

LEYLAND

38 TD and 4/98NT

ENGINE SERVICE MANUAL



9803/1200

LEYLAND 38TD and 4/98NT ENGINE SERVICE MANUAL

Preface

This volume is published mainly for the benefit of JCB Distributor Service Engineers involved in the maintenance and overhaul of the BLMC 38TD and 4/98NT engines fitted to JCB machines. Unless otherwise specified all information is common to both 38TD and 4/98NT engines.

The manual is compiled in numbered sections, the first two of which contain Routine Maintenance and Technical Data. The remaining sections are each concerned with the overhaul of a specific part of the engine.

For Example:—

Section 3 — Cylinder Head

Section 5 — Lubrication System

All sections are listed on the front cover, the bands of which coincide with divider cards for rapid reference. Each individual section also has its own Contents Page.

Torque settings in this publication are given as 'mean' figures and may vary by 3% higher or lower.

All references to cylinder positions are as numbered from Timing Cover end (front) of engine.

Distributor's copies of the manual will be updated as necessary by the issue of Replacement Pages. These should be inserted in the appropriate positions and the displaced pages (if any) withdrawn.

Where possible, revised information will be indicated by an asterisk (*) against the item concerned, the page issue number in the bottom right hand corner being similarly marked. Where the entire page or illustration has been revised, the asterisk will not be used, although the page issue number will be raised.

Further details of special tools required may be found in the Service Tools Catalogue, publication no. 9803/2405.

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SERVICE SCHEDULE

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VALVE CLEARANCES

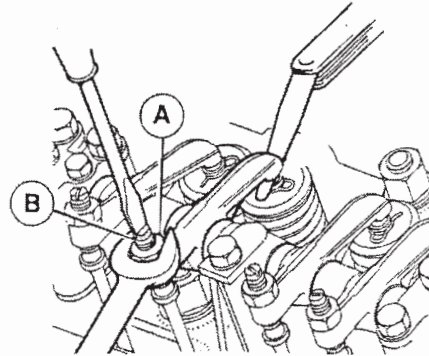
ADJUSTMENT

*Refer to Section 2 Page 1-1 for correct valve clearances.

- 1 Stop engine and remove rocker cover.
- 2 Turn the crankshaft until valve No. 8 is fully open and check the clearance (see Technical Data) of valve No. 1, which will be fully closed.

Check the remaining valve clearances using the table below.

- 3 To adjust, slacken locknut A and turn adjusting screw B until the clearance is correct. Hold the screw against rotation and tighten locknut.



Valve Open	Valve to Adjust
8	1
6	3
4	5
7	2
1	8
3	6
5	4
2	7

ENGINE

Check Level 10 Hours

Drain & Refill 200 Hours

Capacity

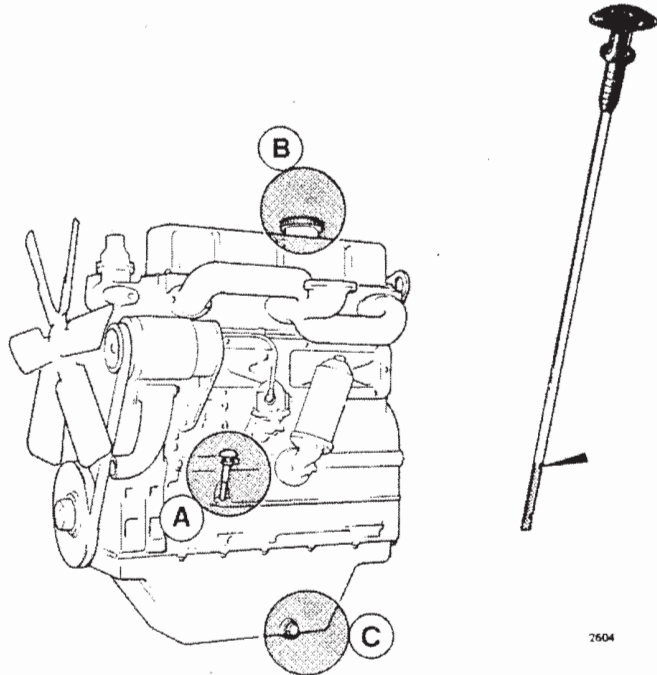
BALANCED ENGINES

Pressed Steel Sump 9.6 litres
2.1 UK gal
Aluminium Sump 11 litres
2.4 UK gal

NON BALANCED ENGINES

Pressed Steel Sump 11 litres
2.4 UK gal
Aluminium Sump 11.5 litres
2.5 UK gal
• Cast Iron Sump 9.1 litres
2.0 UK gal

- A Dipstick
- B Filler Cap
- C Drain Plug



• Recommended Lubricants

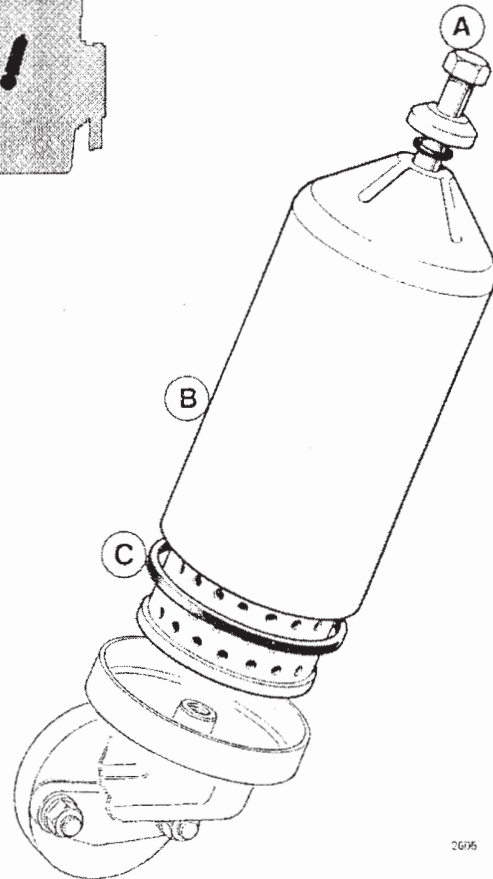
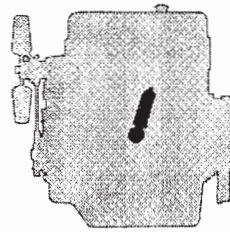
Below -1 deg C 30 deg F	-1 deg to 27 deg C 30 deg F to 81 deg F	Above 27 deg C 81 deg F
Mobil Delvac 1310	JCB Super X Universal Engine Oil or Mobil Delvac 1320	Mobil Delvac 1330

Alternative oils of the correct viscosity may be used, provided they meet U.S. Ordnance Specification MIL-L-2104C.

ENGINE OIL FILTER

Renew Element 200 Hours.

- 1 Unscrew bolt A, remove body and element B.
- 2 Discard element and clean all metal parts.
- 3 Re-assemble with new element and seal C. Smear new seal with oil before assembly.



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FUEL SYSTEM (Simms Minimec)

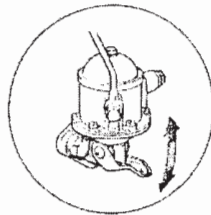
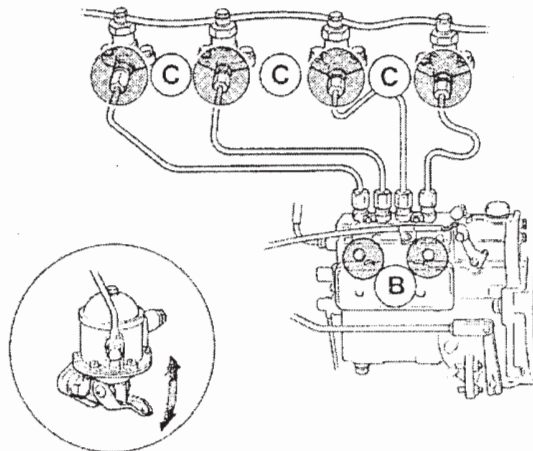
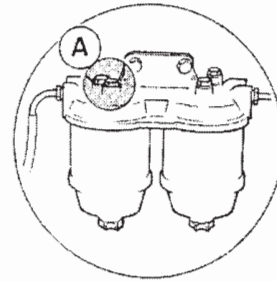
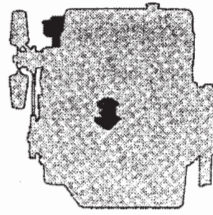
BLEEDING

If engine fails to start or misfires, or if any part of the fuel system has been disconnected, bleed system as follows.

- 1 Slacken screw A.
- 2 Operate lift pump priming lever until air free fuel flows from screw, then re-tighten.

Note: If the lift pump priming lever cannot be operated, turn engine until lever can be moved.

- 3 Slacken screws B, operate lift pump lever until air free fuel flows from screws then re-tighten.
- 4 Slacken unions C, open throttle, push in engine stop control, operate starter until air free fuel flows from unions then re-tighten.



FUEL SYSTEM (CAV DPA to engine no. 35216)

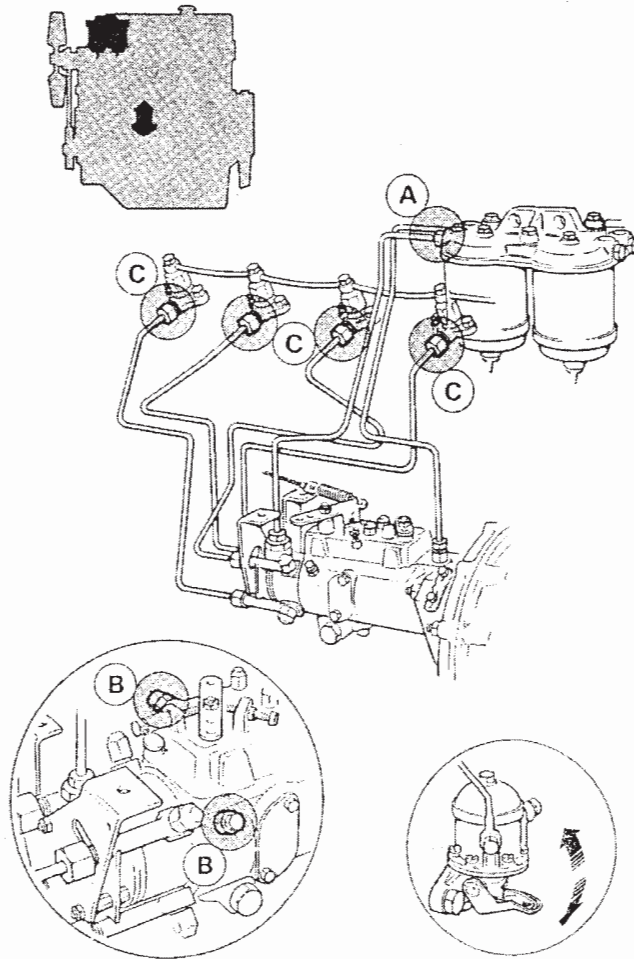
BLEEDING

If engine fails to start or misfires, or if any part of the fuel system has been disconnected, bleed system as follows.

- 1 Slacken union A.
- 2 Operate lift pump priming lever until air free fuel flows from screw, then re-tighten.

Note: If the lift pump priming lever cannot be operated, turn engine until lever can be moved.

- 3 Slacken screws B, operate lift pump lever until air free fuel flows from screws then re-tighten.
- 4 Slacken unions C, open throttle, push in engine stop control, operate starter until air free fuel flows from unions then re-tighten.



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FUEL SYSTEM (CAV DPA from engine no. 35217)

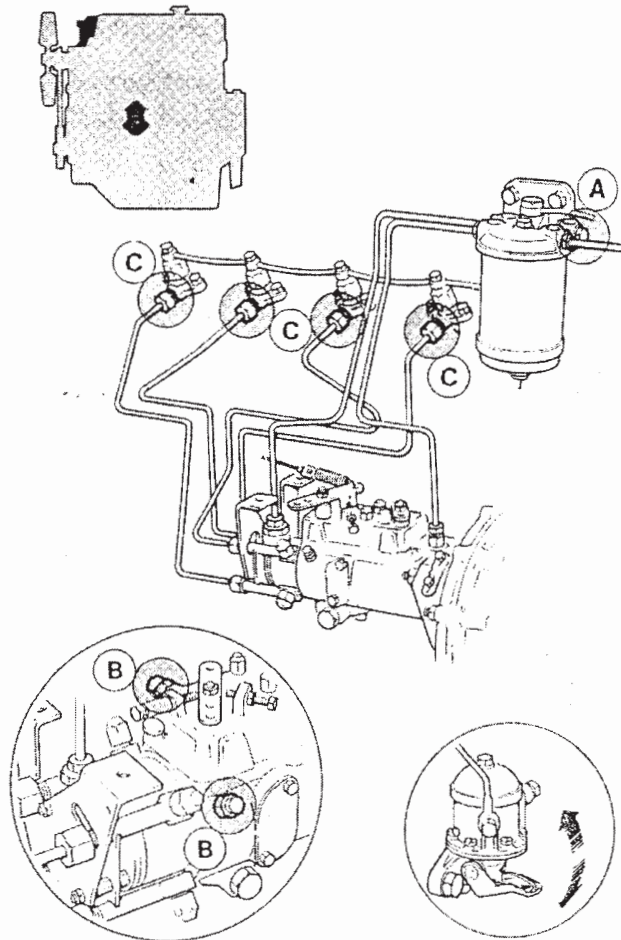
BLEEDING

If engine fails to start or misfires, or if any part of the fuel system has been disconnected, bleed system as follows.

- 1 Slacken screw A.
- 2 Operate lift pump priming lever until air free fuel flows from screw, then re-tighten.

Note: If the lift pump priming lever cannot be operated, turn engine until lever can be moved.

- 3 Slacken screws B, operate lift pump lever until air free fuel flows from screws then re-tighten.
- 4 Slacken unions C, open throttle, push in engine stop control, operate starter until air free fuel flows from unions then re-tighten.



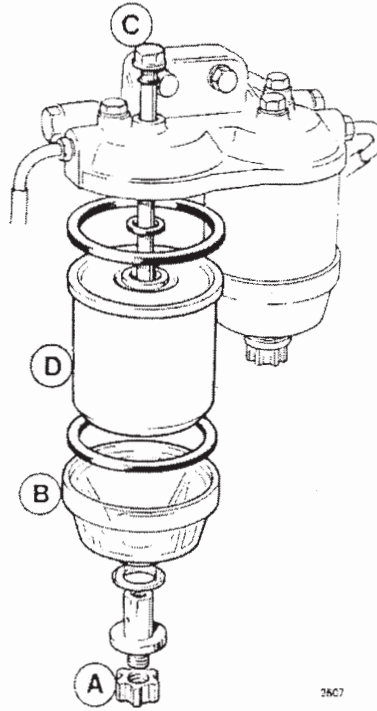
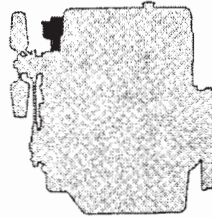
FUEL FILTER

DRAIN 50 Hours

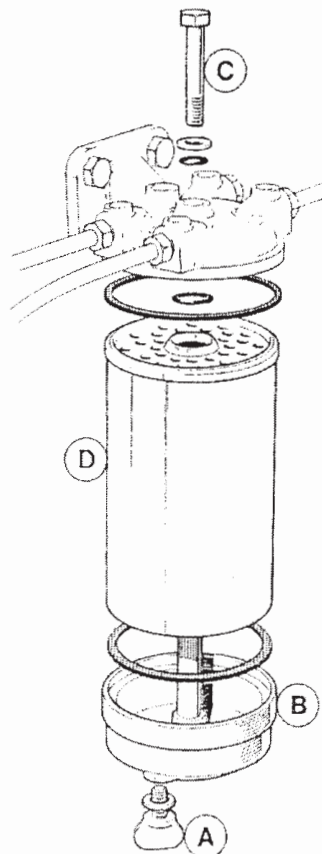
Drain off any water in glass bowl by turning tap A.

RENEW ELEMENTS * 400 Hours

- 1 Support bowl B while unscrewing bolt C.
- 2 Remove bowl and element D using a twisting motion.
- 3 Re-assemble using new element and sealing rings.
- 4 Bleed the fuel system.



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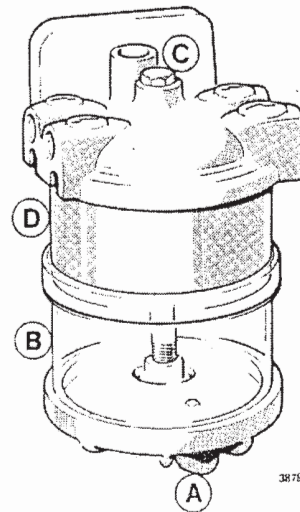
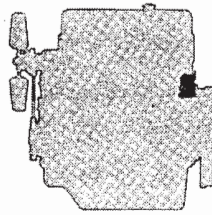
FUEL SEDIMENTER BOWL**DRAIN** 50 Hours

Drain off any water in glass bowl by turning tap A.

CLEAN

Periodically dismantle.

- 1 Clamp inlet fuel line to prevent loss of fuel.
- 2 Support bowl B and unscrew bolt C.
- 3 Wash element D in clean fuel.
- 4 Re-assemble in reverse order ensuring gaskets are in position and bolt is not overtightened.
- 5 Remove fuel line clamp.
- 6 Bleed the fuel system.

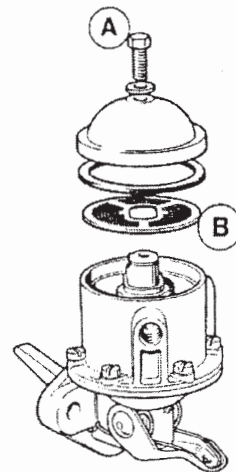
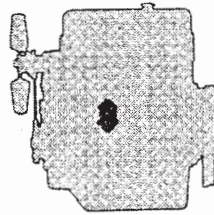


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FUEL LIFT PUMP

*CLEAN GAUZE 400 Hours

- 1 Unscrew bolt A, remove cover and gauze B.
- 2 Wash gauze with petrol and a soft brush.
- 3 Re-assemble, tightening bolt just sufficiently to make a seal.



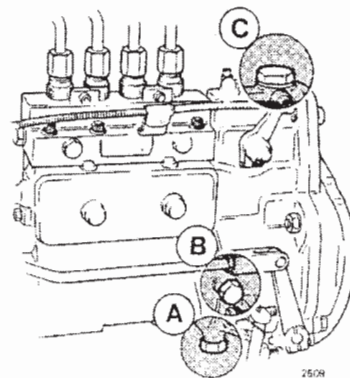
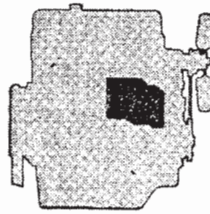
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FUEL INJECTION PUMP

CHECK OIL LEVEL 50 Hours

DRAIN & REFILL 200 Hours

- A Drain plug
- B Level plug
- C Filler plug

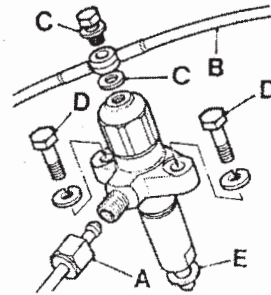
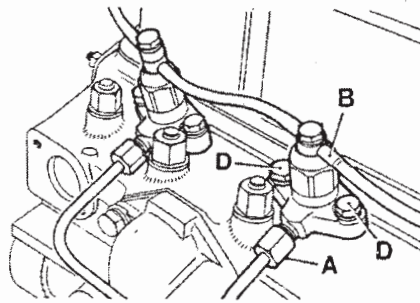


FUEL INJECTORS

CLEAN &
SERVICE

* 400 Hours

- 1 Disconnect feed pipe A and spill rail B. Note the sealing washer C each side of spill rail banjo.
- 2 Remove the injector securing bolts D and the injector.
- 3 Renew sealing washer E when replacing injectors.
- 4 Torque tighten securing bolts D (See Technical Data).
- 5 Bleed the fuel system.



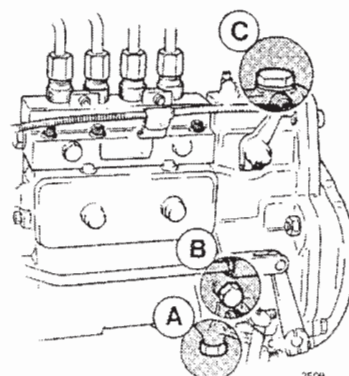
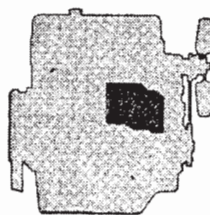
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4-7

FUEL INJECTION PUMP

CHECK OIL
LEVEL 50 HoursDRAIN &
REFILL 200 Hours

- A Drain plug
- B Level plug
- C Filler plug



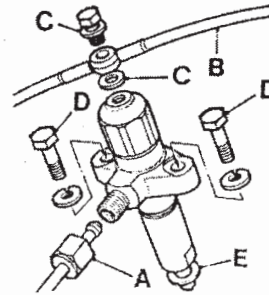
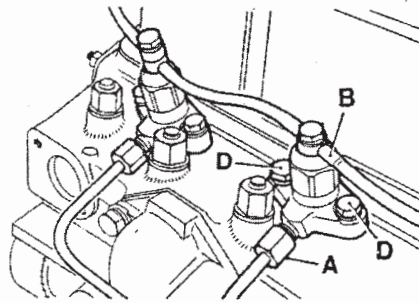
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FUEL INJECTORS

CLEAN &
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* 400 Hours

- 1 Disconnect feed pipe A and spill rail B. Note the sealing washer C each side of spill rail banjo.
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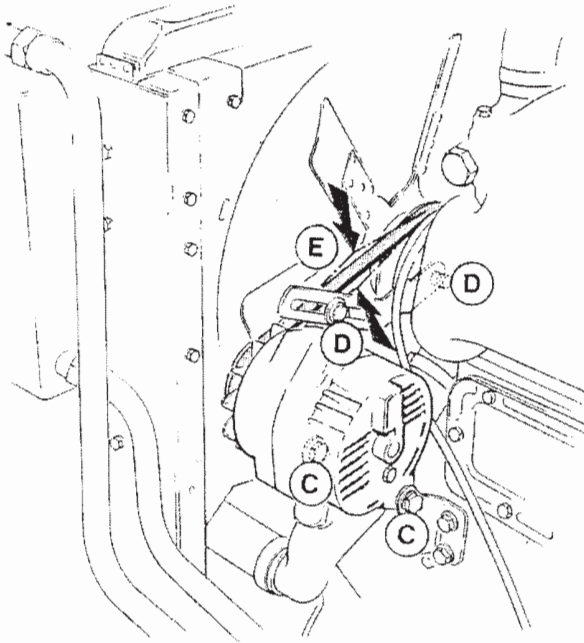
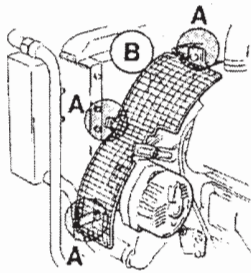
FAN BELT

ADJUSTMENT 50 Hours

- 1 For easier access to alternator, unscrew bolts at A to remove fan guard B.
- 2 Slacken bolts C and D.
- 3 Move alternator away from engine until there is 12mm. (½in.) slack at E.
- *4 Retighten bolts C and D tightening bolt C at rear of alternator last.

*CAUTION: Any leverage required to position the alternator must be applied at the drive end bracket only, using a lever of soft material e.g. wood.

- 5 Refit fan guard and secure.



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1-1

GENERAL

Engine Model No.	38TD	4/98NT
Type	4 cyl. vertical diesel	4 cyl. vertical diesel
Induction	Normally aspirated	Normally aspirated
Injection	Direct	Direct
Valves	Pushrod OHV	Pushrod OHV
Swept Volume	3.77 litres (231in. ³)	3.77 litres (231in. ³)
Bore (nominal)	100mm. (3.937in.)	98mm. (3.858in.)
Stroke (nominal)	120mm. (4.7in.)	125mm. (4.921in.)
Compression Ratio	17.5 : 1	16.8 : 1
Firing Order	1,3,4,2	1,3,4,2
Valve Clearance (hot/cold)		
Inlet/Exhaust	0.33mm. (0.013in.)	0.33mm. (0.013in.)
Injection Timing (static)		
Simms Minimec	20° B.T.D.C.	16° B.T.D.C.
C.A.V. DPA		14° B.T.D.C.
Oil Pressure HOT		
Idling Speed	1.03–1.72 bar (15–25 lbf/in ²)	
Max. Speed	3.79–4.48 bar (55–65 lbf/in ²)	

TORQUE SETTINGS

All torque settings are quoted as 'mean' figures and may be varied by 3% higher or lower.

	Nm	kgf m	lbf ft
Connecting Rod Bolts	81	8.3	60
Crankshaft Pulley Nut	353	36.0	260
Cylinder Head Nuts (cold)	136	13.8	100
Exhaust Manifold Nuts	68	6.9	50
Flywheel Bolts	136	13.8	100
Injector Retaining Bolts	16	1.7	12
Injector Nozzle Nuts	81	8.3	60
*Main Bearing Bolts/Nuts –			
to engine no. 56130 See Note below.	136	13.8	100
from engine no. 56131	163	16.6	120
Fan and Water Pump Pulley Bolts	27	2.7	20
Rocker Shaft Bolts			
5/16in. (7.94mm) dia.	20	2.1	15
3/8in. (9.52mm) dia.	41	4.1	30
Oil Pump Gear (without key)	102	10.4	75
Camshaft Timing Gear (4/98NT from 36425)	115	11.7	85

*NOTE: Apply the higher torque setting to the main bearings of any engine fitted with washers part number 96K934.

1-2

1-2

NOTE: Whilst some components of the 38TD and 4/98NT engines may be dimensionally similar, they are not necessarily interchangeable.

CAMSHAFT

Drive	Gear
Number of Bearings	4 machined in crankcase, No. 1 bearing renewable.
Journal diameter—No. 1	50.72 to 50.74mm. (1.997 to 1.998in.)
*Remainder	45.52 to 47.54mm. (1.871 to 1.872in.)
Bearing Clearance—No. 1	0.04 to 0.10mm. (0.0015 to 0.004in.)
Remainder	0.07 to 0.12mm. (0.00275 to 0.00475in.)
No. 1 Bush Bore diameter	50.787 to 50.825mm. (1.9995 to 2.0001in.)
*End Float	0.05 to 0.30mm. (0.002 to 0.012in.)
Thrust Plate Thickness	7.14 to 7.24mm. (0.281 to 0.285in.)

CONNECTING RODS AND BIG END BEARINGS

Length Centre to Centre	207.90 to 207.95mm. (8.185 to 8.187in.)
*Max. out of parallel of big and small ends.	0.01mm. per 100mm. (0.0001in. per inch) effective mandrel length
Gudgeon Pin Clearance	0.013 to 0.033mm. (0.0005 to 0.0013in.)
*Crankpin Clearance	0.04 to 0.10mm. (0.0015 to 0.004in.)
Crankpin End Float	0.2 to 0.3mm. (0.008 to 0.012in.)

CRANKSHAFT AND MAIN BEARINGS

Journal Diameter	82.53 to 82.55mm. (3.249 to 3.250in.)
Crankpin Diameter	66.66 to 66.67mm. (2.6245 to 2.6250in.)
Journal and Crankpin Undersizes	
First	-0.381mm. (-0.015in.)
Second	-0.762mm. (-0.030in.)
Third	-1.143mm. (-0.045in.)
Main Bearing Clearance	0.07 to 0.10mm. (0.003 to 0.004in.)
End Float	0.20 to 0.38mm. (0.008 to 0.015in.)
*Thrust Washer Thickness (new)	2.31 to 2.36mm. (0.091 to 0.093in.)

* CRANKSHAFT BALANCER

Shaft diameter (through housing bushes)	28.503 to 28.534mm. (1.1222 to 1.234in.)
Shaft clearance in housing bushes	0.066 to 0.152mm. (0.0026 to 0.006in.)
Thrust washer thickness	1.98 to 2.03mm. (0.078 to 0.080in.)
Balance gear backlash	0.05 to 0.15mm. (0.002 to 0.006in.)

CYLINDER BLOCK 38TD

Type	Monobloc casting integral with top half of crankcase
Water Jacket	Full length
Cylinder Liners	Renewable wet type
Standing height	0.08 to 0.15mm. (0.003 to 0.006in.)
Shim thickness	0.076 to 0.127mm. (0.003 to 0.005in.)
Ovality (max)	0.04mm. (0.00175in.)

1-4

1-4

FUEL INJECTION PUMP 38TD

Type	Simms Minimec
Cold starting device	By excess fuel device
Max. speed - no load	2,400 to 2,440 rev/min.
Idling speed	520 to 550 rev/min.

FUEL INJECTION PUMP 4/98NT

Type	Simms Minimec or C.A.V. DPA
Cold Starting device	By excess fuel control
Idling speed	675 to 725 rev/min.

FUEL INJECTORS

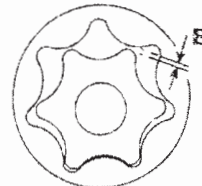
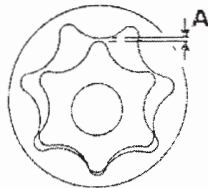
Type	4 hole, long stem
Nozzle opening pressure	175 atm.
Protrusion after machining head	3.99 to 4.17mm. (0.157 to 0.164in.)

FUEL LIFT PUMP

Type	Diaphragm with hand primer
Drive	Mechanical by eccentric on engine camshaft
Inlet depression	25.4 to 38.1 cmHg (10 to 15 inHg.)
Outlet pressure	0.34 to 0.55 bar (5 to 8 lbf/in ²)

LUBRICATION SYSTEM

Oil filter	External full flow type with replaceable element
Oil Pump type	Rotor
Capacity at 1000 rev/min.	30.7 litres/min. (6.75 UK gal/min.)
Pressure at 1000 rev/min.	4.137 bar (60 lbf/in ²)
Rotor end float	0.05 to 0.11mm. (0.002in to 0.0045in.)
Drive gear backlash—pump and crankshaft gear	0.08 to 0.15mm. (0.003 to 0.006in.)
Drive shaft clearance in body	0.063mm. (0.0025in.) max.
*Sump Capacity	
Aluminium Sump	11.5 litres (2.5 UK gal)
Aluminium Sump with Balancer	11 litres (2.4 UK gal)
Pressed Steel Sump	11 litres (2.4 UK gal)
Pressed Steel Sump with balancer	9.6 litres (2.1 UK gal)
Cast Iron Sump	9.1 litres
Relief Valve Spring—free length	57.4mm. (2.265in.)
fitted length	50.8mm. (2.0in.)
Spring fitted load	5.33 Kg (11.75 lb)
Rotor Lobe Clearance	A = 0.203mm. (0.008in.) max. B = 0.152mm. (0.006in.) max.



PISTONS AND RINGS 38TD

Number of Rings	3 compression and 2 oil control
Ring/Groove clearance	
Top Compression	0.24 to 0.28mm. (0.0095 to 0.011in.)
Remainder	0.05 to 0.10mm. (0.002 to 0.004in.)
Ring Gap (new rings and piston)	
Top Compression	0.36 to 0.51mm. (0.014 to 0.020in.)
Remainder	0.28 to 0.41mm. (0.011 to 0.016in.)
Gudgeon Pin fit	0.013mm. (0.0005in.) interference to 0.006mm. (0.00025in.) clearance
Piston to Bore clearance on thrust face at bottom of piston skirt	0.14 to 0.18mm. (0.0055 to 0.007in.)

PISTONS AND RINGS 4/98NT

*Number of Rings	3 compression and 2 or 1 oil control
Ring/Groove clearance	
Top Compression	0.08 to 0.13mm. (0.003 to 0.005in.)
Remainder	0.05 to 0.10mm. (0.002 to 0.004in.)
Ring Gap (new rings and piston)	
Top Compression	0.36 to 0.51mm. (0.014 to 0.020in.)
Remainder	0.28 to 0.41mm. (0.011 to 0.016in.)
Gudgeon Pin fit	0.005mm. (0.0002in.) interference to 0.006mm. (0.00025in.) clearance.
Piston to Bore clearance on thrust face at bottom of piston skirt	0.15 to 0.19mm. (0.006 to 0.0075in.)
*Piston crown height (at T.D.C.)	0.30 to 0.61mm. (0.012 to 0.024in.)

PUSH RODS AND TAPPETS

Tappet inside diameter	28.537 to 28.556mm. (1.1235 to 1.12425in.)
Tappet clearance in guide	0.013 to 0.058mm. (0.0005 to 0.0023in.)

ROCKER SHAFT AND ROCKERS 38TD

Rocker Shaft diameter	18.229 to 18.242mm. (0.7177 to 0.7182in.)
Shaft to Rocker clearance	0.025 to 0.064mm. (0.001 to 0.0025in.)
Spacing Washer thickness	
Between Rocker and Bracket	7.37 to 7.53mm. (0.290 to 0.297in.)
Between Rockers	20.46 to 20.64mm. (0.8055 to 0.8125in.)
Rocker Shaft Oil Relief Valve	
Spring free length	19mm. (0.75in.)
Spring fitted length	16mm. (0.625in.)
Spring fitted load	85gm. (3oz)
Dia. of ball	6mm. (0.236in.)

ROCKER SHAFT AND ROCKERS - 4/98NT

Rocker Shaft diameter	18.229 to 18.242mm. (0.7177 to 0.7182in.)
Shaft to Rocker clearance	0.025 to 0.064mm. (0.001 to 0.0025in.)
Spacing Washer thickness	
Between Rockers and Bracket	6.17 to 6.35mm. (0.243 to 0.250in.)
Between Rockers	20.46 to 20.64mm. (0.8055 to 0.8125in.)
Rocker Shaft Oil Relief Valve	
Spring free length	19mm. (0.75in.)
Spring fitted length	16mm. (0.625in.)
Spring fitted load	85gm. (3 oz)
Dia. of ball	6mm. (0.236in.)

TIMING GEARS

Backlash	0.10 to 0.15mm. (0.004 to 0.006in.)
Idler Gear Bush to Shaft clearance	0.025 to 0.050mm. (0.001 to 0.002in.)
Idler Gear Shaft diameter	28.65 to 28.67mm. (1.1235 to 1.1240in.)
Idler Gear Thrust Washer thickness	1.73 to 1.78mm. (0.68 to 0.70in.)
No. of Teeth—Crankshaft Gear	25
Camshaft Gear	50
Injector Pump Gear	50
Idler Gear	58
Oil Feed Jet diameter	1.59mm. (0.062in.)

VALVES AND SPRINGS 38TD

Spring free length—Inner	45.72mm. (1.8in.)
Outer	57.15mm. (2.25in.)
Spring length—Valve closed—Inner	40.49mm. (1.594in.)
Outer	47.62mm. (1.875in.)
Spring Pressure—Valve open—Inner	18.14kg. (40lb)
Outer	40.82kg. (90lb)
Valve Seat Angle	45°
Valve Seat Face Width	1.40 to 1.78mm. (0.055 to 0.070in.)
Valve Stem to Guide clearance	0.02 to 0.06mm. (0.001 to 0.0025in.)
Valve lift	10.92mm. (0.430in.)
Valve Stand Down	0.51 to 0.76mm. (0.020 to 0.030in.)

VALVES AND SPRINGS 4/98NT

Spring Free length—Inner	45.72mm. (1.8in.)
Outer	57.15mm. (2.25in.)
Spring length—Valve open—Inner	29.56mm. (1.164in.)
Outer	36.70mm. (1.445in.)
Spring pressure—Valve Open—Inner	18.14kg. (40lb)
Outer	40.82kg. (90lb)
Valve seat angle	45°
Valve Seat Face Width	1.40 to 1.78mm. (0.055 to 0.070in.)
Valve Stem to Guide clearance	0.02 to 0.06mm. (0.001 to 0.0025in.)
Valve lift	10.92mm. (0.430in.)
Valve Stand proud	1.6 to 1.8mm. (0.062 to 0.072in.)

WATER PUMP

Pump mounting face to —	
Pulley mounting face	93.22 to 93.98mm. (3.67 to 3.7in.)
Impeller mounting face	18.57 to 18.75mm. (0.731 to 0.738in.)
Spindle diameter	15.91 to 15.92mm. (0.6262 to 0.6267in.)
Impeller bore	15.86 to 15.88mm. (0.6244 to 0.6252in.)
Pulley Hub Bore	15.85 to 15.87mm. (0.6239 to 0.6247in.)
Bearing Assembly diameter	30.01 to 30.02mm. (1.1813 to 1.1818in.)
Body Bore	29.99 to 30.00mm. (1.1807 to 1.1811in.)

Cylinder Head	Description	1-1
	Removal and Replacement	1-1
Valves	Removal and Replacement	2-1
	Overhaul	2-3
Valve Guides	Replacement	2-3
Valve Seats	Renewal	38TD 2-4
		4/98 NT 2-5
Rocker Gear	Description	3-1
	Removal and Replacement	3-1
	Dismantling and Assembly	3-2

REMOVAL AND REPLACEMENT

Description

Push rod operated overhead valves are mounted vertically in replaceable guides in the cast iron cylinder head. The head is retained by studs and nuts to the cylinder block. The cylinder head gasket is of the composition type, with aluminium coated steel reinforcement around the cylinder bores.

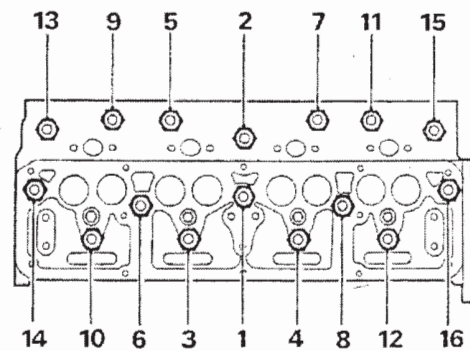
Removal

- 1 Drain cooling system and remove top radiator hose, by-pass hose and heater hoses.
- 2 Disconnect air cleaner, oil feed pipes, temperature sender and breather pipe.
- 3 Remove silencer, inlet manifold and exhaust manifold.
- 4 Remove fuel filters, injector pipes and injectors.
- 5 Remove rocker cover and rocker gear (see page 3 3-1)
- 6 Extract the push rods, keeping them in order for correct re-assembly.
- 7 Unscrew the cylinder head nuts evenly and remove the head and gasket.

Replacement

Reverse the removal sequence with the following additions.

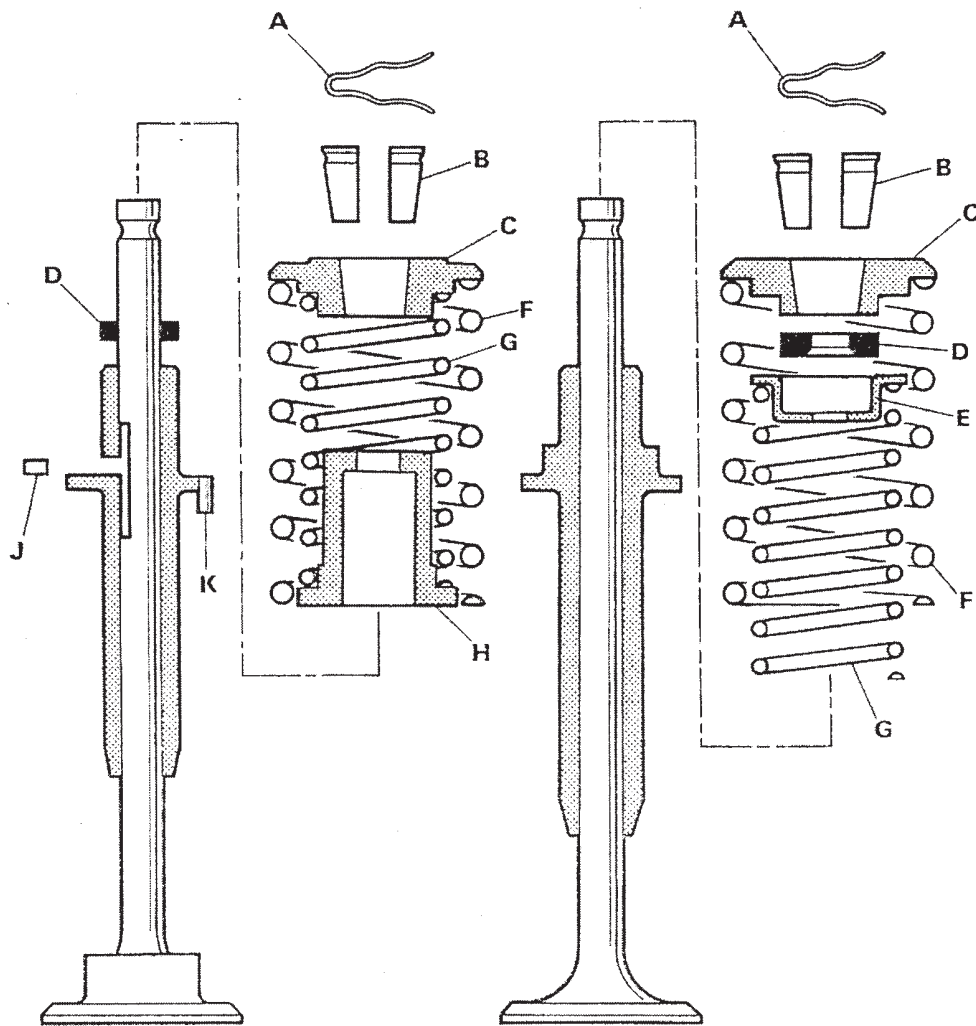
- 1 Check the cylinder head for flatness (see Technical Data).
- 2 Fit a new cylinder head gasket ensuring that it is fitted as marked.
- 3 Following the sequence shown, tighten the head nuts to the correct torque setting.



- 4 Fit injectors using new sealing washers.

NOTE: Run engine until normal working temperature is reached and continue running for a further half hour. Then re-torque cylinder head nuts using tool 18G396.

This procedure should be repeated after 50 hours of running.



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VALVES

Removal

- 1 Compress the valve springs using tools LC6118 and LC6118-6 and remove spring clip A and split collets B.
- 2 Release the compressor and remove the remainder of the components.

NOTE: On inlet valves remove thimble H to allow key J to be removed.

Replacement

Reverse the dismantling sequence with the following additions.

- 1 Overhaul the cylinder head if necessary, as described on page 3 2-3.
- 2 Lubricate valve stems before installation.
- *3 On the inlet Valve polish and lap base of thimble H and valve guide flange. Seal the interface with Loctite 275 or Hylomar joint solution. Ensure that key J is fully home and dowel K does not project above the valve guide flange.
- 4 On exhaust valves ensure that seal D is fitted with chamfer facing down.
- 5 Valve cup C with machined boss must be fitted to inlet valve.

VALVES**Overhaul**

Clean off all carbon from the cylinder head face, valves and ports.

Provided that the valve faces and seats are not excessively pitted, and the valve guides are serviceable, regrind the valves in their existing seats.

The valve seat angle, face width and distance from the head face must remain as specified in the Technical Data section.

If these dimensions cannot be maintained renew the valves and, if necessary, the valve guides.

If the guides are renewed, new valves must be fitted and their seats recut or new inserts fitted.

Valve Guide Replacement

Drive out old valve guides, through the upper face of the cylinder head, using tool 18G228.

Drive in new guides, using tool 18G228, until the shoulder is seated on the cylinder head. Ensure that the slot of each inlet guide engages in its location peg in the cylinder head.

After fitting new valve guides to 38TD engines ream through using tool 18G229A.

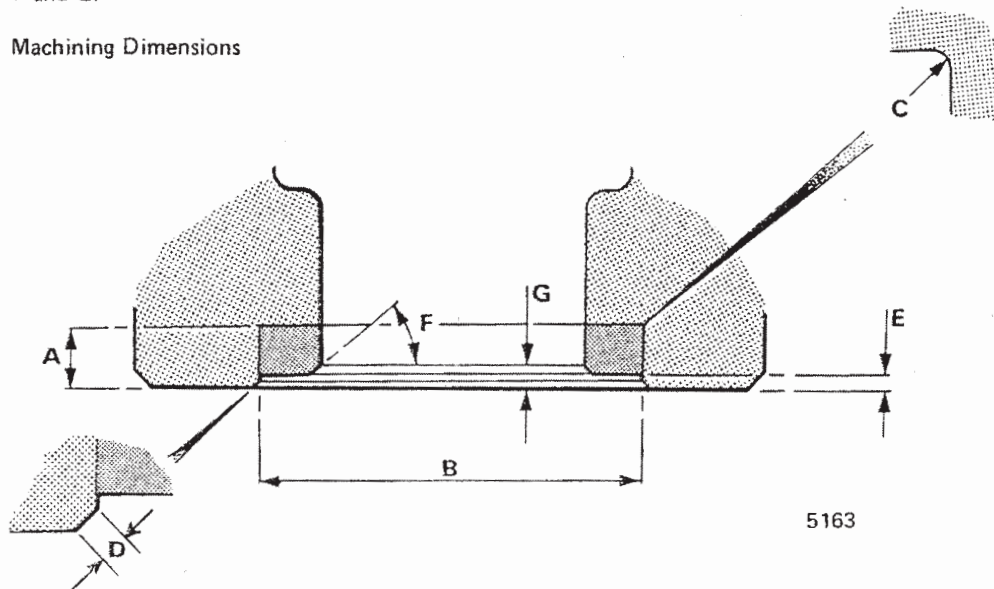
VALVE SEAT RENEWAL 38TD ENGINES

If normal recutting does not restore the valve seats, or if the stand down is excessive, then new inserts should be fitted as follows:

Machine the cylinder head to the given dimensions and press in new inserts.

The inserts should be machined to dimensions F and G.

Machining Dimensions



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INLET

EXHAUST

A	8.25 to 8.33mm. (0.325 to 0.328in.)	8.25 to 8.33mm. (0.325 to 0.328in.)
B	45.07 to 45.10mm. (1.775 to 1.776in.)	41.27 to 41.3mm. (1.625 to 1.626in.)
C	0.38mm. (0.015in.)	0.38mm. (0.015in.)
D	0.50 to 0.76mm. (0.02 to 0.03in.) at 45°	0.50 to 0.76mm. (0.02 to 0.03in.) at 45°
E	1.78 to 2.08mm. (0.07 to 0.08in.)	1.78 to 2.08mm. (0.07 to 0.08in.)
F	45°	45°
G	3.42 to 3.56mm. (0.135 to 0.140in.)	3.42 to 3.56mm. (0.135 to 0.140in.)

VALVE SEAT RENEWAL 4/98 NT ENGINES

If normal recutting does not restore the valve seats, or if the stand-proud is incorrect the cylinder head should be machined as follows:

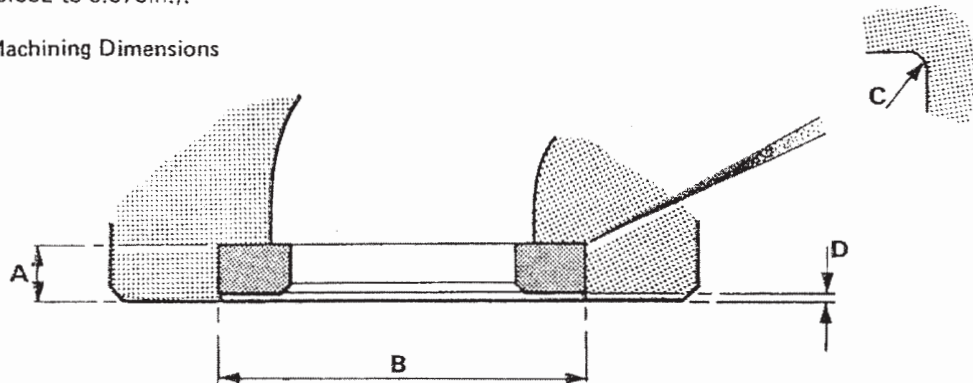
Exhaust valves only are fitted with seat inserts.

To renew inlet valve seats, first remove exhaust valve seat inserts using tools MS284 and 18G284 AAH. Skim cylinder head maintaining the minimum head depth (see Technical Data section).

Machine the exhaust valve insert bores to the given dimensions and press in new *inserts using tool LC176.

Reface all seats at 45° to a face width of 1.40 to 1.78mm. (0.055 to 0.070in.), maintaining the valve stand-proud at 1.6 to 1.8mm. (0.062 to 0.070in.).

Machining Dimensions



A	5.72 to 6.60mm. (0.225 to 0.260in.)
B	41.33 to 41.36mm. (1.6275 to 1.6285in.)
C	0.13 to 0.18mm. (0.005 to 0.007in.)
D	0.13 to 0.33mm. (0.005 to 0.013in.)

ROCKER GEAR

The rocker arms are located between the supports of a two piece rocker shaft. Spacer tubes are fitted between each pair of rockers and between the rockers and the supports.

The plugs in the outer ends of the rocker shaft can be unscrewed for cleaning the internal oilways. The two rockers shafts are retained in the centre support by bolts. Rocker shaft supports are fitted to the ends of the shaft and between each pair of rockers.

To the front intermediate support is fitted an oil relief valve.

Rocker clearance adjustment is by means of screws and locknuts.

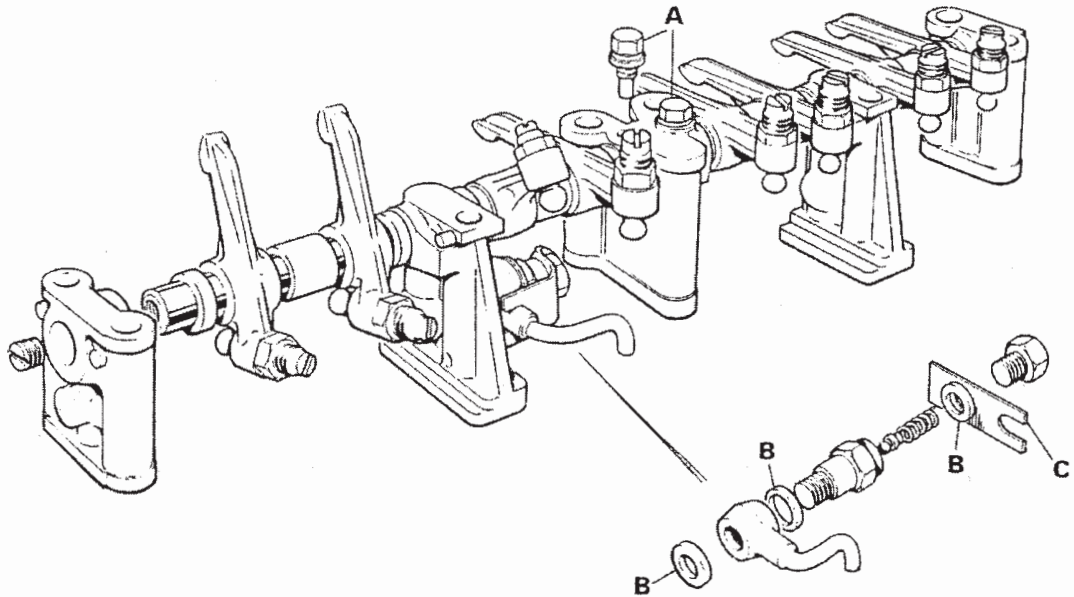
Removal

- 1 Remove the rocker cover.
- 2 Remove the support pillar mounting bolts and lift off the rocker gear assembly.

Replacement

Reverse the removal sequence with the following additions.

- 1 Before tightening the mounting bolts ensure that the rocker adjusting screws are correctly located in the push rod cups.
- 2 Adjust valve clearances.
- 3 Renew rocker cover gasket.



Dismantling

- 1 Remove screws A and separate the two halves of the shaft assembly.

NOTE: The components should be identified to ensure replacement in their original positions.

Assembly

- 1 Check rocker shaft diameter and the bore diameter of the rockers, to ensure that rocker to shaft clearances are not excessive (see Technical Data).
- 2 Check oil relief valve spring, ball and seat for wear (see Technical Data).
- 3 Renew copper gaskets B and tab washer C.

Connecting Rods and Pistons	Removal and Replacement	1-1
	Dismantling and Assembly	2-1
Cylinder Liners	Removal and Replacement	3-1
Crankshaft and Main Bearings	Removal	4-1
	Replacement	4-2
Crankshaft Oil Seals	Removal and Replacement—front	5-1
	—rear	5-2
Camshaft and Timing Gears	Removal	6-1
	Replacement	6-3
Crankshaft Balancer	Removal and Replacement	7-1

CONNECTING RODS AND PISTONS

Removal

- 1 Remove the rocker gear and cylinder head (see Section 3).
- 2 Withdraw the dipstick and remove the sump, after draining the engine oil.
- 3 Remove the balancer gear assembly (see Page 4 7-1).
- 4 Remove the oil pump (see Section 5).
- 5 Unscrew the big end bolts and tap them to release the connecting rods from their caps. Then completely remove the bolts and detach the big end caps. Keep the caps and bearing shells in their original order to ensure their correct replacement.
- 6 Push the connecting rod and piston assembly upwards out of the cylinder bore.

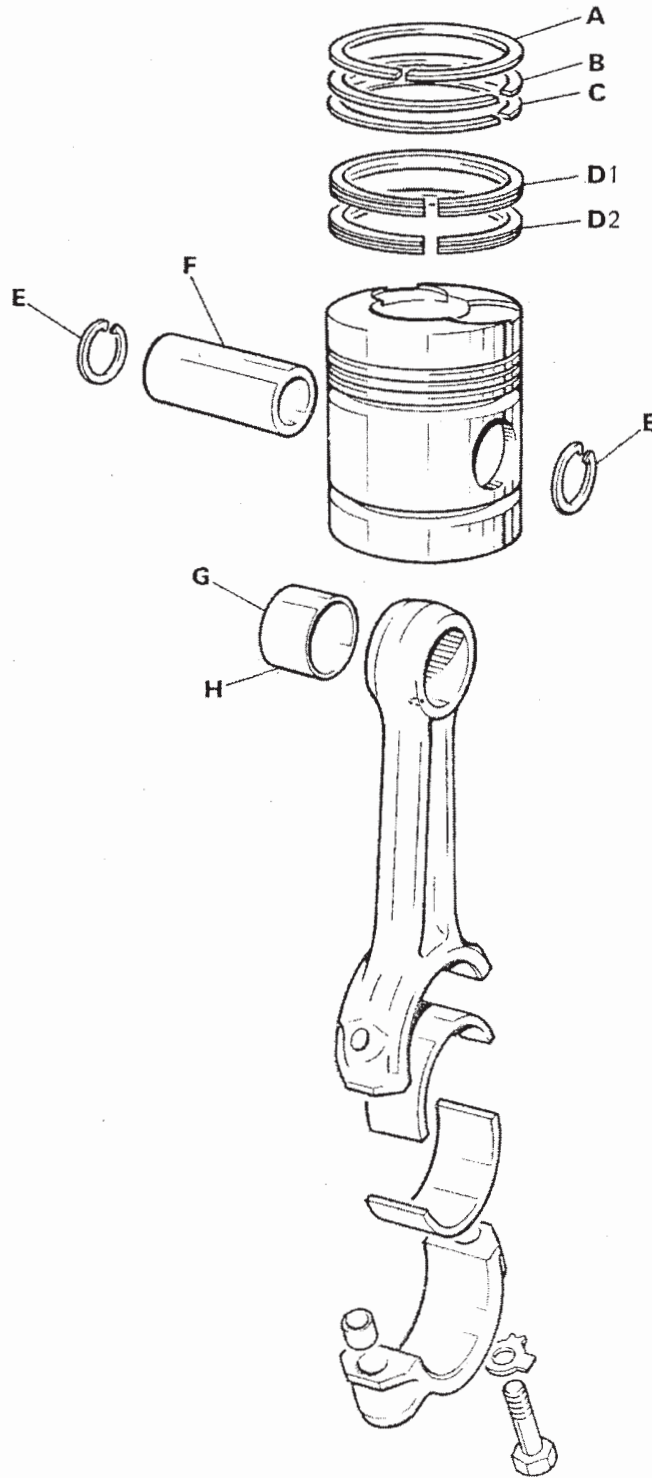
NOTE: To facilitate piston removal it may be necessary to carefully scrape the carbon away from the top of the cylinder bores.

- 7 Retain the connecting rods and pistons with their respective caps in their original order to ensure correct replacement.

Replacement

Refer to Inspection (page 4 2-2) and Cylinder Liners (page 4 3-1), then reverse the removal sequence with the following additions.

- 1 Lubricate the cylinder bores and all bearing surfaces with engine oil.
- 2 Space the piston ring gaps at intervals of 90 degrees around the piston and apply ring compressor 18G55
- *3 Fit pistons and connecting rods to their original bores ensuring that the identification numbers on piston crown, connecting rod and big end cap are toward R.H. side (inlet manifold side) of engine.
- *4 Fit new big end bolts and tighten to the specified torque setting (see Technical Data). Check the crankshaft for free rotation after tightening each big end. Check that each big end bearing has end float on its crankpin.
- 5 Refit balancer, sump and cylinder head. Refill cooling system and sump.
- 6 Adjust valve clearances.



CONNECTING RODS AND PISTONS

Dismantling

- *1 Remove the piston rings A,B,C,D1 and D2.
On latest engines ring D2 is omitted.
- 2 Extract circlips E and push out gudgeon pin F.

Inspection

Check the gudgeon pin clearance in the little end bush G (see Technical Data) If the clearance is excessive renew the bush using tool 18G616.

Examine the piston markings to check for excessive wear or connecting rod misalignment. A heavy marking on the piston above the pin on one side together with a corresponding heavy marking below the pin on the other side, indicates a bent connecting rod which should either be straightened or renewed.

Clean all carbon from the piston ring grooves and, using new piston rings, check ring to groove clearance (see Technical Data). If the clearance is excessive renew the piston.

Check the big end bearing shells and crankshaft journals for excessive wear and scoring.

Assembly

Reverse the dismantling sequence with the following additions.

- 1 Press the gudgeon pin bush G into the connecting rod ensuring that oil hole H aligns with the oil hole in the connecting rod.
- 2 Assemble the pistons to the connecting rods with the valve clearance recess to the cap side of the rod.
- 3 Check the piston ring gaps with each ring in turn positioned squarely on an unworn portion of the cylinder bores (see Technical Data). Fit the rings to the piston.
NOTE: Fit rings B and C with the side marked TOP uppermost.

CYLINDER LINERS

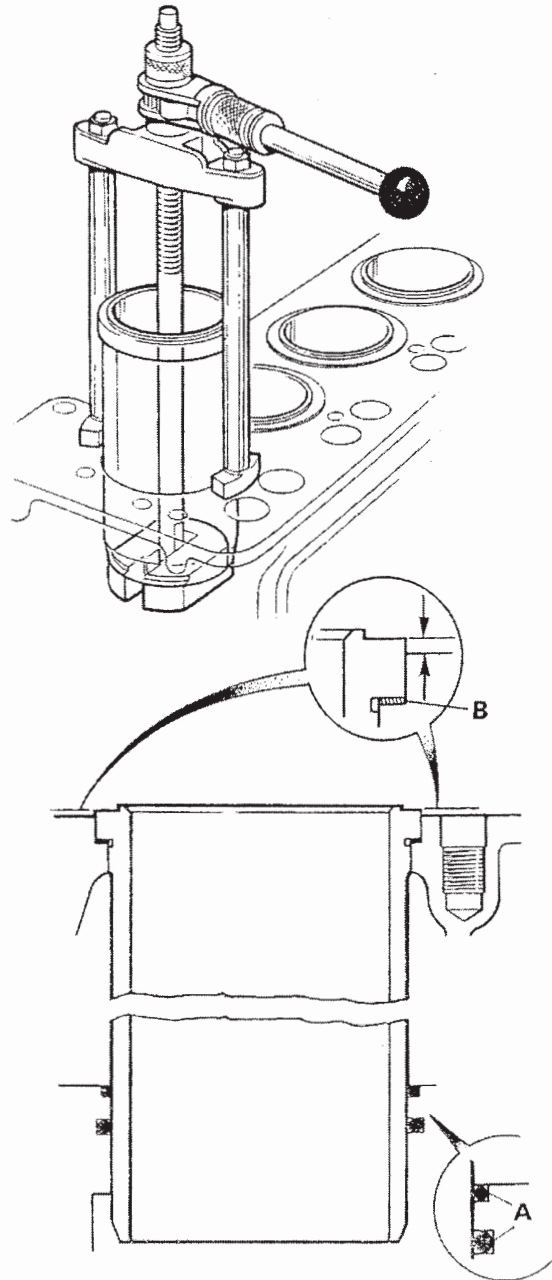
Check the cylinder liners for wear (see Technical Data). Liners outside the specified tolerance band should be replaced as follows.

Removal

- 1 Withdraw the cylinder liner from the top of the cylinder block using tools 18G227C and 18G227E.
- 2 Remove cylinder liner sealing rings A from the groove in the cylinder block.

Replacement

- 1 Insert the liner into the cylinder block without the sealing rings fitted.
- 2 Clamp the liner into the cylinder block and check the liner standing height (see Technical Data). Correct the standing height by adding shims B under the liner flange.
- 3 Remove the liner and fit new sealing rings A in the cylinder block.
- 4 Refit the cylinder liner and shims and check the ovality of the liner in the sealing ring area (see Technical Data).
- 5 If the ovality is incorrect remove the liner and check that the sealing rings are correctly seated.



CRANKSHAFT AND MAIN BEARINGS

Removal

- 1 Withdraw the dipstick and remove the sump after draining the oil.
- 2 Remove alternator, drive belt, fan and water pump pulley.
- 3 Release the lockwasher, unscrew the crankshaft nut and remove pulley and key.
- 4 Remove the engine front mounting plate; alternator mounting bracket and timing cover.
- 5 Remove clutch assembly if fitted.
- 6 Release the three lockplates and remove the flywheel securing bolts. Draw the flywheel from the crankshaft by screwing 3/8in. UNF bolts into the extractor holes.
- 7 Extract the two roll pin dowels and remove the crankshaft rear oil seal and housing.
- 8 Remove the flywheel housing securing bolts and remove the housing complete with the starter motor.
- *9 Remove the retaining plate and distance collar from the auxiliary idler gear spindle. Draw the steering pump idler gear from the spindle using tools 18G231 and 18G231C.
- 10 Remove the main idler gear and thrust washer.
- 11 Remove injector feed pipes spill rail and injectors.
- 12 Invert the engine and remove the balancer unit (see page 4 7-1).
- 13 Remove the oil pump (see Section 5).
- 14 Remove the front main bearing cap with the bearing half and both halves of the thrust washer.
- 15 Remove the connecting rod bearing caps and bearing halves. Push piston and connecting rod assemblies down their cylinders.
- 16 Position the connecting rods to the left hand side of the engine (looking from the flywheel end). Turn the crankshaft until crankpins 2 and 3 are to the left hand side and horizontal.
- 17 Remove the main bearing caps and lift out the crankshaft. Turn the crankshaft anti-clockwise (looking on the timing gear end) to allow its centre webs to clear oil pump delivery pipe connections.
- 18 Collect the main bearing upper halves.

Contd.

CRANKSHAFT AND MAIN BEARINGS**Removal –Contd.**

- 19 Remove oil pump driving gear and the crankshaft gears using tools 18G231 and 18G231B.

Replacement

Reverse the removal sequence with the following additions.

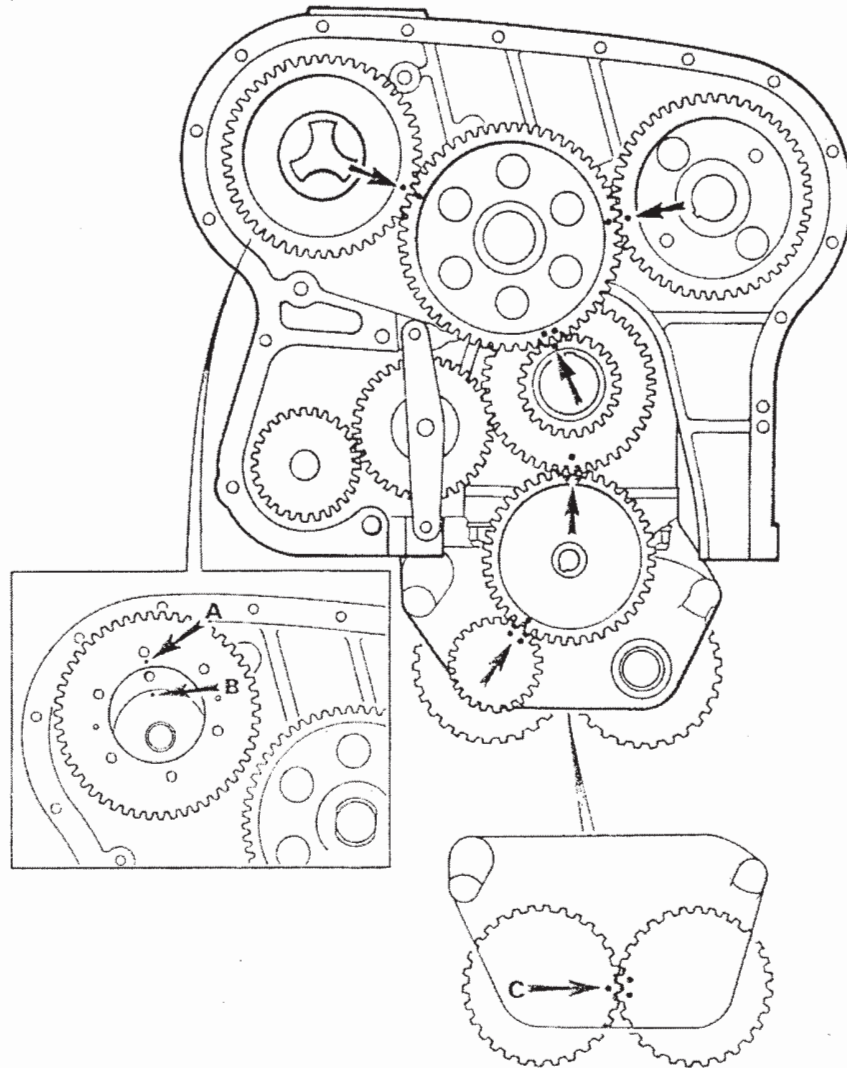
- 1 Refer to Technical Data for torque settings.
- 2 Before refitting the crankshaft, lubricate oil seals, bearings and thrust washers with engine oil.
- 3 Big end and main bearing caps are reference marked to the crankcase.
- 4 Fit the thrust washers with their grooved faces towards the crankshaft thrust faces.
- 5 Check crankshaft bearing clearance and end float, measure end float with the main bearing caps secured (see Technical Data).
- 6 Assemble timing gears with their marks in line (see page 4 4-3).
- 7 Refit balancer gears with the thrust washers on both sides of the gears, and with their timing marks in line (see page 4 4-3).
- 8 Assemble oil pump gear and crankshaft gear (see page 4 4-3) and check backlash.
- 9 Fit the idler gear thrust washer with its grooved side towards the gear.
- 10 Fit the crankshaft oil thrower with its grooved side towards the gear.
- 11 Apply sealing compound to the lower portion of the oil seal housing where it contacts the crankcase and to both sides of the sump gasket. Use tool 18G1110 to fit the rear oil seal and housing to the crankshaft, refit roll pin dowels before tightening the securing bolts.

TIMING GEARS

Replacement

Marks A and B apply only when C.A.V. D.P.A. injection pump is fitted.

Align marks C on balancer gears (if fitted).



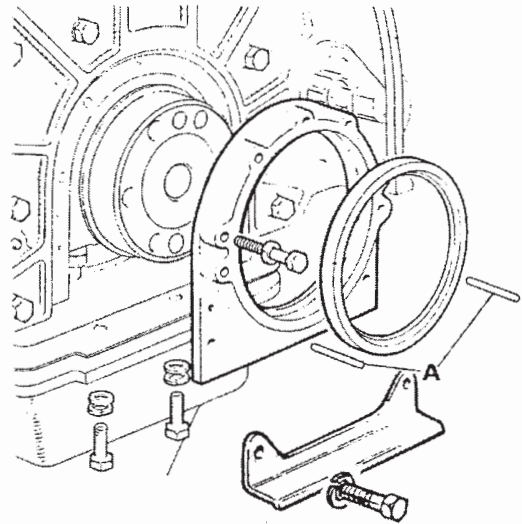
CRANKSHAFT OIL SEAL-REAR**Removal.**

- 1 Remove clutch, if fitted, and flywheel.
- 2 Extract the two roll pin dowels A from the seal housing.
- 3 Remove the securing bolts and withdraw the housing from the crankshaft.

Replacement

Reverse the removal sequence with the following additions.

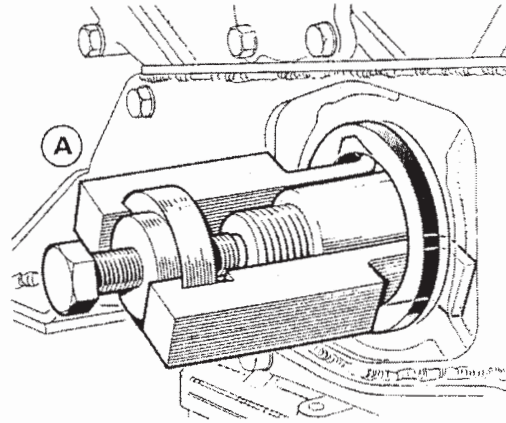
- 1 Use tools 18G134 and 18G134CP to fit oil seal to housing.
- 2 Lubricate the oil seal and crankshaft with engine oil.
- 3 Apply sealing compound to the lower portion of the seal housing where it contacts the crankcase. Use tool 18G1110 to fit oil seal and housing to the crankshaft.
- 4 Fit the roll pin dowels before tightening bolts.



CRANKSHAFT OIL SEAL—FRONT

Removal

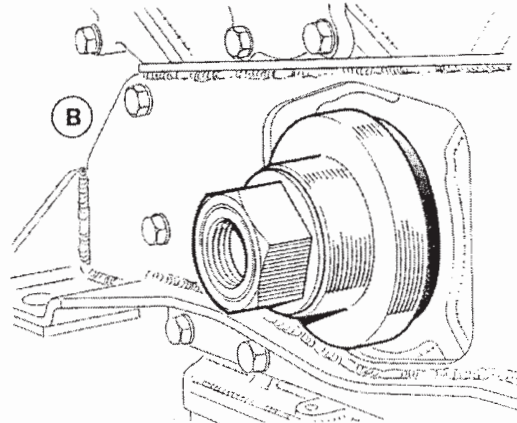
- 1 Release the alternator and remove the drive belt.
- 2 Release the lockwasher, unscrew the crankshaft nut and remove the crankshaft pulley.
- 3 Withdraw the oil seal from the timing cover using tool 18G1111 as at A.



Replacement

Reverse the removal sequence with the following additions.

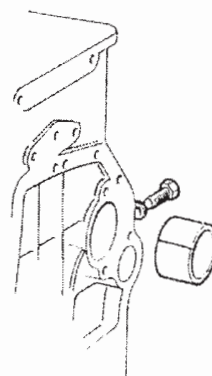
- 1 Lubricate the oil seal and crankshaft with engine oil.
- 2 Use tool 18G1111 to refit oil seal as at B.

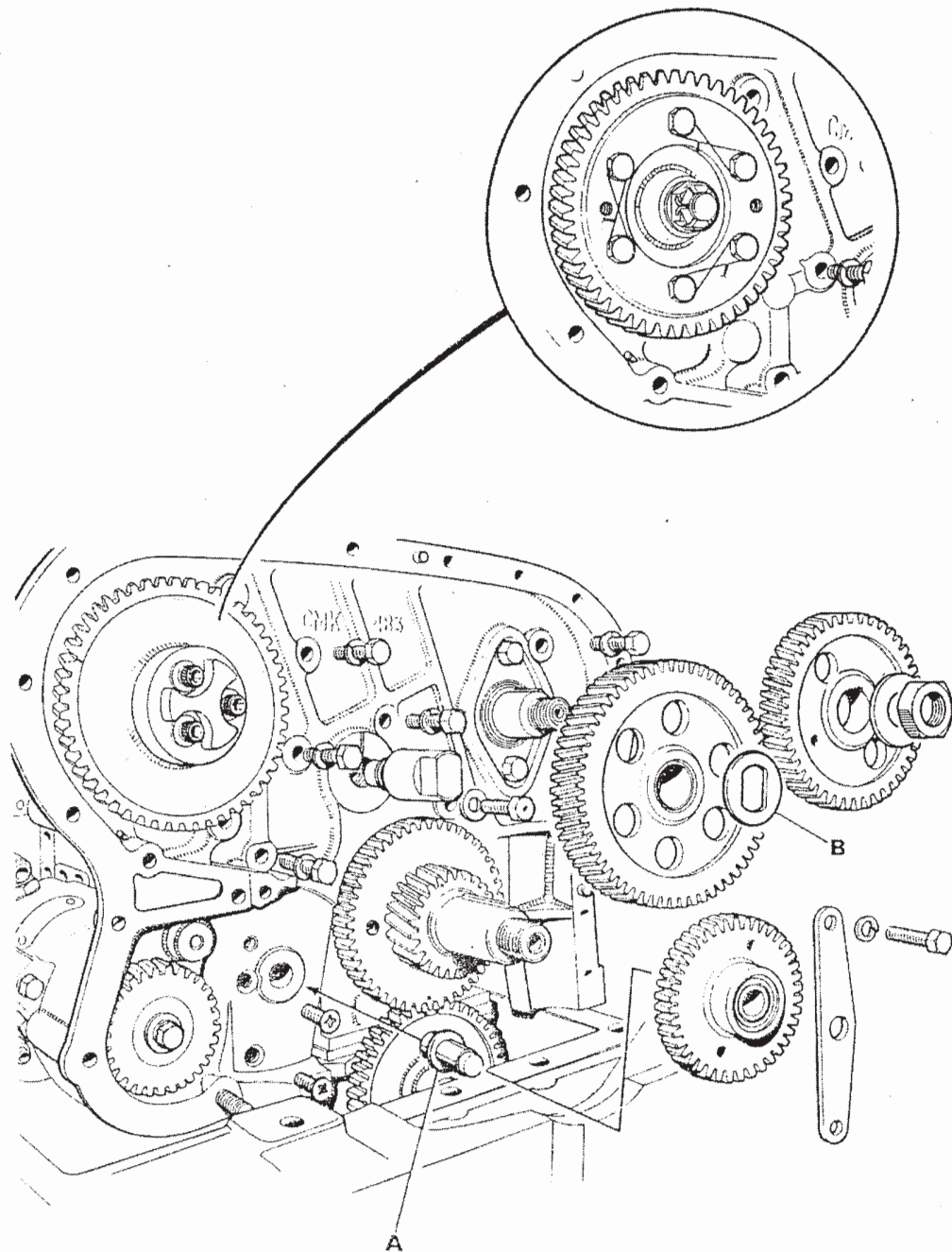


CAMSHAFT AND TIMING GEARS

Removal

- 1 Remove the rocker cover, rocker assembly and push rods.
- 2 Remove the lift pump and its fuel pipes.
- 3 Remove the alternator and drive belt.
- 4 Remove the cylinder head oil feed pipe.
- 5 Remove the tappet cover and lift out the tappets.
- 6 Remove the fan, water pump pulley and crankshaft pulley.
- 7 Remove the engine front mounting plate, sump and gasket.
- 8 Remove the timing cover.
NOTE: The main idler gear thrust washer may stick to the cover.
- 9 Remove the crankshaft oil thrower, refit the crankshaft nut and rotate the crankshaft to align the timing marks (see page 4 4-3).
- 10 Release the lock washer from the camshaft gear and remove the nut. Draw the gear from the camshaft using tools 18G231 and 18G231C.
- 11 Remove the camshaft thrust plate and withdraw the camshaft with a rotary motion.
- 12 Remove the main idler gear and crankshaft gears using tools 18G231 and 18G231B. If removing the idler gear shaft, note it has a left hand thread.
- 13 Remove the retaining plate, distance collar and auxiliary idler gear using tools 18G231 and 18G231C.
- 14 Remove the two countersunk screws, from behind the idler gear and the timing gear oil feed jet.
- 15 Remove the pipes from fuel injector pump and steering pump.
- 16 Remove the bolts securing the timing case and tap the case complete with the injection pump and steering pump, from its dowels.
- *17. If replacing the camshaft front bush, ensure hole in bush aligns with locating screw hole, refit screw and washer.



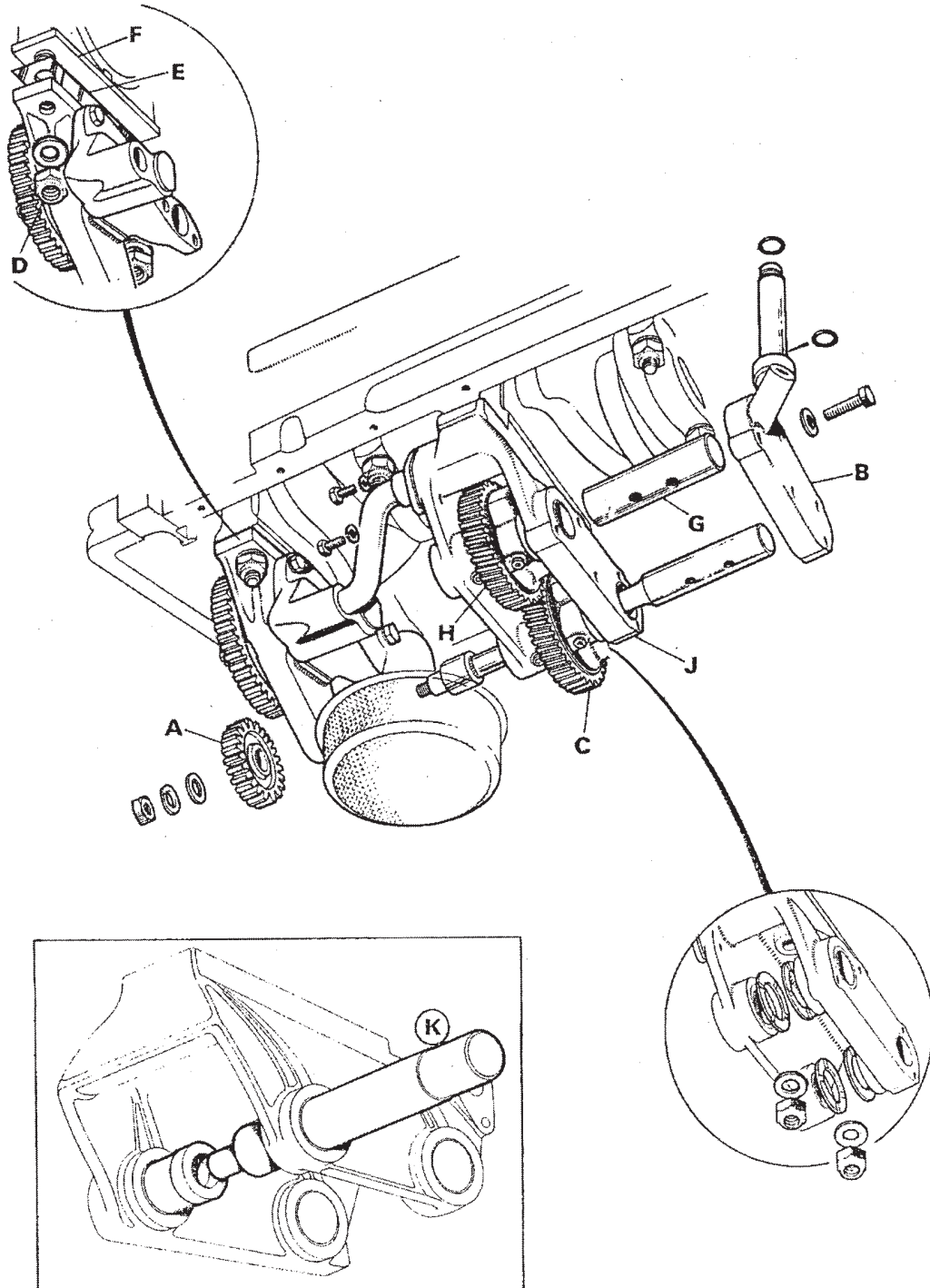


CAMSHAFT AND TIMING GEARS

Replacement

Reverse the removal sequence with the following additions.

- 1 Assemble timing gears with their marks in line (see page 4 4-3).
- 2 Assemble the auxiliary idler gear distance collar A with its recessed face to the gear.
- *3 If bolt is fitted to camshaft, torque tighten (see technical data).
- *4 Check camshaft end float (see Technical Data). If incorrect renew thrust washer B.
- *5 Fit the crankshaft oil thrower with its chamfered face towards the gear.



CRANKSHAFT BALANCER

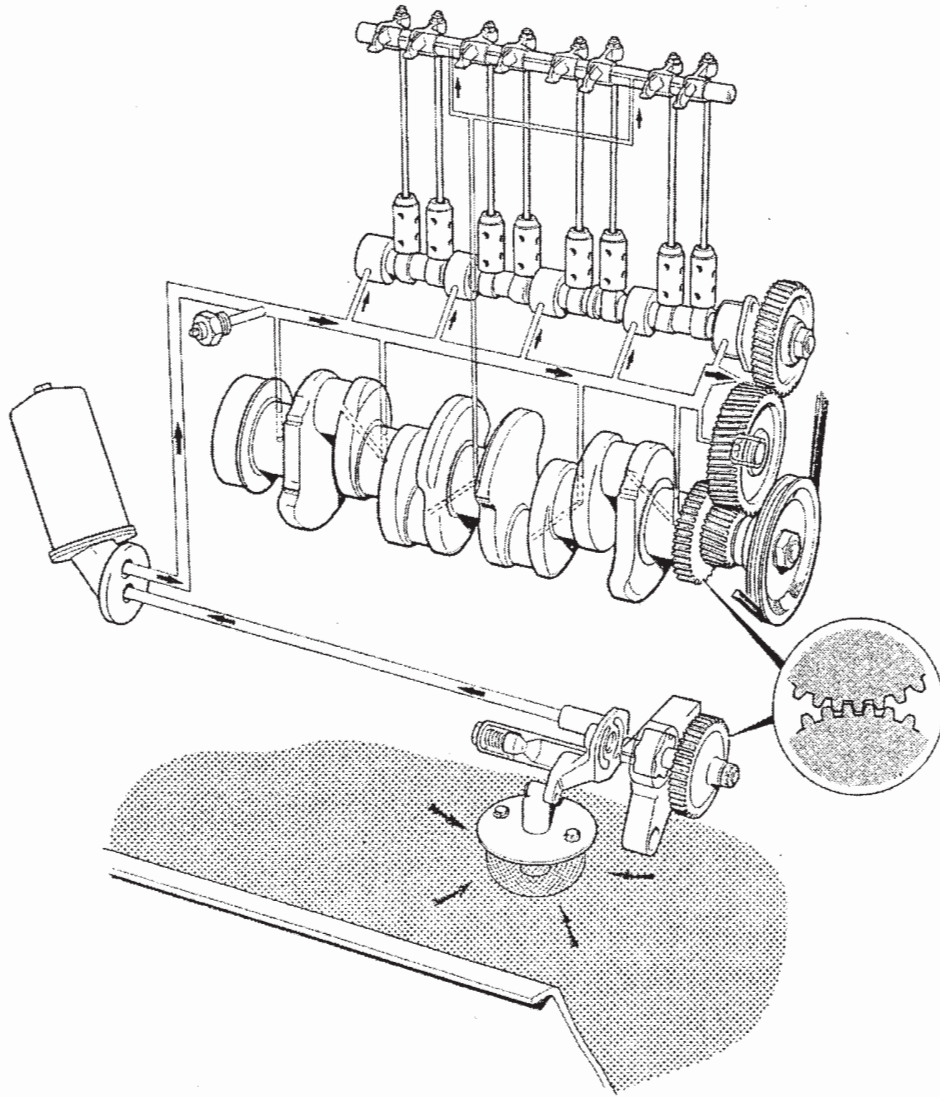
Removal

- 1 Withdraw the dipstick and remove the sump, after draining the oil.
- 2 Remove the balancer gear A from the drive shaft.
- 3 Disconnect the oil pipe from the balancer and remove the rear cover B.
- 4 Remove the drive shaft, right hand balancer gear C and its thrust washers.
- 5 Remove the front main bearing nuts D and oil pump, using tool 18G1185. NOTE: The oil pump mounting studs are also the mounting studs for No. 1 main bearing cap. Shims E are inserted between the oil pump and the bearing cap.
- 6 Remove the front main bearing cap F, bearing half and thrust washer upper and lower halves.
- 7 Withdraw the driven shaft G and remove the left hand balancer gear H and its thrust washers. NOTE: The dowel bolt holes are situated to the rear end of the shaft.
- 8 Remove the balancer gear housing J. NOTE: The balancer mounting studs are also the mounting location for No. 3 main bearing cap.

Replacement

- Reverse the removal sequence with the following additions.
- 1 If the support bracket bushes require replacement press out the old bushes and the new bushes in, from the inside face of the bracket, using tool 18G1186 as at K.
 - 2 Lubricate the bearing surfaces and the thrust washers with engine oil.
 - 3 Fit the thrust washer grooved face towards the crankshaft thrust face.
 - 4 Refit the balancer gear with the thrust washers on both sides of the gear. Apply Loctite to the gear securing screw threads.
 - 5 Align the marks on the balancer gears and timing gears (see page 4 4-3).
 - 6 Check crankshaft end float and oil pump gear backlash (see Technical Data).

General Description		1-1
Oil Pump	Removal and Replacement	2-1
	Dismantling and Assembly	2-1



DESCRIPTION

The engine lubrication system is of the forced feed type, the oil being circulated by an oil pump mounted on the front main bearing cap and gear driven from the front of the crankshaft.

The rotor type pump draws oil from the sump through a strainer. Oil pressure is controlled by a plunger type relief valve, incorporated in the oil pump, which when open bleeds oil back to the sump.

Oil from the pump flows through an externally mounted filter to the main oil gallery.

A drilling from the main gallery feeds oil to the crankshaft main bearings and through the crankshaft to the big end bearings. Oil splash from the crankshaft lubricates the gudgeon pins and cylinder walls.

A second drilling from the main oil gallery feeds oil to the camshaft bearings.

A drilling across the front of the crankcase feeds oil to the timing idler gear bush, the timing gear train being lubricated by an oil jet nozzle screwed into the drilling.

The connection for the oil pressure gauge is taken from the main oil gallery and indicates the pressure of the oil to the crankshaft and camshaft bearings.

An external pipe feeds oil from the main gallery, through a drilling in the cylinder head and intermediate rocker brackets, to the hollow rocker shaft. Oil pressure in the rocker shaft is controlled by an oil pressure valve mounted in the front intermediate rocker bracket.

The rocker bearing surfaces are lubricated by oil from the rocker shaft, oil mist providing the lubrication for the valves and guides.

Discharged oil from the rocker shaft and relief valve drains down the push rod tunnels, lubricating the tappets and cams before returning to the sump.

OIL PUMP

Removal and Replacement

Remove and replace the oil pump (see Section 4 page 7-2)

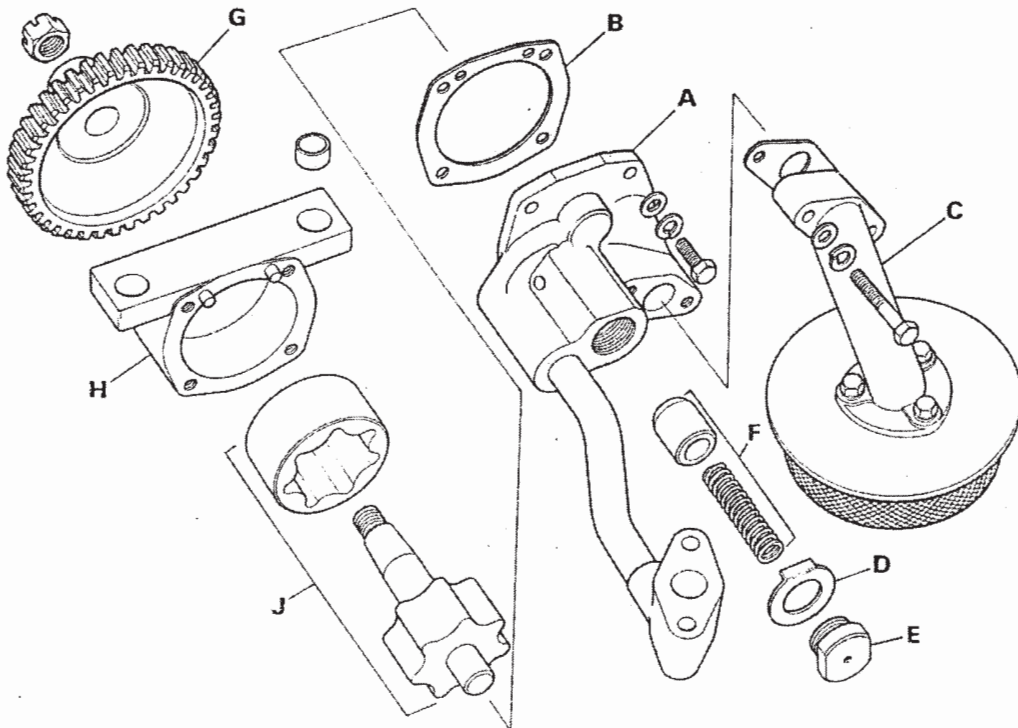
Dismantling

- 1 Remove the oil delivery pipe A and sealing ring B, oil suction pipe and strainer C.
- 2 Release the lock washer D and remove the oil pressure relief plug E, spring and valve F.
- 3 Remove the drive gear G, end cover H, and rotors J.

Assembly

Reverse the dismantling sequence with the following additions.

- 1 Check the rotor lobe clearance (See Technical Data) ensuring that the chamfered edge of the outer rotor is innermost in the pump body.
- 2 Check relief valve spring length (see Technical Data).
- 3 Check pump performance (see Technical Data).



Water Pump	Removal and Replacement	1-1
	Dismantling and Assembly	1-1

1-1

1-1

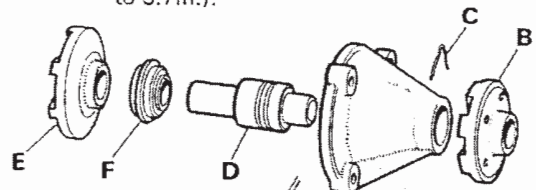
WATER PUMP

Removal

- 1 Drain the cooling system and remove the hoses from the water pump.
- 2 Slacken the alternator and remove the fan belt.
- 3 Remove the fan blades and pulley A.
- 4 Remove the pump assembly from the cylinder block.

X = 18.57 to 18.75mm. (0.731 to 0.738in.)

Y = 93.22 to 93.98mm. (3.67 to 3.7in.)



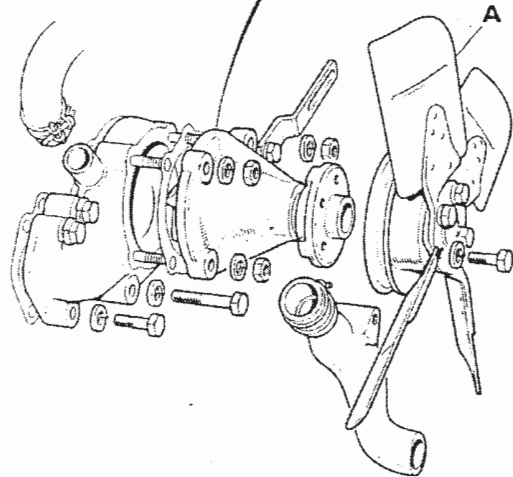
Replacement

Reverse the removal sequence with the following additions:

- 1 Clean the mating faces and fit new gasket.

Dismantling

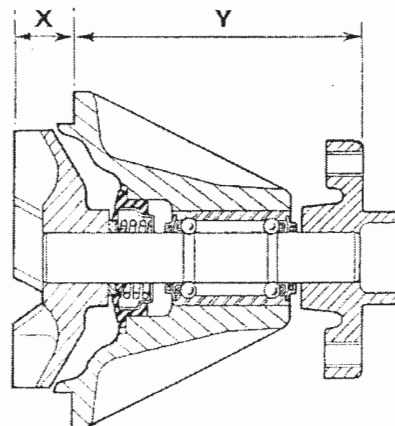
- 1 Pull the hub B off its spindle and remove the locating wire C.
- 2 Drive out the spindle and bearing assembly D rearwards and remove the impeller E.
- 3 Remove the water seal F and check the bearings for wear.



Assembly

Reverse the dismantling sequence with the following additions.

- 1 Renew worn parts.
NOTE: A new pulley hub B must be fitted.
- 2 Press the pulley hub and impeller onto the shaft assembly to the following dimensions.



General Description		1-1
Service Precautions		1-1
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Fuel Injector Sleeves	Removal 4/98NT only	3-1
	* Replacement 4/98NT to engine no. 4461 and 38TD	3-2
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Fuel Injection Pump		
Simms	Removal and Replacement	4-1
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C.A.V.	Removal and Replacement	4-3
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Fuel Lift Pump	Description	5-1
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	Dismantling and Assembly	5-2

GENERAL DESCRIPTION

The fuel system consists of a fuel lift pump, injection pump, injectors and filter.

The fuel lift pump is of the diaphragm type and incorporates a hand priming lever to enable the fuel system to be bled.

Fuel is drawn from the tank by the lift pump via a sedimenter filter and passes through a replaceable element twin bowl filter to the injection pump.

The injection pump delivers fuel at high pressure to each of the four hole, long stem injectors mounted in the cylinder head.

SERVICE PRECAUTIONS

It must be stressed that as the fuel injection equipment is manufactured to extremely fine limits, it is essential that the maximum care is taken to avoid damage and the ingress of dirt. Blanking plugs and dust caps must be fitted whenever applicable.

When overhauling injection pumps specialised equipment is required for calibration, phasing and testing.

FUEL INJECTORS

Removal

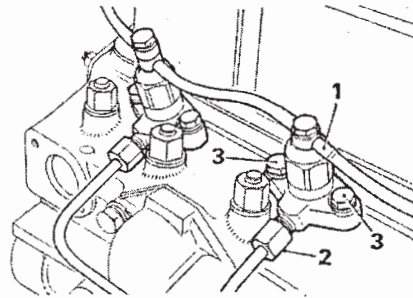
NOTE: Fit blanking plugs or dust caps when removing any pipe.

- 1 Disconnect the injector spill rail by unscrewing the leak-off union screw.
- 2 Unscrew the injector inlet nuts and slacken the injector pipes at the injection pump. Take care not to bend the injector pipes.
- 3 Unscrew the two retaining bolts and remove the injectors.

Replacement

Reverse the removal sequence with the following additions.

- 1 Renew all sealing washers.
- 2 Torque tighten the injector securing bolts (see Technical Data).



FUEL INJECTORS

Dismantling

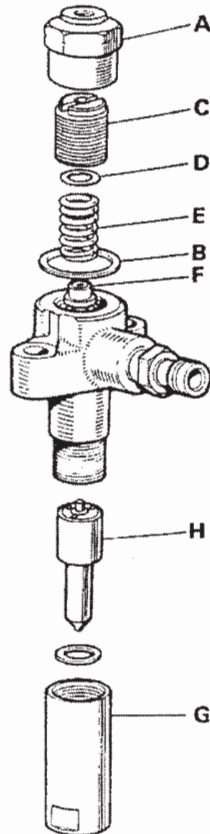
- 1 Remove injector cap nut A and copper joint B.
- 2 Unscrew the spring cap nut C and remove the spring plate D, spring E and spindle F.
- 3 Remove the nozzle nut G, using tool 18G210, and the nozzle H.

NOTE: Each nozzle body and valve are a mated assembly and should always be kept together.

Assembly

Reverse the dismantling sequence with the following additions.

- 1 Clean nozzle assembly of carbon and reverse flush using tools 18G109A and 18G109E.
- 2 Check and adjust nozzle settings (see page 7 2-3).
- 3 Torque tighten the injector nut (see Technical Data).



FUEL INJECTORS

Testing and Setting

Testing of injectors should be carried out using tool 18G109A.

WARNING: When an injector is being tested the spray holes in the nozzle should always face away from the operator.

Nozzle Opening Pressure

- 1 Connect injector to testing machine, open check valve and operate the pump.
- 2 The reading on the pressure gauge at the instant the nozzle sprays, should be 175 atmospheres.
- 3 If the pressure is incorrect adjust the spring cap nut.
- 4 Refit the injector cap nut and copper washer.

Nozzle Spray

- 1 Close the check valve, to cut out the pressure gauge, operate the pump lever at 60 strokes per minute.
- 2 There should be 4 equal sprays from the nozzle evenly distributed over 150mm. (6in.), without any visible core or jets of unatomised fuel.

Pressure Tightness of Seats

- 1 Open the check valve, wipe nozzle dry, and pump slowly until a pressure of 160 atmospheres is obtained.

- 2 Hold pressure for 10 seconds and check the nozzle tip for dryness. Only slight dampness is permissible.

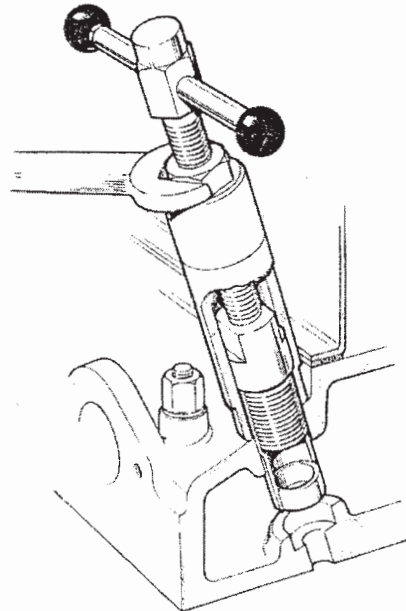
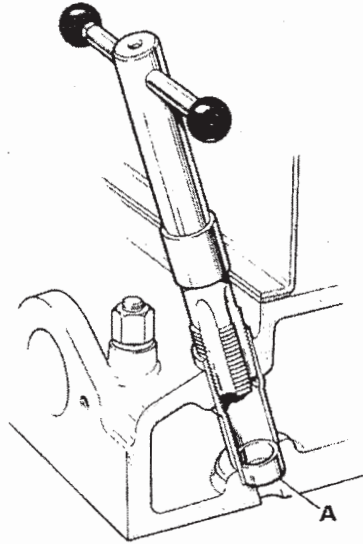
Back Leakage

- 1 Operate pump lever slowly until a pressure of 160 atmospheres is obtained.
- 2 Check that the time taken for the pressure to drop from 150 to 100 atmospheres is not less than 5 seconds.

INJECTOR SLEEVE-4/98NT ONLY

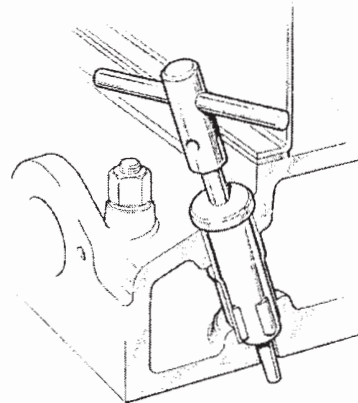
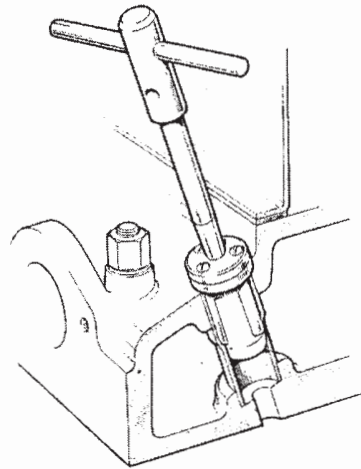
Removal

- 1 Drain the cooling system.
- 2 Disconnect the spill rail and high pressure pipes from the injectors.
- 3 Remove the securing bolts and injectors.
- 4 Insert the sealing plug A, part of tool 18G213A, into the injector sleeve. Using the remainder of the tool cut a thread in the sleeve.
- 5 Use removal tool, 18G213D, to remove the injector sleeve from the cylinder head. Remove the sealing plug for future use.



INJECTOR SLEEVES²4/98NT, To engine no. 4461 and 38TD**Replacement**

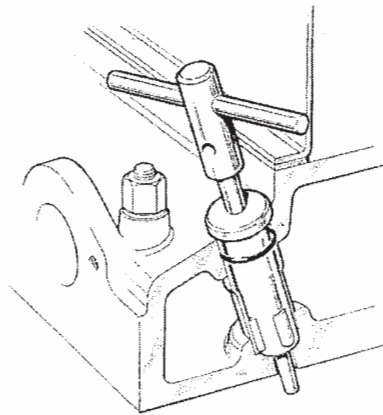
- 1 Position the piston at the bottom of its stroke and push the injector sleeve into position.
- 2 Insert tool 892/00070 into the injector sleeve. Withdraw the tool approximately 6.4 to 9.5mm. (1/4 to 3/8in.).
- 3 Expand the top portion of the injector sleeve by applying pressure and a clockwise rotary motion. Continue until the expander rod reaches its limit of travel, then withdraw the tool using an anti-clockwise rotary motion.
- 4 Use the above procedures with tool 892/00117 to expand the bottom of the sleeve.
- 5 Replace injectors with a new sealing washer.



INJECTOR SLEEVES—4/98NT
from engine no. 4462

Replacement

1. Position the piston at the bottom of its stroke and push the injector sleeve into position.
2. Insert tool 892/00117 into the injector sleeve. Withdraw the tool approximately 6.4 to 9.5mm. (1/4 to 3/8in).
3. Expand the bottom portion of the injector sleeve by applying pressure and a clockwise rotary motion. Continue until the expander rod reaches its limit of travel, then withdraw the tool using an anti-clockwise rotary motion.
4. Replace injectors with a new sealing washer.



FUEL INJECTION PUMP (SIMMS IN-LINE)

Removal

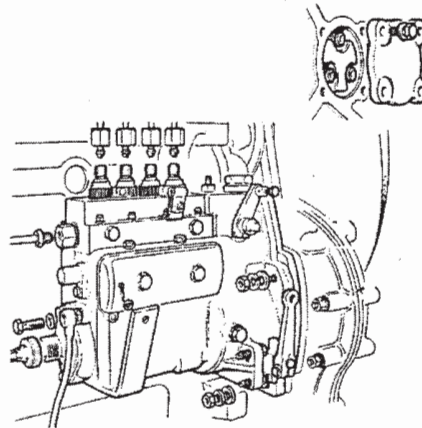
NOTE: Fit blanking plugs and dust caps when removing any pipes.

- 1 Remove the fuel delivery pipe, high pressure pipes and bracket from the engine.
- 2 Disconnect the lubricating oil overflow pipe from the injection pump.
- 3 Rotate the engine crankshaft until No. 1 piston is on its compression stroke. Insert timing pin AMK9990 through the hole in the flywheel housing and into the flywheel.
- 4 Remove the pump drive inspection cover from the timing cover. Scribe a line across the gear cap and timing cover.
- 5 Remove the allen screws in the gear cap, the four pump securing nuts and withdraw the pump.

Replacement

Reverse the removal sequence with the following additions.

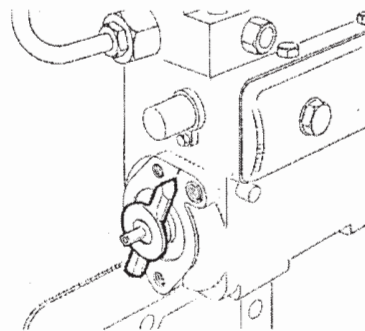
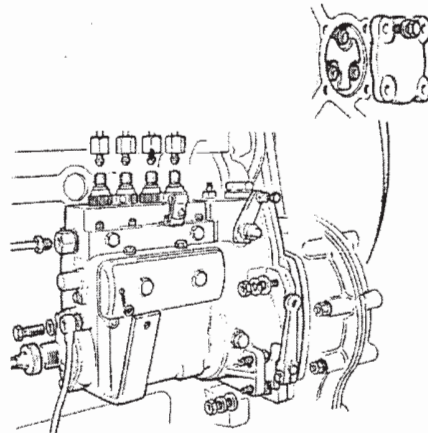
- 1 With the engine crankshaft positioned as for removal, align the injection pump camshaft roll-pin with the slot in the drive gear hub.



- 2 Fit the injection pump, engaging the pump camshaft with the drive gear, and tighten the pump mounting nuts.
- 3 Check the gear cap to cover scribed line, to ensure that the drive gear has not moved, and tighten the allen screws in the cap.
- 4 Set the injection pump timing as page 7 4-2.

FUEL INJECTION PUMP TIMING (SIMMS IN-LINE)

- 1 Rotate the engine crankshaft until No. 1 piston is on its compression stroke. Insert timing pin AMK9990 through the hole in the flywheel housing and into the flywheel. If necessary rotate the crankshaft in its normal direction of rotation, until the pin engages in the flywheel hole.
- 2 Remove the pump drive inspection cover from the timing cover and slacken the allen screws about half a turn.
- 3 Remove the tractometer drive housing from the pump and fit timing pointer 18G1114 to the pump camshaft.
- 4 Rotate the camshaft to align the pointer with the timing mark on the pump body. Tighten the drive gear allen screws.
- 5 Remove the timing pointer and pin and fit the inspection cover.



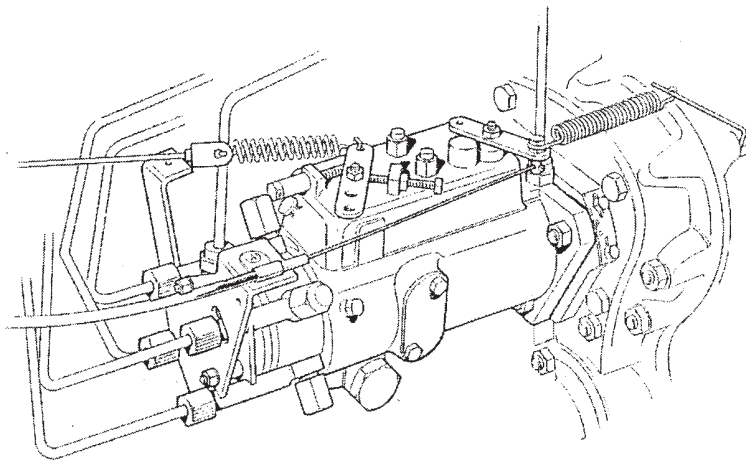
**FUEL INJECTION PUMP
(C.A.V. DPA)****Removal**

NOTE: Fit blanking plugs and dust caps when removing any pipes.

- 1 Remove the fuel delivery and return pipes, high pressure pipes and bracket from the engine.
- 2 Remove the three securing nuts and the injection pump.

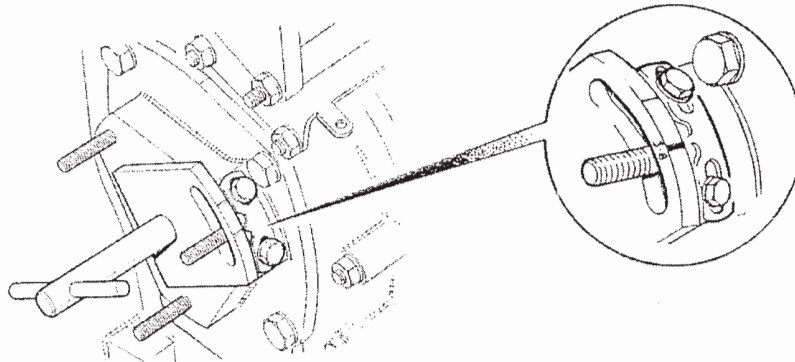
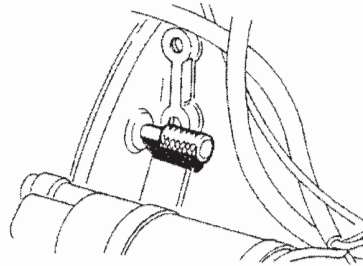
Replacement

Reverse the removal sequence re-timing the injection pump as page 7 4-4.



**FUEL INJECTION PUMP TIMING
(C.A.V. DPA)**

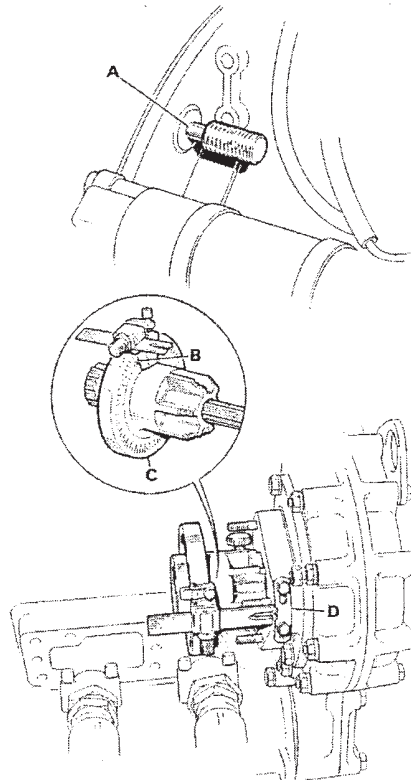
- 1 Rotate the engine crankshaft until No. 1 piston is on its compression stroke. Insert timing pin AMK9990 through the hole in the flywheel housing and into the flywheel. If necessary rotate the crankshaft, in its normal direction of rotation, until the pin engages in the flywheel hole.
- 2 Remove the fuel injection pump (see page 7 4-3)
- 3 Using tool 18G1206 align timing pointer with the tool mark as shown.
- 4 Refit injection pump with the scribed timing mark on its mounting flange in line with the timing pointer.



FUEL INJECTION PUMP TIMING (C.A.V. DPA)

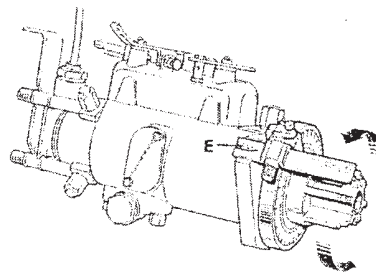
Setting Engine Pointer

- 1 Rotate the engine crankshaft until No. 1 piston is on its compression stroke. Insert timing pin AMK999D (A) through the hole in the flywheel housing and into the flywheel. If necessary rotate the crankshaft, in its normal direction of rotation, until the pin engages in the flywheel hole.
- 2 Remove the fuel injection pump (see page 7 4-3)
- 3 Set the timing pointer B of tool C (MS67B) to the 254° mark and fit the tool into the pump mounting flange.
- 4 Align the timing pointer D with the centre of the slot in the tool timing pointer.



Pump Timing Mark

- 5 Remove the splined shaft, and reverse the pointer of the timing tool before fitting to the pump.
- 6 Using tool 18G109A pressurise pump No. 1 outlet to 30 Ats (29,4 bar; 30 kgf/cm²; 427 lbf/in²).
- 7 Maintaining pressure on the pump handle turn the injection pump, with the timing tool, in the direction shown until it 'locks' at No. 1 position.
- 8 If the scribed line is not in the centre of the timing tool slot E a new line should be scribed.



FUEL LIFT PUMP**DESCRIPTION**

The fuel lift pump is mounted on the opposite side of the crankcase to the injection pump and is driven by an eccentric on the engine camshaft. A priming lever permits hand pumping of fuel to the injection pump for bleeding the system.

As the engine camshaft revolves the eccentric lifts the pump rocker arm, which pulls the diaphragm downwards against the spring pressure. This creates a partial vacuum in the pump chamber which causes the inlet valve to open and draw fuel from the tank.

Fuel from the tank enters the pump sediment chamber and then passes through the filter gauze and the suction valve into the pumping chamber. On the return stroke the spring pressure pushes the diaphragm upwards, forcing the fuel from the pumping chamber through the delivery valve and port to the main fuel filter.

When the main fuel filter is full a pressure is created in the pump chamber. This pressure will hold the diaphragm downward against the spring pressure, and it will remain in this position until the main fuel filter requires further fuel. The rocker arm operates the connecting link and allows an idling movement of the rocker arm when there is no movement of the pump diaphragm.

*** Removal**

- 1 Disconnect and plug the fuel inlet and outlet pipes.
- 2 Unscrew the pump securing nuts and remove the pump from the engine.

Replacement

Reverse the removal sequence with the following addition.

- 1 Replace the fuel pump gasket.

FUEL LIFT PUMP

Dismantling

- 1 Removed the domed cover 1, sealing ring 2 and filter gauze 3.
- 2 Scribe an assembly mark across the body joint flanges, remove the securing screws 4 and separate the pump halves 5 and 6.
- 3 Press the diaphragm 7 downwards, rotate through 90° and withdraw the diaphragm and spring 8.
- 4 Check the rocker arm pin 11 and linkage for wear or damage.
- 5 Secure the pump rocker arm 12 in a vice and tap the pump mounting flange to dislodge the rocker arm and components.

Assembly

Reverse the dismantling sequence with the following additions.

- 1 Assemble the rocker arm 12, operating link 13 and packing washers 10 onto the rocker arm pin 11. Place this assembly, and the rocker arm spring 14 in position in the pump body and tap the rocker arm pin retainers 9 fully into their grooves.
- 2 Lever out the valves 15, renew their gaskets 16 and press new valves into position.

Note: The inlet valve spring must be toward the diaphragm, and the outlet valve spring away from the diaphragm.

- 3 If renewing the diaphragm spring ensure that it is the same colour as the original.

