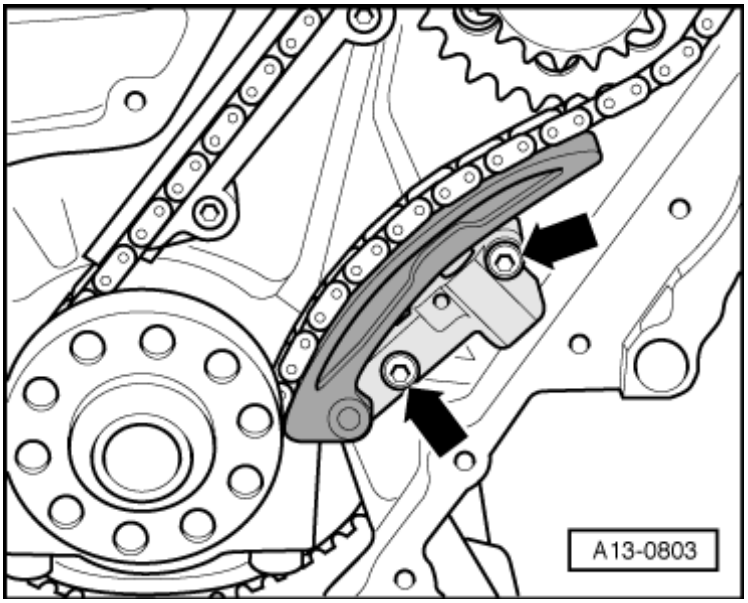

Fig. 83: Chain Tensioner Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- If the cylinder head was removed, install it now, refer to **CYLINDER HEAD**.

-- Install the T10068 A into both camshaft grooves.

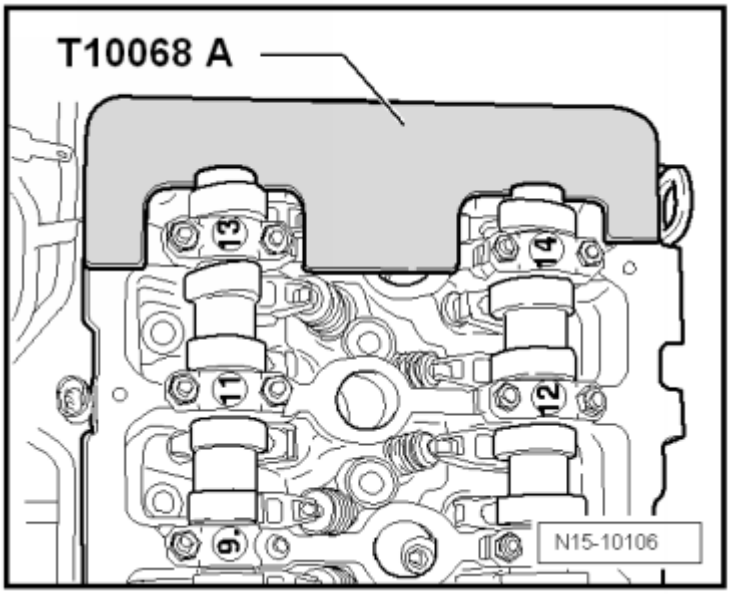

Fig. 84: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Guide the timing chain through the opening in the cylinder head or cylinder head gasket from above.

-- Install the small sprocket with the chain installed into the recess -arrow- and install the bolt hand tight.

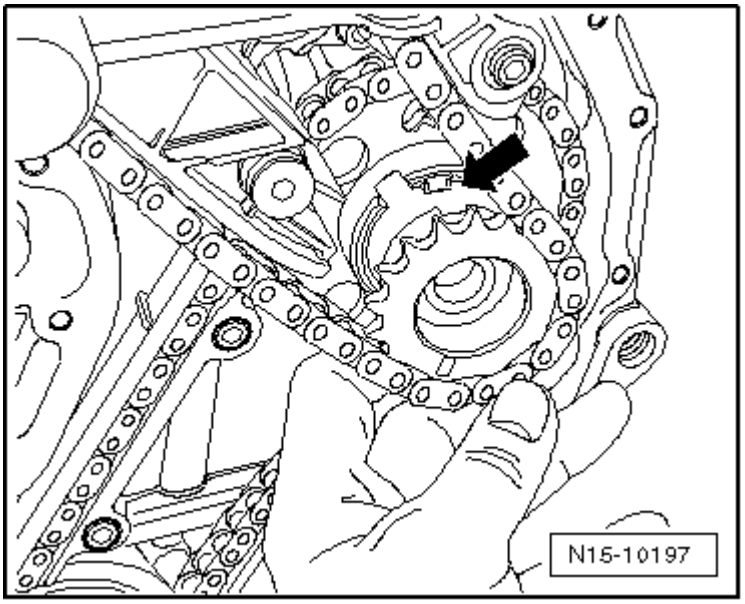

Fig. 85: Inserting Small Drive Pinion With Installed Chain Into Recess And Bolt It On Hand-Tight
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Lock the vibration damper using the T10069.

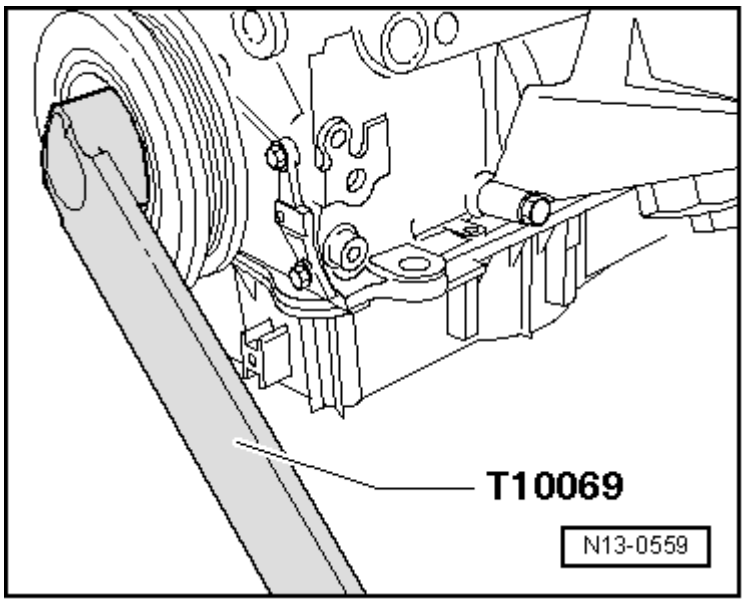

Fig. 86: Counter-Holder T10069 To Hold Vibration Damper
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Using a new bolt, tighten both sprockets to the oil pump shaft. Tighten the bolt to 60 Nm + 90°(1/4) additional turn. Use strength category 10.9 bolts only.

NOTE: Be aware that all sprocket bolts must be replaced.

-- Install the guide rail -2- through the opening in the cylinder head and install the bolts -1 and 3-.

-- Install the tensioning rail -4- and install the pivot pin -5-.

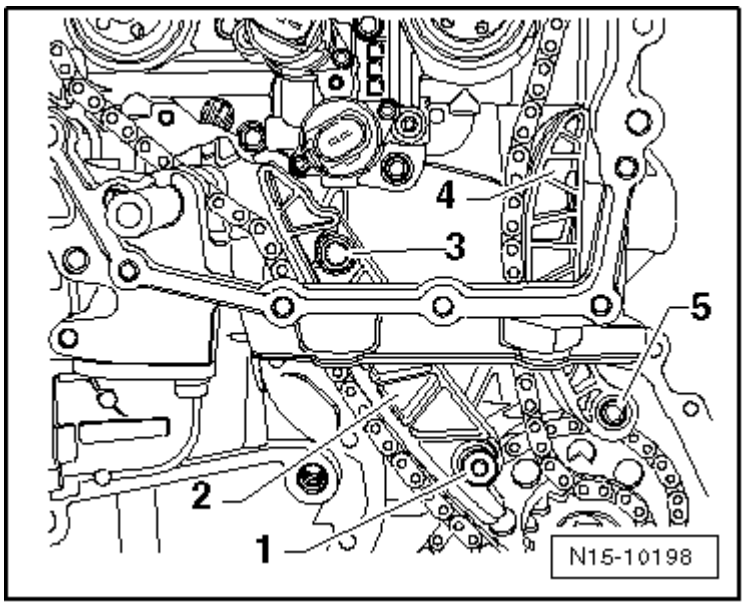

Fig. 87: Inserting Tensioning Track And Installing Tightly On Cylinder Block With Bearing Bolt
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Without a Mechanical Vacuum Pump

-- Lubricate the needle bearing on the inside of the high pressure pump drive pinion -2- with clean engine oil and insert it with the chain installed into its thrust bearing. Make sure the chain lies taut on the guide rail. Now slide in the bearing shaft -3-.

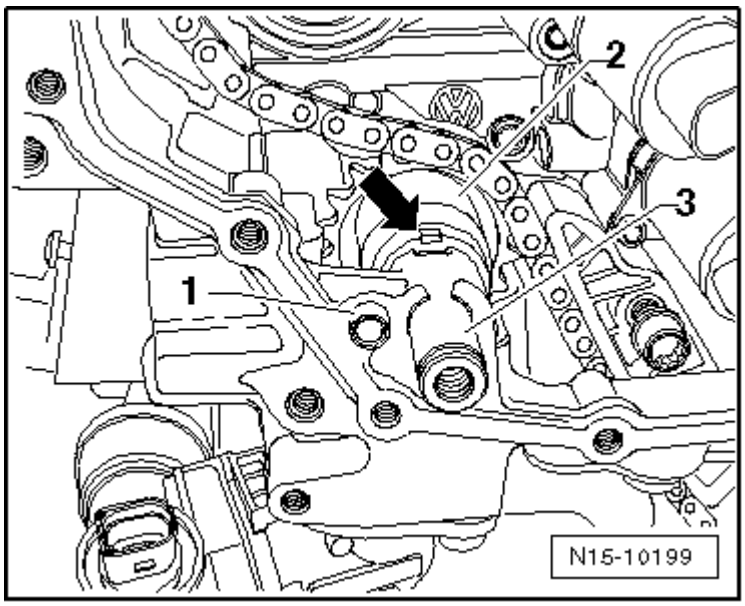

Fig. 88: Identifying Alignment Bushing Is Inserted
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Make sure that alignment bushing -1- is inserted. It is used to secure the T10332.

-- Secure the position of the high pressure pump drive pinion using the T10332.

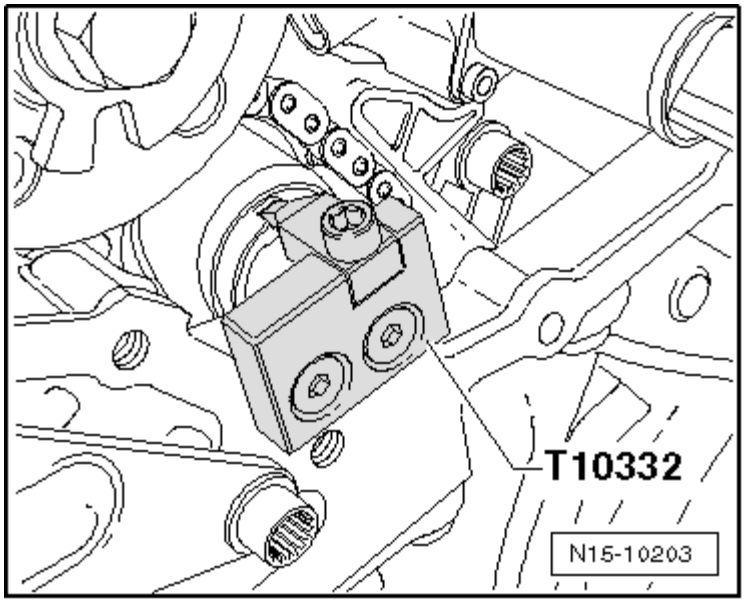

Fig. 89: Securing Position Of Drive Pinion For High Pressure Pump Using Adjustment Tool T10332

Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

With a Mechanical Vacuum Pump

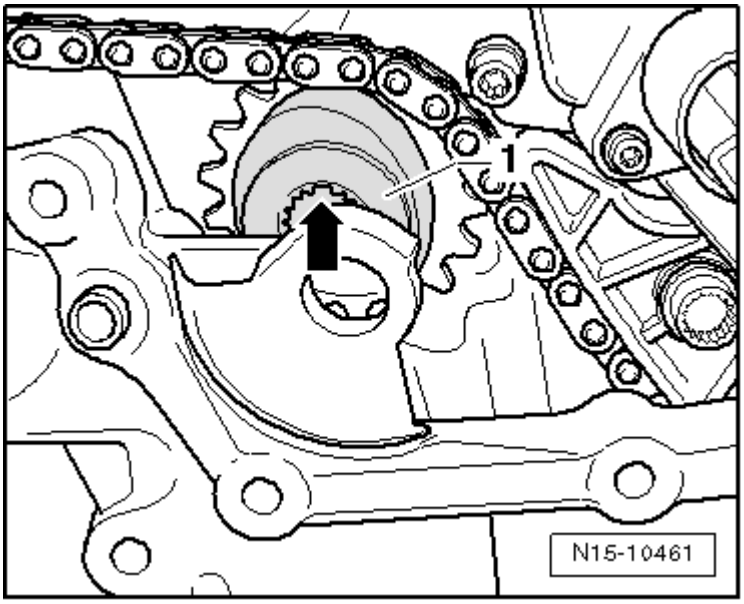

Fig. 90: Installing Sprocket With Chain Mounted
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the high pressure pump drive pinion -1- with the chain mounted. Make sure the chain lies taut on the guide rail.

NOTE: The notch -arrow- must face upward.

-- Lubricate the input shaft -4- with clean engine oil and install it.

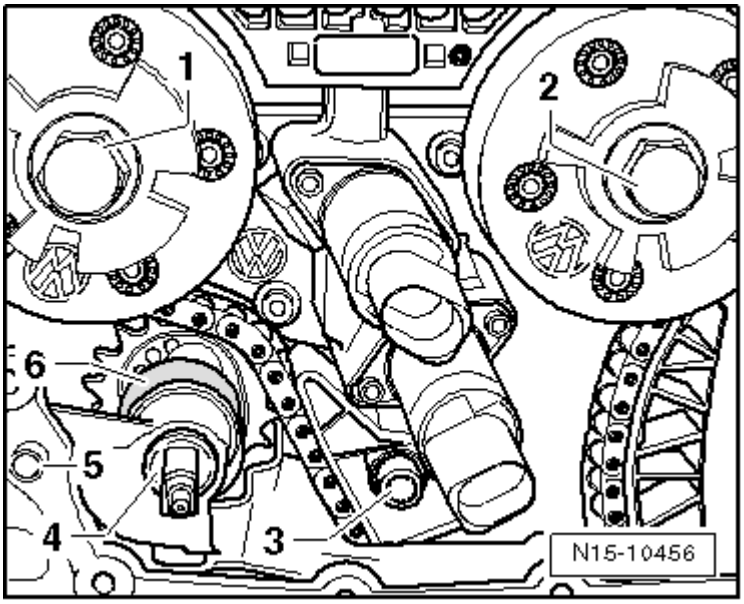

Fig. 91: Coating Drive Shaft With Clean Engine Oil
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Make sure that the alignment bushing -5- is inserted. It is used to secure the T10363.

-- Secure the position of the high pressure pump drive pinion using the T10363. The mark -A- on the high pressure pump drive pinion must be at the top.

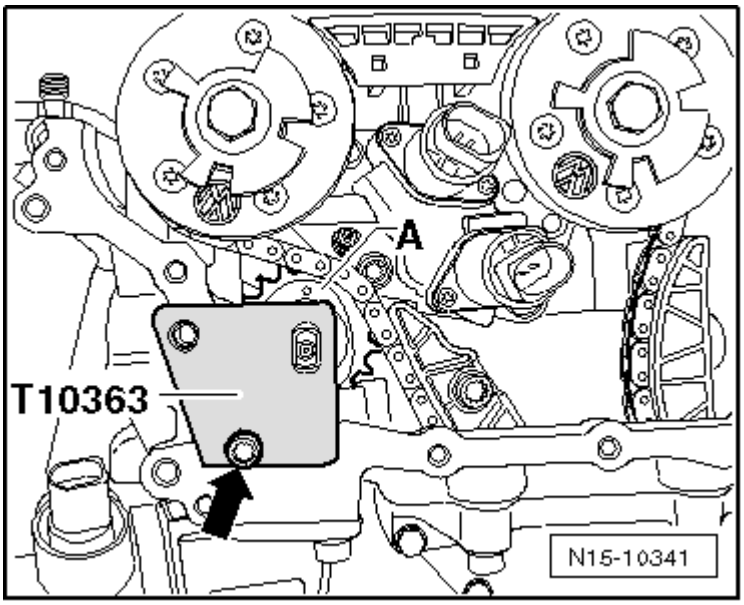

Fig. 92: Securing Position Of Drive Pinion For High Pressure Pump Using Adjustment Tool T10363
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Continuation for All

-- Install the camshaft adjusters, refer to one of the following:

VEHICLES THROUGH 11.08.

VEHICLES FROM 12.08.

MECHANICAL VACUUM PUMP

NOTE: A mechanical vacuum pump is installed from 11.06.

Introduction of non-detachable seals as a running change, identifying feature, refer to MECHANICAL VACUUM PUMP.

Removing

-- Disconnect the vacuum line -A-.

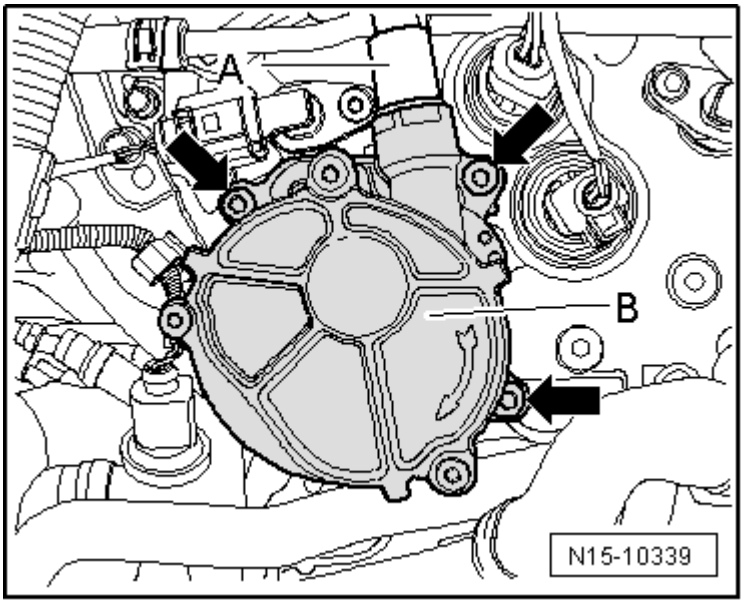

Fig. 93: Identifying Vacuum Line And Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the bolts -arrows-.

-- Carefully remove the vacuum pump from the cylinder head.

NOTE: If the seal -item 7- MECHANICAL VACUUM PUMP OVERVIEW on the input shaft remains stuck on, insert it back in the vacuum pump. Refer to MECHANICAL VACUUM PUMP. New vacuum pumps are supplied with seals. Do not install 2 seals under any circumstances.

Installing

-- Ensure the seal is seated correctly in the vacuum pump. Refer to **MECHANICAL VACUUM PUMP**.

-- Turn the vacuum pump rotor so the flattened sides of the input shaft fit into the rotor.

-- Slide the vacuum pump evenly into the hole on the timing chain cover until flush.

CAUTION: If the vacuum pump is pulled out again, the location of the seal must be checked again. Refer to MECHANICAL VACUUM PUMP.

-- Install and tighten the bolts -arrows- and reconnect the vacuum line -A-.

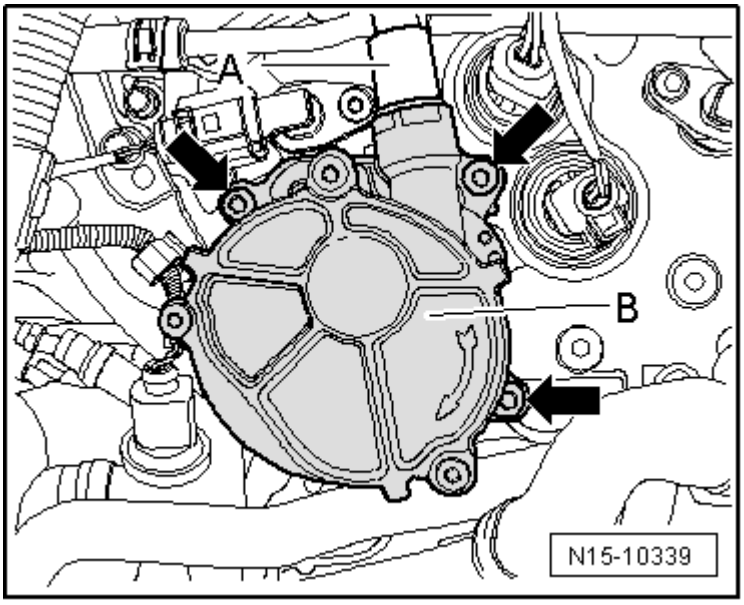

Fig. 94: Identifying Vacuum Line And Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Tightening specifications, refer to **MECHANICAL VACUUM PUMP OVERVIEW**.

Installed Position, Temporary Seal

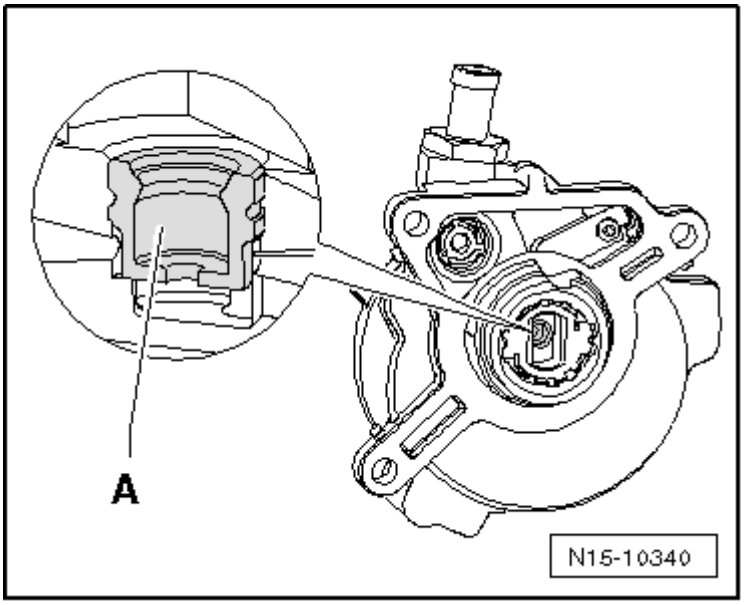

Fig. 95: Sealing Ring Installation Location
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Seal -A- must:

- be inserted with the large opening toward the top in the vacuum pump
- Seat flush with the chamfer in the rotor

Vacuum Pump Seal Characteristics

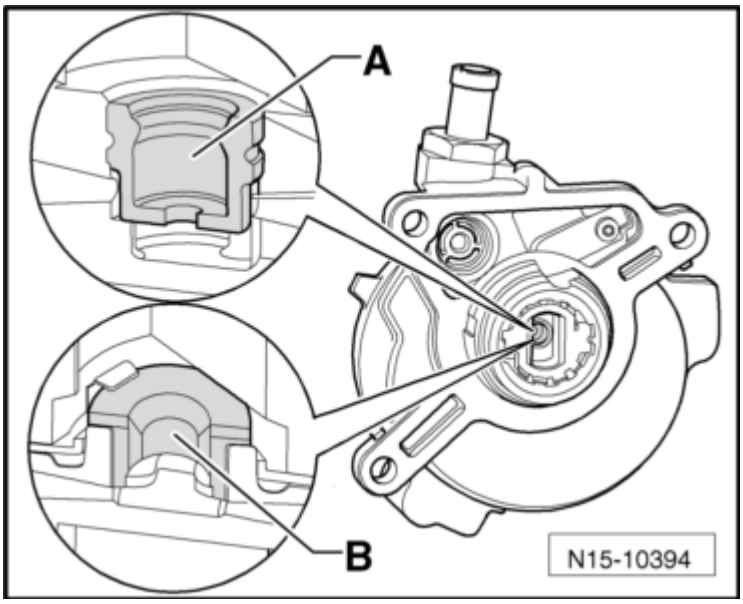

Fig. 96: Characteristics Of Vacuum Pump Seal
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

A - temporary seal, note the installed position when removing and installing.

B - Permanent seal, installed position must not be observed.

COVER SEAL, INSTALLING

Special tools and workshop equipment required

- Fitting Sleeve 3378
- Wheel Bearing Assembly Set 3253.

Installing

-- Do not lubricate the seals.

-- Install the seal in the cover -1- using the 3378 and pull the seal in flush using the 3253/6.

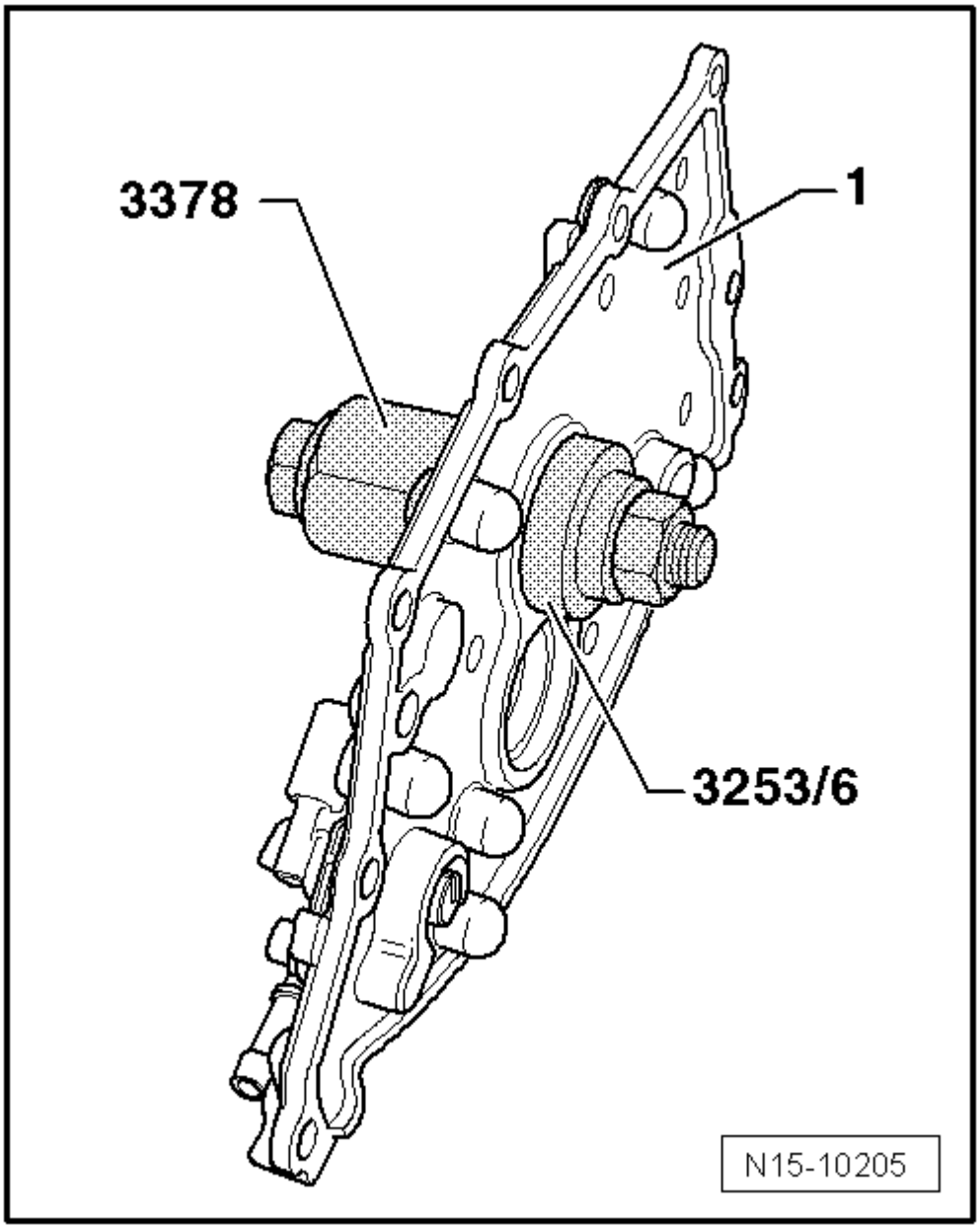

Fig. 97: Installing Sealing Ring Using Seal Installer 3378 Into Cover Piece And Pulling In Flush Using Seal Installer 3253/6 From Assembly Tool 3253
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

CAMSHAFT ADJUSTER VALVES

Special tools and workshop equipment required

- Socket Wrench T10072
- TORX Bit Set V.A.G 1766
- Torque Wrench (5-60 Mm) V.A.G 1783

- Ratchet Insert 1/4" VAS 6234
- Sealant D 176 501 A1
- Sealing compound D 454 300 A2

Requirements

- Remove the cylinder head cover. Refer to **CYLINDER HEAD COVER**

Removing

NOTE: Mark the connector assignment to the component before disconnecting the connectors.

-- Disconnect the following connectors:

- Camshaft adjustment valve 1
- Exhaust camshaft adjustment valve 1
- Camshaft position sensor
- Camshaft position sensor 2

-- Free up the wiring harness.

-- Remove the vacuum pump, if present. Refer to **MECHANICAL VACUUM PUMP**.

-- Remove the three cylinder head cover bolts -arrows-.

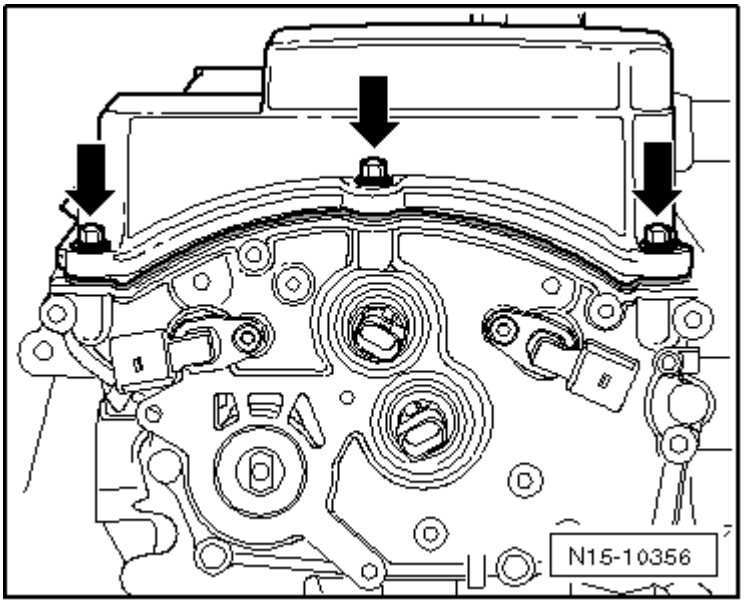

Fig. 98: Identifying Three Cylinder Head Cover Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the upper and lower coolant pipes from the cover.

-- Remove the cover bolts -arrows- from the cylinder head.

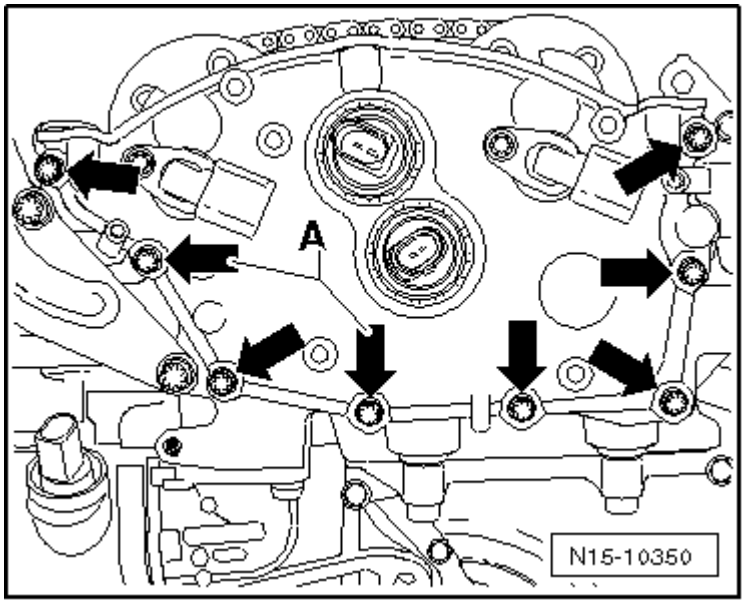

Fig. 99: Identifying Cover Piece On Cylinder Head And Mounting Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The bolts -A- are not on vehicles with a mechanical vacuum pump.

CAUTION:
- **Carefully cover the lower chain compartment so no parts can fall in.**
- **Do not completely remove the camshaft adjustment valve bolts so that the valve is not tilted when removed.**

-- Loosen the camshaft adjustment valve bolts -arrows- approximately 3 mm (5 turns) using the T10072.

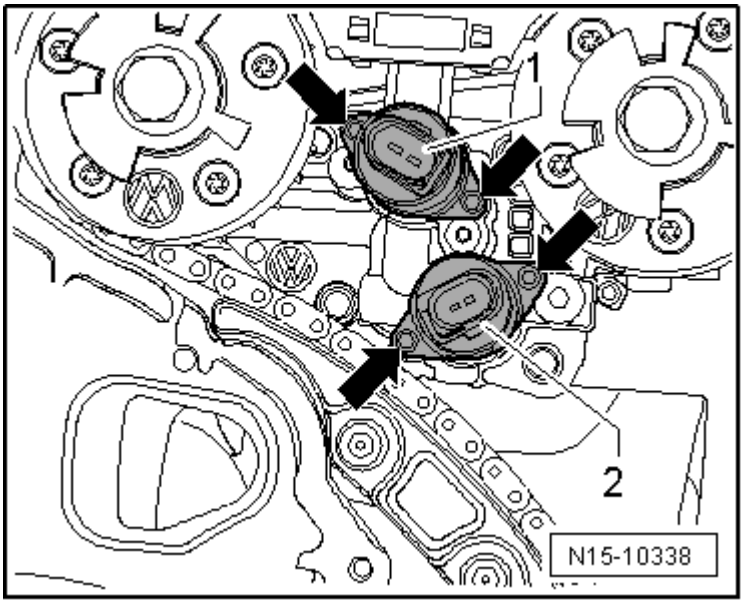

Fig. 100: Identifying Camshaft Adjustment Valve Securing Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Pull the camshaft adjustment valve out of the seal seat in the control housing against the loosened bolts.

-- Completely remove the bolts and remove the camshaft adjustment valve from the control housing.

Installing

CAUTION:
- **The valve seat in the control housing must not be scored or scratched.**
- **The camshaft adjustment valves and control housing must be free of dust and contamination.**
- **The camshaft adjustment valves must not be subjected to knocks or impacts.**
- **Only remove the new camshaft adjustment valve from its packaging right before installation.**
- **Camshaft adjustment valves must not be pulled into the valve seat by the bolts. Only press them in by hand.**

-- Lubricate the seal with clean engine oil.

-- Carefully install the camshaft adjustment valve into the housing and press it in by hand perpendicular to the valve axis until its seated.

-- Install and tighten the bolts -arrows- to 3.8 Nm.

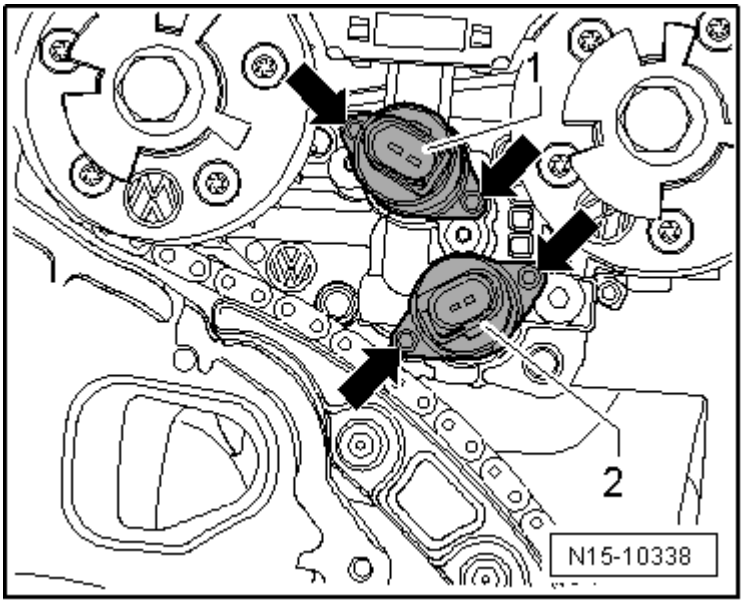

Fig. 101: Identifying Camshaft Adjustment Valve Securing Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Clean the sealing surfaces on the cover and on the cylinder head.

-- If replacing the seals in the cover, refer to **CAMSHAFT TIMING CHAIN COVER SEALS, INSTALLING**.

-- Make sure the seal -arrows- fits correctly inside the cylinder head cover.

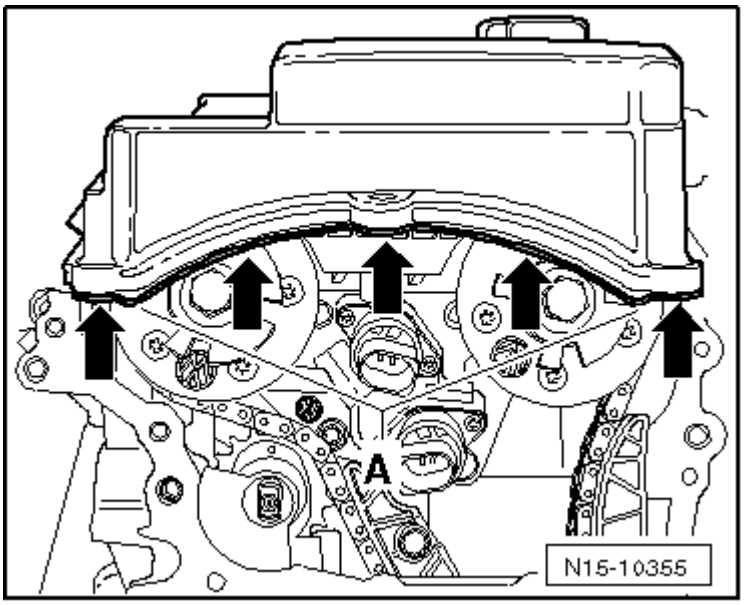

Fig. 102: Ensuring Cylinder Head Cover Seal Is Seated Correctly In Cover
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- If necessary, remove the sealant residue in places -A-.

-- Apply a thin bead of sealant D 176 501 A1 to the sealing surfaces on the cover.

-- Also apply some sealing compound D 454 300 A2 to the areas -arrows- on the cover.

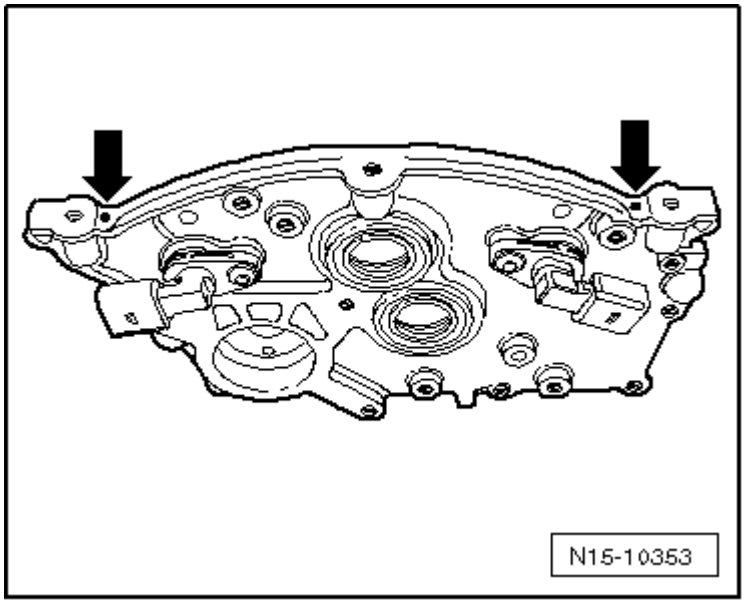

Fig. 103: Sealant Locations For Cover
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The sealant D 176 501 A1 hardens quickly.

-- -1.- slide the cover at a slight angle onto the camshaft adjustment valves. Ensure the cylinder head cover seal is not rolled back.

-- -2.- Press the cover upward and under the cylinder head cover gasket. Press the cover against the cylinder head and onto the alignment pins.

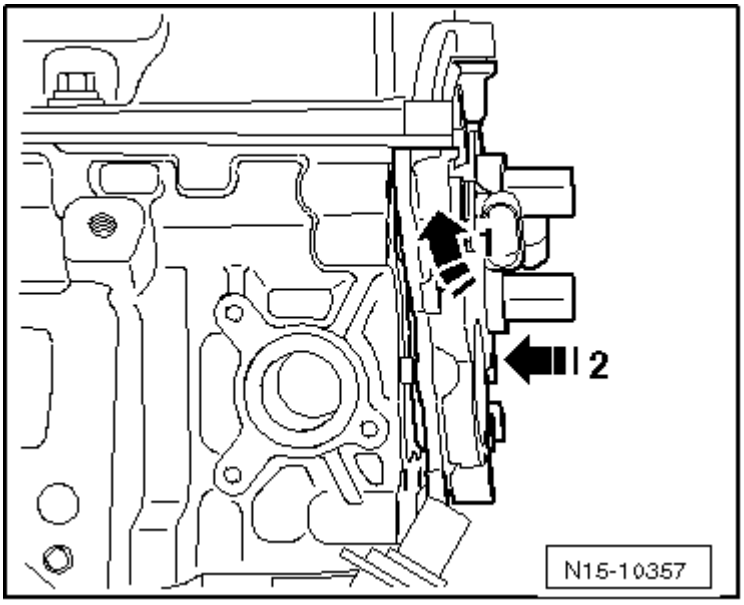

Fig. 104: Pressing Cover Up And Under Cylinder Head Cover Seal, Then Pressing Cover Against Cylinder Head And Onto Alignment Pins
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Make sure the cylinder head cover seal -arrows- is seated correctly. It must not be rolled back.

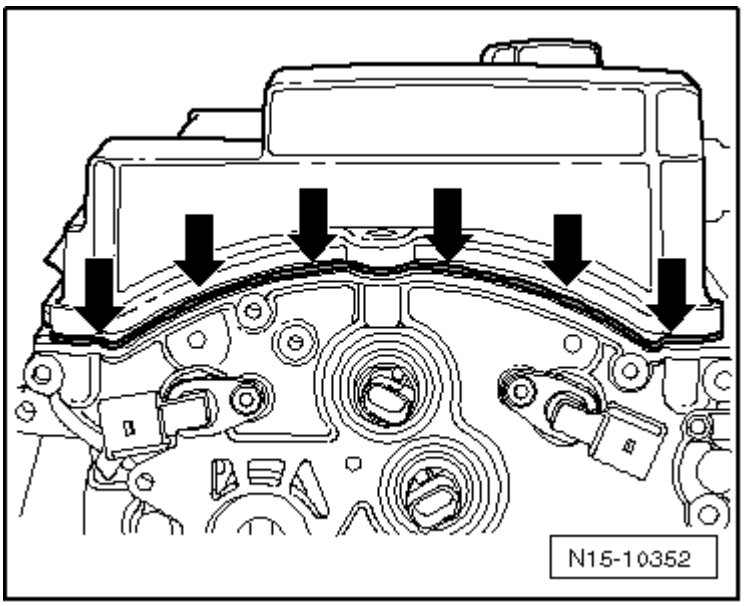

Fig. 105: Ensuring Cylinder Head Cover Seal Is Seated Correctly
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install all cover bolts -arrows- and tighten them lightly.

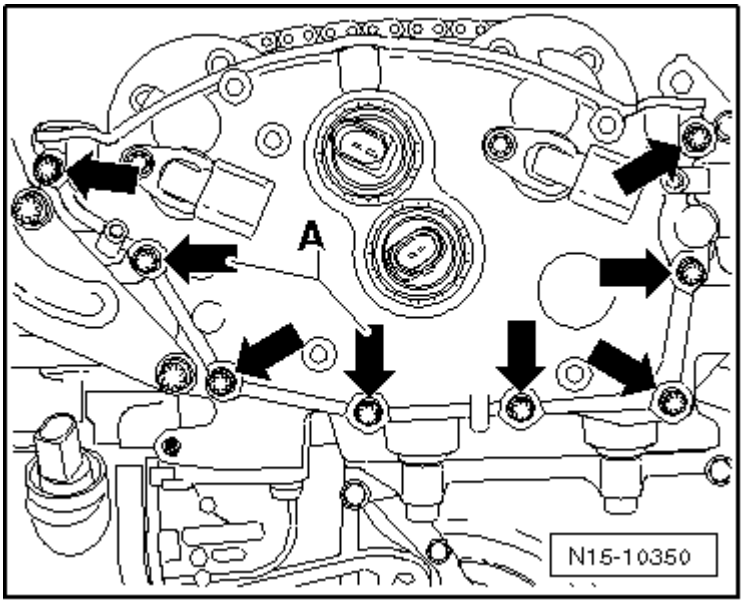

Fig. 106: Identifying Cover Piece On Cylinder Head And Mounting Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The bolts -A- are not on vehicles with a mechanical vacuum pump.

-- Tighten all bolts to specifications, refer to **CYLINDER HEAD OVERVIEW**.

-- Tighten the three cylinder head cover bolts -arrows- to specifications, refer to **CYLINDER HEAD OVERVIEW**.

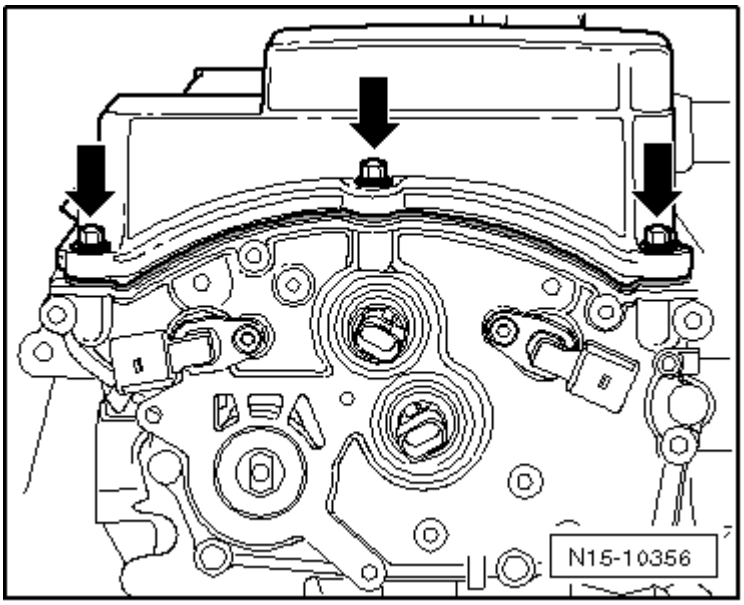

Fig. 107: Identifying Three Cylinder Head Cover Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the vacuum pump, if present. Refer to **MECHANICAL VACUUM PUMP**.

The rest of the installation is basically a reverse of the removal sequence.

CAMSHAFTS

NOTE: The camshafts can only be removed with the engine or cylinder head removed. Refer to REMOVING .

Special tools and workshop equipment required

- Camshaft Bar T10068 A
- Counter-Holder Tool T10069
- Torque Wrench (5-50 Nm) V.A.G 1331
- Torque Wrench (40-200 Nm) V.A.G 1332
- Adjustment Tool T10332 (without mechanical vacuum pump)
- Adjustment Tool T10363 (with mechanical vacuum pump)
- Sealant D 176 501 A1

Requirements

- Engine must be removed.

Removing

CAUTION: When doing any repair work, especially in the engine compartment, pay attention to the following due to clearance issues:

- **Route lines of all types (for example, fuel, hydraulic, Evaporative Emission (EVAP), coolant, refrigerant, brake fluid and vacuum) and electrical wiring so that the original path is followed.**
- **Ensure sufficient clearance to all moving or hot components.**

-- Remove the intake manifold, refer to one of the following:

With a one piece intake manifold, refer to **INTAKE MANIFOLD** .

With a two piece intake manifold, refer to **UPPER INTAKE MANIFOLD** .

-- Remove the cylinder head cover. Refer to **CYLINDER HEAD COVER**.

NOTE: Mark the connector assignment to the component before disconnecting the connectors.

-- Disconnect the following connectors:

- Camshaft adjustment valve 1 -N205-
- Camshaft adjustment valve 1 (exhaust) -N318-
- Camshaft Position (CMP) sensor -G40-
- CMP sensor 2 -G163-

-- Free up the wiring harness.

-- Remove the vacuum pump, if present. Refer to **MECHANICAL VACUUM PUMP**.

-- Remove the upper and lower coolant pipes from the cover.

-- Remove the cover bolts -arrows- from the cylinder head.

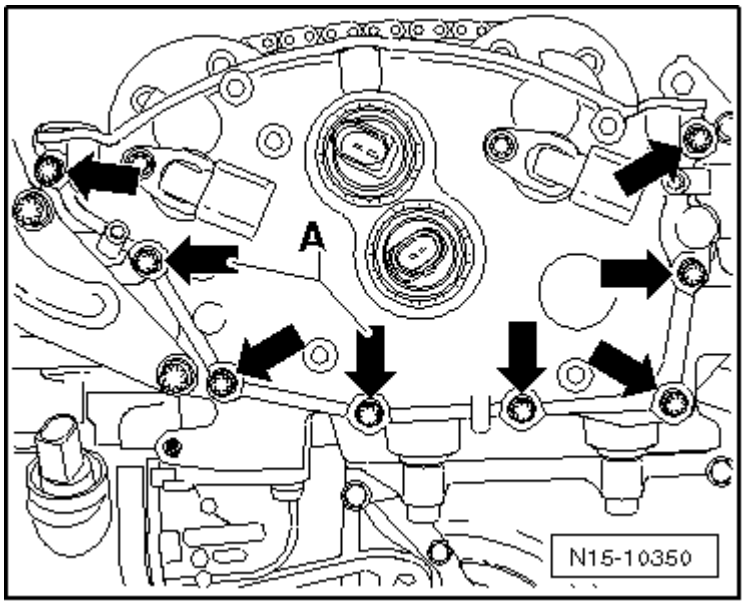

Fig. 108: Identifying Cover Piece On Cylinder Head And Mounting Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The bolts -A- are not on vehicles with a mechanical vacuum pump.

CAUTION: Carefully cover the lower chain compartment so no parts can fall in.

-- Rotate the crankshaft at the vibration damper bolt in engine rotation direction to the Top Dead Center (TDC) cylinder 1 mark -arrow-.

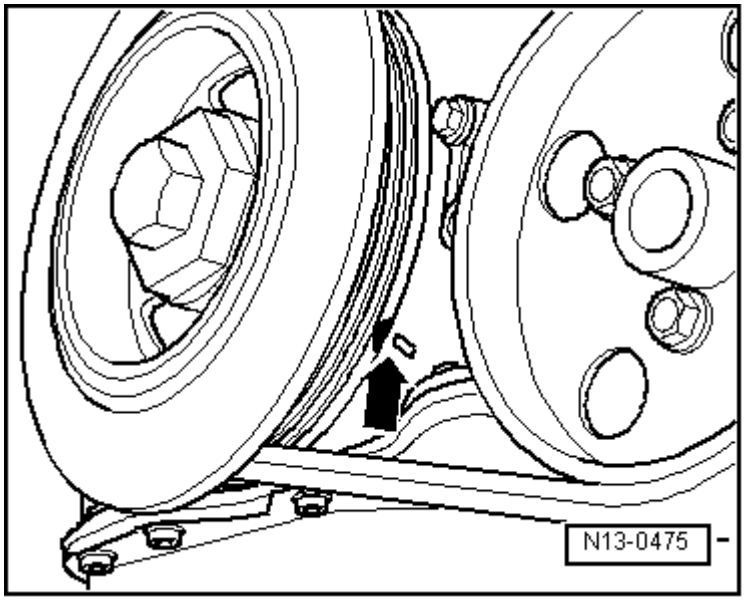

Fig. 109: Identifying Crankshaft At Vibration Damper Securing Bolt In Engine At TDC Cyl. 1
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- It must be possible to install the T10068 A into both camshaft grooves.

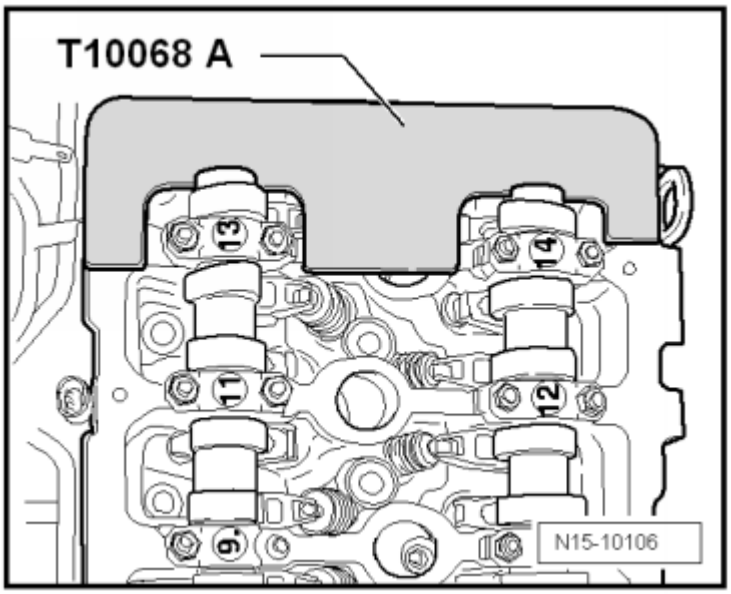

Fig. 110: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Without a Mechanical Vacuum Pump

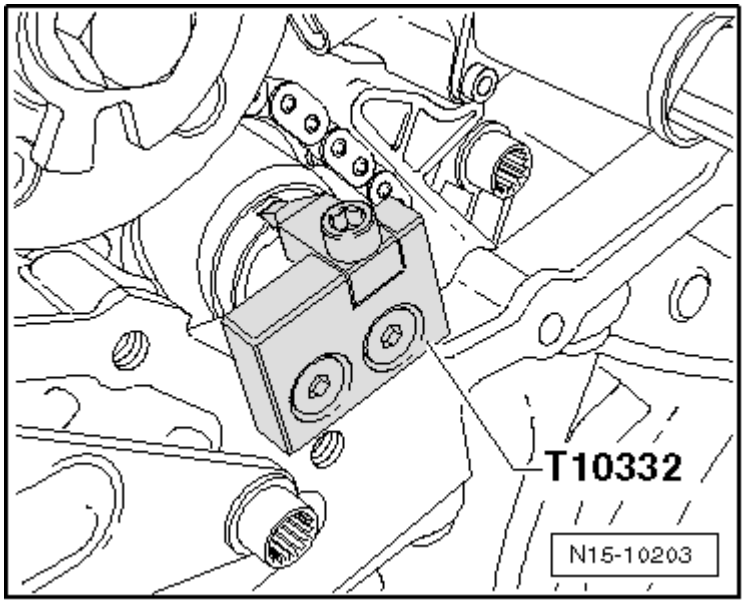

Fig. 111: Securing Position Of Drive Pinion For High Pressure Pump Using Adjustment Tool T10332
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Secure the position of the high pressure pump drive pinion using T10332.

NOTE: If the opening in the high pressure pump drive pinion is not at the top: remove the T10068 A. Rotate the crankshaft further in engine rotation direction until this position has been reached and the T10068 A and T10332 can be installed.

With a Mechanical Vacuum Pump

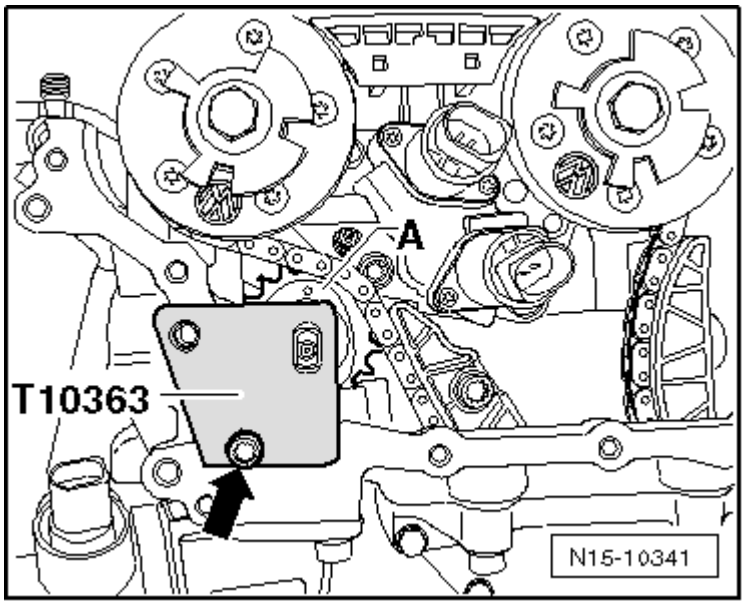

Fig. 112: Securing Position Of Drive Pinion For High Pressure Pump Using Adjustment Tool T10363
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Secure the position of high pressure pump drive pinion using the T10363. The mark -A- on the high pressure pump drive pinion must be at the top.

NOTE: If the mark -A- is not vertical: remove the T10068 A. Turn the crankshaft in engine rotation direction until the mark is vertical and the T10068 A can be installed.

Continuation for All

-- Remove the chain tensioner -arrow-.

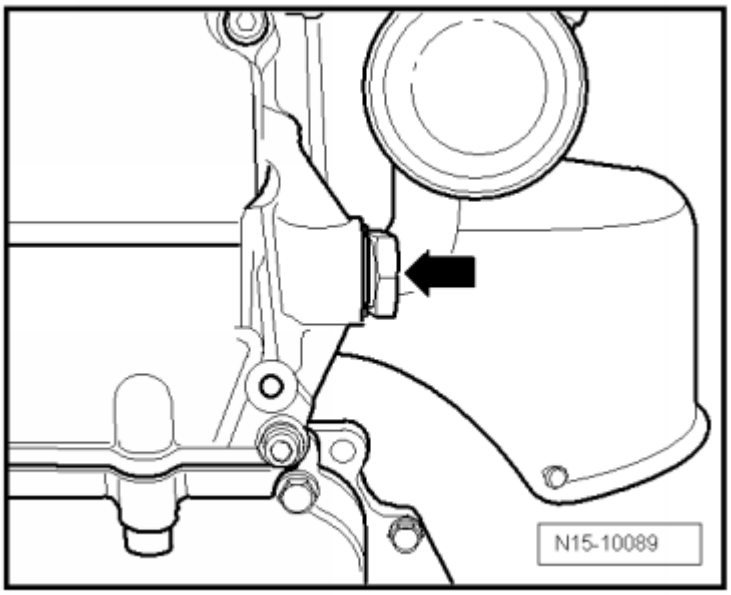

Fig. 113: Chain Tensioner Bolt Camshaft Roller Chain
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: Counter hold the camshaft using a 27 mm open end wrench on the camshaft recesses -arrow-. The T10068 A must not be installed when tightening or loosening the camshaft adjuster bolts.

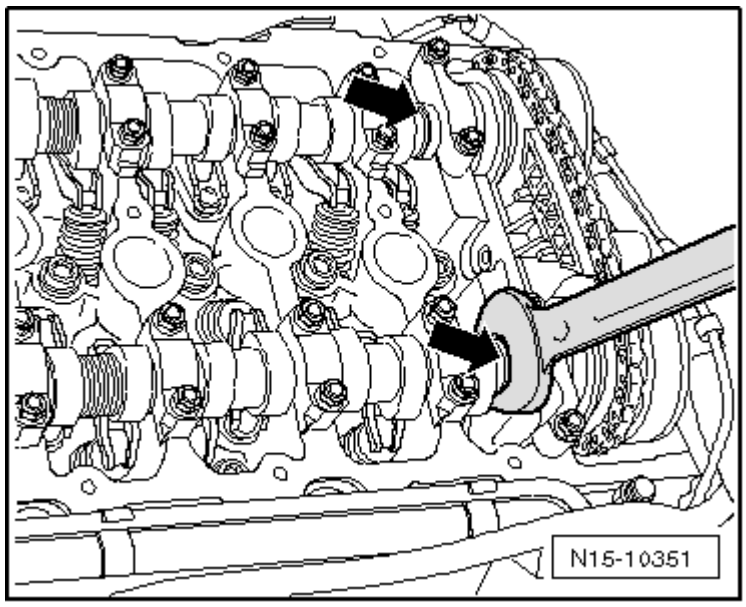

Fig. 114: Counter-Holding At Camshaft Using Wrench
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove the camshaft adjuster bolts -1 and 2-.

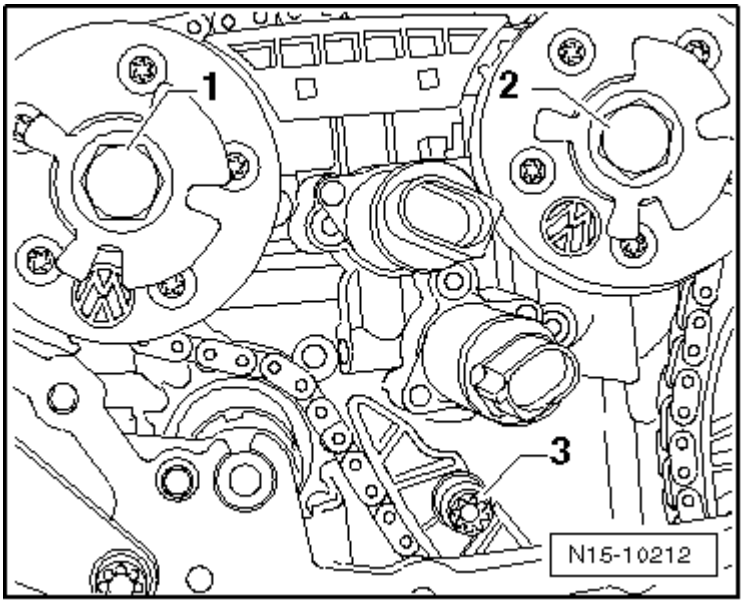

Fig. 115: Camshaft Adjuster Mounting Bolts And Bolts Of Glide Track
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Remove both camshaft adjusters.

-- Remove the 4 control housing bolts -1- from the cylinder head and pull it off from the camshafts in the -direction of the arrow-.

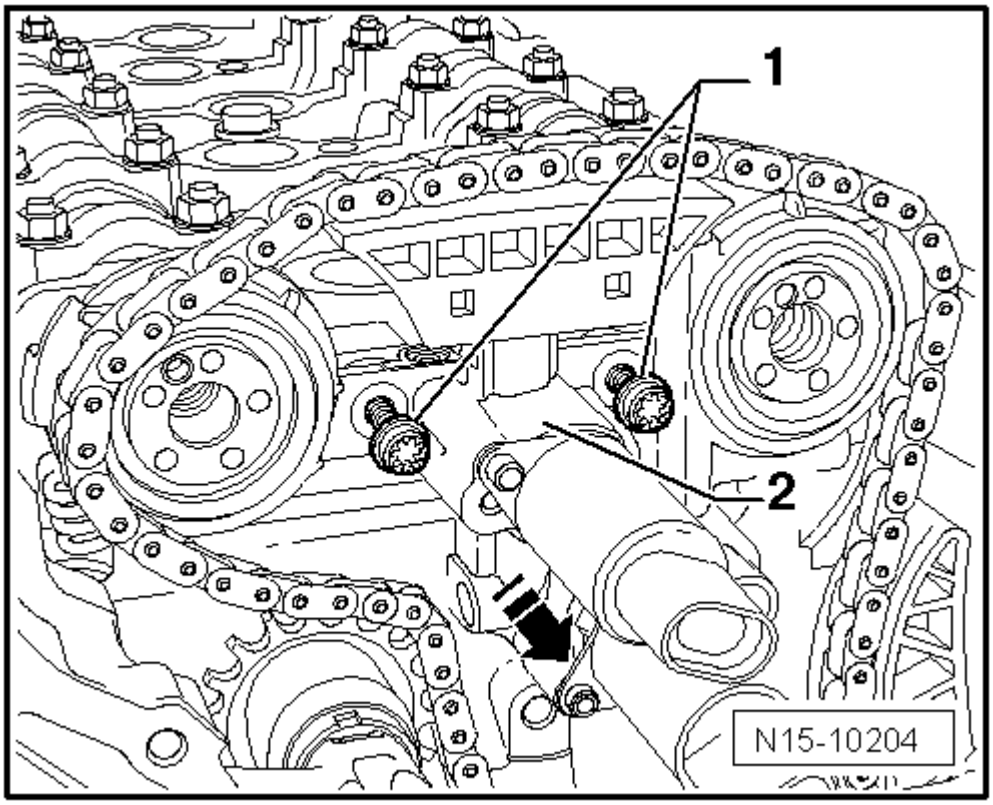

Fig. 116: Control Housing Mounting Bolts And Control Housing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Place the camshaft timing chain to the side.

A - Intake Camshaft

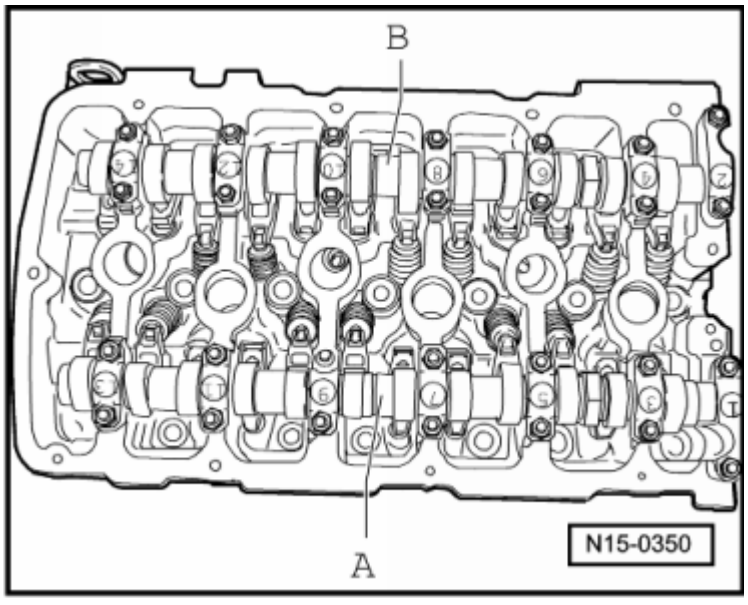

Fig. 117: Identifying Intake Camshaft And Exhaust Camshaft
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- First remove bearing caps 1 and 13.

-- Remove bearing caps 3 and 11.

-- Remove bearing cap 7.

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

B - Exhaust Camshaft

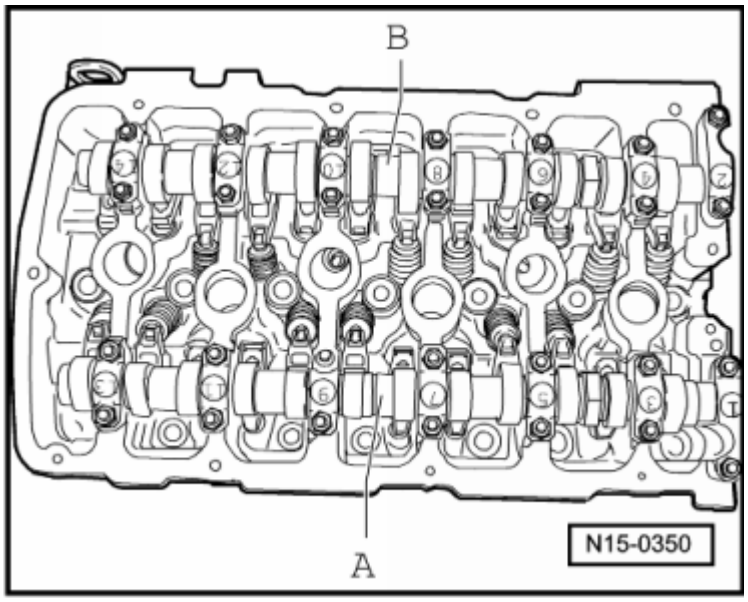

Fig. 118: Identifying Intake Camshaft And Exhaust Camshaft
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- First remove bearing caps 2 and 14.

-- Remove bearing caps 4 and 12.

-- Remove bearing cap 8.

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

Continuation for Both Camshafts

-- Carefully remove the camshafts and place them on a clean surface.

-- Remove the roller rocker levers together with support elements and place them on a clean surface.

-- Ensure that the roller rocker levers and the support elements are not interchanged.

Installing

Requirements

- When installing the camshafts, the cam lobes for cylinder 1 -A- must face each other.

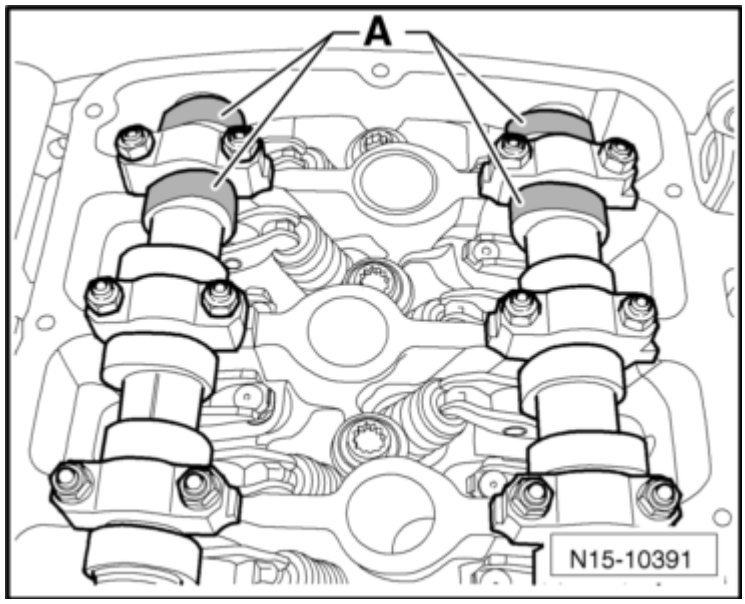

Fig. 119: Camshaft Lobes For Cylinder Facing Each Other
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Procedure

-- Lightly apply grease G 052 723 A2 to the contact surface of bearing caps 7 and 8 before installing.

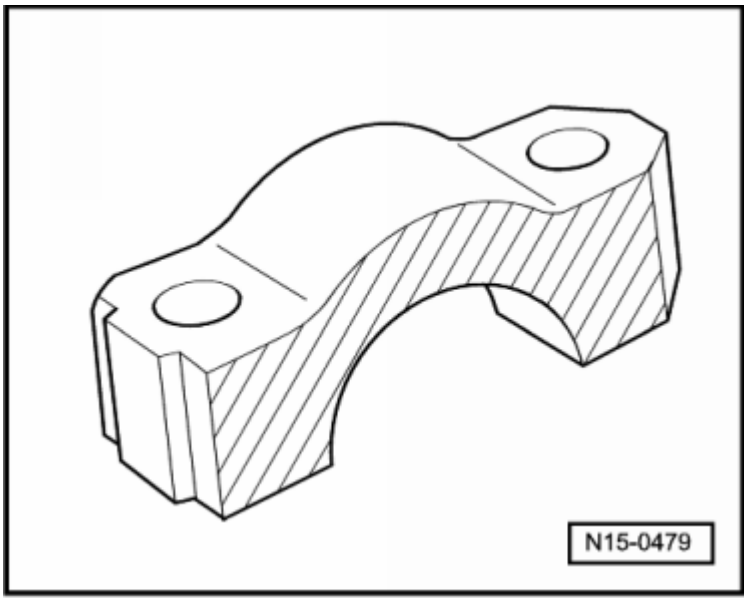

Fig. 120: Coating Bearing Caps 7 And 8 Contact Surface With Adhesive Lubricating Paste

Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the support elements in the cylinder head and install the roller rocker levers onto the respective valve stem end and support element.

-- Make sure that all roller rocker levers -1- properly contact the valve stem tips and are clipped into the respective support elements -2-.

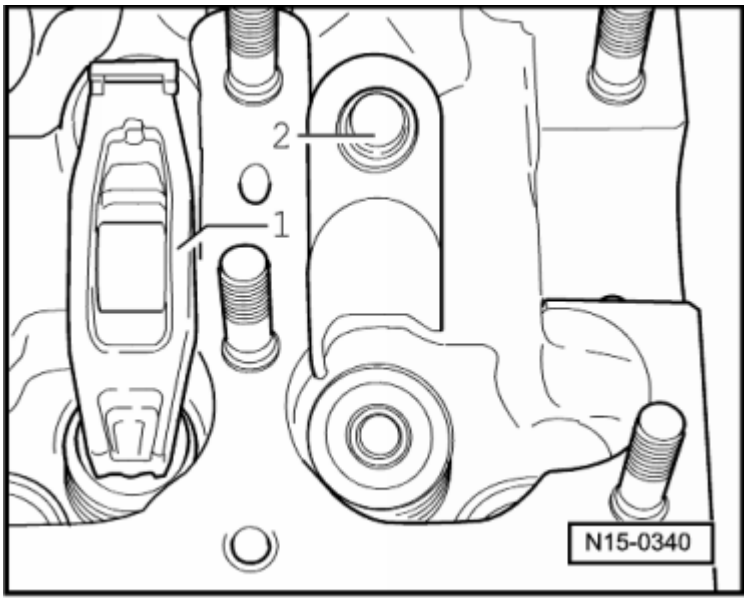

Fig. 121: Identifying Roller Cam Followers And Support Elements
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Lubricate the running surfaces of both camshafts.

-- Place the respective camshaft carefully into the camshaft bearings in the cylinder head. While doing so, observe the identification of the camshafts. Refer to **CAMSHAFT IDENTIFICATION**.

-- Observe the installed position of the bearing caps.

Camshaft Bearing Caps Installed Position

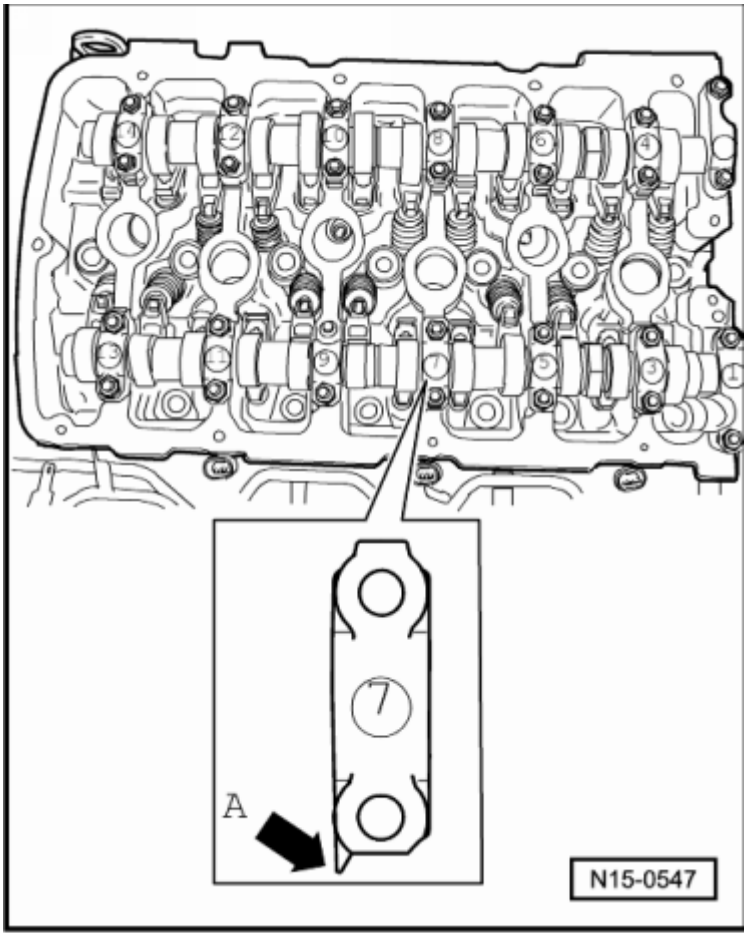

Fig. 122: Identifying Points Of Intake And Exhaust Camshaft Bearing Cap Face Outwards
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

The points -arrow A- on the intake and exhaust camshaft bearing caps face outward.

A - Intake Camshaft

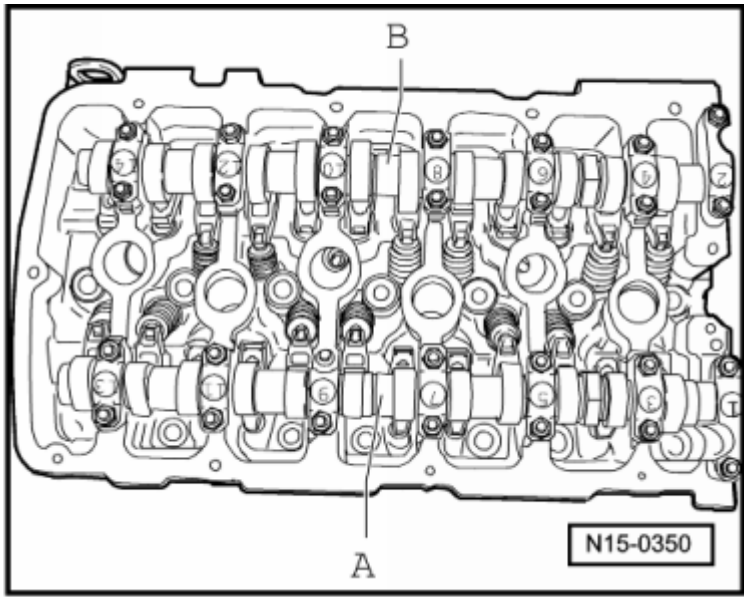

Fig. 123: Identifying Intake Camshaft And Exhaust Camshaft
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install and tighten the bearing caps 5 and 9 alternating in a diagonal sequence to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 1 and 13 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 7 and 13 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 3 and 11 and tighten to 5 Nm + 45° (1/8) additional turn.

B - Exhaust Camshaft

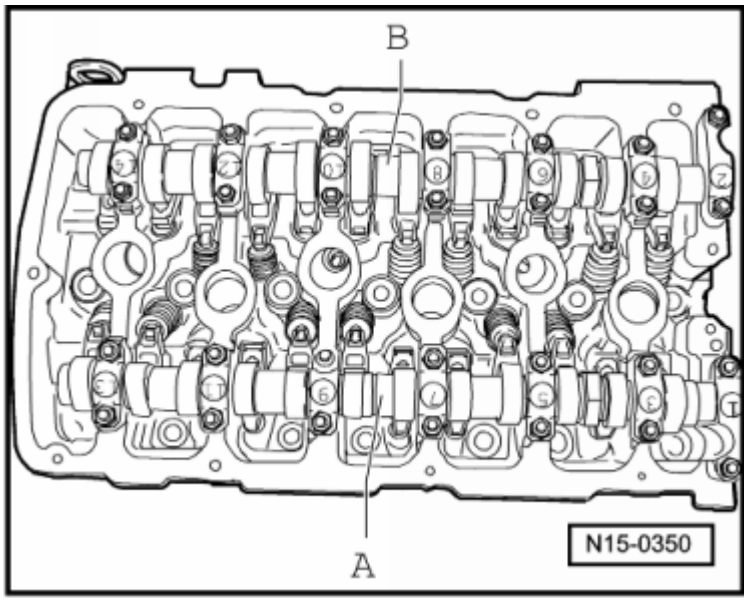

Fig. 124: Identifying Intake Camshaft And Exhaust Camshaft
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install and tighten bearing caps 6 and 10 alternating in a diagonal sequence to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 2 and 14 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 8 and 13 and tighten to 5 Nm + 45° (1/8) additional turn.

-- Install bearing caps 4 and 12 and tighten to 5 Nm + 45° (1/8) additional turn.

Continuation for Both Camshafts

-- Install the T10068 A into both camshaft grooves.

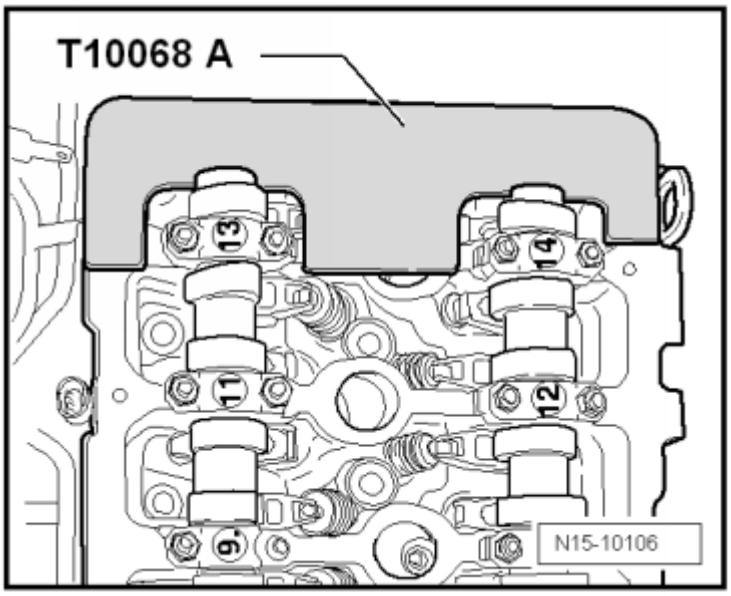

Fig. 125: Identifying Camshaft Bar T10068 A Engage In Shaft Grooves
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Before installing, check the control housing strainer for contamination. Refer to **CONTROL HOUSING OVERVIEW**.

-- Before installing the control housing, lubricate the oil seals on the camshafts.

-- Lubricate the contact surface of the seals in the control housing and then slide the control housing slowly over the seal for the camshafts.

-- Install the control housing and the bolts -arrows- using locking adhesive D 000 600 A2. Tightening specification: 8 Nm.

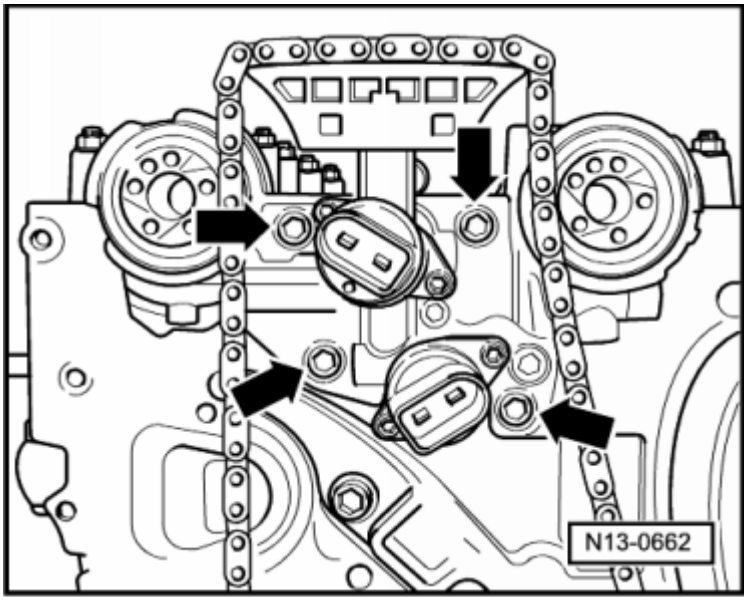

Fig. 126: Locating Control Housing-To-Cylinder Head Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the camshaft adjustors with timing chain. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING**.

-- Clean the sealing surfaces on the timing chain cover and on the cylinder head.

-- If replacing the seals in the cover, refer to **CAMSHAFT TIMING CHAIN COVER SEALS, INSTALLING**.

-- Apply sealant D 176 501 A1 to the sealing surface on the cover and install immediately.

NOTE: The sealant D 176 501 A1 hardens quickly.

-- Install all the bolts -arrows- and hand tight.

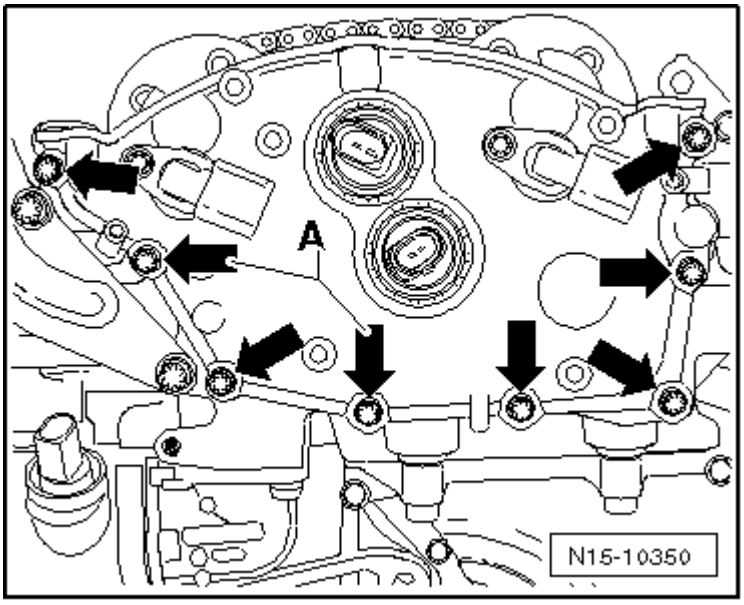

Fig. 127: Identifying Cover Piece On Cylinder Head And Mounting Bolts
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

NOTE: The bolts -A- are not on vehicles with a mechanical vacuum pump.

-- Tighten the bolts to 8 Nm.

-- Install the chain tensioner and tighten it to 50 Nm.

-- Install the vacuum pump, if present. Refer to **MECHANICAL VACUUM PUMP**.

-- Install the cylinder head cover. Refer to **CYLINDER HEAD COVER**.

-- Install the intake manifold, refer to one of the following:

With a one piece intake manifold, refer to **INTAKE MANIFOLD** .

With a two piece intake manifold, refer to **UPPER INTAKE MANIFOLD** .

-- Reset the service position. Refer to **Description and Operation** .

VALVE STEM SEALS

Special tools and workshop equipment required

- Valve Lever VW 541/1 A with Press Tool for VW 541/1A and 2037 VW 541/6
- Adjustable Rod 2036 with Adapter Plates 2036/1
- Spark Plug Removal Tool 3122 B
- Valve Seal Removal Tool 3364

- Valve Stem Seal Driver 3365
- Adapter T40012
- Torque Wrench (5-50 Nm) V.A.G 1331

Removing

-- Remove the camshafts. Refer to **CAMSHAFTS**.

-- Remove the roller rocker levers together with the support elements and place them on a clean surface.

NOTE: Make sure the roller rocker levers and the support elements are not swapped.

-- Remove the spark plugs using the 3122 B.

-- Move the piston for the respective cylinder to the Bottom Dead Center (BDC) position.

-- Install the 2036 with the 2036/1.

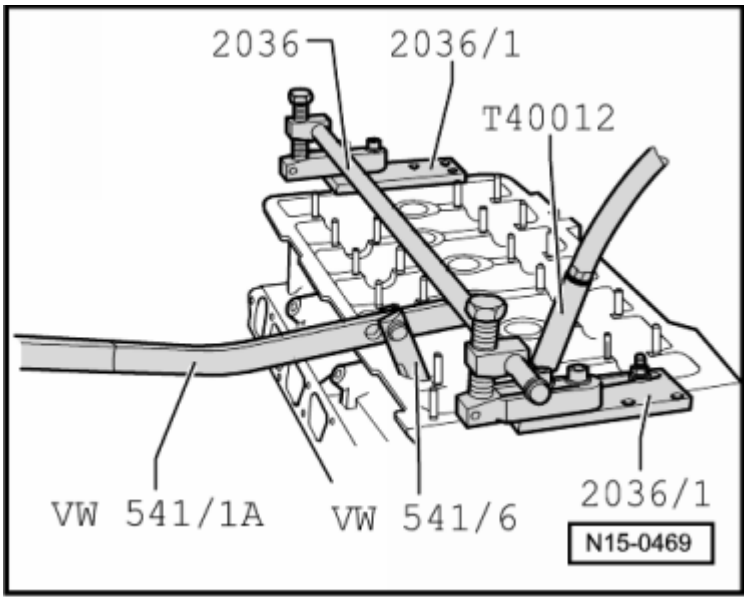

Fig. 128: Identifying Adjustable Rod 2036, Adapter T40012 And Valve Lever VW 541/1 A
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Install the T40012/1 in the spark plug hole, connect the compressed air line with a commercially available adapter and apply a constant pressure of at least 6 bar.

-- Remove the valve springs using the VW 541/1 A and VW 541/6.

NOTE: Tight retainers can be loosened by tapping lightly on the lever.

-- Remove the valve stem seals using the 3364.

Installing

-- Place the plastic sleeve -A- on the valve stem to prevent damage to the new valve stem oil seal.

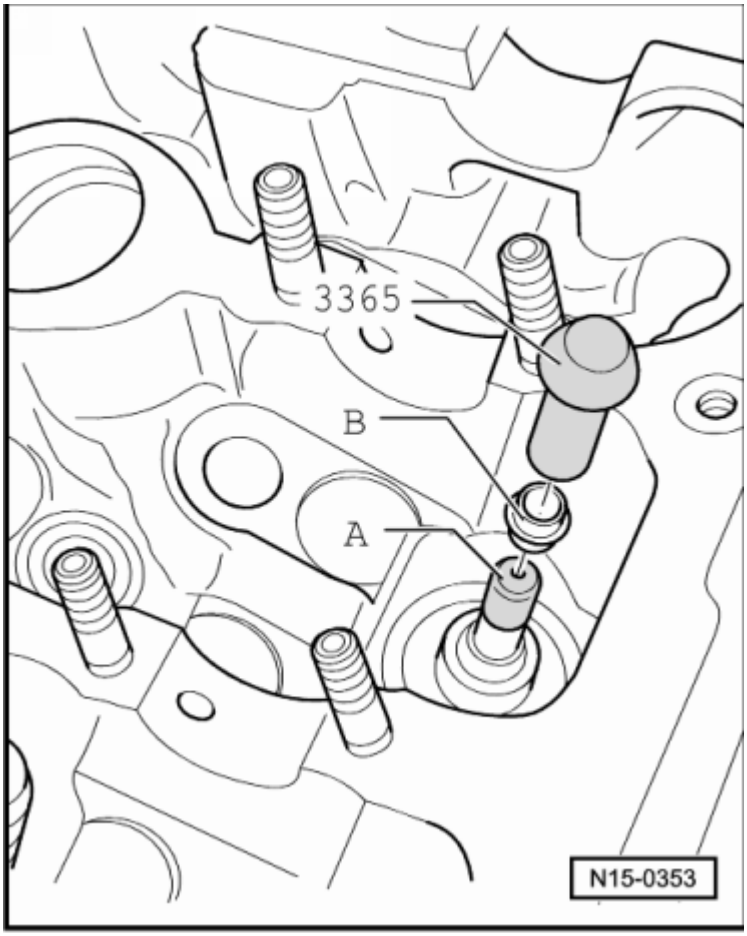

Fig. 129: Identifying Plastic Sleeve, Valve Stem Seal And Valve Stem Seal Driver 3365
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

-- Lubricate the sealing lip of the valve stem oil seal -B-, install it into the 3365 and carefully slide it onto the valve guide.

-- Install the camshafts. Refer to **CAMSHAFTS**.

Install the camshaft adjustor with camshaft drive timing chain. Refer to **CAMSHAFT ADJUSTER WITH TIMING CHAIN, INSTALLING**

SPECIAL TOOLS

Special tools and workshop equipment required

- Straight Edge 500 mm VAS 6075
- Assembly Tool T10118

- Compression Tester V.A.G 1763
- Counter-Holder Tool T10069
- Adjustment Tool T10332 (without mechanical vacuum pump)
- Adjustment Tool T10363 (with mechanical vacuum pump)
- Dial Gauge Holder VW 387

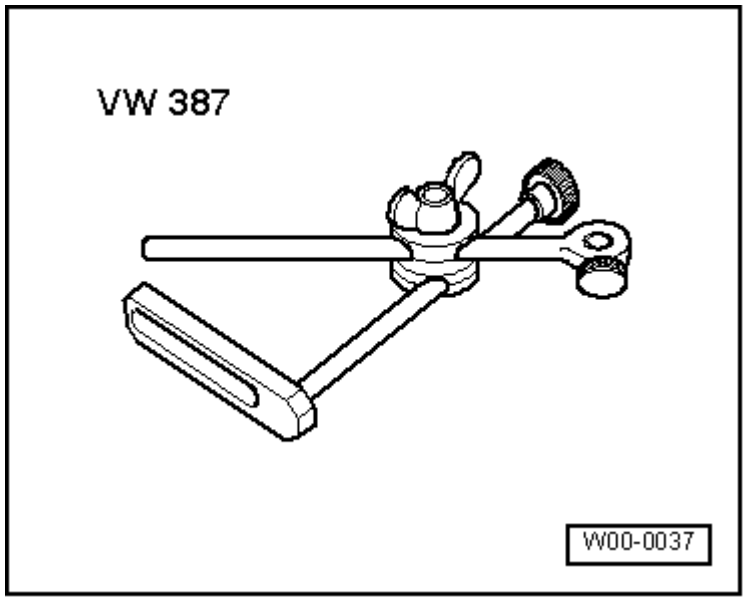

Fig. 130: Dial Gauge Holder VW 387
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Hose Clip Pliers VAS 6362

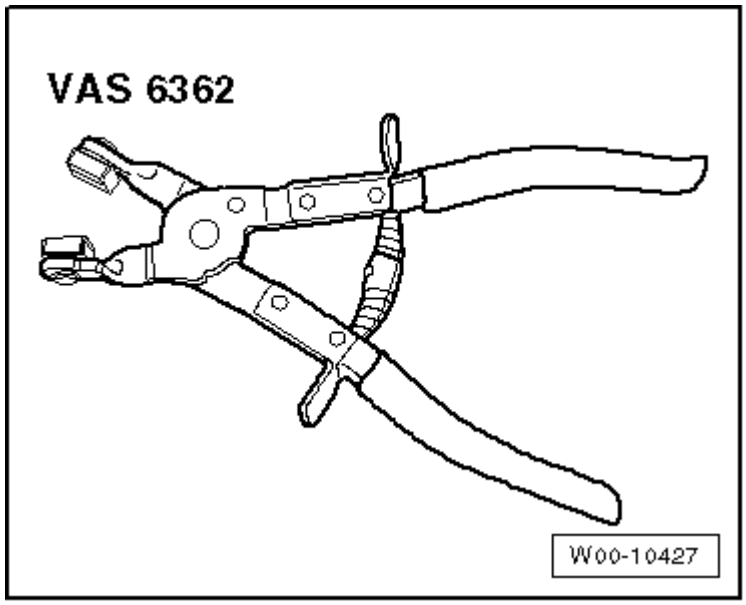

Fig. 131: Clamp Pliers VAS 6362
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Fitting Sleeve 3378

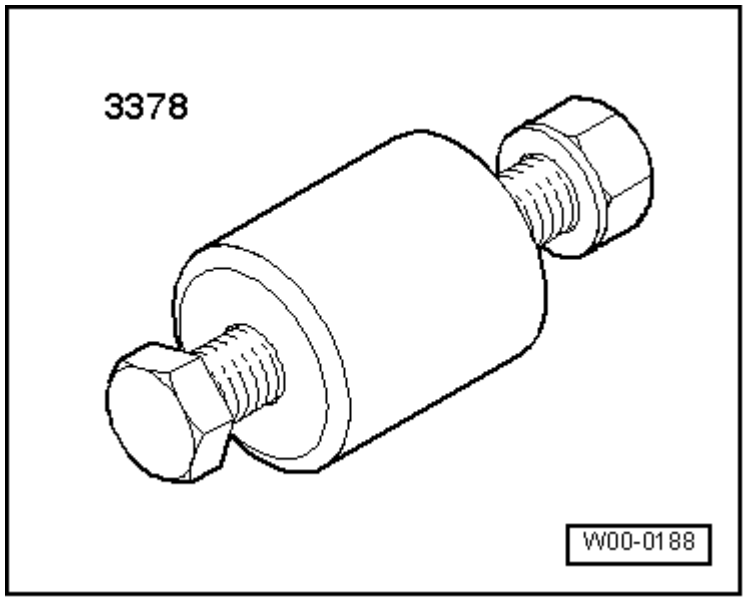

Fig. 132: Fitting Sleeve 3378
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

- Wheel Bearing Assembly Set 3253.

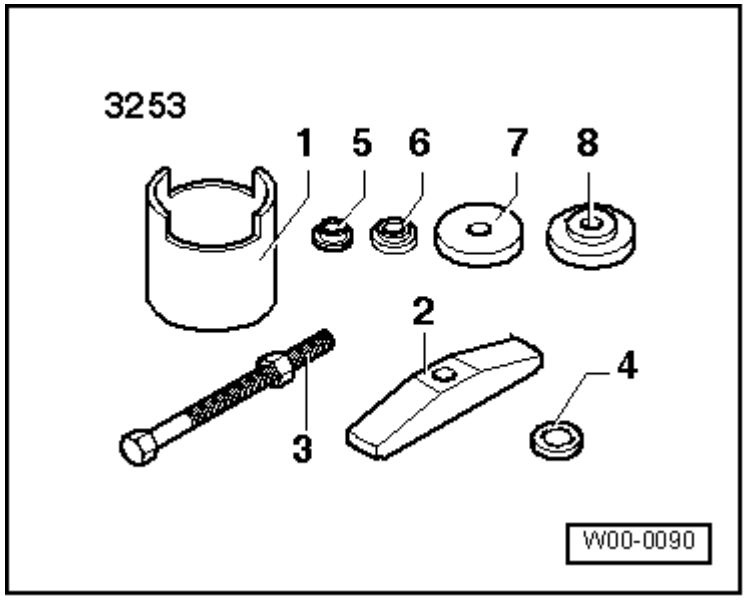

Fig. 133: Assembly Tool 3253
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

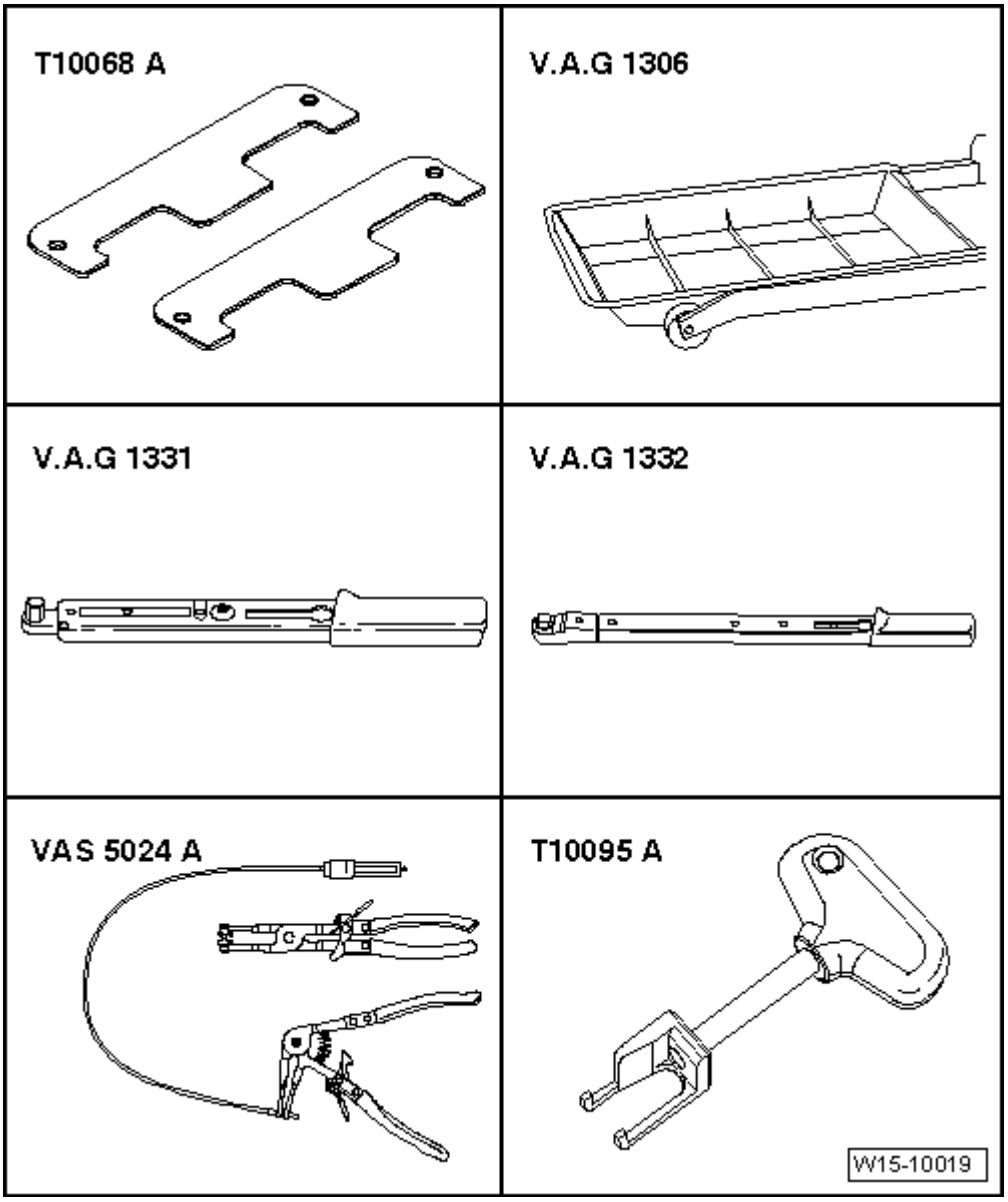

Fig. 134: Identifying Special Tools -- Cylinder Head, Removing And Installing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Special tools and workshop equipment required

- Camshaft Bar T10068 A
- Drip Tray V.A.G 1306
- Torque Wrench (5-50 Nm) V.A.G 1331
- Torque Wrench (40-200 Nm) V.A.G 1332
- Spring Type Clip Pliers VAS 5024 A
- Puller for Ignition Coil T10095 A

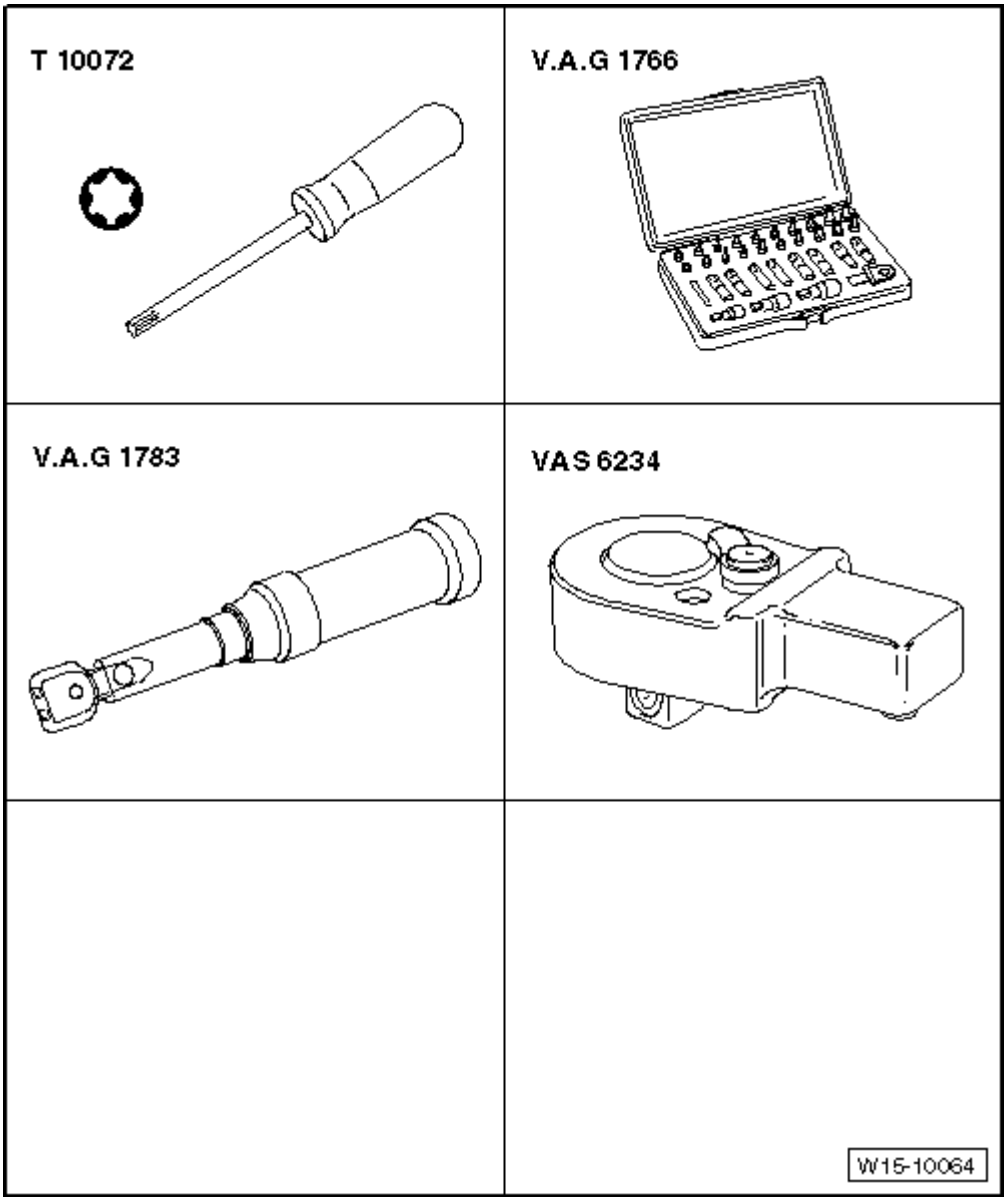

Fig. 135: Identifying Special Tools - Camshaft Adjuster Valves, Removing And Installing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Special tools and workshop equipment required

- Socket Wrench T10072
- TORX Bit Set V.A.G 1766
- Torque Wrench (5-60 Mm) V.A.G 1783
- Ratchet Insert 1/4" VAS 6234

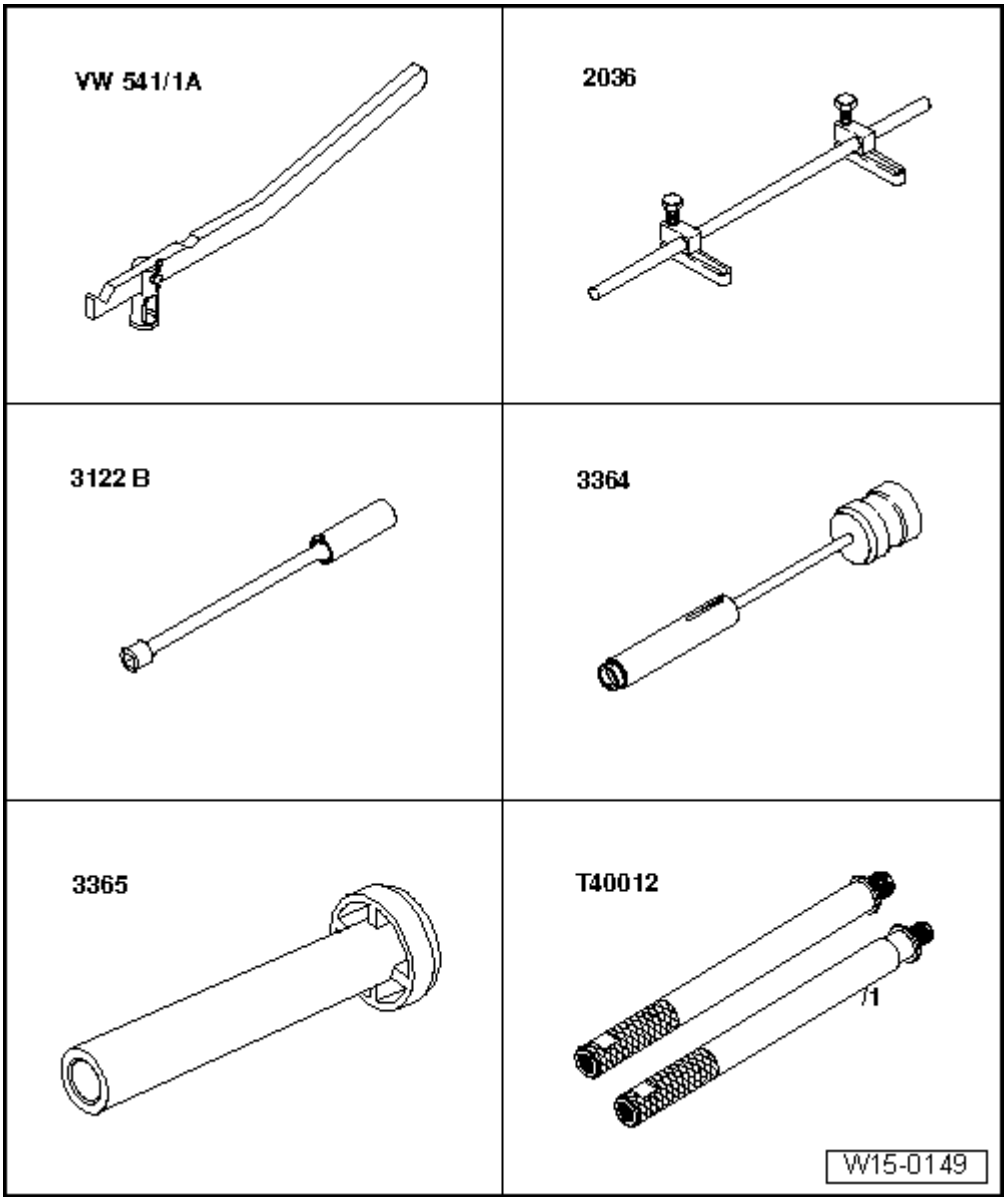

Fig. 136: Identifying Special Tools -- Valve Stem Oil Seals, Replacing
Courtesy of VOLKSWAGEN GROUP OF AMERICA, INC.

Special tools and workshop equipment required

- Valve Lever VW 541/1 A with Press Tool for VW 541/1A and 2037 VW 541/6
- Adjustable Rod 2036 with Adapter Plates 2036/1
- Spark Plug Removal Tool 3122 B
- Valve Seal Removal Tool 3364
- Valve Stem Seal Driver 3365
- Adapter T40012

