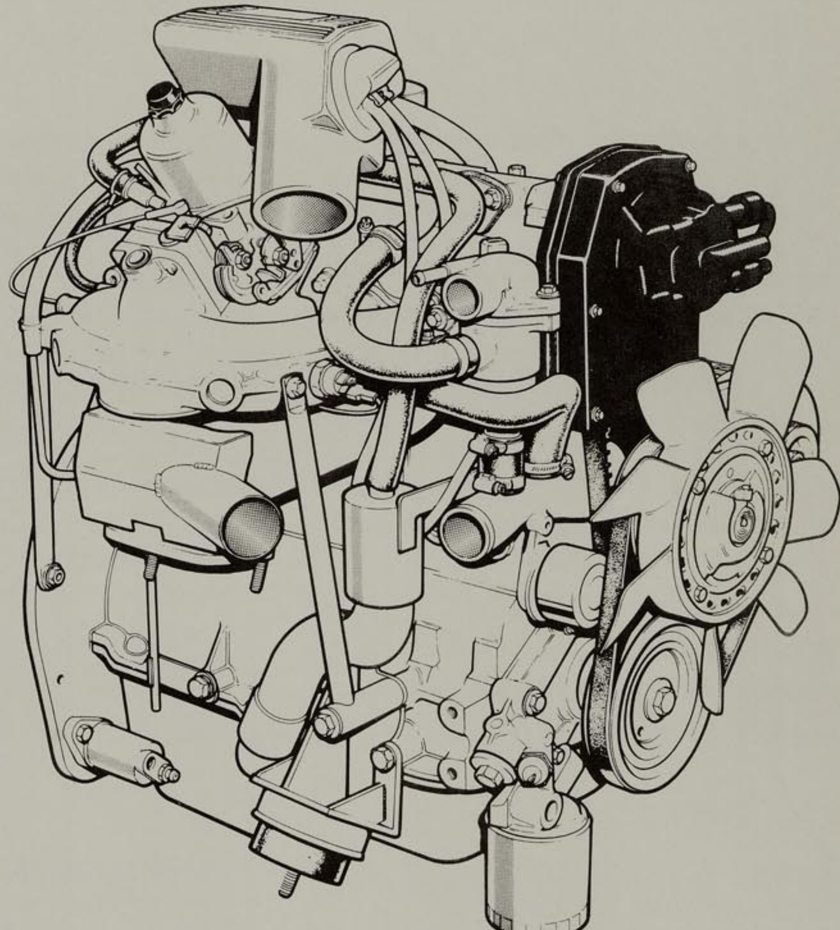
Service Workbook

02 Petrol Engine



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O2 COMMERCIAL ENGINE

Service Workbook

This Service Workbook covers the O2 Commercial engine fitted to 200 models. This engine has been supplied by the Rover Group and, to enable us to provide a comprehensive workbook, we are indebted to them for allowing us to reproduce certain sections of their manual without change.
This Service Workbook is primarily designed to assist skilled technicians in the efficient repair and maintenance of the O2 Commercial engine, but can also be used as a reference workbook for training purposes.
This Service Workbook should always be consulted prior to servicing or repair work.

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02 COMMERCIAL ENGINE

Contents

TECHNICAL DATA (NOTE: 20V E46 engine data not included)

Number of Cylinders	4	
Bore	84,45 mm	3.325 in
Stroke	88,89 mm(75,87mm-1.7L)	3.504 in(2.99in-1.7L)
Valve Operation	Single overhead camshaft	
Compression Ratio	8.0 : 1 (LC) 9.0 : 1 (HC)	

Crankshaft

Main Journal Diameter	54,005 to 54,026 mm	2.1262 to 2.1270 in
Crankpin Diameter	47,661 to 47,648 mm	1.8764 to 1.8759 in
Crankshaft End-thrust	Taken on thrust washers at centre main bearing	
Crankshaft End-thrust	0,025 to 0,14 mm	0.001 to 0.005 in
Spigot Bush Depth	7,6 mm	0.30 in

Main Bearings

Width: Front, Centre & Rear	28,512 mm	1.1225 in
Intermediate	19,37 mm	0.763 in
Diametrical Clearance	0,025 to 0,0686 mm	0.001 to 0.0027in

Connecting Rods

Length Between Centres	149 mm	5.86 in
Locking Method, Big-end	Multi-sided nut	

Big-End Bearing

Width	19,56 to 19,94 mm	0.770 to 0.785 in
Diametrical Clearance	0,025 to 0,0686 mm	0.0010 to 0.0027 in

Gudgeon Pins

Diameter	20,638 to 20,643 mm		0.8125 to 0.8127 in
Fit In: Piston	Hand push fit at 16°C		60°F
Connecting Rod- Minimum torque using 18 G 1306	16 Nm	1,7 kgf m	12 lbf ft

Pistons

Overall Height	60,25 mm	2.372 in
Clearance in Cylinder:		
Below oil control groove	0,02 to 0,06 mm	0.0008 to 0.0024 in
Bottom of skirt	0,01 to 0,038 mm	0.0004 to 0.0012 in
Oversizes	0,51 mm	0.020 in
Width of Ring Grooves:		
Top and second	1,78 to 1,80 mm	0.070 to 0.071 in
Oil control		
- 2000 LC	4,00 to 4,02 mm	0.157 to 0.158 in
- 1700 & 2000 HC	3,00 to 3,02 mm	0.118 to 0.119 in
Gudgeon Pin Bore	20,655 to 20,650 mm	0.8132 to 0.8130 in
Offset from centre	1,58 mm	0.062 in

Piston Rings

Number of Rings	3 (2 compression, 1 oil control)	
Compression:		
Width	1,73 to 1,74 mm	0.068 to 0.069 in
Ring to groove clearance	0,04 to 0,07 mm	0.0015 to 0.0027 in
Fitted gap	0,3 to 0,5 mm	0.012 to 0.020 in
Oil Control		
Fitted gap - 1.7, 2.0 HC	0,38 to 0,58 mm	0.015 to 0.023 in
- 2.0 LC	0,38 to 1,4 mm	0.015 to 0.055 in

Camshaft

End-thrust	Thrust plate in cam cover	
End-float	0,07 to 0,18 mm	0.003 to 0.007 in
Drive Belt (timing)	Toothed belt from crankshaft gear wheel	
Number of teeth	104 x 9,52 mm pitch	104 x 0.375 in pitch
Journal Diameter	47,963 to 47,975 mm	1.888 to 1.889 in
Bearings: Number and type	3, direct in head and cover	
Diametrical clearance	0,043 to 0,094 mm	0.0017 to 0.0037 in

Tappets

Adjustment	Selective internal shim retained in valve spring cap	
Outside Diameter	31,729 to 31,745 mm	1.2491 to 1.2498 in
Shim Sizes	2,31 to 3,17 mm	0.091 to 0.125 in
	– in 0,05 mm (0.002 in) increments	

Valves

Face Angle	45° 30'	
Seat Angle	45°	
Head Diameter: Inlet	40mm	1.575 in
Exhaust	34 mm	1.339 in
Stem Diameter: Inlet	7,41 to 7,42 mm	0.2917 to 0.2923 in
Exhaust	7,39 to 7,41 mm	0.2909 to 0.2917 in
Stem to Guide Clearance: Inlet	0,03 to 0,05 mm	0.001 to 0.002 in
Exhaust	0,04 to 0,073 mm	0.0015 to 0.0027 in
Cam Lift	9,525 mm	0.375 in
(1.7L)	(7,112 mm)	(0.28 in)
Valve Stand Proud	1,0 mm	0.040 in

Valve Guides

Length	38,90 mm	1.532 in
Outside Diameter	12,04 to 12,06 mm	0.474 to 0.475 in
Inside Diameter	7,45 to 7,46 mm	0.293 to 0.2937 in
Fitted Height Above Head	10mm	0.394 in
Interference Fit in Head	0,04 to 0,08 mm	0.0015 to 0.003 in

Valve Springs

Free Length	41,81 mm	1.646 in	
Fitted Length	34,925 mm	1.375 in	
Load at Fitted Length	198 N	20 kgf	44.5 lbf
Number of Working Coils	4.5		
Valve Crash	6,400 rev/min		

Valve Timing

Valve Timing Marks	Camshaft wheel dimple and bearing cover pointer and 90° B.T.D.C. mark on timing disc	
Valve Timing Clearance:		
Inlet and exhaust	0.30 mm	0.012 in
Inlet Valve: Opens	19° B.T.D.C (5° 1.7L)	
Closes	41° A.B.D.C. (45° 1.7L)	
Exhaust Valve: Opens	61° B.B.D.C (40° 1.7L)	
Closes	15° A.T.D.C (10° 1.7L)	

Lubrication

System	Wet sump, pressure fed		
System pressure: Idling	0.7 bar	10 lbf/in^2(min.)	
Above 2500 rpm	3.8 to 5.5 bar	55 to 80 lbf/in^2	
Relief Valve Spring:			
Free length (approximate)	38,7 mm	1.525 in	
Fitted length	24,4 mm	0.960 in	
Load at fitted length	11 N	7,9 kgf	17.4 lbf
Oil Pressure Warning Light Switch	0.4 to 0.7 bar	6 to 10 lbf/in^2	
Oil Pump	Eccentric rotors, mounted around crankshaft		
Oil Filter	Full flow with disposable cartridge element and by-pass valve		
Filter By-pass Valve Opens (nominal)	1 bar	14 lbf/in^2	

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ENGINE TUNING DATA

Type	17V	20V
Capacity	1700 cm^3 (103.7 in^3)	1994 cm^3 (121.63 in^3)
Compression Ratio	8.0 : 1	8.0 : 1 LC 9.0 : 1 HC
Compression Pressure	170-180	170-180 (LC) 190-200 (HC)
	No more than 15% variance between cylinders	
Firing Order	............................1 - 3 - 4 - 2..................................	
Idling Speed (hot)	650 ± 50 rpm	750 ± 50 rpm
Fast Idle Speed (hot)	1300 ± 50 rpm	1300 ± 50 rpm
Tappet Clearance	.............0,30 ± 0,03 mm (0.12 ± 0.001 in).............	
Adjust only if less than	........................0,20 mm (0.008 in)...........................	
Ignition System	.....Programmed ignition with electronic control.....	
Spark Plugs	N9YC	N7YC
Spark Plug Gap	..........................0,85 mm (0.035 in).............................	
Carburetter		
Make/Type	......................SU HIF 44 horizontal..........................	
Specification	FZX 1429	FZX 1485 (LC) FZX 1487 (HC)
Piston Spring Colour	Red	Yellow
Needle	BGJ	BGN (LC) BGM (HC)
Fuel, Minimum Octane Rating	91 RON (2*)	97 RON (4*)
Exhaust Gas Content (CO) At Idle Speed	............................2.25% ± 0.75%...............................	

SERVICE LUBRICANTS

Engine, Carburetter, Oil can.

Multipart Multigrade Super 10W40

Use oil meeting specification BLS 22 OL 07 or the requirements of CCMC G3 or API SF or SF/CD quality having a viscosity band recommended for the temperature range of your locality.

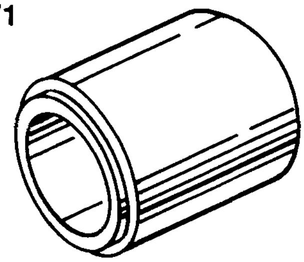
SERVICE SUMMARY

	MILEAGE			
	1,000	12,000 36,000	24,000	48,000
Renew engine oil and filter	NOT ● FILTER	●	●	●
Adjust alternator drive belt tension	●	●	●	RENEW BELT
Top up carburetter piston damper	●	●	●	●
Check/adjust carb. for idle, fast idle, emission setting	●	●	●	●
Renew spark plugs		●	●	●
Renew air cleaner element			●	●
Check valve clearances. Adjust if less than 0.008in.			●	●
Clean engine oil filler cap filter			●	●
Renew anti-freeze solution (50%) (NB 50% solution for top up)		TOP ● UP	●	●
Renew camshaft drive belt.			VISUAL CHECK	●

SPECIAL TOOLS

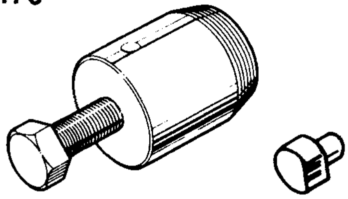
The following new tools are required for the 02 Commercial engine.

18G 1471



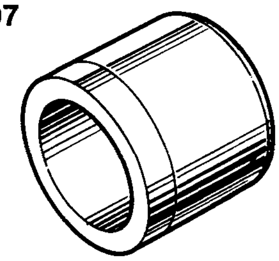
Camshaft front seal replacer

18G 1476



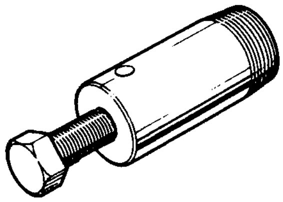
Camshaft front seal remover

18G 1507



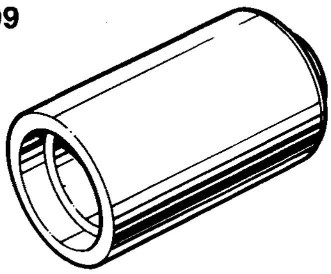
Camshaft rear seal replacer

18G 1508



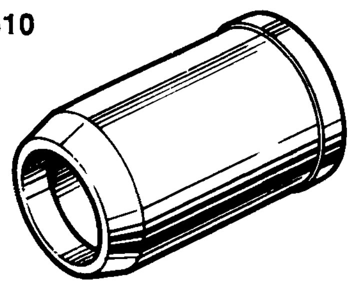
Crankshaft front seal remover

18G 1509



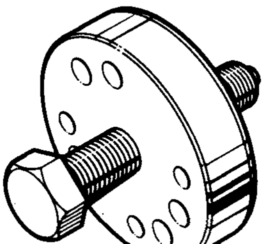
Crankshaft front seal replacer

18G 1510



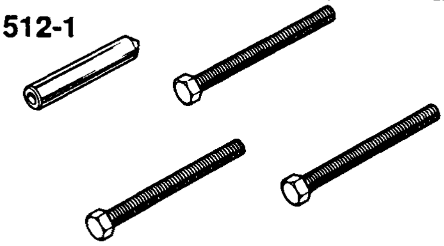
Crankshaft front seal protection sleeve

18G 1512



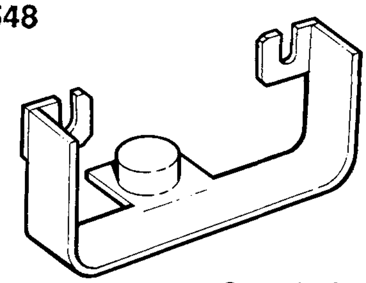
Crankshaft timing belt pulley remover

18G 1512-1



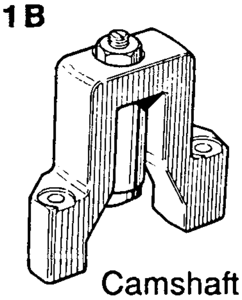
Crankshaft timing belt pulley remover adaptor set

FR 1548



Camshaft retainer

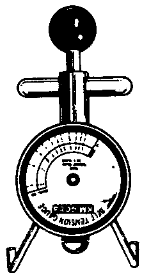
18G 1301B



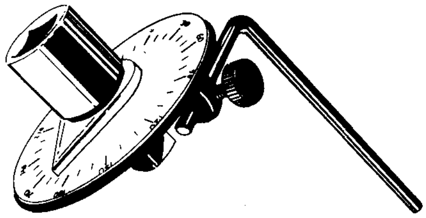
Camshaft setting tool

NEW SPECIAL TOOLS (CONTINUED)

KM 4088 AR



Borroughs gauge (Supplier: Kent-Moore)



Angular Torque Wrench
(Supplier: Sykes-Pickavant or Churchill)

EXISTING SPECIAL TOOLS

MS 1519A (alt. **18G 106A**)	Valve spring compressor
18G 1108	Crankshaft rear oil seal protection sleeve
18G 1195	Clutch plate centraliser
18G 1300	Valve guide remover / replacer
18G 1306	Gudgeon pin remover / replacer
18G 1315	Timing belt tension adapter
18G 1333	Crankshaft needle roller bearing replacer
18G 1339	Valve guide reamer
18G 134CQ	Rear Main Seal Adapter
FR 581	Bearing remover
MS 76	Valve seat cutter handle
MS 150-7	Expandable pilot
MS 621	Adjustable valve seat cutter
18G 1301 } **+ 18G 1301X** }	Camshaft setting tool (superced by **18G 1301B**)

BASIC AND UNIVERSAL TOOLS

MS 38 U3 (**18G 55A**)	Piston ring compressor
18G 191	Setting gauge
18G 257	Circlip pliers
18G 1004	Circlip pliers (small)
18G 372	Torque wrench 30-140 lbf ft
18G 592	Torque wrench 50-250 lbf ft
18G 1205	Flange / pulley holding wrench
18G 134 (**MS 550**)	Drive Handle

TORQUE WRENCH SETTING

	Nm	lbf ft	kgf m
Camshaft Cover Bolts*	16 - 20	12 - 15	1.6 - 2.1
Camshaft Pulley Bolt	61 - 68	45 - 50	6.2 - 6.9
Cylinder Head Bolts*			
Pretighten	47	35	4.8
Final Tighten	81 (+90°)	60 (+90°)	8.3 (+90°)
Main Bearing Cap Bolts*	95 - 115	70 - 85	9.7 - 11.7
Connecting Rod Big End Nuts*	52 - 58	38 - 43	5.2 - 5.9
Crankshaft Pulley Bolt	81 - 88 90-100	60 - 65	8.3 - 9
Flywheel Bolts	80 - 90	59 - 66	8.2 - 9.1
Sump Drain Plug	40 - 45	29 - 33	4.0 - 4.6
Knock Sensor	10 - 15	7.5 - 11	1.0 - 1.5
Oil Filter	8 - 12	6 - 9	0.8 - 1.2
Thermal Transmitter	10 - 15	7.5 - 11	1.0 - 1.5
Oil Pressure Switch	11.5 - 12.5	8.5 - 9	1.1 - 1.2
Spark Plugs	15 - 20	11 - 15	1.5 - 2.1
Oil Pump Backplate Screw	5 - 7	3.5 - 5	0.5 - 0.7

All the above are fitted dry, with the exception of those marked * which should be lightly oiled.

INTRODUCTION

02 COMMERCIAL ENGINE

Please note that this Service Workbook does not include any information relating to the 20V E46 engine.

As its title implies, the 02 engine is a development of the '0' series unit; Leyland DAF are offering three versions of the engine:

1700cc low compression
2000cc low compression
2000cc high compression (300 Series only)

These three units are identified by engine number starting as follows:

1700LC	**17V C95-L**
2000LC	**20V C95-L**
2000HC	**20V C96-H**

A fourth unit, 20V E46, is a low compression 2 litre engine which was introduced during 1989 to replace the 20V C95 and 20V C96 engines. Information on the 20V E46 unit is not included in this Service Workbook.

The 17V and 20V engines both have the same bore size, the capacity change being effected by altering the crankshaft stroke and the piston height. The HC and LC versions of the 20V engine are achieved by altering the size of the combustion chamber area in the piston crowns.

Many detail changes have been made to the engine, and a power increase has been achieved with excellent fuel economy.Externally, among the more obvious changes is the totally new Programmed Ignition System, with the distributor driven by the front of the camshaft.

Other external changes include:

Electric fuel pump mounted underbody, in place of the mechanical pump mounted on the cam cover.
Revised oil pump assembly with new location for oil filter.
Carburetter incorporates an anti-run on valve.
Cylinder head porting sequence revised.
PTC manifold heater to give quick warm-up.

PROGRAMMED IGNITION SYSTEM

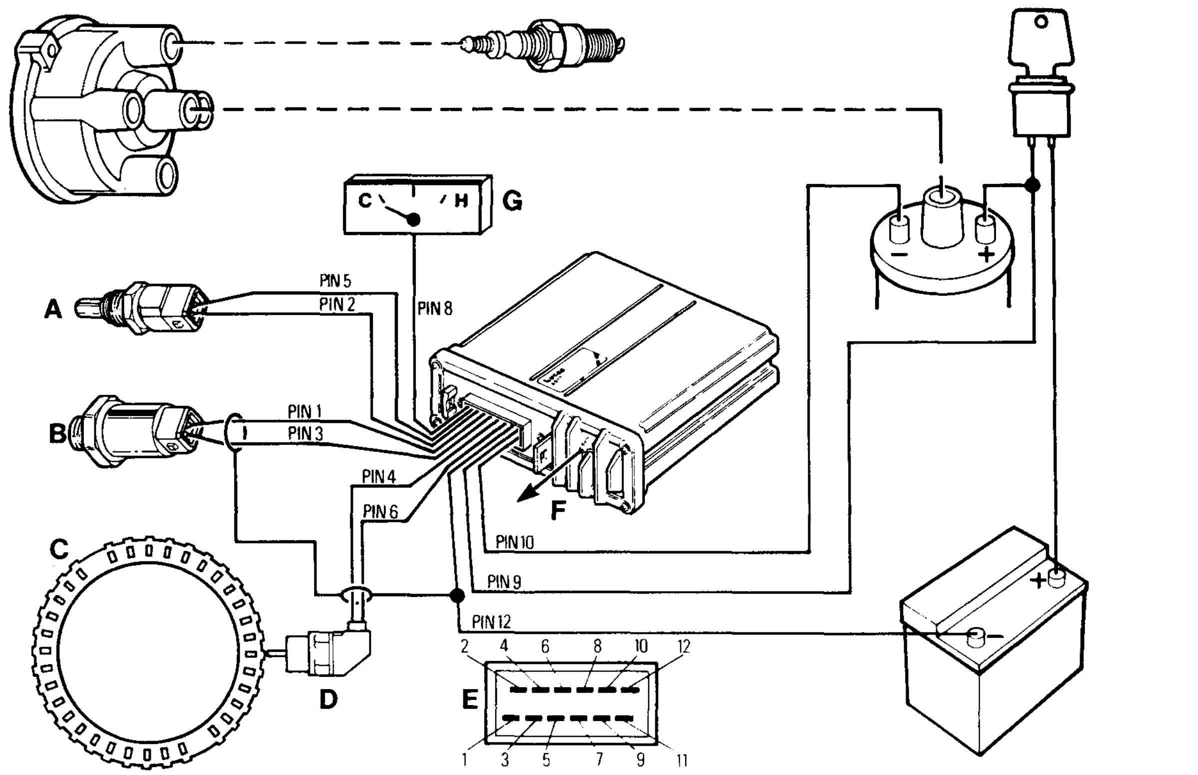
Introduction

This system incorporates standard constant energy features as previously used, except timing is controlled using digital electronic techniques instead of the conventional mechanical and vacuum advance.
An Electronic Control Unit (ECU) determines the correct ignition timing by receiving information from the following sensors:

1. **Crankshaft sensor** (crankshaft position and engine speed)
2. **Temperature sensor** (coolant temperature)
3. **Knock sensor** (combustion detonation)
4. **Carburettor vacuum pipe** (engine load)

A major advantage of this system is a knock sensing facility, enabling the engine to run close to its limits of ignition advance. This improves efficiency, without detonation occurring.

There is no conventional distributor utilised in this system; timing is controlled by the ECU, and spark distribution is accomplished by means of a rotor arm and distributor cap mounted at the No.1 cylinder end of the camshaft. The ECU also contains the ignition amplifier.



A. Coolant Sensor
B. Knock Sensor
C. Reluctor Disc
D. Crankshaft Sensor
E. Terminal Block
F. Vacuum Signal
G. Temperature Gauge

Component parts

The Leyland DAF Programmed Ignition System consists of the following major components:

1. **Reluctor disc**
2. **Crankshaft sensor**
3. **Knock transducer**
4. **Temperature sensor**
5. **Electronic Control Unit (ECU)**
6. **Ignition coil**
7. **High Tension (HT) distributor**

Reluctor disc.
Two circular reluctor inserts are secured to the engine side of the flywheel face near its outer edge; one is positioned inside the other, with their edges facing each other and containing a number of poles. Two missing poles diametrically opposed correspond to the two engine TDC positions, while the smaller poles are spaced at 10° intervals. The two missing poles at TDC, together with other components in the system, provide a basic ignition timing, while the smaller poles give a continual update of crankshaft position and speed to the crankshaft sensor.

Crankshaft sensor.
The crankshaft sensor projects through and is secured to the engine adaptor plate. The sensor armature runs between the two reluctor inserts in the flywheel; it' reads' the poles to provide an input to the ECU.

Knock transducer.
The knock sensor is a piezo electric accelerometer which produces an output voltage to the ECU, proportional to the sensed vibration. This vibration is produced by general mechanical noise and combustion detonation, and sophisticated electronic processing is used to recognise the latter from the mechanical noise.
The position of the sensor is crucial, and a site is chosen which responds equally well to knock vibration from each cylinder,whilst responding poorly to general background mechanical noise.
NOTE: Ensure the mounting faces on sensor and block are in good condition to ensure correct operation, and that the correct torque is used for installation..

Temperature sensor.
Another ECU input, the coolant temperature sensor (located in the thermostat housing), is operative over a range of -40°C to + 140°C, and is also used by the temperature gauge.

Ignition coil.
Similar in appearance to coils used previously, the programmed ignition coil has different electrical characteristics in that the primary coil resistance has been lowered, to ensure HT output is reached faster and is more consistent throughout the engine speed range.

HT distributor cap.
The sole function of the cap is to distribute the HT output; it is made of Valox thermoplastic material which has improved electrical characteristics over the epoxy material used previously.

Rotor arm.
The rotor arm is made from a shock absorbing material called Crasline; it incorporates a metal insert to relieve fixing stresses on the plastic material. The rotor arm is mounted on a 'D' shaped stub shaft bolted to the camshaft pulley, and is fixed to the shaft with a grub screw incorporating a 'patch lock' locking paste.
NOTE: A new screw must be fitted each time the rotor arm is removed, and the rotor thread chased out to remove remnants of old 'patch lock'.

Coolant temperature correction.
This function is provided to ensure maximum driveability at low temperatures by either advancing or retarding the basic ignition, and the data stored is subjected to a load correction value below +70°C coolant temperature.

Electronic control unit (ECU).
This unit consists of a plastic case containing the electronic components mounted on a printed circuit board. All connections are via a 12 pin plug socket assembly, and protected against short circuit and reverse polarity.

The ECU has two main functions:

1. To control ignition timing electronically using information received from the crankshaft sensor (engine speed and position), inlet manifold depression (engine load), knock sensor and coolant temperature sensor.
2. To provide a constant energy drive to the ignition coil, controlling both coil turn-on and turn-off.

OPERATING PRINCIPLES

The ECU is connected electrically to the ignition coil, crankshaft sensor, knock sensor and coolant temperature sensor. Power is supplied to the ECU via the ignition switch.

A pipe from the carburettor is connected to a transducer in the ECU, providing an electrical signal related to engine load.

The signal received by the ECU from the crankshaft sensor provides information on engine speed and position. This is used, with the load signal, to determine optimum timing.

Basic ignition characteristics are stored in the electronic memory of the ECU in the form of a three dimensional map; the map gives the correct advance for 16 engine speeds and 16 engine loads. This technique increases timing accuracy to within 30 RPM and 0.3 to 0.4 in. Hg.

In addition to the basic timing map, the ECU has a separate three dimensional temperature map with 8 speed sites and 8 temperature sites.

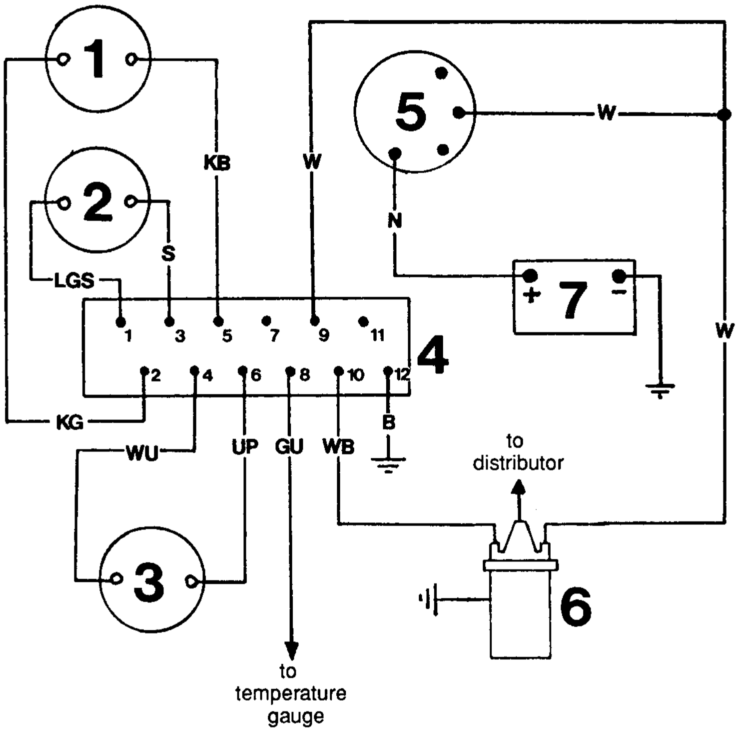
Information from the knock sensor to the ECU detects when knock has occurred on an individual cylinder. At the fourth ignition pulse after the knock has occurred, the timing is retarded in steps of 3°until the knock is eliminated; the ECU will then advance the timing for that same cylinder in steps of 0.625° every 32 engine revs. until the amount of advance required by the electronic memory is restored.

The knock facility enables the engine to run with additional advance, to give optimum engine efficiency without the risk of damage due to knocking.

CABLE COLOUR CODE.
The following colour code information is included to assist with fault diagnosis procedures:

B	Black	**P**	Purple
G	Green	**R**	Red
K	Pink	**S**	Slate
LG	Light green	**U**	Blue
N	Brown	**W**	White
O	Orange	**Y**	Yellow

When two colour code letters are shown on a wire, the first letter denotes the main colour and the second letter denotes the tracer colour.



Programmed Ignition System

Key to Wiring Diagram

1 - Coolant Temperature Transducer
2 - Knock Sensor
3 - Crankshaft Sensor
4 - Electronic Control Unit (E.C.U.) Connector Block
5 - Ignition Switch
6 - Ignition Coil
7 - Battery

PROGRAMMED IGNITION FAULT DIAGNOSIS USING FAST CHECK.

Before connecting the Fast Check, first check the battery condition and HT system. Disconnect the harness from the ECU and connect the fast check. Switch the ignition 'ON', and rotate the Fast Check rotary switch to the 'STATIC' position.
NOTE: When the rotary switch is in the 'STATIC' position the LH set of LED's will indicate a fault. The RH set of LED's should be ignored.

Rotary switch in **'STATIC'** position (ignition ON)

1. The ignition LED should be ON. This LED monitors the feed into the ECU terminal 9 from the ignition switch.

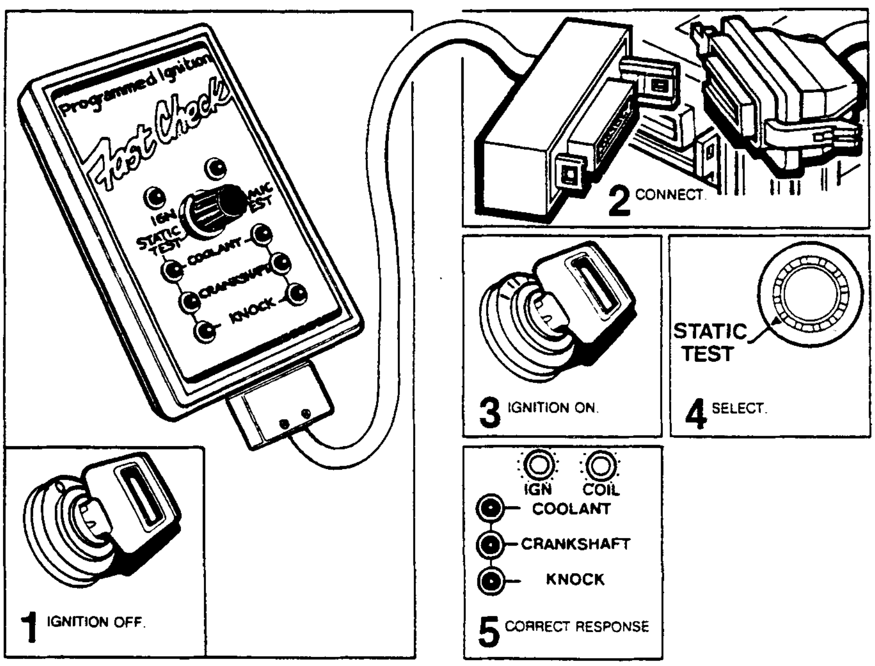
   If the LED is off, check the wiring from the ignition switch to terminal 9 on the ECU. If correct, check the ignition switch.

2 The coil LED should be ON. This LED monitors the feed from the ignition coil negative terminal to terminal 10 on the ECU.

   If the LED is OFF, check the wiring from the coil negative terminal to terminal 10 on the ECU. If correct, check there is a 12 volt feed to the positive terminal on the coil. If correct, check the resistance of the coil primary windings.

3 The LH coolant LED should be OFF.

STATIC TEST



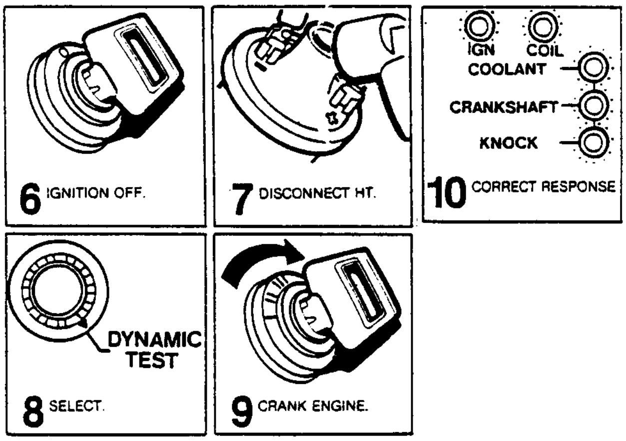
4 The LH crankshaft LED should be OFF. This LED monitors the crankshaft sensor circuit for a short to earth. If the LED is ON, check the wiring for a short to earth. If correct, change the crankshaft sensor.

5 The LH knock sensor should be OFF. This LED monitors the knock sensor circuit for a short to earth. If the LED is ON, check the wiring for a short to earth. If correct, change the knock sensor.

Rotary switch in **'DYNAMIC'** position (engine cranking)

With the rotary switch in the 'DYNAMIC' position, the RH set of LED's will indicate a fault. The LH set of LED's should be ignored.

DYNAMIC TEST



6 The ignition and coil LED should be ON. The diagnosis is the same as described in tests 1 and 2.

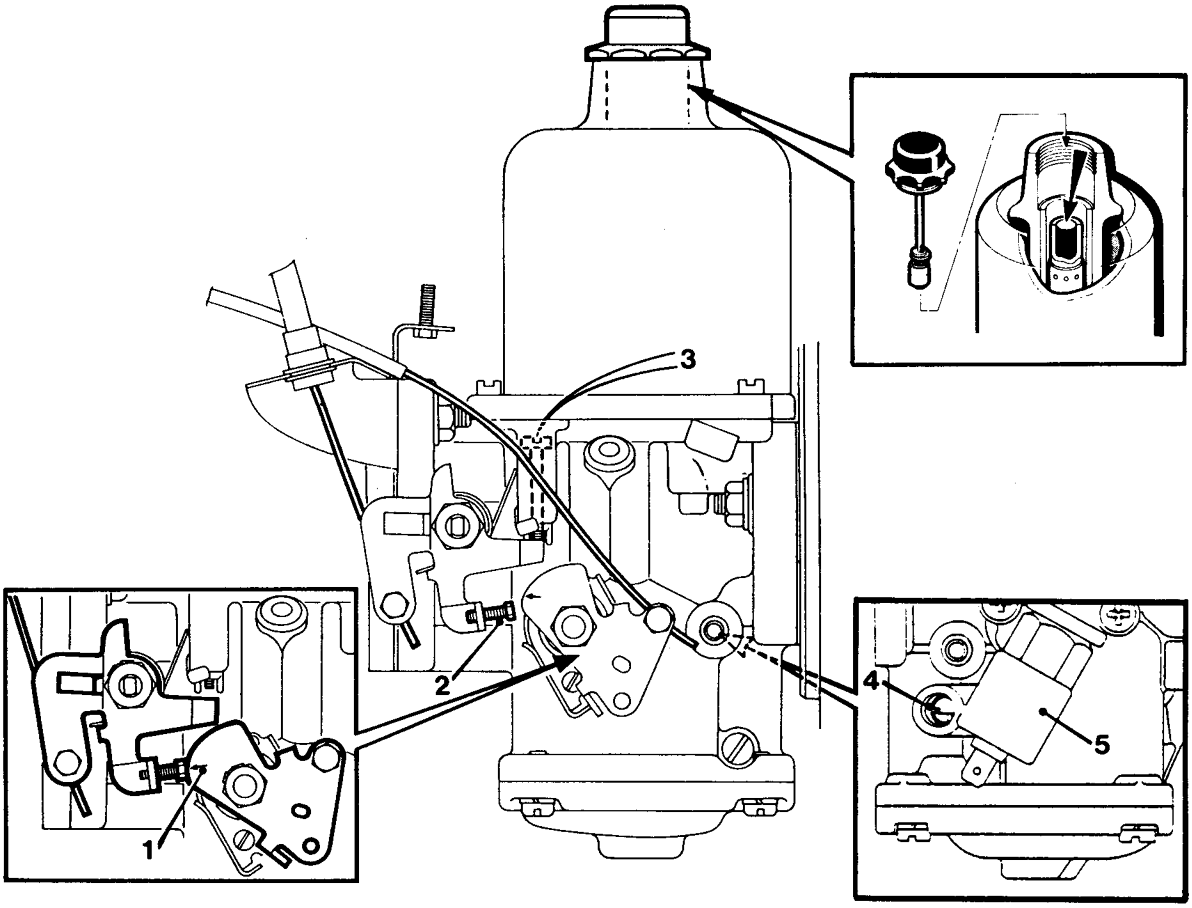
7 The RH coolant LED should be OFF. This LED monitors the operating parameters of the coolant sensor.

8 The RH crankshaft LED should be ON. This LED monitors the operating parameters of the crankshaft sensor.
If the LED is OFF, check the wiring for open or short circuit. If correct, replace the sensor.

9 The RH knock LED should be ON. This LED monitors the operating parameters of the knock sensor.
If the LED is OFF, check the wiring for open or short circuit. If correct, replace the sensor.

CARBURETTER

The carburetter is an HIF 44, having an integral float chamber located in the base. The carburetter is a development of that fitted to the 'O' series engine, and one notable feature of this unit is the anti run-on valve.



Typical HIF 44 Carburetter.

1. Cam position for fast idle adjustment
2. Fast idle screw.
3. Throttle adjusting screw.
3. Throttle adjusting screw.
4. Jet adjusting screw.
5. Anti run-on valve.

CARBURETTER SETTINGS.

Carburetter tuning is confined to setting the idle and fast idle speeds, and the mixture at idle.

1 Check that the piston damper oil level is correct (if necessary top up with engine oil), and that the throttle and choke mechanisms can move freely.

2. Ensure that the mixture control (choke) will return fully, and that the cable has 1,5mm (1/16 in) free play before it starts to pull on the choke lever. Check that there is a small clearance between the fast idle screw (2) and its cam.

3. Run the engine until it reaches normal running temperature.

NOTE: Before making any adjustments, increase the engine speed to 2500 rpm and maintain this speed for 30 seconds to clear the intake manifold of excess fuel. Repeat this procedure at 3 minute intervals if the adjustments cannot be completed within this period of time.

4. Check the engine idle speed and adjust the throttle adjusting screw (3) if necessary.

Engine idle speed: 1700 - 650 rpm +/- 50 rpm
2000 - 750 rpm +/- 50 rpm

5. Slowly turn the jet adjusting screw (4) clockwise to richen or anti-clockwise to weaken the mixture until the fastest idle speed is obtained, then turn the screw anti-clockwise until the speed just commences to fall.

6. Re-check the idle speed and re-adjust if necessary.

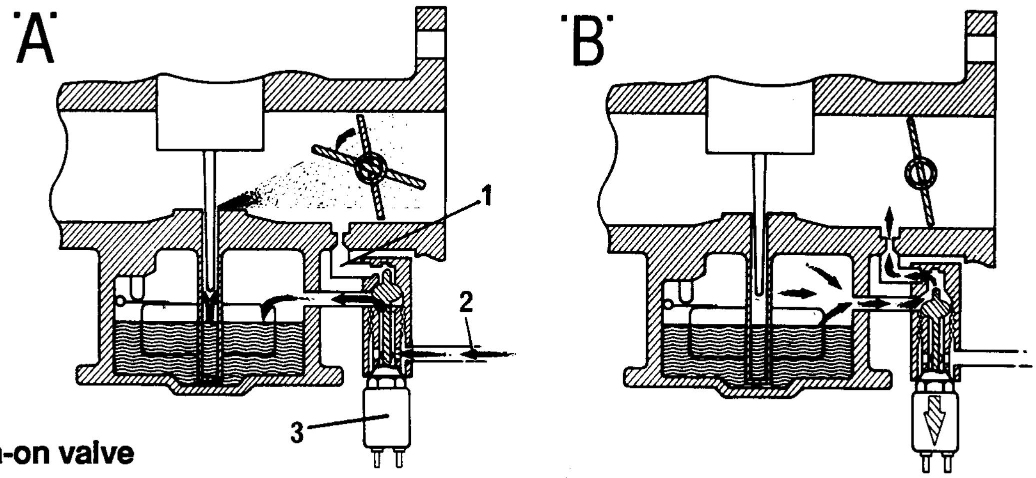
7. Connect an exhaust gas analyser and check the CO level.

CO at idle speed: 2.25% +/- 0.75%

8. Pull out the choke control until the the arrow (1) marked on the cam is aligned with the fast idle adjusting screw (2), and check the fast idle speed. Reset if necessary by adjusting the fast idle screw.

Fast idle speed: 1300 rpm. +/- 50 rpm.

ANTI RUN-ON VALVE.

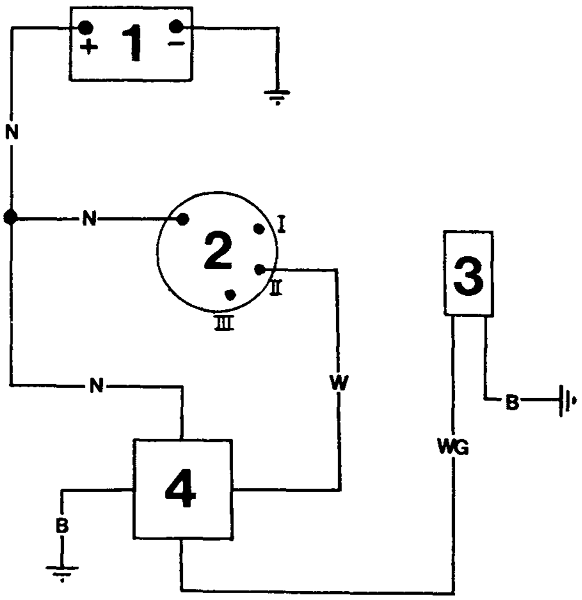


Anti run-on valve

1. Vacuum passage
2. Air
3. Solenoid

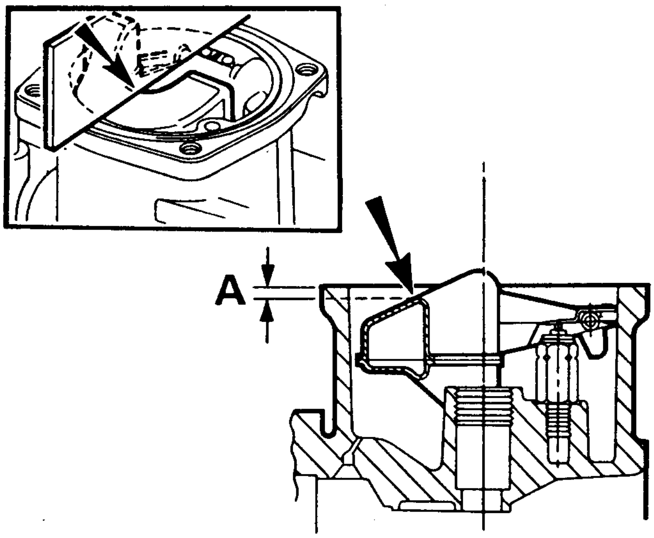
Illustration 'A' shows the 'running' position of the valve; The solenoid is not energised and its valve closes the vacuum passage to the venturi. Air can enter the float chamber via the air passage '2' and the underside of the valve, to allow fuel to be drawn up the jet.
Illustration 'B' shows what happens when the ignition is turned off.The valve moves back and closes off the air passage 2'; the vacuum passage is now open to link the venturi to the float chamber. If the engine attempts to run on,depression in the venturi will also be felt in the float chamber and not allow fuel to be drawn up the jet, so the engine will stop.

1. Battery
2. Ignition switch
3. Anti run-on valve
4. Timer unit



In the wiring diagram for the anti run-on valve it can be seen that there is a timer unit in the circuit. The circuit is inactive until the ignition is turned off; at that time, ie. when the ignition is turned from position '2' to position '1', the timer is activated to allow current to pass to the anti run-on valve. The timer is programmed to operate for 10 seconds only, to ensure the engine stops, after which time the circuit is broken.

FLOAT HEIGHT



Carburetter float adjustment

To check the float height the float chamber cover must be removed and the carburetter inverted so that the needle valve is held in the shut position by the weight of the float.

Referring to the illustration, check that the point on the float indicated is 0,5 to 1,5mm (0.02 to 0.06in.) below the level of the float chamber face (dimension 'A'). If adjustment is required, carefully bend the brass pad.

O2 COMMERCIAL
Service Workbook Supplement

20V E46 Engine

This supplement provides Service Information on the 20V E46 engine, introduced during 1989 from VIN 857038. This engine supercedes the 2 litre 20V C95 and C96 low and high compression engines. and incorporates modifications to ensure maximum durability when unleaded fuel is used.

It is available in low compression form only (8 : 1), and includes changes to the pistons and valve gear; a new ignition electronic control unit (ECU) is also required.

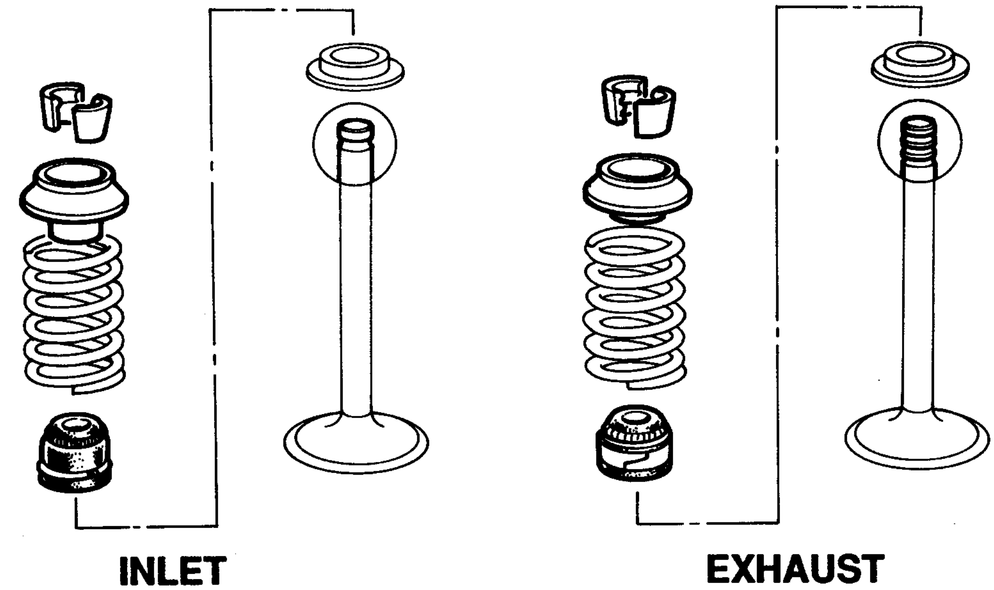
This supplement contains information which is specific to the 20V E46 engine; for all other information on the O2 engine, refer to the O2 Service Workbook, issue 3.

IDENTIFICATION	Engine number has prefix - 20V E46
DATA	
Piston type	Alfin (incorporates cast iron insert around top ring groove)
Valves	
Stem diameter - inlet	7,409 - 7.424 mm (0.2917 - 0.2923 in)
- exhaust	7.969 - 7.987 mm (0.314 - 0.3147 in.)
Valve guides	
Inside diameter - inlet	7,45 - 7.47 mm (0.293 - 0.2943 in)
- exhaust	8,03 - 8,057 mm (0.316 - 0.317 in)
Valve springs	
Load	Variable
Free length	41,3 mm (1.627 in.)
Fitted length	34,9 mm (1.375 in.)
ENGINE TUNING DATA	
Compression ratio	8.0 : 1
Spark plug gap	0,85 mm (0.35 in.)
Carburettor specification	FZX 1493
Fuel minimum octane rating	Unleaded (95 RON) or 2 star** (91 RON)

LEYLAND DAF

VALVE GEAR

A number of changes have been made to valves, springs, seals and guides etc., and are detailed as follows:

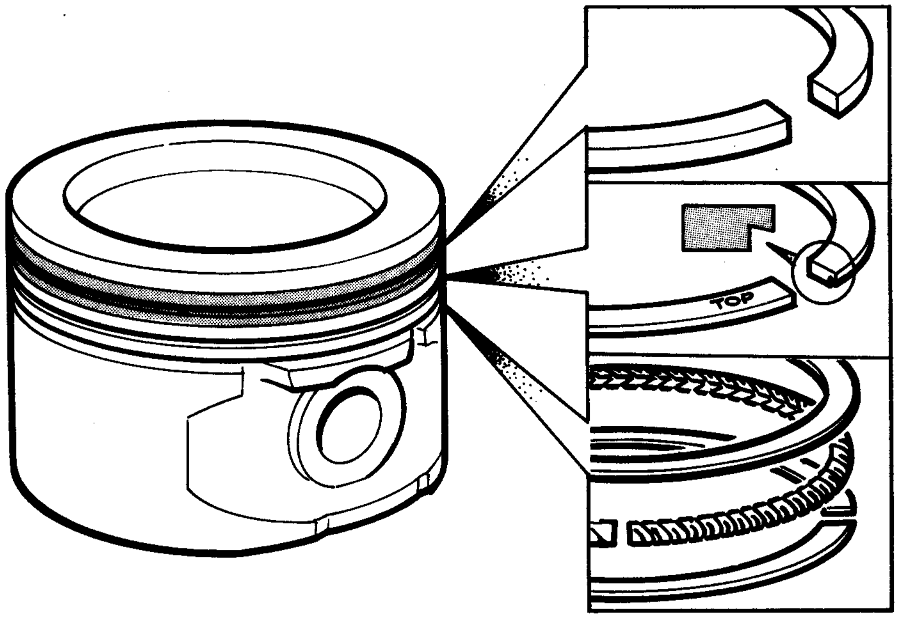


Exhaust valve	-	Sodium filled. Larger stem diameter - 8 mm. Three collet retaining grooves.
Valve guides	-	Exhaust guides have larger internal diameter. **NOTE:** Only one replacement guide is available, and must be reamed out to the appropriate internal diameter - inlet or exhaust - after fitment (see 'DATA' for dimensions).
Springs	-	New, variable rate spring fitted to all valves.
Spring caps	-	Exhaust spring cap has shorter extension under spring location face.
Collets	-	Exhaust valve collets have three ribs to locate in the valve stem grooves.
Valve stem seals	-	Different internal diameters to suit the 7,4mm inlet and 8 mm exhaust valve stem diameters. They can be identified by trial fitment or by the number of external spring coils around the seals.

Inlet stem seal - two spring coils
Exhaust stem seal - one spring coil

PISTONS

A new piston is specified for the 20V E46 engine; it is known as the 'Alfin' piston and can be identified by a cast iron insert around the top ring groove.



The top, compression ring is square faced and can be fitted either way round. However, if a makers name is on one face, this should be positioned to the top as is standard procedure.

The second, compression ring has a stepped face and is fitted with the step downwards. The top face of the ring is marked 'TOP'.

The oil control ring comprises two flat rails with an expander coil separating them.

FUEL PUMP

The fuel pump is a Pierburg electric pump, mounted to the chassis close to the fuel tank and fed from the ignition circuit via a relay. To ensure the fuel pump cannot operate if the engine stops inadvertantly, the relay is part of the oil pressure warning light circuit. A sudden drop in oil pressure will isolate the pump as the oil pressure warning light comes on.

Operation.

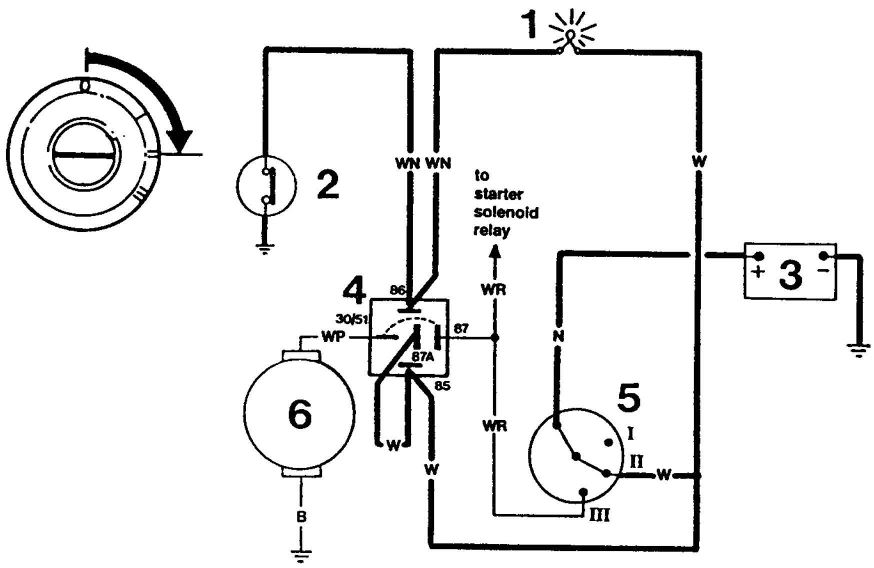


Diagram 'A'

Key to fuel pump circuit diagram

1 - Low Oil Pressure Warning Light
2 - Low Oil Pressure Warning Light Switch
3 - Battery
4 - Fuel Pump Relay
5 - Ignition Switch
6 - Fuel Pump
▬▬ - Circuits Operating

With the ignition on, engine stationary, the relay operates using the oil pressure switch as an earth path via terminals 85, 86 on the relay. There is no feed to the fuel pump (see diagram A).

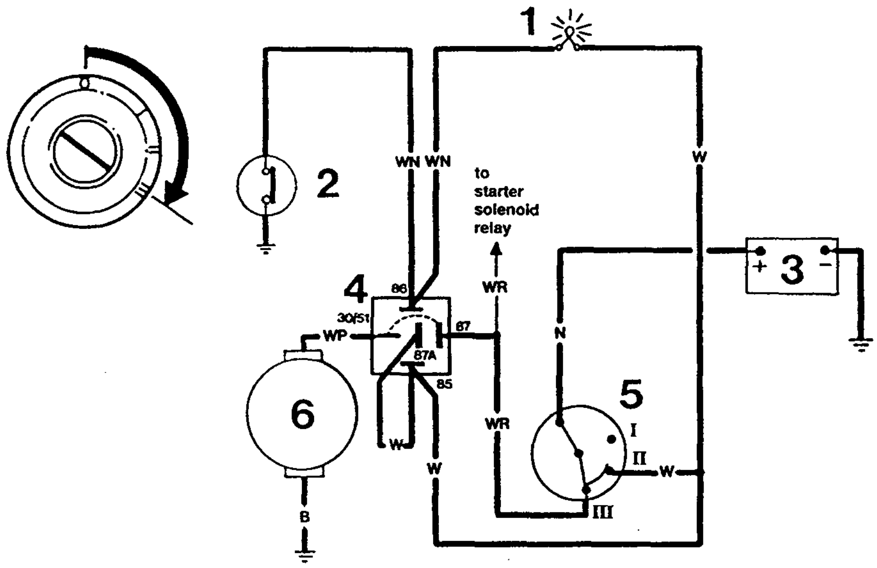


Diagram 'B'

During engine cranking, a feed from position III on the ignition switch feeds the fuel pump via 87, 30/51 on the relay whilst the oil warning light remains on (diagram B).

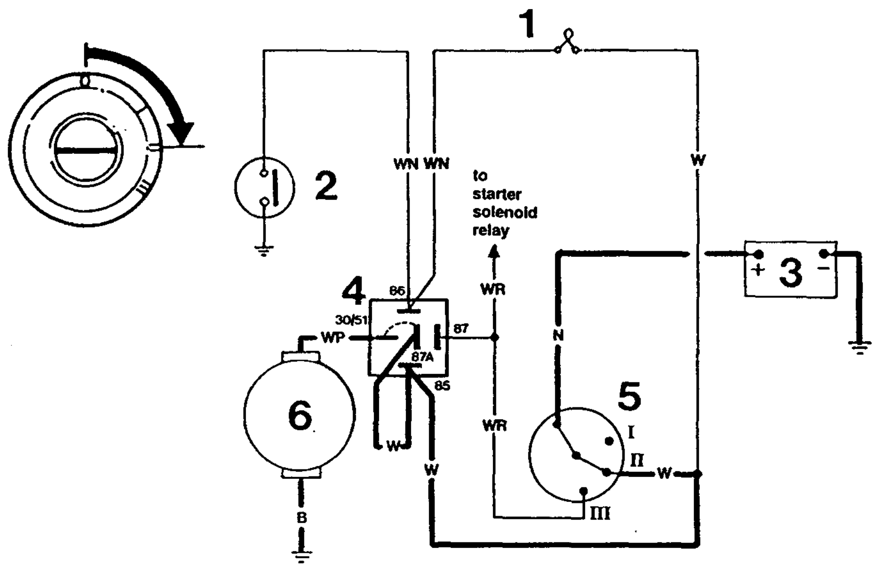


Diagram 'C'

Once the engine has started and the oil light goes out, the relay returns to the out position and the fuel pump is fed via 87A, 30/51. (diagram C)

Summary

Ignition on	- oil light on,	fuel pump off
Engine cranking	- oil light on,	fuel pump on (fed from starter circuit)
Engine started	- oil light off	fuel pump on (fed from ignition circuit)

COOLING SYSTEM

The cooling system is a pressurised spill return system with thermostatic control assisted by a pump and engine driven fan.

An impellor type, belt driven, aluminium alloy water pump is sealed to the cylinder block with a paper type gasket.

The thermostat housing contains a conventional wax pellet type thermostat, and locates the temperature transmitter and an air bleed tapping. The thermostat nominal opening temperature is stamped on the base of the thermostat bulb.

Cooling system data.

Thermostat	Starts to open	Fully open
82°CStd.	82° to 84°C	92° to 96°C

Pressure cap - marked 15psi : 1,0 Kgf/cm^2 (15 lbf/in^2)
Pump bearing end float : 0,05 to 0,13mm, (0.002 to 0.005in)

Fan belt tension:

Borroughs tension gauge reading	5 to 7 units
Deflection at mid-point between pulleys with 5Kgf (11 lbf) load	7 to 9 mm

Coolant drain: Remove bottom hose from radiator.

Anti-freeze.
Use an ethylene glycol based anti-freeze with non-phosphate inhibitors suitable for use in mixed metal engines, to ensure protection of the cooling system against frost and corrosion.
Specification - BLS 22 AF 01
Anti-freeze solution should be 50%, and be changed every 2 years, 24,000 miles

MANIFOLDS

The manifolds are separate; the inlet manifold is aluminium alloy, whilst the exhaust is cast iron. The two manifolds use a common gasket which can be fitted either way round.

Inlet manifold.
The aluminium alloy inlet manifold is heated by two separate systems - electrical and coolant. This is to give good driveability from a cold engine condition.

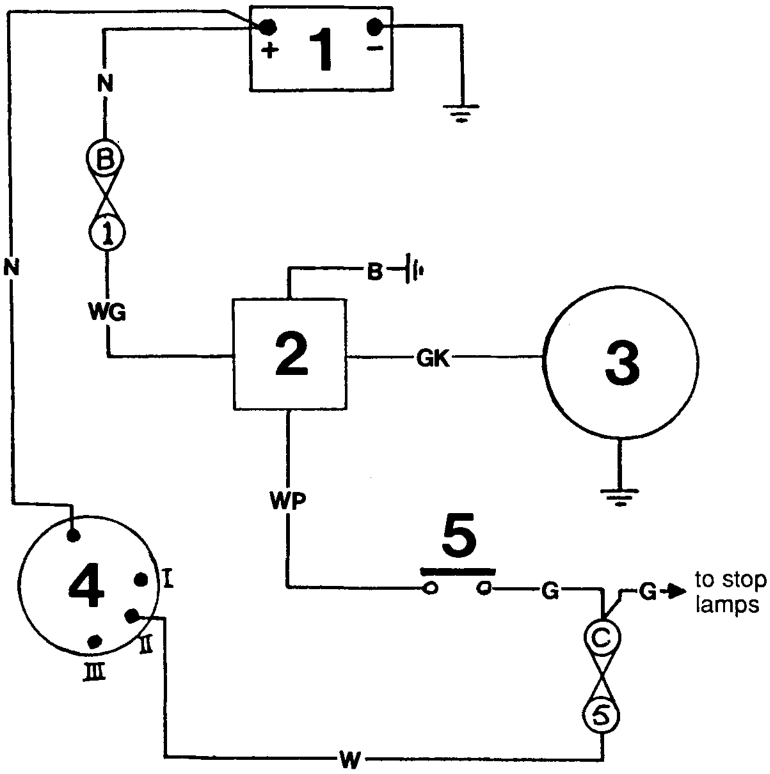
The electrical system contains a heater, sealed to to the underside of the manifold by a gasket and an 'O' ring; the heater is known as a Positive Temperature Coefficient (PTC) heater. It warms the air/fuel mixture entering the cold engine, and continues to operate until a coolant temperature of approximately 55°C is reached.The inlet manifold is now heated to a point where the PTC heater is no longer required, and the relay controlling it receives a 'shut down' signal from a temperature sensor in the inlet manifold.

Manifold Heater

Key to Wiring Diagram

1 - Battery
2 - Manifold Heater Relay
3 - Manifold Heater
4 - Ignition Switch
5 - Manifold Temperature Switch

(fuse symbol) - Fuse



When the ignition is switched on the heater element is energised and, as the current consumption is considerable during the first few seconds of operation, the heater circuit is switched off during the cranking period to enable maximum electrical output to be available for starting the engine. After the engine has fired, and as the electrical element heats up, an increasing resistance within the heater correspondingly consumes less current, until the coolant sensor de-energises the control relay and switches off the PTC heater.

OIL FILLER CAP

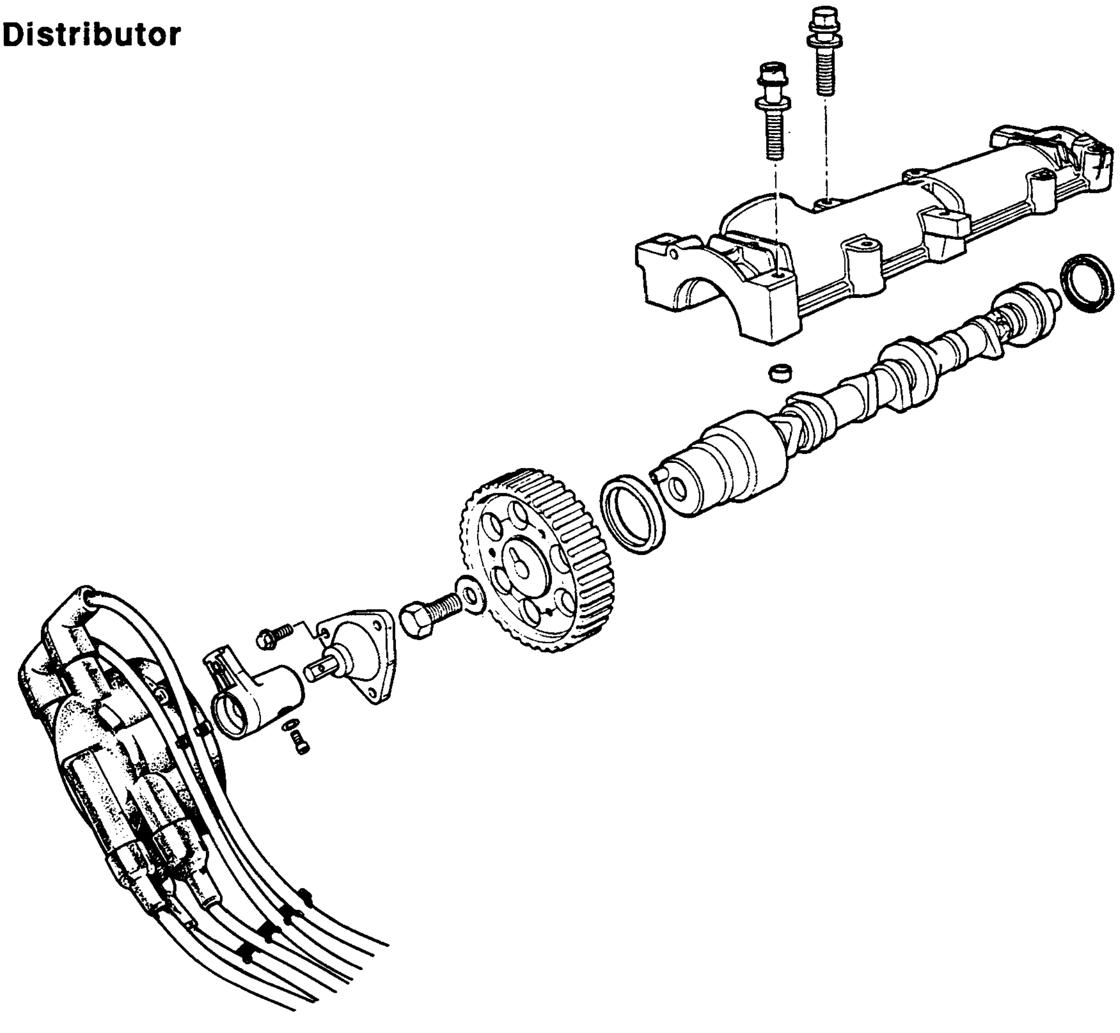
The filter in the oil filler tube cap should be washed and blown dry every 24,000 miles, 40,000 Km.

IGNITION

Spark plugs

Copper core plug	Gap:	0,85 mm, (0.035 in.)
	Type:	1700 - Champion N9YC
		2000 - Champion N7YC

Distributor



The programmed ignition unit supplies High Tension voltage to a distributor driven directly from the front end of the camshaft; eccentrically positioned screws prevent incorrect fitment of the distributor cap.
A grub screw retains the rotor arm to the drive spindle on the camshaft pulley; the screw incorporates a 'patch lock' and must be renewed each time it is taken out.

NOTE: Chase rotor thread to remove all traces of old locking paste before fitting new 'patch lock' grub screw.

CAMSHAFT DRIVE BELT. (Timing belt)

Caution; A timing belt must be handled with care, and the following do's and dont's are very important

Do not use a belt that is contaminated with oil or that has been bent at an acute angle, as this can fracture the reinforcing fibres and cause premature failure.

Timing belts should be stored on edge and circular, do not hang up on pegs.

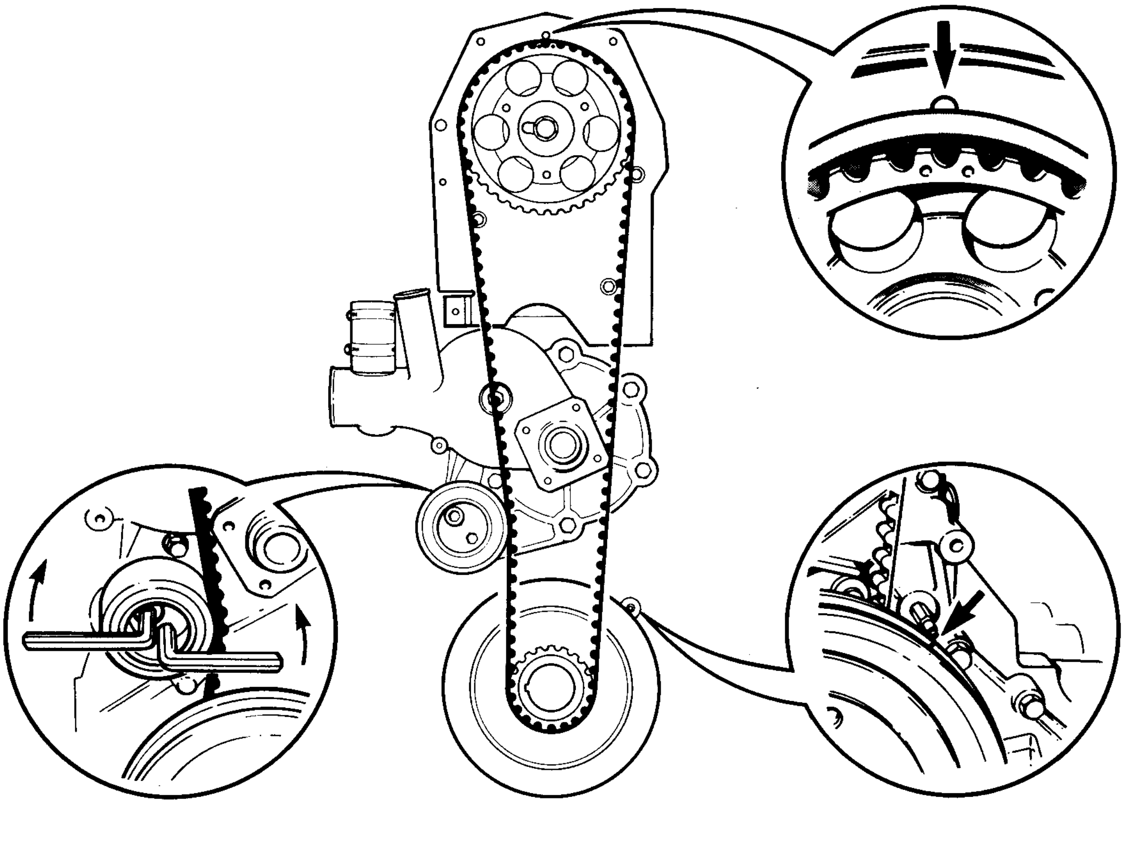
A timing belt develops a wear pattern and, if it is to be re-used, the direction of rotation must be marked on the belt before removal - to ensure it is refitted the same way round. Use chalk or similar soft material to mark the direction of rotation.

A belt must be renewed if it shows signs of damage or uneven wear.

DO NOT attempt to turn an engine via the camshaft and timing belt.

If the camshaft pulley has to be removed, use flange holder **18G 1205** and two suitable belts to hold the pulley whilst removing the centre bolt.

Never use a lever to assist removal or fitting of a belt as it may damage the reinforcing fibres. Use finger pressure only.



Belt service intervals.

Visually inspect for contamination or wear every 24,000 miles (40,000 kms.) or two years.
Replace the belt every 48,000 miles (80,000 kms.) or four years.

Belt removal.

CAUTION: The O2 engine design does not incorporate combustion chambers in the cylinder head and, if the camshaft timing is incorrect, it is possible for the valves to contact the tops of the pistons. It is essential therefore that, before starting any work that involves removing the timing belt, the engine be positioned with the pistons half way up their bores - ie 90°BTDC.This is known as the SAFE POSITION.

The safe position is achieved by aligning the timing marks as follows:

Crankshaft - Nick on rear edge of pulley aligned with pointer on oil pump housing.
Camshaft - Hole at top of camshaft pulley rear cover central to the two pop marks on the pulley.

To remove the timing belt, turn the engine to the 'safe position' by aligning the timing marks, then slacken the tensioner with an Allen key and ease the belt from the pulleys.

CAUTION: Do not attempt to turn the crankshaft with the timing belt removed or the pistons will contact the valves.

Refitting

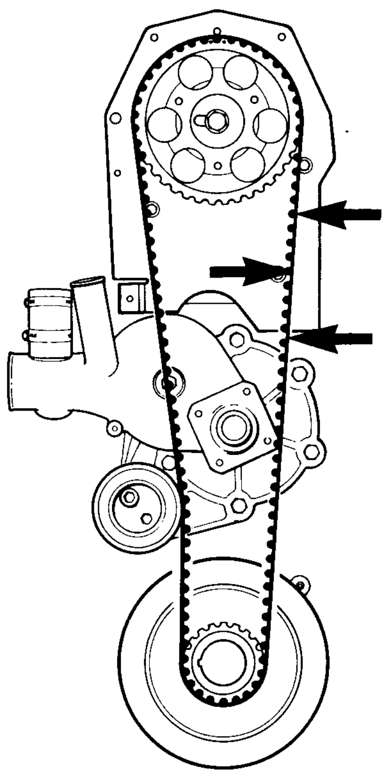
Check that the timing marks on both pulleys are aligned: ie in the 'safe position'

Carefully fit the timing belt using finger pressure only, and centralise it on each pulley. If the old belt is being refitted, make sure it will turn in the same direction of rotation as before.

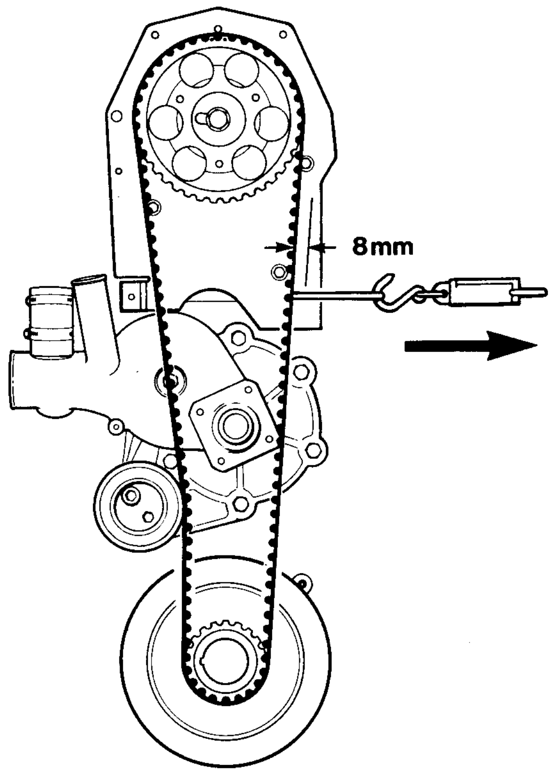
If the tensioner has been removed, refit it with the Allen screw using the inner of the two threaded holes available in the water pump housing.

Insert an 8mm Allen key into the tensioner, rotate it anti-clockwise to tension the belt and tighten the securing Allen screw with a second 8mm Allen key.

Timing belt tensioning.



Using Borroughs gauge



Measuring belt deflection

Squeeze each side of the belt inward towards each other at the same time to equalise the belt tension. Fit a Borroughs gauge to the belt at the position shown in the illustration; if the tension is correct the gauge will read 6 units. Re-adjust the tensioner if necessary.

Alternatively the tension can be checked by measuring belt deflection as follows:

Mark the camshaft pulley rear cover in line with the outer face of the timing belt, and then mark a second line parallel to and 8mm from the first line. An 8mm thick strip of wood may be found useful for this purpose.

Attach tool **18G 1315** and a spring balance to the belt at the point indicated in the illustration, and pull the spring balance in a horizontal plane as shown. If the tension is correct, the belt will align with the 8mm line when the spring balance reads:

49N 11lbf 5kgf

CYLINDER HEAD ASSEMBLY

The cylinder head is a die cast aluminium eight port unit housing a single overhead belt driven camshaft, which directly operates inlet and exhaust valves via bucket tappets. A 'Heron' type combustion chamber is formed by having a flush cylinder head face, creating combustion areas within the bores and recesses in the piston crowns. The cylinder head can be removed from the block as a complete assembly, without disturbing the camshaft cover, camshaft or valve mechanism.

CAUTION: Ensure the engine is set to the 'SAFE POSITION' before removing the camshaft drive belt and cylinder head.

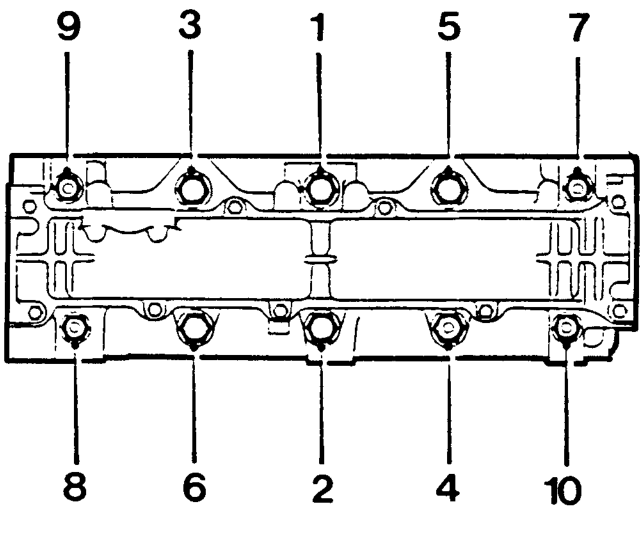
A pre-coated gasket is used and it must be fitted dry. The head is located with two dowels, and secured by ten bolts and load-spreading washers.

NOTE: All cylinder heads are torqued before leaving the factory, and should require no further tightening.

Cylinder head fitting.

Set the crankshaft to the 'SAFE POSITION' - 90° BTDC.

CAUTION: Ensure that the bolt holes and the threads in the cylinder block are clean and dry.



Position a new gasket, which is pre-coated and fitted DRY, onto the cylinder block, and place the cylinder head into position.
Lightly oil the threads and underheads of the cylinder head bolts.
Pre-tighten all the fixing bolts in the sequence shown to 47Nm (35lb ft.)
Further tighten the bolts in the same sequence to 81Nm (60lb ft.)
Finally tighten the bolts in the same sequence by a further 90° turn.

Turn the camshaft to align its timing marks, fit and adjust the timing belt.

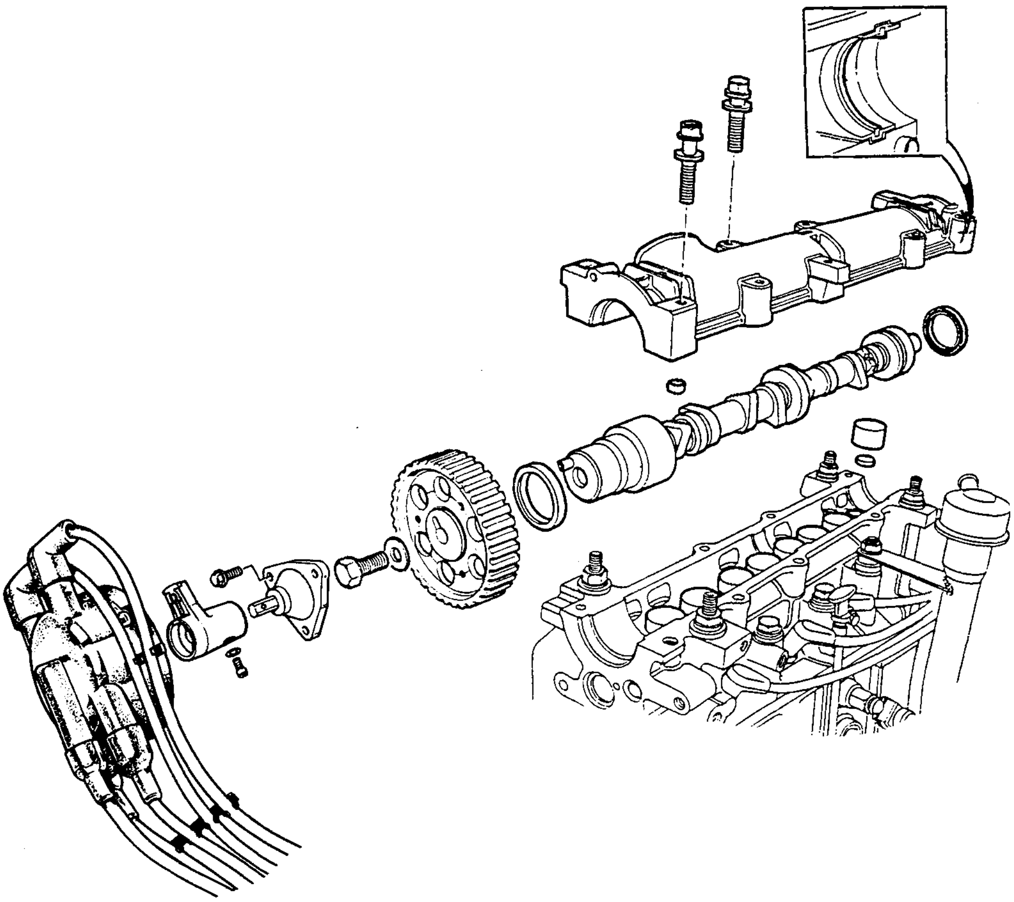
CAMSHAFT COVER.

The camshaft cover is formed from the same material as the cylinder head; it contains the upper part of the camshaft bearings, the lower half being part of the cylinder head. The bearings are line bored, therefore the two are a matched pair.

Camshaft end float: 0,07 to 0,18mm, (0.003 to 0.007in.)

A steel insert in the cam cover runs in a groove machined in the camshaft, to control the camshaft end float.

The camshaft cover is located with two dowels and retained by nine bolts.



To remove the camshaft, turn the engine to the SAFE POSITION (90°BTDC), then remove the HT distributor cap and the rotor arm, the timing belt cover and the rotor arm stub shaft. Slacken the timing belt tensioner and remove the camshaft pulley.Remove the rear timing belt cover and the plate at the rear of the cam cover. Remove the camshaft cover bolts in a staggered sequence a small amount at a time to relieve valve spring tension progressively.
Note the position of the four long bolts and of the harness clips.

Sealing of the camshaft cover to the cylinder head is achieved by applying a thin bead of RTV (Room Temperature Vulcanising) sealer along the entire length of the mating surfaces. Grooves adjacent to each bearing prevent sealant spreading onto the bearing surfaces; ensure the old sealant is cleared out before applying the new sealant.

CAMSHAFT OIL SEALS

Front oil seal
Remove the distributor cap and the camshaft pulley, then use tool **18G 1476** with thrust button **18G 1476/2** to extract the seal which must be discarded.Fit the new seal with tool **18G 1471**.
NOTE: The camshaft drive belt cover backplate will need to be removed for the replacer tool to be fully effective.

Rear oil seal.
The tool to fit the rear oil seal is **18G 1507** . If the cylinder head is being built up on the bench, fit the cam cover then use the tool to tap the seal squarely into place.
If the cylinder head is 'in situ' it is not possible to use the tool due to the proximity of the bulkhead. In this case the seal must be positioned by hand before fitting the cam cover. Make sure the seal is square to the camshaft, and smear the outer surface of the seal as well as the lip with oil prior to fitment, to minimise the possibility of the seal being nipped between the mating surfaces.

When fitting either oil seal, make sure it is lubricated with clean oil prior to fitment, and that the seal lip does not turn back as it is being fitted.

CAMSHAFT

The cast iron camshaft runs in three bearings formed by the camshaft cover and the cylinder head. The bearings are fed by individual drillings from an oil gallery within the head.

Relief oil drain holes are situated next to the inner face of the front and rear seals to prevent a build-up of pressure caused by oil escaping past the camshaft journals.

VALVE CLEARANCES

NOTE: Adjust the valve clearances with the cylinder head fitted to the cylinder block, and the head bolts tightened to the correct torque.

Turn the engine to the SAFE POSITION - 90°BTDC.
Remove the distributor cap, timing belt and camshaft pulley to gain access to the bolt holding the cover backplate to the cam cover; remove the bolt, then temporarily refit the pulley and timing belt, and tension the belt.
Remove the plate at the rear of the cam cover, fit the button on tool **FR 1548** into the hole in the rear of the camshaft and secure the tool to the long cylinder head studs using two nuts. The camshaft is now held in position by the timing belt at the front and by the tool at the rear.
Slacken the bolts retaining the cam cover in a staggered sequence and remove the cover.

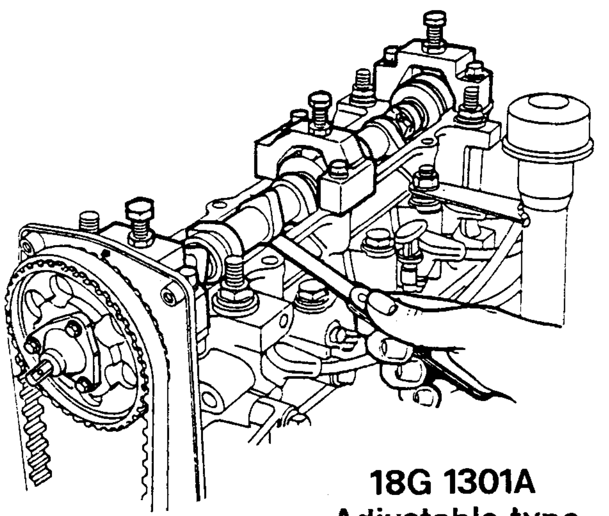
To check valve clearances it is necessary to have the camshaft in its 'working' position; this is achieved using the three part camshaft setting tool **18G 1301B.**

NOTE: The original 18G 1301 can be modified by obtaining conversion kit 18G 1301X which converts it to 18G 1301A; the wider nylon padsmeans the tool can be used on both 'O' Commercial and "O2' engines. WITH THIS TOOL THE NYLON PADS HAVE TO BE ADJUSTED TO THE CORRECT TORQUE FIGURE TO POSITION THE CAMSHAFT DURING CHECKING.
18G 1301A was later superceded by 18G 1301B in which the pad pressure is factory pre-set and MUST NOT BE ADJUSTED.

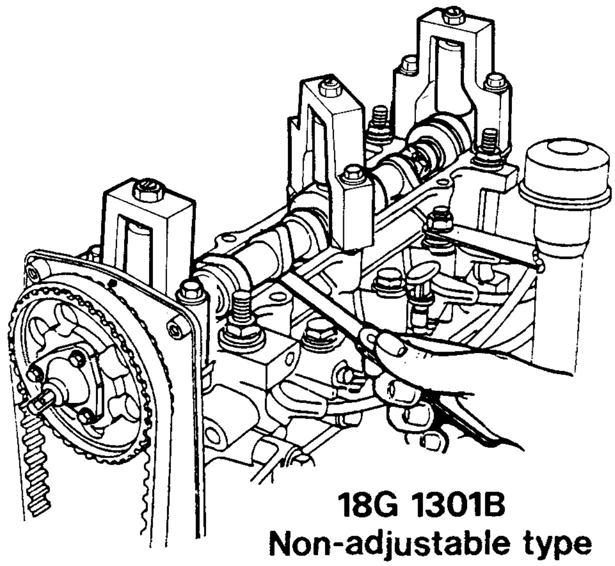
Lubricate the camshaft journals and fit tool **18G1301B** to the cylinder head, ensuring the pressure pads are square to the journals.

NOTE: If **18G1301A** is being used, fit with the pressure pads just clear of the camshaft journals, hold the pressure pads square to the journals and screw down equally to 7Nm, or 60 lbf in. (**Caution - pounds inches**)

Slacken the camshaft retainer tool **FR1548.**



18G 1301A
Adjustable type



18G 1301B
Non-adjustable type

On the two valves that are fully closed, measure and record the clearances between each tappet and the back of its cam. Angled feeler gauges are preferable for accurate results.
Turn the camshaft and repeat for the other six valves.

NOTE: If tool **18G1301A** is being used, the pressure pad screws must be slackened half a turn each time the camshaft has to be rotated, and then retightened to the same torque as before - 7Nm, or 60 lbf in. **(Caution - pounds inches).**

NOTE: Two methods may be used to turn the camshaft when checking valve clearances. Either leave the timing belt in position and turn the crankshaft, or remove the belt and turn the camshaft pulley with flange holder tool **18G 1205.** Before doing this, check that the crankshaft is in the safe position.

CAUTION: Do NOT attempt to turn the camshaft pulley with the timing belt fitted.

Valve clearance (cold) - inlet and exhaust 0,30mm. 0.012in.
NOTE: Tappet adjustment is only necessary if the clearance is less than 0,20mm, 0.008in.

If adjustment is necessary, proceed as follows:
Remove the timing belt, pulley and **FR 1548** (if fitted). Remove **18G 1301B** and lift out the camshaft.
Remove each maladjusted tappet in turn, withdraw the shim and accurately measure its thickness.
Select a correct shim by using the formula:

A + B - C = shim required. A = existing clearance (as measured)
B = thickness of shim removed
C = standard tappet clearance

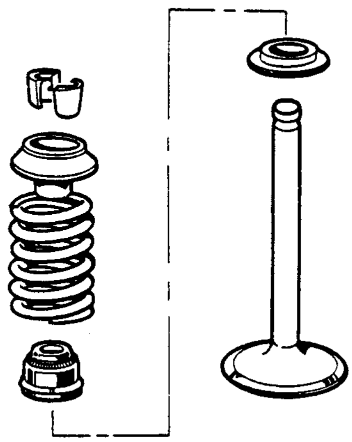
Shims are available from:
2,31 to 3,17mm, (0.091 to 0.125in) thicknesses in 0,05mm (0.002in) steps

CAUTION: Do not use any other shims with chamfered edges as they could dislodge at high speed - ie. valve bounce.

NOTE: When working with the cylinder head on the bench, always support it with two wooden blocks to protect the aluminium face and protruding valve heads.

VALVES AND SPRINGS

Tap the valve spring cups to loosen the cotters, then release the valves by compressing the springs with tool **18G 106A** or **MS 1519A**



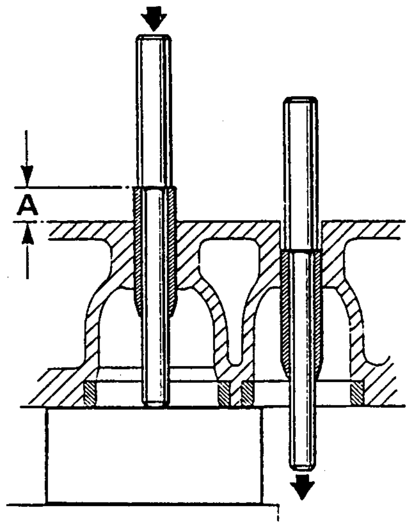
'Umbrella' type valve stem seals are fitted to all valves.

Valve face angle	:	45° 30'
Valve seat angle	:	45°
Valve spring free length	:	41,81mm, (1.646in.)

VALVE GUIDES

Cast iron type, pressed-in interference fit.

To remove a valve guide, First heat the cylinder head to 100°C and press out the guide in the direction of the valve seat, using tool **18G 1300**. To fit the replacement guide, re-heat the cylinder head to 100°C, position the heated head face down on a surface bed,and press in the guide using tool **18G 1300** from the top of the head until the top of the guide is 10mm. above the valve spring seat face, Dimension 'A'.



Ream the new valve guide with reamer tool **18G 1339** and, irrespective of whether a new valve seat has been fitted or not, the concentricity of the valve seat must be checked and refaced as necessary.
NOTE: On 20V E46 engine the internal diameters of inlet and exhaust valves are different.

After lapping in valves during a top overhaul, the stand proud of each valve must be checked, even with a new valve. If the stand proud is below the minimum figure, a new valve seat should be fitted to that valve.

Valve stand proud (minimum), inlet and exhaust - 1,0mm, (0.040in.)

VALVE SEATS

Valve seat inserts are fitted to both inlet and exhaust valves.

To change an insert, machine it out sufficiently to enable it to be split and removed without damaging the head.
Before attempting to fit a new insert, heat the cylinder head to 100°C, then the new insert must be frozen to -35°C before being pressed in flush with the head face.

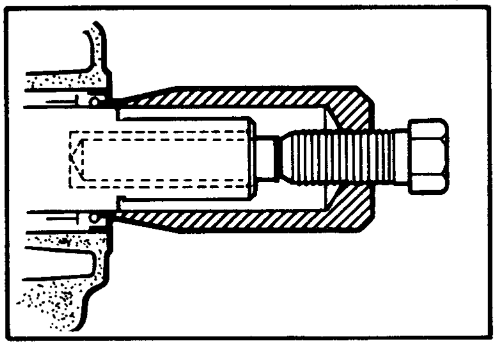
Reface the new valve seats to 45° by removing a minimum of material, using seat cutter MS 621, and expandable pilot MS 150-7, together with the basic handle set MS76.
Lap the valves on to their seats using fine grinding paste. Check the stand proud.

NOTE: Valves and valve seats should receive attention as a pair, i.e. if a valve is replaced the seat must be refaced to provide a good gas tight seal with the new valve, otherwise premature failure of the valve will occur.

CRANKSHAFT SEALS

Front seal.

The crankshaft front seal is located in the oil pump housing: to change it the combined crank pulley/timing belt pulley must first be removed using remover tool **18G 1512** and adaptor **18G 1512-1**. Then remove the crankshaft woodruff key and extract the seal using **18G 1508.**



Tool 18G 1508 removing crankshaft front seal.

In more detail, tool **18G 1508** is used as follows:
The tool is supplied with two bolts, one having a smaller diameter thread. Position the body of the tool over the crankshaft nose, then fit the smaller diameter bolt through the end of the tool and screw it into the crankshaft. Use a spanner to continue tightening the bolt and pull the tool firmly into the seal.
Remove the bolt, fit the thread protector from tool **18G 1512-1** through the hole in the tool body and into the the end of the crank. Screw the larger of the two tool bolts into the body and continue turning to pull the seal clear.

To fit the new seal, use protection sleeve **18G 1510** and replacer **18G 1509.** Because of the proximity of the front chassis cross member, it is advisable to drill a hole in the top face of **18G 1509** and use the crank pulley bolt to draw the new seal in, rather than drift it into place.

Rear seal.

No tool is necessary for removing the rear crankshaft seal. It can be prised out with the adaptor plate in situ, but great care must be taken not to damage the surface of the crankshaft, or alternatively remove the adaptor plate and install the seal with **18G 134 CQ.**

To fit the new seal, first fit the protection sleeve **18G 1108** over the rear of the crankshaft. Lubricate the surface of the sleeve then slide the new seal over it, lip side inwards, and carefully tap it into position flush with the face of the adaptor plate.

CAUTION: Always check the exterior of the replacer sleeve to ensure it is in good condition and will not damage the seal.

ENGINE ADAPTOR PLATE

The engine adaptor plate is sealed to the cylinder block with a paper gasket. The gasket incorporates a bead of sealant which must be towards the engine block.

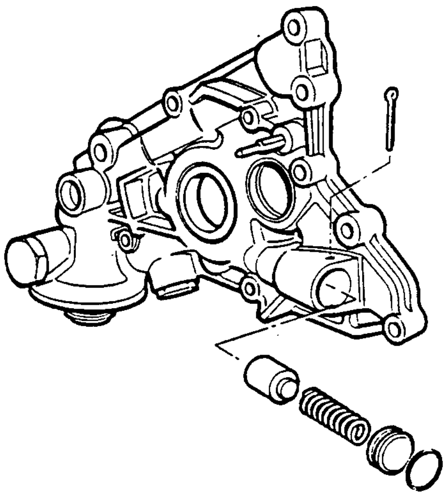
FLYWHEEL

NOTE: If a flywheel is removed, the bolt threads in the crankshaft must be cleaned by re-tapping. Fit using new bolts with 'patch seal'.

The flywheel is located onto the crankshaft with a single dowel.

LUBRICATION

Lubrication is by a wet sump pressure fed, full flow system with a disposable cartridge element housing a bypass valve. Oil pressure is controlled by a pressure relief valve incorporated in the oil pump housing. The oil pump is of the rotor type mounted to the front face of the block and is driven directly off the nose of the crankshaft via a woodruff key.



Apply Hylomar to the oil pressure switch threads and also to a switch extension, if fitted.

The pressure die cast body incorporates the following:

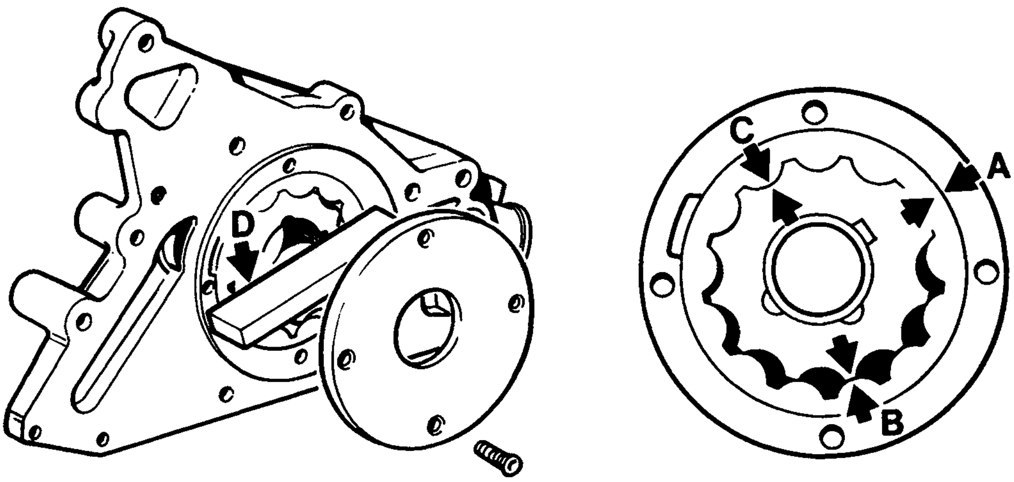
1. Oil pump housing
2. Oil pressure relief valve housing
3. Oil pressure switch tapping
4. Oil filter mounting
5. Crankshaft oil seal housing

Oil is drawn through a gauze strainer and a passage in the block casting to the oil pump and then passes a non-adjustable pressure relief valve to the full flow filter which incorporates a bypass valve. After the filter, the oil passes to the main gallery which runs the length of the engine. From the main gallery, oil is fed to the main bearings and big end bearings and a hole in the top half of each connecting rod big end supplies a spray of lubricant to the underside of the piston for cooling. Oil at reduced pressure is taken through drilled passages in the crankcase to the cylinder head and lubricates the valve gear and the camshaft bearings.

Engine oil capacity: Refill 4 litres / 7 pints including filter.

System pressure (using 10W/30 or 10W/40 oil)		
At idle speed	0.7 bar	10 lbf/in^2 minimum
Above 2500 rpm	3.8 to 5.5 bar	55 to 80 lbf/in^2
Relief valve spring free length	38,73mm	1.525 in
Oil pressure warning light switch	0.4 to 0.7 bar	6 to 10 lbf in^2

OIL PUMP CLEARANCES



To check the oil pump for wear, measure clearances as per the above illustration as follows:

1. Measure the clearance between the outer rotor and the body - 'A'.
   Clearance 'A' : 0,10 mm (0.004 in) maximum

2. Squeeze the inner rotor to the outer rotor at point 'C' and measure the clearances between the two rotors at 'B'.
   Clearance 'B' : 0,10 mm (0.004 in) maximum

3. Place a straight edge across the housing face and measure the clearance between it and the outer rotor 'D'.
   Clearance 'D' : 0,08 mm (0.003 in) maximum

CYLINDER BLOCK

The cast iron block contains 5 main bearings, the bearing caps being located by ring dowels. The caps are numbered one to five and those that could be fitted either way have an arrow which must point to the front of the engine.
Lightly oil the bolt threads and tighten to 10.5 kgfm, 75 lbf ft.

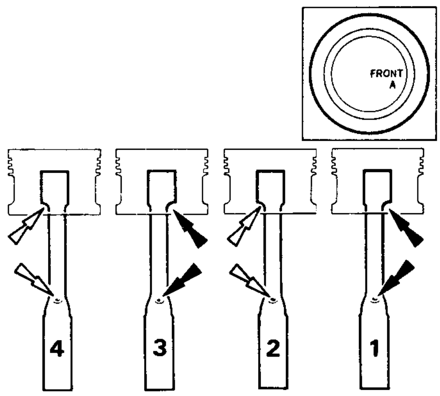
Pistons

The aluminium semi-skirt pistons, with the concave piston crown acting as a combustion chamber, are fitted with 2 compression rings and 1 oil control ring. When the engine is at operating temperature, piston expansion is controlled by circular internal inserts.

Connecting Rods and Gudgeon Pins

Aluminium semi-skirt pistons are secured to the con rods with press fit gudeon pins.

The con rods are forged steel, fitted with bolts and bi-hexagon nuts which are re-usable provided they will turn freely on their threads. If there is any sign of binding, the appropriate nut and bolt must be renewed.
Torque tighten big end nuts to 4.2 to 4.8 kgfm, 31 to 35 lbf ft.
The con rod small end is offset and care must be taken when fitting piston to con rod.



No.1 and No.3 small end large offset faces towards the water pump and No.2 and No.4 large offset faces the flywheel.

The gudgeon pins are offset to the centre of the pistons; to fit the pistons correctly they are identified by the word 'front' to the front of the engine.

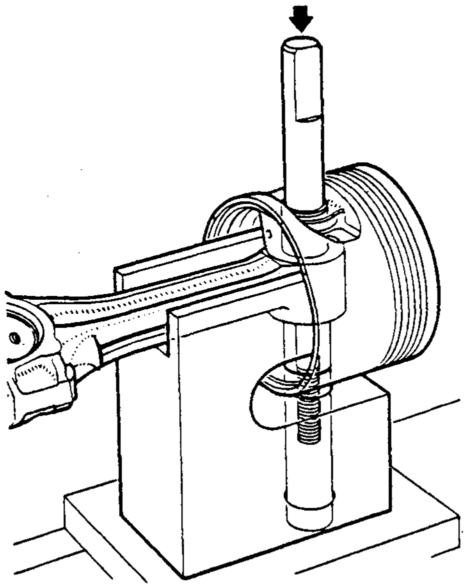
An arrow or groove may also be used to identify the front of the piston.

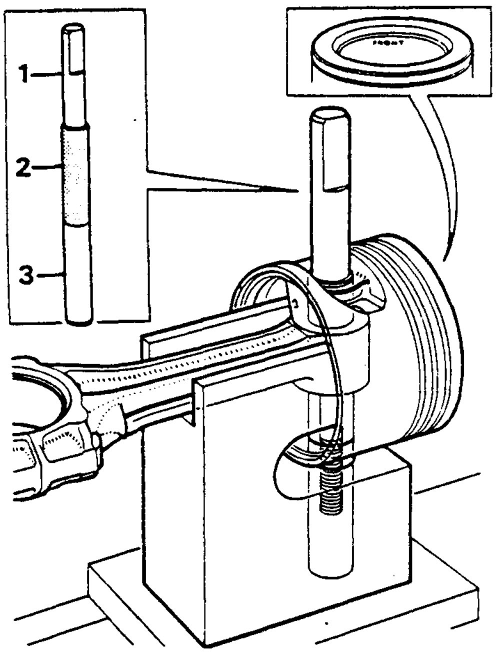
Number the con-rod caps prior to removal, and ensure the identification number on the side of the big end cap and con-rod are adjacent to each other during assembly.
The con-rod squirt hole must face the thrust side of the engine.

Instructions for using 18G 1306 gudgeon pin remover/replacer:

Dismantling

Remove the piston rings over the crown of the piston. Slide the piston and con-rod assembly onto the anvil of the tool ensuring the large offset of the small end is located face down on the top of the anvil. Pass the long threaded spindle of the tool through the gudgeon pin and into the bore of the anvil, threaded end first. Pass the plain ground spindle up through the bore in the base of the anvil and screw both spindles together, sandwiching the gudgeon pin. The assembly should now be as shown in the diagram. Removal is now achieved by pressing through the long spindle, ensuring the press bed is such that it allows the gudgeon pin to pass through.





Replacing

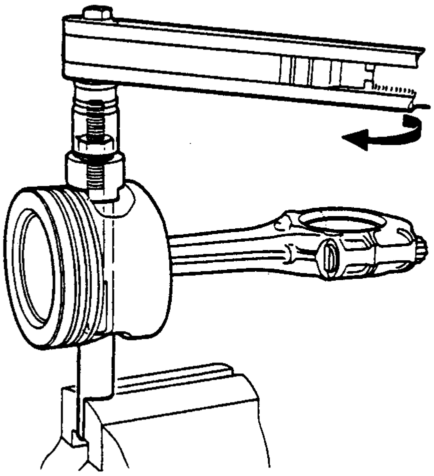
Assemble the long threaded spindle, the gudgeon pin and the plain ground spindle guide so as to sandwich the pin, but do not finally tighten at this stage.

Caution: It is essential that the piston is correctly fitted to the connecting rod; study the illustration showing the refitment of the gudgeon pin. For numbers 1 and 3 cylinders position the con-rod on the anvil so that the small end large boss is facing downwards and the oil squirt hole is facing towards the operator. Fit the piston over the con-rod with the word 'Front' facing downwards and fit the gudgeon pin. On numbers 2 and 4 the con-rod is placed on the anvil with the small end large offset facing downwards and the oil squirt hole facing away from the operator. Place the piston over the con-rod with the word 'Front' on the piston crown facing upwards and fit the gudgeon pin.

Smear the gudgeon pin with graphited oil, and pass the ground spindle through the piston and con-rod and into the anvil bore; ensure the gudgeon pin has entered the piston bore. Finally screw the two spindles together to pinch the gudgeon pin, preventing any movement of the pin. With the tool loaded and ready for assembly, locate it on a solid press bed. Press the pin into the con-rod until it bottoms on the press bed, this will ensure the pin is assembled centrally. Unscrew the spindles and slide the piston assembly off the tool.

Load Testing

This test is to ascertain the suitability of the gudgeon pin fit in the con-rod, and must be carried out on every newly assembled piston. Clamp the long spindle in a vice, clamping on the two flats. Slide the piston assembly onto the spindle. Slide onto the spindle the adapter pad with the milled flats face down onto the piston boss. Screw the nut and washer down onto the adapter pad and apply a torque of 12 lbf ft, 16 Nm, 1.7 kgm. This represents the minimum load for an acceptable fit of the gudgeon pin in the con-rod small end. If the gudgeon pin moves in the con-rod before this torque figure is reached the fit is not acceptable, and a new connecting rod must be fitted.



Ensure the thread and nut on the spindle are well lubricated during the test.

Check that the piston pivots freely on the pin, is free to move sideways and the gudgeon pin will not foul the bore. If stiffness exists, wash the assembly in fuel or paraffin (Kerosene), lubricate the gudgeon pin with Acheson's Colloids 'Oildag' and recheck. If stiffness persists, dismantle and recheck for ingrained dirt or damage.

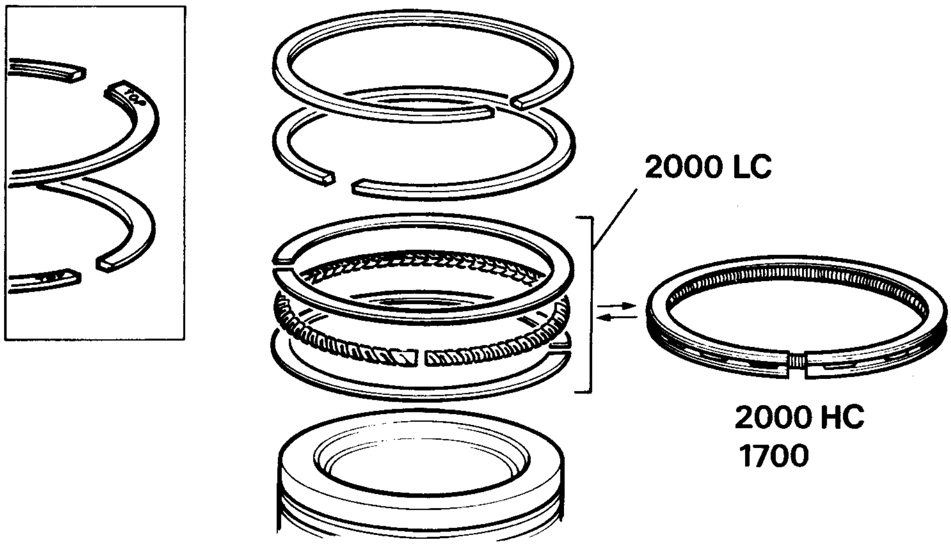
Refitting the piston - connecting rod assembly.

Piston rings.

Ring gaps

compression rings	- all	0,3 to 0,5 mm	(0.012 to 0.020 in)
oil control rings	- 1.7, 2.0 HC	0,38 to 0,58 mm	(0.015 to 0.023 in)
	- 2.0 LC	0,38 to 1,14 mm	(0,015 to 0.045 in)

To check the separate oil control expander fitted between the oil control rings of the 2 litre piston there should be no gap, the ends of the expander should butt together.



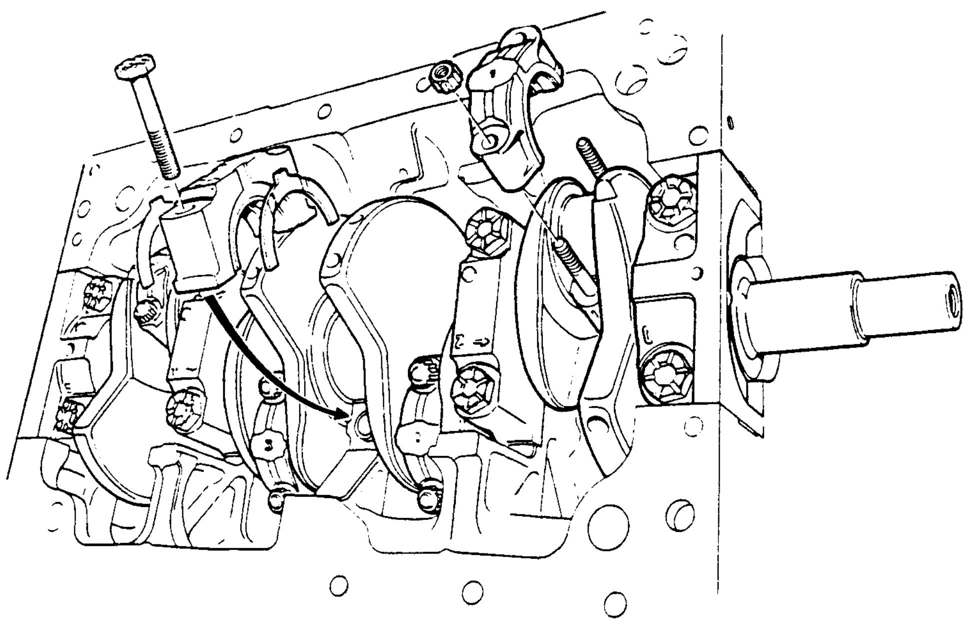
Position each ring squarely into the cylinder bore and check the ring gap. Fit each compression ring with the face marked 'TOP' or 'T' towards the piston crown.
Position the ring gaps at 90° from each other and away from the thrust side of the piston.

Fit each piston and con-rod assembly to its original cylinder using **18G 55A**.

Crankshaft

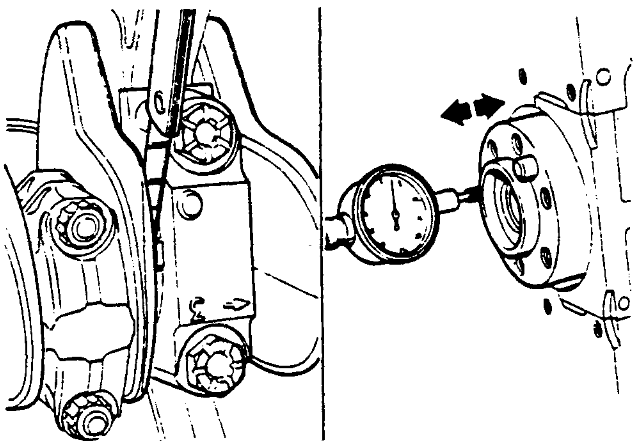
Five main bearing journals with a camshaft belt drive pulley, vibration damper/pulley and woodruff key for oil pump drive, positioned at the front end.

The journal-to-web radii are 'rolled' to increase strength at this point.



Crankshaft end float is controlled by thrust washers at the centre main bearing.

Main journal diameter:	54,005 to 54,026 mm	2.1262 to 2.1270 in
Crankpin journal diameter:	47,635 to 47,647 mm	1.8754 to 1.8759 in
Main bearings:	Five steel backed, thin wall type	
Diametrical clearance:	0.025 to 0,077 mm	0.001 to 0.003 in
Big end bearings:	Four steel backed, thin wall type	
Diametrical clearance:	0,038 to 0,081 mm	0.0015 to 0.0032 in
Crankshaft end thrust:	taken on thrust washers on centre main	
Crankshaft end-float:	0,025 to 0,14 mm	0.001 to 0.005 in
Thrust washers:	Standard and + 0,076 mm, 0.003 in	



Measuring crankshaft end float.

During assembly, apply RTV to the side faces of the rear main bearing cap.

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