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Tappet housing diameter (a -Fig.1)	33.015 \div 33.030
Intake valve seat housing diameter (b -Fig.1)	36.350 \div 36.370
Exhaust valve seat housing diameter (c -Fig.1)	32.550 \div 32.570
Intake and exhaust valve guide housing diameter (d -Fig.1)	12.00 \div 12.018

Intake valve seats

Rated inner diameter	32.500 \div 32.530
Rated outer diameter	36.490 \div 36.510
Contact band angle	45°

Exhaust valve seats

Rated inner diameter	27.470 \div 27.530
Rated outer diameter	32.690 \div 32.710
Contact band angle	45°

Intake and exhaust valve guide

Rated outer diameter	12.040 \pm 12.050
Inner diameter with pressed and bored guide	6.015

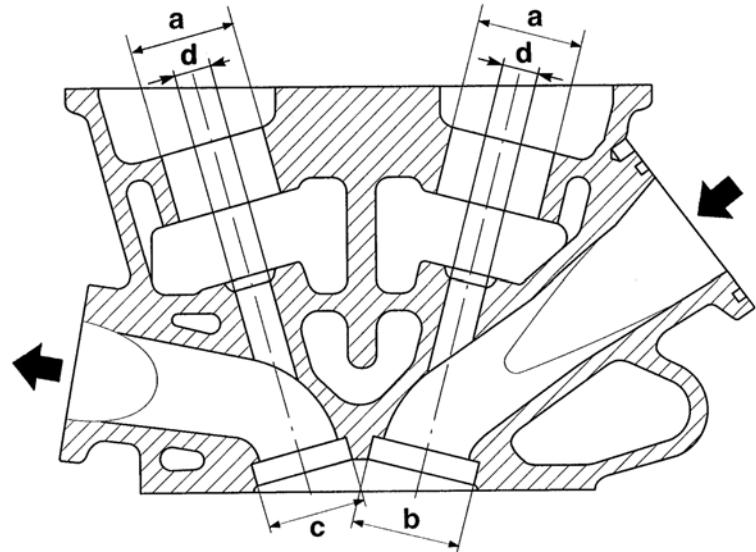


Fig.1

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Intake valves

Stem diameter (d-Fig.2)	5.95 ± 0.02
Reduced stem diameter (d1-Fig.2)	4.59 ± 0.05
Valve head diameter (D-Fig.2)	35.40 ± 0.1
Valve seat angle	$44^{\circ}50' \pm 10'$
Height (h-Fig.2)	104.90 ± 0.15
Tappets support thickness (s-Fig.2)	4.70

Exhaust valves

Stem diameter (d-Fig.2)	5.92 ± 0.02
Valve head diameter (D-Fig.2)	30.20 ± 0.1
Valve seat angle	$44^{\circ}50' \pm 10'$
Height (h-Fig.2)	104.01 ± 0.15
Tappets support thickness (s-Fig.2)	4.70

Tappets

Diameter	$32.974 \div 32.990$
Washer thickness range	$3.25 \div 0.70$
with intervals of	0.05

Valve stem-guide fitting

Intake system assembly clearance	$0.025 \div 0.055$
Exhaust system assembly clearance	$0.035 \div 0.065$

**Maximum shift between valve stem and head
(head-stem concentricity)**

Intake	0.03
Exhaust	0.03

Assembly clearance between tappet and its seat (intake-exhaust)	$0.025 \div 0.071$
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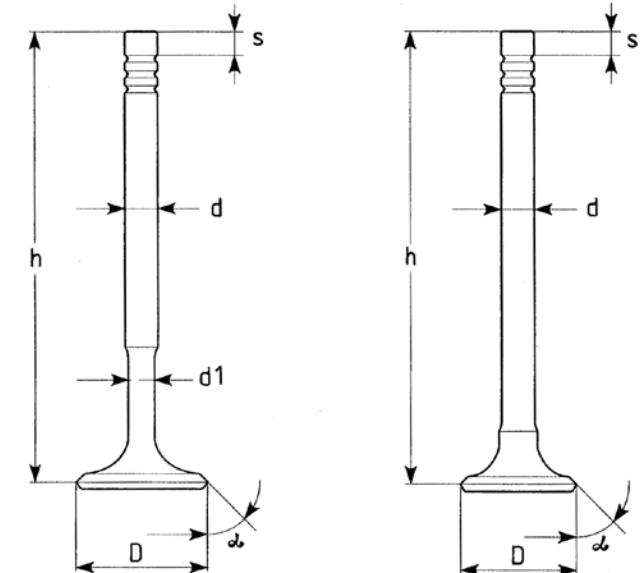


Fig.2

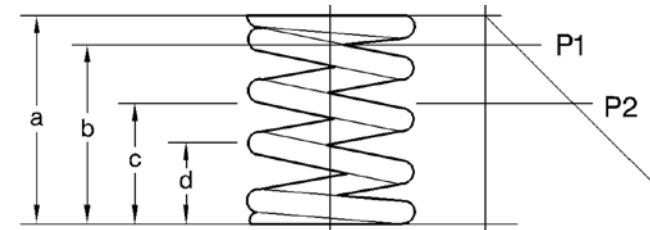
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Inner spring

Free length (a-Fig.3)	44
With closed valve (b-Fig.3)	31
With open valve (c-Fig.3)	19
Compressed (d-Fig.3)	16.25
Load (with closed valve) (P1-Fig.3)	13 ± 0.5 Kg
Load (with open valve) (P2-Fig.3)	25.5 ± 1.2 Kg
Number of active coils	5


Outer spring

Free length (a-Fig.3)	41
With closed valve (b-Fig.3)	33
With open valve (c-Fig.3)	21
Compressed (d-Fig.3)	16.5
Load (with closed valve) (P1-Fig.3)	16 ± 0.5 Kg
Load (with open valve) (P2-Fig.3)	41.2 ± 1.2 Kg
Number of active coils	3.5

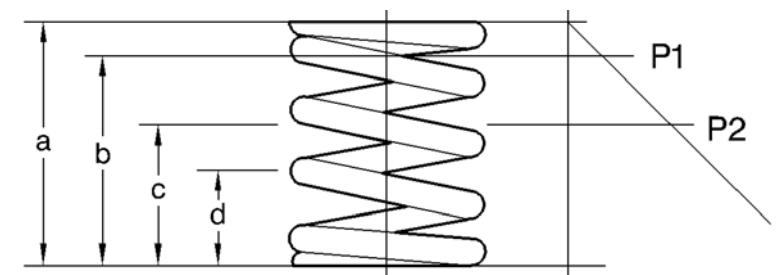


Fig.3

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The present section contains the following adjustment sequences:

- A) MECHANICAL TIMING OF HEAD
- B) VALVE CLEARANCE



A) MECHANICAL TIMING OF HEAD



Mechanical head timing can be carried out two ways:

- using a dial gauge
- using special tools

A1) Mechanical head timing with a dial gauge

Prerequisites

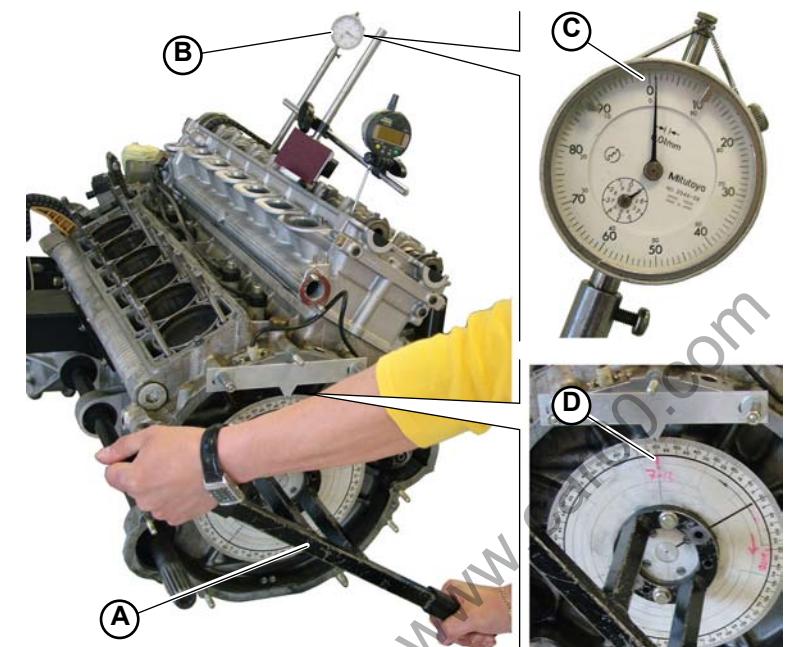
- Engine on a workbench.
- The bolts that secure the variable valve timing mechanism must be loosened so that the chain turns freely, without being integral with the camshaft seat.

Head timing

Intake

(The instructions within brackets refer to the right cylinder bank.)

1. Assemble the crank mechanism on the crankshaft (A-Fig.1).
2. Assemble the dial gauge (B-Fig.1) on cylinder no.1 (no.7).
3. Turn the crankshaft, placing cylinder no.1 (no.7) at the TDC (top dead center); this is verified when the dial gauge's pointer indicates 0 (zero) (C-Fig.1).
4. Reset the goniometer according to the reference mark (D-Fig.1).



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5. Install the digital dial gauge (E-Fig.2) with the support on the spacer ring of the intake valve of cylinder no. 6 (no. 12).



Fig.2

6. Turn the camshaft seat using a 26 mm wrench (F-Fig.3) until the digital dial gauge indicates 1 mm.
7. Tighten the bolts of the variable valve timing mechanism, making it integral with the camshaft seat.
8. Recover the timing chain clearance by turning the crankshaft approximately 60° counter-clockwise.
9. Reset the digital dial gauge (yellow button) and turn the crankshaft clockwise, 12° past the reference mark. The value indicated on the dial gauge must be $1 \text{ mm} \pm 0.05$.



Fig.3

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Exhaust

10. Turn the crankshaft so that it is repositioned with the TDC (top dead center); check that the dial gauge's pointer continues to indicate 0 (zero).
11. Move the digital dial gauge (**E-Fig.4**) onto the exhaust side with the support on the spacer ring of the exhaust valve of cylinder no.6 (no.12).



Fig.4

12. Loosen the bolts of the variable valve timing mechanism.
13. Turn the camshaft seat using a 26 mm wrench until the digital dial gauge indicates 1 mm.
14. Tighten the bolts of the variable valve timing mechanism, making it integral with the camshaft seat.
15. Recover the timing chain clearance by turning the crankshaft approximately 60° counter-clockwise.
16. Reset the digital dial gauge (yellow button) and turn the crankshaft clockwise, 12° before top dead center. The value indicated on the dial gauge must be 1 mm \pm 0.05.
17. Tighten the bolts of the variable valve timing mechanism (**000800-30d**) to the prescribed torque with molicote.

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A2) Mechanical head timing with special tools

Prerequisites

- The bolts that secure the variable valve timing mechanism must be loosened so that the chain turns freely, without being integral with the camshaft.

Head timing

1. If the engine is on a workbench, assemble the crank mechanism on the crankshaft; if the engine is on board, the rotation can be carried out directly from the pulley.
2. Assemble the dial gauge (A-Fig.5) on cylinder no. 1.
3. Turn the crankshaft, placing cylinder no.1 at TDC (top dead center); this is verified when the dial gauge's pointer indicates 0 (zero).
4. Assemble the timing tools on the heads (000200-12c), being careful to install the LH tool on the left head (B-Fig.5) and the RH tool on the right head (C-Fig.5).



The tools must be secured directly onto the camshafts of both heads so that the position of the camshafts is locked into place according to the timing (Fig.6); if the tool is not accurately assembled, turn the camshafts slightly using a 26 mm wrench to the correct position at which to secure the tool.

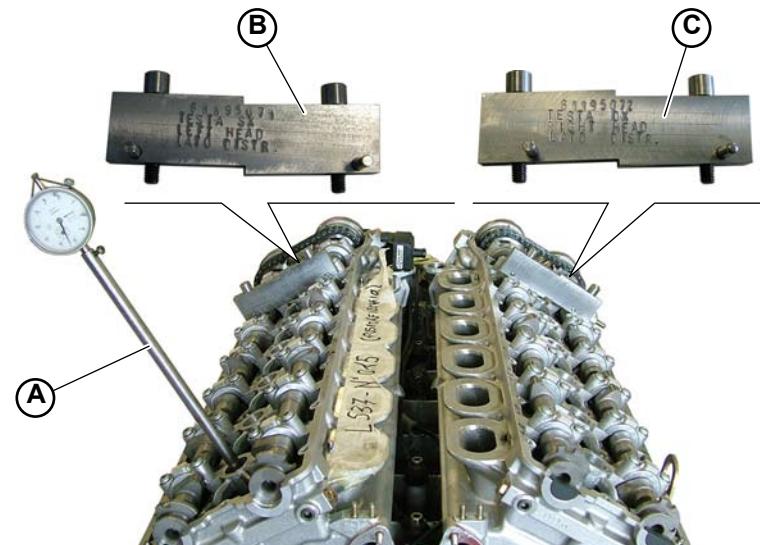


Fig.5

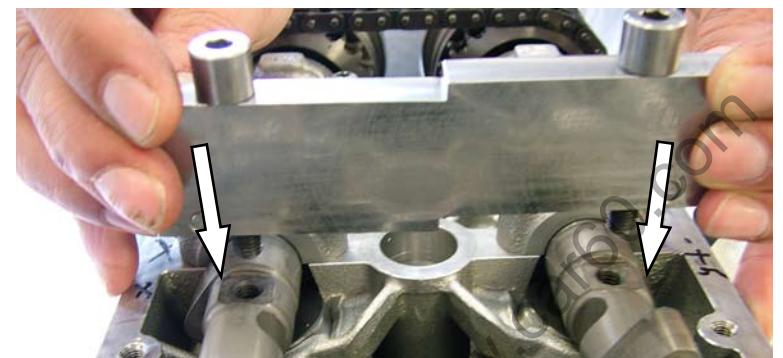


Fig.6

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5. Tighten the variable valve timing bolts (000800-30d) to the prescribed torque with Molicote.



Secure the 4 variable valve timing mechanisms onto the heads, following the ascending assembly order from 1 to 4 shown in Fig.7.

Verifying proper timing

- Remove the U-bolts above the camshafts.
- Rotate the crankshaft counter-clockwise twice using the crank mechanism and locate dead center.
- Verify the planarity between the U-bolts and the camshaft seat.

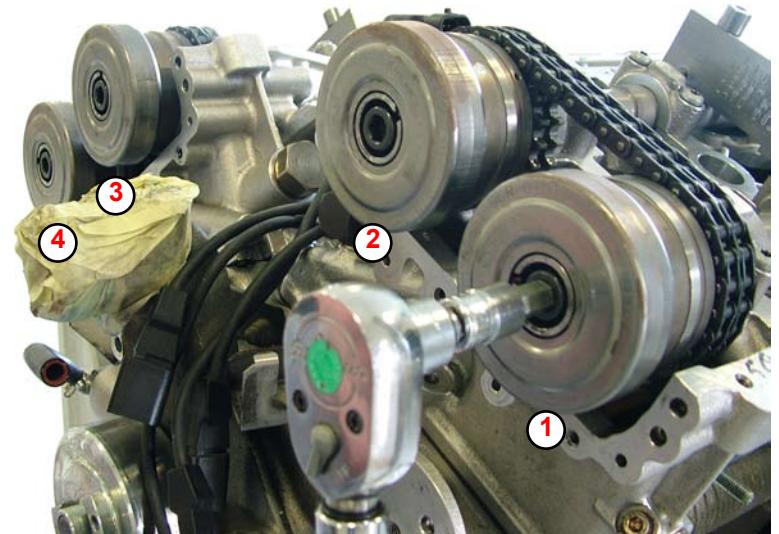


Fig.7

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B) VALVE CLEARANCE



Check the valve clearance when the engine is cold.

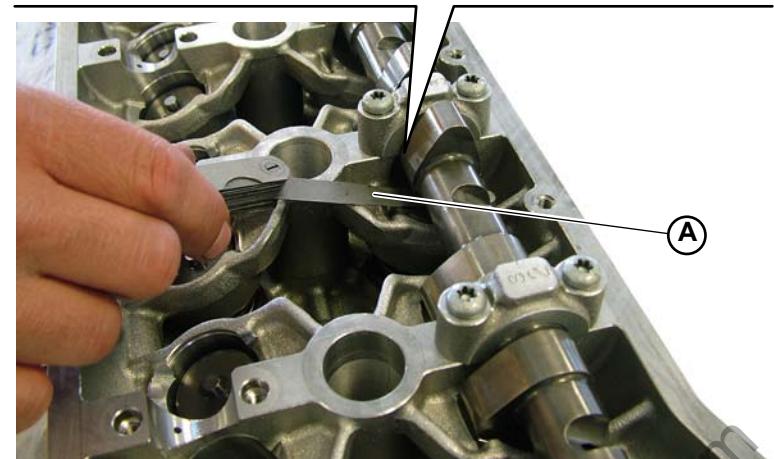
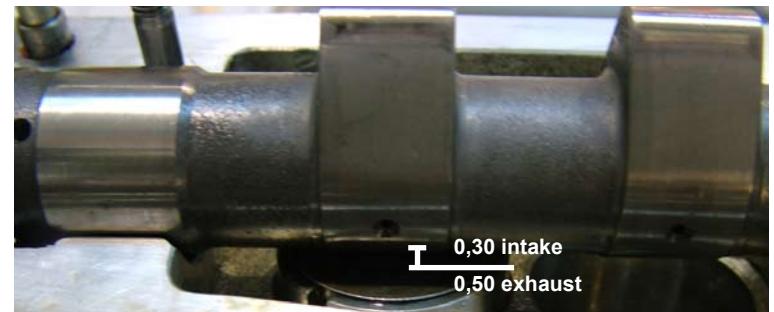
Intake	Exhaust
0.30 ± 0.05 mm	0.50 ± 0.05 mm

1. Check that the valve clearance corresponds to the values above, shown on each tappet: When the head is removed, use the tool (A-Fig.8).



Use the thickness gauge to measure the thickness between all the shims and the camshaft lobes. Make a note of any differences required to achieve the set value.

2. If the clearance differs from the established one, replace the spacer rings (B-Fig.9) under the tappets (B-Fig.9)(010909) until the optimum value is achieved.



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This section explains how to disassemble:

- A) Camshafts
- B) Valves



A) Disassembling the camshafts

STOP Before carrying out this procedure, disassemble the engine head and then continue on a workbench.

Preliminary operations

- Disassemble the intake manifold (012903).
- Disassemble the head covers (010303).
- Disassemble the variable valve timing mechanism (011603).

Disassembling the shafts

1. Remove the supports of the camshafts (A-Fig.1), unscrewing the relative pairs of screws (B-Fig.1).

STOP To remove the camshaft, loosen the screws of the supports and turn the shaft slightly (using a 26 mm wrench), discharging the valves still under pressure; immediate removal of the shaft can be dangerous: the shaft could be launched off of its seat because the valves are still under pressure!

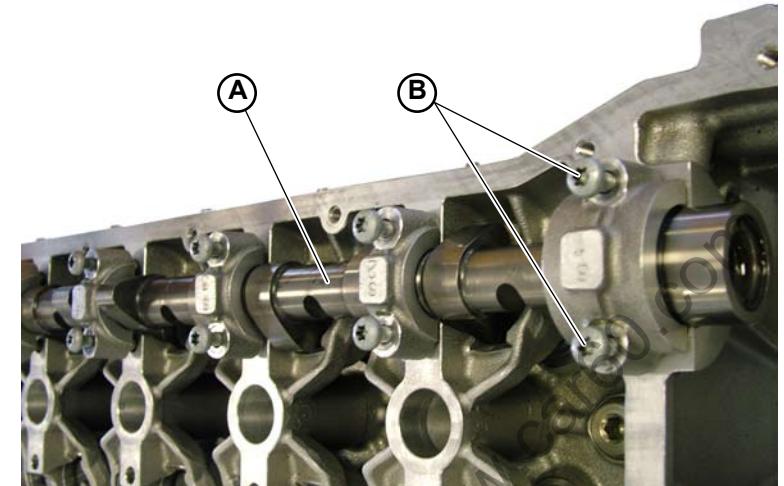


Fig.1

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B) Disassembling the valves

Preliminary operations

- With the engine on a workbench, disassemble the camshafts (Point A).

Disassembling the valves

- Remove the tappets (A-Fig.2) from their housings.

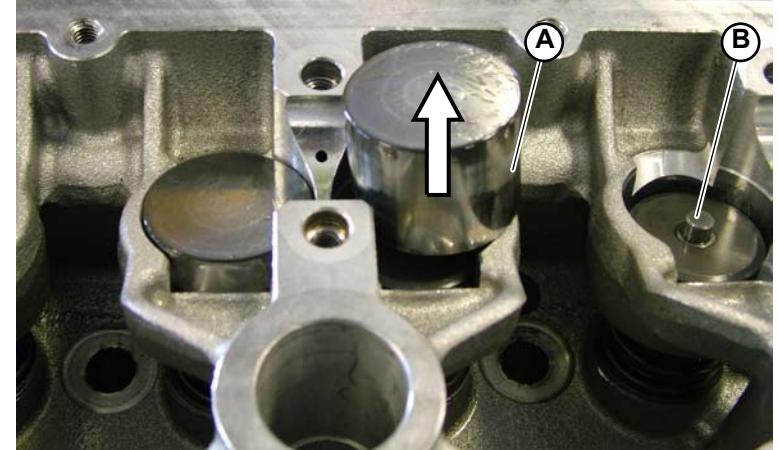


Fig.2

- Remove the spacers (B-Fig.2) positioned underneath the tappets.
- Using the special tool (C-Fig.3), press the spacer ring to extract the 2 cotters (D-Fig.3).

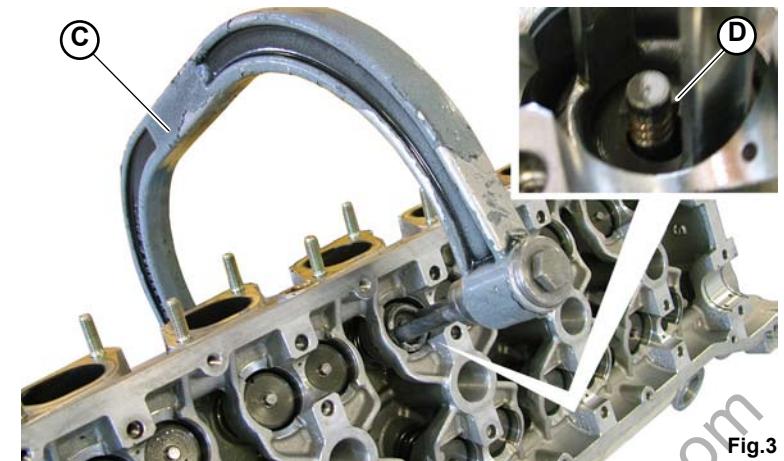


Fig.3

- Remove the cotters (D-Fig.3), then the tool, followed by the entire valve unit (Fig.4):

- valve
- seat
- valve guide
- oil seal
- lower spacer ring
- spring
- spring
- upper spacer ring
- 2 cotters (already removed)
- spacer (already removed)

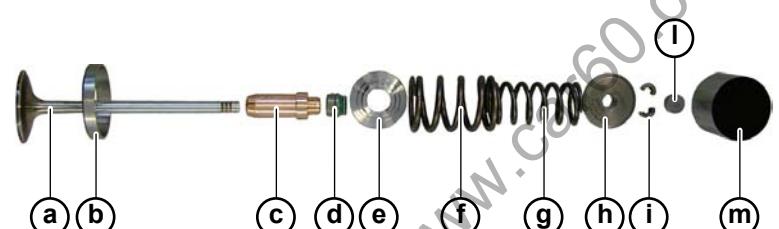


Fig.4

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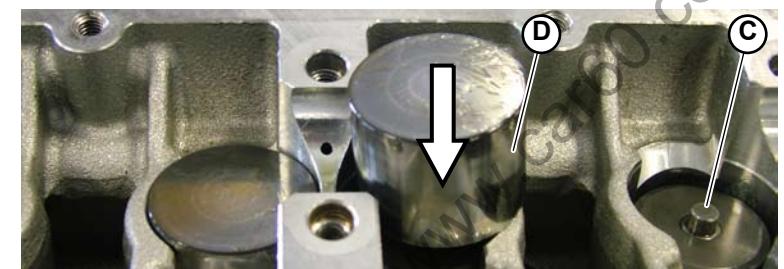
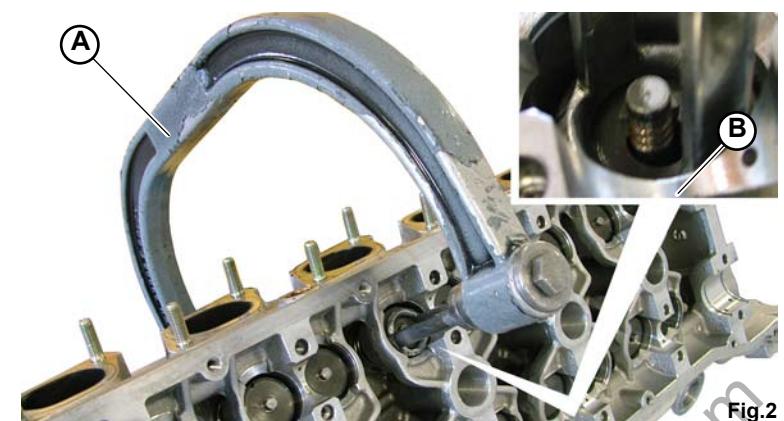
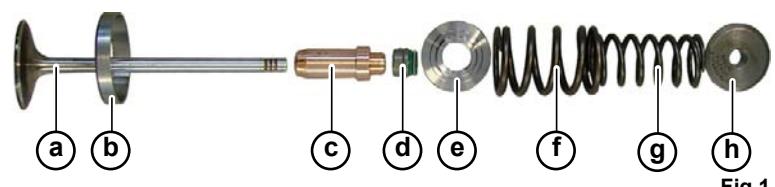
This section explains how to assemble:

- A) Valves
B) Camshafts



A) Assembling the valves

1. Lubricate valve stem (a-Fig.1) and valve guide (b-Fig.1) with engine oil.
2. Insert the valve into the guide (c-Fig.1) and the oil seal (d-Fig.1).
3. Install the lower spacer ring (e-Fig.1), the springs (f/g-Fig.1) and the upper spacer ring (h-Fig.1).
4. Using the special tool (A-Fig.2), press the spacer ring to insert the 2 cotters (B-Fig.2).
5. Position the spacers (C-Fig.3) above the upper spacer rings.
6. Remove the tappets (D-Fig.3) from their housings.



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B) Assembling the camshafts

1. Clean all the camshaft (**A-Fig.4**) and head (**B-Fig.4**) lubrication holes thoroughly; apply only engine oil.
2. Position the camshafts on the supports, following the instructions printed on the head.
3. Position the supports following the numbers printed on the caps and on the head.

- STOP**
- Check that the intake and exhaust components have been positioned properly.
 - Position the supports in the correct order from no. 1 to no. 14; when assembling the first support, make sure that the oil seals (**D-Fig.5**) have been positioned in their respective housings (**E-Fig.5**).

4. Tighten the screws (**C-Fig.4**) of the supports.
Screw attachment; **tightening torque (000800-1b)**.

STOP When assembling the camshaft, as the supports are gradually secured, turn the shaft slightly (using a 26 mm wrench) adjusting its position on the valves, so that all of the screws can be attached.

- Assemble the variable valve timing mechanism (**011605**).
- Assemble the head covers Assemble the head covers (**010305**).
- Assemble the intake manifold (**012905**).
- Assemble the engine(**010005**).

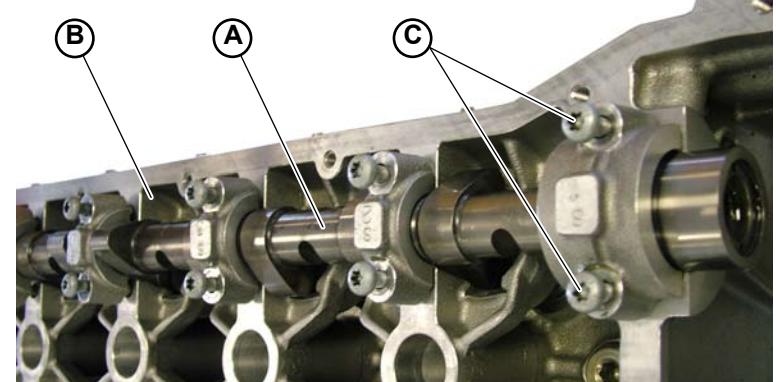


Fig.4

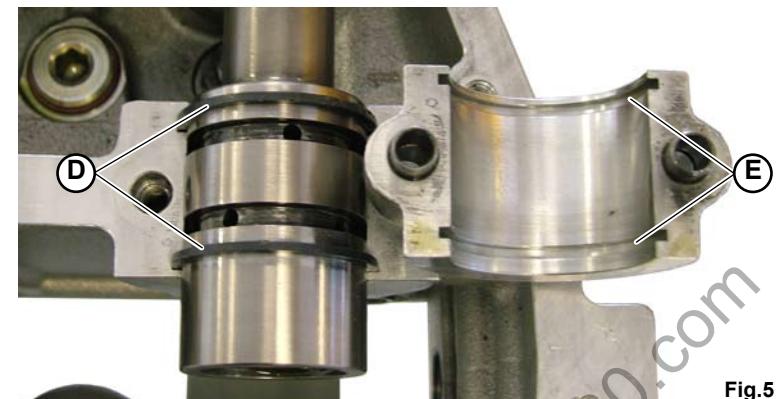


Fig.5

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Valves overhaul

Preliminary operations

- Extract the two camshafts (010903).
- Remove the tappets and the valve unit from their housings (010903) and place them in the correct order on the workbench so it is possible to re-establish their original positions when they are reassembled.

Overhaul

1. Check the head valve (A-Fig.1) and the seat (B-Fig.1) conditions; if necessary, replace the valve or remake the seat.



To clean the valves, proceed as follows:

- position the valve on a pillar drill. Before securing the valve to the drill, wrap tin foil around the drill-valve contact area on the valve.
- Start the pillar drill.
- While the valve is turning, clean with a scouring pad.
- Remove the valve from the drill and wash completely.

Take care not to spoil the valve stem.

2. Check the valve guides (C-Fig.1) and the oil seal (D-Fig.1) wear; if necessary, replace the valve guide following the technical specifications; always replace the seal.
 3. Clean the tappet, spring and shim pack (E-Fig.1) in the following order:
 - a. Wash.
 - b. Remove grease.
 - c. Blow.
- Reassemble the tappets and the valve unit in their housings (010905), placing them in the correct order.
 - Assemble the two camshafts (010905).



Lubricate with oil during the assembly procedure.

- Shim the valves (010902).

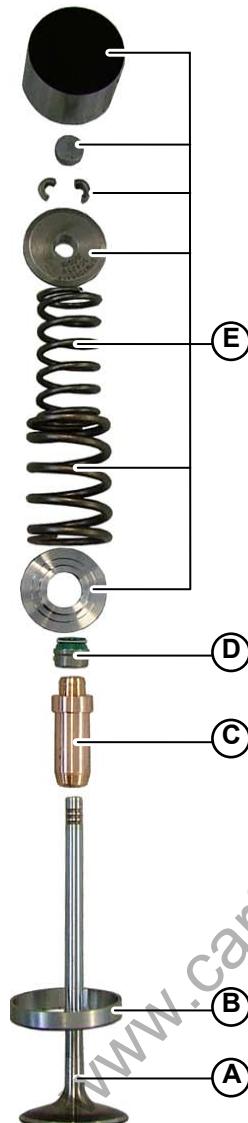


Fig.1