

FREELANDER



K Series Engine Overhaul Manual

K serie motor
revisiehandboek

Moteur de série K
Manuel de révision

Motorbaureihe K
Überholungsanleitung

Motore serie K
Manuale di revisione

Motor serie K
Manual de revisión

Motorda série K
Manual de revisão





'K' SERIES ENGINE

OVERHAUL MANUAL

This overhaul manual is applicable to the 1.8 'K' Series engine fitted to the Land Rover Freelander up to 2001 Model Year. Overhaul procedures for engines fitted to vehicles from 2001 Model Year will be found in the Freelander Workshop Manual Part No. LRL0350.

The engine is fitted with damp cylinder liners and has the following Serial No. prefixes:- J78 and J79

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INTRODUCTION

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.

REPAIRS AND REPLACEMENTS

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.

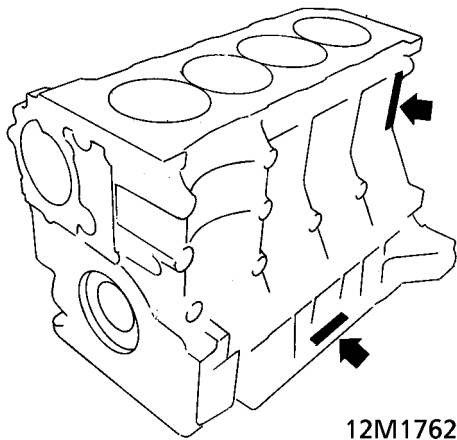
INTRODUCTION

SPECIFICATION

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.

ENGINE NUMBER LOCATION



The engine number will be found stamped either on the LH side of the bearing ladder or cast on the rear LH side of the cylinder block.

COMMENCING ENGINE NUMBERS

Engines fitted with automatic timing belt tensioner

18K4FJ78 151555, 18K4FJ79 153785

Engines fitted with modified camshafts and cylinder heads

18K4FJ78 115630, 18K4FJ79 112575

Cylinder heads fitted with triple angle valve seats

18K4FJ78 679210, 18K4FJ79 682294

Modified - type B crankshafts

18K4FJ78 581313, 18K4FJ79 581313

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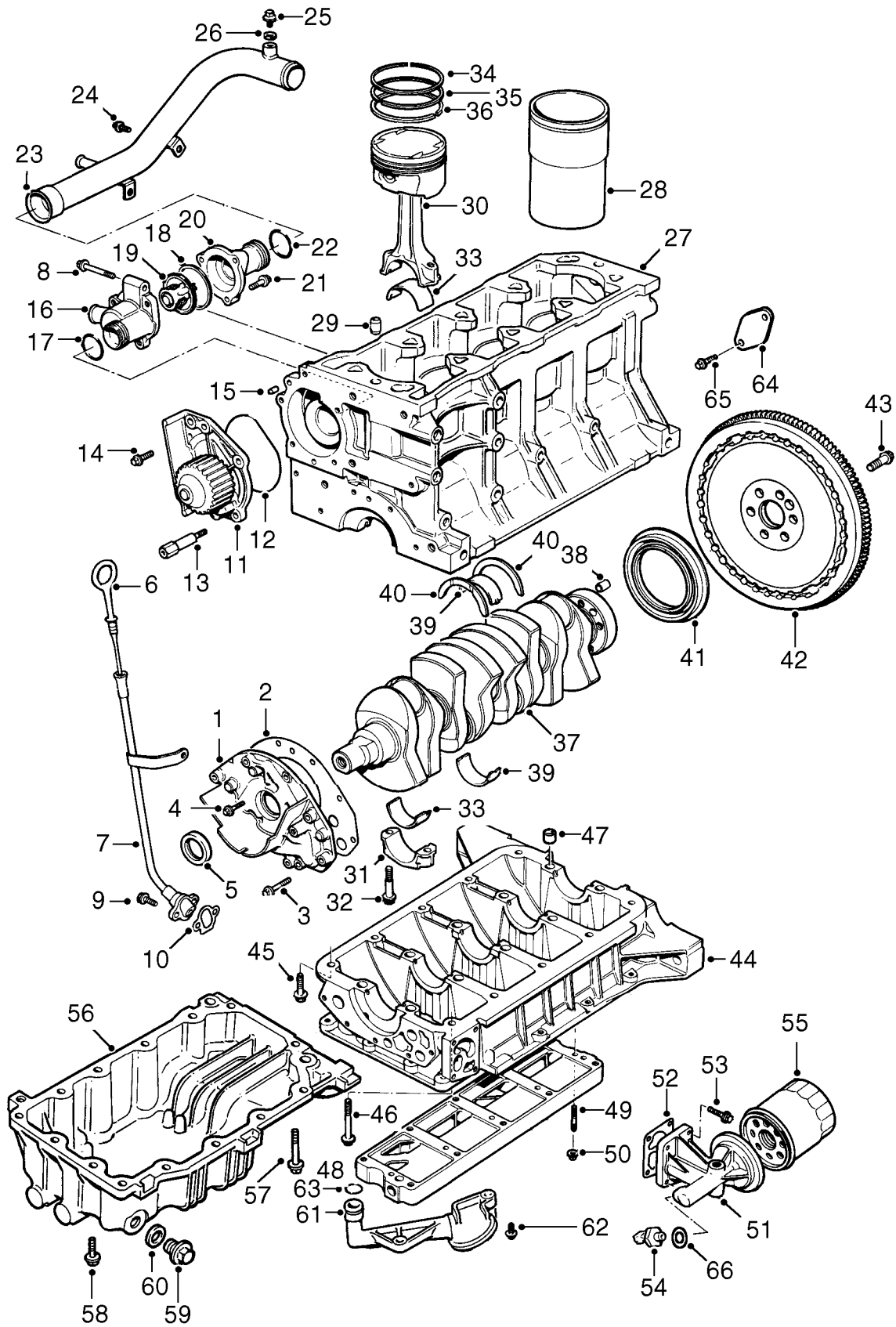
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ENGINE



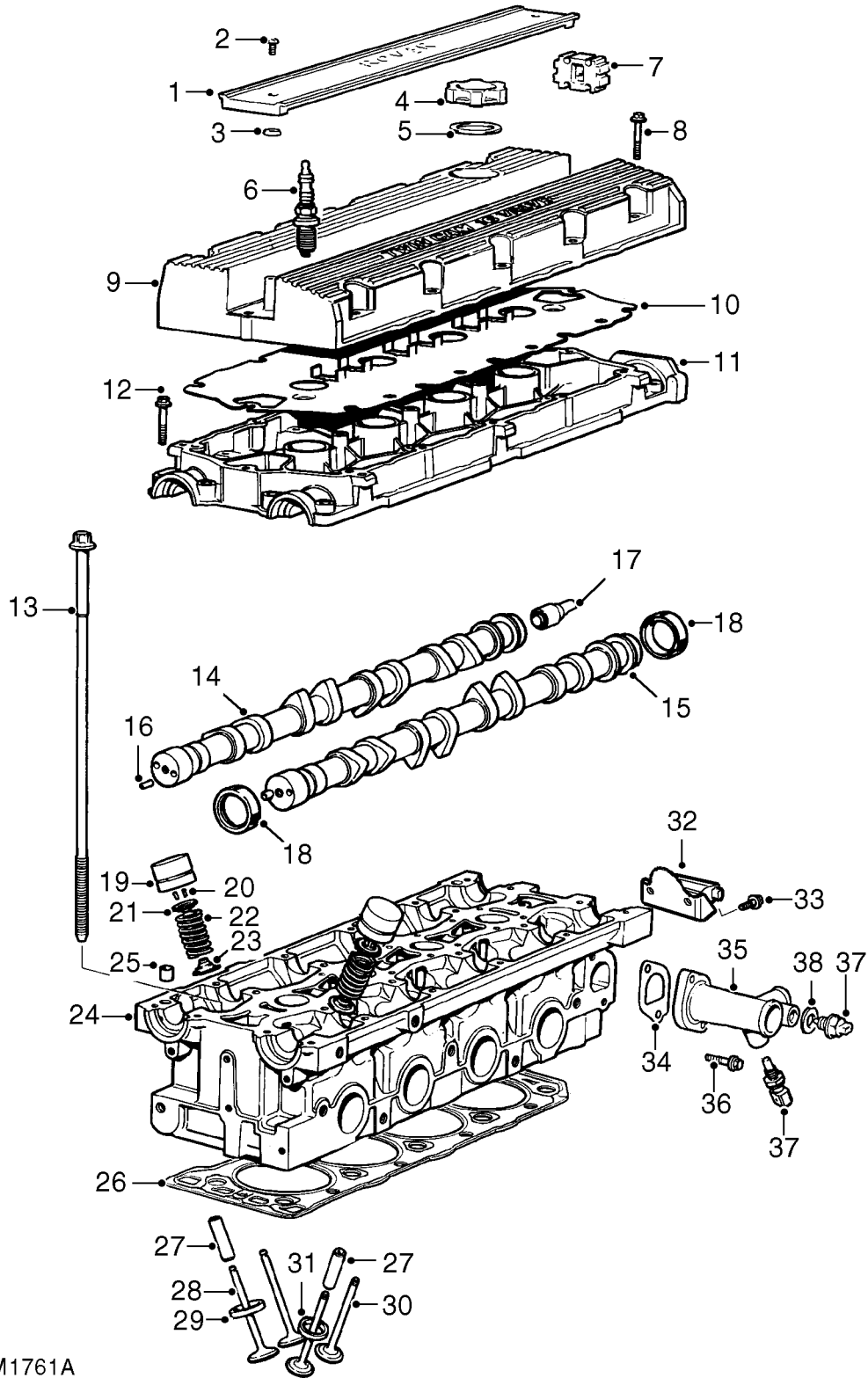
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CYLINDER BLOCK COMPONENTS

1. Oil pump assembly
2. Gasket - oil pump
3. Screw - M6 x 30 - oil pump
4. Screw M6 x 20 - oil pump
5. Crankshaft front oil seal
6. Dipstick
7. Dipstick tube
8. Screw - dipstick tube and thermostat housing
9. Screw - dipstick tube
10. Gasket
11. Coolant pump
12. 'O' ring - coolant pump
13. Pillar bolt - if fitted
14. Bolt - coolant pump
15. Locating dowel
16. Thermostat housing - plastic
17. 'O' ring
18. Seal thermostat
19. Thermostat
20. Cover - plastic
21. Screw
22. 'O' ring
23. Coolant rail
24. Screw - coolant rail
25. Vent screw - if fitted
26. Sealing washer
27. Cylinder block
28. Cylinder liner
29. Ring dowel
30. Piston and connecting rod assembly
31. Big-end bearing cap
32. Connecting rod bolt
33. Big-end bearing shells
34. Top compression ring
35. 2nd compression ring
36. Oil control ring
37. Crankshaft
38. Ring dowel
39. Main bearing shells
 - Plain in block Nos.1 and 5
 - Grooved in block Nos. 2, 3 and 4
 - Plain in bearing ladder
40. Thrust washers
41. Crankshaft rear oil seal
42. Flywheel assembly
43. Flywheel bolt - Patchlok
44. Bearing ladder
45. Bolt - bearing ladder
46. Bolt - bearing ladder
47. Ring dowel
48. Oil rail
49. Stud - oil rail
50. Nut - oil rail
51. Oil filter adapter
52. Gasket
53. Bolt
54. Oil pressure switch
55. Oil filter element
56. Alloy sump
57. Sump bolt - M8 x 25
58. Sump bolt - M8 x 30
59. Drain plug
60. Sealing washer
61. Oil pick-up pipe
62. Bolt - oil pick-up pipe
63. 'O' ring
64. Blanking plate
65. Screw - blanking plate
66. Sealing washer

ENGINE

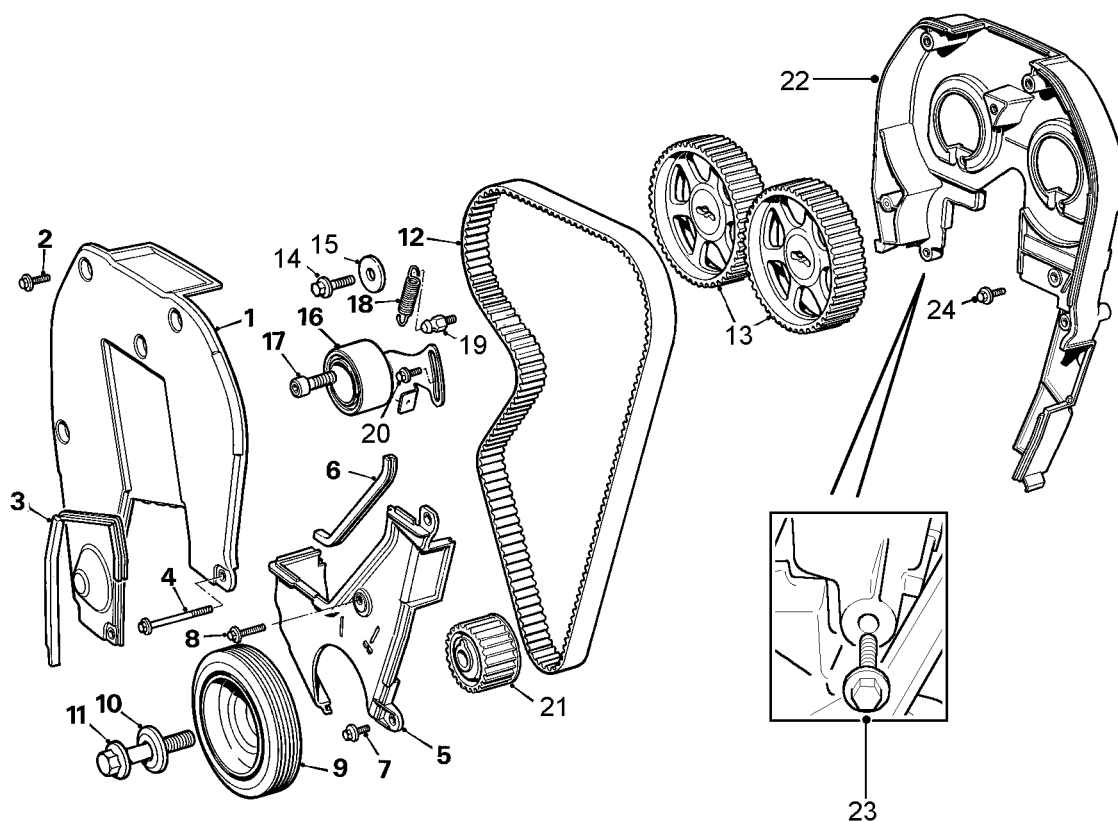


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CYLINDER HEAD COMPONENTS

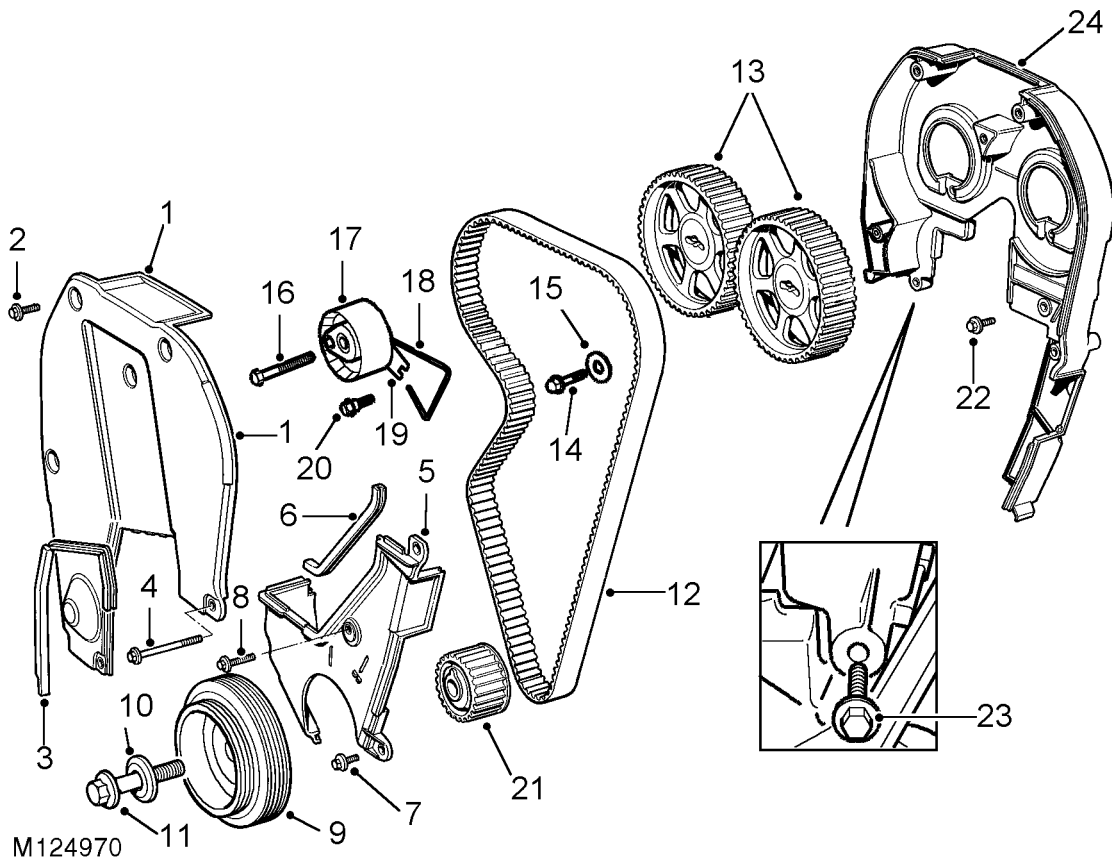
1. Spark plug cover
2. Screw M4 - cover
3. Screw retaining washer
4. Engine oil filler cap
5. Filler cap seal
6. Spark plug
7. Clip - HT leads
8. Bolt M6 - camshaft cover
9. Camshaft cover
10. Camshaft cover gasket
11. Camshaft carrier
12. Bolt M6 - camshaft carrier
13. Cylinder head bolt
14. Camshaft - inlet
15. Camshaft - exhaust
16. Drive pin - camshaft gear
17. Drive spindle - rotor arm
18. Camshaft oil seal
19. Hydraulic tappet
20. Collets - cap
21. Valve spring cap
22. Valve spring
23. Valve stem oil seal
24. Cylinder head
25. Ring dowel - cylinder head to camshaft carrier
26. Cylinder head gasket
27. Valve guide
28. Inlet valve
29. Valve seat insert - inlet
30. Exhaust valve
31. Valve seat insert - exhaust
32. Blanking plate
33. Screw M6
34. Gasket - coolant outlet elbow
35. Coolant outlet elbow
36. Screw M6 - coolant outlet elbow
37. Coolant temperature sensors
38. Sealing washer



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TIMING BELT COMPONENTS - ENGINES FITTED WITH MANUAL TIMING BELT TENSIONER

- | | |
|---|---|
| 1. Upper front cover - timing belt | 14. Camshaft gear bolt |
| 2. Screw M6 - upper cover | 15. Plain washer |
| 3. Seal - upper cover | 16. Tensioner pulley and backplate |
| 4. Bolt M6 x 90 - upper and lower cover | 17. Allen screw - pulley |
| 5. Lower cover - timing belt | 18. Tensioner spring |
| 6. Seal - lower cover | 19. Pillar bolt |
| 7. Screw M6 - lower cover | 20. Flange head screw - tensioner backplate |
| 8. Screw M6 x 16 - lower cover | 21. Crankshaft timing gear |
| 9. Crankshaft pulley | 22. Rear cover - timing belt |
| 10. Special washer - pulley bolt | 23. Screw - rear cover to coolant pump |
| 11. Crankshaft pulley bolt | 24. Screw - rear cover |
| 12. Camshaft timing belt | |
| 13. Camshaft timing gears | |



TIMING BELT COMPONENTS - ENGINES FITTED WITH AUTOMATIC TIMING BELT TENSIONER

- | | |
|--|--|
| 1. Upper front cover - timing belt | 13. Camshaft timing gears |
| 2. Screw M6 - upper cover | 14. Camshaft gear bolt |
| 3. Seal - upper cover | 15. Plain washer |
| 4. Bolt M6 x 90 - upper and lower covers | 16. Bolt - tensioner * |
| 5. Lower cover - timing belt | 17. Tensioner |
| 6. Seal - lower cover | 18. Index wire |
| 7. Screw M6 - lower cover | 19. Pointer |
| 8. Screw M6 x 16 - lower cover | 20. Pillar bolt |
| 9. Crankshaft pulley | 21. Crankshaft timing gear |
| 10. Special washer - pulley bolt | 22. Screw - rear cover |
| 11. Crankshaft pulley bolt | 23. Screw - rear cover to coolant pump |
| 12. Camshaft timing belt | 24. Rear cover |

* New Patchlok bolt must be used when tensioner is refitted

ENGINE

OPERATION

The K Series engine is built up from aluminium castings bolted together. These consist of three major castings; the cylinder head, cylinder block and a bearing ladder which is line bored to provide the main bearing bores. Attached to these are three minor castings; above the cylinder head, the camshaft carrier and the camshaft cover. Below the bearing ladder is an oil rail.

Each of the ten cylinder head bolts passes through the cylinder head, cylinder block and bearing ladder to screw into the oil rail. This puts the cylinder head, cylinder block and bearing ladder into compression with all the tensile loads being carried by the cylinder head bolts. Additional fixings are used to retain the bearing ladder to the cylinder block, and the oil rail to the bearing ladder when the cylinder head bolts are removed.

The cross flow cylinder head is based on a four valve, central spark plug, combustion chamber with the inlet ports designed to induce swirl and control the speed of the induction charge. This serves to improve combustion and hence fuel economy, performance and exhaust emissions. The twin overhead camshafts are retained by the camshaft carrier, which is line bored with the cylinder head. Self adjusting hydraulic tappets are fitted on top of each valve and are operated directly by the camshafts. The camshafts are driven from the crankshaft by a timing belt, belt tension being maintained by either a manually adjusted tensioner or, on later engines, by an automatic tensioner. The valve stem oil seals are moulded onto a metal base which also acts as the valve spring seat on the cylinder head.

Carbon break type exhaust valves are fitted to later engines; these valves can be identified by the machined profile on the valve stem. The profile removes any build up of carbon in the combustion chamber end of the valve guide, thereby preventing the valves from sticking. These valves should be fitted as replacements to all early engines.

The stainless steel cylinder head gasket has moulded seals around all coolant, breather and oil apertures and has steel cylinder bore eyelets. Compression of the gasket is controlled by limiters at each end of the gasket.

The cylinder block is fitted with 'damp' cylinder liners, the bottom, stepped half of the damp liner, being a sliding fit into the lower part of the cylinder block. The liners are sealed in the block with a bead of sealant applied around the stepped portion of the liner. The seal at the cylinder head is effected by the cylinder head gasket with the liner top acting as a break between the combustion chamber and gasket. The aluminium alloy, thermal expansion pistons have a semi-floating gudgeon pin which is offset towards the thrust side and has an interference fit in the small end of the connecting rod. Pistons and cylinder liners are supplied in two grades. Big-end bearing diametric clearance is controlled by three grades of selective shell bearing.

The five bearing, eight balance weight crankshaft has its end-float controlled by thrust washer halves at the top of the central main bearing. Bearing diametric clearance is controlled by three grades of selective shell bearing. Oil grooves are provided in the upper halves of main bearings No. 2, 3 and 4 to supply oil, via drillings in the crankshaft, to the connecting rod big-end bearings.



Lubrication

The lubrication system is of the full-flow filtration, forced fed type. The oil sump is of alloy manufacture, sealed to the bearing ladder with a bead of sealant applied to the flange.

Oil is drawn, via a strainer and suction pipe (1) in the sump, into the crankshaft driven oil pump (2). The oil pump is of the trochoid type which has an integral pressure relief valve (3), excess oil is diverted into the intake (4) of the oil pump. Oil is pumped through the full-flow cartridge type oil filter (5), mounted on an adapter attached to the oil pump housing. The low oil pressure sensor (6) is also screwed into the adapter and registers the oil pressure in the main oil gallery on the outlet side of the filter.

The main oil gallery (7) is fed through the oil rail below the main bearing ladder in which drillings direct the oil to the main bearings. Cross drillings in the crankshaft from No. 2 and 4 main bearings carry the oil to the big-end bearings. A passage in the oil pump housing connects to a drilling (8) in the cylinder block to oilways (9) in the cylinder head.

Oil is fed through the cylinder head to twin full length oilways (10) in the camshaft carrier to supply oil to each hydraulic tappet and camshaft bearing.

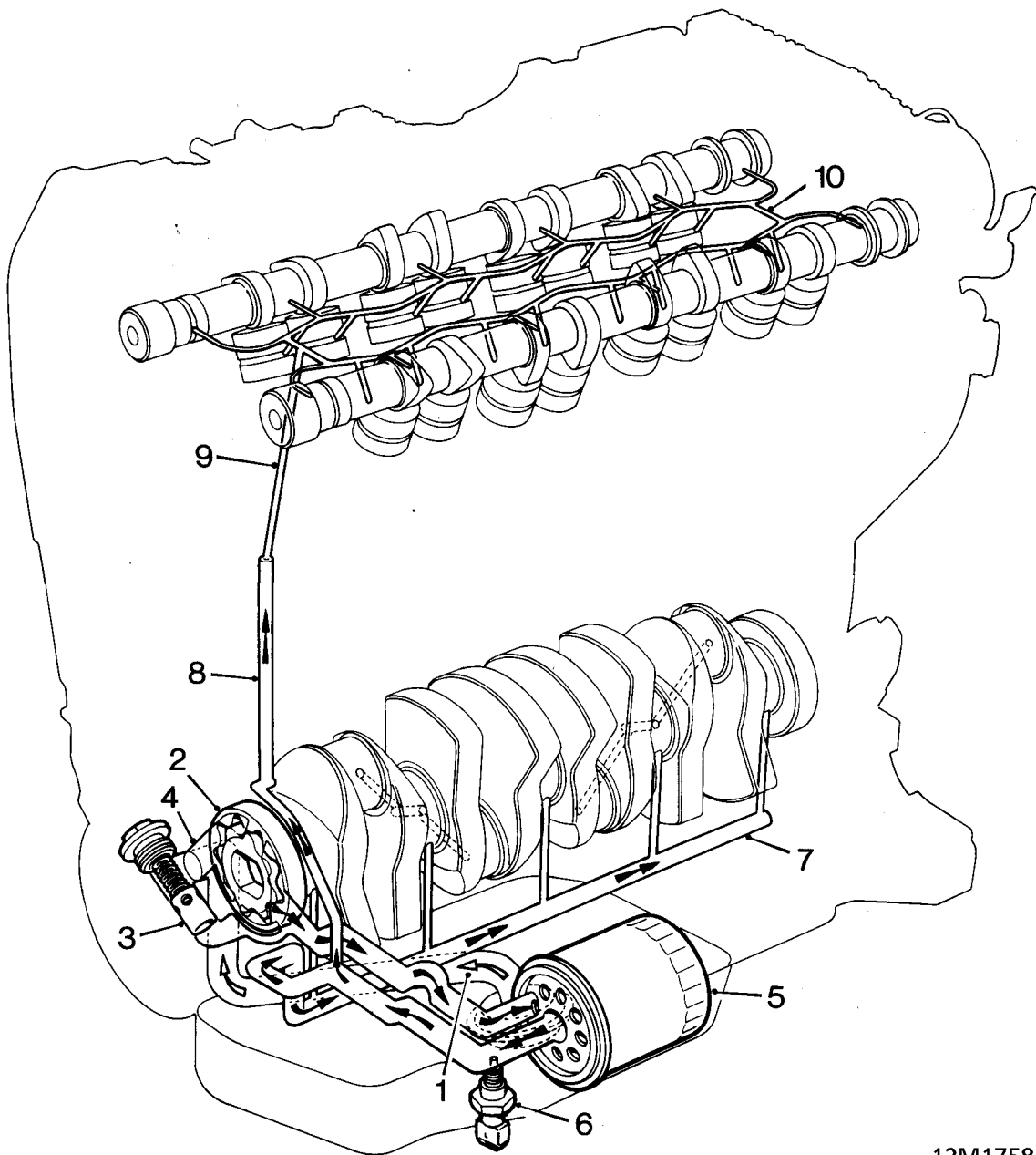
Crankcase ventilation

A positive crankcase ventilation system is used to vent blow-by gas from the crankcase to the air intake system.

Crankcase gases are drawn through a gauze oil separator in the camshaft cover and pass via hoses into the throttle housing.

ENGINE

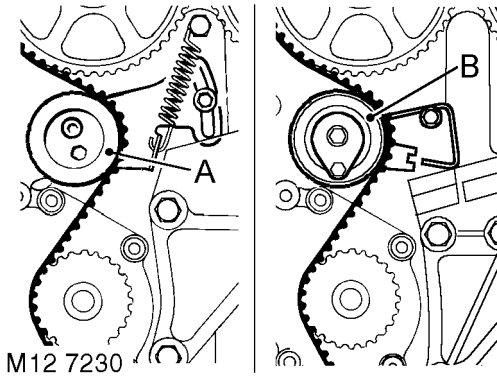
Engine lubrication system




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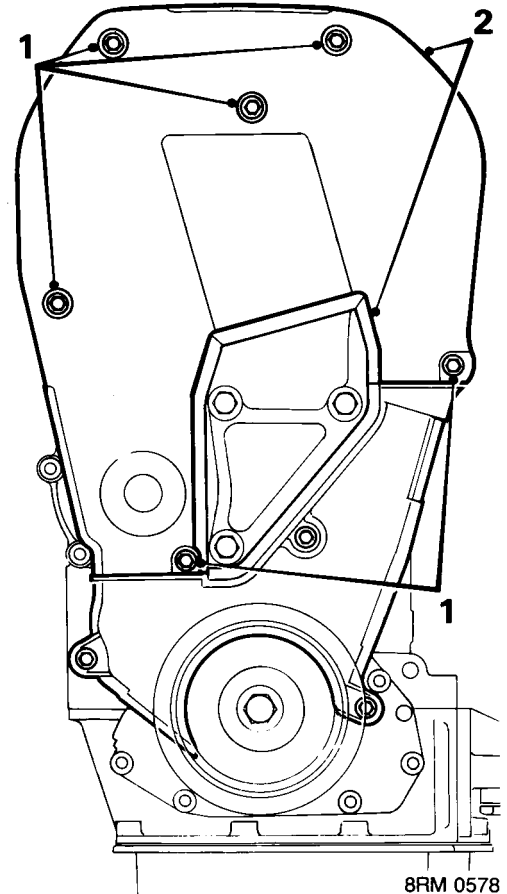
CAMSHAFT TIMING BELT



 **NOTE:** Two types of timing belt tensioner are fitted, type A is a manual tensioner whilst type B is an automatic tensioner. Commencing engine numbers for engines fitted with the automatic tensioner are listed in Information. The tensioners and their timing belts are not interchangeable.

Camshaft timing belt - manual tensioner - remove

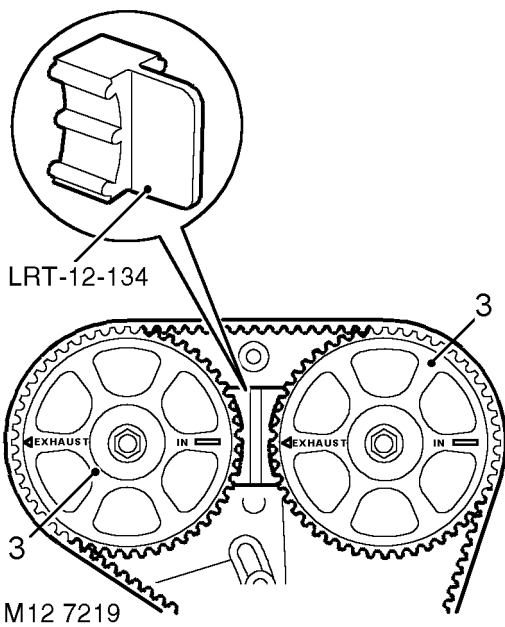
 **CAUTION:** Timing belts fitted to engines with manual timing belt tensioners are not interchangeable with those fitted to engines with automatic tensioners.



1. Slacken bottom bolt and remove 5 screws securing timing belt upper front cover.

 **NOTE:** Remove bottom bolt when cover is not slotted.

2. Remove timing belt upper front cover and seal.

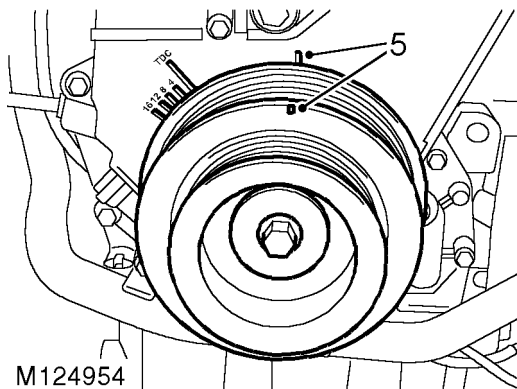


3. Rotate crankshaft to align camshaft gear timing marks 90° BTDC.

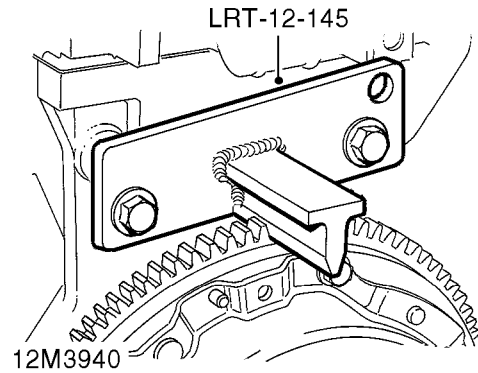


CAUTION: Do not use timing gears, gear retaining bolts or timing belt to rotate crankshaft.

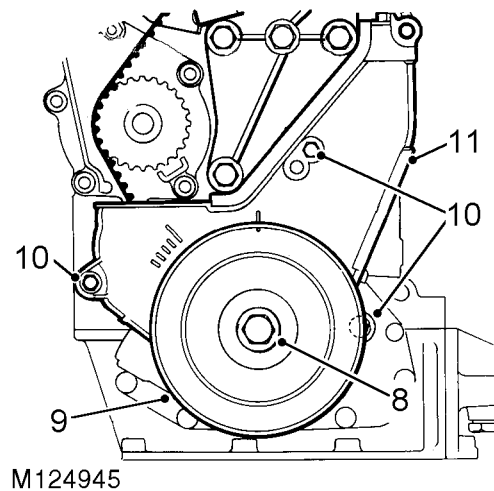
4. Fit camshaft gear locking tool LRT-12-134.



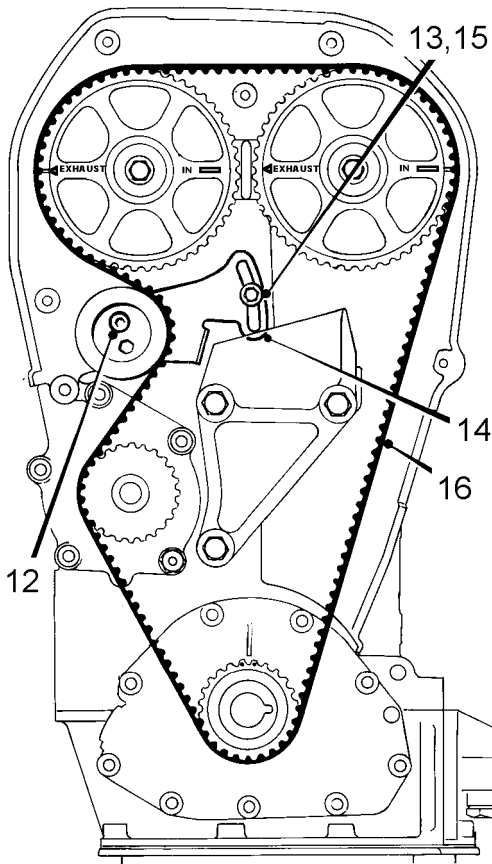
5. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.



6. Fit flywheel locking tool LRT-12-145 .
7. Secure with 2 bolts.



8. Remove crankshaft pulley bolt and washer.
9. Remove crankshaft pulley.
10. Remove 3 bolts securing timing belt lower cover.
11. Remove timing belt lower cover together with seals.



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12. Slacken tensioner pulley Allen screw.
13. Slacken tensioner backplate screw.
14. Push tensioner pulley down to fully OFF position.

NOTE: Tensioner spring and pillar bolt are only fitted for tensioning replacement timing belts.

15. Tighten backplate screw to 10 Nm.
16. Ease timing belt from gears using the fingers only.
17. Discard timing belt.

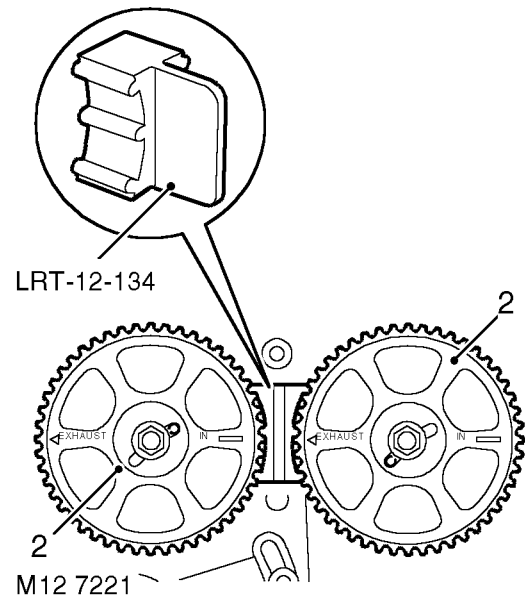
CAUTION: Timing belt must always be replaced during engine overhaul. Do not rotate camshafts or crankshaft with timing belt removed and cylinder head fitted.

Camshaft timing belt - manual tensioner refit

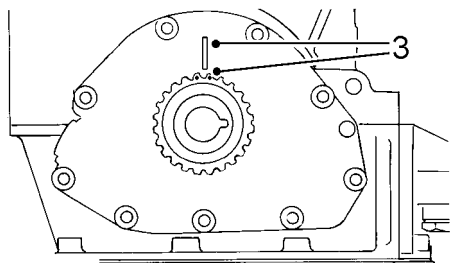
CAUTION: When a replacement timing belt is to be fitted, it will be necessary to fit the tensioner spring and pillar bolt supplied with the replacement belt to adjust belt tension.

1. Clean timing gears, coolant pump drive gear and tensioner pulley.

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. Because of the porous construction of sintered material, oil impregnated in the gears will emerge and contaminate the belt.

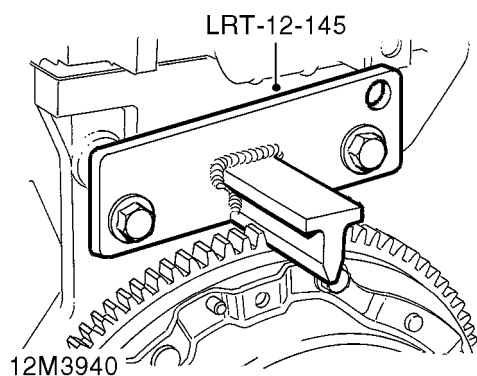


2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool LRT-12-134.

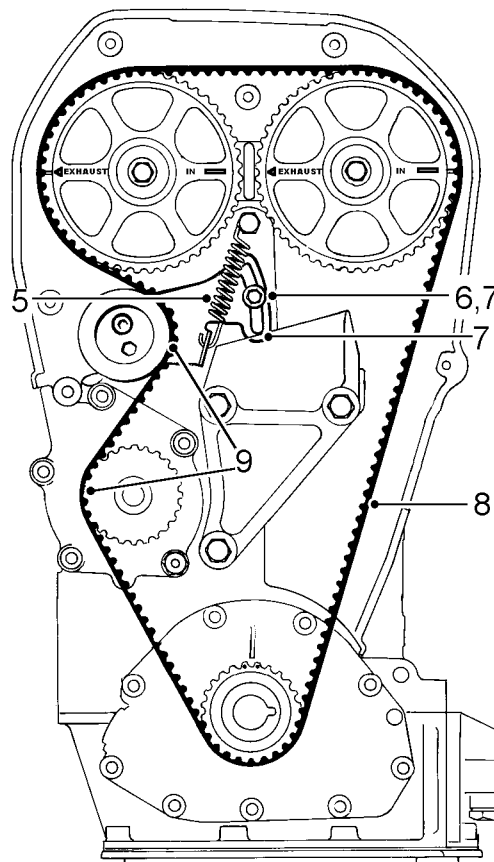


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3. Check that crankshaft gear timing marks are aligned with flange on oil pump - 90° BTDC.

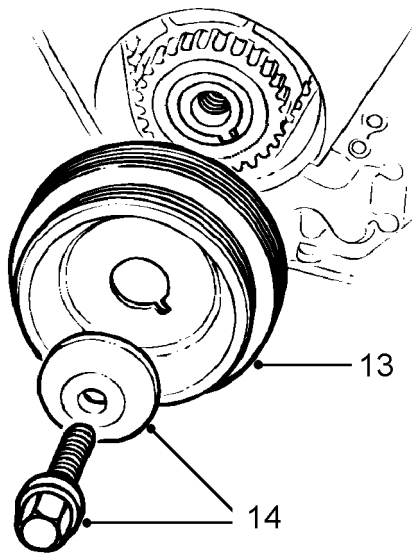


4. Fit flywheel locking tool **LRT-12-145**, secure with 2 bolts.



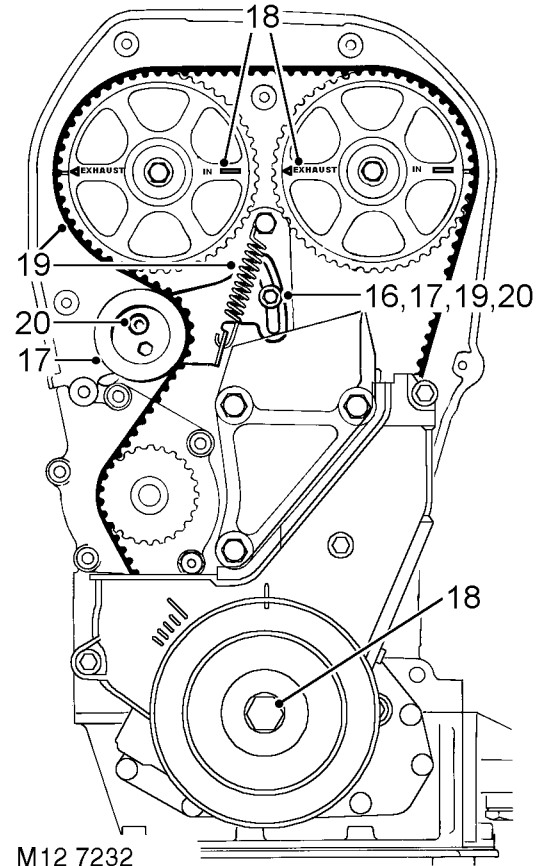
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5. Fit tensioner spring and pillar bolt supplied with replacement timing belt. Connect spring to tensioner backplate and pillar bolt.
6. Slacken tensioner backplate screw, ensure tensioner moves fully through its adjustment range and returns under spring tension.
7. Push tensioner down to fully OFF position and tighten tensioner backplate screw to 10 Nm.
8. Using the fingers only, fit a new timing belt over crankshaft timing gear and then over camshaft gears keeping belt taut between crankshaft timing gear and exhaust camshaft gear.
9. Ease timing belt over tensioner pulley and coolant pump drive gear.
10. Ensure belt is positioned centrally on gears and pulley.
11. Ensure inserts are fitted in timing belt lower cover.
12. Fit timing belt lower cover, ensuring correct position of seals; fit lower cover screws and tighten to 9 Nm.



M124927

13. Fit crankshaft pulley to crankshaft timing gear ensuring that indent on pulley locates over lug on gear.
14. Secure with crankshaft pulley bolt and washer, tighten bolt to 205 Nm.
15. Remove camshaft and flywheel locking tools.



16. Slacken tensioner backplate screw and tension timing belt by applying finger pressure to tensioner backplate.
17. With tensioner pulley against timing belt and backplate held in position, tighten backplate screw to 10 Nm.
18. Rotate crankshaft 2 complete revolutions clockwise and align camshaft gear timing marks.

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

19. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
20. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.
21. Disconnect tensioner spring from pillar bolt, release spring from tensioner, remove and discard spring.
22. Remove and discard pillar bolt.

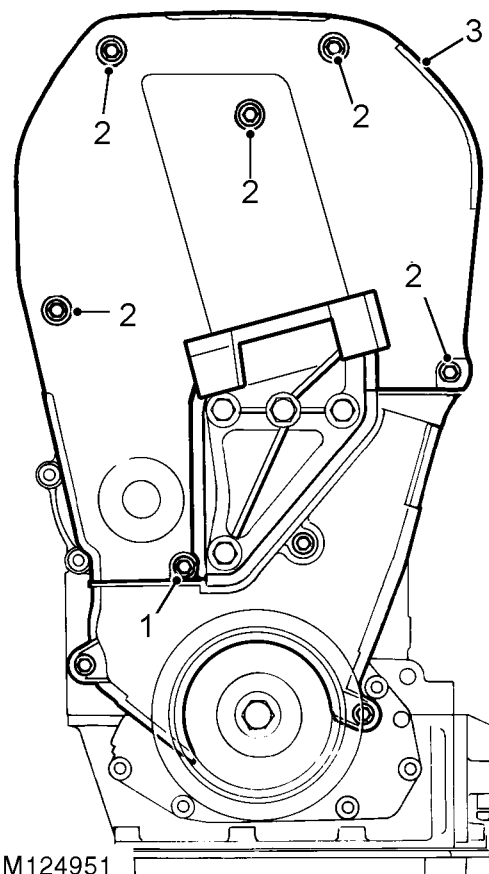
ENGINE

23. Ensure inserts are fitted in timing belt upper front cover.
24. Fit timing belt upper front cover, ensuring correct position of seals, tighten screws and bolt to 5 Nm.

Camshaft timing belt - automatic tensioner - remove



CAUTION: Timing belts fitted to engines with automatic timing belt tensioners are not interchangeable with those fitted to engines with manual tensioners.

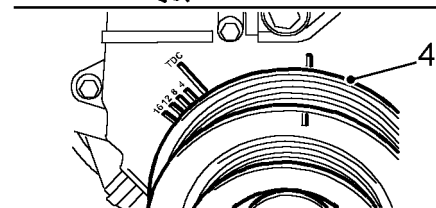
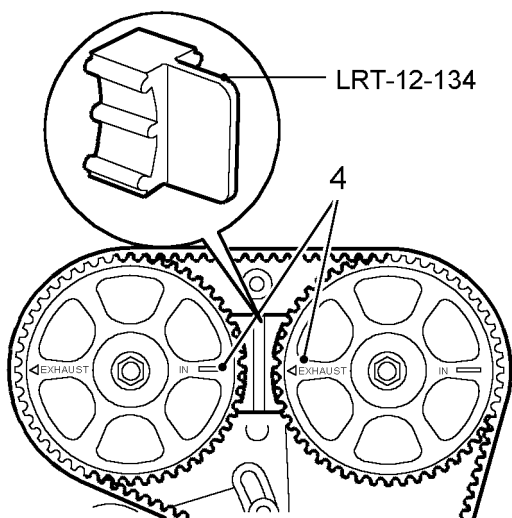


1. Slacken but do not remove bolt securing bottom of timing belt upper front cover.



NOTE: Remove bolt when cover is not slotted.

2. Noting fitted position of longest screw, remove 5 screws securing timing belt upper front cover.
3. Remove timing belt upper front cover together with seal.



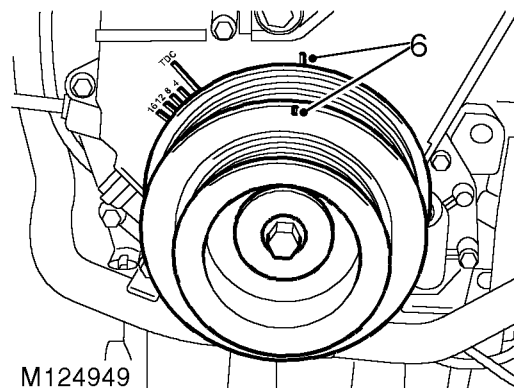
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4. Rotate crankshaft clockwise to align camshaft gear timing marks - 90° BTDC.



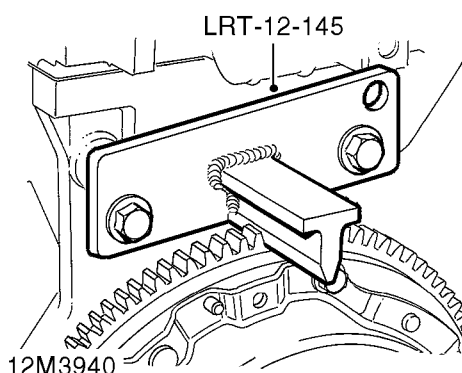
CAUTION: Do not use camshaft gears, gear retaining bolts or timing belt to rotate crankshaft.

5. Fit camshaft gear locking tool **LRT-12-134**.



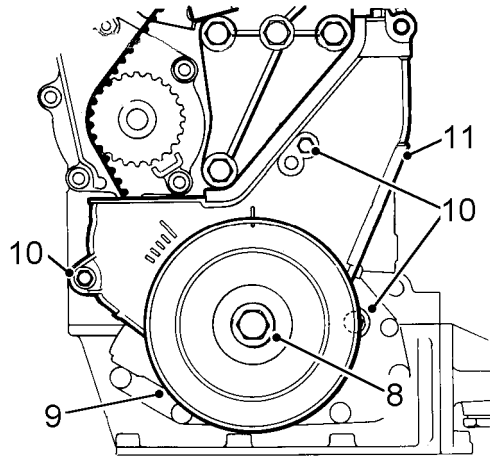
M124949

6. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.



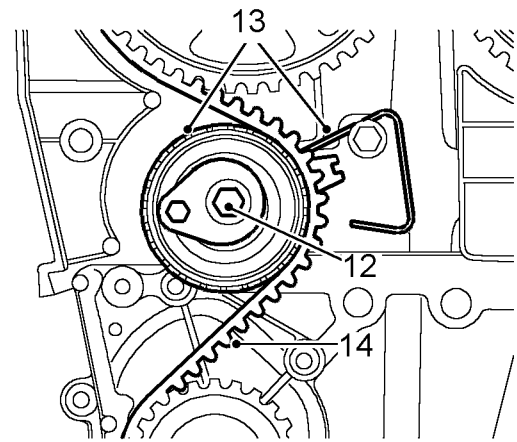
12M3940

7. Fit flywheel locking tool **LRT-12-145**, secure with 2 bolts.



M124945

8. Remove crankshaft pulley bolt and washer.
9. Remove crankshaft pulley.
10. Remove 3 bolts securing timing belt lower cover.
11. Remove timing belt lower cover together with seals.



M124955

12. Remove and discard timing belt tensioner bolt.
13. Disengage index wire from its fitted position whilst at the same time removing the timing belt tensioner.
14. Ease timing belt from gears using the fingers only.
15. Discard timing belt.



CAUTION: Timing belt must always be replaced during engine overhaul. Do not rotate crankshaft with timing belt removed and cylinder head fitted.

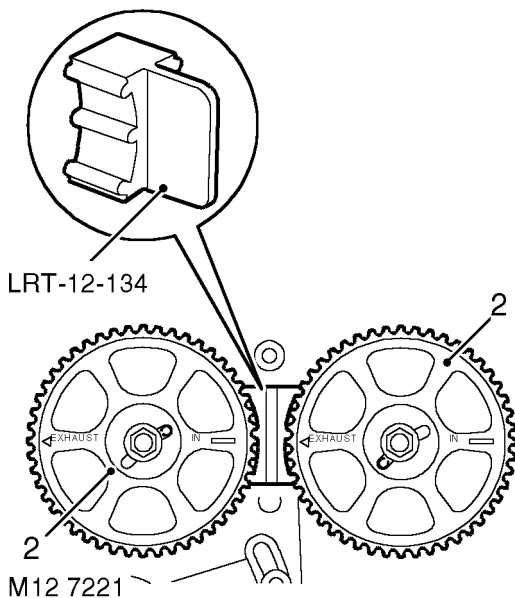


Camshaft timing belt - automatic tensioner - refit

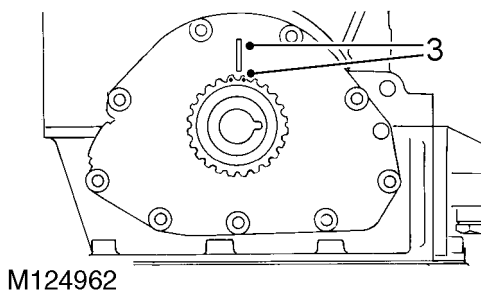


CAUTION: If the sintered gears have been subjected to prolonged oil contamination, they must be soaked in a solvent bath and then thoroughly washed in clean solvent before refitting. Because of the porous construction of sintered material, oil impregnated in the gears will emerge and contaminate the belt.

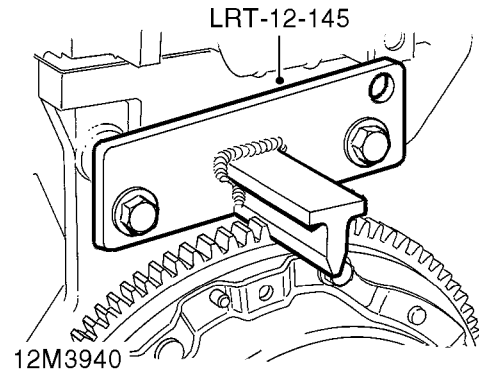
1. Clean timing gears, coolant pump drive gear and tensioner pulley.



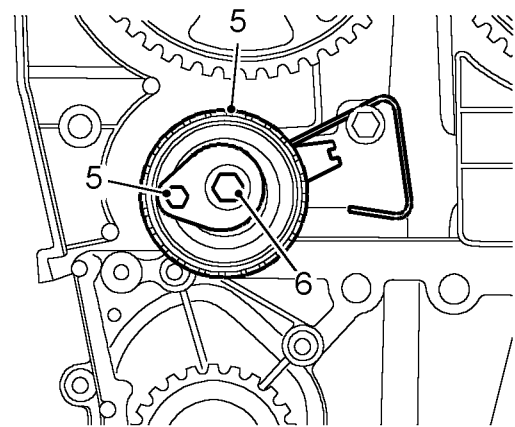
2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool LRT-12-134.



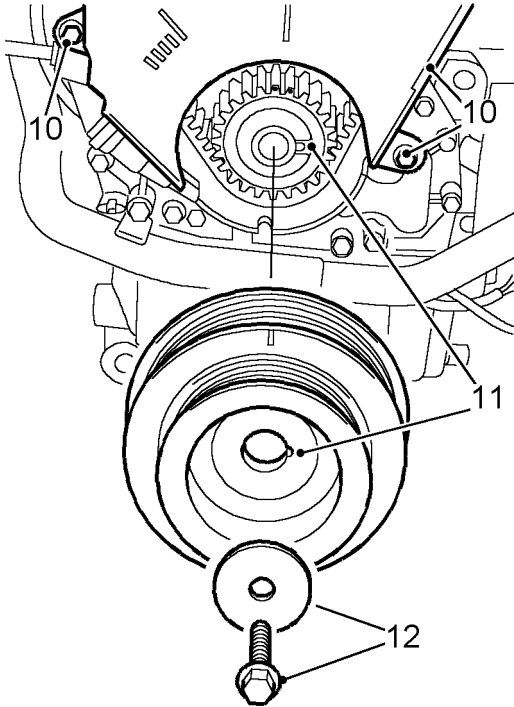
3. Check that crankshaft gear timing marks are aligned with flange on oil pump - 90° BTDC.



4. Fit flywheel locking tool LRT-12-145, secure with 2 bolts.

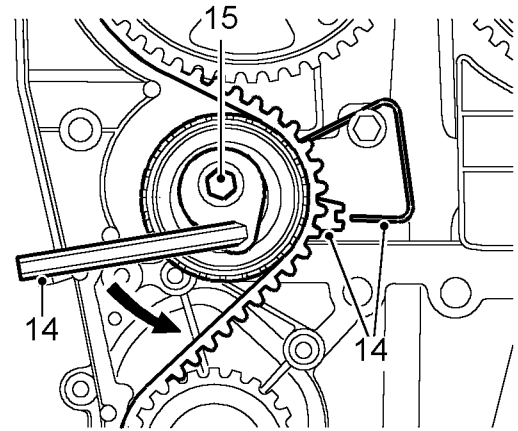


5. Fit timing belt tensioner ensuring that index wire is positioned over pillar bolt and that tensioner lever is at 9 o'clock position.
6. Fit a new tensioner securing bolt and tighten bolt until it is just possible to move tensioner lever.
7. Using the fingers only, fit a new timing belt over crankshaft gear, then camshaft gears, tensioner pulley and coolant pump drive gear ensuring that the belt run between the crankshaft gear and the exhaust camshaft gear is kept taut.
8. Check that timing belt is positioned centrally around gears and tensioner pulley.
9. Ensure inserts are fitted in timing belt lower cover.



M124953

10. Fit timing belt lower cover ensuring correct position of seals, fit screws and tighten to 9 Nm.
11. Fit crankshaft pulley to crankshaft gear ensuring that indent on pulley locates over lug on gear.
12. Fit crankshaft pulley bolt and washer, tighten bolt to 205 Nm.
13. Remove camshaft gear and flywheel locking tools.

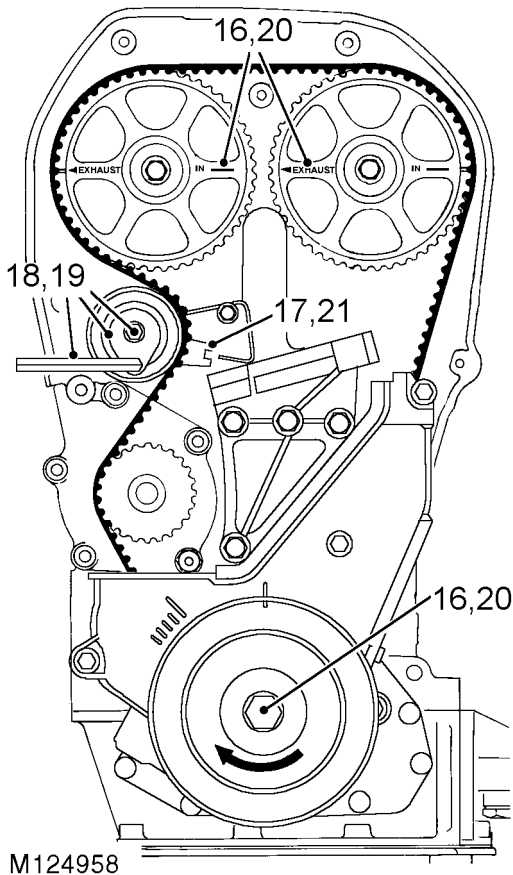


M124957

14. Using a 6 mm Allen key, rotate tensioner anti-clockwise and align the centre of the indent on the tensioner pointer to the index wire.

CAUTION: Ensure that pointer approaches index wire from above. Should pointer go past index wire, release tension completely and repeat tensioning procedure.

15. Ensuring that pointer maintains correct position, tighten tensioner bolt to 25 Nm.



20. Using crankshaft pulley bolt, rotate crankshaft 2 turns clockwise and align camshaft gear timing marks.
21. Check that pointer is still correctly aligned with index wire.
22. Ensure inserts are fitted in timing belt upper front cover.
23. Fit timing belt upper front cover ensuring correct position of seal, fit screws, tighten screws and bottom bolt to 5 Nm.

16. Using crankshaft pulley bolt, rotate crankshaft 2 turns clockwise and align camshaft gear timing marks.



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

17. Check that pointer is still correctly aligned with index wire.



CAUTION: If pointer is not correctly aligned, carry out the following procedure.

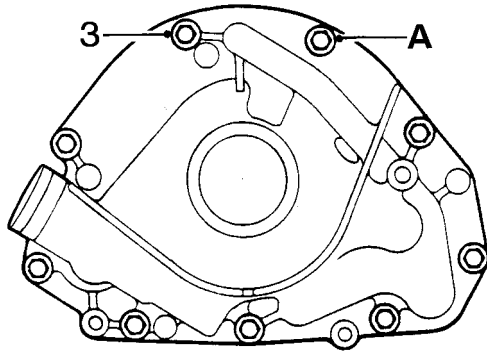
18. Slacken tensioner bolt until it is just possible to move the tensioner lever. Using a 6 mm Allen key, rotate tensioner lever clockwise until pointer is just above the index wire then rotate tensioner lever anti-clockwise until pointer is correctly aligned with index wire.
19. Ensuring that pointer maintains correct position tighten tensioner bolt to 25 Nm.

ENGINE

OIL PUMP

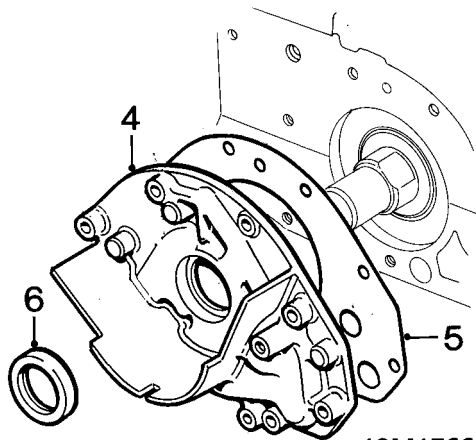
Remove

1. Remove and discard camshaft timing belt.
2. Remove crankshaft timing gear.



12M1765

3. Noting fitted position of M6 x 20 bolt 'A,' remove and discard 9 bolts securing oil pump to cylinder block.



12M1766

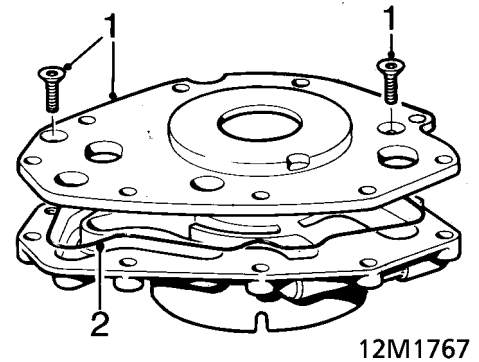
4. Remove oil pump assembly.

NOTE: Dowel located.



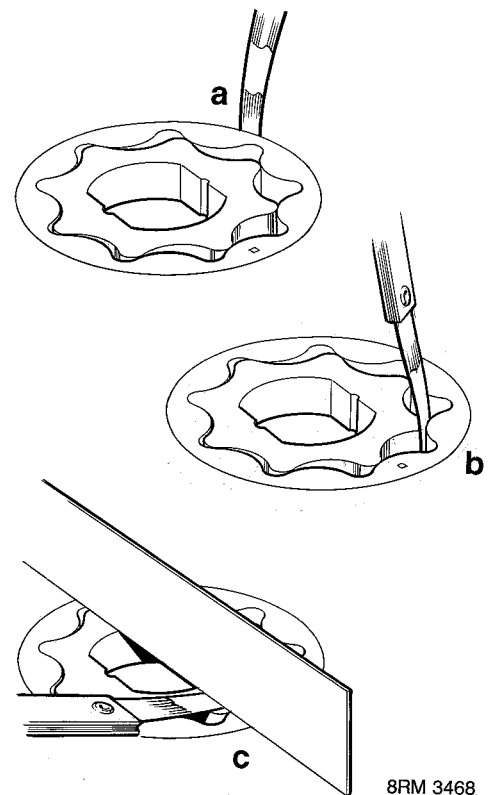
5. Remove and discard oil pump gasket.
6. Remove and discard crankshaft front oil seal.

Inspection



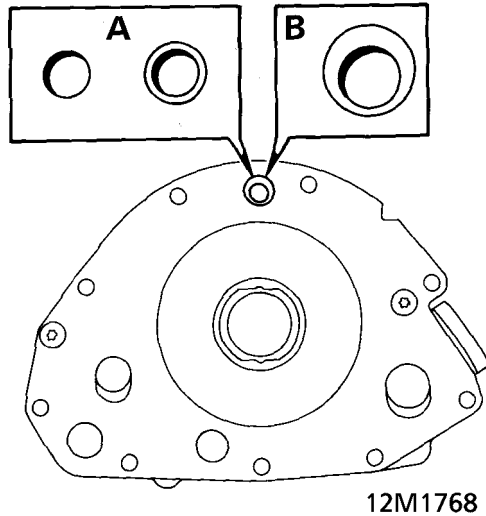
12M1767

1. Remove 2 screws and cover plate.
2. Remove and discard cover plate seal.



8RM 3468

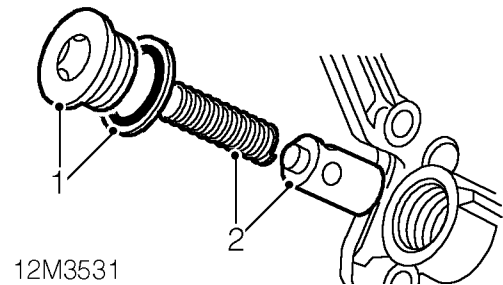
3. Check rotor clearances:
 - a. Outer rotor to housing = 0.28 - 0.36 mm
 - b. Inner rotor tip = 0.05 - 0.13 mm
 - c. Rotor end float = 0.02 - 0.06 mmRenew pump assembly if housing is scored or clearances are excessive.



CAUTION: Two types of oil pump have been fitted. The early type oil pumps can be identified by having either a plain 6 mm diameter oil feed hole or an 8 mm diameter oil feed hole with a 6 mm counterbore - A in illustration. Later type oil pumps all have a 12 mm diameter oil feed hole with an 8 mm diameter offset counterbore - B in illustration. Later type oil pumps may be fitted as replacements to all engines but early type pumps may not be fitted to later engines.

4. Remove all traces of Loctite from cover plate securing screws and tapped holes in oil pump body; ensure screw holes are clean and dry.

Oil pressure relief valve



1. Unscrew plug, discard sealing washer.
2. Remove spring and relief valve sleeve assembly.
3. Check that valve sleeve slides freely in bore and that bore and sleeve are free from scoring and corrosion.

NOTE: Light corrosion may be removed using grade 600 emery cloth soaked in engine oil.

4. Check free length of spring:
Spring free length = 38.9 mm

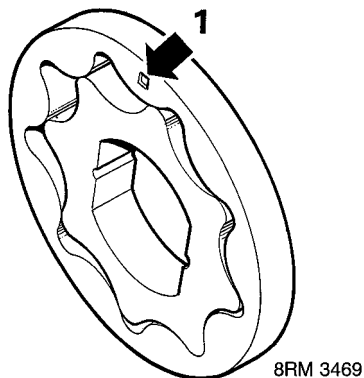
Replace relief valve as an assembly if scoring of plunger is evident or free length of spring is less than specified. Replace oil pump if relief valve bore is scored.

5. Remove all traces of Loctite from plug and threads in relief valve bore.

CAUTION: Do not use a tap.

6. Apply Loctite 577 to threads of plug.
7. Fit plug, use a new sealing washer.

Oil pump assembling



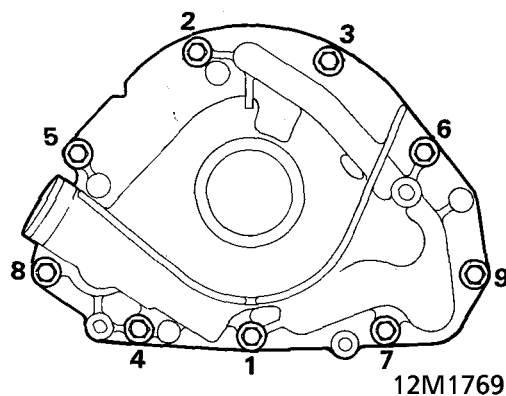
1. Ensure outer rotor identification marking faces outward.
2. Lubricate pump rotors with engine oil.
3. Lubricate a new cover plate seal with engine oil.
4. Fit cover plate seal and cover plate.
5. Apply Loctite 222 to cover plate securing screws, fit and tighten screws.
6. Check that pump rotates freely.

Oil pump - refit

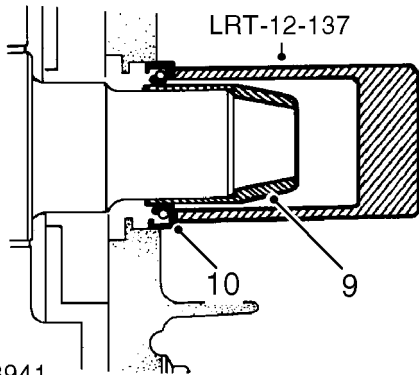
1. Clean oil pump.
2. Using gasket removal spray and a plastic scraper, remove all traces of gasket from oil pump.
3. Clean oil seal running surface on crankshaft.
4. Fit a new, dry, oil pump gasket.
5. Turn oil pump rotor to align drive with crankshaft.
6. Fit oil seal protector sleeve, from seal kit, over crankshaft end.



NOTE: This will assist in locating oil pump inner rotor.



7. Fit oil pump, fit new Patchlok bolts, M6 x 20 bolt at position 3.
8. Tighten in sequence shown to 10 Nm.



9. Ensure oil seal protector sleeve is located over end of crankshaft.
10. Position new seal on crankshaft against oil pump housing. Drift seal into position using tool **LRT-12-137**.



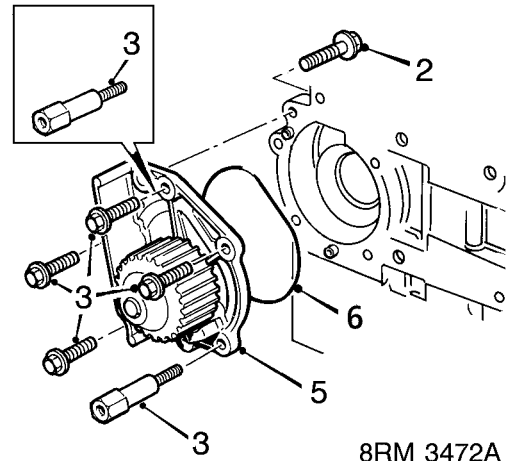
CAUTION: Oil seal must be fitted dry.

11. Remove tool **LRT-12-137** and oil seal protector sleeve.
12. Clean crankshaft timing gear.
13. Fit crankshaft timing gear.
14. Fit and adjust a new camshaft timing belt.

COOLANT PUMP

Remove

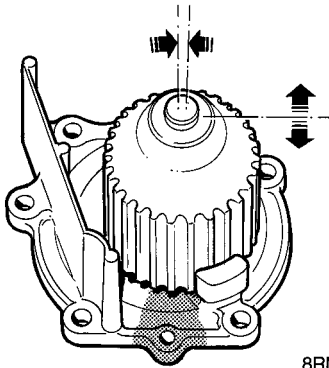
1. Remove and discard camshaft timing belt.



2. Remove bolt securing timing belt rear cover to coolant pump.
3. Remove 3 bolts and 2 pillar bolts securing coolant pump.
4. Release coolant pump from 2 dowels and rear cover.
5. Remove coolant pump.
6. Remove and discard 'O' ring from pump.

ENGINE

Inspection

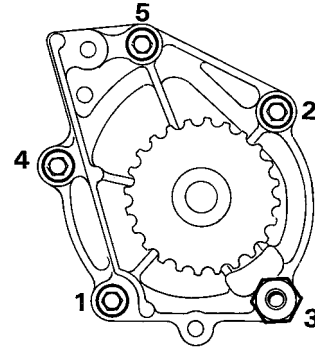


8RM 3473

1. Check for movement of pump spindle in bearing and for coolant leakage from seal.

Refit

1. Clean pump, mating face and dowels.
2. Fit new 'O' ring to coolant pump, use RTV sealant to retain 'O' ring.

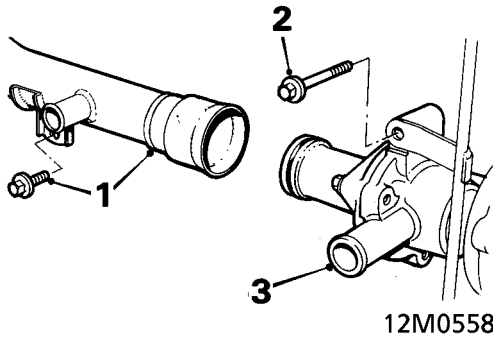


8RM 0055

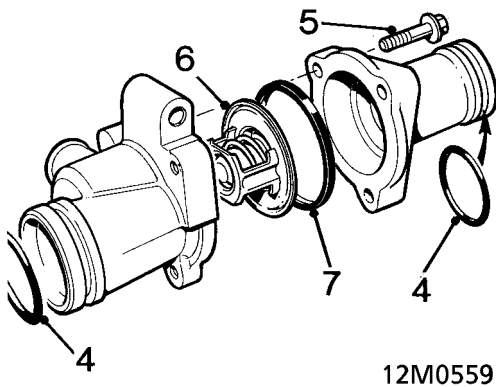
3. Fit coolant pump to cylinder block, tighten bolts in sequence shown to 10 Nm.
4. Fit and adjust a new camshaft timing belt.



THERMOSTAT

Remove

1. Remove 2 bolts securing water rail to cylinder block, release rail from thermostat housing.
2. Remove bolt securing thermostat housing and dipstick tube to cylinder block.
3. Withdraw thermostat housing from coolant pump.



4. Remove and discard 'O' rings from thermostat housing and cover.
5. Remove 3 bolts and remove cover from thermostat housing.
6. Withdraw thermostat from housing.
7. Remove and discard seal from thermostat.

Inspection

1. Test thermostat using thermostat test equipment, renew thermostat if necessary:-
Starts to open = 85° to 91° C
Thermostat fully open = 100° C

ENGINE

Refit

1. Clean thermostat housing, cover and sealing faces.
2. Lubricate new 'O' rings with silicone grease and fit to thermostat housing and cover.
3. Fit a new seal to thermostat.
4. Align and fit thermostat to shoulder in thermostat housing.
5. Fit cover to thermostat housing, fit and tighten bolts to 8 Nm.

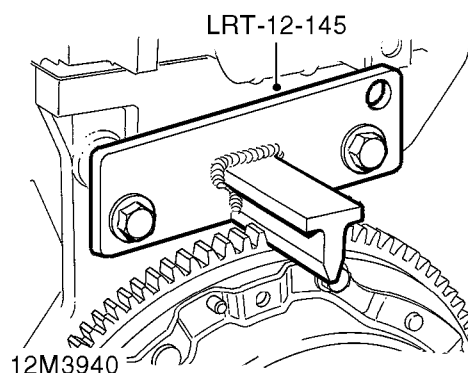


CAUTION: Torque figure must not be exceeded.

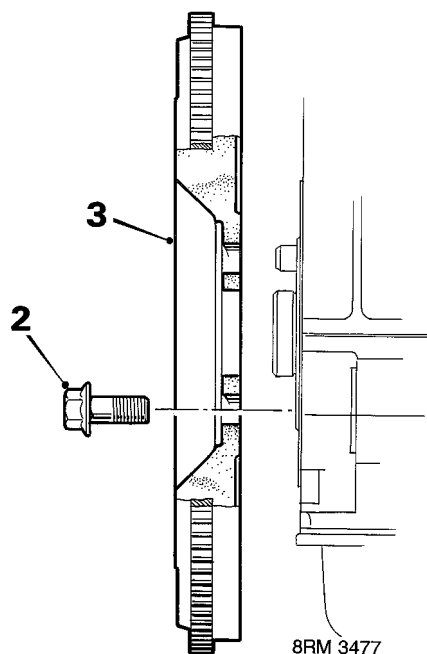
6. Fit thermostat housing to coolant pump, align dipstick tube bracket, fit and tighten bolt to 10 Nm.
7. Connect water rail to thermostat cover.
8. Align water rail to cylinder block, fit and tighten bolts to 25 Nm.

FLYWHEEL AND STARTER RING GEAR

Flywheel - remove



1. Fit flywheel locking tool **LRT-12-145** to cylinder block, tighten 2 bolts.



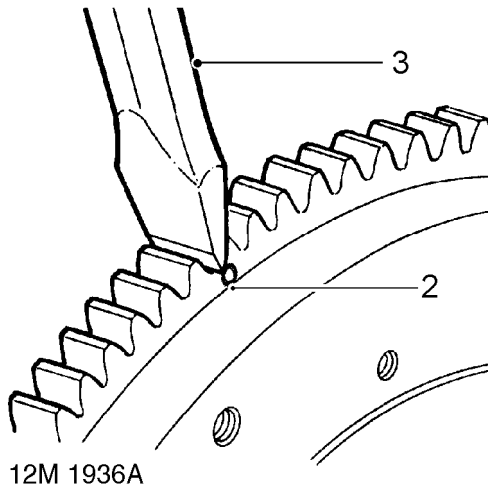
2. Remove and discard 6 bolts securing flywheel.
3. Using assistance, remove flywheel from crankshaft.



NOTE: Dowel located.



Starter ring gear - remove



1. Remove flywheel.
2. Drill a 3 mm diameter hole at 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.**

Starter ring gear - refit

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



WARNING: Handle hot ring gear with care.

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

Flywheel - refit

1. Clean flywheel and crankshaft faces. Use a clean bolt with two saw cuts along threads and clean adhesive from threaded holes in crankshaft.
2. Using assistance, fit flywheel to crankshaft.
3. Fit flywheel locking tool **LRT-12-145**, tighten 2 bolts.
4. Fit and tighten new Patchlok bolts to 80 Nm.

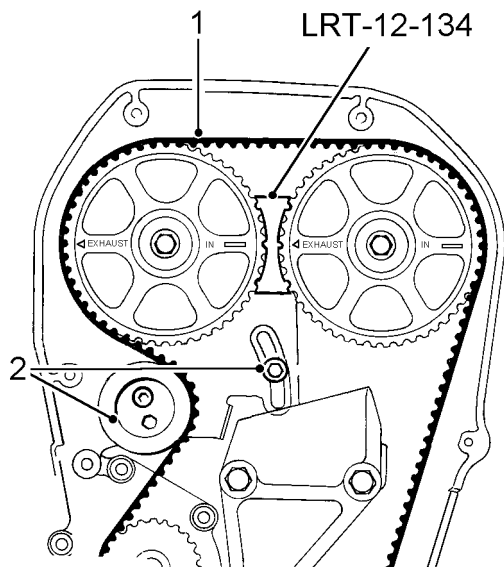
ENGINE

CYLINDER HEAD

Cylinder head - remove



CAUTION: If crankshaft is to be removed during overhaul it will be necessary to check and record crankshaft end-float prior to removing cylinder head.

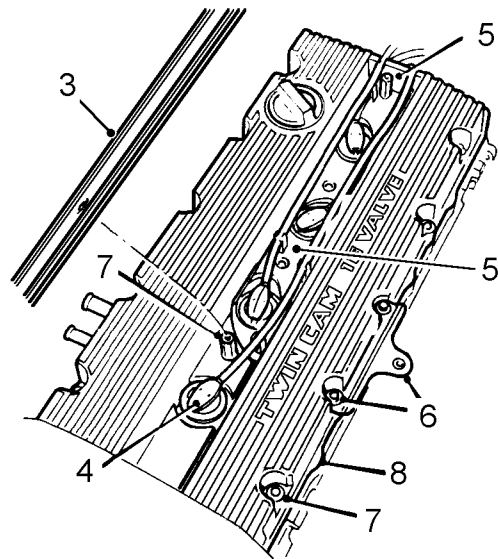


1. Remove and discard camshaft timing belt.



CAUTION: Do not rotate crankshaft whilst timing belt is removed and cylinder head is fitted, pistons will contact the valves.

2. Engines fitted with manual timing belt tensioner: Remove bolt securing timing belt tensioner, remove tensioner.



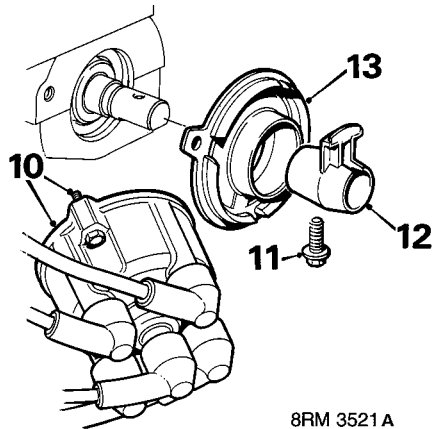
M124931

3. Release 2 screws and remove spark plug cover.
4. Disconnect 4 plug tubes from spark plugs. Remove any debris from spark plug recesses and remove 4 spark plugs.
5. Lift clip plate and grommet and position plug leads aside.
6. If fitted: Remove 2 bolts and air cleaner support bracket.
7. Progressively loosen then remove bolts and on early engines, 2 pillar bolts securing camshaft cover.

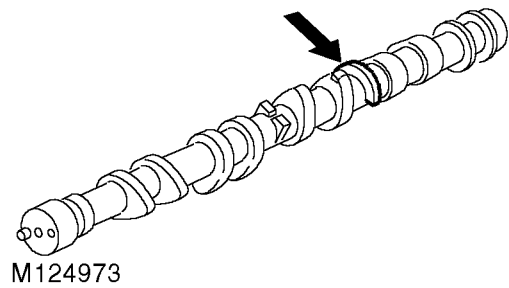


NOTE: On later engines, pillar bolts have been replaced by 'cast-in' supports which are an integral part of the camshaft cover.

8. Remove camshaft cover assembly, remove and discard gasket.
9. Check and record crankshaft end-float.




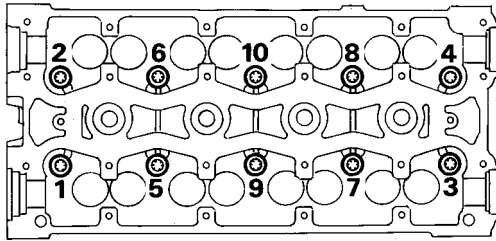
8RM 3521 A



M124973

10. Release 2 screws and remove distributor cap.
11. Remove and discard screw securing rotor arm.
12. Remove rotor arm.
13. Remove anti-flash shield.

 **NOTE:** Later engines are fitted with modified camshafts which incorporate a reluctor ring and the procedure for removing cylinder head bolts differs from early engines. Commencing engine numbers for the modified camshafts are listed in Information.

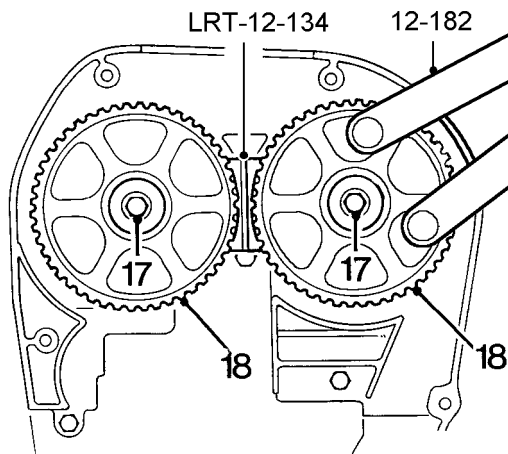


8RM 0740

14. Using sequence shown, progressively loosen cylinder head bolts:
Early engines:- Remove bolts 1 to 8 and store in fitted order.
Later engines with modified camshafts:- Remove bolts 1 to 6 and store in fitted order.



NOTE: It will be necessary to carry out the following operations in order to remove the remaining bolts.



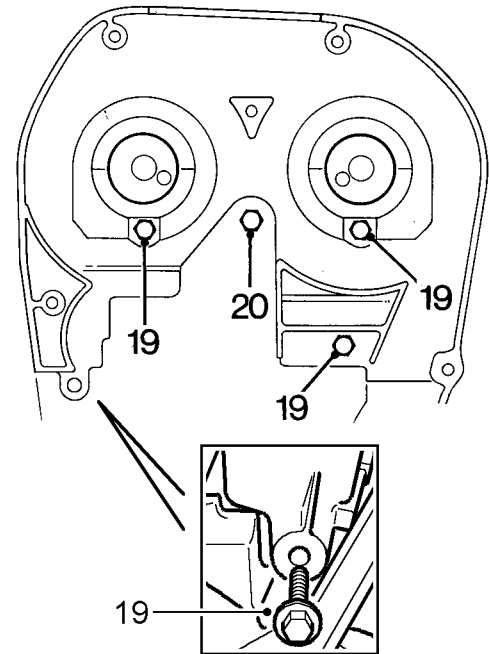
M12 7225

15. Remove locking tool **LRT-12-134** from camshaft gears.
 16. Using tool **12-182**, turn both camshafts clockwise to gain access to bolts:
Early engines:- Bolts 9 and 10
Later engines with modified camshafts:- Bolts 7 and 8.
 Progressively loosen then remove the remaining bolts and store in fitted order.



CAUTION: Removal of cylinder head bolts results in a 'tightening-up' of crankshaft; rotation of crankshaft must, therefore, be kept to a minimum. Do not rotate crankshaft until cylinder liner retainer clamps are fitted.

17. Suitably identify each camshaft gear to its respective camshaft and using tool **12-182** to hold camshaft gear against rotation, remove bolt and plain washer from each camshaft gear.
 18. Remove camshaft gears.



12M0577A

19. Remove screws securing upper part of timing belt rear cover to cylinder head and screw securing rear of cover to coolant pump.



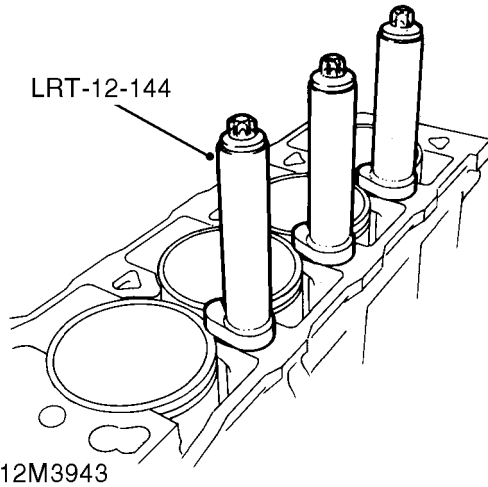
NOTE: This is the longest of the rear cover securing screws.

20. *Automatic timing belt tensioner :-* Remove timing belt tensioner spring pillar bolt.
 21. Using assistance, remove cylinder head assembly from cylinder block.



CAUTION: Cylinder head is dowel located, do not tap it sideways to free it from cylinder block. Place cylinder head assembly on blocks of wood to prevent damaging valves.

22. Remove and discard cylinder head gasket.

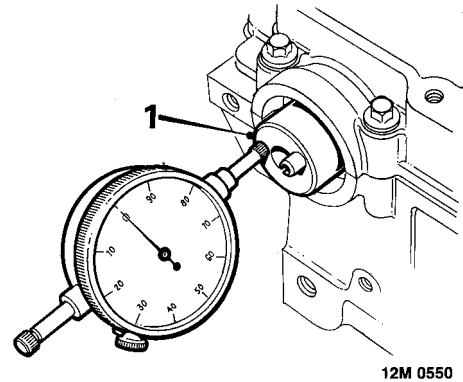


23. Assemble cylinder liner retainer clamps **LRT-12-144** to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Lightly tighten bolts into oil rail sufficient to retain clamps.



CAUTION: Ensure that bolts used are those originally fitted in that location.

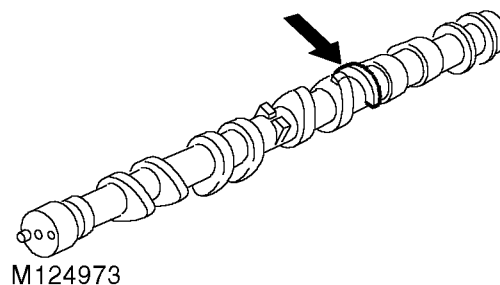
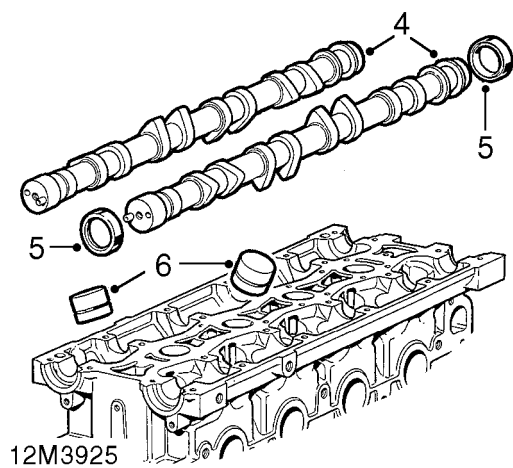
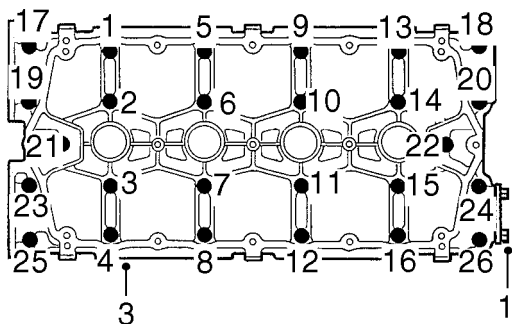
Camshafts - check end-float



1. Check end-float of each camshaft using a DTI.
Camshaft end-float = 0.06 to 0.19 mm
Service limit = 0.3 mm
2. Renew components as necessary to achieve correct end-float.

ENGINE

Camshaft carrier and camshafts - remove



CAUTION: Camshafts fitted to later engines incorporate a reluctor ring, these camshafts are not interchangeable with those fitted to early engines. Commencing engine numbers for the modified camshafts are listed in Information.

1. Remove bolts securing blanking plate to rear of camshaft carrier, remove plate.
2. Using sequence shown, progressively loosen 26 bolts until valve spring pressure is released. Remove bolts.
3. Remove camshaft carrier.

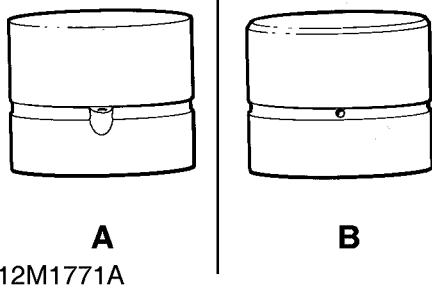
NOTE: Dowel located.



4. Remove 2 camshafts.
5. Remove and discard 4 oil seals from camshafts.
6. Using a stick magnet, remove 16 tappets from cylinder head. Retain tappets in fitted order and invert to prevent oil loss.



Tappets - inspection



CAUTION: A modified tappet has been introduced and will be supplied as a replacement for all engines. The above illustration shows the early tappet A and the modified tappet B. When the modified tappets are already fitted to an engine, they may be replaced on an individual basis but may only be fitted as replacements for early tappets in cylinder sets.

1. Check tappets for signs of wear, scoring and overheating.
2. Measure outside diameter of tappet, measurement must be taken half-way along tappet body.
Tappet outside dia. = 32.959 to 32.975 mm.
3. Ensure oil hole in each tappet is clear.

NOTE: Retain tappets in their fitted order and keep them inverted to prevent oil loss.

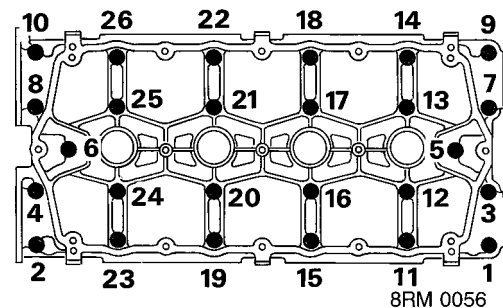
Camshafts and timing gears - inspection

Camshafts

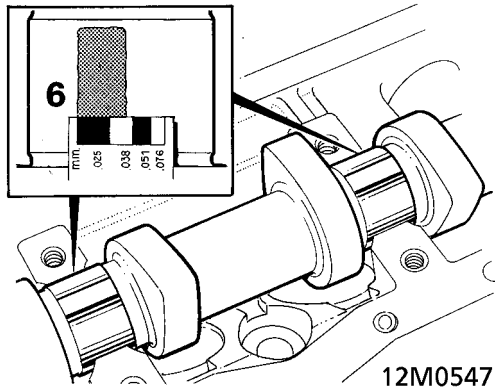
NOTE: Carry out camshaft inspection after removal of valves.

1. Clean camshafts, camshaft carrier and cylinder head bearing surfaces, use suitable solvent to remove sealant.
2. Inspect cams and bearing journals for wear, pitting and scoring; replace components as necessary.

Checking camshaft bearing clearance



3. Position camshaft(s) in cylinder head and place Plastigage across each journal.
4. Fit camshaft carrier and tighten bolts in sequence shown to 10 Nm. Do not rotate camshaft(s).
5. Progressively loosen bolts and then remove camshaft carrier.



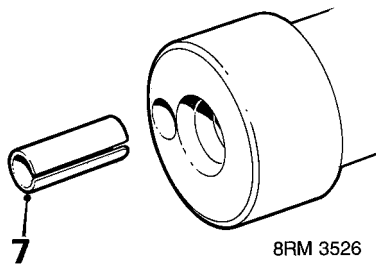
Timing gears

1. Clean timing gears, check gear teeth for damage and drive pin slot for wear, replace gears as necessary.



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

6. Measure widest portion of Plastigage on each journal:
Camshaft bearing clearance = 0.060 to 0.094 mm
Service limit = 0.15 mm
If clearance is excessive, fit new camshaft(s) and repeat check. If clearances are still excessive, replace cylinder head and camshaft carrier assembly.



7. Remove drive pin from old camshaft and fit to new with its split towards centre of camshaft.

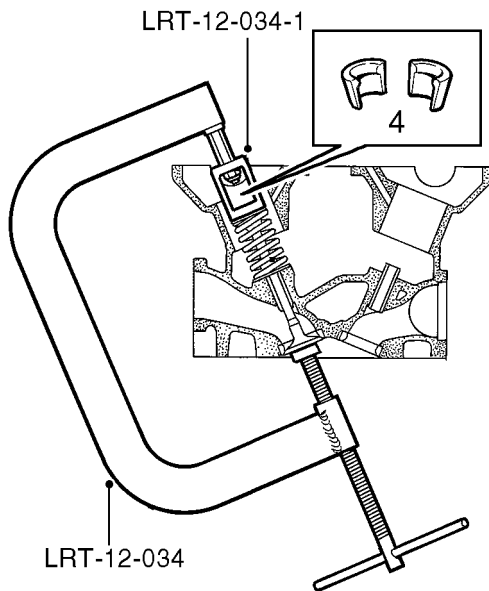


Valves and springs - remove

1. Support cylinder head clear of valves; use hollow drift and tap each spring cap to free collets.
2. Position cylinder head on its exhaust manifold face.

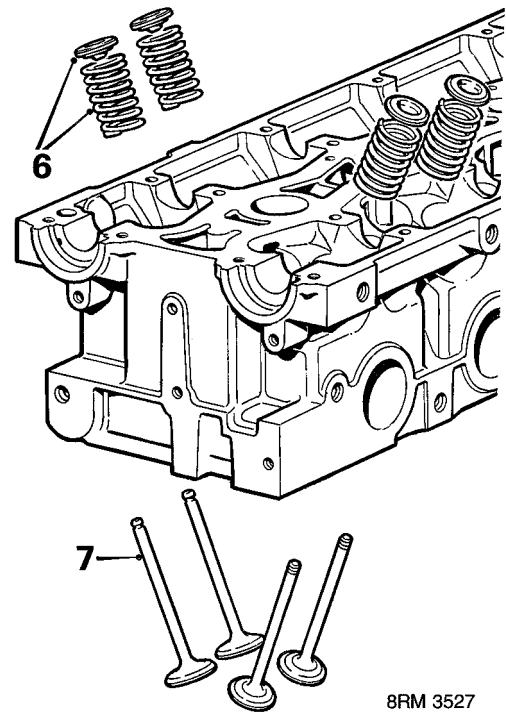


NOTE: : Remove inlet valves with cylinder head in this position.

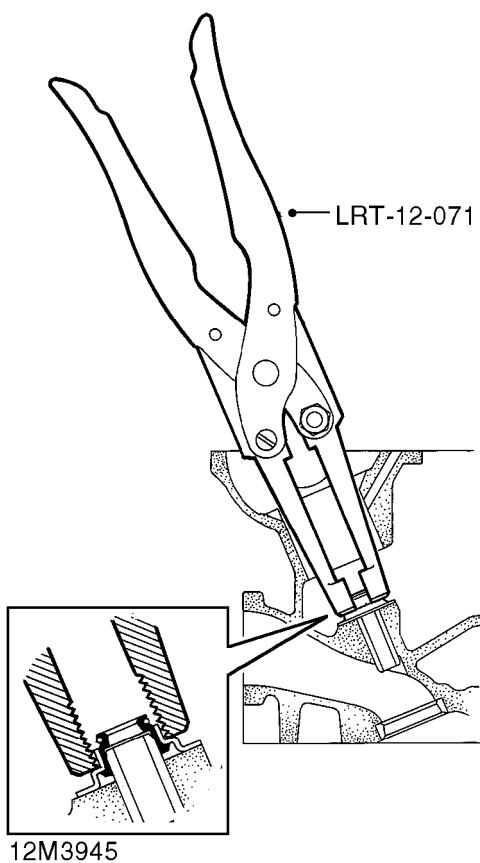


M12 7234

3. Using tool **LRT-12-034** and adaptor **LRT-12-034/1** compress valve spring.
4. Remove 2 collets from valve stem using a magnet.
5. Remove tool **LRT-12-034**.




6. Remove spring cap and valve spring.
7. Remove valve.



Cylinder head - cleaning

1. Clean sealing surfaces on cylinder head and camshaft carrier.
Use foam action gasket remover and a plastic scraper - **DO NOT USE A METAL SCRAPER ON SEALING SURFACES.**
Clean inlet and exhaust manifold joint faces.
2. De-carbonise combustion areas of cylinder head and valves as necessary.
3. Blow out oilways and waterways. Ensure oil feed to camshaft carrier is clear.

 **NOTE: Cylinder heads fitted to later engines have a 4.5 mm diameter hole drilled through the head from the camshaft oil seal recess, ensure drilling is clear.**

8. Using **LRT-12-071**, remove and discard valve stem seal.
9. Repeat operations to remove remaining inlet valves.

 **CAUTION: Retain valves and springs in fitted order.**

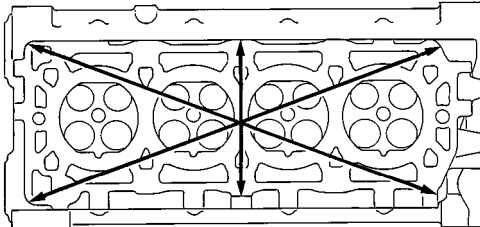
10. Position cylinder head on its inlet manifold face.
11. Repeat operations to remove exhaust valves and valve stem seals.

 **CAUTION: Retain valves and springs in fitted order.**



Cylinder head - inspection

1. Check cylinder head for damage, pay particular attention to gasket face of cylinder head.



12M3926

2. Check cylinder head face for warping, across centre and from corner to corner:
Cylinder head:
Maximum warp = 0.05 mm
3. Check cylinder head height:
New = 118.95 to 119.05 mm.

Cylinder heads may be refaced:
Reface limit = 0.20 mm



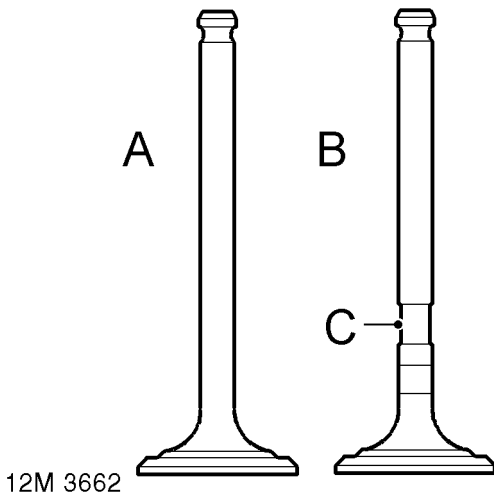
CAUTION: Cylinder heads fitted to engines with automatic timing belt tensioners are not interchangeable with those fitted with manual tensioners.

Valve springs - inspection

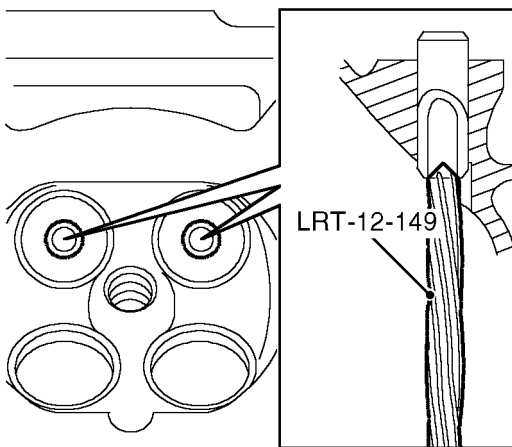
1. Check condition of valve springs:
Free length = 50.0 mm
Fitted length = 37.0 mm
Load - valve closed = 250 ± 12 N
Load - valve open = 450 ± 18 N

ENGINE

Valves and 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.

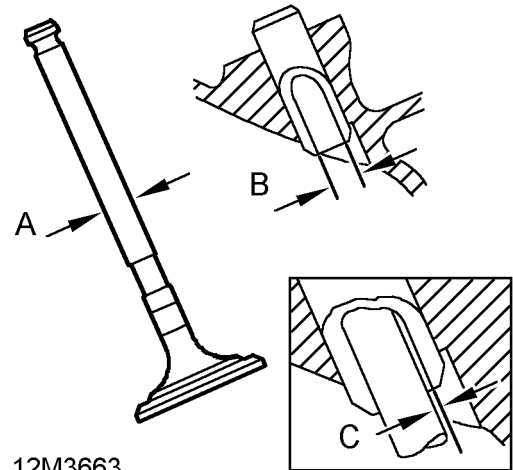


12M3946

1. Remove carbon deposits from exhaust valve guides using tool **LRT-12-149**.

CAUTION: Tool must be inserted into valve guide from combustion face side of cylinder head.

2. Remove carbon from inlet valve guides, inlet and exhaust valves and valve seat inserts. Remove all loose particles of carbon on completion.



12M3663

NOTE: Carbon break exhaust valve illustrated.

3. Check and record existing valve stem diameters **A**, replace any valve with stem diameters less than specified.
4. Check inlet and exhaust valve guide clearances **C** using the following procedures:
5. Insert valve into its respective guide.
6. Extend valve head 10 mm out of valve seat and position a DTI gauge to rear of valve head.
7. Move valve towards front of cylinder head, pre-load gauge to valve head then zero gauge.
8. Move valve towards rear of cylinder head, record gauge reading obtained to give valve stem to guide clearance **C**.
9. Repeat above procedures for remaining valves.

Valve stem diameter **A**:

Inlet = 5.952 to 5.967 mm

Exhaust = 5.947 to 5.962 mm

Valve guides:

Inside diameter **B**:= 6.000 to 6.025 mm

Valve stem to guide clearance **C**:

Inlet = 0.033 to 0.063 mm

Service limit = 0.07 mm

Exhaust = 0.038 to 0.078 mm

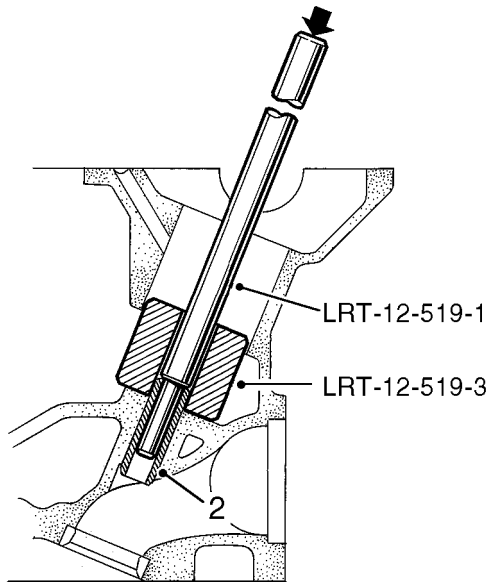
Service limit = 0.11 mm

10. Renew valves and guides as necessary.



Valve guides - renew

1. Support cylinder head face down on wooden blocks.

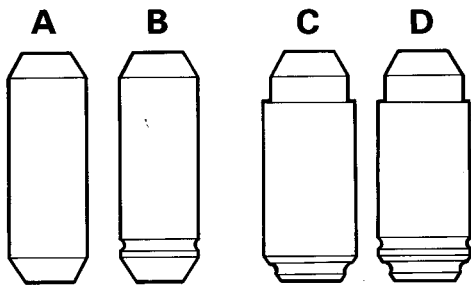


12M3947

2. Position tool guide LRT-12-519-3 in tappet bore and drift out valve guide using tool drift LRT-12-519-1.



NOTE: Retain valve guides in their fitted order.

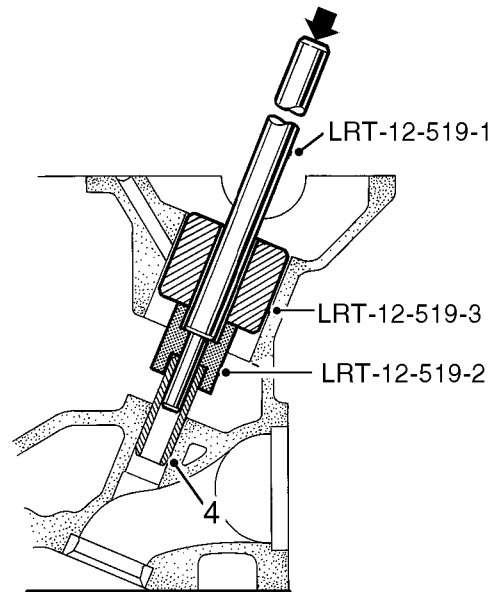


12M0007

3. Identify type of valve guide fitted:-
A - Standard production
C - Production oversize



NOTE: Two replacement sizes of valve guide are available, sizes B and D, replace original guide A with B and original guide C with D.

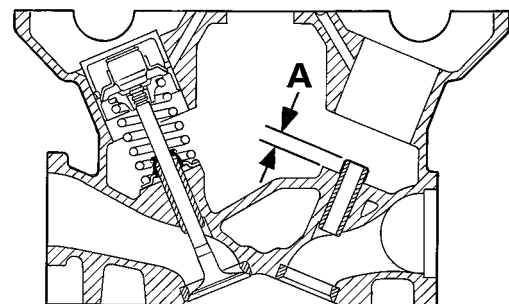


12M3948



NOTE: Cylinder head and valve guides must be at room temperature when fitting guides.

4. Locate valve guide in valve guide bore with identification groove(s) towards valve seat; position depth gauge:- Use depth gauge LRT-12-519-2.
5. Position nylon guide LRT-12-5196-3 in cylinder head, press guide into bore using driver LRT-12-519-1 until depth gauge contacts top of valve guide bore.



8RM 0052

6. Check fitted height A of valve guide = 6.0 mm

ENGINE

Valve seat inserts - renew

CAUTION: Triple angle valve seat inserts have been introduced on later engines; these inserts are not interchangeable with those fitted to early engines. Commencing engine numbers for engines fitted with the new inserts are listed in Information.

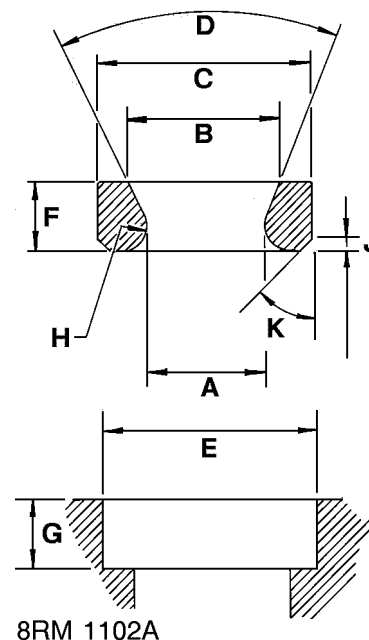
1. Renew valve seat inserts as necessary.

CAUTION: Do not damage counterbore when removing insert.

2. Cool replacement valve seat inserts using liquid nitrogen and press into cylinder head in one continuous operation.

CAUTION: Do not heat cylinder head.

Engines not fitted with triple angle valve seats



Inlet

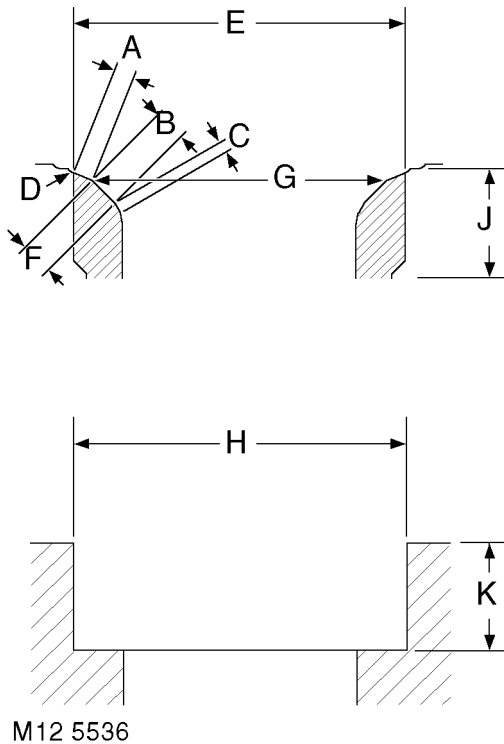
- A:= 22.98 to 23.13 mm
- B:= 25.73 to 25.98 mm
- C:= 29.560 to 29.573 mm
- D:= 38°
- E:= 29.475 to 29.500 mm
- F:= 5.95 to 6.00 mm
- G:= 6.53 to 6.69 mm
- H:= 2.0 mm radius
- J:= 0.75 to 1.25 mm
- K:= 45°

Exhaust

- A:= 19.58 to 19.73 mm
- B:= 21.60 to 21.90 mm
- C:= 25.960 to 25.973 mm
- D:= 30°
- E:= 25.888 to 25.913 mm
- F:= 5.45 to 5.50 mm
- G:= 5.75 to 6.41 mm
- H:= 2.0 mm radius
- J:= 0.75 to 1.25 mm
- K:= 45°



Engines fitted with triple angle valve seats



Inlet

- A: = 15°
- B: = 45°
- C: = 60°
- D: = 0.4 mm radius
- E: = 29.560 to 29.573 mm
- F: = 1.0 to 1.4 mm
- G: = 26.43 mm
- H: = 29.475 to 29.500 mm
- J: = 5.95 to 6.00 mm
- K: = 6.16 to 6.32 mm

Exhaust

- A: = 15°
- B: = 45°
- C: = 60°
- D: = 0.4 mm radius
- E: = 25.960 to 25.973 mm
- F: = 1.4 to 1.8 mm
- G: = 22.83 mm
- H: = 25.913 to 25.888 mm
- J: = 5.45 to 5.80 mm
- K: = 5.7 to 5.86 mm

All engines

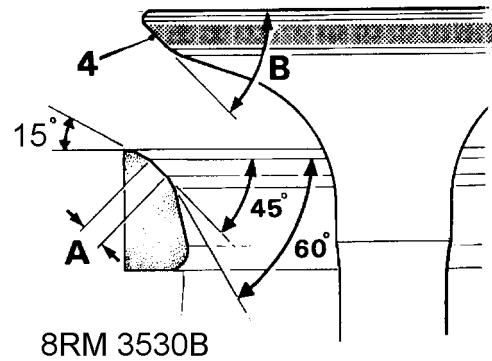
3. Cut valve seat to correct angle and width.
4. Lap valve to seat.

Valve seats - refacing



CAUTION: Renew worn valve guides before refacing valves and seats.

1. Check condition of valve seats and existing valves that are to be re-used.



NOTE: Triple angle valve seat illustrated

2. Recut valve seats and use pilot **MS120-6** and the following cutters:-
 - MS76-120** - 15° - Triple angle valve seats only.
 - MS76-111** - 60° - To narrow valve seats and obtain seat widths.
 - MS76-122** - 45° - Make final cut and remove any burrs.

Valve seat:

Angle = 45°

Width **A**:

Except triple angle valve seats:-

Inlet - 1.5 mm

Exhaust - 1.5 mm

Width **A**:

Triple angle valve seats:-

Inlet - 1.0 to 1.4 mm

Exhaust 1.4 to 1.6 mm

Valve face angle **B**:

Inlet = 45°

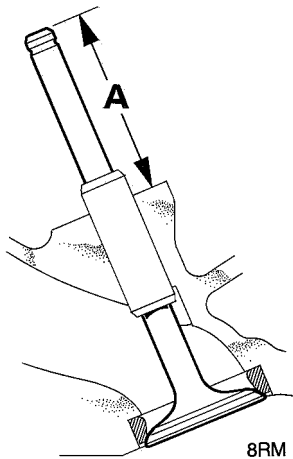
Exhaust = 45°



CAUTION: Inserts must not stand proud of combustion face of head on completion of recutting operation.

ENGINE

3. Lap each valve to seat using fine grinding paste.
4. Apply Prussian Blue to valve seat, insert valve and press it into position several times without rotating. Remove and check valve for even and central seating:
Seating position shown by blue should be in centre of valve face.



5. Check valve stem fitted height A:

New = 38.93 to 39.84 mm

Service limit = 40.10 mm

If valve stem fitted height is above service limit, fit new valve and re-check, if still over limit, renew valve seat insert.

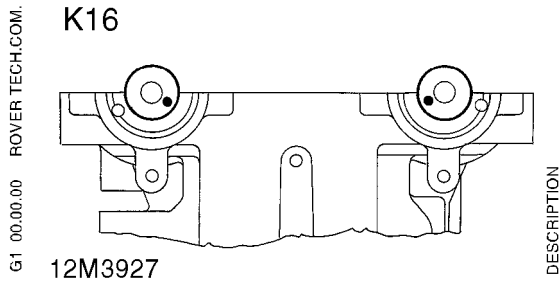
6. Remove all traces of grinding paste on completion.

Valves - assembling

1. Using **LRT-12-071**, fit new valve stem oil seals.
2. Lubricate valve stems and assemble valves, using tool **LRT-12-034** and adaptor **LRT-12-034/1**, to compress valve spring.
3. Use a wooden dowel and mallet, lightly tap top of each valve assembly two or three times to seat valves and collets.
4. Lubricate outside of tappets and fit tappets in original bores.



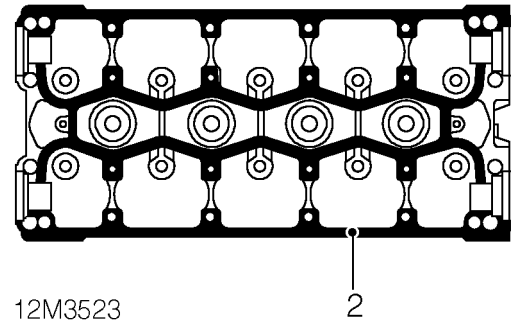
Camshafts - refit



1. Lubricate bearings and fit camshaft(s) and position drive pin for 90° BTDC as follows:
Inlet pin at 4 o'clock.
Exhaust pin at 8 o'clock.

Camshaft carrier and oil seals - refit

1. Ensure 2 locating dowels are fitted in camshaft carrier.

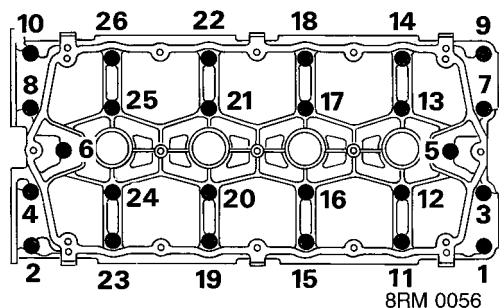


2. Apply continuous, thin beads of sealant, Part Number GUG 705963GM to paths on cylinder head as shown then spread to an even film using a roller.

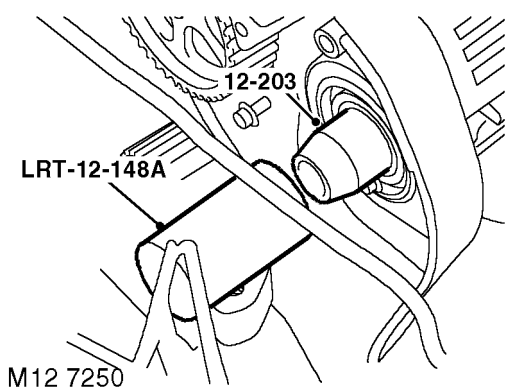
CAUTION: Ensure sealant is kept clear of tappet oil feed holes and lubrication grooves in carrier and that assembly is completed within 20 minutes.

3. Lubricate camshaft cams and journals with engine oil.

CAUTION: Do not lubricate oil seal running surfaces.



4. Fit camshaft carrier and progressively tighten bolts, in sequence shown to 10 Nm.



NOTE: Exhaust camshaft front oil seal illustrated.

5. Fit new camshaft oil seals using oil seal protection sleeve **12-203** and oil seal fitting tool **LRT-12-148A**.



NOTE: Front oil seals are coloured **BLACK**, rear oil seals are coloured **RED**.



CAUTION: Oil seals must be fitted dry. Do not use tool **LRT-12-148** for fitting seals as they will not be positioned correctly within the recess.

6. Fit blanking plate, fit and tighten bolts to 25 Nm.

Cylinder head - refit



CAUTION: If crankshaft has been rotated, check that timing mark on crankshaft timing gear is aligned with flange on oil pump and that tool **LRT-12-145** is locking flywheel.

1. Check cylinder head bolts in oil rail. See **Cylinder head bolt inspection** - Renew bolts as necessary.
2. Check that 2 locating ring dowels are fitted in cylinder block.



CAUTION: The type of ring dowel fitted must be maintained. A nylon ring dowel must not be used in place of a steel ring dowel.

3. Oil cylinder head bolts, under head and threads.
4. Remove cylinder liner retainer clamps **LRT-12-144**.



CAUTION: Do not rotate crankshaft until cylinder head bolts are fitted.

5. Fit new cylinder head gasket DRY, with identification markings facing upwards, on to cylinder block.

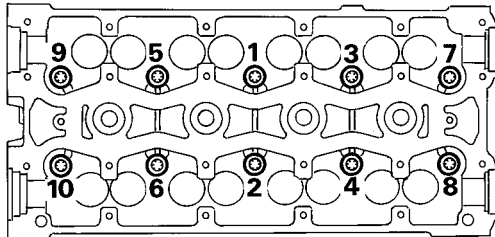


CAUTION: Take care not to damage sealing faces of gasket.

6. Using assistance, fit cylinder head on to cylinder block carefully locating ring dowels.
7. Carefully enter cylinder head bolts in their original fitted locations; DO NOT DROP. Lightly tighten bolts.



8. Temporarily fit timing gears to camshafts, fit but do not fully tighten bolts.
9. Using tool **12-182**, rotate both camshafts clockwise to gain access to bolts:
Early engines:- Bolts 1 and 2
Later engines fitted with modified camshafts:- Bolts 3 and 4



8RM 0057

10. Tighten cylinder head bolts progressively in sequence shown to 20 Nm. Use a felt tip pen to mark position of radial mark on each bolt head. Tighten all bolts in sequence shown through 180°
 Tighten all bolts in sequence shown through another 180° and align mark.



CAUTION: If any bolt is overtightened, back off 90° and re-align.

11. Upon completion of tightening sequence, position camshafts with inlet pin at 4 o'clock and exhaust pin at 8 o'clock; remove timing gears.



CAUTION: Ensure camshafts do not rotate when gears are removed.

12. *Automatic timing belt tensioner:-* Fit tensioner pillar bolt and tighten to 25 Nm.



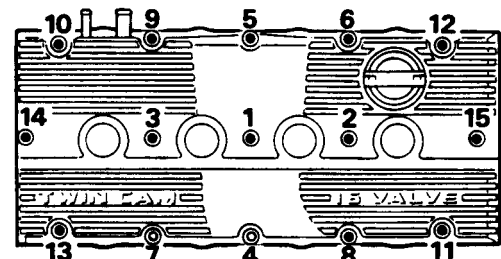
NOTE: Do not fit timing belt automatic tensioner until timing belt is fitted.

13. Fit camshaft cover and timing gears.
14. Fit new spark plugs, tighten to 25 Nm.

Camshaft cover and timing gears - refit

1. Clean mating surfaces and inside of camshaft cover. If necessary, wash oil separator elements in suitable solvent and blow dry.
2. Fit new camshaft cover gasket dry, to camshaft carrier, with either 'TOP' mark towards the inlet manifold or 'EXHAUST MAN SIDE' towards exhaust manifold.

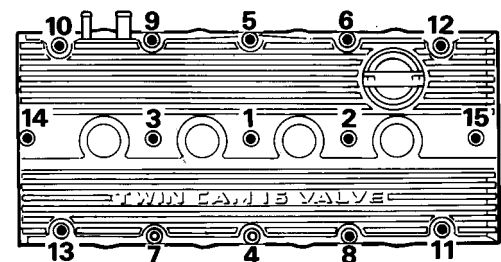
Camshaft cover with pillar bolts



8RM 0060

3. Fit camshaft cover on to camshaft carrier, fit 13 bolts at positions 1 and 4 to 15. Fit pillar bolts at positions 2 and 3. Tighten all bolts in sequence shown to 10 Nm.

Camshaft cover with 'cast-in' supports



12M1772

4. Fit camshaft cover on to camshaft carrier, fit bolts and tighten in sequence shown to 10 Nm.

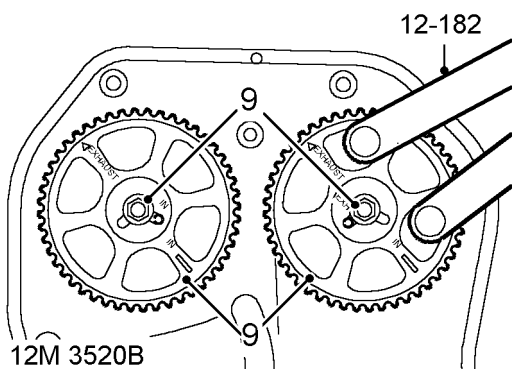
ENGINE

All camshaft covers

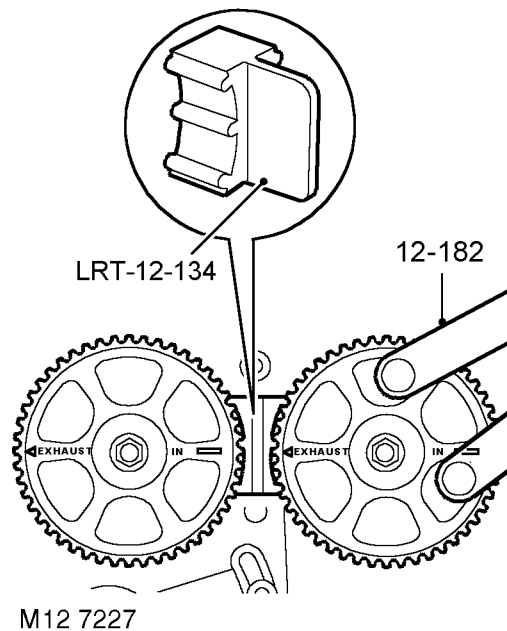
5. *If fitted:* Fit air cleaner support bracket, fit bolts and tighten to 10 Nm.
6. Locate HT leads in clips and press plug tubes on to spark plugs.
7. Fit spark plug cover to camshaft cover, tighten screws to 10 Nm.
8. Fit timing belt upper rear cover to cylinder head, fit screws and tighten to 9 Nm.



NOTE: Longest screw secures cover to coolant pump.



9. Fit camshaft gears to their respective camshafts ensuring that the drive gear pins are located in correct slot in drive gears. Restrain gears using tool **12-182** and tighten bolts to:
M8 bolts - 35 Nm
M10 bolts - 65 Nm



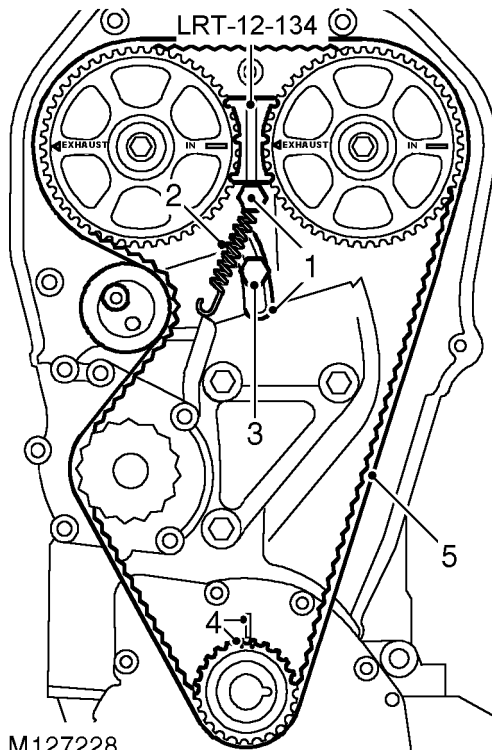
10. Using tool **12-182**, align camshaft gear timing marks.
11. Fit camshaft gear locking tool **LRT-12-134**.
12. *Engines fitted with manual timing belt tensioner:* Fit camshaft timing belt tensioner.
13. *All engines:* Fit new camshaft timing belt.
14. Fit blanking plate to rear of camshaft carrier, fit bolts and tighten to 25 Nm.



Camshaft timing belt manual tensioner - refit



NOTE: On engines fitted with an automatic timing belt tensioner, tensioner is fitted when timing belt is fitted.

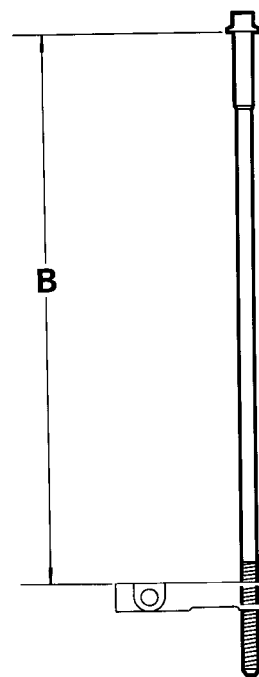
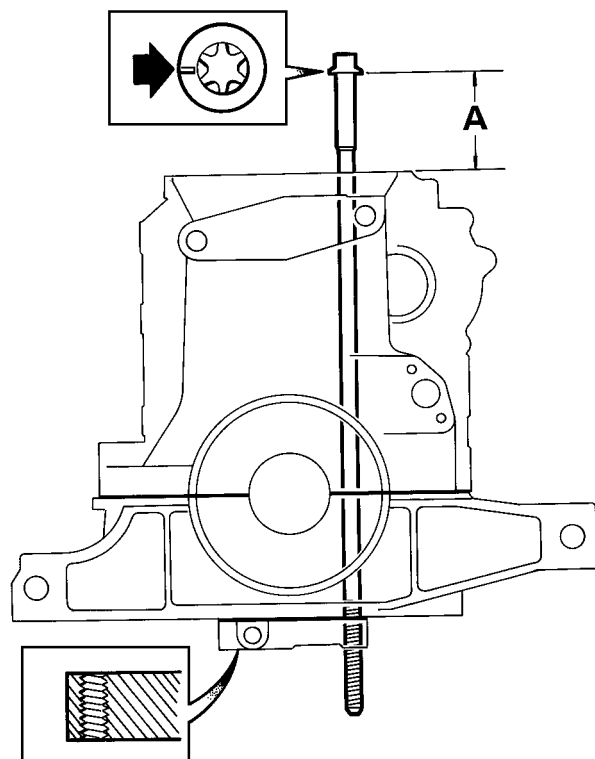


1. Fit timing belt tensioner and pillar bolt.
2. Connect tensioner spring to tensioner and pillar bolt.
3. Tighten tensioner backplate screw to 10 Nm to retain tensioner in released position.
4. Check correct alignment of timing marks on crankshaft gear to mark on oil pump.
5. Fit and adjust a new camshaft timing belt.

Distributor - refit

1. Fit anti-flash shield and rotor arm. Use new rotor arm screw and tighten to 10 Nm.
2. Fit distributor cap assembly.
3. Place HT lead retaining plate and grommet in position, connect plug leads.
4. Fit HT lead cover, tighten screws to 5 Nm.

CYLINDER HEAD BOLTS INSPECTION



8RM 2463

1. Retain bolts in fitted order.
2. Wash all bolts, wipe dry and lightly oil threads.

Cylinder head bolts may be re-used provided they pass one of the following tests.

Test with cylinder head removed

1. Carefully enter cylinder head bolts in their original fitted location, DO NOT DROP. Screw each bolt by hand into oil rail.

CAUTION: It will be necessary to temporarily remove cylinder liner retainer clamps LRT-12-144 in order to test the bolt used with the retainer clamp. Retainer clamps should only be removed one at a time and replaced immediately bolt test is completed. Take great care not to rotate crankshaft or disturb cylinder liners whilst clamps are removed.

2. Measure distance from cylinder block face to under bolt head 'A' in illustration:
97 mm or less, bolt may be re-used.
Over 97 mm, bolt must be discarded.

Test with oil rail removed

1. Ensuring bolts are in their original fitted location, screw each bolt by hand into oil rail.
2. If full length of thread is engaged, bolt may be re-used.
3. If full length of thread is not engaged, measure distance from top face of oil rail to under bolt head 'B' in illustration:
378 mm or less, bolt may be re-used.
Over 378 mm, bolt must be discarded

CAUTION: A new oil rail must be fitted if a thread is damaged. Thread inserts (Helicoil) are not acceptable.



CRANKSHAFT, MAIN & BIG-END BEARINGS

Crankshaft end-float - checking

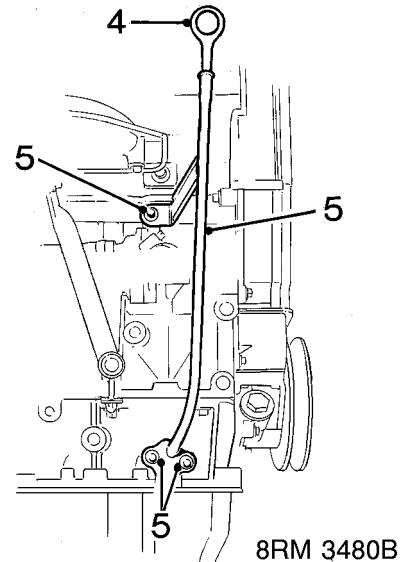


CAUTION: Crankshaft end-float must be checked and recorded prior to removing cylinder head.

1. Check crankshaft end-float, using a DTI. Carefully lever against flywheel and press crankshaft away from DTI, zero DTI and push crankshaft towards DTI:
Crankshaft end-float = 0.10 to 0.25 mm
Service limit = 0.34 mm
2. Record end-float figure obtained.

Crankshaft, main and big-end bearings - remove

1. Remove flywheel.
2. Remove flywheel locking tool **LRT-12-145**.
3. Remove and discard camshaft timing belt.



4. Withdraw dipstick
5. Remove 3 screws and dipstick tube, discard gasket.
6. Remove cylinder head assembly.

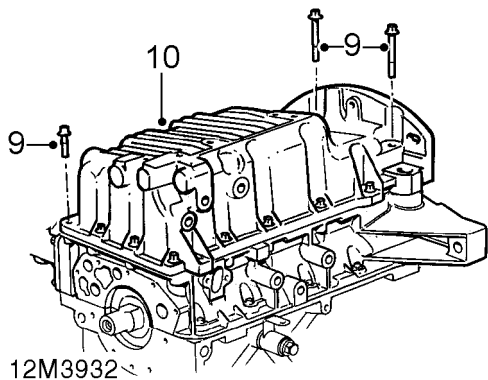


CAUTION: Ensure cylinder liner retainer clamps **LRT-12-144 are fitted.**

7. Remove oil pump.
8. Using assistance, position cylinder block, cylinder head face down, on 2 wooden blocks.



CAUTION: Ensure that wooden blocks are of sufficient thickness to prevent cylinder liner clamps contacting workbench.



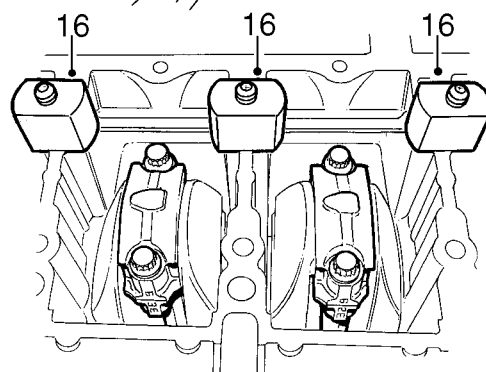
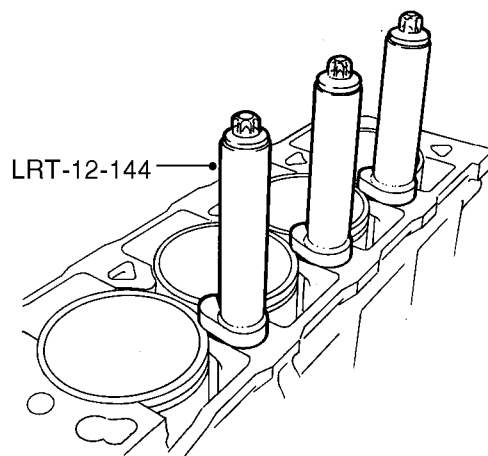
12M3932

9. Progressively loosen then remove 14 bolts securing sump to bearing ladder noting the fitted position of 2 M8 x 60 mm bolts.
10. Using a mallet, gently tap sump sideways to release sealant bond; remove sump.

CAUTION: Do not lever between sump flange and bearing ladder.

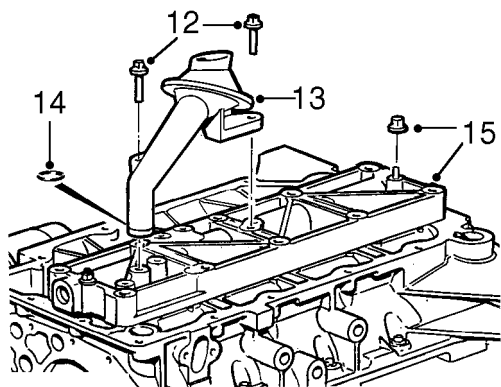
11. Temporarily remove cylinder retainer liner clamps **LRT-12-144**.

CAUTION: Do not rotate crankshaft until retainer clamps are refitted.



12M3934

16. Fit cylinder liner retainer clamps **LRT-12-144** using nylon nuts supplied to retain the clamps. Ensure that feet of clamps do not protrude over cylinder bores. Tighten bolts sufficiently to retain clamps.



12M2933

12. Remove 2 bolts, oil pick-up pipe to oil rail.
13. Remove oil pick-up pipe.
14. Discard 'O' ring.
15. Remove 2 nuts securing oil rail, remove rail.

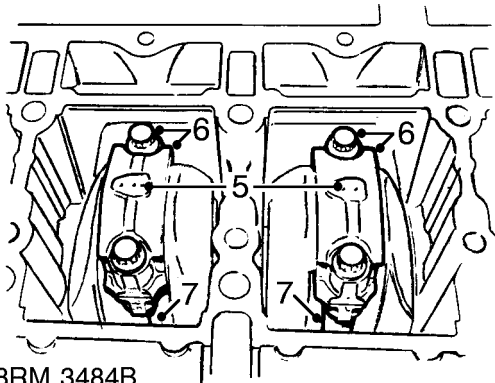


Big-end bearings - remove

1. Refit crankshaft timing gear and pulley.
2. Fit pulley bolt and washer, lightly tighten bolt.
3. Ensure that cylinder liner retainer clamps **LRT-12-144** and nylon nuts are fitted and that feet of clamps do not protrude over cylinder liner bores.
4. Rotate crankshaft to bring numbers 2 and 3 pistons to BDC.



CAUTION: Crankshaft will be tight, do not rotate crankshaft more than absolutely necessary.



8RM 3484B

5. Make cylinder number reference mark on big-end bearing caps.

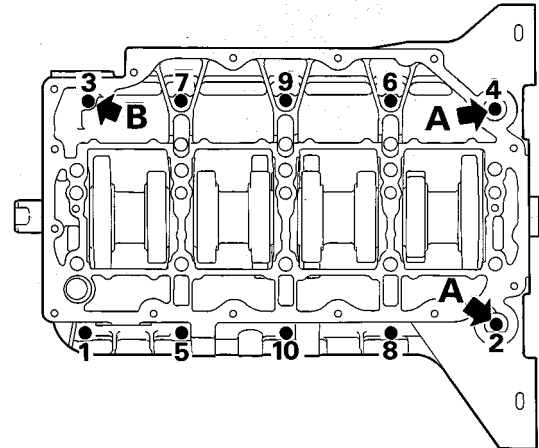


NOTE: Number stamped below cap joint is bearing bore size code. Number stamped on connecting rod is cylinder number and letter is weight code.

6. Remove 4 dowel bolts and 2 big-end bearing caps from numbers 2 and 3 connecting rods, keep dowel bolts and caps in their fitted order. Remove and discard big-end bearing shells.
7. Release connecting rods from the crankshaft, carefully push pistons to top of their bores.
8. Rotate crankshaft 180°.
9. Remove numbers 1 and 4 big-end caps, remove and discard bearing shells. Push pistons to top of their bores.
10. Remove and discard 4 big-end bearing shells from connecting rods.

Crankshaft - remove

1. Remove big-end bearings, caps and bearing shells.
2. Remove pistons and cylinder liners.
3. Using assistance, position cylinder block, cylinder head face downwards on a smooth, clean wooden surface.

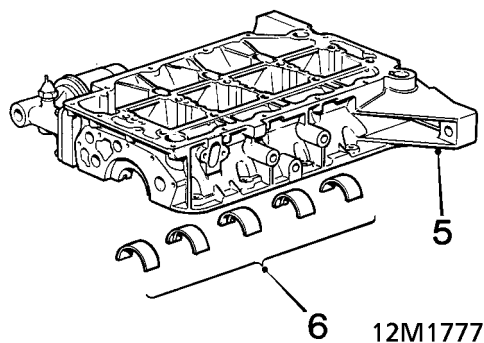


8RM 3485

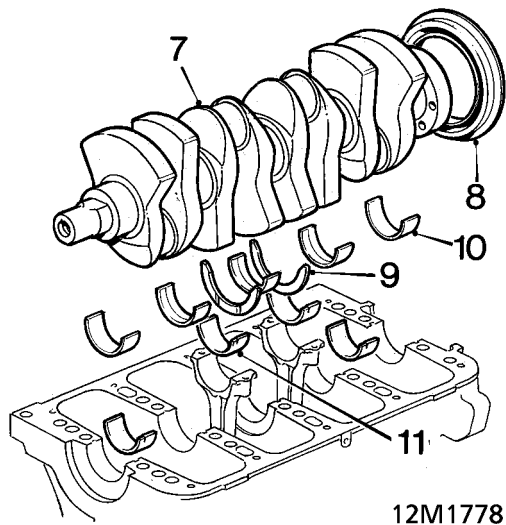
4. Working in sequence shown, loosen then remove 10 bolts securing bearing ladder.



NOTE: 2 bolts 'A' are under the flanges of the rear mounting brackets. Also note position of flanged head longer bolt 'B' at front end of ladder.



5. Remove bearing ladder.
6. Remove and discard main bearing shells from bearing ladder.



7. Using assistance, lift crankshaft from cylinder block.
8. Remove and discard crankshaft rear oil seal.
9. Remove 2 thrust washer halves from number 3 bearing position.

 **CAUTION: Do not discard thrust washers at this stage.**

10. Remove and discard main bearing shells from cylinder block.
11. Remove and discard big-end bearing shells from connecting rods.

Crankshaft - inspection

1. Clean joint surfaces on bearing ladder and cylinder block using suitable solvent. **DO NOT USE A METAL SCRAPER ON SEALING SURFACES.** Blow out crankshaft and bearing ladder oilways.
2. Measure total thickness of thrust washers removed and compare with new. Total thickness of new thrust washer halves = 5.22 to 5.30 mm.
3. Subtract total thickness of original thrust washers from total thickness of new thrust washers.
4. Add figure obtained to crankshaft end-float figure obtained.
5. If resultant figure will ensure crankshaft end-float is within limits specified, fit new thrust washers. If fitting new thrust washers will not bring end-float within limits, crankshaft must be replaced.
Crankshaft end-float = 0.10 to 0.25 mm
Service limit = 0.34 mm



6. Record main bearing code letters from bearing ladder.
Record main bearing code numbers from crankshaft front web. First letter and number is Number 1 main bearing.



CAUTION: Crankshafts fitted to later engines have increased main journal diameters. Commencing engine numbers for the modified crankshafts are listed in Information; the modified crankshafts may be fitted as replacements to engines prior to these numbers. For inspection purposes, journal sizes fitted to early engines are listed as Type A whilst those fitted to later engines are listed as Type B. Main bearing shell sizes and colour codes for both types of crankshaft remain unchanged.

7. Check crankshaft main journal diameters:

Type A crankshafts

Crankshaft journal tolerance :

Grade 1 = 47.993 to 48.000 mm

Grade 2 = 47.986 to 47.993 mm

Grade 3 = 47.979 to 47.986 mm

Clearance in bearings = 0.02 to 0.05 mm

Maximum out of round = 0.010 mm

Type B crankshafts

Crankshaft journal tolerance:

Grade 1 = 48.000 to 48.007 mm

Grade 2 = 47.993 to 48.000 mm

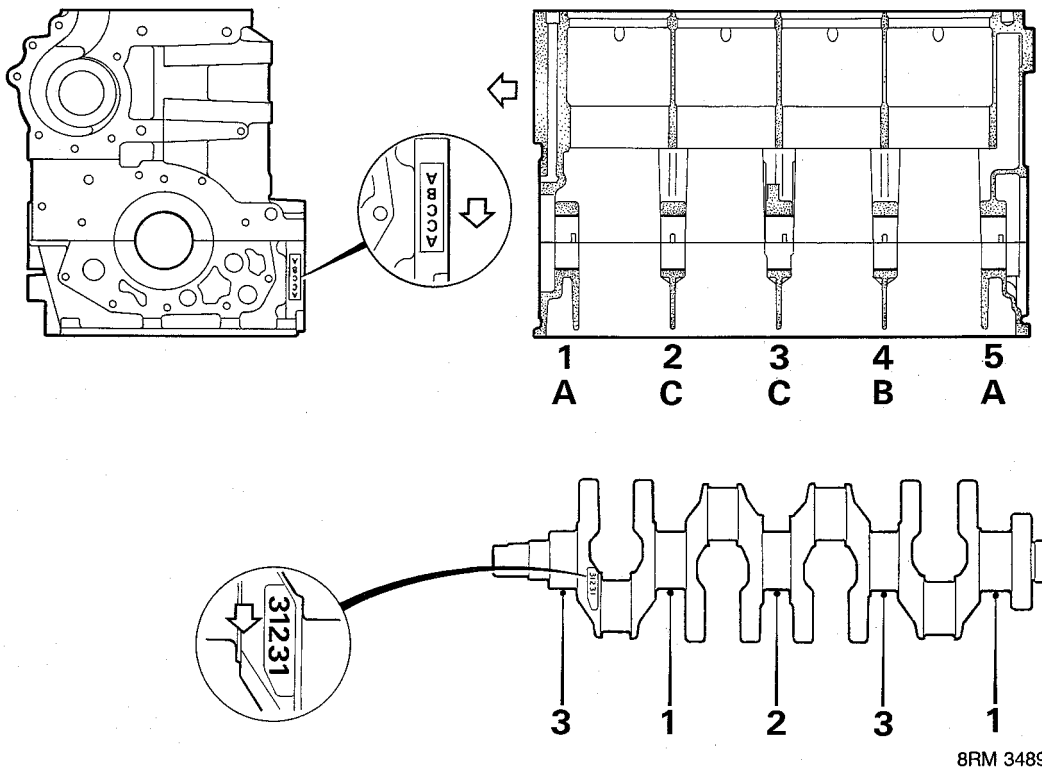
Grade 3 = 47.986 to 47.993 mm

Clearance in bearings = 0.013 to 0.043 mm

Maximum out of round = 0.010 mm

8. Replace crankshaft if outside tolerance.

9. Determine the appropriate bearing shells to be fitted from the main bearing size selection and type tables.



8RM 3489

ENGINE

Main bearings selection

Main bearings size

Bearing ladder	Crankshaft main journals		
	Grade 1	Grade 2	Grade 3
Grade A	BLUE - BLUE	RED - BLUE	RED - RED
Grade B	BLUE - GREEN	BLUE - BLUE	RED - BLUE
Grade C	GREEN - GREEN	BLUE - GREEN	BLUE - BLUE

Colour code on edge of bearing

Thickness progression:

GREEN - Thin

BLUE - Intermediate

RED - Thick



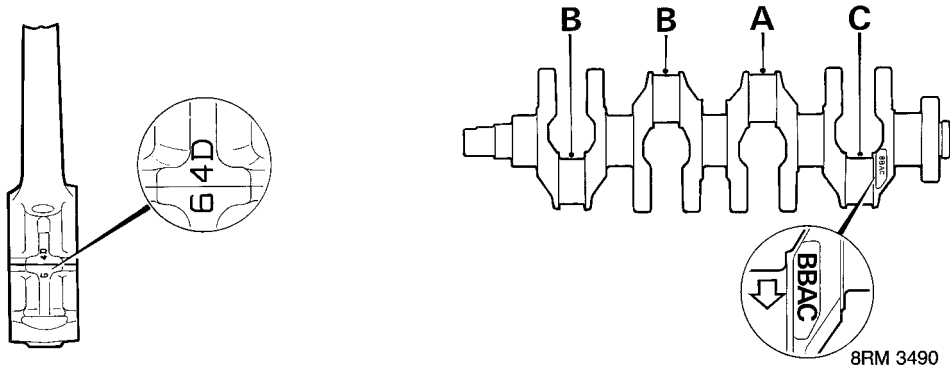
CAUTION: If two bearing colours are to be used, thicker bearing must be fitted to bearing ladder. When original crankshaft is to be refitted, bearing shells must be as selected from table, DO NOT FIT UNDERSIZE BEARINGS.

Main bearings type

	1	2	3	4	5
Block	Plain	Grooved	Grooved	Grooved	Plain
Ladder	Plain	Plain	Plain	Plain	Plain



Big-end bearings selection



1. Record big-end journal code letters from crankshaft rear web.
First letter is number 1 big-end bearing.
Record big-end bearing bore code numbers; this will be 5, 6 or 7, located on the connecting rod bearing cap.

2. Check crankshaft big-end journal diameters:
Big-end journal diameter = 47.986 to 48.007 mm
Maximum out of round = 0.010 mm
Big-end journal tolerance:
Grade A = 48.000 to 48.007 mm
Grade B = 47.993 to 48.000 mm
Grade C = 47.986 to 47.993 mm
Clearance in bearings = 0.021 to 0.049 mm
Big-end/connecting rod end-float = 0.10 to 0.25 mm
3. Select the appropriate big-end bearing shells from the table.
4. Replace crankshaft if outside tolerance.

Big-end bearings size

Big-end bore	Crankshaft big-end journals		
	Grade A	Grade B	Grade C
Grade 5	BLUE - BLUE	RED - BLUE	RED - RED
Grade 6	BLUE - YELLOW	BLUE - BLUE	RED - BLUE
Grade 7	YELLOW - YELLOW	BLUE - YELLOW	BLUE - BLUE

Colour code on edge of bearing

Thickness progression:

YELLOW - Thin

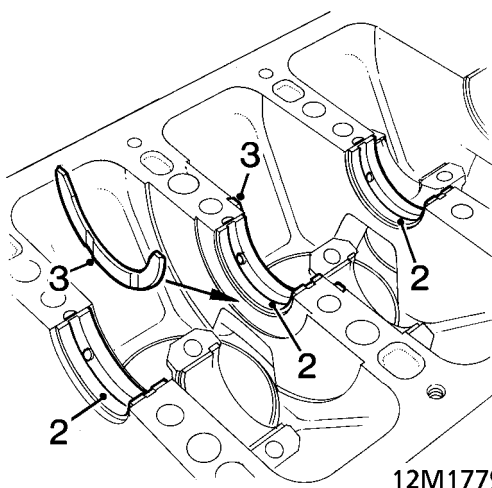
BLUE - Intermediate

RED - Thick

If two bearing colours are to be used, thicker bearing must be fitted to big-end bearing cap.

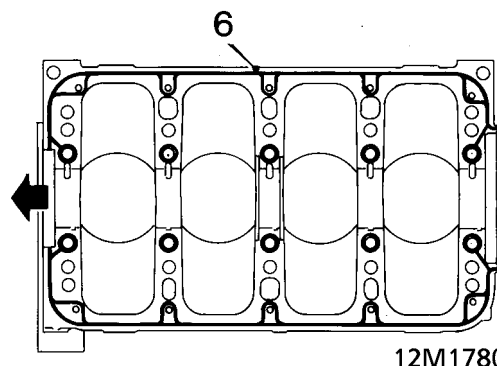
Crankshaft, main and big-end bearings - refit

1. Clean all sealant surfaces on block, bearing ladder and oil rail.
Use foam action gasket remover and a plastic scraper - **DO NOT USE A METAL SCRAPER ON SEALING SURFACES.**
Ensure all oilways are clear.
Examine shoulder location on each big end bolt, renew if damaged.
Check that core plug at each end of oil rail is in good condition, renew as necessary.



2. Fit selected main bearing shells into cylinder block and bearing ladder as indicated in the table.
3. Fit thrust washers into block, each side of Number 3 main bearing with oil grooves facing outwards.
4. Lubricate crankshaft main journals with engine oil. Hold crankshaft with big-end journals horizontal and using assistance, lower crankshaft on to main bearings.

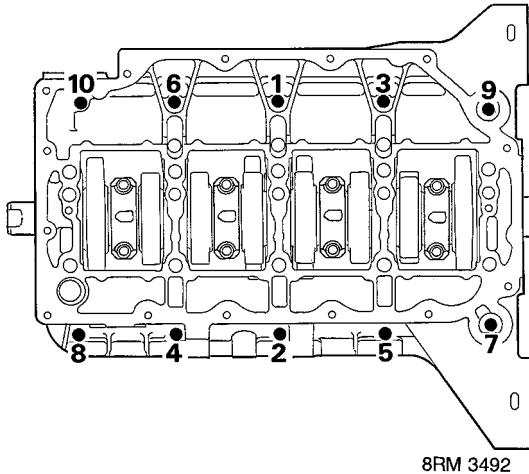
5. Clean sealing surfaces on cylinder block and bearing ladder using suitable solvent.



6. Apply a continuous bead of sealant, Part Number GUG 705963GM to paths shown on cylinder block then spread to an even film using a roller.



CAUTION: To avoid contamination, assembly should be completed immediately after application of sealant.



7. Lubricate main journals with engine oil. Fit bearing ladder to block, fit bolts ensuring that flanged head bolt is fitted at position 10. Tighten bolts in sequence shown to 5 Nm then in same sequence to 30 Nm.

CAUTION: With bearing ladder fitted, crankshaft will be tight; do not rotate crankshaft more than absolutely necessary until cylinder head bolts are tightened to the correct torque.

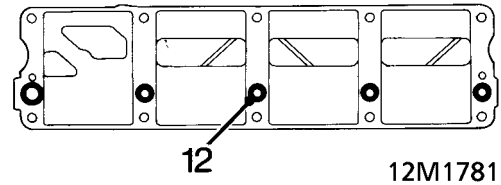
8. Fit cylinder liners and pistons.

CAUTION: Ensure that cylinder liner retainer clamps LRT-12-144 and nylon nuts are fitted immediately cylinder liners are inserted into cylinder block.

9. Lubricate crankshaft big-end journals and bearing shells with engine oil. Carefully pull each connecting rod into place, fit big-end caps noting that featherways abut, fit and lightly tighten dowel bolts in their original fitted order.
10. Tighten big-end dowel bolts in pairs to 20 Nm + 45°.

NOTE: Until the cylinder head is fitted, crankshaft will prove difficult to rotate once big-end bolts are tightened.

11. Using feeler gauges, check that end-float of each big-end bearing/ connecting rod is between 0.10 to 0.25 mm.



12. Apply continuous beads of sealant, Part Number GUG 705963GM to paths on oil rail as shown, then spread to an even film using a roller.

CAUTION: To avoid contamination, assembly should be completed immediately after application of sealant.

13. Using assistance, position cylinder block on its side and temporarily remove cylinder liner retainer clamps LRT-12-144.

CAUTION: Take care not to disturb cylinder liners with retainer clamps removed

14. Fit oil rail to bearing ladder, tighten nuts to 9 Nm.

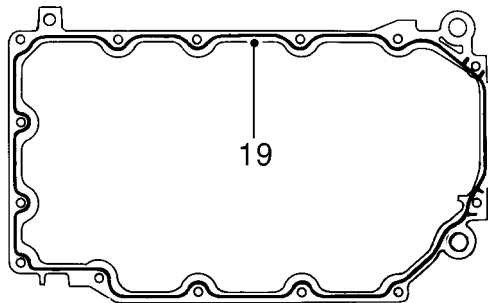
CAUTION: A new oil rail together with a plastic suction pipe must be fitted if a thread for cylinder head bolts is damaged. Thread inserts (Helicoil) are not acceptable.

15. Fit cylinder retainer clamps LRT-12-144, tighten bolts sufficiently to retain clamps.
16. Clean oil pick-up pipe and strainer.
17. Fit new 'O' ring and secure oil pick-up pipe, tighten bolts to 12 Nm.

CAUTION: Bolts used must be M6 x 20.

ENGINE

18. Clean sealing surface on sump flange using suitable solvent.



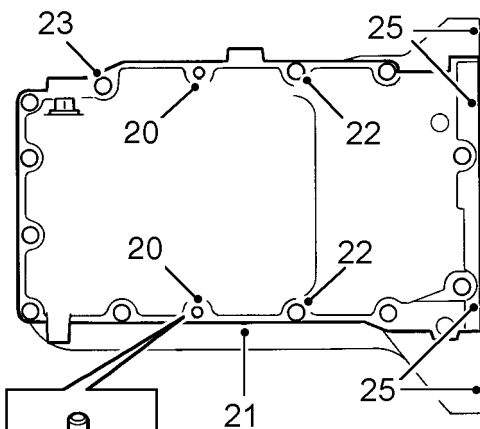
12M3935

19. Apply a 2 mm wide x 0.25 mm thick continuous bead of sealant, Part Number GUG 705963GM to sump flange as shown then spread to an even film using a roller.



CAUTION: To avoid contamination, assembly should be completed immediately after application of sealant.

Do not use RTV or any sealant other than that specified.



12M3936

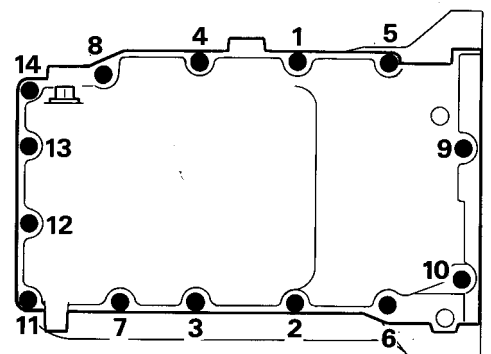
20. Screw alignment pins **LRT-12-146** into holes shown.
 21. Carefully lower sump over pins and on to bearing ladder.
 22. Fit 2 bolts into holes shown, tighten to 4 Nm.

23. Fit 10 bolts into remaining holes, lightly tighten all bolts.



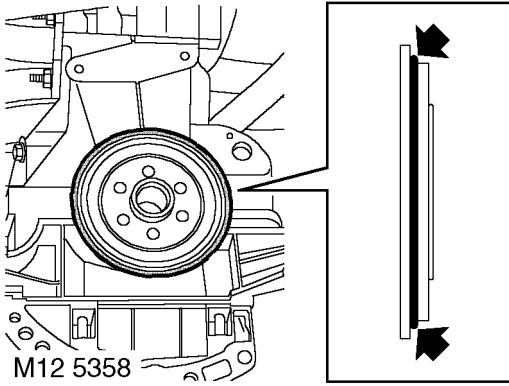
CAUTION: Ensure 2 M8 x 60 bolts are fitted in original locations.

24. Remove alignment pins **LRT-12-146**, fit and lightly tighten remaining 2 bolts.
 25. Using a straight edge, check that machined face of sump flange is level with rear face of cylinder block. Check in 3 positions and if necessary, tap sump gently to re-position.



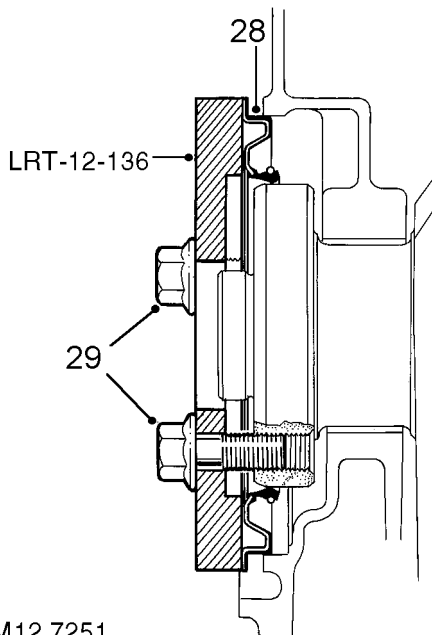
12M1783

26. Using sequence shown, tighten bolts to:
 M8 x 25 - 25 Nm
 M8 x 60 - 30 Nm



27. Apply a continuous bead of sealant, Part No. GAC 8000 to replacement oil seal as shown.

CAUTION: Do not apply oil or grease to any part of the oil seal or running surface of crankshaft. Seal must be fitted immediately after applying sealant.



28. Position oil seal to cylinder block.
 29. Fit oil seal replacer tool **LRT-12-136** to crankshaft, retain tool using 3 slave bolts.
 30. Tighten replacer bolts to press oil seal into cylinder block.

NOTE: Do not remove replacer for one minute to allow seal to relax.

31. Remove tool LRT-12-136.

CAUTION: Allow sealant to cure for 30 minutes before rotating crankshaft.

32. Fit flywheel.
 33. Fit oil pump and new crankshaft front oil seal.
 34. Fit crankshaft timing gear.
 35. Fit cylinder head assembly, do not fit spark plugs at this stage.
 36. Fit a new camshaft timing belt.
 37. Clean joint surfaces. Use a new gasket and fit dipstick tube, tighten bolts to 10 Nm.

NOTE: Ensure bolts securing dipstick tube to bearing ladder are flanged head and do not exceed 12 mm in length.

38. Support engine and using a socket and suitable torque gauge on crankshaft pulley bolt, check that crankshaft can be rotated in a clockwise direction without undue binding; rotational torque should not exceed 31 Nm.
 39. Fit spark plugs, tighten to 25 Nm.
 40. After installation in vehicle, run engine at idle speed for 15 minutes before road testing.

ENGINE

PISTONS, RINGS & CYLINDER LINERS

Pistons and connecting rods - remove

1. Suitably identify each piston assembly with its respective cylinder liner.
2. Remove big-end bearings.
3. Using assistance, position cylinder block on its side.



CAUTION: Ensure that feet of cylinder liner retainer clamps LRT-12-144 do not protrude over cylinder bores.

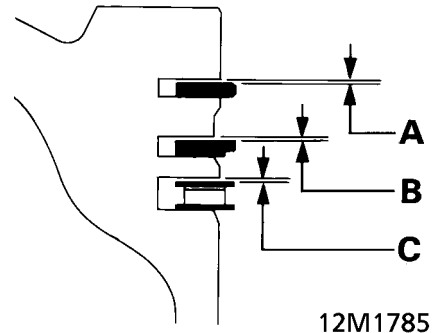
4. Remove ridge of carbon from top of each cylinder liner bore.
5. Push pistons to top of their bores.
6. Carefully push out each piston assembly taking care that big-ends do not contact surface of cylinder liners.
7. Refit caps on to connecting rods, lightly tighten dowel bolts.



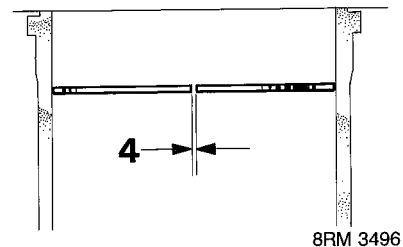
CAUTION: Removal of pistons will necessitate removal and re-sealing of cylinder liners.

Piston rings - checking

1. Using an expander, remove and discard old piston rings.
2. Use squared off end of broken piston ring and clean ring grooves.
3. Check new ring to groove clearance:



Top compression ring **A** = 0.040 to 0.072 mm
2nd compression ring **B** = 0.030 to 0.062 mm
Oil control rails **C** = 0.010 to 0.180 mm



4. Check new ring fitted gap 20 mm from top of cylinder liner bore:



CAUTION: Ensure rings are kept square to liner bore and that they are suitably identified to the bore in which they are checked and fitted to the piston for that bore.

Top compression ring = 0.20 to 0.35 mm
2nd compression ring = 0.28 to 0.48 mm
Oil control rails = 0.15 to 0.40 mm



Pistons - inspection

1. Check pistons for distortion and cracks.
2. Measure and record piston diameter at right angle to gudgeon pin and 8 mm from bottom of skirt.
3. Check piston diameter with figures given.
4. Measure and record piston diameter in line with gudgeon pin hole and 8 mm from bottom of skirt.
5. Check piston ovality with figures given.
6. Repeat above procedures for remaining pistons.

Grade A = 79.975 to 79.990 mm

Grade B = 79.991 to 80.005 mm

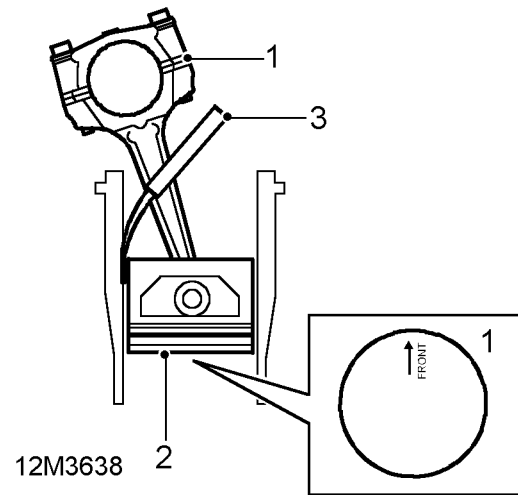
Maximum ovality = 0.3 mm

Service pistons are grade A and B



NOTE: Piston grades A or B are stamped on crown of piston.

Piston to cylinder liner bore clearance - checking



1. Starting with number 1 piston, invert piston and connecting rod and with word FRONT or arrow on piston crown facing towards REAR of cylinder block, insert piston in cylinder liner.
2. Position piston with bottom of skirt 30 mm from top of cylinder block.
3. Using feeler gauges, measure and record clearance between piston and left hand side of cylinder liner - viewed from front of cylinder block.
4. Repeat above procedure for remaining pistons.

Clearance in cylinder bore = 0.01 to 0.04 mm



NOTE: Pistons and connecting rods are only supplied as an assembly.

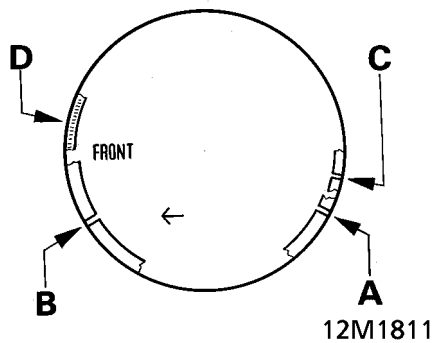
ENGINE

Piston rings - refit



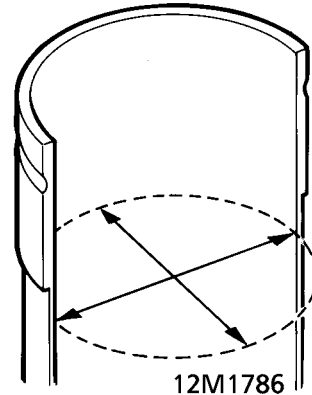
CAUTION: Ensure that piston rings are fitted to piston for the cylinder bore in which they were checked.

1. Fit oil control spring.
2. With 'TOP' or identification markings to top of piston, use an expander to fit piston rings in sequence; oil control, 2nd and top compression.



3. Ensure rings are free to rotate, position compression ring gaps **A** and **B** at 120° to each other and away from thrust side - left hand side of piston when viewed from front. Position oil control ring gap **C** and spring gap **D** at 30° on opposite side of gudgeon pin axis.

Cylinder liners - inspection



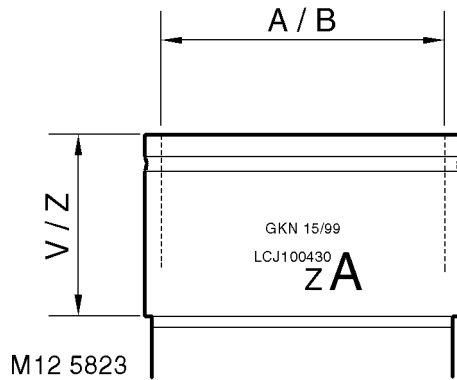
1. Measure wear and taper in two axes 65 mm from top of cylinder liner bore.
RED grade A = 80.000 to 80.015 mm
BLUE grade B = 80.016 to 80.030 mm
Service liners are grade A and B.
Cylinder liner grade will be found marked on outside diameter of liner.




CAUTION: Cylinder liners with excessively glazed, worn, scratched or scored bores must be replaced, do not attempt to hone or remove glazing from bore.



Later engines

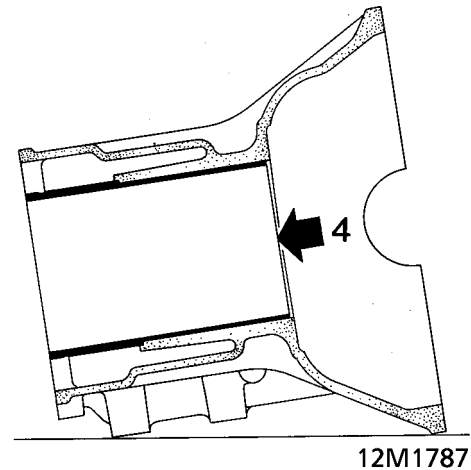



- A/B - Cylinder liner bore/grade
- V/Z - Cylinder liner step height

 **NOTE:** Cylinder liners fitted to later engines have their step heights graded on production. The step heights, V or Z together with the liner part number and colour code are marked on the outside diameter of the liner. If cylinder liner(s) are to be replaced, the replacement liner(s) must have the same step height as the original liner(s). Both step heights are available in red and blue grades of liner.

Cylinder liners - remove

1. Remove pistons.
2. Remove cylinder liner clamps **LRT-12-144**.
3. Using assistance, position cylinder block on its side.




 **CAUTION:** If original cylinder liners are to be refitted, use a felt tipped pen to make suitable alignment marks between liner and cylinder block. Do not etch or stamp liners.

4. Using hand pressure, push cylinder liners out towards cylinder head face of cylinder block; remove liners.


 **CAUTION:** Keep cylinder liners in their fitted order.

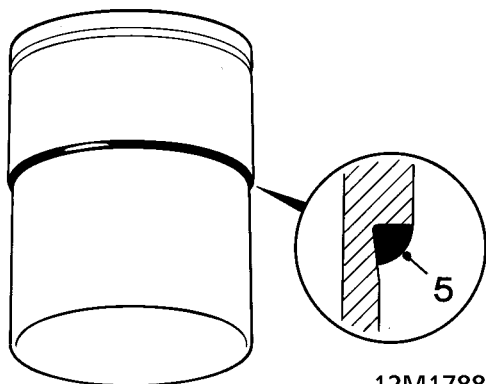
ENGINE

Cylinder liners - refit

 **NOTE: To enable cylinder liner retainer clamps to be fitted when liners are inserted in cylinder block, crankshaft and bearing ladder must be fitted.**

1. Fit crankshaft and bearing ladder.
2. Using assistance, support cylinder block on 2 wooden blocks.
3. Remove sealant from cylinder block and if original cylinder liners are to be refitted, from shoulder of liners.
4. Clean cylinder liners and wipe dry.

 **CAUTION: Ensure that if original cylinder liners are to be refitted, reference marks made during dismantling are not erased.**




12M1788

5. Apply a 2.0 mm thick continuous bead of sealant, Part No. GGC 102 around shoulder of cylinder liner.

 **CAUTION: Do not use any other type of sealant.**


6. Keeping cylinder liner 'square' to cylinder block, push liner fully down until shoulder of liner seats against cylinder block. Do not drop liners into position.

 **CAUTION: If original cylinder liners are to be refitted, align reference marks made during dismantling before liner is pushed fully down.**

7. Fit cylinder liner retainer clamps **LRT-12-144**.
8. Fit pistons.

Pistons and connecting rods - refit

1. Using assistance, support base of cylinder block on 2 wooden blocks.
2. Ensure that cylinder liner retainer clamps **LRT-12-144** are fitted and that feet of clamps do not protrude over cylinder liner bores.
3. Lubricate cylinder bores, pistons and rings with engine oil, ensure ring gaps are correctly spaced.
4. Fit selected bearing shells into big-end bearing caps and connecting rods.
5. Fit a suitable piston ring clamp to each piston in turn and with '**FRONT**' mark on piston to engine front, push piston into bore until flush with top face of cylinder liner. Remove ring clamp.

 **CAUTION: If original pistons are to be fitted, ensure that each piston is inserted in its correct cylinder liner. Do not push pistons below top face of cylinder liner until big-end bearings and caps are to be fitted.**

6. Fit big-end bearings.



DATA

Oil pump

Outer rotor to housing clearance	0.28 to 0.36 mm
Inner rotor tip clearance	0.05 to 0.13 mm
Rotor end float	0.02 to 0.06 mm
Relief valve spring free length	38.9 mm

Cooling system

Thermostat fully open	100°C
Nominal setting	85°to 91°C

Camshafts

Camshaft end-float	0.06 to 0.19 mm
Service limit	0.3 mm
Camshaft bearing clearance	0.060 to 0.094 mm
Service limit	0.15 mm

Tappets

Tappet outside diameter	32.959 to 32.975 mm.
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Cylinder head

Cylinder head maximum warp	0.05 mm
Cylinder head height:	
New	118.95 to 119.05 mm.
Reface limit	0.20 mm

Valve springs

Free length	50.0 mm
Fitted length	37.0 mm
Load - valve closed	250 ± 12 N
Load - valve open	450 ± 18 N

Valves

Valve stem diameter:	
Inlet	5.952 to 5.967 mm
Exhaust	5.947 to 5.962 mm
Valve guides:	
Inside diameter	6.000 to 6.025 mm
Valve stem to guide clearance:	
Inlet	0.033 to 0.063 mm
Service limit	0.07 mm
Exhaust	0.038 to 0.078 mm
Service limit	0.11 mm
Valve stem fitted height:	
New	38.93 to 39.84 mm
Service limit	40.10 mm

Valve guides

Fitted height	6.0 mm
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ENGINE

Valve seats

Angle	45°
Width - Except triple angle valve seats:	
Inlet	1.5 mm
Exhaust	1.5 mm
Width - Triple angle valve seats:	
Inlet	1.0 to 1.4 mm
Exhaust	1.4 to 1.8 mm
Valve face angle:	
Inlet	45°
Exhaust	45°

Crankshaft

Crankshaft end-float	0.10 to 0.25 mm
Service limit	0.34 mm
Thrust washer halves thickness	2.61 to 2.65 mm
Main journal tolerance - Type A crankshaft * :	
Grade 1	47.993 to 48.000 mm
Grade 2	47.986 to 47.993 mm
Grade 3	47.979 to 47.986 mm
Clearance in bearings	0.02 to 0.05 mm
Maximum out of round	0.010 mm
Main journal tolerance - Type B crankshaft * :	
Grade 1	48.000 to 48.007 mm
Grade 2	47.993 to 48.000 mm
Grade 3	47.986 to 47.993 mm
Clearance in bearings	0.013 to 0.043 mm
Maximum out of round	0.010 mm
Big-end journal diameter	47.986 to 48.007 mm
Maximum out of round	0.010 mm
Big end journal tolerance:	
Grade A	48.000 to 48.007 mm
Grade B	47.993 to 48.000 mm
Grade C	47.986 to 47.993 mm
Clearance in bearings	0.021 to 0.049 mm
Big-end end-float	0.10 to 0.25 mm

Piston rings

New ring to groove clearance:	
Top compression ring	0.040 to 0.072 mm
2nd compression ring	0.030 to 0.062 mm
Oil control rails	0.010 to 0.180 mm

Ring fitted gap 20 mm from top of bore:

Top compression ring	0.20 to 0.35 mm
2nd compression ring	0.28 to 0.48 mm
Oil control rails	0.15 to 0.40 mm

* For commencing engine numbers for Type B crankshafts, see Information.

**Piston diameter**

Grade A	79.975 to 79.990 mm
Grade B	79.991 to 80.005 mm
Clearance in bore	0.01 to 0.04 mm
Maximum ovality	0.3 mm

Cylinder block

Cylinder liner bore:

RED grade A	80.000 to 80.015 mm
BLUE grade B	80.016 to 80.030 mm

ENGINE

TORQUE FIGURES

Tensioner pulley backplate screw - Manual timing belt tensioner	10 Nm
Tensioner pulley screw - Manual timing belt tensioner	45 Nm
Timing belt tensioner bolt - Automatic timing belt tensioner +	25 Nm
RH engine mounting bracket bolts	45 Nm
Crankshaft pulley bolt	205 Nm
Timing belt upper front cover screws and bolt	5 Nm
Timing belt lower cover screws	9 Nm
Timing belt rear cover screws	9 Nm
Oil pump bolts*+	10 Nm
Coolant pump bolts*	10 Nm
Coolant pump cover bolts	10 Nm
Thermostat housing bolts	8 Nm
Thermostat housing to cylinder block bolt	10 Nm
Coolant rail to cylinder block bolts	25 Nm
Flywheel - Patchlok bolts +	80 Nm
Cylinder head bolts:*	
All bolts	20 Nm
Mark position of radial marks	
Turn all bolts through 180°	
Turn all bolts through another 180° align marks	
Spark plugs	25 Nm
Camshaft gear bolts:	
M8	35 Nm
M10	65 Nm
Camshaft carrier bolts*	10 Nm
Blanking plate to camshaft carrier bolts	25 Nm
Camshaft cover to carrier bolts*	10 Nm
Air cleaner support bracket bolts	10 Nm
Spark plug cover screws	10 Nm
Big-end bolts	20 Nm + 45°
Bearing ladder to block bolts*	30 Nm
Oil rail to bearing ladder nuts	9 Nm
Alloy sump bolts*	
M8 x 25	25 Nm
M8 x 60	30 Nm
Dipstick tube bolts	10 Nm
Oil temperature sensor to oil filter adapter	
- if fitted	17 Nm
Oil pick-up pipe bolts	12 Nm
Rotor arm screw++	10 Nm
HT lead brackets	10 Nm
HT lead cover screws	5 Nm

* Tighten in sequence

+ New Patchlok bolts must be fitted

++ New screw must be fitted



SERVICE TOOLS

LRT-12-034	Valve Lifter Basic Tool
LRT-12-034/1	Valve Lifter Adaptor
LRT-12-071	Valve Stem Oil Seal Remover/Replacer
LRT-12-134	Camshaft Gears Locking Tool
LRT-12-136	Crankshaft Rear Oil Seal Replacer Tool
LRT-12-137	Crankshaft Front Oil Seal Replacer
LRT-12-144	Cylinder Liner Retainer Clamps
LRT-12-145	Flywheel Locking Tool
LRT-12-146	Sump Alignment Pins - 2 off
LRT-12-148A	Camshaft Oil seal Replacer
LRT-12-149	Valve Guide Reamer
LRT-12-519/1	Valve Guide Remover/Replacer
LRT-12-519/2	Depth Gauge
LRT-12-519/3	Nylon Guide
MS 120-6	Valve Seat Cutter Pilot
MS 76-111	60° Valve Seat Cutter
MS 76-120	15° Valve Seat Cutter
MS 76-122	45° Valve Seat Cutter
12-182	Camshaft Gear Holding Tool
12-203	Protection Sleeve