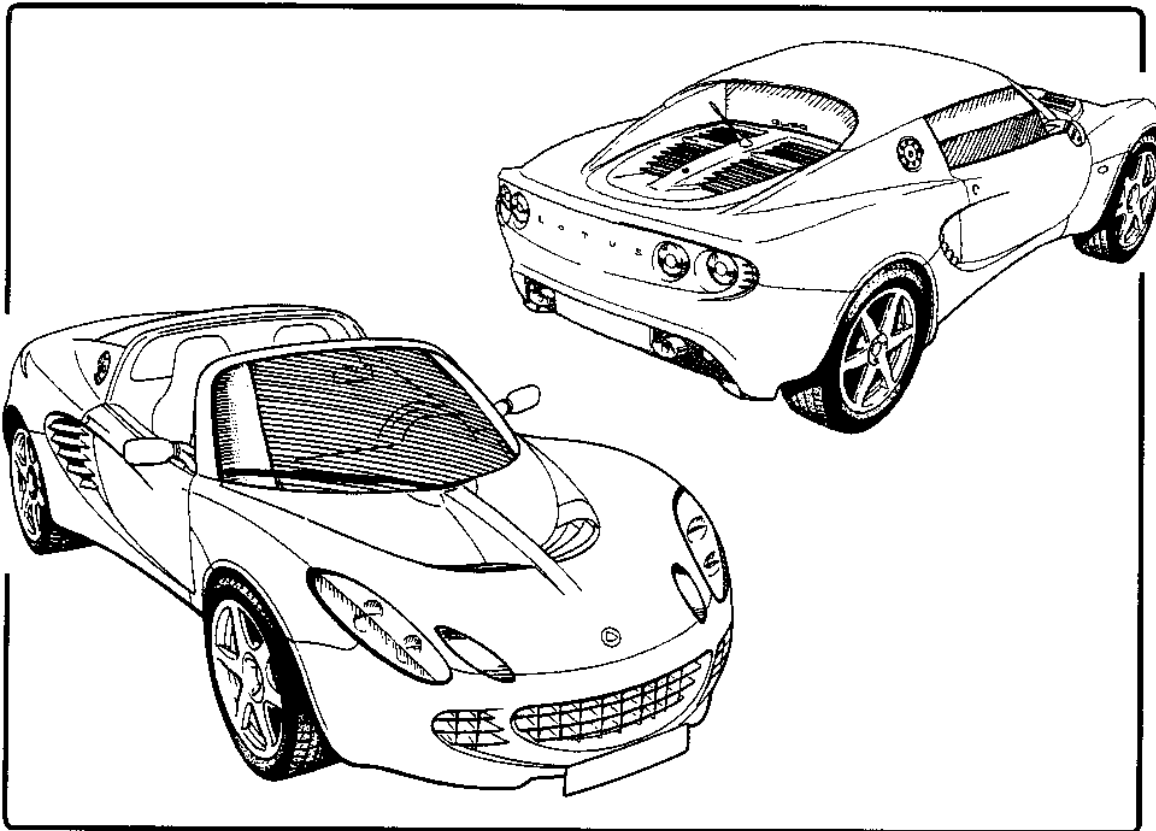




# SERVICE NOTES

# ELISE

2001 Model Year Onwards



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Part Number A117T0327J

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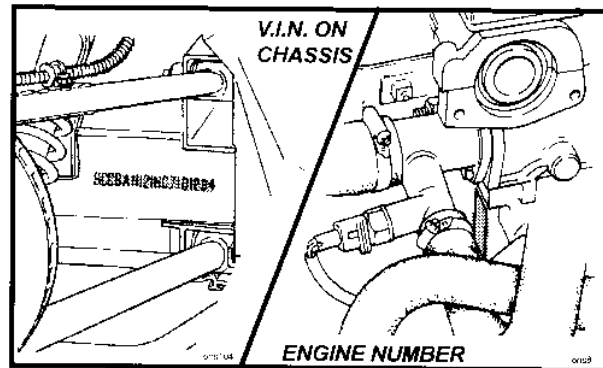
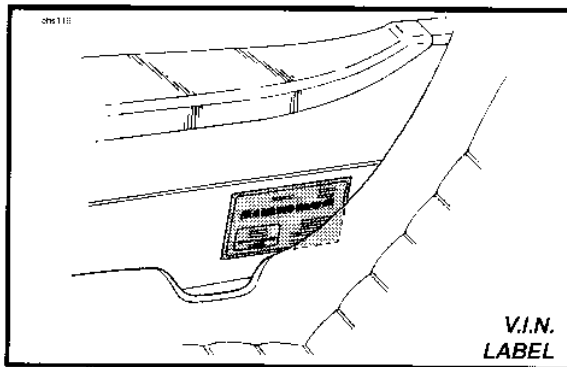
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**VEHICLE IDENTIFICATION NUMBER & ENGINE NUMBER**

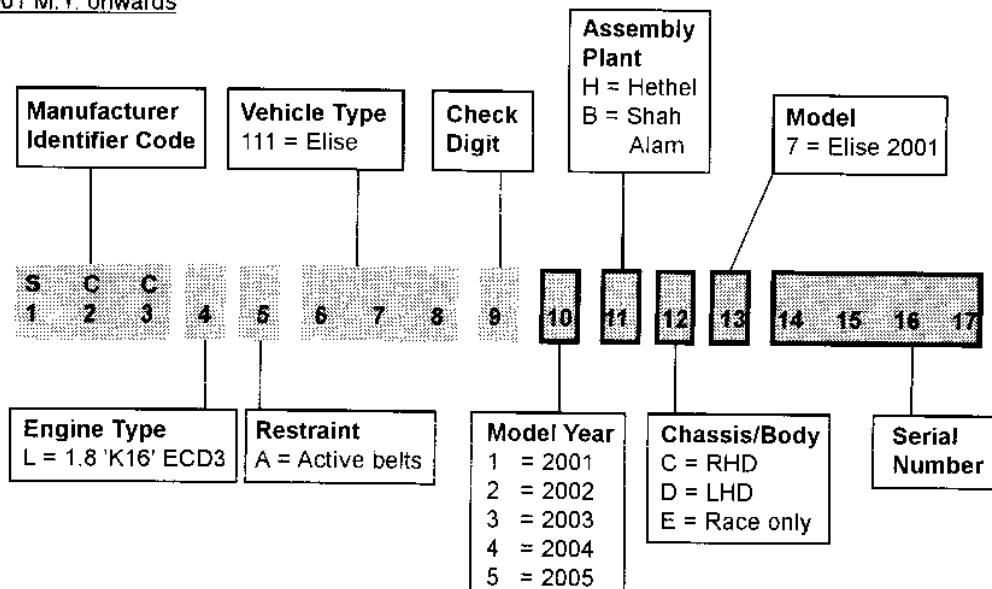
The Vehicle Identification Number (V.I.N.) is stamped on the chassis in the right hand front wheelarch area, viewable with the front wheels turned to right full lock, and is also printed on a label stuck to the inside of the chassis sideframe alongside the driver's seat. The engine number is marked on a vertical patch at the left hand end of the forward face of the cylinder block, and is most easily viewed using a mirror.

Both numbers should always be quoted with any vehicle enquiries, as Factory records are filed against V.I.N., and specification change points are identified by V.I.N. or engine number. The vehicle licence number may not accurately reflect vehicle age, may also be changed during the car's life, and is an unreliable method of vehicle identification.



The V.I.N. comprises 17 characters, coded in accordance with European Economic Community (EEC) directives. For change point identification in Service Notes, Service Bulletins and Service Parts Lists, normally, only characters 10 to 17 will be quoted.

'2001 M.Y. onwards





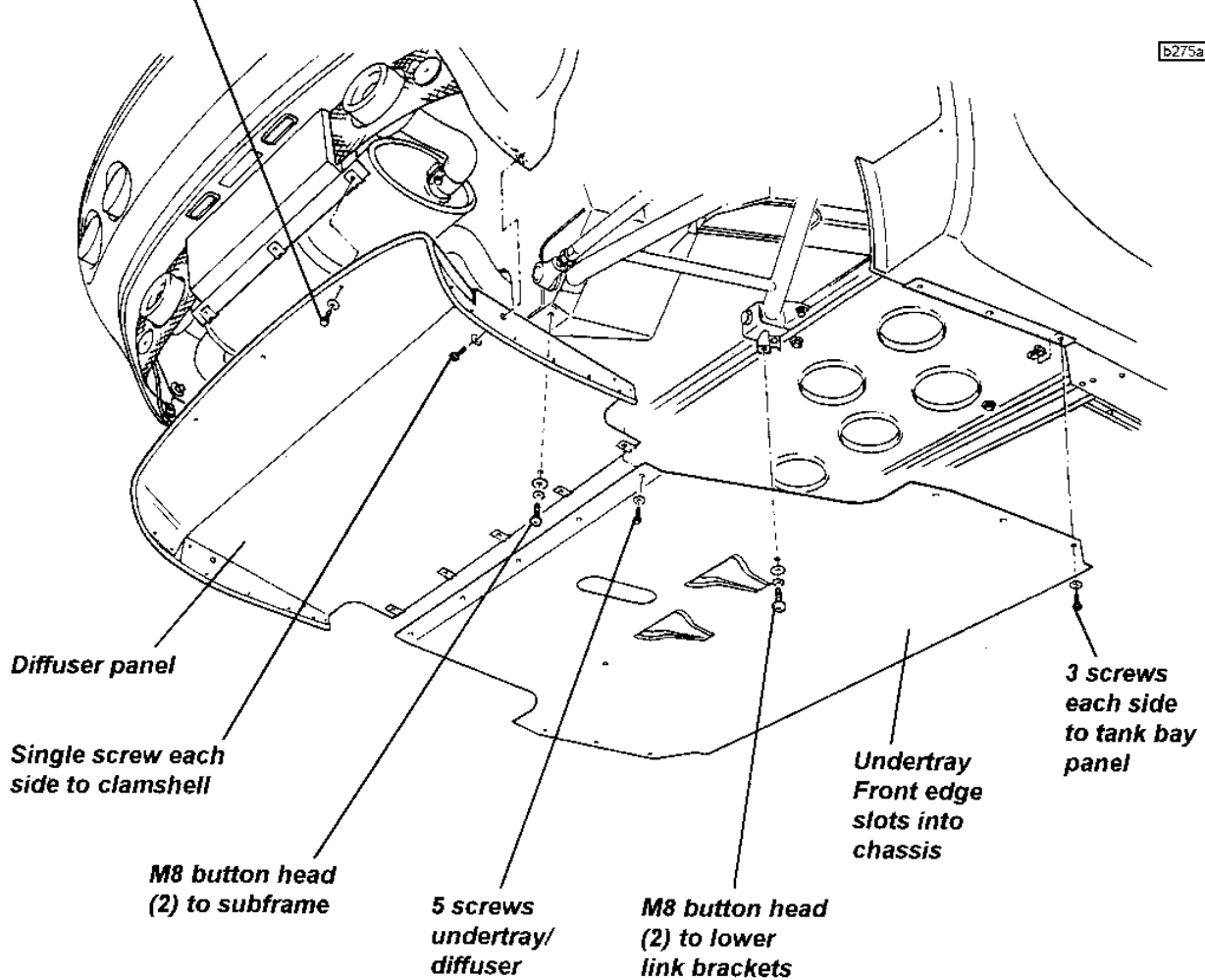
**ENGINE BAY UNDERTRAY/DIFFUSER**

For certain service operations, it may be necessary to remove the engine bay undertray and/or diffuser panel. The panels are retained by:

- Four M8 button head fixings needing a 5mm hexagonal key;
- Sixteen hex. head screws.

3 screws to  
licence plate plinth

b275a



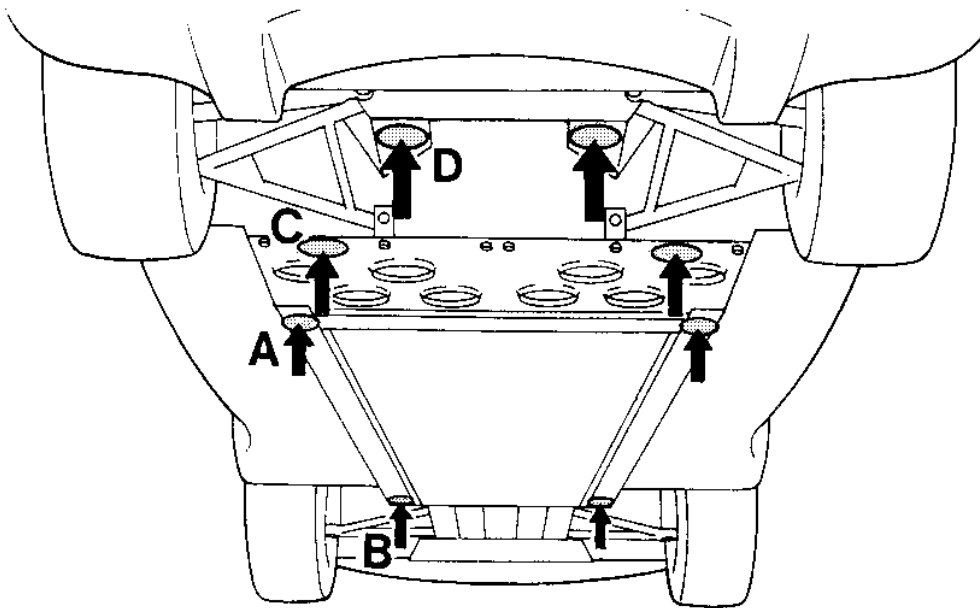


**JACKING POINTS**

Care must be taken when using a lifting jack or hoist only to position the device in one of the the areas shown in the illustration, with a suitable rubber or timber pad protecting the chassis from surface damage. If a 4-point lift is to be used, the engine bay undertray/diffuser panel (if fitted) must first be removed. When using a 4-point lift, it is strongly recommended that for optimum stability and safety, positions B and D are used.

- A; Identified by a blue sticker. Beneath crossmember ahead of fuel tank bay. To be used one side at a time for wheel changing - lifts both wheels on one side. *Do not use with a four point garage lift.*
- B; Beneath the front end of the right or left hand main chassis rail, behind the front wheelarch. Garage use with 4-point lift in conjunction with (C).
- C; *The engine undertray/diffuser panel must first be removed.* Beneath the outboard end of the chassis crossmember ahead of the rear wheelarches. Take care to position the jack between the fixing screws for the fuel tank bay perforated undershield. Garage use with 4-point lift in conjunction with (B).
- D; *The engine undertray/diffuser panel must first be removed.* Beneath the rear subframe, close to the lower wishbone rearmost mountings.

**Jacking at any other point may damage the chassis or body structure and/or jeopardise safety.**



ghs49en



TECHNICAL DATA - ENGINE

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GENERAL

Type designation	K16 (18K4FL70)
Configuration & no. of cylinders	in-line 4
Capacity	1796 cm <sup>3</sup>
Bore	80.00 mm
Stroke	89.30 mm
Valve actuation	Belt driven twin overhead camshafts with hydraulic tappets
Compression ratio	10.5:1 ± 0.5
Firing order	1,3,4,2
Spark plugs	Unipart GSP 66527
Spark plug gap	1.0 ± 0.5 mm
Maximum engine speed	6950 rpm
Idle speed	825 ± 50 rpm
Ignition system	Direct ignition using two double ended coils and 'wasted spark' principle
Fuel system	Fully sequential indirect fuel injection.
Fuel requirement	Unleaded 95 RON minimum
Max. net power (EEC)	89.7 kW (120 bhp; 122 PS) @ 5,600 rpm
Max. net torque (EEC)	168 Nm (124 lbf.ft) @ 4,500 rpm
Exhaust emissions	
- CO	0.4089
- HC	0.0776
- NOX	0.0411
- HC+NOX	0.1186

CYLINDER HEAD

Material	Aluminium alloy
Head face maximum warpage	0.05 mm
Cylinder head height	
- new	118.95 to 119.05 mm
- reface limit	0.20 mm

CAMSHAFTS & VALVE TIMING

Open duration	244° (at crankshaft)
Inlet valve opens	12° BTDC
Inlet valve closes	52° ABDC
Exhaust valve opens	52° BBDC
Exhaust valve closes	12° ATDC
Valve overlap	24°
Valve lift	
- inlet	8.8 mm
- exhaust	8.8 mm

VALVES

Angle of valve seats and faces	45°
Stem diameter	
- inlet	5.952 - 5.967 mm
- exhaust	5.947 - 5.962 mm
Stem clearance in guide	
- inlet	
- new	0.033 - 0.063 mm
- service limit	0.070 mm
- exhaust	
- new	0.038 - 0.078 mm
- service limit	0.110 mm
Valve clearance	Hydraulically controlled.
Valve stem fitted height	
- new	38.93 - 39.84 mm
- service limit	40.10 mm



**VALVE GUIDES**

Inside diameter	6.000 - 6.025 mm
Fitted height	6.0 mm

**VALVE SEATS**

Seat face angle	45°
-----------------	-----

**VALVE SPRINGS**

Free length	50.0 mm
Fitted length	37.0 mm
Load at fitted length	250 ± 12 N
Load at full lift	450 ± 18 N

**CRANKSHAFT**

Crankshaft endfloat	- new	0.10 - 0.25 mm
	- service limit	0.34 mm
Thrust washer thickness		2.61 - 2.65 mm
Main journal diameter		47.979 - 48.007 mm (for grading see Section EE)
Maximum out of round		0.010 mm
Big end journal diameter		47.986 - 48.007 mm (for grading see Section EE)
Maximum out of round		0.010 mm
Big end clearance		0.021 - 0.049 mm

**PISTON RINGS**

New ring to groove clearance	- top compression	0.040 - 0.072 mm
	- second compression	0.030 - 0.062 mm
	- oil control	0.010 - 0.180 mm
New ring gap, 20mm from bore top	- top compression	0.20 - 0.35 mm
	- second compression	0.28 - 0.48 mm
	- oil control	0.15 - 0.40 mm

**PISTON**

Piston diameter (8mm from bottom, 90° to pin)	- grade A	79.975 - 79.990 mm
	- grade B	79.991 - 80.005 mm
Clearance in bore (20mm from bottom of bore)		0.01 - 0.04 mm

**CYLINDER BLOCK**

Cylinder liner bore (65mm from top)	- red grade A	80.000 - 80.015 mm
	- blue grade B	80.016 - 80.030 mm

**OIL PUMP**

Outer rotor to housing clearance	0.28 - 0.36 mm
Inner rotor tip clearance	0.05 - 0.13 mm
Rotor end float	0.02 - 0.06 mm

**COOLANT THERMOSTAT**

Nominal setting	85 - 91°C
Thermostat starts opening	88°C
Thermostat fully open	100°C



TECHNICAL DATA - VEHICLE

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**DIMENSIONS**

Overall length	3785 mm
Overall width - exc. mirrors	1719 mm
- inc. mirrors	1850 mm (approx.)
Overall height (at kerb weight)	1117 mm
Wheelbase	2300 mm
Track - front	1457 mm
- rear	1503 mm
Ground clearance (mid-laden)	130 mm
Front overhang	783 mm
Rear overhang	702 mm
Approach angle (at kerb)	13.5°
Departure angle (at kerb)	23°
Unladen weight - total	774 kg >
- front	294 kg > inc. full fuel tank
- rear	480 kg >
Max. weight - total	1044 kg }
- front	406 kg } inc. occupants & luggage
- rear	638 kg }
Trailer towing	Not permissible

**CAPACITIES**

Engine oil - dry	5.0 litre (8.8 imp. pt)
- refill inc. filter	4.5 litre (7.9 imp. pt)
High/low dipstick mark difference	1.0 litre (1.8 imp. pt)
Transmission oil - dry	2.4 litre (4.2 imp. pt)
- refill	2.1 litre (3.7 imp. pt)
Fuel tank	32 litre (7.0 imp.gall)
Coolant	8.0 litre (14.1 imp. pt)

**WHEELS & TYRES (normal use)**

Wheel type	Rimstock alloy, 4-bolt fixing
Wheel size - front	5.5J x 16 ET 31.3
- rear	7.5J x 17 ET 17.75
Wheel bolt torque	105 Nm (77 lbf.ft)
Tyre type	Bridgestone Potenza RE040
Size - front	175/55 R16
- rear	225/45 R17
Pressure (cold) - front	1.8 bar (26 lb/in <sup>2</sup> )
- rear	1.9 bar (27.5 lb/in <sup>2</sup> )

**WINTER WHEELS & TYRES**

Wheel type	Rimstock alloy 6-spoke, 4-bolt fixing
Wheel size - front	5.5J x 15 ET 31.3
- rear	7J x 16 ET 17.75
Wheel bolt torque	105 Nm (77 lbf.ft)
Tyre type	Bridgestone LM22
Size - front	185/55 R15
- rear	205/55 R16
Pressure (cold) - front	TBA
- rear	TBA
Studding	Not permitted
Tyre chains	Pewag Neon X3-NX369 fitted only on rear winter wheels/tyres



FRONT SUSPENSION

Type

Independent. Upper and lower wishbone; co-axial coil spring/telescopic damper unit; anti-roll bar.

Geometry check ride height (2 persons, 1/2 tank fuel)

- front
- rear

130 mm below front end of chassis siderail  
 130 mm below rear end of chassis siderail  
 0.2 mm toe-out overall; + 0.2, - 0 mm  
 (0.03° toe-out overall; + 0.03°, - 0°)

Alignment

- 0.1°; + 0.1°, - 0.2°. Max side/side; 0.2°  
 + 3.8°; ± 0.2°. Max. side/side; 0.2°  
 12° nominal

Camber

Castor

Steering axis inclination

REAR SUSPENSION

Type

Independent. Upper and lower wishbone; co-axial coil spring/telescopic damper.

Geometry check ride height (2 persons, 1/2 tank fuel)

- front
- rear

130 mm below front end of chassis siderail  
 130 mm below rear end of chassis siderail  
 1.2 mm toe-in each side; + 0.2, - 0 mm  
 (0.18° toe-in each side; + 0.03°, - 0°)  
 Max. difference side/side; 0.2 mm (0.03°)  
 - 1.8°; ± 0.2°. Max. side/side; 0.2°

Alignment

Camber

ELECTRICAL

*Light Bulbs*

Headlamps

<i>Wattage</i>	<i>Type</i>
55	H1 & H7

Driving lamps

55 H3

Front side/parking lamps

5 W5W

Side repeater lamps

5 W5W amber

Front turn indicators

21 PY21w amber

Rear turn indicators

21 H21

Stop/Tail lamps

4/21 P21/4w

Tail lamps

5 R5W

High mounted stop lamp

2.5 16 x LED

Fog/Tail lamps

4/21 P21/4w

Reversing lamp

21 H21

Licence plate lamps

5 C5W

Interior lamp

5 W5W

System voltage/polarity

12V negative earth

Alternator

85A

Battery - type

Tungstone 006

- cranking power

300A (SAE)

- reserve capacity

50 minutes

TRANSMISSION

Type

5 speed manual transaxle.  
Bevel gear differential.

<i>Gear</i>	<i>Ratio</i>	<i>Final Drive</i>	<i>mph(km/h)/1000 rpm</i>
First	2.92 : 1	)	5.8 (9.3)
Second	1.75 : 1	)	9.9 (15.9)
Third	1.31 : 1	) 4.20 : 1	13.1 (21.1)
Fourth	1.03 : 1	)	16.7 (25.7)
Fifth	0.85 : 1	)	19.4 (31.2)
Reverse	3.00 : 1	)	



CLUTCH

Type

Single dry plate. Diaphragm spring cover.  
Hydraulic release.

Friction plate diameter

215 mm

Diaphragm finger clearance

1.00 mm

Diaphragm finger height - new

37.5 - 32.1 mm

- service limit

42.75 mm

Friction plate thickness - new

7.4 - 6.9 mm

- service limit

5.6 mm

Rivet depth - new

1.00 mm

- service limit

0.20 mm

Friction plate run-out - new

0.80 mm

- service limit

1.00 mm

Pressure plate warp - service limit

0.15 mm

BRAKES

Type

Ventilated front & rear discs. Opposed piston alloy front calipers. Single piston sliding rear calipers.

Disc type

Cast iron, curved vane ventilated.

Cross-drilled option.

Disc size - front & rear

288 mm

Operation

Tandem master cylinder

Parking brake

Cable operation of rear calipers, self adjusting for pad wear.

STEERING

Type

Rack and pinion

Turns, lock to lock

2.8

Gear ratio

15.8:1

Rack height plate

7 notch

FUEL CONSUMPTION

93/116/EC - std

- urban

10.1 l/100 km (28.0 mpg)

- extra urban

6.2 l/100 km (45.6 mpg)

- combined

7.7 l/100 km (36.7 mpg)

- CO<sub>2</sub>

183 g/km



CHASSIS

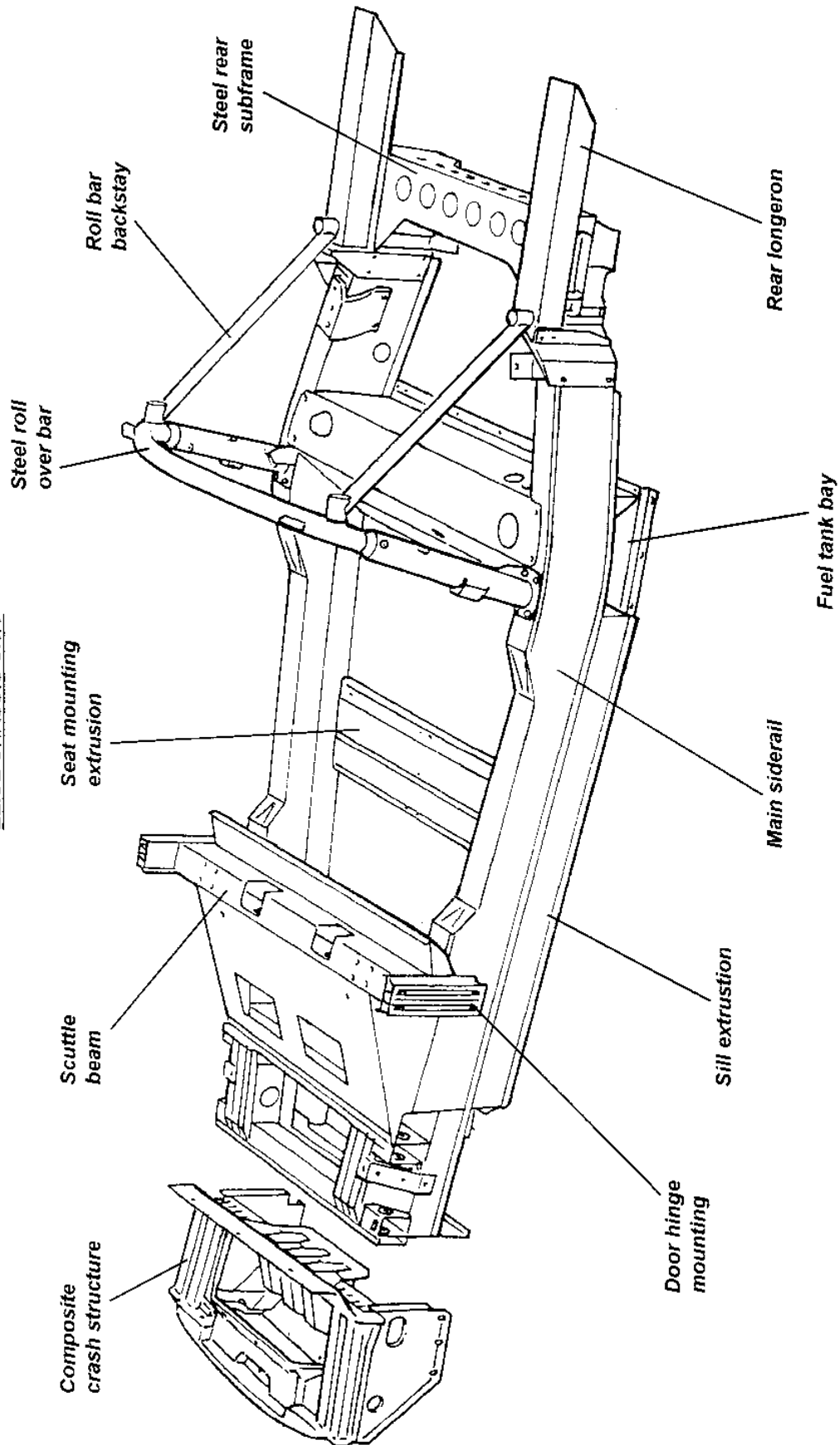
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ELISE CHASSIS UNIT



**AG.1 - GENERAL DESCRIPTION**

The chassis frame of the Lotus Elise is constructed primarily from aluminium alloy extrusions and formed alloy sheet, with the various sections bonded together using an epoxy adhesive with secondary drive-in fasteners. The basic chassis unit includes the passenger cell, front suspension mountings, fuel tank housing, and mid mounted engine bay, with a fabricated sheet steel rear crossmember bolting to the rear of the engine bay to provide rear suspension mountings and rear body support, and a tubular steel roll over bar bolted to the top of the chassis structure for additional occupant protection. The cabin rear bulkhead, body sills (inc. 'B' posts), front energy absorbing crash structure and scuttle/windscreen mounting frame, are all constructed from glass fibre composite and are bonded to the chassis structure using an elastomeric adhesive. The front and rear body sections are each single piece composite mouldings, fixed to the chassis structure with threaded fasteners.

Two main chassis siderail extrusions, 210mm deep and 100mm wide, run along each side of the passenger compartment between the front and rear suspension mountings, splaying outwards towards the rear before curving inwards around the fuel tank bay and terminating at each side of the engine bay to provide platforms for the engine mountings. To enhance cockpit access, the height of the siderails is reduced in the door area, and internal reinforcement added in order to retain torsional rigidity.

Running along the underside of the siderails from the front suspension crossmember to the fuel tank bay are sill extrusions which carry the cockpit floor panel. The single skin floor panel is swaged for stiffness, and is reinforced by a ribbed transverse extrusion running across the inside of the tub, which also provides for the seat mountings. Behind the passenger cell, the siderails are linked by a pair of transverse crossmembers which are used to form an open bottomed fuel tank cell with a detachable, screw fixed, closing panel with swaged lightening holes. Note that this panel contributes to the structural integrity of the chassis, such that the vehicle should not be operated without it fitted.

The rear ends of the siderails are joined behind the engine bay by a galvanised sheet steel fabricated subframe which provides mountings for the rear suspension pivots, engine rear stabiliser and exhaust muffler. Onto each top side of the subframe is bonded and rivetted a box section extruded alloy longeron, which extends rearwards to provide rear body support. Enhanced stiffness of the chassis rear section and additional occupant protection is provided by a tubular steel roll over bar which bolts to the top of the siderails alongside the fuel tank bay, with bracing struts running down to the rear ends of the siderails.

At the front of the passenger compartment, four transverse extrusion beams are used to provide mountings for the front suspension pivots, and house the steering rack, with an upright section used each side to anchor the top of the spring/damper unit. Five interlinked extruded floor sections are used to reinforce this area, with the open topped space between the front ends of the siderails housing the heater/a.c. unit and washer bottle. An extruded scuttle beam links the tops of the siderails, and is reinforced by a panel extending to the steering rack crossmember. These elements are used to mount the steering column and pedal box, with a vertical extrusion fixed to each end of the scuttle beam to carry the door hinge pillar.

To the front end of the chassis is bonded a glass fibre composite 'crash structure' which incorporates tubular sections designed to dissipate collision energy and control the rate of deceleration sustained by the occupants. Ducting and mountings for the horizontally positioned engine cooling radiator are also incorporated in this structure.

The bonded and rivetted alloy chassis structure described above is considered a non-serviceable jig built unit to which no structural repairs are approved. Superficial, cosmetic, or non-structural localised damage may be repaired as necessary, but in the case of accident damage resulting in significant bending, tearing or distortion of the aluminium chassis, such that the specified suspension geometry cannot be achieved by the standard range of suspension adjustment provided, the recommended repair is to renew the partial body assembly, which comprises the chassis and roll over bar together with jig bonded composite rear bulkhead, body sills, windscreen frame and crash structure, and the radiator feed and return pipes, heater pipes, battery cable and clutch pipe which are all routed within the sill panels.



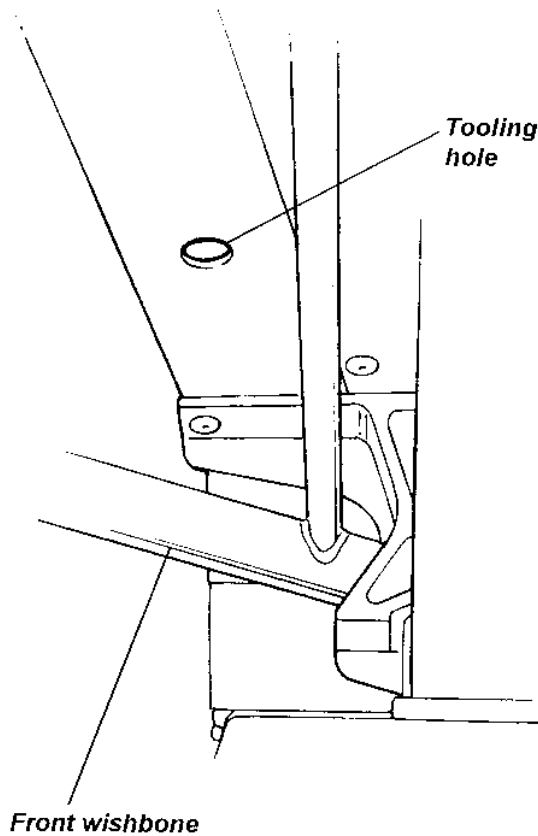


**AF.2 - CHASSIS STRAIGHTNESS CHECK**

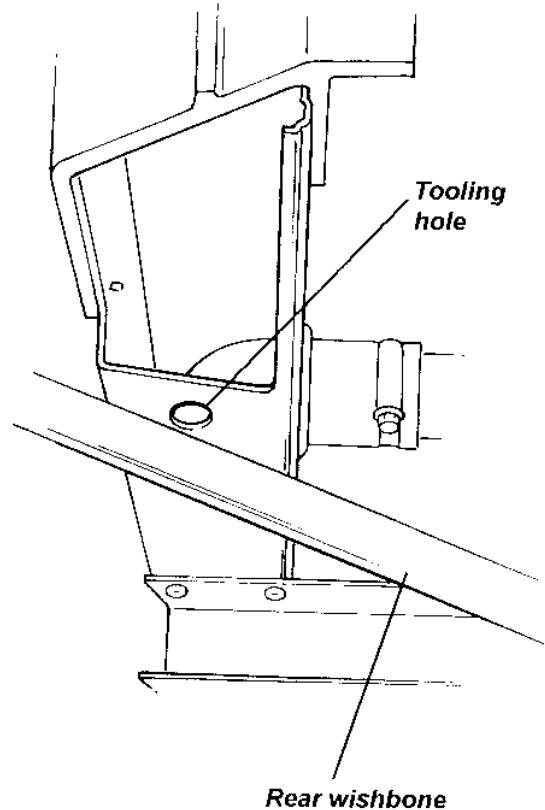
In the absence of visual damage, the chassis may be checked for twist or distortion by utilising the tooling holes in the underside of the main side rails. If computer processed laser measuring equipment is not available, manual checks can be made with reference to an accurately level ground plane, e.g. an accurately set and maintained suspension geometry ramp/lift. Position the car on the lift, and proceed as follows:

1. Identify the tooling holes in the lower surface of each chassis main side rail. At the front end, between the suspension wishbone pivots, and at the extreme rear end of each rail.
2. Measure the height of each tooling hole above the reference plane and use jacks to adjust the height of the chassis in order to equalise any three of these dimensions.
3. Measure the deviation of the fourth dimension from the other three.  
Maximum service deviation =  $\pm 2.0$  mm.
4. Repeat operations (2) and (3) for each combination of corners to result in four values for the 'fourth' dimension deviation. If any one of these exceeds the service specification, the chassis should be considered damaged and replaced by a partial body assembly.

**FRONT**



**REAR**



a27

**AF.3 - REAR SUBFRAME & LONGERONS**

The rear ends of the chassis siderails are linked by a fabricated sheet steel subframe which provides rear suspension mountings, and an anchor point for the engine rear steady bar. At each side, an extruded box section 'longeron' is rivetted and bonded to the top surface of the subframe, and extends rearwards to provide rear body support. A heat shield is fixed between the longerons, to protect the clamshell bootbox from exhaust heat.

**To remove rear subframe assy.**

1. Remove the rear clamshell (see section BP).
2. Remove exhaust catalytic converter and muffler, drill out the rivets and remove the exhaust heatshield.
3. Disconnect the parking brake cables and rear brake hydraulics, and remove both rear suspension assemblies complete with driveshafts.
4. Release the engine rear steady arm from the subframe.
5. Release the roll over bar stays from the damper top mount tapping block, and remove the two bolts each side securing the subframe to the chassis flange. Withdraw the subframe and longerons as an assembly from the car.

Note that it is not generally possible to separate a rear longeron from the subframe without damage to one or both components. If a longeron is damaged but the subframe is to be re-used, the longeron must be cut from the subframe.

**Fitting rear subframe**

When bolting the subframe at each side to the chassis rail rear flange, ensure that the anti-corrosion shim plate is interposed. The lower fixing bolts should be inserted from the rear, and the upper bolts from the front. Torque tighten the bolts to 45 Nm.

If longerons are already fitted to the subframe, fit the rear damper mount tapping block to the chassis before fitting the subframe and after bolting up the subframe, secure the roll over bar stays using the M10 caphead screw and washer at each side to pass through the longeron and into the damper mount tapping block. Torque tighten to 45 Nm.

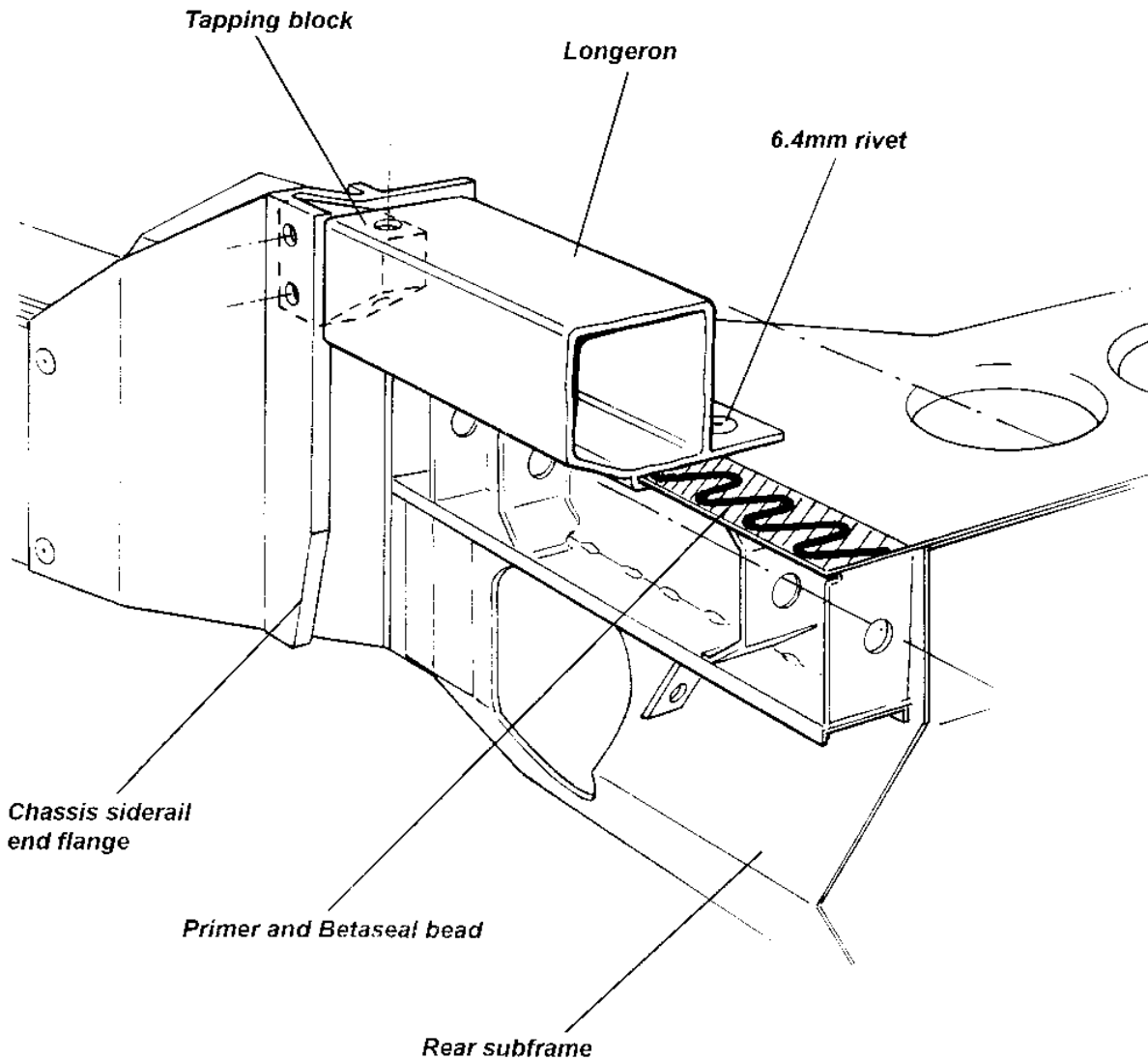
If no longerons are fitted to the subframe, fit the subframe to the chassis, and then fit the longerons to the subframe as follows:

**Fitting rear longerons**

1. Ensure that at each side, the top surface of the subframe is free of zinc flashing, including the outside top lip of the subframe. Dry fit the longeron to ensure that the channel in the extrusion fits onto the outside edge of the subframe, with the longeron lying flat on the subframe top surface. The damper mounting tapping blocks may be fitted before the longerons for easier access, or alternatively, to ease fitment of the longerons, the tapping blocks may be fitted afterwards by feeding down the inside of the longeron.
2. Clean the mating surfaces on the subframe and longeron using Betawipe VP 04604 (A082B6150V) as directed in section BO.
3. Prime the whole of the mating faces of the subframe and longeron with Betaprime 5404 (A082B6337V) as directed in section BO.
4. Apply a 'zig-zag' bead of Betaseal 1701 (A082B6281F) or Betamate E2400 (A082B8415V) to the primed surface of the subframe as detailed in section BO.



5. Hook the longeron over the edge of the subframe and onto the adhesive and slide fully forward until aligned with the rivet holes and roll over bar brace fixing hole in the tapping block. Insert three 6.4 mm (1/4") rivets each side to secure the longeron to the subframe. Fit the M10 caphead screw and washer to secure the roll over bar stay and longeron to the damper mounting tapping block.
6. Fit the exhaust heatshield and other components in reverse order to removal.



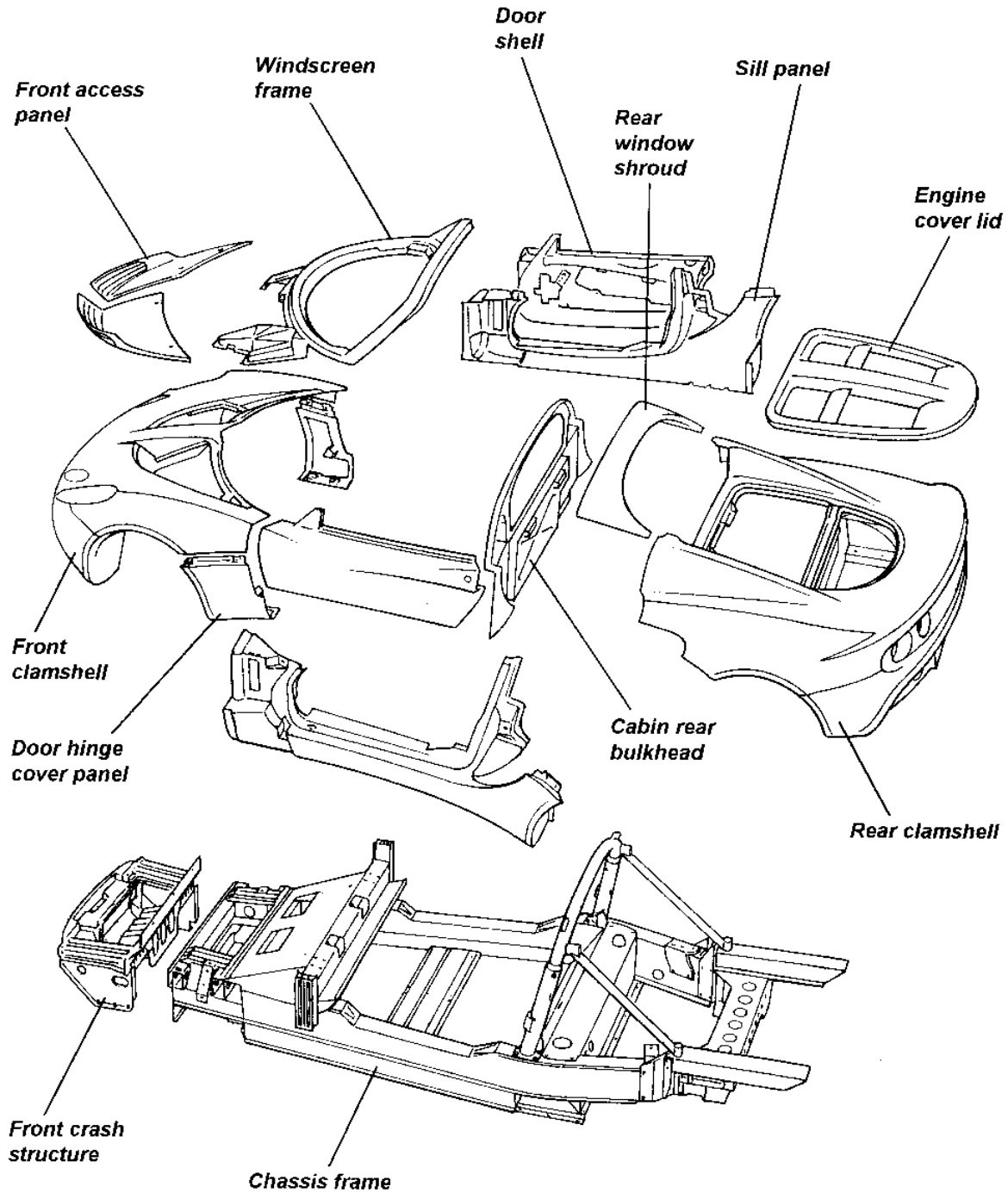
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**BODYCARE & REPAIR****SECTION BO - ELISE 2001 M.Y. Onwards**

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**Body Panels**



b277a



### BO.1 - GENERAL DESCRIPTION

The body panels of the Lotus Elise are constructed of composite materials, with the external panels not being required to contribute to chassis rigidity. The panels are attached to the aluminium chassis and/or other body panels either by elastomeric polyurethane adhesive, or in the case of the front and rear clamshells, are bolted on for ease of dis-assembly and access to chassis parts. The composite mouldings are manufactured by one of several processes (see later) dependent on application, with a nominal thickness of 2.2 - 2.5 mm. The windscreen frame incorporates foam beams to create closed box sections for optimum strength and a 'crash structure' bonded to the front of the chassis incorporates longitudinal box sections to provide specific crush characteristics and absorb crash impact by progressive collapse. This structure also acts as a mounting and duct for the engine cooling radiator which is mounted horizontally on its top surface.

### BO.2 - LOTUS COMPOSITE BODY FEATURES

Composite structures have the ability to absorb high impact loads by progressive collapse, with impact damage being localised. In vehicle accidents this feature protects the occupants from injurious shock loads and greatly reduces the danger of entrapment by deformation of steel body panels. This behaviour also facilitates repair by either replacing the damaged bonded or bolt on panels, and/or integrating a replacement section with the undamaged area, using recognised approved methods which restore the panel to its original condition without residual strain or distortion.

The manufacturing process enables the thickness of composite mouldings to be varied in order to provide efficient structures of high strength and low weight. Composites will not corrode, so the strength of composite components is retained regardless of age, unless physical damage is sustained. On the Elise, the body construction features an assembly of mouldings to form a single piece for the whole of the nose and front wings, and a similar assembly for the whole of the rear body aft of the doors. These two 'clamshells' are fixed using threaded fasteners to permit easy removal for access to chassis or powertrain components, or to allow simple and economic accident repair. Other composite mouldings include the door shells, sills, front compartment lid, windscreen frame and rear bulkhead, some panels being bonded to the aluminium alloy chassis with an elastomeric adhesive.

A composite panel may return to its original shape after deflection, but beyond a certain level of flexibility, such treatment may result in the formation of surface cracks which may not be immediately apparent due to the masking effect of the paint film. A steel panel similarly treated would become dented or deformed. The cracking may be confined to the surface layer with no reduction in panel strength, but if the damage is more severe the composite structure below the surface may be weakened. Localised repairs can be made in either case. Possible causes of surface cracking include:

- Vehicle collision;
- Sitting, leaning heavily or pushing on the body or any composite panel;
- Knocking doors against obstructions when opening;
- Dropping objects onto a panel;
- Allowing unrestrained items to roll about in a luggage compartment;
- Fitting a front access panel or closing the engine cover onto projecting objects, e.g. luggage or tools;
- Applying excessive force to parts attached to composite panels e.g. mirrors, locks, aerial etc. (inc. action by vandals).
- Incorrect jacking.

The composite body panels of the Elise are manufactured by one of several processes dependent on the requirements of the panel concerned:

- The front and rear clamshells, sill panels, windscreen frame, door outer panels and front crash structure are produced by Injection Compression System Resin Transfer Moulding (ICSRTM), whereby a mix of polyester resin and glass fibres is injected into a heated, chrome steel surfaced, closed mould. After filling, the gap between the two halves of the mould is then reduced in order to compress the moulding and ensure complete material flow and consistent structural quality. Panel thickness is a nominal 2.2 mm. The absence of the 'gel coat' used with other processes results in much greater resistance to surface damage, and minimum surface preparation for before painting.



- The front access panels, engine cover lid, door hinge panels, door inners and rear window shroud are produced from Low Pressure Sheet Moulding Compound (LPSMC), whereby flat sheets of composite material are formed using heated, chrome steel surfaced moulds to produce panels with a nominal thickness of 2.5 mm.
- A third process is used for the cabin rear bulkhead, bootbox and radiator mounting panel where the panel surface is not primarily visible. These panels are produced by a Polyurethane Structural Reaction Injection Moulding (PU SRIM) process.

Whichever production process applies, conventional composite repair techniques can be used to rectify structural or surface damage whenever repairs can be determined as being more economic than panel replacement.

### BO.3 - BODYCARE

The acrylic enamel paint finish of the Elise is extremely resistant to all normal forms of atmospheric attack. Following the simple maintenance procedure summarised below will help retain the gloss, colour and protective properties of the paint throughout the life of the vehicle. However, car finishes are not immune to damage, and amongst the more common causes of deterioration are:

- Atmospheric contaminants; dust, soot, ash, and acidic or alkaline aerosol mist can chemically attack paint.
- Abrasion; blowing sand and dust, or a dirty washing cloth.
- Tree sap and insect fluids; can form a water-insoluble polymer that adheres to the paint.
- Bird excrement; highly acidic or alkaline, they can chemically etch the paint. Wash off immediately.
- Leaves; contain tannic acid which can stain light finishes.
- Impact damage; granite chippings thrown up from poor or recently dressed road surfaces can subject the body to severe localised impact, and result in paint chips, especially around the vulnerable frontal panels. Do not follow other vehicles too closely in such circumstances.

#### **Washing**

Lotus recommends that the car be hand washed, using the following instructions:

Many contaminants are water soluble and can be removed before any harm occurs by thorough washing with plenty of lukewarm water, together with a proprietary **car wash** additive (household detergent and washing up liquid can contain corrosive salts, and will remove wax and accelerate oxidation). Frequent washing is the best safeguard against both seen and invisible contaminants. Wash in the shade, and use a cotton chenille wash mitt or a sponge rinsed frequently to minimise entrapment of dirt particles. Use a straight back and forth washing motion to avoid swirled micro scratches, and rinse thoroughly.

In order to minimise degradation from road salt, the underside of the chassis should be rinsed with clean water as soon as possible after driving on treated roads. Many fuel filling stations offer pressure washing facilities ideal for this purpose.

#### **Soft Top Roof:**

1. Careful vacuuming of the soft top before washing may be helpful in removing excess dust and other foreign particles.
2. Wash in partial shade rather than strong sunlight, and wet the whole car before tackling the soft top.
3. Use a sponge (a chamois or cloth will leave lint, and a brush may abrade the threads) to apply a mild soap solution of lukewarm water. Do NOT use a detergent.
4. To avoid rings or spots, wash the entire top uniformly and let the soapy solution remain on the fabric for 2 to 5 minutes.
5. Rinse the whole car to remove all soap from the fabric and to prevent streaking on the car bodywork.
6. Remove surface water with a sponge and allow to air dry in direct sunlight. Ensure that the roof is fully dry before stowing, as prolonged stowage of a wet or damp roof will promote rotting of the fabric.

Keeping the soft top clean by regular washing will enhance the life and maintain the appearance of the roof, and facilitate subsequent cleaning. The use of stronger cleansers should be left to professionals experienced in handling this type of fabric as discoloration and degradation of the special protective inner layer may



result. The application of wax finishes, dressings or preservatives will cause stains which are difficult to remove and therefore should be avoided.

### **Paintwork Polishing**

Eventually some loss of gloss, and an accumulation of traffic film, will occur. At this stage, after normal washing, the application of a good quality liquid polish will restore the original lustre of the paint film. Higher gloss of the paint finish, and added protection against contamination, can be obtained by the use of a wax polish; however, this can only be used successfully on a clean surface, from which the previous application has been removed with white spirit or a liquid polish cleaner.

### **Ventilation**

Water lying on the paint surface for a lengthy period will eventually penetrate the paint film. Although the effects will not be visible immediately, a deterioration in the protective properties of the paint film will ultimately result. It is not recommended to store a wet car in a poorly ventilated garage. If good ventilation cannot be provided, storage outside on a hard standing or under a carport is to be preferred.

## **BO.4 - ACCIDENT DAMAGE ASSESSMENT**

The repair method to be employed in the rectification of accident damage to composite panels, is to be assessed relative to the particular panel and its method of attachment:

- Bolt-on Panels:*
- Front Clamshell;
  - Rear Clamshell;
  - Door Shells;
  - Front Body Access Panels;
  - Engine Cover Lid;
  - Door Hinge Cover Panels;
  - Rear Window Shroud.

These panels are secured by threaded fasteners and are easily removed for access to the back of any damaged area for repair by conventional composite techniques. Instructions for the removal and refitment of these panels are contained in section BP.

- Bonded-on Panels:*
- Windscreen Frame;
  - LH & RH Sill Panels;
  - Front Crash Structure;
  - Rear Bulkhead

These panels are bonded to the chassis or to other panels using a flexible polyurethane adhesive which must be cut before the panel may be removed. In some cases, it may be necessary to partially remove another panel before the subject panel can be released. It is not generally economic to attempt to remove a bonded panel intact for later re-fitment.

The integrity of the front crash structure is crucial to the safety of the car in a frontal collision, and it is recommended not to attempt any major repair of this component. The damaged structure should be cut from the front of the chassis, and a new assembly bonded into position. The shape and positioning of the windscreen frame is crucial to the fit of the windscreen and sealing of the soft top roof, such that the only repairs which should be considered for this panel are cosmetic and superficial; any structural damage should entail panel replacement.

The sill panels include the 'A' and 'B' posts, and involve much labour time to replace. Localised repairs should be performed whenever possible, although access to the inside surface of some parts of the panels is not freely available.

Note that if damage is such as to require replacement of the chassis, replacement chassis assemblies are provided only as a 'partial body assembly' which includes jig bonded front crash structure, windscreen frame, side sills and rear bulkhead. The roll over bar, coolant and heater feed/return pipes, battery cable and clutch hose are also included.



**BO.5 - BODY PANEL BONDING MATERIALS**

The materials used for bonding the body panels are manufactured by Gurit-Essex, and in order to maintain the structural integrity of the vehicle, and in the case of the front crash structure, the safety, it is most important to use only the specified materials. The surface preparation and cleaning and priming operations are crucial to the performance of the adhesive, and must be followed in detail. The products to be used depend on the surface (substrate) onto which they are applied, and the following list identifies each application:

**Anodised aluminium (e.g. chassis and components)**

Cleaner:	Betawipe VP 04604	Lotus part no. A082B6150V
Primer:	Betapnme 5404	Lotus part no. A082B6337V
Adhesive:	Betaseal 1701	Lotus part no. A082B6281F
	or Betamate E2400	Lotus part no. A082B8415V

**Unpainted or painted composite**

Cleaner:	Betaclean 3900	Lotus part no. A100B6008V
Primer:	Betaprime 5404	Lotus part no. A082B6337V
Adhesive:	Betaseal 1701	Lotus part no. A082B6281F
	or Betamate E2400	Lotus part no. A082B8415V

**Zinc plated and passivated steel**

Cleaner:	Beatclean 3900	Lotus part no. A100B6008V
Primer:	Betaprime VP 01706 A+B	Lotus part no. A100B6070V
Adhesive:	Betaseal 1701	Lotus part no. A082B6281F

**Glass**

Cleaner:	Betawipe VP 04604	Lotus part no. A082B6150V
Primer:	Betaprime 5001	Lotus part no. A100B6009V
Adhesive:	Betaseal 1701	Lotus part no. A082B6281F
	or Betamate E2400	Lotus part no. A082B8415V

**Uncoated Lexan/Perspex**

Cleaner:	Abrasion & dry wipe	
Primer:	Betapnme 5404	Lotus part no. A082B6337V
Adhesive:	Betaseal 1701	Lotus part no. A082B6281F
	or Betamate E2400	Lotus part no. A082B8415V

**Residual adhesive (i.e. rebonding to surface after cutting off old panel)**

Cleaner, primer & re-activator:	Betawipe 4000	Lotus part no. A082B6355V
Adhesive:	Betaseal 1701	Lotus part no. A082B6281 F
	or Betamate E2400	Lotus part no. A082B8415V

**Applicator Bottle**

An applicator bottle is available for use with some cleaners and primers, and has a disposable felt pad which should be changed regularly to minimise surface contamination:

Applicator bottle	A000Z1071F
Cap	A082B6353S
Felt pad	A082B6354S

**Product Usage****BETAWIPE VP 04604 (A082B6150V):**

- Description: Activator and cleaning agent used to promote adhesion to the substrate surface. Supplied in a 250ml aluminium container with a YELLOW coloured cap.
- Application: - Wipe on/wipe off type.  
- Pour Betawipe VP 04604 into applicator bottle, and immediately refit the yellow cap onto the container.



- Push the applicator head onto the bottle, and fit the felt pad.
- Wet out the felt pan by inverting the applicator bottle and gently squeezing the sides.
- Wipe the pad over the substrate surface using minimal pressure to wet the surface.
- Immediately wipe off the activated/cleaned surface using a clean fibre free cloth, and discard.

- Notes:
- If the substrate is very dirty, first wipe off the surface with a clean fibre free cloth and discard.
  - Do not leave the caps off Betawipe containers. A milky colour indicates moisture absorption, and the material should be discarded.
  - Only decant a sufficient quantity of Betawipe for the job concerned, and never pour material back into the container from the applicator bottle.
  - Change the felt pad at regular intervals to reduce surface contamination.

**BETACLEAN 3900 (A100B6008V)**

Description: Degreaser and cleaning agent used for the removal of contamination from the substrate surface. Supplied in 1 litre aluminium container with a BLACK coloured cap.

- Application:
- Wipe on/wipe off type.
  - When substrate is very dirty, first wipe off the surface with a clean fibre-free cloth and discard.
  - Dampen a fibre-free cloth with Betaclean 3900, and immediately replace the black cap.
  - Thoroughly clean the substrate surface with Betaclean and discard the cloth.
  - Wipe off the substrate with a clean fibre-free cloth and discard.

**BETAWIPE 4000 (A082B6355V)**

Description: Cleaning agent which activates the old adhesive layer to accept new adhesive. Supplied in 250 ml aluminium containers with a BLUE cap.

- Application:
- The residual adhesive bead should be cut with a scalpal to leave an even thickness of approximately 1 to 2 mm.
  - Dampen a fibre-free cloth with Betawipe 4000 and immediately replace the blue cap.
  - Thoroughly clean the substrate surface with Betawipe and discard the cloth. Do not wipe off.
  - Allow 2 - 3 minutes flash off time before applying adhesive.

**BETAPRIME 5001 (A100B6009V)**

Description: Adhesion promotor used to maximise the performance of the bonding between the cleaned and/or activated surface and the adhesive compound. Supplied in 250 ml aluminium container with GREEN coloured cap.

- Application:
- Two steel balls inside the container are provided to assist mixing of the contents when shaken. Prior to decanting Betaprime 5001, shake the container for at least 60 seconds to disperse the solid content of the material into suspension.
  - Pour the primer into the applicator bottle and immediately replace the green cap.
  - Wet out the felt pan by inverting the applicator bottle and gently squeezing the sides.
  - Wipe the pad over the activated/cleaned substrate surface to apply a continuous film of primer.
  - Allow to dry for a minimum of 15 minutes before applying adhesive. If adhesive is not applied with 72 hours, wipe on/wipe off with Betawipe VP 04604.

- Notes:
- The appearance of the primed areas should be deep black in colour with no streaks or voids. To achieve this appearance, apply in smooth continuous uni-directional movement, not short backward and forward movements. The latter technique results in inconsistent film build. Rework any poor areas after 5 minutes (tack time), applying in the same direction.
  - Replace the felt pad if moisture absorption results in hardening.
  - Never return unused Betaprime back into the aluminium container.

**BETAPRIME 5404 (A082B6337V)**

Description: Adhesion promotor used to maximise the performance of the bonding between the cleaned and/or activated surface and the adhesive compound. Supplied in 250 ml aluminium container with RED coloured cap.

- Application:
- Two steel balls inside the container are provided to assist mixing of the contents when shaken. Prior to decanting Betaprime 5404, shake the container for at least 60 seconds to



disperse the solid content of the material into suspension.

- Pour the primer into the applicator bottle and immediately replace the green cap.
- Wet out the felt pan by inverting the applicator bottle and gently squeezing the sides.
- Wipe the pad over the activated/cleaned substrate surface to apply a continuous film of primer.
- Allow to dry for a minimum of 15 minutes before applying adhesive. If adhesive is not applied with 24 hours, re-activate by applying a further coat of Betaprime 5404.

Notes:

- The appearance of the primed areas should be deep black in colour with no streaks or voids. To achieve this appearance, apply in smooth continuous uni-directional movement, not short backward and forward movements. The latter technique results in inconsistent film build. Rework any poor areas after 5 minutes (tack time), applying in the same direction.
- Replace the felt pad if moisture absorption results in hardening.
- Never return unused Betaprime back into the aluminium container.

#### BETAPRIME VP 01706 A+B (A100B6070V)

Description: Adhesion promotor used to maximise the performance of the bonding between the cleaned and/or activated surface and the adhesive compound. Supplied in 250 ml aluminium containers of component A and component B.

- Application:
- Thoroughly shake component A container to disperse solid material. Remove the lid from the component A container and scrape any sediment from the bottom of the container. Replace the container lid and thoroughly shake again to disperse the solid content.
  - Pour the required amount of component A into a clean container, and add the same volume of component B. Replace lids immediately. Thoroughly mix the two components for 45 seconds minimum.
  - Leave the mixed components to stand for 30 MINUTES. (Discard if unused after 8 hours)
  - Pour the primer into the applicator bottle and wet out the felt pan by inverting the bottle and gently squeezing the sides.
  - Wipe the pad over the cleaned substrate surface to apply a continuous THIN film of primer: A thin, almost transparent film is all that is required. No attempt should be made to attain a completely opaque covering.
  - Allow to dry for a minimum of 4 HOURS, before applying adhesive.

Notes:

- To achieve a continuous thin film of VP 01706, apply in a smooth continuous uni-directional movement, not short backward and forward movements. The latter technique results in inconsistent film build.
- Replace the felt pad if moisture absorption results in hardening.
- Never return unused Betaprime back into the aluminium container.

#### BETASEAL 1701 (A082B6281F)

Description: One component moisture curing adhesive, providing high strength, permanently elastic bonds between various substrates. Supplied in 300 ml aluminium cartridge.

- Application:
- Remove the cartridge end ensuring there is no damage to the reinforcing sleeve.
  - Pierce the neck of the cartridge and screw on the applicator nozzle. Cut the nozzle end to the required diameter and shape.
  - Fit the cartridge into an air assisted gun, and extrude a smooth, even and continuous bead of Betaseal to the previously prepared substrate.
  - Assemble the joint within 5 MINUTES.

Notes:

- If the adhesive has to be touched or manipulated for any reason, use only *wetted* fingers.

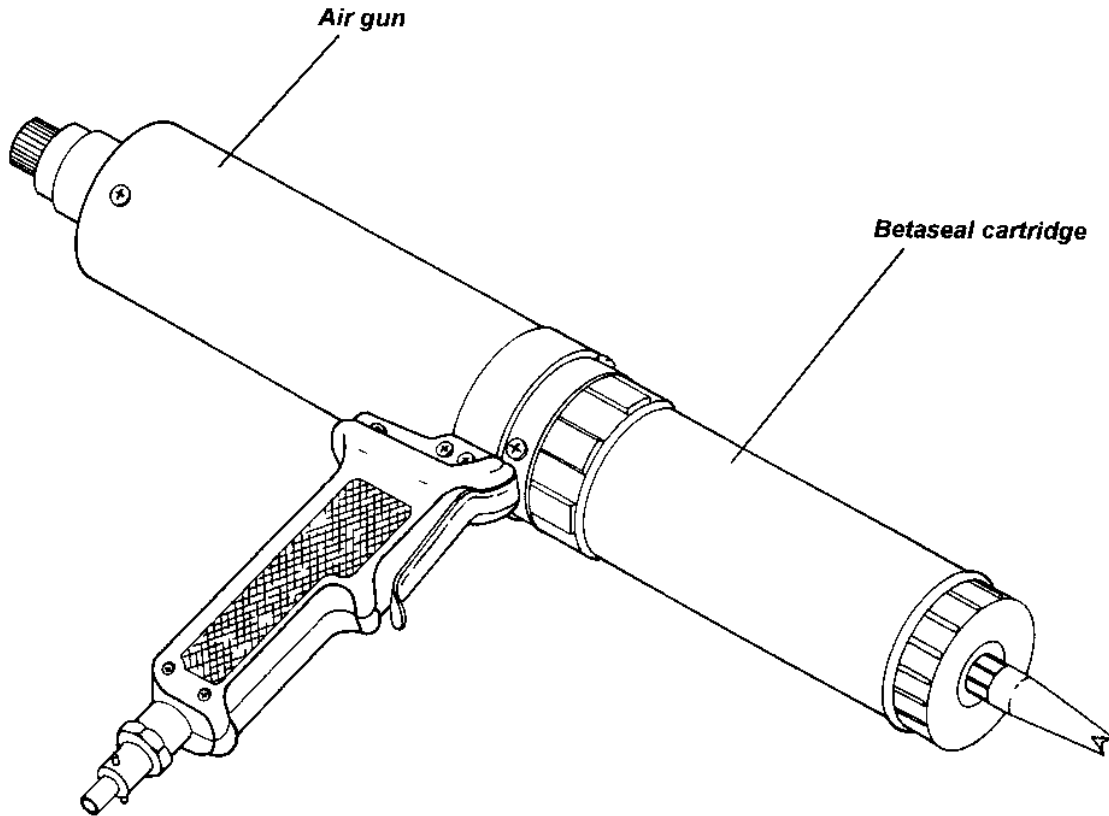
#### BETAMATE E2400 (A082B8415V - 220ml, A100B6258V - 450ml)

Description: Two component chemically curing adhesive, providing high strength, permanently elastic bonds between various substrates. Supplied in 220 and 450 ml aluminium cartridges.

- Application:
- An electrically driven Betagun Mk 11 is required to mix and extrude Betamate E2400. Refer to the operating instructions supplied with the gun.
  - Extrude a smooth, even and continuous bead of Betamate to the previously prepared substrate.
  - Assemble the joint within 5 MINUTES.

Notes:

- If the adhesive has to be touched or manipulated for any reason, use only *wetted* fingers.

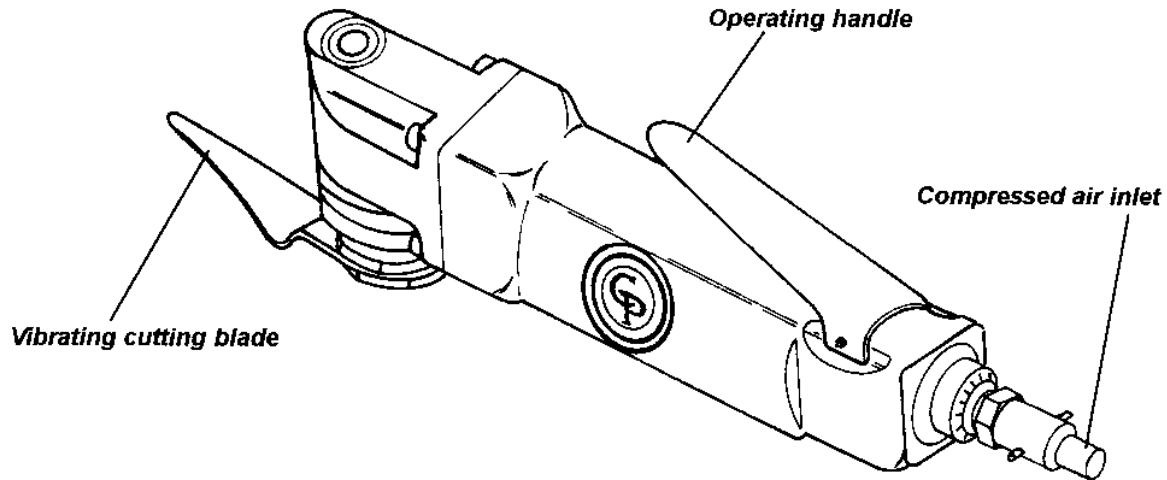


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#### B0.6 - REPLACEMENT OF BONDED-ON PANELS - GENERAL

Bonded body panels are secured using the Gurit-Essex products 'Betaseal' or 'Betamate', which are flexible polyurethane adhesives which must be cut in order for a panel to be removed. The recommended method of adhesive cutting is with the use of a pneumatic tool such as the Chicago Pneumatic CP838 Pneu-Nife which uses a range of differently shaped cutting knives to which is imparted a vibrating action. This tool may also be used to remove windscreens.

Supplier:	Chicago Pneumatic, Utica, New York 13501, USA.
Catalogue no.:	CP838 Pneu-Nife
Recommended air pressure:	60 - 90 PSIG (4.0 - 6.2 bar)
Tool air inlet:	1/4" NPTF, 3/8" mm. hose size

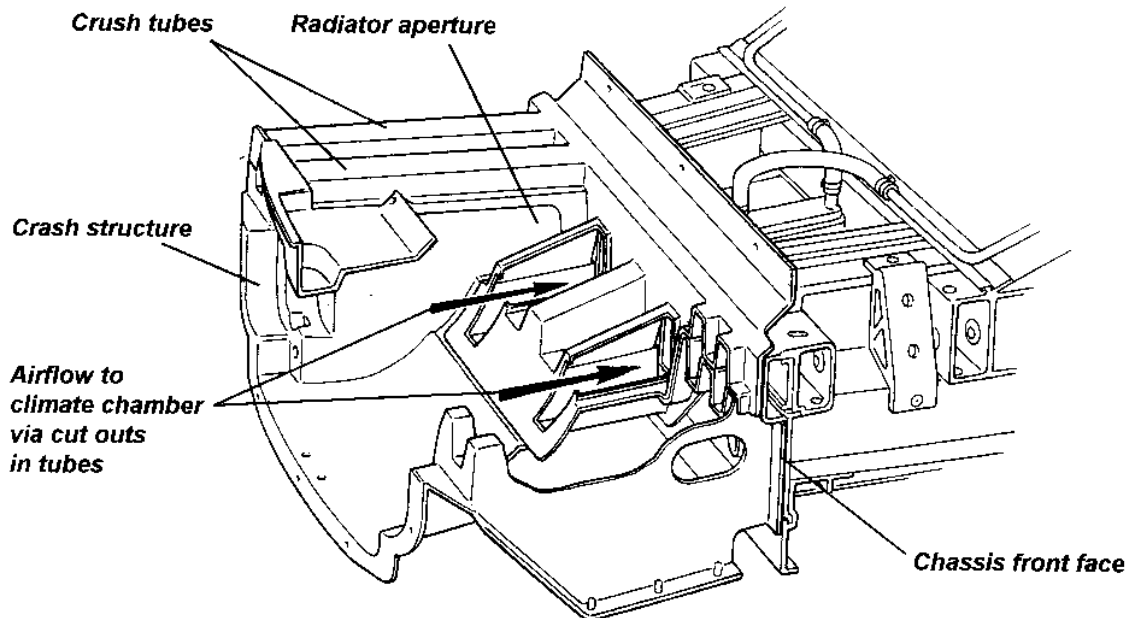


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It is not generally practical to remove a bonded panel intact, for later refitment. Consequently, when necessary, the panel can be cut away for better access to the bonded joint. It is not necessary to remove all traces of sealant from the joint faces on the remaining panels or chassis, but any remaining sealant must be securely bonded and no thicker than 1 mm or the fit and joint gaps will be upset. It is essential always to follow the cleaning/priming/bonding operations meticulously if sufficiently strong and durable bonds are to be obtained. Always use the specified materials.

### BO.7 - FRONT CRASH STRUCTURE

The front crash structure consists of an upper and lower moulding bonded together and supplied only as an assembly. It is bonded to the front face of the chassis, and is braced by an alloy undershield screwed to the bottom front edge of the chassis, and to each lower side of the crash structure. The unit also acts as a ducting for the engine cooling radiator and a.c. condenser (if fitted) which are mounted horizontally on its top surface in a bolted-on composite radiator housing. Longitudinal tubes formed in the construction are designed to produce a particular crush characteristic in order to control the rate of deceleration of the vehicle occupants in a frontal collision.



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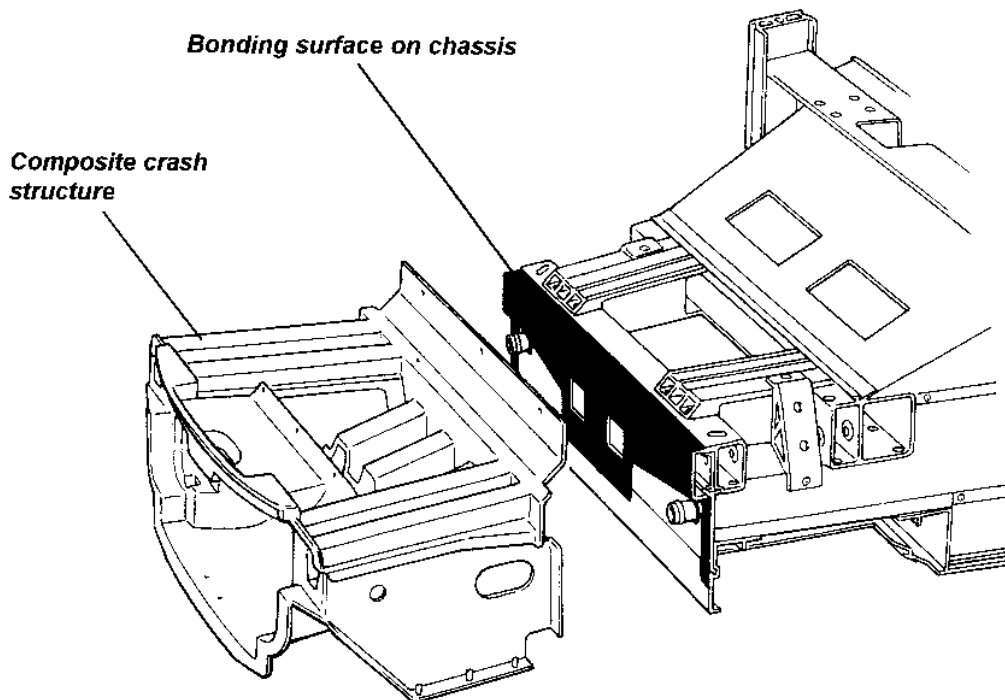
To remove the crash structure:

- Remove the front clamshell (see sub-section BP.5).
- Remove the front undershield by releasing the three screws securing each lower side of the structure to the shield, and the three screws securing the shield to the front lower edge of the chassis.
- Drain the coolant and remove the radiator and pipework (see section KG).
- Remove the driving lamps (if fitted) from the crash structure, along with the towing strut, horn, alarm siren and wiring harness.
- Use a seal cutting knife to cut the bond between the structure and the front face of the chassis. For access to some of the bonding areas, it may be necessary to cut away some parts of the structure, rendering the unit unsuitable for refitment. Take care not to damage the surface of the chassis when cutting the adhesive.

It is not necessary to remove all traces of old adhesive from the chassis, but a uniform surface must be available for the new adhesive bead. The remaining adhesive must be securely bonded and be cut with a scalpal blade to leave an even thickness of 1 - 2 mm.

Prepare the new structure for bonding:

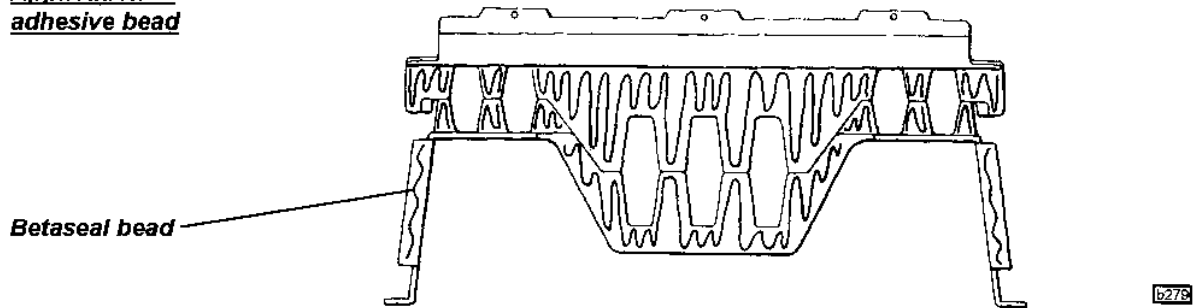
- Dry fit the new structure to the chassis, and check that a good fit is achieved. Fettle the structure or remove old adhesive as necessary until the fit is satisfactory.
- Re-activate the surface of the old adhesive on the chassis using Betawipe 4000 (see sub-section BO.5), and clean and prime the bonding area on the new crash structure using Betaclean 3900 and Betaprime 5404 (see sub-section BO.5).



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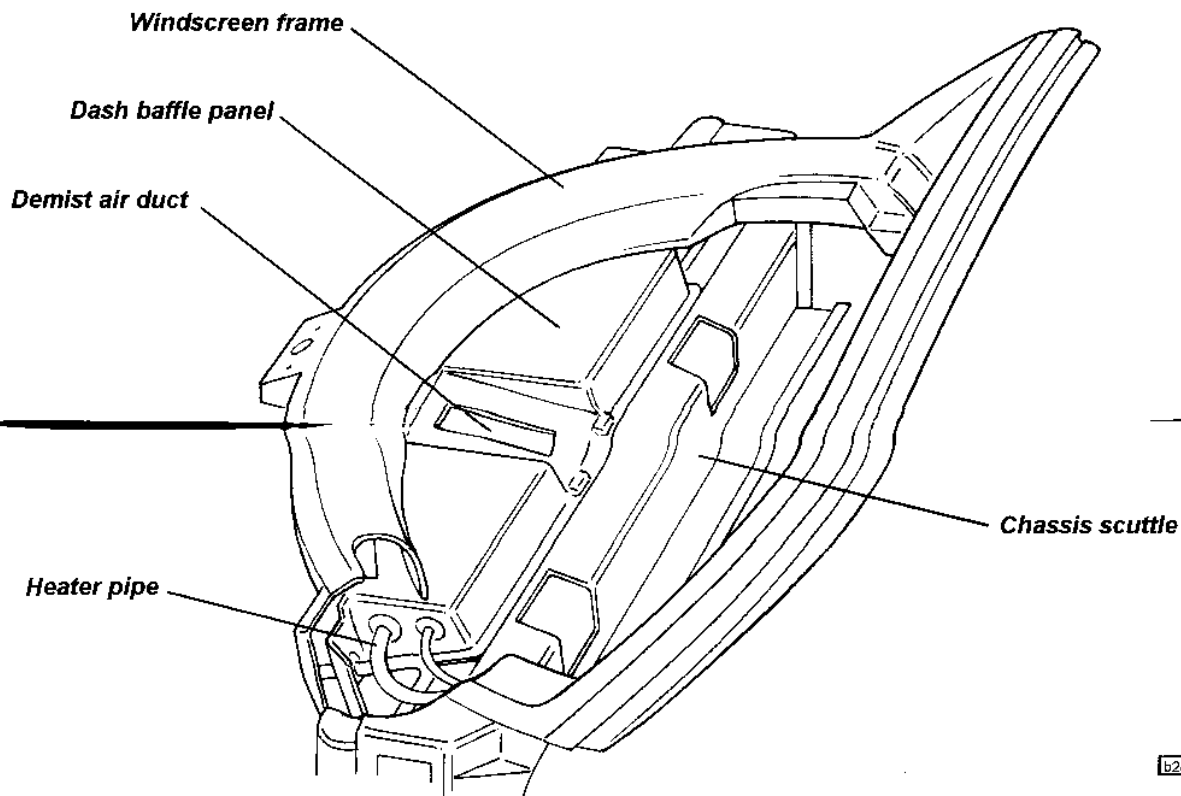
**Application of adhesive bead**



- Apply a bead of Betaseal/mate adhesive (see sub-section BO.5) to the bonding surface in the manner shown.
- Fit the structure to the chassis and press into position to spread the adhesive. Use several clamps around the joint flange to retain the structure until the adhesive has cured; This will take approximately 4 hours dependent on atmospheric conditions, with a longer period required in dry atmospheres.
- Fit the undershield, radiator (see sub-section KG.4), front clamshell (see sub-section BP.5) and remaining parts.

**BO.8 - WINDSCREEN FRAME**

The windscreen frame is a single ICSRTM moulding with hollow, foam filled sections, and incorporates a forward extending buttress at each side to brace the frame against the front chassis. A separate dash baffle panel is used to bridge the space between frame underside and chassis scuttle, and provide for the routing of climate control pipework and air ducting, and other services.

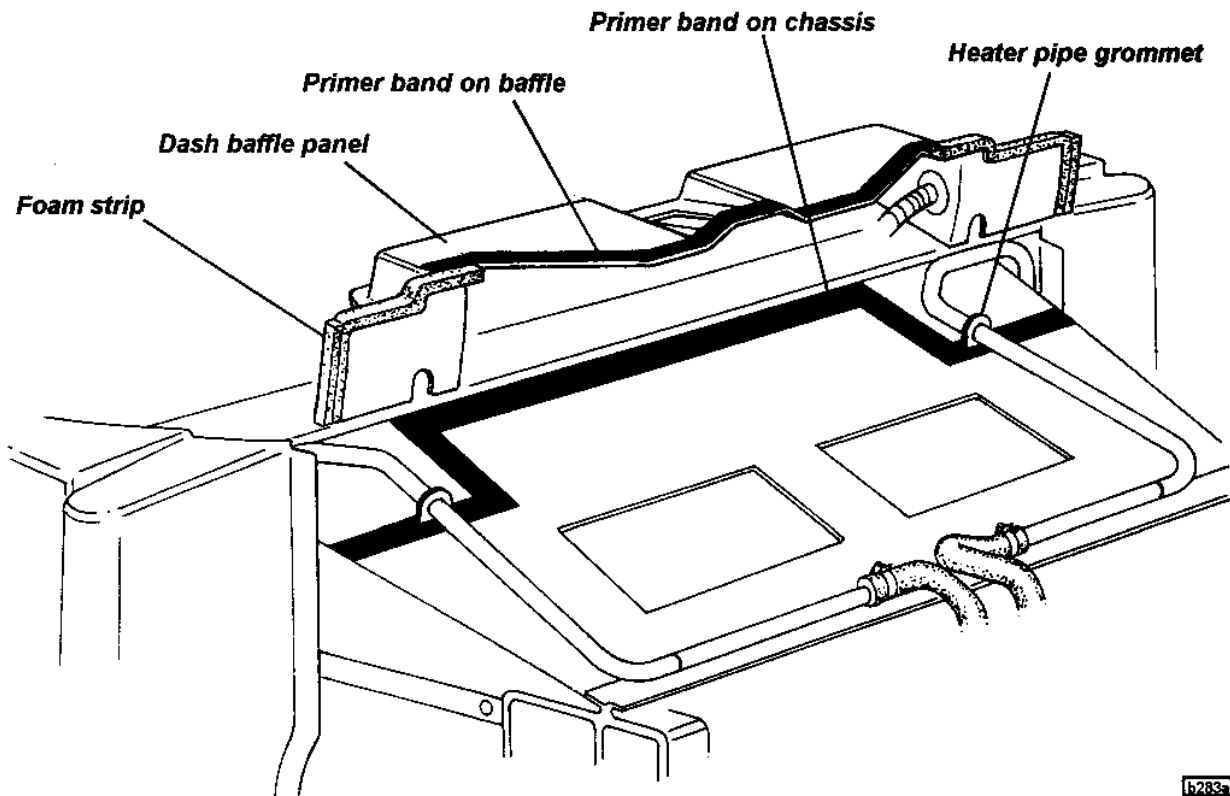




The shape of the frame is critical to the windscreen fit, and structural repairs to the frame itself are not recommended. It is not generally economic to attempt to remove the windscreen frame intact for refitment, as the elastomeric adhesive bonding the frame to the chassis requires cutting with a reciprocating knife, and access to the joints is sometimes obscured. The recommended procedure is to cut the frame as necessary to allow its removal without damage to the dash baffle panel. If the sills are to remain fitted, it will be necessary to carry out some minor work on the screen buttress to sill panel joint, where a panel overlap occurs.

#### To Replace Windscreen Frame

1. Remove the front wheelarch liners and front clamshell (see sub-section BP.5), and for improved access, the two doors.
2. Remove the windscreen (see sub-section BP.14).
3. Remove the instrument binnacle and fascia top panel (see sub-section BP.13), and release the fixings between dash upper extrusion and screen frame.
4. Release the brake hose/pipe connector at the front end of each buttress on the windscreen frame. Release all harnesses and other components from the windscreen frame buttresses as necessary.
5. Remove the wiper motor mechanism from the windscreen frame.
6. Use a sealant cutting tool to cut the bond between the windscreen frame buttresses and chassis, and between the frame and 'B' posts, and between the frame underside and dash baffle panel. Remove the windscreen frame.
7. Cut the adhesive securing the drainage gutter around the front of the frame, to allow transfer to the new frame.
8. If the dash baffle panel is to be replaced, the clutch pipe and climate control cables must be released and threaded through the panel before cutting the adhesive.



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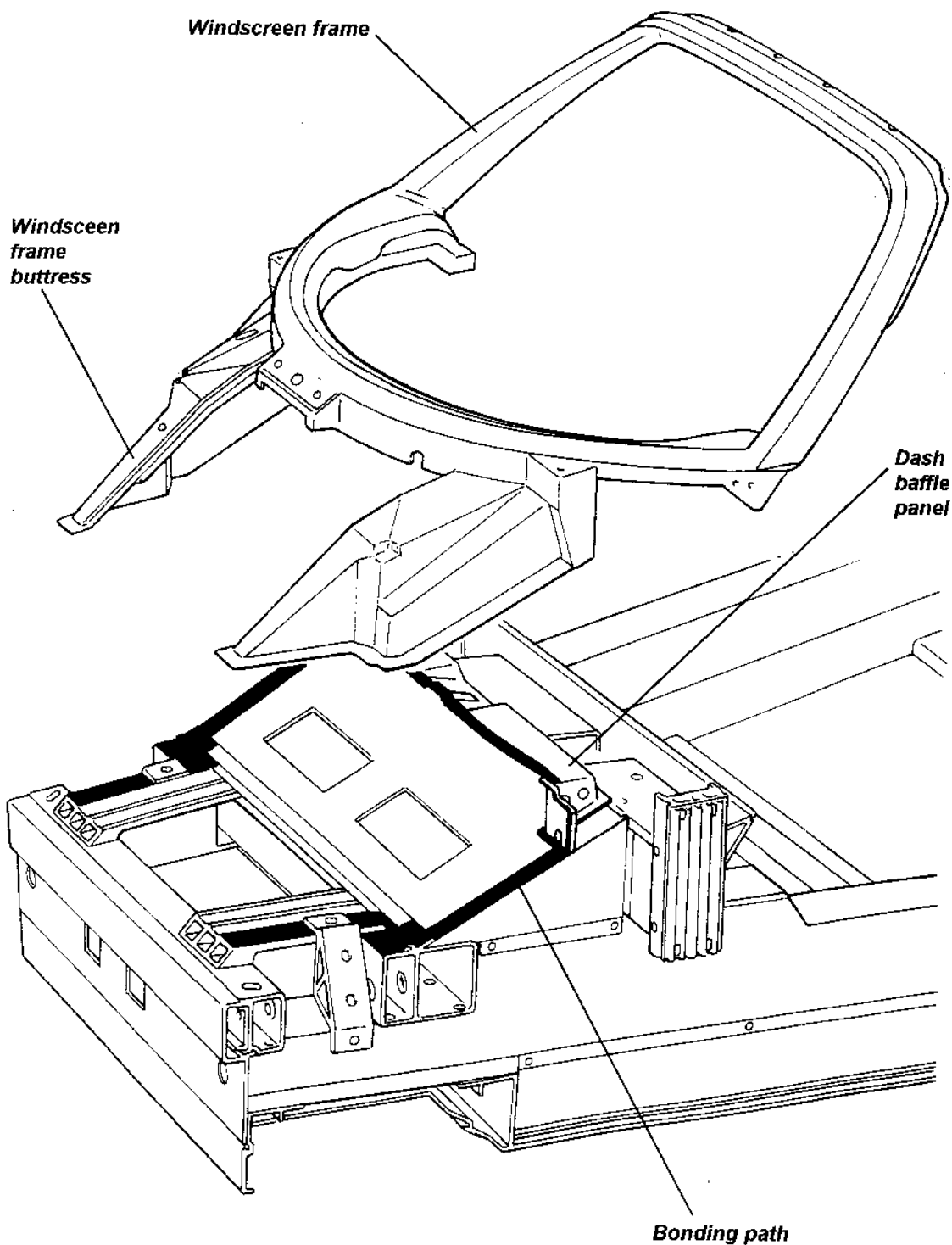




9. To fit a new dash baffle:
  - Ensure the heater feed and return pipes are fitted.
  - Dry fit the panel and mark up the bonding surface on the chassis scuttle.
  - Prepare and re-activate the surface of the old adhesive on the chassis using Betawipe 4000 (see BO.5).
  - Clean and prime the upper and lower bonding faces on the new baffle panel using Betaclean 3900 and Betaprime 5404 (see sub-section BO.5).
  - Apply a bead of Betaseal/mate adhesive (see sub-section BO.5) to the baffle lower flange.
  - Position the panel and press along the length of the joint to ensure sufficient spread of adhesive. Clamp the panel in position until the adhesive cures.
  - Apply self adhesive foam strip A082U6065V to each vertical end face of the baffle panel, wrapping over onto the top edge and along to the primed surface. Apply a second strip up each vertical face.
10. Prepare the old adhesive bead on the chassis for fitment of the windscreen frame by removing excess sealant from all the bonding areas on the chassis, sill panels and dash baffle to leave a consistent and level bonding surface for the new frame. It is not necessary to remove all traces of old adhesive, but a uniform surface must be available for the new adhesive bead. The remaining adhesive must be securely bonded and be cut with a scalpal blade to leave an even thickness of 1 - 2 mm.
11. Fit the wiper motor assembly and windscreen washer jets to the windscreen frame.
12. If necessary, fit a new roof side rail latch plate to the windscreen header rail - it is not recommended to refit a bracket due to the requirement for high surface quality on the bracket.
  - If applicable, completely remove any old adhesive from the header rail taking care not to damage the composite substrate. Lightly abrade the bonding surface on the header rail but do **not** abrade the bracket.
  - Clean the bonding surfaces on the header rail and bracket with Betaclean 3900 (see sub-section BO.5).
  - Prime the header rail with Betaprime 5404, but do **not** prime the bracket.
  - Generously coat the bonding surface of the bracket, with a 50/50 mix of Betamate 7064S (A116B0159V) and Betamate 7014 (A116B0158V). Fit the bracket to the header rail and wipe off extruded adhesive with Betaclean 3900. Position the bracket using tool T000T1422F (RH) or T000T1423F (LH), which should be taped to the header rail for at least 30 minutes.
13. Before fitting the windscreen frame, ensure that two setting rods are available for positioning the frame:
  - Cut two 670mm lengths of locally sourced 10mm diameter steel rod.
14.
  - Prepare and re-activate the old adhesive bead on the chassis using Betawipe 4000 (see BO.5).
  - Clean and prime the bonding area on the new windscreen frame with Betaclean 3900 and Betaprime 5404 (see sub-section BO.5).
  - Apply a bead of Betaseal/mate adhesive (see sub-section BO.5) to the whole of the bonding flange on the windscreen frame and buttresses, including the mating face between frame underside and baffle panel.
  - Carefully fit the windscreen frame onto the chassis and press into position to ensure adequate adhesive compression. Ensure the frame is positioned correctly in relation to the roll-over bar by fitting the two setting rods in the roof siderail locating slots. The rods should locate snugly in the slots with no end play.
  - Clamp the frame into position until the adhesive cures.
  - Ensure good adhesion between the frame and baffle panel.
  - Use a spatula to smooth out or remove any excess or extruded adhesive.
15. Seal the frame panel to the top of the door hinge post at each side by extruding a bead of Betaseal, and smoothing with a spatula to obtain a neat finish.
16. Examine the whole of the bonding jointline for sealing integrity, and if necessary apply additional adhesive to seal any gaps. Use a spatula to smooth any visual areas to a neat finish.
17. Do not disturb the frame until the adhesive has fully cured (see sub-section BO.5).
18. Fit the windscreen (see sub-section BP.14), dash panel and instrument pack (BP.13), front clamshell (BP.5), and other components as necessary.



**Windscreen frame bonding (sills not shown)**



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**BO.9 - SILL PANELS**

The sill panels incorporate the 'A' and 'B' posts, and are bonded to the chassis, windscreen frame and rear bulkhead panel. The sill bottom flange, and rear end of the will top flange are bonded into grooves in the chassis main side rails and it is necessary to cut the sills in the course of their removal: It is not practical to attempt to remove a sill panel intact for later refitment. If sill damage occurs which is not repairable 'in situ', the sill panel should be renewed.

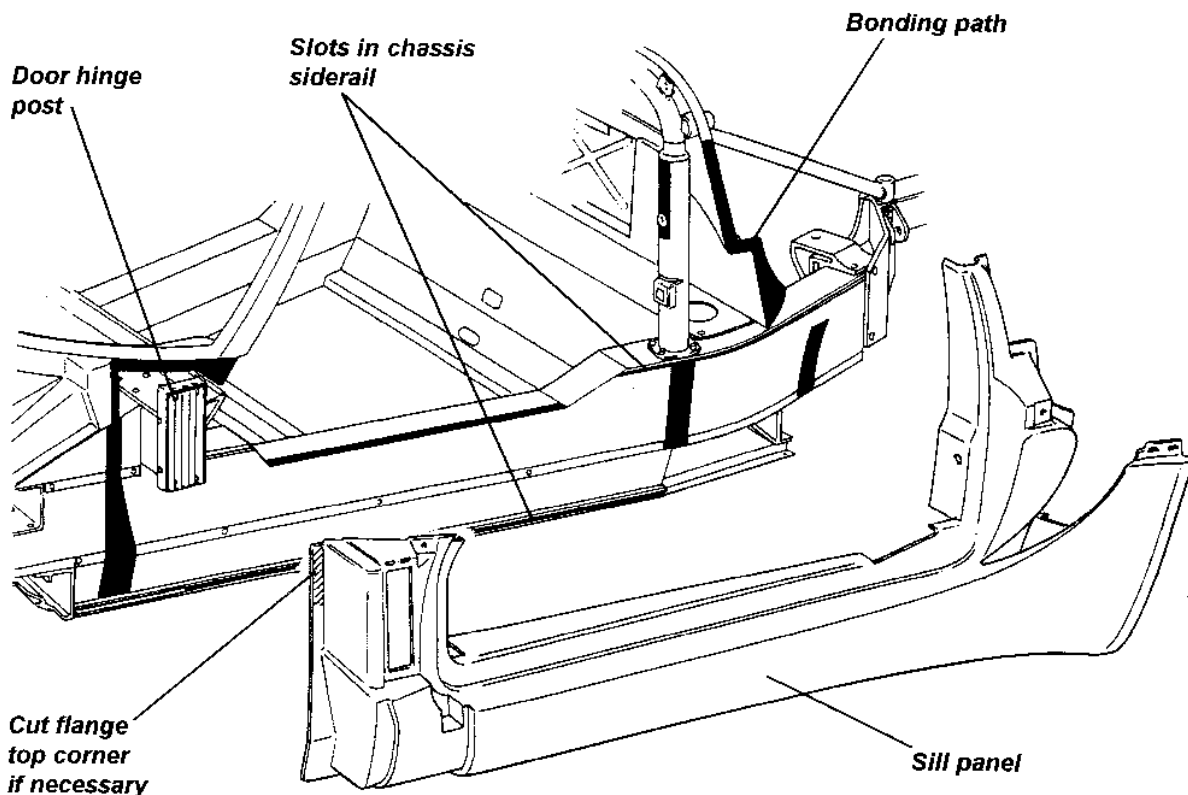
**To Replace Sill Panel**

A short section of sill flange underlaps the windscreen frame buttress flange in the front wheelarch area and requires that some cutting and laminating of the new panel is required on assembly.

1. Remove front and rear clamshells (see sub-sections BP.5, BP.6), dash panel (BP.13) and door hinge bracket (BP.8).
2. Remove the door latch striker pin and washers, noting the assembly sequence. Remove the door sill trim panel from the chassis and the door ajar switch from the sill panel.
3. Use a sealant cutting knife to cut the adhesive bead between sill and chassis/body panels.

Note:

- In the front wheelarch area, a short section of the sill flange underlaps the windscreen frame buttress flange. Unless the windscreen is also to be removed, it will be necessary to cut the sill around this flange in order to release the sill.
- The bottom edge of the sill, and the rear part of the top edge, locate in grooves in the chassis side frame, and may not readily be cut out with the sill intact. Cut the sill as necessary to release the panel, and then remove the remaining edges of the panel from the chassis using a suitable cutting knife.
- Cut the sealant around the door hinge post aperture.
- Cut the sealant between the panel and roll over bar.



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4. Remove excess sealant from all the bonding areas on the chassis and body panels. It is not necessary to remove all traces of old adhesive, but any remaining adhesive must be securely bonded and be cut with a scalpal blade to leave an even thickness of 1 - 2 mm.
5. If necessary, cut the top front corner of the sill flange to allow mating of the panel around the windscreen buttress flange. Dry fit the sill and fettle as necessary to achieve a good fit.
6. Before preparing the surfaces for bonding, ensure that the necessary pipes and cables are fitted to the chassis side rails:  
RH side: - heater feed pipe  
          - a.c. feed and return pipes (if fitted)  
LH side: - heater return pipe  
          - clutch hose  
          - main battery positive cable  
          - radio aerial co-axial cable
7. Prepare the bonding surface of the new sill panel with Betaclean 3900 and Betaprime 5404 (see sub-section BO.5). Prepare surface of the old adhesive bead on the chassis and body panels Using Betawipe 4000 (see sub-section BO.5).
8. Apply a bead of Betaseal/mate adhesive (see sub-section BO.5) to the bonding surface on the chassis and body and fit the sill panel into position, first locating the sill bottom edge into its chassis slot, and press all around the joint to ensure sufficient spread of adhesive. If necessary, use a spatula to smooth or remove any extruded adhesive, and to neaten any visual areas. If necessary, add adhesive to the joint around the door hinge post, and to the windscreen frame, and smooth with a spatula.
9. Clamp the panel into position until the adhesive has cured (see sub-section BO.5).
10. If the top front corner of the sill flange has been cut to fit around the windscreen buttress flange, this area should be reinforced as follows: Roughen the surface of the windscreen buttress flange and the adjacent sill panel in the modified area, and lay up two pieces of chopped strand mat across the joint.
11. Refit the dash panel, front and rear clamshells, doors, both wheelarch liners and other components as necessary.

#### BO.10 - REAR BULKHEAD

The rear bulkhead is a Polyurethane Structural Reaction Injection Moulding (PU SRIM), incorporates the rear window surround, and is bonded to the roll over bar and chassis fuel tank bay. A heat formed polyester fibre heat/acoustic insulator panel is bonded to the rear side of the panel, and incorporates a glass fibre aluminised cloth heat reflector shield in the vicinity of the exhaust manifold. The rear window is bonded directly to the bulkhead using the same materials and procedure as is used for the windscreen.

To replace the rear bulkhead:

1. Remove the rear clamshell (see sub-section BP.6).
2. Remove both seats, and the bulkhead interior trim panel.
3. Remove from the inside of the bulkhead the microwave sensor and immobiliser module. Release all wiring harnesses from the bulkhead clips.
4. Release all fittings from the roll-over bar backstays (air cleaner, roll over valve) and remove both backstays.
5. Taking suitable precautions, remove the fuel filler hose and filler breather hose, and cap the tank apertures to prevent dirt ingress and reduce fire risk.



6. Release the evaporative emissions charcoal canister and fuel filter from their bulkhead mounting brackets.
7. Release the aerial lead from the bulkhead.
8. Using a long knife, cut the adhesive securing the insulator panel to the bulkhead, and remove the panel to improve access to the bulkhead bonded joint.
9. Using a sealant cutting knife, cut the adhesive bead between the top section of the bulkhead and the roll over bar, and between the bottom of the bulkhead and the chassis. If the sill panels are fitted, cut the bond between sill panel 'B' posts and the bulkhead panel.
10. Manoeuvre the bulkhead from the car.

#### To Fit Bulkhead Panel

Before fitting a bulkhead panel, ensure that the following parts are bonded to the panel:

- Header tank mounting bracket;
- Charcoal canister mounting bracket;
- Immobiliser module stud plate;
- Fuel filter mounting bracket;
- Rear window glass;

All the above components are bonded using elastomeric adhesive applied as follows. Refer also to sub-section BO.5:

*Brackets & Studplates:* Clean the bonding surfaces on the bracket and bulkhead with Betaclean 3900 (black cap) and prime both surfaces with Betaprime 5404 (red cap). Apply Betaseal 1701 adhesive to the bracket, and clamp in position until the adhesive has cured.

*Rear Window:* Clean the whole of the bonding surface on the glass with Betawipe VP 04604 (yellow cap), and prime with Betaprime 5001 (green cap). Clean the corresponding surface on the bulkhead with Betaclean 3900 (black cap) and prime with Betaprime 5404 (red cap). Apply a bead of Betaseal 1701 to the periphery of the glass, and press into position on the bulkhead to ensure sufficient compression of the adhesive. Use a spatula to remove excess extruded adhesive and smooth any visual areas. Tape the glass into place if necessary to retain position until the adhesive cures.

*Bonding of Bulkhead Panel:* Clean the mating surfaces of bulkhead, roll over bar and (if fitted) sill 'B' posts, with Betaclean 3900 (black cap) and prime with Betaprime 5404 (red cap). Or, where applicable, use Betawipe 4000 to re-activate old adhesive (refer to sub-section BO.5). Clean the mating surface on the chassis with Betawipe VP 04604 (yellow cap), and prime with Betaprime 5404 (red cap). Apply a bead of Betaseal 1701 to the bonding path on the bulkhead, and manoeuvre into position, pressing all round the joint path to ensure sufficient compression of the adhesive. Use a spatula to remove excess extruded adhesive and smooth any visual areas. Secure in position with tape until the adhesive has cured.

The heat/acoustic insulator panel is bonded to the bulkhead only at its centre section. Clean and prime the centre section on the bulkhead with Betaclean 3900 and Betaprime 5404, and apply Betaseal 1701. Press the insulator panel into position and ensure sufficient compression of adhesive. Tape in place until the adhesive has cured.

Refit remaining components in reverse order to removal.

**BODY FITTINGS****SECTION BP - ELISE 2001 M.Y. Onwards**

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Door Hinge Cover Panel	BP.4	5
Front Clamshell	BP.5	5
Rear Clamshell	BP.6	7
Door Mirrors	BP.7	8
Door Beam & Hinge	BP.8	9
Door Shell Assembly	BP.9	11
Door Glass, Guide Rails & Winder Mechanism	BP.10	12
Door Seals	BP.11	15
Door Latch Mechanism	BP.12	16
Instrument Binnacle & Dash Panel	BP.13	19
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**BP.1 - ROOF**

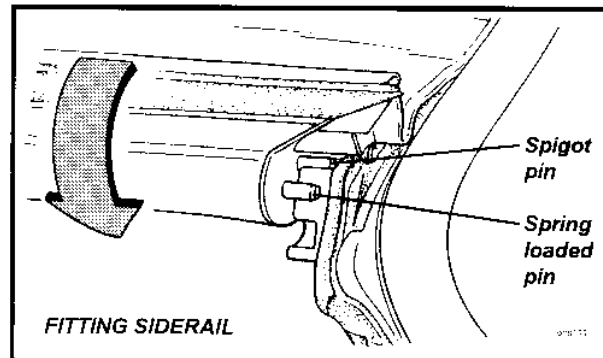
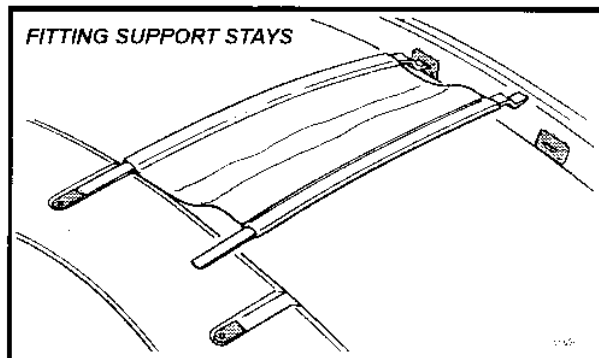
The Lotus Elise has been designed to exploit the pleasures of open top motoring, the better to enjoy exposure to the natural environment, unencumbered by the restrictions and confinement bestowed by a cockpit roof. In order to provide some weather protection to the occupants and vehicle interior, and allow the continued enjoyment of the car in unfavourable weather conditions, two roof configurations are provided; a soft top canopy, and a hard roof option comprising a pair of 'Targa' panels supported from a central spar.

**Soft Top Canopy**

The soft top roof is used in conjunction with a body colour composite panel (rear window shroud) fixed over the roll over bar and extending for a short distance over each rear clamshell buttresses. The rear window shroud incorporates on its underside, a roof tensioning push rod mechanism. A hollow composite roof siderail is used to bridge each top corner of the windscreen frame to the roll over bar, and provide a mounting for a weatherstrip seal, against which the top edge of the door glass abuts. The soft top roof canopy is fixed to each siderail, with each siderail using a spigot pin at the front and rear to engage with a slot in a latch plate on the header rail and roll over bar. A second, spring loaded spigot pin at each end of the siderails, is arranged to slide into a ramped hole on the latch plates to secure and tension the soft top.

**Soft Top - Fitting**

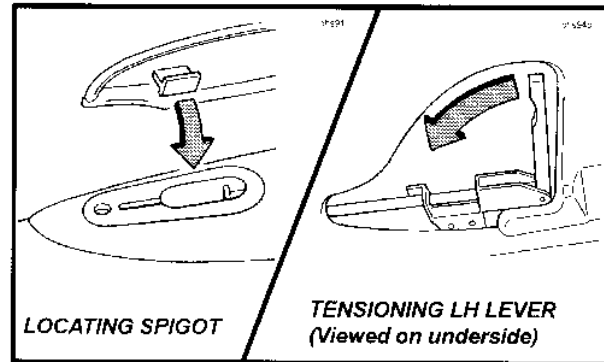
1. From its stowage bag in the rear luggage compartment, withdraw the roof assembly and support stays. Lower both door windows, or open both doors.
2. Insert the two support stays, with the cranked ends foremost, into the roof slots above the rear window, and in the windscreen header rail.



3. Lay the soft top roof onto the support diaphragm, and unroll the canopy with the tails towards the rear, taking care not to damage the paintwork with the tail spigots.
4. Taking one of the roof side rails, engage the spigot pin on the front and rear end of the rail, into the uppermost slot in the latch block on the windscreen header rail and roll over bar. On the inside face of the side rail, locate the two latch release levers, and pull the handles towards each other whilst rotating the side rail downwards, until both spring loaded pins 'click' into their ramped slots indicating that latching is complete. Pull up on the side rail to check security.
5. Repeat this operation for the opposite side rail ensuring that the tensioning cable at the front edge of the canopy is located in the channel ahead of the windscreen header seal, and that the seal is not pinched by the cable.  
Note that the front and rear ends of the spring loaded pins are fitted with plastic end caps to reduce friction. These are glued in position using Loctite 480 after priming with Loctite 770.

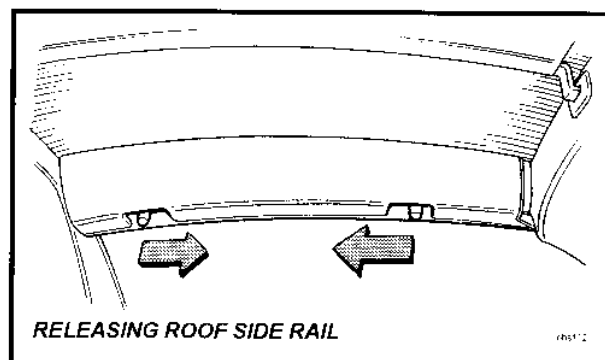
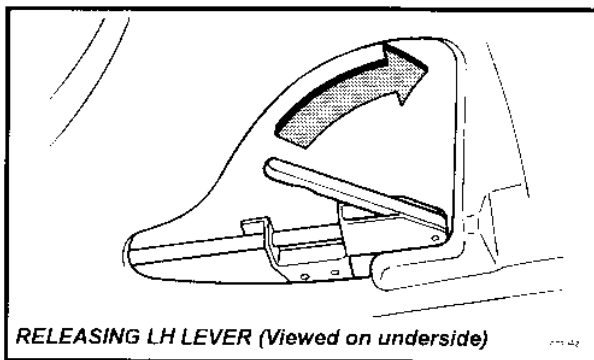


6. Locate the spigot on the underside of each soft top tail into the keyhole slot in the body buttress.
7. Beneath each side of the rear window shroud, locate the tensioning lever, and pull rearwards to tension the canopy.



**Soft Top - Removal**

1. Open both doors or lower both door windows.
2. Beneath each side of the rear window shroud, locate the tensioning lever, and press the lever fully forwards to release the tension from each tailpiece of the soft top canopy.
3. Unhook each tailpiece from the body buttress slot and fold back to guard against paint damage.



4. On the inside of one roof side rail, locate the two latch handles. Press down on the front of the siderail to ease the load on the mechanism and pull the lever handles together to release both latches. Rotate the side rail upwards to release from the latch plates, and repeat for the opposite side.
5. Fold in the roof tails and roll up the roof canopy taking care to protect the side rail inner trim surfaces from being damaged by the tailpiece feet. Place in the roof stowage bag.
6. Unhook the two roof stays and stow in the roof bag.

**Important Note:** If the roof is not fully dry, it should be stowed for no longer than a few days before unrolling or refitting and allowing to air dry completely. Prolonged stowage of a wet or damp roof will promote rotting of the fabric.

**Rear Window Shroud:** The rear window shroud is secured by two fixings accessible from within the cabin above the rear window, and by one screw behind each keyhole slot in the shroud tail. The side rail latch plates must also be released from the roll over bar. Small adjustments to the length of the roof tail tensioning cable may, if necessary, be made at the lever end.

**Roof Cable - Front:** The tension of the steel cable running through the front edge of the roof canopy should be adjusted with the side rails latched. Hook a spring balance under the centre of the cable, and apply an upwards force of 6 kgf. Adjust the cable tension to achieve a vertical gap of 6mm between the cable and top surface of the windscreen surround.

**Roof Cable - Rear:** The roof rear cable tension should be sufficient only to maintain stability of the roof canopy shape.

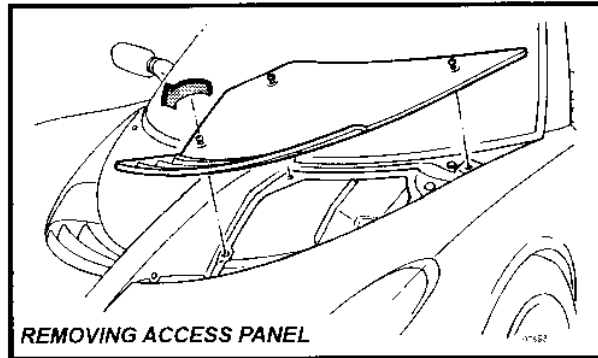




**Side Rail Front Latch Plates:** The latch plates on the windscreen header rail are secured using a two part adhesive. If necessary, use Betaclean 3900 (A100B6008V), Betaprime 5404 (A082B6337V), and a 50/50 mix of two part adhesive Betamate 7064S (A116B0159V) and Betamate 7014 (A116B0158V) to refix.

**BP.2 - FRONT BONNET PANELS**

Two removeable panels are provided in the front body to allow access to the windscreen washer reservoir and the front fusebox and relays. Each panel consists of a glass fibre composite moulding painted body colour, to which is bonded a black plastic slatted grille, providing an outlet for air exhausting from the radiator finning. Each panel is fixed to the clamshell by three screw fasteners, with spigots on the front and inboard edges of the grille engaging with corresponding holes in the clamshell. The outboard fastener uses a mounting plinth adjustable in height to allow optimum panel alignment to be achieved.



Note that on some early cars, the outboard fixing was positioned further inboard, with an adjustable height rubber buffer supplementing panel stability. Panel replacement on these cars would require fitment of the later type panel and adjustable outboard fixing.

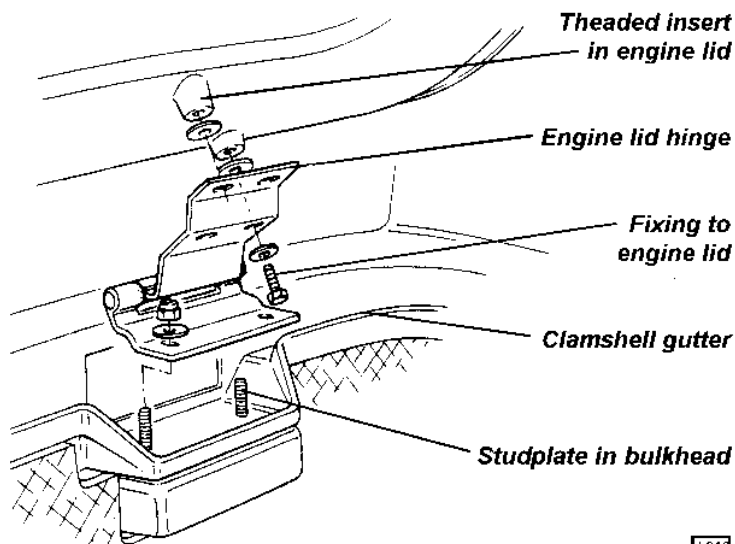
The louvre panel is bonded to the access panel using the following products: Betaclean 3900 (both surfaces); Betaprime 5404 (both surfaces); Betaseal 1701. For further details refer to Sub-Section BO.5.

**BP.3 - ENGINE COVER LID**

The engine cover is moulded from glass fibre composite and incorporates 4 engine cooling outlet grilles bonded into recessed apertures. Two hinges are used to attach the lid to the rear bulkhead, and a single, key operated latch mechanism secures the lid to a striker pin mounted on the clamshell engine/boot bulkhead. The latch is released by inserting the ignition key into the lock and turning clockwise. When closing, fully engage the latch mechanism by pressing down on the cover only immediately above the latch. Note that the lock mechanism plastic cover plate on the inside of the engine lid, serves also to channel any rain water into the engine bay.

To remove the engine cover, disconnect the aerial co-axial cable and amplifier lead, and release the cover from the two identical hinges. Note that the hinges also serve to clamp the clamshell front edge to the cabin rear bulkhead.

Beware that the engine cover is locked whenever it is closed, and always requires the use of the ignition key to release. Owners should be made aware of the importance of having a spare key available in case of inadvertently locking the keys in the boot.



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**ADDENDUM TO BP.3 - Bonding of engine cover latch plates**

The engine cover latch is secured to two steel stud plates bonded to the underside of the composite engine lid. If it is necessary to rebond a stud plate, proceed as follows:

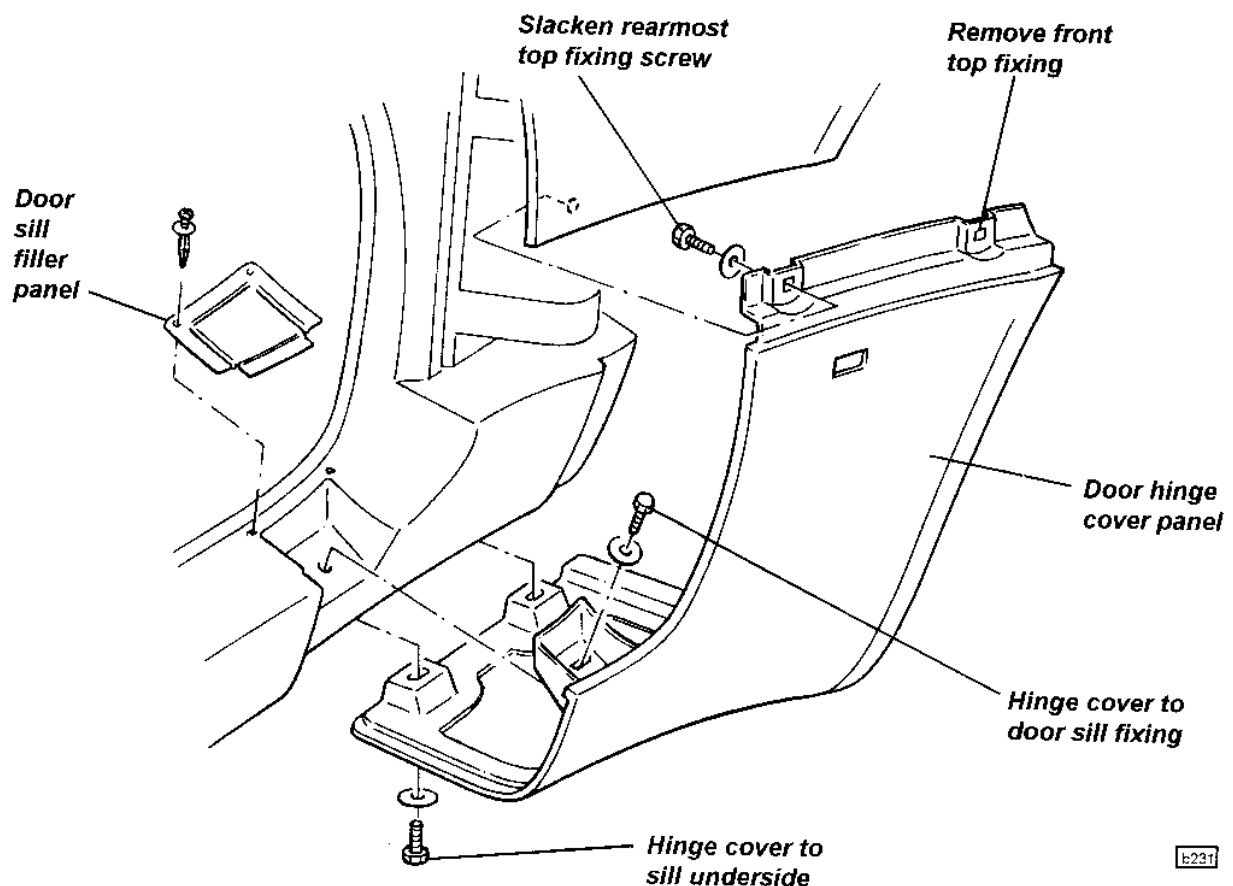
1. Abrade the bonding surface of the stud plates to achieve a metallic finish.
2. Completely remove any old adhesive from the engine lid, taking care not to damage the composite substrate. Abrade the bonding surface.
3. Bolt the two stud plates to the latch mechanism before cleaning the bonding surfaces on both the stud plates and the engine lid with Betaclean 3900 (see sub-section BO.5).
4. Prime the two stud plates and the bonding area on the engine lid with Betaprime 5404 (see sub-section BO.5).
5. Apply a 50/50 mix of Betamate 7064S (A116B0159V) and Betamate 7014 (A116B0158V) to both brackets, and fit into position on the engine cover, ensuring that adhesive is extruded from around both brackets. Wipe off excess adhesive with Betaclean 3900. Centralise the keyhole slot with the engine cover aperture, and secure in position with tape for a minimum of 30 minutes.

**BP.4 - DOOR HINGE COVER PANEL**

A separate glass fibre composite body panel is used to fill the area between the door and wheelarch, and uses threaded fasteners to attach to the rear of the clamshell, top of the sill and bottom inboard edge of the sill panel.

To remove a door hinge cover panel:

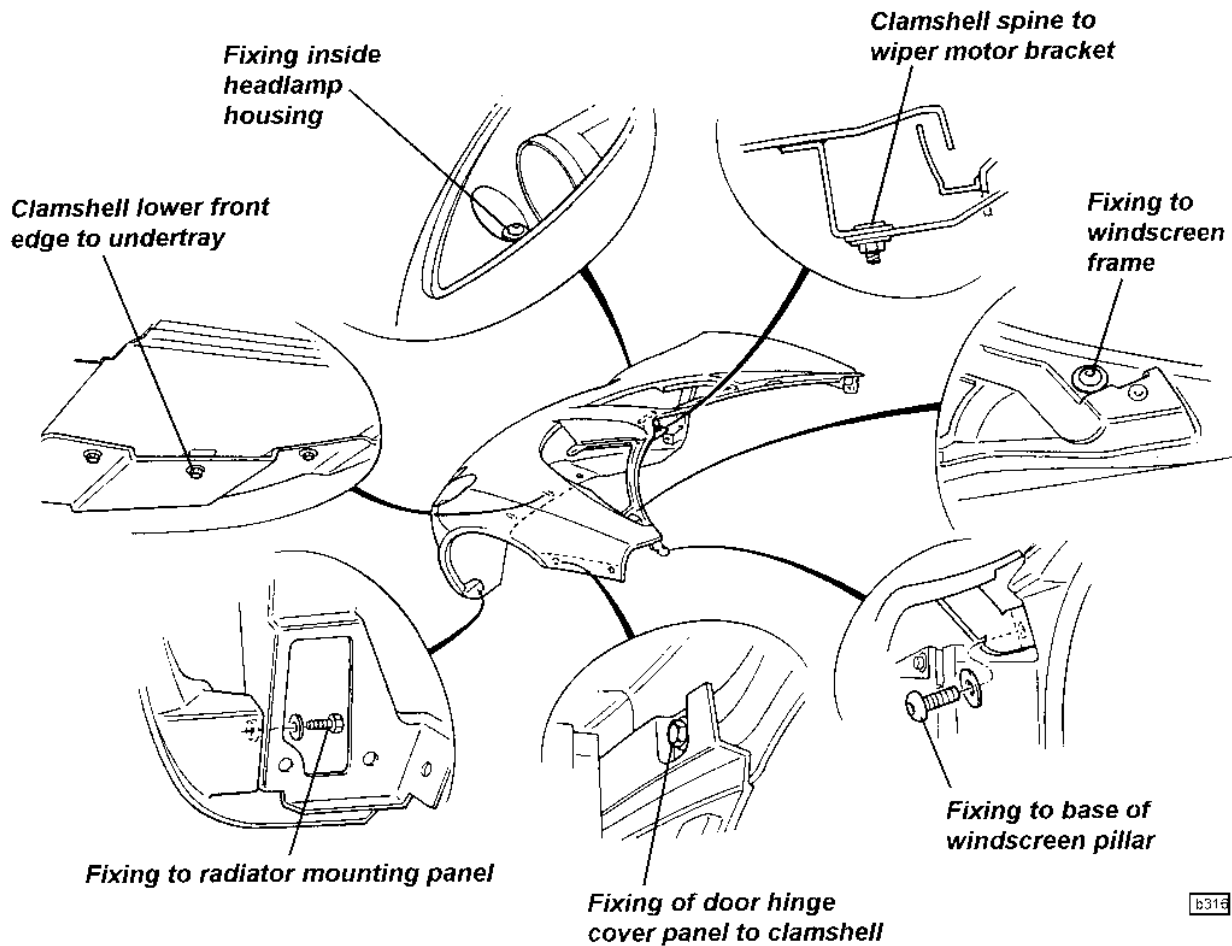
- From beneath the sill, remove the two fixings securing the bottom edge of the hinge panel to the sill.
- Remove the filler panel concealing the fixing securing the hinge cover to the door sill recess, and remove the fixing.
- Remove the wheelarch liner and remove the foremost of the two screws securing the door hinge cover panel to the clamshell.
- From the door aperture, slacken, but do not remove, the rearmost of the two screws securing the door hinge cover panel to the clamshell and withdraw the hinge panel downwards.

**BP.5 - FRONT CLAMSHELL**

The front clamshell is a bonded assembly of several glass fibre composite mouldings incorporating both front wings, the front access aperture, radiator air intake and headlamp housings. The clamshell is secured to the windscreen frame, radiator mounting panel and other panels using threaded fasteners for ease of removal and to facilitate service access and body repair.

**To Remove Front Clamshell**

1. Remove both front body access panels.
2. Remove both front wheelarch liners;



3. Remove both door hinge cover panels:
  - From beneath the sill, remove the two fixings securing the bottom edge of the hinge panel to the sill.
  - Remove the filler panel concealing the fixing securing the hinge cover to the door sill recess, and remove the fixing.
  - From inside each wheelarch, remove the foremost of the two screws securing the door hinge cover panel to the clamshell.
  - From the door aperture, slacken, but do not remove, the rearmost of the two screws securing the door hinge cover panel to the clamshell and withdraw the hinge panel downwards.
4. Via each door aperture, remove the single fixing securing a bracket at the top rear corner of the clamshell to the base of the windscreen pillar.
5. Remove the fixing at each side securing the clamshell to the bottom of the windscreen frame, and the two nuts securing the clamshell spine to the wiper motor bracket extension.
6. Remove the single fixing at the bottom front of each wheelarch, securing the clamshell to the radiator panel extension.
7. Remove the headlamp cover/mask assembly from each side by releasing the three thumbscrews inside the wheelarch. Remove the clamshell fixing at the front of each headlamp housing. Release the headlamp harnesses, and feed through the clamshell hole.
8. Beneath the nose, release the screws fixing the front lower edge of the clamshell to the alloy undertray.
9. Lift the clamshell from the car. Note any spacing washers or shims fitted at any fixing point.

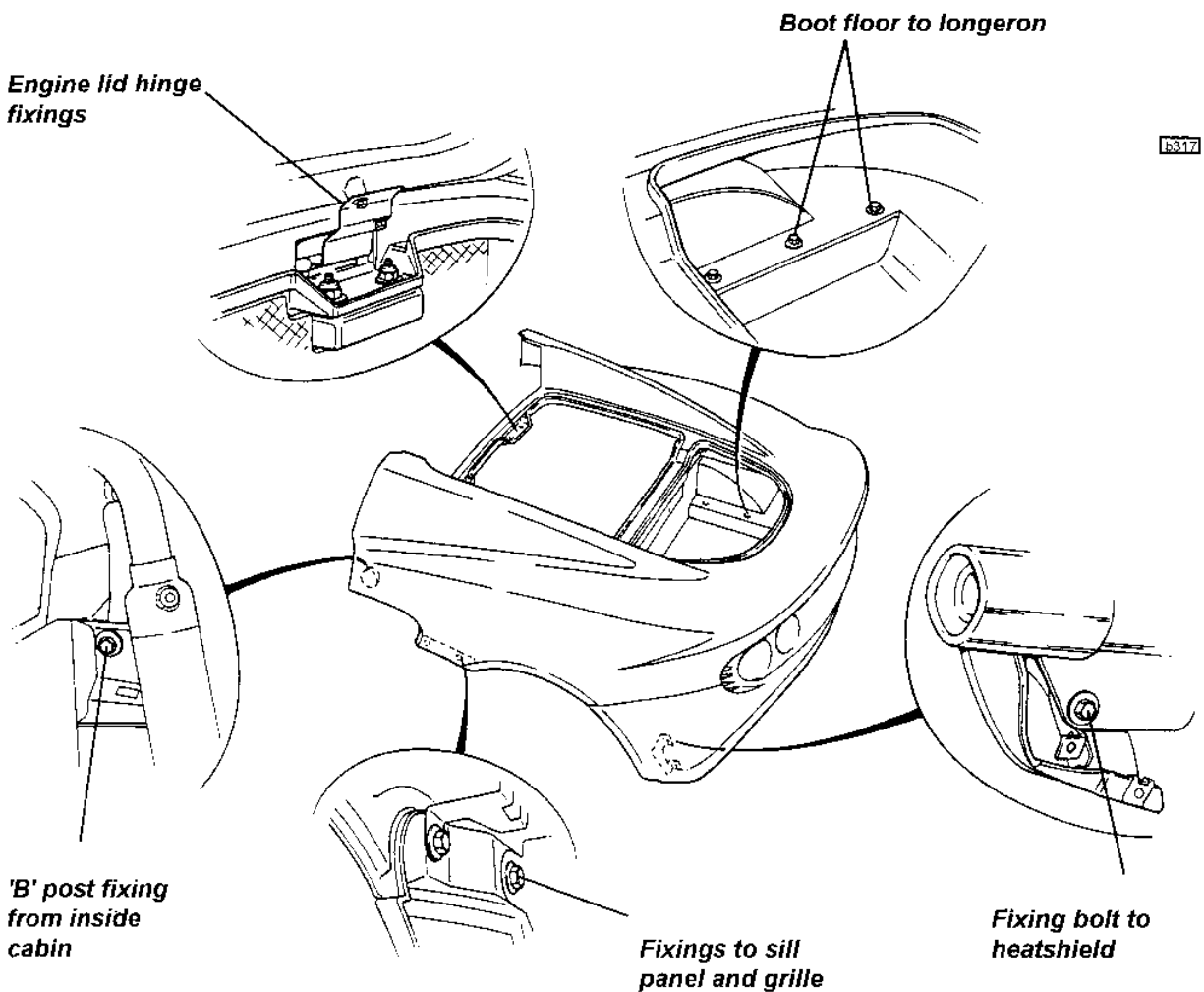


**BP.6 - REAR CLAMSHELL**

The rear clamshell is a one piece composite moulding incorporating both rear wings, the engine bay aperture, rear transom and integral luggage bay. The clamshell is secured to the chassis and other body panels by threaded fasteners for ease of service access and body repair.

**To Remove Rear Clamshell**

1. Remove both rear wheelarch liners;
2. Remove the rear window shroud; two fixings inside cabin above rear window; one screw securing each keyhole slot to the rear buttress.
3. Remove the fuel filler cap and release the eight screws securing the fuel filler neck to the clamshell. Remove the washer ring, and withdraw the neck from the clamshell aperture, noting the earth braid secured to the roll over bar backstay.



4. From inside the cabin, remove the full width trim panel from the rear bulkhead. From the access thus provided, remove the fixing securing the front end of the clamshell to the 'B' post above the engine bay air intake.



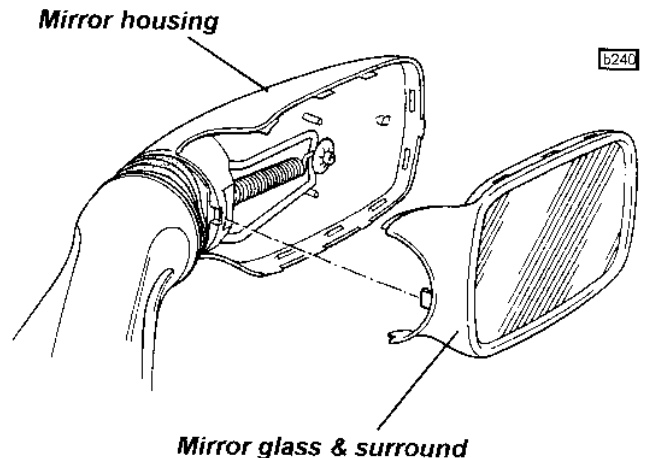
5. From inside each rear wheelarch, release the air intake grille fixings, and the two screws securing the clamshell to the waistline joint of the sill panel. Note that on the left hand side, these fixings also secure the cradle for the engine air intake hose.
6. Disconnect the aerial leads, release the engine lid hinges from the clamshell, and remove the lid.
7. Remove the battery and feed the battery cables through the clamshell grommet. Disconnect the rear harness and feed through the clamshell grommet.
8. Remove the rear diffuser and tailpipe grilles. Release the single fixing securing each bottom rear corner of the clamshell to the vertical heat shield behind the wheelarch.
9. From inside the luggage area, release the three screws each side securing the boot floor to the longerons. Release the two screws securing the ECM mounting bracket to the boot front wall.
10. Withdraw the clamshell from the car, noting any shim washers fitted at mounting points.
11. Refit in reverse order to disassembly.

#### BP.7 - DOOR MIRRORS

The manually adjustable, plastic housed door mirrors, are mounted via an injection moulded plinth to the door shell. A spring loaded ball and socket arrangement provides a means of mirror adjustment, and a sprung attachment of the mirror housing to the pivot socket allows for the mirror to move forwards or backwards on accidental contact, in order to reduce the potential for personal injury or vehicle damage.

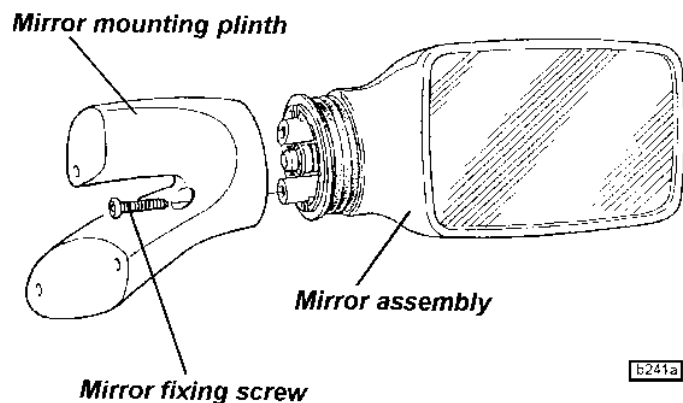
##### *Replacement of mirror glass*

The mirror glass is contained in a plastic surround which is clipped into the housing in order to provide for convenient and inexpensive replacement. To remove a glass, pull back the boot between mirror and plinth, and carefully prise the inboard edge of the mirror surround from its retaining clips. Working around the mirror periphery, continue to prise the surround from the housing taking care not to damage the paint on the housing. Press the new glass/surround into the housing until all the retaining clips are engaged, and reposition the convoluted boot.



##### *Replacement of mirror assembly*

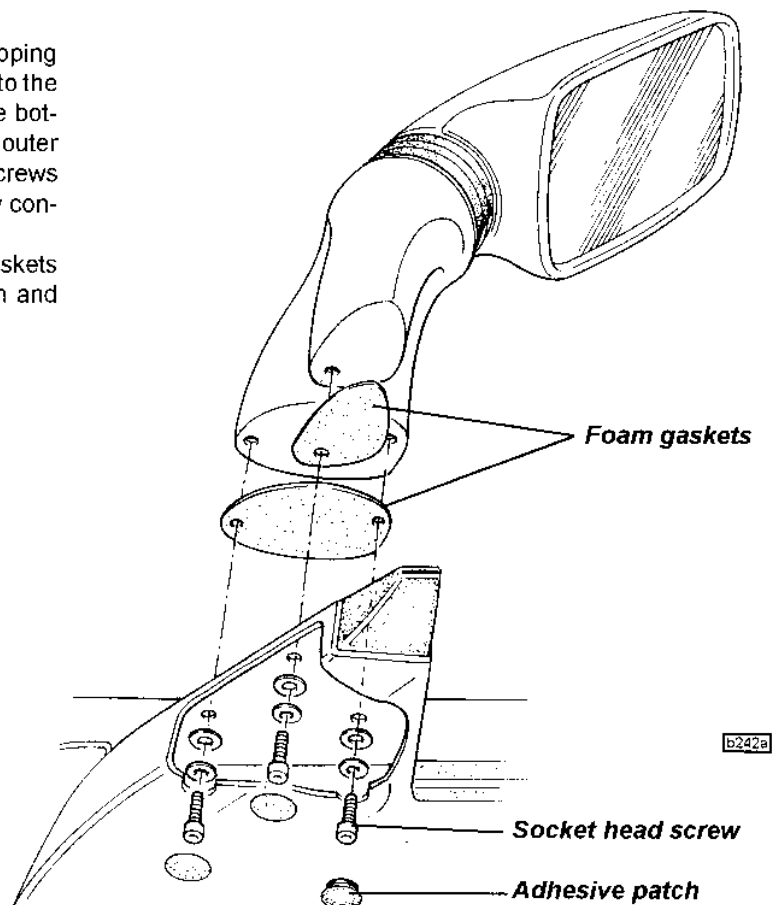
The mirror assembly locates in the plastic injection moulded plinth via two spigots, and is retained by a single screw tapping into the lower spigot. To remove a mirror assembly, use a cross head cranked screwdriver, or similar tool, to remove the screw recessed into the inside face of the mirror plinth.



### *Replacement of mirror plinth*

The mirror plinth incorporates tapping plates to accommodate a single screw into the top leg, and a pair of M5 screws into the bottom leg. The plinth is secured to the door outer leg with access holes for the three screws provided in the inner panel, cosmetically concealed by adhesive patches.

When refitting, ensure that foam gaskets are used between each leg of the plinth and the door shell.



### BP.8 - DOOR BEAM & HINGE

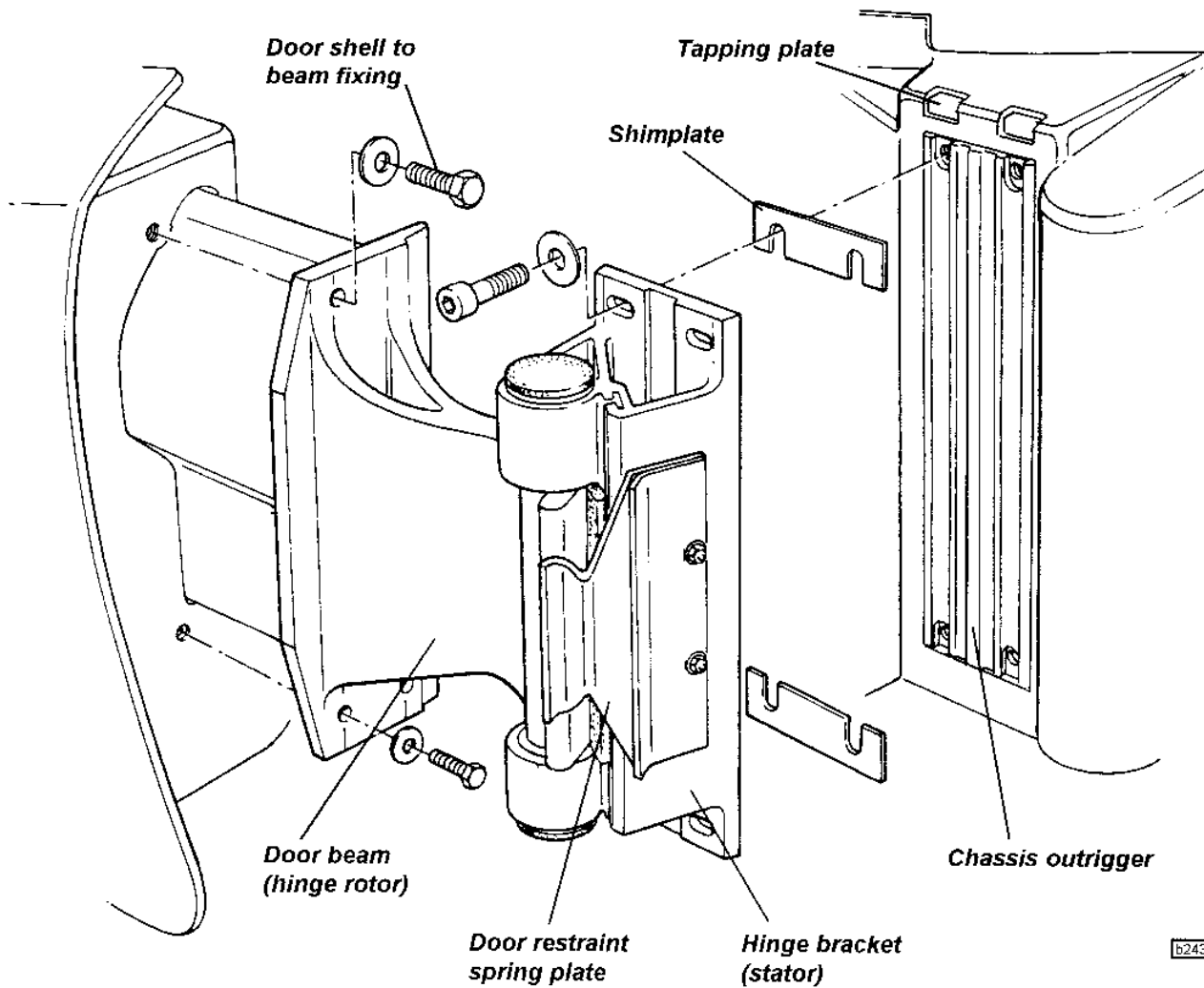
The door shell is bolted to a hollow section extruded aluminium alloy door beam, hinged at the front end to the 'B' post, and carrying the door latch mechanism, via steel brackets, at its rear end. The front end of the door beam is welded to a second extrusion which forms the rotor of the door hinge. The hinge stator (or hinge bracket) is bolted to an outrigger on the chassis, and incorporates two cylindrical bearing housings which accommodate maintenance free pivot bushes.

#### *Door hinge adjustments*

In order to provide for adjustment of door shutlines, the door hinge may be adjusted in two ways:

- i) Height of the hinge, its fore/aft position, and the pivot axis angle (to control the front/rear height alignment) may be adjusted after slackening the hinge bracket fixing bolts. The tapping plates for these bolts are linked in vertical pairs and are captive, but loose, within the chassis outrigger, and allow for some vertical movement. Horizontally slotted fixing holes in the hinge bracket allow for fore/aft movement.
- ii) Slotted shim plates fitted between the hinge bracket and chassis, allow the in/out door front edge alignment to be adjusted in steps of 1 mm, and by varying the shim pack at the top and bottom pairs of fixings, the vertical alignment, as viewed from the front, may be adjusted.

Ensure that the clamping load of the hinge bracket to the chassis is not corrupted by the shim plates bearing against the body. If the surrounding body stands proud of the chassis door hinge outrigger, use a suitably cut down shim plate to act as a spacer between the chassis and the adjustment shim pack or hinge bracket.



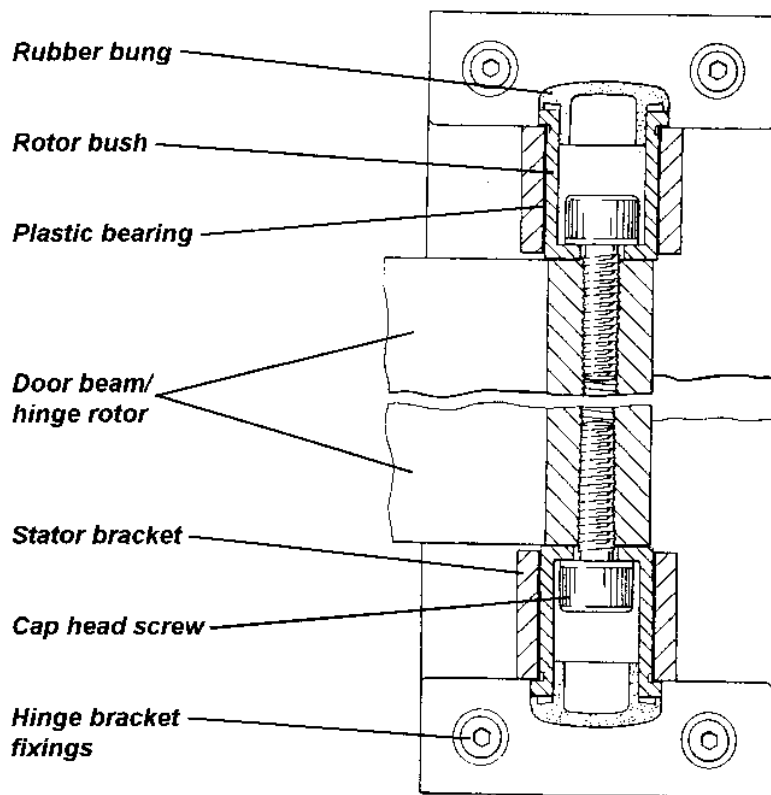
**Door beam pivot bearings**

The door beam hinge uses two maintenance free 'top hat' section synthetic bearings, pressed into the hinge stator bracket. Inside each bearing, is fitted a 'top hat' section steel rotor bush, clamped to the door beam extension by an M10 cap head screw threaded into the door beam.

The door beam extension also incorporates a cheek flange which abuts against a rubber strip on the hinge bracket to limit door opening angle. A spring steel plate fixed to the front of the hinge bracket is designed to engage around the profiled edge of the door beam abutment flange when the door is fully open, in order to provide a sprung restraint for the door in this position.

To remove the door assembly, or for access to the door pivot components, the two M10 cap head rotor bush retaining screws should be removed, and the door assembly withdrawn from the hinge bracket. The rotor bushes and/or bearings may then be withdrawn from the hinge bracket. On re-assembly, note that the bearings and bushes are assembled dry from above and below the upper and lower housings respectively, and the cap head screws tightened to 45 Nm. Insert the rubber bungs into the bush ends to inhibit dirt ingress and corrosion.





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### BP.9 - DOOR SHELL ASSEMBLY

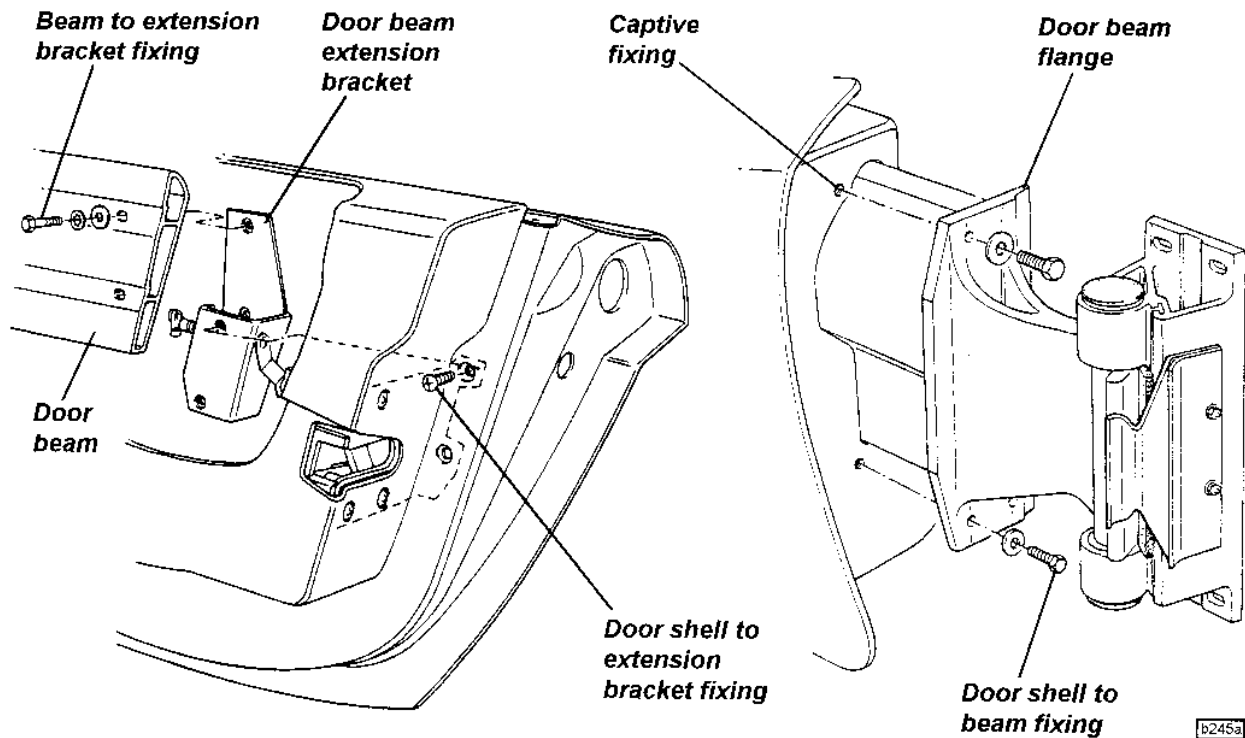
The door shell is mounted on the door beam via three screws through a flange at the front end of the beam, and by the door latch mounting bracket at the rear end. In order to provide fixing points for the beam, lock mechanism and other components, the door shell includes various tapping plates and brackets jig bonded to the inside of the shell, including fixing brackets for the accurate location of the window guide rails.

If a door is to be removed from the car, the preferred method is to release the M10 cap head screws clamping the upper and lower bushes to the door beam. The beam and door shell assembly may then be withdrawn from the hinge stator bracket without losing adjustment of the hinge alignment and door shutlines. If the door shell has to be removed from the beam for repairs or replacement, the beam may be left 'in situ' and the door shell slid off the beam using the following procedure:

#### *Removal of door shell from beam*

The door shell is secured to the beam via three screws through a flange at the front end of the beam, tapping into nut plates bonded into the door shell, and via two bolts at the rear end of the door to the door beam extension bracket. Access to the two rear bolts requires that the door glass first be released:

1. Remove the window winder handle and door trim panel.
2. Release the three screws securing the interior release handle, and unclip the control rod from the mechanism.
3. Remove the two M6 and the single M8 screw securing the door beam flange to the front of the door shell
4. Release the three M6 nuts securing the door glass to the lift channel, and separate the glass from the channel. Tilt the glass as necessary to allow access to the two M8 bolts fixing the rear end of the door beam to the extension bracket. Remove the bolts and withdraw the door assembly from the beam.  
Note that it is necessary to remove the drop glass waist seal before the glass may be withdrawn from the door.



When refitting the door, take care not to scratch the glass if this is contained in the door. Insert the two rear bolts securing the beam to the latch bracket, but do not tighten until the three fixings securing the front of the shell to the beam flange have been fitted and tightened.

#### BP.10 - DOOR GLASS, GUIDE RAILS & WINDER MECHANISM

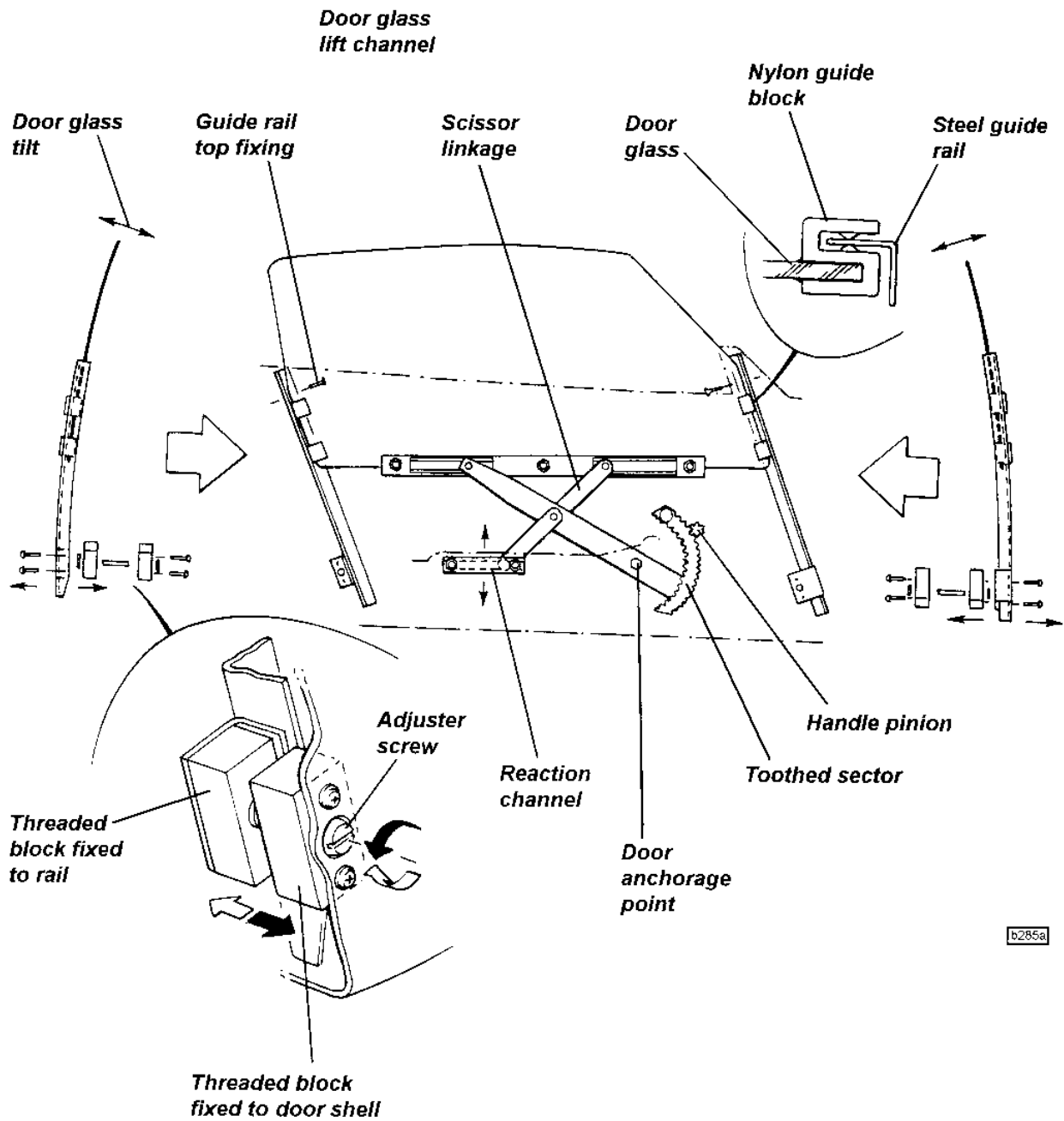
A manually operated door window scissor type lift mechanism is used in conjunction with two steel guide rails and a 'frameless' door design.

The operating principle of the window lift mechanism is that of a scissor linkage, with the front lower end of the primary leg anchored to the door shell, the lower end of the secondary leg sliding in a horizontal channel on the door shell, and the upper ends of both legs sliding in a channel fixed to the bottom edge of the window. The geometry of the system provides for a parallel lift of the glass, where the angle of the bottom edge does not change throughout the range of travel. An extension to the primary scissor leg carries a toothed sector which is engaged by a pinion on the window winder. The front and rear edges of the glass are guided by steel rails which engage with point contact Nylon guide blocks bonded to the glass. The bottom ends of the rails are adjustable in/out to set the inward tilt of the glass, with the 'up' glass position controlled by an eccentric stop on the winder mechanism.

#### Door glass adjustment

To adjust the door glass for optimum weather sealing and ease of operation:

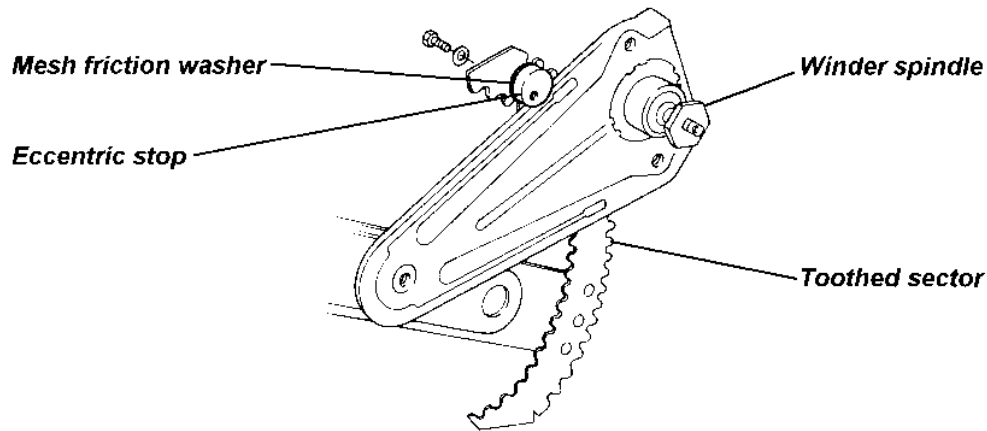
1. Fit the soft top roof and fully raise the window. Check the alignment of the top edge of the glass against the seal, and the seal compression along the cant rail and up the 'A' and 'B' posts. A light compression is required; just sufficient to ensure sealing, without imposing loads on the winder mechanism.
2. To adjust the inward tilt of the glass, screw the adjusters at the bottom of each guide rail in or out as necessary. Access is available without removing the door trim panel. Check that the window glass moves freely throughout the range of travel.



b285a



3. To adjust the alignment of the top edge of the glass, it is necessary to adjust the height of the reaction channel. Remove the window winder handle and door trim panel, slacken the reaction channel fixings, and move the channel up or down as required. Raising the channel will raise the rear edge of the glass.



b274

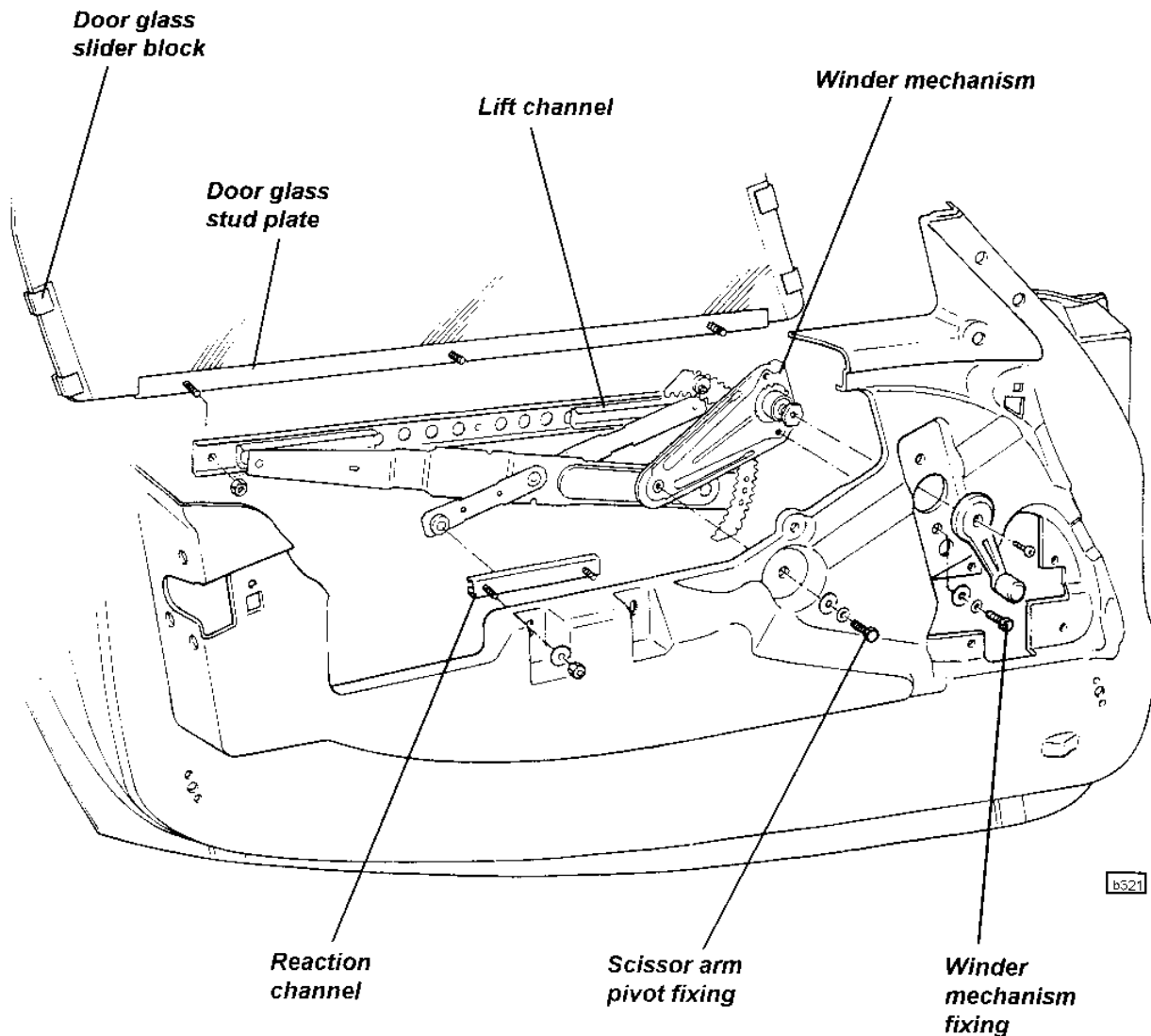
4. To adjust the fully up position of the glass, the eccentric stop on the toothed sector of the winder mechanism must be rotated as necessary. A mesh friction washer is fitted between the eccentric and the sector to help retain adjustment.

*To replace the door window glass*

1. Remove the window winder handle, and the door trim panel.
2. Release the three fixings securing the slider channel to the bottom of the glass.
3. Do not attempt to withdraw the glass from the door without first removing the door waist seal. Carefully prise the one-piece seal off the door shell inner and outer flanges, and release the push fixing from the seal moulding at the rear end of the door. Withdraw the glass from the door shell.
4. Note that new door glasses are supplied complete with jig bonded Nylon sliders and lift channel.
5. Fit the new glass into the door and re-assemble in reverse order to the above.
6. Adjust the glass position as detailed above.

*To replace door winder mechanism*

1. Remove the window winder handle, and the door trim panel.
2. Release the interior release control rod from the door handle and unclip from the latch mechanism.
3. Secure the door glass in the fully raised position, and release the three fixings securing the winder mechanism to the door;
  - two fixings adjacent to the winder spindle;
  - on fixing through the static pivot of the primary scissor arm
4. Maneuvre the mechanism to free the winder spindle from the door, and to disengage the two upper sliding bosses of the scissor arms from the window channel, and the lower sliding boss from the static reaction channel. Withdraw the mechanism from the door.
5. Before fitting a lift mechanism, lubricate the three slider bosses and the sector teeth with Century Luplex M2 grease (or similar). Fit the mechanism into the door and engage the three slider bosses in their lift and reaction channels before securing with the three fixing screws. Note that a single M6 spacer washer is used between the pivot of the primary scissor arm and the door shell.



6. Adjust the glass upstop position, top edge alignment and inward tilt as detailed above.

#### *Door glass guide rails*

Two guide rails are used for door glass: one for the front and one for the rear edge. Each of the steel, black zinc plated, guide rails, is secured by a single screw at the top end to a jig bonded bracket in the door shell, and by a threaded adjuster at the lower end, engaging in a threaded block fixed to the door shell. Screwing the adjusters in or out will set the inward tilt of the glass and the contact between glass and door weatherseal.

To remove a guide rail, first remove the door glass (see above), before releasing the single screw at the top, and releasing the threaded block from the door shell.

#### BP.11 - DOOR SEALS

##### Drop Glass 'Waist' Seal

The door drop glass waist seal is a single unit comprising inner and outer seal extrusions joined around the rear end by a moulded capping piece. Each length of seal is pressed onto the top edge of the inner or outer door panel, with a plastic rivet securing the capping piece. The seal should be removed before withdrawing the door glass or guide channels from the door.



A 'cheater' seal is bonded to the vertical front end of the door glass aperture, up the rear face of the mirror mounting extension. To fit a new seal:

- Clean the bonding surfaces on the door shell edges with Betaclean 3900 (A100B6008V).
- Apply Permabond A905 surface conditioner to the bonding surfaces of door shell and cheater seal.
- Apply Loctite 382 adhesive to the inside of the cheater seal and fit onto the door.

**Door Weatherstrip**

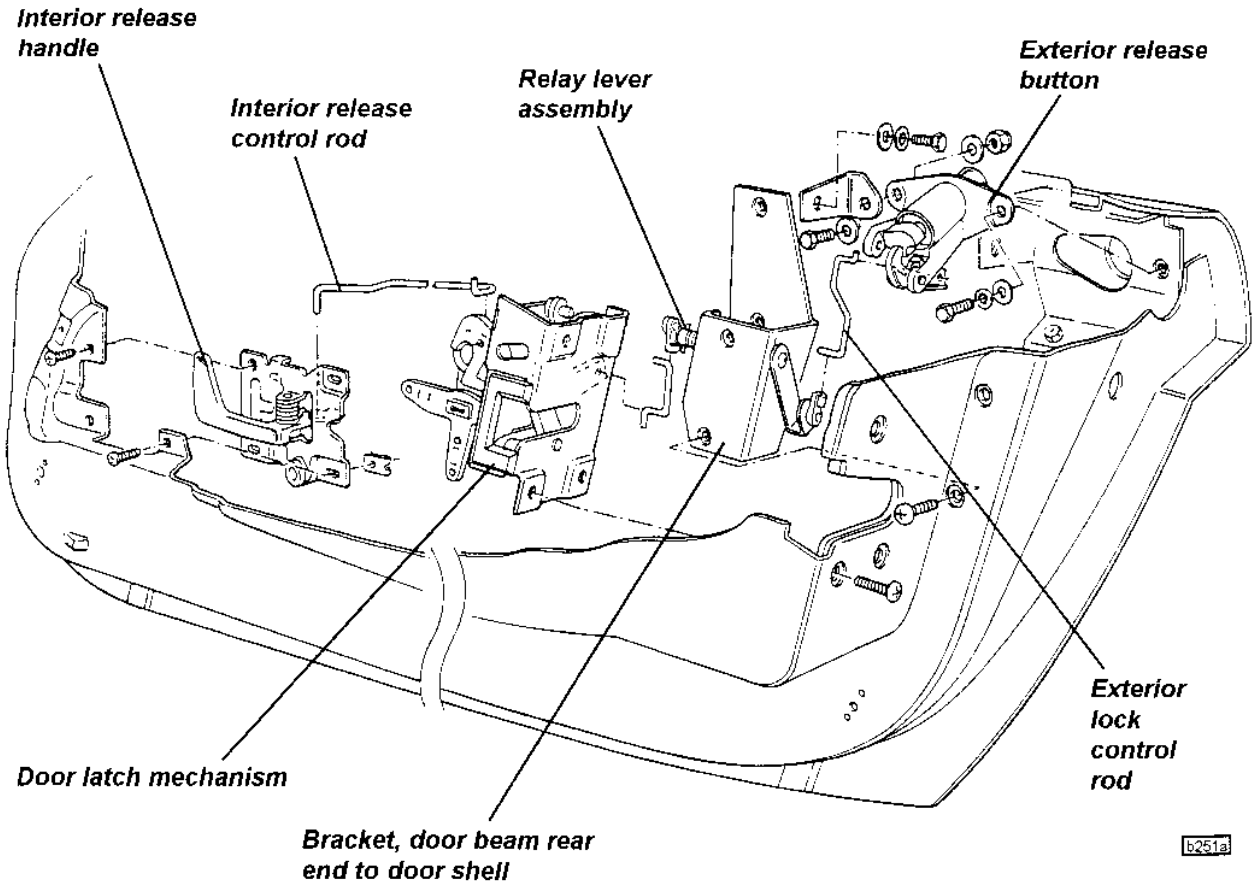
A hollow section rubber weatherstrip is bonded around the door aperture and roof landings to seal against the door shell and roof. Different seal configurations are used for the door and roof areas, with specially moulded sections to interface with the roof cantrails. The seal is divided into front and rear sections, with a joint at the bottom front of each door aperture.

The weatherstrip is manufactured with a self adhesive backing strip. Before fitting a new seal, the bonding area on the body must be completely clean before priming with PP Primer 3842 (A082U6199V). Trial fit the seal before peeling off the protective backing from the adhesive and applying the seal, ensuring that the moulded sections at the cant rail interfaces are correctly positioned.

**BP.12 - DOOR LATCH MECHANISM**

The door latch mechanism is fitted inside the rear face of the door, which is reinforced by a steel plate bonded to the glass fibre composite door shell. The latch engages with a striker pin which passes through the composite sill/'B' post moulding, into a captive nut on the roll over bar. An external locking door release button is mounted via a reinforcing plate, in the top rear of the door outer shell, and transmits its motion around the rear edge of the door glass to the latch mechanism via two short link rods and a relay lever.

The interior release handle is mounted in the front of the door inner shell, and is connected to the latch mechanism by a control rod. No interior control of door locking is provided.

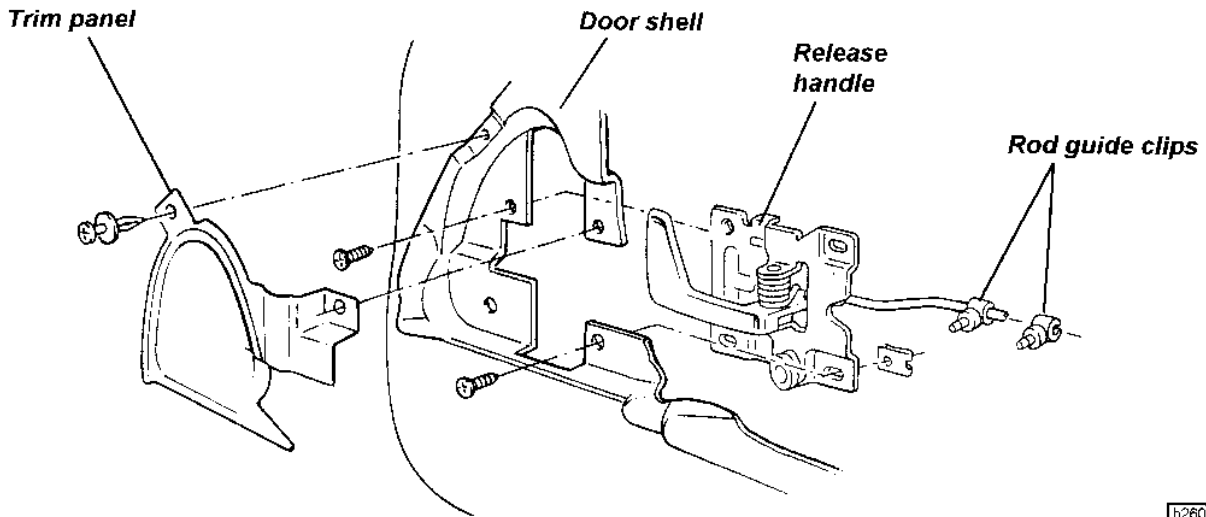


b251a



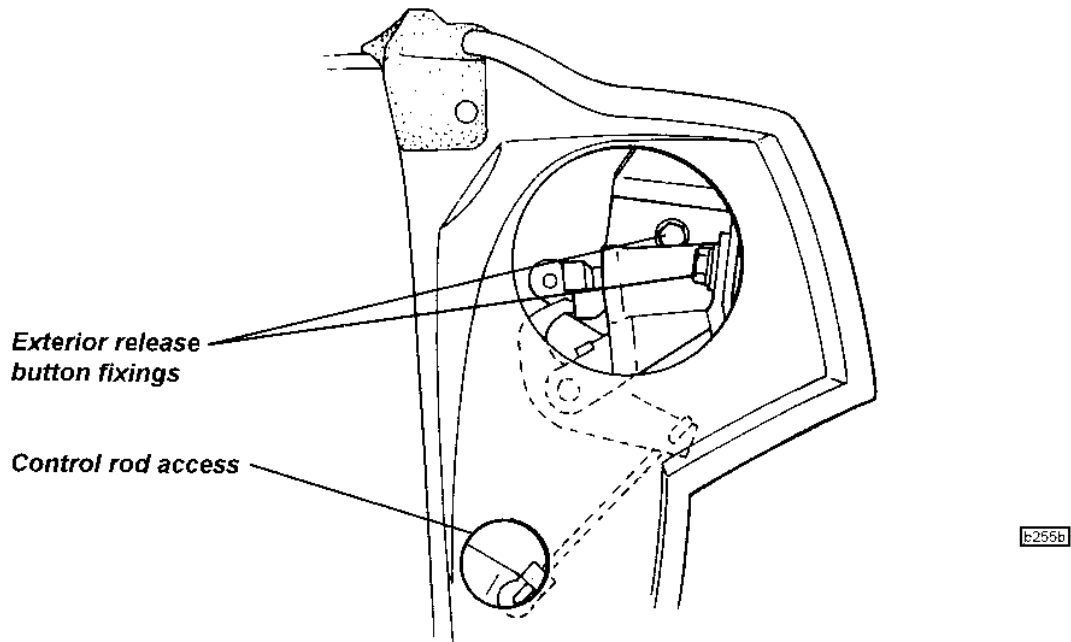
Interior Release Handle

- Remove the window winder handle and door trim panel.
- Remove the four screws securing the interior handle assembly and unclip the control rod end clip to allow the rod to be unhooked from the handle.
- On refitting, ensure that the control rod is located in the guide clips.



Exterior Release Button

- Remove the access disc from the rear face of the door, and the rod access grommet lower down.
- Release the two screws securing the lock assembly and angle bracket to the tapping plate bonded in the door shell.
- Unclip the link rod from the relay lever, and withdraw the lock button from the door.

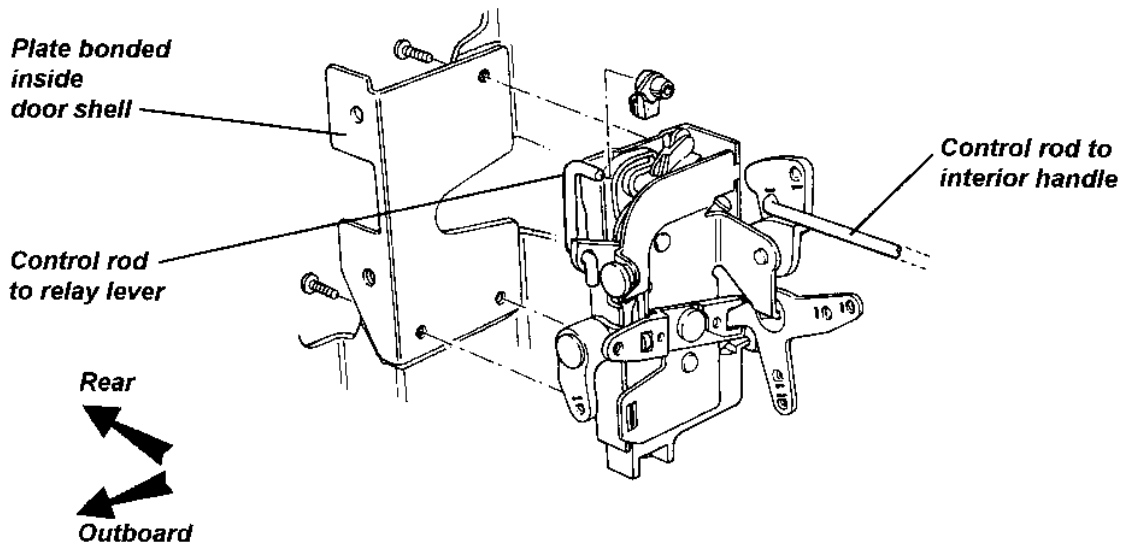




Latch Mechanism

- Remove the window winder handle and door trim panel.
- Unclip the control rod from the interior release handle, and unhook from the latch mechanism.
- Unclip and disconnect the short link rod between the relay lever and the latch mechanism.
- Remove the three M6 screws securing the latch mechanism to the door, and withdraw the latch.

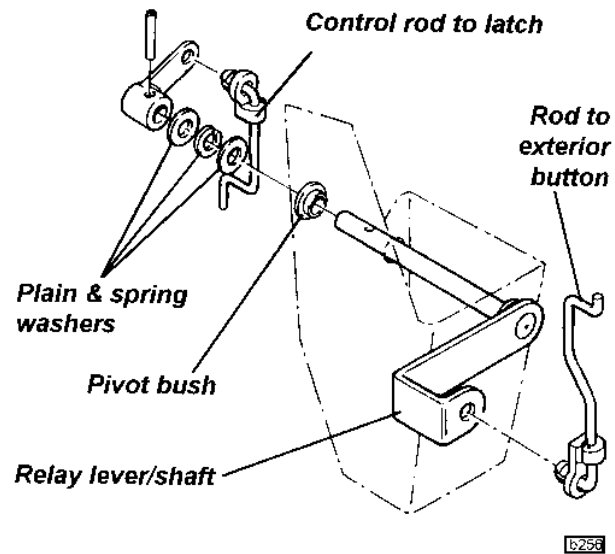
Viewed through outer door skin



Relay Lever Mechanism

The relay lever components comprise a shaft with an integral lever on one end, which connects to the exterior lock button, and a second lever pinned to the other end, which connects to the latch mechanism. The shaft is supported in two fibre bushes housed on the bracket connecting the rear end of the door beam to the door shell. To remove the door beam extension bracket complete with relay lever mechanism:

- Remove the window winder handle and door trim panel.
- Release the three M6 nuts securing the door glass to the lift channel, and separate the glass from the channel. Do not attempt to withdraw the glass from the door without first removing the door glass waist seals.
- Remove the access grommet from the rear face of the door, and unclip the exterior lock link rod from the relay lever. Similarly disconnect the link rod between the relay lever and the latch mechanism.
- Support the door shell before removing the two M8 bolts fixing the rear end of the door beam to the end bracket, and the two screws securing the bracket to the door shell. Remove the bracket complete with relay lever assembly from the door.
- Refit the bracket in reverse order to removal.







**BP.13 - INSTRUMENT BINNACLE & DASH PANEL**

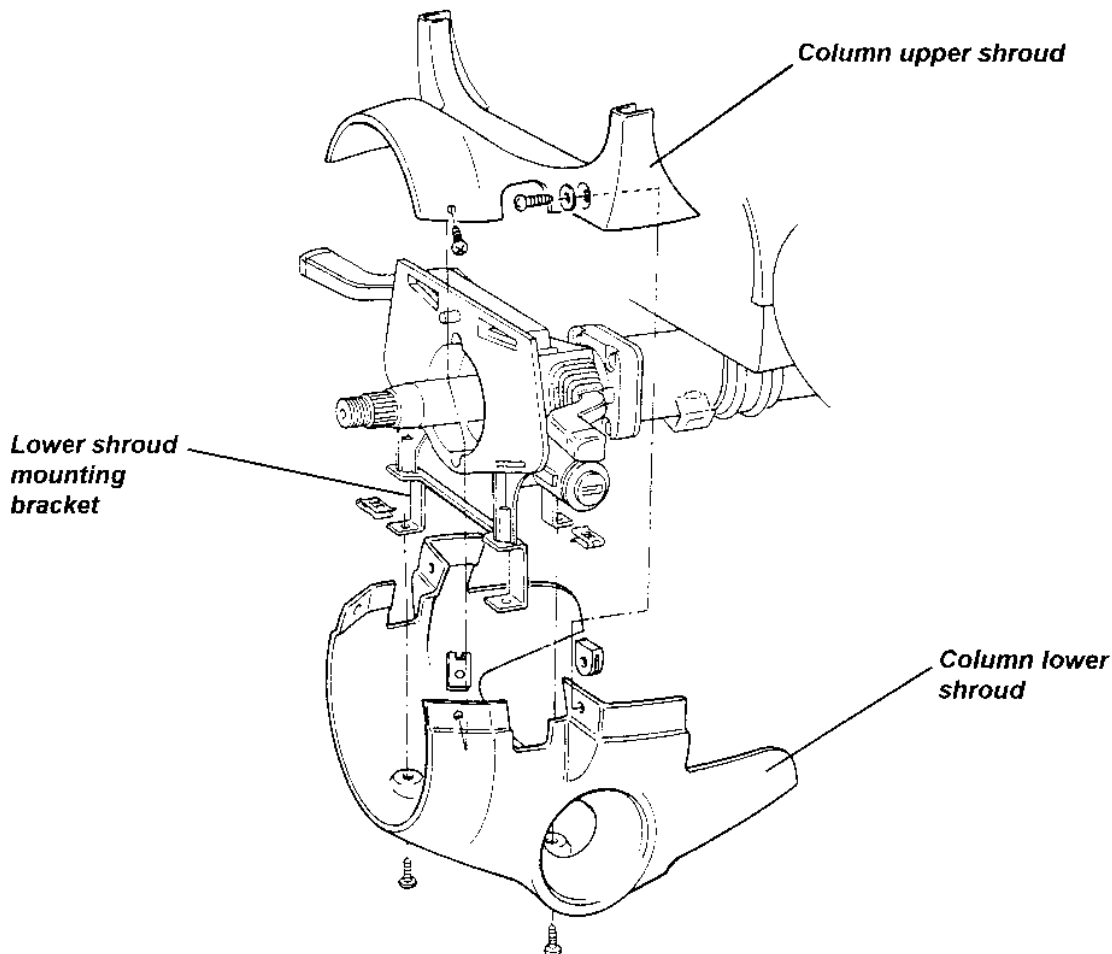
The dash panel comprises principally of three alloy extrusions linking the chassis scuttle crossbeam and the bottom of the windscreen pillars. The lowermost extrusion is bonded to the chassis, and incorporates a curved shelf. The middle and upper extrusions are bonded and rivetted together to form an assembly which locates behind the top edge of the lower extrusion, and is screwed at each end to the composite windscreen frame at the bottom of each screen pillar. The upper extrusion houses the climate controls and audio aperture. A skinned foam fascia top panel joins the top of the dash to the base of the windscreen and incorporates the demist ducting and four windscreen outlet vents, with a moulded plastic capping panel around the front of the fascia top and surrounding the vents. At each end of the fascia, a moulded plastic panel joins the fascia to the door sill finisher, and is used to mount the front speakers and lighting switches.

The dash and fascia are interrupted by the steering column which is secured to the scuttle crossbeam by a pair of extruded alloy support brackets. The instrument pack and its cowl are mounted via a steel bracket secured using the column mounting fixings.

For access to the climate controls, or electrical components mounted on top of the chassis scuttle beam, the fascia top panel must be removed.

**To Remove Fascia Top Panel**

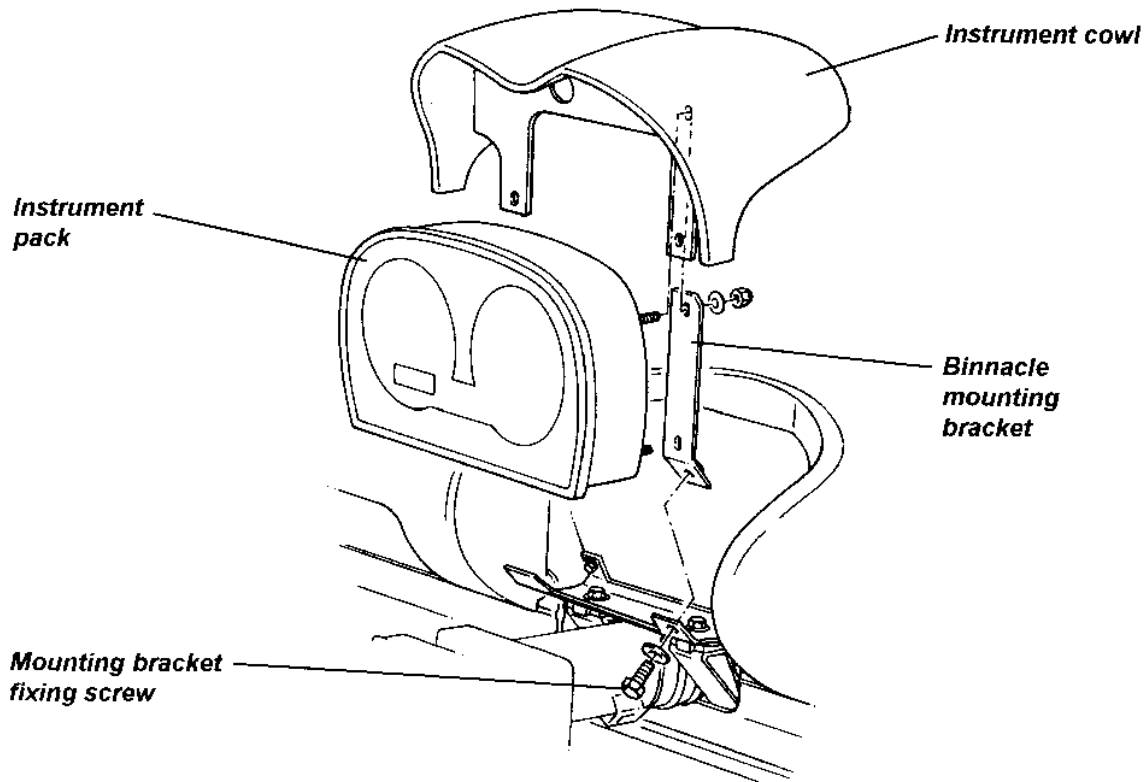
1. Remove the steering column upper and lower shrouds:
  - Remove the four screws securing the shroud upper section.
  - Pull out the grommet from around the ignition switch and remove the three screws securing the lower shroud to the column.
  - Disconnect the trip reset button from the lower shroud.



b258a



2. Release the two fixings securing the binnacle mounting brackets to the column, and withdraw the instrument pack and cowl. Unplug the harness connector.



b259a

3. Release the screws securing each fascia end (speaker) panel, disconnect the switch and speaker harnesses and withdraw the panels.
4. Carefully prise each windscreen outlet vent from the fascia.
5. Remove the screws at each end securing the fascia capping panel, and withdraw the panel.
6. Remove the plastic finisher above the climate controls. Remove the four screws securing the top flange of the dash extrusion to the underside of the fascia top.
7. Lift the rear of the fascia top to release the two locating bosses from the keyhole slots in the dash, and pull the fascia rearwards to withdraw the two front edge spigot pins.

To Remove Dash Panel

1. Remove fascia top panel (see above).
2. Remove the climate controls, audio set, interior light.
3. Release the fixings securing each end of the dash upper extrusion assembly to the windscreen frame and withdraw the dash.



b319

Moulded plastic capping panel

Capping panel fixing

Fascia top panel

Dash fixing to screen frame

Fascia to dash fixing

Keyhole slot for fascia

Climate control recess finisher

Audio set support

Dash lower extrusion with shelf

Fascia top

Middle & centre extrusions

Chassis scuttle beam

Lower extrusion

b202a

**BP.14 - WINDSCREEN**

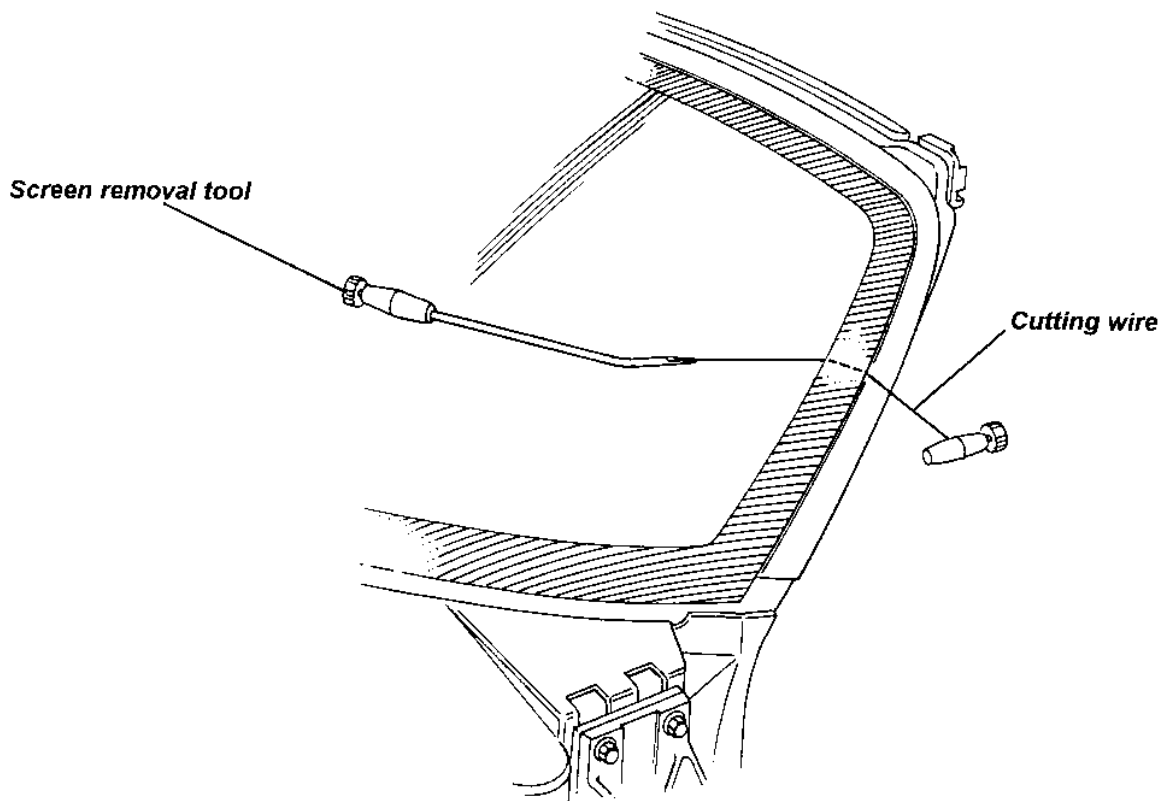
The laminated windscreen, together with self coloured synthetic finisher moulded around the top and side edges, is bonded to the composite windscreen mounting frame using Betaseal flexible polyurethane adhesive. It is not practicable to remove a windscreen from a car and then refit the same glass, as removal of the screen will require cutting the surround finisher which is available only as part of a new windscreen assembly.

**To Replace Windscreen**

Parts required:

- Windscreen
- Betaseal Kit
- Plinth, interior mirror mounting
- Activator Dymax 500E (A111B6187V)
- Adhesive Dymax 840 (A111B6186V)

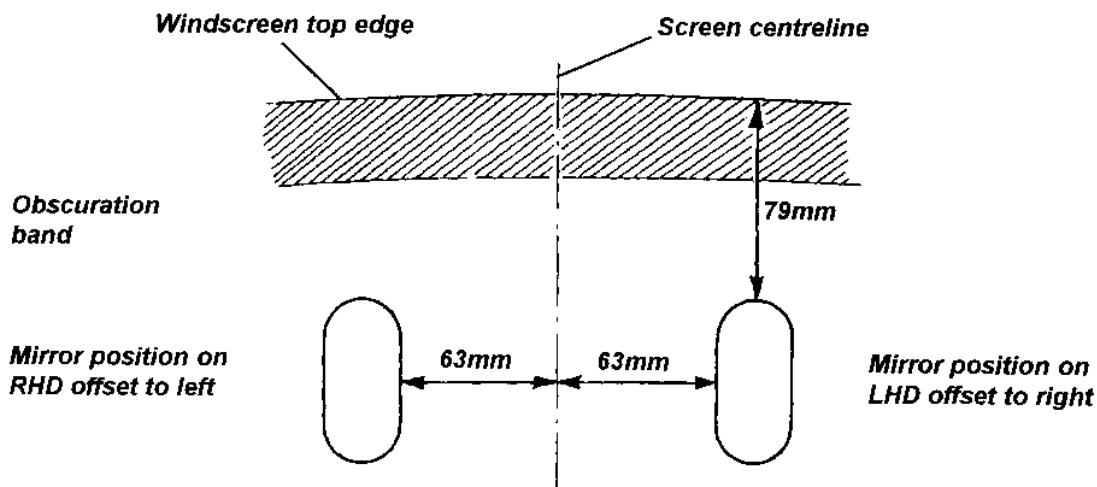
1. Remove the fascia end (speaker) panels, and the fascia top capping panel (around inside base of windscreen).
2. Remove the front clamshell (see sub-section BP.5).
3. Remove the wiper arm from its spindle, and the interior mirror from its plinth.
4. Cut around the whole length of the windscreen surround finisher to allow access to the 'screen adhesive joint. Apply suction handles to the outside surface of the screen.
5. In order to incur the minimum risk of damage to the windscreen composite mounting frame, the preferred method of cutting the windscreen adhesive is by the use of a 'cheese' wire. Protect the visual surface of the windscreen frame with tape before commencing the cutting operation.



t322

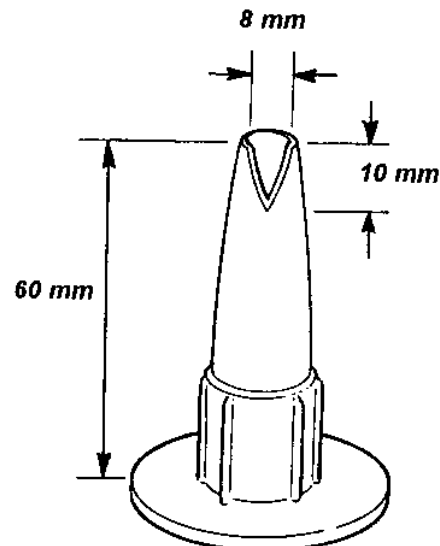


6. After cutting out the screen, remove old adhesive from the windscreen frame sufficiently to leave a consistent and flat surface for the new bond.
7. Clean the whole of the inside surface of the windscreen with a 50% solution of water and isopropanol. Allow to dry.
8. Fit the interior mirror plinth to the inside of the windscreen:
  - Use Betawipe VP04604 (A082B6150V) to clean thoroughly the bonding surface of both the mirror plinth and corresponding surface on the screen.
  - Apply activator Dymax 500E (A111B6187V) to the screen patch.
  - Apply adhesive Dymax 840 (A111B6186V) to the screen.
  - Fit the plinth to the screen with the dimple lowermost and hold for 30 seconds.
  - Allow at least 10 minutes curing time before fitting the mirror.



b263

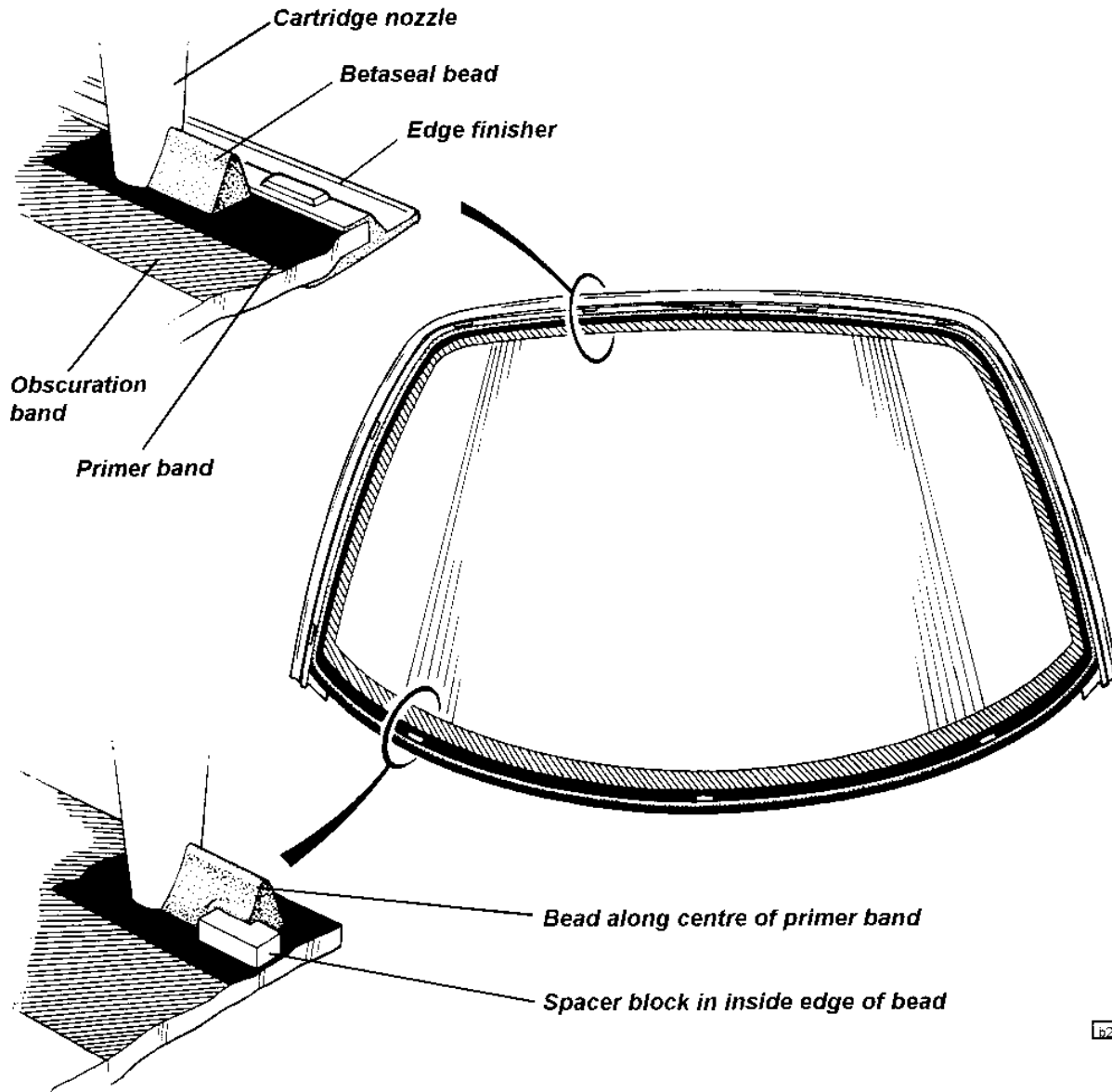
9. Clean the whole of the inside surface of the obscuration band, and the bonding surface on the windscreen frame with the wipe cleaner.
10. Apply a 25 mm wide band of Betaprime around the inside periphery of the glass. Similarly apply to the whole of the bonding surface on the windscreen frame, and to the windscreen bottom laminated edge. Allow to dry for a minimum of 5 minutes. If the screen is not fitted within 48 hours, the primer should be re-applied.
11. Cut the nozzle of the Betaseal cartridge to the dimensions shown to produce a triangular section bead. Holding the cartridge vertically, extrude a bead of adhesive around the screen, using the edge of the finisher as a guide along the top and sides, and following the centreline of the primer band along the lower section.



b264



12. Cut three 4mm spacer blocks from the material supplied in the Betaseal kit, and position in the inside edge of the adhesive bead running along the bottom of the class. These spacers are used to control the fitted height of the glass, and the wiper arm clearance.



b265a

13. Using the suction handles, carefully lower the windscreen onto the frame, with the edge finisher firmly butted against the top and sides of the frame recess. Press around the periphery of the screen to compress the adhesive until contact with the finisher spacers and bottom edge spacer blocks is felt. Carefully examine the integrity of the whole length of the joint, if necessary using a spatula to force extra adhesive into any suspect areas. Wipe off any excess adhesive extruded from the joint, or alternatively, allow the adhesive fully to cure and cut away any excess using a scalpel blade.
14. Use duct tape and/or support blocks to hold the screen in position and do not disturb until the Betaseal is fully cured. This will take approximately 4 hours dependent on atmospheric conditions, with a longer period required in dry atmospheres.
15. Refit wiper arm, interior mirror and front clamshell.



Spillage of material

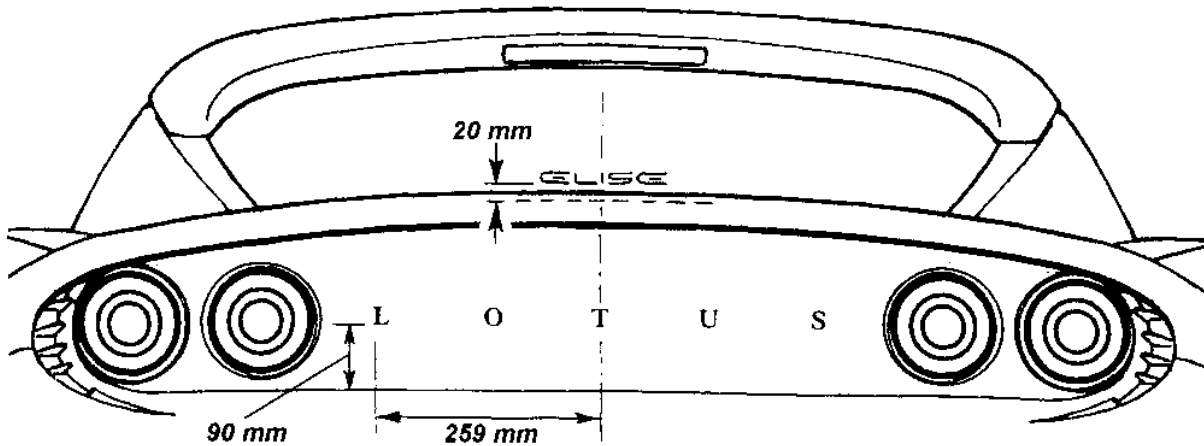
- a) Any spillage of Betaseal onto unprimed glass can be readily peeled off after it has cured.
- b) Any spillage onto the bldy can be removed with either Wipe Cleaner No.4, or white spirit.

Shelf life

- a) Betaseal primer has a useful life of about 24 hrs. after exposure to the air, after which it starts to become spongy. If the material is spongy, DO NOT USE. Always use glass primer immediately on opening, and replace the lid after use.
- b) Betaseal has a shelf life of over 6 months at ambient temperature in the original unopened package.

BP.15 - DECAL POSITIONING

Individual 'L O T U S' self adhesive decals are used on the rear transom, and a single 'elise' decal on the inside of the rear screen.



b324



FRONT SUSPENSION

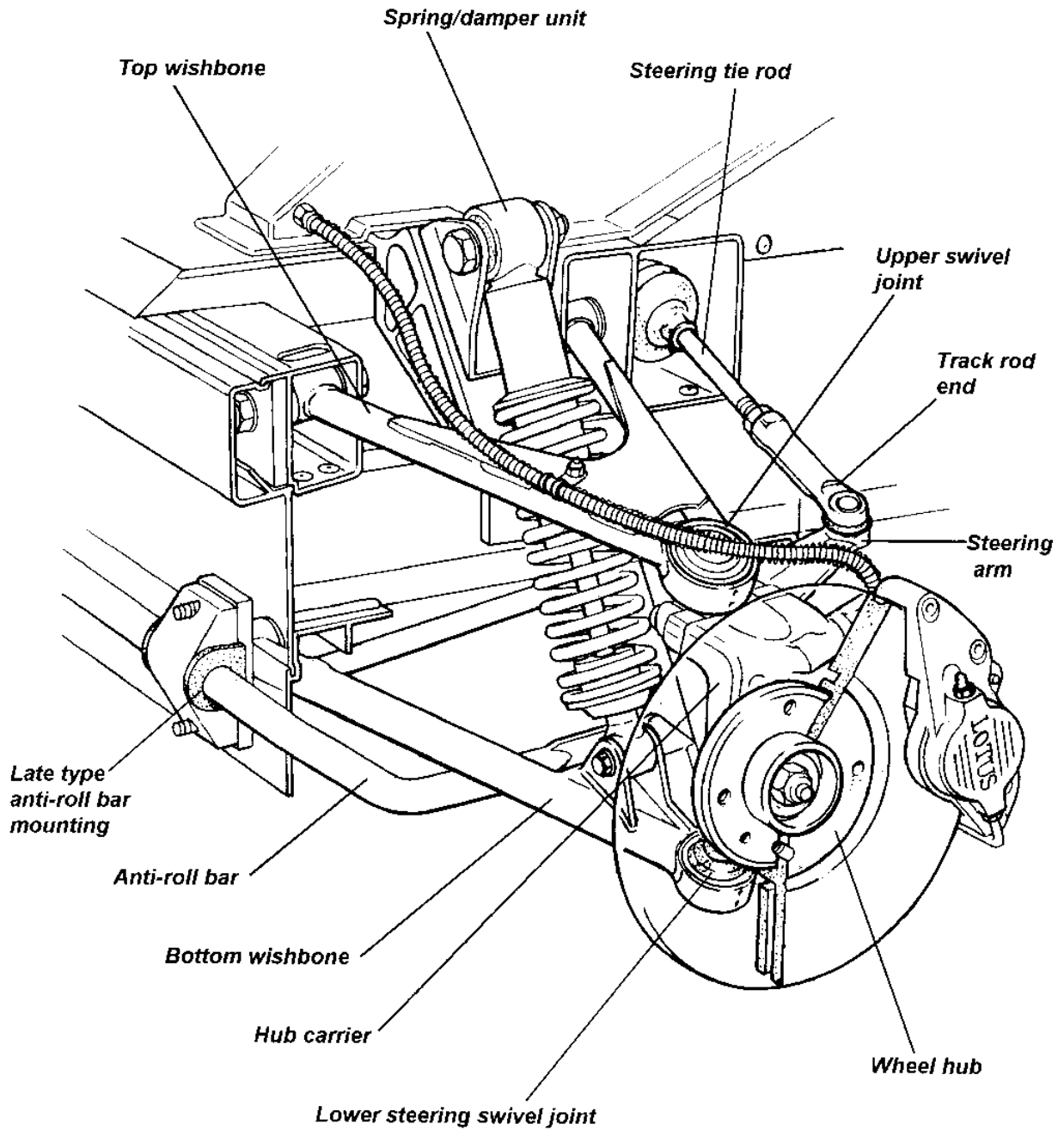
SECTION CH - ELISE 2001 M.Y. Onwards

	<u>Sub-Section</u>	<u>Page</u>
General Description	CH.1	3
Geometry & Adjustments	CH.2	3
Anti-Roll Bar	CH.3	6
Suspension Disassembly/Assembly	CH.4	8
Front Wheel Bearings	CH.5	10





GENERAL LAYOUT



c34a



CH.1 - GENERAL DESCRIPTION

The fully independent front suspension comprises, on each side of the car, upper and lower wishbones, a concentric coil spring/telescopic damper unit, and a tubular anti-roll bar. A forged steel hub carrier, provides a mounting for a the hub bearing unit to which the road wheel is attached via four spline socket bolts.

The upper and lower 'A' frame wishbones are fabricated from steel tube, the upper wishbone braced by sheet steel gussets at its apex, and the lower wishbone braced by a tubular strut at its base. The inboard ends of both wishbones use replaceable bonded rubber pivot bushes to provide maintenance free articulation, with a specification providing accurate and responsive dynamic characteristics. The outer ends of both wishbones incorporate housings into which the upper and lower steering swivel ball joints are pressed. The upper ball pin is secured to the forged steel, rearward facing steering arm, itself fixed to the hub carrier by two M10 bolts. The ball pin of the lower swivel joint is secured directly into a tapered hole in the bottom of the forged steel hub carrier. The Bilstein spring/damper unit acts between the outer end of the lower wishbone and the chassis, and is fitted with the damper rod lowermost in order to minimise unsprung weight.

A forward mounted tubular steel anti-roll bar, is supported in chassis mounted rubber pivot bushes and is operated via short ball jointed drop links from the lower wishbones.

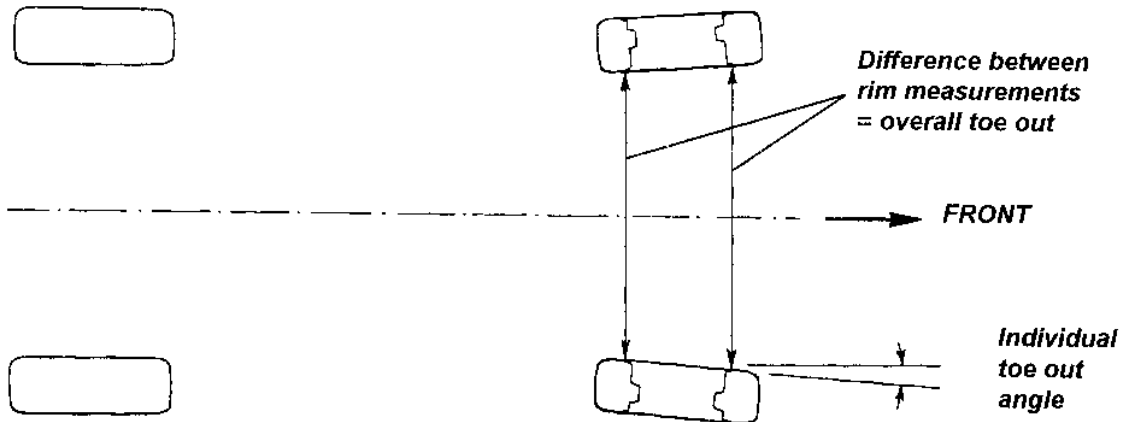
CH.2 - GEOMETRY & ADJUSTMENTS

Provision is made for the adjustment of wheel alignment, camber and castor. Under normal service conditions, no periodic scheduled check of the geometry is necessary, although a front wheel alignment check is recommended when the front tyres are replaced. A full geometry check is required only after front suspension repair, or if excessive tyre wear is evident, or if steering difficulties are encountered. Before any measurements or adjustments are made it is essential first to set the vehicle to its 'mid-laden' ride height, approximating to driver and passenger and a half tank of fuel. This will require the vehicle to be ballasted, or tied down:

Ride height (for geometry check)	- front	130 mm below front end of chassis siderail
	- rear	130 mm below rear end of chassis siderail
Alignment		0.2 mm toe-out overall; - 0, + 0.2 mm (0.03° toe-out overall; - 0, + 0.03°)
Camber		- 0.1°; + 0.1°, - 0.2°. Max side/side 0.2°
Castor		+ 3.8°; + 0.3°, - 0.2°. Max side/side 0.3°
Steering axis inclination		12° nominal

Alignment

Wheel alignment refers to the parallelism of the wheels when viewed from above and is crucial to vehicle stability, handling and tyre wear.

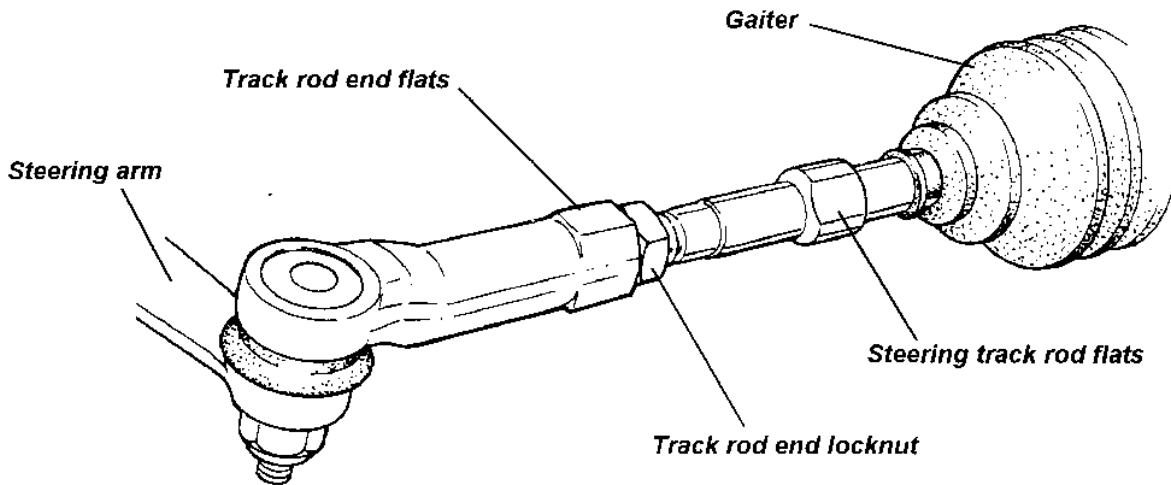


c28



Alignment is measured either by the angle a wheel makes with the vehicle centre line, or the difference in dimension between the wheel rim to wheel rim measurement at the front and rear of the wheel at hub centre height. The wheels are said to 'toe-in' when the wheel paths converge ahead of the vehicle, and 'toe-out' when they diverge. Wheel alignment is designed to vary with both steering angle (Ackerman) and suspension travel (bump steer) and should be measured only 'straight ahead' at the specified ride height.

Front wheel alignment is adjusted by screwing the track rods into or out of the track rod outer end ball joints. In order to preserve the required bump steer characteristic and steering symmetry, the effective length of each track rod must remain equal - adjust each track rod by a similar amount.

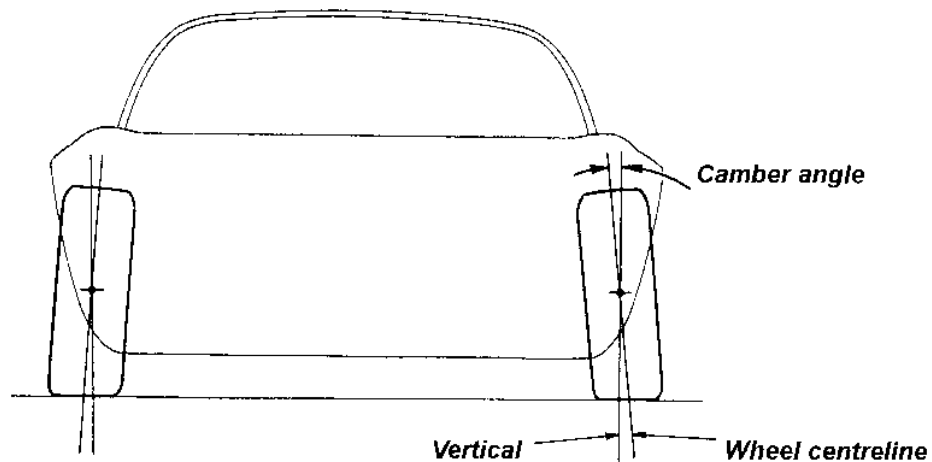


- Hold the track rod end using the flats provided, and slacken the locknut. Repeat for the opposite side.
- Turn each track rod a similar amount. As a guide, turning both track rods by one quarter of a turn will alter overall toe-out by approx. 2.0 mm.
- When adjustment is correct, hold each track rod end and tighten the locknuts to 80 - 82 Nm (58 - 60 lbf.ft).

When slackening or tightening the track rod end locknuts, it is important that the torque reaction is resisted using the track rod end flats, and that the ball joint itself is not allowed to be stressed.

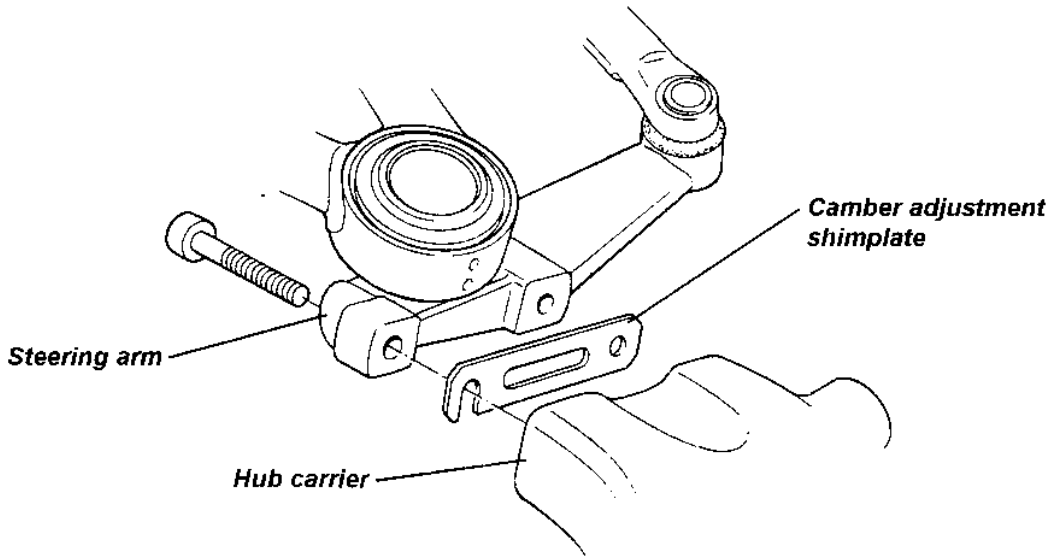
Camber Adjustment

Camber is the angle from vertical of the wheel when viewed from the front, and is said to be negative when the wheel leans inwards at the top (positive when leaning outwards). The primary purpose of camber is to achieve the maximum efficiency of the tyre under cornering loads and body roll, with the specification closely allied to a particular wheel/tyre combination. The camber angle changes with suspension travel, becoming more negative on bump, and should be measured only at the specified ride height. Incorrect camber can result in handling deficiencies and excessive tyre wear.





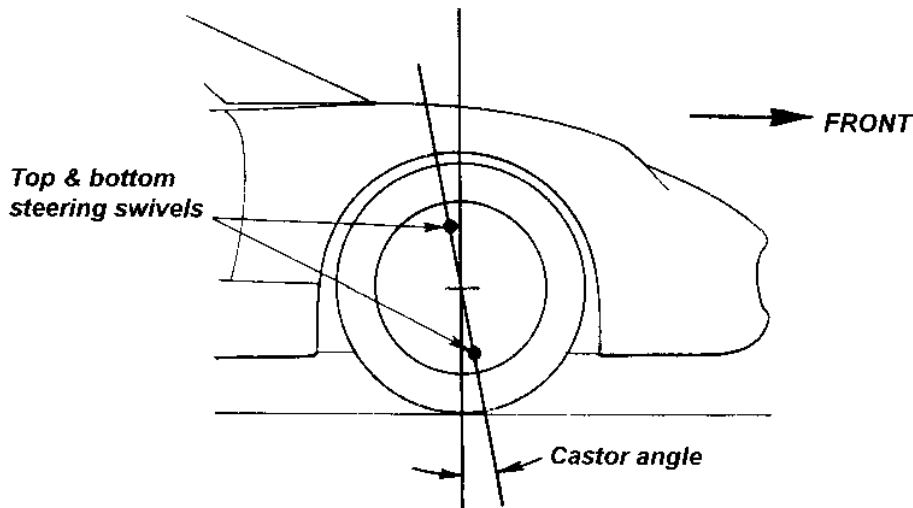
Camber adjustment is effected by adding or deleting shim plates between the steering arm (to which the upper steering swivel joint is fixed) and the hub carrier.



- Shimplates are available in 1mm and 3mm thicknesses.
- Reducing the shim pack thickness will increase negative camber. Adding shims will reduce negative camber.
- A 1mm shim plate will alter camber by approximately 0.25°.
- Apply Permabond A130 (A912E7033) to the two steering arm fixing bolts, and tighten to 45 Nm

Castor Adjustment

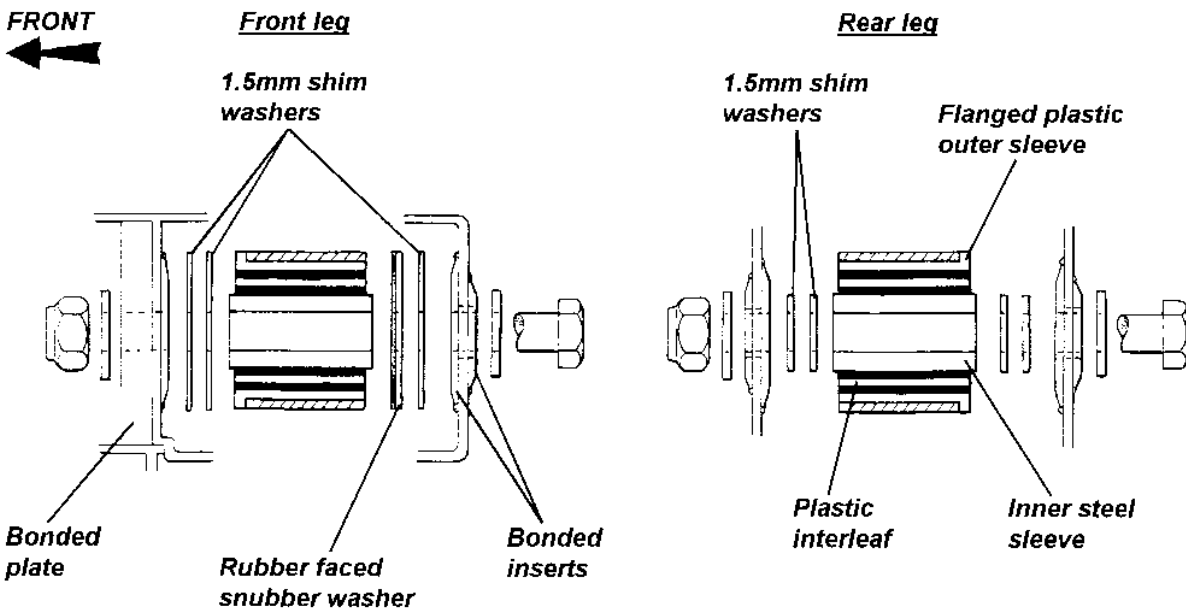
Castor is the angle from vertical of the steering axis of the wheel when viewed from the side. Its primary purpose is to provide a natural straight running tendency of the steered wheels with forward vehicle motion. Castor angles have a complex interaction with other steering geometries and if unbalanced or outside of specification, can result in various stability and handling deficiencies.



The wishbone pivot bushes are bonded rubber type with a plastic flanged outer sleeve, a plain steel inner sleeve, and a plastic interleaf sleeve within the rubber bush to control the flexing characteristic. The top wishbone rear bush, identified by a blue paint mark, has no interleaf sleeve.

The top wishbone pivots are sandwiched between the walls of transverse chassis box sections, the pick up points in which are reinforced either with machined inserts, or in the case of the foremost position, a thick alloy plate, each being bonded to the chassis with epoxy adhesive. Spacer washers are fitted ahead of and behind each of the top wishbone pivot bushes to allow the wishbone to be displaced forwards or backwards, with an associated change of castor angle. A rubber faced snubber washer fitted against the rear face of the top wishbone front bush prevents metal to metal contact under extreme braking forces. The spacer washers may be re-distributed between the front and rear of each pivot bush but the snubber washer position, and the total shim pack thickness of 4 x 1.5mm at each pivot (inc. the 1.5mm snubber washer) must remain unchanged.

### Top Wishbone Inboard Fixing



#### Notes

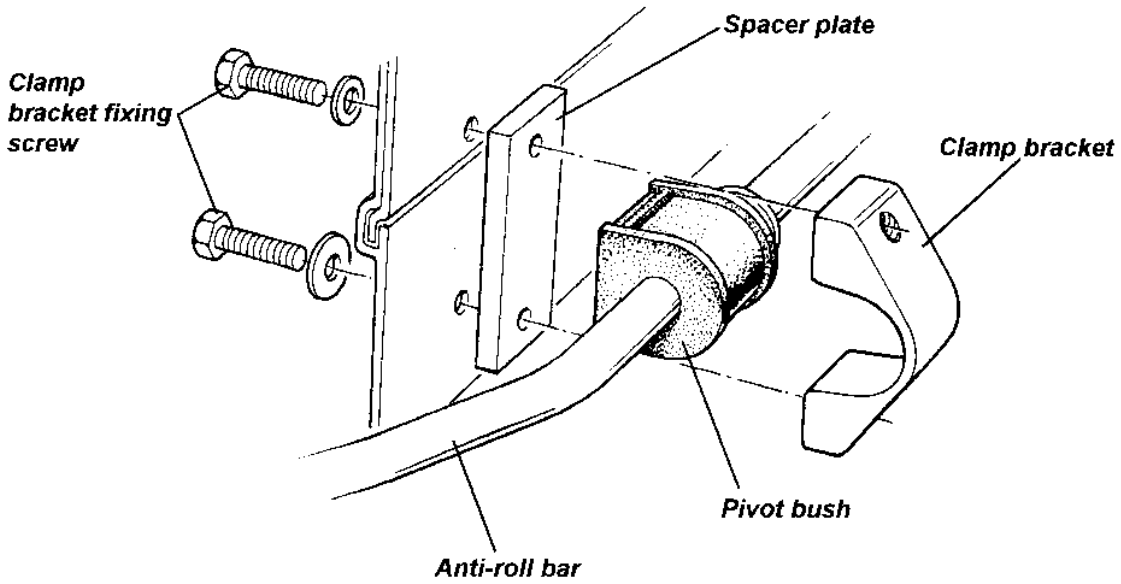
- Shim distribution at the front bush of either wishbone must be copied at the rear bush of that wishbone.
- Transferring a 1.5mm shim washer from ahead of, to behind the pivot bushes, will **reduce** castor by approximately 0.4°.
- Transferring a 1.5mm shim washer from behind, to ahead of the pivot bushes, will **increase** castor by approximately 0.4°.
- Ensure that the load spreading washers are correctly located beneath the bolt heads and nuts as shown in the drawings.
- Ensure that the pivot bolts are tightened only with the vehicle at ride height. Torque to 45 Nm.

### CH.3 - ANTI-ROLL BAR

A tubular steel anti-roll bar is mounted in pivot bushes onto the front face of the chassis, and is linked to the outboard ends of each lower front wishbone via short ball jointed links. The anti-roll bar is secured to the front face of the chassis by rubber pivot bushes and alloy clamp brackets. Washers welded to the bar bear against the inner sides of the bushes to provide lateral location. Castrol LMX rubber grease, or equivalent, should be used when fitting the rubber bushes onto the anti-roll bar.

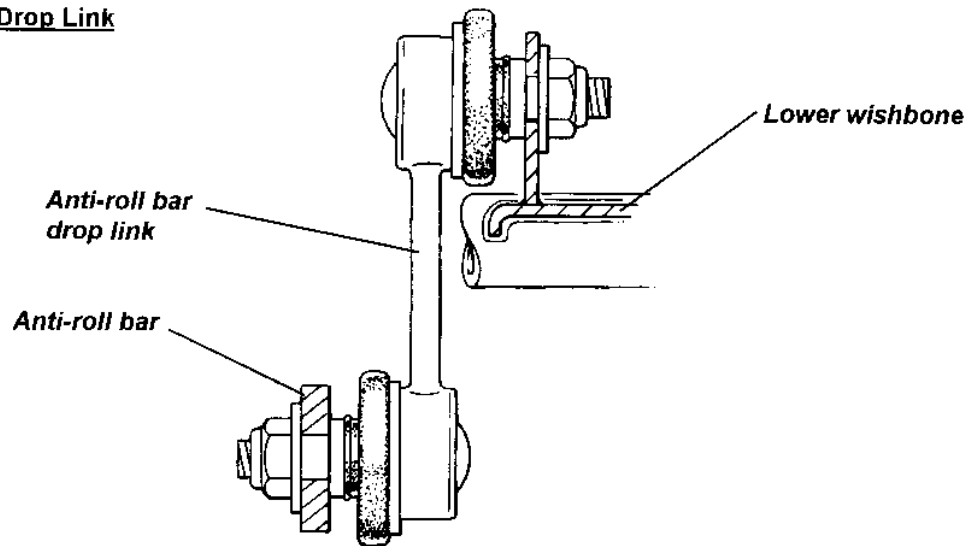


**Anti-Roll Bar Mounting**



c40

**Anti-Roll Bar Drop Link**



c31

**CH.4 - SUSPENSION DISASSEMBLY/ASSEMBLY**

The suspension may be disassembled without the use of any special tools other than a 'Torx' socket for the hub bearing carrier bolts, and a spring compressor, required only if the spring is to be removed from the damper unit. With the car on a wheel free lift and with the front wheels removed:

1. Remove the wheelarch liner(s) as appropriate.
2. Remove the two bolts securing the brake caliper to the hub carrier, release the flexible hose from the top wishbone, and support the caliper aside without straining the brake hose. Release the single countersunk screw, and remove the brake disc.
3. Remove the nut securing the track rod end into the steering arm, and use a ball joint splitter to separate the rod end from the arm.
4. Remove the nut securing the top swivel joint to the steering arm, and use a ball joint splitter to separate the joint from the arm. Remove the two M10 fixing bolts and remove the steering arm from the hub carrier, taking care not to misplace the camber adjustment shim plates.
5. Remove the nut securing the lower swivel joint to the hub carrier, and use a ball joint splitter to separate the ball pin from the carrier.
6. Remove the bolts securing the spring/damper unit to the lower wishbone and chassis anchor bracket, and withdraw the unit, noting the spacer washers fitted at the top end.
7. Disconnect the anti-roll bar drop link from the lower wishbone, and remove the lower wishbone front pivot bolt.
8. Remove the lower wishbone rear pivot bolt from within the cabin footwell, and withdraw the wishbone.
9. Before removing the two pivot bolts for the top wishbone, take careful note of the distribution of castor adjustment washers. Move the steering rack to full lock to provide clearance for the withdrawal of the wishbone rear pivot bolt. Withdraw the wishbone.
10. The wishbone pivot bushes comprise a rubber bush bonded to a steel inner sleeve and a flanged plastic outer sleeve. The bushes may be pressed out of the wishbone eyes, and new bushes fitted using suitable press tool dollies. Smear the outer surface of the new bush with IPC 'P-80' rubber lubricant emulsion (A082C6042V) to ease fitment, and assemble as follows:  
Top wishbone - insert from the outside of both pivot eyes (from front of front eye, and rear of rear eye).  
Lower wishbone - insert from the inside of both pivot eyes (from rear of front eye, and front of rear eye).  
Note that all top wishbone pivot bushes are common with the exception of the top wishbone rear pivot, which contains no interleaf sleeve and is identified by a blue paint mark.
11. Top and bottom swivel joints are identical, and may be replaced if necessary using a suitable press.
12. If the anti-roll bar is to be removed; remove the front alloy undertray, and, by drilling out the rivets, the small alloy closing panel at each side of the crash structure below the anti-roll bar. Release the a.r. bar clamps and drop links, and withdraw the bar.
13. The road spring may be removed from the damper using a suitable spring compressor to allow the spring lower slotted seat to be withdrawn. Note that the spring upper seat is retained by a circlip located in the centre of three available damper body grooves.
14. To remove the hub bearing unit from the hub carrier, release the three Torx head bolts and withdraw the complete unit. The hub unit is not serviceable, and is replaced complete if faulty.



Reassembly

Re-assemble the suspension in reverse order to disassembly with the following notes:

- Take care to assemble each pivot bolt with the correct washers/snubbers/spacers as shown in the diagrams.
- Smear the shank of each pivot bolt with PBC grease, but do not allow contamination of the threads.
- Take care to refit the original camber adjustment shimpack, and distribute the castor shims as noted on removal.
- After re-fitting the anti-roll bar, ensure that the crash structure closing panels are re-riveted.
- Apply PermaBond A130 (A912E7033V) to the threads of the steering arm bolts.
- Lubricate the ends of the damper top eye bush with rubber grease.
- Press the brake pedal to reposition the pads before driving the car.

15. The Service Schedule specifies that the security of the front and rear suspension is checked at each service. This operation requires that all the principal suspension pivot bolts are torque checked, noting the following points:

Where a bolt is tapped into a housing or weldnut, and relies on a thread locking compound for security, it is important to appreciate that if the bolt is disturbed, the locking compound must be re-applied. The following procedure should be adopted for all such fixings:

- Check the torque of the fixing.
- If the specified torque is attained without the fixing being disturbed (moving), take no further action.
- If the bolt moves, the locking action of the thread adhesive will have been compromised. Remove the bolt completely, clean off all old adhesive using a wire brush and acetone, and apply new adhesive as specified.
- Refit the bolt and tighten to the specified torque.
- If for any reason a bolt is found to have become loose, and the car has been operated for any period in this condition, the bolt should be renewed as a standard precaution and related components carefully inspected for hole ovality or wear.

Torque Settings:

	<u>Nm</u>
- Upper and lower wishbone pivot bolts	45
- Upper swivel joint to steering arm	55
- Lower swivel joint to plinth	55
- Steering arm to hub carrier	45
- Track rod end to steering arm	30
- Damper to lower wishbone	45
- Damper to top anchor bracket	45
- Damper anchor bracket to chassis	25
- Hub bearing unit to hub carrier	90
- Brake caliper to hub carrier	45
- Anti-roll bar rubber bush mounting clamps	25
- Anti-roll bar drop links	45

CH.5 - FRONT WHEEL BEARINGS

The sealed front wheel bearings are contained in a steel housing secured to the hub carrier with three 'Torx' bolts. The double row, angular contact, ball bearing is retained in the outer housing and also onto the hub spigot by a shoulder and a peening operation, and is inseperable for service.

If there is found to be any discernible free play in the hub bearing, or any roughness or tight spots can be felt, or any signs of lubricant expulsion are evident, the hub assembly should be replaced - there is no provision for adjustment.

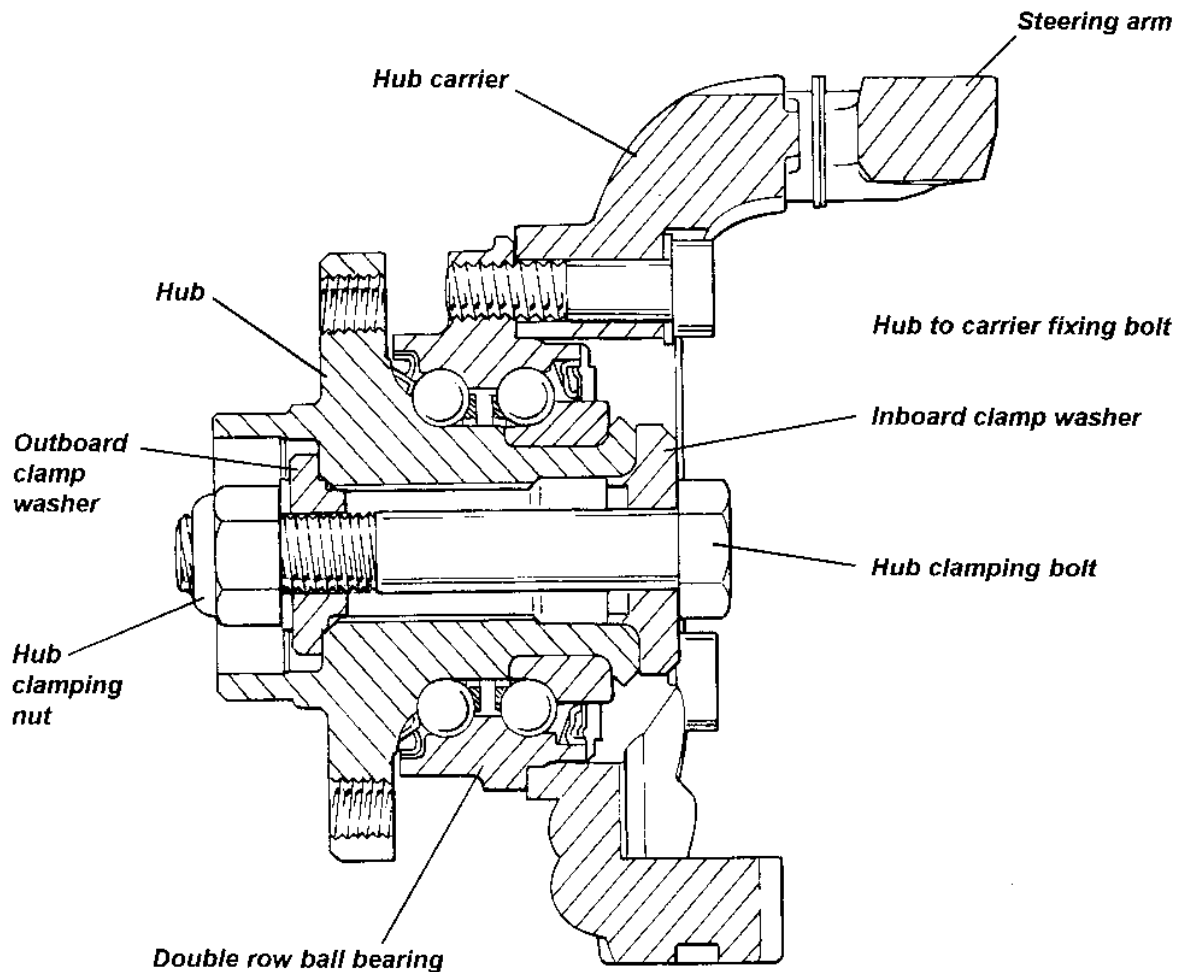
To Replace Hub Bearing Assembly

1. With the wheel removed, release the two fixing bolts, and remove the brake caliper from the hub carrier. Support clear of the brake disc without straining the flexible hose. Release the single countersunk screw and withdraw the brake disc from the hub.





2. Using a Torx socket, release the three bolts securing the hub bearing unit to the hub carrier.
3. **Transfer to the new hub bearing unit**, the M16 bolt and stepped washers clamping the hub into the inner races of the hub bearings, with the nut on the outboard side. Torque tighten to 210 Nm
4. Fit the new hub bearing unit to the hub carrier and retain with the three Torx bolts. Torque tighten to 90 Nm.
5. Refit the brake disc and caliper, using PermaBond A130 (A912E7033) to the threads of the caliper fixing bolts and torque tightening to 45 Nm. Pump the brake pedal to reposition the pads before driving the car.



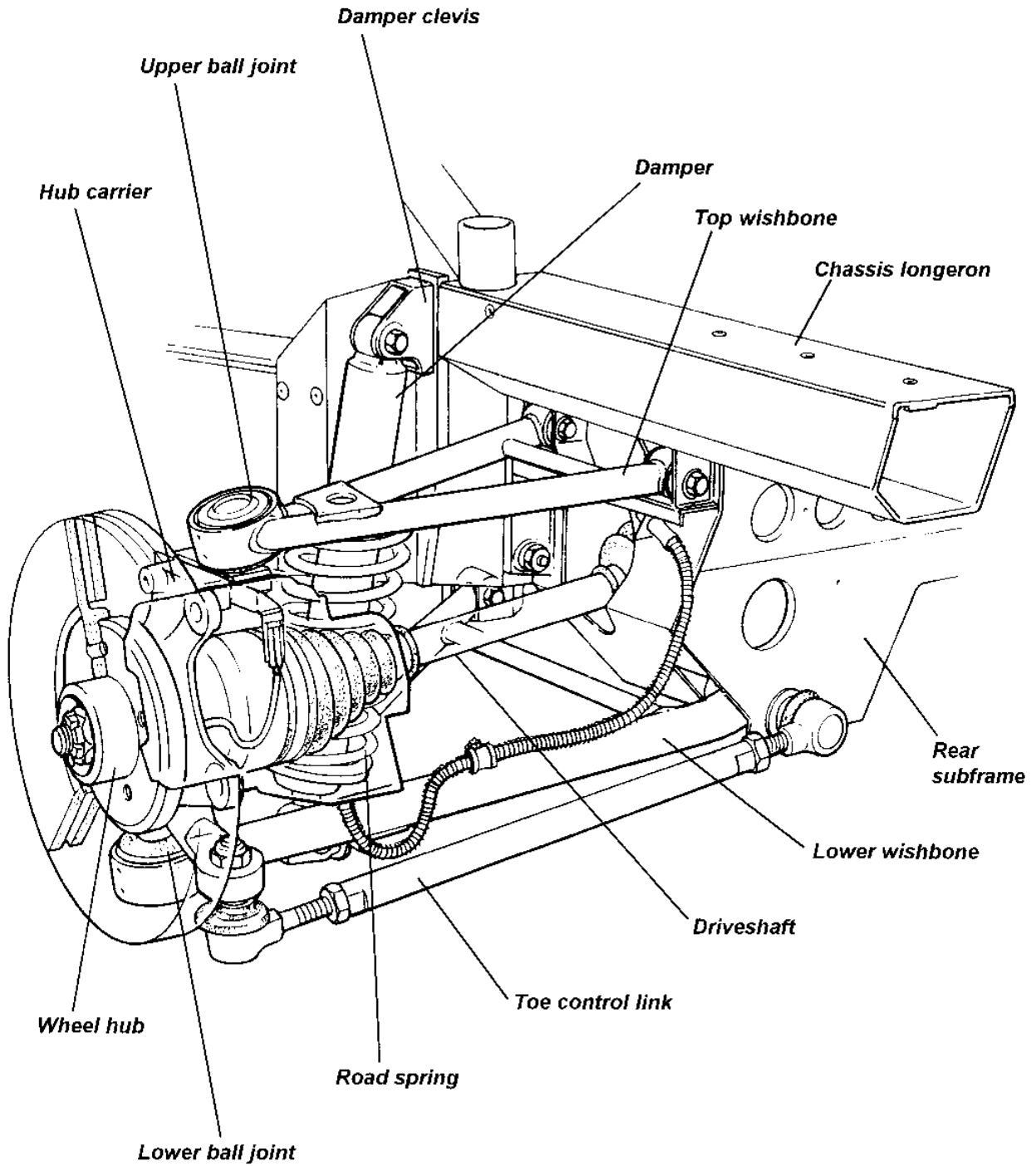
c41



REAR SUSPENSION

SECTION DG - ELISE 2001 M.Y. Onwards

	<u>Sub-Section</u>	<u>Page</u>
General Description	DG.1	3
Geometry & Adjustments	DG.2	3
Suspension Disassembly/Assembly	DG.3	5
Rear Bump Steer Adjustment	DG.4	8
Rear Wheel Bearings	DG.5	10





DG.1 - GENERAL DESCRIPTION

The fully independent rear suspension comprises, on each side of the car, upper and lower tubular steel wishbones, a toe control link, and a concentric coil spring/telescopic damper unit linked between the outboard end of the lower wishbone and the chassis. A forged steel hub carrier, provides a mounting for a the hub bearing unit to which the road wheel is attached via four spline socket bolts.

The upper and lower 'A' frame wishbones are fabricated from steel tube, with the inboard ends of both wishbones using replaceable bonded rubber pivot bushes to provide maintenance free articulation, with a specification providing accurate and responsive dynamic characteristics, with some suppression of noise and vibration. The two legs of the rearward biased top wishbone, pick up on the chassis rear subframe, and converge outboard to a ball joint housing into which is pressed a ball swivel joint. The ball pin of this joint locates in a forged steel plinth which is itself secured to the hub carrier using two horizontally disposed M10 bolts. The braced, wide based, forward biased lower wishbone, is anchored at its front inboard end to the chassis rear crossmember via a steel bracket, and at its rear inboard end to the chassis rear subframe. The outboard end of the wishbone houses another swivel ball joint, the ball pin of which is secured directly into a tapered hole in the forged steel hub carrier. The Bilstein telescopic damper with concentric coil spring, is fitted with the damper rod lowermost to minimise unsprung weight, and acts between the outer end of the lower wishbone and a steel clevis bracket bolted to the rear end of the chassis main side rail.

The adjustable length, double ball jointed, toe control link, shares a chassis anchorage with the rear pivot of the lower wishbone, and is secured directly into a rearward extension of the hub carrier.

The forged steel hub carrier, provides a mounting for a hub bearing unit which is secured by three 'Torx' head bolts, and incorporates a wheel speed sensor on the left hand side to supply engine management and speedometer data.

DG.2 - GEOMETRY & ADJUSTMENTS

Provision is made for the adjustment of wheel alignment and camber. Under normal service conditions, no periodic scheduled check of the geometry is necessary, with a full geometry check required only after suspension repair, or if excessive tyre wear is evident, or handling deficiencies encountered. Before any measurements or adjustments are made, it is essential first to set the vehicle to its 'mid-laden' ride height, approximating to driver and passenger and a half tank of fuel. The following data refers to standard cars with non-adjustable spring/damper units. For cars fitted with Sport suspension, a lower ride height and revised geometry is used - refer to Section XA:

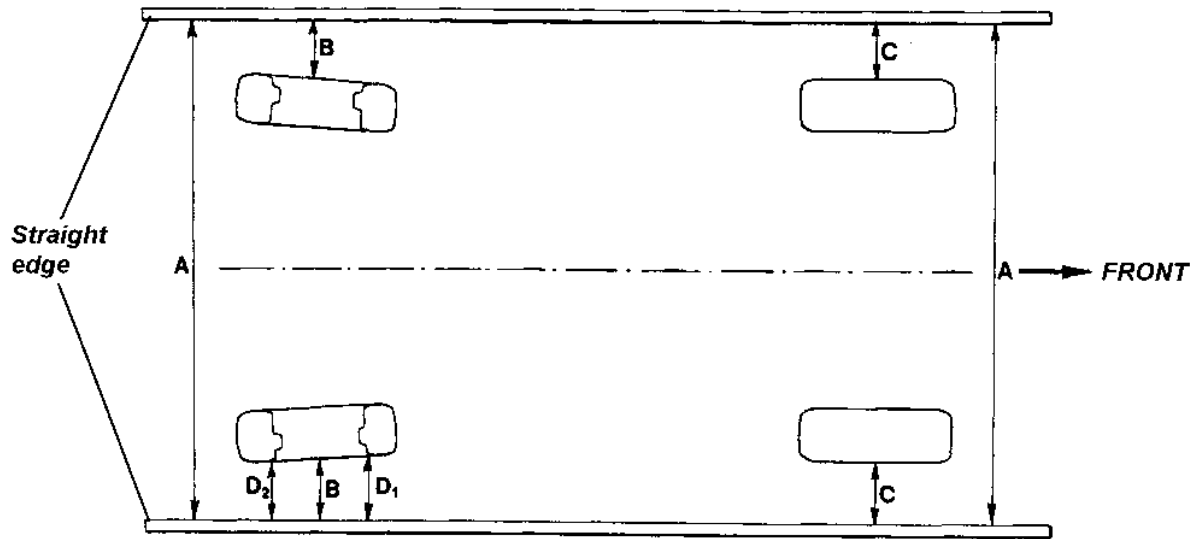
Ride height (for geometry check); - front	130 mm below front end of chassis siderail
- rear	130 mm below rear end of chassis siderail
Alignment;	1.2 mm toe-in each side; + 0.2 mm, - 0. (0.18° toe-in each side; + 0.03°, - 0) Max. difference side/side; 0.2 mm (0.03°)
Camber;	- 1.8°; ± 0.2°. Max. difference side/side; 0.2°

Alignment

Wheel alignment refers to the parallelism of the wheels when viewed from above and is crucial to vehicle stability, handling and tyre wear. It is measured either by the angle a wheel makes with the vehicle centre line, or the difference in dimension between the wheel rim to wheel rim measurement at the front and rear of the wheel at hub centre height. The wheels are said to 'toe-in' when the wheel paths converge ahead of the vehicle, and 'toe-out' when they diverge. Rear wheel alignment should be measured only using equipment which measures **individual** rear wheel alignment relative to the car centreline. Wheel alignment is designed to vary with suspension travel ('bump steer') and the base setting should be measured only at the specified mid laden ride height.

It is possible to accurately measure individual wheel alignment using a pair of long straight bars or round section elastic in conjunction with 4 axle stands or similar. Any bars used must be longer than the length of the car, and be suitably stiff and straight.

Set up the bars or elastic on each side of the car at wheel centre height as shown on the diagram, so that A = A, B = B and C = C.



d21

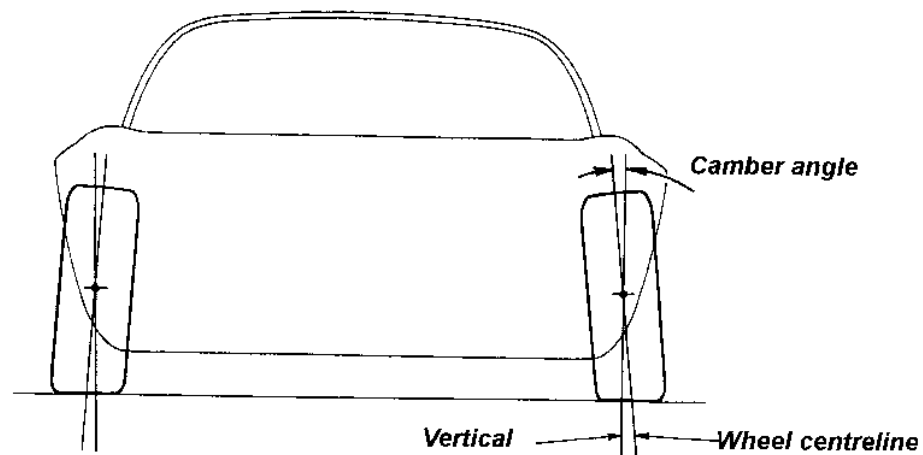
Measure the distance from the bar to the rim of the wheel concerned at the front and rear of the centre line of the wheel ( $D_1$ ,  $D_2$ ). If the front dimension,  $D_1$ , is greater than the rear dimension,  $D_2$ , the wheel has TOE-IN. If the rear dimension is greater than the front dimension, the wheel has TOE-OUT. The difference between the two measurements is the amount the wheel has toe-in or toe-out.

Wheel alignment is adjusted via the toe control link which is equipped with a left hand threaded ball joint at the inboard end, and a right hand threaded ball joint at the outboard end. Slacken both ball joint locknuts, and turn the link rod as necessary to increase or decrease the effective length of the link. As a guide, lengthening the link rod by a turn of one 'flat' ( $60^\circ$ ) will increase toe-in by just less than 1mm.

After adjustment, tighten the two locknuts to 55 Nm taking care to ensure that the ball joint sockets are aligned at  $90^\circ$  to each other.

### Camber Adjustment

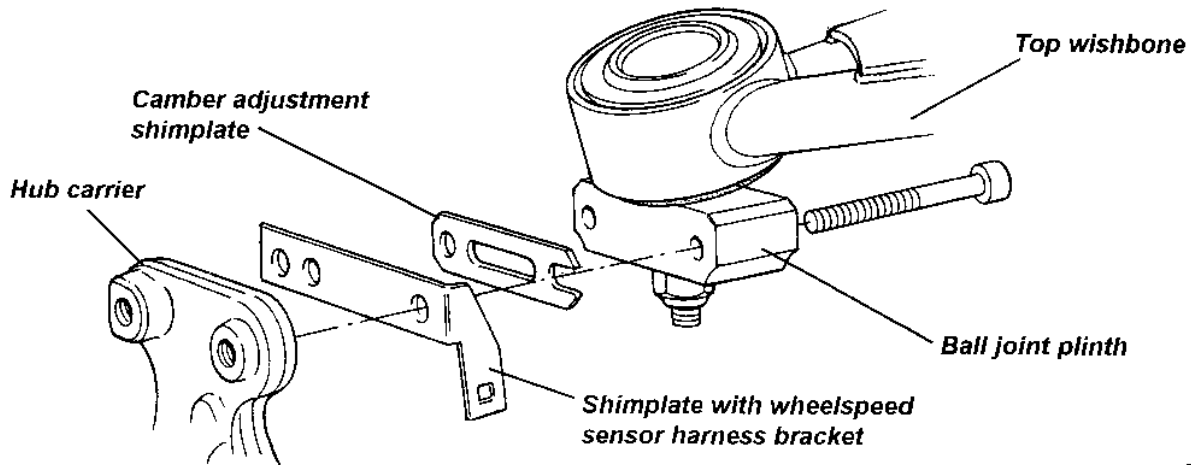
Camber is the angle from vertical of the wheel when viewed from the rear, and is said to be negative when the wheel leans inwards at the top (positive when leaning outwards).



c29



The primary purpose of camber is to achieve the maximum efficiency of the tyre under cornering loads and body roll, with the specification closely allied to a particular wheel/tyre combination. The camber angle changes with suspension travel, becoming more negative on bump, and should be measured only at the specified ride height. Incorrect camber can result in handling deficiencies and excessive tyre wear.



624a

- Camber adjustment shim plates are fitted between the top wishbone ball joint plinth and the hub carrier.
- Shims are available in 1 mm thickness. Note that on the left hand side, the shimplate fitted against the hub carrier must always incorporate the mounting bracket for the wheel speed sensor harness connector.
- Reducing the shim pack thickness will increase negative camber. Adding shims will reduce negative camber.
- A 1mm shim plate will alter camber by approximately 0.3°.
- Apply PermaBond A130 (A912E7033) to the threads of the two ball joint plinth fixing bolts, and torque tighten to 45 Nm.

### DG.3 - SUSPENSION DISASSEMBLY/ASSEMBLY

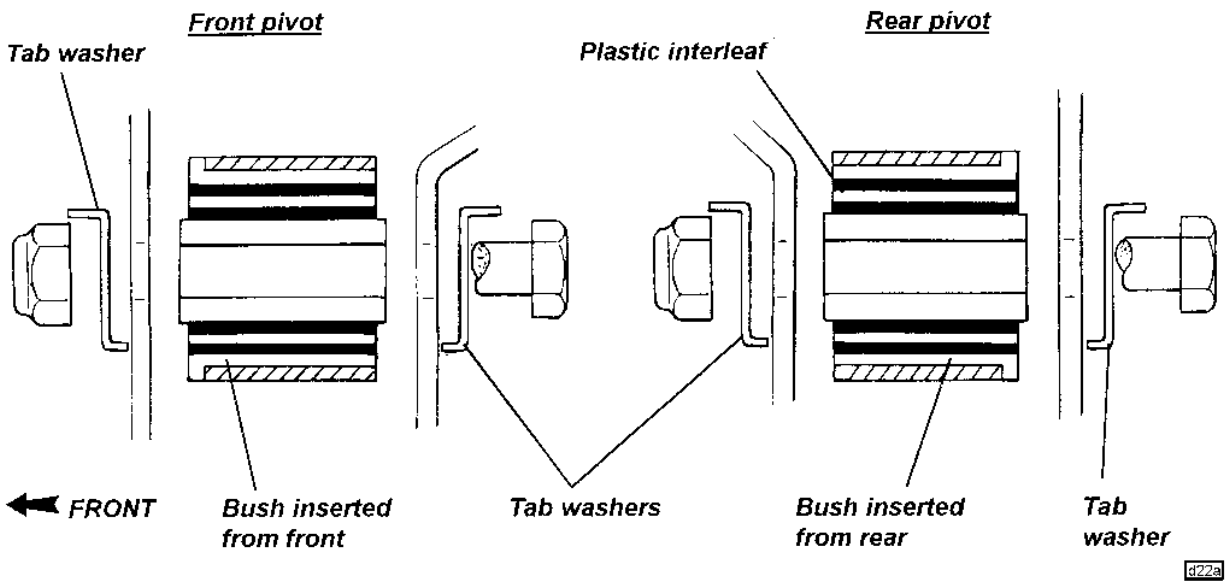
The suspension may be disassembled without the use of any special tools other than a 'Torx' socket for the hub bearing carrier bolts, and a spring compressor, required only if the spring is to be removed from the damper unit. If the hub carrier is to be removed, necessitating withdrawal of the driveshaft, it is recommended first to release the driveshaft nut before dismantling the brakes.

With the car on a wheel free lift and with the rear wheels removed:

1. Remove the engine bay undertray to provide access to the lower wishbone front pivot.
2. Disconnect the parking brake cable from the caliper. Release the 'P' clip securing the brake hose to the top wishbone and remove the two bolts securing the brake caliper to the hub carrier. Support the caliper aside without straining the brake hose. Release the single retaining screw, and remove the brake disc from the hub.
3. On the left hand suspension, disconnect the wheel speed sensor cable, and release from routing clips.
4. Release the bolt securing the outer end of the toe link to the hub carrier, noting the identification of the spacers fitted above and below the hub carrier leg.
5. Remove the nut securing the ball pin of the lower ball joint to the hub carrier, and use a suitable splitter tool to separate the joint.
6. Remove the split pin and driveshaft nut, and use a suitable puller tool to extract the driveshaft from the hub.



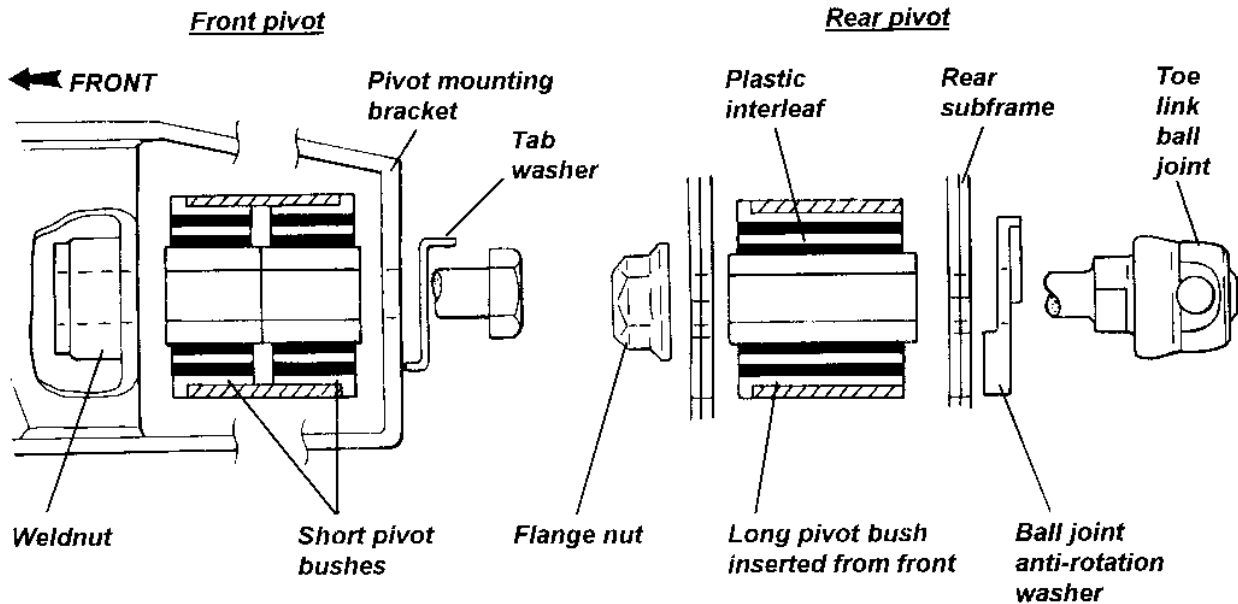
7. Remove the two bolts securing the top swivel joint plinth to the hub carrier, noting and retaining the camber adjustment shim pack.
8. Remove the top wishbone pivot bolts, and withdraw the wishbone from the rear subframe.
9. Remove the top and bottom mounting bolts for the spring/damper unit, and withdraw.
10. Remove the heatshield over the toe-link ball joint, release the toe-link stud, remove the lower wishbone front pivot bolt and withdraw the lower wishbone and toe link.
11. If necessary, remove the top swivel joint ball pin nut, and use a ball joint splitter tool to separate the joint from its plinth. Either swivel joint may be replaced using suitable press tool dollies.
12. The wishbone pivot bushes are bonded rubber type with a plastic flanged outer sleeve, a plain steel inner sleeve, and a plastic interleaf sleeve within the rubber bush to control the flexing characteristic. The bushes may be pressed out of the wishbone eyes, and new bushes fitted using suitable press tool dollies. Smear the outer surface of the new bush with IPC 'P-80' rubber lubricant emulsion (A082C6042V) to ease fitment, and assemble as follows:  
Top wishbone - insert a single 30mm long bush into each pivot eye from the outside end (front of front eye, and rear of rear eye).



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Lower wishbone rear pivot - insert a single 30mm long bush from the front end of the eye.  
Lower wishbone front pivot - insert a 16mm long bush into each end of the front eye.



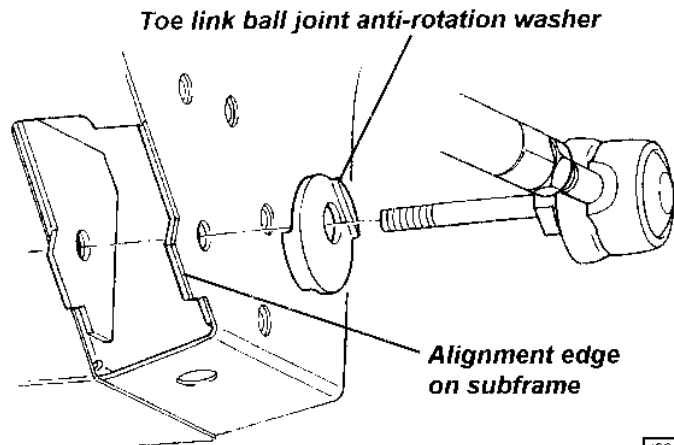
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13. The road spring may be removed from the damper using a suitable spring compressor to allow the spring lower slotted seat to be withdrawn. Note that the spring upper seat is retained by a circlip located in the lowermost of three available damper body grooves.
14. To remove the hub bearing unit from the hub carrier, release the three Torx head bolts and withdraw the complete unit. The hub unit is not serviceable, and is replaced complete if faulty.

**Reassembly**

Re-assemble the suspension in reverse order to disassembly with the following notes:

- Take care to assemble each pivot bolt with the correct washers/snubbers/spacers as shown in the diagrams.
- Smear the shank of each pivot bolt with PBC grease, but do not allow contamination of the threads.
- Take care to refit the original camber adjustment shimpack.
- Apply PermaBond 130 (A912E7033V) to the threads of the top ball joint plinth fixing bolts.
- Lubricate the ends of the damper top eye bush with rubber grease.
- Tab washers are used on the top wishbone pivots, and for the bolt head of the lower wishbone forward pivot. In each case, ensure that one end of the tab washer is folded around the chassis edge, and after torque tightening the nut, form the other end of the washer against the flats of the nut.
- The inboard toe-link fixing incorporates a special ball pin anti-rotation washer, machined with two flats, one of which locates against a flat on the ball pin, and the other against the edge of the subframe. Check that the inboard joint has a LH toe-link thread, and that the batch code stamped on the joint is 43275 or later.



d33





- Ensure that the heatshield is refitted over the toe-link inboard ball joint.
- Take care correctly to assemble the toe-link outboard ball joint (RH toe-link thread) to the hub carrier. The 8mm spacer should be fitted onto the ball joint stud noting that an internal chamfer is provided at both ends to accommodate the root radius of the stud. On top of the hub carrier lug should be fitted the 10mm spacer and Nyloc nut. Check that the batch number stamped on the joint is 43273 or later. For competition optimisation of the bump steer characteristic, refer to DG.4.
- Press the brake pedal to reposition the pads before driving the car.

The Service Schedule specifies that the security of the front and rear suspension is checked at each service. This operation requires that all the principal suspension pivot bolts are torque checked, noting the following points:

Where a bolt is tapped into a housing or weldnut, and relies on a thread locking compound for security, it is important to appreciate that if the bolt is disturbed, the locking compound must be re-applied. The following procedure should be adopted for all such fixings:

- Check the torque of the fixing.
- If the specified torque is attained without the fixing being disturbed (moving), take no further action.
- If the bolt moves, the locking action of the thread adhesive will have been compromised. Remove the bolt completely, clean off all old adhesive using a wire brush and acetone, and apply new adhesive as specified.
- Refit the bolt and tighten to the specified torque.
- If for any reason a bolt is found to have become loose, and the car has been operated for any period in this condition, the bolt should be renewed as a standard precaution and related components carefully inspected for hole ovality or wear.
- At every service interval, the toe-link should be checked for free articulation by using a spanner on the flats of the link and twisting in both directions. The torque required to articulate the joints should be little more than may be applied by hand. If any joint is found to be seized or tight (or if any free play is evident), the joint should be renewed.

**Torque Settings:**

	<b>Nm</b>
- Upper and lower wishbone pivot bolts	45
- Upper and lower swivel joint ball pins	55
- Upper swivel joint plinth to hub carrier	45
- Toe-link outer ball joint to hub carrier*	74
- Toe-link inner ball joint/wishbone to subframe**	74***
- Toe-link ball joint lock nuts	55
- Damper to lower wishbone	45
- Damper to chassis	45
- Brake caliper to hub carrier	45 - 50
	- upper M10
	- lower M8
- Hub bearing unit to hub carrier	26 - 30
- Rear hub nut	90
	220

\* Check batch number of ball joint is 43273 or later

\*\* Check batch number of ball joint is 43275 or later

\*\*\* On 2001 M.Y. cars with VIN serial nos. 0001 to 0041, plus 0056 & 0057, use 45Nm

**DG.4 - REAR BUMP STEER ADJUSTMENT**

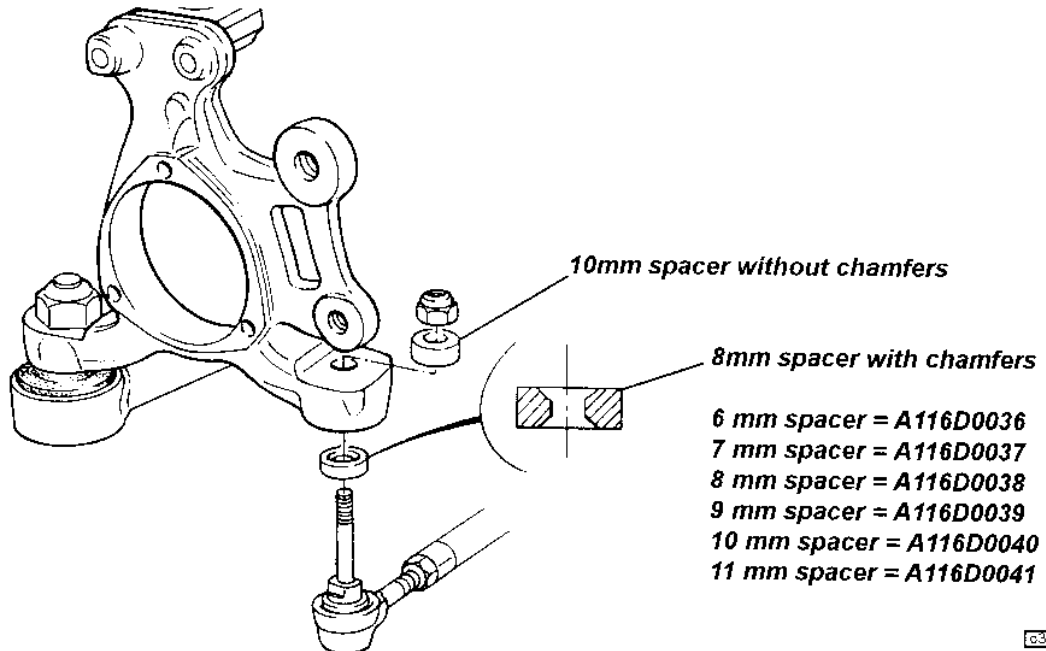
The rear suspension toe-link geometry is designed to apply a small amount of toe variation with suspension travel (roll resultant from cornering forces) in order to produce the desired handling characteristics. The general requirement is for the outside wheel to adopt a small increase in toe-in as the suspension is compressed.

A spacer is fitted between the outboard toe-link and the hub carrier in order to set the joint height in relation to the wishbone outboard pivot. The standard spacer length of 8mm will provide a basically correct geometry, but in order to optimise the characteristic, a dedicated bump steer gauge must be used to measure the toe change for each rear wheel.

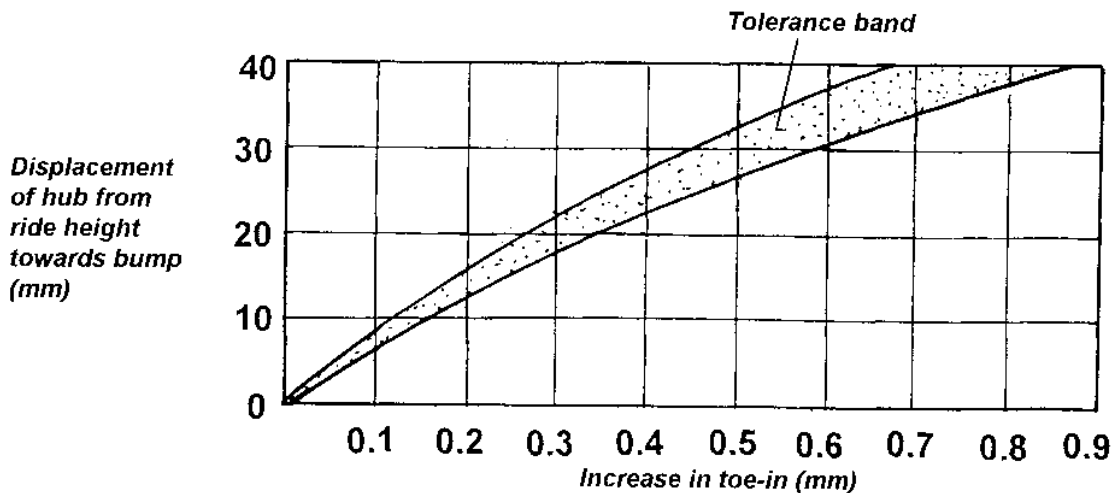


Bump Steer Measurement Procedure

- i) Remove the spring and damper assembly.
- ii) Remove the brake caliper.
- iii) Fit the flat datum plate of the bump steer gauge against the roadwheel mounting face of the brake disc, and retain with two wheel bolts.
- iv) Lock the brake disc to prevent the plate from turning.
- v) Use a jack to set the suspension height to 323mm between damper mounting holes (mid-laden ride height).
- vi) Set the two dial gauges against the plate on a horizontal axis, 16 inches apart. Zero both gauges.
- vii) Jack the the suspension towards bump by 10mm as measured on the datum plate, and record the difference between dial gauge readings - representing the change in toe-in.
- viii) Raise the suspension to 20, 30 and 40mm from the baseline, recording in each case the dial gauge differential.
- iv) Compare readings with the graph below. If readings fall outside of the tolerance band, the 8mm spacer fitted between the toe-link outboard ball joint and the underside of the hub carrier leg must be replaced by one of a different length. Lowering the joint height by 1mm will increase the toe-in at 40mm bump travel by approx. 0.2mm. **Ensure that the spacer fitted first onto the ball joint stud has an internal chamfer to provide clearance for the toe-link stud root radius.**



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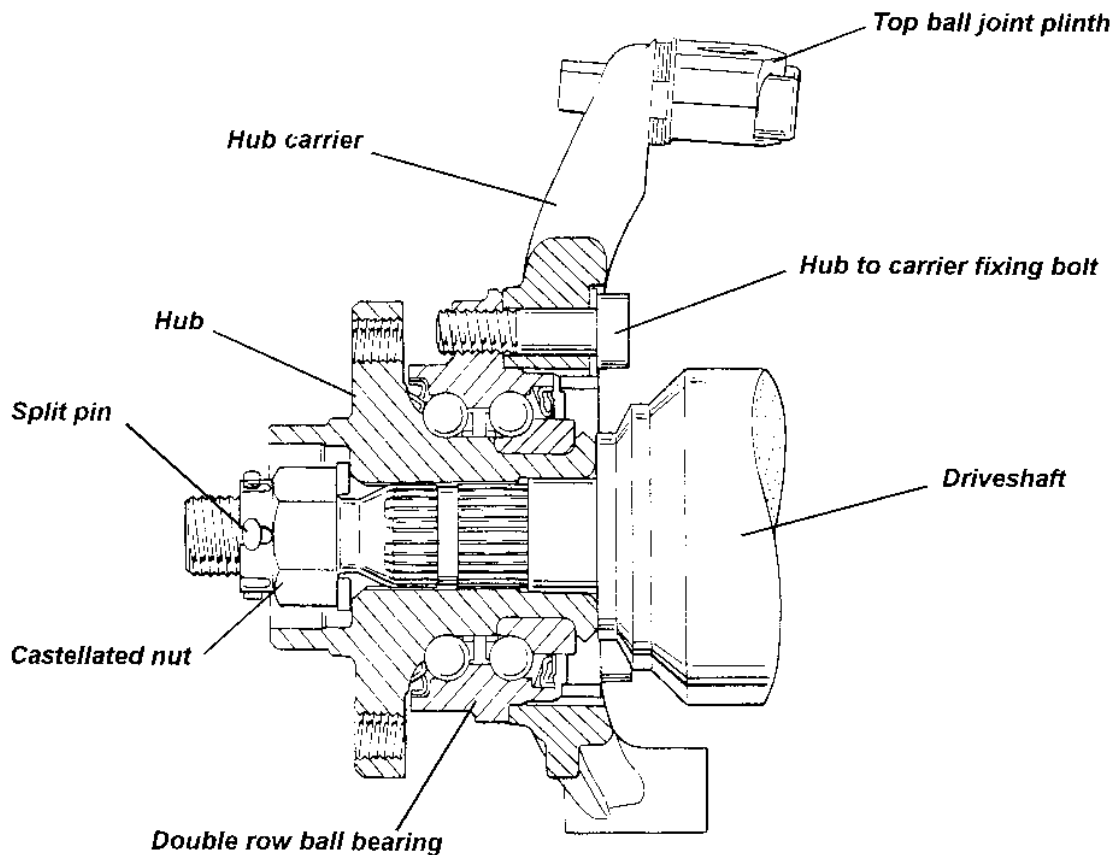
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**DG.5 - REAR WHEEL BEARINGS**

The sealed rear wheel bearings are contained in a steel housing secured to the hub carrier with three 'Torx' bolts. The double row, angular contact, ball bearing is retained in the outer housing and also onto the hub spigot by a shoulder and a peening operation, and is inseparable for service. If there is found to be any discernible free play in the hub bearing, or any roughness or tight spots can be felt, or any signs of lubricant expulsion are evident, the hub assembly should be replaced - there is no provision for adjustment. The left hand hub unit incorporates a wheel speed sensor used to supply the engine management ECM and speedometer.

**To Replace Hub Bearing Assembly**

1. With the wheel removed, apply the parking brake, remove the split pin from the nut retaining the driveshaft in the hub, and release the nut.
2. Release the two fixing bolts, and remove the brake caliper from the hub carrier. Support clear of the brake disc without straining the flexible hose. Release the single countersunk screw and withdraw the brake disc from the hub.
3. Disconnect the wheel speed sensor harness from the LH hub unit.
4. Using a Torx socket, release the three bolts securing the hub bearing unit to the hub carrier, and withdraw the unit from the hub carrier and driveshaft.
5. Fit the new hub bearing unit in reverse order to disassembly, with the following notes:
  - Torque tighten the three Torx bolts securing the hub bearing assembly to the hub carrier to 90 Nm.
  - Torque tighten the driveshaft nut to 220 Nm and retain using a new split pin.
  - Pump the brake pedal to reposition the pads before driving the car.



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ENGINE

SECTION EG - ELISE 2001 M.Y. Onwards

	<u>Sub-Section</u>	<u>Page</u>
General Description	EG.1	2
Maintenance Operations	EG.2	2
Engine Removal/Replacement	EG.3	6
Special Tools	EG.4	7



## EG.1 - GENERAL DESCRIPTION

The 1.8 litre, 16 valve four cylinder engine used in the Lotus Elise is supplied by Rover Group, and is designated 'K16', with an engine number prefix of 18K4F. A full description and overhaul procedure for this unit is contained in the Rover Overhaul Manual RCL 0057, a copy of which follows this section - where variations are listed, refer to 'MPi MEMS3 (2000MY ON)'.

For the Elise 2001 M.Y., the engine is equipped with the Lotus K4 engine management system, utilising a single Engine Control Unit (ECU) to control both the fuel injection and ignition systems. The engine is fully compliant with European Community Directive 3 (ECD3), including full European On Board Diagnostics (EOBD), in order closely to control and monitor exhaust emission levels and illuminate a Malfunction Indicator Lamp (MIL) in the event of a system fault. For engine management details refer to Section EMO.

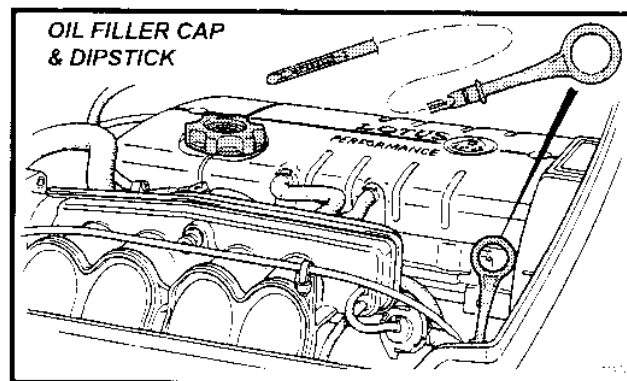
## EG.2 - MAINTENANCE OPERATIONS

### Engine Oil Level Check

The engine oil level should be checked regularly, such as every two or three fuel stops, and the oil level maintained near the top mark on the dipstick. It is especially important to keep a check on the oil level during the vehicle's first 1,000 miles (1,600 km), as both the fuel and oil consumption will be prone to some variance until the engine components have bedded in.

The best time to check the level is when the oil is warm, such as during a fuel stop. Ensure that the car is parked on a level surface and that a few minutes have elapsed since stopping the engine to allow oil to drain back into the sump. If the engine is stopped before reaching normal running temperature, the oil will not drain back to the sump so readily, and the dipstick will display an artificially low reading.

*Dipstick:* The dipstick is identifiable by its yellow loop handle, and is located at the right hand rear of the engine. Withdraw the dipstick, and wipe with a paper towel. Replace the dipstick, pressing firmly to make sure it is fully seated, and withdraw again to inspect the oil level. The correct level is to the upper mark on the dipstick.



*Topping Up:* If topping up is necessary, remove the oil filler cap from the cam cover, and in order to allow the crankcase to ventilate, remove the dipstick. Add a suitable quantity of a recommended engine oil (see 'Recommended Lubricants') taking care not to spill any oil onto engine or electrical components; use a funnel if necessary.

The difference between high and low dipstick marks is equivalent to 1.0 litre (1.8 imp.pt). Allow several minutes for the oil to drain through to the sump before re-checking the oil level. Do NOT overfill, or the oil will become aerated and its lubricating properties degraded. Refit the filler cap and turn clockwise until secure.

### Engine Oil Change

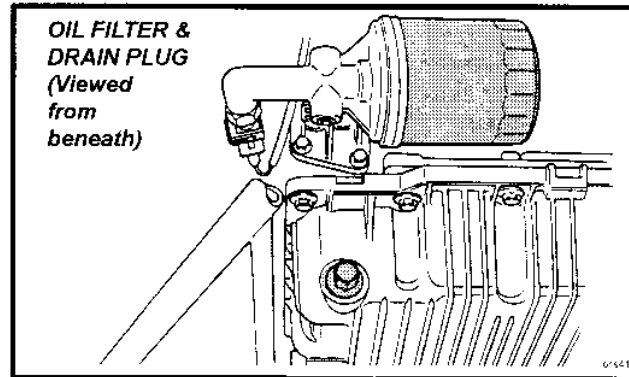
The use of high quality oil, renewed at the specified intervals, is the key to engine longevity and sustained performance. Adhere strictly to the engine oil and filter change intervals specified in the Maintenance Schedule.

For access to the engine sump and filter, the engine bay undertray must first be removed. This is most easily achieved with the vehicle raised on a ramp.



The drain plug is located at the right hand front of the sump, and should be removed to drain the sump immediately after a run when the oil is warm and the impurities are still held in suspension. Take suitable precautions to guard against scalding. Allow to drain thoroughly before cleaning the drain plug, fitting a new sealing washer, and tightening to 25 Nm.

Refill with a recommended lubricant via the oil filler on the camshaft cover, to the top mark on the dipstick. Remove the dipstick to allow crankcase venting, and allow sufficient time for the oil to drain through to the sump before checking the oil level on the dipstick. Take care not to overfill. Refit the oil filler cap securely, and check the oil level again when the engine is fully warm (see above).



#### **Oil Filter**

The oil filter is horizontally mounted at the front of the engine, and is accessible from beneath after removal of the engine bay undershield. The filter should be renewed, at intervals specified in the Maintenance Schedule. Remove the filter by turning in a counterclockwise direction, if necessary using an oil filter wrench, and discard of safely (see 'Used Engine Oil').

Ensure that only a Lotus specified filter is fitted, as parts with identical outward appearance can contain different internal features. Before fitting a new filter, clean the mating face on the engine, and smear the new seal on the filter with clean oil. Add a small amount of clean engine oil into the filter, screw onto its spigot and tighten **BY HAND** sufficiently to make a secure seal, typically 2/3 to 3/4 of a turn after the sealing faces have made contact. Overtightening using a filter wrench may damage the canister and/or complicate subsequent removal.

Start the engine and check for oil leaks. Re-check the security of the filter, further tightening by hand if necessary. Check the oil level (see above) when the engine is fully warm.

#### **Used Engine Oil**

**WARNING:** - Prolonged and repeated contact with used engine oil may cause serious skin disorders, including dermatitis and cancer.

- Avoid contact with skin as far as possible and wash thoroughly after any contact.

- Keep out of reach of children.

**PROTECT THE ENVIRONMENT:** It is illegal to pollute drains, water courses and soil. Use authorised waste collection facilities, including civic amenity sites and garages providing facilities for disposal of used oil and used oil filters. If in doubt, contact your local authority for advice on disposal.

#### *'Severe Service' Conditions*

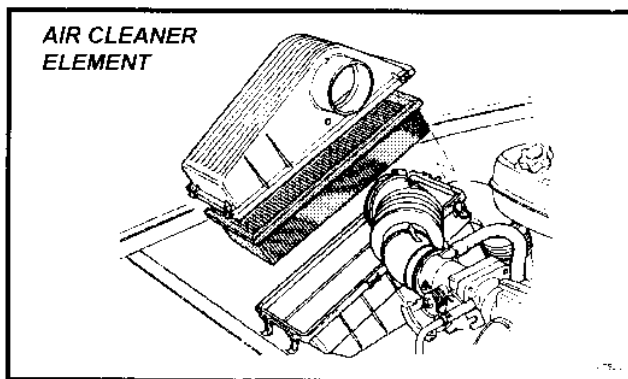
Certain operating conditions can cause rapid degradation of the oil quality, either by the accumulation of dirt particles, or by the absorption of water from condensation. If either of the 'severe service' conditions described below apply, it is recommended that the oil and filter be changed twice as frequently as is listed in the Maintenance Schedule.

- # Driving in dusty areas (e.g. on unmetalled roads); Change the oil and filter as soon as possible after driving in a dust storm.
- # Stop/start city driving with frequent short trips where the engine rarely warms up thoroughly (especially in cold weather); and/or frequent or prolonged idling.



### Air Cleaner Element

The air filter should be inspected at intervals dependent on the operating conditions. When the vehicle is operated in a relatively clean environment, the element should be renewed at intervals specified in the Maintenance Schedule, but where a dusty or smog laden atmosphere prevails, more frequent replacement will be required dependent on the level of pollution.



A disposable folded paper type air cleaner element is fitted in a housing at the left hand side of the engine bay. To replace the filter element, leave the hose attached, and release the four over-centre clips securing the top cover of the air filter housing. Raise the cover and ensure that the filter element remains in the lower housing before swinging the cover aside. Lift out the element and clean the inside of the filter housing and cover, including the joint line recess.

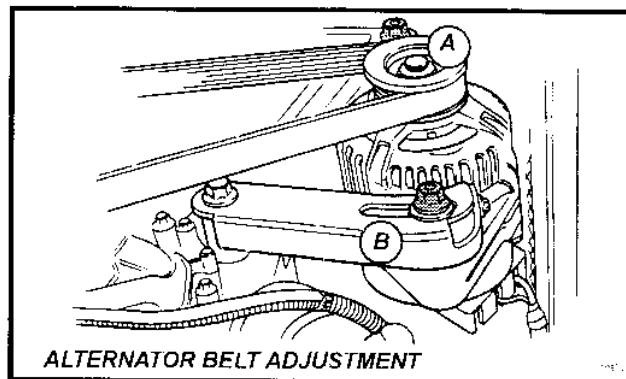
Fit the new element into position in the lower housing, and refit the top cover, ensuring that the filter seal is correctly located in the cover recess. Engage each of the four over-centre fasteners, and snap each clip closed.

### Alternator Belt

A single multi-rib type belt is used to transmit drive from the crankshaft to the alternator. The belt requires no periodic maintenance other than a visual check of its condition. If the belt exhibits any evidence of physical damage, cracking, fraying, perishing, abrasion or contamination, it should be replaced. In the case of oil contamination, the cause must be identified and rectified, and each of the pulleys must be thoroughly degreased before the new belt is fitted.

To replace the belt:

- Remove the engine bay undertray.
- Slacken the alternator pivot bolt (A).
- Slacken the clamping bolt (B) securing the alternator to the slotted strap.
- Turn the adjuster bolt in the end of the slotted strap to allow the alternator to be swung towards the engine, and unhook the belt from the pulleys.
- Fit the new belt over the two pulleys, ensuring it is correctly seated in the grooves, and tension the belt such that moderate finger pressure (10kg) at the centre of a belt run produces a one way deflection of 6 - 8mm on heater cars, or 9 - 10mm on a.c. cars.
- Tighten the clamping and pivot bolts.
- Refit undertray.





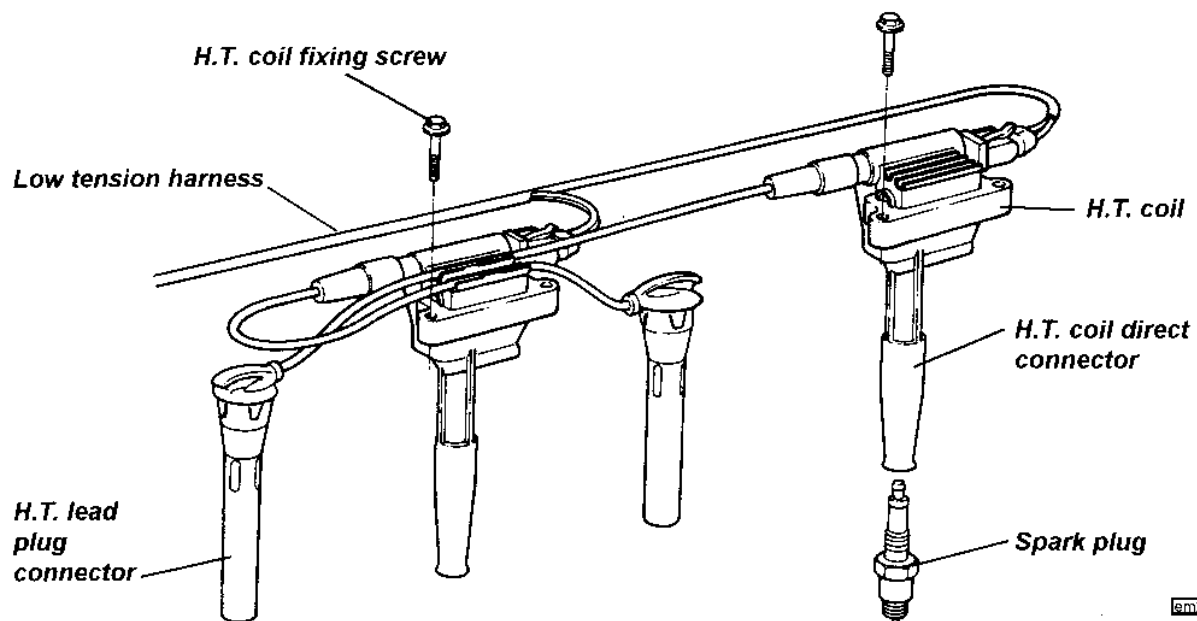
### Spark Plugs

The ignition system uses a distributorless ignition system (DIS) which employs a pair of double ended ignition coils and a 'waste spark' system whereby each coil fires two spark plugs simultaneously (1 paired with 4, and 2 with 3), the spark in the cylinder on the exhaust stroke being 'wasted'. The two H.T. coils are mounted on the cam cover, each connecting directly with one spark plug, and via a short H.T. lead with a second plug.

**WARNING: The H.T. voltage of the ignition system is in excess of 50 kV and the low tension voltage is in excess of 400 volts. Voltages this high can cause serious injury and may even be fatal. Never touch any ignition components while the engine is running or being cranked.**

For access to the spark plugs:

1. Release the three fixings securing the spark plug cover, unscrew the oil filler cap and remove the cover.
2. Pull off the H.T. lead from two of the spark plugs, and release each lead from its routing clips.
3. Release the two screws securing each of the two H.T. coils, pull each coil off its spark plug, and disconnect the low tension connector plug.
4. Remove the spark plugs, taking precautions as necessary to prevent debris from entering the cylinders.
5. Fit the new spark plugs, tightening to 27Nm.
6. Refit the coils, plugging in the low tension harnesses, and tightening the coil fixings to 8 Nm. Fit the H.T. leads and locate in their routing clips.
7. Ensure the 'O' ring is fitted around the oil filler neck before refitting the spark plug cover and tightening to 8 Nm.







## EG.3 - ENGINE REMOVAL/REPLACEMENT

It is recommended to remove the rear clamshell prior to powertrain removal in order to improve access, and to reduce the possibility of paint damage. The engine is removed complete with transmission assembly, and is best performed on a wheel free lift, as the top wishbones need to be released in order for the driveshafts to be withdrawn from the transmission.

### 1. Fuel Pressure Relief Procedure

The fuel line between pump and injector rail, and the injector rail itself, contain pressurised fuel both when the engine is running, and after switching off. The following procedure should be used prior to disconnecting the fuel line:

- Pull out the fuel pump fuse (rearmost of fuse row at LH side of ECU), start the engine, and run until it stops from starvation. Crank the engine for a further few seconds.
- If the engine is a non-runner, pull out the fuel pump fuse, and crank the engine for 20 seconds to minimise residual fuel pressure.
- Disconnect the battery.
- Surround the pipe joint with a shop towel to absorb fuel contained in the pipework before releasing the joint.

**WARNING: Be aware of the possibility of full pressure retention in the fuel line caused by an injector circuit fault.**

2. Remove rear clamshell (see sub-section BP.6).

3. On a.c. cars, recover refrigerant and disconnect both a.c. hoses from the pipes at the rear of the RH sill.

From beneath the car:

4. Drain coolant and, if necessary, engine oil.

5. Disconnect the exhaust manifold from the flexible connector.

6. Remove the gear cables from the transmission lever spigots (prise off), and pull off the spring clips retaining the outer cables to the abutment bracket.

7. Release the earth braid from the transmission end case, and the throttle cable from the sump 'P' clip.

8. Release the engine steady arm from its anchor bracket on the rear of the sump.

9. At each side of the car;

- Release the two pivot bolts securing inboard end of the top wishbone to the subframe.
- The inboard C.V. joint is retained in the transmission by a rounded section circlip, and may be removed using a special wedge tool T000T1276 (RH side only), or by applying a shock pull to the C.V. joint body using a slide hammer with a forked end.

**CAUTION:** Do NOT attempt to remove the inboard C.V. joint from the transmission by pulling on the driveshaft. This action will cause the joint to become disassembled and may entail replacement of the joint. The components of the inboard plunging joint are held in position, for transit purposes only, by a collar within the boot which will be overridden if excessive axial force is used. Apply pressure only to the 'tulip' or outer body of the joint.

- Withdraw the inboard C.V. joint from the transmission, and fit blanking plug T000T1385 into the transmission to limit the amount of oil loss.

From above;

10. Disconnect the air intake hose from the air cleaner housing and remove the air cleaner complete with mounting bracket.

11. Disconnect the hoses from the coolant header tank, and remove the tank from the mounting bracket.



12. Release the coolant outlet hose from the pipe at the front of the engine bay, and the coolant return and heater return hoses from the water rails at the left hand end of the engine.
13. Release the clutch slave cylinder from the mounting bracket, and support aside.
14. Cut the tie wraps, and release the fuel feed and return hoses from their push fit connectors at the LH rear of the engine bay. Release the purge pipe from the throttle body, and the tank breather pipe from the filler neck roll over valve, and secure all pipes clear.
15. Disconnect the throttle cable from the throttle body and its routing clips.
16. Fit engine lifting brackets T000T1283. Support the power unit before removing the LH engine mounting brackets from the transmission housing. Release the RH engine steady arm, and release the mounting bracket from the RH end of the engine.
17. Carefully hoist the power unit from the car, whilst monitoring for any remaining connections.

Refit the unit in reverse order to removal with the following notes:

- Before re-fitting a driveshaft, first renew the round section circlip (A100R6001F) on the end of the inboard joint spigot shaft. Also, check the condition of the transmission output seal, and renew if necessary. Lubricate the lip of the seal with transmission oil, and grease the corresponding shoulder on the driveshaft (C.V. joint) spigot, to reduce the danger of damaging the seal on assembly. Carefully insert the shaft assembly into the differential gear splines until a 'click' indicates that the circlip has engaged in its location. Pull on the body of the joint to check security.
- Refer to section DG for rear suspension assembly details.
- For coolant refilling procedure, refer to section KG.
- For transmission details and gear cable adjustment, refer to section FI.

#### Torque Figures

	<u>Nm</u>
RH engine mounting bracket to engine	145
RH engine mounting bracket to rubber mounting	85
RH engine rubber mounting to chassis	45
RH engine steady arm bolts	85
LH engine mounting bracket to rubber mounting	85
LH engine mounting bracket to engine	45
Lower steady arm bracket to sump	85
Lower steady arm bolts	85 (use PermaBond A130 {A912E7033V} at sump end of arm)

#### EG.4 - SPECIAL TOOLS

The following engine special tools are available under Lotus part number:

Flywheel locking tool (transmission fitted)	T000T1289
Flywheel locking tool (transmission removed)	T000T1367
Camshaft locking tool	T000T1282
Crankshaft rear oil seal replacer	T000T1284
Valve stem oil seal remover/replacer	T000T1285
Cylinder liner clamps	T000T1288
Sump alignment pins (2 off)	T000T1290
Torx E12 cylinder head bolt socket	T000T1366
Crankshaft/camshaft front oil seal replacer	T000T1286
Camshaft holding/turning tool	T000T1280
Engine lifting brackets	T000T1283
Liner sealant	A918E6069V



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# 'K' SERIES ENGINE

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# OVERHAUL MANUAL

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This overhaul manual is applicable to 'K' Series engines fitted with either VVC or non VVC cylinder heads and 'damp' cylinder liners.

This engine is fitted to the following models:

MGF,

Rover 114 and 214/414

New Rover 214, 216, 218 and BRM

New Rover 414 and 416 Coupe,

Cabriolet, Tourer and Sports Models

Rover 25, Rover 45 and Rover 75

**Publication Part No. RCL 0057ENG (5th Edition)**

**Published by Rover Technical Communication**

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## INTRODUCTION

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### How to use this manual

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

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

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

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

WARNINGS, CAUTIONS and Notes have the following meanings:



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



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



**NOTE:** Gives helpful information.

### References

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

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

### Dimensions

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

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

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## REPAIRS AND REPLACEMENTS

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

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

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

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

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

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

Rover Dealers are obliged to supply only Rover recommended parts.

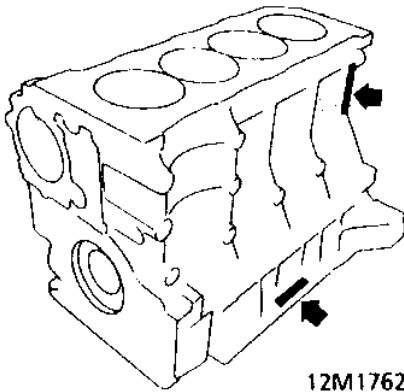
# INTRODUCTION

## SPECIFICATION

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

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

## ENGINE NUMBER LOCATION



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

## ENGINE SERIAL NUMBER PREFIXES

Engines covered by this overhaul manual have the following prefixes in the engine serial number:  
H63, H64, H67, H71, H72, H75, H76, H77, H78  
J31, J32, J78, J79, J89, J90  
K38, K39, K40, K41, K43, K44, K45, K51, K53, K61, K63, K67, K68, K74, K76, K77, K78, K79, K80, K88, K89  
L06, L07, L08, L09, L10, L24, L25, L28, L30, L31, L32, L33, L34, L35, L36, L37, L44, L45, L46, L47, L48, L49, L50, L51, L64, L67, L68, L69, L82, L97, L98, L99 K79, K80, K88, K89  
M01, M21, M22, M23, M26, M27, M28, M29, M30, M31, M36, M37, M38, M39, M41, M42, M47, M48, M49, M50, M51, M52, M53, M54, M55, M56, M62, M64, M65, M67, M68, M70, M71, M72, M73, M75, M76, M79, M80, M81, M82, M83, M84, M85, M86, M87, M88, M89, M90, M91, M92, M93, M94, M95, M96, M97, M98, M99  
N01

## COMMENCING ENGINE NUMBERS



NOTE: The following modifications have been introduced at the following engine numbers. Engines fitted to Rover 25, 45 and 75 models incorporate these modifications from commencement of production.

### K16 Non VVC engines fitted with automatic timing belt tensioner

14K4FK76 646038, 14K4FK76 885300  
14K4FK77 655218, 14K4FK77 885300

14K4FL30 153524, 14K4FL30 885300  
14K4FL31 154156, 14K4FL31 885300

16K4FK79 654924, 16K4FK79 885300  
16K4FK80 655078, 16K4FK80 885300

16K4FL32 153217, 16K4FL33 152709  
16K4FL34 149204, 16K4FL35 145785

18K4FJ31 153993, 18K4FJ32 147263  
18K4FJ78 151555, 18K4FJ79 153785  
18K4FJ89 146503, 18K4FJ90 141815  
18K4FL66 148135, 18K4FL67 665464  
18K4KL36 118709, 18K4KL37 102149


**K16 Non VVC engines fitted with modified camshafts and cylinder heads**

14K4FK76 872191, 14K4FK77 872382  
 14K4FL30 114520, 14K4FL30 872041  
 14K4FL31 104073

16K4FK79 872751, 16K4FK80 872285  
 16K4FL32 114135, 16K4FL33 112837  
 16K4FL34 110965, 16K4FL35 110541

18K4FJ31 112397, 18K4FJ32 111281  
 18K4FJ78 115630, 18K4FJ79 112575  
 18K4FL66 674985, 18K4FL67 110704  
 18K4KJ89 110206, 18K4KJ90 683004  
 18K4KL36 703592, 18K4KL37 703768

**Cylinder heads fitted with triple angle valve seats**

14K4FK76 853697, 14K4FK77 853547  
 14K4FL30 684272, 14K4FL31 682772

16K4FK79 853606, 16K4FK80 853676  
 16K4FL32 684705, 16K4FL33 684141  
 16K4FL34 674890, 16K4FL35 675041

18K4FJ31 685002, 18K4FJ32 678009  
 18K4FJ78 679210, 18K4FJ79 682294  
 18K4FL66 658261, 18K4FL67 615758  
 18K4KL36 667388, 18K4KL37 657611  
 18K4KJ89 673981, 18K4KJ90 637368

**Modified - type B crankshafts**

11K2FK42 602582

14K2FH67 601998  
 14K2FK43 604022, 14K2FK44 585572  
 14K2FL64 589869  
 14K4FH71 589479, 14K4FH72 603771  
 14K4FK76 580134, 14K4FK77 602717

16K4FH75 597254, 16K4FH76 597902  
 16K4FK79 581514, 16K4FK80 583009  
 16K4FK88 605066, 16K4FK89 600785

18K4FJ31 599800, 18K4FJ32 577734  
 18K4FJ79 581514, 18K4FJ89 597466  
 18K4FK61 547750, 18K4FK67 526547  
 18K4FK68 323456, 18K4FL50 527882  
 18F4FL51 551737, 18K4FL82 589737  
 18K4KH77 585941, 18K4KH78 588402  
 18K4KJ90 568275

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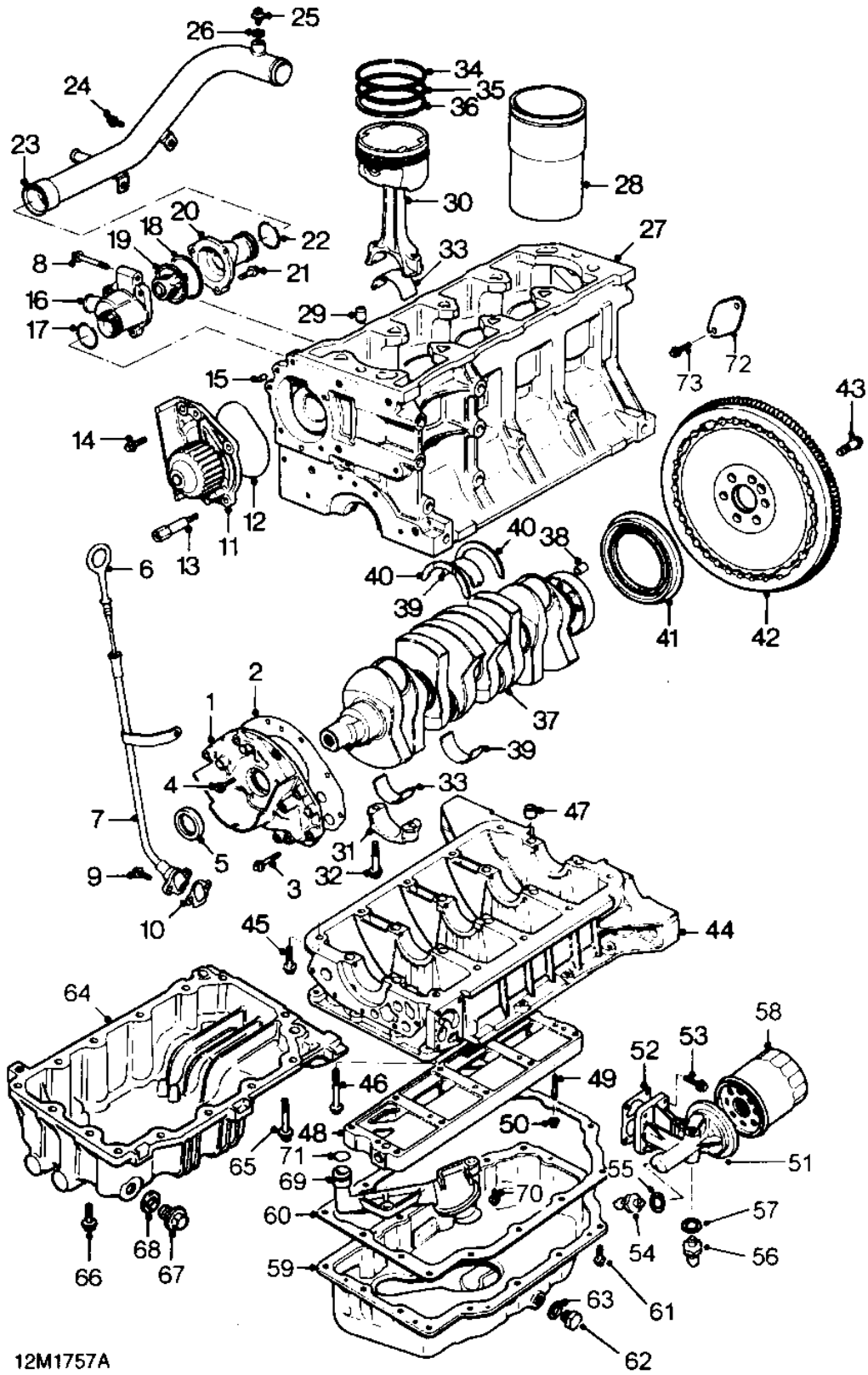






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# ENGINE



12M1757A



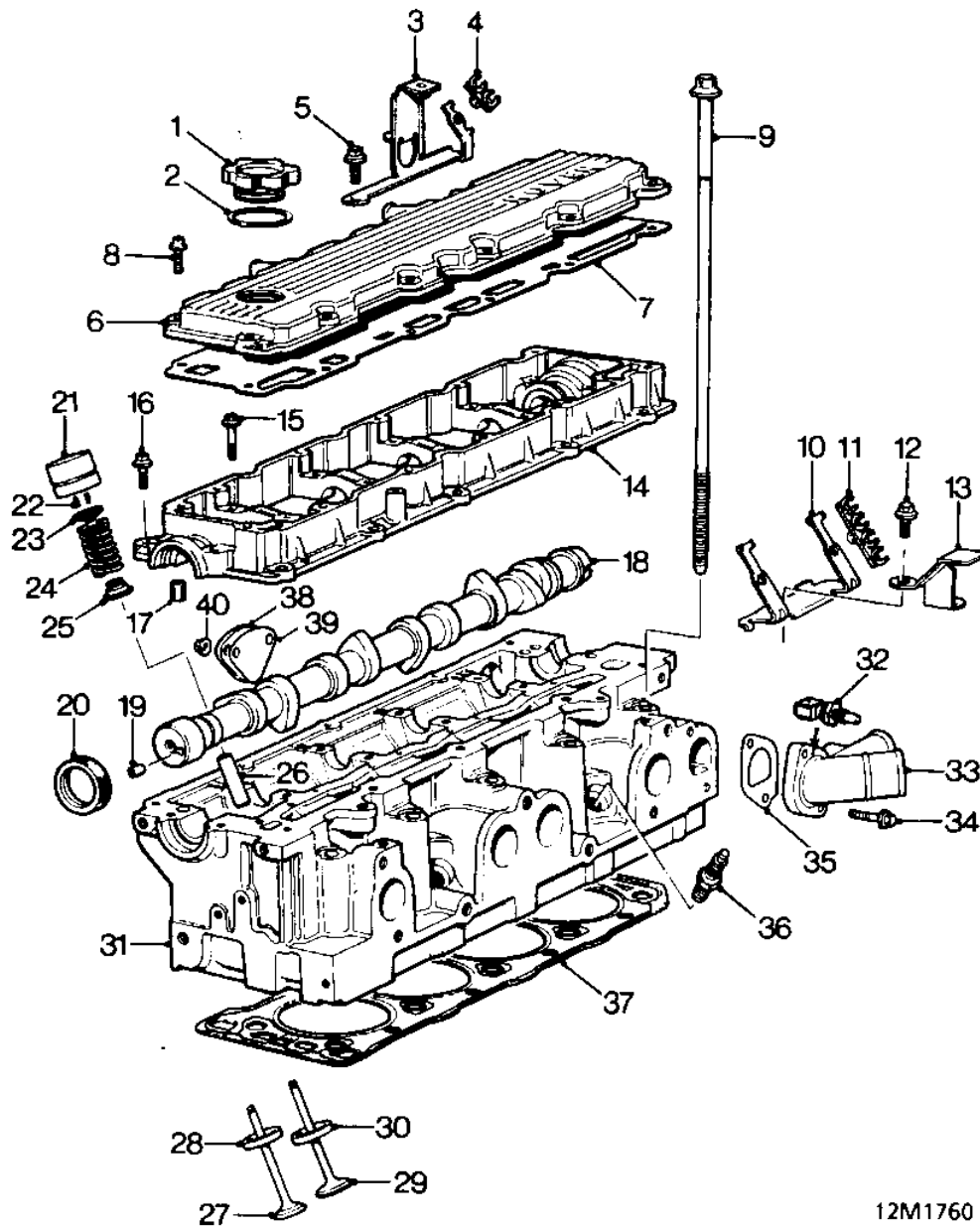

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**CYLINDER BLOCK COMPONENTS**


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

# ENGINE



12M1760



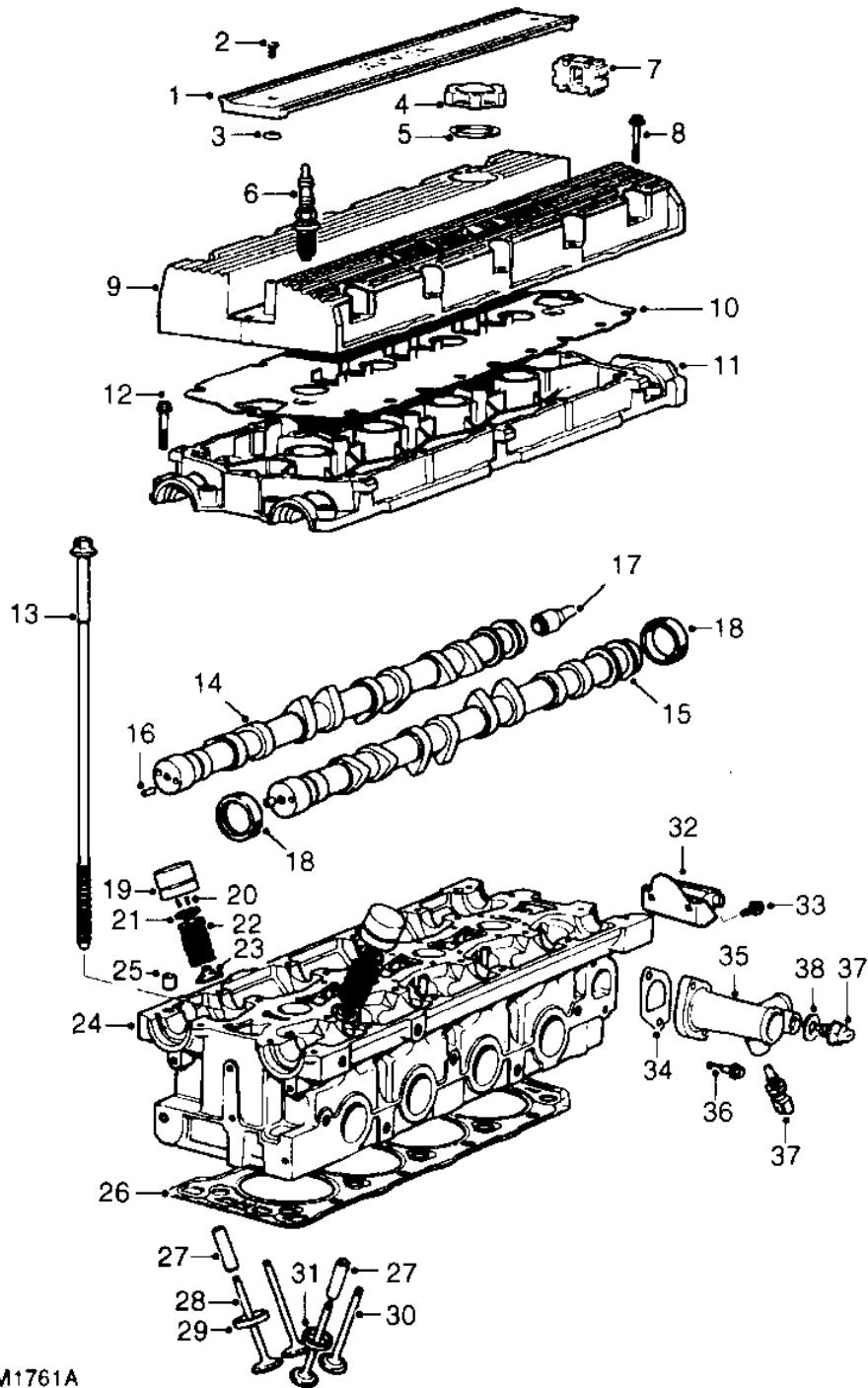
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**CYLINDER HEAD COMPONENTS - K8 ENGINES**

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1. Engine oil filler cap
2. Filler cap seal
3. ht clip mounting bracket
4. Clip - 2 ht leads
5. Bolt, bracket
6. Camshaft cover
7. Gasket
8. Bolt - camshaft cover
9. Cylinder head bolt
10. ht clip mounting bracket
11. Clip - 4 ht leads
12. Bolt, bracket
13. Mounting bracket - duct
14. Camshaft carrier
15. Bolt - camshaft carrier - long
16. Bolt - camshaft carrier - short
17. Locating dowel - camshaft carrier
18. Camshaft
19. Drive pin - camshaft gear
20. Camshaft oil seal
21. Hydraulic tappet
22. Collets - valve
23. Valve spring cap
24. Valve spring
25. Valve stem oil seal
26. Valve guide
27. Exhaust valve
28. Valve seat insert - exhaust
29. Inlet valve
30. Valve seat insert - inlet
31. Cylinder head
32. Coolant temperature sensor
33. Coolant outlet elbow
34. Bolt - coolant outlet elbow
35. Gasket - coolant outlet elbow
36. Spark plug
37. Cylinder head gasket
38. Fuel pump blanking plate - if fitted
39. Gasket
40. Nuts - blanking plate

# ENGINE



12M1761A



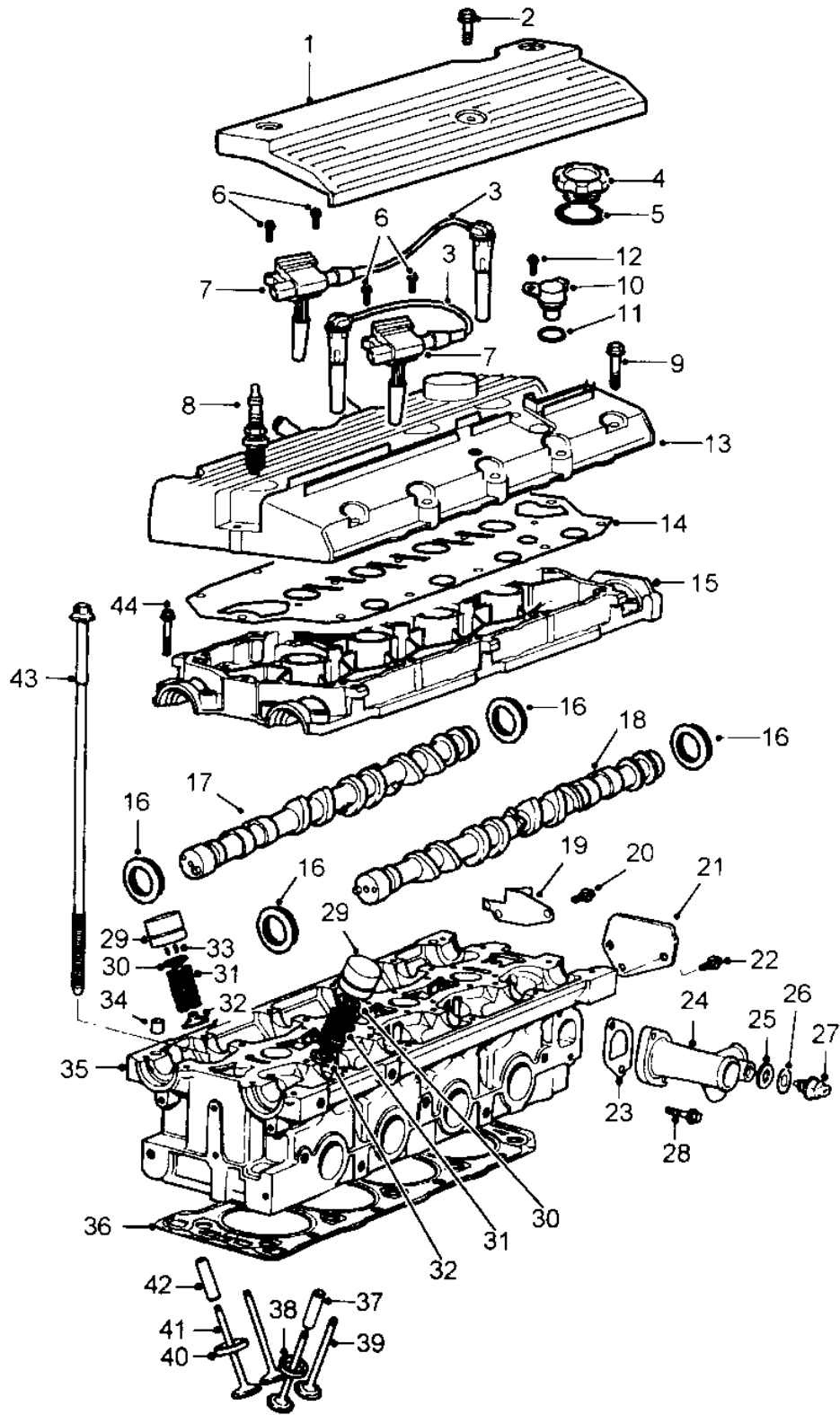
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**CYLINDER HEAD COMPONENTS - K16 NON VVC  
ENGINES FITTED WITH DISTRIBUTOR**

---

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

# ENGINE



M124971





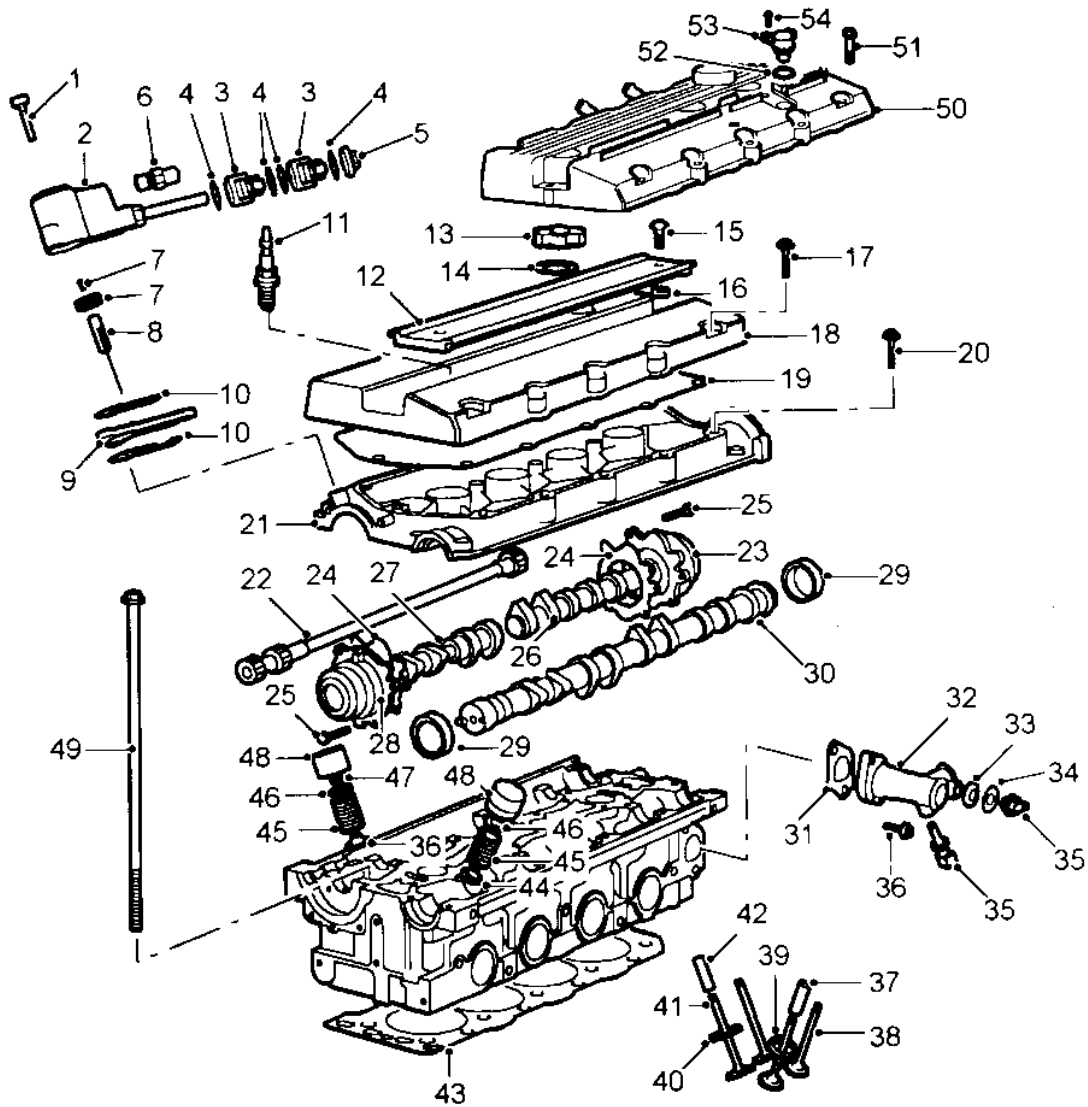
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**CYLINDER HEAD COMPONENTS - K16 NON VVC  
ENGINES FITTED WITH PLUG TOP COIL  
IGNITION SYSTEM**

---

1. Spark plug cover
2. Screw - spark plug cover
3. ht lead and plug tube
4. Oil filler cap
5. Seal - oil filler cap
6. Screws - coils to camshaft cover
7. Coil
8. Spark plug
9. Bolt - camshaft cover
10. Camshaft sensor
11. 'O' ring
12. Bolt - camshaft sensor
13. Camshaft cover
14. Gasket - camshaft cover
15. Camshaft carrier
16. Camshaft oil seal
17. Inlet camshaft
18. Exhaust camshaft
19. Bracket - multiplug
20. Bolt - multiplug bracket
21. Blanking plate - 2 off
22. Bolt - blanking plate
23. Gasket - coolant outlet elbow
24. Coolant outlet elbow
25. Sealing washer
26. Gasket
27. Coolant temperature sensor
28. Bolt - coolant outlet elbow
29. Hydraulic tappet
30. Valve spring cap
31. Valve spring
32. Valve stem oil seal
33. Collets
34. Locating dowel
35. Cylinder head
36. Gasket - cylinder head
37. Exhaust valve guide
38. Valve seat insert - exhaust
39. Exhaust valve
40. Valve seat insert - inlet
41. Inlet valve
42. Inlet valve guide
43. Bolt - cylinder head
44. Bolt - camshaft carrier

# ENGINE



M12 7257




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**CYLINDER HEAD COMPONENTS - K16 VVC ENGINES**


---

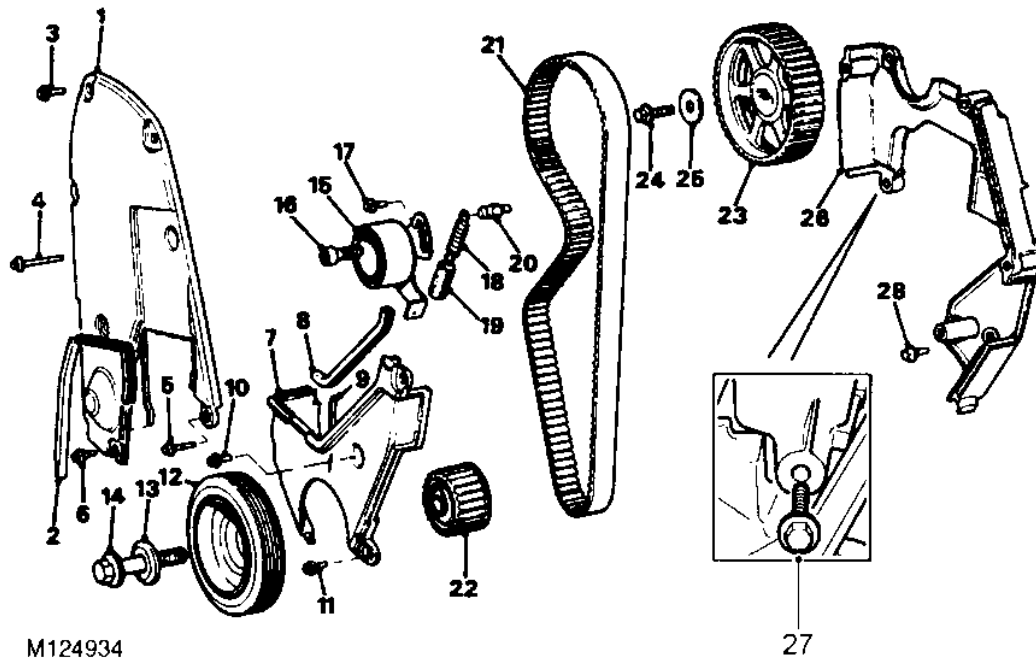
- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Bolts - hydraulic control unit</li> <li>2. Hydraulic control unit body and spool valve</li> <li>3. Solenoids</li> <li>4. 'O' rings</li> <li>5. Spool valve nut</li> <li>6. Oil temperature transmitter</li> <li>7. Piston screw, piston and seal assembly</li> <li>8. Rack</li> <li>9. Seal plate</li> <li>10. Labyrinth seals</li> <li>11. Spark plug</li> <li>12. Spark plug cover</li> <li>13. Oil filler cap</li> <li>14. Filler cap seal</li> <li>15. Screw - spark plug cover</li> <li>16. Washer</li> <li>17. Bolt - camshaft cover *</li> <li>18. Camshaft cover *</li> <li>19. Gasket - camshaft cover</li> <li>20. Bolt - camshaft carrier</li> <li>21. Camshaft carrier</li> <li>22. Control shaft</li> <li>23. Rear VVC housing and mechanism</li> <li>24. Gasket - VVC housing</li> <li>25. Bolt - VVC housing</li> <li>26. Rear inlet camshaft</li> <li>27. Front inlet camshaft</li> </ol> | <ol style="list-style-type: none"> <li>28. Front VVC housing and mechanism</li> <li>29. Exhaust camshaft oil seals</li> <li>30. Exhaust camshaft</li> <li>31. Gasket - coolant outlet elbow</li> <li>32. Coolant outlet elbow</li> <li>33. Sealing washer</li> <li>34. Gasket</li> <li>35. Coolant temperature sensors</li> <li>36. Bolt - coolant outlet elbow</li> <li>37. Exhaust valve guide</li> <li>38. Exhaust valve</li> <li>39. Valve seat insert - exhaust</li> <li>40. Valve seat insert - inlet</li> <li>41. Inlet valve</li> <li>42. Inlet valve guide</li> <li>43. Cylinder head gasket</li> <li>44. Valve stem oil seal</li> <li>45. Valve spring</li> <li>46. Valve spring cap</li> <li>47. Collets</li> <li>48. Hydraulic tappet</li> <li>49. Bolt - cylinder head</li> <li>50. Camshaft cover **</li> <li>51. Bolt - camshaft cover **</li> <li>52. 'O' ring - camshaft sensor **</li> <li>53. Camshaft sensor **</li> <li>54. Bolt - camshaft sensor **</li> </ol> |
|---|---|

\* Early engines

\*\* Later engines

# ENGINE

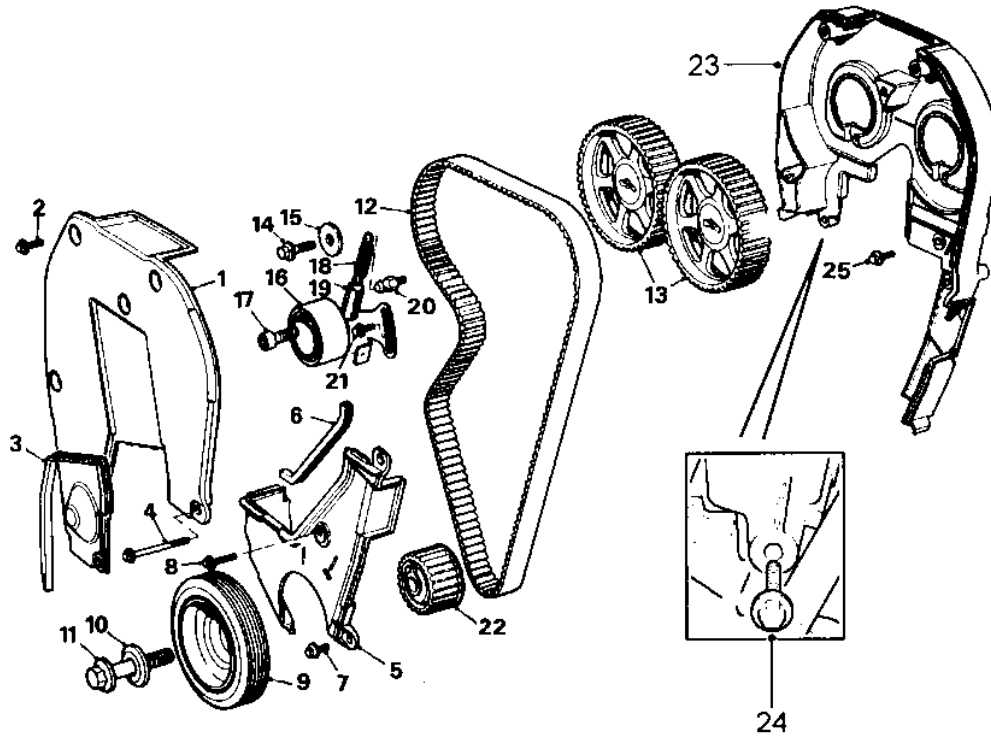
## TIMING BELT COMPONENTS - K8 ENGINES



1. Upper front cover - timing belt
2. Seal - upper cover
3. Screw M6 x 16 - upper cover
4. Bolt M6 x 40 - upper cover
5. Bolt M6 x 20 - upper cover
6. Flange shoulder screw - upper cover
7. Lower cover - timing belt
8. Seal - lower cover to mounting
9. Seal - lower cover to cylinder block
10. Screw - lower cover
11. Screw M6 x 16 - lower cover
12. Crankshaft pulley
13. Special washer - pulley bolt
14. Crankshaft pulley bolt
15. Tensioner pulley and backplate
16. Allen screw - tensioner to cylinder head
17. Flange head screw - tensioner backplate
18. Tensioner spring
19. Sleeve - spring
20. Pillar bolt
21. Camshaft timing belt
22. Crankshaft timing gear
23. Camshaft timing gear
24. Camshaft gear bolt
25. Plain washer
26. Upper rear cover - timing belt
27. Screw - rear cover to coolant pump
28. Screw - rear cover



**TIMING BELT COMPONENTS - K16 NON VVC  
ENGINES FITTED WITH MANUAL TIMING BELT  
TENSIONER**

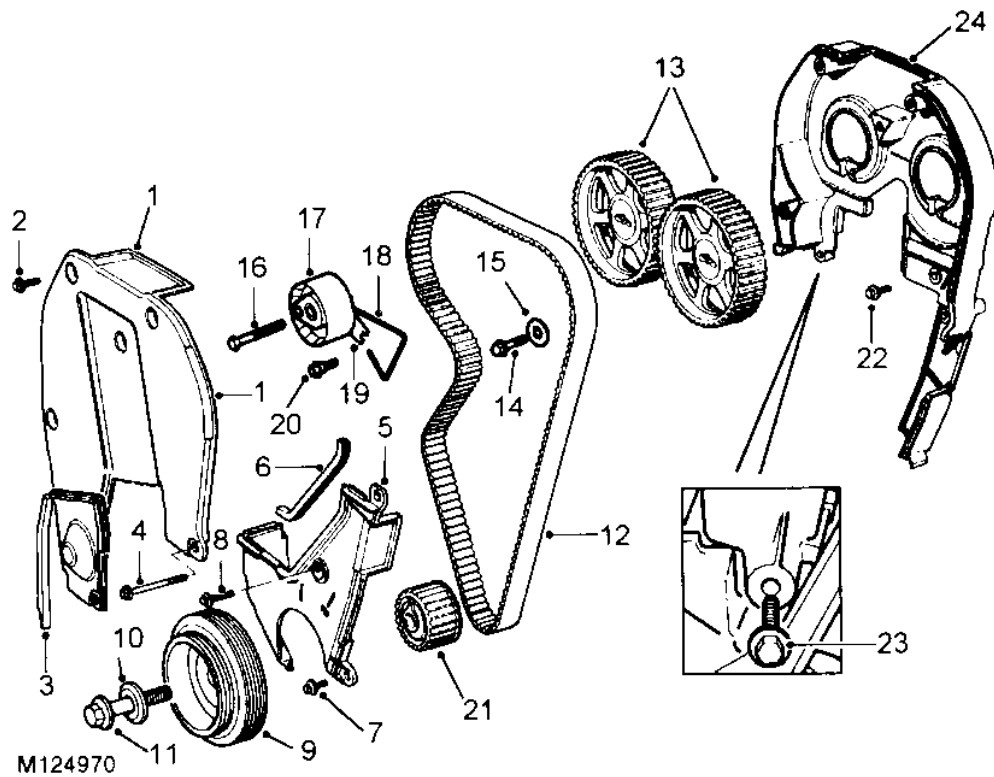


M124933

- |   |   |
|---|---|
| 1. Upper front cover - timing belt      | 15. Plain washer                            |
| 2. Screw M6 - upper cover               | 16. Tensioner pulley and backplate          |
| 3. Seal - upper cover                   | 17. Allen screw - pulley                    |
| 4. Bolt M6 x 90 - upper and lower cover | 18. Tensioner spring                        |
| 5. Lower cover - timing belt            | 19. Sleeve - spring                         |
| 6. Seal - lower cover                   | 20. Pillar bolt                             |
| 7. Screw M6 - lower cover               | 21. Flange head screw - tensioner backplate |
| 8. Screw M6 x 16 - lower cover          | 22. Crankshaft timing gear                  |
| 9. Crankshaft pulley                    | 23. Rear cover - timing belt                |
| 10. Special washer - pulley bolt        | 24. Screw - rear cover to coolant pump      |
| 11. Crankshaft pulley bolt              | 25. Screw - rear cover                      |
| 12. Camshaft timing belt                |   |
| 13. Camshaft timing gears               |   |
| 14. Camshaft gear bolt                  |   |

# ENGINE

## TIMING BELT COMPONENTS - K16 NON VVC ENGINES FITTED WITH AUTOMATIC BELT TENSIONER

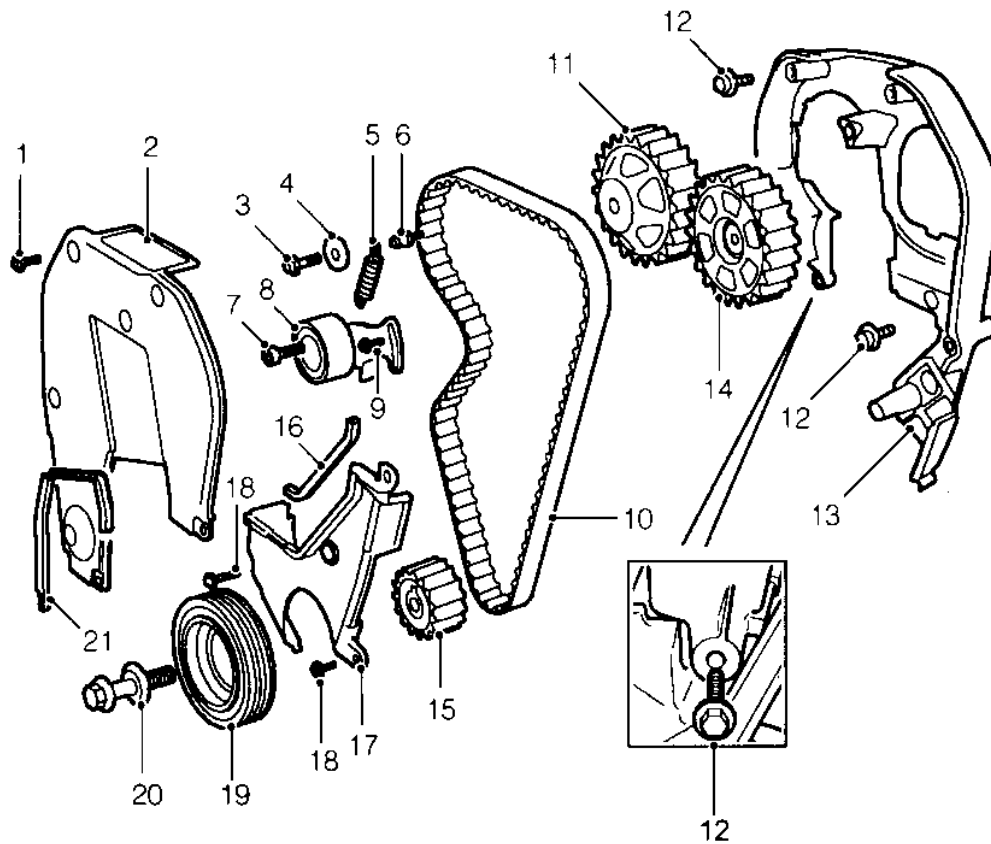


- |  |  |
|--|--|
| 1. Upper front cover - timing belt       | 13. Camshaft timing gears              |
| 2. Screw M6 - upper cover                | 14. Camshaft gear bolt                 |
| 3. Seal - upper cover                    | 15. Plain washer                       |
| 4. Bolt M6 x 90 - upper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

\* New Patchlok bolt must be used when tensioner is refitted



## FRONT TIMING BELT COMPONENTS - K16 VVC ENGINES



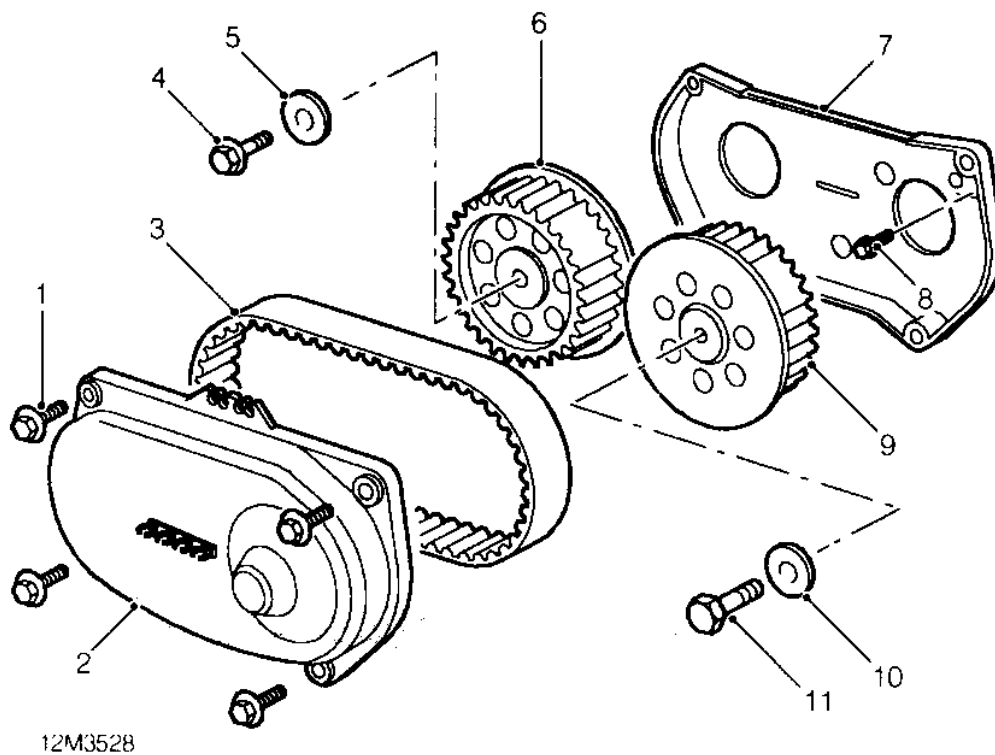
12M3527A

- |   |  |
|---|--|
| 1. Screw - upper front cover                | 12. Screw - timing belt rear cover     |
| 2. Upper front cover - timing belt          | 13. Timing belt rear cover             |
| 3. Camshaft gear bolt                       | 14. Exhaust camshaft front timing gear |
| 4. Washer                                   | 15. Crankshaft timing gear             |
| 5. Tensioner spring *                       | 16. Seal - lower front cover           |
| 6. Pillar bolt *                            | 17. Lower front cover                  |
| 7. Allen screw - tensioner pulley           | 18. Screw - lower front cover          |
| 8. Tensioner pulley and backplate           | 19. Crankshaft pulley                  |
| 9. Flanged head screw - tensioner backplate | 20. Crankshaft pulley bolt and washer  |
| 10. Camshaft timing belt                    | 21. Seal - upper front cover           |
| 11. Front inlet camshaft timing gear        |  |

\*These items are not fitted on production but are supplied with replacement timing belts. They must be removed and discarded on completion of belt tensioning.

## ENGINE

### REAR TIMING BELT COMPONENTS - K16 VVC ENGINES



1. Screw - rear timing belt cover
2. Rear timing belt cover
3. Rear timing belt
4. Bolt - M8 - rear timing gear
5. Washer - rear timing gear bolt
6. Exhaust camshaft rear timing gear

7. Rear timing belt backplate
8. Bolt - rear timing belt backplate
9. Rear inlet camshaft timing gear
10. Washer - rear timing gear bolt
11. Bolt - M10 - rear timing gear





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## OPERATION

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

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

When the cylinder head bolts are removed; additional fixings are used to retain the bearing ladder to the cylinder block and the oil rail to the bearing ladder.

*K8 engine:* The cross flow cylinder head has two valves for each cylinder and the spark plugs set at an angle. The inlet ports are of equal tract, designed to ensure a balanced mixture throughout the speed range to improve combustion and reduce exhaust emissions. The single, overhead camshaft operates both inlet and exhaust valves via hydraulic tappets and is driven from the crankshaft by a timing belt. Belt tension is maintained by a spring loaded tensioner. The camshaft is retained by a one-piece camshaft carrier sealed and bolted to the cylinder head. Positive location is by means of a flange which also controls camshaft end-float.

*K16 engine:* The cross flow cylinder head is based on a four valve, central spark plug, combustion chamber with the inlet ports designed to induce swirl and control the speed of the induction charge. This serves to improve combustion and hence fuel economy, performance and exhaust emissions. The twin overhead camshafts operate the valves via hydraulic tappets, one camshaft operates the exhaust valves whilst the other operates the inlet valves. The camshafts are driven from the crankshaft by a timing belt, belt tension being maintained by either a spring loaded, manually adjusted tensioner or, on later engines by an automatic tensioner. The camshafts are retained by the camshaft carrier, which is line bored with the cylinder head.

Later engines are fitted with a plug top coil ignition system in which the conventional distributor is replaced by a camshaft sensor located in the camshaft carrier adjacent to the exhaust camshaft. Camshafts fitted to some early engines and all engines with plug top coil ignition have an integral reluctor ring which provides an input to the camshaft sensor. Twin coils are fitted on top of the camshaft cover, each coil supplying ht voltage to one pair of spark plugs.

*Variable valve control (VVC):* This system is fitted to some K16 engines. VVC is designed to provide variation in the valve open and close periods by independent positioning of the two inlet camshaft assemblies thereby giving optimum low speed driveability with no detriment to high speed performance.

## ENGINE

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Whilst the exhaust camshaft is similar to camshafts fitted to non VVC K16 engines, there are four inlet camshafts, assembled in pairs, each individual camshaft operating the inlet valves on one cylinder. The front pair of camshafts are driven, via the front VVC mechanism, by the camshaft timing belt; the rear pair of camshafts being driven via the rear VVC mechanism by the rear timing belt which is itself, driven by the exhaust camshaft. Independent positioning of each inlet camshaft is controlled by its respective VVC mechanism. The front and rear VVC mechanisms are connected to each other by the control shaft. Movement of the control shaft is controlled by the piston and rack assembly located within the hydraulic control unit. The piston and rack assembly moves in response to engine speed and load signals received from the MEMS ECM via two solenoids mounted on the hydraulic control unit housing. As the piston and rack moves up or down in response to the signals received, the control shaft rotates and alters the position of the valve timing mechanisms.

*All engines:* Self adjusting hydraulic tappets are fitted on top of each valve and are operated directly by the camshaft(s). The valve stem oil seals are moulded onto a metal base which also act as the valve spring seat on the cylinder head.

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

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

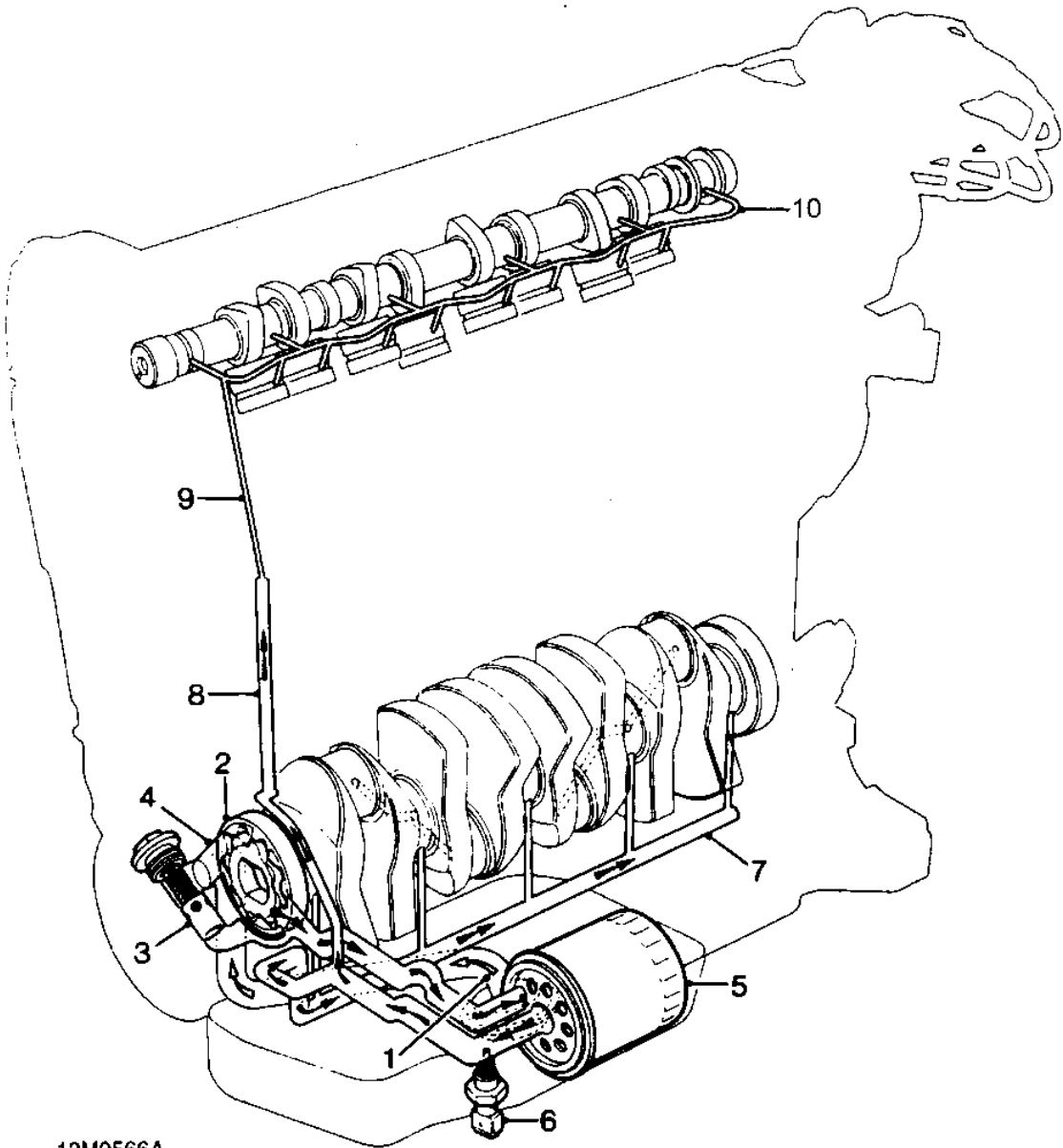
The cylinder block is fitted with 'damp' cylinder liners, the bottom, stepped half of the damp liner, being a sliding fit into the lower part of the cylinder block. The liners are sealed in the block with a bead of Hylomar applied around the stepped portion of the liner. The seal at the cylinder head is effected by the cylinder head gasket with the liner top acting as a break between the combustion chamber and gasket.

The aluminium alloy, thermal expansion pistons have a semi-floating gudgeon pin which is offset towards the thrust side and has an interference fit in the small end of the connecting rod. Pistons and cylinder liners are supplied in two grades. Big-end bearing diametric clearance is controlled by three grades of selective shell bearing.

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



K8 engine lubrication system

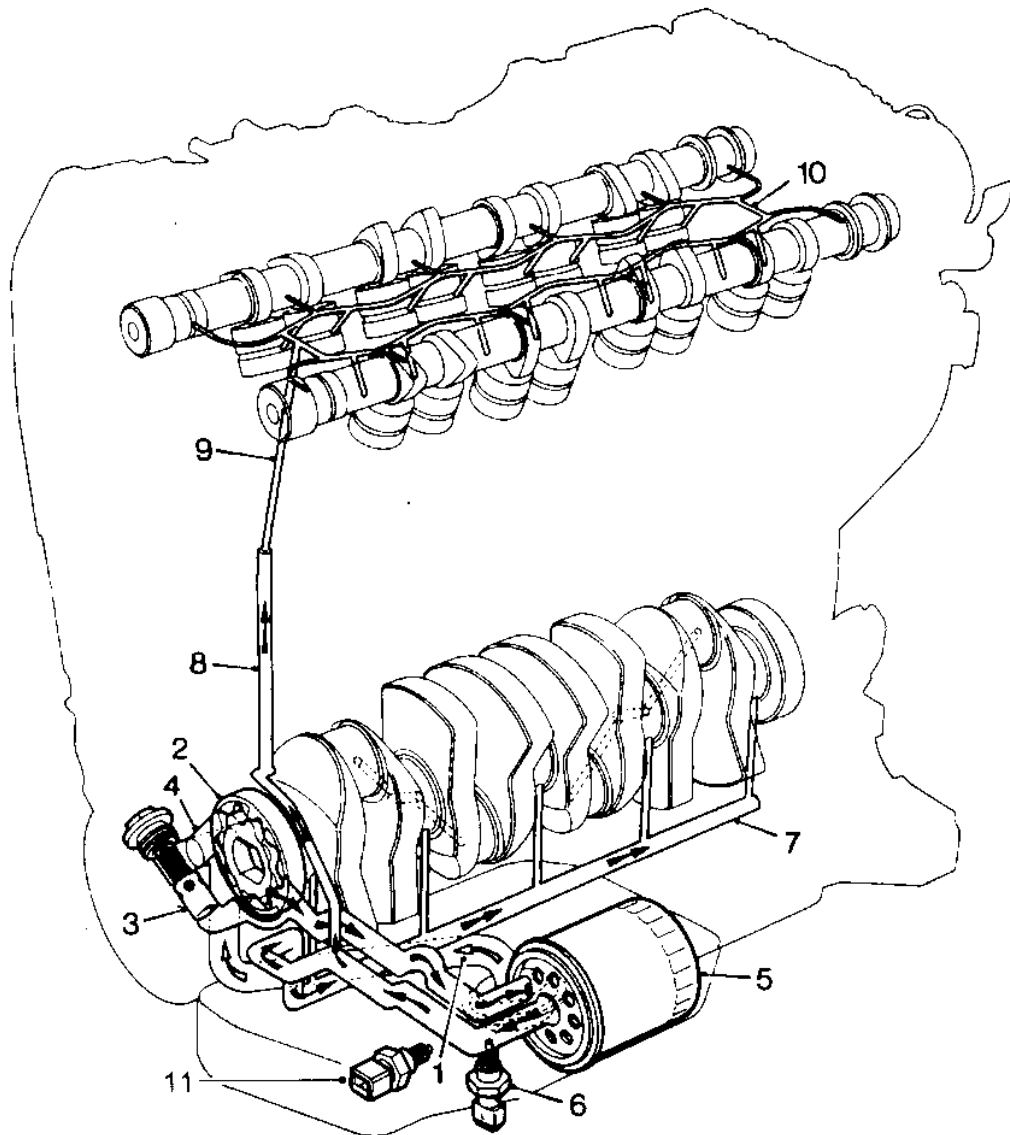


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# ENGINE

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## K16 engine lubrication system



12M1758A

Non VVC camshafts illustrated



## Lubrication

The lubrication system is of the full-flow filtration, forced fed type. The oil sump is of either pressed steel or alloy manufacture. Pressed steel sumps are sealed to the bearing ladder using a positively located gasket incorporating compression limiters. Alloy sumps are sealed to the bearing ladder with a bead of sealant applied to the sump flange.

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

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

*K8 engine:* Oil is fed through the cylinder head to a drilling (10) in the one piece camshaft carrier to supply oil to each hydraulic tappet and camshaft bearing.

*K16 engine:* Oil is fed through the cylinder head to twin full length oilways (10) in the camshaft carrier to supply oil to each hydraulic tappet and camshaft bearing.

*VVC engines:* The VVC mechanisms are lubricated by oil fed via the inlet camshafts.

An oil temperature switch (11) is fitted in the oil filter head for certain models. In the event of engine oil temperature rising above a pre-set level, a warning light will illuminate on the instrument panel.

## Crankcase ventilation

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

*K8 engine:* Crankcase gas is drawn through a gauze oil separator in the camshaft cover and passes via a hose into either the carburettor or throttle body ahead of the throttle disc.

*K16 engine:* Crankcase gas is drawn through a gauze oil separator in the camshaft cover and passes via hoses into the throttle housing.

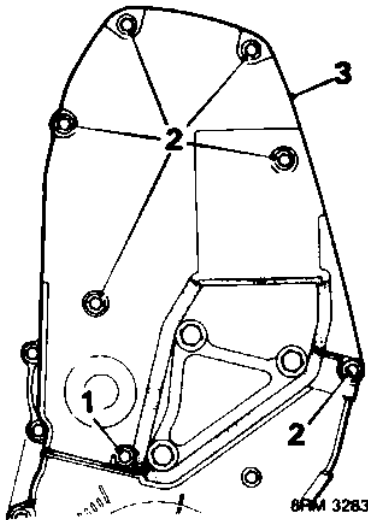


## CAMSHAFT TIMING BELT - K8 ENGINES

Remove



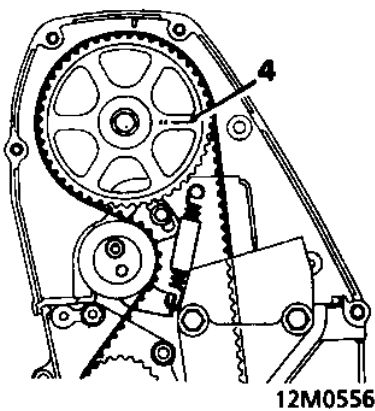
**CAUTION:** Do not use camshaft gear, gear retaining bolt or timing belt to rotate crankshaft.



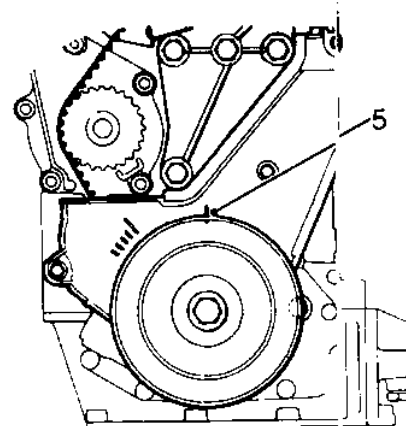
1. Slacken bottom bolt securing timing belt upper front cover.

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

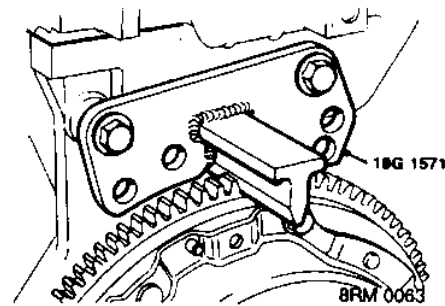
2. Remove 6 bolts from timing belt upper front cover.
3. Remove timing belt upper front cover and seal.



4. Rotate crankshaft clockwise to align camshaft gear timing marks with top face of cylinder head - 90° BTDC.

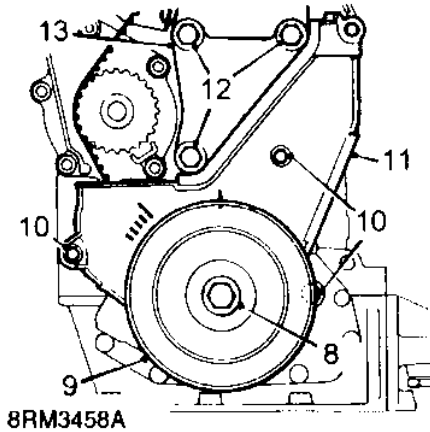


5. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.

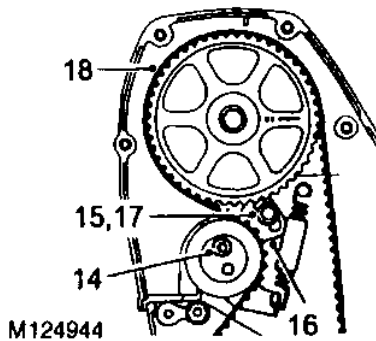


6. Position flywheel locking tool 18G 1571 to flywheel.
7. Secure with 2 bolts.

# ENGINE



8. Remove crankshaft pulley bolt and washer.
9. Remove crankshaft pulley.
10. Remove 3 bolts securing timing belt lower cover.
11. Remove timing belt lower cover together with seals.
12. Remove 3 bolts, mounting bracket to engine.
13. Remove mounting bracket.



14. Slacken tensioner pulley Allen screw.
15. Slacken tensioner backplate screw.
16. Push tensioner pulley down to fully OFF position.
17. Tighten backplate screw to 10 Nm.
18. Ease timing belt from gears using the fingers only.
19. Discard timing belt.



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

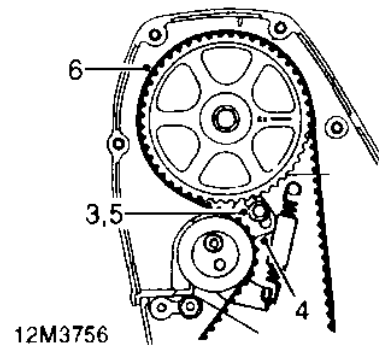
## Refit

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



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

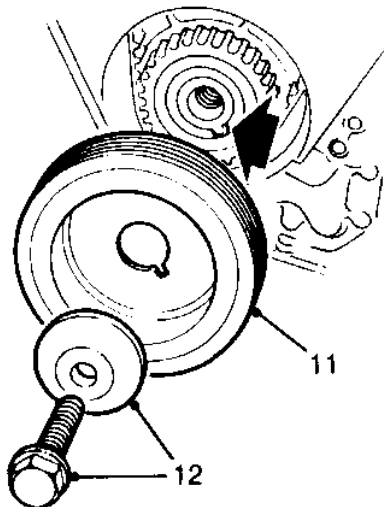
2. Check correct alignment of timing marks for 90° BTDC:  
Crankshaft gear dots align with flange on oil pump.  
Camshaft gear mark to right aligns with top face of cylinder head.



3. Slacken tensioner backplate screw, ensure tensioner moves fully through its adjustment range and returns under spring tension.
4. Push tensioner pulley down to fully OFF position.
5. Tighten backplate screw to 10 Nm.
6. Using the fingers only, fit a new timing belt over crankshaft timing gear, camshaft gear, tensioner pulley and coolant pump drive gear, ensure belt is positioned centrally on gears and pulley and that any slack in the belt is on the tensioner pulley side of the belt.
7. Clean all traces of Loctite from engine mounting bracket securing bolts and apply Loctite 542 to threads of bolts.
8. Fit engine mounting bracket, tighten bolts to 45 Nm.

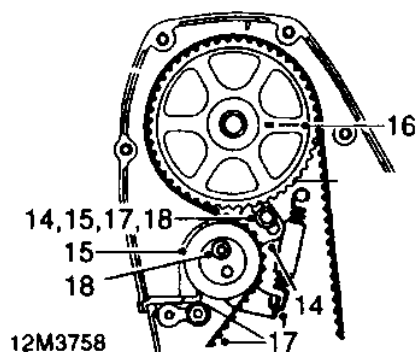


9. Ensure inserts are fitted in timing belt lower cover.
10. Fit timing belt lower cover, ensuring correct position of seals, tighten screws to 10 Nm.



12M3757

11. Fit crankshaft pulley to crankshaft timing gear ensuring that indent on pulley locates over gear lug (arrowed).
12. Fit crankshaft pulley bolt and washer, tighten to 205 Nm.
13. Remove flywheel locking tool 18G 1571.



12M3758

14. Slacken tensioner backplate screw and tension timing belt by applying finger pressure to tensioner backplate.

15. With tensioner pulley against timing belt and backplate held in position, tighten backplate screw to 10 Nm.
16. Rotate crankshaft clockwise 2 complete revolutions and align camshaft gear timing mark with top face of cylinder head.



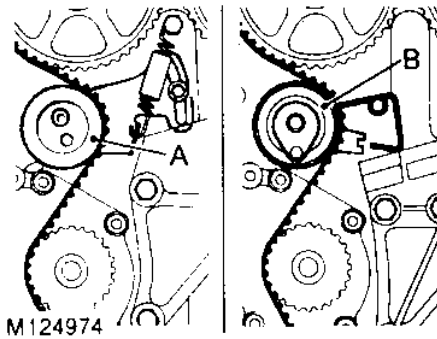
**CAUTION:** Do not use camshaft gear, gear retaining bolt or timing belt to rotate crankshaft.

17. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
18. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.
19. Ensure inserts are fitted in timing belt upper front cover.
20. Fit timing belt upper front cover, ensuring correct position of seals, tighten screws and bolt to 5 Nm.



# ENGINE

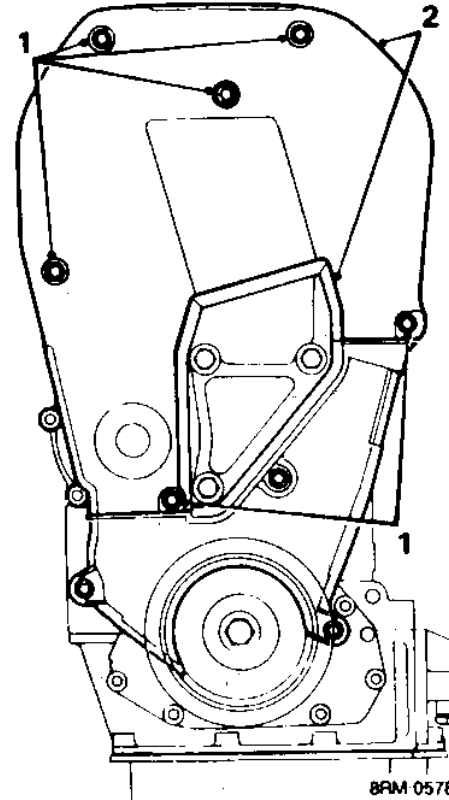
## CAMSHAFT TIMING BELT - K16 ENGINES



NOTE: Two types of timing belt tensioner are fitted to K16 engines, type A is a manual tensioner fitted to some K16 non VVC and all VVC engines. Type B is an automatic tensioner fitted to some K16 non VVC engines. Commencing engine numbers for the automatic tensioner are listed in Information. The tensioners and their timing belts are not interchangeable. The manual timing belt tensioner spring fitted to K16 non VVC engines is fitted with a sleeve, whilst on VVC engines only a spring is fitted.

### Camshaft timing belt - manual tensioner - remove

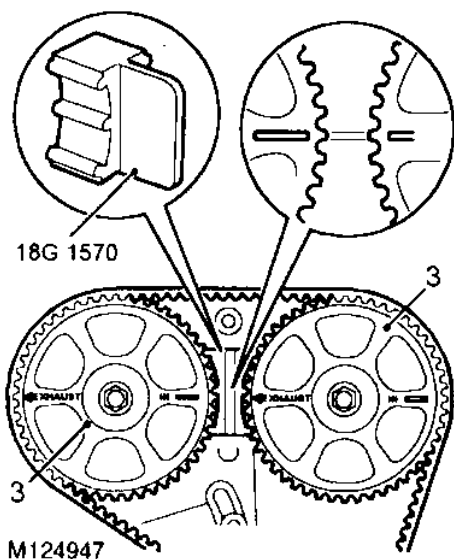
CAUTION: Timing belts fitted to engines with manual timing belt tensioners are not interchangeable with belts fitted to engines with automatic tensioners.



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

NOTE: Remove bottom bolt when cover is not slotted.

2. Remove timing belt upper front cover and seal.

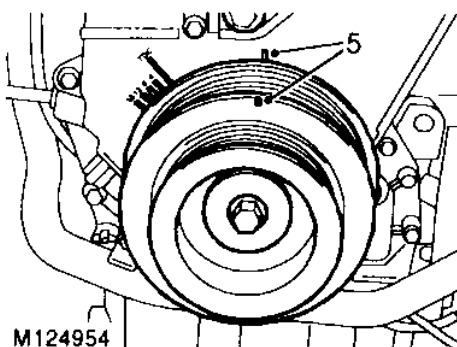


NOTE: VVC camshaft timing gear marks are shown in the inset on the illustration.

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

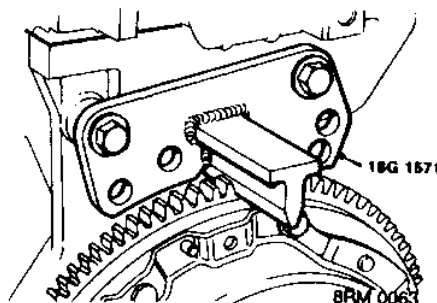
CAUTION: Do not use camshaft gears, gear retaining bolts or timing belt to rotate crankshaft.

4. Fit camshaft gear locking tool 18G 1570.



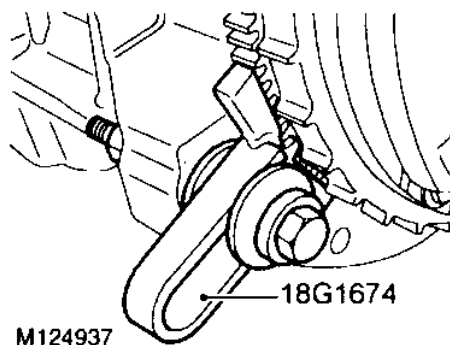
5. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.

#### Flywheel not fitted with a reluctor ring



6. Fit flywheel locking tool 18G 1571.
7. Secure with 2 bolts.

#### Flywheel fitted with a reluctor ring

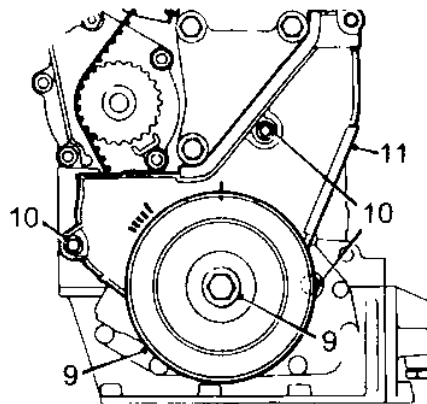


8. Fit flywheel locking tool 18G 1674, tighten bolt.

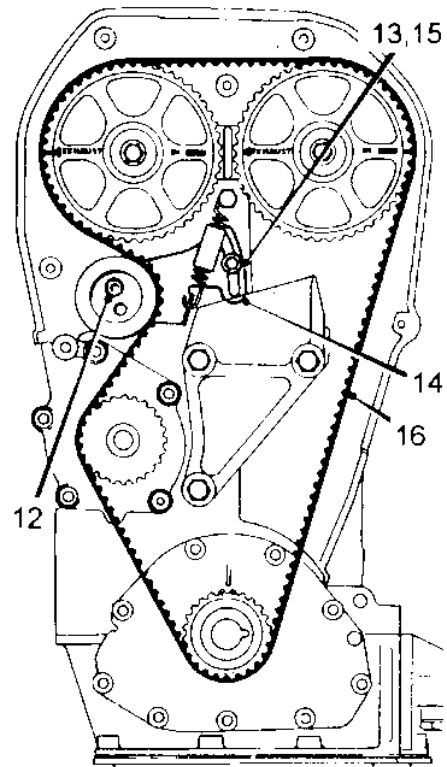
CAUTION: Ensure tooth on tool 18G 1674 engages with teeth on flywheel not the reluctor ring


# ENGINE

## All engines




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




 NOTE: Non VVC camshaft timing gears and tensioner spring illustrated.

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

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

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

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



### Camshaft timing belt - manual tensioner - refit

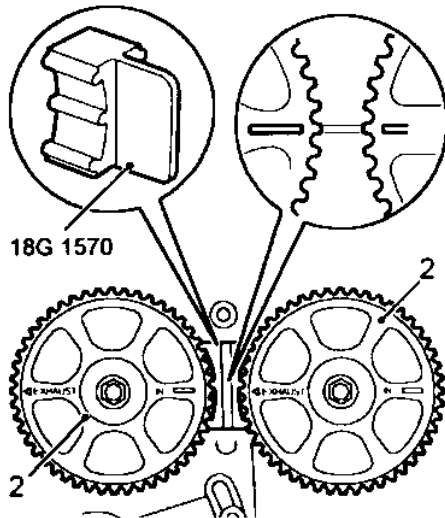


**CAUTION: VVC engines:-** When a replacement timing belt is to be fitted, it will be necessary to fit the tensioner spring and pillar bolt supplied with the replacement belt to adjust belt tension.

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



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

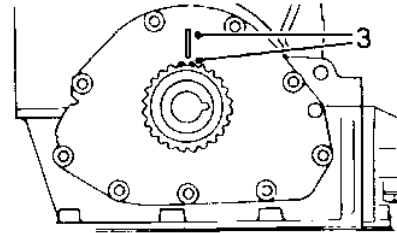


M124929



**NOTE:** VVC camshaft gear timing marks are shown in the inset on the illustration.

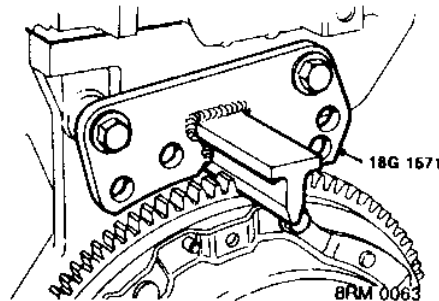
2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool 18G 1570.



M124962

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

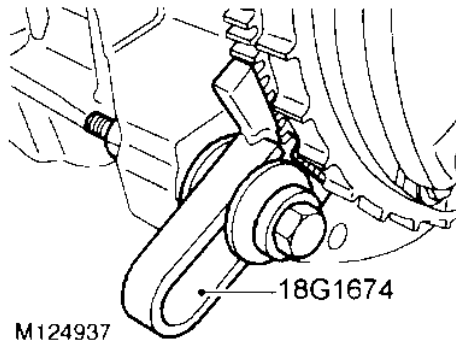
### Flywheel not fitted with a reluctor ring



4. Fit flywheel locking tool 18G 1571, secure with 2 bolts.

## ENGINE

### Flywheel fitted with a reluctor ring



5. Fit flywheel locking tool **18G 1674**, tighten bolt.



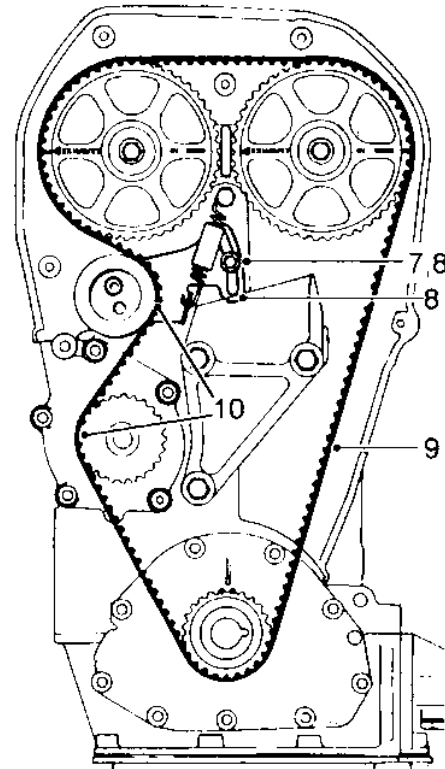
**CAUTION:** Ensure tooth on tool **18G 1674** engages with teeth on flywheel not the reluctor ring.

6. *VVC engines:* Fit tensioner spring and pillar bolt supplied with replacement timing belt, connect spring to tensioner backplate and pillar bolt.



**CAUTION:** Ensure spring is the correct type for the engine being worked on:-

Non VVC engines:- Spring is fitted with a sleeve.  
VVC engines:- Spring is not fitted with a sleeve.



M124926



**NOTE:** Non VVC camshaft timing gears and tensioner spring illustrated.

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



### Camshaft timing belt - manual tensioner - refit

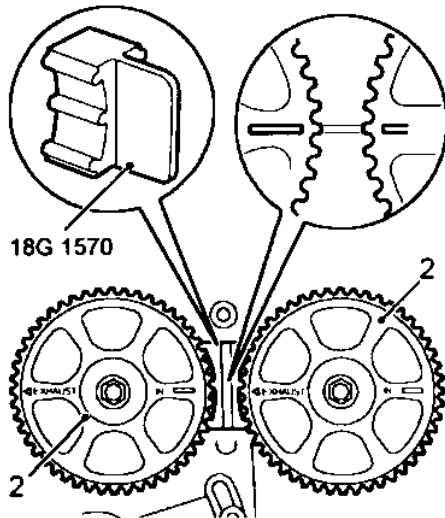


**CAUTION: VVC engines:-** When a replacement timing belt is to be fitted, it will be necessary to fit the tensioner spring and pillar bolt supplied with the replacement belt to adjust belt tension.

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



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

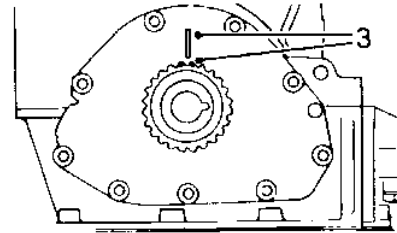


M124929



**NOTE:** VVC camshaft gear timing marks are shown in the inset on the illustration.

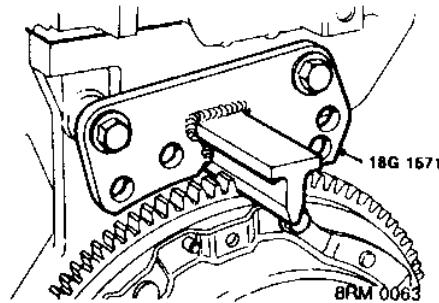
2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool 18G 1570.



M124962

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

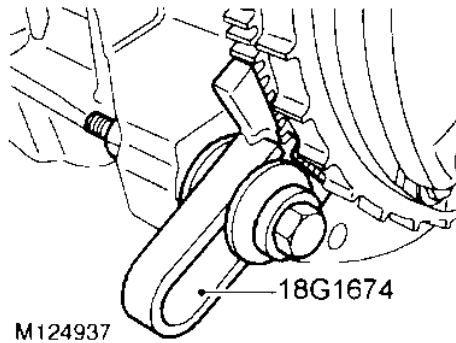
### Flywheel not fitted with a reluctor ring



4. Fit flywheel locking tool 18G 1571, secure with 2 bolts.

## ENGINE

### Flywheel fitted with a reluctor ring



5. Fit flywheel locking tool **18G 1674**, tighten bolt.



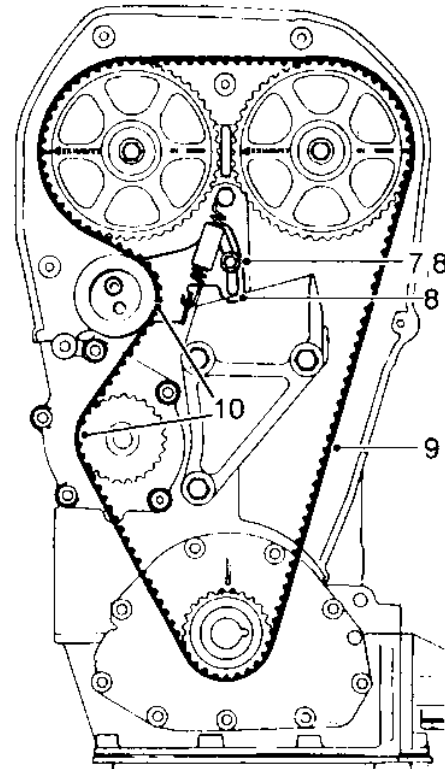
**CAUTION:** Ensure tooth on tool **18G 1674** engages with teeth on flywheel not the reluctor ring.

6. *VVC engines:* Fit tensioner spring and pillar bolt supplied with replacement timing belt, connect spring to tensioner backplate and pillar bolt.



**CAUTION:** Ensure spring is the correct type for the engine being worked on:-

Non VVC engines:- Spring is fitted with a sleeve.  
VVC engines:- Spring is not fitted with a sleeve.

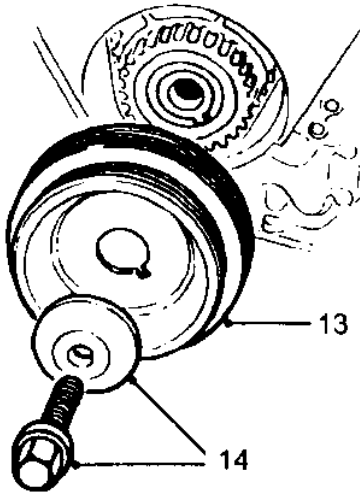


M124926



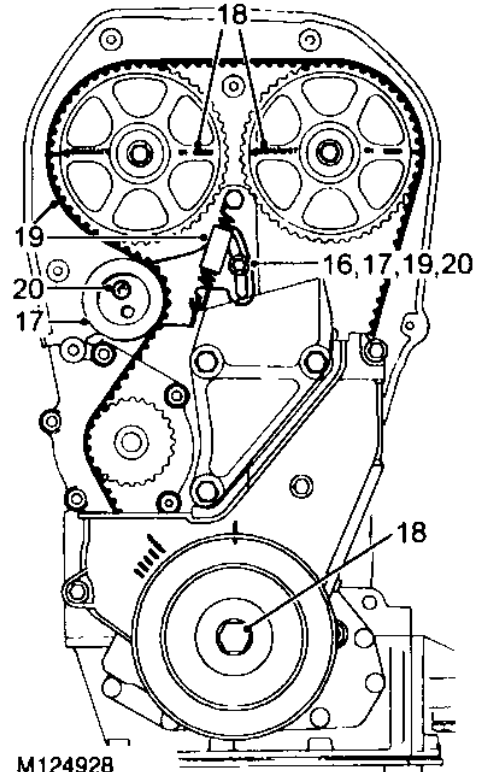
**NOTE:** Non VVC camshaft timing gears and tensioner spring illustrated.

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



M124927

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



M124928

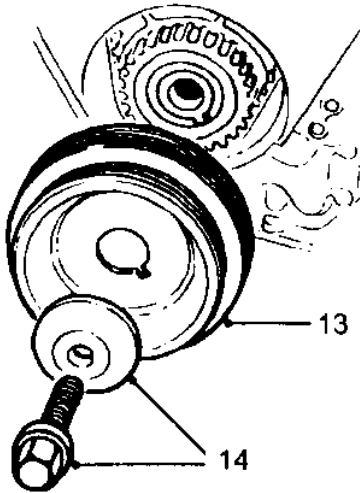
△ NOTE: Non VVC camshaft timing gears and tensioner spring illustrated.

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

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

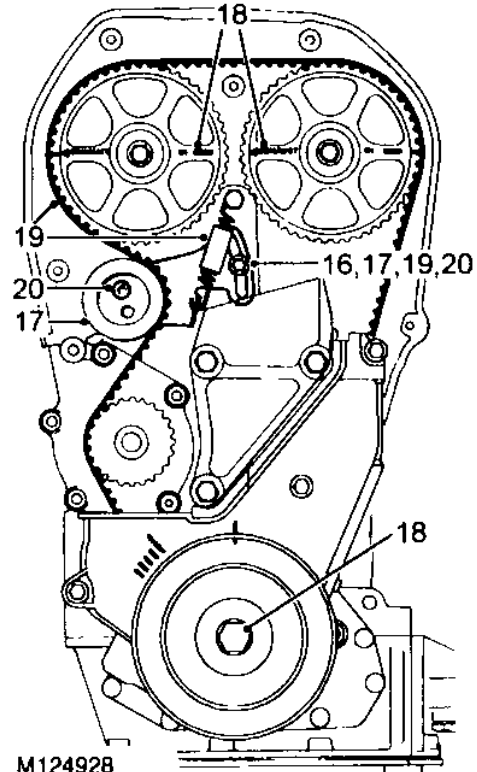
19. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
20. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.





M124927

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



M124928



NOTE: Non VVC camshaft timing gears and tensioner spring illustrated.

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



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

19. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
20. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.

# ENGINE

## VVC engines

21. Disconnect tensioner spring from pillar bolt, release spring from tensioner; remove and discard spring.
22. Remove and discard pillar bolt.

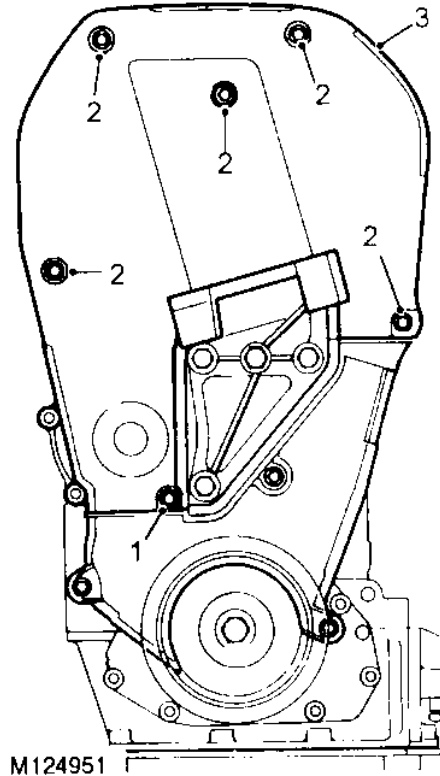
## All engines

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

## Camshaft timing belt - automatic tensioner - remove



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

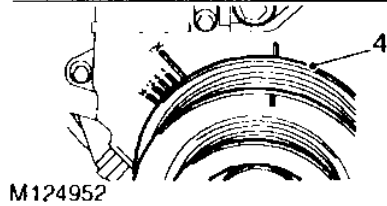
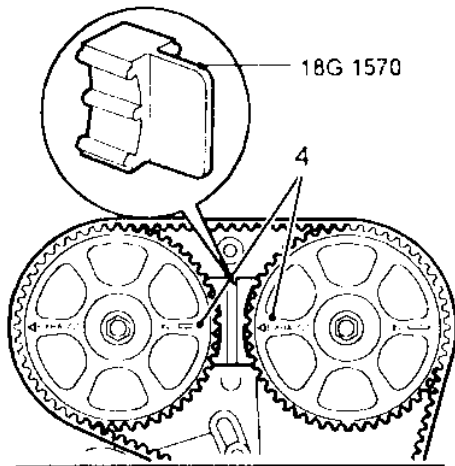


1. Slacken but do not remove bolt securing bottom of timing belt upper front cover.



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

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



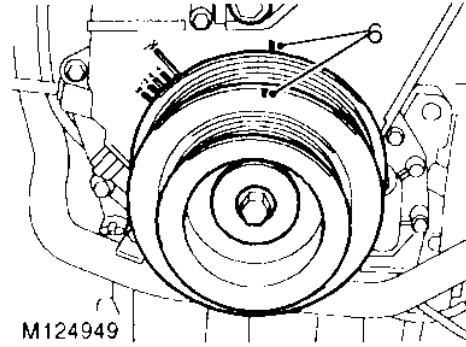
M124952

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



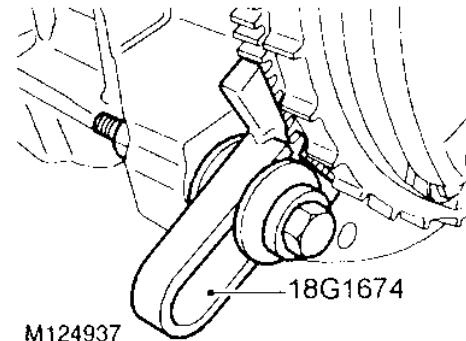
**CAUTION:** Do not use camshaft gears, gear retaining bolts or timing belt to rotate crankshaft.

5. Fit camshaft gear locking tool 18G 1570.



M124949

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

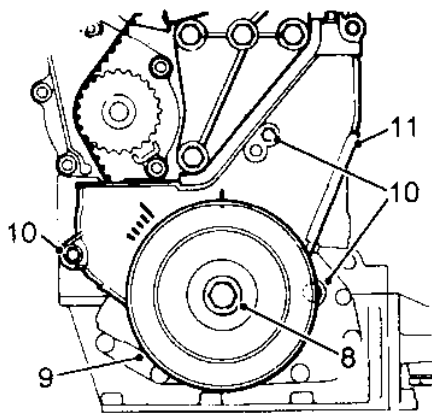


M124937

7. Fit flywheel locking tool 18G 1674, tighten bolt.

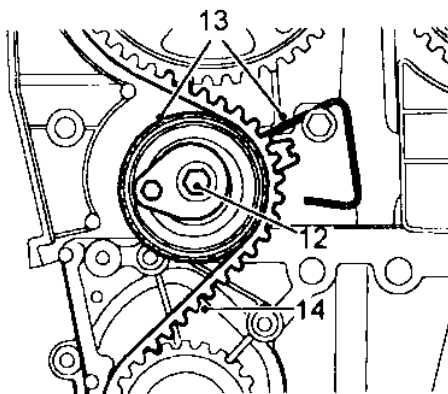


**CAUTION:** Ensure tooth on tool 18G 1674 engages with teeth on flywheel not the reluctor ring.



M124945

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



M124955

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

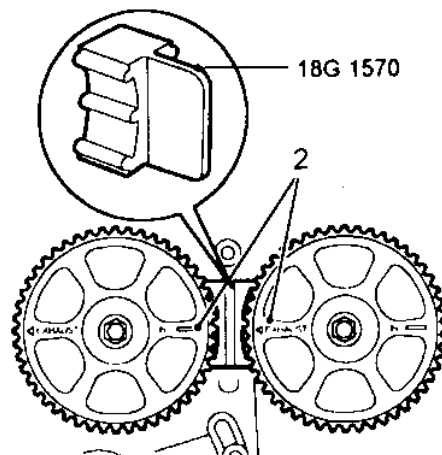
**CAUTION:** Timing belt must always be replaced during engine overhaul. Do not rotate crankshaft with timing belt removed and cylinder head fitted.

## Camshaft timing belt - automatic tensioner - refit



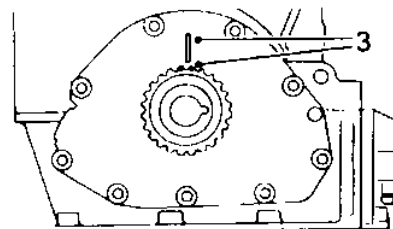
**CAUTION:** If the sintered gears have been subjected to prolonged oil contamination, they must be soaked in a solvent bath and then thoroughly washed in clean solvent before refitting. Because of the porous construction of sintered material, oil impregnated in the gears will emerge and contaminate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

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



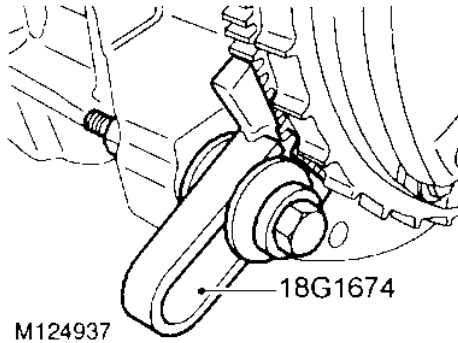
M124961

2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool 18G 1570.

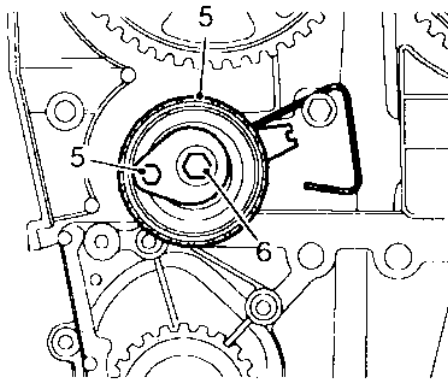


M124962

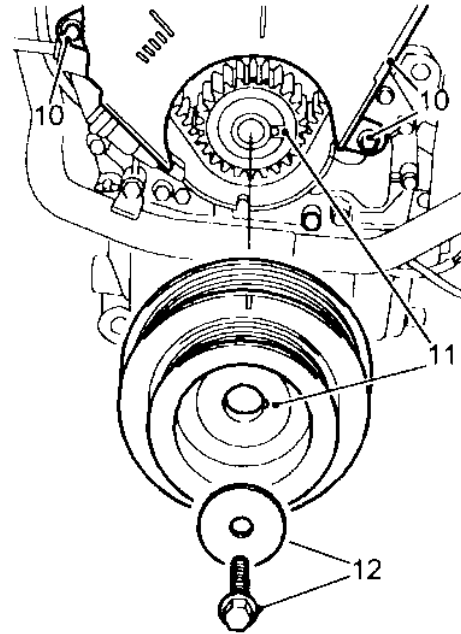
3. Check that crankshaft gear timing marks are aligned with flange on oil pump - 90° BTDC.



4. Fit flywheel locking tool **18G 1674**.



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



10. Fit timing belt lower cover ensuring correct position of seals, fit screws and tighten to 9 Nm.
11. Fit crankshaft pulley to crankshaft gear ensuring that indent on pulley locates over lug on gear.
12. Fit crankshaft pulley bolt and washer, tighten to 205 Nm.
13. Remove camshaft gear and flywheel locking tools **18G 1570** and **18G 1674**.

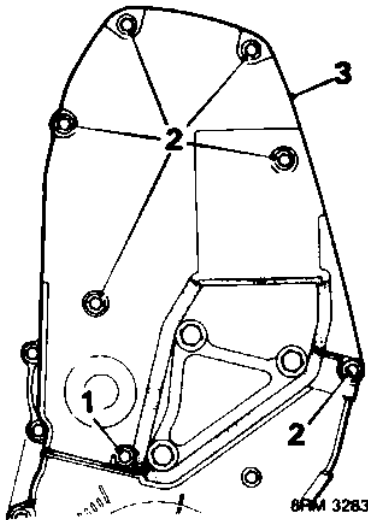


## CAMSHAFT TIMING BELT - K8 ENGINES

Remove



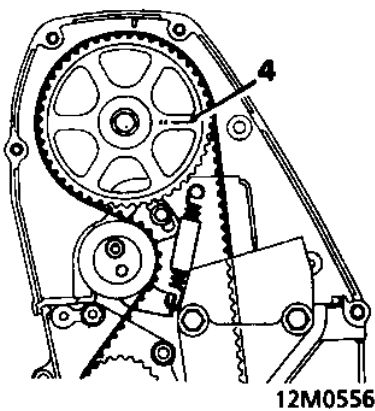
**CAUTION:** Do not use camshaft gear, gear retaining bolt or timing belt to rotate crankshaft.



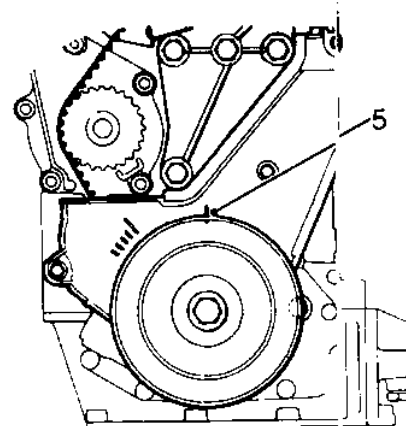
1. Slacken bottom bolt securing timing belt upper front cover.

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

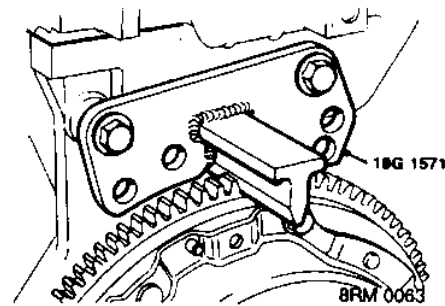
2. Remove 6 bolts from timing belt upper front cover.
3. Remove timing belt upper front cover and seal.



4. Rotate crankshaft clockwise to align camshaft gear timing marks with top face of cylinder head - 90° BTDC.

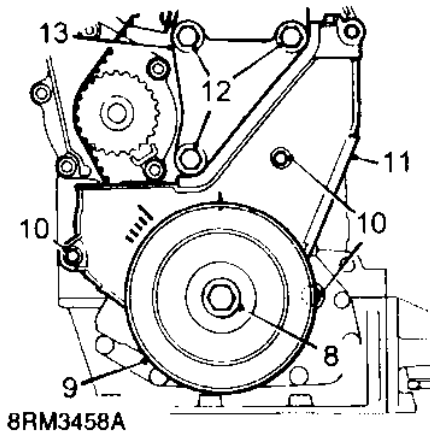


5. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.

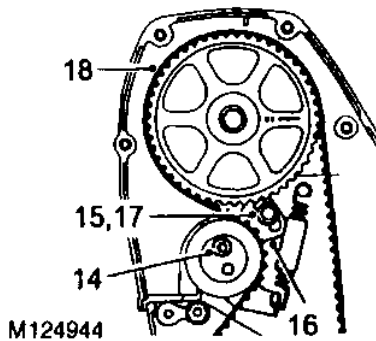


6. Position flywheel locking tool 18G 1571 to flywheel.
7. Secure with 2 bolts.

# ENGINE



8. Remove crankshaft pulley bolt and washer.
9. Remove crankshaft pulley.
10. Remove 3 bolts securing timing belt lower cover.
11. Remove timing belt lower cover together with seals.
12. Remove 3 bolts, mounting bracket to engine.
13. Remove mounting bracket.



14. Slacken tensioner pulley Allen screw.
15. Slacken tensioner backplate screw.
16. Push tensioner pulley down to fully OFF position.
17. Tighten backplate screw to 10 Nm.
18. Ease timing belt from gears using the fingers only.
19. Discard timing belt.



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

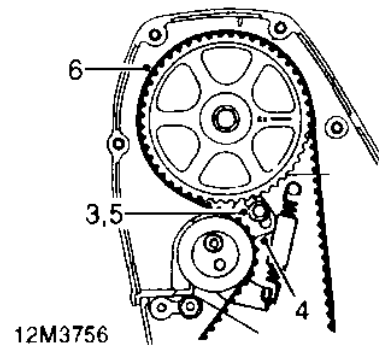
## Refit

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



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

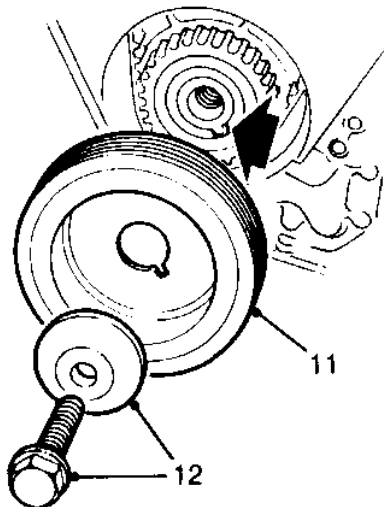
2. Check correct alignment of timing marks for 90° BTDC:  
Crankshaft gear dots align with flange on oil pump.  
Camshaft gear mark to right aligns with top face of cylinder head.



3. Slacken tensioner backplate screw, ensure tensioner moves fully through its adjustment range and returns under spring tension.
4. Push tensioner pulley down to fully OFF position.
5. Tighten backplate screw to 10 Nm.
6. Using the fingers only, fit a new timing belt over crankshaft timing gear, camshaft gear, tensioner pulley and coolant pump drive gear, ensure belt is positioned centrally on gears and pulley and that any slack in the belt is on the tensioner pulley side of the belt.
7. Clean all traces of Loctite from engine mounting bracket securing bolts and apply Loctite 542 to threads of bolts.
8. Fit engine mounting bracket, tighten bolts to 45 Nm.

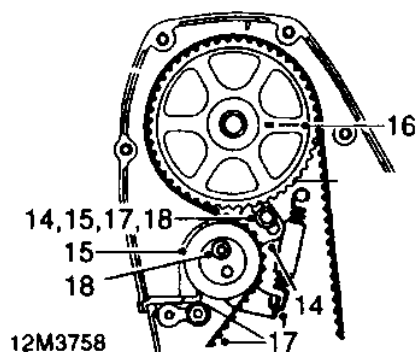


9. Ensure inserts are fitted in timing belt lower cover.
10. Fit timing belt lower cover, ensuring correct position of seals, tighten screws to 10 Nm.



12M3757

11. Fit crankshaft pulley to crankshaft timing gear ensuring that indent on pulley locates over gear lug (arrowed).
12. Fit crankshaft pulley bolt and washer, tighten to 205 Nm.
13. Remove flywheel locking tool 18G 1571.



12M3758

14. Slacken tensioner backplate screw and tension timing belt by applying finger pressure to tensioner backplate.

15. With tensioner pulley against timing belt and backplate held in position, tighten backplate screw to 10 Nm.
16. Rotate crankshaft clockwise 2 complete revolutions and align camshaft gear timing mark with top face of cylinder head.



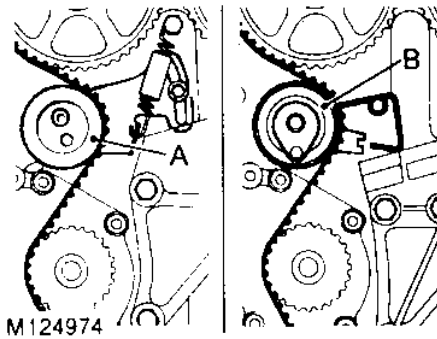
**CAUTION:** Do not use camshaft gear, gear retaining bolt or timing belt to rotate crankshaft.

17. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
18. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.
19. Ensure inserts are fitted in timing belt upper front cover.
20. Fit timing belt upper front cover, ensuring correct position of seals, tighten screws and bolt to 5 Nm.



# ENGINE

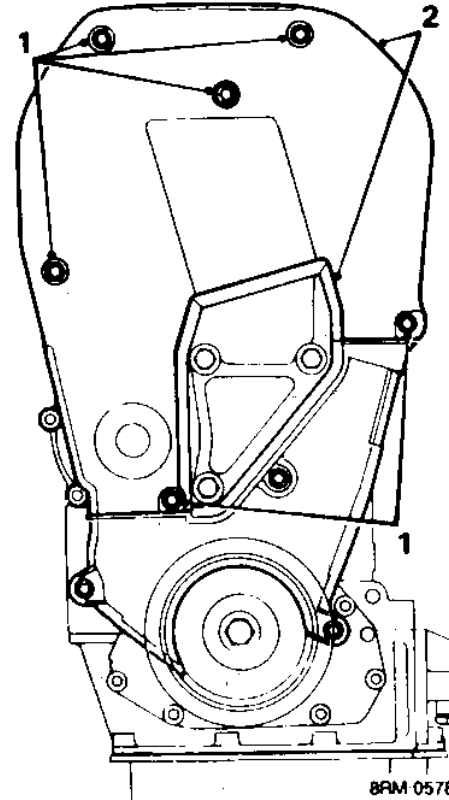
## CAMSHAFT TIMING BELT - K16 ENGINES



NOTE: Two types of timing belt tensioner are fitted to K16 engines, type A is a manual tensioner fitted to some K16 non VVC and all VVC engines. Type B is an automatic tensioner fitted to some K16 non VVC engines. Commencing engine numbers for the automatic tensioner are listed in Information. The tensioners and their timing belts are not interchangeable. The manual timing belt tensioner spring fitted to K16 non VVC engines is fitted with a sleeve, whilst on VVC engines only a spring is fitted.

### Camshaft timing belt - manual tensioner - remove

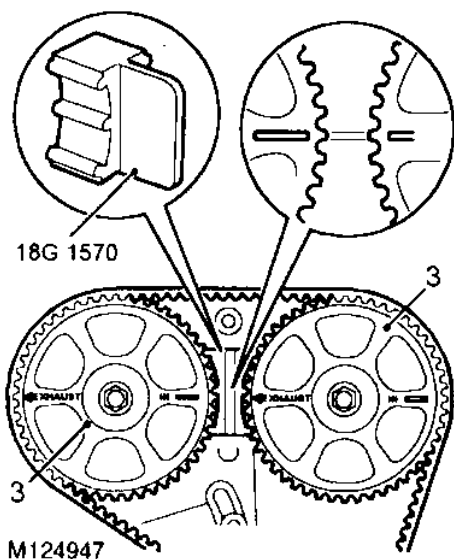
CAUTION: Timing belts fitted to engines with manual timing belt tensioners are not interchangeable with belts fitted to engines with automatic tensioners.



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

NOTE: Remove bottom bolt when cover is not slotted.

2. Remove timing belt upper front cover and seal.

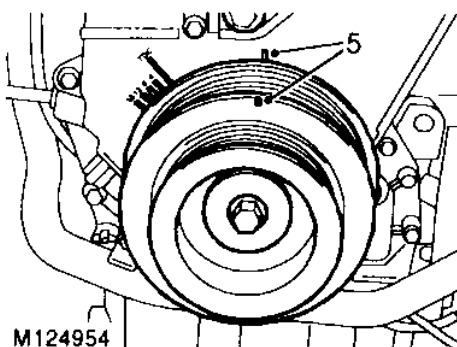


NOTE: VVC camshaft timing gear marks are shown in the inset on the illustration.

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

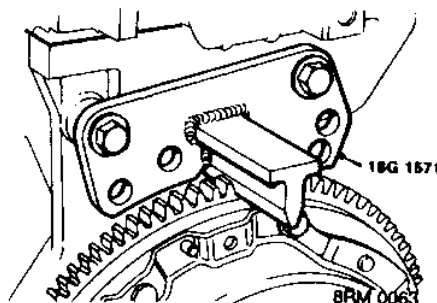
CAUTION: Do not use camshaft gears, gear retaining bolts or timing belt to rotate crankshaft.

4. Fit camshaft gear locking tool 18G 1570.



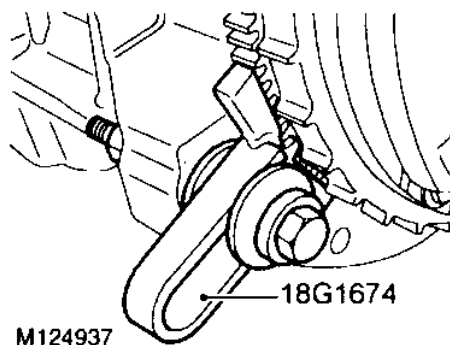
5. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.

#### Flywheel not fitted with a reluctor ring



6. Fit flywheel locking tool 18G 1571.
7. Secure with 2 bolts.

#### Flywheel fitted with a reluctor ring

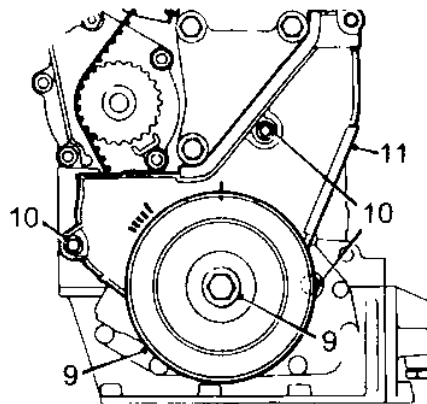


8. Fit flywheel locking tool 18G 1674, tighten bolt.

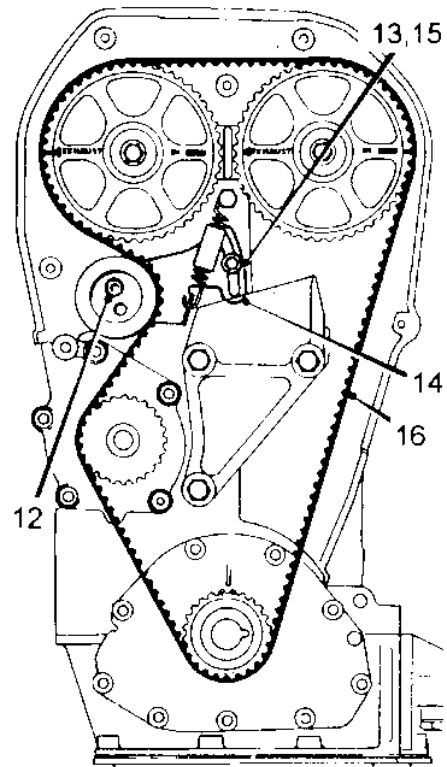
CAUTION: Ensure tooth on tool 18G 1674 engages with teeth on flywheel not the reluctor ring


# ENGINE

## All engines




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




 NOTE: Non VVC camshaft timing gears and tensioner spring illustrated.

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

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

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

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



### Camshaft timing belt - manual tensioner - refit

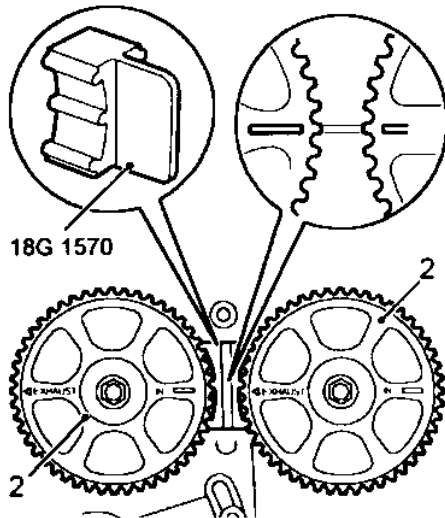


**CAUTION: VVC engines:-** When a replacement timing belt is to be fitted, it will be necessary to fit the tensioner spring and pillar bolt supplied with the replacement belt to adjust belt tension.

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



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

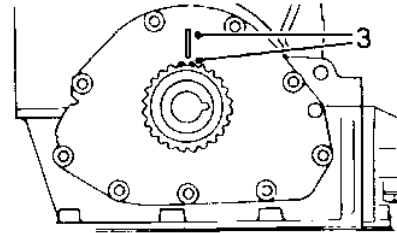


M124929



**NOTE:** VVC camshaft gear timing marks are shown in the inset on the illustration.

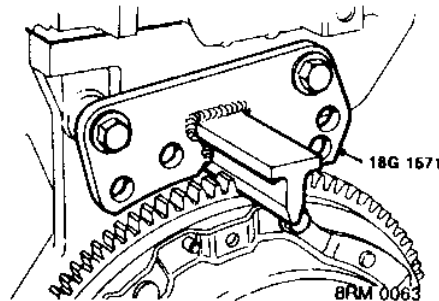
2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool 18G 1570.



M124962

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

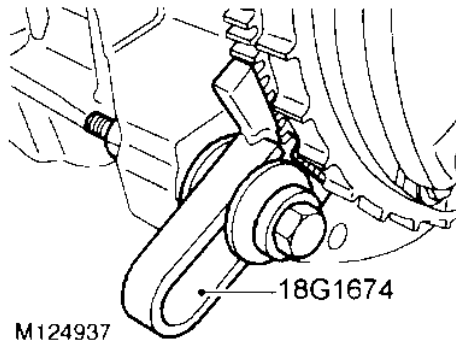
### Flywheel not fitted with a reluctor ring



4. Fit flywheel locking tool 18G 1571, secure with 2 bolts.

## ENGINE

### Flywheel fitted with a reluctor ring



5. Fit flywheel locking tool **18G 1674**, tighten bolt.



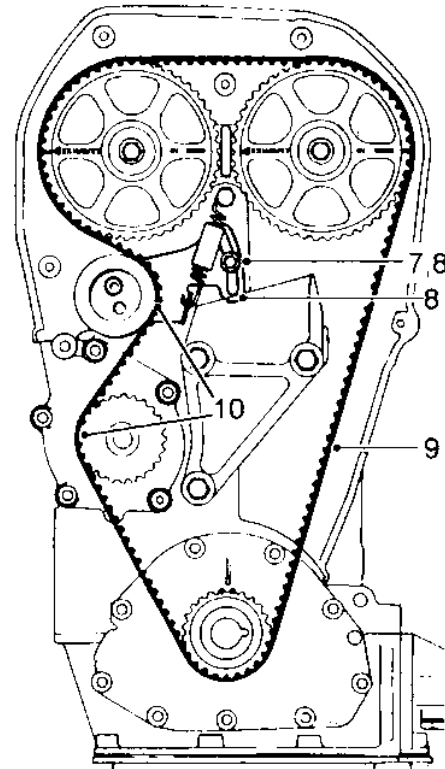
**CAUTION:** Ensure tooth on tool **18G 1674** engages with teeth on flywheel not the reluctor ring.

6. *VVC engines:* Fit tensioner spring and pillar bolt supplied with replacement timing belt, connect spring to tensioner backplate and pillar bolt.



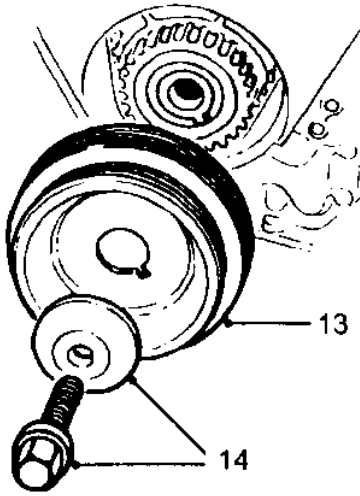
**CAUTION:** Ensure spring is the correct type for the engine being worked on:-

Non VVC engines:- Spring is fitted with a sleeve.  
VVC engines:- Spring is not fitted with a sleeve.



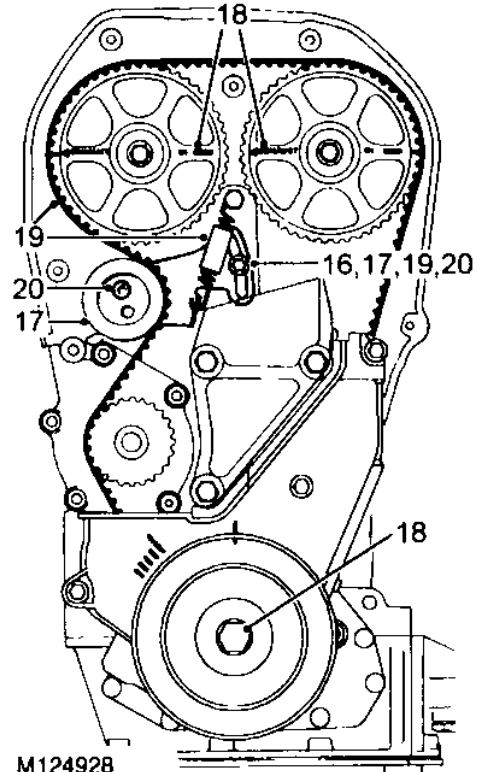
**NOTE:** Non VVC camshaft timing gears and tensioner spring illustrated.

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



M124927

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



M124928



NOTE: Non VVC camshaft timing gears and tensioner spring illustrated.

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



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

19. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
20. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.

# ENGINE

## VVC engines

21. Disconnect tensioner spring from pillar bolt, release spring from tensioner; remove and discard spring.
22. Remove and discard pillar bolt.

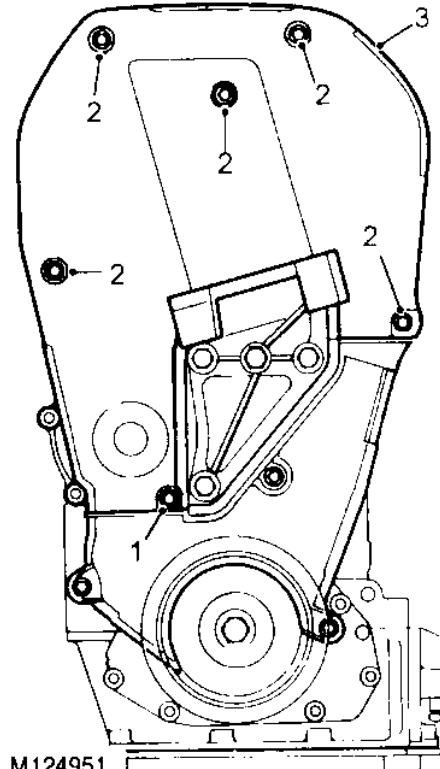
## All engines

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

## Camshaft timing belt - automatic tensioner - remove



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

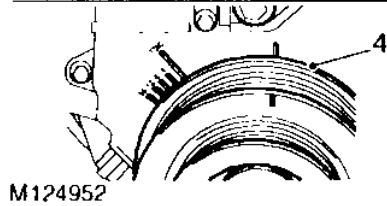
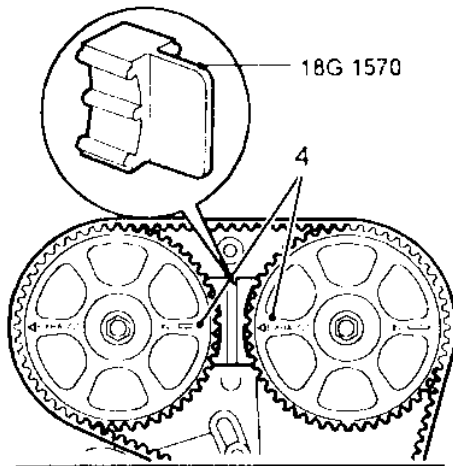


1. Slacken but do not remove bolt securing bottom of timing belt upper front cover.



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

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



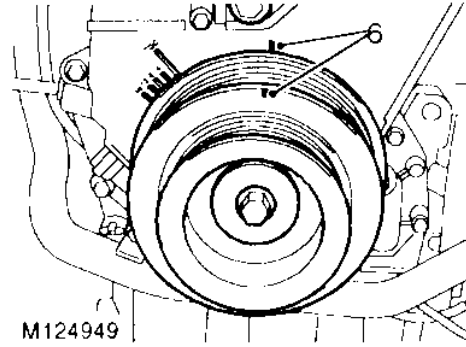
M124952

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



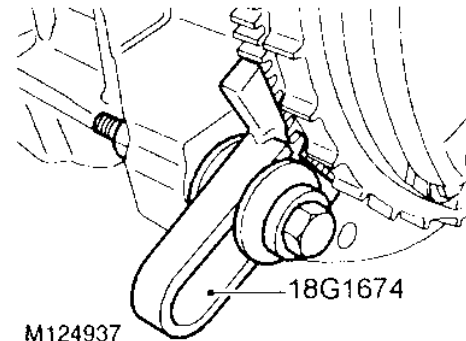
**CAUTION:** Do not use camshaft gears, gear retaining bolts or timing belt to rotate crankshaft.

5. Fit camshaft gear locking tool 18G 1570.



M124949

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



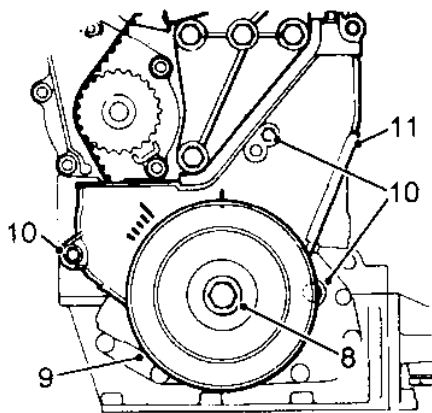
M124937

7. Fit flywheel locking tool 18G 1674, tighten bolt.



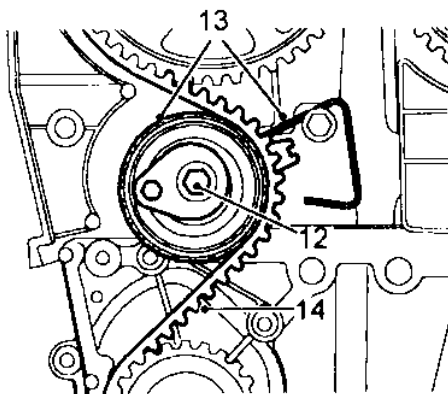
**CAUTION:** Ensure tooth on tool 18G 1674 engages with teeth on flywheel not the reluctor ring.





M124945

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



M124955

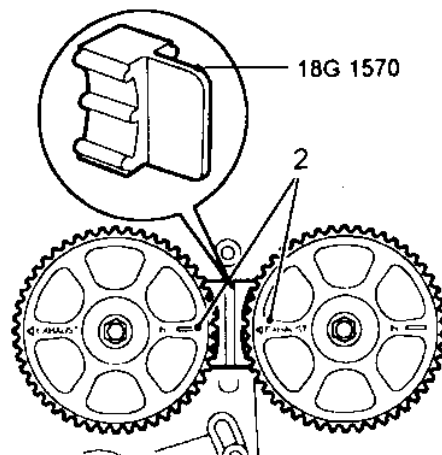
12. Remove and discard timing belt tensioner bolt.
13. Disengage index wire from its fitted position whilst at the same time removing the timing belt tensioner.
14. Ease timing belt from gears using the fingers only.
15. Discard timing belt.

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

## Camshaft timing belt - automatic tensioner - refit

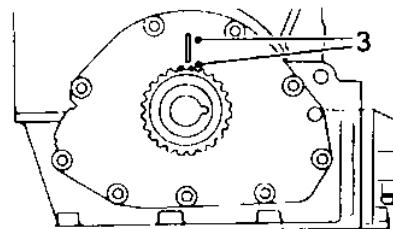
**CAUTION:** If the sintered gears have been subjected to prolonged oil contamination, they must be soaked in a solvent bath and then thoroughly washed in clean solvent before refitting. Because of the porous construction of sintered material, oil impregnated in the gears will emerge and contaminate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

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



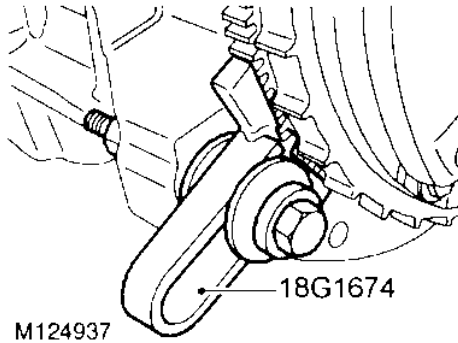
M124961

2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool 18G 1570.

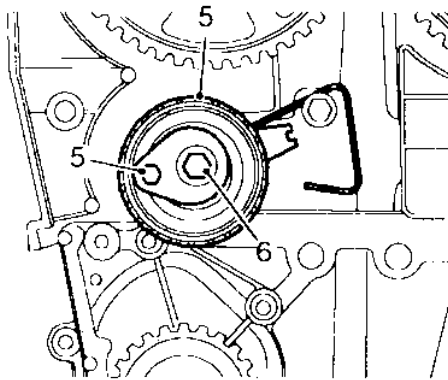


M124962

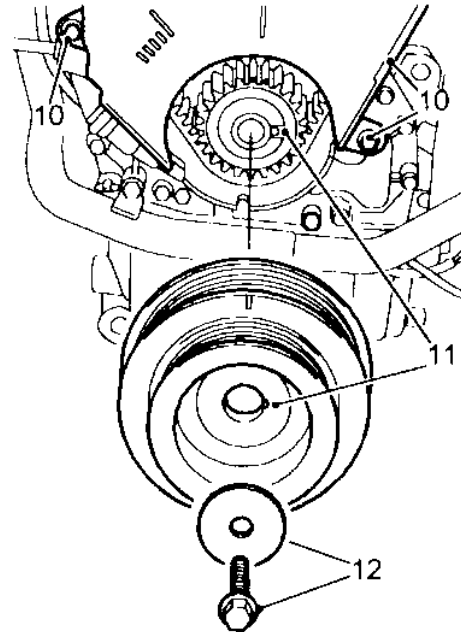
3. Check that crankshaft gear timing marks are aligned with flange on oil pump - 90° BTDC.



4. Fit flywheel locking tool **18G 1674**.

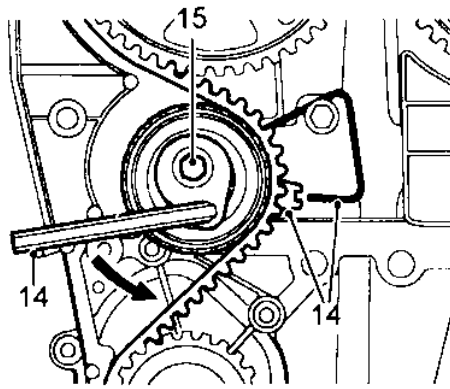


5. Fit timing belt tensioner ensuring that index wire is positioned over pillar bolt and that tensioner lever is at 9 o'clock position.
6. Fit a new tensioner securing bolt and tighten bolt until it is just possible to move tensioner lever.
7. Using the fingers only, fit a new timing belt over crankshaft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



10. Fit timing belt lower cover ensuring correct position of seals, fit screws and tighten to 9 Nm.
11. Fit crankshaft pulley to crankshaft gear ensuring that indent on pulley locates over lug on gear.
12. Fit crankshaft pulley bolt and washer, tighten to 205 Nm.
13. Remove camshaft gear and flywheel locking tools **18G 1570** and **18G 1674**.

## ENGINE

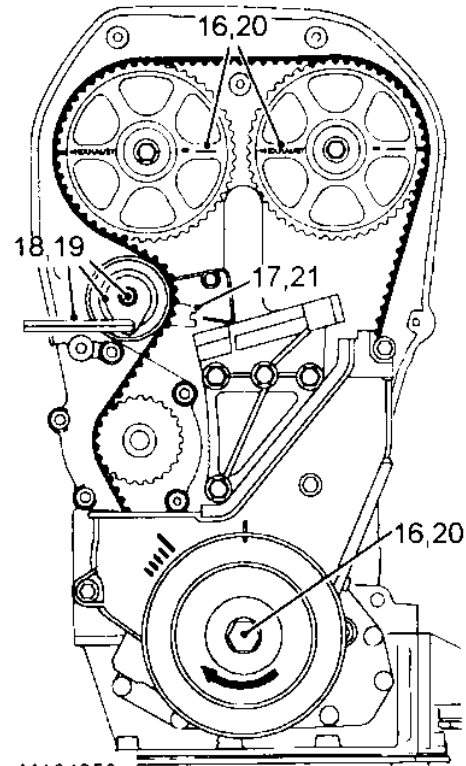


M124957

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

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

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



M124958

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

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

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

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

18. Slacken tensioner bolt until it is just possible to move the tensioner lever. Using a 6 mm Allen key, rotate tensioner lever clockwise until pointer is just above the index wire then rotate tensioner lever anti-clockwise until pointer is correctly aligned with index wire.
19. Ensuring that pointer maintains correct position tighten tensioner bolt to 25 Nm.
20. Using crankshaft pulley bolt, rotate crankshaft 2 turns clockwise and align camshaft gear timing marks.
21. Check that pointer is still correctly aligned with index wire.

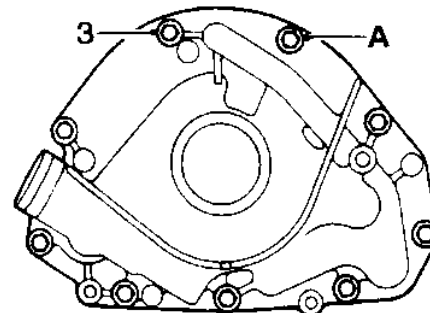


22. Ensure inserts are fitted in timing belt upper front cover.
23. Fit timing belt upper front cover ensuring correct position of seal, fit screws, tighten screws and bottom bolt to 5 Nm.

## OIL PUMP

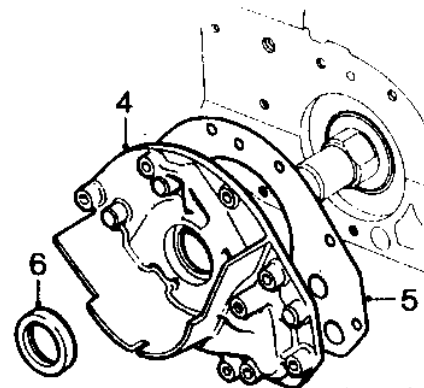
### Remove

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



12M1765

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



12M1766

4. Remove oil pump assembly.

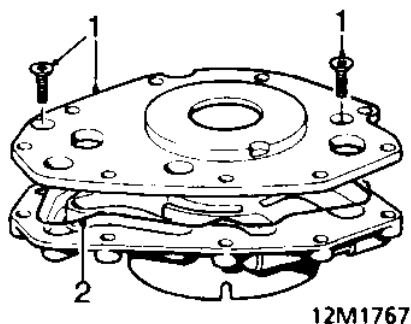
NOTE: Dowel located.



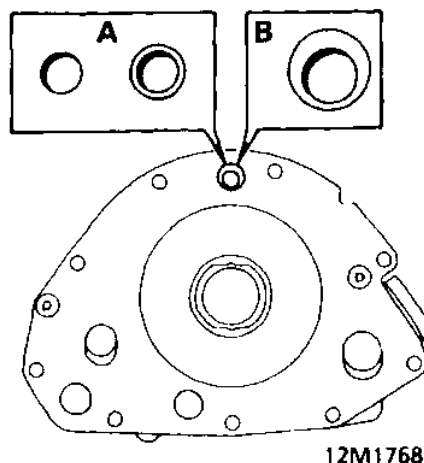
5. Remove and discard oil pump gasket.
6. Remove and discard crankshaft front oil seal.

# ENGINE

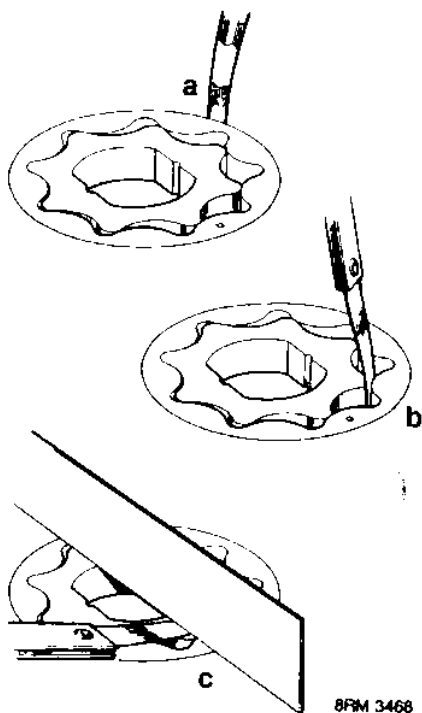
## Inspection



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



**CAUTION:** Two types of oil pump have been fitted. The early type oil pumps, fitted up to Engine No. 820000, can be identified by having either a plain 6 mm diameter oil feed hole or an 8 mm diameter oil feed hole with a 6 mm counterbore - A in illustration. Later type oil pumps, fitted from Engine No. 820000 all have a 12 mm diameter oil feed hole with an 8 mm diameter offset counterbore - B in illustration. Later type oil pumps may be fitted as replacements to all engines but early type pumps may not be fitted to engines from Engine No. 820000.

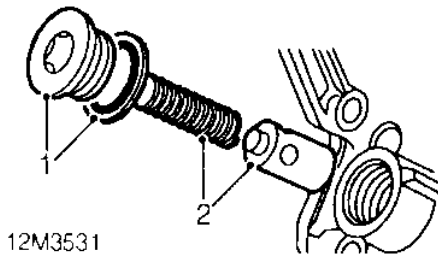


3. Check rotor clearances:
  - a. Outer rotor to housing = 0.28 - 0.36 mm
  - b. Inner rotor tip = 0.05 - 0.13 mm
  - c. Rotor end float = 0.02 - 0.06 mmRenew pump assembly if housing is scored or clearances are excessive.

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



## Oil pressure relief valve



12M3531

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



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

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

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

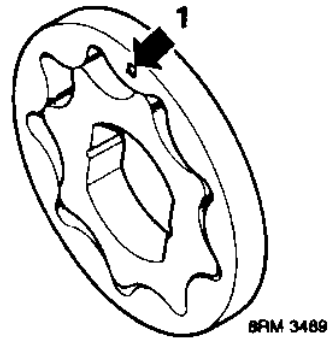
5. Remove all traces of Loctite from plug and threads in relief valve bore.



CAUTION: Do not use a tap.

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

## Oil pump assembling



8FM 3489

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

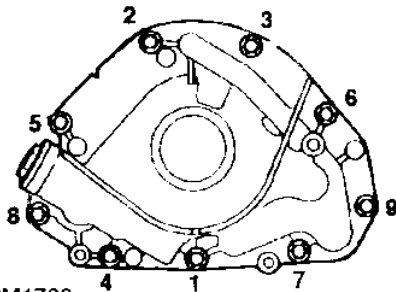
## ENGINE

### Oil pump - refit

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

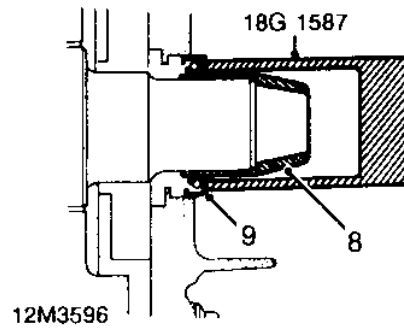


NOTE: This will assist in locating oil pump inner rotor.



12M1769

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



8. Ensure oil seal protector sleeve is located over end of crankshaft.
9. Position new crankshaft front oil seal on crankshaft against oil pump housing. Drift seal into position using tool 18G 1587.



CAUTION: Oil seal must be fitted dry.

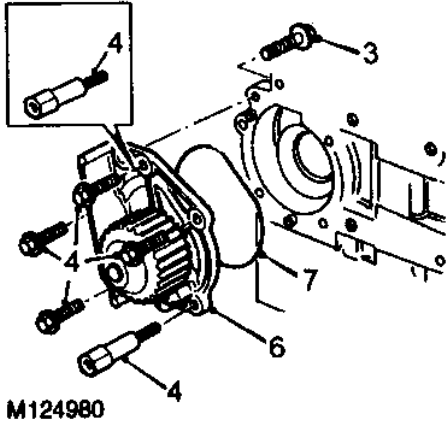
10. Remove tool 18G 1587 and oil seal protector sleeve.
11. Clean crankshaft timing gear.
12. Fit crankshaft timing gear.
13. Fit and adjust a new camshaft timing belt.



## COOLANT PUMP

### Remove

1. Remove and discard camshaft timing belt.
2. Remove thermostat and housing.

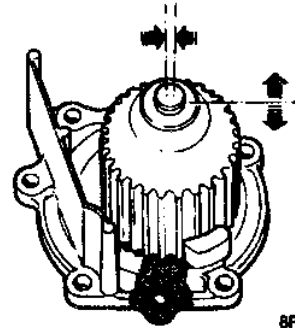


3. *Rear cover fitted:* Remove screw securing timing belt rear cover to coolant pump.
4. Noting their fitted position, remove bolts and pillar bolt securing coolant pump.

△ NOTE: 2 pillar bolts are fitted to some engines.

5. Release coolant pump from 2 dowels and rear cover.
6. Remove coolant pump.
7. Remove and discard 'O' ring from pump.

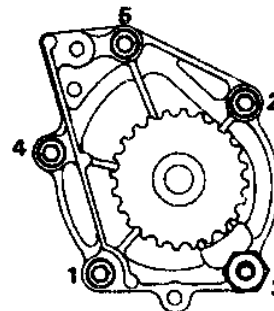
### Inspection



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

### Refit

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



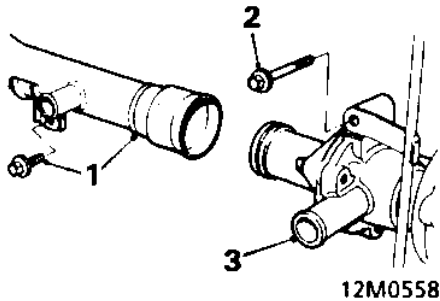
3. Fit coolant pump to cylinder block, fit bolts and pillar bolt(s) and tighten in sequence shown to 10 Nm.
4. *Rear cover fitted:* Fit timing belt rear cover securing screw, tighten to 9 Nm.
5. Fit thermostat and housing.
6. Fit and adjust a new camshaft timing belt.



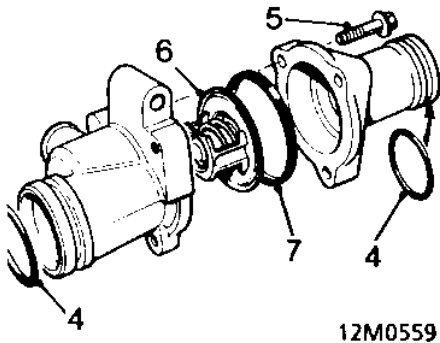
# ENGINE

## THERMOSTAT

### Remove



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



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

### Inspection

1. Test thermostat using thermostat test equipment, renew thermostat if necessary.
2. Thermostat open = 88° C  
Starts to open = 85° to 91° C  
Fully open = 100° C

### Refit

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



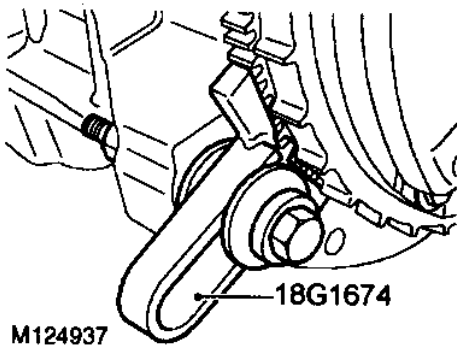
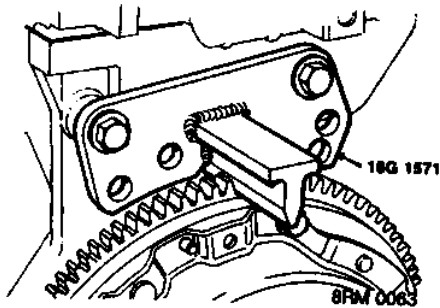
**CAUTION:** Torque figure must not be exceeded.

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



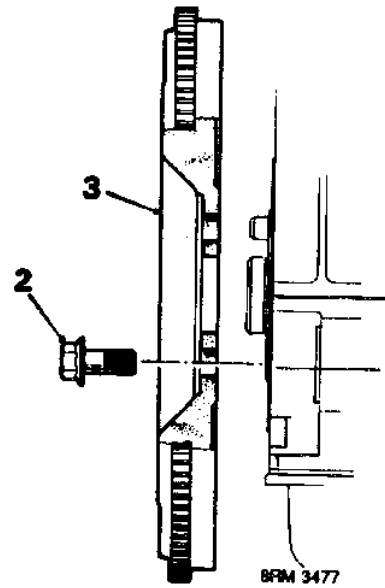
## FLYWHEEL AND STARTER RING GEAR

### Flywheel - remove



1. Fit flywheel locking tool:  
Flywheel without reluctor ring use 18G 1571.  
Flywheel with reluctor ring use 18G 1674.

**CAUTION:** Ensure tool engages teeth on flywheel not the reluctor ring.



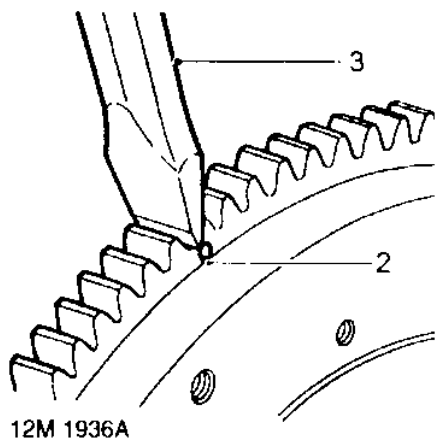
**NOTE:** Flywheel without reluctor ring illustrated.

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

**NOTE:** Dowel located.

## ENGINE

### Starter ring gear - remove



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



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

### Starter ring gear - refit

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



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

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

### Flywheel - refit



**CAUTION:** Flywheels fitted to VVC engines have a reluctor ring with 4 teeth at unequally spaced intervals missing whilst flywheels fitted to engines with plug top coil ignition have reluctor rings with equally spaced teeth. If the flywheel is to be replaced, it is essential that the replacement is of the correct type.

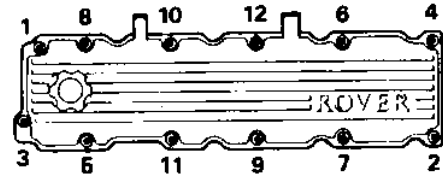
1. Clean flywheel and crankshaft faces. Use a clean bolt with two saw cuts along threads and clean adhesive from threaded holes in crankshaft.
2. Using assistance, fit flywheel to crankshaft, fit and tighten new Patchlok bolts to 80 Nm.



**CYLINDER HEAD**

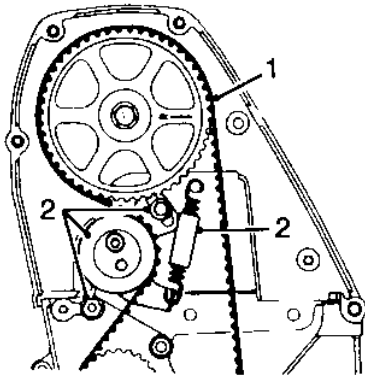
**Cylinder head - K8 engines - remove**

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



12M0549

5. Using sequence shown, progressively slacken and remove 12 bolts securing camshaft cover.
6. Remove camshaft cover, discard gasket.

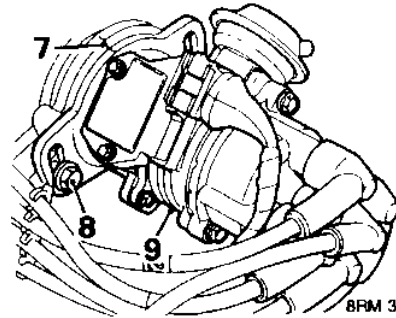
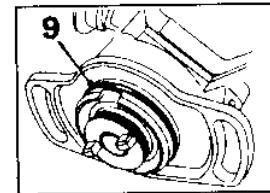


12M0553A

1. Remove and discard camshaft timing belt.

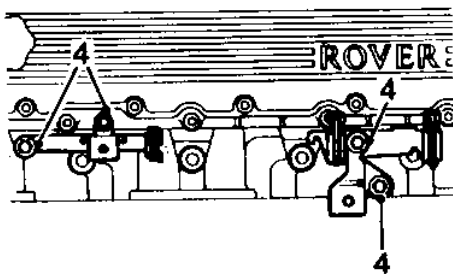
**CAUTION:** Do not rotate crankshaft whilst timing belt is removed and cylinder head is fitted, pistons will contact the valves.

2. Disconnect tensioner spring, remove pillar bolt, screw, tensioner and spring.
3. Disconnect ht leads from spark plugs.



8PM 3516

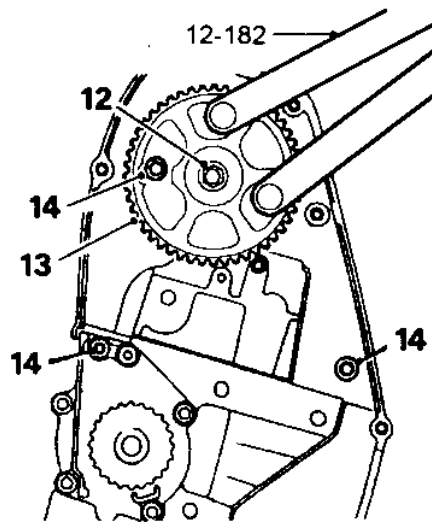
7. Mark distributor flange for refitting reference.
8. Remove 2 screws securing distributor.
9. Remove distributor, discard 'O' ring.
10. Remove any debris from spark plug recesses, remove and discard 4 spark plugs.



12M 0552 A

4. Remove 4 screws securing ht lead brackets, remove brackets.

## ENGINE



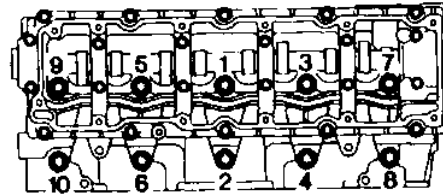
12M 0548A

11. Use tool 12-182 to hold camshaft gear against rotation.
12. Remove bolt and plain washer securing camshaft gear.
13. Remove camshaft gear.
14. Remove screws securing upper part of timing belt rear cover to cylinder head and screw securing rear of cover to coolant pump, remove cover.



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

15. Check and record crankshaft end-float.



16. Using sequence shown, progressively slacken 10 cylinder head to oil rail bolts. Remove bolts and store in fitted order.



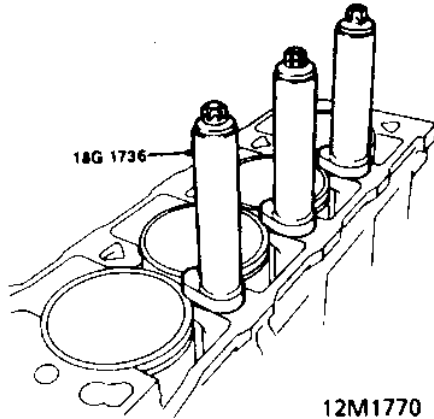
CAUTION: Removal of cylinder head bolts will result in a 'tightening-up' of the crankshaft, rotation of crankshaft must, therefore, be kept to a minimum. Do not rotate crankshaft until cylinder liner retainer clamps 18G 1736 are fitted.

17. Using assistance, remove cylinder head assembly.




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


18. Remove and discard cylinder head gasket.

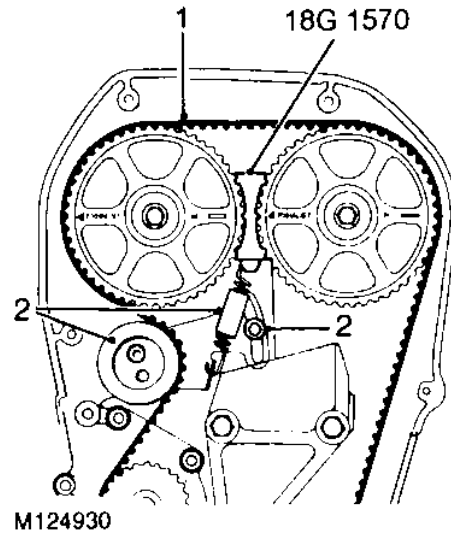


19. Assemble cylinder liner retainer clamps **18G 1736** to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.


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

**Cylinder head - K16 Non VVC engines fitted with distributor - remove**

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

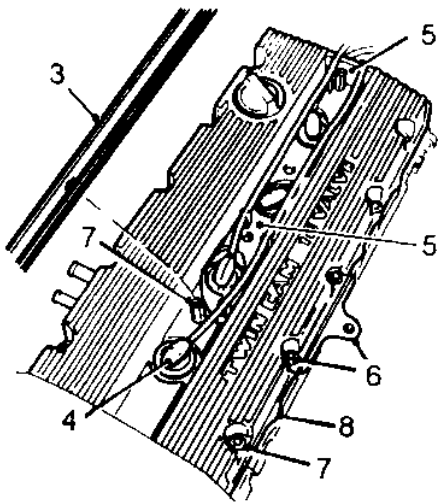


1. Remove and discard camshaft timing belt.

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

2. *Engines fitted with manual timing belt tensioner:-* Disconnect tensioner spring, remove bolt, screw, tensioner and spring.

## ENGINE

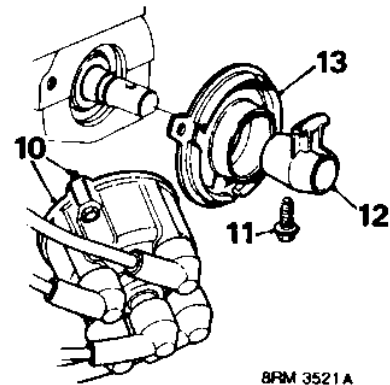


M124931

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

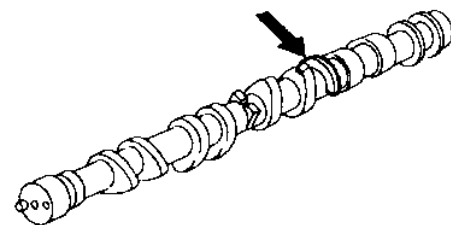
△ NOTE: On later engines, pillar bolts have been replaced by 'cast-in' supports which are an integral part of the camshaft cover.

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



8PM 3521 A

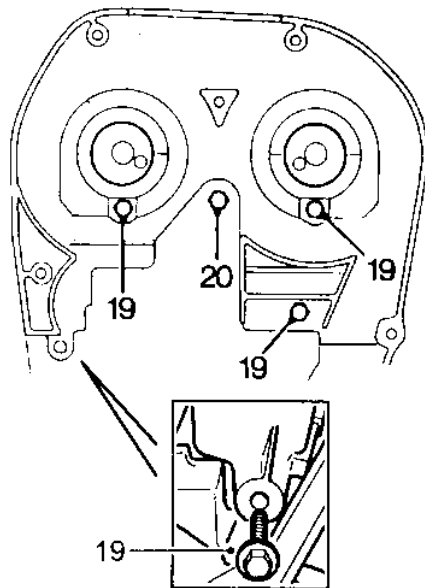
10. Release 2 screws and remove distributor cap.
11. Remove and discard screw securing rotor arm.
12. Remove rotor arm.
13. Remove anti-flash shield.



M124973

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

## ENGINE



12M0577A

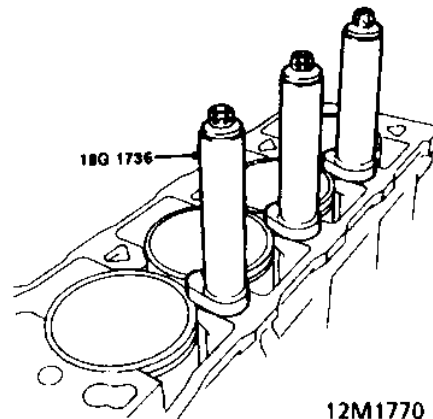
19. Remove screws securing upper part of timing belt rear cover to cylinder head and screw securing rear of cover to coolant pump.

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

20. Remove timing belt tensioner pillar bolt.  
21. Using assistance, remove cylinder head assembly from cylinder block.

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

22. Remove and discard cylinder head gasket.



12M1770

23. Assemble cylinder liner retainer clamps 18G 1736 to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.



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





**Cylinder head - K16 non VVC engines fitted with plug top coil ignition system - remove**

*If fitted*



NOTE: Commencing engine numbers for these engines are listed in Information

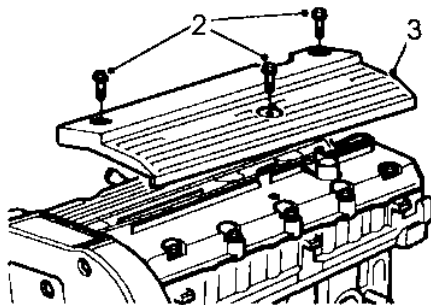


CAUTION: If crankshaft is to be removed during overhaul it will be necessary to check and record crankshaft end-float prior to removing cylinder head.

1. Remove and discard camshaft timing belt.

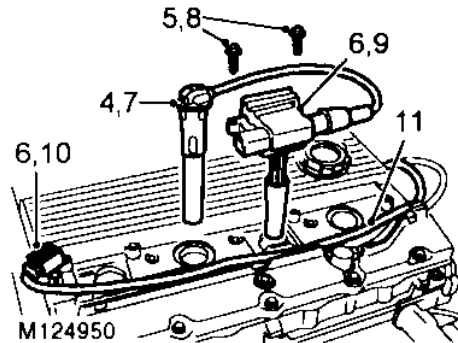


CAUTION: Do not rotate crankshaft whilst timing belt is removed and cylinder head is fitted, pistons will contact the valves.



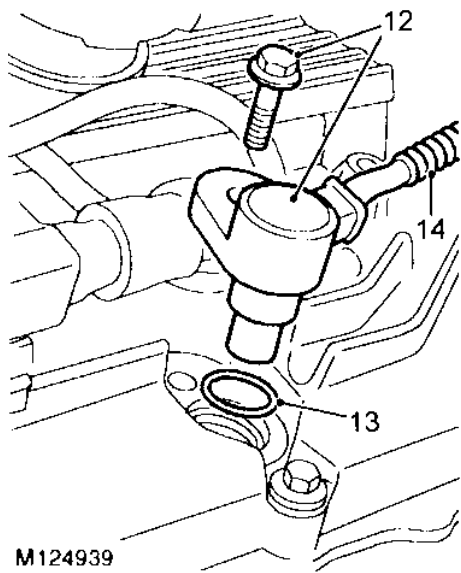
M124959

2. Noting that shortest screw is fitted in centre of spark plug cover, remove 3 screws securing cover to camshaft cover.
3. Remove spark plug cover.

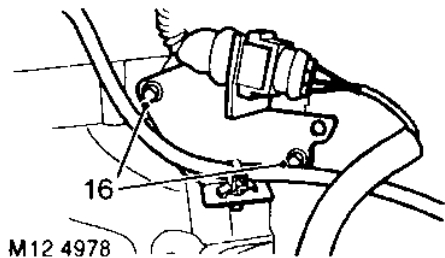


M124950

4. Disconnect ht lead and plug tube from No. 4 spark plug.
5. Remove 2 bolts securing front coil to camshaft cover.
6. Carefully raise coil until plug tube is disconnected from No. 1 spark plug, disconnect multiplug from coil.
7. Disconnect ht lead and plug tube from No. 2 spark plug.
8. Remove 2 bolts securing rear coil to camshaft cover.
9. Carefully raise coil until plug tube is disconnected from No. 3 spark plug.
10. Disconnect multiplug from coil.
11. Release harness from clips.



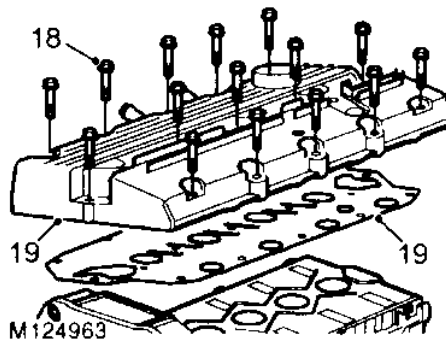
12. Remove bolt securing camshaft sensor to camshaft cover, withdraw sensor.
13. Remove and discard 'O' ring.
14. Release harness from clip.
15. Position harness aside.



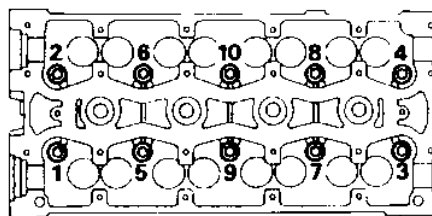
16. Remove 2 bolts securing multiplug bracket to camshaft carrier, remove bracket.

## All cylinder heads

17. Remove any debris from spark plug recesses, remove 4 spark plugs.

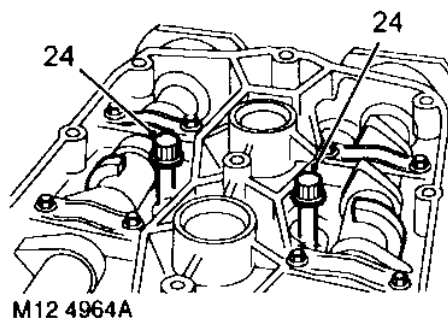
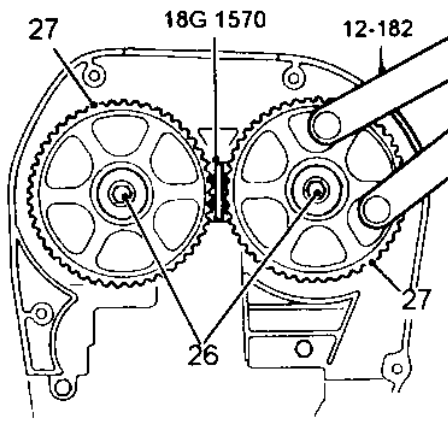


18. Progressively slacken then remove 15 bolts securing camshaft cover.
19. Remove camshaft cover, remove and discard gasket.
20. Check and record crankshaft end-float.

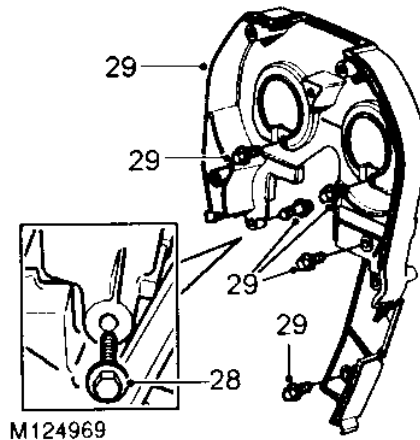


21. Using sequence shown, progressively slacken cylinder head bolts 1 to 6.

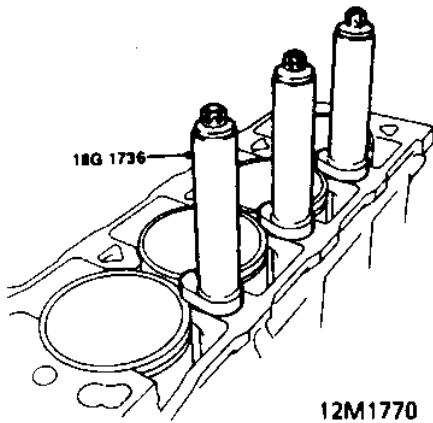
△ NOTE: It will be necessary to carry out the following operations in order to remove the remaining bolts.



22. Remove camshaft locking tool **18G 1570**.
  23. Using tool **12-182**, rotate inlet and exhaust camshafts clockwise until reluctor rings clear bolt heads 7 and 8.
  24. Progressively slacken cylinder head bolts 7 to 10.
  25. Remove 10 cylinder head bolts and store in fitted order.
- CAUTION:** Removal of cylinder head bolts results in a 'tightening-up' of crankshaft; rotation of crankshaft must, therefore, be kept to a minimum. Do not rotate crankshaft until cylinder liner retainer clamps **18G 1736** are fitted.
26. Suitably identify each camshaft gear to its respective camshaft and using tool **12-182** to hold camshaft gear against rotation, remove bolt and plain washer from each camshaft gear.
  27. Remove camshaft gears.



- NOTE:** Timing belt rear cover fitted to engine with 5 bolt front engine mounting illustrated.
28. Remove screw securing rear of timing belt rear cover to coolant pump.
- NOTE:** This is the longest of the rear cover securing screws.
29. Remove screws securing timing belt rear cover, remove cover.
  30. Remove timing belt tensioner pillar bolt.
  31. Using assistance, remove cylinder head assembly from cylinder block.
- CAUTION:** Cylinder head is dowel located, do not tap it sideways to free it from cylinder block. Place cylinder head assembly on blocks of wood to prevent damaging valves.
32. Remove and discard cylinder head gasket.



33. Assemble cylinder liner retainer clamps 18G 1736 to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.

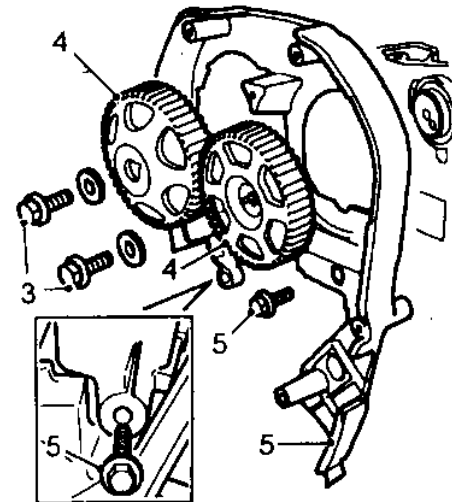
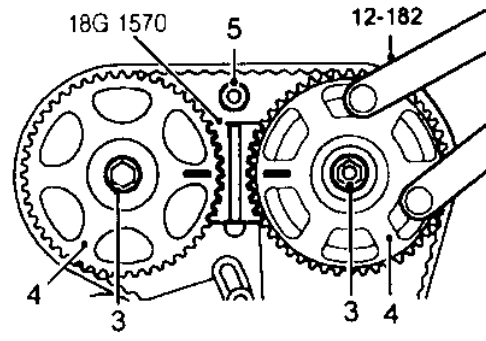
**CAUTION:** Ensure that bolts used are those originally fitted in that location.

## Cylinder head - K16 VVC engines - remove

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

1. Remove and discard camshaft timing belt.

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



M124932A

2. Ensure that tool 18G 1570 is fitted to camshaft gears.
3. Suitably identify each camshaft gear to its respective camshaft and using tool 12-182 to restrain camshaft gears against rotation, remove bolt and plain washer securing each camshaft gear.
4. Remove tool 18G 1570, remove camshaft gears.

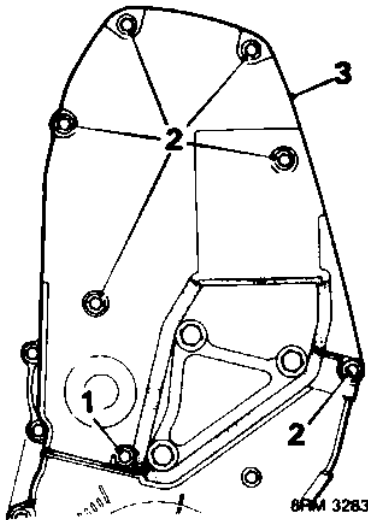


## CAMSHAFT TIMING BELT - K8 ENGINES

Remove



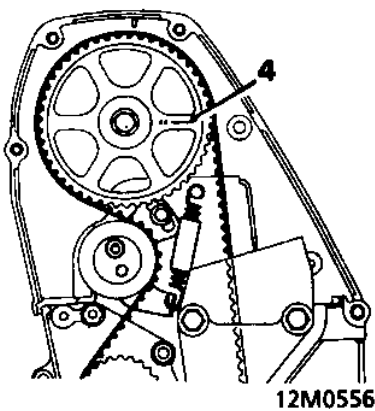
**CAUTION:** Do not use camshaft gear, gear retaining bolt or timing belt to rotate crankshaft.



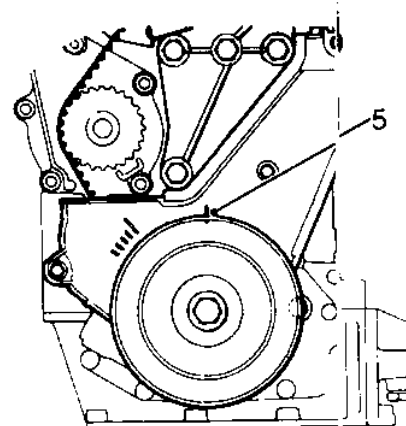
1. Slacken bottom bolt securing timing belt upper front cover.

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

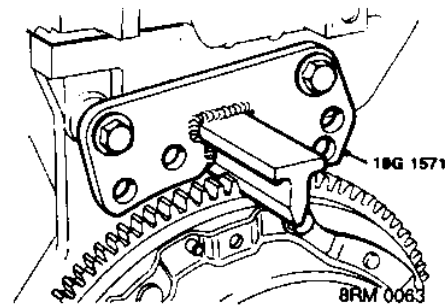
2. Remove 6 bolts from timing belt upper front cover.
3. Remove timing belt upper front cover and seal.



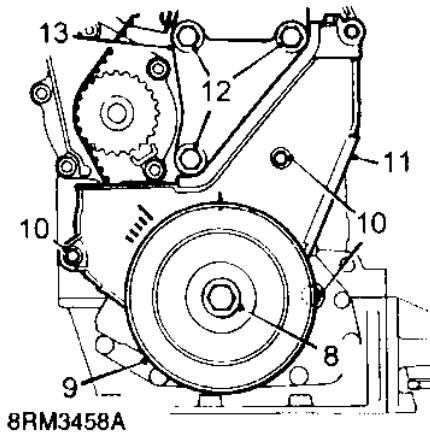
4. Rotate crankshaft clockwise to align camshaft gear timing marks with top face of cylinder head - 90° BTDC.



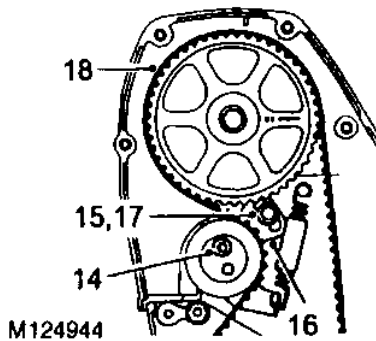
5. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.



6. Position flywheel locking tool 18G 1571 to flywheel.
7. Secure with 2 bolts.



8. Remove crankshaft pulley bolt and washer.
9. Remove crankshaft pulley.
10. Remove 3 bolts securing timing belt lower cover.
11. Remove timing belt lower cover together with seals.
12. Remove 3 bolts, mounting bracket to engine.
13. Remove mounting bracket.



14. Slacken tensioner pulley Allen screw.
15. Slacken tensioner backplate screw.
16. Push tensioner pulley down to fully OFF position.
17. Tighten backplate screw to 10 Nm.
18. Ease timing belt from gears using the fingers only.
19. Discard timing belt.



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

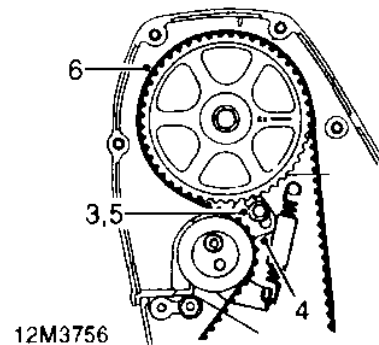
## Refit

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



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

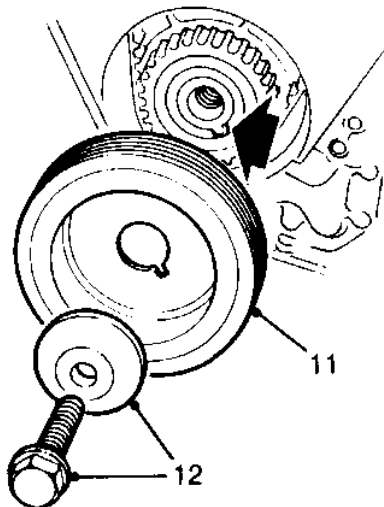
2. Check correct alignment of timing marks for 90° BTDC:  
Crankshaft gear dots align with flange on oil pump.  
Camshaft gear mark to right aligns with top face of cylinder head.



3. Slacken tensioner backplate screw, ensure tensioner moves fully through its adjustment range and returns under spring tension.
4. Push tensioner pulley down to fully OFF position.
5. Tighten backplate screw to 10 Nm.
6. Using the fingers only, fit a new timing belt over crankshaft timing gear, camshaft gear, tensioner pulley and coolant pump drive gear, ensure belt is positioned centrally on gears and pulley and that any slack in the belt is on the tensioner pulley side of the belt.
7. Clean all traces of Loctite from engine mounting bracket securing bolts and apply Loctite 542 to threads of bolts.
8. Fit engine mounting bracket, tighten bolts to 45 Nm.

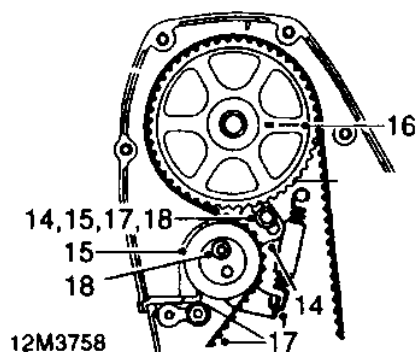


9. Ensure inserts are fitted in timing belt lower cover.
10. Fit timing belt lower cover, ensuring correct position of seals, tighten screws to 10 Nm.



12M3757

11. Fit crankshaft pulley to crankshaft timing gear ensuring that indent on pulley locates over gear lug (arrowed).
12. Fit crankshaft pulley bolt and washer, tighten to 205 Nm.
13. Remove flywheel locking tool 18G 1571.



12M3758

14. Slacken tensioner backplate screw and tension timing belt by applying finger pressure to tensioner backplate.

15. With tensioner pulley against timing belt and backplate held in position, tighten backplate screw to 10 Nm.
16. Rotate crankshaft clockwise 2 complete revolutions and align camshaft gear timing mark with top face of cylinder head.

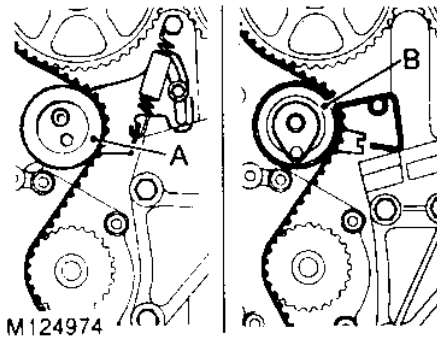


**CAUTION:** Do not use camshaft gear, gear retaining bolt or timing belt to rotate crankshaft.

17. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
18. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.
19. Ensure inserts are fitted in timing belt upper front cover.
20. Fit timing belt upper front cover, ensuring correct position of seals, tighten screws and bolt to 5 Nm.

# ENGINE

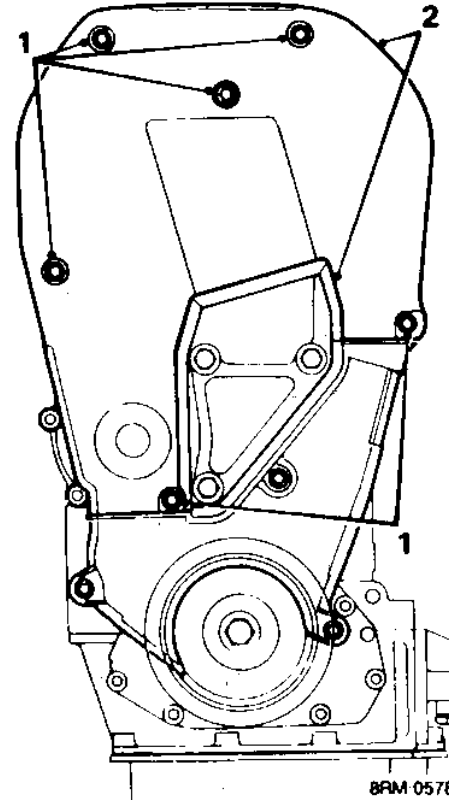
## CAMSHAFT TIMING BELT - K16 ENGINES



NOTE: Two types of timing belt tensioner are fitted to K16 engines, type A is a manual tensioner fitted to some K16 non VVC and all VVC engines. Type B is an automatic tensioner fitted to some K16 non VVC engines. Commencing engine numbers for the automatic tensioner are listed in Information. The tensioners and their timing belts are not interchangeable. The manual timing belt tensioner spring fitted to K16 non VVC engines is fitted with a sleeve, whilst on VVC engines only a spring is fitted.

### Camshaft timing belt - manual tensioner - remove

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

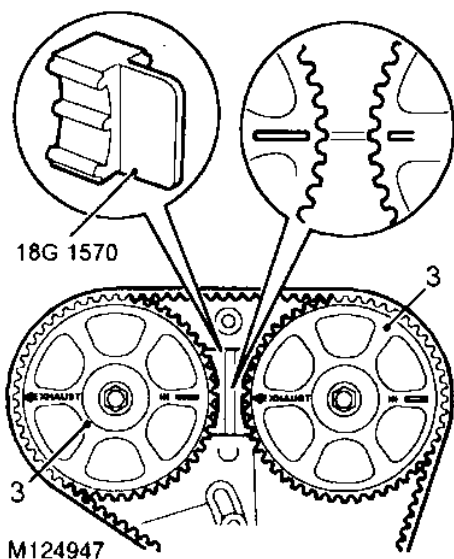


1. Slacken bottom bolt and remove 5 screws securing timing belt upper front cover.

NOTE: Remove bottom bolt when cover is not slotted.

2. Remove timing belt upper front cover and seal.



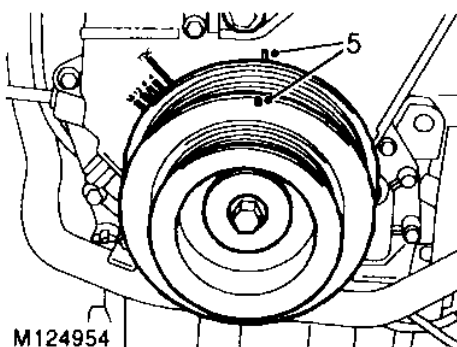


NOTE: VVC camshaft timing gear marks are shown in the inset on the illustration.

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

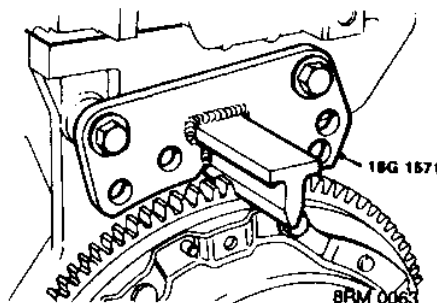
CAUTION: Do not use camshaft gears, gear retaining bolts or timing belt to rotate crankshaft.

4. Fit camshaft gear locking tool 18G 1570.



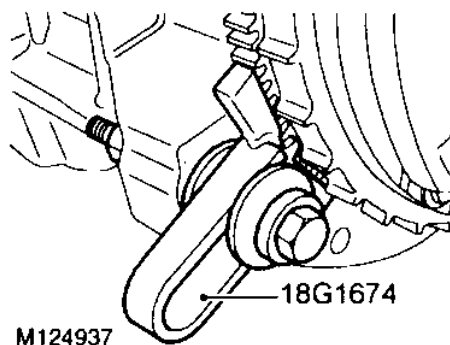
5. Check that timing mark on crankshaft pulley is aligned with mark on timing belt lower cover.

#### Flywheel not fitted with a reluctor ring



6. Fit flywheel locking tool 18G 1571.
7. Secure with 2 bolts.

#### Flywheel fitted with a reluctor ring

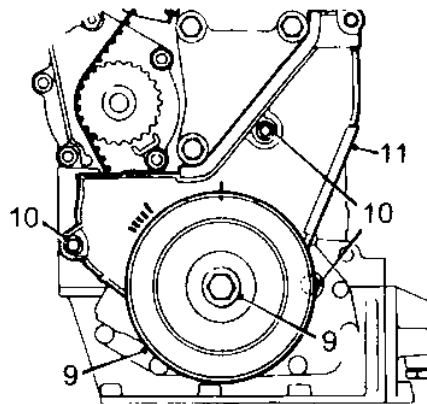


8. Fit flywheel locking tool 18G 1674, tighten bolt.

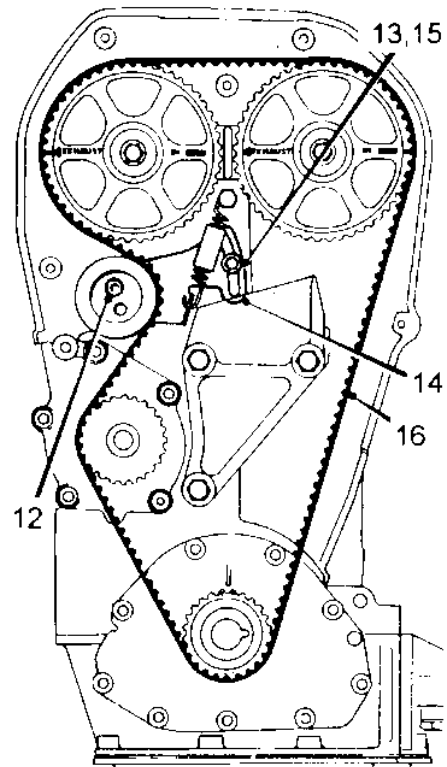
CAUTION: Ensure tooth on tool 18G 1674 engages with teeth on flywheel not the reluctor ring


# ENGINE

## All engines




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




 NOTE: Non VVC camshaft timing gears and tensioner spring illustrated.

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

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

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

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



### Camshaft timing belt - manual tensioner - refit

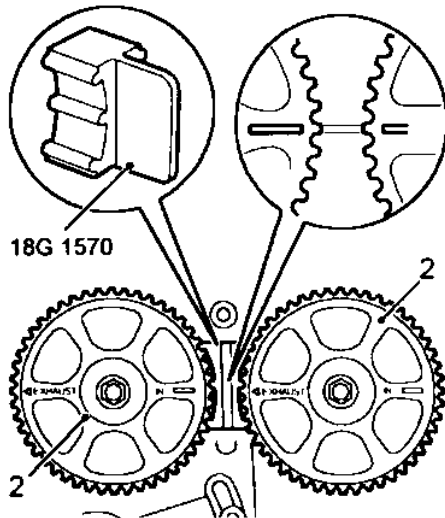


**CAUTION: VVC engines:-** When a replacement timing belt is to be fitted, it will be necessary to fit the tensioner spring and pillar bolt supplied with the replacement belt to adjust belt tension.

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



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

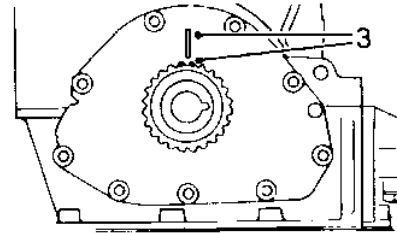


M124929



**NOTE:** VVC camshaft gear timing marks are shown in the inset on the illustration.

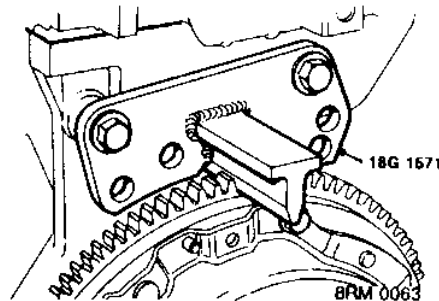
2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool 18G 1570.



M124962

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

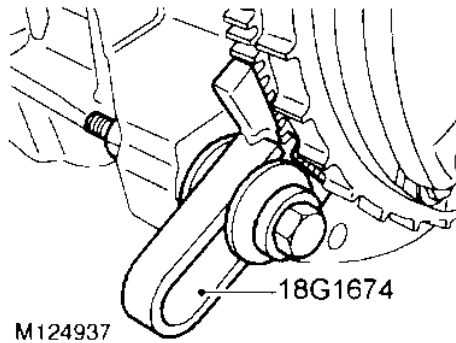
### Flywheel not fitted with a reluctor ring



4. Fit flywheel locking tool 18G 1571, secure with 2 bolts.

## ENGINE

### Flywheel fitted with a reluctor ring



5. Fit flywheel locking tool **18G 1674**, tighten bolt.



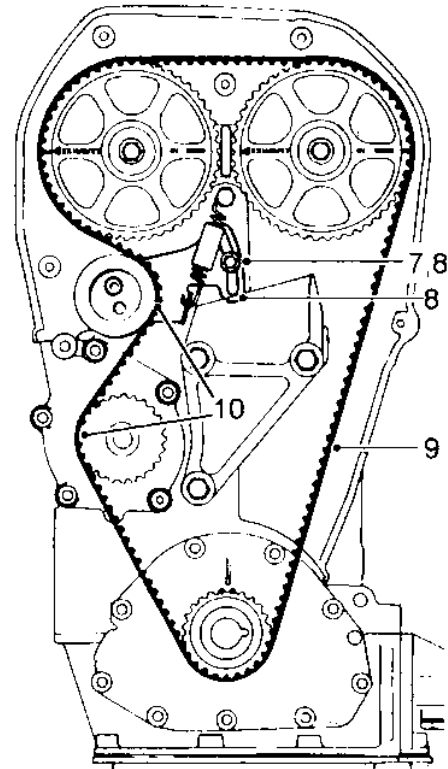
**CAUTION:** Ensure tooth on tool **18G 1674** engages with teeth on flywheel not the reluctor ring.

6. *VVC engines:* Fit tensioner spring and pillar bolt supplied with replacement timing belt, connect spring to tensioner backplate and pillar bolt.



**CAUTION:** Ensure spring is the correct type for the engine being worked on:-

Non VVC engines:- Spring is fitted with a sleeve.  
VVC engines:- Spring is not fitted with a sleeve.

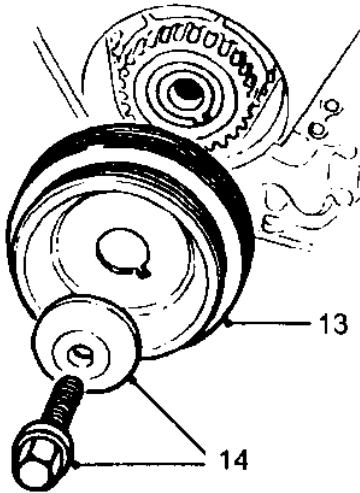


M124926



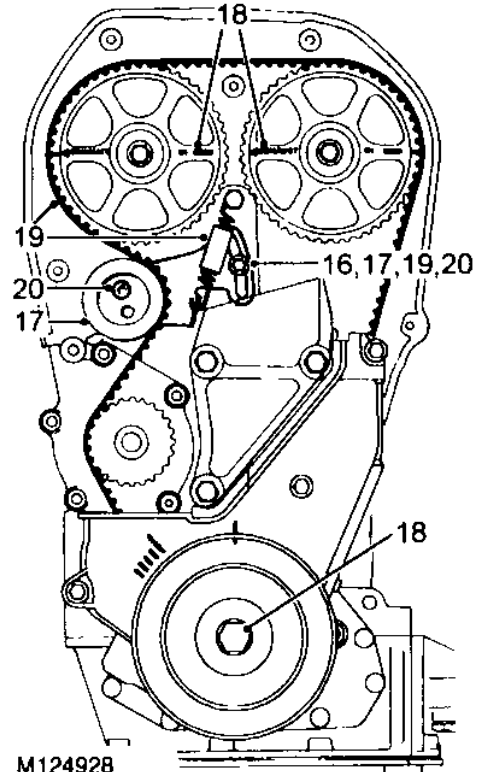
**NOTE:** Non VVC camshaft timing gears and tensioner spring illustrated.

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




M124927


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



M124928

 NOTE: Non VVC camshaft timing gears and tensioner spring illustrated.

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

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

19. Slacken tensioner backplate screw and check that belt is being tensioned by the tensioner spring.
20. Tighten tensioner backplate screw to 10 Nm and tensioner pulley Allen screw to 45 Nm.

# ENGINE

## VVC engines

21. Disconnect tensioner spring from pillar bolt, release spring from tensioner; remove and discard spring.
22. Remove and discard pillar bolt.

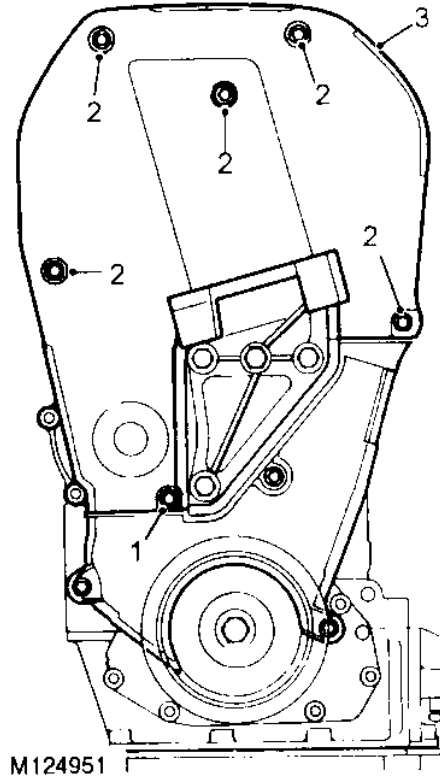
## All engines

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

## Camshaft timing belt - automatic tensioner - remove



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

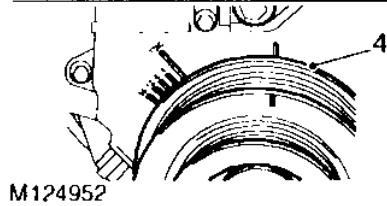
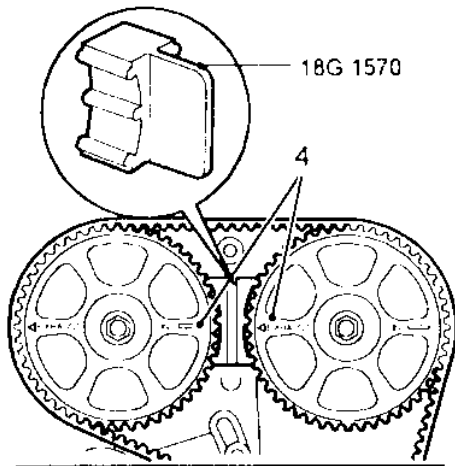


1. Slacken but do not remove bolt securing bottom of timing belt upper front cover.



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

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



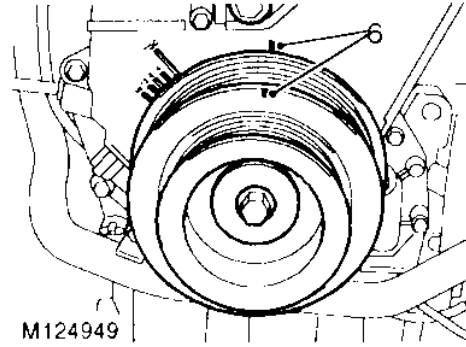
M124952

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



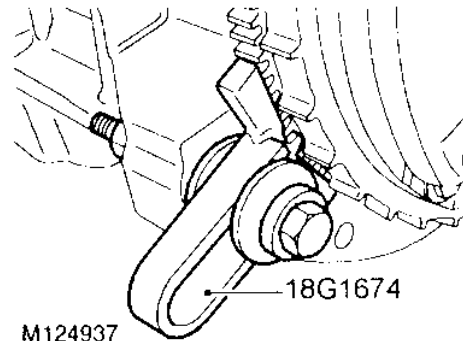
**CAUTION:** Do not use camshaft gears, gear retaining bolts or timing belt to rotate crankshaft.

5. Fit camshaft gear locking tool 18G 1570.



M124949

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

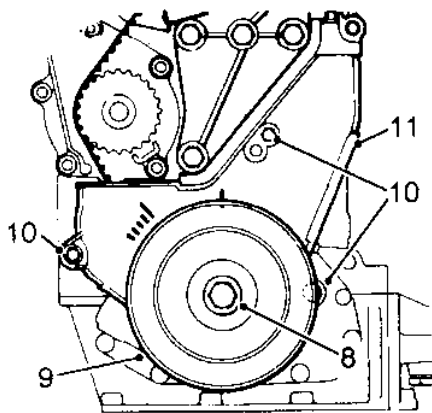


M124937

7. Fit flywheel locking tool 18G 1674, tighten bolt.

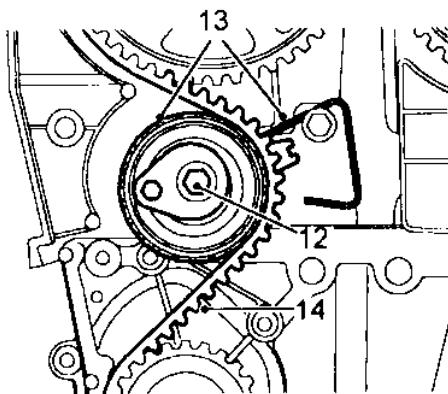


**CAUTION:** Ensure tooth on tool 18G 1674 engages with teeth on flywheel not the reluctor ring.



M124945

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



M124955

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

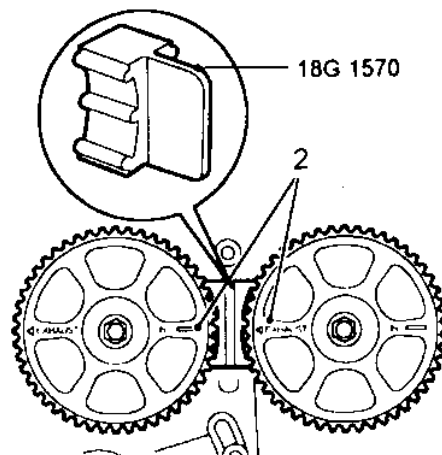
**CAUTION:** Timing belt must always be replaced during engine overhaul. Do not rotate crankshaft with timing belt removed and cylinder head fitted.

## Camshaft timing belt - automatic tensioner - refit



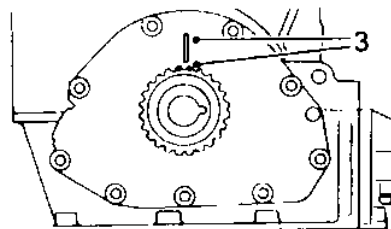
**CAUTION:** If the sintered gears have been subjected to prolonged oil contamination, they must be soaked in a solvent bath and then thoroughly washed in clean solvent before refitting. Because of the porous construction of sintered material, oil impregnated in the gears will emerge and contaminate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

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



M124961

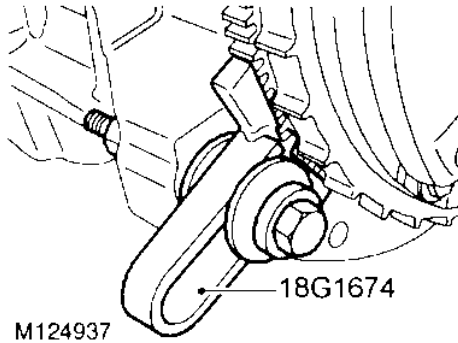
2. Check correct alignment of camshaft gear timing marks, fit camshaft gear locking tool 18G 1570.



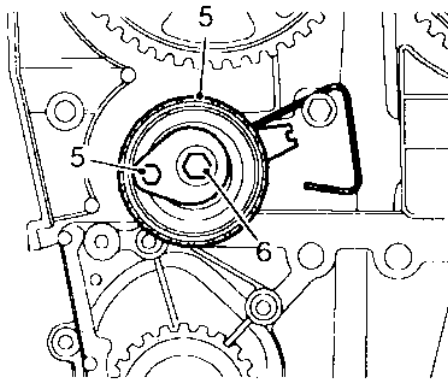
M124962

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

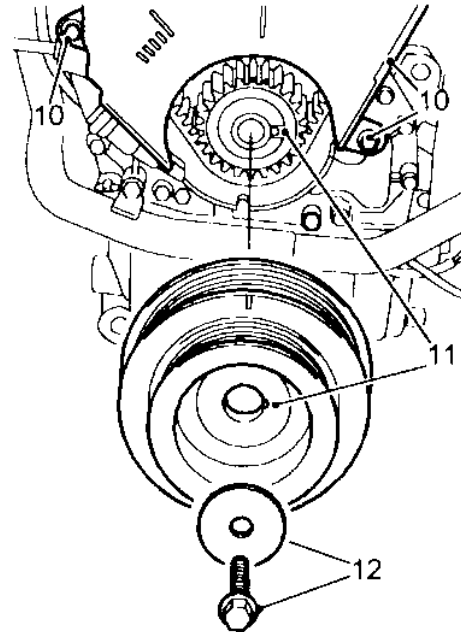




4. Fit flywheel locking tool **18G 1674**.

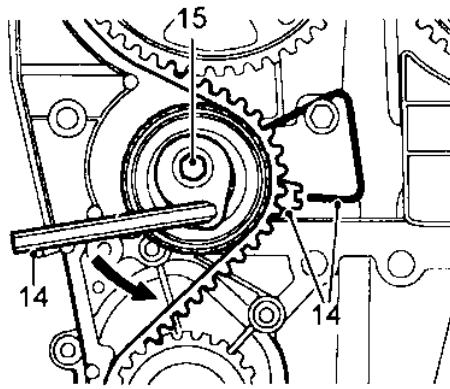


5. Fit timing belt tensioner ensuring that index wire is positioned over pillar bolt and that tensioner lever is at 9 o'clock position.
6. Fit a new tensioner securing bolt and tighten bolt until it is just possible to move tensioner lever.
7. Using the fingers only, fit a new timing belt over crankshaft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



10. Fit timing belt lower cover ensuring correct position of seals, fit screws and tighten to 9 Nm.
11. Fit crankshaft pulley to crankshaft gear ensuring that indent on pulley locates over lug on gear.
12. Fit crankshaft pulley bolt and washer, tighten to 205 Nm.
13. Remove camshaft gear and flywheel locking tools **18G 1570** and **18G 1674**.

## ENGINE

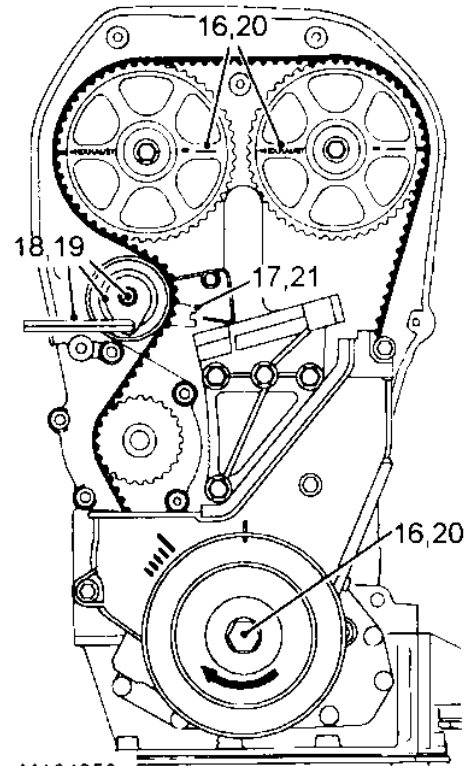


M124957

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

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

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



M124958

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

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

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

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

18. Slacken tensioner bolt until it is just possible to move the tensioner lever. Using a 6 mm Allen key, rotate tensioner lever clockwise until pointer is just above the index wire then rotate tensioner lever anti-clockwise until pointer is correctly aligned with index wire.
19. Ensuring that pointer maintains correct position tighten tensioner bolt to 25 Nm.
20. Using crankshaft pulley bolt, rotate crankshaft 2 turns clockwise and align camshaft gear timing marks.
21. Check that pointer is still correctly aligned with index wire.

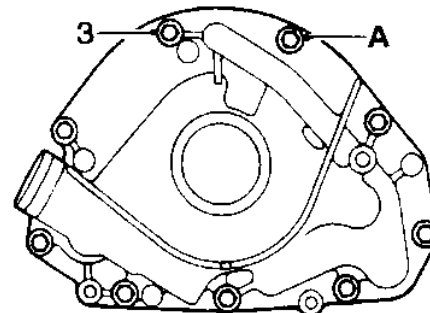


22. Ensure inserts are fitted in timing belt upper front cover.
23. Fit timing belt upper front cover ensuring correct position of seal, fit screws, tighten screws and bottom bolt to 5 Nm.

## OIL PUMP

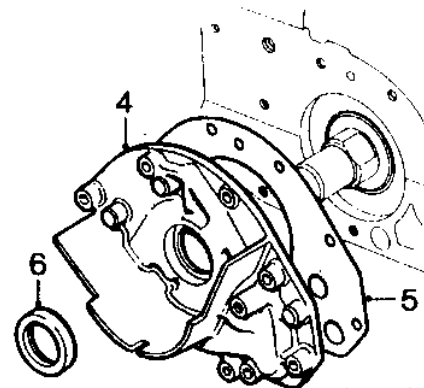
### Remove

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



12M1765

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



12M1766

4. Remove oil pump assembly.

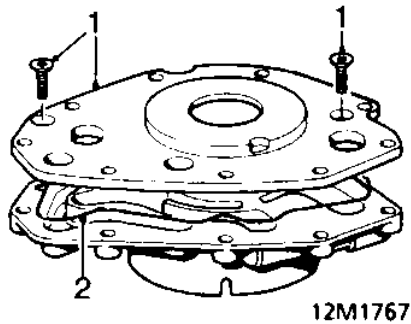
NOTE: Dowel located.



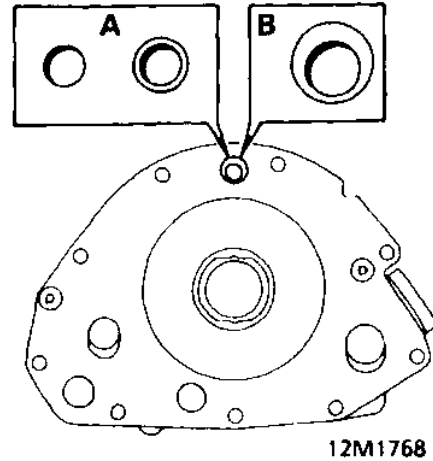
5. Remove and discard oil pump gasket.
6. Remove and discard crankshaft front oil seal.

# ENGINE

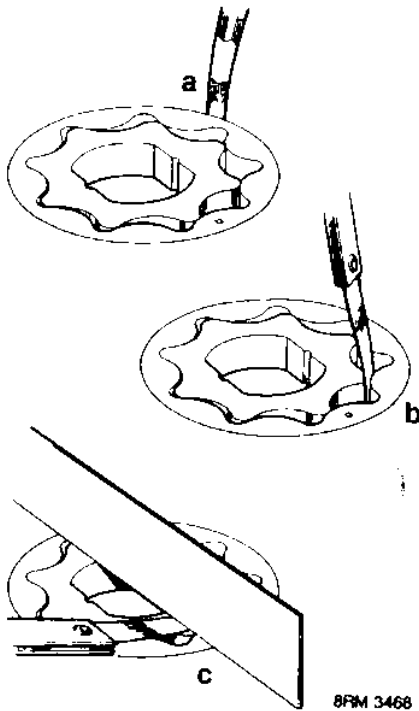
## Inspection



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



**CAUTION:** Two types of oil pump have been fitted. The early type oil pumps, fitted up to Engine No. 820000, can be identified by having either a plain 6 mm diameter oil feed hole or an 8 mm diameter oil feed hole with a 6 mm counterbore - A in illustration. Later type oil pumps, fitted from Engine No. 820000 all have a 12 mm diameter oil feed hole with an 8 mm diameter offset counterbore - B in illustration. Later type oil pumps may be fitted as replacements to all engines but early type pumps may not be fitted to engines from Engine No. 820000.

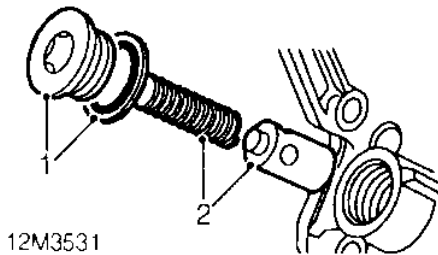


3. Check rotor clearances:
  - a. Outer rotor to housing = 0.28 - 0.36 mm
  - b. Inner rotor tip = 0.05 - 0.13 mm
  - c. Rotor end float = 0.02 - 0.06 mmRenew pump assembly if housing is scored or clearances are excessive.

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



## Oil pressure relief valve



12M3531

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



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

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

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

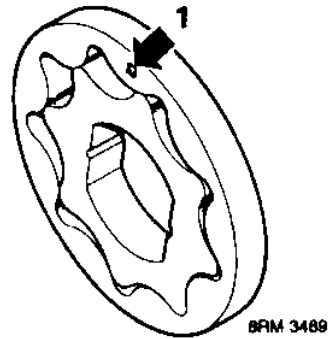
5. Remove all traces of Loctite from plug and threads in relief valve bore.



CAUTION: Do not use a tap.

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

## Oil pump assembling



8FM 3489

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

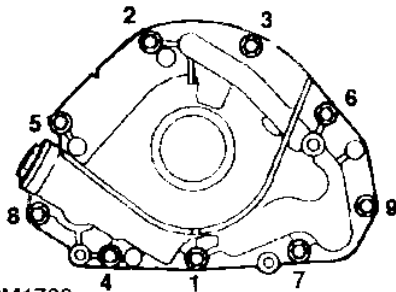
## ENGINE

### Oil pump - refit

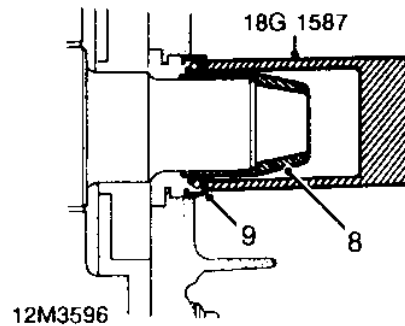
1. Clean oil pump.
2. Using gasket removal spray and a plastic scraper, remove all traces of gasket from oil pump.
3. Clean oil seal running surface on crankshaft.
4. Fit a new, dry, oil pump gasket.
5. Turn oil pump rotor to align drive with crankshaft.
6. Fit oil seal protector sleeve, from seal kit,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



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



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



8. Ensure oil seal protector sleeve is located over end of crankshaft.
9. Position new crankshaft front oil seal on crankshaft against oil pump housing. Drift seal into position using tool 18G 1587.



CAUTION: Oil seal must be fitted dry.

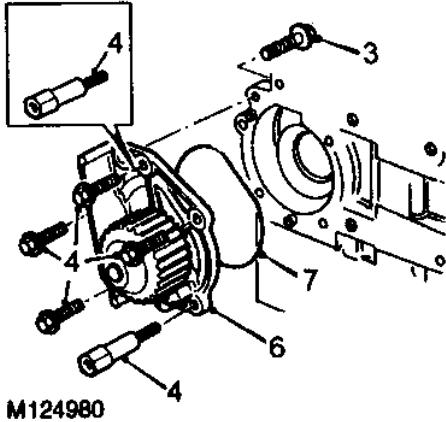
10. Remove tool 18G 1587 and oil seal protector sleeve.
11. Clean crankshaft timing gear.
12. Fit crankshaft timing gear.
13. Fit and adjust a new camshaft timing belt.



## COOLANT PUMP

### Remove

1. Remove and discard camshaft timing belt.
2. Remove thermostat and housing.

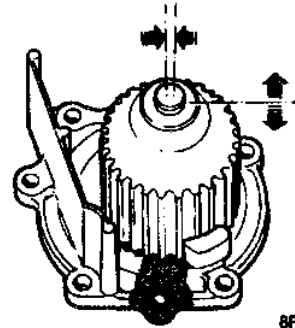


3. *Rear cover fitted:* Remove screw securing timing belt rear cover to coolant pump.
4. Noting their fitted position, remove bolts and pillar bolt securing coolant pump.

△ NOTE: 2 pillar bolts are fitted to some engines.

5. Release coolant pump from 2 dowels and rear cover.
6. Remove coolant pump.
7. Remove and discard 'O' ring from pump.

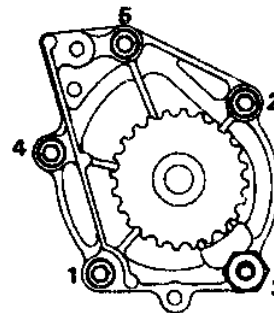
### Inspection



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

### Refit

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

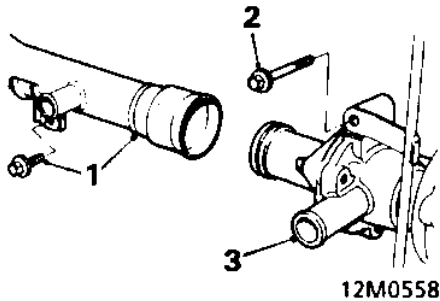


3. Fit coolant pump to cylinder block, fit bolts and pillar bolt(s) and tighten in sequence shown to 10 Nm.
4. *Rear cover fitted:* Fit timing belt rear cover securing screw, tighten to 9 Nm.
5. Fit thermostat and housing.
6. Fit and adjust a new camshaft timing belt.

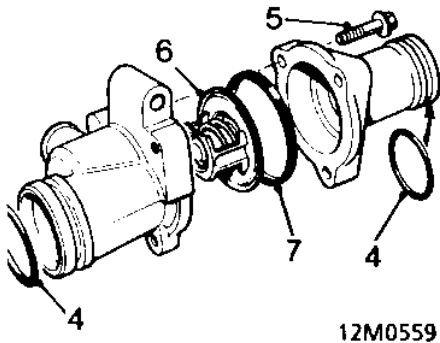
# ENGINE

## THERMOSTAT

### Remove



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



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

### Inspection

1. Test thermostat using thermostat test equipment, renew thermostat if necessary.
2. Thermostat open = 88° C  
Starts to open = 85° to 91° C  
Fully open = 100° C

### Refit

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



**CAUTION:** Torque figure must not be exceeded.

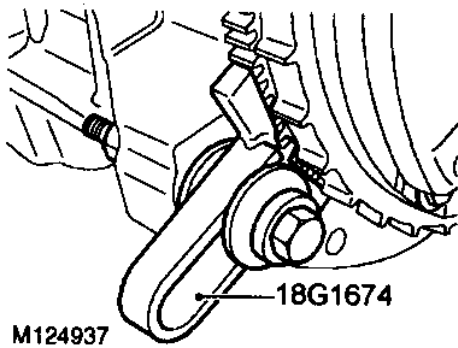
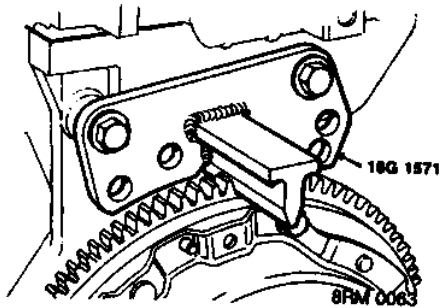
6. Fit thermostat housing to coolant pump, align dipstick tube bracket, fit and tighten bolt to 10 Nm.
7. Connect coolant rail to thermostat cover.
8. Align coolant rail to cylinder block, fit and tighten bolts to 25 Nm.






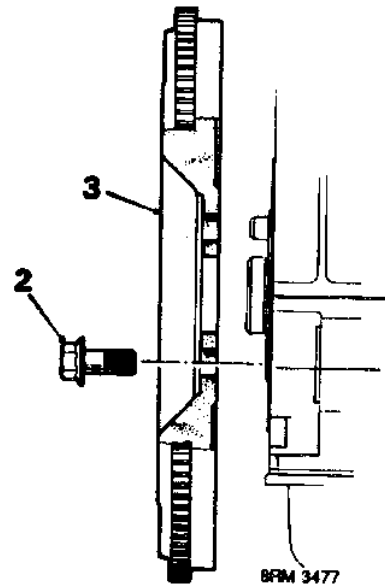
## FLYWHEEL AND STARTER RING GEAR

### Flywheel - remove




1. Fit flywheel locking tool:  
Flywheel without reluctor ring use 18G 1571.  
Flywheel with reluctor ring use 18G 1674.

 **CAUTION:** Ensure tool engages teeth on flywheel not the reluctor ring.



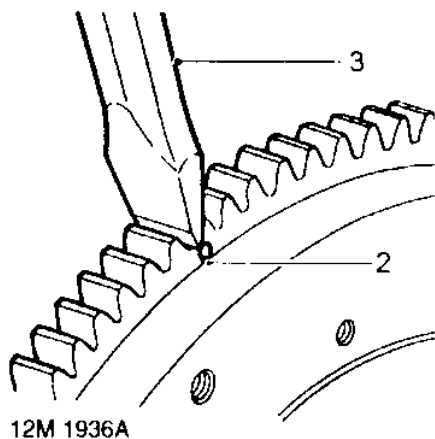
 **NOTE:** Flywheel without reluctor ring illustrated.

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

 **NOTE:** Dowel located.

## ENGINE

### Starter ring gear - remove



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



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

### Starter ring gear - refit

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



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

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

### Flywheel - refit



**CAUTION:** Flywheels fitted to VVC engines have a reluctor ring with 4 teeth at unequally spaced intervals missing whilst flywheels fitted to engines with plug top coil ignition have reluctor rings with equally spaced teeth. If the flywheel is to be replaced, it is essential that the replacement is of the correct type.

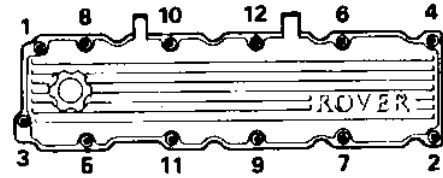
1. Clean flywheel and crankshaft faces. Use a clean bolt with two saw cuts along threads and clean adhesive from threaded holes in crankshaft.
2. Using assistance, fit flywheel to crankshaft, fit and tighten new Patchlok bolts to 80 Nm.



**CYLINDER HEAD**

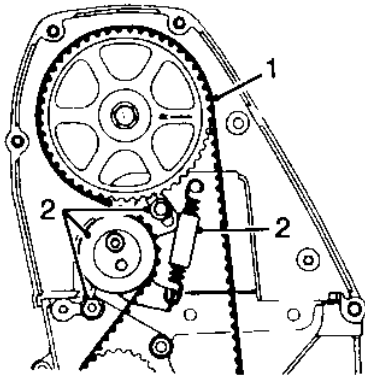
**Cylinder head - K8 engines - remove**

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



12M0549

5. Using sequence shown, progressively slacken and remove 12 bolts securing camshaft cover.
6. Remove camshaft cover, discard gasket.

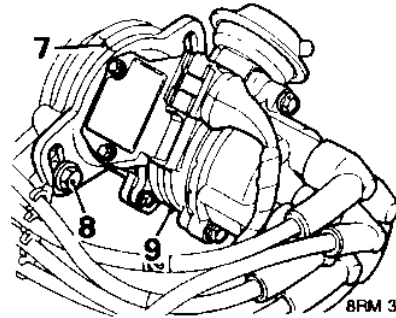
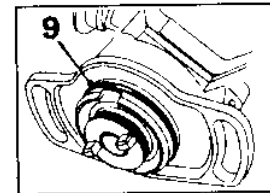


12M0553A

1. Remove and discard camshaft timing belt.

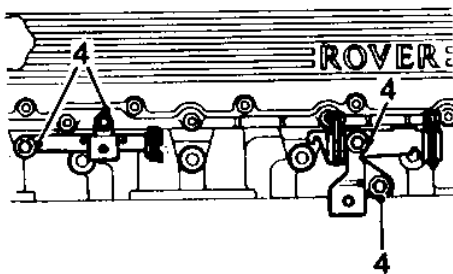
**CAUTION:** Do not rotate crankshaft whilst timing belt is removed and cylinder head is fitted, pistons will contact the valves.

2. Disconnect tensioner spring, remove pillar bolt, screw, tensioner and spring.
3. Disconnect ht leads from spark plugs.



8PM 3516

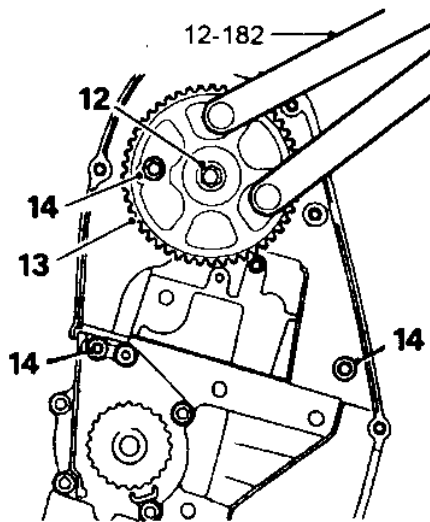
7. Mark distributor flange for refitting reference.
8. Remove 2 screws securing distributor.
9. Remove distributor, discard 'O' ring.
10. Remove any debris from spark plug recesses, remove and discard 4 spark plugs.



12M 0552 A

4. Remove 4 screws securing ht lead brackets, remove brackets.

## ENGINE



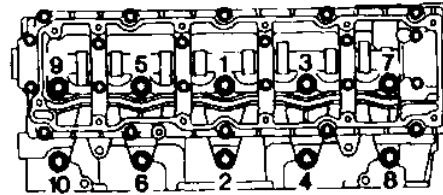
12M 0548A

11. Use tool 12-182 to hold camshaft gear against rotation.
12. Remove bolt and plain washer securing camshaft gear.
13. Remove camshaft gear.
14. Remove screws securing upper part of timing belt rear cover to cylinder head and screw securing rear of cover to coolant pump, remove cover.



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

15. Check and record crankshaft end-float.



16. Using sequence shown, progressively slacken 10 cylinder head to oil rail bolts. Remove bolts and store in fitted order.



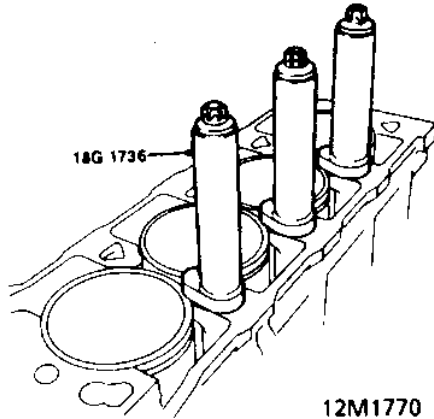
CAUTION: Removal of cylinder head bolts will result in a 'tightening-up' of the crankshaft, rotation of crankshaft must, therefore, be kept to a minimum. Do not rotate crankshaft until cylinder liner retainer clamps 18G 1736 are fitted.

17. Using assistance, remove cylinder head assembly.




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


18. Remove and discard cylinder head gasket.

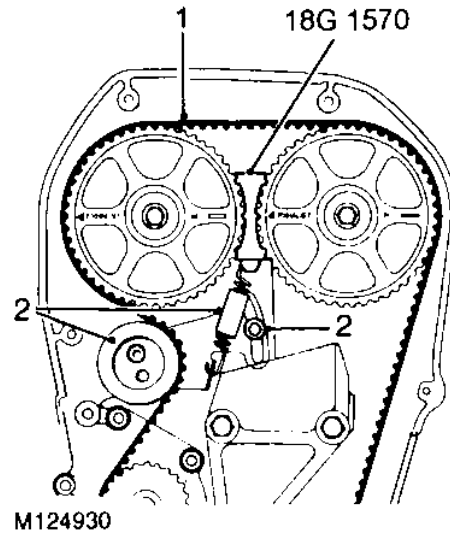


19. Assemble cylinder liner retainer clamps **18G 1736** to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.


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

**Cylinder head - K16 Non VVC engines fitted with distributor - remove**

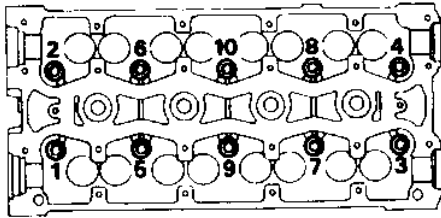
 **CAUTION:** If crankshaft is to be removed during overhaul it will be necessary to check and record crankshaft end-float prior to removing cylinder head.



1. Remove and discard camshaft timing belt.

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

2. *Engines fitted with manual timing belt tensioner:-* Disconnect tensioner spring, remove bolt, screw, tensioner and spring.



8FM 0740

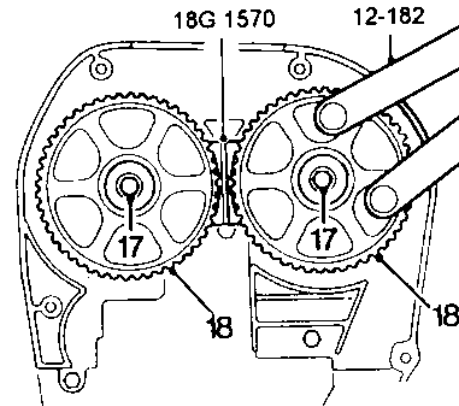
14. Using sequence shown, progressively slacken cylinder head bolts:

*Early engines:-* bolts 1 to 8, remove bolts 1 to 8 and store in fitted order.

*Later engines fitted with modified camshafts:-* bolts 1 to 6, remove bolts 1 to 6 and store in fitted order.



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



12M0576B

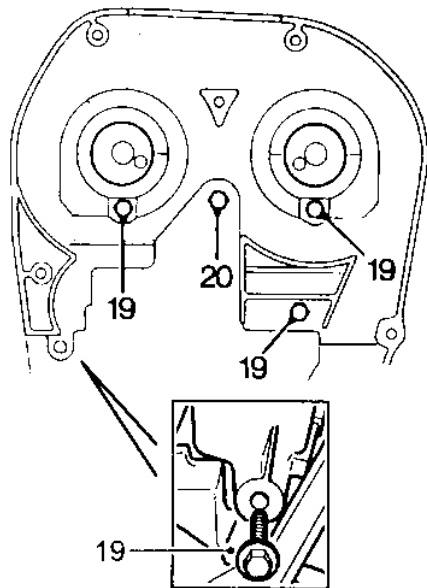
15. Remove locking tool 18G 1570 from camshaft gears.
16. Using tool 12-182, turn both camshafts clockwise to gain access to bolts:  
*Early engines:-* bolts 9 and 10.  
*Later engines fitted with modified camshafts:-* bolts 7 and 8.  
 Progressively slacken then remove the remaining bolts and store in fitted order.



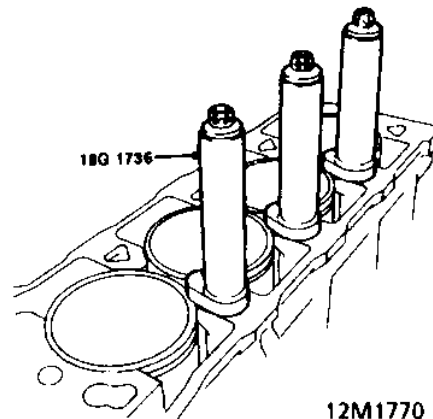
CAUTION: Removal of cylinder head bolts results in a 'tightening-up' of crankshaft; rotation of crankshaft must, therefore, be kept to a minimum. Do not rotate crankshaft until cylinder liner retainer clamps 18G 1736 are fitted.

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

## ENGINE



12M0577A



12M1770

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

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

20. Remove timing belt tensioner pillar bolt.  
21. Using assistance, remove cylinder head assembly from cylinder block.

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

22. Remove and discard cylinder head gasket.

23. Assemble cylinder liner retainer clamps **18G 1736** to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.

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



**Cylinder head - K16 non VVC engines fitted with plug top coil ignition system - remove**

*If fitted*



NOTE: Commencing engine numbers for these engines are listed in Information

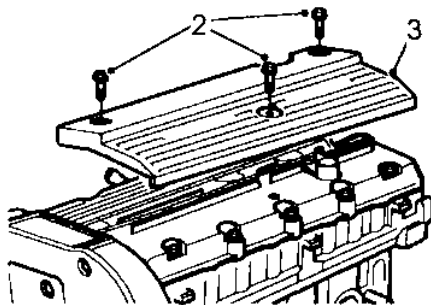


CAUTION: If crankshaft is to be removed during overhaul it will be necessary to check and record crankshaft end-float prior to removing cylinder head.

1. Remove and discard camshaft timing belt.

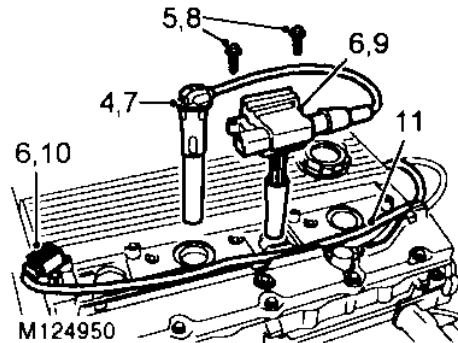


CAUTION: Do not rotate crankshaft whilst timing belt is removed and cylinder head is fitted, pistons will contact the valves.



M124959

2. Noting that shortest screw is fitted in centre of spark plug cover, remove 3 screws securing cover to camshaft cover.
3. Remove spark plug cover.

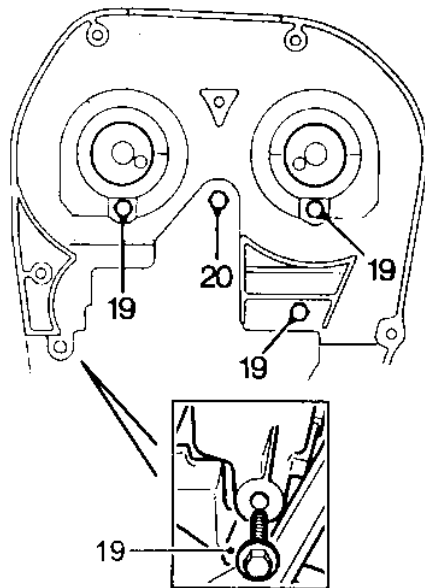


M124950

4. Disconnect ht lead and plug tube from No. 4 spark plug.
5. Remove 2 bolts securing front coil to camshaft cover.
6. Carefully raise coil until plug tube is disconnected from No. 1 spark plug, disconnect multiplug from coil.
7. Disconnect ht lead and plug tube from No. 2 spark plug.
8. Remove 2 bolts securing rear coil to camshaft cover.
9. Carefully raise coil until plug tube is disconnected from No. 3 spark plug.
10. Disconnect multiplug from coil.
11. Release harness from clips.




## ENGINE




12M0577A

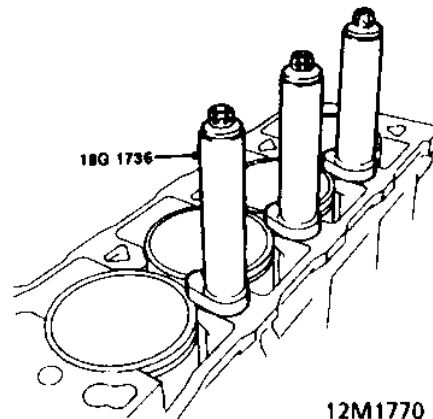
19. Remove screws securing upper part of timing belt rear cover to cylinder head and screw securing rear of cover to coolant pump.

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

20. Remove timing belt tensioner pillar bolt.  
21. Using assistance, remove cylinder head assembly from cylinder block.

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

22. Remove and discard cylinder head gasket.



12M1770

23. Assemble cylinder liner retainer clamps **18G 1736** to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.



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



**Cylinder head - K16 non VVC engines fitted with plug top coil ignition system - remove**

*If fitted*



NOTE: Commencing engine numbers for these engines are listed in Information

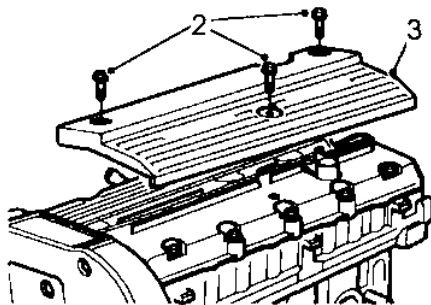


CAUTION: If crankshaft is to be removed during overhaul it will be necessary to check and record crankshaft end-float prior to removing cylinder head.

1. Remove and discard camshaft timing belt.

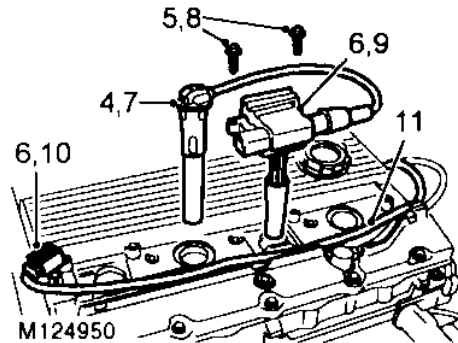


CAUTION: Do not rotate crankshaft whilst timing belt is removed and cylinder head is fitted, pistons will contact the valves.



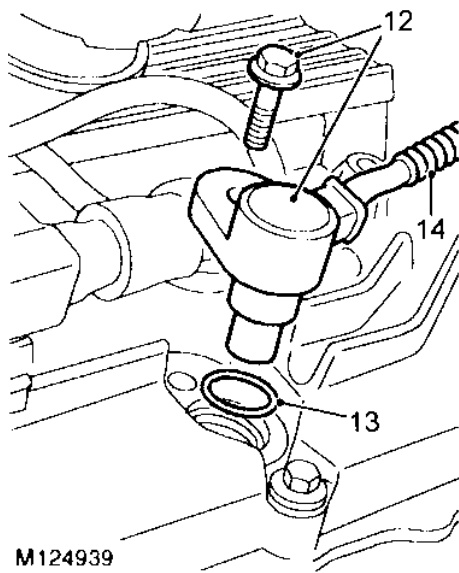
M124959

2. Noting that shortest screw is fitted in centre of spark plug cover, remove 3 screws securing cover to camshaft cover.
3. Remove spark plug cover.

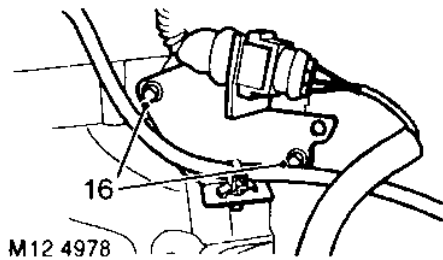


M124950

4. Disconnect ht lead and plug tube from No. 4 spark plug.
5. Remove 2 bolts securing front coil to camshaft cover.
6. Carefully raise coil until plug tube is disconnected from No. 1 spark plug, disconnect multiplug from coil.
7. Disconnect ht lead and plug tube from No. 2 spark plug.
8. Remove 2 bolts securing rear coil to camshaft cover.
9. Carefully raise coil until plug tube is disconnected from No. 3 spark plug.
10. Disconnect multiplug from coil.
11. Release harness from clips.



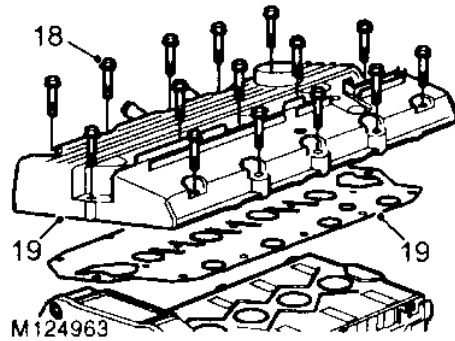
12. Remove bolt securing camshaft sensor to camshaft cover, withdraw sensor.
13. Remove and discard 'O' ring.
14. Release harness from clip.
15. Position harness aside.



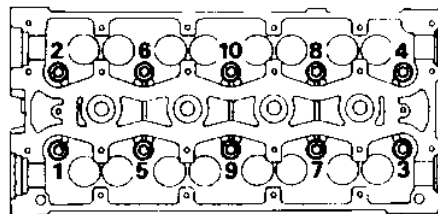
16. Remove 2 bolts securing multiplug bracket to camshaft carrier, remove bracket.

## All cylinder heads

17. Remove any debris from spark plug recesses, remove 4 spark plugs.

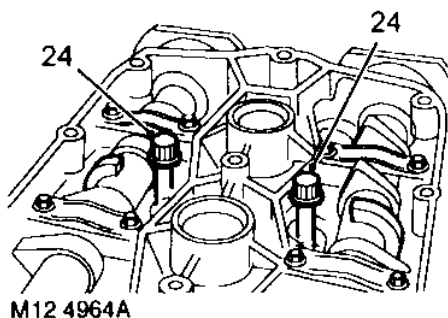
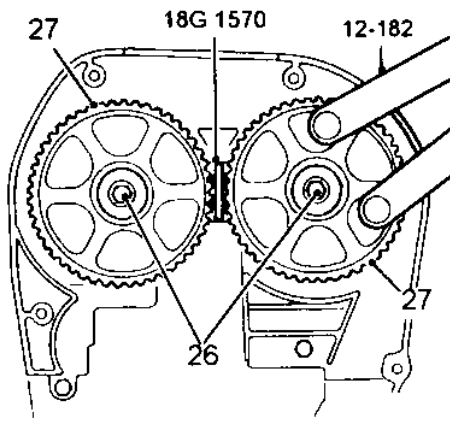


18. Progressively slacken then remove 15 bolts securing camshaft cover.
19. Remove camshaft cover, remove and discard gasket.
20. Check and record crankshaft end-float.

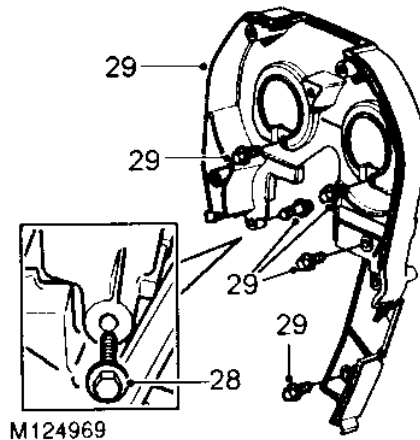


21. Using sequence shown, progressively slacken cylinder head bolts 1 to 6.

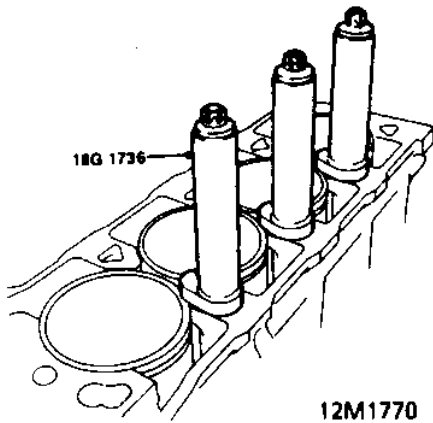
NOTE: It will be necessary to carry out the following operations in order to remove the remaining bolts.



22. Remove camshaft locking tool **18G 1570**.
  23. Using tool **12-182**, rotate inlet and exhaust camshafts clockwise until reluctor rings clear bolt heads 7 and 8.
  24. Progressively slacken cylinder head bolts 7 to 10.
  25. Remove 10 cylinder head bolts and store in fitted order.
- CAUTION:** Removal of cylinder head bolts results in a 'tightening-up' of crankshaft; rotation of crankshaft must, therefore, be kept to a minimum. Do not rotate crankshaft until cylinder liner retainer clamps **18G 1736** are fitted.
26. Suitably identify each camshaft gear to its respective camshaft and using tool **12-182** to hold camshaft gear against rotation, remove bolt and plain washer from each camshaft gear.
  27. Remove camshaft gears.



- NOTE:** Timing belt rear cover fitted to engine with 5 bolt front engine mounting illustrated.
28. Remove screw securing rear of timing belt rear cover to coolant pump.
- NOTE:** This is the longest of the rear cover securing screws.
29. Remove screws securing timing belt rear cover, remove cover.
  30. Remove timing belt tensioner pillar bolt.
  31. Using assistance, remove cylinder head assembly from cylinder block.
- CAUTION:** Cylinder head is dowel located, do not tap it sideways to free it from cylinder block. Place cylinder head assembly on blocks of wood to prevent damaging valves.
32. Remove and discard cylinder head gasket.



33. Assemble cylinder liner retainer clamps 18G 1736 to cylinder head bolts. Position retainer clamps on cylinder liners ensuring clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.

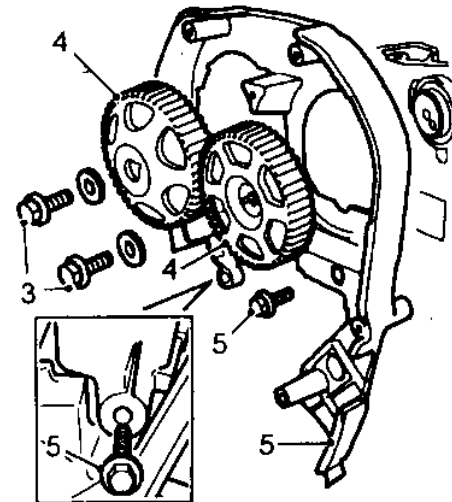
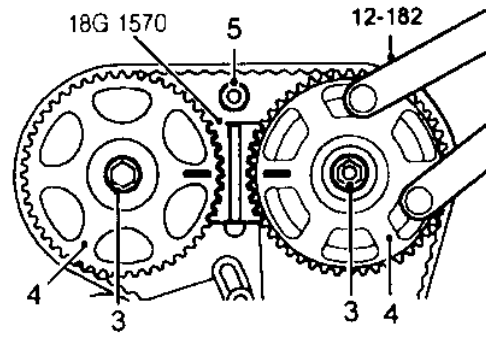
**CAUTION:** Ensure that bolts used are those originally fitted in that location.

## Cylinder head - K16 VVC engines - remove

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

1. Remove and discard camshaft timing belt.

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



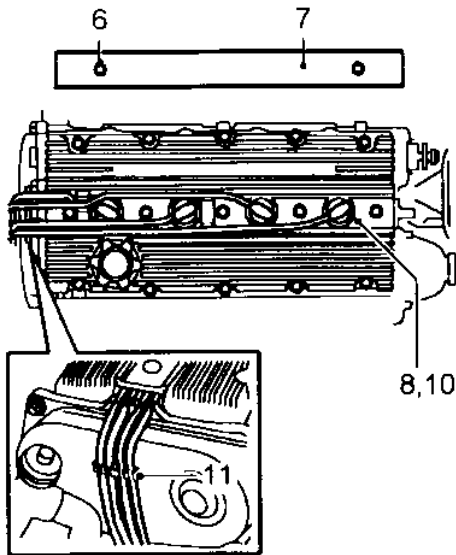
M124932A

2. Ensure that tool 18G 1570 is fitted to camshaft gears.
3. Suitably identify each camshaft gear to its respective camshaft and using tool 12-182 to restrain camshaft gears against rotation, remove bolt and plain washer securing each camshaft gear.
4. Remove tool 18G 1570, remove camshaft gears.



5. Remove screws securing timing belt upper rear cover to cylinder head and rear of cover to coolant pump, remove cover.

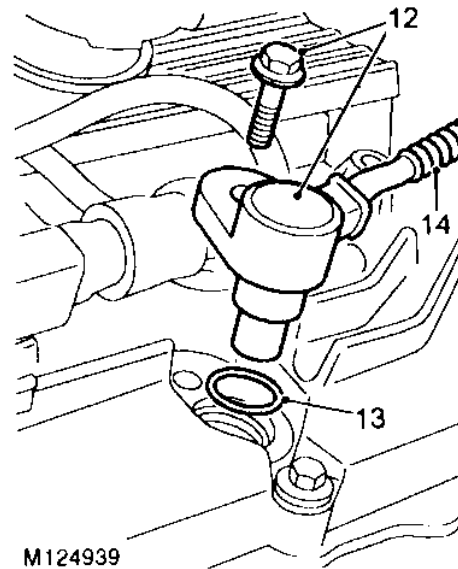
NOTE: This is the longest of the rear cover securing screws.



NOTE: Camshaft cover fitted to early engines illustrated.

6. Remove 2 screws securing spark plug cover.
7. Remove spark plug cover.
8. Disconnect 4 plug tubes from spark plugs.
9. Remove any debris from spark plug recesses.
10. Remove and discard 4 spark plugs.
11. Release HT leads from camshaft rear belt cover.

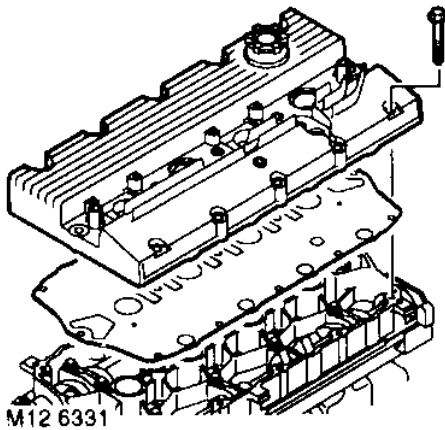
### Later engines



12. Remove bolt securing camshaft sensor, remove sensor.
13. Remove and discard 'O' ring.
14. Release harness from clip.

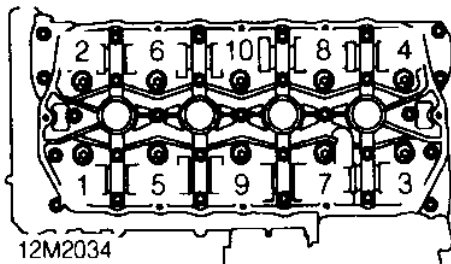
# ENGINE

All engines



NOTE: Camshaft cover fitted to early engines illustrated.

15. Progressively slacken, then remove 15 bolts securing camshaft cover.
16. Remove camshaft cover, remove and discard gasket.
17. Check and record crankshaft end-float.



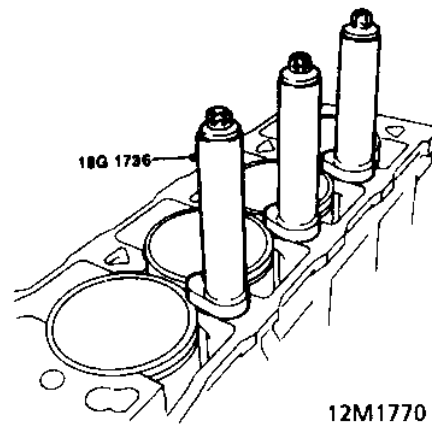
18. Using sequence shown, progressively slacken then remove 10 cylinder head to oil rail bolts.
19. Remove bolts and store in fitted order.

CAUTION: Removal of cylinder head bolts results in a 'tightening-up' of crankshaft; rotation of crankshaft must, therefore, be kept to a minimum. Do not rotate crankshaft until cylinder liner retainer clamps 18G 1736 are fitted.

20. Using assistance, remove cylinder head assembly.

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

21. Remove and discard cylinder head gasket.

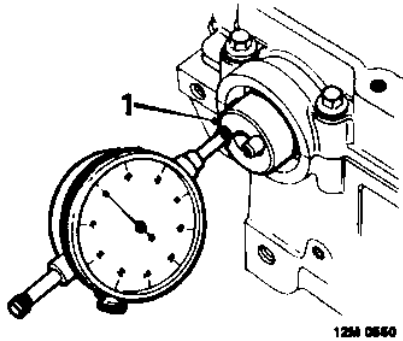


22. Assemble cylinder retainer clamps 18G 1736 to cylinder head bolts. Position retainer clamps on cylinder liners ensuring that clamps do not protrude over liner bores. Screw cylinder head bolts into oil rail and tighten sufficiently to retain clamps.

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

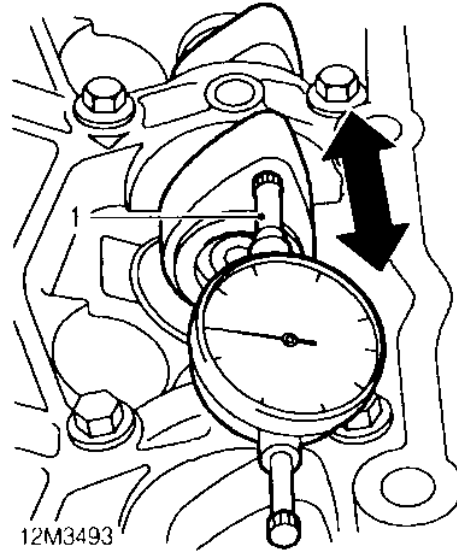


**Camshafts - K8 and all K16 Non VVC engines - check end-float**



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

**Camshafts - K16 VVC engines - check end-float  
inlet camshafts**

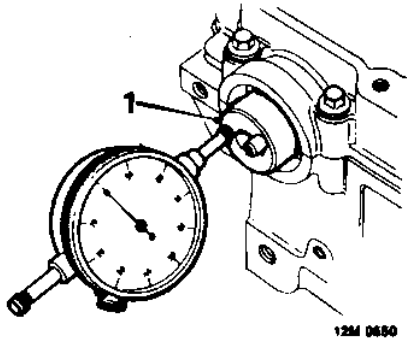


1. Assemble a suitable DTI to camshaft carrier with stylus of gauge contacting face of front camshaft number 4 cam.
2. Move camshaft fully rearwards and zero gauge.
3. Move camshaft fully forwards and note end-float reading on gauge:  
Inlet camshaft end-float = 0.03 to 0.15 mm  
Service limit = 0.25 mm
4. Repeat above procedure for rear camshaft with stylus of gauge contacting face of number 5 cam.
5. Renew camshaft/VVC assemblies as necessary to achieve correct end-float.



# ENGINE

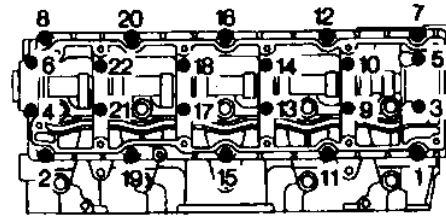
## Exhaust camshaft



6. Check camshaft end-float using a DTI.  
Exhaust camshaft end-float = 0.06 to 0.19 mm  
Service limit = 0.3 mm
7. Renew components as necessary to achieve correct end-float.

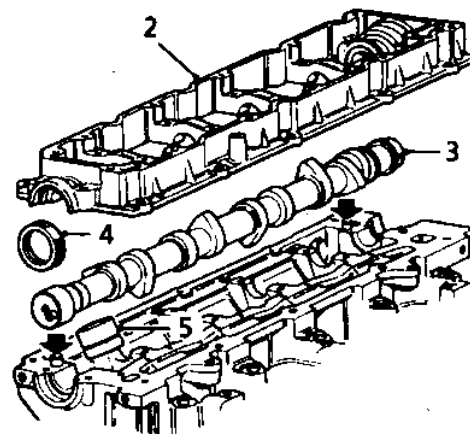
## Camshaft carrier and camshafts - K8 and all K16 Non VVC engines - remove

K8



12M0578

1. Using sequence shown, progressively slacken 22 bolts securing camshaft carrier to cylinder head until valve spring pressure is released; remove bolts.



12M1994

2. Remove camshaft carrier.

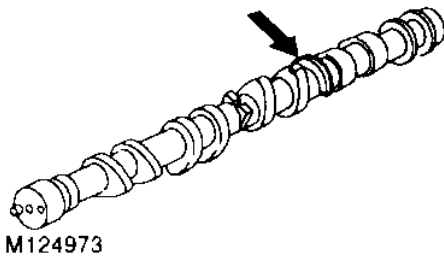
NOTE: Dowel located.



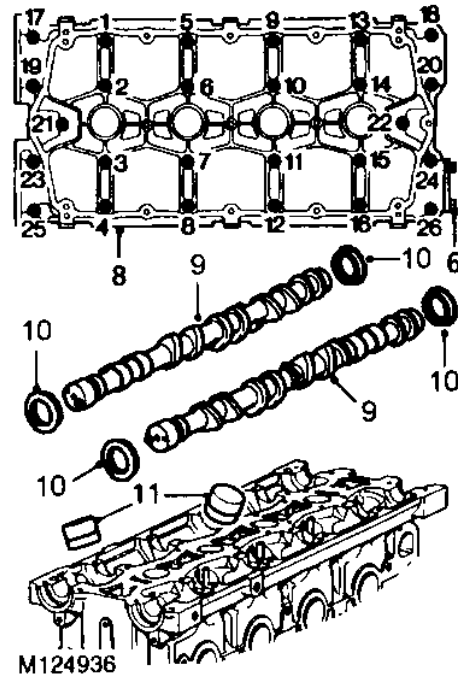
3. Remove camshaft.
4. Remove and discard camshaft oil seals.
5. Using a stick magnet, remove 8 tappets from cylinder head. Retain tappets in their fitted order and invert to prevent oil loss.



K16



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



**NOTE:** Camshafts incorporating a reluctor ring illustrated.

6. Remove 2 bolts securing blanking plate to rear of camshaft carrier, remove plate.

**NOTE:** On engines fitted with plug coil ignition, blanking plates are fitted for both inlet and exhaust camshafts.

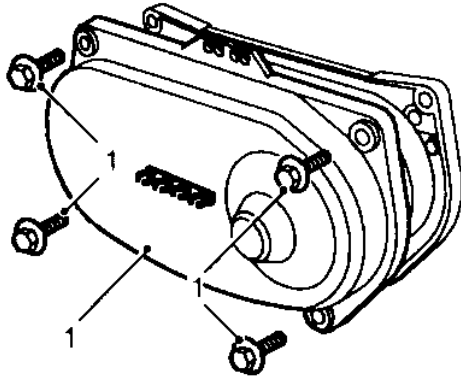
7. Using sequence shown, progressively slacken 26 bolts until valve spring pressure is released. Remove bolts.
8. Remove camshaft carrier.

**NOTE:** Dowel located.

9. Suitably identify each camshaft to its fitted position, remove camshafts.
10. Remove and discard oil seals from camshafts.
11. Using a stick magnet, remove 16 tappets from cylinder head. Retain tappets in fitted order and invert to prevent oil loss.

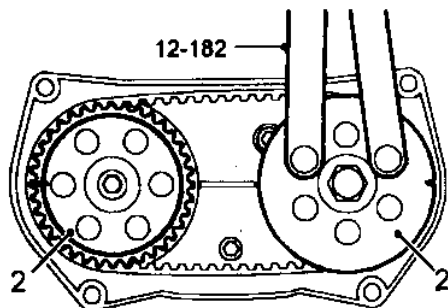
# ENGINE

## Camshaft carrier and camshafts - K16 VVC engines - remove



12M3481

1. Remove 4 bolts securing camshaft rear belt cover, remove cover.



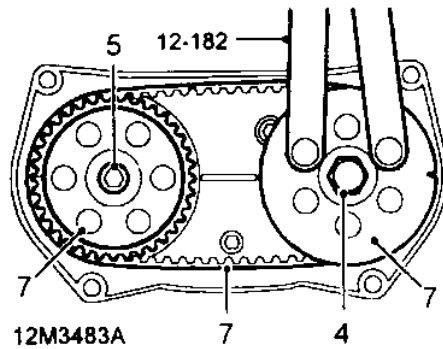
12M3482A

2. Using tool 12-182, rotate inlet camshaft rear timing gear until timing marks on both rear gears are facing outwards.



**NOTE:** With timing marks in this position, the lobes of numbers 3, 4, 5 and 6 cams on the inlet camshafts should be facing upwards.

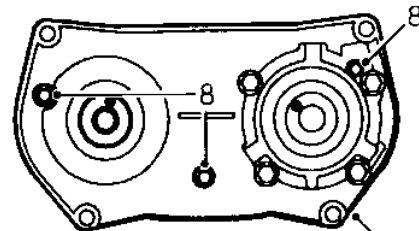
3. Suitably identify each rear camshaft gear to its respective camshaft.



12M3483A

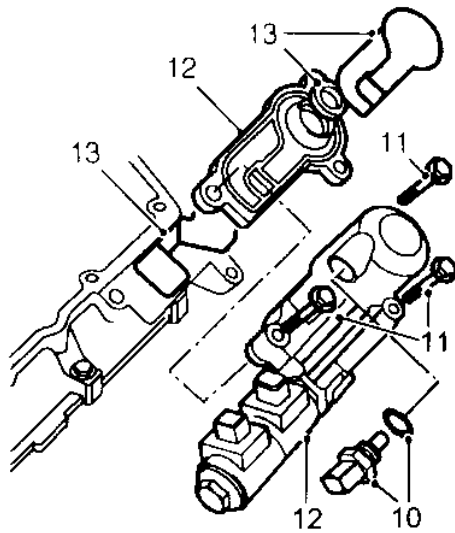
4. Using tool 12-182, restrain rear inlet camshaft timing gear and remove bolt and washer retaining gear.
5. Repeat above procedure for exhaust camshaft rear timing gear.
6. Remove tool 12-182 from gear.
7. Remove both rear timing gears from camshafts, remove and discard rear timing belt.

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



12M3485

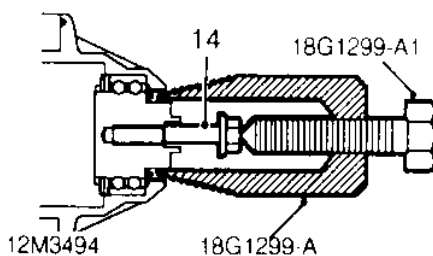
8. Remove bolts securing camshaft rear timing belt backplate.
9. Remove rear timing belt backplate.



12M3486A

10. Remove oil temperature transmitter, from hydraulic control unit, remove and discard sealing washer.
11. Remove 3 bolts securing hydraulic control unit to camshaft carrier.
12. Withdraw hydraulic control unit, remove seal plate.
13. Remove and discard 2 labyrinth seals and rack seal from seal plate.

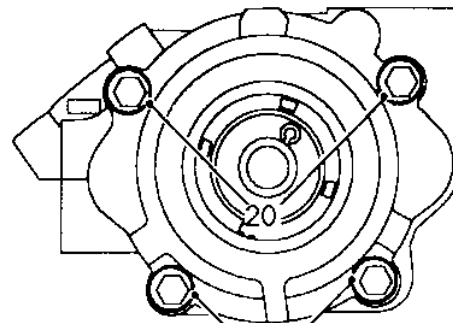
**CAUTION:** Take care not to damage labyrinth seal retaining lugs on seal plate.



12M3494

18G1299-A

14. Fit camshaft gear bolt to front VVC mechanism.
15. Screw tool 18G 1299A and 18G 1299A-1 into oil seal.
16. Remove VVC housing oil seal by tightening centre bolt of tool, discard oil seal.
17. Remove camshaft gear bolt.
18. Repeat above procedures for rear VVC housing oil seal.



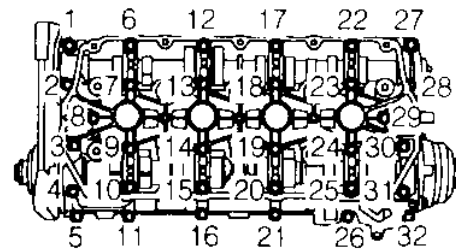
12M3487A

19

19. Remove and discard 2 bolts securing each VVC housing to cylinder head.
20. Slacken 2 bolts securing each VVC housing to camshaft carrier by 1 turn.



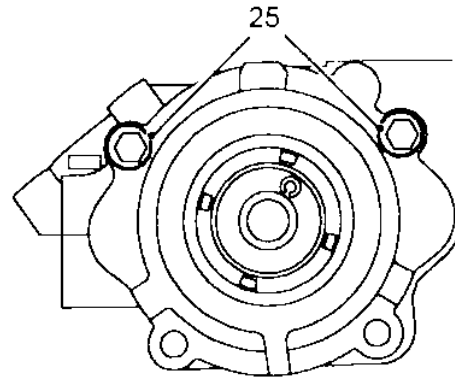
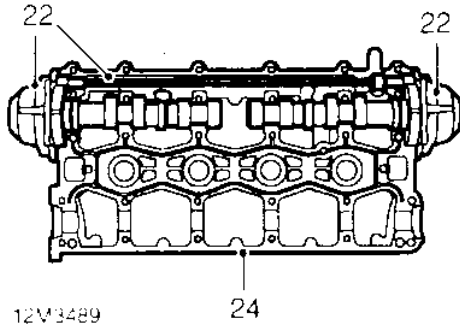
**CAUTION:** Do not exceed 1 turn.



12M3488

21. Using sequence shown, progressively slacken and noting the position of 4 longest bolts, remove 32 bolts securing camshaft carrier to cylinder head.

## ENGINE



**CAUTION:** During the following operations, it is essential to ensure that front and rear inlet camshafts are retained in their respective VVC assemblies. If camshafts are removed from their VVC assemblies, then complete assembly must be replaced; it is not permissible to refit camshafts to VVC assemblies.

22. Ensuring that front and rear inlet camshafts are retained in camshaft carrier and VVC assemblies, carefully release camshaft carrier from cylinder head.



NOTE: Dowel located.

23. Lift camshaft carrier together with front and rear inlet camshafts off cylinder head.



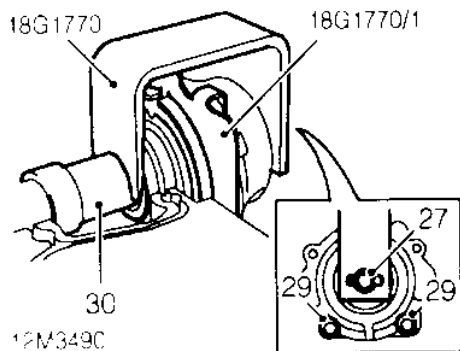
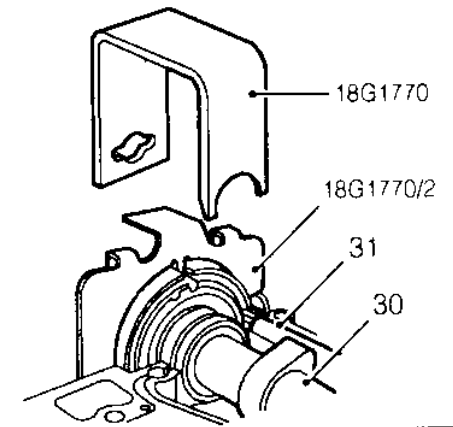
**CAUTION:** Ensure that exhaust camshaft is retained in cylinder head as camshaft carrier is removed.

24. Ensuring that front and rear inlet camshafts are retained in camshaft carrier, invert carrier.


25. Slacken but do not remove 2 bolts securing each VVC housing to camshaft carrier.



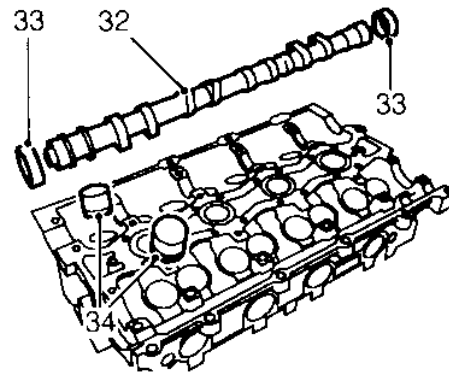
NOTE: Bolts should only be slackened sufficiently to enable timing plates 18G 1770/1 and 18G 1770/2 to be fitted.



26. Fit timing plates **18G 1770/1** to front and **18G 1770/2** to rear VVC assemblies.
27. Assemble clamps **18G 1770** to front and rear inlet camshafts and VVC assemblies, fit camshaft gear bolts and washers to retain clamps.
28. Suitably identify each VVC assembly to its fitted position. Do not attempt to interchange front and rear assemblies.
29. Remove and discard 2 bolts securing each VVC housing to camshaft carrier.
30. Remove front and rear camshafts together with VVC assemblies.

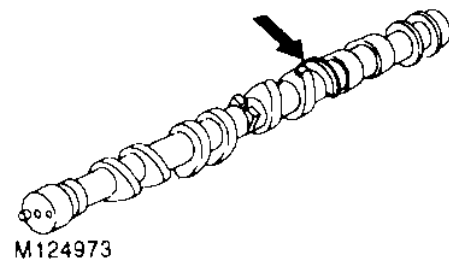
 **CAUTION:** Do not remove clamps **18G 1770**.

31. Remove control shaft from camshaft carrier.




12M3521

32. Remove exhaust camshaft from cylinder head



M124973

 **CAUTION:** In order to commonise exhaust camshafts between VVC and non VVC engines, modified exhaust camshafts incorporating a reluctor ring are fitted to later engines, these camshafts are not interchangeable with those fitted to early engines. Commencing engine numbers for the modified camshafts are listed in Information.

33. Remove and discard exhaust camshaft oil seals.
34. Using a stick magnet, remove 16 tappets from cylinder head. Retain tappets in their fitted order and invert to prevent oil loss.

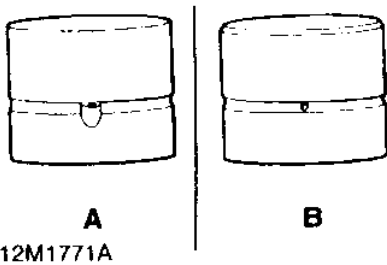
# ENGINE

## Tappets - inspection

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



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



## Non VVC engines



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

## VVC engines



**CAUTION:** Tappets fitted to VVC engines are lighter than those fitted to non VVC engines and whilst similar in appearance to the early tappets A illustrated above, it is essential that early tappets are not fitted to VVC engines. To ensure that correct replacement tappet is fitted, measure overall length of tappet:

Early tappet - Non VVC engines = 26.0 mm  
Later tappet - VVC engines = 24.5 mm

## Camshafts and timing gears - K8 and all K16 Non VVC engines - inspection

### Camshafts



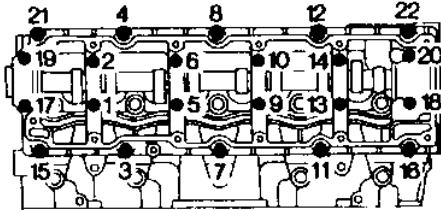
NOTE: Carry out camshaft inspection after removal of valves.

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



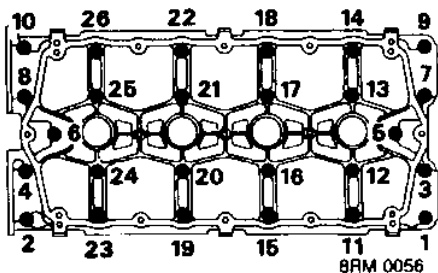
### Checking camshaft bearing clearance - Non VVC engines

K8



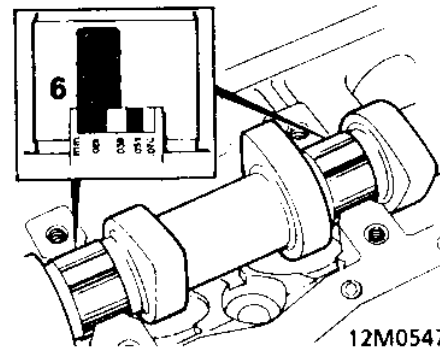
12M0563

K16



8FM 0056

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

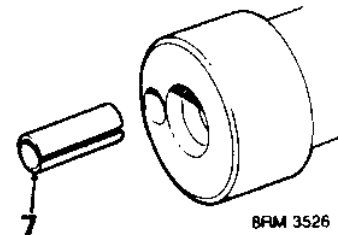


12M0547

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



**CAUTION:** If replacement camshafts are to be fitted, ensure they are correct for engine being worked on.



8FM 3526

7. Remove drive pin from old camshaft and fit to new with its split towards centre of camshaft.
8. Remove all traces of Plastigage using an oily rag.




## ENGINE

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### Timing gears - Non VVC engines

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


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

### Camshafts and timing gears - K16 VVC engines - inspection


#### Camshafts

 **NOTE:** Carry out camshaft inspection after removal of valves.

1. Clean camshaft carrier and cylinder head bearing surfaces, use suitable solvent to remove sealant.

 **CAUTION:** Do not remove clamps 18G 1770 whilst cleaning or inspecting inlet camshafts.

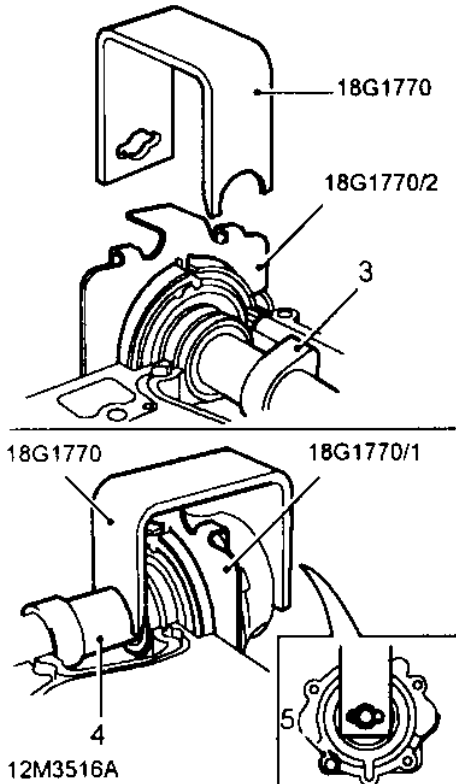
2. Inspect cams and bearing journals for wear, pitting and scoring, replace components as necessary.

 **NOTE:** Inlet camshafts and VVC mechanisms will only be supplied as an assembly.



### Checking camshaft bearing clearance - VVC engines

1. Position exhaust camshaft in cylinder head and place a strip of Plastigage across each camshaft journal.



2. Rotate front and rear VVC control sleeves until timing plates 18G 1770/1 - front and 18G 1770/2 - rear can be inserted through the housing and into the control sleeve slot.

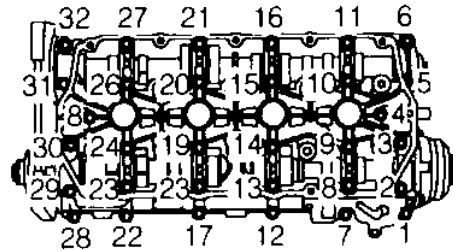
**CAUTION:** Do not remove clamps at this stage, reposition clamps as necessary to enable timing plates to be fitted.

3. Place a strip of Plastigage across each inlet camshaft journal on camshaft carrier and position front inlet camshaft and VVC housing in camshaft carrier.
4. Position rear inlet camshaft and VVC housing in camshaft carrier.
5. Fit and lightly tighten a slave M6 bolt to retain front and rear VVC housings to camshaft carrier.
6. Remove clamps 18G 1770.



**CAUTION:** During the following operations it is essential to ensure that front and rear inlet camshafts are retained in their respective VVC assemblies and the camshaft carrier.

7. Invert camshaft carrier and fit to cylinder head.



12M3503

8. Fit 32 bolts noting that 4 longest bolts are fitted at each end of camshaft carrier.
9. Using sequence shown, progressively tighten bolts 10 Nm.



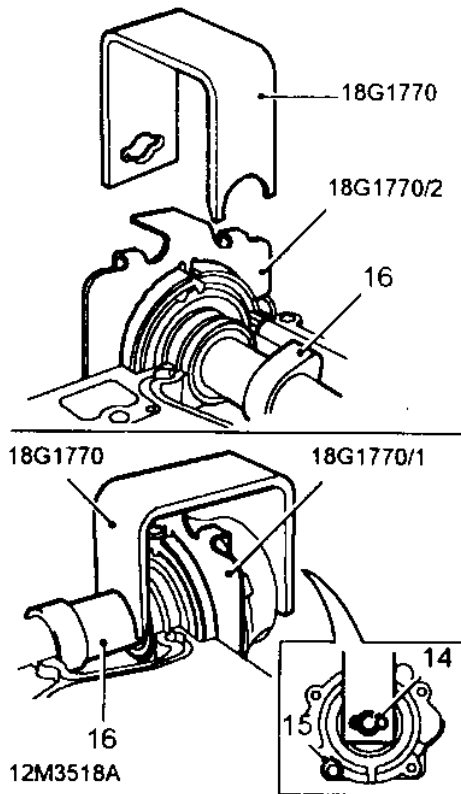
**CAUTION:** Do not rotate camshafts.

10. Progressively slacken then remove 32 bolts securing camshaft carrier to cylinder head.
11. Carefully release camshaft carrier from cylinder head.
12. Lift camshaft carrier together with front and rear inlet camshafts off cylinder head.



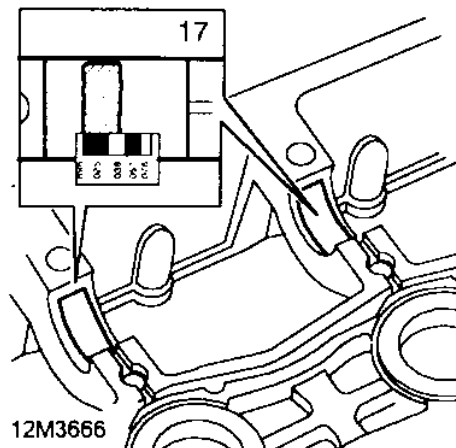
**CAUTION:** Ensure that exhaust camshaft is retained in cylinder head.

13. Invert camshaft carrier.

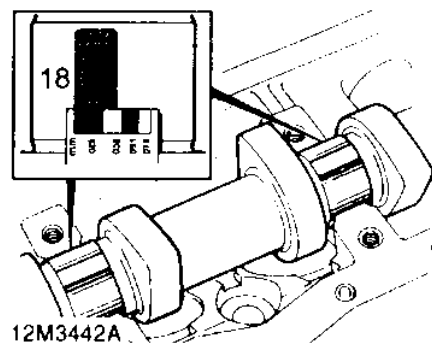


14. Assemble clamps 18G 1770 to front and rear inlet camshafts and VVC assemblies, fit camshaft gear bolts and washers to retain clamps.
15. Remove slave bolts securing VVC housings to camshaft carrier.
16. Remove front and rear inlet camshafts and VVC housings from camshaft carrier.

**CAUTION:** If new VVC housing gaskets have been fitted do not remove timing plates 18G 1770/1 and 18G 1770/2.



17. Measure widest portion of Plastigage on each inlet camshaft journal on camshaft carrier:  
Inlet camshaft bearing journal clearances:  
25 mm diameter journals = 0.025 to 0.060 mm  
Service limit = 0.1 mm  
40 mm diameter journals = 0.030 to 0.070 mm  
Service limit = 0.1 mm



18. Measure widest portion of Plastigage on each exhaust camshaft journal:  
Exhaust camshaft bearing clearance = 0.060 to 0.094 mm  
Service limit = 0.15 mm
19. If bearing clearances on any camshaft are excessive, fit new exhaust camshaft or inlet camshafts and VVC assemblies and repeat check. If clearances are still excessive, replace cylinder head and camshaft carrier assembly.



**CAUTION:** If replacement exhaust camshaft is to be fitted, ensure it is correct for engine being worked on.



**NOTE:** Inlet camshafts are only supplied with VVC mechanisms as an assembly.

20. Remove exhaust camshaft from cylinder head.
21. Remove all traces of Plastigage using an oily rag.

#### Timing gears - VVC engines



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

#### Ensure reference marks are not erased.

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

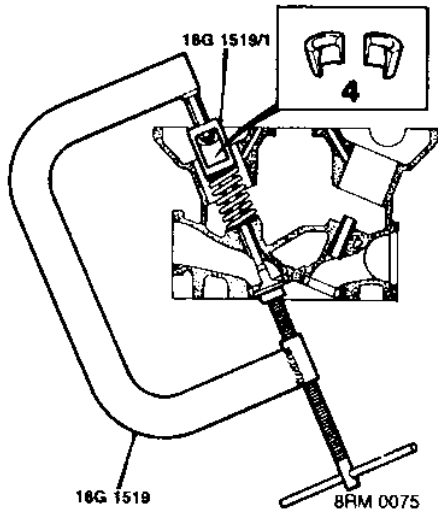
# ENGINE

## Valves and springs - remove

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

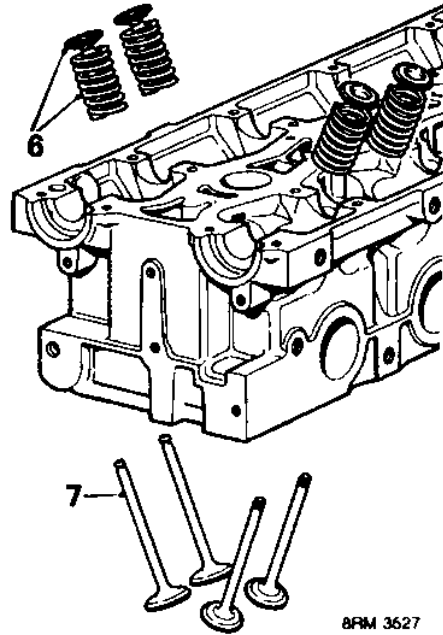


NOTE: K16 engine: Remove inlet valves with cylinder head in this position.



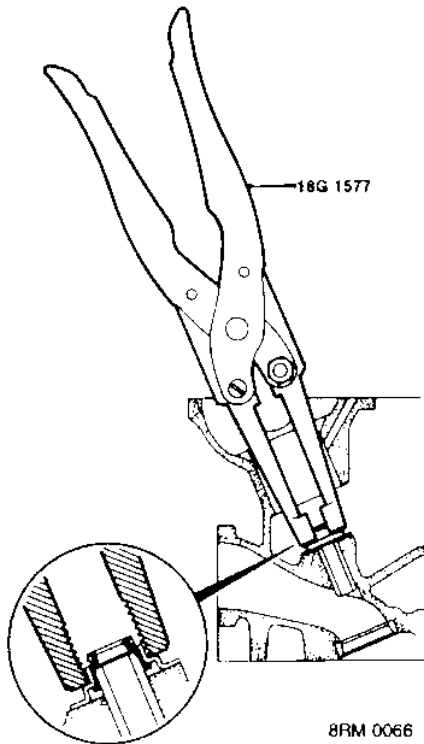
NOTE: K16 Non VVC cylinder head illustrated.

3. Using tool **18G 1519** and adapter **18G 1519/1**, compress valve spring.
4. Remove 2 collets from valve stem using a magnet.
5. Remove tool **18G 1519**.



NOTE: K16 Non VVC cylinder head illustrated.

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



### Cylinder head - cleaning

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

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

4. *K8 engine:* Check fuel pump blanking plate - if fitted for signs of oil leakage. Replace gasket if necessary, tighten blanking plate nuts to 25 Nm.

8. Using **18G 1577**, remove and discard valve stem seal.
9. *K8:* Repeat above operations to remove all remaining valves.  
*K16:* Repeat above operations to remove remaining inlet valves.

△ CAUTION: Retain valves and springs in fitted order.

**K16**

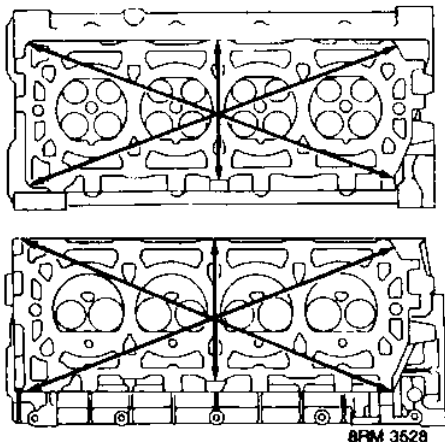
10. Position cylinder head on its inlet manifold face.
11. Repeat above operations to remove exhaust valves and valve stem seals.

△ CAUTION: Retain valves and springs in fitted order.

# ENGINE

## Cylinder head - inspection

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



2. Check cylinder head face for warping, across centre and from corner to corner:

Cylinder head:

Maximum warp = 0.05 mm

3. Check cylinder head height:

New = 118.95 to 119.05 mm.

Cylinder heads may be refaced:

Reface limit = 0.20 mm



**CAUTION:** Cylinder heads fitted to K16 engines with automatic timing belt tensioners are not interchangeable with those fitted to engines with manual tensioners.

## Valve springs - inspection

1. Check condition of valve springs:



NOTE: Valve springs are either colour coded or plain:

K8 - Yellow/red

K16 - Non VVC engines - Plain

K16 - VVC engines - Blue

### K8

Free length = 46.2 mm

Fitted length = 37.0 mm

Load - valve closed = 255 ± 12 N

Load - valve open = 535 ± 20 N

### K16 - Non VVC engines

Free length = 50.0 mm

Fitted length = 37.0 mm

Load - valve closed = 250 ± 12 N

Load - valve open = 450 ± 18 N

### K16 - VVC engines

Free length = 47.6 mm

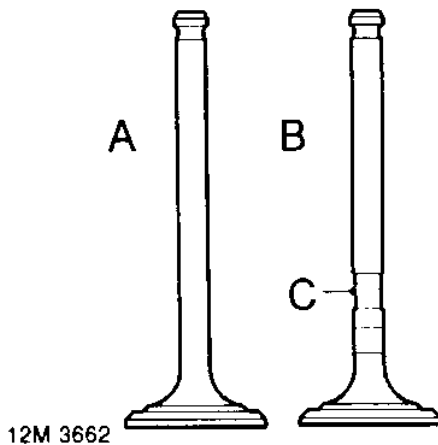
Fitted length = 37.0 mm

Load - valve closed = 210 ± 13 N

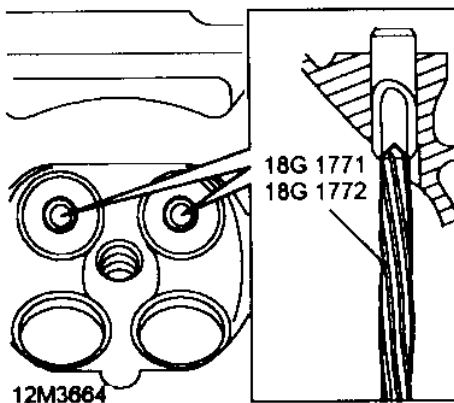
Load - valve open = 440 ± 22 N



## Valves and guides - inspection



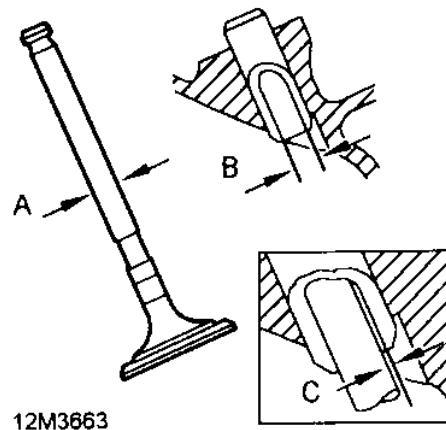
NOTE: Two types of exhaust valve may be fitted, standard valves, A in illustration or carbon break valves, B in illustration. Carbon break valves may be identified by the machined profile C on the valve stem. To prevent exhaust valves from sticking, standard valves should be replaced with carbon break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



1. Remove carbon deposits from exhaust valve guides using tool:  
K8 - 18G 1772  
K16 - 18G 1771

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

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



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



## ENGINE

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### ***K8 - See illustration 8RM 1102A***

#### **Inlet**

**A:**= 29.42 to 29.57 mm  
**B:**= 31.61 to 31.91 mm  
**C:**= 35.594 to 35.614 mm  
**D:**= 35°  
**E:**= 35.500 to 35.525 mm  
**F:**= 5.45 to 5.50 mm  
**G:**= 5.95 to 6.05 mm  
**H:**= 2.0 mm radius  
**J:**= 0.75 to 1.25 mm  
**K:**= 45° **Exhaust**  
**A:**= 26.92 to 27.07 mm  
**B:**= 28.73 to 29.03 mm  
**C:**= 33.06 to 33.08 mm  
**D:**= 26°  
**E:**= 33.000 to 33.025 mm  
**F:**= 5.45 to 5.50 mm  
**G:**= 5.95 to 6.05 mm  
**H:**= 2.0 mm radius  
**J:**= 0.75 to 1.25 mm  
**K:**= 45°

### ***K16 - Non VVC engines - not triple angle valve seats - See illustration 8RM 1102A***

#### **Inlet**

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

#### **Exhaust**

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

### ***K16 - VVC engines - not triple angle valve seats - See illustration 8RM 1102A***

#### **Inlet**

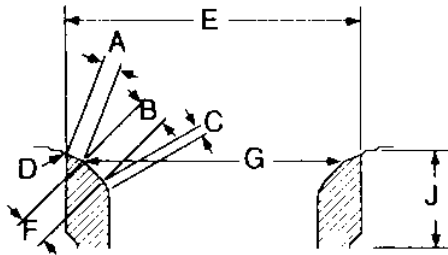
**A:**= 27.38 to 27.62 mm  
**B:**= 29.40 to 29.80 mm  
**C:**= 32.56 to 32.57 mm  
**D:**= 18 to 20°  
**E:**= 32.475 to 32.500 mm  
**F:**= 5.95 to 6.00 mm  
**G:**= 6.46 to 6.62 mm  
**H:**= 7.00 mm radius  
**J:**= 0.74 to 1.25 mm  
**K:**= 44 to 46°

#### **Exhaust**

**A:**= 23.68 to 23.93 mm  
**B:**= 24.80 to 25.20 mm  
**C:**= 28.99 to 29.00 mm  
**D:**= 11 to 13°  
**E:**= 28.88 to 28.91 mm  
**F:**= 5.45 to 5.50 mm  
**G:**= 6.00 to 6.16 mm  
**H:**= 6.0 mm radius  
**J:**= 0.75 to 1.25 mm  
**K:**= 44 to 46°



**K16 - Non VVC engines fitted with triple angle valve seats - See illustration M12 5536**



M12 5536

**Inlet**

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

**Exhaust**

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

**K16 - VVC engines fitted with triple angle valve seats - See illustration M12 5536**

**Inlet**

A: = 15°  
 B: = 45°  
 C: = 60°  
 D: = 0.4 mm radius  
 E: = 32.560 to 32.573 mm  
 F: = 1.0 to 1.4 mm  
 G: = 30.2 mm  
 H: = 32.475 to 32.500 mm  
 J: = 5.95 to 6.00 mm  
 K: = 6.1 mm

**Exhaust**

A: = 15°  
 B: = 45°  
 C: = 60°  
 D: = 0.4 mm radius  
 E: = 28.993 to 29.006 mm  
 F: = 1.4 to 1.8 mm  
 G: = 26.23 mm  
 H: = 28.888 to 28.913 mm  
 J: = 5.45 to 5.50 mm  
 K: = 6.54 mm

**All engines**

1. Cut valve seat to correct angle and width.
2. Lap valve to seat.

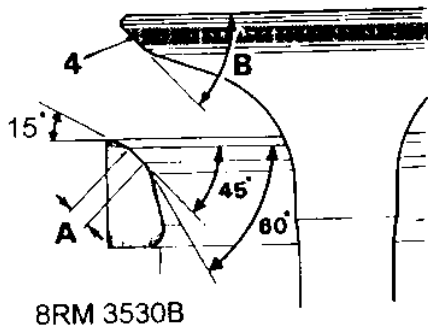
# ENGINE

## Valve seats - refacing



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

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



8RM 3530B



**NOTE:** Triple angle valve seat illustrated

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

Valve seat:

Angle = 45°

Width **A** =

Except triple angle valve seats:

Inlet - 1.5 mm

Exhaust - 1.5 mm

Triple angle valve seats:-

Inlet - 1.0 to 1.4 mm

Exhaust 1.4 to 1.8 mm

Valve face angle **B**:

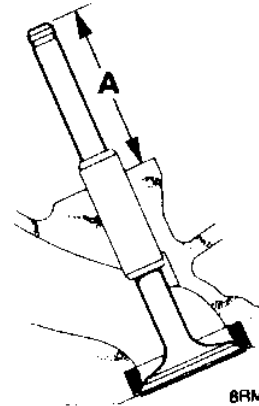
Inlet = 45°

Exhaust = 45°



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

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



8RM 3531

5. Check valve stem fitted height **A**:

**K8:**

New = 38.95 to 40.81 mm

Service limit = 41.06 mm

**K16:**

New = 38.93 to 39.84 mm

Service limit = 40.10 mm

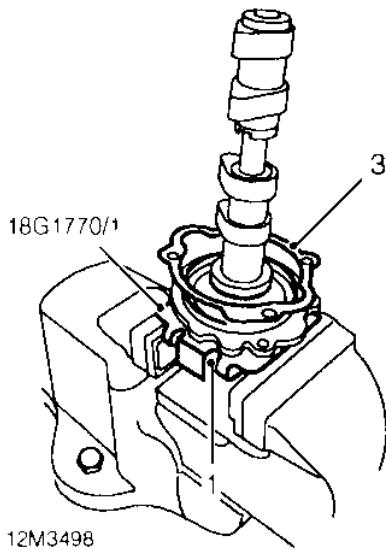
If valve stem fitted height is above service limit, fit new valve and re-check, if still over limit, renew valve seat insert.

**All engines**

6. Remove all traces of grinding paste on completion.



### K16 VVC housing gaskets - remove



1. Secure VVC housing and camshaft in a soft-jawed vice with camshaft positioned upwards.



**CAUTION:** Only tighten vice sufficiently to retain housing, damage to mechanism will result if vice is overtightened.

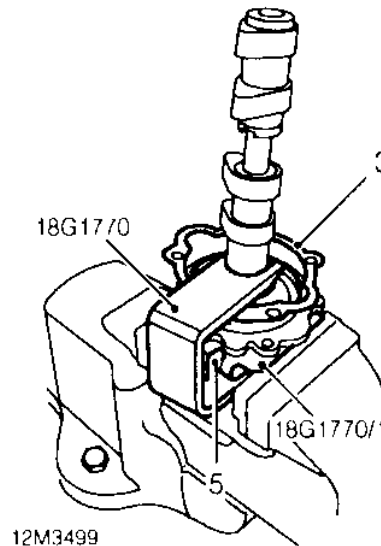
2. Taking care not to allow camshaft to become separated from VVC mechanism, remove clamp 18G 1770 and timing plate 18G 1770/1 - front or 18G 1770/2 - rear.
3. Remove and discard VVC housing gasket.
4. Repeat above procedures for remaining VVC housing gasket.

### K16 VVC housing gaskets - refit



**NOTE:** To assist correct location of VVC housing gasket in its fitted position, apply a light film of grease to gasket face of VVC housing.

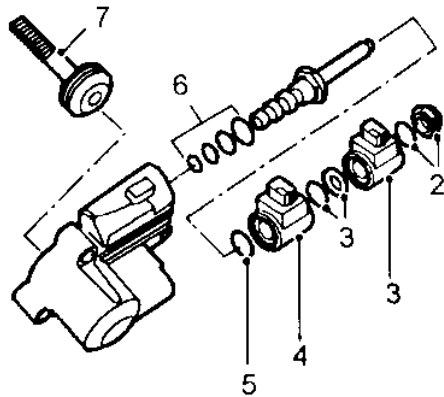
1. Lubricate sealing ring of new gasket with engine oil.



2. Fit timing plate 18G 1770/1 - front or 18G 1770/2 - rear.
3. Fit gasket, align bolt holes.
4. Assemble clamp 18G 1770 to camshaft and VVC assembly, fit camshaft gear bolt and washer to retain clamp.
5. Remove VVC housing and camshaft from vice.
6. Repeat above procedures for remaining VVC housing gasket.

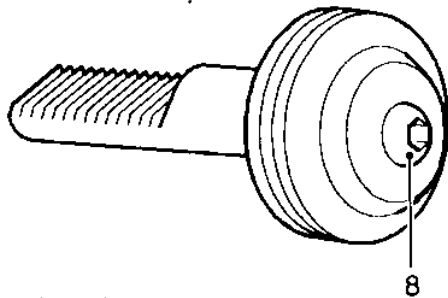
## ENGINE

### Hydraulic control unit - K16 VVC engines - dismantling



12M3495A

1. Suitably identify each solenoid to its fitted position and note the angle at which it is positioned relative to the hydraulic control unit.
2. Remove nut from sleeve bolt, remove and discard 'O' ring.
3. Remove outer solenoid, washer and 'O' rings; discard 'O' rings.
4. Remove inner solenoid.
5. Remove spool valve, remove and discard 'O' ring from spool valve nut.
6. Remove and discard 4 'O' rings from spool valve.
7. Withdraw piston and rack assembly.



12M3496A

8. Remove and discard screw securing piston to rack, remove and discard piston and seal assembly.

### Hydraulic control unit - K16 VVC engines - inspection

1. Check piston and spool valve bores in hydraulic control unit for scoring and corrosion, replace control unit if scoring is evident.
2. Check piston for scoring.



NOTE: Light scoring and corrosion may be removed using grade 600 grade wet or dry paper which has been soaked in engine oil for 30 minutes.

3. Check rack teeth for signs of wear or damage, replace hydraulic control unit if either are evident.
4. Check control shaft teeth for signs of wear or damage, replace control shaft if either are evident.
5. Check that oil passages in spool valve are clear.

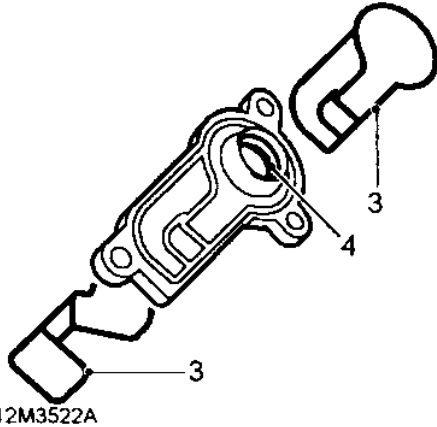


### Hydraulic control unit - K16 VVC engines - assembling



**CAUTION:** It is essential to ensure that absolute cleanliness is maintained during the following operations.

1. Thoroughly clean all components, dry with compressed air.
2. Lubricate new labyrinth seals and rack seal with engine oil.

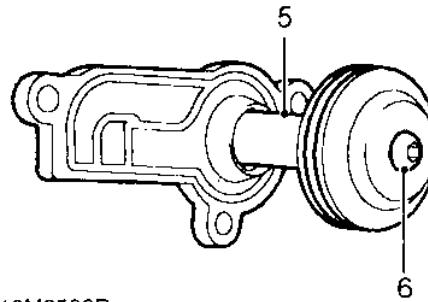


3. Using the fingers only, fit labyrinth seals each side of hydraulic control unit seal plate.



**CAUTION:** Ensure seals are located beneath retaining lugs.

4. Fit new rack seal to plate.

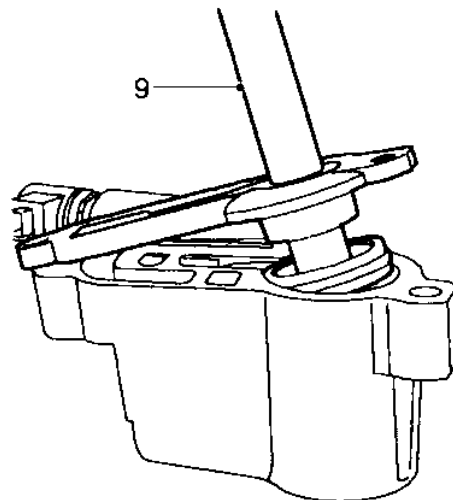


5. Slide piston end of rack through seal.



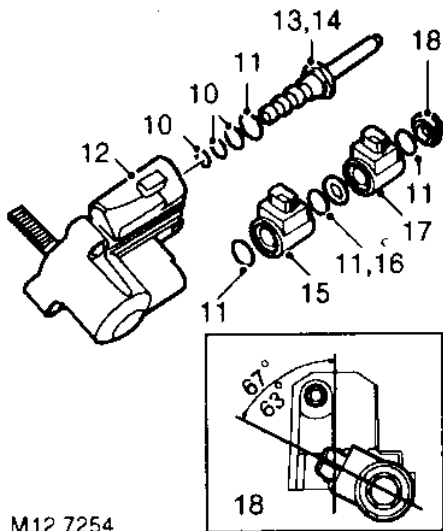
**CAUTION:** Only insert rack through seal for a sufficient distance to enable piston to be fitted and take great care that teeth of rack do not contact seal.

6. Secure rack in a soft-jawed vice, fit new piston and seal assembly to rack, fit and tighten new screw supplied with seal kit to 9 Nm.
7. Lubricate piston bore with engine oil.
8. Position seal plate, piston and rack assembly towards hydraulic control unit with rack teeth facing towards fixing hole adjacent to solenoid side of unit.



9. Insert piston and rack assembly into bore of housing at an angle as shown, taking care not to damage piston seal on machined edge of oil feed channel. Push piston to top of bore.

## ENGINE



M12 7254

### Valves - assembling

1. Using **18G 1577**, fit new valve stem oil seals.
2. Lubricate valve stems and assemble valves, using tool **18G 1519** and adapter **18G 1519/1**, to compress valve spring.



**CAUTION:** Valve springs are either colour coded or plain, ensure correct springs are fitted:

K8 - Yellow/red

K16 - Non VVC engines - Plain

K16 - VVC engines - Blue

3. Use a wooden dowel and mallet, lightly tap top of each valve assembly two or three times to seat valves and collets.
4. Lubricate outside of tappets and fit tappets in original bores.

10. Lubricate 3 new 'O' rings with engine oil and fit to spool valve.
11. Lubricate new 'O' rings with engine oil and fit to each side of spool valve, nut, washer, inner solenoid and sleeve bolt side of outer solenoid.
12. Lubricate spool valve and bore in control unit with engine oil.
13. Position spool valve to control unit, fit valve, twisting it slightly as it is inserted to avoid damaging 'O' rings.
14. Tighten spool valve nut to 26 Nm.
15. Position inner solenoid on spool valve ensuring that lettering on end of solenoid is facing away from control unit.
16. Fit washer and 'O' ring.
17. Position outer solenoid on spool valve ensuring that lettering on end of solenoid is facing away from control unit.
18. Position inner and outer solenoids as shown, fit nut to sleeve bolt and tighten to 12 Nm.



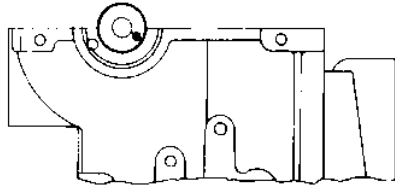
**CAUTION:** Do not exceed specified torque figure.

19. Retain oil temperature transmitter with control unit, plug oil temperature transmitter port to prevent ingress of dirt.

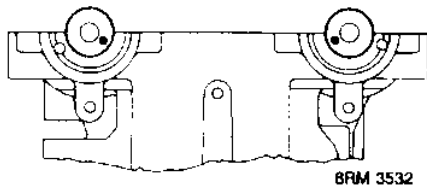


Camshafts - K8 and all K16 Non VVC engines - refit

**K8**



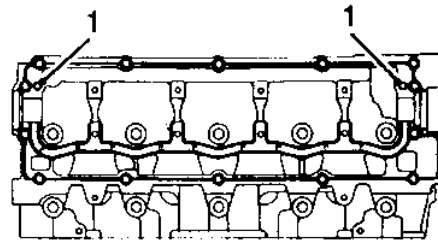
**K16**



8RM 3532

1. Lubricate bearings and fit camshaft(s) and position drive pin for 90° BTDC as follows:  
K8: Pin at 4 o'clock.  
K16: Inlet pin at 4 o'clock.  
Exhaust pin at 8 o'clock.

Camshaft carrier and oil seal - K8 engines - refit



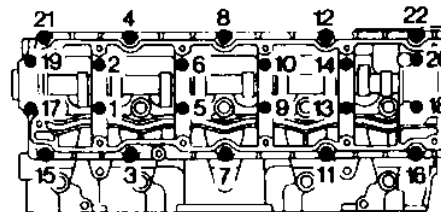
12M0562

1. Ensure 2 locating dowels are fitted in camshaft carrier.
2. Apply continuous, thin beads of sealant, Part Number GUG 705963GM to paths on camshaft carrier as shown and spread to an even film using a roller.



**CAUTION:** Ensure sealant does not enter lubrication grooves on camshaft carrier and that assembly is completed within 20 minutes.

3. Lubricate camshaft cams and journals with engine oil.

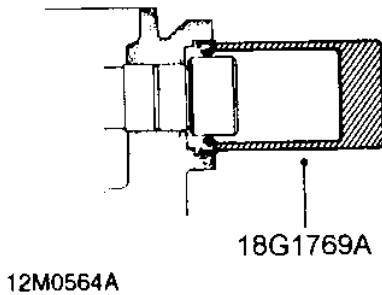


12M0563

4. Fit camshaft carrier, fit and lightly tighten bolts using sequence shown.
5. Tighten all bolts in sequence shown to 10 Nm.



## Camshaft carrier and oil seals - All K16 Non VVC engines - refit



NOTE: Camshaft front oil seal illustrated.



6. Fit oil seal protector **18G 1749** over end of camshaft.
7. Fit new camshaft oil seals using tool **18G 1769A**.

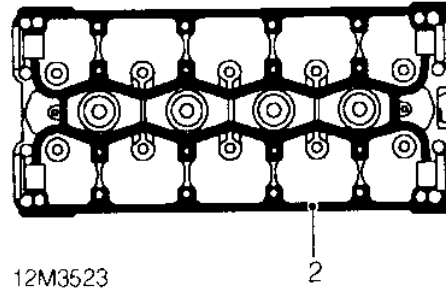


NOTE: Front oil seals are coloured **BLACK**, rear oil seals are coloured **RED**.



CAUTION: Oil seals must be fitted dry. Do not use tool **18G 1769** for fitting seals as they will not be positioned correctly within recess.

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

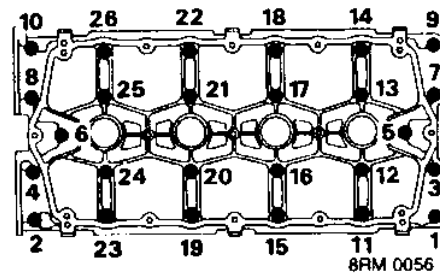


2. Apply continuous, thin beads of sealant, Part Number **GUG 705963GM** to paths on cylinder head as shown then spread to an even film using a roller.

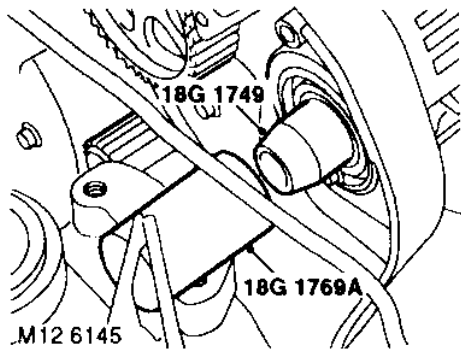


CAUTION: Ensure sealant is kept clear of tappet oil feed holes and lubrication grooves in carrier and that assembly is completed within 20 minutes.

3. Lubricate camshaft cams and journals with engine oil.



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



NOTE: Camshaft front oil seal illustrated.



5. Position oil seal protector **18G 1749** over end of camshaft
6. Fit new camshaft oil seals using tool **18G 1769A**.



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

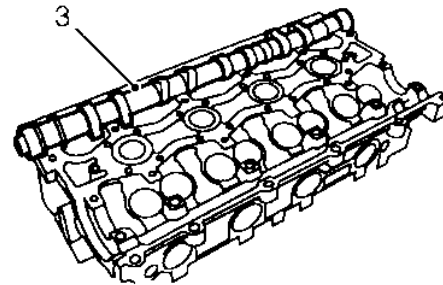


**CAUTION:** Oil seals must be fitted dry. Do not use tool **18G 1769** for fitting seals as they will not be positioned correctly within recess.

7. Fit blanking plate(s), fit and tighten bolts to:  
Inlet camshaft plate - Plug top coil ignition engines only - 6 Nm.  
Exhaust camshaft plate - All engines - 25 Nm.

### Camshaft carrier and camshafts - K16 VVC engines - refit

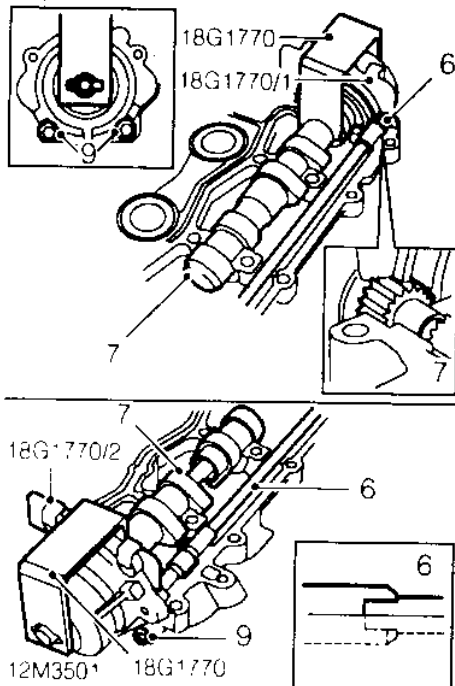
1. Ensure 2 locating dowels are fitted in camshaft carrier.
2. Fit new VVC housing gaskets.



12M3500

3. Lubricate exhaust camshaft cams and journals with engine oil, position camshaft in cylinder head.
4. Lubricate cams and journal of front and rear inlet camshafts with engine oil.
5. Lubricate control shaft with engine oil.

## ENGINE



6. Position control shaft in camshaft carrier ensuring that shaft is fully seated in journals and centre of slot in shaft is aligned with cylinder head mating surface of carrier.
7. Position front and rear inlet camshafts and VVC assemblies in camshaft carrier at the same time engaging teeth of control shaft in VVC assemblies.
8. Check that bolt holes in VVC housings are aligned with bolt holes in camshaft carrier, that centre of slot in control shaft is still aligned with cylinder head mating surface of carrier and timing plates **18G 1770/1** - front and **18G 1770/2** - rear are correctly located in the control sleeves and control shaft is still seated in journals.



**CAUTION:** If bolt holes are not correctly aligned or slot in control shaft has moved, re-position VVC assemblies and shaft as necessary until alignment is correct.

9. Fit and finger tighten slave bolts - front and rear VVC assemblies to camshaft carrier.

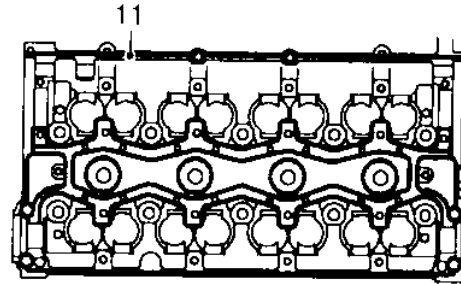


**NOTE:** Slave bolts must be replaced with new Patchlok bolts when camshaft carrier is fitted.

10. Remove clamps **18G 1770**.



**CAUTION:** Do not remove timing plates at this stage or damage to VVC housing seals will result.



M124948

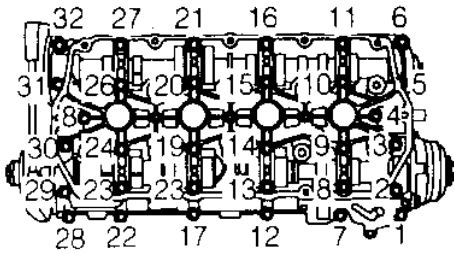
11. Apply continuous, thin beads of sealant, Part Number GUG 705963GM to paths on cylinder head as shown then spread to an even film using a roller.



**CAUTION:** Ensure that sealant is kept clear of oil feed holes, oil grooves and control shaft journals and that assembly is completed within 20 minutes.

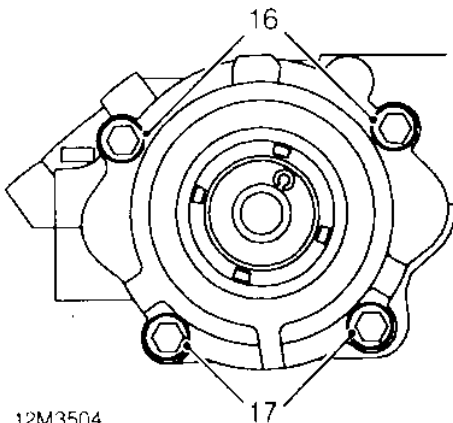
During the following operations it is essential to ensure that front and rear inlet camshafts are retained in the camshaft carrier and their respective VVC assemblies. Take great care not to rotate camshafts or control shaft.

12. Invert camshaft carrier and fit to cylinder head.



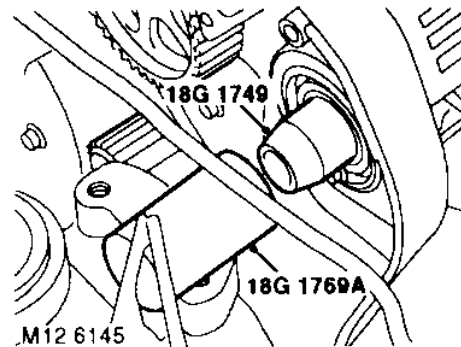
12M3503

13. Fit 32 bolts noting that 4 longest bolts are fitted at each end of camshaft carrier.
14. Using sequence shown, progressively tighten bolts to 10 Nm.
15. Remove timing plates **18G 1770/1** - front and **18G 1770/2** - rear.



12M3504

16. Fit and tighten new bolts - front and rear VVC housings to camshaft carrier to 10 Nm.
17. Fit and tighten new bolts - VVC housings to cylinder head to 10 Nm.



M12 6145

NOTE: Camshaft front oil seal illustrated.

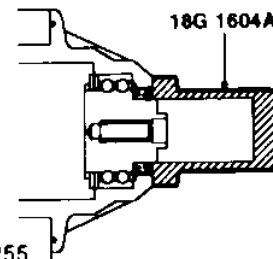


18. Position oil seal protector **18G 1749** over end of camshaft and fit new exhaust camshaft front and rear oil seals using tool **18G 1769A**.

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



CAUTION: Oil seals must be fitted dry. Do not use tool **18G 1769** for fitting seals as they will not be positioned correctly within recess.



M12 7255

19. Fit new front and rear VVC housing oil seals using tool **18G 1604A**.

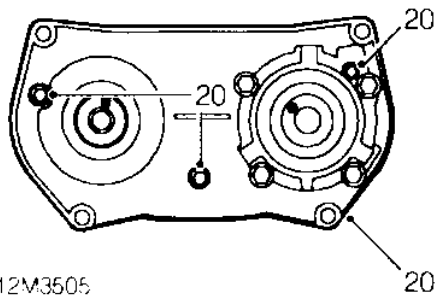
NOTE: Front oil seals are coloured BLACK, rear oil seals are coloured RED.



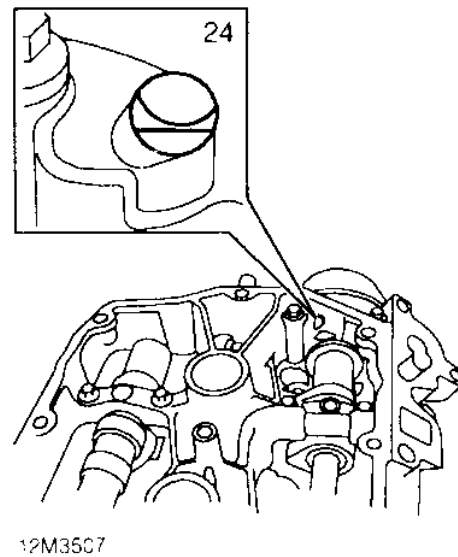
CAUTION: Oil seals must be fitted dry. Do not use tool **18G 1604** for fitting seals as they will not be positioned correctly within recess.



## ENGINE



20. Fit rear timing belt backplate, fit and tighten bolts to:  
M5 bolts - 6 Nm  
M6 bolts - 10 Nm.

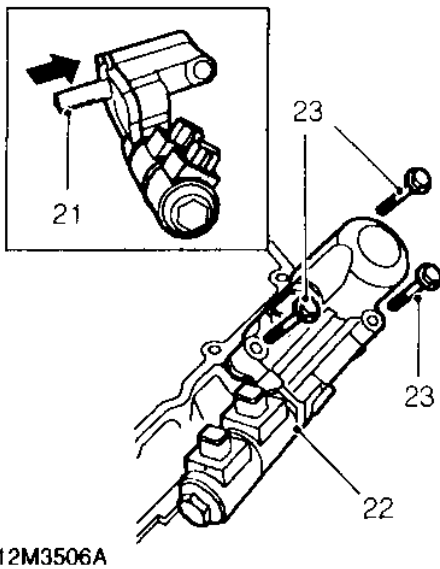


24. Check that timing slots in front and rear VVC control sleeves are visible through holes in camshaft carrier.

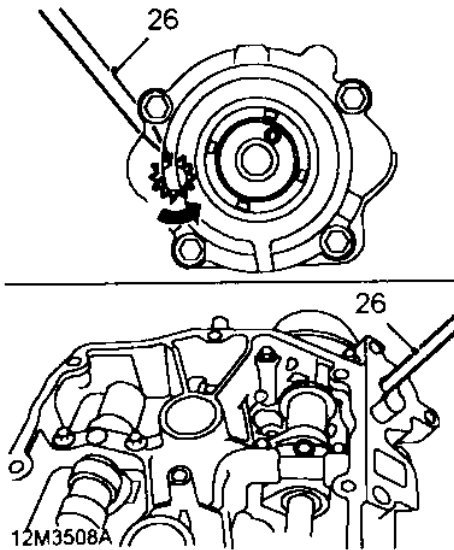


**CAUTION:** If timing slots are not visible, carry out following procedure.

25. Remove hydraulic control unit.



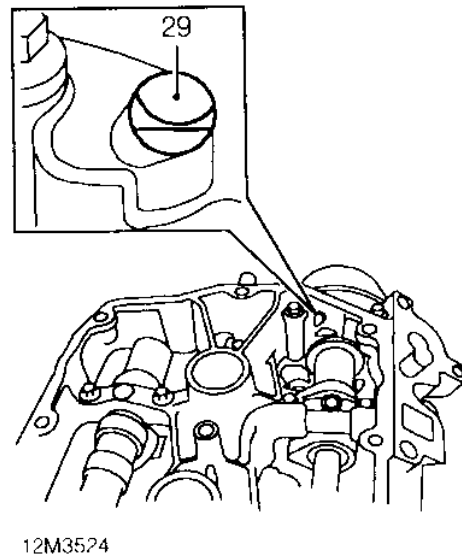
21. Ensure that hydraulic control piston is pushed fully to top of bore and that rack teeth will be aligned to control shaft when control unit is fitted.
22. Position hydraulic control unit and seal plate to camshaft carrier, engage teeth of rack with those of control shaft.
23. Fit and lightly tighten 3 bolts.



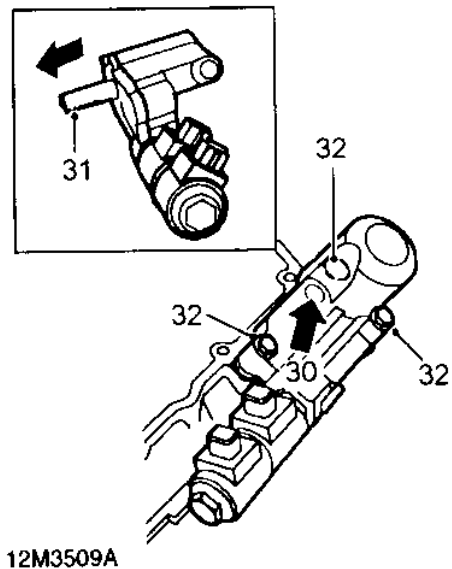
26. Using a screwdriver, rotate control shaft as far as possible in an anti-clockwise direction, viewed from front of camshaft carrier.

NOTE: Timing slots in both VVC control sleeves should now be visible.

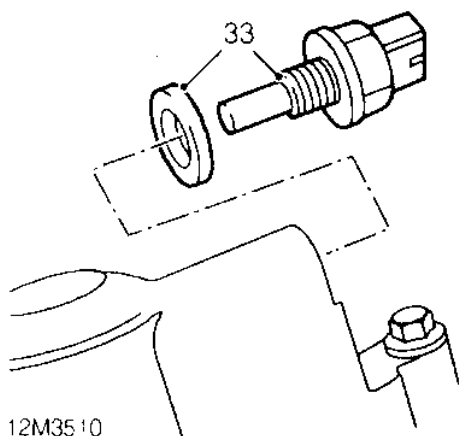
27. Push hydraulic control unit piston to top of bore.  
28. Fit hydraulic control unit, fit and lightly tighten 3 bolts.



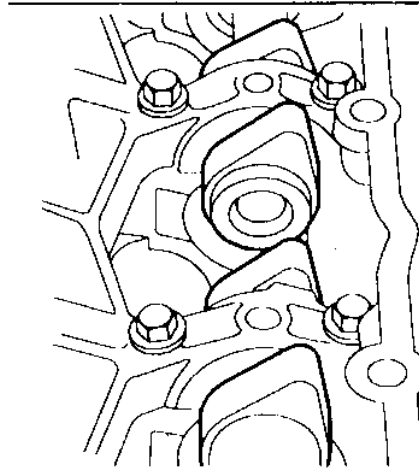
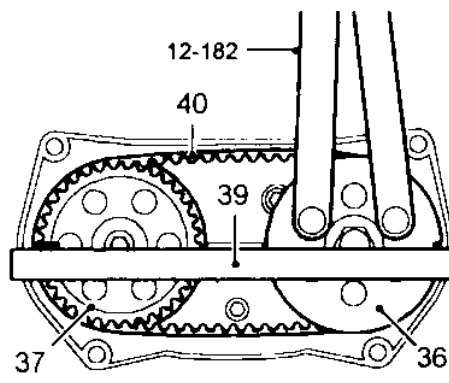
29. Check that timing slots on both front and rear VVC control sleeves are visible. If slots are still not visible, repeat the foregoing procedure as necessary.



30. Apply low pressure air to oil temperature transmitter port in hydraulic control unit to extend rack.  
31. Check that rack is fully extended i.e. rack teeth are at limit of travel and timing slots are no longer visible through holes in camshaft carrier.  
32. Tighten hydraulic control unit bolts to 25 Nm.



33. Fit a new sealing washer to oil temperature transmitter.
34. Fit oil temperature transmitter and tighten to 15 Nm.
35. Thoroughly clean rear timing gears.

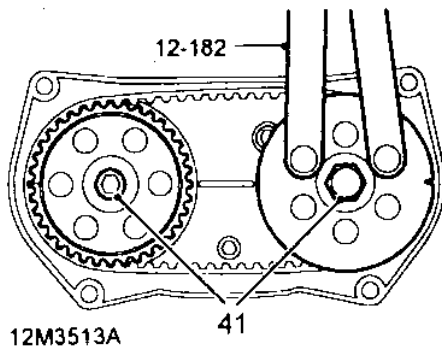


36. Fit rear inlet camshaft timing gear, fit but do not tighten bolt.
37. Fit exhaust camshaft rear timing gear, fit but do not tighten bolt.
38. Using tool 12-182, rotate both timing gears until timing marks on gears are facing outwards.
39. Check alignment of timing marks using a straight edge.

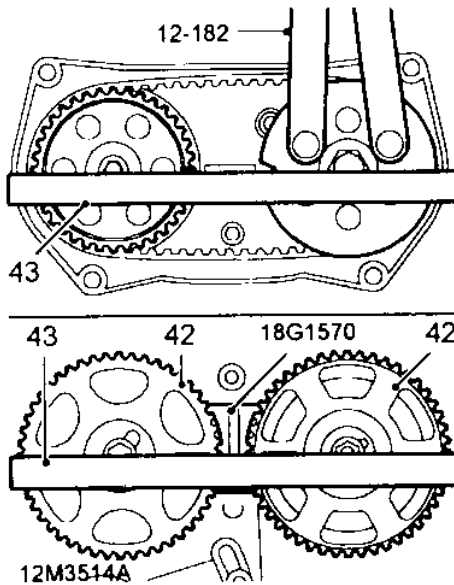
NOTE: With timing marks in this position, the lobes of numbers 3, 4, 5 and 6 inlet cams will be facing upwards.

40. Remove bolt and withdraw rear inlet camshaft gear sufficiently to enable a new rear timing belt to be fitted, fit rear timing belt; refit bolt and washer.

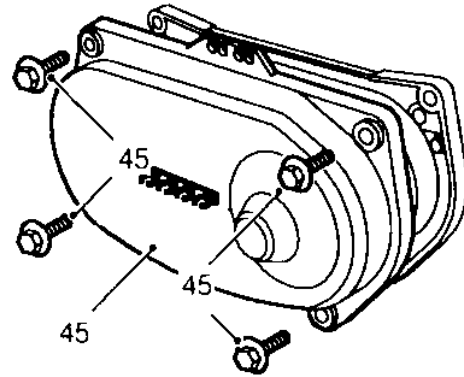
CAUTION: Ensure that camshafts do not rotate.



41. Restrain each timing gear in turn using tool 12-182 and tighten bolts to 65 Nm.



42. Temporarily fit front timing gears to their respective camshafts, rotate gears until timing marks on all 4 gears are aligned, facing inwards; fit tool 18G 1570.
43. Check alignment of each pair of timing marks in turn using a straight edge.
44. Remove tool 18G 1570 and front timing gears.




45. Fit rear timing belt cover, fit and tighten screws to 10 Nm.




## ENGINE

Cylinder head - K8 and K16 Non VVC engines fitted with a distributor - refit


K8

 **CAUTION:** If crankshaft has been rotated, check that timing marks on crankshaft timing gear are aligned with flange on oil pump and that tool 18G 1571 is locking flywheel.


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

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

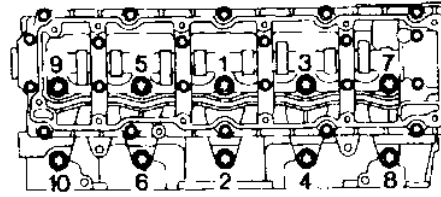
3. Oil cylinder head bolts, under head and threads.
4. Remove cylinder liner retainer clamps 18G 1736.

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

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


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

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



12M 0661

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

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



## K16

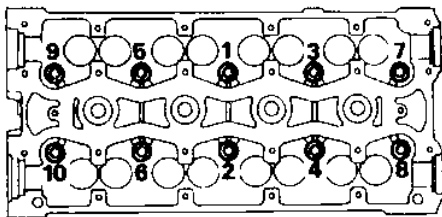
9. Temporarily fit timing gears to camshafts, fit but do not fully tighten bolts.



NOTE: This will enable camshafts to be rotated in order to enable remaining bolts to be tightened:

*Early engines:* - bolts 1 and 2

*Later engines fitted with modified camshafts:* - bolts 3 and 4



8FM 0057

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



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

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



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

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

## K8 and K16

13. Fit new spark plugs, tighten to 25 Nm.  
14. Fit camshaft cover and timing gears.  
15. *K8 engines:* - Fit HT lead brackets, fit and tighten bolts to 10 Nm.

## Cylinder head - K16 Non VVC engines fitted with plug top coil ignition system - refit



CAUTION: If crankshaft has been rotated, check that timing marks on crankshaft timing gear are aligned with flange on oil pump and that tool 18G 1674 is locking flywheel.

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



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

3. Oil cylinder head bolts, under head and threads.
4. Remove cylinder liner retainer clamps 18G 1736.



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

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

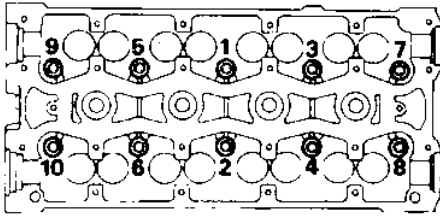


CAUTION: Take care not to damage sealing faces of gasket.

6. Using assistance, fit cylinder head on to cylinder block carefully locating ring dowels.
7. Carefully enter cylinder head bolts in their original fitted locations; DO NOT DROP. Lightly tighten bolts.
8. Temporarily fit timing gears to camshafts, fit but do not fully tighten bolts.




NOTE: This will enable camshafts to be rotated in order to enable bolts 3 and 4 to be tightened.




8RM 0057

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

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

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

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


11. Fit camshaft cover and timing gears.
12. Fit new spark plugs, tighten to 25 Nm.

### ***If fitted***


13. Connect multiplugs to coils, position coils to numbers 1 and 3 spark plugs, fit bolts and tighten to 8 Nm.
14. Secure multiplug harness in clips.
15. Connect HT leads to numbers 2 and 4 spark plugs, secure leads in clips.
16. Position multiplug bracket to camshaft carrier, fit bolts and tighten to 15 Nm.

### ***All engines***


17. Lubricate new 'O' ring with engine oil and fit to camshaft sensor.
18. Fit camshaft sensor, fit bolt and tighten to 5 Nm, secure harness in clip.
19. Fit timing belt tensioner pillar bolt and tighten to 25 Nm.

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


### **Cylinder head - K16 VVC engines - refit**

 **CAUTION:** If crankshaft has been rotated, check that timing mark on crankshaft timing gear is aligned with flange on oil pump and that tool 18G 1571 is locking flywheel.

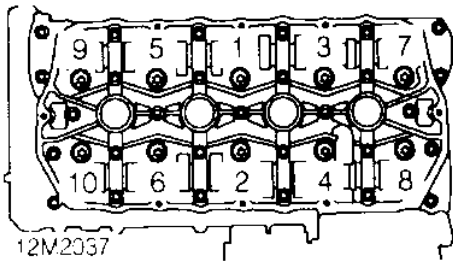
1. Check cylinder head bolts in oil rail. See *Cylinder head bolt inspection* - Renew bolts as necessary.
2. Check that 2 locating dowels are fitted in cylinder block.
3. Oil cylinder head bolts, under heads and threads of bolts.
4. Remove cylinder liner retainer clamps **18G 1736**.

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

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

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

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



12M2037

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



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

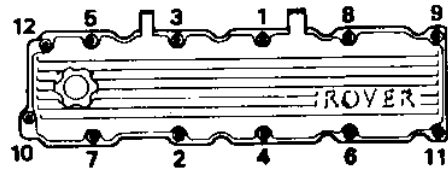
9. Fit camshaft cover and timing gears.  
10. Fit new spark plugs, tighten to 25 Nm.

### Camshaft cover and timing gear - K8 engines - refit

1. Position a new gasket, dry, to camshaft cover.



**NOTE:** Ensure spigots on camshaft cover locate in holes in gasket.

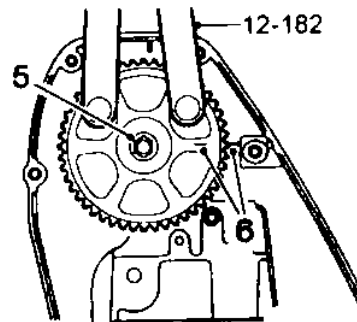


12M0560

2. Position camshaft cover on cylinder head.  
3. Fit bolts and tighten progressively in sequence shown to 10 Nm.  
4. Position timing belt upper rear cover to cylinder head, fit screws and tighten to 9 Nm.



**NOTE:** Longest screw secures cover to coolant pump.



12M 0557A

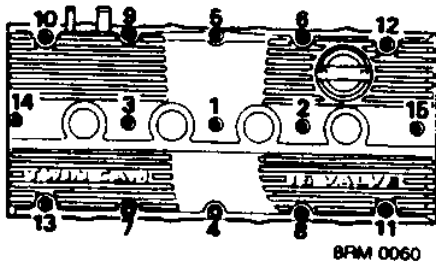
5. Fit camshaft gear to camshaft, hold gear using tool 12-182 and tighten bolt to:  
M8 bolt - 35 Nm  
M10 bolt - 65 Nm
6. Align camshaft gear timing mark to cylinder head top face using tool 12-182.  
7. Fit camshaft timing belt tensioner.

## ENGINE

### Camshaft cover and timing gears - K16 engines not fitted with plug top coil ignition system - refit

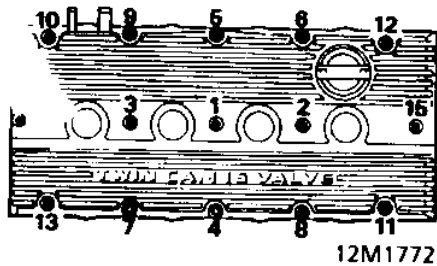
1. Clean mating surfaces and inside of camshaft cover.  
If necessary, wash oil separator elements in suitable solvent and blow dry.
2. Fit new camshaft cover gasket dry, to camshaft carrier, with either 'TOP' mark towards the inlet manifold or 'EXHAUST MAN SIDE' towards exhaust manifold.

#### Camshaft cover with pillar bolts



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

#### Camshaft cover with 'cast-in' supports



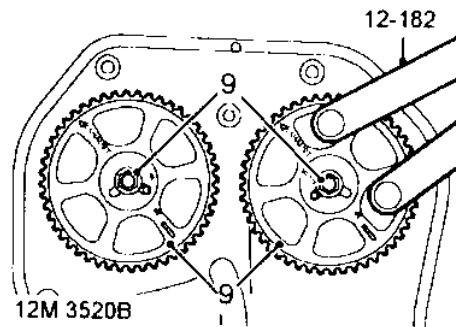
4. Fit camshaft cover on to camshaft carrier, fit bolts and tighten in sequence shown to 10 Nm.

#### All camshaft covers

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

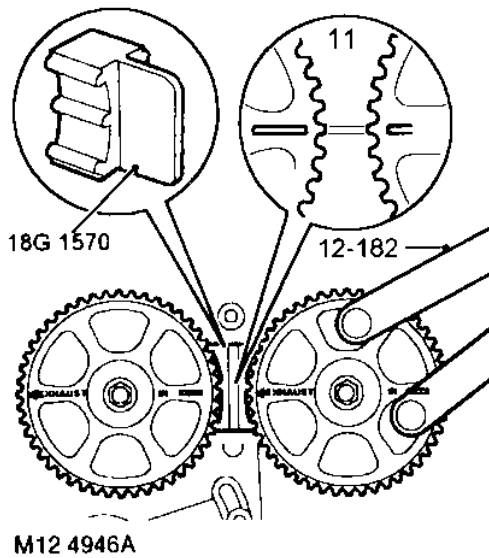


NOTE: Longest screw secures cover to coolant pump.



NOTE: Non VVC timing gears illustrated.

9. Fit camshaft gears to their respective camshafts ensuring that, on non VVC engines, drive gear pins are located in correct slot in drive gears. hold gears using tool 12-182 and tighten bolts to:  
M8 bolts - 35 Nm  
M10 bolts - 65 Nm



NOTE: VVC camshaft timing marks are shown in the inset on the illustration.

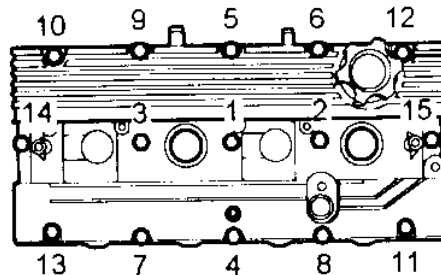
10. *Non VVC engines:* Using tool 12-182, align camshaft gear timing marks.
11. *VVC engines:* Check that camshaft gear timing marks are still aligned, reposition gears if necessary using tool 12-182.
12. Fit camshaft gear locking tool 18G 1570.

#### Later VVC engines

13. Lubricate a new 'O' ring with engine oil and fit to camshaft sensor.
14. Fit camshaft sensor, fit bolt and tighten to 5 Nm.
15. *VVC and K16 engines fitted with manual timing belt tensioner:* Fit camshaft timing belt tensioner.
16. *K16 engines fitted with automatic timing belt tensioner:* Fit new camshaft timing belt.

#### Camshaft cover and timing gears - K16 engines fitted with plug top coil ignition system - refit

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



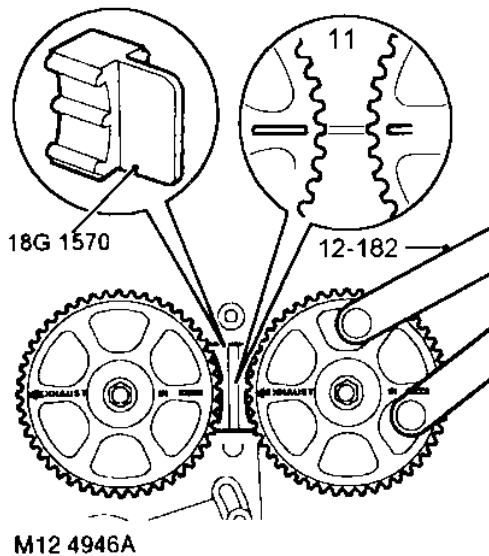
M124976

3. Fit camshaft cover on to camshaft carrier, fit bolts and tighten in sequence shown to 10 Nm.
4. Lubricate a new 'O' ring with engine oil and fit to camshaft sensor.
5. Fit camshaft sensor, fit bolt and tighten to 5 Nm.
6. Secure harness to clips on camshaft cover.
7. Fit spark plug cover, fit screws and tighten to 10 Nm.

NOTE: Short screw is fitted in centre of cover.

8. Position timing belt upper rear cover to cylinder head, fit screws and tighten to 9 Nm.

NOTE: Longest screw secures cover to coolant pump.



NOTE: VVC camshaft timing marks are shown in the inset on the illustration.

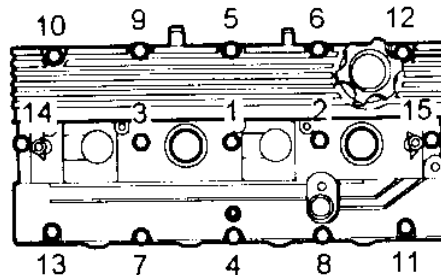
10. *Non VVC engines:* Using tool 12-182, align camshaft gear timing marks.
11. *VVC engines:* Check that camshaft gear timing marks are still aligned, reposition gears if necessary using tool 12-182.
12. Fit camshaft gear locking tool 18G 1570.

#### Later VVC engines

13. Lubricate a new 'O' ring with engine oil and fit to camshaft sensor.
14. Fit camshaft sensor, fit bolt and tighten to 5 Nm.
15. *VVC and K16 engines fitted with manual timing belt tensioner:* Fit camshaft timing belt tensioner.
16. *K16 engines fitted with automatic timing belt tensioner:* Fit new camshaft timing belt.

#### Camshaft cover and timing gears - K16 engines fitted with plug top coil ignition system - refit

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



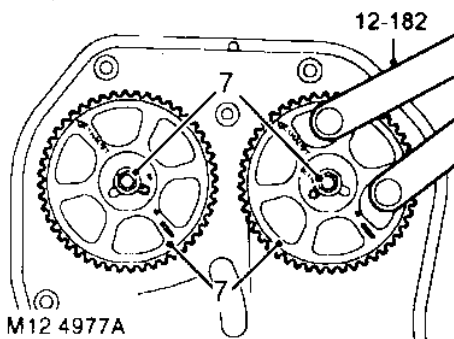
M124976

3. Fit camshaft cover on to camshaft carrier, fit bolts and tighten in sequence shown to 10 Nm.
4. Lubricate a new 'O' ring with engine oil and fit to camshaft sensor.
5. Fit camshaft sensor, fit bolt and tighten to 5 Nm.
6. Secure harness to clips on camshaft cover.
7. Fit spark plug cover, fit screws and tighten to 10 Nm.

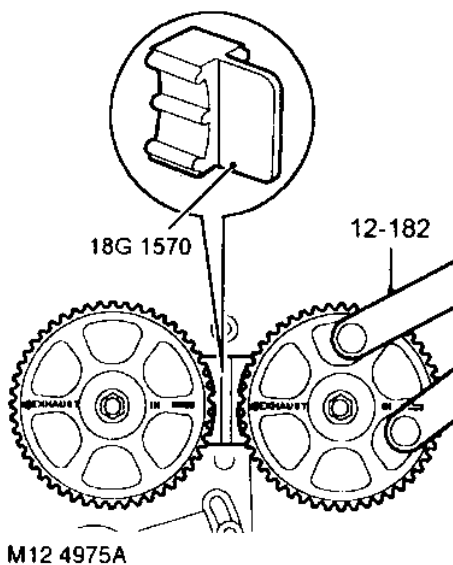
NOTE: Short screw is fitted in centre of cover.

8. Position timing belt upper rear cover to cylinder head, fit screws and tighten to 9 Nm.

NOTE: Longest screw secures cover to coolant pump.



9. Fit camshaft gears to their respective camshafts ensuring that drive gear pins are located in correct slot in drive gears, hold gears using tool 12-182, fit and tighten bolts to 65 Nm.



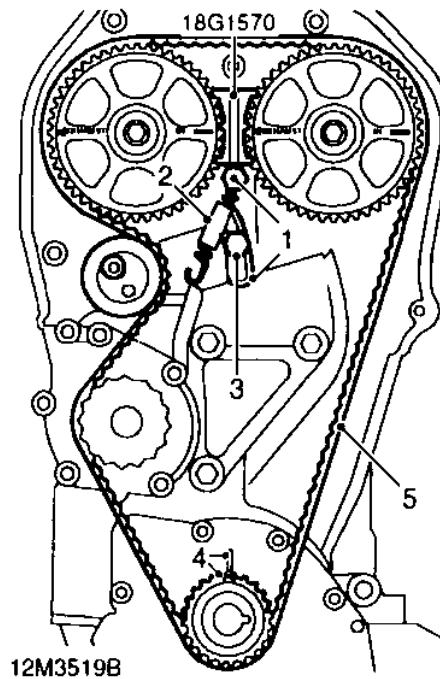
10. Using tool 12-182, align camshaft gear timing marks.  
 11. Fit camshaft gear locking tool 18G 1570.  
 12. Fit new camshaft timing belt.

NOTE: Timing belt tensioner is fitted when timing belt is fitted.

## Camshaft timing belt manual tensioner - refit



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



NOTE: K16 non VVC engine illustrated. On VVC engines, tensioner spring and pillar bolt are supplied with replacement timing belt.

1. Fit timing belt tensioner and pillar bolt, tighten bolt to 25 Nm.
2. Connect tensioner spring to tensioner and pillar bolt.



CAUTION: Ensure correct spring is fitted:  
 K8 and K16 non VVC engines - spring is fitted with a sleeve.  
 K16 VVC engines - spring is not fitted with a sleeve.

3. Tighten tensioner backplate screw to 10 Nm to retain tensioner in released position.





4. Check correct alignment of timing marks on crankshaft gear to mark on oil pump.
5. Fit and adjust a new camshaft timing belt.



**CAUTION: K16 VVC engines:- Remove and discard tensioner spring and pillar bolt on completion of camshaft timing belt adjustment.**

**Distributor - K8 and K16 non VVC engines - if fitted - refit**

**K8**

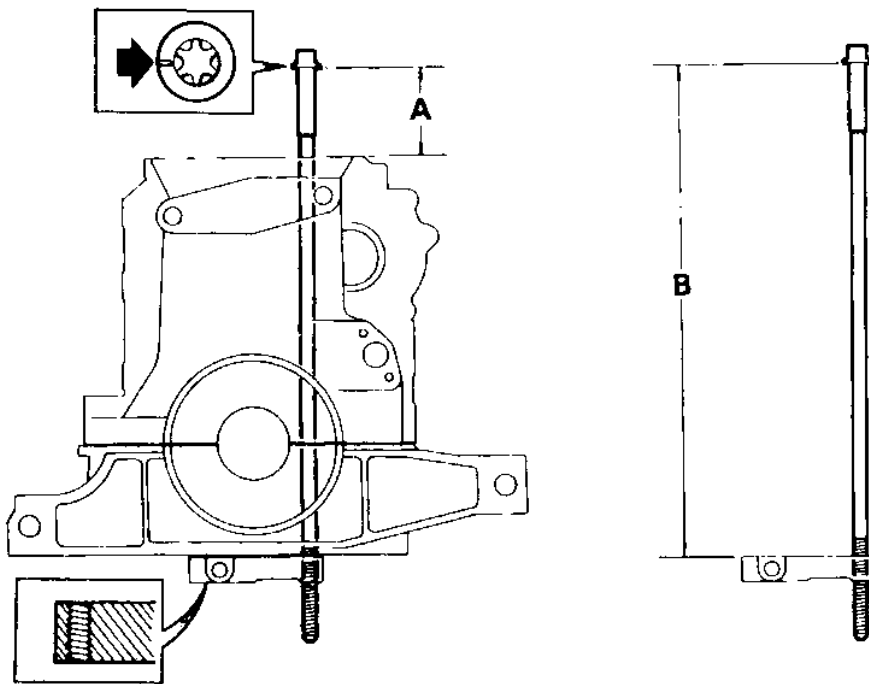
1. Fit new 'O' ring to distributor.
2. Position distributor and turn rotor to engage offset drive, align reference mark or centralise distributor and lightly tighten screws.
3. Fit distributor cap and connect plug leads.

**K16**

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

# ENGINE

## CYLINDER HEAD BOLTS INSPECTION



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

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

### Test with cylinder head removed

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

**CAUTION:** It will be necessary to temporarily remove cylinder liner retainer clamps 18G 1736 in order to test the bolt used with the retainer clamp. Retainer clamps should only be removed one at a time and replaced immediately bolt test is completed. Take great care not to rotate crankshaft or disturb cylinder liners whilst clamps are removed.

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

### Test with oil rail removed

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

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

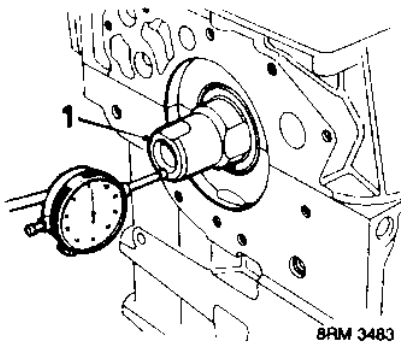


## CRANKSHAFT, MAIN & BIG-END BEARINGS

### Crankshaft end-float - checking



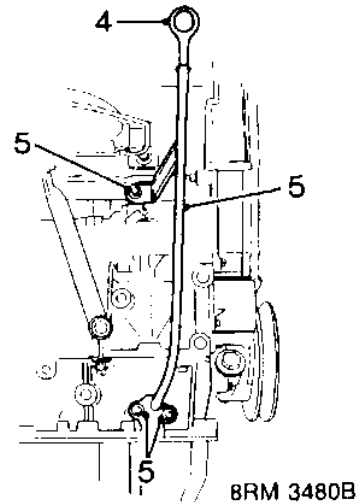
**CAUTION:** Crankshaft end-float must be checked and recorded prior to removing cylinder head.



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

### Crankshaft, main and big-end bearings - remove

1. Remove flywheel.
2. Remove tool 18G 1571.
3. Remove and discard camshaft timing belt.



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

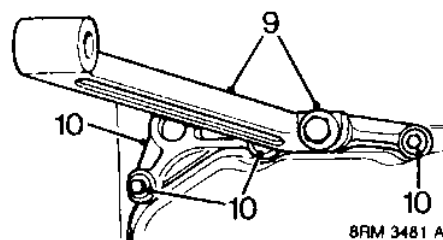


**CAUTION:** Ensure cylinder liner retainer clamps 18G 1736 are fitted.

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



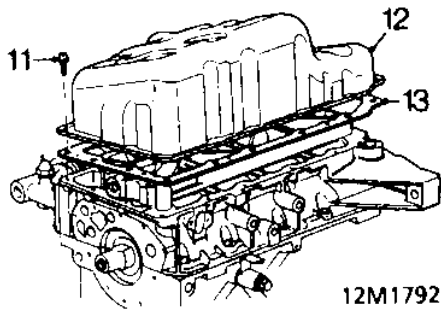
**CAUTION:** Ensure that wooden blocks are of sufficient thickness to prevent cylinder liner clamps contacting workbench.



9. Remove bolt and anti-beaming bracket - where fitted.
10. Remove 3 M6 x 35 bolts and anti-beaming bracket support; discard bolts.

# ENGINE

## Pressed steel sump

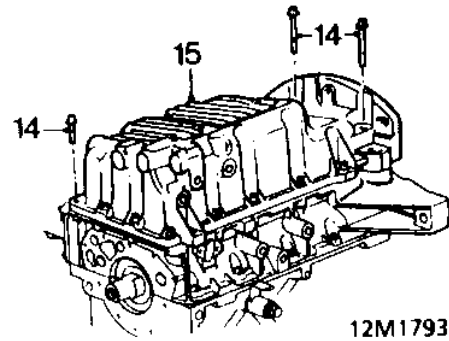


11. Remove and discard 14 bolts securing sump to bearing ladder, (11 bolts if anti-beaming bracket support is removed).
12. Remove sump.
13. Release gasket from sump.



NOTE: Gasket may be re-used if in good condition.

## Alloy sump



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

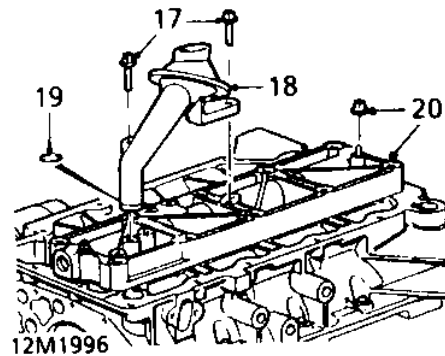


CAUTION: Do not lever between sump flange and bearing ladder.

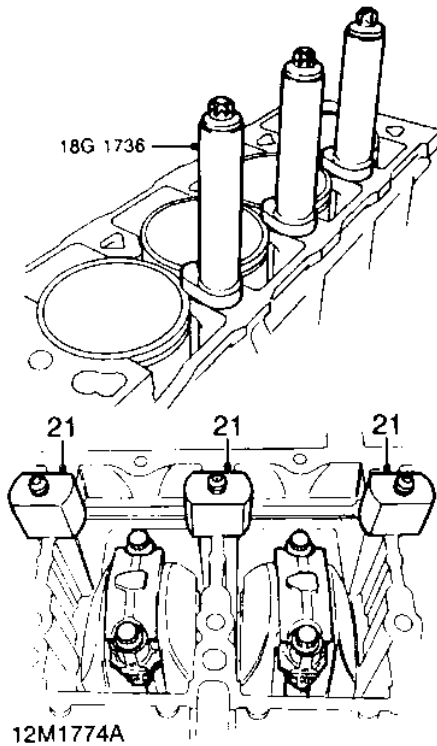
16. Temporarily remove cylinder retainer liner clamps 18G 1736.



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



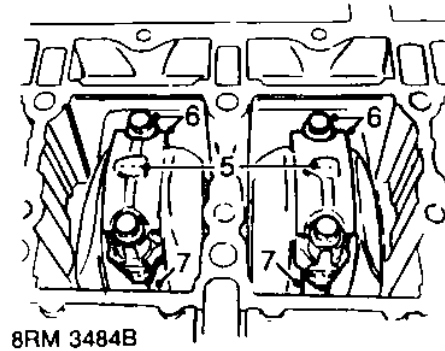
17. Remove 2 screws, suction pipe to oil rail.
18. Remove suction pipe.
19. Discard 'O' ring.
20. Remove 2 nuts securing oil rail, remove rail.



21. Fit cylinder liner retainer clamps **18G 1736** using nylon nuts supplied to retain the clamps. Ensure that feet of clamps do not protrude over cylinder bores. Tighten bolts sufficiently to retain clamps.

### Big-end bearings - remove

1. Refit crankshaft timing gear and pulley.
2. Fit pulley bolt and washer, lightly tighten bolt.
3. Ensure that cylinder liner retainer clamps **18G 1736** and nylon nuts are fitted and that feet of clamps do not protrude over cylinder liner bores.



4. Rotate crankshaft to bring Numbers 2 and 3 pistons to BDC.



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

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



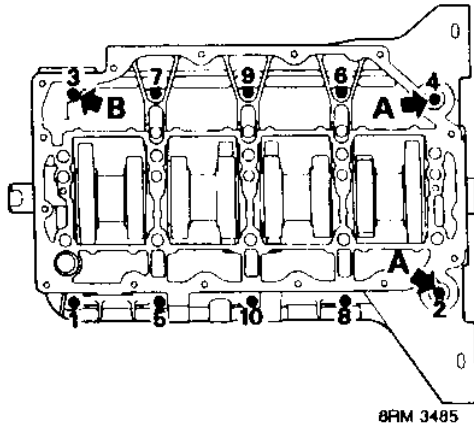
**NOTE:** Number stamped below cap joint is bearing bore size code. Number stamped on connecting rod is cylinder number and letter is weight code.

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


# ENGINE

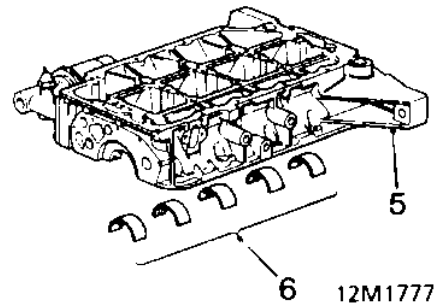
## Crankshaft - remove

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

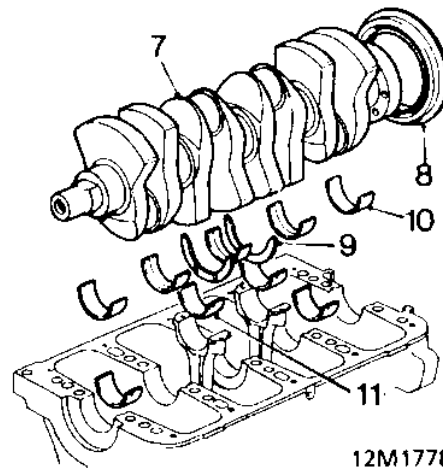


4. Working in sequence shown, slacken then remove 10 bolts securing bearing ladder.


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



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



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

 CAUTION: Do not discard thrust washers at this stage.

10. Remove and discard main bearing shells from cylinder block.



### Crankshaft - inspection

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



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

7. Check crankshaft main journal diameters:

#### *Type A crankshafts*

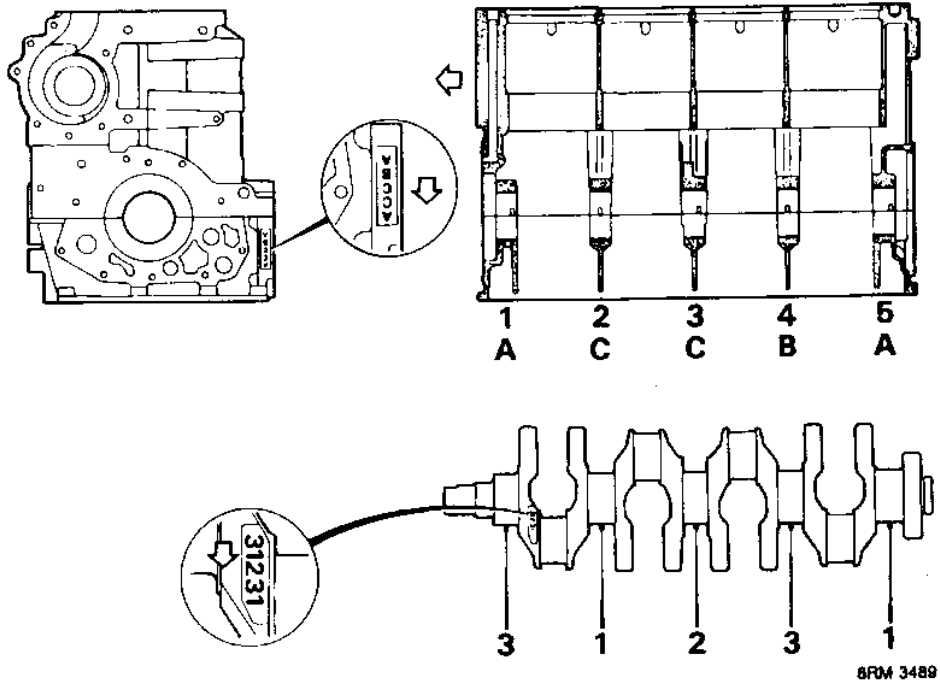
Crankshaft journal tolerance:  
Grade 1 = 47.993 to 48.000 mm  
Grade 2 = 47.986 to 47.993 mm  
Grade 3 = 47.979 to 47.986 mm  
Clearance in bearings = 0.02 to 0.05 mm  
Maximum out of round = 0.010 mm

#### *Type B crankshafts*

Crankshaft journal tolerance:  
Grade 1 = 48.000 to 48.007 mm  
Grade 2 = 47.993 to 48.000 mm  
Grade 3 = 47.986 to 47.993 mm  
Clearance in bearings = 0.013 to 0.043 mm  
Maximum out of round = 0.010 mm

8. Replace crankshaft if outside tolerance.
9. Determine the appropriate bearing shells to be fitted from the main bearing size selection and type tables.

# ENGINE







## Main bearings selection

### Main bearings size selection table

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

Colour code on edge of bearing

Thickness progression:

GREEN - Thin

BLUE - Intermediate

RED - Thick



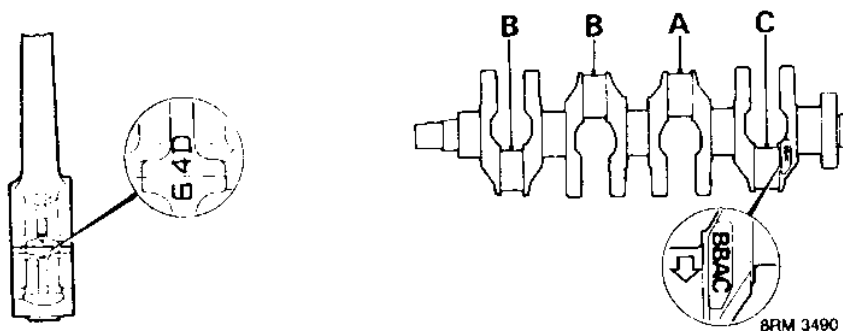
**CAUTION:** If two bearing colours are to be used, thicker bearing must be fitted to bearing ladder.  
When original crankshaft is to be refitted, bearing shells must be as selected from table, **DO NOT FIT UNDERSIZE BEARINGS.**

### Main bearings type table

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

# ENGINE

## Big-end bearings selection



- Record big-end journal code letters from crankshaft rear web.  
First letter is Number 1 big-end bearing.  
Record big-end bearing bore code numbers - this will be 5, 6 or 7 located on the connecting rod bearing cap.
- Check crankshaft big-end journal diameters:  
- 1.1, 1.4 and 1.6 litre  
Big-end journal tolerance :  
Grade A = 43.000 to 43.007 mm  
Grade B = 42.993 to 43.000 mm  
Grade C = 42.986 to 42.993 mm  
Clearance in bearings = 0.021 to 0.049 mm  
Maximum out of round = 0.010 mm  
Big-end/connecting rod end-float = 0.10 to 0.25

mm

### 1.8 litre

Big-end journal tolerance:  
Grade A = 48.000 to 48.007 mm  
Grade B = 47.993 to 48.000 mm  
Grade C = 47.986 to 47.993 mm  
Clearance in bearings = 0.021 to 0.049 mm  
Maximum out of round = 0.010 mm  
Big-end/connecting rod end-float = 0.10 to 0.25 mm

- Select the appropriate big-end bearing shells from the table.
- Replace crankshaft if outside tolerance.

### Big-end bearings size selection table

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

Colour code on edge of bearing

Thickness progression:

YELLOW - Thin

BLUE - Intermediate

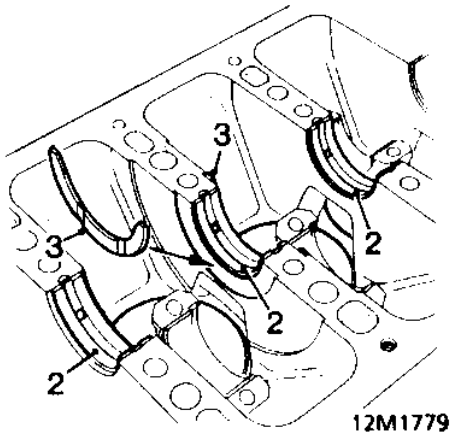
RED - Thick

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



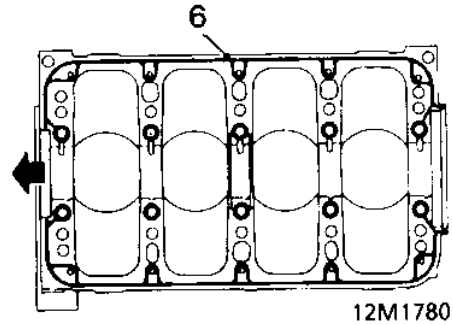
### Crankshaft, main and big-end bearings - refit

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



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

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

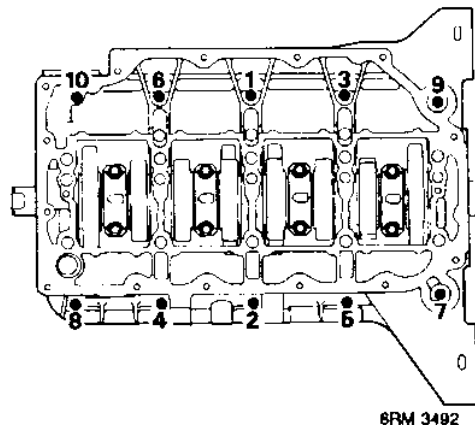


6. Apply a continuous bead of sealant, Part Number GUG 705963GM to paths shown on cylinder block then spread to an even film using a roller.



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

## ENGINE



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

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

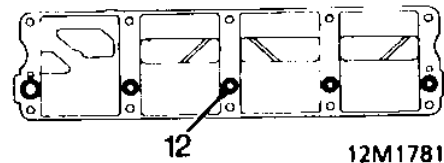
8. Fit cylinder liners and pistons.

**CAUTION:** Ensure that cylinder liner retainer clamps 18G 1736 and nylon nuts are fitted immediately cylinder liners are inserted into cylinder block.

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

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

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



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

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

13. Using assistance, position cylinder block on its side and temporarily remove cylinder liner retainer clamps 18G 1736.

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

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

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

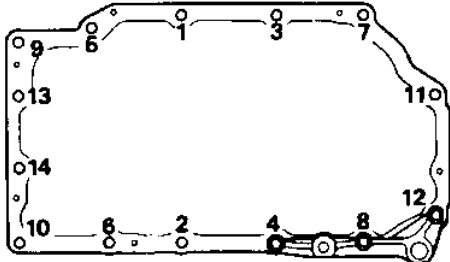
15. Fit cylinder retainer clamps 18G 1736, screw bolts into oil rail and tighten sufficiently to retain clamps.
16. Lubricate a new 'O' ring with engine oil and fit to oil suction pipe.
17. Fit oil suction pipe, fit screws and tighten to 12 Nm.

**CAUTION:** Screws used must be M6 x 20.



### Pressed steel sump

18. Clean inside and joint face of sump. Check condition of gasket, renew if damaged or showing signs of deterioration.
19. Fit gasket to sump, ensure its 7 pegs are fully located.



8RM 0054

20. Fit sump to bearing ladder, fit 11 new Patchlok bolts and using sequence shown, tighten to 5 Nm.

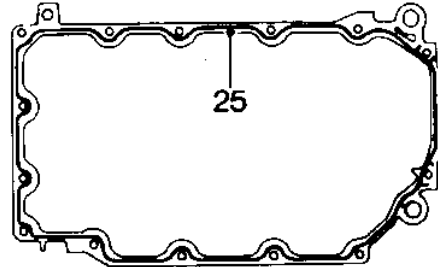


**CAUTION:** Early engines: M6 bolts  
Later engines: M8 bolts

21. Fit anti-beaming bracket support, where fitted; fit and tighten 3 new M6 or M8 x 35 Patchlok bolts at positions 4, 8 and 12 to 5 Nm.
22. Progressively tighten sump bolts in sequence shown to:  
M6/M8 bolts: 10 Nm
23. Fit anti-beaming bracket where fitted, tighten bolt to 45 Nm.

### Alloy sump

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



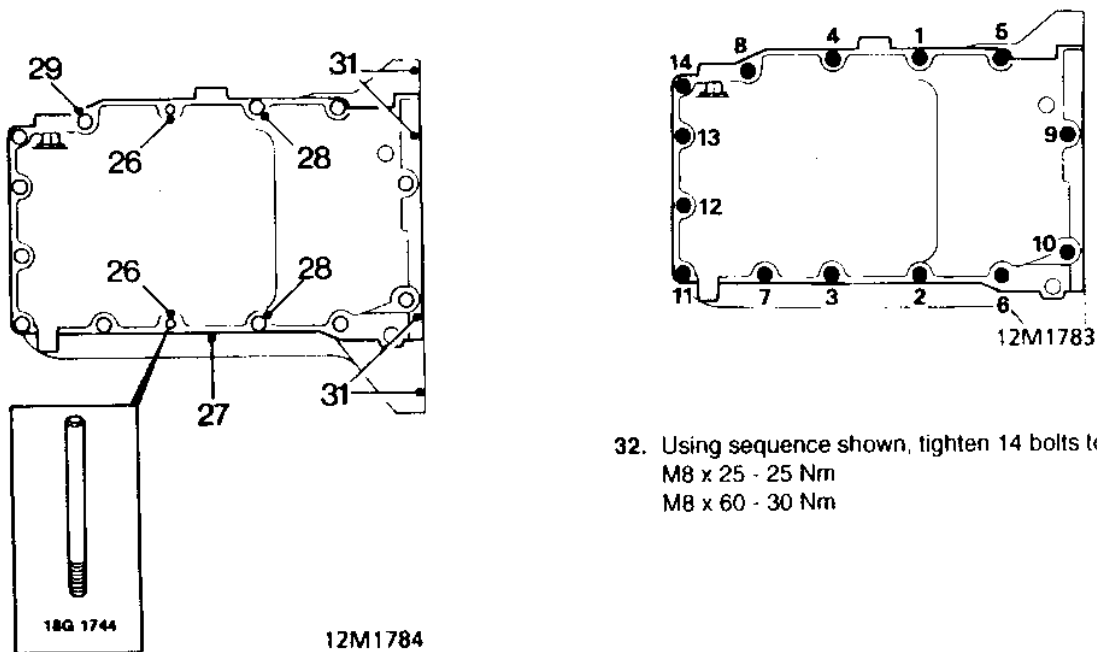
12M1782

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



**CAUTION:** To avoid contamination, assembly should be completed immediately after application of sealant. Do not use RTV or any sealant other than specified.

## ENGINE



32. Using sequence shown, tighten 14 bolts to:  
M8 x 25 - 25 Nm  
M8 x 60 - 30 Nm

26. Screw alignment pins 18G 1744 into holes shown.
27. Carefully lower sump over pins and on to bearing ladder.
28. Fit 2 bolts into holes shown, tighten to 4 Nm.
29. Fit 10 bolts into remaining holes, lightly tighten all bolts.

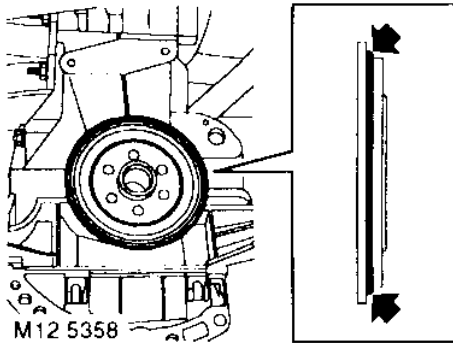


**CAUTION:** Ensure 2 M8 x 60 bolts are in original fitted positions.

30. Remove alignment pins 18G 1744, fit and lightly tighten remaining 2 bolts.
31. Using a straight edge, check that machined face of sump flange is level with rear face of cylinder block. Check in 3 positions and if necessary, tap sump gently to re-position it.

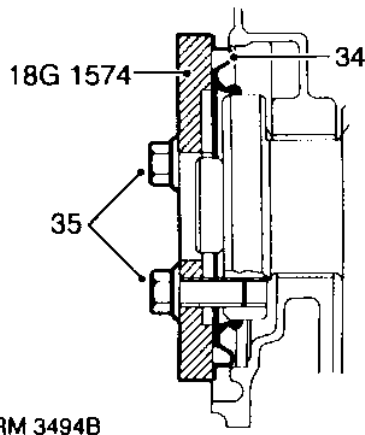


## All engines



33. Apply a 1.5 mm continuous bead of sealant, Part No. GAC 8000 to replacement oil seal as shown.

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



34. Position oil seal to cylinder block.  
 35. Fit oil seal replacer tool **18G 1574** to crankshaft, retain tool using 3 slave bolts.  
 36. Tighten bolts to press oil seal squarely into cylinder block.

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

37. Remove tool **18G 1574**.

**CAUTION:** Allow sealant to cure for a minimum of 30 minutes before rotating crankshaft.

38. Fit flywheel.  
 39. Fit oil pump and front oil seal.  
 40. Fit crankshaft timing gear.  
 41. Fit cylinder head assembly, do not fit spark plugs at this stage.  
 42. Fit a new camshaft timing belt.  
 43. Clean joint surfaces. Use new gasket, dry and fit dipstick tube, tighten bolts to 10 Nm.

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

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

# ENGINE

## PISTONS, RINGS & CYLINDER LINERS

### Pistons and connecting rods - remove

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



**CAUTION:** Ensure that feet of cylinder liner retainer clamps 18G 1736 do not protrude over cylinder bores.

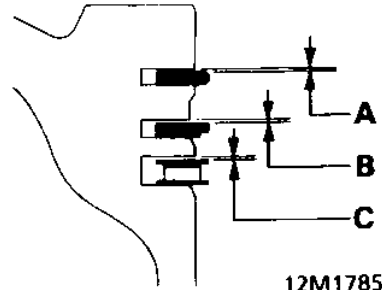
4. Remove ridge of carbon from top of each cylinder liner bore.
5. Push pistons to top of their bores.
6. Carefully push out each piston assembly taking care that big-ends do not contact surface of cylinder liners.
7. Refit caps on to connecting rods, lightly tighten dowel bolts.



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

### Piston rings - checking

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



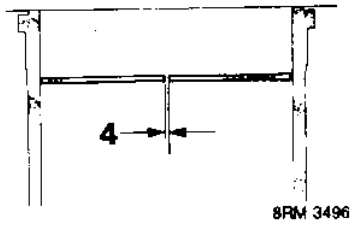
#### **K8 and K16 - 1.1 and 1.4**

Top compression ring - **A** = 0.04 to 0.08 mm  
2nd compression ring - **B** = 0.03 to 0.062 mm  
Oil control rails - **C** = 0.044 to 0.55 mm

#### **K16 - 1.6 and 1.8**

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





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



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

**K8 and K16 - 1.1 and 1.4:**

Top compression ring - = 0.17 to 0.37 mm  
 2nd compression ring - = 0.37 to 0.57 mm  
 Oil control rails = 0.15 to 0.40 mm

**K16 - 1.6 and 1.8:**

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

**Pistons - inspection**

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

**K8 and K16 - 1.1 and 1.4:**

Grade A = 74.940 to 74.955 mm

Grade B = 74.956 to 74.970 mm

Maximum ovality = 0.3 mm

**K16 - 1.6 and 1.8:**

Grade A = 79.975 to 79.990 mm

Grade B = 79.991 to 80.005 mm

Maximum ovality = 0.3 mm

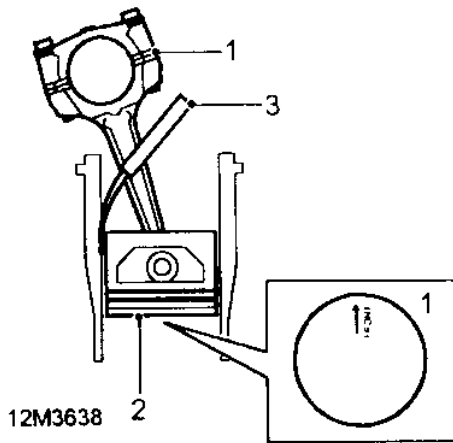
Service pistons are grade A and B



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

# ENGINE

## Piston to cylinder liner bore clearance - checking



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

### Clearance in cylinder liner bore: K8 and K16 - 1.1 and 1.4

0.015 to 0.045 mm

### K16 - 1.6 and 1.8

0.01 to 0.04 mm



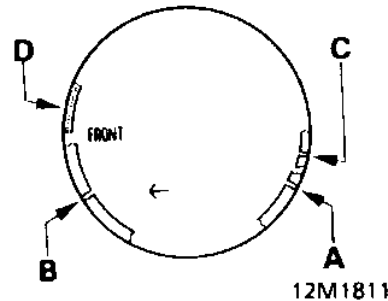
NOTE: Pistons and connecting rods are only supplied as an assembly.

## Piston rings - refit



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

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

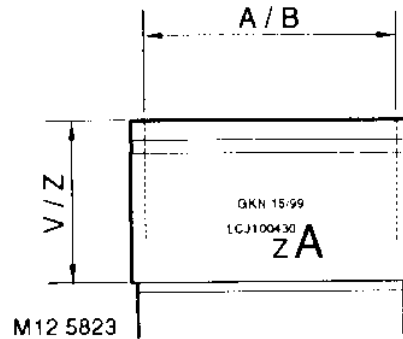
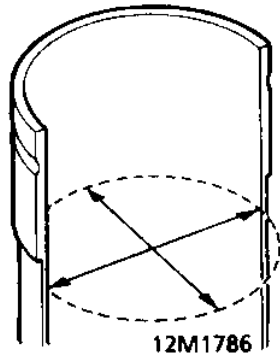


3. Ensure rings are free to rotate, position compression ring gaps A and B at 120° to each other and away from thrust side - left hand side of piston when viewed from front. Position oil control ring gap C and spring gap D at 30° on opposite side of gudgeon pin axis.



## Cylinder liners - inspection

Later 1.8 engines only



1. Measure wear and taper in two axes 65 mm from top of cylinder liner bore.

**1.1 and 1.4:**

RED grade A = 74.970 to 74.985 mm  
 BLUE grade B = 74.986 to 75.000 mm

**1.6 and 1.8:**

RED grade A = 80.000 to 80.015 mm  
 BLUE grade B = 80.016 to 80.030 mm  
 Service liners are grade A and B.

Cylinder liner grade A or B together with the appropriate colour code will be found marked on outside diameter of liner.



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

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

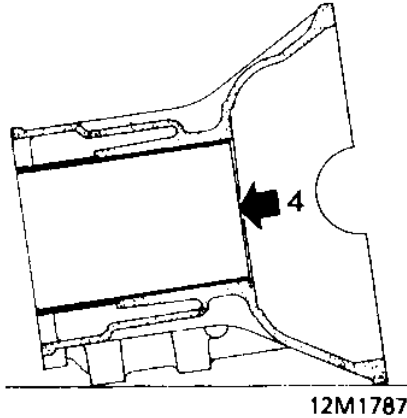



**NOTE:** Cylinder liners fitted to later 1.8 engines have their step heights graded on production. The step heights, V or Z together with the liner part number and colour code are marked on the outside diameter of the liner. If cylinder liner(s) are to be replaced, the replacement liner(s) must have the same step height as the original liner(s). Both step heights are available in red and blue grades of liner.

# ENGINE


## Cylinder liners - remove

1. Remove pistons.
2. Remove cylinder liner clamps **18G 1736**.
3. Using assistance, position cylinder block on its side.




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


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

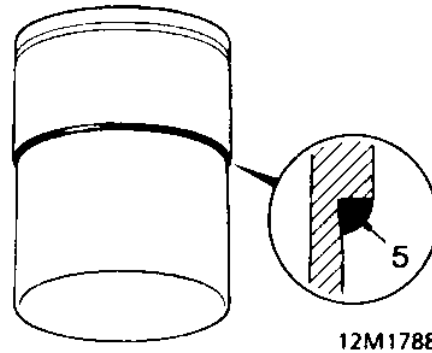
 **CAUTION:** Keep cylinder liners in their fitted order.

## Cylinder liners - refit


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

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


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



5. Apply a 2.0 mm thick continuous bead of sealant from kit, Part Number GGC 102 around shoulder of cylinder liner.

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

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

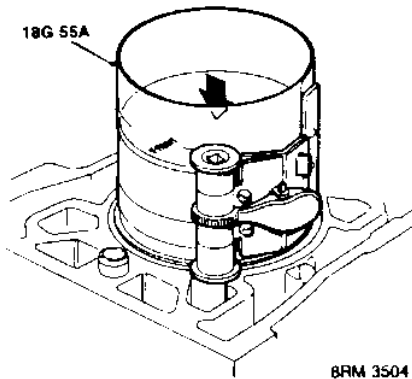
 **CAUTION:** If original cylinder liners are to be refitted, align reference marks made during dismantling before liner is pushed fully down.

7. Fit cylinder liner retainer clamps **18G 1736**.
8. Fit pistons.



### Pistons and connecting rods - refit

1. Using assistance, support base of cylinder block on 2 wooden blocks.
2. Ensure that cylinder liner retainer clamps **18G 1736** are fitted and that feet of clamps do not protrude over cylinder liner bores.
3. Lubricate cylinder bores, pistons and rings with engine oil, ensure ring gaps are correctly spaced.
4. Fit selected bearing shells into big-end bearing caps and connecting rods.



5. Fit ring clamp **18G 55A** to each piston in turn and with '**FRONT**' mark on piston to engine front, push piston into bore until flush with top face of cylinder liner. Remove ring clamp.

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

6. Fit big-end bearings.




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**DATA**


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**Oil pump**

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

**Cooling system**

Thermostat starts to open .....	88° C
Nominal setting .....	85 to 91° C
Thermostat fully open .....	100° C

**Camshafts****Camshaft end-float - K8 and K16 Non VVC**

engines: .....	0.06 to 0.19 mm
- Service limit .....	0.3 mm

**Camshaft end-float - K16 VVC engines:**

Inlet .....	0.03 to 0.15
- Service limit .....	0.25 mm
Exhaust .....	0.06 to 0.19 mm
- Service limit .....	0.3 mm

**Camshaft bearing clearance - K8 and K16**

Non VVC engines: .....	0.060 to 0.094 mm
- Service limit .....	0.15 mm

**Camshaft bearing clearance - K16 VVC engines:**

Inlet - 25 mm diameter journals .....	0.025 to 0.060
- Service limit .....	0.1 mm
Inlet - 40 mm diameter journals .....	0.03 to 0.07 mm
- Service limit .....	0.1 mm
Exhaust .....	0.060 to 0.094 mm
- Service limit .....	0.15 mm

**Tappets**

Tappet outside diameter .....	32.959 to 32.975 mm.
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**Cylinder head**

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

## ENGINE

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### Valve springs

#### *K8 engines*

Free length	46.2 mm
Fitted length	37.0 mm
Load - valve closed	255 ± 12 N
Load - valve open	535 ± 20 N

#### *K16 Non VVC engines*

Free length	50.0 mm
Fitted length	37.0 mm
Load - valve closed	250 ± 12 N
Load - valve open	450 ± 18 N at 28.8 mm

#### *K16 VVC engines*

Free length	47.6 mm
Fitted length	37.0 mm
Load - valve closed	210 ± 13 N
Load - valve open	440 ± 22 N

### Valves

#### *K8 engines*

Valve stem diameter:	
Inlet	6.960 to 6.975 mm
Exhaust	6.952 to 6.967 mm
Valve guides:	
Inside diameter	7.000 to 7.025 mm
Valve stem to guide clearance:	
Inlet	0.025 to 0.065 mm
- Service limit	0.07 mm
Exhaust	0.033 to 0.073 mm
- Service limit	0.11 mm
Valve stem fitted height:	
New	38.95 to 40.81 mm
- Service limit	41.06 mm

#### *K16 engines*

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

**Valve guides**

## Fitted height:

K8 engines	10.3 mm
K16 engines	6.0 mm

**Valve seats**

Angle	45°
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## Width

## Not triple angle valve seats :-

Inlet and exhaust	1.5 mm
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## Triple angle valve seats :-

Inlet	1.0 to 1.4 mm
Exhaust	1.4 to 1.8 mm

## Valve face angle:

Inlet	45°
Exhaust	45°

**Crankshaft**

Crankshaft end-float	0.10 to 0.25 mm
Service limit	0.34 mm

Thrust washer halves thickness	2.61 to 2.65 mm
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## Main journal tolerance - Type A crankshaft\*

Grade 1	47.993 to 48.000 mm
Grade 2	47.986 to 47.993 mm
Grade 3	47.979 to 47.986 mm

Clearance in bearings	0.02 to 0.05 mm
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Maximum out of round	0.010 mm
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## Main journal tolerance - Type B crankshaft\*

Grade 1	48.000 to 48.007 mm
Grade 2	47.993 to 48.000 mm
Grade 3	47.986 to 47.993 mm

Clearance in bearings	0.013 to 0.043 mm
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Maximum out of round	0.010 mm
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## Big-end journal tolerance - 1.1, 1.4 and 1.6 litre:

Grade A	43.000 to 43.007 mm
Grade B	42.993 to 43.000 mm
Grade C	42.986 to 42.993 mm

Clearance in bearings	0.021 to 0.049 mm
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Maximum out of round	0.010 mm
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Big-end/connecting rod end-float	0.10 to 0.25 mm
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## Big end journal tolerance - 1.8 litre:

Grade A	48.000 to 48.007 mm
Grade B	47.993 to 48.000 mm
Grade C	47.986 to 47.993 mm

Clearance in bearings	0.021 to 0.049 mm
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Maximum out of round	0.010 mm
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Big-end/connecting rod end-float	0.10 to 0.25 mm
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\* For commencing engine numbers for Types A and B crankshafts, see Information.



# ENGINE

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## Piston rings

New ring to groove clearance:

### *K8 and K16 - 1.1 and 1.4*

Top compression ring .....	0.04 to 0.08 mm
2nd compression ring .....	0.03 to 0.062 mm
Oil control rails .....	0.044 to 0.055 mm

### *K16 - 1.6 and 1.8*

Top compression ring .....	0.040 to 0.072 mm
2nd compression ring .....	0.030 to 0.062 mm
Oil control rails .....	0.010 to 0.180 mm

Ring fitted gap 20 mm from top of bore:

### *K8 and K16 - 1.1 and 1.4*

Top compression ring .....	0.17 to 0.37 mm
2nd compression ring .....	0.37 to 0.57 mm
Oil control rails .....	0.15 to 0.40 mm

### *K16 - 1.6 and 1.8*

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

## Piston diameter

### *K8 and K16 - 1.1 and 1.4*

Grade A .....	74.940 to 74.955 mm
Grade B .....	74.956 to 74.970 mm
Clearance in bore .....	0.015 to 0.045 mm
Maximum ovality .....	0.3 mm

### *K16 - 1.6 and 1.8*

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

## Cylinder block

Cylinder liner bore:

### *K8 and K16 - 1.1 and 1.4*

RED grade A .....	74.970 to 74.985 mm
BLUE grade B .....	74.986 to 75.000 mm

### *K16 - 1.6 and 1.8*

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



## TORQUE WRENCH SETTINGS

Air cleaner support bracket bolts	10 Nm
Alloy sump bolts*	
M8 x 25	25 Nm
M8 x 60	30 Nm
Bearing ladder to block bolts*	30 Nm
Big-end bolts	20 Nm + 45°
Blanking plate to camshaft carrier bolts:	
Not plug top coil ignition system:	25 Nm
Plug top coil ignition system:	
- Inlet camshaft	6 Nm
- Exhaust camshaft	25 Nm
Camshaft carrier bolts*	10 Nm
Camshaft cover to carrier bolts*	10 Nm
Camshaft gear bolts:	
M8	35 Nm
M10	65 Nm
Camshaft sensor bolts - K16 engines	5 Nm
Coolant pump bolts*	10 Nm
Coolant rail to cylinder block bolts	25 Nm
Crankshaft pulley bolt	205 Nm
Cylinder head bolts*:	
All bolts	20 Nm
- Mark position of radial marks	
- Turn all bolts + 180°	
- Turn all bolts another + 180° align marks	
Dipstick tube bolts	10 Nm
Flywheel+	80 Nm
Fuel pump blanking plate nuts - K8	25 Nm
ht lead brackets - not plug top coil ignition	10 Nm
ht lead cover screws	5 Nm
Hydraulic control unit bolts - K16 VVC engines	25 Nm
Hydraulic control unit piston to rack screw++	9 Nm
Hydraulic control unit oil temperature transmitter	15 Nm
Hydraulic control unit spool valve	
nut - K16 VVC engines	26 Nm
Hydraulic control unit spool valve sleeve	
bolt - K16 VVC engines	12 Nm
Ignition coils to cylinder head - plug top	
coil ignition only	8 Nm
K16 VVC housing bolts	10 Nm
Multiplug bracket to camshaft carrier	
bolts - if fitted	10 Nm
Oil filter adapter bolts	12 Nm
Oil pump bolts* +	10 Nm
Oil rail nuts	9 Nm
Oil suction pipe to bearing ladder bolts	12 Nm
Oil temperature sensor to oil filter	
adapter - if fitted	17 Nm
Pressed steel sump bolts - M6/M8* +	10 Nm

\* Tighten in sequence

+ New Patchlok bolt(s) must be fitted

++ Use new screw supplied with seal kit

## ENGINE

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### Rear timing belt backplate screws - K16 VVC

engines:

M5 .....	6 Nm
M6 .....	10 Nm
Rear timing belt cover screws - K16 VVC engines ..	10 Nm
Rear timing gear bolts - K16 VVC engines .....	35 Nm
RH engine mounting bracket bolts .....	45 Nm
Rotor arm screw .....	10 Nm
Spark plugs .....	25 Nm
Spark plug cover screws .....	10 Nm
Thermostat housing bolts - Alloy housing .....	10 Nm
Thermostat housing bolts - Plastic housing .....	8 Nm
Thermostat housing to cylinder block bolt .....	10 Nm
Timing belt tensioner bolt - Automatic tensioner+ ..	25 Nm
Timing belt tensioner pulley Allen screw - Manual tensioner .....	45 Nm
Timing belt tensioner pulley backplate screw - Manual tensioner .....	10 Nm
Timing belt tensioner pillar bolt .....	25 Nm
Timing belt lower cover screws .....	9 Nm
Timing belt rear cover screws .....	9 Nm
Timing belt upper front cover screws .....	5 Nm

\* Tighten in sequence

+ New Patchlok bolt(s) must be fitted

++ Use new screw supplied with seal kit




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**SERVICE TOOLS**


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18G 55A	Piston Ring Clamp
18G 1299A	K16 VVC Housing Oil Seal Remover
18G 1299A-1	Centre Bolt
18G 1519	Valve Lifter Basic Tool
18G 1519/1	Valve Lifter Adaptor
18G 1570	Camshaft Locking Tool
18G 1571	Flywheel Locking Tool - Flywheel Not Fitted With Reluctor Ring
18G 1574	Crankshaft Rear Oil Seal Replacer Tool
18G 1576/1	Valve Guide Remover/Replacer
18G 1576-2	Depth Gauge - All K16 Engines
18G 1576-3	Nylon Guide
18G 1576-4	Depth Gauge - K8 Engines
18G 1577	Valve Stem Oil Seal Remover/Replacer
18G 1587	Crankshaft Front Oil Seal Replacer
18G 1604A	K16 VVC Housing Oil Seal Replacer
18G 1674	Flywheel Locking Tool - Flywheel Fitted With Reluctor Ring
18G 1736	Cylinder Liner Retainer Clamps
18G 1744	Sump Alignment Pins - 2 off
18G 1769A	Camshaft Front And Rear Oil Seal Replacer
18G 1770	Camshaft Clamp - K16 VVC Engines
18G 1770/1	Timing Plate - Front Inlet Camshaft - K16 VVC Engines
18G 1770/2	Timing Plate - Rear Inlet Camshaft - K16 VVC Engines
18G 1749	Camshaft Oil Seal Protection Sleeve
18G 1771	Valve Guide Reamer - All K16 Engines
18G 1772	Valve Guide Reamer - K8 Engines
MS 120-6	Valve Seat Cutter Pilot
MS 76-111	60° Valve Seat Cutter
MS 76-120	15° Valve Seat Cutter
MS 76-122	45° Valve Seat Cutter
12-182	Camshaft Holding Tool

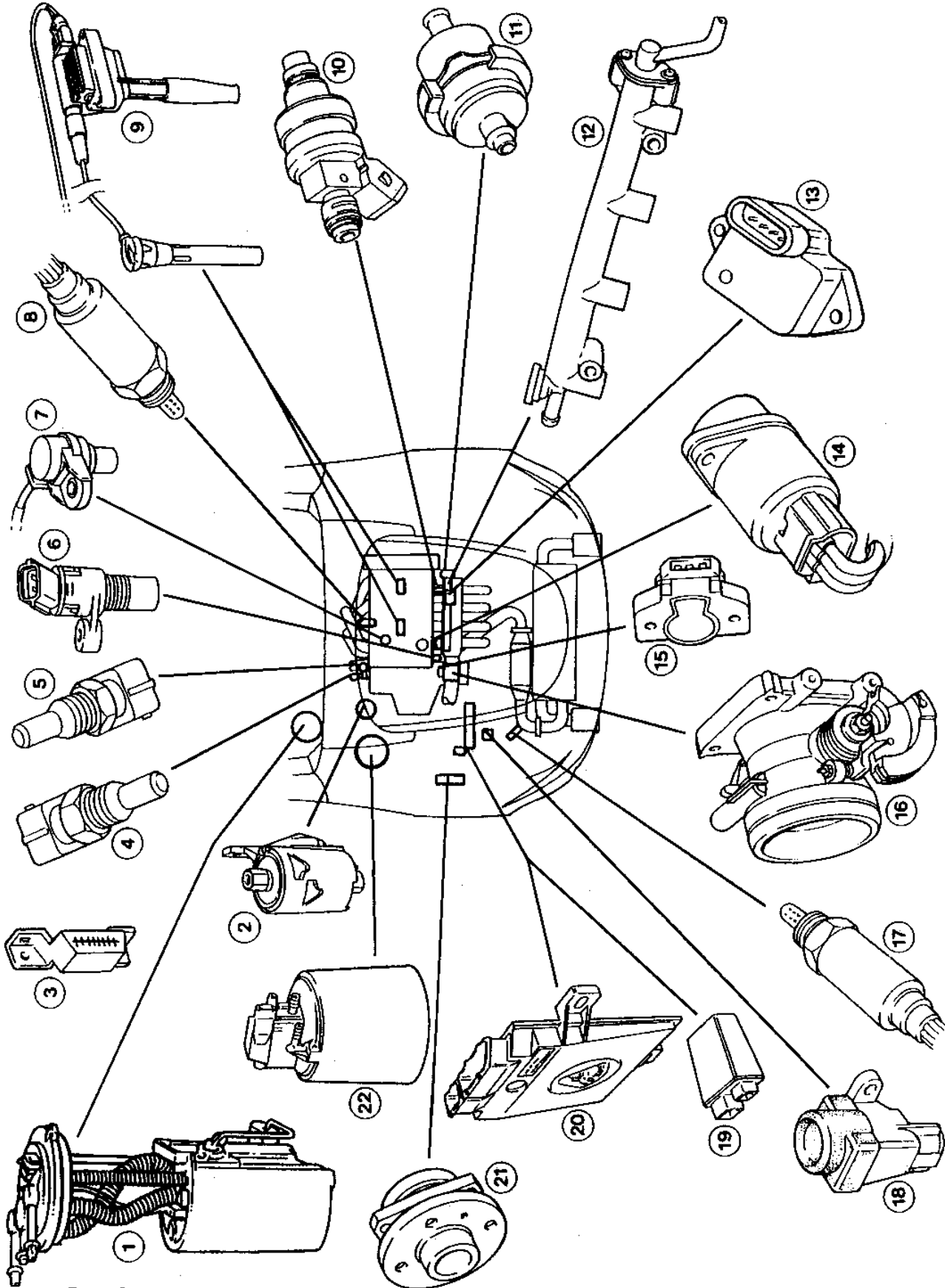
**ENGINE MANAGEMENT & FUEL INJECTION****SECTION EMO - ELISE 2001 M.Y. Onwards**

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COMPONENT LOCATION DIAGRAM

em198a





## EMO.1 - INTRODUCTION

### Key to Component Location Diagram

- |   |  |
|---|--|
| 1. Fuel pump/gauge sender unit                      | 12. Fuel rail  |
| 2. Fuel filter                                      | 13. Inlet Air Temperature & Manifold Absolute Pressure (TMAP) sensor |
| 3. Data Link Connector (DLC) - passenger footwell   | 14. Idle Air Control (IAC) valve                                     |
| 4. Engine Coolant Temperature (ECT) sensor (horiz.) | 15. Throttle Position (TP) sensor                                    |
| 5. Water temperature gauge sender (vertical)        | 16. Throttle body  |
| 6. Crankshaft Position (CKP) sensor                 | 17. Post-cat. Oxygen (O <sub>2</sub> ) sensor                        |
| 7. Camshaft Position (CMP) sensor                   | 18. Inertia switch   |
| 8. Pre-cat. Oxygen (O <sub>2</sub> ) sensor         | 19. Relay module   |
| 9. High tension ignition coil                       | 20. Engine Control Unit (ECU)  |
| 10. Fuel injector                                   | 21. Hub unit with Vehicle Speed Sensor (VSS)                         |
| 11. Fuel pressure regulator valve                   |  |

The 1.8 K Series engine fitted to the Elise from 2001 model year is equipped with the Lotus K4 engine management system. A single Engine Control Unit (ECU) is used to control both the fuel injection and ignition systems, with the control strategy based on engine speed/air density measurement. Engine speed data is derived from a flywheel sensor, with air density calculated from inlet air temperature and manifold air pressure (TMAP) signals. The engine is fully compliant with European Community Directive 3 (ECD3), including full European On Board Diagnostics (EOBD), in order closely to control and monitor exhaust emission levels and illuminate a Malfunction Indicator Lamp (MIL) in the event of a system fault.

The engine features a throttle body housing a single, position sensed, throttle butterfly valve, feeding air into a lightweight moulded plastic intake plenum chamber with four individual intake tracts, each of which is fitted with a fuel injector positioned to spray fuel onto the back of the intake valves. Fuel delivery quantity is controlled by the length of time (pulse width) for which the solenoid operated injectors are energised, with the ECU using a fully sequential strategy for individual control of each injector.

The air/fuel ratio is calculated by the ECU using a three dimensional map to provide a basic fuelling specification under various operating conditions. In order to refine the fuel delivery and cater for special conditions, various types of compensation are provided:

- *Cranking enrichment*; During cranking, when engine speed is below about 400 rpm, the injection pulse width is increased, dependent on coolant temperature, to aid starting.
- *Warm up enrichment*; Immediately after starting, the pulse width is increased, but decays at a rate dependent on coolant temperature.
- *Acceleration enrichment*; Signals received from the throttle position and MAP sensors which indicate acceleration is demanded, will prompt additional fuel for smooth and ready response.
- *Overrun fuel cut-off*; At normal running temperature, when the throttle is closed and engine speed is above about 2,000 rpm, indicating engine overrun, the fuel supply is shut off to enhance economy and reduce emissions.
- *Overspeed fuel cut-off*; At 6950 rpm, the injectors are cut off in order to help protect the engine from overspeed damage.
- *Oxygen sensor feedback*; By measuring the oxygen content of the exhaust gas, any adjustment necessary to maintain the air/fuel ratio to that required by the catalytic converter for optimum conversion efficiency may be computed by the ECU. An electrically heated oxygen sensor is used to ensure its speedy attainment of working temperature after a cold start.
- *Battery voltage correction*; The ECU senses battery voltage, and applies a correction factor to take account of any variation in fuel delivery due to battery voltage fluctuation.

An idle air control valve mounted on the throttle body, is used to regulate the amount of air by-passing the throttle plate, and hence control engine idle speed when the throttle is fully closed.

The ignition system uses a distributorless ignition system (DIS) which employs a pair of double ended ignition coils and a 'waste spark' system whereby each coil fires two spark plugs simultaneously (1 paired with 4, and 2 with 3), the spark in the cylinder on the exhaust stroke being 'wasted'. The two H.T. coils are mounted on the cam cover, each connecting directly with one spark plug, and via a short H.T. lead with a second plug.

The ECU is calibrated to recognise sensor readings which are outside of the acceptable range, and if such a signal is received from the coolant, throttle position or TMAP sensor, it will substitute a default value to enable the engine to continue to run, in a 'back up', or 'get you home' mode.



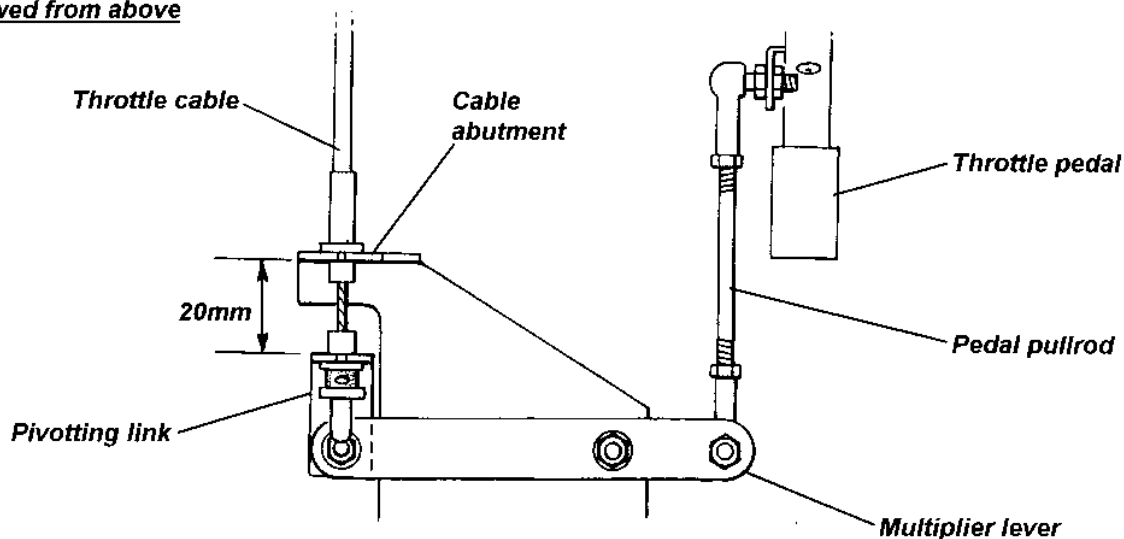
**EMO.2 - THROTTLE CABLE ADJUSTMENT**

Before adjusting the cable, first check that the pedal end of the cable is correctly located, and that the cable is correctly routed with no sharp bends or entrapment. Do not attempt to adjust the throttle cable or idle speed by means of the stop screw on the throttle body, which should not be disturbed.

The throttle cable and associated components must be adjusted in a specific sequence to ensure full and correct throttle operation without cable strain.

- Adjust the pedal upstop for a pedal height 30mm below brake and clutch pedals.
- Adjust the ball jointed pull rod connecting to the pedal to achieve a gap of 20mm between outer cable abutment and multiplier lever pivoting link as shown.
- Adjust the outer cable abutment at the engine end to allow a small amount of free play to accommodate temperature change effects.
- Adjust the pedal downstop so that full travel of the throttle butterfly can just be achieved without allowing the cable to be strained.

**Viewed from above**



1271





EMO.3 - ENGINE CONTROL UNIT (ECU)

The engine ECU is an electronic processor mounted on a steel panel, providing electromagnetic shielding, at the LH rear of the engine compartment. The ECU is an adaptive unit which 'learns' the optimum setting of the idle air control valve, and the fuelling offset required to achieve the correct exhaust oxygen content for a particular engine relative to its wear and performance characteristics. This feature speeds the response of the system, and minimises the time spent adjusting to changed operating conditions.

A summary of the sensors supplying inputs to the ECU, and the components to which the ECU supplies output control, follows:

**Inputs**

- Crankshaft position
- Manifold absolute pressure
- Engine coolant temperature
- Intake air temperature
- Pre and post cat. exhaust oxygen content
- Throttle position
- Camshaft position
- Wheel speed
- Diagnostic input
- Battery supply
- Starter signal
- Earth supply



**Outputs**

- Ignition coils
- Fuel injectors
- Idle air control valve
- Fuel pump relay
- Diagnostic connector
- Oxygen sensor heaters
- Main relay
- Radiator cooling fans
- Speedometer)
- Tachometer ) Instrument pack
- Temp. gauge )

To replace the ECU:

- Disconnect the battery earth cable;
- Remove the ECU protective water shield by releasing the two screws securing the top of the ECU mounting bracket to the body;
- . The two harness connector blocks are retained by sliding retainers incorporated into the connectors. To release, pull each retainer outwards and ease the connector block from the ECU.
- Release the two screws securing the ECU to the mounting bracket, and withdraw the unit from the lower tongue.
- When refitting, position the two connector blocks before pressing in the retaining sliders to secure.
- Ensure that the connector water shield is refitted.

*Illustration overleaf .....*



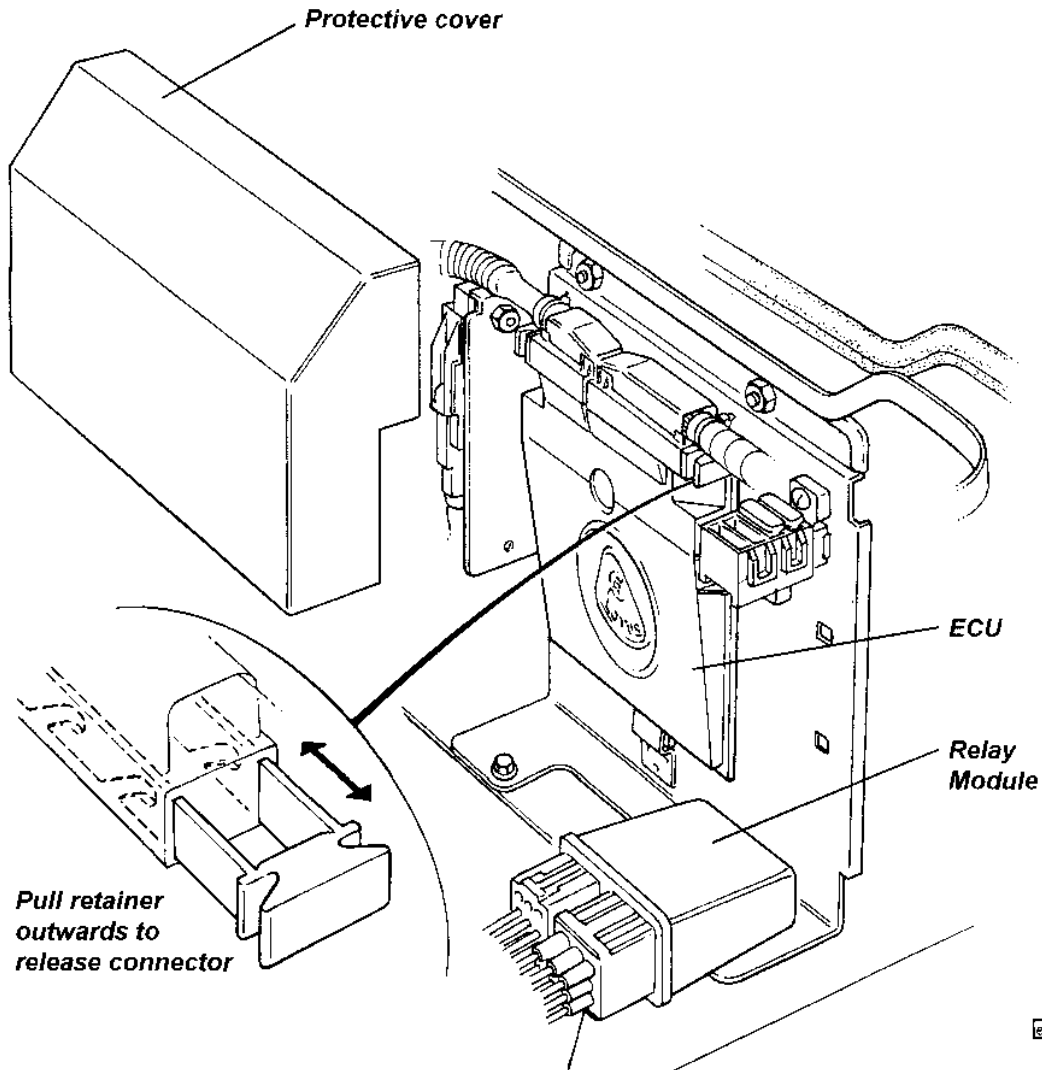
EMO.4 - RELAY MODULE

The relay module is mounted at the left hand rear corner of the engine bay, on a locating tongue incorporated on the bottom of the ECU mounting bracket. The unit incorporates the following relays, but is serviced only as one sealed component:

- **Engine Control Relay;** Supplies current to the fuel pump relay and oxygen sensor heaters when the ignition is switched on.
- **Fuel Pump Relay;** Closed by the ECU for a 2 second period each time the ignition is switched on. Continuously closed during engine cranking and while the engine is running as signalled by the crankshaft sensor.
- **Starter Relay;** Energised by the cranking output from the ignition switch. Supplies current to the starter motor solenoid.

If any of the above functions are faulty, the inputs to the module should be checked, and if the outputs indicate a fault with an internal relay, the relay module should be replaced: Pull the module off its mounting tongue, and release the two harness connector blocks (press the retaining clips). On re-assembly, ensure the connector blocks are fully engaged by the retaining clips.

**Important Note:** The relay module is identical in appearance to the fan control module used on a.c. cars, but the function of the two modules is entirely different and must not be transposed. The relay module A111E6024F has a white label marked YWB100970; The a.c. fan module A117M0038F has a brown label marked YWB100800.



**EMO.5 - INLET AIR TEMPERATURE & MANIFOLD ABSOLUTE PRESSURE (TMAP) SENSOR**

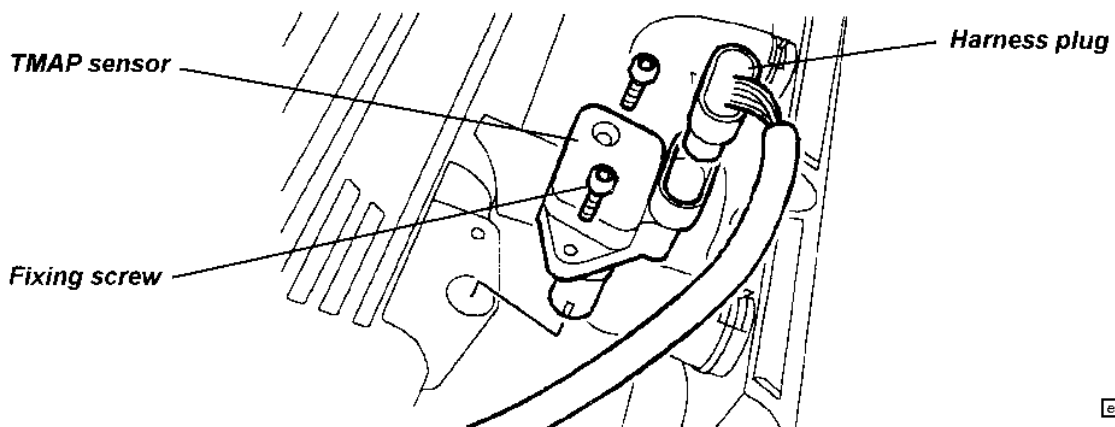
The TMAP sensor, which incorporates separate elements to monitor both temperature and pressure, is mounted directly on the intake plenum for optimum response to temperature and pressure changes, and has a plastic cap to protect the electrical connector from water ingress. The pressure signal provides an indication of engine load, and is fundamental to the calculation of air consumption and fuel calibration. The air temperature sensor is a transducer with a negative temperature coefficient, such that its electrical resistance reduces with increasing temperature. Using this signal in conjunction with that from the pressure sensor, the ECU is able to determine the air consumption of the engine, and adjust the injector pulse width accordingly for correct fuelling. Low air temperature results in denser air requiring more fuel. High air temperatures are also used by the ECU to retard the ignition timing and avoid knock.

The ECU provides a 5 volt supply and earth path to each sensor element, each of which returns a voltage representing the measured value.

**MAP:** When using the 'Lotus Check II' scanner tool, an atmospheric pressure of approximately 100 KPa should be displayed with the engine stopped, and a lower value between 25 - 40 KPa during idle. Very high values may indicate a faulty sensor, or an electrical connection problem. Moderately raised values indicate a possible engine fault. If the MAP signal is absent, the ECU will substitute a default value based on engine speed and throttle angle, and the engine will continue to operate with reduced performance with the MIL illuminated. A fault code will be stored in the ECU for retrieval by the scanner tool.

**IAT:** The scanner tool should display ambient temperature when the engine is completely cold, and higher figures with a warm engine. If the ECU receives no signal from the IAT sensor, a default value will be substituted to allow the engine to continue to run, the MIL will be illuminated and a fault code will be stored in the ECU memory.

To remove the sensor, remove the plastic cap, unplug the electrical connector and release the two 'Torx' screws securing the unit to the intake plenum. When refitting, ensure that the two 'O' rings are fitted on the sensor spigot, and that the protective cover is used over the harness plug.



**EMO.6 - CRANKSHAFT POSITION (CKP) SENSOR**

The signals provided by the crankshaft position sensor enable the ECU to determine:

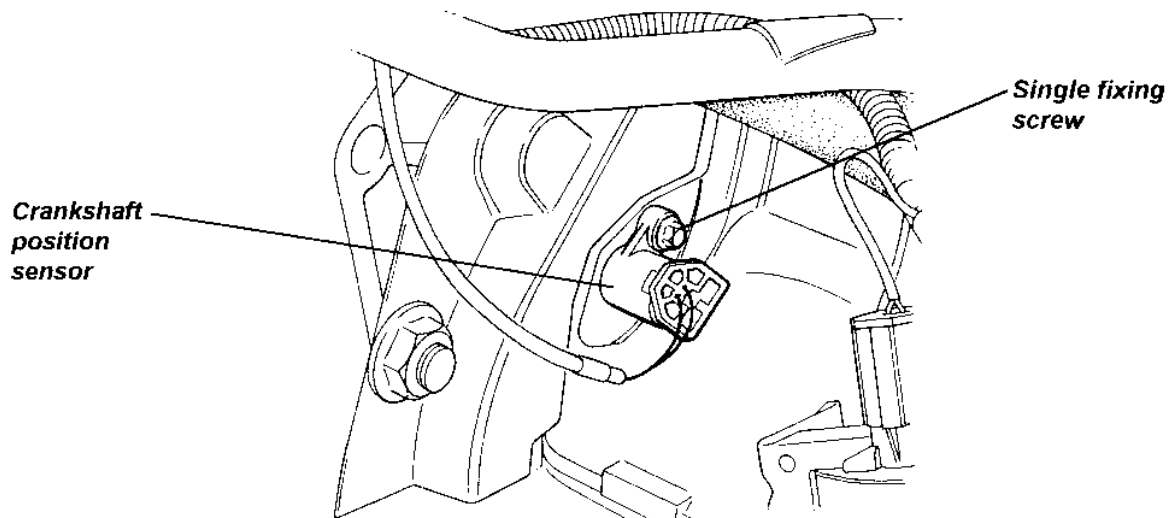
- engine speed;
- crankshaft position.

Note that in order to time the fully sequential injection strategy, the crankshaft position signal must be supplemented by a camshaft position signal.

The variable reluctance type crankshaft sensor is mounted by a single fixing into a flange at the right hand rear of the cylinder block, where it protrudes towards a reluctor ring machined into the engine side of the flywheel. The CKP sensor is positioned at 55° before the cylinder axis as viewed from the front of the clockwise rotating engine. Holes in the reluctor ring are positioned at 10° intervals, with four 'missing' holes to provide timing signals. With number one cylinder at TDC, the missing holes are positioned before the CKP sensor, at 80°, 110°, 260° and 300°.

To prevent damage from engine overspeed on acceleration, the ECU will implement fuel cut-off at engine speeds above approximately 7,000 rpm by inhibiting the earth path for the injectors. Fuel is reinstated as engine speed falls.

If the sensor signal is missing, the engine will not run. Faults in the crankshaft sensor or circuit may be indicated on the scanner tool by a '0' display during cranking. Sensor resistance is 1.3 kohms. Fixing screw torque = 6 Nm.



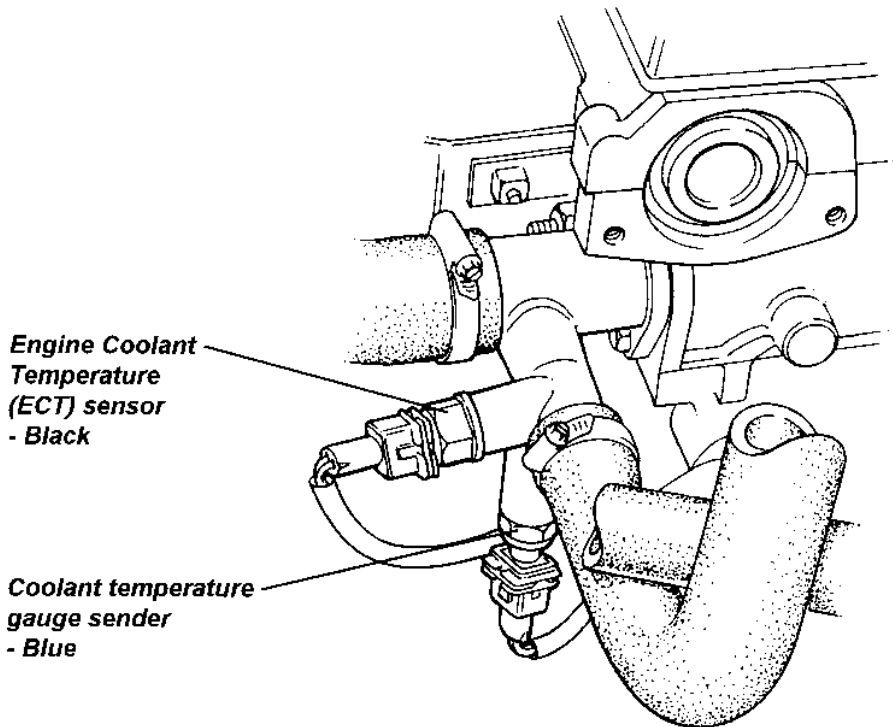
em202

**EMO.7 - ENGINE COOLANT TEMPERATURE (ECT) SENSOR**

The ECU requires a coolant temperature input signal in order to increase fuel delivery and maintain driveability during the cold running and warm-up phase. The signal from this sensor is used for many different parameters within the engine management system to control and switch various components dependent on engine temperature.

The sensor is a thermistor (a resistor which changes value with temperature) mounted in the outlet junction pipe at the flywheel end front side of the engine. Note that the ECT sensor has a brown body and harness connector and is mounted horizontally. This should not be confused with the water temperature gauge sender which is fitted in the same pipe, but has a blue body and harness connector and is mounted vertically from below. Low coolant temperature produces a high resistance, whereas high temperature causes low resistance. At normal running temperature, the resistance will be approximately 300 - 400 ohms.

This data is also used to control the radiator fan, which is switched on by the ECU at a rising coolant temperature of 102°C, and switched off on falling temperature at 98°C.



em204

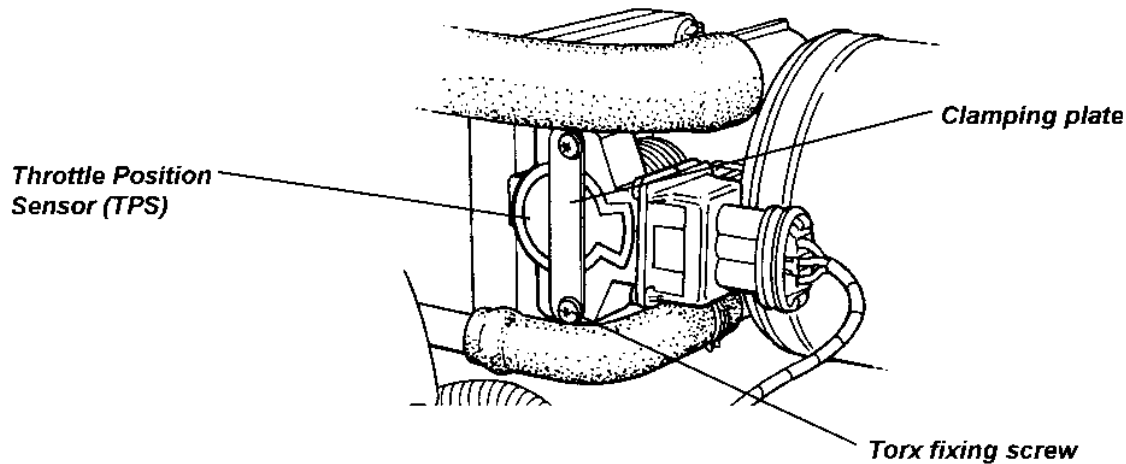
If the ECU receives a signal voltage outside of the acceptable range, a default setting equating to 70°C will be substituted, the cooling fan energised and the MIL illuminated. The Lotus Check II tool will display 70°C in Live Data. Sensor faults may cause several symptoms including poor starting, fast idle speed, poor fuel consumption and cooling fans running continuously.

To replace the sensor, disconnect the harness plug, and position a container to catch the escaping coolant when the sensor is removed. Unscrew the sensor from the junction pipe. Clean the threads of the pipe and sensor before applying Teflon tape to the sensor thread and screwing into the pipe. Tighten to 6 Nm. Refit the harness plug, and top up with coolant (see Cooling Section KF).



### EMO.8 - THROTTLE POSITION SENSOR (TPS)

The throttle position sensor (TPS) is a potentiometer fitted directly to the end of the throttle spindle, and provides the ECU with information on both throttle opening, and rate of change of throttle opening. For example, when a fully closed throttle and appropriate engine speed is signalled, the ECU activates the idle air control valve to regulate idle speed; a rapid or sudden opening of the throttle will initiate fuel enrichment for acceleration; and a closed throttle overrun condition will prompt fuel cut-off.



em198

The ECU provides the 4 kohm sensor with a 5 volt supply, and monitors the returning signal from the earth line bridge, which is proportional to throttle opening. The switch position is not adjustable, as the ECU will learn the lower voltage limit corresponding to a closed throttle.

**Acceleration enrichment:** When the throttle pedal is depressed, the ECU receives a rising voltage from the TPS and detects a rise in manifold pressure from the MAP sensor. The ECU provides additional fuel by increasing the normal injector pulse width and also provides a small number of extra pulses on rapid throttle openings.

**Over-run fuel cut-off:** The ECU implements over-run fuel cut-off when the engine speed is above 2000 rpm with engine at normal operating temperature and the throttle position sensor in the closed position, i.e. the vehicle is coasting with the throttle released. The ECU indexes the idle air control valve open slightly to increase the air flow through the engine to maintain a constant manifold depression and keep emissions low. Fuel is progressively reinstated as the throttle position sensor is opened.

To remove the sensor, disconnect the IAC by-pass hose for access, unplug the harness connector and remove and discard the two Torx screws securing the sensor. Remove the clamping plate and withdraw the sensor from the throttle spindle.

To fit the sensor:

- Clean the mating faces of sensor and throttle body, and align the flat of the sensor with the machined flat on the throttle spindle.

**CAUTION: The TPS can be easily damaged if carelessly fitted. When pressing the sensor onto the spindle, use only finger pressure on the centre of the sensor. Do not use the securing screws to pull the sensor into position.**

- Press the sensor into position and rotate counterclockwise to align the fixing holes.  
**CAUTION: Do not rotate the sensor in a clockwise direction, and ensure it is not rotated beyond its internal stops.**
- Fit the clamping plate and tighten two new Torx screws to 1.5 Nm. Mate the harness connector plug. Refit the IAC hose.
- Operate the throttle and check that full travel of the throttle spindle, from fully closed to fully open, is achieved.
- Use Lotus Check II to carry out a throttle initialisation procedure.



### EMO.9 - IDLE AIR CONTROL (IAC) VALVE

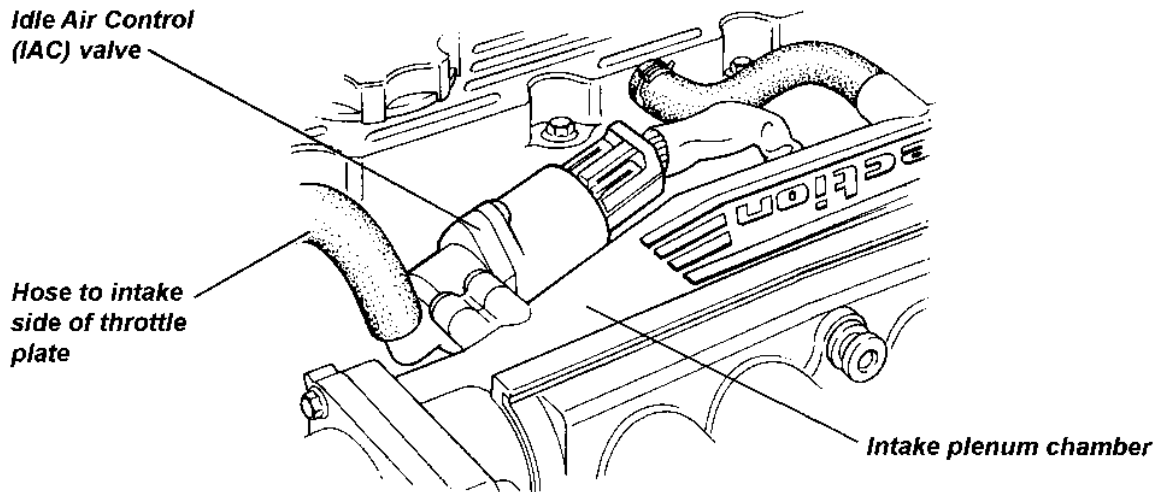
The idle air control (IAC) valve is mounted on the intake plenum, and controls an air passage which bypasses the throttle valve. When the pintle of the valve is fully extended, the passage is closed off for a minimum idle speed, but as the ECU commands the IAC stepper motor to withdraw the pintle, a progressively greater amount of air is allowed to by-pass the throttle. In this way, the ECU is able to control engine idle speed independently of the throttle butterfly.

**NOTE: The closed setting of the throttle butterfly valve is preset during manufacture, and should NOT be adjusted.**

During cold starts, the IAC is opened to provide a raised idle speed, dependent on coolant temperature, with a gradual decay as the engine warms to normal operating temperature. The ECU also uses the fast response of ignition timing variation to maintain idle stabilisation, such that at idle, the ignition timing will be constantly changing. When loads are placed onto or removed from the engine, the ECU senses the change in engine speed and uses both ignition timing and IAC position to control idle speed.

The position of the idle air control valve should be within the range of 10 - 20% (as displayed by a 'Lotus Check II' scanner) when the engine is idling at normal engine temperature. This ensures that the idle air control valve is able to supply varying amounts of by-pass air to compensate for all loads and temperature conditions. If outside of this range, there is likely to be a mechanical fault, such as an intake manifold air leak.

When the ignition is switched off, the ECU will keep the main relay energised for a short period whilst the IAC valve is driven to its power down position, ready for the next engine start.



To remove the valve, unplug the harness connector and remove the two Torx screws securing the valve body to the plenum adaptor. Withdraw the valve and discard the 'O' ring.

To fit the valve:

- Ensure the mating faces of the plenum adaptor and valve are clean.
- Lubricate a new 'O' ring with silicone grease, and fit to the valve.
- Fit the valve into the adaptor, and tighten the two Torx screws to 1.5 Nm.
- Mate the electrical connector plug.



**EMO.10 - OXYGEN (O<sub>2</sub>) SENSORS**

The Lotus K4 system operates a 'closed loop' fuel control system whereby the output signal from an oxygen sensor in the exhaust system downpipe is monitored by the ECU, which constantly adjusts the air/fuel ratio to that providing the most efficient conversion of gases by the catalyst. A lean air/fuel ratio results in the combustion process being unable to utilise all of the available oxygen, leaving a high oxygen content in the exhaust gas. This oxygen sensor output to the ECU is reduced, which signals the ECU to adjust the air/fuel ratio richer, resulting in reduced exhaust oxygen and a higher sensor output voltage. In this way the mixture strength constantly sways either side of the ideal setting.

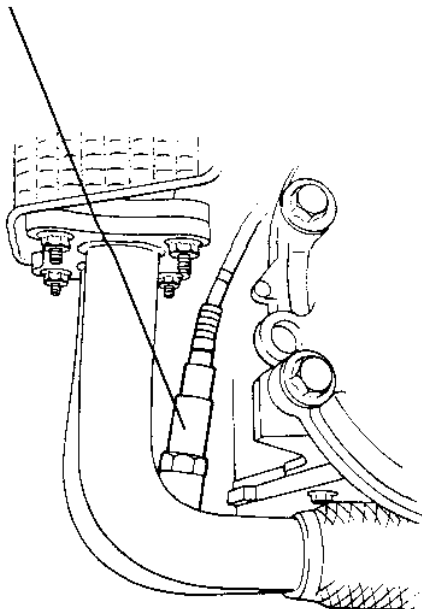
A second oxygen sensor is fitted in the outlet pipe from the catalytic converter, and supplies the ECU with a signal used to monitor the efficiency of the converter. If the upstream sensor should fail, the ECU adopts an 'open loop' strategy, using a fixed oxygen content value, with an adverse effect on emissions. If the downstream sensor fails, the ECU is unable to monitor catalytic converter efficiency. In either case, the MIL would be illuminated.

Because the ceramic element of the sensors becomes active only above 300°C, each sensor is equipped with an integral heating element controlled by the ECU, to ensure that it reaches operating temperature soon after a cold start. The resistance of the sensor heating element should be 6 ohms at 20°C.

Using the 'Lotus Check II' scanner tool, 'O<sub>2</sub> VOLTAGE' shows the voltage across the sensor as read by the ECU. Once the engine is fully warm, and during most idle and driving conditions, this voltage will switch rapidly between 0.7 V - 1.0 V.

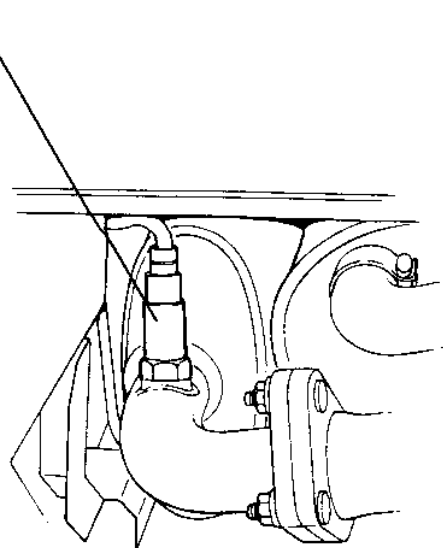
To remove either sensor, unplug and free the electrical connector, and use a 22 mm crows foot spanner to unscrew the sensor from the exhaust. Fit a new sealing washer to the sensor, and apply anti-sieze compound (A910E6966) to the threads **WITHOUT** contaminating the sensor tip, before tightening to 55 Nm and mating the electrical connector plug. Do **NOT** use copper based lubricants when refitting.

*Pre-cat O<sub>2</sub> sensor*



em226

*Post-cat O<sub>2</sub> sensor*



em228

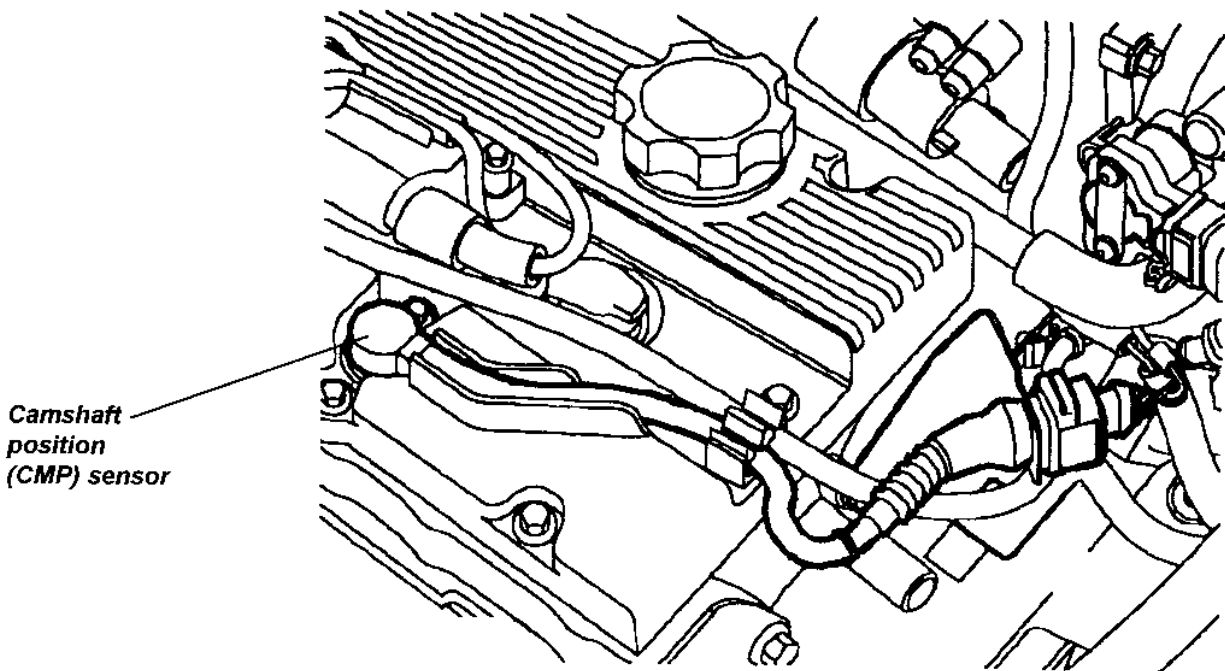




EMO.11 - CAMSHAFT POSITION (CMP) SENSOR

The CMP sensor is used to provide an engine position reference for the sequential injection. The Hall effect sensor is mounted on the left hand rear of the cylinder head, beneath the spark plug cover, and projects into the cam housing to be in close proximity to a half moon retractor on the exhaust camshaft. By interpreting the signal received, the ECU is able to distinguish firing TDC from exhaust TDC, and initiate the injection sequence on engine start. If the CMP signal is missing, the engine will still start and run, but the fuel injection timing may be out of phase, resulting in reduced performance and driveability and increased emissions. If sensor failure occurs whilst the engine is running, the engine will continue to run with correct sequential fuelling until ignition switch off. Note that a cam sensor fault will only be recorded by the ECU if the fault is detected at start-up, which will then illuminate the MIL.

To replace a CMP sensor, remove the spark plug cover, unplug and unclip the sensor harness, and release the single screw securing the sensor. When refitting, tighten the sensor screw to 6 Nm.



em231



## EMO.12 - FUEL SYSTEM

The fuel system is a high pressure recirculating type, using an 'in tank' submerged 3-stage impeller pump, an in line canister filter, a common fuel rail supplying all four injectors, and a fuel pressure regulating valve controlling the return line to the tank.

**WARNING: The fuel line between pump and injector rail, and the injector rail itself, contain pressurised fuel both when the engine is running, and after switching off. This feature aids engine starting by reducing the time needed to build up operating fuel pressure, and inhibiting the formation of vapour pockets in the supply line of a stopped hot engine.**

- i) To minimise the risk of fire and personal injury, relieve the fuel system pressure before servicing the fuel rail or any related component. See 'Fuel Pressure Relief Procedure' below.
- ii) To reduce the possibility of sparks occurring when a fuel line is disconnected, or when fuel vapour is present, the negative battery cable should be disconnected before work is commenced.
- iii) When fuel lines are disconnected, absorb any escaping fuel in an absorbent cloth and dispose of safely.

### Fuel Pressure Relief Procedure

This procedure should be used prior to disconnecting any part of the fuel line except the unpressurised return line.

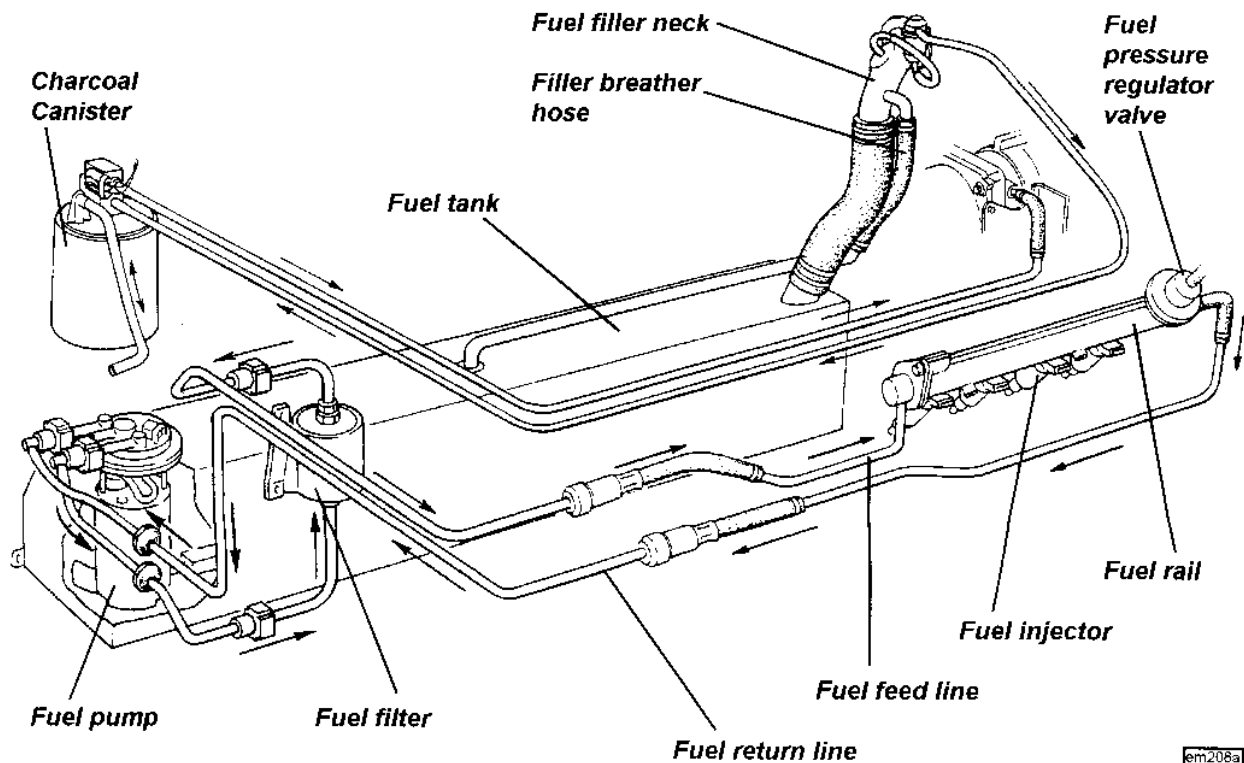
- Pull out the 20A fuel pump fuse (rearmost of fuses to left of engine management ECU), start the engine, and run until it stops from starvation. Crank the engine for a further few seconds.
- If the engine is a non-runner, pull out the fuel pump fuse, and crank the engine for 20 seconds to minimise residual fuel pressure.
- Disconnect the battery.
- Surround the pipe joint with a shop towel to absorb fuel contained in the pipework before releasing the joint.

**WARNING: Be aware of the possibility of full pressure retention in the fuel line caused by an injector circuit fault.**

The modular fuel pump/sender assembly uses an electric motor to power a three stage impeller type pump system submerged within the tank. In order to avoid fuel starvation from surge effects caused by vehicle acceleration and cornering forces, the pump is housed within a reservoir canister kept filled with fuel irrespective of the tank fuel level. The pump connects with a port on the bottom of the canister fitted with a strainer sock in order to screen dirt particles from the fuel line and help separate any water content from the fuel. The first stage impeller pump draws fuel from the tank via this sock, and outputs it into the canister, which fills up to its overflow port in the top surface. The second stage impeller pump draws fuel from within the canister via another strainer sock, and supplies the high pressure third stage turbine pump which outputs fuel from the top end of the pump into the flexible pipe connected to the supply connection on the pump assembly top plate. From here, fuel is piped to the fuel rail on the engine, from which it returns to the inlet connection on the top plate and spills into the canister to supplement the primary pump output and keep the canister fully filled.

An umbrella valve in the bottom of the canister allows fuel to flow into the canister whenever the tank level is higher than the canister level. This feature also permits a continued fuel supply to the secondary pump stage in the event of a blocked primary strainer.

For further details of the fuel pump, filter and tank, refer to section LI.

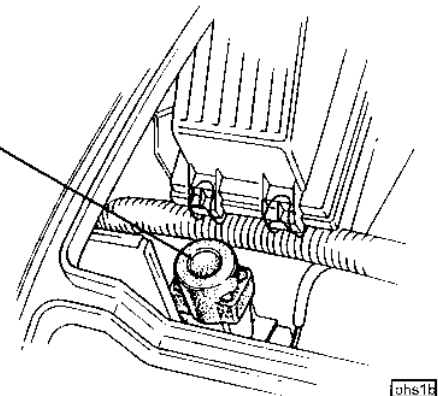


#### Fuel Pump Switching

The fuel pump is controlled by the ECU via the fuel pump relay located in the relay module, and is energised under the following conditions:

- When the ignition is first switched on, the ECU grounds the pump relay coil for a few seconds in order to pressurise the fuel rail, and then switches off.
- When cranking, the ECU receives an engine speed signal from the crankshaft position sensor and operates the pump continuously.
- When the engine is running, the ECU receives an engine speed signal and operates the pump continuously.
- If the engine stalls, the ECU will switch off the pump immediately.
- A safety inertia switch is mounted at the left hand rear of the engine bay, and controls the supply to the fuel pump relay. Vehicle impact will trip the switch and isolate the fuel pump. Reset by pressing the button on top of the switch.

Inertia switch



#### Fuel Rail and Pressure Regulator Valve - Testing

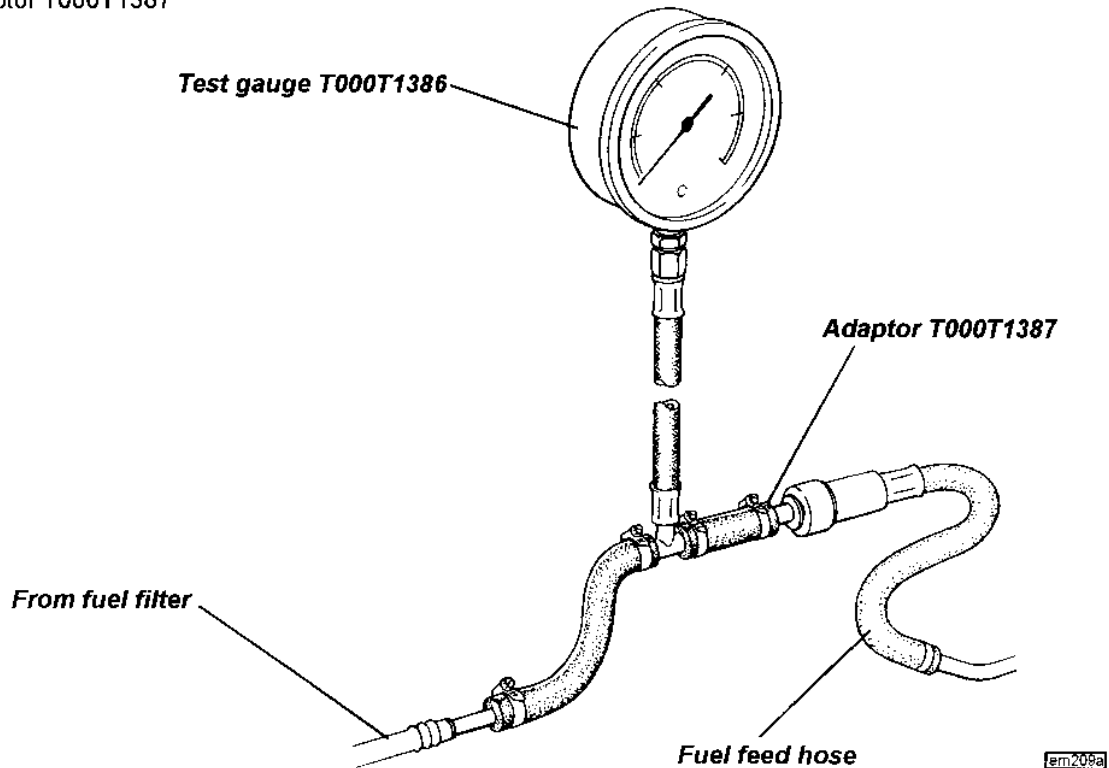
The single fuel rail is used to link the four port injectors to provide a balanced fuel supply at common pressure, and also to retain the port injectors in the inlet manifold. The left hand end of the fuel rail receives fuel from the in line filter, and the right hand end houses the pressure regulator valve, from which fuel returns to the tank. The fuel pressure regulator is a diaphragm operated relief valve with fuel pump pressure acting on one side of the diaphragm, and regulator spring pressure and intake plenum pressure on the other. The



function of the regulator is to maintain a constant pressure differential across the injectors at all times. i.e. a constant difference between fuel pressure supplied to the injector, and inlet manifold pressure at the port injector nozzle. By using an intake plenum pressure (vacuum) signal to modify regulator spring pressure in the valve, the valve is able to regulate fuel supply pressure in accordance with engine load - pressure will decrease at idle and light engine loads, and increase at wide throttle openings. The non-adjustable pressure regulator is factory set to approximately 3.0 bar, and is serviced as a complete assembly.

To check the fuel pressure:

- i) Relieve fuel pressure as detailed above.
- ii) Connect fuel pressure test gauge T000T1386 into the supply line between the fuel filter and fuel rail using adaptor T000T1387



- iii) Disconnect the vacuum hose between the pressure regulator and the intake plenum.
- iv) With the engine idling, the pressure gauge should read 2.9 - 3.1 bar.
  - If below specification, progressively restrict the fuel return line between regulator valve and tank.
    - If the specification can then be achieved, the regulator valve is faulty;
    - If this makes little or no difference, the fuel pump may be restricted or faulty.
  - If above specification, the regulator valve may be faulty.
- v) With the engine still idling, re-connect the vacuum hose to the regulator valve. The pressure should drop to approximately 2.2 bar.
  - If the pressure does not drop, check the hose for kinking or blockage, or replace the regulator valve.
- vi) Switch off the ignition and observe the pressure drop after one minute. Pressure should not drop by more than 0.7 bar.
  - Too great a pressure drop may be caused by (a) faulty regulator valve; (b) faulty non-return valve in the fuel pump; (c) leaking injector
  - If clamping off the return hose reduces the pressure drop, a faulty regulator valve is indicated.
  - If clamping off the supply hose reduces the pressure drop, a faulty fuel pump is indicated.
  - If clamping off both hoses does not reduce the pressure drop, a leaking injector is indicated.
- vii) To check that the pump has sufficient reserves of delivery for full demand conditions, progressively clamp off the return hose with the pump running. The pressure should increase by approximately 2 bar.

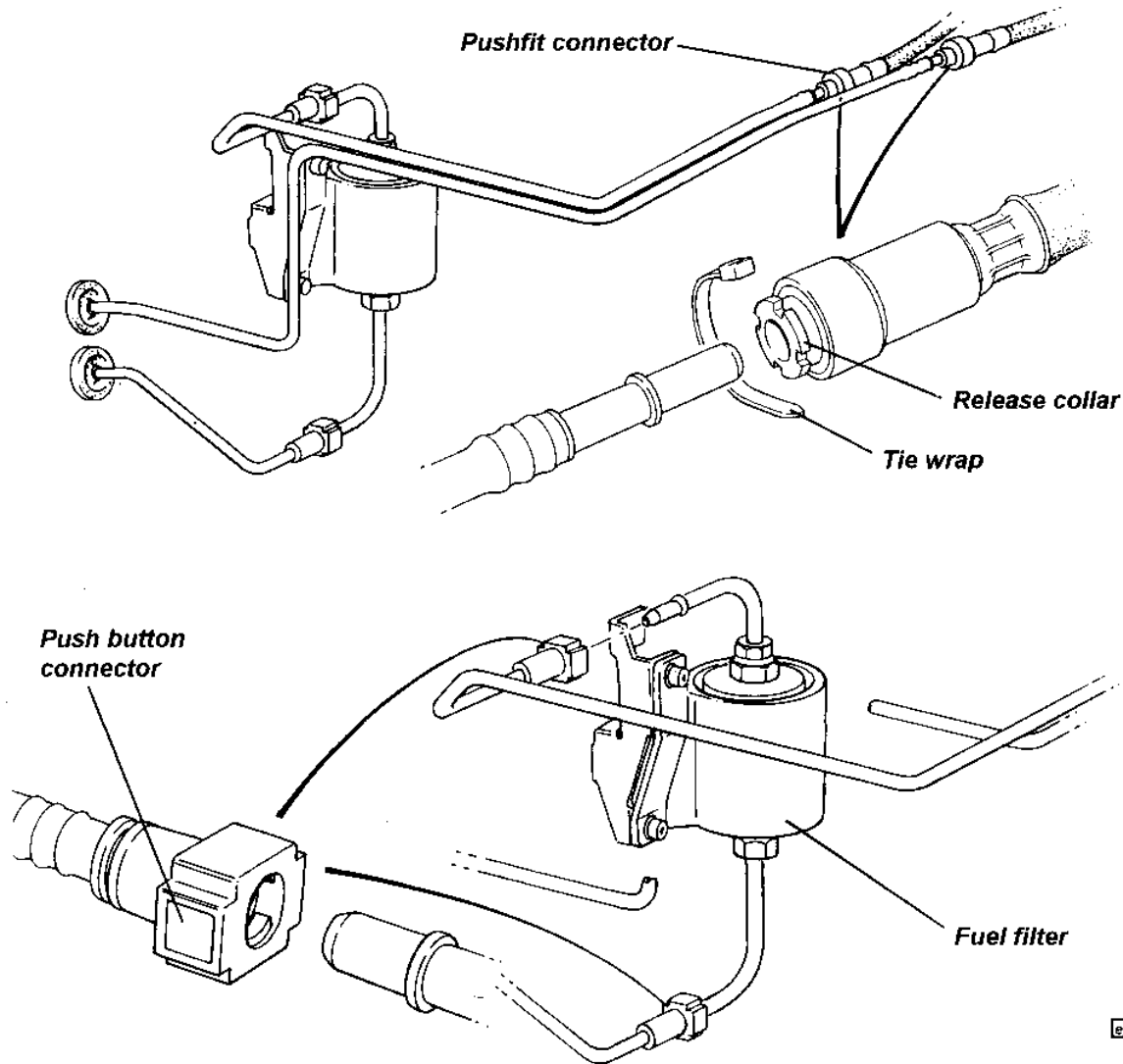
**CAUTION: Only clamp the return hose momentarily and observe the gauge to ensure pressure does not exceed gauge capacity.**

### Push Fit Connectors

The fuel rail feed and return hoses are equipped with push fit connectors to allow easy powertrain removal. The feed line connector is colour coded orange, and the return line connector green. Note that the feed line should not be opened without first carrying out the fuel pressure relief procedure detailed above. With the system depressurised, cut the safety tie wrap from the connector collar, and use an absorbent cloth to collect fuel draining from the pipe before pressing the collar into the connector, and separating the joint.

Clean the pipe spigot and lubricate with a light spray of WD40 or similar before remaking the joint, pressing firmly together until full engagement is indicated by an audible 'click'. Check security by pulling and twisting the joint. To guard against any possibility of accidental release, fit a small tie wrap (A075W6038Z) around the release collar as shown.

The fuel filter uses 'press button' quick release connections, the spigot pipes for which should similarly be lightly sprayed with WD40 before insertion.



### Fuel Injectors

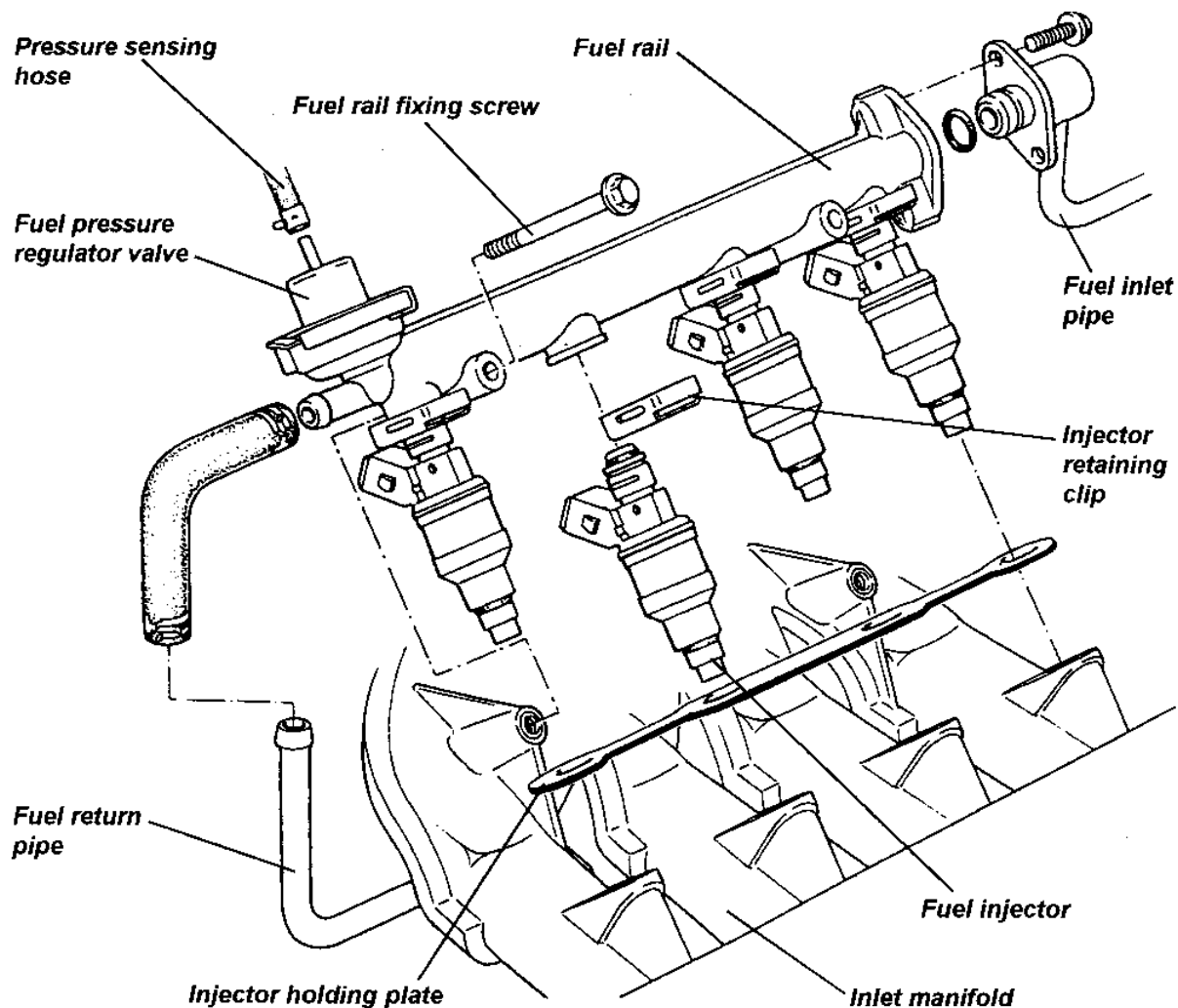
The four fuel injectors are fitted between the pressurised fuel rail and the inlet manifold. Each injector comprises a solenoid operated needle valve and a specially designed nozzle to ensure good fuel atomisation. The ECU energises the injectors under engine run conditions, and provides an earth signal for the period the injectors are required to be open (referred to as 'pulse width'), spraying fuel onto the back of the inlet valves. The Elise 2001 M.Y. uses fully sequential injection, with each injector activated individually.

During cranking, when the engine speed is below approx. 400 rpm, the ECU increases the pulse width (dependent on coolant temperature) to aid starting, and operates the injectors in group mode.

**Fuel Rail and Pressure Regulator Valve - Replacement**

Do not attempt to remove the pressure regulator valve from the fuel rail; The valve is supplied only as an assembly with the rail. The fuel rail is removed from the engine complete with the four fuel injectors.

1. De-pressurise the fuel system, and disconnect the battery.
2. Disconnect the vacuum hose between regulator valve and plenum, and unplug the MAP/IAT sensor harness. Unplug the injector harness from each of the injectors.
3. Release the fuel return hose from the right hand end of the fuel rail and plug the connections.
4. Remove the two screws securing the fuel inlet pipe to the left hand end of the rail and withdraw. Discard the 'O' ring, and plug the connections.
5. Remove the two bolts securing the fuel rail to the inlet manifold, and carefully withdraw the rail complete with the four injectors and pressure regulator valve. Take great care not to damage the injector tips during the removal process. Cap the injectors and plug the manifold ports to prevent dirt ingress.



em210



6. To remove an injector from the rail, remove the injector holding plate, remove the clip, and withdraw the injector from the rail. Discard the two 'O' rings.
7. Before re-fitting the injectors and rail, clean the injector recesses in the rail and inlet manifold, and fit each injector with 2 new 'O' rings lubricated with silicone grease. Fit the injectors into the rail, and retain with the spring clip. Fit the injector holding plate to aid alignment of the injectors.
8. Carefully insert each of the injectors into its inlet manifold bore, and retain the rail with the two fixing bolts, tightened to 10 Nm.
9. Continue re-assembly in the reverse order to disassembly, tightening the inlet pipe to rail screws to 8 Nm.



EMO.13 - IGNITION SYSTEM

The ignition system uses a distributorless ignition system (DIS) which employs a pair of double ended ignition coils and a 'waste spark' system whereby each coil fires two spark plugs simultaneously (1 paired with 4, and 2 with 3), the spark in the cylinder on the exhaust stroke being 'wasted'. The two H.T. coils are mounted on the cam cover, each connecting directly with one spark plug, and via a short H.T. lead with a second plug.

**WARNING: The H.T. voltage of the ignition system is in excess of 50 kV and the low tension voltage is in excess of 400 volts. Voltages this high can cause serious injury and may even be fatal. Never touch any ignition components while the engine is running or being cranked.**

Each ignition coil consists of a pair of windings wrapped around a laminated iron core. The primary winding has a resistance of 0.7 ohms, and the secondary winding 10 kohms.

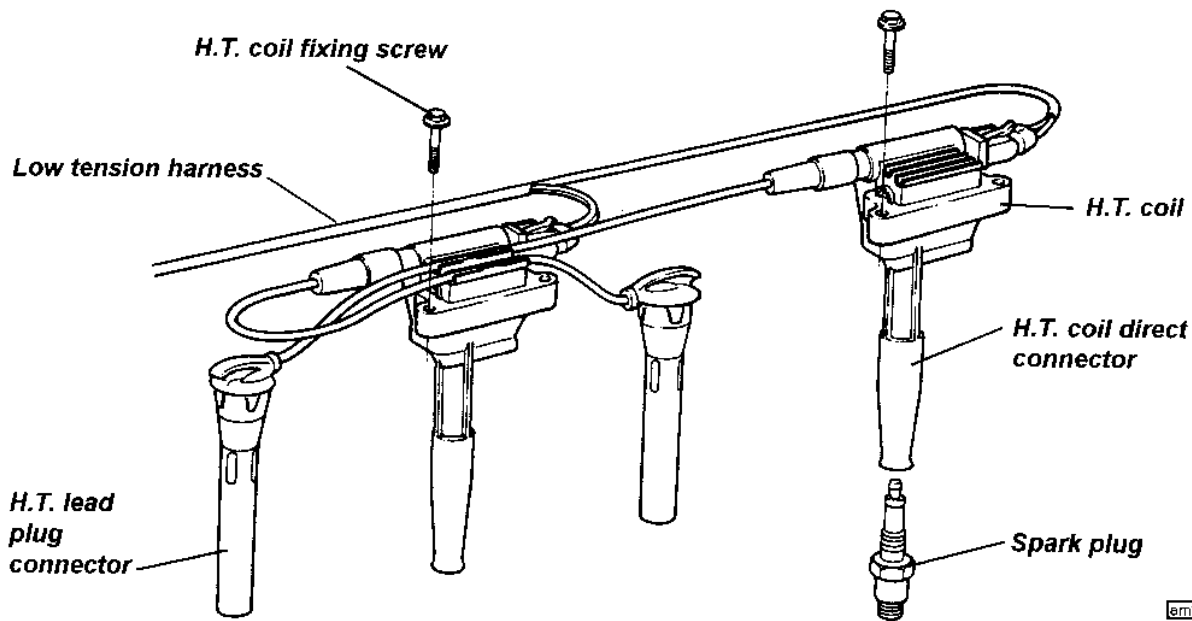
Each double ended coil contains a primary winding, connected in series with the supply and the ECU, and an isolated secondary winding, connected in series with two spark plugs. It is important to note that there is no connection between the primary and secondary windings. The coils are triggered by the ECU which switches off the primary voltage and induces a high tension current to produce a spark in the spark plug connected to each end of the secondary winding. The direction in which the secondary winding is wound determines that plugs 1 & 2 receive positive sparks, and plugs 3 & 4 negative sparks.

**It is important to note** that if it is necessary to run or crank an engine with one or more plug leads disconnected, either the coil low tension must be disconnected, or provision for the spark energy to be dissipated must be made (e.g. fitting a loose, grounded spark plug to the lead); otherwise the electrical stress produced will cause deterioration of the H.T. coil and/or ECU.

Each coil has a primary winding resistance of approx. 0.7 ohms at 20°C and a secondary winding resistance of approx. 10 kilohms.

To Replace Ignition Coil

1. Release the three fixings securing the spark plug cover, unscrew the oil filler cap and remove the cover.
2. Pull off the H.T. lead from the spark plug, and release the lead from its routing clips.
3. Release the two screws securing the H.T. coil, pull the coil off the spark plug, and disconnect the low tension connector plug.
4. When refitting, tighten the coil fixings to 8 Nm. Ensure the 'O' ring is fitted around the oil filler neck before refitting the spark plug cover and tightening to 8 Nm.





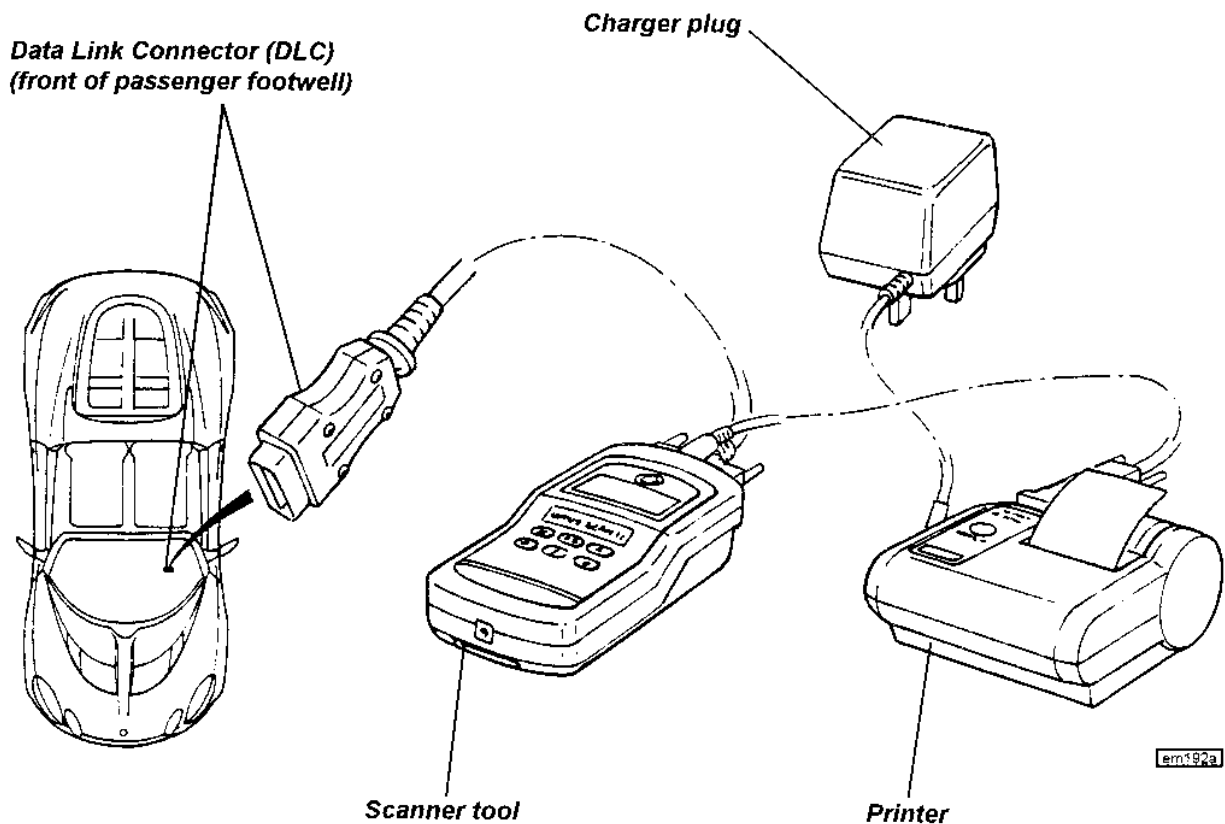
**EMO.14 - 'LOTUS CHECK II' SCANNER TOOL**

In order to provide for communication with the engine management system electronic control module, a hand held electronic scanner 'Lotus Check II' (part number T000T1418F), may be plugged into a special 16 terminal harness connector socket, known as a Data Link Connector (DLC), located at the front of the passenger footwell. Note that this tool may also be used on previous Elise models (excluding Exige, 340R and 160 models).

Amongst the operations available using the 'Lotus Check II' tool are:

- Reading of Trouble Codes
- Clearing of Trouble Codes
- Reading live data
- Test operation of individual solenoids
- Running engine history report
- Reprogramming ECU

Operating instructions are provided with the tool.



**EMO.15 - TROUBLE CODE DIAGNOSIS**

<u>Trouble Code</u>	<u>Description</u>	<u>Page</u>
P0106 )	Manifold Absolute Pressure - Circuit Range/Performance Problem	) 24
P0107 )	- Circuit Low Input	)
P0108 )	- Circuit High Input	)
P0111 }	Intake Air Temperature - Circuit Range/Performance Problem	} 25
P0112 }	- Circuit Low Input	}
P0113 }	- Circuit High Input	}
P0117 ]	Engine Coolant Temperature - Circuit Low Input	] 26
P0118 ]	- Circuit High Input	]
P0121 )	Throttle Position - Circuit Range/Performance Problem	) 27
P0122 )	- Circuit Low Input	)
P0123 )	- Circuit High Input	)
P0131 }	Oxygen Sensor - Circuit Low Voltage - pre catalyst sensor	} 28
P0132 }	- Circuit High Voltage - pre catalyst sensor	}
P0133 }	- Circuit Slow Response - pre catalyst sensor	}
P0134 }	- Circuit No Activity Detected - pre catalyst sensor	} 29
P0135 }	- Heater Circuit Malfunction- pre catalyst sensor	]
P0137 }	- Circuit Low Voltage - post catalyst sensor	] 28
P0138 }	- Circuit High Voltage - post catalyst sensor	]
P0140 }	- Circuit No Activity Detected - post catalyst sensor	} 29
P0141 }	- Heater Circuit Malfunction-post catalyst sensor	}
P0171 ]	Fuel Control System - Too Lean	] 30
P0172 ]	- Too Rich	]
P0201 )	Injector Circuit Malfunction - Cylinder 1	) 31
P0202 )	- Cylinder 2	)
P0203 )	- Cylinder 3	)
P0204 )	- Cylinder 4	)
P0300 }	Misfire Detected - Random	} 32
P0301 }	- Cylinder 1	}
P0302 }	- Cylinder 2	}
P0303 }	- Cylinder 3	}
P0304 }	- Cylinder 4	}
P0335 ]	Engine Speed/Position Sensors - Crankshaft Position Sensor Circuit Malfunction	] 33
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P0420 )	Catalyst System Efficiency - Below Threshold	) 34
P0444 )	Evap. Emission Control System - Purge Control Valve Circuit Open	) 35
P0445 )	- Purge Control Valve Circuit Shorted	)
P0500 )	Vehicle Speed Sensor Malfunction	) 36
P0506 }	Idle Speed Control - RPM Lower Than Expected	} 37
P0507 }	- RPM Higher Than Expected	}
P0562 ]	Battery Voltage - Voltage Too Low	] 38
P0563 ]	- Voltage Too High	]
P0601 )	ECU Integrity - Watchdog	) 39
P0606 )	- Checksum	)
P1100 }	Fuel Pump - #1 Relay or Circuit Open	} 40
P1101 }	- #1 Relay or Circuit Shorted	}
P1301 ]	Misfire - Misfire Level Causing Emissions Increase	] 41
P1302 ]	- Misfire Level Causing Catalyst System Damage	]
P1336 )	Misfire learns not complete	) 42
P1400 )	Coolant Fan Relay - #1 Short Circuit	) 43
P1401 )	- #1 Open Circuit	)
P1460 }	Air Conditioning Control Relay - Open Circuit	} 44
P1461 }	- Short Circuit	}



Circuit Diagram ) Sheet 5	- Fuel Pump, Injectors & Coil Packs
Circuit Diagram ) Sheet 5A	- Sensors
Circuit Diagram ) Sheet 5B	- Sensors (cont.)
Circuit Diagram ) Sheet 5C	- Controls
Circuit Diagram ) Sheet 5D	- Controls (revised recirc. solenoid control)
Circuit Diagram ) Sheet 5E	- Sensors (revised O2 heater control)

### Trouble Code Diagnosis

The reading of trouble codes using the Lotus Check II tool (T000T1418F), or any other OBD II scanner tool, is fully described in sub-section EMO.2. Sub-section EMO.15 contains information on each trouble code, compiled in approximate numerical order, to explain under what conditions the code will be set, and the possible causes. Each table includes data under the following headings:

<b>Description:</b>	Describes the rationale of the code.
<b>Malfunction Criteria:</b>	The limits or conditions which must occur for the code to be set.
<b>Secondary enable conditions:</b>	The conditions which must prevail before the test is run. In some cases, the malfunction test will be run only when certain other conditions apply.
<b>Disabled by faults:</b>	Some trouble codes will be disabled if another code is already set.
<b>Time required:</b>	The continuous time period for which the malfunction criteria must apply.
<b>Potential failure modes:</b>	Suggests possible causes of the problem.
<b>Limp home:</b>	Certain detected problems will cause the ECU to substitute a fixed value for a signal which is perceived as faulty, in order to enable the engine to continue to run, albeit at a reduced level of performance.

### Notes

- i) There are various market and vehicle specifications which may differ in the number of codes which are enabled. Section EMO.15 contains all the potential codes, some of which may not apply to certain markets.
- ii) Some codes may be set and stored in memory to be accessed with the Lotus Check II tool, but *will not* activate the Malfunction Indicator Lamp (MIL).
- iii) These tables should be used only to diagnose set trouble codes. The absence of a set trouble code does not preclude a fault from being present.
- iv) A trouble code will remain stored in the ECU memory after the fault has been rectified (or does not recur) until; a) 40 engine warm up cycles have been completed, or b) the code is cleared using the programme provided in the Lotus Check II tool.

### Diagnostic Trouble Code Report - LSL350

Lotus' policy of continuous product improvement requires that all sources of data are explored and analysed to the potential benefit of Lotus customers past, present and future. Lotus dealers are requested to make full use of the Diagnostic Trouble Code Report Form (LSL350), a copy of which is included at the end of this section, in order to help with diagnosis and their own record keeping, as well as telefaxing the information to Lotus via Technical Service on +44 (0)1953 608253.

***Note that any engine management related warranty claim must be accompanied by a completed Diagnostic Trouble Code Report form LSL350.***



Manifold Absolute Pressure

P0106/7/8

P0106 Circuit Range/Performance Problem

**Description:** Rationality check, manifold pressure not too low at high throttle position

**Malfunction Criteria:** Manifold pressure < 320 mBar  
 Throttle position > 80%  
 + engine speed > 960 RPM

**Secondary enable conditions:** or Manifold pressure > 960 mBar  
 Throttle position < 14.8%  
 + engine speed > 960 RPM

**Disabled by faults:** None

**Time required:** 1 sec

**Potential failure modes:**

- Connector
- Intermittent wire failure
- Blocked sensor port
- Partial short to voltage or ground
- Sensor damaged; check datalist for pressure with engine not running

**Limp home:** Alpha-N. (TPS based MAP measurement).

**Note:** This fault will be indicated by the MIL

P0107 Circuit Low Input

**Description:** Out of limit voltage check

**Malfunction Criteria:** MAP sensor voltage < 0.05V

**Secondary enable conditions:** None

**Disabled by faults:** None

**Time required:** 1 sec

**Potential failure modes:**

- Signal wire shorted to ground
- Signal wire open circuit
- Sensor disconnected
- Reference voltage missing
- Reference voltage wire shorted to ground
- Reference voltage wire open circuit
- Sensor failed
- ECU input circuit failed

**Limp home:** Alpha-N. (TPS based MAP measurement).

**Note:** This fault will be indicated by the MIL

P0108 Circuit High Input

**Description:** Out of limit voltage check

**Malfunction Criteria:** MAP sensor voltage > 4.907V

**Secondary enable conditions:** Throttle position < 80%

**Disabled by faults:** None

**Time required:** 1 sec

**Potential failure modes:**

- Signal wire shorted to 12V or reference 5V
- Ground wire open circuit
- Sensor failed
- ECU input circuit failed

**Limp home:** Alpha-N. (TPS based MAP measurement).

**Note:** This fault will be indicated by the MIL

**Intake Air Temperature**

P0111/2/3

P0112 *Circuit Low Input*

**Description:** Out of limit voltage check  
**Malfunction Criteria:** IAT sensor voltage < 0.05V  
**Secondary enable conditions:** Engine running  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Signal wire short circuit  
- Sensor failed  
- ECU input circuit failed

**Limp home:** If a fault is indicated a substitute value for air inlet temperature is used.  
The value is the lower of either the coolant temperature or 40°C.

**Note:** This fault will be indicated by the MIL.

P0113 *Circuit High Input*

**Description:** Out of limit voltage check  
**Malfunction Criteria:** IAT sensor voltage > 4.93 V  
**Secondary enable conditions:** Engine running  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Signal wire open circuit  
- Sensor failed  
- ECU input circuit failed

**Limp home:** If a fault is indicated a substitute value for air inlet temperature is used.  
The value is the lower of either the coolant temperature or 40°C.

**Note:** This fault will be indicated by the MIL.



**Engine Coolant Temperature**

P0117/8

*P0117      Circuit Low Input*

**Description:** Out of limit voltage check  
**Malfunction Criteria:** CLT sensor voltage < 0.02 V  
**Secondary enable conditions:** Engine running  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Signal wire short circuit  
- Sensor failed  
- ECU input circuit failed  
**Limp home:** If a fault is indicated a substitute value for coolant temperature is used (70°C)  
**Note:** This fault will be indicated by the MIL.

*P0118      Circuit High Input*

**Description:** Out of limit voltage check  
**Malfunction Criteria:** CLT sensor voltage > 4.93 V  
**Secondary enable conditions:** Engine running  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Signal wire open circuit  
- Sensor failed  
- ECU input circuit failed  
**Limp home:** If a fault is indicated a substitute value for coolant temperature is used (70°C)  
**Note:** This fault will be indicated by the MIL.



Throttle Position

P0121/2/3

P0121 Circuit Range/Performance Problem

**Description:** Rationality check, Throttle not too high at low manifold pressure or too low at high manifold pressures

**Malfunction Criteria:** Throttle position > 88%  
**Secondary enable conditions:** Manifold pressure < 600 mBar + vehicle speed > 30 KMH or Throttle position < 25%  
 Manifold pressure > 800 mBar + engine speed > 960 RPM

**Disabled by faults:** None

**Time required:** 1 sec

**Potential failure modes:** - Intermittent wire failure  
 - Partial short to voltage or ground

**Limp home:** If a fault is indicated a substitute value for throttle position is used. If the engine is not running the substitute value is taken from a table referenced by manifold pressure.

**Note:** This fault will be indicated by the MIL

P0122 Circuit Low Input

**Description:** Out of limit voltage check

**Malfunction Criteria:** TP sensor voltage < 0.0488 V

**Secondary enable conditions:** None

**Disabled by faults:** None

**Time required:** 1 sec

**Potential failure modes:** - Signal wire shorted to ground  
 - Signal wire open circuit  
 - Reference voltage missing  
 - Reference voltage wire shorted to ground  
 - Reference voltage wire open circuit  
 - Sensor failed  
 - ECU input circuit failed

**Limp home:** If a fault is indicated a substitute value for throttle position is used.

**Note:** This fault will be indicated by the MIL.

P0123 Circuit High Input

**Description:** Out of limit voltage check

**Malfunction Criteria:** TP sensor voltage > 4.93 V

**Secondary enable conditions:** None

**Disabled by faults:** None

**Time required:** 1 sec

**Potential failure modes:** - Signal wire shorted to 12V or reference 5V  
 - Ground wire open circuit  
 - Sensor failed  
 - ECU input circuit failed

**Limp home:** If a fault is indicated a substitute value for throttle position is used.

**Note:** This fault will be indicated by the MIL.



02 Sensor

P0131/2/3 P0137/8

P0131 ) Circuit Low Voltage - pre catalyst sensor
P0137 ) - post catalyst sensor

Description: Out of limit voltage check
Malfunction Criteria: O2 sensor voltage < 0.005 V
Secondary enable conditions: Duration below voltage > 1 sec
Disabled by faults: None
Time required: 1 sec
Potential failure modes: - Signal wire shorted to voltage
- Sensor failed
- ECU input circuit failed
Limp home: Closed loop fuel control is disabled
Note: These faults will be indicated by the MIL.

P0132 ) Circuit High Voltage - pre catalyst sensor
P0138 ) - post catalyst sensor

Description: Out of limit voltage check
Malfunction Criteria: O2 sensor voltage > 2.0 V
Secondary enable conditions: Duration above voltage > 1 sec
Disabled by faults: None
Time required: 1 sec
Potential failure modes: - Signal wire shorted to voltage
- Sensor failed
- ECU input circuit failed
Limp home: Closed loop fuel control is disabled
Note: These faults will be indicated by the MIL.

P0133 Circuit Slow Response - pre catalyst sensor

Description: Rationality check, slow switching
Malfunction Criteria: - Average switch time lean to rich > 1000 mSec
or - Average switch time rich to lean > 1000 mSec
or - Ratio of average switch times >1.8
or - Ratio of average switch times < 0.2
Secondary enable conditions: Throttle position between 4% and 15%
Manifold pressure < 450 mBar
Engine speed < 2100 RPM
Engine run time > 800 seconds.
Coolant temperature > 80 degrees C
Sensor ready, in closed loop control
Disabled by faults: None
Time required: 5 sec; Two trips with the fault
Potential failure modes: - Sensor contamination; poor / wrong quality fuel
- Sensor gas slots blocked; exhaust deposits
- Grounding circuit problem
Limp home: Closed loop fuel control is disabled
Note: These faults will be indicated by the MIL.



**02Sensor**

P0134/5 P0140/1

P0134 ) No Activity Detected - pre catalyst sensor  
P0140 ) - post catalyst sensor

**Description:** Rationality check, to see if the sensor is active (a non active sensor shows 0.5V nominal)

**Malfunction Criteria:** O2 sensor not ready

**Secondary enable conditions:** Engine run time > 30 seconds

Monitored for 60 seconds.

**Disabled by faults:** None

**Time required:** N/A

**Potential failure modes:**

- Sensor contamination; poor quality fuel
- Sensor gas slots blocked; exhaust deposits
- Heater circuit failure
- Sensor failure
- ECU input circuit failure

**Limp home:** Closed loop fuel control is disabled

**Note:** P0134, P0140 will activate the MIL

P0135 ) Heater Circuit Malfunction - pre catalyst sensor  
P0141 ) - post catalyst sensor

**Description:** Check for open and closed circuit faults.

**Malfunction Criteria:** Logic level low / high

**Secondary enable conditions:** N/A

**Disabled by faults:** None

**Time required:** N/A (two trips required for post catalyst sensors)

**Potential failure modes:**

- If P0134 is not set then Sensor heater circuit failure is most likely, as the sensor is OK when hot.
- Sensor circuit failure
- Sensor failure
- ECU input circuit failure.

**Limp home:** None

**Note:** This fault will be indicated by the MIL.

**Fuel Control System Too Lean Or Rich****P0171/2***P0171 Too Lean*

**Description:** Long term fuel trim too high  
**Malfunction Criteria:** Any of the long term trims > +20%  
**Secondary enable conditions:** Closed loop fuel control active  
**Disabled by faults:** P0131- P0135 disables P0171  
**Time required:** N/A (Two trips required for post catalyst sensors)  
**Potential failure modes:**  
- Fuel pressure problem  
- Air leakage into plenum / injector housing  
- Faulty injectors  
- O2 sensors poisoned  
- Air leakage into exhaust before O2 sensors  
**Limp home:** None  
**Note:** This fault will be indicated by the MIL.

*P0172 Too Rich*

**Description:** Long term fuel trim too low  
**Malfunction Criteria:** Any of the long term trims < -20%  
**Secondary enable conditions:** Closed loop fuel control active  
**Disabled by faults:** P0131- P0135 disables P0171  
**Time required:** N/A (Two trips required for post catalyst sensors)  
**Potential failure modes:**  
- Fuel pressure problem  
- Air leakage  
- Faulty injector/s  
- O2 sensors poisoned  
**Limp home:** None  
**Note:** This fault will be indicated by the MIL.



**Injector Circuit Malfunction**

**P0201 - 0204**

P0201 Cylinder 1  
P0202 Cylinder 2  
P0203 Cylinder 3  
P0204 Cylinder 4

**Description:**

This is a circuit check, to see if an injector is in circuit.

**Malfunction Criteria:**

Logic level low

**Secondary enable conditions:**

Engine running

**Disabled by faults:**

None

**Time required:**

1 sec

**Potential failure modes:**

- Connectors
- Wire open or short circuit
- Relay faulty; injector control
- Inertia switch disturbed (during maintenance or service)
- Injector fault
- ECU injector circuit failed

**Limp home:**

None

**Note:**

These faults will be indicated by the MIL.



**Misfire**

**P0300 - 0304**

- P0300 ) - Random
- P0301 ) - Cylinder 1
- P0302 ) Misfire Detected - Cylinder 2
- P0303 ) - Cylinder 3
- P0304 ) - Cylinder 4

**Description:** The detection system attempts to specify a single misfiring cylinder. If the engine misfire is severe, the system will indicate more than one cylinder. The DTC code storage will rank the cylinders into the most likely problem cylinder.

**Malfunction Criteria:** These codes will be displayed only if P1301 is indicated.

**Secondary enable conditions:** P0300-P0304 active  
Battery voltage between 11 & 16 V  
Engine speed between 750 & 7000 (approx.) RPM  
MAP between 350 & 1100 mBar  
Coolant temperature between -6°C & +120°C

**Disabled by faults:** P0122, P0123, P0107, P0108, P0117, P0108, P0340.

**Time required:** 1000 revs continuously

**Potential failure modes:**  
- Spark plug fault  
- Plug lead loose or faulty  
- Ignition coil circuit problems  
- Ignition coil problem  
- Low compression in cylinder

**Limp home:** None

**Note:**

**Engine Speed / Position Sensors****P0335  
P0340***P0335 Crankshaft Position Sensor Circuit Malfunction*

**Description:** Rationality checks - looks for intermittent loss of crank pulses  
**Malfunction Criteria:** Crankshaft pulses < 20  
**Secondary enable conditions:** Camshaft sensor pulses >3  
**Disabled by faults:** None  
**Time required:** Immediate  
**Potential failure modes:**  
- Connector  
- Incorrect sensor gap  
- Wiring circuit

**Limp home:** None. If a crank sensor circuit fault is present the engine will not fire or start. No fuel will be scheduled

*P0340 Camshaft Position Sensor Circuit Range/Performance*

**Description:** Rationality checks - looks for intermittent loss of crank pulses  
**Malfunction Criteria:** Camshaft pulses < 3  
**Secondary enable conditions:** Crankshaft pulses > 20  
**Disabled by faults:** P0335  
**Time required:** Immediate  
**Potential failure modes:**  
- Connector  
- Sensor gap  
- Wiring circuit

**Limp home:** None. If a Cam sensor circuit fault is present the engine will fire & start but may be wrong injector phasing. However if the failure occurs during driving the engine will continue to run. This usually occurs when the engine is stalled or turned off.



**Catalyst System Efficiency**

**P0420**

*P0420 Below Threshold*

**Description:** This is a check on the oxygen storage efficiency of the catalyst. The O2 sensors at rear of the catalyst check if the oxygen is being used efficiently. The diagnostics analyse the amount of switching activity on the post O2 sensor.

**Malfunction Criteria:** N/A

**Secondary enable conditions:** Engine run time > 880sec  
Coolant temperature > 80 degrees C  
MAP between 250 MAP and 450 MAP  
Vehicle Speed between 40Kmh and 60Kmh  
Engine speed <2100rpm  
Throttle position > 3.9%

**Disabled by faults:** P0117, P0118, P0131, P0135, P0171, P0172, P0300-P0304

**Time required:** 25 sec; 2 trips required

**Potential failure modes:** Catalyst damaged resulting in poor emissions

**Limp home:** None

**Note:** This fault will be indicated by the MIL.



**Evaporative Emission Control System**

**P0444/5**

*P0444 Purge Control Valve Circuit Open*

**Description:** Circuit check  
**Malfunction Criteria:** Logic level High  
**Secondary enable conditions:** Purge valve state off  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Connectors  
- Wire open circuit  
- ECU output circuit failed  
**Limp home:** None  
**Note:** This fault will be indicated by the MIL.

*P0445 Purge Control Valve Circuit Shorted*

**Description:** Circuit check  
**Malfunction Criteria:** Logic level Low  
**Secondary enable conditions:** Purge valve state on  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Connectors  
- Wire short circuit  
- ECU output circuit failed  
**Limp home:** None  
**Note:** This fault will be indicated by the MIL.



**Vehicle Speed Sensor**

**P0500**

*P0500 Vehicle Speed Sensor Malfunction*

**Description:** Rationality checks - looks at the road speed signals when the engine is in overrun, (engine braking). The vehicle speed signal is the vehicle speed sensors. The engine management system uses only one channel  
- Rear right hand wheel speed.

**Malfunction Criteria:** Vehicle speed < 5 Km/h

**Secondary enable conditions:** Throttle closed; MAP < 140 mbar (14 kPa); engine speed < 3000 rpm

**Disabled by faults:** None

**Time required:** 2 seconds; 2 trips required

**Potential failure modes:**  
- Connectors  
- Wiring short or open circuit  
- Sensor fault.

**Limp home:** Vehicle speed = 0 is assumed



**Idle Speed Control****P0506/7***P0506 RPM Lower Than Expected*

**Description:** Engine speed monitoring  
**Malfunction Criteria:** Deviation from target idle speed < -200 RPM  
**Secondary enable conditions:** (Battery voltage between 11 and 15V )  
(Engine idling )  
(Idle control integrator >20 % {lost control} )  
**Disabled by faults:** N/A  
**Time required:** Once fault condition is met = 1 sec; 1 trips required  
**Potential failure modes:** - Connectors  
- IAC stuck / closed / blocked  
**Limp home:** None

*P0507 RPM Higher Than Expected*

**Description:** Engine speed monitoring  
**Malfunction Criteria:** Deviation from target idle speed > +400 RPM  
**Secondary enable conditions:** (Battery voltage between 11 and 15 V )  
(Engine idling )  
(Idle control integrator < -20 % {lost control} )  
**Disabled by faults:** N/A  
**Time required:** Once fault condition is met = 1 sec  
**Potential failure modes:** - Connectors  
- Air leak into plenum  
- Stuck valve  
**Limp home:** None



**Battery Voltage**

**P0562/3**

*P0562      Too Low*

<b>Description:</b>	This is a circuit check, to see if the voltage is too low
<b>Malfunction Criteria:</b>	Battery voltage < 6.0 V
<b>Secondary enable conditions:</b>	Engine running
<b>Disabled by faults:</b>	None
<b>Time required:</b>	10 sec; 2 trips required
<b>Potential failure modes:</b>	Alternator or battery fault
<b>Limp home:</b>	None

*P0563      Too High*

<b>Description:</b>	This is a circuit check, to see if the voltage is too high
<b>Malfunction Criteria:</b>	Battery voltage > 16 V
<b>Secondary enable conditions:</b>	Engine running
<b>Disabled by faults:</b>	None
<b>Time required:</b>	26 sec; 2 trips required
<b>Potential failure modes:</b>	Alternator or battery fault
<b>Limp home:</b>	None



**ECU Integrity**

**P0601/6**

*P0601 Watchdog*

**Description:** This is a rationality check. The ECU will monitor it self for correct software execution.  
**Malfunction Criteria:** Watchdog reset detected.  
**Secondary enable conditions:** N/A  
**Disabled by faults:** None  
**Time required:** N/A  
**Potential failure modes:** ECU fault  
**Limp home:** ECU resets.

*P0606 Checksum*

**Description:** This is a rationality check. The ECU will perform a checksum on all diagnostic and learn data, and compare this against a previously stored value.  
**Malfunction Criteria:** Incorrect checksum result  
**Secondary enable conditions:** N/A  
**Disabled by faults:** None  
**Time required:** N/A  
**Potential failure modes:** ECU fault  
**Limp home:** Default diagnostic and learn values loaded.



**Fuel Pump**

**P1100/1**

*P1100 Relay Or Circuit Open*

**Description:** Open circuit check  
**Malfunction Criteria:** Feedback logic low  
**Secondary enable conditions:** Fuel pump off  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Connectors  
- Wire open circuit  
- Relay missing  
- Relay faulty  
- ECU input circuit failed

**Limp home:**

**Note:** This fault will be indicated by the MIL.

*P1101 Relay Or Circuit Shorted*

**Description:** Short circuit checks  
**Malfunction Criteria:** Feedback logic high  
**Secondary enable conditions:** Fuel pump state on  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Connectors  
- Wire short circuit  
- Relay faulty  
- ECU input circuit failed

**Limp home:**

**Note:** This fault will be indicated by the MIL.

**Misfire****P1301/2***P1301 Misfire Level Causing Emissions Increase*

<b>Description:</b>	Misfire detected which could cause emissions increase by 1.5 X standard, or an I/M emissions failure. Fluctuations in crankshaft speed are used to determine misfire.
<b>Malfunction Criteria:</b>	Misfires on all cylinders evaluated over a 1000 engine revolution period > 3%
<b>Secondary enable conditions:</b>	P0300-P0304 active
<b>Disabled by faults:</b>	P0122, P0123, P0107, P0108, P0117, P0108,
<b>Time required:</b>	1 sec; 2 trips required
<b>Potential failure modes:</b>	<ul style="list-style-type: none"><li>- Spark plug fault</li><li>- Plug lead loose or faulty</li><li>- Ignition coil circuit problems</li><li>- Ignition coil problem</li><li>- Low compression in cylinder</li></ul>
<b>Limp home:</b>	None
<b>Note:</b>	This fault will be indicated by the MIL.

*P1302 Misfire Level Causing Catalyst System Damage*

<b>Description:</b>	Misfire detected which could cause possible damage to the catalytic converter. Fluctuations in crankshaft speed are used to determine misfire.
<b>Malfunction Criteria:</b>	Misfires on all cylinders evaluated over 200 revs > 10%
<b>Secondary enable conditions:</b>	P0300-P0304 active
<b>Disabled by faults:</b>	P0122, P0123, P0107, P0108, P0117, and P0108
<b>Time required:</b>	200 revs continuously
<b>Potential failure modes:</b>	<ul style="list-style-type: none"><li>- Spark plug fault</li><li>- Plug lead loose or faulty</li><li>- Ignition coil circuit problems</li><li>- Ignition coil problem</li><li>- Low compression in cylinder</li></ul>
<b>Limp home:</b>	None
<b>Note:</b>	This fault will be indicated with a flashing 'check engine' light during the misfiring condition.



**Misfire Learns Not Complete**

**P1336**

*P1336*

<b>Description:</b>	Memory Blank (new or reprogrammed ECU)
<b>Malfunction Criteria:</b>	N/A
<b>Secondary enable conditions:</b>	N/A
<b>Disabled by faults:</b>	None
<b>Time required:</b>	None
<b>Potential failure modes:</b>	None
<b>Limp home:</b>	None
<b>Note:</b>	This fault will be indicated by the MIL.



**Coolant Fan Relay**

**P1400/1**

*P1400 #1 Short Circuit*

**Description:** Open circuit check  
**Malfunction Criteria:** Feedback logic low  
**Secondary enable conditions:** fan off  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Connectors  
- Wire open circuit  
- Relay missing  
- Relay faulty  
- ECU input circuit failed

**Limp home:**  
**Note:** N/A

*P1401 #1 Open Circuit*

**Description:** Short circuit checks  
**Malfunction Criteria:** Feedback logic high  
**Secondary enable conditions:** Fuel pump state on  
**Disabled by faults:** None  
**Time required:** 1 sec  
**Potential failure modes:**  
- Connectors  
- Wire short circuit  
- Relay faulty  
- ECU input circuit failed

**Limp home:**  
**Note:** N/A



**Air Conditioning Control Relay**

**P1460/1**

*P1460 Open Circuit*

<b>Description:</b>	Circuit check
<b>Malfunction Criteria:</b>	Logic level low
<b>Secondary enable conditions:</b>	Relay state off
<b>Disabled by faults:</b>	None
<b>Time required:</b>	1 sec; 1 trips required
<b>Potential failure modes:</b>	- Connectors - Wire open circuit - Relay missing - Relay faulty - ECU input circuit failed
<b>Limp home:</b>	None

*P1461 Short Circuit*

<b>Description:</b>	Circuit check
<b>Malfunction Criteria:</b>	Logic level high
<b>Secondary enable conditions:</b>	Relay state on
<b>Disabled by faults:</b>	None
<b>Time required:</b>	1 sec; 1 trips required
<b>Potential failure modes:</b>	- Connectors - Wire short circuit - Relay faulty - ECU input circuit failed
<b>Limp home:</b>	None





TRANSMISSION

SECTION FI - ELISE 2001 M.Y. Onwards

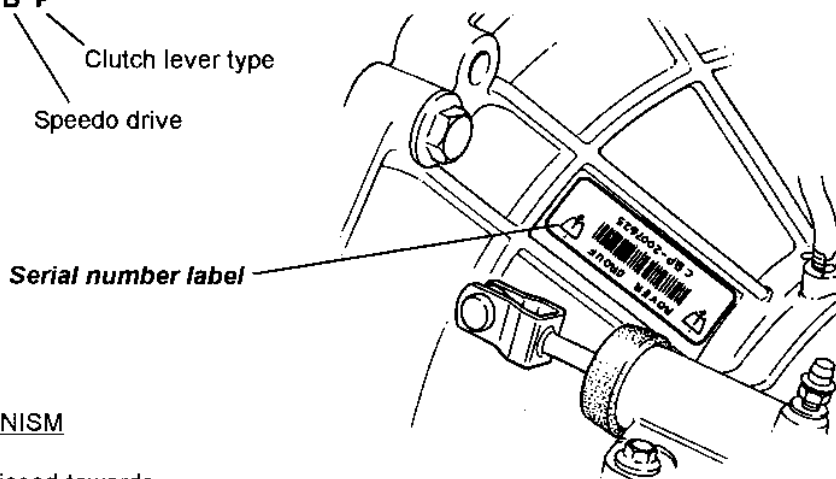
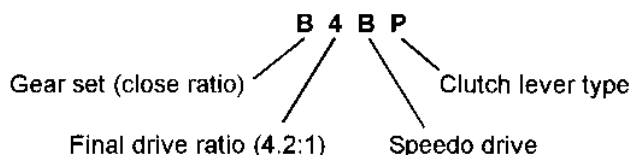
	<u>Sub-Section</u>	<u>Page</u>
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FI.1 - INTRODUCTION

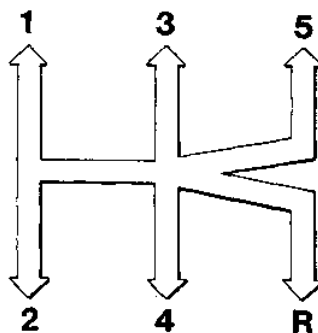
The transmission assembly is an 'end on' type, mounted on the left hand end of the engine unit, and comprises of the clutch housing, five speed gearbox, final drive gears, and differential. The unit is supplied by Rover, and is designated 'PG1', with Rover publication RCL 0124ENG covering the description and overhaul of this transmission. A conventional bevel gear differential is fitted for the Elise application. The gearchange mechanism is different to that used by Rover, with the two cables running beneath the power unit (see subsection FI.2).

The transmission serial number is printed on a bar code label fixed to the top of the clutch housing, and is prefixed by a specification code. In the case of the Elise 2001 M.Y. the code is:



FI.2 - GEARCHANGE MECHANISM

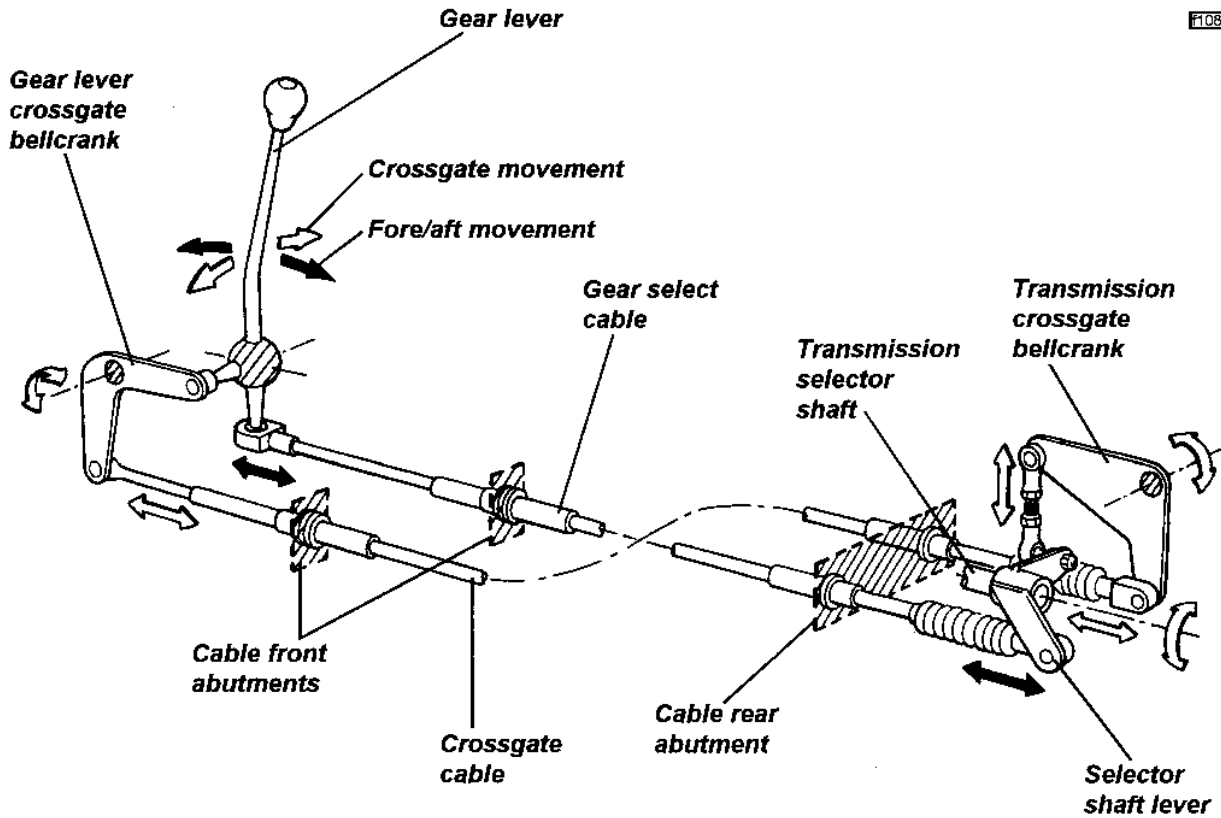
The gearlever is spring biased towards the 3rd/4th gear plane such that it must be moved against light spring pressure to the left before selecting first or second gear, and against similar pressure to the right before selecting 5th or reverse gear. An inhibitor device within the transmission selector mechanism prevents the selection of reverse gear directly from 5th, by requiring that the lever first be moved across the gate to release an interlock. A reverse selector 'brake' mechanism utilises the 4th gear synchroniser to halt the input gear train, and assist the engagement of reverse gear.



A two cable mechanism is used to connect the gearchange lever with the transmission, one cable ('shift') to transmit the fore/aft movement of the lever, and a second ('crossgate') for the sideways movement. The steel gearchange lever incorporates an integral pivot ball which pivots in a two piece nylon socket in an alloy housing. The housing is mounted on a fabricated steel bracket which incorporates abutments for the two cables, and is fixed to the cabin floor crossmembers. Both gearchange cables run down the centre of the cabin floor, beneath the fuel tank bay, and under the engine to connect with the transmission selector shaft at the bottom rear of the power unit.

A vertical extension to the gearchange lever, below the pivot ball, connects via a ball joint to the shift cable. Fore/aft movement of the lever is thus transmitted directly to the cable, the rear end of which is connected directly to the transmission selector shaft via a short leg.

Crossgate movement of the gear lever is transmitted to a second cable via a short horizontal leg protruding from the left side of the gear lever pivot ball. Vertical movement of this leg is translated into a fore/aft motion by a forward mounted bellcrank lever, the other end of which connects with the crossgate cable. The rear end of this cable links via another bellcrank lever, and a ball jointed link, to a lever on the transmission selector shaft, to which is imparted a rotational movement.



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**Gearchange Cable Adjustment**

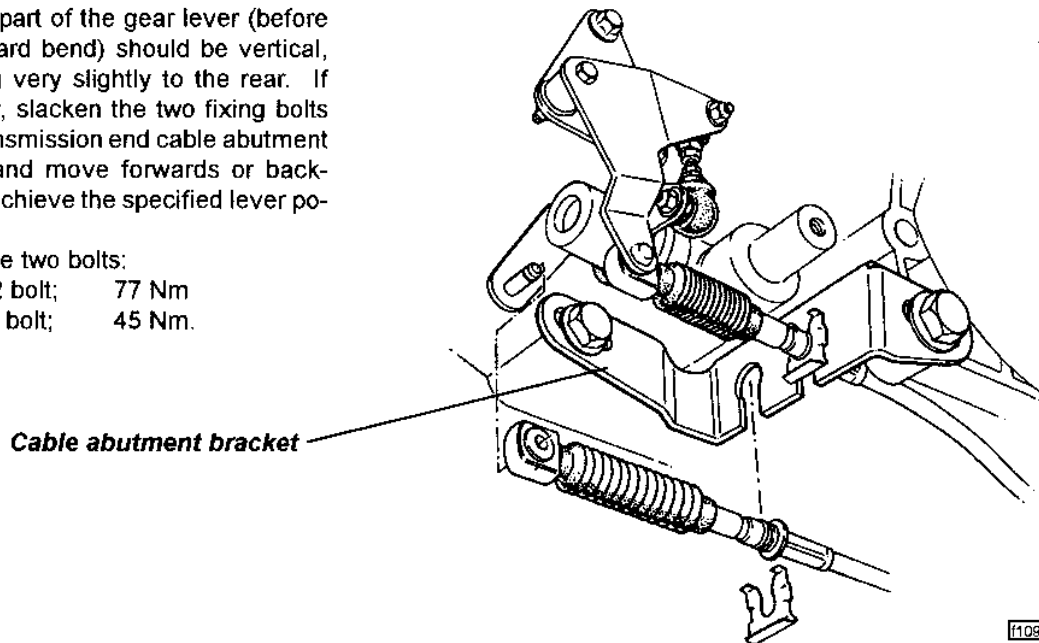
Both gearchange cables, crossgate and select, are of fixed length. Fore/aft adjustment is provided via slotted fixing holes in the transmission end abutment bracket, with crossgate adjustment catered for by an adjustable length tie rod between transmission end bellcrank lever and selector shaft.

With the gearchange mechanism assembled, and the transmission in neutral:

1. Fore/aft position: Viewed from the side, the lower part of the gear lever (before the rearward bend) should be vertical, or leaning very slightly to the rear. If necessary, slacken the two fixing bolts on the transmission end cable abutment bracket, and move forwards or backwards to achieve the specified lever position.

Tighten the two bolts:

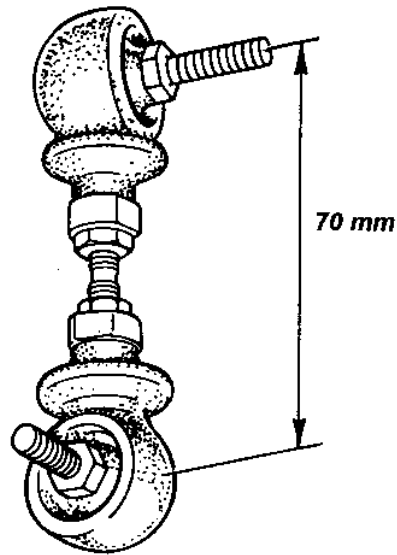
- Front M12 bolt; 77 Nm
- Rear M10 bolt; 45 Nm.



F109



2. Crossgate position: Viewed from behind, the gear lever should be vertical. If necessary, adjust the length of the transmission end bellcrank tie rod. The nominal length between ball joint centres is 70 mm. The tie rod is RH threaded at both ends, so that before an adjustment can be made, the lower ball joint must be released from the selector shaft lever. Adjustments to the tie rod length can be made only in increments of one thread pitch:



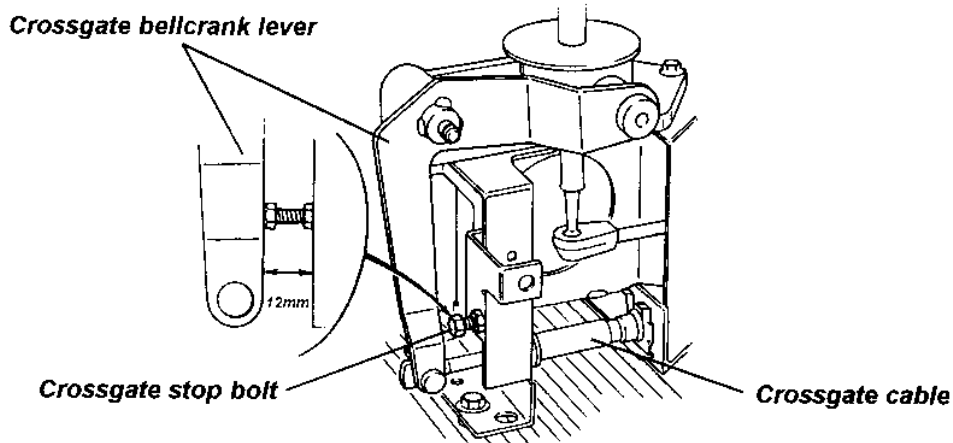
f110

- Lengthen the rod to move the lever position to the left;
- Shorten to move the lever to the right.

Ensure that there is similar thread engagement into each of the two ball joints. Refit the ball joint to the lever and tighten to 4.7 Nm.

3. 5th & reverse crossgate stop: An adjustable stop bolt is provided to limit the gear lever crossgate movement to the right (5th and reverse plane). If any adjustment to the crossgate cable is made, the stop bolt adjustment should be checked. For access to the lever mechanism, the gear lever knob and shroud must first be removed - unscrew the knob, remove the screw each side of the shroud, and lift the shroud over the lever.

The nominal stop bolt setting of 12 mm should be adjusted as necessary to provide minimal clearance when the lever is operated in the 5th/reverse gear plane, as is consistent with satisfactory gear selection.



### Gearlever Replacement

For access to the gear lever assembly, unscrew the gear knob, remove the single screw each side of the gear lever shroud, and lift the shroud over the lever. To remove the gear lever:

- Remove the 'E' clip from the bellcrank lever pivot.
- Unsnap the select cable socket from the gear lever ball.
- Remove the three screws securing the gear lever housing to the mounting bracket, disengage the bellcrank

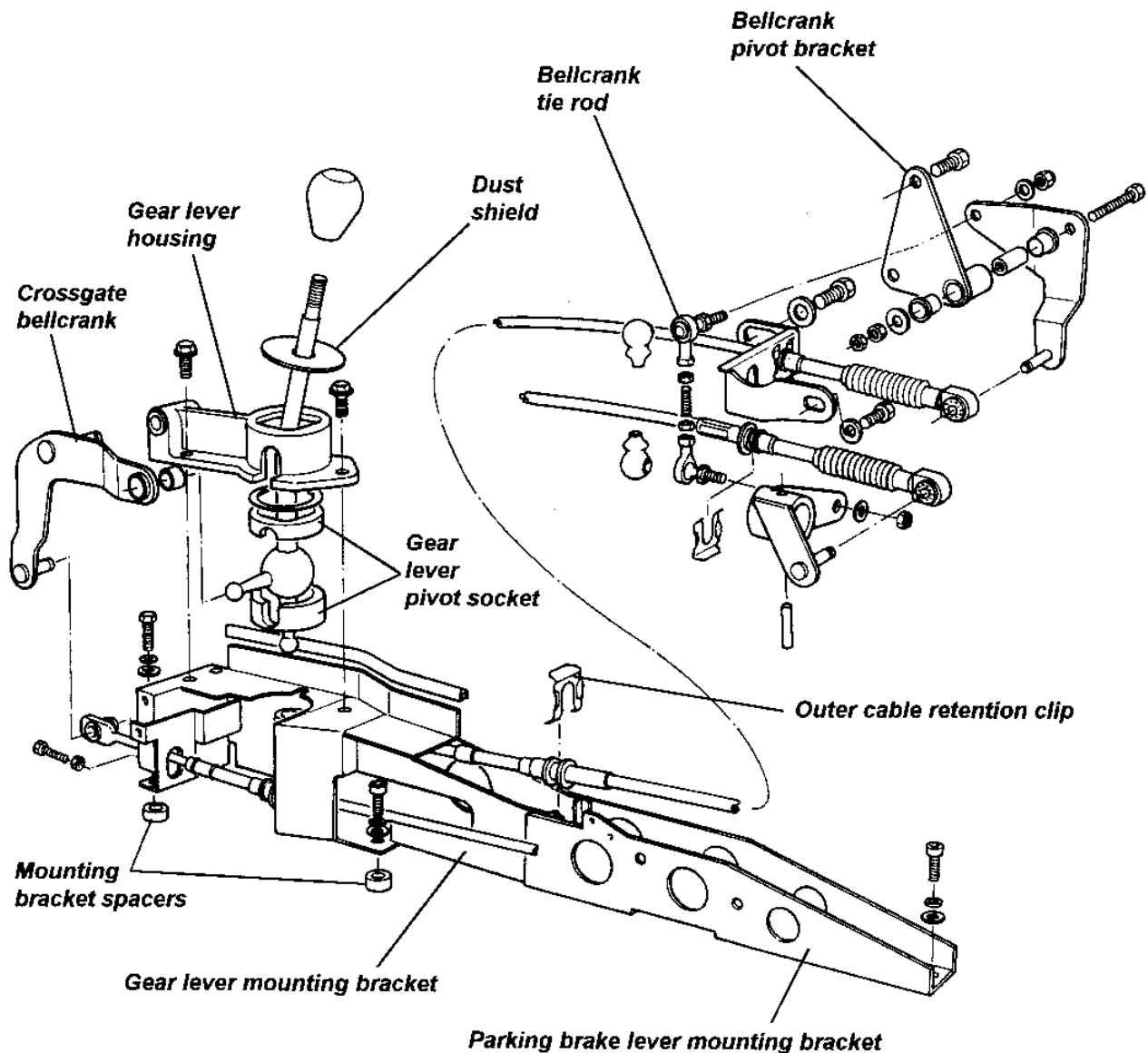


lever pivot and crossgate spigot bush, and withdraw the housing and gear lever assembly.

To re-assemble:

- Fit the pivot socket gasket into the gear lever housing, followed by the top (smaller) section of the pivot socket.
- Apply Dow Corning Molykote 33 Medium silicone grease (A111F6016) to the gear lever pivot ball and to the crossgate spigot ball before fitting the lever into the housing followed by the lower section of the socket. Snap the plastic bush onto the lever crossgate spigot ball.
- Locate the bellcrank lever pivot into the gear lever housing, and retain with the 'E' clip. Fit the crossgate spigot into the bellcrank lever and locate the gear lever housing onto the mounting bracket.
- Fit and tighten the three gear lever housing screws, and snap the select cable socket onto the bottom of the gear lever.
- Check gear linkage operation and adjustments before fitting the pivot ball dust shield over the lever, and refitting the shroud.

NOTE: To avoid the requirement to replace the retaining clip/bush, do not disconnect the crossgate cable from the bellcrank lever unless necessary.



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### Gearchange Cable Replacement

For access to the gear cables, the gear lever shroud and parking brake lever trim must be removed: Unscrew the gear lever knob, remove the single screw each side of the shroud, and withdraw the shroud. Remove the single screw securing the parking brake trim to the rear bulkhead and ease the panel over the lever.

Unclip the crossgate cable from the bellcrank lever, or unsnap the select cable from the lever ball. Pull off the spring clip retaining the cable outer to the abutment bracket, and release the cable from the bracket. At the rear end, prise the cable off the lever, pull off the outer cable spring clip, and release from the abutment bracket. Release cable ties and clips as necessary to allow the cable to be withdrawn, noting the routing past the park brake lever.

Refit in reverse order to removal, paying particular attention to the routing through or alongside the park lever and gear lever mounting brackets. Check the cable adjustments as detailed above.

### Gearlever Mounting Bracket

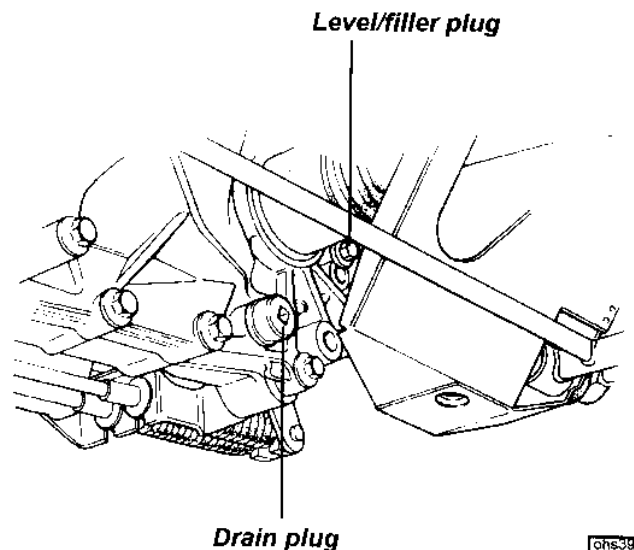
The gear lever mounting bracket is secured to the cabin floor by four M8 bolts, the rearmost of which also fixes the front of the parking brake lever bracket. Note that alloy spacers are used on the front three fixing points between bracket and floor. The whole assembly is offset towards the passenger side of the car, with alternative fixing holes provided either in the mounting bracket, or in the cabin floor.

### FI.3 - LUBRICATION

The PG1 transmission is 'filled for life' with Texaco MTF94 fully synthetic lubricant, and requires no periodic renewal. No other transmission oil is approved. If there are any signs of leakage, the source should be identified and appropriate action taken to rectify the fault.

A filler/level plug is provided on the left hand side of the the final drive housing, and with the car parked on a level surface, the oil level should be up to the level of this hole. A drain plug in the underside of the casing (square socket plug) permits the oil to be drained prior to transmission removal or repair.

Dry fill capacity = 2.4 litres. Refill = 2.1 litres.



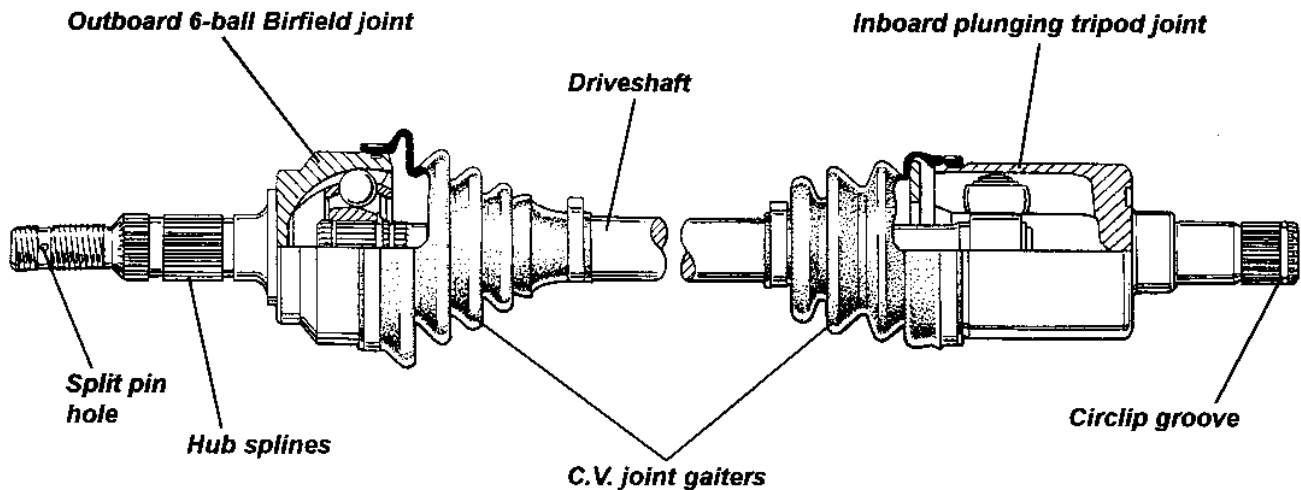
### FI.4 - DRIVE SHAFTS

A driveshaft assembly comprising a steel shaft with a constant velocity joint at each end, is used to transmit the drive from each differential output gear to the rear wheel hub. The two shafts are of unequal length due to the offset transmission housing, with the longer shaft on the right hand side. Both driveshaft assemblies use plunging tripod type inboard C.V. joints, and six ball Birfield type outboard C.V. joints. The outboard joint is available as a service part, as is the inboard joint complete with shaft. Replacement gaiter kits are available for both joints. The joints themselves are packed with grease on initial assembly, and are maintenance free. It is however vitally important that the protective gaiters are carefully inspected at service intervals, to check for splits, tears or punctures, since the joint will deteriorate very quickly once contaminated with dirt or water. Damaged gaiters should be renewed immediately, once the servicibility of the joint has been established.

Clicking noises, torque reversal 'clonks', or shudder and vibration when accelerating are all possible symptoms of worn C.V. joints. It should not be possible to discern any free play in a joint, but care must be taken not to confuse this with transmission backlash, which may be considerable. Any symptoms that could be due to worn driveshaft joint assemblies, should be investigated and rectified without delay, since safety considerations are always of paramount importance.



The inboard C.V. joint is equipped with a male splined spigot shaft which engages with the female splines of the differential output sun gear, and is retained by a round section spring circlip on its end. Each of the two transmission output oil seals runs on a stepped shoulder on the C.V. joint spigot shaft. The outboard end of each driveshaft carries a second C.V. joint whose spigot shaft is used to clamp the hub and wheel bearing into the hub carrier via a thread on the end of the shaft.



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### Driveshaft Replacement

Removing a driveshaft from the transmission will result in some loss of transmission lubricant. It may be preferred to drain off some oil via the transmission drain plug beforehand.

1. Remove the transmission drain plug and drain off approximately 1 litre of oil into a clean container for re-use.
2. Remove the rear road wheel.
3. Before attempting to release the driveshaft hub nut, first use a punch to knock the distorted end of the nut clear of the driveshaft slot. Apply the parking brake and release the driveshaft hub nut.
4. Remove the wheel speed sensor from its plinth to prevent damage during driveshaft removal.
5. To allow the hub carrier to be leant outwards and provide room for the driveshaft to be withdrawn from the transmission and hub, remove the bolt securing the toe link to the hub carrier and remove the two bolts securing the top ball joint plinth to the hub carrier, taking note of the shim pack fitted between plinth and carrier.
6. The inboard C.V. joint is retained in the transmission by a rounded section circlip, and may be removed by applying a shock pull to the C.V. joint body using a slide hammer with a forked end, or on the RH side, by using a special wedge tool T000T1276.

**CAUTION:** Do NOT attempt to remove the inboard C.V. joint from the transmission by pulling on the driveshaft. This action will cause the joint to become disassembled and may entail replacement of the joint. The components of the inboard plunging joint are held in position, for transit purposes only, by a collar within the boot which will be overridden if excessive axial force is used. Apply pressure only to the 'tulip' or outer body of the joint.

Withdraw the inboard C.V. joint from the transmission, taking great care not to damage the output seal, and fit blanking plug T000T1385 into the transmission to limit the amount of transmission oil loss.

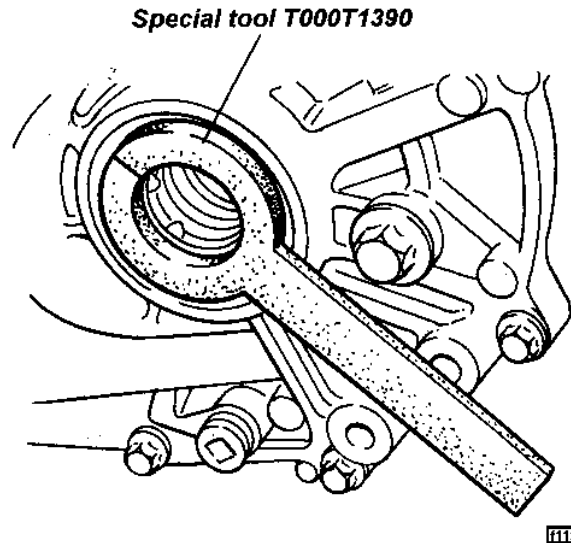
7. Withdraw the driveshaft from the hub using a puller if necessary, and remove the driveshaft assembly from the car.



8. Before re-fitting a driveshaft, first renew the round section circlip (A100R6001F) on the end of the inboard joint spigot shaft, and lubricate the circlip with grease. Also, check the condition of the transmission output seal, and renew if necessary. Lubricate the lip of the seal with transmission oil, and grease the corresponding shoulder on the driveshaft (C.V. joint) spigot, to reduce the danger of damaging the seal on assembly.
9. A special tool T000T1390 is available to protect the seal during driveshaft fitment, and should always be used with the more vulnerable early type seal (see above).

To use the tool:

- Check first that the tool is clean and undamaged before fully inserting into the oil seal. Check that the split joint in the tool is butted correctly.
- Carefully insert the driveshaft through the seal protector until it engages in the splines of the differential output gear.
- Remove the protector tool by pulling over the shaft.
- Press the C.V. joint into the differential gear splines until a 'click' indicates that the circlip has engaged in its location. Pull on the body of the joint to check security.



10. Fit the outer end of the shaft into the hub, and retain with the nut.
11. Refit the top ball joint plinth to the hub carrier with the camber adjustment shim pack in position, and tighten the two socket head bolts to 45 Nm. Apply the parking brake and tighten the driveshaft nut to 220 Nm. Tighten the toe link to hub carrier pivot bolt to 45 Nm. Refit the wheel speed sensor to its plinth.
12. With the car on a level surface, top up the transmission oil to the filler/level plug hole.

#### Driveshaft C.V. Joint and/or Gaiter Replacement

The outboard joint is available as a separate part, whilst the inboard joint is supplied complete with the driveshaft. Gaiter kits are separately available for both joints.

1. Remove the driveshaft assembly from the car (see above).
2. Cut off the gaiter retaining clips from both joints, and slide the gaiters along the shaft.
3. The outboard joint is retained by a round section circlip on the end of the shaft. To remove the joint, hold the drive shaft in a vice, and use a soft mallet to tap the joint over the circlip and off the shaft. If the joint is reluctant to move, use a brass drift on the front face of the inner race.

**CAUTION:** Do not attempt to remove an outboard joint without first removing the shaft assembly from the car. Unless the shaft is securely retained (e.g. in a vise) attempts to remove the outboard joint may result in the inboard joint becoming disassembled.

4. Slide both C.V. joint gaiters off the driveshaft.
5. **Cleaning & Inspection:** Complete disassembly of either joint is NOT recommended. The separate components are a precision fit and develop their own individual wear patterns, such that any interchanging or re-orientation of parts is likely to result in premature failure.





If the grease in the joint is contaminated with dirt or water, it is likely that the joint is damaged, and should be replaced. If the grease is not contaminated, the joint should be degreased by soaking in a suitable solvent (NOT petrol), and then carefully inspected.

On the outboard ball type joint, tilt the inner race to one side to expose each ball. Severe pitting, galling, play between ball and its cage window, any cracking or damage to the cage, or pitting, galling or chips in raceways, call for joint replacement.

On the inboard, tripod type joint, examine the fit between the rollers and the housing. Excessive free play, roughness on either roller or track surfaces, damage to the bearings or trunnion, call for joint replacement. If the joint is found to be serviceable, it must be repacked with special grease as follows:

Outboard joint; 1 sachet A100R6009 (52 ml) - boot kit contains 2 sachets

Inboard joint; 2 sachet A100R6010 (62 ml) - boot kit contains 3 sachets

6. Replace the circlips securing the inboard joint to the transmission and the outboard joint to the shaft. New circlips should always be used to ensure security of joint retention. Note that the circlip for the outboard joint is supplied in the boot kit for either joint, but that the inboard joint circlip should be ordered separately.
7. Tape over the shaft outboard splines to prevent damage to the new gaiters, and slide the inboard gaiter and small retaining clip onto the shaft, followed by the outboard gaiter small clip and gaiter. Remove the tape.
8. Outboard Joint: New joints are pre-packed with grease, but if re-fitting a cleaned out joint, lubricate the joint with one sachet of the special grease provided in the boot kit. Fill the ball tracks with grease both behind and in front of the balls, pack around the balls, and the inside of the splines, so that grease is pushed behind the joint when the shaft is inserted. Use the second grease sachet from the boot kit to fill the inside of the new boot.  
NOTE: The grease provided in the kits is specially formulated for wear resistance and durability. DO NOT use substitutes or mix with other lubricants.
9. Inboard Joint: If re-fitting a cleaned out joint, pack the joint with two of the grease sachets from the gaiter kit. Use the third grease sachet from the gaiter kit to fill the inside of the new gaiter.
10. Slide the outer joint onto the shaft splines, and tap the joint into position until the circlip 'clicks' into its groove. Pull on the joint to ensure it is fully located.
11. Pull each gaiter over its C.V. joint and locate the lips of the gaiter in the grooves on the joint and shaft. Before fitting the gaiter clamps, ensure that the gaiter is ventilated so that it is not dimpled or collapsed. Position the plunging joint with 80 mm between the boot clip grooves before ventilating by inserting a smooth rod (take care not to damage the boot) between the large end of the boot and the joint, and fitting the retaining clips. Tighten the clips using suitable pliers.
12. Refit the driveshaft assemblies to the car (see above).

#### FI.5 - TRANSMISSION REPLACEMENT

With the car supported on a 'wheel free' lift, the transmission can be removed from below, leaving the engine 'in situ':

1. Remove the LH rear lower wishbone:
  - Release the bolt securing the spring/damper unit to the lower wishbone;
  - Release the wishbone to chassis pivot bolts;
  - Release the parking brake cable clip and swing the wishbone out of the way.
2. Release the RH rear suspension toe control link from the hub carrier, and release the top ball joint plinth from the hub carrier taking note of the camber adjustment shimplates. in order to allow withdrawal of the driveshaft from the transmission.



- 3. Remove both inboard C.V. joints by applying a shock pull to the joint body using a slide hammer with a forked end, or on the RH side, by using a special wedge tool T000T1276. Fit blanking plug T000T1385 into the transmission to limit the amount of transmission oil loss.

**CAUTION:** Do NOT attempt to remove an inboard C.V. joint from the transmission by pulling on the driveshaft. This action will cause the joint to become disassembled and may entail replacement of the joint. The components of the inboard plunging joint are held in position, for transit purposes only, by a collar within the boot which will be overridden if excessive axial force is used. Apply pressure only to the 'tulip' or outer body of the joint.

- 4. Remove the 'R' clip and clevis pin connecting the clutch slave cylinder to the release arm. Remove the four bolts fixing the slave cylinder bracket to the transmission, and support aside.
- 5. Release the two bolts securing the starter motor and dirt shield to the clutch housing. Remove the shield, and withdraw and support the starter motor, taking care to protect the live starter motor lead from grounding.
- 6. Remove the dirt shield from the top front of the clutch housing.
- 7. Disconnect the reverse light switch.
- 8. Disconnect the two gearchange cables from their transmission levers, and release the cables from the abutment bracket.
- 9. Remove the air cleaner housing and mounting plate from the roll over bar brace.
- 10. Support the weight of the transmission assembly before removing the LH engine (transmission) mounting and bracket.
- 11. Remove the six bolts securing the clutch housing to the engine:
  - 2 bolts to the sump;
  - 1 bolt each side through the block lower 'wings';
  - 2 bolts securing the top of the clutch housing to the engine.
- 12. Pushing the engine to the right and downwards at the flywheel end, withdraw the transmission from the engine.
- 13. Refit the transmission in the reverse order to removal with the following notes:
  - Check that the type of output shaft seals fitted are compatible with the driveshaft inboard C.V. joints - see Sub-Section FI.4.
  - Use new circlips on the spigots of the inboard C.V. joints, and follow the procedure in Sub-Section FI.4 to refit.

**FI.6 - TRANSMISSION OVERHAUL**

The overhauling of the Rover supplied type PG1 transmission, is detailed in Rover publication RCL 0124ENG. Note that a conventional bevel gear differential is used for the Elise application. Special tools are available through Lotus under the following part numbers:

**Transmission Special Tools**

<b>Description</b>	<b>Lotus Part No.</b>	<b>Churchill Part No. (ref.)</b>
Driveshaft Removal Wedge (RH)	T000T1276	18G1578
Adaptor Plate, bearing puller	T000T1291	18G 2-3
Replacer Dolly, input shaft oil seal	T000T1293	18G 134-4

Continued .....

Transmission Special Tools (continued)

<b>Description</b>	<b>Lotus Part No.</b>	<b>Churchill Part No.(ref.)</b>
Slide Hammer, output shaft bearing remover	T000T1294	18G 284
Adaptor, output shaft bearing remover	T000T1295	18G 284-14
Driver Handle, bearing dolly	T000T1296	18G 1354
Replacer Dolly, output shaft bearing	T000T1297	18G 1354-5
Circlip Pliers, bearing access plug	T000T1298	18G 1392
Thrust Pad, bearing puller	T000T1299	18G 1397
Hex. Socket, M14, access plug	T000T1300	18G 1472
Anti-Spread Plate, input/output shafts	T000T1301	18G 1473
Replacer Dolly, differential bearings	T000T1302	18G 1675
Replacer, clutch release shaft inner bush	T000T1303	18G 1723-1
Replacer, clutch release shaft outer bush	T000T1304	18G 1723-2
Clutch Alignment Mandrel	T000T1277	18G1483
Blanking Plug, driveshaft output	T000T1385	-
Replacer Dolly, output seal, RH	T000T1388	18G1354-16
Replacer Dolly, output seal, LH	T000T1389	18G1354-21
Seal Protector, output shaft seals	T000T1390	-



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# PG1 MANUAL GEARBOX

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# OVERHAUL MANUAL

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**This gearbox is fitted to the following models:-**

Rover 218/418 Diesel  
New Rover 200 Diesel  
New Rover 218  
New Rover 400 Diesel  
Rover 220  
Rover 420  
Rover 600 Diesel  
Rover 600 Ti  
Rover 820  
Rover 800 KV6  
MG-F

**Publication Part No. RCL 0124 ENG (2nd edition)  
Published by Rover Technical Communication  
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## INTRODUCTION

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### How to use this manual

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

This manual contains procedures for the overhaul of the gearbox on the bench with the engine removed. For all other information regarding General Information, Adjustments, Removal of oil seals, gearbox unit, consult the Repair Manual for the model concerned.

This manual is divided into 3 sections, Description and Operation, Overhaul and Data, Torque & Tools. To assist filing of revised information each sub-section is numbered from page 1.

The individual overhaul items are to be followed in the sequence in which they appear. Items numbered in the illustrations are referred to in the text.

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

WARNINGS, CAUTIONS and Notes have the following meanings:



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



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



**NOTE:** Gives helpful information.

### References

With the engine and gearbox assembly removed, the crankshaft pulley end of the engine is referred to as the front.

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

### Dimensions

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

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## REPAIRS AND REPLACEMENTS

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

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

Safety features and corrosion prevention treatments embodied in the car may be impaired if other than Rover recommended parts are fitted. In certain territories, legislation prohibits the fitting of parts not to the manufacturer's specification.

Torque wrench setting figures given in this Manual must be used. Locking devices, where specified, must be fitted. If the efficiency of a locking device is impaired during removal it must be renewed.

The Terms of the vehicle Warranty may be invalidated by the fitting of other than Rover recommended parts. All Rover recommended parts have the full backing of the vehicle Warranty.

Rover Dealers are obliged to supply only Rover recommended parts.

# INTRODUCTION

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## SPECIFICATION

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

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

### Gearbox identification

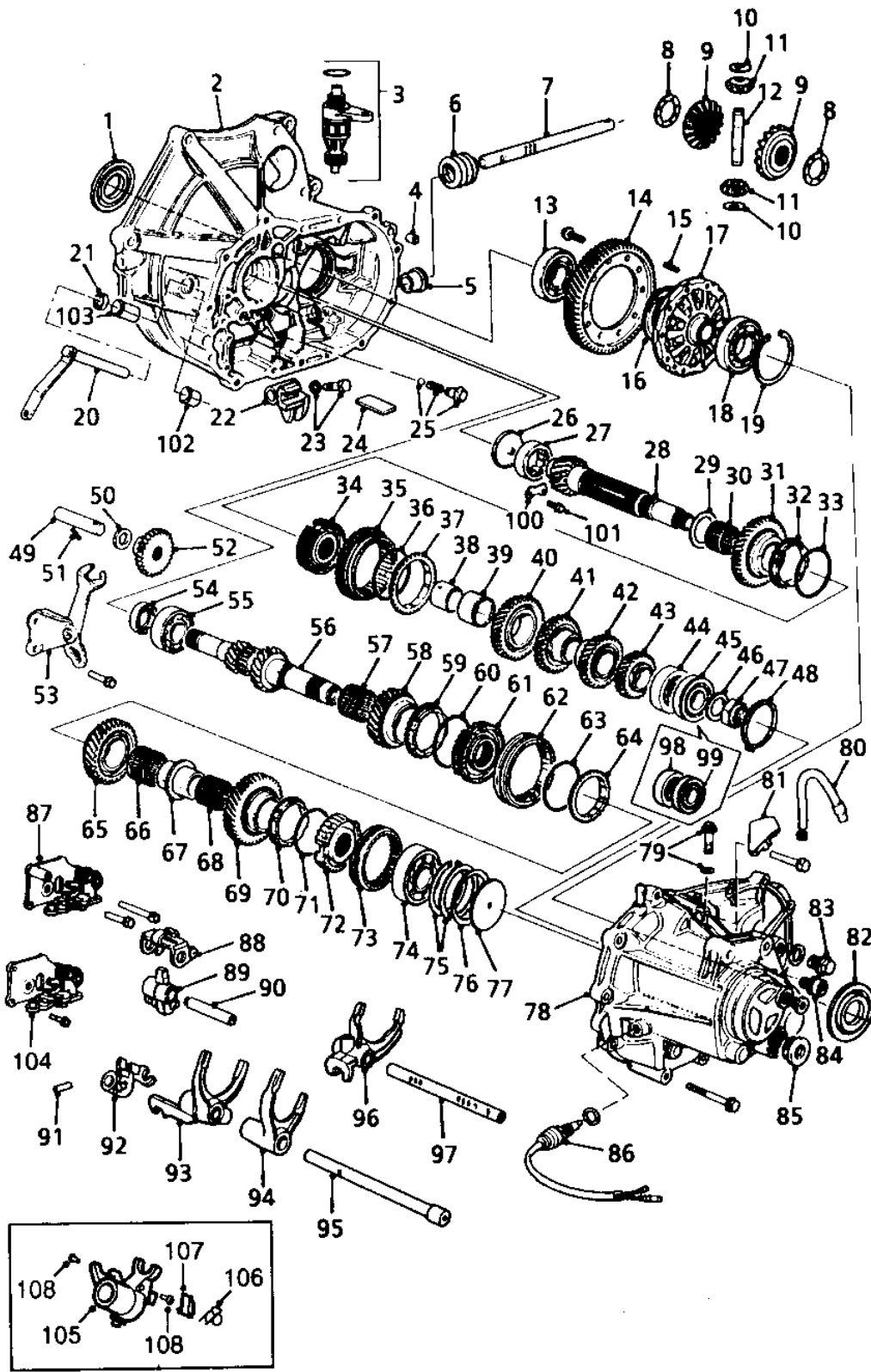
This overhaul manual is applicable to PG1 gearboxes having the following Serial No. prefixes:

C4BP	R4A0
C4BS	R4DT
C6BN	S4DTU
C6BP	S4EM
C6BS	S4FTU
S6BSU	S6A0
C6DTUT	S6BN
C6DTUTH	S6BNU
C6DUTH	S6BS
C6FTUT	S7EMU
K4BS	V4DT
K4BX	V6BS
K6A0	W4DT
K6BN	W4DTUT
K6BS	Y4A0
K7BSUT	
K7BX	
M5BS	



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# MANUAL GEARBOX



37M1297





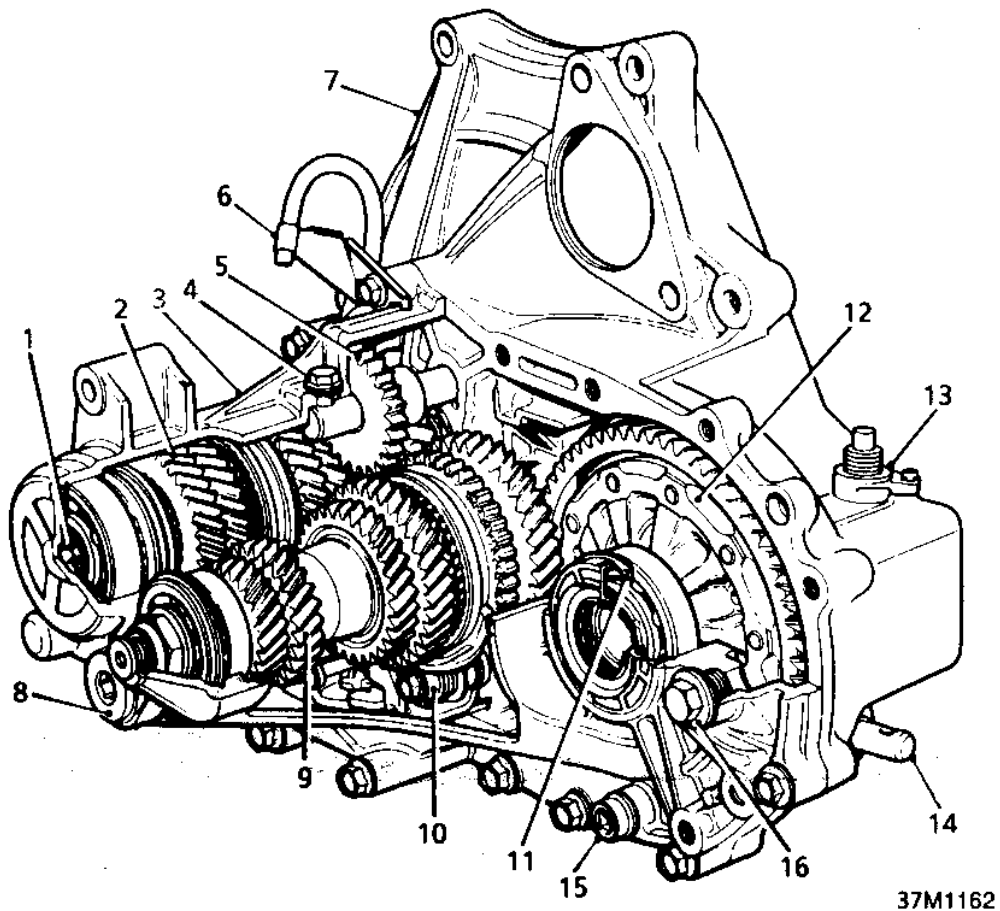
**GEARBOX COMPONENTS**

- |   |   |  |
|---|---|--|
| <ul style="list-style-type: none"> <li>1. Oil seal - differential</li> <li>2. Differential housing</li> <li>3. Speedometer drive pinion and housing</li> <li>4. Dowel</li> <li>5. Oil seal - selector shaft</li> <li>6. Boot</li> <li>7. Selector shaft</li> <li>8. Thrust washer - sun gear</li> <li>9. Sun gear</li> <li>10. Thrust washer - planet gear</li> <li>11. Planet gear</li> <li>12. Pinion shaft</li> <li>13. Ball bearing - differential</li> <li>14. Final drive gear</li> <li>15. Roll pin - differential pinion shaft</li> <li>16. Speedometer drive gear</li> <li>17. Differential casing</li> <li>18. Ball bearing - differential</li> <li>19. Selective shim</li> <li>20. Clutch release shaft</li> <li>21. Oil seal - clutch release shaft</li> <li>22. Selector shaft guide</li> <li>23. Dowel bolt and washer</li> <li>24. Magnet</li> <li>25. Detent cap bolt, ball and spring - selector shaft</li> <li>26. Oil guide plate</li> <li>27. Parallel roller bearing - output shaft</li> <li>28. Output shaft</li> <li>29. Selective thrust washer - 1st gear end float</li> <li>30. Needle roller bearing - 1st gear</li> <li>31. 1st gear</li> <li>32. Synchro ring - 1st gear</li> <li>33. Synchro spring</li> <li>34. Synchro hub - 1st/2nd gear</li> <li>35. Synchro sleeve - 1st/2nd gear</li> <li>36. Synchro spring</li> <li>37. Synchro ring - 2nd gear</li> <li>38. Selective collar - 2nd gear end float</li> </ul> | <ul style="list-style-type: none"> <li>39. Needle roller bearing - 2nd gear</li> <li>40. 2nd gear</li> <li>41. 3rd gear</li> <li>42. 4th gear</li> <li>43. 5th gear</li> <li>44. Ball bearing - output shaft</li> <li>45. Ball bearing - output shaft</li> <li>46. Tongued washer</li> <li>47. Output shaft nut - L.H. thread</li> <li>48. Circlip</li> <li>49. Reverse idler shaft</li> <li>50. Thrust washer - reverse idler gear</li> <li>51. Roll pin - reverse idler shaft</li> <li>52. Reverse idler gear</li> <li>53. Reverse selector fork</li> <li>54. Oil seal - input shaft</li> <li>55. Ball bearing - input shaft</li> <li>56. Input shaft</li> <li>57. Needle roller bearing - 3rd gear</li> <li>58. 3rd gear</li> <li>59. Synchro ring - 3rd gear</li> <li>60. Synchro spring</li> <li>61. Synchro hub - 3rd/4th gears</li> <li>62. Synchro sleeve - 3rd/4th gears</li> <li>63. Synchro spring</li> <li>64. Synchro ring - 4th gear</li> <li>65. 4th gear</li> <li>66. Needle roller bearing - 4th gear</li> <li>67. Distance collar - 4th/5th gears</li> <li>68. Needle bearing - 5th gear</li> <li>69. 5th gear</li> <li>70. Synchro ring - 5th gear</li> <li>71. Synchro spring - 5th gear</li> <li>72. Synchro hub - 5th gear</li> <li>73. Synchro sleeve - 5th gear</li> <li>74. Ball bearing - input shaft</li> <li>75. Selective snap rings - input shaft end thrust</li> <li>76. Belleville washer - input shaft end thrust</li> </ul> | <ul style="list-style-type: none"> <li>77. Oil guide plate</li> <li>78. Gearbox casing</li> <li>79. Reverse idler shaft bolt and washer</li> <li>80. Breather pipe</li> <li>81. Breather pipe bracket</li> <li>82. Oil seal - differential</li> <li>83. Filter/level plug</li> <li>84. Drain plug</li> <li>85. Access plug - output shaft bearing circlip</li> <li>86. Reverse light switch</li> <li>87. Interlock assembly - early gearboxes</li> <li>88. Gearshift holder</li> <li>89. Gearshift arm guide</li> <li>90. Shift shaft</li> <li>91. Roll pin - 5th/reverse gear selector</li> <li>92. Gear selector - 5th/reverse gears</li> <li>93. Selector fork - 3rd/4th gears</li> <li>94. Selector fork - 5th gear</li> <li>95. Selector shaft - 5th/reverse gears</li> <li>96. Selector fork - 1st/2nd gears</li> <li>97. Selector shaft - 1st/2nd gears</li> <li>98. Bearing - roller **</li> <li>99. Bearing - ball **</li> <li>100. Retainer plate - output shaft bearing **</li> <li>101. Retainer plate bolts - Patchlok **</li> <li>102. Clutch release shaft bush - inner</li> <li>103. Clutch release shaft bush - outer</li> <li>104. Interlock assembly - later gearboxes</li> <li>105. Gear selector - 5th/reverse gears/with reverse brake*</li> <li>106. Spring - reverse brake*</li> <li>107. Lock plate - reverse brake*</li> <li>108. Taptite screws - reverse brake*</li> </ul> |
|---|---|--|

\* Gearboxes with reverse brake fitted

\*\* Fitted to gearboxes having the letter U in the gearbox serial number prefix

# MANUAL GEARBOX



## SECTIONED VIEW OF GEARBOX

- |   |                                      |
|---|--------------------------------------|
| 1. Oil guide plate                            | 9. Output shaft assembly             |
| 2. Input shaft assembly                       | 10. Shift arm assembly and interlock |
| 3. Gear case                                  | 11. Selective shim                   |
| 4. Reverse idler shaft bolt                   | 12. Final drive assembly             |
| 5. Reverse idler gear                         | 13. Speedometer drive pinion housing |
| 6. Breather pipe and bracket                  | 14. Selector shaft                   |
| 7. Differential housing                       | 15. Oil drain plug                   |
| 8. Access plug - output shaft bearing circlip | 16. Oil filler/level plug            |




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## DESCRIPTION

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The 5 speed constant mesh gearbox employs single helical gears for speed transmission and final drive. The input shaft carries the primary input gear, reverse pinion, 2nd gear and 3rd, 4th and 5th gear synchromesh hubs and idler gears. It is supported by two ballraces. End float is controlled by selective circlips and a Belleville washer. Its short input end eliminates the need for support in the engine crankshaft. The output shaft carries the final drive pinion, 1st idler gear, 1st and 2nd synchromesh hubs, 2nd speed idler gears and 3rd, 4th and 5th gears. The shaft is supported in the differential housing by a parallel roller bearing and depending on application, is supported in the gearcase by either a double ballrace or a single ballrace and roller bearing. Pinion location is controlled by a selective washer. The rear end of the shaft is secured by a circlip which retains the bearings in the gear case. Synchromesh is by spring rings and spline extensions in the inner faces of the synchromesh sleeves. Gear selection is via an interlock and gearshift holder assembly which transmits movement of the main selector shaft to the selector forks. Later specification gearboxes employ a reverse brake mechanism. Lubrication is by splash. An oil gutter located on the upper side of the gear case collects splashed oil and directs it to oil guide plates which distribute it to the hollow input and output shafts.

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## DESCRIPTION - TORSEN DIFFERENTIAL

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Gearboxes fitted to certain models incorporate a 'Torsen' limited slip differential. The word 'Torsen' is derived from torque sensing which describes the principle of operation.

Two types of differential are fitted, type A is fitted to gearboxes having serial number prefixes K4BX and K7BSUT. Type B is fitted to gearboxes having serial number prefixes C6FTUT; W4DTUT; C6DTUT and C6DTUTH.

### Type A

The assembly comprises a final drive gear bolted to the differential casing; two helical gears splined to the drive shafts and three pairs of element gear assemblies arranged at 120° intervals within the differential casing and running at right angles to the helical gears. Each of the element gear assemblies comprises a worm gear and two spur gears running on a journal pin. The worm gears are in constant

mesh with the helical gears and the spur gears mesh with those of the adjoining element gear assembly. Axial thrust of the helical gears is controlled by a combination of thrust washers and needle roller bearings located at each end of and between the two gears.

### Type B

The assembly comprises a final drive gear bolted to the differential casing two helical side gears splined to the drive shafts and four pairs of element gear assemblies arranged at ninety degree intervals within the differential casing and running parallel to the side gears. Each of the element gear assemblies comprises two helical gears of unequal length, the long gears are in constant mesh with the helical side gears splined to the drive shafts and also with the short gears of the adjoining element. Axial thrust of the helical side gears is controlled by thrust washers located between the end of each gear and the differential casing and by a thrust washer and friction washer located between the two gears.

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## OPERATION

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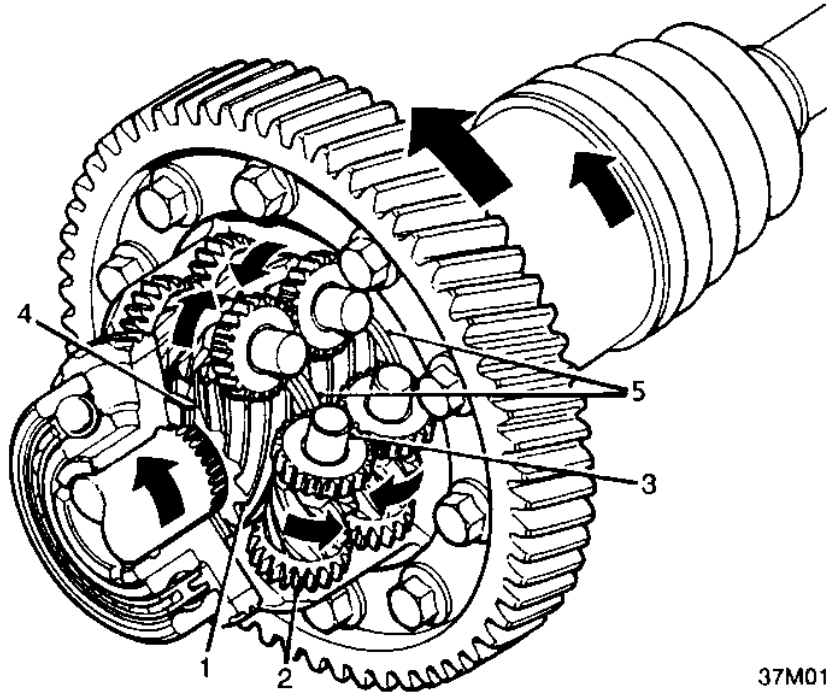
With the exception of reverse all gears are in constant mesh. Forward ratios are obtained by locking a gear to its shaft using its individual synchronizer hub and sleeve. Reverse gear is obtained by engaging reverse idler gear with the reverse gears changing the direction of rotation of the output shaft. When a forward gear is selected the synchronizer sleeve presses the synchromesh female cone into contact with a corresponding male cone in the gear chosen. This synchronizes the speeds of the synchronizer hub and gear. The synchronizer sleeve then engages the gear and by means of a spring ring, teeth extensions on the synchronizer sleeve and detents in the selector shaft holds the selected gear in engagement. Torque is transmitted from the input shaft through the selected gear to the output shaft pinion and final drive gear to the drive shafts.

# MANUAL GEARBOX

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## OPERATION - TORSEN DIFFERENTIAL

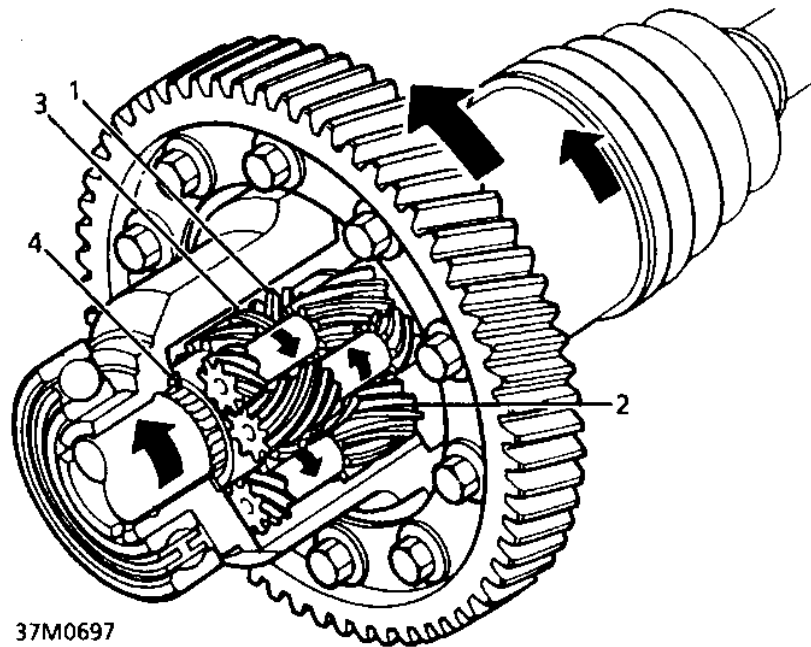
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37M0181

**Torsen differential - Type A - Serial number  
prefixes K4BX and K7BSUT**

1. Helical side gear
2. Element gear assembly - worm and spur gears
3. Journal pin
4. Thrust washer and spacing washer
5. Two thrust washers and needle roller bearing



37M0697

**Torsen differential - Type B - Serial number prefixes C6FTUT; W4DTUT; C6DTUT and C6DTUTH**

1. Helical side gear
2. Element gear assembly - helical gears
3. Friction washers
4. Thrust washers

Unlike a conventional limited slip differential, the torque sensing differential does not rely on the locking value of friction discs but by the friction produced by the teeth of the two helical side gears splined to the drive shafts meshing with the gears of the element gear assemblies. On Type A differentials, additional locking values are generated by the thrust washers and needle roller bearings located at each end of and between the side gears; whilst on Type B differentials, a combination of thrust washers and friction washers is used.

When both front wheel speeds are equal, then the frictional loads imposed by the element gears on the side gears are also equal. However, when the drive resistance on a road wheel is reduced through loss of traction then a torque imbalance is created; less torque being required to turn the wheel with the highest speed. This torque imbalance is sensed by the differential and results in a lowering of the friction imposed by the element gears on the side gear

driving that particular wheel. This causes a reduction in wheel speed until a point is reached where traction is restored, the torque required to turn both wheels is equal and both wheels are rotating at the same speed.

# MANUAL GEARBOX

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## DESCRIPTION - REVERSE BRAKE

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A reverse brake mechanism has been introduced to the PG-1 gearbox, and is operated by the selector fork mechanism, which stops the input shaft from rotating prior to the engagement of reverse gear and provides a quiet and smooth engagement of reverse gear, providing the vehicle is stationary.

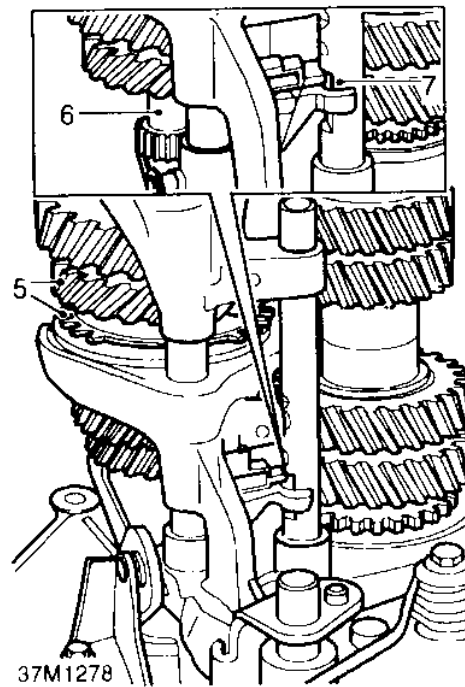
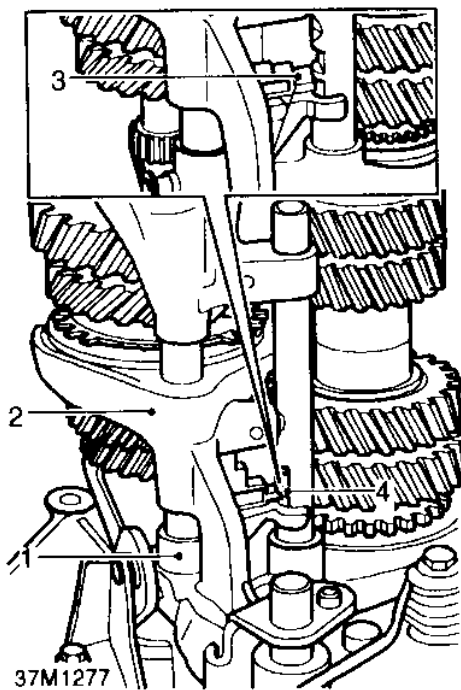
The reverse brake utilizes the 3rd/4th synchro hub for its operation. The 5th/reverse shift piece, which is secured to the selector shaft by a roll pin, and incorporates two guide lugs with two machined grooves that form a platform for a lock plate. The inner face of the lock plate is angled approximately at 45°, with two machined flanges either side of the lock plate which are positioned in machined grooves in the guide lugs. A return spring, which biases the lock plate against the stop surface, extends along the step at the front of the lock plate, with the two free ends of the spring held in position by two 'Taptite' screws either side of the shift piece. A lug on the 3rd/4th selector fork has a machined face at an angle of 45° which acts as a ramp when in contact with the angled face of the lock plate. 1st/2nd selector shaft has a machined abutment surface located below the detent grooves, the abutment surface being the area of contact for the lock plate.



**OPERATION - REVERSE BRAKE**

When selecting reverse gear, the 5th/reverse shift piece (1) moves upwards, and the angled face of the lock plate (3) contacts the ramp of 3rd/4th selector fork (2). The upward movement carries the lock plate (3) outwards until it contacts the abutment (4) on 1st/2nd selector shaft. From this point, continued upward movement of the 5th /reverse shift piece (1) causes the lock plate (3) to move the 3rd/4th selector and synchro sleeve (5) towards 4th gear. The movement of the 3rd/4th synchro sleeve (5) is sufficient to restrain the input shaft (6), thus permitting smooth engagement of reverse gear.

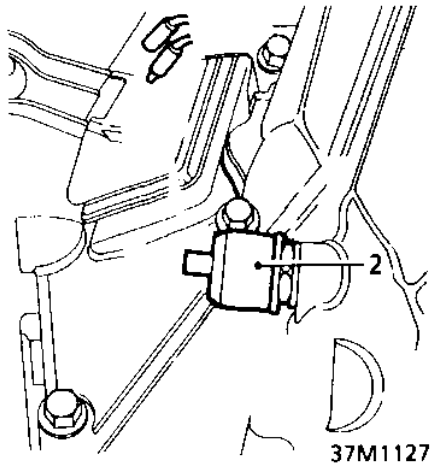
To prevent any further movement of the 3rd/4th synchro sleeve (5) and engagement of 4th gear, the spring on the lock plate (3) moves the lock plate into the machined groove (7) above the abutment (4).



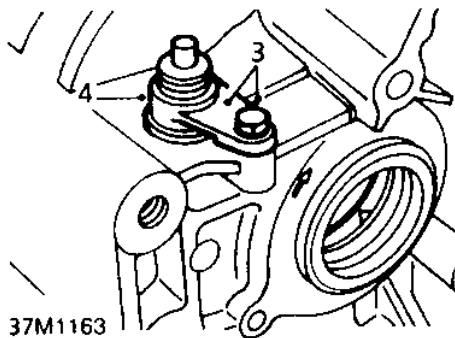


**GEARBOX DISMANTLING**

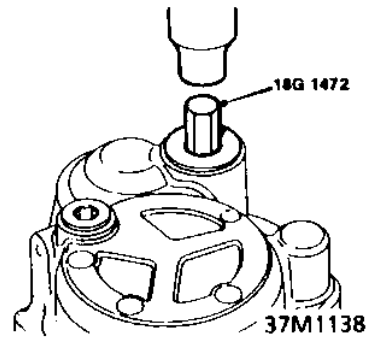
1. Thoroughly clean exterior of gearbox.



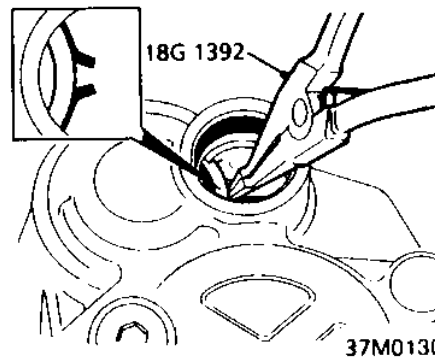
2. Remove reverse light switch; discard sealing washer.



3. Remove bolt and locating plate securing speedometer drive pinion and housing.
4. Remove speedometer drive pinion and housing, discard 'O' ring.



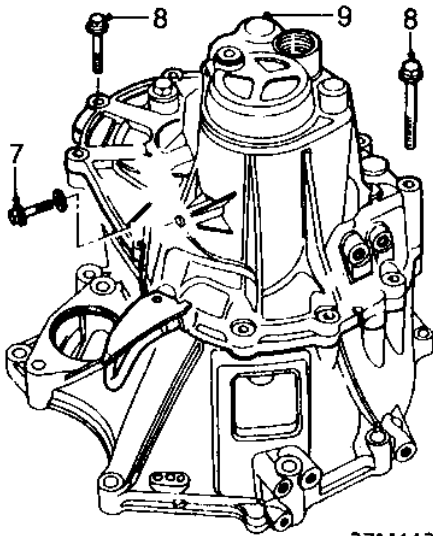
5. Remove access plug using tool 18G 1472.



6. Using tool 18G 1392, release circlip retaining output shaft bearing.

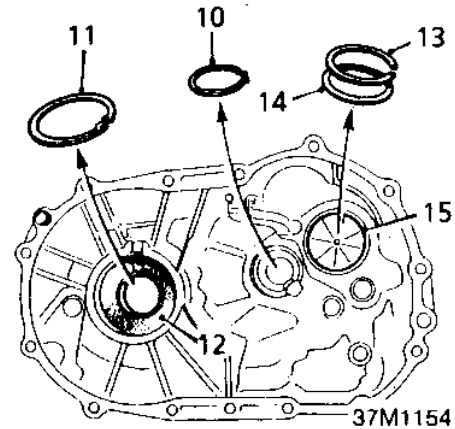


## MANUAL GEARBOX



37M1128

7. Remove bolt retaining reverse idler shaft, discard washer.
8. Noting their fitted position, remove 14 bolts securing gear case to differential housing; release breather pipe bracket.
9. Using a soft-faced mallet, release gear case from differential housing; remove gear case.



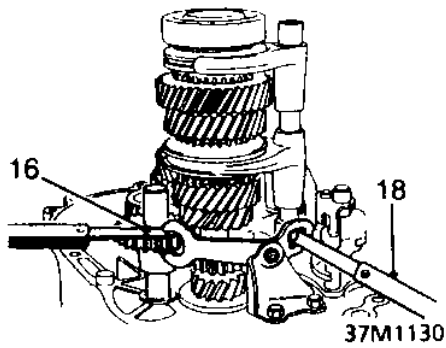
37M1154

10. Remove and discard output shaft bearing circlip from gear case.
11. Remove selective circlip from differential bearing recess in gear case; retain circlip.
12. Remove differential oil seal.




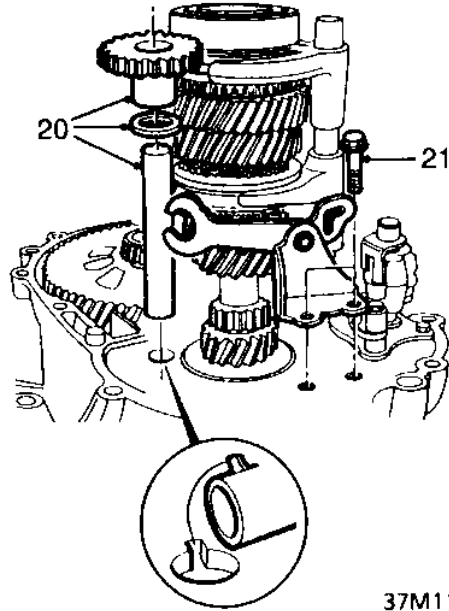
**CAUTION:** Two types of oil seal have been fitted, retain oil seal for reference to ensure that replacement is of correct type.

13. Remove selective circlip(s).
14. Remove and discard Belleville washer.
15. Remove input shaft oil guide plate.



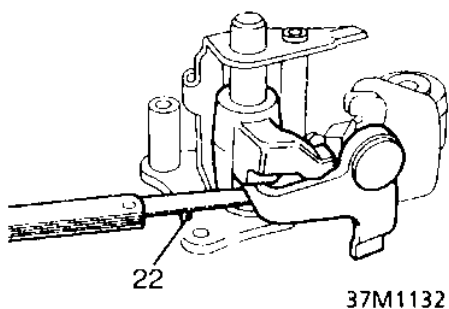
- 16. Using feeler gauges, measure clearance between reverse idler gear and selector fork.  
Clearance = 0.5 to 1.1 mm
- 17. If clearance obtained exceeds above figure, measure width across prongs of selector fork.  
Prong width = 13.0 to 13.3 mm.
- 18. Using feeler gauges, measure clearance between pin and selector fork groove.  
Standard = 0.05 to 0.35 mm  
Service limit = 0.5 mm
- 19. If clearance obtained exceeds service limit, measure width of selector fork groove.  
Groove width = 7.05 to 7.25 mm

 **CAUTION:** If dimensions obtained exceed figures given, selector fork must be replaced.



- 20. Remove reverse idler gear, thrust washer and idler shaft.
- 21. Remove 2 bolts securing reverse selector fork bracket; remove bracket and fork.

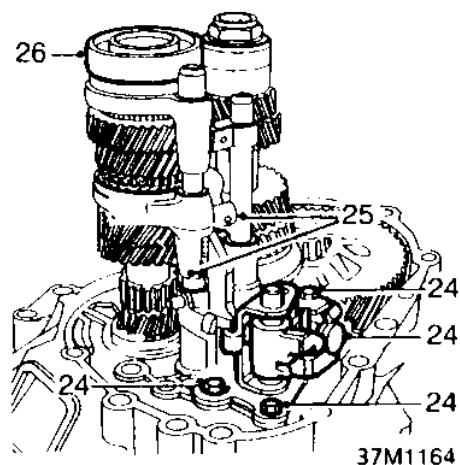
## MANUAL GEARBOX



22. Using feeler gauges, measure clearance between gearshift arm and guide.  
Standard = 0.2 to 0.3 mm  
Service limit = 0.55 mm
23. If clearance obtained exceeds service limit, measure width of groove in guide.  
Groove width = 8.1 to 8.2 mm

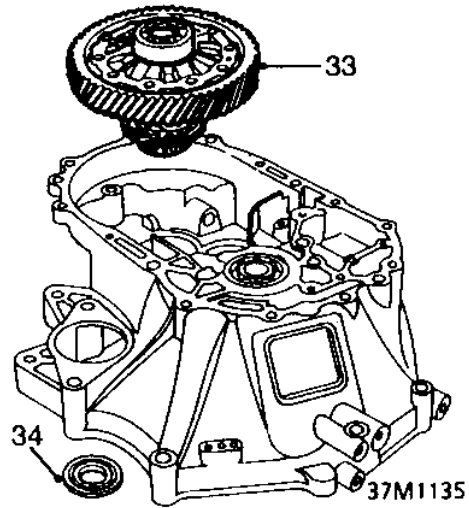
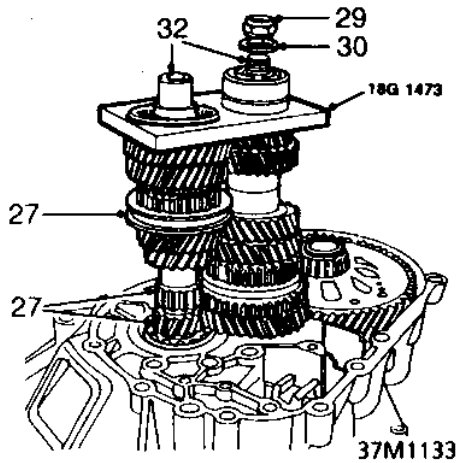


**CAUTION:** If dimensions obtained exceed figures given, interlock assembly must be replaced.



**NOTE:** Latest type interlock assembly illustrated

24. Noting their fitted position, remove 3 bolts and retaining interlock assembly; remove assembly.
25. Raise both input and output shafts slightly, remove selector forks and rails.
26. Using 2 suitable levers, remove input shaft bearing.



27. Move synchro sleeve to engage 1st and 4th gears.



**CAUTION:** Damage to components will result if gears other than 1st and 4th are engaged.

- 28. Position tool 18G 1473 on input shaft and around output shaft bearing.
- 29. Release staking, remove and discard nut from output shaft.



NOTE: Nut has a LH thread.

- 30. Remove and discard tongued washer.
- 31. Remove tool 18G 1473.
- 32. Remove input and output shafts from differential housing.

33. Lift differential assembly out of housing.



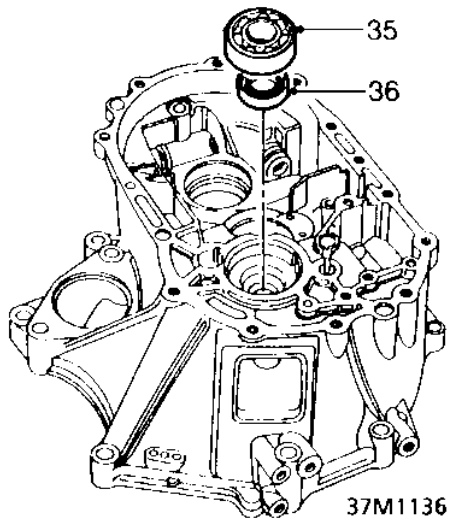
NOTE: Standard differential illustrated.

34. Remove differential oil seal.

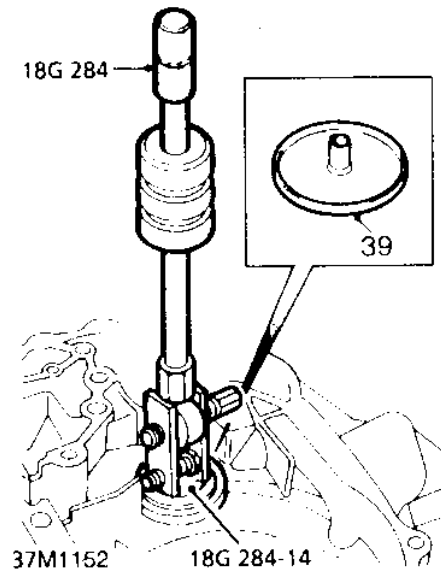


**CAUTION:** Two types of oil seal have been fitted, retain oil seal for reference to ensure that replacement is of the correct type.

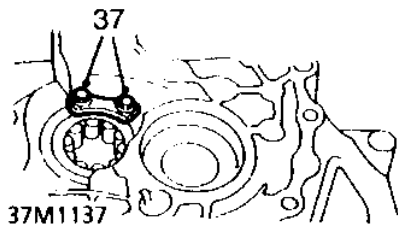
## MANUAL GEARBOX



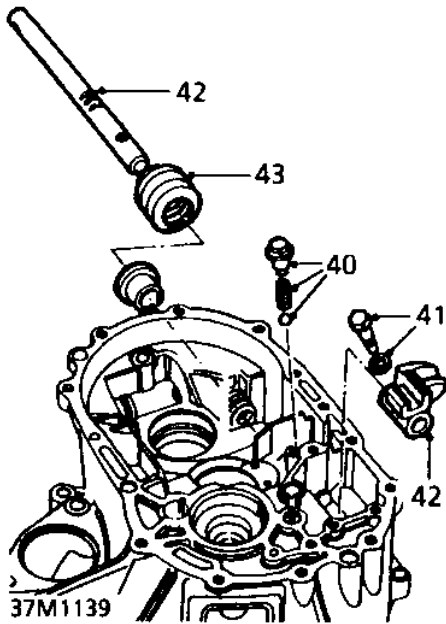
35. Using a soft metal drift, remove input shaft bearing from differential housing; discard bearing
36. Remove and discard input shaft oil seal.



38. Remove output shaft bearing using tools **18G 284** and **18G 284-14**, discard bearing.
39. Remove output shaft oil guide plate.



37. Remove and discard 2 Patchlok bolts securing output shaft bearing retaining plate - if fitted; remove plate.

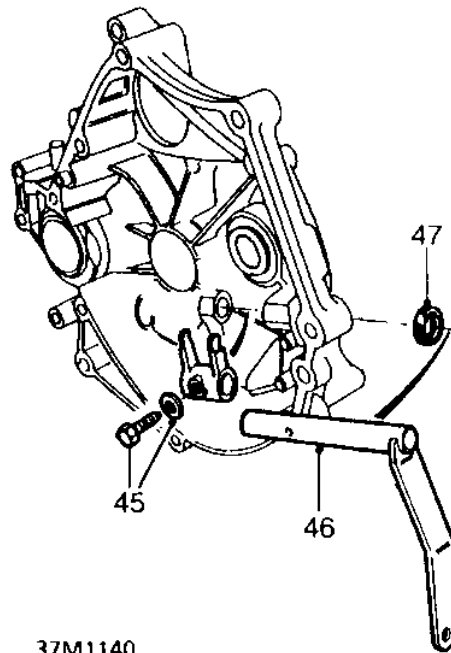


- 40. Remove detent cap bolt and washer, recover detent spring and ball.



NOTE: Use a stick magnet to recover ball.

- 41. Remove bolt and washer securing selector shaft guide to shaft.
- 42. Withdraw selector shaft; remove selector shaft guide.
- 43. Remove gaiter from shaft.
- 44. Remove and discard oil seal.



- 45. Remove bolt and washer securing clutch release fork to release shaft.
- 46. Withdraw release shaft.
- 47. Remove and discard release shaft oil seal.

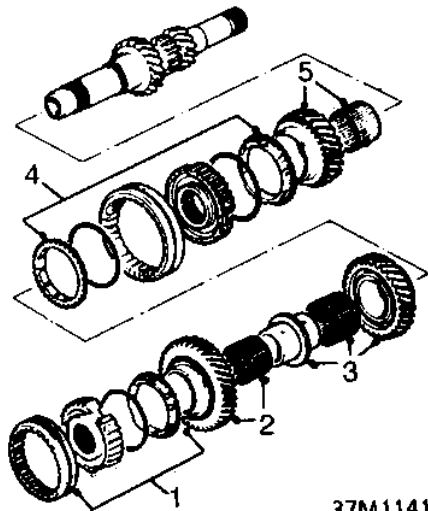
# MANUAL GEARBOX

## COMPONENT DISMANTLING

### Input Shaft

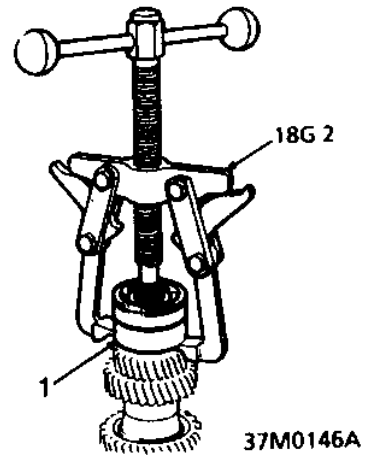


CAUTION: Keep component parts of each synchro assembly together.



1. Remove 5th gear synchro assembly.
2. Remove 5th gear and needle bearing.
3. Remove 4th gear together with collar and needle bearing.
4. Remove 3rd/4th synchro assembly.
5. Remove 3rd gear and needle bearing.

### Output Shaft

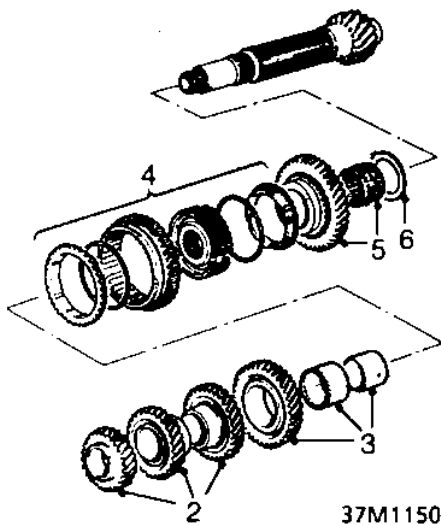


1. Remove bearings using tool 18G 2, note type of bearing fitted; discard bearings.



NOTE: Depending on the application, either a double ballrace or single ballrace and roller bearing is fitted.

Gearboxes having the letter U in the serial number prefix are all fitted with a single ballrace and roller bearing.



37M1150

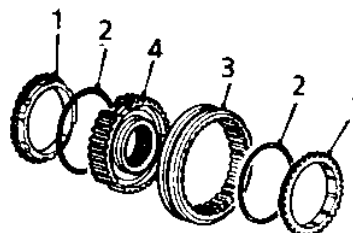
2. Remove 5th, 4th and 3rd gears.
3. Remove 2nd gear, needle bearing and collar.
4. Remove 1st/2nd synchro assembly.



**CAUTION:** Keep component parts of synchro assembly together.

5. Remove 1st gear and needle bearing.
6. Remove and retain selective thrust washer.

**Synchro assemblies**



37M0148

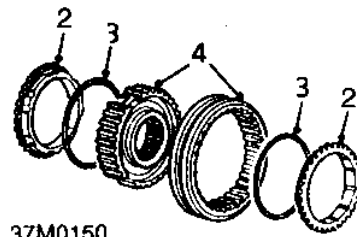
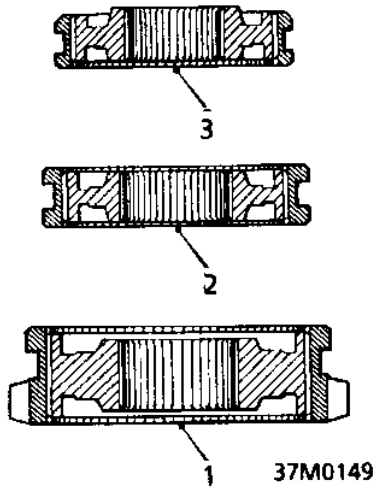
**Synchro Assembly Components**

1. Synchro ring
2. Spring ring
3. Synchro sleeve
4. Synchro hub



**NOTE:** Only one synchro ring and spring ring are fitted to 5th speed synchro.





37M0150

2. Remove 2 synchro rings.
3. Remove 2 spring rings.



NOTE: Only one synchro ring and spring ring are fitted to 5th synchro.

4. Remove synchro hub from sleeve.

## Synchro Assembly Identification

1. 1st/2nd synchro
2. 3rd/4th synchro
3. 5th synchro

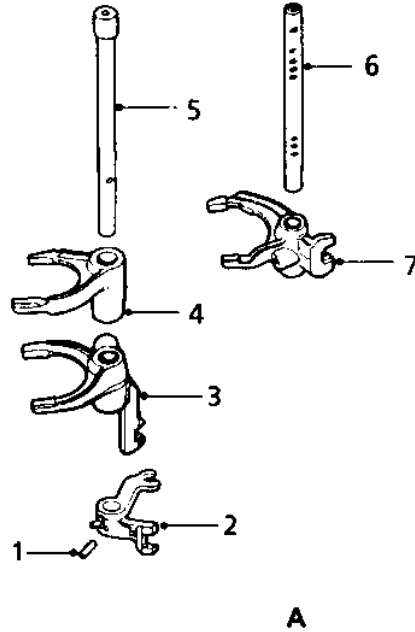
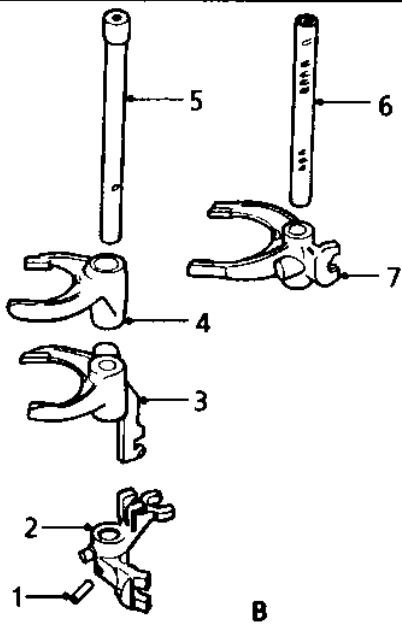


CAUTION: Keep component parts of each synchro assembly together.

1. Suitably mark relative position of each synchro hub to its respective sleeve.



Selector shafts



37M1147

Selector Shaft Components

1. Roll pin
2. 5th/reverse gear selector
3. 3rd/4th gear selector fork
4. 5th gear selector fork
5. 5th/reverse selector shaft
6. 1st/2nd gear selector fork
7. 1st/2nd selector shaft

4. Slide 5th/reverse gear selector off 5th/reverse selector shaft.
5. Slide 3rd/4th and 5th selector forks off 5th/reverse selector shaft.



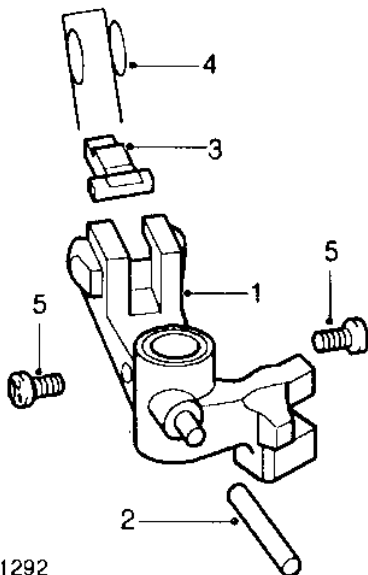
**CAUTION:** Two types of selector shaft assemblies have been fitted. Type A selectors are manufactured from cast steel whilst type B are manufactured from aluminium bronze and are gold in colour. Do not interchange selector forks or shafts between type A and B assemblies.

1. Identify each selector fork and its fitted position to the relevant selector shaft. Slide 1st/2nd gear selector fork off 1st/2nd selector shaft.
2. Slide 1st/2nd selector shaft out of 5th gear selector fork and 5th/reverse gear selector.
3. Using a suitable punch, remove roll pin securing 5th/reverse gear selector; discard roll pin.

# MANUAL GEARBOX

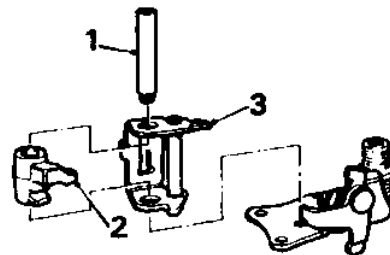
## 5th/Reverse Selector - with reverse brake

The 5th/reverse selector (1) is secured to the selector shaft by a roll pin (2). The selector incorporates the components for the reverse brake operation. This comprises of a lock plate (3) a retaining spring (4). The spring retains the lock plate in position, with The two ends of the spring located under two 'Taptite' screws (5) which are positioned either side of the 5th/reverse selector.



37M1292

## Interlock Assembly

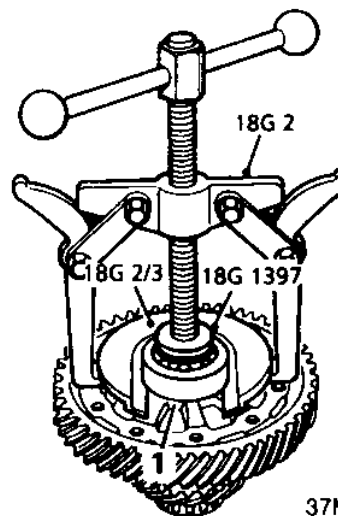


37M1165

NOTE: A modified interlock assembly having 2 springs has been introduced; this assembly may be fitted as a replacement to early gearboxes.

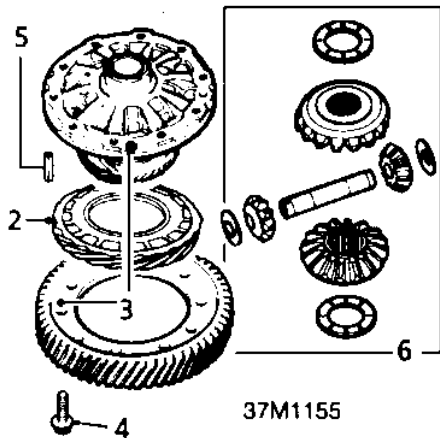
1. Withdraw shift shaft from gearshift holder and arm guide.
2. Release lug on arm guide from slot in interlock.
3. Slide gearshift holder off arm guide.

## Differential Assembly



37M1151

1. Remove bearings using tools 18G 2, 18G 2/3 and 18G 1397; discard bearings.



2. Remove speedometer drive gear from carrier.
3. Suitably mark fitted position of final drive gear to carrier.
4. Progressively slacken, then remove 10 bolts securing final drive gear to carrier; remove gear.



**CAUTION:** With the exception of the speedometer drive gear, Torsen differentials are supplied as a complete assembly; do not dismantle.

5. Using a suitable punch, remove roll pin securing pinion shaft; discard pin.
6. Remove pinion shaft, sun gears, planet gears and thrust washers; retain thrust washers - if fitted.



**NOTE:** Selective thrust washers are fitted to planet gears, non-selective washers are fitted to sun gears.

## INSPECTING COMPONENTS

1. Clean all components ensuring all traces of RTV sealant are removed from gear case, differential housing and access plug. Ensure oil drillings in input and output shafts and oil guide plates are clear. Ensure gearbox breather is unobstructed.



**CAUTION:** Do not clean plastic components with chlorinated solvent e.g. trichloroethane.

2. Check speedometer pinion for wear and pinion housing threads for damage.

## Input and Output Shaft Assemblies

1. Check gears for worn or chipped teeth, cracks or uneven wear.
2. Check coning surfaces of gears for wear.



**CAUTION:** Gearboxes having the letter K in the Serial Number prefix: Commencing at gearbox Serial Numbers K4BS 2027303, K6BS 2018506 and K7BSUT 2002029, the helix angle of 2nd gear on both input and output shafts was changed to 33 and it is essential that if a replacement input shaft or output shaft 2nd gear is to be fitted, the correct replacement is obtained. The 33 helix gears may be fitted to gearboxes built prior to the above Serial Numbers provided that the input shaft and output shaft 2nd gear are replaced together.


3. Check needle bearings for wear and overheating (blueing).



**CAUTION:** Where any of the above are evident, all bearings on the shaft must be replaced.

## MANUAL GEARBOX

4. Check shaft splines for wear and threads of output shaft for damage.
5. Check bearing collars for wear and damage.

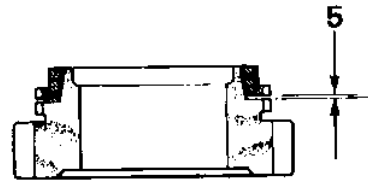
 NOTE: Gearboxes having the letter U in the gearbox serial number prefix are fitted with a modified output shaft assembly having an increased diameter and shot peened gears. Due to the increased diameter of the output shaft, differential housing bearing and the method of retaining the bearing, this assembly must not be fitted to any other type of gearbox.

### Reverse Idler Shaft and Gear

1. Check idler shaft for wear.
2. Check gear for wear, chipping or cracking of teeth.
3. Check needle bearings for wear, replace gear and bearings as an assembly if wear is evident.

### Synchro Assemblies

1. Check component parts of each synchro assembly for wear or damage, ensure teeth on hubs and sleeves are not chipped or rounded off.
2. Ensure teeth on synchro rings are not chipped or damaged, check inner surfaces of rings for wear.
3. Ensure each hub moves freely in its respective sleeve.
4. Place a synchro ring on its respective gear cone and rotate it until it stops (approximately 10 to 20°).



37M0155

5. Measure clearance between synchro ring and gear.  
Ring to gear clearance:  
Standard = 0.85 to 1.1 mm  
Service limit = 0.4 mm (minimum clearance)
6. Repeat for remaining rings and gears.



**CAUTION:** If any ring to gear clearance is less than above service limit, synchro assembly must be replaced.



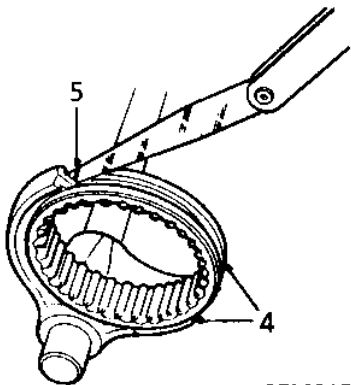
## Selector Shafts and Forks

**CAUTION:** Type B selector shaft assembly: The selector forks fitted to the 5th/reverse selector shaft are matched to the shaft and in the event of any wear or damage, shaft and forks must be replaced as an assembly.

Do not interchange selector forks or shafts between type A and B assemblies.

1. Check shafts for wear and alignment.
2. Check selector forks for wear, cracks or damage.
3. Check the retained detent balls and springs, there must be no visible 'flats' on the balls and springs must keep balls in contact with the staked portion of the selector fork.

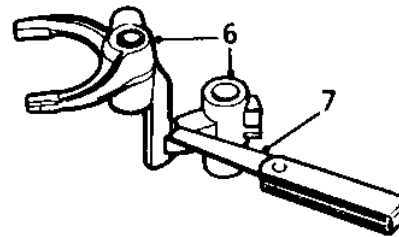
**CAUTION:** It is not possible to replace balls or springs, selector fork must be replaced.



37M0156

4. Assemble each selector fork to its respective synchro sleeve.
5. Check clearance of selector fork in synchro sleeve groove.  
Selector fork to groove clearance:  
Standard = 0.45 to 0.65 mm  
Service limit = 1.0 mm

**CAUTION:** If clearance is found to exceed service limit, selector fork must be replaced.



37M1156

6. Assemble gearshift arm guide to 3rd/4th selector fork.
7. Using feeler gauges, measure clearance between gearshift arm guide and fork.  
Standard = 0.2 to 0.5 mm  
Service limit = 0.8 mm
8. If clearance obtained exceeds service limit, measure width of tongue on gearshift arm guide.  
Standard = 11.9 to 12.0 mm

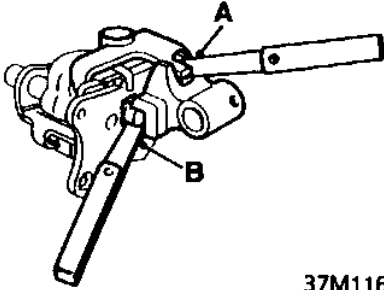
**CAUTION:** If width of tongue is within limits, 3rd/4th selector fork must be replaced, if width of tongue is less than quoted, gearshift arm guide must be replaced.

9. Repeat above procedures for 1st/2nd selector fork.


# MANUAL GEARBOX

## Interlock Assembly


1. Check components for wear or damage, replace assembly if necessary.



37M1166


 **NOTE:** Modified interlock assembly illustrated. This assembly may be fitted as a replacement to early gearboxes but modified interlock assemblies fitted to gearboxes having Serial Number prefixes C4BP and C6BP have uprated springs and must not be interchanged with modified interlock assemblies fitted to other gearboxes.

2. Assemble gearshift arm guide to interlock assembly.
3. Using feeler gauges, measure clearance A.  
Clearance A:  
Standard = 0.02 to 0.3 mm  
Service limit = 0.55 mm
4. If clearance exceeds service limit, check width of groove in gearshift arm guide.  
Groove width = 13.05 to 13.25 mm

 **CAUTION:** If width of groove exceeds above dimension, gearshift arm guide must be replaced. If width of groove is within service limit, replace interlock assembly.

5. Using feeler gauges, measure clearance B between interlock ball and gearshift arm guide.  
Clearance B:  
Standard = 0.05 to 0.25 mm  
Service limit = 0.5 mm

6. If clearance exceeds service limit, measure outside diameter of interlock ball.  
Interlock ball outside diameter = 12.05 to 12.15 mm

 **CAUTION:** If diameter of ball is within limits, replace gearshift arm guide, if diameter of ball is less than 12.05 mm, replace interlock assembly.



## Differential Assembly

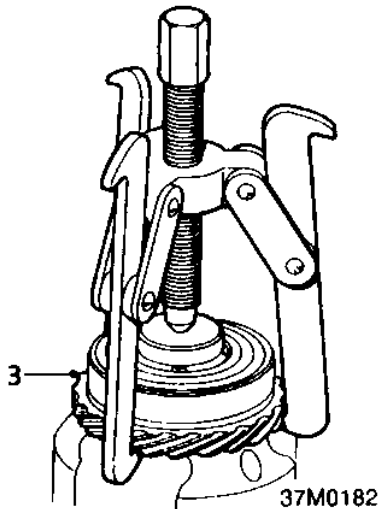
1. Check gear teeth for wear, chipping and signs of overheating.



**CAUTION:** It is not possible to overhaul Torsen differentials. Replace complete assembly if any of the above are apparent.

### Torsen differential

2. Check speedometer drive gear for damage, replace if necessary.



3. Remove speedometer drive gear using a suitable three legged puller and thrust button.

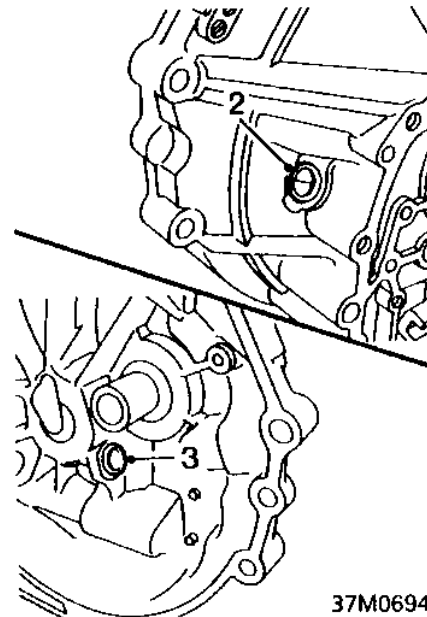
### Standard differential

4. Check pinion shaft for wear.
5. Check speedometer drive gear teeth for wear or damage, replace as necessary.

## Differential Housing

1. Check housing for damage, check that locating dowels are fitted; check clutch release shaft bushes for damage or wear and that shaft is free to turn, replace if necessary using the following procedure.

### Remove



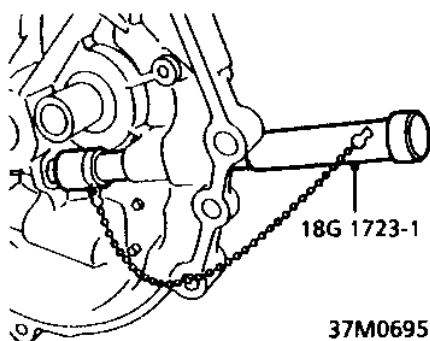
2. *Outer bush:* Using a hacksaw blade, carefully cut a longitudinal slot opposite the split in the bush; prise bush out of differential housing.
3. *Inner bush:* Carefully prise inner bush out of differential housing.



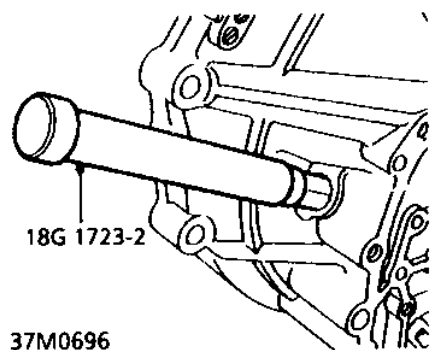
# MANUAL GEARBOX

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## Refit




4. *Inner bush:* Using tool 18G 1723-1, drift inner bush into differential housing.



5. *Outer bush:* Using tool 18G 1723-2, drift outer bush into differential housing.

 **CAUTION:** Ensure end of tool 18G 1723-2 is located in inner bush.

6. *Gearboxes fitted with output shaft bearing retainer plate:* Remove all traces of Patchlok compound from output shaft bearing retainer plate bolt holes using an M6 tap.


 **CAUTION:** Ensure bolt holes are thoroughly cleaned.



**COMPONENT ASSEMBLING**

**Differential**

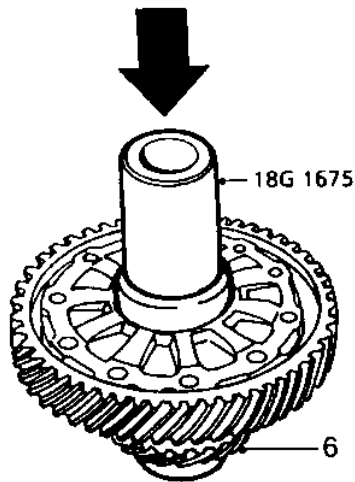
1. Assemble planet gears and original thrust washers.
2. Fit sun gears and original thrust washers - if fitted.
3. Rotate gears and thrust washers to align drillings in carrier.

 **CAUTION:** Do not fit roll pin or final drive gear at this stage.


*Torsen differential*

4. Position speedometer drive gear on carrier.
5. Using a suitable length of tubing, drift gear fully on to carrier.

*Standard differential*




6. Position speedometer drive gear on carrier.
7. Fit new ball bearings to carrier using tool **18G 1675**.


 **NOTE:** Larger of the two bearings is fitted on speedometer drive gear side.

**Synchro Assemblies**

1. Assemble each synchro sleeve to its respective hub ensuring that raised teeth on the sleeve are aligned with the deeper grooves in hub.
2. Fit spring rings to retain hub.

 **NOTE:** Only one spring ring is fitted on 5th speed synchro.

3. Assemble synchro rings to their respective sleeves.

 **CAUTION:** When assembling the 5th gear synchro sleeve to hub, it is possible to position the raised teeth on the synchro sleeve in the machined cut-aways for the synchro ring. Although the gearbox can be assembled, it will not be possible to select 5th gear.

# MANUAL GEARBOX

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## Selector Shafts

---

1. Slide 5th and 3rd/4th selector forks on to 5th/reverse selector shaft.



**CAUTION:** Ensure that longest portion of selector fork lugs face away from shoulder of shaft.

2. Slide 5th/reverse selector on to 5th/reverse selector shaft; secure selector with a new roll pin.



**NOTE:** Make sure the lock plate and retaining spring are correctly located on 5th/reverse selector fitted with reverse brake.

3. Slide 1st/2nd gear selector fork on to 1st/2nd selector shaft.
4. Locate 1st/2nd selector shaft in 5th/reverse gear selector and 5th gear selector fork.
5. Locate lug on shift arm guide in gearshift holder.
6. Position gearshift holder to interlock; fit shaft.

## Reverse Idler Gear and Shaft

---

1. Fit a new thrust washer.
2. Smear needle bearing rollers with petroleum jelly and fit in idler gear.
3. Fit reverse idler gear to shaft.



**NOTE:** Boss on gear must face towards thrust washer.

## Input Shaft

---



**NOTE:** Smear needle bearing rollers with petroleum jelly prior to assembly.

1. Fit needle bearing rollers in third gear.
2. Fit 3rd gear on shaft.
3. Fit 3rd/4th synchro assembly.
4. Fit needle bearing rollers in 4th gear, position gear on collar and fit assembly on shaft.
5. Fit needle bearing rollers in 5th gear, position gear on collar.



**NOTE:** Boss on 5th gear must face away from 4th gear.

6. Fit 5th synchro assembly.



**NOTE:** Machined groove in synchro hub must face towards 5th gear and large chamfer on synchro sleeve must face away from 5th gear.

7. Fit a new input shaft bearing.

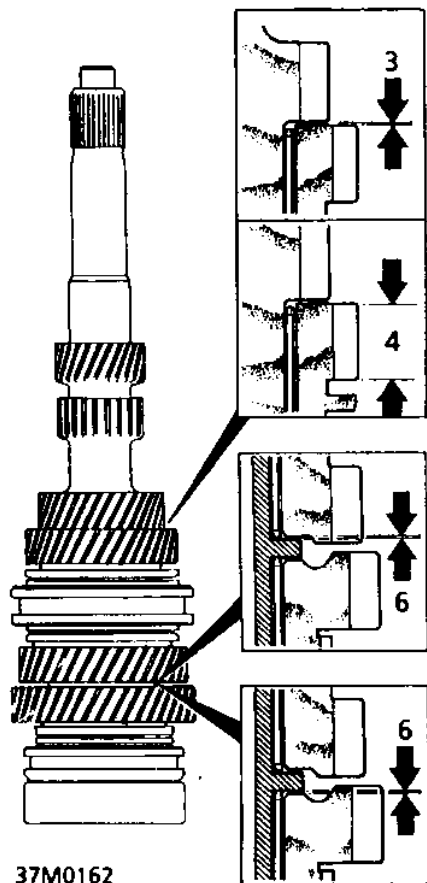


**Input Shaft Gear End-float - Check**

1. Position input shaft on bed of a hand press with bearing located on a suitable socket.
2. Apply downward pressure to input shaft.



NOTE: Maintain pressure whilst checks are carried out.

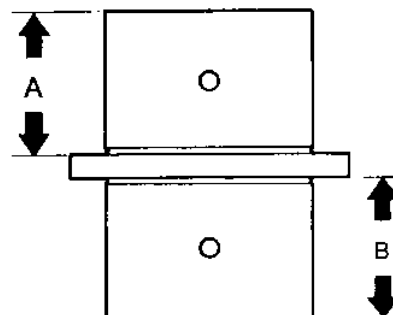


37M0162

3. Using feeler gauges, measure clearance between 2nd and 3rd gears.  
3rd gear clearance:  
Standard = 0.06 to 0.21 mm  
Service limit = 0.3 mm

4. If clearance exceeds service limit, measure thickness of 3rd gear.  
3rd gear thickness:  
Standard = 35.42 to 35.47 mm  
Service limit = 35.30 mm

5. If 3rd gear thickness is greater than service limit, replace 3rd gear synchro assembly; if thickness is less than service limit, replace 3rd gear.
6. Using feeler gauges, measure clearance between the spacer collar and 4th gear and spacer collar and 5th gear.  
4th and 5th gear clearance:  
Standard = 0.06 to 0.21 mm  
Service limit = 0.3 mm



37M0163

7. If clearance of either gear exceeds service limit measure length of appropriate side of spacer collar **A** or **B**.  
Length A = 4th gear side  
Length B = 5th gear side  
Spacer collar length **A** or **B**:  
Standard = 26.03 to 26.08 mm  
Service limit = 26.01 mm
8. If length **A** exceeds service limit, measure thickness of 4th gear.  
4th gear thickness:  
Standard = 30.92 to 30.97 mm  
Service limit = 30.80 mm


## MANUAL GEARBOX

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9. If thickness of 4th gear exceeds service limit, replace 3rd/4th synchro assembly; if thickness of gear is less than service limit, replace gear.
10. If length **B** exceeds service limit, measure thickness of 5th gear.  
5th gear thickness:  
Standard = 30.42 to 30.47 mm  
Service limit = 30.30 mm
11. If thickness of 5th gear exceeds service limit, replace 5th synchro assembly; if thickness of gear is less than service limit, replace gear.

### Output Shaft


---

 NOTE: Smear needle bearing rollers with petroleum jelly prior to assembly.


1. Measure and record thickness of original thrust washer.
2. Fit original thrust washer on shaft.
3. Fit needle bearing rollers in 1st gear.
4. Fit 1st gear on shaft.
5. Fit 1st/2nd synchro assembly.

 CAUTION: Ensure reverse gear on synchro sleeve is adjacent to 1st gear.

6. Measure and record length of 2nd gear collar.
7. Fit 2nd gear collar on shaft ensuring lubrication groove is towards 1st/2nd synchro assembly.
8. Fit needle bearing rollers in 2nd gear.
9. Fit 2nd gear on shaft.
10. Fit 3rd and 4th gears ensuring that bosses on gears are adjacent to each other.
11. Fit 5th gear ensuring that large boss on gear is towards threaded portion of shaft.
12. Fit new output shaft bearings ensuring that snap ring groove in ball race is towards threaded portion of shaft.

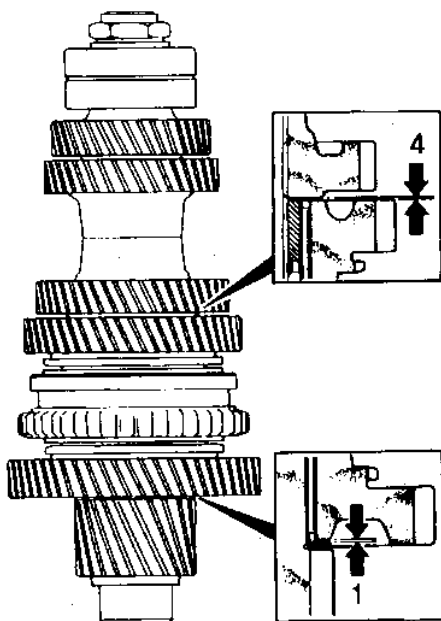
 CAUTION: Ensure that replacement bearings are the same as originally fitted. Where a roller bearing and single ballrace is to be fitted, the single ballrace must be adjacent to threaded portion of shaft.

13. Fit a new tongued washer with dished side of washer towards bearing.
14. Secure final drive pinion of shaft in a soft-jawed vice.
15. Fit a new nut and tighten to 110 Nm.

 NOTE: Nut has a LH thread; do not stake nut at this stage.



Output Shaft Gear End-float - Check



37M0164

6. Compare length of original collar and select a collar which will provide specified clearance. Collars are available in the following lengths: 28.99 mm and 29.04 mm
7. Having determined thickness of selective thrust washer and length of 2nd gear collar required, fit thrust washer and collar.
8. Secure output shaft nut by staking.

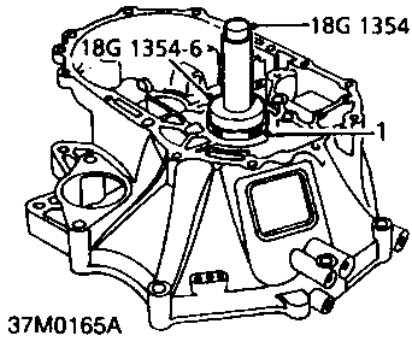
1. Using feeler gauges measure clearance between 1st gear and thrust washer.  
Standard = 0.03 to 0.08 mm  
Service limit = 0.18 mm
2. From clearance obtained, calculate thickness of thrust washer required to give correct clearance. If clearance obtained exceeds service limit, fit a thicker thrust washer; if it is less than 0.03 mm, fit a thinner thrust washer.

NOTE: Thrust washers are available as follows:  
 1.96 to 2.08 mm thick in increments of 0.03 mm.

3. Select a thrust washer of the required thickness to bring end-float within limits.
4. Using feeler gauges measure clearance between 2nd and 3rd gears.  
2nd/3rd gear clearance = 0.03 to 0.10 mm
5. If clearance exceeds figure given, it will be necessary to fit a shorter 2nd gear collar; if clearance is less than figure given, it will be necessary to fit a longer collar.

# MANUAL GEARBOX

## Input Shaft End Thrust - Check and Adjust



1. Fit a new input shaft bearing in differential housing using tools 18G 1354 and 18G 1354-6.



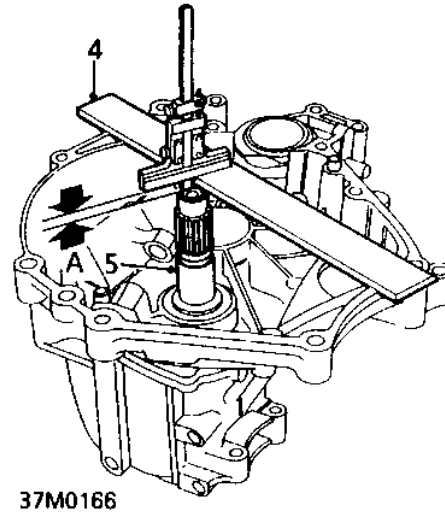
**CAUTION:** Do not fit oil seal at this stage.

2. Position input shaft assembly in differential housing ensuring it is fully inserted in bearing.



**NOTE:** Position housing so that end of shaft is clear of bench.

3. Fit gear case, fit and tighten bolts to 45 Nm.



4. Position a straight edge and depth gauge across face of differential housing.
5. Pull input shaft into differential housing and position end of depth gauge on end of shaft; record measurement shown on gauge.
6. Push input shaft towards gearcase, record measurement shown on gauge.
7. Subtract thickness of straight edge from above readings.
8. Subtract first measurement from second measurement; record figure obtained. Call resultant measurement **A**.
9. Calculate thickness of circlip(s) required by subtracting 0.97 mm from dimension **A**.  
Input shaft end thrust = 0.14 to 0.21 mm



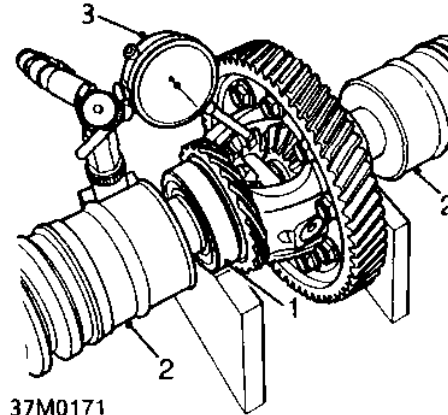
10. Select circlip(s) from sizes available which equal thickness required. Fourteen circlips are available ranging from 0.5 mm to 1.15 mm thick in increments of 0.05 mm.



**CAUTION:** No more than two circlips may be fitted. It is not always possible to select the exact thickness of circlips required; where this occurs, always fit a slightly thinner pack to avoid pre-loading bearings.

11. Remove bolts securing gear case; remove gear case.
12. Remove input shaft assembly.
13. Remove input shaft bearing from differential housing using a soft metal drift.

## Differential Pinion Gear Backlash - Check and Adjust



1. Position differential assembly with bearings located in V blocks.
2. Fit both inboard drive shaft joints to align gears.
3. Assemble a DTI gauge with stylus of gauge contacting one of the planet gears; zero the gauge.
4. Measure and record planet gear backlash.
5. Repeat procedure for other planet gear.
6. Compare backlash figures obtained with the following:  
Planet gear backlash = 0.05 to 0.15 mm
7. If backlash is not as specified, remove planet gears, measure thickness of original thrust washers and from figures obtained, calculate thickness of thrust washers required to give correct backlash.



**CAUTION:** Thrust washers selected must be of equal thickness, and are available from 0.70 to 0.90 mm thick in increments of 0.20 mm.

8. Fit selected thrust washers, secure pinion shaft with a new pin.



# MANUAL GEARBOX

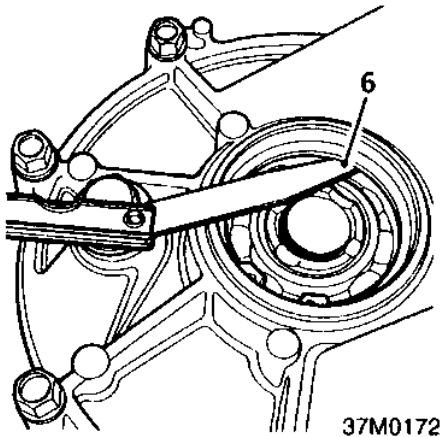
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## **Standard and Torsen differentials:**

9. Fit final drive gear to carrier ensuring reference marks are aligned.
10. Fit 10 bolts and tighten progressively to 110 Nm.

## **Differential Bearing Pre-load - Check and Adjust**

1. Position original selective circlip in gear case.
2. Position differential assembly in differential housing.
3. Fit gear case, fit and tighten bolts to 45 Nm.
4. Lightly drive differential assembly into gear case to seat circlip.
5. Lightly drive differential into differential housing to settle bearing.



6. Using feeler gauges measure and record clearance between circlip and bearing outer face.  
Correct clearance = 0.15 mm maximum

7. If clearance is not as specified, select the appropriate circlip from the range available.



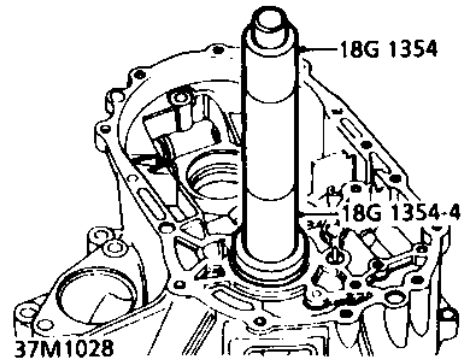
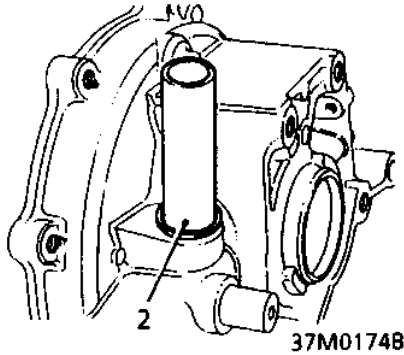
NOTE: Circlips are available from 2.50 to 3.00 mm thick in increments of 0.10 mm.

8. Remove original circlip through oil seal aperture using tool **18G 1392**.
9. Fit selected circlip using tool **18G 1392**.
10. Re-check bearing pre-load using above procedure.
11. Remove differential assembly, retain selected circlip.



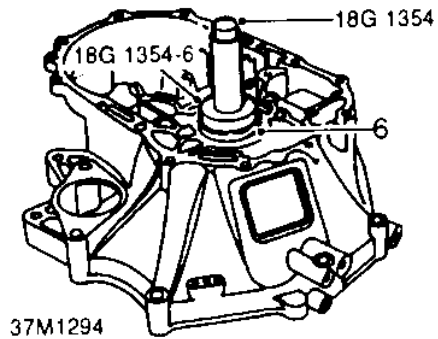
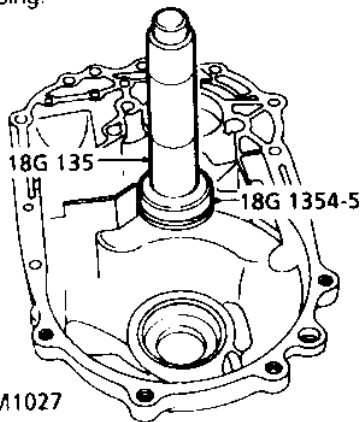
**GEARBOX ASSEMBLING**

1. Lightly lubricate all components with gearbox oil.



5. Fit a new input shaft oil seal in differential housing using tools **18G 1354** and **18G 1354-4**.

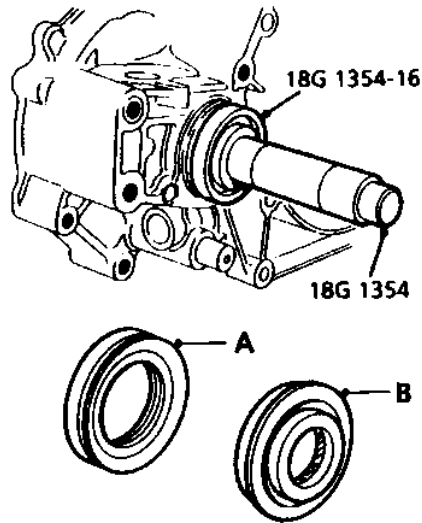
2. Using a suitable piece of tubing, fit a new selector shaft oil seal.
3. Fit output shaft oil guide plate in differential housing.



6. Fit input shaft bearing into differential housing using tools **18G 1354** and **18G 1354-6**.

4. Fit a new output shaft bearing in differential housing using tools **18G 1354** and **18G 1354-5**.

△ NOTE: Depending on application, output shaft bearing may have oil holes drilled in bearing cage: these holes must face towards output shaft when fitting bearing. Bearings without the oil hole may be fitted either way round.



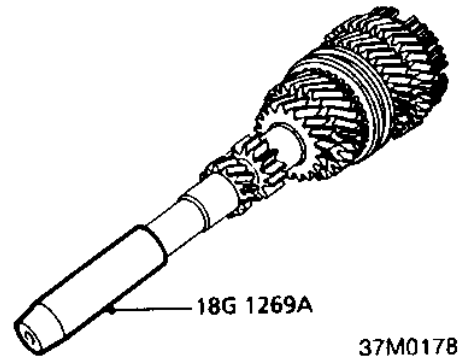
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**CAUTION:** Differential oil seals: Type A are fitted with early drive shafts. Type B oil seals are fitted to later drive shafts. The later oil seals are waxed and must be fitted dry. Ensure that replacement seals are the same type as those removed.

7. Fit a new differential oil seal in differential housing using tools 18G 1354 and 18G 1354-16.
8. Fit output shaft bearing retaining plate - if fitted.

**CAUTION:** Ensure side marked TOP is facing towards output shaft.

9. Fit 2 new Patchlok bolts to secure bearing retaining plate; tighten bolts to 8 Nm.
10. Fit selector shaft and selector shaft guide.
11. Fit and tighten dowel bolt to 28 Nm.
12. Fit detent ball, spring and cap bolt, tighten bolt to 22 Nm.
13. Position differential assembly into housing.



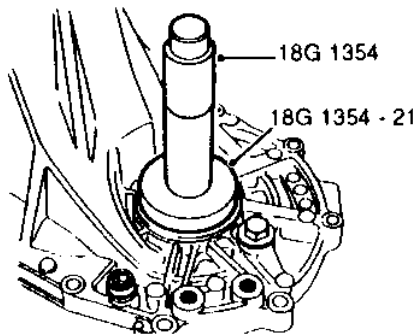
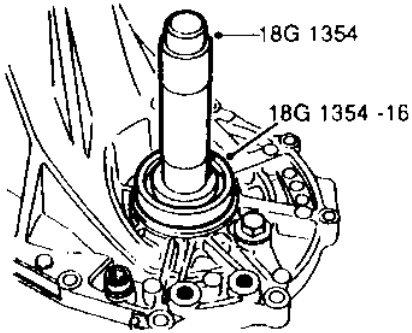
14. Fit seal protector, tool 18G 1269A to input shaft, or apply masking tape to splines to protect oil seal.
15. Place input and output shafts together and fit assembly in differential housing.

**NOTE:** Position housing so that when fitted, end of input shaft is clear of bench.

16. Remove tool 18G 1269A.
17. Ensure output shaft nut is staked.
18. Position gears in neutral.
19. Raise both shafts slightly and fit selector forks assembly ensuring forks are located in grooves in synchro sleeves.
20. Fit reverse idler gear, thrust washer and shaft.

**NOTE:** Large boss on idler gear must be towards differential housing.

21. Fit reverse selector fork and bracket.
22. Fit and tighten retaining bolts.
23. Fit interlock assembly ensuring base of interlock locates in slot at lower end of 1st/2nd selector shaft.
24. Fit and tighten interlock retaining bolts.



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25. Fit new differential oil seals in gear case.



NOTE: Type A oil seal - use 18G1354 and 18G 1354-16

Type B oil seal - use 18G 1354 and 18G 1354-21

- 26. Fit input shaft oil guide plate in gear case.
- 27. Fit a new Belleville washer and selected circlip(s).
- 28. Fit selected circlip(s).
- 29. Fit new output shaft circlip in gear case.
- 30. Fit selected circlip in differential bearing recess in gear case.
- 31. Apply a bead of RTV silicone sealant to mating face of gear case.

- 32. Position gear case over differential housing keeping gear case square to housing.
- 33. Lower gear case into position and at the same time, expand output shaft bearing circlip using tool 18G 1392.
- 34. Push gear case fully down on to differential housing.
- 35. Ensure circlip is fully seated in groove in output shaft bearing, raise output shaft and a click will be heard as circlip enters groove.
- 36. Fit and progressively tighten gear case bolts to 45 Nm.
- 37. Fit reverse idler shaft bolt and tighten to 67 Nm. Use a new washer.
- 38. Apply thread sealant to access plug, fit and tighten plug using tool 18G 1472.
- 39. Fit reverse light switch and new washer, tighten to 25 Nm.
- 40. Fit speedometer drive pinion and housing, use a new 'O' ring; fit retaining plate, fit and tighten bolt to 5 Nm.
- 41. Fit new clutch release shaft oil seal.
- 42. Fit clutch release shaft and fork.
- 43. Fit and tighten bolt to 29 Nm.



**DATA**

Reverse idler gear to selector fork clearance	0.5 to 1.1 mm
Selector fork prong width	13.0 to 13.3 mm
Selector fork groove to pin clearance:	
Standard	0.05 to 0.35 mm
Service limit	0.5 mm
Selector fork groove width	7.05 to 7.25 mm
Gearshift arm to guide clearance:	
Standard	0.2 to 0.3 mm
Service limit	0.55 mm
Interlock shift guide groove width	8.1 to 8.2 mm
Synchro ring to gear clearance:	
Standard	0.85 to 1.1 mm
Service limit (minimum clearance)	0.4 mm
Selector shaft forks in synchro sleeve grooves clearance:	
Standard	0.45 to 0.65 mm
Service limit	1.0 mm
Gearshift arm guide to selector fork clearance:	
Standard	0.2 to 0.5 mm
Service limit	0.8 mm
Gearshift arm guide tongue width	11.9 to 12.0 mm
Gearshift arm guide to interlock assembly clearance:	
Standard	0.05 to 0.35 mm
Service limit	0.6 mm
Gearshift arm guide groove width	13.05 to 13.25 mm
Interlock ball to gearshift arm guide clearance:	
Standard	0.05 to 0.25 mm
Service limit	0.5 mm
Interlock ball outside diameter	12.05 to 12.15 mm
2nd to 3rd gear clearance:	
Standard	0.06 to 0.21 mm
Service limit	0.3 mm
3rd gear thickness:	
Standard	35.42 to 35.47 mm
Service limit	35.30 mm
4th to 5th gear clearance:	
Standard	0.06 to 0.21 mm
Service limit	0.3 mm
Spacer collar length:	
Standard	26.03 to 26.08 mm
Service limit	26.01 mm
4th gear thickness:	
Standard	30.92 to 30.97 mm
Service limit	30.80 mm
5th gear thickness	
Standard	30.42 to 30.47 mm
Service limit	30.30 mm

## MANUAL GEARBOX

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### 1st gear to thrust washer clearance:

Standard .....	0.03 to 0.08 mm
Service limit .....	0.18 mm
2nd to 3rd gear clearance .....	0.03 to 0.10 mm
Input shaft end thrust .....	0.14 to 0.21 mm
Planet gear backlash .....	0.05 to 0.15 mm
Differential bearing to circlip clearance .....	0.15 mm maximum

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### TORQUE SETTINGS

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Final drive pinion nut .....	110 Nm
Differential housing to gearcase bolts .....	45 Nm
Selector shaft guide to selector shaft bolt .....	28 Nm
Cap bolts - detent balls and springs .....	22 Nm
Reverse idler shaft bolt .....	67 Nm
Speedometer drive pinion retaining plate bolt .....	5 Nm
Reverse light switch .....	25 Nm
Clutch release shaft pivot bolt .....	29 Nm
Final drive gear to carrier bolts .....	110 Nm
Output shaft bearing retainer bolts - if fitted .....	8 Nm

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### TOOL NUMBERS

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18G 2 .....	General purpose puller
18G 2/3 .....	Adapter - Differential bearing remover
18G 134 .....	Driver handle - main tool
18G 134-12 .....	Adapter - Type B differential oil seal replacer
18G 284 .....	Slide hammer
18G 284-14 .....	Adapter - Slide hammer
18G 1269A .....	Oil seal protector sleeve
18G 1354 .....	Driver handle (main tool)
18G 1354-4 .....	Input shaft oil seal replacer
18G 1354-5 .....	Bearing replacer
18G 1354-6 .....	Adapter - Input shaft differential bearing
18G 1354-16 .....	Adapter - Type A differential oil seal replacer
18G 1392 .....	Circlip pliers
18G 1397 .....	Bearing puller thrust pad
18G 1472 .....	14 mm Hex key access plug
18G 1473 .....	Anti-spread plate
18G 1675 .....	Differential bearing replacer
18G 1723-1 .....	Clutch release shaft inner bush replacer
18G 1723-2 .....	Clutch release shaft outer bush replacer



WHEELS & TYRES

SECTION GG - ELISE 2001 M.Y. Onwards

	<u>Sub-Section</u>	<u>Page</u>
General Description	GG.1	2
Wheels & Tyres (normal use)	GG.2	2
Winter Tyres & Snow Chains	GG.3	4
Punctured Tyre Emergency Inflator (if fitted)	GG.4	5



GG.1 - GENERAL DESCRIPTION

The single piece, light alloy roadwheels are fitted with Bridgestone Potenza tyres, engineered to provide the optimum balance of ride and handling characteristics. In order fully to exploit the dynamic qualities and packaging opportunities, the wheel and tyre sizes are different front and rear, so that interchanging of wheels and tyres between axles is not permissible. Note that the tyre tread pattern is directional, and must be fitted on the wheel with sidewall arrow pointing in the direction of forward rotation.

The tyres should be inspected frequently by the vehicle user, and also at every service, for signs of cuts, abrasions or other damage, and for any uneven tread wear patterns. Uneven treadwear may indicate that the suspension geometry or dampers require attention. Care should be taken when parking to avoid tyre contact with high or sharp edged kerbs, as mistreatment of this nature can cause internal damage to the tyre structure which may not readily be apparent. The alloy wheel rims may also be distorted or damaged by careless parking, and result in wheel imbalance or loss of tyre pressure. Safety considerations should always be paramount when assessing tyre condition and serviceability, and the tyres replaced if any doubt exists, or if the legal tread depth limits are approached.

The cold tyre pressures should be checked every week, or every 1,000 miles (1,700 km), whichever is the sooner, and corrections made as necessary. Under-inflation will cause excessive wear, rapid deterioration of the tyre sidewalls and heavy steering, whereas overinflation results in a hard ride and increased susceptibility to tyre damage. Both conditions will cause a degradation in the vehicle handling qualities. It is important that the tyre pressures are adjusted only when the tyres are cold (driven less than one mile), as the pressures may increase by 0.3 - 0.5 bar (4 - 8 lb/in<sup>2</sup>) when the tyres are warmed to normal running temperature. The tyre valve dust cap should always be replaced in order to prevent the ingress of dirt and moisture into the valve, which could cause leakage.

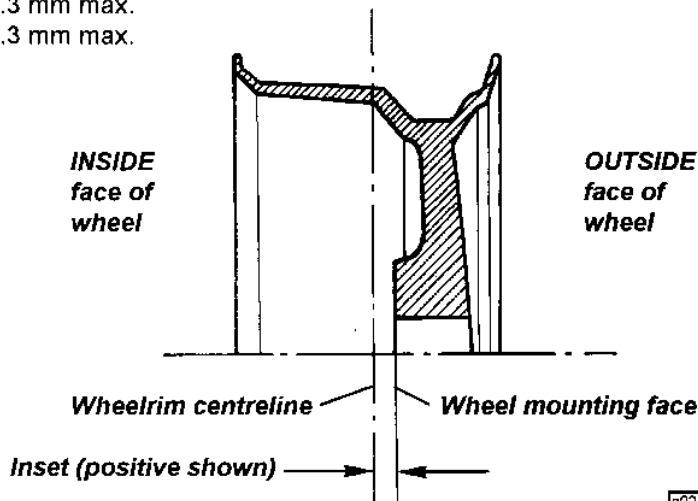
When balancing the wheel and tyre assemblies, the wheels should be located by the centre spigot - NOT by the wheel bolt holes. In order to maintain the correct handling feel and minimum steering wheel shake, it is very important that the radial and lateral run out of the tyres are to the high standard required by Lotus Cars. If any difficulty is experienced with replacement tyres, refer to the tyre manufacturer.

GG.2 - WHEELS & TYRES (normal use)

Wheels

Type	Light alloy; 6 spoke style; 4 bolt fixing
Size - front	5.5J x 16
- rear	7.5J x 17
PCD	100 mm
Inset - front	+ 31.3 mm
- rear	+ 17.75 mm
Centre spigot hole diameter	56.5 mm
Wheel bolt torque	105 Nm
Radial run-out at bead seat	0.3 mm max.
Lateral run-out at rim flange	0.3 mm max.

Note that the inset figure is the displacement of the wheelrim centreline relative to the wheel/hub mounting face. A positive inset indicates that the wheelrim centreline lies inboard of the wheel mounting face, whereas a negative inset means the wheelrim centreline is outboard of the mounting face.



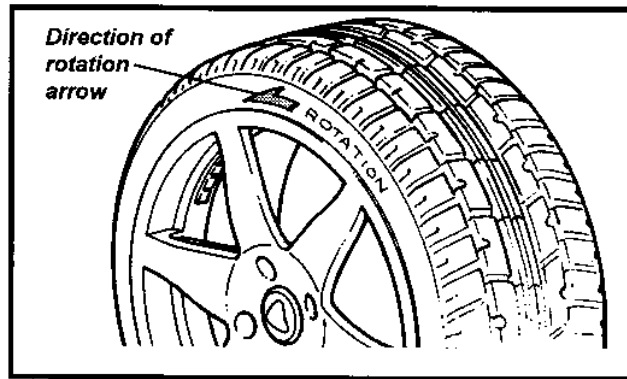
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Wear indicators are moulded into the bottom of the tread grooves at intervals around the tyre, indicated by small pointers on the outer tread blocks. The tyres should be replaced before being worn to this minimum legal tread depth. Note that the 'Potenza' tread pattern is directional, so that the tyre must be fitted onto the wheel with regard to which side of the car the wheel is to be fitted. A direction of rotation arrow is included in the tyre sidewall markings.



**GG.3 - WINTER TYRES & SNOW CHAINS**

If the car is to be used in very cold territories, or driven on snow covered roads, it is recommended to fit winter wheels and tyres developed specifically for such conditions. Winter wheels are smaller than the standard wheels, and allow for the fitment of snow chains on only the rear wheels.

**Winter Wheels**

Type	Light alloy; 6 spoke style; 4 bolt fixing
Size - front	5.5J x 15
- rear	7J x 16
PCD	100 mm
Inset - front	+ 31.3 mm
- rear	+ 17.75 mm
Centre spigot hole diameter	56.5 mm
Wheel bolt torque	105 Nm

**Winter Tyres**

Type	Bridgestone LM22
Size - front	185/55 R15
- rear	205/55 R16
Pressure (cold) - front	1.8 bar (26 lb/in <sup>2</sup> )
- rear	1.9 bar (27.5 lb/in <sup>2</sup> )

**WARNING:**

- When winter tyres are fitted, a maximum speed of 118 mph (190 km/h) must be observed.
- The tyres are NOT suitable for studding.

**Snow Chains**

In extreme conditions, Lotus approves the fitment of Pewag Neon X3 - NX 369 snow chains, used only in conjunction with winter tyres (see above) and fitted only on the rear wheels. Close attention should be paid to the fitting and tensioning instructions supplied with the chains, and the chains should be removed as soon as road conditions allow.

**GG.4 - PUNCTURED TYRE EMERGENCY INFLATOR (If fitted)**

In order fully to exploit the benefits of light weight, and to maximise stowage space, no spare wheel is included in the Elise specification, but a temporary puncture repair facility is provided in the form of a tyre inflator aerosol. The aerosol is mounted in spring clips at the extreme right hand front corner of the rear luggage compartment.

When the aerosol is connected to the tyre valve, and the button pressed, a mixture of liquid latex and propellant is injected into the tyre, such that the solidifying latex is forced into the puncture site at the same time as the tyre is inflated, effecting a temporary repair and enabling the car to be driven at moderate speed to the nearest tyre depot.

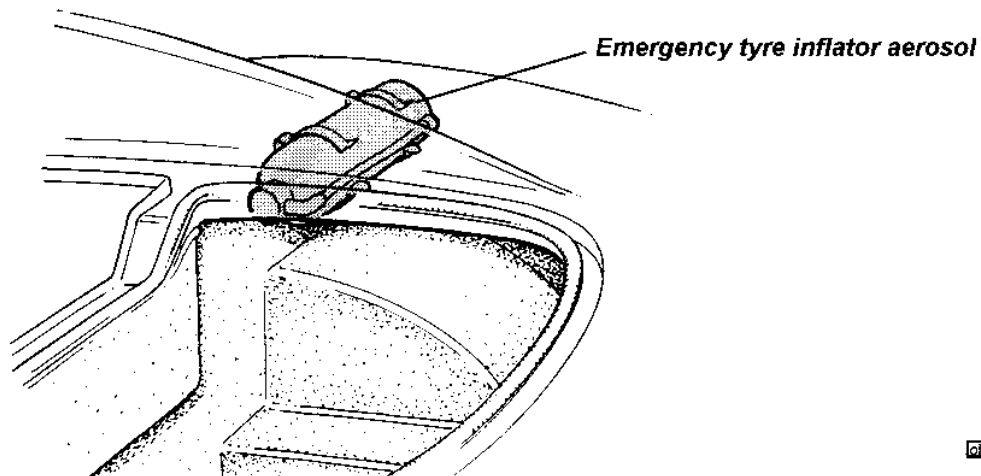
**WARNING:**

- **Use of the aerosol does not constitute a permanent repair, but is designed to allow the car to be driven to the nearest tyre depot. At the earliest opportunity, the tyre should be professionally repaired or replaced dependent on the severity of the damage.**
- **Until the tyre is repaired or replaced, the car should be driven in a moderate manner, not exceeding 30 mph (45 km/h).**
- **Do not use the aerosol for large holes or repairs, or when the tyre sidewall has been damaged, or if the tyre has been displaced from the rim.**
- **For safety reasons, the aerosol should be carried at all times in the designated stowage position. Never carry in the passenger compartment.**

As soon as a puncture is suspected, the car should be stopped at the first safe opportunity. Continued driving on a deflated tyre will cause irreparable damage to the tyre.

*Directions for use of the aerosol:* Before using, carefully read all the instructions on the canister, or on any literature accompanying the product. The following instructions apply to the use of Holts Tyreweld:

1. Remove the object causing the puncture, and position the wheel with the puncture site lowermost. Deflate tyre fully.
2. Shake the can vigorously. In cold conditions, warm the can using the car's heater outlets, or by body warmth.
3. Screw the aerosol tube onto the tyre valve, remove the cap, hold the can upright and press the button until the tyre is firmly inflated.
4. Immediately drive for 6 - 12 miles (10 - 20 km) (or to the tyre depot if nearer) in a moderate manner and not exceeding 30 mph (45 km/h), to allow the sealant to spread. Then check and adjust the tyre pressure as necessary.
5. Have the tyre professionally repaired or replaced at the earliest opportunity, and until such time, limit speed to 30 mph (45 km/h) with a moderate driving manner. Note that some tyre repairers may make an additional charge for cleaning the sealant off the tyre before repair, and that any subsequent repairs may not be guaranteed.
6. Renew the puncture repair aerosol.



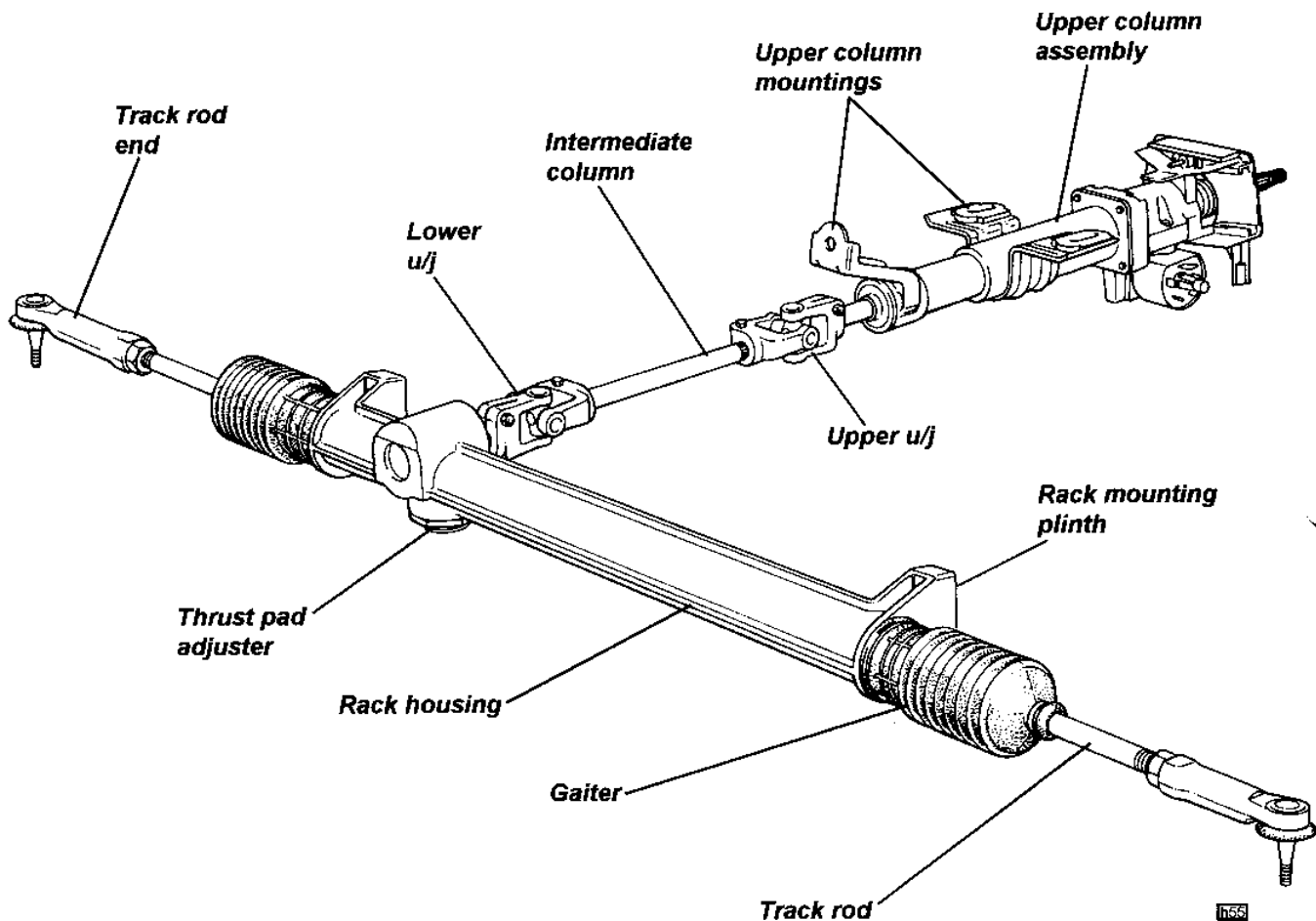
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STEERING

SECTION HF - ELISE 2001 M.Y. Onwards

	<u>Sub-Section</u>	<u>Page</u>
General Description	HF.1	2
Steering Wheel	HF.2	2
Upper Column Assembly	HF.3	4
Intermediate Column	HF.4	7
Front Wheel Alignment & Rack Gaiters	HF.5	8
Rack & Pinion Assembly Removal/Replacement	HF.6	9
Adjustment of Rack Bar Thrust Pad	HF.7	10



### HF.1 - GENERAL DESCRIPTION

The steering system of the Elise comprises a telescopically collapsible upper column assembly, connecting to a rigidly mounted rack and pinion assembly via a universally jointed intermediate shaft. The steering rack tie rods connect to rearward facing steering arms bolted to the forged steel front hub carriers, with geometry providing 30% Ackermann effect, and a toe-out on bump characteristic. No power assistance is provided. The upper column is fixed to the scuttle beam, with the column upper bearing carrier also providing mountings for the steering lock and column switches. 'Break out' inserts fitted in the column upper mounting flanges, allow for telescoping of the column in a frontal collision. The steering rack assembly, which provides 2.4 turns from lock to lock at a 15.8:1 ratio, is rigidly mounted inside a chassis transverse extrusion behind the top wishbone rear pivots.

### HF.2 - STEERING WHEEL

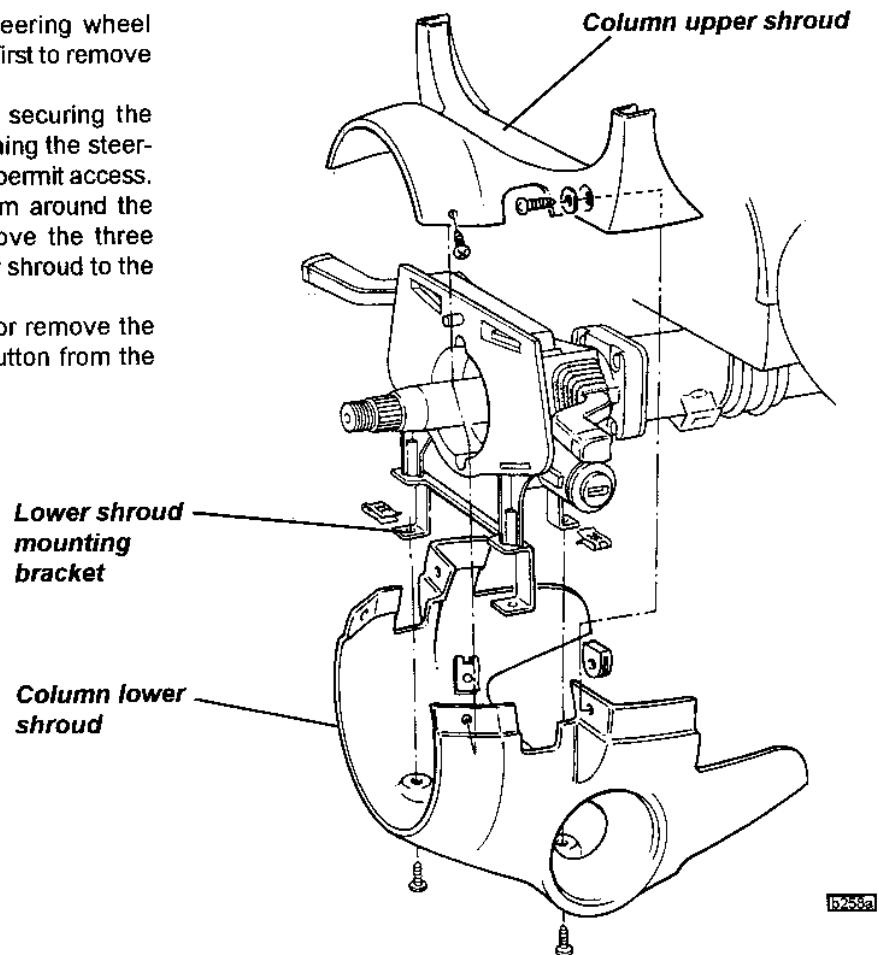
The alloy three spoke steering wheel, has a leather trimmed rim and moulded rubber covered spokes, and is secured to the column via a 36 spline boss. The horn button is mounted in the steering wheel centre pad which is supported by a collapsible steel spider bolted to the hub of the wheel. The positive feed to the horn button is supplied via a spring loaded contact housed in the column switch carrier, and a slip ring mounted on the forward side of the wheel. The earth contact of the button is connected to a terminal on the spider.

#### To Remove Steering Wheel

1. Pull off the centre trim pad with horn button, and disconnect the two horn leads.



2. To allow access for a steering wheel puller tool, it is necessary first to remove the column shroud:
  - Release the four screws securing the shroud upper section, turning the steering wheel as necessary to permit access.
  - Pull out the grommet from around the ignition switch, and remove the three screws securing the lower shroud to the column.
  - If necessary, disconnect or remove the trip/panel lights control button from the lower shroud.



3. Remove the nut securing the steering wheel boss to the column. Match mark the boss and column to enable alignment to be maintained on re-assembly.
4. Use a suitable steering wheel puller tool to locate behind the steering wheel boss and bear against the end of the column.  
**CAUTION: If excessive force is applied to either the wheel or column without an appropriate puller, the telescoping mechanism of the outer column may be overridden, necessitating column replacement.**
5. If necessary, unclip the slip ring from the steering wheel boss and withdraw with the horn lead. Withdraw the column bearing preload spring.
6. To refit the steering wheel, reverse the above procedure with the following notes:
  - Clip the horn slip ring to the steering wheel boss with the turn indicator cancelling vane on the left hand side.
  - Ensure that the column bearing preload spring is fitted over the inner column before fitting the wheel with the match marks aligned. If re-alignment is necessary, see later.
  - Torque tighten the steering wheel to column nut to 25 Nm.

#### Steering Wheel Alignment

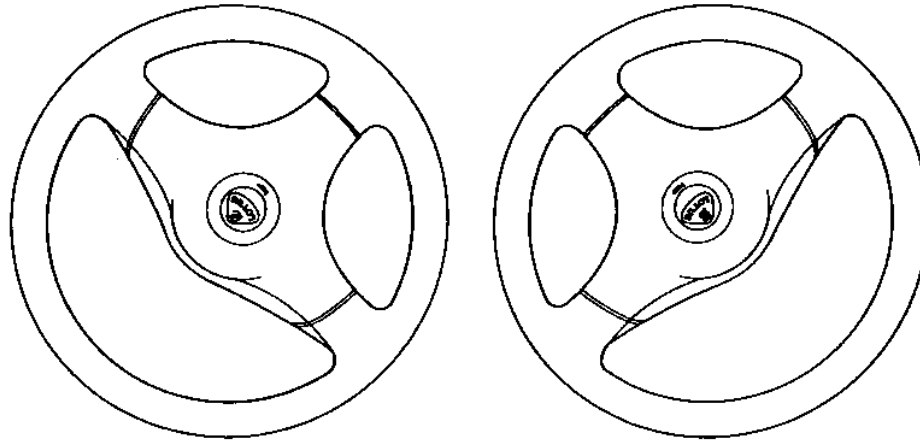
Ideally, the steering wheel should align in the straight running position, with the steering rack centralised and with equal track rod lengths. In practice, some compromise to track rod lengths may have to be made. To arrive at the optimum setting, proceed as follows:

Note that the only two splined joints in the steering system which allow a choice of position are the lower w/j to rack pinion shaft, and the steering wheel to column.



1. Set the front wheel alignment to specification with equal track rod lengths (see sub-section CH.2).
2. Turn the steering to each full lock in turn and set the steering wheel on the column splines such that its orientation in one full lock position is the nearest possible mirror image of its position at the opposite full lock.

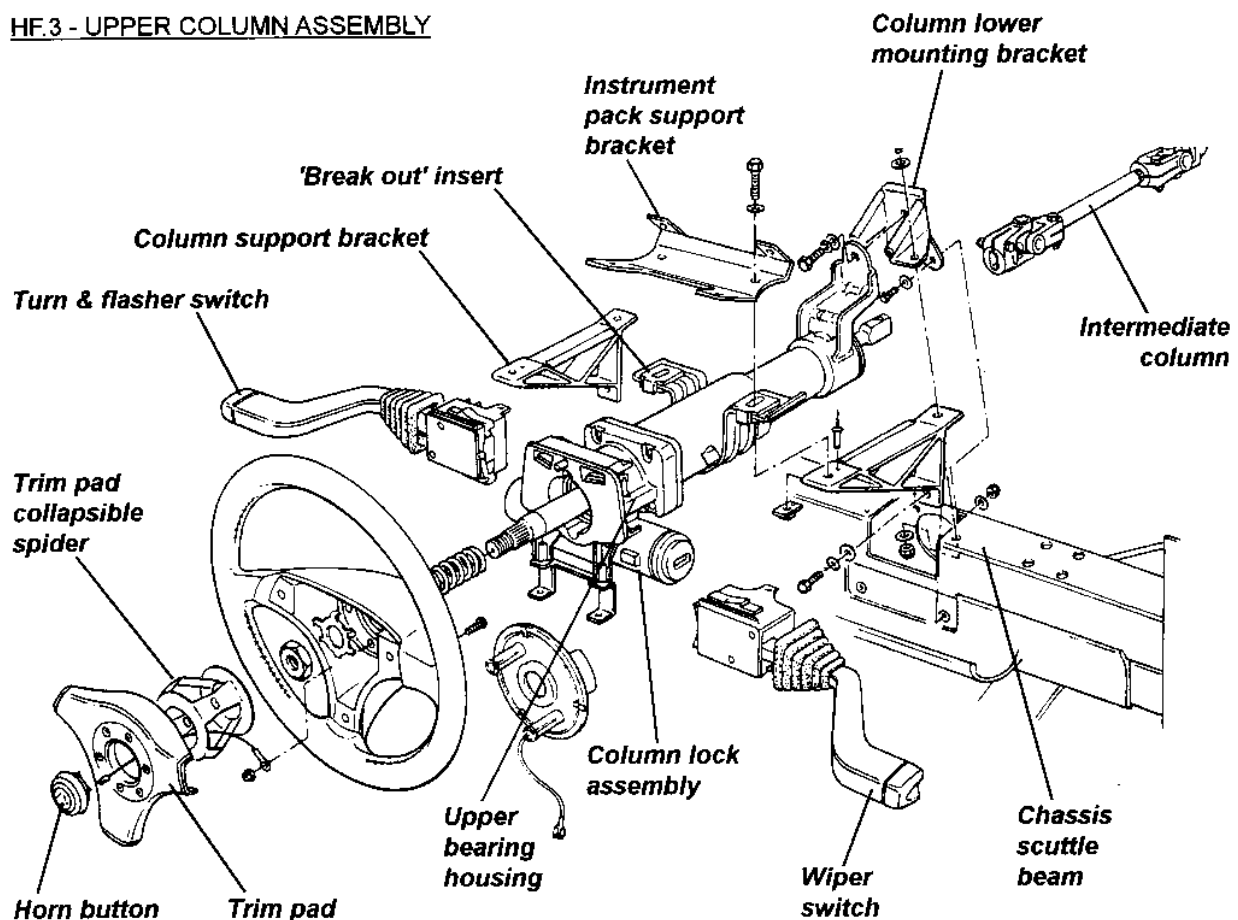
**Mirror image wheel positions**



HF3

3. Secure the steering wheel before road testing the car and marking the actual 'straight ahead' position of the steering wheel which should deviate from the ideal position by less than 5°. Final alignment is achieved by asymmetric adjustment of the track rods, retaining the overall toe-out setting.

**HF.3 - UPPER COLUMN ASSEMBLY**

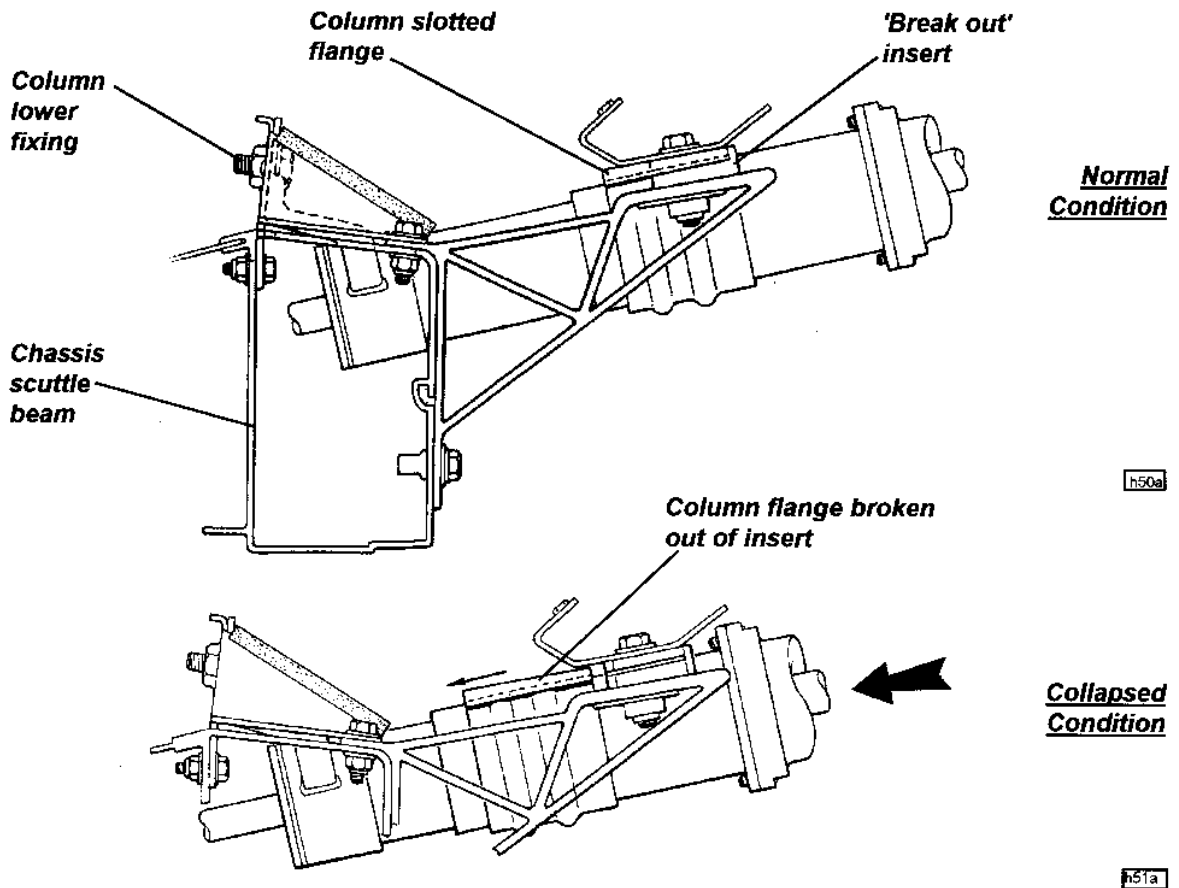


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The upper steering column assembly comprises an inner column which connects the steering wheel to the intermediate shaft, and a tubular steel outer column which, with its alloy upper bearing housing, supports the inner column and carries the column lever switches for lighting and wiper control, and also the ignition switch/steering lock.

Both inner and outer columns are of fixed length, but are telescopically collapsible when subjected to crash forces. The two parts of the inner column are fixed together by plastic pins designed to shear and allow telescoping to occur beyond a specified axial load. The two part outer column tube uses gripper rings to retain the column length, with the lower part mounted by a single fixing to the chassis scuttle beam via a three point fixing steel bracket. The upper part of the outer column has two open slotted mounting flanges each of which is fitted with a 'break out' alloy insert, bolted through to an extruded alloy plinth fixed to the scuttle beam. In the event of an extreme axial load being applied to the column via the steering wheel, as may occur during a vehicle frontal collision, the plastic retaining pins in the column flange inserts will shear and allow the upper part of the column to break free of the upper fixings and telescope forwards, reducing the potential for column induced injury.

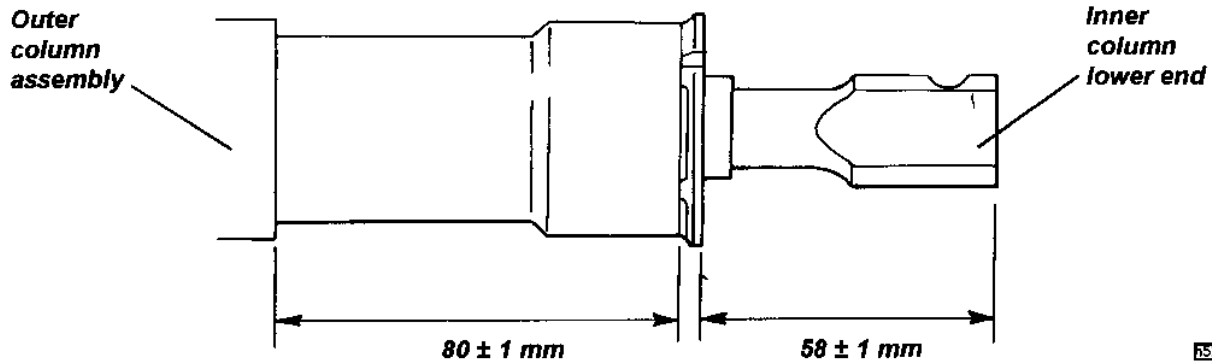


Dimensional Check

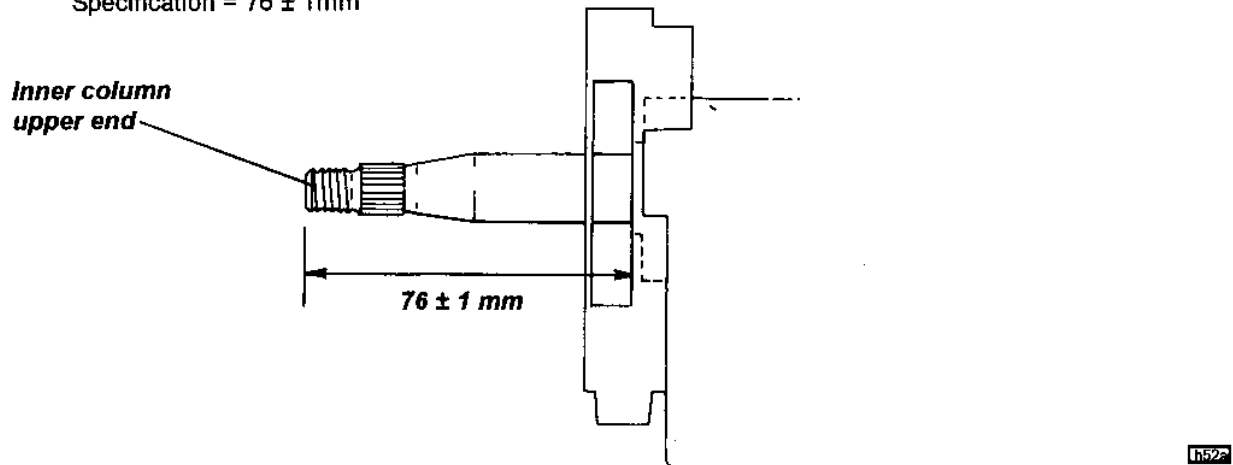
If the vehicle is involved in an accident, or any part of the column is subjected to an abnormal load, the column should be carefully examined to establish if any telescoping has occurred. Perform the following checks, and replace the complete upper column assembly if any of the dimensions are outside specification:

1. Outer Column:  
Measure the length of the lower part of the outer column as shown:  
Specification =  $80 \pm 1$ mm
2. Inner Column Lower:  
Measure the length of the exposed part of the inner column as shown:  
Specification =  $58 \pm 1$ mm

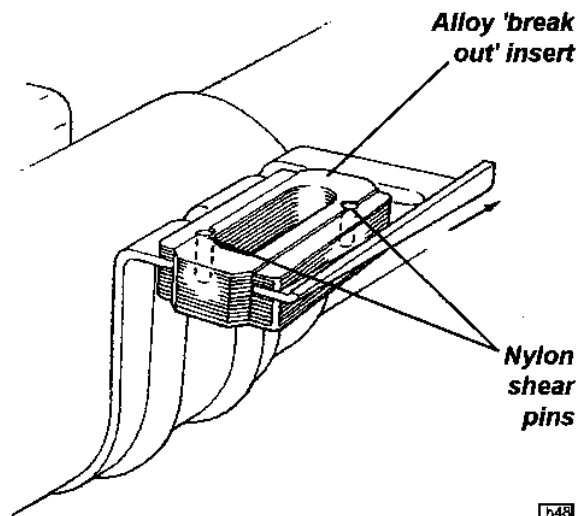




3. Inner Column Upper  
With the steering wheel removed, measure the length of the exposed part of the upper column as shown:  
Specification =  $76 \pm 1 \text{ mm}$



4. 'Break out' Inserts  
Remove the column shrouds and the column flange fixing bolts, and check that each of the alloy 'break out' inserts is securely attached to the column flange. If the plastic pins are sheared, the column assembly must be replaced.

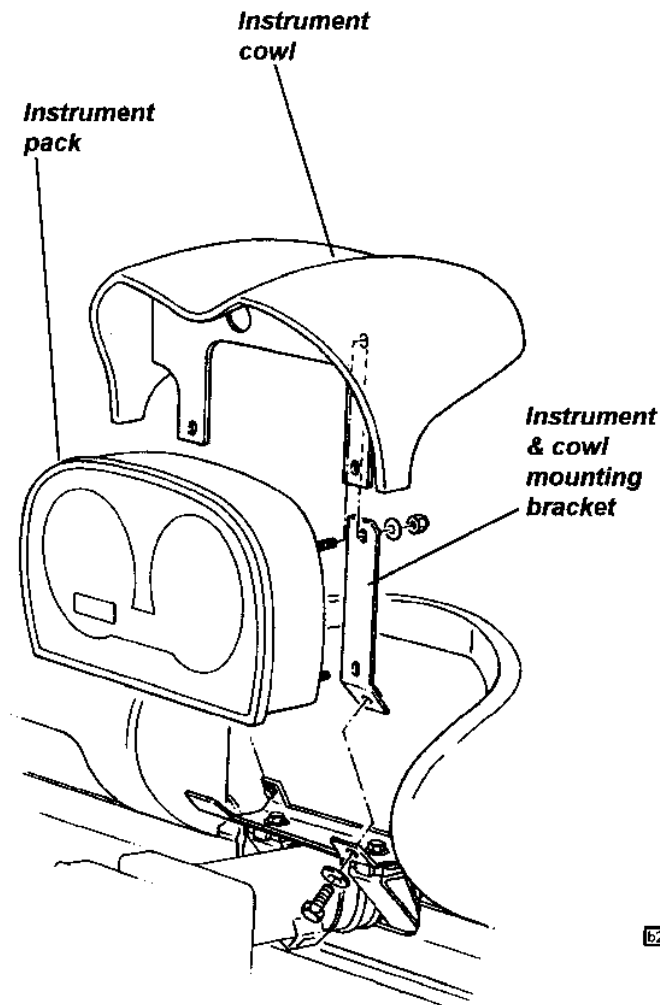


To Remove Upper Steering Column Assembly

1. Disconnect the battery, and remove the column shrouds (see sub-section HF.2).
2. Disconnect the column lever switches, or release the retaining pawls and slide the switches out of the carrier. Disconnect the horn contact pin.
3. To disconnect the ignition switch: prise open the terminal cover, and use a small screwdriver to release



- the retaining barb located between the white and yellow cables. Withdraw the connector.
- If necessary, remove the steering lock/ignition key barrel: Turn the key to position 'I', depress the spring pin accessible via a hole in the column switch carrier, and withdraw the lock barrel.
  - If necessary, remove the ignition switch: First remove the steering lock/ignition key barrel (see above). Remove the retaining grub screw and withdraw the switch.
  - If necessary, remove the steering lock assembly: Remove the spline head screw securing the column switch carrier, and drill or chisel out the two shear head bolts fixing the lock assembly to the column.
  - Remove the pinch bolt securing the upper universal joint to the intermediate column.
  - Remove the two fixings for the instrument pack mounting brackets, and remove the instrument pack and cowl assembly after unplugging the single harness connector.
  - Remove the two bolts securing the instrument pack mounting bracket and column upper mounting flanges to captive nuts in the column support brackets. Remove the instrument pack support bracket with instrument controller after unplugging the harness.
  - Release the upper column single lower fixing and withdraw the column assembly from the scuttle and off the intermediate steering column.
  - Refit the column in reverse order to removal with the following notes:
    - The groove for the pinch bolt allows assembly of the universal joint to the intermediate column in only one orientation. Torque tighten the pinch bolt to 35 Nm.
    - Torque tighten the column lower fixing bolt to 45 Nm
    - Torque tighten the two column upper fixing bolts to 22.5 Nm.
    - If applicable, use new shear bolts to secure the steering lock assembly, and tighten until sheared.



#### HF.4 - INTERMEDIATE COLUMN

The intermediate steering column consists of a symmetrical splined shaft and two different hook type universal joints. The lower joint uses an un-indexed 36 spline connection to the steering rack pinion shaft, and the upper joint accommodates a double flatted boss on the end of the upper column, with a pinch bolt groove



allowing assembly in only one orientation. The intermediate shaft itself, uses a splined joint at each end and an indexed pinch bolt groove.

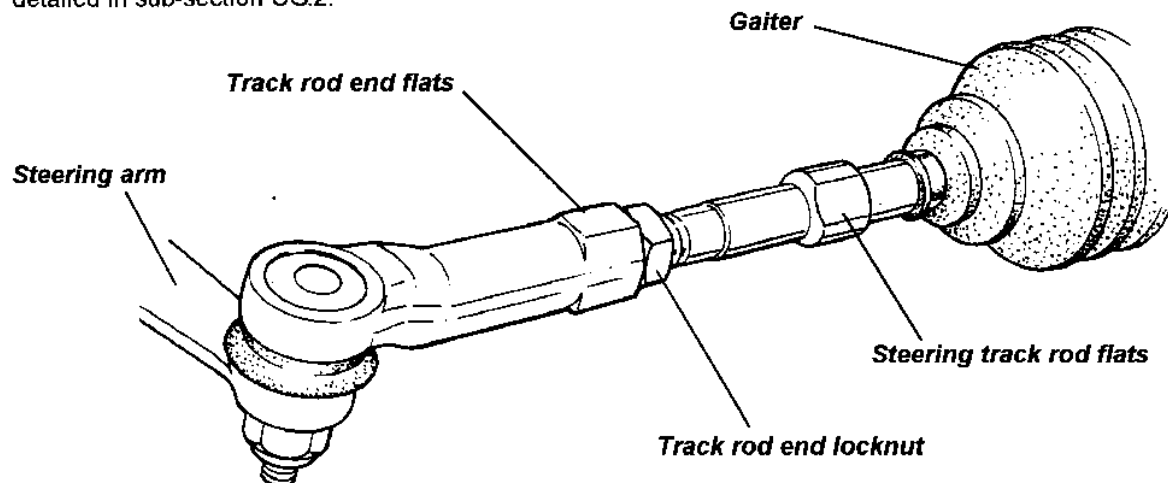
To remove the intermediate column assembly, the upper column must first be removed (see sub-section HF.3), after which the rack pinion shaft pinch bolt may be removed and the column assembly withdrawn. Match marking the lower u/j to the pinion shaft will aid steering wheel alignment on re-assembly. Torque tighten the pinch bolts to 35 Nm.

#### HF.5 - TRACK ROD ENDS & RACK GAITERS

##### Front Wheel Alignment

Alignment is measured either by the angle a wheel makes with the vehicle centre line, or the difference in dimension between the wheel rim to wheel rim measurement at the front and rear of the wheel at hub centre height. The wheels are said to 'toe-in' when the wheel paths converge ahead of the vehicle, and 'toe-out' when they diverge. Wheel alignment is designed to vary with both steering angle (Ackerman) and suspension travel (bump steer) and should be measured only 'straight ahead' at the specified ride height.

Provision is made for the adjustment of front wheel alignment at the joint between the steering rack track (tie) rods, and the outer ball joints ('track rod ends'). The required ride height and alignment specification is detailed in sub-section CG.2.



Note that in order to preserve the required bump steer characteristic and steering symmetry, the effective length of each track rod must remain equal - adjust each track rod by a similar amount:

- Hold the track rod end using the flats provided, and slacken the locknut. Repeat for the opposite side.
- Turn each track rod a similar amount. As a guide, turning both track rods by one quarter of a turn will alter overall toe-out by approx. 2.0 mm.
- When adjustment is correct, hold each track rod end and tighten the locknuts to 80 - 82 Nm (58 - 60 lbf.ft).

When slackening or tightening the track rod end locknuts, it is important that the torque reaction is resisted using the track rod end flats, and that the ball joint itself is not allowed to be stressed.

##### Track Rod Ends

The track rod ends are sealed for life and maintenance free, but if replacement is required; remove the ball pin nut and use a ball joint splitter tool to separate the joint from the steering arm. Unscrew the joint from the track rod. On re-assembly, tighten the ball joint to steering arm nut to 30 Nm, and set the front wheel alignment as detailed in sub-section CH.2.

##### Steering Rack Gaiters

The convoluted gaiters sealing each end of the steering rack housing to the track rods, should be inspected at service intervals and replaced immediately if found to be torn, cracked or otherwise damaged. The ingress of dirt or water into the rack housing will cause rapid deterioration of the track rod inner ball joints and

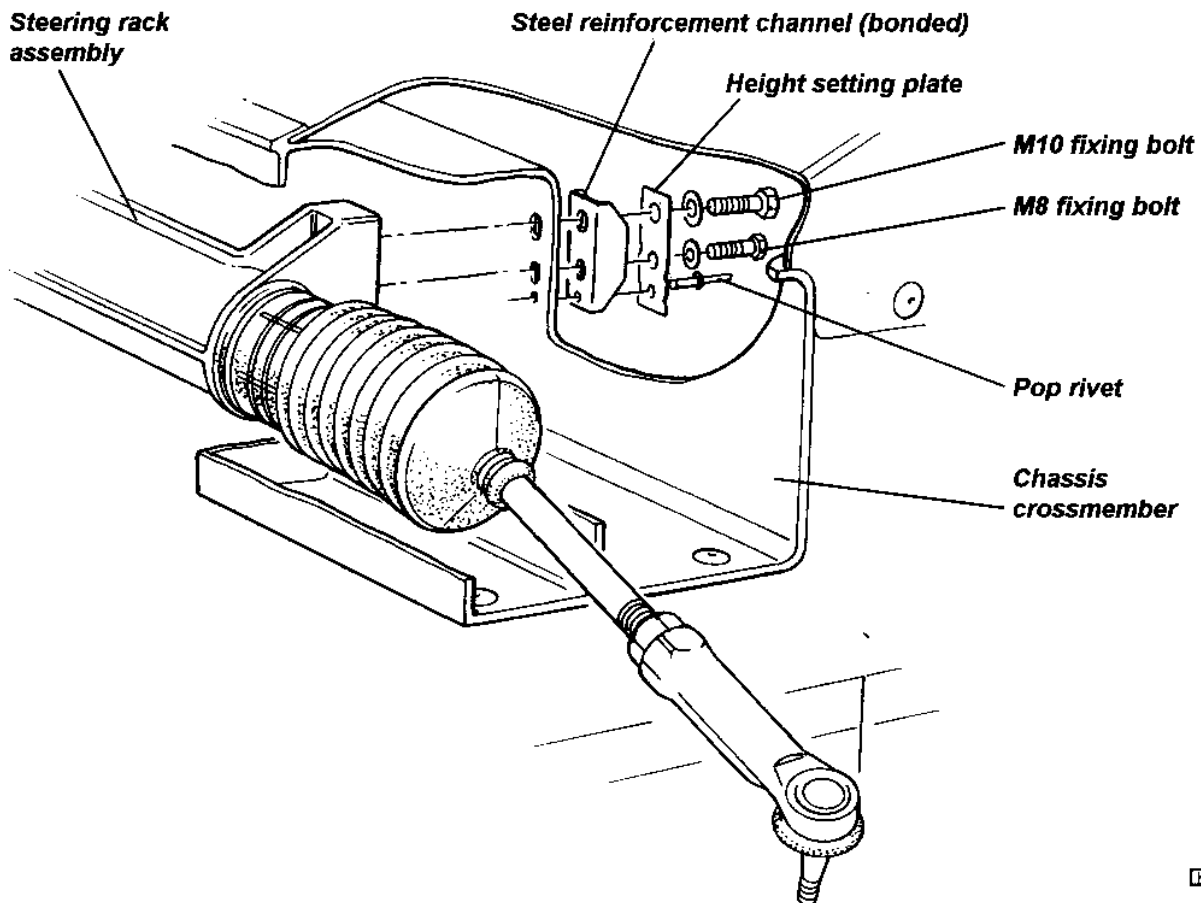


rack and pinion mechanism.

To replace a gaiter, remove the track rod end (see above), release the gaiter clips, and slide the gaiter off the housing and track rod. Check for consequent damage or wear and replace the steering gear assembly if necessary. Fit the new gaiter into position, and secure with new retaining clips.

### HF.6 - RACK & PINION ASSEMBLY REMOVAL/REPLACEMENT

The rack and pinion assembly is mounted inside an extruded chassis box section crossmember at the top front of the footwell. Each of the two rack housing mounting plinths uses an M10 (upper) and M8 (lower) fixing bolt to secure the housing to the vertical rear face of the crossmember. A steel reinforcement channel is bonded to the outside of the crossmember, with a riveted height setting plate to define the vertical position of the housing. Note that the only approved repairs or adjustments to the steering rack assembly are the replacement of the track rod ends and rack housing gaiters, and the adjustment of the rack pressure pad.



#### To Remove/Replace Steering Assembly

1. Remove the nut securing each track rod end to the steering arm, and use a ball joint splitter to separate the joint.
2. From inside the footwell, match mark the pinion shaft against the u/j yoke to aid steering wheel alignment on re-assembly, and remove the pinch bolt.
3. From inside the footwell, remove the two M8 and M10 bolts securing the rack housing.
4. Draw the housing forwards to disengage the intermediate shaft u/j, and manoeuvre the assembly out of the chassis crossmember.

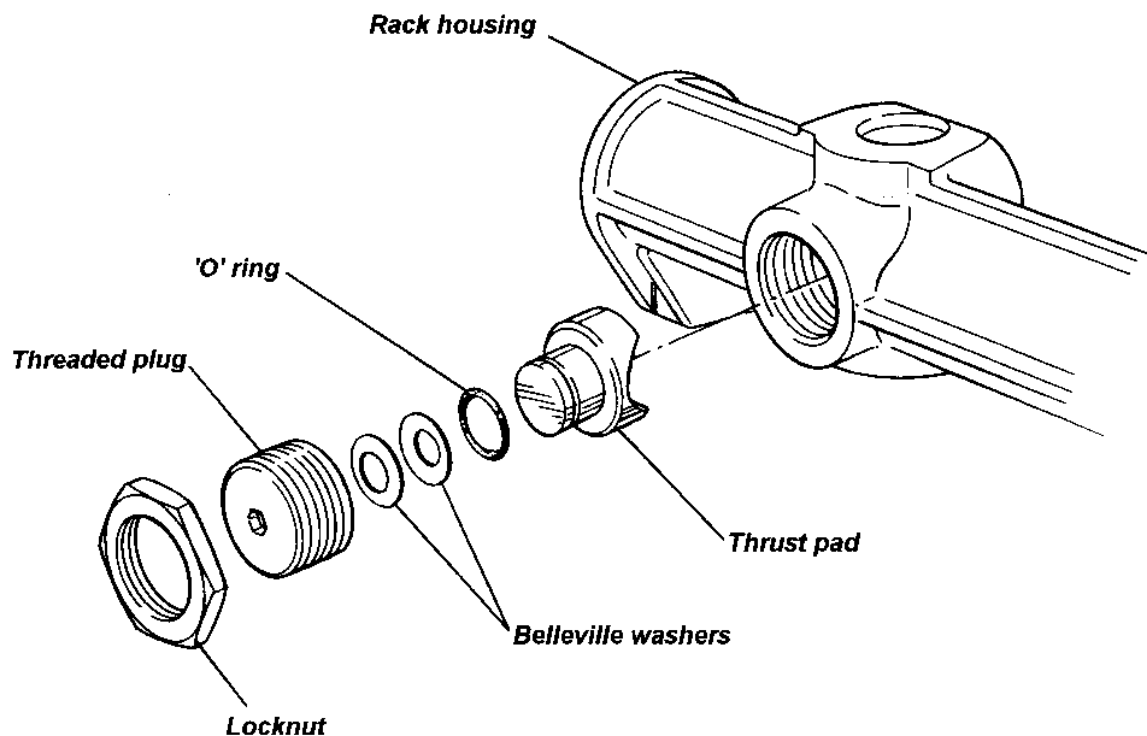


5. On-reassembly, check that the correct rack height setting plate is fitted. Variations are available to suit both standard (130/130mm) and sport (100/110mm) ride heights. Fitment of the wrong plate will result in an incorrect bump steer characteristic and degraded handling. The plates are identified by notches in the vertical edges: Standard specification (130/130); 7 notches. Sport suspension (100/110); 10 notches. If necessary, drill out the head of the pop rivet retaining the plate, taking care not to damage or enlarge the chassis hole, and rivet the new plate into position.
6. Feed the rack assembly into the chassis crossmember and engage the pinion shaft into the lower u/j with the match marks aligned. If a new assembly is being fitted, follow the 'Steering Wheel Alignment' procedure in sub-section HF.2.
7. New fixing bolts for the steering rack housing are pre-coated with thread locking compound. If existing bolts are to be re-used, wire brush the threads before re-applying a suitable thread locking compound and torque tightening the M8 bolts to 22.5 Nm, and the M10 bolts to 45 Nm.
8. Fit the lower u/j pinch bolt, and tighten to 35 Nm.
9. Fit the track rod ends into the steering arms, and tighten the nuts to 30 Nm.
10. Check and adjust the front wheel alignment as detailed in sub-section CH.2.

#### HF.7 - ADJUSTMENT OF RACK BAR THRUST PAD

A thrust pad backed by a pair of belleville washers, is used to control the preload between the rack bar teeth and the pinion gear, and is adjustable via a threaded backstop plug. The correct preload allows the horizontally mounted rack bar (column disconnected) to be pulled through its full travel by a steady force of 12 to 16 lbf. (50 - 70 N). The rack and pinion assembly must be removed from the chassis before any adjustment may be carried out.

To adjust the thrust pad, release the locknut (36mm socket) and use a 5.5mm hexagonal bit to adjust the backstop as required before tightening the locknut. For an approximate initial setting, screw in the backstop plug until solid, then back off ½ turn.

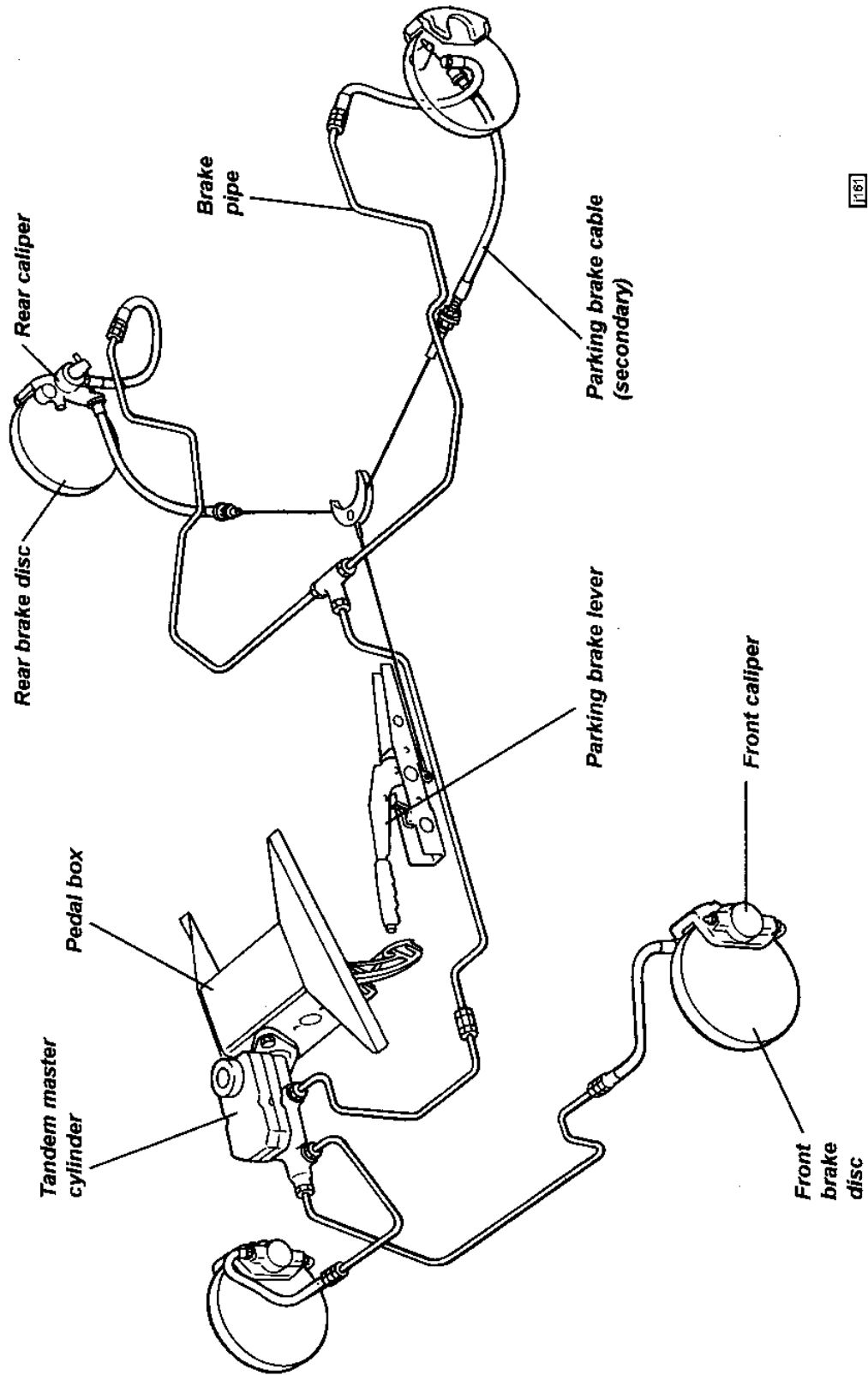




**BRAKE SYSTEM & PEDAL BOX**

**SECTION JI - ELISE 2001 M.Y. Onwards**

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Parking Brake Mechanism	Jl.5	6
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GENERAL LAYOUT



### JI.1 - GENERAL DESCRIPTION

The braking system of the Lotus Elise 2001 M.Y. onwards, comprises ventilated discs all round with AP Racing 2-piston fixed calipers on the front and Brembo single piston sliding calipers on the rear. A tandem master cylinder, without servo assistance, operates the calipers via a front/rear split hydraulic circuit. The centrally mounted parking brake lever, operates the rear caliper pistons by control cables.

The AP Racing front calipers, have lightweight alloy bodies housing two opposed pistons, and are mounted via two bolts directly to the rear of the forged steel hub carriers. The rear brakes use Brembo cast iron, single piston calipers, sliding on pins mounted directly to the forged steel hub carriers. A ventilated cast iron brake disc with curved internal vanes is common to all four wheels, and is sandwiched between the road wheels and hubs, retained for convenience by a single countersunk screw. Optional sport discs are cross-drilled for additional cooling, weight saving and improved pad scouring, but are likely to generate increased levels of noise.

The tandem master cylinder is made by ITT, and incorporates a front section to supply both front brakes, and a rear section to supply the rear brakes. A translucent fluid reservoir surmounting the cylinder, services both front and rear circuits, and also, via a flexible hose, the clutch master cylinder. A fluid level sensor is incorporated into the filler cap, and lights a fascia tell tale lamp if the level becomes dangerously low.

The parking brake ratchet lever is mounted between the seats and uses a short primary cable and balancing yoke to actuate a single control cable linked to each rear caliper. Adjustment of the caliper mechanism to compensate for brake pad wear is automatic. The parking brake should be applied by pulling up the lever with high effort, and engaging the highest ratchet setting attainable. When parking the car on a slope, the additional precaution should be taken of leaving the transmission in first or reverse gear and steering the wheels towards the kerb. If the parking brake is applied when the brakes are hot (e.g. after prolonged or vigorous braking), special care should be taken to ensure that the parking brake is securely engaged in order to allow for any potential affect on brake performance as the discs cool.

The braking system is designed to enhance brake performance during high speed driving, with good fade and pad wear characteristics, and have a higher friction level when heated to normal working temperature than when cold. Required pedal effort will reduce as cold brakes become heated to normal working temperature, and the braking efficiency will increase significantly as new discs or pads become 'bedded in'. After fitting new brake components, maximum braking efficiency will be achieved if, for the first few hundred miles, needless heavy braking is avoided, and the brake pads are allowed to 'bed in' fully before being used to their full potential.

### JI.2 - BRAKE FLUID CHECK & CHANGE

Before checking the brake fluid level, ensure that the car is parked on a level surface, and remove the driver's side front body access panel. The level of fluid in the reservoir may be inspected without disturbing the filler cap, and should lie between the 'MIN' and 'MAX' marks moulded on the translucent reservoir body. The level will fall progressively as the brake pads wear in service, and should be checked at each service interval. A sensor incorporated into the filler cap will light a fascia mounted tell tale lamp if the level becomes dangerously low. As a bulb check, the tell tale should light for about six seconds when the ignition is first turned on, but may also be tested by pressing the button on the filler cap, which action should light the tell tale with the ignition switched on.

An internal baffle divides the reservoir into two compartments, with the front section supplying the front brake circuit, and the rear section the rear brakes in addition to, via a short flexible hose, the clutch master cylinder. Service wear of the clutch friction plate will cause fluid to be displaced from the self adjusting clutch slave cylinder, back to the reservoir, and will counteract to some extent the dropping of the level due to brake pad wear.

If the reservoir needs topping up, first clean around the cap to reduce the possibility of contamination before unscrewing the cap; it is not necessary to disconnect the level sensor cables. Take suitable precautions to guard against damage to paintwork caused by brake fluid dripping from the level sensor.

Use only a fresh supply of DOT 4 *non-mineral* type fluid, identified by a yellow and black symbol.



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Do NOT use DOT 5 silicone fluid, or any fluid which has been exposed to the atmosphere for more than a brief period, or any fluid suspected of being wet, dirty or contaminated. Do not overfill. Replace the filler cap securely.

Some service operations, such as replacing brake pads, will result in the displacement of fluid from the hydraulic circuit back into the reservoir. In order to prevent fluid overflowing from the reservoir, it may be necessary to remove some fluid using a 'squeeze bulb' type tool.

**Renewal of Brake Fluid**

Brake fluid absorbs water from the atmosphere over a period of time (hygroscopical), resulting in a lowering of the boiling point of the fluid, and corrosion of the hydraulic system. For optimum safety and brake performance, the brake fluid should be renewed every twelve months.

The fluid may be changed and bled of air using pressure or vacuum assisted equipment, or standard manual techniques. Each brake caliper is provided with a bleed nipple for this purpose. The clutch release system hydraulic fluid should be changed at the same time.

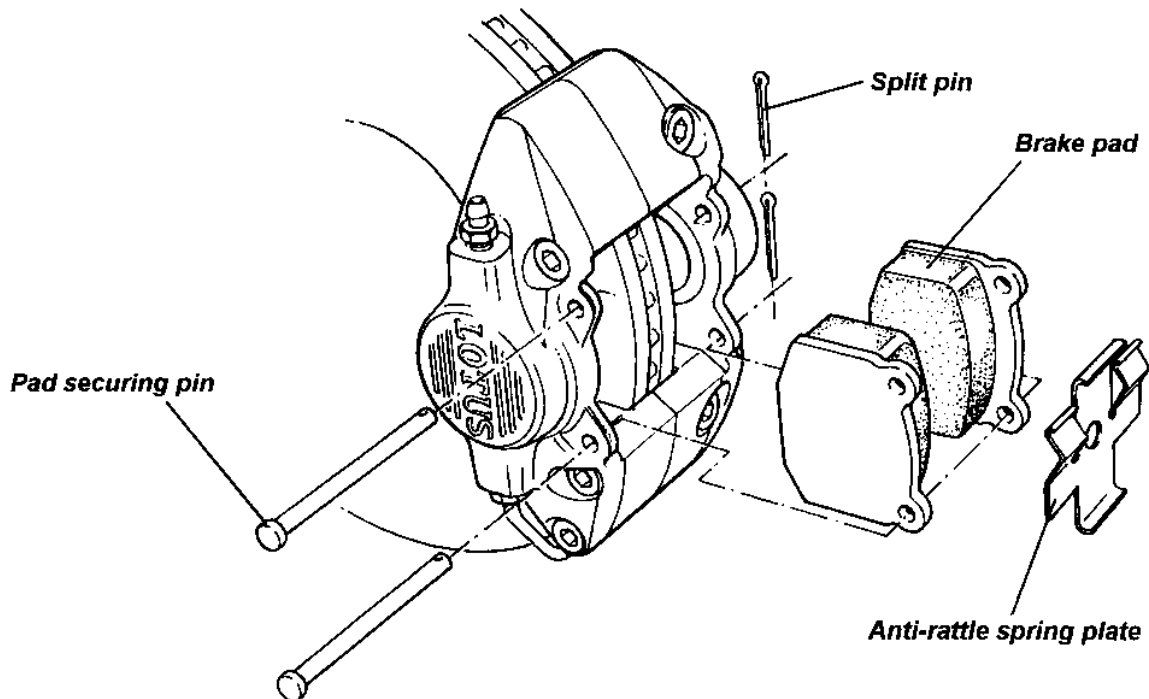
**J1.3 - FRONT BRAKE PAD REPLACEMENT**

Pad thickness may be checked with the wheel removed without disturbing the caliper.

- Standard pad thickness (excluding backplate); 9.0 mm
- Minimum pad thickness (excluding backplate); 2.5 mm

If the thickness of any pad is below the specified minimum, the axle set of pads should be renewed. Note that the pads are identified with T 4097 FF on the backplate. The pad backplates are factory fitted with anti-squeal overlays marked GM 027216.

1. To remove the brake pads; Remove the securing split pin and withdraw the lower of the two pad retaining pins, taking precautions to restrain the anti-rattle spring. Remove the second retaining pin and the anti-rattle spring plate. Withdraw the pads from the caliper. Measure the lining thickness and renew the axle set of pads if any lining is below 2.5 mm.



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2. Before replacing the pads, inspect the caliper for any signs of fluid leakage from a piston seal or joint, and replace the caliper if any such signs are evident. Clean the pad recess in the caliper taking suitable precautions to protect from dust inhalation.
3. If refitting the existing brake pads, refit each pad in the same position as originally fitted.
4. If fitting new pads, the pistons must be pushed back into the caliper to provide the necessary clearance. This action will return fluid to the master cylinder such that some fluid may need to be removed in order to prevent overflowing. Take care to avoid damaging the brake disc surface, or distorting the disc.
5. Position the pads in the caliper, and insert the upper pad retaining pin from the outboard side. Secure with the split pin.
6. Fit the anti-rattle spring into position with the side tangs pressing against the top end of the pad backplates, and the centre tang beneath the retaining pin. Insert the second pad retaining pin into the caliper, passing over the lower central anti-rattle spring tongue.
7. Before driving the car, press the brake pedal several times to bring the pads to their correct running position. Top up the master cylinder reservoir if necessary to bring the level to the 'MAX' mark.
8. Ensure the customer is made aware that maximum braking efficiency will be achieved if, for the first few hundred miles, needless heavy braking is avoided, and the brake pads are allowed to 'bed in' fully before being used to their full potential.

**J1.4 - REAR BRAKE PAD REPLACEMENT**

Pad thickness may be checked after removing the road wheel, without disturbing the caliper.

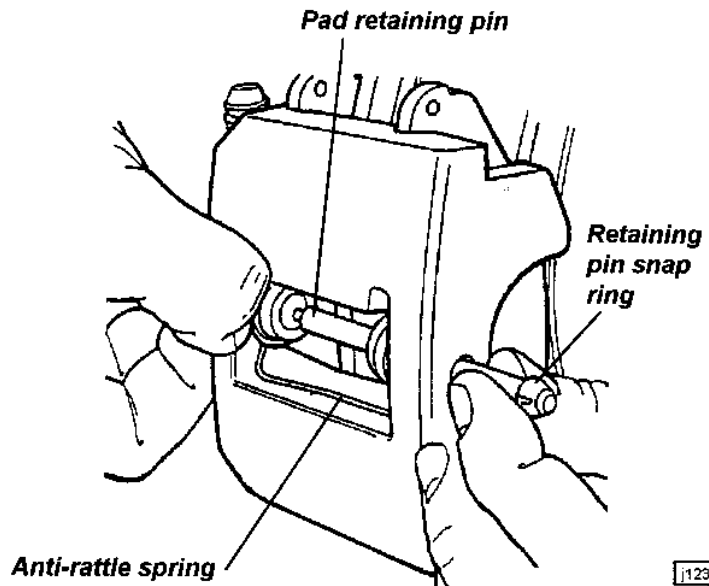
Standard pad thickness (excluding backplate);	6.5 mm
Minimum pad thickness (excluding backplate);	2.5 mm

If the thickness of any pad is below the specified minimum, the axle set of pads should be renewed. Note that the pad backplates are marked T 4097 FF and are factory fitted with anti-squeal overlays marked 07.5899.41 Brembo.

*Tools Required:*

Piston Retraction Tool T000T1242

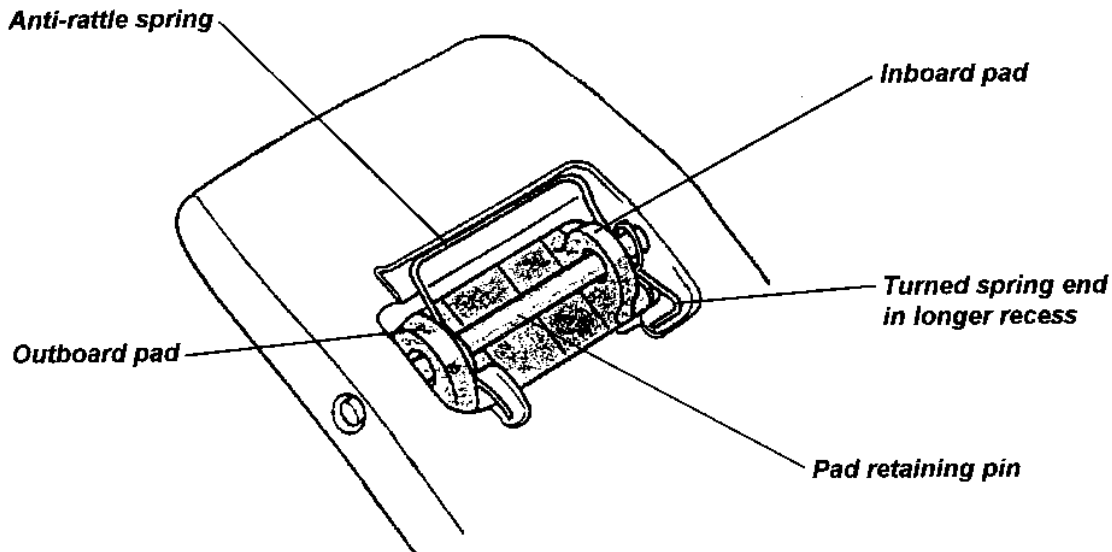
1. Remove the rear road wheels.
2. At each rear corner: using a suitable pin punch, knock the pad retaining pin out of the caliper towards the outside, taking precautions as necessary to restrain the anti-rattle spring from flying off as the pin is withdrawn.
3. Remove the anti-rattle spring, and withdraw both brake pads from the caliper. Measure the thickness of the lining material, and renew the axle set of pads if any are below 2.5 mm.



1123



4. Before refitting the pads, inspect the piston boot for splits, cracks or other damage, and for any signs of fluid leakage or wetness. If any such signs are apparent, the complete caliper should be replaced as Brembo do not recommend that this caliper be dismantled.
5. If refitting the existing brake pads, refit each pad in the same position as originally fitted.
6. Before fitting new rear pads, the caliper piston must be screwed back into the caliper down the parking brake actuation mechanism. This operation requires the use of special tool T000T1242 and the removal of the brake disc:
  - Remove the single socket head screw retaining the brake disc, and remove the disc.
  - Fit special tool T000T1242 into the holes in the caliper piston, and screw the piston back down the parking brake mechanism screwthread until fully bottomed.
  - Refit the brake disc, and tighten the countersunk retaining screw to 12 Nm.
7. Slide the brake pads into the caliper. Position the pad anti-rattle spring in the caliper aperture, with the spring ends located in the recesses provided. Ensure that the spring is fitted the correct way up, with the turned spring end in the longer recess. Press the spring eyes into alignment whilst the pad retaining pin is inserted through the caliper from the outside. Ensure that the pin passes through both eyes of the anti-rattle spring, and both brake pads, and that the pin is fully installed with the snap ring seated in the outboard side of the caliper.



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8. Refit the roadwheels and press the brake pedal several times to set the brake pad position. Before switching on the ignition, check the fluid level in the reservoir and top up if necessary.
9. Ensure the customer is made aware that maximum braking efficiency will be achieved if, for the first few hundred miles, needless heavy braking is avoided, and the brake pads are allowed to 'bed in' fully before being used to their full potential.

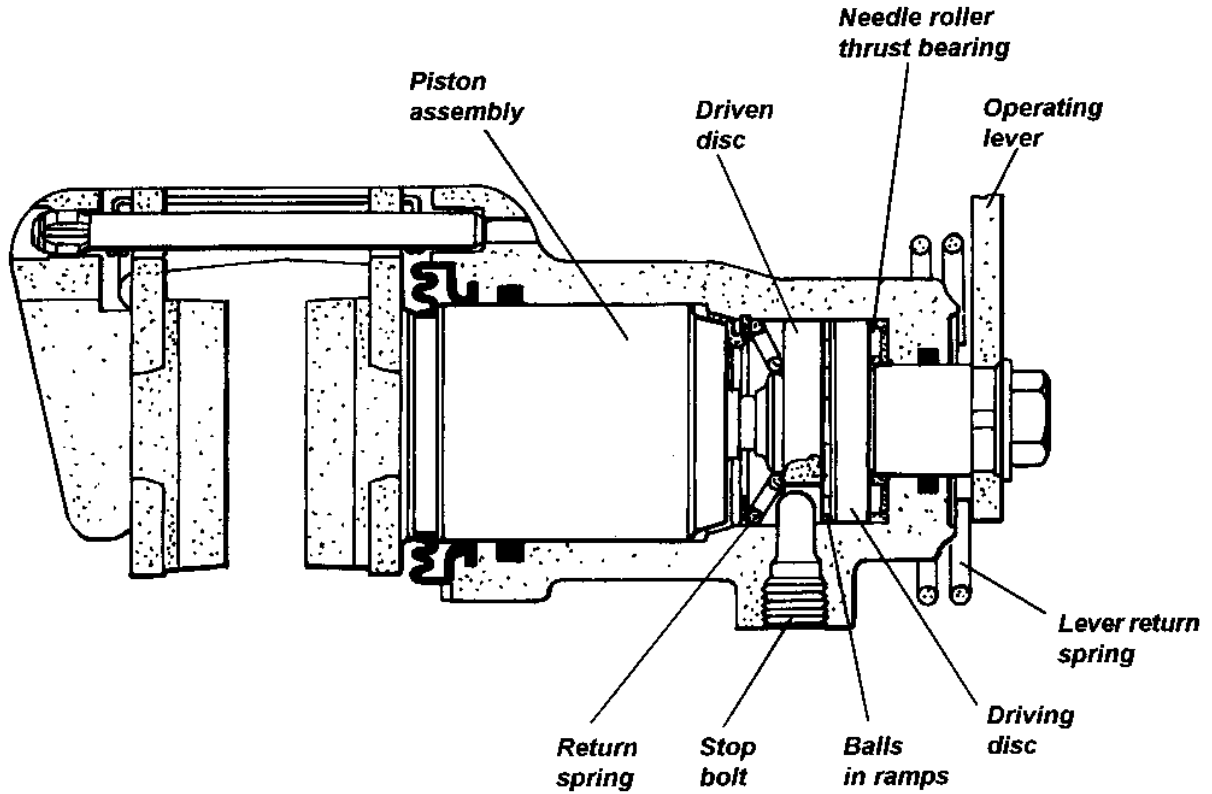
#### JI.5 - PARKING BRAKE MECHANISM

Operation of the parking brake lever applies a pull to a short link cable which connects via a horseshoe compensator to the centre of a single cable linking the two rear calipers. At each caliper, the cable connects to a lever which operates the hydraulic piston by mechanical means:

Movement of the caliper lever causes rotation of one of a pair of steel discs, rotation of the other being restrained by a stop bolt in the cylinder. Hardened balls housed in ramps machined in the discs, force the discs

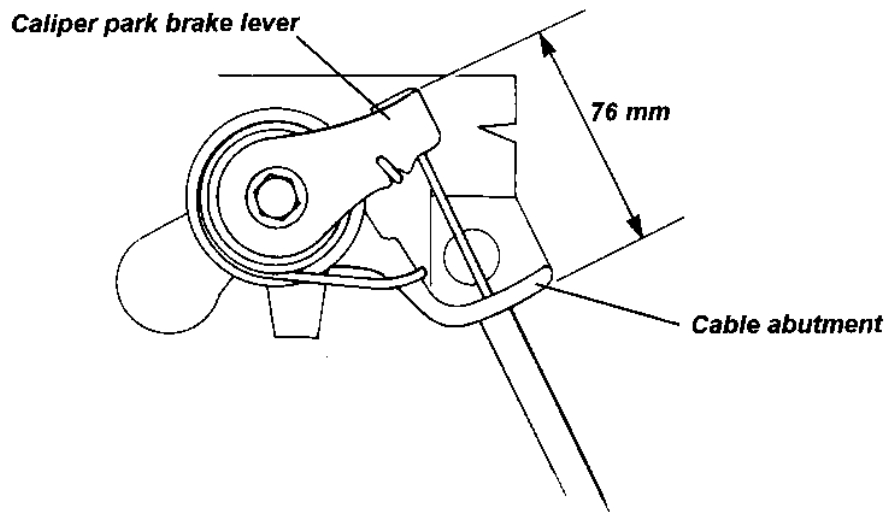


apart, and in so doing, apply an axial force to the piston via a screwthread and nut. The nut is restrained in the piston by a one way clutch which grips the nut when the parking brake is applied, but allows it to turn when the mechanism relaxes, or when the piston is operated hydraulically by the footbrake. In this way, the mechanical mechanism is adjusted automatically to compensate for pad wear.



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For the auto adjustment system to function correctly, it is essential that each caliper parking brake lever is allowed to return fully when the brake is released, and is not prevented from doing so by maladjustment of the parking brake cable. To check that the caliper levers are fully returned; with the parking brake 'off', measure the distance between the cable abutment and caliper lever as shown.

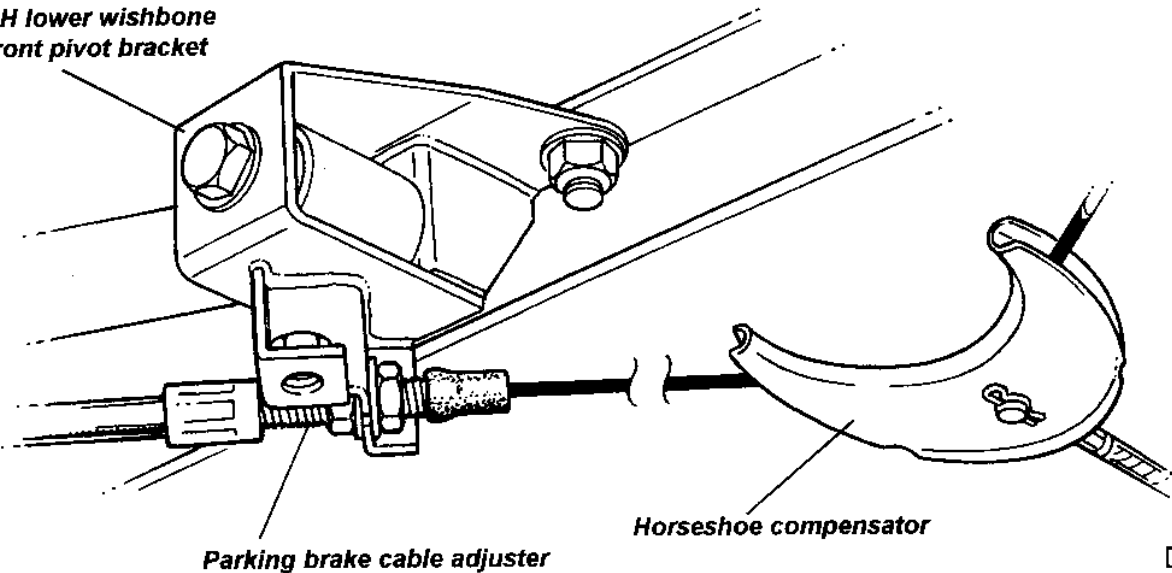


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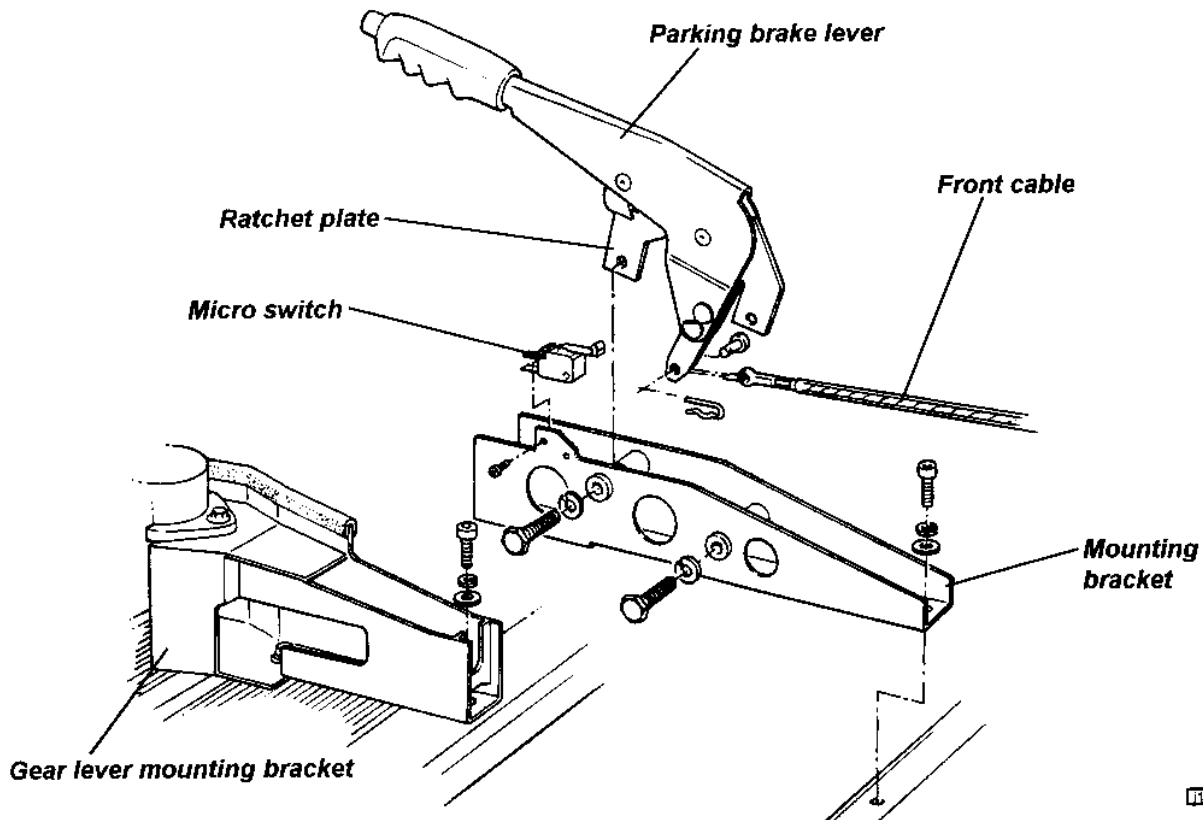


After verifying this dimension, any slack in the rear cable may be adjusted out at the left hand outer cable abutment, which is integral with the pivot bracket for the front leg of the lower wishbone. Remove the engine bay undertray for access. After adjustment, re-check the caliper lever 'off' dimension.

LH lower wishbone  
front pivot bracket



The parking brake lever is sandwiched into a mounting bracket by two flat head bolts securing the ratchet plate. The mounting bracket (in conjunction with the gearchange lever bracket) is not drive handed, but is offset, via alternative fixing holes in the chassis, *towards the passenger side*. The ratchet pawl operates a micro switch to light the 'brakes' tell tale lamp in the instrument panel whenever the ignition is switched on and the parking brake is applied. The short front cable is secured to both the lever assembly and the compensator horseshoe by clevis pins with retaining 'R' pins.



**JI.6 - BRAKE DISCS**

All four wheel brakes use a brake disc which is sandwiched between the wheel and its hub flange, being centralised by the hub spigot, and transmitting torque via the clamping force of the road wheel bolts. A countersunk screw is used to retain the discs for convenience when servicing.

The same disc is used at each corner of the car, and features cast iron construction with internal curved vane cooling. The opposite direction of rotation of the curved vanes on each side of the car does not significantly affect the cooling performance of the disc. The condition of the brake disc friction surface is a major factor in brake performance and feel, with a good surface quality and minimal run-out and thickness variation being required. After an extended lay up, some surface corrosion may develop on the discs which will cause a degradation in braking quality until the surfaces are cleaned up by normal brake action. Excessive run-out or thickness variation as a result of overheating or extended wear, may cause brake judder and/or extended pedal travel due to pad 'knock off'. Scoring and ridging of the braking surfaces will be exacerbated by operation in dusty or unmetalled road environments, and will reduce braking performance.

No skimming or re-surfacing of the brake discs is permitted. If the disc becomes badly scored, or is out of specification in any way, it should be renewed. NOTE: Ensure that there is no discernible free play in the wheel bearings before attempting to measure brake disc run-out.

**Brake disc thickness**

New	26.0 mm (1.02 in)
Service minimum	24.9 mm (0.98 in)

**Runout**

New maximum	0.03 mm (0.001 in)
Service maximum	0.10 mm (0.004 in)

**Front Disc Replacement**

1. Remove the road wheel.
2. Remove the two bolts securing the brake caliper to the hub carrier, and withdraw the caliper from the disc. Secure clear without straining the flexible hose.
3. Remove the single countersunk screw, and withdraw the disc from the hub.
4. Before re-fitting a disc, ensure that the mating face between disc and hub is scrupulously clean. Mount the disc onto the hub and align the wheel bolt holes.
5. Apply Permatbond A130 (A912E7033) to the threads of the caliper fixing bolts. Fit the caliper over the disc and secure to the hub carrier with the two bolts. Tighten to 45 Nm (33 lbf.ft).
6. Refit the road wheel and operate the brakes before driving the car to set the brake pad position.

**Rear Disc Replacement**

Replacement of the rear discs is similar to that for the front discs, except that if the brake pads are removed, it is not necessary to remove the brake caliper to enable the disc to be withdrawn from the hub.



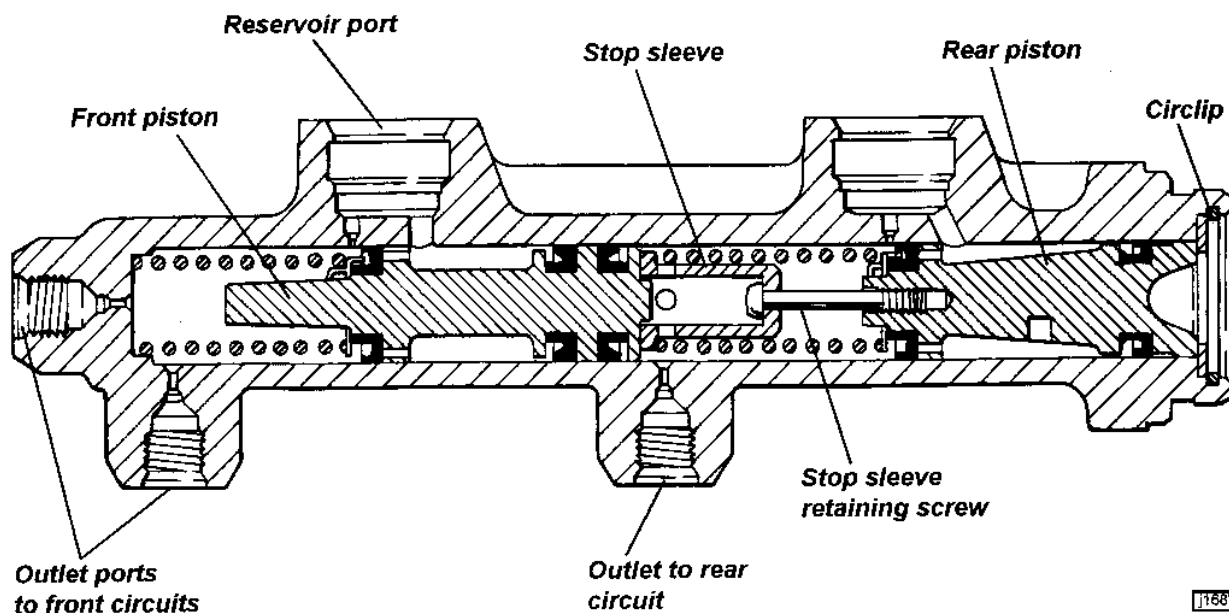
**J1.7 - BRAKE MASTER CYLINDER**

The tandem brake master cylinder is mounted in the front compartment and is secured to the pedal box by two M8 bolts. To remove the unit, proceed as follows:

1. Syphon fluid from the reservoir to reduce spillage.
2. Disconnect the clutch master cylinder supply hose from the reservoir and plug the hose.
3. Release the three brake pipes from the master cylinder, and plug the pipes and ports.
4. Release the master cylinder from the pedal box:
  - The top fixing bolt uses a Nyloc nut and flat washer on the inside of the box.
  - The lower fixing bolt uses a captive nut plate within the pedal box.

**To Replace Seals**

1. Thoroughly clean the exterior of the master cylinder assembly before commencing, in a clean environment, any dismantling operation.
2. Carefully withdraw the fluid reservoir spigots from the master cylinder grommets.
3. Remove the pushrod boot and the front piston stop bolt and washer.
4. Using a rounded end mandrel, press the rear piston into the cylinder sufficiently to relieve load on the cylinder end circlip. Remove the circlip and stop washer, and carefully remove the pistons and springs from the cylinder. If necessary, knock the cylinder against a wood or plastic surface to extract the front piston assembly.

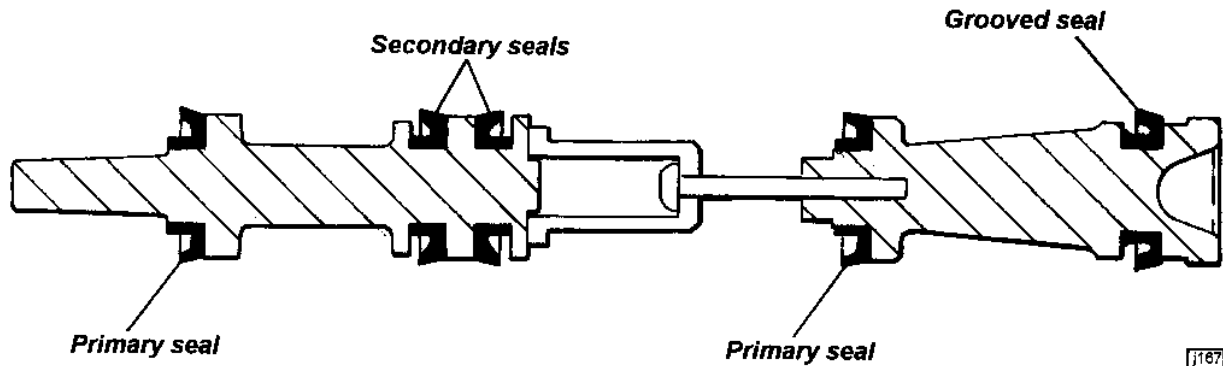


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5. Press the stop sleeve against the rear piston and release the screw retaining the sleeve. Remove the stop sleeve, screw, spring and spring seat washer. Carefully remove the primary seal and grooved seal from the rear piston.
6. From the front piston, remove the primary seal and the two secondary seals.
7. Thoroughly clean the cylinder bore, inlet and outlet ports, and all component parts using brake cleaning fluid or alcohol and blow dry with compressed air. Carefully inspect the master cylinder bore for scoring and corrosion. Any more than the slightest signs of either of these effects indicates that the unit should be renewed.
8. Thinly coat the cylinder bore with ATE Brake Cylinder Paste or ATE Brake Assembly Spray or a similar product, to facilitate assembly and prevent corrosion.
9. Before assembling the seals onto the pistons, note that three different seals are used, with the part number printed on the lip of each seal.

Primary seal	03.3301-1933.1
Secondary seal	03.3301-1934.1
Grooved seal	03.3402-1901.1

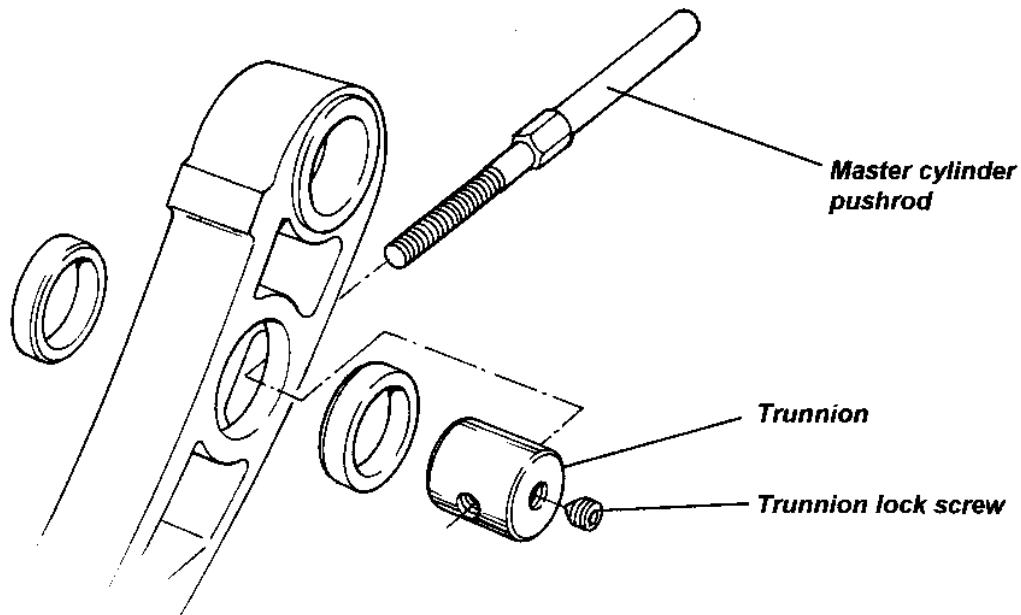


10. Assemble the front piston:
  - Fit a primary seal (03.3301-1933.1) into the front groove of the piston with the lip facing forwards.
  - Fit the support ring onto the piston nose to retain the seal and form a seat for the cylinder front spring.
  - Fit a pair of secondary seals (03.3301-1934.1) into the two grooves at the rear end of the piston, with the lip of the front seal facing forwards, and the lip of the rear seal facing rearwards.
11. Assemble the rear piston:
  - Fit a grooved seal (03.3402-1901.1) into the rear groove with the lip facing forwards.
  - Fit a primary seal (03.3301-1933.1) onto the front of the piston with the lip facing forwards.
  - Fit the spring support ring onto the piston spigot, spring and stop sleeve, and compress the spring to enable the retaining screw to be fitted and tightened.
12. Thinly coat all piston seals and the piston shoulders with ATE Brake Cylinder Paste or ATE Brake Assembly Spray or similar.
13. Fit the front piston return spring onto its seat on the front piston, and carefully insert the front piston assembly into the cylinder taking great care not to damage the lips of the forward facing seals.
14. Fit the rear piston assembly into the cylinder, again taking great care not to damage the lips of the forward facing seals. Using a rounded end drift, press the piston against its spring to enable the stop washer and retaining circlip to be fitted into the end of the cylinder.





15. Thinly coat the two reservoir spigots and sealing grommets with ATE Brake Cylinder Paste or ATE Brake Assembly Spray or similar, and insert the grommets into their locations in the master cylinder body. Fit the reservoir to the master cylinder with the two spigots fully inserted into their grommets. Ensure that the cap is positioned towards the rear with the clutch fluid take off on the left.
16. Lubricate the pushrod boot with rubber grease before fitting onto the end of the master cylinder, with its lip correctly located in the groove.
17. Fit the master cylinder assembly to the pedal box, inserting the brake pedal pushrod through the master cylinder boot to engage into the hollow of the rear piston. Retain with the two M8 bolts and tighten to 28 Nm (21 lbf.ft).
18. Check the pushrod length:  
The pushrod length must be adjusted to apply a slight preload to the master cylinder with the pedal released. Too much preload will not allow the reservoir port to open. Too little preload will allow free play and a rattle from the pedal:
  - Remove the locking grub screw (3 mm key) in the end of the pedal trunnion, apply PermaBond A131 threadlock, and refit loosely;
  - Screw the pushrod into or out of the trunnion until the pedal just contacts the pedal box flange (upstop).
  - Apply ½ turn of preload to the pushrod, and tighten the trunnion lock screw to 5 Nm.



c48

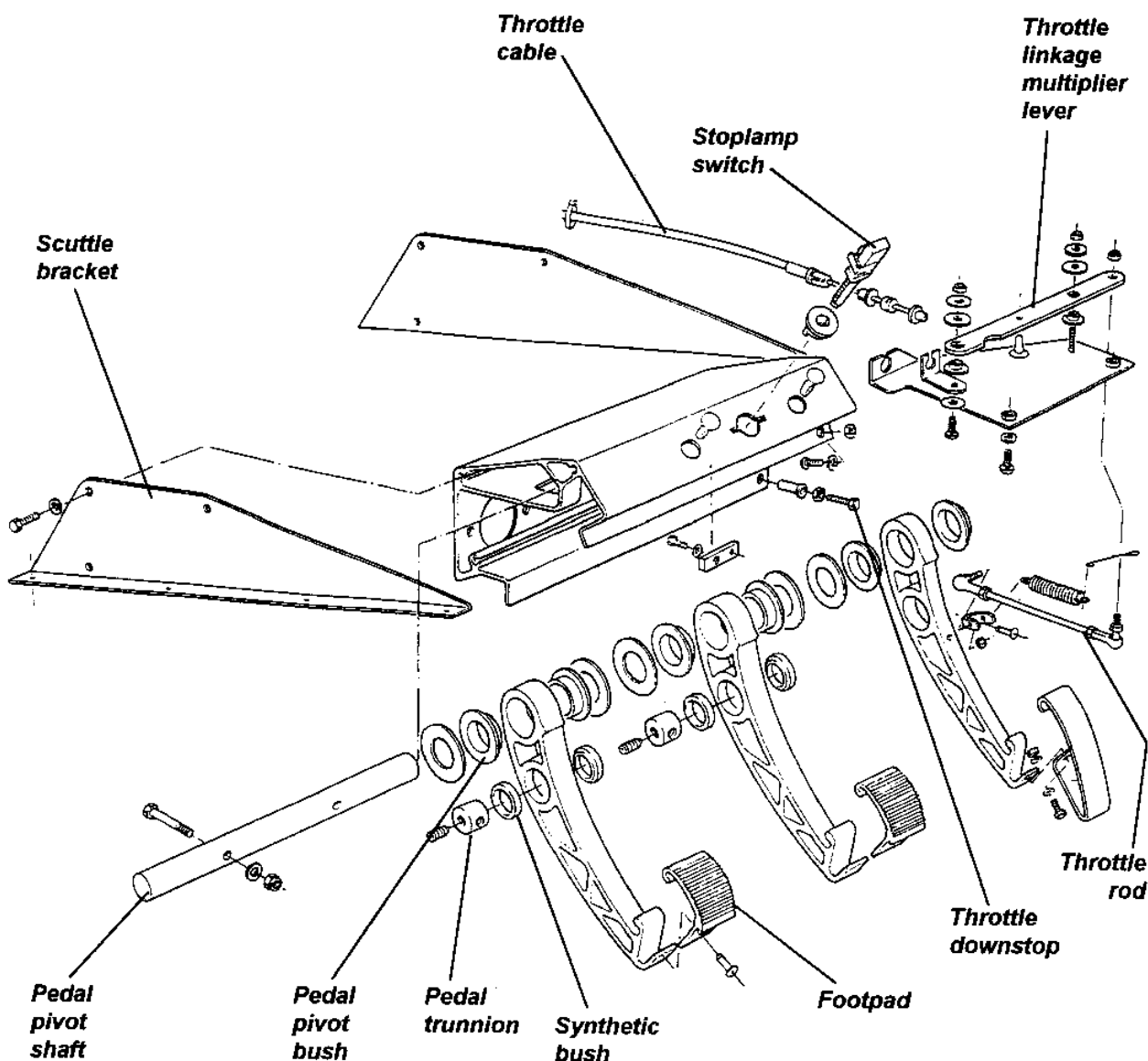
19. Check the stop light switch adjustment: With the pedal released, check that the switch plunger is depressed, with about 1 mm of the white plunger visible - or check the operation of the brake lamps. If necessary, twist the switch body 90° counterclockwise to release from the quickthread, and reset its position to achieve the desired result.
20. Connect the brake pipes to the cylinder; rear circuit to the rear port, front circuits to the two front ports. Fit the clutch fluid supply hose to the reservoir spigot.
21. Fill the reservoir with DOT 4 non-mineral type brake fluid, and bleed the complete brake system of air using standard vacuum assisted, pressure assisted or manual techniques.



JI.8 - PEDAL BOX

The extruded aluminium alloy pedal box is secured to the chassis scuttle via six horizontally disposed M6 screws, three fixing each side of the box to a vertical bracket, itself bonded and rivetted to the chassis. A steel pivot shaft is clamped into the pedal box, and serves all three pedals, which are themselves common alloy extrusions, with the throttle pedal being a narrower section than that used for the brake and clutch. An extruded footpad is keyed and bolted or rivetted to the bottom of each pedal. The brake and clutch pedals use cylindrical trunnions to actuate their master cylinder pushrods, with the bore for the brake pedal trunnion being machined nearer to the pedal pivot than that for the clutch pedal. Two synthetic bush rings are pressed into the pedal bores to provide a maintenance free pivot for the steel trunnions.

The throttle pedal uses a ball jointed rod, and multiplier lever to operate a throttle control cable which is routed along the cockpit centre, beneath the gear lever and parking brake lever trim panels.

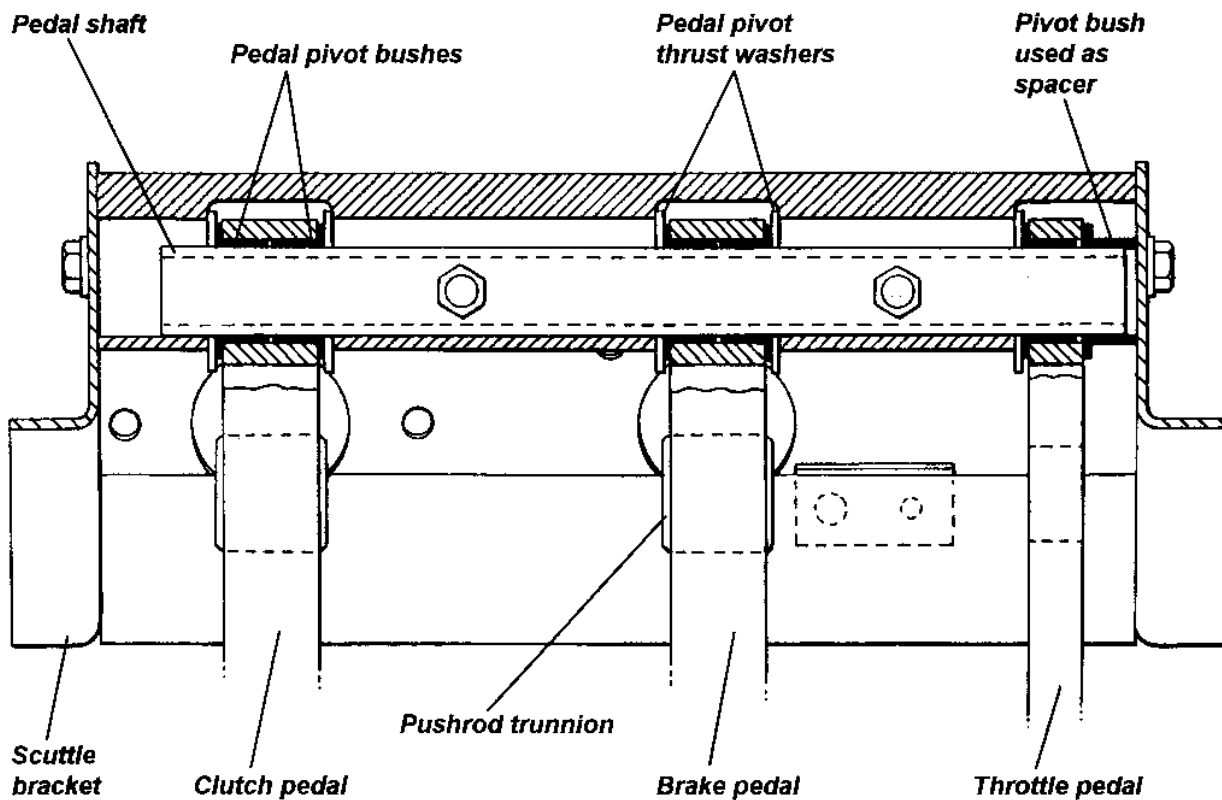


J16Ca



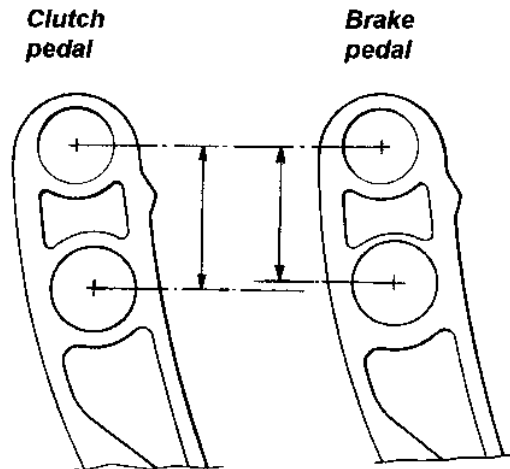
The pedal box may be removed from the car complete with pedals, but to avoid hydraulic fluid loss and the necessity for subsequent bleeding, the brake and clutch master cylinders should be released from the pedal box before removal:

1. Release brake master cylinder from the pedal box (see sub-section JI.7) and ease the cylinder clear of the pedal box to disengage the pushrod, without straining the hydraulic pipes.
2. Release the clutch master cylinder from the pedal box: Remove the two Nyloc nuts and flat washers from inside the pedal box, and ease the cylinder clear of the pedal box to disengage the pushrod.
3. From within the footwell, release the ball jointed rod from the throttle pedal.
4. Twist and withdraw the brake light switch from the top rear of the pedal box.
5. Remove the upper and intermediate steering columns (see sub-sections HF.3 & HF.4).
6. Remove the three M6 screws securing each end of the pedal box to the scuttle beam brackets, and withdraw the complete pedal box downwards into the footwell. For access to the inboard fixings, it may be necessary to release, or modify, the climate distribution chamber
7. With the pedal box removed, the space bush and throttle pedal may be slid off the end of the pivot shaft. The shaft may be withdrawn after removal of its two retaining bolts, freeing the brake and clutch pedals and their thrust washers. Note that brake and clutch pedals are fitted with two 'top hat' section plastic pivot bushes, with a plastic thrust washer fitted each side of both pedals. The throttle pedal uses a single bush fitted from the inboard side, with a thrust washer on the inboard side and a pivot bush used as a spacer between the pedal and the scuttle bracket.





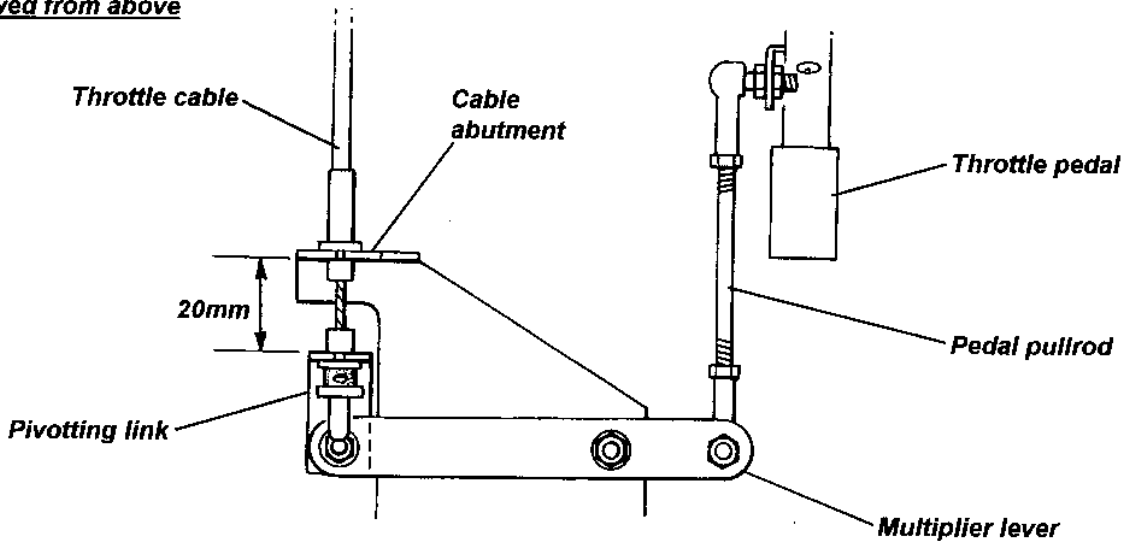
8. On re-assembly, note that no lubricants are used in conjunction with plastic bushes.  
 Take care to correctly identify the brake and clutch pedals: The bore for the pushrod trunnion is offset on the brake pedal towards the pivot.



1168

7. Refit in reverse order to removal, adjusting the brake pedal pushrod as detailed in sub-section J1.7 and the clutch pedal in a similar manner. The throttle pedal upstop should be adjusted as follows:
- Adjust the pedal upstop for a throttle pedal height approximately 30mm lower than the clutch and brake pedals.
  - Adjust the length of the ball jointed pull rod to achieve a gap of 20mm between the outer cable abutment and the inner cable pivoting link on the multiplier lever.
  - Adjust the cable slack at the engine end abutment as detailed in section EMN (or 'Lotus Check' operating instructions).
  - Adjust the pedal downstop so that full travel of the throttle butterfly can just be achieved without allowing the cable to be strained. Check that at full throttle, there is adequate clearance between throttle body quadrant and cable adjuster.

**Viewed from above**



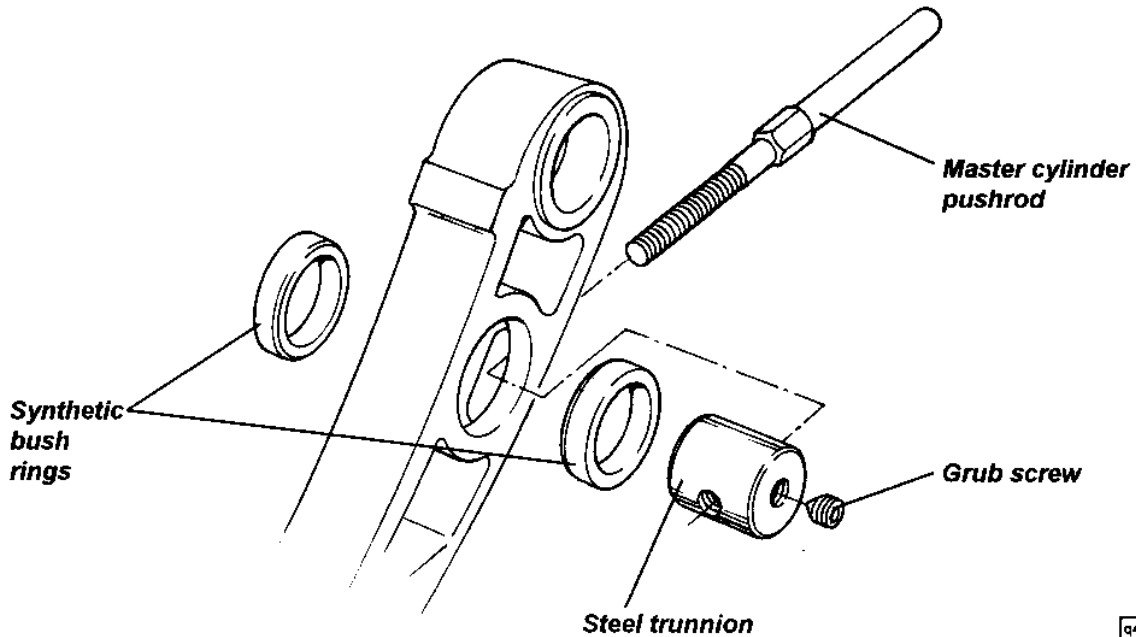
1171

Torque Settings	Nm
Pedal box to chassis	9
Brake master cylinder to pedal box	28
Clutch master cylinder to pedal box	28
Brake pipes to master cylinder	15



Pedal Trunnion Bushes

The brake and clutch pedals each use cylindrical steel trunnion to actuate the master cylinder pushrod, with the trunnion supported by two synthetic bush rings pressed into the pedal bore. The bush rings may be replaced with the pedal 'in-situ', by using a suitable bolt with clamp washers to press the rings into position, noting that each bush has an outer diameter chamfer at one end to aid insertion.

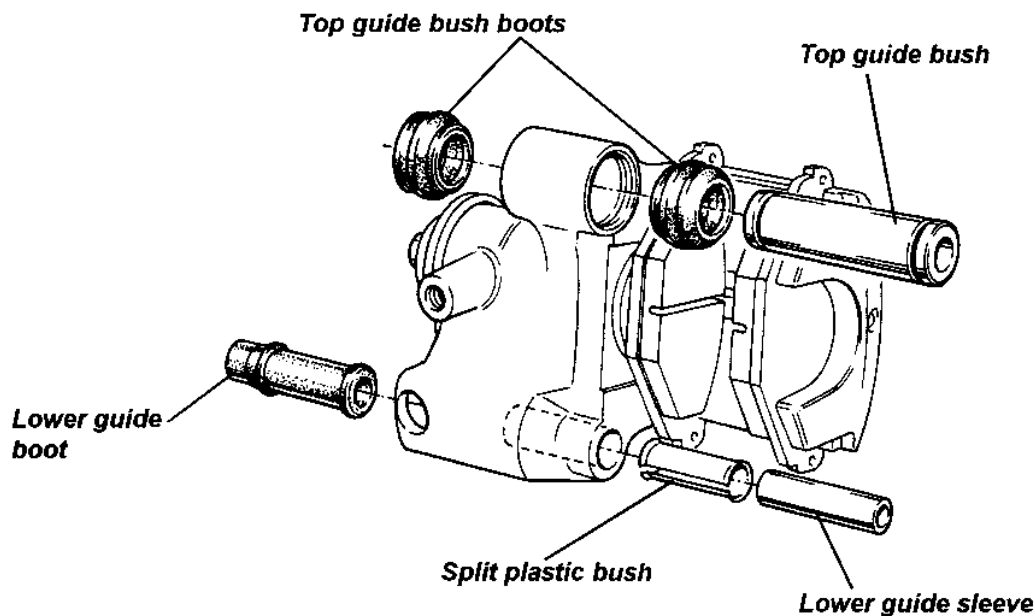


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J1.9 - CALIPER OVERHAUL

The front brake calipers are manufactured by A.P. Racing, and are to be dismantled or overhauled only by their factory at Wheeler Road, Seven Stars Industrial Estate, Coventry, CV3 4LB.

The Brembo rear brake calipers may have the sliding pins overhauled as detailed below, but any signs of hydraulic leakage from the cylinder indicate that the unit should be replaced.



r163

**Rear Caliper Sliding Pins**

The sliding bushes and sleeves of the Brembo rear calipers may be replaced without disturbing the hydraulic connection:

- a) Disconnect the parking brake cable from the caliper.
- b) Remove the cap head bolt securing the bottom guide bush to the hub carrier.
- c) Remove the hex. head bolt securing the top guide bush to the hub carrier, and withdraw the caliper from the car with the brake hose still connected.
- d) Slide out the lower steel guide sleeve and withdraw the bush/boot from the caliper. Pull the boots off the top steel guide bush and slide out the bush from the caliper.
- e) Clean the guide bores in the caliper body with brake cleaner. Lubricate the new bushes and boots with silicone grease provided in the repair kit, and reassemble into the caliper in reverse order to disassembly.
- f) Refit the caliper to the hub carrier using Permabond A134 on the threads of both bolts, torque tightening the two fixings to:  
Upper M10 bolt;           45 - 50 Nm (33 - 37 lbf.ft)  
Lower M8 caphead;       26 - 30 Nm (19 - 22 lbf.ft)
- g) Reconnect the parking brake cable and operate the footbrake to reposition the pads before driving the car.



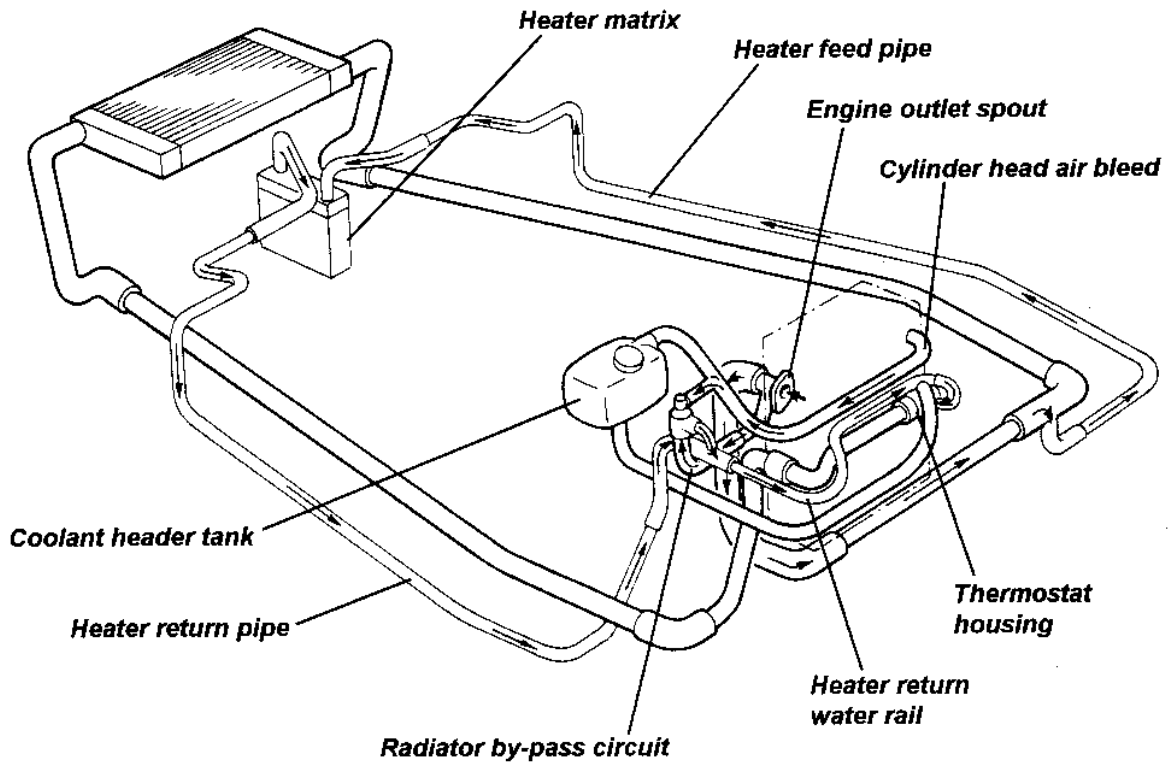
ENGINE COOLING

SECTION KG - ELISE 2001 M.Y. Onwards

	<u>Sub-Section</u>	<u>Page</u>
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Radiator & Cooling Fan	KG.4	6
Radiator Fan Control	KG.5	8
Radiator Feed & Return Pipes	KG.6	8
Water Pump & Thermostat	See Section EE	

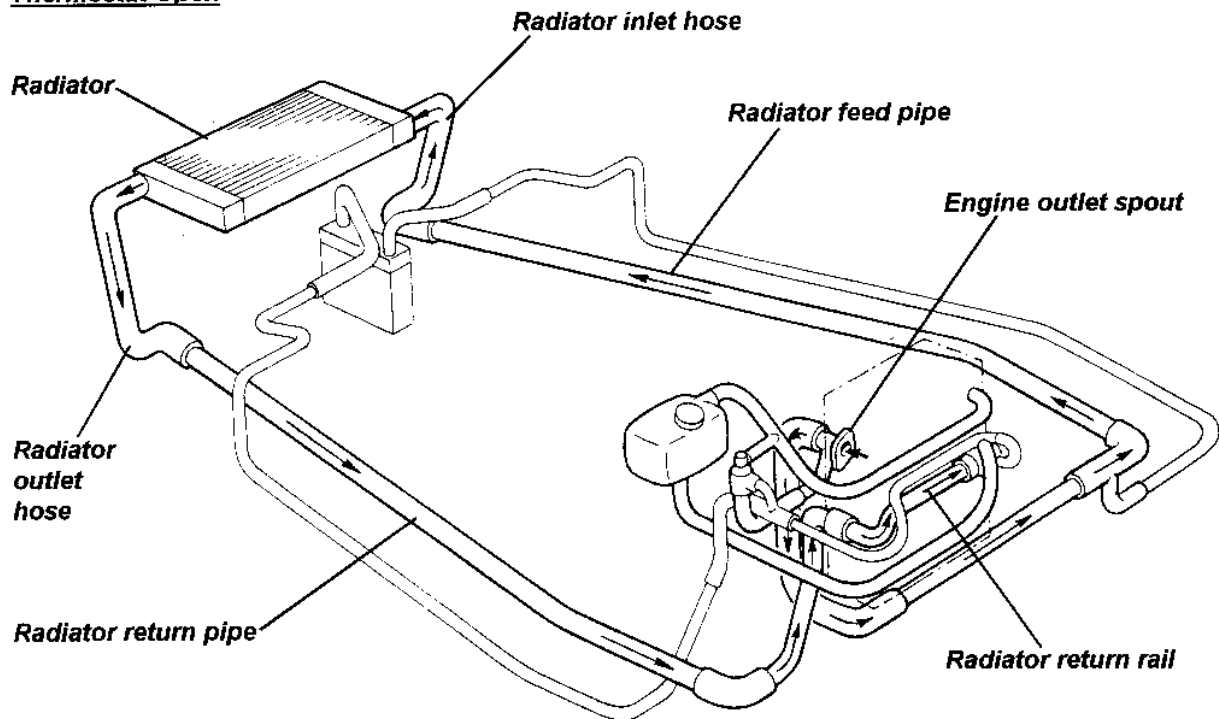


**Thermostat Closed**



k59a

**Thermostat Open**



k56a





### KG.1 - GENERAL DESCRIPTION

The engine cooling system comprises an engine driven water pump, a front mounted radiator with electric cooling fan(s), and associated ducting, pipework and controls.

The centrifugal water pump is mounted on the front face of the cylinder block, and is driven by the camshaft toothed belt. Water is discharged from the pump into the front of the cylinder block, around the cylinder liners and up into the cylinder head, before exiting the engine via an outlet elbow at the left hand rear of the head. From the outlet elbow, there are three routes through which water may flow:

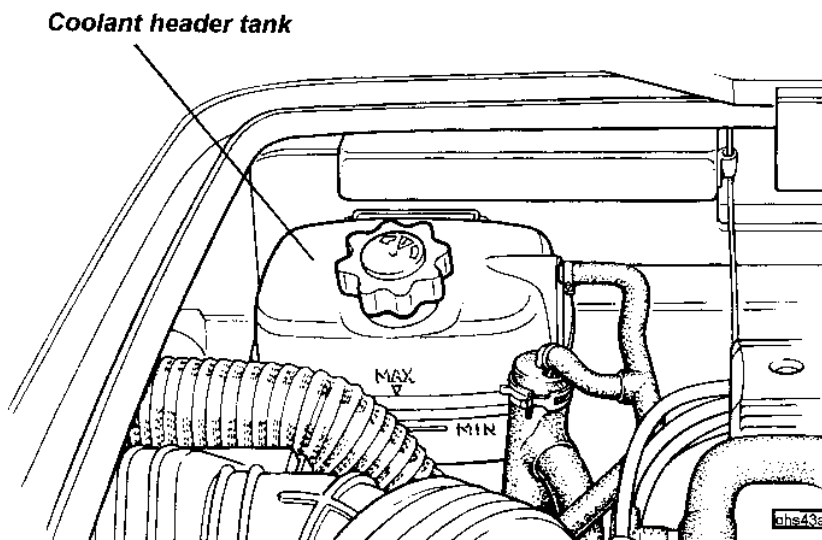
- Radiator circuit; The larger of the two spouts on the outlet elbow is connected via an alloy pipe running through the chassis right hand side rail, to the front mounted radiator. Water returns from the radiator via a pipe in the chassis left hand side rail to the engine bay. One of a pair of steel tube water rails fixed to the engine, then directs this water around the back and the right hand side of the engine to a plastic bodied thermostat housing fixed to the back of the water pump.
- Heater circuit; A take-off for the heater is provided in the radiator feed circuit at the right hand front of the engine bay, from where it is routed through an alloy pipe fixed to the outside face of the RH chassis side rail, to the heater matrix mounted in the chassis well ahead of the cabin footwell. Water returns from the heater via an alloy pipe routed outside the LH chassis side rail, connecting with a second steel tube engine mounted water rail, to the water pump side of the thermostat housing.
- Radiator by-pass circuit; The smaller of the two spouts on the cylinder head outlet elbow connects directly with the heater return pipework. When the thermostat is closed, the radiator return circuit is shut off, so that water is forced to flow through the heater and by-pass circuits, thus ensuring optimum heater performance.

The header tank is mounted at the left hand front of the engine bay, with a hose from its underside connecting with the heater return rail near the thermostat housing. An air bleed hose connects the header tank air space with the radiator by-pass circuit and a cylinder head spigot at the front end of the inlet manifold. The tank is fitted with a 110 kPa (15 lb/in<sup>2</sup>) pressure cap to raise the boiling point of the coolant to over 120°C.

The engine cooling radiator is of aluminium construction with plastic end tanks and is horizontally mounted at the front of the vehicle, on top of the glass fibre composite 'crash structure' which also serves as a duct to direct airflow from the body nose air intake, to the underside of the radiator. A single 100 mm diameter electric cooling fan is fitted to the underside of the radiator to supplement, when required, the ram air flow, and a moulded duct directs air exhausting from the top of the radiator through outlets incorporated into the front bonnet. On cars equipped with air conditioning, the condenser is sandwiched between the radiator and crash structure, with two cooling fans attached to its underside. Separate coolant temperature sensors for the engine management system (which also controls the radiator fan), and the temperature gauge are fitted in the cylinder head outlet elbow.

### KG.2 - MAINTENANCE

Under normal operating conditions, the engine cooling system, being a closed circuit, should not require any topping up between services. As a precaution however, every week, the level of coolant in the engine cooling header tank should be checked. The translucent header tank is marked with both cold and hot level indicators. The level of coolant will rise as the engine warms up and the coolant expands, and will fall again





as it cools down.

**WARNING: Do NOT remove the cap from the engine cooling header tank when the engine is warm, as serious scalding could result from boiling water and/or steam.**

When fully cold, the level of coolant should be up to the 'cold' mark moulded on the header tank. If overfilled, the excess coolant will be ejected when the engine is warm, and if the level is allowed to fall too low, overheating may result. If necessary, top up the system using an approved coolant mixture (see below) to maintain full protection from freezing damage and corrosion.

#### Anti-Freeze/Corrosion Inhibitor

It is necessary that the coolant contains an anti-freeze with corrosion inhibitor to protect the engine and heat exchangers from both frost damage, and corrosion of the metallic elements. A good quality mono-ethylene glycol anti-freeze, provides protection against these dangers as well as raising the boiling point of the coolant. The car is factory filled, for all markets, with a 50% concentration of 'Unipart Superplus Antifreeze & Summer Coolant', which is the only recommended coolant product, and provides freezing protection down to approximately - 35°C. In warm climates it is recommended that the concentration is not allowed to fall below 25%, in order to maintain full corrosion protection.

The simplest means of checking the antifreeze concentration is to measure the specific gravity (density) of the coolant at a known temperature, using a hydrometer. The following table provides a general guide:

<b>Concentration</b>	<b>Density @</b>	
	<b>20°C</b>	<b>60°C</b>
25%	1.039	1.020
33%	1.057	1.034
50%	1.080	1.057

The coolant density reflects the effective level of mono-ethylene glycol, and not the level of corrosion inhibitors present, whose effectiveness diminishes over a period of time. The coolant should therefore be renewed every 24 months to ensure optimum corrosion protection.

In areas where the tap water is extremely hard (exceeding 250 parts per million), use of this water will lead to 'furring up' of the system over a period of time. In such areas, distilled, de-ionised or filtered rain water should be used.

#### Radiator Fin Cleaning

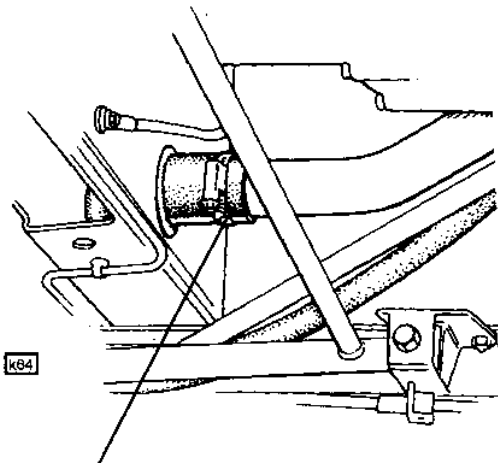
At service intervals, the matrix of the engine cooling radiator should be checked for clogging by insects, leaves and other debris. If necessary, use a water jet from both above and below to clean the fins, taking care not to damage the fragile tubes or distort the finning. At the same time, check the integrity of all cooling system joints, and the condition of all flexible hoses. In snowy conditions, ensure the radiator air exit is cleared of snow before driving the car.

#### KG.3 - DRAIN/REFILL PROCEDURE

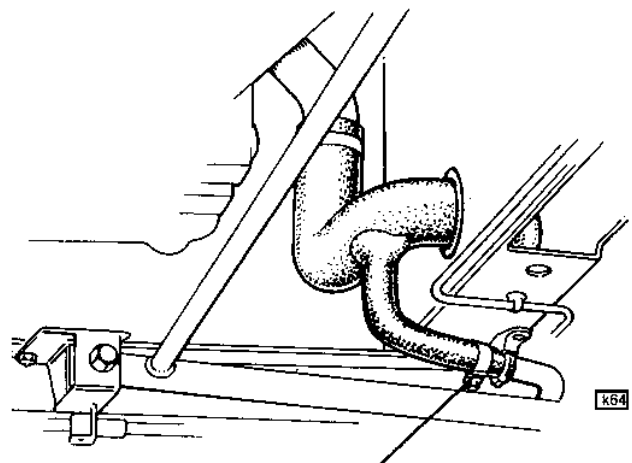
To drain the engine cooling system, remove the header tank cap, and disconnect the radiator feed and return hoses from the rear ends of the water rails running down each sill. If necessary, raise the front of the car to aid draining. Note that draining of the heater matrix is not easily possible with the unit 'in situ', and that if draining for the purpose of coolant change, this volume should be disregarded.

To refill the system:

- 1 Refit the hoses, and fill with the recommended coolant mix via the header tank.

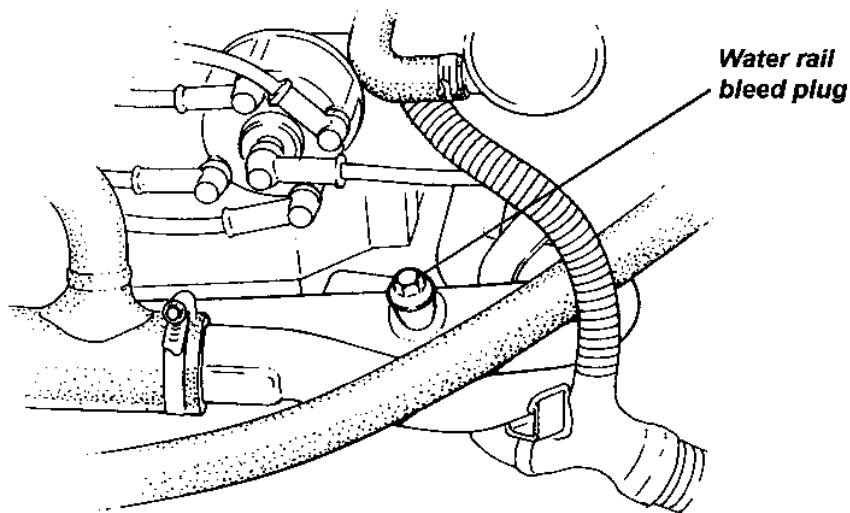


**Disconnect LH return hose at this point**

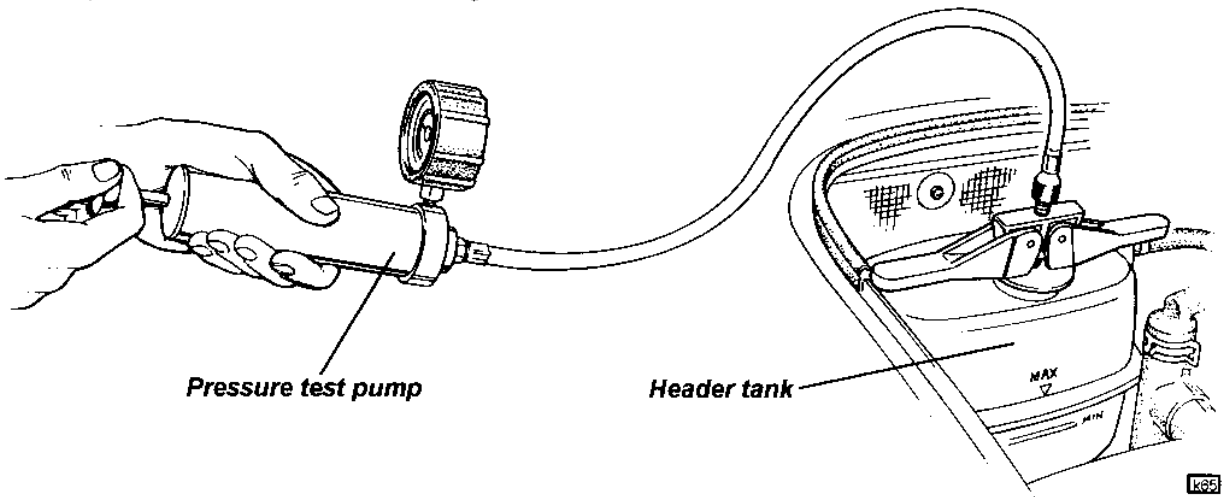


**Disconnect RH hose at this point**

2. Remove the bleed screw in the return water rail at the left hand side of the engine, taking care not to misplace the sealing washer.

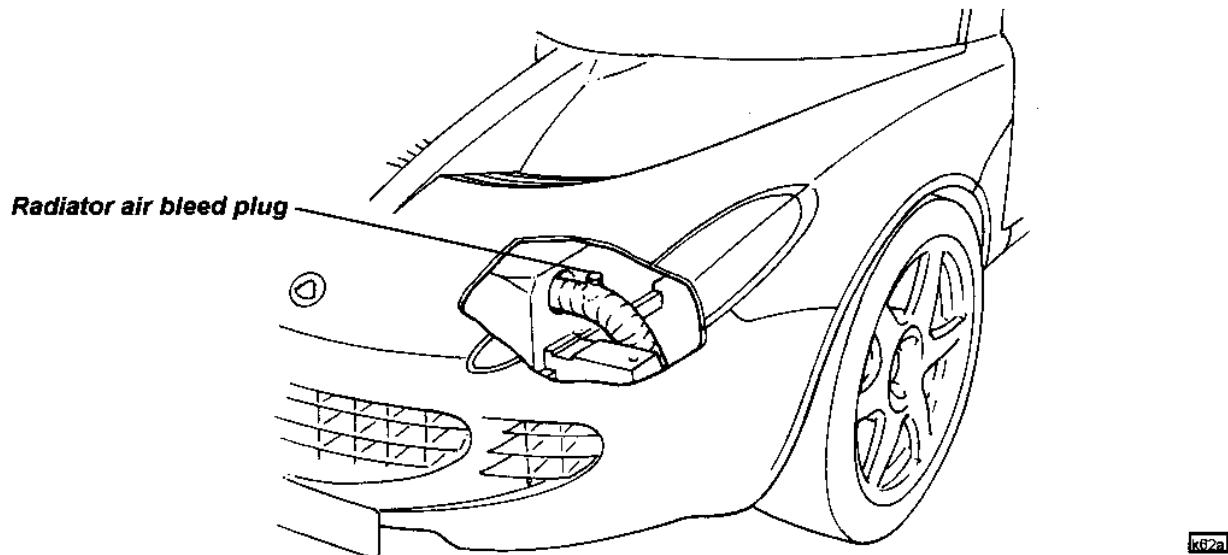


3. Using radiator pressure test equipment, pressurise the header tank to circulate the coolant. When necessary, refill the header tank and repeat. When a steady stream of coolant flows from the bleed port, replace the screw and washer and tighten.





4. Release the front end of the LH front wheelarch liner, to provide access to the radiator outlet hose bleed screw. Pressurise the system to 35 kPa (5 lbf/in<sup>2</sup>) and open the radiator hose bleed screw until a steady stream of coolant flows. Tighten the bleed screw.



5. Remove the pressure test equipment and top up the header tank to the cold level. With the header tank cap removed, start and run the engine at idle until the water temperature gauge reads 60 - 65°C. Increase engine speed to 2000 rpm and observe the temperature gauge which should indicate 93 - 98°C before dropping to 90°C due to the action of the thermostat and the circulation of air pockets. After a further rise and fall of indicated temperature, re-bleed at the radiator hose with the engine running.
6. Continue to run the engine at 2000 rpm until the radiator return pipe at the engine feels hot, at which time the header tank cap should be replaced. Check that the radiator fan cuts in at 103 - 105°C and brings down the temperature to 90 - 95°C, before the cycle repeats.
7. Stop the engine and allow to cool fully before topping up the header tank to the 'low' mark.

#### KG.4 - RADIATOR & COOLING FAN

The aluminium cored radiator is positioned horizontally on top of the composite 'crash structure' in the front services compartment. A composite moulding is used to mount the radiator, and also, via extensions at each side, to provide a mounting point for the inside front of the clamshell wheelarch. The radiator must be removed for access to the cooling fan(s).

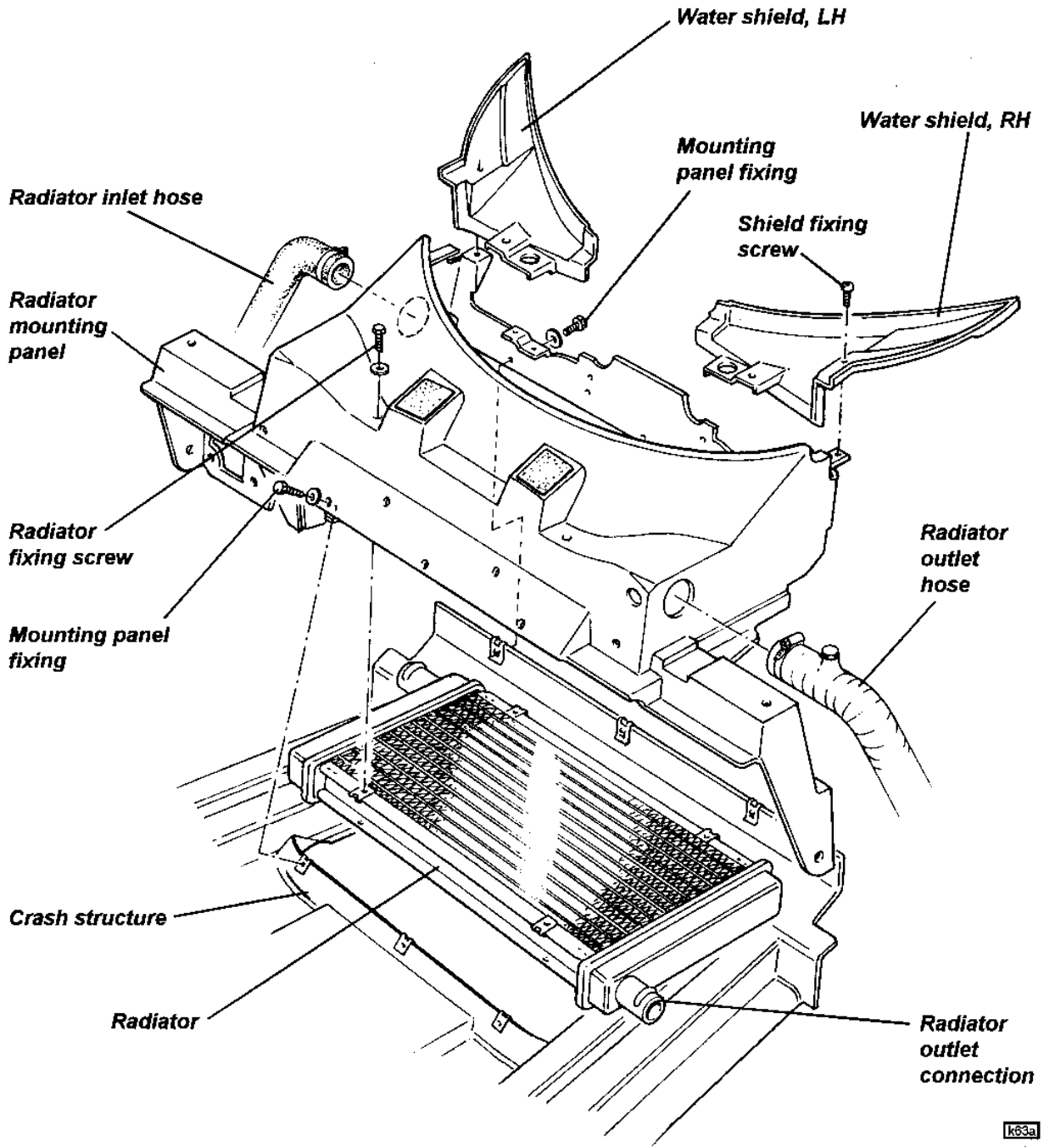
##### To Remove Radiator

1. Remove the front clamshell (see sub-section BP.5).
2. Drain the coolant and disconnect the feed and return hoses from the radiator.
3. Release the two fixings securing each water shield to the top rear edge of the radiator mounting panel, and withdraw both shields.
4. Release the tie wraps, and unplug the rad. fan harness connector(s).
5. Release the single fixing at the bottom of each side extension securing the mounting panel to the bottom flange of the crash structure.



6. Release the three fixings securing the back edge of the mounting panel to the vertical flange on the crash structure, and the three fixings along the front edge of the panel.
7. Release the four fixings securing the radiator to the mounting panel, and withdraw the panel from the radiator.
8. Withdraw the radiator and cooling fan assembly. On a.c. cars, lift the radiator/condenser assembly only sufficiently to release the cooling fans or radiator as required, without disconnecting the refrigerant circuit.

Lift away the panel complete with the radiator and fan.



k63a

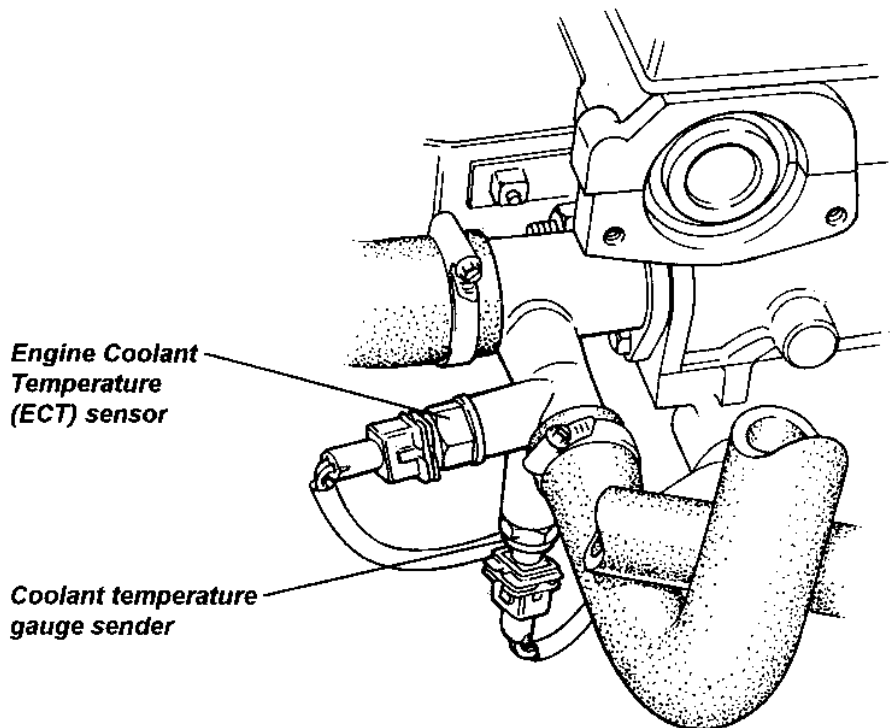


6. Release the fan motor from the radiator by removing the four nuts securing the fan shroud to the mounting brackets rivetted to the radiator frame. Withdraw the fan harness through the mounting panel grommet.
7. Remove the four screws securing the radiator to the mounting panel.
8. Refit the radiator in reverse order to removal and refill with coolant and bleed as detailed in sub-section KG.3.

#### KG.5 - RADIATOR FAN CONTROL

The engine management ECM requires a coolant temperature input signal in order to increase fuel delivery and maintain driveability during the cold running and warm-up phase. The Engine Coolant Temperature (ECT) sensor supplies this signal, which is also used by the ECM to control the radiator cooling fan. The fan is switched on at a rising coolant temperature of 102°C, and switched off on falling temperature at 96°C. Note that during a 15 minute period following ignition switch off, the cooling fan will operate if coolant temperature rises above 112°C, switching off again at 106°C. This feature helps prevent heat soak boiling.

The sensor is a thermistor (a resistor which changes value with temperature) mounted in the outlet junction pipe at the flywheel end front side of the engine. Note that the ECT sensor is mounted horizontally, and should not be confused with the water temperature gauge sender which is fitted in the same pipe, but vertically from below. Low coolant temperature produces a high resistance, whereas high temperature causes low resistance. At normal running temperature, the resistance will be approximately 300 - 400 ohms.



If the ECM receives a signal voltage outside of the acceptable range, a default setting equating to 60°C will be substituted, and the cooling fan energised.

To replace the sensor, disconnect the harness plug, and position a container to catch the escaping coolant when the sensor is removed. Unscrew the sensor from the junction pipe. Clean the threads of the pipe and sensor before applying Teflon tape to the sensor thread and screwing into the pipe. Tighten to 6 Nm. Refit the harness plug, and top up with coolant.

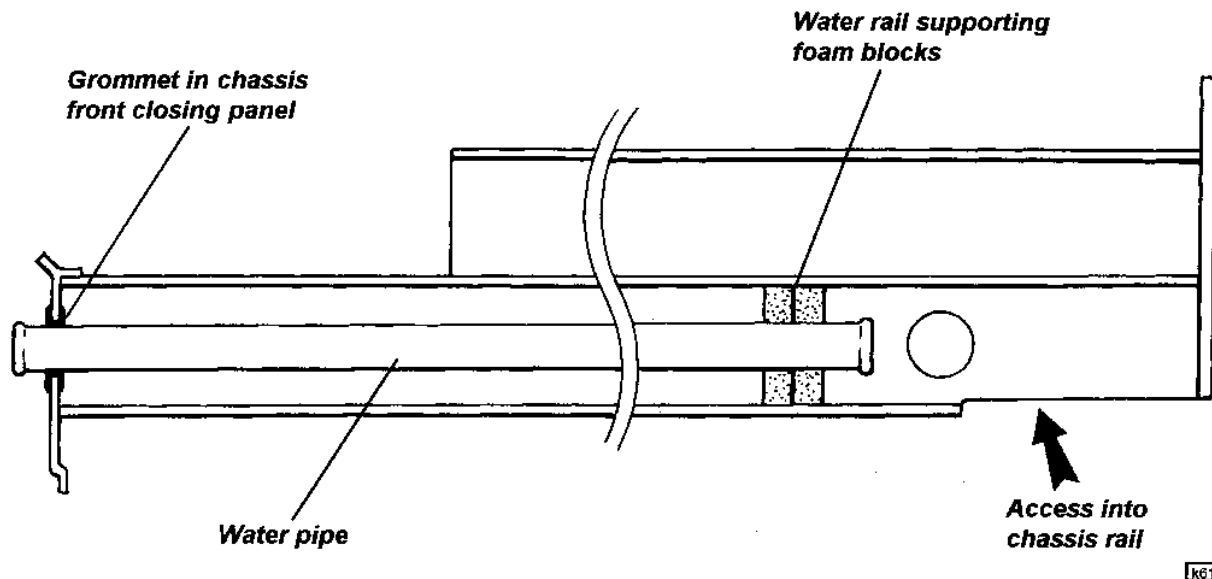
For further information on engine management, see Section EMO.



### KG.6 - RADIATOR FEED & RETURN PIPES

The radiator feed and return pipes are routed through the chassis main side rails, feed on the right, and return on the left. Each pipe is located by a grommet in the chassis front closing panel, and by a pair of shaped foam blocks inserted into the rear end of each chassis rail.

On initial build, the water pipes are fitted before the crash structure is bonded to the front of the chassis. A new chassis assembly is supplied with both water pipes and the crash structure pre-fitted. If a pipe is to be replaced in service without the crash structure being removed:



1. Drain the coolant and remove the front clamshell (see sub-section BP.5).
2. **WARNING: The machined edges of the chassis extrusions and the ends of the drive fasteners can present sharp edges and points representing a potentially serious hazard. It is strongly recommended that industrial gloves are worn, and other suitable precautions taken to provide protection from cuts and abrasions.**  
Release the hoses from the front and rear end of the water pipe.
3. Using the access provided from the open underside of the rear end of the chassis side rail, push the water pipe forwards until obstructed by the crash structure. It is recommended that a suitable hole be cut in the flat vertical face of the crash structure, adjacent to the fog lamp harness grommet, in order to allow the pipe to be withdrawn forwards.
4. Retrieve the two support foams from inside the chassis rail. Fit the grommet into the hole in the chassis front closing plate, and smear with rubber grease. Feed the pipe through the access hole and grommet, and position with 35 - 40 mm of pipe protruding.
5. At the rear end of the pipe, fit two foam support blocks onto the pipe, and push into the chassis rail to expose approximately 35 - 40 mm of pipe. After fitting the hoses, manipulate the pipe to check for absence of chassis contact 'knock'.
6. Blank off the access hole in the crash structure with a suitable grommet.



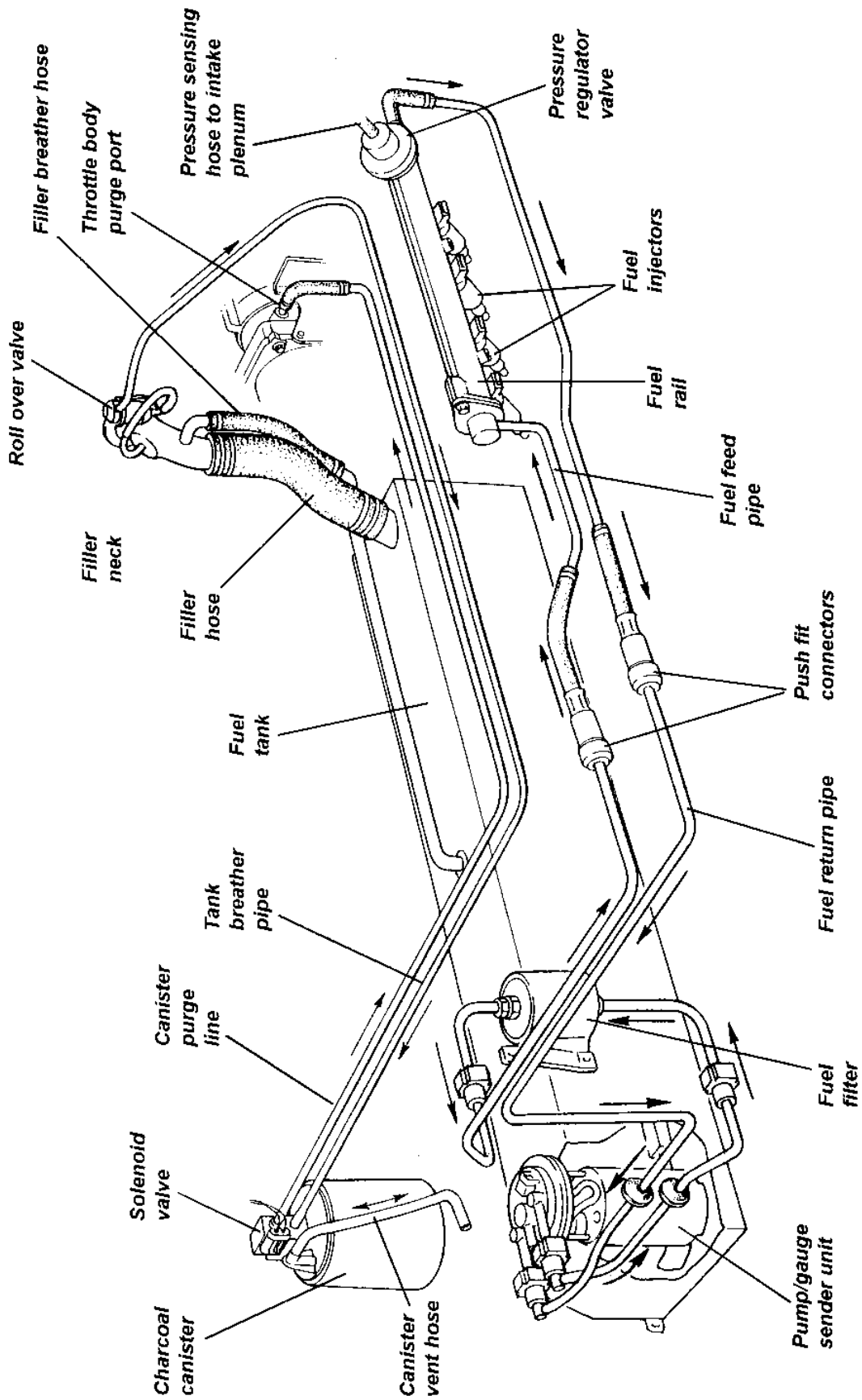
FUEL SYSTEM

SECTION LI - ELISE 2001 M.Y. Onwards

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Precautions	LI.3	4
Fuel Filter	LI.4	4
Fuel Tank	LI.5	5
Fuel Pump/Sender Assembly	LI.6	8
Charcoal Canister	LI.7	10



FUEL SYSTEM GENERAL LAYOUT



cm203a



### LI.1 - GENERAL DESCRIPTION

The 32 litre (7.0 imp.gall) fabricated steel fuel tank is mounted within the chassis crossmember between the passenger compartment and engine bay, with the fuel filler neck connecting to the right hand top of the tank, and the fuel pump/fuel gauge sender unit mounted into the left hand top surface. The modular fuel pump/sender assembly uses an electric motor to power a three stage impeller type pump system submerged within the tank, and incorporates a reservoir canister to avoid fuel starvation from surge effects caused by vehicle acceleration and cornering forces.

The supply pipe from the pump is routed via a replaceable fuel filter mounted at the left hand lower front corner of the engine bay, before connecting with the left hand end of the engine fuel rail. The fuel rail supplies all four injectors, and is fitted at the right hand end with a pressure regulating valve which maintains the pressure of fuel supplied to the injectors at 2.0 to 3.0 bar, dependent on engine load. Excess fuel is returned to the tank via a fuel return line. The constant circulation of fuel through the in-line fuel filter, fuel rail, pressure regulator valve and return line, helps avoid excessive fuel temperature with the consequent risk of vapour locks.

When the ignition is switched on, the engine management ECM energises the fuel pump which will continue to run for as long as the ECM receives ignition pulses from the ignition module (engine cranking or running). If no ignition pulses are received, the ECM switches off the pump either 2 seconds (approx) after the ignition was switched on, or about 10 seconds after a stall. A safety inertia switch is incorporated into the fuel pump electrical circuit, and operates in a severe impact (indicative of a vehicle collision) to switch off the fuel pump feed and minimise the fire risk. The switch is located to the rear of the air filter housing, and is reset once tripped, by pressing the rubber button on the top of the switch.

A roll over valve is mounted behind the fuel filler neck, and is connected between a breather spigot on the neck, and the charcoal canister. This valve allows venting of the tank under normal circumstances, but prevents fuel spilling from the vent pipe if the vehicle is inverted or excessively tilted in an accident. The evaporative emissions control system (EECS) prevents untreated fuel vapour from the tank reaching the atmosphere, by routing the tank vent pipe from the roll over valve to a vapour storage charcoal canister mounted at the left hand side of the engine bay. When the engine is stopped, fuel vapour from the tank is absorbed by a bed of charcoal in the canister. When the engine is running, the engine management ECM opens a solenoid operated purge valve on the canister which allows a port on the throttle body downstream of the throttle valve to draw air through the canister, purging absorbed fuel from the charcoal, and consuming the resultant vapour in the normal combustion process. In this way, the charcoal bed is 'cleaned' ready to absorb more tank vapour.

Full details of fuel pump testing, fuel rail, pressure regulator and fuel injectors, are contained in engine management section EMN.

### LI.2 - FUEL FILLING

#### Fuel Requirement

Only UNLEADED fuel with a minimum octane rating of 95 RON ('Premium' unleaded in U.K.) should be used. Unleaded fuel with an octane rating higher than 95 RON offers no additional benefit.

Note that the filler neck is restricted in size so that only the smaller diameter nozzle used on **unleaded** petrol pumps may be inserted. The use of leaded fuel, or lead replacement petrol (LRP), would cause irreparable contamination of the precious metals used in the catalytic converter and of the exhaust gas sensor used by the computer controlled engine management system.

#### Fuel Filling

**WARNING: Be aware of the danger of explosion when dealing with petrol and its attendant fumes. Before stopping at a filling station, ensure that all cigarettes are extinguished, and that no naked flames or other potential ignition sources are present. Switch off the engine before refuelling.**

*Filler Cap:* The key locking filler cap is located in the right hand rear quarter panel:

- To unlock the cap, insert the key (same key as ignition), turn ¼ counterclockwise and withdraw the cap with the key. As the cap is unlocked, any slight pressure differential between the tank and atmosphere will be released, and a brief hiss may be heard, which is completely normal. Note that the key can be withdrawn only from a locked cap.



- To refit, engage the ears on the cap with the slots in the neck, turn the key ¼ clockwise to lock and withdraw the key.

*Filling Procedure:* Insert the pump nozzle fully into the neck, and fill until the first time the auto-shut off mechanism is triggered. Do not attempt to 'brim' the tank to the top of the filler neck, as expansion of the fuel due to temperature change (especially in hot weather - the temperature in underground storage tanks is significantly colder) may cause flooding of the charcoal canister, or spillage of fuel.

The total fuel tank capacity is 32 litres (7.0 imp.gal).

### LI.3 - PRECAUTIONS

The fuel line between pump and injector rail, and the injector rail itself, contain pressurised fuel both when the engine is running, and after switching off. This feature aids engine starting by reducing the time needed to build up operating fuel pressure, and inhibiting the formation of vapour pockets in the supply line of a stopped hot engine.

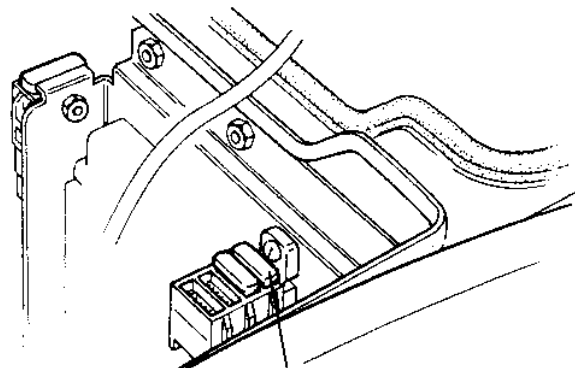
- To minimise the risk of fire and personal injury, relieve the fuel system pressure before servicing any part of the fuel supply circuit. See 'Fuel Pressure Relief Procedure' below.
- To reduce the possibility of sparks occurring when a fuel line is disconnected, or when fuel vapour is present, the negative battery cable should be disconnected before work is commenced.
- When fuel lines are disconnected, absorb any escaping fuel in an absorbent cloth and dispose of safely.

### Fuel Pressure Relief Procedure

This procedure should be used prior to disconnecting any part of the fuel line except the unpressurised return line.

- Pull out the fuel pump fuse (to rear of engine management ECM at LH side of rear luggage compartment), start the engine, and run until it stops from starvation. Crank the engine for a further few seconds.
- If the engine is a non-runner, pull out the fuel pump fuse, and crank the engine for 20 seconds to minimise residual fuel pressure.
- Disconnect the battery.
- Surround the pipe joint with a shop towel to absorb fuel contained in the pipework before releasing the joint.

**WARNING: Be aware of the possibility of full pressure retention in the fuel line caused by an injector circuit fault.**

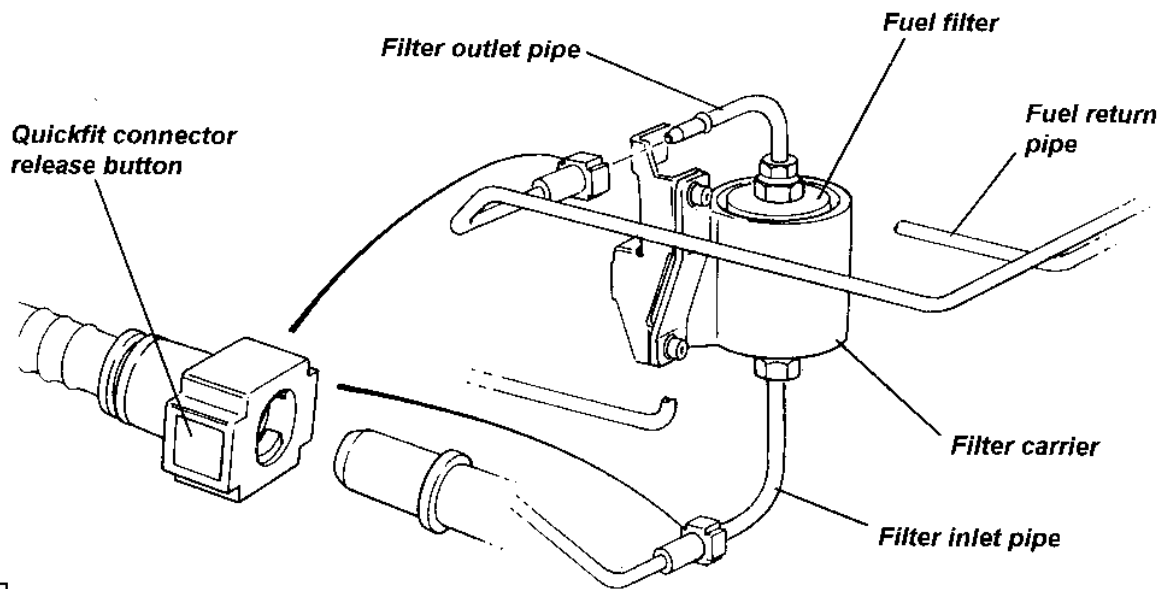


Fuel pump fuse (20A)

ghs113

### LI.4 - FUEL FILTER

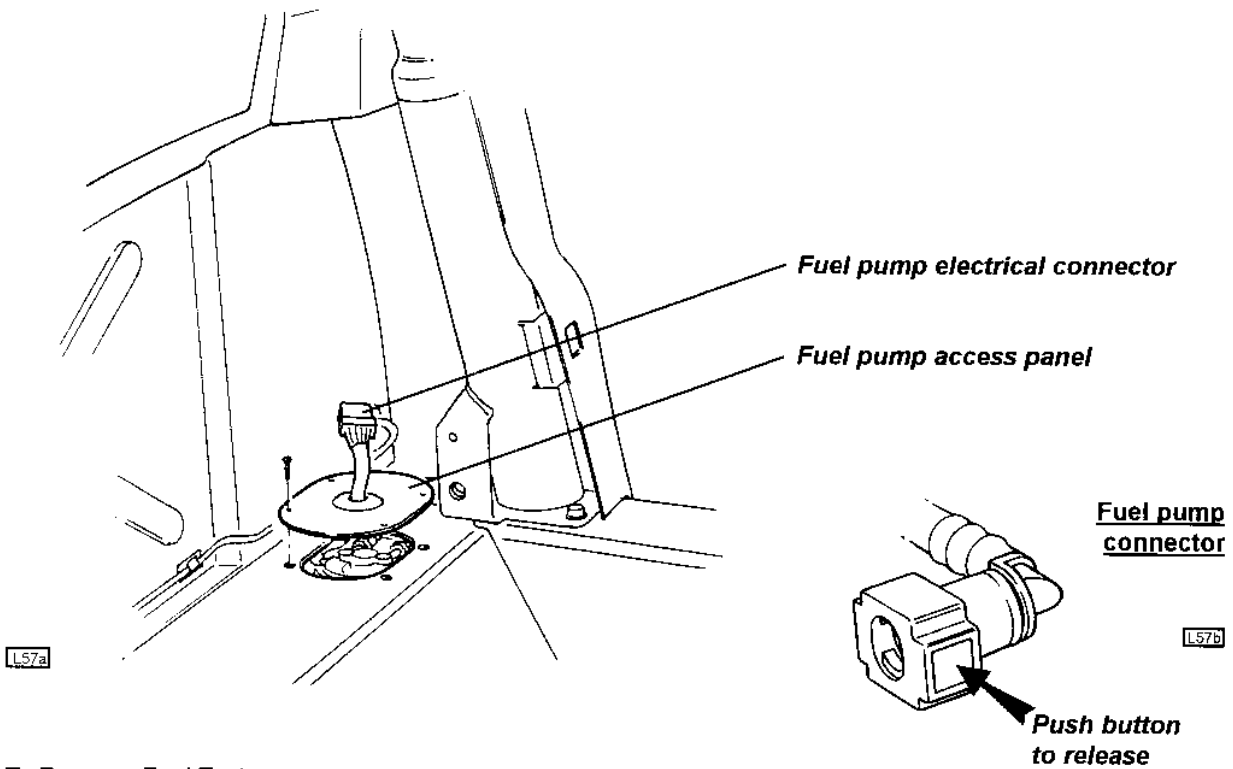
The fuel filter is fitted in the feed line between pump and injector rail, and protects the delicate injectors from dirt particles and debris not screened out by the pump inlet strainers. The paper element fuel filter is contained within a sealed steel canister, mounted, at the lower left hand front corner of the engine bay, in a plastic holder. Each end of the filter canister is fitted with a short elbow pipe to which the fuel pipes are connected by quick-fit couplings. At intervals specified in the maintenance schedule, the fuel filter should be renewed by following the procedure below;



1. Remove the engine bay undertray for access.
2. **WARNING:**
  - i) The fuel in the filter and connecting pipework remains pressurised after switching off the ignition. Before disconnecting the fuel line, carry out the fuel pressure relief procedure detailed in sub-section LI.3.
  - ii) In order to minimise the possibility of syphoning of fuel from the filter inlet pipe after disconnection, first remove the fuel filler cap to release any tank pressure.  
Squeeze the two release buttons in each of the quick fit connectors, and withdraw each pipe. Raise and secure the supply pipe from the tank to a level above the fuel tank to prevent the possibility of syphoning.
3. Press back the retaining clip, and withdraw the filter canister from its carrier. Remove the two elbow pipes from the canister.
4. Fit the two elbow pipes to the new filter canister, torque tightening to 27 - 34 Nm. Note that the top, outlet end of the canister is identified by 'O' in the canister end face, and position the outlet pipe approximately 30° counterclockwise with respect to the bottom pipe when viewed from above. Fit the canister into its holder (direction of flow arrow pointing upwards), and check that the retaining clip is engaged.
5. Lubricate the spigot on each elbow pipe with a light spray of WD40 before firmly pushing the connector onto the spigot until an audible 'click' is heard. Check security by pulling and twisting the joint.
6. Start the engine, and check for fuel leaks.

#### LI.5 - FUEL TANK

The fabricated steel fuel tank is mounted within the chassis crossmember between the engine bay and passenger compartment. A removeable panel is provided in the top of the chassis crossmember in the cabin, which provides to the fuel pipe connections and harness connector. If the pump/gauge sender unit is to be replaced, the tank must be removed from the chassis.



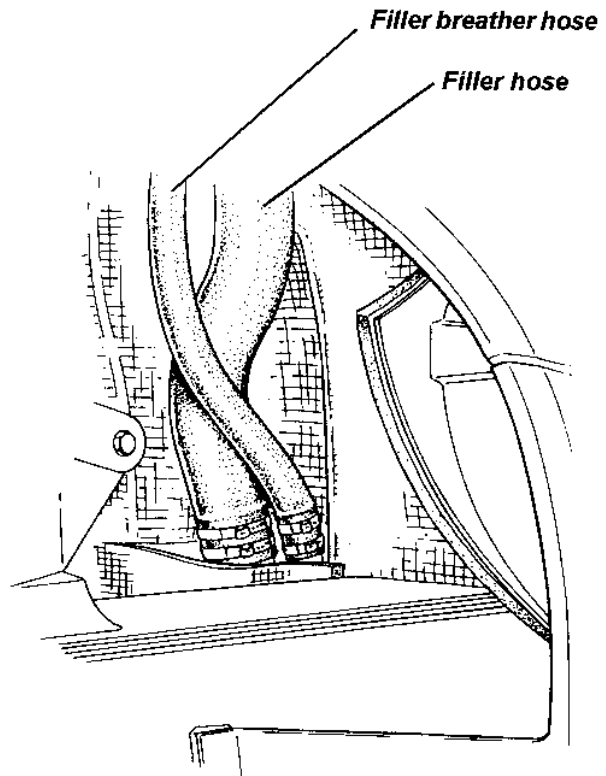
**To Remove Fuel Tank**

1. Remove the left hand seat and rear bulkhead trim panel. From the left hand rear corner of the cabin, disconnect the pump harness, and remove the access panel on the top of the chassis rear crossmember for access to the fuel pump connections.

**WARNING:** The fuel line between pump and engine remains pressurised after switching off the ignition. Before disconnecting the fuel line, carry out the fuel pressure relief procedure detailed in sub-section LI.3.

Release the feed and return pipes from the fuel pump by squeezing together the release buttons on the push fit connectors, and withdrawing from the spigots.

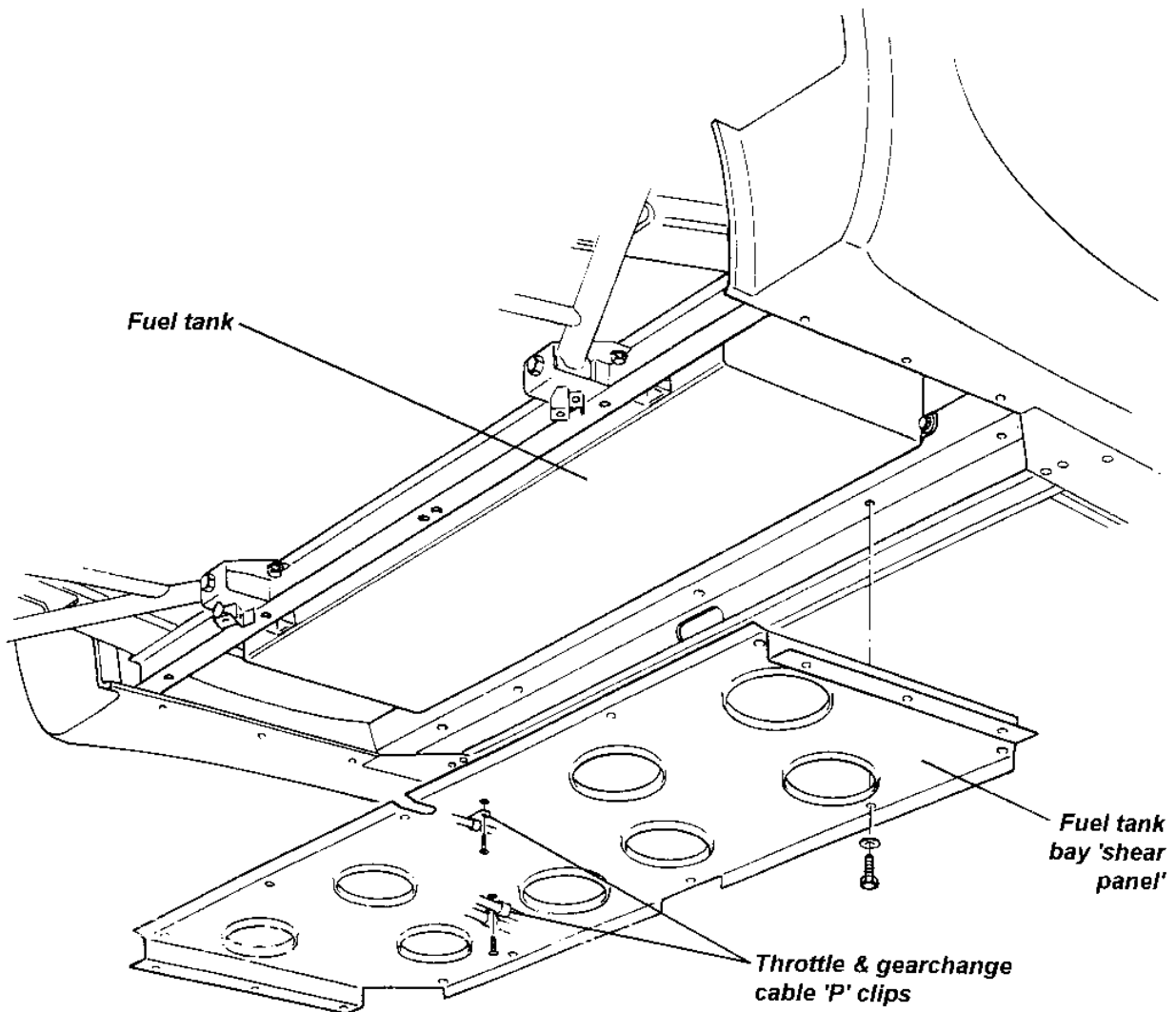
2. If necessary, syphon fuel from the tank to reduce the weight before removal.
3. Remove the RH rear wheel and wheelarch liner to provide access to the filler hose connections. Release the filler hose and filler breather hose from the tank spigots, and cap both orifices to prevent debris ingress and reduce the fire hazard.



sb53a



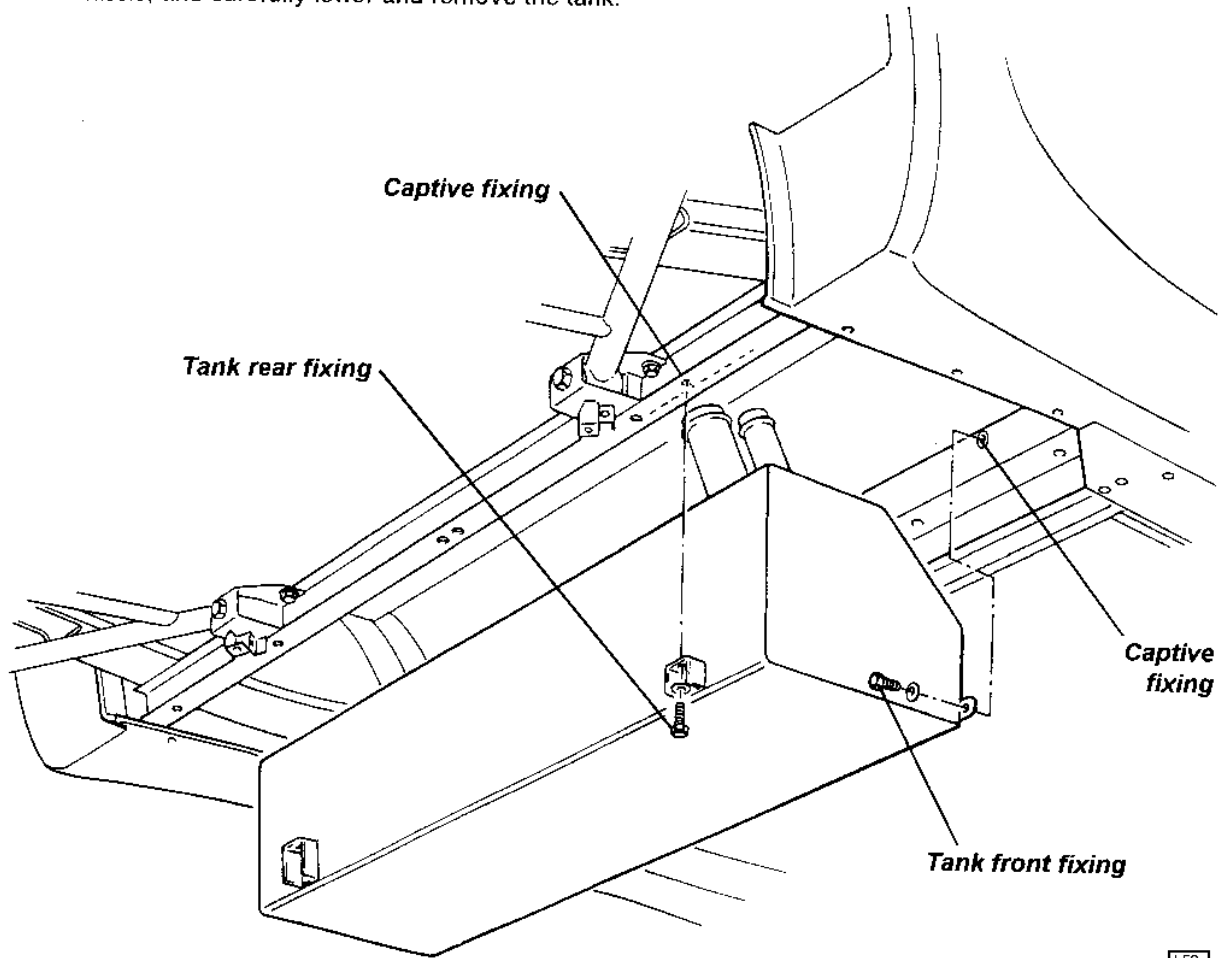
4. Remove the engine bay undertray/diffuser.
5. Disconnect control cables:
  - Release the two gearchange cables from the transmission levers and abutment bracket.
  - Release the parking brake cable from the horseshoe compensator and abutment brackets.
  - Release the throttle cable from the engine.
  - Release the gearchange cable and throttle cable 'P' clips from the perforated 'shear panel' below the fuel tank.
6. Release the fixings along the front and rear edge, and remove the 'shear panel' which closes the chassis box section housing the fuel tank. Note that this panel is a structural part of the chassis, and that the car should not be used without the panel fitted.



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- Support the tank before removing the four bolts securing the fixing brackets at the base of the tank to the chassis, and carefully lower and remove the tank.



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- Refit the tank in reverse order to removal, taking care to connect the fuel pipes to the correct spigots on the fuel pump assembly;
  - Feed spigot marked 'F' (rearmost);
  - Return spigot marked 'R' (foremost).
  - Note that the centre (vent) connector is not used, and is blanked off internally.Ensure that the 'shear panel' is fitted beneath the fuel tank bay before driving the car.

#### LI.6 - FUEL PUMP/SENDER ASSEMBLY

The combined fuel pump/fuel gauge sender assembly is mounted submerged in the left hand side of the fuel tank, and utilises an electric motor to power a three stage impeller type pump, and a reservoir canister to avoid fuel starvation from surge effects caused by vehicle acceleration and cornering forces.

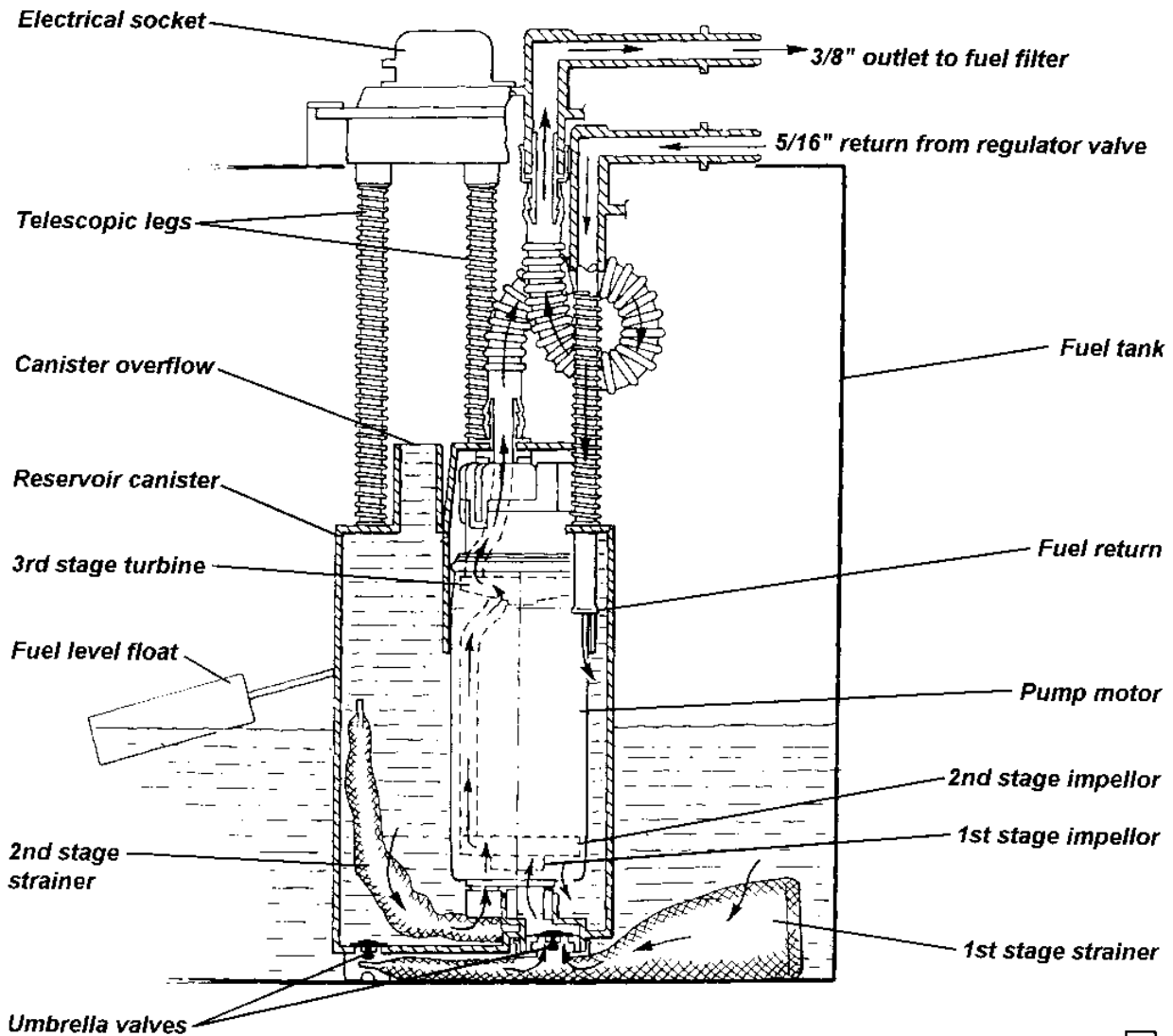
The complete unit is spring loaded against the bottom of the tank by three telescopic legs carried on the end plate, which is sealed and secured to a flange in the tank top surface by an 'O' ring and circlip. The orientation of the unit is dictated by a tab on the pump endplate.

The pump is housed within a reservoir canister kept filled with fuel even at very low tank levels. The pump connects with a port on the bottom of the canister fitted with a strainer sock in order to screen dirt particles from the fuel line and help separate any water content from the fuel. The first stage impeller pump draws fuel from the tank via this sock, and outputs it into the canister, which fills up to its overflow port in the top surface. The second stage impeller pump draws fuel from within the canister via another strainer sock, and supplies the high pressure third stage turbine pump which outputs fuel from the top end of the pump into the



flexible pipe connected to the supply connection on the pump assembly top plate. From here, fuel is piped to the fuel rail on the engine, from which it returns to the inlet connection on the top plate and spills into the canister to supplement the primary pump output and keep the canister fully filled. An umbrella valve in the bottom of the canister allows fuel to flow into the canister whenever the tank level is higher than the canister level. This feature also permits a continued fuel supply to the secondary pump stage in the event of a blocked primary strainer.

A removeable panel in the chassis behind the LH seat provides access to the fuel pipe connections, but if the fuel pump or gauge sender unit require attention, it is necessary to remove the fuel tank from the chassis.



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To Test Fuel Pump Output

The procedure for testing fuel pressure, set by the pressure regulator valve on the end of the fuel rail, is detailed in section EMO. Base fuel pressure is 3.0 bar. If the result of this test is satisfactory, the fuel pump delivery quantity may be checked as follows:

**WARNING:** Take all necessary precautions to guard against fire and explosion risk when dealing with fuel and fuel vapour.

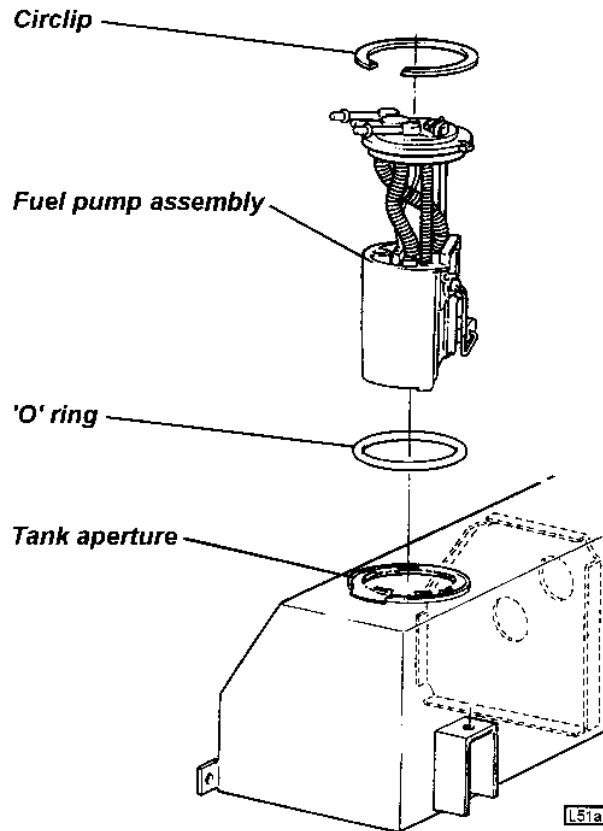




1. Disconnect the fuel rail return line (e.g. at quick fit connector), and arrange for collection of return fuel into a suitable container.
2. Arrange for an auxiliary 12 volt feed to the fuel pump to allow continuous operation.
3. Run the pump for one minute and measure the fuel quantity delivered.  
Specification = 2.0 - 2.8 litres.  
If below specification, check the fuel filter for restriction before replacing the fuel pump.

To Remove Pump/Sender Assembly

1. Remove the fuel tank (see sub-section LI.5).
2. Release the circlip securing the pump assembly into the tank top flange, noting that the unit is lightly spring loaded, and withdraw the unit and sealing 'O' ring. Take suitable precautions to catch any dripping fuel. Cap the tank aperture to prevent dirt ingress and to reduce the fume hazard.
3. To release the fuel gauge sender unit, unclip the black foot from the base of the canister, and disengage the sender mounting bracket from the canister. Disconnect the electrical cables from the unit and withdraw. Take care not to damage the float arm.
4. For access to the pump, depress the three retaining barbs, and withdraw the reservoir canister from the pump assembly. Unplug the pump electrical connector, and pull the pump from its outlet spigot.
5. Thoroughly clean the fuel inlet strainer socks on the pump and canister before refitting.



Re-fitting Pump/Sender Assembly

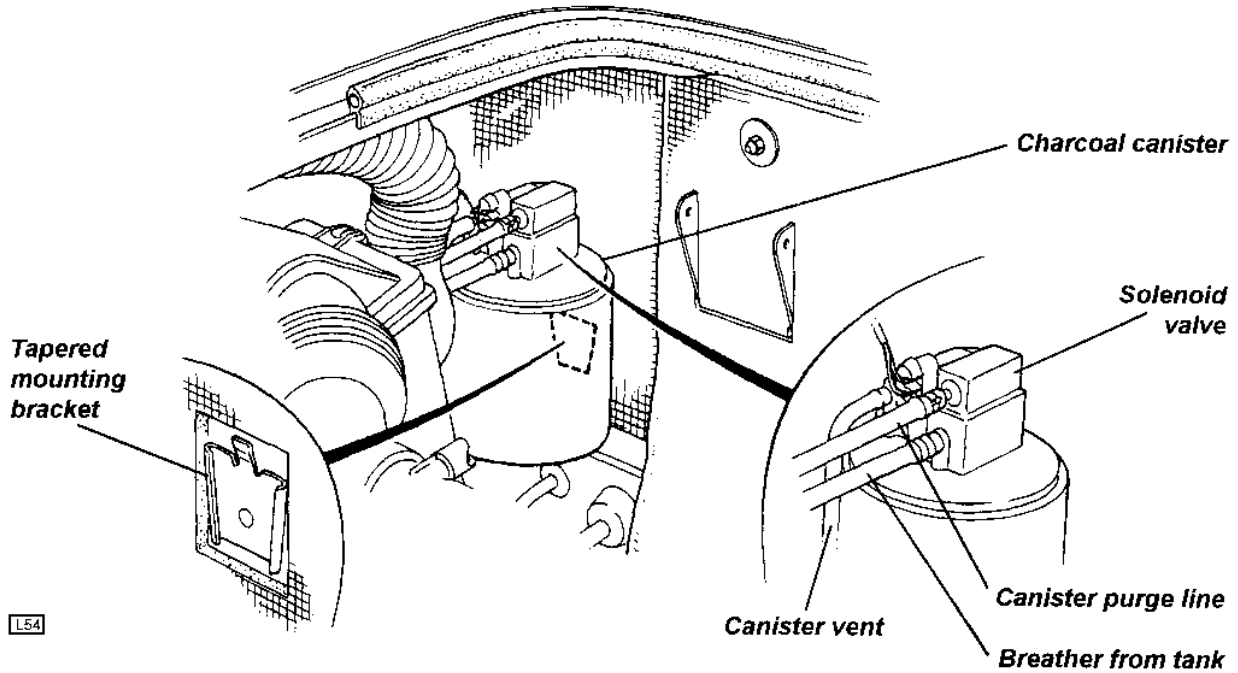
Fit the pump assembly into the tank aperture using a new 'O' ring, and locate the positional tab on the pump top plate in the tank flange slot. Retain with the circlip. Refit the fuel tank and 'shear' panel.

LI.7 - CHARCOAL CANISTER

In order to prevent fuel vapour venting from the fuel tank to atmosphere, the breather pipe from the tank is routed to a canister filled with activated-charcoal, which absorbs and stores the fuel vapour when the engine is stopped. When the engine is running, the canister is connected to the depression in the intake plenum via a port in the throttle body, such that fresh air is drawn through the canister to purge the charcoal of its absorbed fuel, with the resultant gas then consumed by the engine in the normal combustion process.

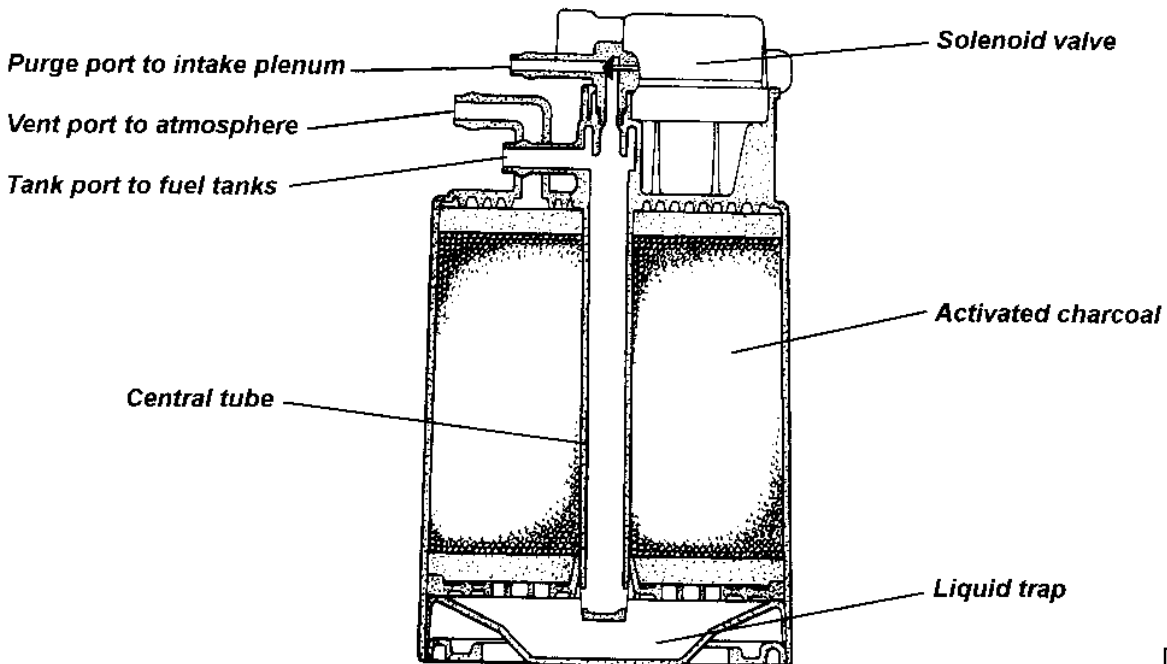
Charcoal Canister

This is mounted at the left hand front corner of the engine bay via a tapered lug on the canister and corresponding bracket on the bulkhead.



Fuel vapour from the top of the fuel tank filler neck is routed via a roll-over valve (to prevent fuel spillage if the car is inverted) mounted on a bracket integral with the filler neck, to the canister port labelled 'tank'. A central tube in the canister connects this port to the underside of the charcoal bed, below which is a reservoir to collect any liquid fuel.

The top side of the charcoal bed is connected via a port in the top of the canister, to atmosphere. A purging port, controlled by a solenoid valve on the top of the canister, connects the tank vent and underside of the charcoal bed with a port on the throttle body such that when the valve is open, the depression in the engine intake draws air through the charcoal bed to purge the canister of vapour, and prepare the charcoal for further absorption.



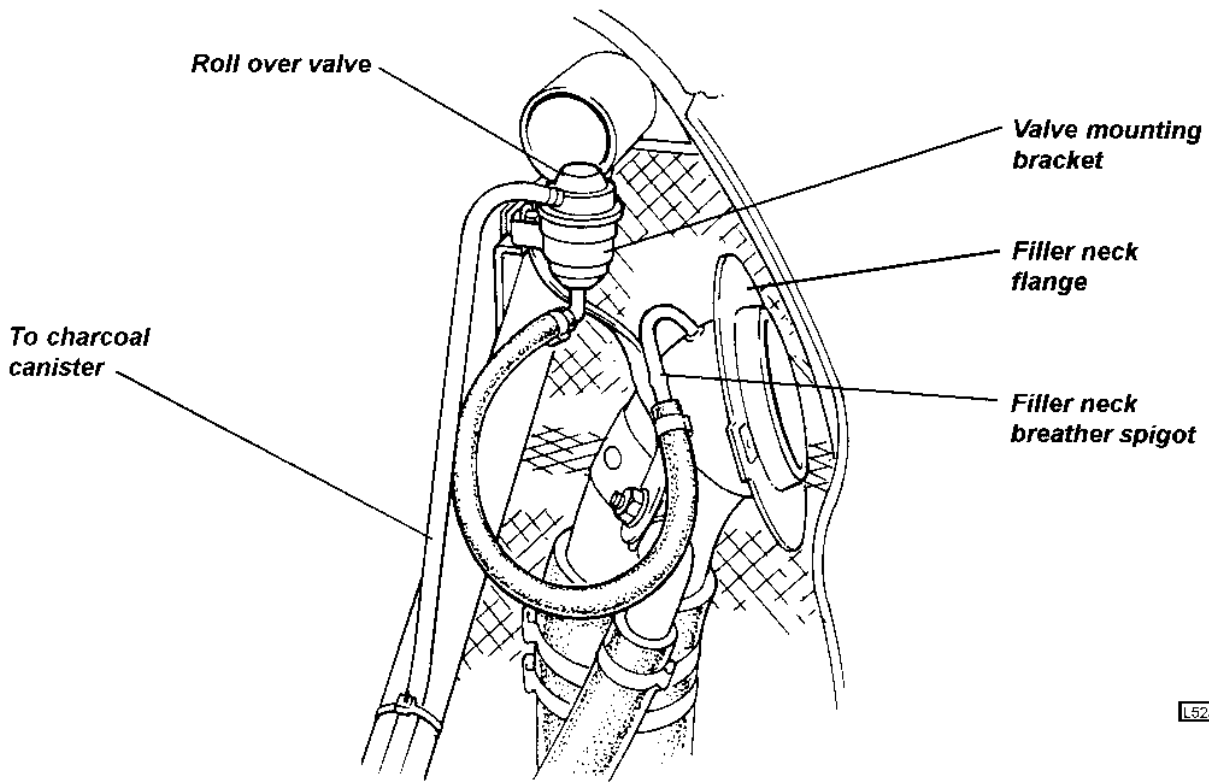


Control System

The canister purge valve is controlled by the engine management ECM, which keeps the valve closed (unenergised) when the engine is cold or idling in order to protect the catalyst and maintain idle quality. At coolant temperatures above 75°C and engine speeds above 1600 rpm, the ECM opens the valve and allows purging of the charcoal to take place, burning the resultant gas in the normal combustion process.

Roll Over Valve

The roll over valve is fitted on a bracket fixed to the roll over bar backstay, and is positioned above the filler neck within the rear clamshell butress. The RH rear wheelarch liner must be removed for access to the valve.



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**ELECTRICS****SECTION MO - ELISE 2001 M.Y. Onwards**

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## MO.1 - VEHICLE SECURITY ALARM

The Elise 2001 Model Year uses the same Meta vehicle security system as is used on 340R and Exige, being either an M36 T2 electronic immobiliser meeting Thatcham category 2 requirements, or, as an optional upgrade, a full M99 T2 alarm system incorporating M23 cockpit intrusion sensing and a self powered siren, which meets Thatcham 1.

### **Keys**

A single key operates the doors, combined ignition switch/steering lock and fuel filler cap. The head of the key incorporates an electronic transmitter for operation of the engine immobiliser and security alarm system.

A duplicate key is supplied with the new vehicle and, on receipt, should be separated and kept in a safe place for use in an emergency. The electronic code number for the transmitter is printed on a plastic card which should be kept safe with the vehicle documents, along with a record of the mechanical key number which is stamped on the blade. If a key is lost, and/or if additional keys are required, a duplicate(s) should be ordered immediately. Dealers should ensure that customers are always in possession of spare keys. Additional spare mechanical keys may also be supplied with the new vehicle for emergency use.

### **Standard Immobiliser**

In order to provide a measure of automatic vehicle security, independent of any driver initiative, the system will 'passively' immobilise the engine's cranking and running circuits about 20 seconds after the following sequence of events:

- The ignition is switched from on to off;
- The driver's door is opened.

The immobilised state will be indicated by an alarm tell tale in the tachometer upper face blinking once every 2 seconds. To mobilise the engine, press once the button on the transmitter key head (with ignition either on or off). Mobilisation will be acknowledged by the alarm tell tale being extinguished.

### **Upgraded Security System**

For enhanced protection from theft and vandal damage, the Elise may be specified factory built with a Meta M99 T2 vehicle security system which incorporates the following features:

- Ingress protection using sensing switches on the front access panels and engine lid.
- Selectable cockpit intrusion sensing using a microwave sensor.
- Automatic (passive) engine immobilisation to prevent the engine from being started.
- Self powered siren to maintain protection if the vehicle battery is disconnected.
- 'Dynamic coding' of the transmitter keys; Each time the transmitters are used, the operating frequency is randomly changed to guard against the possibility of code copying.

### *Passive Immobilisation*

In order to provide a measure of automatic vehicle security, independent of any driver initiative, the system will 'passively' immobilise the engine's cranking and running circuits about 20 seconds after the following sequence of events:

- The ignition is switched from on to off;
- The driver's door is opened.

The immobilised state will be indicated by an alarm tell tale in the tachometer upper face blinking once every 2 seconds. To mobilise the engine, press once the button on the transmitter key head (with ignition either on or off). Mobilisation will be acknowledged by the alarm tell tale being extinguished.

### **Arming the Alarm**

Remove the ignition key, close (and lock) both doors, and check that the engine lid and front access panels are shut. Press the transmitter button for about 2 seconds. This command will be acknowledged by:

- Two flashes of the hazard warning lamps;
- The alarm tell tale lighting, and blinking off once a second. After a set-up period of 25 seconds has elapsed, the tell tale will go out, and blink on once a second. Check that these indications occur. If not, press the button a second time, as the first press may have only switched off the passive immobilisation (see above).

Note that if the system is armed when a door, engine lid or front access panel is not fully closed, four beeps will be heard as warning. If still open after 25 seconds, the alarm will be armed with that switch excluded



from the circuit.

After arming the system, a period of at least 25 seconds must elapse before all functions and sensors become fully active. After this time, the alarm will be triggered by any of the following actions:

- Opening a door, engine lid or front access panel;
- Movement detected within the cockpit;
- Energising the ignition circuit ('hot wiring');
- Interruption of the vehicle battery power supply.

When triggered, the electronic siren will sound and the hazard warning lamps will flash for a period of approximately 30 seconds before closing down and resetting, ready for any further triggering input. If a trigger is continuously present, the alarm will repeat after a short delay, and continue in this sequence for about ten cycles. To silence the alarm, disarm as described below.

**Disarming the Alarm**

To disarm the alarm prior to entering the vehicle, or if the alarm has been triggered, press once the button on the transmitter key. This command will be acknowledged by:

- One flash of the hazard warning lamps;
- Extinguishing of the alarm tell tale.

If the alarm had been triggered during the last armed period, the alarm tell tale will light and 'off blink' a code(s) for about 30 seconds to indicate which of the triggers was responsible:

- 1 blink off every 6 seconds - microwave sensor;
- 2 blink offs every 6 seconds - door switch;
- 4 blink offs every 6 seconds - engine lid or front access panel;
- 8 blink offs every 6 seconds - ignition input;

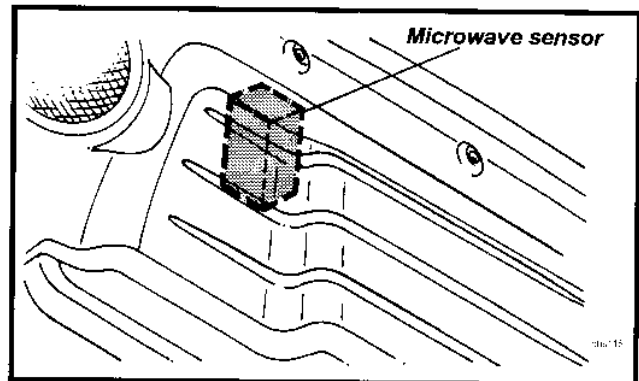
This coding will be repeated each time the alarm is disarmed until the memory is cleared by pressing the transmitter button with the ignition switched on.

**Intrusion Sensing**

A microwave sensor is mounted on the rear bulkhead, concealed by a trim panel, and is able to detect substantial physical movement within the cockpit, and trigger the alarm. The range and sensitivity of the intrusion sensor may be adjusted if necessary by turning an adjuster screw on the unit.

If desired, the alarm may be armed without the intrusion sensor or battery interruption circuits being active by:

- with the alarm disarmed, hold the transmitter button pressed for a 4 second period. This will be acknowledged by 3 flashes of the hazard lamps, and blinking of the alarm tell tale.



Note:

- # Intrusion sensing will automatically be reinstated the next time the alarm is armed.
- # Do not inhibit operation of the microwave sensor by placing bags or large objects against the cabin rear bulkhead.

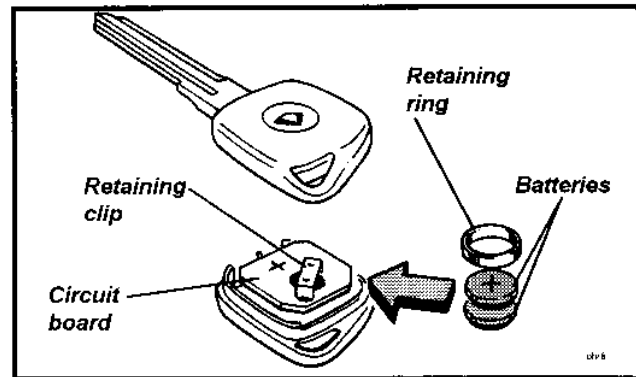


**Transmitter Key Battery Replacement**

The batteries for the key head transmitters should be renewed every 12 months to ensure continuity of operation.

To replace transmitter battery:

- a). Use a thin blade to prise apart the two halves of the transmitter key head, and withdraw the battery.
- b). The transmitters are powered by a 3v long life lithium battery type CR2032. With normal use, this should last between 3 and 5 years. After opening the new battery packaging, touch only the sides of the battery, and fit the battery into the key case with the positive side (+) upwards as shown.
- c). Press the battery case together.



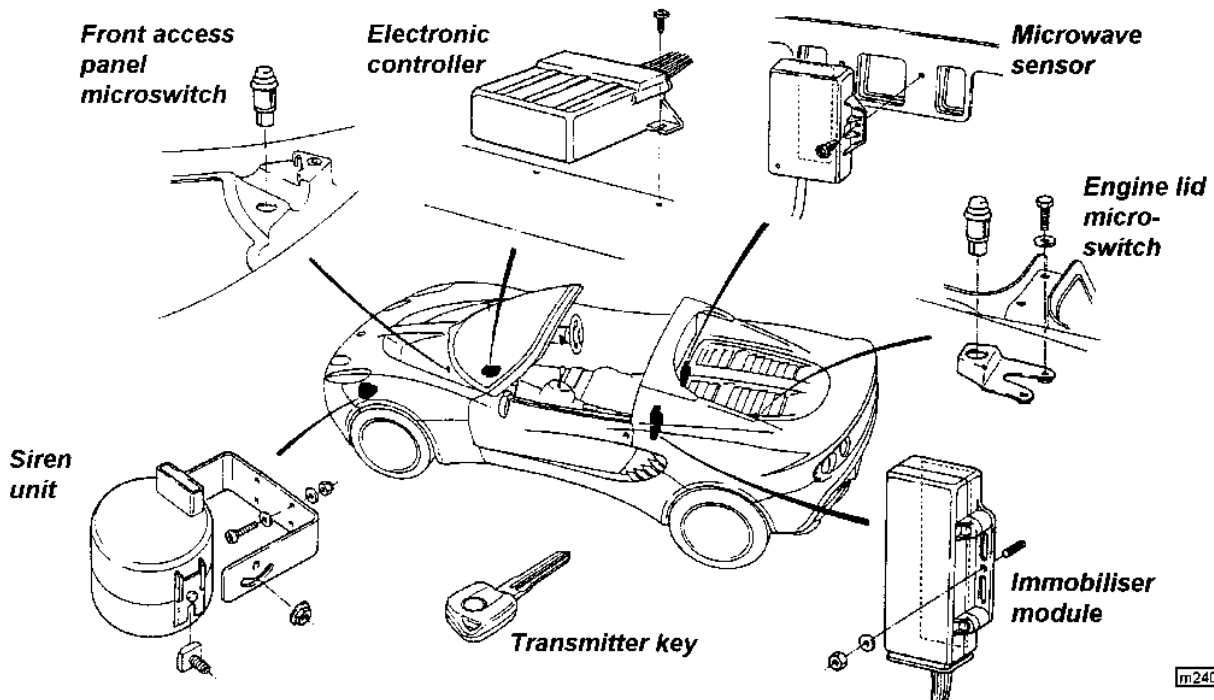
**Disconnecting the Vehicle Battery**

- Before disconnecting the battery, ensure that the alarm system is disarmed.
- On reconnection of the battery, the alarm will automatically be set. Have the transmitter ready to disarm.

**Component Location**

The alarm system components are located as follows:

- Electronic Controller: Mounted on top of scuttle beam at passenger's end. Accessible after removal of fascia top.
- Siren Unit: Mounted on front of radiator duct LH extension, beneath LHF turn lamp. Accessible only after removal of front clamshell.
- Immobiliser Module: Mounted on left hand end of cabin rear bulkhead. Accessible after removal of cabin rear corner trim panel.
- Microwave Sensor: Mounted centrally on cabin rear bulkhead, beneath trim panel.
- Engine Lid Sensor: Mounted on luggage compartment bulkhead, alongside the latch.
- Front Access Panel Sensors: Mounted on brackets fixed to topshell at outboard edge of aperture.



m240

**Replacement Transmitter Keys**

Additional keys may be added to a security system provided that there is at least one functioning transmitter. If all transmitter keys are lost, damaged or broken, the controller/immobiliser must be renewed, and will be supplied with two coded transmitter keys. Replacement keys must be ordered from Lotus against the electronic code number printed on the plastic card supplied with the new car. Note that the controller can accommodate a total of 7 key codings, including those supplied new with the vehicle, before the controller must be returned to the factory for memory clearing to allow any further key coding operations. When ordering the key, use form LSL419 and also quote the asterisk marking of the coding positions (1 to 7) as marked on the plastic card.

On receipt of a coded key(s), the mechanical key blade must be copy cut to the existing key, or to key code number by a locksmith, and two CR1220 batteries fitted. The controller must then be programmed to recognise each of the coded keys to be used by the following procedure:

- Using the existing functioning transmitter key, press the button 17 times, at which point the alarm system will cease to respond, and all other keys will be inhibited. The remote control enabling mode has been entered.
- Within an 8 second period, press once the button of any other original coded transmitter key, or of a coded replacement transmitter key. The controller signals that recognition has been accomplished by the alarm changing status (from on to off, or vice versa), after which it stops responding to that particular transmitter. An original transmitter button may need to be pressed twice.
- Within a further 8 second period, press the button of another replacement transmitter key, and continue this procedure for each of the keys to be used. Any keys not operated in this manner will no longer be recognised (e.g. any lost or stolen keys).
- After an 8 second period with no key button operation, the remote control enabling mode is exited, and normal operation resumed.

Replacement vehicle lock sets include two uncoded blank transmitter keys to allow copy cutting of the key blade, and transfer of the old transmitter printed circuit board into the head of the new key.





**MO.2 - SWITCHES & INSTRUMENTS - DRIVER'S INFORMATION**

**Ignition Switch/Steering Lock**

The switch/lock is located on the right hand side of the steering column.

- I - Insert the key into the slot, and turn clockwise to position 'I' to unlock the steering column. If the key is reluctant to turn, wriggle the steering wheel to ease the load on the steering lock.
- II - Turn to position 'II' to switch on the ignition and operate auxiliary equipment.
- III - Turn further clockwise to 'III' against spring pressure to operate the starter motor. As soon as the engine starts, allow the key to return to position 'II'. To stop the engine, turn the key back to 'I'.

*Passive Immobilisation:* If the ignition has been switched off for longer than 20 seconds, the passive immobilisation security feature will operate and disable the ignition and starter circuits, this condition being indicated by the alarm tell tale blinking once every 2 seconds. To mobilise the engine, press once the button on the transmitter key head (with ignition on or off), and check that the tell tale is extinguished.

- B - To remove the key, turn fully counterclockwise to 'B' and withdraw. The steering column lock will be activated when the key is withdrawn but may not engage until the steering is turned and the mechanism is aligned.

DO NOT leave the ignition switched on for long periods without the engine running, since although the ignition system itself draws no current when the engine is stopped, a battery drain will occur through other circuits even when auxiliary equipment is not being used.

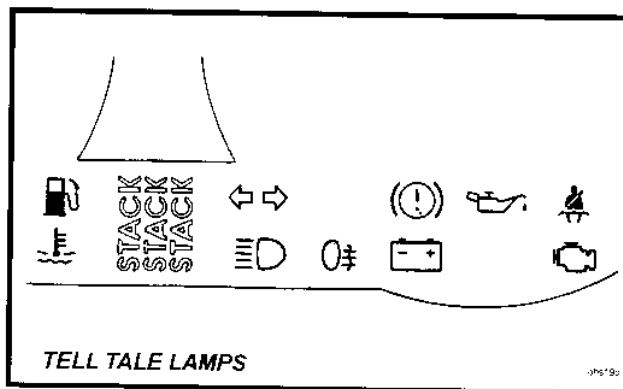
For security reasons, and to guard against battery drain, always remove the key when leaving the car.

**WARNING:**

- Do not push or tow the car unless the key is first used to unlock the column and is then left in the lock.
- Never withdraw the key until the vehicle is stationary.
- To reduce the risk of theft, or danger to a child remaining in the vehicle, always remove the key when leaving a parked car.

**Tell Tale Lamps**

A block of tell tale lamps is incorporated into the instrument cluster to indicate the operational status of various systems.



**Bulb Check**

In order to check that the warning systems are operative, all the tell tale lamps (except the 'Alarm' tell tale; see Vehicle Security Alarm) should light for about six seconds following ignition switch on. If any lamp should fail to light, it is possible that the bulb or warning circuit may be faulty.

**Turn Tell Tale**

When the left hand or right hand turn indicators are operating, this green tell tale flashes in unison. The flasher relay may also be heard to operate. If the tell tale fails to light, or flashes at an unusual or irregular rate, check the operation of the turn indicator lamps immediately.

***Brakes Tell Tale***

This tell tale will glow red with the ignition switched on whenever the parking brake is applied. Driving the car with the brake not fully released will cause overheat damage to the rear brakes. Each time the parking brake is released, check that the tell tale is extinguished.

With the parking brake released, if the tell tale should light at any time after the check period, stop the car immediately, as the circuit has detected a dangerously low level of brake fluid in the master cylinder reservoir, possibly caused by a hydraulic leak in one of the separate front or rear brake circuits. There is a danger that air may enter the hydraulic system and cause spongy operation and extended pedal travel. The divided brake circuit should ensure that emergency braking will remain, but the car should not be driven until the fault has been identified and rectified.

***Oil Pressure Tell Tale***

This red tell tale warns of low engine oil pressure. The lamp will be lit whenever the ignition is on and the engine is stopped, but should extinguish as soon as the engine is started. If the lamp fails to go out after engine start up, or comes on when the engine is running, stop the engine immediately and do not restart until the cause has been investigated and rectified. Continuing to run the engine with little or no oil pressure could cause major internal damage, possibly resulting in seizure.

***Seat Belt Tell Tale***

The red seat belt tell tale is provided as a reminder that both driver and passenger should always wear the seat belts, no matter how short the journey. The lamp will light for about 8 seconds following ignition switch on, before being extinguished.

***Main Beam Tell Tale***

This lamp glows blue whenever the headlamp main beams are operating.

***Battery Charging Tell Tale***

This red tell tale will light whenever the ignition is on and the engine is stopped. If it lights any time that the engine is running, the battery is not being charged, which may be due to a broken alternator drive belt, or an electrical fault. Urgent attention is required, but as the engine coolant pump is independently driven, the car need not be stranded, subject to battery condition and local circumstances.

***Alarm Tell Tale***

The alarm tell tale is located at the top of the tachometer display, and indicates the status of the immobiliser and alarm.

- Tell tale out; engine is mobilised, and the alarm is off.
- Blinking every 2 seconds; engine immobilised.
- Blinking once per second; alarm armed.

For full details of the security alarm system, refer to the earlier section 'Vehicle Security'. Note that the tell tale also functions as a high rpm warning - see 'Tachometer'.

***Malfunction Indicator Lamp***

The Malfunction Indicator Lamp (MIL) is provided to warn the driver that the engine management system has detected a fault which may result in increased toxic emissions from the exhaust.

- i) If the lamp lights steady whilst driving, dealer advice should be sought without delay, and all unnecessary journeys avoided.
- ii) If the lamp flashes, an engine misfire has been detected which is sufficiently severe to cause overheat damage to the catalytic converter. Slow down immediately and be prepared to stop.
  - If the MIL then stops flashing, and is lit steady, proceed with caution and seek dealer advice.
  - If the MIL continues to flash, stop the engine and seek dealer advice. Continuing to drive the car with a flashing MIL lamp may cause overheat damage to the exhaust catalyst and increased toxic emissions.



## Instruments

### Speedometer

This instrument displays road speed in either MPH (with a secondary scale in km/h), or km/h according to market.

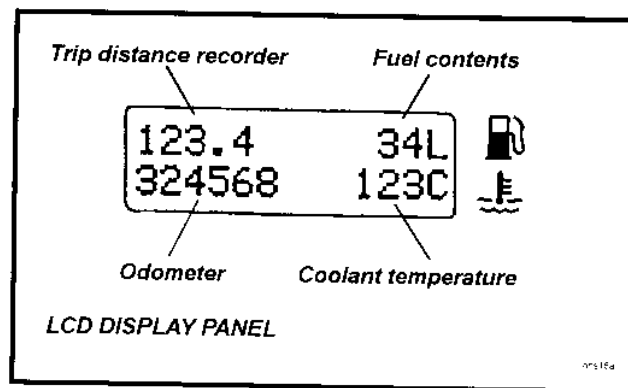
### Tachometer

The tachometer indicates engine speed in revolutions per minute. A safeguard in the engine management system limits continuous engine speed to 6,950 rpm. Do not run the engine continuously at its maximum speed, or allow overspeeding to occur on the overrun by changing down through the gears too early, as this imposes very high loads on engine components, resulting in premature wear and possible failure. A red tell tale lamp in the top of the tachometer face lights at engine speeds over 6,500 rpm to warn that maximum engine speed is being approached. Note that this lamp also functions as an alarm system tell tale (see 'Vehicle Security').

Recalibration of the tachometer needle position will occur during a three second period following ignition switch on.

## LCD Display Panel

A liquid crystal display (LCD) panel is provided below the instruments in order to display fuel level, coolant temperature, total mileage and trip functions. The panel is blank until the ignition is switched on.



### Fuel Contents Display

The fuel tank usable capacity is approximately 32 litres (7.0 imp.gal), with the approximate available fuel quantity displayed at the top right hand corner of the LCD panel:

- 6 litres upwards: Displays available fuel quantity in litres.
- 0 - 5 litres: Display flashes 'Refill'.

When the fuel level drops to 5 litres, the display flashes 'Refill', and in order to ensure the vehicle is not stranded, and to protect against the potentially damaging effects of fuel starvation, it is strongly recommended to refuel at the first opportunity after 'Refill' is displayed..

### Coolant Temperature Display

The engine coolant temperature will be displayed at the bottom right hand corner of the panel as soon as the temperature reaches 40°C. The running temperature will fluctuate a certain amount as the operating conditions change, and during periods of idling or in heavy traffic, the temperature may rise to over 100°C, with the cooling fan switching on at approximately 104°C. The display will flash at temperatures over 110°C in order to prompt closer monitoring of high temperatures, but as the pressurised cooling system has a boiling point of over 120°C, only if the temperature approaches this level need there be any cause for concern. If this should occur, allow the engine to idle for a few minutes whilst monitoring the temperature, and if it continues to rise, switch off and seek qualified assistance.

After a heavy snowfall, ensure that the radiator cooling outlet grilles in the front body are cleared of snow before driving the car, or overheating may occur.



**Odometer**

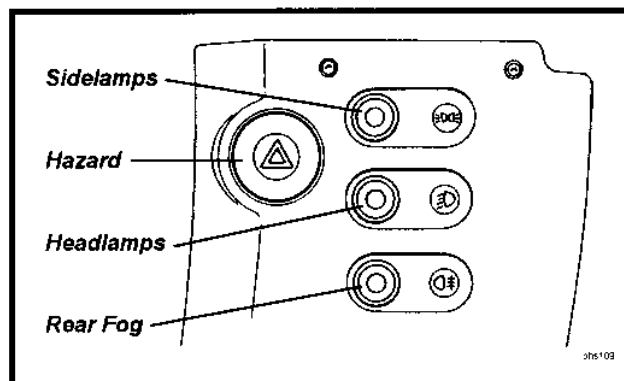
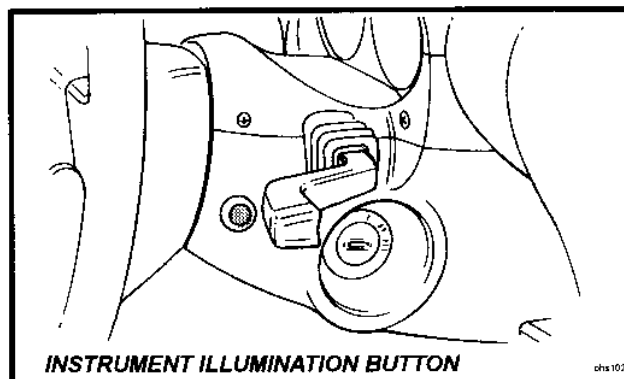
An odometer (total distance recorder) reading is displayed at the bottom left hand corner of the panel, and is calibrated in the same units (miles or kilometres) as is the speedometer.

**Trip Recorder**

A trip recorder is provided at the top left hand corner of the panel, calibrated in the same units as is the speedometer. In order to zero the trip display, switch on the ignition, and press for a moment (less than 1 second), the small button on the steering column shroud between the ignition switch and steering wheel. This dual function button also controls the panel illumination - see 'Instrument & Switch Illumination'.

**Fascia Switches**

Lighting functions are controlled by a vertical row of three push button switches mounted in the fascia outboard of the steering column. Each switch is pressed once to switch on, and pressed a second time to switch off. A symbol is positioned alongside each switch to indicate its function, and is backlit blue when the sidelamps are switched on.



**Sidelamp Switch**

The topmost switch functions with or without ignition, and switches on the sidelamps. A tell tale in the switch button lights up green to indicate when the circuit is active. Note that the headlamps must be off before the sidelamps can be switched off. A 'lights on' warning buzzer functions with lights on, ignition off, door open.

**Headlamp Switch**

The centre switch functions with or without ignition, and switches on the headlamps together with the sidelamps if not already selected by the sidelamps switch. A tell tale in the switch button lights up green to indicate when the circuit is active. The steering column lever switch (see later) is used to select main beam or dip. Pressing the switch a second time will switch off the headlamps, but leave the sidelamps on.

**Rear Fog Lamp Switch**

The lowermost switch controls the single rear fog lamp, and may be selected only after first switching on the ignition, and then the headlamps. A tell tale in the switch button lights up amber to indicate when the circuit is active. Note that the switch will default off whenever the headlamps or ignition are switched off, requiring re-selection when the operating conditions are once again met.

**Hazard Warning Lamps Switch**

The hazard warning switch is located outboard of the steering column, and has an icon in the switch button which is back lit when the ignition is switched on. The switch is operative at all times, and when pressed flashes all the turn indicator lamps, and the switch tell tale, in unison. Press a second time to switch off.

**Instrument Illumination**

A small button is provided on the steering column shroud, between the ignition switch and steering wheel, by which the brightness of the instrument illumination may be adjusted. To cycle through the four levels of brightness, press and hold the button, and release at the desired setting.

This dual function button also resets the trip distance recorder - see 'Trip Recorder'.



**Auxiliary Power Socket**

An auxiliary power socket is fitted in the trim shroud ahead of the gear lever, and is operative at all times. The socket provides for electrical accessories using the format of a standard cigarette lighter element, and is fitted with a protective flap. Maximum current draw should not exceed 15 amps.

**WARNING: Do not leave small children unattended in the car since careless interference with the power socket could be dangerous.**

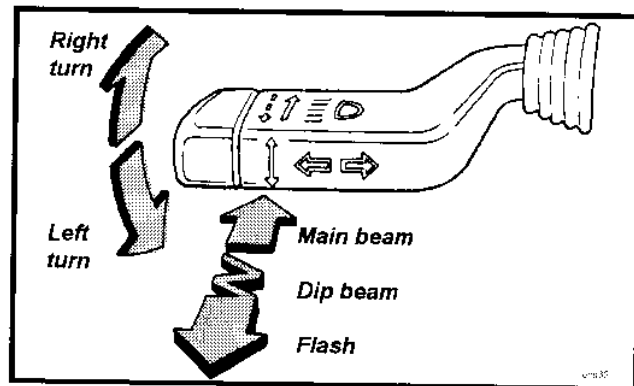
**Column Switches & Horn**

*Headlamp Dipswitch/Flasher/Turn Indicators*

The steering column left hand lever switch controls the headlamps main beam/dip, headlamp flash and turn indicators.

*Headlamp Dipswitch:* To switch on the headlamps, press the headlamp switch in the fascia outboard of the steering column. The left hand lever switch is then used to select main or dip beam. Main beam is obtained with the lever furthest forward, away from the steering wheel, and dip beam with the lever moved back towards the wheel. The main beam tell tale lamp in the instrument panel lights when main beam is operating.

Note that on cars equipped with the optional driving lamps mounted in the radiator air intake, the driving lamps operate in conjunction with the bonnet mounted headlamp main beams.



*Headlamp Flasher:* The headlamp flasher is operative at all times. If the lever is pulled towards the steering wheel against spring pressure, the headlamp main beams will light.





*Turn Indicators:* The turn indicators operate only with the ignition switched on. Move the lever down to indicate a left hand turn, and up for a right hand turn. The switch will be cancelled when the steering wheel is returned to the straight ahead position.

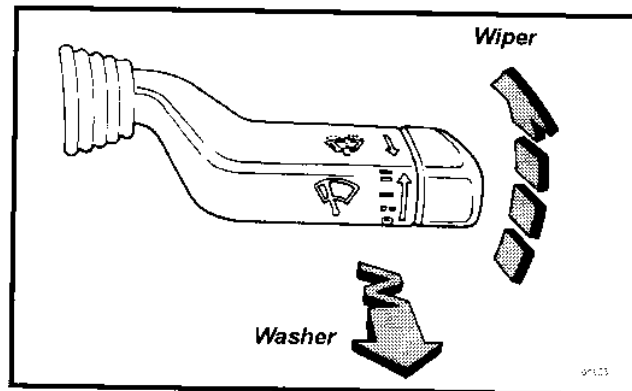
For convenience, when signalling a lane change, pressing the switch up or down only lightly, will allow it to return under spring action upon release.

**Windscreen Wiper/Washer**

The steering column right hand lever switch controls the windscreen wiper and washer, and is operative only with the ignition switched on. Never use the wiper on a dry screen.

*Windscreen Wiper:* The wiper is controlled by the up/down position of the lever switch, which operates as follows:

-  Moved fully down, the wiper is switched off.
-  Move up to the first position for intermittent wipe. The wiper will make one sweep about every five seconds.
-  Select the next position for normal wiper operation.
-  Move fully upwards for quick wipe, to be used only in heavy rain.





**Windscreen Washer:** Two windscreen washer jets are provided, one each side of the wiper spindle. Pulling the control lever towards the steering wheel will operate both the washer pump and the wiper. When the switch is released, the wiper will continue for a further four sweeps.

**Horn:** The windtone horn, which functions at all times, is operated by a central button in the steering wheel.

#### **Interior Lamp**

An interior lamp is mounted above the climate controls, and is equipped with a three position rocking lens:

- Lens rocked forwards; lamp is switched on with or without ignition.
- Lens central; lamp is switched off.
- Lens rocked rearwards; a driver's courtesy mode applies, where the lamp is switched on whenever the driver's door is opened, and goes out when the door is closed.

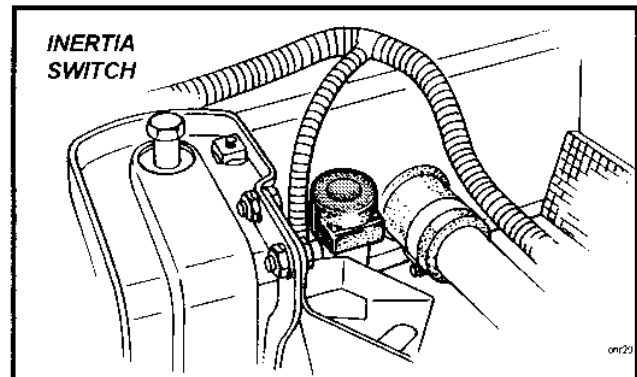
#### **Interior Lamp**

An interior lamp is mounted above the climate controls, and is equipped with a three position rocking lens:

- Lens rocked forwards; lamp is switched on with or without ignition.
- Lens central; lamp is switched off.
- Lens rocked rearwards; a courtesy mode applies, where the lamp is switched on whenever a door is opened, and goes out when both doors are closed.

#### **Inertia Switch**

The safety inertia switch is designed to operate on impact, typified by vehicle collision, to switch off the fuel pump, and thus minimise any fire hazard. The inertia switch is mounted at the left hand rear corner of the engine bay, and is reset by pressing the rubber diaphragm button on the top of the unit.





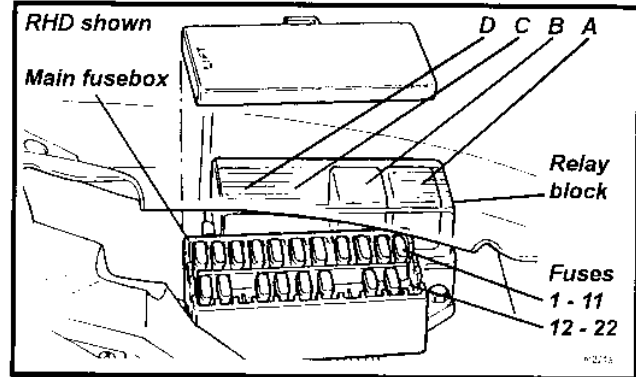
MO.3 - COMPONENT LOCATION & FUSE RATINGS

Main Fusebox

The main fusebox is located in the front services compartment, on the passenger side, and is protected by a clear plastic cover. For access, remove the passenger side front body access panel, followed by the radiator air deflector panel. Twenty two slots are provided for 'Littel' type fuses which are numbered, and coloured according to their amperage rating, and may be pulled out from their slots using the fuse extractor tool provided on the fusebox lid.

Fuses

Slot	Rating	Circuit
1	20A	Aux. power socket
2	2A	Alarm siren
3	20A	Interior fan
4	15A	Wiper motor
5	7.5A	Stop lamp
6	7.5A	Direction indicators.
7	10A	Ignition services
8	7.5A	Battery services
9	10A	Hazard lamps
10	7.5A	Horn
11	10A	Alarm pwr; interior lamp
12	25A	Cooling fan
13	7.5A	Audio ignition
14	-	
15	7.5A	Audio +ve; switch module
16	10A	Sidelamps; rear fog
17	10A	Dip beam LH
18	10A	Dip beam RH
19	-	
20	15A	Main beam LH
21	15A	Main beam RH
22	-	



Relays

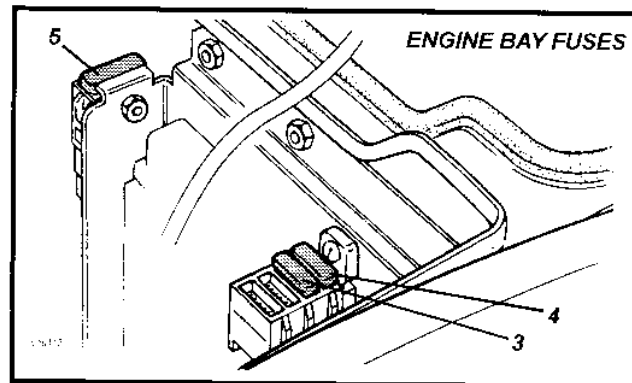
- A Horn
- B Cooling fan
- C -
- D -

Engine Compartment

Fuses and relays associated with the engine management system are located at the rear of the engine bay adjacent to the engine ECM. The multi-function relay unit containing the engine control relay, fuel pump relay and starter relay is mounted on the chassis rear subframe below the engine ECM.

Fuses

Slot	Rating	Circuit
1	-	
2	-	
3	20A	Start immobiliser
4	20A	Fuel pump
5	80A	Alternator output

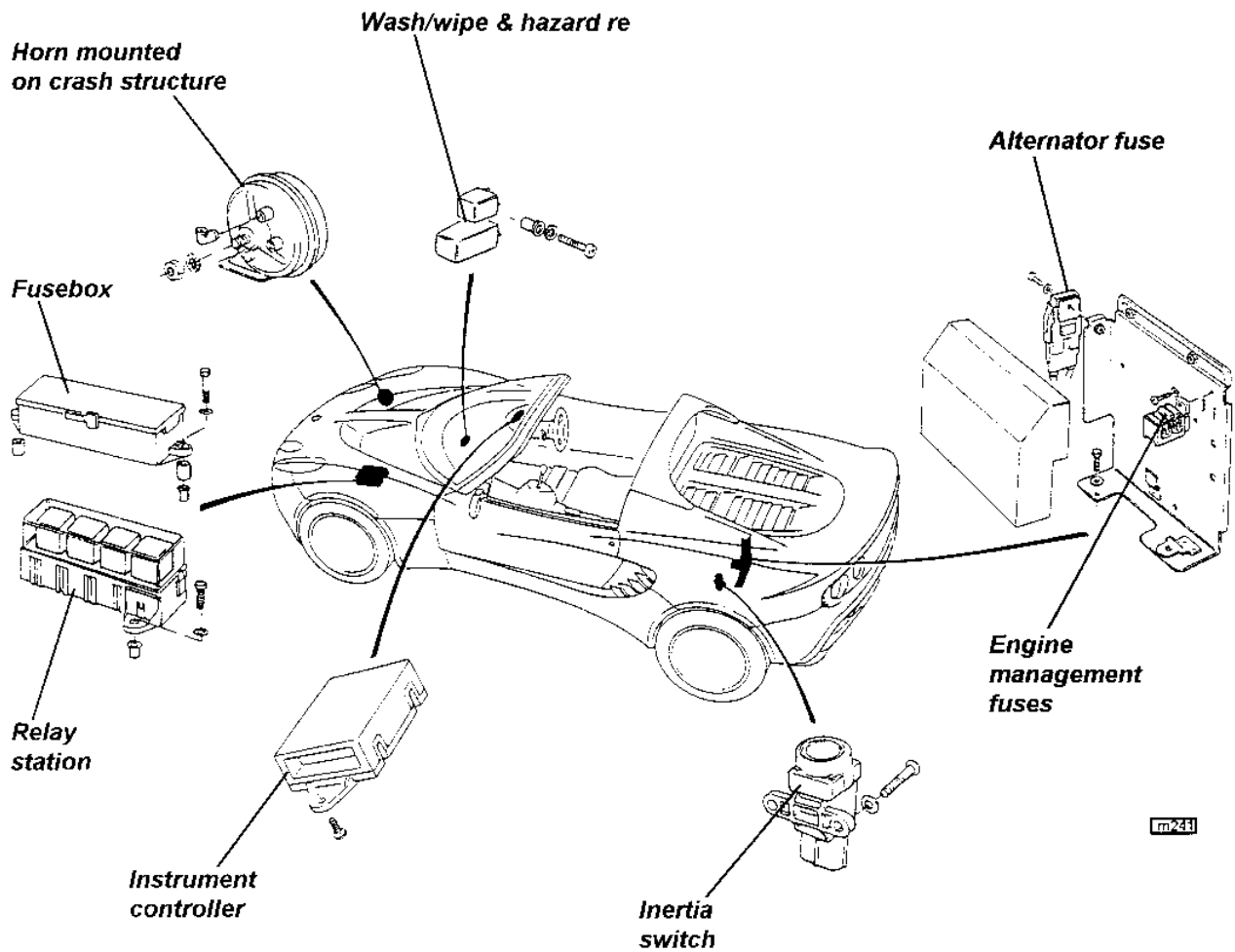




*Fuse colours:*

- |              |               |                   |
|--------------|---------------|-------------------|
| 2A - Black;  | 5A - Orange;  | 15A - Light Blue; |
| 3A - Violet; | 7.5A - Brown; | 20A - Yellow;     |
| 4A - Pink;   | 10A - Red;    | 25A - Clear.      |

The wash/wipe module, and hazard flasher relay are together mounted on the front of the passenger side chassis scuttle beam. For the location of the vehicle alarm system components, see sub-section MO.1. Engine management components are detailed in Section EMN.





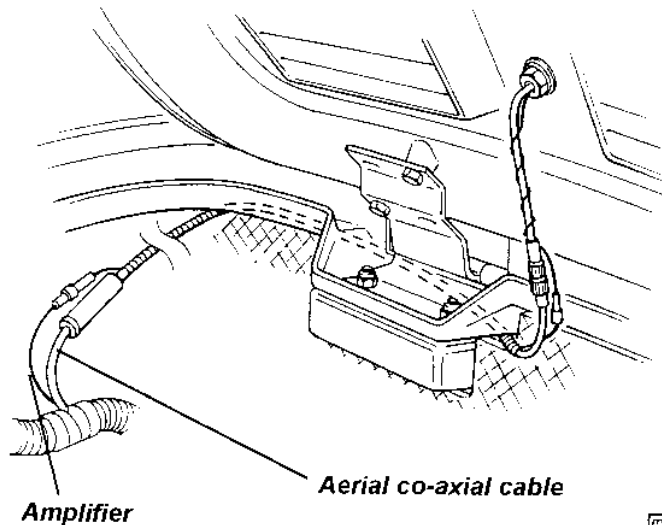


**MO.4 - AUDIO EQUIPMENT**

The Elise may be specified with various audio equipment options. All cars are fitted with a main wiring harness which includes: an ISO 16-way connector located behind the standard ISO size audio aperture in the dash panel; speaker wiring terminating behind the cabin LH rear corner trim panel; and an aerial co-axial cable terminating in the LH front corner of the engine bay.

*Aerial*

On cars equipped with a 'radio fitting kit' (RFK), a maintenance free, transformer type, flexible aerial is mounted on the engine cover, and features an antenna mast which may be unscrewed by hand from its base if necessary to guard against vandalism. All cars are fitted with an aerial co-axial lead routed between the radio plug and the LH front corner of the engine bay, from which point an aerial extension lead is used to connect with the aerial. The aerial amplifier lead is built into the main harness, and is tied back at the corner of the engine bay. The co-axial cable extension and the amplifier lead are routed along the top of the engine bulkhead before connecting with the aerial base.



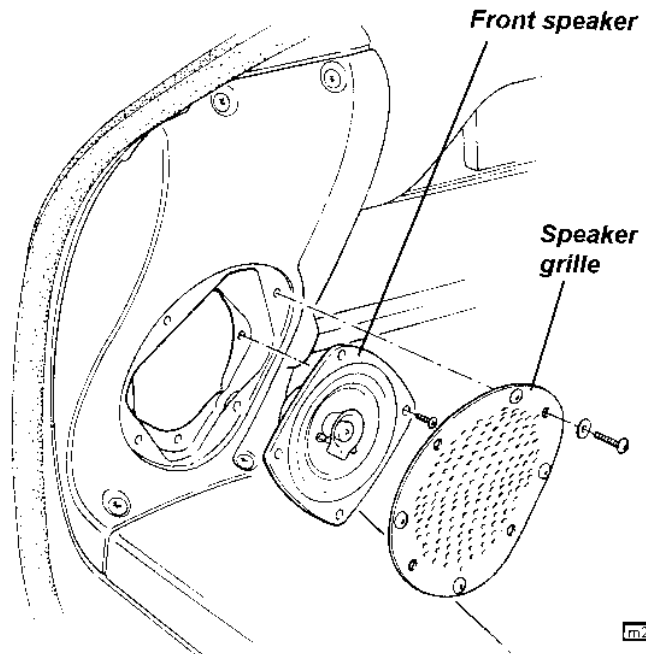
m242

*Speakers*

RFK cars are fitted with two rear speakers, one mounted in each cabin rear corner in a sound deadening full width rear bulkhead trim panel. An upgraded audio option uses the same rear speakers, in conjunction with a pair of front speakers, mounted one in each dash end panel.

Speaker specifications are as follows:  
*Rear:* Alpine SPS 1329; 80W peak; 20W RMS; 130mm dia.; 4 ohms.  
*Front:* Alpine SPS 1029; 60W peak; 15W RMS.

To remove the rear bulkhead trim panel, remove the four screws securing the top edge of the panel to the bulkhead plinth, and ease the panel from behind the roll over bar at each side.



m243



## MO.5 - BATTERY, BATTERY CABLES & EARTHING POINTS

### Battery

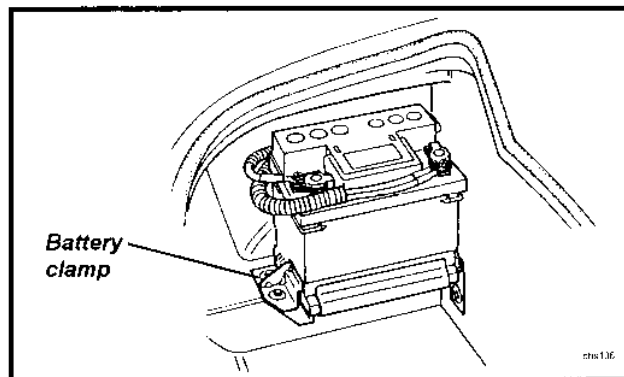
**WARNING: POISON/DANGER - CAUSES SEVERE BURNS - KEEP OUT OF REACH OF CHILDREN.**  
Contains sulphuric acid - avoid contact with skin, eyes or clothing. If in contact with skin or eyes; flush with copious amounts of water. Remove contaminated clothing. Seek immediate medical attention. If ingested; seek immediate medical attention. Do not induce vomiting or give fluids to drink. Batteries produce explosive gases. Keep sparks, flames and cigarettes away. Ventilate when charging or using in enclosed space. Always shield eyes when working near batteries.

### Battery Access

The Tungstone Type 006 'maintenance free' battery is located at the left hand front of the rear luggage compartment. No routine inspection or topping up of the electrolyte is required, but at intervals specified in the Maintenance Schedule, the battery terminals should be checked for security and condition, and protected with petroleum jelly.

To remove the battery, pull back the carpet, disconnect both battery cables (see below), and pull off the breather pipe (if applicable). Release the single screw securing the clamp bracket at the rear base of the battery, and manoeuvre the battery from the base retaining shoes at the front and right hand side. When lifting out the battery, take all appropriate precautions to safeguard personal health.

Refit the battery, with its terminals inboard, by reversing the above procedure. Remember to push on the breather pipe (if applicable), and reconnect the battery cables as detailed below.



### Disconnecting the Battery

If the battery is to be disconnected, the following precautions should be taken:

- i) Wait for at least ten seconds after switching off the ignition to allow the engine management system to adjust the setting of some components ready for re-starting.
- ii) If the car is fitted with the upgraded security alarm, immediately before disconnection, mobilise the engine using the transmitter button with ignition **off**, and disconnect the battery within 25 seconds. If disconnected after this time, or when immobilisation is in effect, the alarm will be triggered.
- iii) Ensure that all electrical loads (e.g. lights) are switched off.
- iv) Disconnect the **negative** (earth; black; '-') battery cable first, and re-connect last. If the battery positive terminal is inadvertently earthed (e.g. when using a spanner) whilst the negative terminal is still connected, the resultant short circuit with heavy sparking and current flow could cause serious burns.
- v) If the vehicle is fitted with security coded audio equipment, check that the code is available for entering after battery reconnection.

### Battery Reconnection

- i) Check again that all electrical loads are switched off.
- ii) Connect the positive battery cable first, followed by the negative (earth) cable.
- iii) Be aware that the vehicle security alarm may be triggered by the action of battery re-connection. Have the alarm transmitter key ready to disarm the alarm (see 'Vehicle Security Alarm').
- iv) After reconnection, a change in the engine performance characteristics may be noted for a period whilst the computer controlled engine management system 're-learns' some of its settings.
- v) If necessary, enter the security code into audio equipment.

**Battery Charging**

Under conditions of normal daily use, it should not be necessary to use external battery charging equipment. In a low usage regime, however, it is important to maintain the charge state of the battery using a trickle charger, or an automatic battery management charger such as that available through Lotus After Sales. Such a device, when connected to a vehicle battery, is able to continuously monitor battery charge state and switch on and off automatically in order to maintain the battery in a fully charged state without danger of damage through overcharging.

If the battery becomes discharged to the extent that the vehicle cannot be started, the recommended course of action is to fit a substitute battery whilst the original battery is trickle charged. If, in an emergency, the vehicle has to be 'jump' started, the subsequent conditions of vehicle use may not allow for sufficient alternator charging of the battery to achieve a fully charged state. The battery should be trickle charged until 12.8 volts is recorded, which process may take 24 hours or longer. Putting the battery into service at a lower state of charge will reduce the time period for which the vehicle can be parked. A battery left in a fully discharged state for a prolonged period, may not be recoverable to its original condition.

Unless using an automatic battery management charger, the battery should be removed from the car for recharging, to a well ventilated area to avoid a build up of fumes in the luggage compartment and to prevent damage to the car's electrical system. Observe the safety precautions listed above when removing the battery and take care to avoid sharp knocks or shocks, keeping the battery as upright as possible. Beware of the considerable weight of a battery, and take necessary precautions against personal injury.

Check that the electrolyte level is between the upper and lower markers on the battery case, and if necessary add distilled water. The recommended bench charge rate is 4 amps. When the battery is fully charged (12.8 volts), allow the battery to stand for an hour before refitting into the battery well and reconnecting the leads - see above.

**Quiescent Drain**

With a fully charged battery, the current drain with all electrical equipment switched off (no radio fitted) should be as follows:

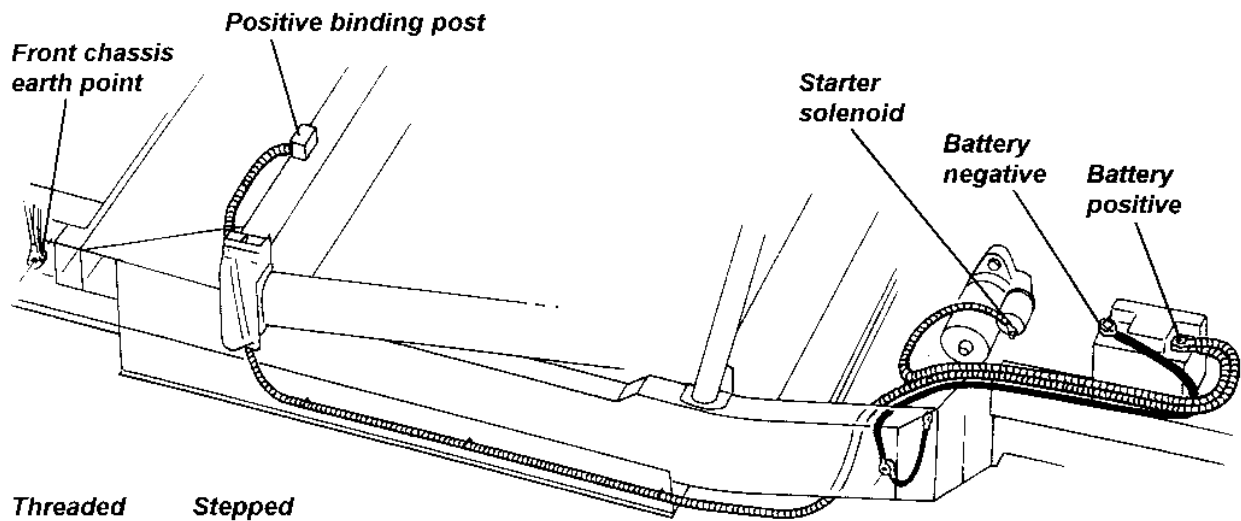
Immobiliser active	15 mA
Alarm set	20 mA

If current drain is found to be significantly in excess of these figures, the cause must be established by isolating components (e.g. at fusebox) and rectifying faults as necessary.

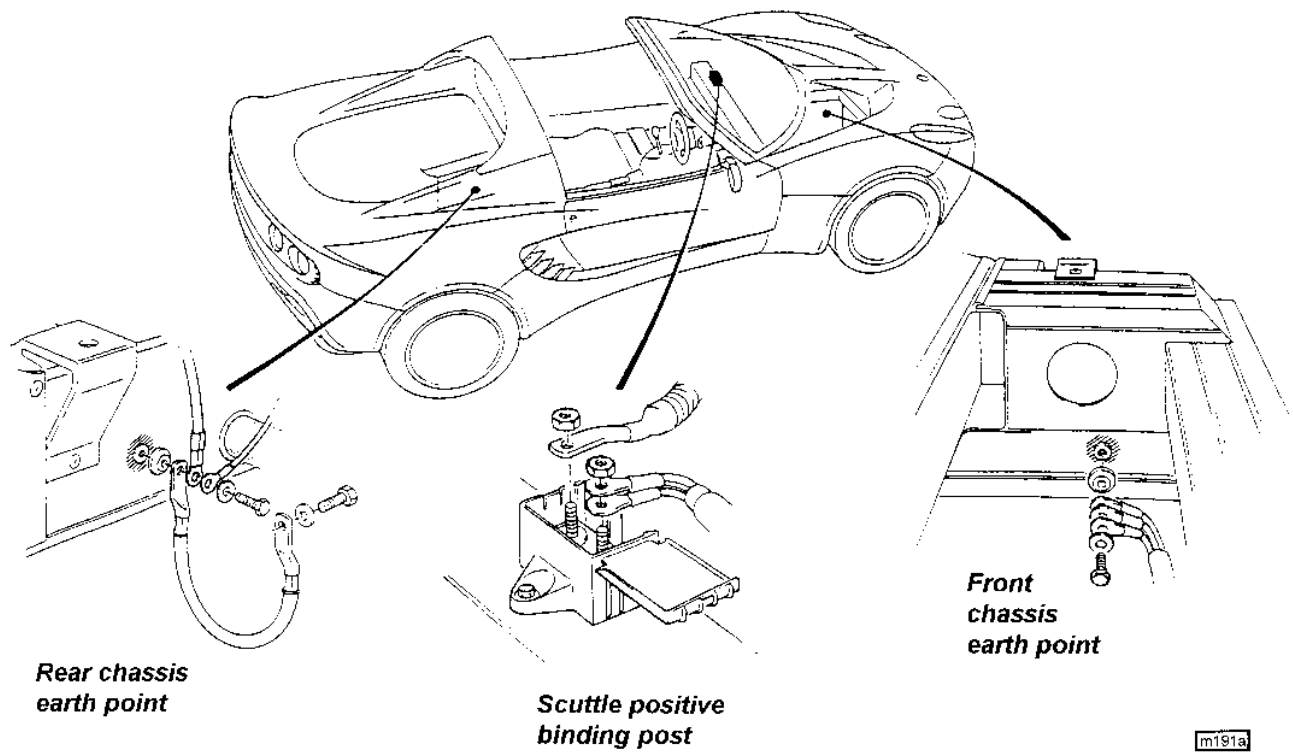
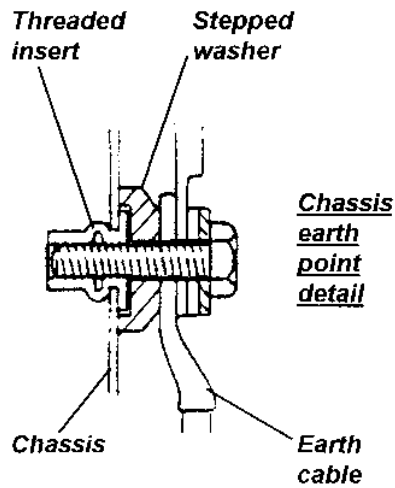
**Battery Cables**

Two main battery positive cables are used to connect to i) the starter motor solenoid, and ii) the front positive binding post. The starter solenoid terminal is used directly to supply the engine harness. The front positive post is mounted in an insulated box on the LH top of the scuttle beam, and is used to supply the main fusebox and other front mounted components with 12 volts. The supply cable runs from the battery, through the LH sill, fixed to the outside of the chassis LH side rail together with the heater return pipe and clutch hydraulic hose, and penetrates the scuttle baffle panel to the top of the scuttle beam.

The battery earth cable connects to a chassis earth point on the inside surface of the LH chassis rail at the side of the engine bay, accessible from beneath. From here, a second cable connects with the transmission casing to provide an engine earth. A second earth point is used at the front of the chassis to provide for front mounted components, and is located within the front services compartment on the inside surface of the chassis LH siderail. Each chassis earth point uses an M8 threaded insert and a special stepped washer which must be fitted the correct way round in order to contact the chassis (anodisation removed around insert). The chassis and cable earth terminals should be coated with petroleum jelly to protect from corrosion.



m245



m191a

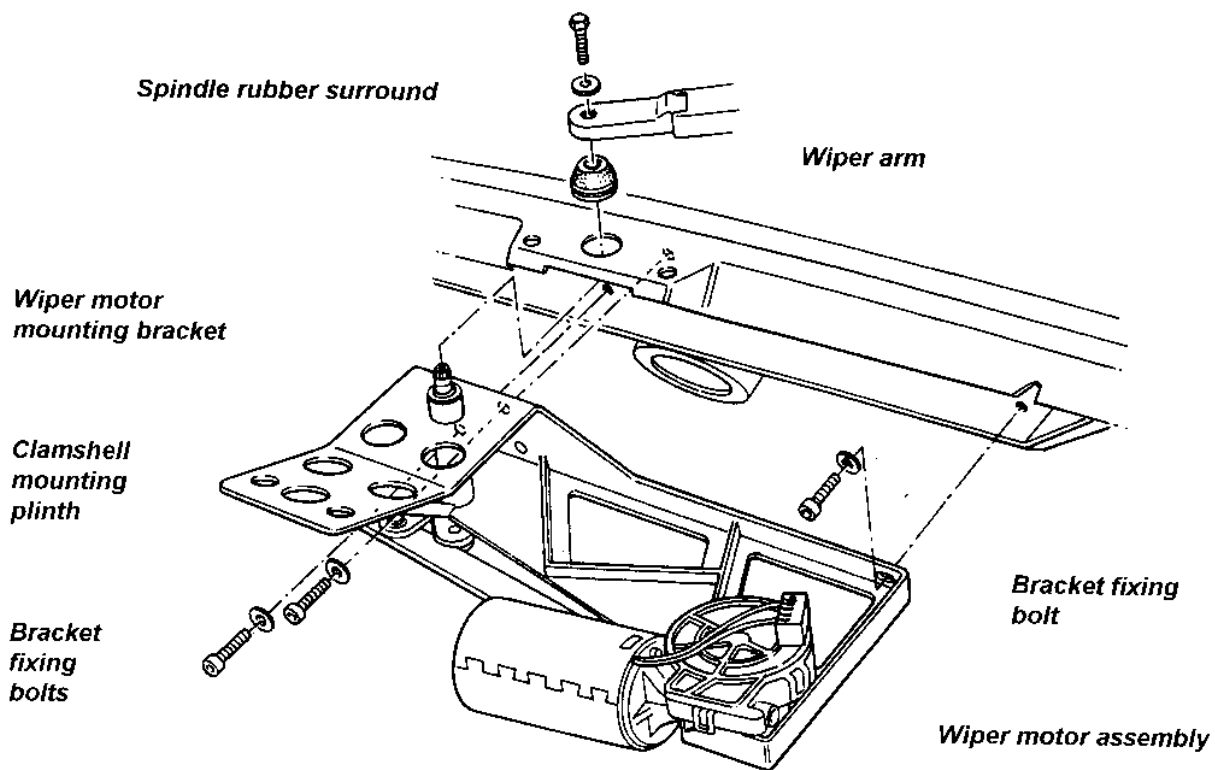


### MO.6 - WIPER MECHANISM

The windscreen wiper mechanism comprises a uni-directional motor with an external rotary link, a connecting rod, and a pair of actuating links which join the connecting rod to the arms of the wiper spindle. This mechanism provides the wiper with a motion which is slowed at each end of its travel in order to ease the inertia loads during direction changes, to the benefit of refinement and durability. The motor and wheelbox are mounted on a single fabricated steel bracket which is bolted to the windscreen scuttle panel.

To remove the wiper mechanism:

1. Remove the front clamshell (see sub-section BP.5).
2. Remove the wiper motor protective cover by releasing the two screws into the windscreen buttress, and the patch of adhesive between the inboard end and the screen gutter. Disconnect the harness plug from the motor. Disconnect the washer tubing.
3. Remove the wiper arm from the spindle, and the spindle rubber surround.



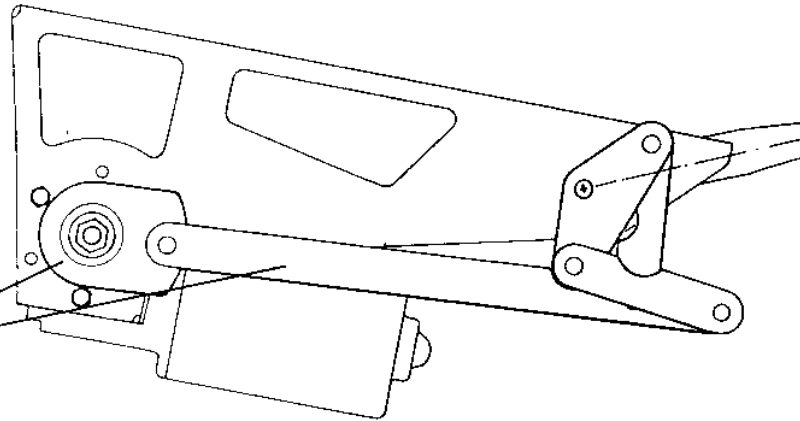
m208

4. Release the three screws securing the motor mounting bracket to the windscreen frame - one at each side of the spindle, one at the motor end, and withdraw the complete mechanism from the car.
5. If the motor is separated from the mechanism, the position of the rotary link should be marked against the motor shaft for reference when re-fitting. The motor should be in the 'park' position before fitting, and the mechanism at full travel so that the rotary link and connecting rod are aligned in the fully extended position.



**RHD Shown**  
**(LHD symmetrically**  
**opposite)**

**Wiper linkage**  
**in full travel**  
**position**

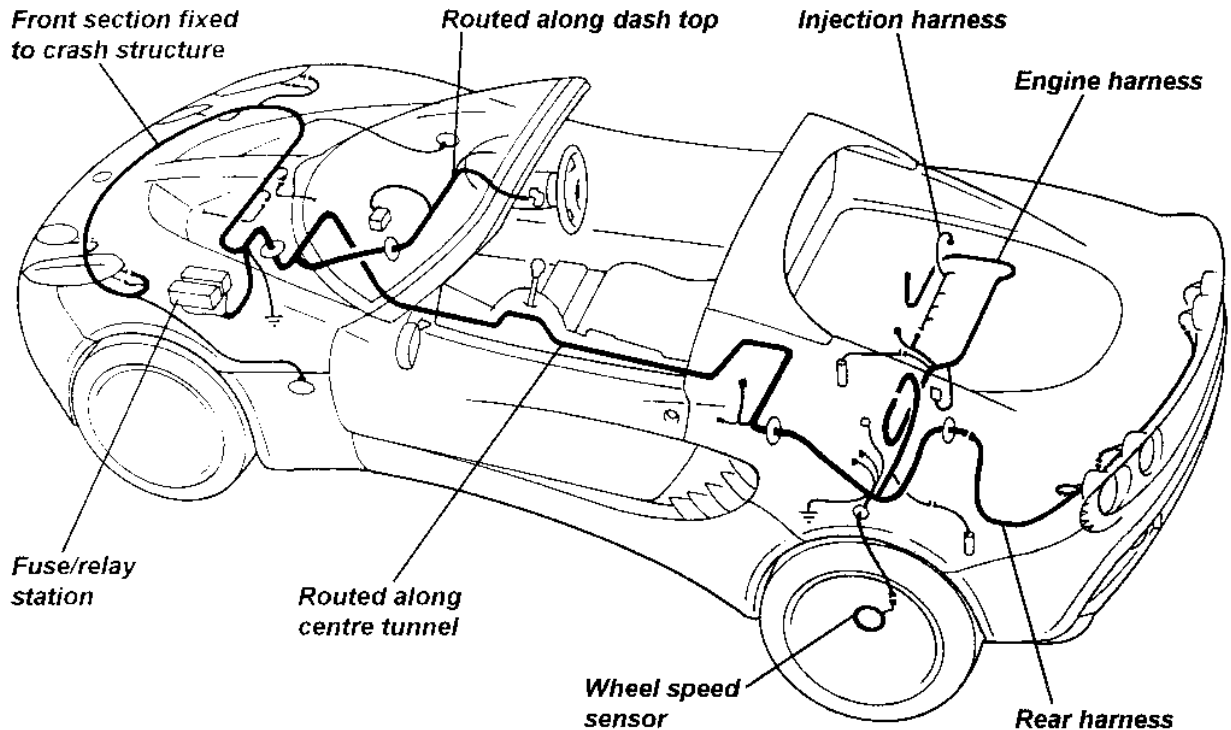


m209

- 6. Re-assemble in the reverse order to removal, torque tightening the bracket bolts to 20 Nm.

**MO.7 - HARNESS ROUTING**

The main harness runs from the main fusebox/relay station at the passenger side of the front services compartment, and divides into two branches; one running forwards across the front of the chassis well to feed the interior fan motor, horn and driving lamps, and then round the front of the crash structure to supply the front lights and horn, and ii) a second branch running rearwards through the scuttle where it divides again to run across the dash top for the instrument pack and switchgear, and along the cockpit centre tunnel to the rear of the car. At the rear of the tunnel the harness passes through the fuel tank bay to emerge at the left hand front of the engine bay, from where it runs to the engine ECM panel, and through a grommet into the rear luggage compartment to a rear harness connector. Separate harnesses are provided for the rear lighting, engine, and fuel injectors.



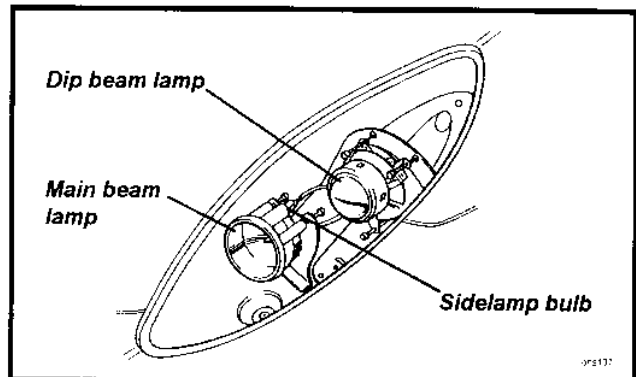
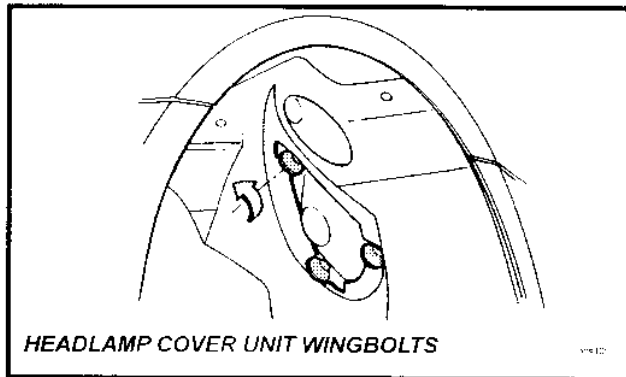
m244



**MO.8 - FRONT LAMP ASSEMBLIES**

**Headlamp Units**

The front clamshell incorporates, at each side, a headlamp housing, in each of which are mounted a halogen projector type dip beam lamp (upper), and a halogen main beam lamp (lower), which also incorporates the sidelamp bulb. A moulded plastic mask and clear acrylic cover are bonded together and are fitted over each headlamp housing, with a rubber surround finisher, with the unit retained by three slotted thumbscrews accessible from within the front wheelarch. For access to the headlamps, release the three thumbscrews and withdraw the headlamp cover assembly.



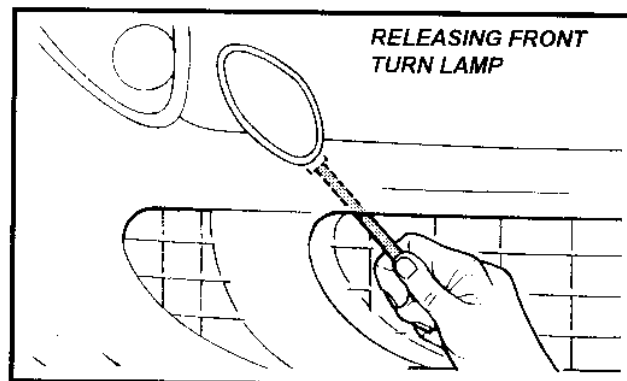
Headlamp bulbs may be replaced after disconnecting the cables (Dip; blue/yellow, black. Main; blue/black, black) and releasing the spring clip. Both the 55W H1 dip beam bulb, and the 55W H7 main beam bulb incorporate orientation features which must be correctly located on re-fitting. The holder for the T4W bayonet fitting sidelamp bulb may be twisted to release from the main beam headlamp.

If the car is to be used temporarily in an opposite drive hand territory, a masking lever incorporated in each dip beam headlamp should be moved to provide a horizontal cut off and prevent dazzle.

**Front Turn Lamps**

For access to the front turn indicator bulb, the lamp unit must be released from the body. Using the tool provided in the toolkit, or a suitable stiff rod, via an access hole in the outer top corner of the air intake aperture, compress the retaining clip at the front corner of the turn lamp, and withdraw the lamp from the body. Twist the bulb holder counterclockwise to release from the lamp, and replace the bayonet fitting amber bulb.

After replacing the bulb and holder, engage the lamp unit top corner lip in the body aperture, and press the bottom corner to engage the spring clip.





MO.9 - CIRCUIT DIAGRAMS

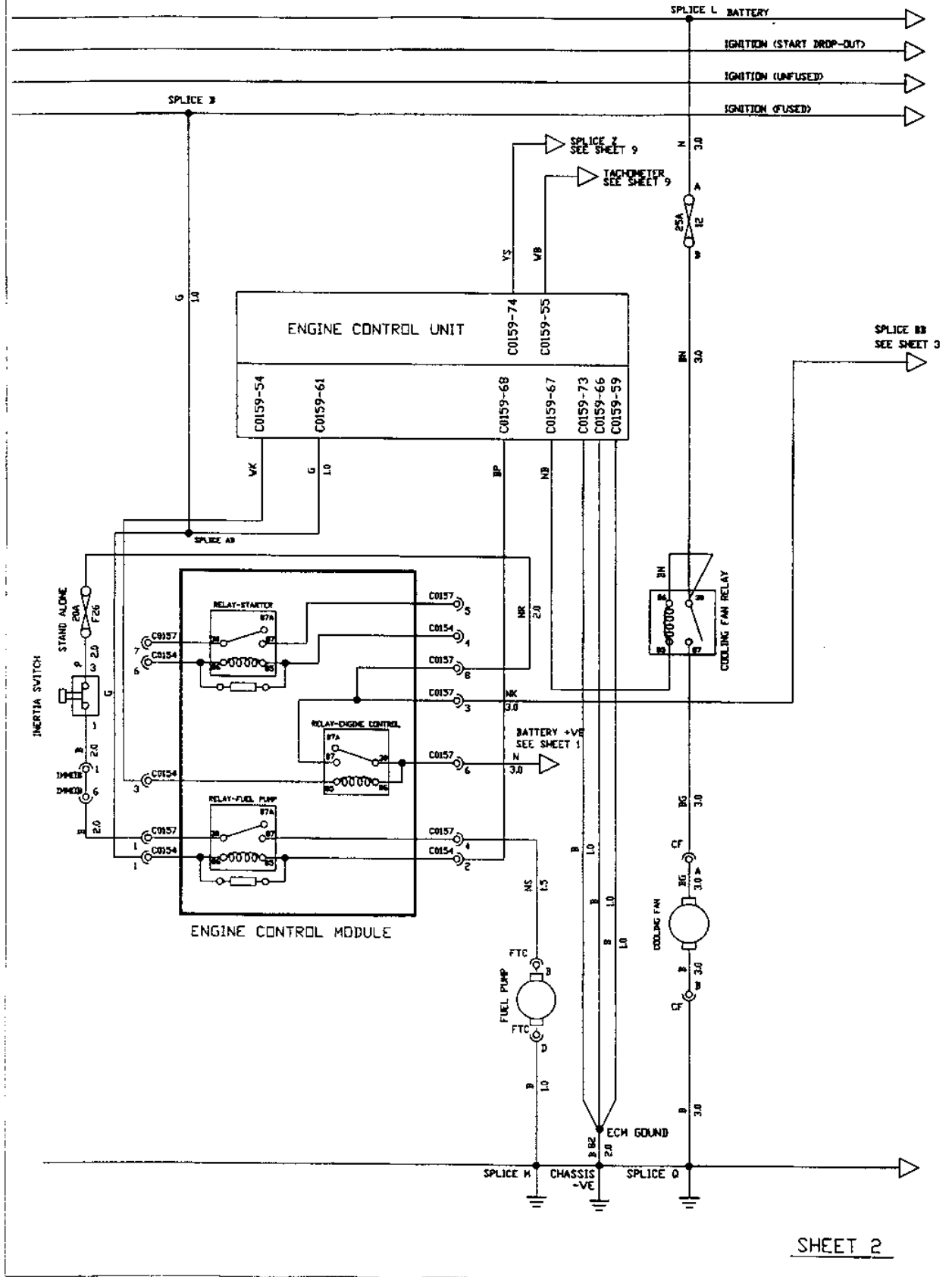
<i>Circuit</i>	<i>Sheet</i>
Start, Alternator & Ignition	1
Fuel Pump, Cooling Fan, Engine Management 1	2
Engine Management 2	3
Alarm & Interior Lamp	4
Stop & Reverse Lamps	5
Direction Indicators & Hazard Lamps	6
Headlamps, Sidelamps, Fog Lamp	7
Instruments	9
Windscreen Wipers	10
Interior Fan & Air Conditioning (Option)	11
Radio & Auxiliary Power Socket	12
Power & Ground Structure	13
Inter-Harness Connectors	14







FUEL PUMP-COOLING FAN-ENGINE MANAGEMENT 1



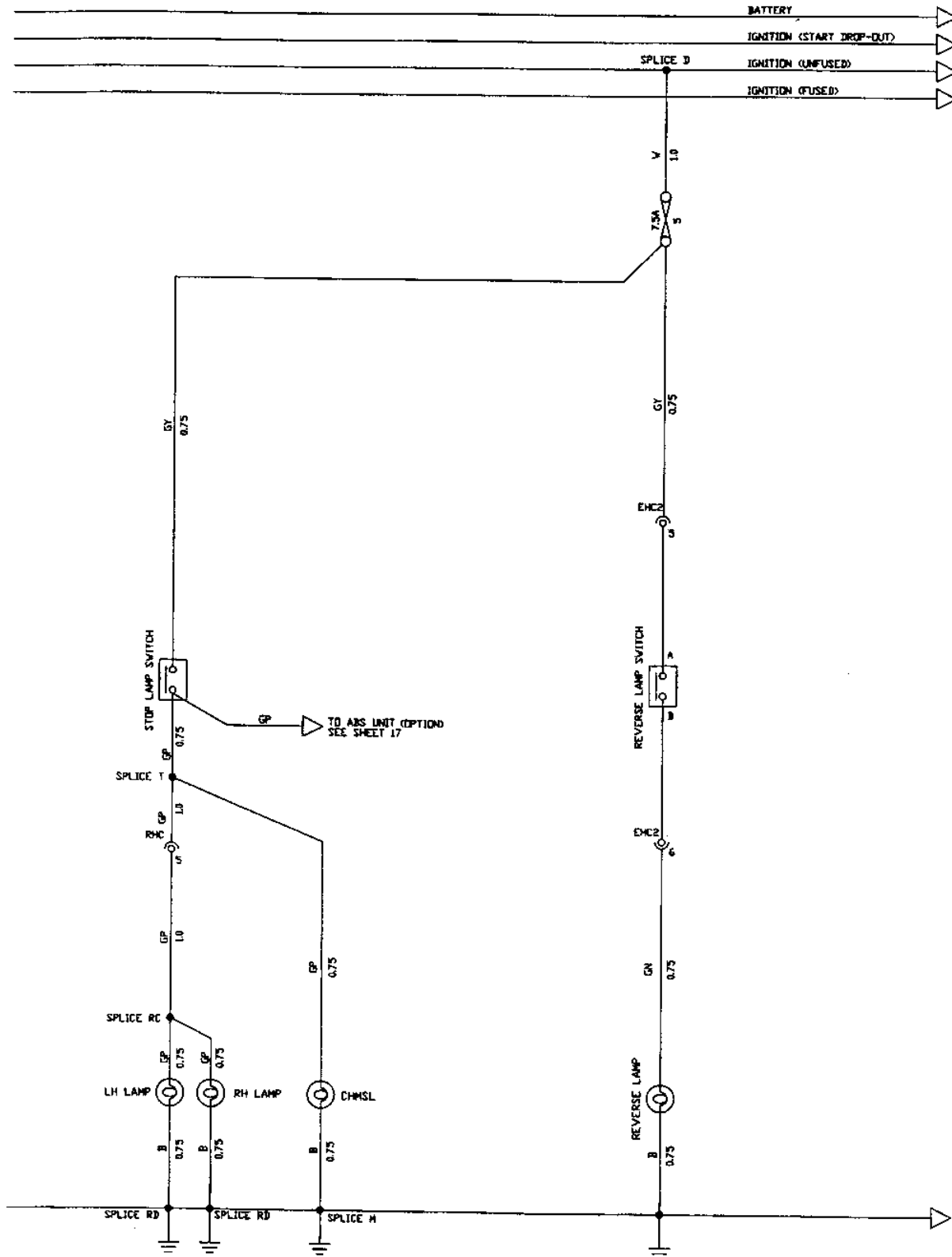
SHEET 2







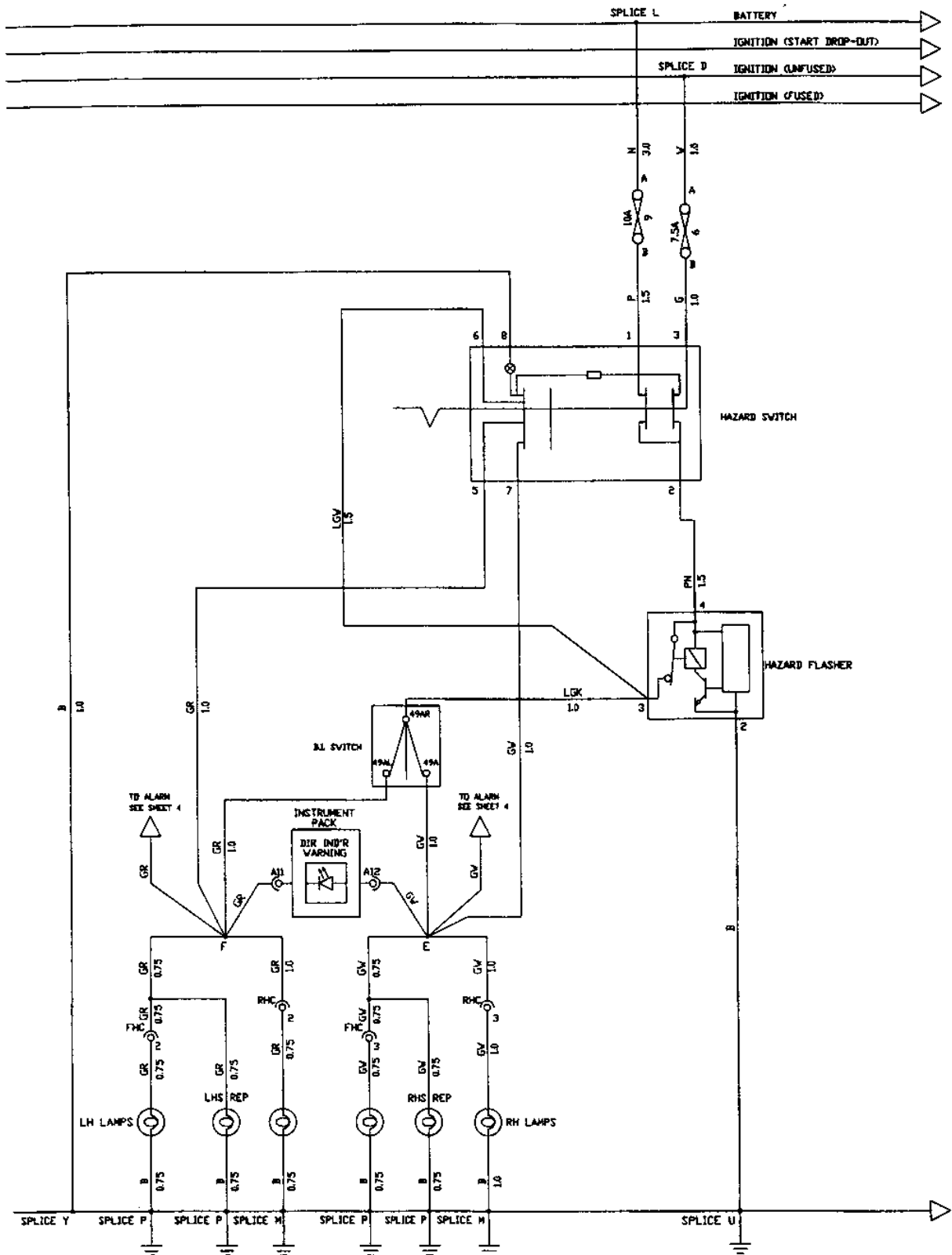
STOP & REVERSE LAMPS



SHEET 5

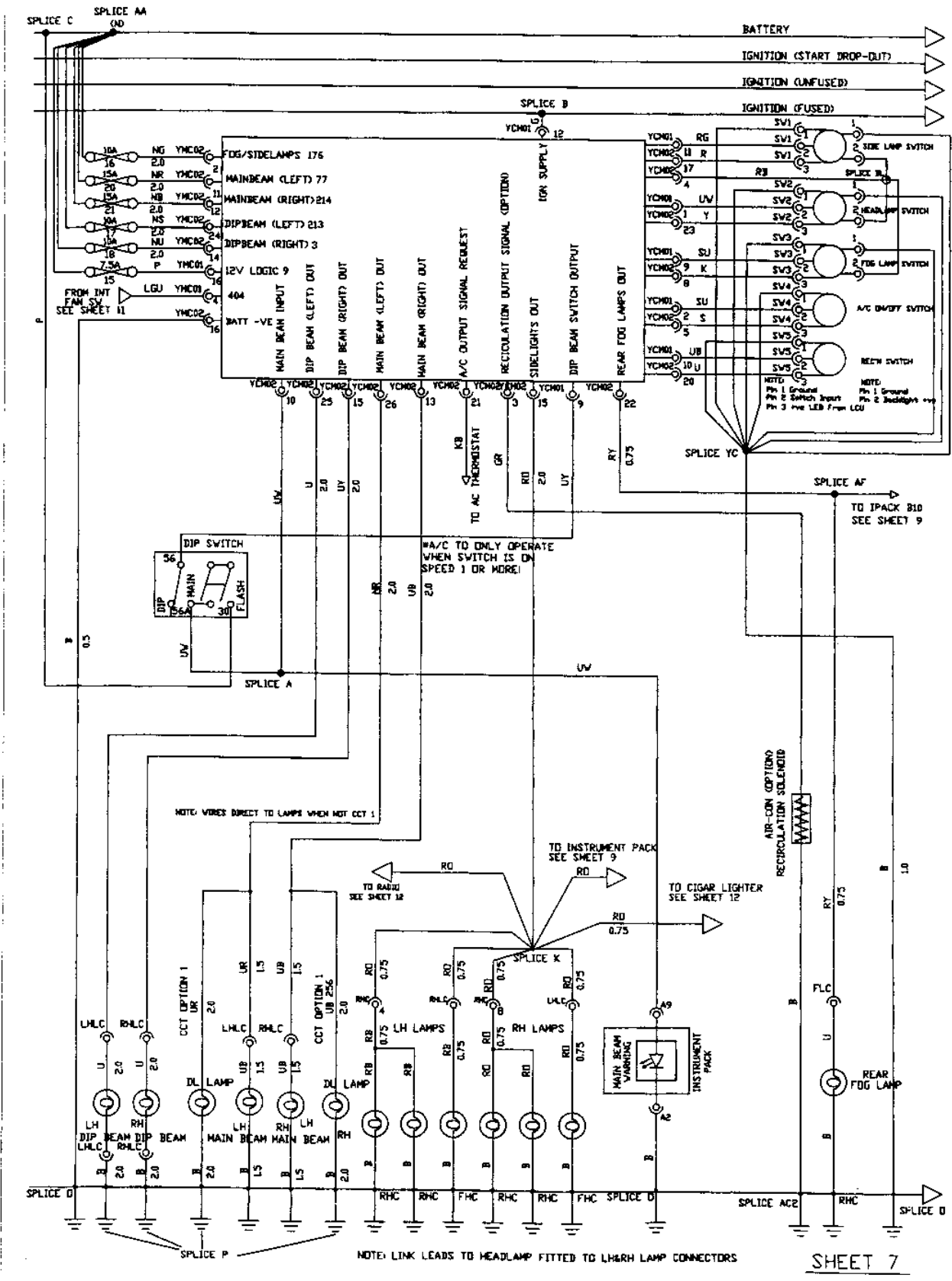


DIRECTION INDICATORS & HAZARD LAMPS



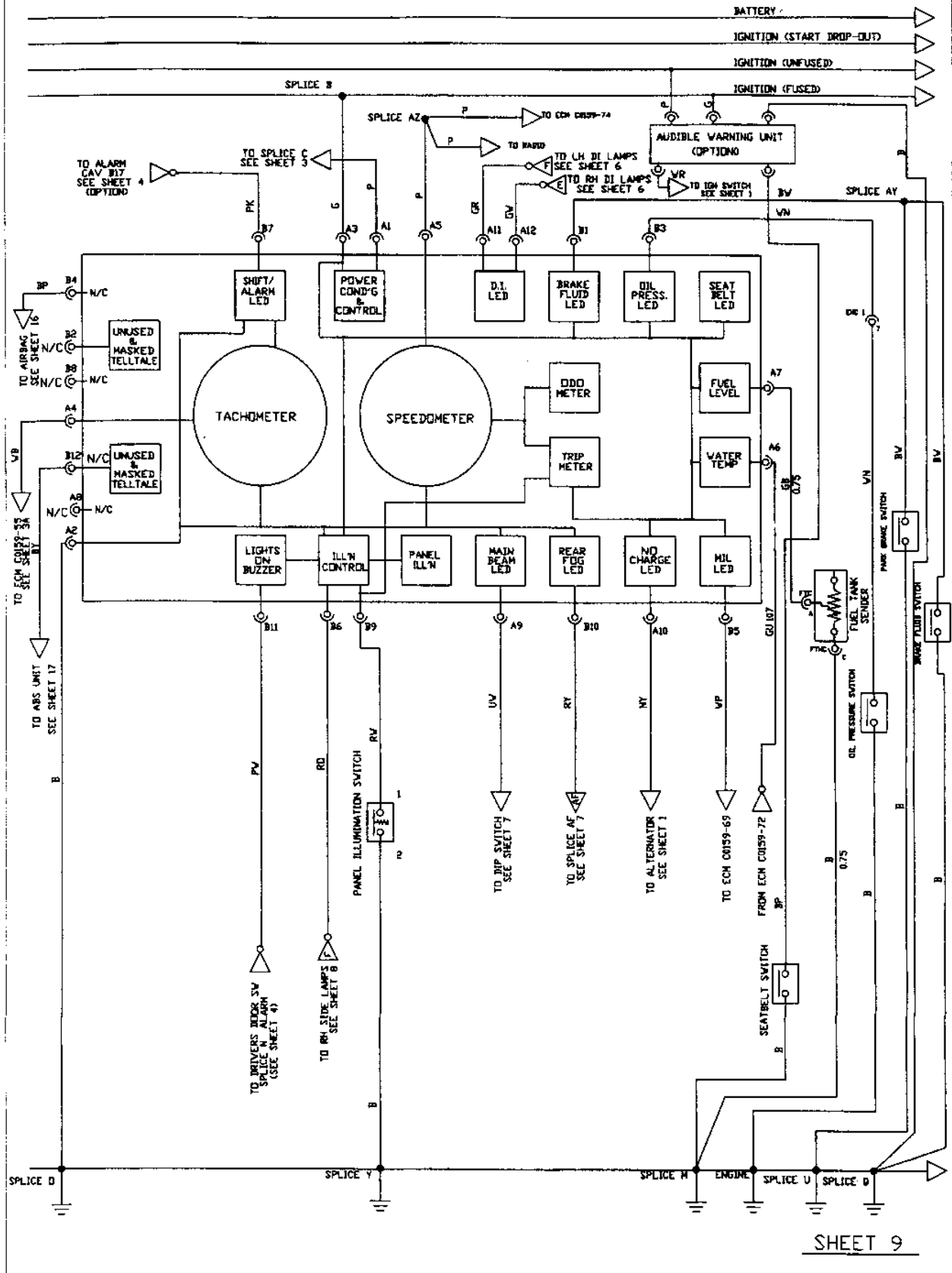


HEADLAMPS SIDELAMPS & FOG LAMP





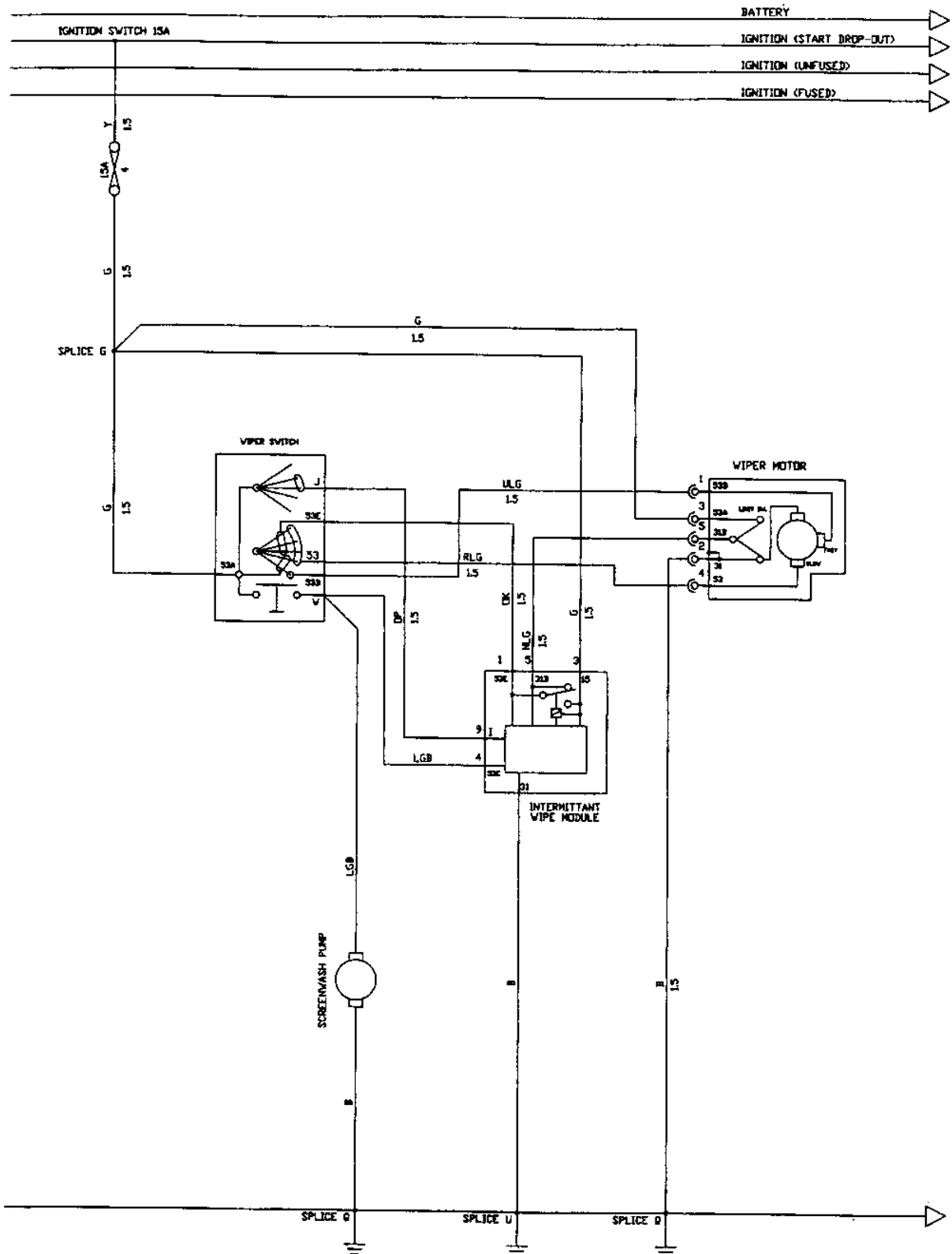
INSTRUMENTS





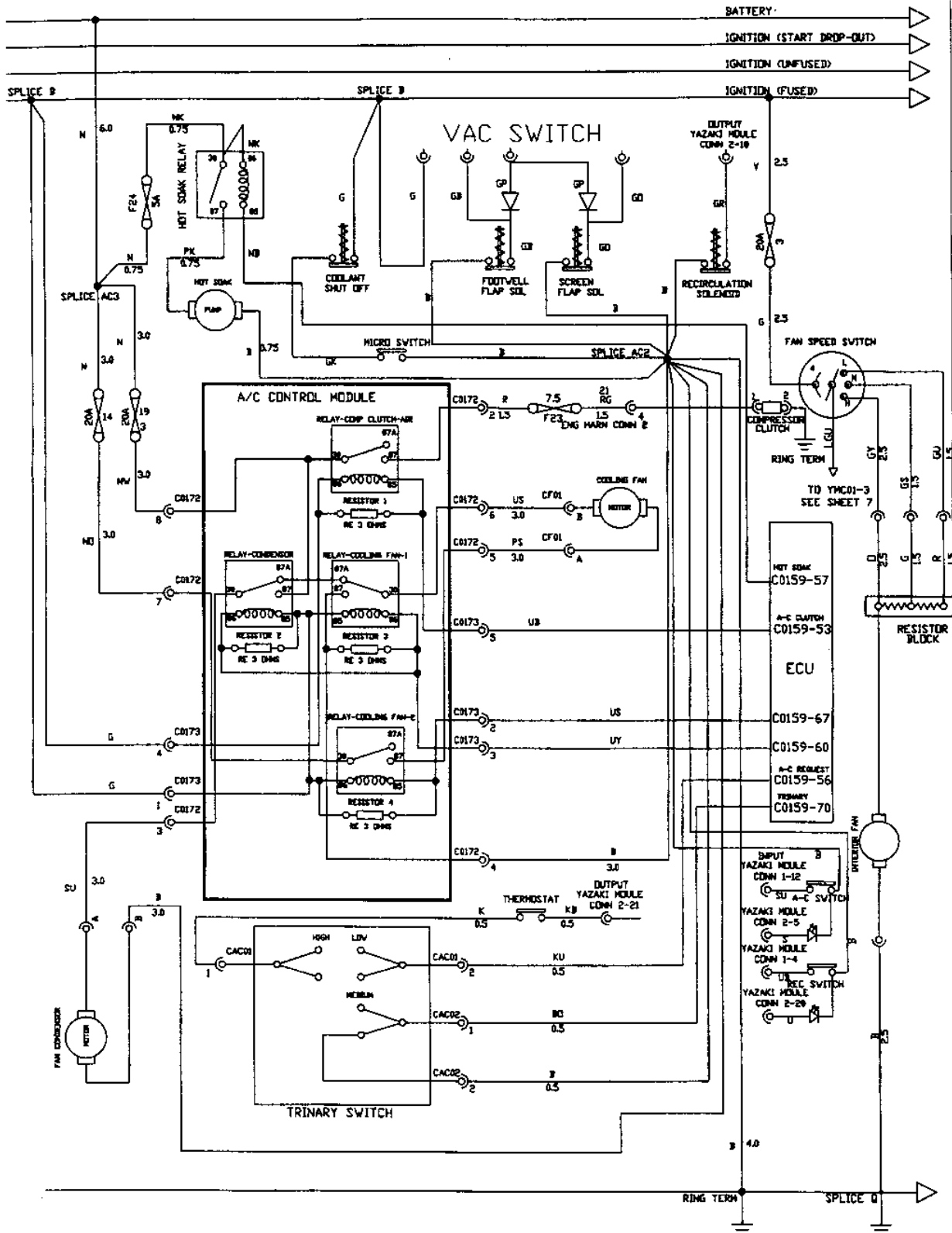


WINDSCREEN WIPERS



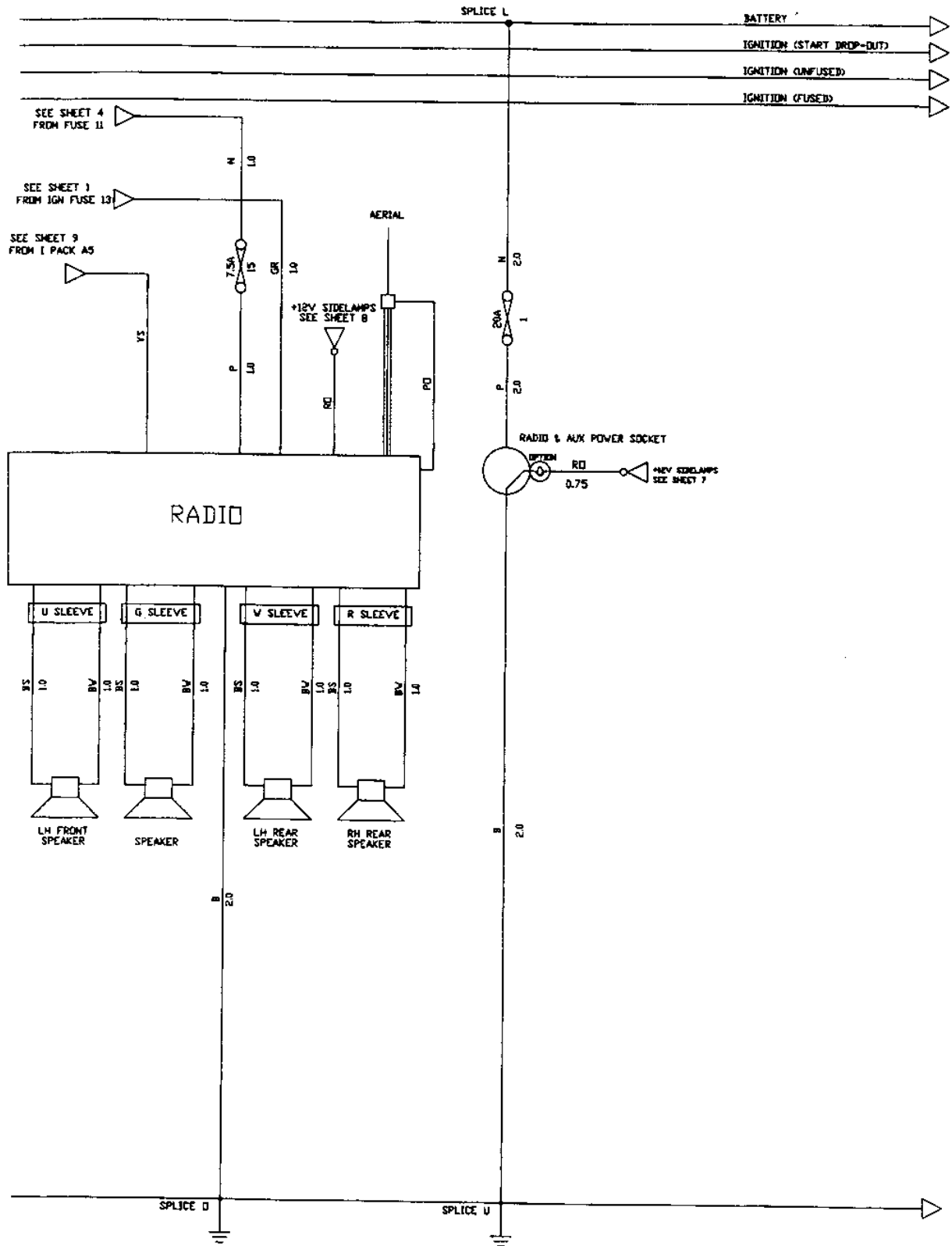


INTERIOR FAN / AIR CONDITIONING (OPTION)



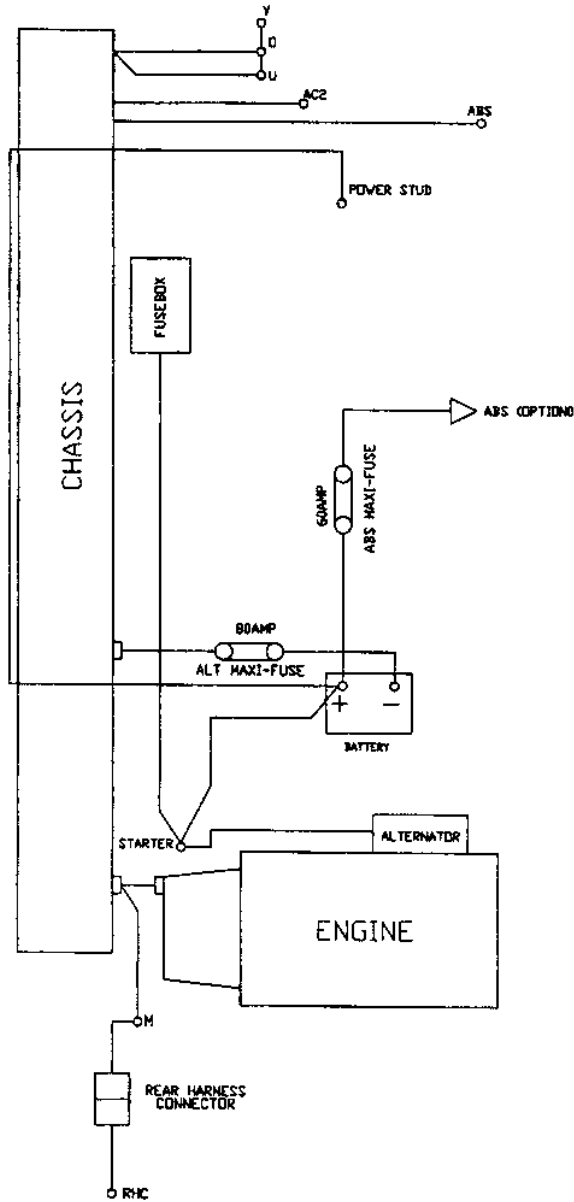


RADIO (OPTION) & AUX POWER SOCKET





POWER & GROUND STRUCTURE

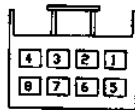




INTER-HARNESS CONNECTORS

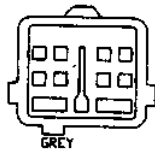
CONNECTOR ON  
MAIN HARNESS

CONNECTOR ON  
MATING HARNESS



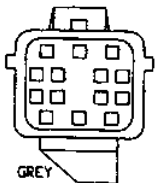
YAZAKI H 7283-3360-40

REAR  
HARNESS CONNECTORS  
(RHC)



GREY  
SUMITOMO H 6189-0555 X 1

ENGINE HARNESS  
CONNECTOR 1 (EHC 1)

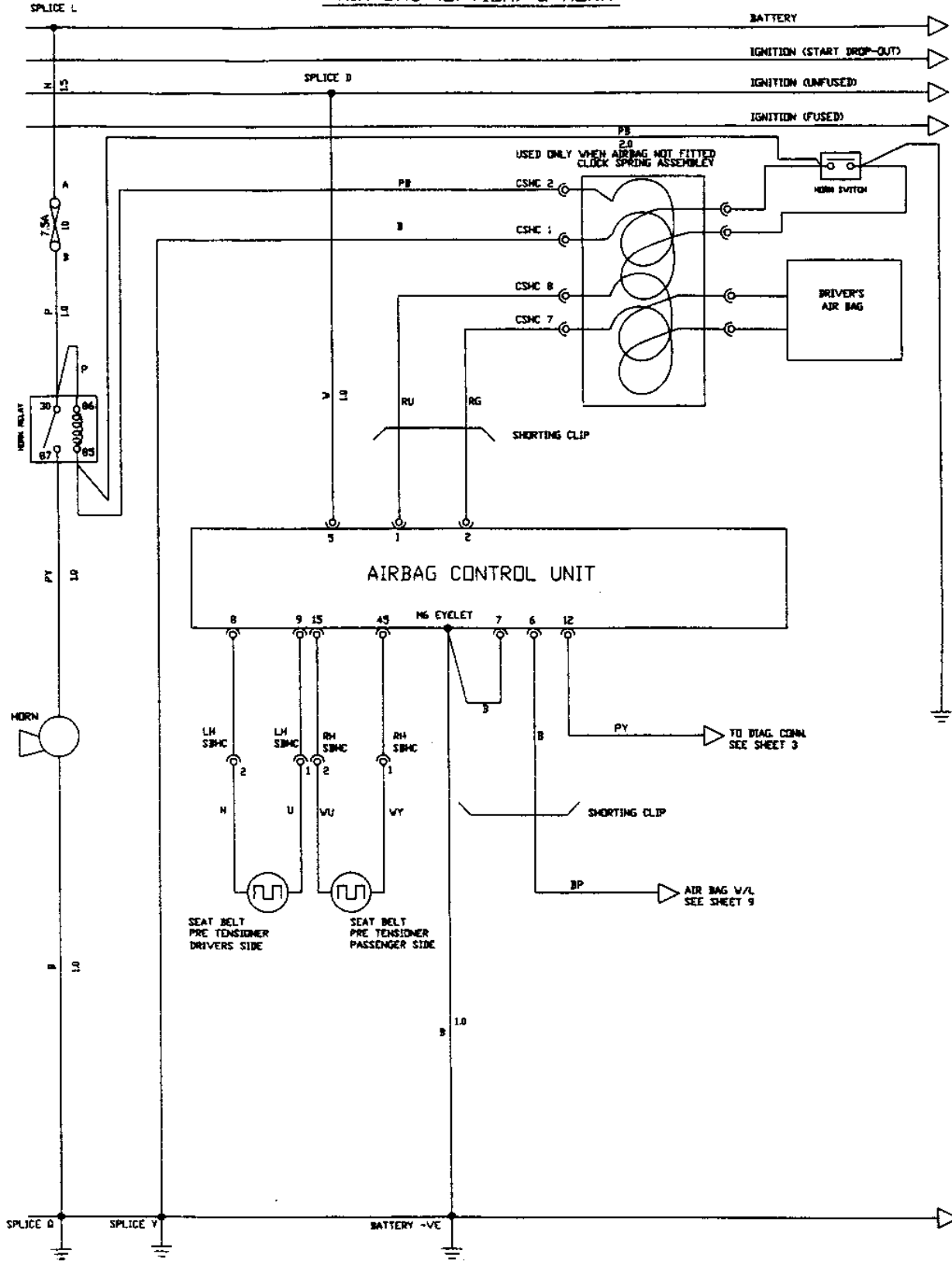


GREY  
SUMITOMO H 6189-0136 X 1

ENGINE HARNESS  
CONNECTOR 2 (EHC 2)



AIR BAG (OPTION) & HORN





MAINTENANCE & LUBRICATION

SECTION OH - ELISE 2001 M.Y. Onwards

	<u>Page</u>
Recommended Lubricants	2
Maintenance Schedule	4
Pre-Delivery Inspection	7

**RECOMMENDED LUBRICANTS****Engine**

The engine is factory filled with a top quality 10W/40 mineral oil to be used during the running-in period until the After Sales Service. Once running-in has been completed, it is considered that semi-synthetic or fully synthetic engine oils represent the best value in terms of fuel economy and wear protection. A multigrade oil is designated with a low temperature viscosity grade (first number with 'W' for winter) followed by a high temperature viscosity grade. Oils with low cold viscosity, offer benefits in terms of fuel economy, ease of cranking and starting, and cold run protection. Oils with high hot viscosity offer increased protection at high temperatures and high rpm, and will tend to reduce oil consumption. For the Elise, the viscosity should be within the following range:

**Cold viscosity; 0 - 20W**  
**Hot viscosity; 50 - 60**

For use in extreme cold climates, an oil with a low temperature viscosity of 0W should be used. In all cases, the oil quality grades which must be met are either European standard ACEA A3, or American standard API SJ. Check that this is printed on the oil container. For the Elise, Lotus specifically recommends the following fully synthetic products:

**Mobil 1 Motorsport 15W/50**  
**Castrol Formula RS 10W/60**

Capacity - refill inc. filter	4.5 litre (7.9 imp.pt)
- dry inc. filter	5.0 litre (8.8 imp.pt)
Difference between high & low dipstick marks	1.0 litre (1.8 imp.pt)
Oil change interval	9,000 miles (15,000 km)

**Transmission (gearbox & final drive)**

Only specified lubricant	Texaco MTF 94 (A111F6017V)
Capacity - refill	2.1 litre (3.7 imp.pt)
- dry	2.4 litre (4.2 imp.pt)
Oil change interval	Filled for life

**Brake & Clutch System**

Type	Non-mineral (non-petroleum) hydraulic fluid
Specification	DOT 4
Capacity - brake	1.5 litre
- clutch	0.5 litre
Fluid change interval	12 months

**Engine Coolant Additive**

Type	Unipart Super Plus Anti-Freeze & Summer Coolant
Concentration	50%
System capacity	8.0 litre
Coolant change interval	24 months





MAINTENANCE SCHEDULE - ELISE 2001 M.Y. Onwards

LSL408

Date: ..... Owner's Name: ..... Vehicle: .....

Vehicle Registration No.: ..... V.I.N.: .....

Recorded Mileage: ..... Months Since Last Service: ..... Job No.: .....

EXPLANATORY NOTES:

Required Maintenance

In order to maintain warranty validation and help ensure proper safety, emissions performance and dependability of the vehicle, Lotus Cars Ltd. requires that the vehicle be serviced in accordance with this schedule. Each service should be performed either within 1,000 miles (1,600 km) of the distances stipulated, or within one month of the anniversary of the previous service, whichever first occurs. Any necessary repairs should be completed without delay.

A cross (X) in the following table indicates an operation to be performed. The corresponding box should be ticked (✓) when the operation has been satisfactorily performed, or the X circled if extra work and time is required. The approval of the customer should be obtained before any extra work is undertaken, details of which should be recorded in the space provided at the end of the schedule.

After Sales Service

There is no charge to the vehicle owner for the labour content of the After Sales Service. Only materials used will be charged. To maintain warranty validity, an Engine History Report print out from the Lotus Check II scanner tool must be submitted to the Warranty Department.

'Inspect' means assess condition and test for correct operation. Extra time is required to adjust or repair - advise customer beforehand if necessary.

'Check' means test and adjust/fill or tighten as necessary. Labour time is included.

Odometer Reading	Time Period	Service Type
1,000 to 1,500 miles (1,500 to 2,500 km)	To be performed within 12 months of vehicle date of sale.	After Sales Service.
9,000 miles (15,000 km)	Or 12 months since last service.	A
18,000 miles (30,000 km)	" " " " " "	A
27,000 miles (45,000 km)	" " " " " "	B
36,000 miles (60,000 km)	" " " " " "	A
45,000 miles (75,000 km)	" " " " " "	A
54,000 miles (90,000 km)	" " " " " "	C
63,000 miles (105,000 km)	" " " " " "	A
72,000 miles (120,000 km)	" " " " " "	A
81,000 miles (135,000 km)	" " " " " "	B
90,000 miles (150,000 km)	" " " " " "	A
99,000 miles (165,000 km)	" " " " " "	A
108,000 miles (180,000 km)	" " " " " "	C



Op No.	OPERATION DESCRIPTION	SERVICE TYPE				
		After Sales	A	B	C	Other Intervals
1	Fit protective covers to seats, footwells, steering wheel & rear body	X	X	X	X	
	<b>Lubrication</b>					
2	Renew engine oil & filter*	X	X	X	X	
3	Inspect engine & transmission for oil leaks	X	X	X	X	
4	Check transmission oil level		X	X	X	
	* in 'severe service' conditions (dusty areas, or cold, stop/start driving), change twice as frequently or as required.					
	<b>Engine</b>					
5	Renew air cleaner element* (refer above)			X	X	
6	Renew spark plugs			X	X	
7	Inspect auxiliary drive belt condition		X	X	X	
8	Renew cam belt				X	
9	Renew fuel filter				X	
10	Connect 'Lotus Check II' and check for fault codes	X	X	X	X	
11	Print Engine History Report from 'Lotus Check II' & return to Lotus	X				
12	Inspect & record tailpipe CO		X	X	X	
	<b>Cooling System</b>					
13	Inspect radiator, hoses & pipework for damage or leaks. Clean radiator finning		X	X	X	
14	Check coolant level	X	X	X	X	
15	Renew coolant					24 months
	<b>Braking System</b>					
16	Inspect parking brake adjustment	X	X	X	X	
17	Inspect operation of brake tell tales	X	X	X	X	
18	Inspect brake pad thickness & disc condition ^		X	X	X	
	^ In conditions where the brakes are subject to heavy use, inspection may be required more frequently					
19	Inspect brake hoses, pipes & hydraulic units		X	X	X	
20	Check brake fluid level	X	X	X	X	
21	Renew brake/clutch fluid					12 months
	<b>Steering &amp; Suspension</b>					
22	Check security and condition of front & rear suspension inc. free articulation of rear toe link ball joints		X	X	X	
23	Inspect dampers for leaks & performance		X	X	X	
24	Inspect front & rear wheel bearings for play		X	X	X	
25	Inspect condition of driveshaft gaiters		X	X	X	
26	Inspect steering ball joints & gaiters		X	X	X	
27	Inspect free play at steering wheel		X	X	X	



Op No.	OPERATION DESCRIPTION	SERVICE TYPE				
		After Sales	A	B	C	Other Intervals
	<b>Wheels &amp; Tyres</b>					
28	Inspect tyre condition & set pressures	X	X	X	X	
	<b>Electrical</b>					
29	Check battery terminals for security & condition		X	X	X	
30	Inspect operation of all lights		X	X	X	
31	Inspect operation of all electrical equipment		X	X	X	
	<b>Body</b>					
32	Check adjustment of hinges & latches. Lubricate door check plate	X	X	X	X	
33	Inspect operation & condition of seat belts		X	X	X	
34	Top up screenwash reservoir	X	X	X	X	
35	Renew alarm transmitter batteries (check with customer)					12 months

**Road Test Performance**

Engine performance ..... Tailpipe CO .....

Clutch operation ..... Gearbox operation .....

Brake performance ..... Steering performance .....

Driveline & suspension noise/vibration ..... Wheel balance .....

General comments .....

Additional work required .....

.....

.....

.....

.....

Work completed by .....

**Recommended Service Times**

- After Sales Service: 1.3 hr
- A Service: 2.3 hr
- B Service: 2.7 hr
- C Service: 6.2 hr
- (Add 0.5 hr to all if undershield fitted)

Dealer stamp:

Date:

Useviceltabelen\_on\_t3.cmf



PRE-DELIVERY INSPECTION - ELISE 2001 M.Y. Onwards

LSL345B

Model: ..... Colour: ..... V.I.N.: S C C \_ \_ \_ \_ \_

OPERATION	Elise
Fit protective covers to seats, footwells & steering wheel	X
<b>Engine Bay</b>	
Check engine & transmission oil levels	X
Check security of engine oil filter	X
Check coolant level	X
<b>Start Engine</b>	
Check engine & transmission for oil leaks	X
Check cooling system for leaks	X
Use 'Lotus Check It' scanner tool to check for stored codes	X
<b>Fuel Tank</b>	
Completely fill fuel tank and check for leaks	X
<b>Wheels &amp; Tyres</b>	
Check cold tyre pressures, inc. spare (if fitted)	X
Check torque of wheel bolts	X
<b>Electrical</b>	
Check security of battery terminals	X
Check operation of all exterior & interior lamps	X
Check headlamp alignment	X
Check operation of horn(s) & hazard switch	X
Check wiper operation at all speeds & park position	X
Check washer operation, jet alignment & reservoir level	X
Check operation of all instruments & set time clock	X
Check operation of heater/air conditioning and blower fan	X
Check operation of audio equipment	X
<b>Body</b>	
Check brake/clutch fluid level	X
Check operation of doors & door locks	X
Check adjustment & operation of engine lid	
Check soft top roof erection & stowage	X
Check operation of seat belts	X
Check interior trim for damage and cleanliness	X
Check all paintwork for damage	X
Check presence of toolkit & literature pack	X
<b>Road Test &amp; Valet</b>	
Carry out road test report overleaf	X
Carry out full vehicle valet	X

:\service\table\sn\_pdi\_monza.emf



**Road Test Performance**

Engine performance ..... Brake performance .....

Clutch operation ..... Gearbox operation .....

Steering performance ..... Wheel balance .....

Driveline & suspension noise/vibration .....

General comments.....

Additional work required .....

.....

Work completed by .....

**Notes**

The PDI is subject to the following conditions:

- a) It is the responsibility of the supplying dealer to ensure that the car is delivered to the customer in the best possible condition.
- b) All costs incurred during the inspection are the responsibility of the supplying dealer.
- c) Failure to return a signed copy of this inspection to Lotus Cars Ltd. by the dealer, may result in warranty claims on the particular car being rejected.

Dealer stamp:

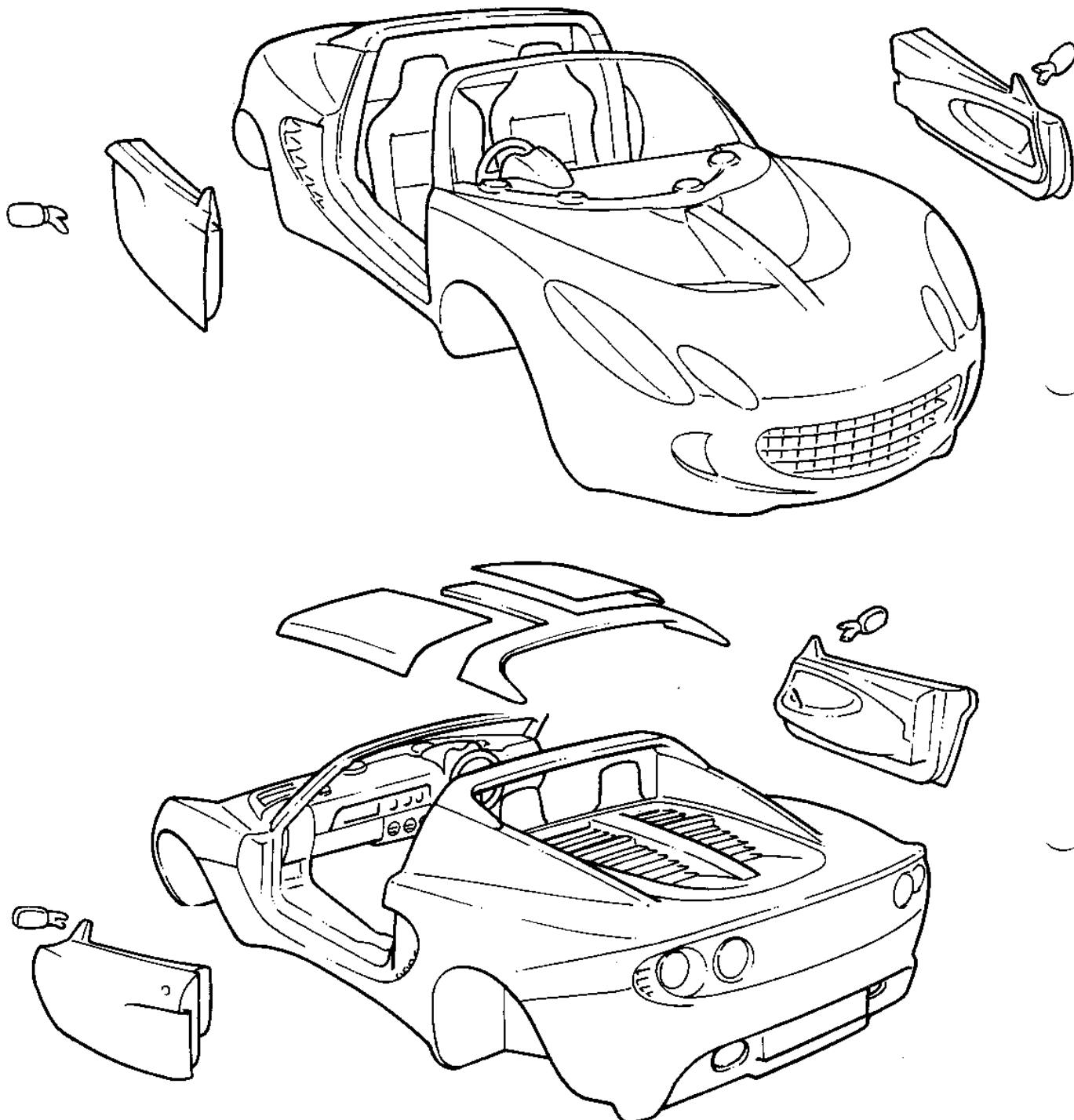
Dealer signature: .....

Date: .....



**BODY PAINT INSPECTION - ELISE 2001 M.Y. Onwards**

LSL 407



V.I.N.: .....

COLOUR: .....

OWNER: .....

DATE OF PURCHASE: .....

<u>CODES</u>			
B	Blistering	N	Shading
C	Chips	O	Overspray
D	Distortion	P	Pre-Releases
F	Flaking	R	Run
G	Gel Crazing	S	Scratches
H	Pin Holes	T	Thin Paint
K	Sinkage	U	Dirt Under Paint
M	Mat Creases	V	VOIDS



HEATING & VENTILATION

SECTION PI - ELISE 2001 M.Y. Onwards

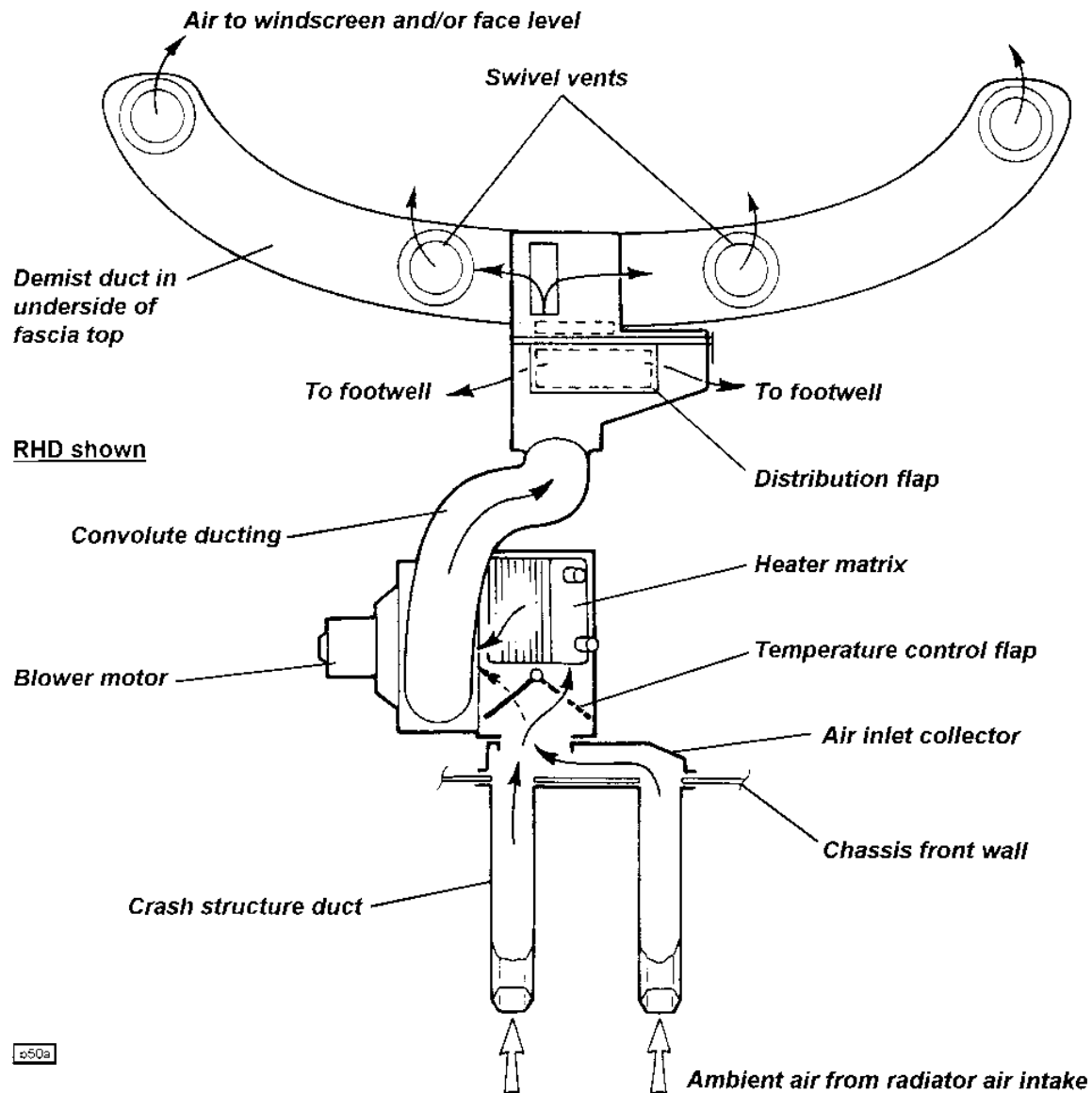
	<u>Sub-Section</u>	<u>Page</u>
General Description	PI.1	2
Control Cables	PI.2	4
Heater Unit	PI.3	6
Air Distribution Unit	PI.4	6



PI.1 - GENERAL DESCRIPTION

The principal components of the heater/ventilation system comprise a heater matrix unit, incorporating an air blend temperature control flap, a blower fan, and a distribution chamber. The system provides heated or ambient air to the fascia vents or footwells, as demanded by two rotary controls in the fascia in conjunction with a four speed fan selector switch. Airflow from each of the fascia outlet vents may be individually adjusted for volume and direction by direct manipulation of the vent, and may be optimised for either windscreen demisting or face level ventilation.

Air for the ventilation system is bled off from the radiator air intake duct, via open ends in two of the 'crush tubes' in the composite crush structure bonded to the front of the chassis. A pair of holes in the chassis front crossmember mate with these tubes and admit air into the heater unit, mounted in the climate chamber chassis 'well' ahead of the cabin footwells. The air blender flap directs the airflow either through or around the heater matrix to control air temperature. The heater matrix is a water/air heat exchanger mounted vertically in a plastic moulding, and is fed with engine coolant at all times (no water valve is used) by an alloy pipe running within the RH sill, and connected to a junction hose at the rear end of the radiator main feed chassis rail. Water returns to the engine via an alloy pipe running within the LH sill and connecting with the engine coolant return pipe at the left hand end of the engine.



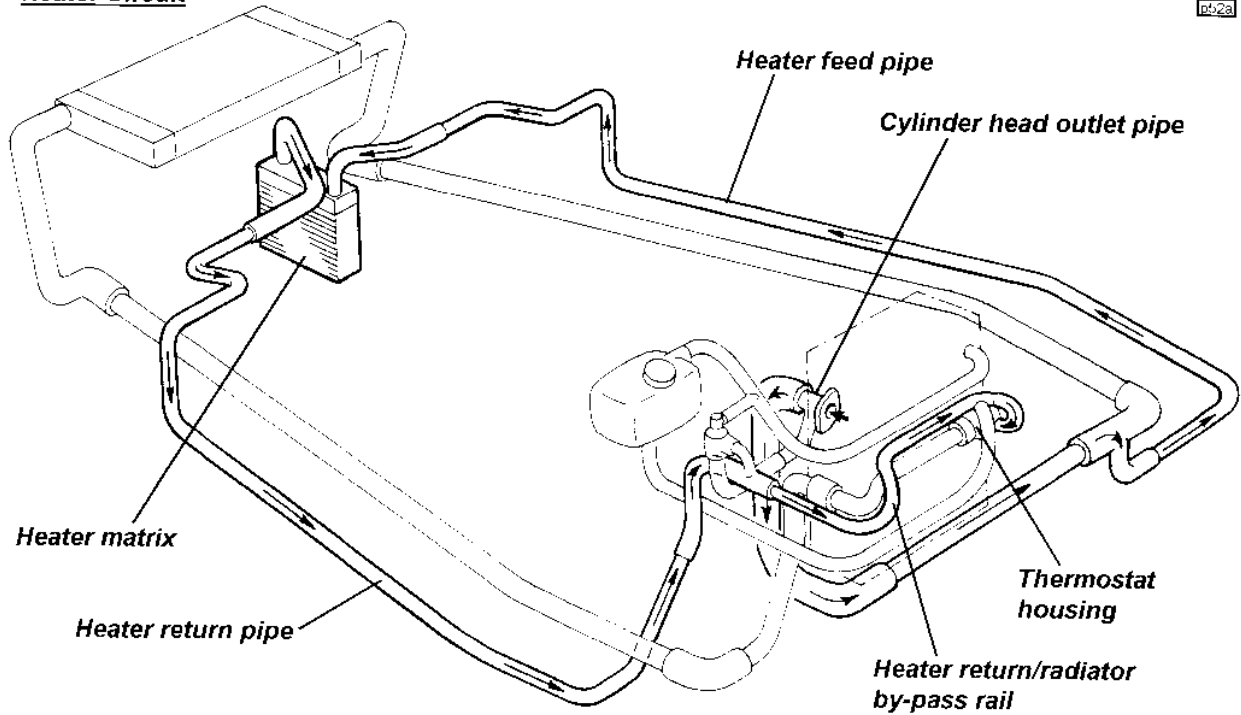
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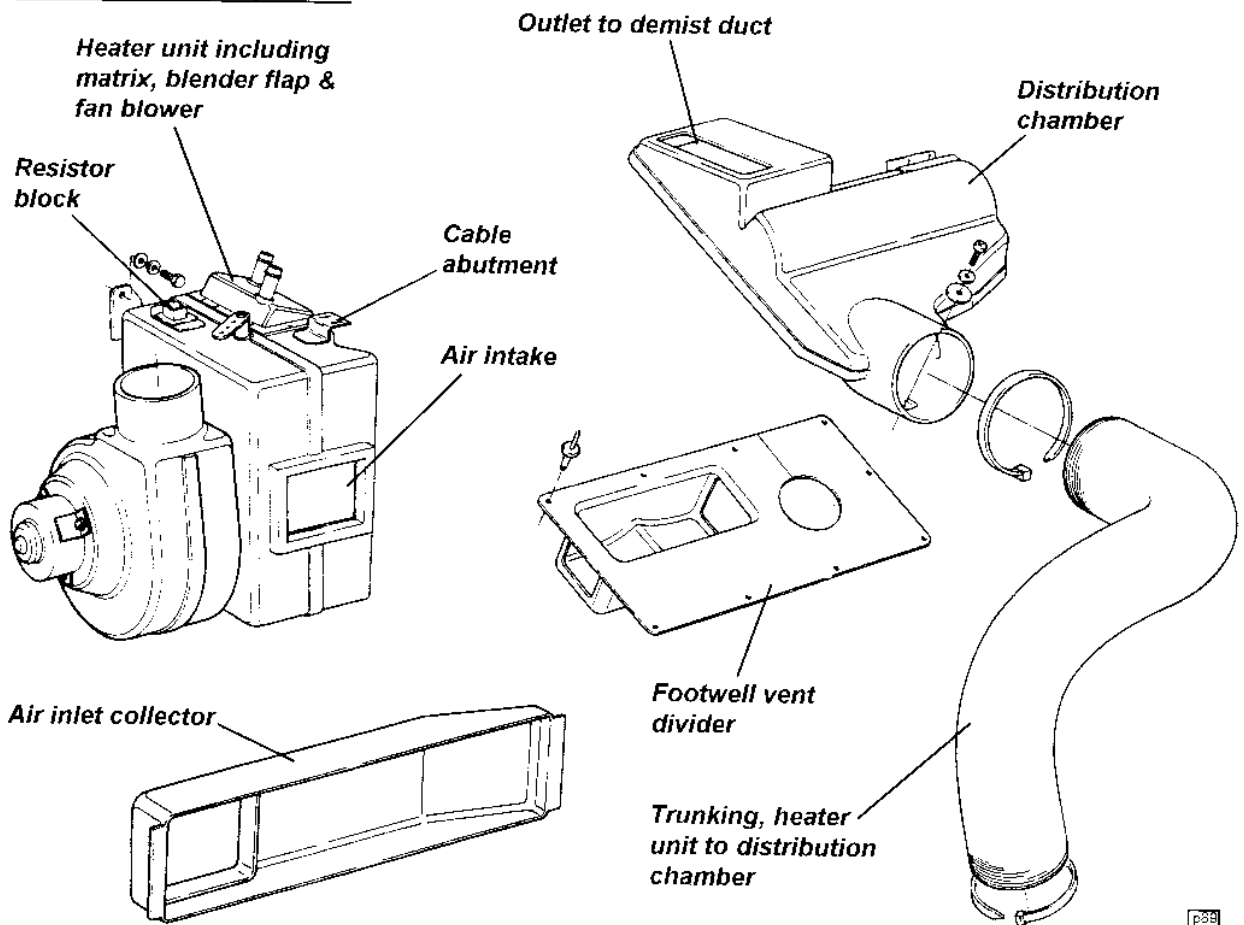


**Heater Circuit**

pt.2a



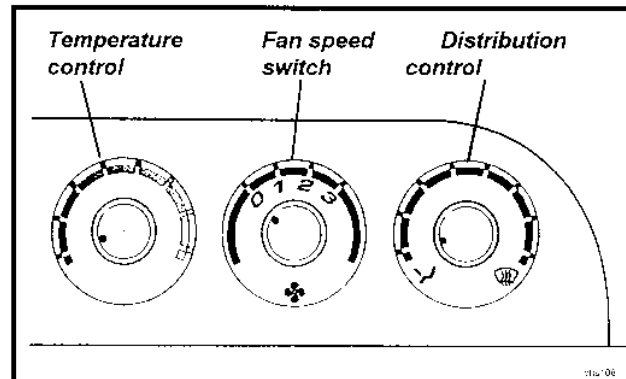
**Heater System Components**



p.2a



The air blend temperature flap is cable operated from a sector rack and pinion rotary control on the fascia. The drum type blower fan draws air through the heater unit and supplies it via a duct to the distribution chamber mounted on the top side of the chassis above the footwells. The distribution flap has a horizontal pivot and is cable operated to control the proportion of air flowing to the footwells and fascia vents, via a divided moulding in the top of the footwell, and a duct moulded into the underside of the fascia top which supplies all four fascia vents.



#### PI.2 - CONTROL CABLES

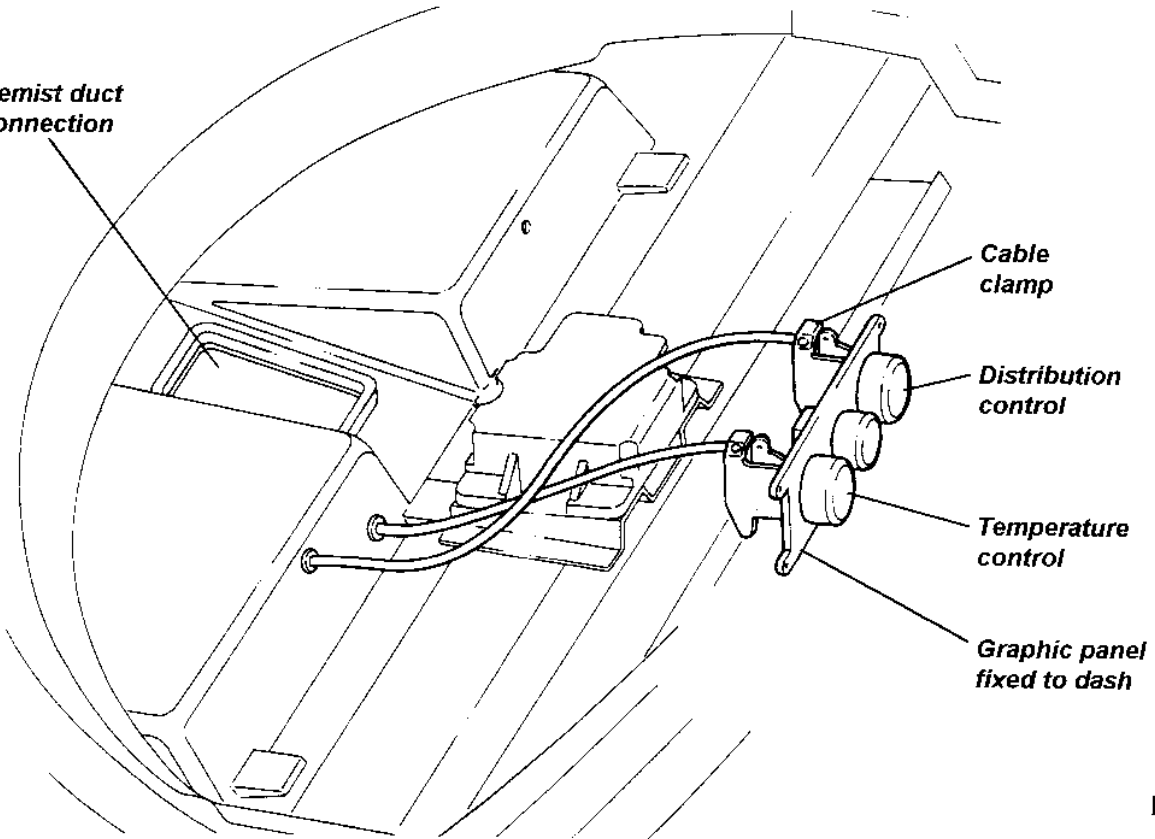
For access to the heater controls and input end of the cables, the fascia top must be removed:

1. Remove the fascia top:
  - Remove both fascia end panels (speaker panels).
  - Remove the steering column shrouds.
  - Remove the instrument pack.
  - Carefully prise out each of the four windscreen/face level outlet vents.
  - Release the fixings at each end, and withdraw the 'screen landing panel.
  - Remove the small trim panel over the heater controls.
  - Release the four fixings securing the fascia top to the top flange of the dash upper extrusion.
  - Lift the rear edge of the fascia top and pull rearwards to disengage the two keyhole slots in the panel from the spigots on the dash extrusion, and the two locating pins on the front edge of the panel.
2. The two identical rotary controls for the temperature and distribution are fitted with push-on knobs with orientation flats. Each rotary control is secured to the graphic panel by a spindle nut, with the panel fixed to the dash panel via four screws.
3. The control outer cable is secured to the rotary control base plate by a clamp and screw, with the inner cable using a formed end to locate on the sector pin.
4. The output end of each outer cable is secured to a bracket on either the distribution unit or heater unit, by a spring clamp which allows length adjustment to be made. The inner cable uses a formed end to hook into the temperature flap lever or distribution flap lever. The outer cable should be positioned in the spring clamp so as to allow full travel of the flap to be achieved in both directions by manipulation of the rotary control.

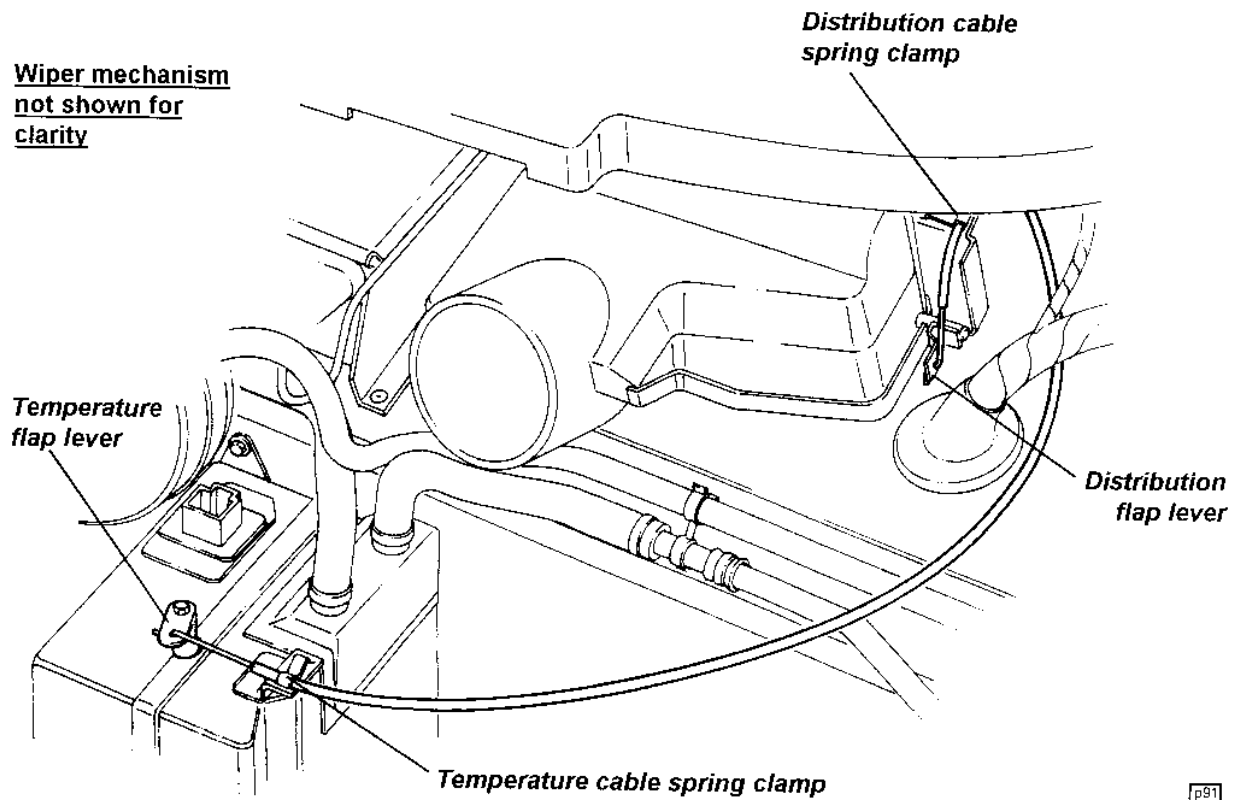
Limited access to the distribution flap cable on the outboard side of the distribution chamber is available from beneath the wiper motor mechanism. Remove the wiper motor cover for improved vision.



Demist duct connection



Wiper mechanism not shown for clarity



**PI.3 - HEATER UNIT**

The heater matrix and air blend temperature flap are assembled in a moulded plastic box to which is rivetted the fan blower unit, with the complete assembly forming a single service unit.

To replace the heater unit:

1. Remove the front clamshell (see sub-section BP.5).
2. Remove the trunking between fan blower and distribution unit. Remove washer bottle.
3. Drain coolant and disconnect the two water hoses from the heater unit.
4. Disconnect the electrical harness from the resistor block and fan motor.
5. Release the two M6 fixings securing the heater unit to the chassis footwell crossmember and withdraw the unit from the chassis.

**PI.4 - AIR DISTRIBUTION UNIT**

The air distribution unit is fitted between the top side of the chassis scuttle and the underside of the fascia top/demist duct. Sandwiched between the distribution unit and the chassis is a footwell vent divider panel which serves to direct the footwell airflow, blank off the unused pedal box chassis aperture (for opposite drive hand) and also incorporates the main wiring harness grommet. Sandwiched between the distribution unit and the fascia top duct is the scuttle baffle panel which is bonded to the chassis scuttle.

The distribution unit may be removed from the car after removing the front clamshell and wiper mechanism:

1. Remove the front clamshell (see sub-section BP.5).
2. Remove the wiper mechanism and washer bottle.
3. Release the outer control cable spring clamp, and unhook the inner cable from the lever.
4. Remove the trunking between fan blower and distribution unit, and from the aperture exposed, release the single M5 screw securing the unit to the chassis scuttle.
5. Withdraw the unit from the car.
6. When refitting, use foam tape as necessary to ensure adequate sealing of the demist duct outlet to the baffle panel.



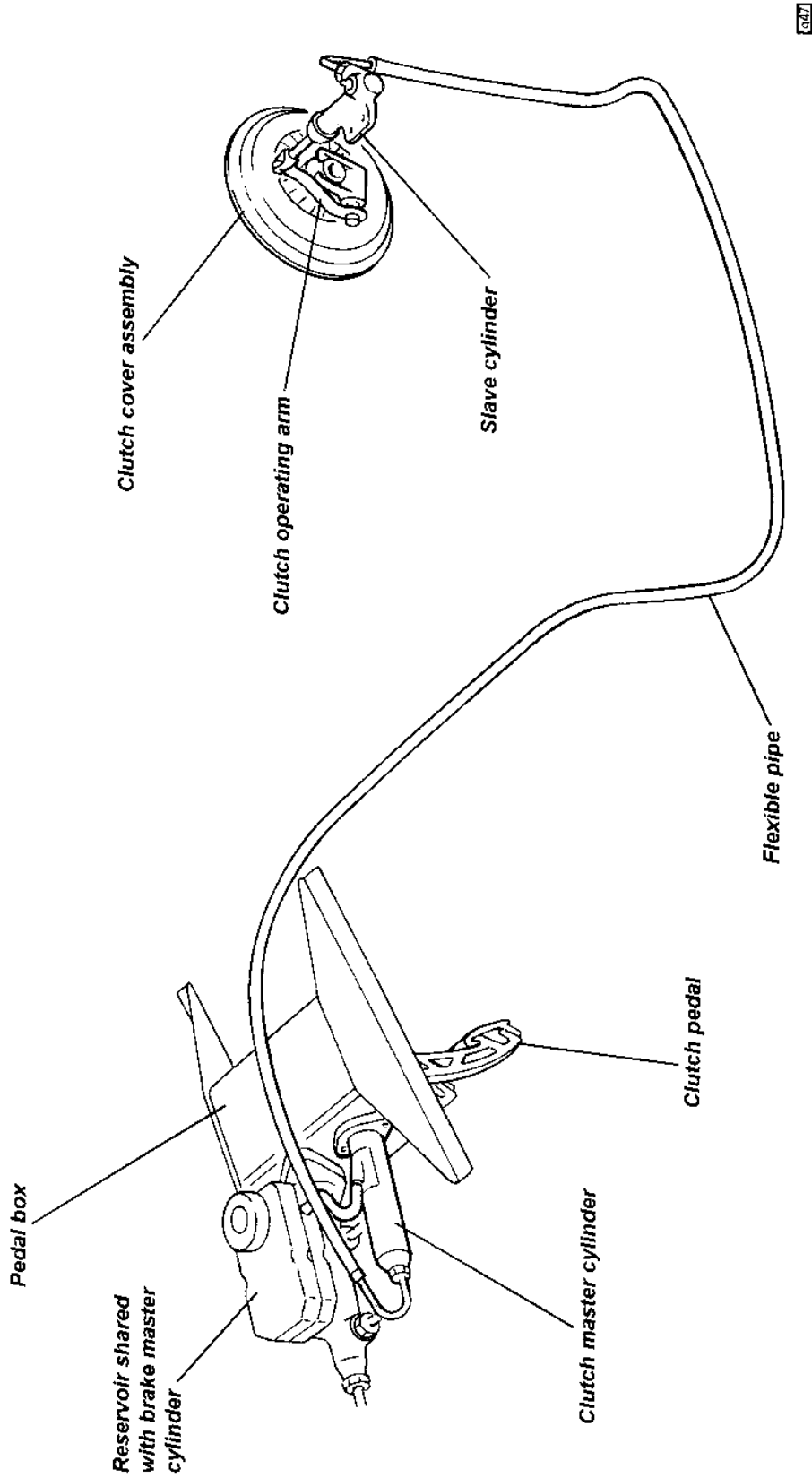
CLUTCH

SECTION QG - ELISE 2001 M.Y. Onwards

	<u>Sub-Section</u>	<u>Page</u>
General Description	QG.1	3
Adjustment	QG.2	3
Hydraulic Release System	QG.3	4
Clutch Assembly	QG.4	9



Clutch system general arrangement





QG.1 - GENERAL DESCRIPTION

The driving element of the clutch assembly consists of the rear face of the engine flywheel, and a pressure plate fixed to the flywheel via the spring diaphragm clutch cover assembly. The driven element, is a single, dry, double sided friction plate, splined to the gearbox input shaft, and interposed between the flywheel and pressure plate. The diaphragm spring in the clutch cover clamps the friction plate between the pressure plate and flywheel to provide the drive connection between engine and gearbox. The gearbox input shaft, on which the friction plate is free to slide axially, is 'overhung' from the gearbox, with no spigot bearing in the rear end of the crankshaft.

The hydraulic clutch release mechanism uses a master cylinder fixed to the pedal box, and a slave cylinder mounted on a fabricated steel bracket attached to the transmission case. The master cylinder is connected to the fluid reservoir of the brake master cylinder, and uses a steel braided flexible synthetic pipe routed through the LH sill to connect with the slave cylinder. The slave cylinder operates a release arm which is connected by shaft to the release fork inside the clutch housing. The fork presses the ball type release bearing against the inner ends of the diaphragm spring fingers, which pivot about their fulcrums and relieve the clamping force applied to the pressure plate via the diaphragm outer edge. The release bearing slides on a guide sleeve surrounding the gearbox input shaft. A preload spring inside the slave cylinder applies light pressure to the release lever in order to ensure that contact between the release bearing and diaphragm spring fingers is maintained.

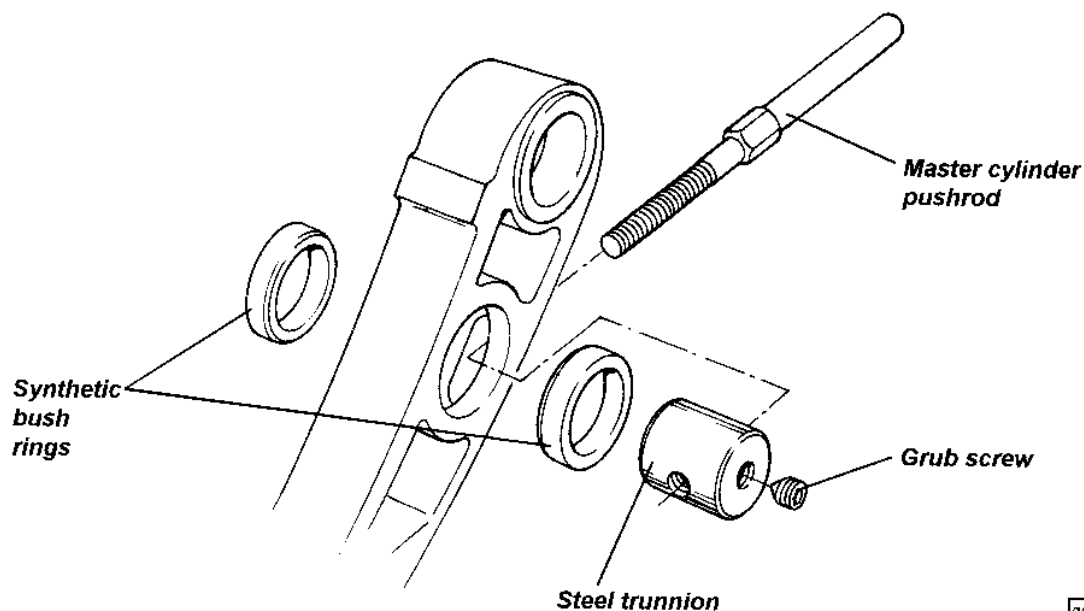
QG.2 - ADJUSTMENT

No routine adjustment of the clutch or release mechanism is required. The clutch slave cylinder is self adjusting, with the 'rest' position of the piston dependent on the thickness, or degree of wear, of the friction plate. As wear of the friction plate takes place, and its thickness is reduced, the slave cylinder piston is pushed progressively further back on the return stroke with fluid being returned to the master cylinder reservoir.

The master cylinder pushrod length requires adjusting only on assembly in order to ensure:

- a) the master cylinder piston is allowed fully to return under the action of its internal spring, and open the port to the fluid reservoir;
- b) maximum effective stroke of the cylinder is achieved.

The effective length of the pushrod can be adjusted by screwing the hexagonal pushrod into or out of the pedal trunnion. Too much preload will not allow the reservoir port to open, whereas too much free play will not allow sufficient fluid displacement and may induce a rattle from the pedal. To check the pushrod adjustment:



Q48



- i) Remove the locking grub screw (3 mm key) in the side of the pedal trunnion, and apply PermaBond A131 to the thread. Refit loosely.
- ii) Screw the pushrod into or out of the trunnion until the pedal just contacts the pedal box flange (upstop).
- iii) Apply ½ turn of preload to the pushrod, and tighten the trunnion lock screw to 5 Nm.

Note that no pedal downstop is fitted, and that the pedal will contact the pedal box before the master cylinder 'bottoms out'.

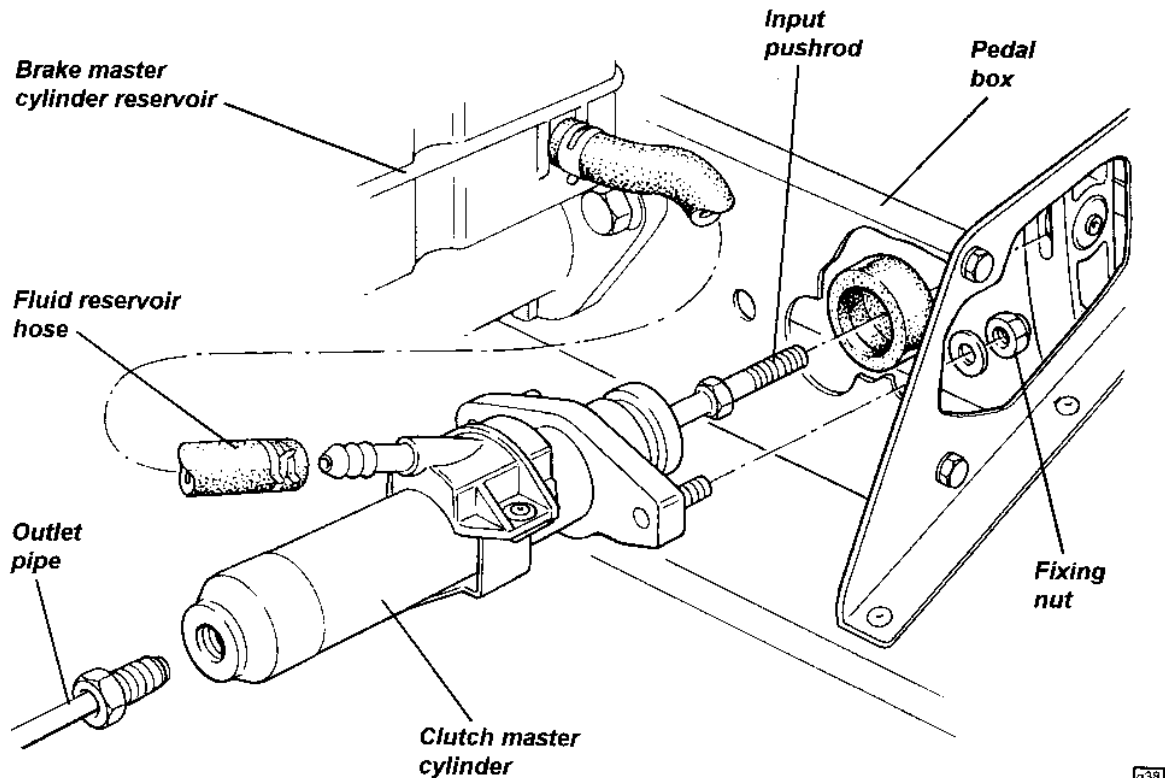
Adjusted as above, full pedal travel should produce a slave cylinder pushrod movement of 13 - 15 mm. If this is not achieved, bleed the hydraulic system using new DOT 4 non-mineral type fluid.

Note that the two synthetic bush rings, used to support the steel trunnion, may be replaced with the pedal 'in-situ', by using a suitable bolt with clamp washers to press the rings into position. Each bush has an outer diameter chamfer at one end to aid insertion.

QG.3 - HYDRAULIC RELEASE SYSTEM

Master Cylinder

The 5/8" (15.9 mm) bore master cylinder is mounted on the pedal box, and is accessible from within the front services compartment. The cylinder is not equipped with its own fluid reservoir, but instead is linked via hose to the adjacent brake fluid reservoir.



g38

To replace the master cylinder:

- Clean the master cylinder and surrounding area with methylated spirit. **Do not use petrol or paraffin.**
- Take all necessary precautions to guard against contamination of painted surfaces with brake fluid.
- Disconnect and immediately plug and cap the hose connection to the fluid reservoir, and the output pipe connection.

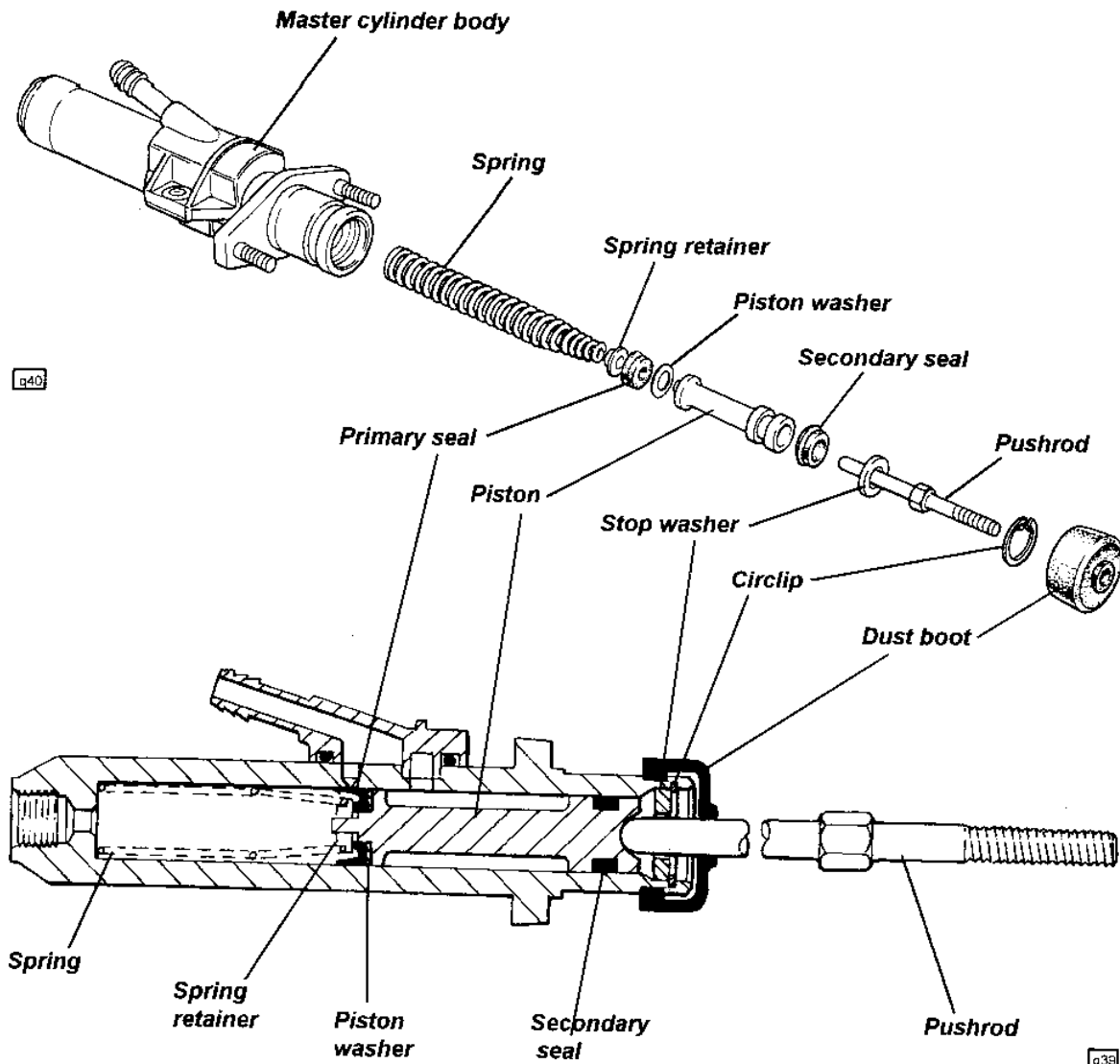




- From inside the footwell, remove the two bolts securing the cylinder to the pedal box. Withdraw the cylinder from the front services compartment.
- To refit, reverse the removal procedure, taking care to feed the pedal pushrod through the dust boot and into the end of the master cylinder as the cylinder is positioned. Tighten the outlet pipe connection to 20 - 24 Nm and bleed the hydraulic system of air.

*To overhaul the master cylinder:*

- Clamp the cylinder in a soft jawed vice, and pull the rubber dust boot off the cylinder end.
- Remove the circlip from the end of the cylinder, taking care not to scratch the bore surface. Remove the stop washer and extract the cylinder internal parts. Lay the components in their correct order on a clean sheet of paper.
- Remove the rubber seals from the piston, taking note of the position and orientation of all parts.
- Clean all parts thoroughly with only new brake fluid, and dry with a lint free cloth. Carefully examine the cylinder bore for scoring, corrosion or visible wear, and replace if any such signs are apparent. Check that all drillings in the cylinder body and piston are clear. If the cylinder is serviceable, rebuild the unit using new seals and components from the appropriate overhaul kit.
- Note that the chamfer on the inside diameter of the stop washer should face rearwards (i.e. towards open end of cylinder).

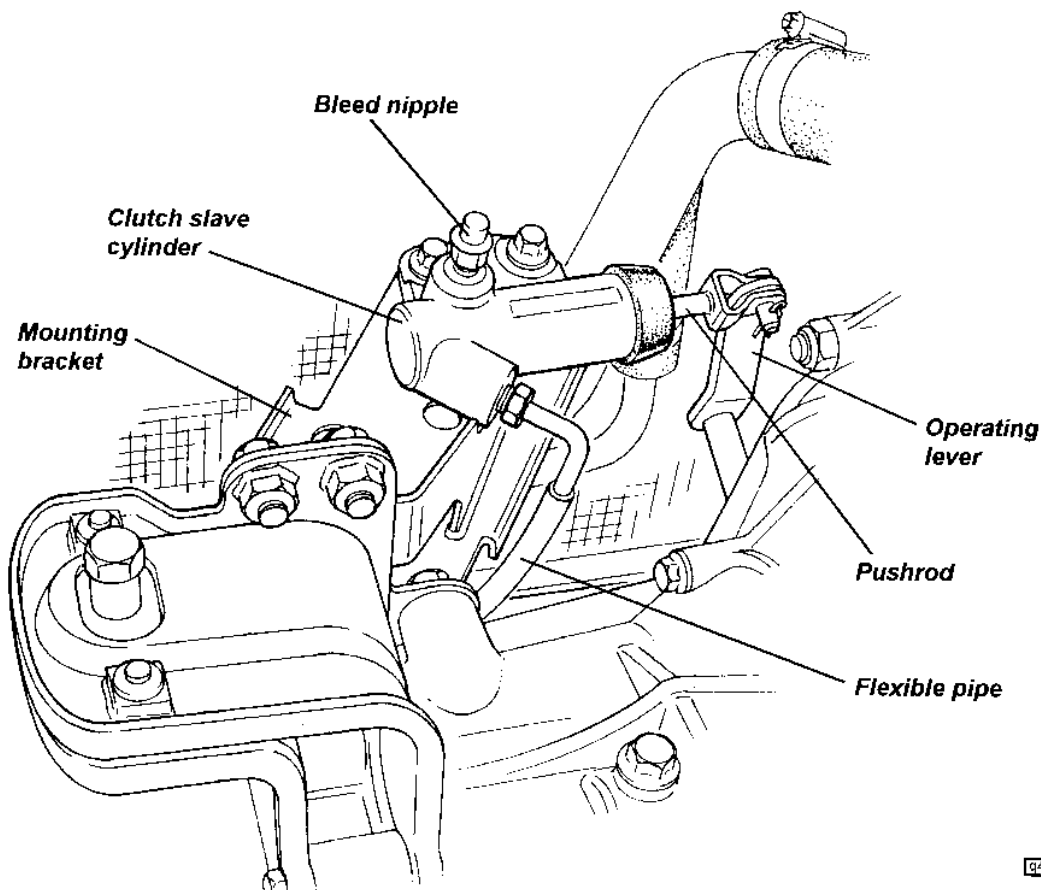




- On reassembly, scrupulous cleanliness is essential. Clean hands thoroughly beforehand.
- Lubricate all seals, the cylinder bore, and all internal components with clean brake fluid.
- Fit the secondary seal into its groove on the piston, with the lip towards the front.
- Fit the piston washer, primary seal and spring retainer onto the front end of the piston, with the lip of the seal facing forwards.
- Insert the spring and piston assembly into the cylinder, taking care not to bend back the seal lips. Fit the stop washer and retain by fitting the circlip into the groove in the rear end of the cylinder bore. Check that the circlip is seated correctly in the groove. Pack the inside of the dust boot with rubber grease and seat the lip of the boot in the groove on the outside of the cylinder body.
- Use a suitable rod to operate the piston by hand several times to check for free movement of the internal parts.
- Refit the cylinder as detailed above.

### Slave Cylinder

The slave cylinder is secured by two bolts to a mounting bracket on the transmission, and is connected to the clutch operating lever by a fixed length pushrod and clevis pin. A sleeve nut is used to connect the flexible hydraulic pipe, and a bleed nipple is provided by which to bleed air from the hydraulic system.



### *To replace the slave cylinder:*

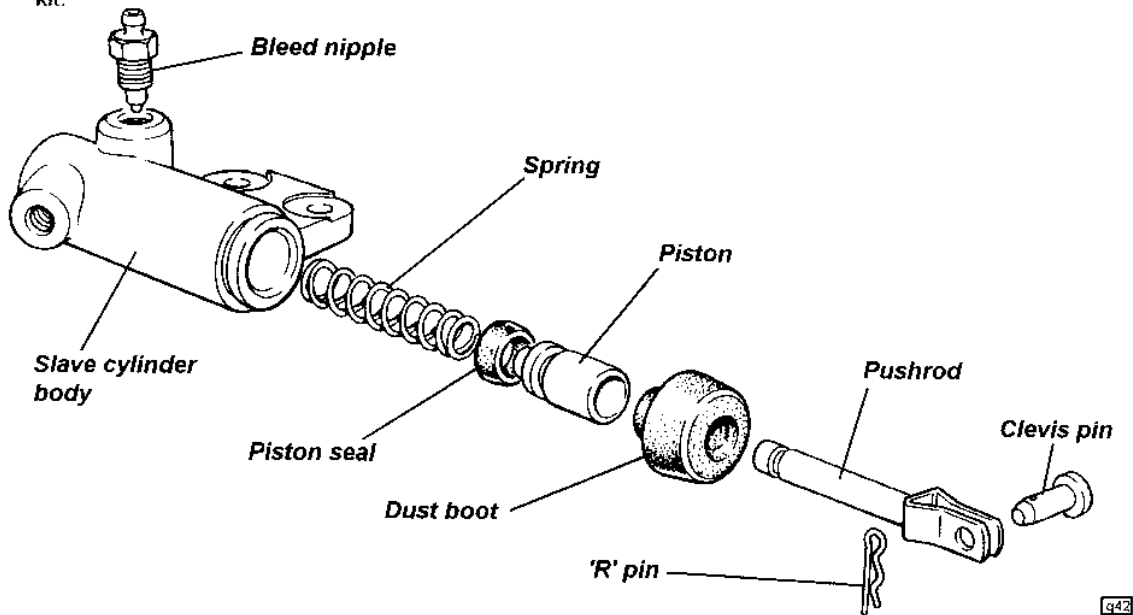
- Clean the slave cylinder and surrounding area with methylated spirit. **Do not use petrol or paraffin.**
- Take all necessary precautions to guard against contamination of painted surfaces with brake fluid.
- Remove the 'R' pin and clevis pin connecting the pushrod to the clutch operating lever.
- Disconnect and immediately plug and cap the hydraulic hose connection.
- Remove the two bolts securing the cylinder to the mounting bracket, and withdraw the cylinder.



- To refit, reverse the removal procedure, tightening the slave cylinder mounting bolts to 25 Nm. Clean and refit the specially coated clevis pin and 'R' pin to connect the pushrod to the release lever and check that the pushrod is correctly centralised in the slave cylinder piston. Tighten the hydraulic pipe connection to 20 - 24 Nm, and bleed the hydraulic system of air in the usual way. Tighten the bleed nipple to 7 Nm.

*To overhaul the slave cylinder:*

- Clamp the cylinder in a soft jawed vice, and withdraw the pushrod and rubber dust boot from the cylinder.
- Withdraw the piston and spring and remove the rubber seal from the piston, taking note of the orientation.
- Clean all parts thoroughly with only new brake fluid, and dry with a lint free cloth. Carefully examine the cylinder bore for scoring, corrosion or visible wear, and replace if any such signs are apparent. If the cylinder is serviceable, rebuild the unit using new seals and components from the appropriate overhaul kit.



- On reassembly, scrupulous cleanliness is essential. Clean hands beforehand.
- Lubricate the seal, the cylinder bore, and all internal components with clean brake fluid.
- Fit the seal into its groove on the piston, with the lip towards the closed end of the cylinder.
- Insert the spring and piston assembly into the cylinder, taking care not to bend back the seal lips.
- Pack the inside of the dust boot with rubber grease and seat the lip of the boot in the groove on the outside of the cylinder body.
- Fit the pushrod through the dust boot and press the piston against its spring several times to check for free movement of the piston.
- Refit the cylinder as detailed above.

Hydraulic Hose

The one piece, steel braided, flexible synthetic hose between master and slave cylinders is routed through the dash baffle panel and along the outside of the left hand chassis sideframe, enclosed within the composite sill panel, and wrapped with foam sleeving to suppress rattles. The hose is common to right and left hand drive, with the surplus length on left hand drive cars being accommodated by routing the hose in a loop in the front of the sill area. Service replacement hoses are supplied with a separate front end 'U' bend to aid assembly of the hose through the sill and baffle panel.

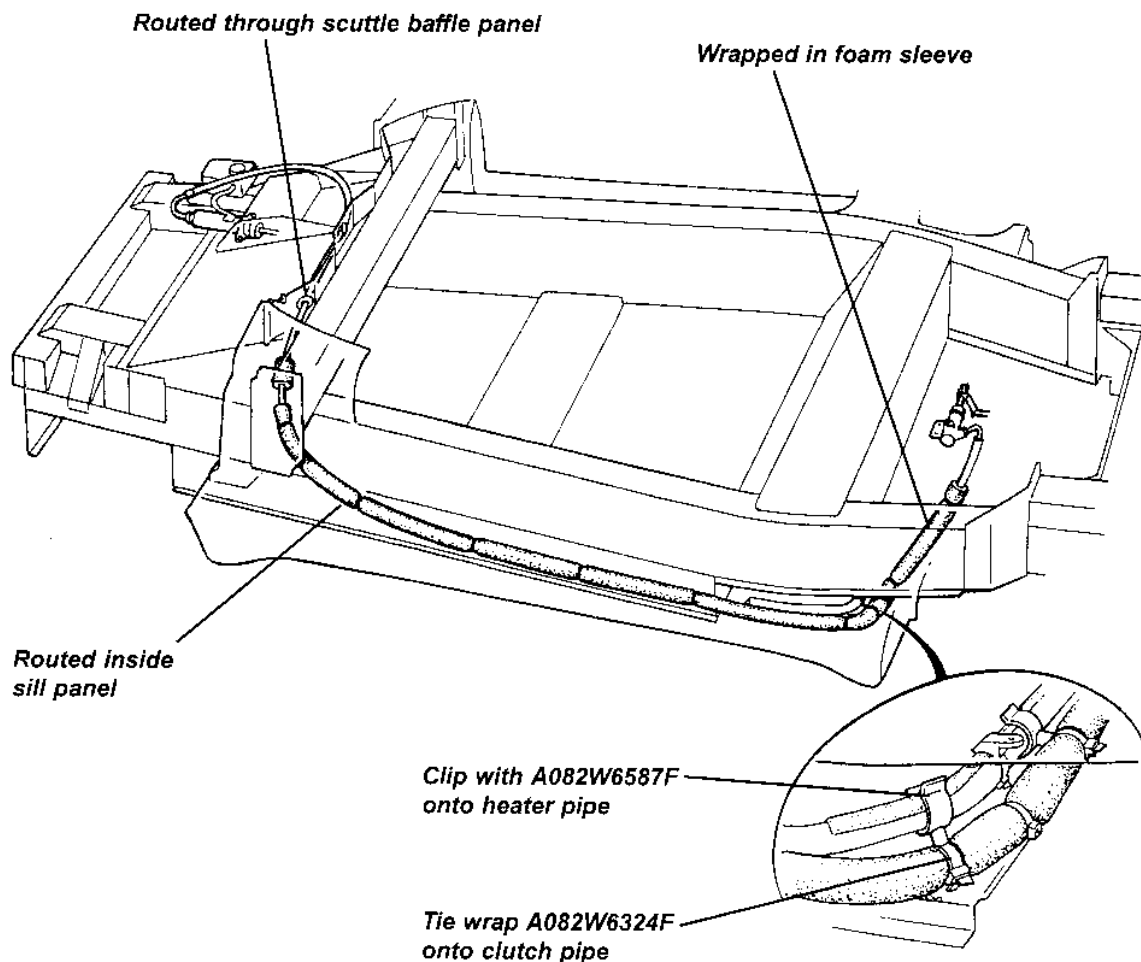
Note that the hose should not be withdrawn from the car without first attaching a guide wire with which to aid routing of the new hose.



Replacing Hydraulic Hose

During this operation, take all appropriate precautions to protect against damage caused by contamination of painted surfaces with hydraulic fluid.

1. For access to the dash baffle, remove the dash panel, fascia left hand end panel, and the left hand sill trim (see Service Notes sub-section BP.13). Remove the engine bay undertray/diffuser panel and the shear panel beneath the fuel tank.
2. Release the clutch hose from the master cylinder and slave cylinder, and immediately cap the cylinder ports to minimise fluid loss and prevent dirt ingress. Drain the hose of fluid, and cap both ends to prevent drips and fluid contamination of painted surfaces.
3. To ease withdrawal of the hose, cut off the 'U' bend from the front end, and securely attach a guide wire.
4. Cut the cable ties securing the hose to the heater pipe clips; 2 at the front end, and 3 at the rear end.
5. Remove the grommet from the scuttle baffle panel, and withdraw the hose towards the rear, leaving the draw wire in its place.



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6. Service replacement hoses are supplied with a detachable front end 'U' bend which should be removed before routing the hose. Check that the anti-rattle lagging is fitted. Attach the hose to the guide wire and draw the new clutch hose into place from the rear.
7. Feed the hose through the baffle panel and fit the grommet. If fitting on a LHD car, loop the hose in the 'A' post area to accommodate the excess length.
8. Fit the 'U' bend pipe to the front end of the hose and connect to the master cylinder, tightening to 20 - 24 Nm. Connect the hose rear end to the slave cylinder and tighten to 20 - 24 Nm.
9. Secure the hose (and aerial co-ax. cable) as previously to the heater pipe, using pipe clips A082W6587F and tie strap clips A082W6324F. Use of these clips ensures that the two lines are separated, in order to minimise heat transmission from the heater pipe to the clutch fluid.
10. Bleed the clutch system of air using conventional techniques, and refit all panels removed for access.

#### QG4 - CLUTCH ASSEMBLY

The clutch assembly comprises the friction plate, clutch cover assembly (pressure plate/diaphragm spring) and release bearing. For access to the clutch assembly, the transmission must first be removed, with or without the engine 'in situ'. Access is improved if the rear topshell is removed.

#### Removal of clutch assembly:

- With the car supported on a 'wheel free' lift:
1. Remove the LHR lower wishbone:
    - Release the bolt securing the spring/damper unit to the lower wishbone;
    - Release the wishbone to chassis pivot bolts;
    - Release the parking brake cable ties, and swing the wishbone out of the way.
  2. Release the RHR suspension toe control link from the hub carrier, and release the top ball joint plinth from the hub carrier taking note of the camber adjustment shimplates in order to allow withdrawal of the driveshaft from the transmission.
  3. Release both driveshaft inboard C.V. joints from the transmission using special wedge tool T000T1276 on the RH side, and/or applying a shock pull to the C.V. joint body using a slide hammer with a forked end. Fit blanking plug T000T1014 into the transmission to limit the amount of transmission oil loss.

**CAUTION:** Do NOT attempt to remove an inboard C.V. joint from the transmission by pulling on the driveshaft. This action will cause the joint to become disassembled and may require replacement of the joint. The components of the inboard plunging joint are held in position, for transit purposes only, by a collar within the boot which will be overridden if excessive axial force is used. Apply pressure only to the 'tulip' or outer body of the joint.

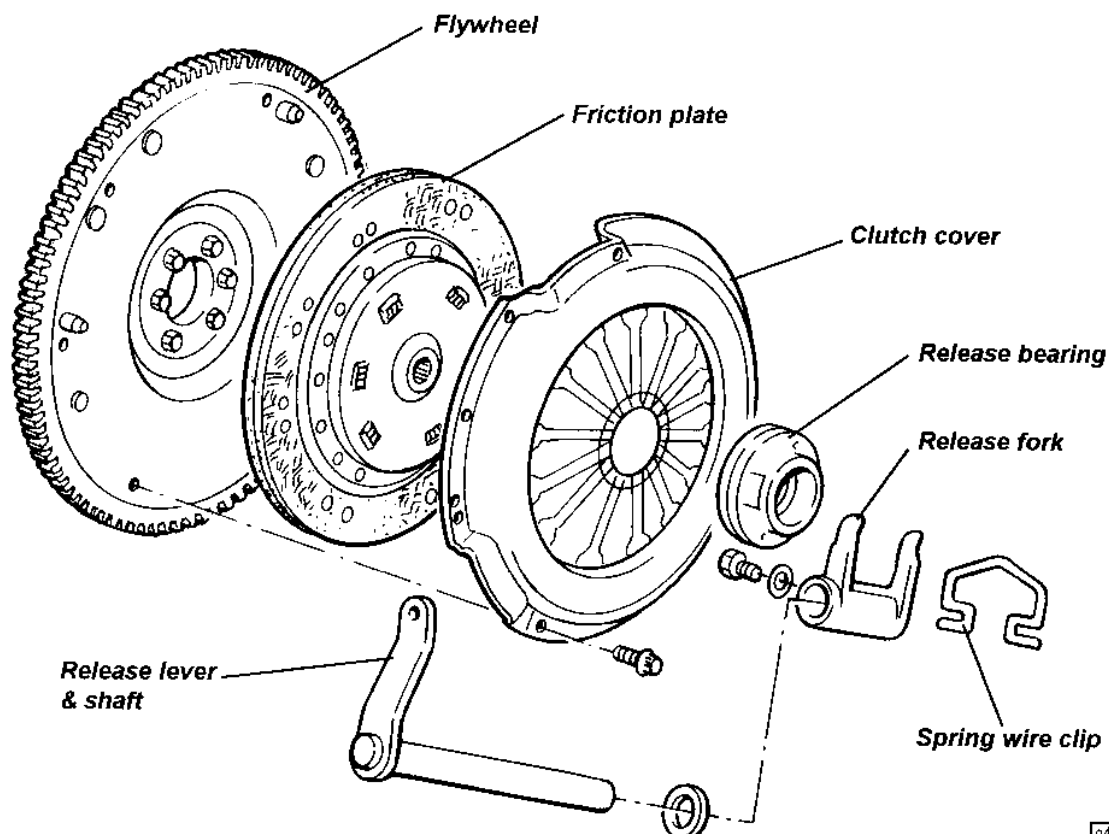
4. Remove the intake hose between air cleaner housing and engine. Pull out the button retaining the housing to the mounting bracket, and withdraw the cleaner housing from its mounting grommets. Release the mounting bracket from the roll over bar strut.
5. Remove the 'R' clip and clevis pin connecting the clutch slave cylinder to the release arm. Remove the four bolts fixing the slave cylinder bracket to the transmission, and support aside.



6. Release the two bolts securing the starter motor and dirt shield to the clutch housing. Remove the shield, and withdraw and support the starter motor, taking care to protect the live starter motor lead from grounding.
7. Remove the dirt shield from the top front of the clutch housing.
8. Disconnect the reverse light switch.
9. Disconnect the two gearchange cables from their transmission levers, and release the cables from the abutment bracket.
10. Support the weight of the transmission assembly before removing the LH engine (transmission) mounting and bracket.
11. Remove the six bolts securing the clutch housing to the engine:
  - 2 bolts to the sump;
  - 1 bolt each side through the block lower 'wings';
  - 2 bolts securing the top of the clutch housing to the engine.
12. Pushing the engine to the right and downwards at the flywheel end, withdraw the transmission from the engine.

Inspection of components:

13. Before removing the clutch cover from the flywheel, place a flat plate over the ends of the diaphragm spring fingers, and use a feeler gauge to measure the any gaps between individual fingers and the plate. If any clearance is greater than 1mm, the clutch cover assembly should be replaced.
14. Progressively loosen, and then remove the six fixings securing the clutch cover to the flywheel. Remove the cover and friction plate.



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15. Examine the friction plate for oil contamination, broken cush drive springs, cracking of the spring apertures, or any other damage.

Measure the overall thickness across the friction material;

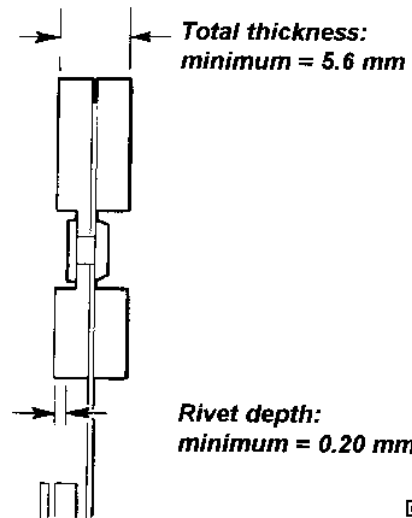
New thickness: 6.9 - 7.4 mm  
Service limit: 5.6 mm

Measure the depth of the rivet heads below the friction material surface;

New rivet depth: 1.0 mm  
Service limit: 0.2 mm

Measure axial run-out of the friction plate surface;

New run-out: 0.8 mm max.  
Service limit: 1.0 mm max.



Renew the plate if any damage is detected, or if outside service limits. If there were symptoms of clutch judder, the friction plate should be replaced as a precaution regardless of inspection results.

16. Inspect the surface of the pressure plate for excessive wear or scoring, and replace if in any doubt. If there were symptoms of clutch judder, or the cover is accidentally dropped, the clutch cover assembly should be replaced as a precaution regardless of inspection results.
17. Check the surface condition and run-out of the flywheel friction surface (see section ED.14) and replace the flywheel if necessary.
18. Withdraw the release bearing and examine for signs of wear, damage or roughness, and replace if in doubt.
19. Examine the condition of the clutch release fork, pivot shaft bushes and oil seal (see transmission repair section), and replace components as necessary.

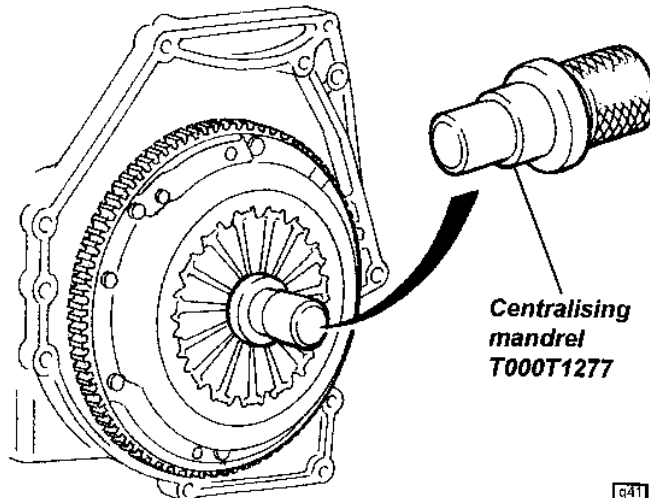
Re-fitting of clutch assembly:

20. Smear the splines of the friction plate with molybdenum disulphide grease, and fit against the flywheel with the 'FLYWHEEL SIDE' marking towards the flywheel. Fit the clutch cover over the friction plate and locate on the flywheel dowels.

Two types of centralising tool are available:

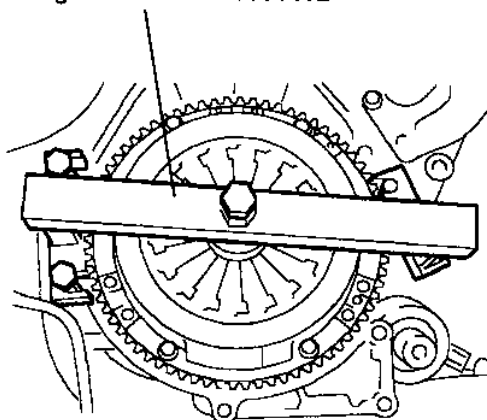
**Using Centralising Tool T000T1277**

21. Fit clutch alignment mandrel T000T1277 to centralise the friction plate, and fit the clutch cover retaining screws finger tight. Using a diagonal sequence, progressively tighten the cover screws, and monitor the free turning of the mandrel. If the diaphragm spring fingers begin to pinch the mandrel, and a drag on its turning is felt, remove the tool. Finally tighten the cover fixing screws to 25 Nm.



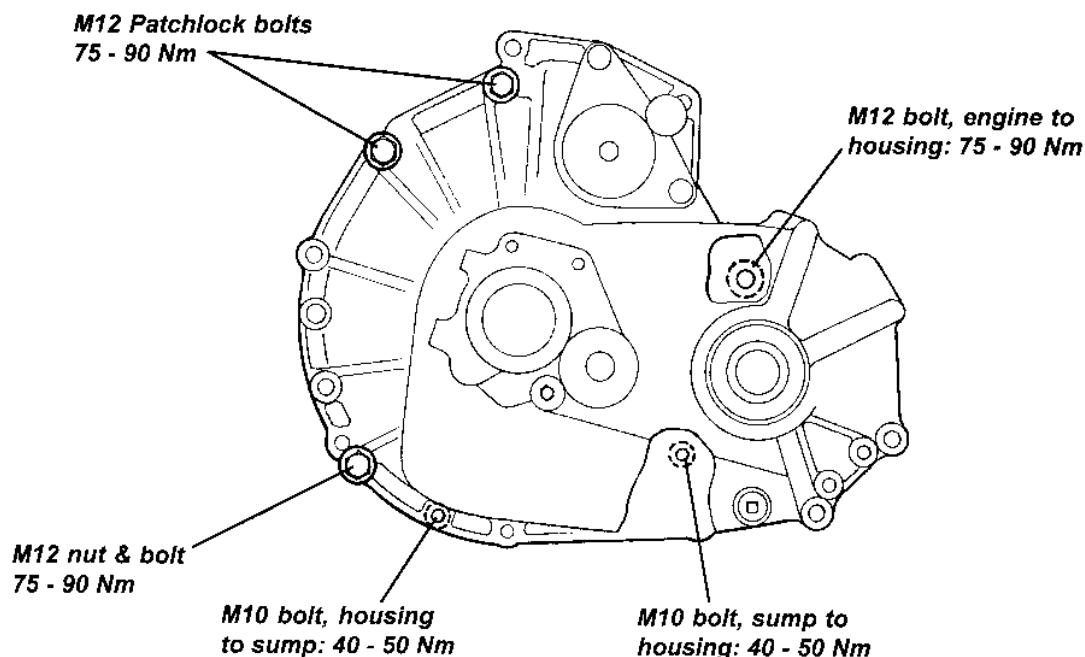
**Using Alignment Tool T000T1412**

21. - Loosely assemble clutch plate and cover onto flywheel dowels and fit but do not tighten cover bolts.
  - Unwind tool T000T1412 until 60mm dia. flange touches the body of the clutch tool.
  - Secure the clutch tool to the block (as shown) using existing bolts.
  - Wind bolt onto clutch cover fingers, ensuring that the hub of the driven plate is engaged.
  - Wind in the bolt to compress the clutch fingers until the driven plate is released and can be rotated.
  - Tighten the clutch cover bolts in a diametrically opposite sequence to 25 Nm.
  - Unwind the bolt to unload the clutch fingers, and then remove the tool.

**Alignment tool T000T1412**

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22. Refit the transmission to the engine, engaging the gearbox input shaft into the friction plate splines, and locating the clutch housing onto the engine mating face dowels.
23. Continue re-assembly in the reverse order to disassembly with the following notes:
  - Use new circlips on the spigots of the inboard C.V. joints, and check that the driveshafts are fully inserted into the transmission by pulling on the inboard joint bodies.
  - Use a new 'O' ring on the speedo drive cable, and lubricate on assembly.
  - Renew the two topmost bell housing to engine patchlock bolts, or apply a suitable threadlocking compound if re-using original bolts.
  - Use special tool T000T1390 to protect the output shaft seals during driveshaft refitment; see subsection FH.5.

**Engine/Transmission Fixings (viewed onto LH end)**

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