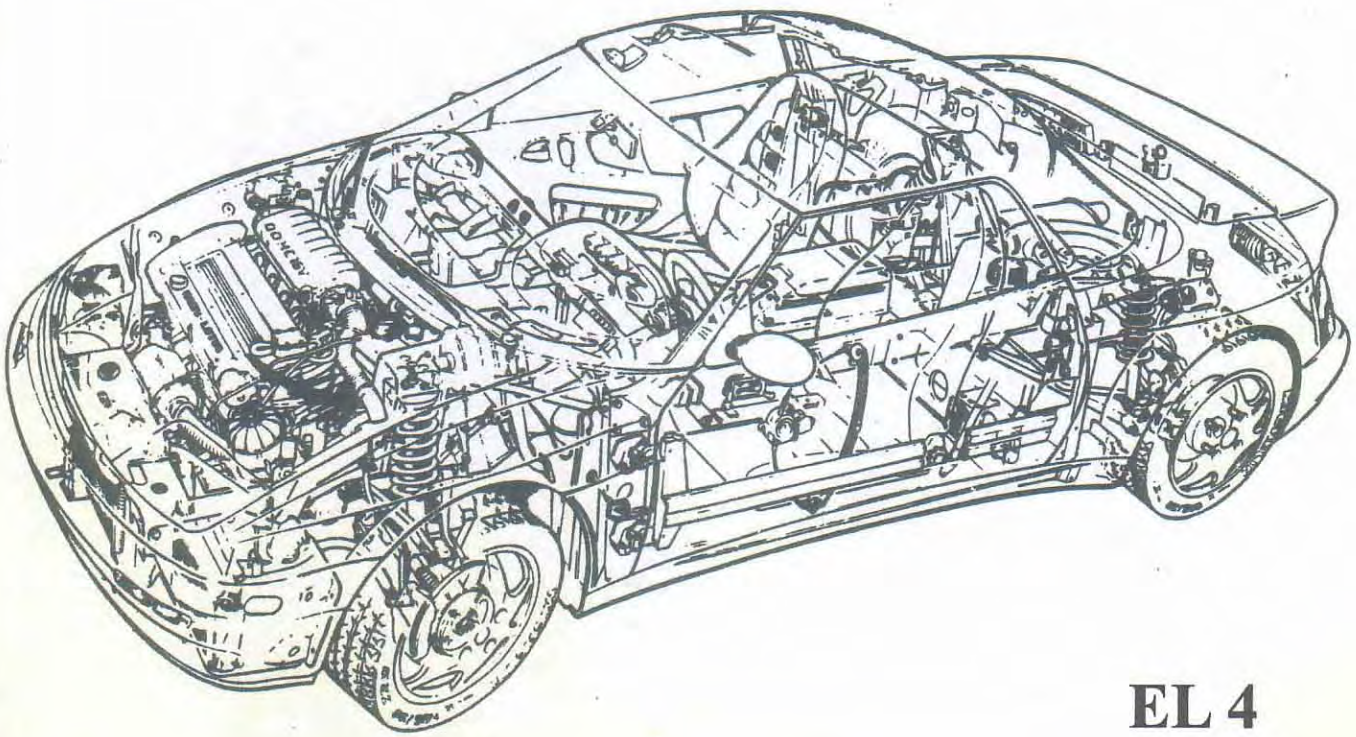
Training Centre

Course Notes

ELAN

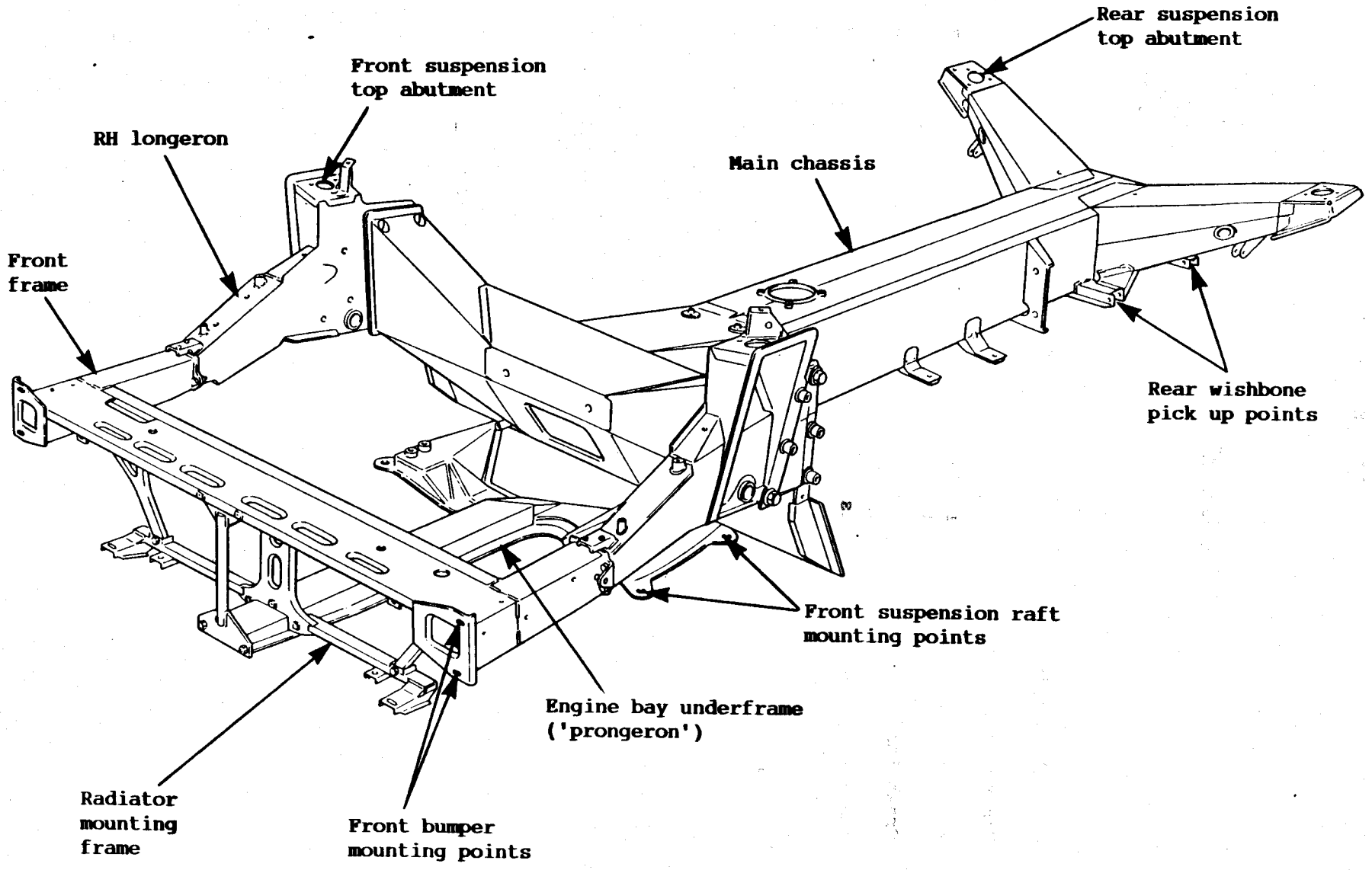
CHASSIS / SUSPENSION



EL 4

CHASSIS

SECTION AD - ELAN


Rear suspension top abutment
Front suspension top abutment
RH longeron
Main chassis
Front frame
Rear wishbone pick up points
Front suspension raft mounting points
Engine bay underframe ('prongeron')
Radiator mounting frame
Front bumper mounting points

AD.1 - GENERAL DESCRIPTION

The chassis unit is fabricated principally from 'Zintec' electroplated zinc precoated steel sheet, and in certain critical areas, 'Tenform' high strength steel. Various welding processes are used in the construction of a central square box section 'backbone' with a crossmember at the front and two box section outriggers at the rear.

The chassis structure ahead of the front crossmember is bolted together for ease of assembly and repair, and carries the engine and transmission, front suspension, cooling radiators and front bodywork. The chassis front crossmember provides mounting points for the two bolt on longerons, which extend forwards alongside the engine bay, and carry the front suspension unit top abutments, and the raft top bushes (see section CE). Each longeron is secured to the chassis front crossmember with six high tensile bolts, two of which are taper seat bolts for accurate location. A front frame is bolted between the front ends of the longerons, and provides the mounting points for the front bumper. A separate radiator mounting frame hangs from this front frame to support the engine radiator and air conditioning evaporator. A 'crash structure' is bonded to the top surface of the front frame, and consists of a composite box containing a series of composite tubes with longitudinal axes, such that in the event of a frontal collision, the assembly will progressively collapse and reduce the deceleration forces suffered by the vehicle occupants. An engine bay underframe (prongeron) bolts to the bottom of the chassis front crossmember, carries the front suspension raft lower bushes, and extends forwards to bolt to the radiator mounting frame.

The box section outriggers at the rear, form the top abutments for the rear suspension units, and carry the top link anchorage points. An extension of the centre backbone to the rear of the outriggers, carries the rearmost pivots for the wide based lower wishbones.

Sixteen body to chassis mounting points are widely spread along the chassis, using aluminium bobbins with plain holes in the body, and cage nuts in the chassis. Four of the body/chassis fixings double as inboard seat mountings.

The complete chassis frame is painted by an electrophoretic process before being covered with a grey polyester based anti-chip surfacer to protect the treatment from erosion. Further corrosion protection is provided by a 'Dinitrol' wax based coating, sprayed over both inner and outer steel surfaces. The wax treatment process is manufactured, and the corrosion warranty administered by Dinol-Protectol, with re-treatment inspections required after one year, and at two year intervals thereafter. For details of this warranty and retreatment/. inspection, refer to the separate literature supplied by Dinol-Protectol Ltd., Conduit Place, 100 Ock Street, Abingdon, Oxon, OX14 5DH.

Collision damage to the vehicle can subject parts of the chassis to abnormally high loads and initiate defects which may not be readily apparent. Consequently, if the vehicle's suspension or steering is damaged, then consideration must be given to secondary, or shock damage. For example, all mountings and mechanism attachments should be carefully examined for both mis-alignment and micro cracks. If any suspension pivot studs or suspension links are bent through collision impact, pay particular attention to the above points.

If any visible damage is found, such as panel wrinkling, broken welds, cracks etc, or if a dimensional check reveals any distortion, a **NEW CHASSIS** should be fitted. It is not recommended to perform any repairs to the chassis involving welding, heating, stretching or patching. The application of high temperatures to the chassis may cause internal stressing or weakening of the structure and incipient failure. In all cases, safety considerations must be regarded as paramount.

AD.2 - DIMENSIONAL CHECK

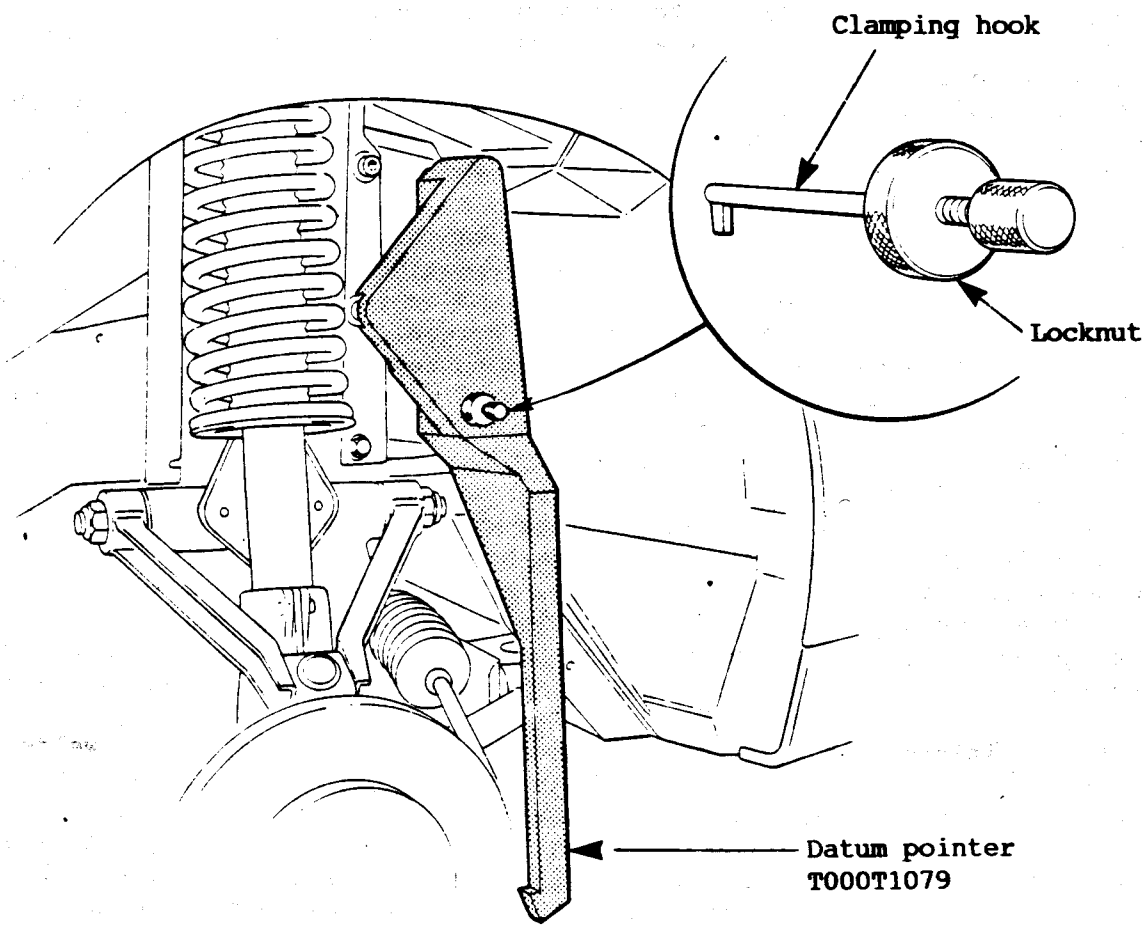
In general terms, when assessing accident damage, if after any suspension rebuild (if necessary) the specified suspension geometry can be achieved using such adjustment procedures as are specified in sections CE and DD, and a thorough visual inspection of the chassis reveals no signs of secondary damage, the chassis may be deemed serviceable.

In order to help assess chassis distortion without dissassembly of the suspension or body, a pair of chassis datum pointers may clamped against the longeron mounting bolts, and measurements made from the datum points thus provided.

Tools required: Datum pointers T000T1079
3m steel tape measure

With the car raised on a ramp, with the suspension and wheels fitted:

1. Position one of the datum pointers against the cap heads of the longeron fixing bolts, and fit the clamping hook through the pointer into the chassis hole.
2. Pull the hook back to engage against the chassis, and tighten the lock nut securely.
3. Fit the other datum pointer in a similar manner.



4. Measure from the inside corner of one datum pointer to the rear of the channel section forming the chassis pick-up for the rear pivot of the rear lower wishbone (dimension a). Repeat for the opposite side.

5. Repeat (4), but measuring diagonally to the pick up point on the opposite side of the car (dimension b).

6. Measure between the inside surfaces of the bottom ends of the pointers (dimension c).

7. Measure between the centrelines of the inboard boltheads fixing the underframe to the chassis front crossmember (dimension d).

8. Measure between the front and rear pick ups for the rear wishbone pivots on each side, as shown in the diagram (dimension e).

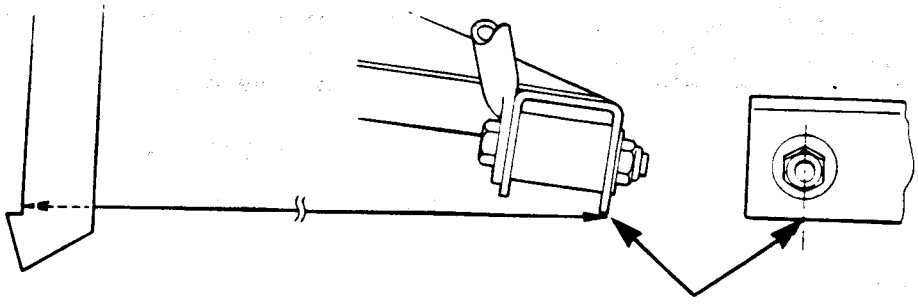
9. From inside the boot, measure between the centreline of the tops of the rear damper stems (dimension f).

10. From inside the boot, measure between the centreline of the tops of the rearmost inboard studs, securing the top spring abutments to the chassis (dimension g).

11. Compare the measurements obtained above with those in the table below, and if any dimension is outside tolerance, a chassis distortion is indicated, necessitating chassis replacement.

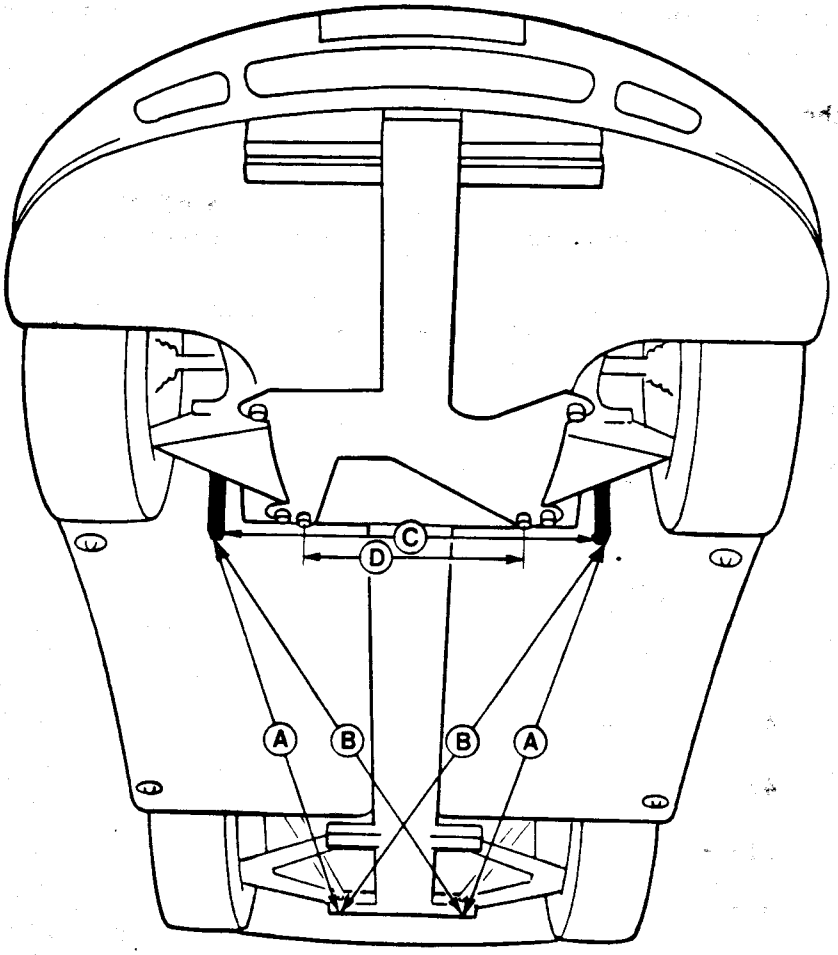
Dimension	Tolerance
a	2312 - 2316 mm
b	2396 - 2400 mm
c	1040 - 1042 mm
d	461 - 463 mm
e	434.5 - 436.5 mm
f	913 - 917 mm
g	888 - 892 mm

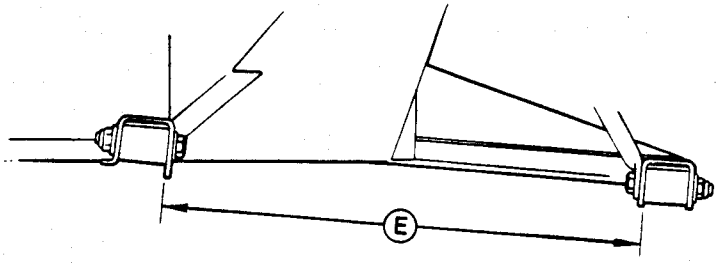
Inside corner of datum pointer



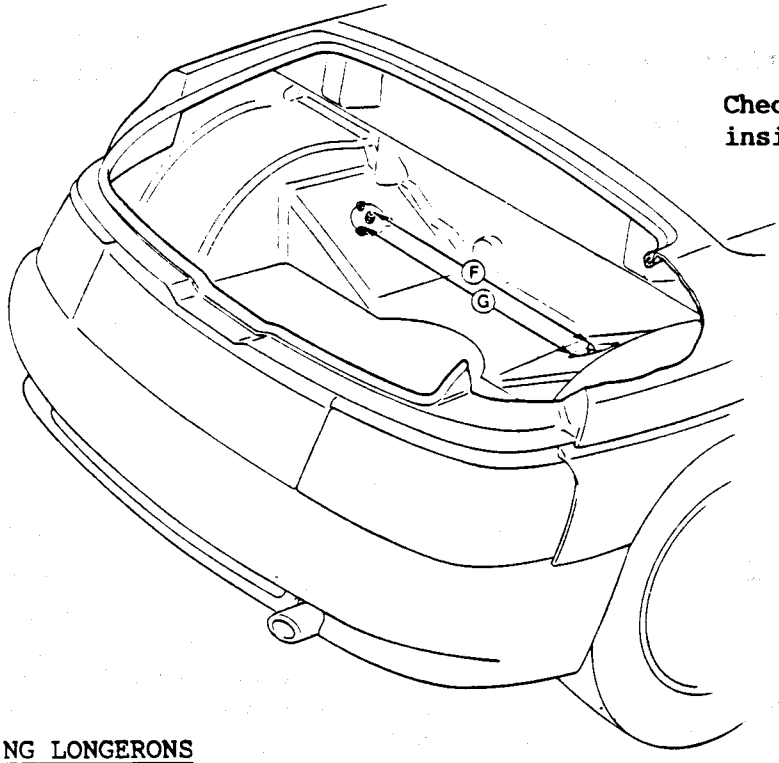
Rear side of channel section below centreline of pivot bolt

Chassis Check Dimensions





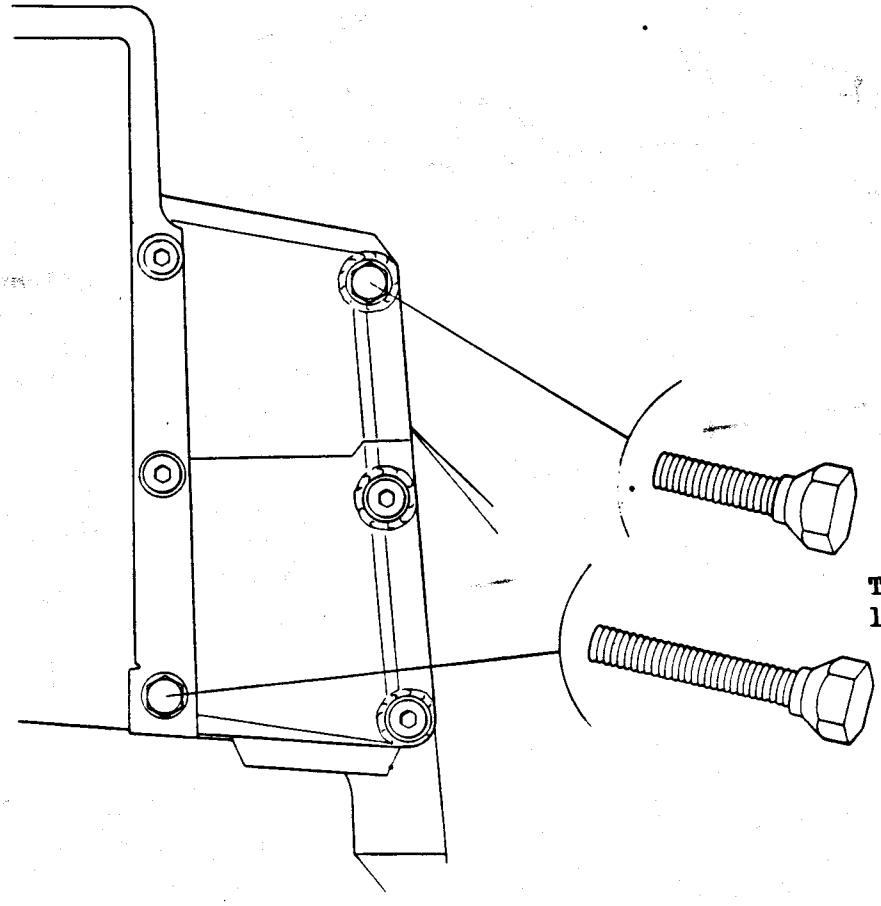
Inside surfaces of channel sections



Check dimensions inside boot

AD.3 - FITTING LONGERONS

When fitting the longerons to the chassis front crossmember, note that the longerons are positioned by two bolts with taper seats, and these must be tightened first, before the remaining 4 cap head bolts are tightened. Take care to fit the correct length bolts in the correct holes, using flat under the cap head bolt heads, but not on the taper seat location bolts. Torque tighten all longeron fixing bolts to 120 Nm (89 lbf.ft).



Taper seat location bolts

Earth braids are fitted between the inboard rear sides of each longeron, and the chassis front crossmember, with a shakeproof washer between the braid eyelet and the chassis member to ensure good electrical contact.

AD.4 - CRASH STRUCTURE

The 'crash structure' consists of a composite box, containing a series of composite tubes with longitudinal axes, bonded to the top surface of the chassis front frame with polyurethane adhesive. The box incorporates mounting points in the form of tapped aluminium bobbins, for the attachment of the electric water pump, front topshell, and on USA models, the SIR forward discriminating sensor.

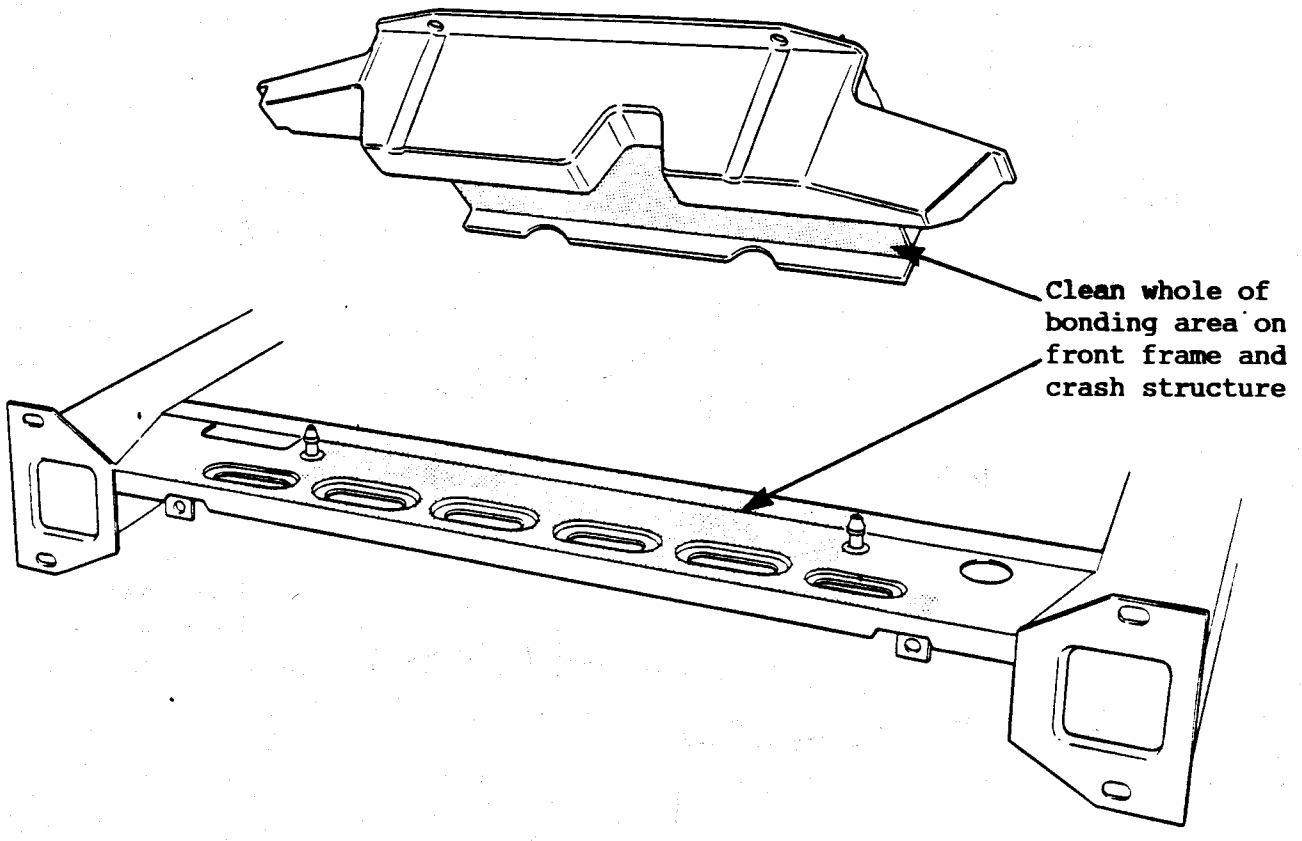
The crash structure is not repairable, and if damaged should be cut from the front frame and a new box fitted as detailed below.

Materials Required

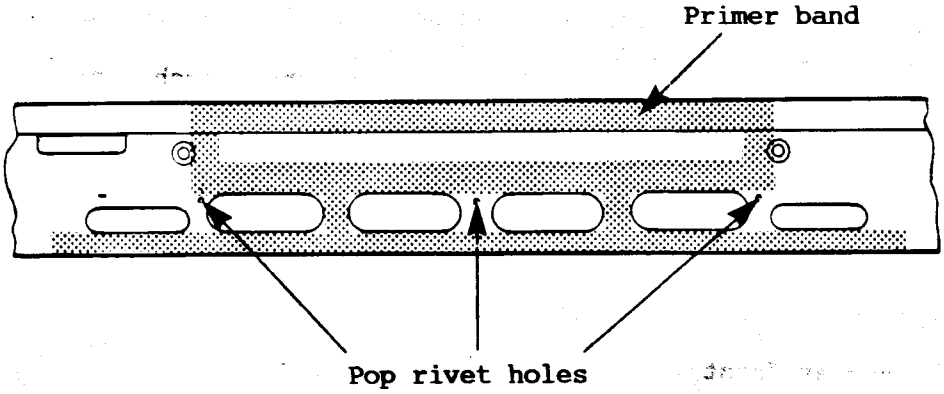
Betaseal Kit A075B6158F

1. The bonding surface on the top of the chassis front frame is not painted with the grey polyester surfacer, so that the adhesive can bond directly to the electrophoretic coat. Dry fit the box onto the frame and check that the three locating pop rivet holes are aligned.

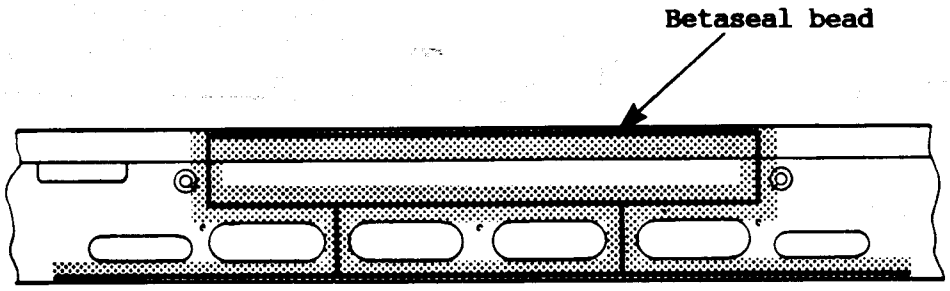
2. Clean the whole of the bonding area on the chassis frame and crash box with the wipe cleaner in the Beataseal kit. Wipe off the excess cleaner and allow to dry.



3. Shake the Betaseal primer container for at least 30 seconds before opening. Use a brush to apply the primer to the front frame as shown in the diagram, and also to the whole of the bonding area on the crash structure. Allow to dry for a minimum of ten minutes.



4. Cut the Betaseal nozzle at 45° so that the width of the nozzle tip is about 5 mm. Remove the desiccant from the HV3 cartridge, fit into the application gun, and extrude a bead of sealant onto the front frame as shown in the diagram.



5. Fit the box into position, and align the rivet holes. Press down using firm hand pressure to spread the adhesive, and fit the three pop pivets A075W6090 to secure the structure until the adhesive has cured. Paddle any extruded Betaseal back into the joint using a spatula.

Precautions

Avoid skin or eye contact with the Betaseal adhesive, and inhalation of the vapour from the cleaner or primer. High concentrations of the vapours are noxious - use in conditions of good ventilation. Flash point 12 - 15°C.

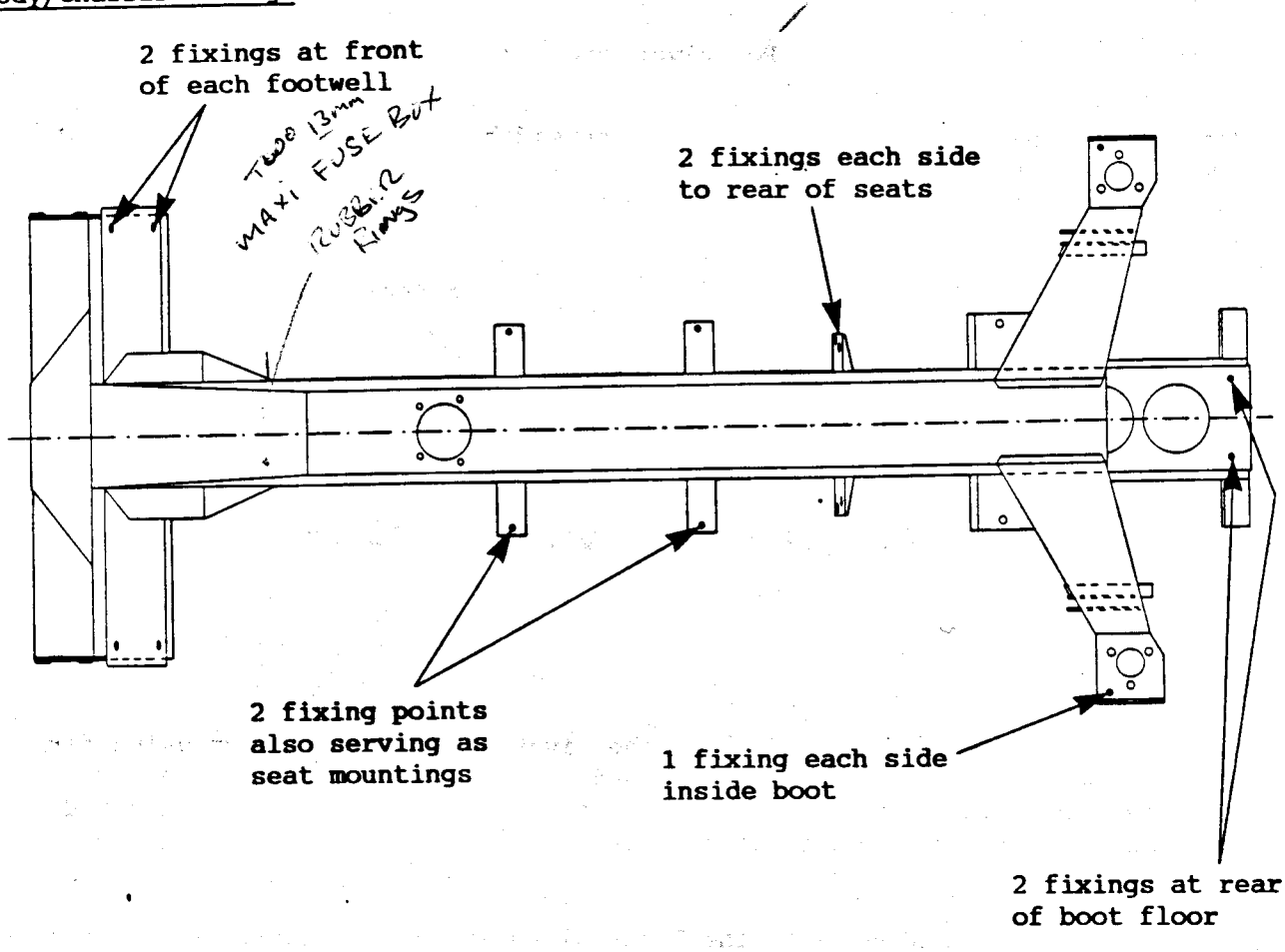
AD.5 - BODY/CHASSIS MOUNTING POINTS

There are 16 main mounting points securing the body to the chassis, each using a two piece aluminium bobbin crimped together and bonded to the body, and an M10 bolt picking up in a caged nut on the chassis. The mounting points are symmetrical about the car centreline, and are located as follows:
On each side of the car;

- 2 at the front of each footwell, into the rear of the chassis front crossmember.
- 2 alongside the bottom of each side of the centre tunnel, also serving as seat mountings, and picking up short outriggers from the side of the chassis centre backbone.
- 2 in each side on the rear bulkhead, adjacent to the centre tunnel, picking up a bracket at the rear of the chassis backbone.
- 1 at each side of the boot, inboard of the rear wheel arch, into the chassis rear suspension top platform.
- 2 in the spare wheel well, into the chassis rear extension.

See section BK.17 for body/chassis removal procedure.

Body/Chassis Fixings



ENGINE COOLING

Type	Closed water circuit. Engine driven centrifugal pump. Thermostat controlled radiator circuit. 2 electric fans with thermal switch. Auxiliary electric pump on Turbo models with ign. off thermal control.
Header tank pressure cap	110 kPa (15 lb/in²)
Anti-freeze/corrosion inhibitor	recommended 40% concentration minimum 25% year round maximum 60% in severe climates

ELECTRICAL EQUIPMENT

Voltage polarity	12V negative earth
Battery - type	Delco Freedom maintenance free model 842
- amp hour	55 amp hr @ 20 hr rating
- cold start performance (DIN)	255A
- Euro-standard size code	L2
Alternator - make	Nippondenso
- rated output	60 A
- regulated voltage	14.2 to 14.8 V
- drive belt tension	41 ± 10 kgf (90 ± 20 lbf) using a Burroughs gauge
Starter motor - type	Nippondenso pre-engaged
- rated output	1.2 Kw
Inertia switch	7g
Wiper system	Mechanical linkage, 2 x 585 mm blades

Light Bulbs	European	USA	Wattage	Replacement Bulb Number	Type
Headlamps - outer	*		55	448	H1
- inner	*		55	448	H1
- outer		*			
- inner		*			
Front side/parking lamps	*	*	5	501	W10/5
Front sidemarker lamps		*	5	501	W10/5
Front turn indicator lamps	*	*	21	382/1156	P25-1
Side repeater lamps	*		5	501	W10/5
Tail lamps	*		5	207	R19/5
Rear turn	*		21	382	P25-1
Stop lamps	*	*	21	382/1156	P25-1
Tail/turn		*	21/5	380/1157	P21/5W
High mounted stop lamp		*		891	
Rear fog lamps	*		55	453	H3
Reversing lamps	*	*	21	382/1156	P25-1
Rear sidemarker lamps		*	5	501	W10/5
Interior lamps	*	*	5	501	W10/5
Boot lamp	*	*	10	258	SU8.5-8

FUEL CONSUMPTION - United Kingdom DoE

Test	Naturally Aspirated		Turbocharged	
	Imperial mpg	Metric l/100 km	Imperial mpg	Metric l/100 km
Urban cycle	25.9	10.9	26.2	10.8
Constant 56 mph (90 km/h)	40.8	6.9	42.2	6.7
Constant 75 mph (120 km/h)	35.2	8.0	31.8	8.9

TORQUE SETTINGS

	Nm	lbf.ft
Chassis		
Longeron to chassis	120	89
Front frame to chassis	22	16
Radiator support frame to front frame	10	7.5
Radiator frame 'Y' brackets, top	10	7.5
Radiator frame 'Y' brackets, bottom	22	16
Radiator frame front strut (towing eye), top	10	7.5
Radiator frame front strut (towing eye), bottom	22	16
Radiator frame to underframe	10	7.5
Underframe to chassis	75	55
Underframe to support stay	75	55
Support stay to chassis	75	55
Body		
Rear bumper to body	16 - 20	12 - 15
Body to chassis	49	36
Front Suspension		
Damper top stem nut	20 - 30	15 - 22
Top wishbone inboard pivot	55 - 58	41 - 43
Raft top mounting bolt	75 - 80	55 - 59
Sandwich plate to raft	22 - 25	16 - 18
Top wishbone to ball joint *	22 - 25	16 - 18
Lower wishbone inboard pivot bolt *	68 - 72	50 - 53
Lower wishbone inboard pivot end plate	22 - 25	16 - 18
Lower wishbone strut to main member	41 - 45	30 - 33
Suspension strut yoke to lower wishbone	105 - 110	77 - 81
Ball joint to anti-roll bar *	25 - 27	18 - 20
Yoke to suspension unit	35 - 38	26 - 28
Lower swivel joint to hub carrier	61 - 67	45 - 49
Top swivel joint to hub carrier *	61 - 67	45 - 49
Raft front and rear mounting bolts * *	75 - 80	55 - 59
Spring top seat to chassis	22 - 25	16 - 18
Track rod end to steering arm	58 - 64	43 - 47
Driveshaft to front hub	225 - 235	166 - 173

Torque settings contd.

	Nm	lbf.ft
Rear Suspension		
Damper top stem nut	20 - 30	15 - 22
Spring top seat to chassis	22 - 25	16 - 18
Damper to lower wishbone*	68 - 72	50 - 53
Top link, outboard* and inboard**	75 - 80	55 - 59
Top link camber adjustment bolts	22 - 25	16 - 18
Lower wishbone inboard pivot (to chassis)*	65 - 70	48 - 52
Lower wishbone outboard pivot (to hub carrier)*	95 - 100	70 - 74
Anti-roll bar to wishbone ball joint	36 - 40	27 - 30
Anti roll bar ball joints to lower wishbone	36 - 40	27 - 30
Anti-roll bar drop links	36 - 40	27 - 30
Hub nut	see section DD.6	
Stub axle to hub carrier**	60 - 65	44 - 48
Brake caliper bracket to hub carrier**	35 - 39	26 - 29
Brake caliper to mounting bracket	100 - 110	74 - 81

* Tighten only at ride height.
** Apply thread locking compound unless renewing bolts (pre-applied).

Transmission		
Speedo drive retaining plate	6	4.5
Drain plug	39	29
Gearlever base unit to mounting bracket	15	11
Gearlever mounting bracket screws	22.5	17
Clutch housing to cylinder block	90	66
Jackshaft bearing bracket to block	38	28
Bearing retainer plate	19	14
Interlock plunger retaining plate	19	14
Gearbox casing to clutch housing	37	27
Reverse idler shaft retaining bolt	37	27
Selector detent plugs	25	19
5th speed drive & driven gear nuts	127	94
Gear selector housing	19	14
End cover	19	14
Crown wheel to carrier	113	83
Wheels		
Wheel bolts	80 - 88	59 - 65
Steering		
Rack housing to chassis	120	89
High pressure pipe from pump to pinion housing	30	22
Low pressure pipe from pinion housing	40	30
Pipe connections, pinion housing to rack tube	12	9
Outer column to pedal box	10	7.5
Column to scuttle beam	15	11
Upper u/j to intermediate shaft	40	30
Lower u/j to pinion shaft	25	18
Steering wheel to column	40	30
Track rod end locknut	60	44
Track rod end to steering arm	58 - 64	43 - 47
Track rod ball joint to steering rack	72.5	54
PAS pump pivot & strap bolts	18	13

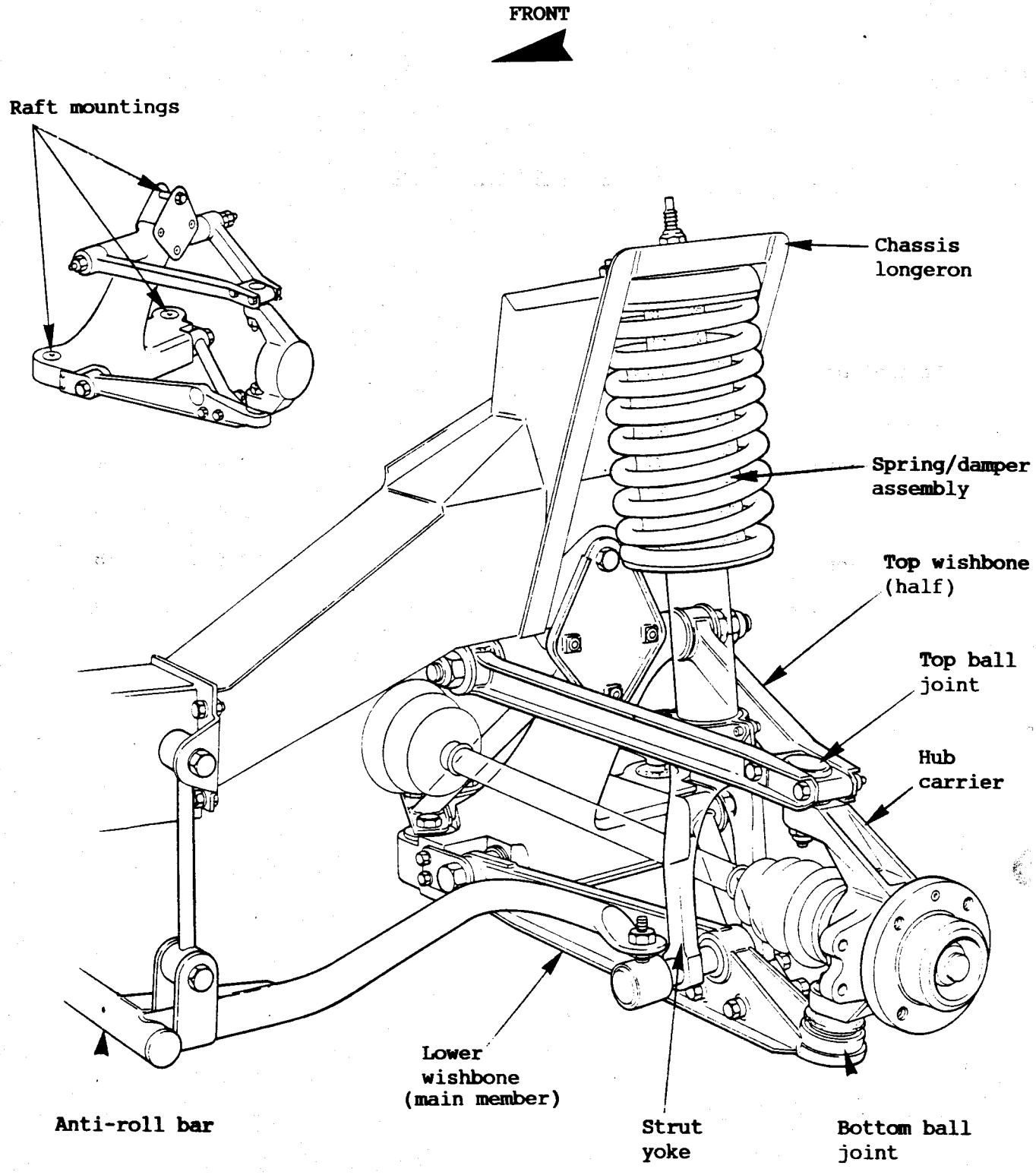
Torque settings contd.

		Nm	lbf.ft
Brakes			
Front caliper mounting bolts		85 - 110	63 - 81
Rear caliper mounting bolts		90 - 110	66 - 81
Brake hose to caliper		40	30
Bleed nipple		9 - 16	7 - 12
Parking brake cable abutment to caliper		33 - 52	24 - 38
Servo to pedal box		16 - 20	12 - 15
Pedal box to bulkhead		22	16
Master cylinder to servo		15 - 18	11 - 13
Brake pipe tube nuts, M10 & M12		15	11
Cooling System			
Oil cooler banjo bolts		27	20
Fuel System			
Tank strap bolts		12	9
Fuel filter connections		27	20
Air Conditioning			
Evaporator inlet connection		11 - 16	8 - 12
Evaporator outlet connection		18 - 23	13 - 17
Refrigerant hose connections:	5/8"-18	11 - 16	8 - 12
	3/4"-16	20 - 27	15 - 20
	7/8"-14	24 - 30	18 - 22
	1 1/16"-14/16	38 - 44	28 - 33
Clutch			
Operating arm pinch bolt		38	28
Clutch cover		19	14

Training Course Notes

FRONT SUSPENSION

SECTION CE - ELAN


FRONT
Raft mountings
Chassis longeron
Spring/damper assembly
Top wishbone (half)
Top ball joint
Hub carrier
Lower wishbone (main member)
Anti-roll bar
Strut yoke
Bottom ball joint

CE.1 - GENERAL DESCRIPTION

The front suspension comprises of upper and lower wishbones with concentric coil spring/telescopic damper unit and an anti-roll bar. The upper and lower wishbones on each side of the car are mounted on a separate cast alloy 'raft' (subframe) which is itself mounted to the chassis on three bonded rubber bushes, and helps to isolate the body from suspension noise and harshness, whilst maintaining accurate wheel control.

The lower wishbone uses a main fabricated steel track control arm to carry the spring/damper unit, and, at its outboard end, the lower steering swivel ball joint. A separate tubular steel strut is bolted to this member, and leads rearwards to form a wishbone. The upper wishbone comprises two similar pressed steel links, bolted together at their outboard end where they sandwich the top steering swivel ball joint. Both upper and lower ball joints are secured to a cast iron hub carrier with integral rearward facing steering arm. The co-axial coil spring/damper unit uses a two piece yoke at its lower end to straddle the driveshaft. A forward mounted tubular anti-roll bar, picks up off the damper lower mount, and is supported by two hanging links. The coil spring/ damper unit is secured at its upper end, to the chassis longeron.

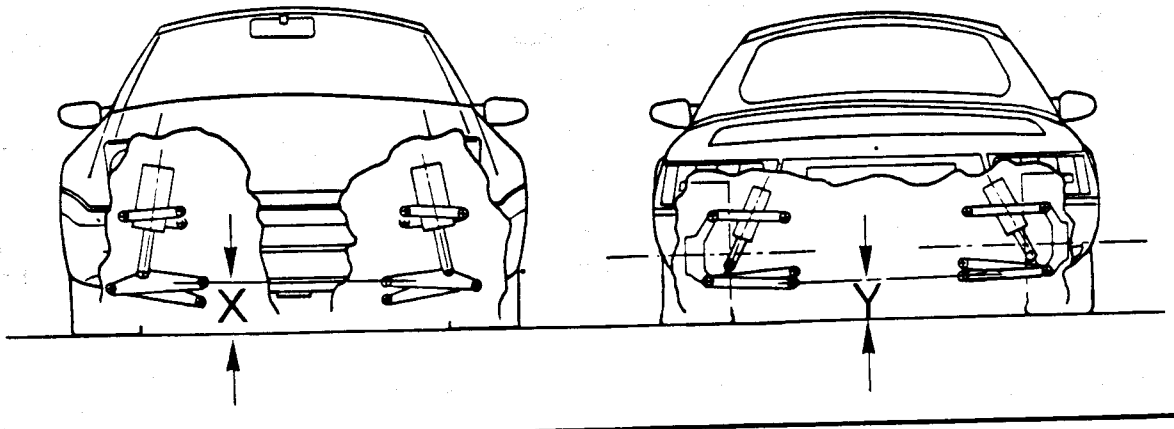
The inboard pivots of the upper and lower wishbones, take the form of bonded rubber bushes with longitudinal pivot axes. These bushes are anchored to separate cast aluminium alloy 'rafts' on each side of the car which serve to transfer all the longitudinal, lateral and torque loadings from the front suspension, into the chassis. Each raft is mounted to the chassis by three bonded rubber bushes, the lower two having vertical axes, and the single top bush having a transverse axis. The lower rear bush is bolted to directly to the chassis front crossmember, the lower front bush to the detachable underframe, and the top bush, via sandwich plates, to the chassis longeron. The compliance of the raft rear bush is sufficiently soft in order that on meeting a sharp bump, the front wheel is allowed to move back slightly as the raft pivots about its upper and front lower bushes. This movement has only a minimal effect on the steering, but significantly reduces the noise and harshness transmitted to the cabin. This feature allows for stiffer wishbone bushes to be used, in order to maintain accurate wheel control for optimum handling.

The hub carrier uses a single, double row ball bearing to support the wheel hub, into which is fitted the driveshaft.

CE.2 - GEOMETRY

Suspension and steering geometry should be checked only at mid-laden ride height:

Ride height - front (X)	165 ± 2 mm	mid-laden	(with 75 kg driver
- rear (Y)	174 ± 2 mm	mid-laden	+ ½ tank of fuel)



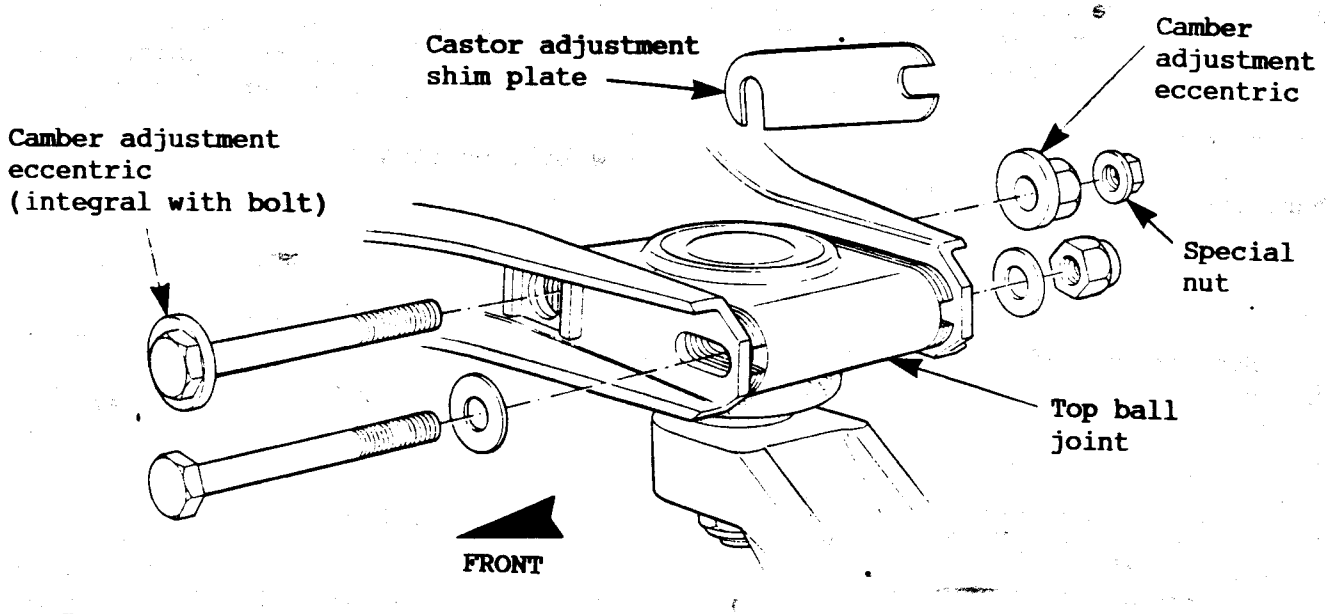
Ride height at kerb condition (full fuel tank, no occupants)	
- front	170 ± 2 mm
- rear	180 ± 2 mm
Castor:	+ 1°; + ½°, - 0
Camber:	- ¼°; ± ¼°
Steering axis inclination:	10½°
Toe-in:	Zero
Scrub radius:	- 3 mm

CE.3 - ADJUSTMENTS

Castor, camber and toe-in are adjustable, and should be checked and/or adjusted in the following order:

Castor: Castor adjustment shims are fitted between the top ball joint and the two top wishbone arms. A total of eight 1 mm shims must always be maintained, but may be transferred between front and back of the ball joint as required. Transferring a single 1 mm shim from front to back of the joint will reduce castor by approx. ¼°.

Camber: Provision is made for the adjustment of wheel camber at the top swivel joint to wishbone fixing. Two bolts are used to to clamp the two halves of the top wishbone to the swivel joint. Both fixings use a slotted hole in the wishbone arms, with an eccentric adjuster incorporated into the inboard fixing. This bolt has an integral eccentric washer under its head which locates between two vertical guides on the front half of the wishbone. A similar arrangement on the rear half of the wishbone uses a separate eccentric washer to mirror the position of the bolt eccentric.



To make an adjustment, first slacken the outboard bolt, and then slacken the nut of the inboard bolt whilst holding the bolt stationary. Turn the bolt (with integral eccentric) and rear eccentric together, as necessary to increase or decrease camber. Ensure that both eccentrics are turned the same amount, and that the position of one is mirrored by the other. A total adjustment of about 1.8° is available. On completion, torque both nuts to 22 - 25 Nm (16 - 18 lbf.ft).

Toe-in: To adjust the toe-in, hold each track rod end by the flats provided (22 mm) whilst releasing the locknut. Turn each track rod, using the flats provided (13 mm) an EQUAL amount, to adjust the effective track rod length as necessary. When adjustment is correct, hold the track rod end and tighten the locknut to 60 Nm (44 lbf.ft).

CE.4 - SUSPENSION DISASSEMBLY

If the complete suspension assembly is to be removed from one side of the car in order to provide access, or for other work in that area to be performed, the complete wishbone/hub carrier assembly may be removed by releasing the cast alloy raft from the chassis:

Complete Suspension Assembly

1. Track Rod End: Remove the nut securing the track rod end to the steering arm, and use a ball joint seperator to release the joint.

2. Strut Yoke: Release the ball joint from the end of the anti-roll bar, and whilst supporting the weight of the suspension, release the nut and withdraw the bolt securing the strut yoke to the lower link. Release the four bolts, and remove the two halves of the yoke from the suspension strut.

3. Driveshaft & Brake Caliper: Unpeen, remove and discard the hub nut. Release the brake caliper from the hub carrier, and the flexible hose from the top wishbone, and support clear, without straining the hose.

4. Top Raft Fixing: Release the three bolts securing the sandwich plates to the top of the raft, and the single bolt through the top mounting. Remove the two plates.

5. Lower Raft Fixings: Release the raft lower front mounting bolt, and lower rear mounting bolt. Push the driveshaft out of the hub, and withdraw the complete wishbone suspension assembly from the car. Note: take care not to 'stretch' the driveshaft, and pull apart the inboard joint.

Spring/Damper Assembly

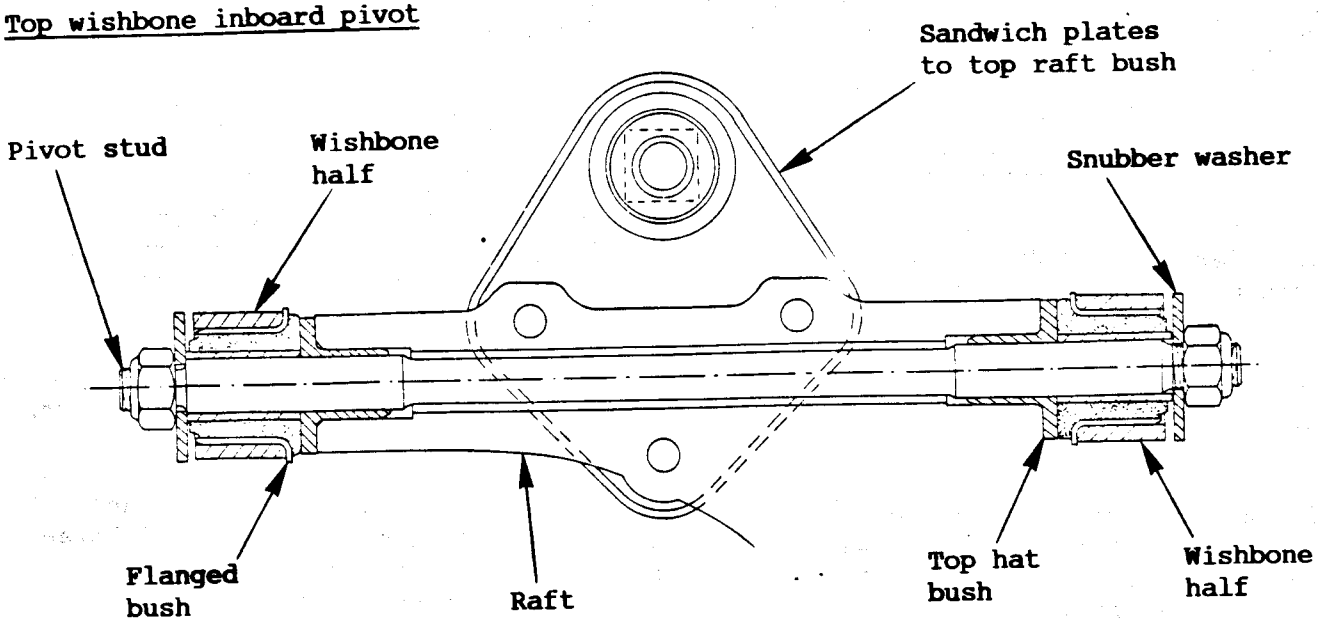
The spring/damper assembly uses a spring top seat which is bolted to the chassis, and also retains the top of the damper strut. This allows the complete assembly to be withdrawn from the vehicle without the use of spring compressors: remove the yoke from the lower end of the damper body, and release the three nuts securing the top spring seat to the chassis. Withdraw the damper and spring assembly. Do NOT remove the damper stem top nut without first fitting spring compressor clamps.

Before re-assembling the unit, ensure that the damper stem rubber bushes, and the spring top rubber seat are in good condition. Replace if necessary. Pay careful attention to the correct location of the damper stem bushes and washers. Hold the top of the stem whilst torque tightening the stem nut to 20 - 30 Nm (15 - 22 lbf.ft).

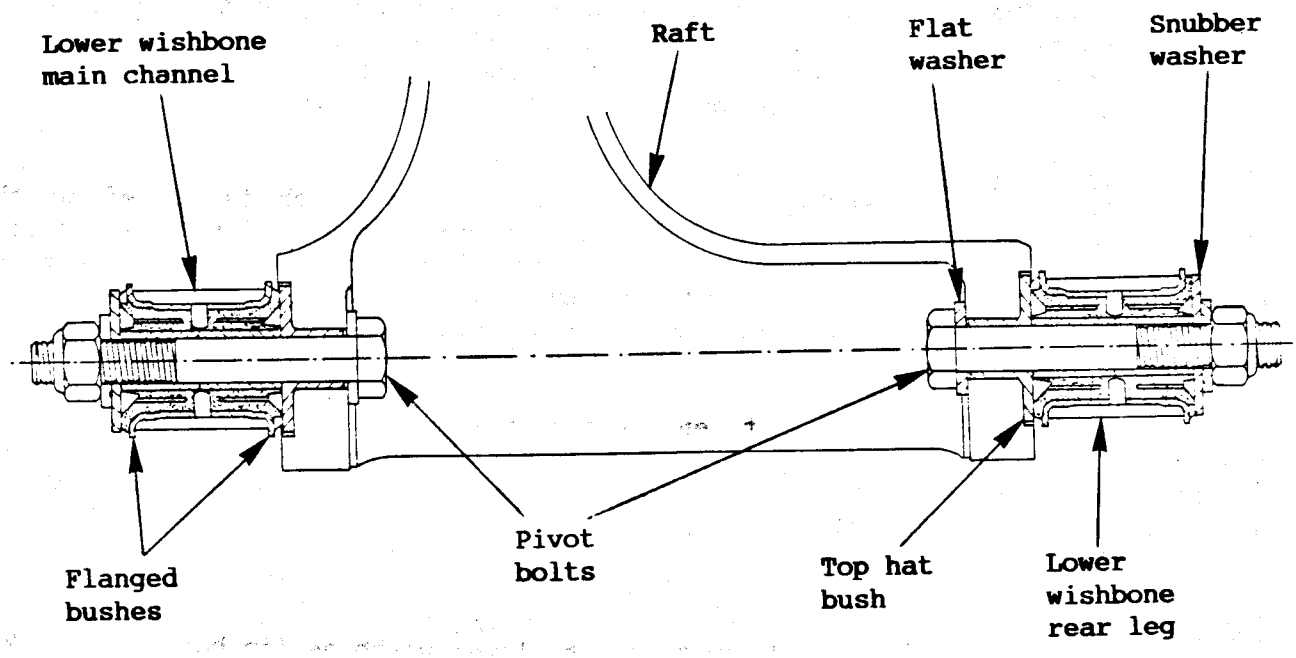
Bush Replacement

1. Lower Wishbone: The inboard pivots of the lower wishbone (in both main link, and tubular steady link) are split, flanged sleeve, bonded rubber bushes, which may be drawn or pressed from the wishbone before new items are pressed into position.
   The sleeved bush for the suspension strut to lower wishbone may be replaced

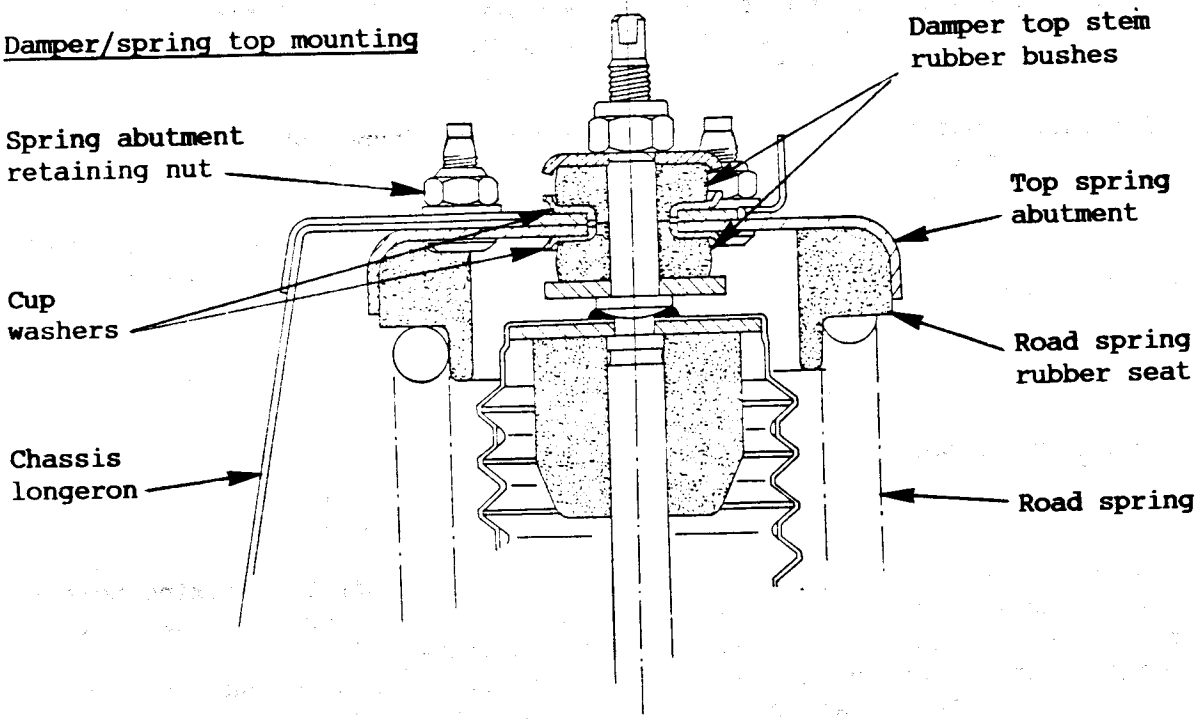
Top wishbone inboard pivot



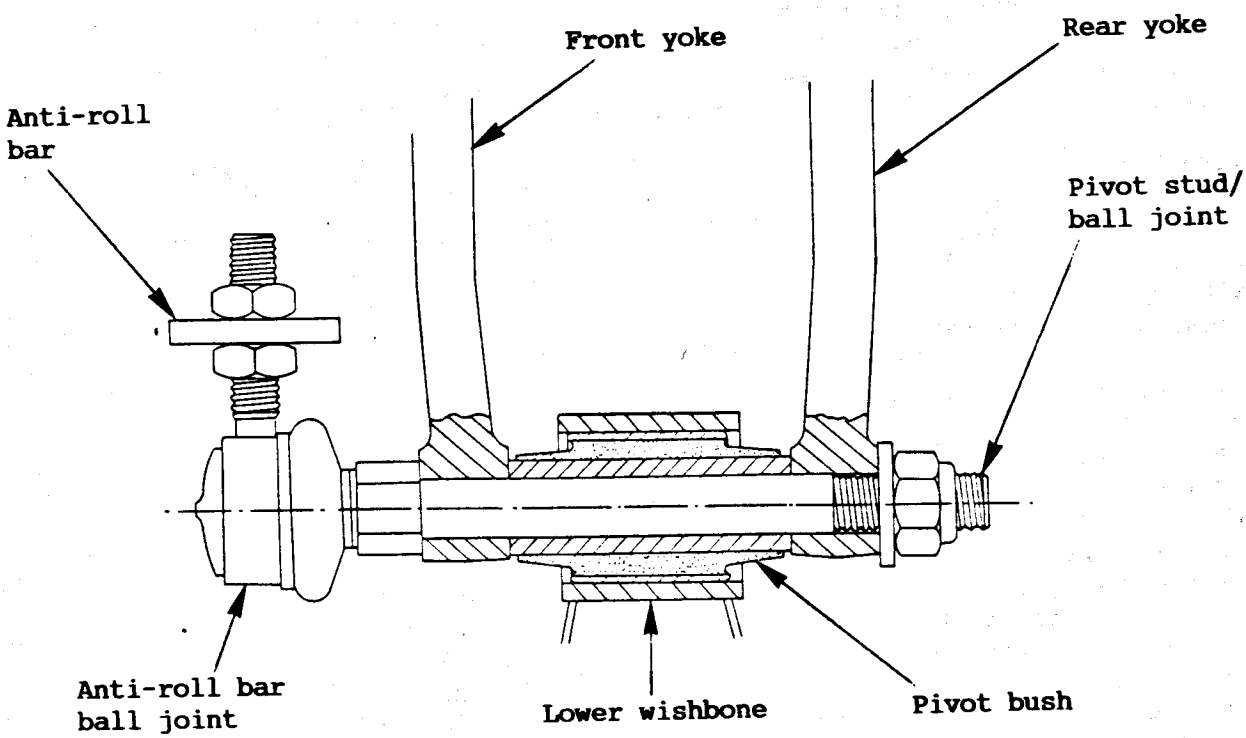
Lower wishbone inboard pivot



Damper/spring top mounting



Spring/damper assembly to lower wishbone



using a press with a suitable sleeve tool.

2. Top Wishbone: The inboard end of each top wishbone half, is fitted with a flanged sleeve bonded rubber bush which may be replaced using a press. Note that the bush is fitted from the **inside** of the arm.

3. Raft: The raft front bush is a split, flanged sleeve type, which may be prised out, and new bushes pressed in.
The raft rear bush is a single flanged sleeve type, fitted from below.
The raft top mounting is a split, flanged sleeve, bonded rubber bush, pressed into the chassis longeron, and may be removed by drawing/pressing out each half of the bush in turn.

CE.5 - SUSPENSION RE-ASSEMBLY

Note the following points when re-assembling the suspension:

i) Use a copper based grease on the shank of the top wishbone to raft fixing stud to prevent corrosion, and aid subsequent disassembly. Thoroughly degrease the threads before fitting the nyloc nuts.

ii) Tighten the wishbone pivot bolts and damper to lower wishbone fixing bolt ONLY with the car at normal ride height, otherwise the bonded bushes will be preloaded, resulting in premature wear and increased ride height.

iii) Pay careful attention to the correct assembly of the snubber washers and ensure that the steel inserts are fitted into the alloy suspension carrier at the wishbone pivot points.

iv) Note that no washers are used beneath the heads of the upper and lower swivel joint nuts, or the track rod end ball joint nut.
It is most important that the ball joint nuts are correctly torqued, especially the bottom ball joint for which an open ended torque wrench must be used, or alternatively, remove the driveshaft to allow access with a socket wrench.

v) After re-assembly, carry out a geometry check, and make any adjustments as necessary as detailed in CE.3.

vi) Refit the brake caliper (see section JE.5).

vii) Torque tighten all fixings as below.

Torque Settings

	Nm	lbf.ft
1. Damper top stem nut	20 - 30	15 - 22
2. Top wishbone inboard pivot	55 - 58	41 - 43
3. Raft top mounting bolt	75 - 80	55 - 59
4. Sandwich plate to raft	22 - 25	16 - 18
5. Top wishbone to ball joint	22 - 25	16 - 18
6. Lower wishbone inboard pivot bolt	68 - 72	50 - 53
7. Lower wishbone inboard pivot end plate	22 - 25	16 - 18
8. Lower wishbone strut to main member	41 - 45	30 - 33
9. Suspension strut yoke to lower wishbone	105 - 110	77 - 81
10. Ball joint to anti-roll bar	25 - 27	18 - 20
11. Yoke to suspension unit	35 - 38	26 - 28
12. Lower swivel joint to hub carrier	61 - 67	45 - 49
13. Top swivel joint to hub carrier	61 - 67	45 - 49
14. Raft front and rear mounting bolts	75 - 80	55 - 59
15. Spring top seat to chassis	22 - 25	16 - 18
16. Track rod end to steering arm	58 - 64	43 - 47
17. Driveshaft to front hub	225 - 235	166 - 173

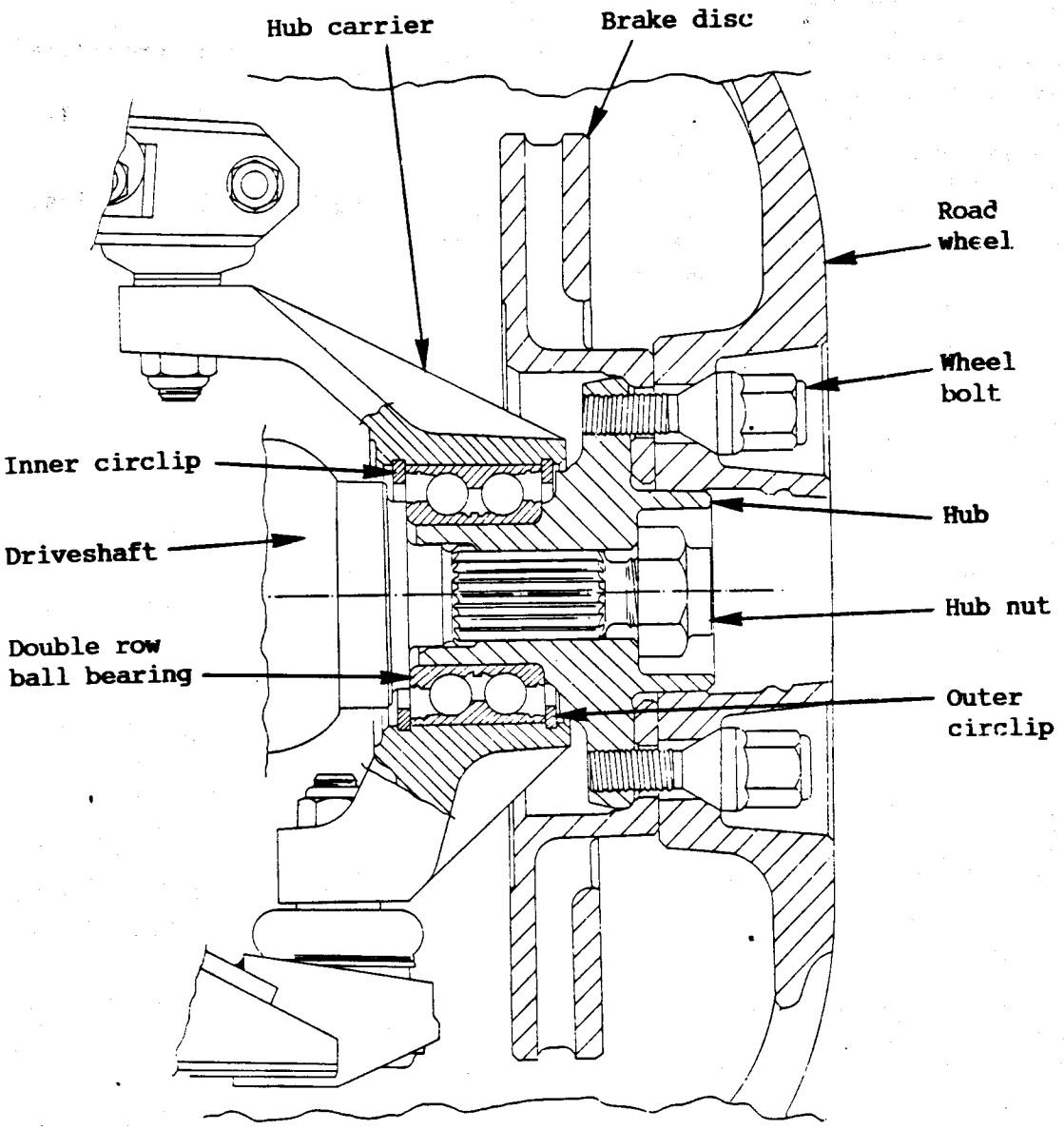
CE.6 - HUB BEARING REPLACEMENT

1. Hub Nut: Unpeen, remove and discard the hub nut.

2. Brake Caliper: Prise off the dust caps covering the ends of the two caliper sliding pins, and remove the two socket head bolts securing these pins, and the brake caliper, to the hub carrier. Support the caliper clear of the brake disc without straining the flexible hose.

3. Brake Disc: Release the single screw securing the brake disc, and withdraw the disc from the hub.

4. Ball Joints: Separate the steering track rod end, and top and bottom swivel joints from the hub carrier, by removing the ball joint nut, and using a suitable ball joint splitter tool.



An alternative way of releasing the top swivel joint is to remove the two bolts securing the joint to the top wishbone, having first marked the position of the camber adjustment eccentrics to aid re-assembly.

5. Hub Carrier: Press the driveshaft out of the hub as the hub carrier assembly is removed to the bench. Take care not to 'stretch' the driveshaft, and pull apart the inboard C.V. joint.

6. Hub & Bearing: Use a split collar tool to support the hub carrier on a hydraulic press, and press the hub from the bearing. Remove the two circlips securing the bearing in the hub carrier, and press out the bearing outer race.

7. Assemble Hub: Fit the outer circlip into the hub carrier, and press the hub bearing, via the outer race, into the hub carrier. Fit the inner circlip. Press the hub bearing, via the inner race, onto the hub.

8. Refit Hub Carrier: Refit the hub carrier reversing the removal procedure, and noting the following points:
   - Use a new hub nut, and peen into the driveshaft slot after torquing.
   - Use an open ended torque spanner to tighten the top and bottom ball joint nuts to their specified torque.
   - Fit new dust caps over the brake caliper mounting bolts/sliding pins.
   - Refit the brake caliper (see section JE.5).
   - Tighten all fixings to the specified torque.

BK.5 - DOOR MIRRORS

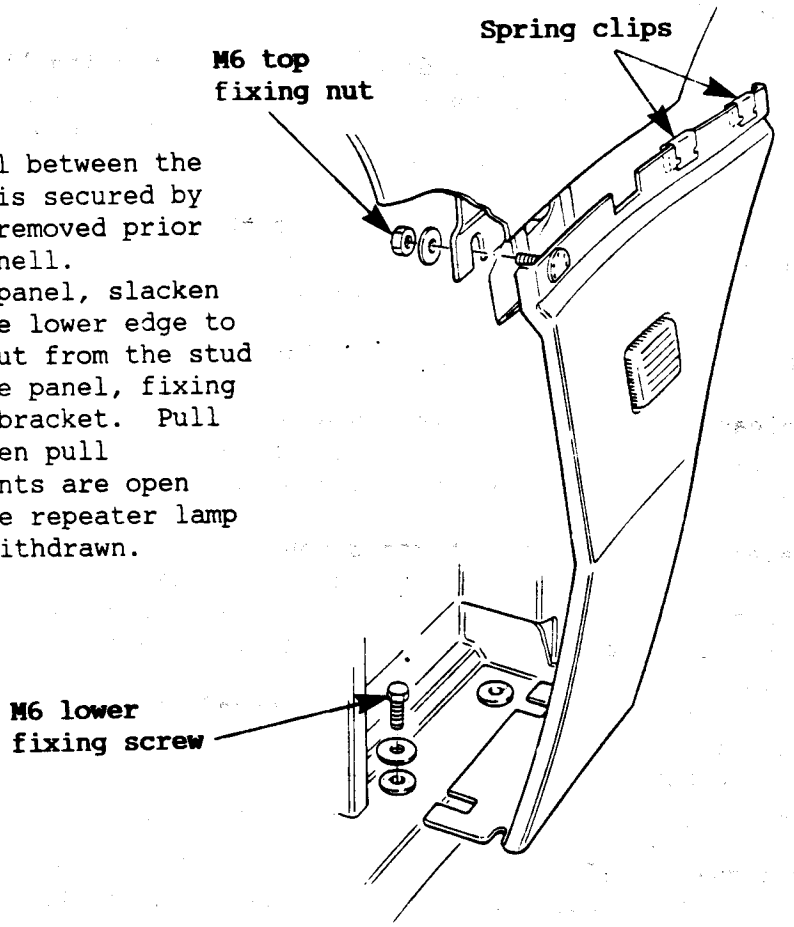
The door mirrors are mounted to the doors via a spring pivot which enables the mirrors to move forwards or backwards on accidental contact, and then return to their former position.

To remove a mirror assembly, remove the door trim panel, disconnect the mirror harness, and release the three screws securing the mirror assembly to the door shell.

BK.6 - 'A' POST PANELS

The exterior body panel between the door and front wheelarch, is secured by three screws, and must be removed prior to removing the front topshell.

To remove an 'A' post panel, slacken the two screws securing the lower edge to the sill, and remove the nut from the stud at the top rear edge of the panel, fixing the panel to the topshell bracket. Pull out the lower edge, and then pull downwards. All fixing points are open slots. Disconnect the side repeater lamp harness, as the panel is withdrawn.



BK.7 - FRONT TOPSHELL

The front topshell is a composite moulding comprising of both upper front wings and the bonnet landing platform. A fresh air intake duct is incorporated in each side of the topshell, but is fettled only for right or left hand drive. The topshell is secured by 17 threaded fasteners, and may be removed for improved access during engine removal etc.

Topshell Removal

1. Disconnect battery.
2. Remove the front bumper/spoiler (see BK.8).
3. Disconnect the windscreen washer tubing, unbolt the bonnet from its hinges, and remove the bonnet panel.

4. Remove both lower 'A' post panels by slackening the two screws securing the lower edge to the sill, and removing the nut from the stud at the top rear edge of the panel, fixing the panel to the topshell bracket. Pull out the lower edge, and then pull downwards. All fixing points are open slots. Disconnect the side repeater lamp harness, and push the harness with its grommet through the bulkhead.

5. Remove the chargecooler outlet pipe between chargecooler and plenum intake hose. Disconnect the air intake duct from the bulkhead adaptor on the passenger side.

6. At each headlamp motor, disconnect the actuating link, unplug the harness connectors, and via the access holes in the wheelarch, remove the two bolts securing the motor to its mounting bracket. Remove the three bolts securing each headlamp motor mounting bracket to the chassis.

7. At the right hand side, disconnect the boost gauge transducer hose. At the left hand side, **label** and disconnect the vacuum hoses to the vacuum solenoid valves for EGR and evaporative emissions (USA cars).

8. Release the bonnet latch mechanism from the topshell.

9. Release the relay base and fuse holder for the electric water circulation pump, from the topshell on the left hand suspension turret. Release the harness from the open 'P' clips on the topshell.

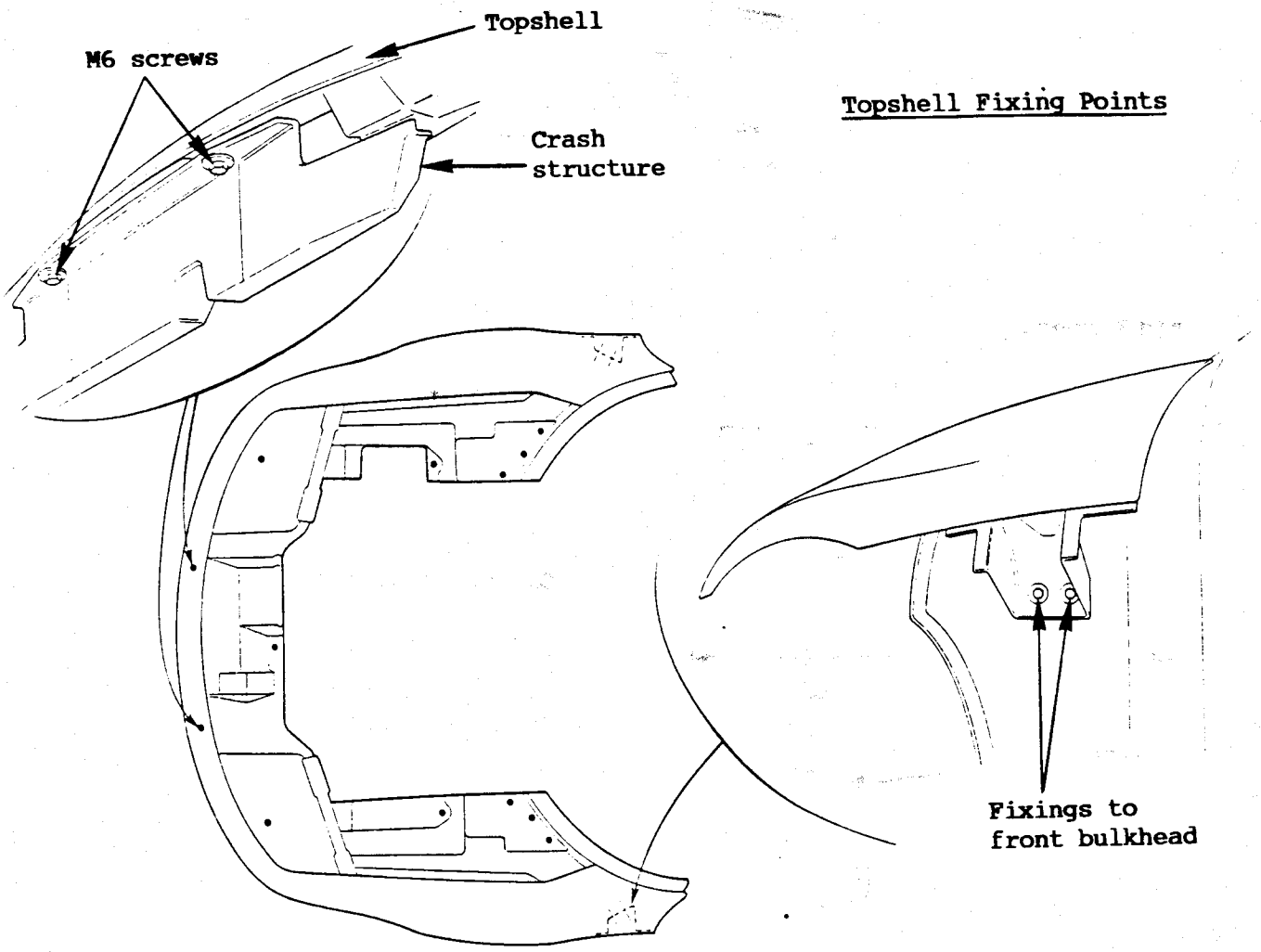
10. Release the following harness connections:
- main harness connector block at each side rear end;
- earth leads from the bonnet hinges, and push the leads through the topshell;
- earth lead to chassis longeron in each wheelarch;
- horns, behind oil cooler;
- radiator fan harness connector (behind left hand pod well);
- vacuum solenoid valve connectors (label) at left hand side;
- two connectors to the receiver drier pressure switch;
- two single bullets in the reverse light switch harness;

11. Release the 17 topshell fixings:
- two screws beneath each rear end securing the topshell to the front bulkhead. Note any spacers fitted;
- two screws at each side securing the top rear edge to the body near the base of the windscreen;
- one screw each side into the top of the suspension turret;
- one screw each side ahead of the suspension turret;
- one screw each side in the headlamp pod well;
- one central screw behind the bonnet latch.
- two screws through the front flange of the chassis mounted crash structure into the underside of the topshell front edge.

12. With the aid of an assistant, lift the topshell up and off the car, taking care not to allow the panel to twist excessively. Take care to note the position and number of spacer washers fitted at any of the fixing points.

Topshell Fitment

Reverse the removal procedure, noting the following points:
- First ensure that the topshell harness is fitted securely to the underside of the topshell;

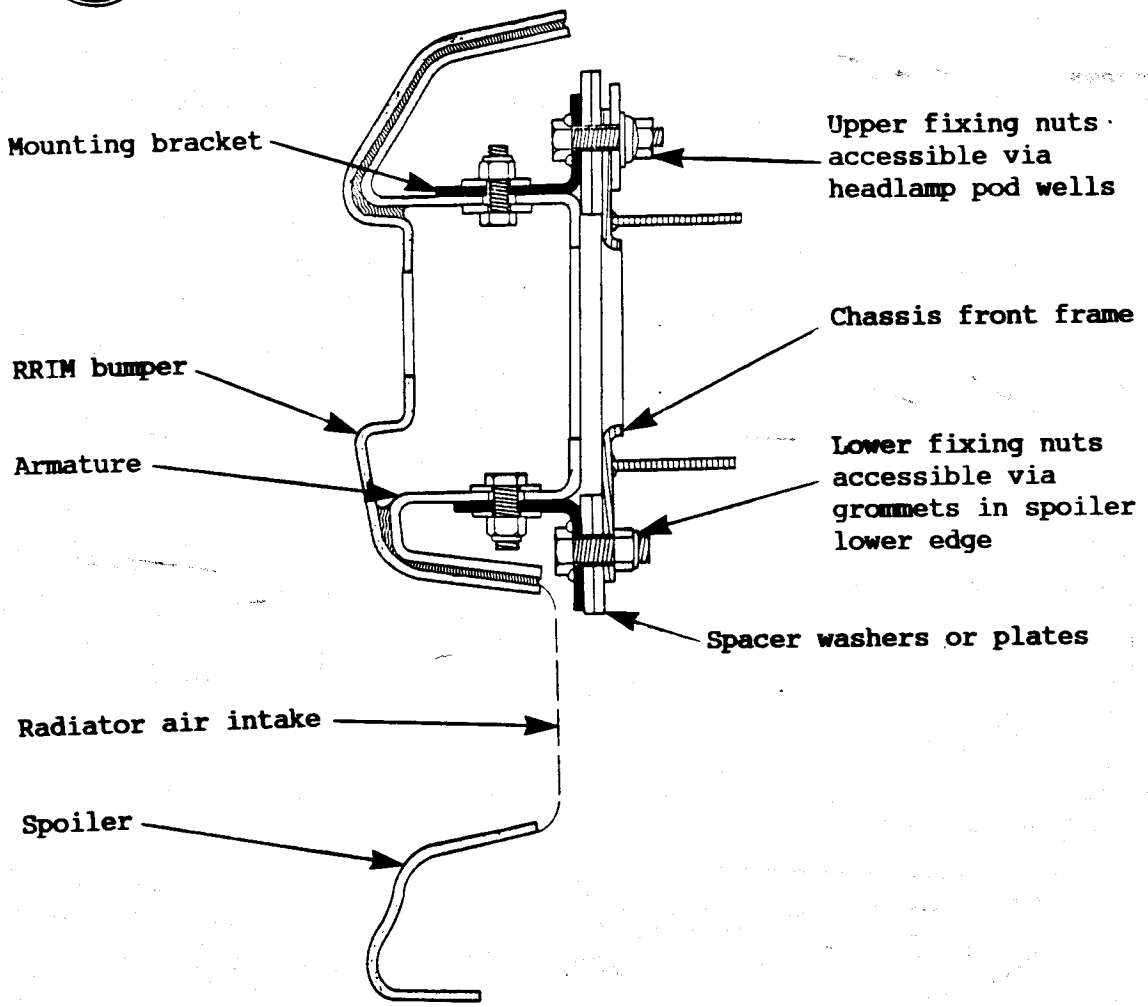


Topshell Fixing Points

- Check that the bonnet release cable is fitted into position and connected to the latch mechanism;
- Adjust the rear ends of the topshell to align with the front edges of the doors;
- At each fixing point, examine the gap between topshell and chassis, and fit spacer washers as necessary to avoid any stressing of the composite panel, which could result in the promotion of gel cracks;
- Apply a thread locking compound to the topshell fixing screws.

BK.8 - FRONT BUMPER/SPOILER

The front bumper/spoiler consists of a Reinforced Reaction Injection Moulding (RRIM) which is bonded to a stiffening and shock absorbing composite armature. The armature is fitted with mounting brackets which locate in two fixing holes at each front corner of the chassis front frame. On USA specification cars, a stronger armature is used, and the space between the bumper moulding and the armature is filled with energy absorbing foam. The bottom of the spoiler wraps underneath the oil cooler and chargecooler ducts, and a rubber skirting strip is fixed around the lower edge. Mesh grilles are secured by screws in each of the three air intake apertures in the spoiler, and the front side/turn lamps, and side marker lamps on USA cars, are fitted into recesses in the bumper.



To Remove

1. Remove the front undershield from the spoiler, engine bay underframe and side radiator ducts, and release the remaining fixing at each side securing the underside of the spoiler to the rad. ducts.

2. Release the front of the wheel arch liners to permit access to the bumper rear end fixings. At each side, release the height adjustment bracket from the bumper top edge, and the two M6 screws securing captive nuts in the ends of the bumper armature to the rear ends of the radiator ducts.

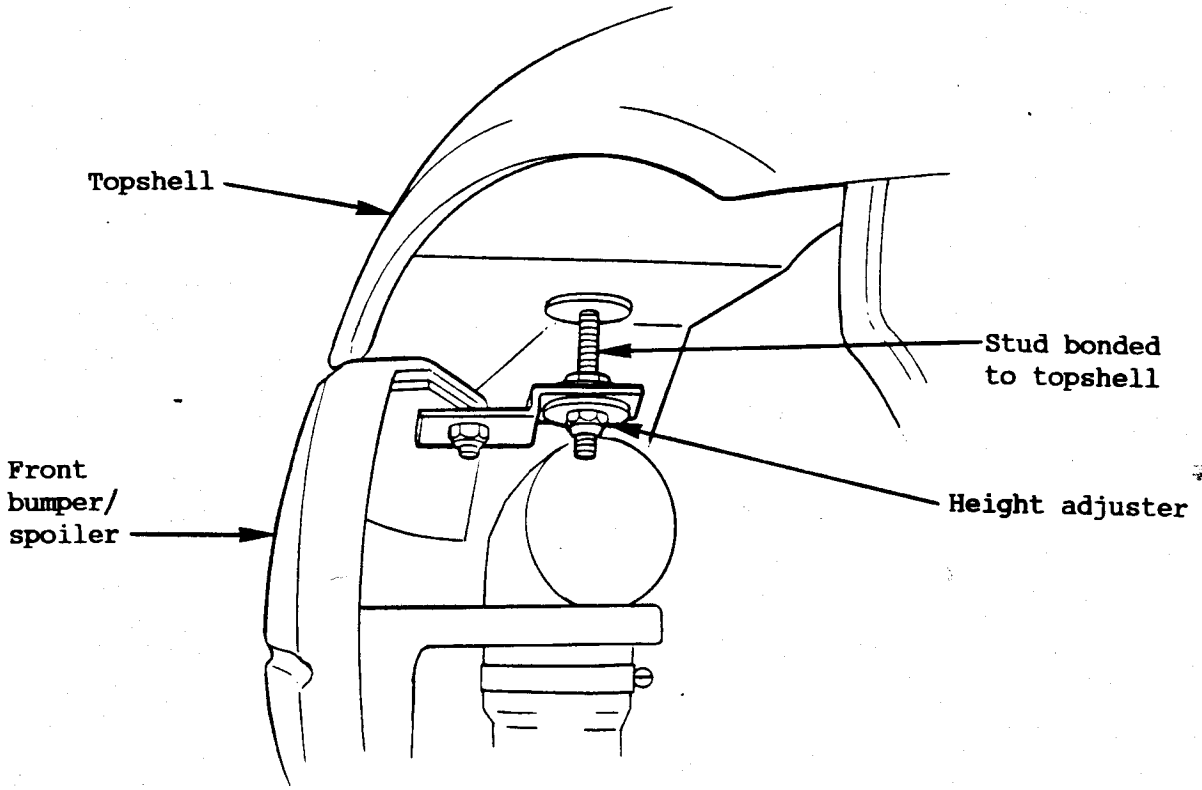
3. For access to the two lowermost bumper main fixing nuts, pull out the access grommet from the underside of the spoiler at each side, and reach up to the M8 fixing nut behind the flange on the chassis front frame.

4. The two top bumper fixings are accessible at the front of the headlamp recesses, with the headlamps raised.

5. Withdraw the bumper assembly sufficiently to disconnect the side/turn lamp and side marker lamp harnesses.

To Refit

When refitting a bumper assembly, fit spacer plates or body washers onto the four main fixing studs as required in order to achieve correct alignment (5mm gap) with the topshell front edge. Reverse the removal procedure, using the height adjuster brackets at each rear end to control the gap between the bumper and topshell before tightening the bumper to rad. duct fixings.



BK.9 - REAR BUMPER

The rear bumper is a Reinforced Reaction Injection Moulding (RRIM), bonded to a stiffening and shock absorbing composite armature. The armature is bolted to the rear of the body undertray with four bolts. On USA specification cars, a stronger armature is used, and the space between the armature and bumper is filled with energy absorbing foam. The mounting bolts on these cars are fitted with rubber bushes on the inside of the body to provide some compliance and allow the armature to flex on impact.

To Remove

1. On USA cars, at each side, disconnect the side marker lamp harness and release the grommet from the body aperture.

2. Remove the five screws securing the lower rear edge of the bumper moulding to the body.

3. From inside the boot, remove the four fixing nuts with spacer washers and, on USA cars, rubber bushes, and withdraw the bumper assembly.

Blank page follows:

3. Position the screen pillars for optimum alignment with the screen landing on the scuttle, and nip up the pillar and header rail bolts. Dry fit the windscreen, and check that a minimum screen to landing variation is achieved. Reposition the pillars if necessary, before tightening the pillar to hinge post fixings and the header rail bolts.

4. If necessary, fettle the header rail to screen pillar screen landing surface to achieve a minimum step.

5. Seal the gap between the screen pillars and front bulkhead.

6. Refit remaining parts in reverse order to disassembly.

BK.17 - BODY REMOVAL PROCEDURE

There are 16 main mounting points securing the body to the chassis, each using a two piece aluminium crimped together and bonded to the body, and an M10 bolt picking up in a caged nut on the chassis. The body may be removed from the chassis using a wheel free type four point lift, leaving the engine in place, by the following procedure:

1. Depressurise the fuel system by tripping the inertia switch (in battery compartment) to disable the fuel pump, and starting the engine. After the engine stops from fuel starvation, crank for several seconds to dissipate the remaining fuel pressure.
   Disconnect the battery.
   Disconnect the fuel feed and return pipes at the rear of the engine bay.

2. Remove the front topshell (see section BK.7).

3. Recover or de-pressurise the air conditioning system (see section PE), and disconnect the two evaporator connections at the rear of the engine bay.

4. Drain the cooling system, and disconnect the two heater hose connections at the rear of the engine bay.

5. Disconnect the throttle and clutch cables.

6. Disconnect the brake pipes from the master cylinder, and plug the cylinder ports. Cap the pipe ends.

7. Disconnect the vacuum hose to the brake servo.

8. Disconnect the vacuum hose to the water valve.

9. Disconnect the speedo cable from the transmission.

10. Disconnect the following electrical connections in the engine bay:
- main earth cable and smaller earth lead at RHF of chassis front crossmember, plus starter motor feed cable, and release from the plenum bracket.
- alternator connector block, starter motor solenoid connector, oil pressure gauge sender connector (rear side of block), and on N/A cars, the ignition coil flying lead connector.
- ECM earth cable from front end of intake plenum, and release cable from chassis.
- unplug two engine harness connector blocks near the front of the header tank, and on N/A cars the dropping resistor connector, and on Turbo cars the boost vac. solenoid at the rear of the air filter. Unplug the electric water pump harness to main harness connector. Release the harness from the chassis.

11. Remove the struts between the suspension turrets and the 'A' posts.

12. From inside the car, remove the pinch bolt securing the upper steering column u/j, and the bolt securing the upper column assembly to the pedal box. Remove the steering column shrouds and release the fixings securing the top of the column to the scuttle beam, and withdraw the column from the u/j before temporarily refitting the bolts. On USA cars fitted with SIR, see separate publication 'Section WB' for precautions to be taken.

13. Remove the tunnel top trim panel, gear lever knob and gear lever gaiter (see section VD). Remove the carpeted trim panels behind the seats. Unbolt the parking brake lever mounting bracket from the tunnel top.

14. Remove the fascia mask (see section VD), and remove the two bolts securing the scuttle beam brace to the tunnel top.

15. From beneath the rear of the car, release the parking brake cables from the rear calipers, and unclip the cables from the top links.

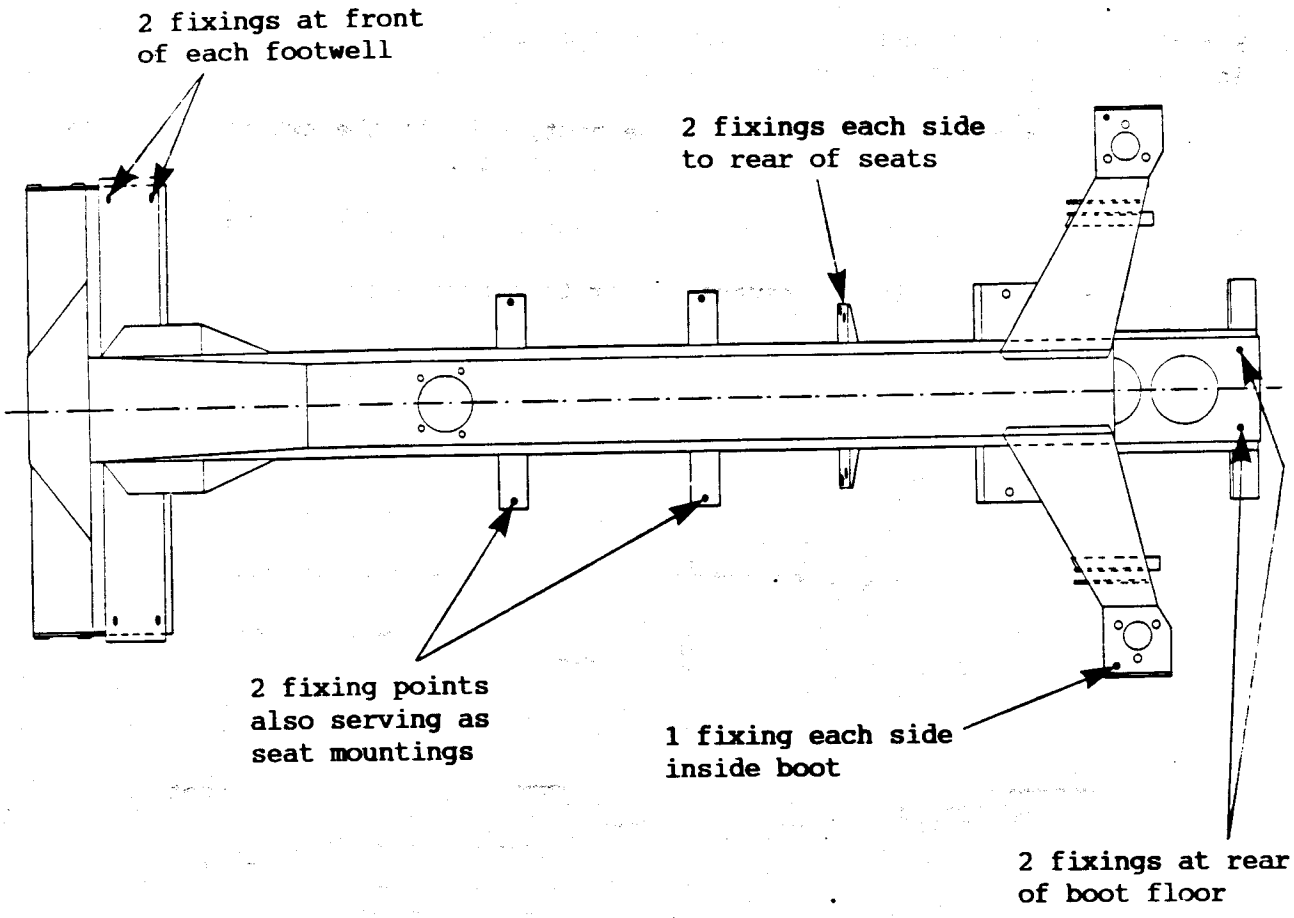
16. Release the rear silencer from the body mountings.

17. Disconnect the battery main earth lead from the front of the RHR chassis leg.

18. Remove the 16 M10 bolts securing the body to the chassis:
- 2 at the front of each footwell, into the back of the chassis front crossmember.
- 2 alongside the bottom of each side of the centre tunnel, also serving as seat mountings, and picking up short outriggers from the side of the chassis centre section.
- 2 in each side on the rear bulkhead, adjacent to the centre tunnel, picking up a bracket at the rear of the chassis backbone.
- 1 at each side of the boot, inboard of the rear wheelarch, into the chassis rear suspension top platform.
- 2 in the spare wheel well, into the chassis rear extension.

19. Position a four point lift beneath the body jacking points, and raise the body clear of the chassis.

Body/Chassis Fixings



Preparation Before Body Fitting

Before re-fitting the body, check that the following seals are fitted first:

- Self adhesive foam gasket around the parking brake mounting on the chassis.
- Self adhesive foam gasket around the gear change lever.
- Self adhesive foam gaskets around each rear suspension damper top mount.
- Rubber washers on each of the two spigot bosses for the scuttle brace, at the front of the chassis centre section.

Body Fitting Procedure

It is important when fitting the body to the chassis, that the following tightening sequence is used, to ensure that the body is correctly positioned, and not unduly preloaded.

1. Lower the body onto the chassis, ensuring that the wiring harnesses or parking brake cables are not trapped between the body and chassis.

2. With the body sat firmly on the chassis mounting points, first fit the two M10 bolts and washers at the front of each footwell into the chassis front crossmember. Torque tighten to 49 Nm (36 lbf.ft).

3. Fit the two bolts and washers at each side of the rear of the centre section, and torque tighten to 49 Nm (36 lbf.ft).

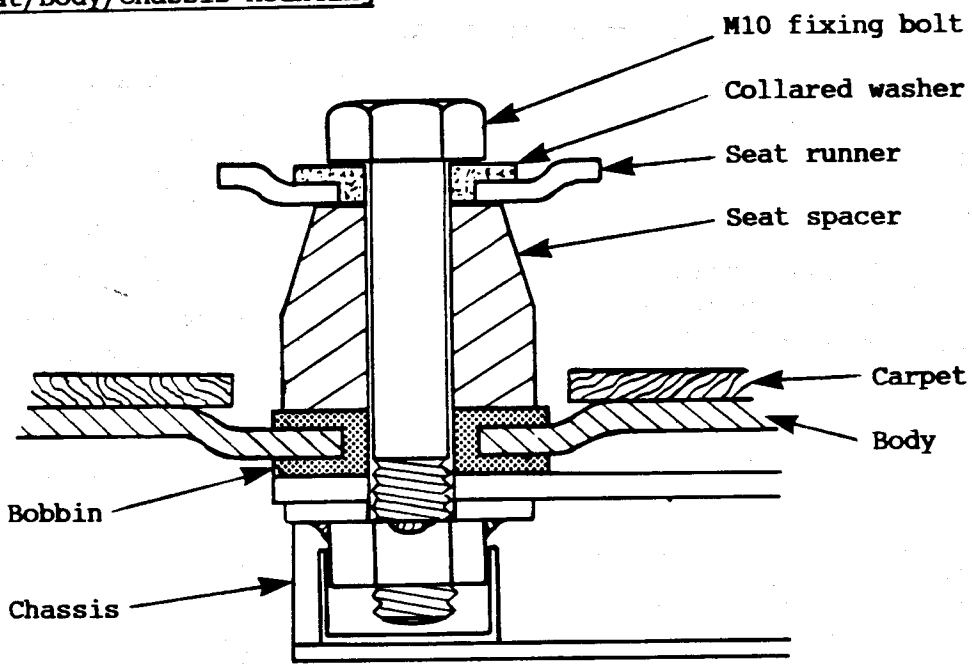
4. Fit the single bolt and washer into the top of each rear suspension turret inside the boot, and torque tighten to 49 Nm (36 lbf.ft).

5. Position the spare wheel bracket in the boot, and fit the two fixing bolts and washers. Torque tighten to 49 Nm (36 lbf.ft).

6. Fit the seat inboard mounting bolts, and torque tighten to 49 Nm (36 lbf.ft).

Continue re-assembly in the reverse order to disassembly.

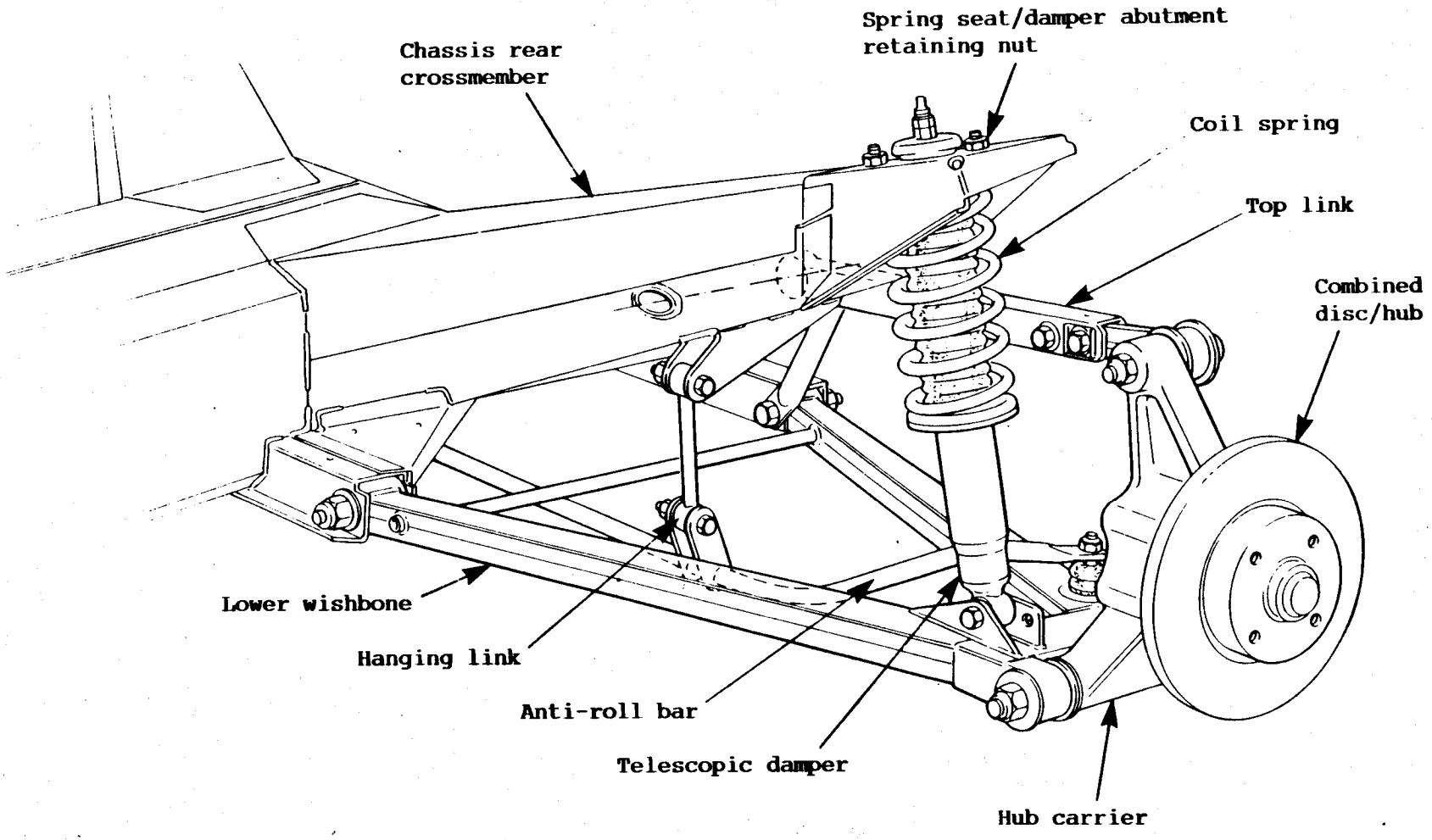
Inboard Seat/Body/Chassis Mounting



Training Course Notes

REAR SUSPENSION

SECTION DD - ELAN


Spring seat/damper abutment retaining nut
Chassis rear crossmember
Coil spring
Top link
Combined disc/hub
Lower wishbone
Hanging link
Anti-roll bar
Telescopic damper
Hub carrier

DD.1 - GENERAL DESCRIPTION

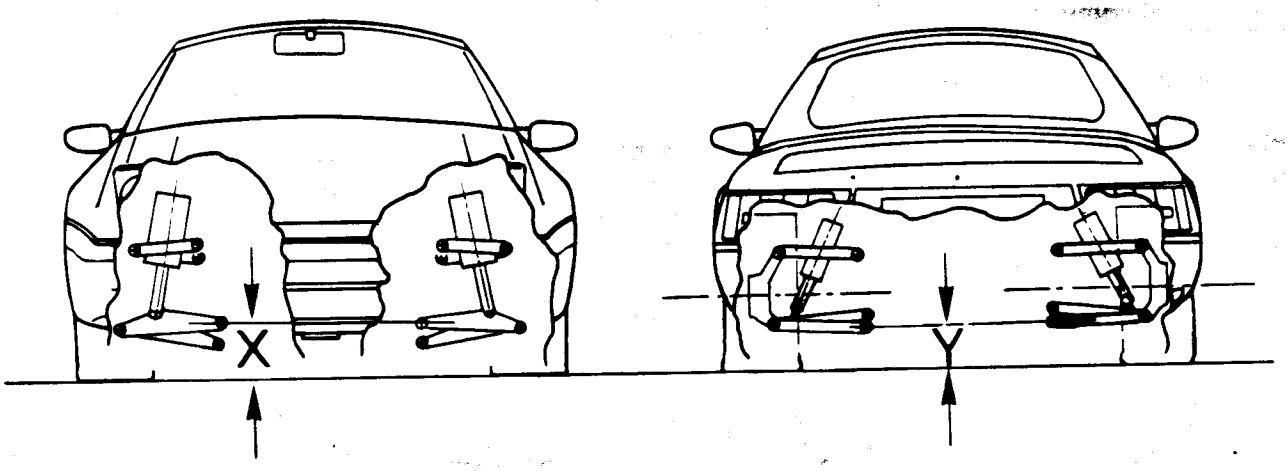
The rear suspension consists of a wide based lower wishbone, a single top link, a concentric coil spring/telescopic damper and an anti-roll bar. The box section fabricated steel lower wishbone, transfers the lateral loads and brake torque into the chassis, and also controls the rear wheel toe-in. The single inverted U-section top link controls wheel camber. The telescopic damper connects between the lower wishbone and the chassis, and incorporates the coil spring lower seat. The top end of the spring abuts against the chassis rear crossmember via a bolt on seat, into which is secured the top of the damper stem. The anti-roll bar is suspended forward of the rear axle line on two hanging links, and connects with each lower wishbone via ball joints.

A flanged stub axle is bolted to the aluminium alloy hub carrier, and supports the rear hub, which is integral with the brake disc, on a pair of taper roller bearings, adjustable for end float.

DD.2 - GEOMETRY

Suspension geometry should be checked only at mid-laden ride height:

Ride height - front (X)	165 ± 2 mm	mid-laden	(with 75 kg driver
- rear (Y)	174 ± 2 mm	mid-laden	+ ½ tank of fuel)



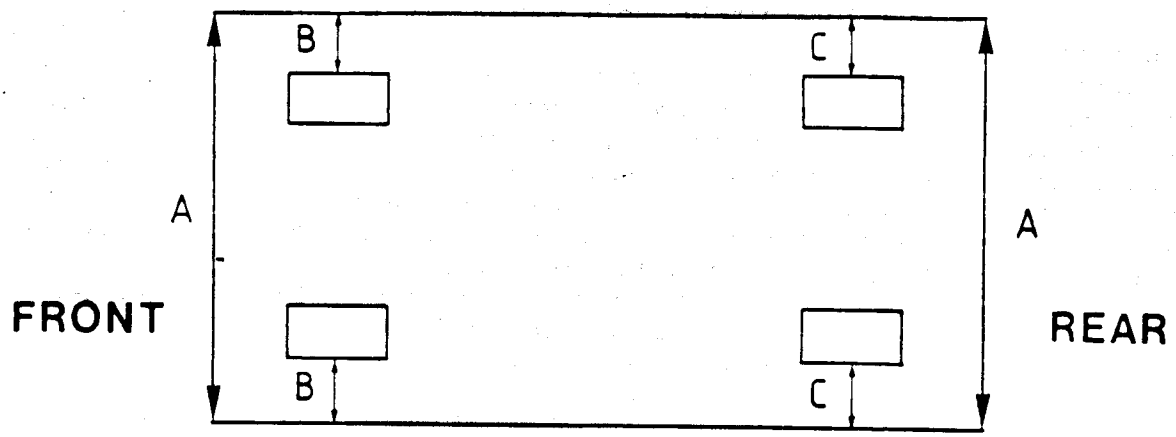
Ride height at kerb condition (full fuel tank, no occupants):

- front	170 ± 2 mm
- rear	180 ± 2 mm
Camber:	- ½°; ± ¼°
Toe-in:	+ 2.0 mm **each side**; ± ½ mm

It is essential that rear wheel alignment is checked using equipment which measures individual wheel alignment. The most reliable and accurate method is considered to be the use of parallel bars, used as follows:

Two bars which are longer than the overall length of the car, and 4 axle stands are required. The bars should be obtained locally and should be of 'T' or square section and be sufficiently rigid to avoid significant bending or sagging between supports.

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

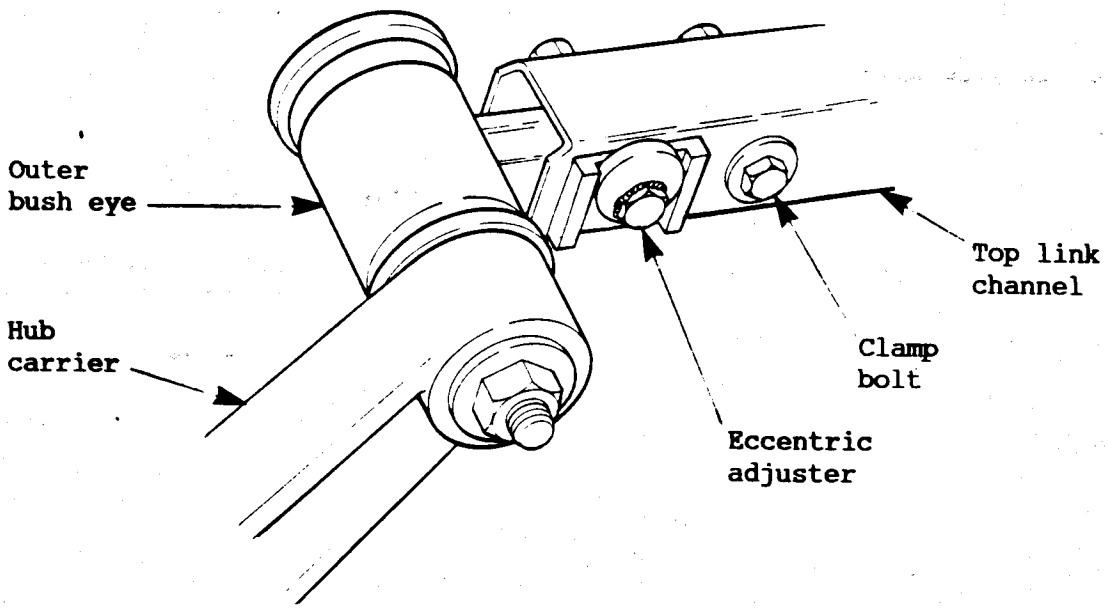


Measure the distance from the bar to the RIM of the wheel concerned at front and rear of the centre line of the wheel. If the front dimension is greater than the rear dimension, the wheel has TOE-IN. If the rear dimension is greater than the front dimension, the wheel has TOE-OUT. The difference between the two measurements is the amount the wheel has TOE-IN or TOE-OUT.

DD.3 - ADJUSTMENTS

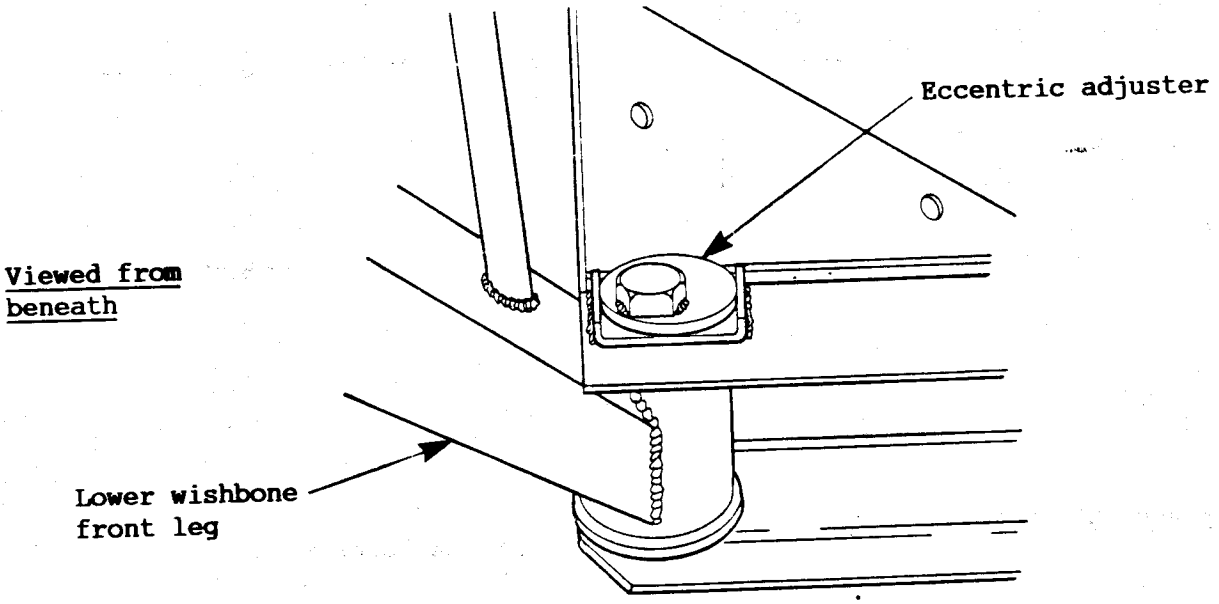
Camber and toe-in are adjustable.

Camber: Provision is made for the adjustment of wheel camber at the top link. The top link consists of an inverted U-section channel welded to the inboard bush eye, and a separate cast iron outer bush eye bolted to the channel with two bolts. Both fixings use a slotted hole in the channel section, with an eccentric adjuster incorporated at the outboard fixing. This bolt has an integral eccentric washer under its head which locates between two vertical guides on the front side of the channel. Plain washers and nuts are used on both bolts on the rear side of the link, and a plain washer beneath the head of the inboard bolt.



To make an adjustment, first slacken the inboard bolt, and then slacken the nut of the outboard bolt whilst holding the bolt stationary. Turn the bolt (with integral eccentric), as necessary to increase or decrease camber. A total adjustment of about 1.5° is available. On completion, torque both nuts to 22 - 25 Nm (16 - 18 lbf.ft).

Toe-in: Provision is made for the adjustment of toe-in, by an eccentric adjuster at the lower wishbone front fixing. To make an adjustment, slacken the forward fixing bolt nut, and turn the bolt (with integral eccentric) as required before re-tightening to 65 - 70 Nm (48 - 52 lbf.ft). A total adjustment of about 4.5 mm is available.



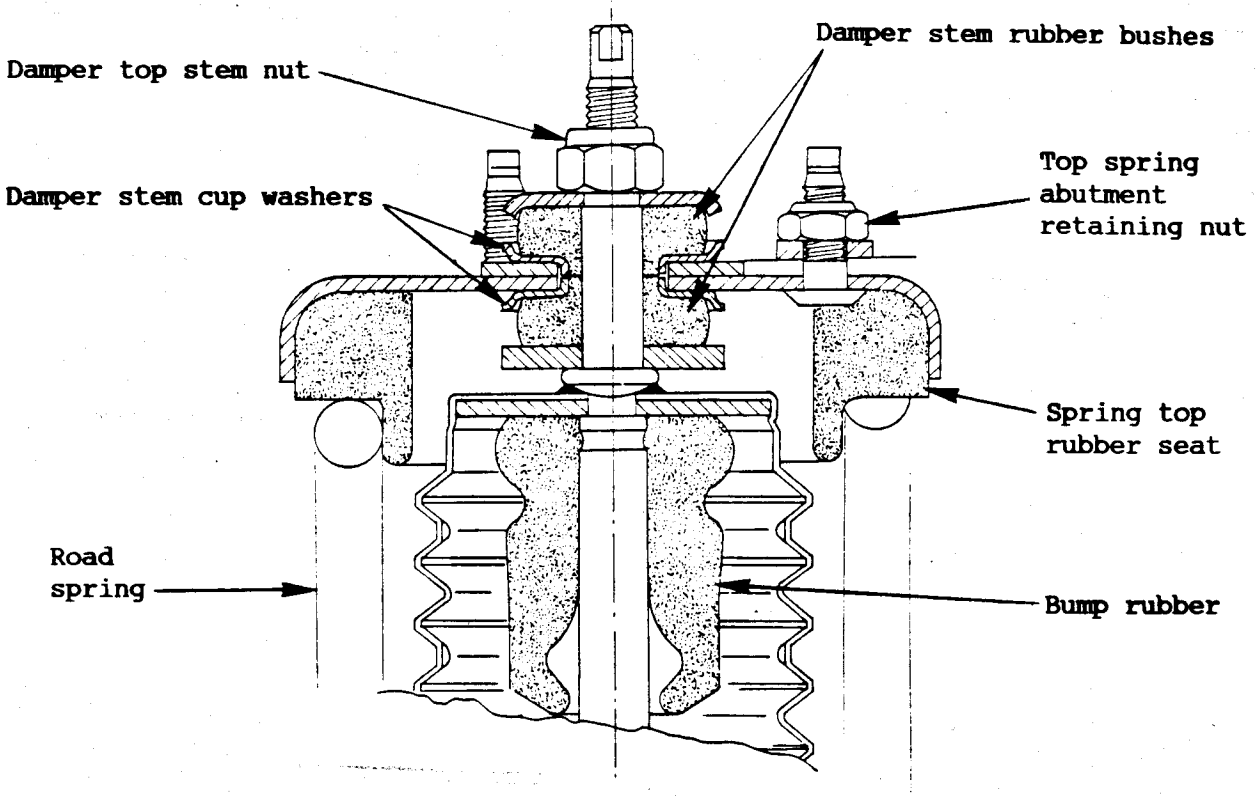
DD.4 - SUSPENSION DISASSEMBLY

The suspension strut assembly uses a spring top seat which is bolted to the chassis, thus allowing the complete strut assembly to be withdrawn from the vehicle without the use of spring compressors:

- support the weight of the suspension, and remove the bolt securing the lower end of the damper to the lower wishbone.
- remove the access grommet from within the boot, and release the three nuts securing the spring top seat to the chassis. Withdraw the complete spring/damper assembly.
- do NOT remove the damper stem top nut without first fitting spring compressors clamps.

Before re-assembling the unit, ensure that the damper stem rubber bushes, and the spring top rubber seat are in good condition. Replace if necessary. Pay careful attention to the correct location of the damper stem bushes and washers. Hold the top of the stem whilst torque tightening the stem nut to 20 - 30 Nm (15 - 22 lbf.ft).

Note that if the lower wishbone is to be removed, the brake hose between chassis and wishbone should first be clamped off, and then disconnected from the wishbone.

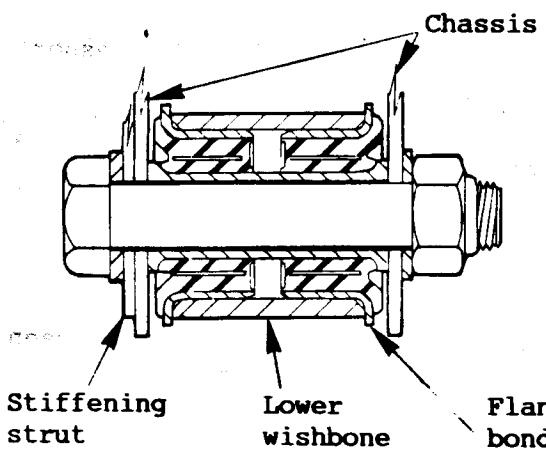


Bush Replacement

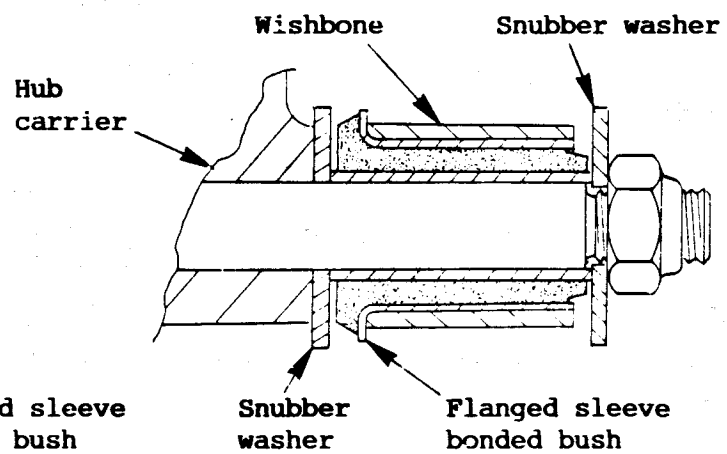
1. Lower Wishbone Inner Bush: Each inboard pivot of the lower wishbone is fitted with a pair of flanged sleeve bonded rubber bushes, which may be drawn or pressed out. New bushes may be pressed into position. Note that the front (hard) bush is colour coded orange, and the rear (soft) bush, white.

2. Lower Wishbone Outer Bush: Each outboard pivot of the lower wishbone is fitted with a single, flanged sleeve bonded rubber bush, which may be replaced using a press. Note that the bush is fitted from the **inside** of the wishbone.

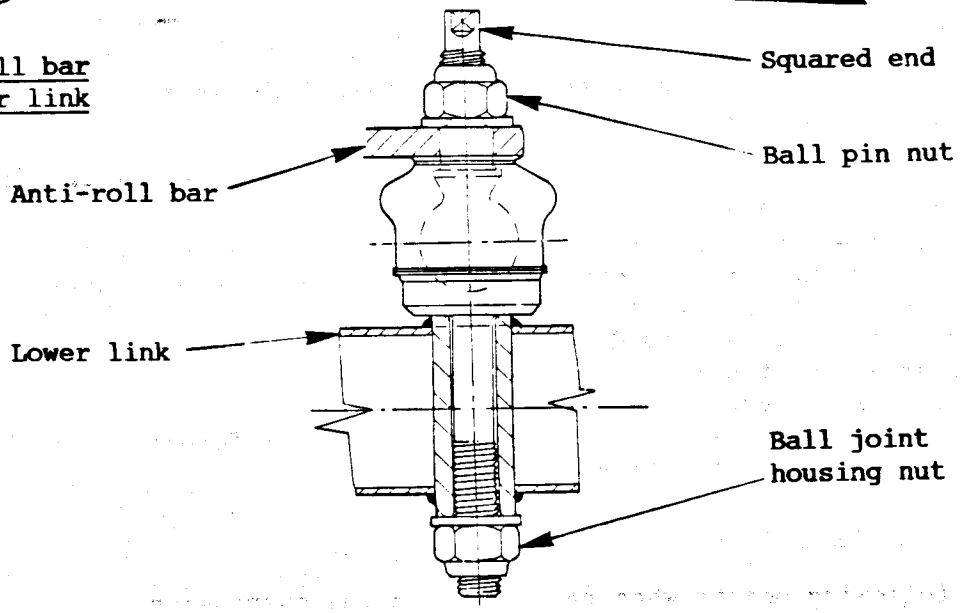
Lower wishbone inner bush



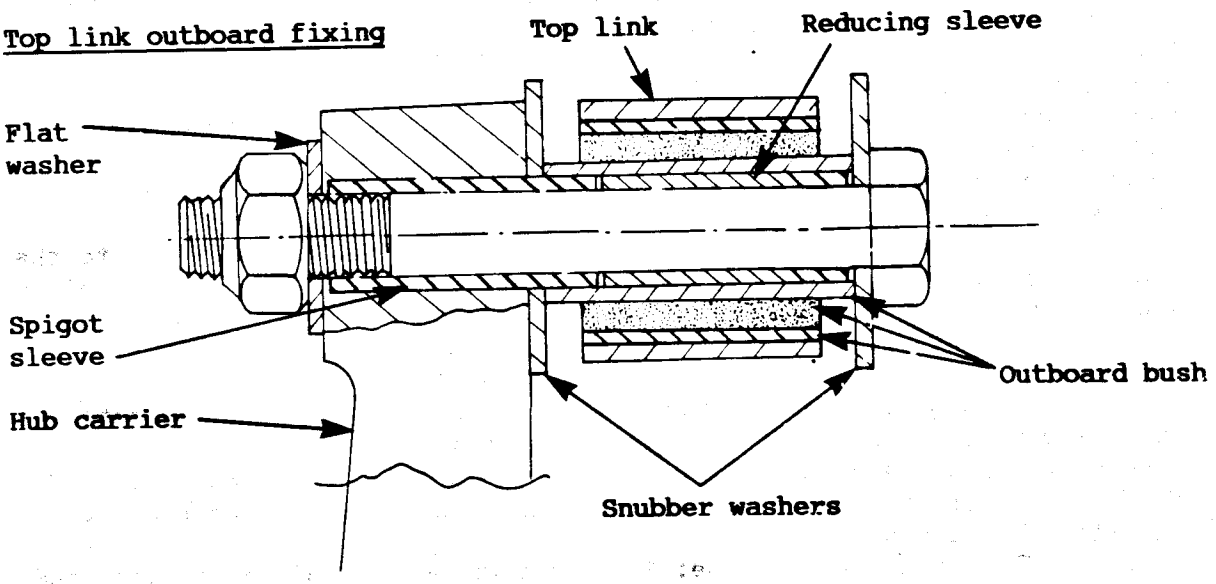
Lower wishbone outer bush



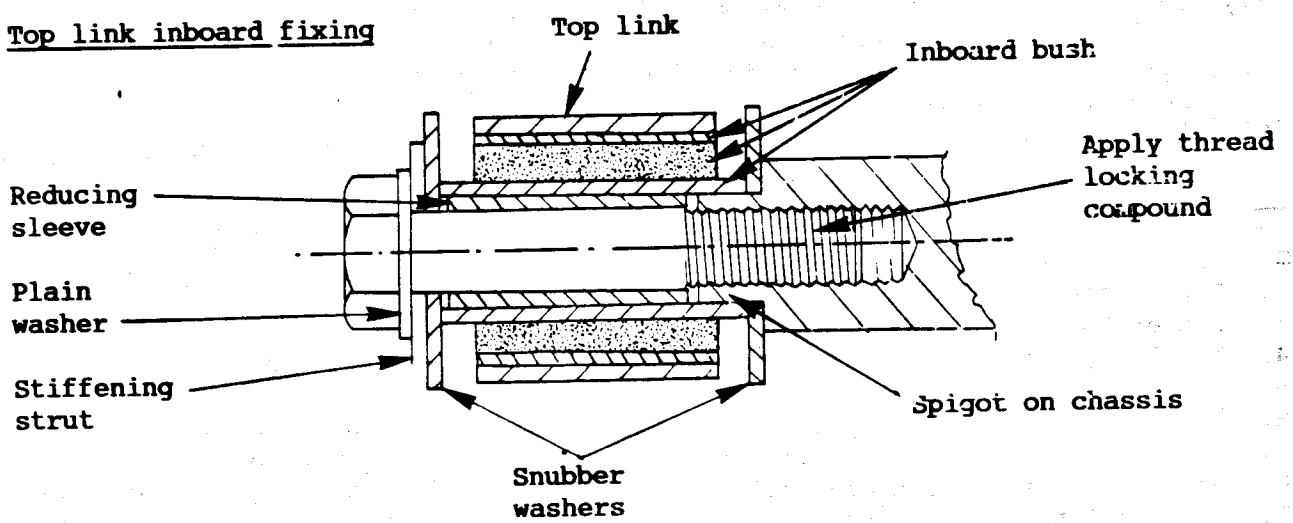
Anti-roll bar to lower link



Top link outboard fixing



Top link inboard fixing



3. Damper Lower Eye: The damper uses a plain sleeved bonded rubber bush at its lower end, which may be replaced using a press.

4. Top Link Bushes: Note that the top link pivots are 'overhung' at both inner and outer ends, and for added security, each of the bonded rubber pivot bushes is located by a spigot. At the outboard end, a spigot sleeve is fitted into the hub carrier bore, and projects from the hub carrier to spigot into the top link bush. An identical sleeve is fitted into the bore of the bush to maintain the reduced diameter.
A similar arrangement pertains at the inner end of the top link, except that the spigot is an integral part of the chassis.
Both bushes may be renewed using a press, but do not forget to fit the reducing sleeve into the inside bore.

DD.5 - SUSPENSION RE-ASSEMBLY

Note the following points when re-assembling the suspension:

i) Copper Grease: Use a copper based grease on the shank of the lower wishbone outboard pivot stud to prevent corrosion, and aid subsequent disassembly. Ensure the threads are thoroughly de-greased before fitting the nyloc nuts.

ii) Pivot Bolts: Tighten the lower wishbone pivot bolts, top link pivot bolts, and damper to wishbone bolt, ONLY with the car at ride height, otherwise the bonded rubber bushes will be pre-loaded, resulting in premature wear and incorrect ride height.

iii) Snubber Washers: Pay careful attention to the correct assembly of the snubber washers.

iv) Top Link Outboard Pivot: Ensure that the spigot sleeve is fitted into the top lug of the hub carrier, a snubber washer is fitted OVER the end of the sleeve, and that the spigot engages into the top link bush. Check also that the reducing sleeve is fitted into the bush, a snubber washer is positioned under the bolt head, and a flat washer under the nut.

v) Top Link Inboard Pivot: Check that the reducing sleeve is fitted into the bush, and that spigot on the chassis spigots into the bush inner sleeve. Unless renewing the pivot bolt, **apply thread locking compound** to the thread, and fit through the stiffening strut and snubber washer before entering the bush and chassis.

vi) Anti-Roll Bar to Lower Wishbone: Fit and tighten the ball joint into the lower wishbone, before fitting the anti-roll bar onto the ball joint. Hold the squared end of the ball pin whilst tightening the nyloc nut.

vii) Geometry Check: After re-assembly, carry out a geometry check, and make any adjustments as necessary as detailed in DD.3.

viii) Brakes: Refit the brake caliper referring to section JE, and pump the brake pedal after re-assembly to restore pad position.

ix) Tighten all fixings to the specified torque loading.

Torque Settings

	Nm	lbf.ft
1. Damper top stem nut	20 - 30	15 - 22
2. Spring top seat to chassis	22 - 25	16 - 18
3. Damper to lower wishbone*	68 - 72	50 - 53
4. Top link, outboard* and inboard**	75 - 80	55 - 59
5. Top link camber adjustment bolts	22 - 25	16 - 18
6. Lower wishbone inboard pivot (to chassis)*	65 - 70	48 - 52
7. Lower wishbone outboard pivot (to hub carrier)*	95 - 100	70 - 74
8. Anti-roll bar to wishbone ball joint	36 - 40	27 - 30
9. Anti roll bar ball joints to lower wishbone	36 - 40	27 - 30

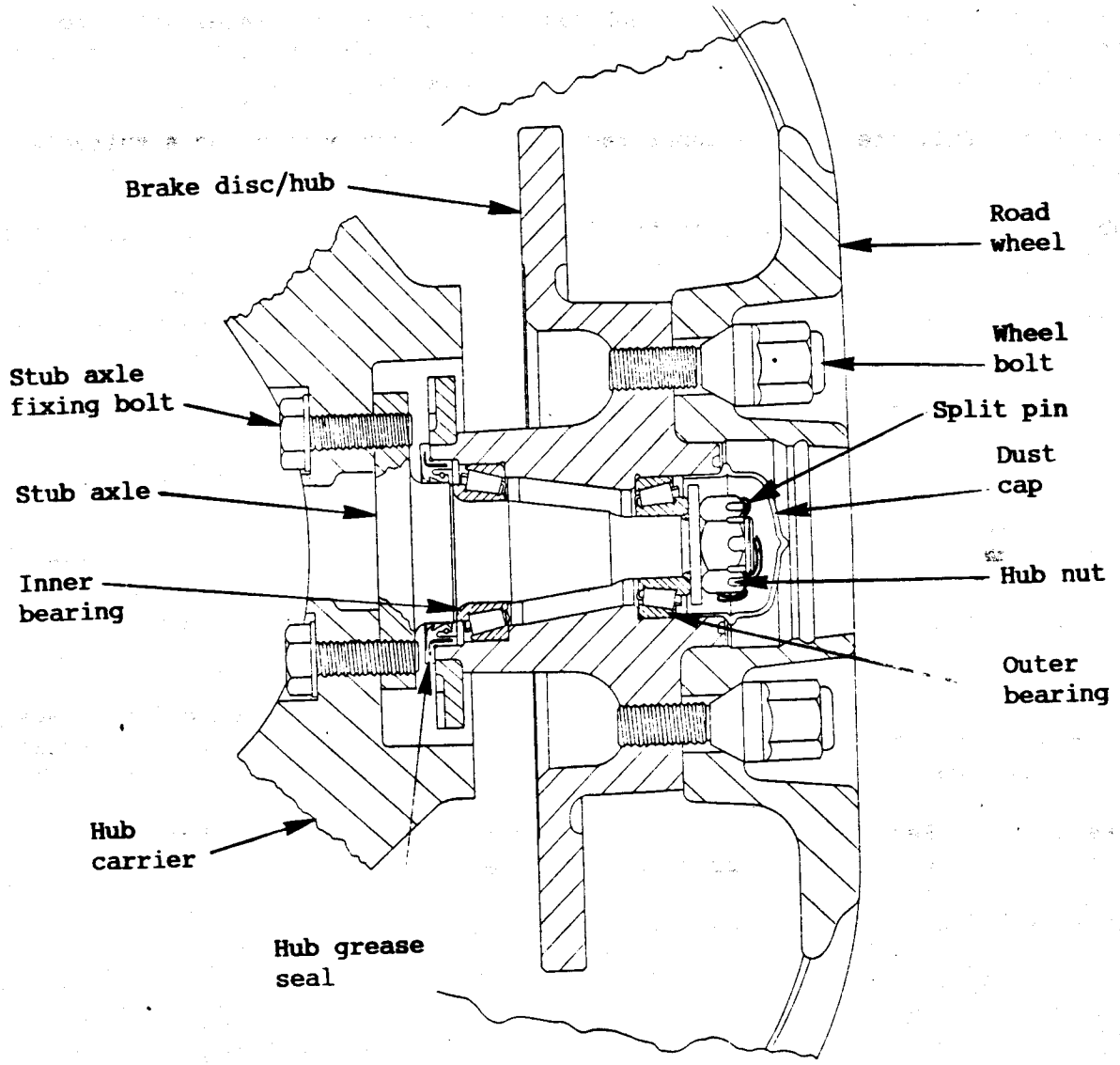
Torque settings contd.

	Nm	lbf.ft
10. Anti-roll bar drop links	36 - 40	27 - 30
11. Hub nut	see DD.6	
12. Stub axle to hub carrier**	60 - 65	44 - 48
13. Brake caliper bracket to hub carrier**	35 - 39	26 - 29
14. Brake caliper to mounting bracket	100 - 110	74 - 81

* Tighten only at ride height.
** Apply thread locking compound unless renewing bolts (pre-applied).

DD.6 - HUB BEARINGS

Each rear hub is supported on two taper roller bearings, which are adjustable for endfloat:



Adjustment

- Prise out the dust cap from the hub centre.
- Remove the split pin and tighten the hub nut to 25 Nm (18 lbf.ft) whilst rotating the wheel to settle the bearings.
- Slacken the nut, and re-tighten using fingers only.
- If necessary, tighten further, the smallest amount necessary to insert the split pin, bending the short end over the nut, and the long end over the end of the axle.
- Refit the hub dust cap.

Replacement

1. Brake Caliper: Release the two brake caliper mounting bolts, and support the caliper clear of the brake disc, without straining the flexible brake hose.

2. Brake Disc/Hub: Prise out the hub dust cap, pull out the split pin and remove the hub nut and washer. Withdraw the combined hub and brake disc.

3. Seal & Outer Races: Prise out the hub oil seal. Use a soft metal drift to knock out both the outboard bearing races from the hub. Cut outs are provided in the bearing recesses in the hub for this purpose.

4. Inner Race: Pull the inboard inner race from the stub axle using a suitable puller.

5. Stub Axle: If necessary, release the four bolts securing the stub axle to the hub carrier, and withdraw the axle.

6. Re-assembly: When re-fitting the stub axle, ensure that the contact surfaces of the stub axle flange and hub carrier, and the threads and clamping surfaces of the fixing bolts, are all scrupulously clean. Unless renewing the bolts, apply thread locking compound before fitting and torque tightening the four bolts (see torque list above).

7. Outer Races & Lubrication: Clean the bearing recesses in the hub before pressing the new races into position (correct way round!). Pack the new bearings with a lithium base wheel bearing grease, working into the roller cages. Coat the inside of the hub, outer races and dust cap with grease. Fit the inboard bearing rollers and inner race and retain in position by pressing in the new grease seal.

8. Hub Assembly: Fit the hub onto the axle, followed by the outboard inner race, washer and hub nut. Tighten the hub nut as detailed above, and fit the split pin and dust cap.

9. Brake Caliper: Refit the brake caliper, and torque tighten the two fixing bolts (see above). Pump the brake pedal to restore brake pad position.

10. Tighten all fixings to the specified torque loading.

Training Course Notes

STEERING

SECTION HC - ELAN

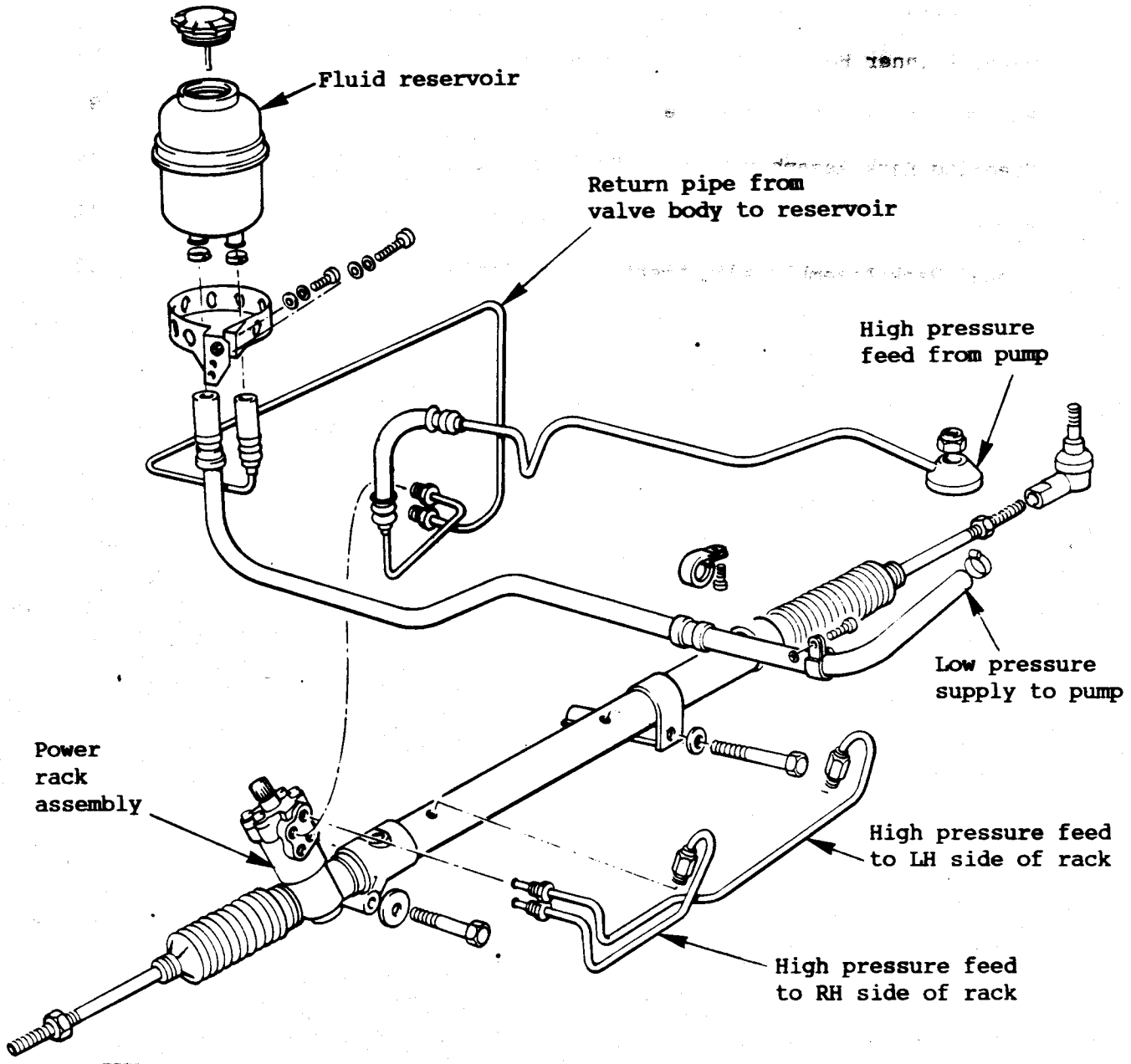
HC.1 - GENERAL DESCRIPTION

The steering system comprises an upper column assembly, fixed on cars with S.I.R., and tilt adjustable on cars without, both types being collapsible in the event of vehicle frontal collision, and a manual or power assisted rack and pinion assembly.

The rack and pinion assembly is secured rigidly to the chassis front crossmember by two fixing bolts, and connects with each front hub steering arm via ball jointed track rods. The constant ratio steering rack assemblies are geared for 3.0 (manual) or 2.7 (power) turns lock to lock.

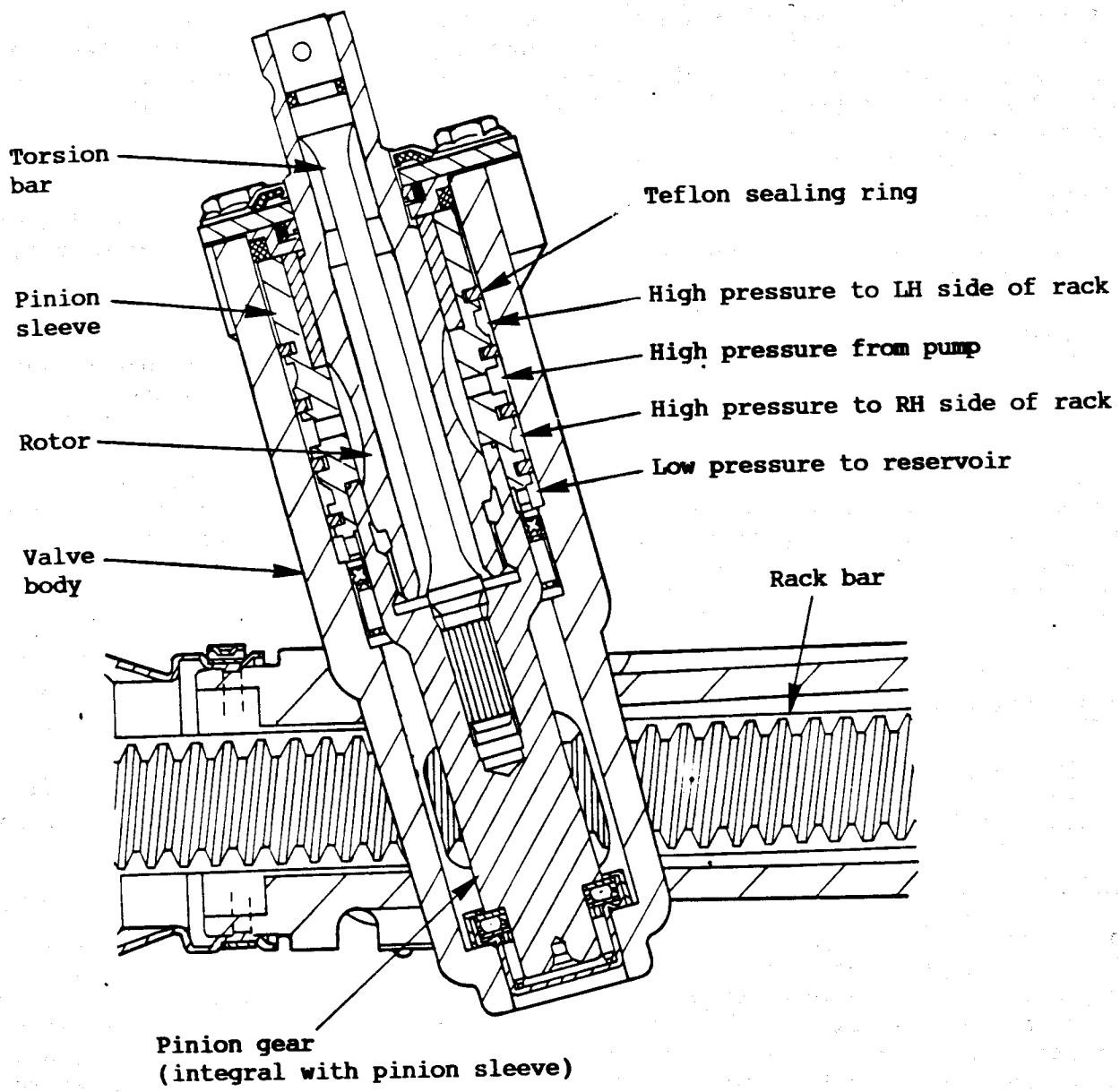
Power Assisted Steering (PAS)

The PAS system uses a hydraulic pump, mounted on the front side of the engine driven by multi-vee belt from the crankshaft, to supply oil to the valve body of the steering rack, which distributes hydraulic pressure to either side of a piston on the steering rack to lessen load at the steering wheel. A reservoir for the hydraulic fluid is mounted at the right hand rear of the engine bay.



The steering rack assembly comprises a steel tube which houses the steering rack bar, with an aluminium alloy housing fixed at one end, which supports the pinion and valve body assembly. Each end of the rack tube is hydraulically sealed to the sliding rack bar by neoprene rings, and a piston at the centre of the bar divides the tube into two hydraulic chambers, with each chamber linked to the valve body by steel pipes.

The valve body, which is integral with the rack housing, contains three main elements: a pinion sleeve, which consists of a cylindrical sleeve fitted with teflon sealing rings to divide the hydraulic circuits, and an integral pinion gear which engages with the rack teeth; a torsion bar which runs down the middle of the pinion sleeve to connect the steering column to the pinion gear; and a rotor, which is secured together with the top of the torsion bar to the steering column, and rotates within the pinion sleeve to control the hydraulic ports. The valve body is provided with four hydraulic connections:



- high pressure input from the pump
- low pressure return to the reservoir
- high pressure output to the left hand side of the rack piston
- high pressure output to the right hand side of the rack piston

When no torque is applied to the steering wheel, all four ports are interconnected so that oil from the pump flows through the valve body and back to the reservoir, and to both of the rack housing hydraulic chambers to apply an equal pressure to both sides of the rack piston.

When the steering wheel is turned, the rotor is turned by the column, but the rotation of the pinion sleeve is governed by the steering resistance at the road wheels, and the subsequent twist of the torsion bar. Thus the angular displacement between the rotor and pinion sleeve is dependent on the steering resistance and subsequent torque. As the torque (and angular displacement) increases, one of the output ports to the rack is progressively biased towards the low pressure return connection to the reservoir, whilst the other output port is biased towards the high pressure feed from the pump. In this way, a pressure differential is created between the two rack chambers, which tends to move the piston and provide steering assistance. When the input torque at the steering wheel is reduced, the angular displacement between the rotor and pinion sleeve is reduced so that the pressure balance tends to be restored, and steering assistance lessened. The same sequence happens when the steering wheel is turned in the opposite direction, and a pressure differential is created in the reverse sense.

The maximum angular displacement between rotor and pinion sleeve is limited mechanically to prevent excessive torque being applied to the the torsion bar, and to provide a mechanical link in the unlikely event of a torsion bar failure. Manual control of the steering would thus be retained, albeit with a small amount of 'lost motion'.

The engine driven vane type hydraulic pump, incorporates a pressure relief valve to control maximum pressure when the rack reaches its lock stops, and steering torque is still applied. The output of the pump is designed to fall off with increasing pump speed, in order to provide a measure of 'speed sensitivity', with greater power assistance being provided at low engine speed for parking manoeuvres etc., and less assistance at high speed. A pressure switch in the output side of the pump, senses when a high pump pressure is developed (with corresponding engine load), signals the engine management ECM to increase the opening of the idle air control valve to maintain idle speed and prevent stalling.

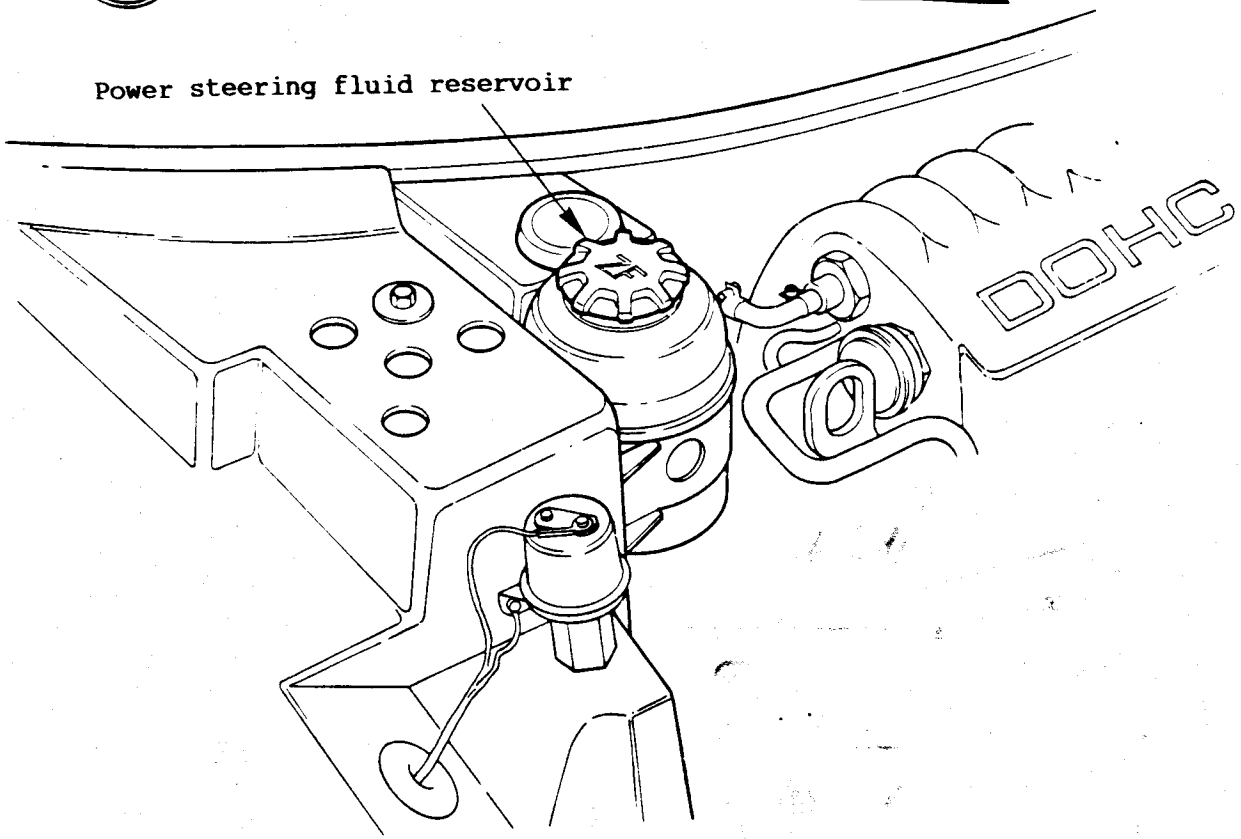
HC.2 - PAS FLUID CHECK & OIL CHANGE PROCEDURE

Recommended Hydraulic Fluid

The ONLY approved fluid for use in the power steering hydraulic system is: Nippon Oils 'Besco A.T.F. - Dexron' available under Lotus part number A100H6088V

Fluid Level Check

The power steering reservoir is located at the right hand rear of the engine bay, secured to the spring turret on the chassis. At every vehicle service, clean the cap and top of the fluid reservoir before unscrewing the cap and inspecting the fluid level shown on the dipstick integral with the cap. The two marks on the dipstick correspond to the correct hot level (top mark - use when car has been driven several miles, and the reservoir is hot to the touch), and to the correct cold level (lower mark). Top up if necessary using ONLY the approved fluid (see above).



Hydraulic Fluid Change

The power steering oil should be changed at intervals specified in the Maintenance Schedule (see section 0). To change the fluid, proceed as follows:

- Drain the fluid by removing the reservoir cap and disconnecting the high pressure feed and low pressure return pipes from the valve body on the steering rack (i.e. NOT the two pipes from valve body to rack housing), and collecting the oil.
- When the oil has drained thoroughly, refit the two pipes to the rack, torque tightening to: High pressure feed (upper, M14); 30 Nm (22 lbf.ft)
  Low pressure return (lower, M16); 40 Nm (30 lbf.ft)
- Fill the reservoir with new fluid, trip the inertia switch to prevent the engine starting, and crank the engine in short bursts whilst turning the steering slowly from lock to lock. Keep the reservoir topped up during this procedure, and on no account allow to fall sufficiently for air to enter the system while the engine is being cranked, or the pump may be damaged. Continue with this procedure until there is no evidence of air bubbles appearing in the reservoir.
- Top up the reservoir to the cold mark on the dipstick.
- Reset inertia switch, run engine, operate steering and inspect for leaks and correct power steering operation.

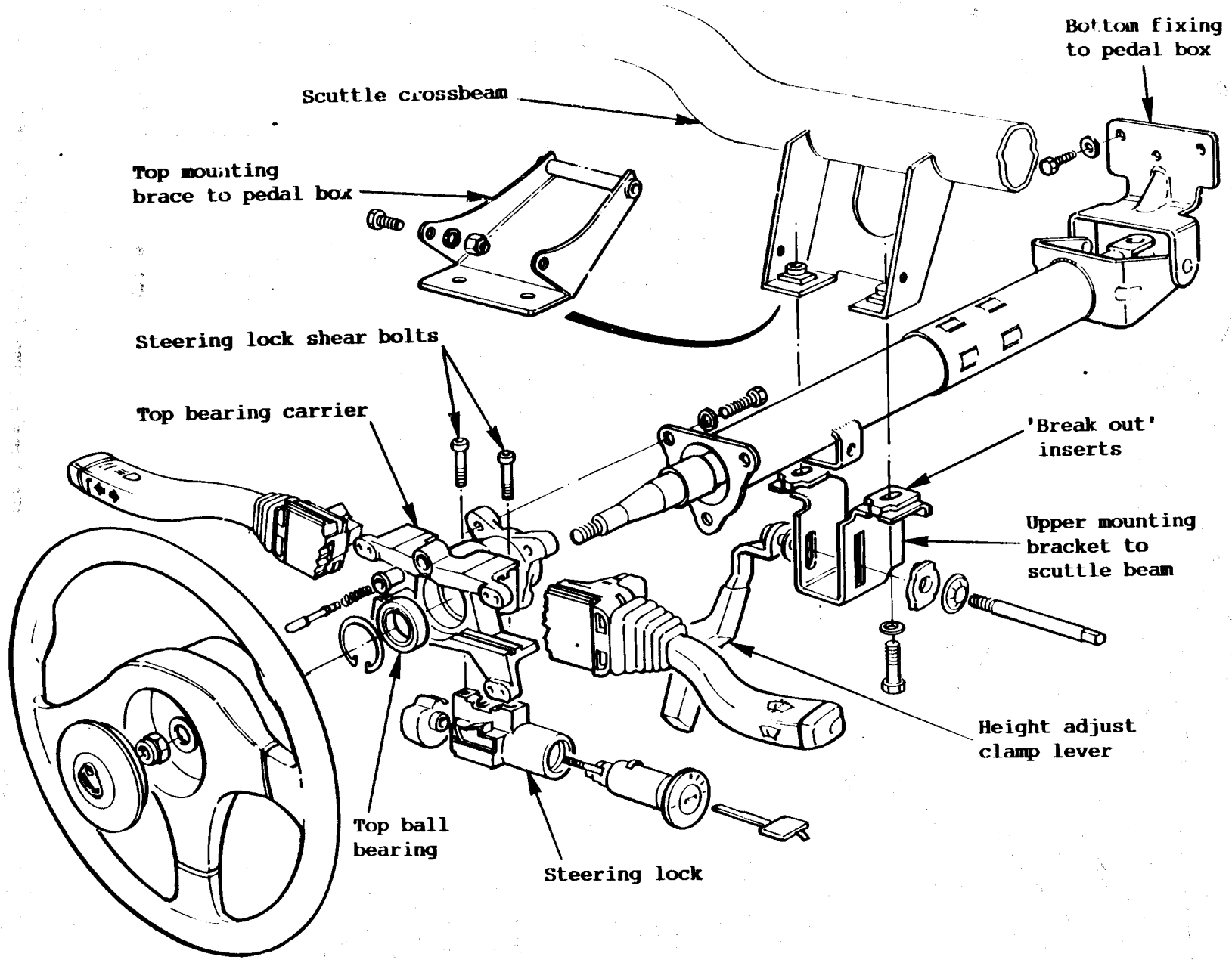
HC.3 - UPPER COLUMN ASSEMBLY

Two types of upper steering column are used on the Elan; a tilt adjustable column for markets outside the USA, and a non-adjustable version with S.I.R. (Supplementary Inflatable Restraint) on USA vehicles.

Column Removal

For removal and replacement of the USA type column (with S.I.R.), see separate publication 'Section WB').

For non S.I.R. columns:


Bottom fixing
to pedal box
Scuttle crossbeam
Top mounting
brace to pedal box
Steering lock shear bolts
Top bearing carrier
'Break out'
inserts
Upper mounting
bracket to
scuttle beam
Height adjust
clamp lever
Top ball
bearing
Steering lock

1. Remove the steering wheel:
   - press the centre horn pad and turn counterclockwise to release from the bayonet type fixing;
   - remove the nut and washer retaining the steering wheel and mark the releteive positions of the wheel and inner column to aid refitting;
   - pull the wheel off the column using minimum force. If necessary, use a suitable puller.

   DO NOT apply excessive axial force to either the inner or outer column without the use of a steering wheel puller, or the mechanism retaining the telescopic length of the collapsible column may be overridden, necessitating column replacement.

2. Remove the steering column shrouds and unplug the electrical connector blocks for the column switches, ignition switch and horn. Depress the plastic tabs, and slide out the two column switches.

3. Remove the pinchbolt securing the column upper u/j to the intermediate shaft.

4. Remove the two bolts securing the bottom of the column to the pedal box, and the two bolts securing the top of the column to the scuttle beam.

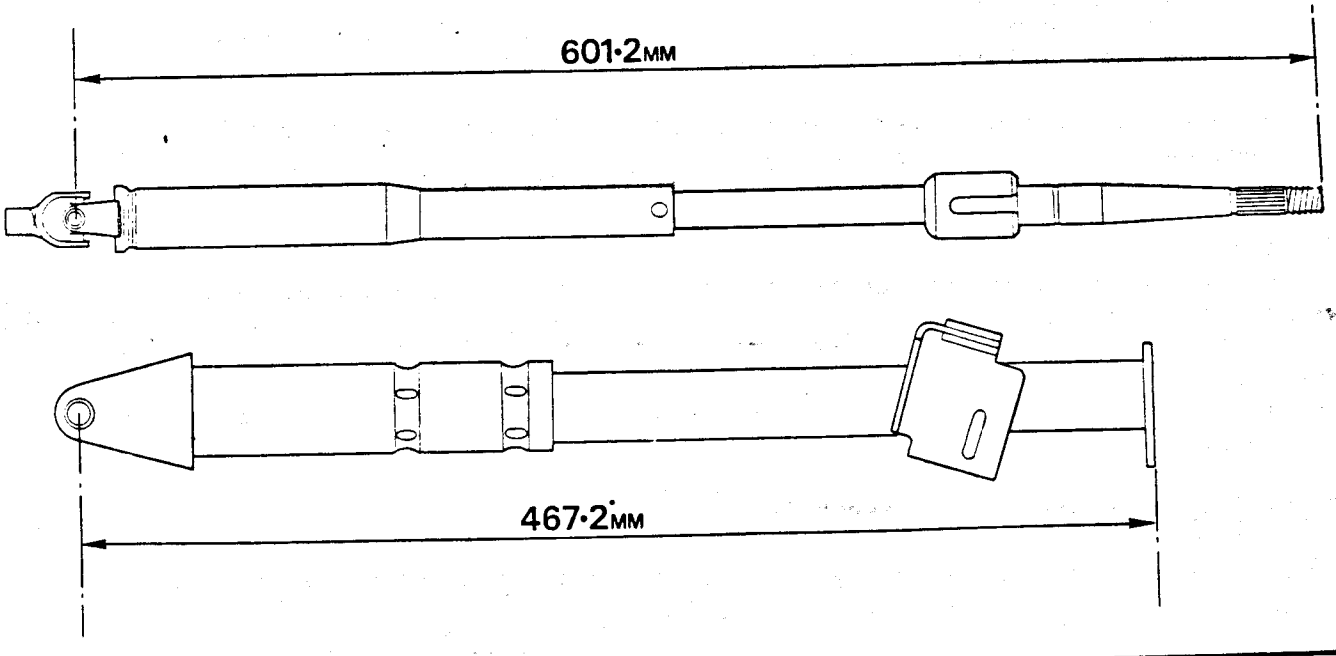
5. Withdraw the column assembly, pulling the upper u/j off the splines of the intermediate shaft.

6. If necessary, the inner column may be withdrawn from the outer after removing the circlip from the top end of the inner column.

7. If necessary, remove the three bolts securing the top bearing carrier to the outer column. Use a centre punch or chisel to remove the two steering lock shear bolts. Remove the circlip and press out the ball bearing from the carrier.

Column Inspection

In order to check whether the inner or outer columns have 'telescoped', check the following dimensions, and replace the column assembly if outside specification:
(Note: these dimensions do NOT apply to S.I.R. columns. See section WB)



Column Replacement

Refit the column in the reverse order to removal noting the following points:

- when refitting the column top bearing carrier, do not omit the cushion spacer between the bearing and the shaft circlip.
- fit new column lock shear bolts, and tighten until sheared.
- torque tighten:

column to pedal box fixings; 10 Nm (7.5 lbf.ft).
column to scuttle beam; 15 Nm (11 lbf.ft).
u/j to intermediate shaft; 40 Nm (30 lbf.ft) using Permabond A121.
steering wheel to column; 40 Nm (30 lbf.ft).

HC.4 - OUTER & INNER BALL JOINTS & GAITERS

Outer Ball Joints

The outer ball joints (track rod ends), are secured to the hub carrier steering arms by tapered ball pin shanks and nyloc nuts. The track rods are threaded into the ball joints, and provide a means of adjustment of toe-in.

Toe-in adjustment: To adjust the toe-in, hold each track rod end by the flats provided (22 mm) whilst releasing the locknut. Turn each track rod, using the flats provided (13 mm) an EQUAL amount, to adjust the effective track rod length as necessary. When adjustment is correct, hold the track rod end and tighten the locknut to 60 Nm (44 lbf.ft).

Ball joint replacement: If the ball joint gaiter is damaged, or if any play in the joint is discernible, the joint should be replaced. Before removing the joint, measure the length of thread protruding in order that the initial setting of the new joint may be approximately correct. Remove the nyloc nut, and use a ball joint splitter tool to seperate the joint from the steering arm. Release the locknut, and unscrew the joint from the track rod.

Screw the new joint onto the track rod to the position measured above, and fit the tapered ball pin into the steering arm. Fit a new nyloc nut (no washer) and torque tighten to 58 - 64 Nm (43 - 47 lbf.ft). Check and adjust toe-in and tighten locknuts as above.

Rack Gaiters

Damaged rack gaiters should be replaced immediately to prevent loss of lubricant, dirt ingress and damage to the inner ball joints or rack assembly.. To replace the rack gaiters, first remove the track rod ends, and then cut the gaiter clips before withdrawing the gaiters from the rack.

Before fitting new gaiters, examine the condition of the inner ball joints and replace if necessary (see below).

Fitting the non-pinion end gaiter: Fit the new gaiter into its location groove on the end of the rack housing, and secure with a new clip. Before fitting the gaiter clamp at the track rod, smear the groove in the rod with rubber grease to enable the track rod to be turned for tracking adjustment without damaging the gaiter.

Fitting the pinion end gaiter: Fit as for the non-pinion end gaiter, except that before fitting the large end clip, raise the driver's side of the vehicle to prevent the oil running out, and inject the rack teeth area with 0.14 litres of EP80 oil.

Track Rod/Inner Ball Joint Assemblies

The track rods are integral with the inner ball joints, which are not adjustable or serviceable in any way. If any play is discernible in a joint, the

track rod/ball joint assembly should be replaced in the following manner:

- Remove the steering rack assembly from the car (see section HC.6).
- Remove both rack gaiters.
- Each ball joint is threaded into the end of the rack bar, and is provided with flats to enable the joint to be turned. **It is most important that the pinion gear teeth are not allowed to provide the reaction torque when fitting or removing the inner ball joints.** i.e. hold one of the joints, whilst unscrewing the other, and use a soft jawed clamp to hold the rack across the surface of the teeth to unscrew the second joint.
- Fit the new joints in the reverse order to disassembly, tightening each joint to 72.5 Nm (54 lbf.ft) whilst not allowing the pinion gear teeth to bear any of the reaction load.
- Deform the tab ring into the slot provided on the rack body.
- Refit the rack gaiters as above.
- Refit steering rack assembly.

HC.5 - PAS PUMP & TESTING PROCEDURE

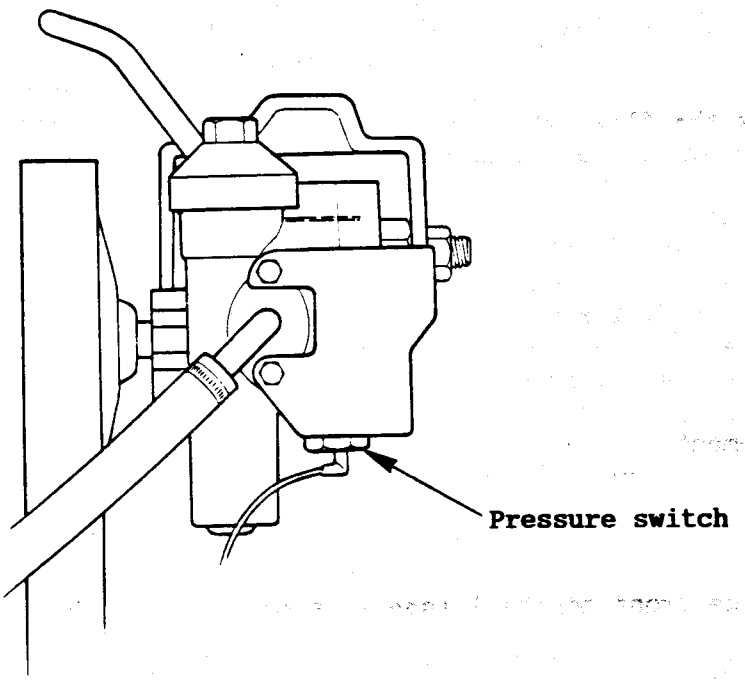
Drive Belt

The 10 vane, constant displacment pump, is a non-serviceable unit mounted on the left hand front of the cylinder block, driven by multi-vee belt from the crankshaft. The drive belt should be tensioned to 65 ± 7 kgf (145 ± 15 lbf) using a Burroughs gauge. To adjust belt tension, slacken the pivot bolt securing the pump mounting bracket to the cylinder block, and the two bolts securing the adjuster strap. Swing the pump bracket to achieve the specified tension, and tighten the three bolts to 18 Nm (13 lbf.ft).

Power Steering Pressure Switch (PSPS)

When a high torque is applied to the steering wheel, and a heavy load placed on the pump, a pressure switch in the outlet side of the pump, closes at about 40 kgf/cm² (570 lb/in²) and signals the engine management ECM to open the idle air control valve and raise idle speed to prevent stalling. The air conditioning compressor (on cars so equipped) is also switched off when the power steering pressure switch (PSPS) closes.

PAS pump viewed from front side



To check that the PSPS is functioning, let the engine idle, and hold the steering against the left hand lock stop. The idle speed should increase. Switch on the air conditioning and repeat the test. The compressor should switch off, and the idle speed increase. If the system does not perform as specified, verify PSPS switching using a continuity meter across the switch terminals.

To replace the switch, first remove the radiator bottom hose for improved access, before unscrewing the switch from the underside of the pump body. Plug the hole immediately to reduce oil loss.

Pressure Test

To check both the pump output, and the steering rack assembly seals for leakage, a test gauge T000T1085 is needed to measure the line pressure and flow rate in the output hose from the pump:

1. Disconnect the output pipe connection from the top of the pump, using a shop towel to collect any draining fluid, and fit the test gauge between the pump and the disconnected pipe. Top up the PAS reservoir if necessary.

2. Open the gauge valve fully, start the engine, and slowly close the gauge valve until a pressure of about 20 kgf/cm² (300 lbf/in²) is registered. Run in this condition until the system reaches a normal running temperature of 50 - 60°C (120 - 140°F). If necessary, add fluid to the reservoir to bring the level up to the 'max' mark.

3. Raise engine speed to 1500 rpm. Briefly close the gauge valve fully and record the highest pressure reading. **NOTE:** Do not shut the valve for longer than 10 seconds because the fluid temperature will rise quickly, resulting in a false pressure reading. Briefly shut the valve twice more, and record the pressure readings.
   Specification; 80 - 85 kgf/cm² (1140 - 1200 lbf/in²)
   If the pressures recorded are outside of specification, the pump should be replaced.

4. With the gauge valve open, hold the steering against the left hand lock stop for a moment and record the maximum pressure, and then hold against the right hand lock stop and record the pressure.
   If readings are less than 80 kgf/cm² (1140 lbf/in²), a leaking valve body seal or rack piston seal is indicated.

5. To check the flow rate, with engine speed held at 1300 rpm, adjust the gauge valve to achieve a pressure reading of less than 5 kgf/cm² (70 lbf/in²), and measure the flow rate.
   Specification; 8 ± 0.75 litre/min.
   To check that the flow rate drops off at higher engine speed, raise to 3,500 rpm, re-adjust the gauge valve to achieve less than 5 kgf/cm² pressure, and measure the flow rate.
   Specification; 5 ± 0.75 litre/min.
   If either reading is out of specification, the pump should be renewed.

Pump Replacement

The pump and mounting bracket may be withdrawn from beneath after releasing the compressor, anti-roll bar and bottom hose, or from above after removing the front topshell. Using the latter method:

1. Remove the front topshell (see section BK)..

2. Disconnect both hoses/pipes from the pump and drain the fluid into a suitable container. Unplug the PSPS electrical connector.

3. Slacken the belt tension, release the bolts securing the pump to the mounting bracket, and remove the pump and pulley assembly.

4. If a new pump is to be fitted, use a suitable puller to withdraw the pulley from the old pump, and fit to the new pump using special tool T000T1030. Pull the pulley onto the pump shaft until the pulley boss is flush with the shaft end. **If the special tool is not used, damage may be caused to the pump internals.**

5. Refit the pump in the reverse order to removal, tensioning the belt as above. Tighten the outlet pipe banjo bolt.

HC.6 - STEERING RACK ASSEMBLY REMOVAL/REPLACEMENT PROCEDURE

Removal

1. From inside the driver's footwell, remove the pinchbolt securing the upper column to the intermediate shaft. Release the fixing bolts securing the upper column to the pedal box and scuttle, and separate the upper u/j from the column. Release the sealing shroud from the floor panel and remove over the intermediate shaft. Remove the pinch bolt securing the lower u/j to the rack pinion shaft, mark their relative positions, and slide off the shaft.

2. Remove both front road wheels, and the track rod end nyloc nuts. Use a ball joint splitter tool to disconnect each track rod end from its steering arm.

3. Remove the engine bay underframe, and the driver's side underframe to chassis tubular stay.

4. On PAS assemblies, disconnect the feed and return pipes (two larger diameter pipes) from the valve body, and collect the fluid. Plug the pipes and ports. Remove the two valve body to rack housing pipes, and plug the ports.

5. Release the two rack housing mounting bolts, withdraw the pinion housing from the chassis and slide the rack assembly out through the driver's side wheelarch.

Replacement

Refit the rack in the reverse order to removal, noting the following points:

- Fit the pinion shaft into the lower u/j splines with the marks made on disassembly aligned. Torque pinch bolt to 25 Nm (18 lbf.ft).
- Tighten rack housing to chassis bolts to 120 Nm (89 lbf.ft).
- On PAS cars, tighten hydraulic connections on pipe between valve body and rack tube to 12 Nm (9 lbf.ft). Tighten feed (top, M14) connection to 30 Nm (22 lbf.ft) and return (lower, M16) connection to 40 Nm (30 lbf.ft).
- Tighten track rod end to steering arm connections to 58 - 64 Nm (43 - 47 lbf.ft).
- On PAS cars, refill and bleed the hydraulic system (see HC.2).
- Adjust front wheel toe-in (see section CE).

Universal Joint Phasing

In order to retain the correct steering 'feel' and weighting, it is important that the upper and lower steering column u/js are orientated at 90° to each

other. When refitting the steering gear to the car, it is recommended to adopt the following method of positioning the shafts and u/js:
- the upper u/j is integral with the upper steering column assembly. Locking the column with the key will define its position.
- the top end of the intermediate shaft has a flat for the u/j pinch bolt, so that the shaft may be fitted in one position only.
- the lower u/j should be fitted to the intermediate shaft phased at 90° to the upper u/j.
- with all of the above positioned, the rack should be centralised (use the centralising pin T000T1073 in the hole provided adjacent to the spring plunger housing), and the lower u/j fitted to the pinion shaft.

HC.7 - PAS RACK ASSEMBLY SEAL & BUSH REPLACEMENT

The only repairs that may be carried out on the steering rack assembly main components, is the fitment of replacement seals and non-pinion end rack bush, contained in the seal kit.

1. Remove the steering rack assembly from the car (see section HC.6) to a clean working area.

2. Remove the rack gaiters and track rods (see section HC.4).

3. Release the two screws securing the spring loaded plunger at the back of the rack (opposite the pinion housing), and remove the plunger assembly.

4. Pull off the pinion shaft dust seal and discard. Release the four bolts securing the pinion housing top plate, and remove the plate and shims. Carefully withdraw the complete valve/pinion assembly from the housing, and lay aside. Protect from dust and dirt.

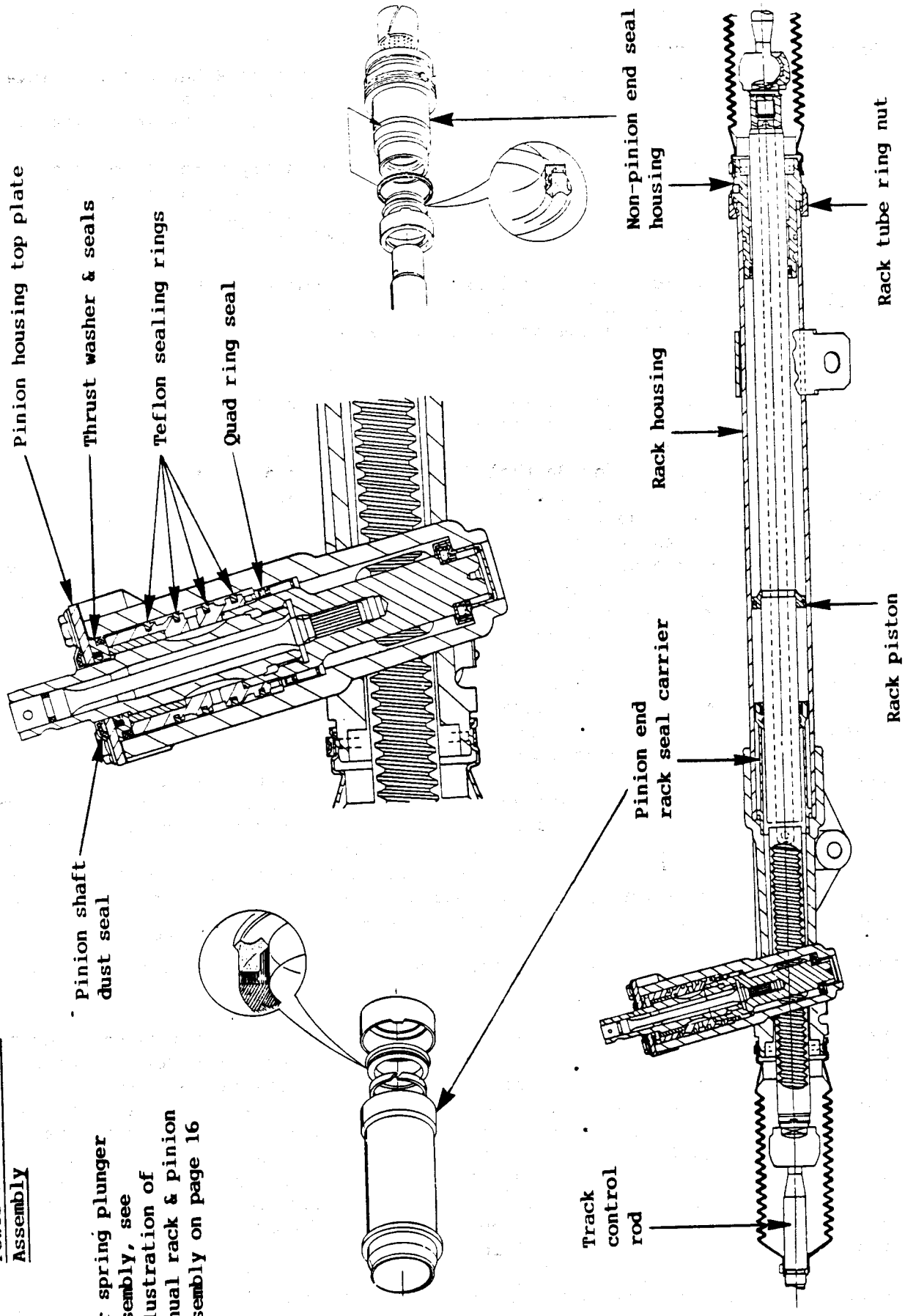
5. At the non-pinion end of the rack tube, prise up the peening on the rack tube ring nut, and whilst holding the seal housing by the flats provided, unscrew the ring nut. Pull the rack bar and non-pinion end housing from the tubular steel rack housing. Slide the end seal housing from the rack bar.

6. Remove the locating screw securing the pinion end rack seal carrier into the rack tube. Tap the non-pinion end of the rack tube against a hardwood bench or similar to dislodge the pinion end seal carrier, and remove from the tube.

7. Pinion end rack seal carrier:
   - Prise off the cap, and remove the rack bar seal and tape bearing. Fit new parts from the seal kit and replace the cap.
   - Remove the sealing ring from the spigot end of the seal carrier, and fit the new seal inside the rack tube, against the shoulder.

8. Fit new inner and outer piston ring seals to the rack piston. Lubricate the rack/rack tube with the specified hydraulic fluid, and carefully fit the pinion end seal carrier over the rack teeth and up to the rack piston. Lubricate the spigot end of the seal carrier, and insert the rack and seal carrier into the tube. Use the rack piston to seat the seal carrier into position, and retain by fitting the locating screw, with new sealing washer. Torque tighten to 14 Nm (10.3 lbf.ft), and stake the screw at three positions.

Power Rack & Pinion Assembly



For spring plunger assembly, see illustration of manual rack & pinion assembly on page 16

9. Non-pinion end housing:
   - Prise off the seal retaining cap, and discard the rack bar seal. Remove and discard the rack tube seal. Prise out the rack bar bush.
   - Fit a new bush, and new tube and rack bar seals. Refit the seal retaining cap.
   - Fit the housing into the end of the rack tube, apply Duralac jointing compound or similar to the ring nut threads, and screw on the ring nut. Hold the end housing whilst torque tightening the ring nut to 75 Nm (55 lbf.ft). Peen over the end of the nut into the housing hole.

10. To correctly position and centralise the rack, remove the blanking plug adjacent to the spring plunger housing, and insert a 4.7 mm rod, or special tool T000T1073 to engage the drilling in the back of the rack bar.

11. Valve/pinion assembly:
   - Pull the thrust washer and seals off the top end of the rotor. Remove the pinion sleeve sealing rings by carefully cutting through each of the four teflon rings.
   - Use special expander/guide tool T000T1072 to fit a new sealing ring into each of the four grooves, working from the bottom groove upwards.
   - Lubricate a new quad ring seal, and locate between the lower end of the pinion sleeve and the roller bearing.
   - Using the tapered guide tool T000T1071, insert the valve/pinion assembly into the housing, so that when the teeth are fully engaged, the pinch bolt groove on the rotor faces the pinion end of the rack tube.
   - Fit a new seal onto the outside of the thrust plate, and a new 'O' ring and step seal to the inside of the plate. Use the tapered guide tool T000T1071 to fit the plate into position over the top of the rotor.
   - Press down on the thrust washer, and measure the distance between thrust washer top surface and pinion housing top face. This should be between 0.1 mm (minimum) and 0.8 mm (maximum). Add 0.05 to 0.1 mm to this figure, and select a shim pack of that thickness to fit between the pinion housing and top plate. Shims are available in thicknesses of 0.05, 0.15 and 0.25 mm.
   - Fit the shims onto the thrust washer, followed by the top plate and four fixing screws. Torque tighten to 10 Nm (7.5 lbf.ft).
   - Smear the lip of a new dust seal with rubber grease, fit over the top of the rotor and press into position leaving a gap of approx. 1 mm between the metal shield and the pinion housing top plate.

12. Remove the rack bar centralising tool, but do not refit the blanking plug at this stage.

13. Refit the spring plunger assembly into the back of the rack housing using a new sealing ring, and torque tighten the fixing screws to 23 Nm (17 lbf.ft). Check the adjustment of the plunger: with the rack centralised, release the locknut, and tighten the adjusting screw until firm resistance is felt. Back off the adjusting screw the minimum amount necessary so that when the rack is moved through its full travel (by turning the pinion shaft), no increase in resistance (tight spot) is found. If it is necessary to back off the screw more than 1/8th of a turn to achieve this, the rack teeth are badly worn, and the complete assembly should be replaced. Hold the adjusting screw and tighten the locknut to 23 Nm (17 lbf.ft).

14. Refit the track rods and rack gaiters (see section HC.4).

15. Inject into the rack and pinion area, via the centralising screw hole, 0.14

litres of EP 80 oil. Refit the blanking plug, and torque tighten to 8 Nm (6 lbf.ft).

16. Refit the steering rack assembly to the car (see section HC.6).

HC.8 - MANUAL RACK ASSEMBLY SEAL & BUSH REPLACEMENT

The only repairs that may be carried out on the steering rack assembly main components, is the replacement of the non-pinion end rack bush, and the adjustment of the rack spring plunger.

1. Remove the steering rack assembly from the car (see section HC.6) to a clean working area.

2. Remove the rack gaiters and track rods (see section HC.4).

3. Remove the blanking plug adjacent to the plunger housing at the back of the unit, centralise the rack, and insert a 4.7 mm rod, or special tool T000T1073 to engage the drilling in the back of the rack bar. Mark the position of the pinion shaft relative to the housing to aid re-assembly. Remove the centralising tool.

4. Release the two screws securing the spring loaded plunger at the back of the rack (opposite the pinion housing), and remove the plunger assembly.

5. Pull off the pinion shaft dust seal and discard. Release the four bolts securing the pinion housing top plate, and remove the plate and shims. Carefully withdraw the pinion shaft and top thrust bearing, and lay aside.

6. Withdraw the rack from the housing.

7. Prise out the teflon bush from the non-pinion end of the rack housing, and fit a new bush into position, after first heating the bush in boiling water to increase its flexibility and speed recovery time.

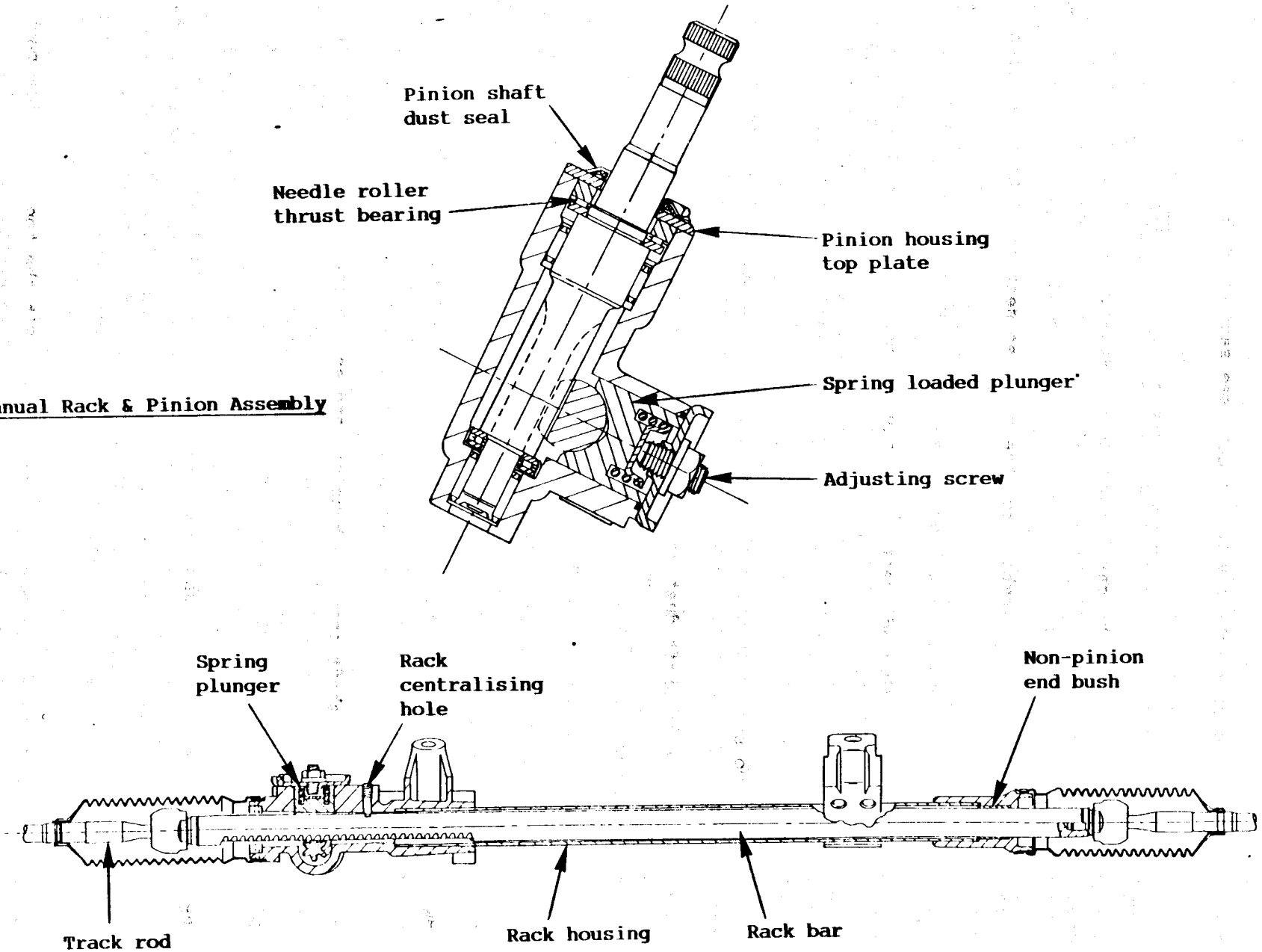
8. Thoroughly clean the rack before smearing the whole length with Shell Retinax A, or equivalent grease, and apply about 30g of grease to the rack teeth area. Fit the rack into the housing, and fit the centralising tool as in (3).

9. Insert the pinion shaft into the housing, and engage the pinion gear teeth with those on the rack so that the mark made in operation (3) is correctly aligned. Apply Shell Retinax A, or equivalent grease into the top of the pinion housing before fitting the thin thrust washer, needle roller thrust bearing, and thick thrust washer.

10. Press down on the thrust washer and measure the distance between the top surface of the thrust washer and the pinion housing top face. This should be between 0.34 mm (minimum) and 0.84 mm (maximum). Add 0.05 to 0.1 mm to this figure, and select a shim pack of that thickness to fit between the pinion housing and top plate. Shims are available in thicknesses of 0.05, 0.15 and 0.25 mm.

11. Pack the top of the pinion housing with grease. Fit the top plate shim pack and top plate, and retain with the four screws. Torque tighten to 20 Nm (15 lbf.ft).

Manual Rack & Pinion Assembly



12. Remove the centralising tool and refit the blanking plug, tightening to 8 Nm (6 lbf.ft).

13. Smear the lip of a new pinion shaft dust seal with rubber grease, fit over the top of the shaft and press into position leaving a 1 mm gap between the metal shield and the pinion housing top plate.

14. Refit the spring plunger assembly into the back of the rack housing using a new sealing ring, and torque tighten the fixing screws to 23 Nm (17 lbf.ft) Check the adjustment of the plunger: with the rack centralised, release the locknut, and tighten the adjusting screw until firm resistance is felt. Back off the adjusting screw the minimum amount necessary so that when the rack is moved through its full travel (by turning the pinion shaft), no increase in resistance (tight spot) is found. If it is necessary to back off the screw more than 1/8th of a turn to achieve this, the rack teeth are badly worn, and the complete assembly should be replaced. Hold the adjusting screw and tighten the locknut to 23 Nm (17 lbf.ft).

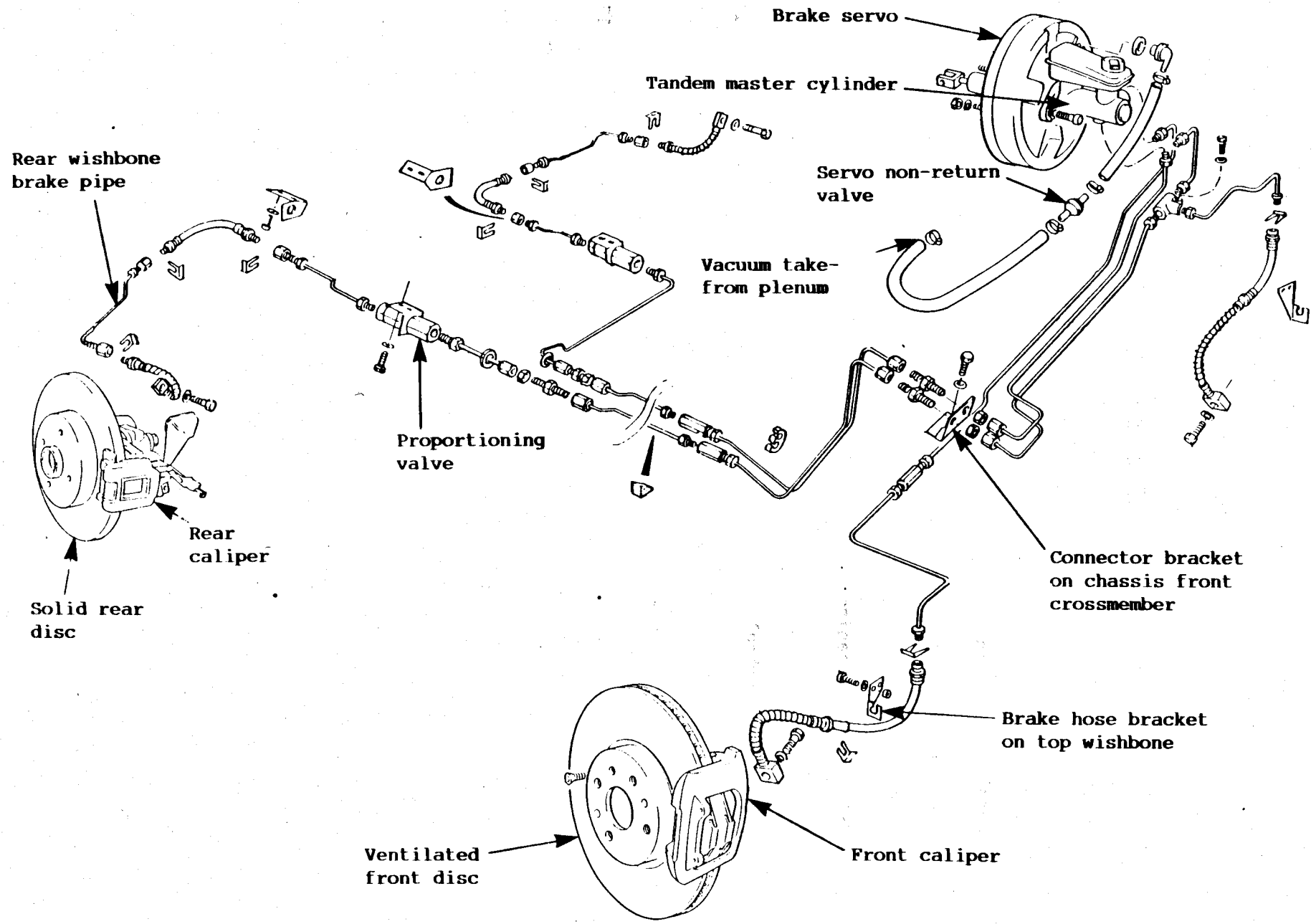
13. Refit the track rods and rack gaiters (see section HC.4).

14. Refit the steering rack assembly to the car (see section HC.6).

Training Course Notes

BRAKES

SECTION JE - ELAN

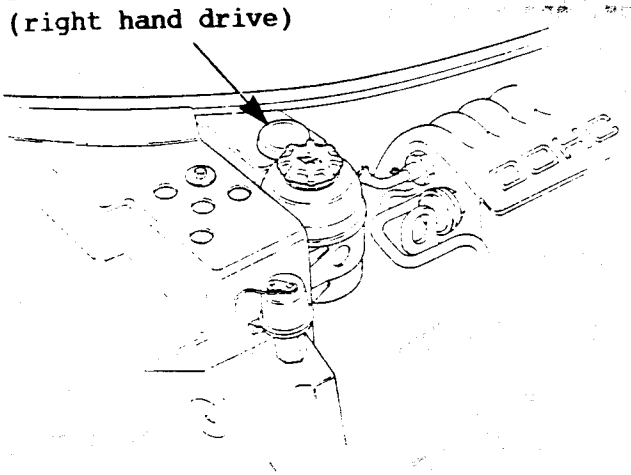

Brake servo
Tandem master cylinder
Rear wishbone brake pipe
Servo non-return valve
Vacuum take-from plenum
Proportioning valve
Rear caliper
Solid rear disc
Connector bracket on chassis front crossmember
Brake hose bracket on top wishbone
Ventilated front disc
Front caliper

E.1 - GENERAL DESCRIPTION

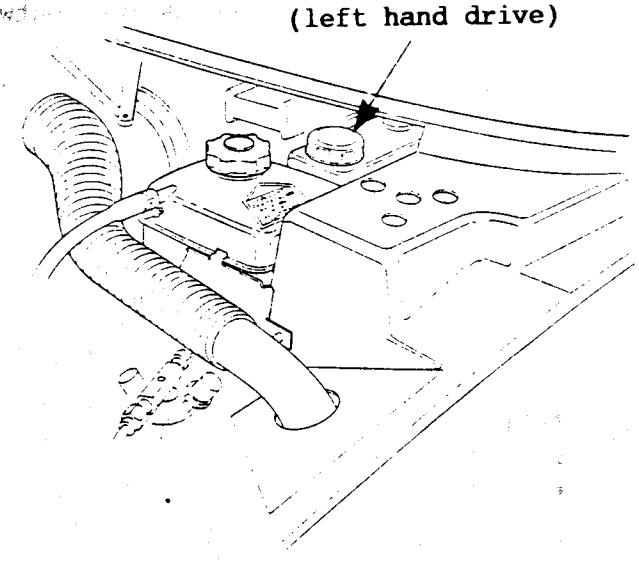
The braking system comprises a tandem master cylinder and direct acting vacuum servo unit operating single piston sliding calipers for each wheel, with ventilated front, and solid rear discs.

The hydraulic circuit is diagonally split (LH front/RH rear, and RH front/LH rear) for independent operation from the separate compartments of the tandem master cylinder, with separate hydraulic lines feeding each caliper. A brake pressure proportioning valve is incorporated into each of the rear brake lines in order to control rear brake line pressure under heavy braking, and reduce the likelihood of rear wheel lock up. A single divided reservoir serves both compartments of the tandem master cylinder, and is provided with a low fluid level warning switch, which operates a fascia mounted tell tale lamp.

Brake fluid reservoir (right hand drive)



Brake fluid reservoir (left hand drive)



Single piston sliding calipers are used at each wheel. The caliper body is supported on two hardened steel sleeves, which allow the caliper free lateral movement. When the brakes are applied, hydraulic pressure in the caliper cylinder, forces the piston outwards and the caliper body inwards, resulting in the brake pads being clamped to the disc, producing the required friction.

The parking brake lever connects, via a compensating link (to equalise the pull applied to each cable), to two cables, one leading to each rear caliper. Each cable operates a lever on the caliper which turns an actuating screw (quick thread) inside the caliper cylinder, forcing the piston against the pad and disc and applying the brake. A self adjusting mechanism within the cylinder, takes the form of a spring clutch wrapped around the piston 'nut' in which the parking brake actuator screw operates. On application, the one way spring clutch locks the nut to the piston, so that the piston is forced to move axially when the actuating screw is turned. On release, a 'piston retainer' outboard of the piston hydraulic seal, exerts sufficient grip on the piston to prevent it being drawn back by the mechanism. This compels the spring clutch to release the nut, so that the actuator screw and nut turn as one, as the screw returns to its start position. This results in any free play being automatically taken up, with the nut starting from a position further along the thread the next time the parking brake is applied. Operating the piston hydraulically, via the footbrake, has a similar effect, with the piston moving outwards and the nut being allowed to turn within it by the spring clutch. This automatically adjusts the parking brake mechanism ready for the next application.

JE.2 - FRONT BRAKE PAD REPLACEMENT

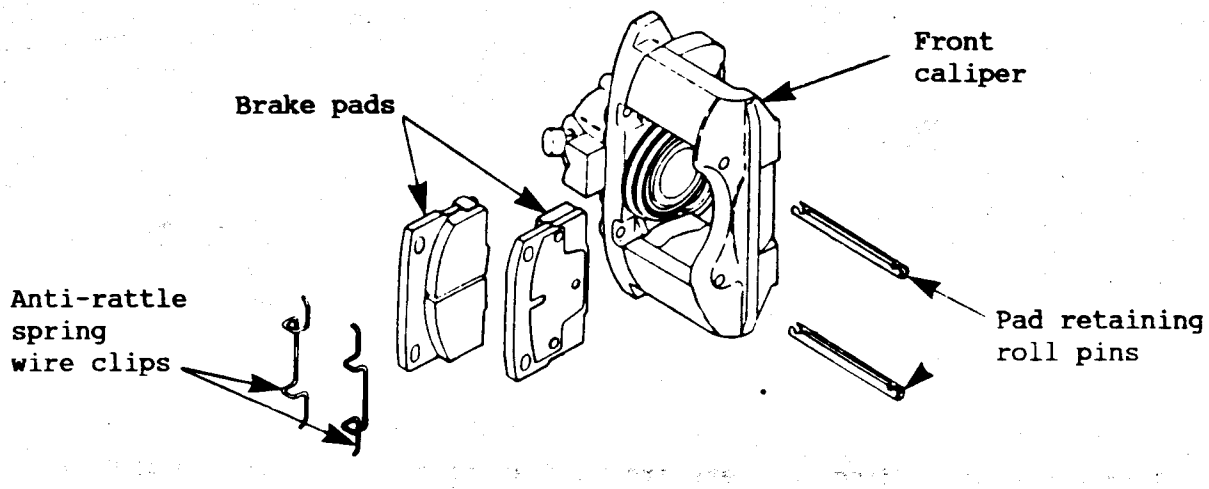
Pad thickness may be checked without disturbing the caliper.
Standard pad thickness - 15.5 mm (0.6 in.)
Minimum pad thickness - 2.0 mm (0.08 in.)

To Replace Front Pads

1. Remove Fluid: If well worn pads are to be replaced with new, syphon brake fluid from the master cylinder reservoir to leave it approx. one third full.

2. Remove Pins: Use a pin drift and hammer to knock out the two pad retaining roll pins, from inside to outside. Remove the wire spring from each pad.

3. Withdraw Pads: Pull the caliper outwards, and withdraw the outboard pad. Push the caliper inwards, and withdraw the inboard pad.



4. Push Back Piston: The piston must be pushed fully back into its bore to provide clearance in the caliper for the new pads. Use proprietary caliper pliers.

5. Clean: Clean the brake pad recesses in the caliper, using a vacuum brush to remove any dry dust.

   WARNING: Inhalation of brake dust can be injurious to health. Never use an airline to blow away dust from around any brake assembly.

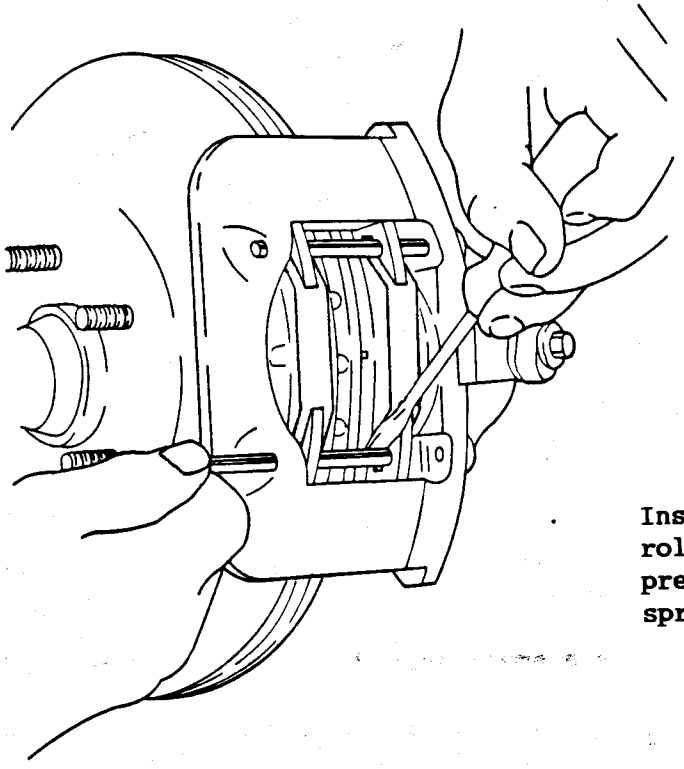
   Inspect the condition of the piston boot, and replace if necessary (see below).

6. Check Discs: Before fitting new brake pads, always check the thickness, surface condition and run-out of the brake discs. See section JE.7.

7. Fit Pads: Ensure that the piston is pushed fully back into its bore before attempting to fit new pads. Fit the inboard pad into position before pulling the caliper outboard and fitting the outboard pad.

8. Fit Pin: Fit one of the two spring pins through the caliper body holes and pad backplates, with the slot in the pin positioned so that it faces the remaining pin. Use only a brass drift to instal the pins, as a steel drift may damage the ends of the pins and make their subsequent removal difficult.

9. Fit Springs & Pin: Fit the remaining pin through the outboard half of the caliper body, before fitting the two pad anti-rattle wire spring clips - fit one end of the spring under the spring pin previously fitted, hook the centre of the spring over the pad backplate, and push the other end of the spring under the second pin as it is inserted. Repeat for the second spring and fully press home the spring pin with the brass drift.
Check that the two springs are fitted centrally on the pad backplates, with each end of the springs projecting beneath the pins an equal amount.



Inserting second roll pin whilst pressing down spring clip

10. Fluid Level: Top up the master cylinder reservoir to the full level, and pump the brake pedal several times to restore working pad position. Recheck reservoir level.

JE.3 - REAR BRAKE PAD REPLACEMENT

Pad thickness may be checked without disturbing the caliper.
Standard pad thickness - 14.5 mm (0.57 in).
Minimum pad thickness - 1 mm (0.04 in).

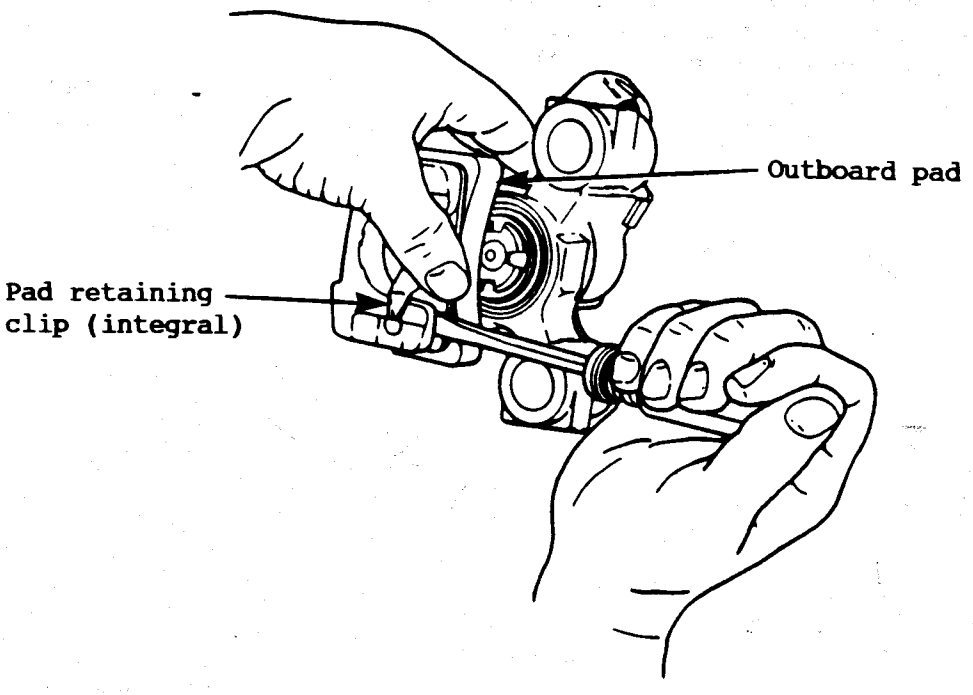
To Replace Rear Pads

Tools required: Piston Pusher T000T0988

1. Parking Brake Cable: Unhook the parking brake cable from the caliper lever arm, if necessary slackening the cable adjuster on tne tunnel top.

2. Withdraw Caliper: Remove the two caliper mounting bolts, and withdraw the caliper from the disc, taking great care not to damage the sliding pin boots. Do not strain the flexible brake hose.

3. Remove Outboard Pad: Use a screwdriver to disengage the buttons on the outboard pad backplate, from the holes in the caliper housing, and withdraw the outboard pad with its integral retaining clip.



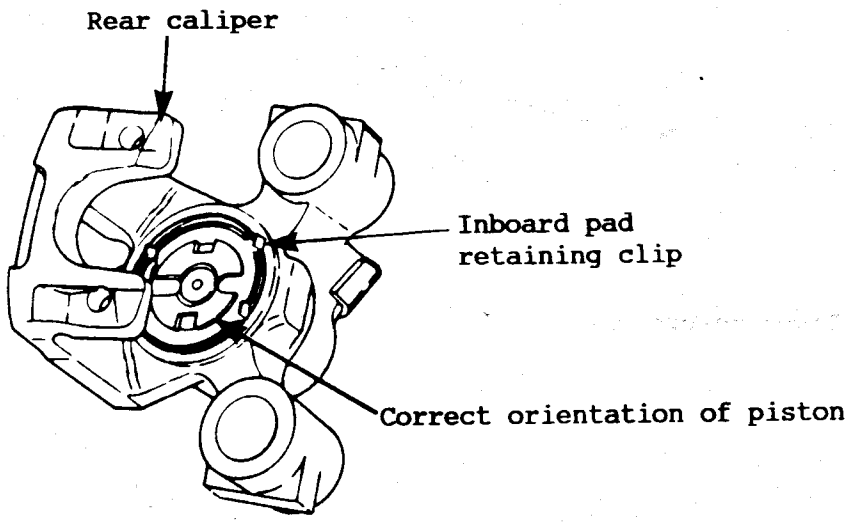
4. Remove Inboard Pad: Prise the inside edge of the inboard pad out from its retaining clip, and then withdraw the pad from the clip and caliper.

5. Remove Check Valve: Use a small screwdriver to prise out the two way check valve from the piston.
If there is any sign of fluid leakage from the piston hole after removal of the check valve, the caliper should be overhauled as detailed in JE.6.
Check the condition of the piston boot, and replace (see JE.6) if necessary.

6. Bottom Piston: Before new pads may be fitted, it is necessary to fully return the piston in its bore. If necessary, syphon fluid from the master cylinder reservoir to make room for the fluid returned from the caliper. Use tool T000T0988 to engage in the slots of the piston, and turn the piston:
- clockwise on LH caliper, or;
- counterclockwise on RH caliper;
to wind the piston back down the parking brake mechanism, whilst pressing the piston down the bore.

7. Fit Check Valve: Lubricate a new check valve with clean brake fluid, and fit into the piston hole.

8. Fit Inboard Pad: Check that the piston is correctly orientated - the axes of the cross shaped slot in the piston should be radial and tangential. Turn the piston if necessary. Check also that the pad retaining clip is fully located in the groove on the end of the piston.



Engage the outside edge of the pad backplate into the retaining clip, before pressing the pad flat against the piston to engage the clips on the inside edge of the backplate. Check that the pad lies flat against the piston, with the buttons on the pad backplate engaged with the slot in the piston.

9. Fit Outboard Pad: Press the pad into position, so that the buttons on the pad backplate engage with the holes in the caliper housing, with the pad retained by the two legs of the clip.

10. Refit Caliper: Carefully examine the sliding pin boots for nicks, cuts or deterioration, and replace if necessary (see JE.6). Position the caliper over the brake disc, taking care not to damage the sliding pin boots, and refit the two caliper retaining bolts. Torque tighten the bolts to 90 - 110 Nm (66 - 80 lbf.ft).

11. Parking Brake Cable: Refit the parking brake cable to the abutment bracket and caliper lever arm, and if necessary, re-adjust cable as detailed in JE.4.

12. Top up the master cylinder reservoir to the full level, and pump the brake pedal, hard, several times to restore working pad position. Recheck reservoir level. Check parking brake operation.

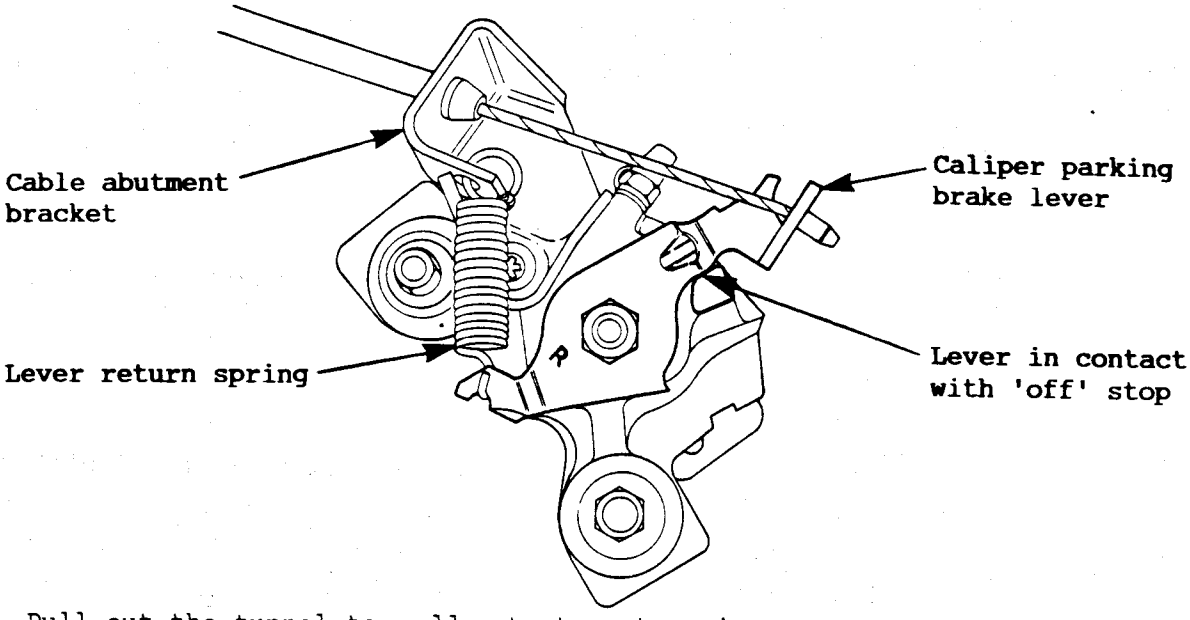
JE.4 - PARKING BRAKE MECHANISM

It is important, if the self adjusting mechanism is to function correctly, that the caliper levers are fully back against their stop brackets when the parking brake is 'off'.

To Adjust:

1. Ensure that the pads are at their working position, by applying hard pressure to the footbrake pedal several times.

2. At each caliper, check that the parking brake lever is fully against its 'off' stop bracket, and check that when the parking brake is applied and released, the caliper levers return immediately, and are not delayed by excess friction in the cables or linkage. Rectify as necessary.



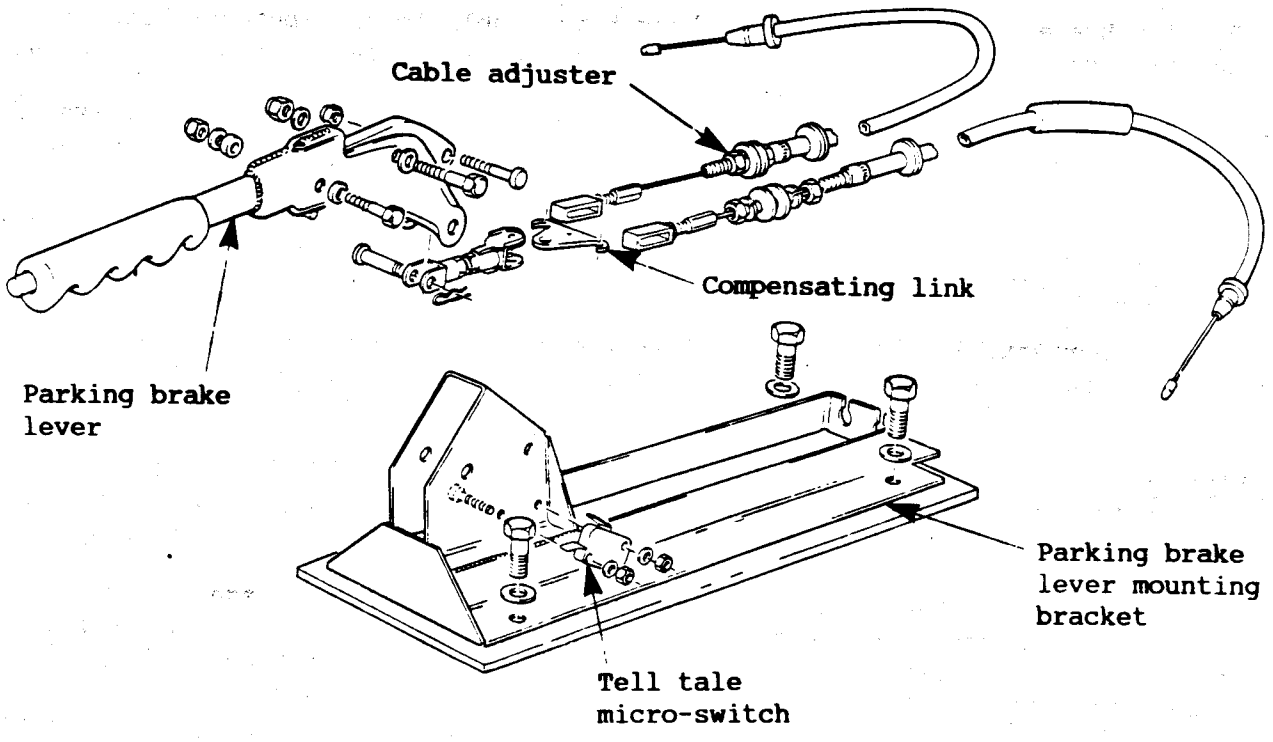
3. Pull out the tunnel top oddments tray to gain access to the parking brake cable adjusters at their forward end abutment. Use the adjusters to remove the slack from each cable, but ensure that the caliper levers are still in contact with their stops.

4. Operate the parking brake several times to allow the automatic adjusters within the caliper to take up any excess clearance, and check that the parking brake lever travels no more than 7 clicks when fully applied.

5. Refit the tunnel top tray.

Cable Replacement:

Remove the tunnel top trim to gain access to the front end of the cables:



i) Remove the filler panel from between the rear of the centre tunnel console and the rear wall, by releasing the single retaining screw.
ii) Pull out and disconnect the mirror control switch, to the rear of the gear lever.
iii) Pull out and disconnect the two window switches, each side of the parking brake lever, and release the two console front fixing screws via the switch apertures.
iv) Pull out the oddments tray from the rear of the tunnel top, and release the two console rear fixings via the tray aperture. Pull the console to the rear to disengage the tongues from the main fascia, and then lift the console over the parking brake lever.

The front end of each cable is fitted with an eye which hooks onto the compensating link which is itself connected by a short link to the parking brake lever. Back off the cable adjuster to enable the eye to be unhooked from the compensator, and release the cable adjuster from the abutment bracket. Unhook the cable at the caliper lever, and release from the cable abutment and retaining clips on the rear suspension top link. Withdraw the cable through the body with its grommets.

Reverse the removal procedure to refit a cable, and adjust as detailed above.

Parking Brake Lever:

The parking brake lever incorporates a pawl and ratchet mechanism which is released by a button in the end of the handgrip. If the pawl or ratchet teeth become excessively worn, they should be replaced as a pair.

To remove the parking brake lever, release the clevis securing the tie rod to the compensator lever, remove the clevis pin retaining the ratchet plate, and release the lever pivot bolt. Withdraw the lever assembly from the mounting bracket. The mounting bracket is secured to the chassis centre section by four M8 bolts with weldnuts.

JE.5 - FRONT CALIPER OVERHAUL

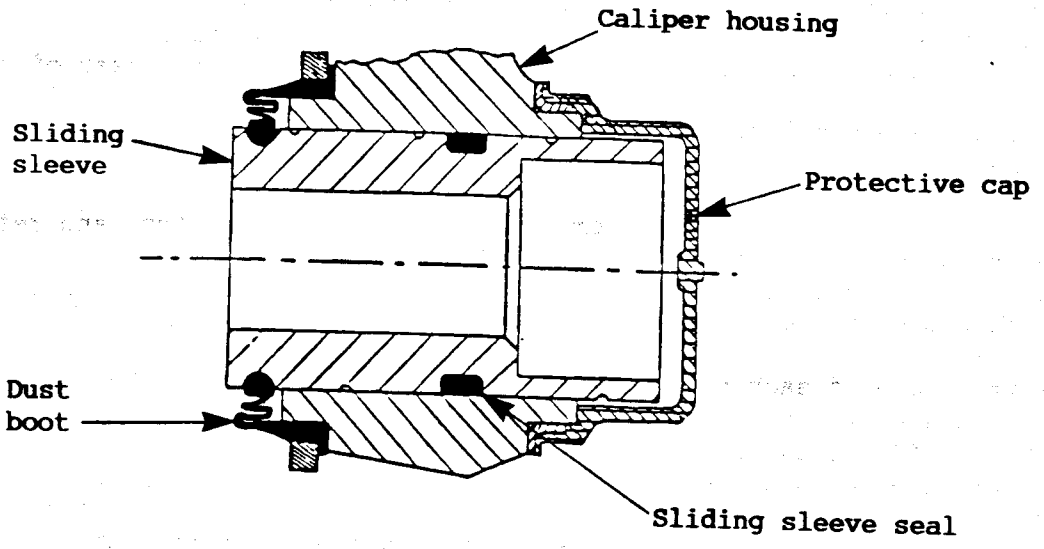
Tools required: Sliding pin boot/cap installer T000T0986

1. Remove Brake Pads: See section JE.2.

2. Hydraulic Hose: Fit a brake hose clamp before releasing the banjo bolt securing the flexible hose to the caliper. Remove the bleeder valve. Seal the hose and caliper openings to prevent fluid loss and dirt ingress.

3. Mounting Bolts: The caliper is mounted via the two sliding sleeves, each of which is secured by a socket head bolt concealed by a protective cap over the end of the sleeve. Prise off the caps, and release the two socket head screws. Withdraw the caliper to a clean bench.
   Do NOT disturb the two bolts securing the two halves of the caliper body together.

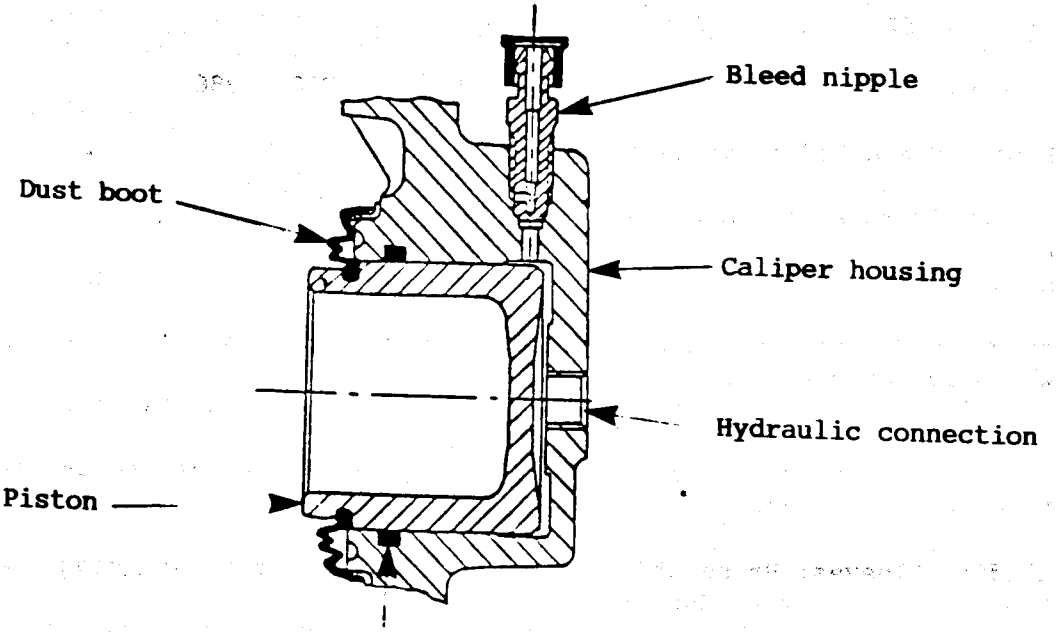
4. Sliding Sleeves: Prise off the boots, and push the two sliding sleeves from the caliper bracket. Carefully examine the rubber boots for cuts, nicks or deterioration and the bolts and sleeves for any signs of corrosion. Replace any faulty parts as necessary.



5. Piston & Dust Boot: Prise the piston dust boot from the caliper housing, and pull off from its groove in the piston. Insert a 15 mm thick piece of hardwood wrapped in shop towel into the caliper gap, and eject the piston from its bore by applying compressed air to the hydraulic inlet connection.

   WARNING: KEEP FINGERS WELL CLEAR during this operation.

6. Piston Seal: Remove the piston seal from the cylinder groove using a plastic tool. Do not use a metal tool, or the cylinder wall or the seal groove may become scratched.



7. Clean: Clean all parts in denatured alcohol, and dry with unlubricated compressed air (lubricated shop air may damage rubber brake components). Blow out all the passages in the caliper housing and bleeder valve.

8. Inspect: Inspect the following components;
   - caliper bore and seal groove for scoring, nicks, corrosion or visible wear;
   - piston for scoring, nicks, corrosion or damaged chrome plating;
   - caliper bridge for any signs of cracking.

   If any light corrosion cannot be polished out using crocus cloth, or if any other faults are found, the components must be replaced.

9. Piston Seal: Lubricate a new piston seal with clean brake fluid, and fit into the cylinder groove, making sure it is not twisted.

10. Piston and Boot: Fit a new piston boot lubricated with the rubber grease supplied in the repair kit, into the groove on the piston, as shown in the diagram. Lubricate the piston with clean brake fluid, and insert into the cylinder, pushing to the bottom of the bore.
    Seat the boot in the caliper housing counterbore using a suitable press tool. Let any trapped air escape from behind the boot, by easing the boot away from the piston groove using a plastic tool.

11. Sliding Sleeves: Apply a thin coat of the special grease provided in the repair kit, to the surface of the sleeves. Fit the seal rings into their grooves in the centre of the sleeves, ensuring that the seals are not twisted.
    Slide the sleeves into their caliper bores from the disc side, leaving the boot grooves accessible. Apply some of the grease to the lips of each dust boot, and fit into the sleeve groove. Press the boot collar into position on the housing using a suitable tool.

12. Fit Caliper: Fit the caliper over the brake disc. **CAUTION** - Take great care not to damage the sliding pin boots when fitting the caliper. Fit the two caliper mounting bolts using a thread locking compound (e.g. Loctite). Torque tighten to 85 - 110 Nm (63 - 81 lbf.ft). Fit the protective caps to the ends of the sliding pins using special tool T000T0986.

13. Flexible Hose: Fit the flexible hose to the caliper using new or annealed copper washers, and torque tighten to 40 Nm (30 lbf.ft). Fit the bleed nipple and torque to 9 - 16 Nm (80 - 140 lbf.in).

14. Brake Pads & Bleeding: Refit the brake pads as detailed in JE.2. Remove the brake hose clamp, and bleed the brake system to expel all air.

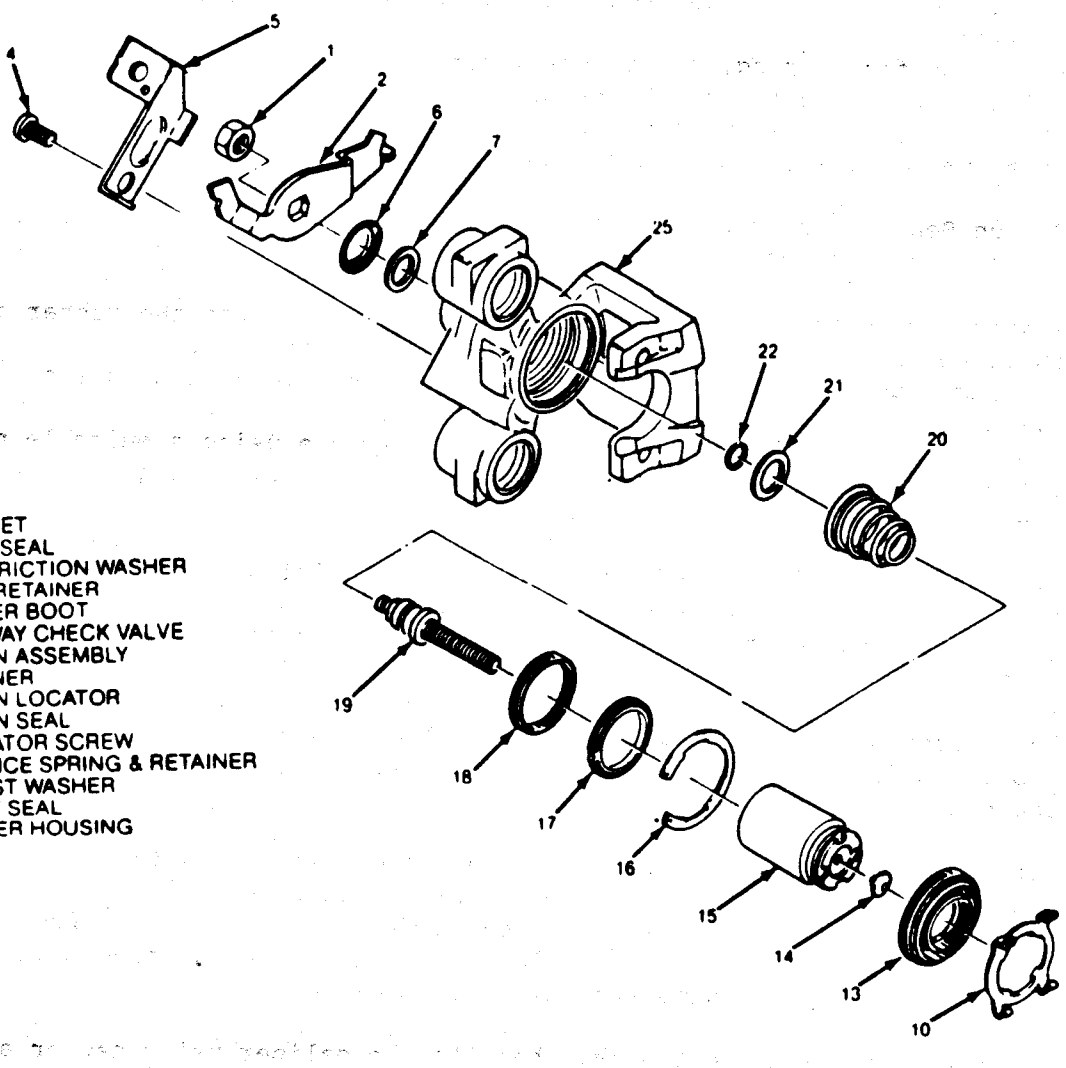
JE.6 - REAR CALIPER OVERHAUL

Tools required: Piston Locator Installer T000T0987
Piston Pusher T000T0988

1. Hydraulic Hose: Fit a brake hose clamp before releasing the banjo bolt securing the flexible hose to the caliper. Remove the bleeder valve. Seal the hose and caliper openings to prevent fluid loss and dirt ingress.

2. Caliper & Pads: Remove the caliper and brake pads (see JE.3).

3. Sliding Sleeves: Pull off the boots, and push the two sliding sleeves from the caliper bracket. Carefully examine the rubber boots for cuts, nicks or deterioration and the bolts and sleeves for any signs of corrosion: Replace any faulty parts as necessary.

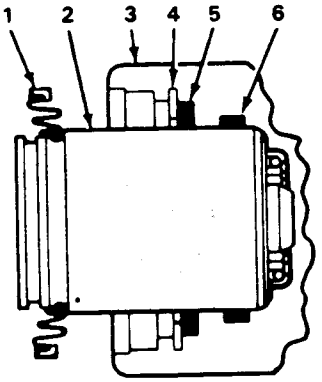


4. Remove Piston: Remove the securing nut and pull off the parking brake lever arm, lever seal and anti-friction washer. Use a spanner to turn the actuator screw in the brake apply direction, and so push the piston out of the cylinder. Use clean rags or shop towels to protect the piston during this operation, and remove the pad retaining clip from the piston if this has not already been done.

5. Actuator Screw: Remove the balance spring from inside the cylinder, and push out the actuator screw. Remove the screw thrust washer, and the shaft seal.

6. Piston Boot: Prise out the piston boot taking care not to scratch the cylinder bore.

7. Piston Locator & Seal: Remove the circlip, and pull out the piston locator. Use a plastic tool to remove the piston seal from its groove in the cylinder, in order to prevent scratching the cylinder wall or groove.



1. Dust boot
2. Piston
3. Caliper housing
4. Circlip
5. Piston locator
6. Piston seal

8. Inspect: Carefully inspect the cylinder wall and groove, and piston surface for any signs of;
   - scoring
   - nicks
   - corrosion
   - visible wear or damage to chrome plating

   If any light corrosion cannot be polished out using crocus cloth, or if any other faults are found, the components must be replaced.

9. Clean: Clean all parts in clean, denatured alcohol, and dry with unlubricated compressed air (lubricated shop air may damage rubber brake components). Blow out all the passages in the caliper housing and bleeder valve.

10. Abutment Bracket: If necessary, remove the parking brake cable abutment bracket. When re-fitting, torque tighten the single fixing screw to 33 - 52 Nm (24 - 38 lbf.ft).

11. Piston Seal: Lubricate a new piston seal with clean brake fluid, and carefully fit into its groove in the cylinder wall. Ensure the seal is not twisted.

12. Piston Locator: Lubricate a new piston locator, and fit onto the piston using installer tool T000T0987

13. Actuator Screw: Fit the thrust washer onto the actuator screw, with the copper side of the washer towards the piston and the grayish side towards the caliper housing. Lubricate the shaft seal and fit into the actuator screw groove. Fit the screw fully into the piston.

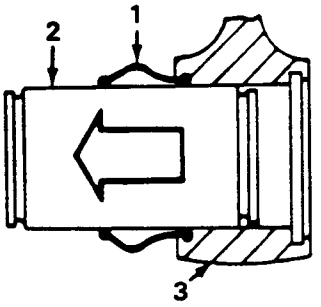
14. Piston: Lubricate the cylinder bore. Fit the balance spring onto the end of the piston, and insert the piston with actuator screw into the cylinder. Push the piston into the bore until the locator is past the circlip groove. Fit the retainer circlip using circlip pliers.
    Fit the lubricated piston boot into its groove in the end of the piston, before pressing the piston to the bottom of the bore.

15. Lever Arm: Fit the lubricated anti-friction washer over the end of the actuator screw, followed by the lubricated lever seal with the sealing bead towards the caliper body. Fit the lever arm in the correct orientation (between the cable abutment and 'off' stop) and retain with the nut. Hold the lever whilst torque tightening the nut to 40 - 55 Nm (30 - 40 lbf.ft)
    Fit the lever return spring.

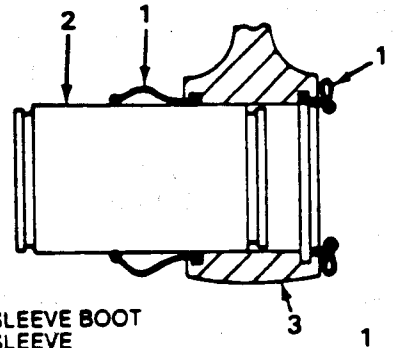
16. Piston Boot: Seat the piston boot in its counterbore in the caliper using a suitable tool.

17. Sliding Sleeves: Use silicon grease to lubricate the sliding surfaces of the sliding sleeves and corresponding surfaces in the caliper bracket. Lubricate both lips of the four sleeve boots. Instal each sliding pin in the following manner; **CAUTION**: Use no other grease than that specified.

    - fit one boot into its groove in the caliper and slide the pin in from the opposite side of the caliper hole, pushing through the boot inside diameter.

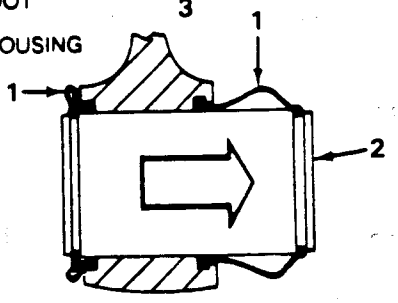


    - fit the second boot into the caliper groove.



1 SLEEVE BOOT
2 SLEEVE
3 CALIPER HOUSING

    - Push the pin back through the second boot and locate the inside diameter of both boots in their grooves on the sliding pin.



18. Fit Check Valve: Lubricate a new check valve with clean brake fluid, and fit into the piston hole.

19. Fit Inboard Pad: Check that the piston is correctly orientated - the axes of the cross shaped slot in the piston should be radial and tangential. Turn the piston if necessary. Check also that the pad retaining clip is fully located in the groove on the end of the piston.
    Engage the outside edge of the pad backplate into the retaining clip, before pressing the pad flat against the piston to engage the clips on the inside edge of the backplate. Check that the pad lies flat against the piston, with the buttons on the pad backplate engaged with the slot in the piston.

20. Fit Outboard Pad: Press the pad into position, so that the buttons on the pad backplate engage with the holes in the caliper housing, with the pad retained by the two legs of the clip.

21. Refit Caliper: Position the caliper over the brake disc, taking care not to damage the sliding pin boots, and refit the two caliper retaining bolts. Torque tighten the bolts to 90 - 110 Nm (66 - 80 lbf.ft).

22. Parking Brake Cable: Re-connect the parking brake cable to the abutment bracket and lever arm.

23. Flexible Hose: Fit the flexible hose to the caliper using new or annealed copper washers, and torque tighten to 40 Nm (30 lbf.ft). Fit the bleed nipple and torque to 9 - 16 Nm (80 - 140 lbf.in).

24. Bleeding: Top up the master cylinder reservoir. Operate the parking brake several times to attain the correct brake pad position (until parking brake lever feels 'firm'). Remove the brake hose clamp before bleeding the system to expel all air.
Test operation of footbrake and parking brake.

JE.7 - BRAKE DISCS

Check the braking surface on both sides of the brake discs for scoring or corrosion. Replace if in doubt.
Measure the discs thickness and run-out:

	Front	Rear
Thickness, nominal	24.0 mm (0.95 in.)	12.7 mm (0.50 in.)
Minimum regrind thickness	23.0 mm (0.91 in.)	11.5 mm (0.45 in.)
Minimum thickness (wear limit)	22.0 mm (0.87 in.)	10.9 mm (0.43 in.)
Maximum run-out, installed	0.10 mm (0.004 in)	0.10 mm (0.004 in)
Maximum run-out, removed	0.03 mm (0.001 in)	0.03 mm (0.001 in)

NOTE: Ensure the rear wheel bearings are correctly adjusted before measuring rear disc run-out.
If the run-out is excessive, replace the disc.

JE.8 - BRAKE SERVO UNIT

The brake vacuum servo is a non-servicable sealed unit which if found to be faulty, must be replaced as a unit, complete with the vacuum non-return valve fitted into the vacuum line between servo unit and intake plenum chamber.

As a quick check of servo operation proceed as follows: With engine stopped, press the brake pedal several times to exhaust the servo unit of vacuum. Keeping the pedal pressed (which should be 'hard' and 'high'), start the engine; the pedal should drop slightly as the servo vacuum builds up, and extra force is produced. If the pedal does not drop, it is most likely that there is a fault in the vacuum supply line. Check the vacuum hose, connections and non-return valve. If the vacuum supply is not defective, the servo unit should be replaced.

It is essential that the servo piston is allowed to return fully when the brakes are released, and is not pre-loaded by mal-adjustment of the input pushrod. Check that there is a small amount of free play at the pushrod when the brake pedal is released.

To Remove Servo Unit

The servo unit, if diagnosed as being faulty, must be withdrawn together with the pedal box, towards the inside of the car.

1. Centre Console: Remove the centre console and instrument panel (see section M).

2. Fascia: Remove the fascia panel (see section V).

3. Steering Column: Remove the steering column (see section H).

4. Throttle Cable: Pull off the spring clip, and unhook the cable from the throttle pedal.

5. Clutch Cable: Pull back the clutch release lever on the transmission, and unhook the cable from the clutch pedal.

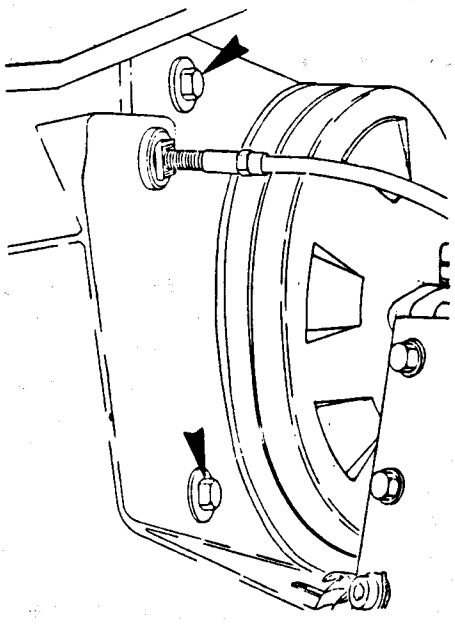
6. Wiring Harness: Disconnect the main earth point from the rear face of the pedal box. Release the cable ties securing the main harness in the carrier duct across the back of the pedal box, and push the harness out of the duct. Disconnect the brake light switch.

7. Master Cylinder: Release the two nuts securing the master cylinder to the servo. Leave the hydraulic system undisturbed.

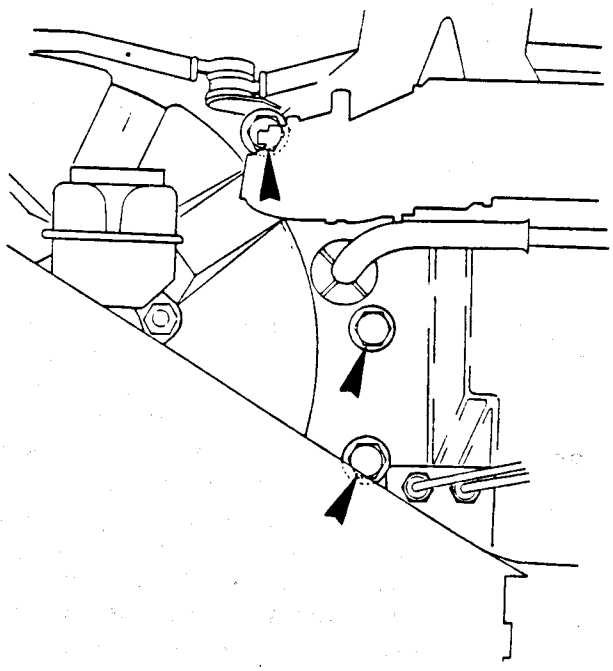
8. Vacuum Hose: Disconnect the brake servo hose.

9. Pedal Box: Release the five bolts from the engine side of the front bulkhead securing the pedal box, and withdraw the pedal box complete with servo into the driver's footwell.

Servo outboard fixings viewed from wheelarch



Servo inboard fixings viewed from engine bay

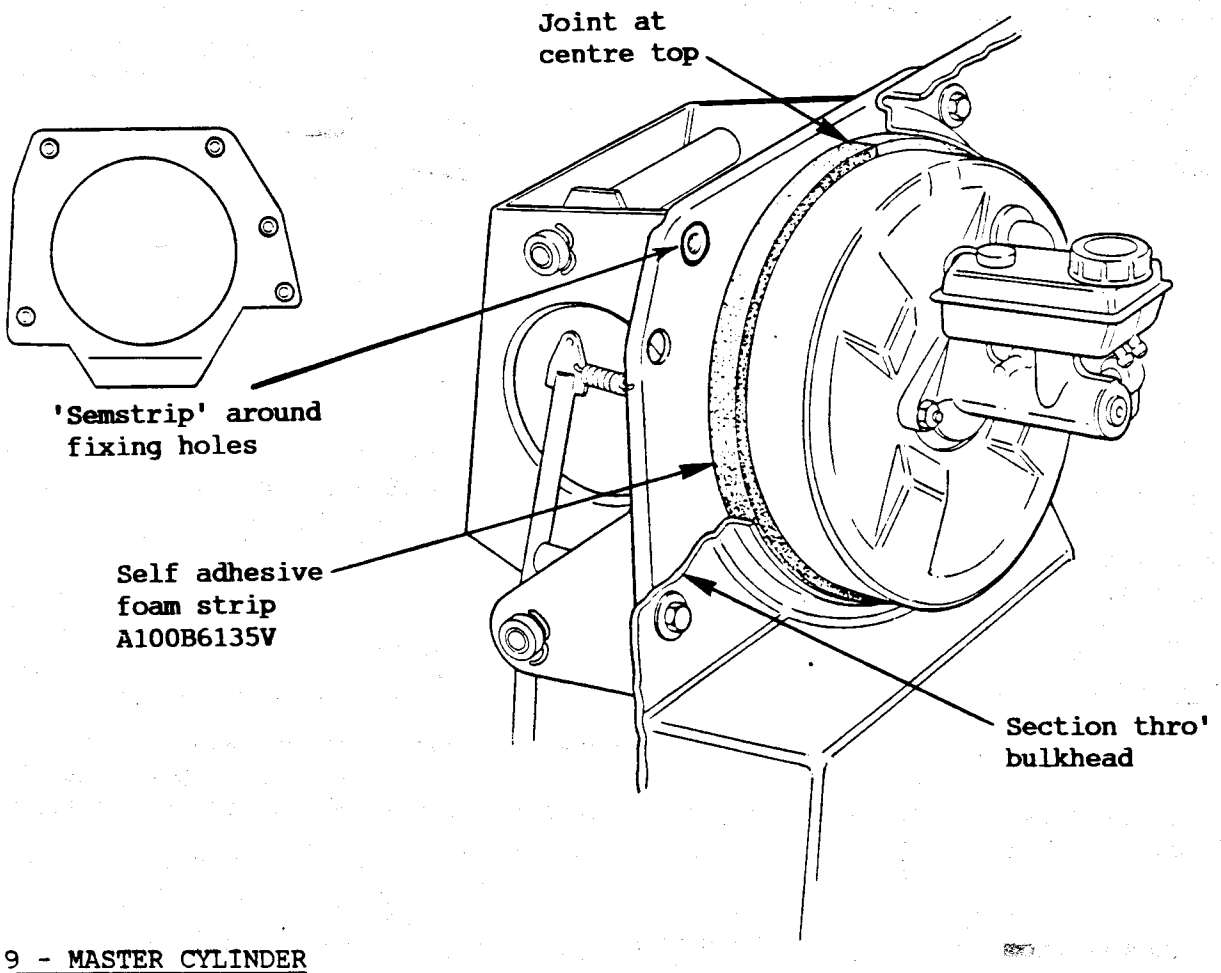


10. Servo: Disconnect the servo pushrod from the pedal, release the four nuts securing the servo to the pedal box, and withdraw the servo unit.

To Replace Servo Unit

Reverse the removal procedure to replace the servo, noting the following points:

- Torque tighten servo to pedal box nuts to 16 - 20 Nm (12 - 15 lbf.ft). Adjust servo input pushrod for slight free play when brake is off. Apply a 700mm length of self adhesive foam strip (A100B6135V) around the body of the servo unit, aligning with the rear edge. Position the joint at the centre top.
- Apply a ring of 'Semstrip' A100J6021 on the pedal box around each of the pedal box fixing holes, to seal the pedal box to the bulkhead.
- Torque tighten pedal box fixing bolts to 22 Nm (16 lbf.ft).



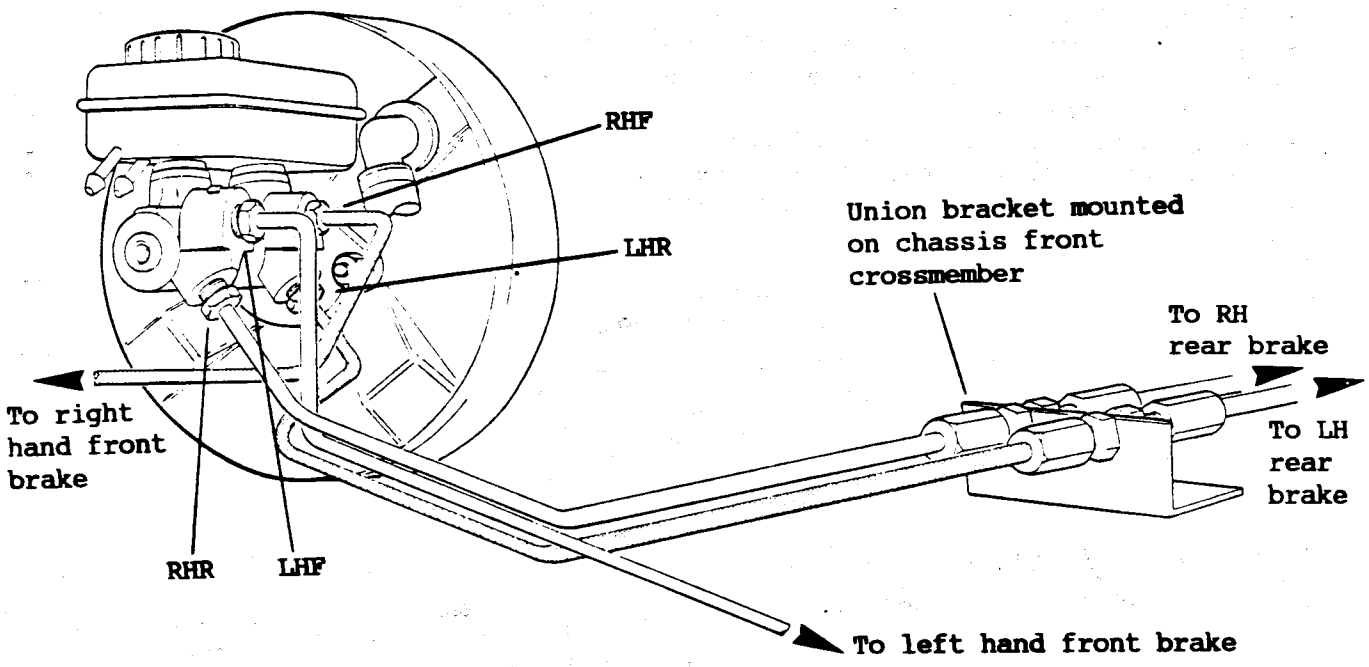
JE.9 - MASTER CYLINDER

The brake master cylinder is a non-servicable sealed assembly, which must be replaced as a complete unit if found to be faulty.

To Replace Master Cylinder

- Before removing the master cylinder, syphon out as much brake fluid as possible from the reservoir to reduce the amount of spillage.
- Disconnect the low fluid tell tale harness from the reservoir cap.
- Disconnect the three brake pipes from the master cylinder ports, and plug the pipes and ports to reduce spillage and prevent dirt ingress.
- Remove the two nuts securing the master cylinder to the brake servo, and withdraw the master cylinder.

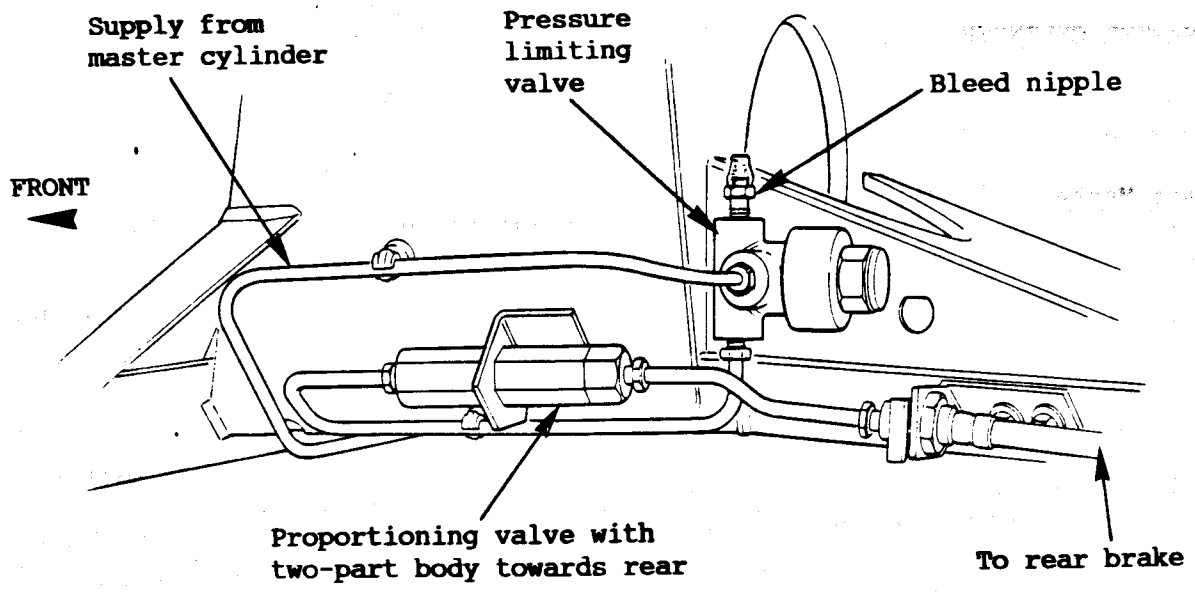
Refit the master cylinder in the reverse order to that above, refill with brake fluid, and bleed the complete system in the usual manner.



- Torque tighten master cylinder to servo fixings to 15 - 18 Nm (11 - 13 lbf.ft).
- Torque tighten brake pipes to master cylinder to 10 - 15 Nm (7.5 - 11 lbf.ft).

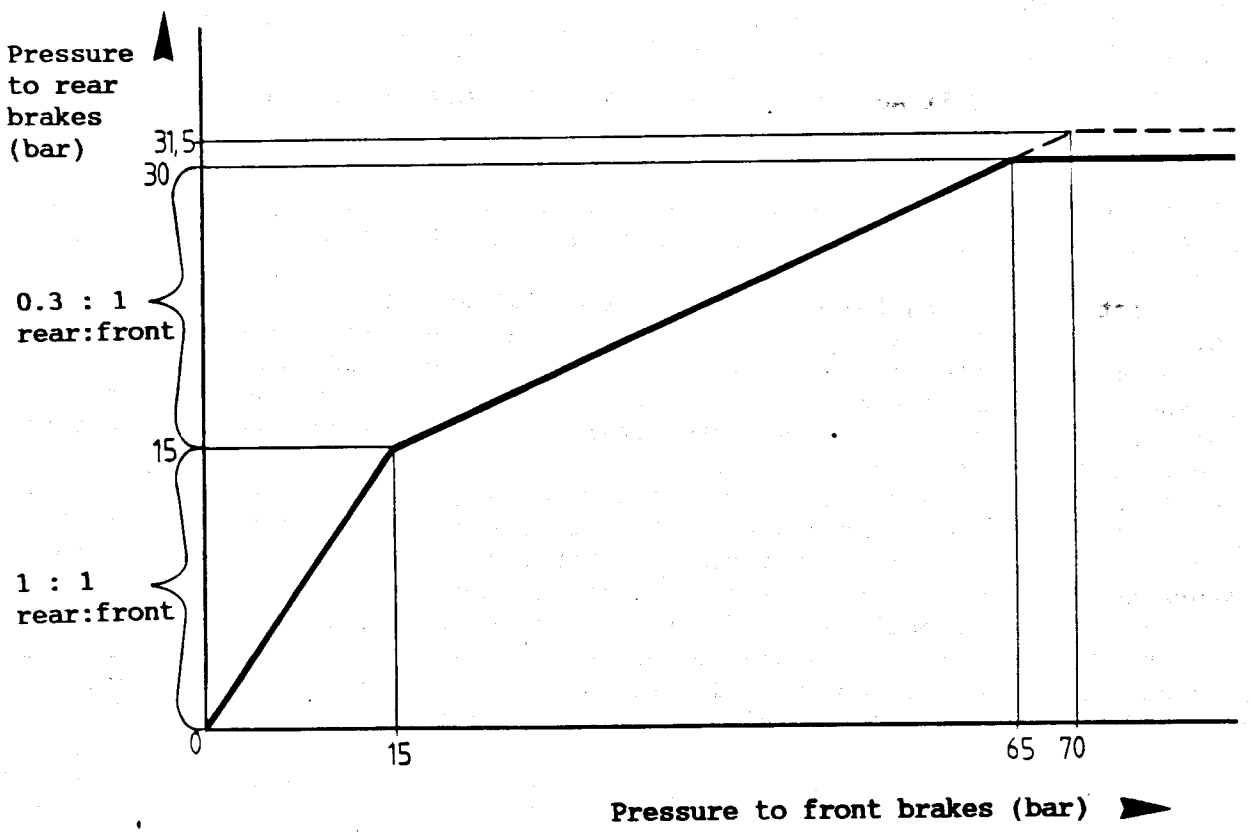
JE.10 - PRESSURE LIMITING & PROPORTIONING VALVES

A brake pressure limiting valve and a pressure proportioning valve are fitted into each of the rear brake lines in order to control the rear brake pressure under severe braking, and reduce any tendency for the rear wheels to lock before the front.



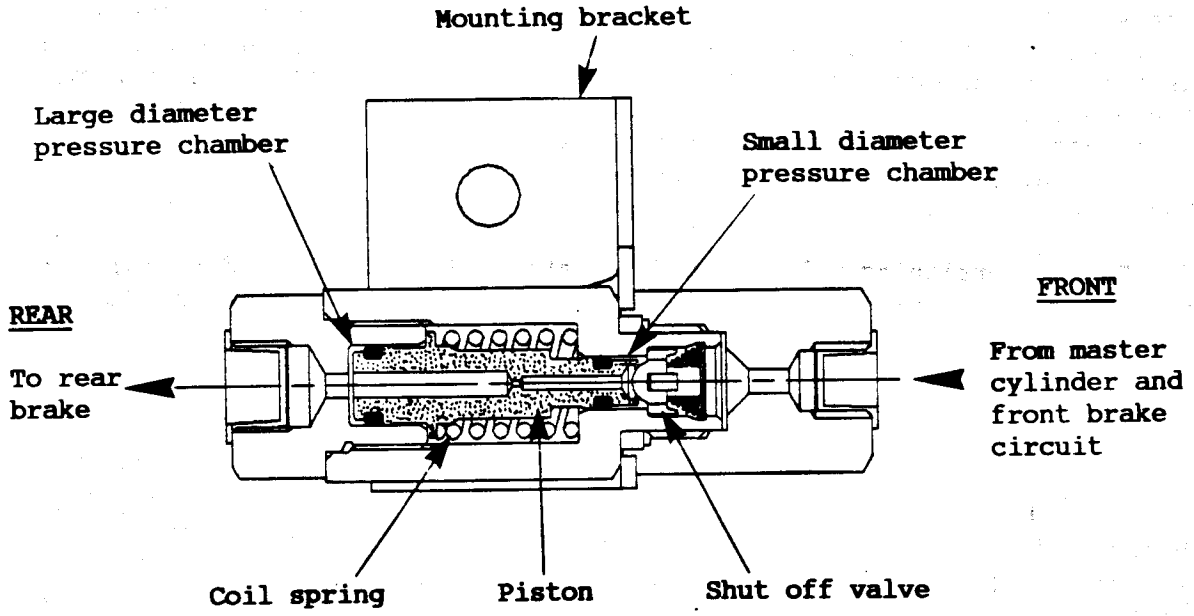
The limiting valves are fitted upstream of the proportioning valves, and are set at either 70 bar, or on later cars, 65 bar. This figure is stamped on the valve end plate. At brake line pressures below the valve calibration, the valve is open, and allows unrestricted flow of brake fluid from the master cylinder to the proportioning valve. When the output pressure from the master cylinder (same front and rear) reaches the limiting valve calibration pressure, the valve closes, and allows no further increase in pressure to the rear brake circuit. The valve opens again when supply pressure drops below 70 or 65 bar.

The proportioning valves are designated 0.3/15, which indicates;
- up to the 'break point' of 15 bar, the pressure in each rear brake circuit is the same as that in the front circuit.
- as the front circuit pressure increases from 15 bar to 65 or 70 bar (see above), the corresponding increase in rear circuit pressure is in the ratio of 0.3:1.



Operation of Proportioning Valve

The brake proportioning valves are fitted, one each side of the chassis centre 'backbone', between the front and rear pivots for the rear wishbones. Each unit consists of an anodised aluminium body containing a spring loaded piston, through the centre of which the brake fluid flows from the front to the rear circuit. A small diameter pressure chamber at the front end of the piston, is connected to the front brake line, and includes a shut off valve. A larger diameter pressure chamber at the rear end of the piston is connected to the rear brake circuit.



At brake line pressures below 15 bar, the proportioning valve is open, and fluid flows through the unit freely to provide equal front and rear brake line pressures.

The piston is spring loaded towards the outlet end, but the hydraulic force on the piston from the large diameter outlet (rear) end, is greater than that from the small diameter inlet (front) end. At a pressure of 15 bar, the difference in hydraulic force is equal to the force on the piston from the spring, with the result that the piston starts to move towards the inlet end of the unit, closing the valve as it does so.

As front brake pressure is increased beyond 15 bar, the valve will open only sufficiently to allow the pressure in the outlet side to increase by 0.3 of this amount, since this is all that is required for the larger diameter outlet end pressure chamber to close the valve and maintain the pressure balance.

The reverse logic applies as the brake pressure is reduced, with the valve opening to allow the rear pressure to fall at a rate of 0.3 of the front pressure reduction until the break point at 15 bar, when the piston spring overcomes the pressure differential, and the valve stays open, equalising front and rear pressures.

Valve Servicing

NO SERVICING OF THE PRESSURE LIMITING OR PROPORTIONING VALVES IS PERMITTED. Do not attempt to disassemble or repair a limiting or proportioning valve. Each proportioning valve assembly incorporates a mounting bracket which should not be disturbed. If a proportioning valve is found to leak brake fluid, or if the performance test indicates a faulty unit, **BOTH PROPORTIONING VALVES SHOULD BE RENEWED AS A PAIR.**

Both right and left hand proportioning valve assemblies are identical, and due to the offset fixing bracket hole, cannot be fitted and connected up the wrong way round without considerable modification to the brake pipes. The two part body of the valve should be to the rear.

Torque tighten brake pipe connections to 15 Nm (11 lbf.ft).

Performance Test

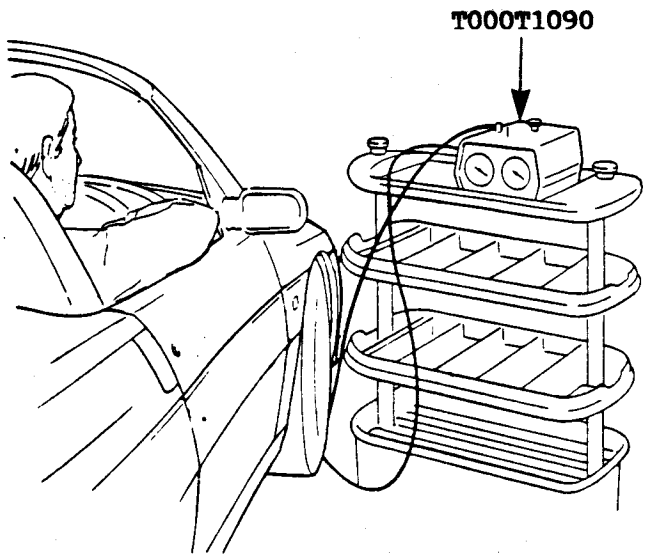
Tools Required: Test gauge T000T1090

1. Referring to the test gauge manufacturer's instructions, remove the bleed nipple from one of the rear calipers, and connect the test gauge adaptor to the caliper.

2. Connect the other test gauge pipe to the diagonally opposite front brake caliper bleed nipple port.

3. After bleeding the system, operate the brakes to achieve the front brake line pressures in the following table, and note the corresponding rear brake line pressure.
   Do not exceed a front brake pressure of 100 bar.

Front Pressure (bar)	Rear Pressure (bar)
5	5
30	17.8 - 21.2
85	with 70 bar limiter 28 - 35
	with 65 bar limiter 26.5 - 33.5



4. If the rear pressure is out of tolerance at any of the test points, comparison of the pressure rise characteristic with the graph at the start of this sub-section should indicate the probable faulty component. Note that proportioning valves should be renewed only as a pair.

5. Repeat the test on the opposite circuit.

6. Remove test gauge, refit bleed nipples and bleed brakes.