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# Engine – Cylinder Head, Valve Drive

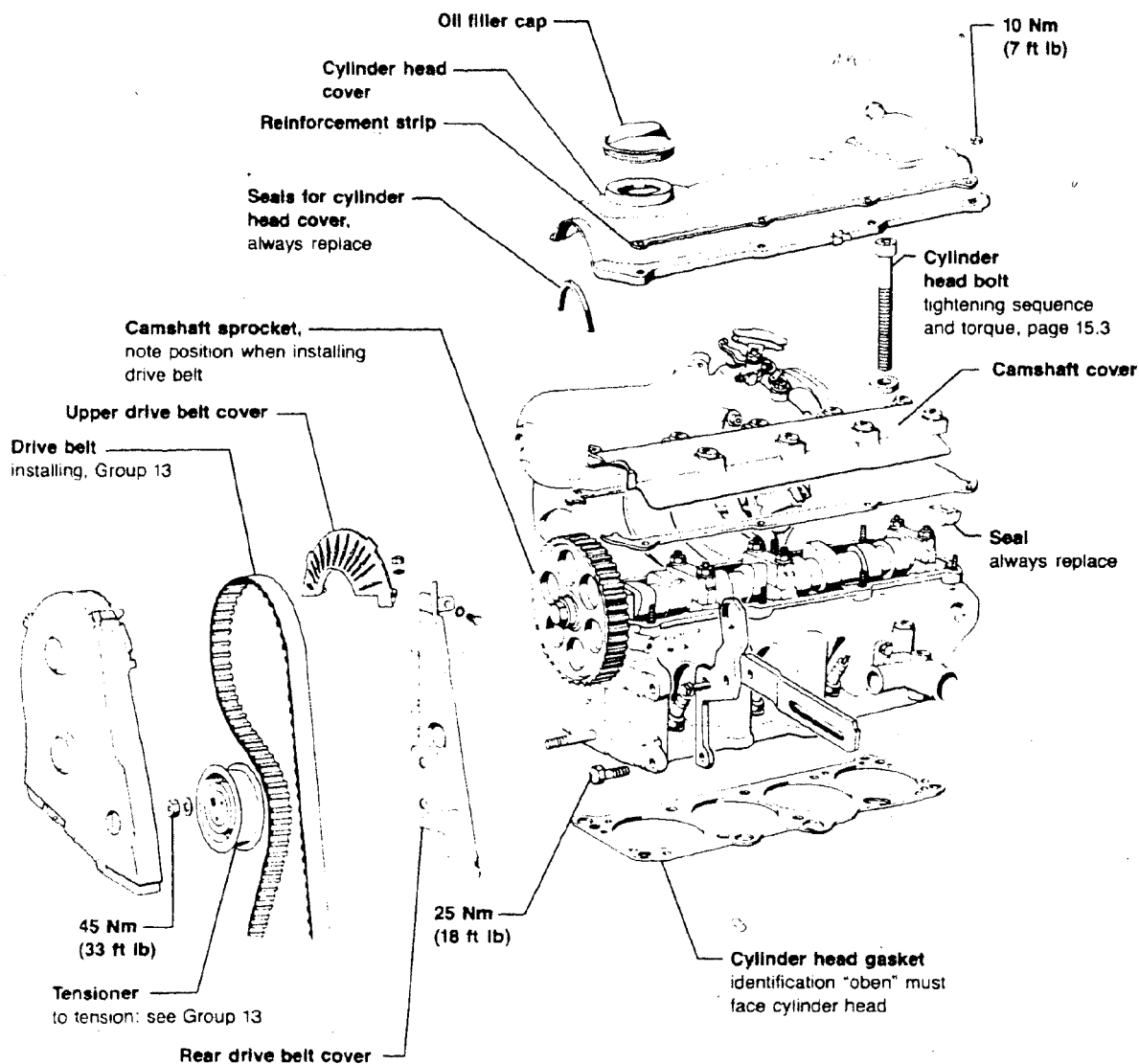
## Notes

- The cylinder head can be removed with the engine installed.
- When installing a rebuilt cylinder head, oil the contact surfaces between the cam lobes and the lifters.

## CAUTION

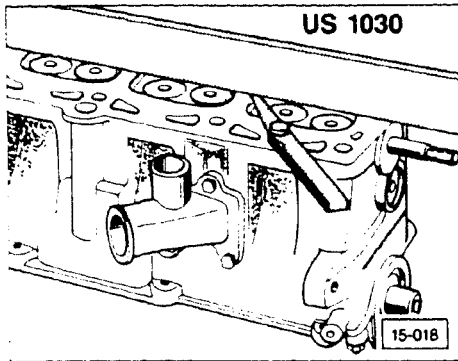
Coolant/antifreeze **must not** be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.

Compression pressures, checking page 15.4



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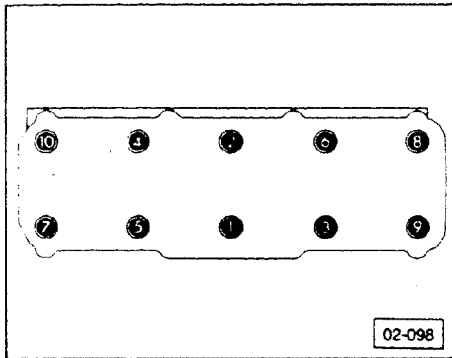


## ► Cylinder head, distortion checking

### Note

Cylinder head should be clean and free of gasket material before performing this check.

- use straight edge **US 1030** and feeler gauge to check for distortion
  - maximum permissible distortion allowed: 0.1 mm (0.004 in)



## ► Cylinder head, installing

- position cylinder head on engine block
- install cylinder head
- note proper positioning
- fit all cylinder head bolts
- **hand tighten only**
- tighten cylinder head bolts in three-step sequence as follows:

### Tightening torque: Engine cold

- tighten in sequence to 40 Nm (29 ft lb)
- tighten in sequence to 60 Nm (43 ft lb)
- tighten in sequence additional 1/2 turn (180°) further in one movement (two 90° turns are permissible)
- remove cylinder head bolts in reverse sequence

### Note

It is not necessary to re-tighten cylinder head bolts during scheduled maintenance or after performing repairs.

## Compression pressure, checking

Check these first:

- engine oil temperature minimum **30°C (86°F)**
  - throttle plate completely open
  - ignition coil lead removed from ignition distributor and connected to ground
  - all spark plugs removed
- use pressure recorder **US 1120** to measure compression

### Note

See operating instructions for recorder **US 1120**

- operate starter until recorder shows **NO** further pressure increase

### Compression pressure values

Engine code letters	new	wear limit
3A	10.5-13.5 bar (152-196 psi)	7.5 bar (109 <sup>3</sup> psi)

- permissible difference between all four cylinders: 3 bar (44 psi)

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## Camshaft, cylinder head, valves

### Note

Heads with fine cracks between valve seats and plug threads can be installed again without reducing engine service life provided that cracks are small and not more than 0.5 mm wide or when only the first coils of the plug threads are cracked.

**Bearing caps**  
note offset, Fig. 3  
installing, page 15.6

20 Nm  
(15 ft lb)

**Camshaft**  
checking axial play, Fig. 1  
removing and installing, page 15.7  
identify camshaft, Fig. 2  
check radial play with plastigage  
wear limit: 0.1 mm (0.004 in)  
impact 0.01 mm maximum (0.0004 in)

**Hydraulic valve lifter**  
before installing check axial  
play of camshaft  
lubricate contact surfaces  
do not interchange lifters  
remove and store with contact  
surface facing downwards  
checking, page 15.8

**Woodruff key**  
check fit

**Valve keeper**

**Upper spring seat**  
identified by wide outer chamfer

80 Nm  
(59 ft lb)

**Lower spring seat**  
remove-install with 3047

**Outer valve spring**  
**Inner valve spring**  
remove install with 2037

**Valve stem seal**  
replacing, page 15.13

**Valve guide**  
checking wear, page 15.12  
replacing, page 15.12

**Cylinder head**  
valve seat refacing, page 15.11

**Camshaft oil seal**  
removing and installing,  
page 15.9

**Seal**  
always replace

**Resurfacing dimension**  
minimum dimension:  
 $a = 132.6 \text{ mm (5.22 in)}$

### CAUTION

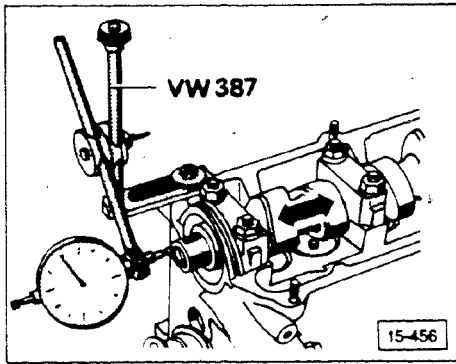
Coolant antifreeze **must not** be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.

**Valves**  
do not reface  
dimensions, Fig. 4,  
page 15.10

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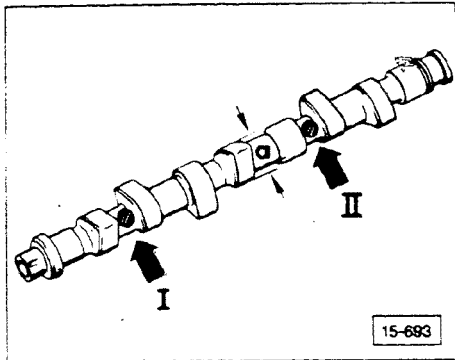
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## Camshaft



► Fig. 1 Checking axial play

- measure with lifters removed and with bearing caps 1 and 5 installed. Install dial indicator adaptor **VW 387** as shown.
- move camshaft back and forth longitudinally (**arrow**) to measure axial play
  - wear limit 0.15 mm (0.006 in)

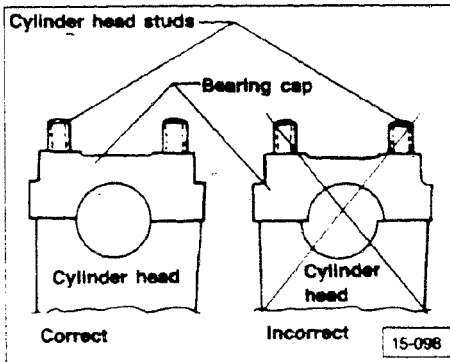


► Fig. 2 Camshaft identification

- base circle diameter of cam  
a = 34.0 mm (1.3 in)

Engine Code	Arrow I	Arrow II
3A	G	026

## Camshaft bearing caps



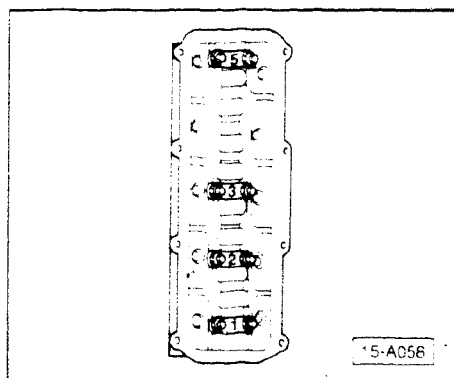
► Fig. 3 Installation position

- before installing camshaft, place bearing caps into position to determine correct installation position (as shown)

## Camshaft, installing and removing

### Removing

- remove upper drive belt cover
- remove cylinder head cover
- turn crankshaft to TDC on cylinder no. 1
- slacken and remove drive belt
- remove camshaft sprocket
- remove woodruff key from camshaft



- remove bearing caps 1 and 3
- remove bearing caps 2 and 5 alternately and diagonally

### Installing

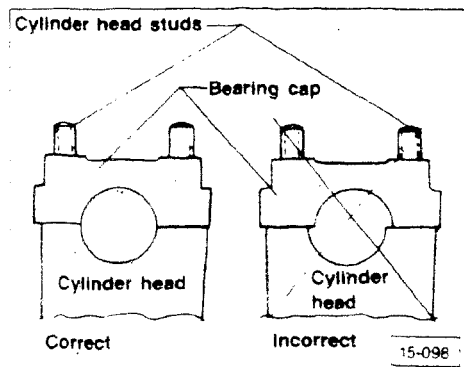
#### Note

Cams lobes for cylinder No. 1 must point upwards when installing camshaft.

#### Note

Before you install the camshaft, note the possible offset if the bearing caps are installed backwards. Set in place prior to installation to position properly.

- mount bearing caps 2 and 5
  - tightening torque: 20 Nm (15 ft lb)
- mount bearing caps 1 and 3
  - tightening torque: 20 Nm (15 ft lb)
- mount camshaft sprocket
  - tightening torque: 80 Nm (59 ft lb)





## Hydraulic valve lifters, checking

### Note

Always place removed valve lifter on a clean surface with the contact surface (camshaft side) facing downward.

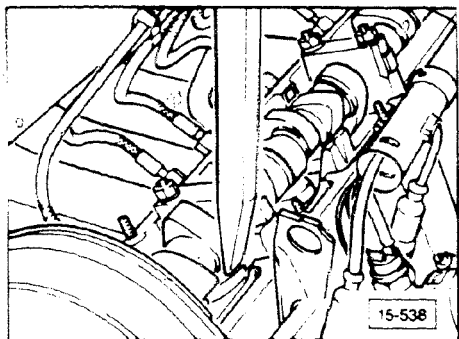
Always replace complete valve lifter (valve lifter cannot be adjusted or repaired).

It is normal if you hear intermittent valve noise when you first start the engine.

- run engine until radiator fan comes on at least once
- bring engine speed to approximately 2500 RPM for 2 minutes

If valve lifter is still noisy, replace as follows:

- remove cylinder head cover
- turn crankshaft pulley bolt clockwise until cam lobes of cylinder to be checked point upward
- push down against valve lifter with light pressure using a suitable wood stick. If valve lifter can be pushed down more than 0.1 mm (0.004 in) replace lifter.



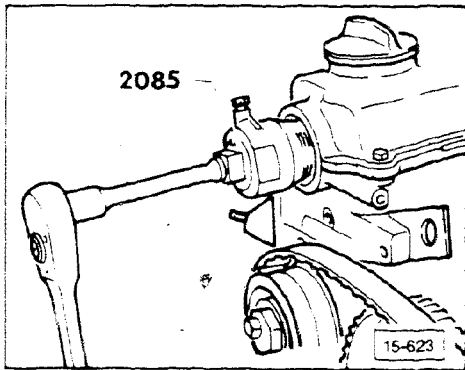
### CAUTION

After replacing lifters, do not start engine for approximately 30 minutes, because the valves may hit the piston. Lifter must be allowed to bleed down to proper adjustment.

## Camshaft oil seal, removing and installing

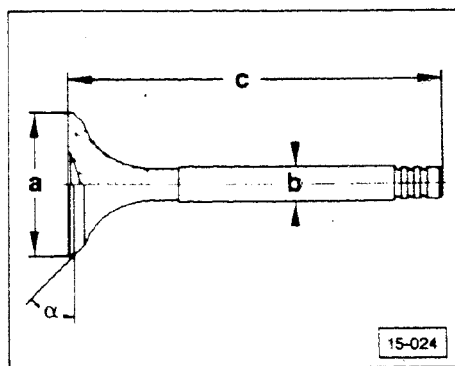
### Removing

- remove upper drive belt cover
- set crankshaft to TDC on cylinder no. 1
- slacken drive belt and remove
- remove camshaft sprocket
- remove woodruff key from cam
- install mounting bolt (with washer) for camshaft sprocket up to stop
- remove inner part of oil seal extractor **2085** two turns (approximately 3.0 mm) from outer part of tool and lock with screw
- lubricate threaded head of oil seal extractor
- mount extractor and push in as far as possible into oil ring
- loosen knurled screw and turn inner part of puller against camshaft until oil seal is pulled out
- clamp extractor in vise and remove oil seal with pliers



### Installing

- coat seal seat and seal lips lightly with oil
- press oil seal into cylinder head until **flush** using **10-203**



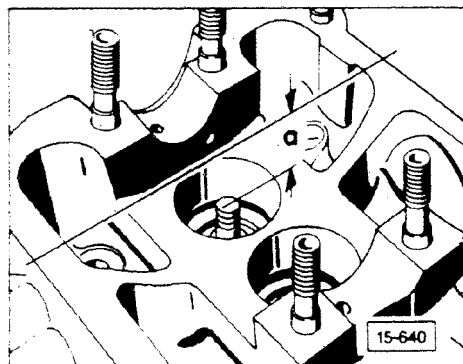
► Fig. 4 Valve dimensions, mm

	Intake valve	Exhaust valve
Diameter <b>a</b>	40.0	33.0
Diameter <b>b</b>	7.97	7.95
Length <b>c</b>	91.0	90.8
Angle $\alpha$	45°	45°

## CAUTION

Do not reface **valves** on a machine:  
lap by hand only if necessary.

## Valve seats, refacing



Calculating the maximum permissible refacing dimension

- insert valve and hold firmly against valve seat
- measure distance **a** between end of valve shaft and upper edge of cylinder head
- calculate refacing dimension **b** (see following illustrations) using the measured distance **a** (above) and:

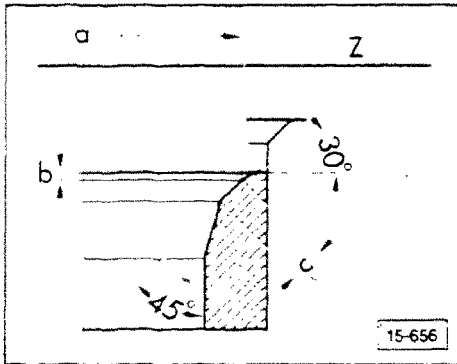
### Minimum dimension

If the measured distance **a** is smaller than the minimum dimension, the hydraulic valve lifter will not work and the cylinder head must be replaced.

Minimum dimension — intake valve = 33.8 mm  
Minimum dimension — exhaust valve = 34.1 mm

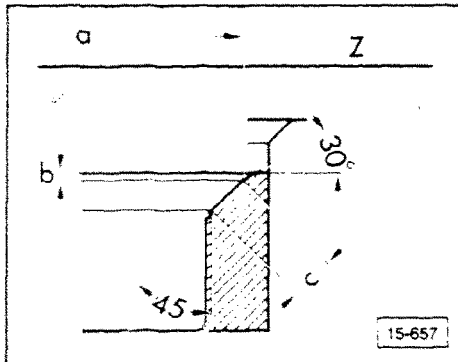
measure distance **a**  
– minimum dimension

= maximum permissible refacing  
dimension **b**



## ► Intake valve seat, refacing

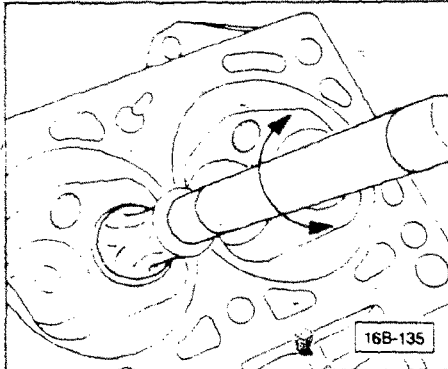
- a** = 0 39.2 mm (1.543 in)
- b** = maximum permissible refacing dimension (calculated on page 15.10)
- c** = approximately 2.0 mm (0.079 in)
- Z** = cylinder head lower edge
- 30°** = upper correction angle
- 45°** = valve seat angle



## ► Exhaust valve seat, refacing

- a** = 32.4 mm (1.275 in)
- b** = maximum permissible refacing dimension (calculated on page 15.10)
- c** = approximately 2.4 mm (0.094 in)
- Z** = cylinder head lower edge
- 30°** = upper correction angle
- 45°** = valve seat angle

Exhaust valve **seats** have a reduced diameter. Take care when refacing the seats to ensure that this dimension is not enlarged beyond the specification.



## Valve, lapping

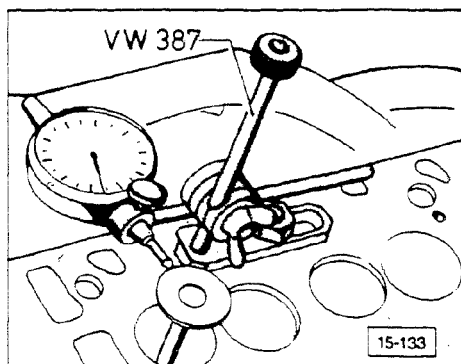
### Note

Do not reface the valves on a machine; lap by hand only if necessary.

- apply lapping compound to valve seat surface, insert valve and rotate in both directions (**arrow**) using lapstick

### CAUTION

After lapping valve, remove all traces of lapping compound.



## Valve guides, checking

Check these first:

remove any combustion residue with suitable cleaner

use dial indicator adaptor **VW 387**

- insert **new** valve in guide. End of valve stem must be flush with end of valve guide

### Note

Install intake or exhaust valves in their respective guides only.

- push-pull valve back and forth against dial indicator. Dial indicator reading shows valve guide wear

Dial indicator reading, maximum	Intake valve	Exhaust valve
	1.0 mm (0.039 in)	1.3 mm (0.051 in)

## Valve guides, replacing

### Note

Cylinder heads on which the valve seat surface can no longer be refaced or cylinder heads that have been refaced down to the minimum dimension cannot be repaired further.

- press out worn valve guides from camshaft side of head using **10-206**.

### Note

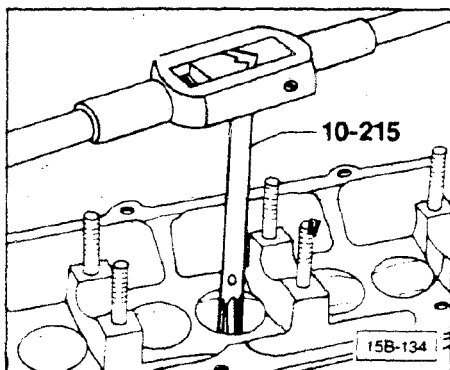
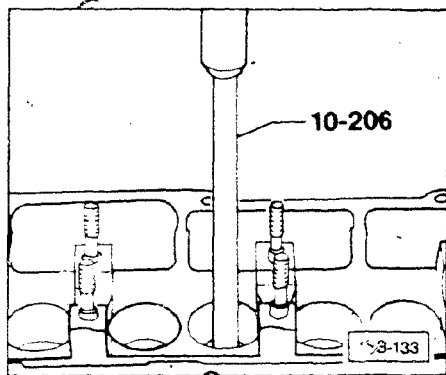
Valve guides with collar version: press out from combustion chamber side of head.

- coat new guides with oil and press into cold cylinder head from camshaft side. Press guides in completely

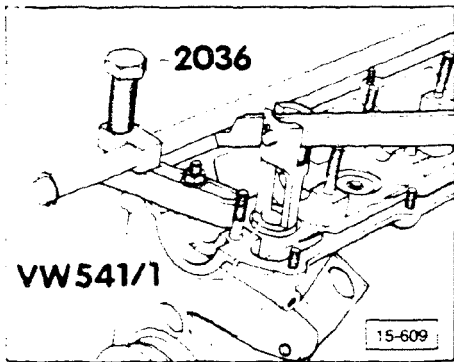
### Note

When valve guide shoulder has made contact, do not increase pressure above 1 ton or the valve guide shoulder may shear off

- ream valve guide using cutting oil and hand reamer **10-215**
- reface valve seat



# Engine – Cylinder Head, Valve Drive



## Valve stem seals, replacing (with cylinder head installed)

- remove camshaft and lifters
- remove spark plugs
- set piston of respective cylinder to the bottom dead center position
- insert installation tool **2036** and adjust position of studs
- insert leak down tester **US 1106** or equivalent into spark plug hole and apply steady air pressure of at least 6 bar (87 psi) gauge pressure
- remove valve springs with tool **VW 541/1**

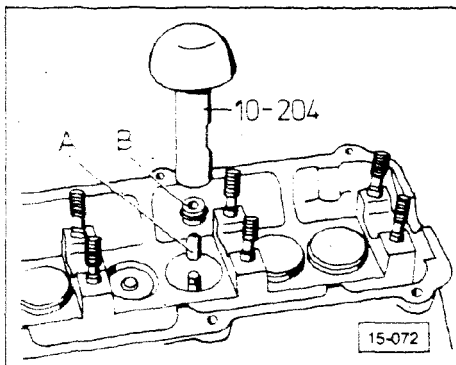
### CAUTION

Do not install seal without using plastic seal protector, otherwise seal will be damaged and engine will use excessive oil.

### Note

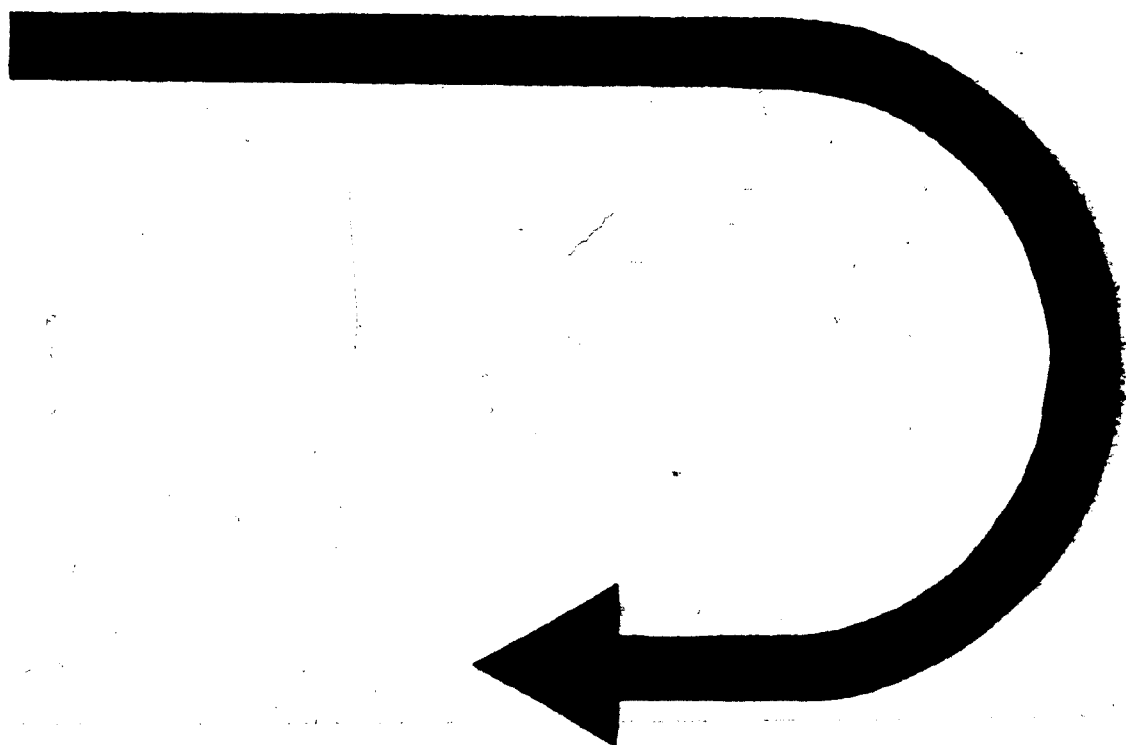
If the valve keepers are hard to remove, loosen them by tapping lightly on the lever of the fitting tool.

- remove valve stem seals using tool **3047A**



- place plastic sleeve **A** on valve stem
- lubricate valve stem seal **B**, place on fitting tool **10-204** and push carefully on to valve guide

CONTINUED IN THE  
BEGINNING OF NEXT ROW



# Engine – Cylinder Head, Valve Drive

## Notes

Upper intake manifold, fuel injectors (see Repair Group 25).

Cylinder head can be removed with engine installed.

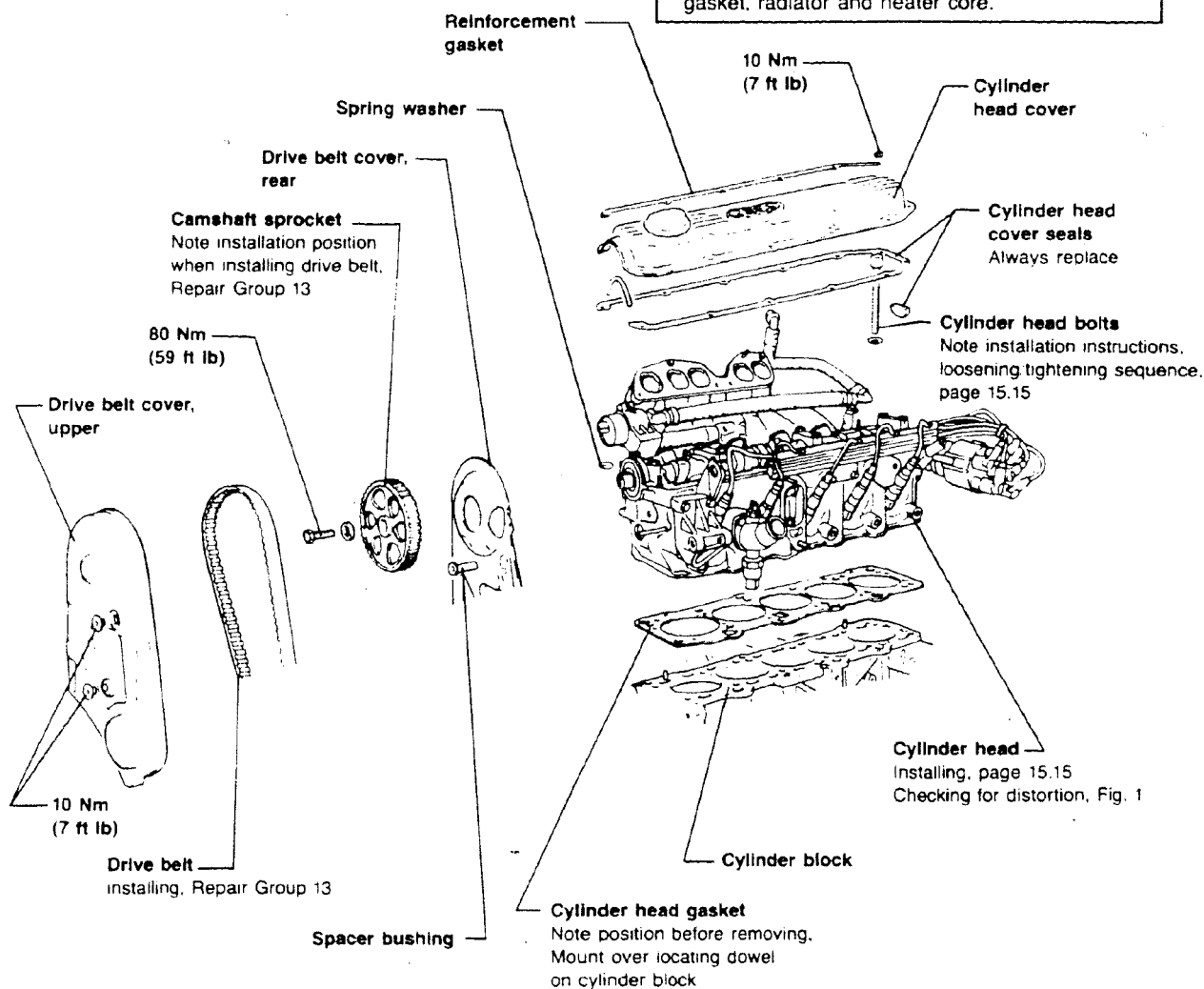
When installing rebuilt cylinder head, lubricate camshaft lobes, and hydraulic lifters.

## CAUTION

Always replace gaskets and seals.

## CAUTION

Coolant/antifreeze **must not** be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.



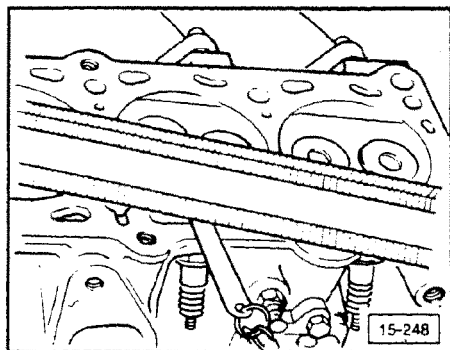
## CAUTION

Mounting camshaft sprocket incorrectly will result in valve timing being advanced and possibility of valves hitting pistons.

15-699

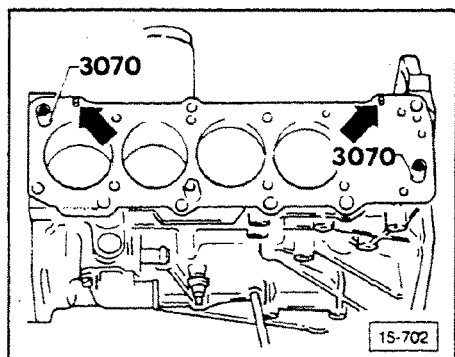
G-2





► Fig. 1 Cylinder head, checking for distortion

- maximum 0.1 mm (0.004 in.)

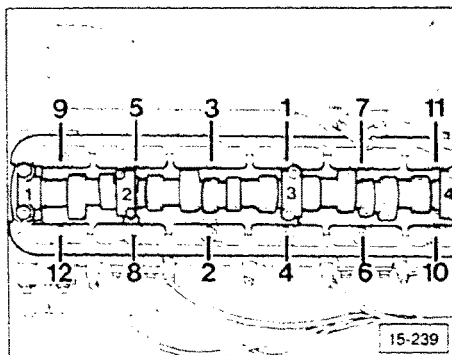


## Cylinder head, installing

### Note

**DO NOT** set crankshaft at TDC.

- screw guide pins from tool **3070** into cylinder head bolt holes **9** and **10**
- install cylinder head gasket onto centering pins (**arrows**)
- mount cylinder head to cylinder block
- install remaining 10 cylinder head bolts
- hand tighten only
- with screwdriver from **3070**, remove guide pins from holes **9** and **10**
- install cylinder head bolts into **9** and **10**
- hand tighten only



## Cylinder head bolts, removing/ installing

- tighten in numerical order, loosen in reverse order
- tighten bolts in **three** step sequence — engine cold
  - step 1 = 40 Nm (29 ft lb)
  - step 2 = 60 Nm (44 ft lb)
  - step 3 = 1/2 turn (180°) further without stopping (two 90° turns are OK)

### CAUTION

It is not necessary to retorque cylinder head bolts after repairs.

## Compression pressure, checking

- engine oil temperature minimum 30°C (86°F)
- throttle plate completely open
- ignition coil lead removed from ignition distributor and connected to ground
- check compression pressure using pressure recorder US1120
- follow operating instructions for recorder
- operate starter until recorder unit indicates no further pressure increase

## Compression pressure values

Engine code letters	new	wear limit
NG	10-14 bar (145-203 psi)	8 bar (116 psi)

- permissible difference between all four cylinders: 3 bar (43.5 psi)

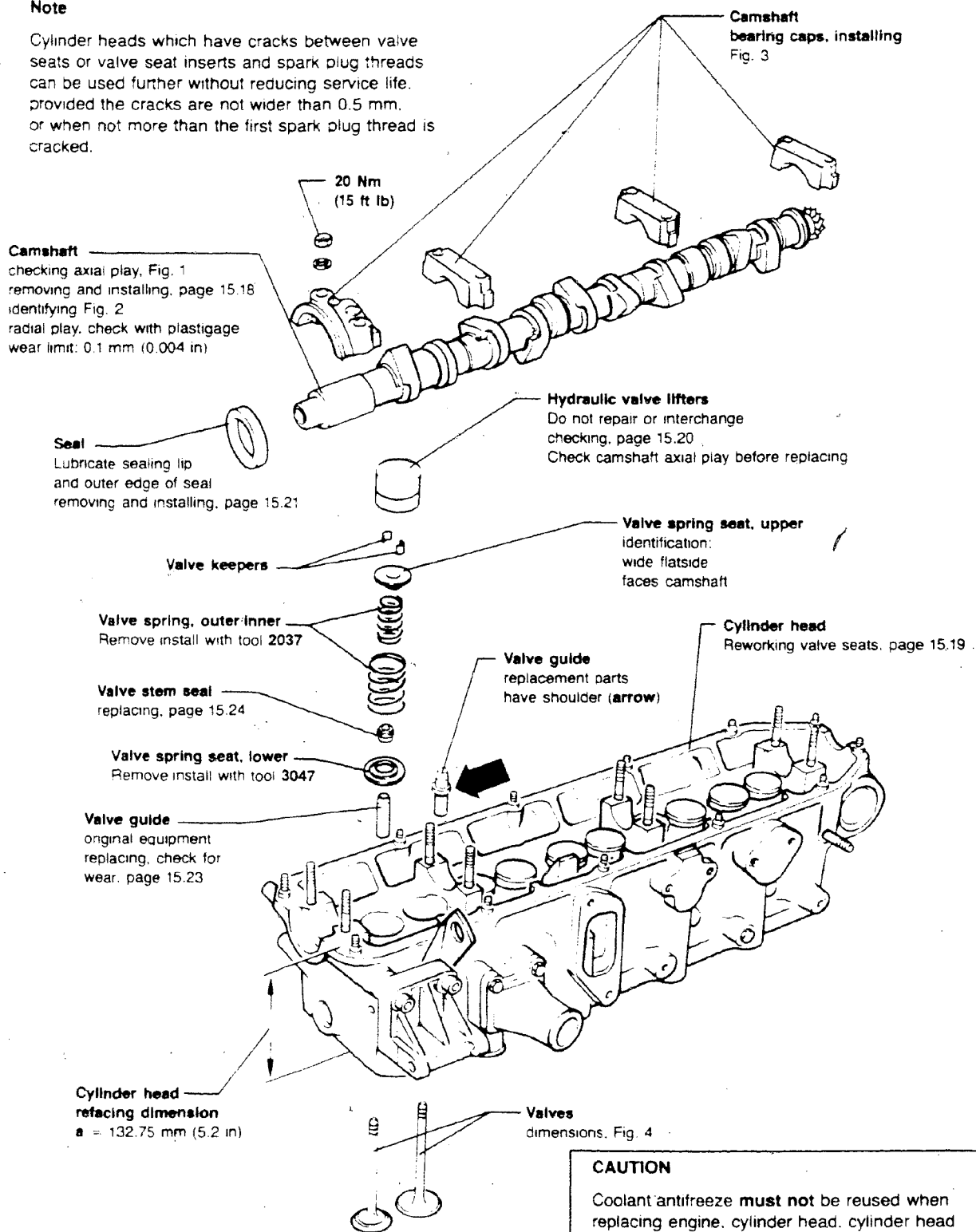
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# Engine – Cylinder Head, Valve Drive

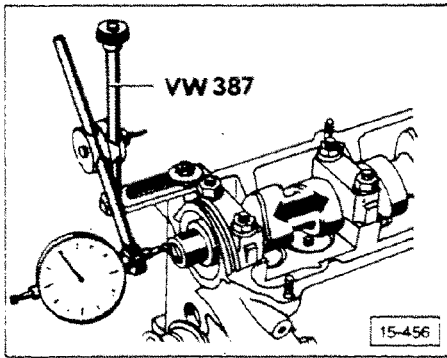
## Note

Cylinder heads which have cracks between valve seats or valve seat inserts and spark plug threads can be used further without reducing service life, provided the cracks are not wider than 0.5 mm, or when not more than the first spark plug thread is cracked.



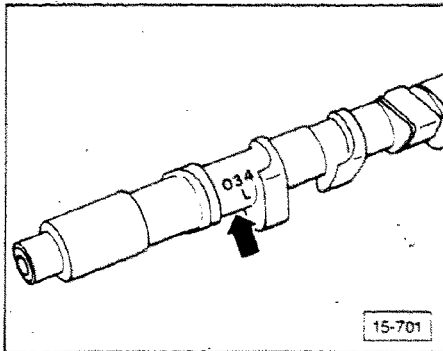
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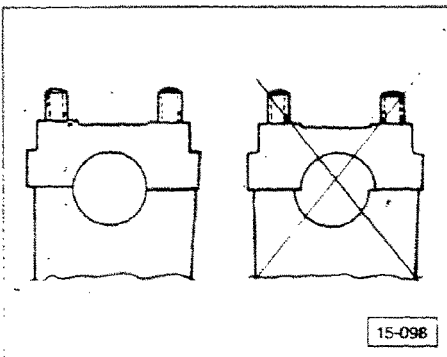
► Fig. 1 Camshaft axial play, checking

- measure with valve lifters removed, and bearing caps 1 and 4 installed
- maximum 0.15 mm (0.006 in.)



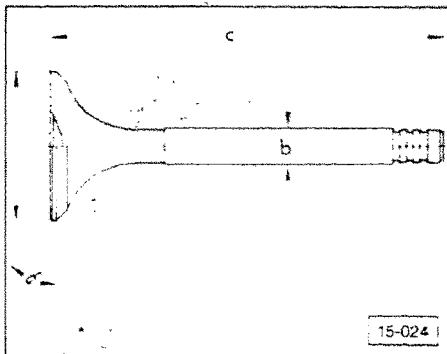
► Fig. 2 Camshaft identification

Identification between the cam of the 1st cylinder: 034L



► Fig. 3 Camshaft bearing caps, installing

- lubricate bearing surfaces and camshaft journals
- install caps in proper order — observe off center bearing position

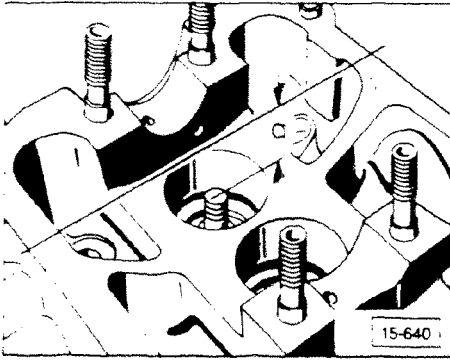


► Fig. 4 Valve dimensions

	Intake	Exhaust
a	40.0 mm (1.575 in.)	33.0 mm (1.299 in.)
b	7.97 mm (.314 in.)	7.95 mm (.313 in.)
c	91.0 mm (3.582 in.)	90.8 mm (3.575 in.)
α	45°	45°

### CAUTION

Do not reface valves, only reface seats.



## Valve seats, refacing

Calculating the maximum permissible refacing dimension

- insert valve and hold firmly against valve seat
- measure distance **a** between end of valve shaft and upper edge of cylinder head
- calculate refacing dimension **b** (see following illustrations) using the measured distance **a** (above) and:

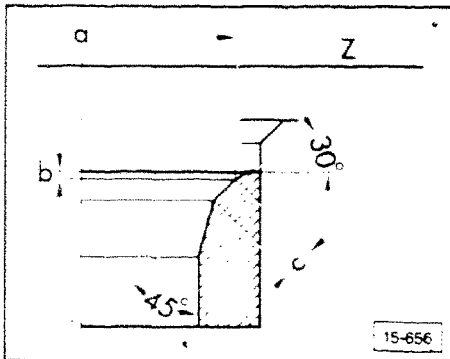
Minimum dimension — intake valve = 33.8 mm  
Minimum dimension — exhaust valve = 34.1 mm

measure distance **a**  
- minimum dimension

- maximum permissible refacing dimension **b**

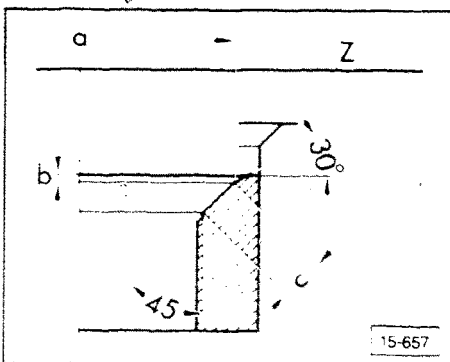
## Minimum dimension

If the measured distance **a** is smaller than the minimum dimension, the hydraulic valve lifter will not work and the cylinder head must be replaced.



## Intake valve seat, refacing

- a** = 39.2 mm (1.543 in.)
- b** = maximum permissible refacing dimension
- c** = approximately 2.0 mm (0.079 in.)
- Z** = cylinder head lower edge
- 30° = upper correction angle
- 45° = valve seat angle



## Exhaust valve seat, refacing

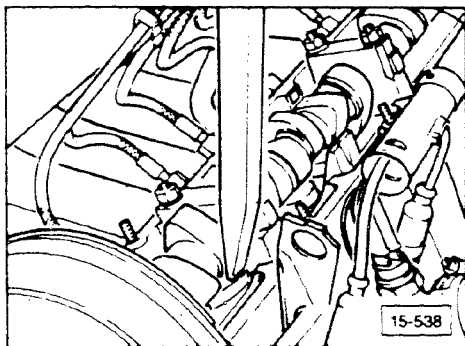
- a** = dia. 32.4 mm (1.276 in.)
- b** = maximum permissible refacing dimension
- c** = approximately 2.0 mm (0.079 in.)
- Z** = cylinder head lower edge
- 30° = upper correction angle
- 45° = valve seat angle

Exhaust valve seat rings are also made with a narrowed diameter. When refacing make sure radius of the narrowed diameter is not damaged.

## Hydraulic valve lifters, checking

### CAUTION

After replacing lifters, do not start engine for approximately 30 minutes, otherwise valves may hit piston. Lifter must be allowed to bleed down to proper adjustment.



Always place removed valve lifter on a clean surface with the contact surface (camshaft side) facing downward.

Always replace complete valve lifter. Lifter cannot be adjusted or repaired.

Unusual noise from valve lifter while starting is normal.

- run engine until radiator fan comes on at least once
- bring engine speed to approximately 2500 RPM for two minutes

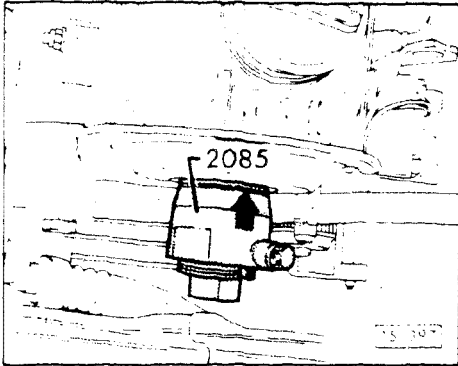
If valve lifter is still noisy, replace as follows:

- remove cylinder head cover
- turn crankshaft pulley bolt clockwise until cam lobes of cylinder to be checked point upward
- push down against valve lifter with light pressure using a suitable wood stick (as shown). If valve lifter can be pushed down more than 0.1 mm, replace lifter.

## Camshaft oil seal, removing/ installing

### Removing

- remove upper drive belt cover
- set crankshaft to TDC on cylinder no. 1
- slacken drive belt and remove
- remove camshaft sprocket
- remove woodruff key from camshaft
- install mounting bolt for camshaft sprocket with washer up to stop
- remove inner part of oil seal extractor **2085** two turns (approximately 3.0 mm) from outer part of tool and lock with screw
- lubricate threaded head of oil seal extractor. Mount and push in as far as possible into oil ring
- loosen knurled screw and turn inner part of puller against camshaft until oil seal is pulled out
- clamp extractor in vice and remove oil seal with pliers



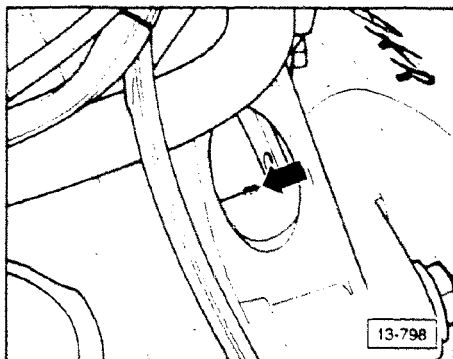
### Installing

- coat oil seal seat and seal lip lightly with oil
- press oil seal into cylinder head until **flush** using **10-203**, with special hex head bolt **10-203/1**

### CAUTION

**DO NOT** press oil seal in to stop. The oil return bore will be covered.

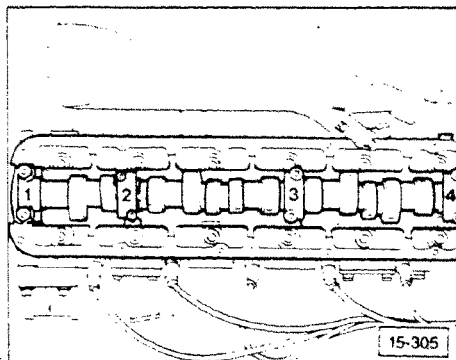




## Camshaft, installing and removing

### Removing

- remove upper drive belt cover
- remove upper part of intake manifold
- remove cylinder head cover
- turn crankshaft to TDC on cylinder no. 1
- slacken and remove drive belt
- remove camshaft sprocket
- remove woodruff key from camshaft

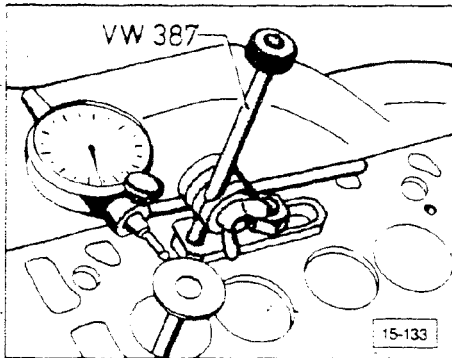


- remove bearing caps 1, 3
- loosen bearing caps 2 and 4 alternately and diagonally

### Installing

When installing the camshaft, the cams for number 1 cylinder must be pointing upwards. When installing bearing caps, note center offset of bore. Before installing caps, place in position and determine installed position.

- tighten bearing caps 2 and 4 alternately and diagonally
  - tightening torque: 20 Nm (15 ft lb)
- install bearing caps 1 and 3
  - tightening torque: 20 Nm (15 ft lb)
- position camshaft sprocket and tighten
  - tightening torque: 80 Nm (59 ft lb)



## Valve guide, checking for wear

Due to slight difference in stem dimensions, **only** use intake valve in intake guide, and exhaust valve in exhaust guide.

- remove carbon
- install **VW 387** and dial indicator
- insert new valve into valve guide
- valve stem end must be flush with valve guide end
- rock valve back and forth (**arrow**) against dial indicator. Dial indicator reading shows valve guide wear

	Intake valve	Exhaust valve
Maximum dial indicator reading	1.0 mm (0.039 in)	1.3 mm (0.051 in)

## Valve guides, replacing

Cylinder heads on which the valve seat surface can no longer be refaced or cylinder heads that have been refaced down to the minimum dimension cannot be repaired further.

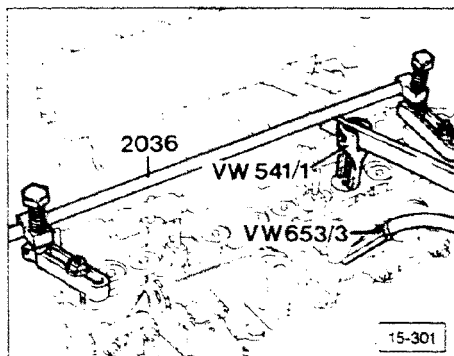
- press worn valve guides out from camshaft side with tool **10-206**
  - valve guides with shoulder (service version) must be pressed out from **combustion** side
- coat new guides with oil and press into cold cylinder head to the shoulder from camshaft side with tool **10-206**
- ream valve guides by hand with reamer tool **10-215**
  - use proper cutting lubricant
- reface valve seats

### CAUTION

Once guide shoulder is seated do not use more than 1 ton pressure or guide shoulder may break.

## CAUTION

Once guide shoulder is seated do not use more than 1 ton pressure or guide shoulder may break.



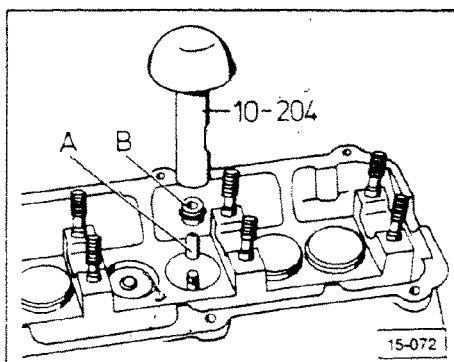
## Valve stem seal, removing/installing

### Removing (with cylinder head installed)

- remove spark plugs
- remove camshaft and hydraulic lifters
- turn crankshaft until piston of cylinder concerned is in BDC position
- install tool 2036 and adjust to stud height
- insert pressure hose US 1106 or VW653/3 into spark plug threads and apply steady pressure of at least 6 bar (87 psi)
- remove valve springs with lever VW541/1

If valve keepers are very hard to come out, they can be loosened by tapping **lightly** on assembly lever with hammer.

- remove valve stem seal with tool 3047



### Valve stem seal

#### Installing

- slide plastic sleeve A onto valve stem
- lubricate valve stem seal B
- push seal carefully onto valve guide using plastic seal protector

## CAUTION

When installing valve stem seals, always use plastic sleeve to prevent damage.

## Fuel Quality and Carbon Deposits

Research by Audi and other manufacturers has shown that the performance of gasoline engines today is directly related to the type and quality of fuel used.

Fuel without the proper additives can cause carbon deposits to form on intake valves and fuel injectors.

These carbon deposits can cause reduced engine power, unstable idle and hesitation during acceleration after starting a cold engine.

The extent of carbon build-up varies depending on the type of fuel, type of driving and operating conditions.

### Intake valves

Moderate to heavy deposits, grades 4-10, (refer to current campaign circular for further description of deposit grading system) can be removed by using the "Kent-Moore Carbon Blaster."

Light deposits (grades 1-3) on intake valves can be removed as follows:

- add one 591 ml. (20 fl. oz.) bottle of "Autobahn Gasoline Additive", P/N: ZVW 246 001 to fuel tank.
- fill fuel tank completely. Best results are achieved with extended freeway style driving. Do not refill fuel tank until fuel gauge reads 1/4 full.

#### CAUTION

Do not exceed the following recommendations when using the 591 ml. (20 fl. oz.) bottle of "Autobahn Gasoline Additive":

Normal vehicle oil change interval	Maximum gas additive treatments between oil changes
8000 km (5000 mi.)	2
12000 km (7500 mi.)	4

## Fuel injectors

Injectors can be cleaned by using the fuel injection system cleaning kit, US G16 (see current service literature for instructions outlining use of US G16 kit).

### NOTE

After cleaning injectors, the idle speed (idle valve adjustment) and CO content should be checked and adjusted if necessary.

### Prevention

Carbon deposit build-up on intake valves and injectors can be prevented through the use of gasolines containing the proper deposit control additives. U.S. suppliers such as Shell, Exxon, Chevron and Amoco, among others, advertise and sell gasoline which contains these additives. When in doubt, owners should consult with their local service station or oil company about available gasolines with additives that will keep intake valves and injectors clean.

In areas where gasoline containing deposit control additives is unavailable, the specially formulated 192 ml. (6.5 fl. oz.) bottle of "Autobahn Additive" should be used as follows:

- add one 192 ml. (6.5 fl. oz.) bottle of "Autobahn Gasoline Additive", P/N: ZVW 246 003 to fuel tank before every fill up.
- for best results, do not refill fuel tank until the fuel gauge reads 1/4 full.

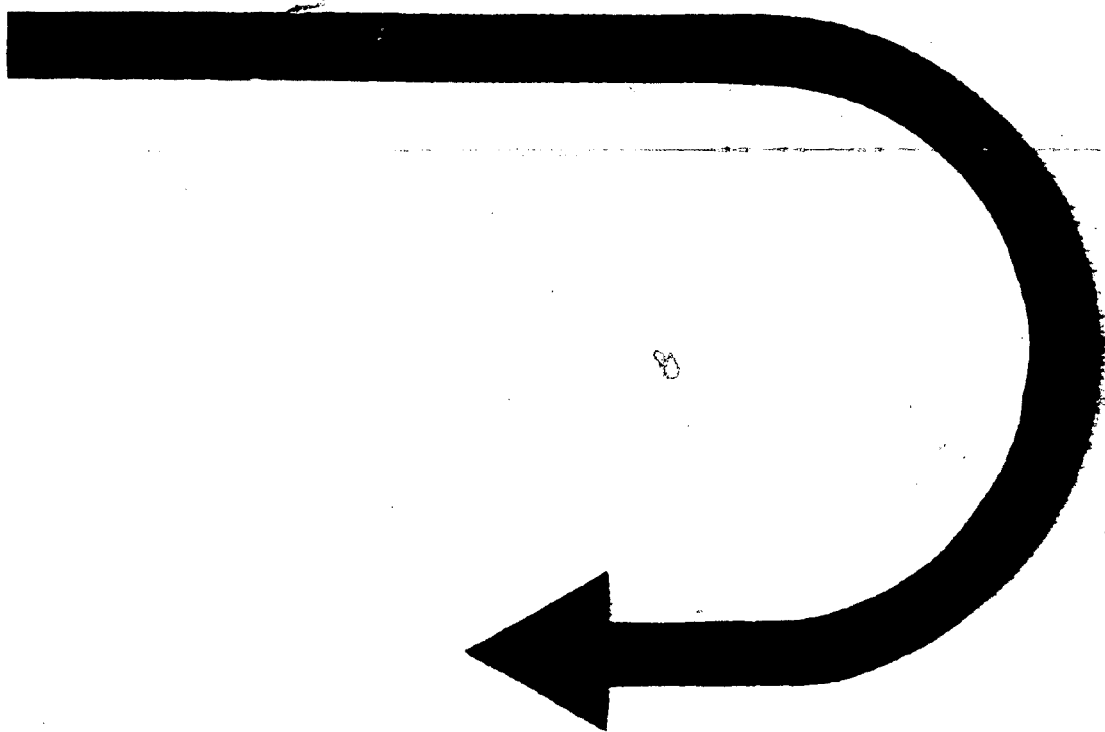
#### CAUTION

Part numbers are for reference only. Always check with your Parts Department for latest parts information.

**THIS FRAME INTENTIONALLY LEFT**

**BLANK**

CONTINUED IN THE  
BEGINNING OF NEXT ROW

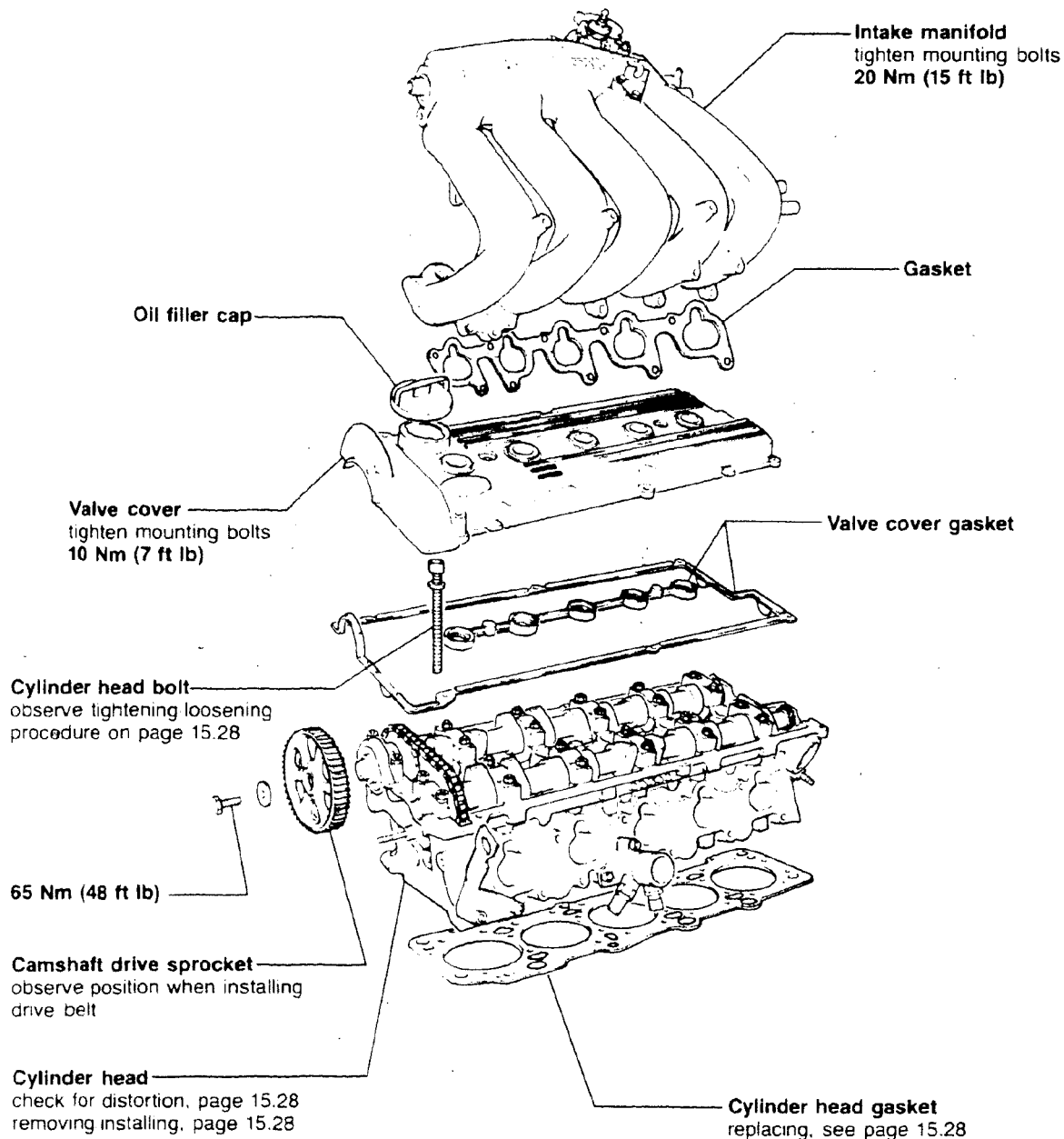


- removing/installing fuel injectors, Group 24
- drive belt installing, Group 13
- cylinder head can be removed/installed with engine installed
- all gaskets are to be replaced during assembly
- when installing a replacement cylinder head, lubricate the surfaces between the lifter and the cam lobe

## CAUTION

After installing new lifters, the engine must **NOT** be started for at least thirty minutes or piston damage could occur.

- check compression pressure, page 15.29



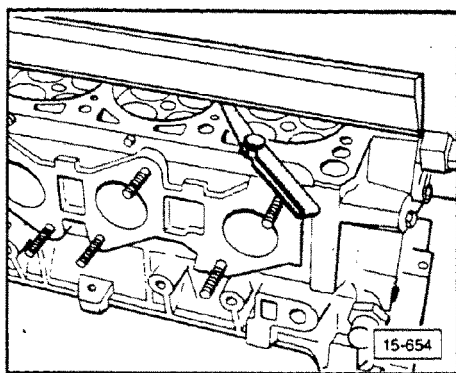
15-540

H-2

Coupe

Cylinder head, component layout

15.27



## Cylinder head distortion, checking

### Note

Cylinder head should be clean and free of gasket material before performing this check.

- use straight edge **US 1030** and feeler gage to check for distortion
  - maximum permissible distortion is 0.1 mm (0.004 in.)

## Cylinder head, refacing

- measure distance between cylinder head bolts surface and lower edge of cylinder head
  - minimum dimension 118.1 mm (4.65 in.)

## Cylinder head, installing

### Note

Prior to installing cylinder head be sure that crankshaft is at **TDC** and that camshaft markings are aligned. Also see Group 13.

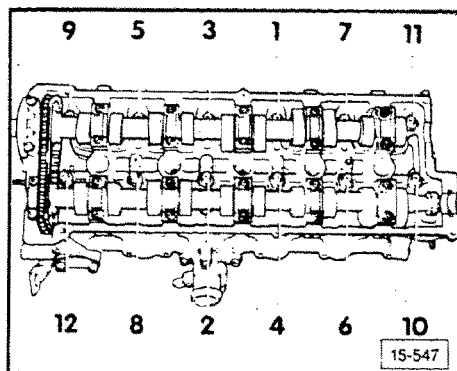
- install cylinder head gasket on locating pins with word **OBEN** (and/or part number) facing cylinder head
- install cylinder head, insert head bolts finger tight
- tighten cylinder head bolts in three step sequence as follows

### Tightening torque, engine cold

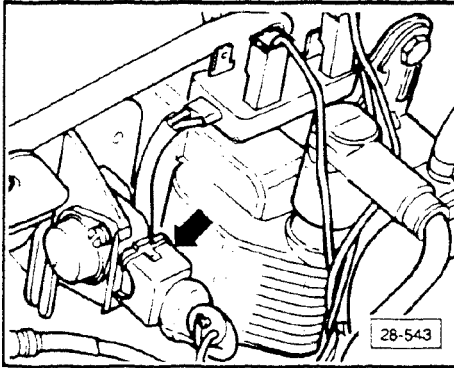
- Step I 40 Nm (29 ft lb)  
Step II 60 Nm (44 ft lb)  
Step III 1/2 additional turn (180°) to each bolt in one movement  
(two 90° turns are permissible)
- remove cylinder head bolts in reverse sequence

### Note

It is not necessary to re-tighten cylinder head bolts during scheduled maintenance or after performing repairs.







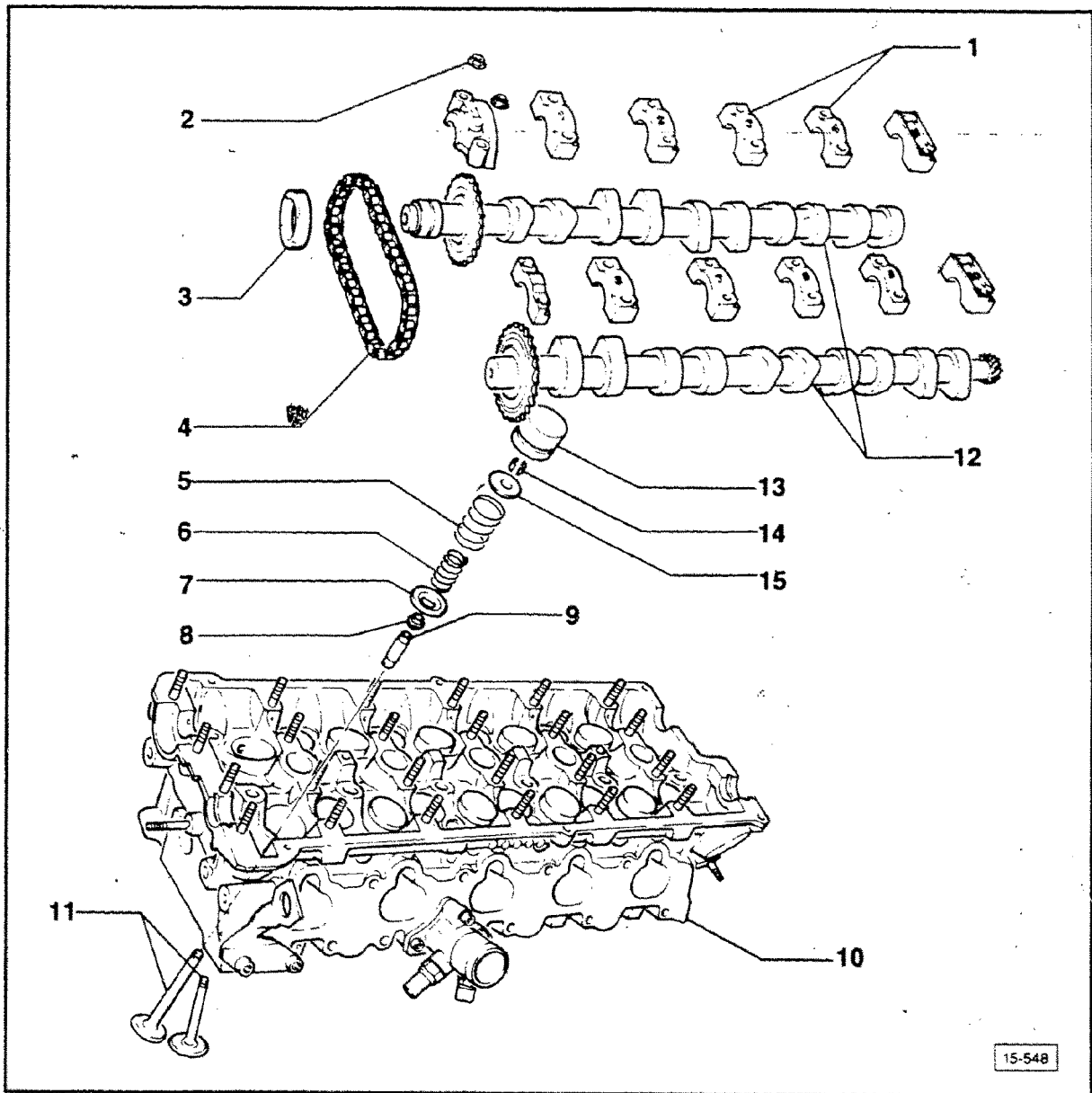
## Cylinder compression, testing

### Requirements

- engine oil temperature 30°C (86°F) minimum
  - throttle valve fully opened
  - disconnect power output stage of ignition coil
  - remove all spark plugs
  - remove fuse 13
- check compression pressure using **US 1120** recorder tester
  - operate starter until recorder shows **NO** further increase in pressure

Engine code letters	Compression values	
	New	Wear limit
7A	10 to 14 bar (145 to 203 psi)	8 bar (116 psi)

Maximum permissible difference between all cylinders: 3 bar (44 psi)



## Note

Heads with fine cracks between valve seats and spark plug threads can be installed again without reducing engine service life provided that the cracks are small and not more than 0.5 mm wide or when only the first of the spark plug threads is cracked.

- 1 — Bearing caps
- 2 — 15 Nm (11 ft lb)
- 3 — Oil seal  
replacing, see page 15.38
- 4 — Drive chain

- 5 — Valve spring, outer  
removing/installing: use tool 2037 and/or mounting tool 2036 along with VW 541/1 and thrust piece VW 541/5
- 6 — Valve spring, inner  
removing/installing: use tool 2037 and/or mounting tool 2036 along with VW 541/1 and thrust piece VW 541/5
- 7 — Valve spring seat, lower  
remove and install using 3047 A
- 8 — Valve stem seal  
replacing, page 15.36

H-5

Coupe

Valve train, component layout

15.30

- 9 — **Valve guide**
  - checking, page 15.34
  - installing, page 15.35
- 10 — **Cylinder head**
  - refacing valve seats, page 15.32
  - checking for distortion, page 15.28
  - refacing, page 15.28
- 11 — **Intake and exhaust valves**
  - lap only, do **NOT** grind
- 12 — **Camshafts**
  - axial clearance, checking page 15.39
  - radial clearance, checking page 15.39
  - removing installing, page 15.39
- 13 — **Valve lifters**
  - checking, page 15.37
- 14 — **Valve keepers**
- 15 — **Valve spring retainer, upper**

**CAUTION**

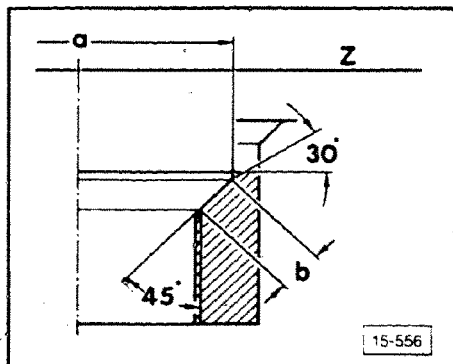
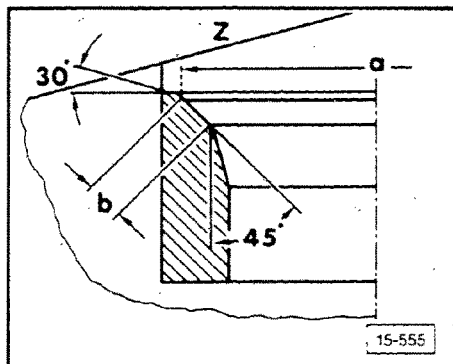
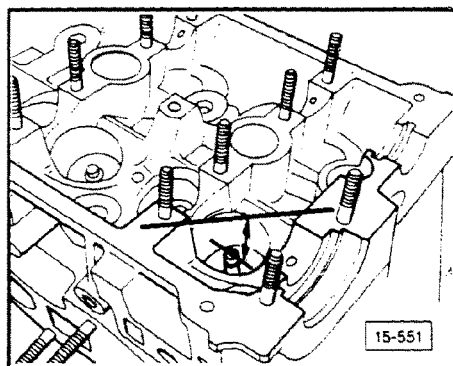
Exhaust valve is sodium filled, see page 15.33 for disposal procedures.

## Valve seats, refacing

### CAUTION

Only rework the valve faces enough to achieve a suitable contact. Calculate the maximum permissible refacing dimension prior to refacing.

If the refacing dimension is exceeded, proper function of the hydraulic lifter will not be assured and the cylinder head will have to be replaced.



### Calculating the maximum permissible refacing dimension

- insert valve into seat and push valve firmly against seat
- measure distance between center of valve stem end and upper edge of cylinder head

The measured distance minus the minimum dimension results in the maximum permissible refacing dimension.

Minimum dimensions:

Intake valve = 36.0 mm

Exhaust valve = 36.3 mm

### Intake valve seat, refacing

- a = 31.2 mm
- b = 1.5 to 1.8 mm (if necessary, rework valve seat with a 75° correcting cutter)
- z = cylinder head lower edge
- 30° = upper correcting angle
- 45° = valve seat angle \*

### Exhaust valve seat, refacing

- a = 27.6 mm
- b = approximately 1.8 mm
- z = cylinder head lower edge
- 30° = upper correcting angle
- 45° = valve seat angle \*

\*Pay attention to permissible refacing dimension

## Intake and exhaust valves, refacing

### CAUTION

Do **NOT** reface valves. Only lapping is permitted.

## Exhaust valve, discarding

Before discarding exhaust valves read this warning:

### WARNING

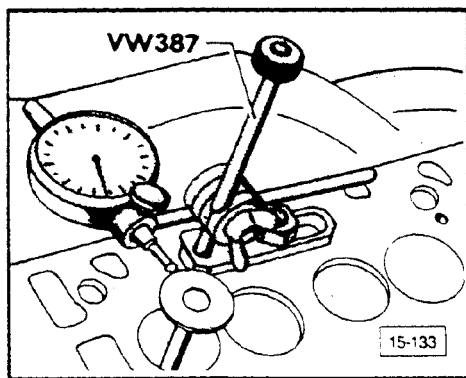
Exhaust valves are sodium filled. Before discarding these valves neutralize the sodium to avoid possible injury to people in the recycling chain.

Before discarding observe the following:

- always wear protective goggles or glasses
- note that sodium reacts violently with water
- when cutting valves, valves must not come into contact with water
- use grinding equipment which does not use water or other liquids for lubrication and/or cooling
- to neutralize sodium, drop cut-off valve stems into a bucket of water and move quickly away from water bucket
- do not drop more than 10 valve stems at a time into water bucket

### Discarding procedure

- use grinding stone or grinding disc to cut valve stem off near head of valve
- drop cut-off valve stems into bucket of water (sodium will now react with water!)
- once reaction has stopped (water stops bubbling) scrap valve stems
- water is bio-degradeable and may be discarded accordingly



## Valve guide wear, checking

### Note

When repairing engines with leaking valves, it is insufficient to merely replace the valves and machine the seats. The valve guides must also be checked for wear, a condition which increases with higher mileage.

- insert **NEW** valve into cylinder head/guide to depth where stem end is flush with guide

### CAUTION

There are differences in intake and exhaust valve stem diameters. Be sure to insert intake valves **ONLY** into intake guides and exhaust valves **ONLY** into exhaust guides.

- install tool **VW 387** onto cylinder head, adjacent to guide being checked
- rock valve back and forth (**arrow**) against dial indicator and note total travel

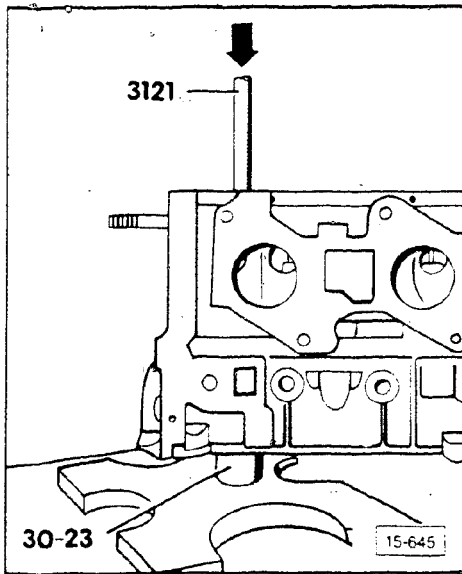
### Wear limits

Dial indicator reading (max.)	Intake valve	Exhaust valve
	1.0 mm (0.039 in.)	1.3 mm (0.051 in.)

## Valve guides, removing/installing

### Removing

- insert tool **3121** into valve guide from combustion chamber side
- push out worn valve guide from combustion chamber side using sleeve **30-23** as support



### Installing

- coat new guide with oil and using tool **3121** press guide into (cold) cylinder head (from camshaft side) up to shoulder of guide

#### CAUTION

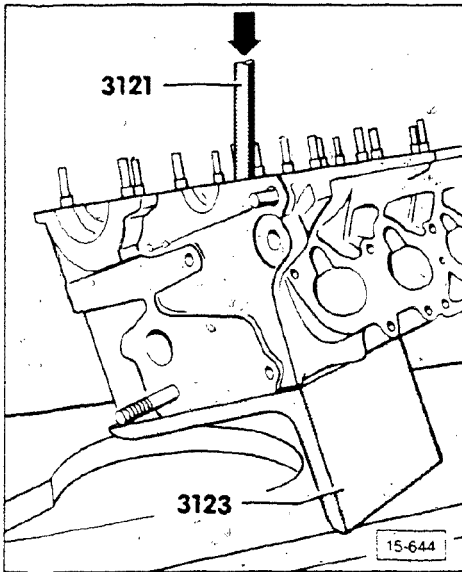
Once guide shoulder is seated do **NOT** apply more than 1 ton of pressure or shoulder of guide may break.

- ream valve guides to size using tool **3120** and proper cutting lubricant
- machine valve seats

#### CAUTION

Only rework the valve seats enough to achieve a suitable contact. Calculate the maximum permissible refacing dimension **PRIOR** to refacing. (Procedure, page 15.32.)

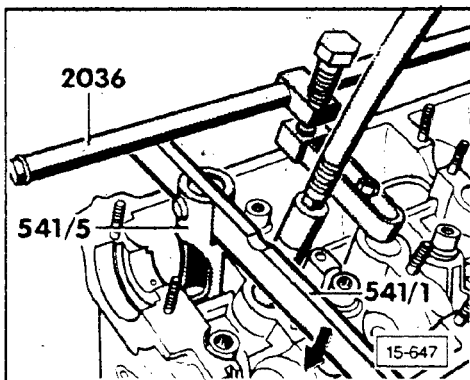
If the refacing dimension is exceeded, proper function of the hydraulic lifter will not be assured and the cylinder head will have to be replaced.



## Valve stem seals, installing

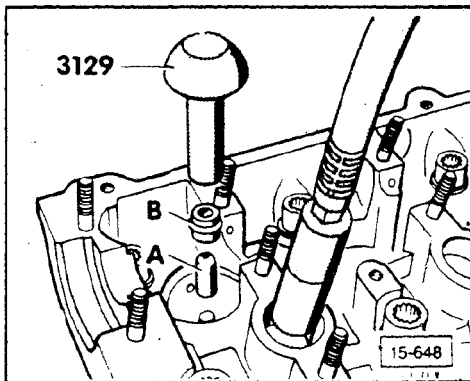
(with cylinder head installed)

- remove camshaft and valve lifters
- remove spark plugs
- rotate crankshaft until piston of cylinder to be repaired is at Bottom Dead Center position
- install pressure hose **VW 653/3** (or equivalent) into spark plug hole and apply continual pressure of at least 6 bar (87 psi)
- install tool **2036** and adjust bearing to height of stud
- remove valve springs using tool **541/1** in combination with spacer **541/5**



### Note

Tight valve keepers can be loosened by tapping lightly on tool lever.



- remove valve stem seals using tool **3047 A**
- slide plastic seal protector **A** onto valve stem
- lubricate valve stem seal **B**
- carefully push seal onto valve guide using tool **3129**

### CAUTION

Do **NOT** install seal without using plastic seal protector, otherwise seal will be damaged.



## Hydraulic valve lifters, checking

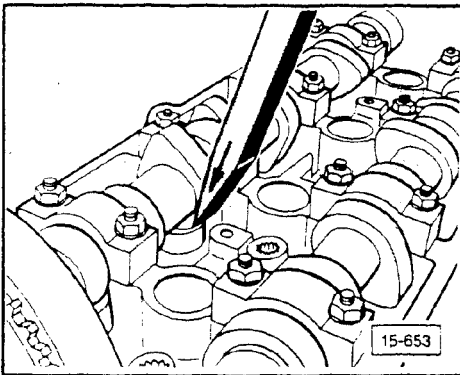
- store hydraulic valve lifters upside down
- always mark before removing to ensure re-installation in original location
- prior to installing, check axial clearance
- prior to installing, lubricate cam/lifter contact surfaces

### CAUTION

Hydraulic valve lifters are **NOT** adjustable.

Noisy lifters may be replaced after the following checks:

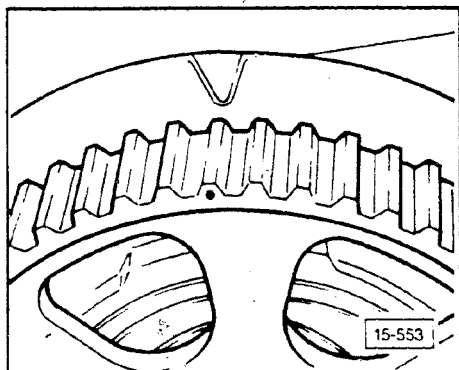
- run engine until radiator fan comes on at least once
- bring engine speed to approximately 2500 RPM for 2 minutes
  - if valve lifter is still noisy; replace
- remove intake manifold
- remove valve cover
- turn crankshaft pulley bolt clockwise until cam lobes of cylinder to be checked are pointing up
- push down with suitable wood stick against valve lifter as shown
  - if valve lifter can be pushed down, lifter must be replaced



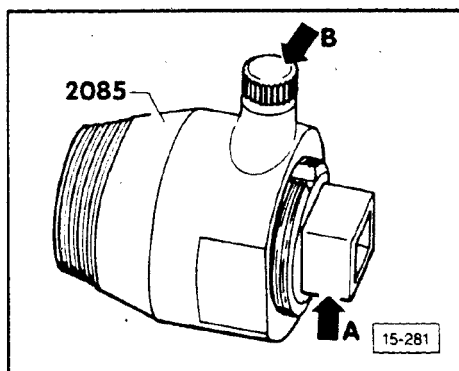
### CAUTION

After replacing lifters **DO NOT** start engine for approximately 30 minutes to allow the lifters to bleed down.

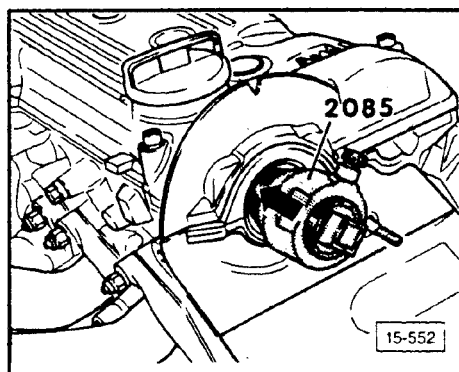
## Camshaft oil seal, removing



- remove upper drive belt cover
- set crankshaft to **TDC** for cylinder 1
- slacken drive belt on water pump and remove
- remove camshaft drive sprocket
- screw mounting bolt for camshaft sprocket (including washer) onto camshaft up to stop



- unscrew inner part (**arrow A**) 3 to 4 turns
- lock in position with setscrew (**arrow B**)



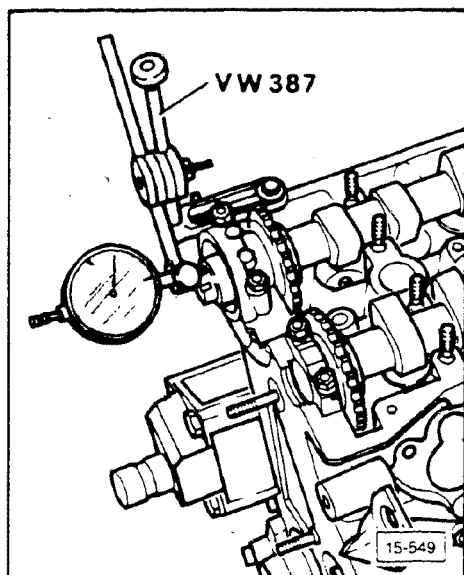
- coat threaded end of puller with oil
- set puller into oil seal and turn clockwise while pushing toward cylinder head as far as it will go (**arrow**)
- loosen knurled screw on tool and turn inner part of puller against camshaft until oil seal is pulled out
- clamp oil seal puller in vise and remove seal with pliers

## Camshaft oil seal, installing

- lightly coat oil seal lip and oil seal seat with oil
- push seal over sleeve of tool **10-203**
- press oil seal into cylinder head until flush with chamfered edge

### Note

Do **NOT** press in oil seal any farther than flush, otherwise oil hole will be blocked.



## Camshaft axial clearance, checking

- measure with valve lifters and drive chain removed, first and last bearing caps installed
  - wear limit 0.2 mm (0.008 in.)

## Camshaft radial clearance, checking

### Requirement

- valve lifters removed
- carefully clean camshaft bearing caps, seats and journals
- install camshaft on cylinder head so cam lobes do not touch valve spring retainers or valves
- lay "Plastigage"® across journal
- install bearing caps in correct position and tighten to 20 Nm (15 ft lb)

### CAUTION

Do **NOT** rotate camshaft.

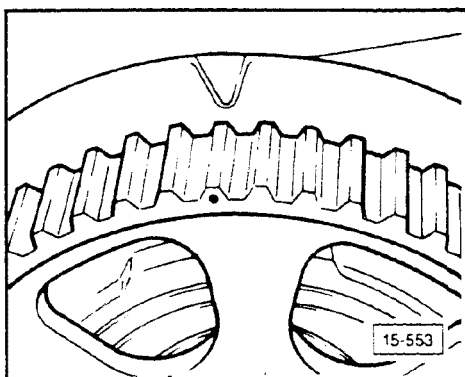
- remove bearing caps
- compare width of flattened "Plastigage"® with scale
  - wear limit 0.2 mm (0.008 in.)

### If limit exceeded

- install new camshaft for trial measurement and measure again

### If clearance still exceeds limit

- replace cylinder head



## Camshafts, removing

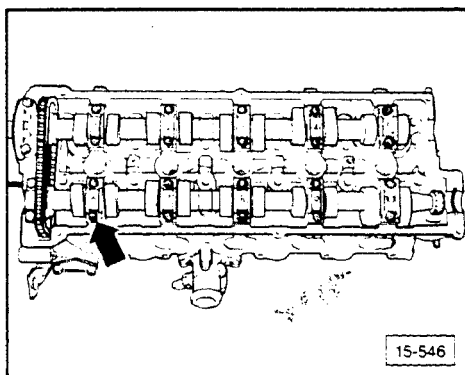
- remove upper drive belt cover
- remove intake manifold
- remove valve cover
- set camshaft to **TDC** for cylinder 1
- slacken drive belt on water pump and remove
- remove camshaft drive sprocket

## Exhaust camshaft

- remove bearing cap in front of chain as well as bearing caps 2 and 4
- loosen bearing caps 1, 3 and 5 alternately and diagonally

## Intake camshaft

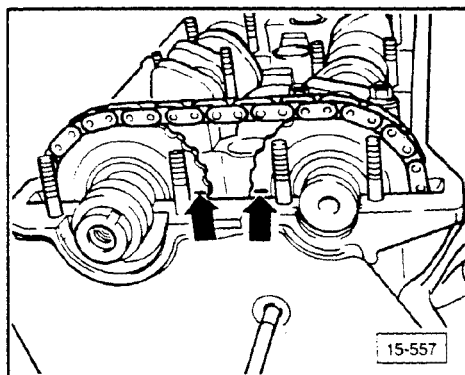
- remove bearing cap in front of chain as well as bearing caps 7 and 9
- loosen bearing caps 6, 8 and 10 alternately and diagonally



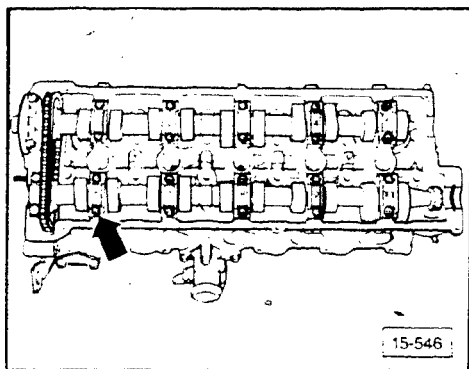
## Camshafts, installing

### Intake camshaft

- install camshaft with chain so that marking on cam sprockets (**arrows**) line up



# Engine – Cylinder Head, Valve Drive



- install bearing caps with recessed corners pointing toward intake side of cylinder head (arrow)

## Note

The ignition distributor must be removed when installing the camshaft.

- tighten bearing caps 6, 8 and 10 alternately and diagonally
  - torque to 15 Nm (11 ft lb)
- install remaining bearing caps
  - torque to 15 Nm (11 ft lb)

## Exhaust camshaft

- tighten bearing caps 1, 3 and 5 alternately and diagonally
  - torque to 15 Nm (11 ft lb)
- install remaining bearing caps
  - torque to 15 Nm (11 ft lb)
- install camshaft drive sprocket
  - torque to 65 Nm (48 ft lb)
- install drive (timing) belt, see Group 13 for timing procedures

## CAUTION

After replacing lifters do **NOT** start engine for approximately 30 minutes to allow the lifters to bleed down.

After working on the valve train, turn the engine over slowly and carefully by hand several times to be sure that the valves do **NOT** contact the pistons for any reason.