

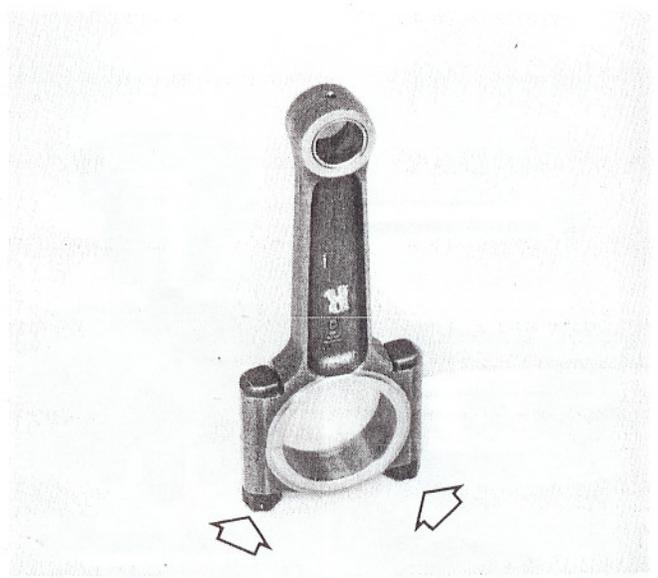


**Checking connecting rods**

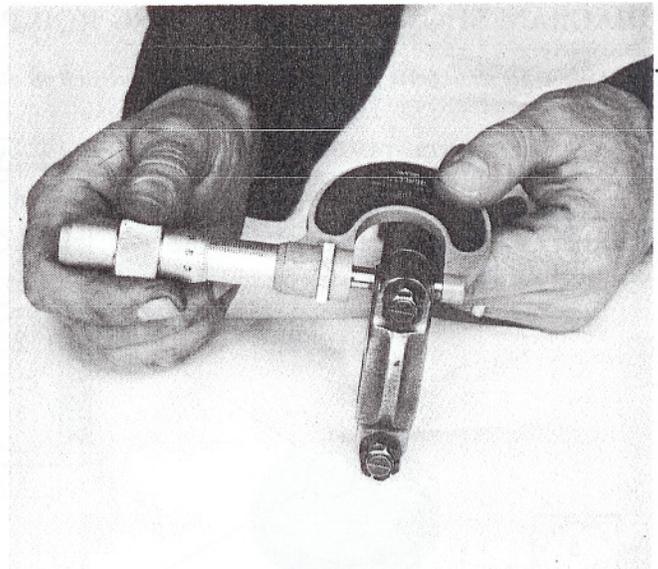


Each time the connecting rods are removed the nuts for the bolts fixing the con rod caps (shown in the diagram at the side) must always be replaced.

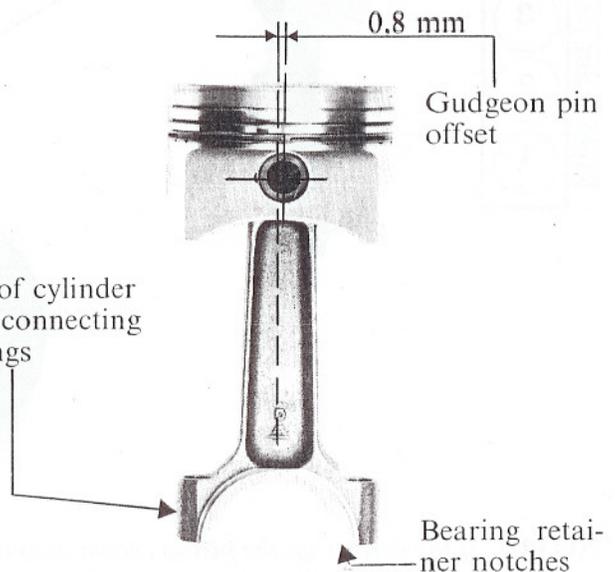
When the connecting rods are replaced make sure that the new ones have the same lettering, in other words that they are the same weight (in the diagram at the side the letter R coincides with a weight of 580 - 584 g.)



20,850 ÷ 20,900



**Measuring thickness of con rod caps**

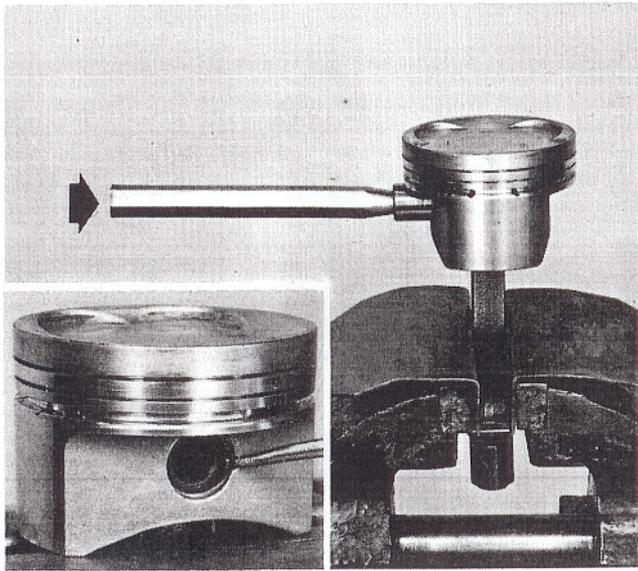


**Diagram showing connecting rod-piston assembly**



If the connecting rod has to be replaced, the number of the cylinder to which it belongs is stamped on the area opposite the half bearing retainer notches.

### 10.



**Fitting gudgeon pin circlips**

**Fitting gudgeon pin in connecting rod-piston assembly**

The gudgeon pin is fitted using an ordinary steel drift.

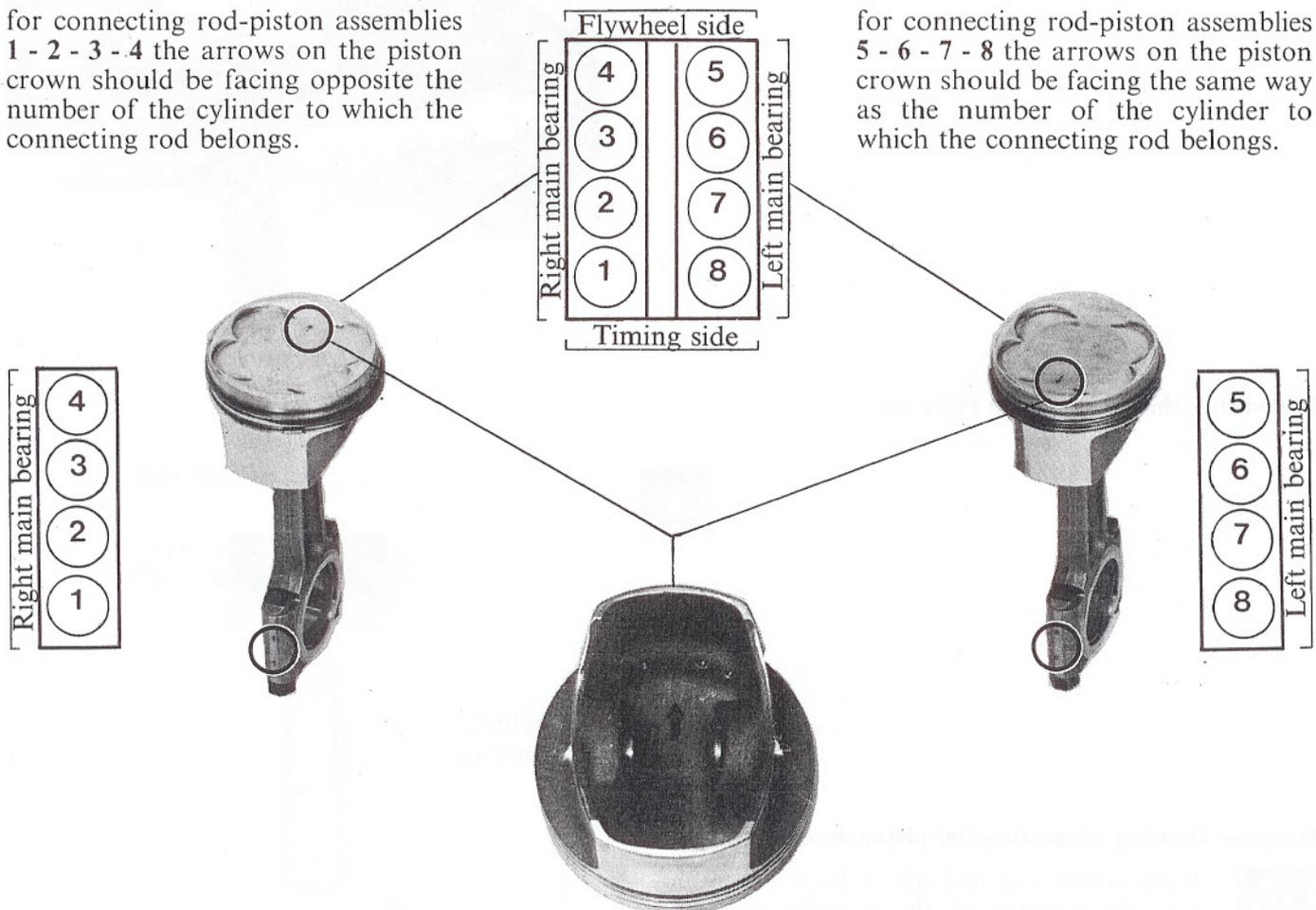
### DIAGRAM SHOWING CONNECTING ROD-PISTON ASSEMBLY



*In order to fit the connecting rod-piston assembly correctly, bear in mind the following rules:*

for connecting rod-piston assemblies 1 - 2 - 3 - 4 the arrows on the piston crown should be facing opposite the number of the cylinder to which the connecting rod belongs.

for connecting rod-piston assemblies 5 - 6 - 7 - 8 the arrows on the piston crown should be facing the same way as the number of the cylinder to which the connecting rod belongs.

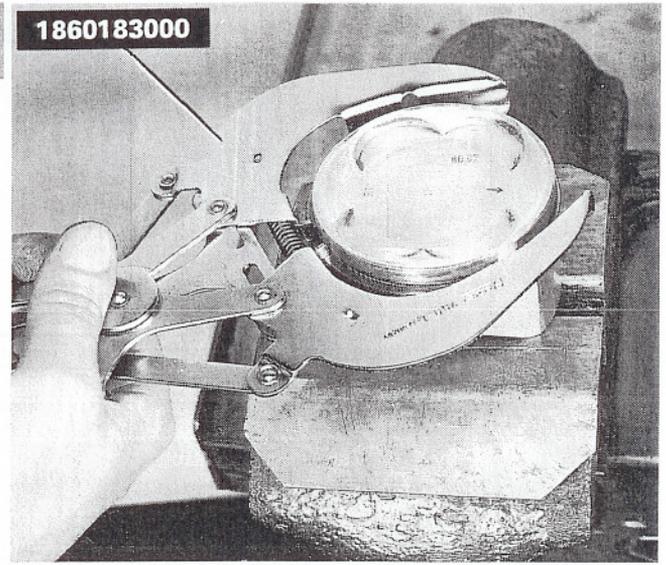


**NOTE** *If the arrows on the piston crown are no longer visible, it is advisable to renew this reference by looking under the gudgeon pin where there is a raised arrow.*

**Fitting and positioning piston rings on pistons**

The piston rings should be fitted with the word "TOP" upwards.

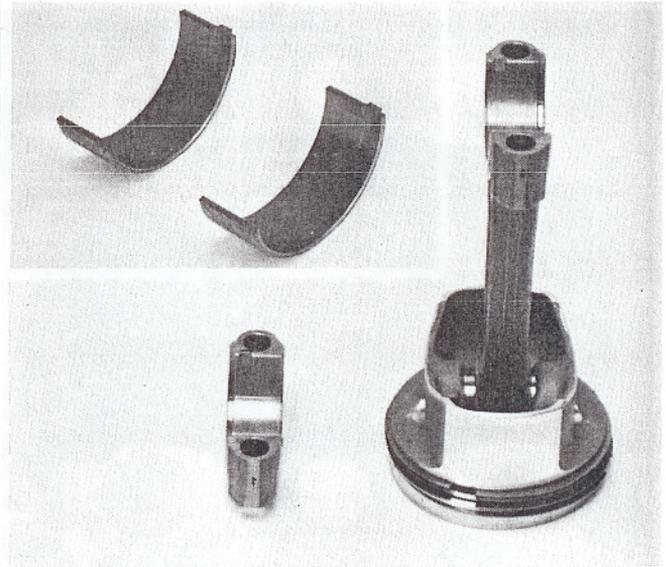
After fitting, turn the piston rings so that they are offset 180° from each other

**BIG END BEARINGS****Fitting**

**NOTE** Big end bearings are available as spares with undersize diameters of 0,254 – 0,508 mm.

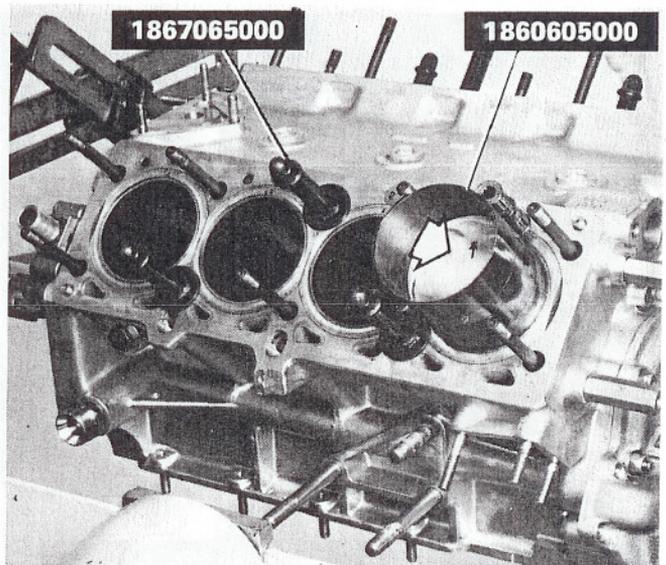


Do not carry out any adjustments to the bearings; therefore if any grooves or traces of seizing is noticed they must be replaced. Carefully clean the external surfaces of the bearings and the relevant housings when fitting.

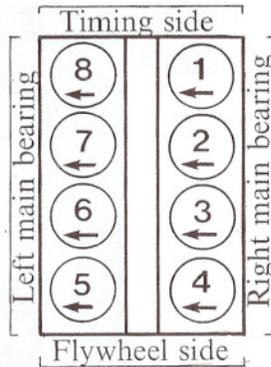
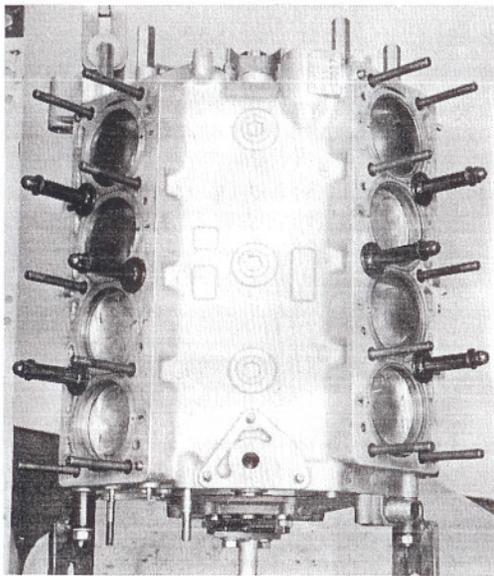
**Fitting connecting rod-gudgeon pin-piston assembly in cylinder bore**

The parts concerned with engine oil before fitting.

**NOTE** The arrows on the piston crown should be facing the same direction as the direction of rotation of the engine (seen from the timing side).

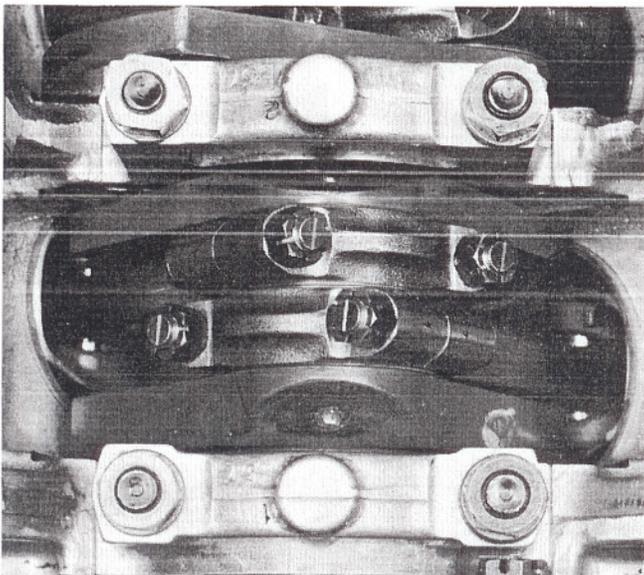


**10.**



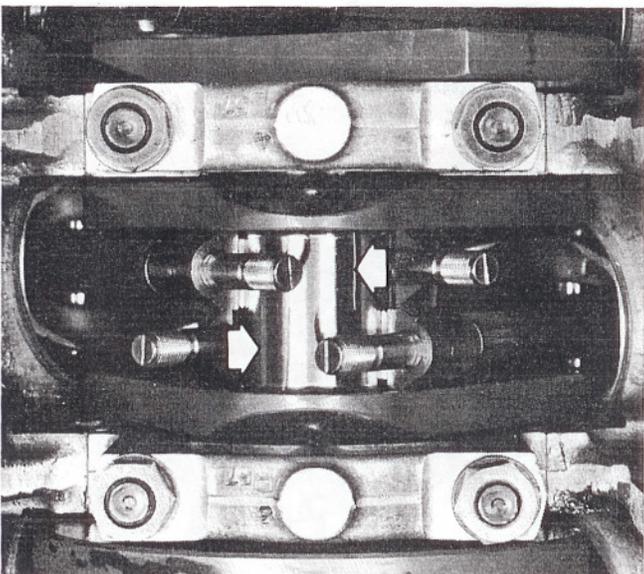
**Checking correct fitting of pistons in cylinder bores**

By looking at the cylinder block from above, check that the arrows for pistons 1 - 2 - 3 - 4 are facing the longitudinal axis of the engine (inlet side) and that the arrows for pistons 5 - 6 - 7 - 8 are facing the outside (exhaust side).



**Checking correct fitting of connecting rod**

By looking at the cylinder block from below, check that the identification numbers stamped on the connecting rods (corresponding to the cylinders to which they belong) are facing outwards and are legible (as shown in the diagram at the side).

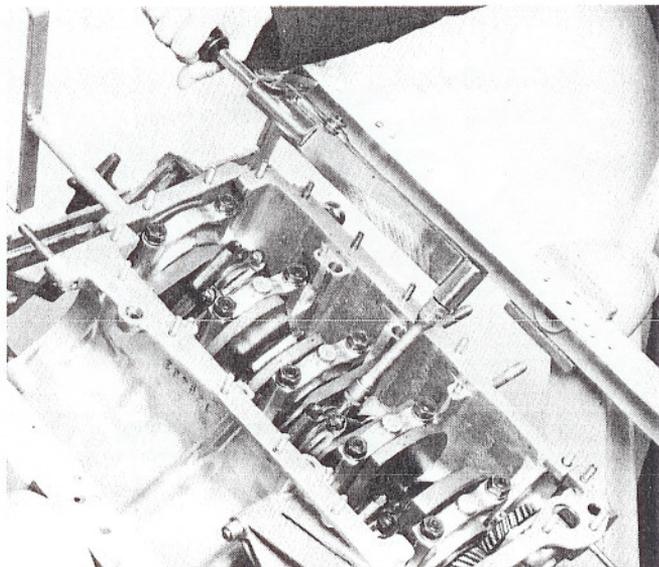


**MEASURING BEARING CLEARANCE**

**Measuring bearing clearance using plastigage (1st operation)**

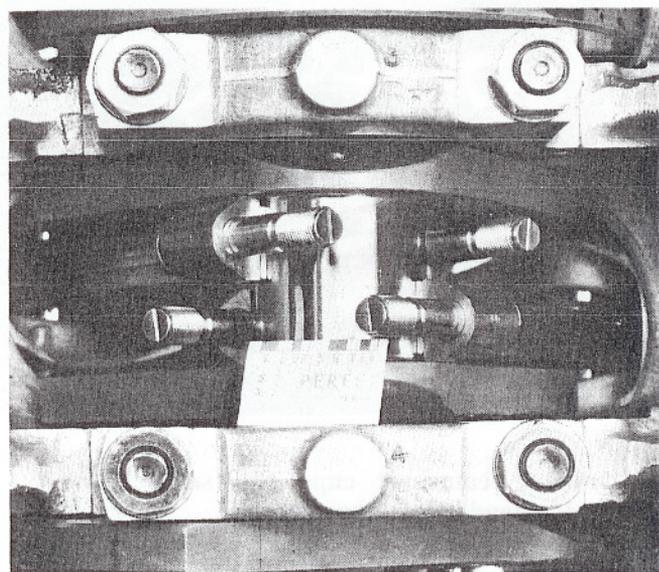
The arrows show the calibrated wires.

6,5 daNm



Tightening bolts securing con rod caps to torque  
(2nd operation)

0,046 ÷ 0,095



Measuring crank pin clearance using special  
gauge (3rd operation)

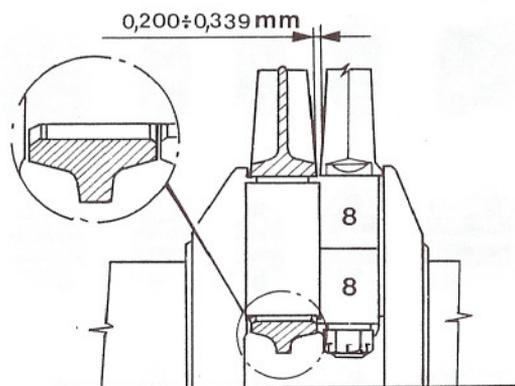
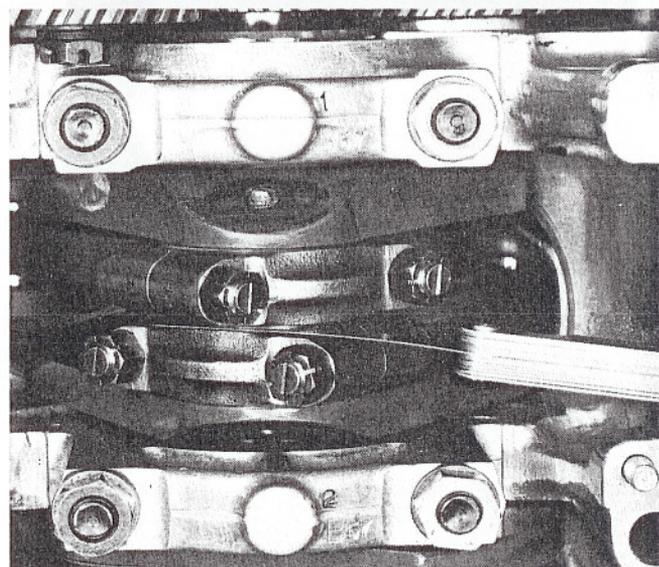


The parts concerned using engine oil  
before fitting.



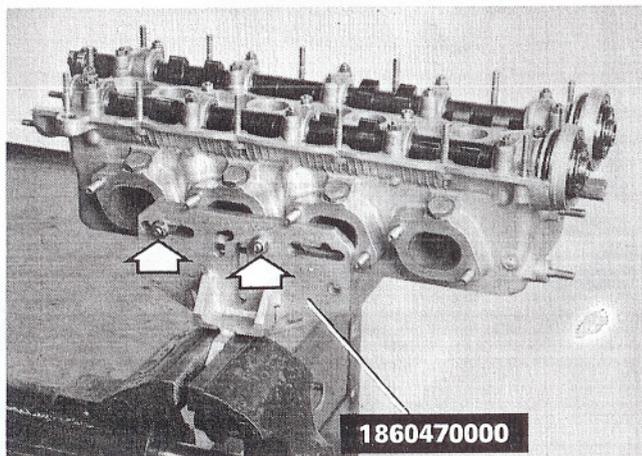
Retighten the nuts fixing the con rod  
caps to torque.

0,200 ÷ 0,339



Checking clearance between con rods and crank  
pins

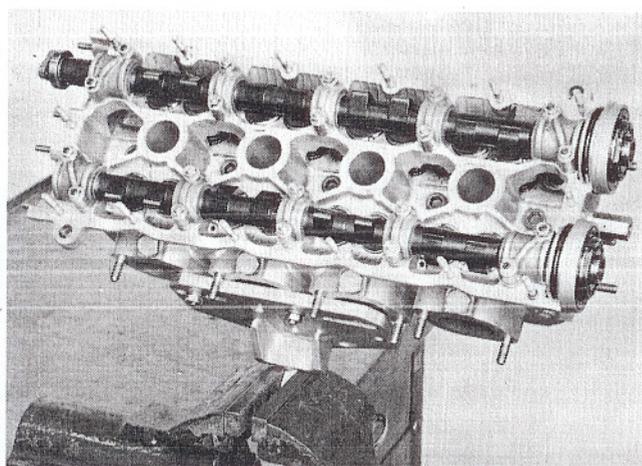
### 10.



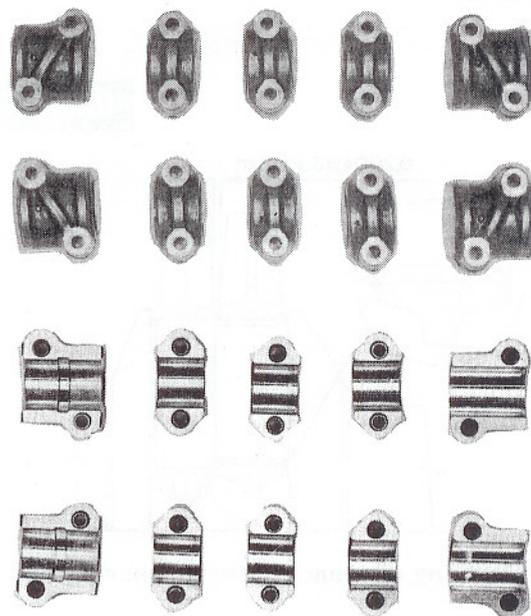
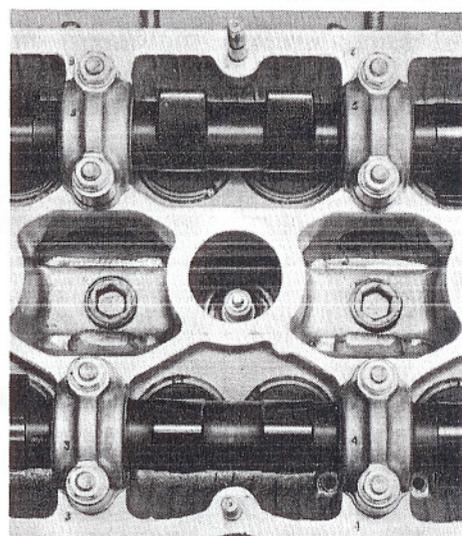
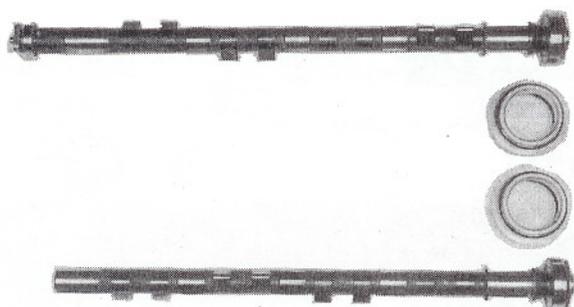
#### DISMANTLING AND CHECKS

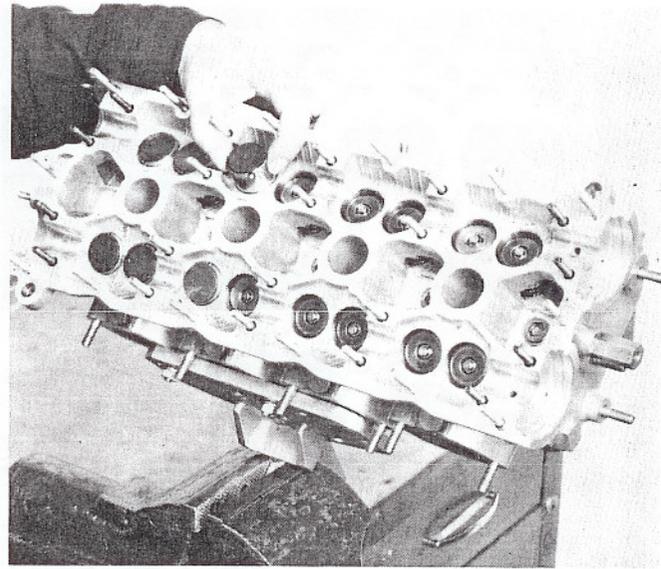
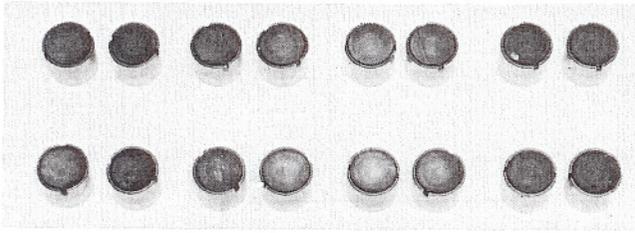
#### Fixing cylinder head to support 1860470000

The arrows show the points for fixing the cylinder head to support 1860470000.



#### Removing camshaft caps and seals between cylinder heads and tappet cover

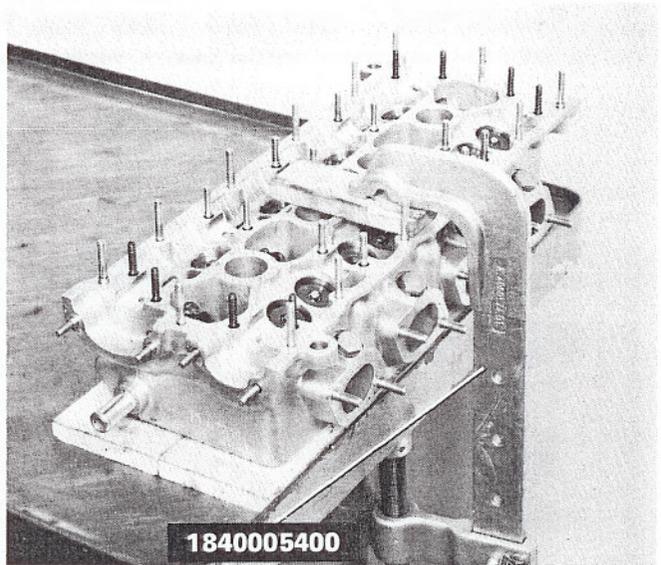




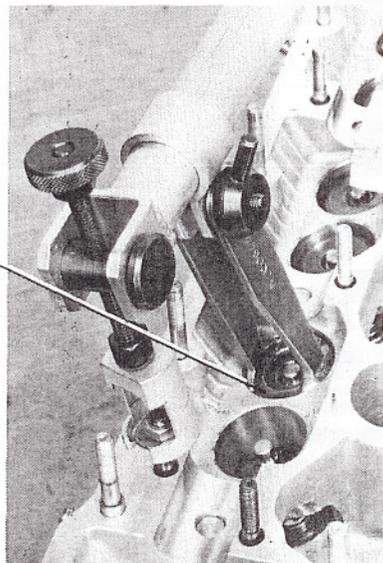
Removing tappets



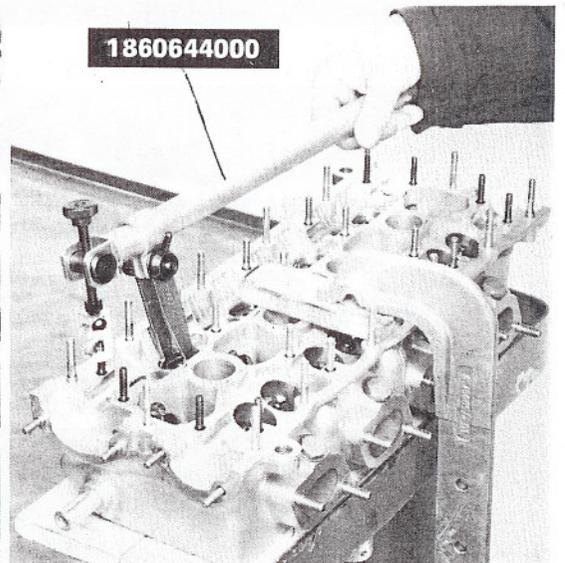
*Make sure that each tappet is matched with the correct housing when refitting the components.*



Rest the cylinder head on a wooden support about 10 mm thick and fix it to the work bench using an adjustable vice (1840005400)

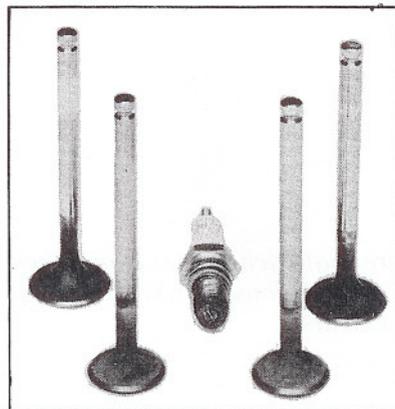
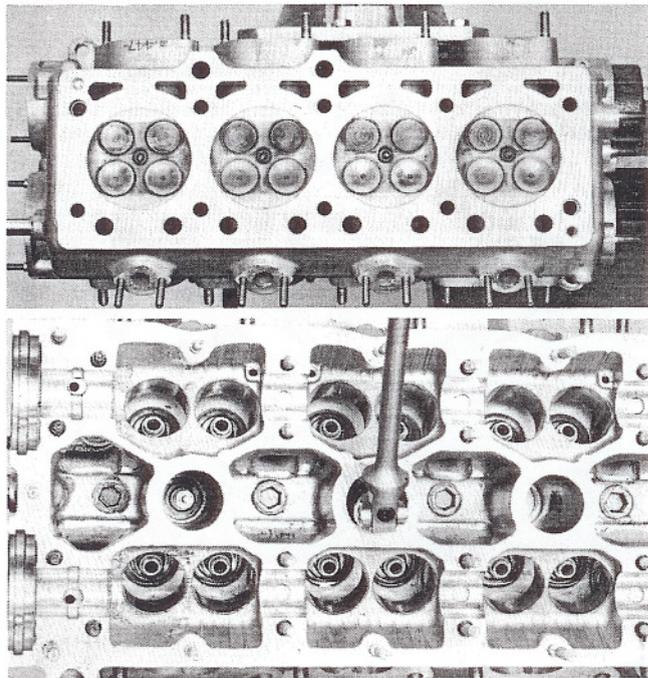


1860644000

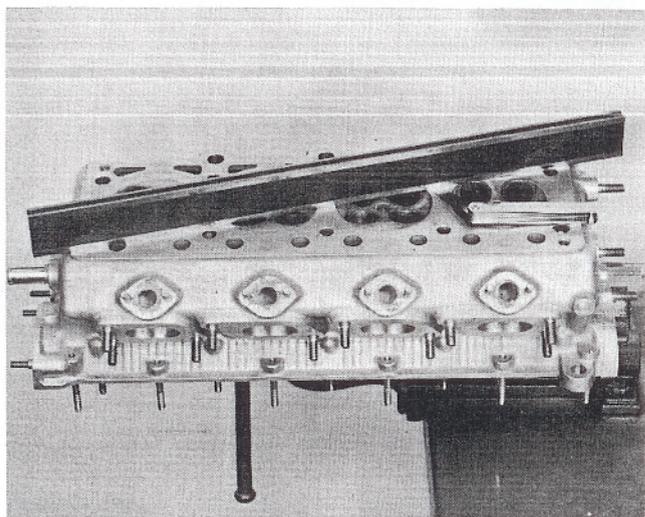


Fitting cotters, caps, springs and valves

### 10.

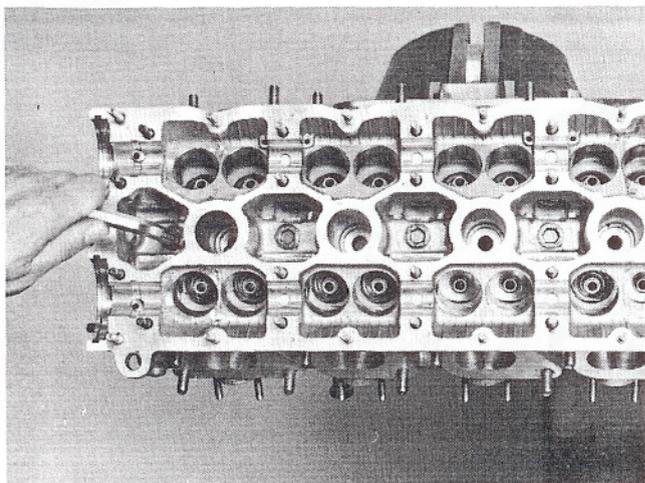


Removing valves and spark plugs



#### Checking cylinder head surface

Use a steel rule to check the plane of the cylinder head. The maximum distortion allowed is 0.05 mm for a length of 100 mm.

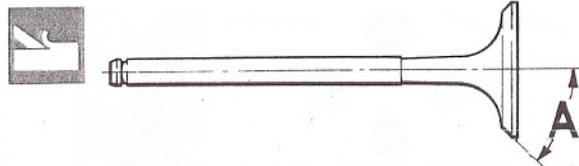
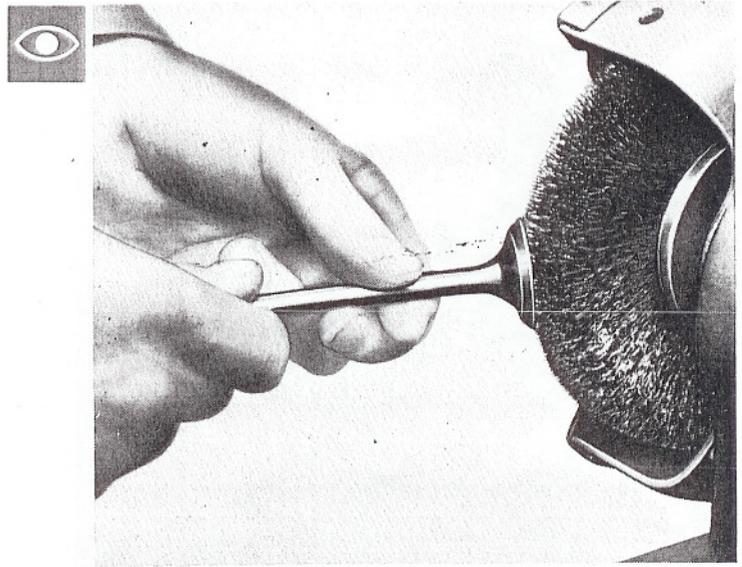


Removing-refitting cylinder head plugs

## VALVES

## De-carbonizing valves

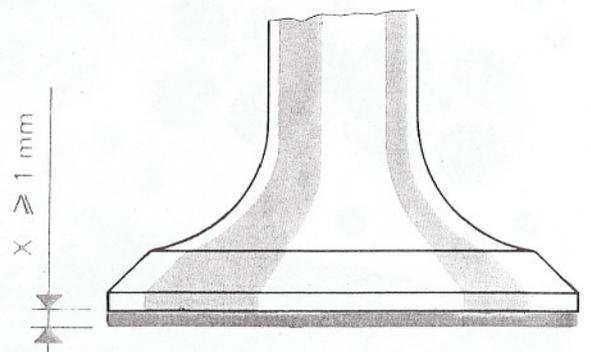
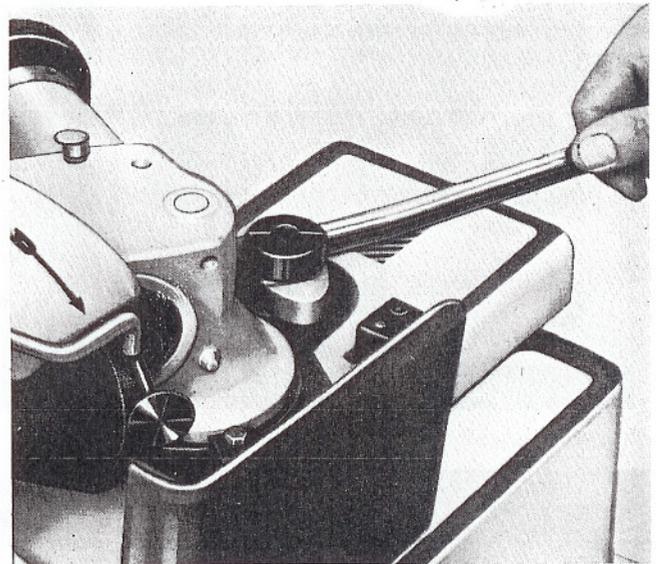
Check that there are no grooves or signs of seizing in the valve stem; also check that the diameter of the valve stem is within the prescribed values using a micrometer.



## Refacing valve using a grinder

The valve face must be cut to  $45^{\circ}15' \pm 5'$  for the exhaust valve and  $45^{\circ} \pm 5'$  for the inlet valve and the valve seat refaced removing as little material as possible.

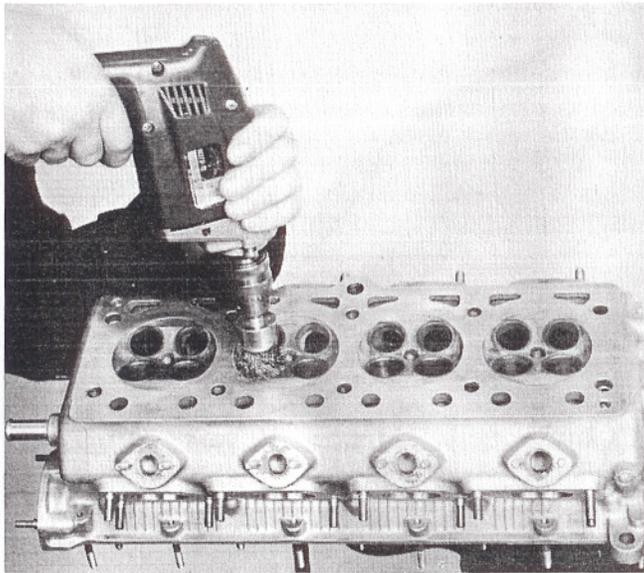
If there are signs of notches on the upper edge of the valve stem, face it using a grinder and remove as little material as possible.



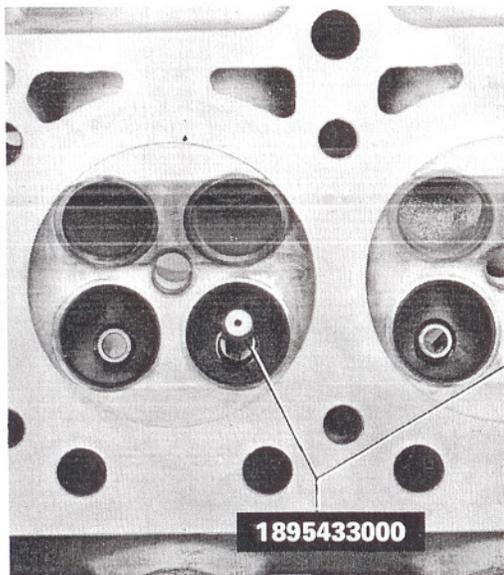
## Checking distance (X)

After carrying out the previous operations, check that thickness (X) of the valve at the edge of the valve head is not less than 1 mm, other-

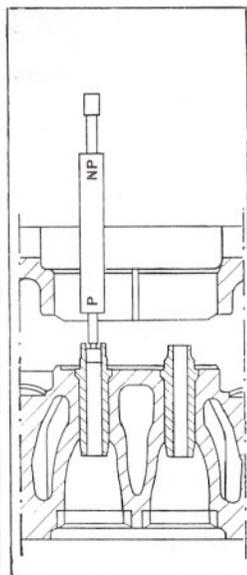
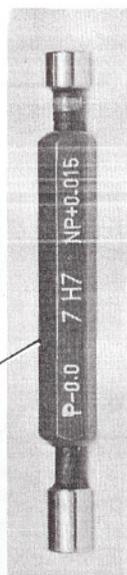
10.



De-carbonizing and cleaning valve seats and ports



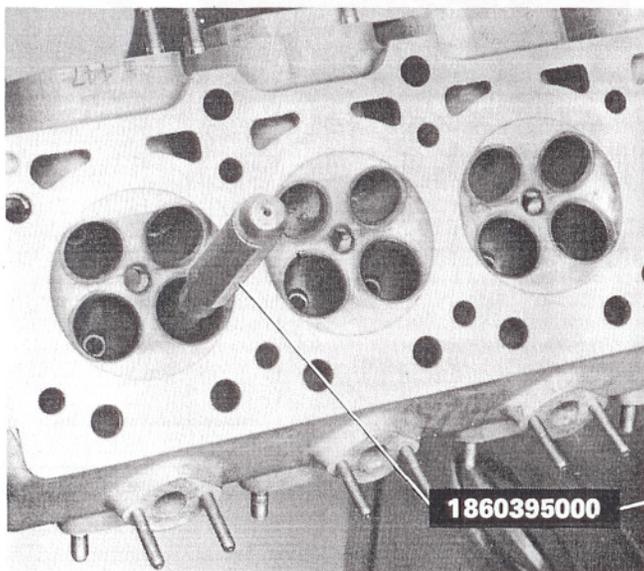
1895433000



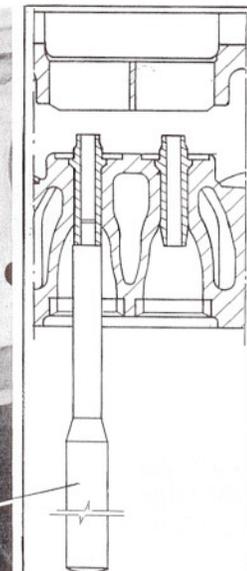
VALVE GUIDES

0,030 ± 0,060

Checking wear and ovality of valve guides using gauge 1895433000 (go-no go)



1860395000

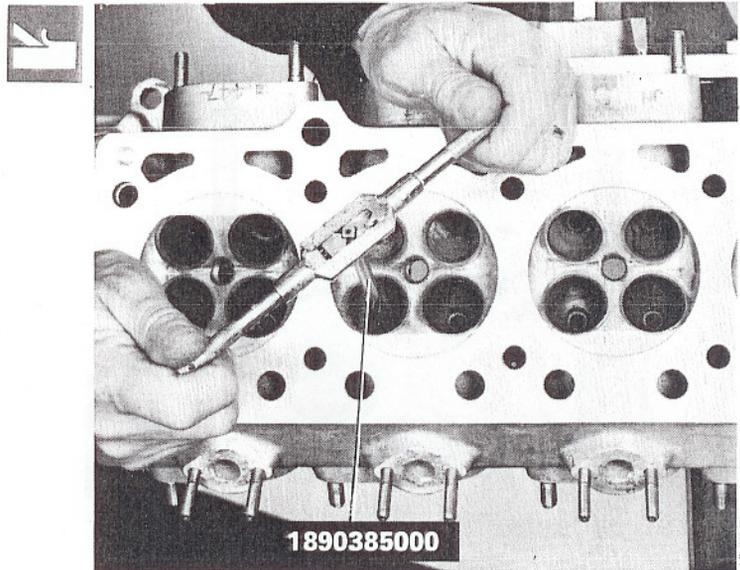
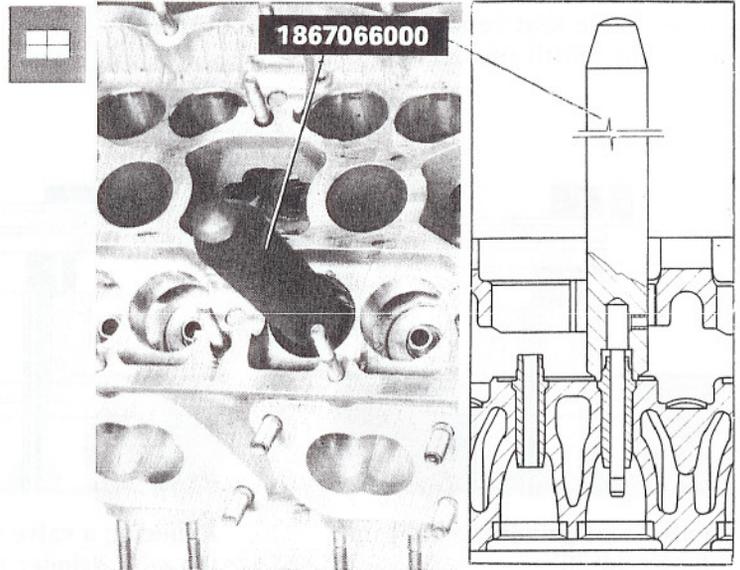


Removing valve guide

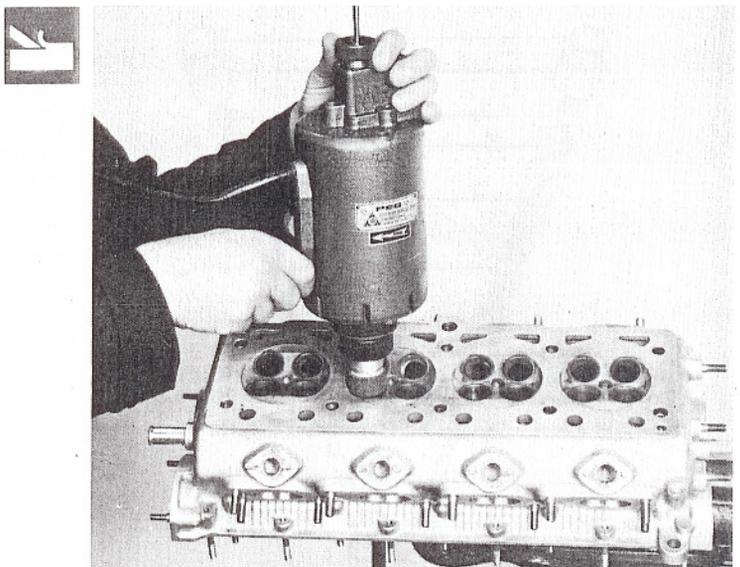
**Fitting valve guides**

Valve guides are available as spares with oversize external diameters of 0.2 mm.

**NOTE** *Before fitting new valve guides, heat the cylinder head to 100°C.*

**Reaming valve guide inner surface**

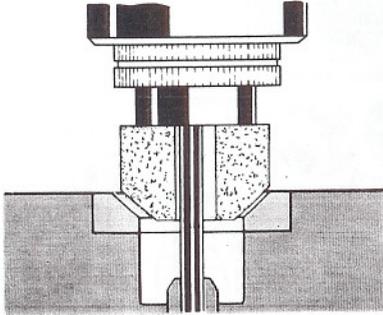
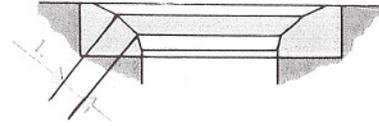
This should be carried out to clear the valve guide of any distortions suffered during fitting.

**Refacing valve seats on cylinder head**

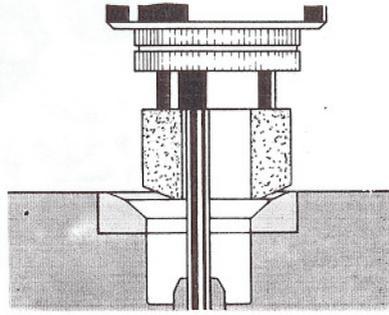
**NOTE** *The valve seats are refaced on the cylinder head every time the valves or valve guides are refaced or replaced.*

### 10.

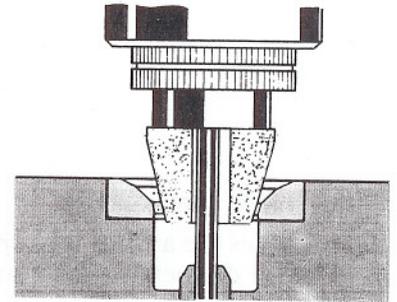
L = Valve seat refaced at 45° and reduced to the width prescribed.



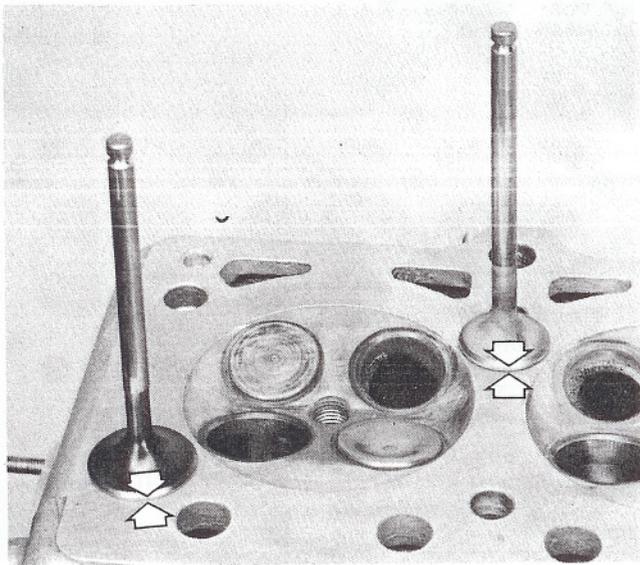
Valve seat grinding with grinder at 44°30'



Reducing a valve seat from the top with grinder at 20°

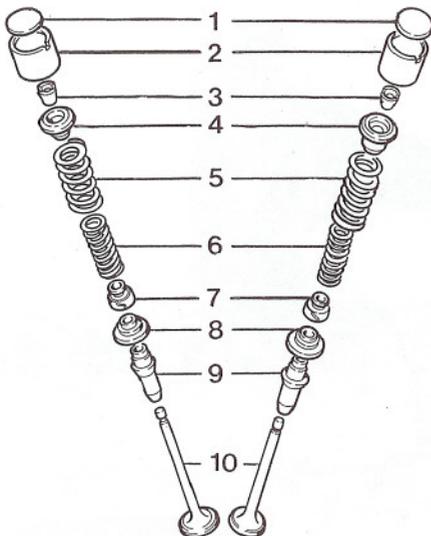


Reducing a valve seat from the bottom with grinder at 75°



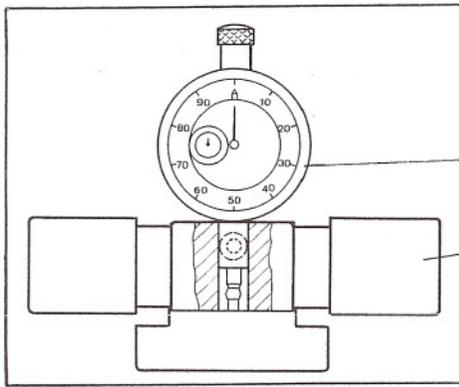
#### Checking valve for correct seating

**NOTE** *If the valve stem is not properly centered, the cylinder head seats must be faced.  
If this is not possible then the valve seat must be replaced.*



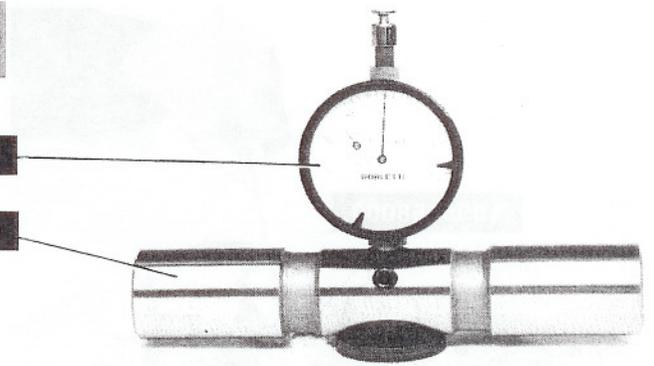
#### Tappet components available as spares

1. Tappet shims
2. Tappets
3. Cotters
4. Upper caps
5. External valve springs
6. Internal valve springs
7. Oil seals (on valve guides)
8. Lower caps
9. Valve guides
10. Valves

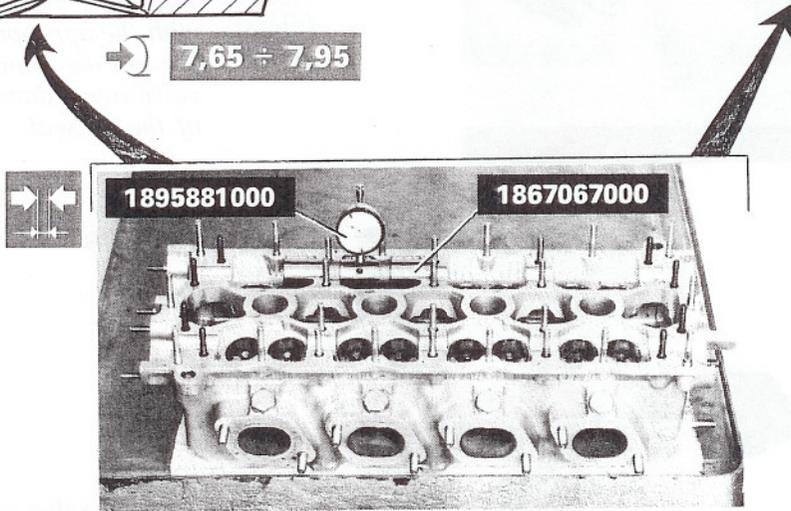
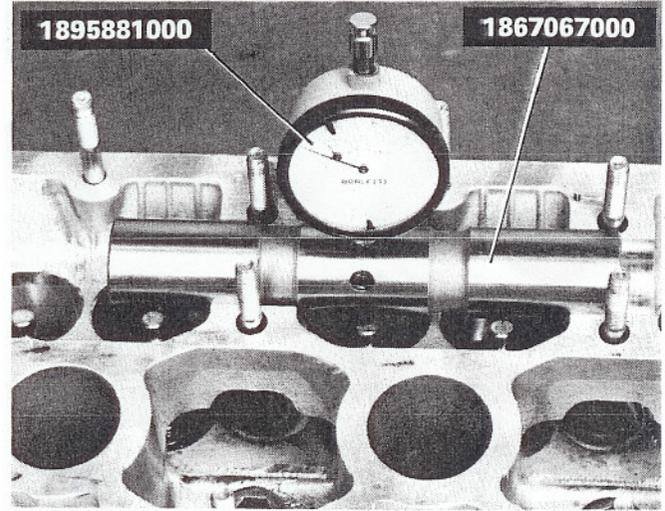
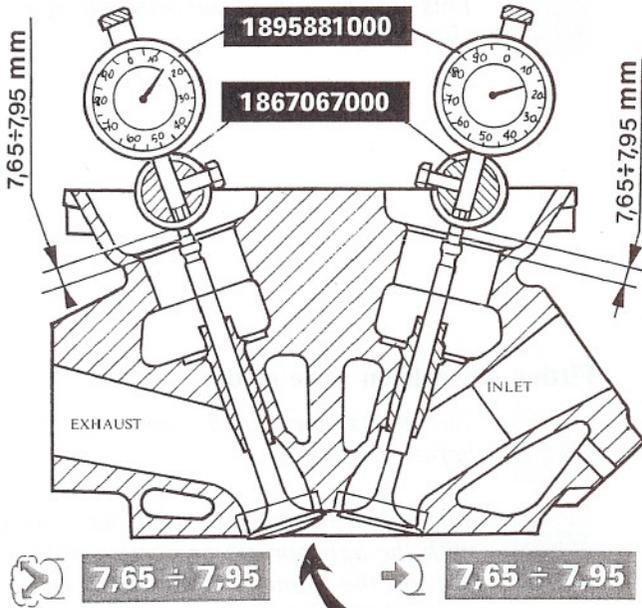


1895881000

1867067000



Zeroing dial gauge fitted on valve seat centre bearing on cylinder head



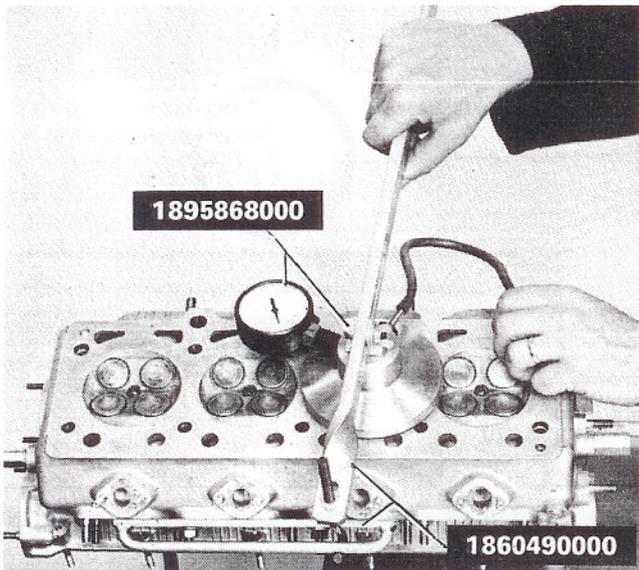
**Checking valve seat wear in cylinder head**

Fit the dial gauge 1895881000 on the support to check the valve seats.

Zero the dial gauge, fitted on the support, with a flat plate (for example a tappet shim) and lock it in this position using a bolt.

Fit tool 1867067000 complete with dial gauge (zeroed) in the two camshaft seats, rest the dial gauge pointer on the end of the valve stem and check that the clearance is between 7.65 and 7.95 mm.

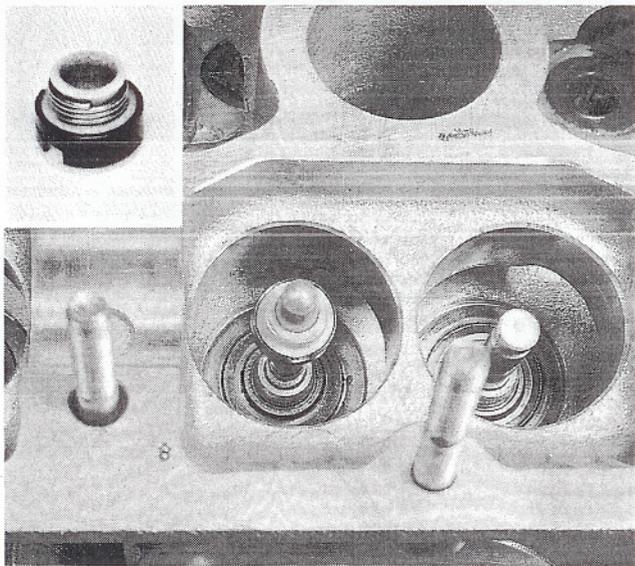
## 10.



### Valve leakage test



*This test is carried out with the spark plugs fitted.*



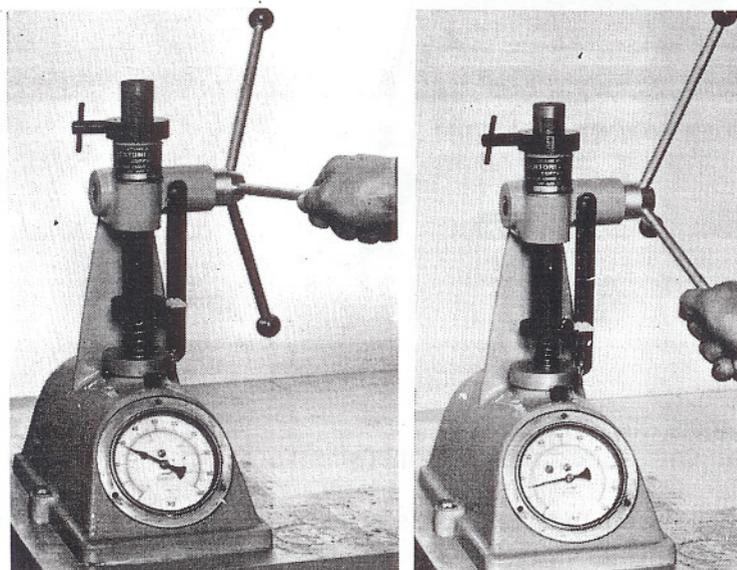
### Fitting oil seals on valve guides



*The parts concerned with engine oil before fitting.*



*The oil seals are available as spares with the appropriate protective boot to prevent the spline for the cotter (on the valve stem) damaging the inner surface of the oil seal.*



### SPRINGS

#### Checking valve spring loading

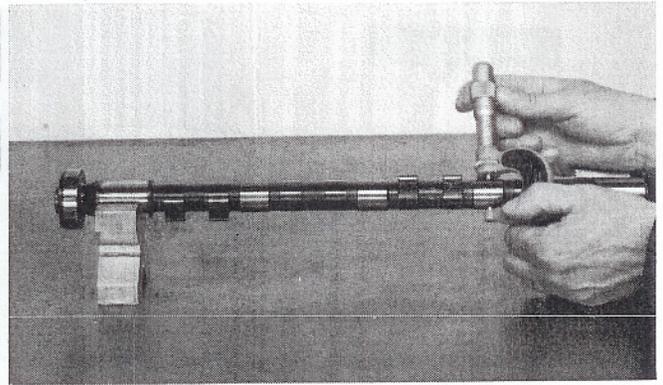
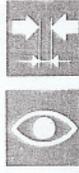
**NOTE** *Before fitting the valve springs, internal and external, they must be checked to ensure that the minimum loads are within the recommended values.*



*It is advisable to replace the springs each time the engine is overhauled.*

CAMSHAFTS

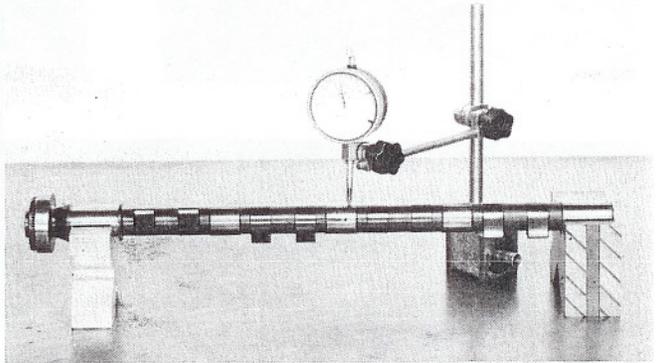
24,937 ÷ 24,950



Measuring camshaft bearings

**NOTE** *The surfaces of the cams and the bearings must not show any traces of seizing or grooves or the camshaft must be replaced.*

0,044



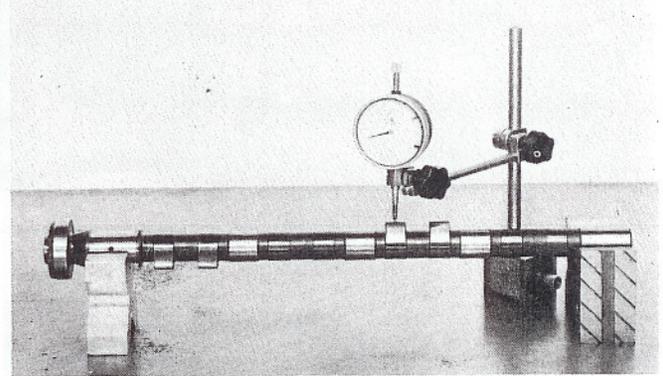
Checking eccentricity of camshaft bearings

The maximum permissible eccentricity is 0.044 mm; if this is not the case, replace the camshaft.



8,78

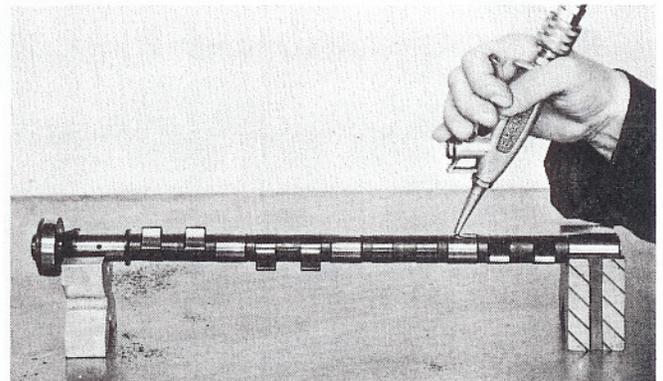
7,82



Cam lift measurement



*Excess wear of even one single cam means that the camshaft has to be replaced.*

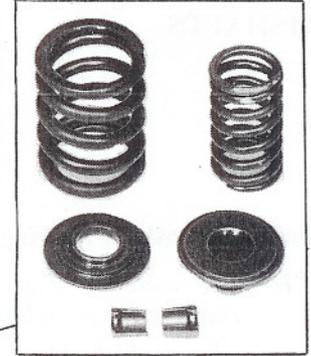
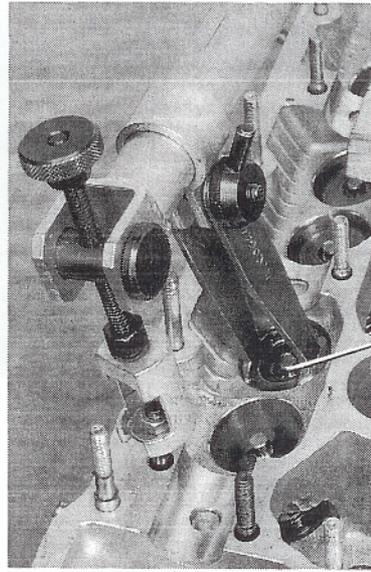
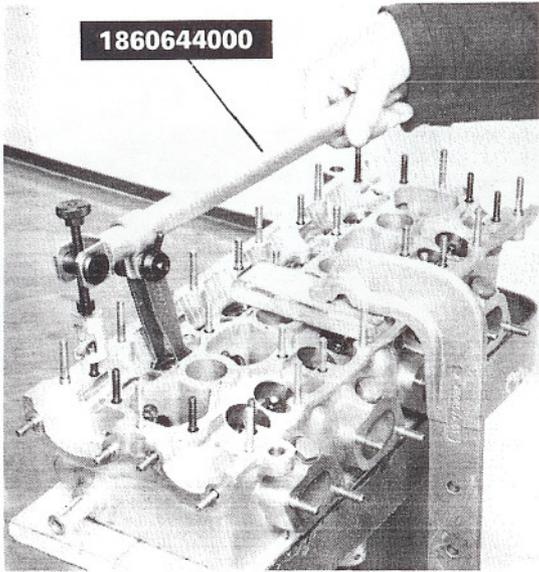


Cleaning inside of camshaft lubrication ducts

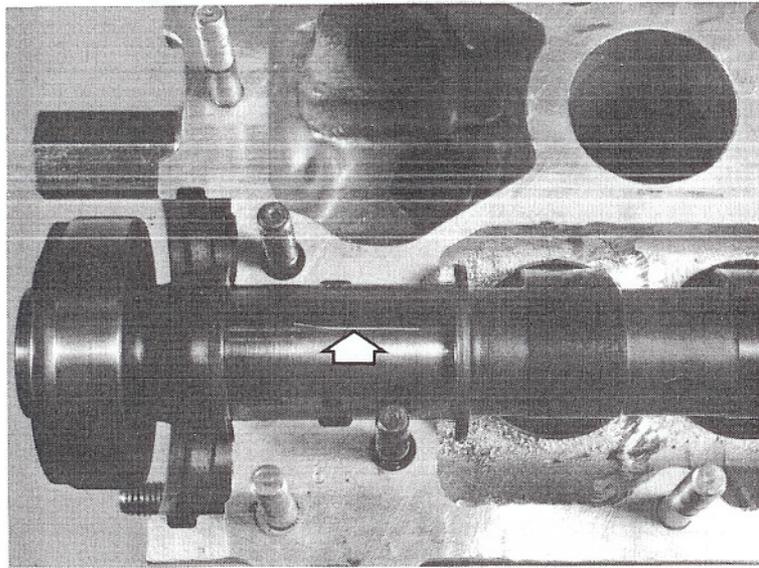


*Each time the camshaft has to be replaced the appropriate caps also have to be replaced and the camshaft seats have to be reamed at a specialist workshop.*

10.



Fitting caps, internal and external spring and cotters



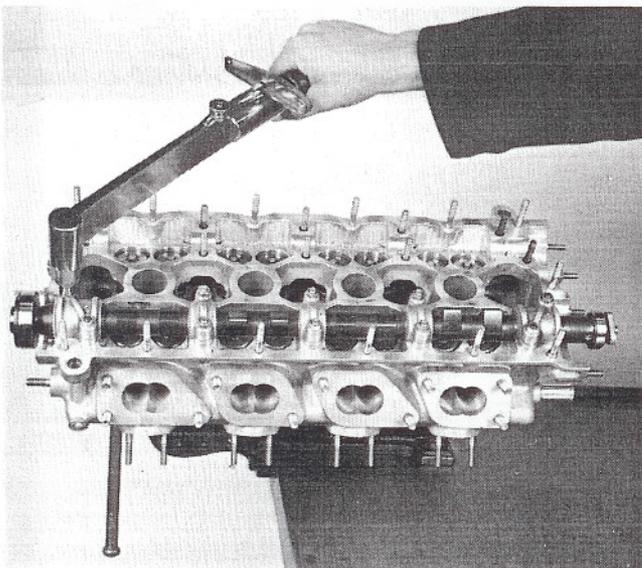
MEASURING CAMSHAFT BEARING CLEARANCE

Using plastigage to measure clearance (1st operation)

The arrow shows the calibrated wire.



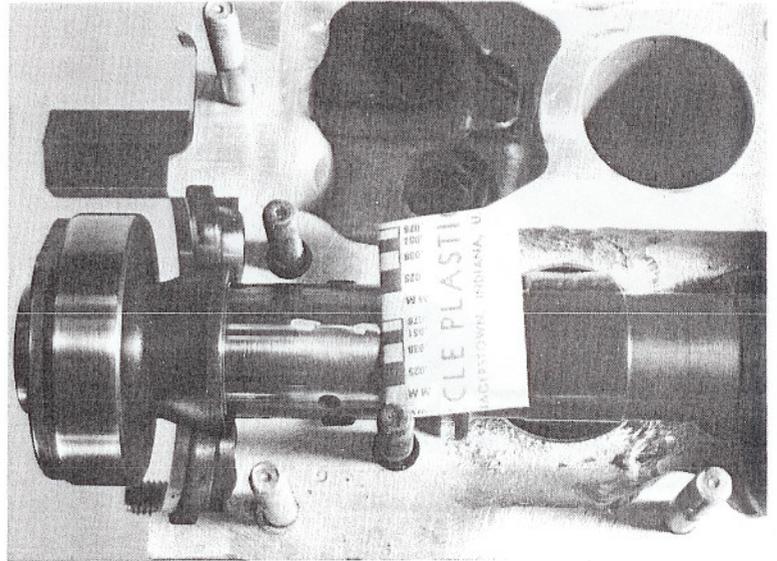
Temporarily fit the camshafts and the relative caps. The caps match the cylinder heads and are not interchangeable; the matching number is stamped on both the cylinder head and the cap.



0,9 daNm

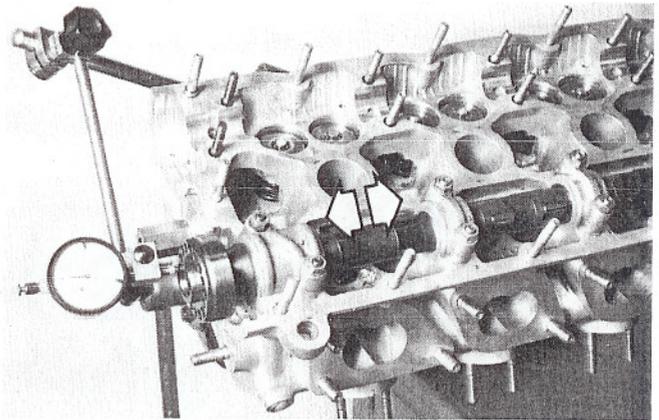
Tightening bolts fixing camshaft caps to torque (2nd operation)

0,040 ÷ 0,073



Measuring camshaft bearing clearance using special gauge (3rd operation)

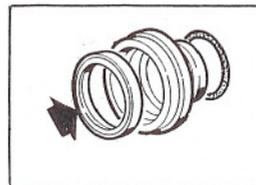
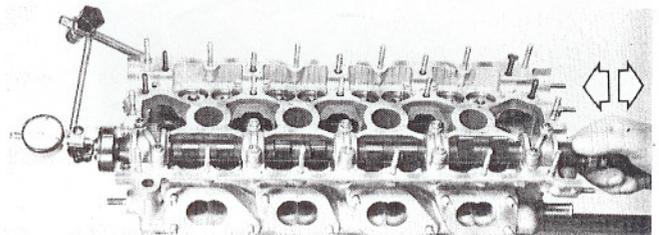
0,050 ÷ 0,169



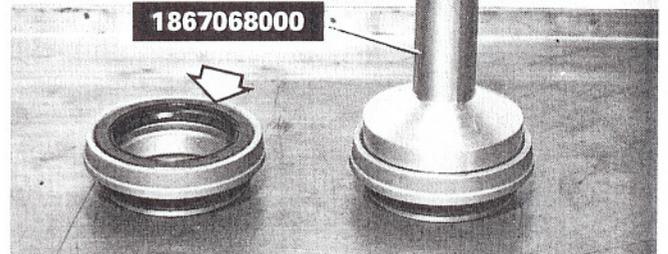
*Before checking the end float, check that the camshafts rotate freely by fitting them by hand.  
If this is not the case, the shaft seats can be reamed at specialist workshops.*

**Checking and measuring camshaft end float**

If the clearance is larger than the recommended figure the complete cylinder head must be replaced.



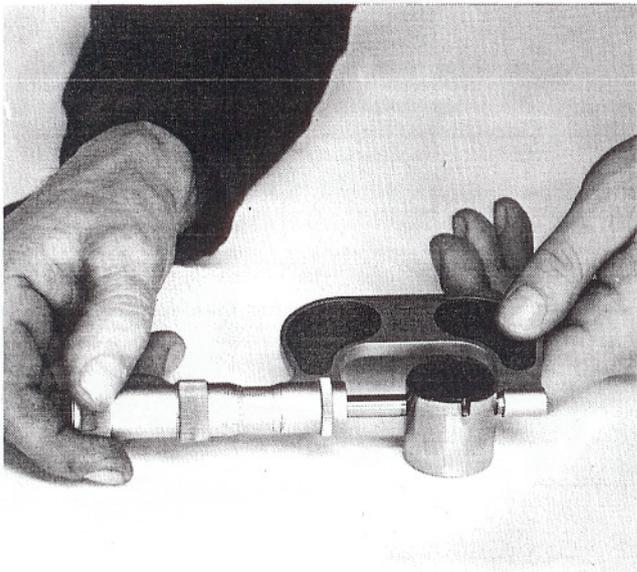
1867068000



**Fitting seal on cylinder head front cover**

The arrow shows the seal.

10.



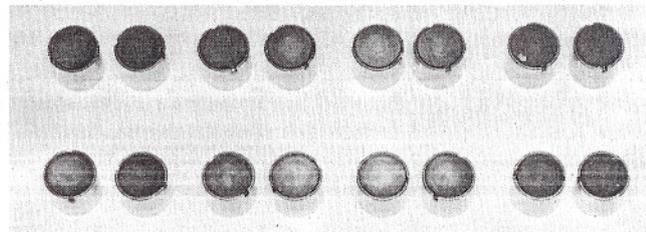
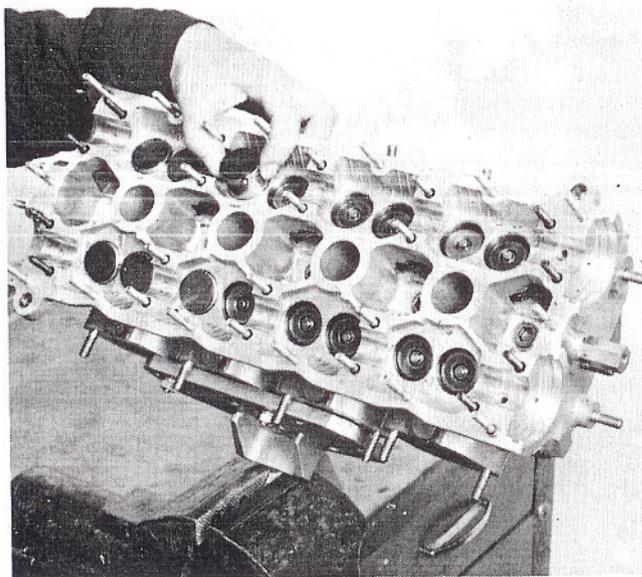
TAPPETS



32,974 ÷ 32,990

Checking tappet diameter

If the tappets are excessively oval, they must be replaced.



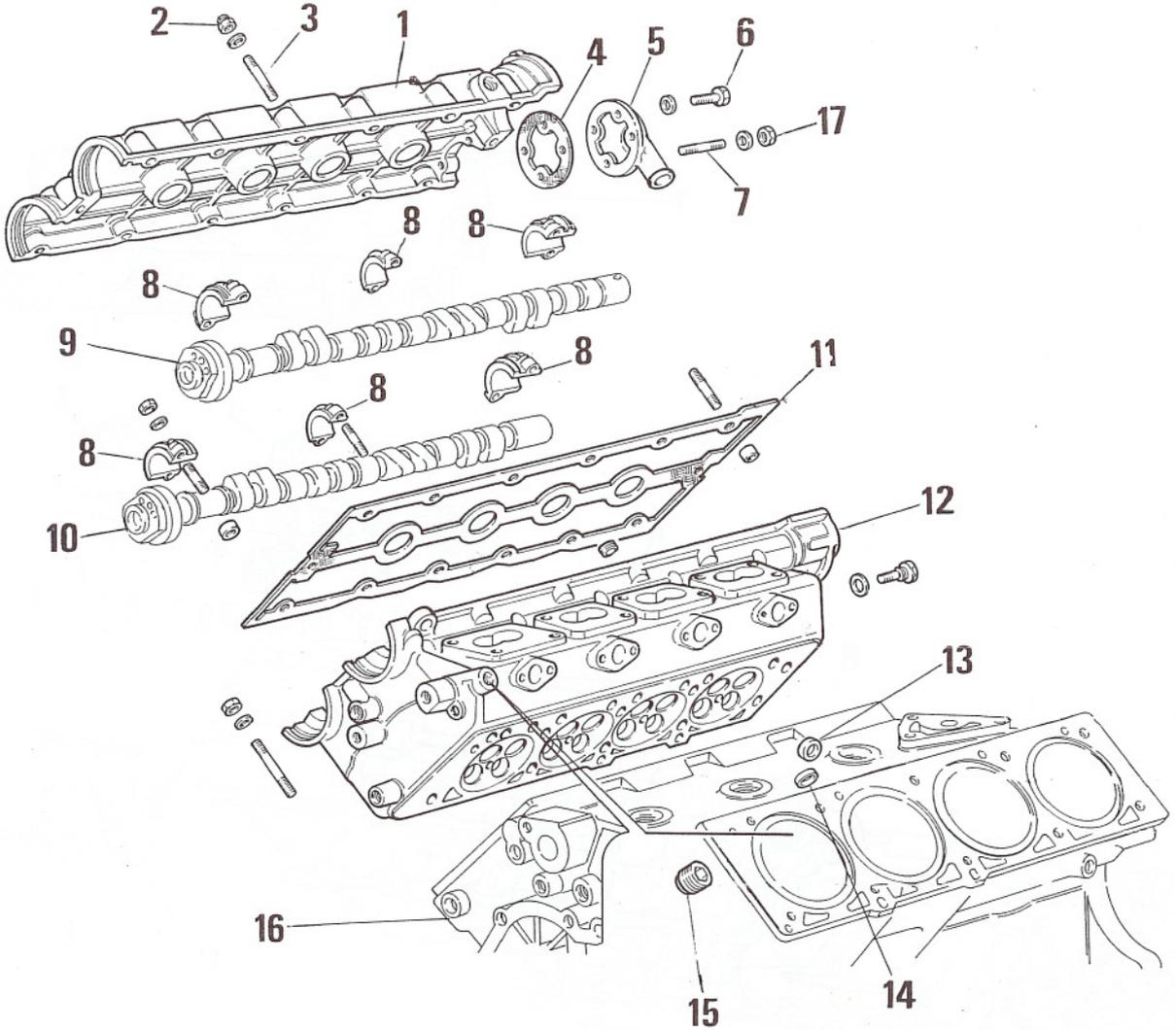
Fitting tappets

If the tappet housing is extremely worn, the cylinder head must be replaced.



*The parts concerned with engine oil before fitting.*

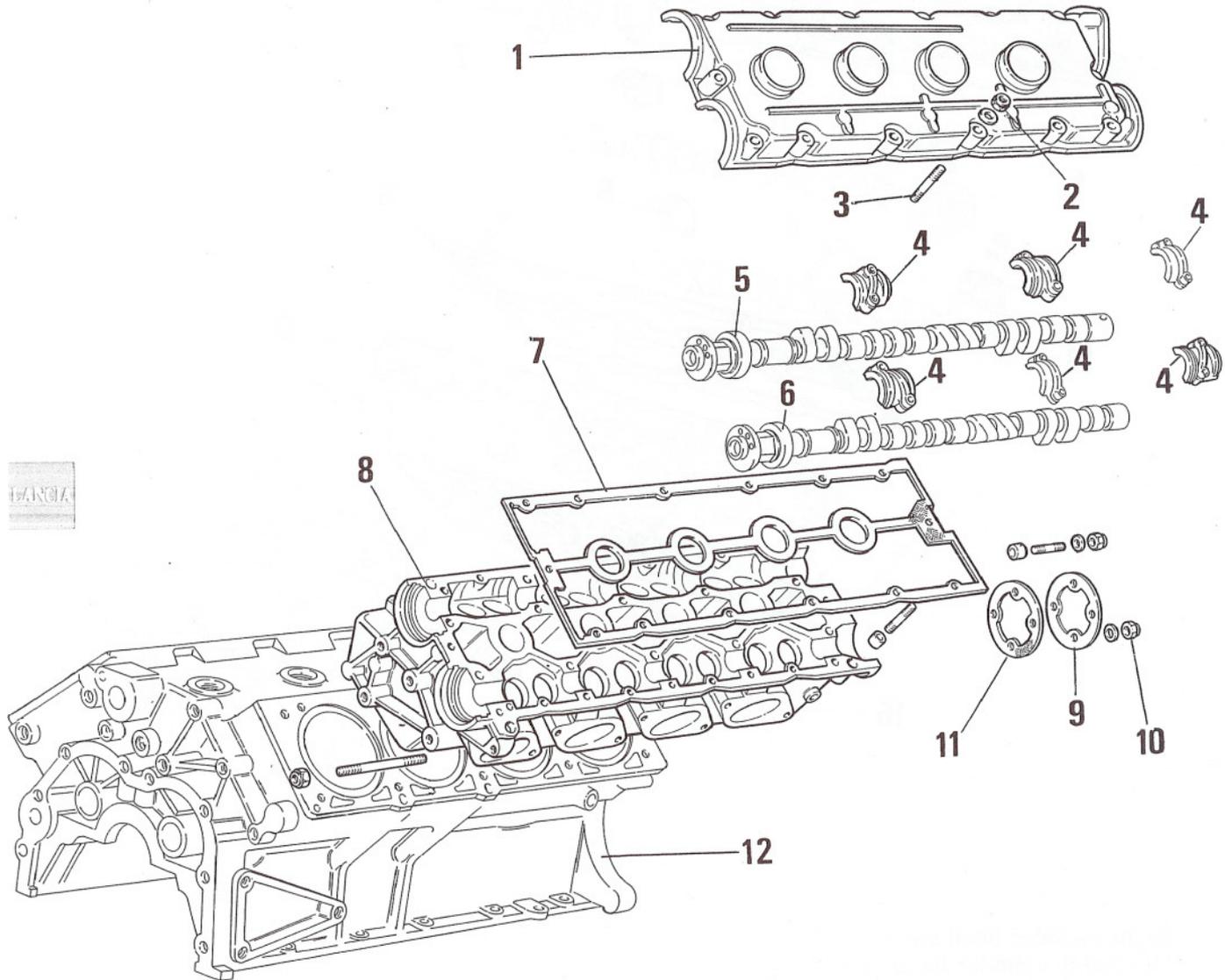
Right cylinder head assembly components available as spares



1. Right cylinder head cover
2. Nut fixing cylinder head cover
3. Stud
4. Seal
5. Oil breather cover
6. Bolts fixing oil breather cover
7. Stud
8. Caps fixing camshafts to cylinder head
9. Inlet valve camshaft
10. Exhaust valve camshaft
11. Right cylinder head cover gasket
12. Right cylinder head
13. Inlet valve seat
14. Exhaust valve seat
15. Cylinder head plug
16. Cylinder block
17. Nut fixing oil breather cover

10.

Left cylinder head components available as spares



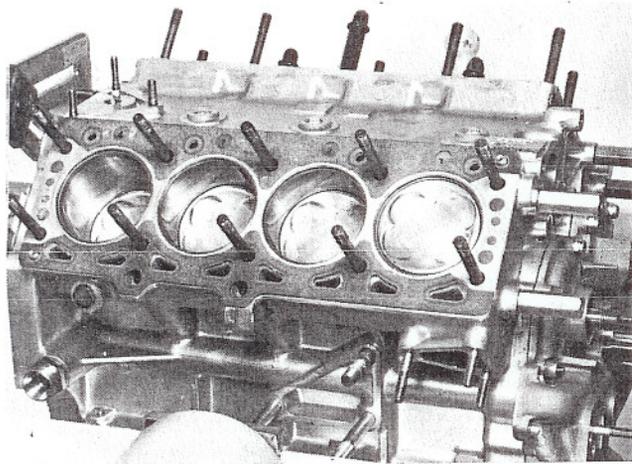
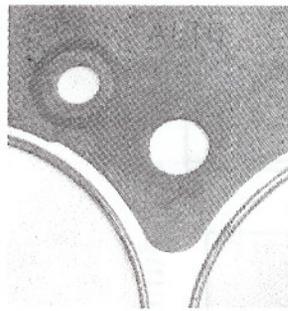
1. Left cylinder head cover
2. Nut fixing cylinder head cover
3. Stud
4. Caps fixing camshafts to cylinder head
5. Inlet valve camshaft
6. Exhaust valve camshaft
7. Left cylinder head cover gasket
8. Left cylinder head
9. Rear cover
10. Nut fixing rear cover to cylinder head
11. Rear cover seal
12. Cylinder block

Cylinder head gaskets

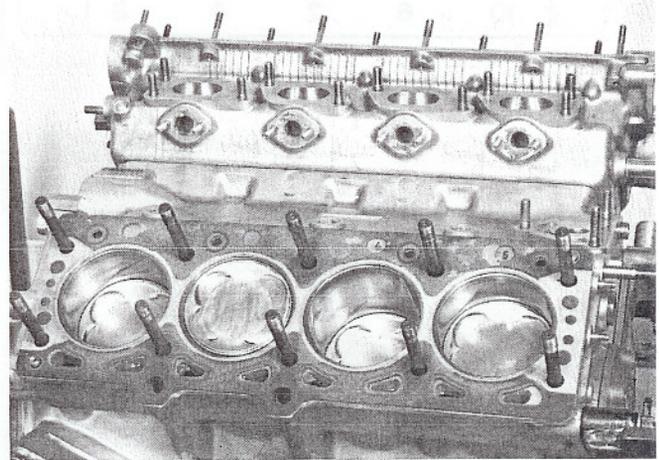


*Position the cylinder head gaskets with the word "ALTO" facing the operator.*

Bring piston no. 1 to TDC; remove the tools retaining the cylinder bores, then fit the gaskets.



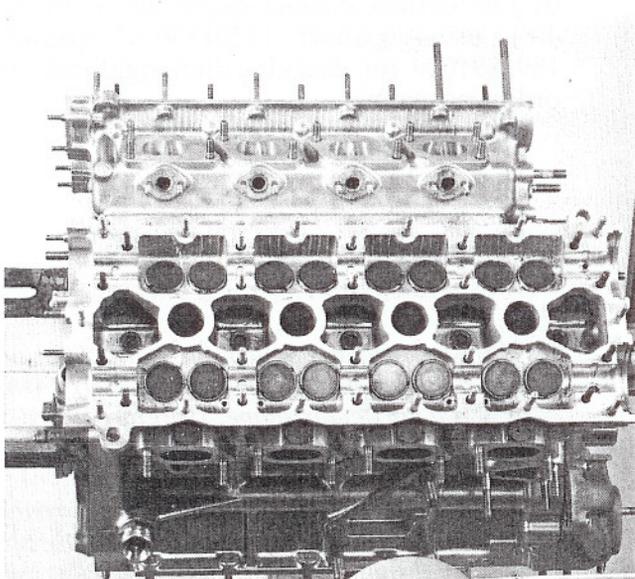
Fitting right cylinder head gasket



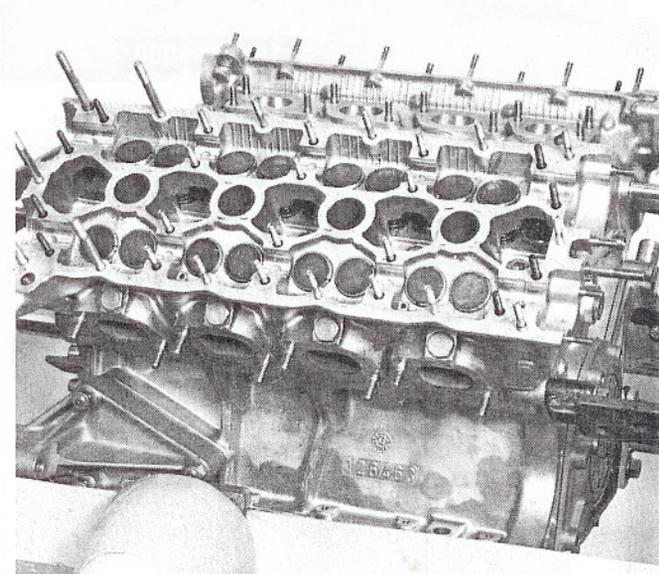
Fitting left cylinder head gasket



*Do not lubricate the gaskets or get oil on them and take care that the cylinder head and block surfaces are properly clean.*



Fitting right cylinder head

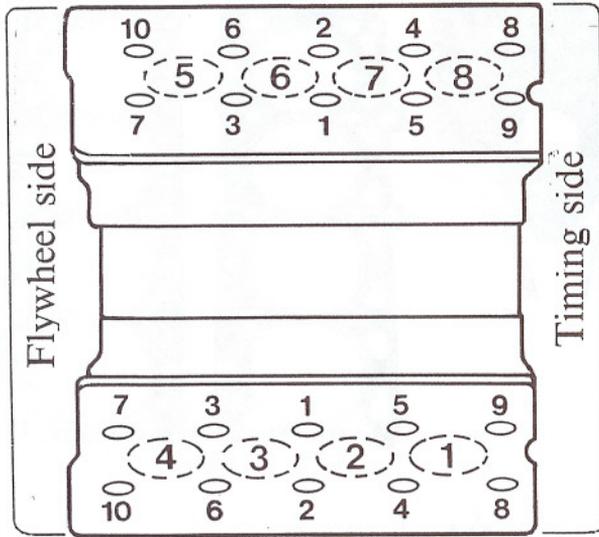


Fitting left cylinder head



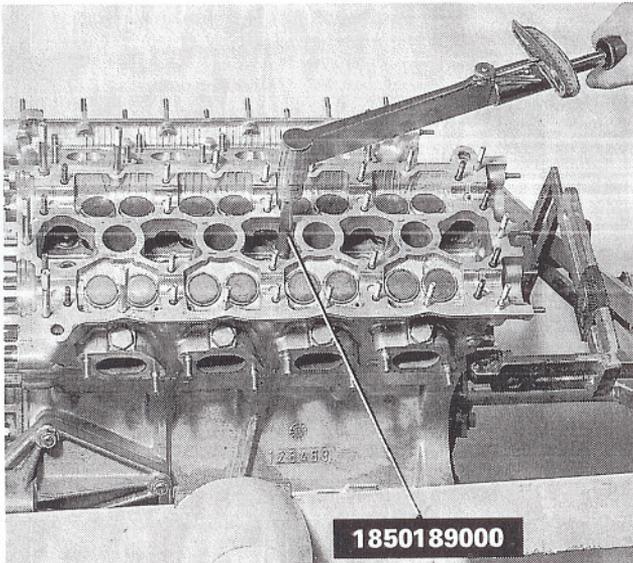
*Fit the cylinder heads without the camshafts on the cylinder block studs.*

10.



CYLINDER HEAD TIGHTENING

Diagram showing order for tightening cylinder head fixing nuts

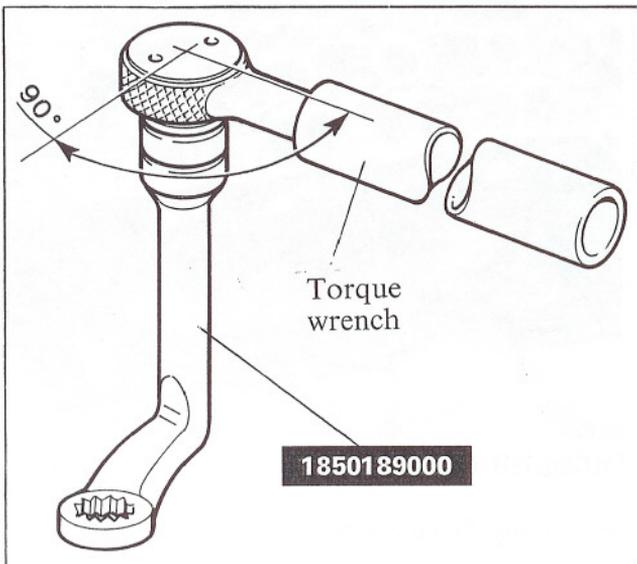


4,5 daNm

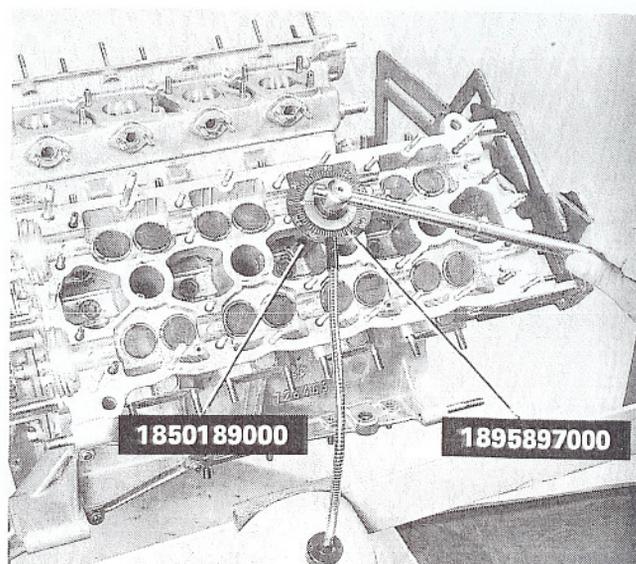
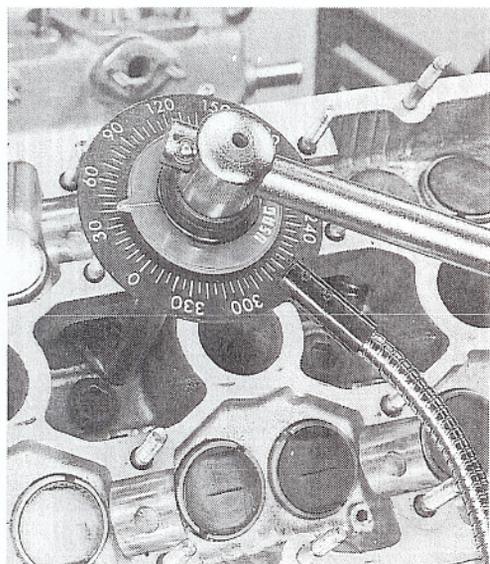
The procedure for correctly tightening the cylinder head nuts is as follows, taking into account that for each stage the order shown in the diagram above must be followed:

- lubricate the stud threads and the sliding surfaces between the cylinder head fixing nut and washer with MOLIKOTE grease;
- tighten the nuts using spanner 1850189000 to a torque of 4.5 daNm;
- further tighten the nuts (in the order given) by 120° in three distinct stages (40° + 40° + 40°), using spanner 1850189000, spanner 1895897000 for checking the angle and an ordinary spanner.

Tightening cylinder head fixing nuts to torque

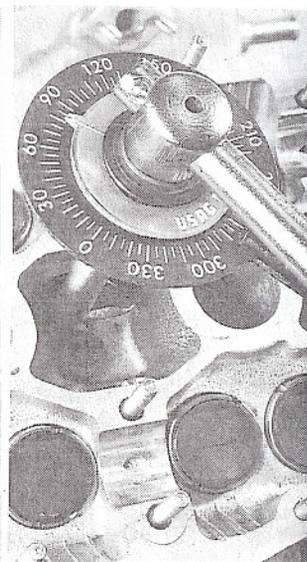
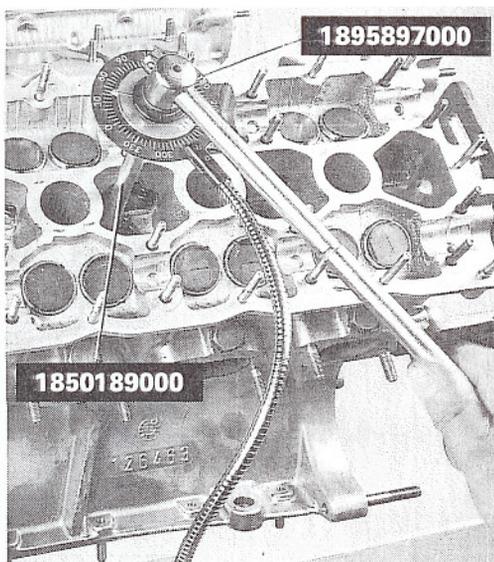


The special spanner for tightening the cylinder head fixing nuts 1850189000 is a particular shape; therefore in order not to alter the lever arm and consequently the tightening torque (4.5 daNm) the axis of the torque wrench should form an angle of 90° with the special tool (as illustrated in the diagram at the side).

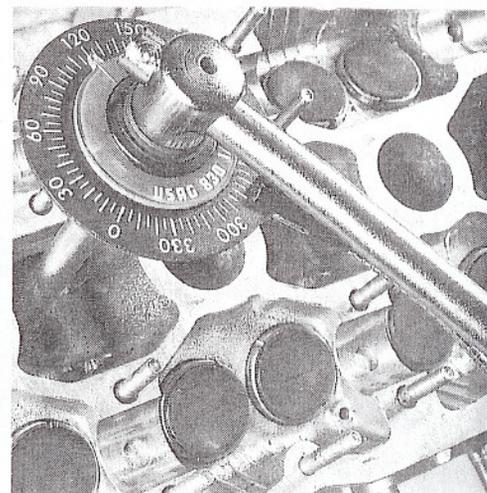
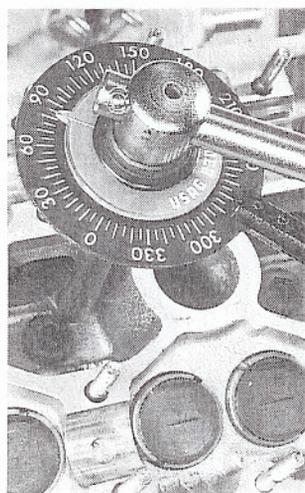


In order to carry out the angular tightening (120°) proceed as follows:

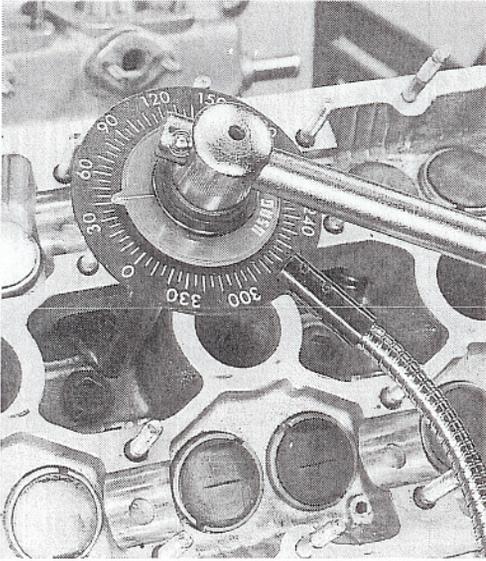
- fit spanner 1895897000 to check the closing angle, between spanner 1850189000 and an ordinary spanner;
- fix the magnet (at the end of the cable) to the rotating stand;
- turn the red index until it corresponds to zero;
- tighten the nut as far as possible and read off the angle on the goniometer;



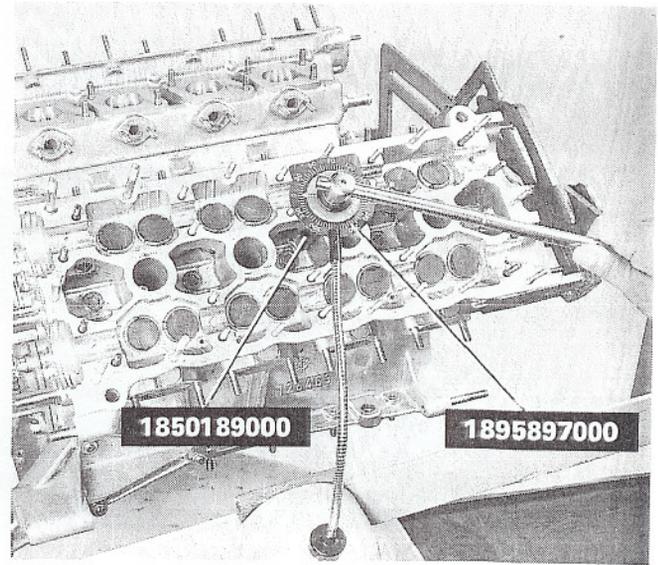
- remove the ordinary spanner and return it to its original position then insert the spanner in the goniometer once again and rotate the goniometer index until it returns to the value previously read off;
- further tighten the nut and read off the new angle shown on the goniometer;
- repeat the operation several times (3 - 4) until the correct angle of 120° is reached.



*With the adoption of torque + angle cylinder head tightening it is no longer necessary to retighten the cylinder head nuts during the first free service 1000 - 1500 km (600 - 1000 miles).*



+ 40°



1850189000

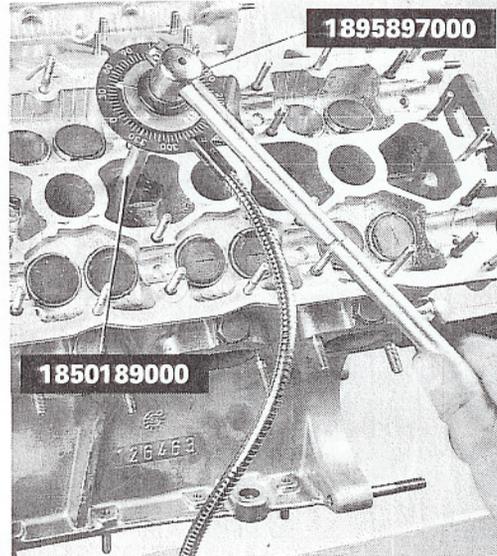
1895897000

+ 40°



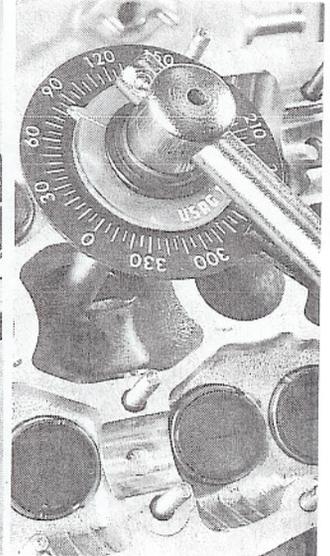
In order to carry out the angular tightening (120°) proceed as follows:

- fit spanner 1895897000 to check the closing angle, between spanner 1850189000 and an ordinary spanner;
- fix the magnet (at the end of the cable) to the rotating stand;
- turn the red index until it corresponds to zero;
- tighten the nut as far as possible and read off the angle on the goniometer;



1895897000

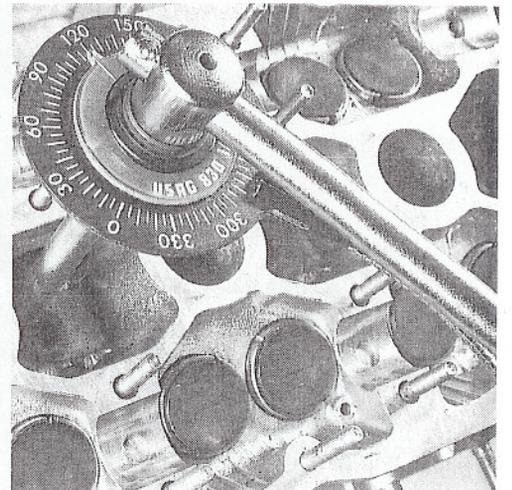
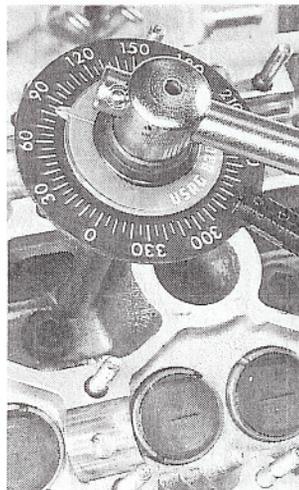
1850189000



+ 40°

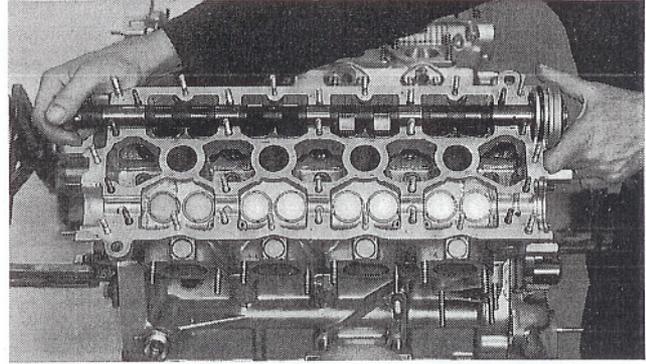
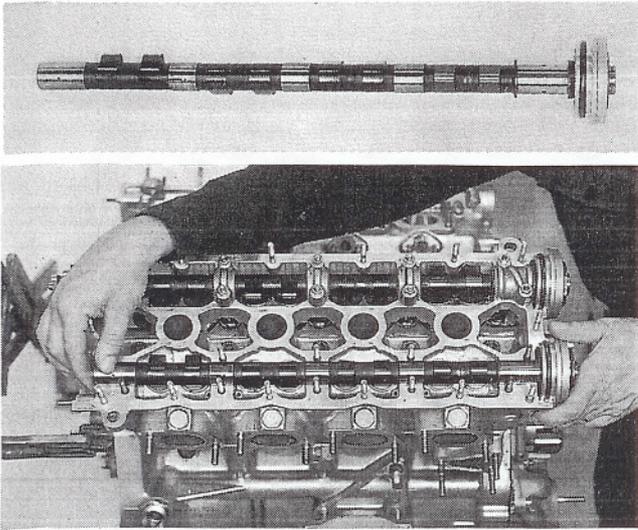


- remove the ordinary spanner and return it to its original position then insert the spanner in the goniometer once again and rotate the goniometer index until it returns to the value previously read off;
- further tighten the nut and read off the new angle shown on the goniometer;
- repeat the operation several times (3 - 4) until the correct angle of 120° is reached.

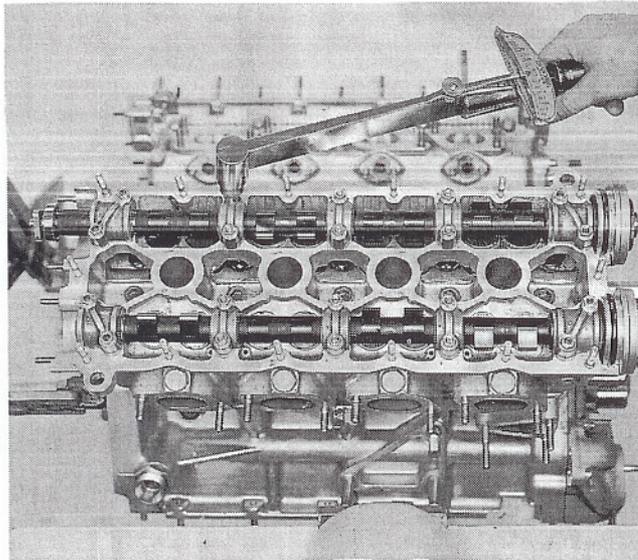


With the adoption of torque + angle cylinder head tightening it is no longer necessary to retighten the cylinder head nuts during the first free service 1000 - 1500 km (600 - 1000 miles).

**10.**



**Fitting camshafts (complete with front covers) on cylinder heads**

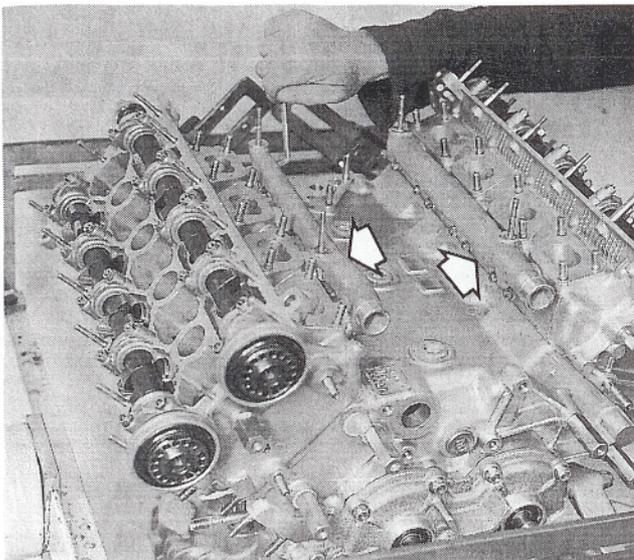


**0,9 daNm**



*There are reference marks on the 4 camshafts and on the relative caps on the timing side. When fitting the caps the 4 reference marks should coincide so that piston no. 1 (right main bearing) and piston no. 7 (left main bearing) are at TDC with piston no. 1 during the explosion stroke.*

**Tightening camshaft cap fixing nuts to torque**



**Fitting ducts (for the flow of coolant from the cylinder heads to the pump) on the cylinder heads**