

# FREELANDER



## L Series Diesel Engine Overhaul Manual

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L-Serie Dieselmotor  
revisiehandboek

Moteur Diesel de série L  
Manuel de révision

L Diesel motor  
Überholungsanleitung

Motore Diesel serie L  
Manuale di revisione

Motor Diesel serie L  
Manual de revisión

Motor Diesel da série L  
Manual de revisão





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**'L' SERIES  
DIESEL ENGINE**

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**OVERHAUL  
MANUAL**

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**This engine is fitted to the following model:**

**Land Rover Freelander - Up to 2001 Model Year**

**Publication Part No. LRL 0157 ENG (2nd. Edition)  
Published by Land Rover Technical  
Communication  
© 2000 Land Rover Group Limited**



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## INTRODUCTION

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### How to use this manual

To assist in the use of this manual the section title is given at the top and the relevant sub-section is given at the bottom each page.

To help readers find the information they need, the first page of each section is marked with a black tab which lines up with the corresponding tab on the title page. In addition the symbol at the top of each RH page identifies each section or group of sections.

Each section starts with a contents page, listing the information contained within. Some sections are divided into sub-sections such as Description and Operation, Adjustments, Repairs and Data, Torque and Tools. To assist filing of revised information each of the sub-sections is numbered from page 1.

Each Adjustment and Repair procedure is fully illustrated showing a number against each text item. Service tools are shown in use where usage is not obvious. The illustration appear before the text which refers to it. Adjustment and Repair operations also include relevant data, torque figures and useful assembly details.

WARNINGS, CAUTIONS and Notes have the following meanings:



**WARNING: Procedures which must be followed precisely to avoid the possibility of injury.**



**CAUTION: Calls attention to procedures which must be followed to avoid damage to components.**



**NOTE: Gives helpful information.**

### References

References to the LH or RH side given in this manual are made when viewing the vehicle from the rear. With the engine and gearbox assembly removed, the crankshaft pulley end of the engine is referred to as the front.

Operations covered in this manual do not include reference to testing the vehicle after repair. It is essential that work is inspected and tested after completion and if necessary a road test of the vehicle is carried out particularly where safety related items are concerned.

### Dimensions

The dimensions quoted are to design engineering specification with Service limits where applicable.

During the period of running-in from new, certain adjustments may vary from the specification figures given in this manual. These will be reset by the Dealer at the First Service, and thereafter should be maintained at the figures specified in this manual.

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## REPAIRS AND REPLACEMENTS

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When replacement parts are required it is essential that only Land Rover recommended parts are used.

Attention is particularly drawn to the following points concerning repairs and the fitting of replacement parts and accessories.

Safety features and corrosion prevention treatments embodied in the car may be impaired if other than Land Rover recommended parts are fitted. In certain territories, legislation prohibits the fitting of parts not to the manufacturer's specification. Torque wrench setting figures given in this Manual must be used. Locking devices, where specified, must be fitted. If the efficiency of a locking device is impaired during removal it **must be renewed**.

Owners purchasing accessories while travelling abroad should ensure that the accessory and its fitted location on the car conform to legal requirements.

The Terms of the vehicle Warranty may be invalidated by the fitting of other than Land Rover recommended parts.

All Land Rover recommended parts have the full backing of the vehicle Warranty.

Land Rover Dealers are obliged to supply only Land Rover recommended parts.

# INTRODUCTION

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## SPECIFICATION

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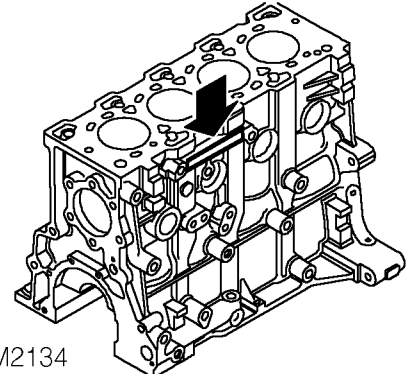
Land Rover are constantly seeking to improve the specification, design and production of their vehicles and alterations take place accordingly. While every effort has been made to ensure the accuracy of this Manual, it should not be regarded as an infallible guide to current specifications of any particular vehicle.

This Manual does not constitute an offer for sale of any particular vehicle. Land Rover Dealers are not agents of Land Rover and have no authority to bind the manufacturer by any expressed or implied undertaking or representation.

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## ENGINE NUMBER LOCATION

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The engine number is located on the side of the cylinder block adjacent to Number 2 cylinder.

### Engine identification

Engines fitted to Freelander have the following prefixes to the engine serial numbers:-

20T2N 17N  
20T2N 18N  
20T2N 20N  
20T2N 21N

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# ENGINE

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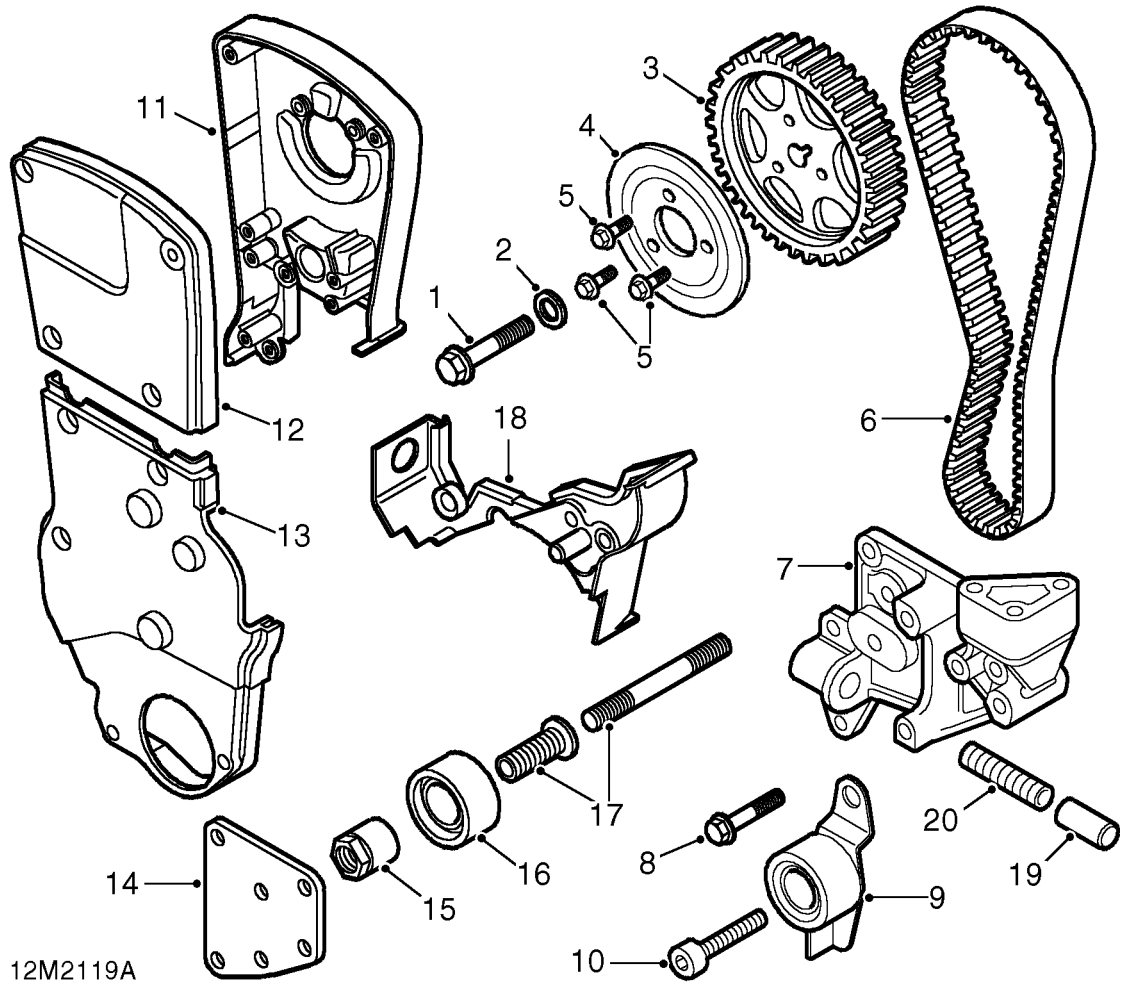
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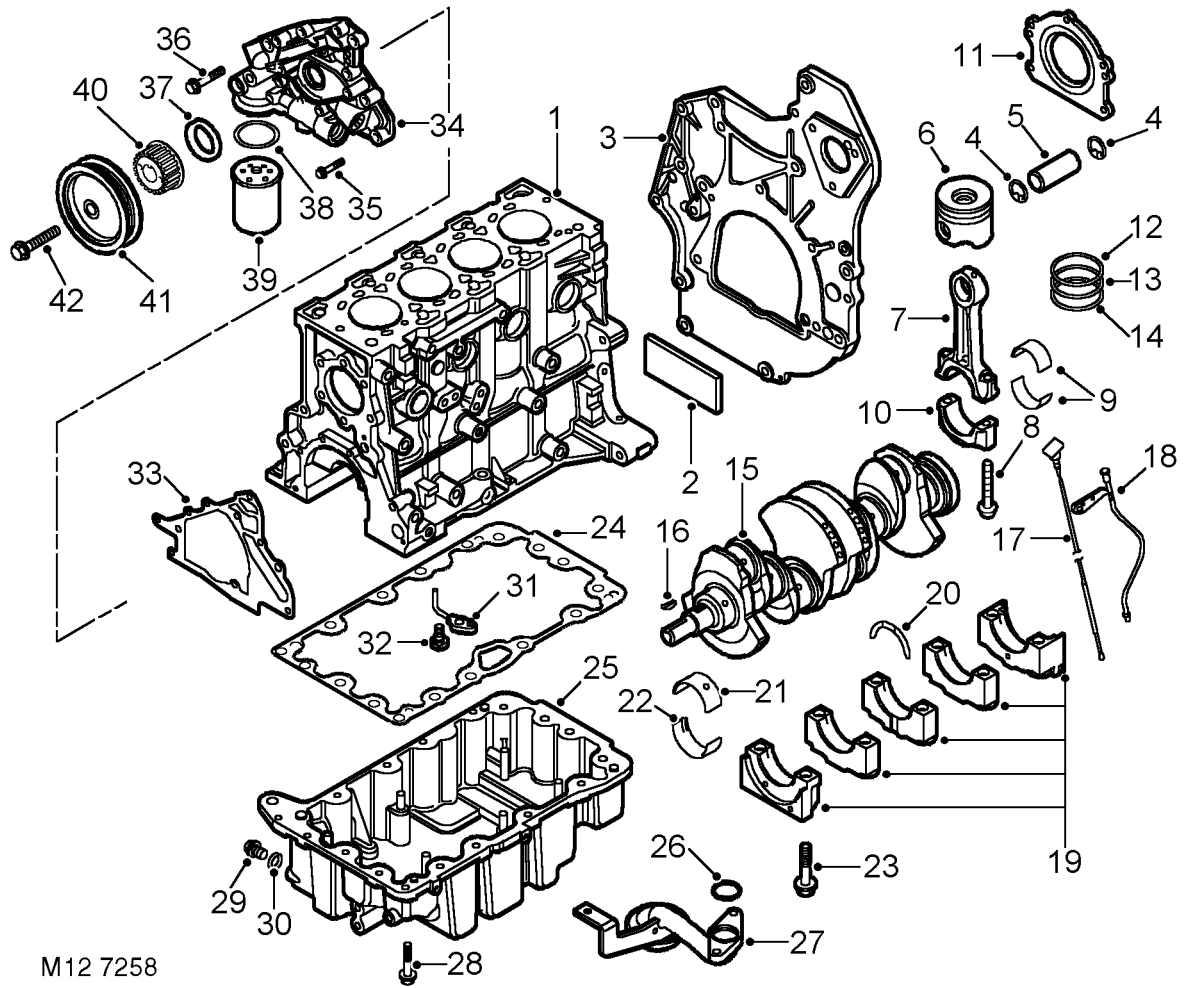
12M2119A

### CAMSHAFT TIMING BELT COMPONENTS

- |  |                                       |
|--|---------------------------------------|
| 1. Bolt - timing belt gear             | 11. Timing belt upper rear cover      |
| 2. Washer                              | 12. Timing belt upper front cover     |
| 3. Timing belt gear                    | 13. Timing belt lower front cover     |
| 4. Timing belt gear damper             | 14. Engine front mounting cover plate |
| 5. Torx screws - damper to timing gear | 15. Nut - idler pulley                |
| 6. Camshaft timing belt                | 16. Idler pulley                      |
| 7. Tensioner housing                   | 17. Stud and adaptor - idler pulley   |
| 8. Bolt - tensioner pulley             | 18. Timing belt lower rear cover      |
| 9. Tensioner pulley                    | 19. Tensioner plunger                 |
| 10. Allen screw - tensioner pulley*    | 20. Tensioner spring                  |

\* Later engines - Allen screw is replaced by a bolt.

# ENGINE





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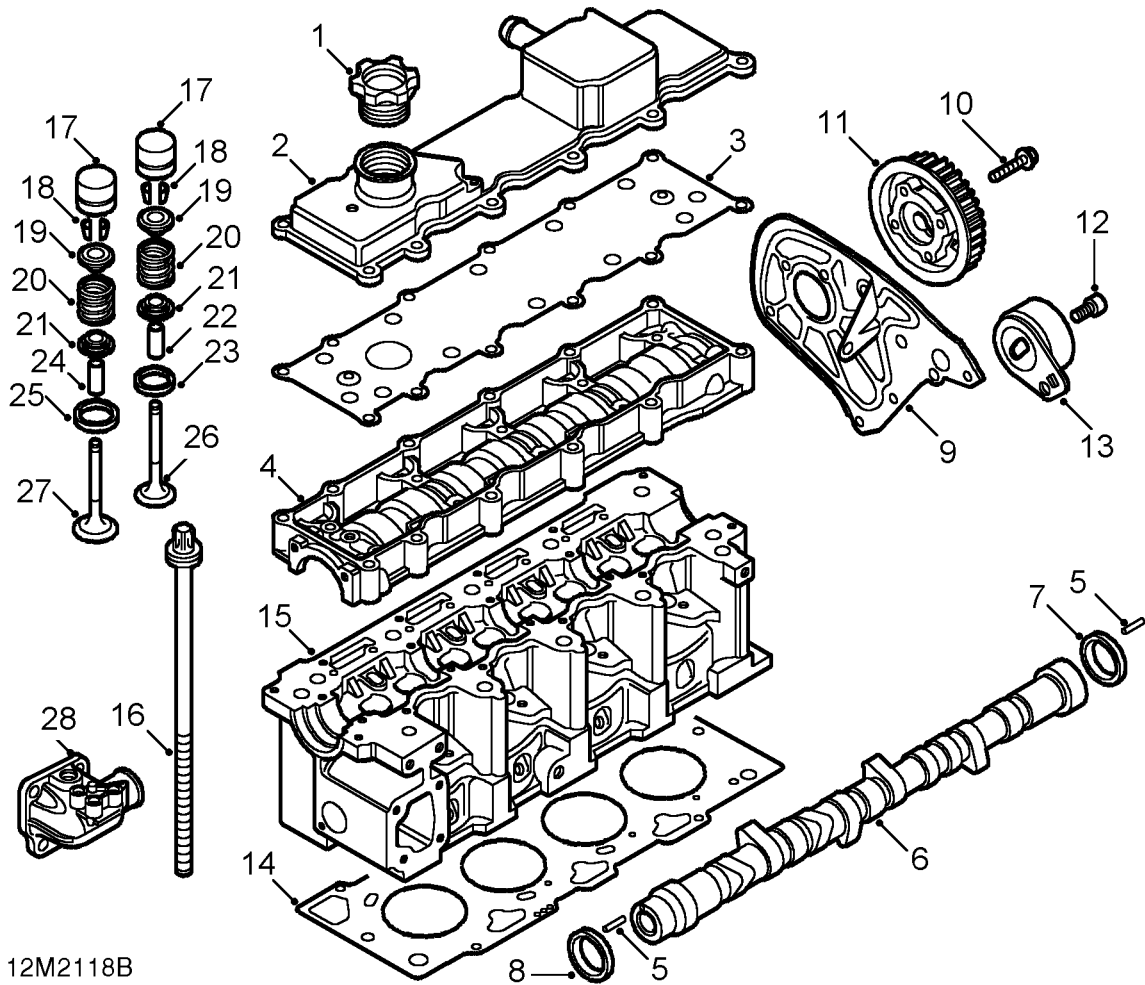
**CYLINDER BLOCK COMPONENTS**

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1. Cylinder block
2. Foam pad
3. Gearbox adaptor plate
4. Circlip - gudgeon pin
5. Gudgeon pin
6. Piston
7. Connecting rod
8. Bolt - connecting rod
9. Big-end bearing shells
10. Big-end bearing cap
11. Crankshaft rear oil seal and housing
12. Top compression ring
13. 2nd compression ring
14. Oil control ring
15. Crankshaft
16. Woodruff key
17. Dipstick
18. Dipstick tube
19. Main bearing cap
20. Thrust washer
21. Upper main bearing shell - grooved
22. Lower main bearing shell - plain
23. Bolt - main bearing cap
24. Gasket - sump
25. Sump
26. 'O' ring
27. Oil strainer and pick-up pipe
28. Bolt - sump
29. Drain plug
30. Sealing washer
31. Oil squirt jet
32. Banjo bolt
33. Gasket - oil pump
34. Oil pump
35. Bolt - M6
36. Bolt - M10
37. Crankshaft front oil seal
38. Sealing ring
39. Oil filter element
40. Timing gear
41. Crankshaft pulley
42. Bolt - crankshaft pulley

# ENGINE

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**CYLINDER HEAD COMPONENTS**

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1. Oil filler cap
2. Camshaft cover
3. Gasket - camshaft cover
4. Camshaft carrier
5. Drive pin
6. Camshaft
7. Camshaft rear oil seal
8. Camshaft front oil seal
9. Fuel injection pump drive belt rear cover
10. Bolt - fuel injection pump drive gear
11. Fuel injection pump drive gear
12. Allen screw
13. Fuel injection pump drive belt tensioner
14. Gasket - cylinder head
15. Cylinder head
16. Bolt - cylinder head
17. Tappet
18. Collets
19. Spring cap
20. Valve spring
21. Spring seat and valve stem oil seal
22. Valve guide - exhaust
23. Valve seat insert - exhaust
24. Valve guide - inlet
25. Valve seat insert - inlet
26. Exhaust valve
27. Inlet valve
28. Coolant outlet elbow

# ENGINE

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## OPERATION

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The 'L' Series 2.0 litre engine is a 4 cylinder, in-line, direct injection diesel engine having 2 valves per cylinder operated by a single overhead camshaft. A cast iron cylinder block incorporates direct bored cylinders, each pair of cylinders being strategically positioned to reduce engine length and give good structural rigidity.

An alloy camshaft carrier is bolted directly to the alloy cylinder head, the camshaft bearing journals are line bored between the two components. The camshaft operates the valves via hydraulic tappets, the camshaft gear, which incorporates a torsional damper, is driven by an internally toothed drive belt by a gear on the front of the crankshaft. Belt tension is achieved by means of a semi-automatic tensioner and an idler pulley is also fitted. A gear on the rear end of the camshaft drives the fuel injection pump belt.

A single spring is fitted to each valve, the valve stem oil seals are moulded onto a metal base which also forms the valve spring seat on the cylinder head. The valve stems run in guides pressed into the cylinder head.

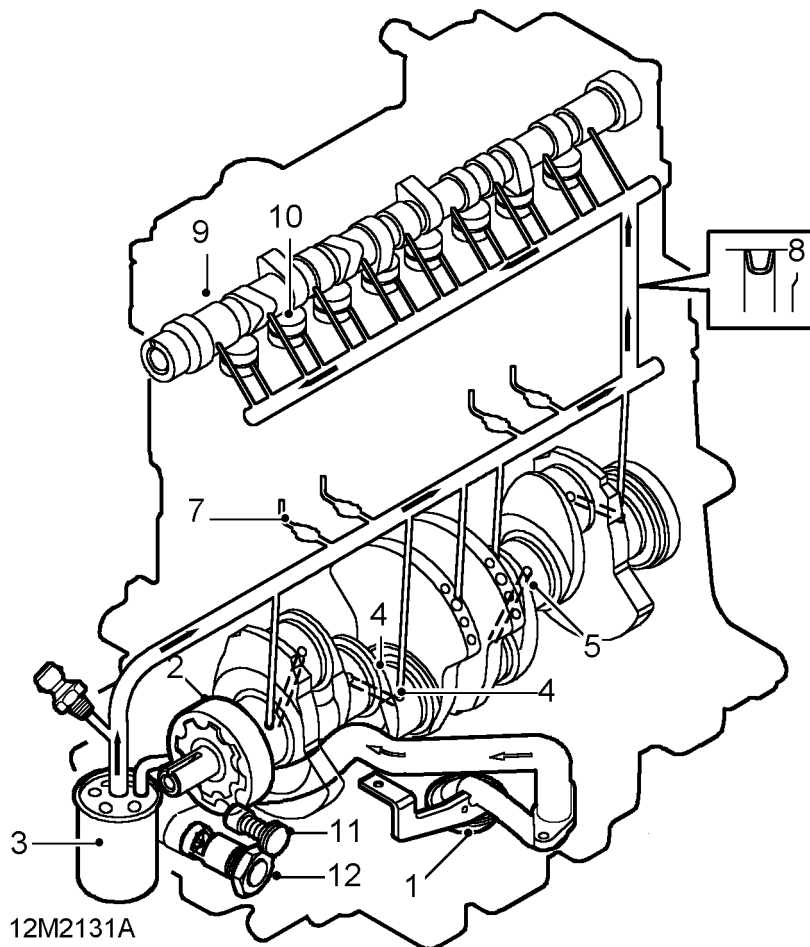
Exhaust valves fitted to later engines are of the carbon break type, a machined profile on the valve stem removes any build up of carbon in the combustion chamber end of the valve guide thereby preventing valves from sticking. These valves may be fitted as replacements to all early engines.

The aluminium alloy, graphite coated pistons are fitted with two compression and an oil control ring, the top ring is located in a steel insert which helps to provide a minimal reaction to compression forces. The piston crowns are domed in the centre, the combustion chamber being formed in a bowl around the dome. Fully floating gudgeon pins retain the pistons to the connecting rods, the pins are offset towards the thrust side of the pistons which are retained in the pistons by circlips. Oil squirt jets, located in the cylinder block provide additional piston cooling and gudgeon pin lubrication. Plain big-end bearing shells without location tags are fitted, with the connecting rod bearing caps retained by flange headed bolts to the connecting rods. The big-end has a 'Fracture Split' type joint between the connecting rod and the bearing cap. To prevent incorrect fitment of the bearing cap to connecting rod, the bolts are off-set by 1mm.

The crankshaft runs in 5 main bearings, grooved shells are fitted in the cylinder block with plain bearing shells in each main bearing cap. Positive location of each main bearing cap is by means of hollow dowels. Crankshaft end-float is controlled by single size thrust washers, located each side of the centre - Number 3 main bearing in the cylinder block. The crankshaft front oil seal is located in the oil pump body whilst the rear oil seal is integral with a housing bolted to the rear of the cylinder block. Additional oil sealing is provided by RTV sealant injected into grooves and along the joint lines of the front main - Number 1 bearing cap and the crankshaft rear oil seal.

A rotor type oil pump is driven from the front of the crankshaft, the pump is sealed to the cylinder block with a gasket.

The cast alloy sump is bolted to the cylinder block and rear main bearing cap and is sealed to the block with a rubber gasket which incorporates location lugs for the block and sump. Compression limiters in the bolt holes prevent distortion of the gasket.



## Lubrication

Oil is drawn through a gauze strainer (1) and through a passage in the cylinder block to the oil pump (2). Pressurised oil flows via the full flow filter (3) to the main oil gallery in the cylinder block. Drillings from the main oil gallery direct oil to the crankshaft main bearings (4) and cross drillings in the crankshaft direct oil to the big-end bearings (5). Additional drillings in the cylinder block supply oil at reduced pressure to the oil squirt jets (7) for piston cooling and gudgeon pin lubrication and via a restrictor (8) in the top of the cylinder block to the rear of the cylinder head. A full length drilling in the cylinder head directs oil to the camshaft journals (9) and tappets (10).

An oil pressure relief valve (11) is located in the oil pump body which also carries the oil filter adapter and the return union for the externally mounted oil cooler.

A thermostatic valve (12), comprising a valve, spring and diverter plug is located in the oil pump body. The oil flow union to the oil cooler is screwed into the end of the diverter plug. The valve is closed during engine warm-up thereby preventing oil flow to the oil cooler. As the oil reaches a pre-determined temperature, the valve opens and allows oil to flow to the cooler.

## Crankcase ventilation

A positive crankcase ventilation system is used to vent crankcase gases to the air induction system.

The gases are drawn from the camshaft cover, through a depression limiting valve and into the turbocharger intake.

As engine speed increases, the depression limiting valve progressively closes thereby limiting the depression in the crankcase.

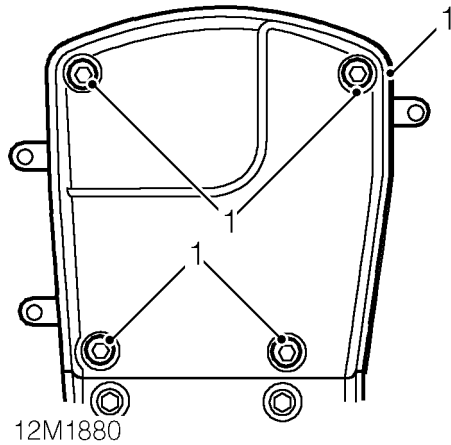




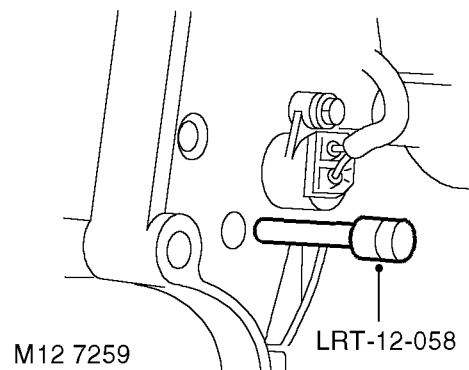
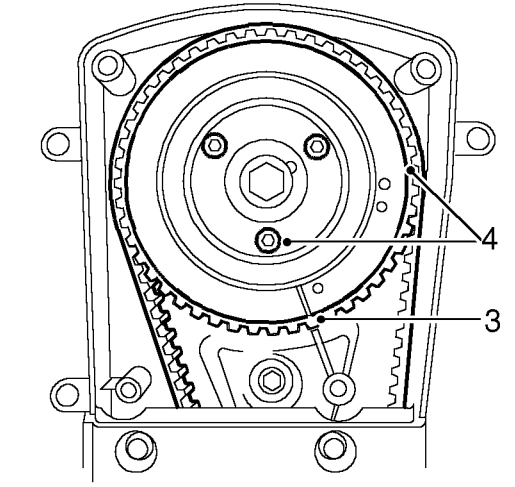


## CAMSHAFT TIMING BELT AND TENSIONER

### Camshaft timing belt - remove



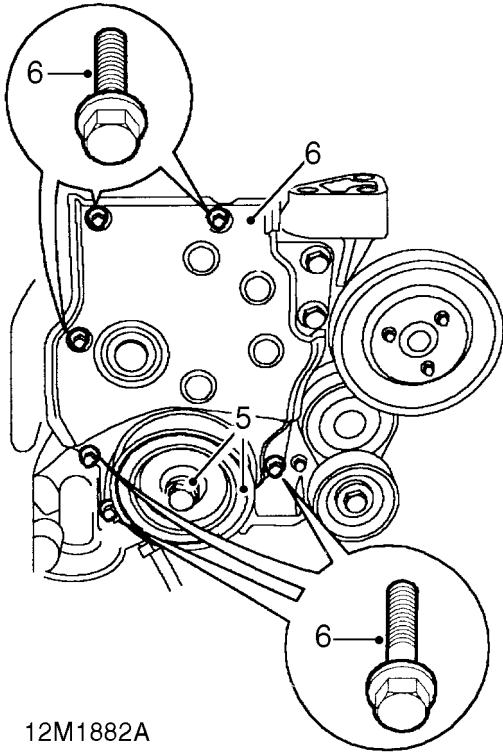
1. Remove 4 screws securing camshaft timing belt upper front cover. Remove cover.



2. Insert timing pin **LRT-12-058** through hole in gearbox adaptor plate, hold pin in contact with flywheel and using assistance, rotate crankshaft clockwise by means of crankshaft pulley bolt until timing pin can be felt to enter hole in flywheel.
3. Check that timing mark on camshaft gear damper is aligned with mark on timing belt upper rear cover.

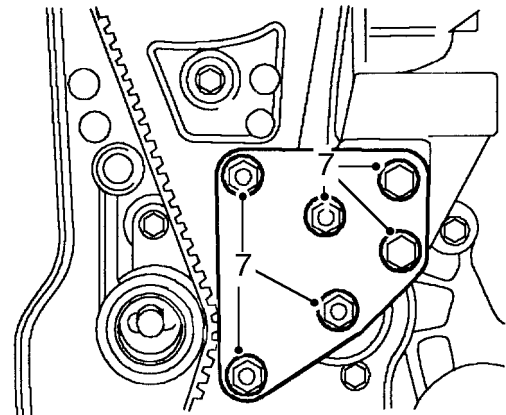
**CAUTION:** Do not use camshaft timing belt gear, fuel injection pump drive belt gear, gear retaining bolts or timing belt to rotate crankshaft.

4. Remove and discard 3 Torx screws securing damper to camshaft gear. Remove damper.



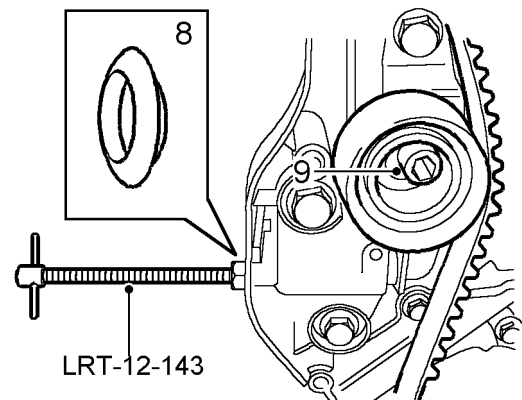
12M1882A

5. Remove crankshaft pulley bolt, withdraw pulley.
6. Noting fitted position of 3 longest screws, remove 6 screws securing camshaft timing belt lower front cover. Remove cover.



12M1883A

7. Remove 4 nuts and 2 bolts securing engine front mounting cover plate, remove plate.



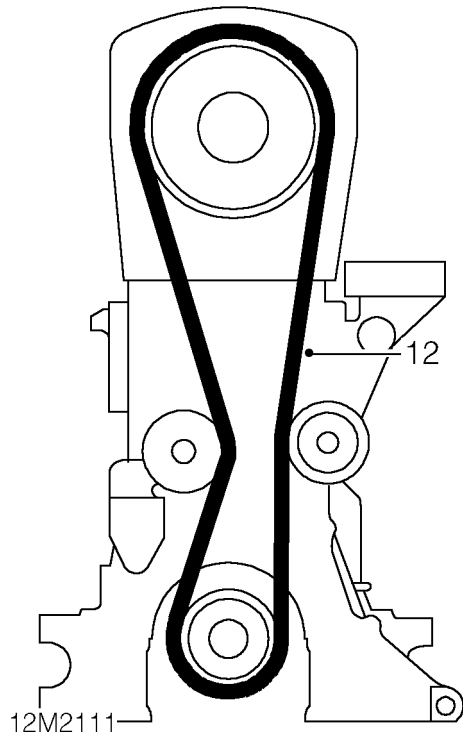
12M4069A

8. Remove timing belt tensioner access plug from camshaft timing belt lower rear cover.
9. Loosen but do not remove Allen screw securing timing belt tensioner pulley.



**NOTE: Later engines - Allen screw is replaced by a bolt.**

10. Screw timing belt tensioner retractor tool **LRT-12-143** into timing belt tensioner plunger.
11. Tighten nut on tool **LRT-12-143** until timing belt tension is released.



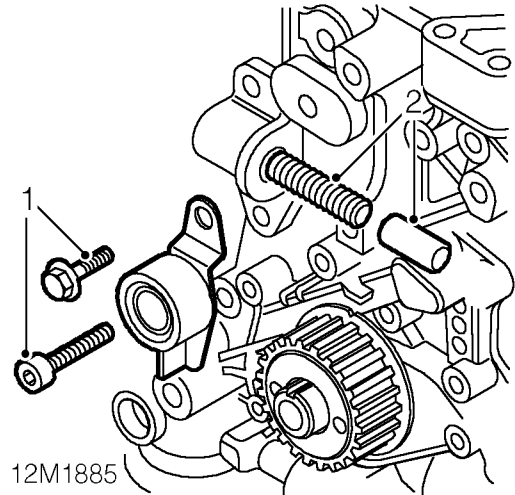
12. Remove and discard camshaft timing belt.



**CAUTION:** Ease timing belt from gears using fingers only, metal levers may damage the belt and gears. Do not rotate camshaft or crankshaft with timing belt removed and cylinder head fitted.

13. Remove tensioner retractor tool **LRT-12-143**.

### Tensioner - remove



1. Remove Allen screw and bolt securing timing belt tensioner. Remove tensioner.



**NOTE:** Later engines - Allen screw is replaced by a bolt.

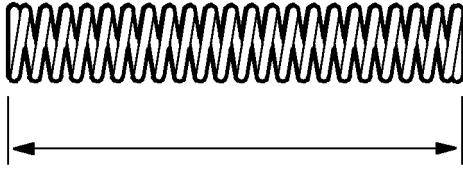
2. Remove tensioner spring and plunger.

# ENGINE

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## Camshaft timing belt tensioner and idler pulley - inspection

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12M1886

1. Check tensioner spring for distortion, check spring free length:  
Free length = 65 mm.
2. Check tensioner plunger and bore of housing for wear and corrosion.



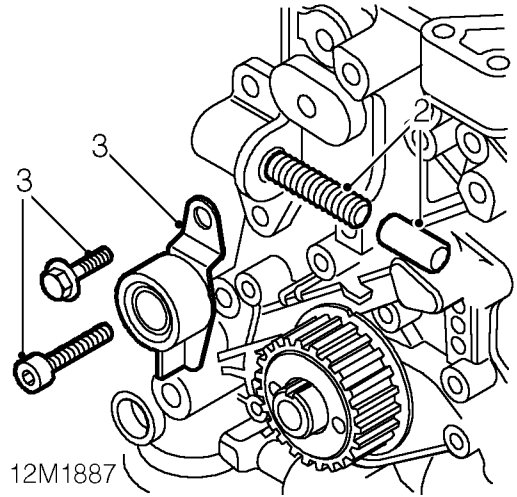
**CAUTION: Do not attempt to remove corrosion by means of emery cloth, components must be replaced.**

3. Check that tensioner and idler pulleys rotate smoothly and belt surfaces are smooth and clean.

## Tensioner - refit

---

1. Ensure that bore of plunger housing is clean.



12M1887

2. Smear tensioner plunger with molybdenum disulphide based grease, locate spring and plunger in housing.
3. Position tensioner on cylinder block, fit and tighten bolt to 45 Nm, fit but do not fully tighten Allen screw or bolt.



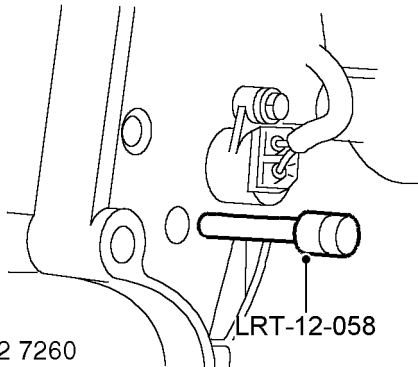
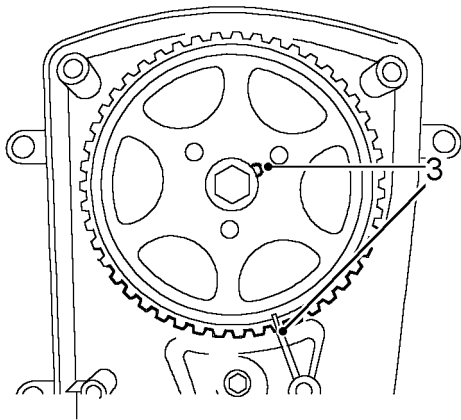
### Camshaft timing belt - refit and adjust

1. Clean tensioner and idler pulleys and timing belt gears.



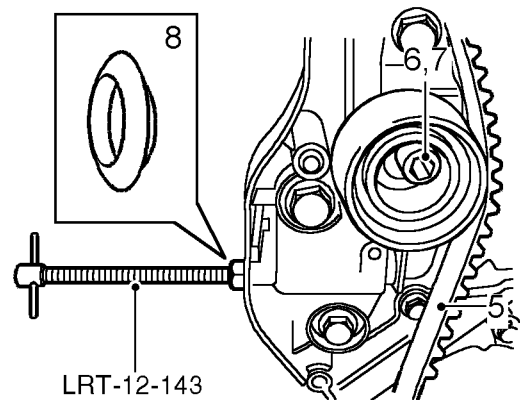
**CAUTION:** If the sintered gears have been subjected to prolonged oil contamination, they must be soaked in a solvent bath and then thoroughly washed in clean solvent before refitting.

2. Check that camshaft timing belt upper and lower cover sealing strips are correctly located in covers.



M12 7260

3. Ensure that timing pin **LRT-12-058** is inserted in flywheel, and camshaft gear timing mark is aligned exactly with pointer on timing belt upper rear cover.



M12 7261

4. Screw timing belt tensioner retractor tool **LRT-12-143** into tensioner plunger. Tighten nut on tool to fully retract tensioner.
5. Using the fingers only, ease a new timing belt over crankshaft and camshaft gears keeping it as taut as possible on the idler pulley side.
6. Loosen Allen screw until tensioner pulley moves easily without tipping.



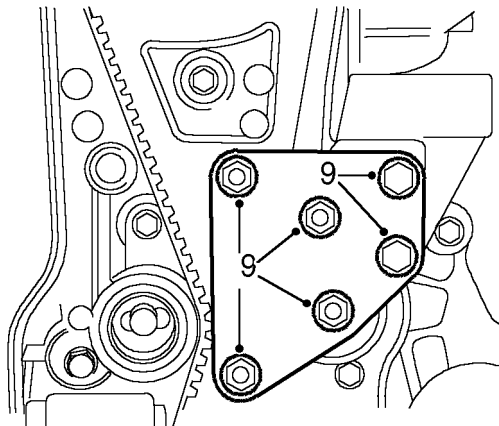
**NOTE:** Later engines - Allen screw is replaced by a bolt.

7. Loosen nut on tool **LRT-12-143** until tensioner is released; tighten Allen screw or bolt to 55 Nm and remove tool.



**CAUTION:** Do not exceed specified torque figure.

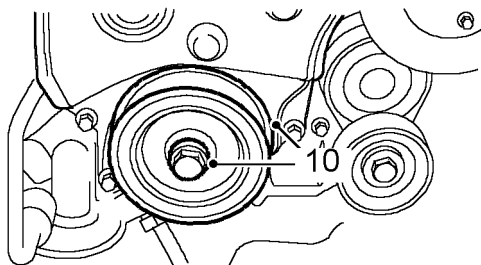
8. Insert timing belt tensioner access plug into lower rear cover.



12M4169

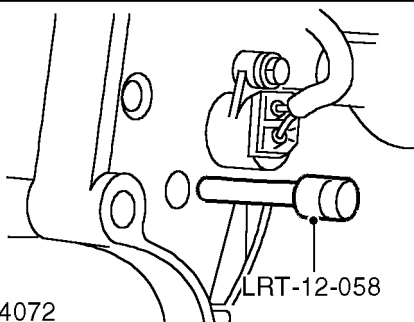
**CAUTION:** If engine front mounting plate was removed, clean all traces of Loctite from plate and cylinder block. Reseal plate to block using Loctite 638.

- Fit engine front mounting plate, fit 4 nuts and 2 bolts and tighten bolts to 45 Nm and nuts to 30 Nm then further 120°.



12M4072

- Locate crankshaft pulley on crankshaft, fit and lightly tighten bolt.
- Remove timing pin **LRT-12-058**.

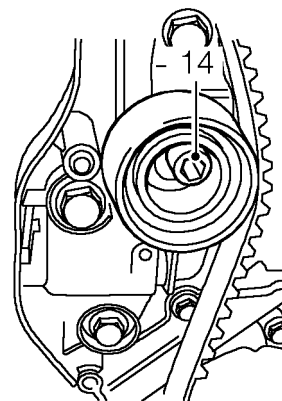


- Using crankshaft pulley bolt, rotate crankshaft 2 turns clockwise and refit timing pin **LRT-12-058**.



**CAUTION:** Do not use camshaft timing belt gear, gear retaining bolt or timing belt to rotate crankshaft.

- Check that camshaft gear timing mark is aligned exactly with pointer on timing belt upper rear cover.



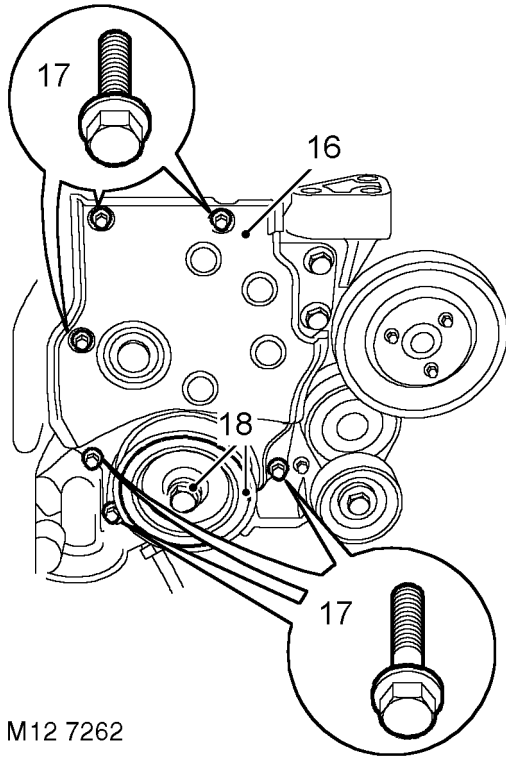
12M1932

- Loosen Allen screw or bolt until tensioner pulley moves to tension belt then tighten screw or bolt to 55 Nm.



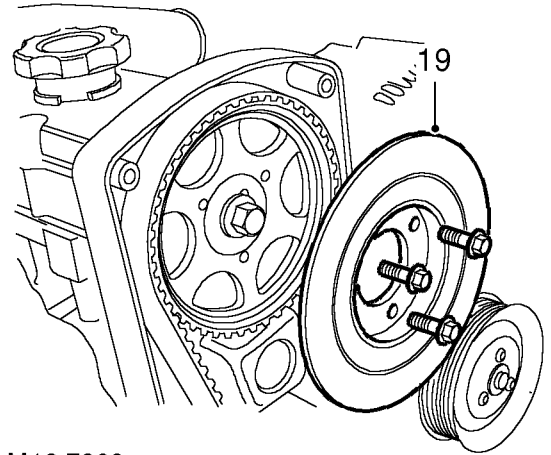
**CAUTION:** Do not exceed specified torque figure.

- Remove crankshaft pulley bolt and pulley.



M12 7262

16. Position camshaft timing belt lower front cover to timing belt lower rear cover.
17. Fit lower front cover securing screws ensuring that 3 longest screws are in correct fitted position, tighten all screws to 5 Nm.
18. Fit crankshaft pulley and bolt, tighten bolt to 63 Nm then a further 90°. Remove timing pin **LRT-12-058**.



M12 7263

19. Fit camshaft gear damper, ensuring that the timing mark on the damper is aligned to the timing mark on the camshaft gear.
20. Fit new Torx screws and tighten to 10 Nm.

**NOTE:** Do not fit camshaft timing belt upper front cover until engine has been installed in vehicle and FIP timing belt has been fitted and adjusted.

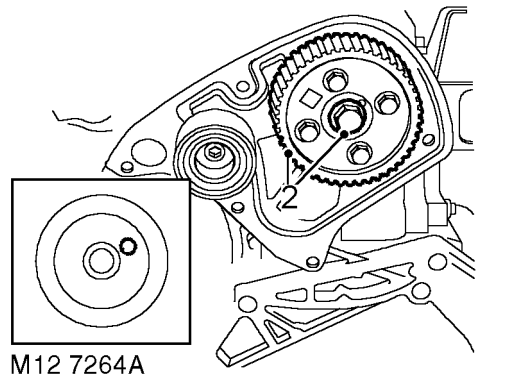
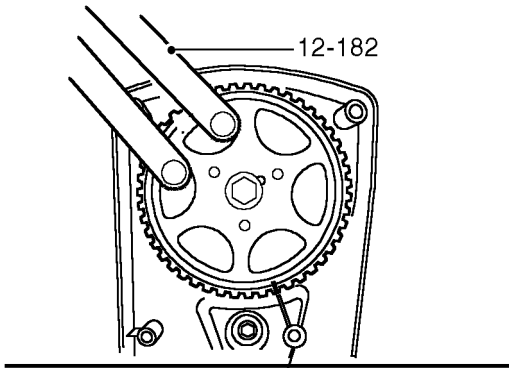


# ENGINE

## CYLINDER HEAD ASSEMBLY

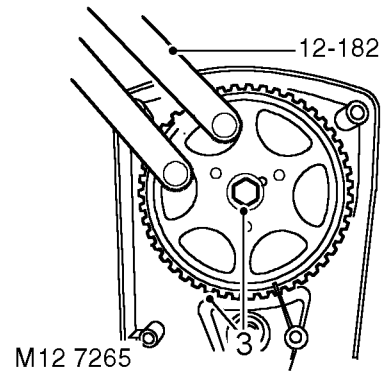
### Remove

1. Remove and discard camshaft timing belt.



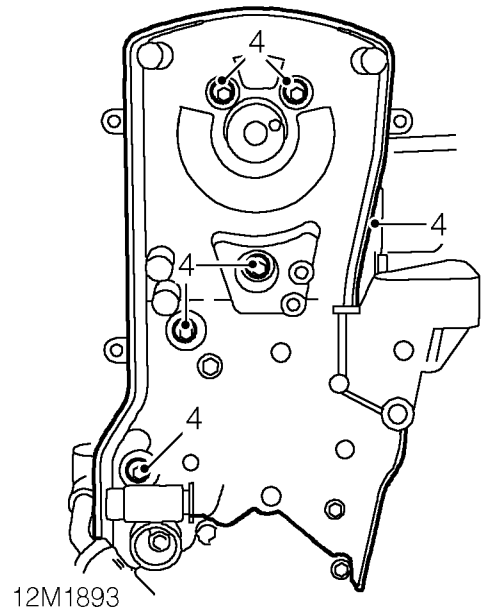
2. Restrain camshaft timing belt gear using tool **12-182** and remove bolt securing fuel injection pump drive belt gear to camshaft, remove gear, discard bolt.

**CAUTION:** Ensure camshaft does not rotate when removing bolt and do not rotate crankshaft or camshaft with timing belt removed and cylinder head fitted.



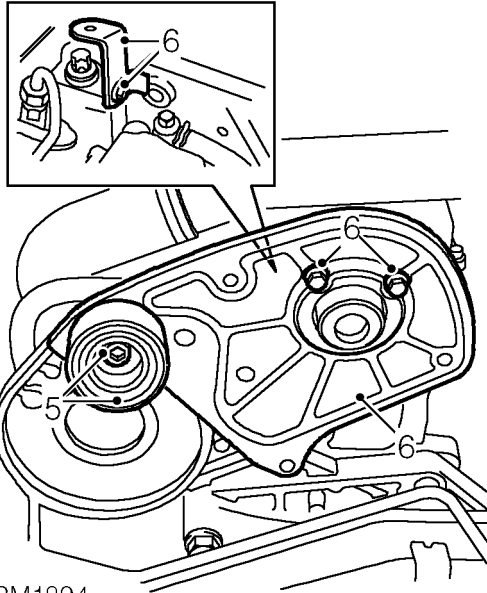
3. Restrain camshaft timing belt gear using tool **12-182** and remove bolt securing camshaft timing belt gear. Remove gear and discard bolt.

**CAUTION:** Ensure camshaft does not rotate when removing bolt and do not rotate crankshaft or camshaft with timing belt removed and cylinder head fitted.



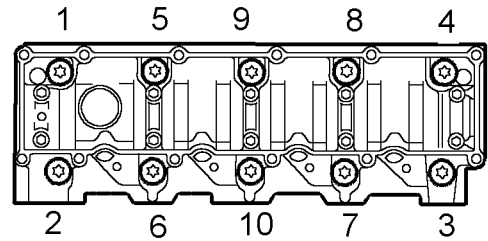
4. Remove 5 screws securing camshaft timing belt upper rear cover, remove cover, recover sealing strip.

**NOTE:** Shortest screws are fitted in camshaft carrier.



12M1894

5. Remove Allen screw securing fuel injection pump drive belt tensioner, remove tensioner.
6. Remove 3 screws securing fuel injection pump drive belt rear cover, remove cover and collect bracket.
7. Progressively loosen then remove 12 bolts securing camshaft cover.
8. Remove camshaft cover and discard gasket.



M12 6088

9. Using sequence shown, progressively loosen then remove 10 Torx bolts and washers.



**CAUTION: Keep bolts in their fitted order, do not attempt to remove washers from bolts.**

10. Using assistance, remove cylinder head assembly and support each end of cylinder head on blocks of wood to protect valves which, when open, protrude below face of cylinder head.



**CAUTION: Cylinder head is dowel located, do not tap it sideways to free it from cylinder block.**

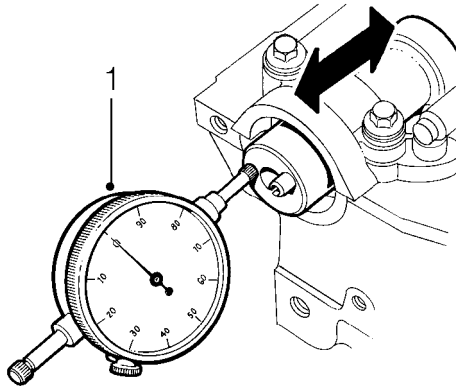
11. Remove and discard cylinder head gasket.

# ENGINE

## Camshaft - check end-float



**NOTE:** Prior to removing the camshaft, check end-float.



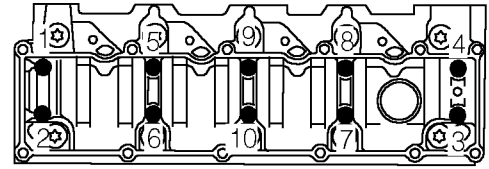
12M1897

1. Position a suitable DTI to front of camshaft. Move camshaft rearwards and zero DTI. Move camshaft forwards and measure end-float: End-float - maximum = 0.51 mm.



**CAUTION:** Camshaft end-float is controlled by the width of Number 1 bearing in the camshaft carrier. If end-float exceeds the above dimension, remove the camshaft and repeat the end-float check using a new camshaft. If end-float still exceeds the maximum, a new cylinder head and camshaft carrier assembly must be fitted.

## Camshaft - remove



12M1898

1. Using sequence shown, loosen the 10 camshaft carrier retaining bolts 2 to 3 turns.



**CAUTION:** Do not fully remove bolts at this stage.

2. Gently tap the camshaft carrier upwards to break the sealant bond.



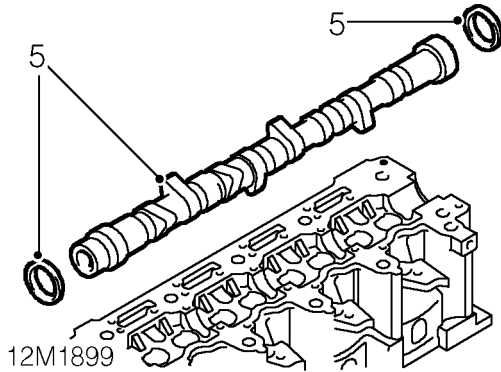
**CAUTION:** Camshaft carrier is dowel located, do not tap it sideways.

3. Using the same sequence, continue to progressively loosen the carrier retaining bolts until all loading is removed from the carrier.

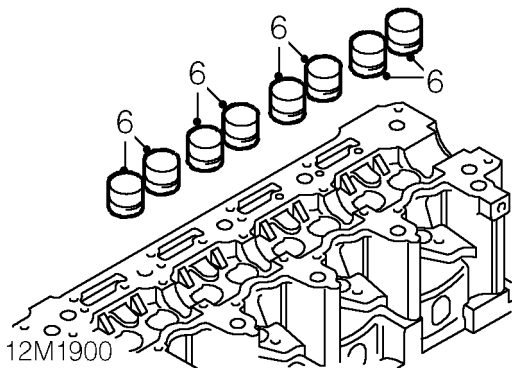


**CAUTION:** If bolts are removed completely before loading is removed from the camshaft carrier, the carrier may be suddenly released and damage caused as a result.

4. Remove retaining bolts, remove camshaft carrier.



5. Remove camshaft, remove and discard front and rear oil seals.



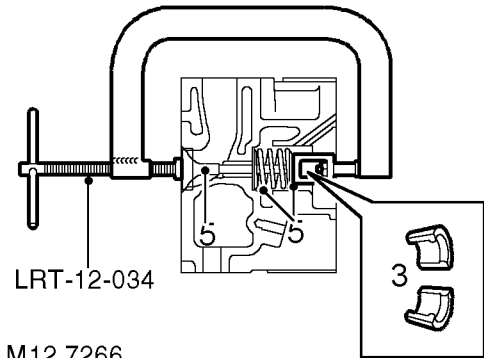
6. Using a stick magnet, remove 8 tappets from the cylinder head.



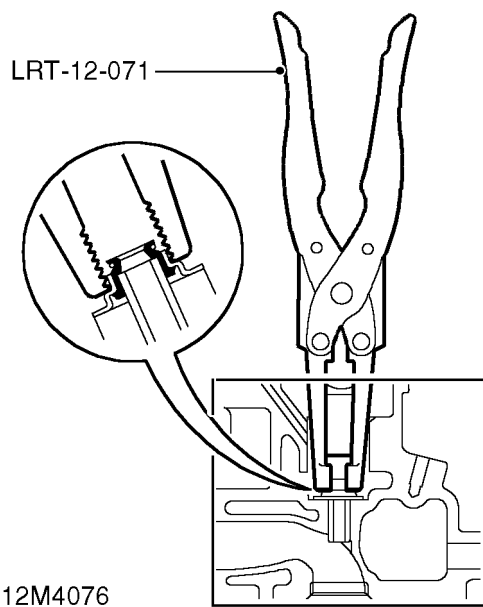
**CAUTION:** Keep tappets in their fitted order and store inverted to prevent oil loss. Do not squeeze tappet chambers together.

### Valves and springs - remove

1. Support cylinder head clear of valves, use a hollow drift and tap each spring cap to free collets.



2. Using tool **LRT-12-034**, compress valve spring.  
 3. Remove 2 collets from valve stem using a stick magnet.  
 4. Remove tool **LRT-12-034**.  
 5. Remove spring cap and valve spring, remove valve.



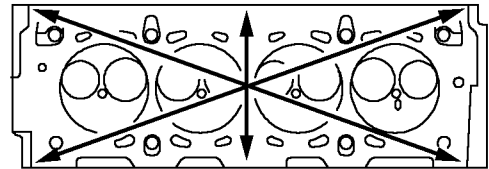
6. Using tool **LRT-12-071**, remove valve stem oil seal; discard seal.
7. Repeat above operations to remove remaining valves.



**CAUTION: Keep component parts of each valve assembly in their fitted order.**

## Cylinder head - inspection

---



12M1903

1. Check cylinder head for warping across centre and from corner to corner:  
Maximum warp = 0.10 mm



**CAUTION: Cylinder head may not be refaced. Replace head assembly if warping exceeds figure given.**

2. Check tappet bores for scoring and signs of wear or damage. Slight scoring or burring may be removed using fine emery cloth.



### Tappets - inspection

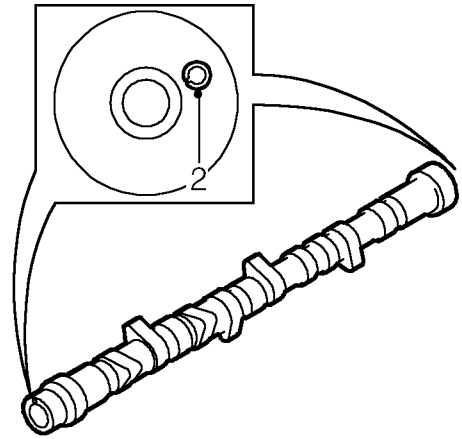
1. Check tappets for signs of wear, scoring and overheating, replace as necessary.
2. Ensure oil hole in each tappet is clear.
3. Check outside diameter of each tappet:  
Diameter = 34.959 to 34.975 mm.



**CAUTION:** Keep tappets in their fitted order and store inverted to prevent oil loss. Do not squeeze tappet chambers together.

### Camshaft and bearings - inspection

1. Check camshaft cams and bearing journals for signs of scoring and excessive wear.



12M1904

2. Check camshaft timing belt gear and fuel injection pump drive belt gear drive pins for damage and wear, replace if necessary ensuring that split in pin faces towards centre of camshaft.
3. Check bearing journals in cylinder head and camshaft carrier for signs of scoring and excessive wear.



**CAUTION:** Cylinder head and camshaft carrier are machined together as an assembly. If bearing journals in either component are found to be damaged, complete assembly must be replaced.

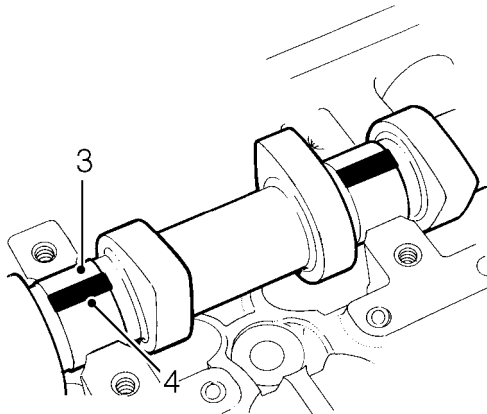
# ENGINE

## Camshaft bearings - check clearance

1. Clean all traces of oil from camshaft, cylinder head and camshaft carrier.
2. Use suitable cleaning solvent and remove all traces of sealant from cylinder head and camshaft carrier.

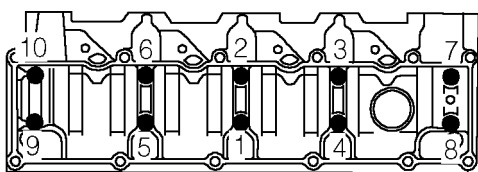


**CAUTION: Do not use a metal scraper.**



12M1905

3. Position camshaft in cylinder head.
4. Place a piece of Plastigage along the centre line of each camshaft journal.
5. Support each end of cylinder head on blocks of wood.

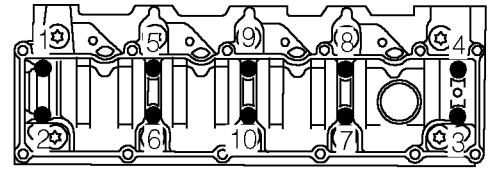


12M1906

6. Carefully fit the camshaft carrier, fit 10 retaining bolts and tighten in sequence shown to 11 Nm.

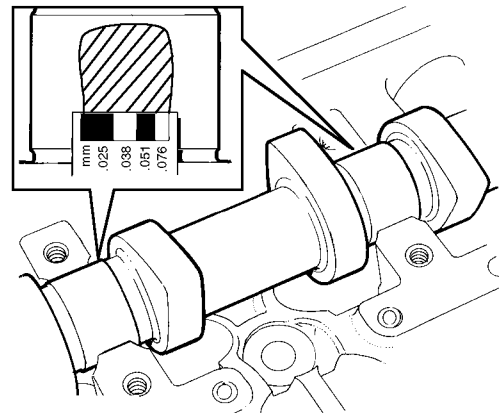


**CAUTION: Do not rotate camshaft.**



12M1898

7. Using sequence shown, progressively loosen, then remove 10 retaining bolts.
8. Carefully remove camshaft carrier.



12M1907

9. Measure and record widest portion of Plastigage on each camshaft journal.
10. Compare figures obtained with camshaft bearing clearance:  
Bearing clearance = 0.043 to 0.094 mm
11. If any bearing clearance is found to be excessive, repeat the above procedure using a new camshaft.

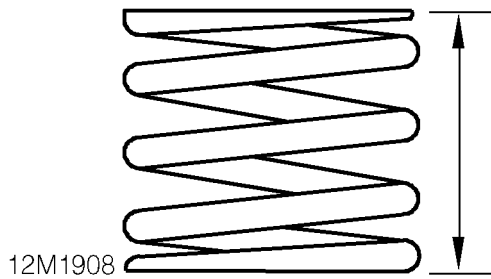


**CAUTION: If, after repeating the bearing clearance check with a new camshaft the clearances are still excessive, a new cylinder head and camshaft carrier assembly must be fitted.**

12. Remove Plastigage using an oily cloth, do not use a scraper.



### Valve springs - inspection

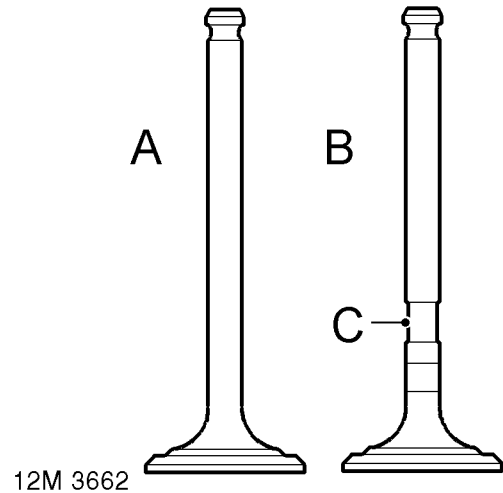


1. Check valve springs free length:  
Free length = 37mm



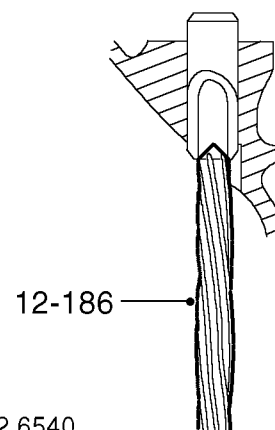
**CAUTION:** Valve springs must be replaced as a set.

### Valves and valve guides - inspection



**NOTE:** Two types of exhaust valve may be fitted, standard valves - A in illustration or carbon break valves - B in illustration. Carbon break valves may be identified by the machined profile - C on the valve stem. To prevent valves from sticking, standard valves should be replaced with carbon break valves during engine overhaul.

1. Clean carbon from valves, check valves for burning, pitting or cracking; replace as necessary.



M12 6540

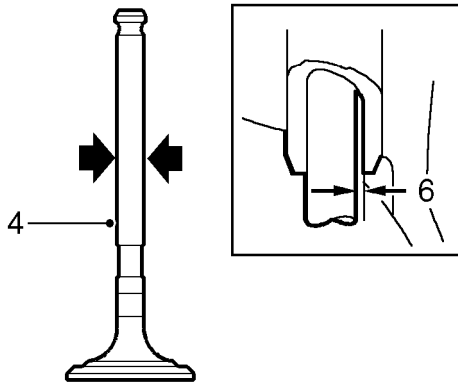
2. Remove carbon deposits from valve guides using tool **12-186**.



**CAUTION:** Tool must be inserted from combustion chamber face side of cylinder head.

3. Remove carbon from valve seat inserts; remove all loose particles of carbon on completion.





M12 6541

4. Check and record diameter of each valve stem, replace any valve if diameter is less than specified.  
Inlet = 6.907 to 6.923 mm.  
Exhaust = 6.897 to 6.913 mm.
5. Check inlet and exhaust valve to guide clearances using the following procedures:
  6. Insert a valve into its respective guide.
  7. Extend valve out of seat by 10 mm.
  8. Position a DTI gauge on to rear side of valve head. Move valve towards front of cylinder head, pre-load gauge to valve head and zero gauge. Move valve towards rear of cylinder head, record gauge reading obtained to give valve stem to guide clearance.
9. Repeat above procedures for remaining valves.  
Maximum valve to guide clearance:  
Inlet valve = 0.056 mm.  
Exhaust valve = 0.066 mm
10. Renew any guide and its associated valve if movement/clearance is excessive.

## Valve guides - renew

1. Check area on camshaft side of cylinder head around valve guide to be replaced for marks denoting previous valve guide replacement:  
+ denotes 1st replacement  
- denotes 2nd replacement

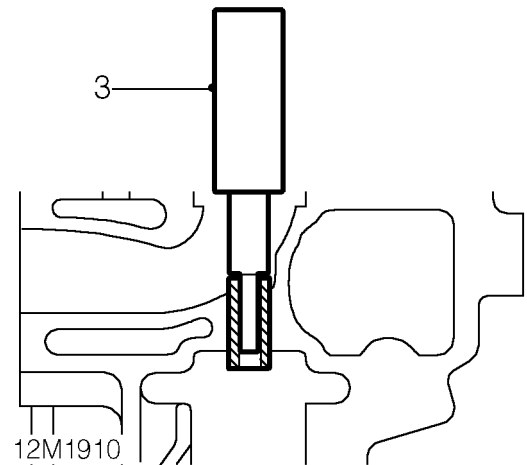


**CAUTION: Valve guides may only be replaced twice.**

2. Heat cylinder head uniformly to a temperature of 120°C.



**WARNING: Take care when handling hot cylinder head.**

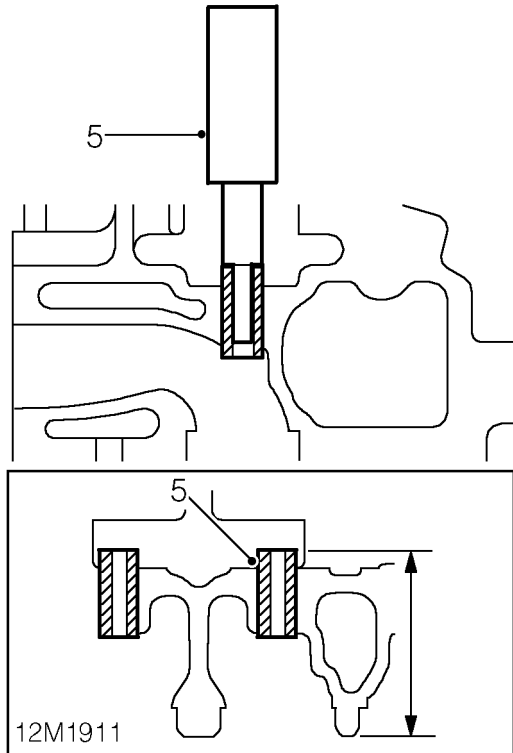


3. Using a suitable piloted mandrel, press valve guide out of cylinder head from combustion face side; discard guide.



**NOTE: Only one size of replacement guide is available.**

4. Reheat cylinder head to 120°C.



5. Using the piloted mandrel, press replacement valve guide into cylinder head from camshaft side of head until fitted height of guide from combustion face side of cylinder head to top of guide is 61.1 to 61.7 mm
6. Allow cylinder head to air cool.
7. Ream bores of replacement valve guide ensuring that reamer is kept perpendicular to and concentric with valve seat.  
Valve guide bore diameter = 6.950 to 6.963 mm

**!** **CAUTION: If valve seat insert has also been replaced, guide and insert must be machined together.**

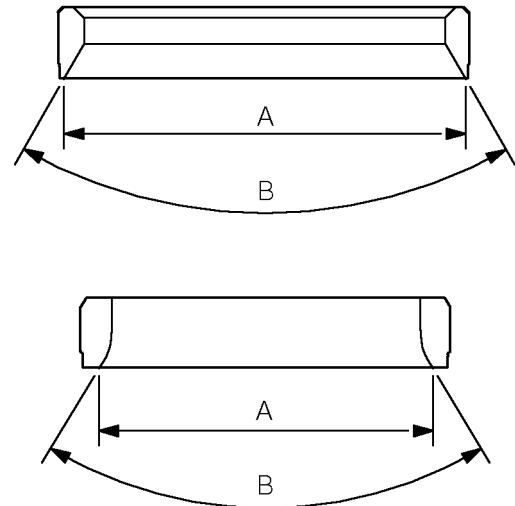
8. Suitably mark cylinder head on camshaft side of head to denote that guide has been replaced.  
1st replacement guide +  
2nd replacement valve guide -

**!** **CAUTION: A new valve must always be fitted whenever a guide is replaced.**

## Valve seat inserts and valves - refacing and lapping-in

### Refacing valve seat inserts

1. Check valve seat inserts for pitting and burning, if necessary, valve seats may be refaced providing valve head stand down is within limits after refacing.



12M1912

2. Using valve seat cutter pilot **MS 76**, and a 60° cutter, tool **MS 76-111**, cut valve seat insert to correct angle and width:

Inlet valve seat insert:

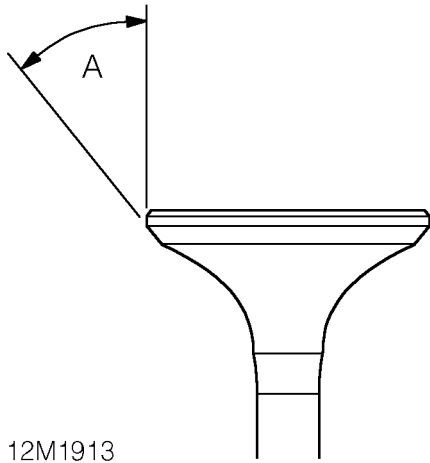
Seat width A = 35.697 mm

Seat angle B = 60°

Exhaust valve insert:

Seat width A = 31.05 to 31.55 mm

Seat angle B = 58° to 62°

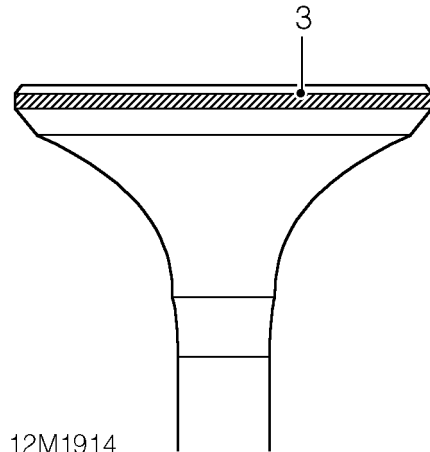


12M1913

3. Check face angle **A** of each valve, renew any valve with incorrect face angles, do not attempt to recut.  
Valve face angle - Inlet and exhaust =  $45^{\circ}$  to  $45^{\circ}30'$ .

## Lapping-in valves

1. Lap each valve to its seat using grinding paste.
2. Apply Prussian Blue to valve seat, insert valve into guide and press it firmly, without rotating, on to seat.



12M1914

3. Remove valve and check that a continuous, even line of Prussian Blue has been transferred on to valve face; continue lapping-in valve as necessary.

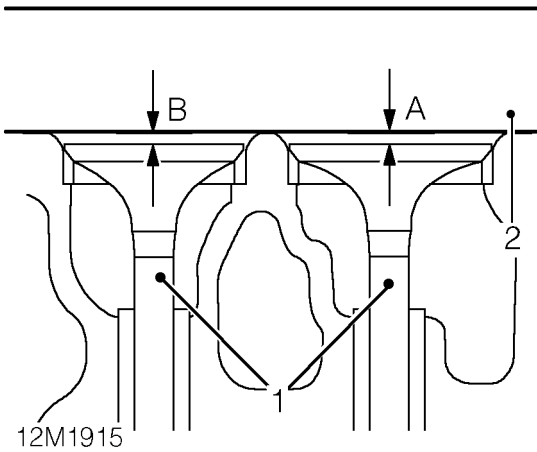


**NOTE:** Line does not have to be across whole width of valve face.

4. On completion of lapping-in, check valve head stand down. **See this section**



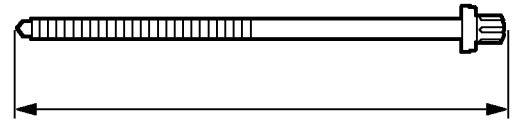
## Valve head stand down



1. Insert each valve into its respective guide.
2. Using a straight-edge and feeler gauges, check and record stand down of each valve head.
3. Compare figures obtained with figures given below. If any valve has a stand down greater than specified, valve seat insert and valve must be replaced:  
 Valve head stand down:  
 Inlet valve **A**= 1.45 mm.  
 Exhaust valve **B**= 1.35 mm.

## Cylinder head bolts - inspection

1. Keeping bolts in their fitted order, clean bolts and washers, lightly oil threads.



12M1916

2. Check bolt heads and threads for damage, replace individual bolts as necessary.
3. Check length of bolt from top of bolt head to end of bolt. If any bolt exceeds 243.41 mm in length, all 10 bolts and washers must be replaced.



**CAUTION: Do not attempt to remove washers from bolts. Keep bolts in their original fitted order.**

# ENGINE

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## Cylinder head and camshaft carrier - cleaning

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**CAUTION: Use a suitable solvent to remove old sealant from cylinder head and camshaft carrier faces.**

1. Clean mating surfaces of cylinder head and camshaft carrier, remove any deposits from camshaft oil seal recesses using a plastic scraper.
2. Clean gasket material from cylinder head and block using gasket removal spray and plastic scraper.



**CAUTION: Do not use a metal scraper.**

3. Clean all traces of carbon from combustion face areas.
4. Blow out all oilways and waterways.
5. Ensure threaded holes in cylinder block and camshaft carrier are clean and dry.
6. Check core plugs for corrosion and signs of leakage and replace if necessary; use Loctite 577 to seal replacement plugs.

## Valves - assembling

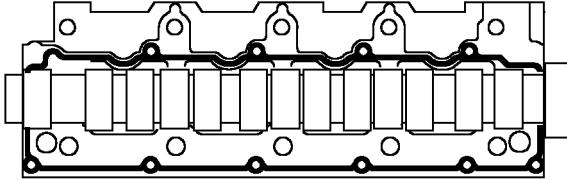
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1. Lubricate valve stem oil seals, valve guides, valve stems, spring caps and springs with engine oil.
2. Using tool **LRT-12-071**, fit new valve stem oil seals.
3. Assemble valves, springs and spring caps ensuring that they are in their correct fitted order.
4. Compress valve springs using tool **LRT-12-034**, fit collets, remove tool.
5. Using a wooden dowel and mallet, tap each spring cap lightly to seat collets.



## Tappets and camshafts - assembling

1. Lubricate tappets and tappet bores with engine oil. Fit tappets ensuring they are in their correct fitted order.



M12 7267

2. Apply a continuous bead of sealant, Part No. GUG 705963GM to paths on cylinder head as shown then spread to an even film using a roller.

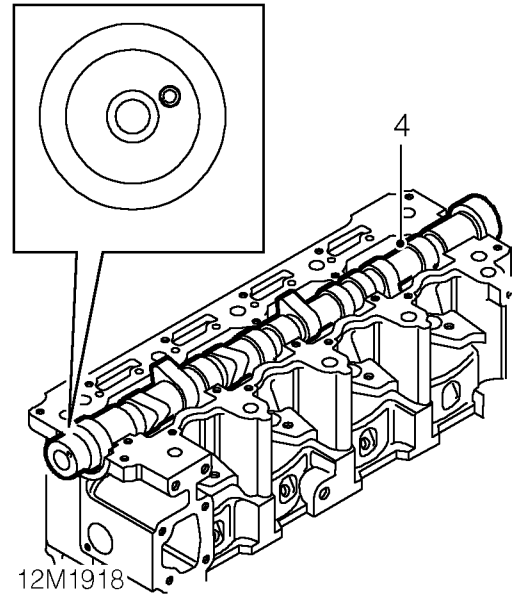


**CAUTION: Ensure sealant does not block oilways or is spread on to bearing journals. Assembly must be completed within 20 minutes of applying sealant.**

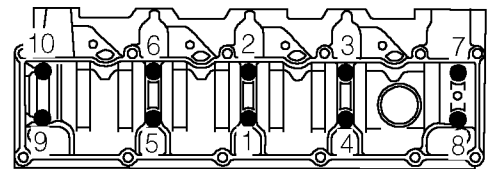
3. Lubricate cams and bearing journals on camshaft, cylinder head and camshaft carrier with engine oil.



**CAUTION: Do not lubricate oil seal running surfaces on camshaft.**



4. Position camshaft in cylinder head with camshaft timing belt gear drive pin at approximately 2 o'clock position.
5. Fit camshaft carrier, fit and lightly tighten bolts.



12M1906



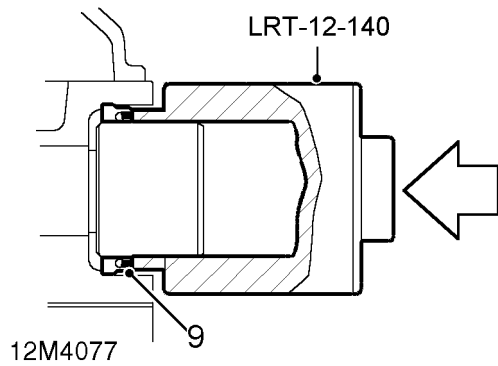
**CAUTION: With camshaft carrier bolted down, some valves will protrude below face of cylinder head; support each end of cylinder head on blocks of wood.**

6. Using sequence shown, progressively tighten camshaft carrier bolts to 11 Nm.



**CAUTION: Bolts must be tightened to correct torque within 20 minutes of applying sealant.**

7. Check that all bolts are tightened to the correct torque.



8. Ensure tool **LRT-12-140** is clean.
9. Fit oil seals using using tool **LRT-12-140**.

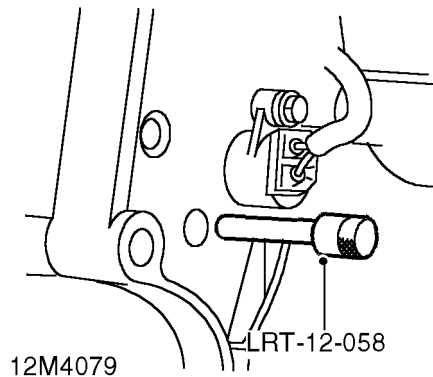
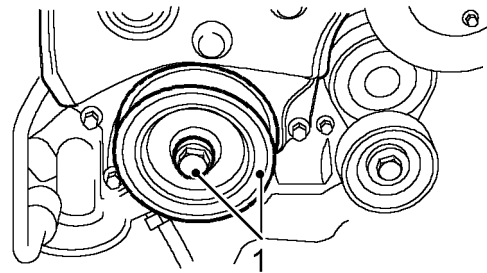


**CAUTION: Oil seals must be fitted dry.**

## Cylinder head gasket selection

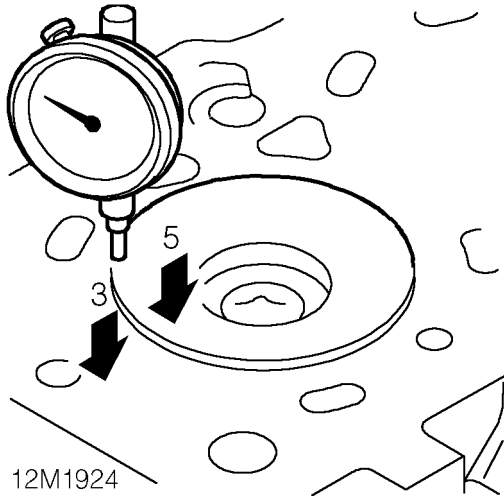


**NOTE:** There are three thicknesses of cylinder head gasket available and in order that the correct gasket is fitted, it is necessary to determine the stand proud (protrusion) of each piston above the top face of the cylinder block.



**NOTE:** Gaskets have either 1, 2 or 3 identification holes and the following procedure must be followed in order that the correct gasket is selected.

1. Temporarily assemble pulley to crankshaft, fit pulley bolt and washer and lightly tighten bolt.
2. Remove timing pin **LRT-12-058** - if fitted.



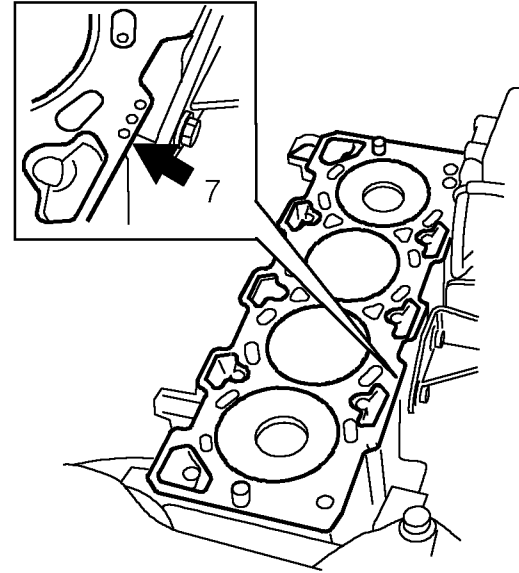
12M1924

3. Assemble a magnetic base DTI to cylinder block top face, zero DTI with stylus touching block top face.
4. Rotate crankshaft in a clockwise direction until Number 1 piston is at TDC.
5. Position stylus near edge of piston crown, measure and record Number 1 piston protrusion.



**NOTE: Measurement must be taken at front and rear of piston.**

6. Repeat above procedure for remaining pistons.



12M1923

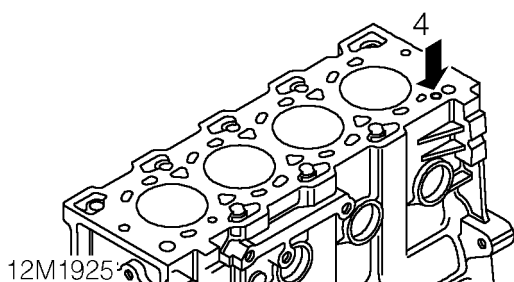
7. From readings obtained, determine highest piston protrusion figure and select the appropriate cylinder head gasket:
  - Protrusion 0.10 to 0.25 mm - Select gasket with one identification hole.
  - Protrusion 0.25 to 0.40 mm - Select gasket with two identification holes.
  - Protrusion 0.40 to 0.55 mm - Select gasket with three identification holes.



# ENGINE

## Cylinder head - refit

1. Fit crankshaft pulley bolt and washer and lightly tighten bolt.
2. Remove timing pin **LRT-12-058**.
3. Ensure that cylinder block and head faces are clean and dry and that all traces of gasket material have been removed. Check that cylinder head location dowels are fitted in cylinder block.



4. Check that oil feed restrictor in cylinder block is clear and that restrictor is below block face.
5. Ensure that cylinder head bolt holes in cylinder block are clean and dry.
6. Using crankshaft pulley bolt, rotate crankshaft **anti-clockwise** until Numbers 1 and 4 pistons are approximately 25 mm below cylinder block top face.
7. Position camshaft timing gear drive pin at 2 o'clock.
8. Position selected cylinder head gasket on cylinder block ensuring that it is correctly orientated.



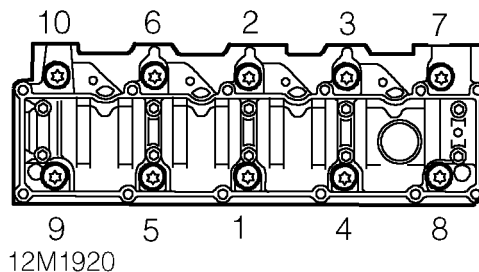
**CAUTION: Gasket must be fitted dry.**

9. Using assistance, fit cylinder head ensuring that it is correctly located on dowels.
10. Lubricate cylinder head bolt threads and undersides of bolt heads with engine oil.



**CAUTION: Do not oil undersides of washers.**

11. Carefully enter cylinder head bolts in their fitted order. **DO NOT DROP BOLTS INTO CYLINDER BLOCK.**

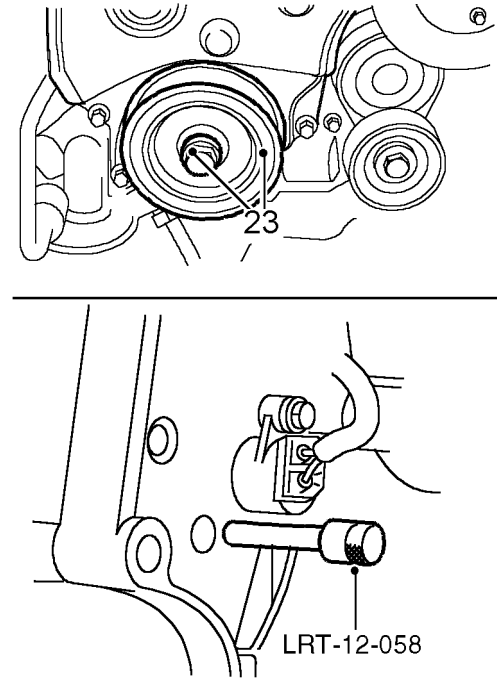
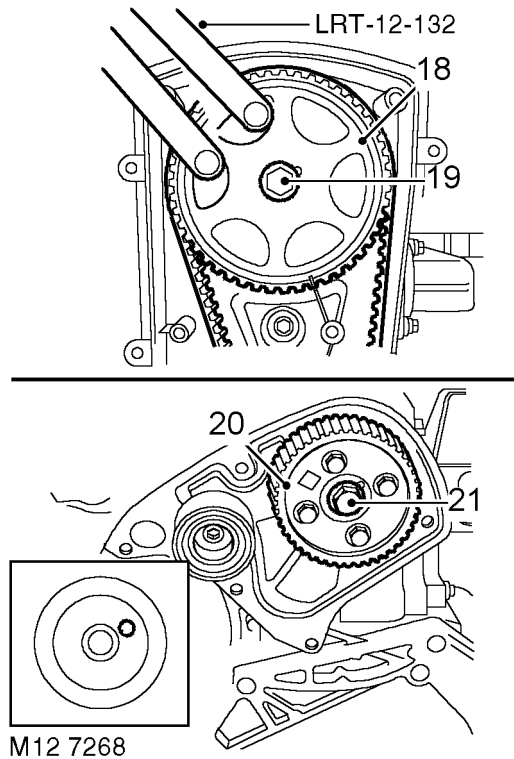


12. Using sequence shown, tighten cylinder head bolts to:  
Stage 1 - 30 Nm  
Stage 2 - 65 Nm  
Stage 3 - Further 90°  
Stage 4 - Further 90°



**CAUTION: Ensure that correct tightening sequence is followed for all four tightening stages.**

13. Fit fuel injection pump drive belt rear cover and mounting bracket, fit 3 screws and tighten to 8 Nm.
14. Fit fuel injection pump drive belt tensioner, fit but do not fully tighten Allen screw.
15. Ensure sealing strip is correctly located on camshaft timing belt upper rear cover.
16. Fit upper rear cover ensuring that 2 shortest screws are fitted in camshaft carrier.
17. Tighten screws to 8 Nm.



12M4081

18. Fit camshaft timing belt gear, ensuring that drive pin is located in slot in gear. Lubricate threads of a new gear retaining bolt with engine oil, fit and lightly tighten bolt.
19. Restrain camshaft timing belt gear using tool **12-182** and tighten bolt to 20 Nm then a further 90°.
20. Fit fuel pump drive belt gear to camshaft ensuring that drive pin is located in slot in gear. Lubricate threads of a new gear retaining bolt with engine oil, fit and lightly tighten bolt.
21. Restrain camshaft timing belt gear using tool **12-182** and tighten fuel pump drive belt gear bolt to 20 Nm then a further 90°.



**CAUTION: Ensure camshaft does not rotate as bolts are tightened.**

22. Ensure that camshaft gear timing mark is aligned with pointer on timing belt upper rear cover.

23. Hold timing pin **LRT-12-058** in contact with flywheel and using assistance, rotate crankshaft **clockwise** by means of crankshaft pulley bolt until timing pin can be felt to enter hole in flywheel.



**CAUTION: Do not rotate crankshaft too far, pistons may contact the valves.**

24. Remove crankshaft pulley bolt and washer.
25. Fit new camshaft timing belt and adjust tension.
26. Fit crankshaft pulley.
27. Fit pulley bolt and washer, tighten bolt to 63 Nm then further 90°.
28. Remove timing pin **LRT-12-058**.

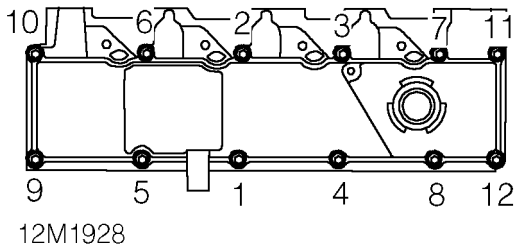
## ENGINE

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29. Fit a new gasket to camshaft cover ensuring that raised holes in gasket are towards the cover and are located on the two spigots.



**CAUTION: Gasket must be fitted dry.**



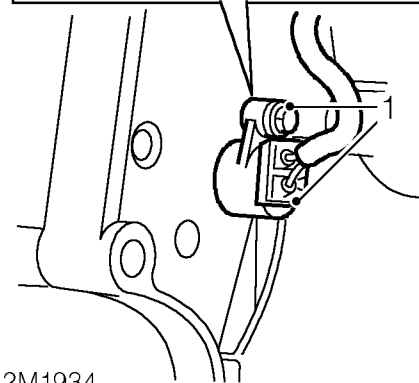
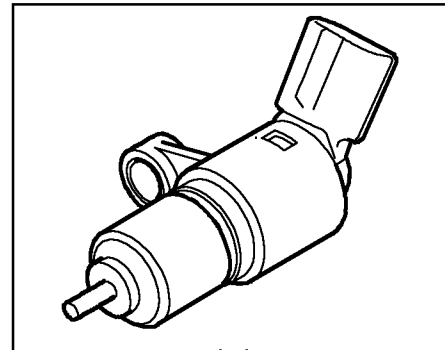
30. Fit camshaft cover bolts and tighten in sequence shown to 12 Nm.

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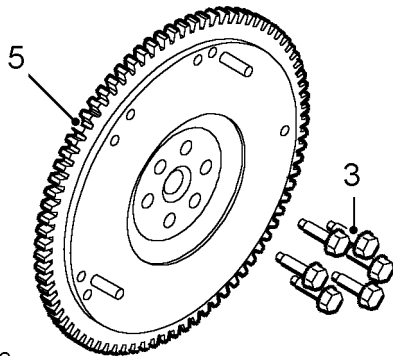
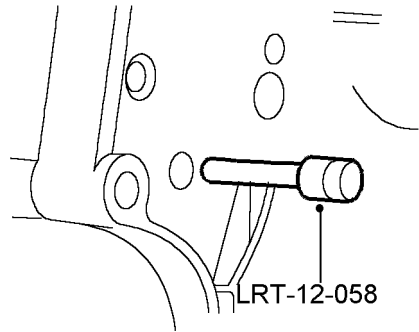
## FLYWHEEL AND STARTER RING GEAR

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### Flywheel - remove



1. Remove bolt securing crankshaft sensor to gearbox adaptor plate. Remove sensor.



12M4082

2. Hold timing pin **LRT-12-058** in contact with flywheel and using assistance, rotate crankshaft clockwise by means of crankshaft pulley bolt until timing pin can be felt to enter hole in flywheel.



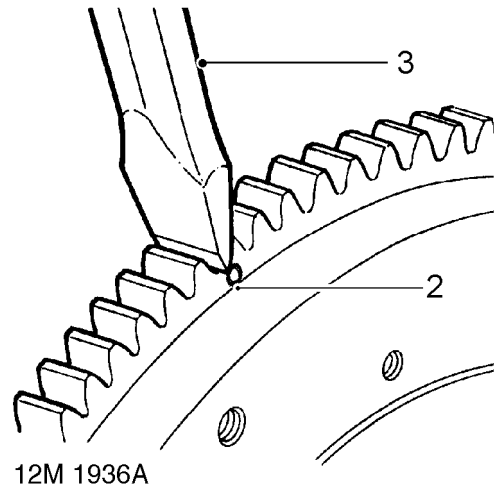
**CAUTION: Do not rotate crankshaft with timing belt removed and cylinder head fitted.**

3. Remove and discard 6 bolts securing flywheel to crankshaft.
4. Remove timing pin **LRT-12-058**.
5. Using assistance, remove flywheel.



**NOTE: Dowel located.**

### Starter ring gear - remove



1. Remove flywheel.
2. Drill a 3 mm diameter hole at the root of 2 teeth.
3. Apply a cold chisel to root of teeth, break ring gear and remove from flywheel.



**WARNING: Suitable eye protection must be worn.**

# ENGINE

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## Starter ring gear - refit

1. Heat ring gear evenly to 350°C indicated by light blue colour. Locate ring gear on flywheel and press on to flange.



**WARNING: Handle hot ring gear with care.**

2. Allow ring gear to air cool.
3. Fit flywheel.

## Flywheel - refit

1. Clean threads in crankshaft using an old flywheel bolt having 2 saw cuts at 45° along thread of bolt.



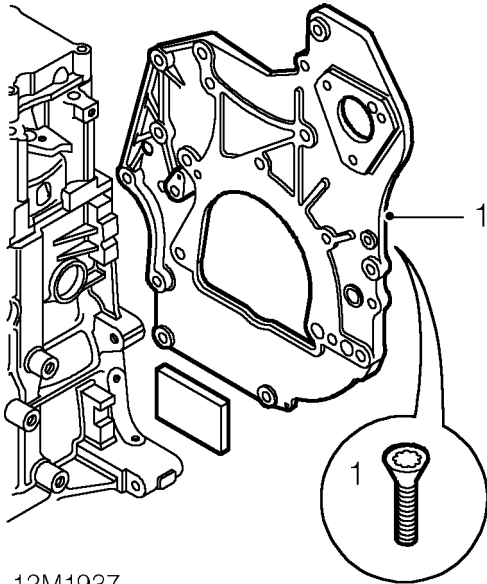
**CAUTION: Do not use a tap to clean threads.**

2. Clean flywheel faces.
3. Using assistance, position flywheel on crankshaft, fit and lightly tighten new Patchlok bolts.
4. Insert timing pin **LRT-12-058** into flywheel.
5. Tighten bolts to 15 Nm then a further 90°.
6. Position crankshaft sensor to gearbox adaptor plate, fit and tighten bolt to 8 Nm.



## GEARBOX ADAPTOR PLATE

### Remove



12M1937

1. Remove 4 Torx screws securing adaptor plate to cylinder block. Remove plate.

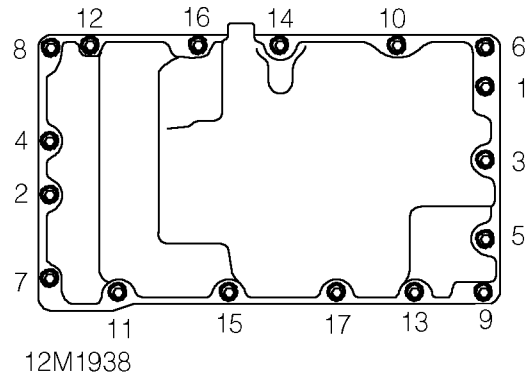
### Refit

1. Check condition of foam rubber pad, replace if necessary.
2. Remove all traces of Loctite from Torx screws.
3. Ensure tapped holes in cylinder block are clean and dry.
4. Apply Loctite 275 to threads of Torx screws.
5. Position adaptor plate to cylinder block, fit and tighten Torx screws to 45 Nm.

## SUMP AND OIL STRAINER

### Sump - remove

1. Remove dipstick.
2. Remove oil pump.
3. Remove and discard crankshaft rear oil seal and housing.



4. Using sequence shown, remove 17 bolts securing sump to cylinder block.
5. Remove sump.

### Later engines

**NOTE:** Later engines are fitted with a modified sump gasket which has an additional locating/sealing area retained by the oil strainer flange. This gasket should be used as a replacement for all engines. In order to fit the modified gasket, it will be necessary to remove the oil strainer and pick-up pipe.

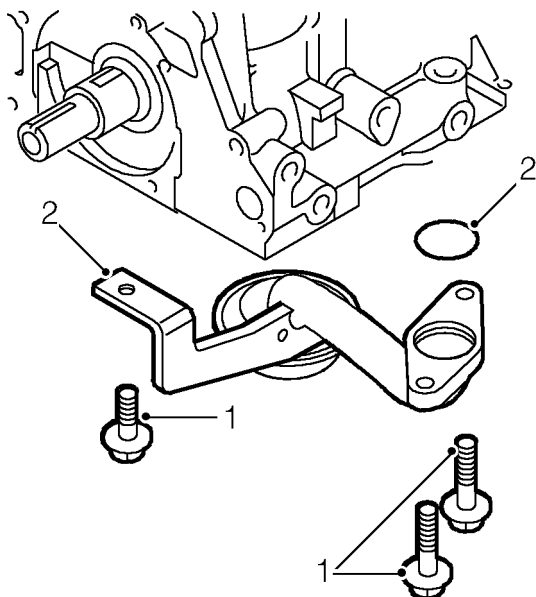
6. Remove oil strainer and pick-up pipe.

### All engines

7. Remove and discard sump gasket.

# ENGINE

## Oil strainer and pick-up pipe - remove

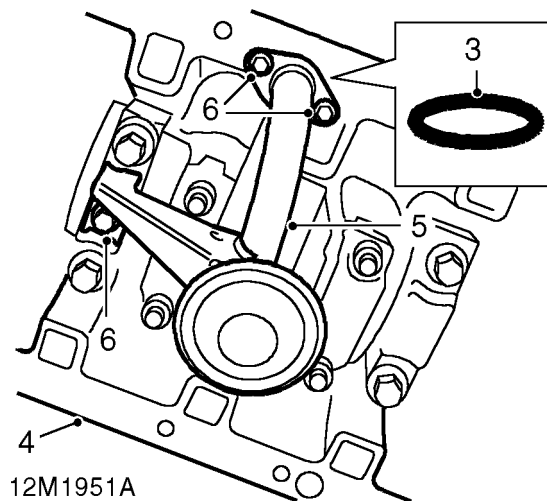


12M1939

1. Remove 3 bolts securing oil strainer and pick-up pipe to cylinder block and main bearing cap noting that shortest bolt is fitted in main bearing cap.
2. Remove oil strainer and pick-up pipe, remove and discard 'O' ring.
3. *Later engines fitted with modified sump gasket:* Remove and discard sump gasket.

## Oil strainer and pick-up pipe - refit

1. Clean strainer and pick-up pipe.
2. Ensure bolt holes in cylinder block and main bearing cap are clean and dry.



12M1951A

3. Lubricate a new 'O' ring with engine oil and fit to pick-up pipe flange.
4. Position new sump gasket to cylinder block ensuring that locating lugs are inserted in holes in block.



**CAUTION: Gasket must be fitted dry.**

5. Position strainer and oil pick-up pipe to cylinder block and main bearing cap.
6. Fit 3 bolts noting that shortest bolt is fitted into main bearing cap. Tighten bolts to 8 Nm.

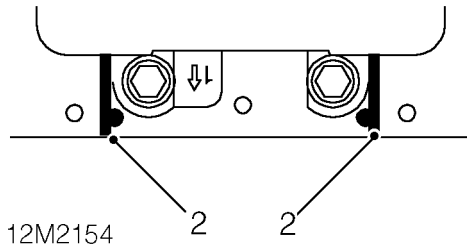


**NOTE: Patchlok bolts may be re-used provided threads are undamaged.**



## Sump - refit

1. Clean sump flange and mating surfaces of cylinder block, ensure bolt holes in cylinder block and main bearing cap are clean and dry.

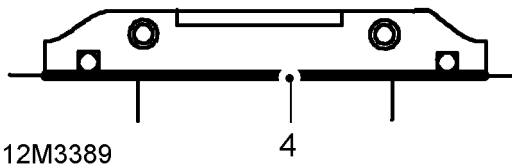


2. Using sealant, Part Number GUG 705963GM, fill grooves on each side of front - Number 1 main bearing cap and along joint lines of main bearing cap and cylinder block.



**CAUTION: Do not apply sealant until immediately prior to fitting sump. Do not spread sealant bead.**

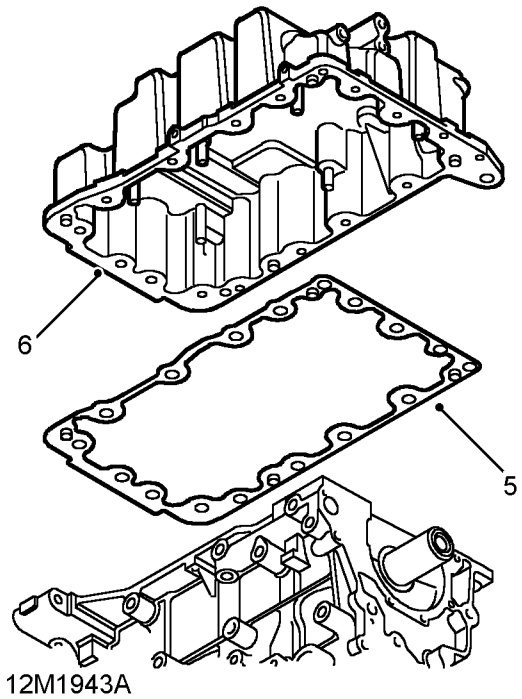
3. Fit a new crankshaft rear oil seal and housing.



4. Apply a 1 mm bead of sealant, Part No. GUG 705963GM to joint line of crankshaft rear oil seal housing, rear main bearing cap and cylinder block and around edges of sump bolt holes in rear main bearing cap.



**CAUTION: Do not apply sealant until immediately prior to fitting sump. Do not spread sealant bead.**



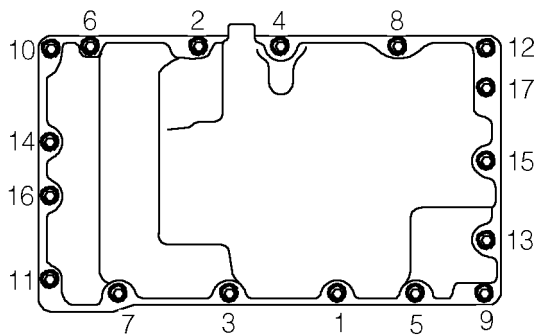
5. Position new gasket to sump ensuring that locating lugs are inserted in holes in sump; fit oil strainer and pick-up pipe.



**NOTE: Gasket must be fitted dry.**

6. Position sump to cylinder block ensuring that locating lugs are inserted in holes in block.





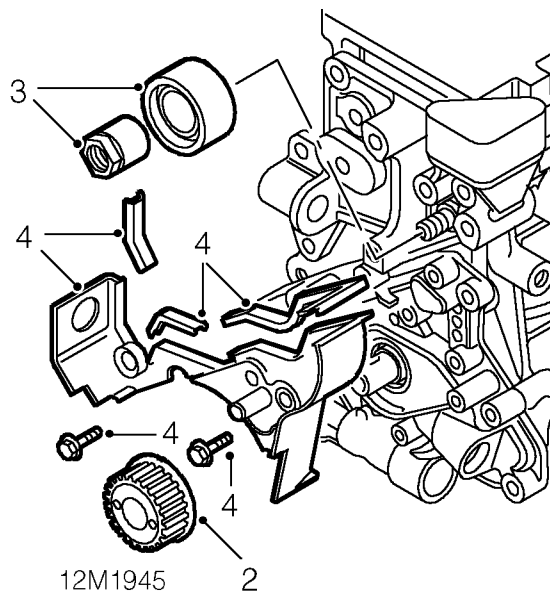
12M1944

7. Fit and lightly tighten 17 bolts.
8. Using sequence shown, tighten bolts to 25 Nm.
9. Using the same sequence, re-check that all bolts are torqued to 25 Nm.
10. Fit dipstick.
11. Fit oil pump.

## OIL PUMP

### Remove

1. Remove camshaft timing belt.



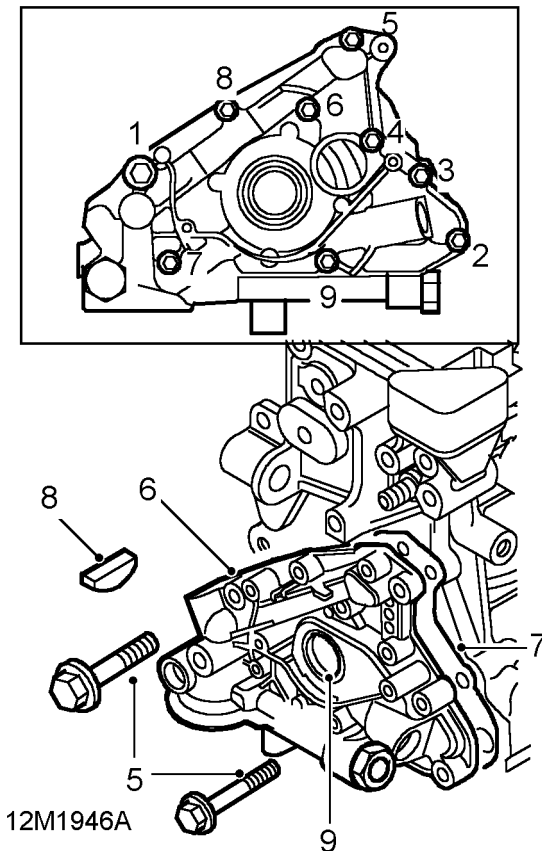
2. Slide timing gear off crankshaft.

**NOTE:** The key is an integral part of the gear.

3. Remove nut securing camshaft timing belt idler pulley, remove pulley.

**NOTE:** Idler pulley mounting stud may be unscrewed as nut is removed.

4. Remove 2 bolts securing camshaft timing belt lower rear cover, remove cover and sealing strips.



5. Using sequence shown, remove 1 M10 and 8 M6 bolts securing oil pump to cylinder block.

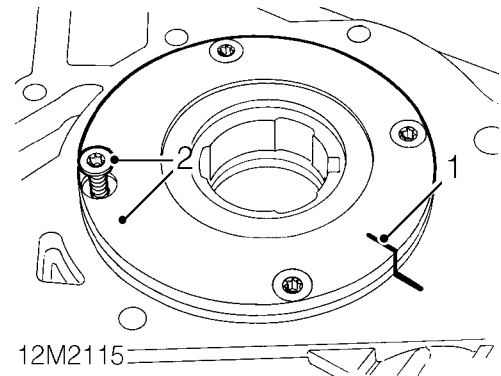
**NOTE:** Longest M6 bolt is fitted at position 9 (see inset).

6. Remove oil pump.  
7. Remove and discard gasket.  
8. Recover Woodruff key from crankshaft.  
9. Remove and discard crankshaft front oil seal from oil pump body.

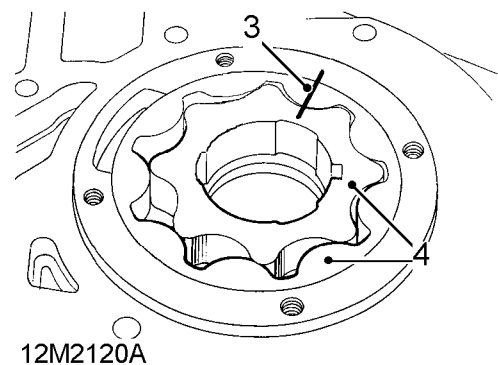
## Oil pump - inspection

### Oil pump

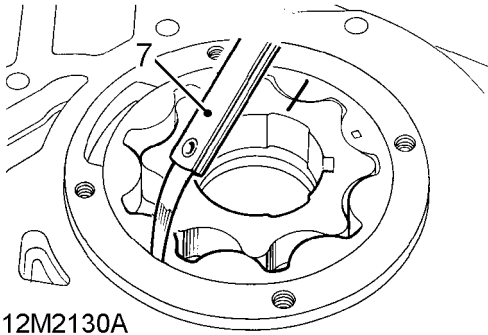
**CAUTION:** Overhaul procedures for the oil pump are limited to carrying out dimensional checks. In the event of wear or damage being found, a replacement pump must be fitted.



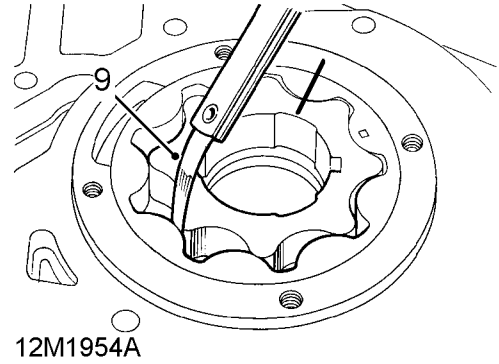
1. Make suitable alignment mark between pump backplate and body.
2. Remove 4 Torx screws securing backplate to body, remove backplate.



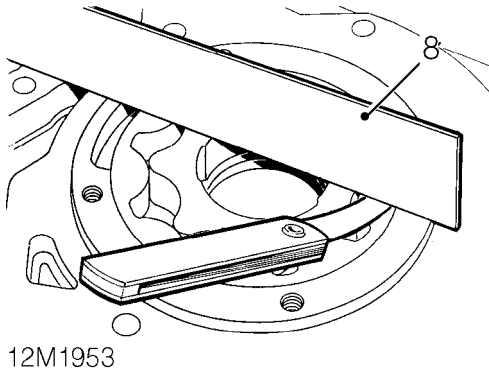
3. Using a felt tipped pen, make suitable alignment marks between inner and outer rotors and pump body.
4. Remove inner and outer rotors.
5. Check rotors and pump body for signs of scoring and wear.
6. Fit rotors ensuring that reference marks are aligned and chamfered side of outer rotor carrying a square identification mark is facing away from backplate side of pump body.



7. Using feeler gauges, check pump body to rotor clearance.  
Clearance = 0.05 to 0.10 mm.



9. Using feeler gauges, check clearance between inner and outer rotor lobes.  
Clearance = 0.025 to 0.12 mm.
10. Renew oil pump assembly if excessive scoring exists or clearances exceed specified limits.

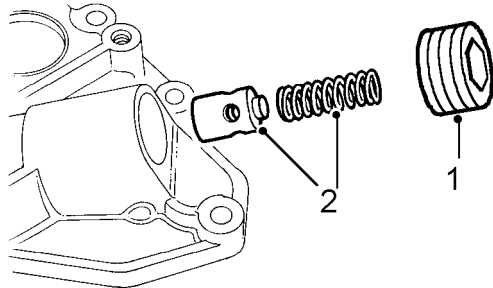


8. Place a straight edge across pump body and using feeler gauges, measure end-float of outer rotor.  
End-float = 0.03 to 0.08 mm.



## Oil pressure relief valve - remove

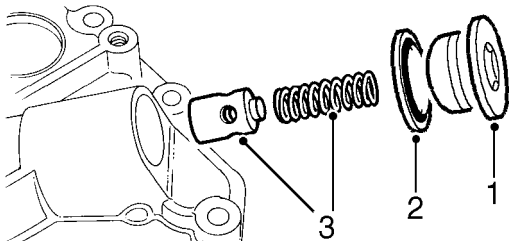
### Early engines



12M1955A

1. Remove and discard plug.
2. Remove spring and relief valve plunger.

### Later engines



M12 6510

1. Remove and discard plug.
2. Remove and discard Dowty washer.
3. Remove spring and relief valve plunger.

### All engines

4. Check plunger and bore for wear, corrosion and scoring.



**NOTE:** Light scoring may be removed using grade 600 emery cloth soaked in oil.

5. Check spring free length.  
Free length = 38.9 mm.
6. Renew relief valve as an assembly.

## Oil pressure relief valve - refit

1. Remove all traces of sealant from plug threads in oil pump body.
2. Lubricate spring, relief valve plunger and bore with engine oil.
3. Fit plunger and spring.

### Early engines

1. Apply Loctite 577 to threads of replacement plug.
2. Fit plug and tighten to 25 Nm.



**CAUTION:** Do not attempt to re-seal and fit the original plug.

### Later engines

1. Fit a new Dowty washer to replacement plug.
2. Apply Loctite 577 to threads of plug.
3. Fit plug and tighten to 25 Nm.



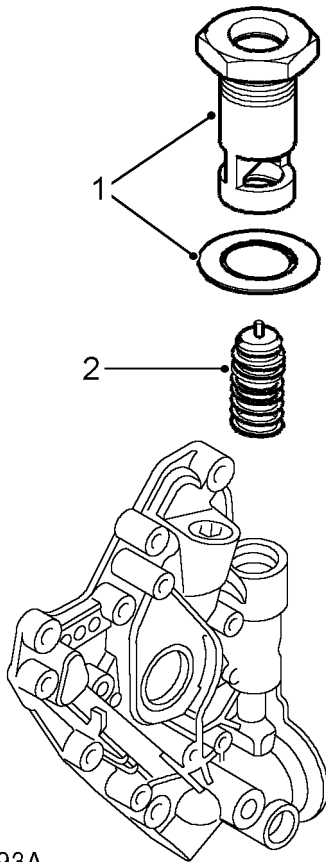
**CAUTION:** Do not attempt to re-seal and fit the original plug.

### All engines

4. Check oil pressure switch - if fitted for damage, replace as necessary. Apply Loctite 577 to threads of replacement switch; fit switch and tighten to 16 Nm.

# ENGINE


## Thermostatic valve




1. Remove diverter plug, remove and discard Dowty washer.
2. Withdraw spring and valve from oil pump body.

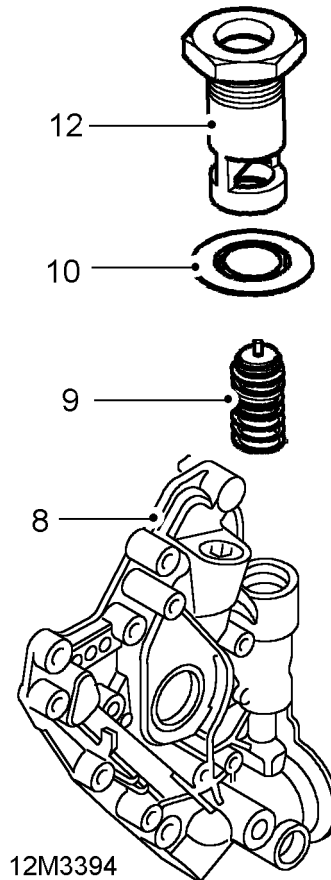
 **CAUTION: Do not separate spring from valve.**

3. Check spring for distortion and corrosion.
4. Check valve for corrosion, seating faces of valve and diverter plug for damage and pitting; replace valve as an assembly.
5. Check valve bore for corrosion.


 **NOTE: Light corrosion may be removed from valve bore using grade 600 emery cloth soaked in oil.**

6. Remove all traces of Loctite from threads of diverter valve plug and oil pump body.


 **CAUTION: Do not remove blanking plug from oil gallery below thermostatic valve bore.**



7. Lubricate valve, spring and bore with engine oil.
8. Secure oil pump body in a soft-jawed vice with thermostatic valve bore facing upwards.

 **CAUTION: Valve bore must be as near vertical as possible.**

9. Insert valve and spring in bore ensuring that it is positioned centrally in bore.

 **CAUTION: Valve will not seat correctly in diverter plug if it is not positioned centrally.**

10. Fit a new Dowty washer to diverter plug.
11. Apply Loctite 577 to threads of diverter plug.
12. Fit diverter plug, carefully tighten plug by hand ensuring that valve is not displaced as plug is tightened.
13. When diverter plug is screwed fully down, tighten to 35 Nm.



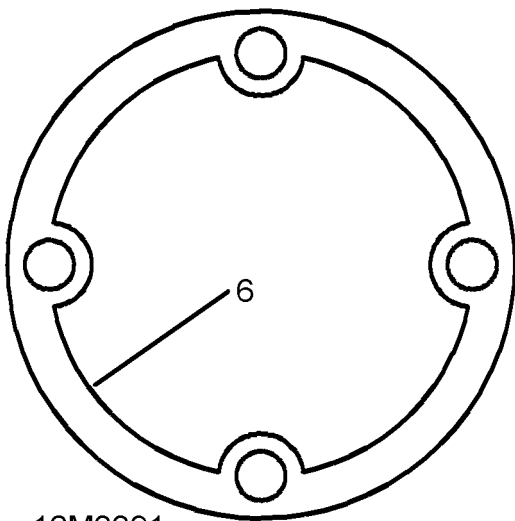
## Oil pump - assembling

1. Using gasket removal spray and plastic scraper, remove all traces of gasket material from oil pump body.
2. Using suitable solvent, remove all traces of sealant from oil pump body and backplate.
3. Remove all traces of Loctite from Torx screws and holes in oil pump body, ensure holes are clean and dry.



**CAUTION: Do not use a tap.**

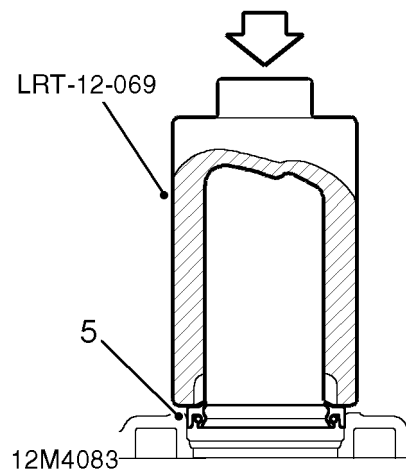
4. Ensure all components are clean, lubricate rotors and housing with engine oil.
5. Fit rotors ensuring that reference marks are aligned and chamfered side of outer rotor carrying a square identification mark is facing away from backplate side of pump body.



6. Apply a 1 mm bead of Loctite 573 to pump backplate as shown.
7. Fit pump backplate ensuring reference marks on backplate and pump body are aligned.
8. Apply Loctite 222 to threads of Torx screws, fit and tighten screws.
9. Check that pump rotates freely.

## Oil pump - refit

1. Using gasket removal spray and plastic scraper, remove all traces of gasket from cylinder block.
2. Using a suitable cleaning solvent, remove all traces of sealant from joint faces of front - Number 1 main bearing cap.
3. Clean oil seal running surface on crankshaft.
4. Check that crankshaft front oil seal recess in pump body is clean and dry.



5. Fit new crankshaft front oil seal to pump using tool LRT-12-069.

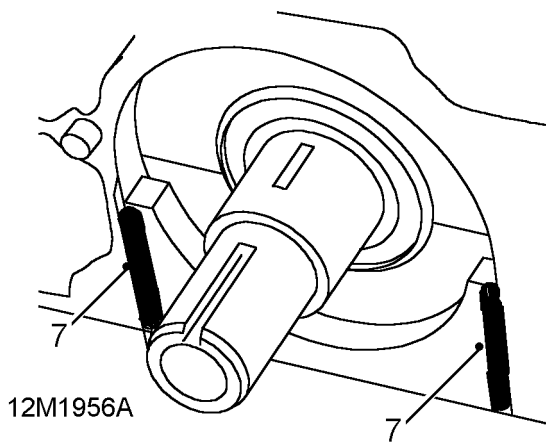


**CAUTION: Oil seal must be fitted dry.**



**NOTE: Replacement oil pumps are supplied with oil seal fitted.**

6. Fit Woodruff key to crankshaft.



- Using sealant, Part No. GUG 705963GM, apply a 1 mm thick bead of sealant to joint line of front - Number 1 main bearing cap and cylinder block.

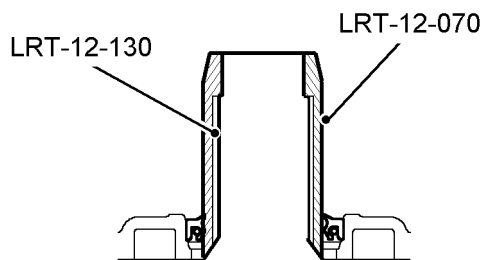


**CAUTION:** Do not fill grooves on either side of main bearing cap or apply sealant to sump mating flange of main bearing cap until immediately before sump is fitted.

- Position a new gasket to cylinder block.



**CAUTION:** Gasket must be fitted dry.



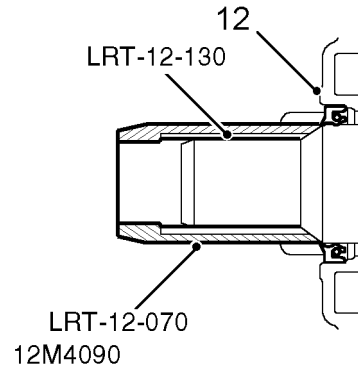
12M4084

- Insert oil seal protector **LRT-12-070** and adaptor sleeve **LRT-12-130** into oil pump inner rotor.



**NOTE:** This will assist in locating oil pump inner rotor on Woodruff key.

- Align Woodruff key slots in oil pump inner rotor with Woodruff key
- Ensure bolt holes in cylinder block are clean and dry.



- Slide oil pump over crankshaft ensuring Woodruff key is located in keyway in inner rotor, locate oil pump on dowels.



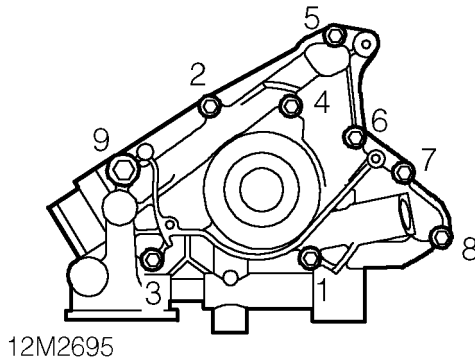
**NOTE:** Tools LRT-12-070 and LRT-12-130 will be displaced as pump is fitted.





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**CRANKSHAFT, MAIN AND BIG-END BEARINGS**



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**Crankshaft rear oil seal - remove**


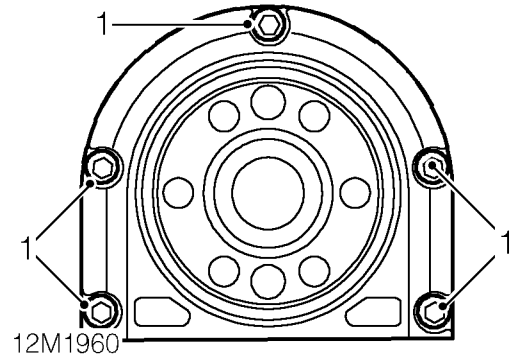
13. Fit and lightly tighten bolts ensuring that longest M6 bolt is fitted at position 1 and M10 bolt at position 9.

 **NOTE: Patchlok bolts may be re-used provided threads are undamaged.**

14. Gradually tighten bolts in sequence shown until oil pump is pulled against cylinder block.

 **CAUTION: Bolt tightening must be done gradually due to tight fit of pump rotor on crankshaft. Damage to oil pump will result if the above procedure is not followed.**

15. Finally, tighten bolts in sequence shown to:  
M6 bolts - 8 Nm  
M10 bolt - 45 Nm
16. Ensure sealing strips are fitted to camshaft timing belt lower rear cover.
17. Fit lower rear cover, fit and tighten screws to 8 Nm.
18. Fit camshaft timing belt idler pulley ensuring that recessed side of centre boss faces away from engine.
19. If idler pulley stud was unscrewed during nut removal, clean old Loctite from threads of stud and ensure hole in cylinder block is clean and dry. Apply Loctite 275 to threads of stud and screw it into block, tighten stud to 12 Nm.
20. Apply Loctite 275 to threads of idler pulley nut, fit and tighten nut to 45 Nm.
21. Slide timing gear on to crankshaft.
22. Fit new camshaft timing belt and adjust tension.

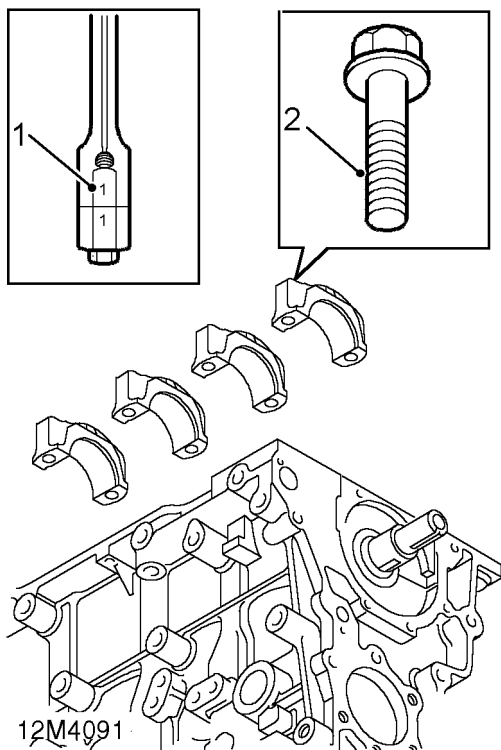


1. Remove 5 bolts securing rear oil seal housing to cylinder block, remove and discard housing and oil seal.



# ENGINE

## Big-end bearings - remove



1. Suitably mark cylinder reference number on each big-end bearing cap and connecting rod.
2. Remove 2 bolts securing each big-end bearing cap, remove caps and recover big-end bearing shells.

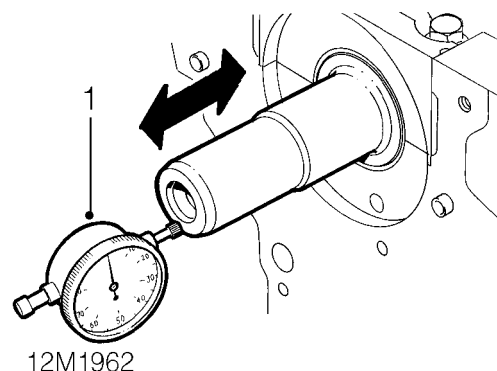
**NOTE:** The big-end bearing shells do not have location tags for locating the bearings in the connecting rod and bearing cap. The big-end to connecting rod bolts are off-set 1 mm to prevent incorrect fitment of the bearing cap to the connecting rod.

**CAUTION:** Keep bolts and bearing caps in their fitted order. Big-end bearing shells should always be replaced whenever crankshaft is removed.

3. Push each connecting rod up cylinder bore until connecting rod is clear of the crankshaft journals.

**CAUTION:** Ensure connecting rods do not contact oil squirt jets or cylinder bores.

## Crankshaft end-float - check



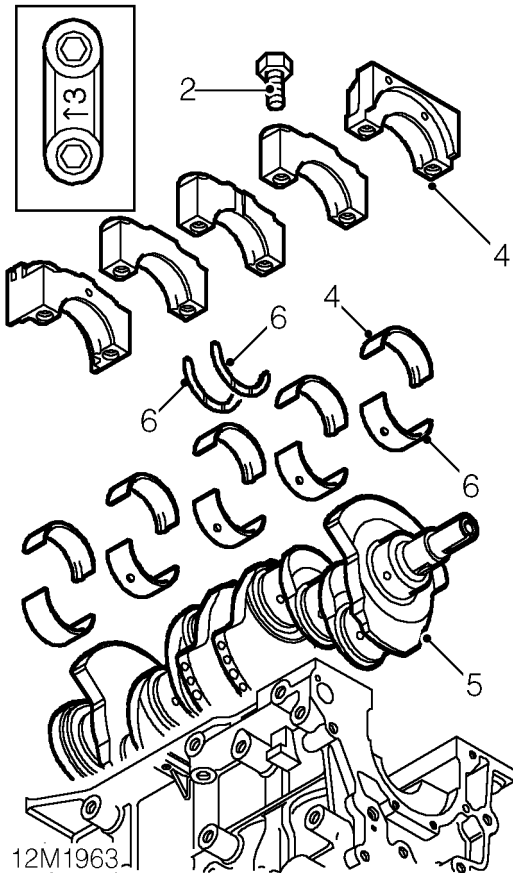
1. Attach a magnetic base Dial Test Indicator to front of cylinder block, move crankshaft rearwards, position stylus on end of crankshaft and zero DTI.
2. Move crankshaft forwards, measure and record end-float figure obtained:  
End-float = 0.03 to 0.26 mm
3. If end-float exceeds above dimension, new thrust washers must be fitted:  
Thrust washer thickness = 2.31 to 2.36 mm



## Crankshaft - remove



**NOTE: Crankshaft end-float must be checked prior to removing crankshaft.**



1. Check that identification marks 1 to 5, and the direction arrows which face towards the front of the engine are marked on each main bearing cap.



**NOTE: The identification marks on number 2 main bearing cap are concealed by the oil strainer mounting bracket which is secured to the bearing cap.**

2. Starting at centre main - Number 3 main bearing cap and working outwards, progressively loosen, then remove 2 bolts securing each cap.



**CAUTION: Keep bolts in their fitted order.**

3. Using fingers only, rock each main bearing cap until it is released from locating dowels.

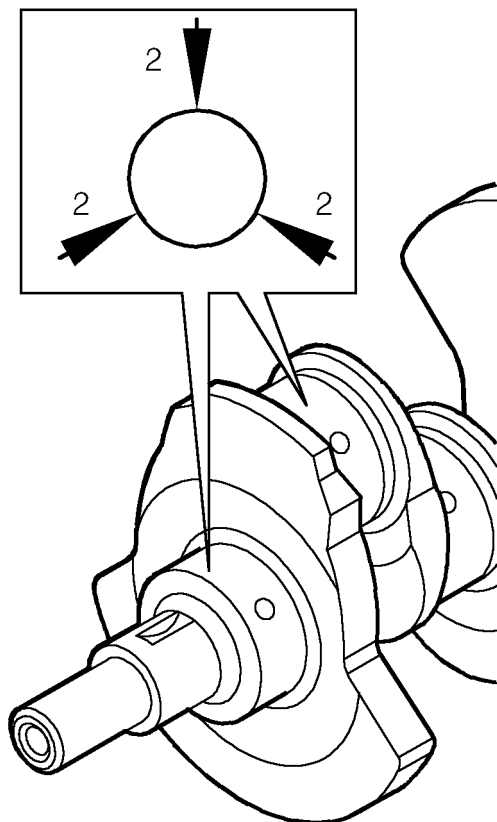


**CAUTION: Do not tap caps sideways.**

4. Remove main bearing caps and plain bearing shells.
5. Using assistance, remove crankshaft.
6. Recover upper, grooved main bearing shells and 2 thrust washers.
7. Using a suitable cleaning solvent, remove sealant from front - Number 1 main bearing cap and cylinder block.

## Crankshaft - inspection

1. Clean crankshaft, ensure all oilways are clear.



12M2127

2. Check crankshaft journals for wear and ovality, make three checks at 120° intervals in centre of journals.

Crankshaft bearing journal diameters:

Main bearings = 60.703 to 60.719 mm

Big-end bearings = 57.683 to 57.696 mm

Clearance in bearings = 0.005 mm



**CAUTION:** Crankshaft journals may not be reground undersize, if journals are worn, crankshaft must be replaced. Main and big-end bearings are only available in one size and should always be replaced whenever crankshaft has been removed.

3. Check thrust washers for wear and scoring, replace as necessary:  
Thrust washer thickness = 2.31 to 2.36 mm

## Crankshaft - refit



**CAUTION:** If crankshaft end-float exceeded 0.26 mm, new thrust washers must be fitted.

1. Clean main bearing shell locations in cylinder block, clean main bearing caps.
2. Check that ring dowels are fitted in main bearing cap locations and that bolt holes are clean and dry.
3. Check threads of main bearing cap bolts for damage, renew bolts in pairs.
4. Lubricate new upper main bearing shells with engine oil and ensuring that they are centrally positioned, fit to their locations in cylinder block.



**NOTE:** These bearing shells are grooved.

5. Lubricate thrust washers with engine oil and fit, oil groove side outwards to each side of centre - (Number 3) main bearing in cylinder block.
6. Lubricate crankshaft journals with engine oil and using assistance, position crankshaft in cylinder block.



**CAUTION:** Ensure thrust washers are not displaced as crankshaft is fitted.

7. Lubricate new main bearing shells with engine oil and fit to main bearing caps.



**NOTE:** These bearing shells are plain.

8. Fit main bearing caps ensuring that they are correctly orientated and in their fitted order.



**CAUTION:** Do not apply sealant to grooves in front - (Number 1) main bearing cap until immediately before sump is fitted.



9. Lubricate threads of main bearing cap bolts with engine oil, fit and lightly tighten bolts.
10. Starting from the centre - Number 3 main bearing cap and working outwards, tighten bolts to 112 Nm.
11. Check that crankshaft rotates smoothly.
12. Re-check crankshaft end-float. **See this section**



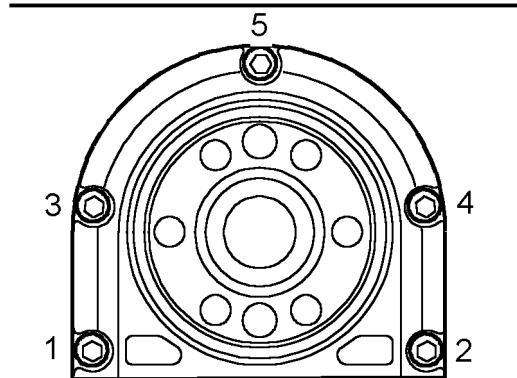
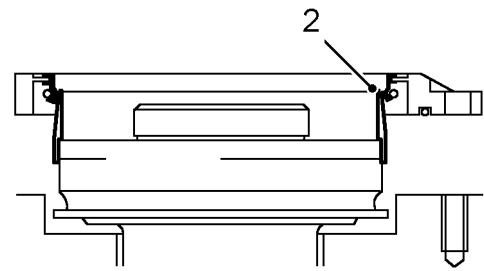
**CAUTION: If original thrust washers have been refitted and end-float exceeds 0.26 mm, crankshaft must be removed and new thrust washers fitted. If, with new thrust washers fitted, end-float is still excessive, crankshaft must be replaced.**

### Crankshaft rear oil seal - refit



**CAUTION: Rear oil seal and housing must be fitted prior to fitting sump.**

1. Ensure oil seal running surfaces on crankshaft and oil seal housing mating surface on cylinder block are clean and oil free and that bolt and dowel holes are clean and dry.



12M1964A



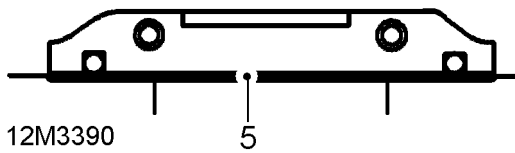
**CAUTION: Do not lubricate oil seal or running surface on crankshaft. The oil seal is pre-lubricated at manufacture. Do not separate protector sleeve from oil seal and do not touch lip of seal. If seal is inadvertently handled it must not be fitted as the coating applied to the seal during manufacture will be destroyed and oil leakage can result.**

2. Slide oil seal protector sleeve, oil seal and housing over end of crankshaft.
3. Position oil seal and housing on cylinder block.



**NOTE: Oil seal protector will be displaced as seal and housing are fitted.**

4. Fit bolts and working in sequence shown, tighten to 8 Nm.



5. Apply a 1 mm thick bead of sealant, Part Number GUG 705963GM along joint line of seal housing, rear main bearing cap and cylinder block and around sump bolt holes in rear main bearing cap.



**CAUTION: Do not apply sealant until immediately prior to fitting sump, do not spread sealant bead.**

## Big-end bearings - refit

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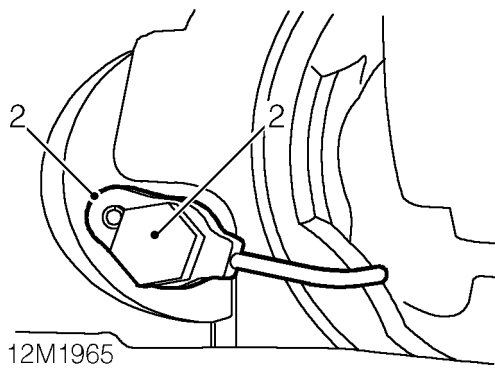
1. Rotate crankshaft until big-end bearing journals are correctly positioned.
2. Lubricate crankshaft big-end journals with engine oil.
3. Fit new big-end bearing shells to connecting rods, lubricate shells with engine oil.
4. Taking care not to damage oil squirt jets or to displace bearing shells, pull connecting rods on to crankshaft journals.
5. Check that new big-end bearing shells are correctly located on big-end bearing caps, lubricate shells with engine oil.
6. Fit big-end bearing caps ensuring that they are in their correct fitted order.
7. Lubricate threads of connecting rod bolts with engine oil. Fit bolts to their respective connecting rods and tighten to 20 Nm then a further 90°.



## PISTONS, CONNECTING RODS AND CYLINDER BORES

### Pistons and connecting rods - remove

1. Remove crankshaft.



2. Remove and discard banjo bolts securing oil squirt jets to cylinder block, remove jets.



**NOTE:** Each jet is located by means of a roll pin.

3. Suitably identify each piston and connecting rod assembly to its respective cylinder bore.
4. Using assistance, lay cylinder block on its side.
5. Push each piston and connecting rod up cylinder bore taking care to keep connecting rod clear of bore walls; remove pistons and connecting rods.
6. Recover big-end bearing shells from connecting rods.



**CAUTION:** Big-end bearing shells should always be replaced whenever pistons and connecting rods are removed.

### Piston rings - remove

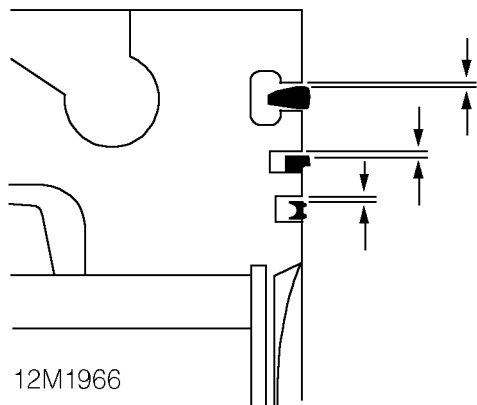
1. Using a suitable expander, remove and discard piston rings.
2. Use a squared off end of a broken piston ring to clean groove in piston.



**CAUTION:** Do not use a wire brush or emery cloth.

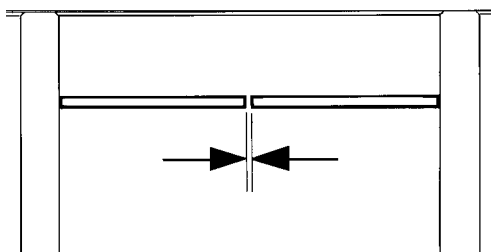
# ENGINE

## Piston ring gaps - checking



12M1966

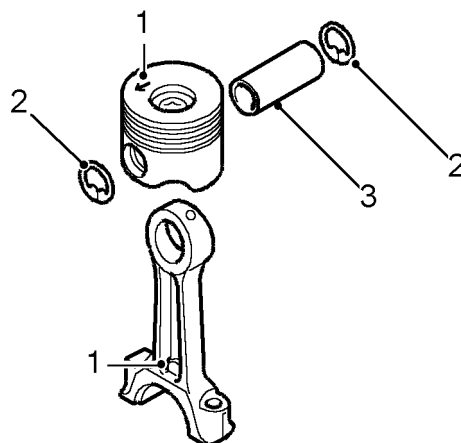
1. Check new ring to groove clearance:  
Top compression ring = 0.115 to 0.135 mm.  
2nd compression ring = 0.050 to 0.082 mm.  
Oil control rails = 0.050 to 0.082 mm.



12M2108

2. Check new ring fitted gap 30 mm from top of cylinder bore, ensure rings are kept square to bore when checking gaps.  
Fitted gap:  
Top compression ring = 0.25 to 0.27 mm.  
2nd compression ring = 0.40 to 0.42 mm.  
Oil control rails = 0.30 to 0.32 mm.

## Pistons - remove



12M4092

1. Suitably identify each piston to its connecting rod, note position of cast boss on connecting rod relative to arrow on piston crown.
2. Remove and discard circlips securing gudgeon pin.
3. Push gudgeon pin out of piston and connecting rod.

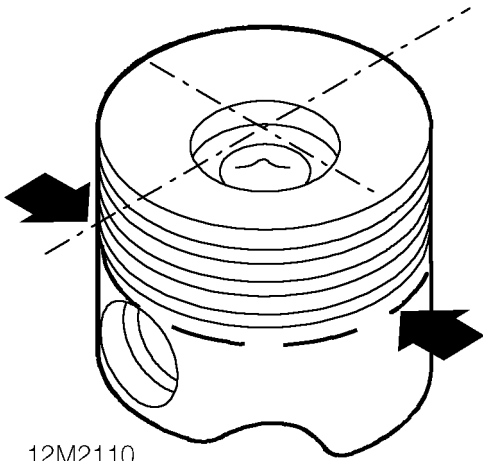


**CAUTION: Keep gudgeon pins with their respective pistons and lightly tighten bolts to retain bearing caps to connecting rods.**



## Pistons and connecting rods - inspection

1. Check pistons for cracks, distortion and damage.

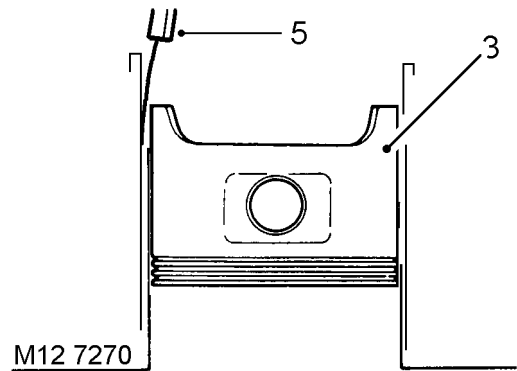


12M2110

2. Measure and record piston diameter at right angles to gudgeon pin hole and 44 mm from bottom of skirt:  
Diameter = 84.262 mm.



**CAUTION: Measurement point must be on the ungraphited area of the piston.**



M12 7270

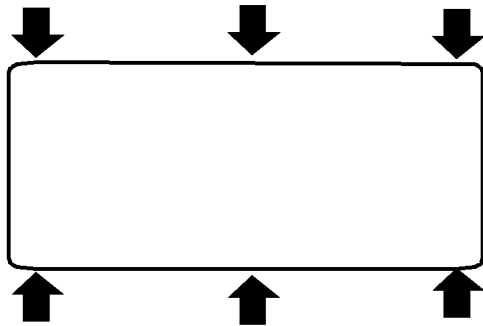
3. Starting with Number 1 piston, invert piston and with arrow on piston crown pointing towards REAR of cylinder block, insert piston into top of Number 1 cylinder bore.
4. Position piston with bottom of skirt 25 mm from top of cylinder bore.
5. Using feeler gauges, measure and record clearance between piston skirt and left hand side of cylinder bore 70 mm from top of bore (viewed from front of cylinder block).  
Piston to cylinder bore clearance = 0.18 to 0.2 mm.
6. Repeat procedures for remaining pistons.



**CAUTION: Oversize pistons are not available, if clearances are excessive, measure diameter of cylinder bore before proceeding further - See Cylinder bores - inspection. If, after inspection, cylinder bores are found to be the correct size, pistons must be replaced.**



7. Check fit of each gudgeon pin in its respective piston, pin must be a tight, sliding fit with no perceptible side play.



12M2112

8. Measure gudgeon pin diameter at each end and centre of pin:  
Diameter = 29.995 to 30.000 mm.
9. Renew gudgeon pins and pistons as an assembly if diameters are less than specified or if excessive pin to piston side play is evident.
10. Check connecting rods for alignment, reject any connecting rod which is bent.
11. Check small-end bushes for wear, check that gudgeon pin is a close/sliding fit in the bush, with no perceptible side play.



**CAUTION: Small-end bushes may not be replaced, a new connecting rod must be fitted.**

12. Using fingers only, check that each big-end bearing cap bolt runs freely in the threads of its respective thread in the connecting rod. If any bolt is tight, then the bolt must be replaced.

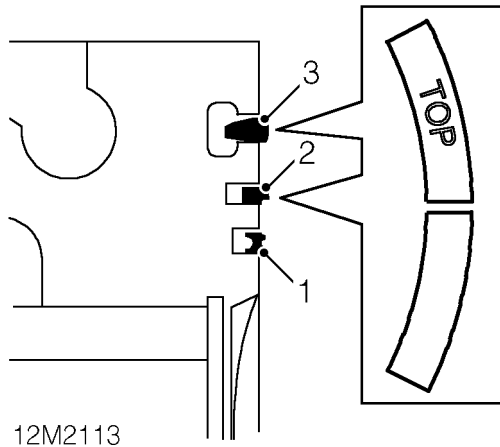
## Pistons - refit

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1. Lubricate gudgeon pin and small-end bush with engine oil.
2. Position piston to its respective connecting rod with the direction of the arrow on the piston crown on the same side as the cast boss on the piston.
3. Fit gudgeon pin, fit new circlips ensuring they are fully seated in their grooves.
4. Repeat above procedures for remaining pistons.



### Piston rings - refit

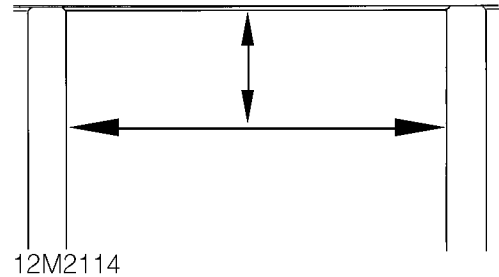


12M2113

1. Fit oil control rails and spring.
2. Fit 2nd compression ring with 'TOP' marking upwards.
3. Fit top compression ring with 'TOP' marking upwards.
4. Check that rings are free to rotate, position ring gaps at 120° to each other and away from thrust side - left hand side of piston - viewed from front of piston.

### Cylinder bores - inspection

1. Check cylinder bores for scoring.



12M2114

2. Check cylinder bores for wear, measure and record diameter of each bore, 70 mm from top of bore.



**CAUTION: Measurements must be taken from side to side and front to rear of bore.**

Bore diameter = 84.442 to 84.460 mm.



**CAUTION: No reboring, honing or glaze busting of cylinder bores is permissible; cylinder block must be replaced if cylinder bores are worn beyond limits.**

# ENGINE

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## Cylinder block

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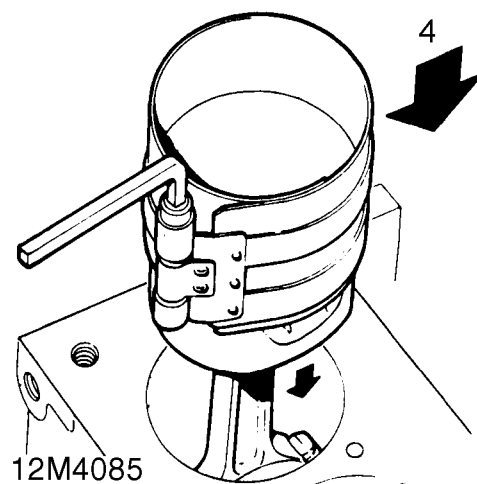
1. Check that all oilways are clear and that oil restrictor located in oilway to cylinder head is fitted below face of cylinder block.
2. Check that main bearing cap, crankshaft rear oil seal housing and cylinder head locating dowels are fitted.
3. Check core plugs for leakage and corrosion, replace as necessary.

 **NOTE: Seal replacement core plugs and main oil gallery plug on rear of cylinder block with Loctite 577, tighten main oil gallery plug to 45 Nm. Seal dipstick tube in cylinder block with Loctite 638.**

## Pistons and connecting rods - refit

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1. Lubricate cylinder bores, pistons, rings and crankshaft big-end journals with engine oil.
2. Lubricate new big-end bearing shells with engine oil and fit to connecting rods and bearing caps.
3. Check that piston ring gaps are positioned at 120° to each other and away from thrust - left hand side of piston - viewed from front of piston.



4. Fit suitable piston ring clamp to each piston in turn and ensuring that pistons are in their correct fitted order and that the arrow on piston crown and the cast boss above the big-end is facing towards front of cylinder block, push pistons into their respective cylinder bores.

 **CAUTION: Ensure that connecting rods do not contact cylinder bores.**

5. Do not pull connecting rods fully down cylinder bores at this stage.
6. Check that cut-out in each piston skirt is positioned above oil squirt jet location.
7. Ensure oil squirt jets are clear and that roll pins are inserted in jet housings.



8. Position oil squirt jets in cylinder block ensuring that roll pins are inserted in locating holes.
9. Apply Loctite 275 to threads of new banjo bolts.



**CAUTION: Do not allow Loctite to enter oil hole in banjo bolts.**

10. Fit and tighten banjo bolts to 12 Nm.
11. Fit crankshaft and big-end bearings.






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**ENGINE DATA**


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**Oil pump**

Outer rotor to body clearance .....	0.05 to 0.10 mm
Rotor lobe clearance .....	0.025 to 0.12 mm
Outer rotor end float .....	0.03 to 0.08 mm
Relief valve spring free length .....	38.9 mm

**Camshaft**

Camshaft end-float .....	0.51 mm - max.
Camshaft bearing clearance .....	0.043 to 0.094 mm
Camshaft timing belt tensioner spring free length ...	65 mm

**Tappets**

Tappet outside diameter .....	34.959 to 34.975 mm.
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**Cylinder head**

Cylinder head maximum warp .....	0.10 mm
Cylinder head bolt length .....	243.41 mm

**Valve springs**

Free length .....	37.0 mm
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**Valves**

Valve stem diameter:

Inlet .....	6.907 to 6.923 mm
Exhaust .....	6.897 to 6.913 mm

Valve stem to guide clearance - maximum:

Inlet .....	0.056 mm
Exhaust .....	0.066 mm

Valve face angle .....

45°to 45°30'

Valve head stand down:

Inlet .....	1.45 mm
Exhaust .....	1.35 mm

Valve guides:

Inside diameter after reaming .....	6.950 to 6.963 mm
Fitted length above cylinder head .....	61.1 to 61.7 mm

Valve seat inserts:

Seat angle

Inlet .....	60°
Exhaust .....	58°to 62°

Insert diameter

Inlet .....	35.697 mm
Exhaust .....	31.05 to 31.55 mm

DATA, TORQUE & TOOLS

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# ENGINE

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## Crankshaft

End-float .....	0.03 to 0.26 mm
Thrust washer halves thickness .....	2.31 to 2.36 mm
Main journal diameter .....	60.703 to 60.719 mm
Clearance in bearings .....	± 0.005 mm
Big-end journal diameter .....	57.683 to 57.696 mm
Clearance in bearings .....	± 0.005 mm

## Piston rings

New ring to groove clearance:

Top compression ring .....	0.115 to 0.135 mm
2nd compression ring .....	0.050 to 0.082 m m
Oil control rails .....	0.050 to 0.082 mm

Ring fitted gap 30 mm from top of cylinder bore:

Top compression ring .....	0.25 to 0.27 mm
2nd compression ring .....	0.40 to 0.42 mm
Oil control rails .....	0.30 to 0.32 mm

## Pistons

Piston diameter .....	84.262 mm
Clearance in bore .....	0.18 to 0.2 mm

## Cylinder block

Cylinder bore .....	84.442 to 84.460 mm
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**TORQUE FIGURES**


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Camshaft timing belt upper front cover screws . . . . .	5 Nm
Camshaft timing belt lower front cover screws . . . . .	5 Nm
Camshaft timing belt upper rear cover screws . . . . .	8 Nm
Camshaft timing belt lower rear cover screws . . . . .	8 Nm
Camshaft timing belt tensioner bolt . . . . .	45 Nm
Camshaft timing belt Allen screw or bolt . . . . .	55 Nm
Camshaft timing belt idler pulley nut . . . . .	45 Nm
Idler pulley stud . . . . .	12 Nm
Engine front mounting cover plate nuts . . . . .	30 Nm then further 120°
Engine front mounting cover plate bolts . . . . .	45 Nm
Crankshaft pulley bolt . . . . .	63 Nm then further 90°
Oil pump bolts - Patchlok: *	
M6 . . . . .	8 Nm
M10 . . . . .	45 Nm
Thermostatic valve diverter plug . . . . .	35 Nm
Oil pressure switch . . . . .	16 Nm
Oil pressure relief valve plug . . . . .	25 Nm
Oil pick-up pipe bolts - Patchlok . . . . .	8 Nm
Fuel injection pump drive belt backplate screws . . . . .	8 Nm
Camshaft timing belt gear bolt + . . . . .	20 Nm then further 90°
Camshaft gear damper Torx screws + . . . . .	10 Nm
Fuel injection pump drive belt gear bolt + . . . . .	20 Nm then further 90°
Camshaft cover bolts . . . . .	12 Nm
Camshaft carrier to cylinder head bolts * . . . . .	11 Nm
Cylinder head Torx bolts *	
Stage 1 . . . . .	30 Nm
Stage 2 . . . . .	65 Nm
Stage 3 . . . . .	Further 90°
Stage 4 . . . . .	Then further 90°
Flywheel bolts - Patchlok + . . . . .	15 Nm then further 90°
Gearbox adaptor plate Torx screws . . . . .	45 Nm
Crankshaft sensor to adaptor plate bolt . . . . .	8 Nm
Oil sump bolts . . . . .	25 Nm
Oil sump drain plug . . . . .	25 Nm
Main bearing cap bolts . . . . .	112 Nm
Connecting rod cap bolts . . . . .	20 Nm then further 90°
Crankshaft rear oil seal housing bolts * . . . . .	8 Nm
Oil squirt jet banjo bolts . . . . .	12 Nm
Main oil gallery plug . . . . .	45 Nm

+ New bolts /Torx screws must be used.

\* Tighten in sequence



# ENGINE

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## TOOL NUMBERS

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LRT-12-069	Replacer - Crankshaft Oil Seal
LRT-12-070	Oil Seal Protection Sleeve
LRT-12-130	Adaptor Sleeve
LRT-12-034	Valve Spring Compressor
LRT-12-058	Timing Pin
LRT-12-071	Valve Stem Oil Seal Remover/replacer
LRT-12-140	Replacer - Camshaft Oil Seals
LRT-12-143	Camshaft Timing Belt Tensioner Retractor
MS 76	Valve seat cutter pilot
MS 76-111	60°cutter
12-182	Camshaft timing gear holding tool
12-186	Valve guide reamer