3.5/3.9 & 4.2 litre V8 ENGINE

Overhaul Manual

3.5, 3.9 & 4.2 LITRE V8 ENGINE

OVERHAUL MANUAL

These engines, with or without suffix B added to the engine serial number are fitted to the following models:

Discovery
Defender
Range Rover Classic

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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 of each page.

This manual contains procedures for overhaul of the V8 engine on the bench with the gearbox, clutch, inlet manifold, exhaust manifolds, coolant pump, starter motor, alternator, and all other ancillary equipment removed. For information regarding General Information, Adjustments, removal of oil seals, engine units and ancillary equipment, consult the Repair Manual.

This manual is divided into 3 sections:
- Data, Torque & Tools
- Description and Operation and
- Overhaul

To assist filing of revised information each sub-section is numbered from page 1.

Individual items are to be overhauled in the sequence in which they appear in this manual. Items numbers in the illustrations are referred to in the text.

Overhaul operations include reference to Service tool numbers and the associated illustration depicts the tool. Where usage is not obvious the tool is shown in use. Operations also include reference to wear limits, relevant data, and specialist information 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

With the engine and gearbox assembly removed, the crankshaft pulley end of the engine is referred to as the front. References to RH and LH banks of cylinders are taken viewing from the flywheel end of the engine.

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.

Engine serial number

The engine serial number and conpression ratio will be found stamped on a cast pad on the cylinder block between numbers 3 and 5 cylinders. The compression ratio is above the serial number.

Dimensions

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

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.

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.

The terms of the vehicle warranty may be invalidated by the fitting of parts 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.

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 component or vehicle. Land Rover dealers are not agents of the Company and have no authority to bind the manufacturer by any expressed or implied undertaking or representation.

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DATA

Firing order	1, 8, 4, 3, 6, 5, 7, 2 Cylinders 1, 3, 5, 7 - LH side of engine Cylinders 2, 4, 6, 8 - RH side of engine	
Cylinder head		
Maximum warp	0.05 mm	0.002 in
Reface limit from new	0.50 mm	0.02 in
Valve springs		
Free length	48.30 mm	1.90 in
Fitted length	40.40 mm	1.60 in
Load - valve closed	339 ± 10 N	76 ± 2 lbf
Load - valve open	736 ± 10 N	165 ± 2 lbf
Valves		
Valve stem diameter:		
Inlet - All engines	8.660 to 8.680 mm	0.340 to 0.341 in
Exhaust:		
Standard and carbon break valves - Early engines	8.651 to 8.666 mm	0.340 to 0.341 in
Modified carbon break valves - Later engines	8.641 to 8.656 mm	0.336 to 0.340 in
Valve head diameter:		
Inlet	39.75 to 40.00 mm	1.56 to 1.57 in
Exhaust	34.226 to 34.480 mm	1.34 to 1.35 in
Valve installed height:		
Standard and carbon break valves - Inlet and exhaust - Early engines - maximum	47.63 mm	1.9 in
Modified valves - Inlet and exhaust - Later engines - Maximum	44.16 to 45.29 mm	1.741 to 1.802 in
Valve stem to guide clearance:		
Inlet - All engines	0.025 to 0.066 mm	0.001 to 0.002 in
Exhaust:		
Standard and carbon break valves - Early engines	0.038 to 0.078 mm	0.0015 to 0.003 in
Modified carbon break valves - Early engines	0.048 to 0.088 mm	0.0019 to 0.0035 in
Valve guides		
Valve guide installed height	15.0 mm	0.59 in
Inside diameter after reaming	8.7 mm	0.34 in
Valve seats		
Valve seat width:		
Inlet	36.83 mm	1.45 in
Exhaust	31.50 mm	1.24 in
Valve seat angle:		
Engines built prior to '99 MY	46° to 46° 25'	
Engines built from '99 MY	45° to 45° 30'	
Valve seat diameter:		
Inlet	36.83	1.45 in
Exhaust	31.50 mm	1.24 in
Valve seating width:		
Inlet	0.89 to 1.4 mm	0.035 to 0.055 in
Exhaust	1.32 to 1.83 mm	0.052 to 0.072 in
Valve face angle	45°	

Oil pump - Engine numbers without suffix B		
Gear to cover face minimum clearance	0.05 mm	0.002 in
Oil pressure relief valve - Engine numbers without suffix B		
Spring free length	81.28 mm	3.2 in
Oil pump - Engine numbers with suffix B		
Inner to outer rotor clearance - maximum	0.25 mm	0.01 in
Rotors to cover plate clearance - maximum	0.1 mm	0.004 in
Drive gear wear step depth - maximum	0.15 mm	0.006 in
Oil pressure relief valve - Engine numbers with suffix B		
Spring free length	60.0 mm	2.4 in
Oil pressure by-pass valve - Engine numbers with suffix B		
Spring free length	60.0 mm	2.4 in
Camshaft		
Maximum run-out	0.05 mm	0.002 in
End-float - Camshafts with thrust plate	0.05 to 0.35 mm	0.002 to 0.014 in
Piston rings		
Ring to groove clearance:		
Top compression	0.05 to 0.10 mm	0.002 to 0.004 in
2nd compression	0.05 to 0.10 mm	0.002 to 0.004 in
Ring fitted gap:		
Top compression	0.30 to 0.50 mm	0.012 to 0.02 in
2nd compression	0.40 to 0.65 mm	0.016 to 0.026 in
Oil control rails	0.38 to 1.40 mm	0.014 to 0.05 in
Oil control ring width	3.00 mm	0.12 in - maximum
Pistons		
Clearance in bore	0.015 to 0.045 mm	0.001 to 0.002 in
Gudgeon pins		
Length	72.67 to 72.79 mm	2.85 to 2.86 in
Diameter	22.215 to 22.220 mm	0.87 to 0.871 in
Clearance in piston	0.006 to 0.015 mm	0.0002 to 0.0006 in
Connecting rods		
Length between centres	143.71 to 143.81 mm	5.66 to 5.67 in
End-float on crankshaft	0.15 to 0.36 mm	0.006 to 0.014 in
Cylinder bore		
Cylinder bore diameter:		
3.5 engine	88.86 to 88.90 mm	3.498 to 3.500 in
3.9 engine	94.00 to 94.04 mm	3.700 to 3.702 in
4.2 engine	94.00 to 94.04 mm	3.700 to 3.702 in
Maximum ovality	0.013 mm	0.0005 in

Crankshaft

Main journal diameter	58.409 to 58.422 mm	2.29 to 2.30 in
Maximum regrind diameter	57.900 to 57.914 mm	2.28 to 2.281 in
Maximum out of round	0.040 mm	0.002 in
Big-end journal diameter	50.800 to 50.812 mm	1.99 to 2.00 in
Maximum regrind diameter	50.292 to 50.305 mm	1.97 to 1.98 in
Maximum out of round	0.040 mm	0.002 in
End-float	0.08 to 0.26 mm	0.003 to 0.010 in
Maximum run-out	0.08 mm	0.003 in
Spigot bearing inside diameter	19.177 + 0.025 - 0.00 mm	0.75 + 0.001 - 0.00 in

Main bearings

Main bearing diametrical clearance	0.010 to 0.048 mm	0.0004 to 0.002 in
Undersizes	0.254, 0.508 mm	0.01, 0.02 in

Big-end bearings

Big-end bearing diametrical clearance	0.015 to 0.055 mm	0.0006 to 0.0021 in
Undersizes	0.254, 0.508 mm	0.01, 0.02 in
Endfloat on journal	0.15 to 0.36 mm	0.006 to 0.01 in

Flywheel

Flywheel minimum thickness	39.93 mm	1.6 in

Drive plate

Drive plate setting height	8.08 to 8.20 mm	0.32 to 0.33 in

ENGINE

Crankshaft pulley bolt	270 Nm	200 lbf.ft
Timing cover to cylinder block bolts **	22 Nm	16 lbf.ft
Camshaft gear bolt	50 Nm	37 lbf.ft
Rocker cover bolts: + ****		
Stage 1	3 Nm	2.5 lbf.ft
Stage 2	8 Nm	6 lbf.ft
Rocker shaft to cylinder head bolts	38 Nm	28 lbf.ft
Cylinder head bolts - Engine numbers without suffix B: + *		
Bolts 11 to 14 - Outer row	60 Nm	44 lbf.ft
Bolts 2, 4, 6, 8 and 10 - Centre row	90 Nm	66 lbf.ft
Bolts 1, 3, 5, 7 and 9 - Inner row	90 Nm	66 lbf.ft
Cylinder head bolts - Engine numbers with suffix B: + */****		
Stage 1	20 Nm	15 lbf.ft
Stage 2	Further 90°	
Stage 3	Further 90°	
Lifting eye to cylinder head bolts	40 Nm	30 lbf.ft
Connecting rod nuts/bolts:		
Nuts:	50 Nm	37 lbf.ft
Bolts		
Stage 1	20 Nm	15 lbf.ft
Stage 2	Further 80°	
Main bearing cap bolts + *		
Initial torque - all bolts:	14 Nm	10 lbf.ft
Final torque:		
Numbers 1 to 4 main bearing cap bolts:	70 Nm	52 lbf.ft
Rear main bearing cap bolts:	90 Nm	66 lbf.ft
Flywheel bolts	78 Nm	58 lbf.ft
Drive plate and clamp ring bolts	45 Nm	33 lbf.ft
Drive plate hub aligner Allen bolts	85 Nm	63 lbf.ft
Oil sump drain plug	45 Nm	33 lbf.ft
Oil sump bolts +	23 Nm	17 lbf.ft
Oil pick-up pipe bolts	10 Nm	8 lbf.ft
Oil strainer nut - Engine numbers with suffix B	22 Nm	16 lbf.ft
Oil pressure relief valve plug - Engine numbers without suffix B	45 Nm	33 lbf.ft
Oil pump cover to timing cover - Engine numbers without suffix B	12 Nm	9 lbf.ft
Oil pump cover plate screws - Engine numbers with suffix B **	4 Nm	3 lbf.ft
Oil pump cover plate bolt - if fitted **	8 Nm	6 lbf.ft
Oil pressure switch	15 Nm	11 lbf.ft
Oil strainer bolts	10 Nm	7 lbf.ft
Distributor clamp nut	20 Nm	15 lbf.ft
Spark plug	20 Nm	15 lbf.ft
Coolant pump/timing cover to cylinder block	22 Nm	16 lbf.ft
Camshaft thrust plate bolts - If fitted	25 Nm	18 lbf.ft
Secondary air injection adapters - If fitted ***	33 Nm	24 lbf.ft

\+ Tighten in sequence
* Lightly oil threads prior to assembly.
** Coat threads with sealant Part number STC 50552 prior to assembly.
*** New adapters must be fitted
**** New bolts must be fitted

GENERAL

For bolts and nuts not otherwise specified:

METRIC

M5	4 Nm	3 lbf.ft
M6	6 Nm	4 lbf.ft
M8	18 Nm	13 lbf.ft
M10	35 Nm	26 lbf.ft
M12	65 Nm	48 lbf.ft
M14	80 Nm	59 lbf.ft
M16	130 Nm	96 lbf.ft

UNC / UNF

1/4	9 Nm	7 lbf.ft
5/16	25 Nm	18 lbf.ft
3/8	40 Nm	30 lbf.ft
7/16	75 Nm	55 lbf.ft
1/2	90 Nm	66 lbf.ft
5/8	135 Nm	100 lbf.ft

SEALANTS

A range of sealants is used when overhauling the engine, the sealant applications, together with the appropriate part number is listed below.

Timing cover bolts	STC 50552
Sump to cylinder block	STC 50550
Oil pump cover plate screws and bolt - Engine numbers with suffix B	STC 50552
Cylinder head threaded core plugs	STC 50552
Rear main bearing cap to cylinder block mating faces	STC 50550

SERVICE TOOLS

Land Rover Number	Description
LRT-12-010*	Protection sleeve - crankshaft rear oil seal
LRT-12-013	Remover/replacer - gudgeon pin
LRT-12-014	Adapter remover/replacer - gudgeon pin
LRT-12-034	Valve spring compressor
LRT-12-037	Drift - remover - valve guide
LRT-12-039A	Drift - replacer - valve guide
LRT-12-080	Crankshaft pulley retaining tool
LRT-12-089	Replacer - timing cover oil seal
LRT-12-090**	Retainer - oil pump gears
LRT-12-091**	Replacer - crankshaft rear oil seal
LRT-12-095**	Protection sleeve - crankshaft rear oil seal
LRT-12-126/1	Bush - remover/replacer - gudgeon pin
LRT-12-126/2	Adapter - remover/replacer - gudgeon pin
LRT-12-183	Sump alignment tool - 2 off
LRT-12-208	Distance piece - valve guide
LRT-99-003	Driver handle

* Engine numbers without suffix B
** Engine numbers with suffix B

The use of approved special service tools is important. They are essential if service operations are to be carried out efficiently and safely. Where special tools are specified, **only these tools should be used to avoid the possibility of personal injury or damage to the components.** Also, the amount of time they save can be considerable.

Special tools bulletins will be issued periodically giving details of new tools as they are introduced.

All orders and enquiries from the United Kingdom and European countries except Germany, Austria, Switzerland and Spain and countries not in the following list should be sent direct to:

SPX UK Ltd.,
Genoa House,
Everdon Park,
Daventry,
Northants,
England, NN11 5YJ

Telephone: 00 44 (0) 132 7303467/303455
Fax: 00 44 (0) 1327 706632
e-mail: spxsalesuk@servicesolutions.spx.com

Overseas orders for the following countries should be placed with the local XPS distributor.

Germany, Austria and Switzerland
SPX Europe GMBH,
Porschestrasse 4,
63512 Hainburg,
Germany,

Telephone: 0049 61829590
Fax: 0049 6182959299

Spain
SPX Iberica SA,
C/Francisco Aritio
158 nave 72 (Nudo Oeste),
19004 Guadalajara,
Spain

Telephone: 0034 949208381
Fax: 0034 949208327

North America
SPX Corporation,
665, Eisenhower Drive,
Owatonna,
MN 55060,
USA

Telephone: 0018 772979110
Fax: 0018 005787375

SPX Australia,
28, Clayton Road,
Notting Hill,
Victoria 3168,
Australia,

Telephone: 00 (61) 00395446222
Fax: 00 (61) 0395445222
e-mail: sales@spx.com.au

Japan and East Asia
Jatek Ltd.,
5 - 53, Minawacho 2-chome,
Kohoku-ku,
Yokohama,
Kanagawa 223-0051,
Japan

Telephone: 0081 455627700
Fax: 0081 455627800

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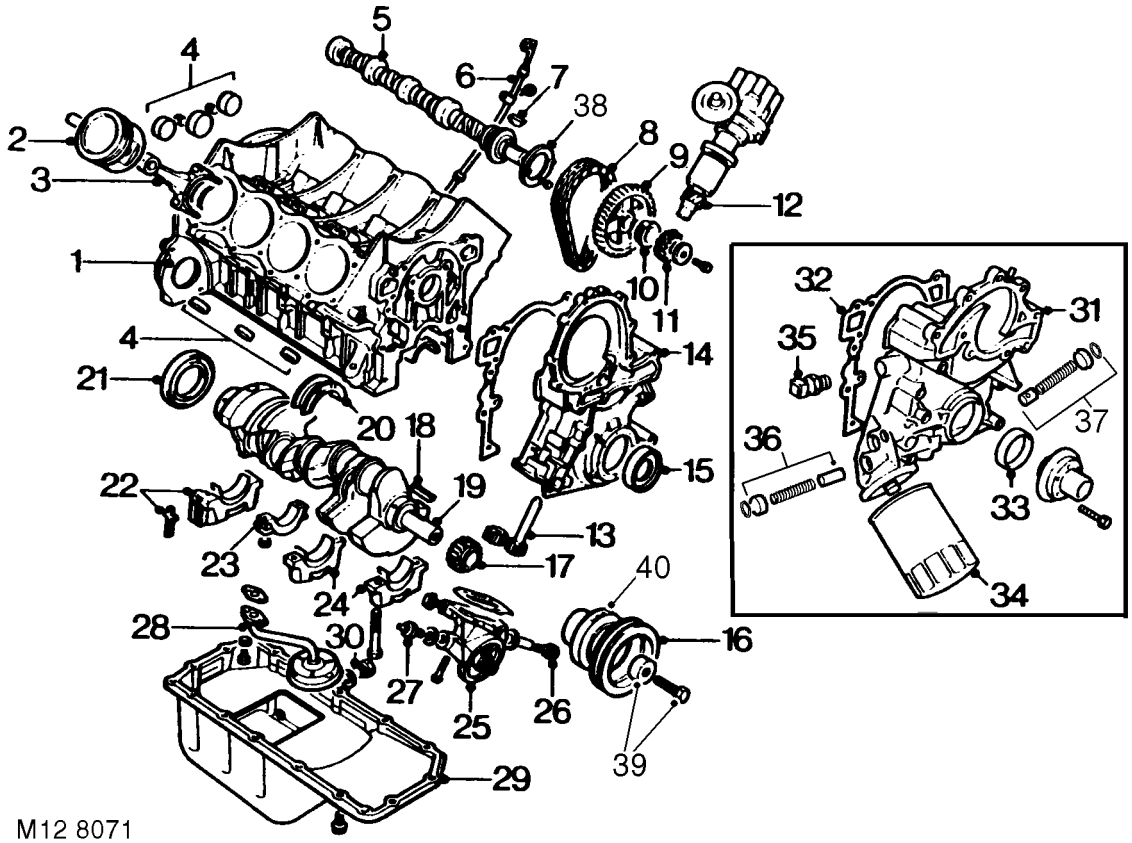
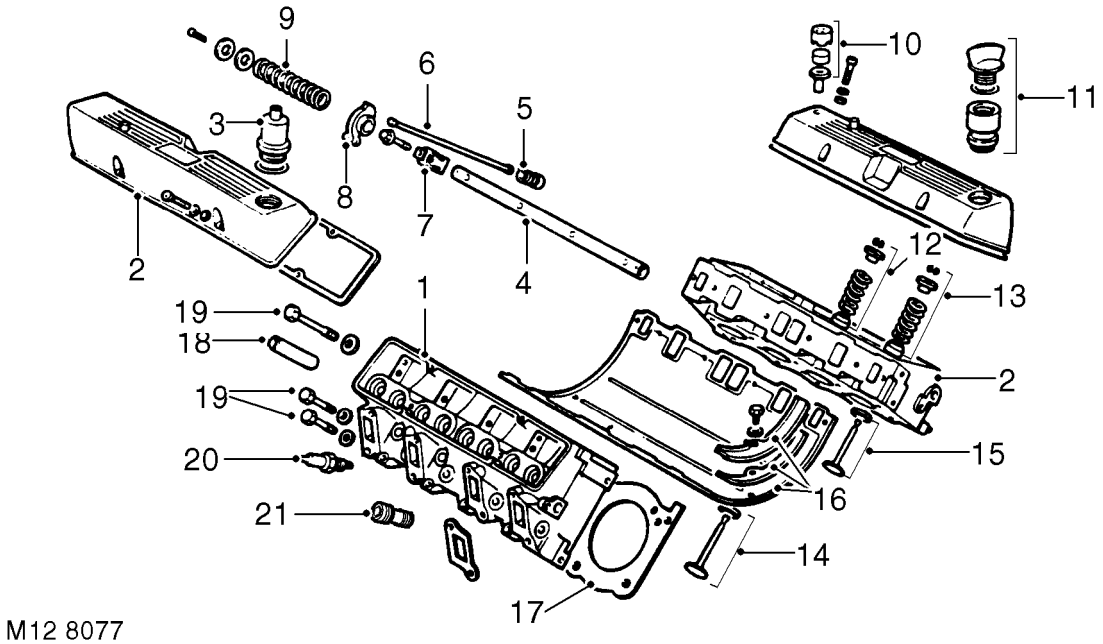

M12 8071

CYLINDER BLOCK COMPONENTS

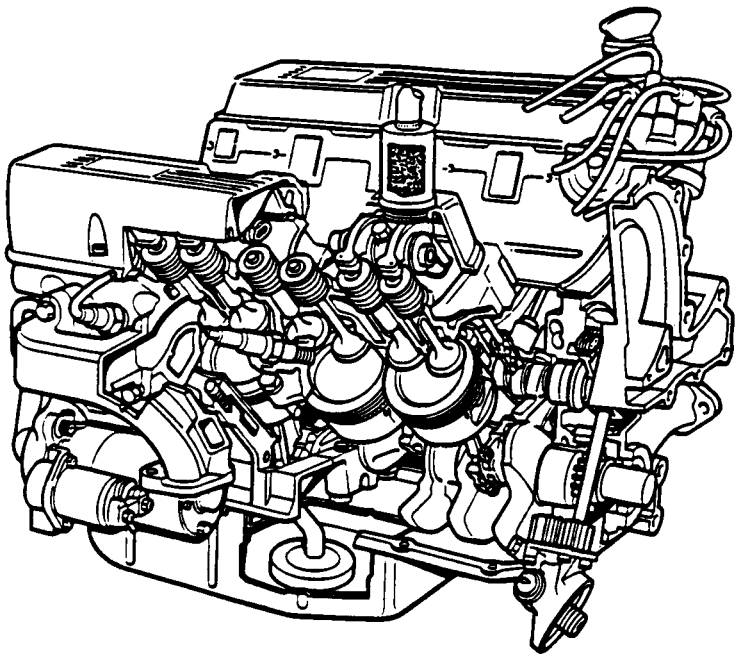
1. Cylinder block
2. Piston and gudgeon pin
3. Connecting rod
4. Core plugs
5. Camshaft
6. Dipstick
7. Camshaft key
8. Timing chain
9. Camshaft sprocket
10. Spacer
11. Distributor drive gear - if fitted
12. Distributor - if fitted
13. Oil pump gears *
14. Timing cover and gasket *
15. Timing cover oil seal *
16. Crankshaft pulley
17. Crankshaft sprocket
18. Woodruff key
19. Crankshaft
20. Centre main bearing shell - upper
21. Crankshaft rear oil seal
22. Rear main bearing cap and side seals
23. Connecting rod cap
24. Main bearing caps
25. Oil pump cover *
26. Oil pressure relief valve assembly *
27. Oil pressure switch *
28. Oil pump suction pipe and strainer
29. Sump
30. Drain plug
31. Timing cover **
32. Timing cover gasket **
33. Timing cover oil seal **
34. Oil filter **
35. Oil pressure switch **
36. Oil pressure by-pass valve assembly **
37. Oil pressure relief valve assembly **
38. Camshaft thrust plate - if fitted
39. Crankshaft pulley bolt and washer
40. Mud flinger

* Engine numbers without suffix B
** Engine numbers with suffix B



CYLINDER HEAD COMPONENTS

1. Cylinder head
2. Rocker cover
3. PCV filter
4. Rocker shaft
5. Tappet
6. Pushrod
7. Rocker shaft bracket
8. Rocker arm
9. Rocker shaft spring
10. PCV air intake filter
11. Engine oil filler cap
12. Inlet valve seal, spring, cap, and collets
13. Exhaust valve seal, spring, cap and collets
14. Inlet valve and seat
15. Exhaust valve and seat
16. Inlet manifold gasket and seals
17. Cylinder head gasket
18. Valve guide
19. Bolts - cylinder head
20. Spark plug
21. Secondary air injection adapter - if fitted



12M1087

Engine without suffix B added to serial no. illustrated

OPERATION

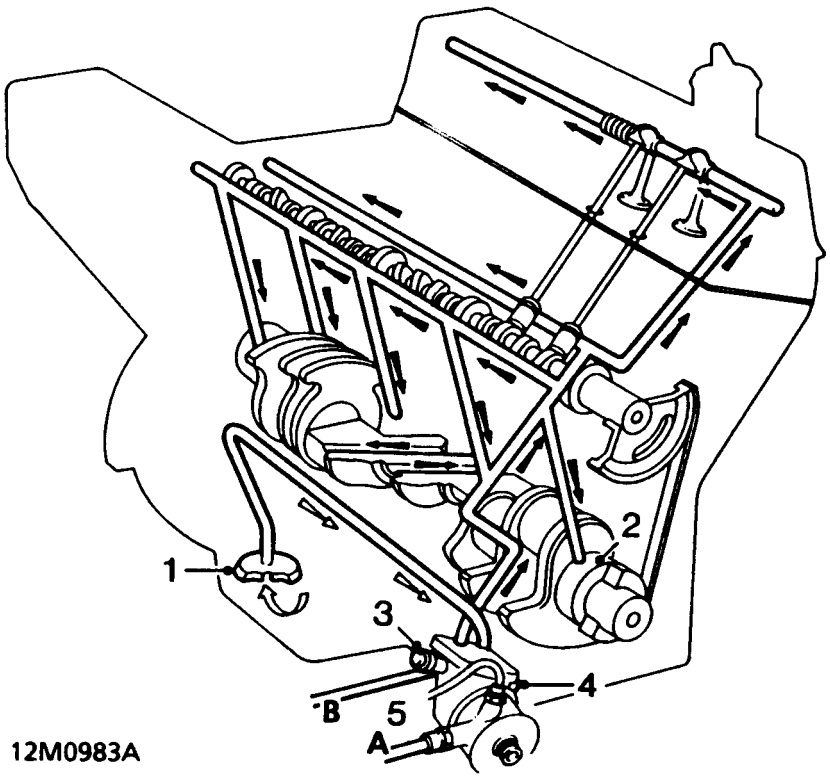
The V8 engine is an eight cylinder, water cooled unit comprising of cast aluminium cylinder block and cylinder heads.

The two banks of cast iron cylinder liners are shrink fitted and are located on stops in the cylinder block. The banks of cylinders are set at 90° to each other. The crankshaft is carried in five main bearings, end-float being controlled by the thrust faces of the upper centre main bearing shell.

The centrally located camshaft is driven by the crankshaft via an inverted tooth chain. The valves are operated by rockers, pushrods and hydraulic tappets. The distributor - if fitted, is driven by a skew gear from the front of the camshaft.

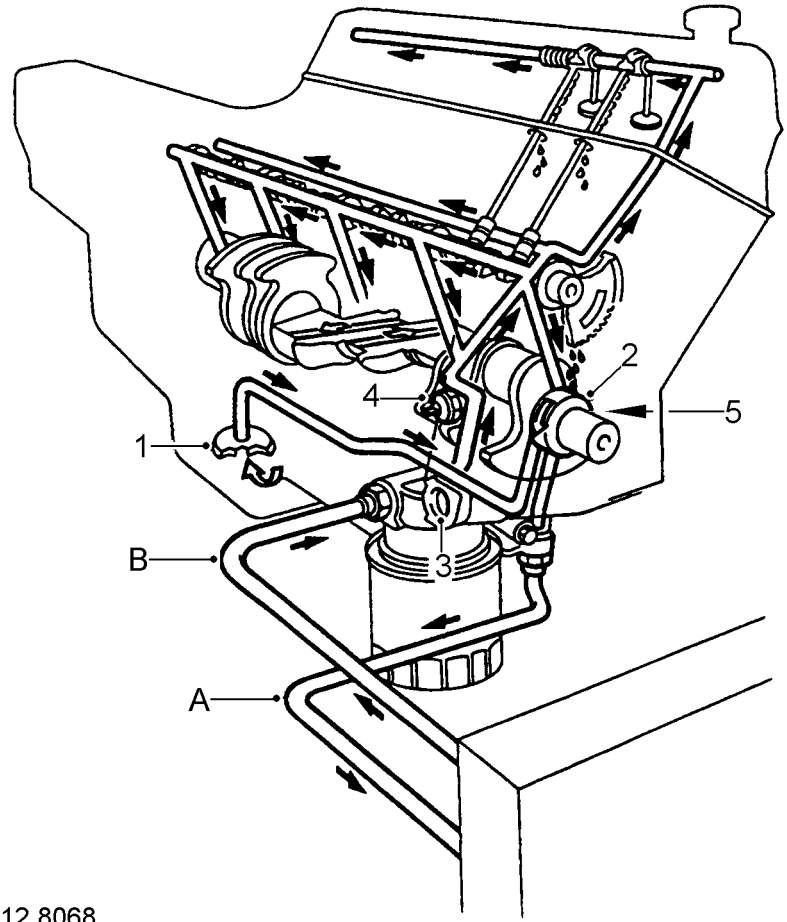
The aluminium alloy, pistons have two compression rings and an oil control ring and are secured to the connecting rods by semi-floating gudgeon pins. On later 4.2L engines the gudgeon pin is offset 0.5 mm (0.02 in), identified by an arrow mark on the piston crown, which must always point to the front of the engine. Plain, big-end bearing shells are fitted to each connecting rod.

Lubrication - Engine numbers without suffix B



1. Oil strainer
2. Crankshaft main bearing oil feed
3. Oil pressure relief valve
4. Oil pump
5. Main galleries
A Oil to cooler
B Oil from cooler

Lubrication - Engine numbers with suffix B



M12 8068

1. Oil strainer
2. Oil pump
3. Pressure by-pass valve
4. Oil pressure switch
5. Oil pressure relief valve

A Oil to cooler
B Oil from cooler

Engine numbers without suffix B

The full flow lubrication system uses an external gear pump which is driven by the distributor drive shaft. The oil pump gears are housed in the timing cover and the oil pressure relief valve and warning light switch are fitted to the oil pump cover.

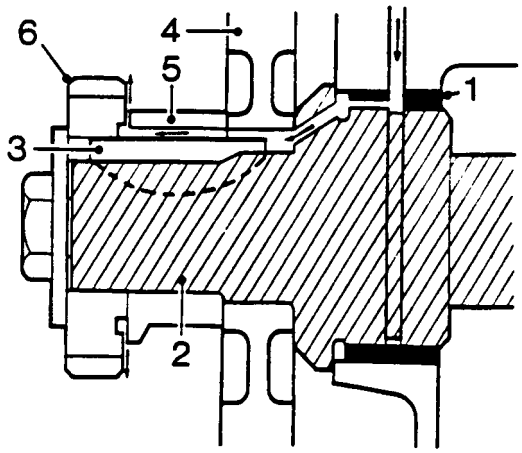
Engine numbers with suffix B

The full flow lubrication system uses a gear type oil pump driven from the crankshaft. The assembly is integral with the timing cover which also carries the full flow oil filter, oil pressure switch and pressure relief valve.

All engines

Oil is drawn from the pressed steel sump through a strainer and into the oil pump, excess pressure being relieved by the pressure relief valve. The oil pressure warning light switch is screwed into the oil pump cover and registers the oil pressure in the main oil gallery on the outflow side of the filter. Pressurised oil passes through an oil cooler - if fitted to the full flow oil filter and through internal drillings to the crankshaft where it is directed to each main bearing and to the big end bearings via Nos. 1, 3 and 5 main bearings. An internal drilling in the cylinder block directs oil to the camshaft where it passes through further internal drillings to the hydraulic tappets, camshaft journals and rocker shaft. Lubrication to the thrust side of the cylinders is by oil grooves machined in each connecting rod big end joint face, which are timed to align with holes in the big end journals on the power and exhaust strokes.

Distributor drive and timing chain lubrication

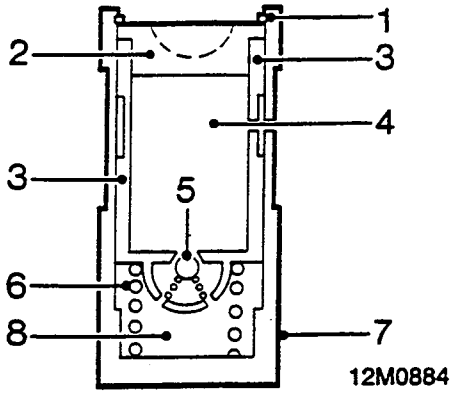


12M1086

1. Bearing
2. Camshaft
3. Key
4. Camshaft timing chain sprocket
5. Spacer
6. Distributor drive gear

The distributor drive and timing chain are lubricated from the camshaft front bearing. The feed to the timing chain is channelled along the camshaft sprocket, key and spacer.

Hydraulic tappets



12M0884

1. Clip
2. Pushrod seat
3. Inner sleeve
4. Upper chamber
5. Non-return ball valve
6. Spring
7. Outer sleeve
8. Lower chamber - high pressure

The purpose of the hydraulic tappet is to provide maintenance free and quiet operation of the inlet and exhaust valves. It achieves this by utilising engine oil pressure to eliminate the mechanical clearance between the rockers and the valve stems.

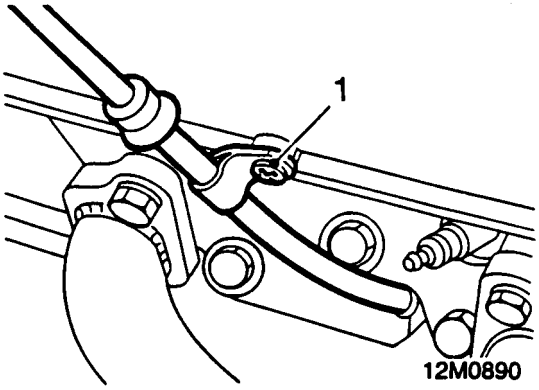
During normal operation, engine oil pressure present in the upper chamber passes through the non-return ball valve and into the lower, high pressure, chamber.

When the cam begins to lift the outer sleeve, the resistance of the valve spring felt through the push rod and seat causes the tappet inner sleeve to move downwards inside the outer sleeve. This downward movement of the inner sleeve closes the ball valve and increases the pressure in the lower, high pressure chamber, sufficiently to ensure that the push rod opens the valve fully.

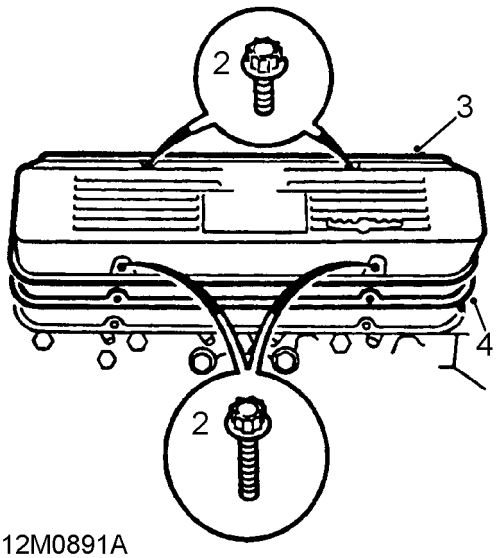
As the tappet moves off the peak of the cam the ball valve opens to equalise the pressure in both chambers which ensures the valve closes when the tappet is on the back of the cam.

ROCKER SHAFTS

Rocker shafts - remove



1. *LH rocker shaft only:* Remove screw securing dipstick tube to rocker cover.

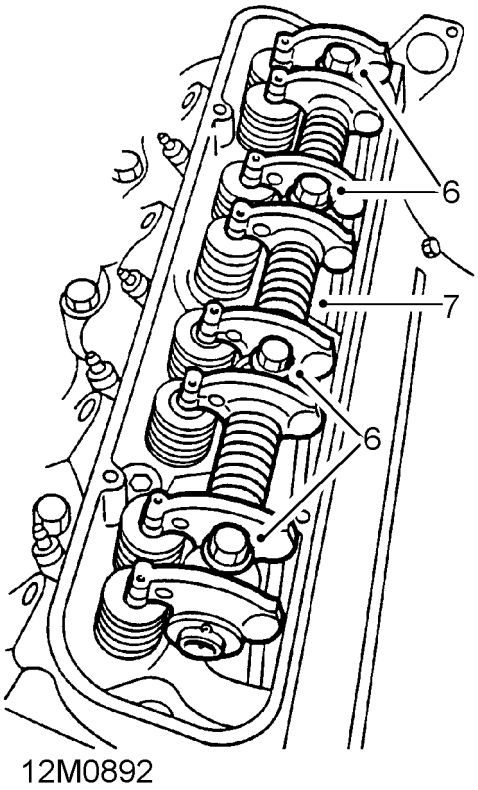


2. Noting fitted position of 2 longer screws or multi-hex bolts, remove and discard screws/bolts securing rocker cover to cylinder head.
3. Remove rocker cover.
4. Remove and discard gasket from rocker cover.

NOTE: Gaskets fitted to early engines were cork; these must be replaced with later type gaskets which incorporate compression limiters in the bolt holes.

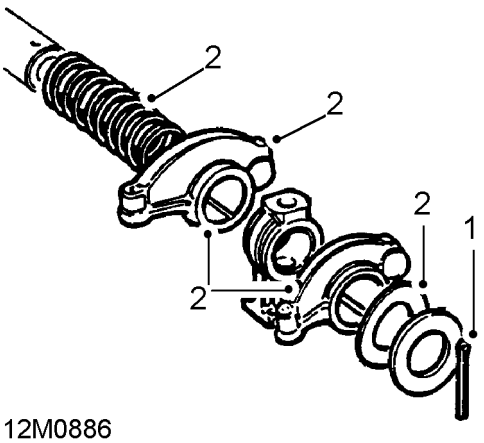
5. Mark each rocker shaft in relation to original cylinder head.

CAUTION: Incorrect fitment of rocker shafts will lead to an oil feed restriction.



6. Progressively slacken and remove 4 bolts securing rocker shaft assembly to cylinder head.
7. Remove rocker shaft assembly.
8. Remove pushrods and store in fitted order.
9. Repeat above procedures for remaining rocker shaft.

Rocker shafts - dismantling



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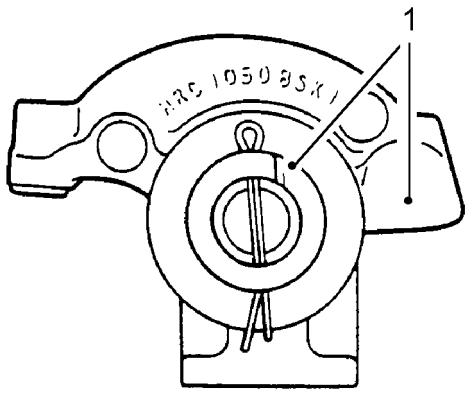
1. Remove and discard split pin from one end of rocker shaft.
2. Remove plain washer, wave washer, rocker arms, brackets and springs.

Inspecting components

1. Thoroughly clean components.
2. Inspect each component for wear, in particular rocker arms and shafts. Discard weak or broken springs.
3. Inspect push rod seats in rocker arms.
4. Check push rods for straightness and inspect ball ends for damage, replace as necessary.

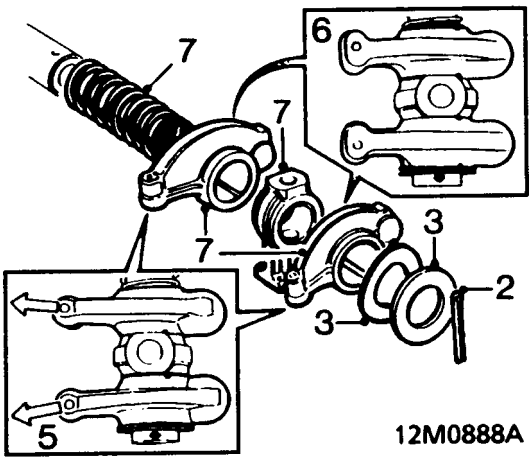
Rocker shafts - assembling



12M0887

1. Assemble rocker shafts with identification groove at one o'clock position with push rod end of rocker arm to the right.

CAUTION: If rocker shafts are incorrectly assembled and fitted to engine, oil supply to rocker arms will be restricted.



12M0888A

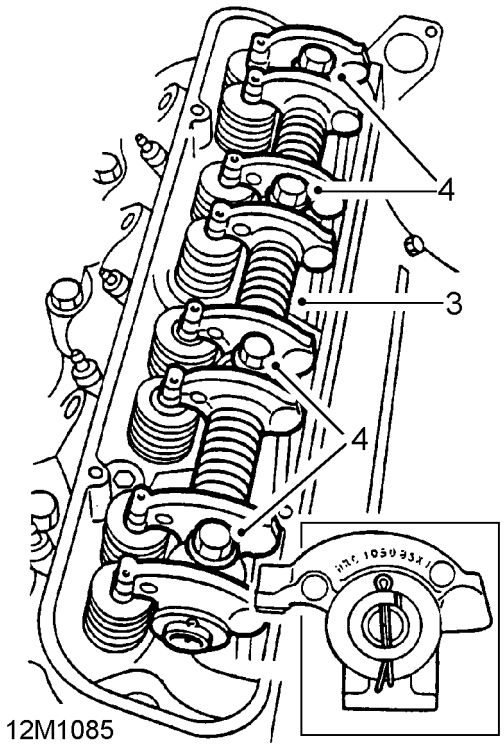
2. Fit new split pin to one end of rocker shaft.
3. Fit plain washer and wave washer.
4. Lubricate rocker arm bushes with clean engine oil.
5. Early type rocker arms are angled, and must be fitted with the valve end of the rocker arms angled away from each other as illustrated.
6. On later type rocker arms the valve end is offset and must be fitted as illustrated.

NOTE: Early and late rocker arms are interchangeable provided the complete set is changed.

7. Assemble rocker arms, brackets and springs to rocker shaft.
8. Compress springs, fit wave washer, plain washer and secure with new split pin.

Rocker shafts - refit

1. Lubricate push rods with engine oil.
2. Fit push rods in removed order.



3. Fit each rocker shaft assembly, ensuring identification groove is uppermost and towards front of engine on RH side and towards rear of engine on LH side.

CAUTION: Incorrect fitment will result in an oil feed restriction.

4. Fit bolts and tighten to 38 Nm (28 lbf.ft).
5. Clean gasket surface in rocker cover and on cylinder head, ensure bolt holes are clean and dry.
6. Fit new gasket, dry, to rocker cover.

CAUTION: Replace cork gasket(s) with modified gaskets which incorporate compression limiters in the bolt holes.

7. Fit rocker cover to cylinder head, fit new, 'patched' multi-hex bolts and tighten by diagonal selection to:
   Stage 1 - 3 Nm (2.5 lbf.ft)
   Stage 2 - 8 Nm (6 lbf.ft)

CAUTION: The 2 short screws/bolts must be fitted on side of cover nearest centre of engine. Ensure that outer rim of gasket is correctly positioned around periphery of rocker cover.

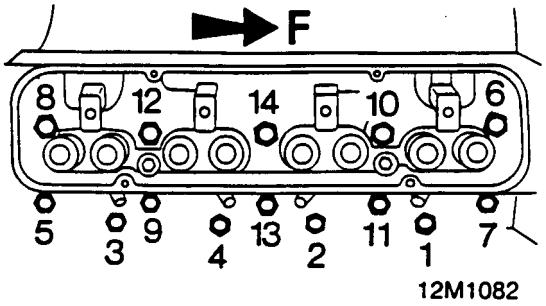
8. **LH rocker shaft only:** Align dipstick tube to rocker cover, fit and tighten screw.

CYLINDER HEAD

Cylinder head - remove

1. Remove rocker shaft assembly.
2. Mark heads LH and RH for reassembly.

Engine numbers without suffix B



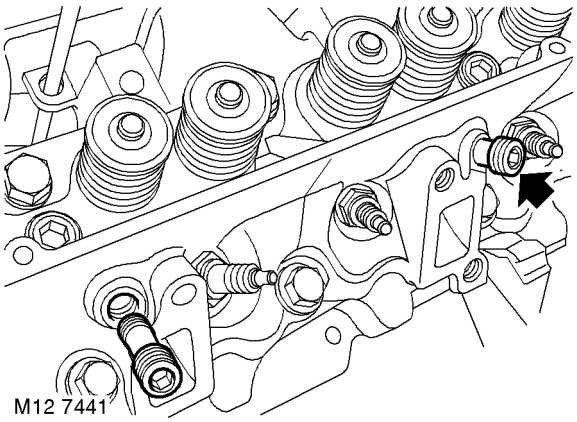
12M1082

NOTE: RH cylinder head illustrated

3. Using sequence shown, remove 14 bolts securing cylinder head to cylinder block.

Engine numbers with suffix B

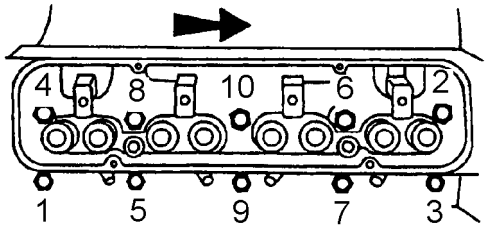
Engines fitted with secondary air injection (SAI)


M12 7441

4. Using a suitable hexagonal drive bit, remove and discard 2 secondary air injection adapters from cylinder head.

NOTE: To release the adapter thread locking agent and prevent damage to the cylinder head, remove the adapters by loosening then tightening slightly. Repeat this procedure until the adapters are removed.

CAUTION: Do not use an air tool to remove adapters.



12M1249A

NOTE: RH cylinder head illustrated

5. Using sequence shown, remove and discard 10 bolts securing cylinder head to cylinder block.

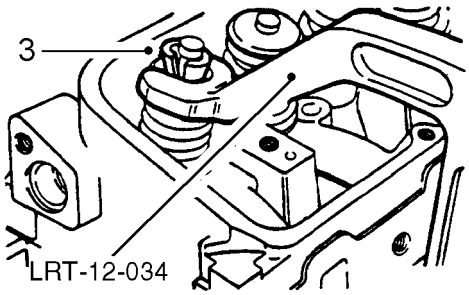
NOTE: No bolts are fitted in the four lower holes in each cylinder head.

All engines

6. Release cylinder head from 2 dowels and remove cylinder head.
7. Remove and discard cylinder head gasket.

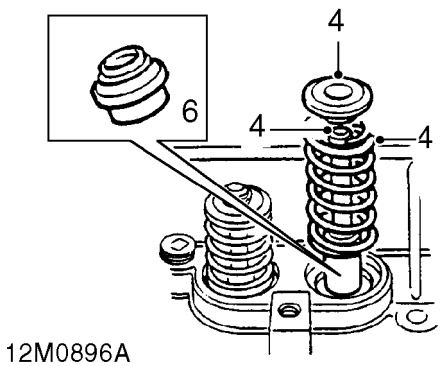
Valves and springs - remove

1. Remove spark plugs.



12M0895B

2. Using valve spring compressor **LRT-12-034** or a suitable alternative, compress valve spring.
3. Remove 2 collets.



12M0896A

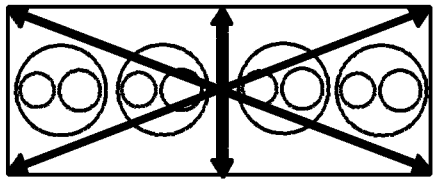
4. Release spring compressor and remove valve, valve spring cap and valve spring.
5. Repeat above operations for remaining valves.

CAUTION: Keep valves, springs, caps and collets in fitted order.

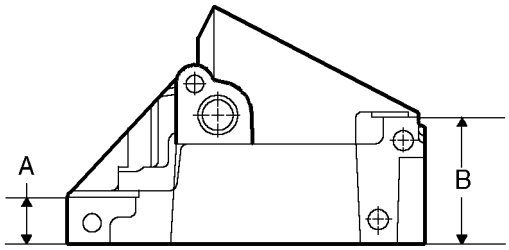
6. Remove and discard valve stem oil seals.

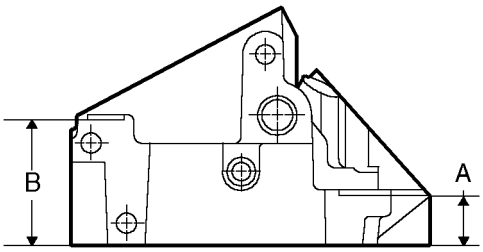
Cylinder head - inspection

1. Clean all traces of gasket material from cylinder head using a plastic scraper.
2. Check core plugs for signs of leakage and corrosion, replace as necessary. Apply sealant, Part number STC 50552 to threads of threaded core plugs.


12M2902A

3. Check gasket face of each cylinder head for warping, across centre and from corner to corner:
   Maximum warp = 0.05 mm (0.002 in)





12M4236

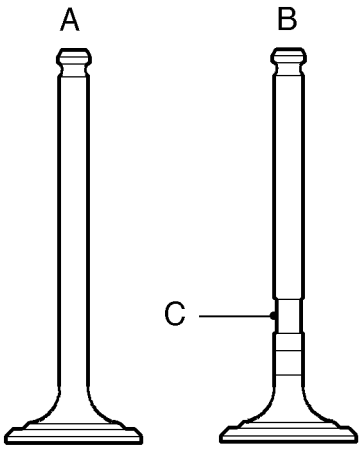
4. Check cylinder head height at each end of cylinder head:

Engine numbers without suffix B
A= 23.9 mm (0.94 in) - new
B= 63.5 mm (2.5 in) - new

Engine numbers with suffix B
A= 22.94 mm (0.903 in) - new
B= 62.56 mm (2.463 in) - new

5. Cylinder heads may be refaced:
Reface limit = 0.50 mm (0.02 in) from new dimension.

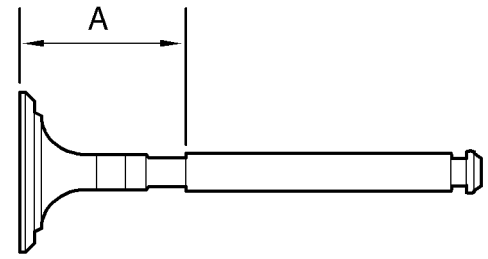
Valves, valve springs and guides - inspection



12M3676

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 exhaust valves sticking, standard exhaust valves should be replaced with carbon break valves during engine overhaul.

NOTE: Modified inlet valves, carbon break exhaust valves and valve guides are fitted to later engines. The modified exhaust valves may be identified by measuring the distance A from the valve head face to the top of the undercut on the valve stem. Additionally, the exhaust valves have a black nitrided finish whilst the inlet valves have a chrome finish.

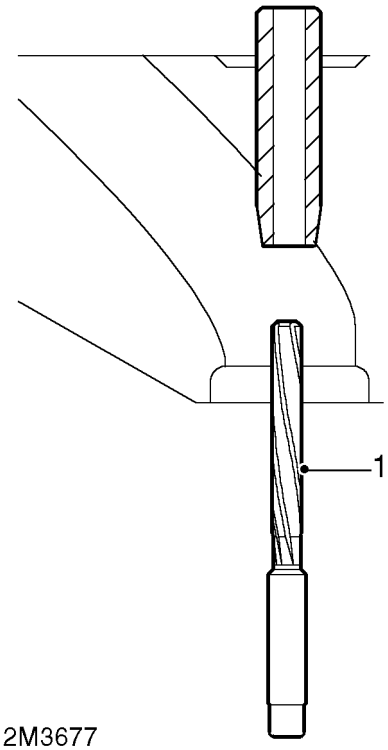


M12 7488

Early valves - dimension A = 29.5 to 30.5 mm (1.16 to 1.20 in)
Later valves - dimension
A = 32.5 to 33.5 mm (1.28 to 1.32 in)
The modified valves may be fitted to early engines in engine sets provided that the modified valve guides are also fitted.

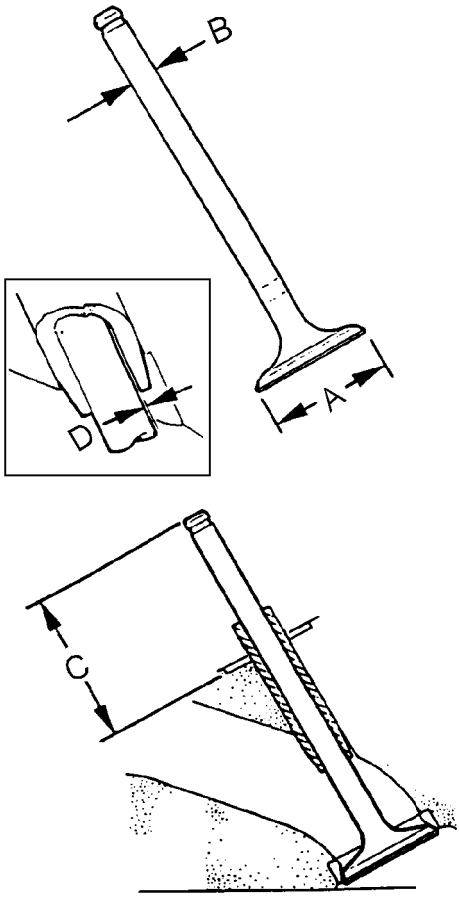
Valve guides

NOTE: The modified valve guides fitted to later engines are 5 mm (0.211 in) shorter than the early type guides, the overall length of the modified guide being 57 mm (2.24 in); the reduction in length being the distance the guide protrudes into the combustion chamber side of the cylinder head. The modified guides may be fitted to early engines, both with and without suffix B to the engine serial number in engine sets provided that the modified inlet and carbon break exhaust valves are also fitted.



12M3677

1. Remove carbon deposits from valve guides using an 8.70 mm (0.34 in) diameter reamer inserted from combustion face side of cylinder head.
2. Clean valve springs, cotters, caps and valves. Clean inlet valve guide bores. Ensure all loose particles of carbon are removed on completion.
3. Check existing valve stem to guide clearances, valve head diameters and fitted height of valves.



12M0897

4. Check valve head diameter **A:**
   Inlet = 39.75 to 40.00 mm (1.56 to 1.57 in)
   Exhaust = 34.226 to 34.48 mm (1.34 to 1.35 in)

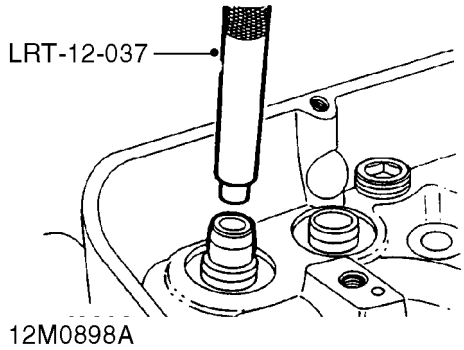
5. Check valve stem diameter **B:**
   Inlet = 8.660 to 8.680 mm (0.340 to 0.342 in)
   Exhaust:
   Standard and carbon break valves fitted to early engines = 8.651 to 8.666 mm (0.340 to 0.341 in)
   Modified carbon break valves fitted to later engines = 8.641 to 8.656 mm (0.336 to 0.340 in)
6. Check installed height of each valve **C**:
   Valve installed height **C:**
   Standard and carbon break valves fitted to early engines = 47.63 mm (1.9 in)
   Modified inlet and carbon break exhaust valves fitted to later engines = 44.163 to 45.29 mm (1.741 to 1.802 in)
7. Check valve stem to guide clearance **D** using the following procedures:
8. Insert each valve into its respective guide.
9. Extend valve head approximately 13 mm (0.6 in) out of valve seat and position a suitable dial test indicator to rear of valve head.
10. Move valve towards front of cylinder head and zero dial test indicator gauge ensuring that stylus of gauge remains in contact with valve head.
11. Move valve towards rear of cylinder head and record gauge reading to give valve stem to guide clearance:
    Inlet valves - Early and later engines = 0.025 to 0.066 mm (0.001 to 0.002 in)
    Exhaust valves:
    Standard and carbon break exhaust valves fitted to early engines = 0.038 to 0.078 mm (0.0015 to 0.003 in)
    Modified carbon break exhaust valves fitted to later engines = 0.048 to 0.088 mm (0.0019 to 0.0035 in)
12. Repeat above procedures for each valve in turn.
13. Renew valves, guides and valve seat inserts as necessary.

CAUTION: If modified valves and guides are to be fitted, they must be replaced in engine sets.

14. Check condition of valve springs:
    Free length = 48.30 mm (1.90 in)
    Fitted length = 40.40 mm (1.60 in)
    Load at fitted length = 339 ± 10 N (76 ± 2 lbf)
    Load at valve open length = 736 ± 22 N (165 ± 2 lbf)

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

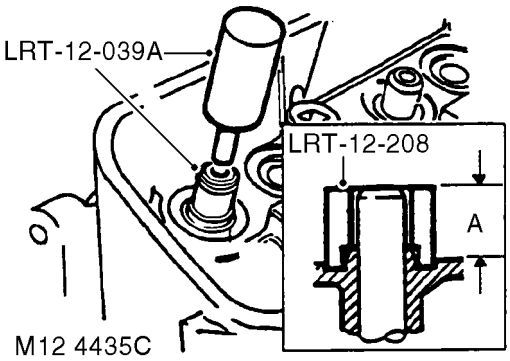
Valve guides - renew



1. Using valve guide remover, **LRT-12-037** press valve guide out into combustion face side of cylinder head.

NOTE: Service valve guides are 0.025mm (0.001 in) oversize on outside diameter to ensure interference fit.

2. Lubricate new valve guide with engine oil and with tapered portion of guide leading, place in position on valve spring side of cylinder head.



3. Using **LRT-12-039A** partially press guide into cylinder head, remove tool.
4. Fit **LRT-12-208** over valve guide and continue to press guide into cylinder head until tool **LRT-12-039A** contacts tool **LRT-12-208** . Remove tool.
5. Check valve guide installed height **A** = 15.0 mm (0.590 in)
6. Using piloted reamers, ream valve guides from valve spring side of head in 2 stages, with the final cut being 0.1 mm (0.004 in) to give a finished internal diameter of 8.70 mm (0.34 in) diameter.
7. Remove all traces of swarf on completion.

Valve seat inserts - inspection

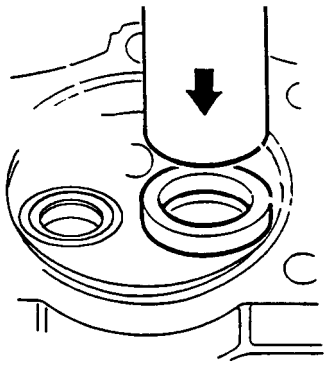
1. Check valve seat inserts for pitting, burning and wear. Replace inserts as necessary.

Valve seat inserts - renew

NOTE: Service valve seat inserts are available 0.025 mm (0.001 in) oversize on outside diameter to ensure interference fit.

1. Remove worn valve seats.

CAUTION: Take care not to damage counterbore in cylinder head.



12M3642

2. Heat cylinder head evenly to approximately 120°C (250° F).

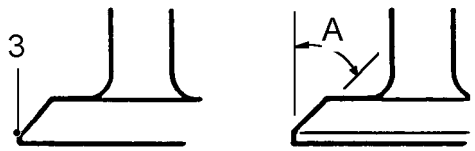
WARNING: Handle hot cylinder head with care.

3. Using a suitable mandrel, press new insert fully into counterbore.
4. Allow cylinder head to air cool.

Valve seats and seat inserts - refacing

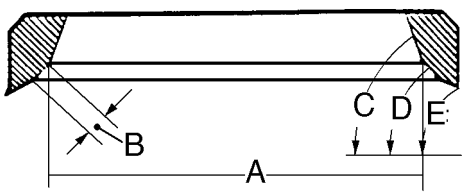
CAUTION: Renew worn valve guides and seat inserts before refacing valve seats.

1. Check condition of valve seats and valves that are to be re-used.
2. Remove carbon from valve seats.



12M0901

3. Reface valves as necessary. If a valve has to be ground to a knife-edge to obtain a true seat, replace valve.
   Valve seating face angle **A** = 45°



M128061

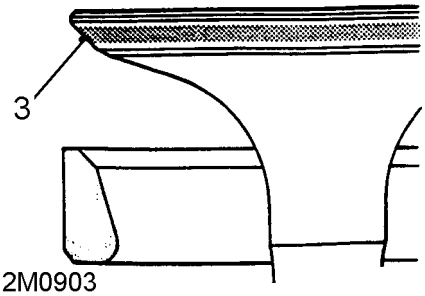
4. Using suitable piloted cutters cut valve seats to the following dimensions:
   Valve seat:
   Width **A**:
   Inlet = 36.83 mm (1.45 in)
   Exhaust = 31.50 mm (1.24 in)

   Seating width **B**:
   Inlet = 0.89 to 1.4 mm (0.035 to 0.055 in)
   Exhaust = 1.32 to 1.83 mm (0.052 to 0.072 in)

   Angle **C** = 56° to 70°
   Angle D:
   Up to'99 Model Year = 46° to 46° 25'
   '99 Model year onwards = 46° to 46° 30'
   Angle **E = 20°**

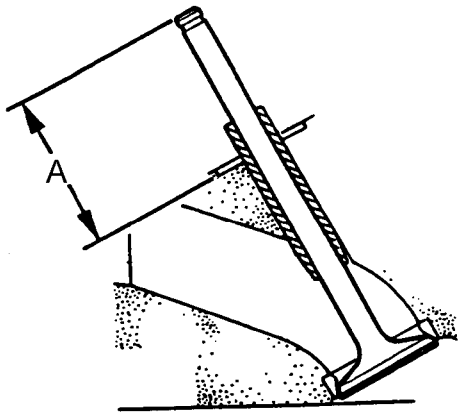
Valves - lapping-in

1. Lap each valve to its seat using fine grinding paste.
2. Clean valve and seat.



12M0903

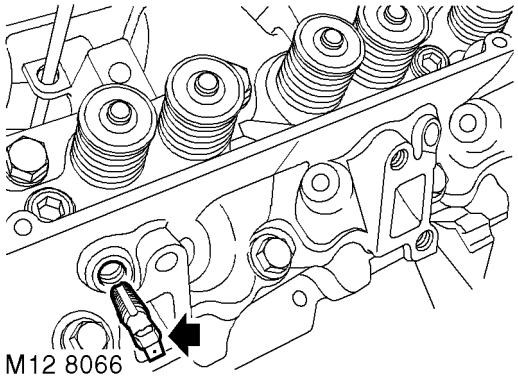
3. Coat valve seat with a small quantity of engineer's blue, insert valve and press it into position several times without rotating. Remove valve and check for even and central seating. Seating position shown by engineer's blue should be in centre of valve face.



12M0904

4. Check valve installed height **A** if valve seats have been recut or new valves or valve seat inserts have been fitted.
   Valve installed height **A:**
   Standard and carbon break exhaust valves - Inlet and exhaust - Early engines = 47.63 mm (1.9 in) - maximum
   Modified valves - Inlet and exhaust - Later engines = 44.16 to 45.29 mm (1.741 to 1.802 in) - maximum
5. Thoroughly clean cylinder head, blow out oilways and coolant passages.

Engines fitted with secondary air injection (SAI)



1. Using a 5/8 in x 20 TPI (threads per inch) UNF tap having a class 2A thread, remove deposits from secondary air injection adapter tappings in cylinder head.

CAUTION: Ensure that tap used has 20 TPI.

Valves and springs - refit

1. Fit new valve stem oil seals, lubricate valve stems, fit valves, valve springs and caps, compress valve springs using **LRT-12-034** and fit collets.
2. Using a wooden dowel and mallet, lightly tap each valve stem two or three times to seat valve cap and collets.
3. Fit spark plugs and tighten to 20 Nm (15 lbf.ft)

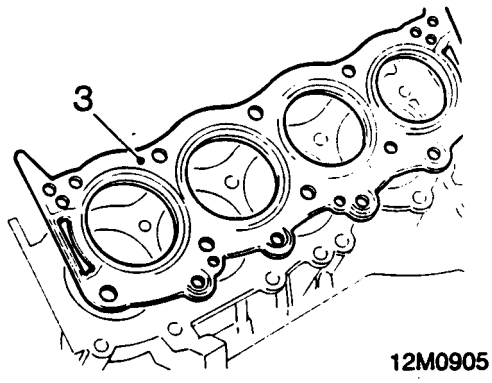
Cylinder head - refit

1. Clean cylinder block faces using a suitable gasket removal spray and plastic scraper; ensure that bolt holes in cylinder block are clean and dry.

CAUTION: Do not use metal scraper or machined surfaces may be damaged.

2. *Engine numbers without suffix B:* Thoroughly clean threads of cylinder head bolts.

CAUTION: Cylinder head bolts fitted to engines without suffix B added to serial number are not interchangeable with those fitted to engines with suffix B added to serial number.



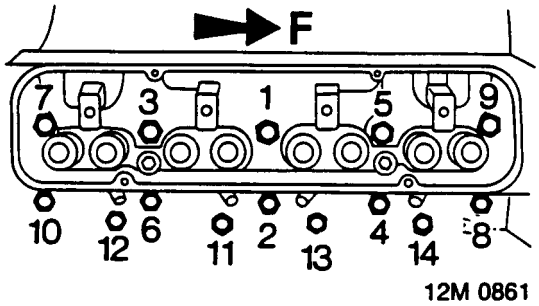
3. Fit cylinder head gasket with the word 'TOP' uppermost.

NOTE: Gasket must be fitted dry.

CAUTION: Engines without suffix B have a steel gasket whilst engines with suffix B have a composite gasket. The two types of gasket are not interchangeable and it is essential to ensure that the correct type of gasket is fitted.

4. Carefully fit cylinder head and locate on dowels.

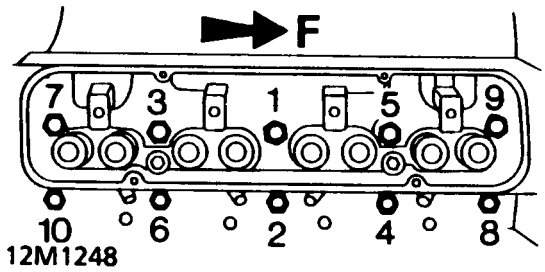
Engine numbers without suffix B



NOTE: RH cylinder head illustrated

5. Lightly oil threads of cylinder head bolts.
6. Fit cylinder head bolts:
   Long bolts: 1, 3 and 5.
   Medium bolts: 2, 4, 6, 7, 8, 9, and 10.
   Short bolts: 11, 12, 13 and 14.
7. Using sequence shown, progressively tighten cylinder head bolts to:
   Bolts 11 to 14 - Outer row - 60 Nm (44 lbf.ft)
   Bolts 2, 4, 6, 8 and 10 - Centre row - 90 Nm (66 lbf.ft)
   Bolts 1, 3, 5, 7 and 9 - Inner row - 90 Nm (66 lbf.ft)

Engine numbers with suffix B



NOTE: RH cylinder head illustrated

8. Lightly oil threads of NEW cylinder head bolts.
9. Fit cylinder head bolts:
   Long bolts: 1, 3 and 5
   Short bolts: 2, 4, 6, 7, 8, 9 and 10

NOTE: There are no bolts fitted in the four lower holes in each cylinder head.

10. Using sequence shown, tighten cylinder head bolts to:
    Stage 1 - 20 Nm (15 lbf.ft)
    Stage 2 - 90°
    Stage 3 - Further 90°

CAUTION: Do not tighten bolts 180° in one operation.

Engines fitted with secondary air injection (SAI)

11. Fit new secondary air injection adapters and using a suitable hexagonal drive bit, tighten to 33 Nm (24 lbf.ft).

CAUTION: Do not use air tools to tighten adapters.

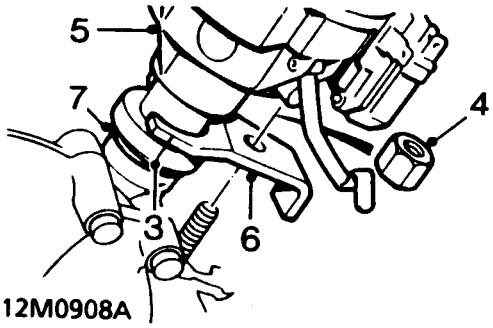
All engines

12. Fit rocker shaft assembly.

TIMING CHAIN AND GEARS

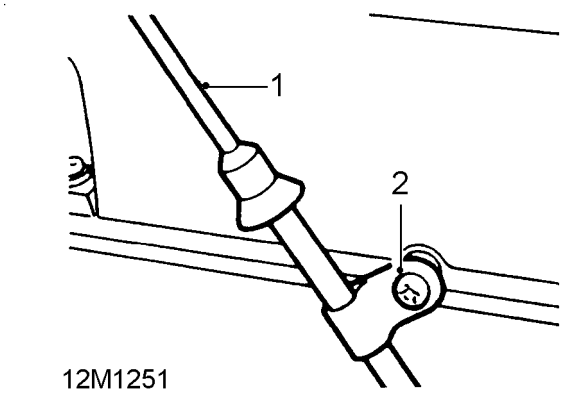
Distributor - if fitted - remove

1. Remove distributor cap.
2. Rotate crankshaft until centre line of rotor arm is aligned with No. 1 spark plug segment in distributor cap and No. 1 piston is at TDC.



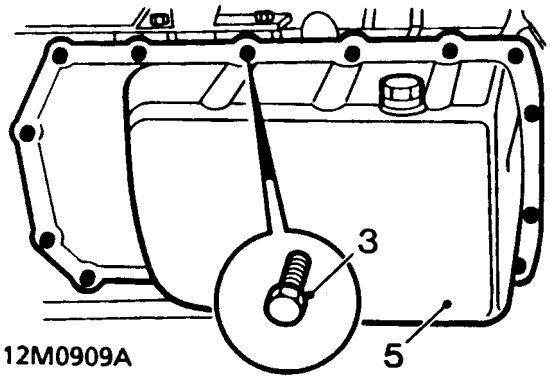
3. Scribe an alignment mark between distributor body and clamp.
4. Remove nut securing distributor clamp.
5. Remove distributor.
6. Remove clamp.
7. Remove and discard 'O' ring from distributor.

Sump - remove



12M1251

1. Remove dipstick.
2. Remove screw securing dipstick tube to LH rocker cover.



12M0909A

NOTE: Sump fitted to engines without suffix B engine numbers illustrated.

3. Remove 16 bolts securing sump to cylinder block.

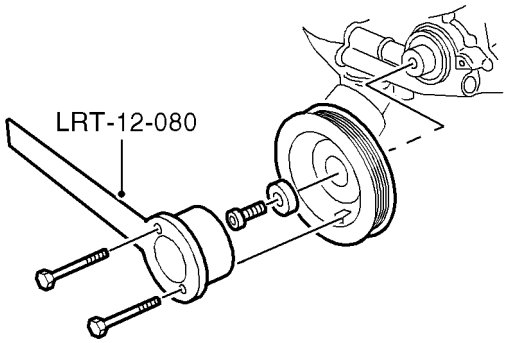
NOTE: Engine numbers with suffix B, 17 bolts are used to secure sump to cylinder block.

4. Carefully release sump from cylinder block.

CAUTION: Take care not to damage sealing faces of cylinder block and sump.

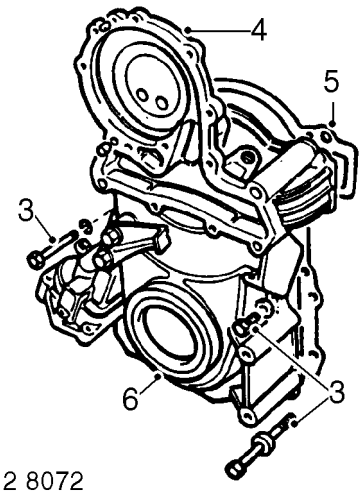
5. Remove sump.

Timing cover - remove - Engine numbers without suffix B



M12 4445A

1. Secure tool **LRT-12-080** to crankshaft pulley with 2 bolts.
2. Restrain crankshaft pulley using **LRT-12-080** remove crankshaft pulley bolt and collect spacer washer, remove crankshaft pulley.

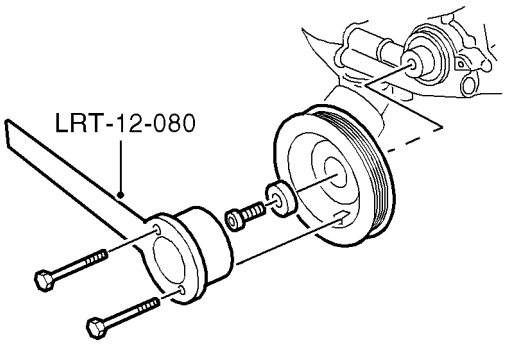


M12 8072

3. Remove bolts and nut securing timing cover to cylinder block.
4. Release and remove timing cover.
5. Remove and discard gasket.
6. Remove and discard oil seal from timing cover.

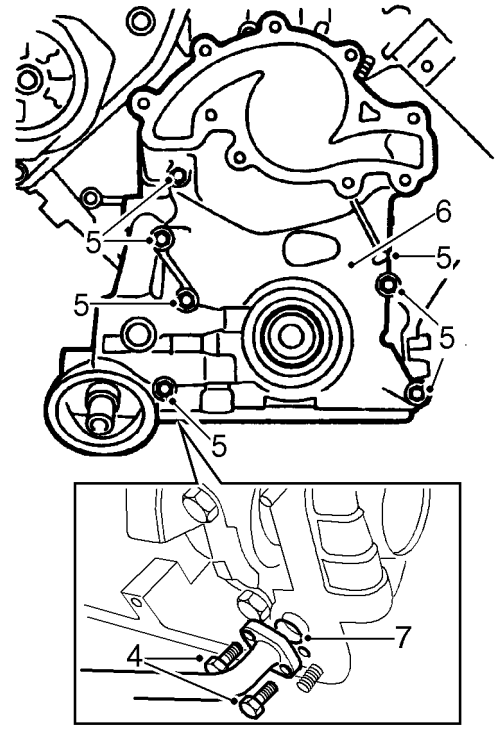
Timing cover - remove - Engine numbers with suffix B

NOTE: Timing cover, oil pump, oil pressure by-pass valve and oil pressure relief valve are only supplied as an assembly.



M12 4445A

1. Secure tool **LRT-12-080** to crankshaft pulley with 2 bolts.
2. Restrain crankshaft pulley using **LRT-121-080** remove crankshaft pulley bolt and collect spacer washer; remove crankshaft pulley.
3. Remove sump.



M12 8073

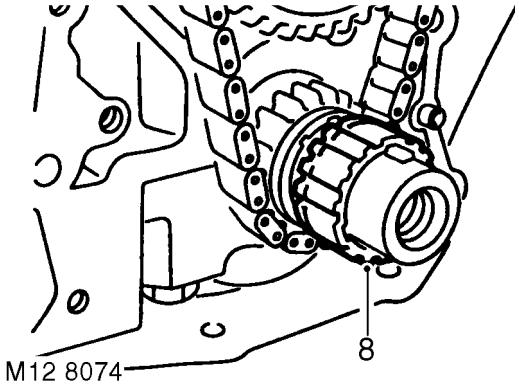
4. Remove 2 bolts securing oil pick-up pipe to timing cover.
5. Noting their fitted position, progressively slacken then remove bolts securing timing cover to cylinder block.

CAUTION: Do not attempt to remove oil pump drive gear at this stage.

6. Release timing cover from oil pick-up pipe, remove cover.

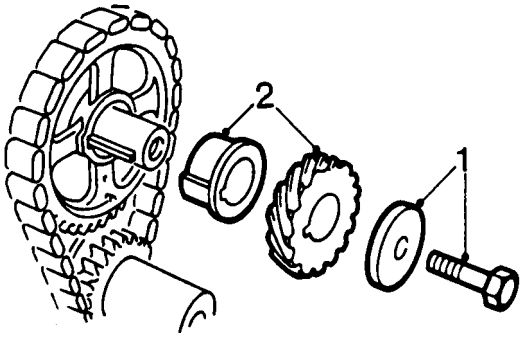
NOTE: Dowel located.

7. Remove and discard 'O' ring from oil pick-up pipe.

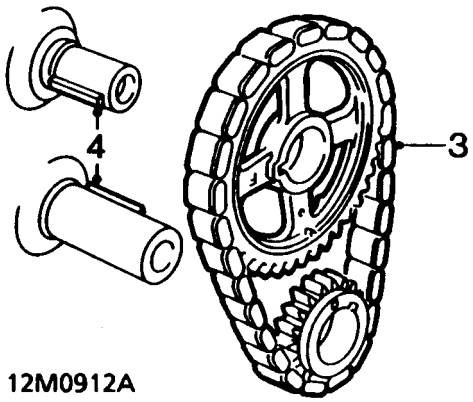


8. Remove oil pump drive gear.
9. Remove and discard gasket.
10. Remove and discard oil seal from timing cover.

Timing gears - remove



1. Restrain camshaft gear and remove bolt securing gear, collect washer.
2. Remove distributor drive gear - if fitted and spacer.



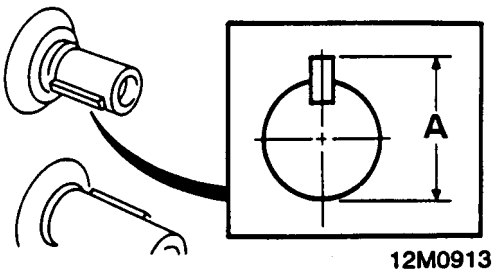
3. Remove timing chain and gears as an assembly.
4. Collect Woodruff keys from camshaft and crankshaft.

Timing chain and gears - inspection

1. Thoroughly clean all components.
2. Inspect distributor drive gear - if fitted for wear.
3. Inspect timing chain links and pins for wear.
4. Inspect timing chain gears for wear. Renew parts as necessary.

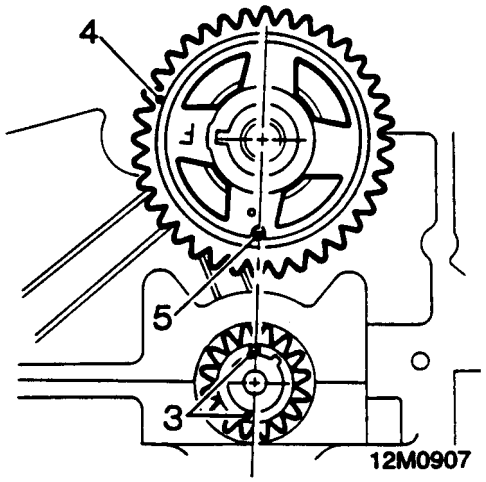
Timing gears - refit

1. Clean gear locations on camshaft and crankshaft, fit Woodruff keys.

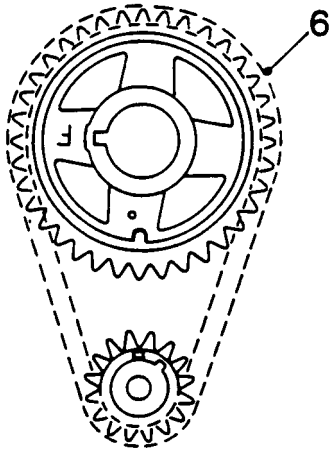


2. Check camshaft Woodruff key is fully engaged in keyway.

CAUTION: Space between Woodruff key and keyway acts as an oil feed. It is therefore most important that key is properly seated and parallel to axis of camshaft. Overall dimension 'A' must not exceed 30.15 mm (1.2 in).



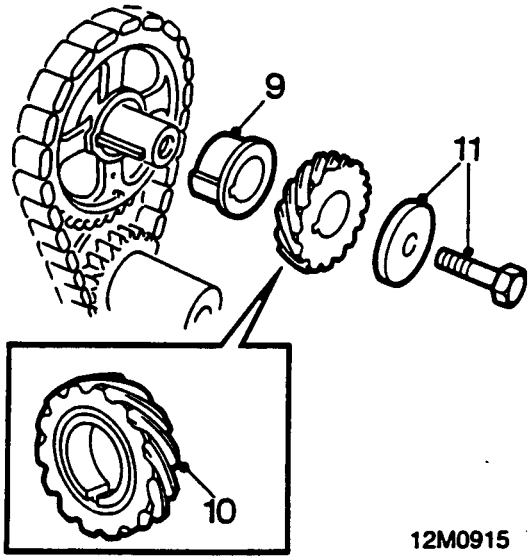
3. Temporarily fit crankshaft gear, and if necessary turn crankshaft to bring timing mark on gear to the twelve o'clock position, remove gear.
4. Temporarily fit camshaft gear with marking 'F' facing forwards.
5. Turn camshaft until mark on camshaft gear is at the six o'clock position, remove gear without moving camshaft.



12M0914

6. Position timing gears on work surface with timing marks upwards and aligned.
7. Fit timing chain around gears, keeping timing marks aligned.
8. Fit gear and chain assembly.

NOTE: Timing marks and 'F' mark on camshaft gear must be facing forwards.



12M0915

9. Fit spacer to camshaft with flange facing forwards.
10. Fit distributor drive gear - if fitted to camshaft with grooved face towards camshaft gear.
11. Fit camshaft gear bolt and washer, restrain camshaft gear and tighten bolt to 50 Nm (37 lbf.ft).

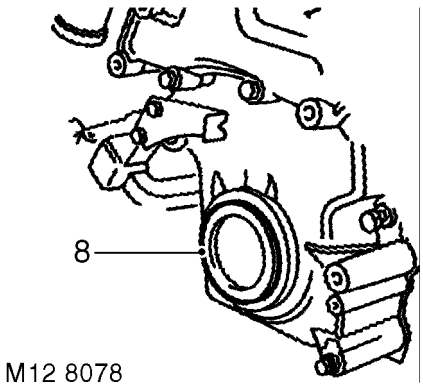
Timing cover - refit - Engine numbers without suffix B

1. Clean sealant from threads of cover bolts.
2. Clean all traces of old gasket material from timing cover and mating face of cylinder block, ensure that bolt holes are clean and dry.

CAUTION: Use a plastic scraper.

3. Use a lint free cloth and thoroughly clean oil seal location in timing cover.
4. Position new gasket, fitted dry, to cylinder block.
5. Coat threads of timing cover bolts with sealant, Part number STC 50552.
6. Fit timing cover, fit bolts and nut and tighten progressively, by diagonal selection to 22 Nm (16 lbf.ft).
7. **Unwaxed oil seal only:** Lubricate new oil seal sealing surfaces with engine oil.

CAUTION: If replacement oil seal has a waxed coating, it must be fitted dry DO NOT lubricate oil seal or recess in timing cover.



M12 8078

8. Locate seal to timing cover and press seal in squarely until flush with front face of timing cover.
9. Fit crankshaft pulley.
10. Fit spacer washer to pulley bolt.
11. Fit bolt and using tool **LRT-12-080** restrain crankshaft pulley and tighten bolt to 270 Nm (200 lbf.ft).
12. Remove tool **LRT-12-080**.

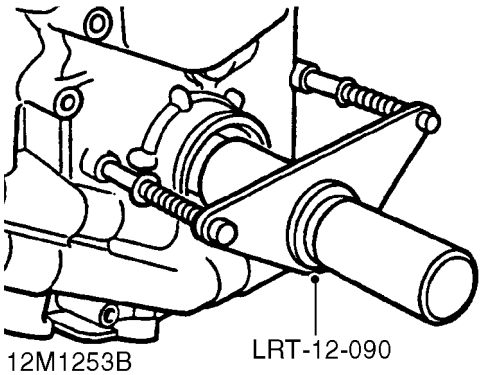
Timing cover - refit - Engine numbers with suffix B

NOTE: Timing cover, oil pump, oil pressure by-pass valve and oil pressure relief valve are only supplied as an assembly.

1. Clean sealant from threads of timing cover bolts.
2. Clean all traces of gasket material from mating faces of timing cover and cylinder block, ensure that bolt holes are clean and dry.

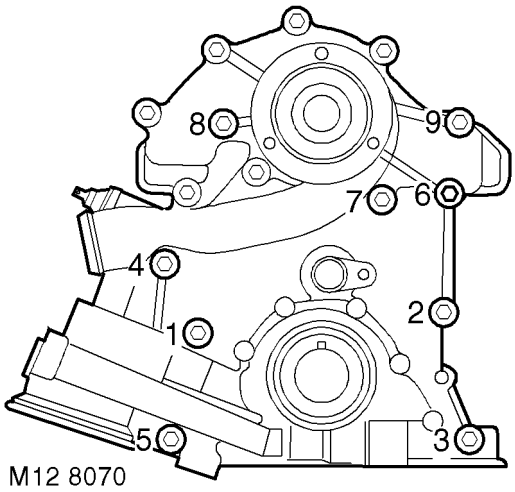
CAUTION: Use a plastic scraper.

3. Clean oil seal location in timing cover.
4. Position a new gasket, fitted dry, to timing cover locating dowels.
5. Position oil pump drive gear in timing cover with groove towards front of timing cover.
6. Lubricate a new 'O' ring with engine oil and fit to oil pick-up pipe.



12M1253B

7. Locate tool **LRT-12-090** on timing cover and oil pump drive gear.
8. Position timing cover to cylinder block and oil pick-up pipe and at the same time, rotate tool **LRT-12-090** until drive gear keyway is aligned with Woodruff key.
9. Fit timing cover.
10. Smear threads of timing cover bolts with sealant, Part number STC 50552.

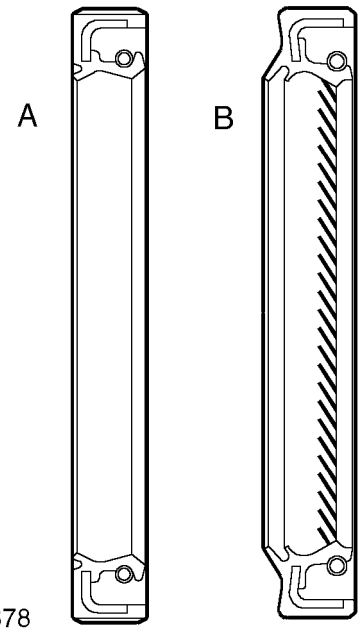


M12 8070

11. Fit timing cover bolts and using sequence shown,tighten to 22 Nm (16 lbf.ft).

CAUTION: Ensure CMP sensor multiplug bracket - if fitted is secured by bolt. Do not fit coolant pump bolts at this stage.

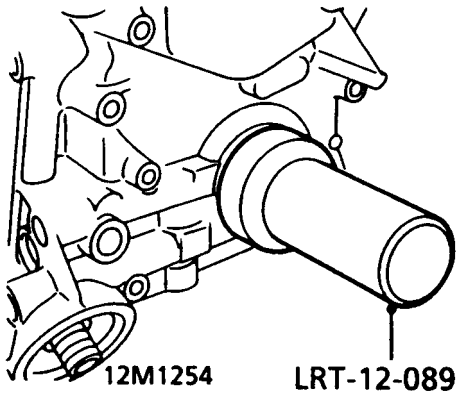
12. Remove tool **LRT-12-090.**
13. Fit oil pick-up pipe bolts and tighten to 10 Nm (8 lbf.ft).



12M3678

A- Early type seal
B- Later type seal - use as replacement for all engines

CAUTION: Replacement oil seal is pre-greased, DO NOT use any additional lubricant.

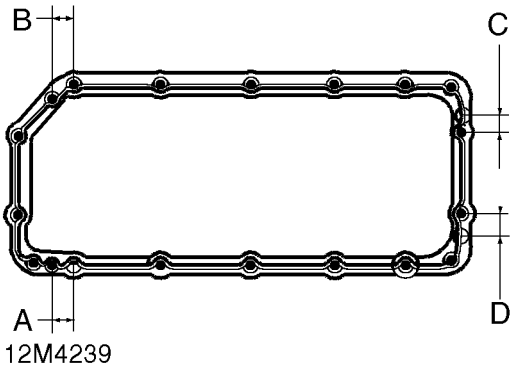


14. Fit timing cover oil seal using tool **LRT-12-089.**
15. Fit sump.
16. Fit crankshaft pulley, fit bolt and spacer washer.
17. Using tool **LRT-12-080** to restrain crankshaft, tighten bolt to 270 Nm (200 lbf.ft).
18. Remove tool **LRT-12-080**.

Sump - refit

1. Remove all traces of old sealant from mating faces of cylinder block and sump; ensure bolt holes are clean and dry.

CAUTION: Use a plastic scraper.



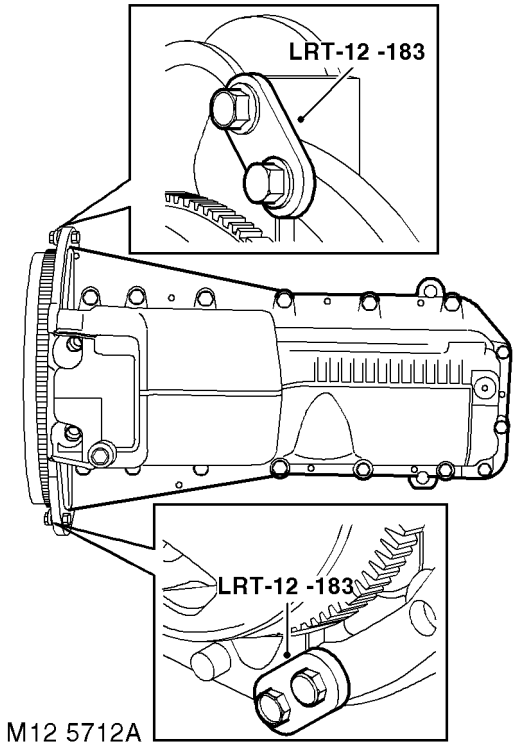
12M4239

NOTE: Sump fitted to engines with suffix B engine numbers illustrated.

2. Clean mating faces with suitable solvent. Apply a bead of sealant, Part number STC 50550 to sump joint face as shown:
   Bead width - areas A, B, C and D = 12 mm (0.5 in)
   Bead width - remaining areas = 5 mm (0.20 in)
   Bead length - areas A and B = 32 mm (1.23 in)
   Bead length - areas C and D = 19 mm (0.75 in)

CAUTION: Do not spread sealant bead. Sump must be fitted immediately after applying sealant.

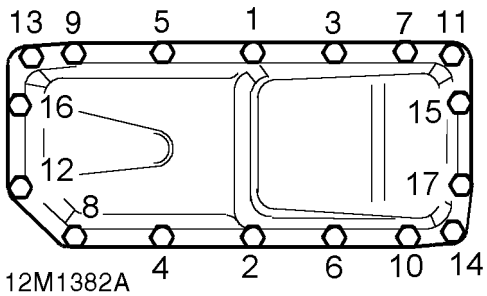
3. Fit sump, taking care not to damage sealant bead.



M12 5712A

4. Noting that the two parts of the tool are 'handed', fit tool **LRT-12-183** to the engine backplate using slave bolts.
5. Secure the tool to the sump using the bolts which are part of the tool.

NOTE: The holes in the tool are larger than the diameter of the bolts in order to allow the sump to move as the sump bolts are tightened.



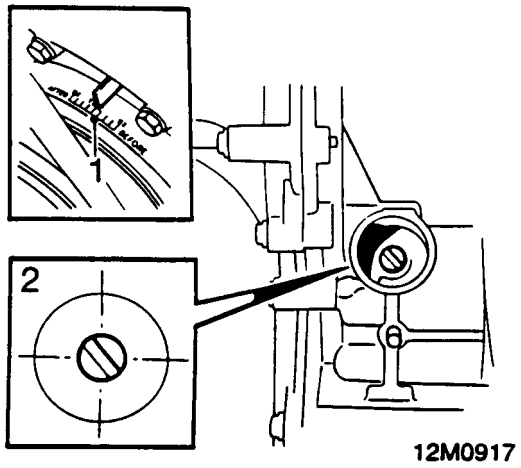
12M1382A

6. Fit sump bolts and using sequence shown, tighten progressively to 23 Nm (17 lbf.ft).

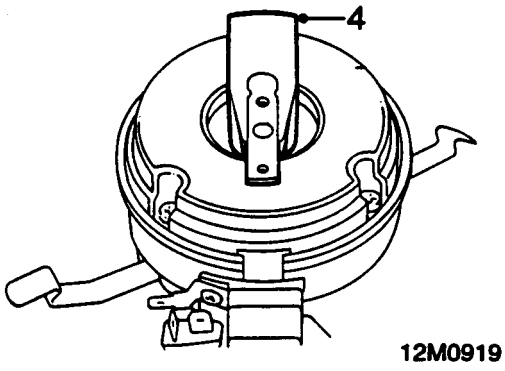
NOTE: Engine numbers without suffix B - use sequence numbers 1 to 8 and 10 to 16.

7. Remove tool **LRT-12-183**.
8. Fit and tighten screw securing dipstick tube to LH rocker cover.
9. Fit dipstick.

Distributor - if fitted - refit

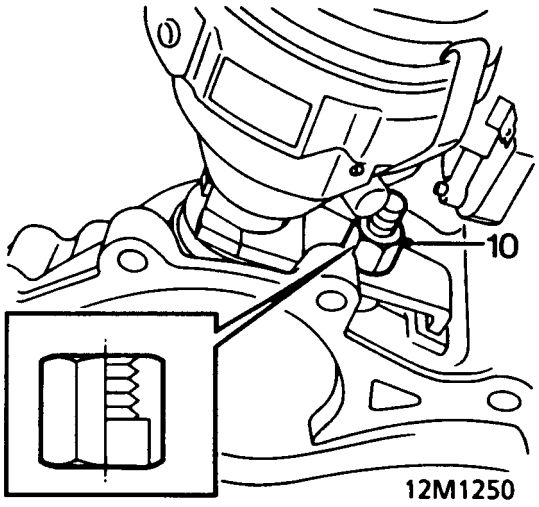


1. Ensure timing pointer is aligned with 3° mark on crankshaft pulley and No.1 piston is on the compression stroke.
2. *Engine numbers without suffix B:* Position oil pump drive shaft tongue at the ten to four position.
3. Lubricate a new 'O' ring with engine oil and fit to distributor.



4. Turn distributor drive until rotor arm is approximately 30° anti-clockwise from No.1 spark plug segment in distributor cap.
5. Insert distributor into timing cover, engage drive gear and push distributor down until 'O' ring enters bore; position distributor clamp on stud.

6. *Engine numbers without suffix B:* Locate slotted adapter to oil pump drive shaft tongue.
7. Check that centre line of rotor arm is aligned with No.1 spark plug segment in distributor cap and reference marks on distributor body and clamp are aligned; reposition distributor if necessary.
8. Remove rotor arm.
9. Rotate distributor to position pick-up opposite nearest reluctor tooth.



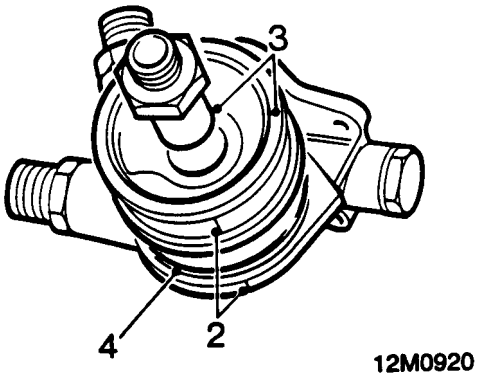
10. Fit distributor clamp nut ensuring that counterbored portion is towards clamp; tighten nut to 20 Nm (15 lbf.ft).
11. Fit rotor arm.

CAUTION: This distributor setting is to enable engine to be started. When engine is refitted, ignition timing must be set using electronic equipment.

OIL COOLER ADAPTER - ENGINE NUMBERS WITHOUT SUFFIX B

Oil cooler adapter - remove

1. Remove oil filter element.



2. Mark position of adapter in relation to oil pump cover.
3. Remove centre screw and withdraw adapter.
4. Remove and discard sealing ring.

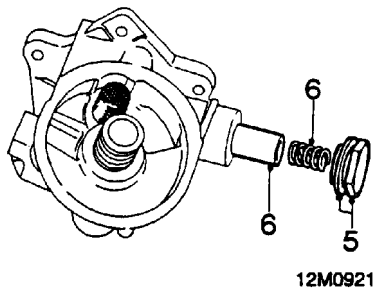
Oil cooler adapter - refit

1. Thoroughly clean adapter.
2. Lubricate a new sealing ring with engine oil, fit adapter, ensuring marks previously made line up, fit and tighten centre screw.
3. Lubricate sealing ring of oil filter with engine oil.
4. Screw filter on to filter head until it seats then tighten a further half-turn.

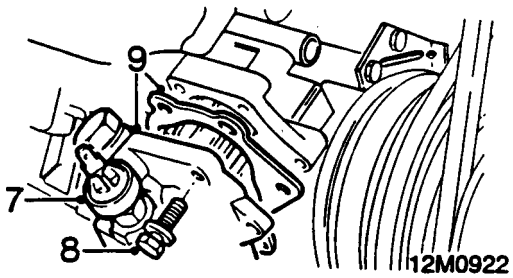
OIL PUMP - ENGINE NUMBERS WITHOUT SUFFIX B

Oil pump - remove

1. Remove sump.
2. Remove distributor.
3. Remove timing cover.
4. Remove oil cooler adapter - if fitted.



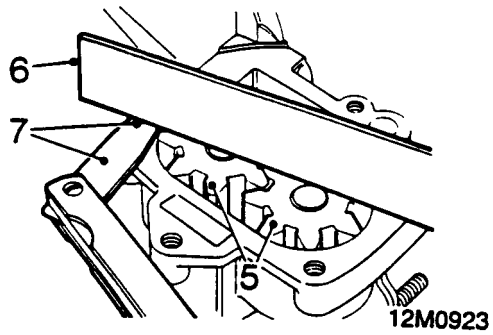
5. Remove oil pressure relief valve plug, discard sealing washer.
6. Withdraw pressure relief valve spring and valve.



7. Remove oil pressure switch, discard sealing washer.
8. Remove bolts securing oil pump cover.
9. Remove cover, remove and discard gasket.
10. Withdraw oil pump gears.

Oil pump - inspection

1. Throughly clean oil pump gear housing, cover and gears.
2. Clean oil pressure relief valve bore in housing.
3. Clean relief valve filter screen.
4. Inspect pump gears for wear and scoring.



5. Fit pump gears into housing.
6. Place straight edge across gears.
7. Check clearance between straight edge and cover face.
   Gear to cover face minimum clearance = 0.05 mm (0.002 in).
   If clearance is below minimum specified check gear recess in housing for wear. Renew housing if necessary.
8. Remove oil pump gears from housing.
9. Clean oil pressure relief valve and spring.
10. Inspect relief valve for wear and scoring.
11. Inspect relief valve spring for wear or signs of collapse.
    Relief spring free length = 81.28 mm (3.2 in)
12. Check relief valve slides freely in its bore with no perceptible side movement.

Oil pump - refit

1. Lubricate relief valve, spring, and bore in housing with clean engine oil.
2. Fit relief valve and valve spring.
3. Fit new sealing washer to plug, fit plug and tighten to 45 Nm (33 lbf.ft).
4. Pack oil pump housing with Petroleum Jelly.

CAUTION: Use only Petroleum Jelly, no other grease is suitable.

5. Fit oil pump gears ensuring that Petroleum Jelly is forced into every cavity between teeth of gears.

CAUTION: Unless pump is fully packed with Petroleum Jelly it may not prime itself when the engine is started.

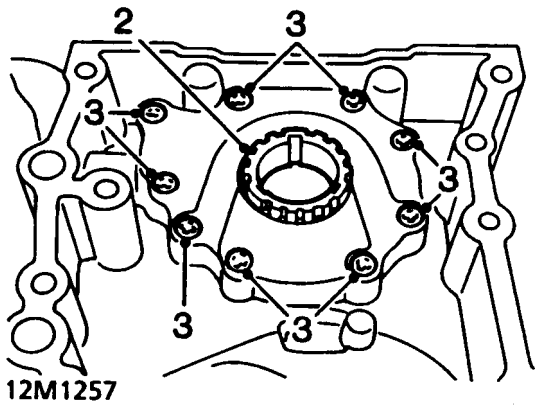
6. Fit new pump cover gasket, dry.
7. Position cover, fit bolts and tighten progressively to 12 Nm (9 lbf.ft).
8. Fit oil cooler adapter.
9. Fit timing cover.
10. Fit distributor.
11. Fit sump.

OIL PUMP - ENGINE NUMBERS WITH SUFFIX B

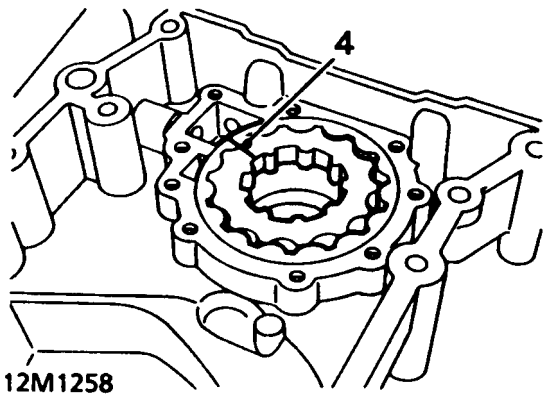
CAUTION: Overhaul procedures for the oil pump, oil pressure by-pass valve and oil pressure relief valve are limited to carrying out dimensional checks. In the event of wear or damage being found, a replacement timing cover assembly must be fitted.

Oil pump - remove

1. Remove timing cover.

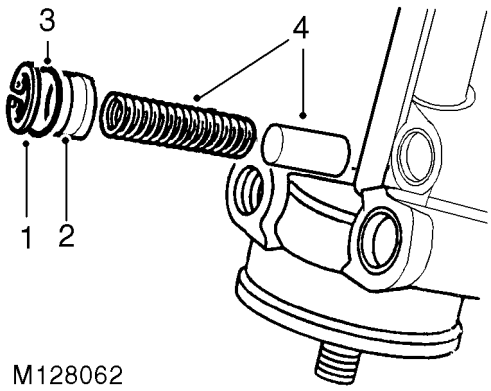


2. Remove oil pump drive gear.
3. Remove screws and bolt - if fitted securing cover plate, remove plate.



4. Make suitable alignment marks on inner and outer rotors, remove rotors.

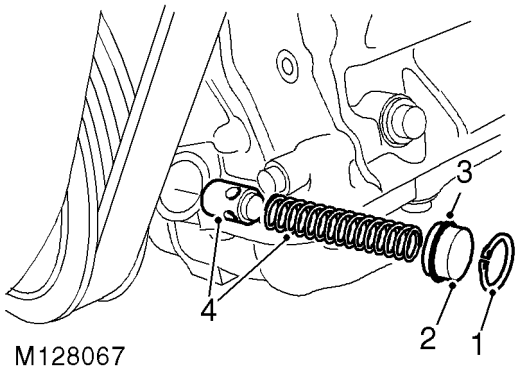
Oil pressure by-pass valve - remove



1. Remove circlip.
2. Remove by-pass valve plug.
3. Remove and discard 'O' ring from plug.
4. Remove by-pass valve spring and plunger.
5. Check plunger and bore of by-pass valve in oil pump body for scoring and corrosion.

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

Oil pressure relief valve - remove



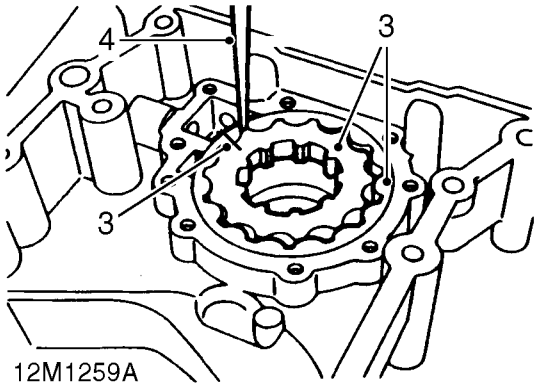
M128067

1. Remove circlip.
2. Remove relief valve plug.
3. Remove and discard 'O' ring from plug.
4. Remove relief valve spring and piston.
5. Check piston and bore of relief valve in oil pump body for scoring and corrosion.

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

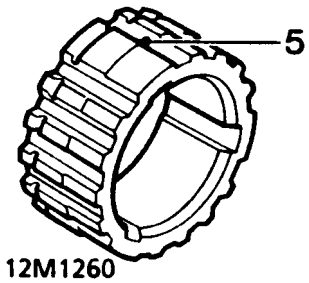
Oil pump - inspection

1. Thoroughly clean oil pump drive gear, cover plate, rotors and housing. Remove all traces of sealant from cover plate securing screws and bolt - if fitted; ensure tapped holes in timing cover are clean and dry.
2. Check mating surfaces of cover plate, rotors and housing for scoring.



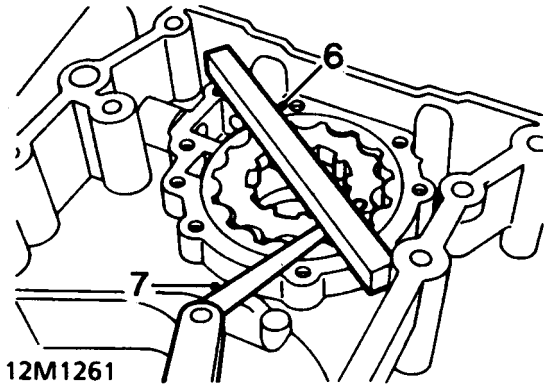
12M1259A

3. Assemble rotors and oil pump drive gear in housing ensuring that reference marks are aligned.
4. Using feeler gauges, check clearance between teeth of inner and outer rotors:
   Maximum clearance = 0.25 mm (0.01 in)



12M1260

5. Remove oil pump drive gear, check depth of any wear steps on gear teeth:
   Wear step maximum depth = 0.15 mm (0.006 in)



6. Place a straight edge across housing.
7. Using feeler gauges, check clearance between straight edge and rotors:
   Maximum clearance = 0.1 mm (0.004 in)

Oil pressure by-pass valve - inspection

1. Clean by-pass valve components and plunger bore in timing cover.
2. Check plunger and bore for scoring and that plunger slides freely in bore with no perceptible side movement.
3. Check by-pass valve spring for damage and distortion; check spring free length:
   Spring free length = 60.0 mm (2.4 in).

Oil pressure relief valve - inspection

1. Clean relief valve components and piston bore in timing cover.
2. Check piston and bore for scoring and that piston slides freely in bore with no perceptible side movement.
3. Check relief valve spring for damage and distortion; check spring free length:
   Spring free length = 60.0 mm (2.4 in).

Oil pump - refit

1. Lubricate rotors, oil pump drive gear, cover plate and housing with engine oil.
2. Assemble rotors in housing ensuring that reference marks are aligned.
3. Position cover plate to housing.
4. Apply sealant, Part number STC 50552 to threads of cover plate screws and bolt - if fitted, fit but do not fully tighten screws and bolt.
5. Position drive gear in oil pump, tighten cover plate screws and bolt - if fitted to:
   Screws - 4 Nm (3 lbf.ft).
   Bolt - 8 Nm (6 lbf.ft)
6. Fit timing cover.

Oil pressure by-pass valve - refit

1. Lubricate new 'O' ring with engine oil and fit to by-pass valve plug.
2. Lubricate by-pass valve spring, plunger and plunger bore with engine oil.
3. Assemble plunger to by-pass valve spring, insert plunger and spring into bore.
4. Fit by-pass valve plug, depress plug and fit circlip.
5. Ensure circlip is fully seated in groove.

Oil pressure relief valve - refit

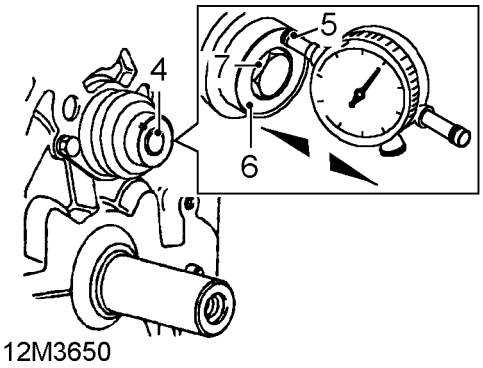
1. Lubricate new 'O' ring with engine oil and fit to relief valve plug.
2. Lubricate relief valve spring, piston and piston bore with engine oil.
3. Assemble piston to relief valve spring, insert piston and spring into piston bore.
4. Fit relief valve plug, depress plug and fit circlip.
5. Ensure circlip is fully seated in groove.

CAMSHAFT AND TAPPETS

Camshaft end-float - check

NOTE: this check is only applicable to camshafts fitted with thrust plate.

1. Remove rocker shaft assemblies.
2. Remove push rods and store in fitted order.
3. Remove timing chain and gears.

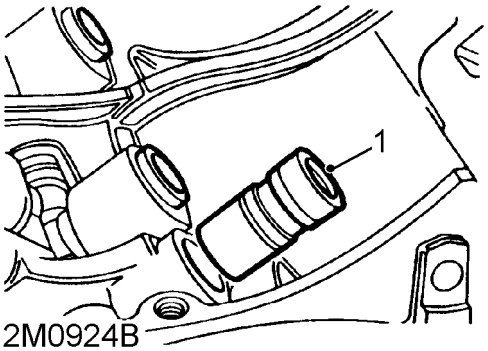


12M3650

4. Temporarily fit camshaft gear bolt.
5. Attach a suitable DTI to front of cylinder block with stylus of gauge contacting end of camshaft.
6. Push camshaft rearwards and zero gauge.
7. Using camshaft gear bolt, pull camshaft forwards and note end-float reading on gauge. End-float = 0.05 to 0.35 mm (0.002 to 0.014 in)

8. if end-float is incorrect, fit a new thrust plate and re-check. If end-float is still incorrect, a new camshaft must be fitted.

Camshaft and tappets - remove

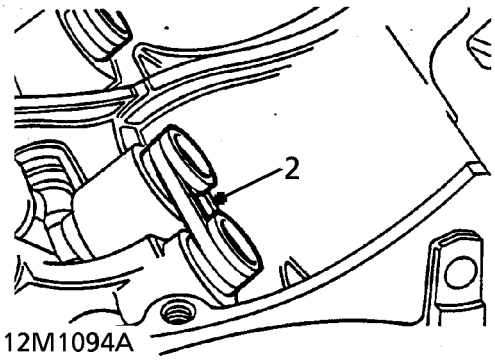


12M0924B

1. Remove tappets and retain with their respective push rods.

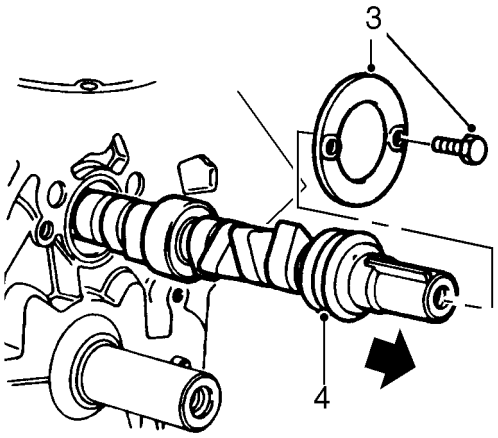
CAUTION: Store tappets upright to prevent oil loss.

NOTE: If tappets cannot be removed due to damaged camshaft contact area, proceed as follows:



12M1094A

2. Lift tappets in pairs to the point where damaged face is about to enter tappet bore and fit rubber bands to retain tappets. Repeat until all tappets are retained clear of camshaft lobes. The tappets can then be withdrawn out the bottom of their bores when the sump and camshaft are removed.



12M0925B

3. Remove 2 bolts securing camshaft thrust plate - if fitted to cylinder block, remove plate.
4. Withdraw camshaft, taking care not to damage bearings in cylinder block.

Camshaft and tappets - inspection

1. Throughly clean all components.
2. Inspect camshaft bearing journals and lobes for signs of wear, pitting, scoring and overheating.
3. Support camshaft front and rear bearings on vee blocks, and using a DTI, measure camshaft run-out on centre bearing. Maximum permitted run-out = 0.05 mm (0.002 in).
4. Inspect camshaft thrust plate - if fitted, for wear, replace plate if wear is evident.
5. Clean and inspect tappets. Check for an even, circular wear pattern on the camshaft contact area. If contact area is pitted or a square wear pattern has developed, tappet must be renewed.
6. Inspect tappet body for excessive wear or scoring. Replace tappet if scoring or deep wear patterns extend up to oil feed area. Clean and inspect tappet bores in engine block.
7. Ensure that tappets rotate freely in their respective bores.
8. Inspect push rod contact area of tappet, replace tappet if surface is rough or pitted.

Camshaft and tappets - refit

1. Lubricate camshaft journals with clean engine oil and carefully insert camshaft into cylinder block.
2. Fit camshaft thrust plate - if fitted, ensuring that it is correctly located in camshaft groove. Fit bolts and tighten to 25 Nm (18 lbf.ft).

NOTE: If camshaft or thrust plate has been replaced, it will be necessary to re-check camshaft end-float.

3. Immerse tappets in clean engine oil. Before fitting, pump the inner sleeve of tappet several times using a push rod, to prime tappet and reduce tappet noise when engine is first started.
4. Lubricate tappet bores with clean engine oil and fit tappets in removed order.

NOTE: Some tappet noise may be evident on initial start-up. If necessary, run the engine at 2500 rev/min for a few minutes until noise ceases.

5. Fit timing chain and gears.
6. Fit rocker shaft assemblies.

PISTONS, CONNECTING RODS, PISTON RINGS AND CYLINDER BORES

Pistons and connecting rods - remove

1. Remove cylinder head(s).
2. Remove big-end bearings.
3. Remove carbon ridge from top of each cylinder bore.
4. Suitably identify each piston to its respective cylinder bore.
5. Push connecting rod and piston assembly to top of cylinder bore and withdraw assembly.
6. Repeat above procedure for remaining pistons.

CAUTION: Big-end bearing shells must be replaced whenever they are removed.

Piston rings - remove

1. Using a suitable piston ring expander, remove and discard piston rings.
2. Remove carbon from piston ring grooves.

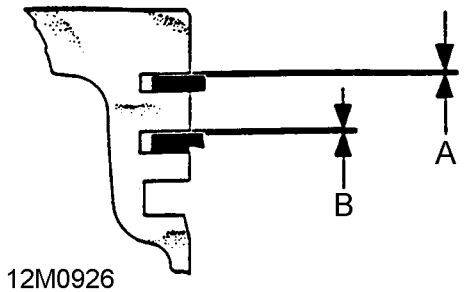
NOTE: Use an old broken piston ring with a squared off end.

CAUTION: Do not use a wire brush.

Piston rings - inspection

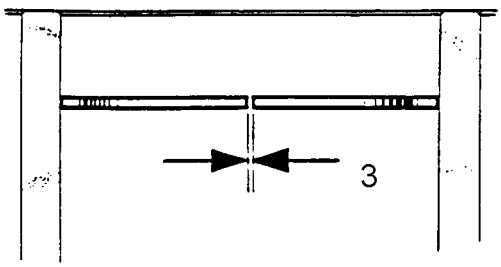
1. Temporarily fit new compression rings to piston.

NOTE: The ring marked 'TOP' must be fitted, with marking uppermost, into second groove. The chrome ring fits into top groove and can be fitted either way round.



12M0926

2. Check compression ring to groove clearance:
   Top compression ring **A** = 0.05 to 0.10 mm (0.002 to 0.004 in)
   2nd compression ring **B** = 0.05 to 0.10 mm (0.002 to 0.004 in)

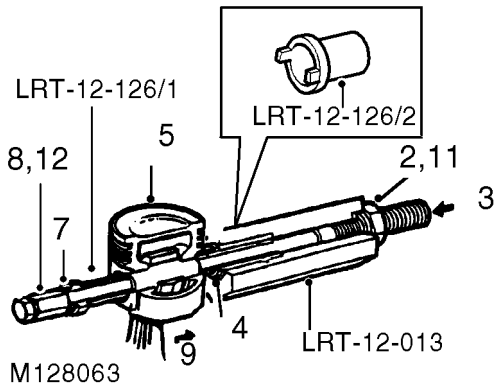


12M0927

3. Insert piston ring into its relevant cylinder bore, held square to bore with piston and check ring gaps.
   Top compression ring = 0.30 to 0.50 mm (0.012 to 0.02 in)
   2nd compression ring = 0.40 to 0.65 mm(0.016 to 0.26 in)
   Oil control ring rails = 0.38 to 1.40 mm (0.14 to 0.05 in)

CAUTION: Ensure that on completion of checking, piston rings are identified and retained with the cylinder in which they were checked.

Pistons - remove



1. Clamp hexagon body of **LRT-12-013** in vice.
2. Screw large nut back until flush with end of centre screw.
3. Push centre screw forward until nut contacts thrust race.
4. Locate remover/replacer adapter **LRT-12-126/2** with its long spigot inside bore of hexagon body.
5. Locate piston and connecting rod assembly on centre screw and up to adapter **LRT-12-126/2** ensuring that prongs of adapter are positioned on piston either side of gudgeon pin.
6. Fit remover/replacer bush **LRT-12-126/1** on centre screw with flanged end away from gudgeon pin.
7. Screw stop nut on to centre screw.

CAUTION: Ensure that LRT-12-126/1 is correctly located in gudgeon pin bore of piston.

8. Lock the stop nut securely with the lockscrew.
9. Push connecting rod to right to locate end of gudgeon pin in adapter **LRT-12-126/2.**
10. Ensure that **LRT-12-126/1** is still located in gudgeon pin bore of piston.
11. Screw large nut up to **LRT-12-013** .
12. Hold lockscrew and turn large nut until gudgeon pin is withdrawn from piston.

CAUTION: Ensure that prongs of adapter LRT-12-126/2 remain in contact with piston and do not contact gudgeon pin.

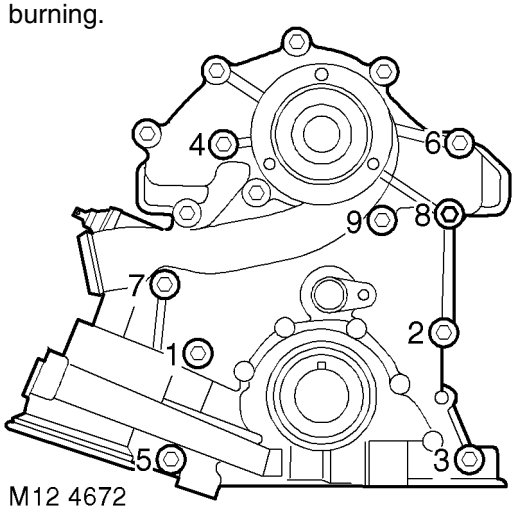
13. Dismantle tool **LRT-12-013** and remove piston, connecting rod and gudgeon pin.

NOTE: Keep each piston and gudgeon pin with their respective connecting rod.

14. Repeat above operations for remaining pistons.

Pistons and connecting rods - inspection

1. Clean carbon from pistons
2. Inspect pistons for distortion, cracks and burning.



M12 4672

3. Measure and record piston diameter at 90° to gudgeon pin axis and 10 mm (0.4 in) from bottom of skirt.
4. Check gudgeon pin bore in piston for signs of overheating.

NOTE: Pistons fitted on production are graded A or B, the grade letter is stamped on the piston crown. Grade B pistons are supplied as service replacements. Worn cylinder liners fitted with grade A pistons may be honed to accept grade B pistons provided that specified cylinder bore and ovality limits are maintained.

CAUTION: DO NOT attempt to de-glaze cylinder bores.

CAUTION: Ensure replacement pistons are correct for the compression ratio of the engine. The compression ratio will be found on the cylinder block above the engine serial number. Ensure that replacement connecting rods are correct for engine being overhauled.

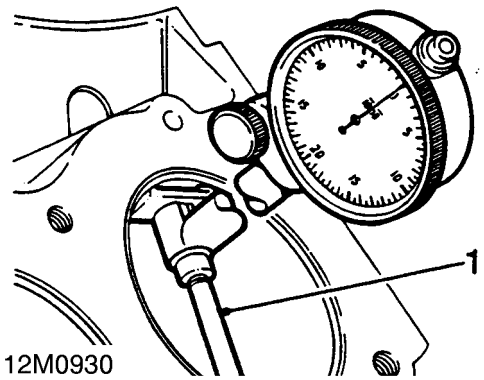
5. Check connecting rods for alignment.

Gudgeon pins - inspection

NOTE: Gudgeon pins are only supplied as an assembly with replacement pistons.

1. Check gudgeon pins for signs of wear and overheating.
2. Check clearance of gudgeon pin in piston: Gudgeon pin to piston clearance = 0.006 to 0.015 mm (0.0002 to 0.0006 in)
3. Check overall dimensions of gudgeon pin: Overall length = 72.67 to 72.79 mm (2.85 to 2.86 in)
   Diameter - measured at each end and centre of pin = 22.215 to 22.220 mm (0.87 to 0.871 in)

Cylinder liner bore - inspection



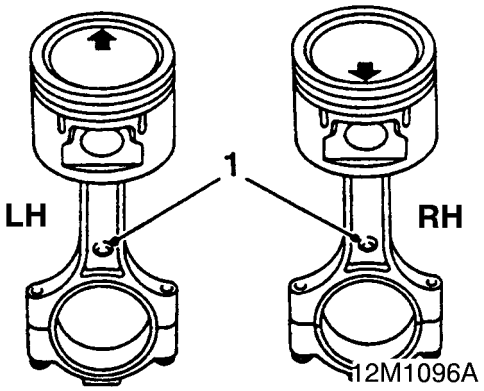
1. Measure cylinder bore wear in two axis 40 to 50 mm (1.5 to 1.9 in) from top of bore:
   Cylinder bore diameter - standard:
   3.5 litre = 88.86 to 88.90 mm (3.498 to 3.50 in)
   3.9 litre = 94.00 to 94.04 mm (3.700 to 3.702 in)
   4.2 litre = 94.00 to 94.04 mm (3.700 to 3.702 in)
   Maximum ovality = 0.013 mm (0.0005 in)
2. Compare cylinder bore diameter with piston diameter and calculate piston to cylinder bore clearance.
   Piston to cylinder bore clearance = 0.015 to 0.045 mm (0.001 to 0.002 in)

CAUTION: The temperature of piston and cylinder block must be the same to ensure accurate measurement.

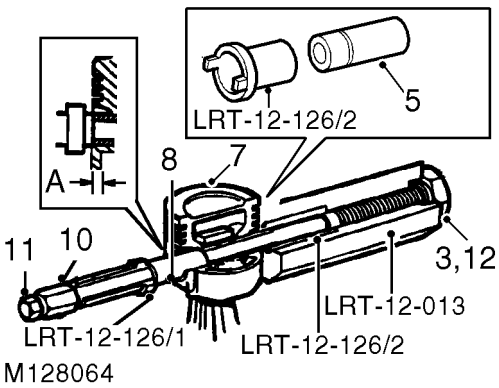
CAUTION: DO NOT attempt to de-glaze cylinder bores.

Pistons - refit

CAUTION: On later 4.2L engines the piston has a 0.5 mm (0.02 in) offset gudgeon pin which can be identified by an arrow mark on the piston crown. This arrow MUST always point to the front of the engine.



1. *4.2L engine only:* Assemble pistons to connecting rods with arrow on piston pointing towards domed shaped bosses on connecting rod for RH bank of cylinders, and arrow pointing away from dome shaped bosses for LH bank of cylinders.



2. Clamp hexagon body of **LRT-12-013** in vice.
3. Screw large nut back until flush with end of centre screw.
4. Locate remover/replacer adapter **LRT-12-126/2** with its long spigot inside bore of hexagon body.
5. Fit parallel sleeve, part of tool **LRT-12-013** with grooved end towards open end of **LRT-12-013** up to shoulder of centre screw.
6. Lubricate gudgeon pin and bores of connecting rod and piston with graphited oil.

7. Locate connecting rod and piston to centre screw with connecting rod entered on parallel sleeve up to the machined groove on the sleeve.

CAUTION: Ensure that the parallel sleeve used is the same diameter as the gudgeon pin.

8. Fit gudgeon pin on to centre screw and into piston bore up to connecting rod.
9. Fit remover/replacer bush **LRT-12-126/1** with flanged end towards gudgeon pin.
10. Screw the stop nut on to the centre screw and position piston against remover/replacer adapter **LRT-12-126/2.**

CAUTION: Ensure that prongs of LRT-12-126/2 remain in contact with piston and do not contact the gudgeon pin.

11. Lock the stop nut securely with the lockscrew.
12. Lubricate centre screw threads and thrust race with graphited oil, screw large nut up to **LRT-12-013.**
13. Set torque wrench to 16 Nm (12 lbf.ft), and using socket on large nut, pull gudgeon pin in until flange of **LRT-12-126/1** is distance **'A'** from face of piston.
    Distance **'A'** = 0.4 mm (0.016 in).

CAUTION: If torque wrench 'breaks' during above operation, fit of gudgeon pin to connecting rod is not acceptable and components must be replaced. The centre screw and thrust race must be kept well lubricated throughout operation.

14. Dismantle tool **LRT-12-013** , remove piston, check no damage has occurred during pressing and piston moves freely on gudgeon pin.
15. Repeat above operations for remaining pistons.

Piston to cylinder bore clearance - checking

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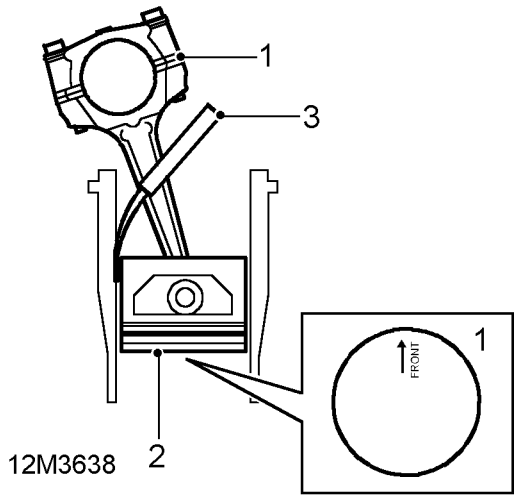
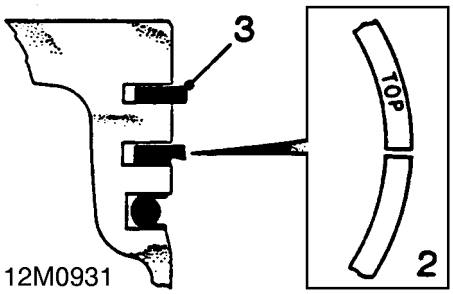


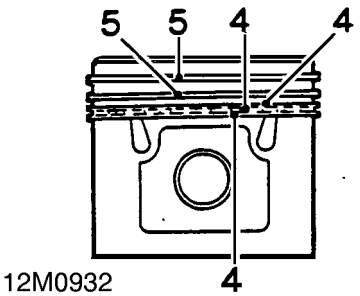
1. Starting with number 1 piston, invert piston and with arrow on piston crown pointing towards REAR of cylinder block, insert piston in cylinder liner.
2. Position piston with bottom of skirt 30 mm (1.2 in) from top of cylinder block.
3. Using feeler gauges, measure and record clearance between piston and left hand side of cylinder block:
   Piston to bore clearance = 0.15 to 0.045 mm (0.001 to 0.002 in)
4. Repeat above procedures for remaining pistons.

Pistons and connecting rods - refit

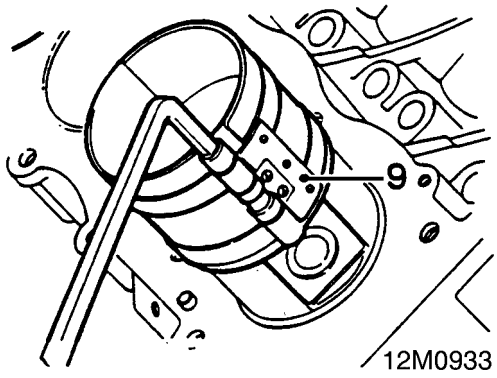
1. Fit oil control ring rails and expander, ensuring ends butt and not overlap.



2. Fit ring marked 'TOP' with marking uppermost into second groove.
3. Fit top compression ring into groove either way round.



4. Position oil control expander ring joint and ring rail gaps all at one side, between gudgeon pin and away from left hand side of piston - viewed from front of piston. Space gaps in ring rails approximately 25 mm (1.0 in) each side of expander ring joint.
5. Position compression rings with ring gaps on opposite sides of piston between gudgeon pin and right hand side of piston - viewed from front of piston.
6. Thoroughly clean cylinder bores.
7. Lubricate piston rings and gudgeon pin with engine oil.
8. Lubricate cylinder bores with engine oil.



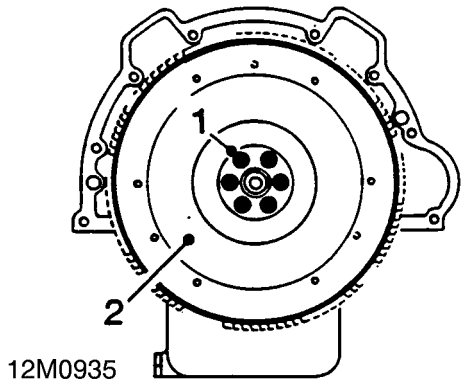
9. Fit ring clamp to piston and compress piston rings.
10. Insert connecting rod and piston assembly into respective cylinder bore ensuring domed shaped boss on connecting rod faces towards front of engine on RH bank of cylinders, and towards rear on LH bank of cylinders.
11. Fit big-end bearing caps and bearing shells.

NOTE: When both connecting rods are fitted to each journal, bosses will face towards each other.

12. Fit cylinder head(s).

FLYWHEEL AND STARTER RING GEAR

Flywheel - remove

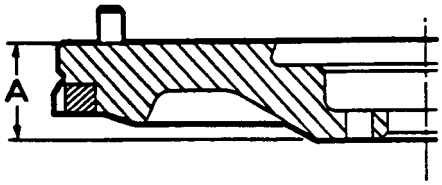


12M0935

1. Restrain flywheel and remove 6 bolts securing flywheel.
2. Remove flywheel.

NOTE: Dowel located. On early engines, balance weights were on engine side of flywheel; replacement flywheels will have balance weights on clutch side.

Flywheel and starter ring gear - inspection



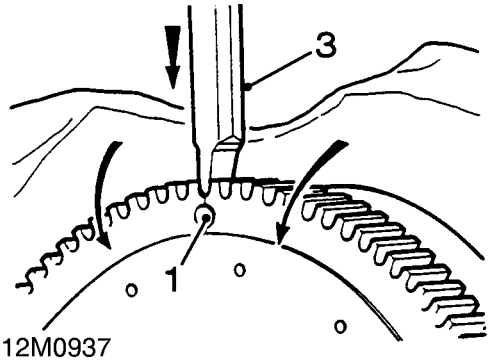
12M0936

1. Inspect flywheel face for cracks, scores and overheating. The flywheel can be refaced providing thickness does not go below minimum.
   Flywheel minimum thickness **A** = 39.93 mm (1.6 in)
2. Inspect ring gear for worn, chipped and broken teeth.

CAUTION: Do not attempt to remove reluctor ring

3. Renew ring gear if necessary.

Starter ring gear - renew



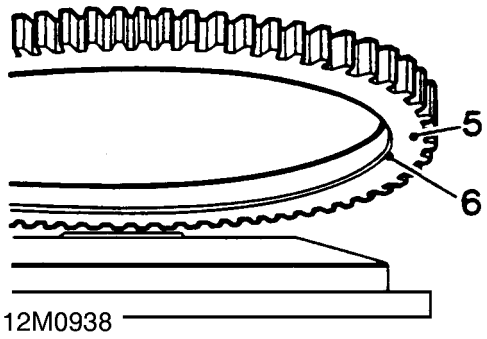
1. Drill a 9.5 mm (0.375 in) diameter hole axially at base of tooth and inner diameter of starter ring, sufficiently deep enough to weaken ring gear.

CAUTION: Do not allow drill to enter flywheel.

2. Secure flywheel in soft jawed vice.
3. Split ring gear using a cold chisel.

WARNING: Wear safety goggles and take precautions against flying fragments when splitting ring gear.

4. Remove flywheel from vice, remove old ring gear, and place flywheel, clutch side down, on a flat surface.



5. Heat new ring gear uniformly to between 170° and 175° C (340° and 350° F).

CAUTION: Do not exceed this temperature.

WARNING: Handle hot ring gear with care.

6. Locate ring gear on flywheel with chamfered inner diameter towards flywheel flange.

NOTE: If ring gear is chamfered on both sides, it can be fitted either way round.

7. Press ring gear on to flywheel until it butts against flywheel flange.
8. Allow flywheel to air cool.

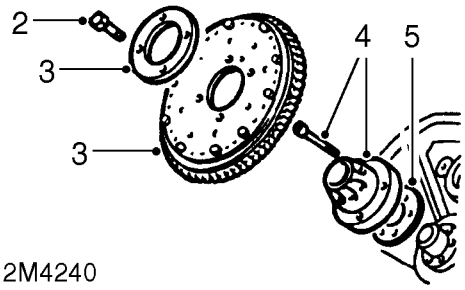
Flywheel - refit

1. Ensure bolt holes in crankshaft are clean and dry.
2. Fit flywheel and locate on 2 dowels.
3. Fit flywheel bolts.
4. Using assistance, restrain flywheel and tighten flywheel bolts to 78 Nm (58 lbf.ft).

DRIVE PLATE AND RING GEAR ASSEMBLY

Drive plate and ring gear assembly - remove

1. Suitably identify each component to its fitted position.



12M4240

2. Remove 4 bolts securing drive plate assembly.
3. Remove clamp ring and drive plate assembly.

NOTE: Dowel located.

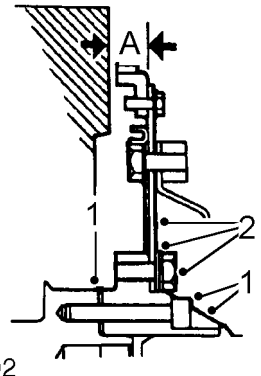
4. Remove 6 Allen bolts securing hub aligner to crankshaft, remove hub aligner.
5. Remove and retain selective shim - if fitted.

Drive plate and ring gear - inspection

1. Inspect drive plate for cracks and distortion.
2. Renew drive plate if necessary.
3. Inspect ring gear for worn, chipped and broken teeth.
4. Renew ring gear assembly if necessary.

Drive plate and ring gear assembly - check setting height

NOTE: The following procedures are only applicable to shimmed drive plates, there is no need to check setting height on drive plates which are not shimmed.



12M1402

1. Ensure bolt holes in crankshaft are clean and dry. Fit original selective shim and hub aligner, fit Allen bolts and tighten to 85 Nm (63 lbf.ft).
2. Fit drive plate assembly and clamp ring ensuring that reference marks are aligned; fit bolts and tighten to 45 Nm (33 lbf.ft).

CAUTION: If a new drive plate assembly is being fitted, paint mark on plate must face towards torque converter.

3. Check the setting height:
   Drive plate setting height **A** = 8.08 to 8.20 mm (0.32 to 0.33 in)
4. If setting height is not as specified, remove clamp ring, drive plate assembly, hub aligner and selective shim.

5. Measure existing shim and, if necessary, select appropriate shim to obtain specified setting height.
   Shims available:
   1.20 - 1.25mm (0.048 to 0.050 in)
   1.30 - 1.35mm (0.051 to 0.053 in)
   1.40 - 1.45mm (0.055 to 0.057 in)
   1.50 - 1.55mm (0.059 to 0.061 in)
   1.60 - 1.65mm (0.063 to 0.065 in)
   1.70 - 1.75mm (0.067 to 0.070 in)
   1.80 - 1.85mm (0.071 to 0.073 in)
   1.90 - 1.95mm (0.075 to 0.077 in)
   2.00 - 2.05mm (0.079 to 0.081 in)
   2.10 - 2.15mm (0.083 to 0.085 in)

6. Retain selected shim

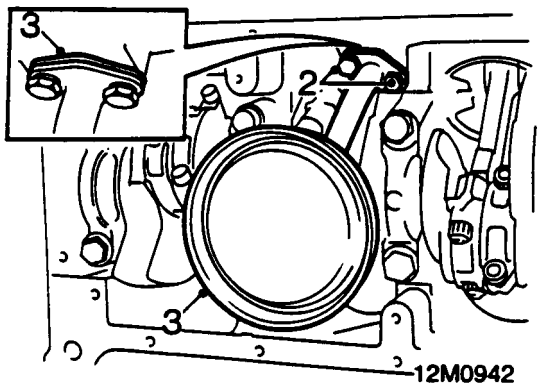
Drive plate and ring gear assembly - refit

1. Position selected shim - if fitted to crankshaft.
2. Fit hub aligner, fit Allen bolts and tighten to 85 Nm (63 lbf.ft).
3. Fit drive plate assembly and clamp ring ensuring that reference marks are aligned or that paint mark is towards torque converter.
4. Fit bolts and tighten to 45 Nm (33 lbf.ft).

CRANKSHAFT, MAIN AND BIG-END BEARINGS

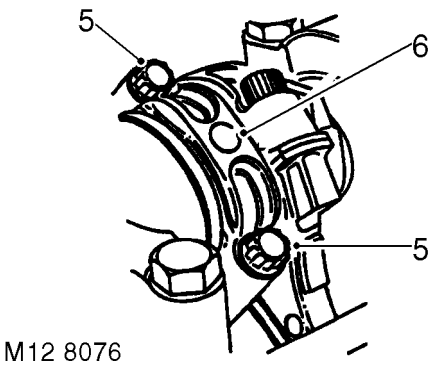
Big-end bearings - remove

1. Remove timing chain and gears.



NOTE: Oil strainer fitted to engines without suffix B to the serial number illustrated.

2. Remove 2 bolts or nut on engines with suffix B to the serial number securing oil strainer.
3. Remove strainer, remove and discard gasket - if fitted.
4. Suitably identify bearing caps to their respective connecting rods.



5. Remove 2 nuts/bolts securing each bearing cap.
6. Remove bearing cap, remove and discard bearing shell.

CAUTION: Keep bearing caps and nuts/bolts in their fitted order.

7. *Bolts fitted in connecting rods:* Fit a length of plastic tubing over each connecting rod bolt.
8. Push each piston up its respective bore, remove and discard shells from connecting rods.

NOTE: Big-end bearing shells must be replaced whenever they are removed.

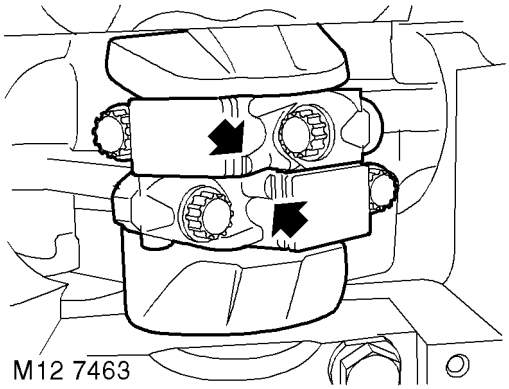
Big-end bearings - refit

1. Fit new bearing shells to each connecting rod.

NOTE: Big-end bearings are available in 0.254 and 0.508 mm (0.01 and 0.02 in) oversizes.

2. Lubricate bearing shells and crankshaft journals with engine oil.
3. Pull connecting rods on to crankshaft journals and remove plastic tubing from bolts - if fitted.
4. Fit new bearing shells to each big-end bearing cap.

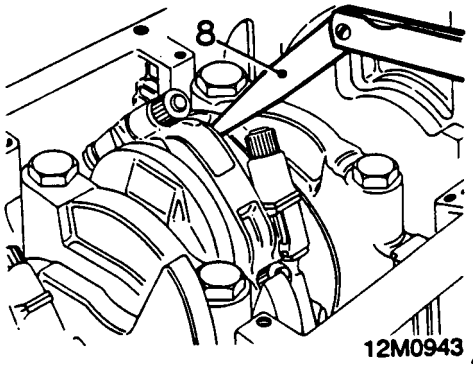
NOTE: If crankshaft has been reground, ensure appropriate oversize bearing shells are fitted.



5. Lubricate bearing shells and fit bearing caps ensuring reference marks on connecting rods and bearing caps are aligned.

NOTE: Rib on edge of bearing cap must face towards front of engine on RH bank of cylinders and towards rear on LH bank of cylinders.

6. Fit bearing cap nuts/bolts and tighten to:
   Nuts - 50 Nm (37 lbf.ft).
   Bolts:
   Stage 1 - 20 Nm (15 lbf.ft)
   Stage 2 - Further 80°
7. Check connecting rods move freely sideways on crankshaft. Tightness indicates insufficient bearing clearance or misaligned connecting rod.



8. Check clearance between connecting rods on each crankshaft journal.
   Connecting rod clearance = 0.15 to 0.36 mm (0.006 to 0.014 in).
9. Clean oil strainer.

Engines numbers without suffix B

10. Clean mating faces of strainer and cylinder block.
11. Fit new gasket, dry.
12. Position oil strainer to stud.
13. Fit oil strainer, fit nut but do not tighten at this stage.

NOTE: This will allow for correct positioning of oil strainer when timing cover is fitted.

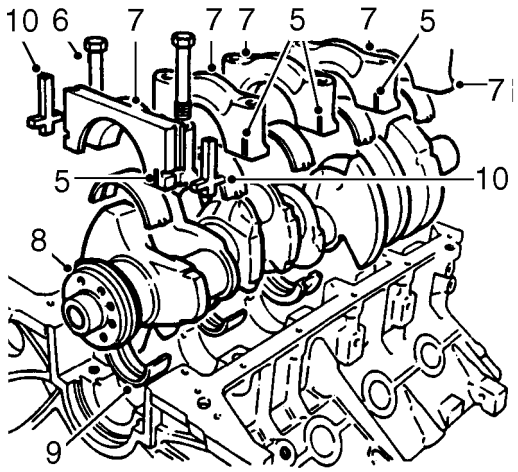
CAUTION: Ensure nut is tightened to 22 Nm (16 lbf.ft) when oil pick-up pipe is fitted to timing cover.

Engines numbers with suffix B

14. Clean mating faces on strainer and cylinder block.
15. Fit new gasket to strainer, position strainer, fit bolts and tighten to 10 Nm (7 lbf.ft).
16. Fit timing chain and gears.

Crankshaft - remove

1. Remove flywheel or drive plate and ring gear assembly.
2. Remove timing cover.
3. Remove timing gears.
4. Remove big-end bearings.



12M0944A

5. Make suitable reference marks between each main bearing cap and cylinder block.
6. Starting at centre main bearing and working outwards, progressively slacken then remove 10 main bearing cap bolts.

CAUTION: Keep bolts in their fitted order.

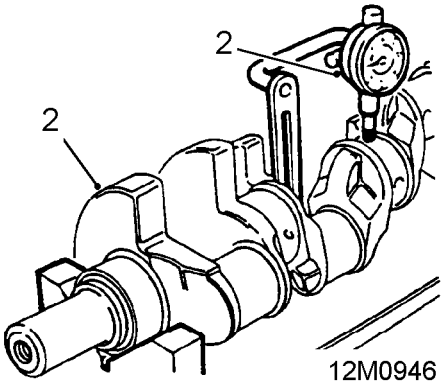
7. Remove 5 main bearing caps and bearing shells, discard shells.
8. Lift out crankshaft and rear oil seal. Remove and discard oil seal.
9. Remove and discard 5 bearing shells from cylinder block.

NOTE: Main bearing shells must be replaced whenever they are removed.

10. Remove and discard cruciform seals from rear main bearing cap.
11. Remove Woodruff key from crankshaft.

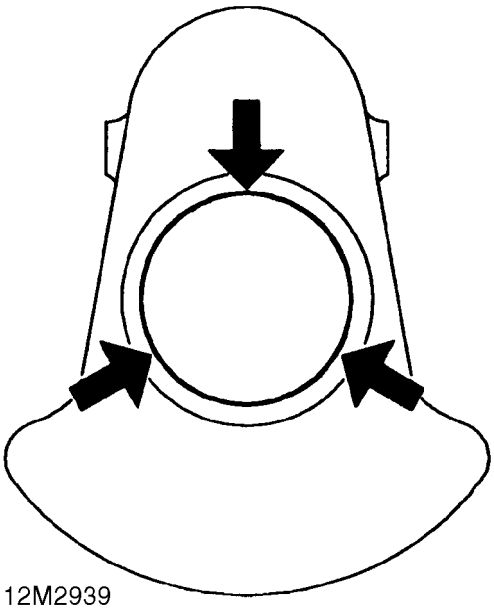
Crankshaft - inspection

1. Clean crankshaft and blow out oil passages.



12M0946

2. Support crankshaft front and rear bearing journals on vee blocks, and using a DTI, measure run-out on centre main bearing. Maximum permitted run-out = 0.08 mm (0.003 in)
   If run-out exceeds permitted maximum, crankshaft is unsuitable for regrinding and should be replaced.

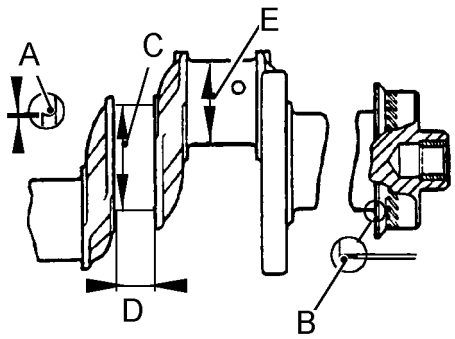


12M2939

3. Measure each journal for overall wear and ovality, make 3 checks at 120° intervals.
   Main bearing journal diameter = 58.409 to 58.422 mm (2.29 to 2.30 in)
   Maximum out of round = 0.040 mm (0.002 in)
   Big-end bearing journal diameter = 50.800 to 50.812 mm (1.99 to 2.00 in)
   Maximum out of round = 0.040 mm (0.002 in)
   If measurements exceed permitted maximum, regrind or fit new crankshaft.

NOTE: Crankshaft main bearings are available in 0.254 and 0.508 mm (0.01 and 0.02 in) oversizes. When fitting 0.508 mm (0.02 in) oversize bearings, centre main bearing, which controls crankshaft end-float, has thrust faces increased in thickness by 0.254 mm (0.01 in). Therefore if 0.508 mm (0.02 in) oversize bearings are to be fitted, 0.127 mm (0.005 in) must be machined off each thrust face of centre main bearing shell to achieve correct end-float. Ensure an equal amount of material is removed from each thrust face.

Crankshaft dimensions:



12M0947

Bearing journal radius - all journals except rear main journal **A** = 1.90 to 2.28 mm (0.075 to 0.09 in).
Rear main bearing journal radius **B** = 3.04 mm (0.012 in)

Bearing journal diameter **C** :
Standard = 58.409 to 58.422mm (2.29 to 2.3 in).
0.254 mm (0.01 in) undersize = 58.154 to 58.168 mm (2.290 to 2.300 in)
0.508 mm (0.02 in)undersize = 57.900 to 57.914 mm (2.280 to 2.281 in)

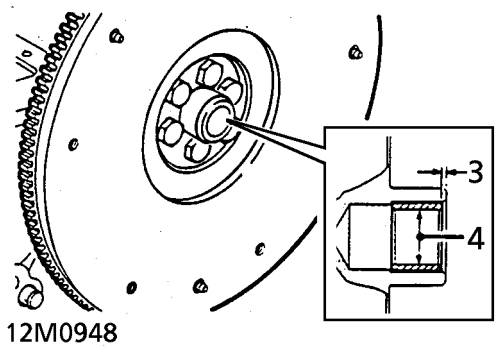
Bearing journal width **D** = 26.975 to 27.026 mm (1.062 to 1.064 in).

Bearing journal diameter **E** :
Standard = 50.800 to 50.812 mm (1.99 to 2.00 in).
0.254 mm (0.01 in) undersize = 50.546 to 50.558 mm (1.98 to 1.99 in)
0.508 mm (0.02 in) undersize = 50.292 to 50.305 mm (1.97 to 1.98 in)

1. Check crankshaft spigot bearing for wear, replace if necessary:
   Spigot bearing inside diameter = 19.177 + 0.025 - 0.000 mm (0.75 + 0.001 - 0.000 in)

Crankshaft spigot bearing - renew

1. Carefully extract old spigot bearing.
2. Clean bearing recess in crankshaft.



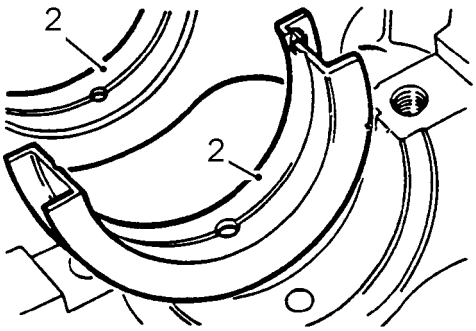
12M0948

3. Fit new bearing flush with, or to a maximum of 1.6 mm (0.06 in) below end face of crankshaft.
4. Ream bearing to correct inside diameter. Spigot bearing inside diameter = 19.177 + 0.025 - 0.000 mm (0.75 + 0.001 - 0.000 in)
5. Remove all traces of swarf.

Crankshaft - refit

1. Clean main bearing caps, bearing shell recesses and mating surfaces of cylinder block.

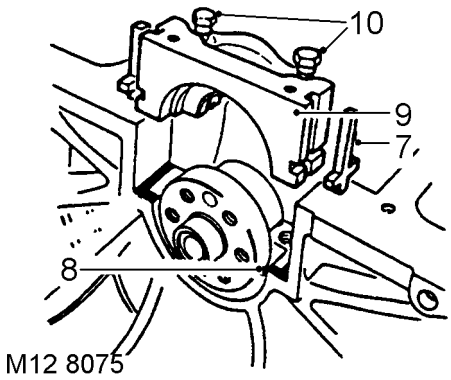
CAUTION: Ensure main bearing cap bolt holes in cylinder block are clean and dry.



12M0949

2. Fit new upper main bearing shells, with oil holes and grooves, in cylinder block, ensuring flanged shell is fitted in centre position.
3. Lubricate main bearing shells with engine oil and position crankshaft in cylinder block.
4. Fit new main bearing shells to bearing caps and lubricate with engine oil.
5. Lubricate main bearing shells and fit numbers 1 to 4 bearing caps ensuring reference marks made during dismantling are aligned.
6. Fit numbers 1 to 4 main bearing cap bolts and tighten to 13 Nm (10 lbf.ft).

CAUTION: Do not tighten bolts further at this stage.



M12 8075

7. Fit new cruciform seals to rear main bearing cap.

CAUTION: Seals must protrude approximately 1.5 mm (0.05 in) above bearing cap face. Do not trim off excess material at this stage.

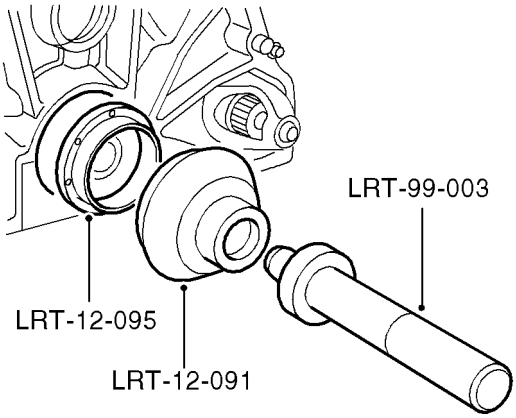
8. Apply a 3 mm (0.12 in) wide bead of sealant, Part number STC 50550 to bearing cap rear mating face on cylinder block.

CAUTION: Ensure sealant does not enter bolt holes.

9. Lubricate rear main bearing shell and cruciform seals with engine oil, fit bearing cap assembly.
10. Fit rear main bearing cap bolts and tighten to 13 Nm (10 lbf.ft).

CAUTION: Do not tighten bolts further at this stage.

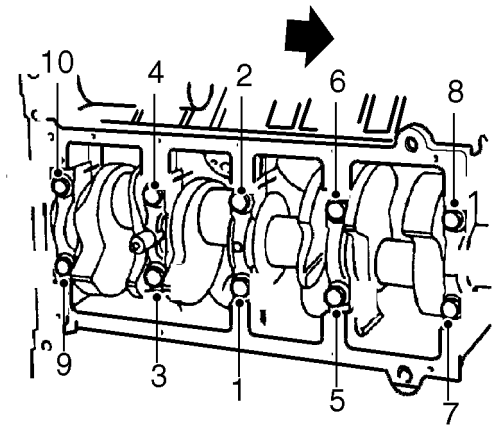
11. Clean seal location and running surface on crankshaft.
12. *Engine numbers without suffix B:* Clean seal protector **LRT-12-010** and lubricate with engine oil.
13. *Engine numbers with suffix B:* Clean seal protector **LRT-12-095** and lubricate with engine oil.
14. Lubricate oil seal lip with engine oil.



M12 7456

NOTE: Seal protector LRT-12-095 illustrated.

15. Position seal protector to crankshaft.
16. *Engine numbers without suffix B:* Fit oil seal squarely using hand pressure only until fully seated in recess.
17. *Engine numbers without suffix B:* Remove seal protector **LRT-12-010**
18. *Engine numbers with suffix B:* Fit seal using tools **LRT-12-091** and **LRT-99-003** .
19. *Engine numbers with Suffix B:* Remove seal protector **LRT-12-095** .



12M4238

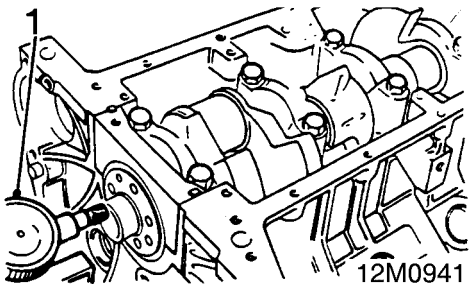
20. Using sequence shown, tighten main bearing cap bolts to:
    Numbers 1 to 4 bearing caps - 70 Nm (52 lbf.ft)
    Rear bearing cap -90 Nm (66 lbf.ft)

21. Trim off excess material from cruciform seals.
22. Fit Woodruff key to crankshaft.
23. Check crankshaft end-float.

NOTE: If 0.508 mm (0.02 in) oversize main bearings have been fitted, it may be necessary to machine thrust faces of centre main bearing to achieve correct end-float. Ensure an equal amount of material is removed from each thrust face.

24. Fit big-end bearings.
25. Fit timing chain and gears.
26. Fit flywheel or drive plate and ring gear assembly.

Crankshaft end - float - check



12M0941

1. Set-up DTI to measure end float.
2. Move crankshaft forwards and zero gauge.
3. Move crankshaft rearwards, record end-float reading obtained.
   Crankshaft end-float = 0.08 to 0.26 mm (0.003 to 0.010 in).
4. Remove DTI.

NOTE: Crankshaft end-float is controlled by thrust faces on upper half of centre main bearing shell.