Ministry of Defence

de&s

DE&S Secretariat (Land Equipment)

DESSEC-PolSecLE-JSC-WPNS@mod.gov.uk

Defence Equipment & Support
Maple 0a # 2043
MOD Abbey Wood
Bristol BS34 8JH

[redacted]

Via:

[redacted]

31st October 2018 Our Ref: FOI2018/12796

Dear [redacted],

Thank you for your letter of 3rd October 2018 requesting the following information:

I am trying to find out if it is still possible to obtain AESP's relating to land rovers that entered service prior to 1997.
*I am interested in the 2320-D-122-*** range of publications.*

Specifically, 2320-D-122-512
2320-D-122-522
2320-D-122-523
2320-D-122-524
2320-D-122-601
2320-D-122-711

Are these still available or have they all been superseded by the 2320-D-128 range.

In response to my letter of 12th October 2018, you responded on 13th October refining your request as follows:

I would like to adjust my request to include 2320-D-122-522 and 2320-D-122-524.

However if this would still exceed the allowable limits for time/cost of an FOI request then 2320-D-122-524 and 2320-D-122-601 would be acceptable.

A search for the information has now been completed within the Ministry of Defence, and I can confirm that information in scope of your request is held. It is possible to supply Army Equipment Support Publications 2320-D-122-524 and 601 within the appropriate limit set by the Freedom of Information (FOI) Act.

The information you have requested can be found below, but some of the information falls entirely within the scope of the absolute exemption provided for at section 40 (Personal Data) of the FOIA and has been redacted.

Section 40(2) has been applied to some of the information in order to protect personal information as governed by the Data Protection Act 1998. Section 40 is an absolute exemption and there is therefore no requirement to consider the public interest in making a decision to withhold the information.

If you have any queries regarding the content of this letter, please contact this office in the first instance.

If you wish to complain about the handling of your request, or the content of this response, you can request an independent internal review by contacting the Information Rights Compliance team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.gov.uk). Please note that any request for an internal review should be made within 40 working days of the date of this response.

If you remain dissatisfied following an internal review, you may raise your complaint directly to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not normally investigate your case until the MOD internal review process has been completed. The Information Commissioner can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website at https://ico.org.uk/.

Yours sincerely,

DES SEC Pol Sec Land Equipment

ARMY EQUIPMENT
SUPPORT PUBLICATION

2320-D-122-601
5th Edition January 2005
(Superseding edition dated Feb 95)

~~FOR OFFICIAL USE ONLY~~
~~CROWN COPYRIGHT RESERVED~~

CONDITIONS OF RELEASE

1 ~~This information is released by the UK Government for Defence purposes only~~.

2 ~~This information must be afforded the same degree of security protection as that afforded to information of an equivalent security marking originated by the recipient Government or as required by the recipient Government's security regulations~~.

3 ~~This information may be disclosed only within the Defence Department of the recipient Government, except as otherwise authorized by the Ministry of Defence (Army)~~.

4 This information may be subject to privately owned rights.

LAND ROVER 90/110/127 ALL VARIANTS (EXCLUDING APV, SAS AND CRASH RESCUE AMBULANCE)

MAINTENANCE SCHEDULE (JOINT SERVICE)

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence
Issued by
DEFENCE LOGISTICS ORGANISATION

AMENDMENT RECORD

Amdt No.	Incorporated By (Signature)	Date
1	Incorporated	09/05
2	Incorporated	10/06
3	Incorporated	10/07
4	Incorporated	12/07
5	Incorporated	12/07
6	Incorporated	12/07
7	Incorporated	02/10
8	Incorporated	05/10
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

Amdt No.	Incorporated By (Signature)	Date
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		

CONTENTS

PRELIMINARY MATERIAL

PREFACE

Sponsor: SUV IPT
Project No.: SUV/8/26/3
File ref:

Publication Authority: CTS TD Andover

INTRODUCTION

1 Service users should forward any comments on this publication through the channels prescribed in AESP 0100-P-011-013. An AESP Form 10 is provided at the end of this publication; it should be photocopied and used for forwarding comments on this AESP.

2 AESPs are issued under Defence Council authority and where AESPs specify action to be taken, the AESP will of itself be sufficient authority for such action and also for the demanding of the necessary stores, subject to the provisions of Para 3 below.

3 The subject matter of this publication may be affected by Defence Council Instructions (DCIs), Standing Operating Procedures (SOPs) or by local regulations. When any such instruction, order or regulation contradicts any portion of this publication it is to be taken as the overriding authority.

RELATED AND ASSOCIATED PUBLICATIONS

Related publications

4 The Octad for the subject equipment consists of the publications shown opposite. All references are prefixed with the first eight digits of this publication. The availability of the publications can be checked by reference to the relevant Group Index (see AESP 0100-A-001-013).

Category/Sub-category			Information Level			
			1 User/ Operator	2 Unit Maintenance	3 Field Maintenance	4 Base Maintenance
1	0	Purpose and Planning Information	101	101	101	101
	1	Equipment Support Policy Directives	111	111	111	111
2	0	Operating Information	201	*	*	*
	1	Aide-Memoire	*	*	*	*
	2	Training Aids	*	*	*	*
3		Technical Description	*	302	*	*
4	1	Installation Instructions	411	*	*	*
	2	Preparation for Special Environments	421	*	*	*
5	1	Failure Diagnosis	*	512	*	*
	2	Repair Instructions	*	522	*	524
	3	Inspection Standards	*	532	533	*
	4	Calibration Procedures	*	*	*	*
6		Maintenance Schedules	601	601	601	601
7	1	Illustrated Parts Catalogues	711	711	711	711
	2	Commercial Parts Lists	721	721	721	721
	3	Complete Equipment Schedule, Production	*	*	*	*
	4	Complete Equipment Schedule, Service Edition (Simple Equipment)	741	*	*	*
	5	Complete Equipment Schedule, Service Edition (Complex Equipment)	*	*	*	*
8	1	Modification Instructions	811	811	811	811
	2	General Instructions, Special Technical Instructions and Servicing Instructions	821	821	821	821
	3	Service Engineered Modification Instructions (RAF only)	831	831	831	831

*Category/Sub-category not published

Associated publications

5

Reference	Title
JSP 317	Joint Service Safety Regulations for the Storage and Handling of Fuels and Lubricants (3rd Edition March 1995)
JSP 341	Defence Road Transport Regulations
JSP 375	MOD Health and Safety Handbook
JSP 418	MOD Environment Manual
JSP 437	Personal Protective Equipment Catalogue
JSP 515	Hazardous Stores Information System (HSIS)
AP 3260 Book 1	Mechanical Transport Maintenance Regulations for the Royal Air Force - Maintenance Repair Policy
AP 4545 Vol 2	Mechanical Transport - General Orders and Modifications (Royal Air Force only)

MAINTENANCE SCHEDULE

INTRODUCTION

1 This Maintenance Schedule is the authority for carrying out all scheduled maintenance tasks on the subject equipment and takes precedence over any other conflicting publication.

2 The Unit Commander/MT Officer is responsible for ensuring that the operations detailed in this Maintenance Schedule are properly carried out. **He may order any operation to be carried out more frequently than is specified if the conditions under which the equipment operates render it necessary**. For Army equipment he should consult his REME advisor before ordering such changes.

3 Scheduled Maintenance is to be recorded in the appropriate equipment document in accordance with JSP 341, Chap 16 and AP 3260, Book 1, Chap 3 (RAF only).

4 Serial numbers left blank in the tables may be taken up by amendment action at a later date.

DEFINITIONS

5 As far as this document is concerned, the following definitions apply:

5.1 Examine. Carry out a survey of the condition of an item. For example, the condition of an item can be impaired by the following:

NOTE

The term Examine does not call for dismantling unless specifically instructed to do so in the relevant Operation.

5.1.1 Insecurity of attachment.

5.1.2 Cracks or fractures.

5.1.3 Corrosion, contamination or deterioration.

5.1.4 Distortion.

5.1.5 Loose or missing fasteners.

5.1.6 Chafing, fraying, scoring or wear.

5.1.7 Faulty or broken locking devices.

5.1.8 Loose clips or packing, obstruction of, or leakage from pipelines.

5.1.9 Discolouration due to overheating or leakage of fluids.

5.1.10 Damage due to external sources.

5.2 Check. Make a comparison of measurement of time, pressure, temperature, resistance, dimension or other quantity, with a known figure.

5.3 Operate. As far as possible, ascertain that a component or system functions correctly without the use of test equipment or reference to measurement.

5.4 Replenish. Refill a container to a pre-determined level, pressure or quantity, this includes any necessary cleaning of orifices, examination of caps, covers, gaskets and washers, renewal of locking devices and clearing of vents.

5.5 Replace. Remove an item and then fit a new or reconditioned item.

WARNINGS, CAUTIONS AND MAINTENANCE NOTES

6

6.1 Before any maintenance task is carried out, the WARNINGS, CAUTIONS and Maintenance Notes preceding the appropriate table must be read and understood.

6.2 The Health and Safety at Work Act 1974 (HSWA 1974) requires employers to ensure, as far as is reasonably practicable, the health, safety and welfare at work of all employees and that of others who may be affected by their acts, or omissions, at work. A further requirement is the provision of such information, instructions, training and supervision as necessary to ensure the health and safety at work of all employees.

MAINTENANCE INTERVALS AND AREAS OF RESPONSIBILITY

7 Table 4 - action on receipt. The maintenance detailed in Table 4 covers the action taken when the equipment arrives on a unit. These operations will normally be of a once only nature, eg the recording of lifting equipment with the appropriate test authority, actions that are necessary to be undertaken before the equipment is put into service or actions that are only required during the running in period. The tasks are to be carried out by the tradesmen annotated against the operation.

8. Table 5 - out of phase maintenance. The maintenance detailed in Table 5 covers tasks that do not fall into line with the manufacturer's standard time/usage intervals. The tasks are to be carried out by REME, RAF MT Mechanical/Technician, General Electrical Mechanic/Technician or Qualified Tradesmen unless annotated otherwise.

9 Table 6 - driver/operator maintenance.

9.1 The maintenance detailed in Table 6, columns A, B and C is to be carried out by the driver/ operator or their civilian equivalent at the following intervals:

9.1.1 A - before use (only on days used).

9.1.2 B - after use (after the equipment has been operated).

9.1.3 C - weekly when in use **(where the equipment is not in use, the equipment is to have level A and C maintenance carried before the equipment is used).**

9.1.4 D - not taken up.

10 Table 7 - time/usage maintenance.

10.1 The maintenance detailed in Table 7, columns 1st, A, B and C is to be carried out at the following intervals:

10.1.1 1st (RAF initial) - after the first 1,000 miles (1,600 km).

10.1.2 A (RAF lubrication) - every 6,000 miles (10,000 km) or 6 months whichever occurs first.

10.1.3 B (RAF minor) - every 12,000 miles (20, 000 km) or 12 months whichever occurs first.

10.1.4 C (RAF major) - every 24,000 miles (40,000 km) or 24 months whichever occurs first.

10.2 Column D contains the area maintenance indicator which may be used, at the discretion of the Unit Commander or MT Officer, to carry out area maintenance at the appropriate time/usage intervals.

NOTES (RAF only)

(1) Vehicles that do less than 6,000 miles (10,000 km) annually and are on area maintenance are to have a lubrication maintenance at 6 monthly intervals in accordance with AP 3260, Chap 3.

(2) The number in the area maintenance column indicates which area is to be carried out.

(3) The area maintenance detailed is to be carried out in conjunction with its associated prime mover/specialist equipment scheduled maintenance if applicable.

10.3 The maintenance detailed in Table 7 will be carried out by:

10.3.1 REME Vehicle Mechanic (VM) where annotated (VM) in the table.

10.3.2 Unit appointed personnel, supervised by an Army Class 1 Driver. Where it is specifically indicated (VM), the task should be undertaken by a REME tradesman.

10.3.3 RAF MT Mechanic/Technician or General Mechanic/Technician Electrical as appropriate to the operation.

10.3.4 Qualified Tradesman (QT). A person is qualified to carry out any task designated 'QT' when he/she has been formally taught how to carry out that task during a trade training course.

10.3.5 The civilian equivalent of the above tradesmen.

11 Table 8 - out of use maintenance.

11.1 For RAF equipment. Out of use vehicle or vehicles in second echelon are to be maintained in accordance with AP 3260, Book 1, Chap 1, Para 0109 and Chap 2, Para 0227. Any specific operation appertaining to this equipment will be listed in Table 8.

11.2 For Army equipment. This maintenance is to be carried out as follows:

11.2.1 When the equipment is taken out of use for periods exceeding one month on the advice of the local REME advisor/MT Officer.

11.2.2 Any equipment taken out of use for periods exceeding 4 months is to be put into preservation in accordance with EMER Wheeled Vehicles A 019 Miscellaneous Instruction No. 9.

11.2.3 The equipment is to be cleaned, dried and stored under cover where possible.

11.2.4 Any overdue maintenance is to be carried out when the equipment is brought back into use.

TABLE 1 EQUIPMENT APPLICABILITY

NOTES

(1) This Maintenance Schedule is applicable to all variants of Truck Utility Light Land Rover fitted with the diesel engine, Truck Medium Land Rover fitted with the diesel engine, and the Winterised Truck Utility Light Land Rover.

(2) The following variants, listed with their associated AESP, are **NOT** covered by this publication.

Serial (1)	Equipment Asset Code (2)	Designation (3)	Contract Numbers (4)
1	1703-3100	Truck Utility, Medium, Mobile, Police Operations, 4x4, Land Rover 127 (Royal Air Force only) (AESP 2320-D-123)	
2	1738-3101	Truck Utility, Medium, Lightly Armoured Protected (VPK) 4x4, Land Rover (AESP 2320-D-127)	
3	1826-4100 1826-9100 1833-4100 1833-9100	Truck Utility, Medium, GS, FFR, 12V and 24V, LHD and RHD (RAF Rapier) Soft Top, W/Winch 4x4 Land Rover 127 (Royal Air Force only) (AESP 2320-D-124)	

TABLE 2 FUELS, LUBRICANTS AND ASSOCIATED PRODUCTS

NOTES

(1) Only the products listed below are to be used on this equipment.

(2) Oil changes at the -15 deg C point shall only be made on the advice of the MT Officer.

(3) The capacities listed are to be used as a guide only. A physical check is to be carried out to ensure that all fluid levels are correct. This check should be carried out with the vehicle unladen and standing on level ground whenever possible.

Ser	Assembly/System	Product		Capacity	
		Above -15 deg C	Below -15 deg C	Litres	Pints
(1)	(2)	(3)	(4)	(5)	(6)
	DIESEL ENGINE				
1	Engine and filter	OMD 90	OMD 55	6.85	12.00
2	Engine and filter with oil cooler	OMD 90	OMD 55	7.95	14.00
3	Cooling system 50/50% mix	AL39/Water mixture	AL39/Water mixture	10.80	19.00
4	Gearbox				
	4.1 5 speed LT 77	OX 75	OX 75	2.20	3.90
	4.2 5 speed R380 from VIN LA 939975	MTF 94	MTF 94	2.20	3.90
5	Fuel (diesel models)				
	5.1 Rear tank (110 model)	Dieso	Dieso	79.50	17.40 gal
	5.2 Side tank (110 model)	Dieso	Dieso	45.50	10.00 gal
	5.3 Side tank (90 model)	Dieso	Dieso	54.50	12.00 gal
	COMMON ITEMS				
6	Transfer gearbox	OEP 220	OEP 38	2.80	4.90
7	Front axle differential	OEP 220	OEP 38	1.70	3.00
8	Rear axle differential (90 model)	OEP 220	OEP 38	1.70	3.00
9	Rear axle differential (110 model)	OEP 220	OEP 38	2.38	4.00
10	Swivel pin housing. Refer to AESP 2320-D-122-821 Gen Instr No. 87				
11	Steering box (manual)	OEP 220	OEP 38	0.43	0.75
12	Brake/clutch reservoir	OX 8	OX 8		
13	(DELETED)				
14	Windscreen washers	Windscreen fluid/AL11 water mix	Windscreen fluid/AL11 water mix		
15	Batteries	PX7/Demin water	PX7/Demin water		
16	General greasing	XG 279	XG 279		
17	Oil can lubrication	OMD 90	OMD 90		
18	Alternator bearing grease	XG 279	XG 279		

TABLE 3 EQUIPMENT DATA

Serial (1)	Item (2)	Detail (3)
	ADJUSTMENTS	
1	Alternator belt (12 and 24 volt)	12 mm (0.5 in.)
2	Power steering pump belt	12 mm (0.5 in.)
3	Valve clearance (hot and cold)	
	Inlet	0.25 mm (0.010 in.)
	Exhaust	0.25 mm (0.010 in.)
4	Front wheel alignment (toe out)	1.2 mm - 2.4 mm (3/64-3/32 in.)
5	Engine idling speed	700 +/- 50 rev/min
6	Axle hub end float	0.05 mm - 0.1 mm (0.002-0.004 in.)
7	Injector break-off pressure	135 atmospheres
8	Steering lock stops with tracta joint gaiters and irrespective of tyre fitted	56 mm (2.2 in.)
9	Steering lock stops without tracta joint gaiters and fitted with the following tyres:	
	9.1 Michelin XZL	54 mm (2.125 in.)
	9.2 All other types	51 mm (2 in.)
10		
	TORQUE WRENCH SETTINGS	
11	Cylinder head nuts and bolts	115-130 Nm (85-96 lb ft)
12	Timing belt tensioner:	
	New belt	24-29 Nm (17-21 lbf ft)
	Used belt	19-24 Nm (14-18 lbf ft)
13	Front axle swivel bearing pre-load	5.4-6.7 Nm (4-5 lbf ft)
14	Wheel nuts (front and rear)	170 Nm (125 lbf ft)
15		
	TYRES	
16	Size	7.50 R 16 Radial tubeless (tube to be fitted)
17	Pressures:	
	17.1 Normal use:	Front Rear
	90 models fitted with 7.50x16 radial ply tyres	1.9 bar (28 lbf/in.^{2}) 2.75 bar (40 lbf/in.^{2})
	110 models fitted with 7.50x16 radial ply tyres	1.9 bar (28 lbf/in.^{2}) 3.3 bar (48 lbf/in.^{2})
	17.2 Emergency soft:	Unladen Laden
	90 Models	Front Rear Front Rear
		1.0 bar 1.0 bar 1.0 bar 1.7 bar
		(15 lbf/in.^{2})(15 lbf/in.^{2})(15 lbf/in.^{2})(25 lbf/in.^{2})
	110 Models	1.0 bar 1.0 bar 1.0 bar 1.7 bar
		(15 lbf/in.^{2})(15 lbf/in.^{2})(15 lbf/in.^{2})(25 lbf/in.^{2})
	Emergency soft pressure should only be used in extreme conditions where extra flotation is required. MAX speed 20 km/h (12 mile/h). Return pressures to normal immediately firm ground is regained.	
	WEIGHTS	
18	Unladen weights 110 models:	
	18.1 Soft top 12 volt	1740 kg (3837 lb)
	18.2 Hard top 12 volt	1760 kg (3880 lb)

(continued)

TABLE 3 EQUIPMENT DATA (continued)

Serial (1)	Item (2)	Detail (3)
	18.3 Hard top 12/24 volt	1745 kg (3848 lb)
	18.4 Hard top 12/24 volt FFR	1900 kg (4189 lb)
19	Unladen weights 90 models:	
	19.1 Soft top 12 volt	1580 kg (3483 lb)
20	Gross vehicle weights 110 models:	
	20.1 Front axle	1200 kg (2646 lb)
	20.2 Rear axle	1850 kg (4078 lb)
	20.3 Total	3050 kg (6724 lb)
21	Gross vehicle weight 90 models:	
	21.1 Front axle	1200 kg (2646 lb)
	21.2 Rear axle	1500 kg (3307 lb)
	21.3 Total	2550 kg (5621 lb)

TABLE 4 ACTION ON RECEIPT

Table 4 Maintenance is to be carried out in accordance with the instructions shown at Page 2, Para 6 and 7.

Serial (1)	Action (2)
	NOT TAKEN UP

TABLE 5 OUT OF PHASE MAINTENANCE

Table 5 Maintenance is to be carried out in accordance with the instructions shown at Page 2, Para 6 and 8.

Serial (1)	Action (2)	Interval (3)
1	During summer months the heater should be operated with a cold engine, for 10 minutes, with the engine heating set to 'warm' and in the slowest fan position. (Winterised version only).	Monthly
2	Engine oil.	
	2.1 Change engine oil and filter. Annotate docs to indicate date/mileage changed.	Every 12,000 miles (20,000 km), or 2 years, whichever occurs soonest.
3	Replace camshaft timing belt. (VM)	48,000 miles (80,000 km), or 5 years whichever occurs soonest.
4	Cooling system: Drain, flush and replenish. (All variants)	5 yearly

(continued)

TABLE 5 OUT OF PHASE MAINTENANCE (continued)

Serial (1)	Action (2)	Interval (3)
5	R380 Gearbox oil.	
	5.1 Gearbox Oil. Drain/replenish. (for all climates below +35C	96,000 miles (155,000 km) or every 5 years whichever occurs first.
	5.2 Gearbox Oil. Drain/replenish. (for all climates above +35C	Every 2 years

TABLE 6 DRIVER/OPERATOR MAINTENANCE

Table 6 Maintenance is to be carried out by the tradesmen and at the intervals shown at Page 2, Para 9.1 and 9.2 of this publication.

The following WARNINGS, CAUTIONS and Maintenance Notes must be read and understood before commencing these maintenance tasks.

WARNINGS

(1) HEALTH HAZARD. FLUID AL 11 IS HIGHLY INFLAMMABLE. THE PREPARATION OF THE FLUID FOR WINDSCREEN WASHERS IS TO BE CARRIED OUT IN THE OPEN AND AWAY FROM NAKED FLAME. MINIMUM PRECAUTION AFTER USE IS TO WASH ANY AFFECTED SKIN AREAS WITH SOAP AND WATER.

(2) HEALTH HAZARD. FLUID AL 39 IS BOTH TOXIC AND HAZARDOUS. REFER TO LOCAL UNIT ORDERS OR DCIs FOR FULL SAFETY PROCEDURES. MINIMUM PRECAUTION AFTER USE IS TO WASH ANY AFFECTED SKIN AREAS WITH SOAP AND WATER.

(3) HEALTH HAZARD. THE HANDLING OF FUELS, LUBRICANTS AND ASSOCIATED PRODUCTS CAN BE HAZARDOUS. REFER TO UNIT STANDARD OPERATING PROCEDURES, SAFETY PROCEDURES, INSTRUCTIONS ON CONTAINERS AND ALL OTHER RELEVANT REGULATIONS FOR FULL OPERATIONAL SAFETY PROCEDURES.

(4) HEALTH HAZARD. EXHAUST FUMES ARE HAZARDOUS; DO NOT RUN VEHICLE ENGINES MORE THAN NECESSARY WITHIN AN ENCLOSED SPACE WITHOUT SUITABLE EXTRACTION EQUIPMENT OPERATING.

CAUTIONS

JACKING OF VEHICLE. The handbrake acts on the transmission, not on the rear wheels. When jacking the vehicle, apply handbrake, engage first gear and ensure wheels are chocked.

Ser	Task	Maintenance Interval			
		A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)
1	Examine the vehicle for obvious signs of damage, oil leaks, fuel leaks and defects.	X	X		
2	Ensure that the vehicle has sufficient fuel, oil and coolant for the journey or task.	X			

(continued)

TABLE 6 DRIVER/OPERATOR MAINTENANCE (continued)

Ser	Task	Maintenance Interval			
		A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)
3	Doors, locks, safety catches and bonnet catches: Examine and operate.	X			
4	Windows and windscreen: Examine and operate.	X			
5	Rear view mirrors: Examine for any cracks and deterioration of reflective surfaces.	X			
6	Seat belts and attachments: Examine and operate.	X			
7	Fire extinguisher(s): Ensure vehicle is fitted with serviceable extinguisher(s) (if fitted).	X			
8	All lights, horn windscreen wipers and washers, directional indicators, hazard warning lamps, heaters and demisters, instruments and gauges: Ensure correct operation and check for damage.	X			
9	Windscreen washer reservoir: Check level and replenish as necessary.	X			
10	Spare wheel carrier/stowage: Examine for security of attachment and damage.	X			
11	Tyres (including spare wheel): Examine for cuts and other damage, check tread depth.	X			
12	Check tyre pressures (including spare wheel).			X	
13	Wheels: Visually examine for security.	X			
14	Registration marker and legal plates: Examine.	X			
15	Reflectors: Examine for damage and security of attachment.	X			
16	Towing pintle: Examine and ensure that locking latch is free, locking pins are in place and attached by securing chains.	X			
17	Special to role type fittings: Examine (if applicable).	X			
18	Alternators 12/24 V drive belts: Examine for fraying.	X			
19	Power steering reservoir where fitted: Check level and replenish as necessary.	X			
20	Power steering drive belt where fitted: Examine for fraying.	X			
21	Brake and clutch reservoir: Check levels and replenish as necessary (OX 8).	X			
22	Batteries: Examine, check electrolyte level and replenish as necessary, including radio batteries. Ensure terminals are coated with protective (PX7).			X	
23	CES equipment carried on the vehicle: Examine.	X			
24	Carry out a short mobile functional test in order to confirm the serviceability of all functions of starting, driving through the gears, braking and steering.	X			
25	Fuel cap, seal and locating lugs: Examine for damage and security of attachment. If the seal, cap or lugs are damaged, report the vehicle unserviceable.	X			
26	ADP 658A/FMT658A/FMT1001/FMT1001A (Duty movement authorisation/driver tasking sheet) as appropriate: Sign.	X			
27	Report all damage or faults occurring during use.		X		

TABLE 7 TIME/USAGE MAINTENANCE

Table 7 Maintenance is to be carried out by the tradesmen and at the intervals shown at Pages 2 and 3, Para 10.1 of this publication.

The following WARNINGS, CAUTIONS and Maintenance Notes must be read and understood before commencing these maintenance tasks.

WARNINGS

(1) HEALTH HAZARD. DO NOT USE AN AIRLINE TO CLEAR BRAKE OR CLUTCH DUST WHICH CONTAINS MATERIALS HAZARDOUS TO HEALTH.

(2) HEALTH HAZARD. FLUID AL 11 IS HIGHLY INFLAMMABLE. THE PREPARATION OF THE FLUID FOR WINDSCREEN WASHERS IS TO BE CARRIED OUT IN THE OPEN AND AWAY FROM NAKED FLAME. MINIMUM PRECAUTION AFTER USE IS TO WASH ANY AFFECTED SKIN AREAS WITH SOAP AND WATER.

(3) HEALTH HAZARD. FLUID AL 39 IS BOTH TOXIC AND HAZARDOUS. REFER TO LOCAL UNIT ORDERS OR DCIs FOR FULL SAFETY PROCEDURES. MINIMUM PRECAUTION AFTER USE IS TO WASH ANY AFFECTED SKIN AREAS WITH SOAP AND WATER.

(4) HEALTH HAZARD. USED ENGINE OIL IS HAZARDOUS TO HEALTH. PROLONGED SKIN CONTACT SHOULD BE AVOIDED.

(5) HEALTH HAZARD. THE HANDLING OF FUELS, LUBRICANTS AND ASSOCIATED PRODUCTS CAN BE HAZARDOUS. REFER TO UNIT STANDARD OPERATING PROCEDURES, SAFETY PROCEDURES, INSTRUCTIONS ON CONTAINERS AND ALL OTHER RELEVANT REGULATIONS FOR FULL OPERATIONAL SAFETY PROCEDURES.

(6) HEALTH HAZARD. EXHAUST FUMES ARE HAZARDOUS; DO NOT RUN VEHICLE ENGINES MORE THAN NECESSARY WITHIN AN ENCLOSED SPACE WITHOUT SUITABLE EXTRACTION EQUIPMENT OPERATING.

(7) FIRE HAZARD. FUEL SPILLAGES ARE HIGHLY INFLAMMABLE AND MUST NOT BE EXPOSED TO A NAKED FLAME, SPARK OR INTENSE HEAT SOURCES. WIPE UP ALL SPILT FUEL IMMEDIATELY AND DISPOSE OF CONTAMINATED CLEANING MATERIAL ACCORDING TO LOCAL STANDING ORDERS.

(8) PERSONAL INJURY. EXTREME CARE MUST BE TAKEN WHEN DRAINING HOT ENGINE OIL; HOT ENGINE OIL CAN CAUSE SEVERE PERSONAL INJURY.

(9) PERSONAL HYGIENE. WHERE NECESSARY, WEAR PROTECTIVE CLOTHING/ APPARATUS, APPLY BARRIER CREAM AND OBSERVE NORMAL PERSONAL HYGIENE.

CAUTIONS

(1) JACKING OF VEHICLE. The handbrake acts on the transmission, not on the rear wheels. When jacking the vehicle, apply handbrake, engage first gear and ensure wheels are chocked.

(2) BRAKES. Diesel engine vehicles must not be operated with the brake servo hose disconnected.

(3) FUELS. When changing to low temperature fuels, ensure that the fuel pump and fuel lines are filled with low temperature fuel.

MAINTENANCE NOTE

The relative position of the front propeller slip joint is indicated by arrows. The arrows must be in line to position the trunnions correctly.

TABLE 7 TIME/USAGE MAINTENANCE (continued)

(3) When replenishing the engine coolant, warm up the vehicle to normal operating temperature after bleeding the cooling system, then switch on the heater for a short time with the vehicle heating system set to "warm" and the slowest fan position. Recheck coolant level. (Winterised version only).

Ser	Task	Fig 1 Item No.	Product	Maintenance Period				
				1st	A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Engine: Drain engine oil, replace filter and replenish. See Table 5, Ser 2.	13	OMD 90	X				1
2	Engine mountings: Examine.			X		X	X	1
3	Air cleaner: Clean and examine dump valve. Replace filter element.					X	X	1
4	Heater air intake dump valve: Examine and clean					X	X	1
5	Fuel system: Examine fuel tank(s), fuel lines, taps and connections for leaks, corrosion and chaffing.			X		X	X	1
6	Coolant system: Examine radiator, mountings and hoses for leaks, corrosion and chaffing.			X		X	X	1
7	Viscous fan drive: Examine. (VM)			X		X	X	1
8	Alternator and power steering (where fitted) drive belts: Examine for fraying and check tension. (VM)			X	X	X	X	1
9	Exhaust system: Examine.			X		X	X	1
10	Engine idling speed: Check and adjust as necessary. (VM)			X		X	X	1
11	Engine controls: Examine, operate and lubricate.		OMD 90	X	X	X	X	1
12	Flywheel housing: Drain (only if wading plug fitted).			X	X	X	X	1
13	Exhaust emission: Carry out smoke test. (VM)			X		X	X	1
14	Valve clearances: Check and adjust as necessary. (VM)			X			X	1
15	Cooling system: Drain flush and replenish (see Table 5, Ser 4). (For winterised variants, see Maintenance Note 3).		AL 39					1
16	Heater water radiators: Examine for leaks, corrosion, damage and security of attachment. (Winterised version only). (VM)			X		X	X	1
17	Webasto heater: Examine for leaks, damage and security of attachment. (Winterised version only). (VM)			X		X	X	1
18	Webasto heater: Clean the combustion air and exhaust pipes. Check CO_2 value and adjust as necessary. (Winterised version only). (VM)			X		X	X	1

(continued)

TABLE 7 TIME/USAGE MAINTENANCE (continued)

Ser	Task	Fig 1 Item No.	Product	Maintenance Period				
				1st	A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
19	Engine timing cover filter: Remove filter, clean and refit. (VM)				X	X	X	1
22	Fuel filter(s): Replace.						X	1
21	Fuel sediment bowl: Drain, clean and refit.			X	X	X	X	1
22	Fuel lift pump: Examine.				X	X	X	1
23	Fuel injection pump: Examine			X		X	X	1
24	Replace camshaft timing belt. (VM). See Table 5, Ser 3.							1
25								
26								
27								
28								
	MK 6(b) DIESEL ENGINE							
29	Engine breather system: Remove oil cyclone and depression valve, clean and refit. (VM)					X	X	1
30								
31								
	STEERING AND SUSPENSION							
32	Steering wheel, column, linkage, ball joints and universal joints: Examine, lubricate and check torque settings of UJ bolts. (VM)		XG 279	X	X	X	X	2
33	Steering box: Examine, check oil level and replenish as necessary.	1	OEP 220	X	X	X	X	2
34	Steering swivel pin housing: Refer to AESP 2320-D-122-821 Gen Instr No. 87.	2						2
35	Coil springs, pins rebound pads and brackets: Examine. (VM)			X		X	X	2
36	Panard rod, radius arms, link rods, bushes and pins: Examine. (VM)			X		X	X	2
37	Anti-roll bar, bushes, ball joints and link assembly: Examine. (VM)			X		X	X	2
38	Fulcrum bracket ball joint: Examine and lubricate. (VM)	10	XG 279	X	X	X	X	2
39	Shock absorbers, mountings and bushes: Examine. (VM)			X		X	X	2
40	Wheel nuts: Check tightness to recommended torque setting. (VM)			X	X	X	X	2

(continued)

TABLE 7 TIME/USAGE MAINTENANCE (continued)

Ser	Task	Fig 1 Item No.	Product	Maintenance Period				
				1st	A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
41	Wheels and tyres including spare: Examine particularly for correct type of tyre. Check tyre pressures.			X	X	X	X	2
42	Front wheel hub bearings: Check and adjust as necessary. (VM)			X		X	X	2
43	Front wheel alignment: Check and adjust as necessary. (VM)			X		X	X	2
44								
45	**TRANSMISSION**							
46	Gearbox: Examine, check oil level and replenish as necessary.	12						
	46.1 LT77 gearbox.		OX 75	X	X	X		3
	46.2 R380 gearbox from VIN LA 939975.		MTF94		X	X		3
47	Gearbox: Examine, drain and replenish. (Remove and clean filter LT77 gearbox only)	12						
	47.1 LT77 gearbox.		OX 75				X	3
	47.2 R380 gearbox from VIN LA 939975 (see table 5, serial 5).		MTF94					
48	Transfer box: Examine, check oil level and replenish as necessary.	11	OEP 220		X	X		3
49	Transfer box: Examine, drain and replenish.	11	OEP 220				X	3
50	Gear/transfer box, control levers and linkage: Examine and lubricate.		OMD 90	X	X	X	X	3
51	Clutch pedal and operating mechanism: Examine, operate and check free play.			X		X	X	3
52	Propeller shafts: Examine and lubricate U/Js and sliding joint. Check security of flange bolts.	7	XG 279	X	X	X	X	3
53	Front and rear axles: Examine, check breather pipes for damage. Check oil level and replenish as necessary.	4,8	OEP 220	X	X	X		3
54	Front and rear axles: Drain and replenish.	4,8	OEP 220				X	3
55	Rear axle hub bearings: Check and adjust as necessary. (VM)			X	X	X	X	3
56								
57								

(continued)

TABLE 7 TIME/USAGE MAINTENANCE (continued)

Ser	Task	Fig 1 Item No.	Product	Maintenance Period				
				1st	A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
58	**BRAKES**							
59	Brake pipes and hoses: Examine.			X		X	X	4
60	Brake pedal and operating mechanism: Examine, operate and check free play. (VM)			X		X	X	4
61	Brake master cylinder: Examine. (VM)				X	X	X	4
62	Brake vacuum pump: Examine. (VM)			X	X	X	X	4
63	Brake servo: Examine. (VM)			X	X	X	X	4
64	Change brake fluid. Record fluid change in vehicle docs. (VM)	5	OX 8				X	4
65								
66	Front brake callipers, friction pads and discs: Examine. (VM)			X	X	X	X	4
67	Rear drum brakes: Remove drums, clean and examine, check brake linings, examine wheel cylinders, refit drums and adjust brakes as necessary. (VM)				X	X	X	4
68	Rear disc brakes: Examine callipers, friction pads and discs. (VM)			X	X	X	X	4
69	Transmission brake: Examine and adjust as necessary. Lubricate linkage. (VM)		OMD 90	X	X	X		4
70	Transmission brake: Remove brake drum, inspect, adjust as necessary. Lubricate linkage. (VM)		OMD 90				X	4
71	Brake system: Carry out roller brake test or decelerometer test (RAF in accordance with AP 4545, Vol 2, Leaflet A64). (VM)				X	X	X	4
72								
73	**ELECTRICS**							
74	Battery area: Examine, restore surface finish as required.			X	X	X	X	5
75	Starter motor: Examine for security.			X		X	X	5
76	Alternator 12 V: Examine, check output. (VM)			X		X	X	5
77	Alternator 24 V: Examine, check output and lubricate as necessary. (VM)		XG 279	X	X	X	X	5
78	Electrical wiring, junction boxes and conduit: Examine for signs of burning, chaffing or other damage and for security of attachments. (VM)				X	X	X	5

(continued)

TABLE 7 TIME/USAGE MAINTENANCE (continued)

Ser	Task	Fig 1 Item No.	Product	Maintenance Period				
				1st	A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
79	Lamps, horn, windscreen wipers/ washers, direction indicators and hazard flashers: Examine and ensure correct operation.			X	X	X	X	5
80	Heaters and demisters: Examine and operate.			X	X	X	X	5
81	Reflectors: Examine.			X	X	X	X	5
82	Switches and warning devices: Examine.			X	X	X	X	5
83	Instruments, gauges and transmitters: Examine and operate.			X	X	X	X	5
84	Fuses: Examine fuse box and check for correct rating.			X	X	X	X	5
85	Engine stop controls: Examine and operate.			X	X	X	X	5
86	Headlamp alignment: Check adjustment (RAF in accordance with AP 4545, Vol 2, Leaflet A13). (VM)			X	X	X	X	5
87	Intervehicle start socket and cable: Test insulation and operation. (Winterised version only). (VM)			X	X	X	X	5
88	Front and rear screen heaters: Examine, ensure correct operation. (Winterised version only).			X	X	X	X	5
89	Check all visible harness cables to confirm they are free from damage (cuts/fretting etc).	See Annex A				X	X	5
90	**BODY AND CHASSIS**							
91	Body, interior and exterior: Examine.			X		X	X	6
92	Chassis and cross member bolts. Examine.			X		X	X	6
93	Doors, locks, hinges and stay: Examine and lubricate.		OMD 90	X	X	X	X	6
94	Bonnet, lock, hinges and stay: Examine and lubricate.		OMD 90	X	X	X	X	6
95	Tailboard, hinges, chains and lockpins: Examine and lubricate.		OMD 90	X	X	X	X	6
96	Mudguards and bumper bars: Examine.			X	X	X	X	6
97	Tilt frame and canvas cover: Examine.			X	X	X	X	6
98	Seat belt mountings, seat belts and buckles: Examine.			X	X	X	X	6
99	Seats and seat adjusters: Examine.			X	X	X	X	6
100	Wiper arms and blades: Examine.			X	X	X	X	6

(continued)

TABLE 7 TIME/USAGE MAINTENANCE (continued)

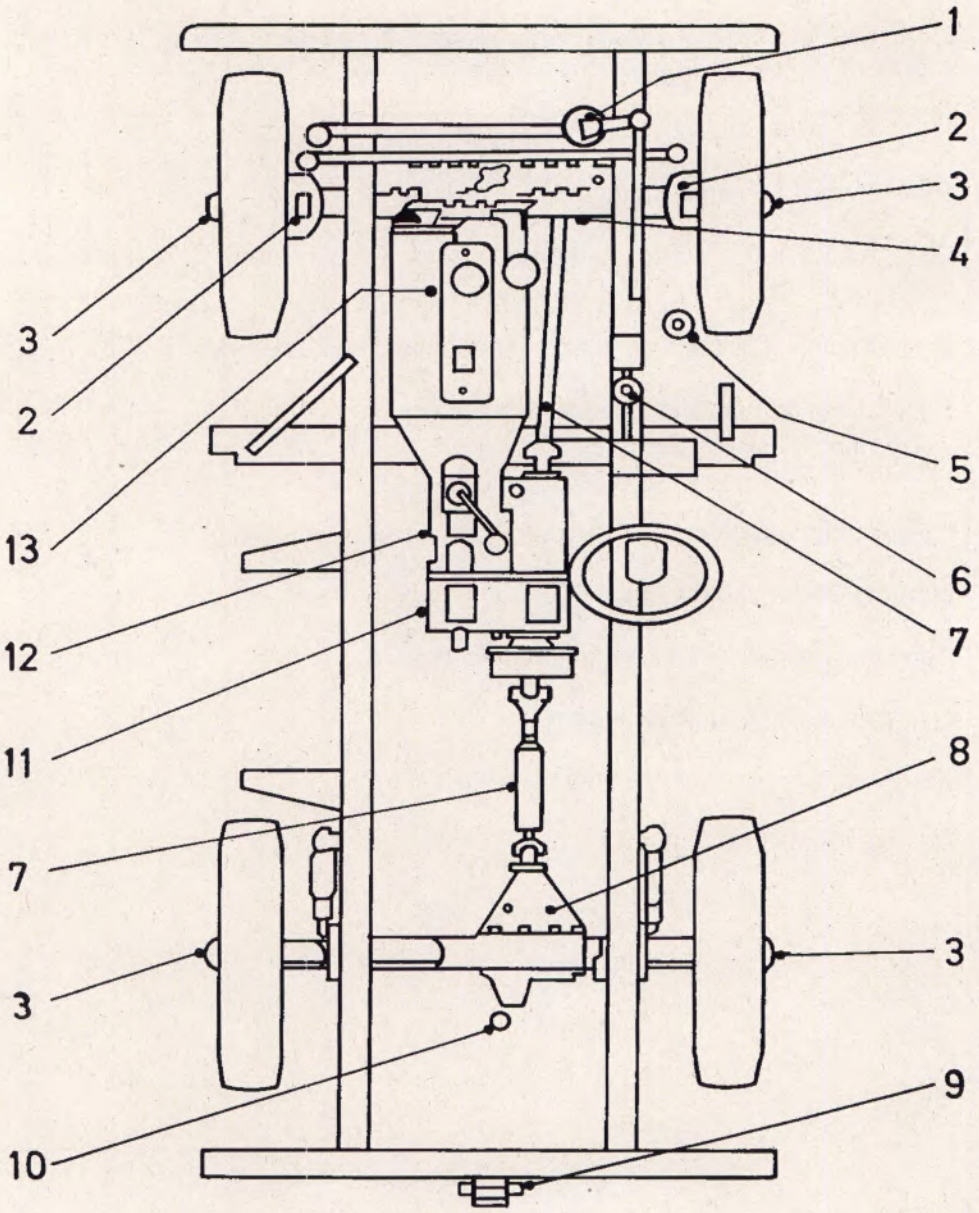
Ser	Task	Fig 1 Item No.	Product	Maintenance Period				
				1st	A	B	C	D
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
101	Rear view mirror(s): Examine.			X	X	X	X	6
102	Windscreen and windows: Examine.			X	X	X	X	6
103								
104	Fire extinguisher(s): Ensure fire extinguisher(s) is/are serviceable (if fitted).			X	X	X	X	6
105	Special to role type fittings: Examine.			X	X	X	X	6
106	Equipment lockers: Examine.			X	X	X	X	6
107	Rear towing attachment: Examine. Ensure locking latch is free, locking pins in place and attached by securing chains. Lubricate.		OMD 90 XG 279	X	X	X	X	6
108	Legal/warning plates: Examine, check security of attachment.			X	X	X	X	6
109	Oil can lubrication: General lubrication of all catches, controls, pivot pins, locks, linkage and pins. Towing pintle.	9	OMD 90	X	X	X	X	6
110	Rear access ladder: Examine. (Heli Support Variants).			X	X	X	X	6
111	Roof mounted servicing platform, hinges, chains, locking pins: Examine and lubricate. (Heli Support Variants).		OMD 90	X	X	X	X	6
112	Vehicle body interior: Examine for condition and security of attachment to fall screen blinds. (Winterised version only).			X	X	X	X	6
113	Vehicle body interior: Examine for condition of insulating panels, matting and security of attachment. (Winterised version only).			X	X	X	X	6
114	Observation hatch: Examine for condition of rubber seal and function of locking mechanism. (Winterised version only).			X	X	X	X	6
115								
116								
117	Road test: Check steering, brakes and performance. (NCO MT Technician or VM)			X	X	X	X	All
118	Record action in AB 562/FMT 1004 (Army only).			X	X	X	X	All
119	Sign AF G1084A or STAMA Worksheet (RAF only).			X	X	X	X	All
120								
121								

TABLE 8 OUT OF USE MAINTENANCE

Table 8 Maintenance is to be carried out in accordance with the instructions shown at Page 3, Para 11.1 and 11.2.

WARNINGS, CAUTIONS and Maintenance Notes preceding Tables 6 and 7 must be read and understood before commencing these maintenance tasks.

Serial (1)	Operation (2)
	Prior to vehicle entering storage:
1	Carry out Table 6, Columns A, B and C maintenance, check coolant specific gravity and patch paint.
2	Carry out next maintenance due if it falls during out of use period.
3	Rectify all faults affecting road/task worthiness.
4	Fill fuel tanks.
5	Isolate batteries by master switch or disconnecting earth lead.
	Monthly whilst vehicle in storage.
6	Carry out Table 6, Columns A and B maintenance.
7	Operate equipment and all systems.
8	Carry out road test over 8 km (5 miles) if possible.
9	Update AB 562/FMT 1004.



V7289/1

Fig 1 Lubrication diagram

ANNEX A

LAND ROVER 90/110/127 ALL VARIANTS (EXCLUDING APV, SAS AND CRASH RESCUE AMBULANCE)

WIRING HARNESS FITTING REMINDERS

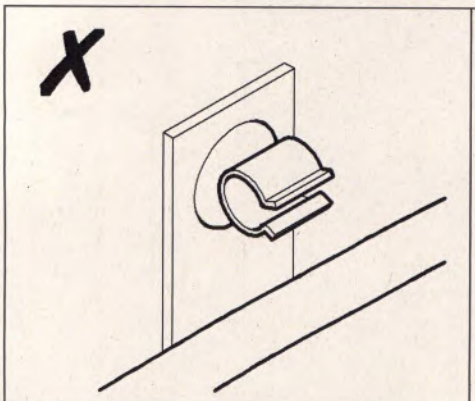
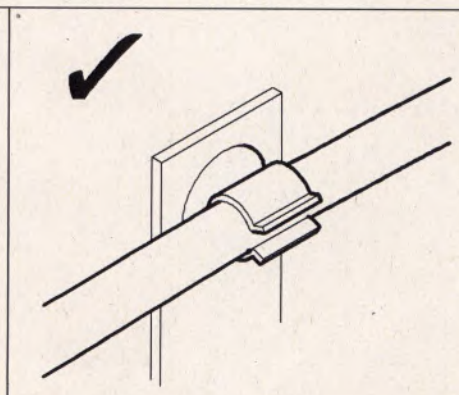
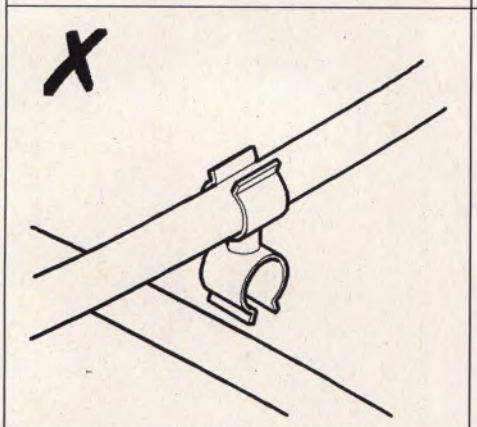
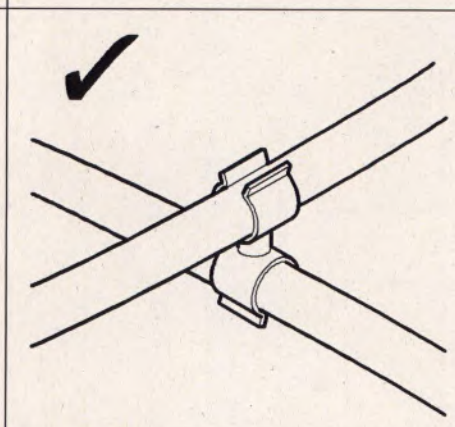
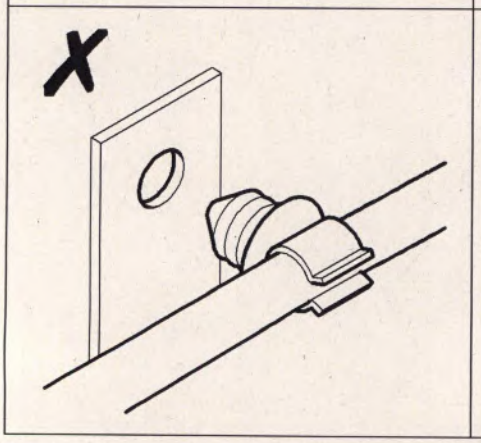
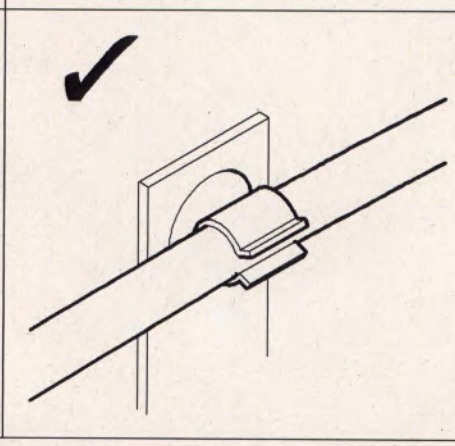
Para

Table Page

INTRODUCTION

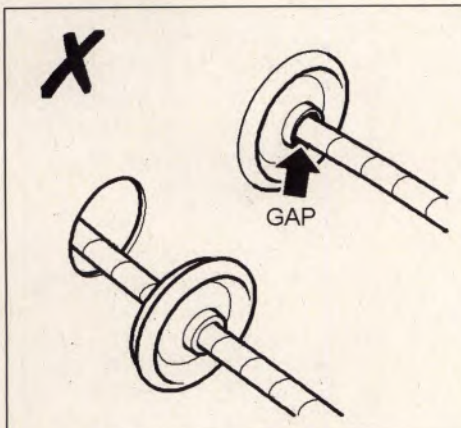
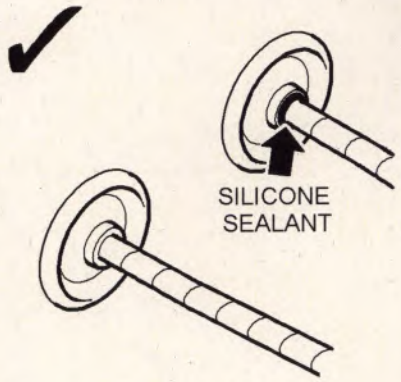
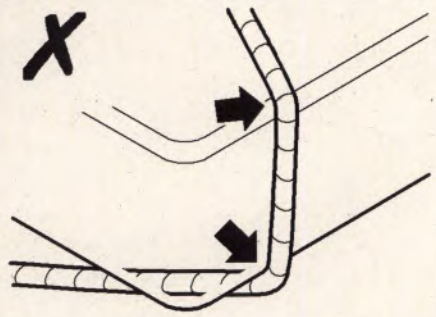
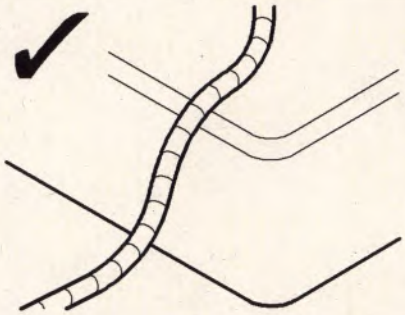
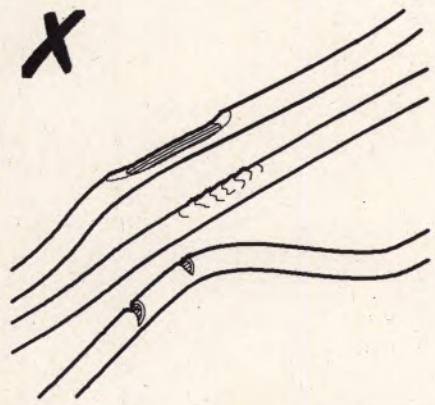
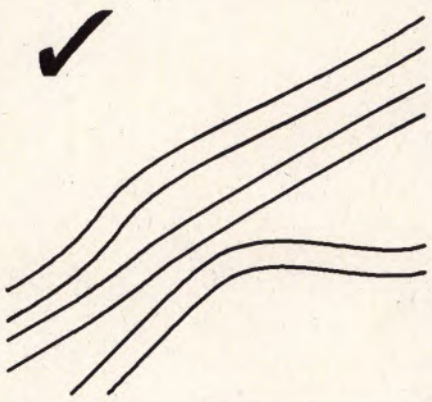
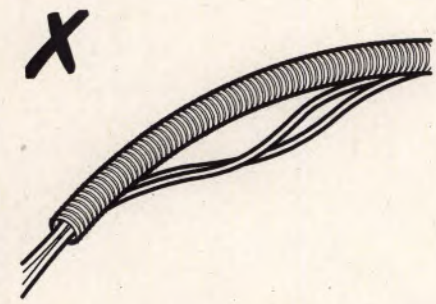
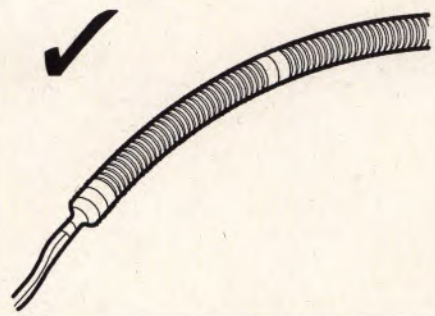
1 This Annex details the correct fitting of wiring harnesses and cables. See Table 1.

TABLE 1 FITTING REMINDERS

		Ensure cables and harnesses are secured into cable clips when fitted.
		Ensure that cables are clipped into cradle clips.
		Ensure cable clips are secured to panels/brackets.

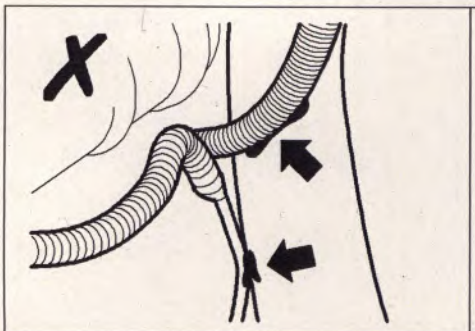
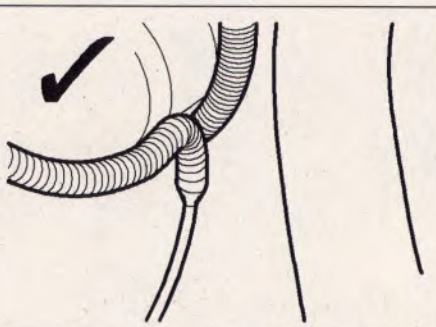
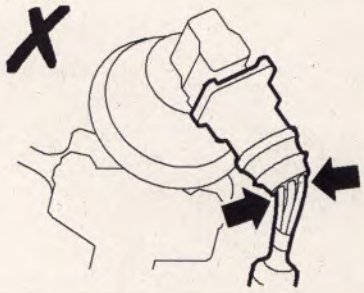
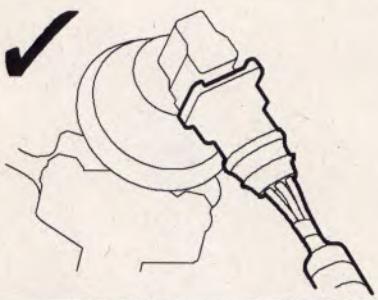
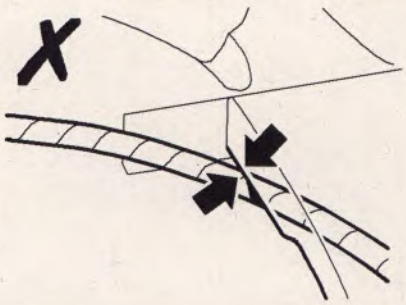
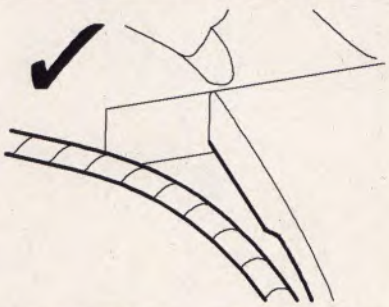
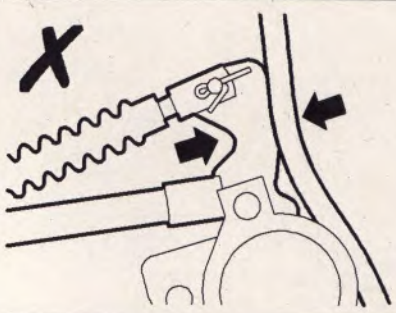
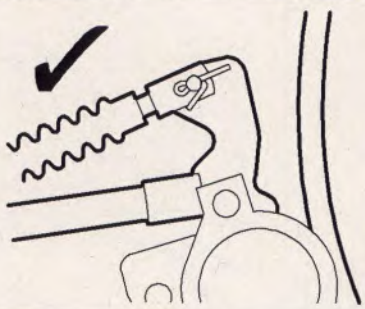
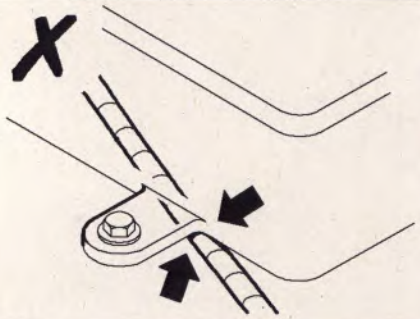
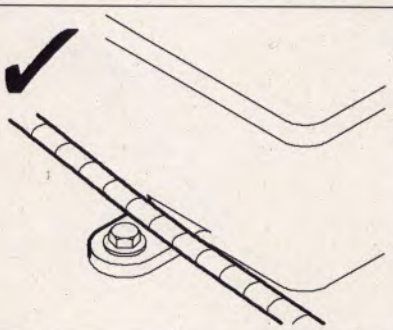
(Continued)

TABLE 1 FITTING REMINDERS (continued)

		Ensure grommets are fitted correctly. Fill any gaps between grommets and cables with silicone sealant.
		Ensure cables are routed correctly.
		Route cables so that cuts and fretting to cables is avoided.
		Ensure cables are correctly fitted into protective tubing.

(Continued)

TABLE 1 FITTING REMINDERS (continued)

		Ensure wiring harnesses and cables do not come into contact with exhaust pipes and other hot components.
		Ensure that wiring and connectors are not strained.
		Ensure that cables do not run across sharp edges.
		Ensure that cables do not interfere with the operation of moving parts.
		Ensure that cables are not trapped under components.

ARMY EQUIPMENT
SUPPORT PUBLICATION

2320-D-122-601

COMMENT(S) ON AESP*

To: FRACAS
BFPO 794

From: .....
.....
.....
.....

Sender's Reference	BIN Number	Date
AESP* Title:		
Chapter(s)/Instruction	**Page(s)/Paragraph(s)**	
If you require more space, please use the reverse of this form or a separate piece of paper. **Comment(s):**		

Signed: ..... Telephone No.: .....

Name (Capitals): ..... Rank/Grade: ..... Date: .....

✂.....

FOR AESP* SPONSOR USE ONLY

To: .....
.....
.....
.....

From: .....
.....
.....
.....

Thank you for commenting on AESP*: .....

Your reference: ..... Dated: .....

Action is being taken to:	Tick		Tick
Issue a revised/amended AESP*		Under investigation	
Incorporate comment(s) in future amendments		No action required	
Remarks			

Signed: ..... Telephone No.: .....

Name (Capitals): ..... Rank/Grade: ..... Date: .....

* AESP or EMER
AESP Form 10 (Issue 5.0 dated Dec 01)

LAND ROVER 90/110/127 ALL VARIANTS (EXCLUDING APV, SAS AND 127 CRASH RESCUE AMBULANCE)

REPAIR INSTRUCTIONS

REPRINTED INCORPORATING AMDTS Nos 1 to 3

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence
Issued by
ARMY TECHNICAL SUPPORT AGENCY
Directorate of Technical Services

AMENDMENT RECORD

Amdt No.	Incorporated By (Signature)	Date
1	[redacted]	5/91
2	[redacted]	4/5/96
3	[redacted]	4/5/96
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

Amdt No.	Incorporated By (Signature)	Date
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		

CONTENTS

PREFACE

Sponsor:
DGES(A)
File ref: D/DGES(A)548/3/3 ES52c

Publication Agency:
ATSA Chertsey
Project No: ES52c4293(217)
File ref: ES52c/4293/AESP/BVP

INTRODUCTION

1 Service users should forward any comments on this publication through the channels prescribed in AESP 0100-P-011-013. An AESP Form 10 is provided at the end of this publication; it should be photocopied and used for forwarding comments on this AESP.

2 The subject matter of this publication may be affected by Defence Council Instructions (DCIs), Standard Operating Procedures (SOPs) or by local regulations. When any such instruction, order or regulation contradicts any portion of this publication it is to be taken as the overriding authority.

RELATED AND ASSOCIATED PUBLICATIONS

Related publications

3 The Octad for the subject equipment consists of the publications shown below. All references are prefixed with the first eight digits of this publication. The availability of the publications can be checked by reference to the relevant Group Index (see AESP 0100-A-001-013).

Category/Sub-category			Information Level			
			1 User/ Operator	2 Unit Maintenance	3 Field Maintenance	4 Base Maintenance
1	0	Purpose and Planning Information	101	*	*	*
	1	Equipment Support Policy Directives	*	*	*	*
	2	Purpose and Planning Information, Medical and Dental	*	*	*	*
2	0	Operating Information	201	*	*	*
	1	Aide Memoire	*	*	*	*
	2	Training	*	*	*	*
3		Technical Description	*	302	*	*
4	1	Installation Instructions	411	*	*	*
	2	Preparation for Special Environments	421	*	*	*
5	1	Failure Diagnosis	*	512	*	*
	2	Repair Instructions	*	522	*	524
	3	Inspection Standards	*	532	533	*
	4	Calibration Standards	*	*	*	*
6		Maintenance Schedule	601	*	*	*
7	1	Illustrated Part Catalogue	711	*	*	*
	2	Commercial Parts Lists	721	*	*	*
	3	Complete Equipment Schedule, Production	*	*	*	*
	4	Complete Equipment Schedule, Service Edition (Simple Equipment)	*	*	*	*
	5	Complete Equipment Schedule, Service Edition (Complex Equipment)	*	*	*	*
8	1	Modification Instruction	811	*	*	*
	2	General Instruction, Special Technical Instructions and Servicing Instructions	821	*	*	*
	3	Service Engineered Modification Instructions (RAF only)	*	*	*	*

*Category/Sub-category not published

Associated publications

4	Reference	Title
	EMER Wksp N111	Preservation, Identification and Packaging of Assemblies (including engines)
	EMER Wksp N345	Split Shell Bearings, Assembly Techniques using Pastigauge Method
	EMER T & M A 028 Chap 100	Testing Internal Combustion Engines Rover Inst No 9
	Equipment Table Scale 03498 and 03499	Land Rover Special Tools
	AESP 2920-C-102-302	Generator No. 16 Mk 1 90 AMP (Lucas CAV AC 172)

2320-D-122524
XXXX-X-XXX-XXX

ARMY EQUIPMENT
SUPPORT PUBLICATION

COMMENT(S) ON AESP

To: ATSA DTS 3.2
Ha-Ha Road
Woolwich
LONDON SE18 4QF

From: .....
.....
.....
.....

Senders Reference	BIN Number	Date
AESP Title:		
Chapter(s)/Instruction	**Page(s)/Paragraph(s)**	

If you require more space please use the reverse of this form or a separate piece of paper.
Comment(s):

Signed: ..... Telephone No.: .....

Name (Capitals): ..... Rank/Grade: ..... Date: .....

✂ .....

ATSA DTS 3.2 USE ONLY

To: .....
.....
.....
.....

From: ATSA DTS 3.2
Ha-Ha Road
Woolwich
LONDON SE18 4QF

Thank you for commenting on AESP

Your reference ..... Dated .....

Action is being taken to:	Tick		Tick
Issue a revised/amended AESP		Under investigation	
Incorporate comment(s) in future amendments		No action required	
Remarks			

Signed: ..... Telephone No.: .....

Name (Capitals): ..... Rank/Grade: ..... Date: .....

AESP Form 10 (Issue 3 dated Oct 97)

ARMY EQUIPMENT
SUPPORT PUBLICATION

Chapter 1-1

2.5 LITRE DIESEL ENGINE

CONTENTS

(continued)

CONTENTS (Cont'd)

(continued)

CONTENTS (Cont'd)

INTRODUCTION

1 This Chapter details the Base Repairs for the Land Rover 2.5 litre diesel engine, with the exception of the engine fuel and cooling systems which are dealt with in Chaps 11 and 12 respectively.

ENGINE REMOVAL FROM VEHICLE

2 To remove the engine from the vehicle refer to Cat 522 Chap 1-1 Para 2.

ANCILLARIES REMOVAL

3 Remove the engine ancillaries as follows:

3.1 Mount the engine on a suitable work stand.

3.2 Remove the 12 volt alternator and its associated mounting brackets (Cat 522 Chap 13 Para).

3.3 Remove the starter motor (Cat 522 Chap 13 Para).

3.4 Remove the inlet and exhaust manifolds.

3.5 Remove the fan and viscous coupling assembly (Cat 522 Chap 1-1 Para 45.3).

3.6 Disconnect the coolant by-pass hose from the water pump, release the securing bolts and remove the water pump.

3.7 Disconnect and remove the fuel supply pipes and the DPS pump (Cat 522 Chap 11-1 Para 3).

3.8 Remove the fuel lift pump (Cat 522 Chap 11-1 Para 70).

3.9 Remove the vacuum pump complete with DPS pump lever bracket.

3.10 Remove the oil filter assembly from the cylinder block. Unscrew the element and discard (Cat 201).

3.11 Restrain the flywheel, remove the crankshaft pulley securing bolt and withdraw the pulley.

3.12 Remove the clutch assembly (Cat 522 Chap 2 Para 3).

3.13 Remove dipstick, oil sump and oil circulation pump (Cat 522 Chap 1-1 Para's 65 and 67).

ENGINE

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	NSN/Part No where applicable (3)	Designation (4)
1	RO 274388		Drift
2	RO 531760		Adaptor
3	RO 274394		Guide plug
4	RO 274389		Reamer
5	18G 705-1A		Collets
6	RO 270304		Seal guides
7	18G 134-11	6MT2/5120-99-724-4437	Seal replacer

Dismantling

Cylinder head assembly

4 For cylinder head assembly removal, dismantling and overhaul refer to Cat 522 Chap 1-1 Para 4.

Timing covers and pulleys

5 For timing covers and pulleys removal and refitting refer to Cat 522 Chap 1-1 Para 41.

Tappet assemblies

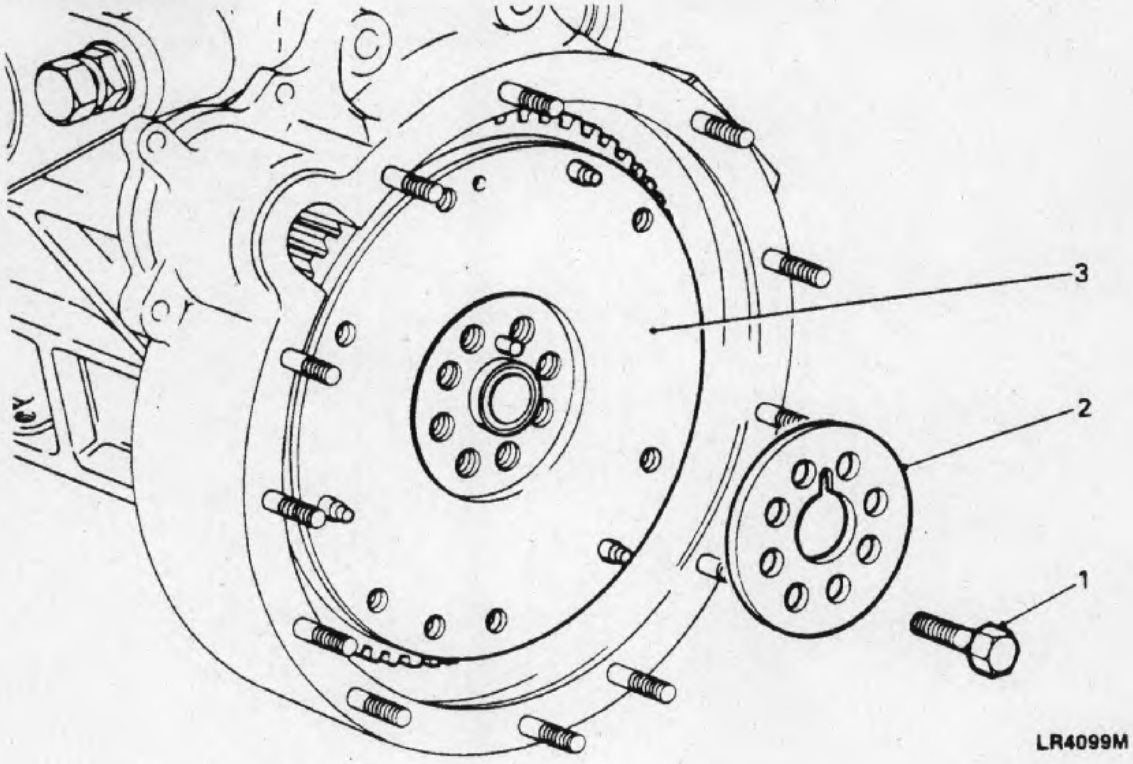
6 For tappet assemblies removal and refitting refer to Cat 522 Chap 1-1 Para 8.

Flywheel

7 Remove the flywheel retaining bolts (Fig 1 (1)) and withdraw the reinforcing plate (2) and flywheel (3).

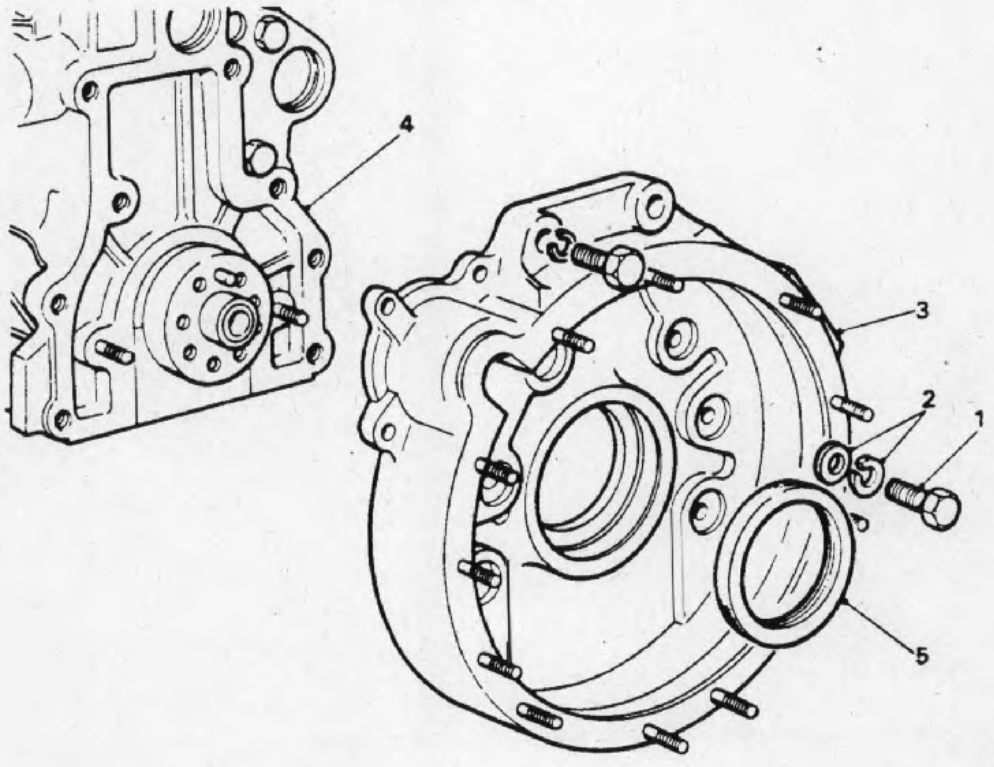
Flywheel housing

8 Remove the bolts (Fig 2 (1)) and washers (2) securing the flywheel housing (3) to the cylinder block (4), withdraw the housing and remove and discard the rear main bearing oil seal (5).



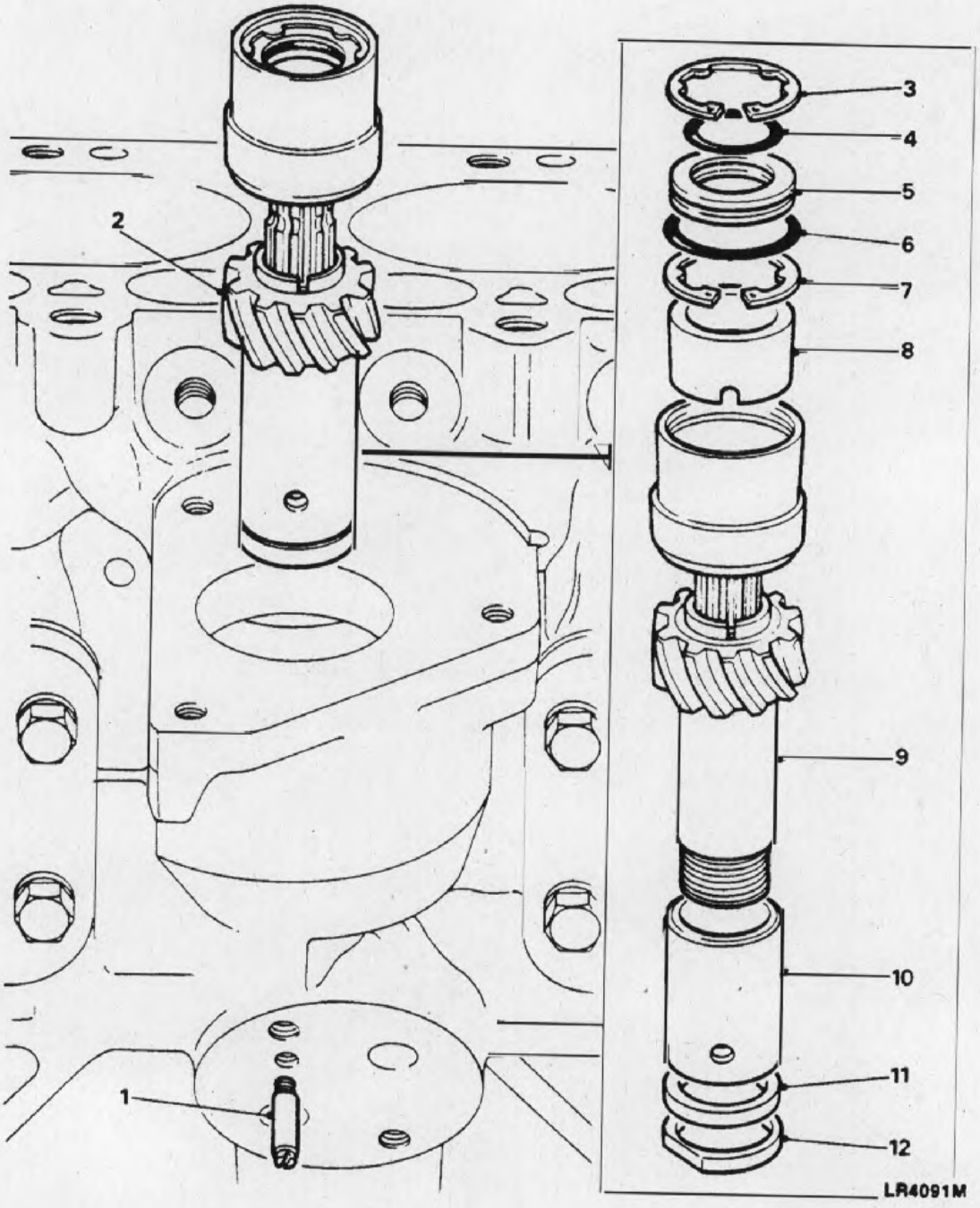
1 Retaining bolt 2 Reinforcing plate 3 Flywheel

Fig 1 Flywheel removal



1 Securing bolt 3 Flywheel housing 5 Rear main oil seal
2 Washers 4 Cylinder block

Fig 2 Flywheel housing removal



1	Locating screw	7	Lower circlip
2	Skew gear assembly	8	Sleeve
3	Upper circlip	9	Skew gear
4	Inner sealing ring	10	Bush
5	Seal collar	11	Thrust washer
6	Outer sealing ring	12	Locknut

Fig 3 Exploded view of skew gear and coupling assembly

Skew g ar and coupling

9 To remove and dismantle the skew gear and coupling proceed as follows:

9.1 Remove the skew gear bush locating screw (Fig 3 (1)) from the oil filter mounting face on the cylinder block.

9.2 Using long nosed pliers lift out the skew gear and coupling assembly (2).

9.3 Skew gear coupling, dismantling.

9.3.1 Using suitable circlip pliers remove the upper circlip (3).

9.3.2 Withdraw the seal collar (5) and remove the inner and outer sealing rings (4) and (6).

9.3.3 Remove the lower circlip (7) and remove the sleeve (8).

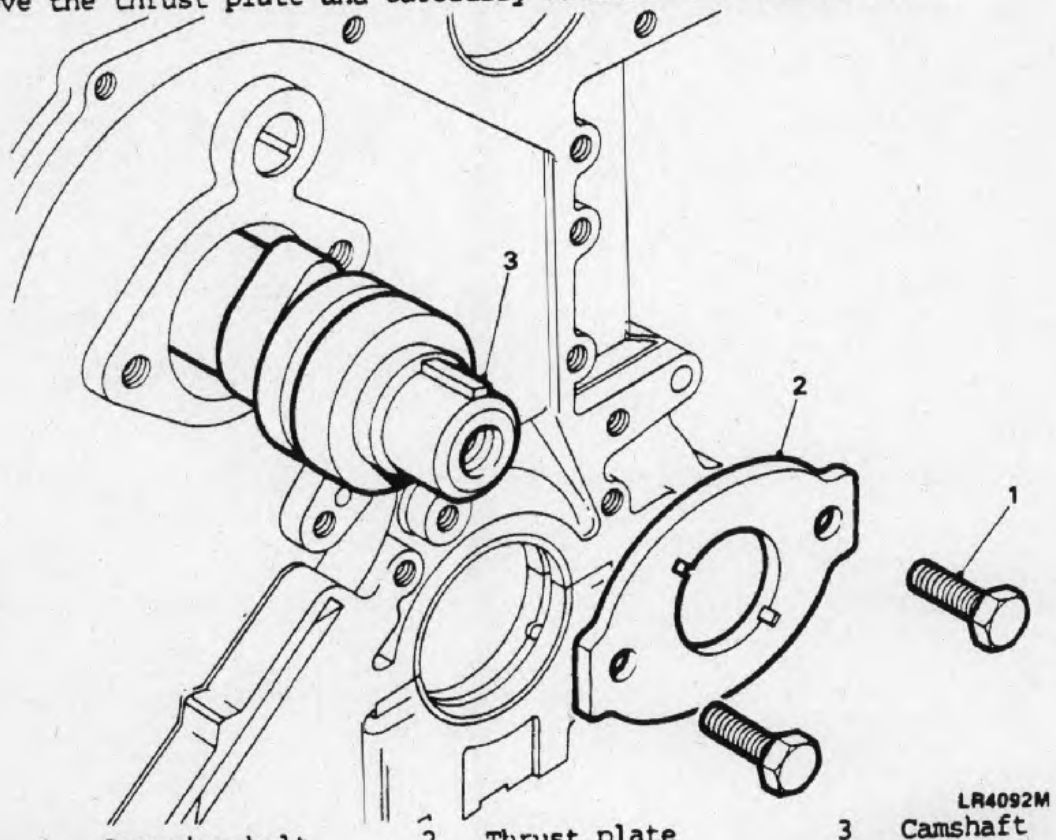
9.4 Skew gear bush, removal.

9.4.1 Hold the skew gear firmly in a soft jawed vice to prevent damage to the gear teeth. If available insert a scrap drive shaft in the gear internal splines and grip the shaft.

9.4.2 Turn the locknut (12) clockwise (left hand thread) to remove and withdraw the thrust washer (11) and bush (10) from the skew gear (9).

Camshaft

10 Remove the two bolts (Fig 4 (1)) securing the camshaft thrust plate (2), remove the thrust plate and carefully withdraw the camshaft (3).



1 Securing bolt 2 Thrust plate 3 Camshaft

Fig 4 Camshaft removal

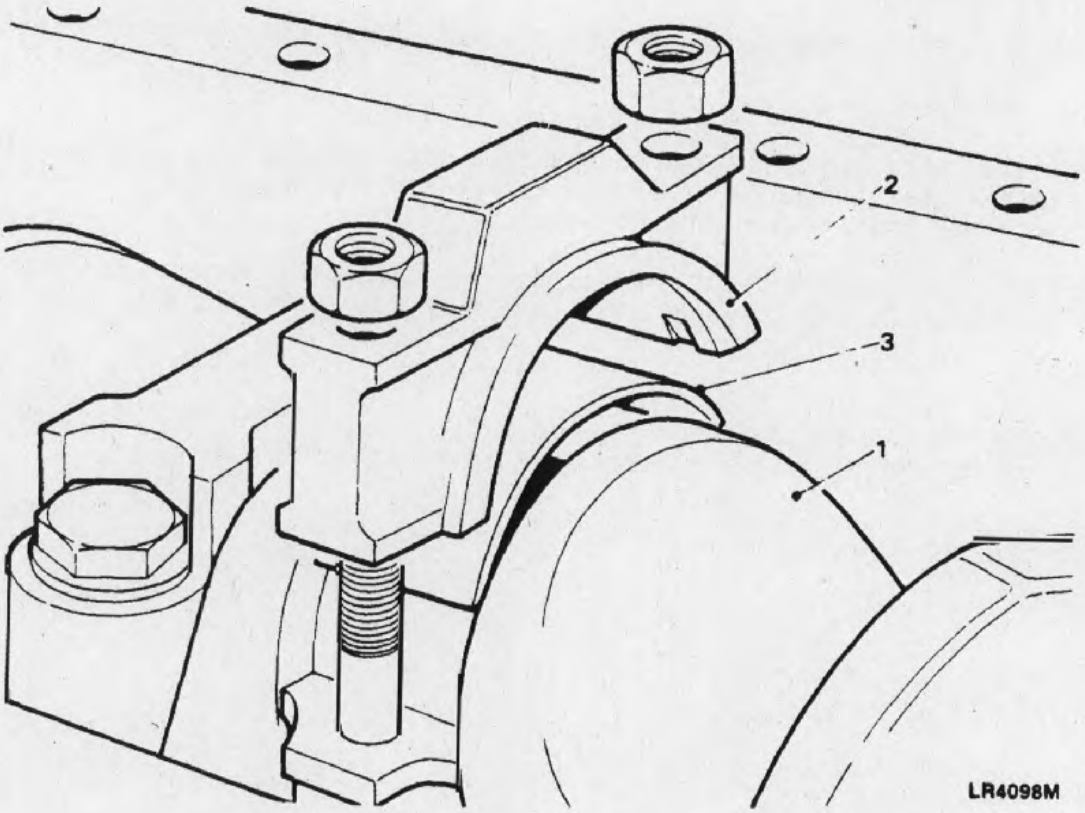
Connecting rods and pistons

11 To remove the connecting rods and pistons proceed as follows:

Not ...

Until it is decided if new components are required all parts must be kept in their related sets and the position of each piston to its connecting-rod should be noted.

11.1 Turn the crankshaft (Fig 5 (1)) to bring the connecting-rod caps (2) to an accessible position and remove each cap and lower bearing shell (3) in turn. Note that the connecting-rod caps are numbered one to four.



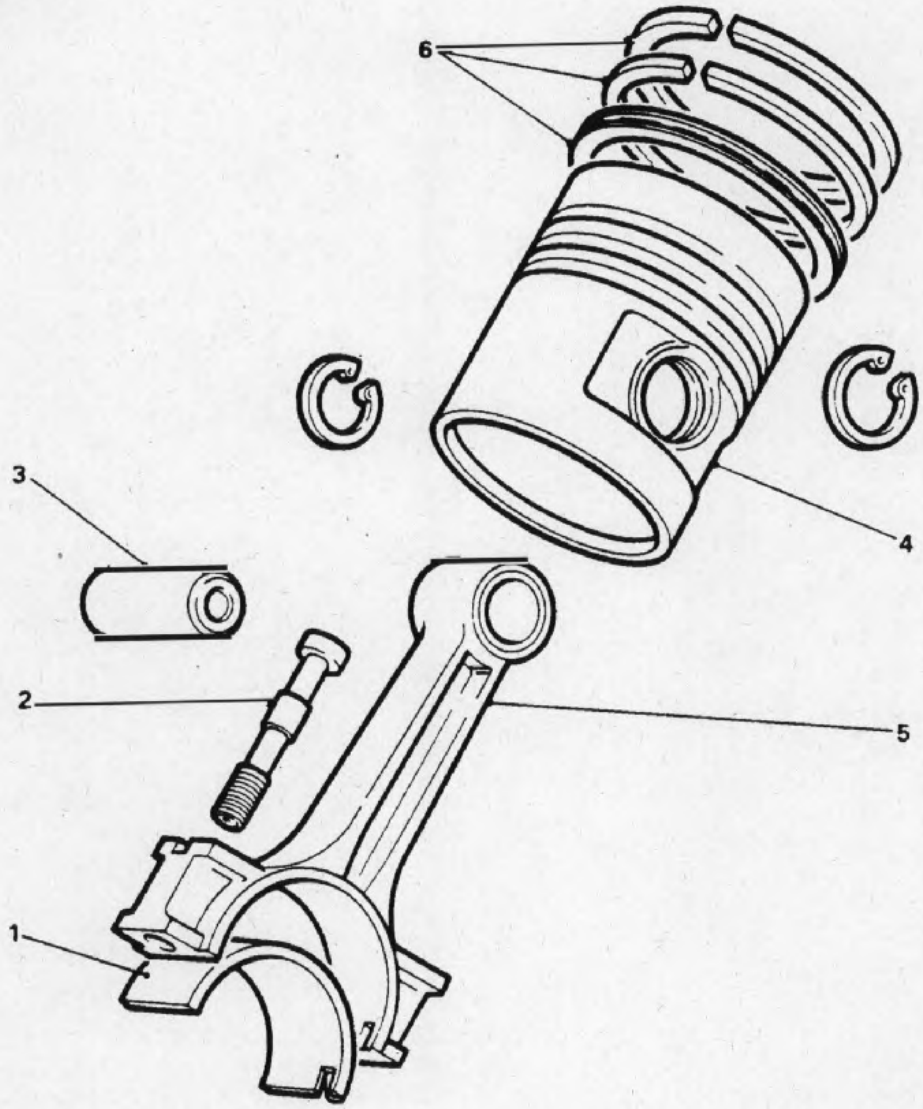
1 Crankshaft 2 Connecting-rod cap 3 Lower bearing shell

Fig 5 Connecting-rod caps removal

11.2 Push each piston assembly up the bore and withdraw from the cylinder block.

11.3 Remove the upper bearing shells (Fig 6 (1)) and the cap securing bolts (2).

11.4 Remove the gudgeon pin (3) from each piston (4) and detach the connecting-rods (5).



1	Upper bearing shell	4	Piston
2	Securing bolt	5	Connecting-rod
3	Gudgeon pin	6	Piston rings

Fig 6 Piston and connecting-rod

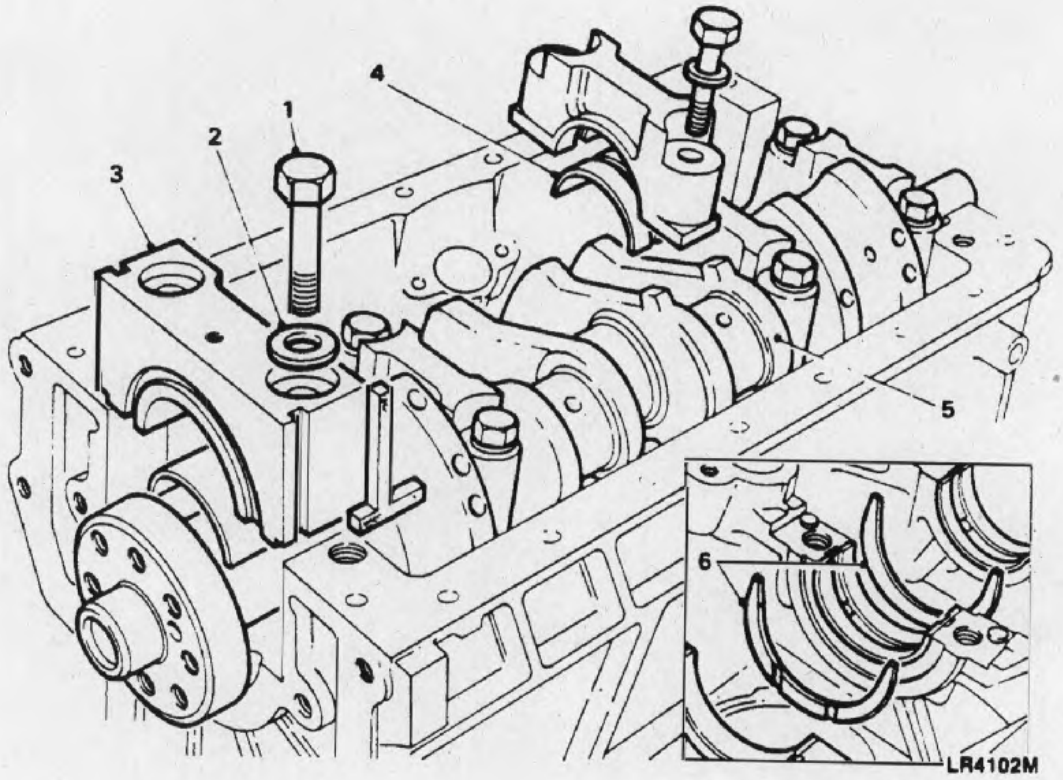
11.5 Remove the piston rings (6) and retain with their respective pistons.

Crankshaft

12 To remove the crankshaft proceed as follows:

12.1 Remove the bolts (Fig 7 (1)) and washers (2) securing the main bearing caps (3) remove the caps and lower bearing shells (4).

12.2 Lift out the crankshaft (5), collect the upper bearing shells from the saddles and the thrust washers (6) from the centre saddle.



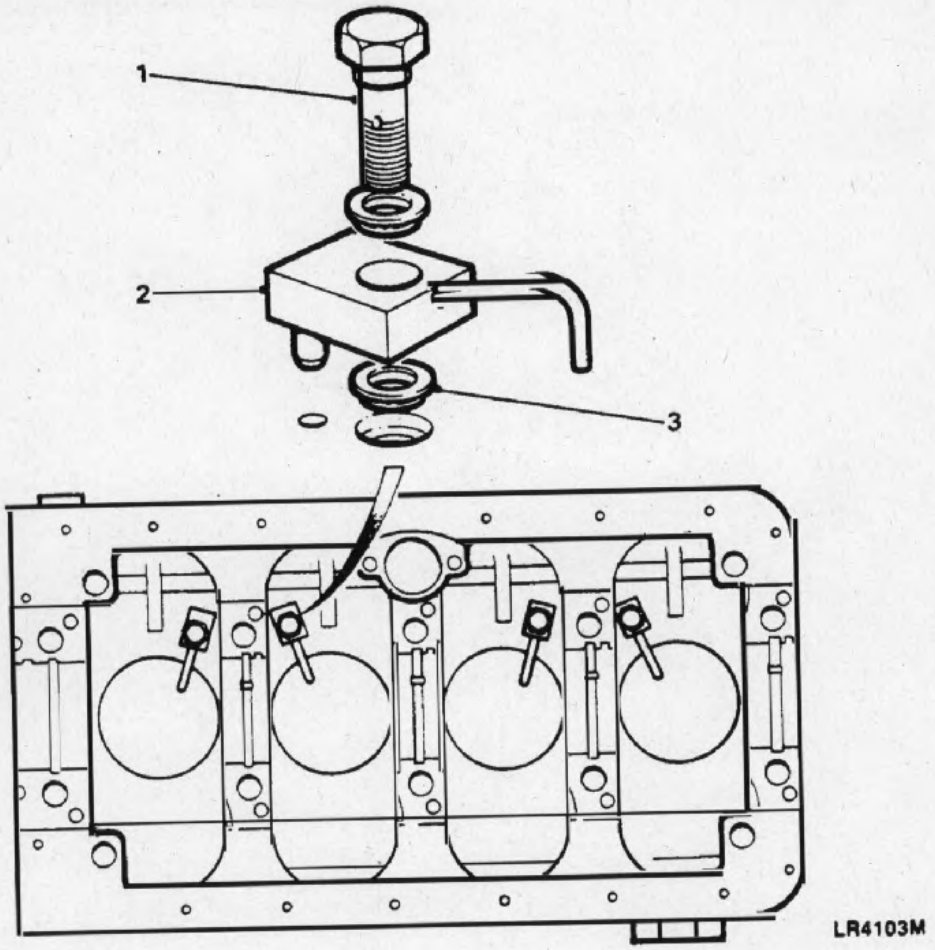
1	Bolt	4	Lower bearing shell
2	Washer	5	Crankshaft
3	Main bearing cap	6	Thrust washers

Fig 7 Crankshaft removal

12.3 Retain the bearings shells in sets identified to the location from which they were removed.

Oil jet tube assemblies

13 Remove the relief valve/securing screws (Fig 8 (1)) securing the jet tube assemblies (2) to the cylinder block. Withdraw the jet tubes and identify to the locations from which they were removed. Ensure that the washers (3), fitted under the jet tube bodies, are retrieved from the recesses in the the cylinder block.



1 Relief valve 2 Jet tube assembly 3 Washer

Fig 8 Oil jet tube assemblies

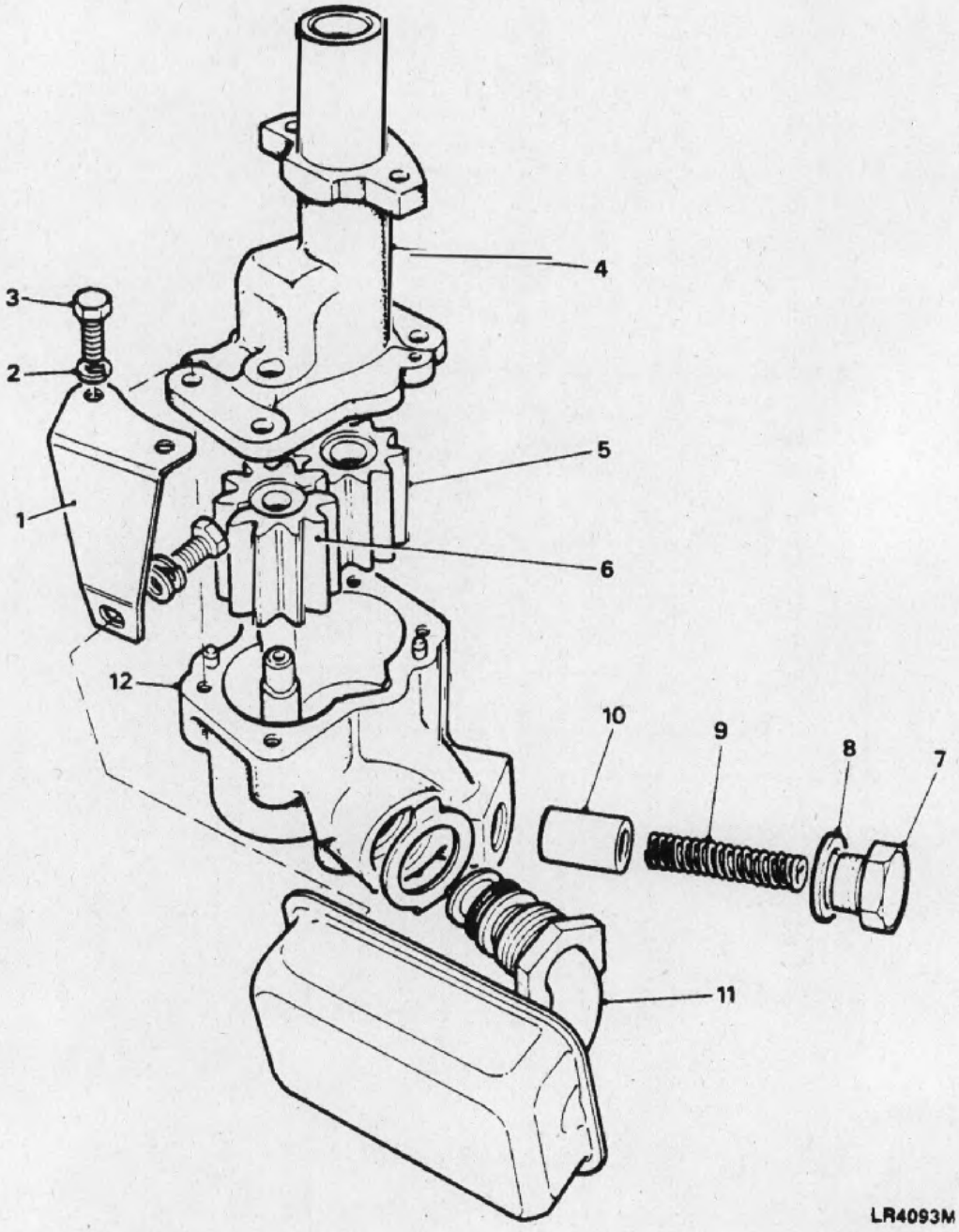
Oil pump

14 To dismantle the oil pump proceed as follows:

14.1 Remove the strainer (Fig 9 (1)) from the oil pump (Cat 522 Chap 1-2).

14.2 Remove the four bolts (3) and washers (2), lift off the oil pump cover (4) and withdraw the driven and idler gears (5) and (6) from the pump body (12).

14.3 Remove the oil pressure relief valve plug (7) sealing washer (8), and withdraw the spring (9) and plunger (10).



1	Support bracket	7	Relief valve plug
2	Washers	8	Sealing washer
3	Bolts	9	Relief valve spring
4	Cover	10	Relief valve plunger
5	Driven gear	11	Strainer
6	Idler gear	12	Body

Fig 9 Oil pump dismantling

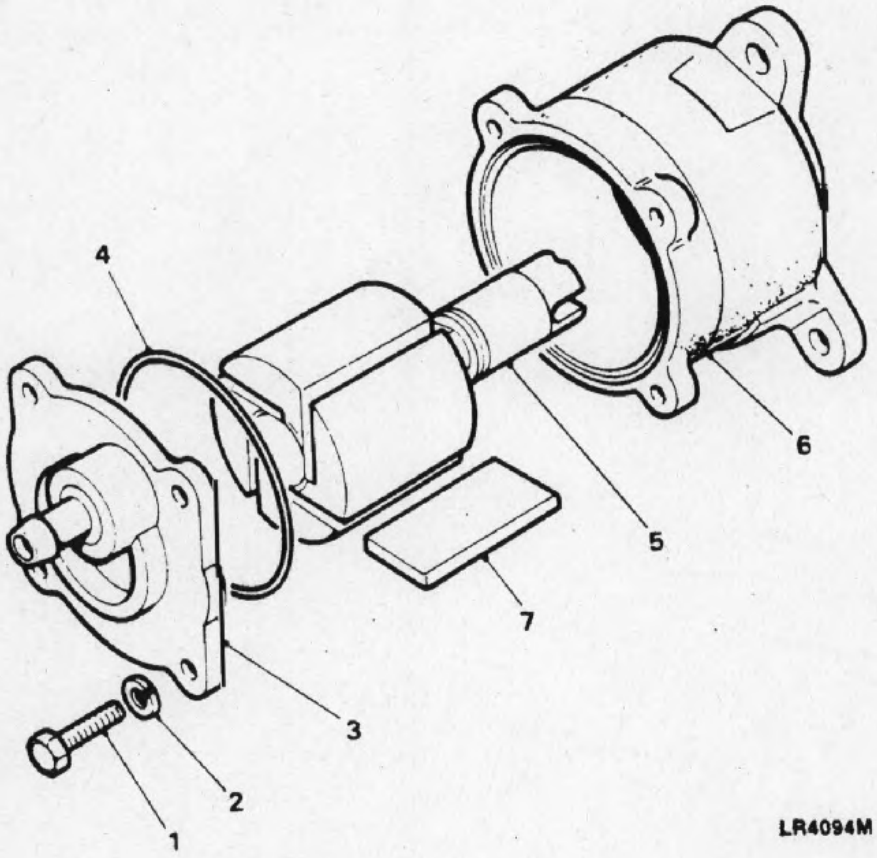
Vacuum pump

15 To dismantle the vacuum pump proceed as follows:

15.1 Remove the four bolts (Fig 10 (1)) and washers (2) securing the end plate (3), withdraw the end plate and 'O' ring seal (4).

15.2 Tap the shaft end of the rotor (5) to remove it from the pump body (6).

15.3 Remove the blades (7) from the rotor (5).



1	Bolt	5	Rotor
2	Washer	6	Body
3	End plate	7	Rotor blade
4	'O' ring seal		

Fig 10 Vacuum pump

CLEANING

16 Thoroughly clean and degrease all components ensuring that oil lubrication drillings and passage-ways are clear. Remove all carbon deposits from pistons.

EXAMINATION

Cylinder block

17 Examine the cylinder block as follows:

17.1 Visually examine the cylinder block for cracks, stripped threads and general damage.

17.2 Main bearing caps and cylinder block saddles. Check for distortion.

17.2.1 Fit the main bearing caps without the bearing shells, fit the securing bolts and tighten to a torque of 130 to 136 Nm (96 to 100 lbf ft).

17.2.2 Slacken the bolt on one side of each bearing cap and check, with feeler gauges (Fig 11), that no clearance exists at the join face between the cap and saddle.

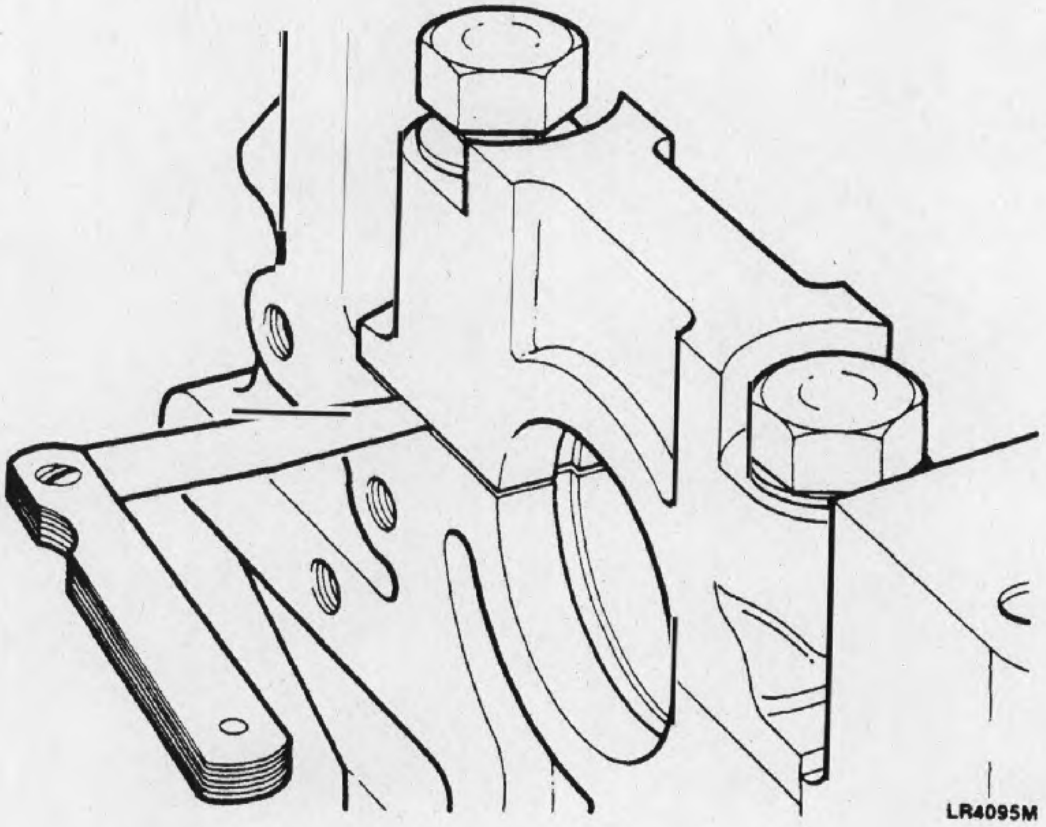


Fig 11 Checking main bearing caps

17.3 Cylinder bores. Examine the cylinder bores as follows:

17.3.1 Measure the bores for ovality using an internal micrometer. Check the ovality of each bore by taking a measurement at the top of the bore at two points diametrically opposite. The difference between the two figures is the ovality of the top of the bore.

17.3.2 Tak similar measurements at approximately 50mm (2.0in) from the bottom of the bore so that the overall ovality may be determined. Maximum permissible ovality 0.076mm (0.003in).

17.3.3 Check the taper of each bore by taking a measurement at the top and bottom of the bore at right angles to the gudgeon pin line. The difference between the two measurements is the taper. Maximum permissible taper 0.101mm (0.004in).

17.3.4 Check the bores for maximum overall wear by taking measur ments at as many points possible down the bore at right angles to the gudgeon pin line. The largest dimension recorded is the maximum wear and should be compared with the original diameter of the cylinder bore. Maximum permissible overall wear 0.101mm (0.004in).

17.3.5 If any of the above limits are exceeded the cylinders must be rebored or sleeved depending upon the general condition of the bores and the amount of wear.

17.3.6 If the overall wear, taper and ovality are within the acceptable limits and the original pistons are serviceable, new piston rings may be fitted. It is important however that the bores are deglazed, with a hone, to give a cross-hatched finish to provide a seating for the new rings. It is vital to thoroughly wash the bores to remove all traces of abrasive material after honing.

17.4 Camshaft bearings. Check the camshaft bearings as follows:

17.4.1 Check the camshaft bearings for pitting or scoring, if damage is evident they must be renewed.

17.4.2 Measure the internal diameter of each bearing at several points using an internal micrometer. A comparison of the bearing diameters with those of the respective camshaft journals will give the amount of clearance. The bearings should be renewed if the clearance exceeds 0.0508mm (0.002in).

Crankcase main bearings

18 To examine the crankcase main bearing shells proceed as follows:

18.1 Check the bearing shells for pitting, scoring or excessive wear. If damage is evident they must be renewed.

18.2 Assemble the bearing shells to the locations from which they were removed on the crankcase, fit the bearing caps and tighten to the correct torque.

18.3 Using an internal micrometer, measure each bearing at several points and note the largest recorded dimension of each bearing.

18.4 Check the respective crankshaft journals at several points noting the smallest diameter recorded. The maximum wear is the difference between this figure and the largest dimension taken from the respective main bearing shell.

Crankshaft

19 To examine the crankshaft proceed as follows:

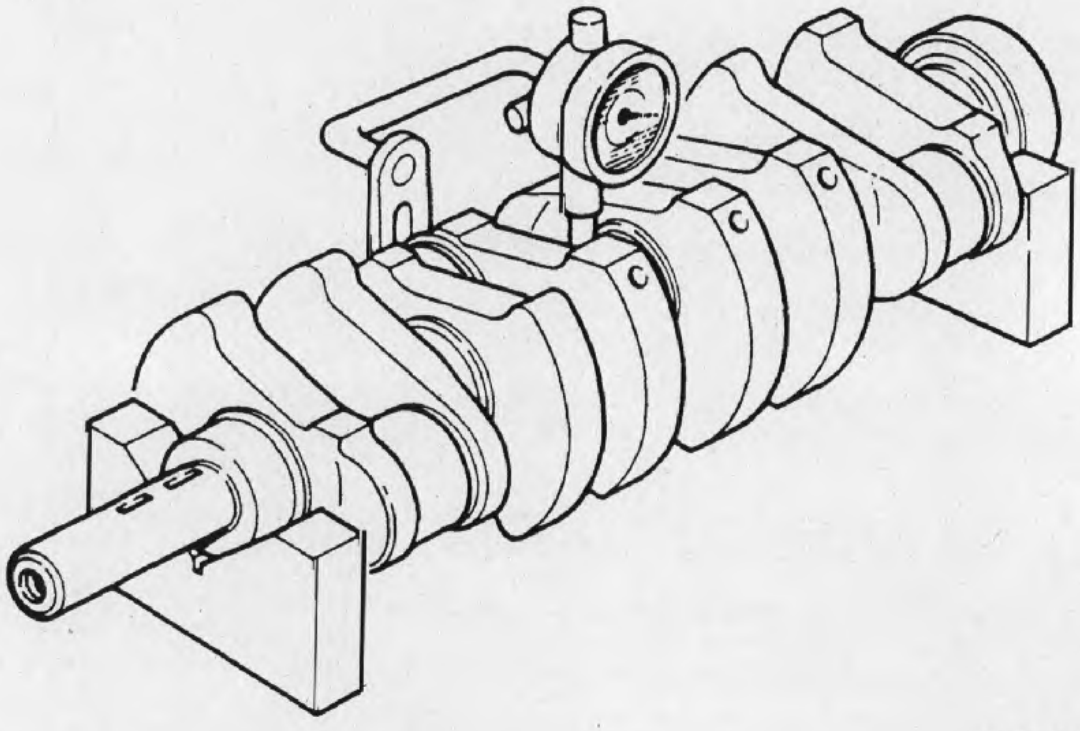
19.1 Visually examine the main bearing journals and crankpins for obvious wear, scores, grooves and overheating. Ensure that all oilways are clear. If it is considered that the shaft is worth more detailed examination, measure and note the ovality and taper of each main bearing journal and crankpins as follows:

19.1.1 Ovality. Take two readings at right angles to each other at various intervals. The maximum ovality must not exceed 0.040mm (0.0015in).

19.1.2 Taper. Take two readings parallel to each other at both ends of the main bearing journal and crankpin. The maximum permissible taper must not exceed 0.025mm (0.001in).

19.1.3 Straightness. Support the front and rear main bearing journals in 'Vee' blocks (Fig 12) and position a dial indicator to check the run-out at the centre main bearing journal. Run-out must not exceed 0.076mm (0.003in) taking into account any ovality in the centre journal.

19.1.4 Overall wear limits. The overall allowable wear limits should not exceed 0.114mm (0.0045in) for main bearing journals and 0.088mm (0.0035in) for crankpins. Crankshafts worn beyond the limits of maximum taper, ovality and overall wear can be ground undersize, for which bearing shells are available. Crankshafts exceeding the limits of straightness must be scrapped, no attempt should be made to straighten them.



LR4104M

Fig 12 Checking crankshaft for straightness

Camshaft

20 Examine the camshaft for scored, worn, pitted or chipped cams. Worn, corroded and discoloured bearing journals. Worn and chipped gear teeth. If any of the foregoing are evident the camshaft must be renewed.

Pistons and connecting-rods

21 To examine the pistons, piston rings, gudgeon pins and connecting-rods proceed as follows:

21.1 Pistons and rings. Carry out a visual examination of the pistons and rings, discard any that are considered to be unserviceable. Pistons which appear to be serviceable should be subjected to a more detailed examination described under 'New pistons' in the Repairs and replacements section of this Chap.

21.2 Gudgeon pins. Check the gudgeon pins for wear, cracks, scores and overheating. The fit in the piston must be a tight push fit at a temperature of 20°C. Check the gudgeon pin for ovality and taper using a micrometer.

21.3 Connecting-rods. Check the connecting-rods and caps for distortion as follows:

21.3.1 Fit the connecting-rod caps less the bearing shells to their respective connecting-rods. Tighten the nuts to a torque of 37 to 41 Nm (27 to 30 lbf ft); then release the nut on one side only. Using feeler gauges, check that no gap exists between the joint faces (Fig 13). If there is a gap the connecting-rod is distorted and must be renewed.

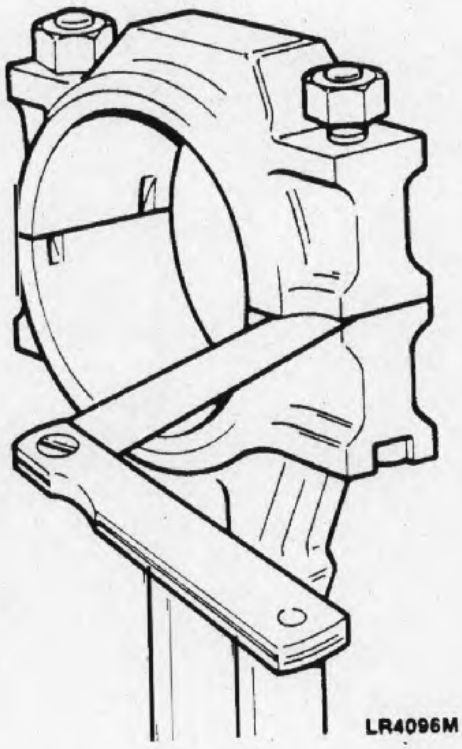


Fig 13 Checking connecting-rod caps for distortion

21.3.2 Using a connecting-rod alignment gauge, check the rods for bend and twist. The maximum allowable for both conditions must not exceed 0.0127mm (0.0005in) per 25.4mm (1.0in) between bore centres.

21.3.3 Examine and check the small-end bearing for wear, if necessary r new the bush. The correct clearance of the gudgeon pin in the small-end bush is 0.003 to 0.0157mm (0.0001 to 0.0006in).

21.3.4 Connecting-rod bearings that are worn, pitted or scored and show signs of overheating must be discarded. If more than one of the bearings show these signs they must all be renewed. When fitting new or used bearings to serviceable crankpins the clearances must be checked.

Flywh el and starter ring gear

22 To examine the flywheel and starter ring gear proceed as follows:

22.1 Examine the flywheel clutch face for wear or scores, these may be corrected by machining, provided that the overall thickness is not reduced below 36.96mm (1.455in).

22.2 Examine the starter ring gear teeth, if chipped or worn the gear should be renewed.

Oil pump

23 To examine the oil pump proceed as follows:

23.1 Examine the gears for wear, scores and pitting. If the gears appear serviceable check for end float as follows:

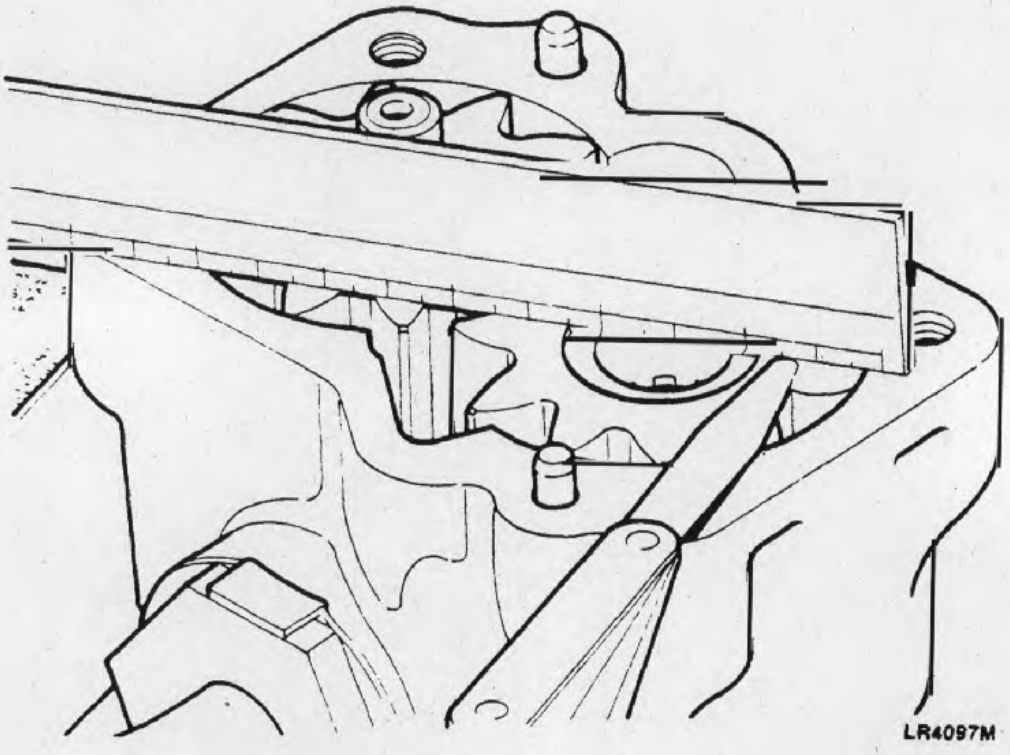


Fig 14 Checking oil pump gears end float

23.1.1 Assemble the gears to the pump body. Place a straight edge across the pump body face (Fig 14) and using feeler gauges measure the clearance between the straight edge and the gears. The correct clearance for both gears is 0.026 to 0.115mm (0.001 to 0.0045in).

23.2 Check the idler gear spindle for wear, if wear is evident it should be renewed (Para 39).

Vacuum pump

24 To examine the vacuum pump carry out the following:

24.1 Inspect the components for wear or damage and renew as necessary.

24.2 Check the rotor to body clearance, fit the rotor to the body and using feeler gauges measure the clearance at the narrowest point between the rotor and body. The correct clearance is 0,05mm (0.002in).

24.3 Check the clearance between the rotor and end plate by placing a straight edge across the body and using feeler gauges measure the clearance. The correct clearance is 0,101 to 0,127mm (0.004 to 0.005in).

REPAIR AND REPLACEMENT

Cylinder bores

25 Worn cylinder bores may only be reclaimed by fitting cylinder sleeves, boring sizes are given at serial 25.1. Worn sleeves may be removed and new sleeves fitted when required.

25.1 Machine the bores to be sleeved to 94,412 to 94,437mm (3.717 to 3.718in). These dimensions will give the sleeve a 0.076 to 0,127mm (0.003 to 0.005in) interference fit.

25.2 Press the sleeves squarely into the bores using a pressure of two to three tons. Excessive pressure could damage the sleeve and cylinder block. The sleeves must not be proud of the cylinder block top face or more than 2,54mm (0.10in) below the surface.

25.3 Bore and hone the sleeves to accommodate the pistons with the required clearances.

Camshaft bearings renew

G neral

26 The special tools required to carry out the following operations are no longer available from the manufacturers, the operations are described for workshops that have the tools, if the tools are not available the work should be entrusted to line-boring specialists.

Bearing removal

27 To remove the bearings proceed as follows:

27.1 Drift out the front and rear bearings using special tool Serial No 1 and withdraw them through the side cover apertures.

27.2 With the same tool drift out the two centr bearings into the vacuum pump drive chamber and collapse them to assist withdrawal (Fig 15).

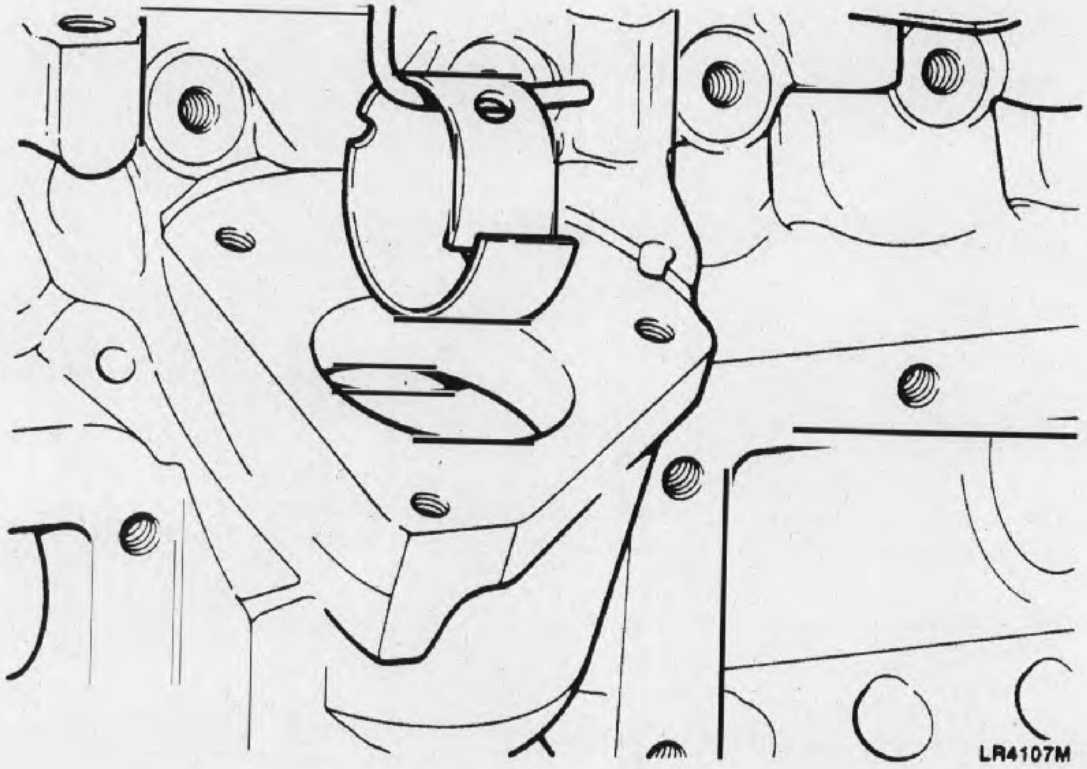


Fig 15 Removing collapsed camshaft bearing

Bearing fitting

Note ...

The the two centre and rear bearings are of the same width, whereas the front bearing is wider and has an additional oil feed hole.

28 To fit the new bearings proceed as follows:

28.1 Position the cylinder block vertical, rear face down (Fig 16).

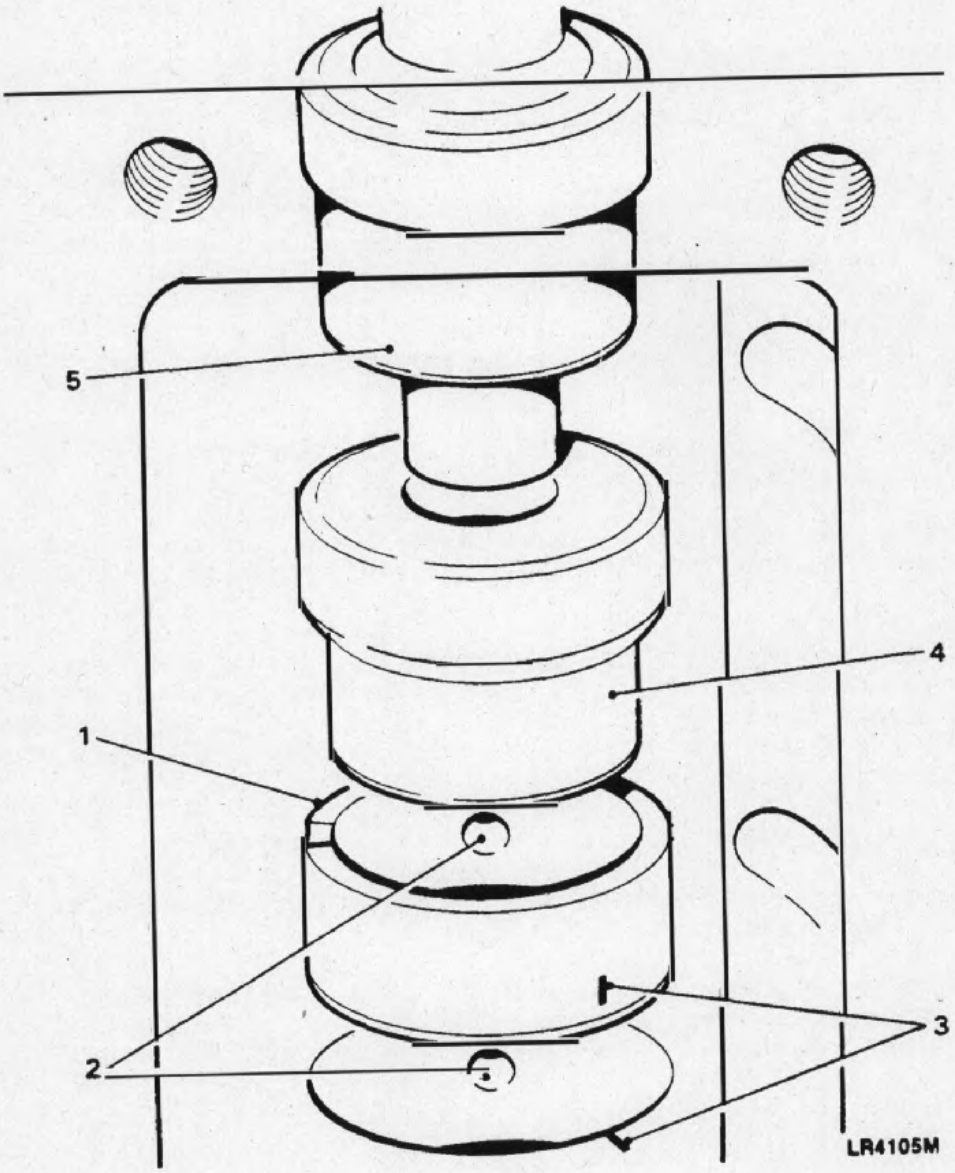
28.2 Place a new bearing (1) in the front camshaft chamber and position it so that it is above the second bearing housing, counting from the front of the block. The chamfer on the bearing edge must be towards the housing bore.

28.3 Align the oil hole (2) in the bearing with the innermost oil feed drilling in the housing bore. Accuracy is essential otherwise misalignment of the oil holes may result. When the bearing is in place it cannot be rotated to correct any error.

28.4 Add pencil marks (3) to the bearing outer diameter and the cylinder block adjacent to the housing to assist in checking alignment.

28.5 Having visually aligned the bearing, place the special adaptor (4) (Serial No 2) inside it.

28.6 Maintain the bearing in a level position. Pass the drift (5) through the front bearing housing into th camshaft chamber so that it r sts on top of the adaptor. Drift the bearing into the housing, ensuring that it is not drifted to far and that the oil holes are correctly aligned.



1	Bearing	4	Special adaptor
2	Oil holes	5	Drift
3	Pencil marks		

Fig 16 Fitting camshaft bearings

28.7 Repeat the foregoing operations to fit the front bearing. The small oil hole in this bearing aligns with a v rtical drilling in the block which in turn feeds a horizontal drilling for the tappet mechanism.

28.8 Drift the front bearing in so that the outer edge is just below the machined surface of the front face. This is to ensure that when the camshaft thrust plate is fitted it will not stand proud on the bearing edge.

28.9 Turn the cylinder block over so that the rear face is uppermost and repeat the foregoing procedures for the two remaining bearings.

Ream bearings

29 Ream the bearings to size as follows:

Note ...

No lubricant is necessary for this operation since the best results are obtained when the bearings are cut dry.

29.1 Locate the guide plug (Serial No 3) (Fig 17 (1)) into the front camshaft bearing and retain using the thrust plate securing screws, do not tighten the screws at this stage.

29.2 Insert the reamer (Serial No 4) (2) from the rear of the cylinder block, locating it through the guide plug at the front.

29.3 Locate the guide collar immediately in front of the reamer cutter into the rearmost bearing, then tighten the screws retaining the guide plug at the front.

29.4 Position the cylinder block vertically, rear face uppermost and ream the rear and two centre bearings. As each bearing is cut the reamer should be held steady by the operator whilst an assistant, using a high pressure air line, blows away the white metal cuttings before allowing the reamer to enter the next bearing.

29.5 Remove the guide plug and ream the front bearing.

29.6 Remove the reamer handle and bolt (3) and withdraw the reamer, turning it in the same direction as for cutting.

29.7 Remove the plugs from the ends of the oil gallery passage and clean the gallery and oil feed passages to the camshaft and crankshaft bearings, using a high pressure air line. Refit the plugs and lock in position.

29.8 The hexagon headed plugs at the rear of the block should have new washers fitted and their threads coated with suitable jointing compound.

29.9 Thoroughly clean the cylinder block to remove all traces of metal cuttings.

Key to Fig 17

1	Guide plug	2	Reamer
3	Handle		

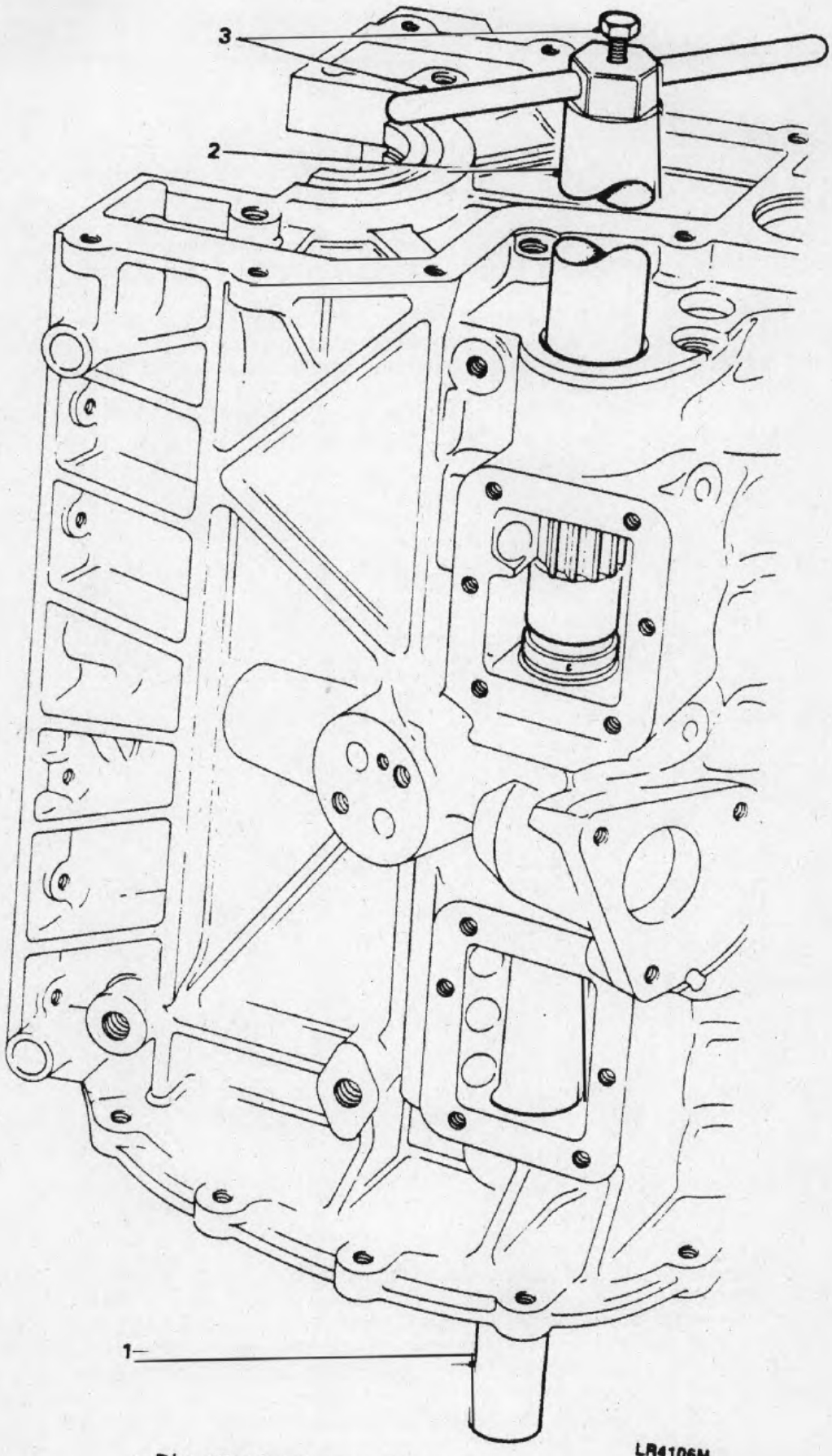


Fig 17 Reaming camshaft bearings

Crankshaft

Regrinding

30 Crankshaft main bearing and crankpin journals may be ground undersize and undersize shell bearings fitted. The following points must be observed when carrying out the regrinding operations:

30.1 Rotation of the crankshaft and grinding wheel must be in the same anti-clockwise direction, viewed from the flywheel end of the crankshaft.

30.2 Ensure that when grinding the stone travels beyond edge of the journals (Fig 18 (A)) to avoid formation of a step (B) as illustrated. Care should also be taken not to machine or damage the fillet radii (C).

30.3 Final finishing of the journals should be achieved by using a static lapping stone with the crankshaft rotating in a clockwise direction.

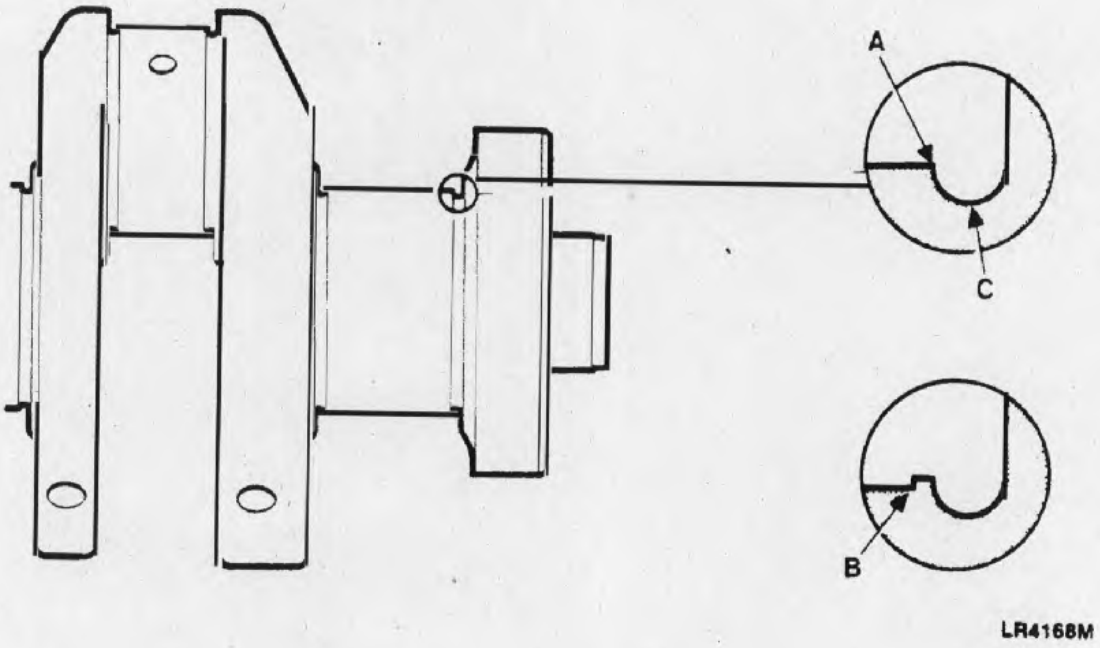


Fig 18 Regrinding crankshaft

New pistons

Gen ral

31 Original pistons fitted to new engines are specially graded to facilitate assembly. The grade letter on the piston crown should be ignored when ordering new pistons. Land Rover service standard size pistons are supplied 0,025mm (0.001in) oversize to allow for production tolerances on new engines. When fitting new pistons to a standard size cylinder block the bores must be honed to accommodate the pistons with the correct clearances. In addition, new pistons are available 0.50mm (0.020in) oversize for fitting to rebored cylinder blocks.

32 For clearance limits for new standard size pistons in a standard cylinder bore refer to Cat 533.

Checking cl arances

33 When checking clearances the cylinder block and pistons must be at the same temperature to ensure accuracy. To check the clearances carry out the following:

33.1 Using a suitable micrometer measure the pistons at the bottom of the skirt at right angles to the gudgeon pin bore (Fig 19).

33.2 With an internal micrometer or cylinder gauge measure the bore at approximately half-way down (Fig 19).

33.3 The clearance is determined by subtracting the piston diameter from the bore diameter.

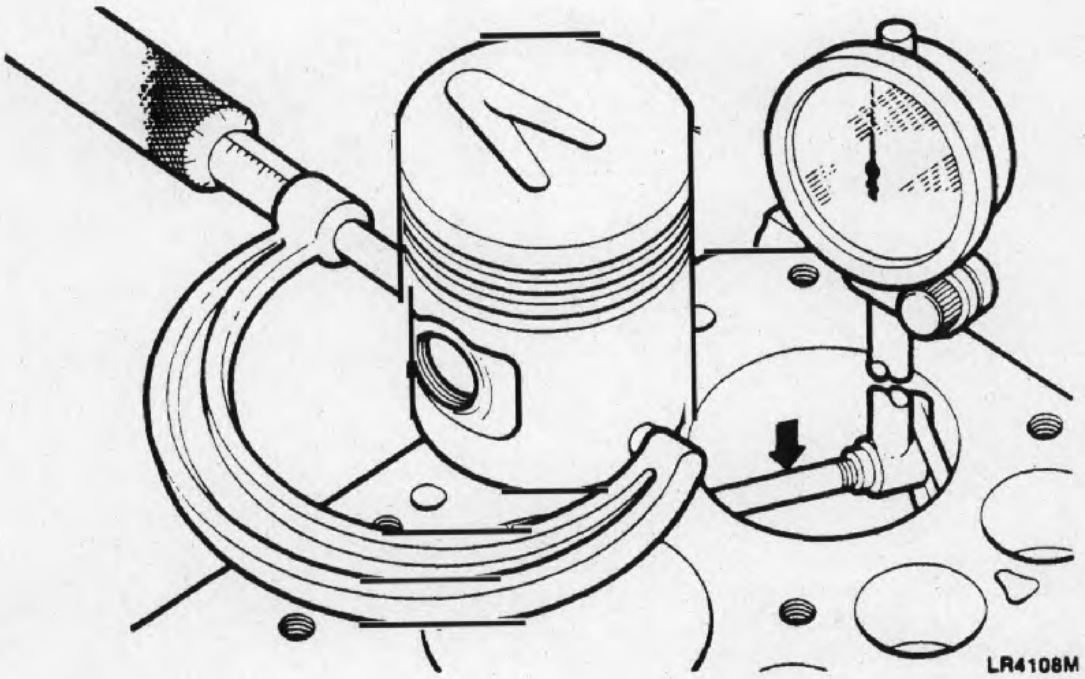


Fig 19 Checking piston to bore clearance

33.4 An alternative method of assessing the clearance is to place a long, suitably sized, feeler gauge down the thrust side of the bore and inserting the appropriate piston, 'upside down', in the bore and position it with the gudgeon pin bore parallel to the crankshaft axis (Fig 20). Push the piston down the bore and stop at the tightest point and whilst holding the piston still, slowly withdraw the feeler gauge. If a steady resistance of approximately 2.5kg (6lb) is felt, the clearance is satisfactory.

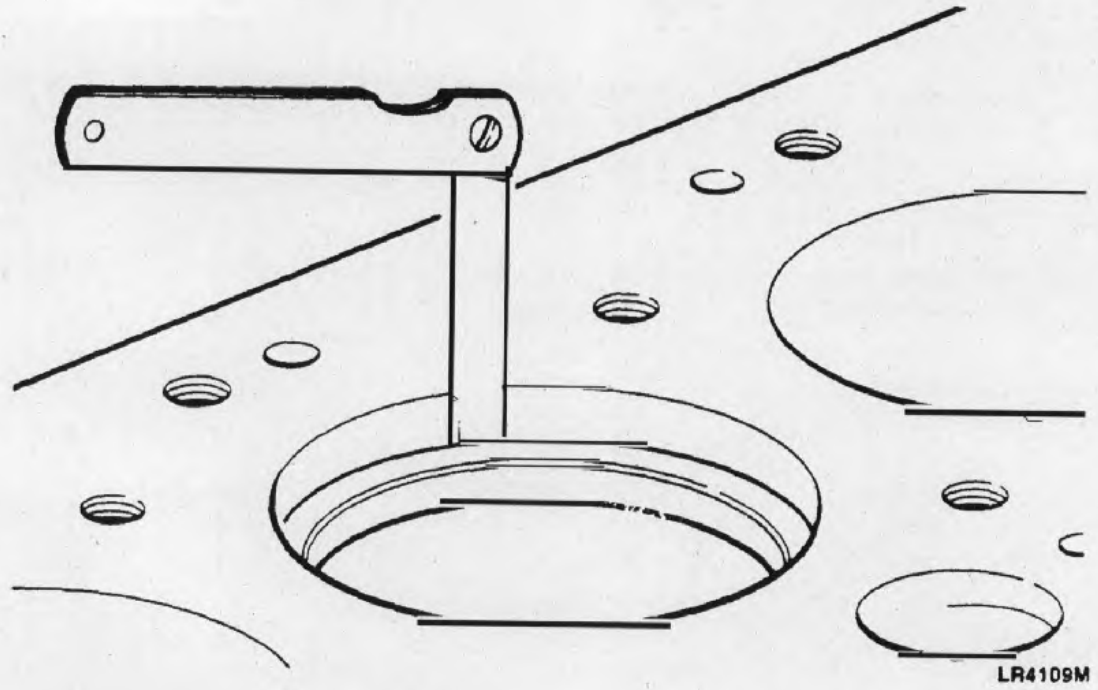


Fig 20 Alternative method of checking piston to bore clearance

Piston rings

General

34 Normally when an engine is being overhauled the piston rings are discarded unless the pistons have been removed for a different purpose and the engine has only completed a small mileage. Before refitting the pistons the rings should be examined for wear and damage. In addition the rings must be checked for side clearance in the pistons and gap in the bores. These checks must also be carried out when fitting new rings to new and used pistons.

Checking gaps

35 When checking the ring gap in worn bores, that are within the acceptable taper and ovality limits, the ring must be inserted squarely into the bottom of the bore at the lowest point of the piston travel. To ensure squareness, push the ring down the bore to the correct position with a piston. With newly machined bores, the ring may be inserted squarely into any position in the bore. To check the gaps proceed as follows:

35.1 Using an appropriate feeler gauge check the gaps of all the rings, in turn, including the oil control ring assembly (Fig 21).

35.2 For correct gaps refer to Cat 533. If any gap is less than that specified, remove the ring, and file the ends square, whilst holding the ring in a filing jig or vice.

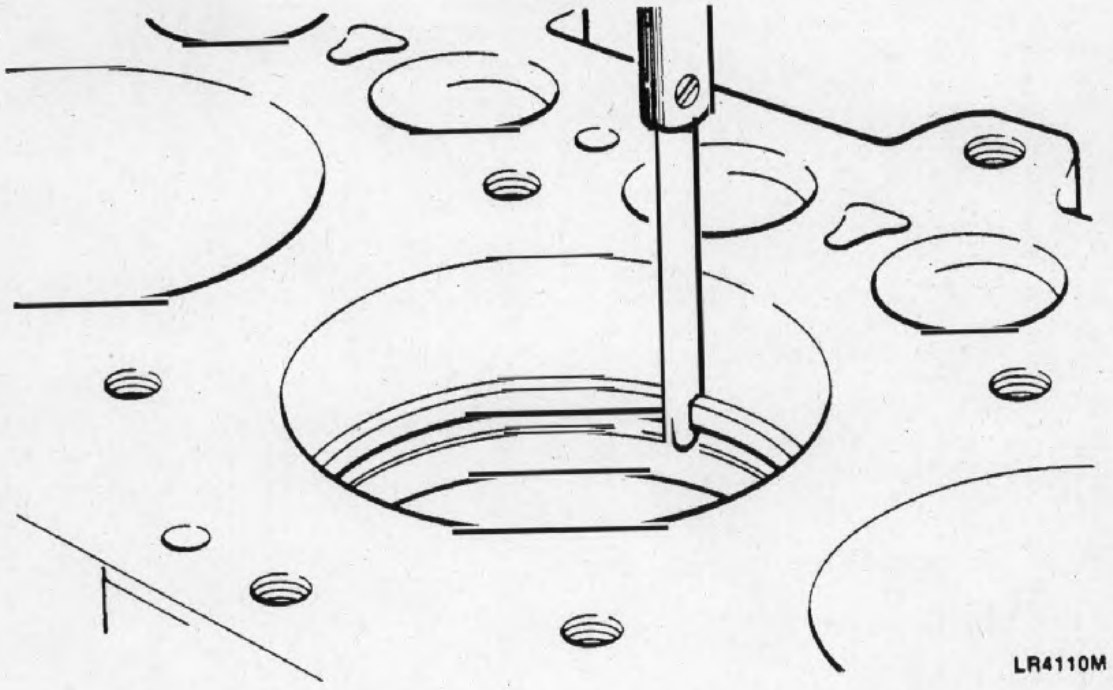


Fig 21 Checking piston ring gaps

Checking side clearance

36 To check the piston ring side clearance carry out the following:

36.1 Fit the oil control ring to the bottom groove. Fit the unpolished compression ring with the word 'TOP' uppermost to the second groove. Insert the polished chrome ring with the internal chamfer to the top groove with the word 'TOP' uppermost.

36.2 After fitting each ring, roll it around the piston groove to ensure that it is free and does not bind.

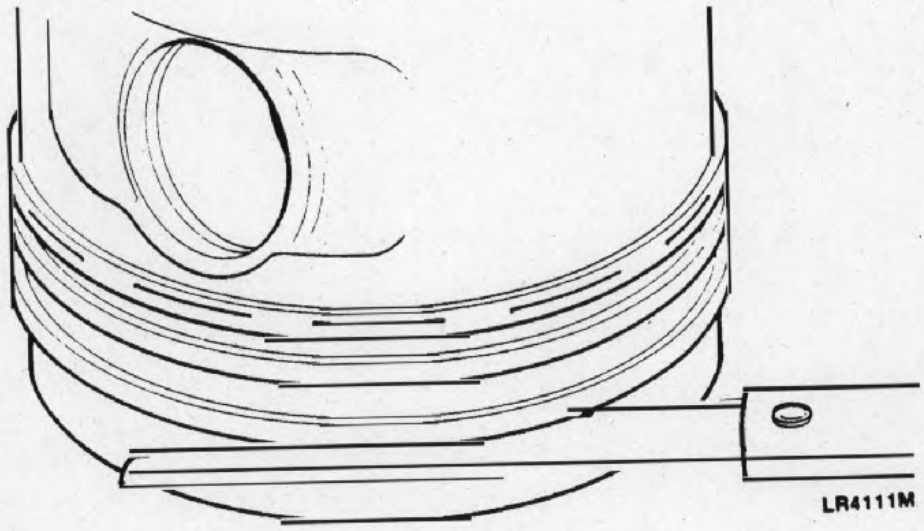


Fig 22 Checking piston ring side clearance in groove

36.3 Using feeler gauges check the clearance between the rings and piston groove (Fig 22). For acceptable clearances refer to Cat 533. Clearances in xcess of the limits are unacceptable and the ring and or the pistons should be renewed.

Flywheel and starter ring gear

Reface flywheel

37 To reface the flywheel proceed as follows:

37.1 Remove the clutch location dowels.

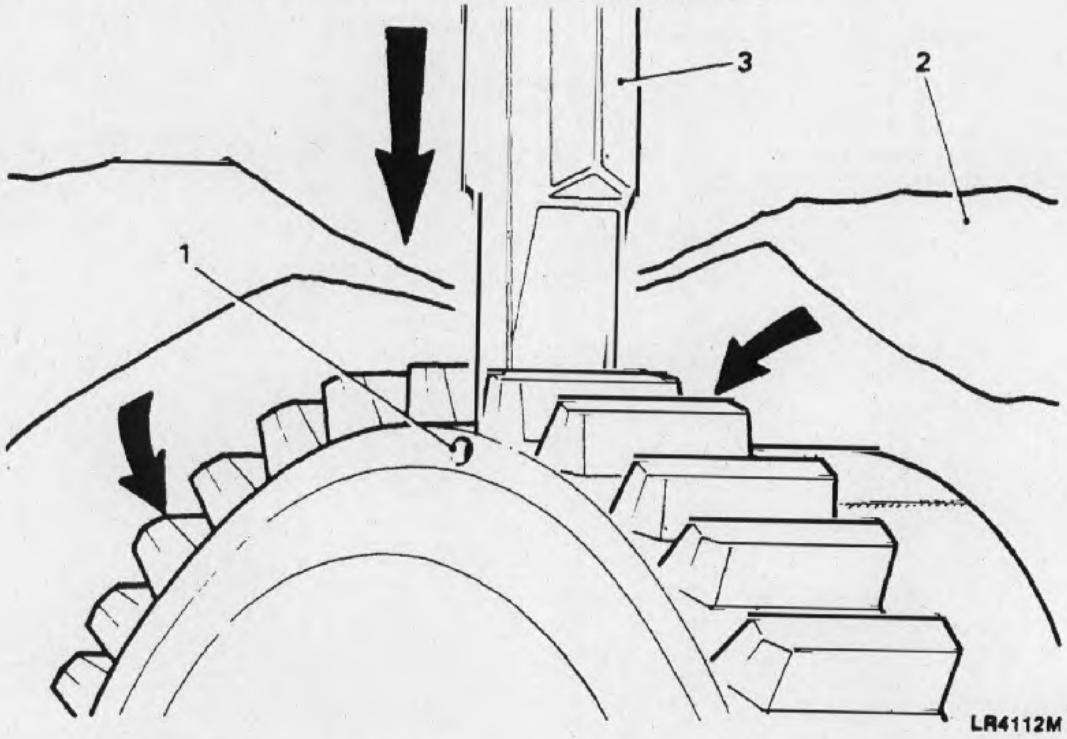
37.2 Machine the flywheel over the complete clutch face, removing only the minimum material necessary to obtain a smooth flat surface parallel with the crankshaft mating face and within the allowable refacing dimensions (Cat 533).

37.3 Fit new clutch location dowels.

Renewing starter ring gear

38 To renew the starter ring gear carry out the following:

38.1 Drill an 8.0mm (5/16in) hole between the root of two teeth (Fig 23 (1)) and the inner diameter of the starter ring, deep enough to weaken the ring. Do not allow the drill to enter the flywheel.



1 Drilled hole 2 Protective cloth 3 Cold chisel

Fig 23 Removing starter ring gear

38.2 Secure the flywheel in a vice fitted with soft jaws and place a suitable piece of cloth (2) over the flywheel to protect the operator from flying fragments.

WARNING ...

ADEQUATE PRECAUTIONS MUST BE TAKEN AGAINST FLYING FRAGMENTS WHEN SPLITTING THE RING GEAR.

38.3 Place a cold chisel (3) above the drilled hole and strike it sharply to split the ring gear.

38.4 Heat the new ring gear uniformly to between 225°C and 250°C, do not exceed the higher temperature.

38.5 Place the flywheel, clutch face down, on a flat surface.

38.6 Locate the heated starter ring gear in position with the square edge of the teeth against the flywheel flange (Fig 24).

38.7 Press the starter ring gear firmly against the flange until the ring contracts sufficiently to grip the flywheel. Allow the ring gear to cool gradually, do not hasten cooling in anyway.

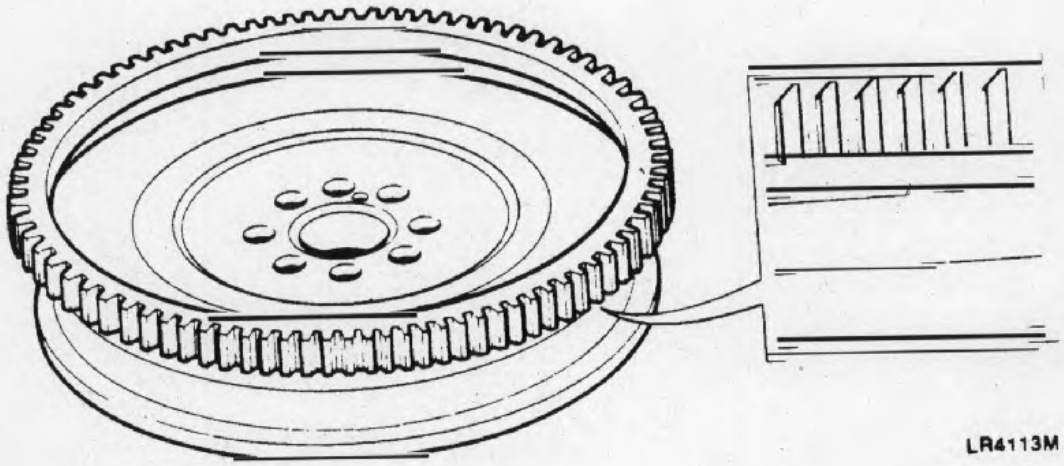


Fig 24 Fitting starter ring gear

Oil pump

Idler gear spindle

39 To renew the idler spindle proceed as follows:

39.1 Drill out the peened over end of the spindle and withdraw the spindle from the pump body.

39.2 Fit the new spindle to the pump body with the two gears.

39.3 Fit the cover and secure with the four bolts.

39.4 Support the pump body and peen over the end of the new spindle.

39.5 Remove the cover and gears and check spindle for security.

Skew gear and coupling

Coupling

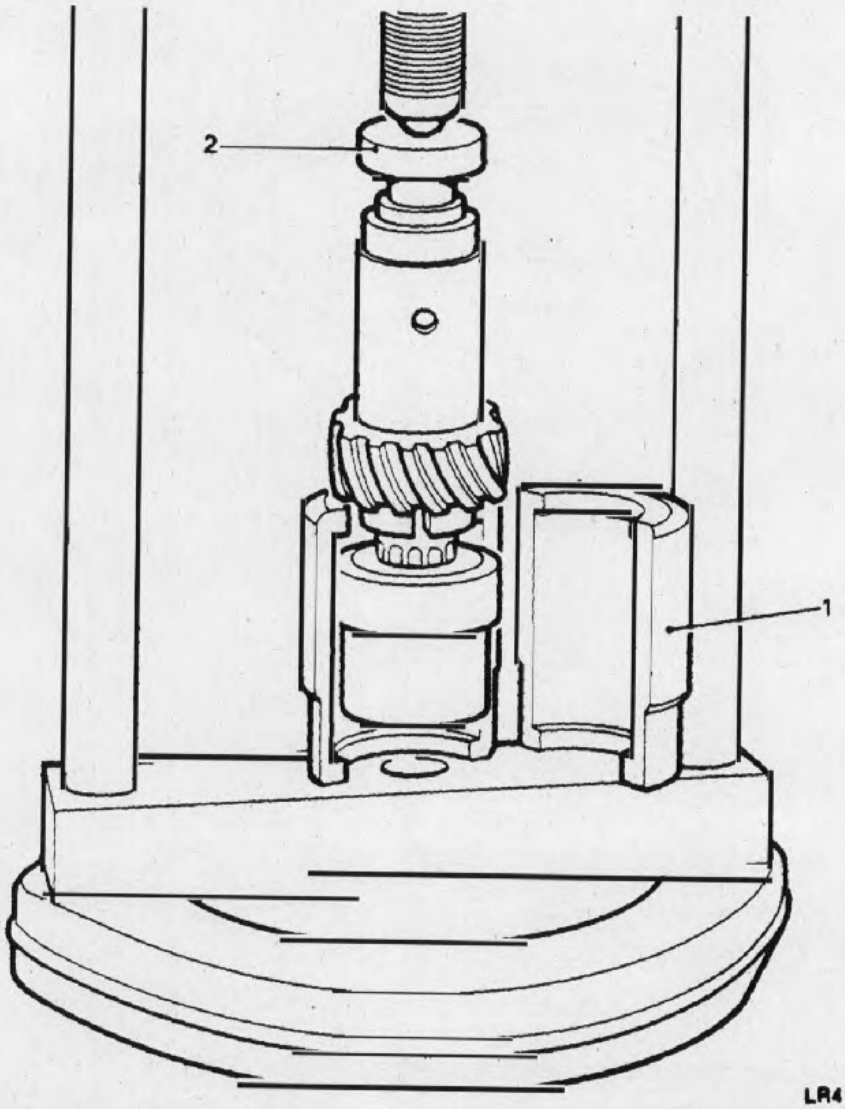
40 To renew the skew gear coupling carry out the following:

40.1 Position the skew gear and coupling in a press and support it, with collets (Serial No 5) (Fig 25 (1)) or suitable metal bars.

40.2 Insert a suitable mandrel (2) between the press ram and the end of the coupling shaft and press out the coupling from the skew gear.

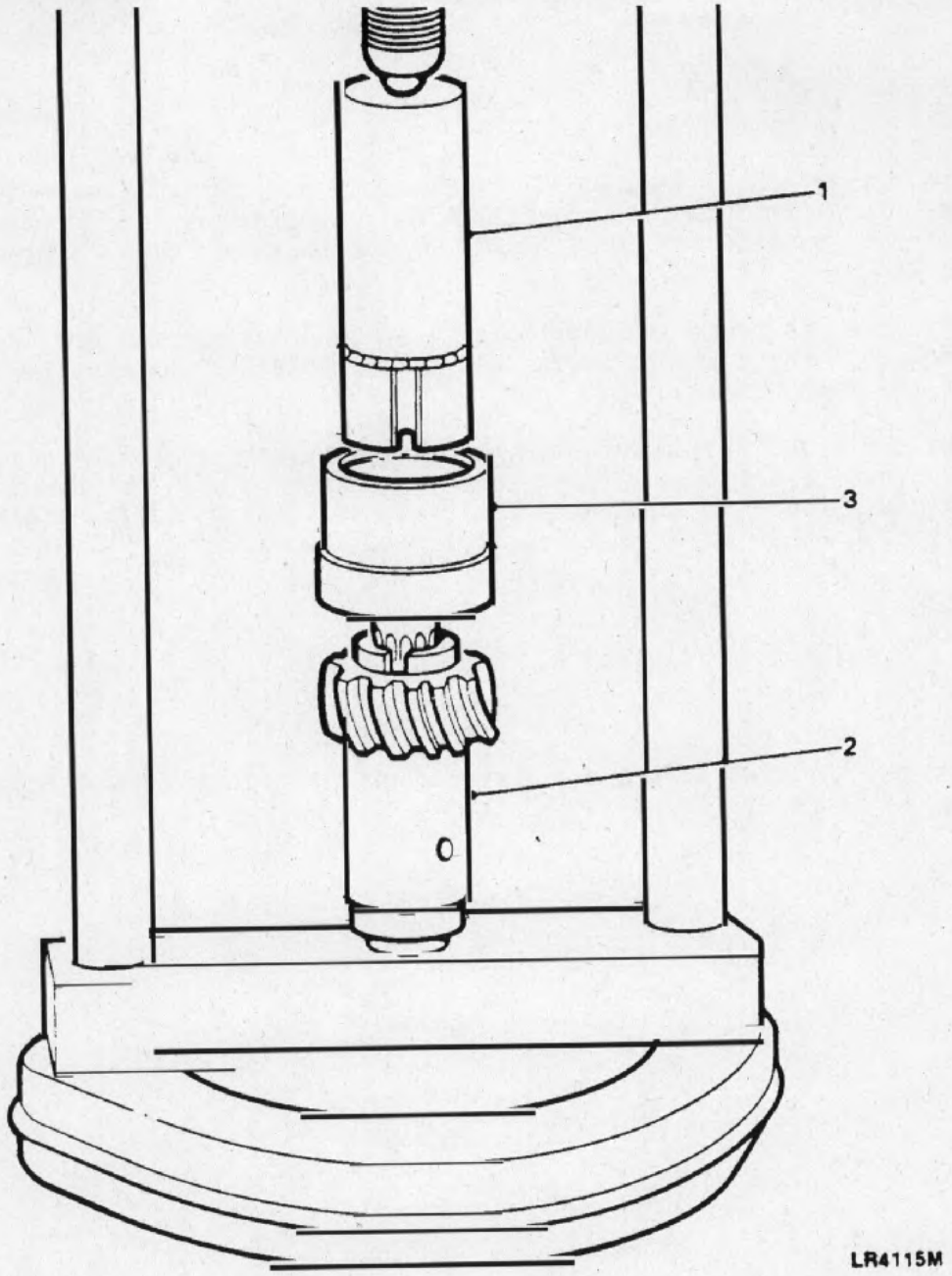
40.3 Using the sleeve from the old coupling, manufacture a suitable press tool by welding a length of steel bar or tube to the sleeve. Increase the depth of the cross-pin slot so that it will not bear upon the cross-pin when used to press in the new coupling.

40.4 Dismantle the new coupling (Para 9.3). This is necessary, as in the assembled condition there is no suitable surface for the press tool to bear upon.



1 Collets 2 Mandrel

Fig 25 Removing coupling from skew gear



1 Press tool 2 Skew gear 3 Coupling sleeve

Fig 26 Fitting coupling sleeve to skew gear

40.5 Fill the annular groove round the splines of the coupling with silicone rubber sealant.

40.6 Assemble the skew gear and coupling sleeve, with the manufactured press tool in position inside the coupling, place under the press and slowly press in the new coupling. Clean off surplus sealant and swarf from the internal splines of the skew gear.

40.7 Reassemble the coupling in reverse order of dismantling.

REASSEMBLY

Oil jet tube assemblies

Note ...

The oil jet tubes assemblies are 'Handed' and can only be be fitted the one way. It is important to note that the jet retaining bolt contains a non-return valve and under no circumstances should an ordinary bolt be fitted.

41 Fit the jet tubes as illustrated (Fig 8) ensuring that the pegs locate in the holes in the cylinder block, and that the larger diameter washer is fitted under the bolt head.

42 Before tightening the retaining bolts ensure that the jet pipes do not foul the crankshaft or pistons. When the crankshaft and pistons have been fitted slowly turn the crankshaft and check that no fouling occurs. Tighten the bolts to a torque of 14 to 20 Nm (10.3 to 15 lbf ft).

Crankshaft

Main bearing nip and clearance

Note ...

New main bearing shells are supplied with a protective coating and must be degreased before being fitted.

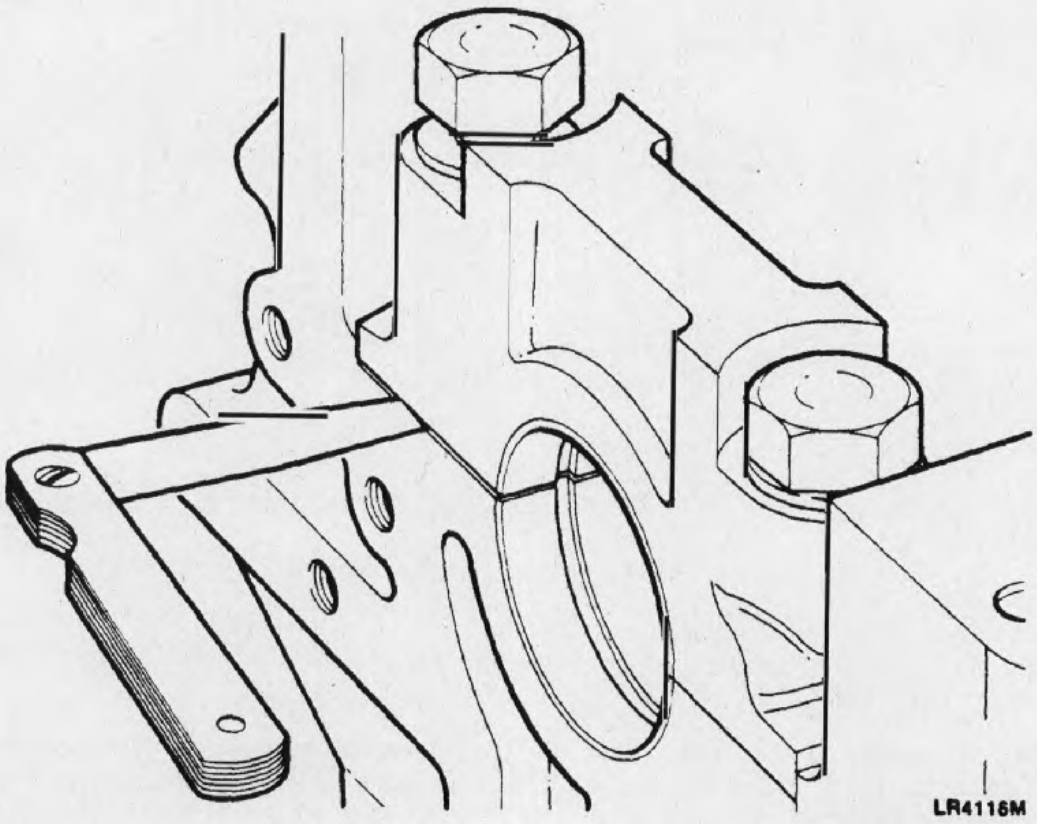


Fig 27 Checking main bearing nip

43 Check the main bearing nip and clearanc as follows:

43.1 Fit the bearing halves in the crankcase saddles and caps and tighten to the correct torque.

43.2 Slacken the bolts on one side of the caps only and, with feeler gauges, check the gap between the joint faces (Fig 27). The clearance or nip must be within 0.10 to 0.15mm (0.004 to 0.006in).

43.3 The bearing nip can be adjusted by selective assembly of the bearing halves, available in varying thicknesses. Do not file or machine the caps or saddles to achieve the correct clearance. Note that the rear main bearings are wider than the remaining four.

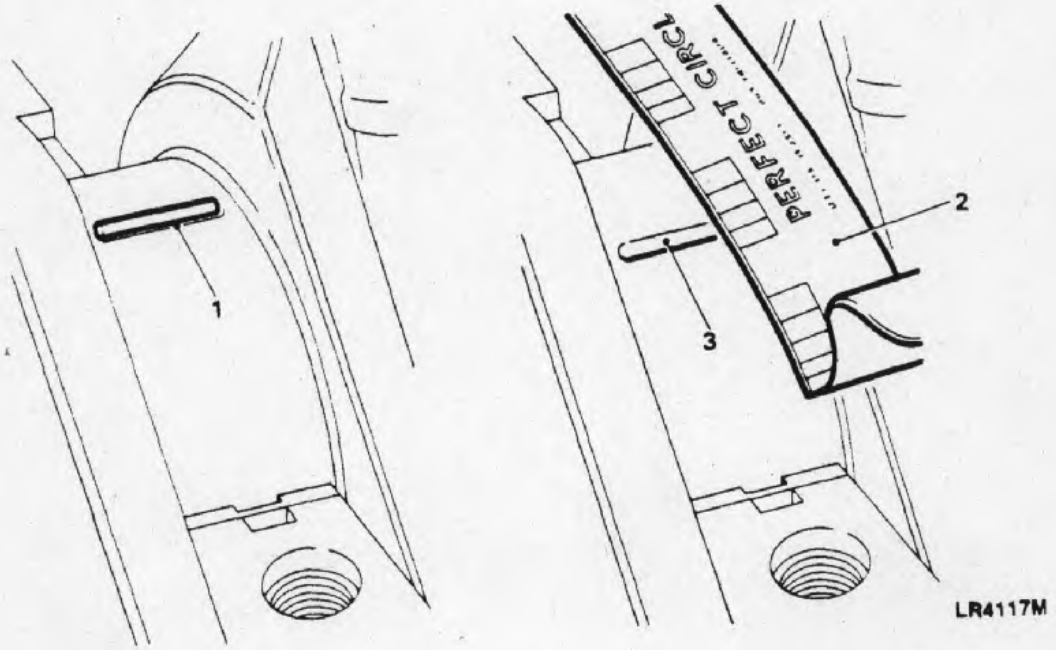
43.4 To make a final check that the clearance is correct, leave the bearing halves in the saddles and carefully lower the crankshaft into position.

43.5 Check each bearing in turn by inserting a 0.063mm (0.0025in) shim paper between the bearing cap and crankshaft journal and tighten the bolts to a torque of 37 to 41 Nm (27 to 30 lbf ft).

43.6 If the clearance is correct, there should be a slight increase in the resistance to rotation of the crankshaft.

43.7 As an alternative 'Plastigauge' may be used to check the clearance. To use the 'Plastigauge' method proceed as follows:

43.7.1 Locate the crankshaft in position on the upper bearing halves in the crankcase and wipe away any oil from the journals, as 'Plastigauge' is soluble in oil.



1 Plastigauge 2 Scale 3 Compressed plastigauge

Fig 28 Checking main bearing clearance with 'Plastigauge'

43.7.2 Place a piece of 'Plastigauge' across the lower half of each crankshaft journal (Fig 28 (1)) or bearing cap shell. Fit the cap and tighten to the correct torque.

43.7.3 Remove the cap and bearing and using the scale (2) supplied measure the compressed 'Plastigauge' at its widest point. The graduation that most closely corresponds with the widest point (3) indicates the bearing clearance.

43.7.4 If new bearings are being fitted use selective assembly to obtain the correct clearance.

43.7.5 Wipe off, not scrape, the 'Plastigauge' with an oily rag from the journals or bearings.

Crankshaft end-float

44 To adjust the crankshaft end-float proceed as follows:

44.1 Lift out the crankshaft and insert a standard size thrust washer both sides of the centre main bearing saddle with the grooves towards the crankshaft (Fig 29).

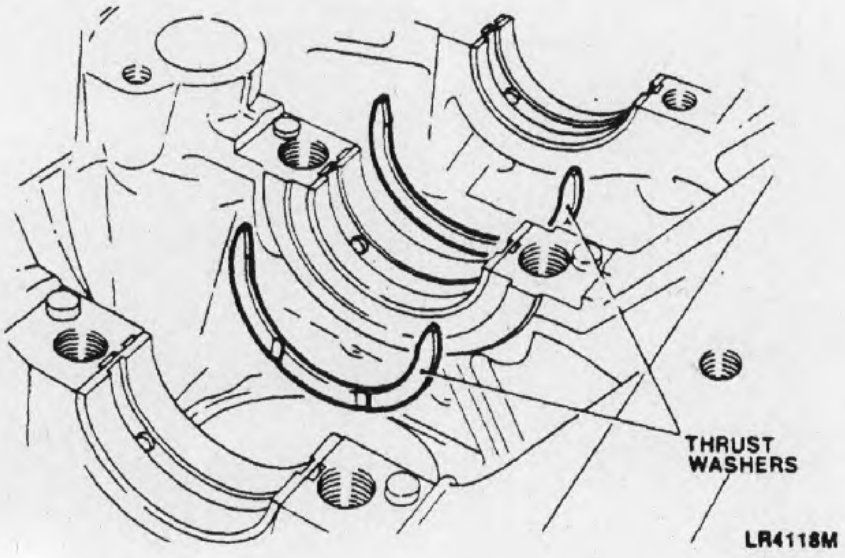


Fig 29 Fitting thrust washers to crankcase centre saddle

44.2 Place the crankshaft in position in the crankcase and mount a dial test indicator to read off the end of the crankshaft (Fig 30). A feeler gauge may be used instead of a dial indicator.

44.3 Determine the end-float by moving the crankshaft away from the indicator and zero the dial. Move the crankshaft in the opposite direction and note the indicator reading. Alternatively measure the clearance with a feeler gauge. The end float should be 0.05 to 0.15mm (0.002 to 0.006in).

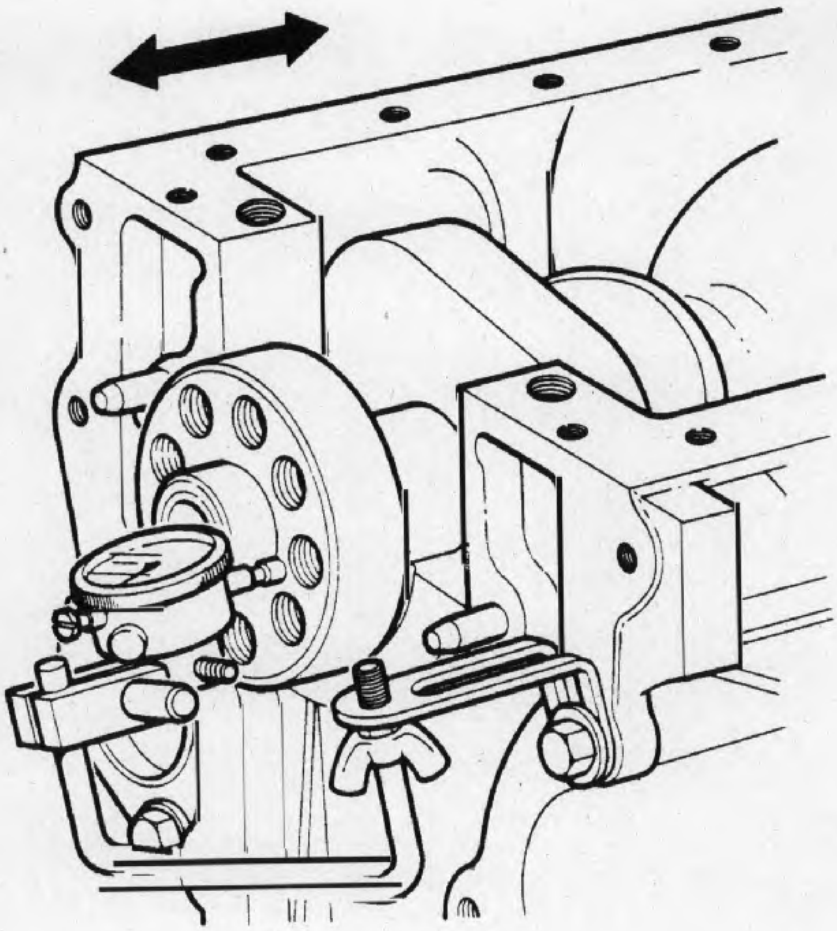


Fig 30 Checking crankshaft end-float

44.4 If adjustment is required use oversize thrust washers. Variation of thrust washer thickness at each side of the crankshaft journal must not exceed 0.08mm (0.003in) to ensure that the crankshaft remains central.

Main bearing caps

45 To fit the main bearing caps proceed as follows:

45.1 Lubricate the crankshaft main bearing journals with clean engine oil and fit the appropriate bearing caps and lower shells to the crankcase with the exception of number five main bearing. Ensure that the caps locate properly over the dowels. Using new bolts and washers evenly tighten to the bolts to a torque of 130 to 136 Nm (96 to 100 lbf ft).

45.2 Ensure that the number five main bearing cap is clean and free from old cork seal material. Attach the cork seal guides (Serial No 6) to the crankcase (Fig 31), ensuring that they are parallel to the crankcase edge.

45.3 To prevent any cork seal material becoming trapped between the bearing cap and crankcase, chamfer the inner edge of the corks 0.40 to 0.80mm (1/64 to 1/32in) wide (Fig 31).

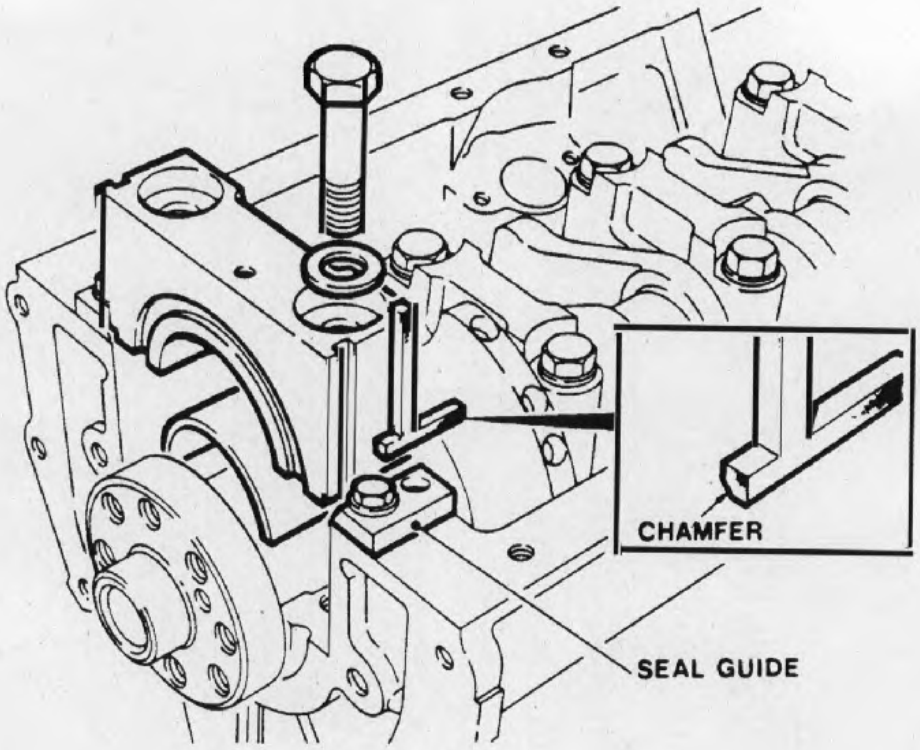


Fig 31 Fitting No 5 main bearing cap

45.4 Immerse the cork seals in clean engine oil and fit them to the bearing cap. Fit the bearing cap and lower shell to the crankcase, secure with new bolts and washers and tighten to a torque of 130 to 136 Nm (96 to 100 lbf ft).

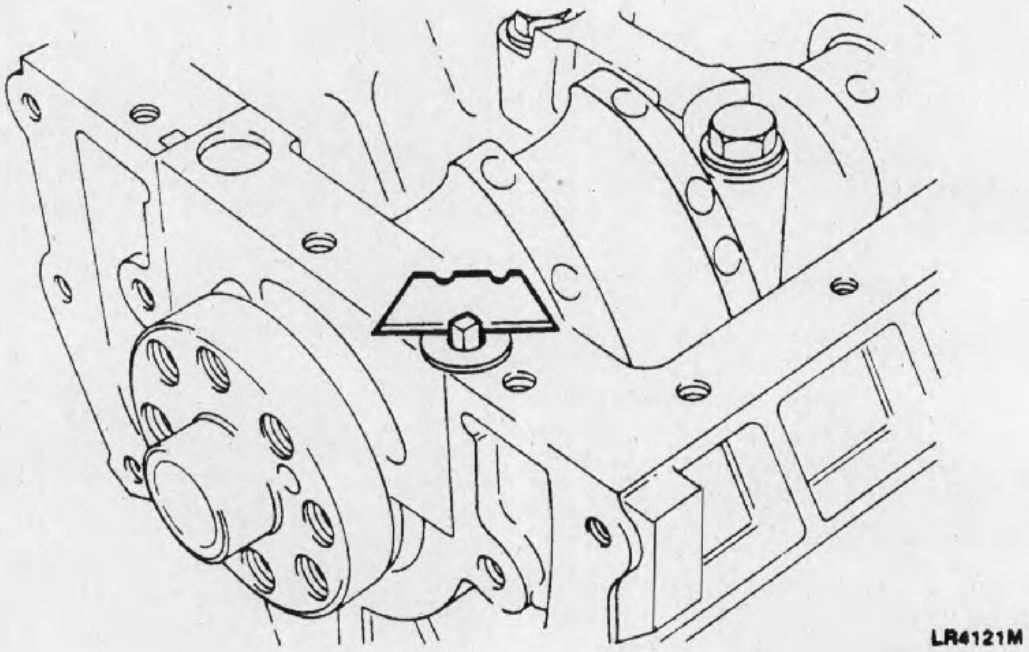


Fig 32 Trimming cork seals

45.5 To allow for shrinkage after fitting 1 av the cork seals standing proud of the crank case sump face. If possible delay the fitting of the sump for approximately twelve hours and leav th seal protruding 2.40mm (3/32in) and then place a 6.350mm (1/4in) washer over the seal and cut off the surplus. If it is necessary to fit the sump immediately, trim the seals off leaving 0.80mm (1/32in) proud (Fig 32). Apply Hylomar SQ32M to the protruding end of the seals.

Flywheel housing and rear main oil seal

46 To fit the flywheel housing and rear main oil seal proceed as follows:

46.1 Check that the crankshaft oil seal journal is clean. Make sure that the seal housing in the flywheel housing is clean, dry and free from burrs. Do not touch the seal lip and ensure that the outside diameter is clean and dry.

46.2 The PTFE seal used in this location is supplied with a former to maintain the correct shape and must not be removed until the seal is to be fitted.

46.3 Using the special seal replacer tool (Serial No 7) and with the lip side leading drive in the seal as far as the tool allows (Fig 33).

46.4 Apply a bead of Hylogrip 2000 sealant to the rear face of the flywheel housing to the dimensions and configuration shown in Fig 34. The bead of sealant should be 5.5mm (0.216in) wide and 0.25mm (0.009in) thick.

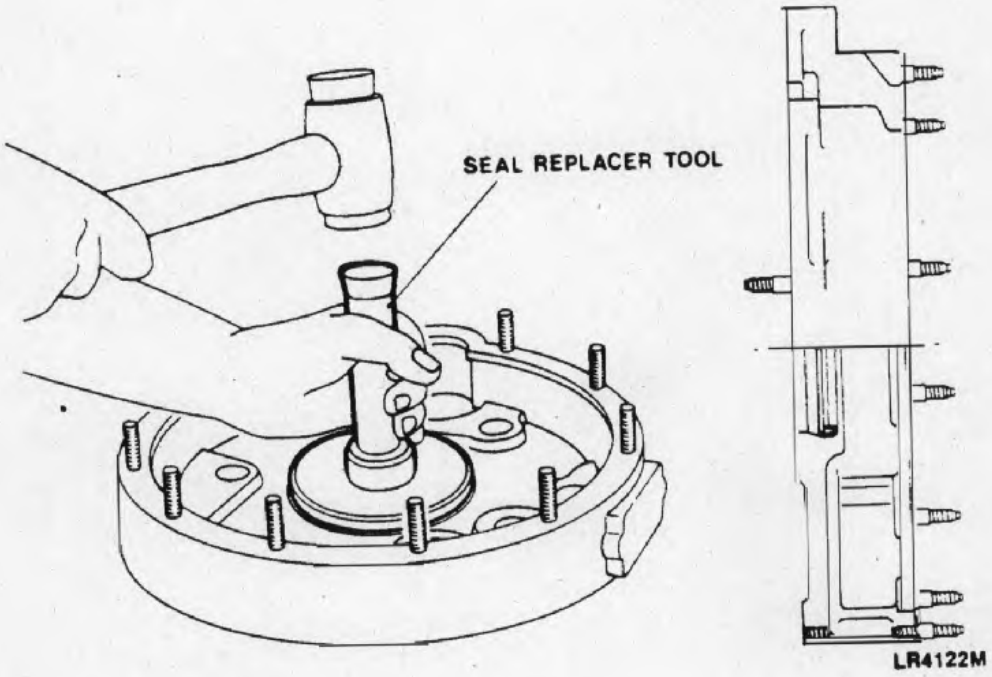


Fig 33 Fitting rear main oil seal

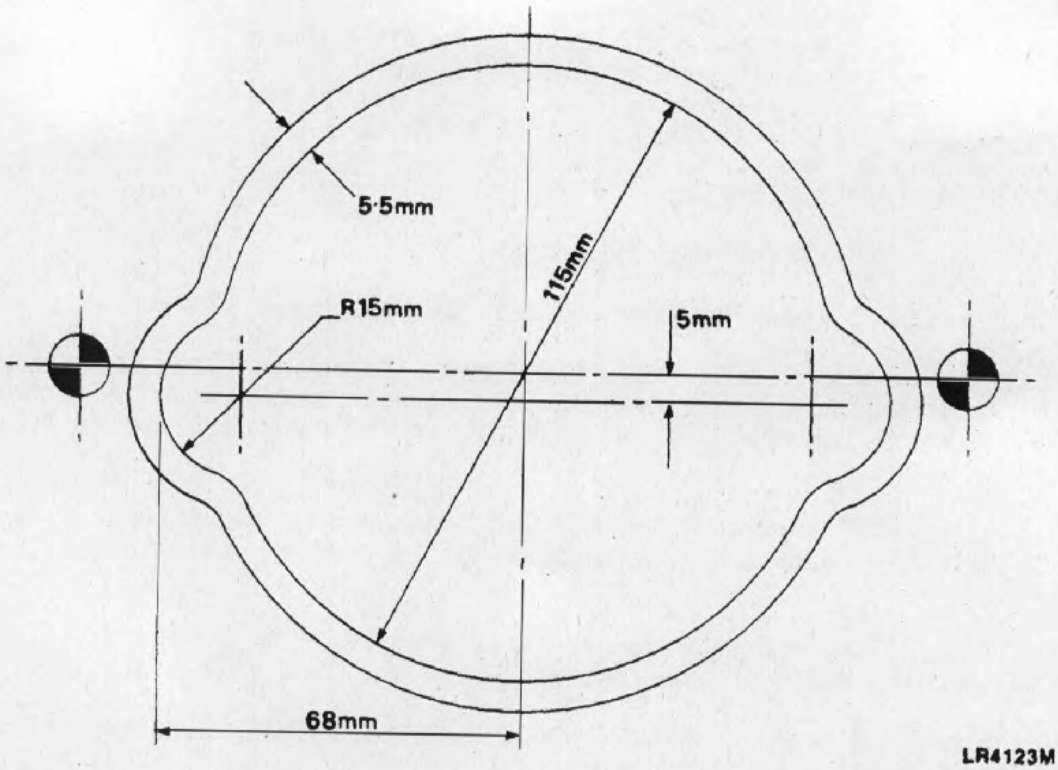


Fig 34 Flywheel housing sealant configuration

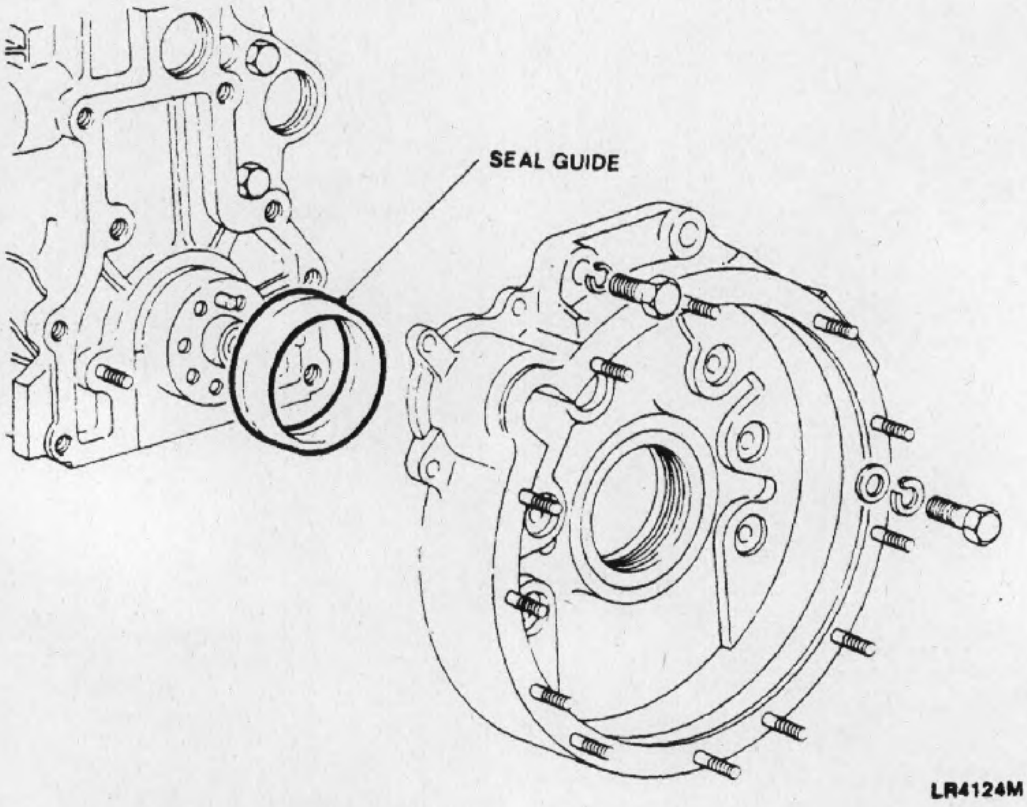


Fig 35 Fitting flywheel housing

46.5 Examine the seal guide Part No 18G 1344 (Fig 35) and repair any damage that could d stroy th seal lip.

46.6 Lubricate the outside diameter of the seal guide and the seal journal with concentrated 'Oildag' in a 25% solution with clean engine oil.

46.7 Place the seal guide on the crankshaft flange (Fig 35) and, using the two dowels protruding from the cylinder block rear face as a guide to ensure initial squareness, fit the flywheel housing and remove the seal guide. Secure the flywheel housing evenly tightening the bolts to a torque of 40 to 50 Nm (30 to 36.8 lbf ft).

Connecting-rod bearing nip and clearance

Note ...

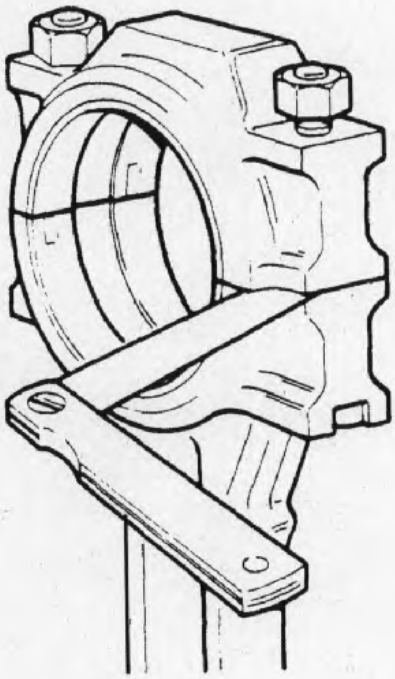
New bearing halves are supplied with a protective coating and must be degreased before fitting.

47 To check the connecting-rod bearing nip and clearance proceed as follows:

47.1 Fit the bearing halves to the connecting-rod and cap, fit the nuts and bolts and tighten to a torque of 37 to 41 Nm (27 to 30 lbf ft).

47.2 Slacken the nut on one side only and check the clearance between the joint faces, using feeler gauges (Fig 36). The clearance should be 0.10 to 0.20mm (0.004 to 0.008in).

47.3 The bearing nip can be adjusted by selective assembly of the bearing shells which are available in slightly varying thicknesses. Do not file or machine the caps or rods to vary the bearing nip.



LR4125M

Fig 36 Checking connecting-rod bearing nip

47.4 Make a final check to prove the clearance by inserting a 0.063mm (0.0025in) shim paper between the crankpin and one half of the bearing and tightening to the correct torque. The connecting-rod should resist rotation with the shim paper fitted and move freely with it removed.

47.5 As an alternative, 'Plastigauge' may be used to determine the bearing clearances by following the procedure in Para 43.7.

Connecting-rod end float

48 Fit the connecting-rods, complete with bearings, to their respective crankpins. Move the connecting-rod to one side and check the clearance on the opposite side (Fig 37), using feeler gauges. The clearance should be 0.15 to 0.356mm (0.006 to 0.014in). When check is completed remove connecting-rods from crankshaft.

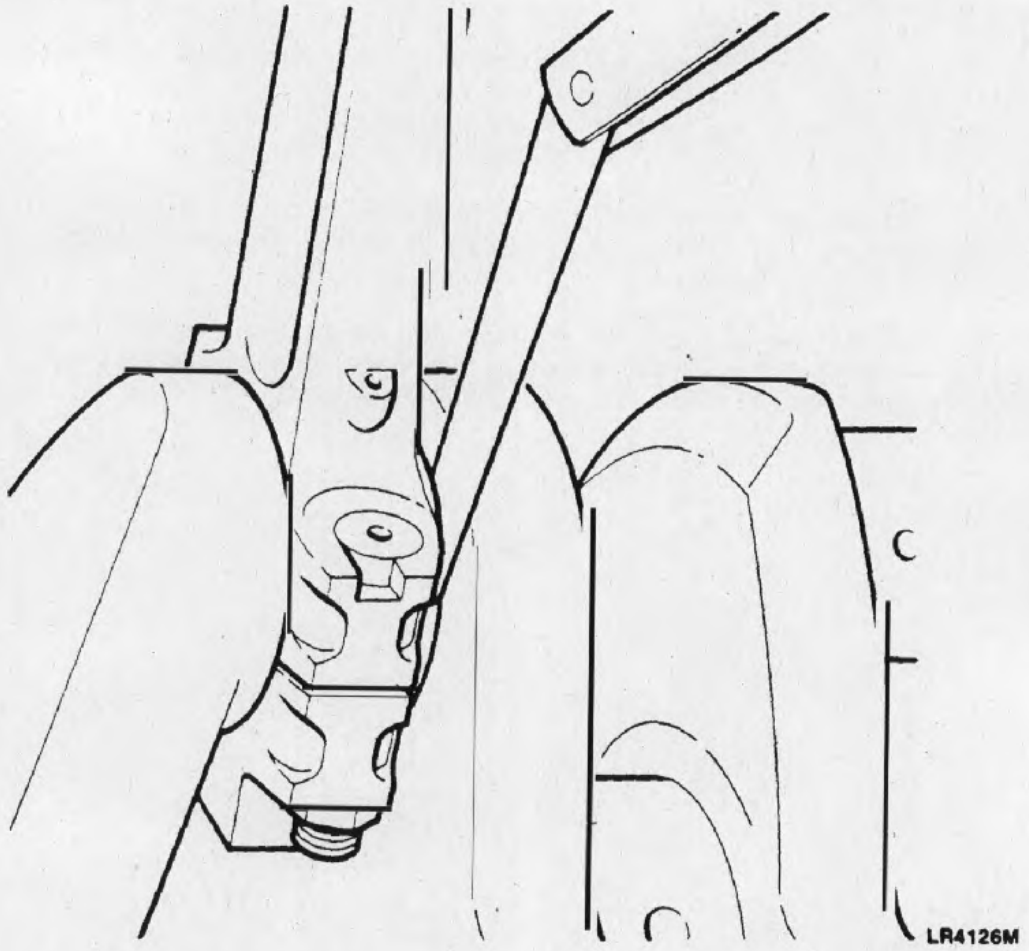


Fig 37 Checking connecting-rod end float

Pistons to connecting-rods

Note ...

The pistons must be assembled with the point of the 'V', on the piston crown, on the same side as the bearing shell location slots in the connecting-rods.

49 Insert a circlip in one side of the gudgeon pin bore and assemble the piston to th conn cting-rod with the gudg on pin. Fit circlip to the opposite side of the gudg on pin bore to secure the assembly.

Piston and connecting-rod assemblies

50 To fit the piston and connecting-rod assemblies to the cylinder block and crankshaft proceed as follows:

50.1 Turn the crankshaft to position numbers one and four crankpins at bottom dead centre.
Notes ...

(1) When fitting the connecting rods and pistons ensure that the bolts do not foul and damage the crankpins. As a precaution it is recommend d that rubber or soft plastic sleeves are placed over the threads.

(2) The connecting-rod bolts have eccentric heads that locate in a recess in the connecting-rod. It is essential that the head of each new bolt is properly located before tightening.

50.2 Stagger the compression rings so that the gaps are equidistantly spaced round the piston but, so arranged, that no gap is positioned on the thrust side of the piston i.e. opposite the camshaft. Turn the oil control ring so that the gap is in line with the gudgeon pin.

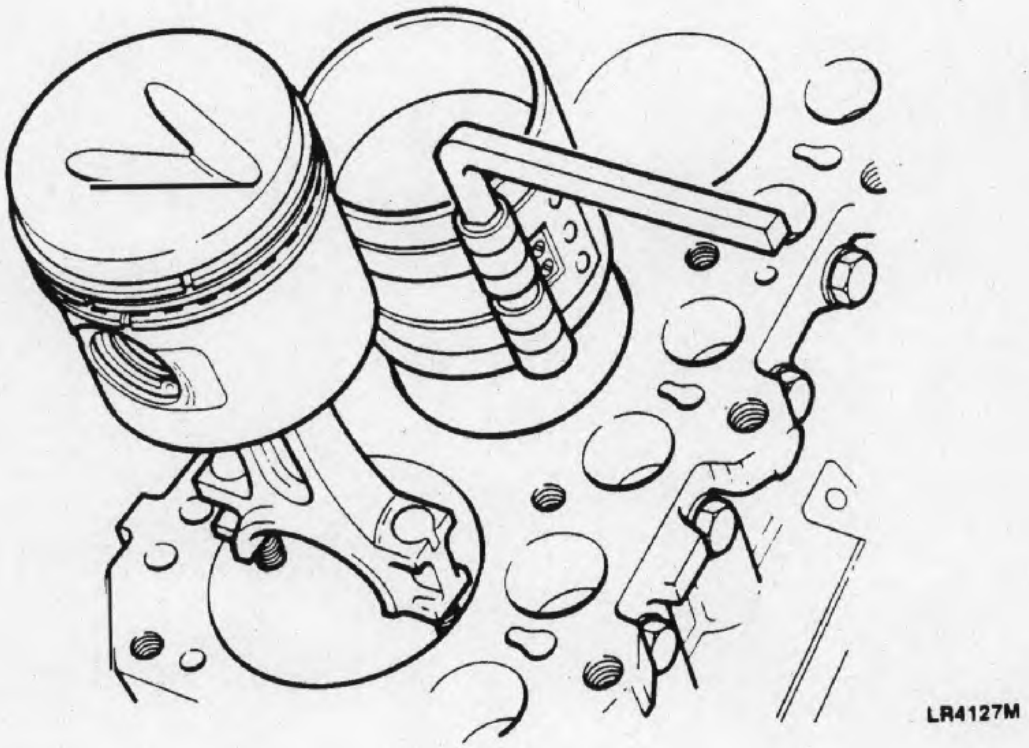


Fig 38 Fitting piston assemblies

50.3 Lubricate the cylinder walls, piston rings and crankpins. Compress the piston rings with a suitable compressor tool (Fig 38) and carefully lower the connecting-rod into the bore, ensuring that the piston is assembled with point of the 'V' on the piston crown facing the camshaft side of the engine.

50.4 Using a soft mallet, sharply tap the piston into the bore so that the whole of the piston is just below the surface of the cylinder block.

50.5 Check that the bearing shell is properly located in the connecting-rod and pull the rod onto the crankpin. Locate the bearing shell correctly and fit the cap so that the identification numbers are together on the camshaft side of the engine. Fit new nuts and tighten to a torque of 37 to 41 Nm (27 to 30 lbf ft).

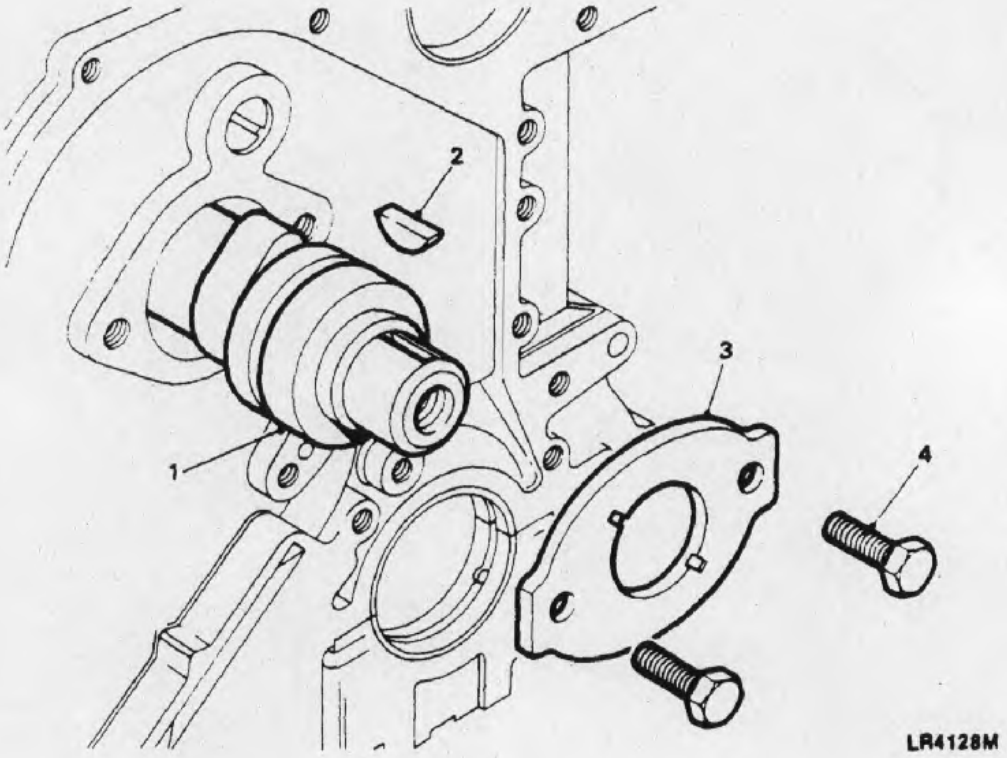
50.6 Repeat the foregoing instructions for fitting the remaining piston and connecting-rod assemblies.

Camshaft

51 To fit the camshaft proceed as follows:

51.1 Lubricate the camshaft bearings and with care, insert the camshaft (Fig 39 (1)) into the cylinder block. Temporarily fit a new thrust plate (3) and secure with the two bolts (4).

51.2 Check the camshaft end float by temporarily fitting the woodruff key (2) and the camshaft pulley. Mount a dial test indicator (Fig 40), with the stylus in a loaded condition resting upon the machined face of the cylinder block.



1 Camshaft
2 Woodruff key
3 Thrust plate
4 Bolt

Fig 39 Fitting camshaft

51.3 Zero the dial and move the camshaft back and forward and note the reading. The-end float should be within 0.06 to 0.13mm (0.0025 to 0.0055in).

51.4 If the end-float is outside these limits, fit different thrust plates until the correct tolerance is achieved. Remove the test indicator, pulley and woodruff key.

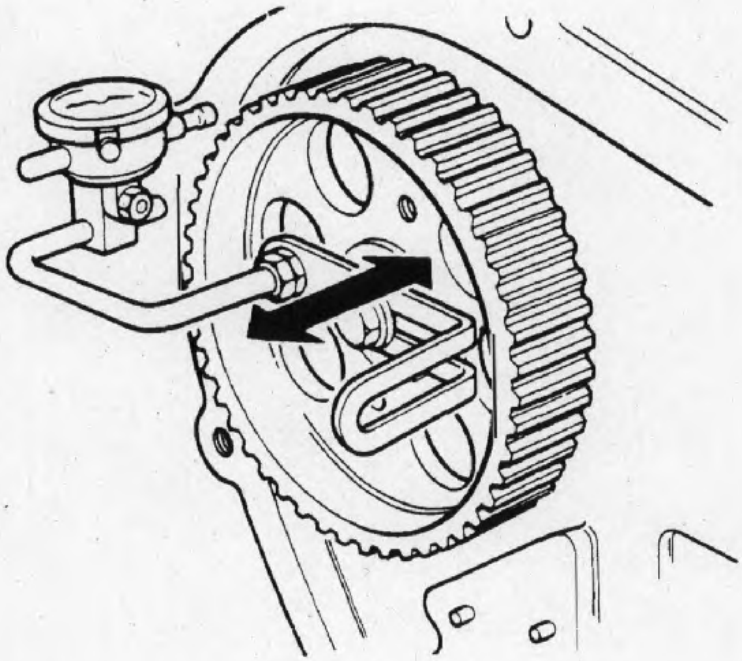


Fig 40 Checking camshaft end-float

Tappets

52 To fit the tappet assemblies, refer to Cat 522 Chap 1-2 Para 27.

Skew gear

53 Lubricate and insert the skew gear assembly into mesh with the camshaft gear. Align the location hole in the bush and fit a new screw into the cylinder block.

Timing belt, pulleys and covers

54 To fit the timing belt pulleys and covers refer to Cat 522 Chap 1-2 Para 52.

Cylinder head assembly

55 To fit the cylinder head assembly refer to Cat 522 Chap 1-2 Para 30.

ANCILLARIES

56 Refit the engine ancillaries in reverse order to removal (Para 3).

REFIT ENGINE TO VEHICLE

57 To refit the engine to the vehicle refer to Cat 522 Chap 1-2 Para 3.

Chapter 1-2

3.5 LITRE V8 PETROL ENGINE

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for Land Rover 3.5 litre V8 petrol engine with the exception of the engine fuel and cooling systems which are dealt with in Chapters 11 and 12 respectively.

ENGINE REMOVAL FROM VEHICLE

2 To remove the engine from the vehicle (Cat 522 Chap 1-2).

ANCILLARIES REMOVAL

3 To remove the engine ancillaries proceed as follows:

3.1 Mount the engine on a suitable work stand.

3.2 Remove the 12 volt alternator and its associated mounting brackets (Cat 522 Chap 13).

3.3 Remove the starter motor (Cat 522 Chap 13).

3.4 Remove the inlet and exhaust manifolds (Cat 522 Chap 1-2).

3.5 Remove the fan and viscous coupling assembly (Cat 522 Chap 1-2).

3.6 Release the securing bolts and remove the water pump (Cat 522 Chap 1-2).

3.7 Remove the oil filter assembly. Unscrew the element and discard (Cat 201).

3.8 Restrain the flywheel, remove the crankshaft pulley securing bolt and withdraw the pulley (Cat 522 Chap 1-2).

3.9 Remove the clutch assembly (Cat 522 Chap 2-2).

3.10 Remove the dipstick, oil sump and oil circulation pump (Cat 522 Chap 1-2).

3.11 Remove the power steering pump (Cat 522 Chap 7-2) (127 vehicles only).

3.12 Disconnect the spark plug H.T. leads and remove the distributor cap (Cat 522 Chap 1-2).

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	Designation (3)
1	RO605351	Guide bolts
2	18G537	Torque wrench
3	18G1150	Piston pin remover/replacer - basic tool
4	18G1150E	Adaptor remover/replacer - piston pin
5	18G106A	Spring compressor
6	RO600959	Drift for valve guide replacement
7	MS76	Valve cutter handle set
8	MS621	Valve seat cutter
9	RO605774A	Distance piece for valve guide
10	RO274401A	Drift for valve guide removal
11	RO1014	Crankshaft rear seal sleeve

ENGINE

Dismantling

Cylinder head assembly

4 For cylinder head assembly removal, dismantling and overhaul refer to Cat 522 Chap 1-2.

Timing covers, pulleys and distributor drive

5 For timing covers, pulleys and distributor drive removal and refitting refer to Cat 522 Chap 1-2.

Tappet assemblies

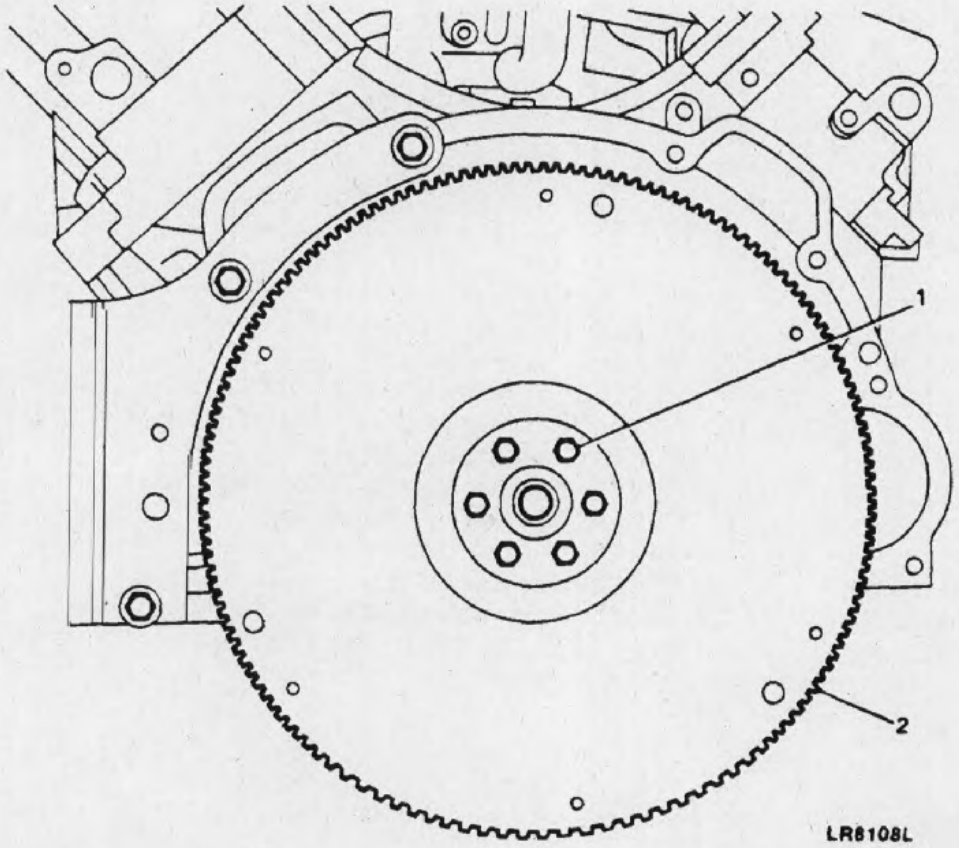
6 For tappet assemblies removal and refitting refer to Cat 522 Chap 1-2.

Flywheel

7 Prevent the crankshaft from turning and remove the retaining bolts (Fig 1 (1)) and withdraw the flywheel (2) from the crankshaft.

WARNING ...

HOLD THE FLYWHEEL FIRMLY WHILE THE LAST BOLT IS BEING REMOVED TO PREVENT THE FLYWHEEL FALLING AND CAUSING PERSONAL INJURY.



1 Retaining bolts 2 Flywheel

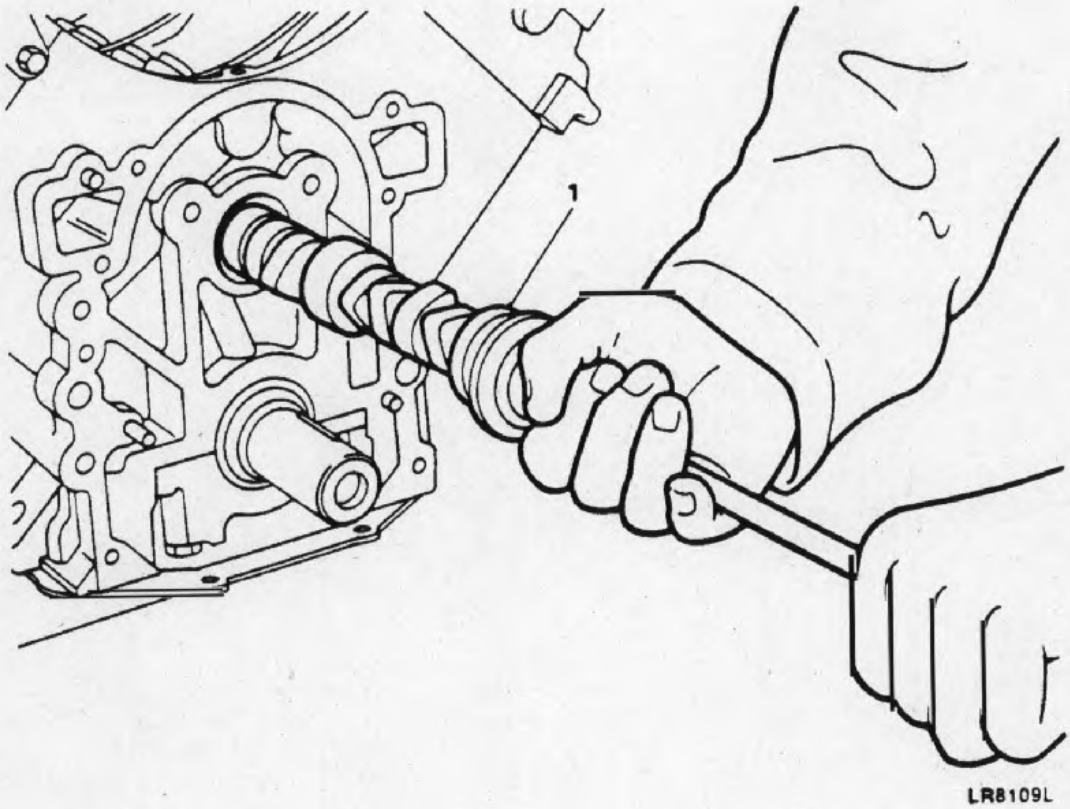
Fig 1 Flywheel removal

Camshaft

8 To remove the camshaft proceed as follows:

8.1 If there are any tappets that could not be removed earlier due to enlarged cam faces, insert the tappet next to the damaged one and lift them both clear of the camshaft and secure together with a rubber band.

8.2 Withdraw the camshaft (Fig 2 (1)) whilst taking care not to damage the bearings in the cylinder block. To assist in keeping the camshaft horizontal whilst withdrawing it from the cylinder block, insert a screw driver or suitable bar into the threaded hole in the end of the shaft to enable it to be supported by both hands to prevent the shaft falling on the bearings as it is released from the rear bearing.



1 Camshaft

Fig 2 Camshaft removal

Connecting-rods and pistons

9 To remove and dismantle the connecting-rods and pistons proceed as follows:

Note ...

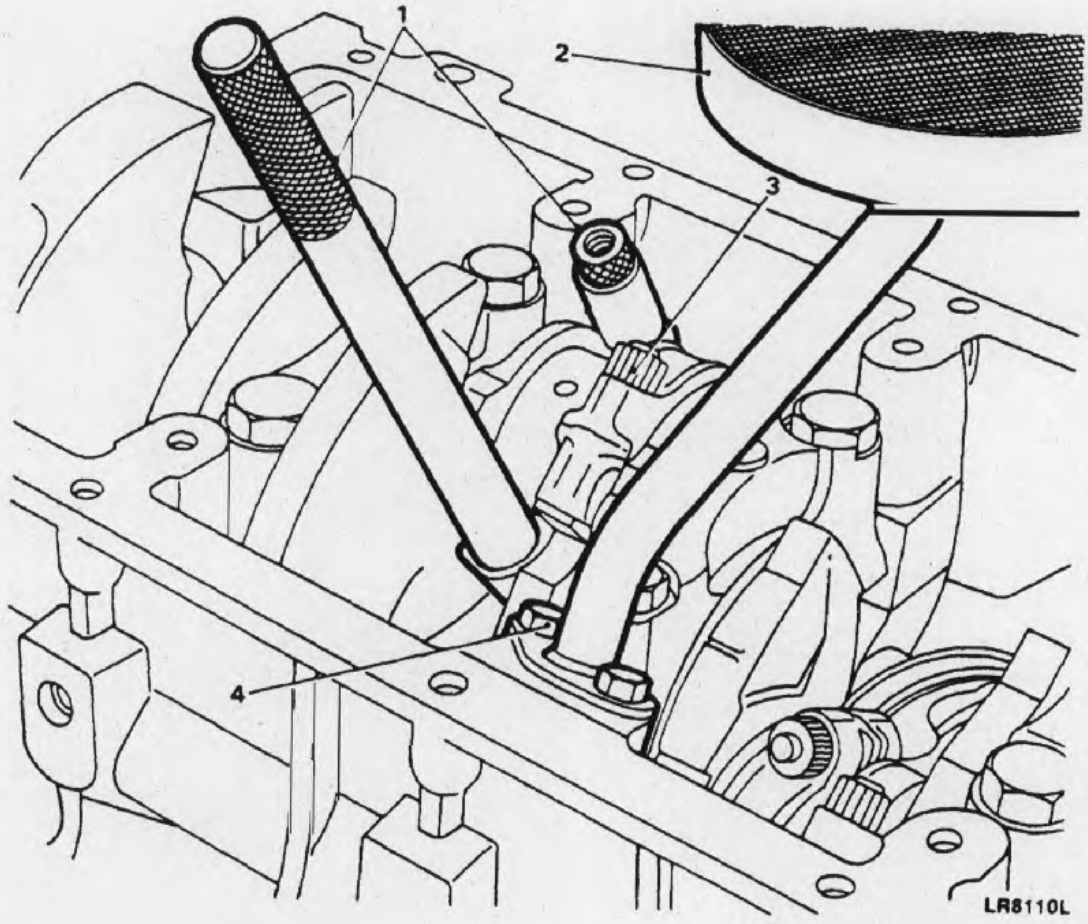
Until it is decided if new components are required all parts must be kept in their related sets and the position of each piston to its connecting-rod should be noted.

9.1 Remove the sump bolts (Fig 3 (4)) and oil strainer (2).

9.2 Turn the crankshaft so that the first piston to be removed is at bottom dead centre.

9.3 Remove the connecting-rod caps (3) and retain them in sequence for reassembly.

9.4 Screw the guide bolts 605351 (1) on to each connecting-rod in turn. Fit the longer guide bolt to the lowest connecting-rod bolt.



1 Guide bolts
2 Strainer
3 Connecting-rod cap
4 Sump bolts

Fig 3 Connecting-rod cap removal

9.5 Check that the connecting-rod big end is aligned exactly with the bore and push the connecting rod and piston assembly up the cylinder bore and withdraw it from the top (Fig 4). Retain the connecting-rod and piston assemblies in sequence with their respective caps and bearing shells.

9.6 Remove the guide bolts from the connecting-rod and repeat the above instructions on the remaining connecting-rods and pistons.

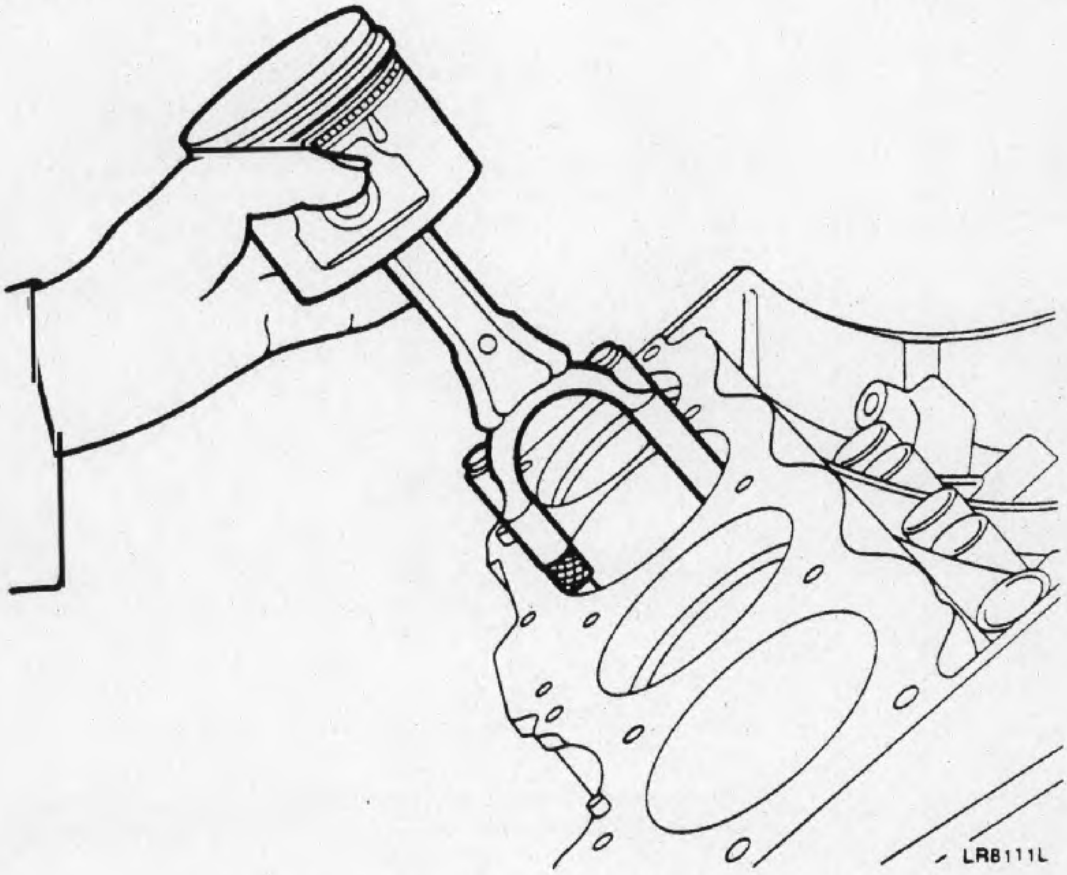


Fig 4 Piston and connecting-rod

9.7 Remove the piston rings over the crown of the piston using a piston ring expander tool.

9.8 Withdraw the gudgeon pin from the connecting-rod small end using tool 18G1150 as follows:

9.8.1 Clamp the hexagon body (Fig 5 (7)) of tool 18G1150 in a vice.

9.8.2 Position the large nut (9) flush with the end of the centre screw.

9.8.3 Push the nut fowards until the nut contacts the thrust race (8).

9.8.4 Locate the piston adaptor (6) with its long spigot inside the bore of the hexagon body (7).

9.8.5 Fit the remover/replacer bush (3) on the centre screw with the flanged end away from the gudgeon pin.

9.8.6 Screw the stop-nut (2) about halfway onto the smaller threaded end of the centre screw, leaving the gap 'A' measuring 3,0 mm (0.125 in) between the nut (2) and the remover/replacer bush (3).

9.8.7 Lock the stop-nut (2) securely with the lock screw (1).

9.8.9 Check that the remover/replacer bush (3) is correctly positioned in the bore of the piston (4).

9.8.10 Push the connecting-rod to the right (5) to expose the end of the gudgeon pin, which must be located in the end of the adaptor (6).

9.8.11 Screw the large nut (9) up to the thrust race (8).

9.8.12 Hold the lock screw (1) and turn the large nut (9) until the gudgeon pin has been withdrawn from the piston. Dismantle the tool.

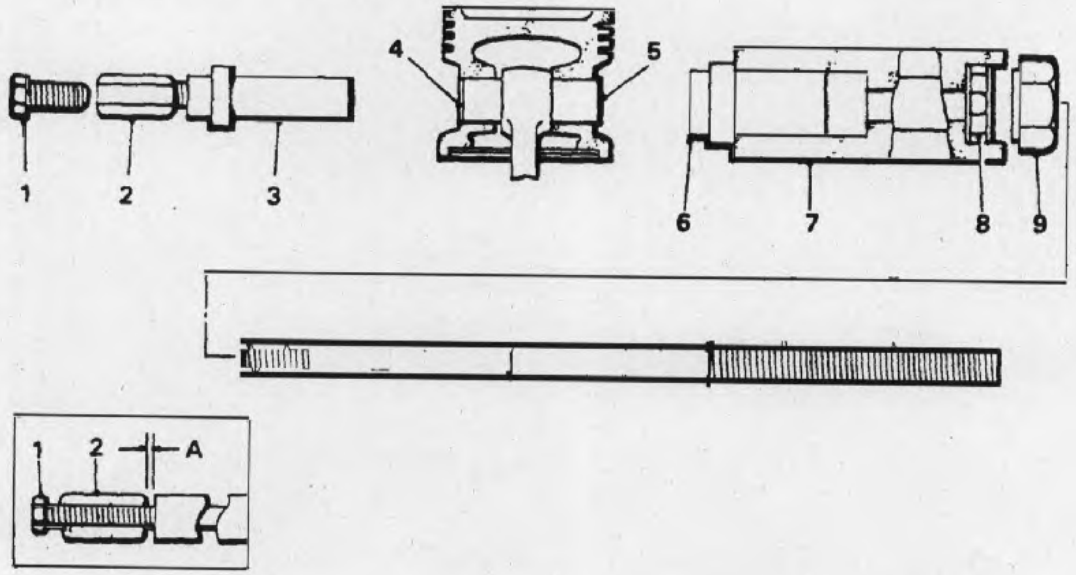


Fig 5 Detaching piston from connecting-rod

Crankshaft

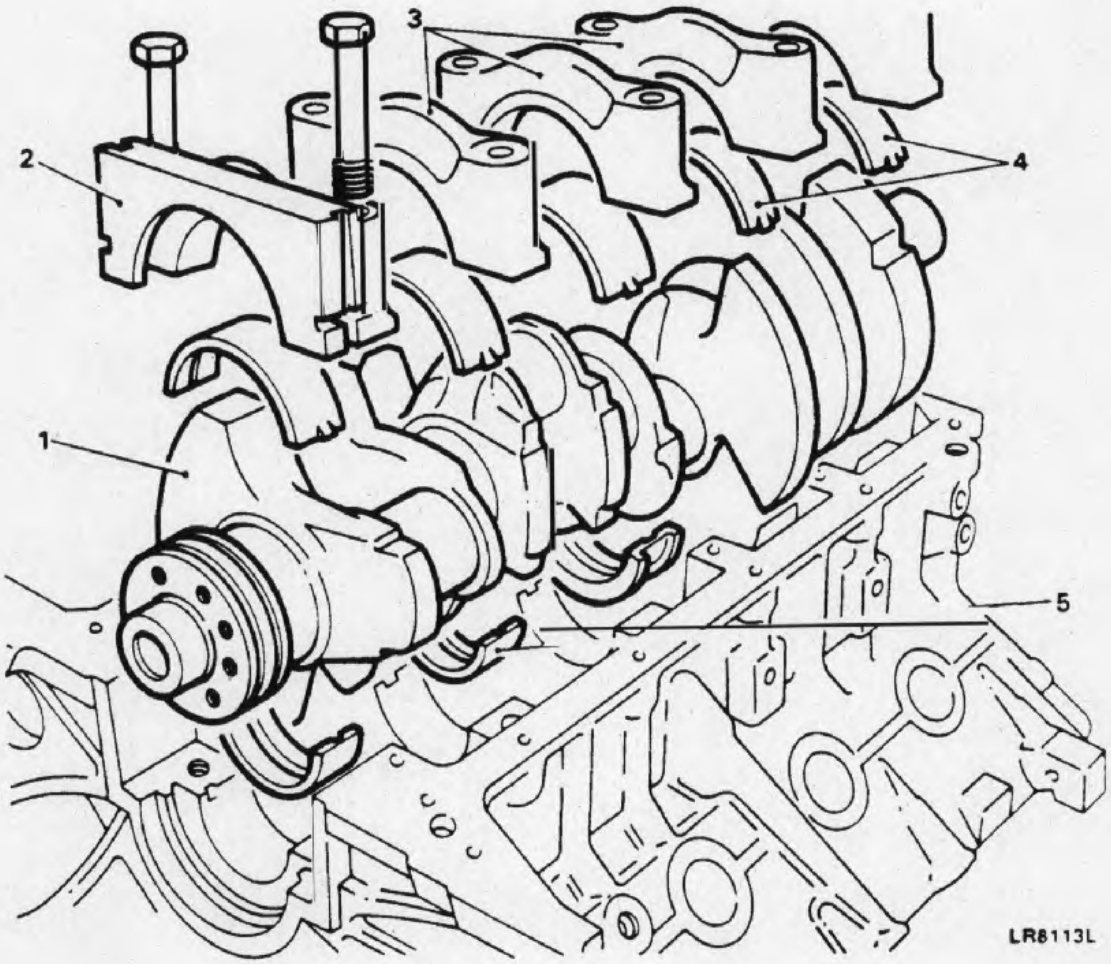
10 To remove the crankshaft proceed as follows:

10.1 Remove the main bearing caps (Fig 6 (3)) and lower the bearing shells (2) and retain in sequence. It is important to keep them in pairs and mark them with the number of the respective journal until it is decided if the bearing shells are to be refitted.

10.2 Remove the rear main bearing cap (2), taking care not to damage the cylinder block face.

10.3 Lift out the crankshaft and rear oil seal (1).

10.4 Remove the upper bearing shells (5) from the cylinder block.



1 Crankshaft
2 Rear main bearing cap
3 Bearing caps
4 Lower bearing shells
5 Upper bearing shells

Fig 6 Crankshaft removal

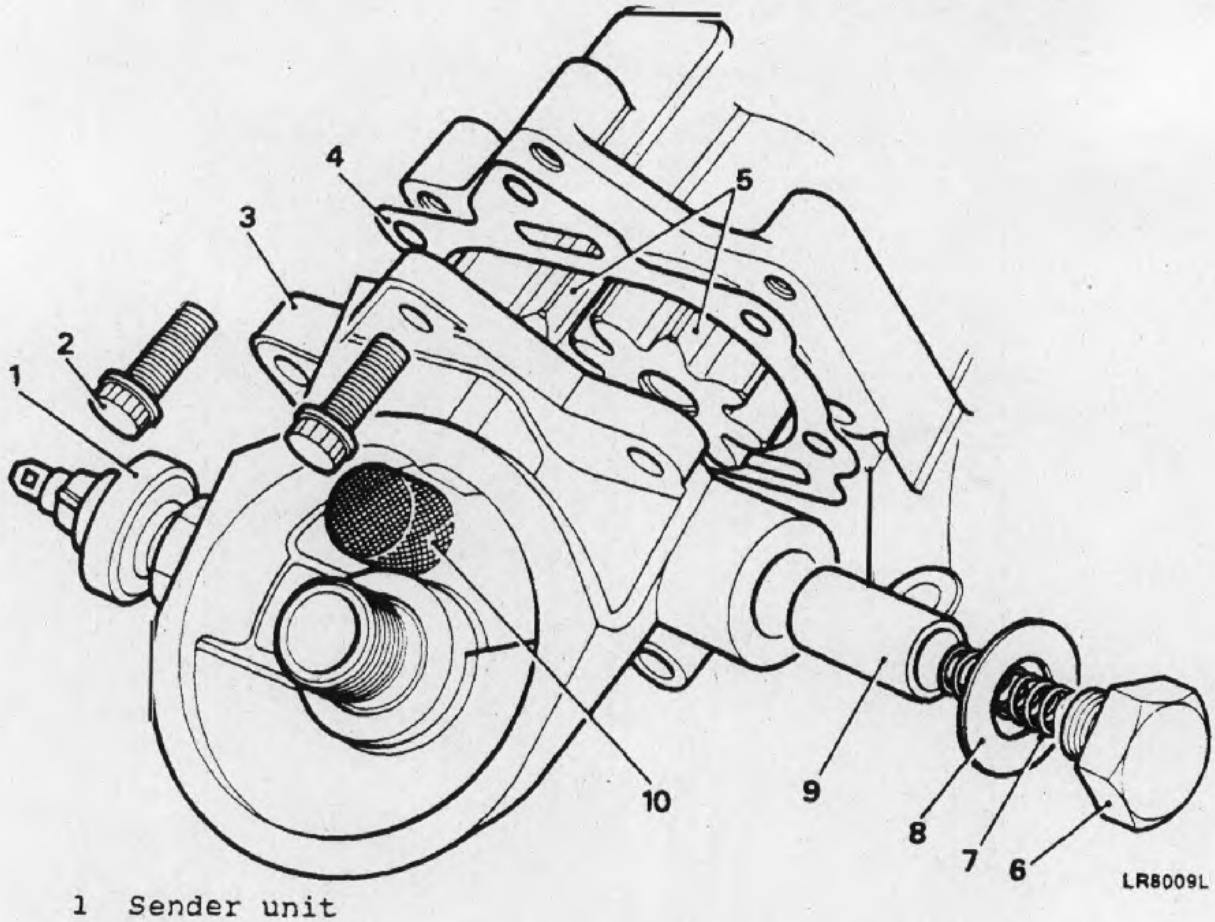
Oil pump

11 To dismantle the oil pump proceed as follows:

11.1 Remove the screws (Fig 7 (2)) and withdraw the oil pump cover (3) and gasket (4).

11.2 Remove the oil pump gears (5).

11.3 Remove the pressure relief valve plug (6) and release the spring (7), relief valve (9) and plug washer (8).



1 Sender unit
2 Screw
3 Oil pump cover
4 Gasket
5 Gears
6 Plug
7 Spring
8 Washer
9 Relief valve
10 Strainer

Fig 7 Oil pump dismantling

Cleaning

12 Thoroughly clean and degrease all components ensuring that oil lubrication drillings and passage ways are clear. Remove all carbon deposits.

Examination

Cylinder block

13 To examine the cylinder block proceed as follows:

13.1 Visually examine the cylinder block for cracks, stripped threads and general damage.

13.2 Check the main bearing caps and cylinder block saddles for distortion as follows:

13.2.1 Fit the main bearing caps without bearing shells and tighten to the correct torque.

13.2.2 Slacken and remove the bolt on one side of each bearing cap and check with a feeler gauge (Fig 8) that no clearance exists at the joint face between the cap and saddle.

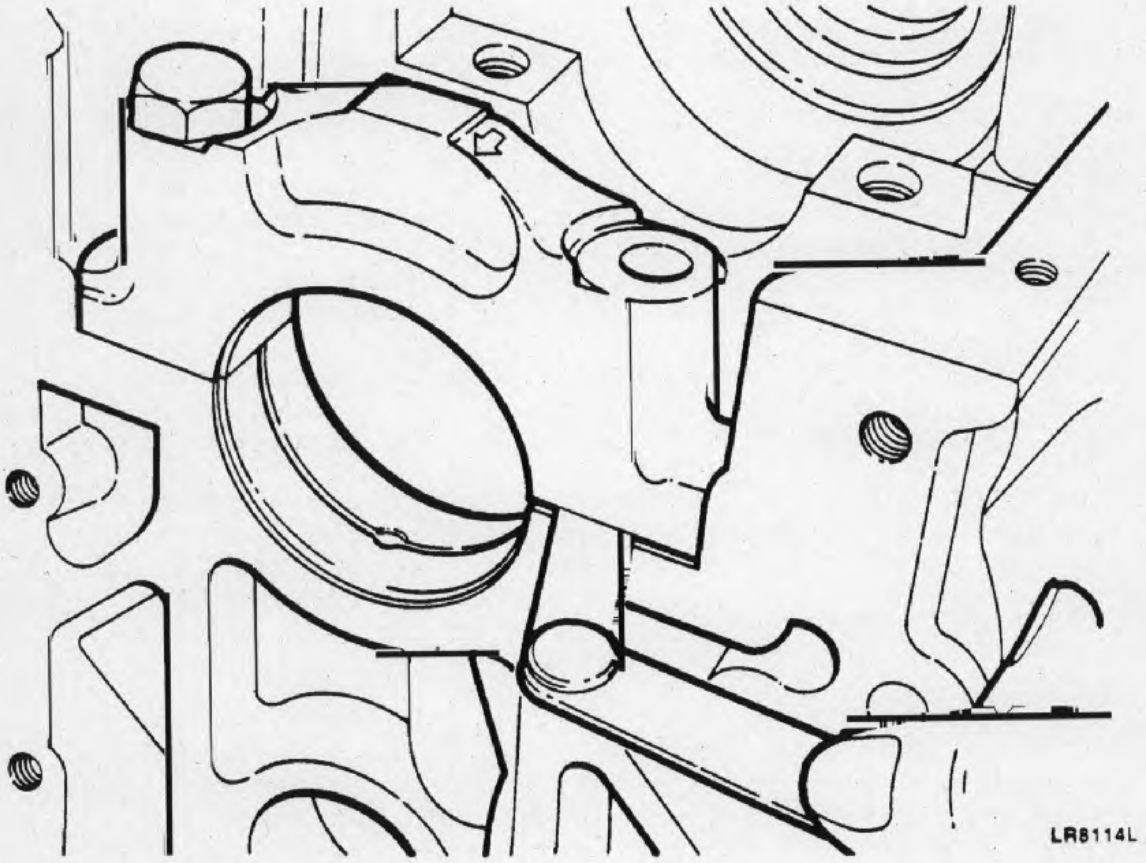


Fig 8 Checking main bearing caps

13.3 Examine the cylinder bores as follows:

13.3.1 Measure the cylinder bores for ovality using an internal micrometer. Check the ovality of each bore by taking measurements 40 mm to 50 mm (1.5 in to 2.0 in) from the top of the cylinder at two points diametrically opposite. The difference between the two figures is the ovality of the bore.

13.3.2 Take similar measurements approximately 50 mm (2.0 in) from the bottom of the bore to determine ovality.

13.3.3 Measure the cylinder bores for taper using a cylinder gauge. Check the taper of each bore by taking measurements at the top and bottom of the bore at right angles to the gudgeon pin line. The difference between the two measurements is the taper.

13.3.4 Check maximum overall bore wear by taking measurements at as many points as possible down the bores at right angles to the gudgeon pin line. The largest recorded figure is the maximum wear and should be compared to the original diameter of the cylinder bore.

Maximum permissible ovality 0,127 mm (0.005 in)
Maximum permissible taper 0,254 mm (0.010 in)
Maximum permissible overall wear 0,177 mm (0.007 in)

13.3.5 If the measurements taken are greater than the above figures the cylinders may be rebored to a suitable oversize (Para 20).

13.3.6 If the overall wear, taper and ovality are well within the acceptable limits and the original pistons are serviceable, new piston rings may be fitted. It is important however, that the bores are deglazed with a hone to give a cross-hatched finish to provide a seating for the new rings. It is vital to thoroughly wash the bores afterwards to remove all traces of abrasive material.

13.4 To examine the camshaft bearings proceed as follows:

13.4.1 Check the camshaft bearings for pitting or scoring.

13.4.2 Measure the internal diameter of each bearing with an internal micrometer. A comparison of the bearing diameters with those of the respective camshaft journals will give the amount of clearance. The clearance should not exceed 0,0254 mm (0.001 in).

Note ...

Each of the five camshaft bearings is a different diameter, with the smallest at the rear and the largest at the front. The bearings are machined into the cylinder block. If they are excessively worn, pitted or scored the cylinder block must be renewed.

Crankcase main bearings

14 To examine the crankcase main bearings proceed as follows:

14.1 Check the bearing shells for pitting, scoring or excessive wear. If damage is evident they must be renewed.

14.2 Assemble the bearing shells to the locations from which they were removed on the crankcase, fit the bearing caps and tighten to the correct torque.

14.3 Using an internal micrometer, measure ach bearing at several points and note the largest record d dimension of each bearing.

14.4 Check the respective crankshaft journals at several points noting the smallest diameter recorded. The maximum wear is the difference between this figure and the largest dimension taken from the respective main bearing shell.

Crankshaft

15 To examine the crankshaft proceed as follows:

15.1 Degrease the crankshaft and clear out the oil ways which can become clogged after long service.

15.2 Examine visually, the crankpins and main bearing journals for obvious wear, scores, grooves and overheating. A decision at this stage should be made as to whether the condition of the shaft is worth continuing with a more detailed examination. To proceed, measure with a micrometer and note the ovality and taper of each main bearing journal and crankpin. Also check for crankshaft straightness and overall wear as follows:

15.2.1 Measure the ovality by taking two readings at right angles to each other at various intervals. The maximum permissible ovality must not exceed 0,040 mm (0.0015 in).

15.2.2 Measure the taper by taking two readings parallel to each other at both ends of the main bearing journal and crankpin. The maximum permissible taper must not exceed 0,025 mm (0.001 in).

15.2.3 Check for straightness by supporting the front and rear main bearing journals in 'V' blocks and position a dial indicator to check the run-out at the centre main bearing journal (Fig 9). Run-out must not exceed 0,076 mm (0.003 in) taking into account any ovality in the centre journal.

15.2.4 The overall wear limit should not exceed 0,114 mm (0.0045 in) for main bearing journals and 0,088 mm (0.0035 in) for crankpins. A crankshaft worn beyond the limits of maximum taper, ovality and overall wear can be ground undersize, for which bearing shells are available. A crankshaft exceeding the limits of straightness must be scrapped, and no attempts should be made to straighten it.

Camshaft

16 Examine the camshaft for scored, worn, pitted or chipped lobes. The cam lobes are in fact manufactured with a slight taper with the highest point at the rear. This taper ensures that the tappet rotates in operation thus reducing wear and causes the shaft to be thrust onto the cylinder block. Check for worn, corroded and discoloured bearing journals.

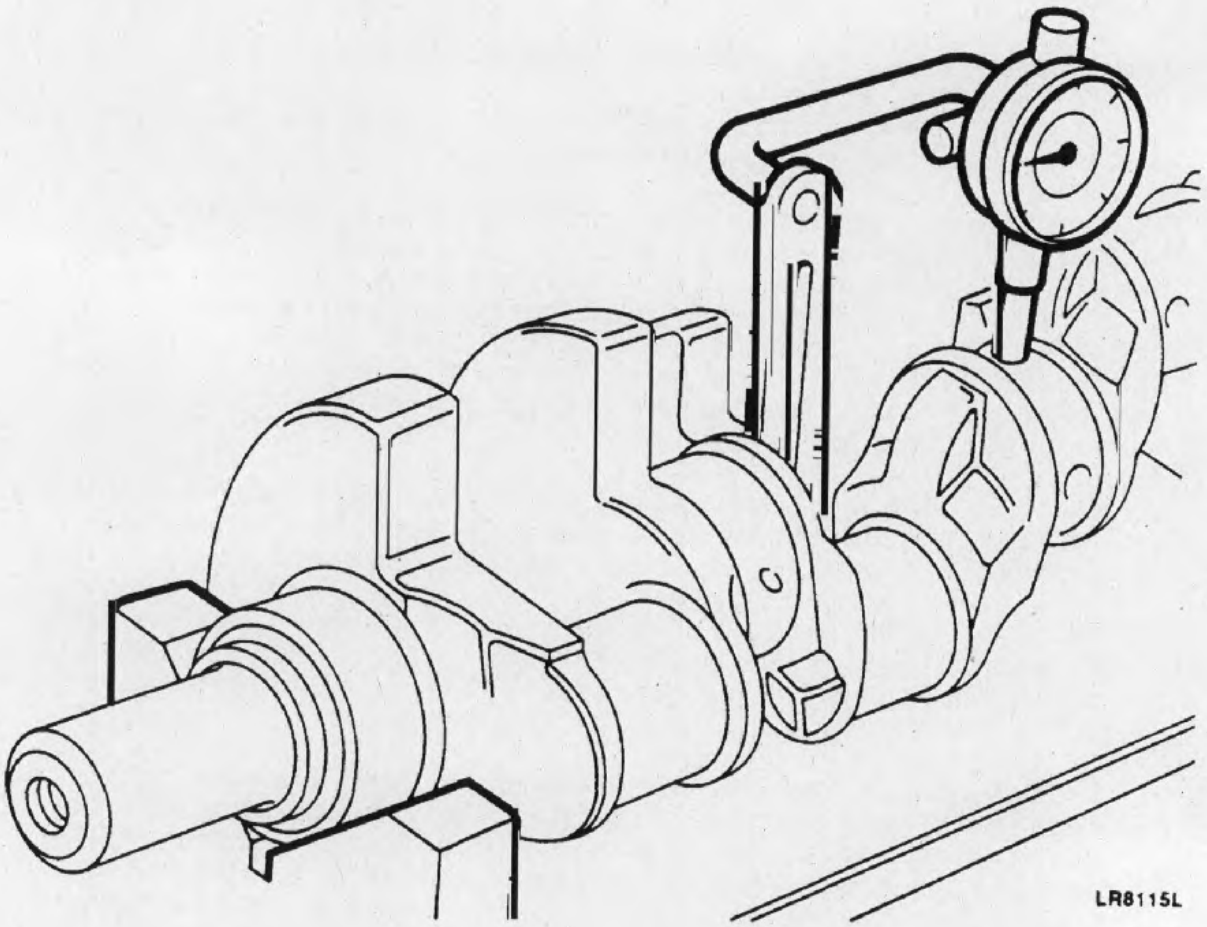


Fig 9 Checking crankshaft for straightness.

Pistons and connecting-rods

17 To examine pistons, piston rings, gudgeon pins and connecting-rods proceed as follows:

17.1 Carry out a visual examination of the pistons and rings, discard any that are considered to be unserviceable. Pistons which appear to be serviceable should be subjected to a more detailed examination described under 'New pistons' in the Repairs and replacements section of this Chapter.

17.2 Check the gudgeon pins for wear, cracks scores and overheating. The fit in the piston must be a tight push fit at a temperature of 68°F (20°C). Check the gudgeon pin for ovality and taper using a micrometer.

17.3 Check the connecting-rods by removing the bearing shells and refitting the cap. Tight n the nuts to the correct torque and ensure that the dome on the cap and rod are aligned. Slacken the nut on one side and with a feeler gauge, check the clearance between the rod and the cap on the side slackened off (Fig 10). A rod in good condition should have no gap.

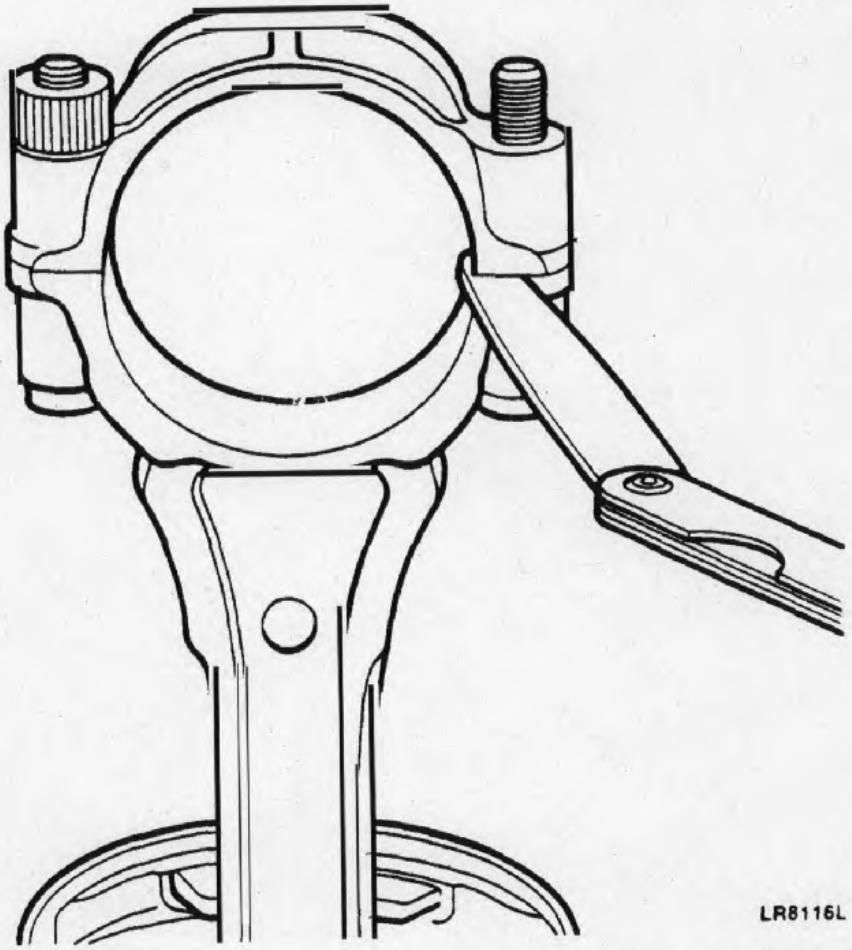


Fig 10 Checking connecting-rod cap for distortion

17.4 If the necessary equipment is available the rods should be checked for bend and twist, especially on high mileage engines and ones that show evidence of overheating.

Flywheel and starter ring gear

18 To examine the flywheel and starter ring gear proceed as follows:

18.1 Examine the flywheel clutch face for cracks, scores and overheating. If the overall thickness of the flywheel is in excess of the minimum thickness i.e. 39,93 mm (1.572 in) it can be refaced provided that after machining it will not be below the minimum thickness.

18.2 Examine the starter ring gear teeth, and if chipped or worn the gear should be renewed.

Oil pump

19 To examine the oil pump proceed as follows:

19.1 Clean all the components including the recess in the front cover and examine the oil pump gears for wear, scores and pitting. If the gears appear to be serviceable check for end float as follows:

19.1.1 Fit the oil pump gears and shaft into the front cover.

19.1.2 Place a straight edge accross the gears and check the clearance using a feeler gauge between the straight edge and the front cover (Fig 11). If less than 0,05 mm (0.0018 in) the gear recess is worn and the cover should be renewed.

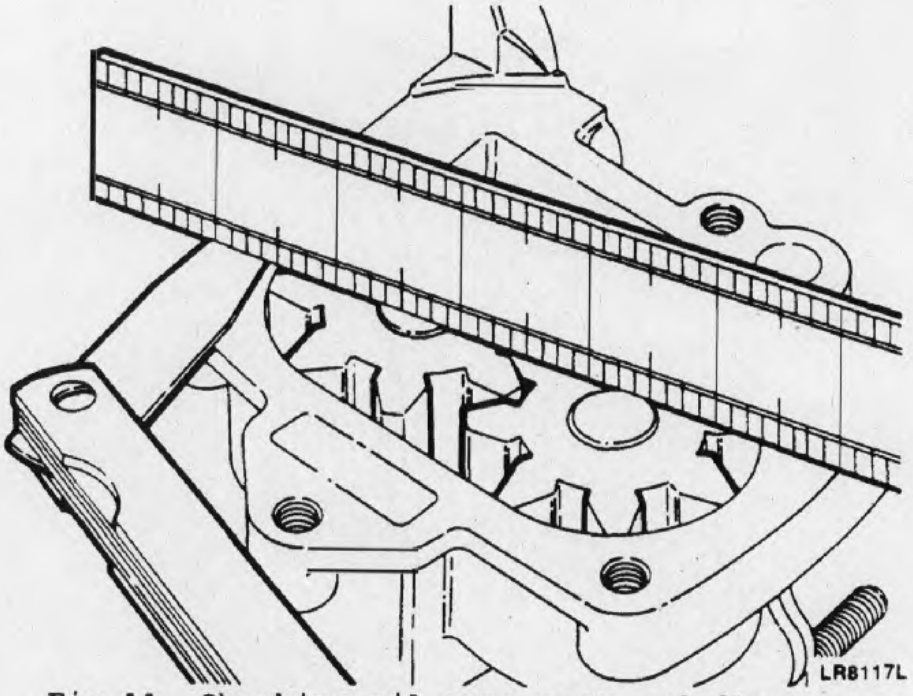


Fig 11 Checking oil pump gear end float

19.2 Check the pump gear cover thrust face for wear. If scored it may be restored by careful refacing.

19.3 Check the oil pressure relief valve for wear and scores as follows:

19.3.1 Check the relief valve spring for wear at the sides or signs of collapse.

19.3.2 Check the gauze filter for clogging.

19.3.3 Check the fit of the relief valve in its bore. The valve must be an easy slide fit with no perceptible side movement.

19.3.4 Renew any parts if their condition is doubtful.

Repair and replacement

Cylinder bores

20 Cylinder blocks can be restored by reboring and fitting oversize pistons. The cylinder bores are cast iron lined and are shrunk into the bores. The liners must not be bored out more than 0,508mm and if they have been bored already beyond this oversize, the cylinder block must be renewed. If the cylinder block is satifactory for reconditioning the following points must be observed:

20.1 Fit the bearing caps and tighten the bolts to the correct torque before machining to prevent distortion during the operation.

20.2 Thoroughly wash the bores after machining to remove all traces of abrasive material.

Camshaft bearings

21 The camshaft bearings are machined into the cylinder block. If the bearings are excessively worn, pitted or scored the cylinder block must be renewed since the bearings are not available as replacements parts.

Crankshaft regrinding

22 Crankshaft main bearing and crankpin journals may be ground undersize and oversize shell bearings fitted. The following points must be observed when carring out regrinding operations:

22.1 Care must be taken not to remove too much material from the thrust faces of the centre main bearing journal. This is because oversize bearings of 0,25 mm are the same width across the thrust face as the standard bearing, whereas the 0,508 mm oversize bearing is 0,25 mm wider.

22.2 The journals and thrust faces on either side of the centre main journal must be machined in accordance with the dimensions in Table 2 (also refer to Fig 12 (1)). For example: If a 0,5 mm (0.020 in) oversize bearing is fitted, then 0,12 mm (0.005 in) must be machined off each thrust face of the centre journal, maintaining the correct radius (4).

22.3 The radius for all journals except the rear main bearing is 1,90 to 2,28 mm (0.075 to 0.090 in).

22.4 The radius for the rear main bearing journal is 3,04 mm (0.120 in).

22.5 For main bearing journal diameter, thrust face width and connecting-rod journal diameter refer to Table 2.

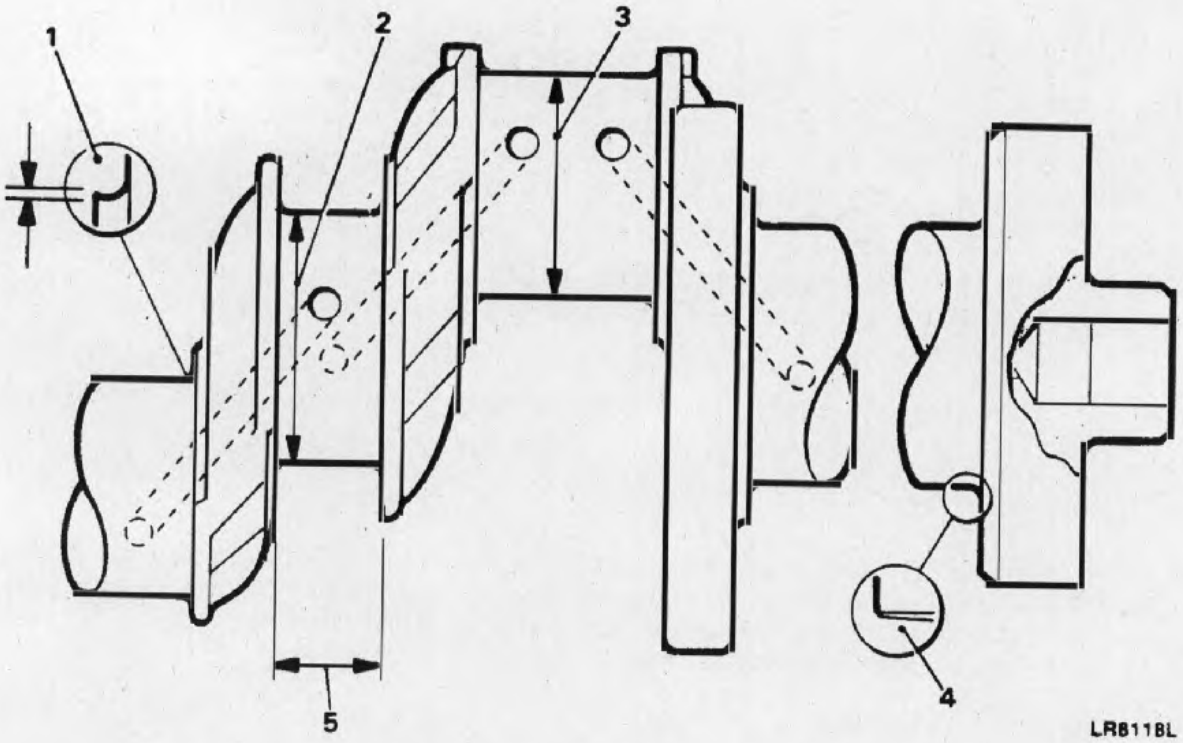


Fig 12 Regrinding crankshaft

TABLE 2 CRANKSHAFT REGRINDING DIMENSIONS

CRANKSHAFT DIMENSIONS - MILLIMETRES			
Crankshaft	Diameter (2)	Width (5)	Diameter (3)
Standard	58,400-58,413	26,975-27,-26	50,800-50,812
0,254 U/S	58,146-58,158	26,975-27,026	50,546-50,559
0,508 U/S	57,892-57,904	27,229-27,280	50,292-50,305
CRANKSHAFT DIMENSIONS - INCHES			
Crankshaft	Diameter (2)	Width (5)	Diameter (3)
Standard	2,2992-2,2997	1,062-1,064	2,0000-2,0005
0,010 U/S	2,2892-2,2897	1,062-1,064	1,9900-1,9905
0,020 U/S	2,2792-2,2797	1,072-1,074	1,9800-1,9805
Main bearing journal size		Thrust face width	
Standard		Standard	
0,25 mm (0.010 in) undersize		Standard	
0,50 mm (0.020 in) undersize		0,25 mm (0.010 in) oversize	

Crankshaft spigot bearing

23 To replace the crankshaft spigot bearing proceed as follows:

23.1 Carefully remove the old bearing.

23.2 Fit the new spigot bearing flush with, or to a maximum of 1,6 mm (0.063 in) below the end face of the crankshaft (Fig 13).

23.3 Ream the spigot bearing to 19,177 + 0,025 mm (0.7504 + 0.001 in) inside diameter. Ensure all swarf is removed.

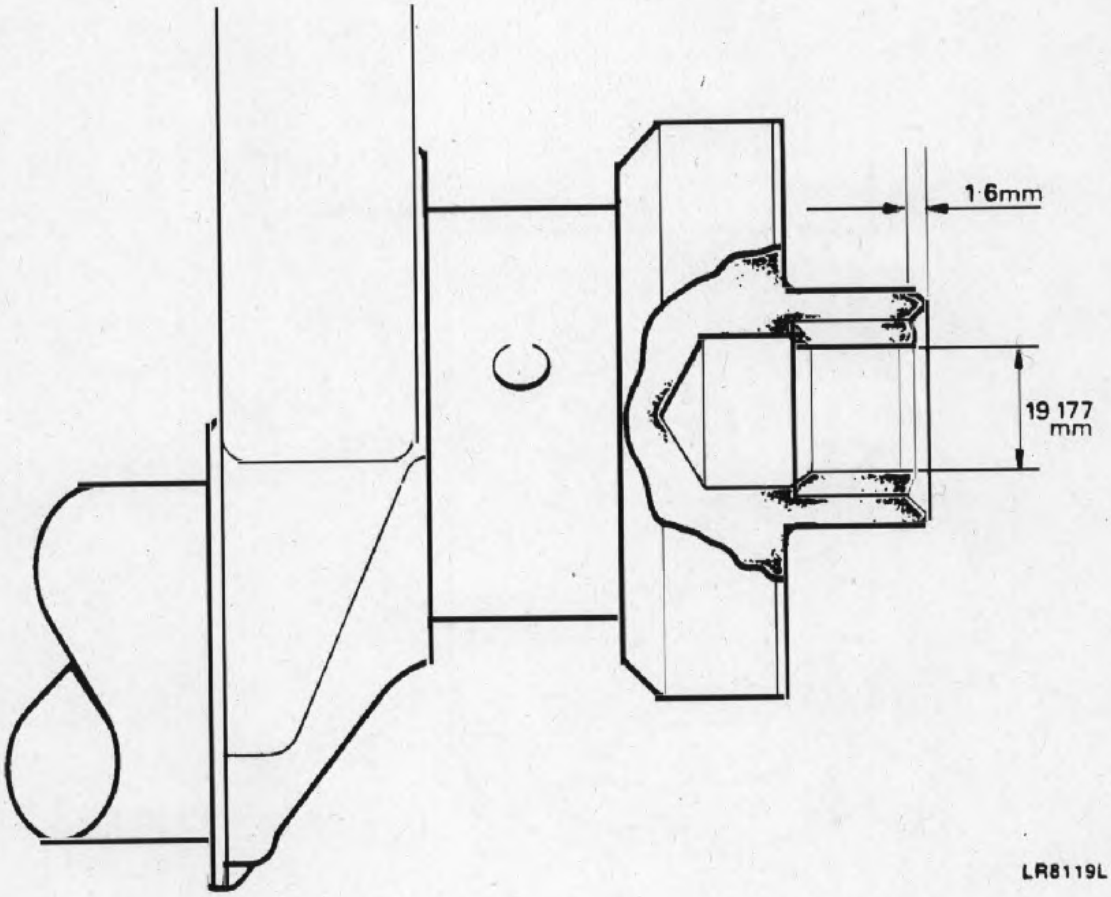


Fig 13 Renew spigot bearing

New pistons

24 New pistons are available in service standard size and in oversizes of 0,25 mm (0.010 in) and 0,50 mm (0.020 in). Service standard size pistons are supplied 0,0254 mm (0.001 in) oversize. When fitting new service standard size pistons to a cylinder block, check for correct piston to bore clearance, honing the bore if necessary.

25 Checking clearances. When checking clearances the temperature of the piston and cylinder block must be the same to ensure accurate measurement. To check the clearances proceed as follows:

25.1 Mark each new piston with the number of the bore to which it will be fitted.

25.2 Using a suitable micrometer measure each piston at the bottom of the skirt at right angles to the gudgeon pin (Fig 14).

25.3 With an internal micrometer or cylinder gauge measure the bore at approximately half way down.

25.4 The clearance is determined by subtracting the piston diameter from the bore diameter. A running clearance of 0,018 to 0,040 mm (0.0007 to 0.0016 in) is permissible. Be sure to keep each piston hereafter identified with its cylinder bore.

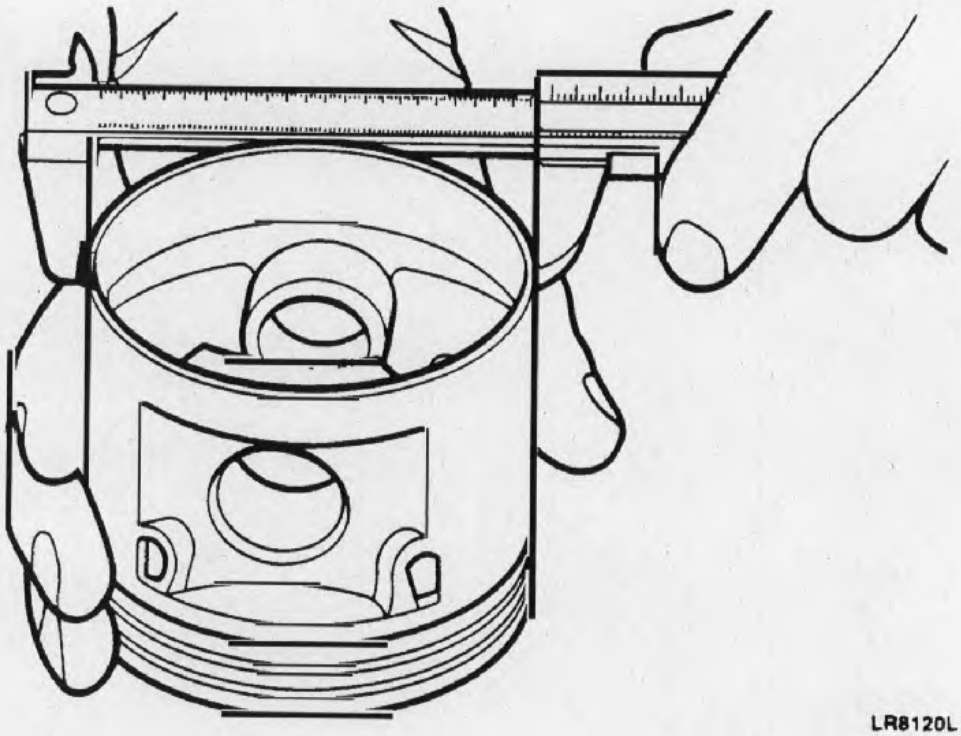


Fig 14 Checking piston to bore clearance

Piston rings

26 Normally when an engine is being overhauled the piston rings are discarded unless the pistons have been removed for a different purpose and the engine has only completed a small mileage. Before refitting the pistons and rings should be examined for wear and damage. In addition the rings must be checked for gap in the bores and side clearance in the pistons. These checks must also be carried out when fitting new rings to new and used pistons.

27 Checking gaps. Check the compression ring gaps in the applicable cylinder, held square to the bore with the piston (Fig 15). The gaps must be checked with the ring at the bottom of the piston stroke, about 82 mm (3.25 in) down the cylinder. The gap should be within 0,44 to 0,56 mm (0.017 to 0.022i n). To increase the gap use a fine-cut file preferably with the ring held in a filing rig.

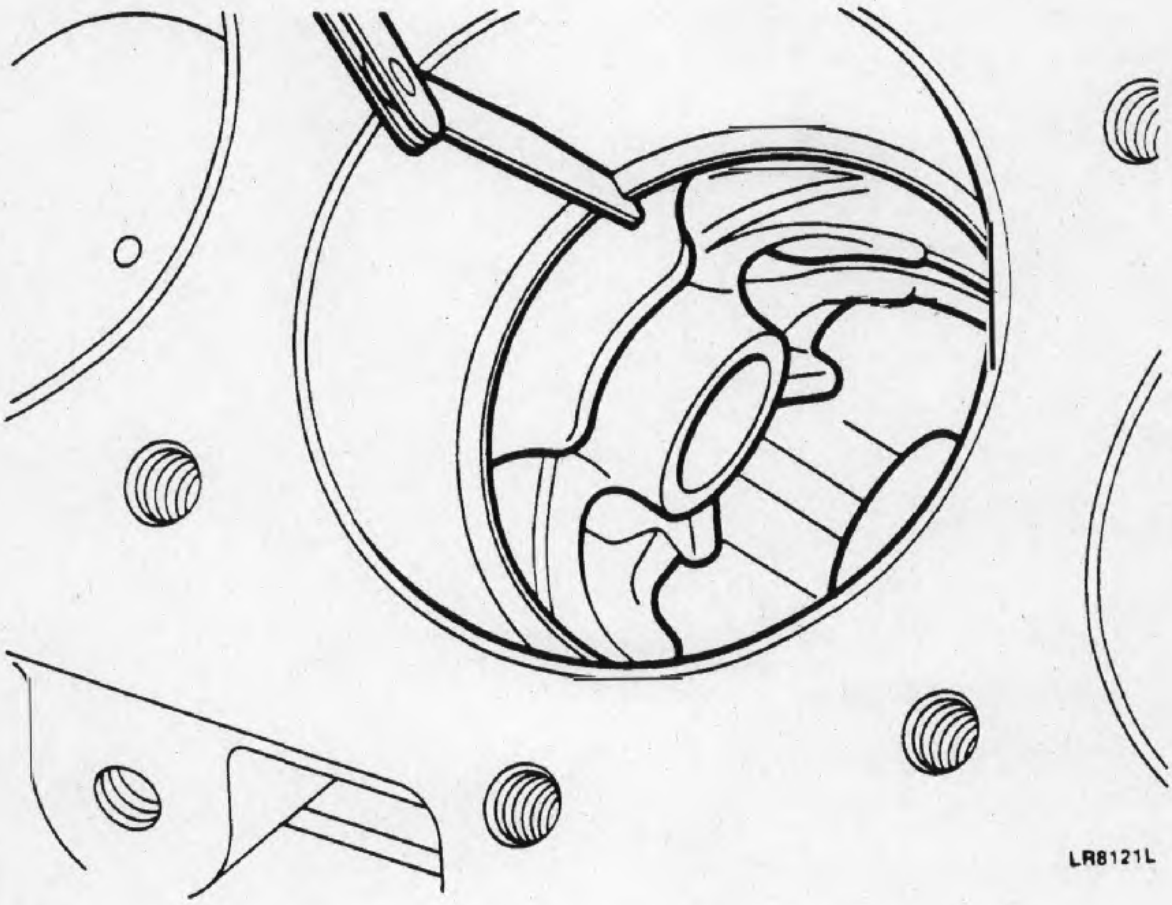


Fig 15 Checking piston ring gap

28 Fitting piston rings and checking side clearance. To fit the piston rings and check the side clearance proceed as follows:

28.1 Fit the rings to the pistons starting with the oil control ring assembly as follows:

28.1.1 Fit the expander ring (Fig 16 (4)) into the bottom groove making sure that the ends butt and do not overlap.

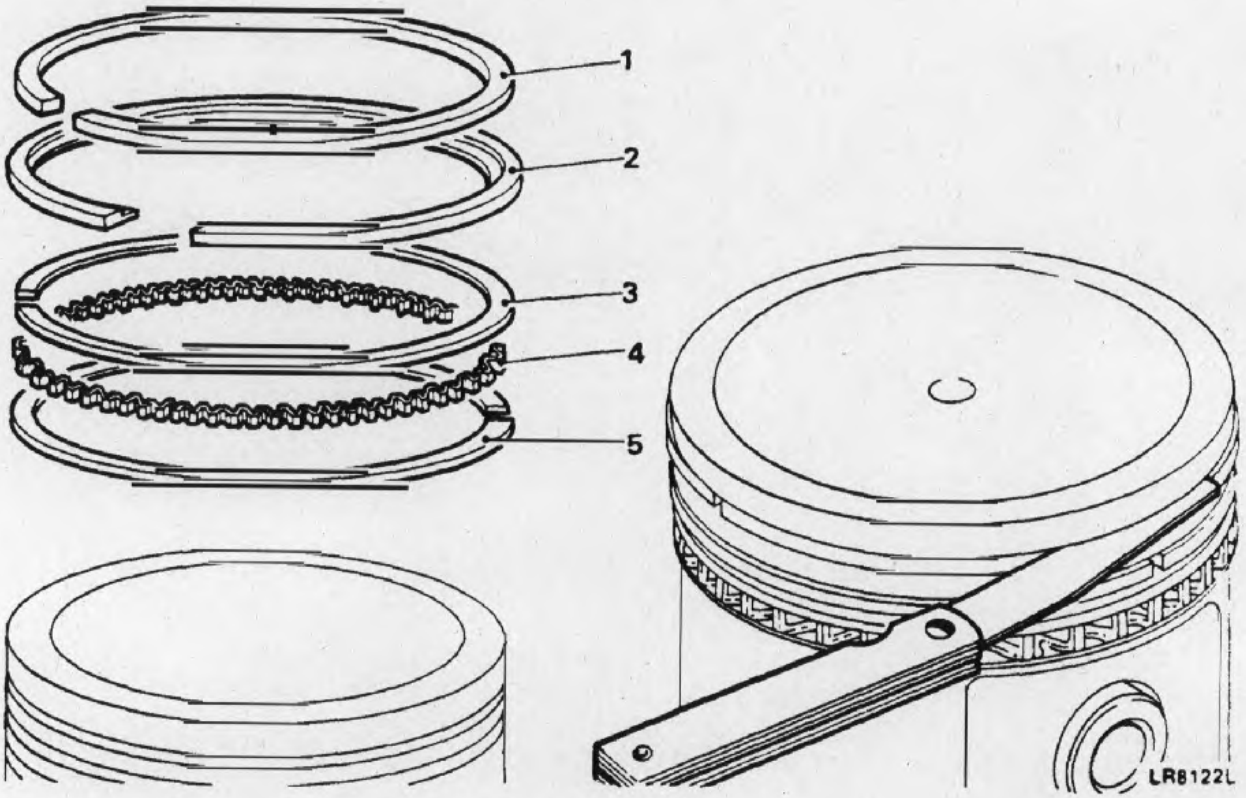
28.1.2 Fit two ring rails (3),(5) to the bottom groove, one above and one below the expander ring. The rail gaps must be diametrically opposite each other so that the gaps do not align with the expander joint.

28.1.3 Preferably, using a piston ring expander tool, fit the stepp d second compression ring (2) with the word 'TOP' uppermost.

28.1.4 The top compression ring (1) can be fitted either way around.

28.1.5 After fitting each ring, roll it around the piston groove to ensure that it is free and does not bind.

28.2 Check the top and second compression ring clearance in the piston grooves with a feeler gauge. The clearance for both rings is 0,05 to 0,10 mm (0.002 to 0.004 in). Clearances in excess of the limits are unacceptable and the ring and or pistons should be renewed.



1 Top compression ring
2 Stepped compression ring
3 Ring rail
4 Expander ring
5 Ring rail

Fig 16 Fitting piston rings and checking side clearance

Flywheel refacing

29 To reface the flywheel proceed as follows:

29.1 Remove the three clutch location dowels.

29.2 Machine the flywheel over the complete clutch face, removing only the minimum material necessary to obtain a smooth flat surface parallel with the crankshaft mating face. The flywheel must not be machined below the allowable thickness of 39,93 mm (1.572 in).

29.3 Fit new clutch location dowels.

Starter ring gear

30 To renew the starter ring gear proceed as follows:

30.1 Drill a 10 mm (0.375 in) diameter hole axially between the root of any tooth and the inner diameter of the starter ring sufficiently deep to weaken the ring. Do not allow the drill to enter the flywheel.

30.2 Secure the flywheel in a vice fitted with soft jaws and place a cloth over the flywheel to protect the operator from flying fragments.

WARNING ...

TAKE ADEQUATE PRECAUTIONS AGAINST FLYING FRAGMENTS WHEN SPLITTING THE RING GEAR. WEAR PROTECTIVE INDUSTRIAL GOGGLES.

30.3 Place a chisel immediately above the drilled hole and strike it sharply to split the starter ring gear (Fig 17).

30.4 Heat the new ring gear uniformly to between 170 to 175°C (338 to 347°F) but do not exceed the higher temperature.

30.5 Place the flywheel, clutch side down, on a flat surface (Fig 18).

30.6 Locate the heated starter ring in position on the flywheel, with the chamfered inner diameter towards the flywheel flange. If the starter gear ring is chamfered both sides, it can be fitted either way around.

30.7 Press the starter ring gear firmly against the flange until the ring contracts sufficiently to grip the flywheel.

30.8 Allow the flywheel to cool gradually. Do not hasten cooling in any way or distorting may occur.

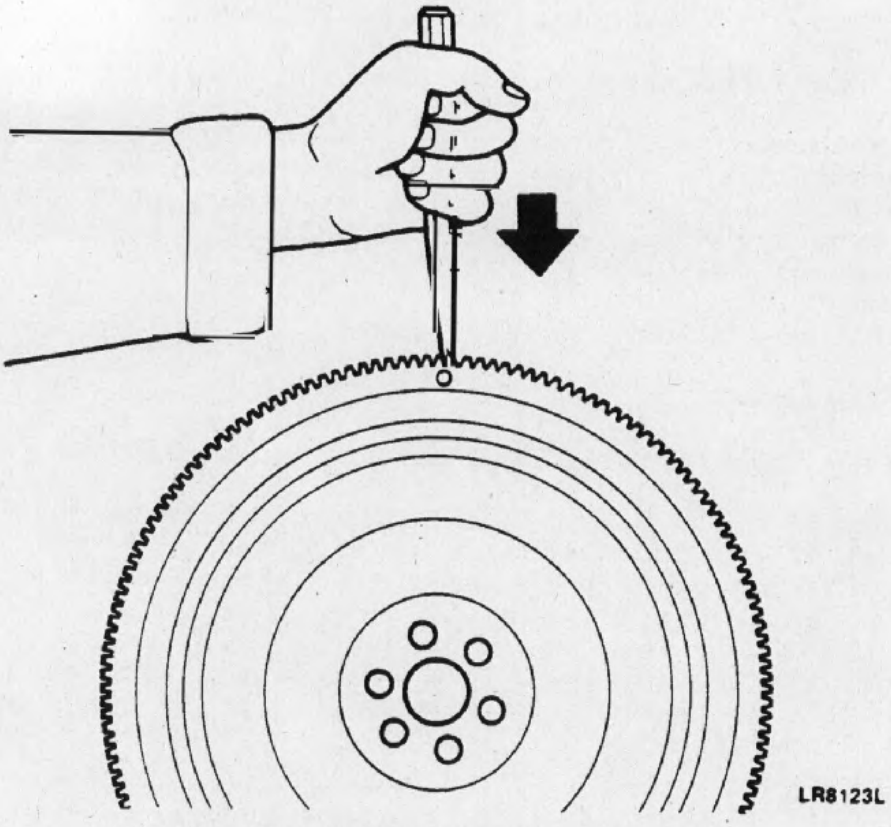


Fig 17 Removing starter ring gear

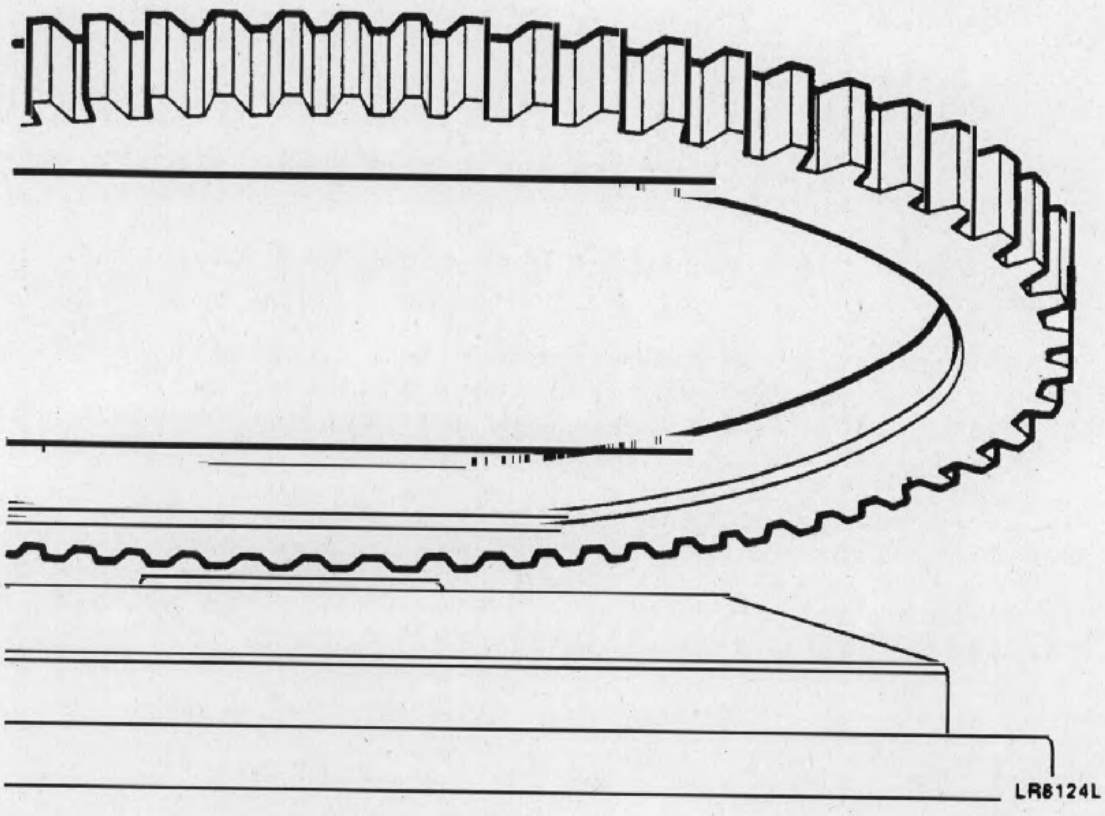


Fig 18 Fitting starter ring gear

Reassembly

Oil pump

31 To reassemble the oil pump proceed as follows:

31.1 Insert the relief valve spring (Fig 7 (8)).

31.2 Locate the sealing washer (6) on the relief valve plug (9).

31.3 Fit the relief valve plug (9) and tighten to 61 Nm (45lbs ft).

31.4 Fully pack the oil pump gear housing (3) with petroleum jelly.

CAUTION ...

Grease must not be used since most greases contain additives which do not dissolve in engine oil and may cause malfunction of the hydraulic tappets, and or block the oil pick-up strainer. Unless the pump is fully packed with petroleum jelly it may not prime itself when the engine is started.

31.5 Fit the oil pump gears (5) so that the petroleum jelly is forced into every cavity between the teeth of the gears.

31.6 Place a new gasket (4) on the oil pump cover (3).

CAUTION ...

Since it is the thickness of the gasket which determines the clearance of the gears it is vital that only a genuine Land Rover replacement part is used, otherwise the end clearance may be reduced sufficiently to cause the pump to seize.

31.7 Locate the oil pump cover (3) in position and fit the special fixing bolts (2) and tighten alternately and evenly to the correct torque.

Crankshaft main bearing nip and clearance

32 To check the main bearing nip and clearance proceed as follows:

Note ...

New main bearing shells are supplied with a protective coating and must be degreased before fitting.

32.1 Fit the main bearing shells into the cylinder block and main bearing cap locations. The shell bearing with a groove and oil hole must be located in the cylinder block whilst the plain bearing is located in the cap.

32.2 Fit and secure the main bearing caps, observing the numerical sequence and the arrow stamped on ach, tightening the bolts to the recommended torque.

32.3 Slacken one bolt on each of the main bearings caps and check the clearance using a feeler gauge between the cylinder block and cap face on the side that the bolt is slackened (Fig 19). The clearance should be between 0,10 mm and 0,15 mm.

32.4 Clearances in excess of this tolerance may be corrected either by selective assembly of the shell bearing or by rubbing down the face edge of one half of the shell using very fine emery cloth on a flat surface. It is very unusual to find a clearance less than 0,10 mm but should this be the case the bearing will not be securely clamped in position and is therefore likely to turn during normal engine running. It is therefore important that the correct bearing nip is achieved.

32.5 If the diameter of the shell bearing is too large for its location the edges may be reduced by gently rubbing on fine emery cloth on a flat surface, but if they are too small and therefore likely to turn in operation, one or both halves of the shell bearing are faulty and should be renewed.

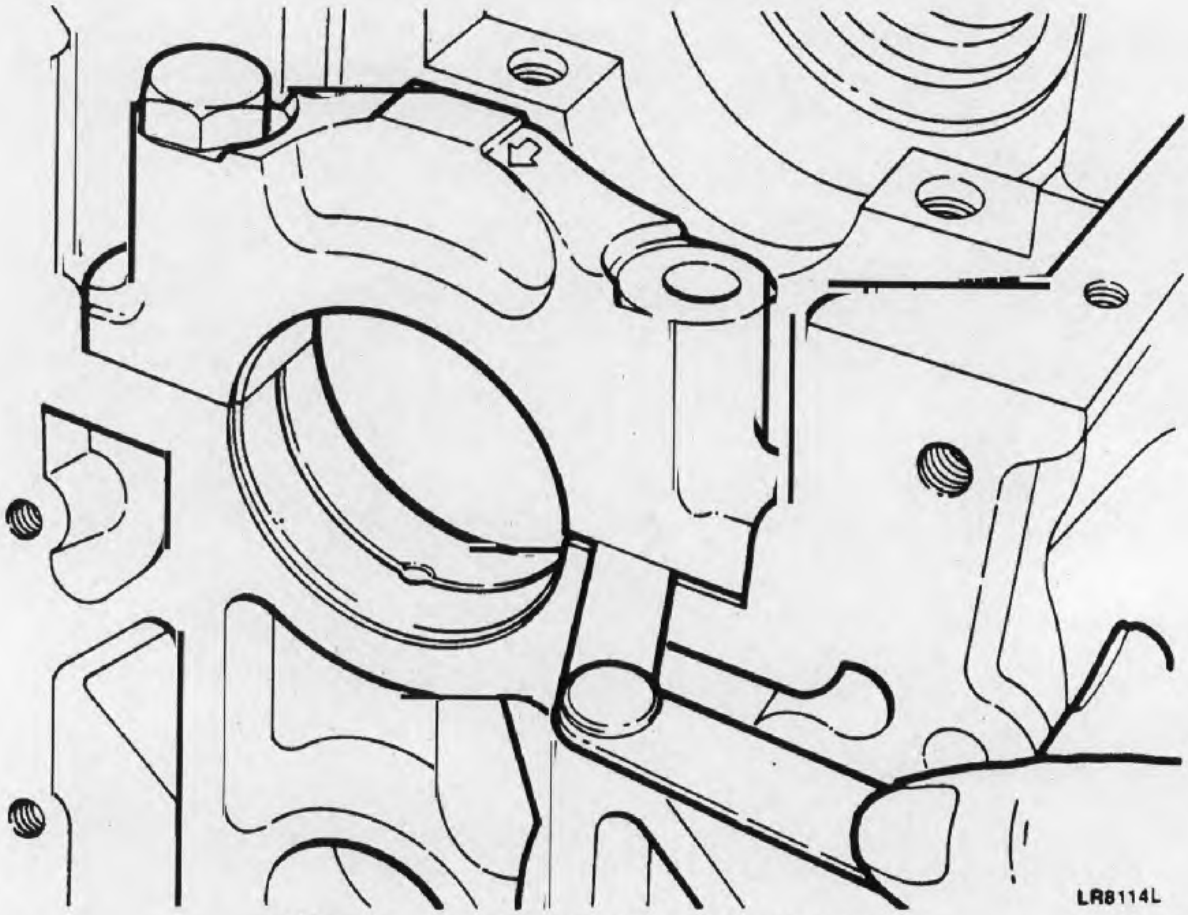


Fig 19 Checking main bearing nip

32.6 As an alternative 'Plastigauge' may be used to check the clearance particularly if an incorrect clearance is suspected. To use the 'Plastigauge' method proceed as follows:

32.6.1 Locate the upper main bearing shells into the cylinder block. These must be the shells with the oil drilling and oil groov s.

32.6.2 Locate the flanged upper main bearing shell in the centre position.

32.6.3 Lower the crankshaft into position on the bearings.

32.6.4 Place a piece of 'Plastigauge' across the centre of the crankshaft main bearing journals (Fig 20).

32.6.5 Locate the bearing lower shell into the main bearing cap.

32.6.6 Fit numbers one to four main bearings caps and shells and tighten to the correct torque.

32.6.7 Fit the rear main bearing cap and shell and tighten to the correct torque. Do not allow the crankshaft to be rotated while the 'Plastigauge' is in use.

32.6.8 Remove the main bearing caps and shells and using the scale printed on the 'Plastigauge' packet, measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds to the width of the 'Plastigauge' indicates the bearing clearance.

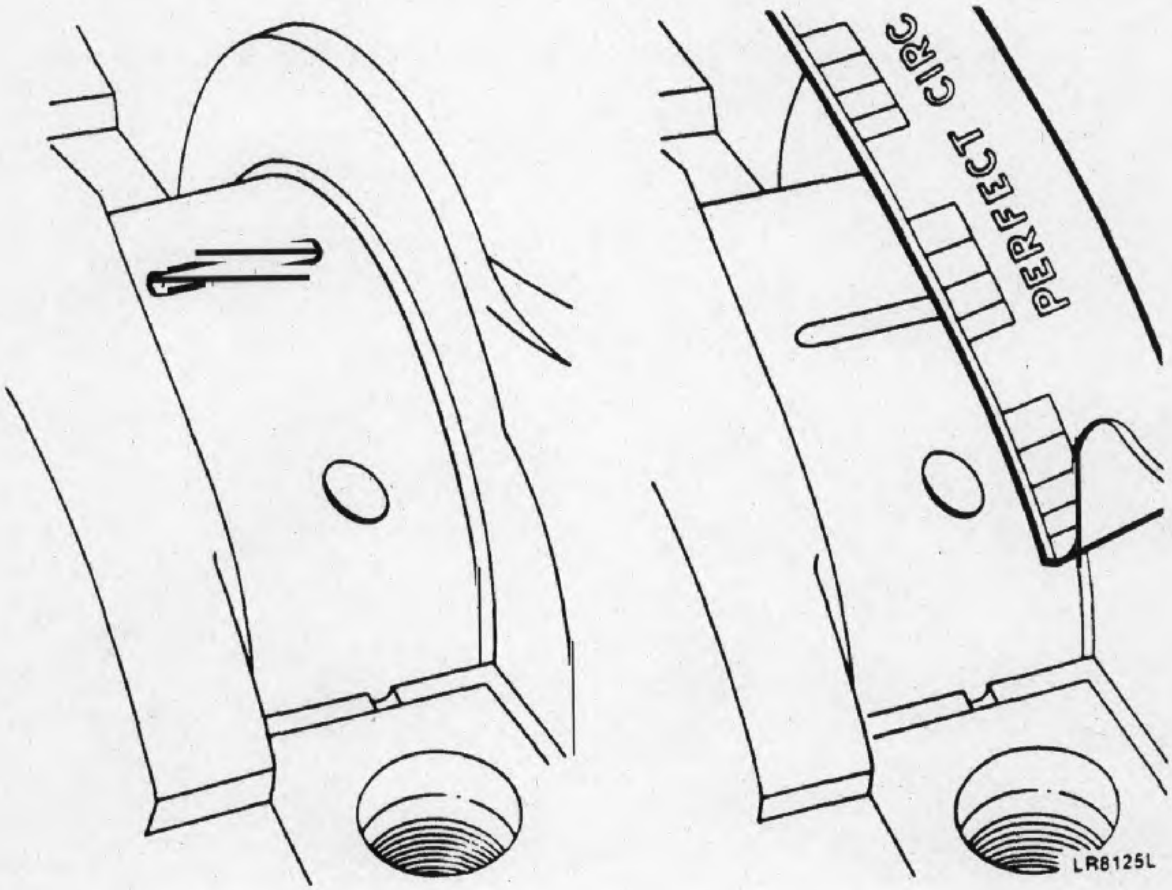


Fig 20 Checking main bearing clearance with Plastigauge

32.6.9 The correct bearing cl arance with new or overhauled components is 0,010 to 0,048 mm (0.0004 to 0.0019 in). If the correct clearance is not obtained initially, use selective bearing assembly.

32.6.10 Wipe off the Platigauge with an oily rag. Do not scrape it off.

32.7 Lift out the crankshaft and lubricate the main bearing journals and bearing shells with clean engine oil and lower the crankshaft into position again.

Crankshaft end float

33 To check the crankshaft end float proceed as follows:

33.1 The end-float can be checked with either a dial test indicator or a feeler gauge. Mount a dial test indicator on the cylinder block with the indicator stylus resting on the end of the crankshaft (Fig 21).

33.2 Push the crankshaft back and zero the gauge.

33.3 Move the crankshaft forward and note the gauge reading.

33.4 Similarly, using a feeler gauge, push the crankshaft back and measure the clearance between the bearing flange and crankshaft thrust face (Fig 21).

33.5 The correct end float is between 0,10 to 0,20 mm (0.004 to 0.008 in).

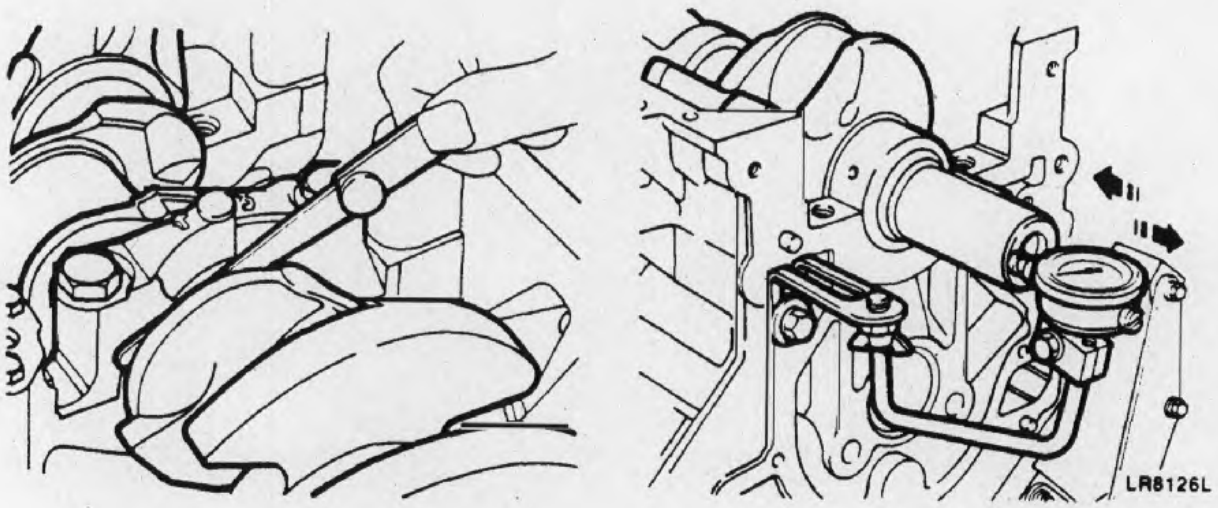


Fig 21 Checking crankshaft end-float

Crankshaft main bearing caps

34 To fit the crankshaft main bearing caps proceed as follows:

34.1 Lubricate the lower main bearing shells and fit numbers one to four main bearing caps and shells only, leaving the fixing bolts finger tight at this stage.

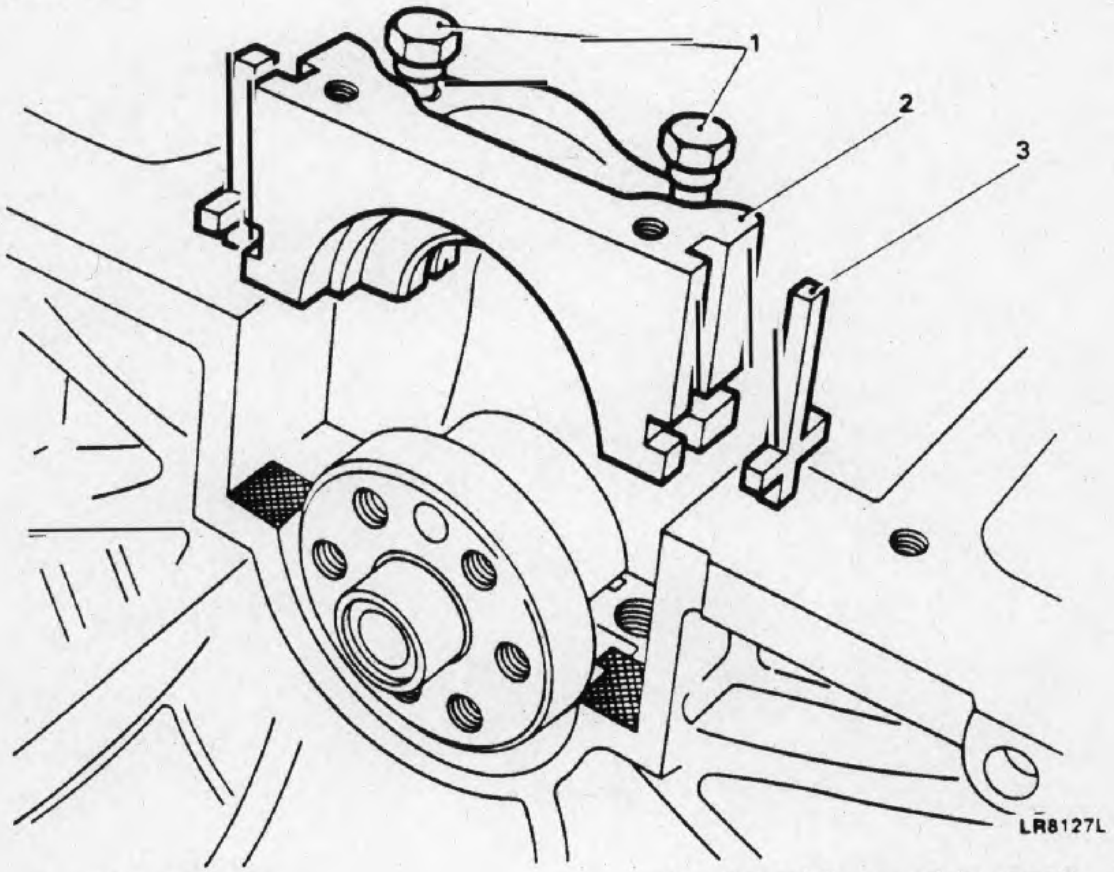
34.2 Fit the cruciform side seals (Fig 22 (3)) to the grooves each side of the rear main bearing cap. Do not cut the side seals to length, they must protrude 1,5 mm (0.062 in) approximately above the bearing cap parting face.

34.3 Apply Hylomar PL32M jointing compound to the rearmost half of the rear main bearing cap parting face or, if preferred, to the equivalent area on the cylinder block.

34.4 Lubricate the bearing half and bearing cap side seals with clean engine oil.

34.5 Fit the bearing cap assembly (2) to the engine. Do not tighten the fixings at this stage but ensure that the cap is fully home and squarely seated on the cylinder block.

34.6 Tension the cap bolts (1) equally by one-quarter turn approximately, then back off one complete turn on each fixing bolt.



1 Cap bolts
2 Bearing cap
3 Cruciform side seal

Fig 22 Fitting No.5 main bearing cap

Rear main oil seal

35 To fit the rear main oil seal proceed as follows:

CAUTION ...

Do not handle the seal lip, visually check that it is not damaged and ensure that the outside diameter remains clean and dry.

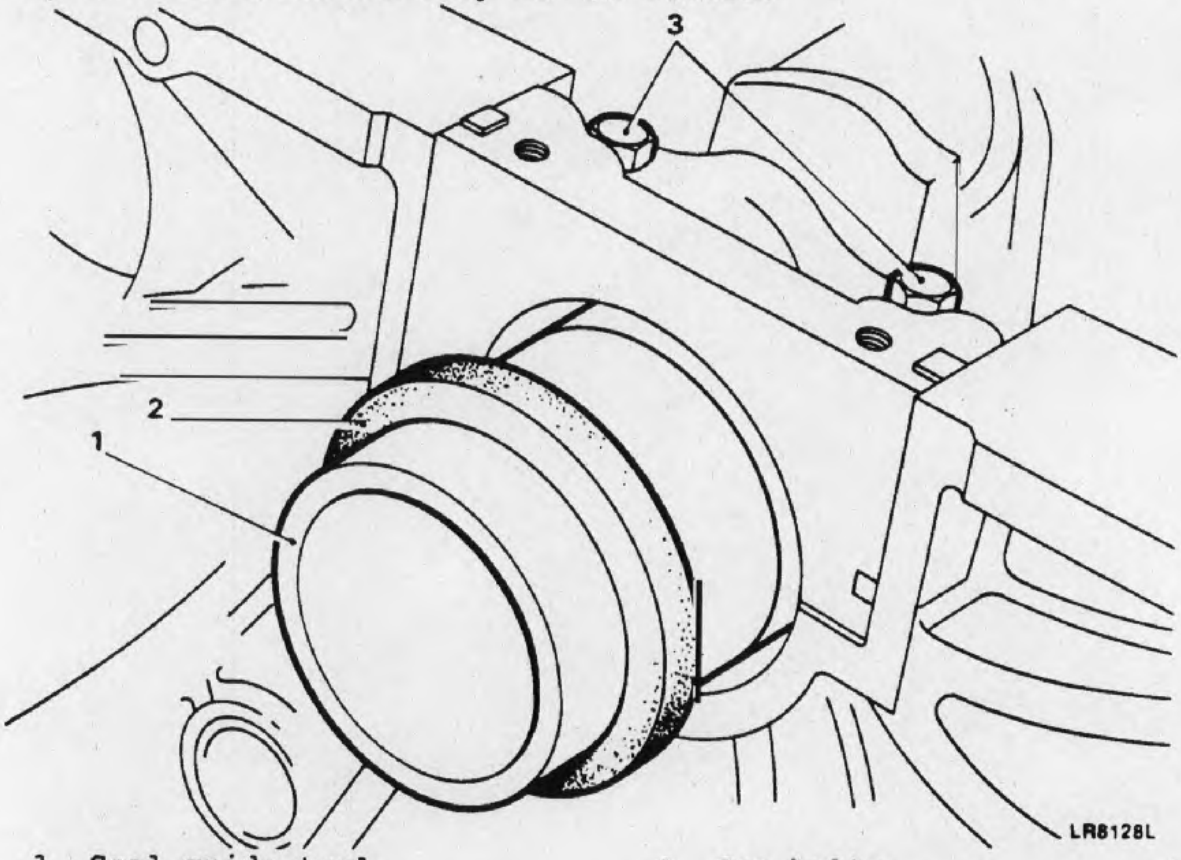
35.1 Position the seal guide RO1014 (Fig 23 (1)) on the crankshaft flange.

35.2 Ensure that the oil seal guide and the crankshaft journal are scrupulously clean, then coat the seal guide and oil seal journal with clean engine oil.

Note ...

The lubricant coating must cover the seal guide outer surface completely to ensure that the oil seal lip is not turned back during assembly. Position the oil seal, lipped seal towards the engine, on to the seal guide. The seal outside diameter must be clean and dry.

35.3 Push home the oil seal (2) fully and squarely by hand into the recess formed in the cap and block until it abuts against the machined step in the recess.



1 Seal guide tool
2 Rear main oil seal
3 Cap bolts

Fig 23 Fitting rear main oil seal

35.4 Withdraw the seal guide.

35.5 Tighten the main bearing cap bolts (Fig 23 (3)) to the correct torque noting that the bolts for numbers one to four bearings have a different torque to number five bearing cap bolts.

35.6 Turn the crankshaft to ensure that it turns freely.

Connecting-rod bearing nip and clearance

36 To check the connecting-rod bearing nip and clearance proceed as follows:

Note..

New bearing halfs are supplied with a protective coating and must be degreased before fitting.

36.1 Fit the new bearing shells to each connecting-rod and tighten both nuts to the correct torque.

36.2 Slacken one nut on each rod and with a feeler gauge, measure the clearance between the parting face of the rod and the cap (Fig 24). This clearance should be between 0,1 and 0,2 mm (0.003 and 0.007 in).

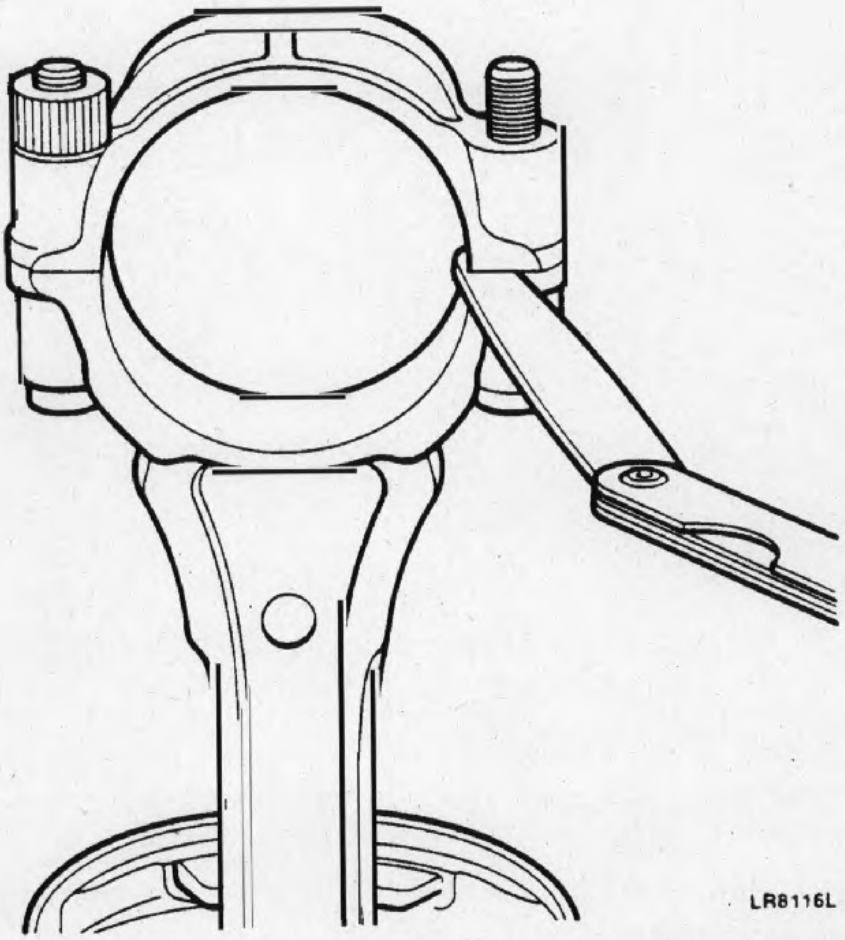


Fig 24 Checking connecting-rod bearing nip

36.3 To overcome a clearance in excess of 0,25 mm (0.010 in), rub down the edge of the shell with fine emery cloth on a flat surface.

36.4 Refit the bearing, tighten the nuts, slacken one nut as previously described and check the clearance again. Repeat this procedure if necessary, until satisfied the clearance is correct. Ensure that the dome on the connecting-rod and cap are aligned.

Connecting-rod end float

37 Fit the connecting-rods complete with bearings to their respective crankpins. Move the connecting-rod to one side and using a feeler gauge (Fig 25) check that the side-play clearance between each pair of connecting-rods on the crank pins is 0,15 to 0,37 mm (0.006 to 0.014 in).

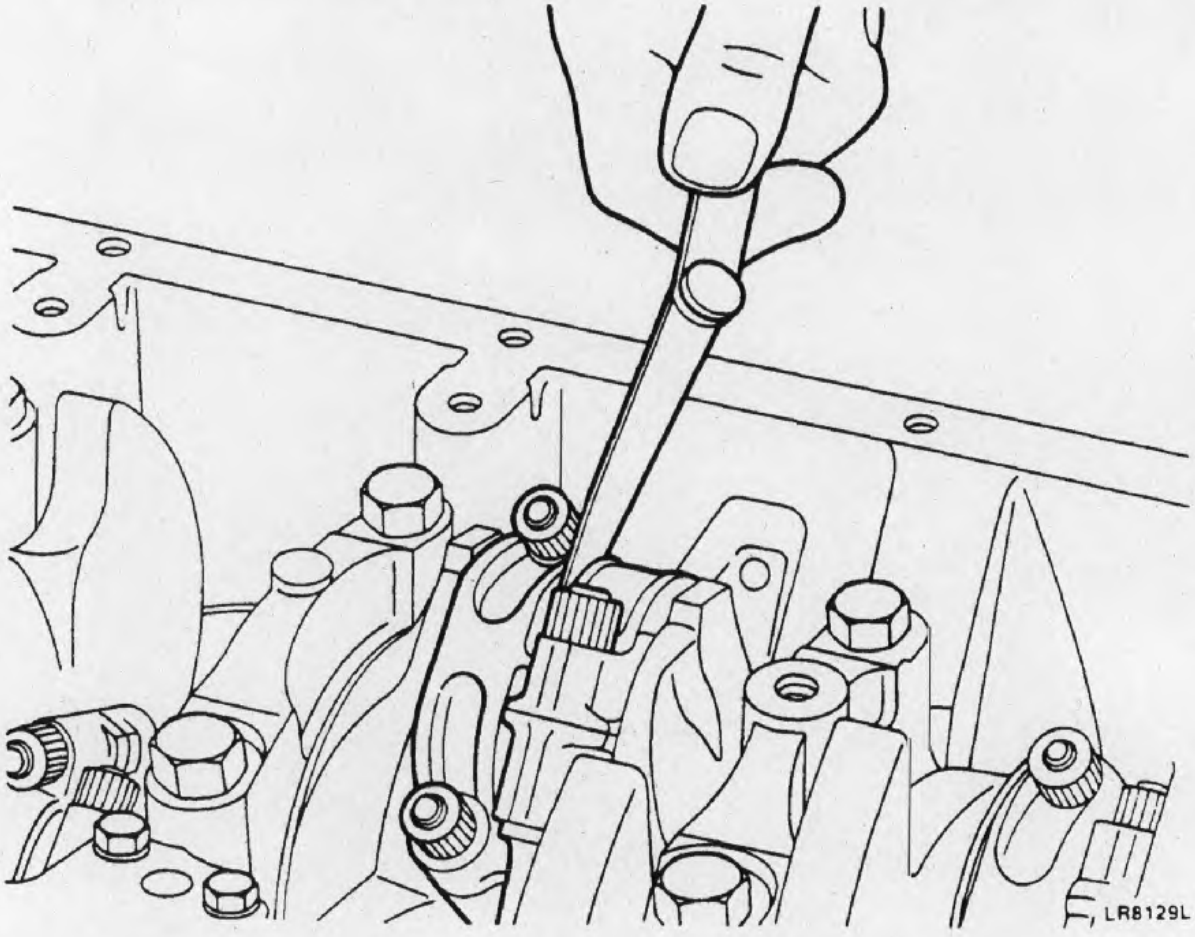


Fig 25 Checking connecting-rod end float

Pistons to connecting-rods

38 If tool 18G1150 was used for dismantling, refit each piston to its connecting-rod as follows:

38.1 Clamp the hexagon body (Fig 26 (7)) of 18G1150 in a vice, with the adaptor 18G1150E positioned as for piston removal.

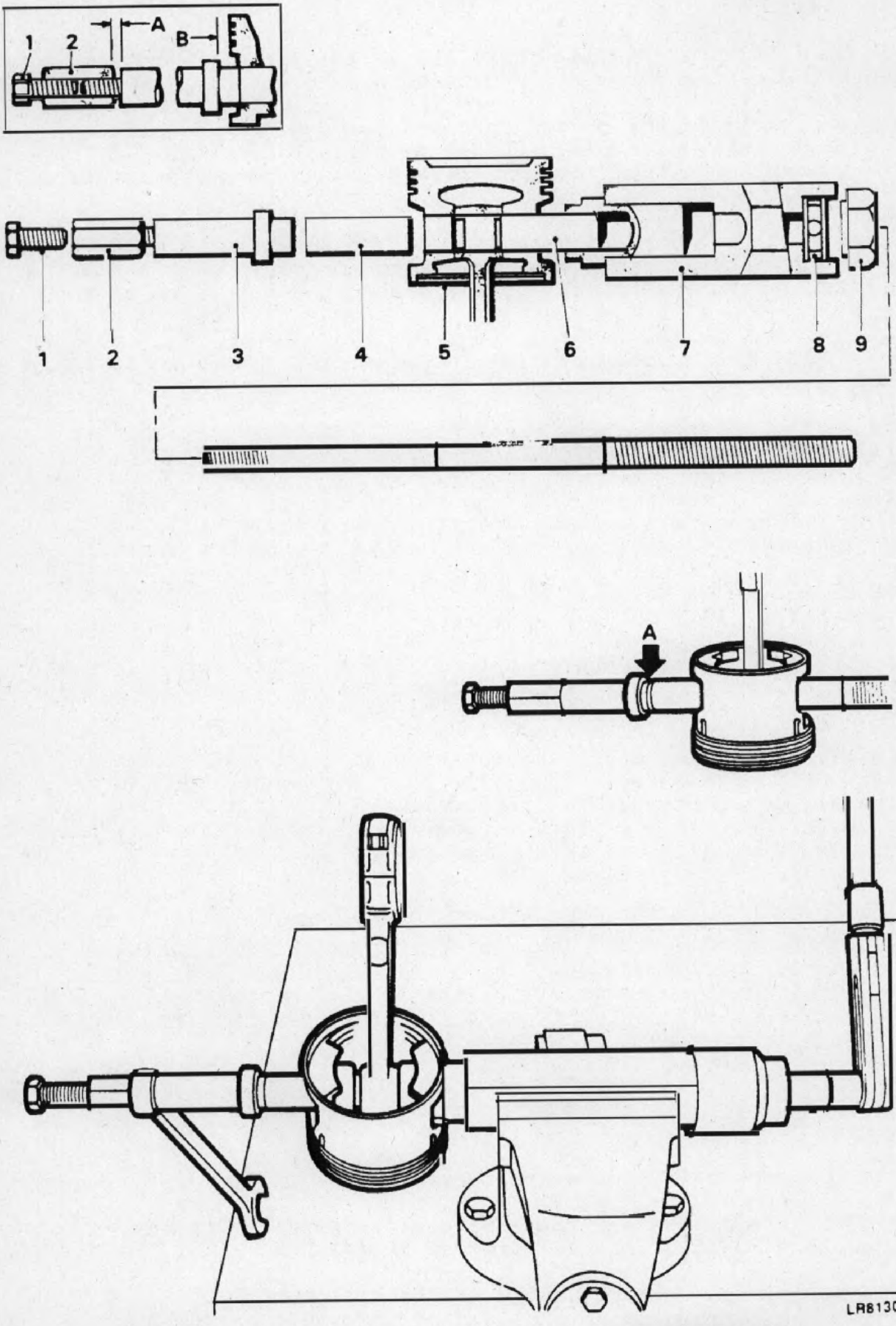


Fig 26 Fitting pistons to connecting-rods

38.2 Remove the large nut (9) of 18G1150 and push the centre screw approximately 50 mm (2.0 ins) into the body until the shoulder is exposed.

38.3 Slide the parallel guide sleeve (6), grooved end last, onto the centre screw and up to the shoulder.

38.4 Lubricate the gudgeon pin and bores of the connecting-rod and piston with graphite oil (Acheson's Colloids 'Oildag'). Also lubricate the ball race and centre screw of 18G1150.

38.5 Fit the connecting-rod and piston (5) together onto the tool with the markings together if the original pair are being used and with the connecting-rod around the sleeve up to the groove.

38.6 Fit the gudgeon pin (4) into the piston bore up to the connecting-rod.

38.7 Fit the remover/replacer bush (3) 18G1150/3 with its flanged end towards the gudgeon pin.

38.8 Screw the stop-nut (2) on to the centre screw and adjust this nut to obtain a 1mm (0.03125 in) end-float 'A' on the whole assembly, and lock the nut securely with the screw.

38.9 Slide the assembly back on the large nut (9) up to the thrust race (8).

38.10 Set the torque wrench to 12 lbf ft. This represents the minimum load for an acceptable interference fit of the gudgeon pin in the connecting-rod.

38.11 Using the torque wrench and socket on the large nut (9), holding the lock screw (1), pull the gudgeon pin in until the flange of the remover/replacer bush (3) is 4 mm (0.16 in) from the face of the piston. Under no circumstances must this flange be allowed to contact the piston.

CAUTION ...

If the torque wrench has not broken throughout the pull, the fit of the gudgeon pin to the connecting-rod is not acceptable and necessitates the renewal of components. The large nut and centre screw of the tool must be kept well-oiled.

38.12 Remove the tool and check that the piston moves freely on the gudgeon pin and that no damage occurred during pressing.

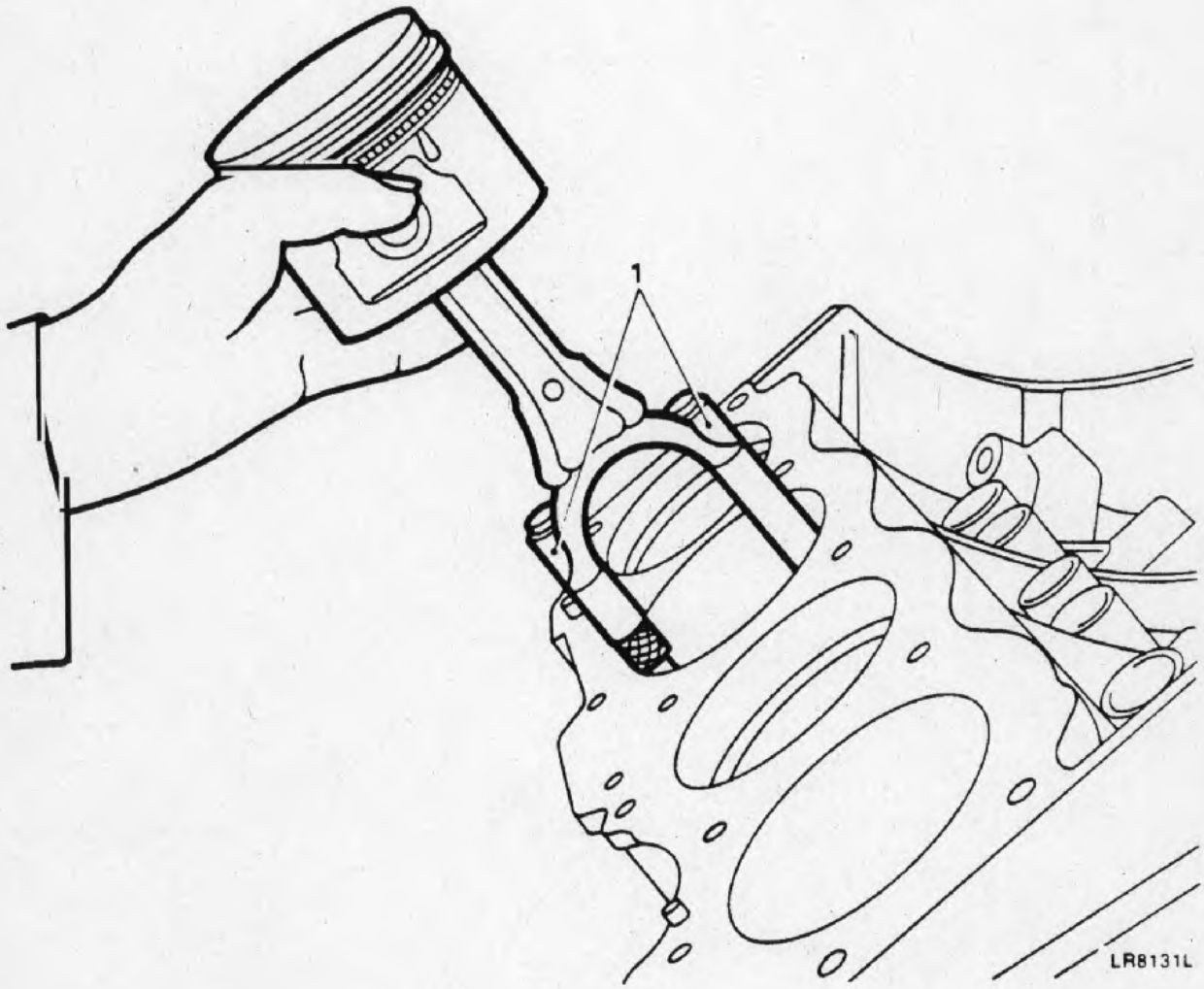
Piston and connecting-rod assemblies

39 To fit the piston and connecting-rod assemblies to the cylinder block and crankshaft proceed as follows:

39.1 Position the applicable crankshaft journal at B.D.C. and place the bearing upper shell in the connecting-rod.

39.2 Retain the upper shell by screwing the guide bolts 605351 (Fig 27 (1)) on to the connecting-rod bolts.

39.3 Insert the connecting-rod and piston assembly into its respective bore, noting that the domed shape boss on the connecting-rod must face towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank. When both connecting-rods are fitted, the bosses will face inwards towards each other.



1 Guide bolts

Fig 27 Fitting piston and connecting-rod into cylinders

39.4 Space the piston ring gaps at intervals of 45° avoiding gaps at 90° to the gudgeon pin. Fig 28 shows the correct position of the ring caps in relation to piston in the bore.

39.5 Using a piston ring compressor, tap the piston into the cylinder bore, until the piston crown is just below the cylinder block top face (Fig 29).

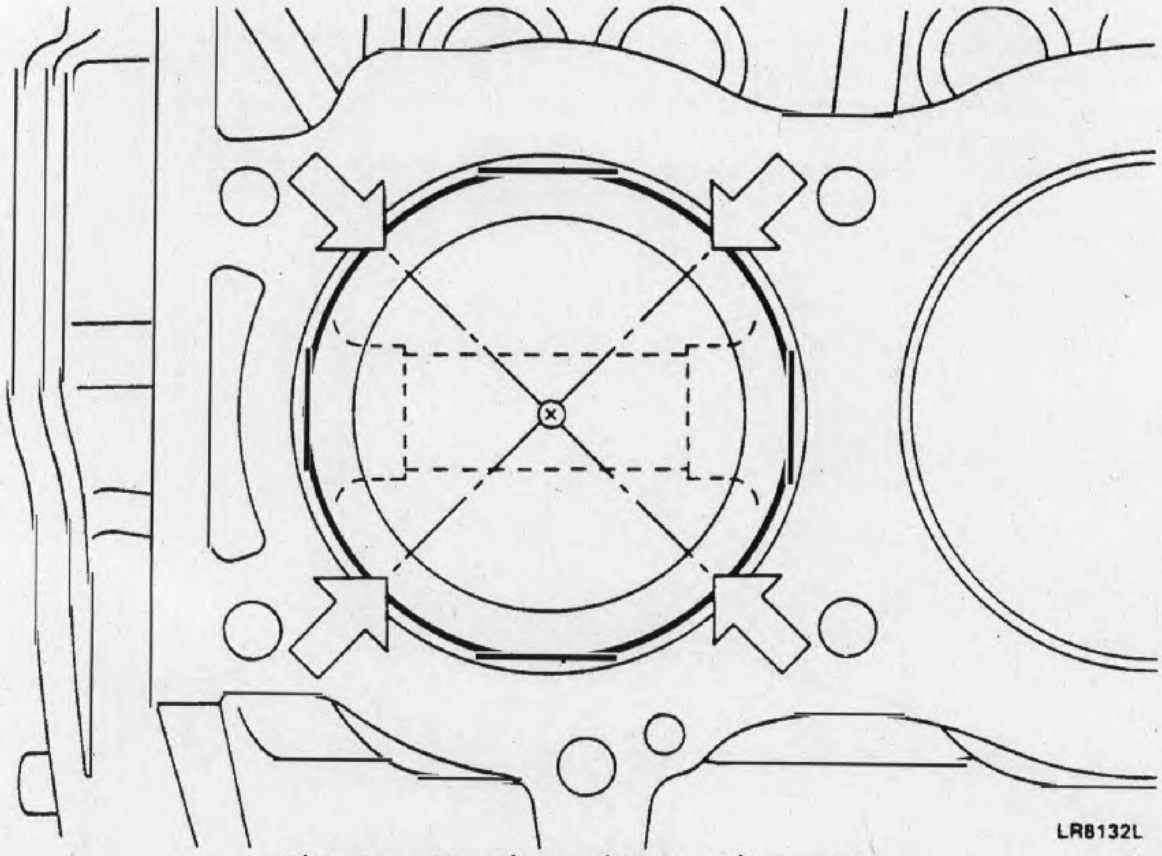


Fig 28 Spacing piston ring caps

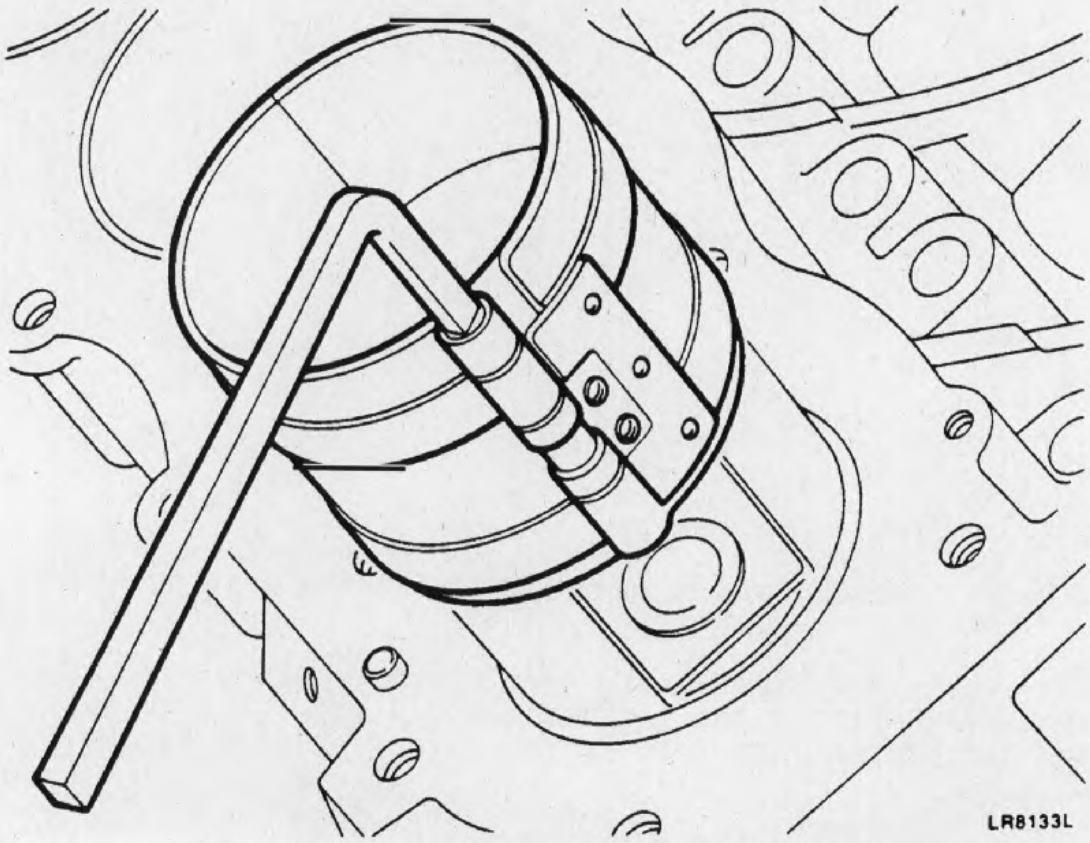


Fig 29 Fitting piston ring compressor

39.6 Lubricate the bearings and pull the connecting-rod on to the crankpin using the guide rods (Fig 30).

39.7 Locate the bearing lower shell in the connecting-rod cap and lubricate.

39.8 Fit the cap and shell on to the connecting-rod, noticing that the dome on the edge of the cap must be towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank, pointing in the same direction as the dome on the connecting-rod.

39.9 Fit and tighten the connecting-rod nuts to the correct torque.

39.10 Repeat the above procedure for the remaining connecting-rods and pistons.

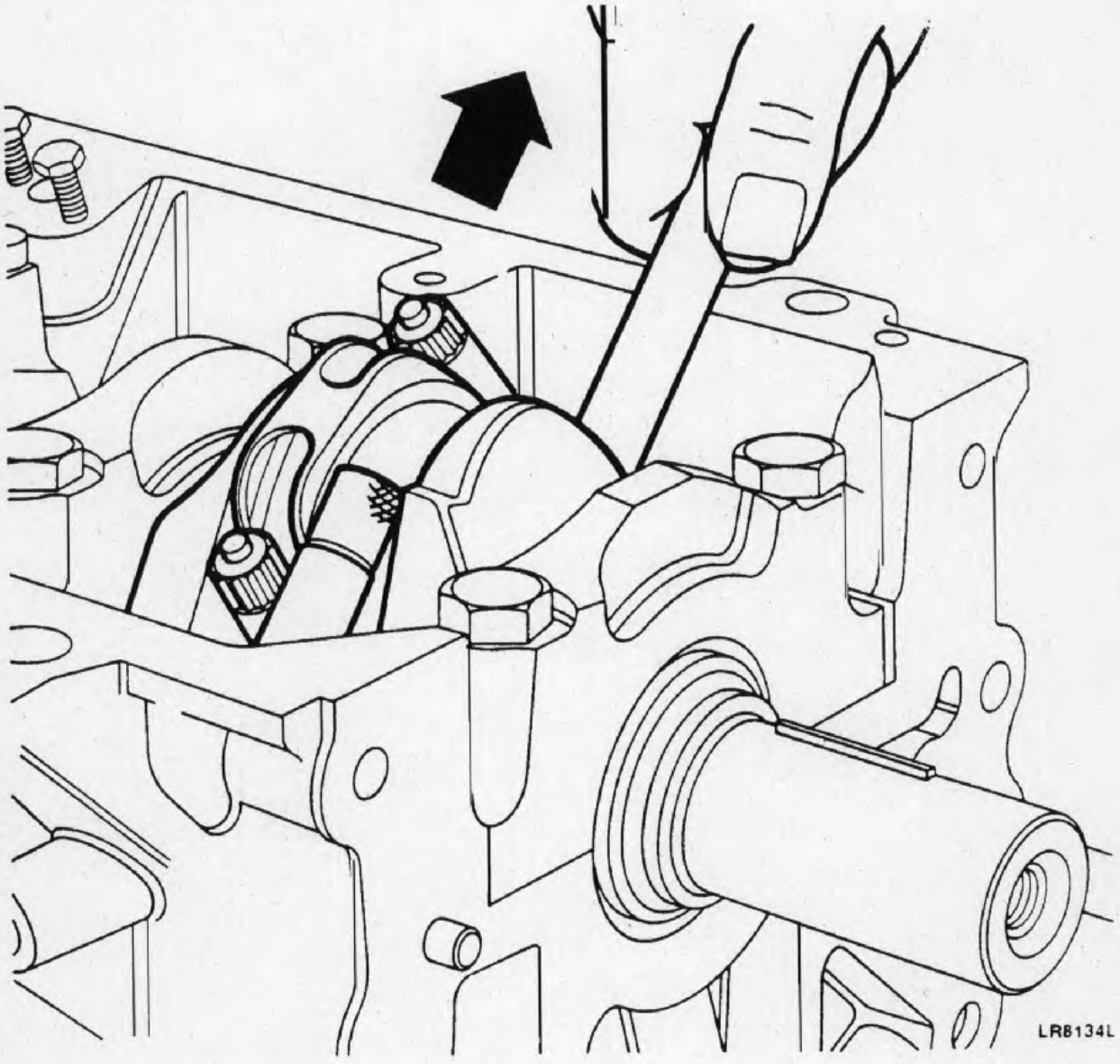


Fig 30 Fitting pistons and connecting-rod to crankshaft

Camshaft

40 To fit the camshaft proceed as follows:

Note ...

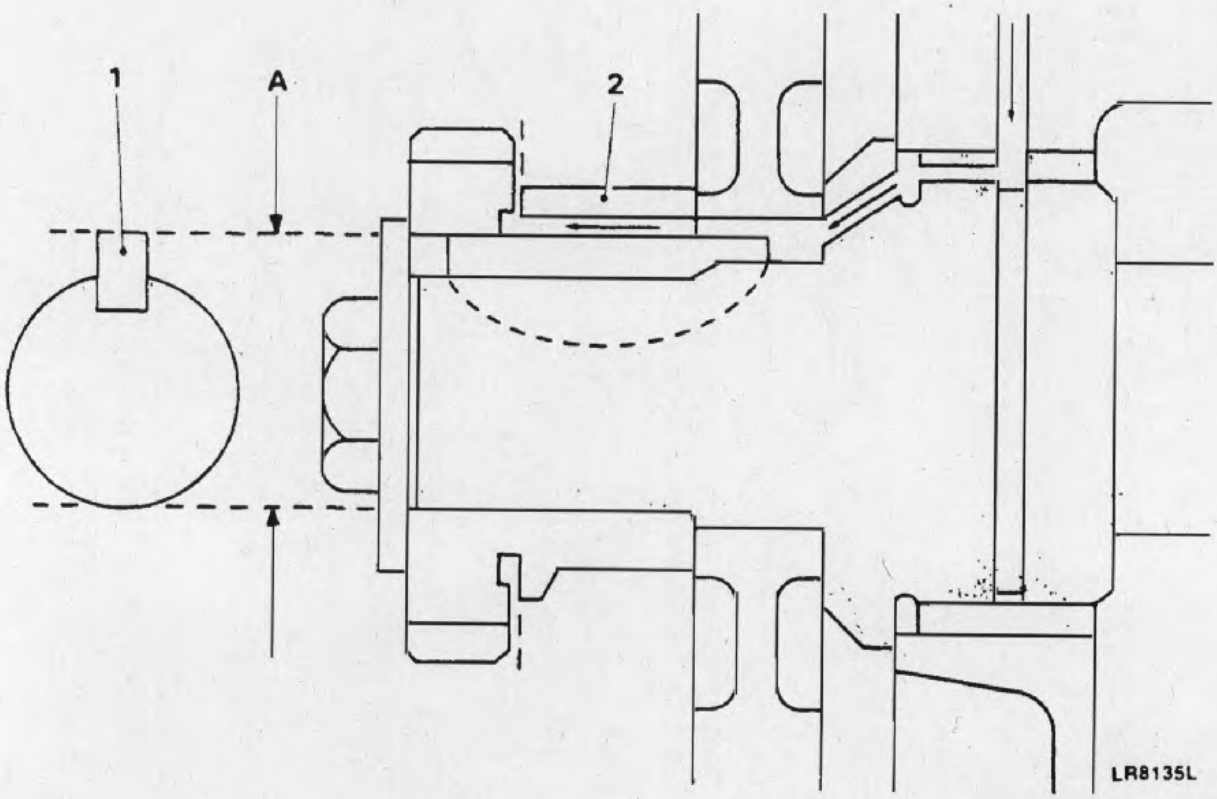
It is very important that the sprocket key in the front of the camshaft is fitted securely and parallel to the shaft.

40.1 Fit the sprocket key (Fig 31 (1)) to the shaft ensuring that the overall dimension 'A' does not exceed 30,15 mm (1.187 in).

Note ...

Lubrication for the timing chain and gears is supplied by the front camshaft bearing through a channel (2) along the top of the keyway to an annular groove in the rear face of the oil pump distributor drive gear. Lubrication of the timing chain will be severely restricted if the key is loose enough to be effected by centrifugal force, or is fitted inclined into its groove in the shaft. The key must be securely fitted parallel to the shaft.

40.2 Lubricate the journals (Fig 32) and with care, insert the camshaft into the the cylinder block.



1 Sprocket key 2 Lubrication channel

Fig 31 Fitting camshaft sprocket key

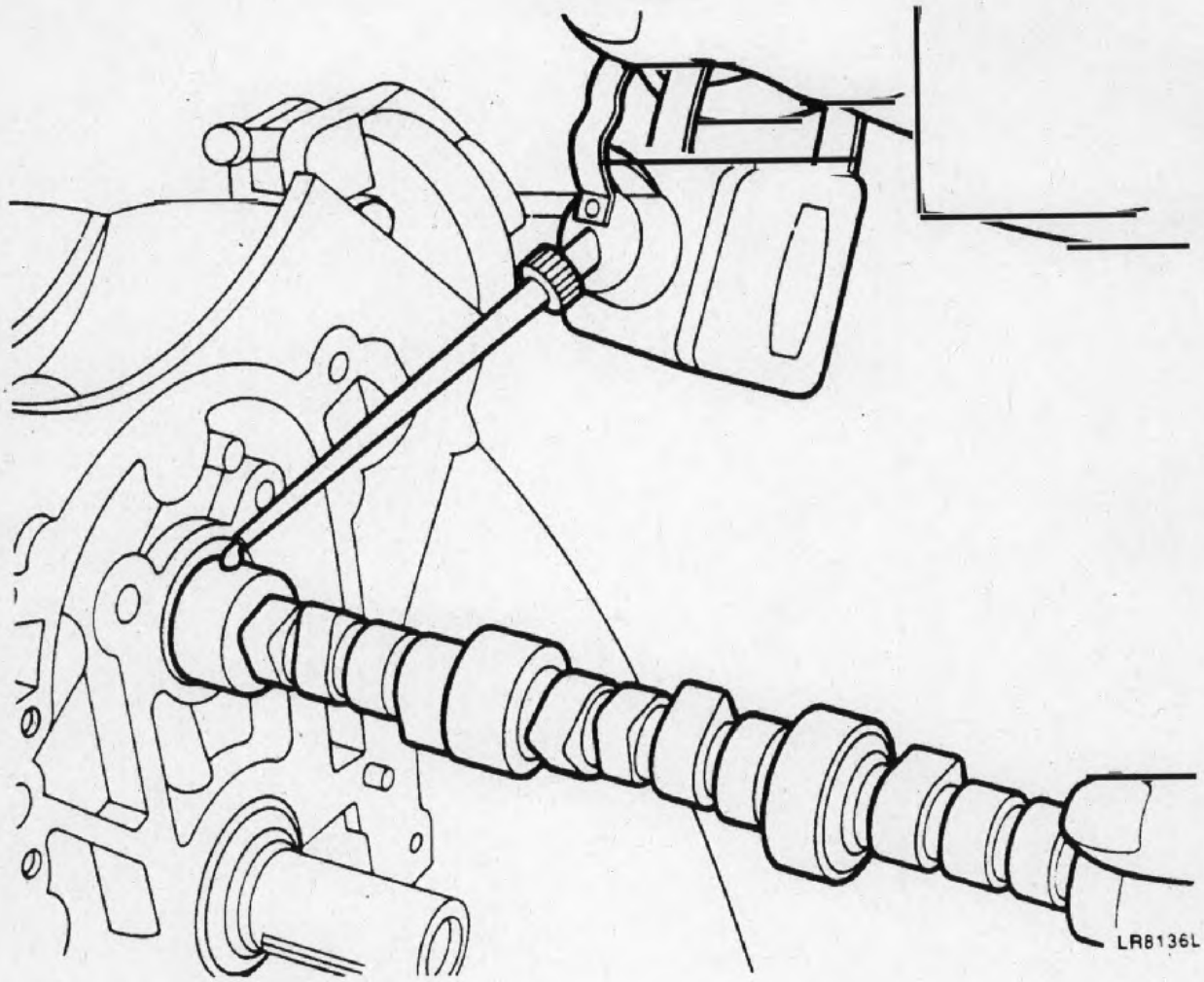


Fig 32 Fitting camshaft to cylinder block

Tappets

41 Fit the tappet assemblies (Cat 522 Chap 1-2).

Timing belt, pulleys and covers

42 Fit the timing belt, pulleys and covers (Cat 522 Chap 1-2).

Cylinder head assembly

43 Fit the cylinder head assembly (Cat 522 Chap 1-2).

ANCILLARIES

44 Fit the engine ancillaries in reverse order (Cat 522 Chap 1-2).

REFIT ENGINE TO VEHICLE

45 Fit the engine to the vehicle (Cat 522 Chap 1-2).

Chapter 3-1

LT77 FIVE SPEED MANUAL GEARBOX

CONTENTS

INTRODUCTION

1 This Chapter details the Base Repairs for the Land Rover LT77 Five Speed Manual Gearbox.

REMOVAL

2 To remove the gearbox from the vehicle refer to Cat 522 Chap 3 Para 4.

Note ...

The special tools listed in the following table will be referred to in the text, where used, by the serial number shown in the table.

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	NSN/Part No where applicable (3)	Designation (4)
1	18G. 705		Bearing remover
2	18G. 705-1A		Adaptor for mainshaft
3	18G. 705-5		Adaptor for layshaft
4	18G. 1400		Synchromesh hub and gear cluster remover
5	18G. 1400-1		Adaptor mainshaft fifth gear
6	18G. 47BA		Adaptor layshaft bearing remover
7	18G. 47BAX		Conversion kit
8	18G. 284		Impulse extractor
9	18G. 284AAH		Adaptor for input bearing pilot track
10	18G. 1422		Mainshaft rear oil seal replacer
11	18G. 1431		Mainshaft fifth gear and oil seal collar replacer
12	MS. 47		Hand press

LOCALLY MANUFACTURED TOOLS

3 The following locally manufactured tools are also recommended to assist in carrying out gearbox overhaul.

3.1 Gearbox support stand (Fig 1).

3.2 Slave bearing for calculating 1st gear bush end float (Fig 2).

3.3 Layshaft support plate and spacer (Fig 3).

3.4 Reverse shaft retainer (Fig 4).

3.5 Guide studs (Fig 5).

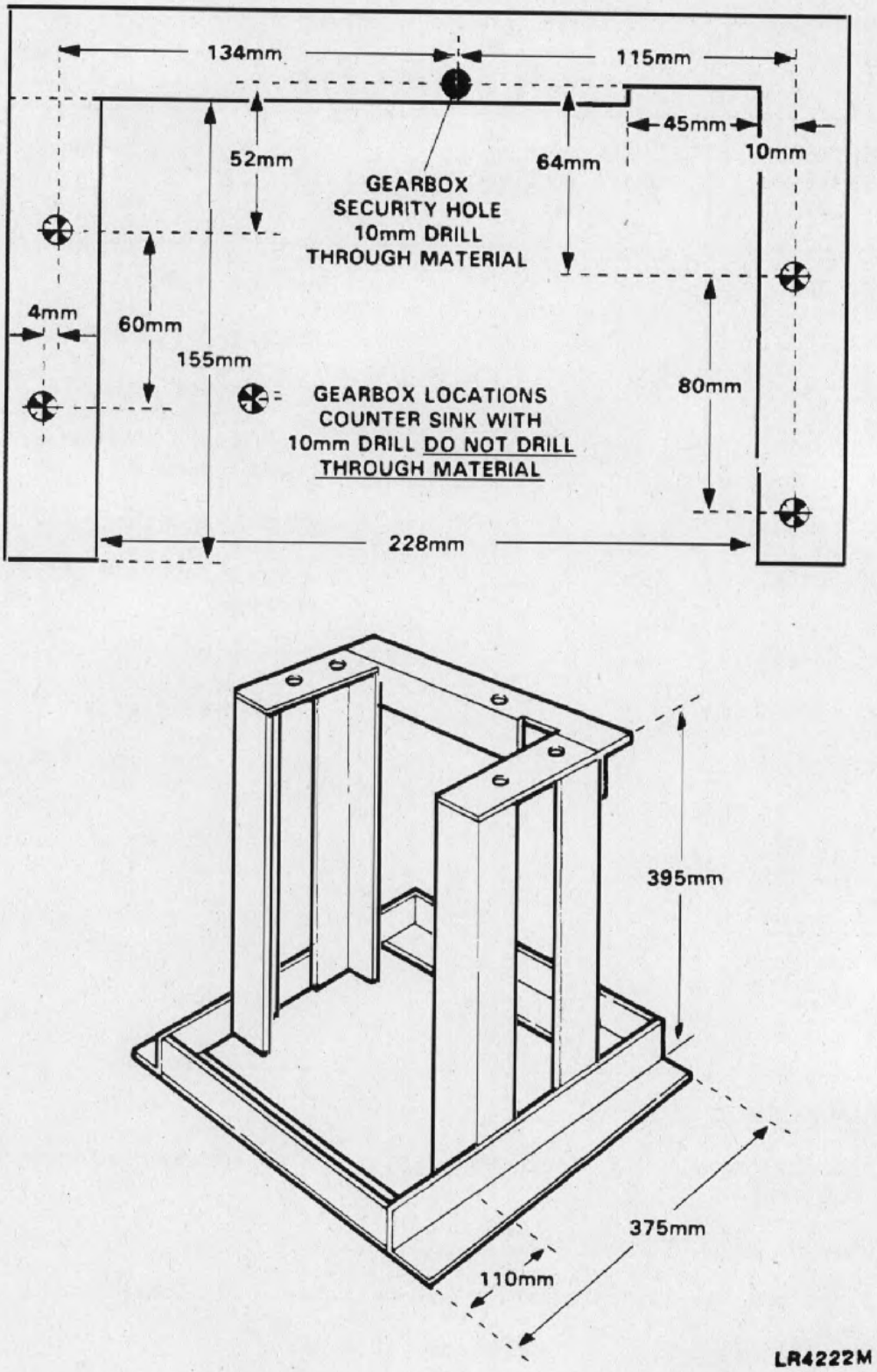


Fig 1 Gearbox support stand

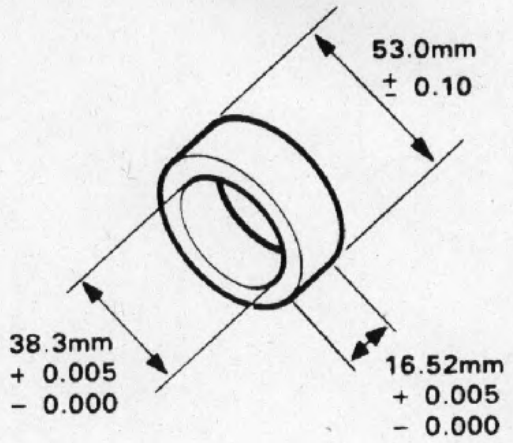


Fig 2 Slave bearing for calculating first gear bush end-float

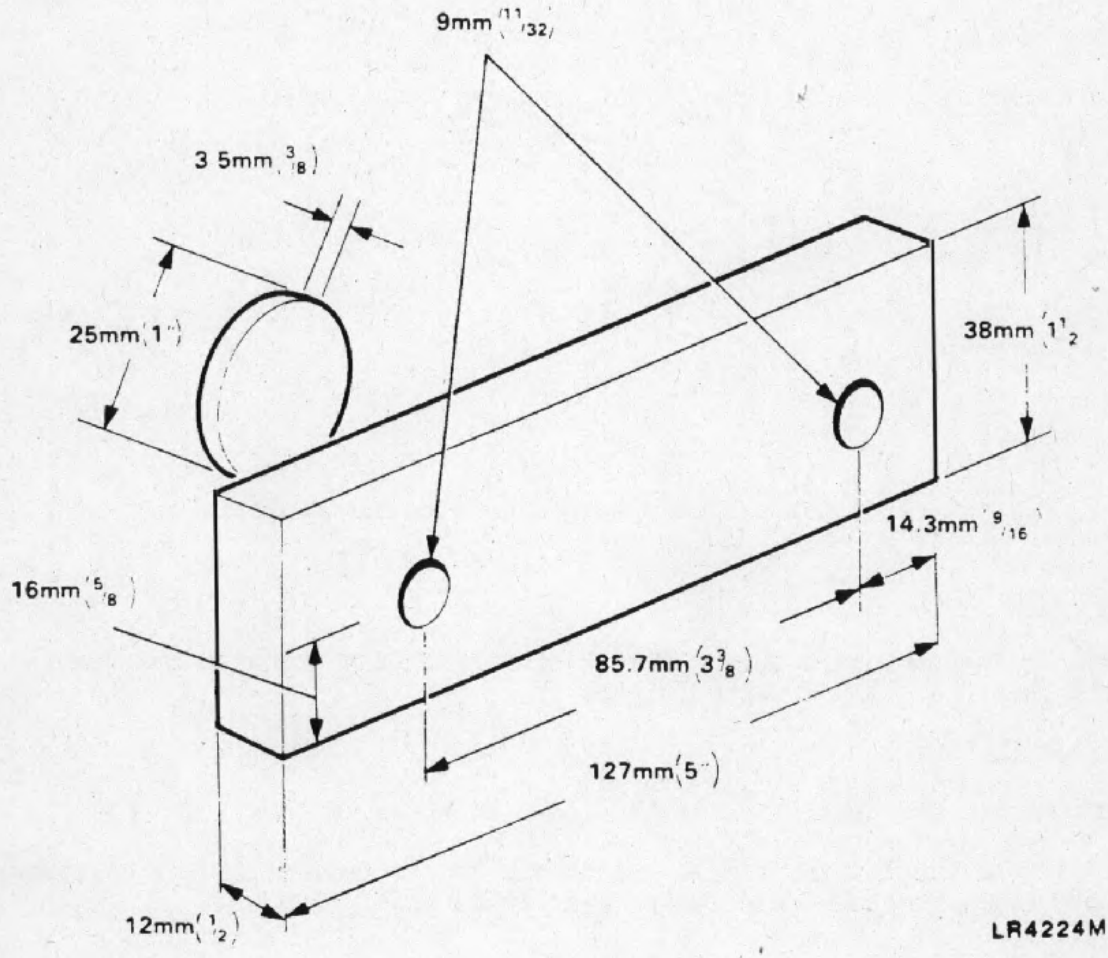
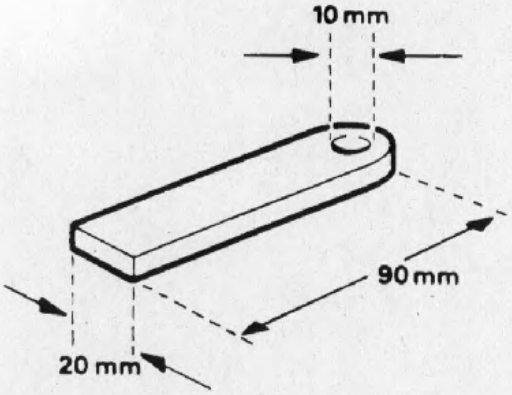


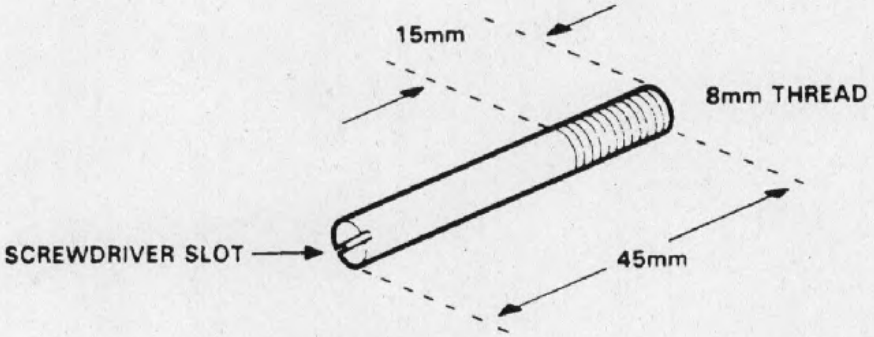
Fig 3 Layshaft support plate and spacer



MATERIAL 3-5mm MILD STEEL

LR4225M

Fig 4 Reverse shaft retainer



LR4226M

Fig 5 Guide studs, main casing to centre plate

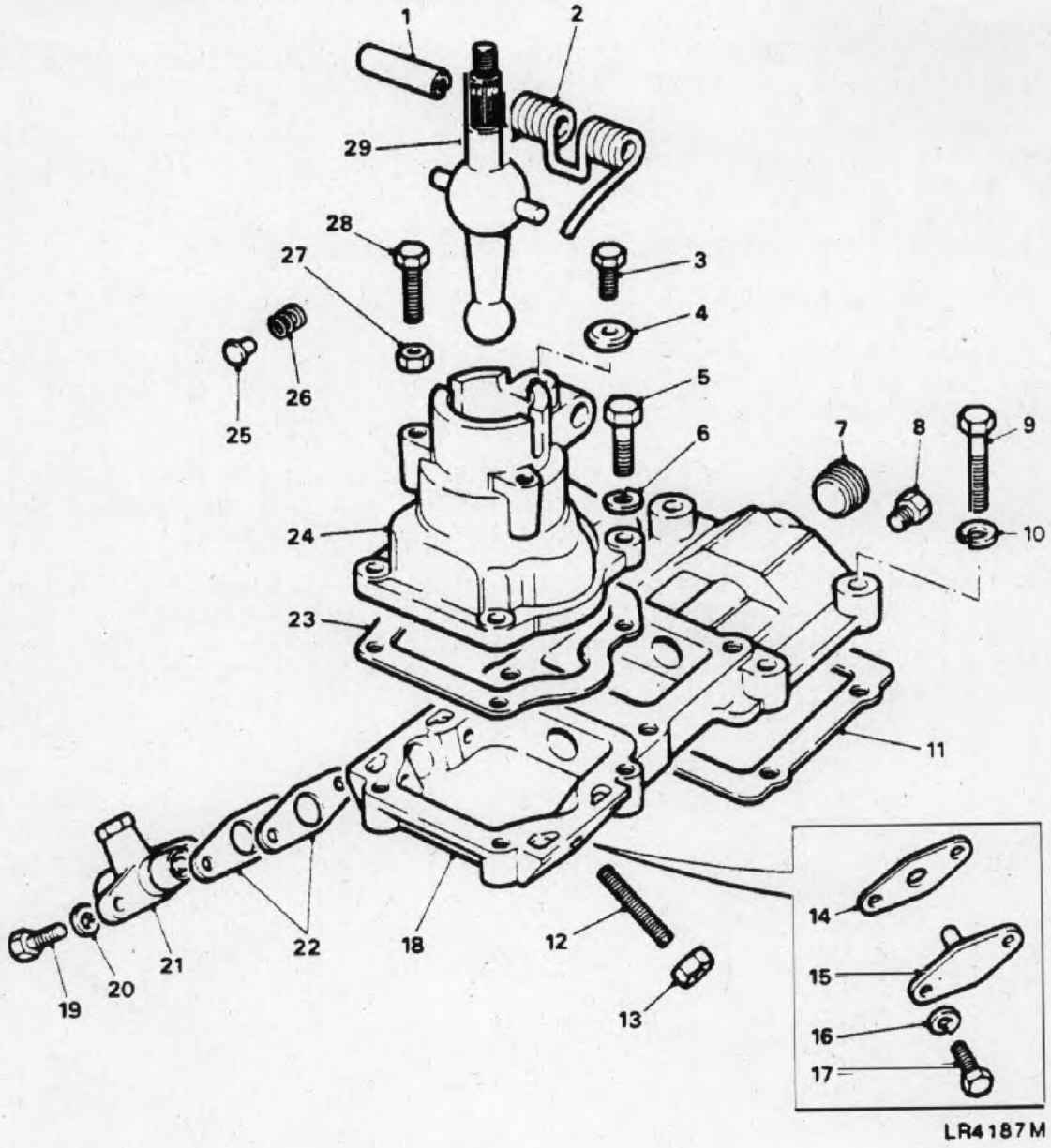
DISMANTLING

4 Place the gearbox on a suitable work bench with the transfer box removed, ensuring that the oil has been drained.

Gear selector housing

5 To dismantle the gear selector housing proceed as follows:

5.1 Using a length of suitable tubing dislodge both legs of the bias spring (Fig 6 (2)) from the cross pin on gear lever shaft (29).



1	Roll pin	
2	Bias spring	
3	Screw	
4	Special washer	
5	Bolt	
6	Spring washer	
7	Blanking plug	
8	Blanking plug	
9	Bolt	
10	Spring washer	
11	Gasket	
12	Adjusting screw	)Later
13	Locknut	)models
14	Shim	)Early
15	Fifth gear stop	)models
16	Spring washer	
17	Bolt	
18	Selector housing	
19	Bolt	
20	Spring washer	
21	Reverse gear plunger	
22	Shim	
23	Gasket	
24	Gear lever housing	
25	Nylon plunger	
26	Spring	
27	Locknut	
28	Adjusting screw	
29	Gear lever shaft	

Fig 6 Gear lever and selector housing

CAUTION ...

Take care when releasing the retainer bolt as the gear lever ball is spring loaded in its seat by a strong spring and nylon plunger.

5.2 Remove the screw (3) and special washer (4), to release the gear lever shaft (29), carefully withdraw the shaft from its housing (24) and retrieve the spring (26) and nylon plunger (25).

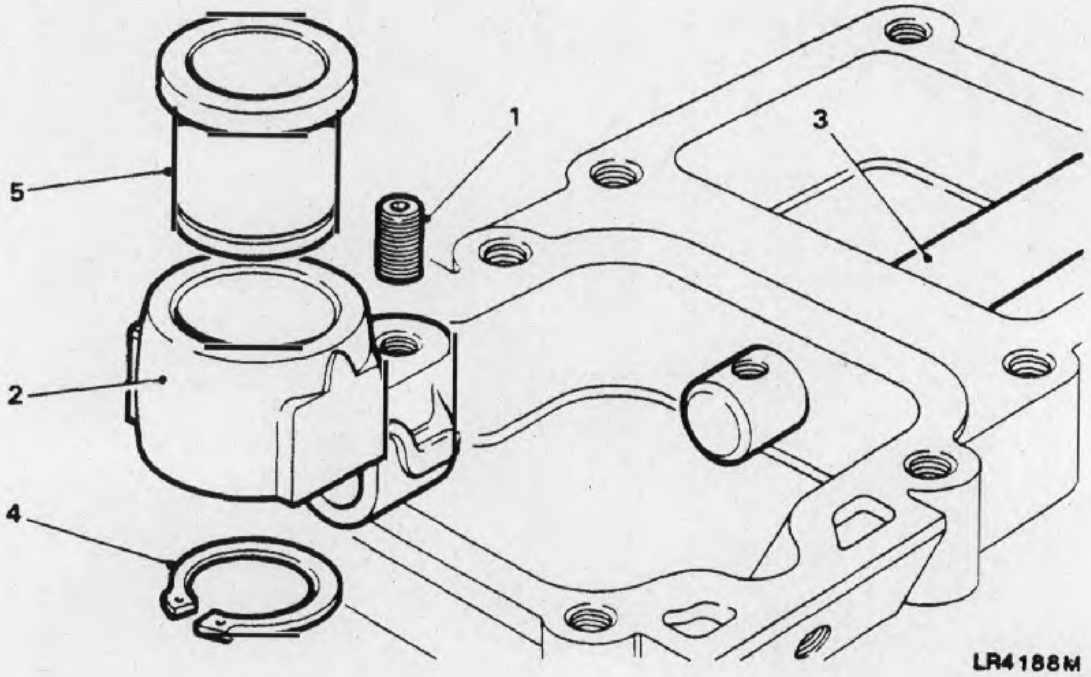
5.3 Remove the two adjusting screws (28) and locknuts (27).

5.4 Remove the roll pin (1) and detach the bias spring (2).

5.5 Remove the four bolts (5) and spring washers (6) securing the gear lever housing (24) to the selector housing (18). Lift off the housing and discard the gasket (23).

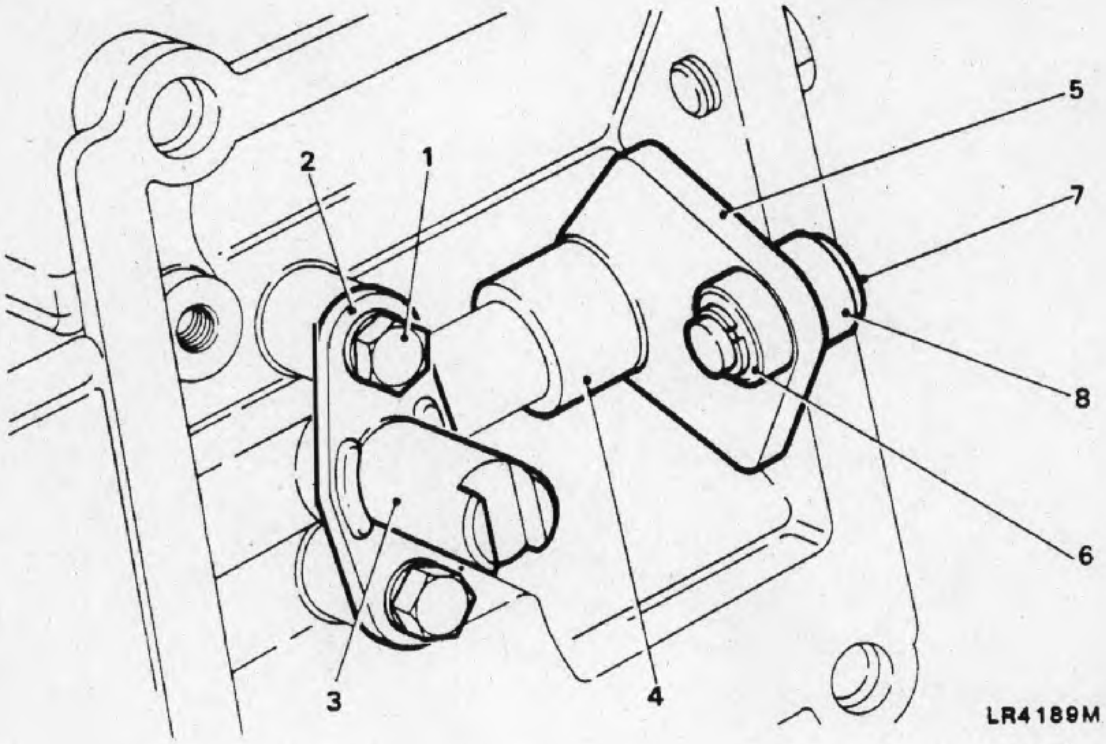
5.6 Remove the bolts (19) and washers (20) retaining the reverse gear plunger assembly (21) to the selector housing. Withdraw the assembly taking care not to lose the shims (22) fitted to the mounting face.

5.7 Remove the bolts (17) and spring washers (16) securing the fifth gear stop (15), withdraw the stop taking care not to lose the shims (14). Later models of the gearbox are fitted with an adjusting screw and locknut, if a later model gearbox is being worked upon, slacken the locknut (13) and remove the adjusting screw (12).



1 Locating screw
2 Yoke
3 Selector shaft
4 Circlip
5 Nylon seat

Fig 7 Yoke and selector shaft removal



1	Bolts	5	Quadrant
2	Spring washer	6	Circlip
3	Fifth gear spool retainer	7	Roller pin
4	Roll pin	8	Roller

Fig 8 Spool and quadrant removal

5.8 Remove the bolts (9) and spring washers (10) securing the selector housing (18) to the extension case. Lift off the housing and discard the gasket (11).

5.9 Remove the locating screw (Fig 7 (1)) from the yoke (2), pull the selector shaft (3) rearwards and remove the yoke from the selector housing.

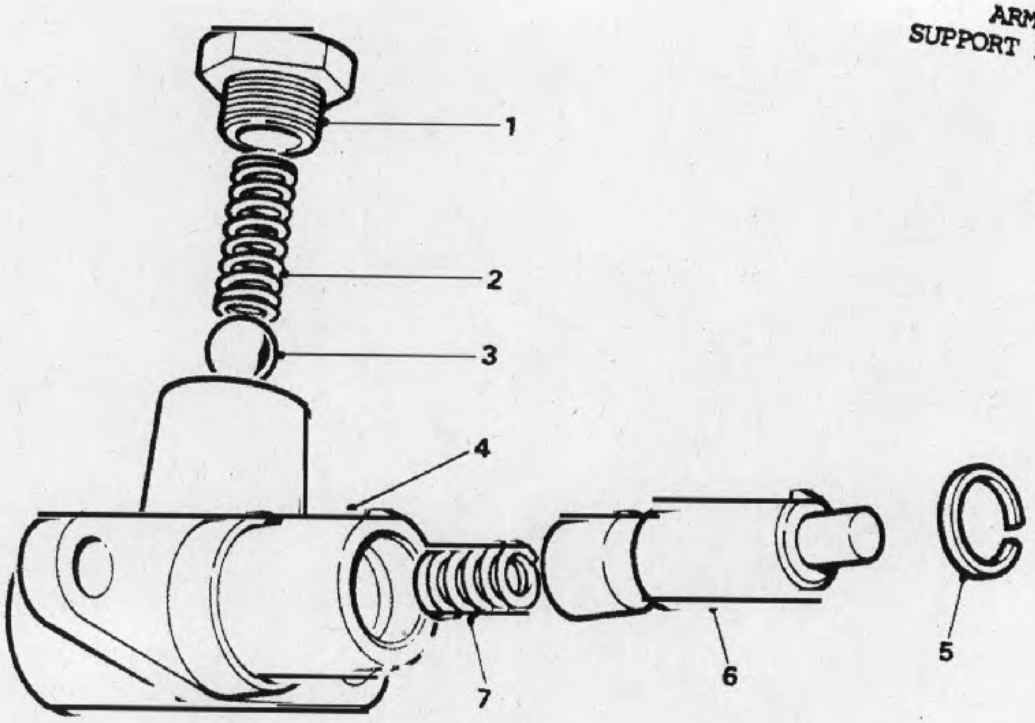
5.10 Release the circlip (4) and detach the nylon seat (5) from the yoke.

5.11 Invert the selector housing, remove the bolts (Fig 8 (1)) and spring washers (2) and lift off the fifth gear spool retainer (3).

5.12 Remove the two blanking plugs (Fig 6 (7) and (8)) from the rear of the housing (18).

5.13 Place the gear selector housing into a vice having soft jaws, using a suitable pin punch, drift out the selector quadrant roll pin (Fig 8 (4)). Push the selector shaft forward, remove the quadrant (5) and withdraw the shaft through the large blanking plug orifice. Remove the housing from the vice.

5.14 Remove the selector quadrant roller circlip (6) and withdraw the pin (7) and rollers (8).



LR4190M

1 Plug
2 Spring
3 Detent ball
4 Housing
5 Circlip
6 Plunger
7 Spring

Fig 9 Reverse gear plunger assembly

Reverse gear plunger assembly

6 To dismantle the reverse gear plunger assembly carry out the following:

6.1 Remove the plug (Fig 9 (1)), spring (2) and detent ball (3) from the plunger housing (4).

6.2 Detach the circlip (5) and pull out the plunger (6) followed by the spring (7) from the plunger housing.

Note ...

Later models have no circlip (5) fitted.

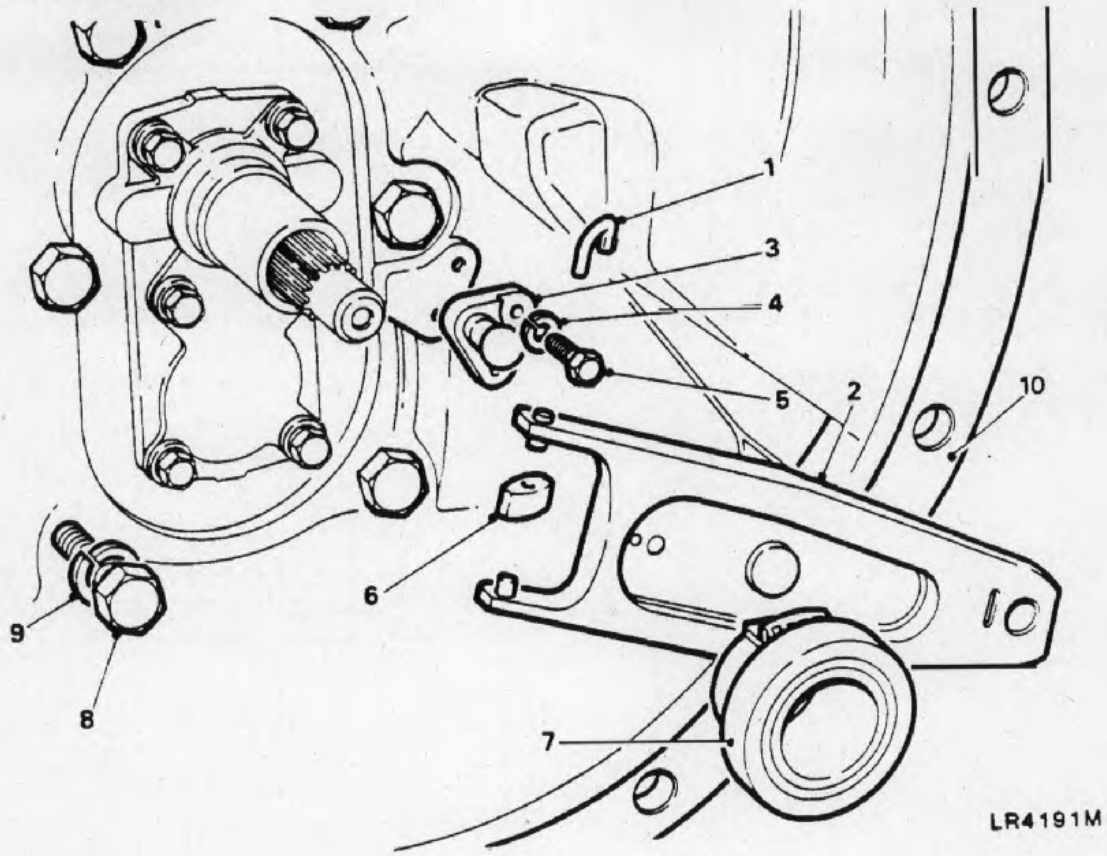
Bell housing and clutch release lever

7 Remove the bell housing and clutch release lever as follows:

7.1 Remove the clutch release bearing carrier clip (Fig 10 (1)) and withdraw the release bearing and carrier (7).

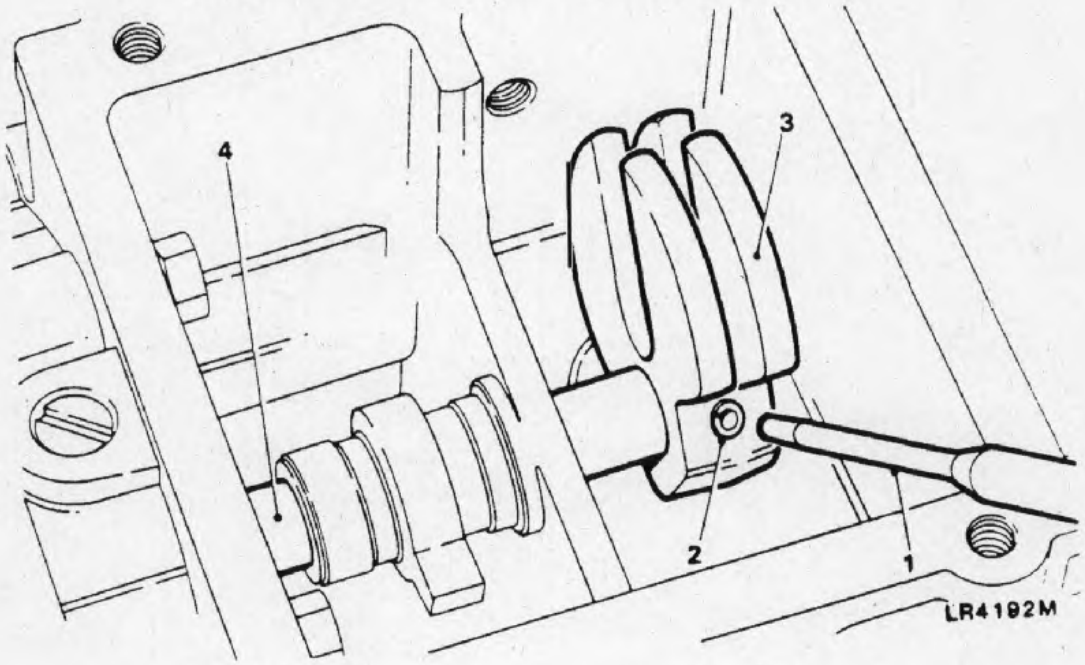
7.2 Detach the clutch release lever (2) from the clutch release lever pivot (3), complete with slipper pads (6). Remove the bolts (5) and spring washers (4) securing the pivot and detach it from the bell housing (10).

7.3 Remove the bolts (8) and washers (9) securing the bell housing (10) and remove the bell housing.



1	Bearing carrier clip	6	Slipper pad
2	Clutch release lever	7	Release bearing and carrier
3	Lever pivot	8	Bolt
4	Spring washer	9	Spring washer
5	Bolt	10	Bell housing

Fig 10 Bell housing and clutch release lever



1	Pin punch	3	Yoke
2	Roll pin	4	Selector rail

Fig 11 Yoke removal from selector rail

Casings and gears

8 To dismantle the casings and gears proceed as follows:

8.4 Using a suitable pin punch (Fig 11 (1)), remove the roll pin (2) r taining the selector yoke (3).

8.5 Push the selector rail (4) forward to engage a gear, and manoeuvre the selector yoke (3) from the rail. Return the selector rail to neutral.

8.6 Remove the two dowel tubes from the front of the casing and secure the gearbox to the locally manufactured workstand.

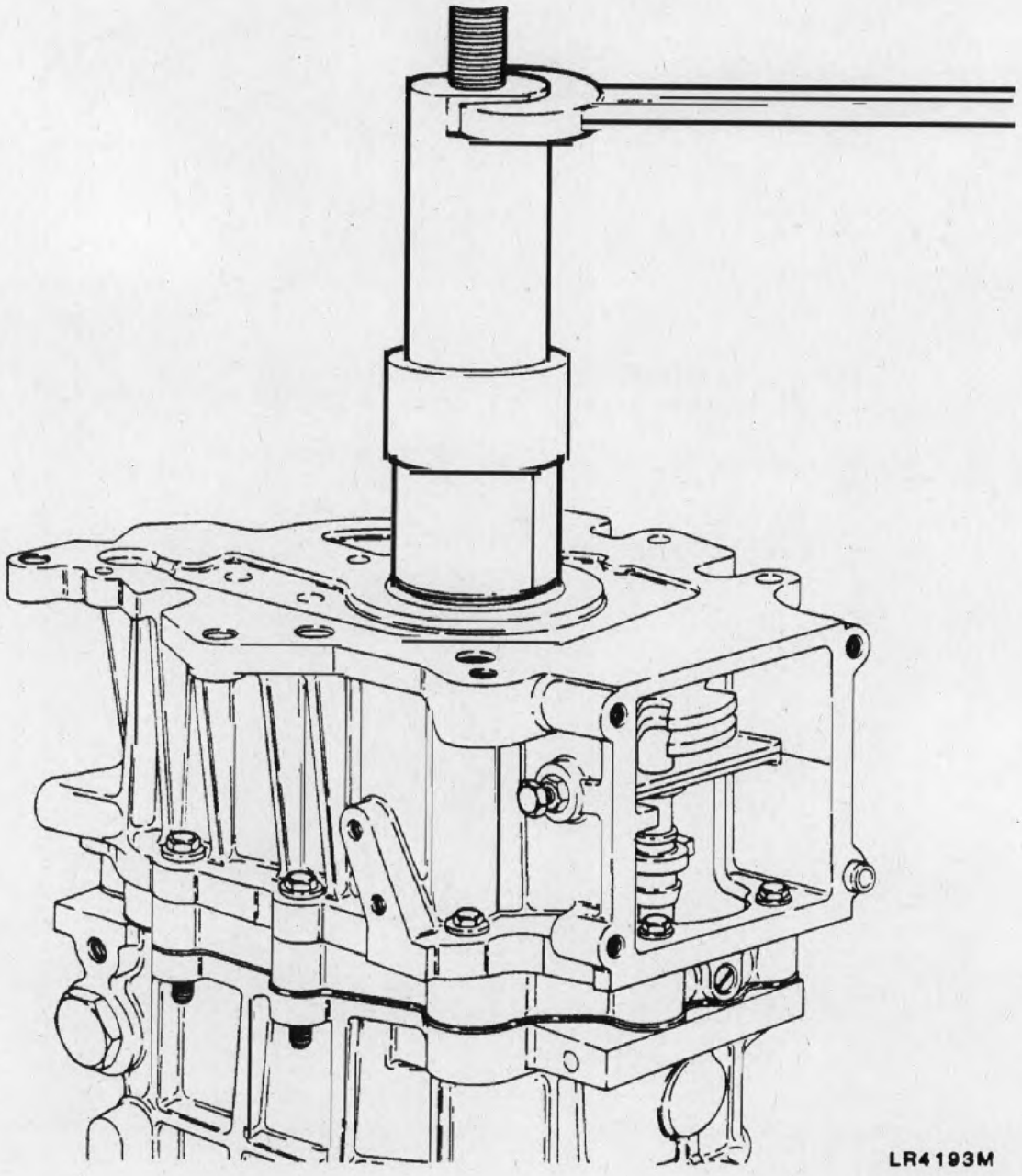
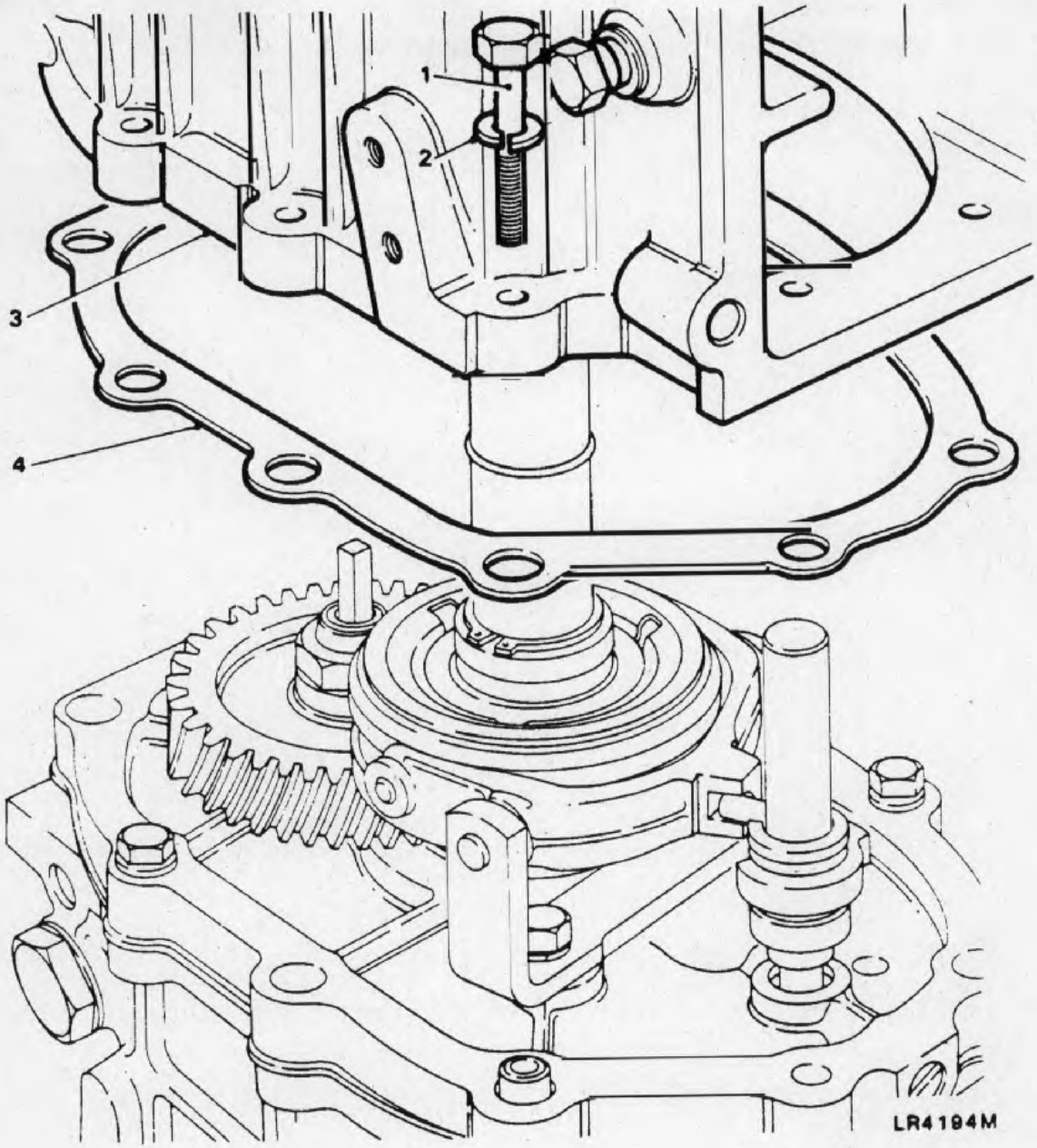


Fig 12 Removing oil seal collar



1 Bolt
2 Spring washer
3 Extension case
4 Gasket

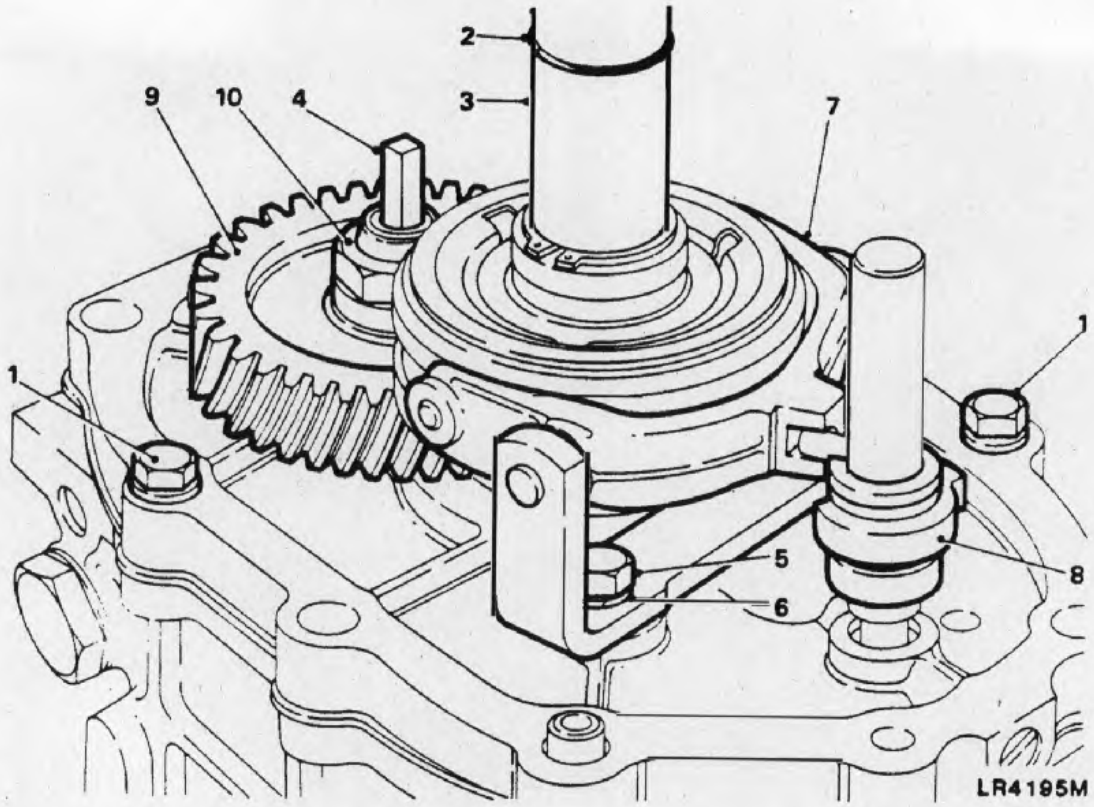
Fig 13 Extension case removal

8.7 Remove the circlip retaining the mainshaft oil seal collar, located at the rear of the extension case.

8.8 Using special tools (Serial No's 1 and 2) remove the oil seal collar (Fig 12).

8.9 Remove the bolts (Fig 13 (1)) and spring washers (2) securing the extension case (3) to the main gearcase, withdraw extension case and remove and discard the gasket (4).

8.10 Fit two slave bolts M8 x 35 mm (Fig 14 (1)) to the casing to retain the centre plate to the main gearcase.



1	Slave bolt	6	Spring washer
2	'O' ring seal	7	Selector fork and bracket
3	Main shaft	8	Selector spool
4	Oil pump drive shaft	9	Fifth gear
5	Bolt	10	Nut

Fig 14 Fifth gear selector fork and bracket removal

8.11 Remove the oil seal collar 'O' ring seal (2) from the main shaft (3).

8.12 Withdraw the oil pump drive shaft (4).

8.13 Remove the bolts (5) and spring washers (6) securing the fifth gear selector fork and bracket (7), lift off the assembly complete with the fifth gear selector spool (8).

8.14 Engage reverse gear by turning the selector rail anti-clockwise and pulling rearwards. Move the fifth speed synchromesh assembly into mesh with the fifth gear (9).

8.15 De-stake the nut (10) securing the fifth gear to the layshaft and remove nut.

8.16 Select neutral by pushing the selector rail inwards and turning clockwise and return the fifth speed synchromesh assembly to its out of mesh position.

8.17 Remove the circlip retaining the fifth speed synchromesh assembly to the main shaft.

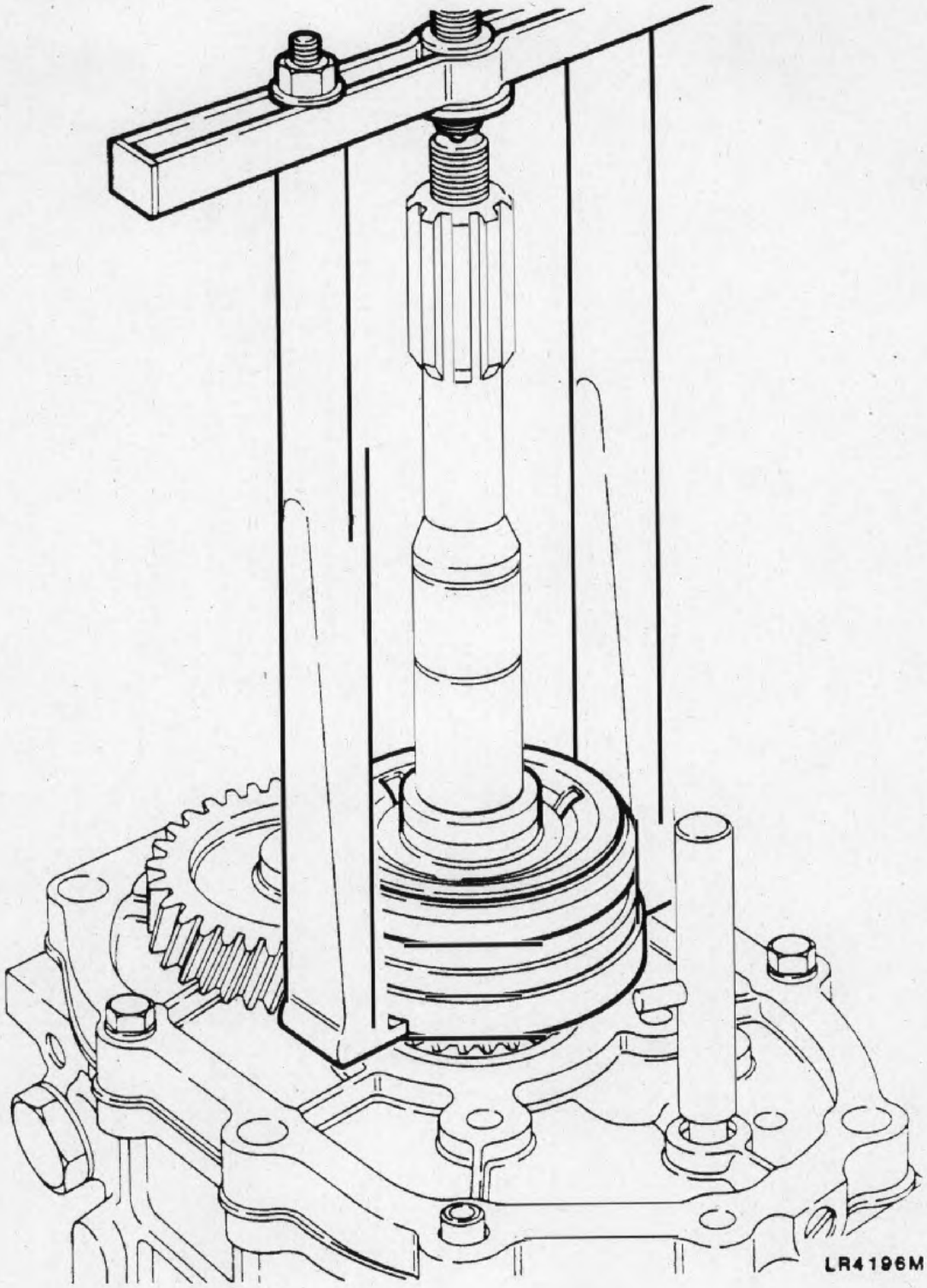


Fig 15 Fifth gear synchromesh removal

8.18 Using special tools (Serial No's 4 and 5) (Fig 15) withdraw the selective washer, fifth gear synchromesh assembly and baulk ring, fifth gear (driven) and spacer from the mainshaft.

8.19 Remove the split roller bearing assembly from the mainshaft.

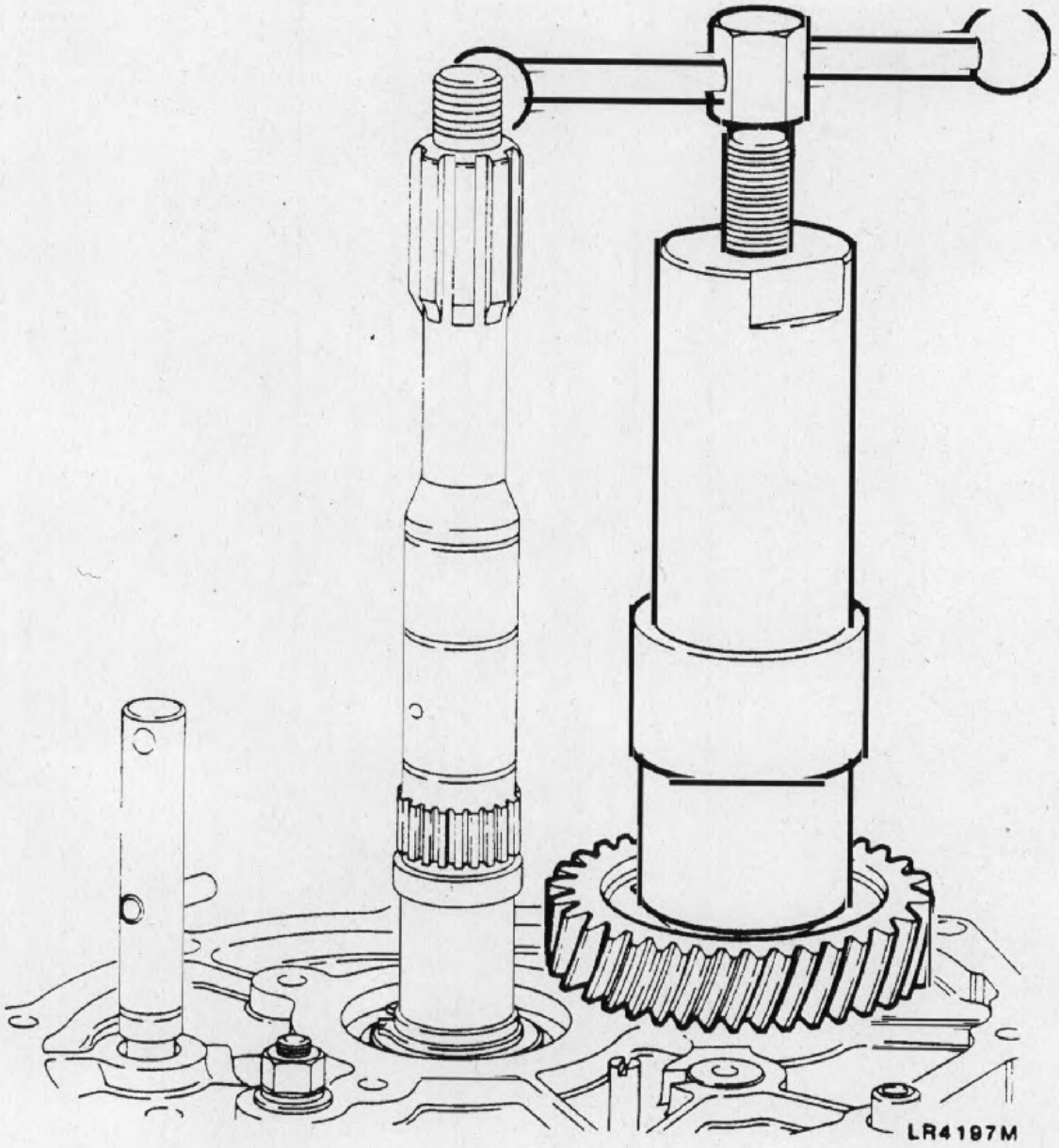


Fig 16 Layshaft fifth gear removal

8.20 Using special tools (Serial No's 1 and 2) (Fig 16) remove the layshaft spacer (if fitted) and layshaft fifth gear.

8.21 Remove the selector shaft circlip which prevents the selector shaft over-travelling.

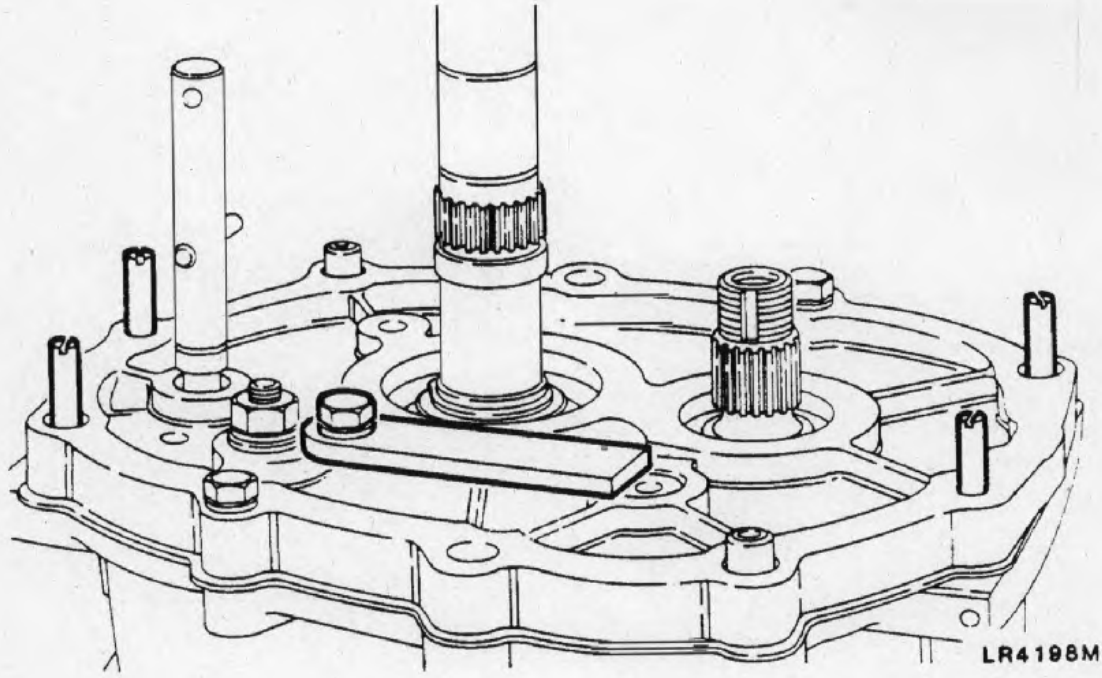


Fig 17 Reverse shaft retainer and guide stud locations

8.22 Fit the locally manufactured reverse shaft retainer (Fig 4) and guide studs (Fig 5) to the locations shown (Fig 17). Invert the gearbox on the stand, so that the front of the gearbox is uppermost, ensuring that the four studs locate correctly on the workstand.

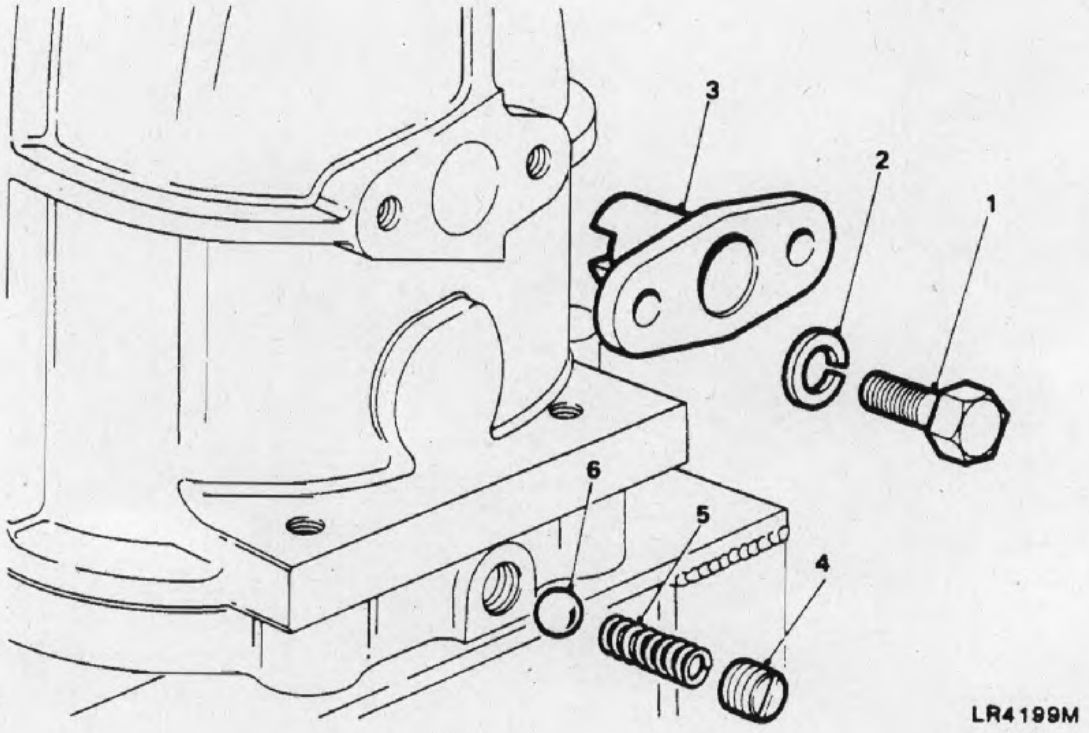
8.23 Remove the six bolts and spring washers securing the front cover to the main gearcase, withdraw cover and remove and discard gasket.

8.24 Remove the input shaft and layshaft selective washers from their respective locations on the shafts.

8.25 Remove the two bolts (Fig 18 (1)) and spring washers (2) securing the locating boss (3) for the selector shaft front spool and withdraw the locating boss.

8.26 Remove the spring retaining plug (4), selector detent spring (5) and detent ball (6) from the top of the centre plate.

8.27 Remove the slave bolts and carefully lift off the main gearcase, leaving the centre plate and gear assemblies in position. Remove and discard the gasket.



1	Bolt	4	Plug
2	Spring washer	5	Spring
3	Locating boss	6	Detent ball

Fig 18 Selector shaft locating boss and detent components

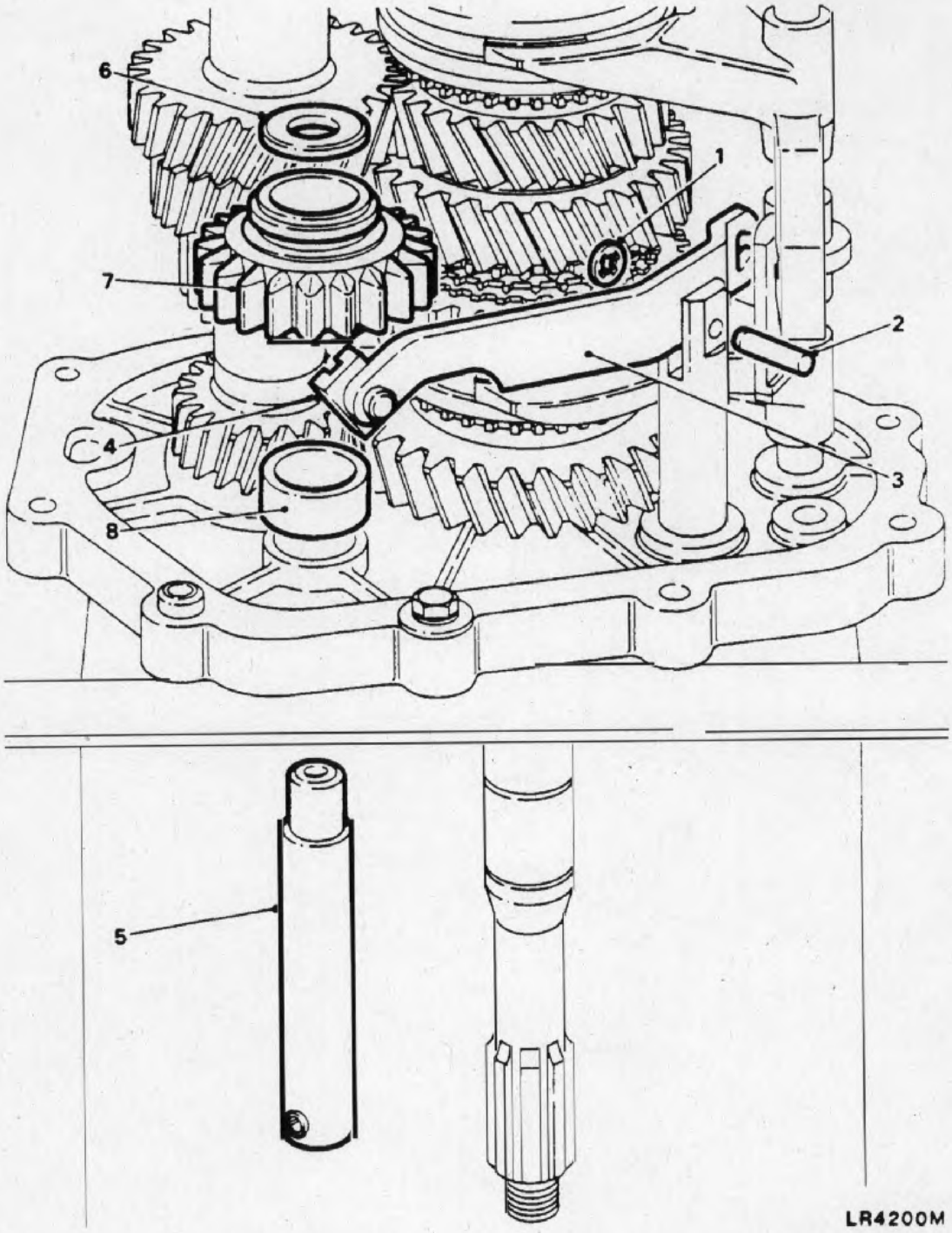
8.28 Using suitable slave bolts and nuts, secure the centre plate to the locally manufactured stand.

8.29 Remove the circlip (Fig 19 (1)), pivot pin (2), reverse lever (3) and slipper pad (4). Detach the reverse shaft retainer and slide out the reverse shaft (5). Lift off the thrust washer (6), reverse gear (7) and spacer (8).

8.30 Lift off the layshaft cluster, then remove the input shaft and fourth gear synchromesh baulk ring (Fig 20).

8.31 Rotate the fifth gear selector shaft clockwise (viewed from above) to align the fifth gear selector pin with the slot in the centre plate (Fig 21).

8.32 Remove the mainshaft and selector fork assemblies from the centre plate and detach the selector fork assembly from the mainshaft gear cluster.



1	Circlip	5	Reverse shaft
2	Pivot pin	6	Thrust washer
3	Reverse lever	7	Reverse gear
4	Slipper pad	8	Spacer

Fig 19 Reverse idler assembly

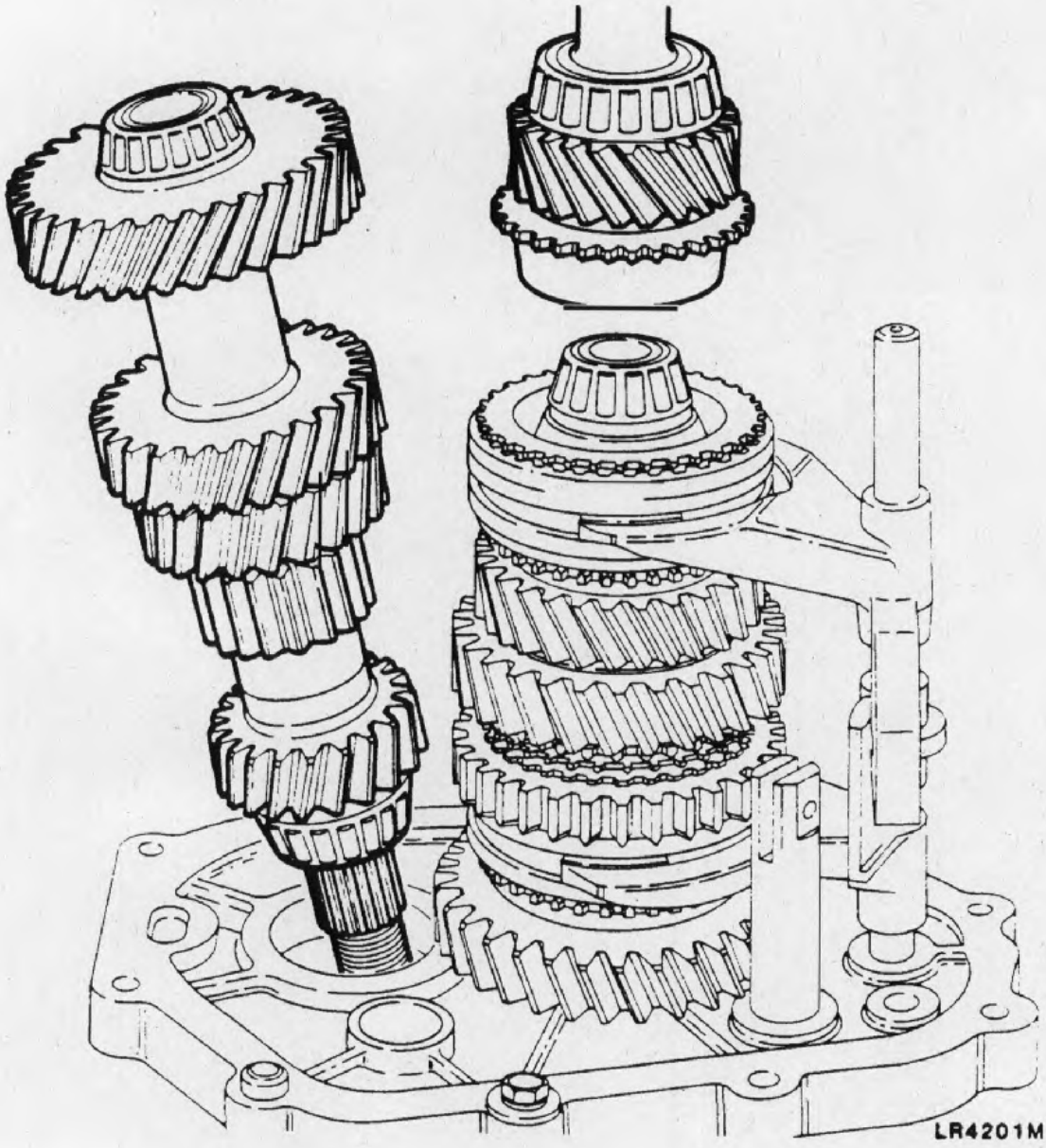


Fig 20 Layshaft cluster and input shaft removal

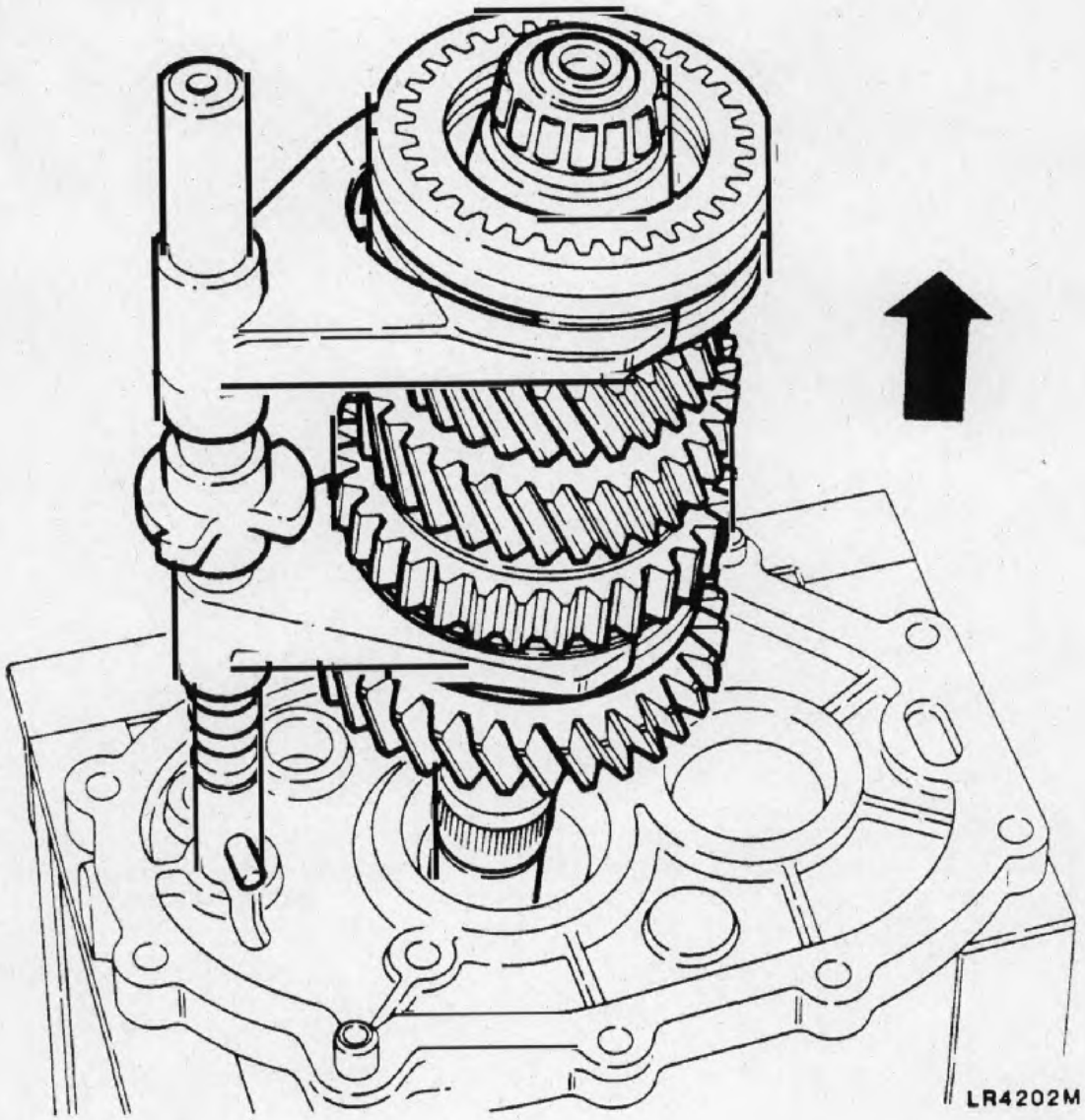


Fig 21 Mainshaft and selector forks removal

8.33 Remove the slave bolts from the centre plate and remove the plate from the stand.

Front cover

9 Remove and discard the oil seal from the front cover. Do not fit a new seal at this stage.

Layshaft

10 Using special tools (Serial No's 1 and 3) remove the layshaft bearings (Fig 22).

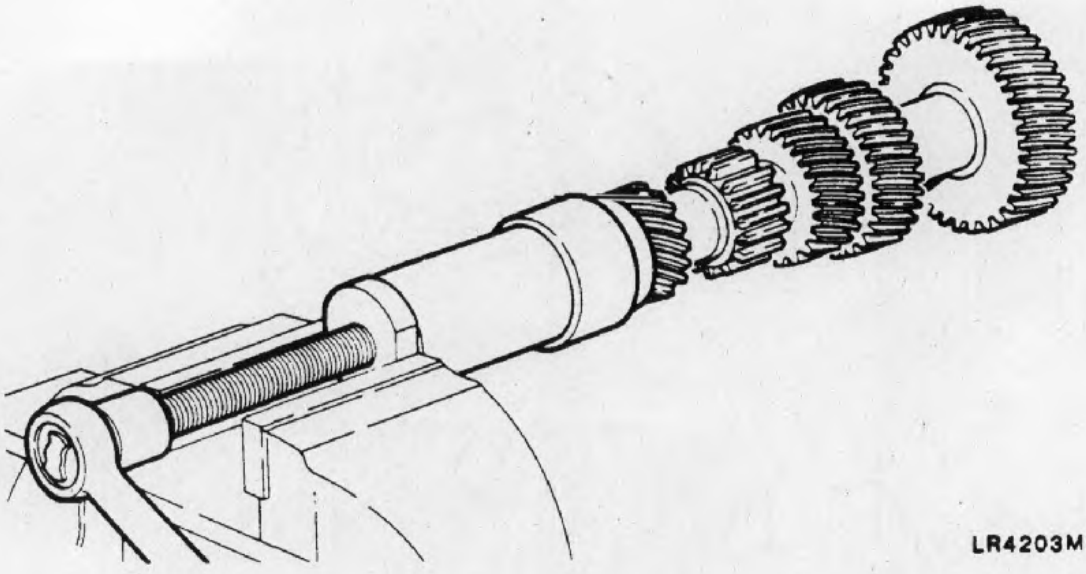


Fig 22 Removing the layshaft bearings

Mainshaft

11 To dismantle the mainshaft assembly carry out the following:

11.1 Remove the centre bearing circlip (Fig 23 (14)).

11.2 Using press, special tool (Serial No 12) or a suitable alternative, and suitable metal blocks, remove the centre bearing (15), first gear bush (16), first gear (18), needle roller bearing (17), and synchromesh baulk ring (20).

Key to Fig 23

1	Input shaft	21	Outer member
2	Bearing	22	Inner member
3	Spacer	23	Slipper
4	3rd/4th synchro assy	24	Slipper ring
5	Baulk ring	25	Baulk ring
6	Slipper ring	26	2nd gear
7	Slipper	27	Needle roller bearing
8	Inner member	28	Circlip
9	Outer member	29	Spacer
10	Baulk ring	30	Support plate
11	3rd gear	31	5th gear synchro assy
12	Needle roller bearing	32	Outer member
13	Main shaft	33	Inner member
14	Circlip	34	Slipper
15	Bearing	35	Slipper ring
16	Bush 1st speed gear	36	Baulk ring
17	Needle roller bearing	37	5th gear
18	1st gear	38	Needle roller bearing
19	1st/2nd synchro assy	39	Collar
20	Baulk ring		

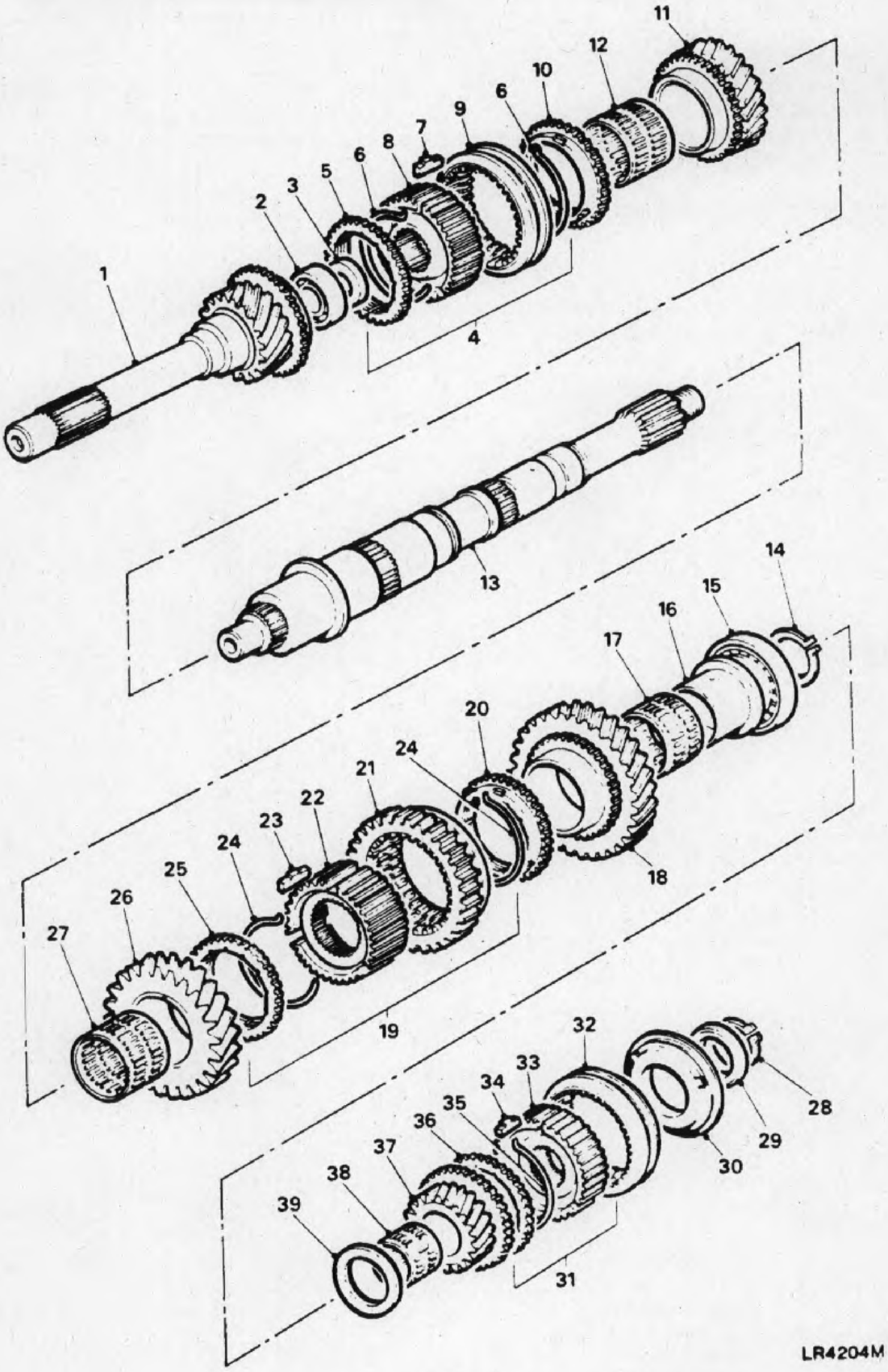


Fig 23 Main shafts and gears

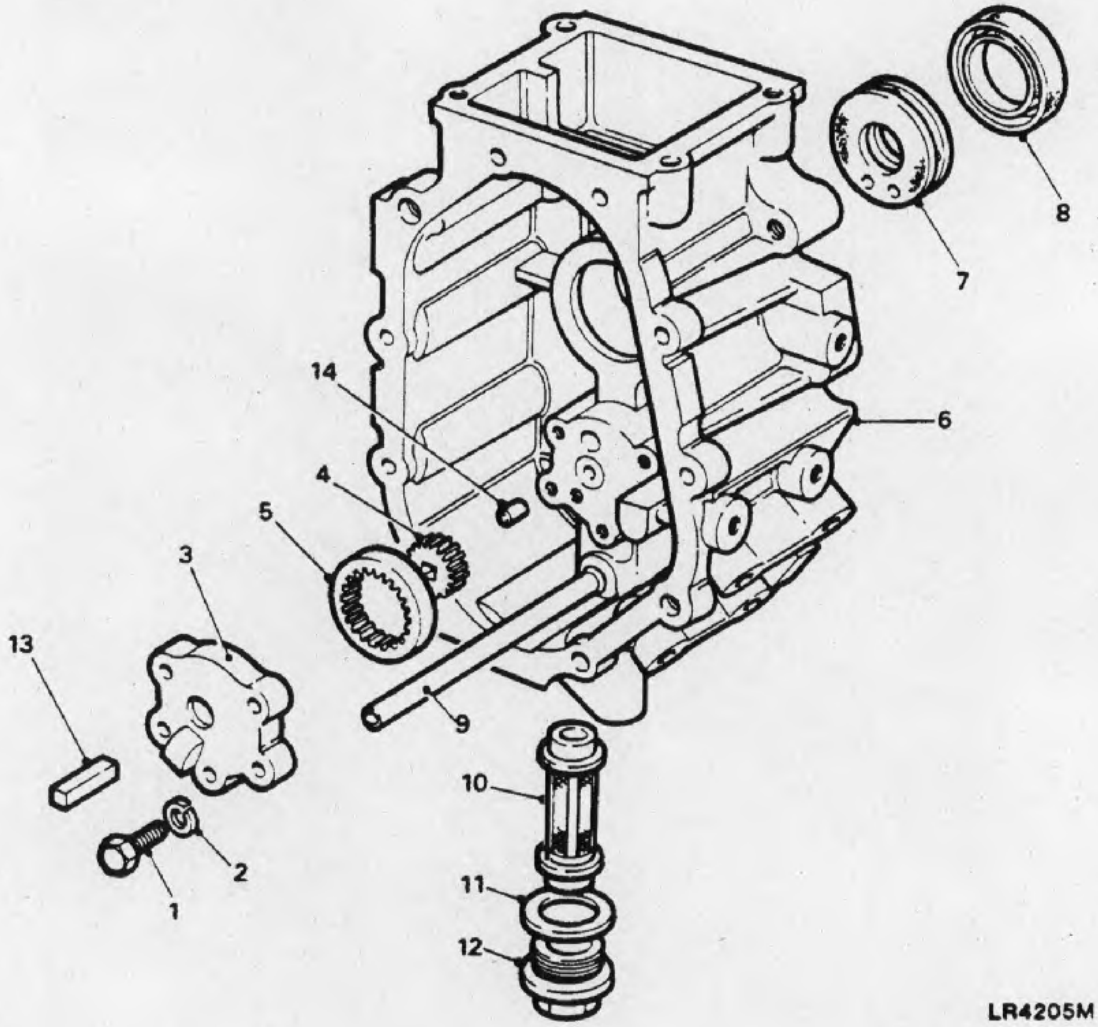
11.3 Place the support blocks under the second gear (26) and utilising the press release the second gear (26) and the first and second gear synchromesh assembly (19).

11.4 With the support blocks fitted under the third speed gear (11), press out the mainshaft (13) through the pilot bearing spacer (3), third and fourth synchromesh assembly (4), third gear (11) and third gear needle roller bearing (12).

First and second gear synchromesh assemblies

Note ...

Components from the synchromesh assemblies should be retained in sets and identified as to which assembly they belong.



1	Bolt	8	Oil seal
2	Spring washer	9	Oil pick up pipe
3	Oil pump housing	10	Filter
4	Inner gear	11	Sealing washer
5	Outer gear	12	Drain plug
6	Extension casing	13	Oil pump drive shaft
7	Ferrobestos bush	14	Dowel

Fig 24 Extension casing

12 Mark the inner and outer members to assist with reassembly, remove the slipper rings (24) and withdraw the slippers (23). Remove inner member (22) from the outer member (21).

Third and fourth gear synchromesh assemblies

13 Mark the inner and outer members to assist with reassembly, remove the slipper rings (6) and withdraw the slippers (7). Remove inner member (8) from the outer member (9).

Fifth gear synchromesh assembly

14 Lever the support plate (30) off the fifth gear synchromesh assembly, remove the slipper rings (35) from the front and rear of the assembly, detach the slippers (34) and slide the inner member(33) from the outer member(32).

Extension case

15 Remove the components from the extension case as follows:

15.1 Remove the bolts (Fig 24 (1)) and spring washers (2) securing the oil pump housing (3), withdraw the housing and the oil pump gears (4) and (5). Do not withdraw the oil pick-up pipe (9).

15.2 Remove the oil drain plug (12) washer (11) and filter (10).

15.3 Invert the casing, extract the oil seal (8) and press out the ferrobestos bush (7).

Input shaft

16 Using special tools (Serial No's 6 and 12) remove the input shaft bearing. Insert the shaft in a soft jawed vice and with the aid of special tools (Serial No's 8 and 9) extract the pilot bearing track (Fig 25).

Reverse idler gear

17 Remove one of the circlips from the reverse idler gear, note the location of the needle roller bearings, remove both bearings and the remaining circlip.

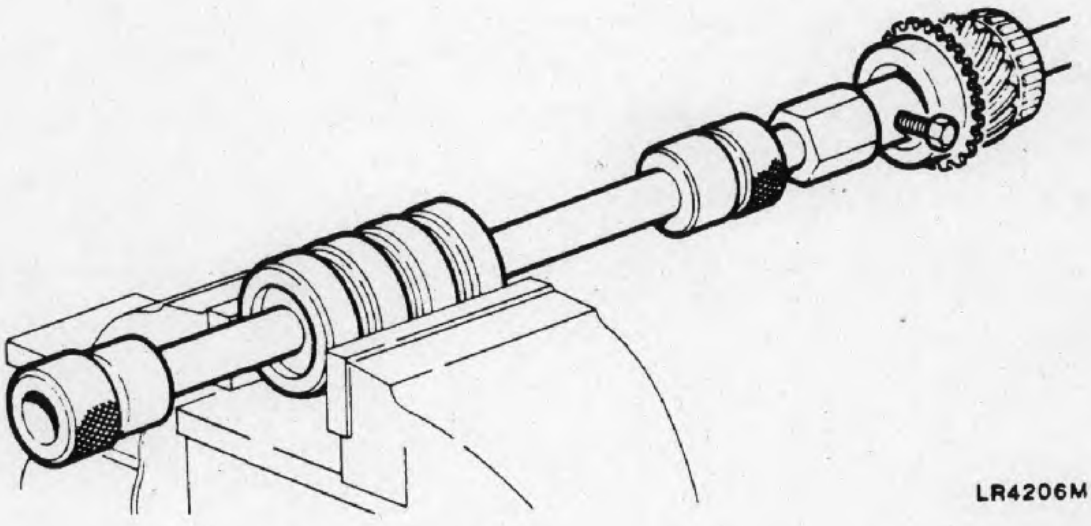


Fig 25 Removing input shaft pilot bearing track

Centre plate

18 Remove the layshaft, main bearing tracks and reverse pivot post from the centre plate.

Main gearbox casing

19 Remove the mainshaft and layshaft bearing and from the casing and the plastic oil trough from the front of the casing.

Selector rail

20 The selector rail is supplied complete with first and second selector fork, pin and fifth speed selector pin. Should any of the parts within the assemble r quire replacement a new assembly must be fitted.

CLEANING

21 Clean all components thoroughly using a suitable solvent. Ensure all lubrication drillings are clear of sludge or contamination.

EXAMINATION

22 Examine the components as follows referring to Cat 533 for dimensions and wear tolerances:

22.1 Examine the casings for cracks, stripped threads in the various bolt holes and the machined mating faces for burrs, nicks or any condition that would render the casing unfit for further service. Damaged threads may be reclaimed by fitting wire thread inserts.

22.2 Inspect all gears for chipped or broken teeth, and for signs of excessive wear, inspect all spline teeth on the synchromesh assemblies.

22.3 Check synchromesh slippers and slipper rings for wear and breakage.

22.4 Check the wear between all synchromesh baulk rings and gears by pushing the baulk ring against the gear and measuring the gap between the ring and gear. The minimum permissible gap is 0,64 mm (0.025 in), if this clearance is not obtained new baulk rings must be fitted.

22.5 Inspect all circlip grooves for burrs or rough edges, if this condition is apparent remove by carefully stoning with a fine stone.

22.6 Generally examine all other components for wear or damage, fit new components as necessary.

REPAIRS AND REPLACEMENT

23 It is recommended that all seals, gaskets, circlips, lock washers, needle and roller bearings are renewed at overhaul.

REASSEMBLY

24

Layshaft

25 Using special tool (Serial No 12) and a suitable tube, fit new bearing cor s to the layshaft.

Synchromesh assemblies

26 Assemble the synchromesh gears as follows:

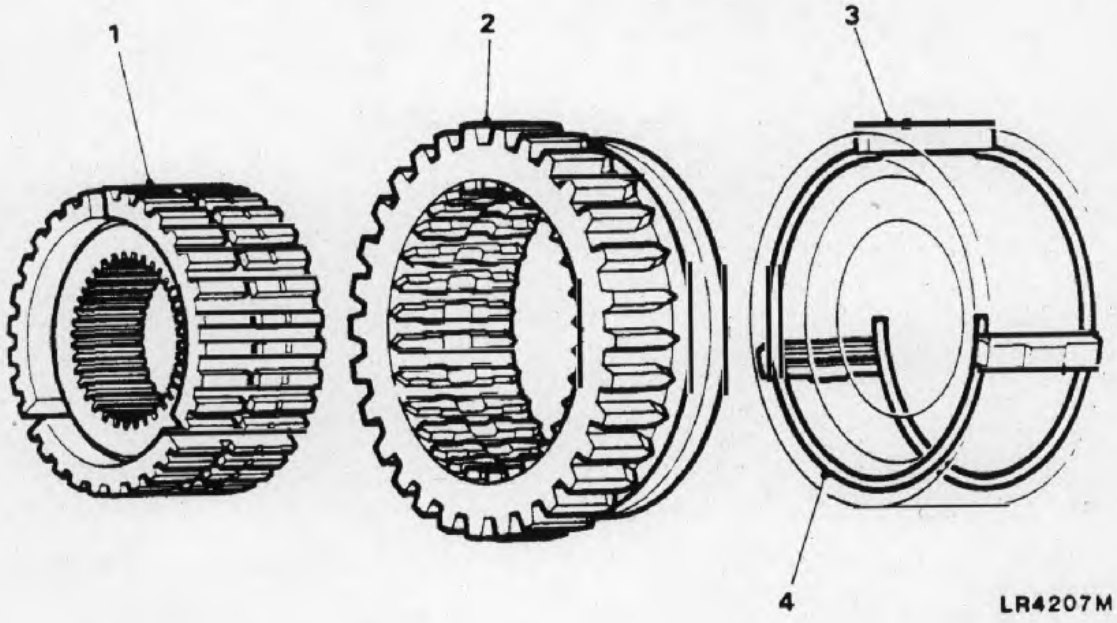
Notes ...

(1) On earlier models, the second gear synchromesh baulk ring has wider slipper slots to allow the ring more freedom for easy engagement and is straw coloured for identification purposes. Later models have Molybdenum-sulphide coated baulk rings.

(2) When refitting existing baulk rings, they must be fitted to their original locations from which they were removed.

26.1 Assemble the first and second synchromesh inner member (Fig 26 (1)) to the outer member (2) with the longer splines on the inner member positioned at the selector fork annulus end of the outer member.

26.2 Fit the slippers (3) and locate the slipper rings (4) to each side of the assembly, the slipper rings must be fitted with both hooked ends located in the same slipper, but running in opposite directions and finishing against the other two slippers (Fig 26).



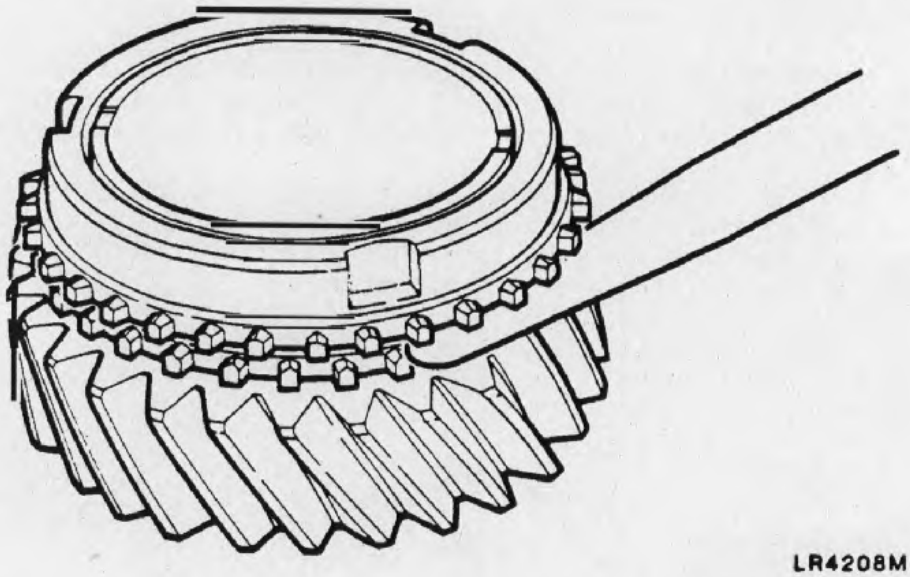
1 Inner member
2 Outer member
3 Slipper
4 Slipper ring

Fig 26 Assembling synchromesh gear

26.3 Assemble the third and fourth synchromesh inner member to the outer member followed by the slippers and rings, ensuring that the rings are fitted in the same manner as in Para 26.2.

26.4 Assemble the fifth synchromesh gear, again ensuring that the slipper rings are fitted as described for the first and second synchromesh assembly. Fit the backplate to the rear of the assembly ensuring that the tag locates in the slot on the assembly.

26.5 Check the clearance between all the baulk rings and synchromesh gears by pushing the baulk ring against the the gear and measuring the gap (Fig 27). The minimum clearance is 0,38 mm (0.015 in) for the Molybdenum-sulphide coated baulk rings and 0,64 mm (0.025 in) for the earlier type baulk ring, a clearance less than the above minimum indicates that a new baulk ring must be fitted.



LR4208M

Fig 27 Checking baulk ring clearance

First gear bush end float

27 To obtain the correct first gear bush end-float carry out the following:

27.1 Lubricate the second gear needle roller bearing (Fig 23 (27) with light oil and fit the bearing, second gear (26) and second gear synchromesh baulk ring (25) to the main shaft (13).

27.2 Fit the first and second gear synchromesh assembly (19) with the selector fork annular groove to the rear of the mainshaft.

27.3 Fit the first gear bush (16), the locally manufactured slave bearing (Fig 2) and a new circlip to the mainshaft. When fitting the circlip, care must be taken to ensure that it is not opened beyond the minimum necessary to pass over the shaft.

27.4 Press the slave bearing spacer back against the circlip to allow the bush maximum end-float. Measure the clearance between the rear of the bush and the face of the slave bearing spacer (Fig 28). The maximum clearance should be 0,075 mm (0.003 in).

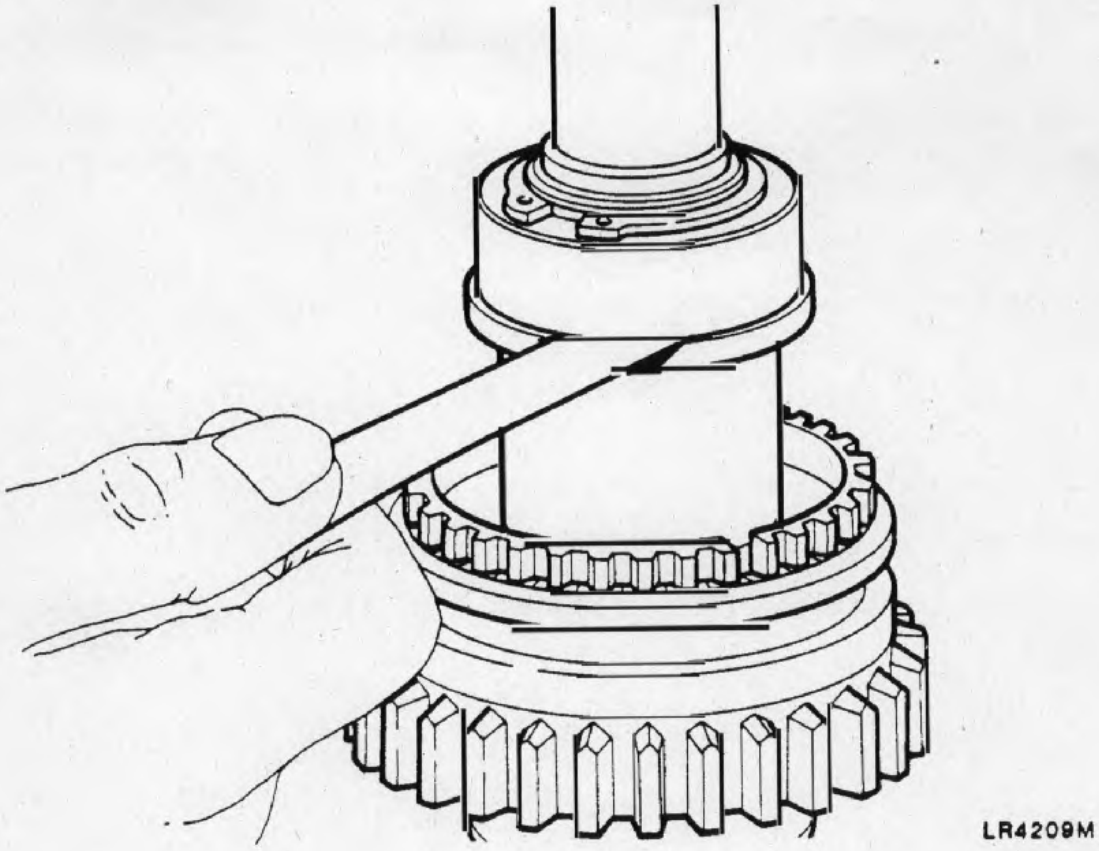


Fig 28 Checking first gear bush end float

27.5 First gear bushes are available having a range of varying thickness collars (Cat 721). From the range avaiable select a bush that will give the required clearance.

27.6 Remove the circlip, slave bearing spacer and existing first gear bush from the mainshaft.

27.7 Lubricate the first gear needle roller bearing (Fig 23 (17)) and fit to the first gear (18).

27.8 Fit the selected first gear bush to the assembled first gear and needle roller bearing, place the first gear synchromesh baulk ring (20) followed by the first gear assembly onto the mainshaft.

27.9 Using special tools (Serial No's 6, 7 and 12) fit the centre bearing and circlip to the mainshaft.

27.10 Invert the mainshaft, lubricate the third gear needle roller bearing (12) and fit to the front end of the mainshaft.

27.11 Fit to the mainshaft the third gear (11), third gear synchromesh baulk ring (10), third and fourth gear synchromesh assembly (4), with the projection on the front of the inner member toward the front of the mainshaft, and the fourth gear baulk ring (5).

27.12 Fit the spacer (3) and bearing (2) to the front of the mainshaft.

Input shaft

28 Using special tool (Serial No 12) and a suitable tube, fit the pilot bearing track to the input shaft. Fit the input shaft bearing using the above tool in conjunction with special tools (Serial No's 6 and 7).

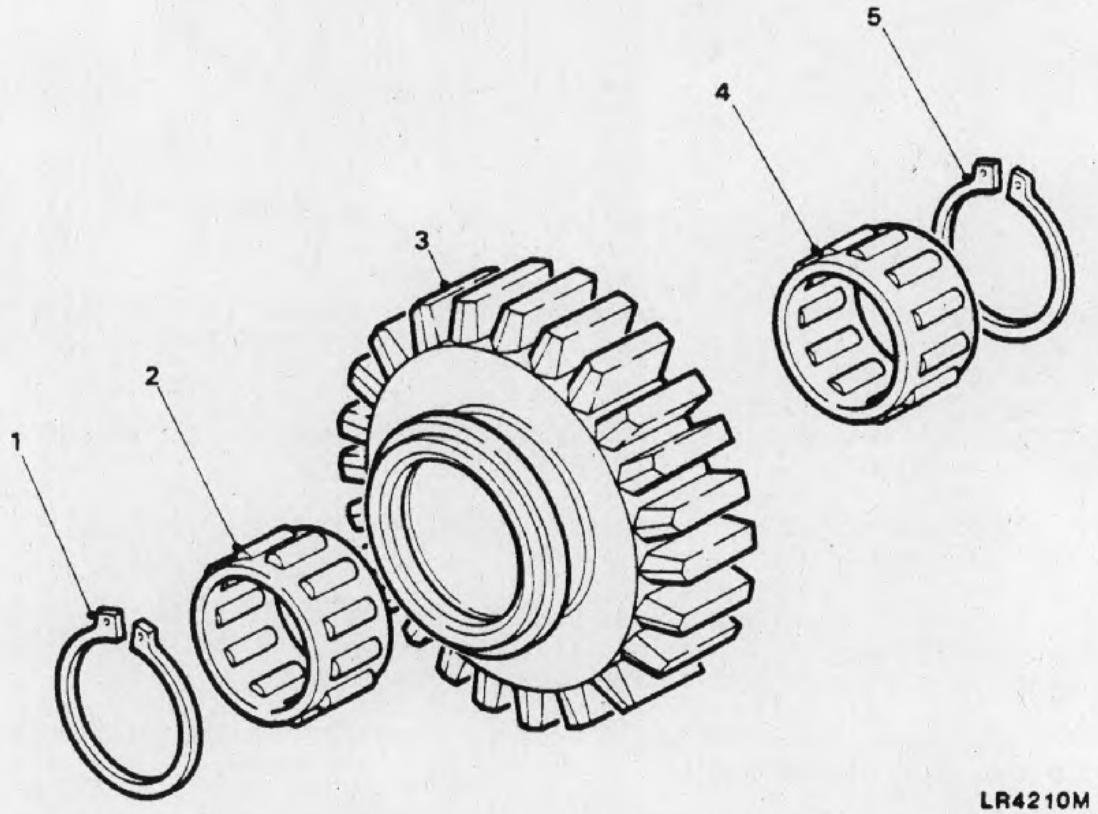
Reverse idler gear (assembly)

29 To assemble the reverse idler gear needle roller bearings proceed as follows:

29.1 Fit a new circlip (Fig 29 (2)) to the rear of the reverse idler gear (4).

29.2 Lubricate the needle roller bearings (3) and (5) with light oil and fit to the gear, the shorter bearing (5) should be fitted to the rear of the reverse idler gear.

29.3 Fit a second new circlip (2) to the front of the gear to retain the bearings.



1	Circlip	3	Gear
2	Front needle roller bearing	4	Rear needle roller bearing

Fig 29 Reverse idler gear

Extension case (assembly)

30 Fit the components to the extension case as follows:

30.1 Using a suitable press, fit a new ferrobestos bush (Fig 24 (7)) to the case, ensuring that the two drain holes are towards the bottom of the case.

30.2 Using special tool (Serial No 10) fit a new oil seal (8) to the rear of the extension case. Ensure the seal lips are towards the ferrob stos bush. Lubricate the seal lips with a suitable SAE 140 oil.

30.3 Assemble the oil pump gears (4) and (5) to the oil pump body (3), ensuring the square drive in the inner gear faces the layshaft.

30.4 Fit the oil pump body to the extension casing ensuring correct location with the dowels, secure with bolts (1) and spring washers (2). Tighten the bolts to a torque of 7 to 10 Nm (5 to 7 lbf ft).

30.5 Ensure that the oil pick-up pipe (9) is free of contamination or blockage..

30.6 Fit a new oil filter (10), fibre sealing washer (11) and plug (12), tighten the plug to a torque of 25 to 35 Nm (19 to 26 lbf ft).

Centre plate

31 Fit the centre plate to the locally manufactured stand, secure with two slave bolts, then proceed as follows:

31.1 Place the new mainshaft and layshaft bearing tracks in their respective locations on the centre plate.

31.2 Lightly lubricate the selector shaft with a light oil.

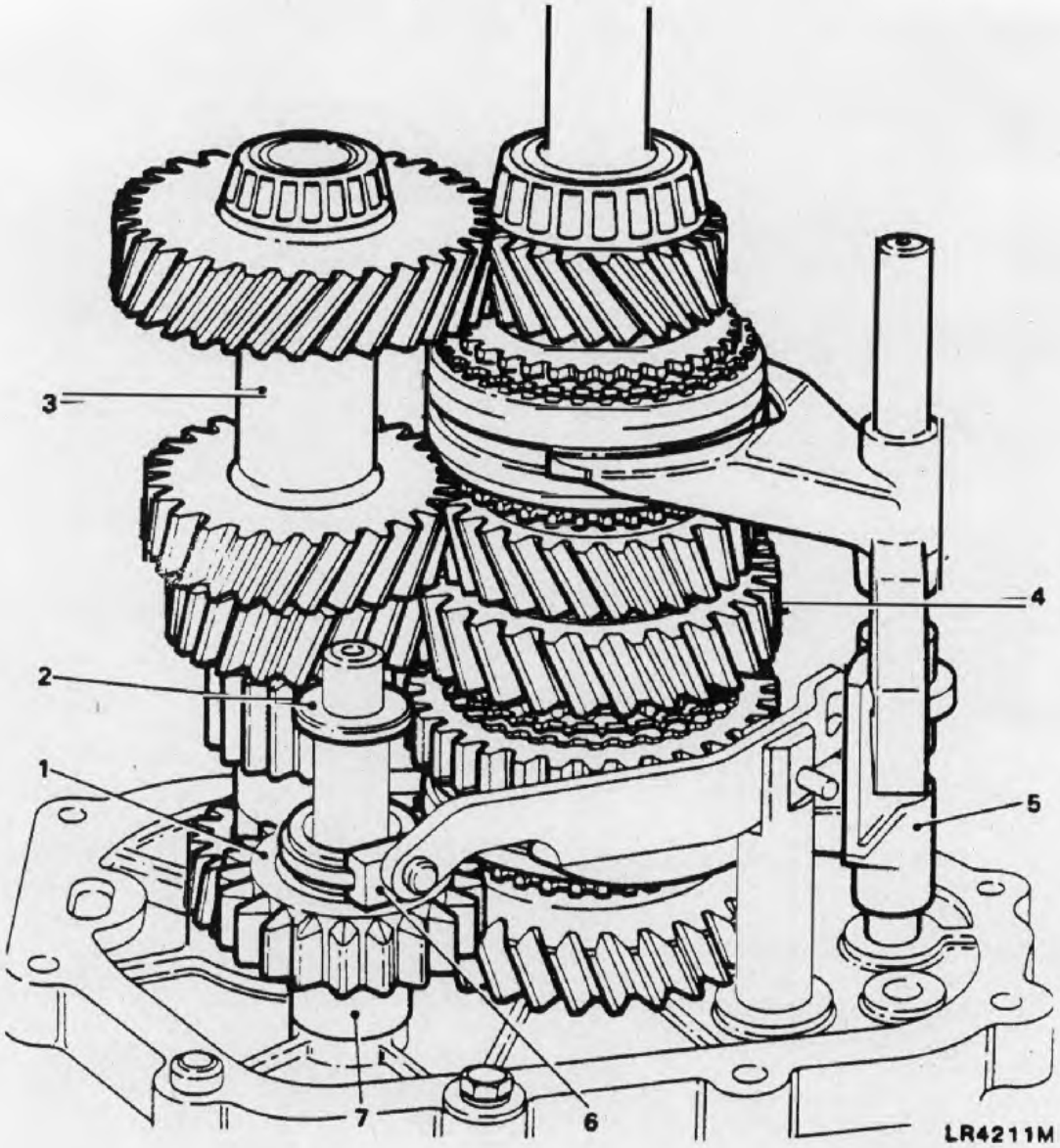
31.3 Take the selector shaft complete with the first and second gear selector fork, front spool and third and fourth gear selector fork. Engage both selector forks with their respective synchromesh assemblies on the mainshaft, simultaneously engaging the selector shaft and mainshaft assemblies in the centre plate (Fig 30), whilst rotating the fifth gear selector pin to align with the slot in the centre plate.

31.4 Fit the layshaft to the centre plate (Fig 30).

31.5 Rotate the selector shaft and spool to enable the reverse crossover lever forks to correctly align to the reverse pivot shaft.

31.6 Reposition the selector shaft and locate the lever between the fork on the reverse gear pivot shaft. Insert the pivot pin and fit a new circlip, ensuring that it is not opened beyond the minimum necessary to pass over the shaft.

31.7 Fit the slipper pad to the reverse lever. If a new reverse lever pivot has been fitted, it will be necessary to ascertain that its radial location is consistant with the reverse pad slipper engagement-clearance. The radial location is determined during initial assembly.



1	Reverse gear assembly	5	Selector shaft assembly
2	Reverse gear spacer (front)	6	Slipper pad
3	Layshaft assembly	7	Reverse gear spacer (rear)
4	Mainshaft assembly		

Fig 30 Fitting mainshaft, selector shaft, layshaft, and reverse gear assemblies

31.8 Fit the reverse gear spacer (Fig 30 (7)) and reverse gear assembly (2), locating the slipper pad lip (6) to the reverse gear groove.

31.9 Fit the reverse gear shaft from the underside of the centre plate, nsuring the roll pin is aligned with the slot in the centre plate casing. S cure the shaft with the locally manufactured retainer (Fig 4).

31.10 Lubricate the detent ball and spring with light oil, and fit to the top of the centre plate. Smear Hylomar PL32 or Loctite 290 to the plug threads and screw in the plug flush with the case. Stake the plug to prevent rotation using a suitable centre punch.

31.11 Remove the slave bolts.

31.12 Fit the fourth gear synchromesh baulk ring (Fig 23 (5)) to the third and fourth gear synchromesh assembly, the input shaft (1) to the main shaft, reverse gear spacer (Fig 30 (2)) to the reverse gear and fit a new gasket to the centre plate.

Main gearbox casing

32 To assemble the main gearbox casing carry out the following:

32.1 Insert a new plastic oil trough (Fig 31) to the back of the casing, ensuring the open trough faces the top of the casing.

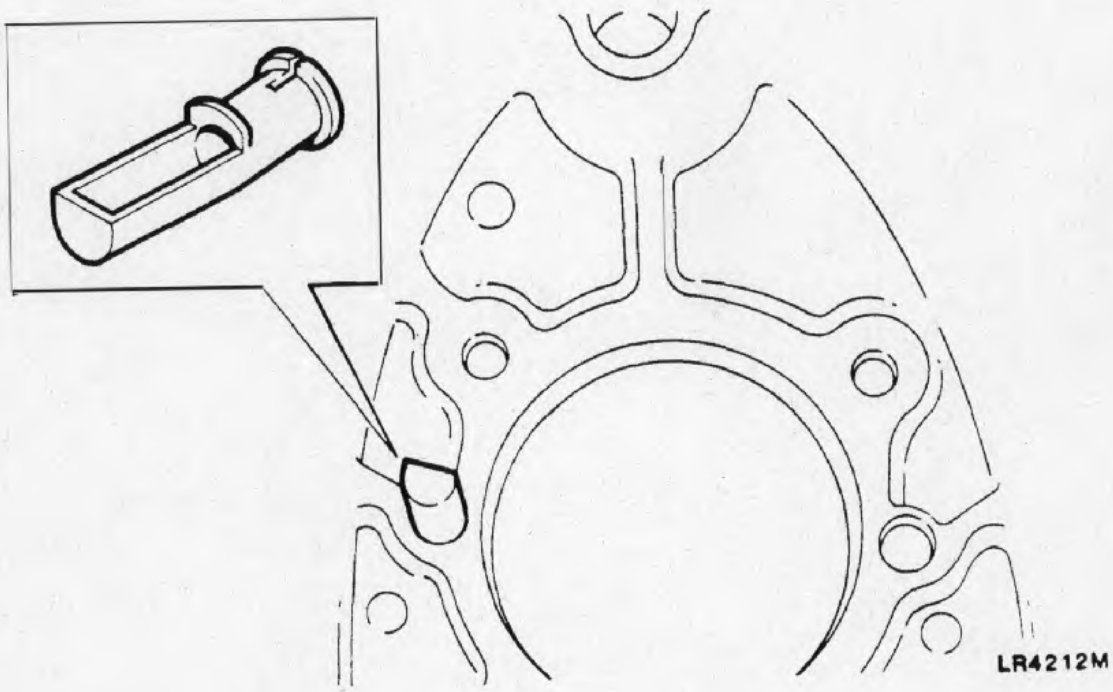


Fig 31 Oil trough location in main casing

32.2 Fit the two locally manufactured guide studs (Fig 5) into the casing, one at each side (Fig 32), then carefully lower the casing over the assembled gear train ensuring the centre plate dowels and selector shaft are engaged in their respective locations.

32.3 Using M8 x 35 mm slave bolts and plain washers, to prevent damaging the rear face of the centre plate, evenly draw the gearcase into position on the plate.

32.4 Fit the front spool retainer to the top of the gearcase using Hylomar PL32 to seal between the gearbox and flanges. Later models are fitt d with an 'O' ring seal, on these models the application of sealant is not necessary. Apply Loctite 290 or Hylomar PL32 to the securing bolt threads, fit the bolts and spring washers and tighten to a torque of 7 to 10 Nm (5 to 7 lbf ft).

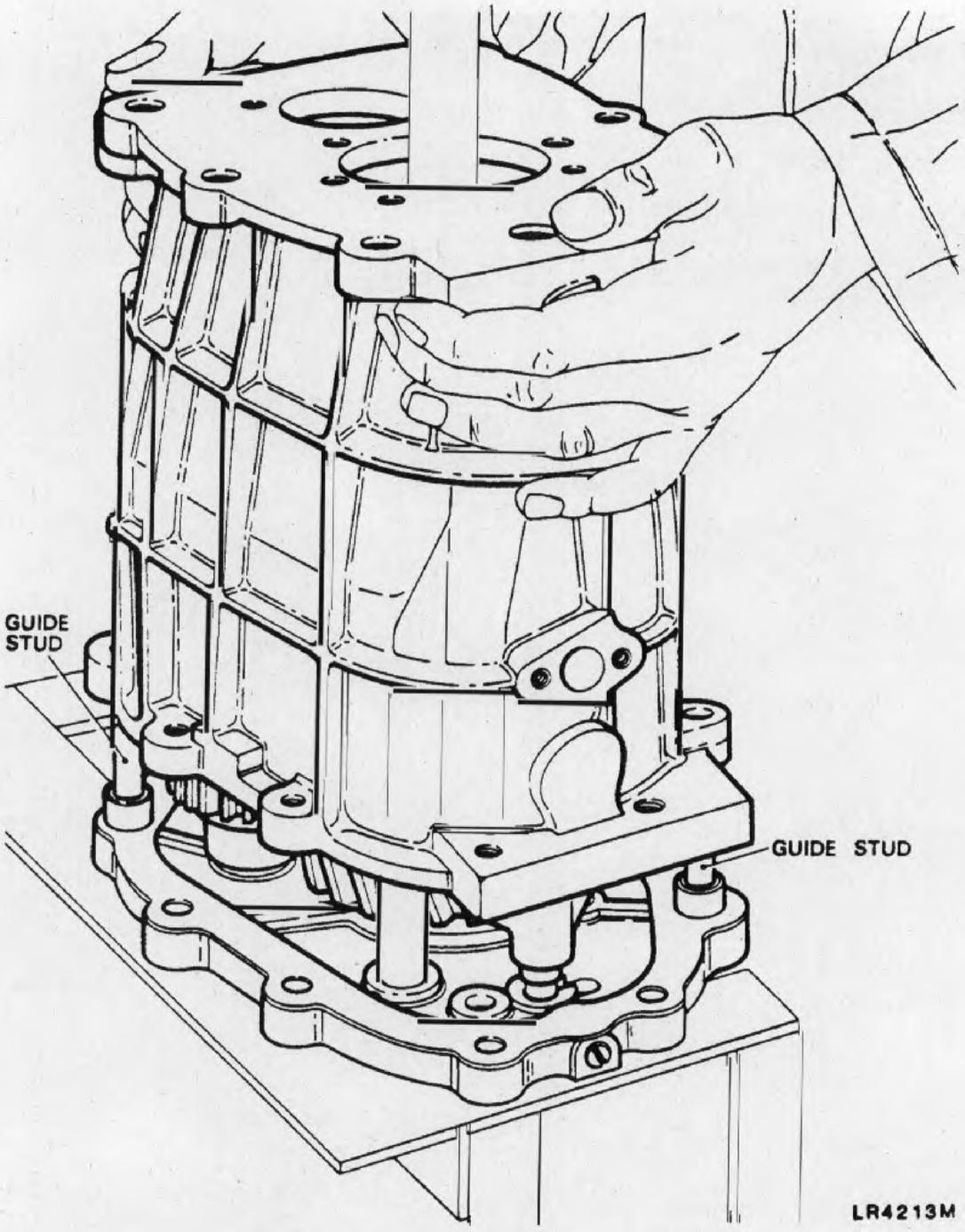


Fig 32 Main casing guide stud location

CAUTION ...

It is essential that the gear selector rail is not rotated or disturbed in any way during the remainder of the assembly, as it is possible for the selector to disengage from the selector forks. should disengagement occur, the main casing and centre plate will have to be dismantled.

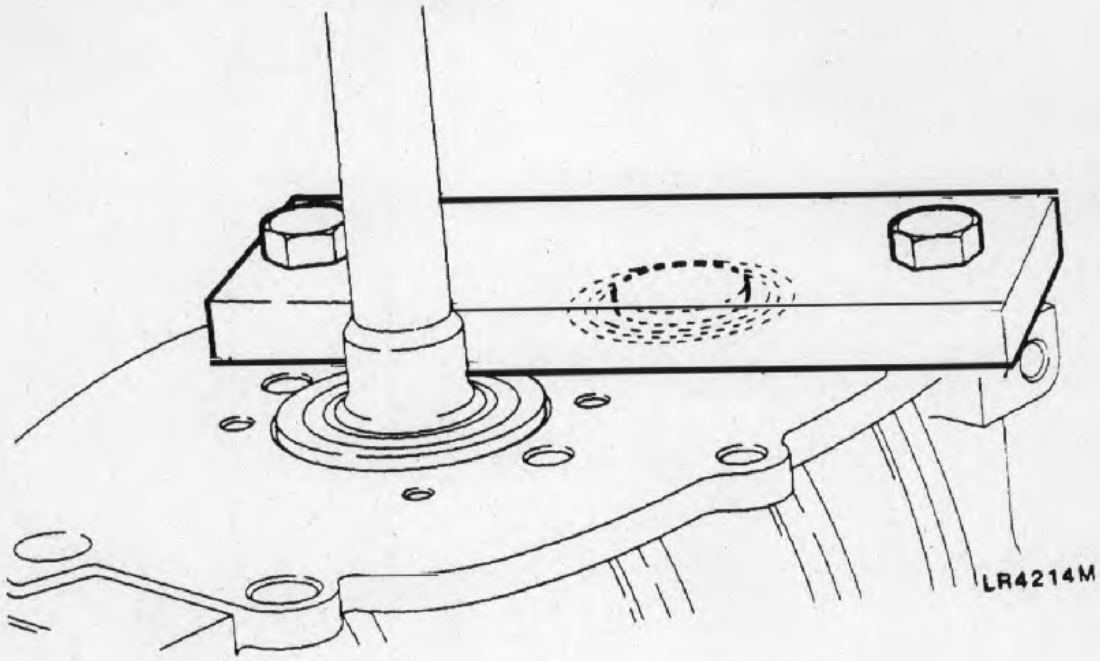


Fig 33 Fitting layshaft support plate

32.5 Fit the layshaft and input shaft bearing outer tracks.

32.6 Fit the locally manufactured layshaft support plate and spacer (Fig 3), using two M8 x 25 mm bolts and washers, with the spacer situated between the support plate and layshaft (Fig 33). The support plate also retains the input bearing outer track.

32.7 Remove the bolt securing the casing to the workstand, invert the complete assembly and resecure to the stand. Remove the reverse gear shaft retainer from the centre plate.

32.8 Fit the fifth gear (Fig 34) to the layshaft, using special tool (Serial No 10), ensuring that the annular extraction groove is toward the rear and fit a new special nut. Tighten the nut finger tight only at this stage.

32.9 Fit the fifth speed gear collar (Fig 35 (1)), needle roller bearing (2), fifth speed gear (3) and the baulk ring (4) to the main shaft.

32.10 Using special tool (Serial No 11) fit the fifth gear synchromesh assembly ensuring that the inner member seats against the shoulder on the main shaft.

32.11 Fit a slave spacer with an oversize bore to the rear of the synchromesh assembly and temporarily secure with the circlip.

32.12 Measure the clearance between the spacer and the circlip (Fig 36), which should be between 0,005 and 0,055 mm. Select the appropriate spacer from the range available (Cat 721) to give the required clearance.

32.13 Remove the slave spacer, fit the selected spacer and a new circlip.

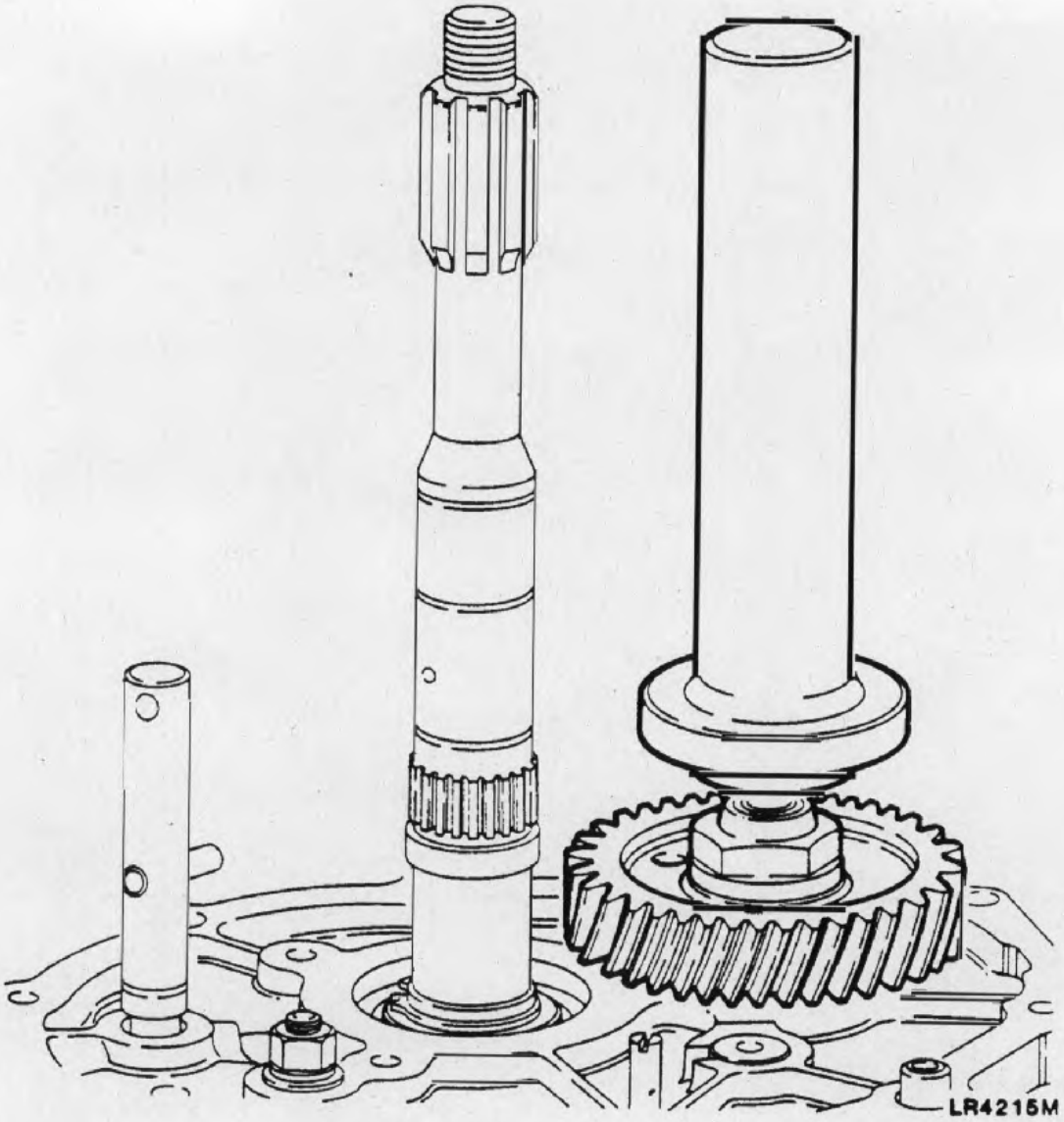


Fig 34 Fitting the fifth speed layshaft gear

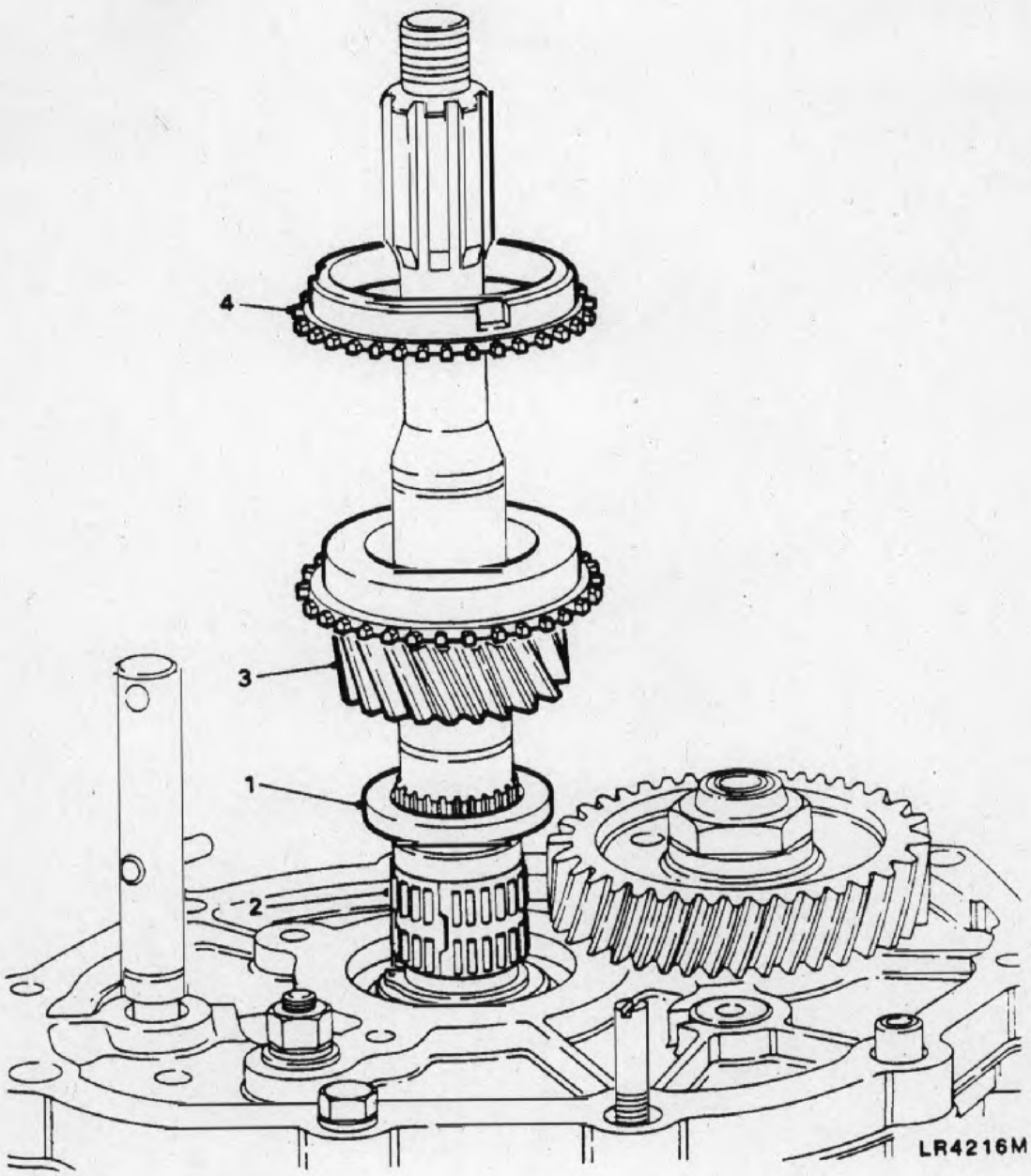
Mainshaft and layshaft end-float

33 To measure and adjust the mainshaft and layshaft end-float, remove the layshaft support plate and proceed as follows:

Not ...

When ascertaining the mainshaft end-float care must be taken when checking the dial gauge readings to ensure that the end-float only, as distinct from side movement is recorded. To assist in differentiating between end-float and side movement, wrap approximately ten turns of masking tape around the plain portion of the input shaft below the splines. Ensure that the rise and fall of the input shaft is not restricted by the tape.

33.1 Place a mainshaft and layshaft spacer of nominal thickness 1,02 mm on the mainshaft and layshaft bearing tracks, fit the front cover and gasket, secure with the bolts and spring washers and tighten the bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).



1 Collar
2 Needle roller bearing
3 Fifth speed gear
4 Baulk ring

Fig 35 Fitting the fifth gear and synchromesh baulk ring

33.2 Invert the gearbox on the stand and rotate the mainshaft to correctly seat the bearing.

33.3 Place a suitable ball bearing in the mainshaft centre and mount a dial gauge on the gearcase with the stylus resting on the ball bearing centre. Zero the gauge.

33.4 Check the end-float by a push-pull action to the main shaft. The required mainshaft end-float measurement should be between 0,01 to 0,06 mm (0.0004 to 0.002 in) with no pre-load.

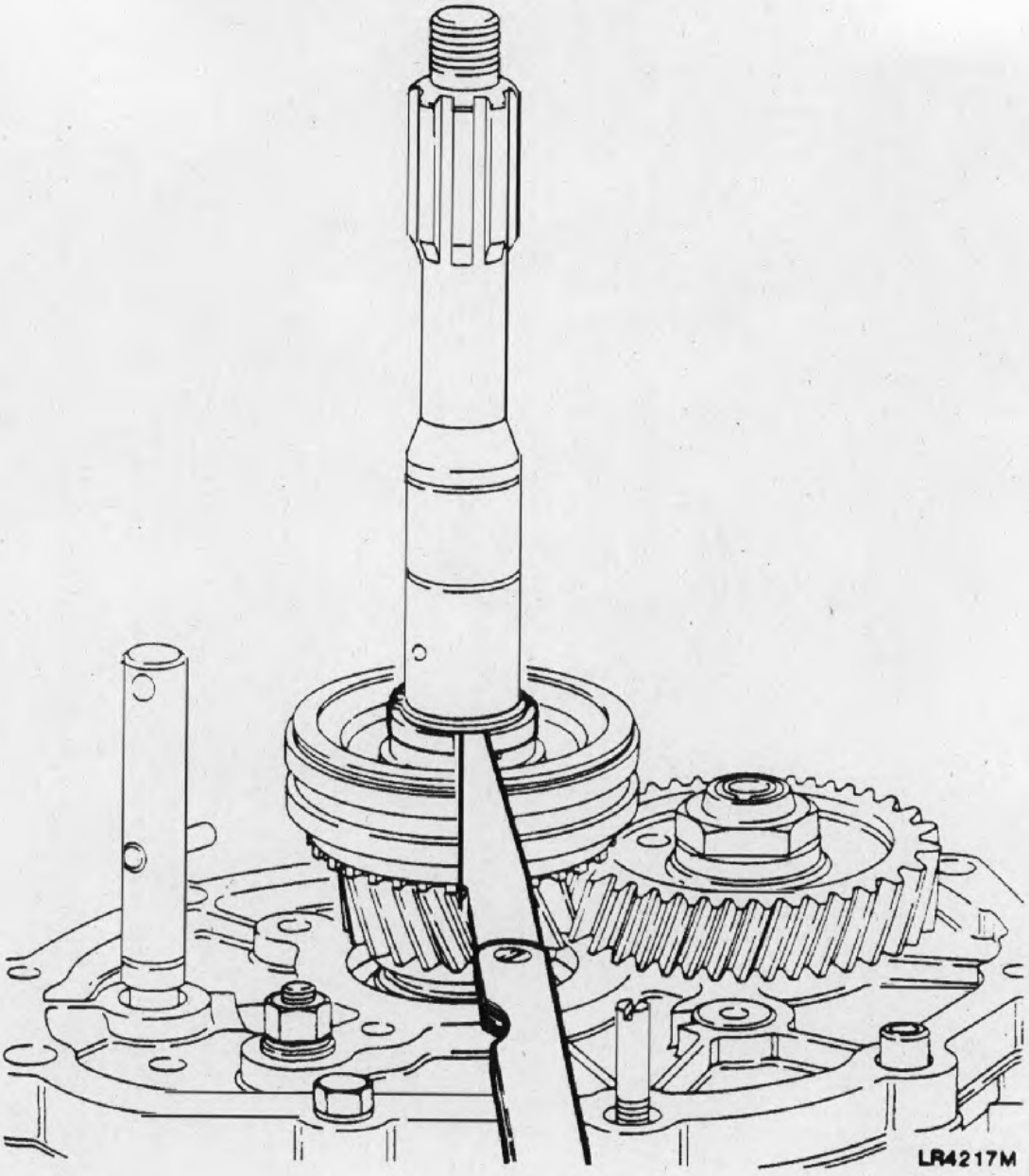


Fig 36 Measuring clearance between the spacer and circlip

33.5 Select from the range of spacers available (Cat 721) an appropriate spacer to give the specified mainshaft end-float. Remove the dial gauge and ball bearing.

33.6 Rotate the layshaft to correctly seat the bearing.

33.7 Place a suitable ball bearing in the layshaft centre and mount the dial gauge on the gearcase, with the stylus resting on the ball bearing c ntre. Zero the gauge.

33.8 With the aid of levers approximately 23 cm long, to prevent component damage, check the end-float by a gentle push-lift action. The required layshaft setting is 0,025 mm (0.001 in) end-float, 0,025 mm (0.001 in) pre-load.

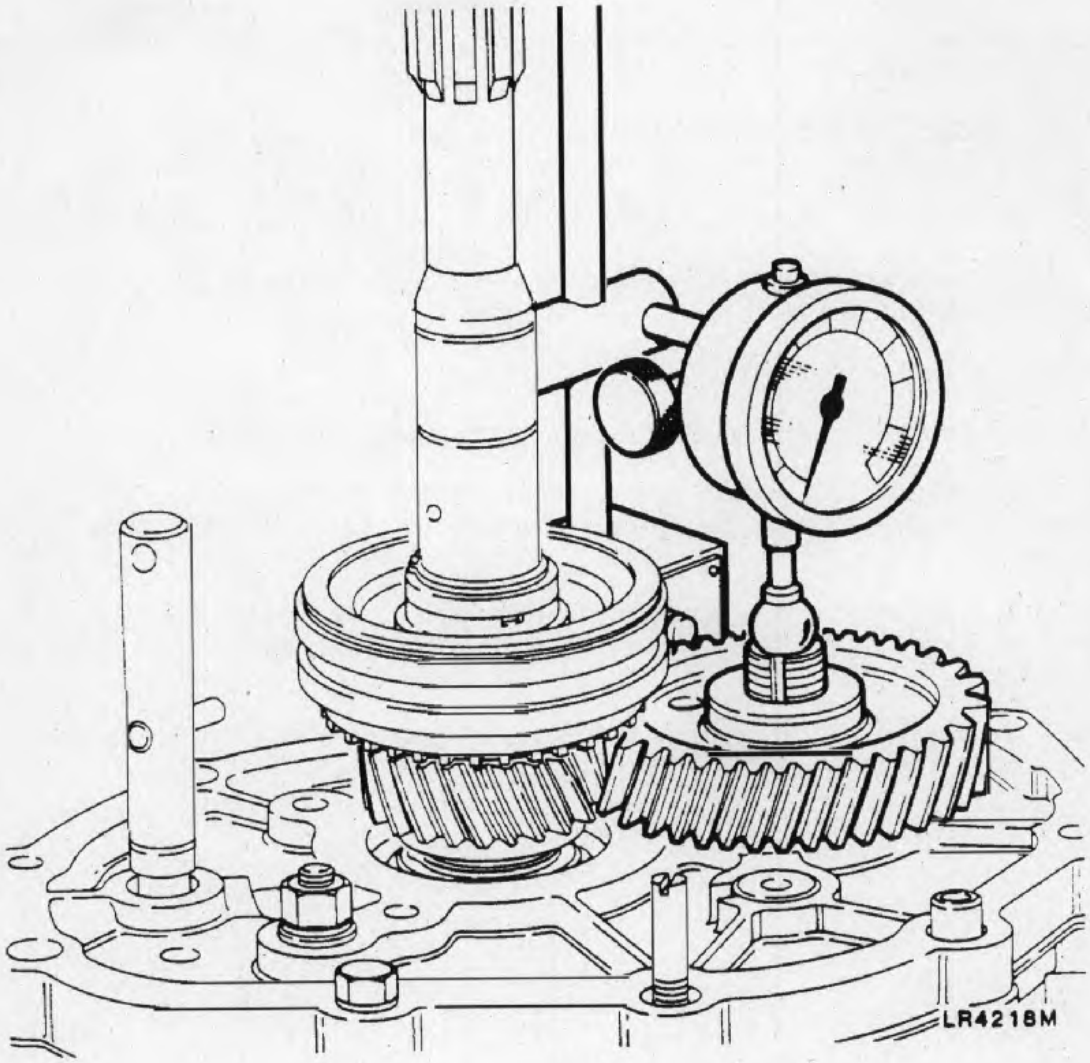


Fig 37 Checking layshaft end-float

33.9 The spacer thickness required equals, the nominal thickness of the spacer, plus the end-float measurement obtained. Remove the gauge and ball bearing.

33.10 Select from the range of spacers available (Cat 721) an appropriate spacer to give the specified layshaft end-float.

33.11 Having ascertained the mainshaft and layshaft end-float, remove the front cover and fit selected spacers to the mainshaft and layshaft bearing tracks.

33.12 Fit a new oil seal to the front cover, ensuring that the seal lips face towards the gearbox. Lubricate the seal lips with SAE 140 gear oil.

33.13 Mask the splines of the main shaft with masking tape to protect the oil seal,refit the front cover and remove the spline masking tape.

33.14 Refit the bolts and spring washers having coated the threads of the bolts with Hylomar PL 32 or Loctite 290. Tighten the bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).

33.15 Invert the g arbox on the stand and remove th guide studs fitted to the centre plate.

33.16 Select reverse gear by turning the selector rail anti-clockwise and pulling rearwards. Move the fifth speed synchromesh hub into mesh with the fifth gear. Tighten the fifth gear layshaft nut to a torque of 204 to 231 Nm (150 to 170 lbf ft) stake the nut using a suitable round nosed punch.

33.17 Return the gear train to neutral by pushing the selector rail inwards and turning clockwise.

Fifth gear selector fork assembly

34 To fit the fifth gear selector fork proceed as follows:

34.1 Fit the selector fork and bracket to the fifth gear synchromesh hub assembly, ensuring that the largest groove lip is facing the rear of the gearbox.

34.2 Fit the fifth gear spool to the selector shaft with the longer shoulder toward the gearbox, rotate and engage the selector fork into the groove.

34.3 Secure the bracket with the bolts and spring washers and tighten the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

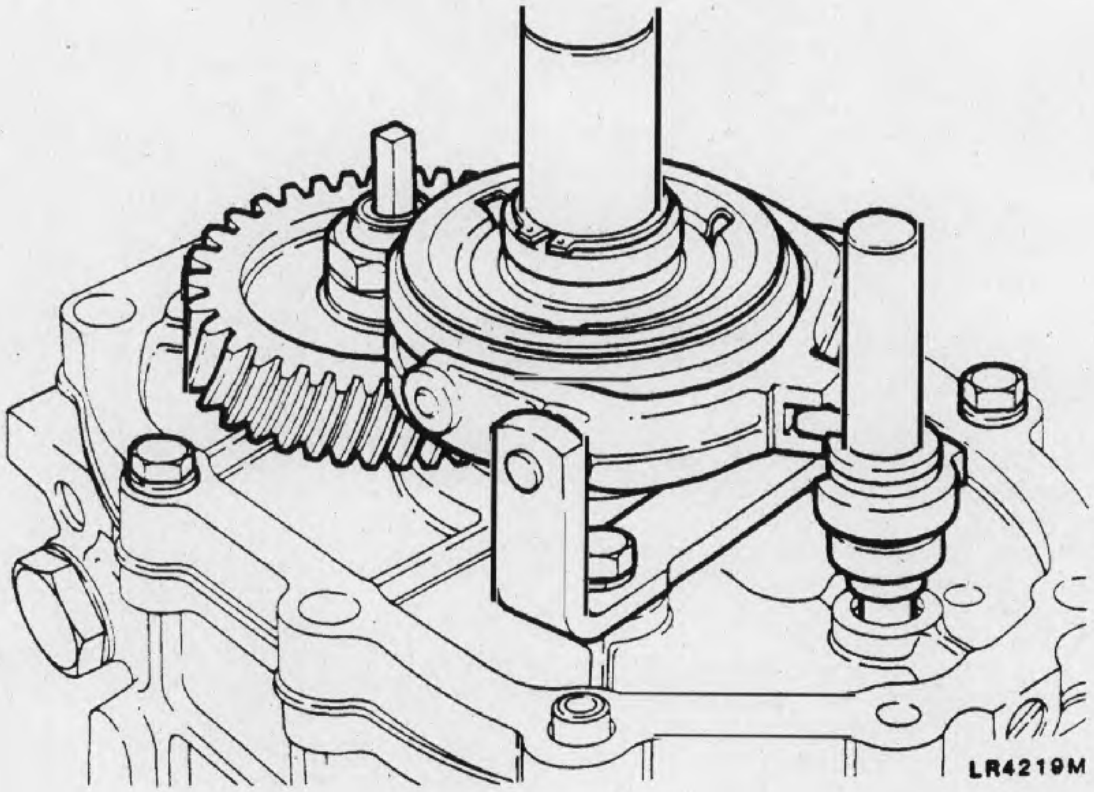


Fig 38 Fitting fifth gear selector fork

34.4 Fit a new circlip to the selector shaft ensuring that it is not expanded beyond the minimum n cessary.

34.5 Remove the slave bolts securing the centre plate to the main casing.

34.6 Position the gearbox assembly horizontally and fit the oil pump drive shaft to its location in the end of the layshaft.

Extension case (fitting)

35 To fit the extension case proceed as follows:

35.1 Fit a new gasket to the centre plate.

35.2 Rotate the oil pump, in the extension casing, to align the shaft location with the shaft.

35.3 Carefully fit the extension case ensuring that the oil pump drive shaft engages with the oil pump. Secure the extension case with the bolts and spring washers and tighten the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

35.4 Using a large screwdriver, ease the selector shaft forward to select a gear. It may be found necessary to rotate the mainshaft to ease gear selection.

35.5 Fit the selector yoke to the selector shaft and secure with a new roll pin. Pull the selector shaft rearwards to select a neutral position.

35.6 Cover the mainshaft splines with masking tape and fit a new oil seal collar 'O' ring seal. Remove the masking tape.

35.7 Using special tool (Serial No 11) fit the oil seal collar to the mainshaft, ensuring the collar is not pushed too far on the shaft, fit only with sufficient clearance to allow the spring ring to engage in its groove.

35.8 Fit a new gasket to the top of the extension case and fit the gear change housing by engaging the male selector yoke with the female yoke. Align the housing locating dowels and fit the housing. Secure with the three bolts and washers and tighten the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

Bell housing

36 To fit the bell housing proceed as follows:

36.1 Locate the bell housing with the hollow dowels fitted to the front face of the main casing and fit the two long bolts (M12 x 45 mm) with spring and plain washers to the dowel locations. Fit the remaining four bolts (M12 x 30 mm) with spring washers only and tighten all six bolts to a torque of 65 - 80 Nm (48 - 59 lbf ft).

36.2 Fit the clutch release lever pivot and secure with the bolts and spring washers, tighten the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

36.3 Prior to reassembly lubricate the following items with a thin film of molybdenum disulphide grease:

36.3.1 Clutch release lever fulcrum pivot socket.

36.3.2 The clutch release lever slipper pad pins and the faces of each slipper pad.

36.3.3 Ball ends of the clutch operating rod.

36.4 Fit the slipper pads to the clutch release lever and locate the lever socket on the pivot.

36.5 Lubricate the inner face of the clutch release bearing carrier with molybdenum disulphide grease and fit to the front cover spigot, locating the slipper pads to the carrier recesses. Fit a new carrier clip.

36.6 Refit the gearbox oil level and drain plugs, using a new fibre washer with the drain plug. Tighten both plugs to a torque of 25 - 35 Nm (19 - 26 lbf ft).

Reverse gear plunger (assembly)

37 To assemble the reverse gear plunger carry out the following:

37.1 Prior to assembling lubricate the short spring and plunger with BP Energrease L2 or a suitable alternative.

37.2 Fit the short spring (Fig 9 (7)) into the plunger base (6), slide the assembly into the housing (4) and retain with a new circlip (5) if fitted.

37.3 Ensure the spring is not trapped, the detent groove should be fully visible down the bore.

37.4 Lubricate the detent ball (3) with light oil and fit to the bore in the housing (4) followed by the long spring (2).

37.5 Coat the threads of the plug (1) with Loctite 290 or Hylomar PL 32 fit the plug to the housing and tighten to a torque of 22 - 28 Nm (16 - 21 lbf ft).

Gear selector housing

38 To assemble and fit the gear selector housing proceed as follows:

38.1 Fit the rollers (Fig 8 (8)) and pin (7) to the selector quadrant (5) and secure with a new circlip (5).

38.2 Lubricate the selector housing shaft with light oil and fit a new 'O' ring seal.

38.3 Insert the shaft in the selector housing, through the large blanking plug orifice, ensuring that the yoke securing screw location at the end of the shaft is uppermost.

38.4 Place the selector housing in a vice having soft jaws and fit the selector quadrant to the shaft and secure with a new roll pin. On completion remove the housing from the vice.

38.5 Coat the threads of th two blanking plugs (Fig 6 (7 and 8)) with Loctite 290 and fit them to their respectiv locations in the selector housing. Tighten the large blanking plug to a torque of 25 - 35 Nm (19 - 26 lbf ft) and the smaller one to 20 - 27 Nm (15 - 20 lbf ft).

38.6 Fit the fifth gear spool retainer (Fig 8 (3)) to the selector housing, secure with bolts and spring washers and tighten the bolts to a torque of 7 - 10 Nm (5 - 7 lbf ft).

38.7 Fit the nylon seat (Fig 7 (5)) to the yoke (2) and secure with a new circlip (4).

38.8 Invert the selector housing and fit the yoke to the selector shaft, coat the threads of the securing screw (1) with Loctite 290, fit to the yoke ensuring correct engagement with the indent on the shaft (3). Tighten the screw to a torque of 22 - 28 Nm (16 - 21 lbf ft).

38.9 Fit the selector housing to the extension case with a new gasket interposed between the mating faces and ensuring correct location with the hollow dowels. Secure with bolts and spring washers tightening the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

38.10 Position a new gasket between the gear lever housing and selector housing. Secure the housings together with bolts and washers tightening the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

38.11 Fit the two bias spring adjustment screws (Fig 6 (28)) and locknuts (27). Place the bias spring (2) in position on the gear lever housing (24) and retain with a new roll pin (1).

38.12 Coat the upper and lower spheres of the gear lever shaft (29) with Duckhams Q 5848 or Shell Alvania R1 grease, fit the spring (25) and plunger (25). Ensure that the plunger is facing the front, install the lever in its housing and secure with the special washer (4) and screw (3).

38.13 Fit the main gear lever and secure with its nut.

Reverse gear plunger (fitting)

39 To fit and adjust the reverse gear plunger assembly carry out the following:

39.1 Ensure that both legs of the bias spring are relaxed. Select first or second gear, it may be necessary to rotate the main shaft whilst manipulating the gear lever.

39.2 Locate the reverse gear plunger assembly on the right-hand side of the selector housing when viewed from the rear, apply light pressure on the gear lever to the left and gently screw in both the securing bolts a little at time by hand until the plunger is felt to contact the selector yoke.

39.3 Measure the clearance between the two mating faces (Fig 39). To the measurement obtained add 0,06 mm and select suitable thickness shims from the range available (Cat 721) to equal the total.

39.4 Fit the shims between the mating faces and secure the assembly to the housing with the spring washers and bolts, tighten the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

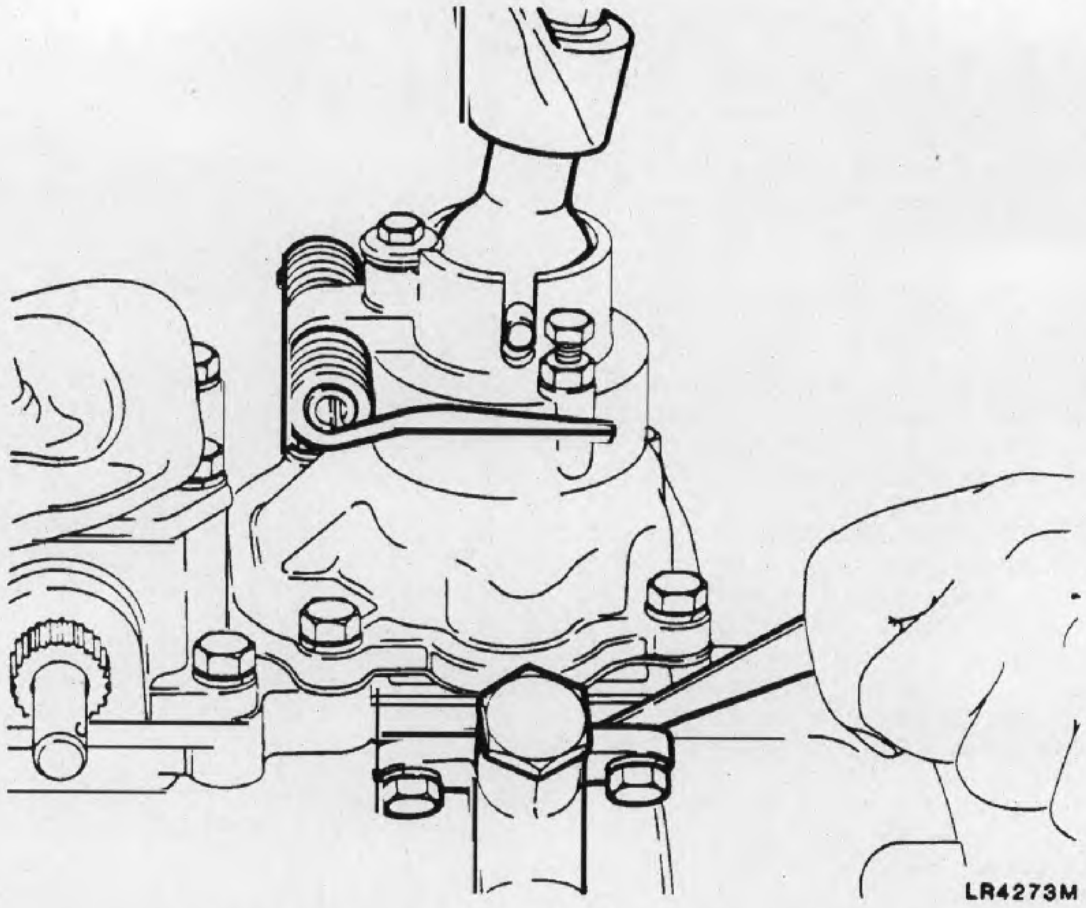


Fig 39 Setting reverse gear plunger assembly

Fifth gear stop

40 One of two types of fifth gear stop may be found on the gearbox. Earlier type gearboxes were fitted with a flanged stop shimmed and secured to the housing in a similar manner as the reverse gear plunger assembly. Later models of the gearbox are fitted with an adjusting screw and locknut.

41 If the gearbox being overhauled is fitted with the earlier type fifth gear stop (flanged type) the procedure for fitting and adjusting is as follows:

41.1 Loosely fit the stop plate to the selector housing without shims.

41.2 Select fifth gear and whilst applying light pressure on the gear lever to the left gently screw in both the securing bolts until the stop is felt to contact the selector yoke.

41.3 Measure the clearance between the two mating faces. To the dimension obtained add 0,06 mm and select suitable thickness shims from the range of available.

41.4 Fit the shims between the mating faces and secure the stop to the housing with the spring washers and bolts, tighten the bolts to a torque of 22 - 28 Nm (16 - 21 lbf ft).

42 If the fifth gear stop is of the later type (adjusting screw) carry out the following:

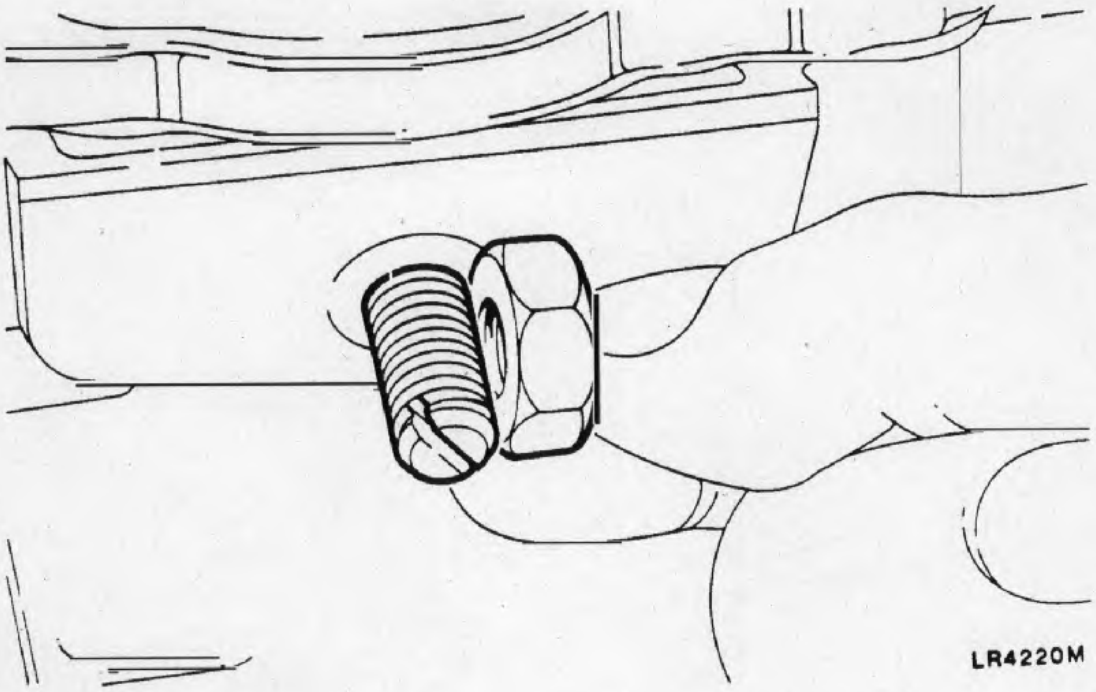


Fig 40 Setting fifth gear adjusting screw stop

42.1 Fit the adjusting screw (Fig (40)) to the selector housing, screw in until it protrudes from the housing approximately the diameter of the locknut.

42.2 Select fifth gear, apply light pressure on the gear lever to the left, turn the adjusting screw inwards until it is felt to contact the selector yoke, then turn the screw outwards one half of a turn and secure the setting with the locknut.

Bias spring adjustment

43 The object of this setting is to adjust both bolts so that the spring legs apply an equal pressure on each end of the lever cross pin when third or fourth gear is engaged. Thus ensuring that when the gear lever is in neutral the gear shift mechanism is automatically aligned for third and fourth gear selection. To carry out the setting proceed as follows:

43.1 Select fourth gear, using a suitable piece of tubing, locate the legs of the bias spring over the cross pin so that they rest on the adjustment screws.

43.2 Apply light pressure to the gear lever to the right (Fig 41) and adjust the left hand screw to give a clearance of 0,05 mm between the spring leg and the screw head. Push the gear lever in the opposite direction (to the left) and adjust the right hand screw and spring leg to the same clearance value. Tighten both locknuts when the clearance is set equal.

43.3 Return the gear lever to the neutral position and rock across the gate several times. When released the gear lever should align with the third and fourth gear locations. If not repeat the adjustment procedure.

43.4 Remove the gear lever, fit the rubber grommet and refit the gear lever.

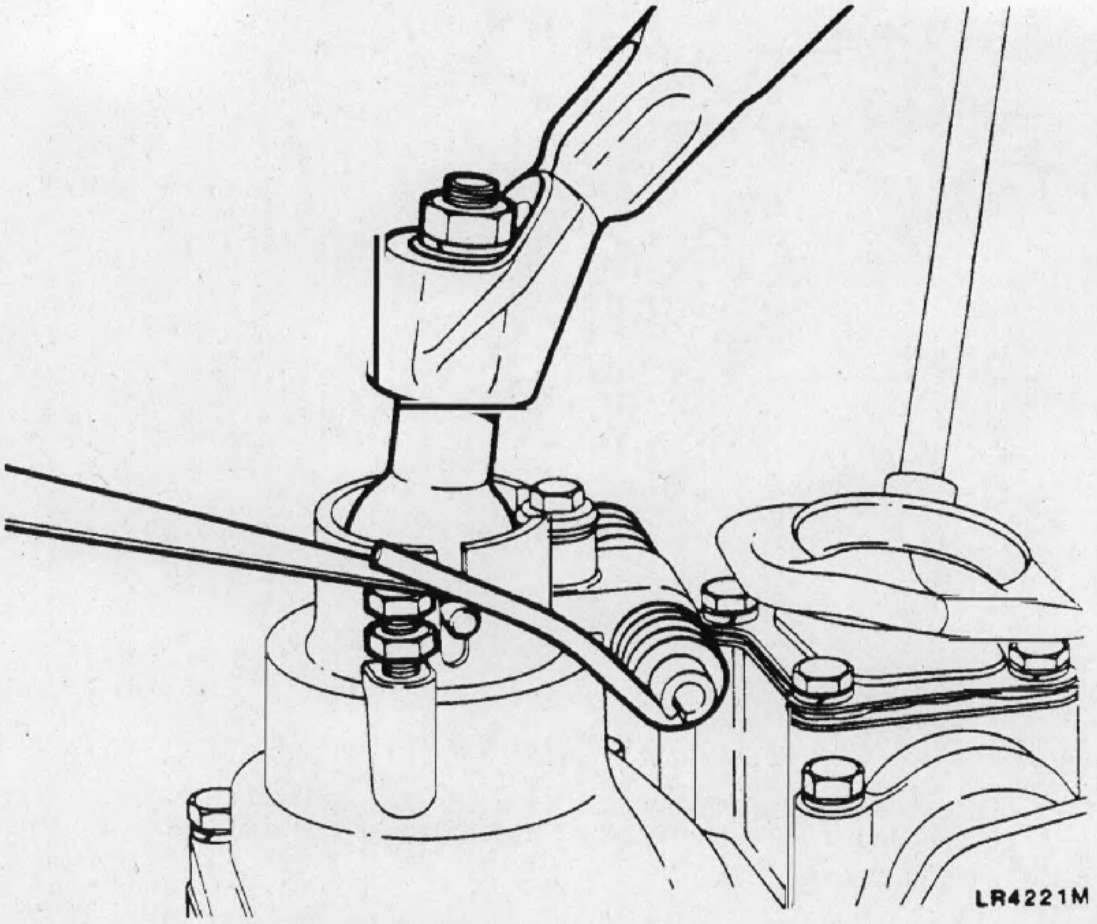


Fig 41 Bias spring adjustment

REFITTING

44 To refit the gearbox to the vehicle refer to Cat 522 Chap 3.

Chapter 3-2

LT85 PUMPED FIVE SPEED MANUAL GEARBOX

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the LT85 Five speed manual gearbox fitted to Land Rover 127 vehicles.

Note ...

It should be noted that certain background detail (ie casings) of illustrations appearing in this Chapter may not represent the LT85 Pumped five speed manual gearbox. This will not detract from the main detail illustrated.

REMOVAL

2 For removal of gearbox from the vehicle refer to Cat 522 Chap 3-2.

SPECIAL TOOLS

3 The special tools listed in the following table will be referred to in the text when used, by the serial number shown in the table.

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	Designation (3)
1	18G 1294	Guide studs
2	18G 1400	Two legged puller
3	18G 1431	Replacer, mainshaft bearings
4	MS 284	Slide hammer
5	MS 550	Driver handle
6	LST 101	Gauge, first gear end float
7	LST 102	Remover/replacer, mainshaft rear oil seal
8	LST 284-1	Adapter/remover, reverse idler shaft
9	LST 550-1	Adapter/remover/replacer, layshaft front bearing roller
10	LST 550-2	Adapter/remover/replacer, layshaft rear bearing outer track
11	LST 550-3	Adapter/remover/replacer, mainshaft front and rear bearing
12	LST 1431-1	Remover/replacer, front plate and mainshaft

LOCALLY MANUFACTURED TOOLS

4 The following locally manufactured tools are also recommended to assist in carrying out gearbox overhaul:

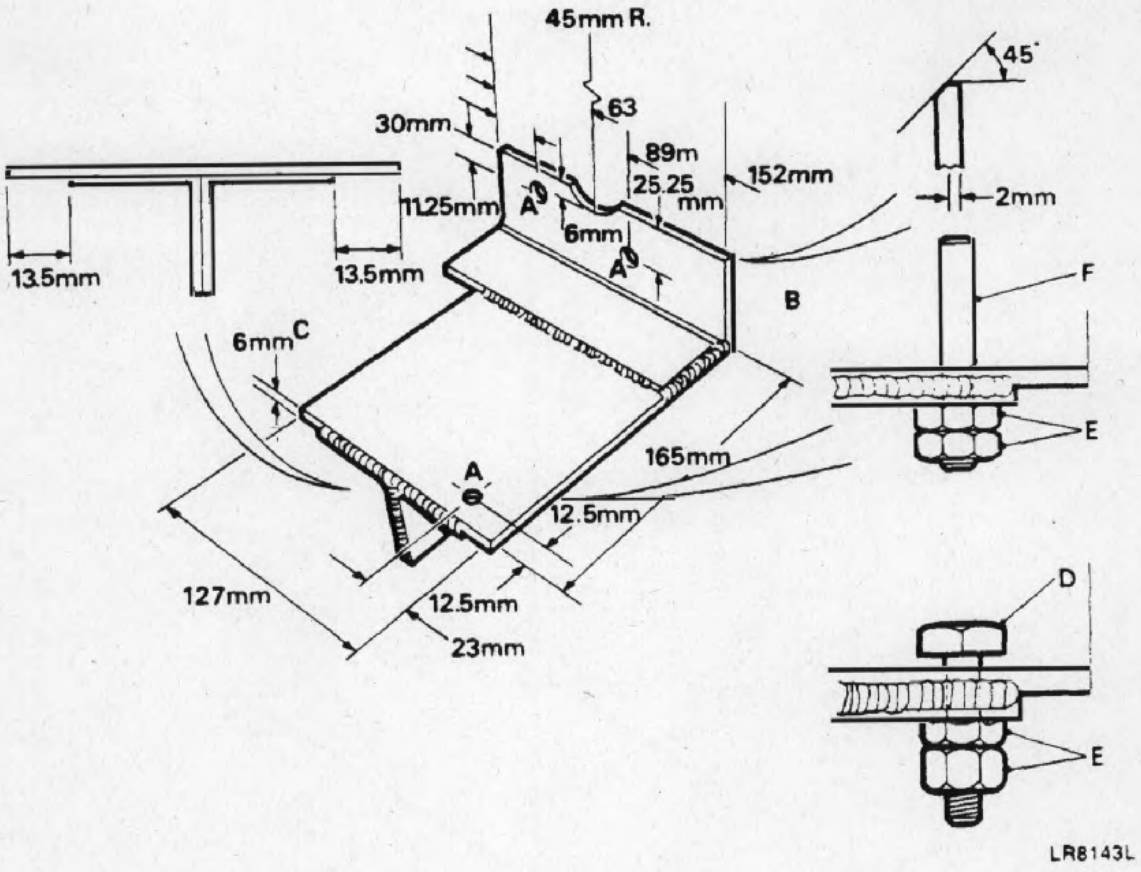
4.1 Stand for securing the gearbox in a vice (Fig 1).

4.2 Spacer for retaining layshaft rear bearing (Fig 2).

4.3 Two spacers for retaining front bearing plate (Fig 3). Dimension 'A' must not be more than 12 mm.

4.4 Selector detent spring retaining tool and spacers (Fig 4). Spacer 'A' can be made up from washers.

4.5 Gauge for reverse cross-over lever adjustment (Fig 5).



A 11 mm dia. holes
B Make from 50 mm x 6 mm angle
C Make from 6 mm plate
D 10 mm dia. bolt (hex. head)
E 10 mm nuts
F 10 mm dia. stud x 70 mm with 25 mm of thread for adjustment. (LT85 Divided case gearbox only)

Fig 1 Gearbox support stand

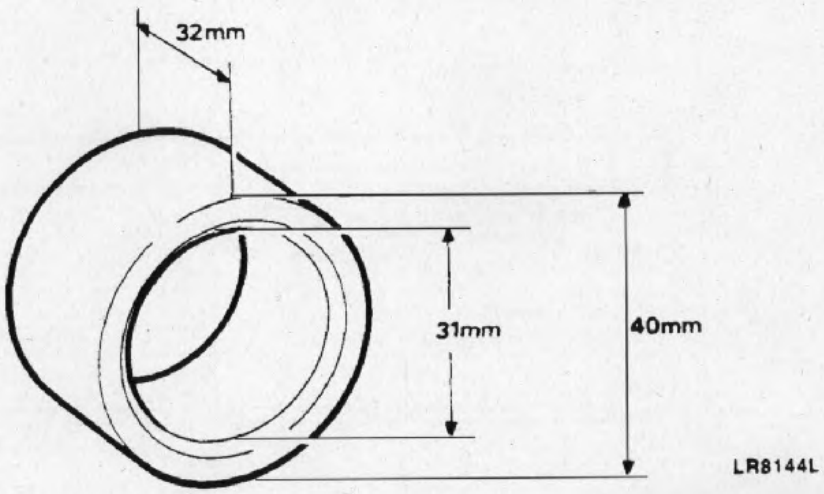


Fig 2 Layshaft rear bearing retaining spacer

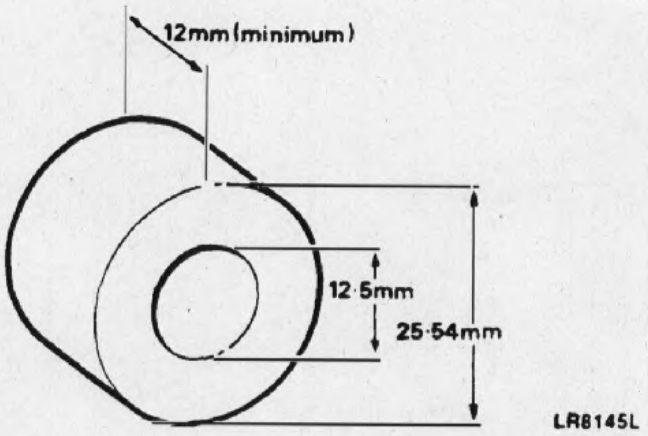


Fig 3 Front bearing plate retaining spacer

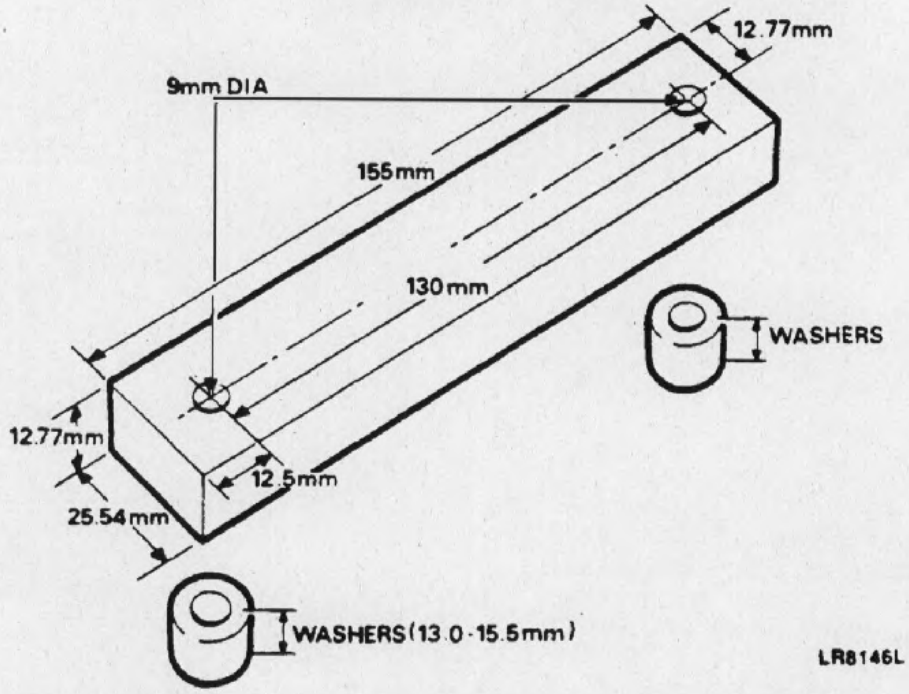


Fig 4 Selector detent spring retaining tool and spacers

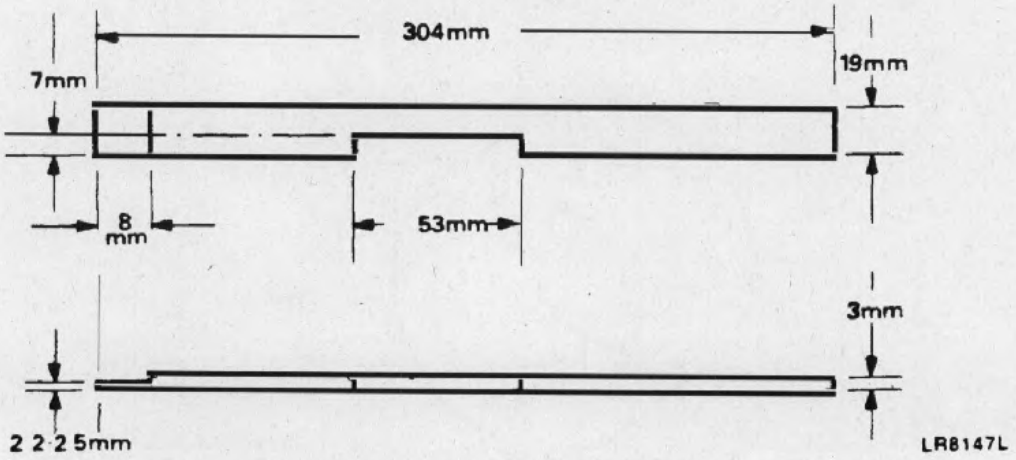


Fig 5 Cross-over lever adjustment gauge

Dismantling

5 Place the gearbox on a suitable work bench with the transfer box removed and support with a suitable wooden block. Ensure the gearbox oil has completely drained. Before overhaul commences it is recommended that the gearbox is fitted to a manufactured support stand (Fig 1) as follows:

5.1 Remove the four bolts and detach the LH mounting bracket.

5.2 Remove the extension housing (Para 6).

5.3 Fit manufactured stand to gearbox and secure with two bolts, nuts, spring and plain washers. Adjust the fixings 'D' and 'E' so that contact is made with the gearbox.

5.3 With assistance, fit the gearbox and stand into a vice and firmly secure.

Extension housing

6 To remove the extension housing from the main gearbox casing proceed as follows:

6.1 Remove the eight bolts, spring washers and single nut.

6.2 Carefully withdraw the extension housing squarely off the location dowels and manoeuvre over the mainshaft.

6.3 Remove and discard the gasket.

6.4 Invert the housing and remove the rear oil seal using a suitable drift.

6.5 Remove the drain plug, washer and filter.

Gear change lever assembly

7 To dismantle the gear change lever assembly proceed as follows:

7.1 Remove four bolts and spring washers (Fig 6 (3)) and lift bias spring housing (1) from gearbox.

7.2 Remove bias spring adjusting screws (2).

7.3 Remove bias springs and shims (4). Care should be taken when removing lower shims to avoid them slipping under gear lever pivot bar and into the gearbox.

7.4 Remove bias spring housing gasket (6).

7.5 Remove gear lever, complete with gaiter and nylon cup (5).

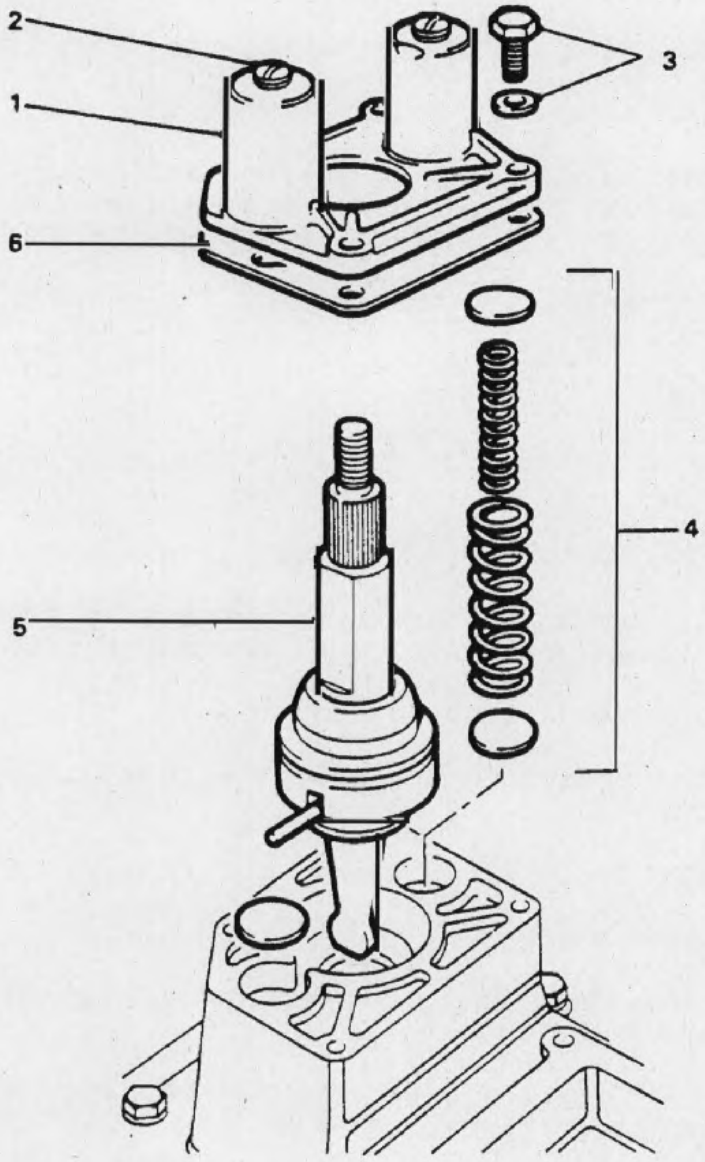
7.6 Remove breather pipe banjo union fixing bolt.

7.7 Remove the eight bolts and spring washers and lift top cover and breather pipes from gearbox.

7.8 Remove top cover filler plug.

7.9 Remove detent springs.

7.10 Remove top cover gasket.



1 Bias spring housing
2 Spring adjustment screw
3 Bolts and spring washers
4 Bias springs and shims
5 Gear lever assembly
6 Gasket

Fig 6 Gear change lever assembly dismantle

Bell housing and clutch release lever

8 To remove/dismantle the bell housing and clutch release lever proceed as follows:

8.1 Remove six bolts and washers and withdraw bell housing, complete with clutch release lever, sleeve and thrust bearing.

8.2 Remove the bell housing gasket.

8.3 Fit the two bell housing fixing bolts, with spacers to front bearing plate.

8.4 Remove clip (Fig 7 (1)) retaining thrust bearing carrier to clutch operating lever fork.

8.5 Withdraw thrust bearing (6) and carrier from sleeve.

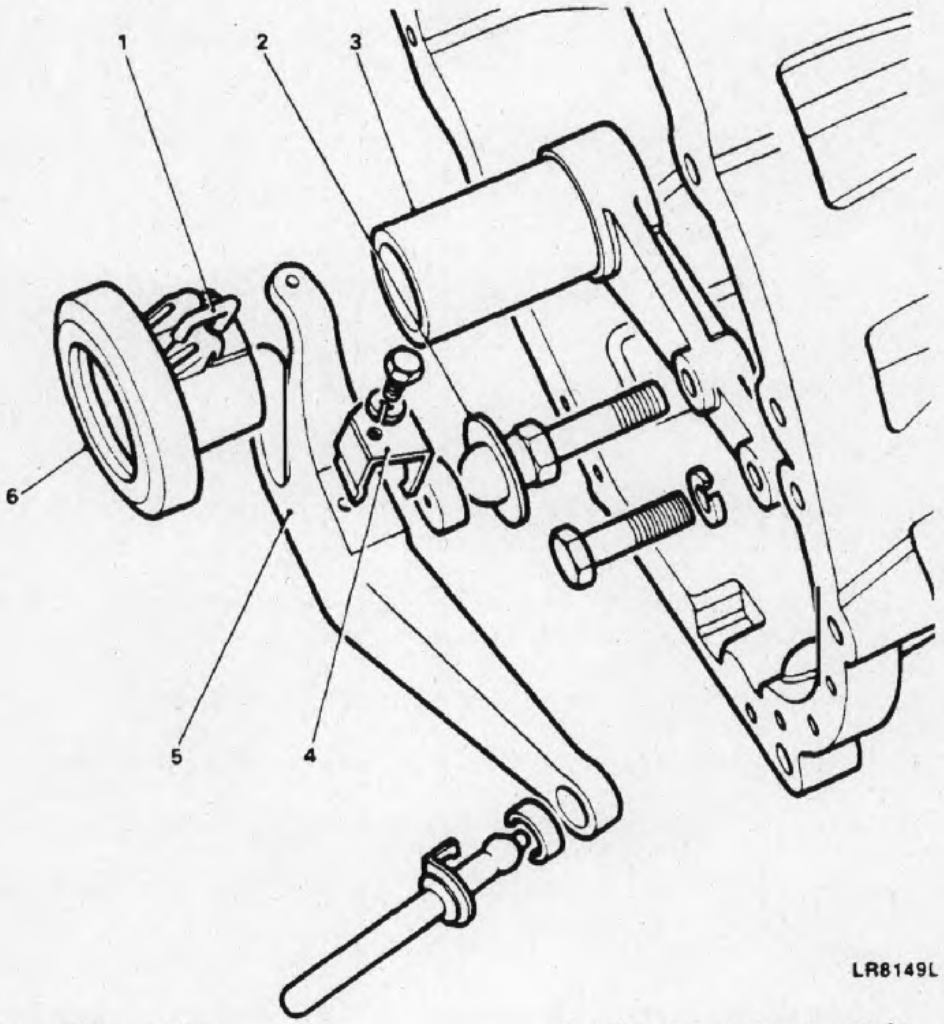
8.6 Remove bolt and spring washer securing operating lever pivot clip (4) to lever. Remove pivot clip.

8.7 Remove operating lever (5) and pivot slotted washer.

8.8 Remove operating lever pivot (2).

8.9 Unscrew single bolt and remove bearing sleeve (3) from bell housing.

8.10 Remove bearing sleeve dowels, if necessary.



1 Carrier clip
2 Lever pivot
3 Bearing sleeve
4 Lever pivot clip
5 Operating lever fork
6 Thrust bearing

Fig 7 Bell housing and clutch release lever removal

Selector rails and forks

9 To dismantle the selector rails and forks proceed as follows:

9.1 Using a suitable magnet withdraw the selector rail detent balls from drillings in gearbox. If detent balls are tight leave operation until after selector rails have been withdrawn, when the detent balls can be pushed down into the selector rail bore, then removed.

9.2 Release reverse gate spring (Fig 8 (2)) from knock-over lever and remove from reverse gear rail.

9.3 Raise knock-over lever and tap down reverse jaw roll-pin (1) until jaw is free on rail.

9.4 Remove clamp bolt (10) from reverse cross-over lever and withdraw reverse selector rail (11) and jaw from gearbox.

9.5 Remove split pin, washer and clevis pin (4) securing 5th gear selector rail to selector fork and bracket assembly.

9.6 Push selector rail forwards and tap down 5th gear jaw roll pin (6) until jaw is free on rail.

9.7 Withdraw 5th gear selector rail and jaw from gearbox.

9.8 Remove clamp bolt (8) from 3rd/4th selector fork and move selector rail forward.

9.9 Tap down 3rd/4th jaw roll pin (5) until jaw is free on selector rail.

9.10 Withdraw 3rd/4th selector rail and jaw.

9.11 Remove interlock from 3rd/4th selector rail.

9.12 Tap down 1st/2nd jaw roll pin (3) until jaw is free on selector rail.

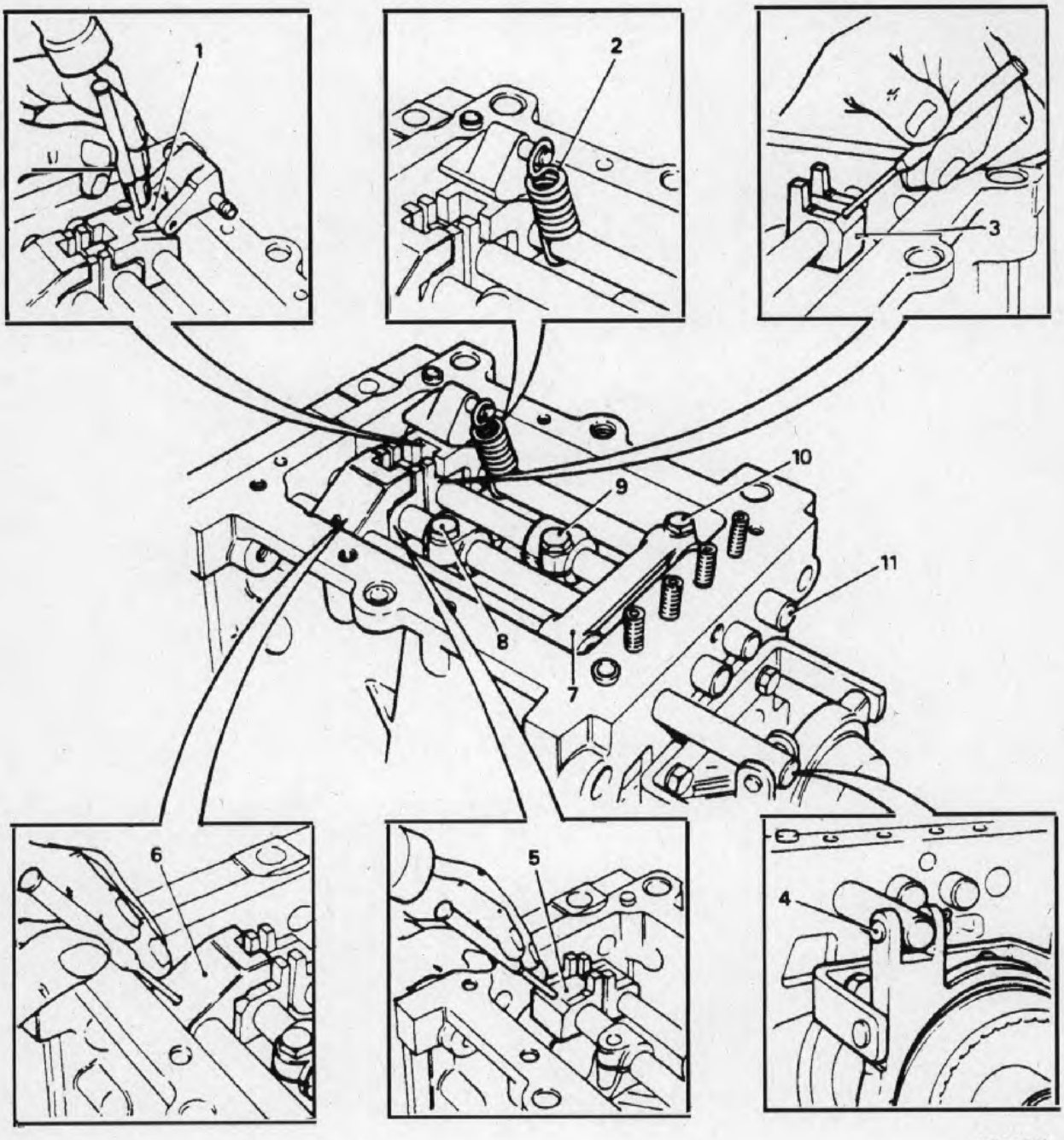
9.13 Remove clamp bolt (9) from 1st/2nd selector fork and withdraw 1st/2nd selector rail and jaw.

9.14 Remove interlock from 1st/2nd selector rail.

9.15 Lift reverse cross-over lever (7) from gearbox.

9.16 Remove 1st/2nd and 3rd/4th selector forks (Fig 9).

9.17 Remove interlock plungers (Fig 10 (2)) and also detent balls (1) if not removed in Para 9.1.



1 Reverse jaw roll pin
2 Reverse gate spring
3 1st/2nd jaw roll pin
4 Clevis pin
5 3rd/4th jaw roll pin
6 5th jaw roll pin
7 Reverse cross-over lever
8 Clamp bolt
9 Clamp bolt
10 Clamp bolt
11 Reverse selector rail

Fig 8 Selector rails and forks removal

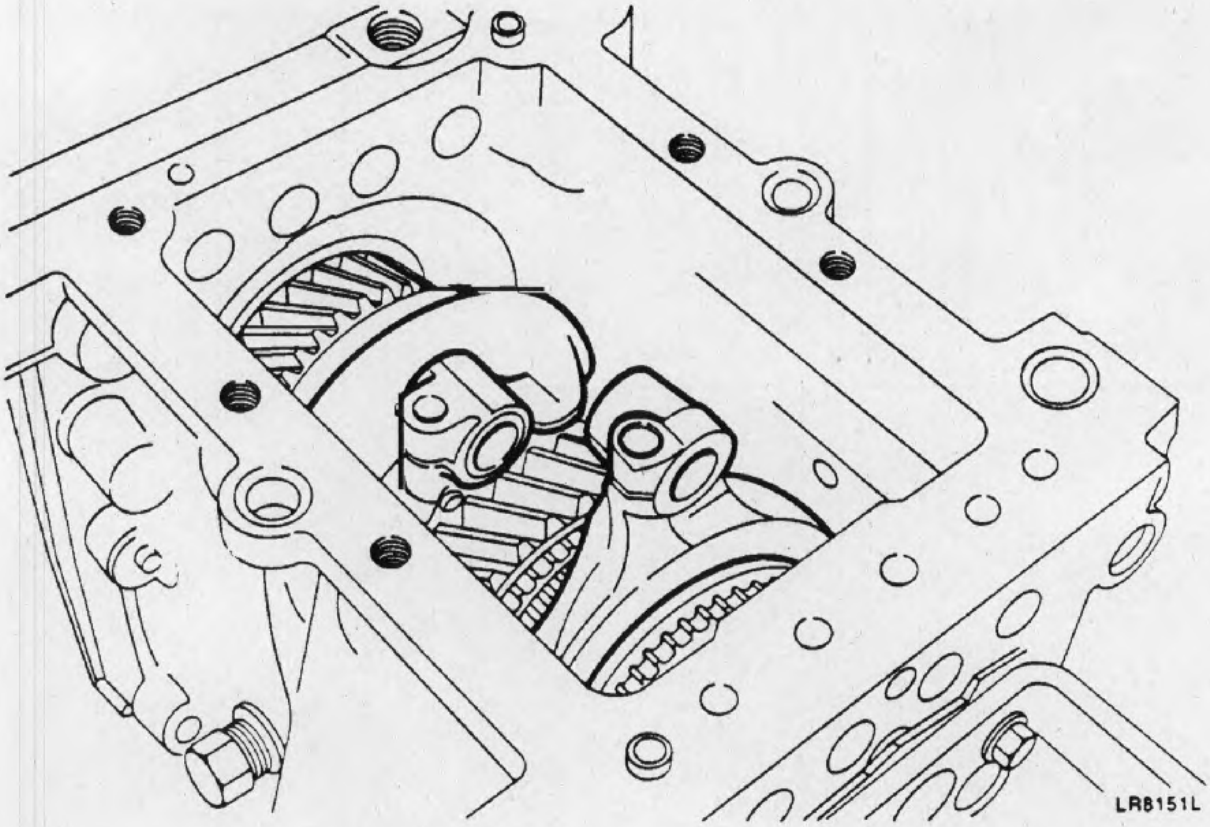
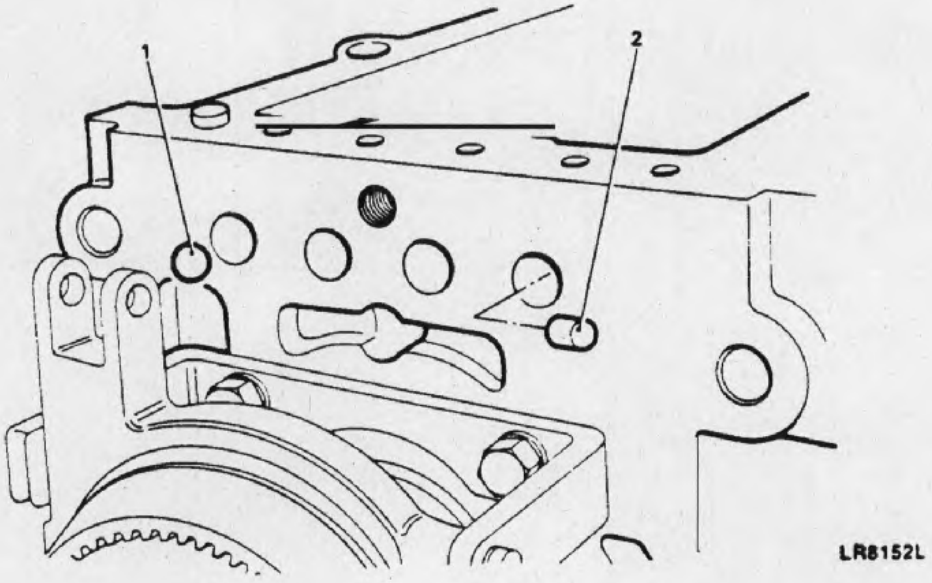


Fig 9 First/second and third/fourth gear selector fork removal



1 Detent ball

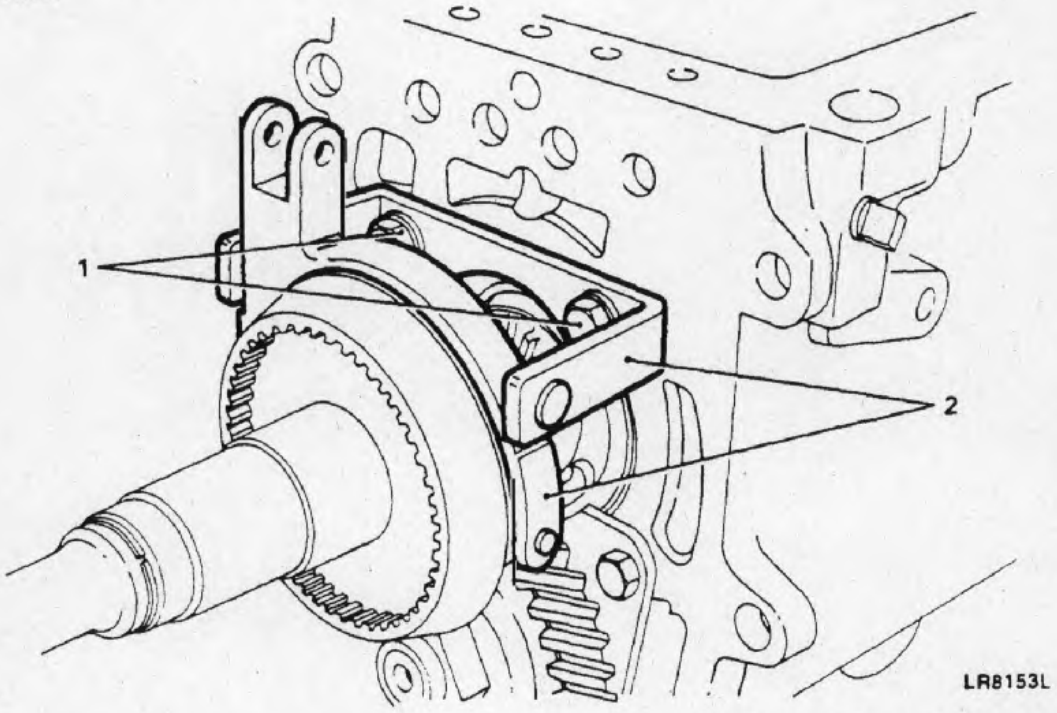
2 Interlock plunger

Fig 10 Interlock plungers and detent balls removal

9.18 Remove two bolts, spring washers and plain washers (Fig 11 (1)) securing 5th gear fork and bracket assembly (2) to gearbox. Be careful not to displace selector fork slipper pads when removing fork.

9.19 Remove slipper pads from selector fork.

9.20 If necessary, remove circlips and selector fork pivot pins.



1 Fork and bracket fixings 2 Fork and bracket assembly

Fig 11 Fifth gear selector fork removal

Front bearing plate and gears

10 To dismantle the front bearing plate and gears proceed as follows:

10.1 Remove circlip (Fig 12 (1)), selective washer (2), oil seal collar (3) and 'O' ring (4) from mainshaft.

10.2 Remove 5th gear synchromesh hub (5) and baulk ring (6).

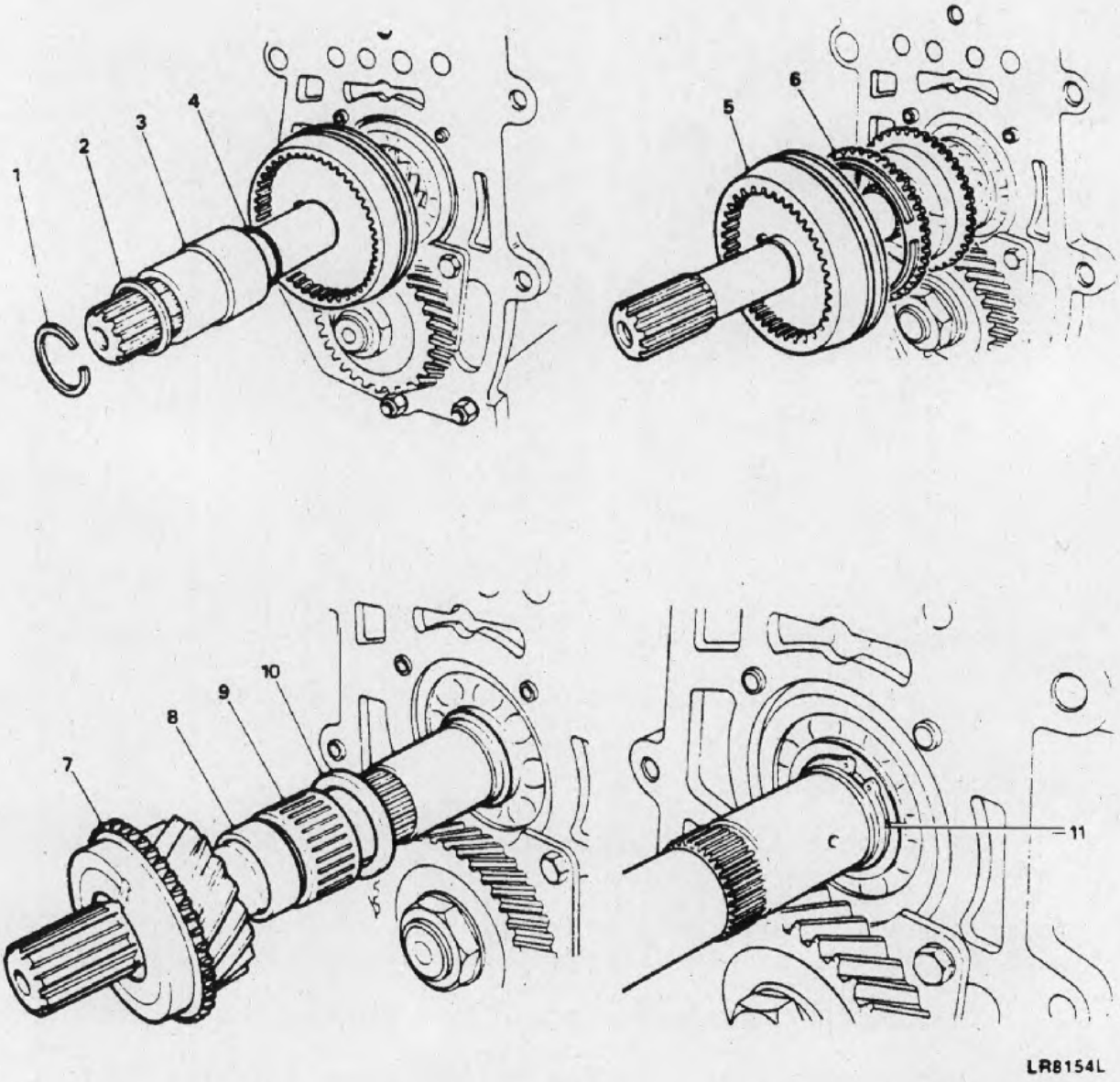
10.3 Remove 5th gear (7), spacer (8), needle roller bearing (9) and thrust washer (10).

10.4 Remove mainshaft rear bearing circlip (11).

10.5 Release stake nut collar from recess in layshaft, remove stake nut (Fig 13 (1)) and 5th gear (2) from layshaft.

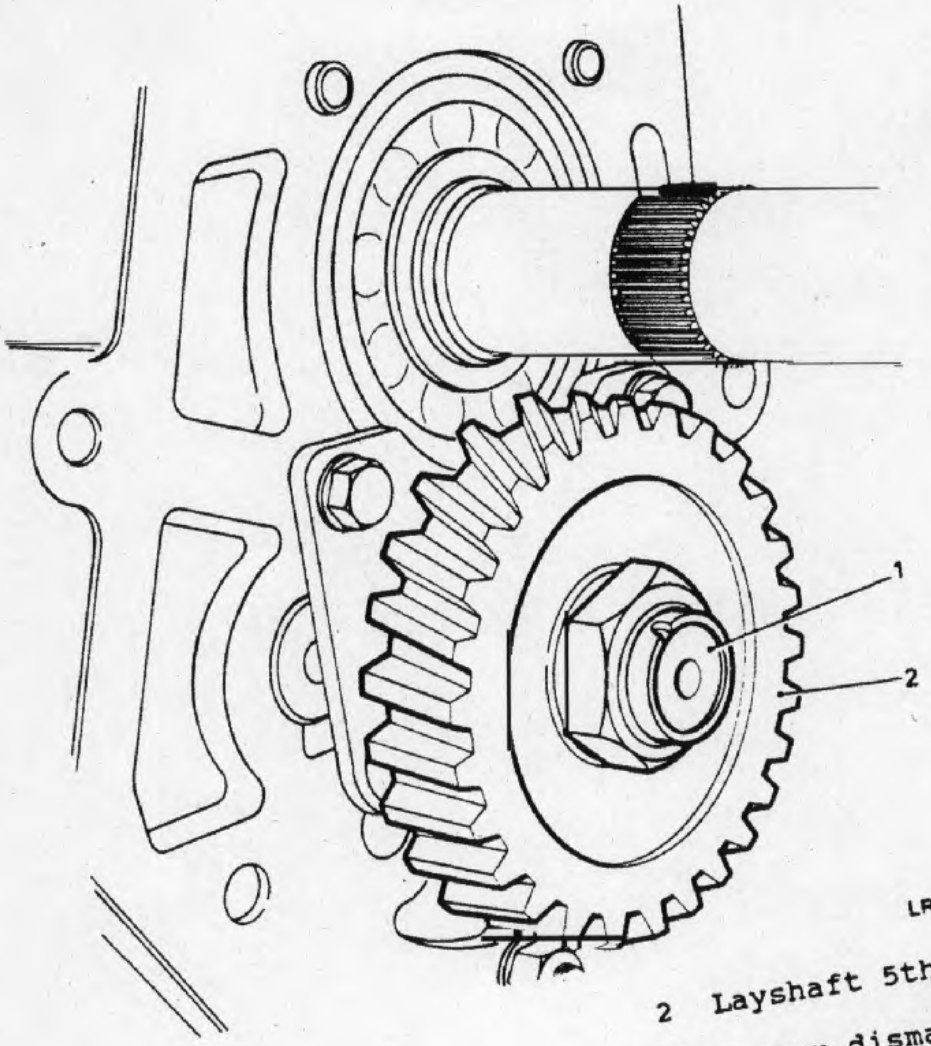
Note ...

To facilitate this operation lock gearbox by engaging both 1st and 4th gears.



1 Circlip
2 Selective washer
3 Oil seal collar
4 'O' ring
5 5th gear synchromesh hub
6 Baulk ring
7 Mainshaft 5th gear
8 Spacer
9 Needle roller bearing
10 Thrust washer
11 Circlip

Fig 12 Mainshaft fifth gear dismantling



1 Stake nut

2 Layshaft 5th gear

Fig 13 Layshaft fifth gear dismantling

10.6 Fit manufactured spacer (Fig 2) to layshaft to retain rear bearing and secure in position with stake nut finger-tight only.

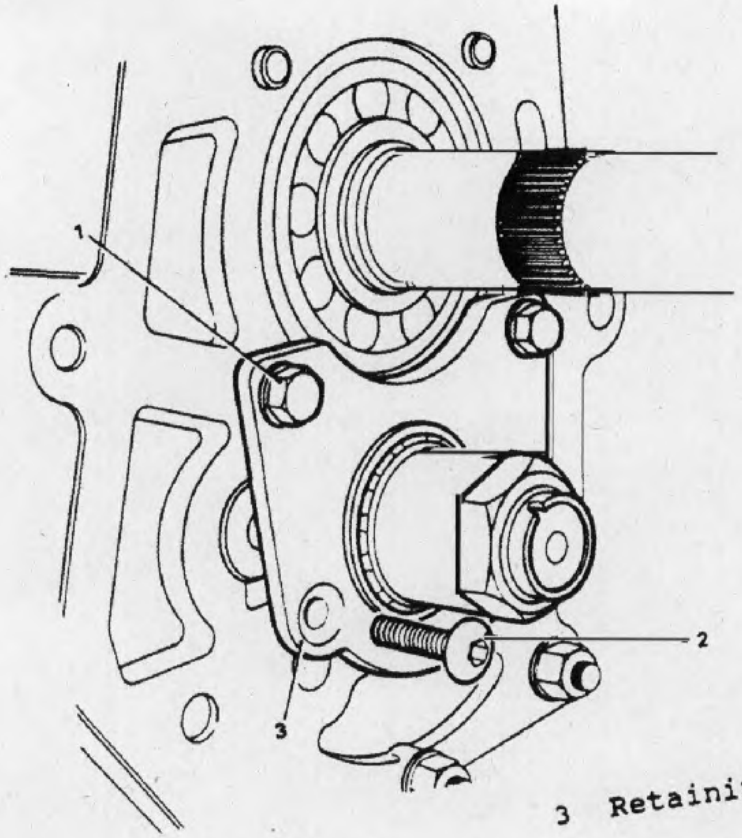
10.7 Disengage 1st and 4th gears.

10.8 Remove two socket head setscrews (Fig 14 (2)) and two bolts (1) with spring washers and remove reverse shaft and layshaft bearing track retaining plate (3).

10.9 Remove reverse lever pivot bolt (Fig 15 (1)) and lift reverse lever (2) from gearbox.

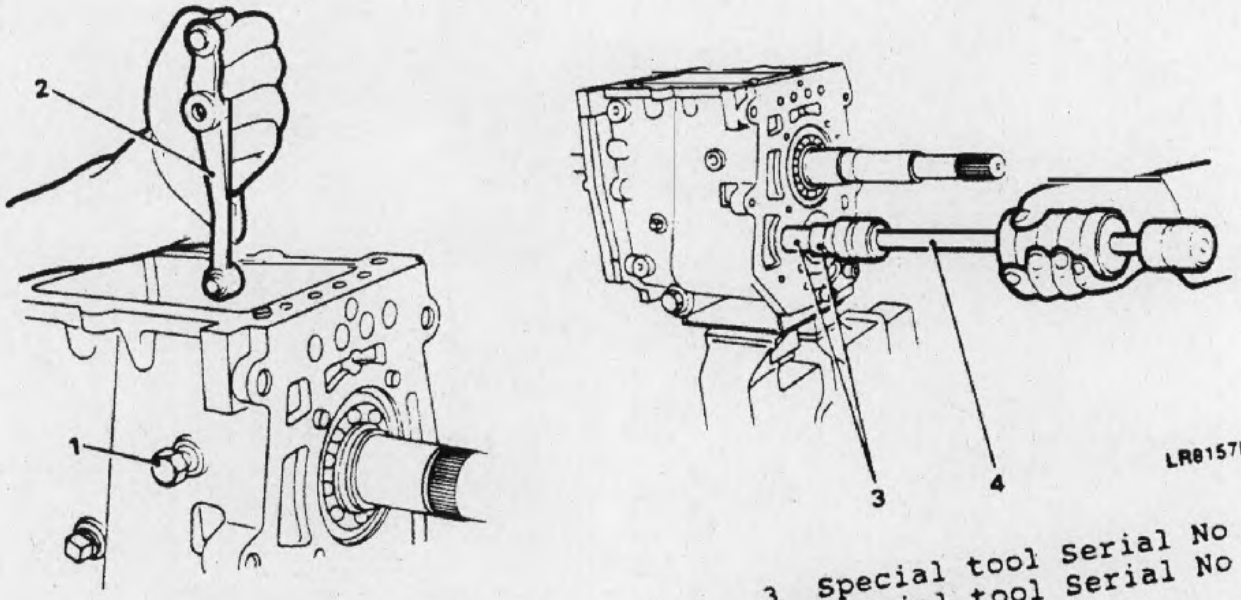
10.10 Fit special tool (TABLE 1 Serial No 8) to reverse idle shaft (Fig 15 (3)).

10.11 Fit special tool (Serial No 4) to special tool (Serial No 8) and withdraw reverse idler shaft from gearbox (Fig 15 (4)). Reverse idler gear and thrust washer will drop into bottom of gearbox.



1 Bolt
2 Socket head setscrew
3 Retaining plate

Fig 14 Layshaft bearing retaining plate removal



1 Pivot bolt
2 Reverse lever
3 Special tool Serial No 8
4 Special tool Serial No 4

Fig 15 Reverse idler shaft removal

10.12 Remove seven bolts and spring washers and withdraw front cover and gasket from front b aring plate.

10.13 Remove layshaft front bearing spacer (Fig 16 (3)).

10.14 Remove input shaft bearing circlip (1) and selective washer (2).

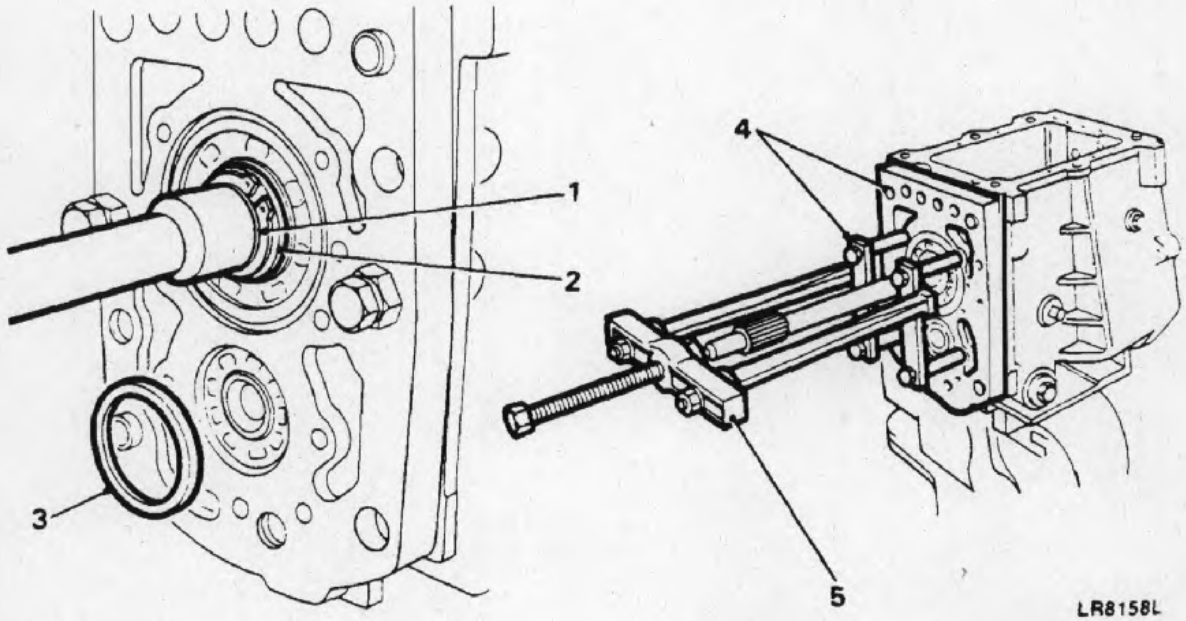
10.15 Remove bolts and spacers retaining front bearing plate to gearbox.

10.17 Fit special tool (Serial No 12) to front bearing plate with 90 mm bolts (Fig 16 (4)).

10.18 Locate special tool (Serial No 2) as shown (Fig 16 (5)) and remove front bearing plate from input shaft and gearbox.

Note ...

Centre bolt and legs of special tool (Serial No 2) must be aligned squarely with input shaft.



1 Circlip
2 Selective washer
3 Bearing spacer
4 Special tool Serial No 12
5 Special tool Serial No 2

Fig 16 Front bearing plate removal

10.19 Remove the gasket and dismantle the bearing plate as follows:

10.19.1 Support front bearing plate on wooden blocks.

10.19.2 Using special tools (Serial No's 11 and 5) remove input shaft bearing from bearing plate (Fig 17).

10.19.3 Remove circlip from bearing.

10.19.4 Using special tool (Serial No 9) remove layshaft front bearing from bearing plate (Fig 17).

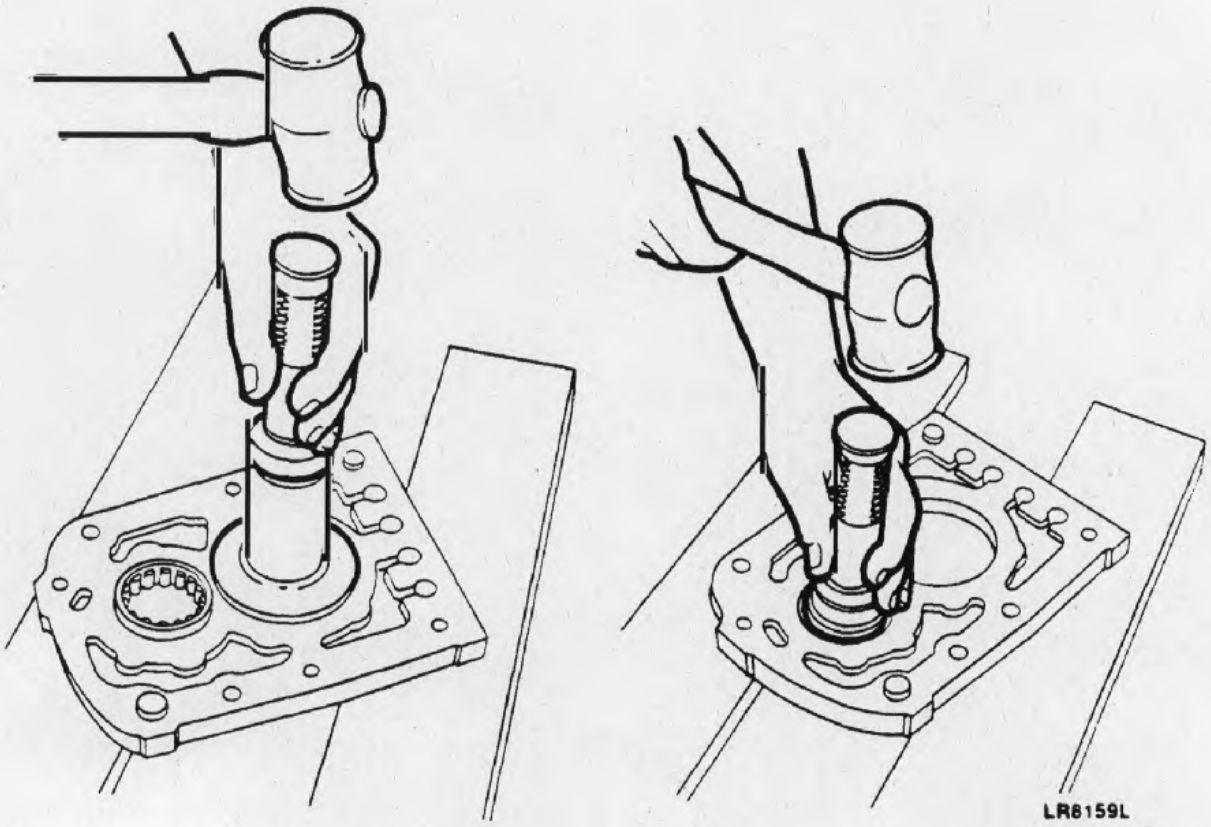


Fig 17 Front bearing plate dismantle

10.20 Remove stake nut and spacer from layshaft.

10.21 Fit special tool (Serial No 12) to rear of gearbox with 95 mm bolts in top locations and 90 mm bolts in lower (Fig 18).

10.22 Locate special tool (Serial No 2), again ensuring centre bolt and legs are aligned squarely (Fig 18).

10.23 Extract mainshaft from rear bearing. To facilitate operation assistance will be needed to support mainshaft and layshaft.

10.24 Tap layshaft forwards and remove rear bearing race.

10.25 Withdraw mainshaft and layshaft assemblies.

10.26 Remove reverse idler gear and thrust washer from gearbox.

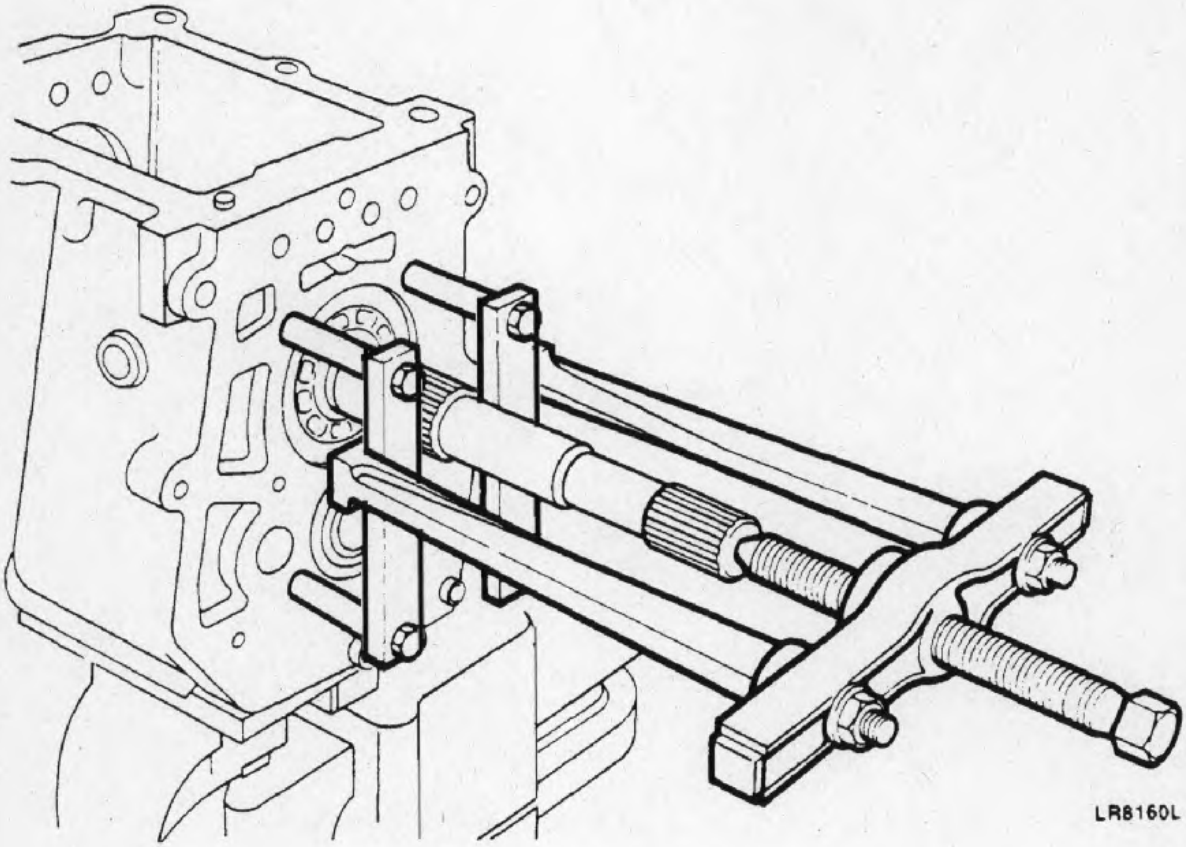


Fig 18 Mainshaft removal

Front cover and oil pump

11 To dismantle the front cover and oil pump proceed as follows:

11.1 Remove cover plate (Fig 19 (7)), drive gear (6) and impeller gear (5).

11.2 Remove cover plate 'O' ring (4).

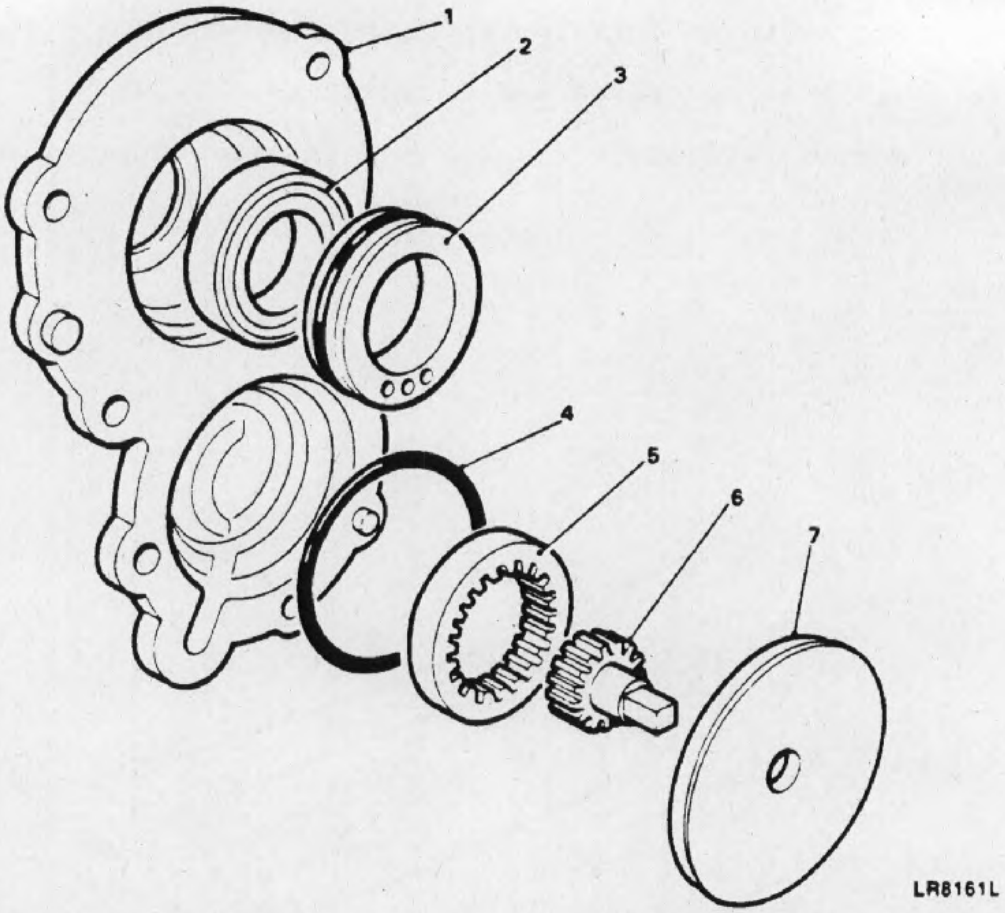
11.3 Position wooden blocks under front cover (1) and remove oil feed ring (3) and oil seal (2).

Layshaft

12 To dismantle the layshaft proceed as follows:

12.1 Remove layshaft rear bearing inner race.

12.1 Fit layshaft to vice and lever off front bearing inner track (Fig 20).



1 Front cover
2 Oil seal
3 Oil feed ring
4 Cover plate 'O' ring
5 Impeller gear
6 Drive gear
7 Cover plate

Fig 19 Front cover and oil pump dismantle

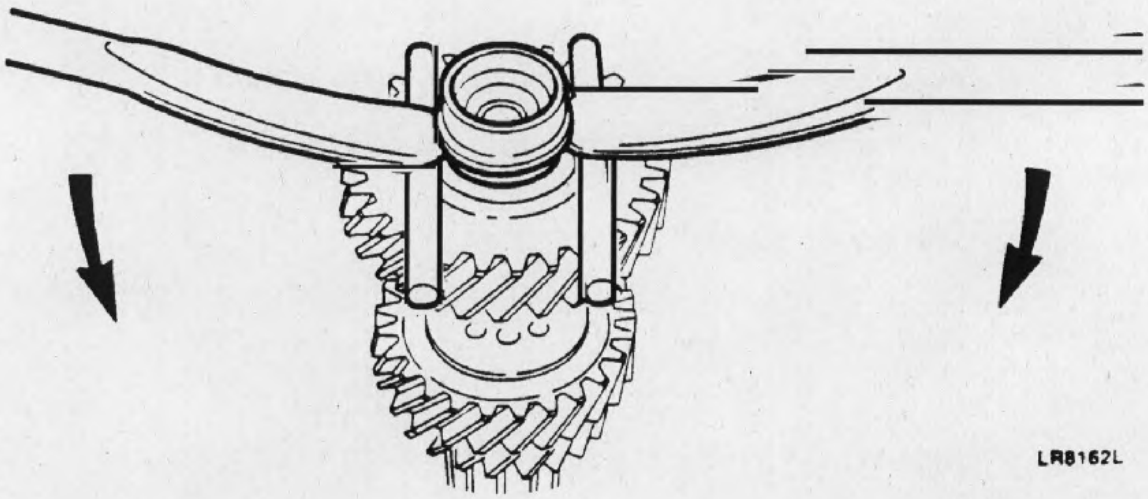


Fig 20 Layshaft dismantle

Mainshaft

13 To dismantle the mainshaft proceed as follows:

13.1 Secure the mainshaft assembly in a vice and remove the circlip (Fig 21 (1)) retaining the 3rd/4th synchromesh hub and gear assembly (3).

13.2 Remove the selective washer (2), 3rd/4th synchromesh assembly (3) and baulk ring (4).

13.3 Remove the 3rd gear (7), spacer (5), and needle roller bearing (6).

13.4 Separate from the assembly the 1st gear (8), 1st gear bush (9), spacer (10), needle roller bearing (11), selective washer (12) and rear bearing snap ring (13).

13.5 Remove the 1st gear baulk ring (14), 1st/2nd synchromesh assembly (15), 2nd gear baulk ring (16), 2nd gear spacer (17), 2nd gear needle roller bearing (18) and 2nd gear (19).

Key to fig 21

1	Circlip	11	1st gear bush
2	Selective washer	12	Selective washer
3	3rd/4th synchro assembly	13	Rear bearing snap ring
4	3rd/4th gear baulk ring	14	1st gear baulk ring
5	3rd/4th gear spacer	15	1st/2nd synchro assembly
6	3rd/4th gear bearing	16	2nd gear spacer
7	3rd gear	17	2nd gear bearing
8	1st gear	18	2nd gear baulk ring
9	1st gear spacer	19	2nd gear
10	1st gear bearing		

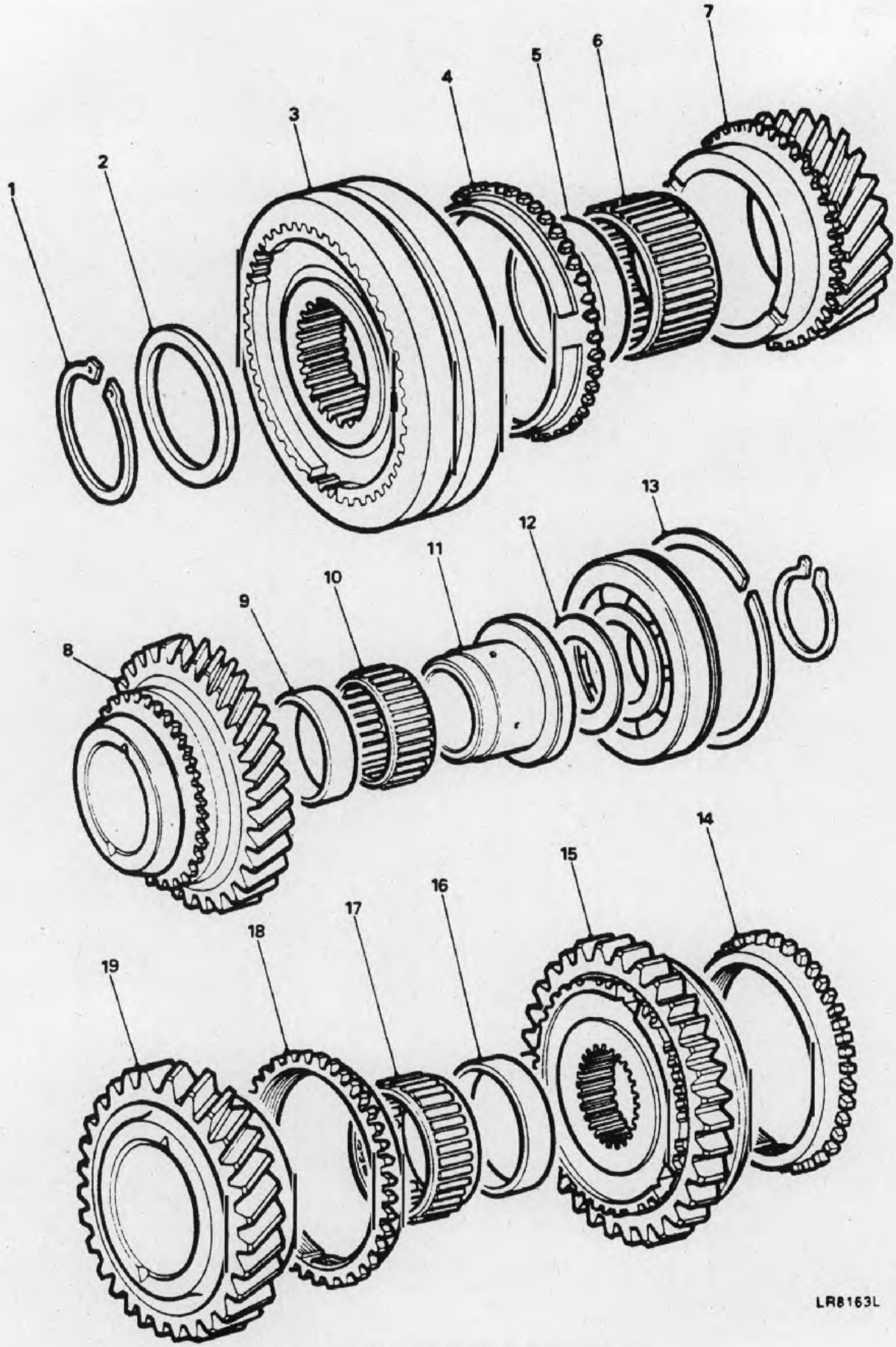


Fig 21 Mainshaft dismantle

Synchromesh assemblies

14 To dismantle the synchromesh assemblies proceed as follows:

Note ...

Components from the synchromesh assemblies should be retained in sets and identified as to which assembly they belong.

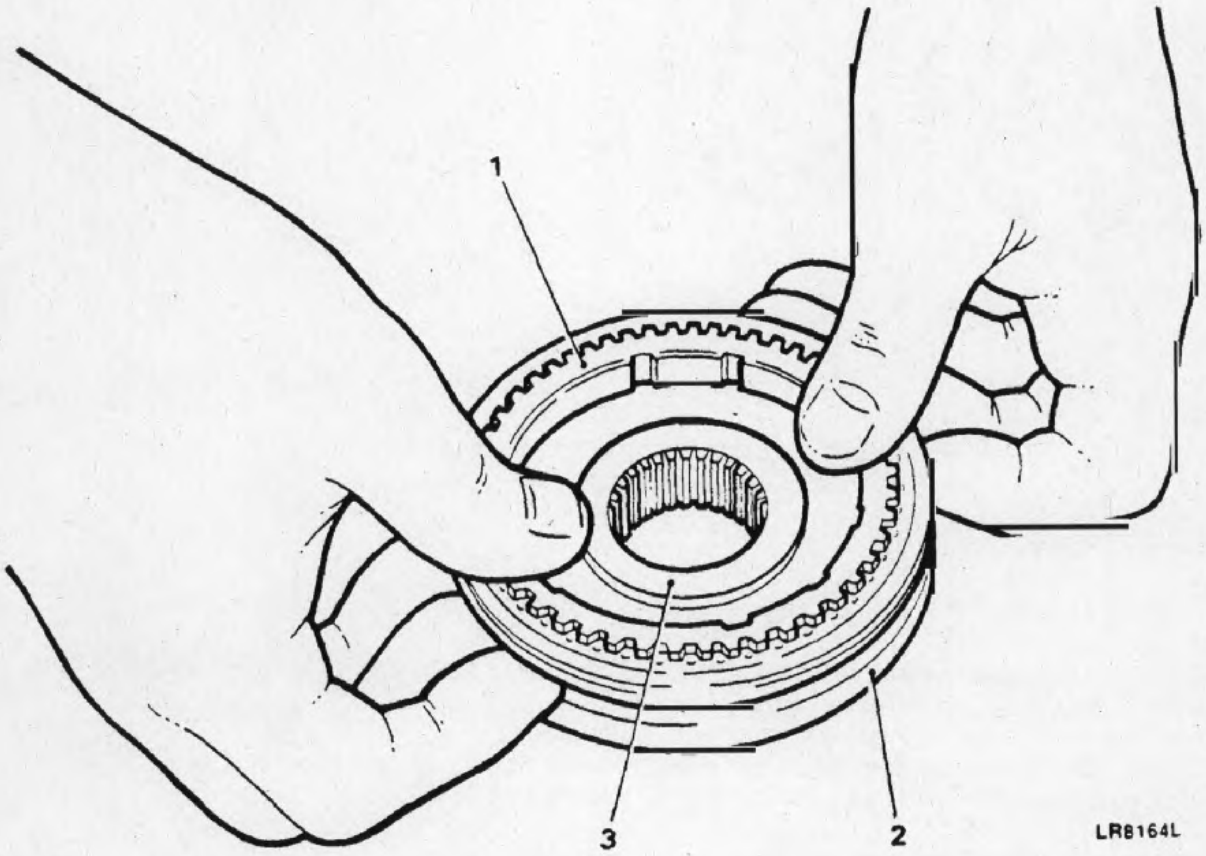
14.1 Before dismantling, mark relationship of synchromesh hub to sleeve.

14.2 Fit synchro baulk rings (Fig 22 (1)).

14.3 Place synchromesh assembly and baulk rings into a plastic bag to ensure none of the components are lost during next operation.

14.4 Press sleeve (2) from hub (3).

14.5 Retrieve synchromesh balls, springs and slipper pads and remove baulk ring.

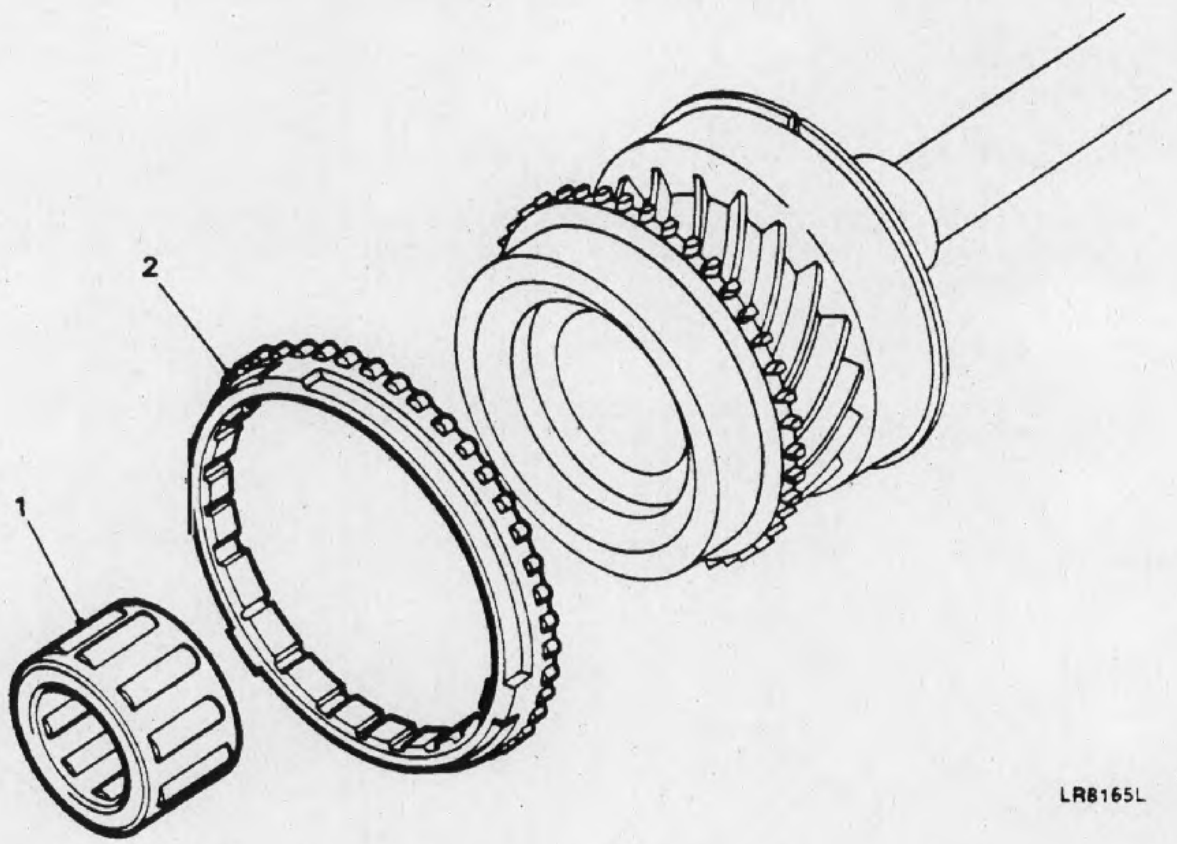


1 Synchromesh baulk rings
2 Sleeve
3 Hub

Fig 22 Synchromesh assembly dismantle

Input shaft

15 Remove the 4th gear baulk ring (Fig 23 (2)) and needle roller b aring (1).



1 Needle roller bearing 2 4th gear baulk ring

Fig 23 Input shaft dismantle

Reverse idler gear

16 To dismantle the reverse idler gear proceed as follows:

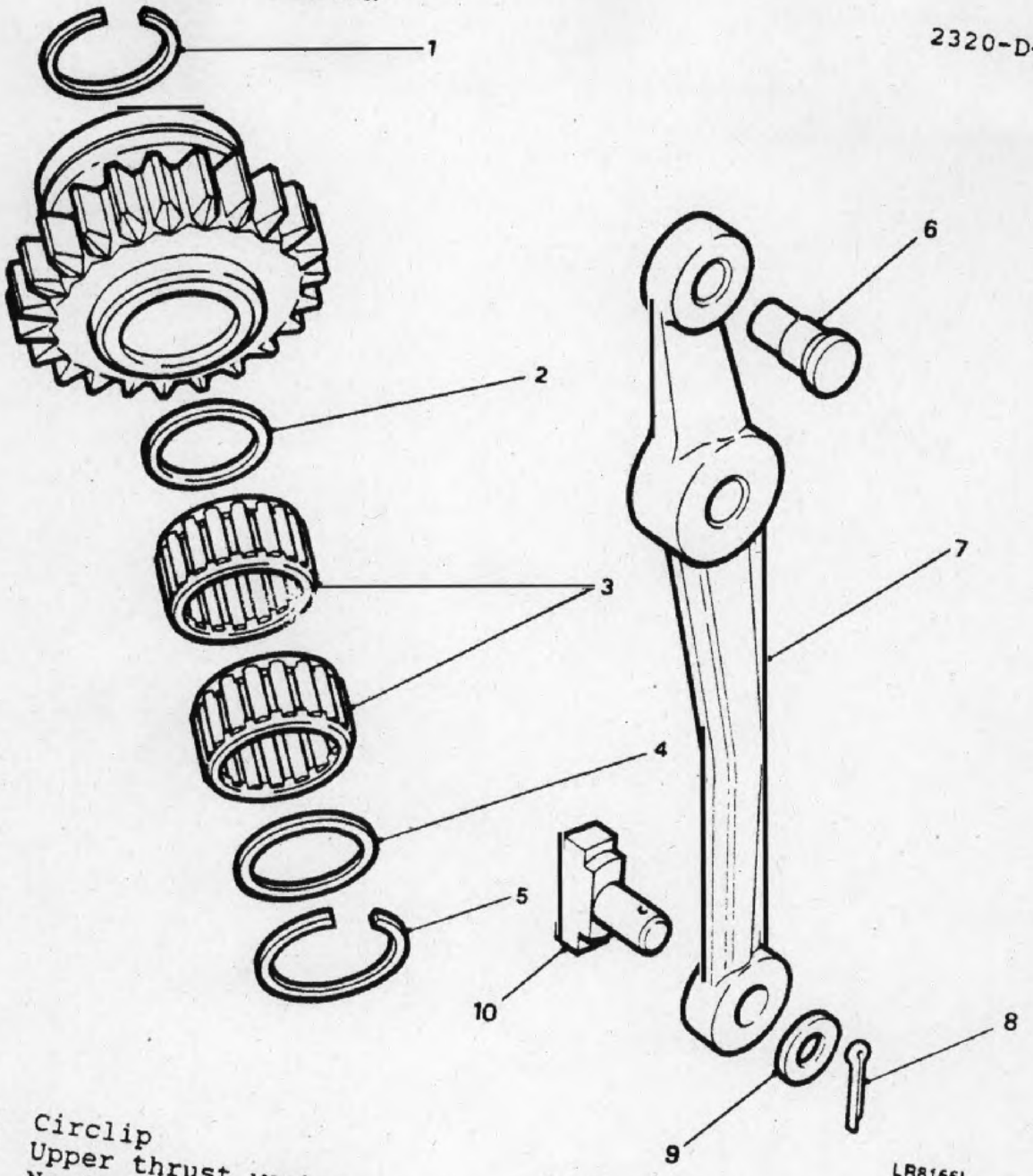
16.1 Secure reverse gear in vice and remove circlip (Fig 24 (1)) retaining bearings.

16.2 Remove upper thrust washer (2), two needle roller bearings (3) and lower thrust washer (4).

16.3 Invert reverse gear and remove second circlip (5).

16.4 If necessary, remove split pin (8) and withdraw slipper pads (10) and washer (9) from reverse gear lever (7).

16.5 Press out reverse lever cross link operating pin (6), if necessary.



1 Circlip
2 Upper thrust washer
3 Needle roller bearings
4 Lower thrust washer
5 Circlip
6 Reverse cross link pin
7 Reverse gear lever
8 Split pin
9 Washer
10 Slipper pads

Fig 24 Reverse idler gear dismantle

Main gearbox casing

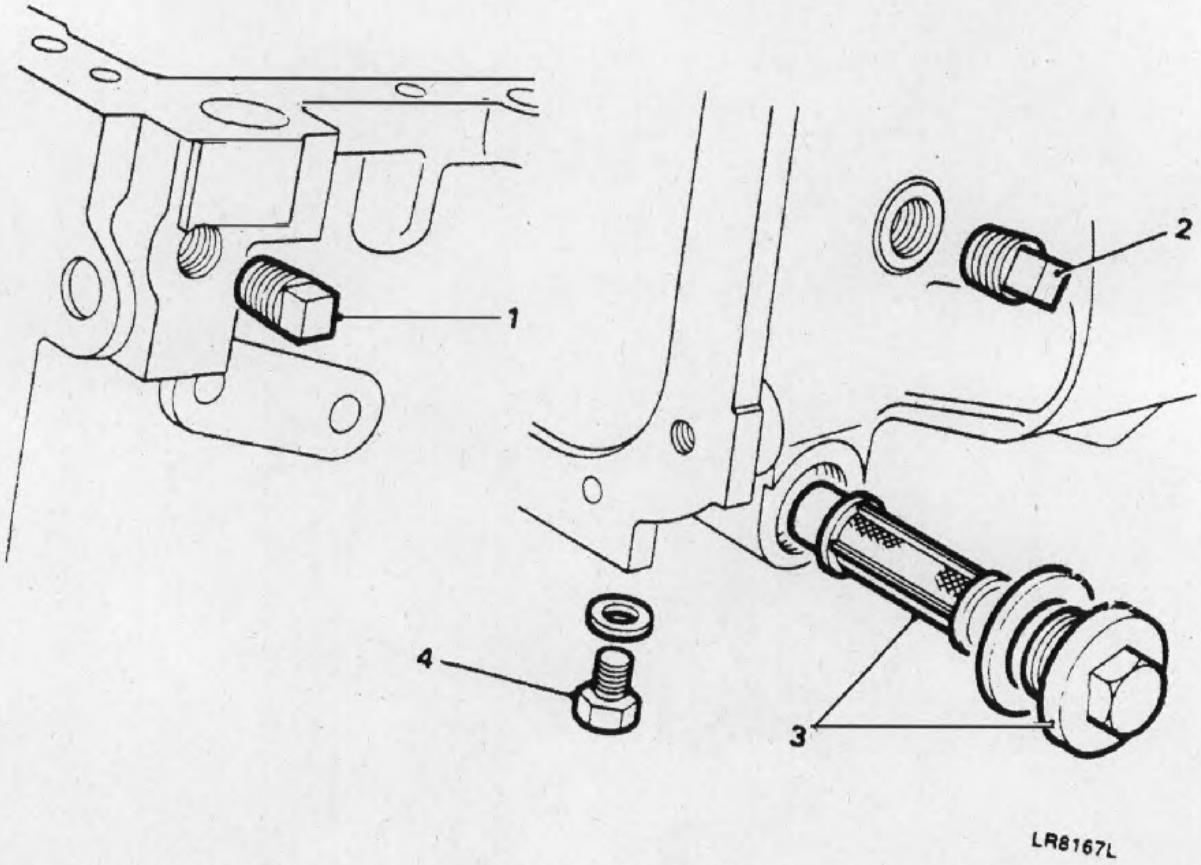
17 To dismantle the main gearbox casing proceed as follows:

17.1 Remove drain plug (Fig 25 (4)).

17.2 Remove retaining plug and oil filter (3).

17.3 Remove filler/level plug (2).

17.4 Remove interlock cross drilling plug (1).



1 Interlock cross drilling plug
2 Filler/level plug
3 Oil filter and plug
4 Drain plug

Fig 25 Main gearbox case drain plugs

17.5 Remove top cover location dowels and 5th gear fork bracket dowels, if necessary.

17.6 Remove gearbox from locally manufactured stand and position on suitable wooden blocks.

17.7 Remove mainshaft rear bearing (Fig 26) using special tools (Serial No's 11 and 5).

17.8 Remove rear bearing circlip and clean.

17.9 Using special tools (Serial No's 10 and 5) remove layshaft rear bearing outer track (Fig 27).

Note ...

Use rounded end of tool.

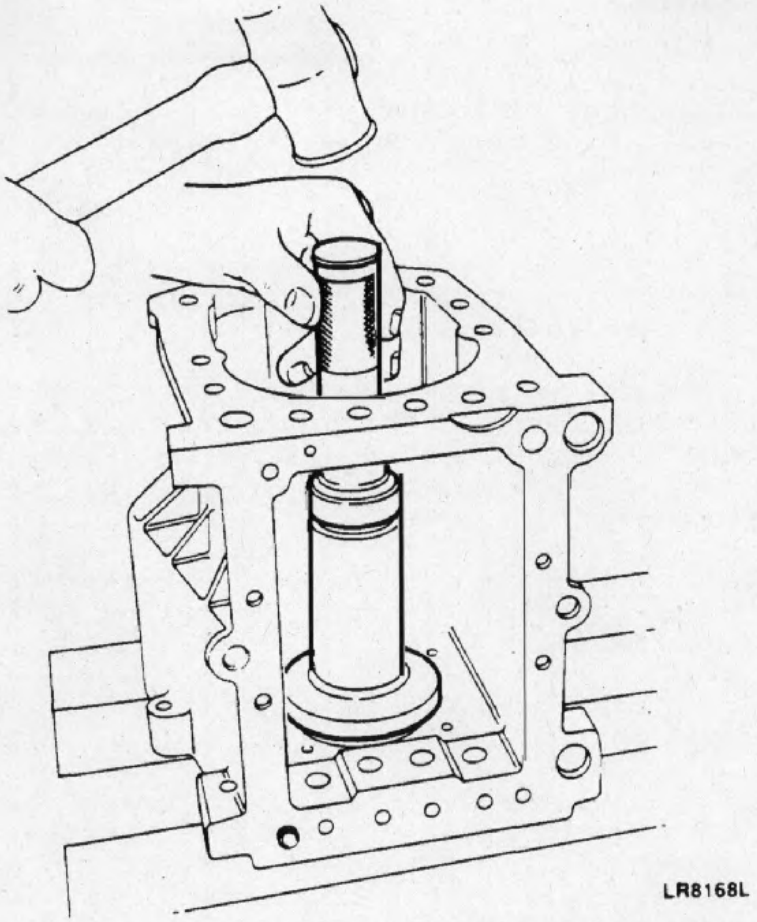


Fig 26 Mainshaft rear bearing removal

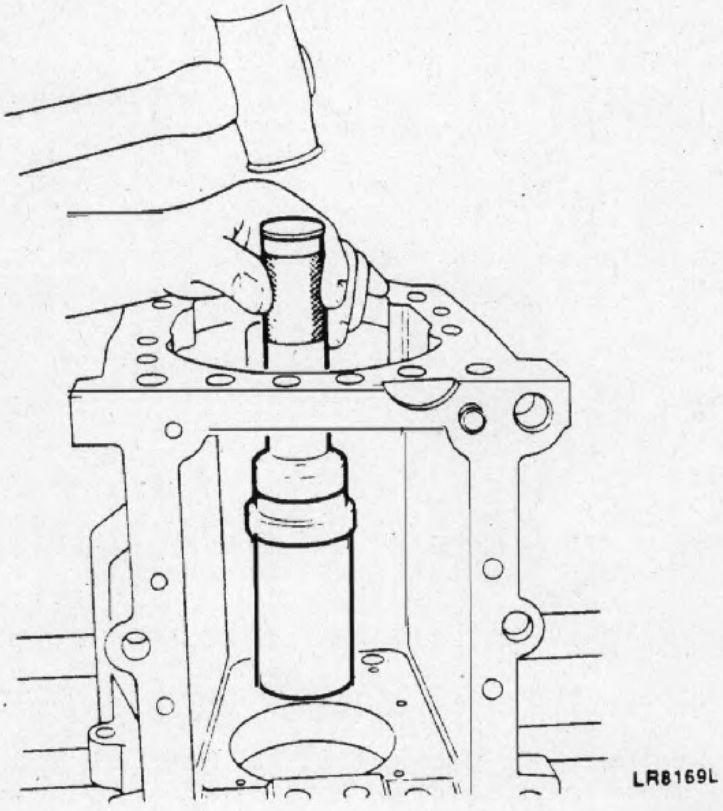


Fig 27 Layshaft rear bearing outer track removal

Cleaning

18 Clean all components thoroughly using a suitable solvent. Ensure all lubrication drillings are clear of sludge or contamination.

Examination

19 Examine the components as follows referring to Cat 533 for dimensions and wear tolerances:

19.1 Examine the casings for cracks, stripped threads in the various bolt holes and the machined mating faces for burrs, nicks or any condition that would render the casing unfit for further service. Damaged threads may be reclaimed by fitting wire thread inserts.

19.2 Inspect all gears for chipped or broken teeth, and for signs of excessive wear, inspect all spline teeth on the synchromesh assemblies.

19.3 Check synchromesh slippers and slipper rings for wear and breakage.

19.4 Check the wear between all synchromesh baulk rings and gears by pushing the baulk ring against the gear and measuring the gap between the ring and gear. The minimum permissable gap is 0,64mm (0.025in). If this clearance is not obtained new baulk rings must be fitted.

19.5 Inspect all circlip grooves for burrs or rough edges. If this condition is apparent remove by carefully filing with a fine file.

19.6 Generally examine all other components for wear or damage and fit new components if necessary.

Repairs and replacement

20 It is recommended that all seals, gaskets, circlips, lock washers, needle and roller bearings are renewed at overhaul.

Reassembly

Main gearbox casing

21 To reassemble the main gearbox casing proceed as follows:

21.1 Heat gearbox case to facilitate fitting of mainshaft rear bearing and layshaft bearing track.

21.2 Fit circlip to mainshaft rear bearing.

21.3 Position rear bearing in gearbox seating.

21.4 Using special tools (Serial No's 11 and 5) tap rear bearing into position (Fig 28).

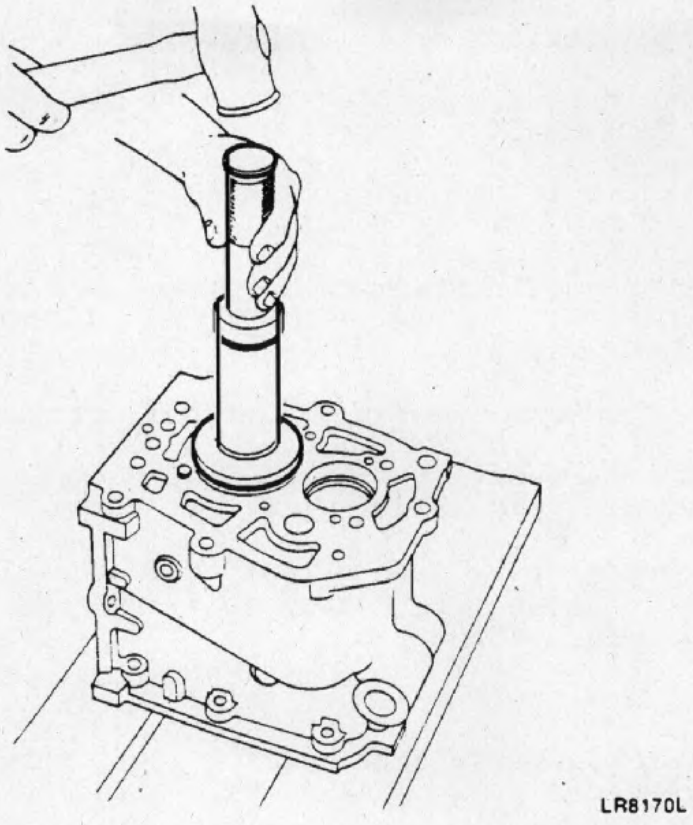


Fig 28 Fitting mainshaft rear bearing

21.5 With gearbox still warm fit layshaft rear bearing outer track (Fig 29) using special tools (Serial No's 10 and 5).

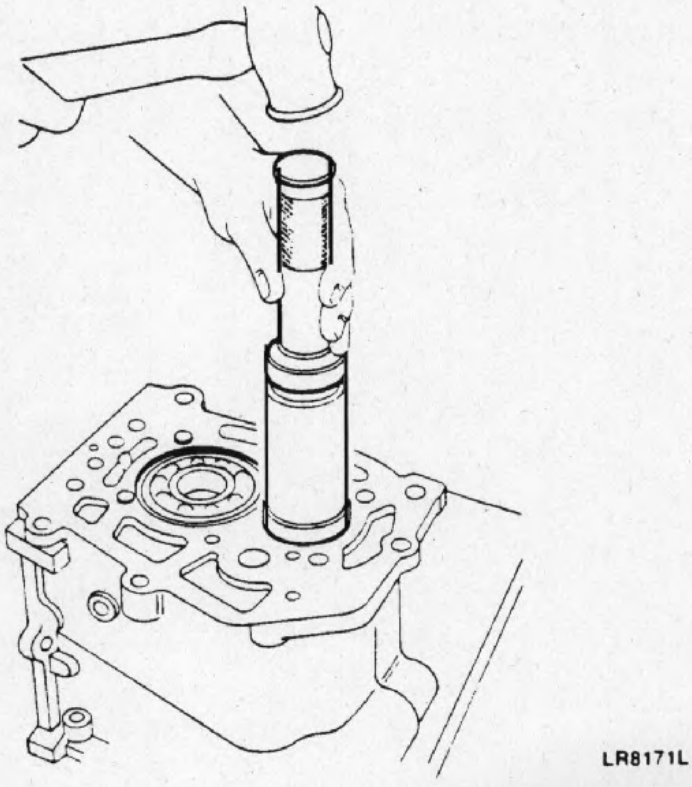


Fig 29 Fitting layshaft rear bearing outer track

21.6 Fit interlock drilling plug (Fig 25 (1)) .

21.7 Fit level/filler plug (2) - do not tighten at this stage.

21.8 Fit oil filter and retaining plug (3) using new copper washer.

21.9 Fit magnetic drain plug (4) and new copper washer.

Reverse idler gear

22 To reassemble the reverse idler gear proceed as follows:

22.1 If previously dismantled, refit the reverse lever cross link operating pin (Fig 24 (6)).

22.2 If previously dismantled, refit the slipper pads (10) and washer (9) to the reverse gear lever (7) and secure with split pin (8).

22.3 Replace and fit second circlip (5).

22.4 Invert reverse gear and fit lower thrust washer (4), lubricate and fit two needle roller bearings (3) and fit upper thrust washer (2).

22.5 Replace and fit circlip (1) retaining bearings.

Input shaft

23 To reassemble the input shaft proceed as follows:

23.1 Lubricate mainshaft pilot bearing and fit to input shaft.

23.2 Fit 4th gear baulk ring to input shaft.

Third gear end float

24 To check the third gear end float proceed as follows:

24.1 Locate the main shaft in a vertical position (Fig 30).

24.2 Fit 3rd gear and needle roller bearing to the shaft and replace the 3rd/4th synchromesh inner member.

24.3 Press down on the synchromesh inner member and check the gear running clearance with a feeler gauge. A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back lash. New or little worn components will usually have a clearance of between 0,075 to 0,125 mm (0.003 to 0.005 in).

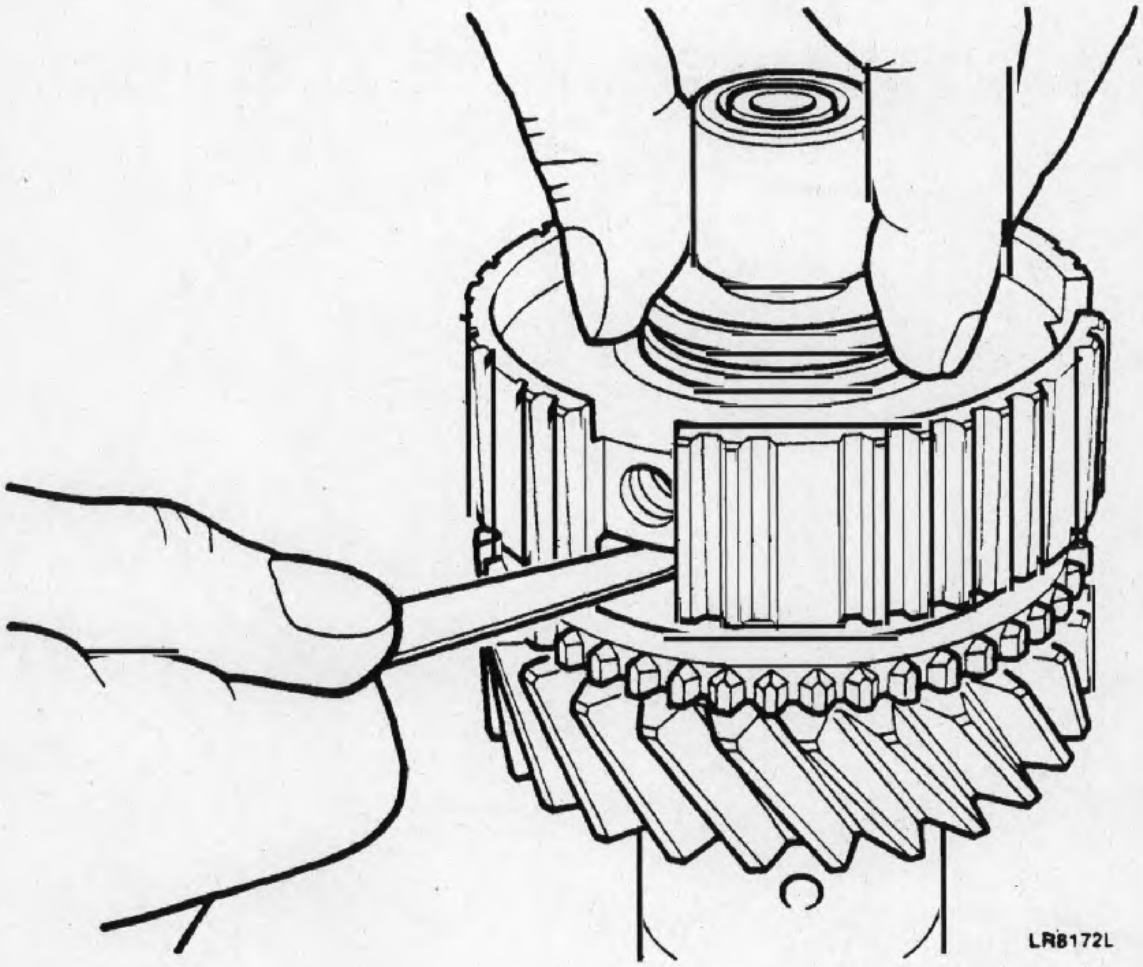


Fig 30 Checking third gear end float

Third and fourth gear synchromesh end float

25 To check the third and fourth gear synchromesh end float proceed as follows:

25.1 Locate the mainshaft in a vertical position (Fig 31).

25.2 Fit 3rd gear needle roller bearing, spacer, 3rd gear, baulk ring and synchromesh with the large area thrust face towards 3rd gear and the chamfer on the outer member towards the front.

25.3 Fit the original selective washer and retain with the circlip.

25.4 Check the clearance between the washer and the synchromesh hub which must not exceed 0,075 mm (0.003 in). The condition is ideal when the selective washer can be just turned by hand. i.e. minimum end float.

25.5 Secure components with a new circlip.

25.6 Renew oil seal in the front of the mainshaft at this stage and invert the shaft ready for assembly of the rear end.

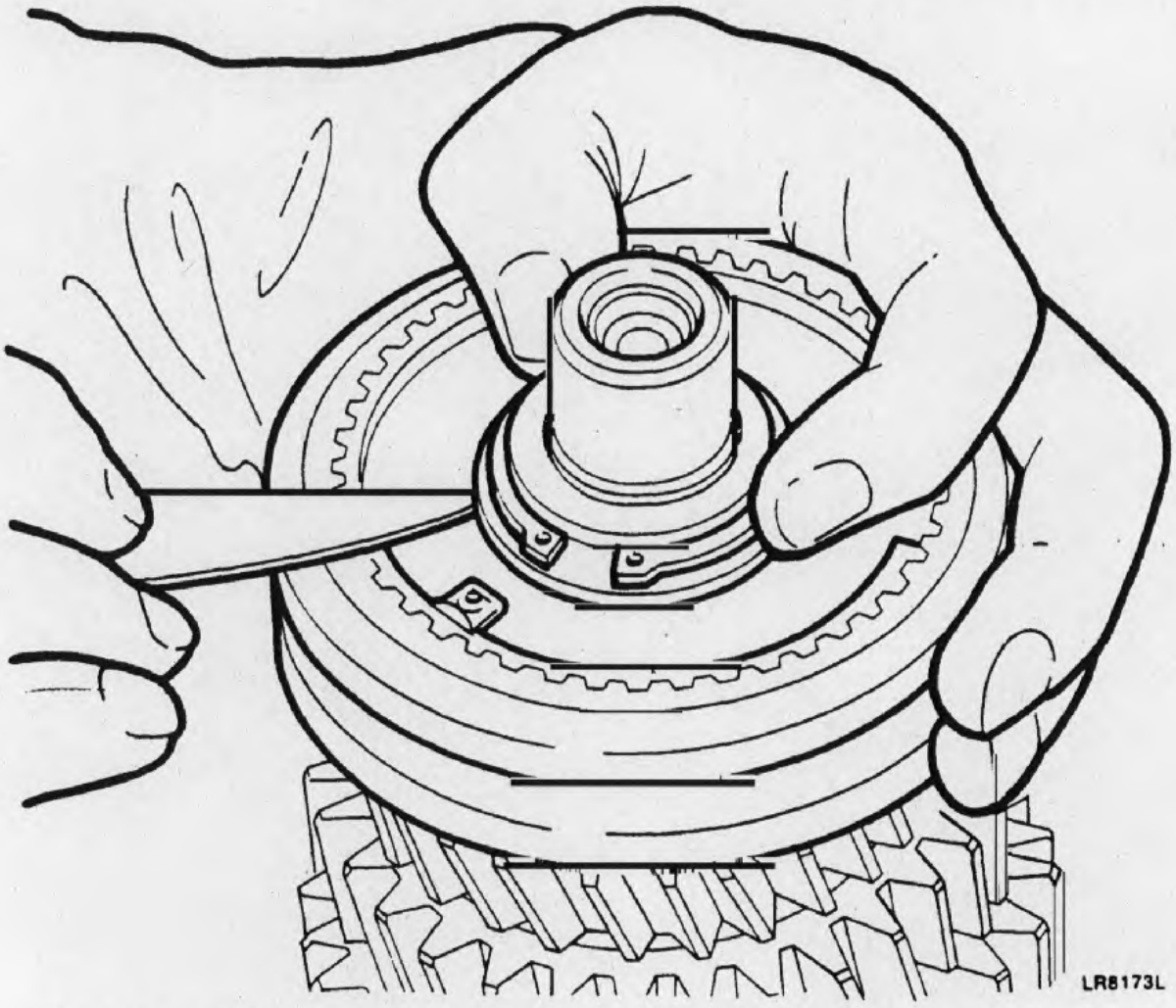


Fig 31 Checking third and fourth gear synchromesh end float

Second gear end float

26 To check the second gear end float proceed as follows:

26.1 Fit 2nd gear needle roller bearing, spacer, 2nd gear and synchromesh inner member with the selector groove towards the rear (Fig 32).

26.2 Press down on the synchromesh inner member and check 2nd gear end float. A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back lash. New or little worn components will usually have a clearance of between 0,075 to 0,125 mm (0.003 to 0.005 in).

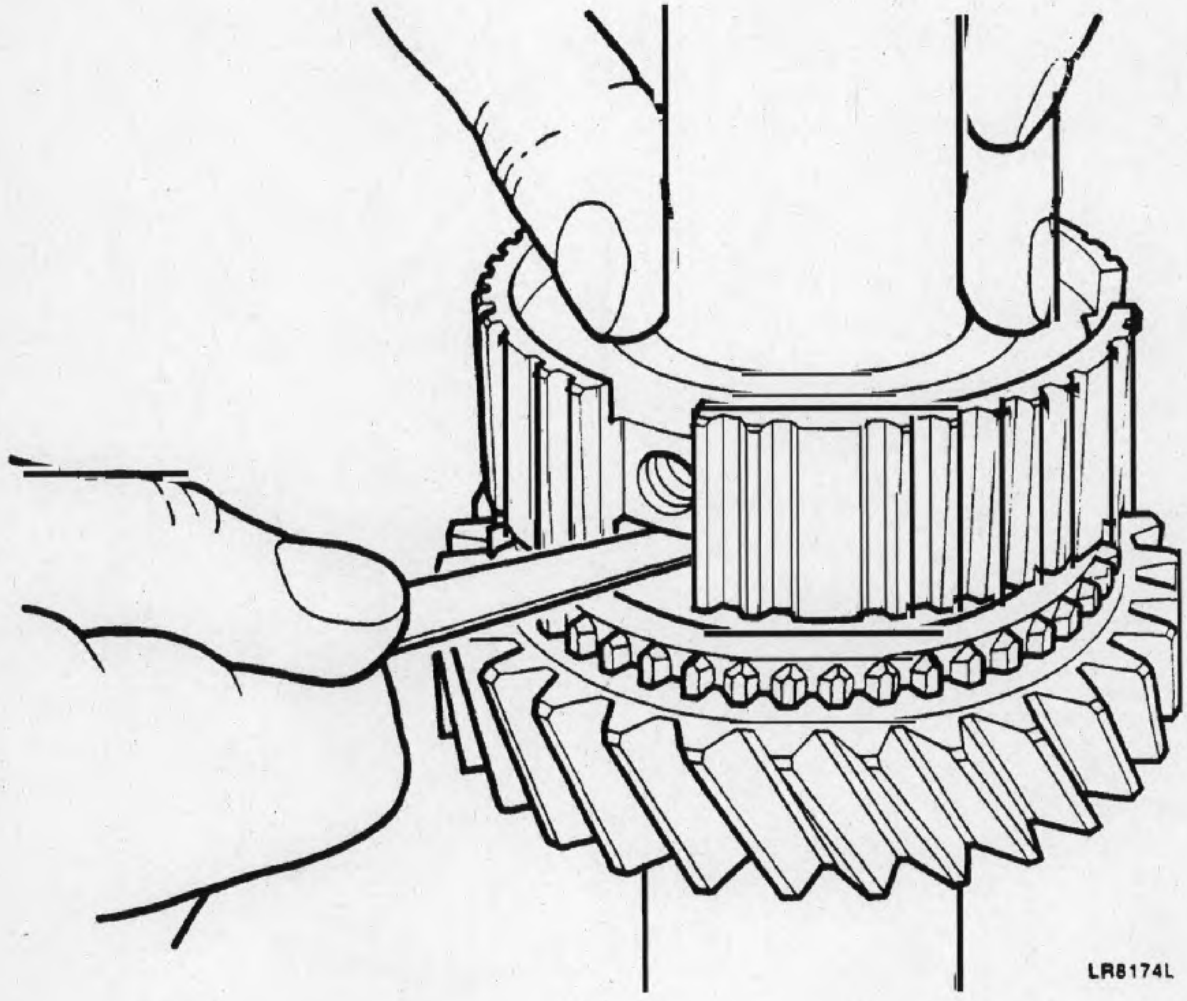


Fig 32 Checking second gear end float

First gear to bush end float

27 To check the first gear to bush end float proceed as follows:

Note ...

It is not necessary to assemble the components on to the mainshaft to perform this procedure.

27.1 Assemble 1st gear on to the bush.

27.2 Using a suitable straight edge or flat plate (the oil pump back plate is ideal) check the end float of 1st gear on the bush (Fig 33). A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back lash. New or little worn components will usually have a clearance of between 0,075 to 0,125 mm (0.003 to 0.005 in).

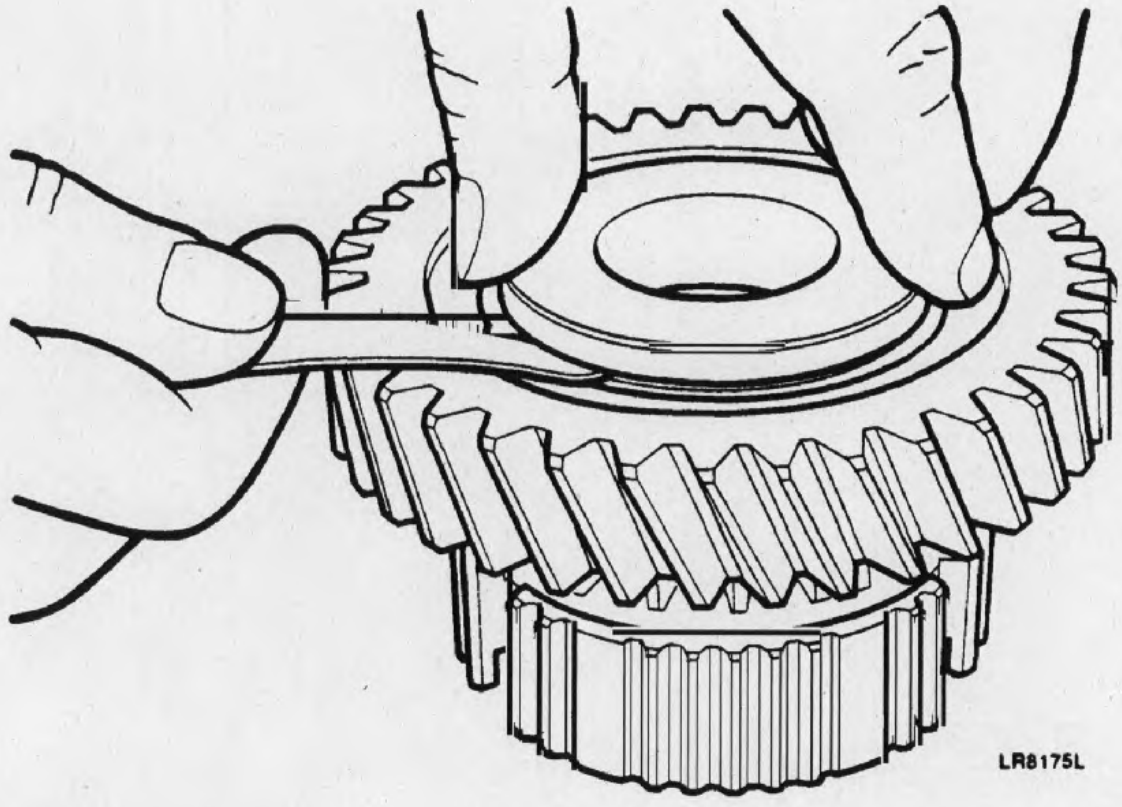


Fig 33 Checking first gear to bush end float

First and s cond gear synchrom sh end float

28 To check the first and second gear synchrom sh nd float proceed as follows:

28.1 Fit the 1st gear baulk ring, 1st gear bush and gear, original selective washer, special tool (Serial No 6) and circlip onto the shaft.

28.2 Check the end float (Fig 34).

28.3 Choose a suitable selective shim washer to obtain the correct tolerance. The clearance between the washer and the synchromesh hub must not exceed 0,075 mm (0.003 in). The condition is ideal when the selective washer can be just turned by hand, i.e. minimum end float.

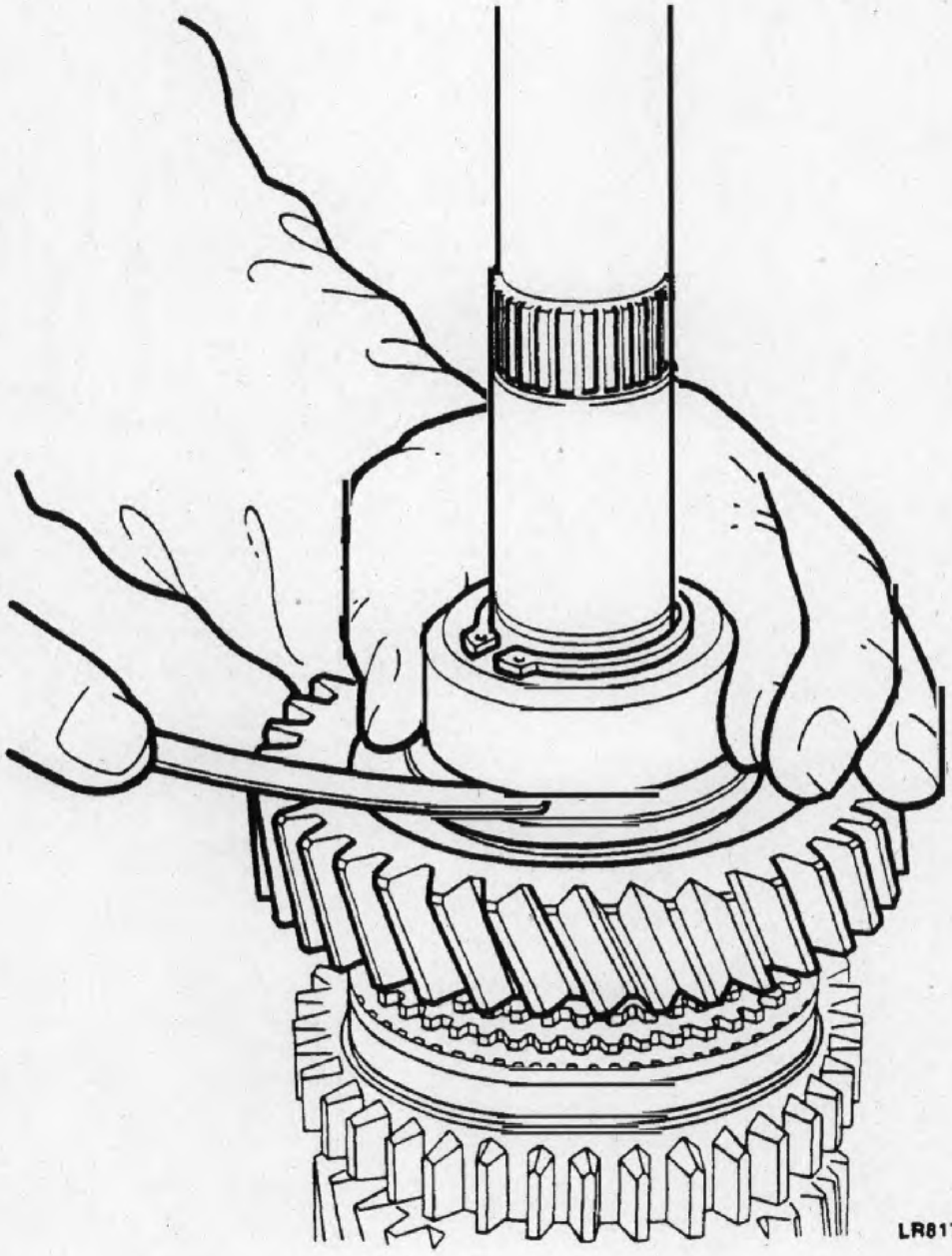


Fig 34 Checking first and second gear synchromesh end float

Fifth gear end float

29 To check the fifth gear end float proceed as follows:

29.1 Fit 5th fear thrust washer, 5th gear, needle bearing and spacer followed by synchromesh unit but leave out the baulk ring at this stage.

29.2 Press down on the synchromesh inner member and check the gear end float (Fig 35). A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back lash. New or little worn components will usually have a clearance of between 0,075 to 0,125 mm (0.003 to 0.005 in).

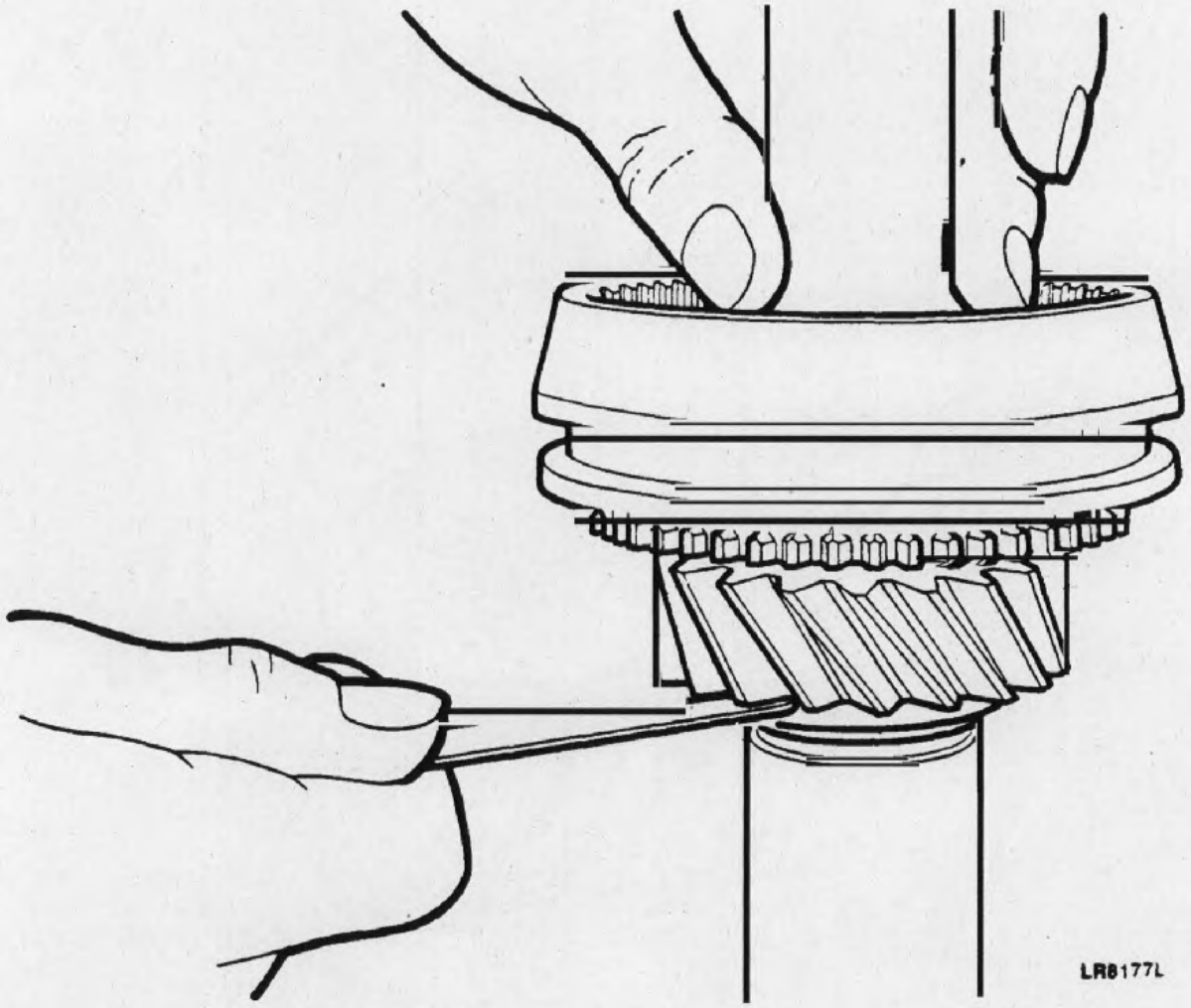


Fig 35 Checking fifth gear end float

Fifth g ar synchrom sh end float

30 To check the fifth gear synchrom sh end float proceed as follows:

30.1 Fit the 5th gear synchromesh backing plate, seal collar, original selective shim washer and circlip.

30.2 Check the clearance (Fig 36).

30.3 Choose a suitable selective shim washer to obtain the correct tolerance. The clearance between the washer and the synchromesh hub must not exceed 0,075 mm (0.003 in). The condition is ideal when the selective washer can be just turned by hand. i.e. minimum end float.

30.4 With all the mainshaft adjustments correct, remove the 5th gear components ready for assembly.

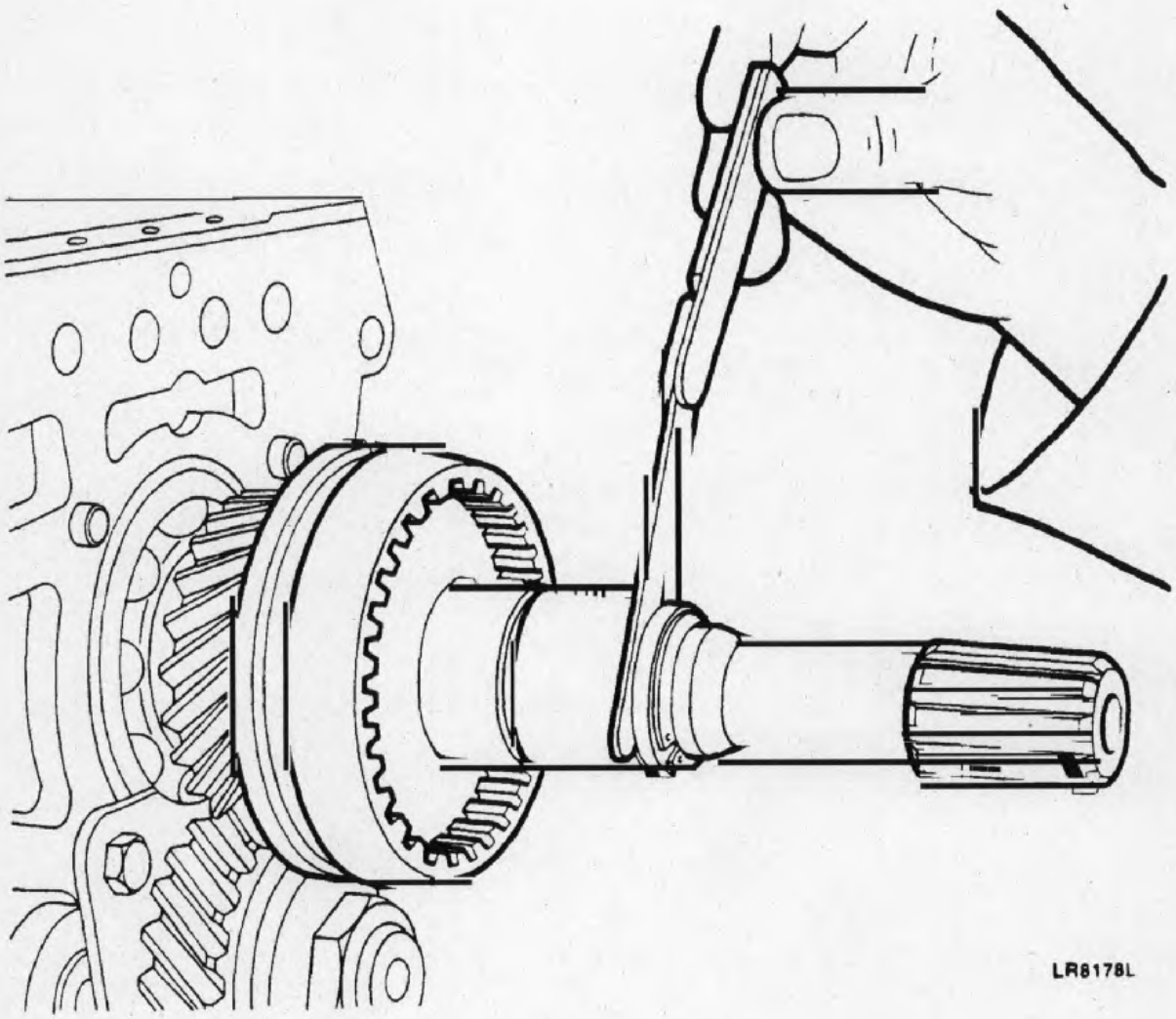


Fig 36 Checking fifth gear synchromesh end float

Synchromesh assembli s

31 To reassemble the synchromesh assemblies proceed as follows:

Note ...

Before reassembling the synchromesh assemblies, carry out the ch cks for 3rd, 2nd and 5th gear end floats (Para 24, 26 and 29).

31.1 Fit the 1st and 2nd gear synchromesh hub to sleeve ensuring the alignment marks match up.

31.2 Place hub and sleeve over suitable block.

31.3 With hub resting on block adjust height of hub sufficiently to fit springs.

31.4 Locate slipper pads (Fig 37 (3)), fit springs and press balls down to be retained by synchromesh sleeve.

31.5 Fit baulk ring (1) to hub and sleeve (2).

31.6 Carefully invert synchromesh assembly, and fit second baulk ring.

31.7 Press synchromesh sleeve over hub to locate balls in position.

31.8 Remove baulk rings.

31.9 Repeat the operation for 3rd/4th gear synchromesh assembly omitting the gear end float checks.

Note ...

When reassembling 3rd/4th gear synchromesh the large chamfer on synchro sleeve faces the small boss on the hub.

31.10 Repeat operation for 5th gear synchromesh assembly.

Note ...

When reassembling 5th gear synchromesh the chamfer on the hub faces to the rear.

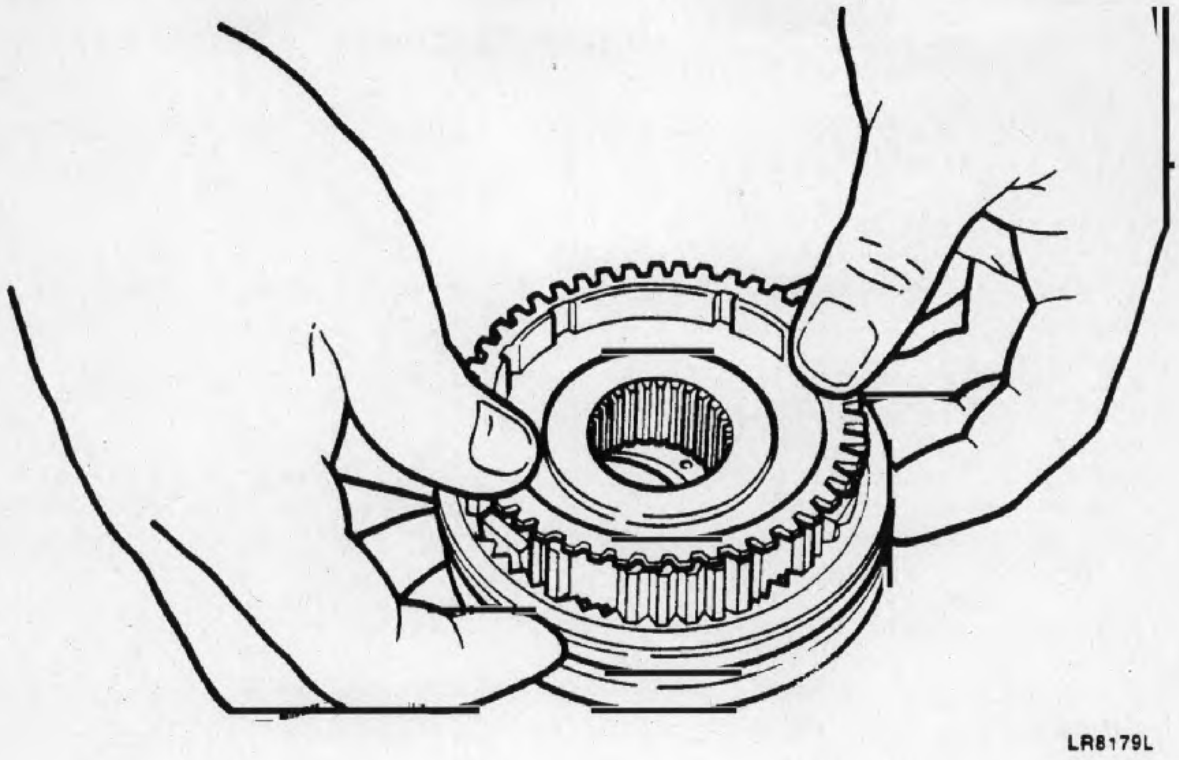


Fig 37 Reassembling synchromesh assemblies

Layshaft

32 To reassemble the layshaft proceed as follows:

32.1 Fit layshaft front bearing track.

32.2 Fit rear bearing race to layshaft, ensuring the identification numbers etc., of the bearing are facing forwards.

Note ...

The inner tracks are offset and the bearings must be fitted with narrow shoulders together.

Oil pump assembly

33 To reassemble the oil pump proceed as follows:

33.1 Lubricate lip of new oil seal (Fig 19 (2)) and position in front cover seating (1) with close side downwards.

33.2 Fully seat oil seal in position using a suitable tube.

33.3 Fit oil feed ring (3), ensuring the three holes of the feed ring are at the bottom and the centre hole is aligned with the mating oil pump feed drilling in the front cover.

33.4 Fully seat feed ring in position using a suitable tube.

33.5 Fit cover plate 'O' ring (4), lubricate and fit impeller gear (5), and drive gear (6).

33.6 Fit cover plate (7), ensuring chamfer of centre hole is facing towards oil pump.

Front bearing plate and gears

34 To reassemble the front bearing plate and gears proceed as follows:

34.1 Heat front bearing plate to facilitate refitting of input shaft and layshaft bearings.

34.2 Using special tool (Serial No 9) fit layshaft bearing (Fig 38), with 6,5 - 7 mm of bearing protruding from front of bearing plate. This allows easier assembly of the layshaft and mainshaft at a later stage.

34.3 Fit circlip to input shaft bearing.

34.4 With the front bearing plate still warm fit input shaft bearing (Fig 39), using special tool (Serial No's 11 and 5).

34.5 Allow front bearing plate to cool, position on suitable stand and fit input shaft into bearing (Fig 40).

34.6 Secure bearing plate in vice, fit original selective washer and retain with circlip (Fig 41 (1)).

34.7 Measure the clearance between washer and input shaft bearing. If a measurement in excess of 0,075 mm is obtained remove circlip and washer.

34.8 Select and measure new washer to take up the excessive running clearance.

34.9 Fit new selective washer and retain with circlip.

34.10 Recheck to ensure a running clearance of 0.075 mm is obtained between washer and bearing.

34.11 Position front bearing plate on suitable stand.

34.12 Lower mainshaft assembly (Fig 42 (1)) into input shaft at the same time rotating to engage baulk ring slots and lugs.

34.13 Engage 3rd gear.

34.14 Fit layshaft assembly (2) to front bearing plate and mesh with mainshaft (1).

Note ...

Take care to ensure that the front layshaft bearing rollers are not put out of alignment, then return 3rd/4th synchromesh hub to neutral.

34.15 Remove the rear bearing circlip and dummy bearing.

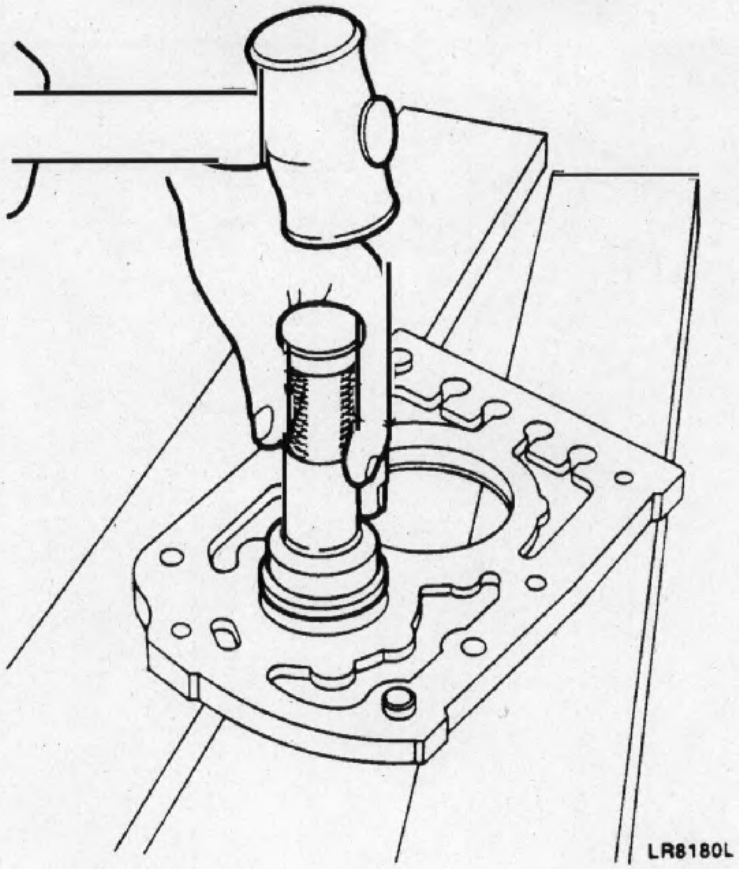


Fig 38 Fitting layshaft bearing

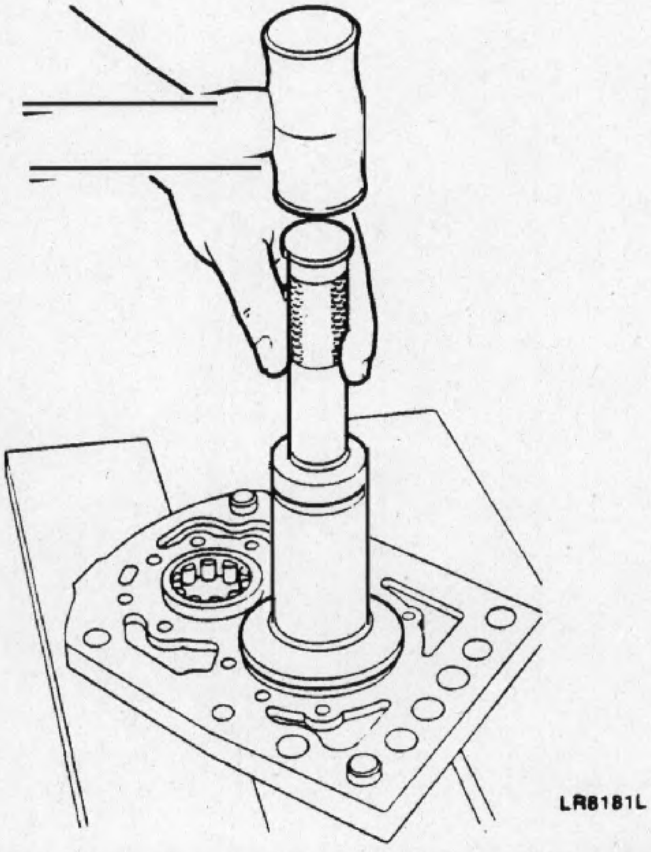


Fig 39 Fitting input shaft bearing

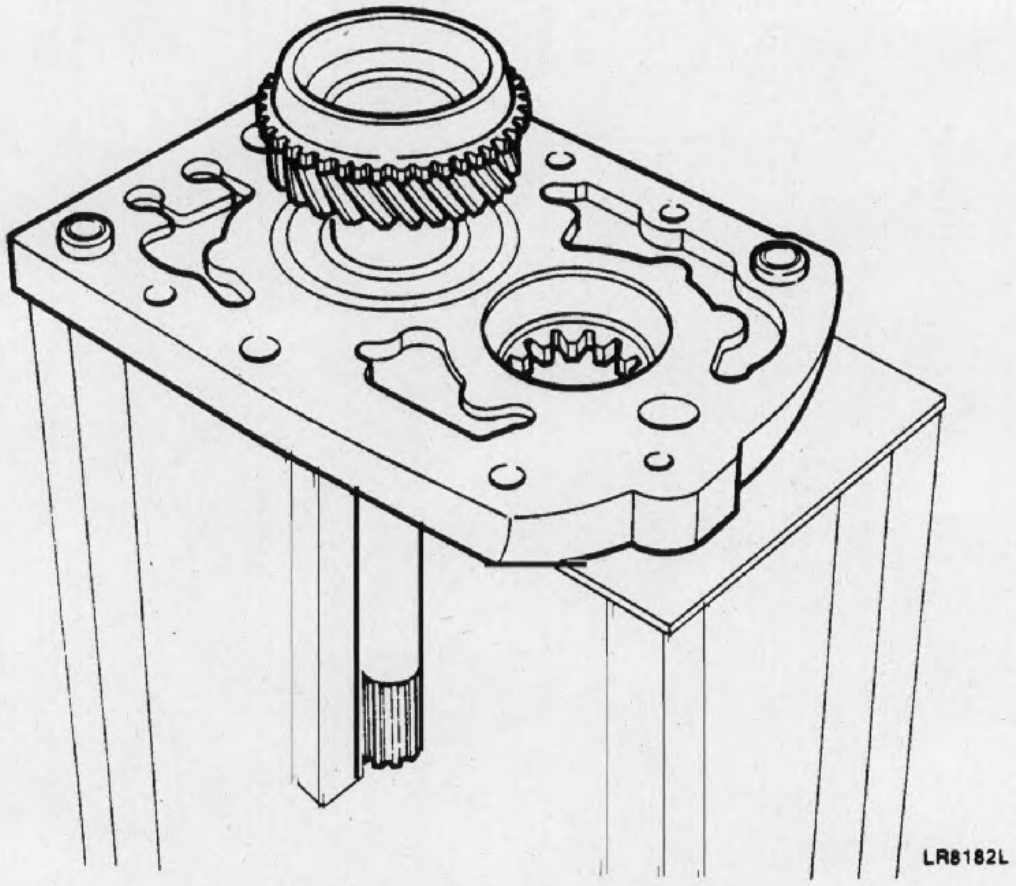
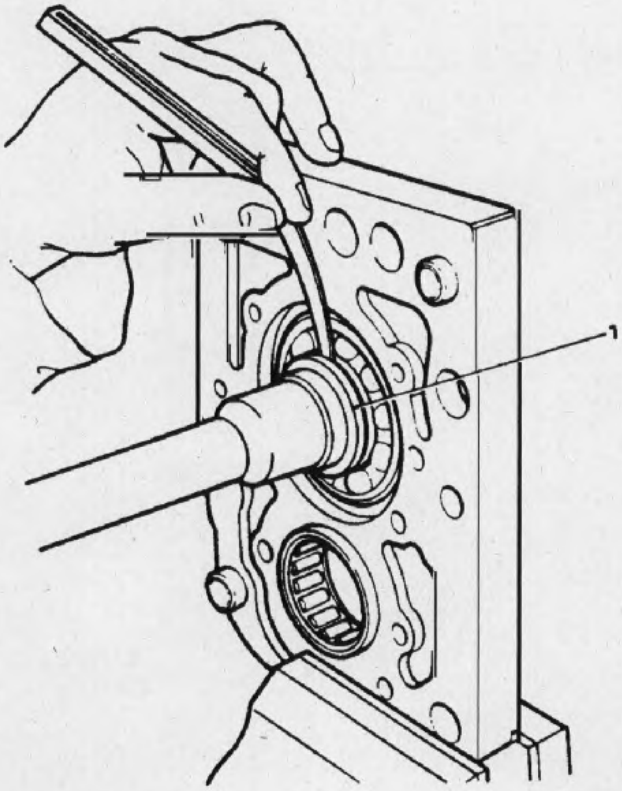
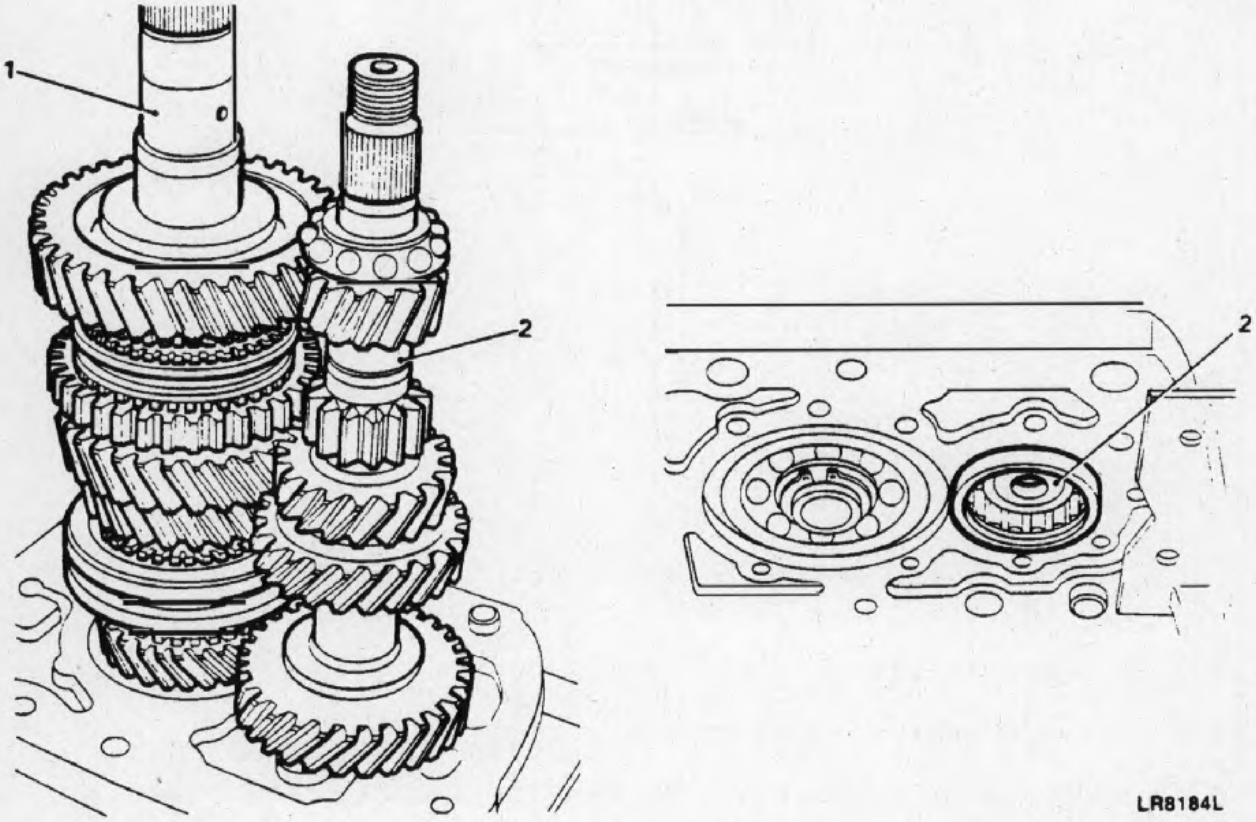


Fig 40 Fitting input shaft to front bearing plate



1 Circlip

Fig 41 Checking input shaft bearing clearance



1 Mainshaft assembly

2 Layshaft assembly

Fig 42 Fitting mainshaft and layshaft to front bearing plate

Reverse gear assembly and front cover

35 To reassemble the reverse gear assembly and front cover proceed as follows:

35.1 Fit thrust washer (Fig 43 (2)) to reverse gear (1), chamfer towards gear, locate gear in gearbox case, and retain temporarily in position with a screwdriver, or similar implement.

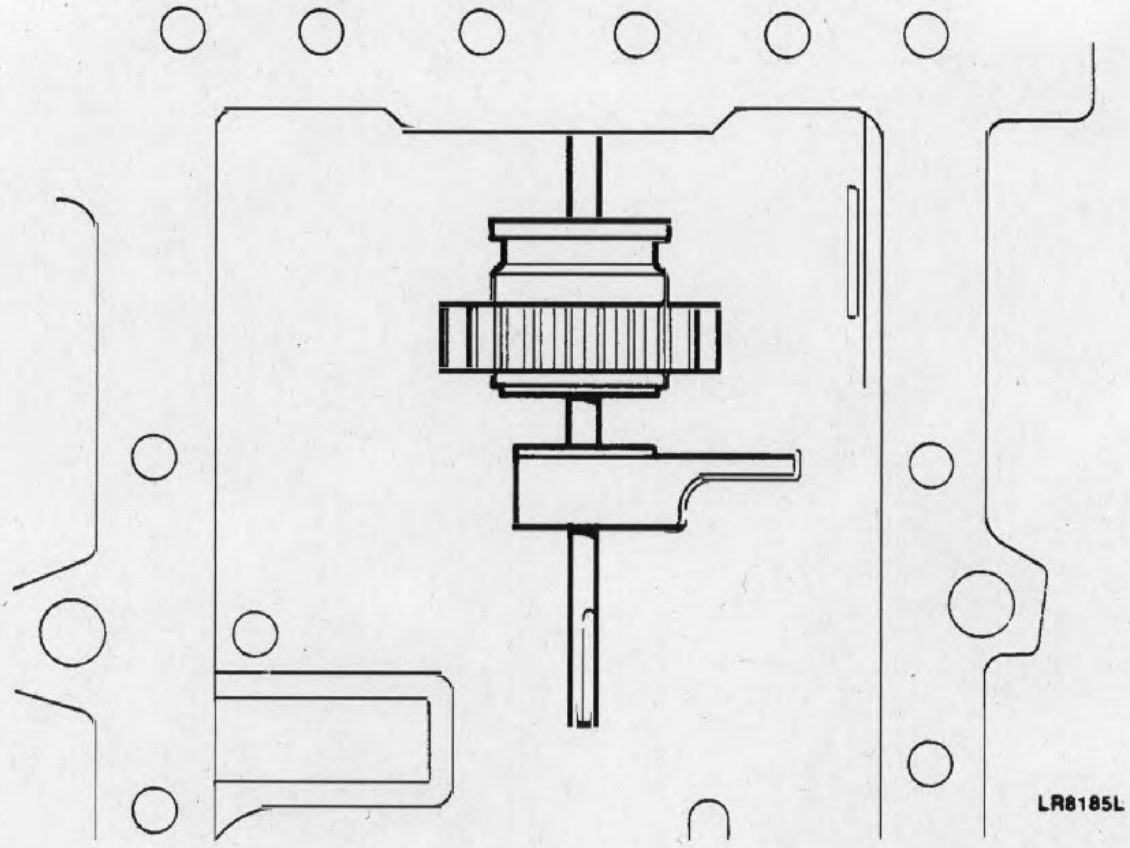


Fig 43 Retaining reverse idler gear

35.2 Fit special tool (Serial No 1) to gearbox (Fig 44).

35.3 Fit new gasket on front bearing plate.

35.4 Lower gearbox case over mainshaft/layshaft assemblies using special tool (Serial No 1) to locate front bearing plate.

35.5 Fit special tool (Serial No 12) over mainshaft and locate on rear bearing.

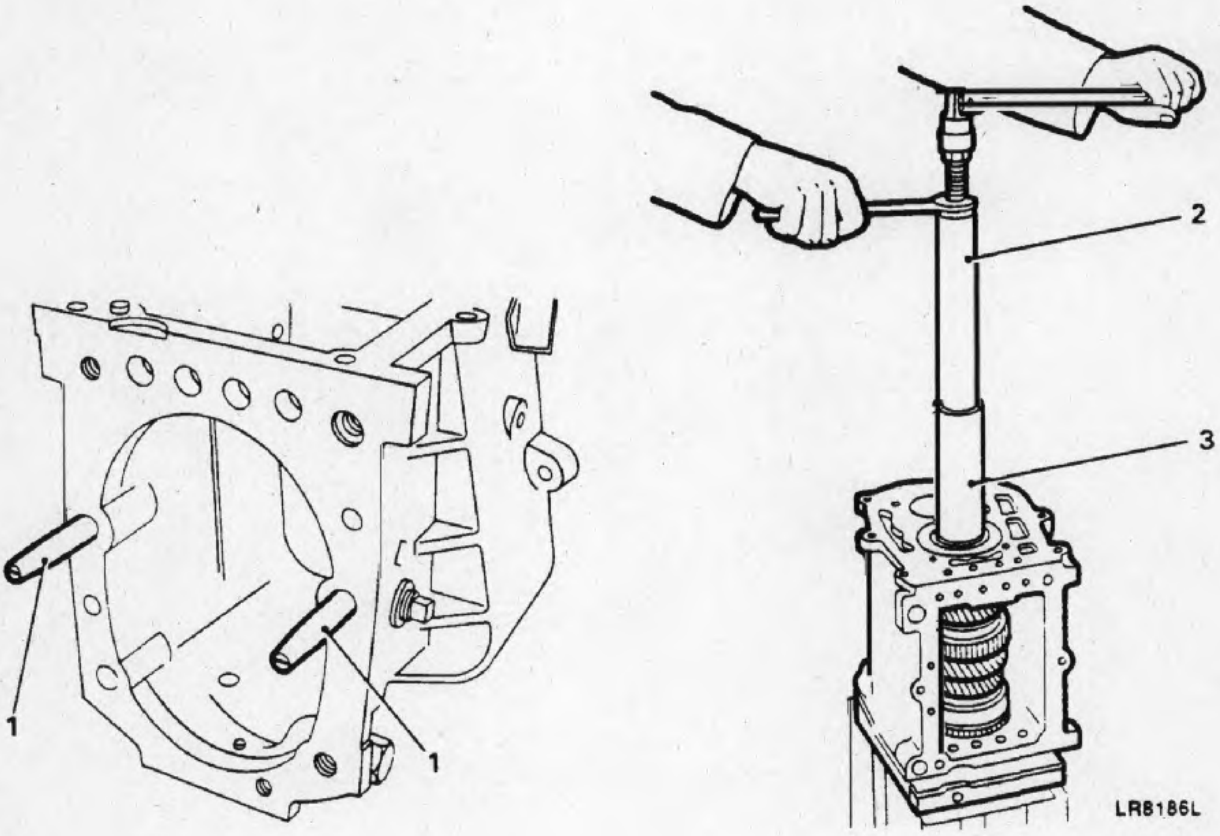
35.6 Fit special tool (Serial No 3) over mainshaft and locate on special tool (Serial No 12).

35.7 With assistance, to prevent gearbox and mainshaft rotation, and using above tools, pull gearbox to front bearing plate.

35.8 Fit layshaft rear bearing (identification numbers to r ar), locally manufactured dummy spacer, and retain temporarily with layshaft nut (Fig 45).

35.9 Remove special tool (Serial No 1).

35.10 Temporarily fit two bell housing bolts with spacers, to secure front bearing plate to gearbox.



1 Special tool (Serial No 1)
2 Special tool (Serial No 3)
3 Special tool (Serial No 12)

Fig 44 Fitting front bearing plate to main casing

35.11 Remove special tools (Serial No's 3 and 12) and check that the mainshaft is engaged through bearing sufficiently to fit mainshaft bearing circlip.

35.12 Remove screwdriver from reverse shaft location and fit reverse shaft (Fig 45).

35.13 Invert gearbox and fit spacer to layshaft front bearing.

35.14 Using special tools (Serial No's 9 and 5) locate layshaft front bearing to final position (Fig 46).

35.15 Temporarily remove layshaft bearing spacer.

35.16 Fit locally manufactured stand to underside of gearbox and secure with two bolts, nuts, spring and plain washers. Adjust bolt under the filter housing as necessary.

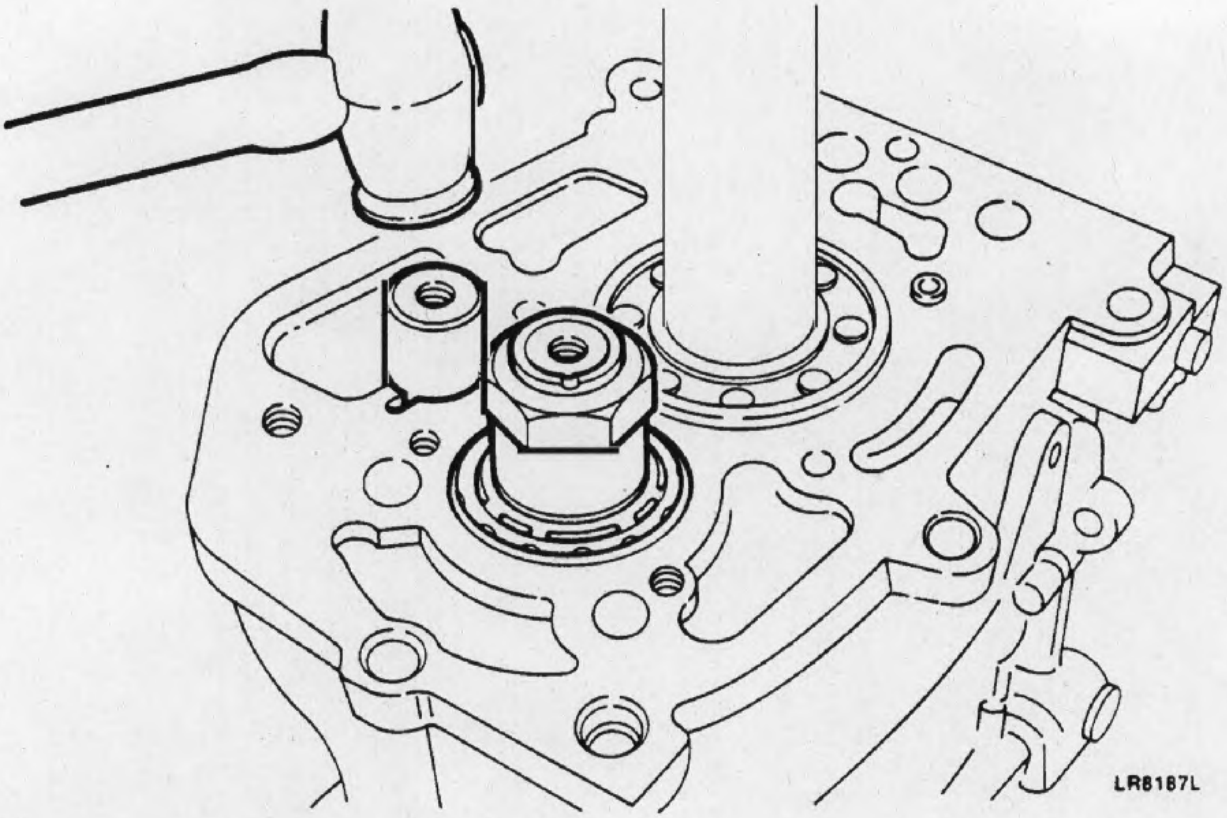


Fig 45 Fitting reverse gear shaft

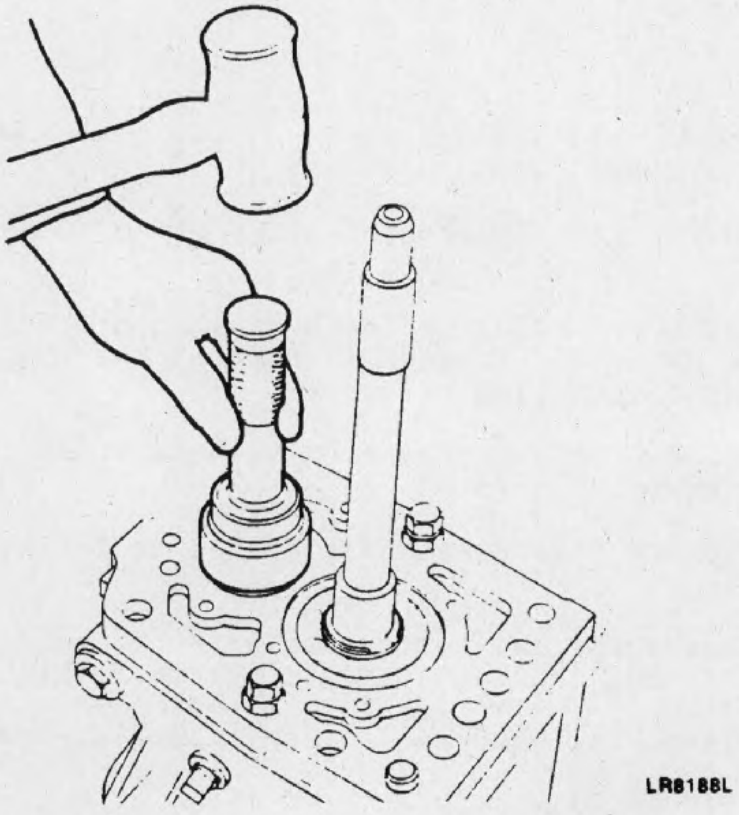


Fig 46 Fitting layshaft front bearing

35.17 S cur gearbox stand in vice.

35.18 Ch ck that 4th gear baulk ring and all other baulk rings are free.

35.19 Fit layshaft front bearing spacer.

35.20 Fit new gasket to front cover.

35.21 Tape input shaft splines, to prevent damage to front cover oil seal when fitting.

35.22 Ensure oil pump drive aligns with the square seating in the layshaft and fit front cover to front bearing plate and secure with seven bolts and spring washers.

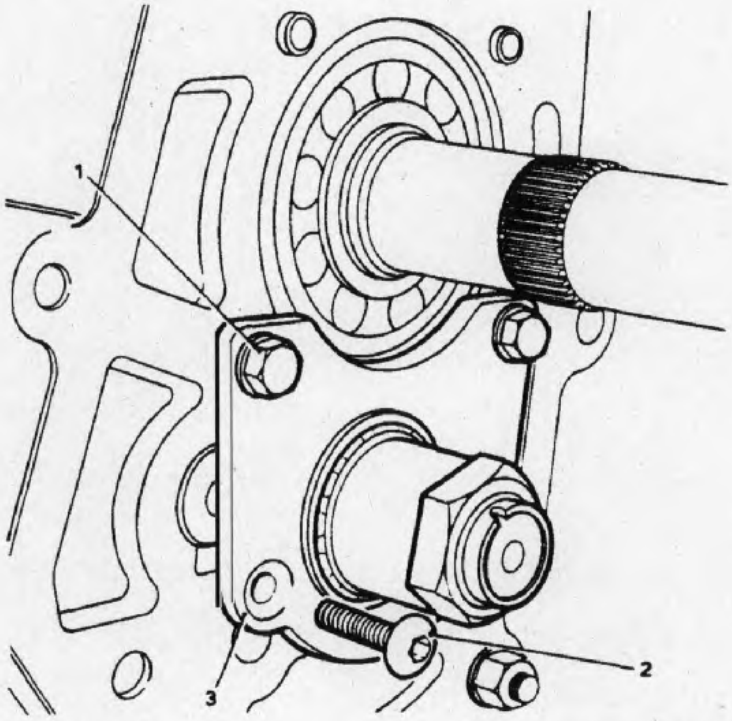
35.23 Remove tape from input shaft splines.

35.24 Fit reverse lever to reverse gear.

35.25 Apply Loctite Stud and Bearing Fit (270) to pivot bolt threads, fit bolt in gearbox and locate in reverse lever pivot boss.

35.26 Position reverse shaft, layshaft bearing track retaining plate (Fig 47 (1)) and secure top of plate with two bolts (2) and spring washers.

35.27 Apply Loctite Stud and Bearing Fit (270) to socket head setscrews (3) and secure bottom of retaining plate.



1 Retaining plate
2 Bolts
3 Socket head setscrews

Fig 47 Fitting reverse gear shaft retaining plate

Fifth gear assembly

36 To reassemble the fifth gears to layshaft and mainshaft proc ed as follows:

36.1 Remove nut from layshaft and remove dummy spacer.

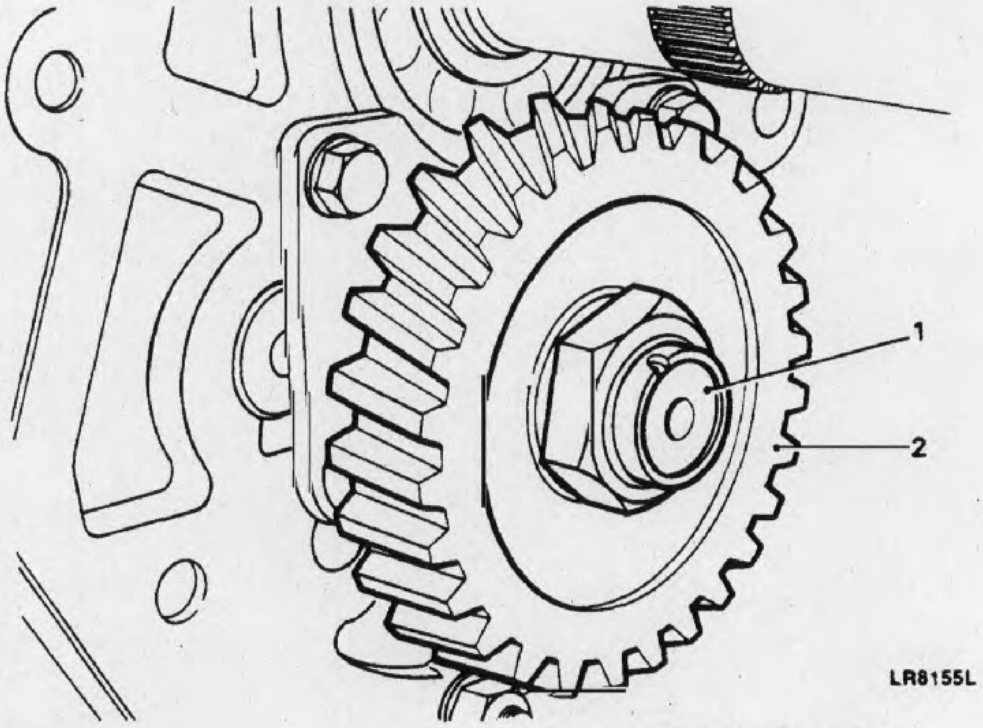
36.2 Fit 5th gear (Fig 48 (2)) to layshaft with large boss to the rear.

36.3 Rotate layshaft to give access to stake slot.

36.4 To facilitate next operation, lock gearbox by engaging 1st and 4th gears.

36.5 Fit a new 5th gear retaining nut (1) and tighten to the specified torque.

36.6 Stake retaining nut collar into recess in layshaft.



1 Stake nut 2 Layshaft 5th gear

Fig 48 Layshaft fifth gear assembly

36.8 Return 1st and 4th gear synchrosmesh to neutral.

36.9 Fit mainshaft rear bearing circlip (Fig 49 (11).

36.10 Fit thrust washer (10).

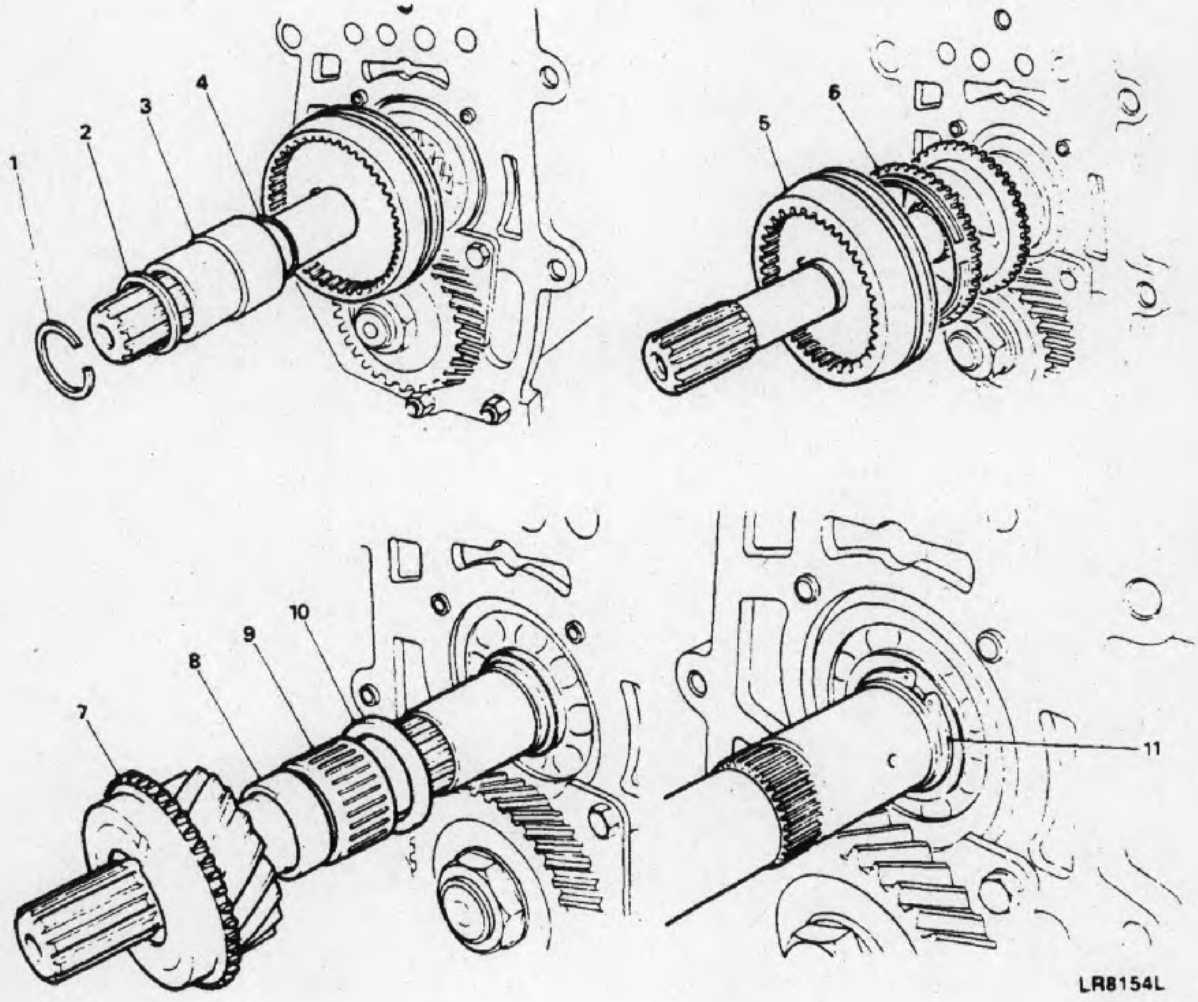
36.11 Lubricate needle roller bearings (9) and fit to mainshaft followed by spacer (8) and 5th gear (7).

36.12 Fit baulk ring (6) and 5th gear synchromesh hub assembly (5).

36.13 Tape mainshaft splin s and fit 'O' ring (4) to its seating on mainshaft.

36.14 Fit oil seal collar (3) and locate in peg on hub backing plate.

36.15 Fit the washer (2) selected during the 5th gear end float check and retain with circlip (1). Remove tape.



1	Circlip	7	Mainshaft 5th gear
2	Selective washer	8	Spacer
3	Oil seal collar	9	Needle roller bearing
4	'O' ring	10	Thrust washer
5	5th gear synchromesh hub	11	Circlip
6	Baulk ring		

Fig 49 Mainshaft fifth gear assembly

Selector rails and forks

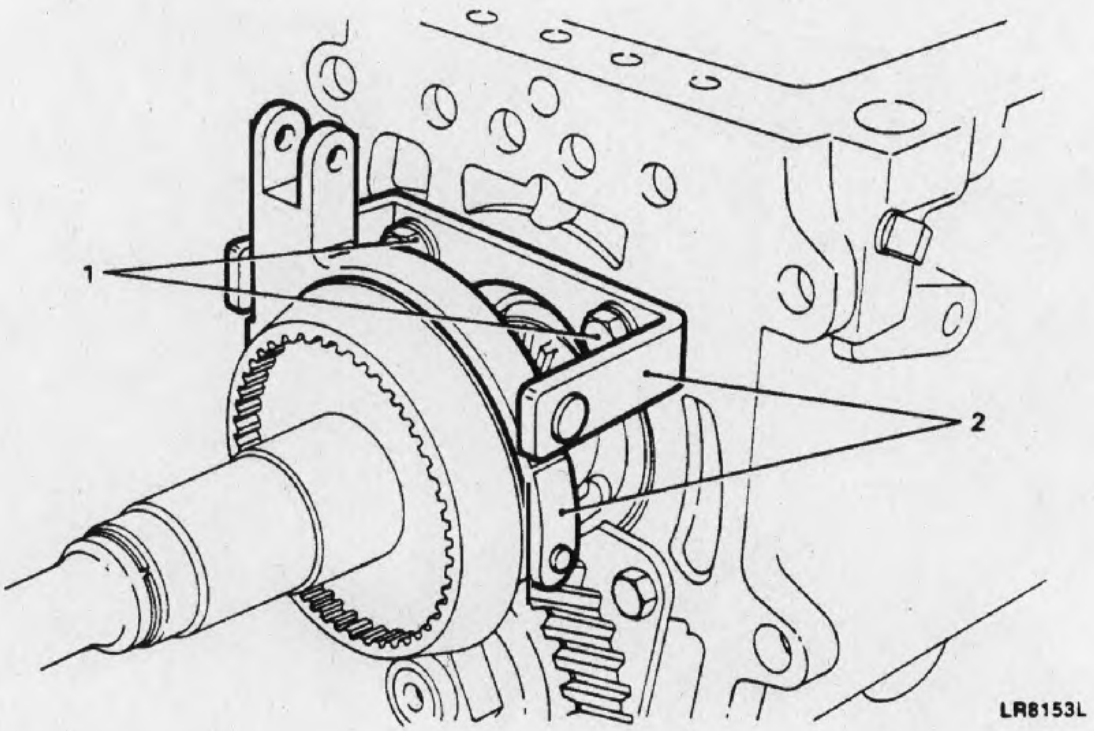
37 To reassemble the selector rails and forks proceed as follows:

37.1 If previously removed, refit 5th gear selector fork pivot pins and secure with circlips.

37.2 If previously removed, refit slipper pads to selector fork.

37.3 Locate 5th gear fork and bracket (Fig 50 (2)) onto synchro hub and gearbox dowels.

37.4 Secure fork bracket to gearbox with two bolts, plain washers and spring washers (1).



1 Fork and bracket fixings 2 Fork and bracket assembly

Fig 50 Fifth gear selector fork assembly

37.5 Fit selector rail interlock plungers (Fig 51) into the cross-drilling in the gearbox case.

37.6 Fit 1st/2nd and 3rd/4th selector forks (Fig 52).

37.7 Fit reverse cross-over lever.

37.8 Insert interlock (Fig 53) into 1st/2nd selector rail.

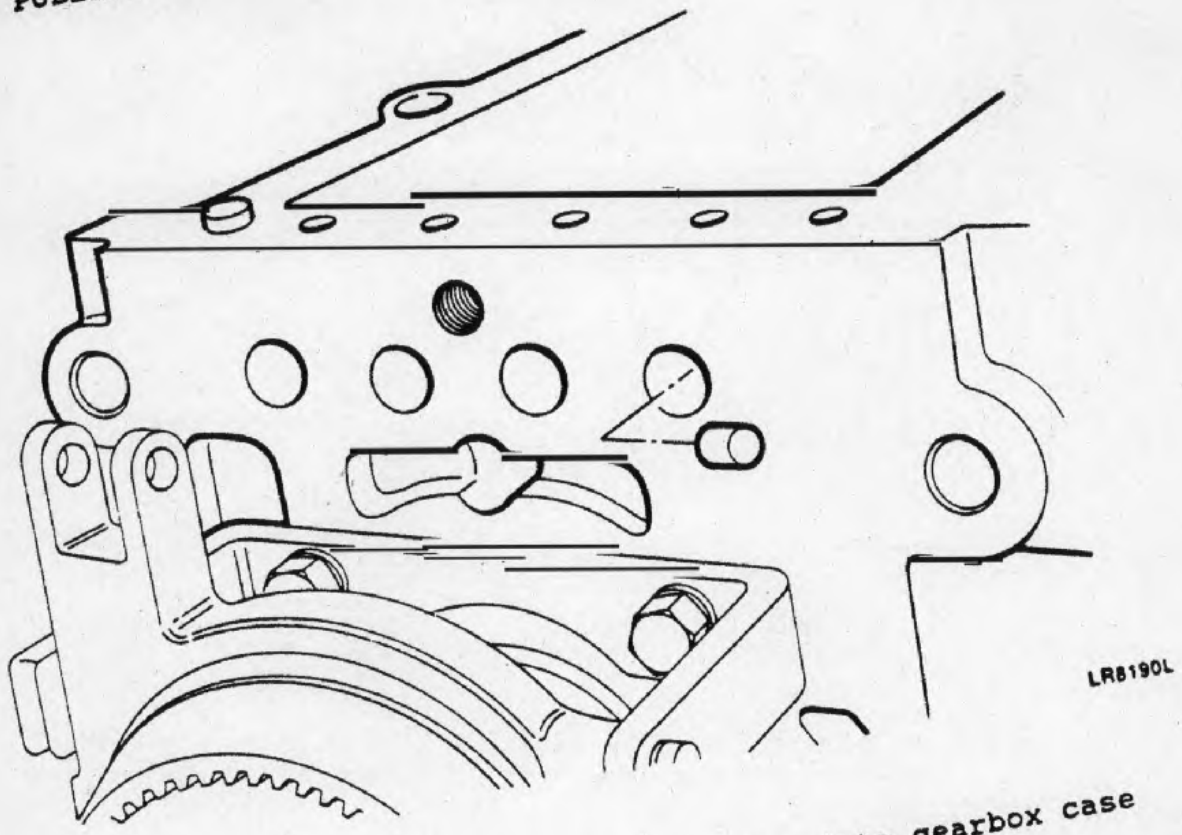


Fig 51 Inserting interlock plungers into gearbox case

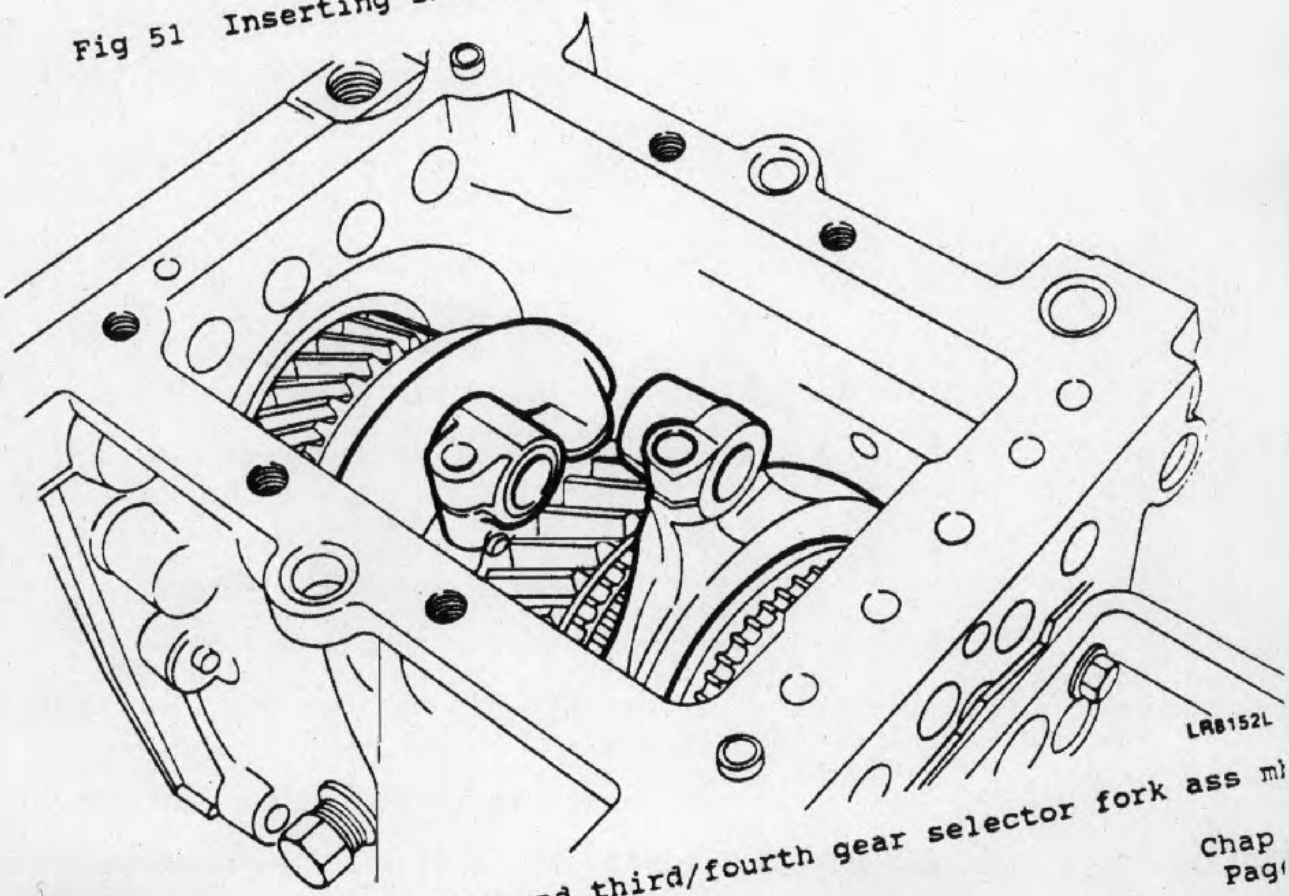


Fig 52 First/second and third/fourth gear selector fork ass m

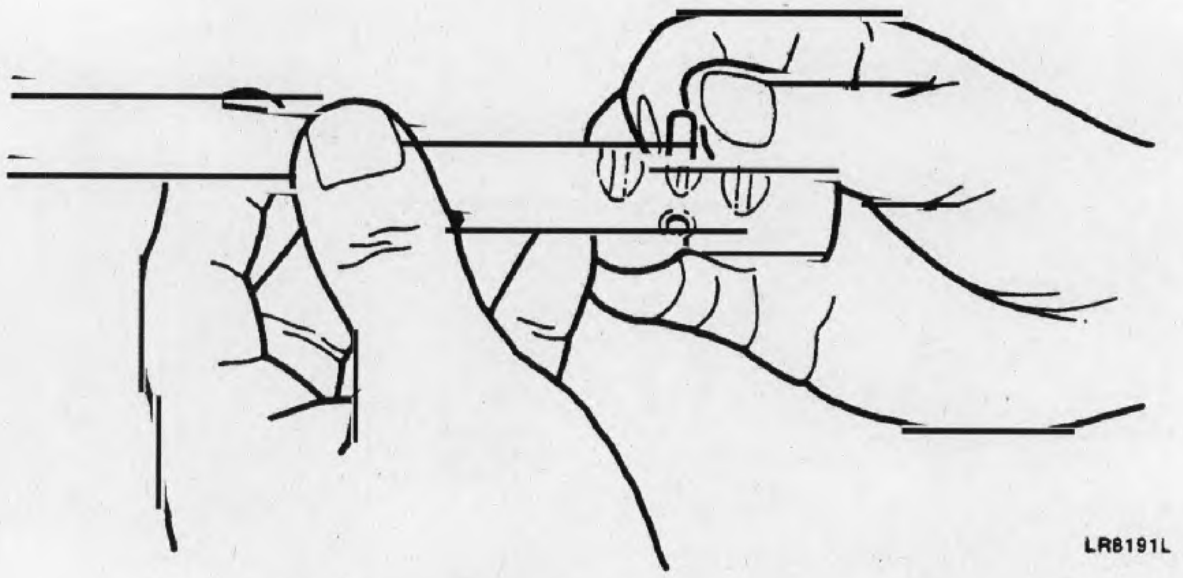


Fig 53 Inserting interlock to selector rail

37.9 Push 1st/2nd selector rail (Fig 54 (8)) through gearbox seating and locate in reverse cross-over lever and selector fork; do not tighten fork clamp bolt.

Note ...

1st/2nd fork clamp bolt is not a set bolt.

37.10 Fit 1st/2nd selector jaw (5) to rail and align for roll pin.

37.11 Using suitable drift, tap in roll pin (4) to secure jaw and rail.

37.12 Repeat operation for 3rd/4th selector rail (9) and jaw (12).

37.13 Push 5th gear selector rail (10) through gearbox seating and locate in reverse cross-over lever.

37.14 Fit 5th gear selector jaw (13) to rail (14), align for roll pin (15).

37.15 Locate selector rail into 5th gear selector fork and secure with clevis pin (11), washer, and split pin.

37.16 Fit roll pin and secure selector rail and jaw.

37.17 Push reverse selector rail (7) through gearbox seating and locate in reverse cross-over. Do not tighten lever clamp bolt.

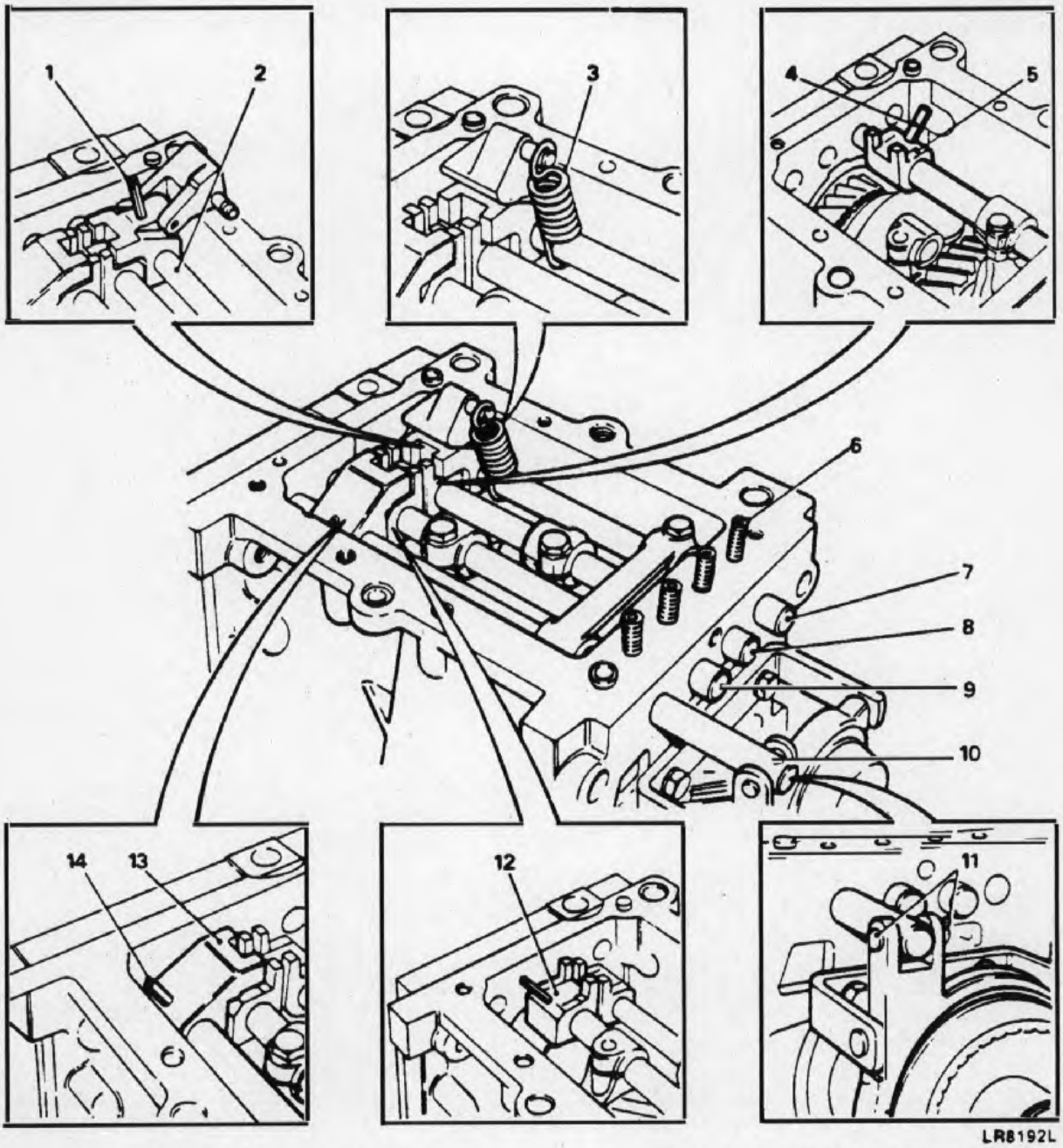
37.18 Fit jaw (2) to rail and align for roll pin (1).

37.19 Using a suitable drift, fit roll pin to secure s lector rail and jaw.

Note ...

The roll pin must be inserted sufficiently to be flush with the underside face of the selector jaw.

37.20 **Fit reverse gate spring (3) to selector rail and knock-over lever.**



1	Reverse jaw roll pin	8	1st/2nd selector rail
2	Reverse selector jaw	9	3rd/4th selector rail
3	Reverse gate spring	10	5th selector rail
4	1st/2nd jaw roll pin	11	Clevis pin
5	1st/2nd selector jaw	12	3rd/4th selector jaw
6	Detent balls and springs	13	5th selector jaw
7	Reverse sel ctor rail	14	5th jaw roll pin

Fig 54 Sel ctor rails and forks assembly

Selector fork adjustment

38 To adjust the selector forks proceed as follows:

38.1 Fit top cover gasket.

38.2 Secure locally manufactured detent spring retaining tool and spacers (Fig 55) to gearbox using two 8 x 50mm bolts and plain washers.

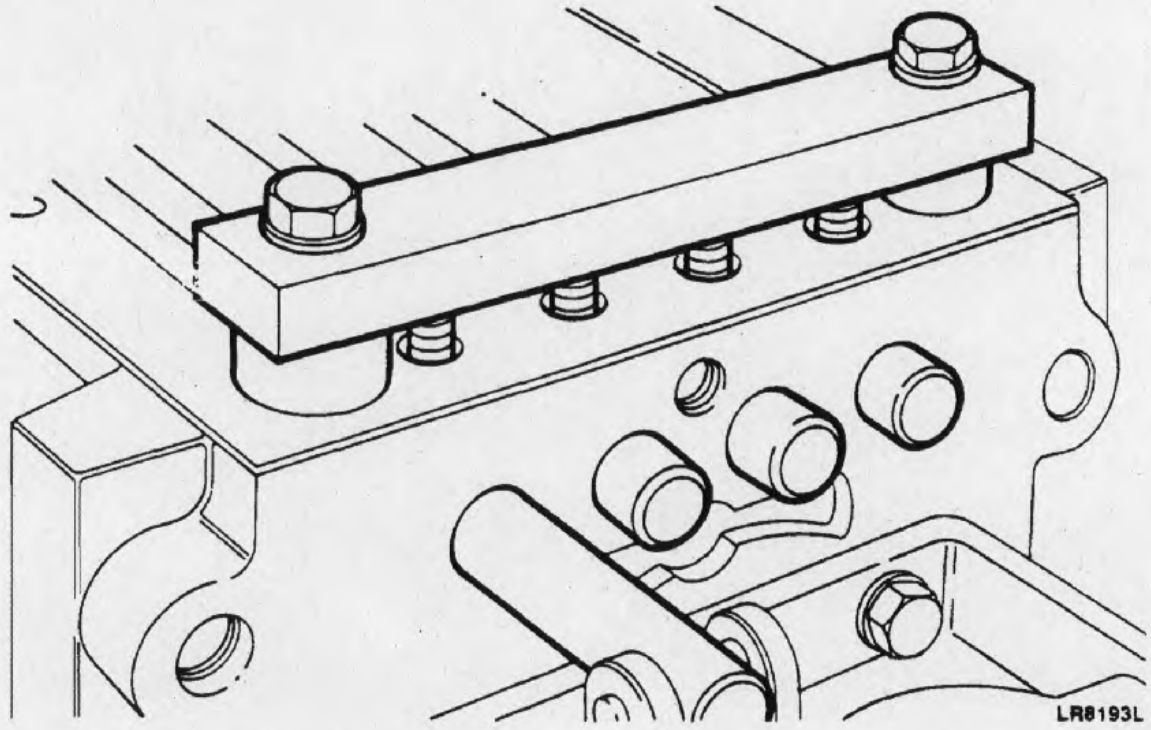


Fig 55 Securing detent spring retaining tool and spacers

38.3 Tighten bolts and compress detent springs until retaining plate contacts the two spacers.

38.4 Ensure that 1st/2nd selector rail and synchro sleeve are in neutral position. Tighten clamp bolt sufficiently to liminate any rock in the selector fork and move selector fork r arwards (Fig 56 (2))

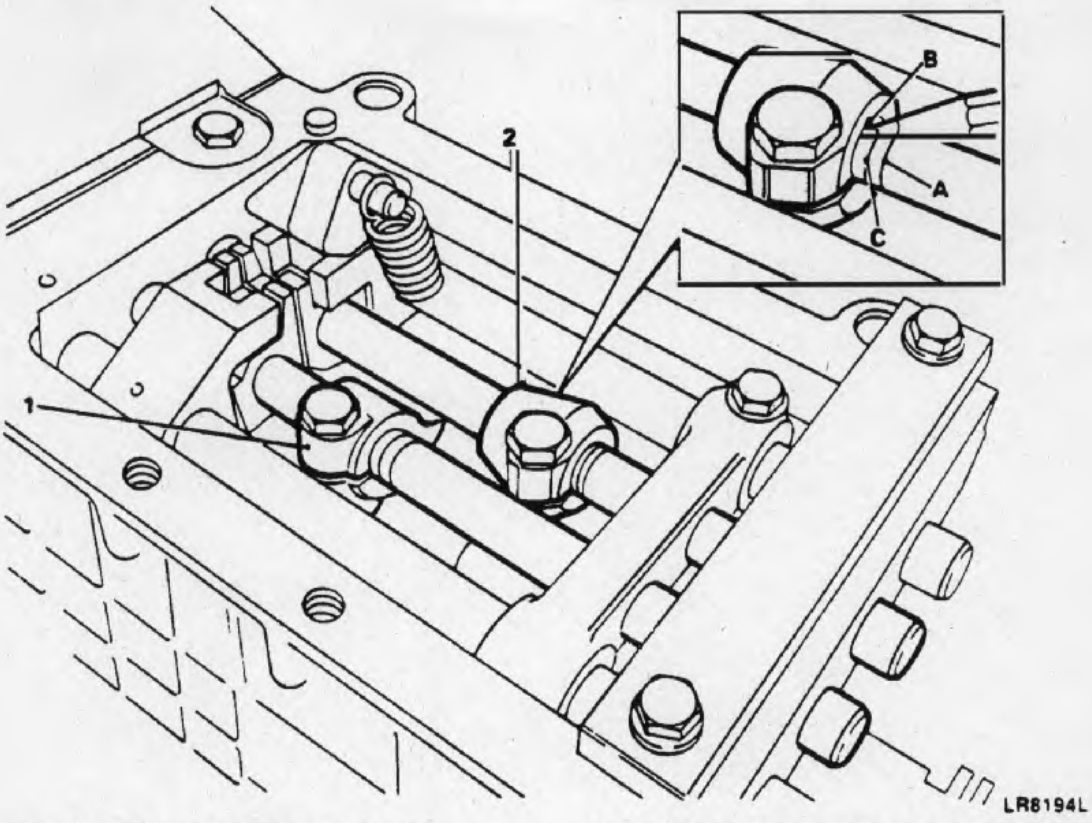
38.5 Scribe a pencil line 'A' on rail at rear of fork yoke.

38.6 Move fork forwards on rail and scribe line 'B' on rail at rear of fork yoke.

38.7 Scribe a line 'C' midway between the other lines on the selector shaft.

38.8 Move selector fork to centre line and tighten clamp bolt.

38.9 Repeat operation for 3rd/4th selector fork (1) and rail.



1 3rd/4th selector fork 2 1st/2nd selector fork

Fig 56 Selector fork adjustment

Reverse cross-over lever adjustment

39 The purpose of the following adjustment is to ensure that when 1st gear is selected the outer member of the 1st/2nd synchro member is not also engaged with the reverse idler:

39.1 Move reverse gear thrust washer fully forward.

39.2 Fit locally manufactured gauge (Fig 57 (1)) to reverse selector shaft (5).

39.3 Move rail rearwards and select reverse gear.

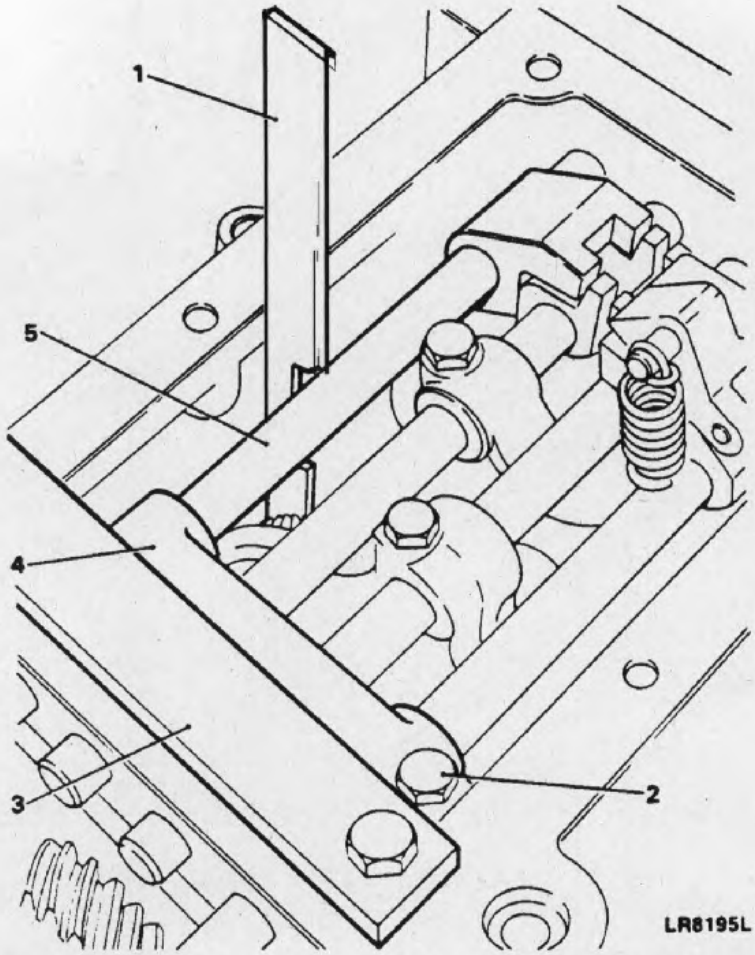
39.4 Move cross-over lever (4) rearwards to lightly nip gauge between reverse gear and thrust washer.

39.5 Tighten reverse cross-over lever clamp bolt (2) and return rail to neutral. Remove gauge.

39.6 Move 1st/2nd rail rearwards and select first gear. Ensure a minimum clearance of 1,0mm has been obtained between reverse gear idler and reverse gear on 1st/2nd synchromesh sleeve. If there is not enough clearance, readjust the reverse cross-over lever.

39.7 Return 1st/2nd rail back to n utral.

39.8 Remove detent spring retaining tool and spacers (3).



1 Adjustment gauge
2 Clamp bolt
3 Spring retaining tool
4 Reverse cross-over lever
5 Reverse selector shaft

Fig 57 Reverse cross-over lever adjustment

G ar change lever assembly

40 To reassemble the gear change lever assembly proceed as follows:

40.1 Fit top cover and locate over detent springs.

40.2 Fit top cover filler plug.

40.3 Position breather pipe, locate retaining clips, secure top cover and pipe clips with eight bolts and washers.

40.4 Fit breather pipe banjo union and fibre washers.

40.5 Lubricate gear lever ball and lower yoke.

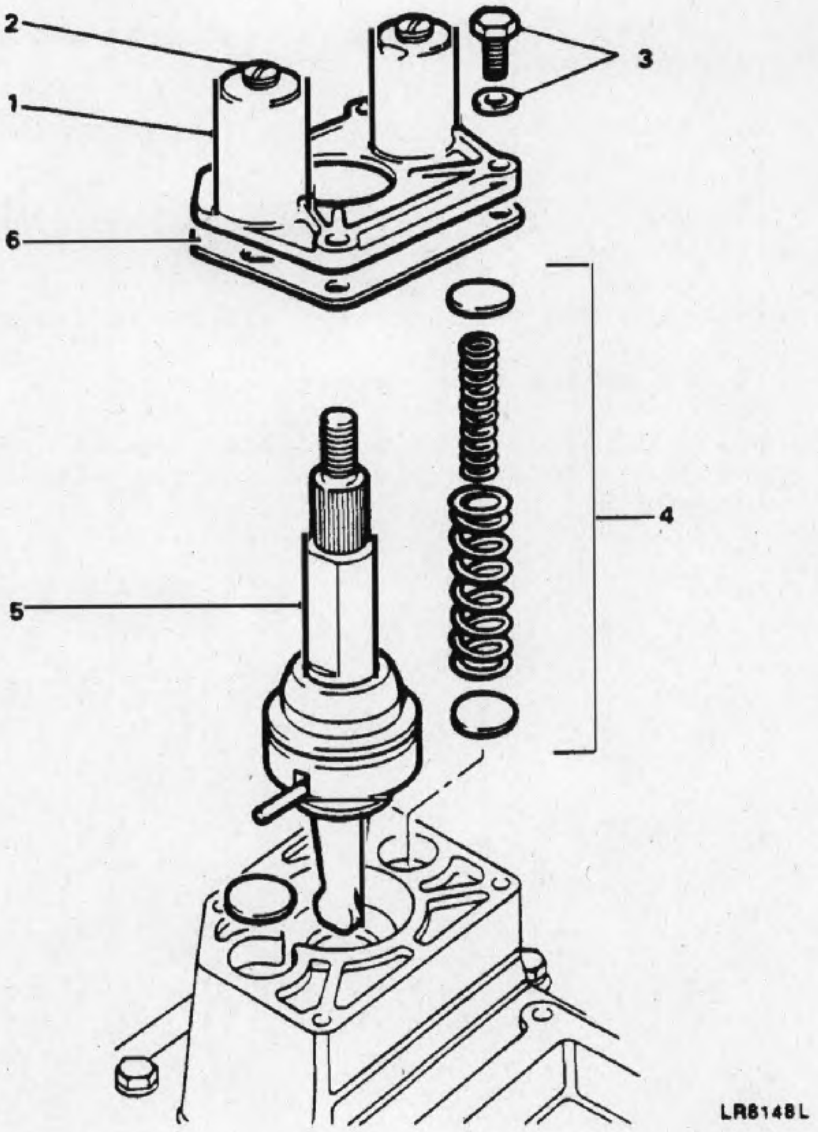
40.6 Fit lower gear lever, cup and grommet (Fig 58 (5)).

40.7 Fit n w gasket (6) to housing.

40.8 Grease bias springs.

40.9 Carefully fit shims and bias springs (4), spring housing (1) and s cure with four s tscr ws, and spring washers (3).

40.10 Refit bias spring screws (2) - two turns at this stage.



1 Bias spring housing
2 Spring adjustment screw
3 Bolts and spring washers
4 Bias springs and shims
5 Gear lever assembly
6 Gasket

Fig 58 Gear change lever assembly

Bell housing and clutch release lever

41 To reassemble the bell housing and clutch release lever proceed as follows:

41.1 Apply grease to the lever pivot and inner face of bearing carrier.

41.2 If removed, refit bearing sleeve dowels.

41.3 Fit bearing sl ve (Fig 59 (3)) to b ll housing and secure with singl bolt.

41.4 Fit operating lever pivot (2).

41.5 Fit pivot slotted washer and operating lever (5)

41.6 Fit operating pivot clip (4) to lever and secure with bolt and spring washer.

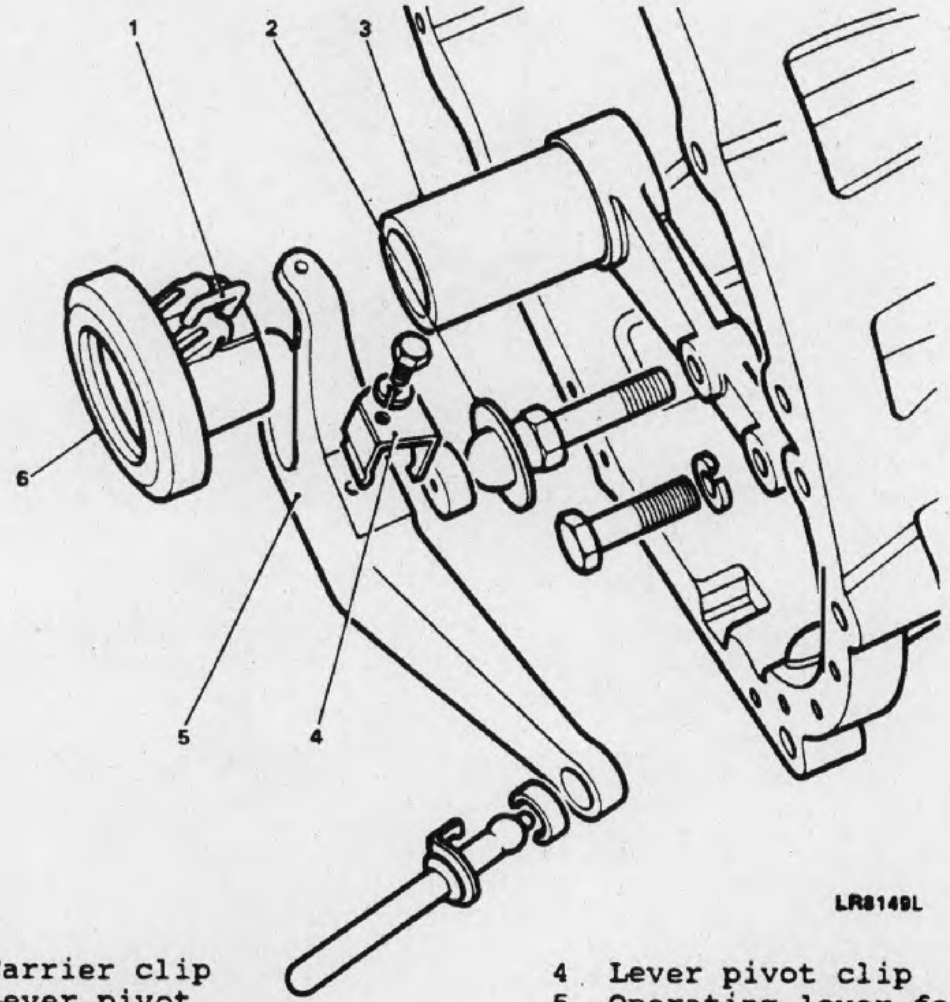
41.7 Fit carrier assembly and thrust bearing (6) to sleeve (3).

41.8 Fit thrust bearing carrier to clutch operating lever fork and secure with retaining clip (1).

41.9 Remove the two temporarily bell house fixings.

41.10 Fit new bell housing gasket.

41.11 Locate bell housing squarely on dowels and secure housing and front bearing plate to gearbox with six bolts and spring washers.



1 Carrier clip
2 Lever pivot
3 Bearing sleeve
4 Lever pivot clip
5 Operating lever fork
6 Thrust b aring

Fig 59 Bell housing and clutch release lever assembly

Ext nsion housing

42 To reassemble and fit the extension housing proceed as follows:

42.1 If necessary, replace extension housing dowels.

42.2 Using special tool (Serial No 7) fit new oil seal to extension housing.

42.3 The special nut retaining the 5th gear to the layshaft must be secured in position, by carefully forming the collar of the nut into the layshaft slots (Fig 60).

CAUTION ...

A round nose tool must be used for this operation to avoid splitting the collar of the nut. Also, the 5th layshaft gear should be supported by a wooden block when the nut is being deformed, to prevent damage to the bearings adjacent to the gear.

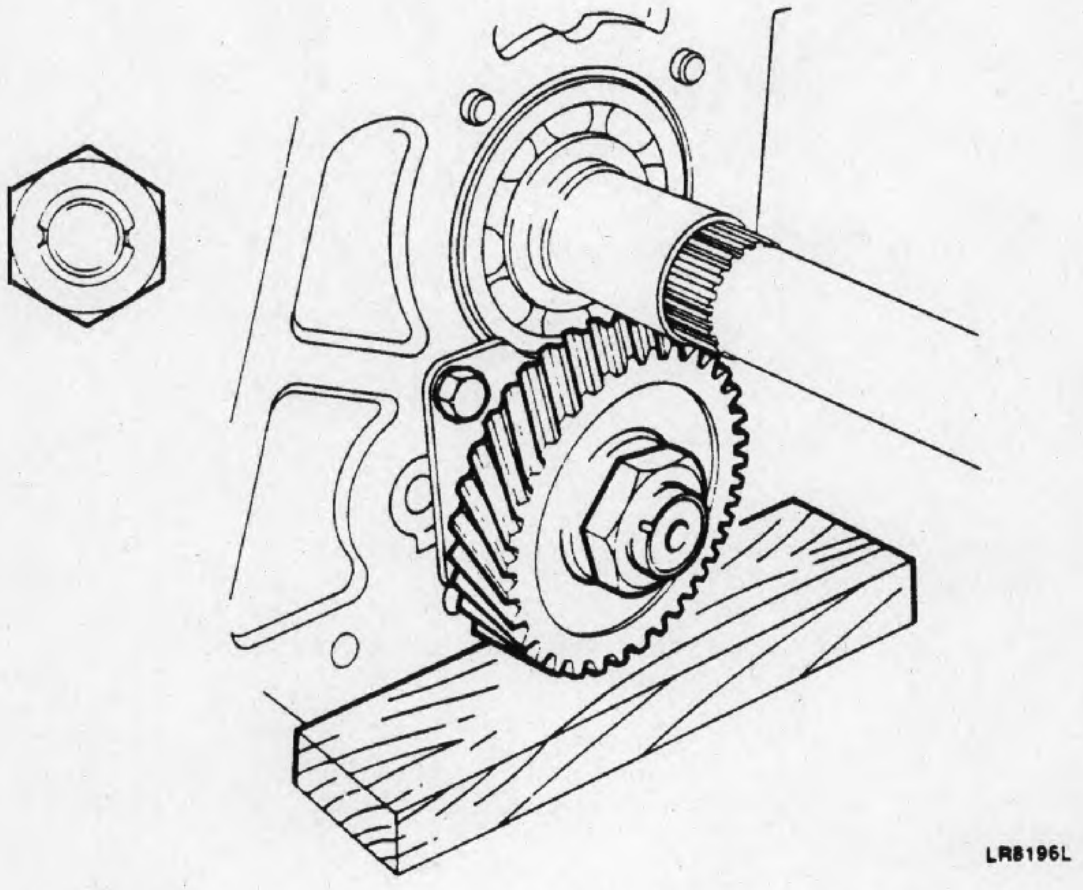


Fig 60 Layshaft fifth gear special nut

42.4 Support underside of gearbox with wooden block.

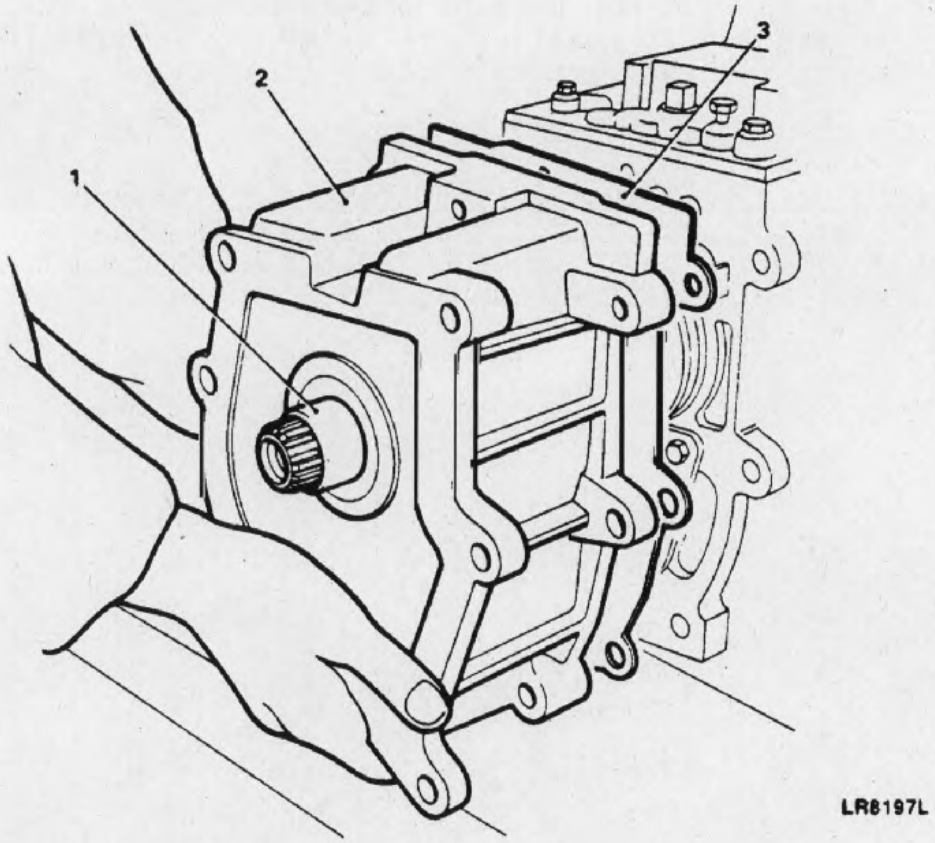
42.5 Lubricate oil seal protection sleeve special tool (Serial No 7) and fit to oil seal from inside extension housing (Fig 61 (1)).

42.6 Fit new gasket (2) to extension housing.

42.7 Carefully manoeuvre extension housing (3) over mainshaft and position squarely on dowels.

42.8 Remove oil seal protection sleeve.

42.9 Secure extension housing to gearbox with eight bolts, spring washers and single nut.



1 Special tool (Serial No 7)
2 Extension housing
3 Gasket

Fig 61 Fitting extension housing

Note ...

Fig 62 shows correct bolt lengths and their locations in extension housing.

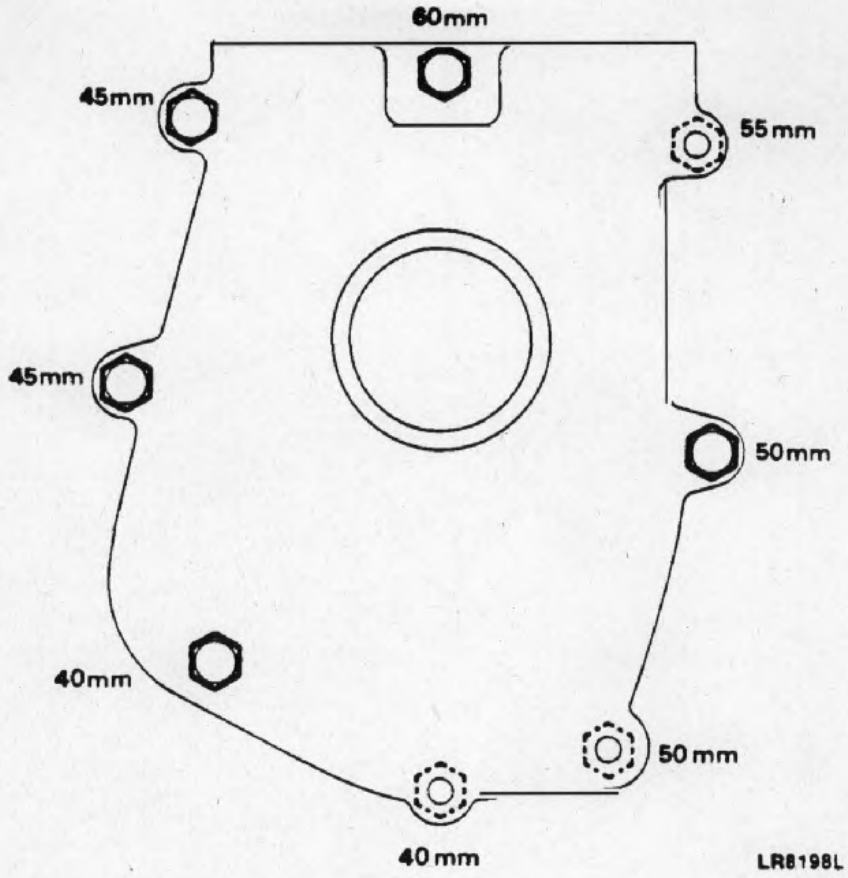


Fig 62 Extension housing bolt locations

Third and fourth gear selector rail adjustment

43 To adjust the third and fourth gear selector rail proceed as follows:

43.1 Slacken 3rd/4th stop screw (Fig 63 (1)) in extension housing.

43.2 Select 3rd gear.

43.3 Tighten stop screw until it makes contact with 3rd/4th selector rail.

43.4 Turn back stop screw one turn. Retighten locknut.

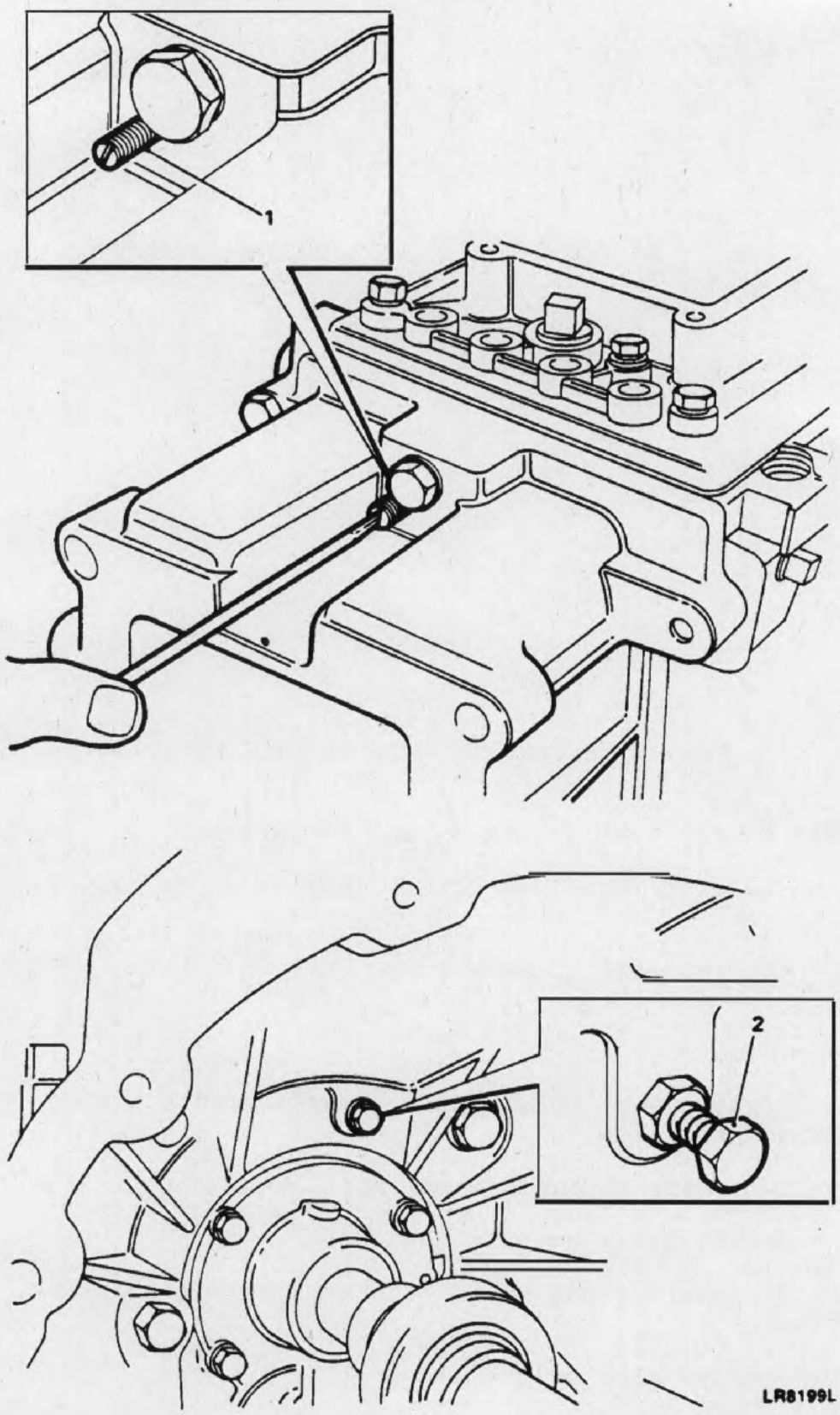
43.5 Return gear lever to neutral.

43.6 Slacken locknut on 3rd/4th stop bolt (2) inside bell housing.

43.7 Unscrew stop bolt.

43.8 Select 4th gear and screw in stop bolt until contact is made with 3rd/4th selector shaft.

43.9 Turn back stop bolt one turn and retighten locknut. Return gear 1 ver to neutral.



1 Adjustm nt scr w 2 Stop bolt

Fig 63 Third/fourth gear selector rail adjustment scr w

Bias spring adjustment

44 To adjust the bias springs proceed as follows:

44.1 Apply Loctite Stud and Bearing Fit (270) to bias spring screws and tighten up until screw heads are flush with top face of bias spring housing (Fig 64).

Gearbox mounting

45 Refit mounting to extension housing and secure with four bolts.

Refitting

46 To refit the gearbox to the vehicle refer to Cat 522 Chap 3-2.

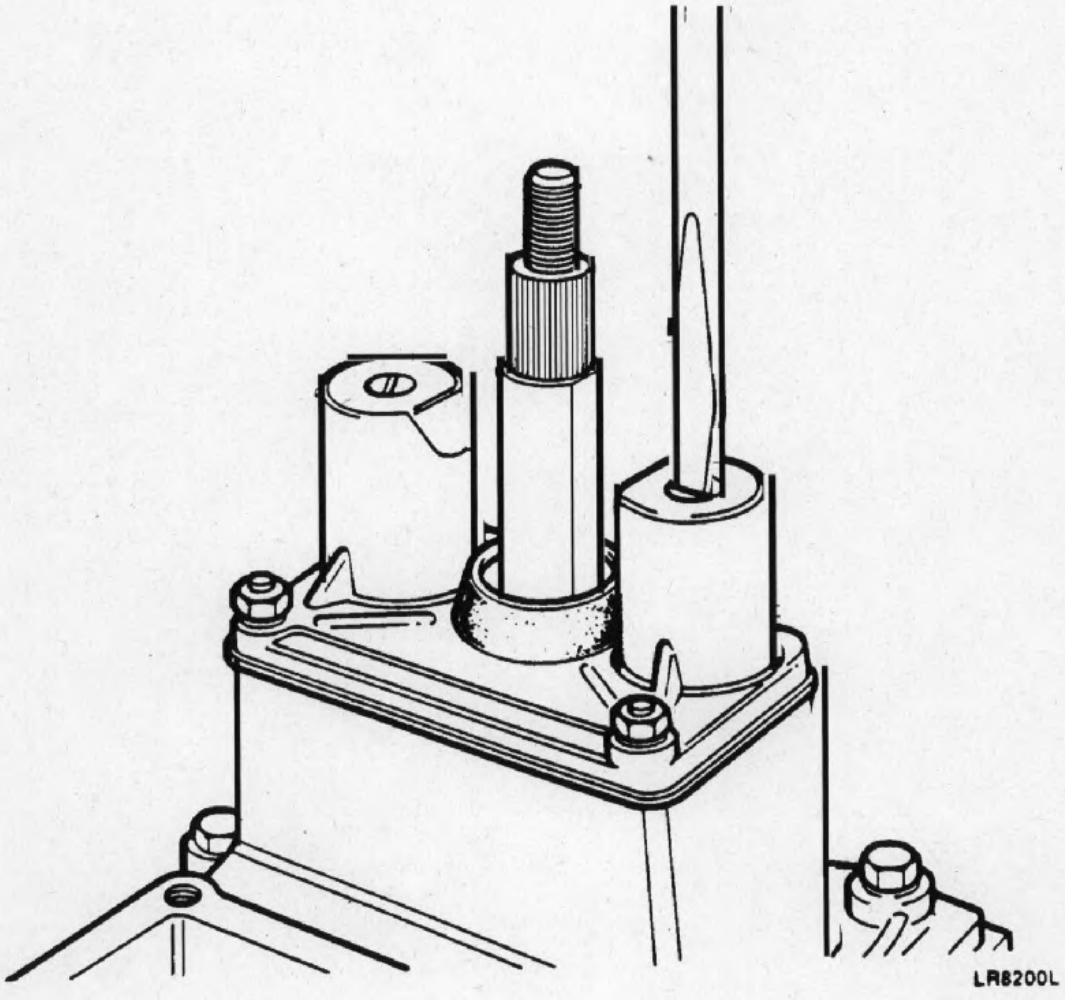


Fig 64 Bias spring adjustment

Chapter 3-3

LT85 LIGHTWEIGHT DIVIDED-CASE MANUAL GEARBOX

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the LT85 Lightweight divided-case manual gearbox fitted to Land Rover 110 vehicl s.

Note ...

Various Base repair procedures are identical to those listed in Cat 524 Chap 3-2, and therefore, the applicable paragraphs have been cross-referenced accordingly. It should be noted however, that certain background detail (ie casings) of illustrations appearing in Chap 3-2 may not represent the LT85 Lightweight divided-case gearbox. This will not detract from the main detail illustrated.

REMOVAL

2 For removal of gearbox from the vehicle refer to Cat 522 Chap 3-2.

SPECIAL TOOLS

3 The special tools listed in the following table will be referred to in the text when used, by the serial number shown in the table.

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	Designation (3)
1	18G 284	Impulse extractor
2	LST 284-1	Remover/adaptor, reverse idler shaft
3	LST 101	Gauge, first gear end float
4	LST 102	Remover/replacer, mainshaft oil seal
5	MS 47	Hand press

LOCALLY MANUFACTURED TOOLS

4 For locally manufactured tools which are also recommend d to assist in carrying out gearbox overhaul refer to Cat 524 Chap 3-2.

Note ...

The locally manufactured tool referred to in Para 4.3 is not required for the LT85 Lightweight divided-case gearbox.

Dismantling

5 Place the gearbox on a suitable work bench with the transfer box removed and support with a suitable wooden block. Ensure the gearbox oil has completely drained. Before overhaul commences it is recommended that the gearbox is fitted to a manufactured support stand (Cat 524 Chap 3-2 Fig 1) as follows:

5.1 Remove the four bolts and detach the l.h. mounting bracket.

5.2 Remove the extension housing (Para 6).

5.3 Fit manufactured stand to gearbox and secure with two bolts, nuts, spring and plain washers. Adjust the fixings 'E' and 'F' so that contact is made with the gearbox.

5.3 With assistance, fit the gearbox and stand into a vice and firmly secure.

Extension housing

6 To remove the extension housing from the main gearbox casing refer to Cat 524 Chap 3-2.

Gear change lever assembly

7 To dismantle the gear change lever assembly refer to Cat 524 Chap 3-2.

Bell housing and clutch release lever

8 To remove/dismantle the bell housing and clutch release lever refer to Cat 524 Chap 3-2.

Selector rails and forks

9 To dismantle the selector rails and forks refer to Cat 524 Chap 3-2.

Casing and gears

10 To dismantle the casing and gears proceed as follows:

10.1 Remove circlip (Fig 1 (1)), selective washer (2), oil seal collar (3) and 'O' ring (4) from mainshaft.

10.2 Remove 5th gear synchromesh hub (5) and baulk ring (6).

10.3 Remove 5th gear (7), spacer (8), needle roller bearing (9) and thrust washer (10).

10.4 Release stake nut collar from recess in layshaft, remove stake nut (Fig 2 (1)) and 5th gear (2) from layshaft.

Note ...

To facilitate this operation lock gearbox by engaging both 1st and 4th gears.

10.5 Fit manufactured spacer (Cat 524 Chap 3-2 Fig 2) to layshaft to retain rear bearing and secure in position with stake nut finger-tight only.

10.6 Disengage 1st and 4th gears.

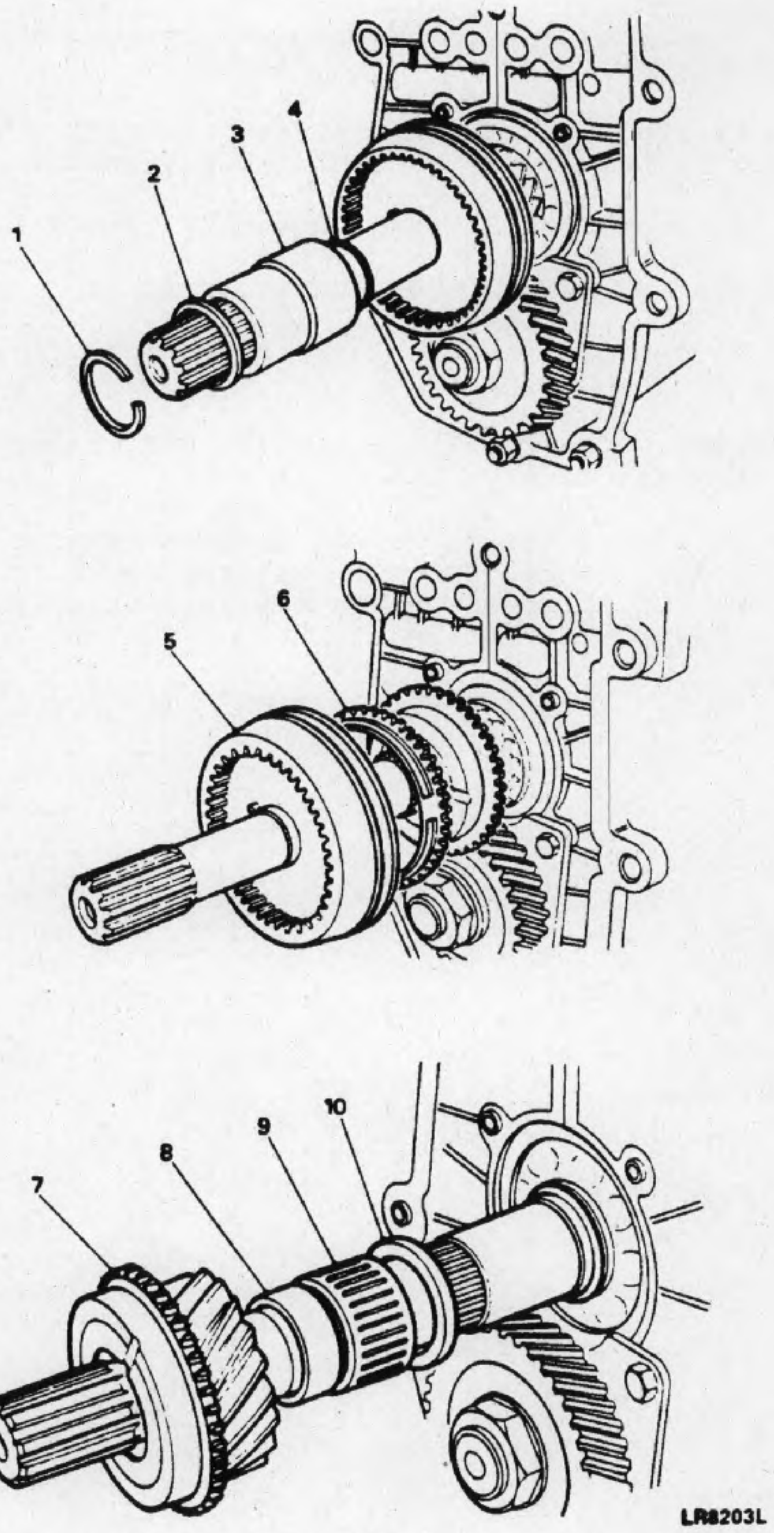
10.7 Remove two socket head setscrews (Fig 3 (2)) and two bolts (1) with spring washers and remove reverse shaft and layshaft bearing track retaining plate (3).

10.8 Remove the seven bolts and withdraw the front cover (Fig 4 (1)) and gasket (2).

10.9 Remove the layshaft front bearing spacer and shims (3).

10.10 Remove the gearbox case and sand from the vice.

10.11 Remove the stand from the case.



1	Circlip	6	Baulk ring
2	Selective washer	7	Mainshaft 5th gear
3	Oil seal collar	8	Spacer
4	'O' ring	9	Needle roller bearing
5	5th gear synchromesh hub	10	Thrust washer

Fig 1 Mainshaft fifth gear dismantling

10.12 R move the s ven bolts Fig 5 (1)) that s cure the two halves of the case together.

10.13 Rest the case on the bench with the reverse gear idler side downwards.

10.14 Carefully separate the case by tapping with a hide mallet alternately at the four corners, to break the seal.

10.15 Lift-out the layshaft assembly (Fig 6 (2)).

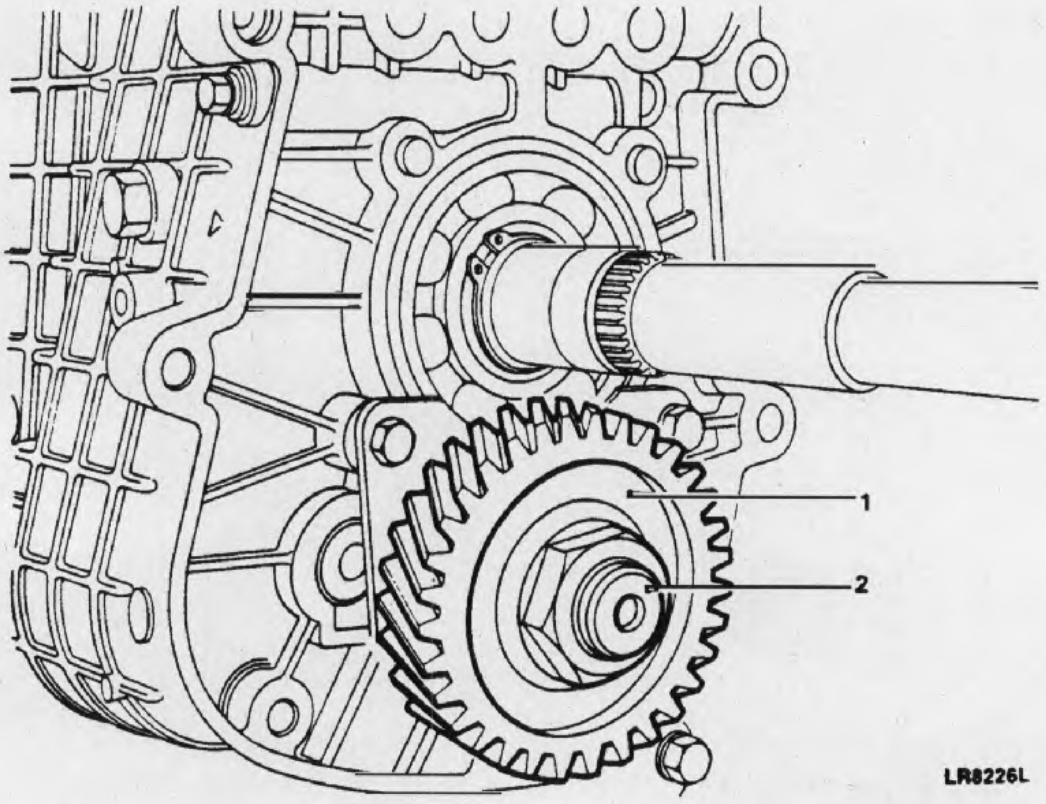
10.16 Remove the mainshaft assembly (1).

10.17 Remove the reverse lever pivot bolt (Fig 7 (3) from the outside of the casing.

10.18 Remove the reverse lever (5) and spacer (4) from the idler gear and case.

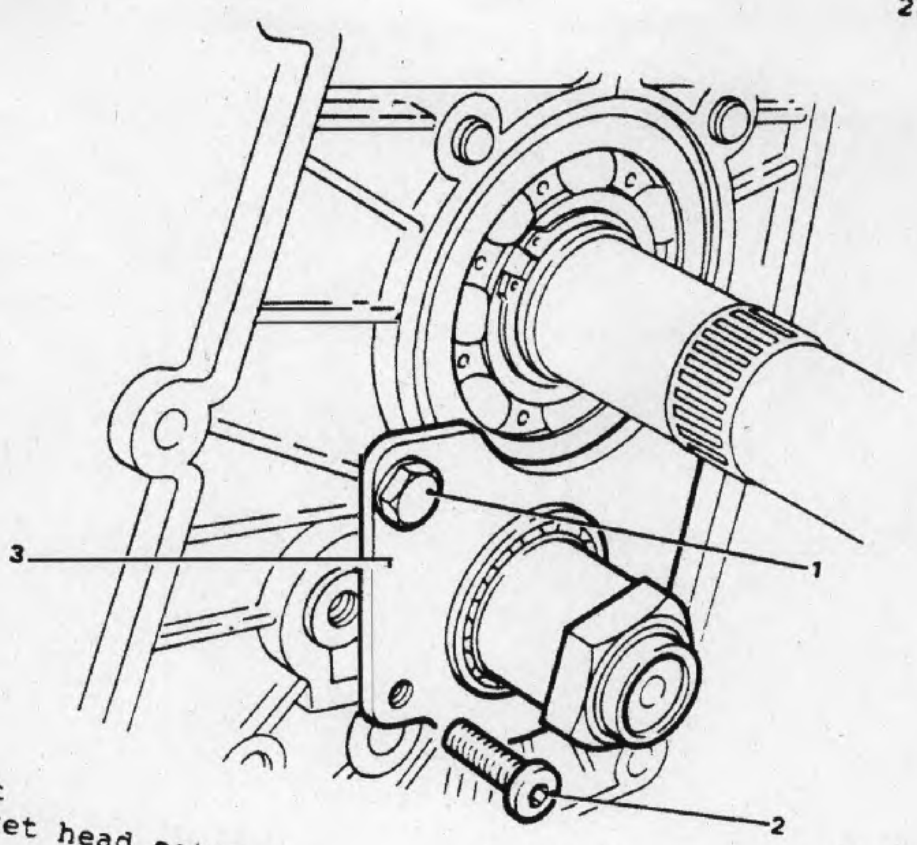
10.19 To remove the reverse gear idler shaft, place the case on a block of timber and with assistance, hold the case firmly and drive-out the shaft using special tools (TABLE 1 Serial No 1 and 2) as ilustrated in Fig 7.

10.20 Remove the reverse idler gear (2) and thrust washer (1).



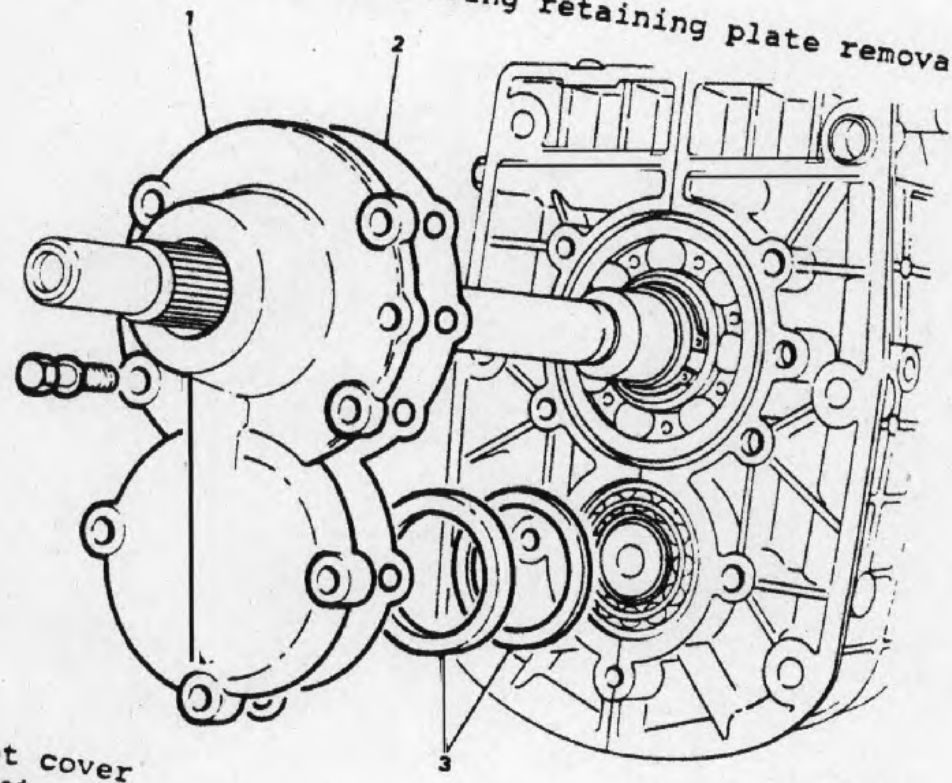
1 Stake nut 2 Layshaft 5th gear

Fig 2 Layshaft fifth gear dismantling



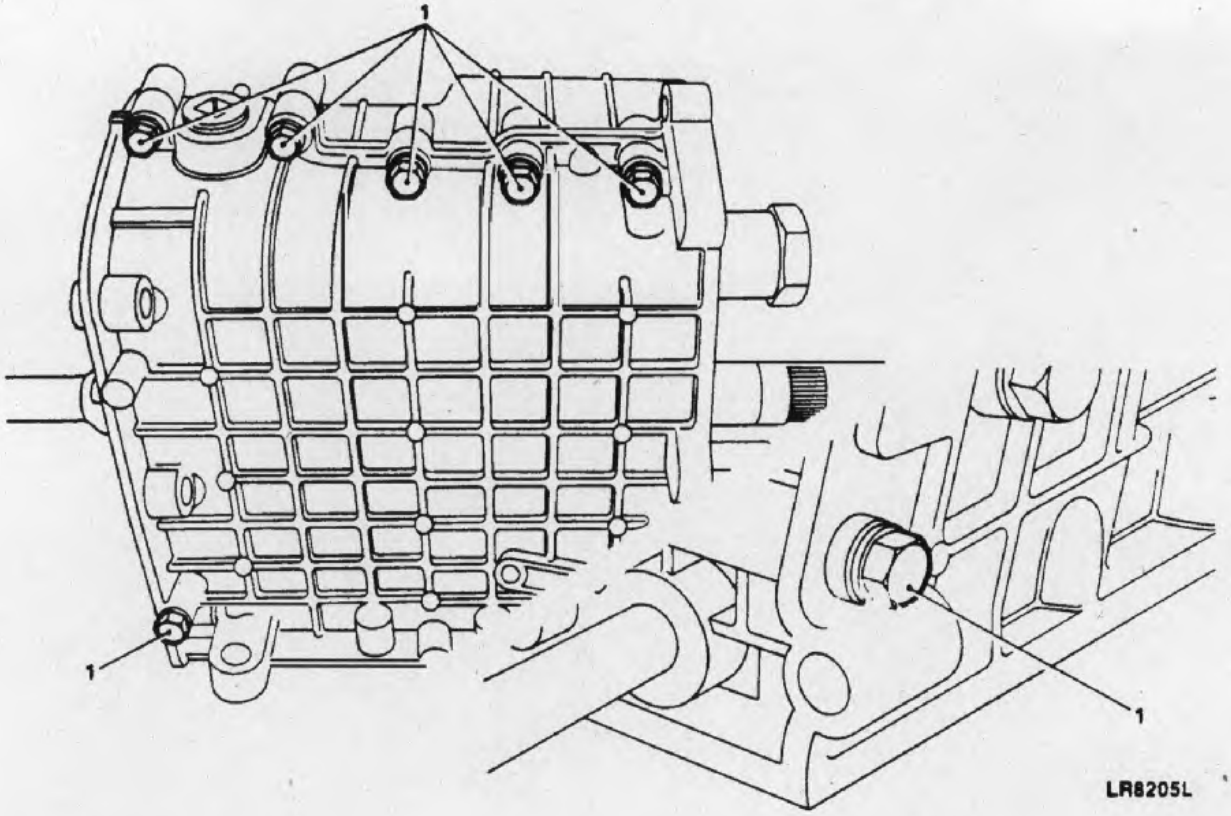
1 Bolt
2 Socket head setscrew
3 Retaining plate

Fig 3 Layshaft bearing retaining plate removal



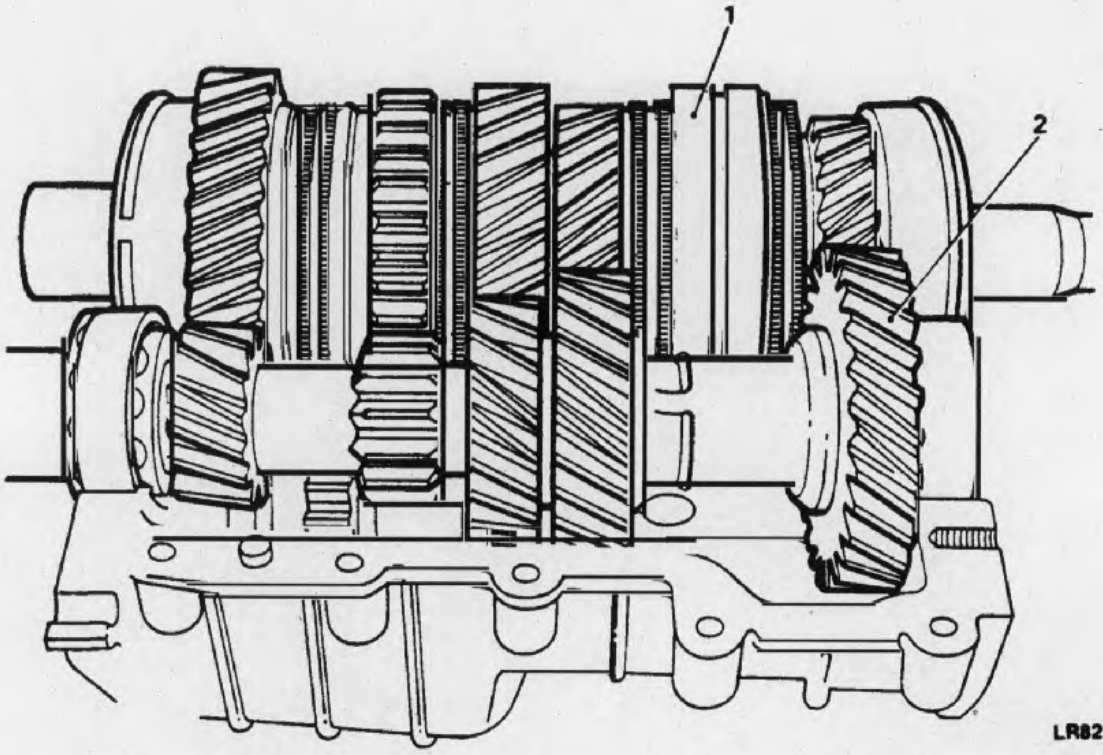
1 Front cover
2 Gasket
3 Spacer and shims

Fig 4 Front cover removal



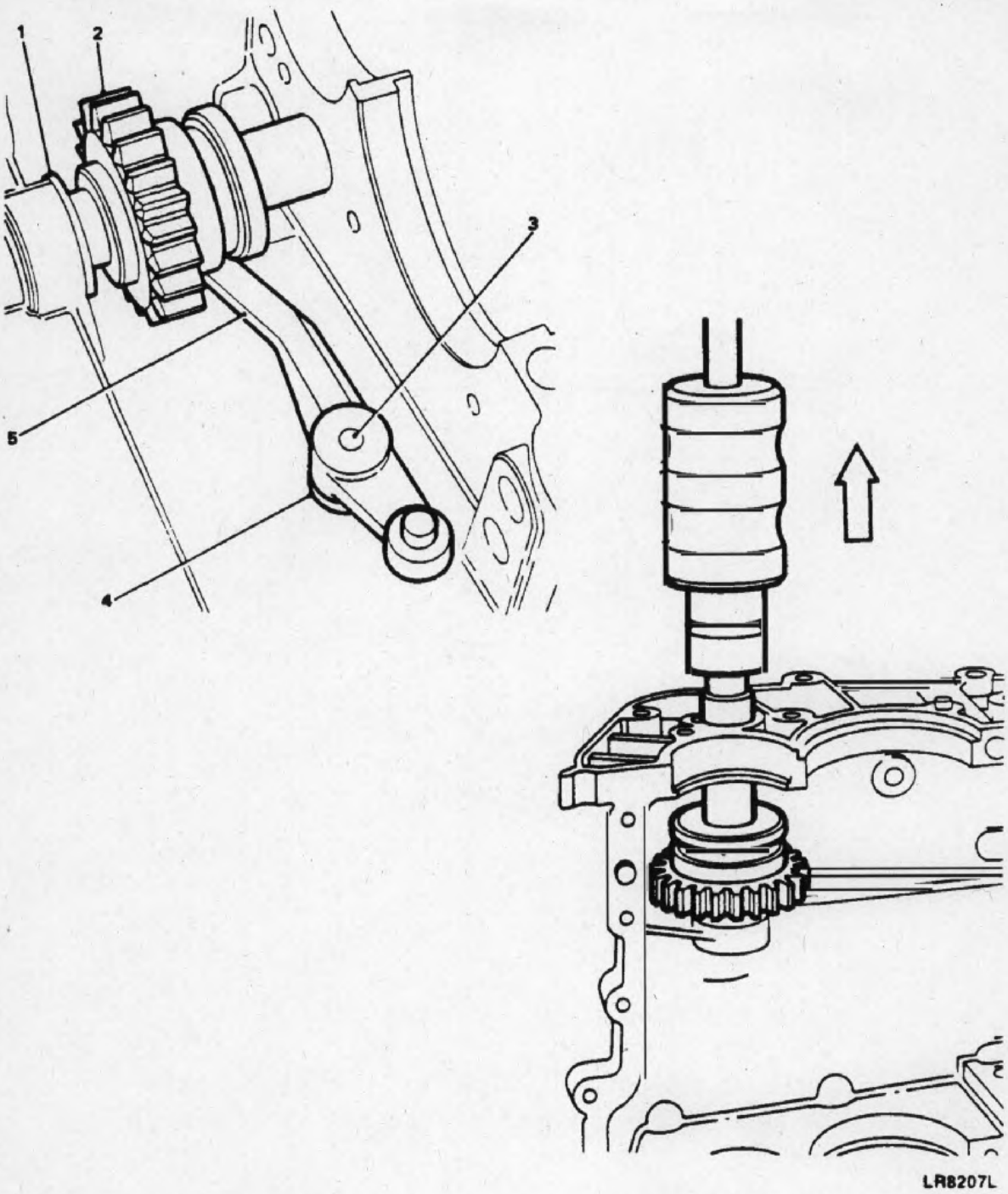
1 Bolts

Fig 5 Divided-case fixings



1 Mainshaft assembly 2 Layshaft assembly

Fig 6 Layshaft and mainshaft removal



1 Thrust washer
2 Reverse idler gear
3 Pivot bolt
4 Spacer
5 Reverse lever

Fig 7 Reverse idler gear and lever removal

Front cover

11 To dismantle the front cover proceed as follows:

11.1 Place the front cover on a block of timber and drift-out the oil seal (Fig 8).

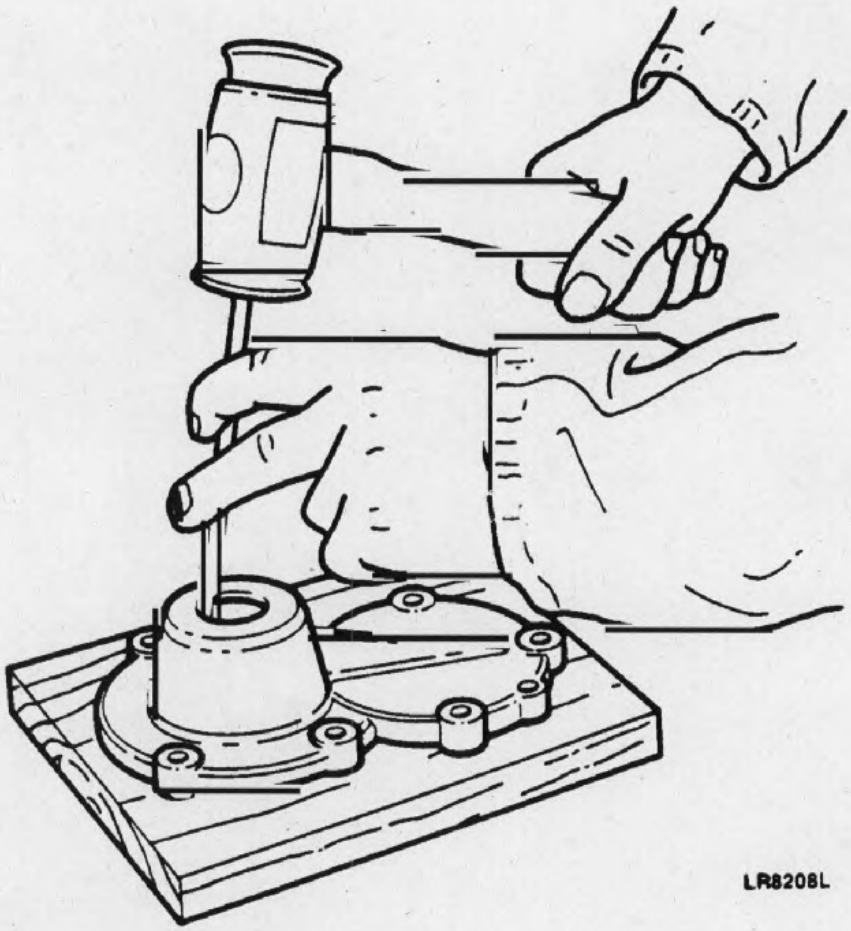


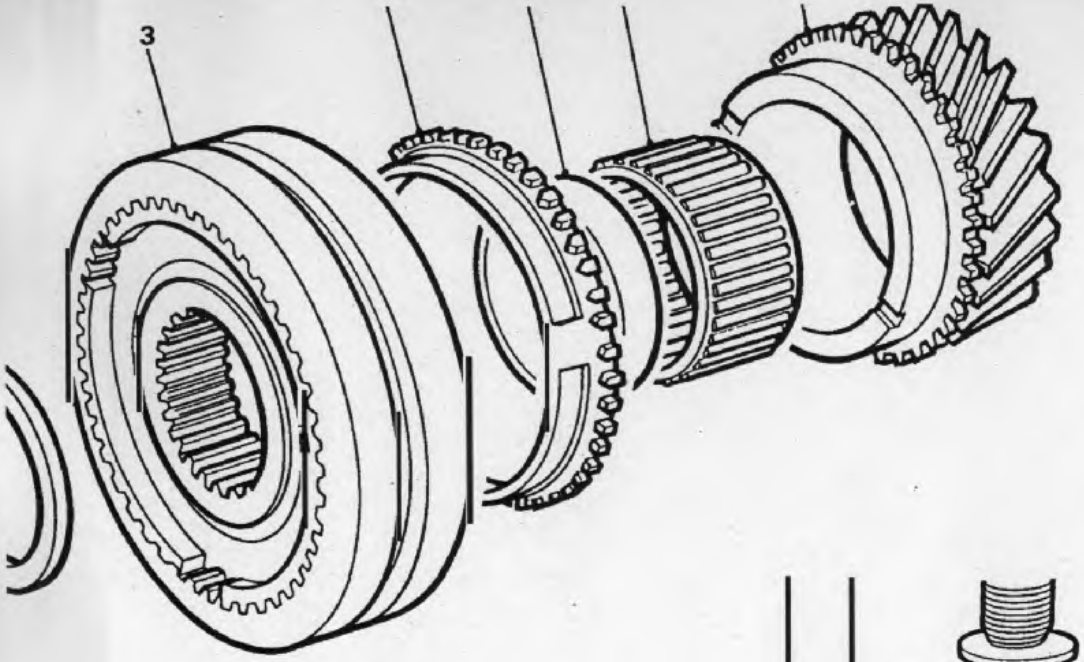
Fig 8 Front cover oil seal removal

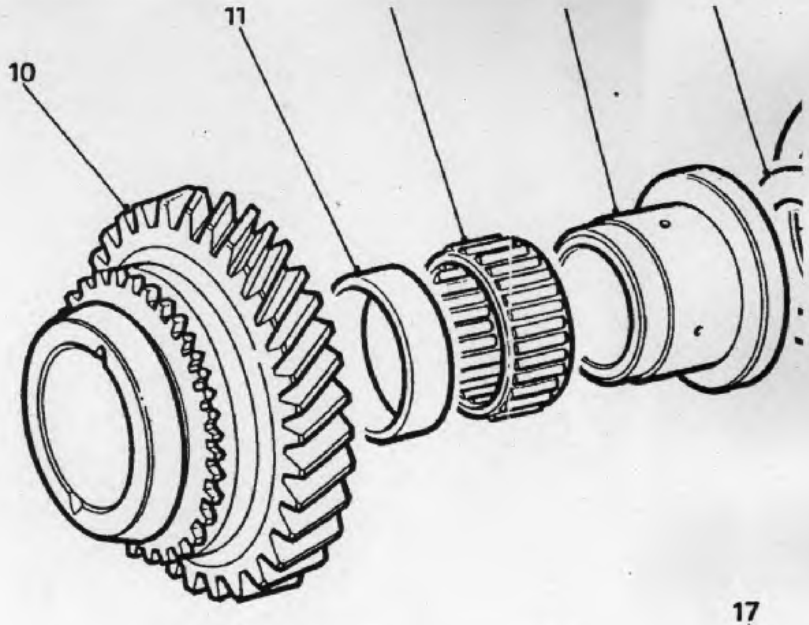
Layshaft

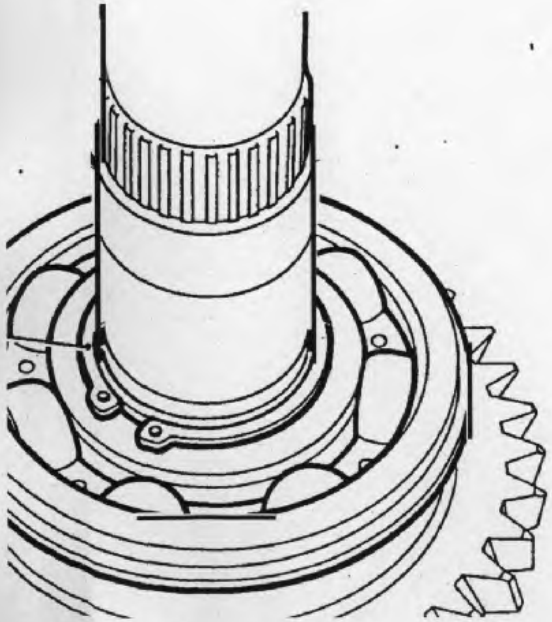
12 To dismantle the layshaft refer to Cat 524 Chap 3-2.

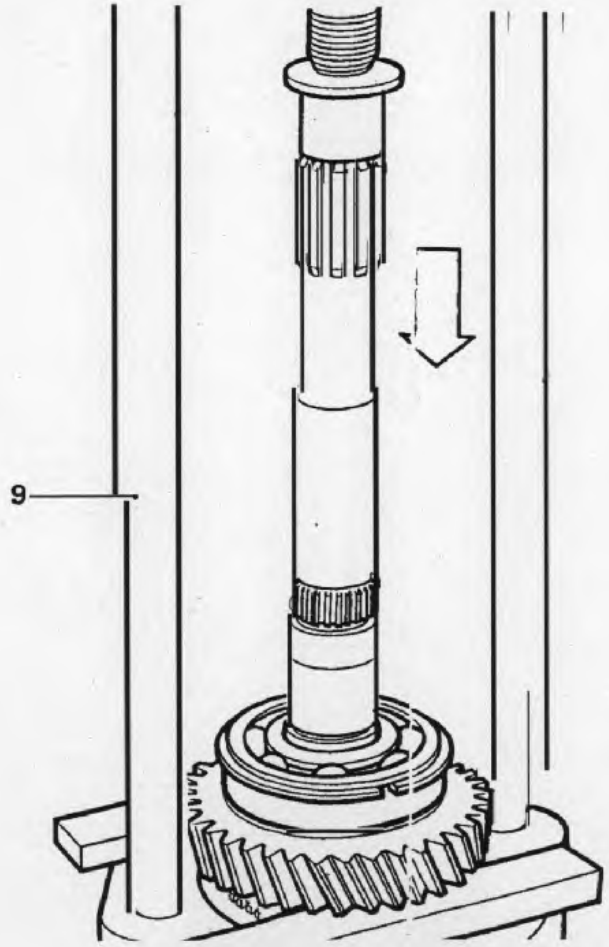
Key to fig 9

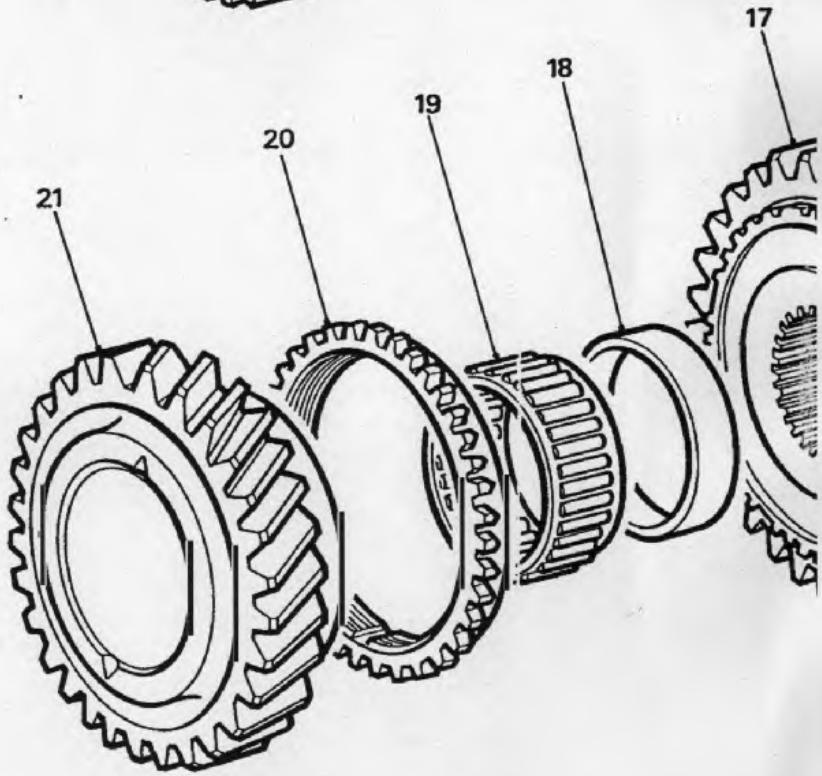
1 Circlip
2 Selective washer
3 3rd/4th synchro assembly
4 3rd/4th gear baulk ring
5 3rd/4th gear spacer
6 3rd/4th gear bearing
7 3rd gear
8 Rear bearing circlip
9 Special tool (Serial No 5)
10 1st gear
11 1st gear spacer
12 1st gear bearing
13 1st gear bush
14 Selective washer
15 Rear bearing snap ring
16 1st gear baulk ring
17 1st/2nd synchro assembly
18 2nd gear spacer
19 2nd gear bearing
20 2nd gear baulk ring
21 2nd gear


3


10
11




9


17
18
19
20
21

Mainshaft

13 To dismantle the mainshaft proceed as follows:

13.1 Secure the mainshaft assembly in a vice and remove the circlip (Fig 9 (1)) retaining the 3rd/4th synchromesh hub and gear assembly (3).

13.2 Remove the selective washer (2), 3rd/4th synchromesh assembly (3) and baulk ring (4).

13.3 Remove the 3rd gear (7), spacer (5), and needle roller bearing (6).

13.4 Invert the mainshaft assembly in the vice and remove the mainshaft rear bearing circlip (8)

13.5 Using special tool (Serial No 5) (Fig 9 (9)), and a support under the first gear, press the mainshaft assembly from the rear bearing.

13.6 Separate from the assembly the 1st gear (10), 1st gear bush (13), spacer (11), needle roller bearing (12), selective washer (14) and rear bearing snap ring (15).

13.7 Remove the 1st gear baulk ring (16), 1st/2nd synchromesh assembly (17), 2nd gear baulk ring (20), 2nd gear spacer (18), 2nd gear needle roller bearing (19) and 2nd gear (21).

Synchromesh assemblies

14 To dismantle the synchromesh assemblies refer to Cat 524 Chap 3-2.

Input shaft

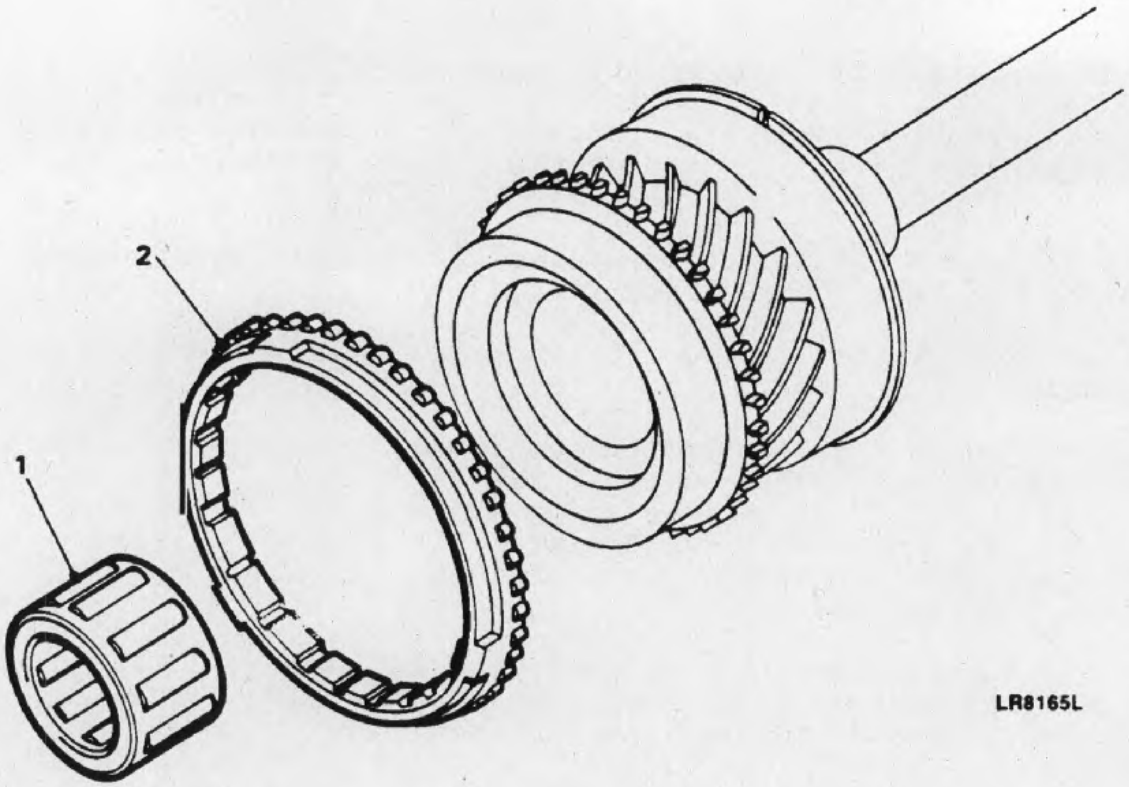
15 To dismantle the input shaft proceed as follows:

15.1 Remove the 4th gear baulk ring (Fig 10 (2)) and needle roller bearing (1).

15.2 Remove the circlip (Fig 11 (1)) and selective thrust washer (2).

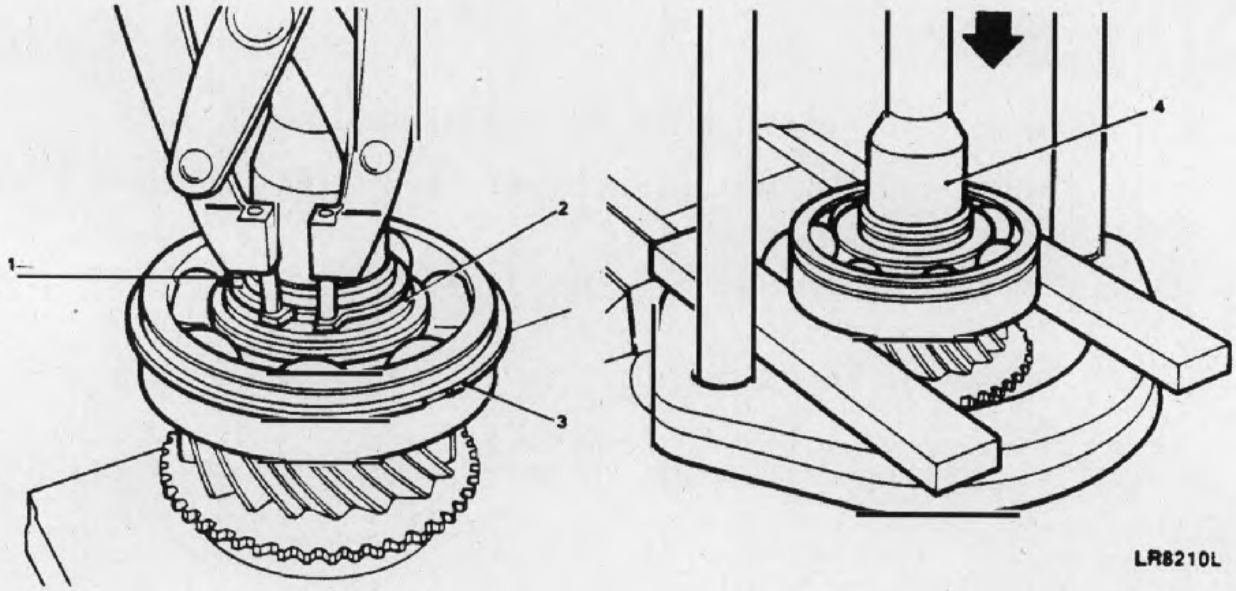
15.3 Remove the snap ring (3) from the bearing.

15.4 Using special tool (Serial No 5), (Fig 11 (4)) and two suitable steel blocks, press the input shaft from the bearing.



1 Needle roller bearing
2 4th gear baulk ring

Fig 10 Input shaft dismantle



1 Circlip
2 Selective thrust washer
3 Snap ring
4 Special tool (Ser No 5)

Fig 11 Input shaft bearing removal

Reverse idler gear

16 To dismantle the reverse idler gear refer to Cat 524 Chap 3-2.

Main gearbox casing

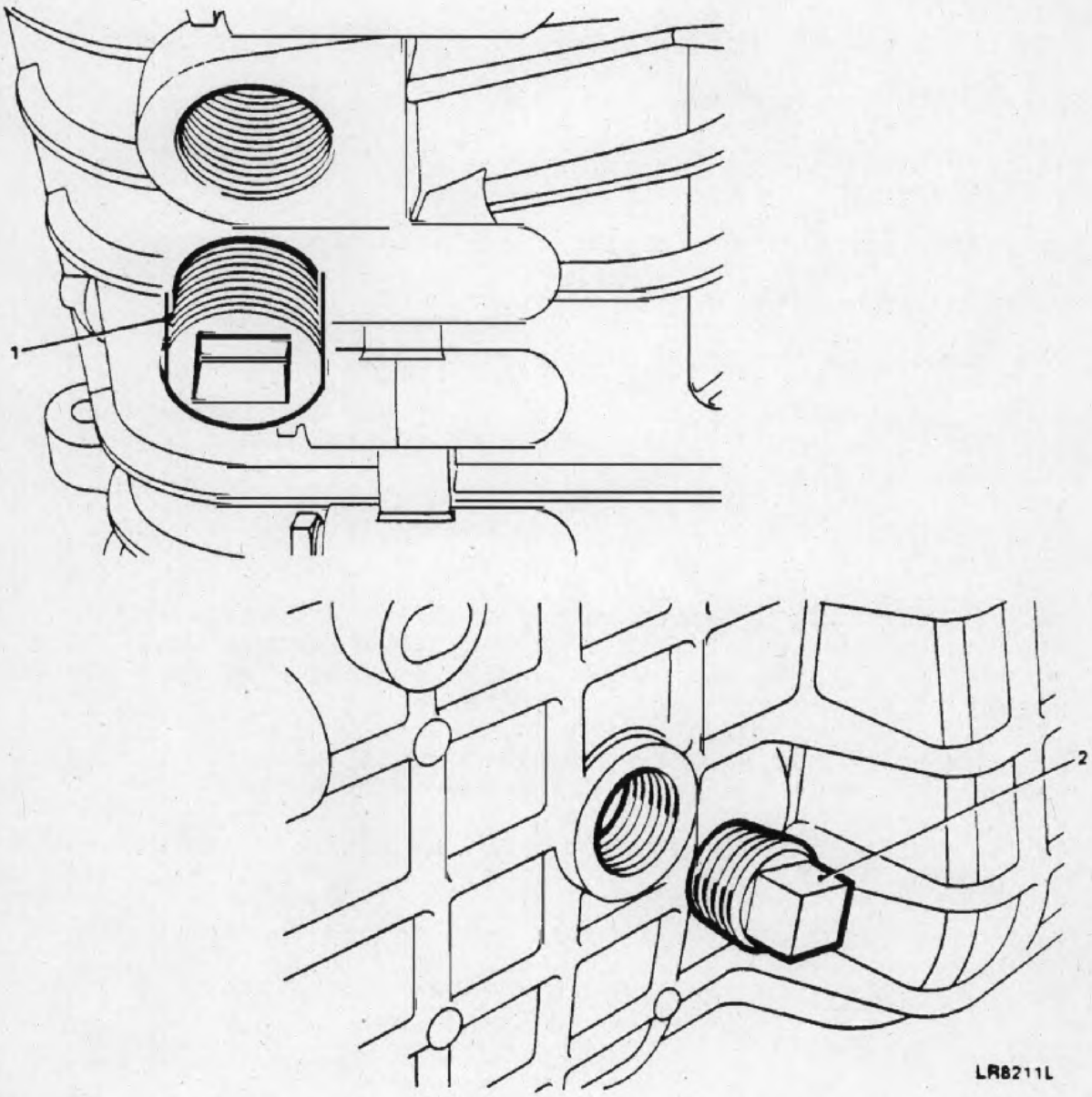
17 To dismantle the main gearbox casing proceed as follows:

17.1 Remove drain plug (Fig 12 (1)).

17.2 Remove filler/level plug (2).

17.3 Remove interlock cross drilling plug.

17.4 Remove the six hollow dowels.



1 Drain plug

2 Filler/level plug

Fig 12 Main gearbox case drain/fill plugs

Cleaning

18 For cleaning of components refer to Cat 524 Chap 3-2.

Examination

19 For examination of components refer to Cat 524 Chap 3-2.

Repairs and replacement

20 For repairs and replacement refer to Cat 524 Chap 3-2.

Reassembly

Main gearbox casing

21 To reassemble the main gearbox casing proceed as follows:

21.1 Fit the six hollow dowels.

21.2 Fit interlock drilling plug.

21.3 Fit level/filler plug (Fig 12 (2)) - do not tighten at this stage.

21.4 Fit magnetic drain plug (1) and new copper washer.

Input shaft assembly

22 To reassemble the input shaft proceed as follows:

22.1 Using special tool (Serial No 5) and a suitable tube, fit the input shaft to the bearing with the snap ring groove outwards (Fig 13).

22.2 Fit the original selective washer (Fig 14 (2)) and circlip (1).

22.3 Check with a feeler gauge, the clearance between the bearing and washer. If the clearance is in excess of 0,075 mm remove the circlip and washer and select and measure a new washer to take-up the excess clearance.

22.4 Fit the new selective washer, retain with the circlip and recheck that the above clearance is maintained.

22.5 Lubricate the mainshaft pilot bearing (3) and fit to the mainshaft.

22.6 Fit the fourth gear baulk ring (4) to the input shaft.

22.7 Fit the snap ring (6) to the bearing (5).

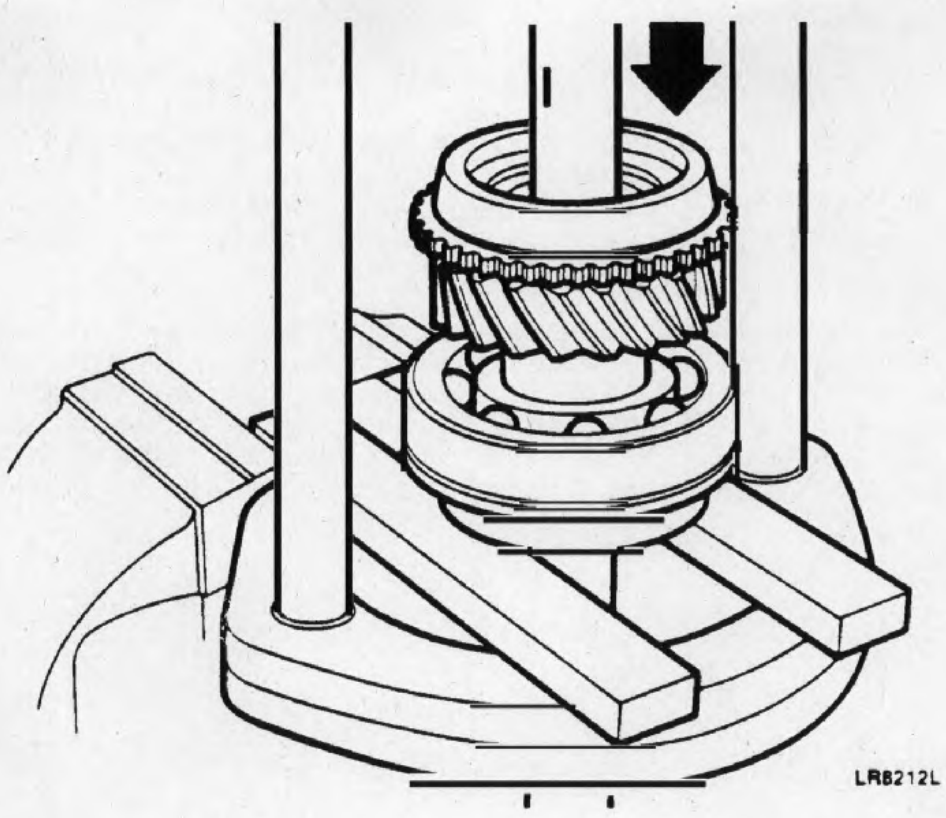
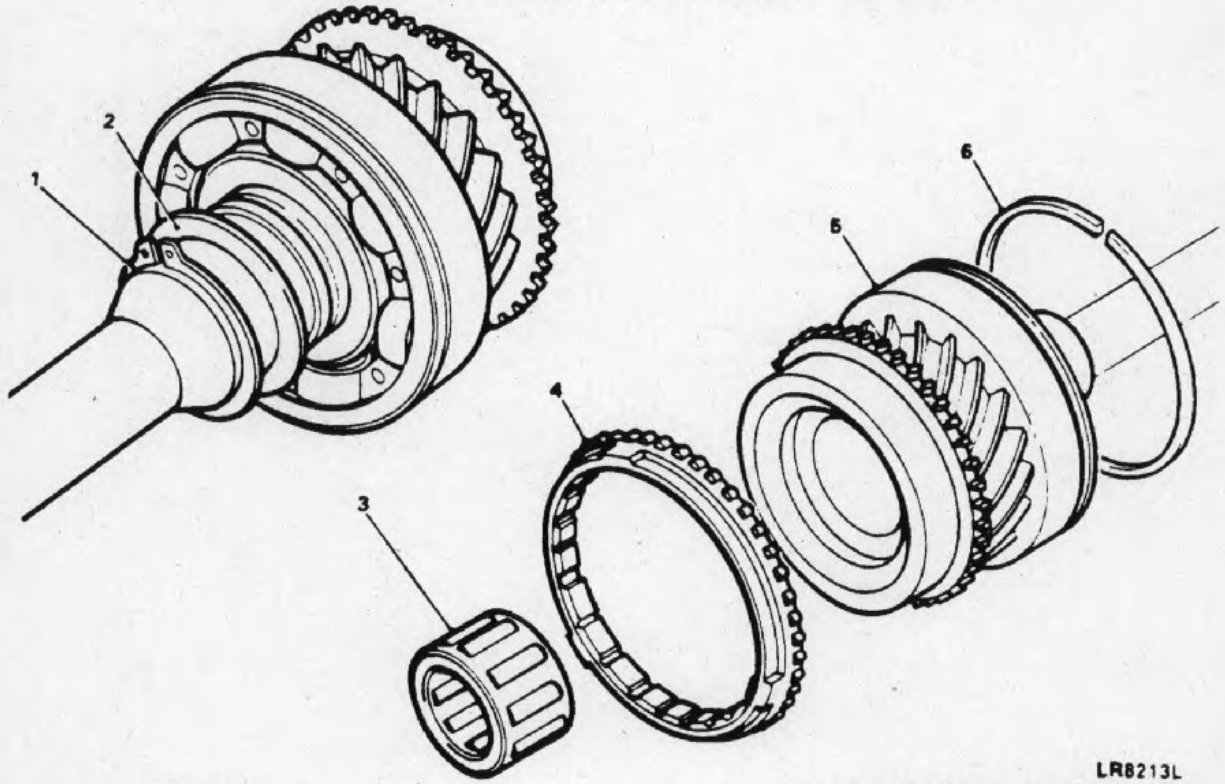


Fig 13 Fitting input shaft bearing



1 Circlip
2 Selective washer
3 Pilot bearing
4 4th gear baulk ring
5 Bearing
6 Snap ring

Fig 14 Input shaft assembly

Third gear end float

23 To check the third gear end float proceed as follows:

23.1 Locate the main shaft in a vertical position (Fig 15).

23.2 Fit the 3rd gear, needle roller bearing and spacer to the mainshaft and replace the 3rd/4th synchromesh inner member.

23.3 Press down on the synchromesh inner member and check the gear running clearance with a feeler gauge. A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back-lash. New or little worn components will usually have a clearance of between 0,075 and 0,125 mm (0.003 to 0.005 in).

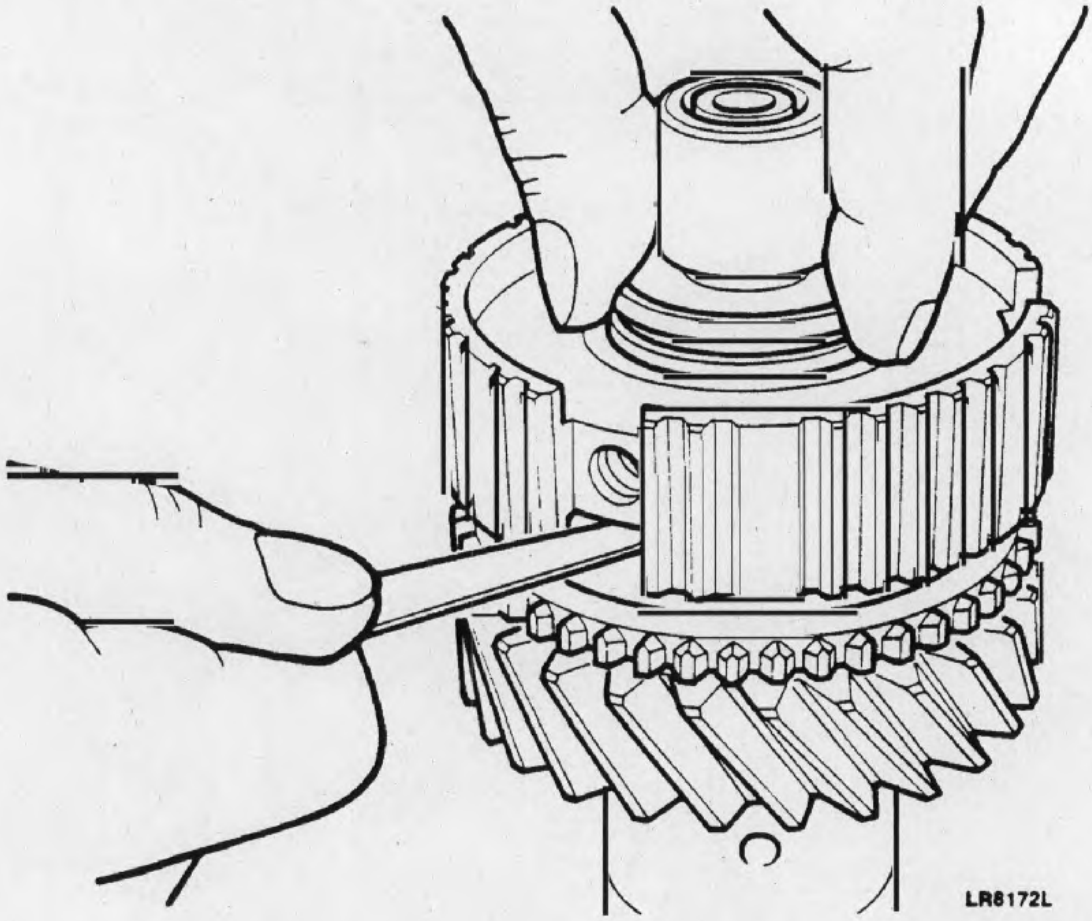


Fig 15 Checking third gear end float

Second gear nd float

24 To check the second gear end float proceed as follows:

24.1 Invert the mainshaft for assembly of the rear end components.

24.2 Fit 2nd gear needle roller bearing, spacer, 2nd gear and synchromesh inner member.

24.3 Press down on the synchromesh inner member and check 2nd gear end float (Fig 16). A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back lash. New or little worn components will usually have a clearance of between 0,075 to 0,125 mm (0.003 to 0.005 in).

24.4 Remove the synchromesh inner member and assemble it to the outer member with the slippers, balls and springs.

24.5 Fit the 2nd gear baulk ring to the mainshaft and the 1st/2nd synchromesh hub with the selector groove towards the rear end of the shaft.

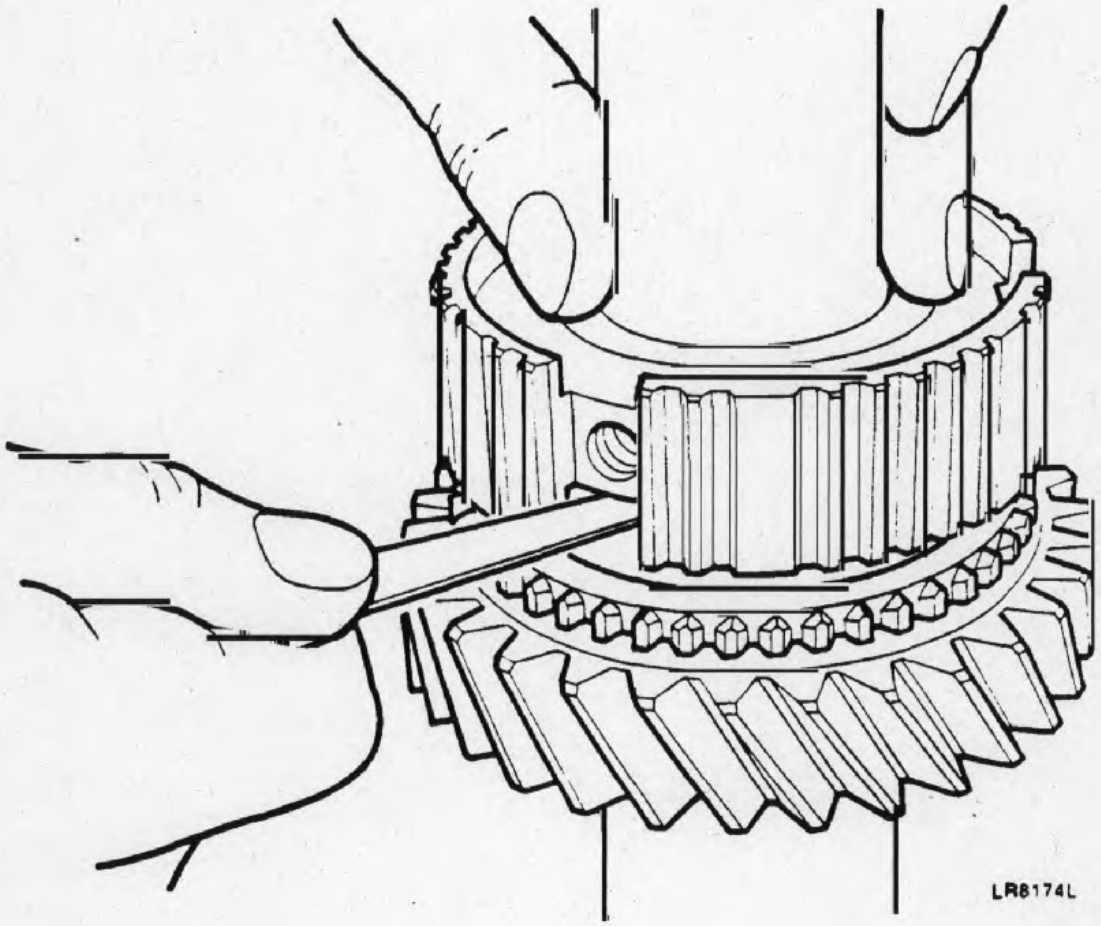


Fig 16 Checking second gear end float

First gear to bush nd float

25 To check the first gear to bush end float proceed as follows:

Note ...

It is not necessary to assemble the components on to the mainshaft to perform this procedure.

25.1 Assemble the spacer, needle bearing and bush to the 1st gear.

25.2 Using a suitable straight edge or flat plate, check the end-float of the 1st gear on the bush (Fig 17). A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back lash. New or little worn components will usually have a clearance of between 0,075 to 0,125 mm (0.003 to 0.005 in).

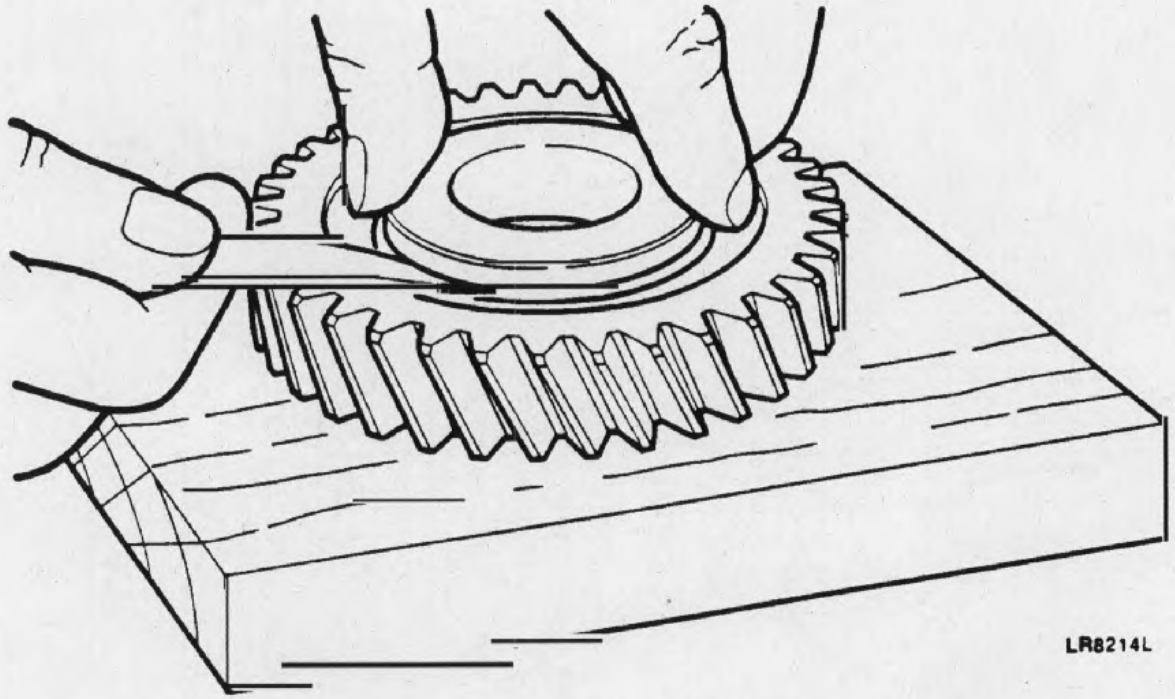


Fig 17 Checking first gear to bush end float

First and second gear synchromesh nd float

26 To check the first and second gear synchromesh end float proceed as follows:

26.1 Assemble, to the 1st gear, the spacer, needle roller bearing and 1st gear bush and fit the assembly to the mainshaft.

26.2 Fit the original selective washer and special tool (Serial No 3) and retain with the circlip (Fig 18). With a feeler gauge, check the end-float as illustrated. Choose a suitable selective washer to obtain a minimum clearance of 0.075 mm (0.003 in).

26.3 Remove the special tool (Serial No 3) and fit the selective washer.

26.4 Start the mainshaft rear bearing squarely on the mainshaft and without inverting the shaft, use either a press, capable of accommodating the complete mainshaft assembly, or drive the bearing into position using a suitable tube (Fig 19). Secure the assembly with the circlip.

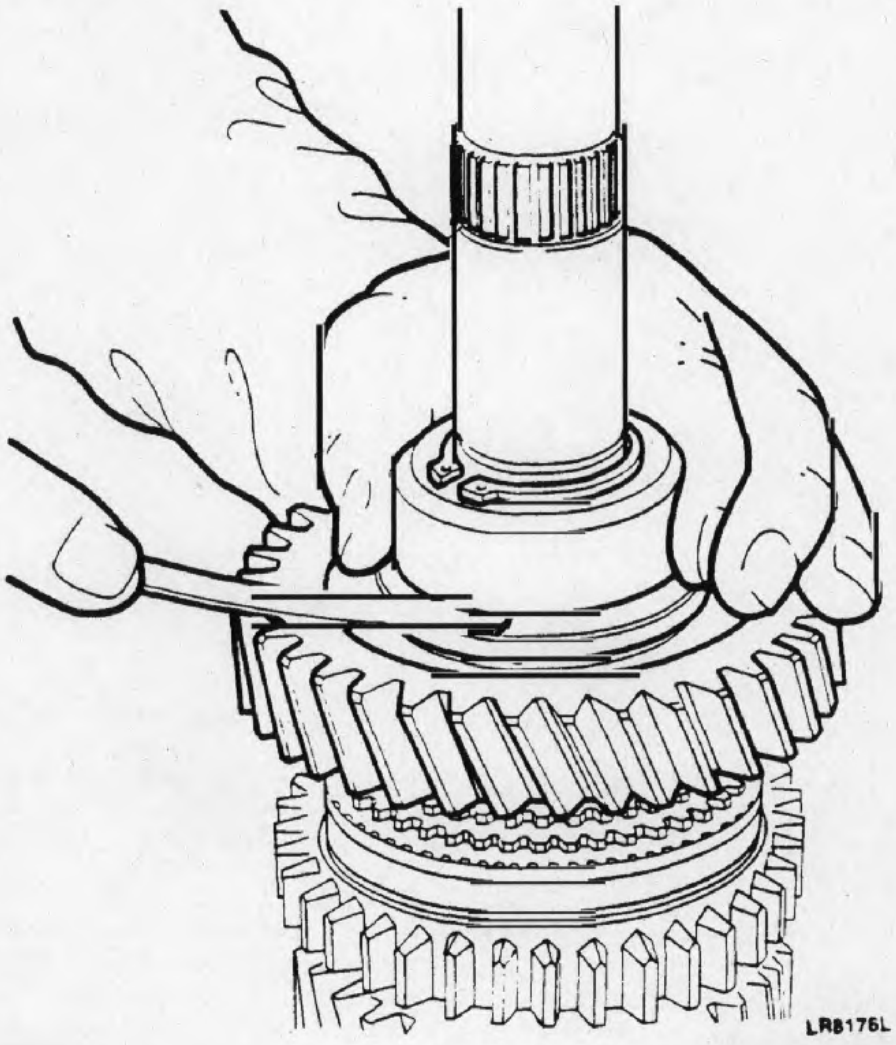


Fig 18 Checking first/second gear synchromesh end float

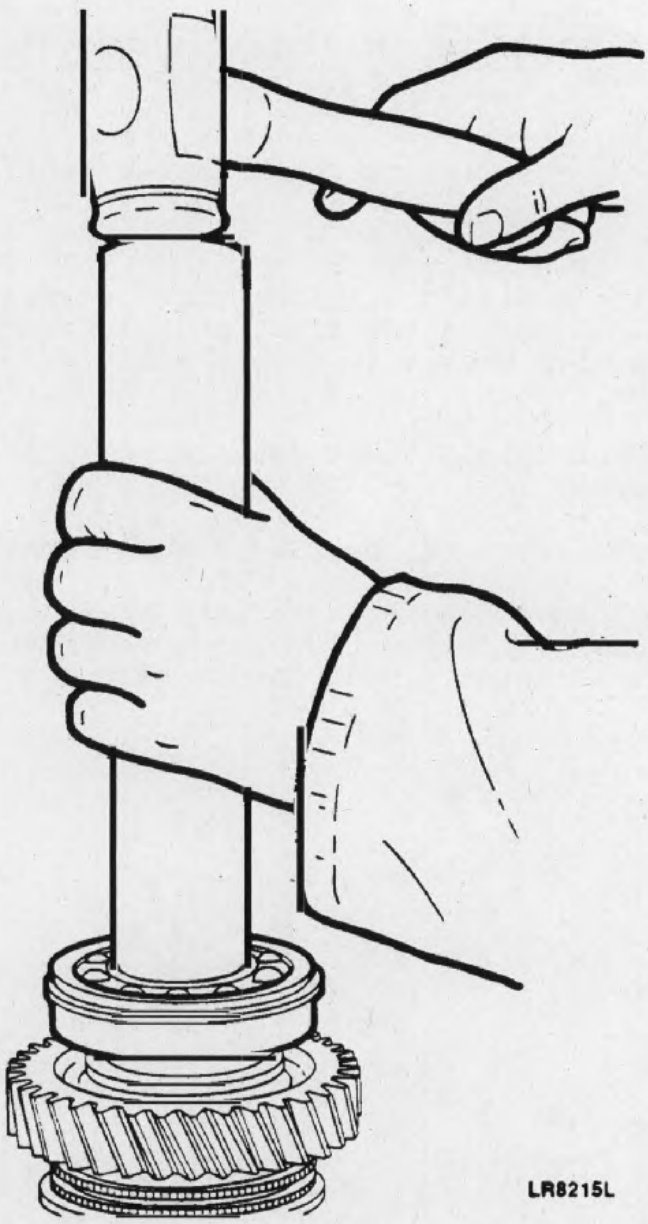


Fig 19 Fitting mainshaft rear bearing

Fifth gear end float

27 To check the fifth gear end float proceed as follows:

27.1 Fit the 5th gear thrust washer with the scallop side towards the gear. Fit the 5th gear, needle bearing and spacer followed by the synchromesh assembly, less the baulk ring at this stage.

27.2 Press down on the synchromesh inner member and check the gear end float (Fig 20). A clearance in excess of 0,19 mm (0.008 in) indicates that the thrust faces are worn and may be the cause of gear noise or transmission back lash. New or little worn components will usually have a clearance of between 0,075 to 0,125 mm (0.003 to 0.005 in).

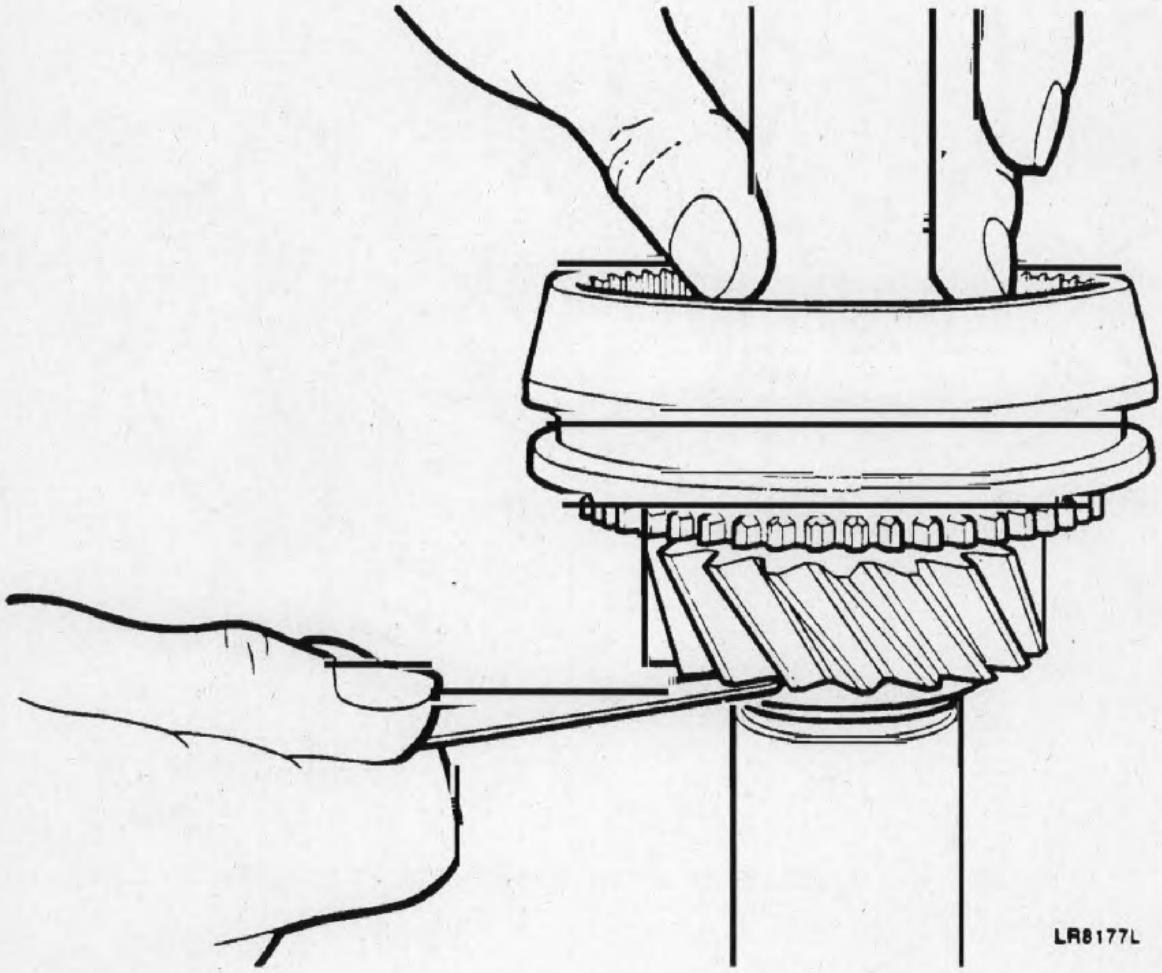


Fig 20 Checking fifth gear end float

Third and fourth gear synchromesh end float

28 To check the third and fourth gear synchromesh end float proceed as follows:

28.1 Invert the mainshaft to a vertical position (Fig 21).

28.2 Fit the 3rd gear needle roller bearing, spacer, 3rd gear, baulk ring and synchromesh with the larger thrust face towards 3rd gear and the chamfer on the outer member towards the front.

28.3 Fit the original selective washer and retain with the circlip.

28.4 Check the clearance between the washer and the synchromesh hub. The clearance must not exceed 0.075 mm (0.003 in). The condition is ideal when the selective washer can be just turned by hand.

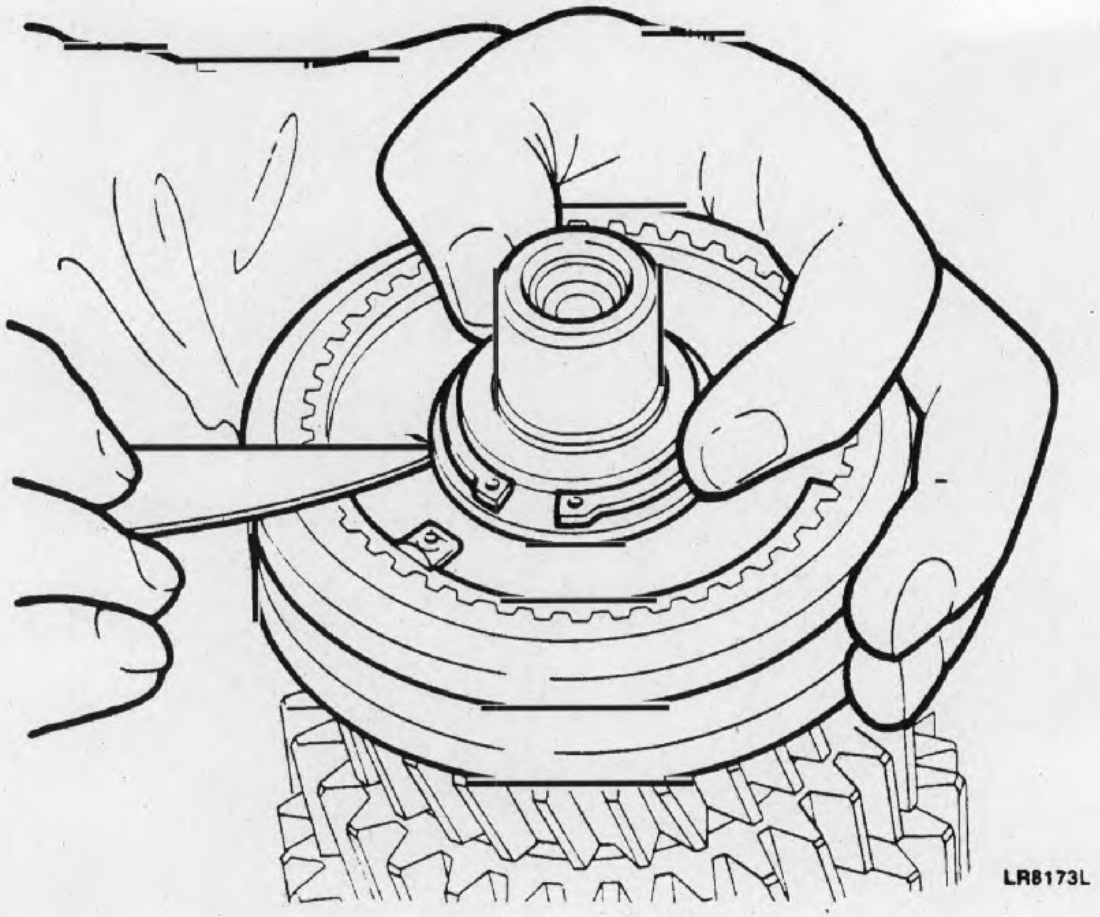


Fig 21 Checking third/fourth gear synchromesh end float

Synchromesh assemblies

29 For reassembling the synchromesh assemblies refer to Cat 524 Chap 3-2.

Layshaft assembly

30 To reassemble the layshaft proceed as follows:

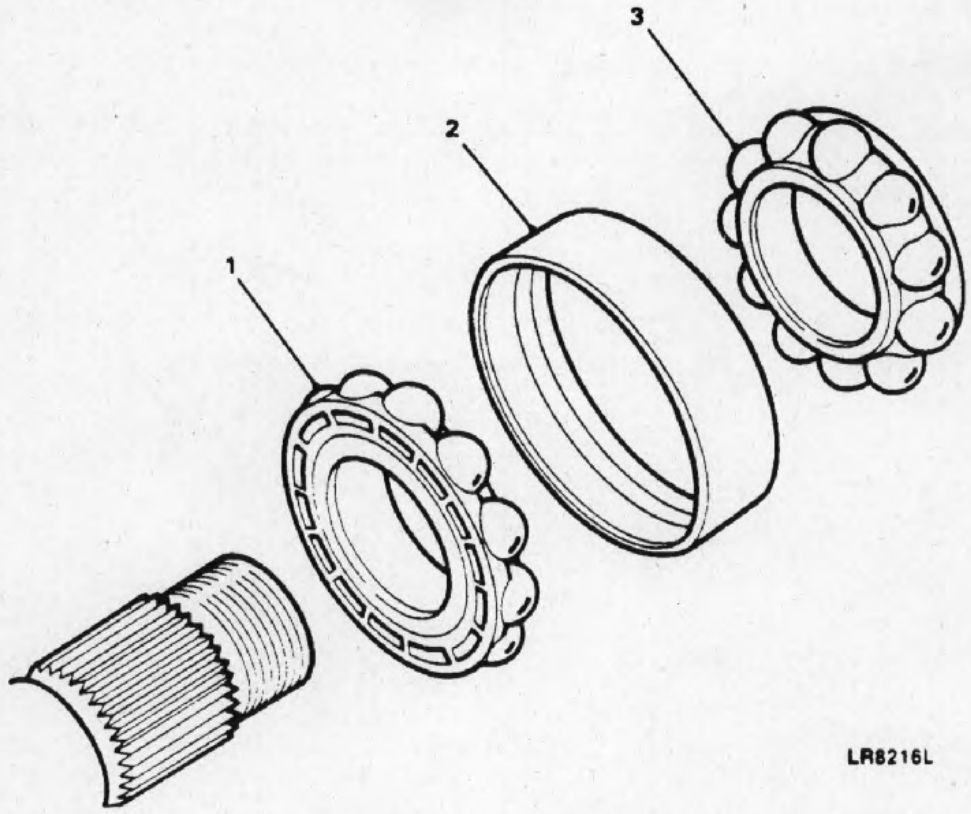
30.1 Fit the rear bearing assembly and note that the inner bearing (Fig 22 (1)) must be fitted with the identification numbers facing inwards towards the layshaft first gear.

30.2 Fit the track (2) and outer bearing (3) with the identification numbers facing outwards towards the 5th gear.

30.3 Fit the dummy spacer and stake nut loosely to retain the bearing assembly in position on the shaft.

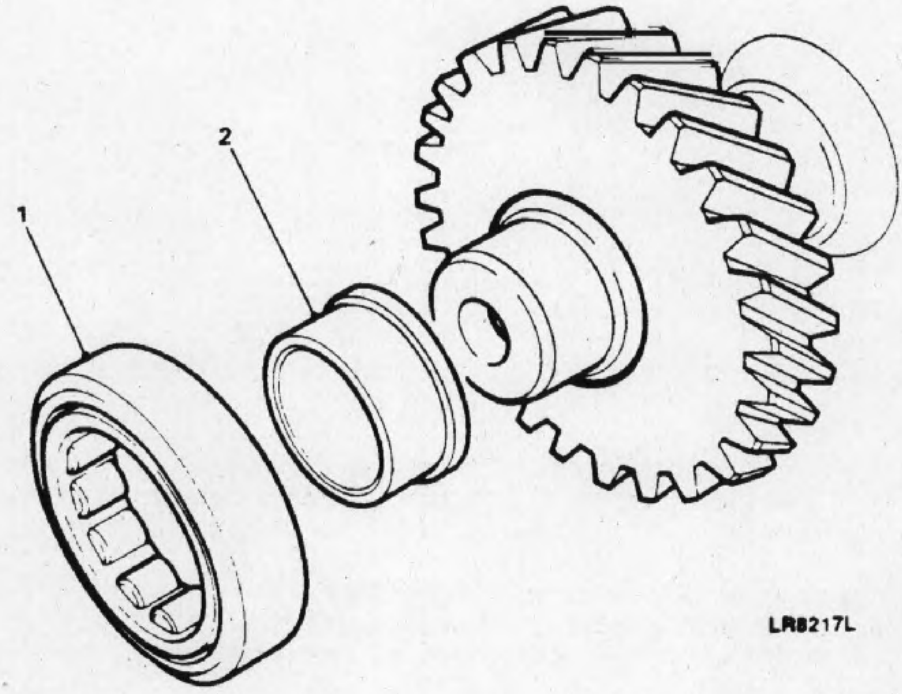
30.4 Fit the front bearing inner track (Fig 23 (2)) with the shoulder towards the gear. Carefully tap the track squarely into position with a hide mallet.

30.5 Fit the front bearing race (1).



1 Inner bearing
2 Track
3 Outer bearing

Fig 22 Fitting layshaft rear bearing



1 Front bearing race
2 Track

Fig 23 Fitting layshaft front bearing inner track

Front cover assembly

31 To reassemble the front cover proceed as follows:

31.1 Lubricate the outer diameter of a new seal and using a suitable tube, drift-in the seal, lip side trailing, squarely into the cover (Fig 24).

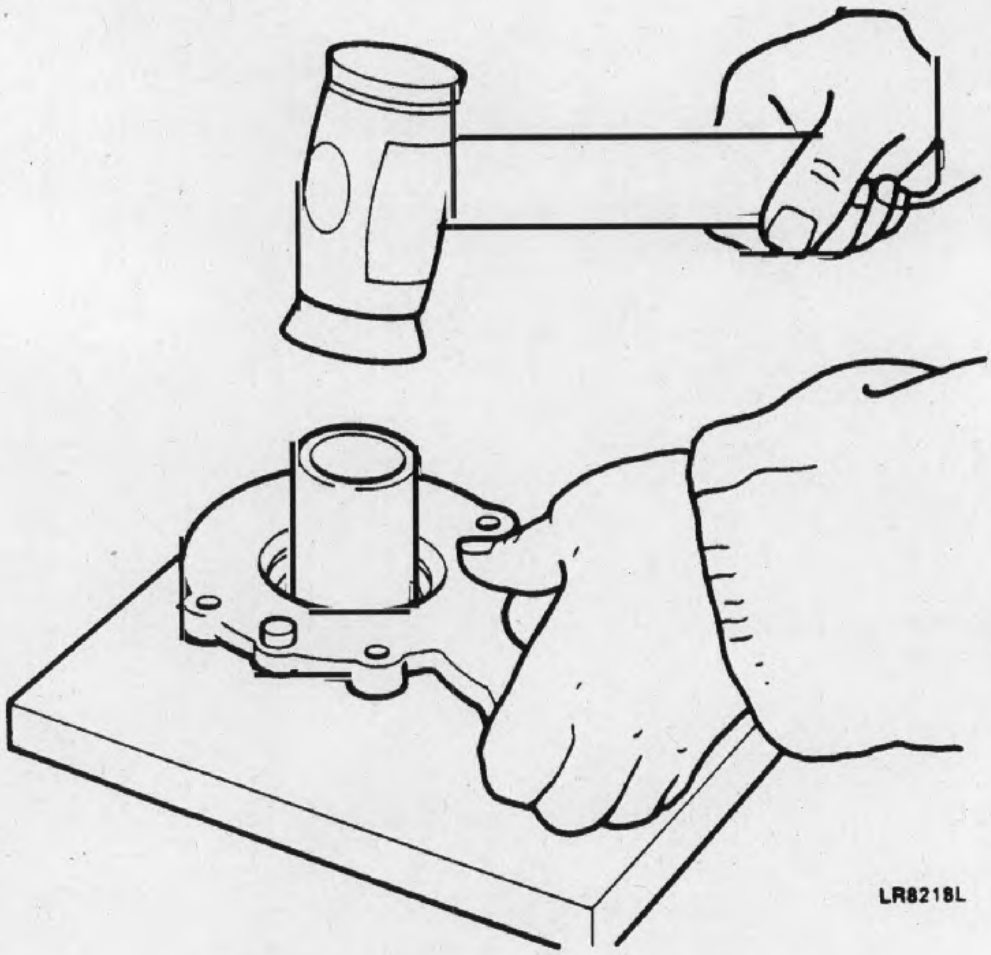


Fig 24 Fitting front cover oil seal

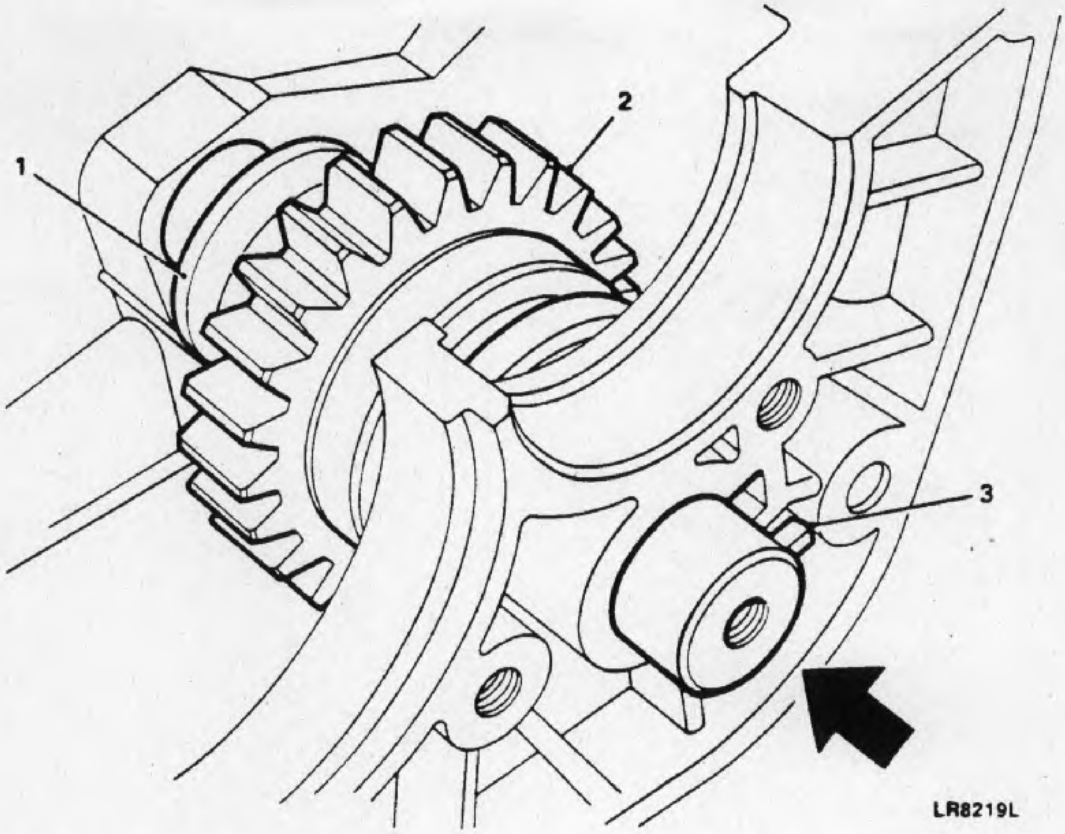
Reverse idler shaft and gear

32 To reassemble the reverse idler shaft and gear proceed as follows:

32.1 Position the reverse idler gear (Fig 25 (2)) and thrust washer (1) in the casing with the thrust washer and the chamfer on the thrust washer, towards the gear.

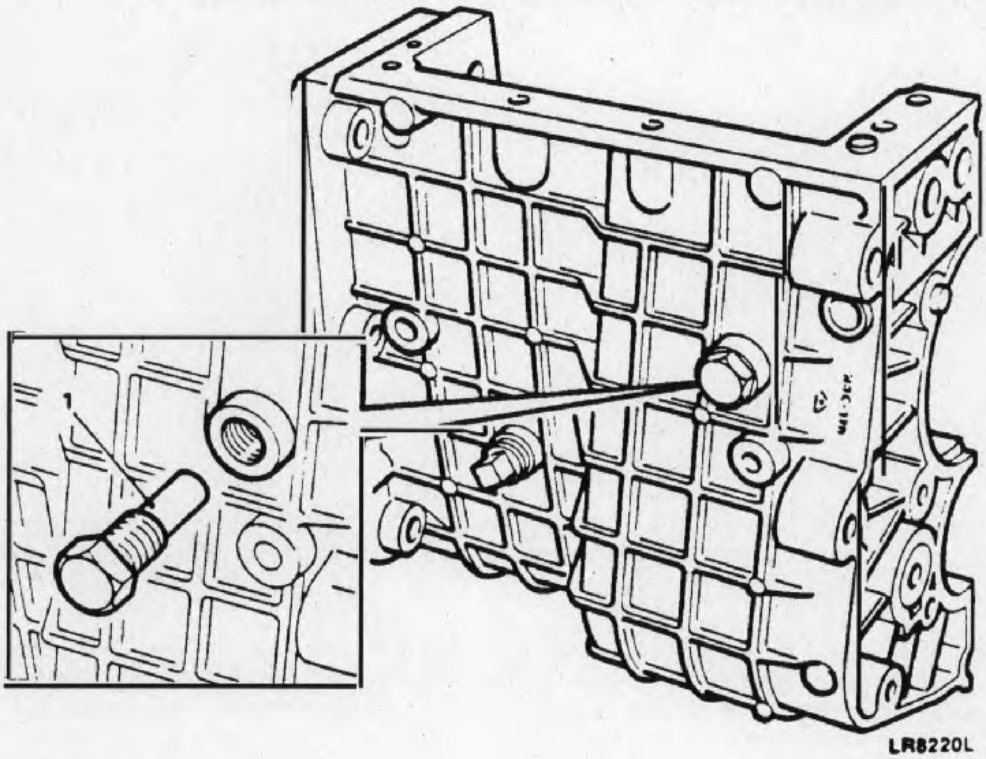
32.2 Insert the idler shaft into the casing and through into the idler gear and washer. Ensure that the roll pin (3) in the shaft lines-up with the cut-out in the casting, then drive the shaft fully home.

32.3 Coat the threads of the reverse lever pivot bolt (Fig 26 (1)) with Loctite 270 and fit to the casing and tighten to the correct torque.



1 Thrust washer
2 Reverse idler gear
3 Roll pin

Fig 25 Reverse idler shaft and gear assembly

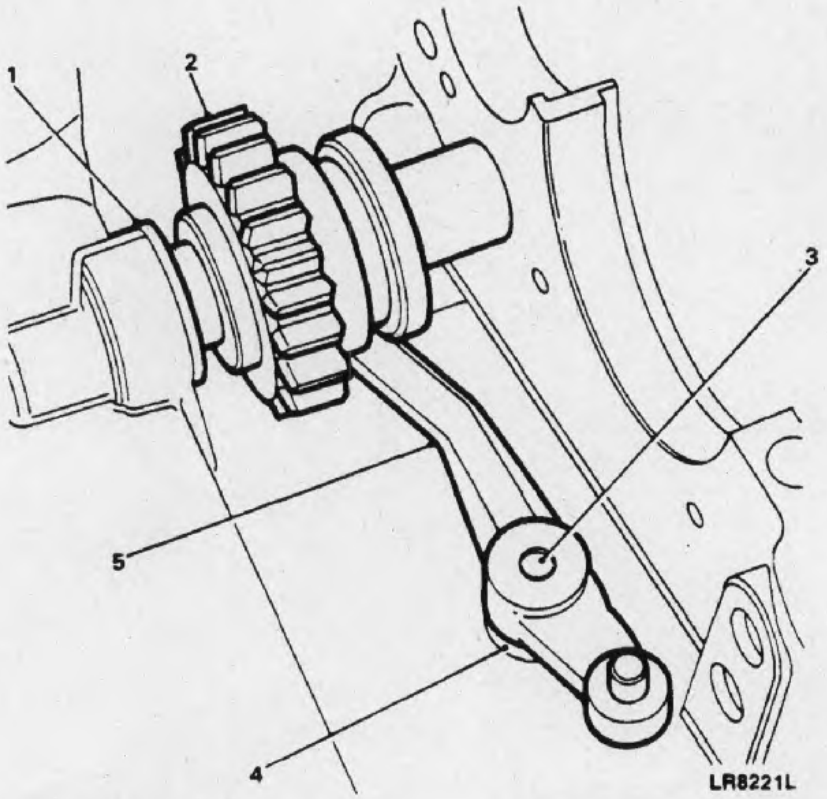


1 Pivot bolt

Fig 26 Fitting reverse lever pivot bolt

32.4 Fit the spacer (Fig 27 (4)) next to the casing.

32.5 Fit the lever (5) to the pivot whilst ensuring that the slipper locates in the reverse idler gear groove.



1 Thrust washer
2 Reverse idler gear
3 Pivot bolt
4 Spacer
5 Reverse lever

Fig 27 Fitting reverse gear lever

Mainshaft, input shaft and layshaft fitting

33 To fit the mainshaft input shaft and layshaft proceed as follows:

33.1 Fit the input shaft to the mainshaft assembly ensuring that the baulk ring (Fig 28 (1)) engages correctly into the 3rd/4th synchromesh hub (2).

33.2 Lower the assembly into the gear case noting that the snap rings (3) on the front and rear bearings locate against a shoulder in the casing.

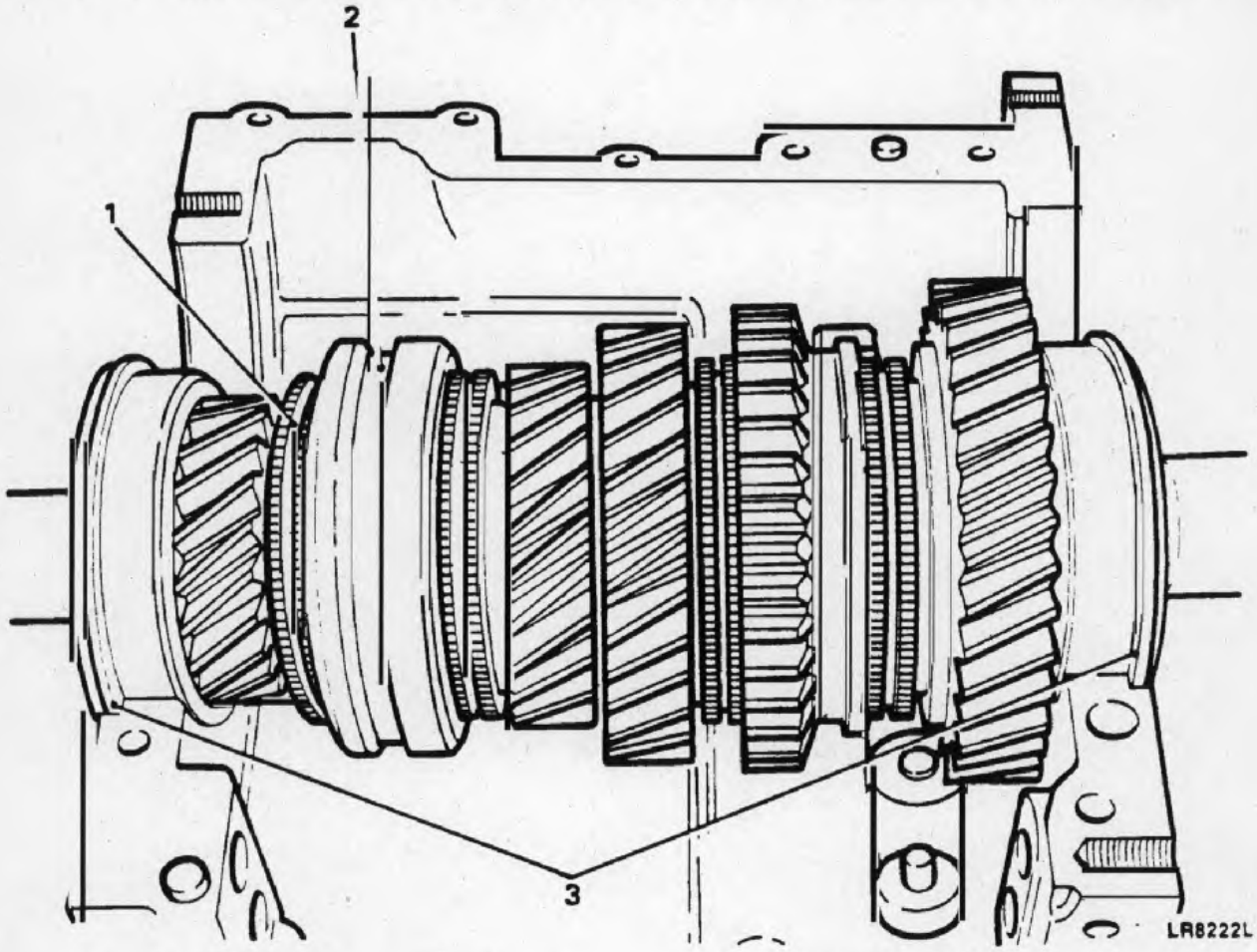
33.3 Hold the layshaft above the mainshaft assembly and engage the two sets of gears into mesh and roll the layshaft into position in the case. Check that the rear bearing locates against the shoulder in the case.

33.4 Wipe clean the mating faces of both cases and apply Loctite Instant Gasket in accordance with the manufacturers instructions.

33.5 Lower the mpty case into position over the gears locating on the dowels.

33.6 Loosely secure the cases with the seven bolts and tighten to the correct torque 22 to 28 Nm (16 to 21 lbs ft). Clean away any surplus sealant.

33.7 Refit the stand to the gearbox and secure in the vice.



1 Baulk ring
2 3rd/4th gear synchro hub
3 Snap rings

Fig 28 Fitting mainshaft and input shaft

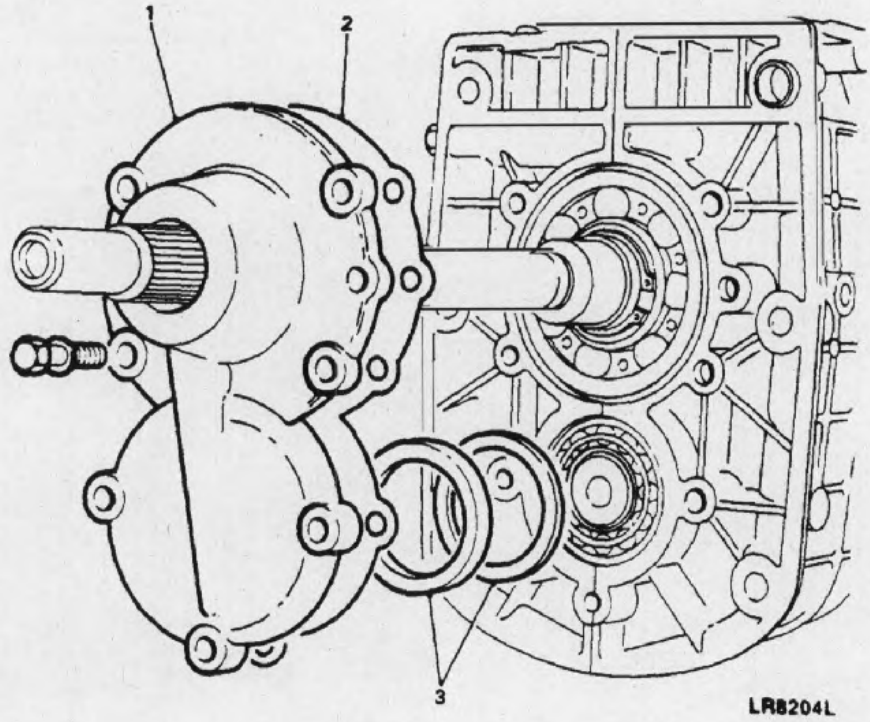
Front cover

34 To reassemble the front cover proceed as follows:

34.1 Fit the original shim and spacer (Fig 29 (3)) to the layshaft front bearing.

34.2 Fit a new gasket (2) to the cover and lubricate the oil seal lip.

34.3 Taking care not to damage the seal lip, fit the cover (1) to the gearbox locating it over the dowels. Secure with the seven bolts and spring washers and tighten evenly to the correct torque.



1 Front cover
2 Gasket
3 Spacer and shims

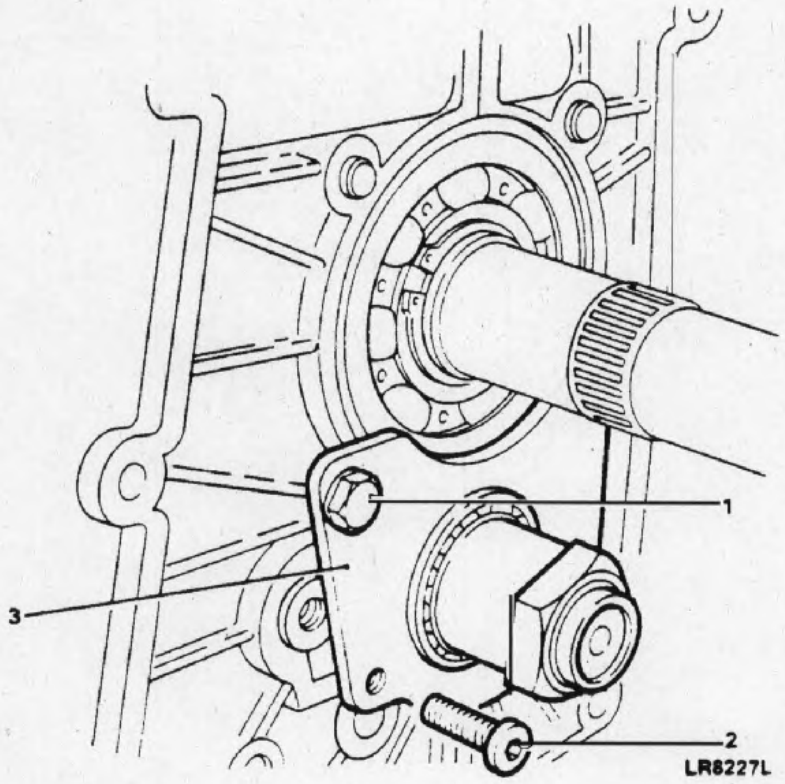
Fig 29 Fitting front cover

Rear retaining plate

35 To fit the rear retaining plate proceed as follows:

35.1 Fit the retaining plate (Fig 30 (3) to the gearbox and secure the top of the plate with the two bolts (1) and spring washers.

35.2 Apply Loctite 270 (stud and bearing fit) to the socket headed (2) screw threads and secure the lower end of the retaining plate.



1 Bolt
2 Socket head setscrew
3 Retaining plate

Fig 30 Fitting rear retainer plate

Layshaft fifth gear assembly

36 To reassemble the layshaft fifth gear proceed as follows:

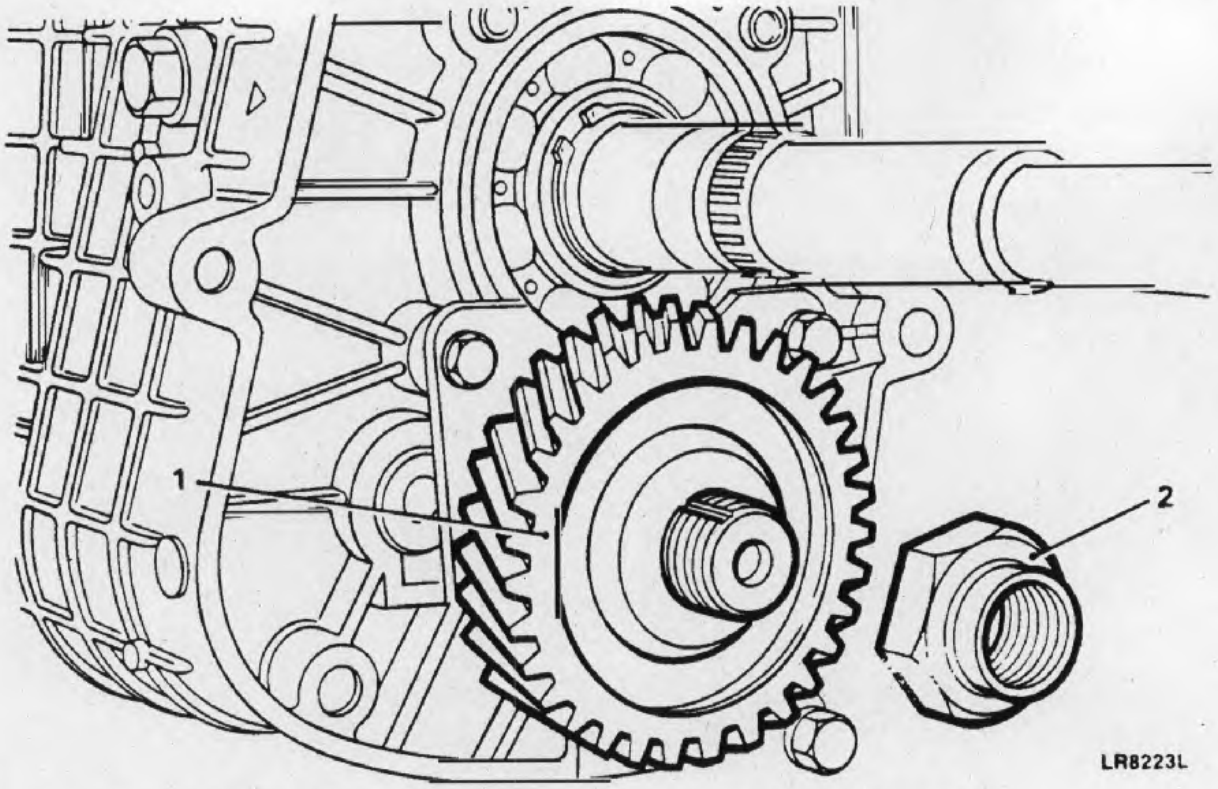
36.1 Remove the nut and dummy spacer from the layshaft.

36.2 Fit the 5th gear (Fig 31 (1)) to the layshaft with the large boss to the rear.

36.3 To facilitate the next instruction, lock the gearbox by engaging 1st and 4th gears.

36.4 Fit a new 5th gear retaining nut (2) and tighten to the correct torque. Do not stake the nut at this stage.

36.5 Disengage the 1st and 4th gears.



1 Layshaft 5th gear 2 Retaining nut

Fig 31 Layshaft fifth gear assembly

Fifth gear synchromesh end float

37 To check the fifth gear synchromesh end float proceed as follows:

37.1 Fit the thrust washer (Fig 32 (1)), groove outwards, towards 5th gear.

37.2 Lubricate and fit the needle roller bearing (2) to the mainshaft.

37.3 Fit the spacer (3) and 5th gear (4).

37.4 Fit the 5th gear synchromesh cone and hub assembly (5).

37.5 Fit the 5th gear synchromesh hub retaining plate, peg (6) outwards.

37.6 Omit the 'O' ring and fit the sleeve with the slot over the peg.

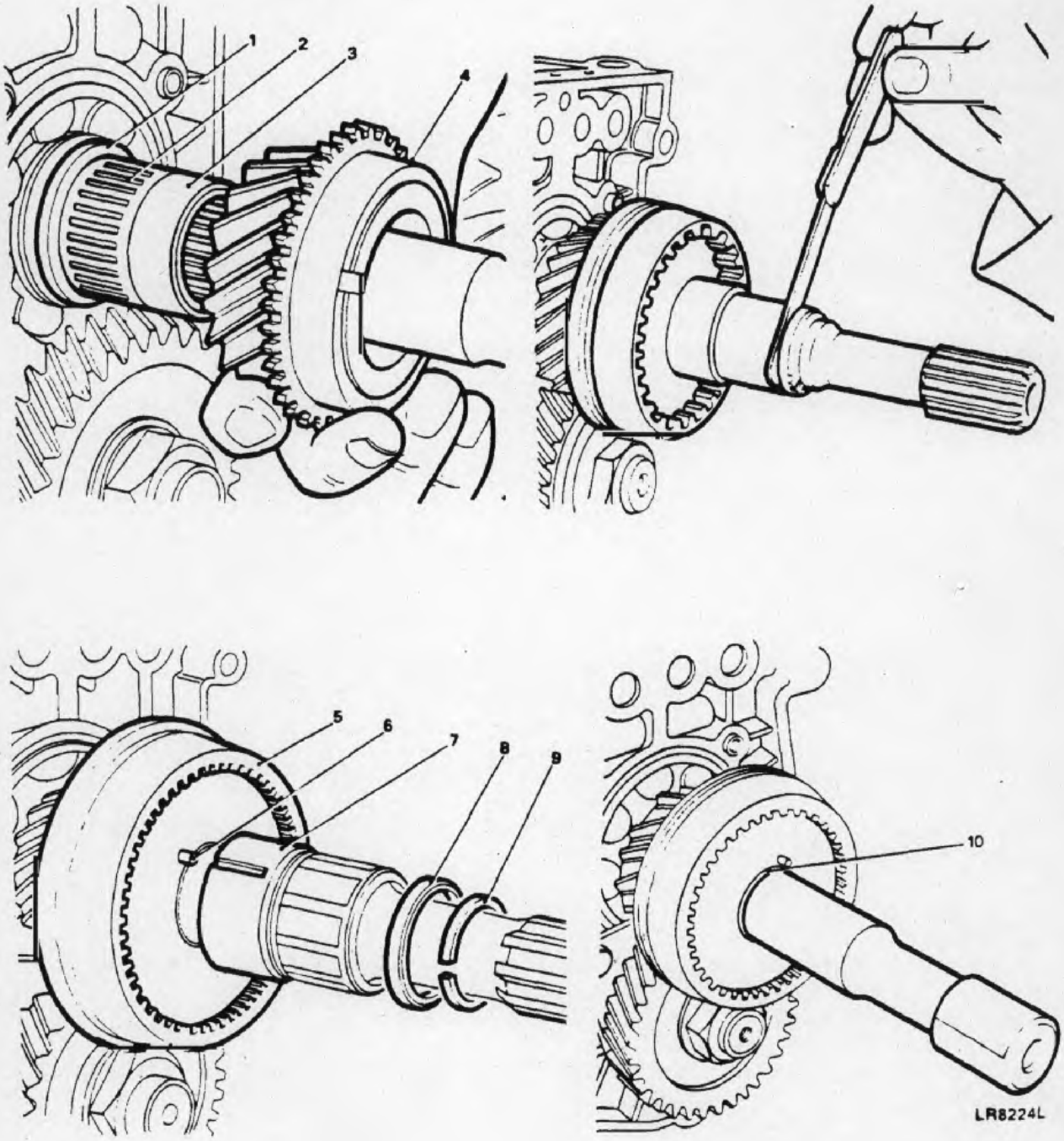
37.7 Fit the original selective washer (8) and retain with the snap ring (9).

37.8 Using a feeler gauge, measure the clearance between the washer and sleeve. If necessary exchange the washer for one that will provide a clearance of 0,075 mm (0.003 in).

37.9 Remove the snap ring, selective washer and sleeve.

37.10 Wind protective tape round the mainshaft splines and the 'O' ring seal (10) against the synchromesh hub retaining plate.

37.11 Refit the sleeve, selective washer and snap ring and remove the protective tape.



1 Thrust washer
2 Needle roller bearing
3 Spacer
4 5th gear
5 Cone and hub assembly
6 Peg
7 Sleeve
8 Selective washer
9 Snap ring
10 'O' ring

Fig 32 Checking mainshaft fifth gear end float

Selector rails and forks

38 For reassembly of the selector rails and forks refer to Cat 524 Chap 3-2.

Selector fork adjustment

39 For adjustment of the selector forks refer to Cat 524 Chap 3-2.

Reverse cross-over lever adjustment

40 For adjustment of the reverse cross-over lever refer to Cat 524 Chap 3-2.

Gear change lever assembly

41 For reassembly of the gear change lever refer to Cat 524 Chap 3-2.

Bell housing and clutch release lever

42 For reassembly of the bell housing and clutch release lever refer to Cat 524 Chap 3-2.

Extension housing

43 For reassembly and fitting of the extension housing refer to Cat 524 Chap 3-2.

Note ...

The extension housing bolt locations are unique to the LT85 Lightweight divided-case gearbox. Refer to Fig 33 of this Chapter.

Third and fourth gear selector rail adjustment

44 For adjustment of the third and fourth gear selector rail refer to Cat 524 Chap 3-2.

Bias spring adjustment

45 For adjustment of the bias springs refer to Cat 524 Chap 3-2.

Gearbox mounting

46 Refit mounting to extension housing and secure with four bolts.

<u>Refitting</u>

47 To refit the gearbox to the vehicle refer to Cat 522 Chap 3-2.

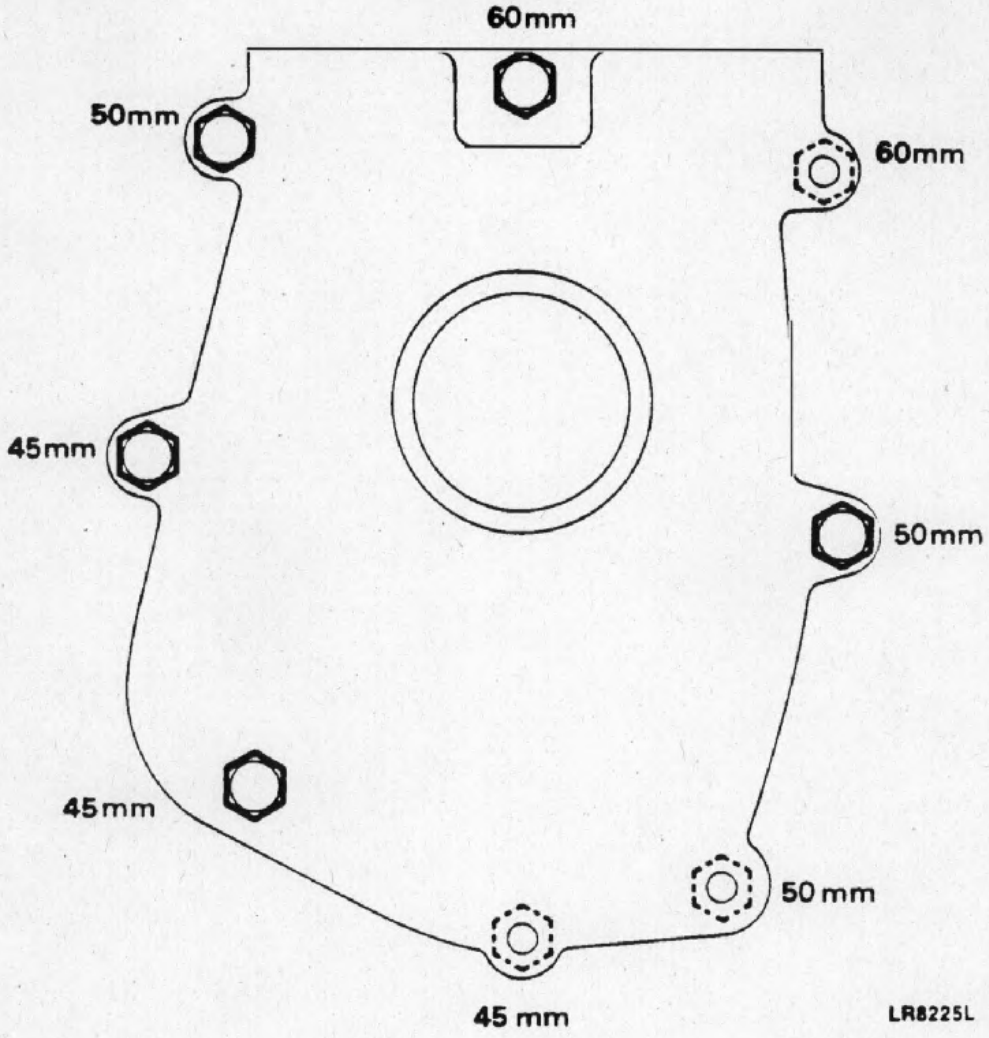


Fig 33 Extension housing bolt locations

CHAPTER 3-4

R380 FIVE SPEED MANUAL GEARBOX

CONTENTS

NOTE

The special tools listed in the following table will be referred to in the text, where used, by the serial number shown in the table.

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	NSN/Part No where applicable (3)	Designation (4)
1	LRT-37-009	5120-99-810-6713	Bearing remover
2	LRT-37-010	4910-99-257-5580	Adaptor for mainshaft
3	LRT-37-022		Adaptor for layshaft
4	LRT-99-004	5120-99-806-9013	Impulse extractor
5	LRT-37-001	5120-99-825-0835	Adaptor for input shaft bearing
6	LRT-37-004	5120-99-725-6474	Adaptor for input shaft pilot bearing track
7	LRT-37-021		Adaptor for mainshaft rear support bearing track and oil seal collar replacer
8	LRT-37-014	5120-99-660-2936	Mainshaft rear oil seal replacer
9	LRT-37-015	5120-99-087-0966	Mainshaft rear support bearing track and oil seal collar replacer
10	LRT-51-003	4910-99-824-1266	Flange holder
11	LRT-99-002	2240-99-796-3199	Hand press
12	LRT-99-004		Impulse extractor
13	LRT-37-022		Adaptor for layshaft bearings
14	LRT-37-023		Layshaft holding tool
15	LRT-37-024		Rear mainshaft bearing track remover

INTRODUCTION

1 This chapter details the base repair procedures for the R380 five speed manual gearbox as fitted to Land Rover 90/110 vehicles.

REMOVAL

2 For removal of the gearbox from the vehicle refer to Cat 522 Chap 3-2.

SPECIAL TOOLS

3 The special tools listed in Table 1 will be referred to in the text when used, by the serial shown in the table.

DISMANTLING

4 Place the gearbox on a suitable bench with the transfer box removed and support with a suitable wooden block. Ensure the gearbox is completely drained of oil. It is recommended that the gearbox is fitted to a manufactured wooden stand.

Gear selector housing

5 To dismantle the gear selector housing proceed as follows:

5.1 Using a suitable length of tubing dislodge both legs of the bias spring (Fig 1 (2)) from the cross pin on the gear lever shaft (25).

CAUTION

HAZARD TO PERSONNEL. TAKE CARE WHEN RELEASING THE RETAINER BOLT AS THE GEAR LEVER BALL IS SPRING LOADED IN ITS SEAT BY A STRONG SPRING AND NYLON PLUNGER.

5.2 Remove the screw (3) and special washer (4) to release the gear lever shaft (25), carefully withdraw the shaft from its housing and retrieve the spring (2) and nylon plunger (21).

5.3 Remove the two adjusting screws (12) and locknuts (13).

5.4 Remove the roll pin (1) and detach the bias spring (2).

5.5 Remove the four bolts (5) and spring washers (6) securing the gear lever housing to the selector housing (14). Lift off the housing and discard the gasket.

5.6 Slacken the locknut (13) securing the fifth gear stop and remove the adjusting screw (12).

5.7 Remove the bolts (9) and washers (10) securing the selector housing (14) to the extension case. Lift off the housing and discard the gasket.

5.8 Remove the locating screw (Fig 2 (1)) from the yoke (2), pull the selector shaft (3) rearwards and remove the yoke from the selector housing.

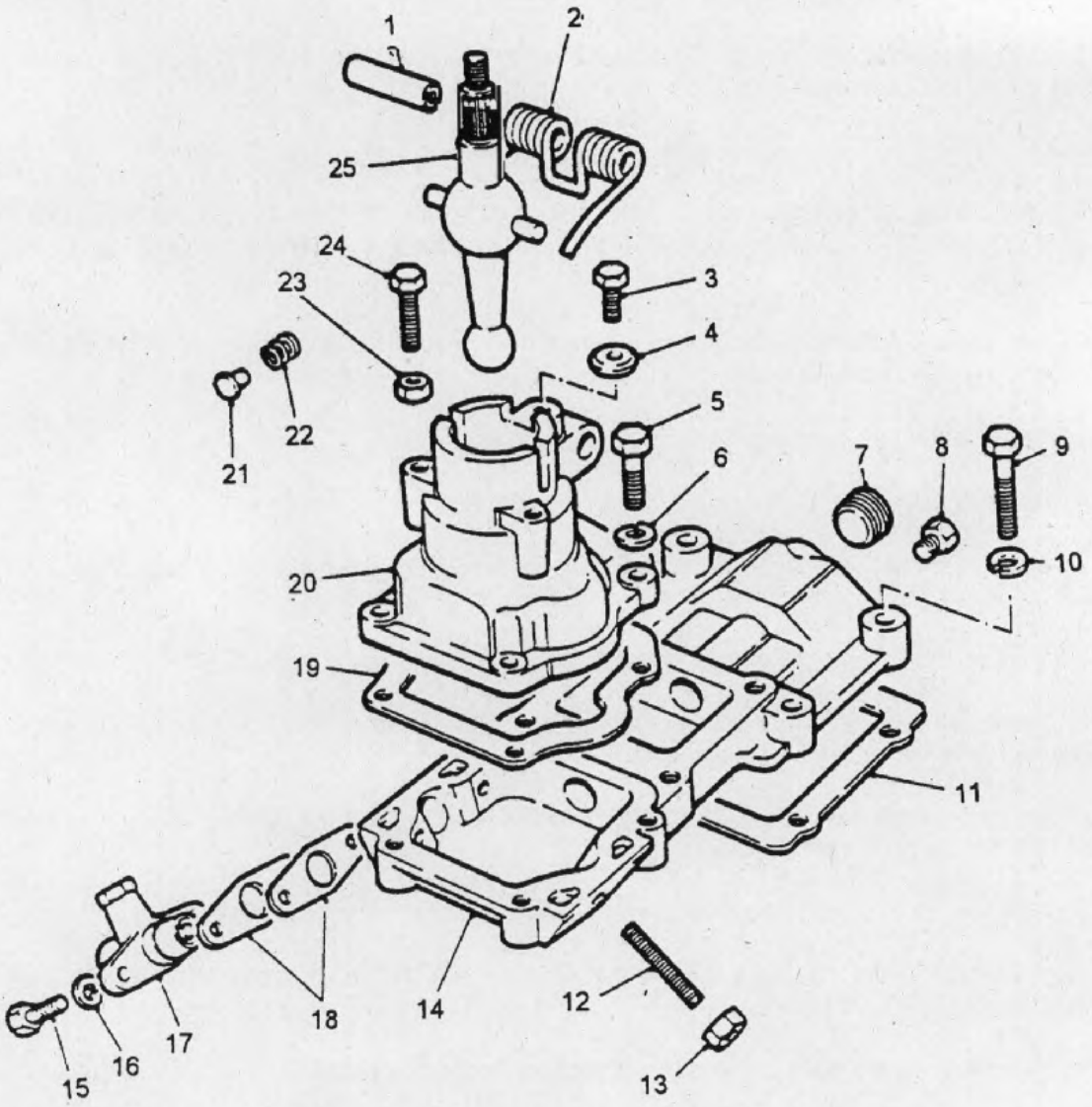
5.9 Release the circlip (4) and detach the nylon seat (5) from the yoke (2).

5.10 Invert the selector housing remove the two bolts (Fig 3 (1)) and washers (2) and lift off the fifth gear spool retainer (3).

5.11 Remove the two blanking plugs from the rear of the housing.

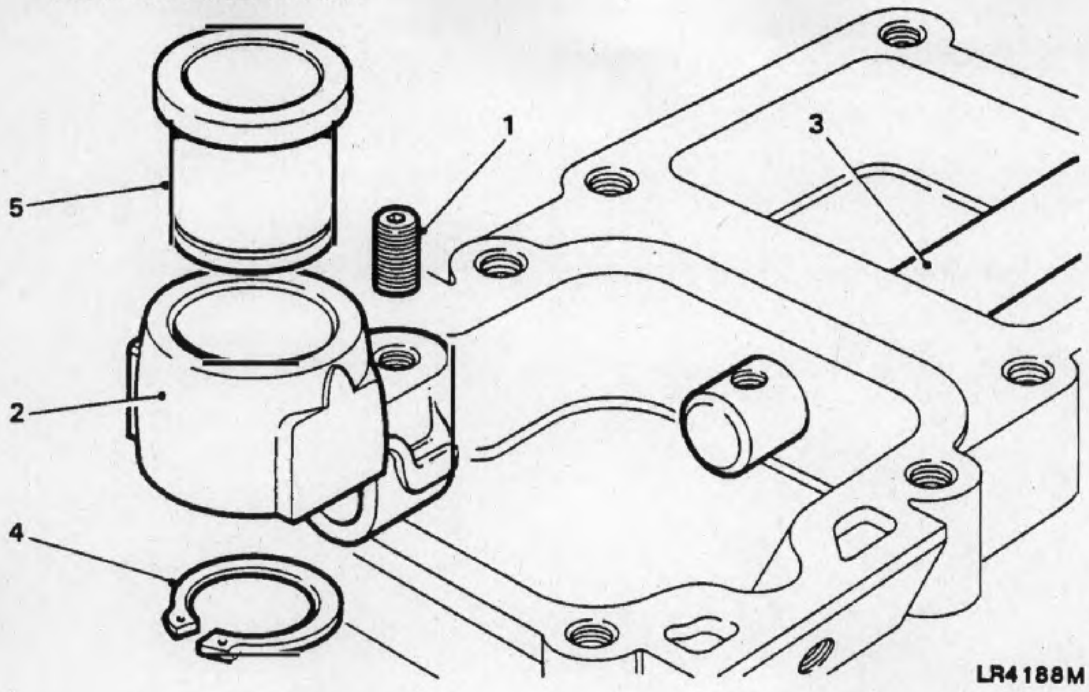
5.12 Place the gear selector housing into a vice with soft jaws. Using a suitable pin punch, drift out the selector quadrant roll pin (4). Push the selector shaft forward, remove the quadrant (5) and withdraw the shaft through the large blanking plug orifice. Remove the housing from the vice.

5.13 Remove the selector quadrant roller circlip (6) and withdraw the pin (7) and rollers (8).



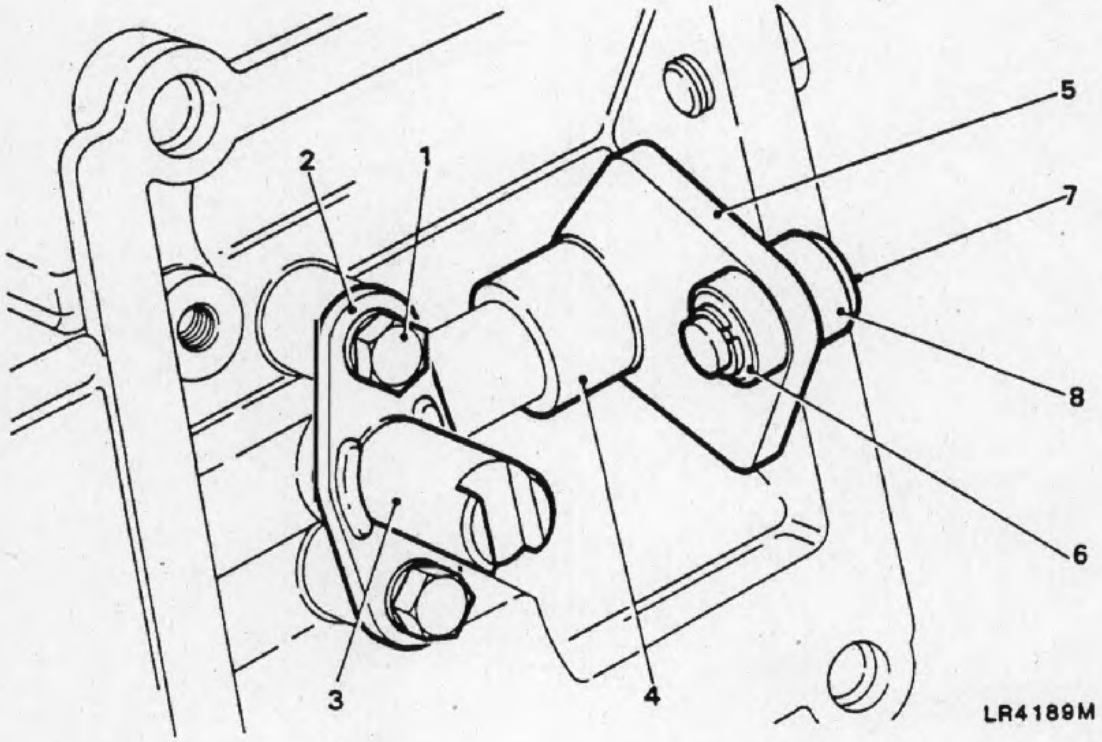
1	Roll pin	14	Selector housing
2	Bias spring	15	Bolt
3	Screw	16	Spring washer
4	Special washer	17	Reverse gear plunger
5	Bolt	18	Shim
6	Spring washer	19	Gasket
7	Blanking plug	20	Gear lever housing
8	Blanking plug	21	Nylon plunger
9	Bolt	22	Spring
10	Spring washer	23	Locknut
11	Gasket	24	Adjusting screw
12	Adjusting screw	25	Gear lever shaft
13	Locknut		

Fig 1 Gear lever and selector housing



1 Locating screw
2 Yoke
3 Selector shaft
4 Circlip
5 Nylon seat

Fig 2 Yoke and selector shaft removal



1 Bolts
2 Spring washer
3 Fifth gear spool retainer
4 Roll pin
5 Quadrant
6 Circlip
7 Roller pin
8 Roller

Fig 3 Spool and quadrant

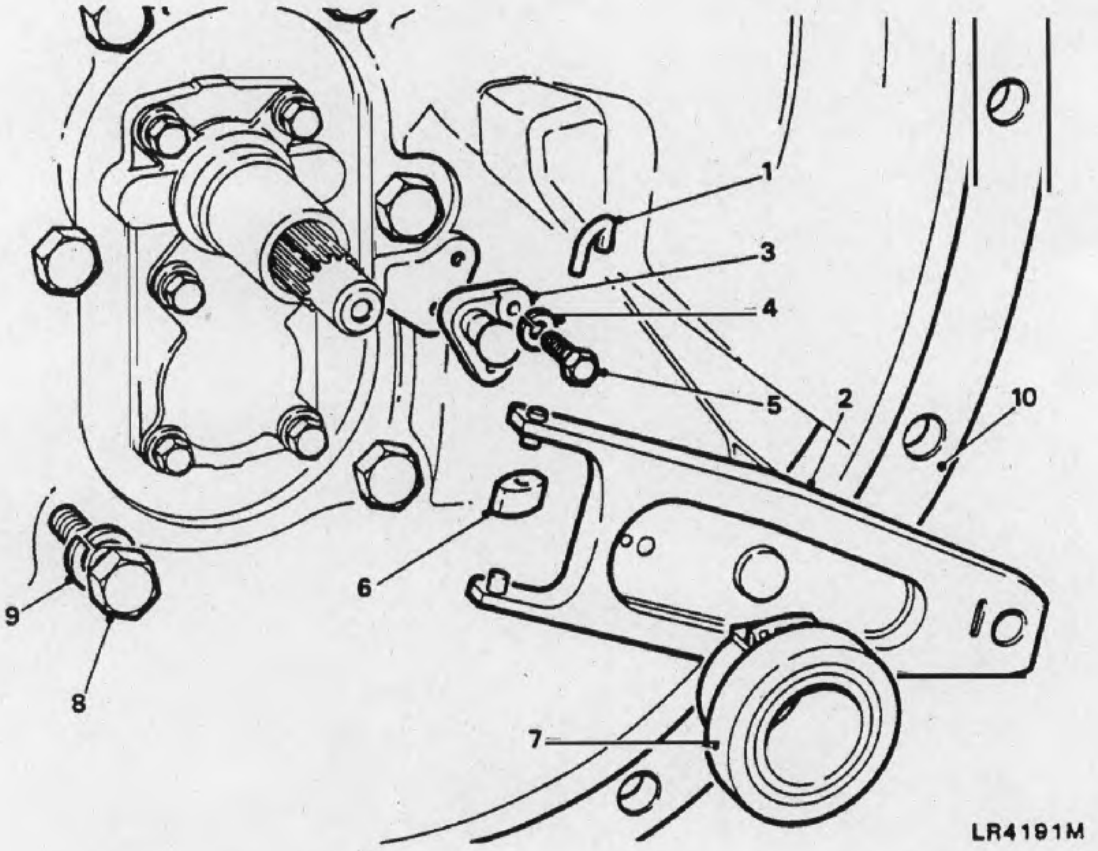
Bell housing and clutch release lever

6 Remove the bell housing and clutch release lever as follows:

6.1 Remove the clutch release bearing carrier clip (Fig 4 (1)) and withdraw the release bearing and carrier (7).

6.2 Detach the clutch release lever (2) from the clutch release lever pivot (3) complete with slipper pads (6).

6.3 Remove the bolts (8) and washers (9) securing the bell housing (10) and remove the bell housing.



1	Bearing carrier clip	6	Slipper pad
2	Clutch release lever	7	Release bearing and carrier
3	Lever pivot	8	Bolt
4	Spring washer	9	Spring washer
5	Bolt	10	Bell housing

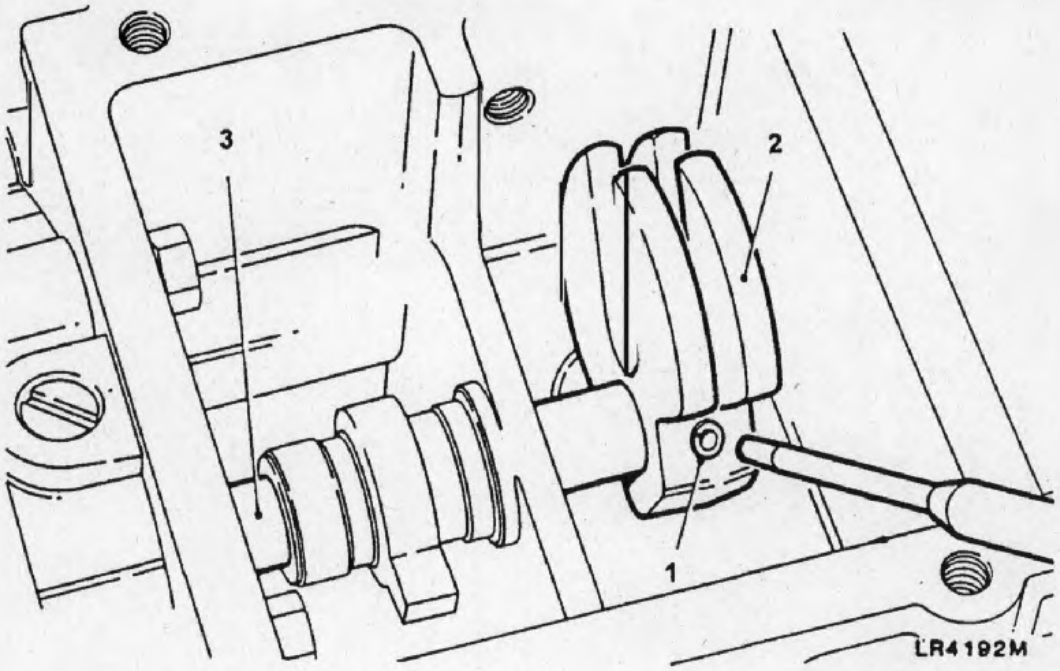
Fig 4 Bell housing and clutch release lever

Casing and gears

7 Remove the grub screw (Fig 5 (1)) from the selector yoke (2). Push selector rail (3) froward to engage a gear and manoeuvre the selector yoke from the rail. Return the selector rail to neutral.

8 Thread a 12 mm bolt into the end of the output shaft and using special tools (Ser Nos 1 and 2) remove the oil seal collar.

9 Remove reverse/fifth gear selector spool retainer.



1 Grub screw
2 Yoke
3 Selector rail

Fig 5 Yoke removal from selector rail

10 Remove the bolts and washers securing the extension case in the main gearcase.

11 Place a suitable container underneath the box to catch any oil spillage and remove extension case.

12 Remove and discard the oil filter.

13 Fit two slave bolts M8 x 35 mm to the casing, to retain the centre plate to the main gearcase.

14 Using a suitable two legged puller, remove the fifth gear layshaft support bearing track (Fig 6 (18)) from the end of the layshaft.

15 Select first and fifth gears to lock the gearbox.

16 Using special tool (Ser No 13) and two long bolts, hold the layshaft fifth gear (18) and remove the nut (19). Select neutral.

17 Remove thrust collar segments (11), retaining ring (12) and segments.

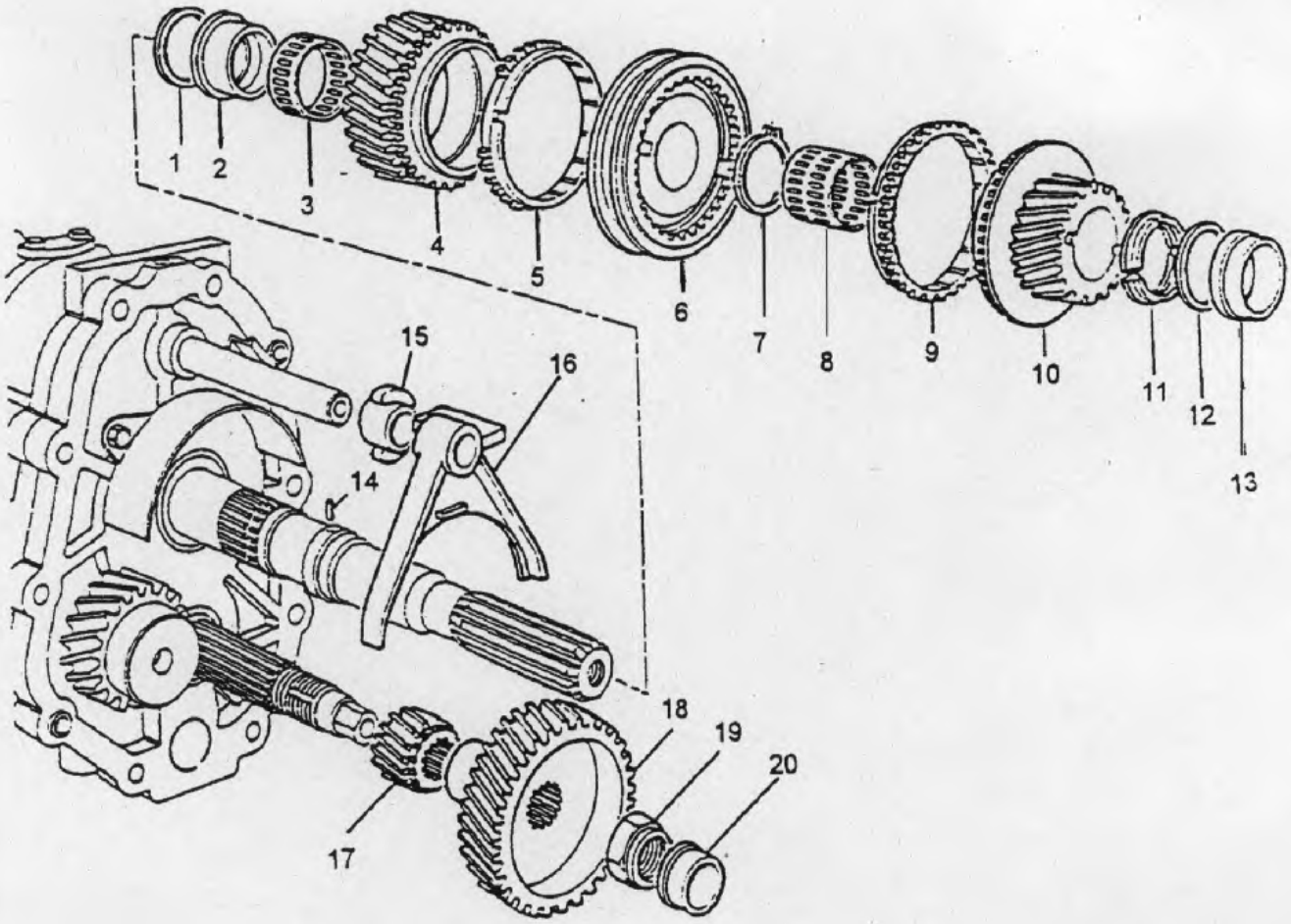
18 Drift out the roll pin (14) on the mainshaft.

19 Remove the layshaft fifth gear (18) from the layshaft.

20 Remove the mainshaft rear support bearing track (13) from mainshaft using tools (Ser Nos 1 and 2).

21 Remove the 12 mm bolt from end of mainshaft.

22 Remove the mainshaft fifth gear (10) and synchromesh baulk ring (9) from the mainshaft.



1 Selective spacer
2 Reverse gear bush
3 Needle roller bearing
4 Reverse gear
5 Synchromesh baulk ring
6 Fifth and reverse gear synchromesh hub
7 Circlip
8 Needle roller bearing
9 Synchromesh baulk ring
10 Fifth gear
11 Thrust collar segments
12 Retaining ring
13 Mainshaft rear support bearing track
14 Roll pin
15 Selector spool
16 Selector fork
17 Layshaft reverse gear
18 Layshaft fifth gear
19 Fifth laygear nut
20 Layshaft support bearing

Fig 6 Fifth and reverse gear

23 Remove mainshaft fifth gear split needle roller bearing (8).

24 Remove circlip (7) securing the fifth and reverse gear synchromesh hub (6).

25 Rotate the selector spool (15) clear of the synchromesh hub fork (16) and remove the fifth and reverse synchromesh hub assembly (6), complete with fork and spool.

26 Remove mainshaft reverse gear (4) complete with needle roller bearing (3) and bush (2). Noting selectable spacer between reverse gear bush and centre plate bearing.

27 Remove layshaft reverse gear (17).

28 Remove the two bolts and spring washers securing the locating boss for the main case spool retainer and withdraw the locating boss.

29 Remove the spring retaining plug, selector detent spring and detent ball from the top of the centre plate.

30 Align the selector shaft pin with slot in centre plate and using wooden blocks and a hide mallet, drive off the centre plate.

31 Collect the detent ball and spring. Remove the bearing tracks and shims.

32 Remove the layshaft, mainshaft and selector shaft from the casing as a complete unit.

33 Remove the input shaft and fourth gear baulk ring. These may come away when carrying out the operation detailed in Para 32.

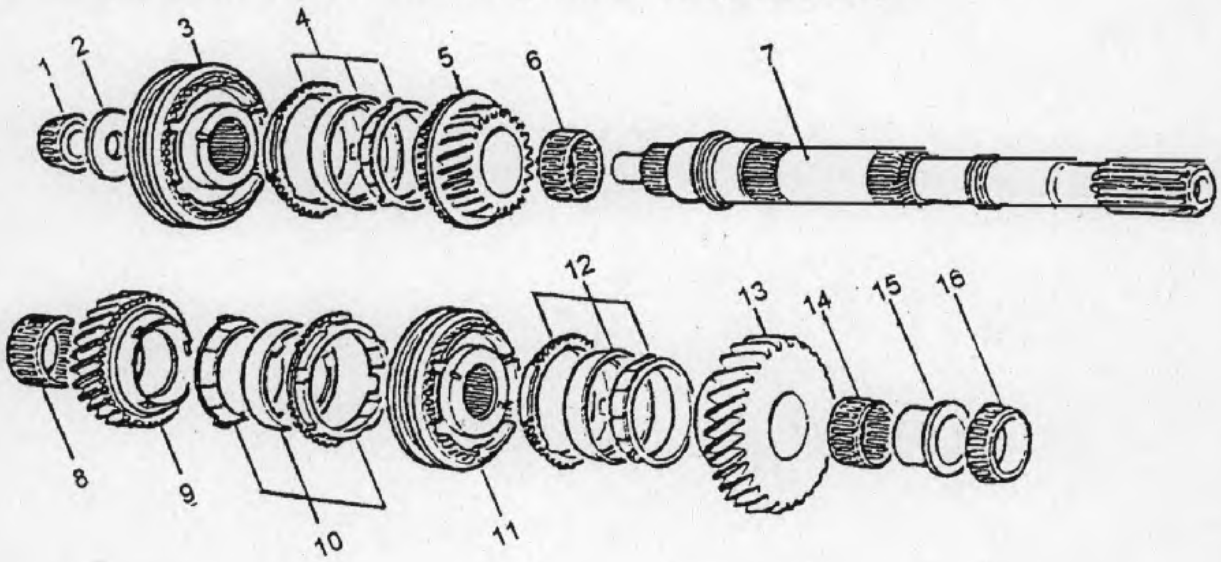
Front cover

34 Separate the front cover from gearbox, remove bearing tracks. Ensure that the spring clips are intact.

35 Remove and discard the oil seal. Do not fit a new seal at this stage.

Layshaft

36 Using special tools (Ser Nos 11 and 13), withdraw the layshaft bearings.



1 Pilot bearing
2 Spacer
3 Third/fourth gear synchromesh
4 Third gear synchromesh baulk rings
5 Third gear
6 Needle roller bearing
7 Mainshaft
8 Needle roller bearing
9 Second gear
10 Second gear synchromesh baulk ring
11 First/second gear synchromesh selector hub
12 First gear synchromesh baulk rings
13 First gear
14 Needle roller bearing
15 Bush
16 Mainshaft support bearing

Fig 7 Mainshaft and gears

37 Using tool (Ser No 10) and support bars under the first gear (Fig 7 (13)), remove the mainshaft support bearing (16) from the mainshaft (7).

38 Remove first gear (13), bush (15), needle roller bearing (14) and first gear synchromesh baulk rings (12).

39 Remove the first/second gear synchromesh selector hub (11), second gear synchromesh baulk rings (10), second speed gear (9) and needle roller bearing (8).

40 Invert mainshaft (7). Using tool (Ser No 10) and support bars under third gear (5), press off the pilot bearing (1).

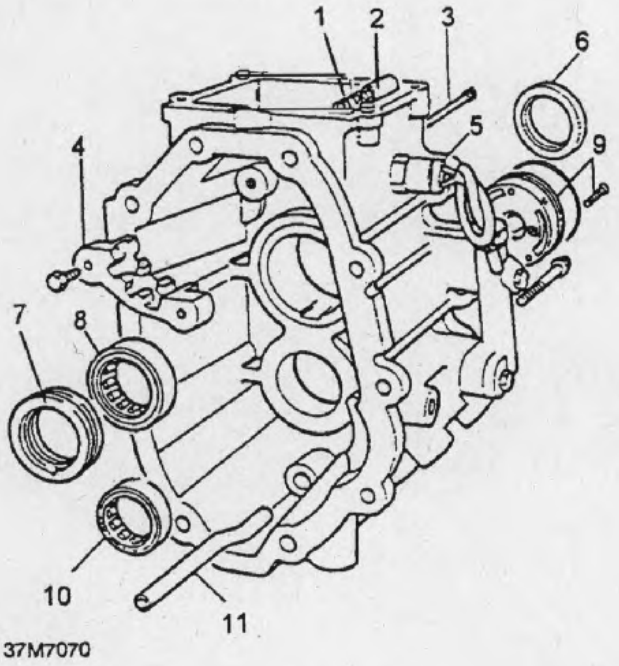
41 Remove spacer (2), third/fourth gear synchromesh (3) with baulk rings (4), third gear (5) and needle roller bearing (6).

Synchromesh assemblies

42 Mark the inner and outer members to assist with reassembly, remove the spring clips from both sides and withdraw the slippers. Separate the inner member from the outer member.

Extension casing

43 Remove the three screws securing the oil pump body (Fig 8 (9)).



1 Spring
2 Reverse inhibition cam
3 Shaft retaining inhibition cam
4 Gate plate
5 Reverse light switch
6 Rear mainshaft oil seal
7 Oil pick-up ring
8 Mainshaft support bearing
9 Oil pump body
10 Layshaft support bearing
11 Oil pick-up pipe

Fig 8 Extension casing

44 Remove the oil pick-up pipe (11).

45 Using a suitable drift remove layshaft support bearing (10).

46 Extract rear mainshaft oil seal (6).

47 Drift out the mainshaft rear support bearing (8) and oil pick-up ring (7).

48 Remove the shaft retaining the reverse inhibition cam (2), and remove the cam (3) and spring (1).

49 Remove the screws securing the gate plate (4) and remove the gate plate.

Input shaft

50 Insert the shaft in a soft vice jaws and using tools (Ser Nos 4 and 6), extract the pilot bearing track.

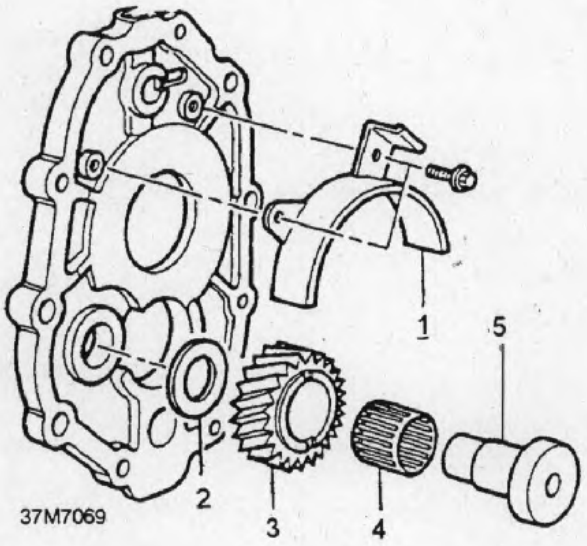
51 Support tool (Ser No 5) in a soft jawed vice, ensuring that the bearing is supported by the lip inside the tool, remove the taper roller bearing.

Centre plate

52 If necessary remove the splash shield (Fig 9 (1)).

53 Using a suitable press, remove the reverse idler gear shaft (5).

54 Remove the reverse idler gear (3), needle bearing (4) and spacer (2) from the shaft (5).



1 Splash shield
2 Spacer
3 Reverse idler gear
4 Needle bearing
5 Reverse idler gear shaft

Fig 9 Centre plate

Selector rail

55 The selector rail is supplied complete with first and second selector fork, pin and fifth speed selector pin. Should any of the parts within the assembly require a replacement, a new assembly must be fitted.

CLEANING

56 Clean all components thoroughly using a suitable solvent. Ensure all of the lubrication drillings are clear of sludge or contamination.

EXAMINATION

57 Examine the components in accordance with EMER T&M A028 Chap 056 and Chap 012 referring to Cat 533 for dimensions and wear tolerances.

58 Examine all casings for cracks, stripped threads in all the bolt holes and the machined mating faces for burrs, nicks or any other condition that would render the casing unfit for further service. Damaged threads may be reclaimed by fitting wire thread inserts.

59 Inspect all gears for excessively worn, chipped or broken teeth. Inspect all spline teeth on the synchromesh assemblies.

60 Inspect synchromesh slippers and slipper rings for wear and breakage. Examine the dog teeth on all gears for wear and damage.

61 Inspect all circlip grooves for burrs or rough edges, if any are apparent remove by carefully stoning with a fine stone.

62 Generally examine all other components for wear or damage, fit new components as necessary.

REPAIR AND REPLACEMENT

63 It is recommended that all seals, gaskets, circlips, lock washers, needle and roller bearings are renewed at overhaul.

REASSEMBLY

Layshaft

64 Using press and support bars fit new taper roller bearings.

Synchromesh assemblies

NOTES

(1) All the synchromesh assemblies are similar and stripping and reassembly is the same for all.

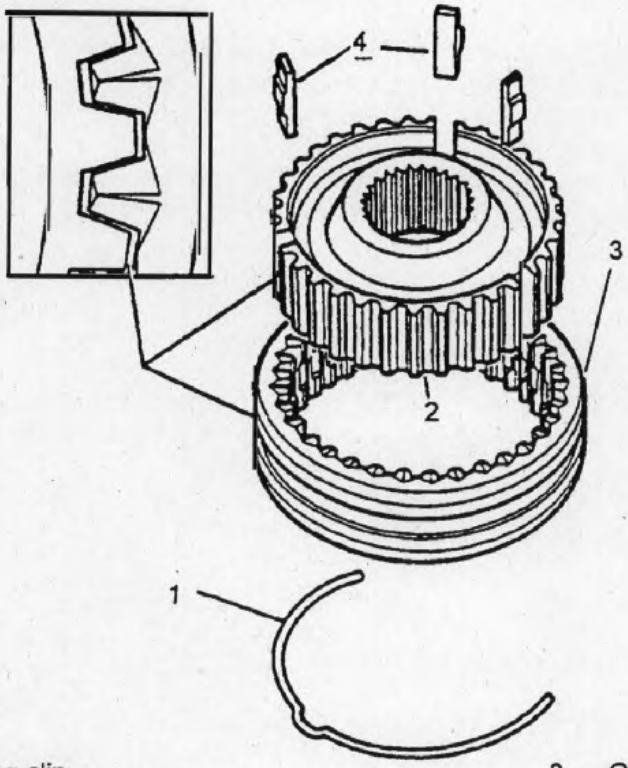
(2) Inner and outer members have a master spline and can only be assembled in one way.

65 Refit the inner member (Fig 10 (2)) to the outer member (3), fit the slippers (4) and secure with a spring (1) each side of the synchromesh.

NOTE

When refitting existing baulk rings, they must be fitted to their original locations from which they were removed.

66 Check the clearance of all baulk rings and gears by pressing the baulk rings against the gear and measuring the gap, as shown in Fig 11. The minimum clearance is 0.5 mm (0.020 in.).



1 Spring clip
2 Inner member
3 Outer member
4 Slipper

Fig 10 Synchromesh gear assembly

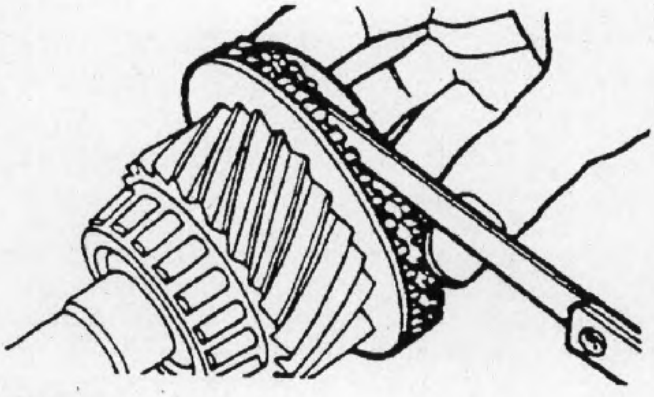


Fig 11 Checking baulk ring clearance

Mainshaft

67 Clamp the mainshaft in protected vice jaws, output end upwards.

68 Fit the second gear needle roller bearing (Fig 7 (8)), second gear (9) and synchromesh baulk rings (10) onto mainshaft. Rotate each of the baulk rings to ensure that they locate onto each other.

69 Assemble the first/second synchromesh selector hub (11) onto the mainshaft spline, noting the second speed side marking. Rotate the baulk ring slightly as the hub is lowered to ensure that the ring is located correctly inside the hub.

70 Fit the first gear synchromesh baulk rings (12), needle roller bearing (14), first gear (13) and bush (15) onto the mainshaft ensuring that the baulk rings are located correctly inside the selector hub.

71 Using tool (Ser No 11), bearing guide LRT 37 019, collets (Ser No 5) and adaptor LRT 37 002 press on the mainshaft taper roller bearing (16), taking care not to disturb the lay of the synchromesh baulk rings and gears.

72 Check the end float of the first and second gear assembly using a feeler gauge between the first gear and mainshaft bearing. Maximum clearance should be 0.05 mm to 0.15 mm (0.002 in. to 0.006 in.).

73 Invert the mainshaft in the vice and fit the third gear needle roller bearing (6), third gear (5) and synchromesh baulk rings (4).

74 Assemble the third/fourth gear synchromesh selector hub (3), noting the third speed side markings, onto the mainshaft splines. Ensure that the baulk rings are located into the recesses in the selector hub.

75 Check the end float of the assembly as in Para 80.

76 Fit the spacer (2) onto the mainshaft.

77 Using special tool (Ser No 11) press on a new pilot bearing (1).

REVERSE IDLER GEAR ASSEMBLY

78 Fit a new needle bearing (Fig 9 (4)) to the idler shaft (5), fit the reverse idler gear (3) and spacer (2).

79 Using a suitable tool, press the idler shaft assembly into the centre plate. The maximum clearance should be 0.05 mm to 0.04 mm (0.002 in. to 0.0016 in.). Refit the splash shield (1) if removed.

Mainshaft and layshaft end float

NOTES

(1) The end float setting for both the mainshaft and layshaft has to be determined before the gearbox is assembled.

(2) When determining the mainshaft end float, care must be taken to ensure that no side movement is recorded. To assist in dampening out the side movement, wrap approximately ten turns of masking tape around the plain portion of the input shaft below the splines. Ensure that the rise and fall of the shaft is not hindered by the tape.

80 Fit bearing tracks to the main casing front cover and fit the front cover to the casing without the oil seal.

81 Clamp the casing in a soft jawed vice with the front cover facing downwards.

82 Fit the input shaft without the 4th gear baulk ring. Fit the mainshaft assembly to the input shaft.

83 Fit the mainshaft bearing shim and track to the centre plate. Fit the centre plate to the casing using eight slave bolts and tighten to 22 to 28 Nm (16 to 21 lbf ft).

84 Fit a large ball bearing in the indent at the end of the mainshaft.

85 Mount a Dial Test Indicator (DTI) on the gearbox. Rotate the mainshaft to settle the bearings.

86 Lift the mainshaft and note the reading. The required end float for the mainshaft is 0.0125 to 0.06 mm (0.0005 to 0.0025 in.).

87 If the reading is incorrect dismantle and select appropriate shims to achieve the correct end float.

88 When the correct end float has been achieved remove the centre plate and mainshaft. Fit layshaft assembly and replace the centre plate.

89 Secure the centre plate with eight slave bolts and tighten to a torque of 22 to 28 Nm (16 to 21 lbf ft).

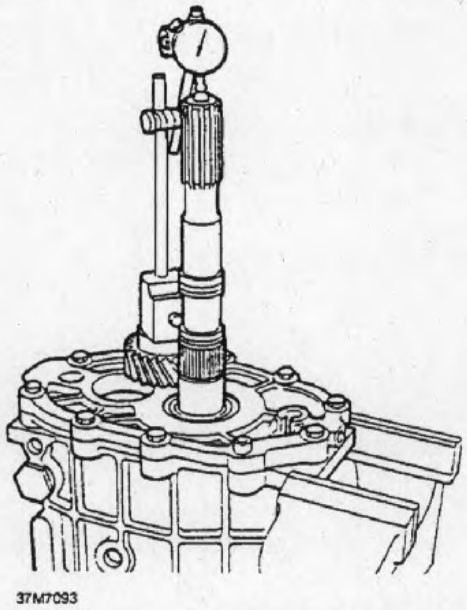


Fig 12 Mainshaft end float

90 Fit a large ball bearing in the indent at the end of the mainshaft.

91 Mount the DTI and with the aid of a lever, 23 cm in length, check the end float by a gentle push lift action. The layshaft end float should be 0.000 mm ± 0.025 mm (0.0 in. ± 0.01 in.) with a pre-load of 0.025 mm (0.001 in.).

92 If reading is incorrect, dismantle and place appropriate shims to achieve the required end float, repeat Paras 90 to 91.

93 Dismantle the assembly in preparation for assembly.

Extension case (assembly)

94 Smear a light coat of vaseline into the pump recess.

95 Renew the 'O' ring and press the pump unit (Fig 8 (9)) firmly into the recess.

NOTE

Ensure 'TOP' marking on pump is to the top of the casing.

96 Tap pump lightly at the edges until screws take to threads and pull down the pump by tightening the screws.

NOTE

Ensure that the threads have properly engaged before tightening.

97 Fit a new mainshaft support bearing (8).

98 Using tool (Ser No 8) fit a new mainshaft rear oil seal (6).

99 Press in a new layshaft support bearing (10).

100 Fit a new oil pick-up ring (7) taking care to align hole with the centre of drain slot.

101 Refit the gate plate (4).

102 Renew copper washer and refit the reverse light switch (5), if removed. Tighten to 22 to 26 Nm (16 to 21 lbf ft).

103 Refit the reverse inhibition cam (2) and spring (1).

104 Apply Hylogrip 2000 and refit the shaft.

105 Refit oil pipe (11), bend uppermost.

Centre plate

106 Place the centre plate onto the locally manufactured stand and secure using two slave bolts.

107 Place selected shims for the mainshaft and layshaft in the centre plate and press in new bearing tracks.

108 Using a dummy bar to temporarily hold the ball in place, refit the inboard detent ball and spring.

109 Lightly lubricate the selector shaft with a light oil.

110 Ensure that both synchromesh units are in neutral and fit selector shaft assembly to the mainshaft.

111 Fit the mainshaft and selectors as a complete unit to the centre plate, ensuring that the pin is aligned with the slot in the plate.

112 Fit fourth gear synchromesh baulk ring.

113 Fit the layshaft to centre plate whilst lifting mainshaft to clear the layshaft rear bearing.

Main gearbox casing

114 Fit two locally manufactured guide studs into the casing, one at each side, carefully lower the casing over the assembled gear train. Ensure that the centre plate dowels and selector shaft are engaged in their correct location.

115 Using M8 x 35 mm slave bolts and plain washers, to prevent damage to the rear face of the centre plate, evenly draw the gearcase into position on the plate.

116 Refit the fifth gear spool retainer, using a new 'O' ring, and tighten to a torque of 7 to 10 Nm (5 to 7 lbf ft).

NOTE

It is essential that the gear selector rail is not rotated or disturbed in any way during the remainder of the assembly, as it is possible for the selector to disengage from the selector forks. Should disengagement occur, the main casing and centre plate will have to be dismantled.

Fifth and reverse gear assembly

117 Fit mainshaft reverse gear selective spacer (Fig 6 (1)), bush (2) and needle bearing (3).

118 Fit the mainshaft reverse gear (4) and the synchromesh baulk ring (5).

119 Fit layshaft reverse gear (17).

120 Assemble selector spool (15), selector fork (16) and reverse/fifth gear synchromesh hub (6). Fit as one assembly to mainshaft splines and selector shaft, ensuring that synchromesh baulk ring locates inside the hub.

121 Fit new circlip (7) to mainshaft.

NOTE

The fit of the circlip is controlled by selectable washer behind the reverse gear.

122 Fit fifth gear split needle bearing (8).

123 Fit fifth gear (10) and fifth gear synchromesh baulk ring (9) to mainshaft.

124 Fit layshaft fifth gear (18).

125 Fit new mainshaft thrust collar roll pin (14). Locate fifth gear segments (11) and retaining ring (12).

126 Select fifth and first to lock the gearbox, using tool (Ser No 10) to hold the layshaft fifth gear, tighten the layshaft nut to 203 Nm (150 lbf ft).

127 Select neutral and stake the layshaft nut.

128 Using special tools (Ser No 9 and 7) press mainshaft rear support bearing track to collar on mainshaft as shown in (Fig 13).

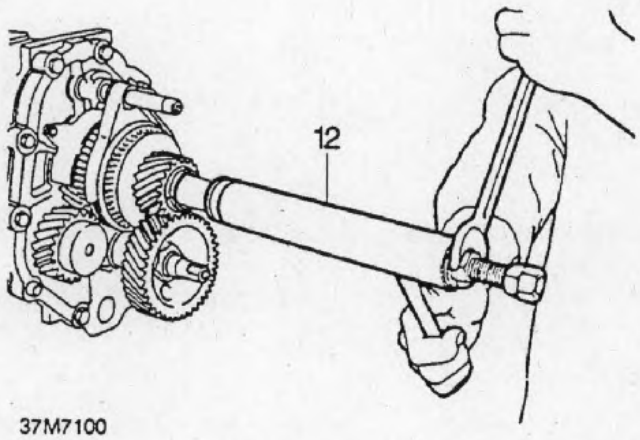


Fig 13 Replacement of rear support bearing

129 Apply a small amount of heat to the layshaft rear support bearing and fit to layshaft.

Extension housing

130 Remove all slave bolts from centre plate and casing.

131 Refit oil filter.

132 Apply Hylogrip 2000 to mating surfaces and fit extension housing ensuring oil pipe locates in filter and the roller bearings are not dislodged. Secure the extension case with the bolts and spring washers and tighten the bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).

133 Apply Hylogrip 2000 and fit extension case spool retainer.

134 Using special tools (Ser Nos 7 and 9) press on new mainshaft oil seal collar.

135 Fit selector rod yoke and secure with new grubscrew.

136 Apply Hylogrip 2000 to the mating surfaces and refit the gear change housing by engaging the male selector yoke with female yoke. Align the housing locating dowels and fit the housing. Secure using the three bolts and washers and tighten the bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).

NOTE

If the oil cooler or bypass blocks have been removed during overhaul, replace all 'O' rings on assembly.

Bell housing

137 Locate the bell housing (Fig 4 (10)) with the hollow dowels fitted to the front face of the main casing and fit two long bolts (M12 x 45 mm) with spring and plain washers to the dowel locations. Fit the remaining four bolts (M12 x 30 mm) with spring washers only. Tighten all six bolts to a torque of 65 to 80 Nm (16 to 21 lbf ft).

138 Fit the clutch release lever pivot (3) and secure with the bolts (5) and spring washers (4). Tighten the bolts to 22 to 28 Nm (16 to 21 lbf ft).

139 Prior to reassembly lubricate the following items with a thin film of molybdenum disulphide grease:

139.1 Clutch release lever fulcrum pivot socket (2).

139.2 Clutch release lever slipper pad pins and the faces of each slipper pad (6).

139.3 Ball ends of the clutch operating rod.

140 Fit the slipper pads to the clutch release lever and locate the lever socket on the pad.

141 Lubricate the inner face of the clutch release bearing carrier (7) with molybdenum disulphide grease and fit to the front cover spigot, locating the slipper pads (6) to the carrier recess. Fit a new carrier slip

142 Refit the gearbox oil level plug and drain plugs, using a new fibre washer with the drain plug. Tighten both plugs to a torque of 25 to 35 Nm (19 to 26 lbf ft).

Gear selector housing

143 To assemble the gear selector housing proceed as follows:

143.1 Fit the rollers (Fig 3 (8)) and pin (7) to the selector quadrant (5) and secure with a new circlip (6).

143.2 Lubricate the selector housing shaft with light oil and fit a new 'O' ring seal.

143.3 Insert the shaft into the selector housing through the large blanking plug orifice. Ensure that the yoke securing screw location at the end of the shaft is uppermost.

143.4 Place the selector housing into a soft jawed vice. Fit the selector quadrant (5) to the shaft and secure with a new roll pin (4). Remove the housing from the vice.

143.5 Coat the threads of the two blanking plugs with Loctite 290. Fit the plugs to their respective locations in the selector housing, tighten the larger plug to a torque of 25 to 35 Nm (19 to 26 lbf ft) and the smaller to 20 to 27 Nm (15 to 20 lbf ft).

143.6 Fit the reverse/fifth gear spool retainer (3) to the selector housing. Secure with bolts (1) and spring washers (2) and tighten to a torque of 7 to 10 Nm (5 to 7 lbf ft).

143.7 Fit the nylon seat (Fig 2 (5)) to the yoke (2) and secure with new circlip (4).

143.8 Invert the housing and fit the yoke (2) to the selector shaft (3). Coat the threads of the securing screw with Loctite 290 and fit to the yoke. Ensure that the screw engages with the indent on the shaft and tighten to a torque of 22 to 28 Nm (16 to 21 lbf ft).

143.9 Apply Hylogrip 2000 to mating surfaces and fit selector housing, secure with bolts and spring washers. Tighten bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).

143.10 Position a new washer joint between the gear lever housing and selector housing. Secure housing with bolts and washers, tighten to a torque of 22 to 28 Nm (16 to 21 lbf ft).

143.11 Fit the two bias spring adjustment screws and locknuts. Place the bias spring in position on the gear lever housing and retain with a new roll pin.

143.12 Coat upper and lower spheres of the gear lever shaft with Alvina R1 grease. Fit the spring and plunger, ensure that the plunger is facing the front, install the lever in its housing and secure with special washer and screw.

BIAS SPRING ADJUSTMENT

144 The purpose of this adjustment is to ensure that the bias spring legs apply equal pressure on both ends of the gear lever cross pin, when third or fourth gear is engaged. This will ensure that when the lever is in neutral the selector is aligned for third or fourth gear.

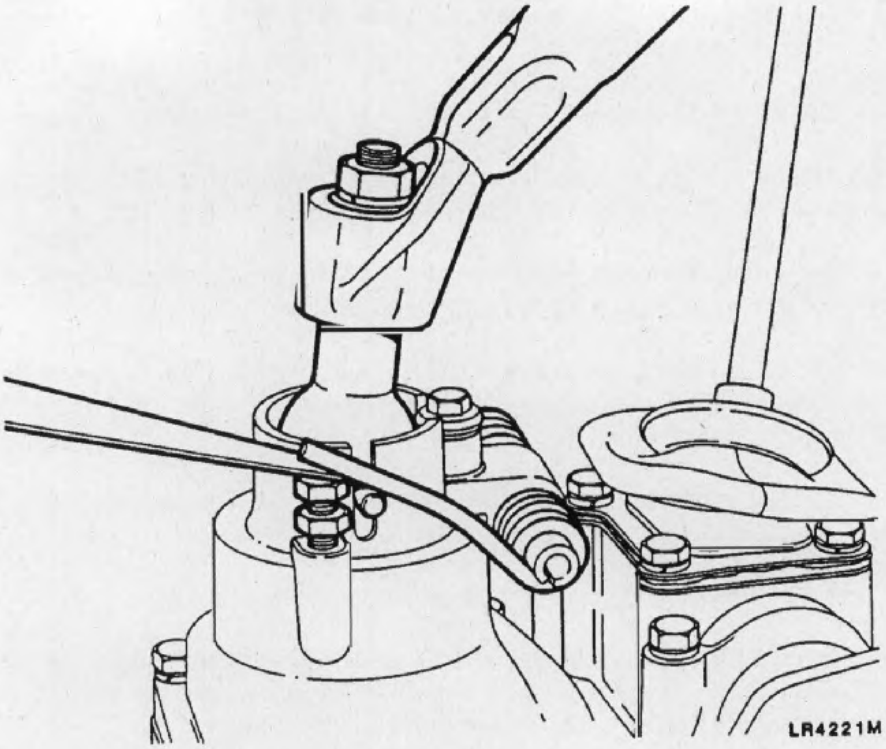


Fig 14 Bias spring adjustment

144.1 Select third or fourth gear, adjust the two adjusting screws until both legs of the spring are approximately 0.5 mm (0.019 in.) clear of the cross pin in the gear lever.

144.2 Apply a slight load to the gear lever in a left hand direction and adjust the right hand adjusting screw downward until the right hand spring leg just makes contact with the cross pin.

144.3 Repeat the same procedure for the left hand adjusting screw.

144.4 Lower both adjusting screws, equal amounts, until the radial play is just eliminated.

144.5 Tighten both locknuts.

144.6 Return gear lever to neutral. Rock across the gate several times, the gear lever should return to the third and fourth gate.

REFITTING

145 To refit the gearbox to the vehicle refer to Cat 522 Chap 3-1.

Chapter 4

TRANSMISSION

LT230T TRANSFER GEARBOX AND PROPELLER SHAFTS

CONTENTS

TABLE 1 SPECIAL TOOLS

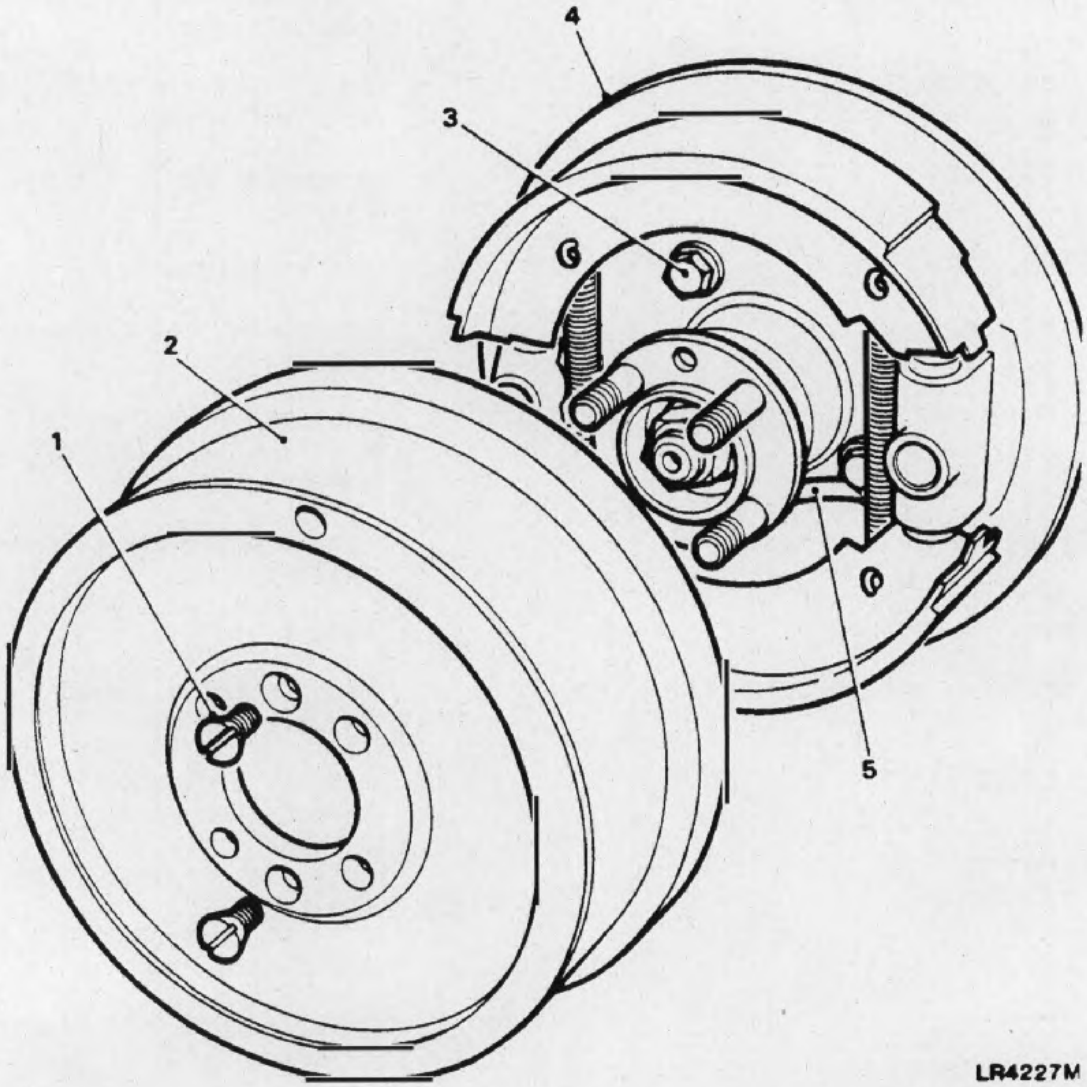
Ser No (1)	Manufacturers Part No (2)	NSN/Part No where applicable (3)	Designation (4)
1	18G. 47-7		Input gear cluster bearing cones remover/replacer
2	18G. 47BB-1		Adaptor centre differential bearing remover
3	18G. 47BB-3		Adaptor centre differential remover button
4	18G. 1205		Propeller shaft flange wrench
5	18G. 1271		Oil seal remover
6	18G. 1422		Mainshaft rear oil seal replacer
7	18G. 1423	LV6/MT2 5120-99-725-6477	Adaptor/socket centre differential stake nut remover/replacer
8	18G. 1424		Centre differential bearing replacer
9	MS 47		Hand press
10	MS 550		Bearing and oil seal replacer handle
11	LST 47-1		Adaptor centre diff rential bearing remover
12	LST 104		Intermediate gear dummy shaft
13	LST 105		Input gear mandrel
14	LST 550-4		Intermediate gear bearing replacer

INTRODUCTION

1 This Chapter details the Base repairs for the Land Rover LT230T Transfer Gearbox as fitted to Land Rover 90/110 vehicles having 2.5 litre diesel engin s.

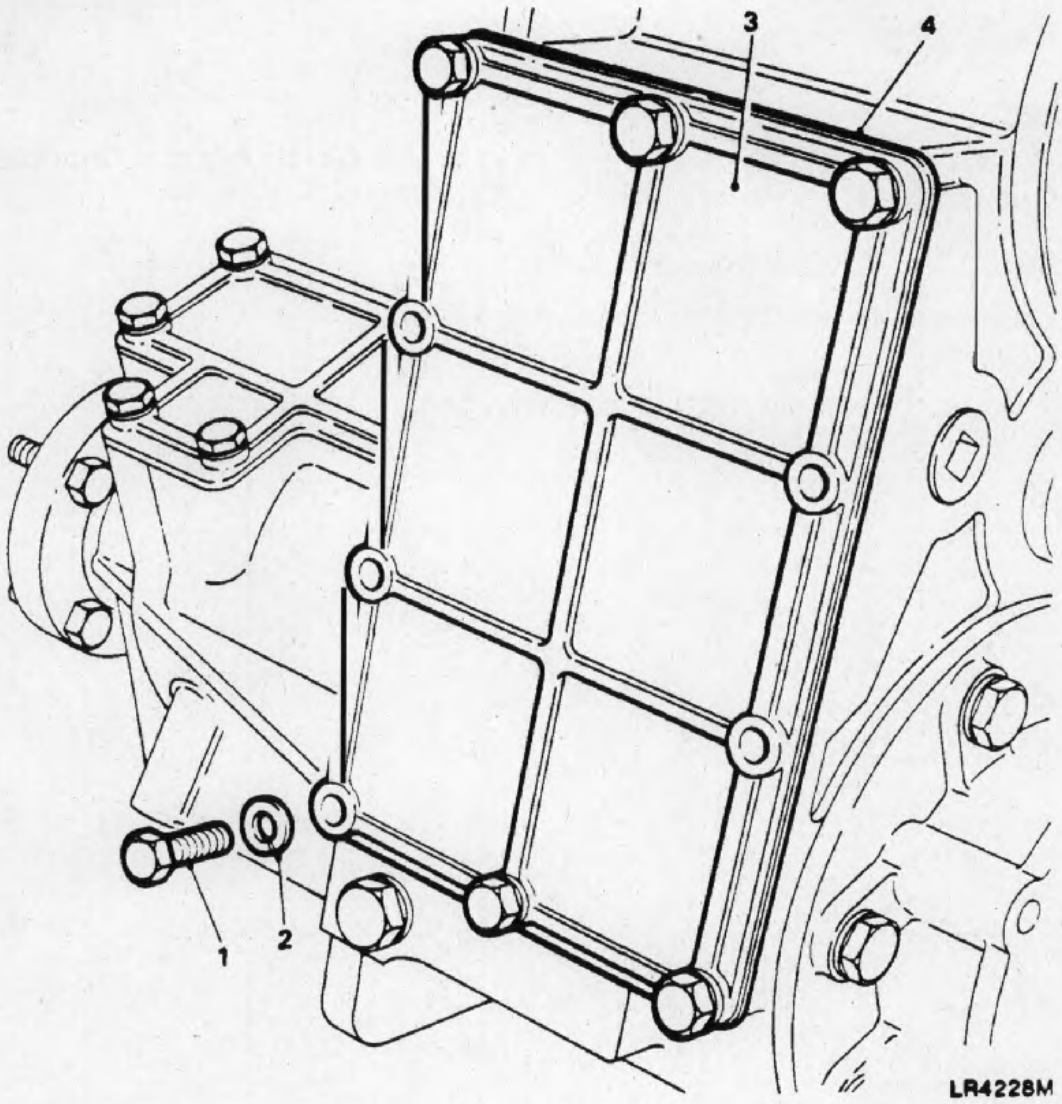
REMOVAL

2 To remove the transfer gearbox from the vehicle refer to (Cat 522).



1 Countersunk screw
2 Brake drum
3 Bolt
4 Backplate and shoes
5 Oil catcher

Fig 1 Transmission brake



1	Bolt	3	Cover
2	Spring washer	4	Gasket

Fig 2 Bottom cover

DISMANTLING

Transmission brake

3 To remove the transmission brake carry out the following:

3.1 Remove the two countersunk screws (Fig 1 (1)) and withdraw the brake drum (2).

3.2 Using a hexagonal type sock t remove four bolts (3) securing the ass mbled back-plate and shoes (4). Withdraw the backplat compl t with the oil catcher (5).

3.3 To overhaul the brake drum refer to Chap 10.

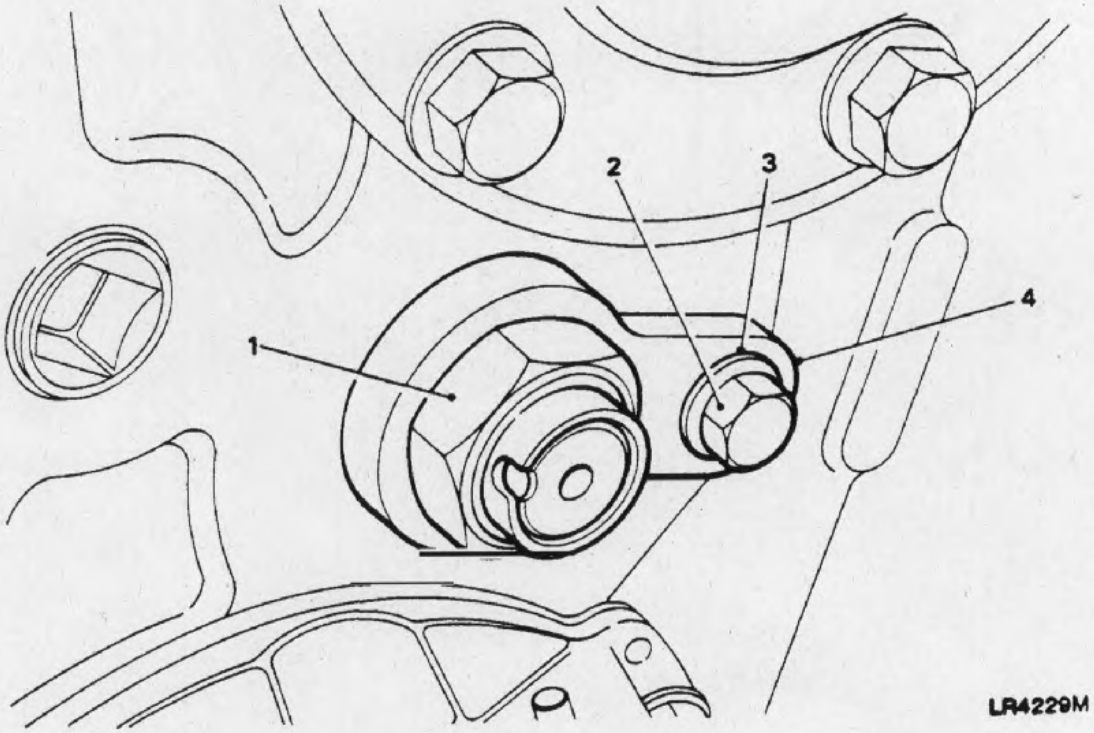
Bottom cover

4 Remov the remaining six bolts (Fig 2 (1)) and spring washers (2) retaining the bottom cover (3), withdraw the cover and discard the gasket (4).

Intermediate shaft and gear cluster

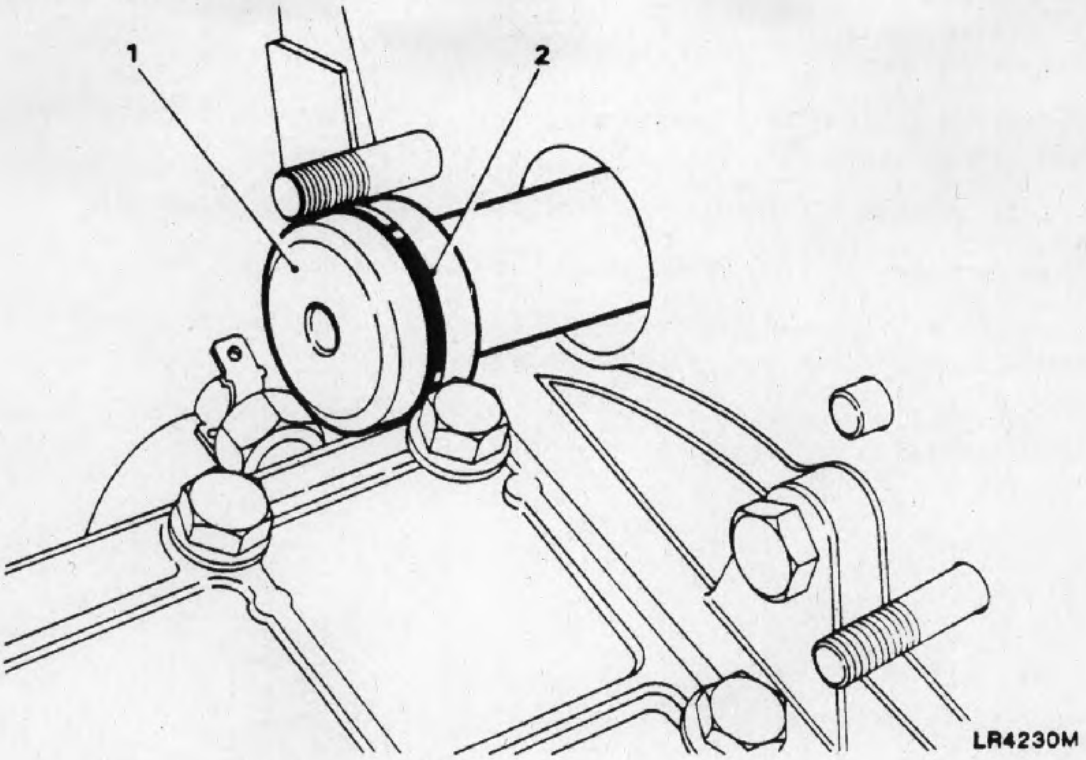
5 To remove and dismantle the intermediate shaft and gear cluster carry out the following:

5.1 Release stake nut (Fig 3 (1)) from recess in intermediate shaft, remove stake nut and discard.



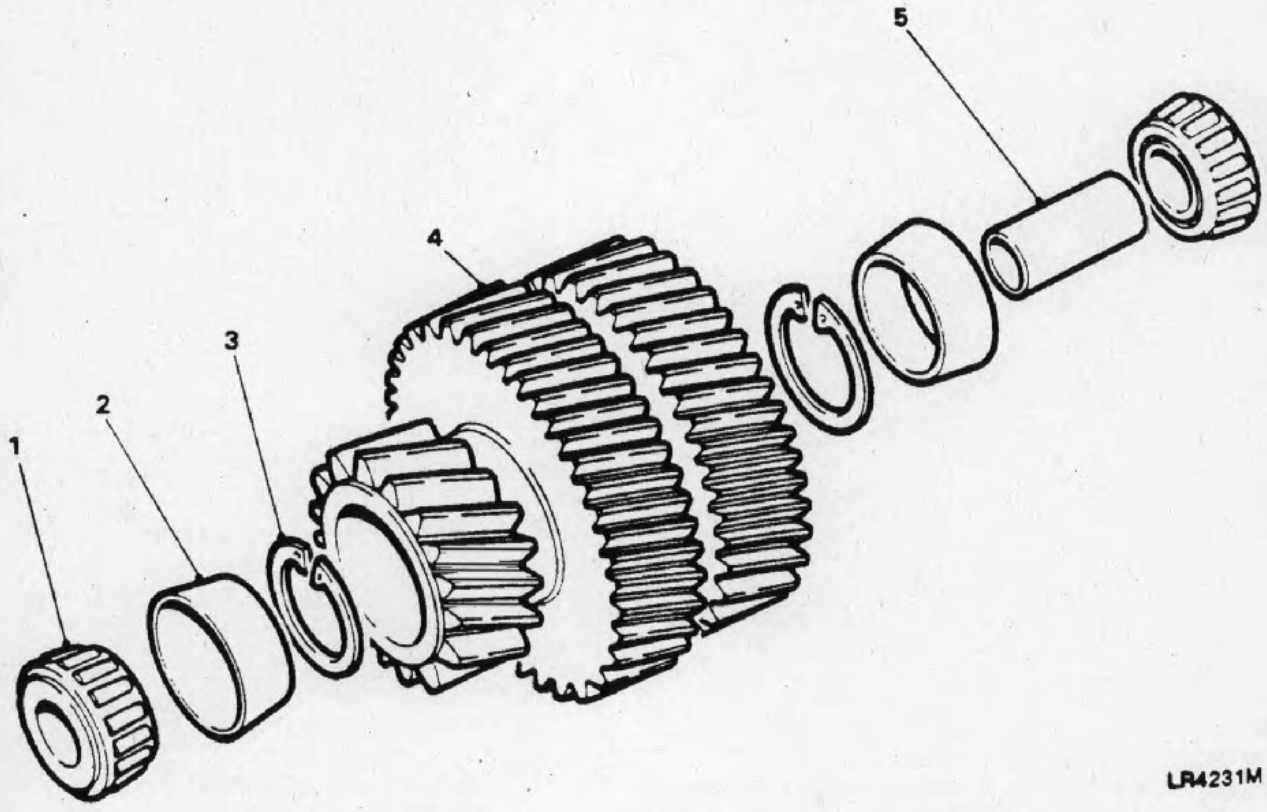
1	Stake nut	3	Plain washer
2	Bolt	4	Anti-rotation plate

Fig 3 Intermediate shaft stake nut and anti-rotation plate



1 Intermediate shaft 2 'O' ring seal

Fig 4 Intermediate shaft removal



1 Taper roller bearing
2 Bearing track
3 Circlip
4 Intermediate gear cluster
5 Bearing spacer

Fig 5 Intermediate gear cluster and bearings

5.2 Unscrew the single bolt (2), with plain washer (3) and remove anti-rotation plate (4) at the r ar face of the transf r box.

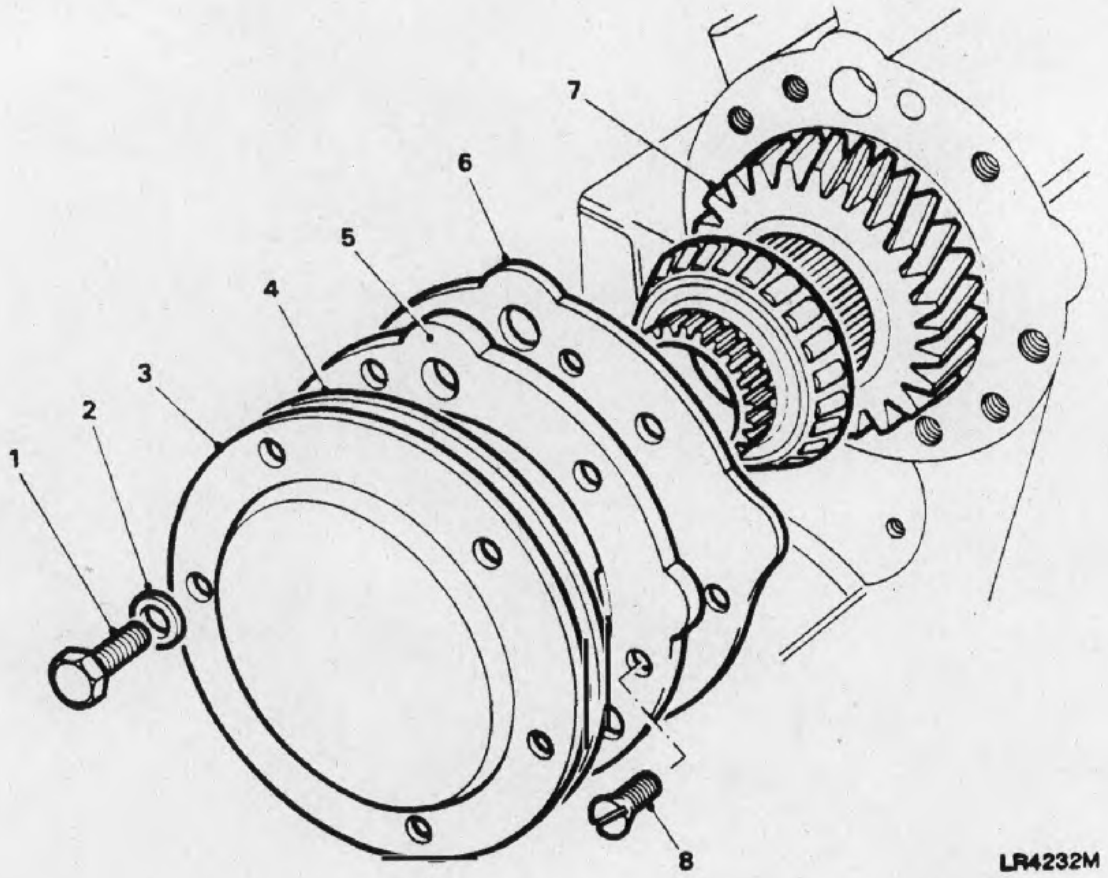
5.3 Tap the intermediate gear shaft (Fig 4 (1)) from the transfer box and, remove the 'O' ring seal (2).

5.4 Lift out the intermediate gear cluster and bearing assembly.

5.5 Remove the 'O' ring from inside the transfer case and discard.

5.6 Remove the taper roller bearings (Fig 5 (1)) and bearing spacer (5) from the intermediate gear cluster assembly (4).

5.7 Drive out the bearing tracks (2). The circlips (3) need only be removed if replacement is necessary.



1	Bolt	5	Bearing housing
2	Washer	6	Gasket
3	Power take-off cover	7	Input gear assembly
4	Gasket	8	Countersunk screw

Fig 6 Power take-off cover and input bearing housing

Power take-off cover

6 Remove the six bolts (Fig 6 (1)) and washers (2) retaining the power take-off cover (3), withdraw the cover and discard the gasket (4).

Input gear

7 To remove the input gear carry out the following:

7.1 Remove the two countersunk screws (8) and detach the bearing housing (5).

7.2 Remove the gasket (6) and discard.

7.3 Withdraw the input gear assembly (7).

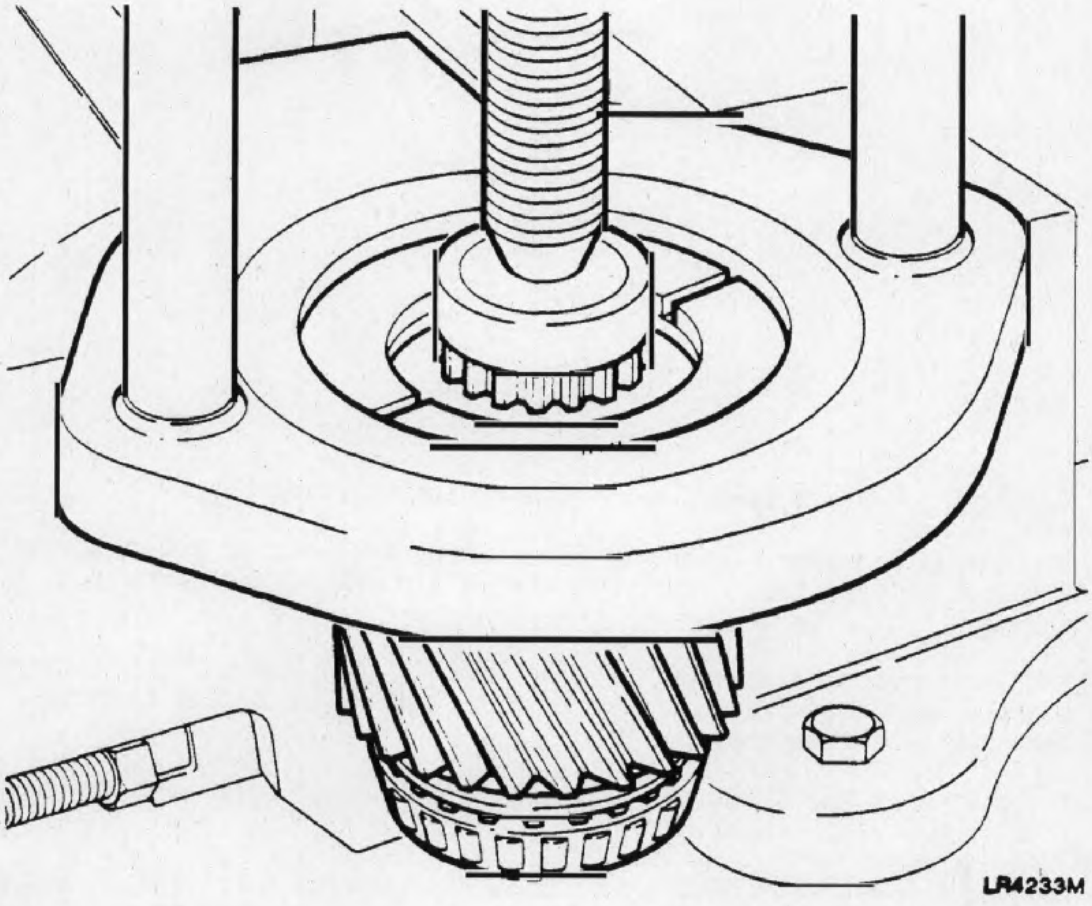


Fig 7 Removing bearings from input gear

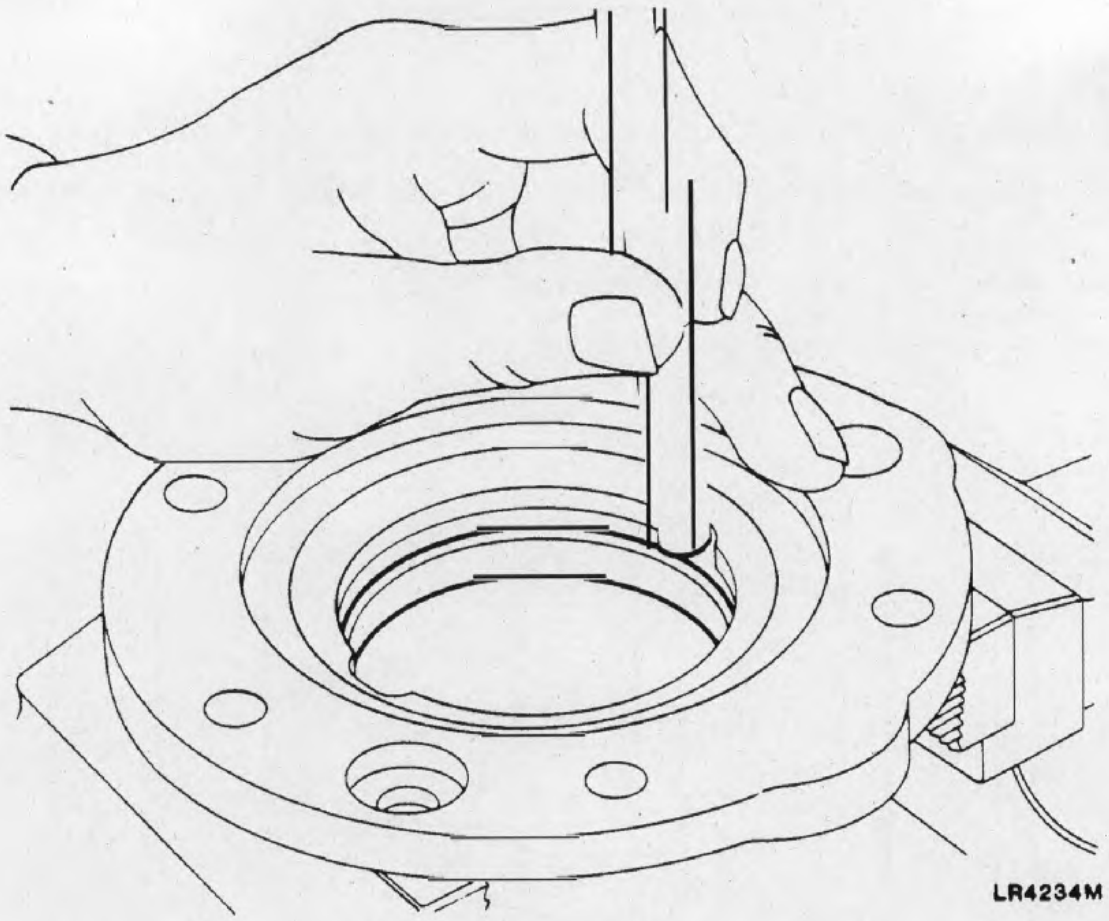


Fig 8 Removing input gear bearing track

7.4 Clean the input gear assembly and examine for wear or damage. Remove the bearings only if they are to be renewed. To remove the bearings proceed as follows:

7.4.1 Secure special tool (Serial No 9) in the vice and using special tools (Serial No's 1 and 3), remove the rear taper roller bearing from the input gear assembly.

7.4.2 Invert the input gear assembly in the hand press and remove the front taper roller bearing.

7.5 Secure the bearing housing in a vice fitted with soft jaws. Drive out the input gear bearing track (Fig 8), remove the shim, measure and note thickness of shim for assembly purposes.

High/low cross-shaft housing

8 To remove and dismantle the high/low cross shaft housing proceed as follows:

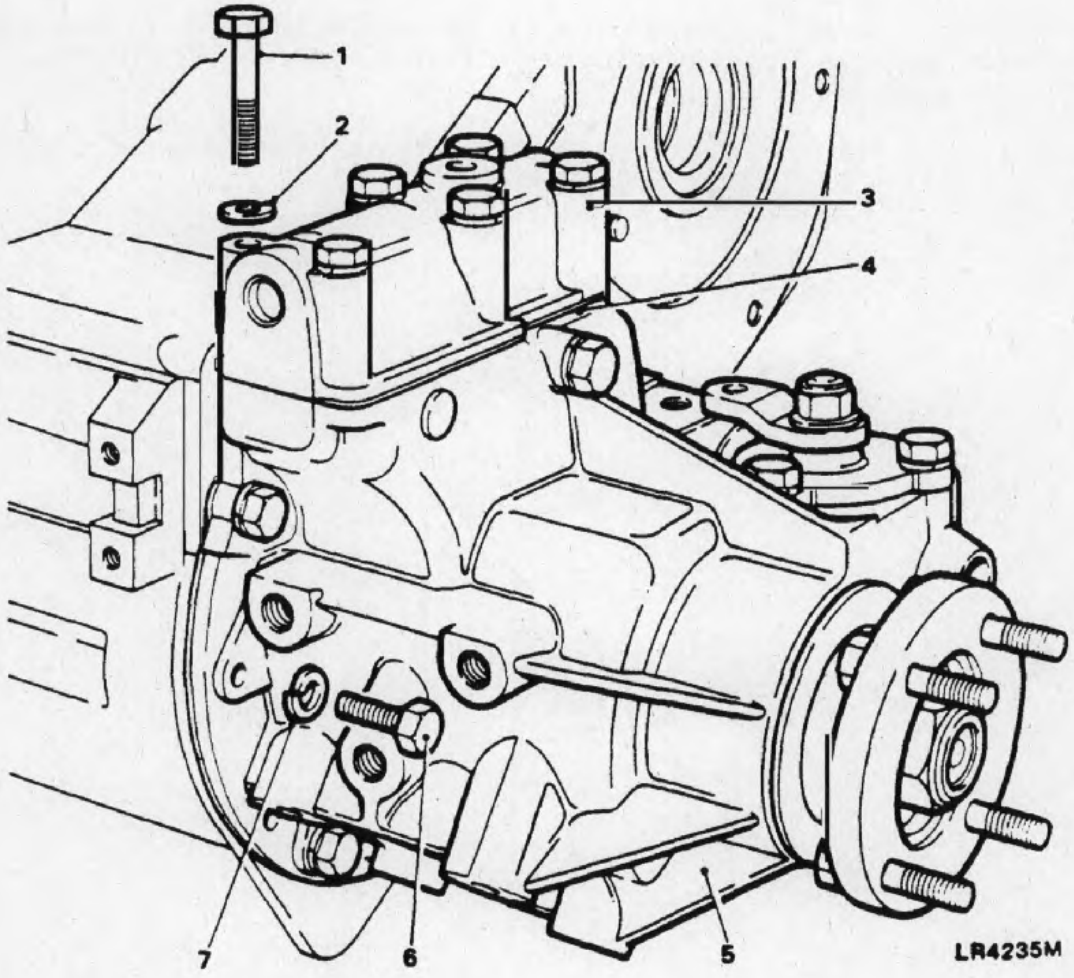
8.1 Remove the six bolts (Fig 9 (1)) and washers (2) retaining the cross-shaft housing (3), arth lead and retaining clip. Detach the housing and discard the gasket (4).

8.2 Secur the cross-shaft housing in a vice having soft jaws (Fig 10).

8.3 Remove the selector finger grub screw (2), withdraw the cross-shaft (1) from the housing and remove the selector finger (5).

8.4 Remove the 'O' ring seals (3) from the cross-shaft.

8.5 If necessary, drift out selector housing cup plug (4).



1	Bolt	5	Front output housing
2	Spring washer	6	Bolt
3	Cross-shaft housing	7	Spring washer
4	Gasket		

Fig 9 Front output housing

Front output housing

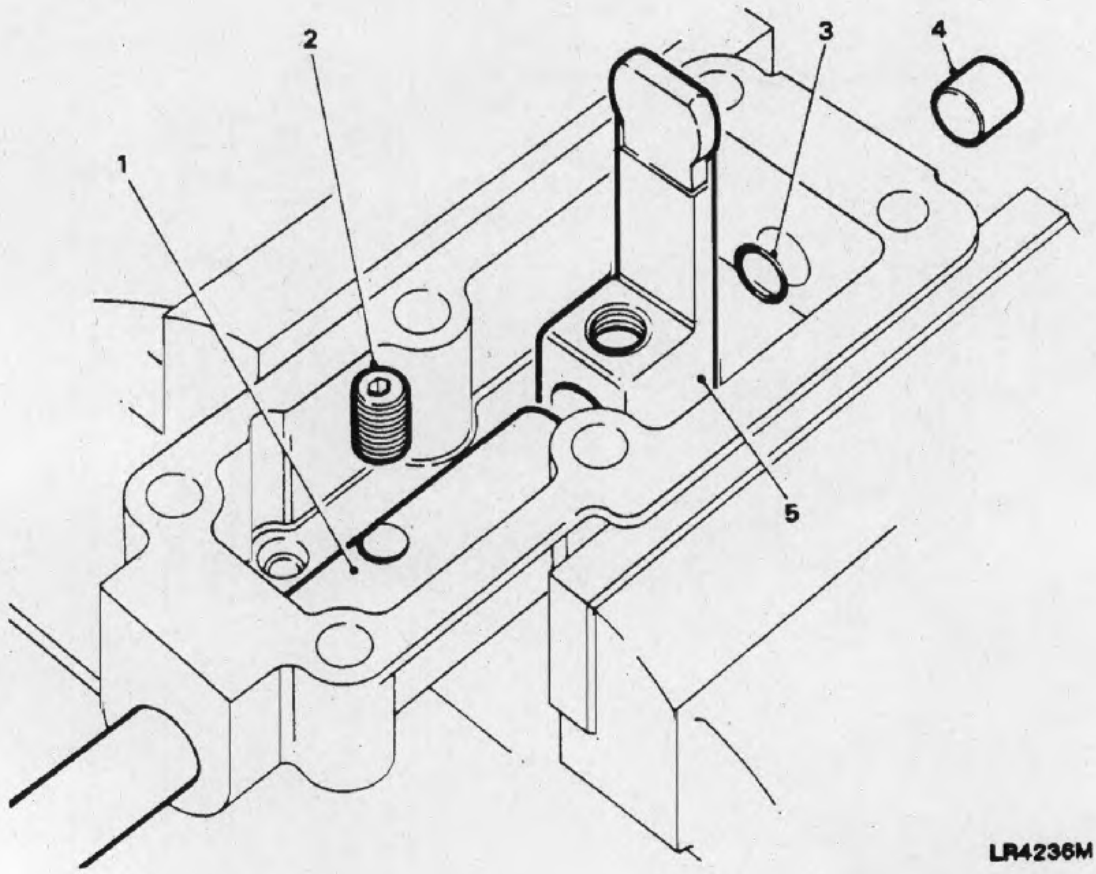
9 To remove and dismantle the front output housing carry out the following:

9.1 Remove the eight bolts (Fig 9 (6)) and spring washers (7) and detach th output housing (5) from the transfer box casing, taking care not to mislay the dowel. Remove the gasket and discard.

9.2 Unscrew the seven retaining bolts (Fig 11 (8)) and spring washers (9) and remove the differential lock selector side cover (10) and gasket, discard the gasket.

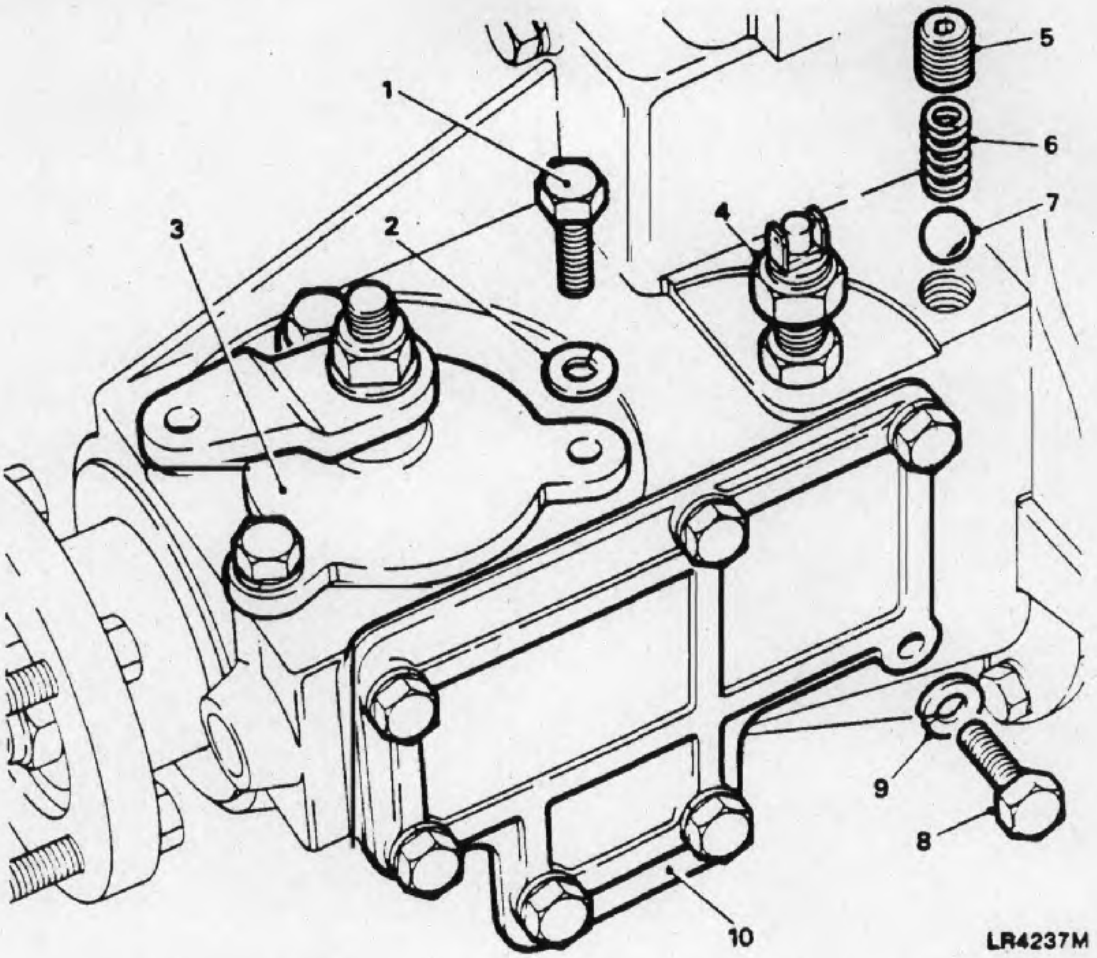
9.3 Unscrew the three retaining bolts (1) and spring washers (2) and lift the differential lock finger housing and actuator assembly (3) from the front output housing.

9.4 Slacken the locknut and unscrew the differential lock warning light switch (4).



1 Cross-shaft
2 Grub screw
3 'O' ring seal
4 Cup plug
5 Selector finger

Fig 10 High/low cross-shaft



1	Bolt	6	Spring
2	Spring washer	7	Detent ball
3	Differential lock finger housing	8	Bolt
		9	Spring washer
4	Differential lock switch	10	Side cover
5	Detent plug		

Fig 11 Differential lock finger housing

9.5 Remove the selector shaft detent plug (5), spring (6) and the ball (7) using a suitable magnet.

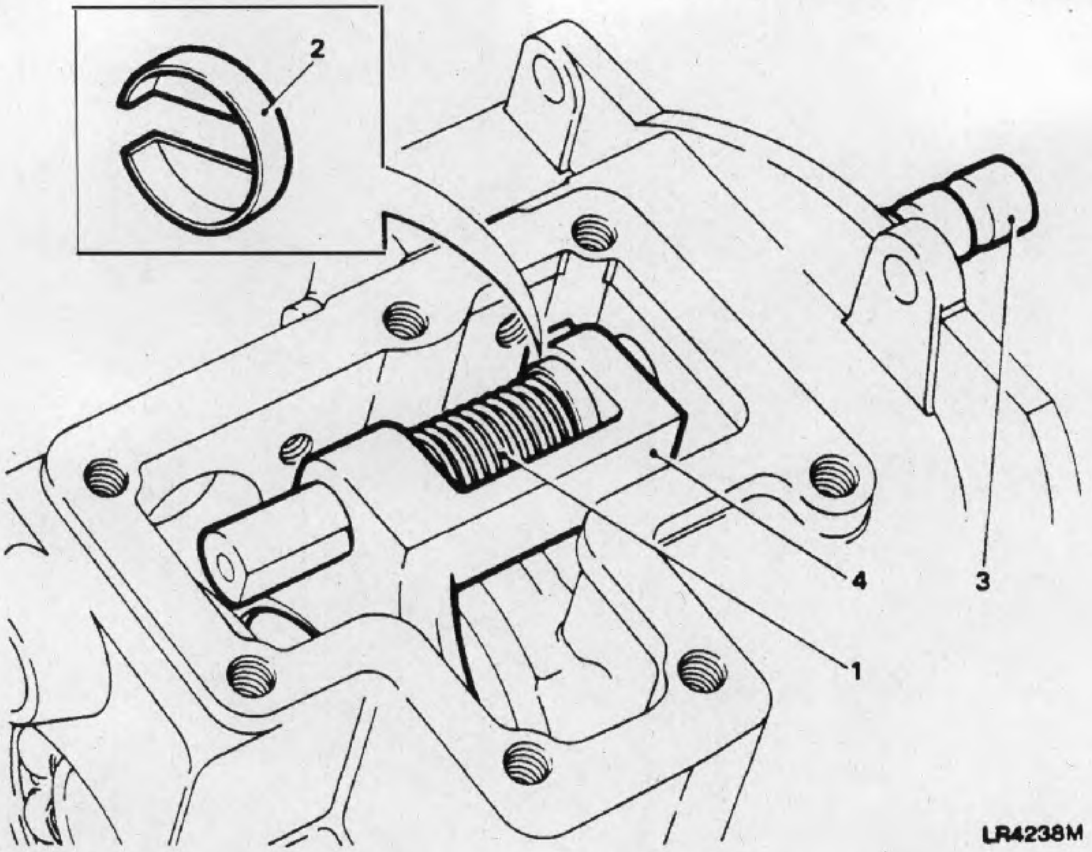
9.6 Compress the selector fork spring (Fig 12 (1)) and remove the two spring retaining caps (2).

9.7 Withdraw the selector shaft (3) from the rear of the output housing.

9.8 Remove the selector fork (4) and spring (3) through the side cover aperture.

9.9 Remove the lock-up sleeve from the rear of the output housing.

9.10 Using special tool (Serial No 4), a suitable socket wrench and ensuring that flange bolts are fully engaged in the wrench, r move the flange nut (Fig 13), followed by the steel and felt washers.



1	Spring	3	Selector shaft
2	Spring cap	4	Selector fork

Fig 12 Removing selector shaft, fork spring and spring caps

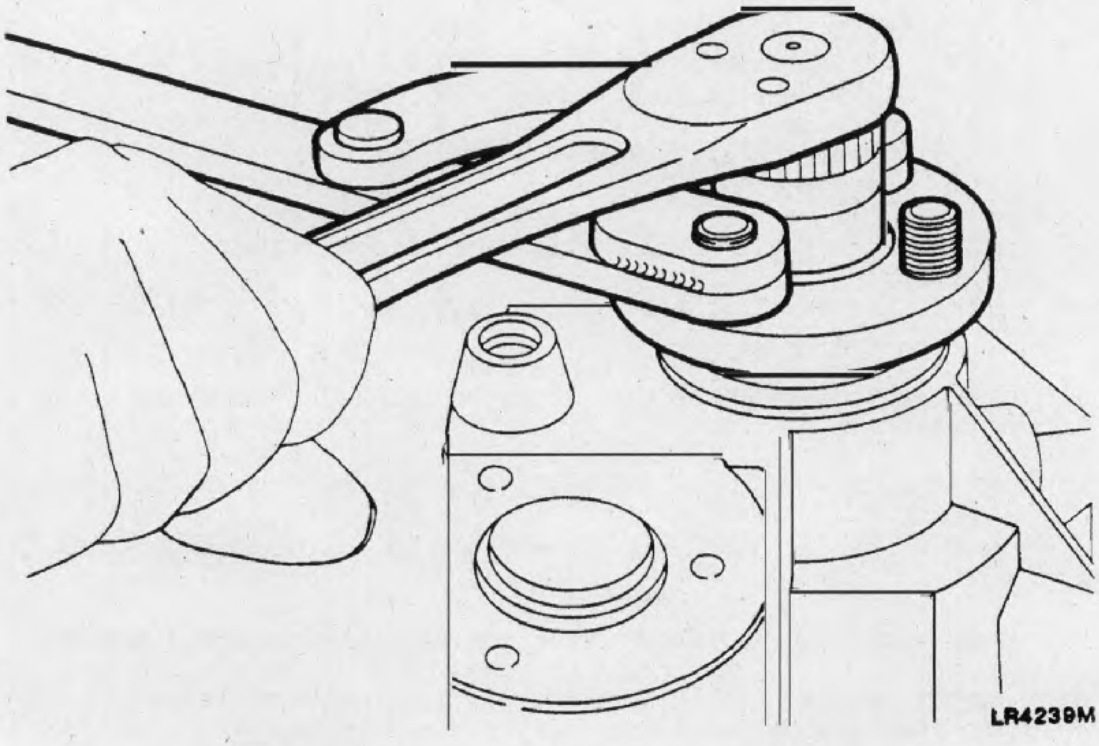


Fig 13 Flange nut removal

9.11 Remove the output flange and oil seal shield. These parts need not be separated unless the flange bolts are to be renewed.

9.12 Drift the output shaft rearwards from housing using a soft headed mallet.

9.13 Slide off the collar from the output shaft.

9.14 Prise out and discard the oil seal from the output housing using special tool (Serial No 5) (Fig 14).

Fig 14 Front output housing oil seal removal

9.15 Remove the circlip with suitable circlip pliers.

9.16 Invert the housing and drift out the bearing from inside the case (Fig 15).

9.17 Drift out the centre differential front taper roller bearing track and shim (Fig 16). Measure and note the shim thickness for use at reassembly.

9.18 Drift out the selector shaft cup plug from housing (Fig 16).

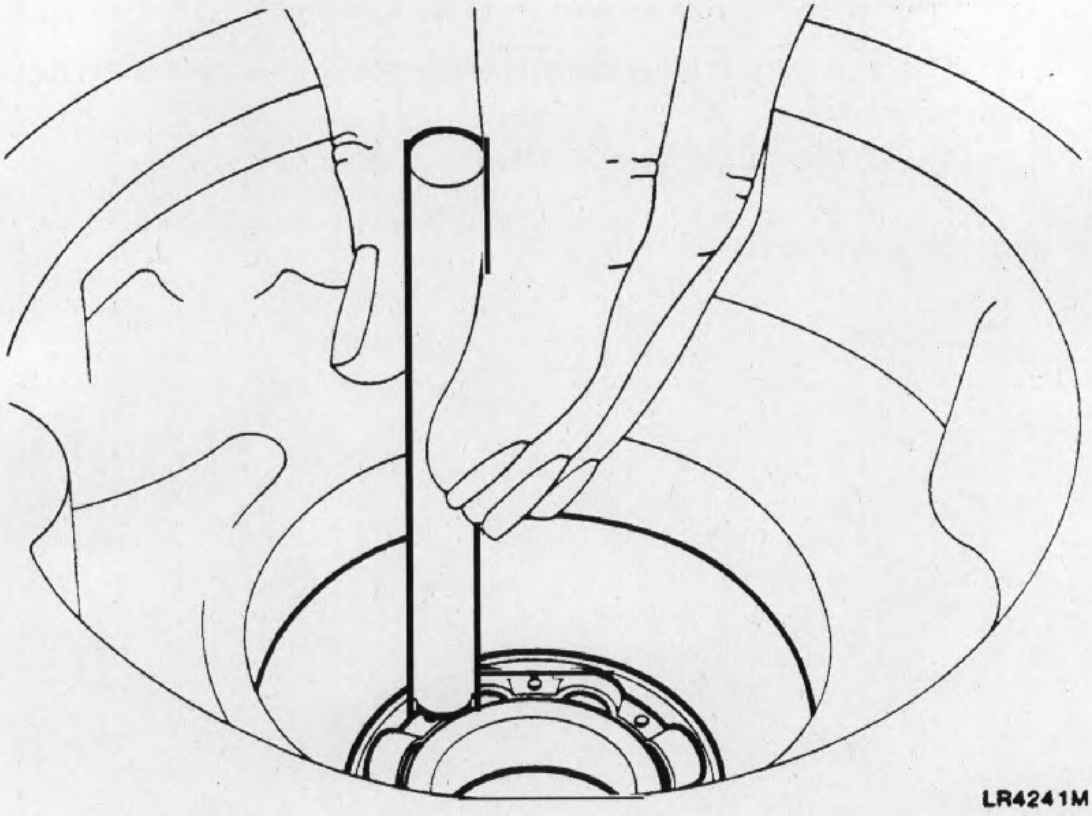


Fig 15 Front output bearing removal

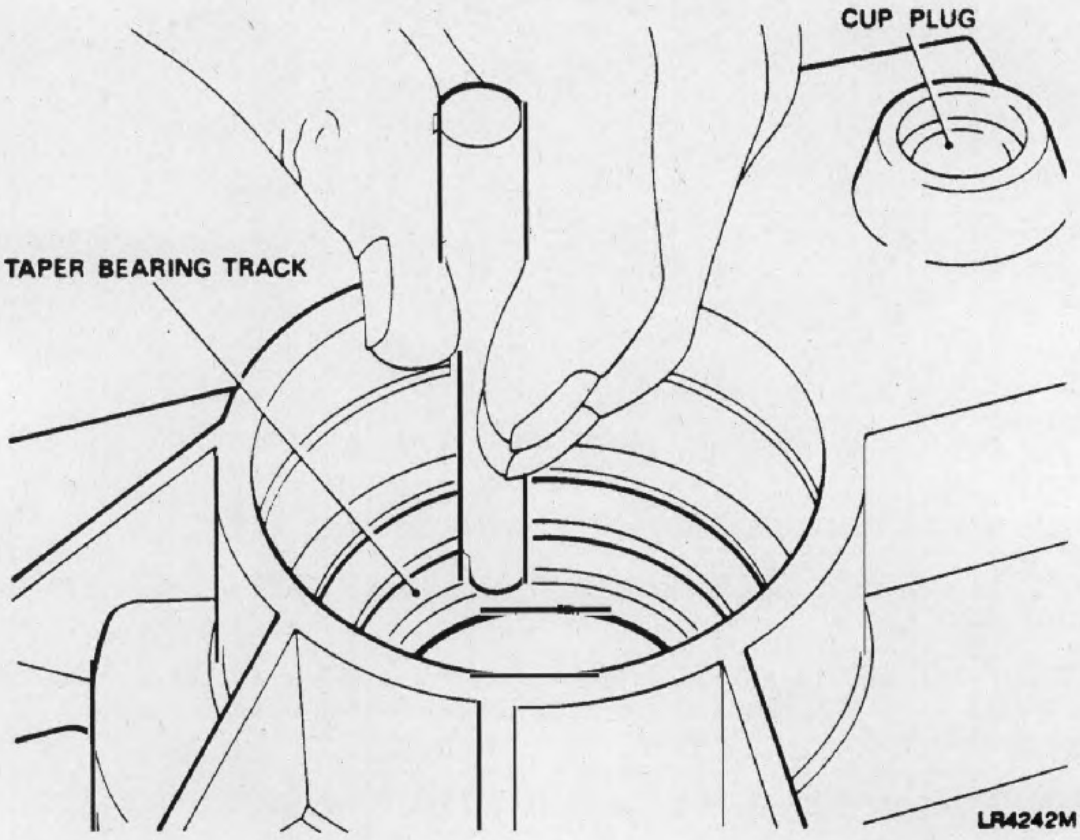


Fig 16 Removing differential bearing track and s lector shaft cup plug

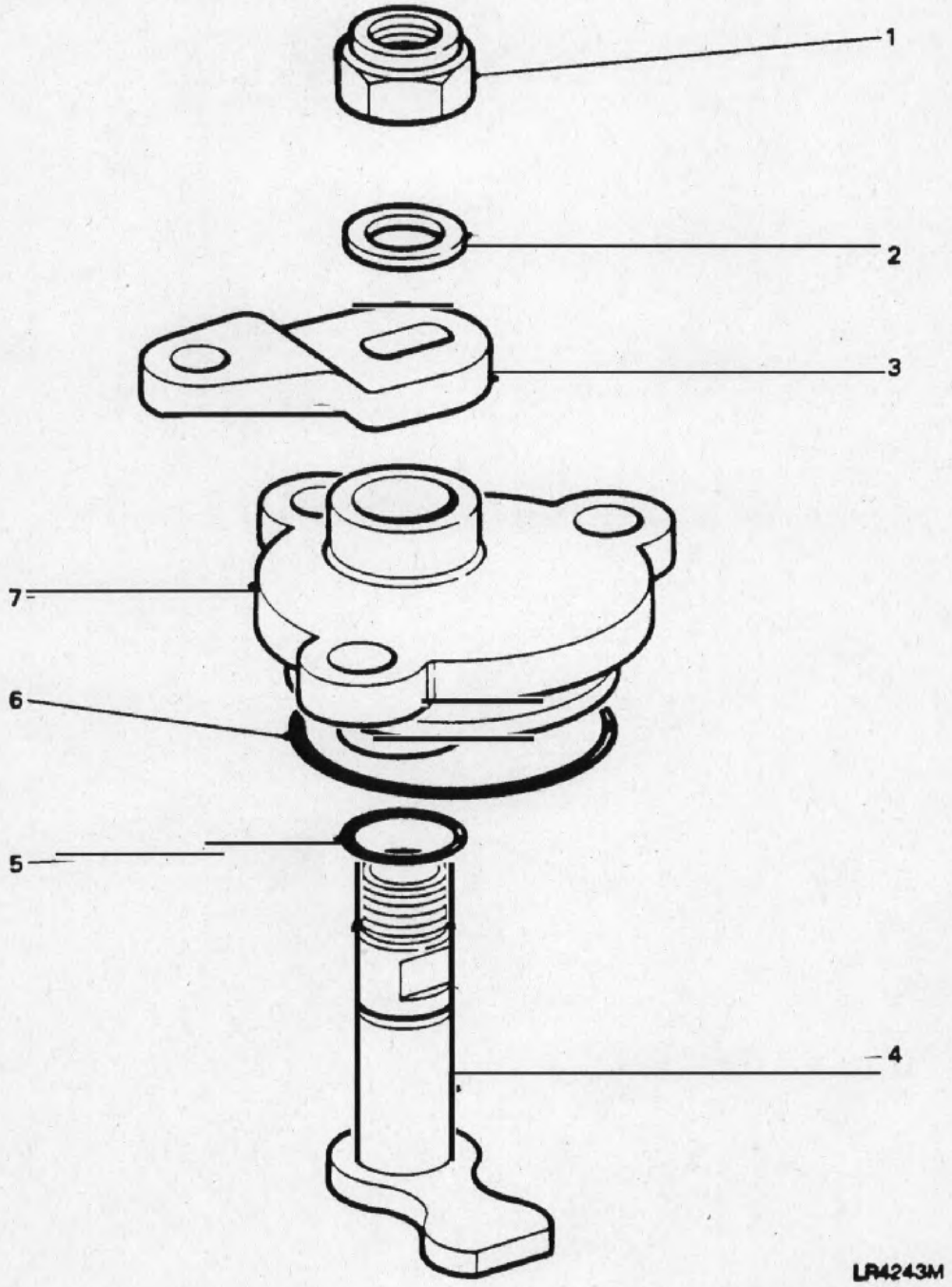
Differential lock finger housing

10 Dismantl the differential lock finger housing as follows:

10.1 Unscrew and discard the 'Nyloc' nut (Fig 17 (1)), remove the washer (2) and operating lever (3).

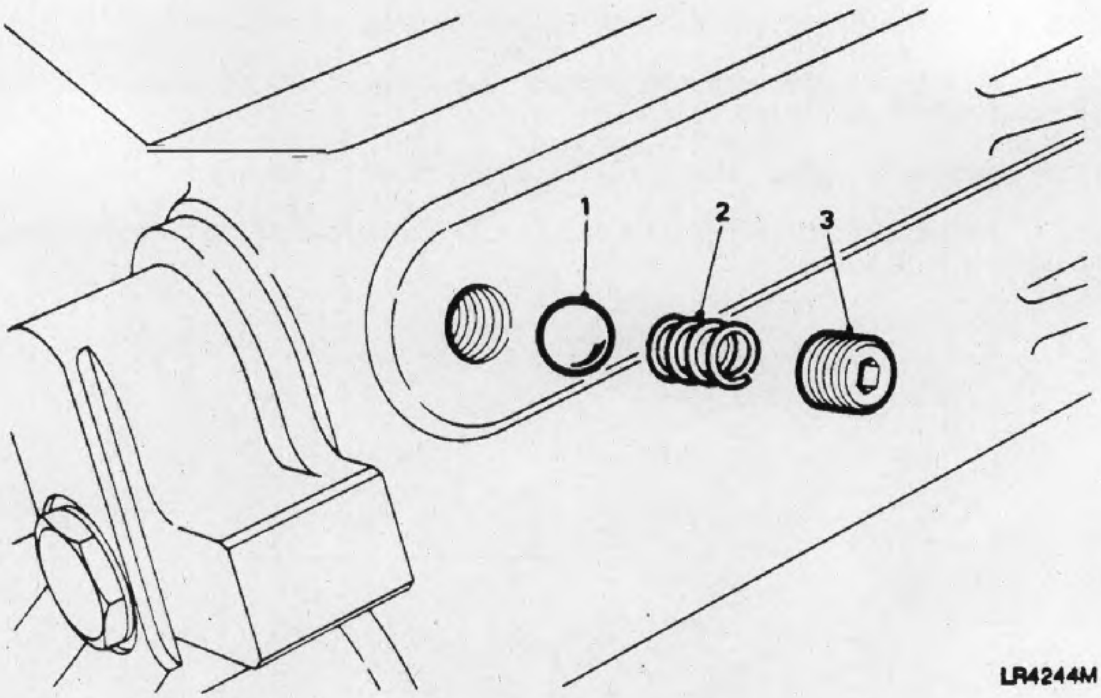
10.2 Remove the pivot shaft (4) from the finger housing (7).

10.3 Remove the 'O' rings (5) and (6) from the pivot shaft and finger housing and discard.



1	'Nyloc' nut	5	'O' ring seal
2	Washer	6	'O' ring seal
3	Operating lever	7	Finger housing
4	Pivot shaft		

Fig 17 Differential lock finger housing assembly



1 Ball 2 Spring 3 Detent plug

Fig 18 High/low selector shaft detent plug, ball and spring

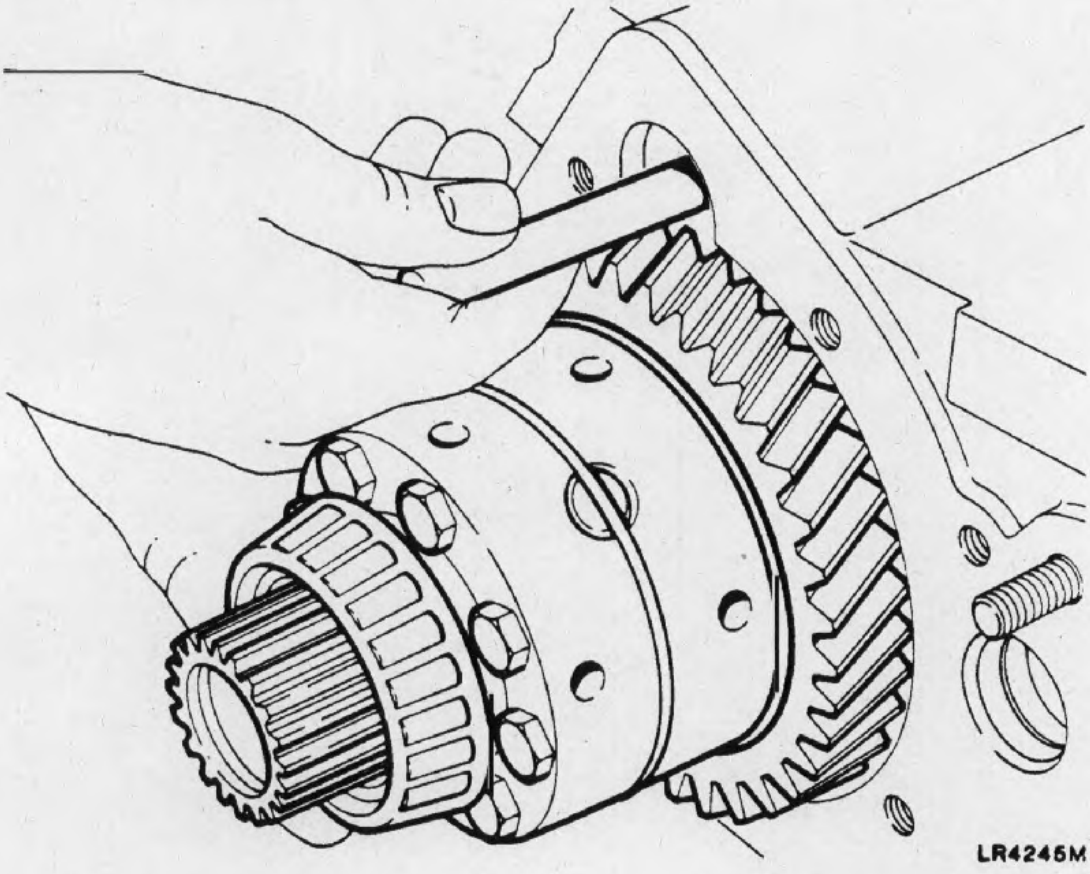


Fig 19 Removing the centre differential and s lector shaft assembly

Centr diff rential unit

11 To remove and dismantle the centre differential unit proceed as follows:

11.1 Remove high/low selector shaft detent plug (Fig 18 (3)), spring (2) and retrieve the ball (1) with a suitable magnet, then withdraw the centre differential and selector shaft/fork assembly (Fig 19).

11.2 Secure the centre differential unit to a vice fitted with soft jaws, release stake nut from recess.

11.3 Using special tool (Serial No 7) and a suitable socket wrench remove and discard the stake nut (Fig 20).

11.4 Remove the differential unit from the vice.

11.5 Secure special tool (Serial No 9) in the vice with special tool (Serial No 2) fitted and using special tool (Serial No 3) remove the rear taper bearing and collars (Fig 21).

11.6 Remove the high range gear (Fig 22 (2)) and bush (1), taking care not to disturb the high/low sleeve (3).

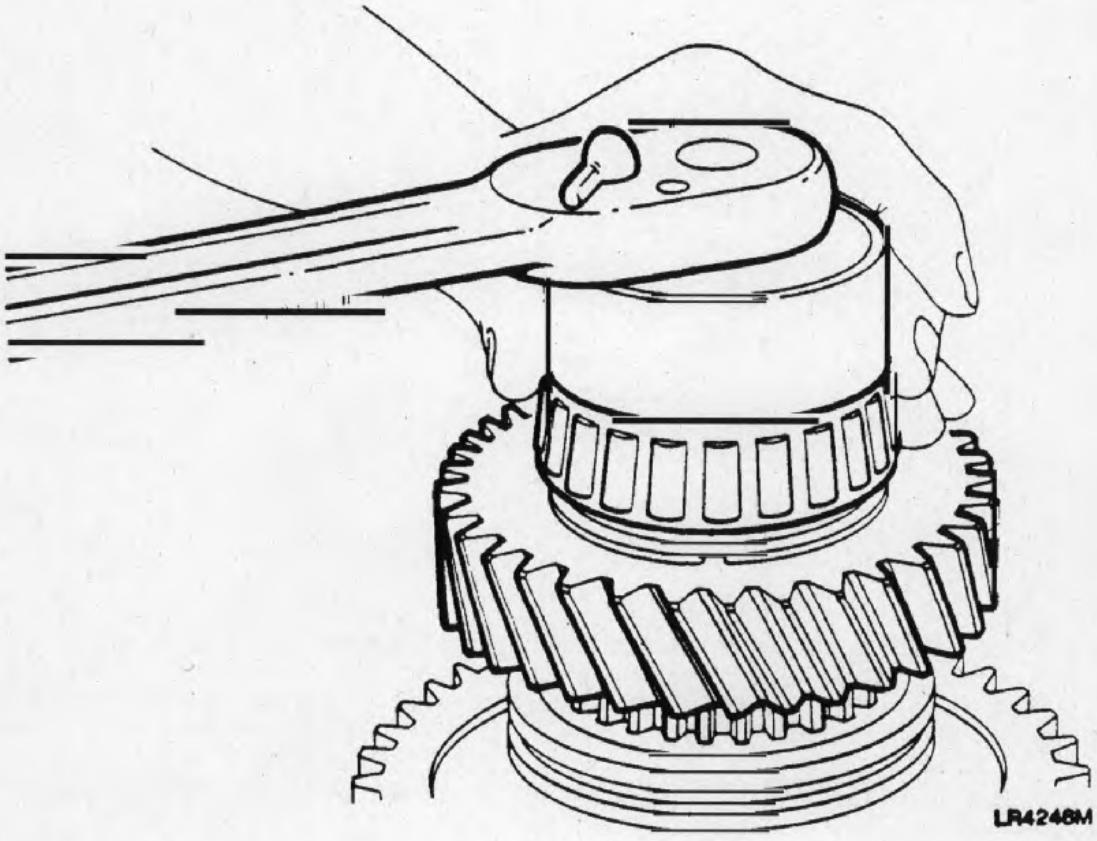
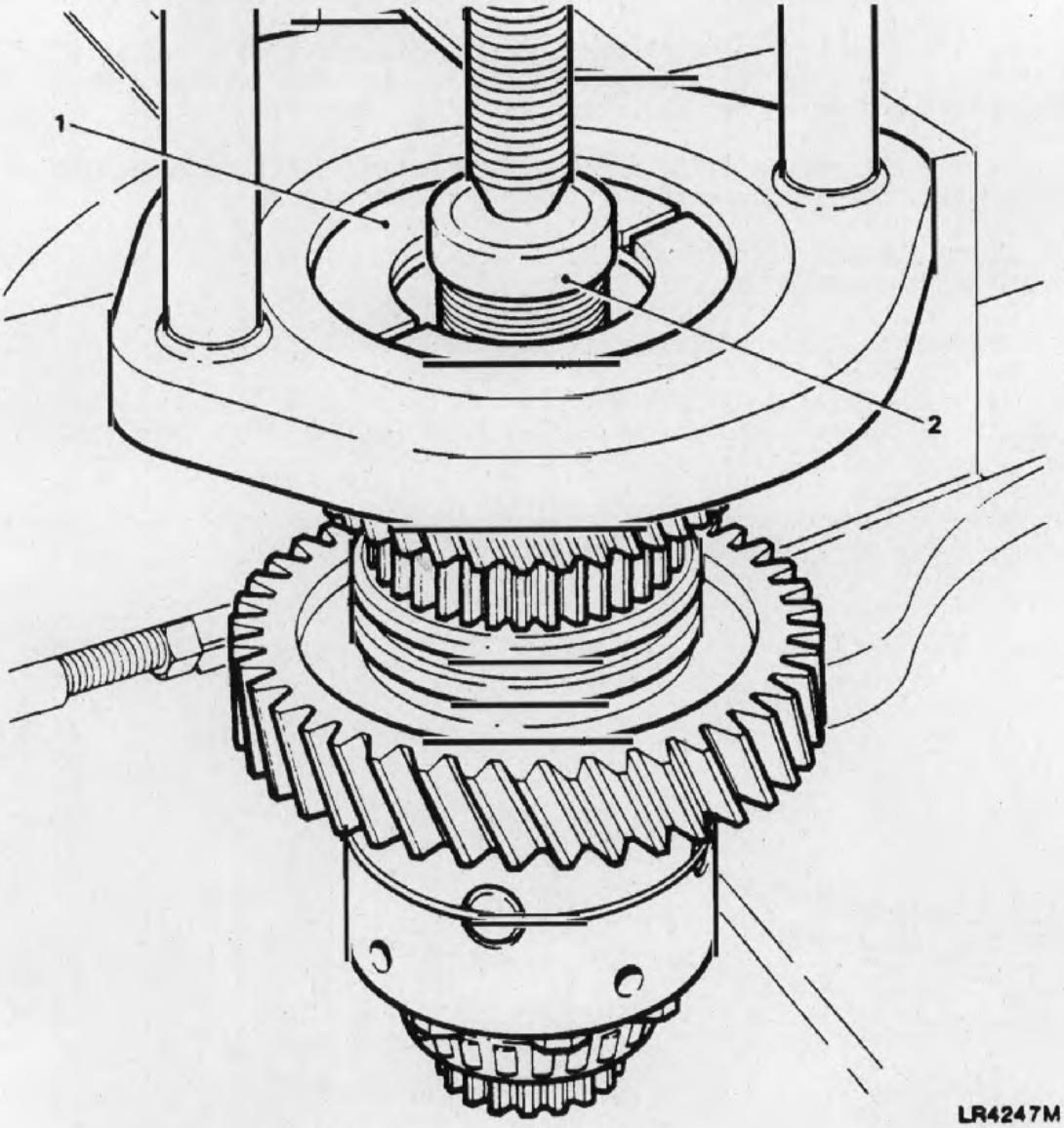


Fig 20 Removing stake nut from diff r ntial



1 Collar 2 Button

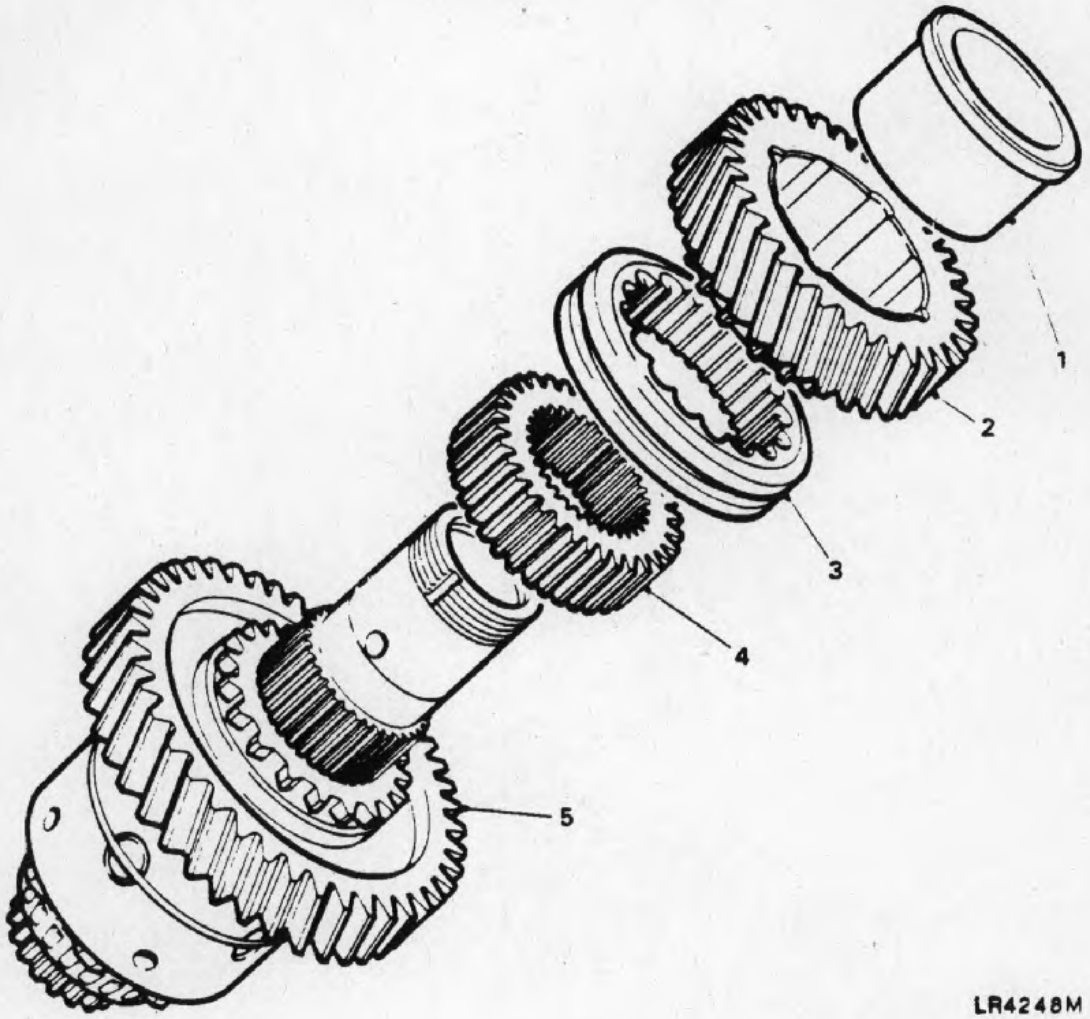
Fig 21 Removing differential rear taper bearing

11.7 Mark the relationship of the high/low sleeve (3) to the hub (4) and then remove the sleeve.

11.8 Using a suitable press behind the low range gear carefully remove the high/low hub (4) and low range gear (5).

11.9 Remove adaptor, special tool (Serial No 2) from the hand press and fit adaptor special tool (Serial No 11), then remove the front taper roller bearing.

11.10 Remove hand press from the vice.



1	Bush	4	High/low hub
2	High range gear	5	Low range gear
3	High/low sleeve		

Fig 22 High and low range gears

11.11 Using soft jaws secure the differential unit in the vice by gripping the hub splines.

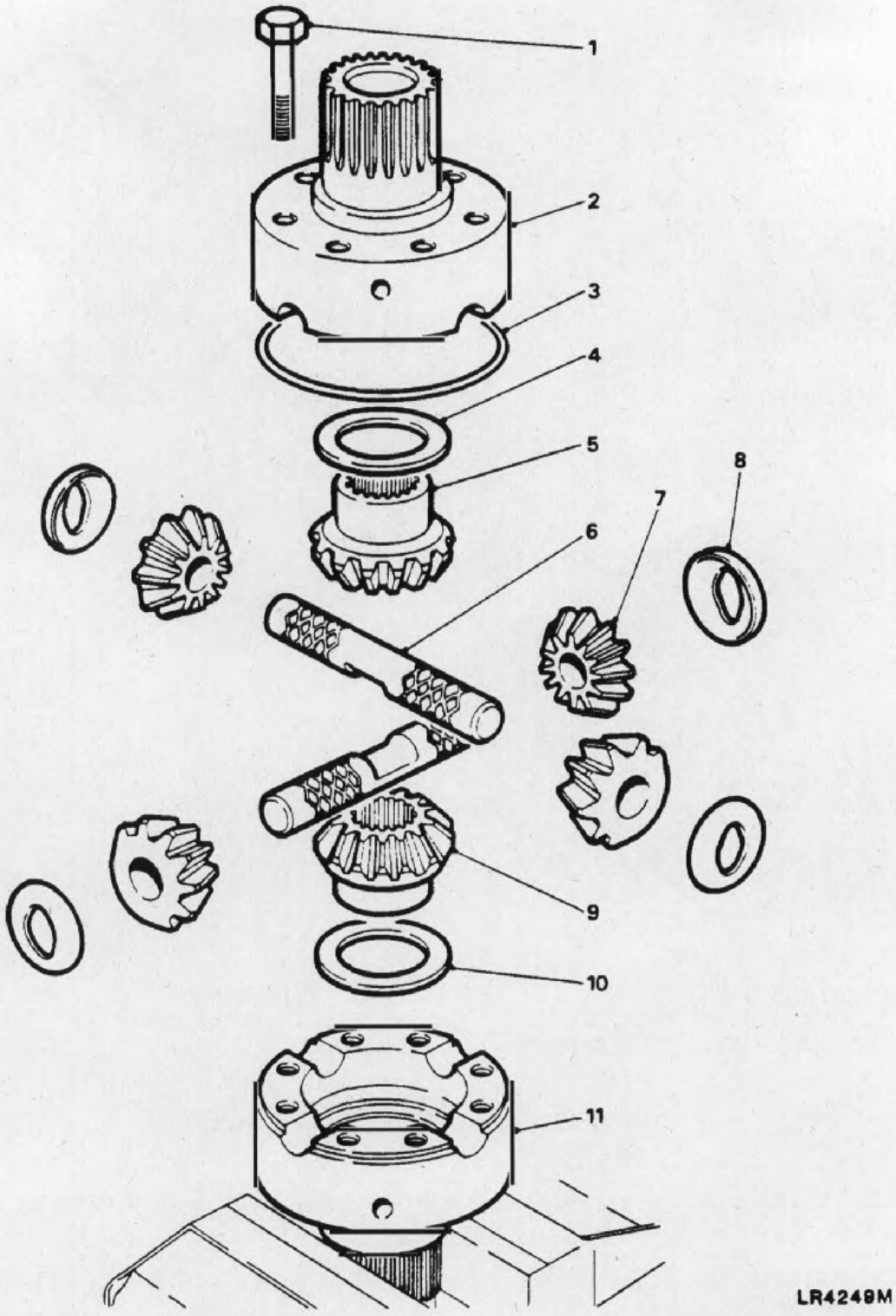
11.12 Remove the eight retaining bolts (Fig 23 (1)) and lift off the front differential case half (2).

11.13 Release the retaining ring (3) and remove the front upper bevel gear (5) and thrust washer (4).

11.14 Remove the pinion gears (7), dished washers (8) along with the cross shafts (6).

11.15 Remove the rear lower bevel gear (9) and thrust washer (10) from the rear differential case half (11).

11.16 Remove the rear differential case half from the vice.



1	Bolt	7	Pinion gear
2	Front differential case half	8	Dished washer
3	Retaining ring	9	Bevel gear
4	Thrust washer	10	Thrust washer
5	Bevel gear	11	Rear differential case half
6	Cross shaft		

Fig 23 Exploded vi w of differential

Rear output housing

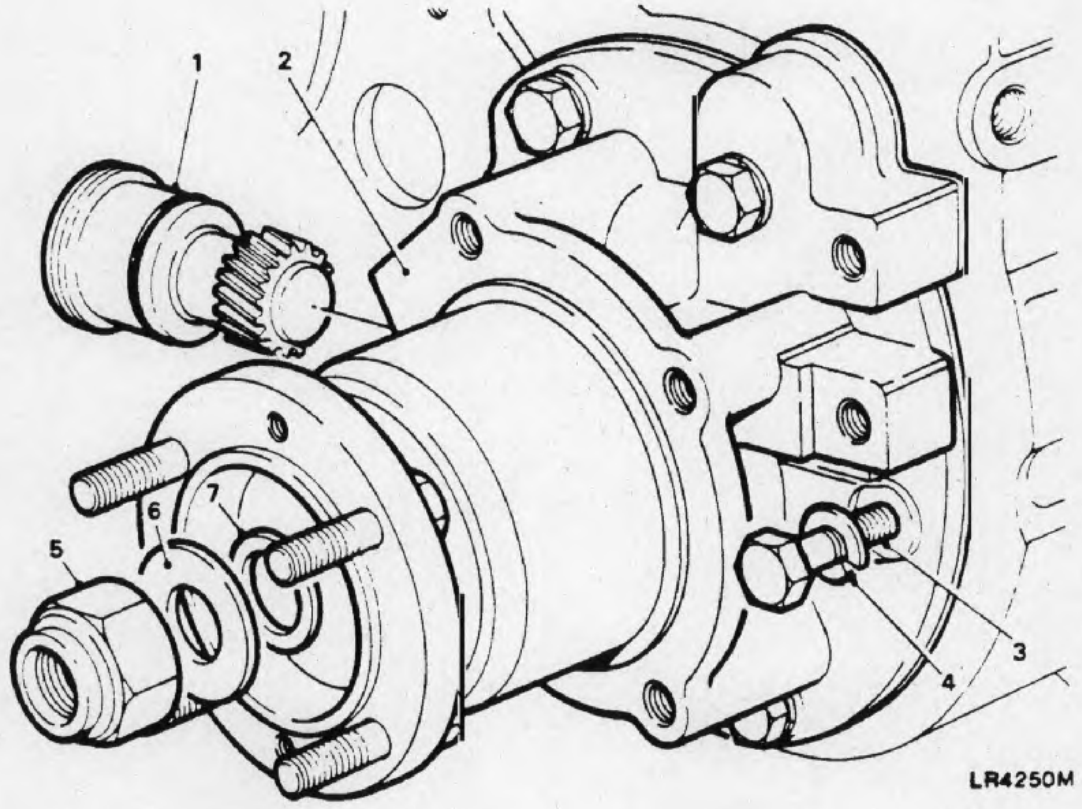
12 To remove and dismantle the r ar output housing carry out the following:

12.1 Remove the six bolts (Fig 24 (3)) and spring washers (4) and detach the rear output housing and shaft assembly (2) from the transfer casing. Remove the gasket and discard.

12.2 Using special tool (Serial No 4) and a suitable socket wrench, remove the flange nut (5), steel washer (6) and felt washer (7), ensure flange bolts are fully engaged in the wrench.

12.3 Remove output flange with circlip attached. If necessary, use a two-legged puller. The circlip need only be released if the flange bolts require renewing.

12.4 Remove the speedometer drive housing (1), if necessary ease out with a flat bladed screwdriver.



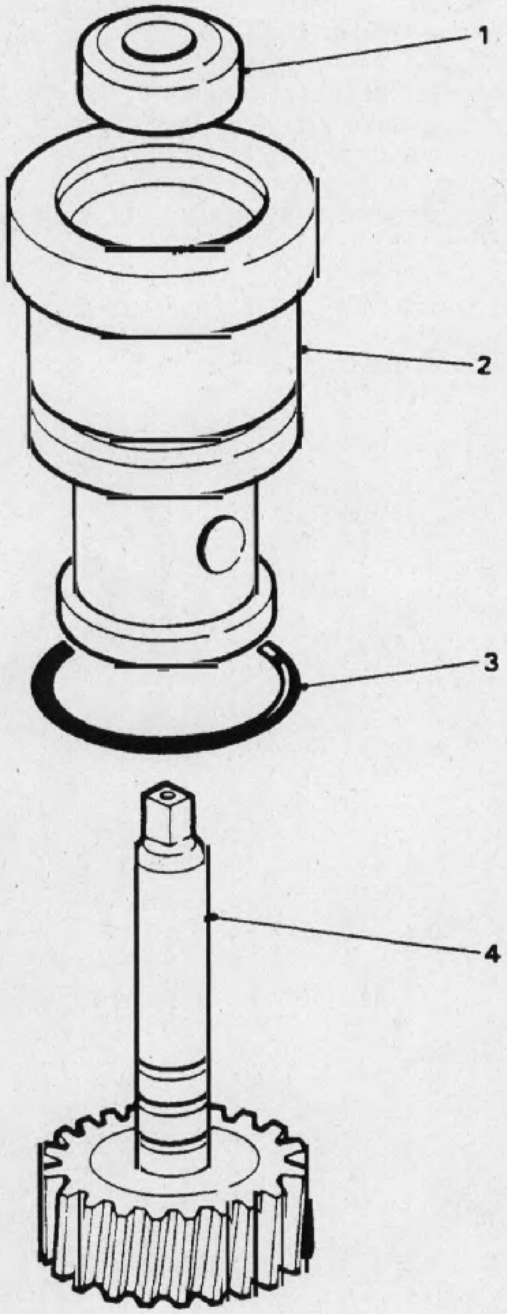
1	Speedometer drive housing	5	Flange nut
2	Rear output housing	6	Steel washer
3	Bolt	7	Felt washer
4	Spring washer		

Fig 24 Rear output housing

12.5 Remove speedometer gear (driven) (Fig 25 (4)) from its housing (2).

12.6 Remove the 'O' ring (3) and oil seal (1) and discard.

12.7 Drive the output shaft from rear output housing, by striking the flange end of the shaft with a soft headed mallet. Slide the spacer and speedometer drive gear off the shaft.



1	Oil seal	3	'O' ring seal
2	Speedometer drive housing	4	Driven gear

Fig 25 Speedometer drive housing and driven gear

12.8 Carefully prise the oil catch ring off the output housing using a screwdriver in the slot provided.

12.9 Prise out and discard the seal from the output housing using special tool (Serial No 5) (Fig 26).

12.10 Using suitable circlip pliers, remove the circlip retaining the bearing, and drive out the bearing from the rear of the housing (Fig 27).

Transfer case

13 To dismantle the transfer case carry out the following:

13.1 Remove the magnetic drain plug, copper washer and filler/level plug. Discard the copper washer.

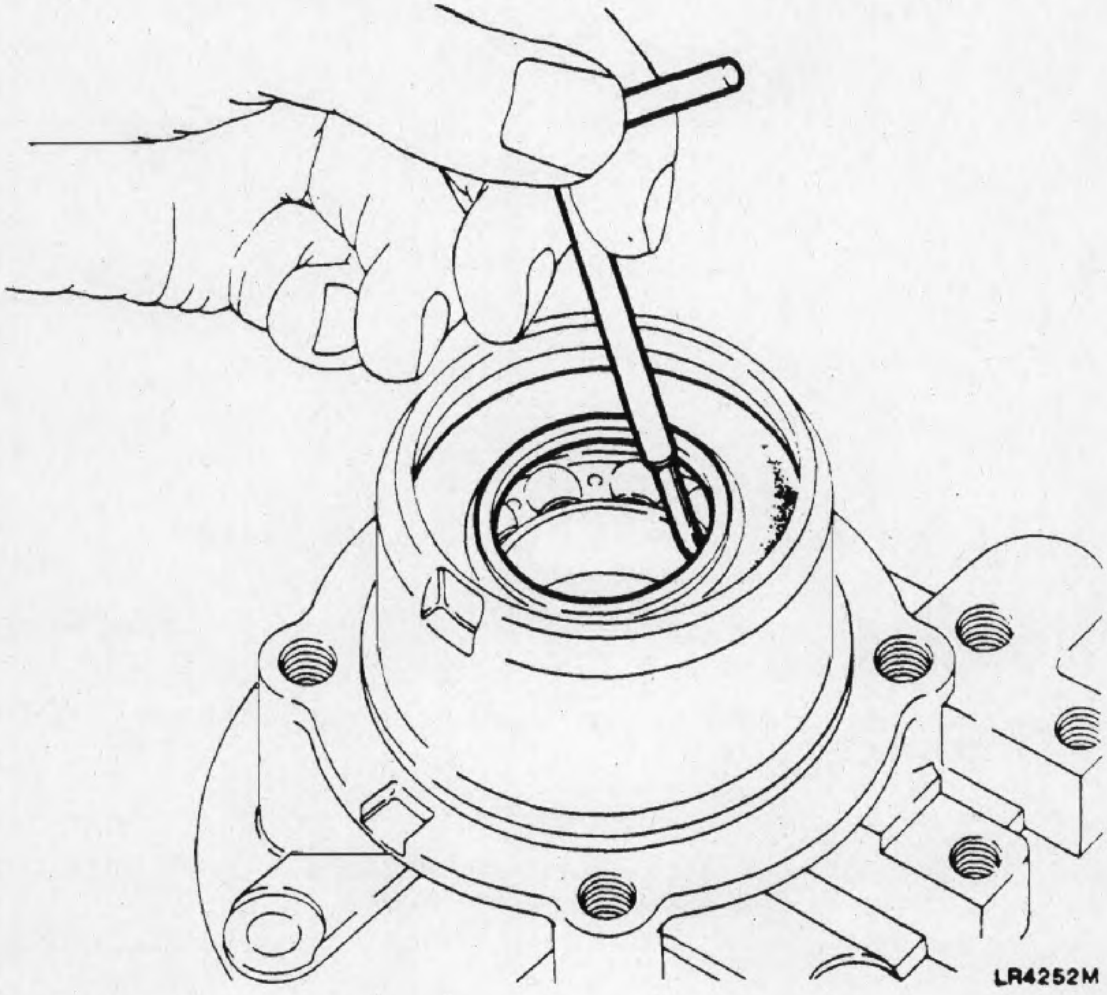


Fig 26 Removing oil seal from rear output housing

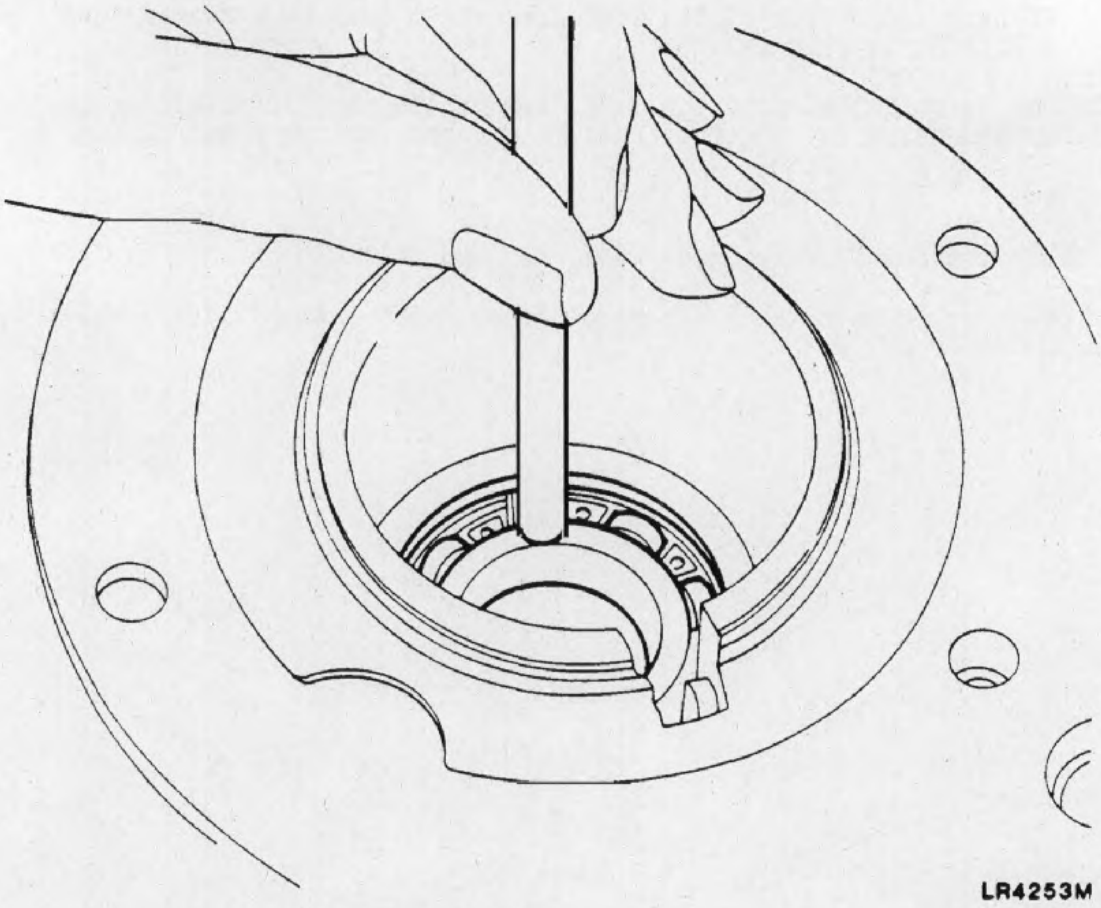


Fig 27 Removing bearing from rear output housing

13.2 Prise out and discard the oil seal at the front of the casing using special tool (Serial No 5).

13.3 Drift out the differential rear bearing track and the input gear front bearing track (Fig 28).

CLEANING

14 Thoroughly clean all components ensuring removal of all gasket material and s aling/locking compounds from mating faces and threads.

EXAMINATION

15 Examine all casings for cracks and damaged threads, inspect bearings and bearing tracks for wear and damage. Closely examine all gears and splines for wear and damage.

REPAIRS AND REPLACEMENT

16 Renew all seals, 'O' rings, gaskets, self locking nuts staked nuts and lock washers.

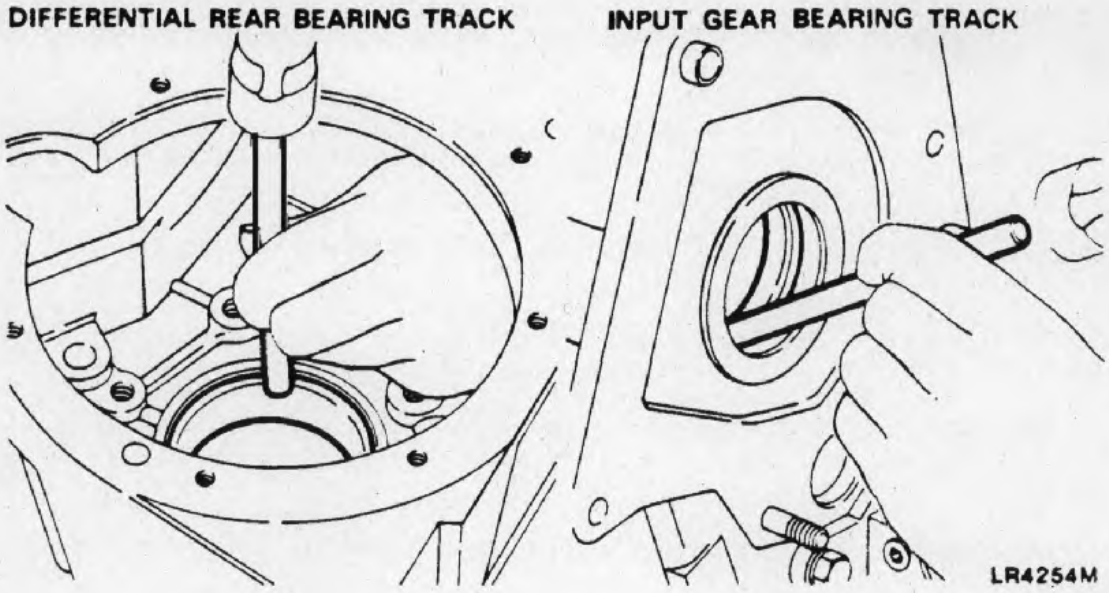


Fig 28 Removing bearing tracks from transfer case

REASSEMBLY

Centre differential unit

17 To reassemble the centre differential unit carry out the following:

17.1 Using soft jaws secure the rear differential case half (Fig 23 (11)) in the vice by gripping the hub splines.

17.2 Lubricate and install the cross shafts (6) and pinion gears (7) with new dished washers (8). Do not fit the rear bevel gear (9) at this stage.

17.3 Lubricate and fit the front bevel gear (5) and from the range available (Cat 721) the thinnest thrust washer (4).

17.4 Fit the front differential case half (2) ensuring that the two engraved arrows are aligned. Fit the securing bolts (1) and tighten to a torque of 55 to 64 Nm (40 to 47 lbf ft).

17.5 Lubricate and insert the rear output shaft into the bevel gear and check that the gears are free to rotate.

17.6 Fit the handbrake drum to the output drive flange and check the torque required to rotate the gears. tie a length of string around the brake drum, attach a spring balance to the string and carefully tension the string until a load to turn is obtained (Fig 29). Alternatively use a torque meter applied to the brake drum flange nut.

17.7 Rotate the drum slowly by hand to overcome the initial load when using either method.

Notes ...

(1) Gears that have been run will rotate smoothly and will require a torque of 0,56 Nm (5 lbf in). Equivalent force using a spring balance: 0,45kg (1 lb).

(2) New gears will rotate with a notchy feel and will require a torque of not more than 2,26 Nm (20 lbf in). Equivalent force using a spring balance: 1.72 kg (3.8 lb).

(3) Keep all components well lubricated when carrying out these adjustments.

17.8 If the torque reading is too low change the thrust washer for a thicker one from the range available (Cat 721).

17.9 When the correct thickness of thrust washer has been determined, dismantle the unit and place the front bevel gear and thrust washer to one side.

17.10 Reassemble the unit with the rear bevel gear and thinnest thrust washer fitted.

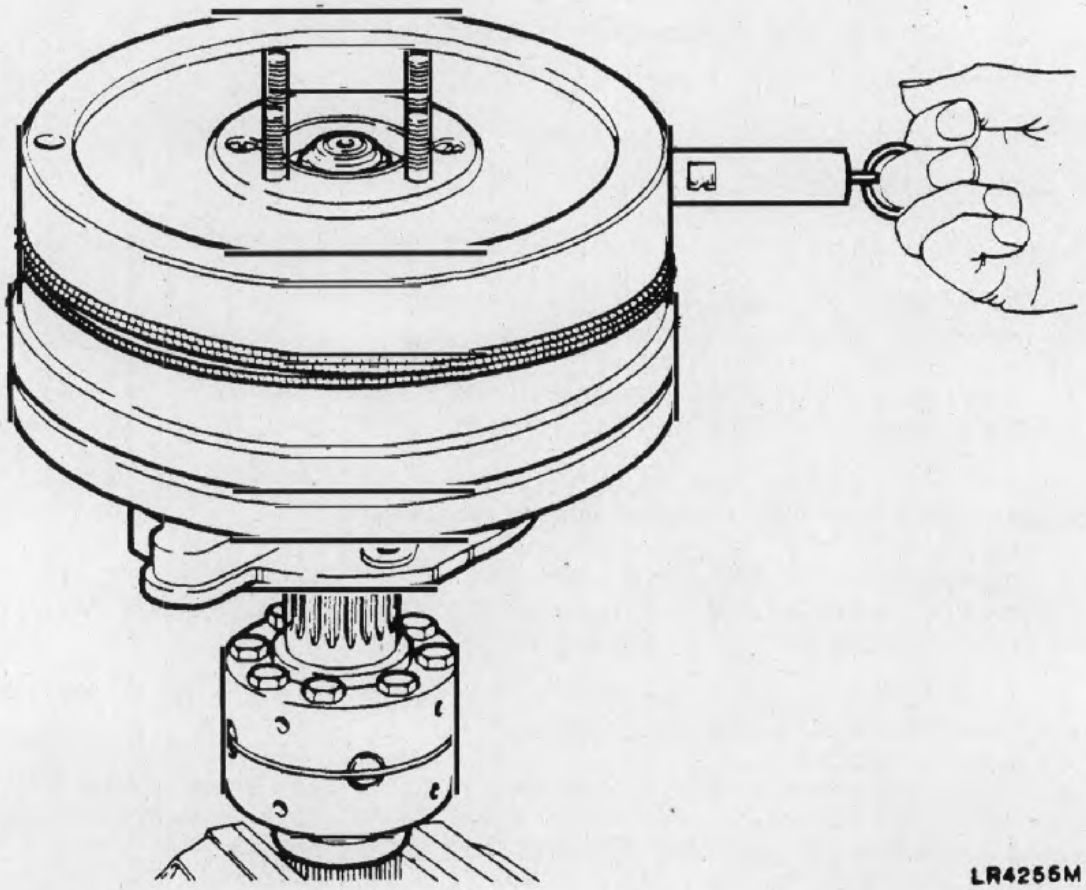


Fig 29 Checking torque required to rotate differential g ars

17.11 Invert the assembly in the vic and repeat the for going procedure to obtain the corr ct thrust washer thickness for th rear bevel gear.

17.12 Dismantle the unit and fit the selected thrust washer and bevel gear to the rear differential half.

17.13 Fit the assembled cross shafts and pinions to the rear differential half and secure with the retaining ring.

17.14 Lubricate all the components with a light oil.

17.15 Fit the selected thrust washer and bevel gear to the front upper differential half.

17.16 Fit the front and rear differential case halves together, ensuring correct meshing of the gears and aligning the engraved arrows. Secure with the eight bolts tightened to a torque of 55 to 64 Nm (40 to 46 lbf ft).

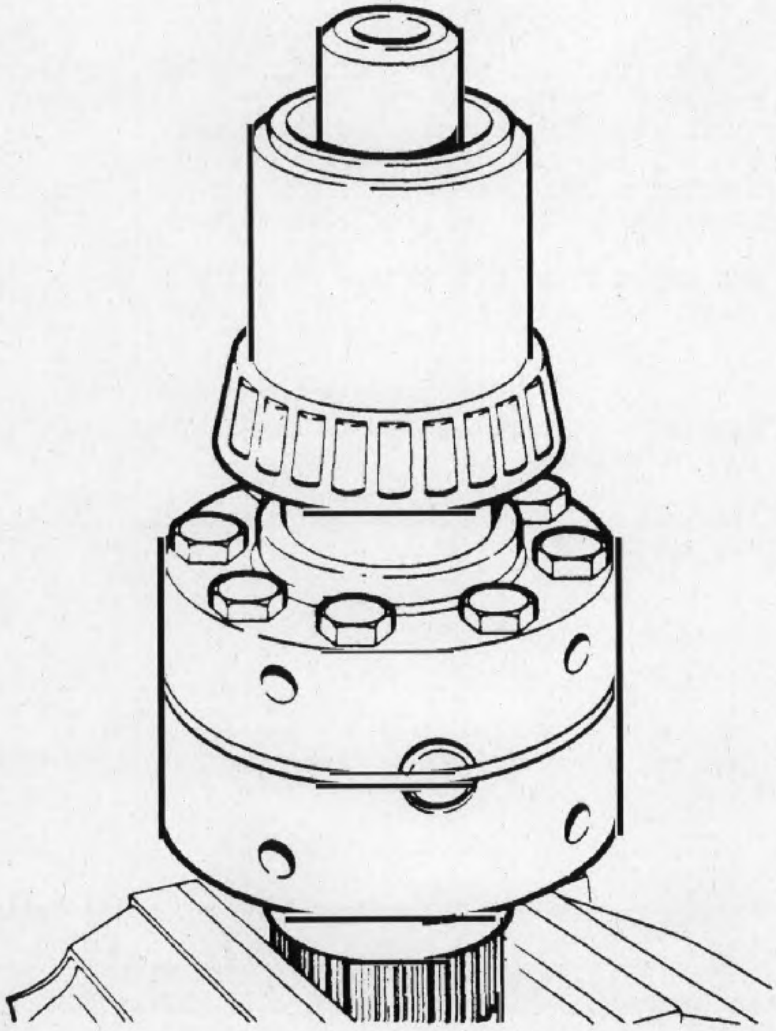


Fig 30 Fitting front differential bearing

17.17 Check the overall torque required to turn the differential. This should be approximately equal to the resistance of both bevel gears added tog ther.

17.18 Locate the front differential bearing onto the front shaft and press into position using the larger end of special tool (Serial No 8).

17.19 Invert the differential unit and secure in the vice.

Not ...

During the following operations all parts should be lubricated with light oil as they are fitted.

17.20 Fit the low range gear (Fig 22 (5)), with its dog teeth away from the differential assembly.

17.21 Press the high/low hub (4) onto the differential splines.

17.22 Slide the high/low selector sleeve (3) onto the hub ensuring alignment of the marks made during dismantling.

17.23 Fit the bush (1) into the high range gear (2) so that the flange is fitted on the opposite side of the gear to the dog teeth. Slide the bushed gear onto the differential assembly with the dog teeth down.

17.24 Locate the rear differential bearing onto the hub and press it into position using the smaller end of special tool (Serial No 8).

17.25 Fit the stake nut and tighten to a torque of 66 to 80 Nm (50 to 59 lbf ft) using special tool (Serial No 7).

Note ...

If the clearances vary from those specified in the following check the assembly must be rebuilt using the relevant new parts.

17.26 Check the end float of the high and low range gears 0.05 to 0.15 mm (0.002 to 0.005 in) (Fig 31).

CAUTION ...

A round nose tool must be used for this operation to avoid splitting the collar of the nut.

17.27 Peen the stake nut collar by carefully forming the collar of the nut into the slot as illustrated (Fig 31).

Selector fork assembly

18 If the selector fork assembly has been dismantled carry out the following:

18.1 Fit the selector fork (Fig 32 (1)) to the shaft (2) with its boss towards the three detent grooves. Align the tapped hole in the fork boss with the detent in the shaft nearest to the detent grooves.

18.2 Apply Loctite 270 to the grub screw threads, fit the grub screw (3) and tighten to a torque of 22 to 28 Nm (16 to 21 lbf ft).

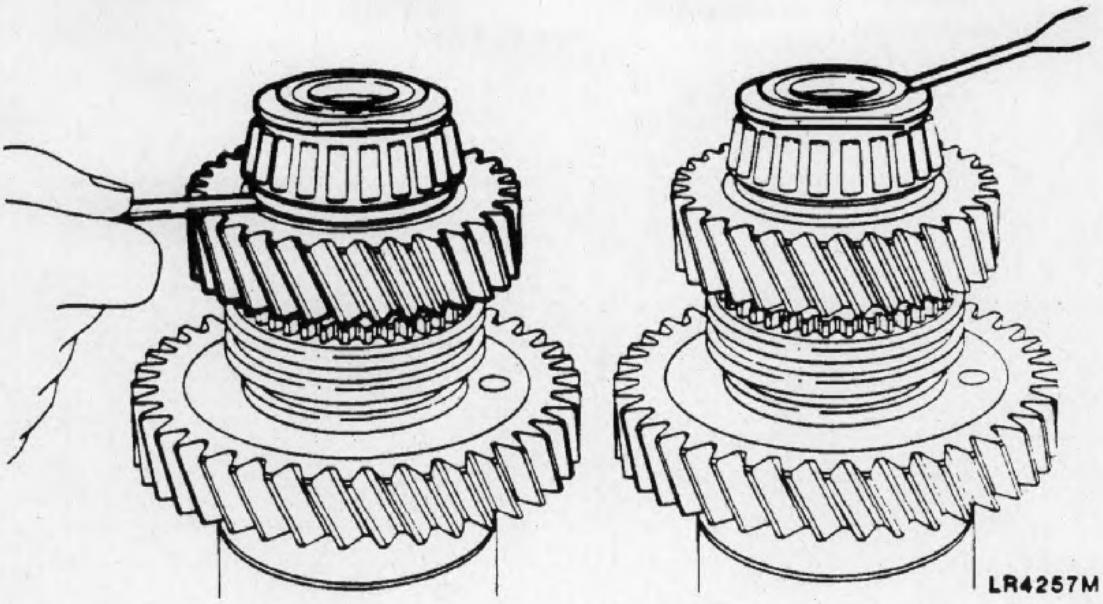
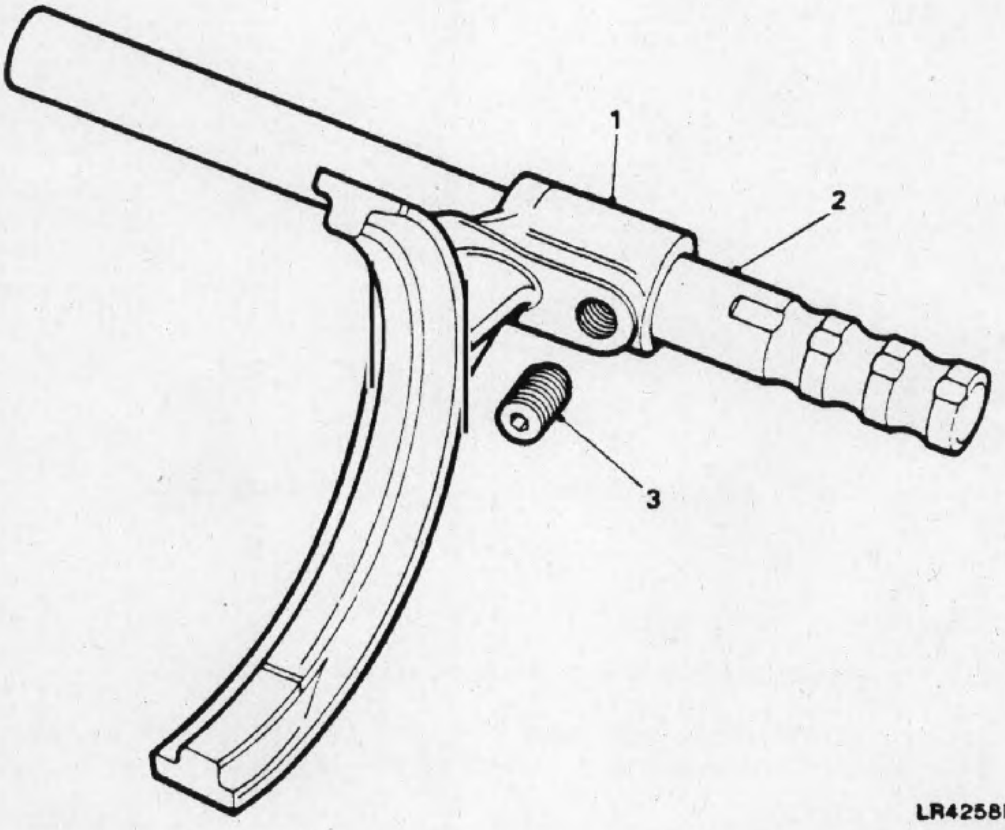


Fig 31 Checking end-float and peening stake nut



1 Selector fork 2 Shaft 3 Grub screw

Fig 32 Selector fork assembly

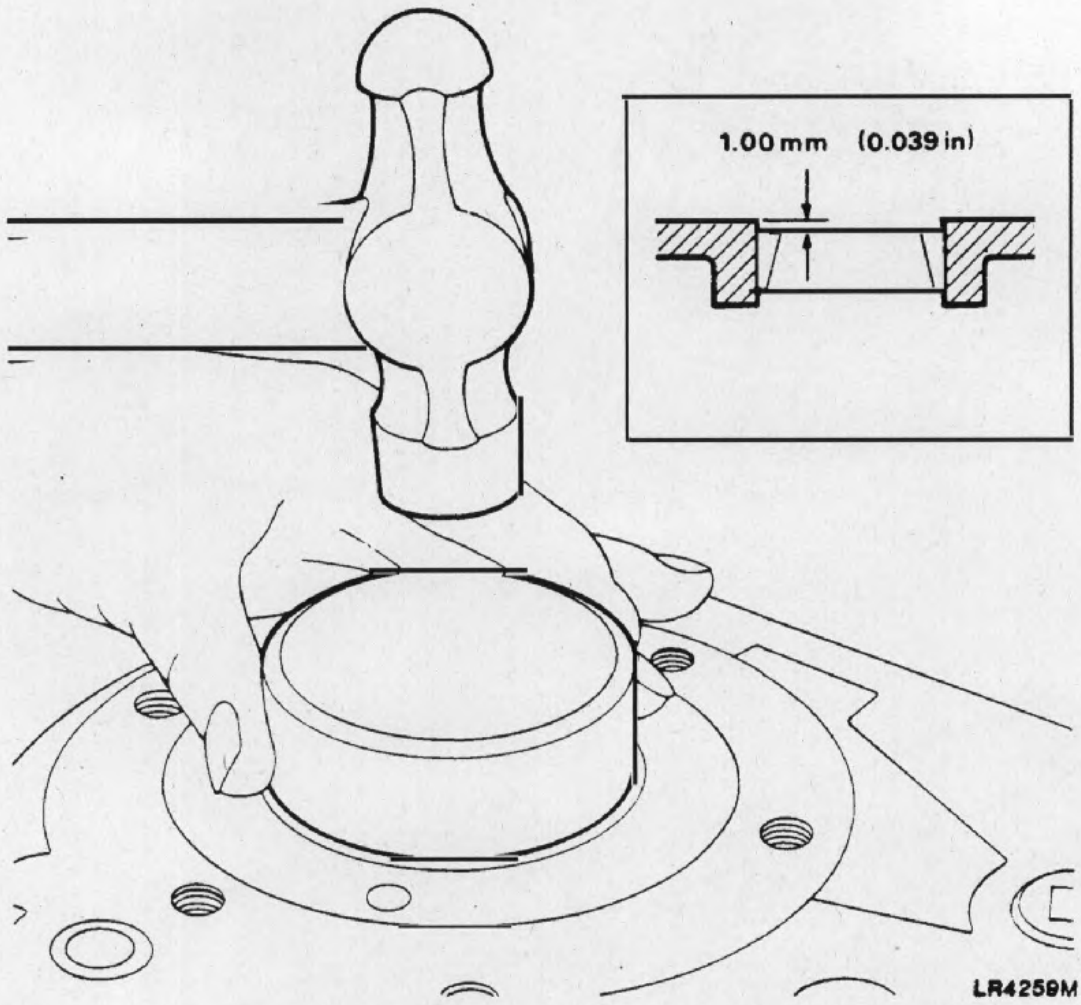


Fig 33 Fitting differential rear bearing track

Transfer case

19 Assemble the components to the transfer case as follows:

19.1 Fit the differential rear bearing track 1.00 mm (0.039 in) below the outer face of the casing using a suitable tool (Fig 33).

19.2 Support the transfer case on the bench with the rear face uppermost and drive in the front taper bearing track (Fig 34).

19.3 Reposition the casing so that the front face is uppermost and fit the oil seal, open side inwards, using special tool (Serial No 6).

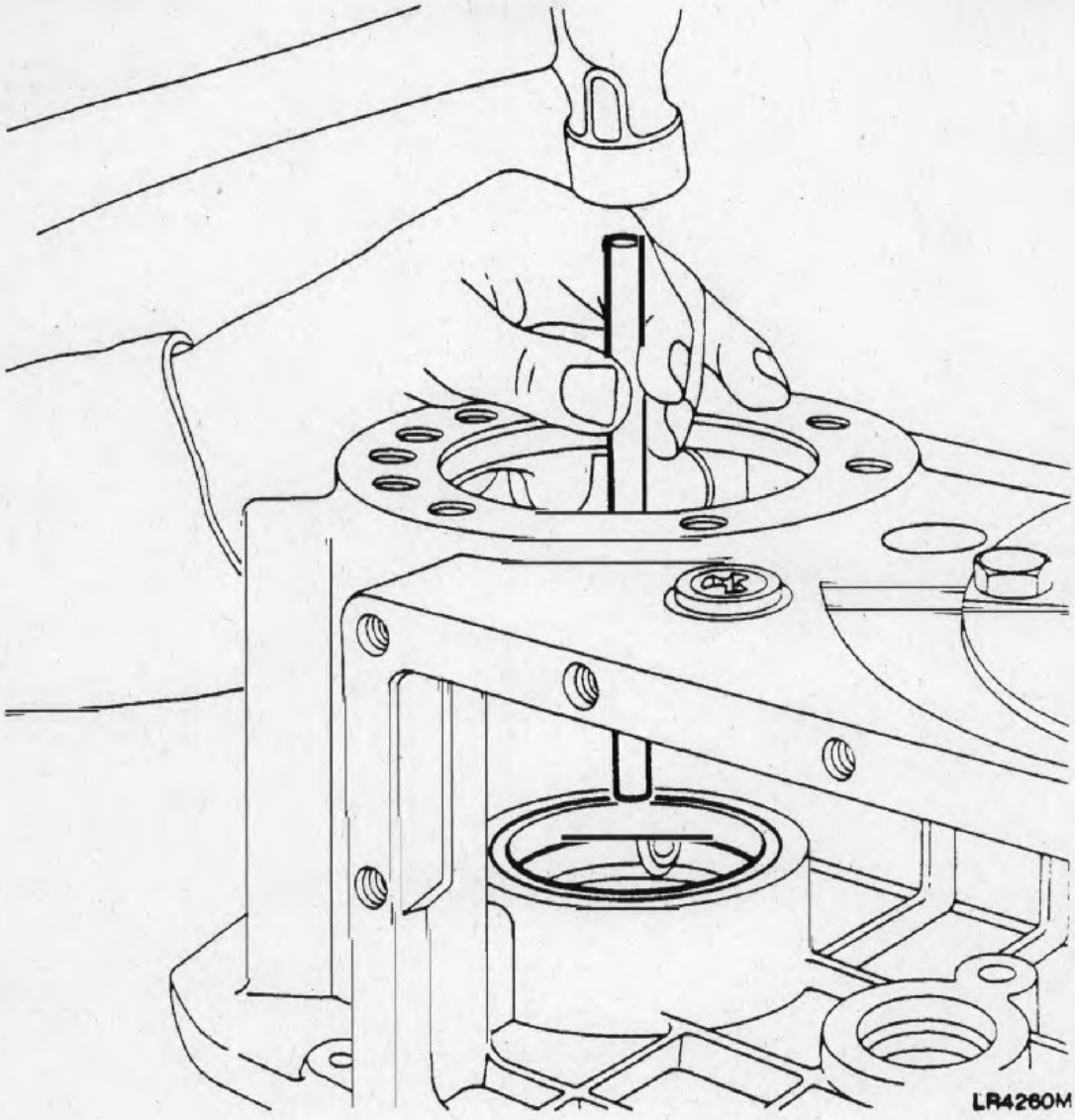


Fig 34 Fitting front taper bearing track

19.4 If removed, refit the studs, coating the threads with Loctite 290 and dowels to the front face of the casing, ensuring that the radial dowel blade is set in line with the circle formed by the front output housing fixing holes. Also ensure, when fitting studs, that the torque does not exceed the maximum quoted for the associated nut.

19.5 Fit the magnetic drain plug and tighten to a torque of 25 to 35 Nm (19 to 26 lbf ft). Loosely fit the filler level plug.

Rear output housing

20 To assemble the rear output housing proceed as follows:

20.1 Press the output bearing into the housing. Do not use excessive force. To facilitate fitting the bearing, heat the output housing case to a maximum temperature of 100°C (212°F).

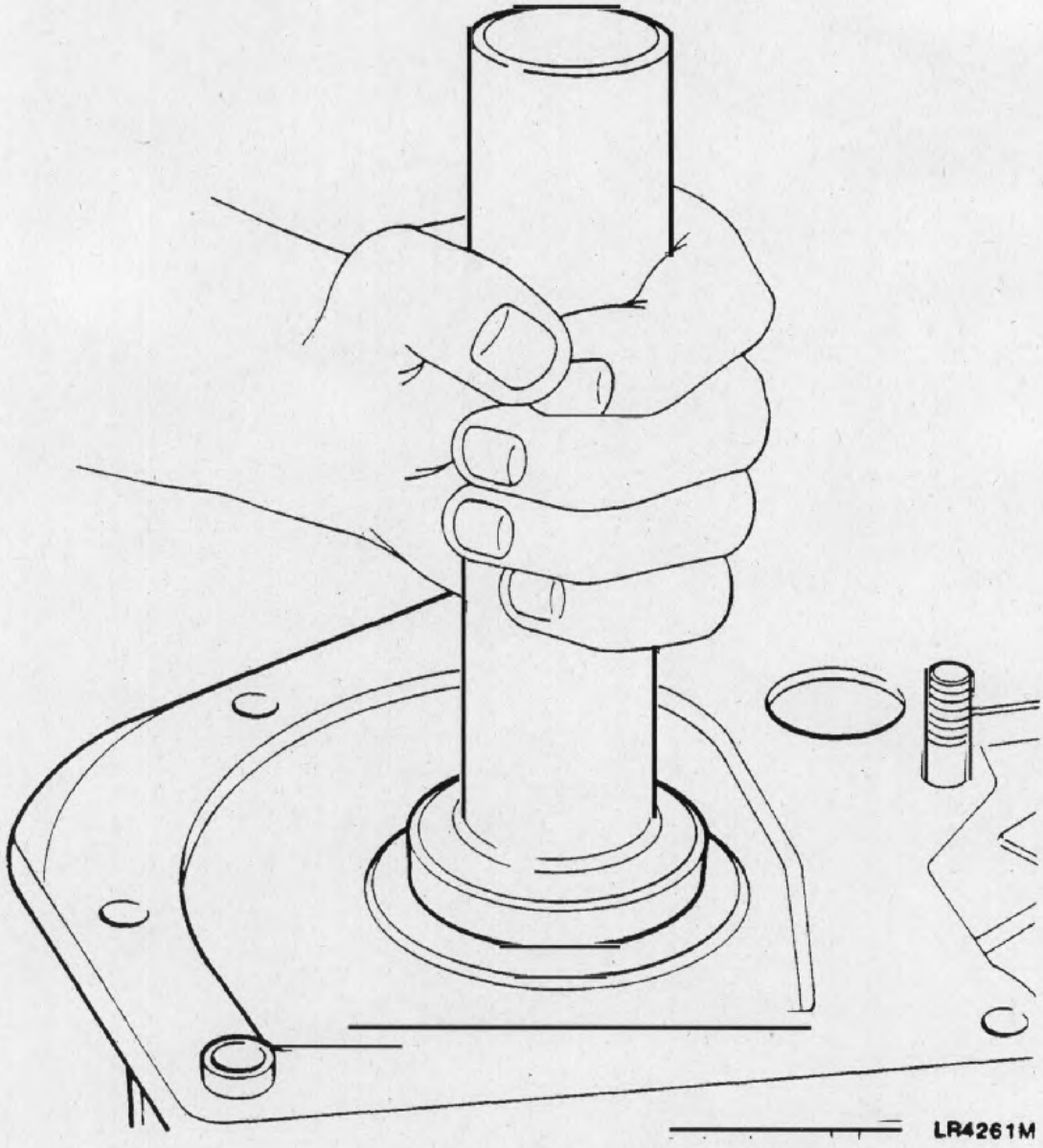


Fig 35 Fitting oil seal to transfer case

20.2 Fit the circlip to retain the bearing, using suitable circlip pliers.

20.3 Pre-grease between the seal lips and fit new seal, open side inwards, using special tool (Serial No 6). The seal should just make contact with the bearing circlip.

20.4 Carefully charge the lips of the seal with clean grease and refit the oil catch ring to the output housing.

20.5 Slide the speedometer drive gear (Fig 36 (2)) and spacer (3) onto the output shaft (1).

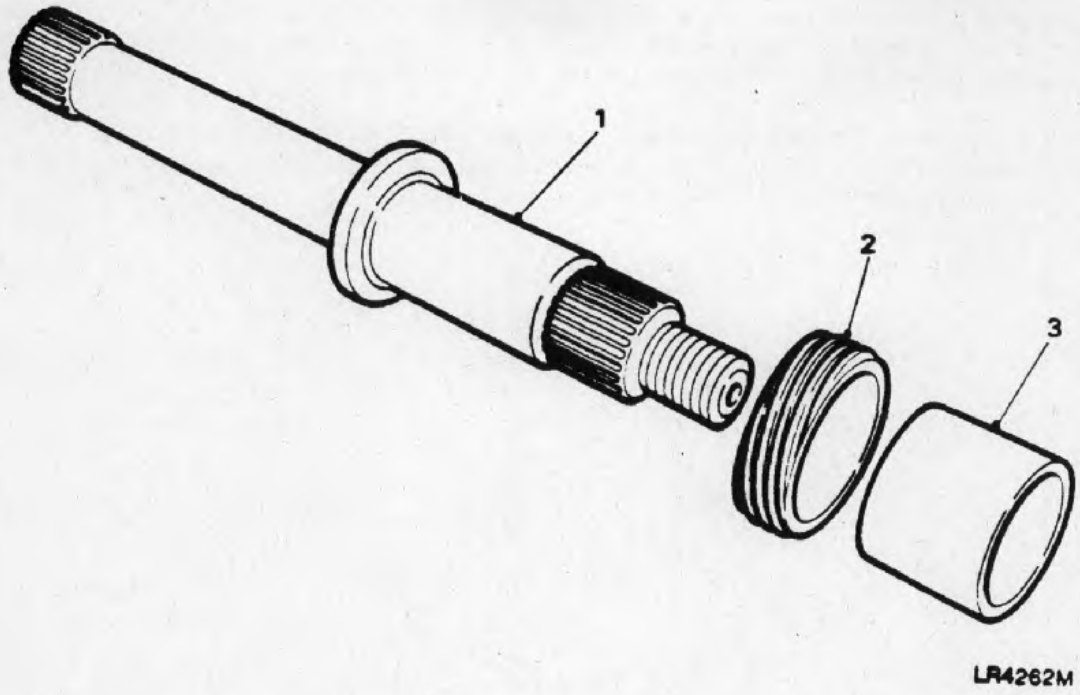


Fig 36 Fitting speedometer drive gear and spacer to output shaft

20.6 Locate the output shaft into the bearing in the housing and drive into position.

20.7 Fit the 'O' ring (Fig 25 (3)) and oil seal (1), open side inwards, to the speedometer drive housing (2).

20.8 Lubricate the 'O' ring and seal with oil.

20.9 Locate the shaft of the speedometer driven gear (4) in the speedometer drive housing (2) and press into position.

20.10 Fit the assembled speedometer housing in the output housing and press in until flush with the housing face.

20.11 Grease the output housing gasket and position onto the rear face of the transfer box casing.

20.12 Fit the output housing and ensure that there is a clearance of 1.00mm (0.039 in) between the housing face and gasket.

20.13 Smear Loctite 290 on the threads of the six output housing bolts, fit with spring washers and tighten evenly to a torque of 40 to Nm (29 to 37 lbf ft), which will pull the rear bearing track into position.

Centre differential assembly refit

21 To fit the centre differential assembly carry out the following:

21.1 Fit the selector fork/shaft assembly to the high/low selector sleeve on the differential assembly, with detent groove to the rear of the differential assembly.

21.2 Locate the differential assembly compl te with s l ctor fork into the transfer case (Fig 37) and engage the selector shaft into its hole. It may be necessary to rotate the output shaft to ease fitment.

21.3 Fit the selector shaft detent ball and spring through the side of the transfer case (Fig 18). Apply Loctite 290 to the detent plug, gently screw fully home and then unscrew two turns.

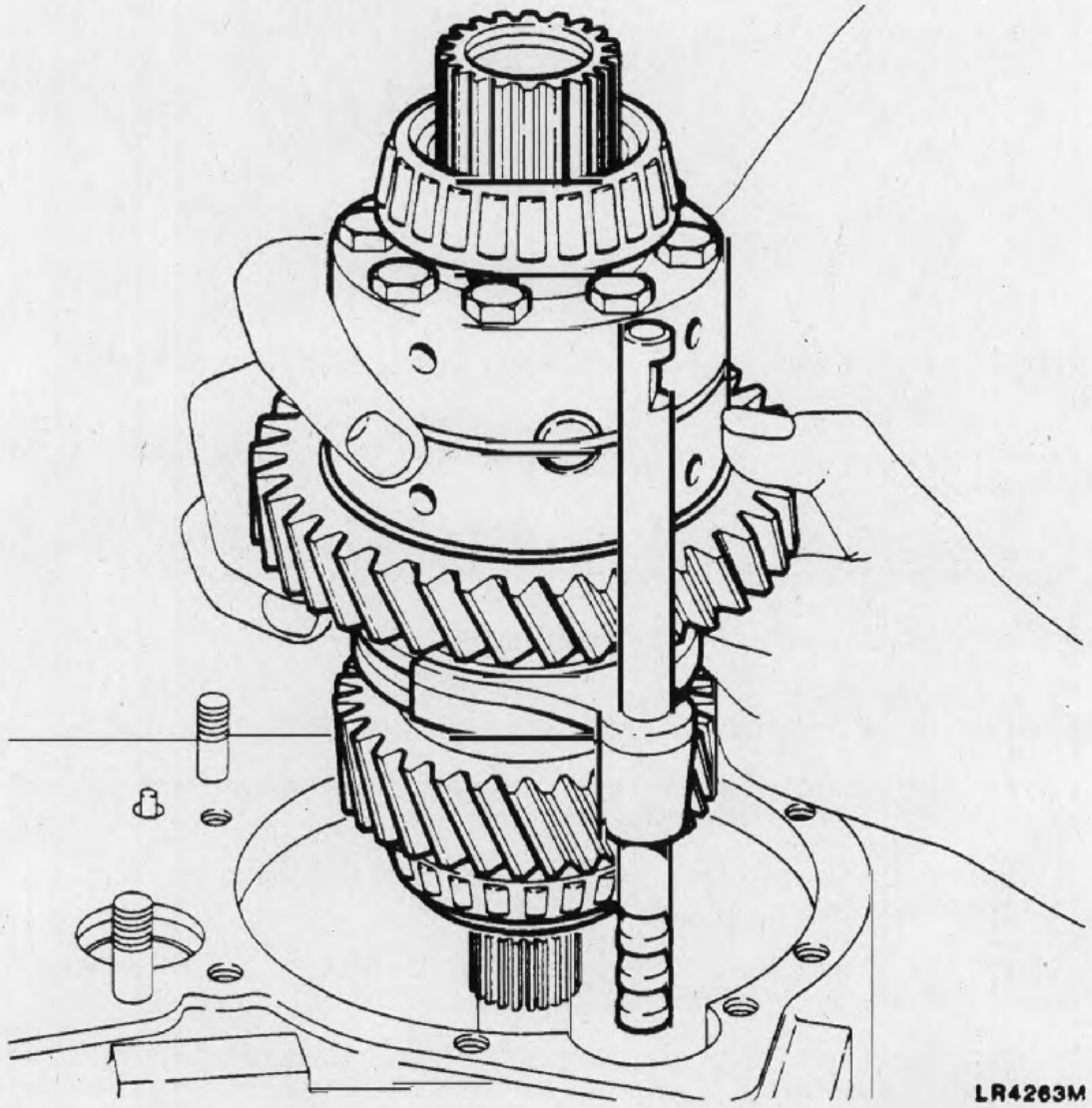


Fig 37 Fitting centre differential and selector shaft assembly

Front output housing

22 To assemble the front output housing carry out the following:

22.1 Press the output bearing into the housing. Do not use excessive force. To facilitate fitting the bearing, heat the front output housing to a maximum temperature of 100°C (212°F).

22.2 Fit the circlip to retain the bearing, using suitable circlip pliers.

22.3 Pre-grease between the lips and fit a new oil seal, open side inwards, using special tool (Serial No 6). The seal should just make contact with the bearing circlip.

22.4 Carefully charge the lips of the seal with clean grease.

22.5 Slide the collar onto the output shaft, with its chamfered edge towards the drive flange.

22.6 Fit the output shaft through the bearing and drive home.

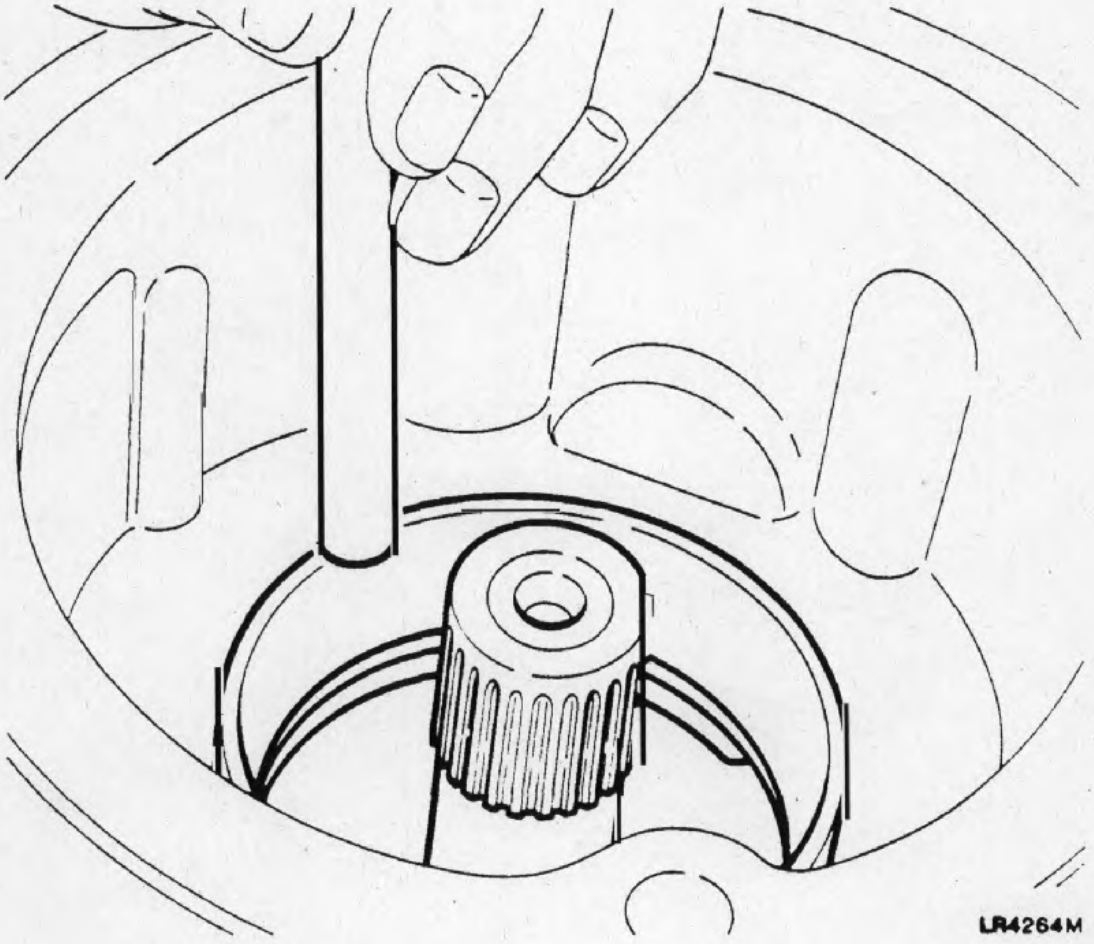


Fig 38 Fitting differential front bearing track to housing

Adjusting front differential bearing pre-load

23 To adjust the front differential bearing pre-load carry out the following:

23.1 Fit the original differential front bearing track shim or one of the same thickness, noted during dismantling, in the front output housing.

23.2 Fit the differential front bearing track in the housing using a soft drift (Fig 38).

23.3 Fit a new gasket and locate the front output housing on the transfer case.

23.4 Secure housing with the eight retaining bolts and washers, the upper middle bolt being longer than the rest. Do not fully tighten the bolts at this stage.

23.5 Engage high or low gear.

23.6 Check the rolling resistance of the differential using a spring balance and a length of string wound around the exposed splines of the high/low hub (Fig 39). Alternatively a suitable torque meter may be used.

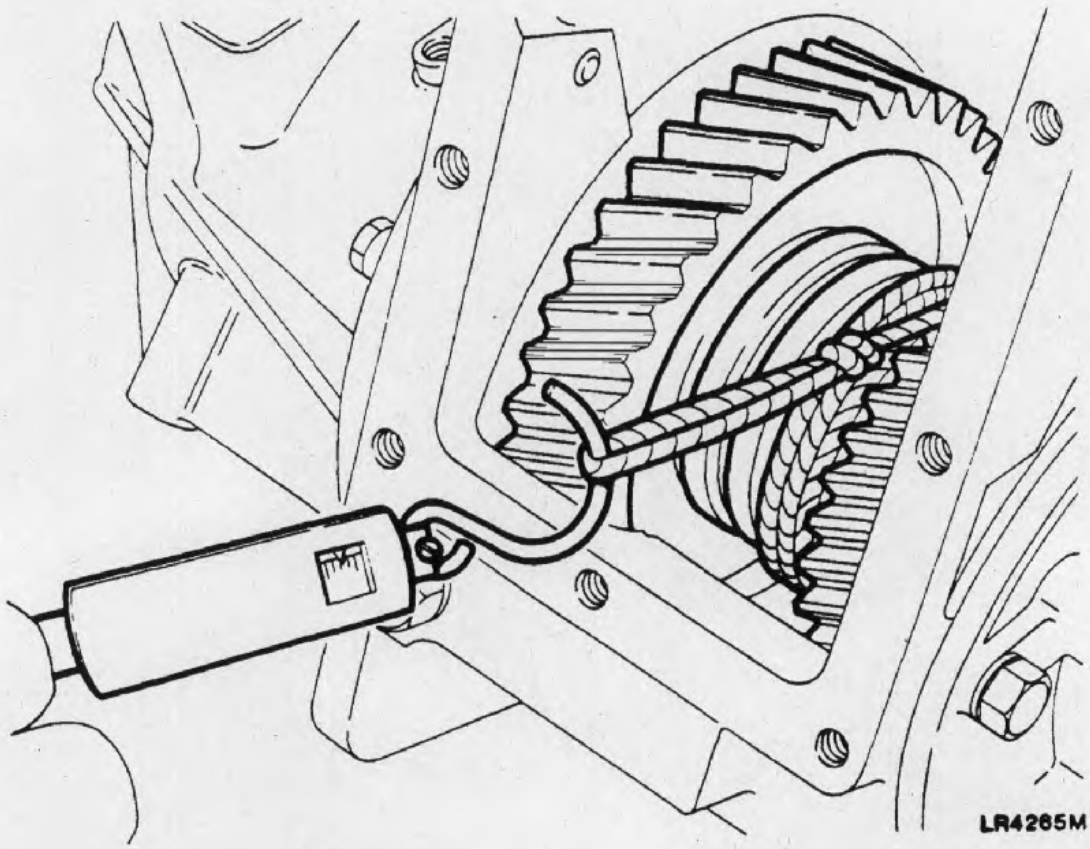


Fig 39 Checking differential rolling resistance

23.7 With the correct shim fitted the load to turn using a spring balance should be 1.36 kg to 4.53 kg (3 lb to 10 lb). Using a torque meter the reading should be 0.56 to 1.69 Nm (5 to 15 lbf in). These figures apply to new or used bearings. New bearings will register at the top end of the scale and used bearings will register at the lower end.

23.8 If the reading is in excess of the above measurements, remove the front output housing assembly from the transfer case.

Note ...

A thicker shim will increase the rolling resistance and a thinner one will reduce it.

23.9 Using a suitable extractor, withdraw the centre differential bearing track and change the shim for one of a suitable thickness from the range available (Cat 721), to increase or decrease the resistance, as required.

23.10 Fit the new shim and drive the differential bearing track back into its housing until fully home, again using a suitable soft drift.

23.11 Having obtained the correct load to turn, place the transfer box on the bench with the front face uppermost.

23.12 Apply Loctite 290 to the threads of the front output housing retaining bolts and tighten to a torque of 22 to 28 Nm (16 to 21 lbf ft).

23.13 Fit the front output flange, felt washer, steel washer and a new flange nut.

23.14 Using special tool (Serial No 4) and a suitable torque wrench and ensuring that the flange bolts are fully engaged in the wrench, tighten the flange nut to a torque of 146 to 179 Nm (108 to 132 lbf ft). This will pull the output shaft up to the correct position. Check that the oil seal shield does not foul the housing.

23.15 Repeat the above operation for the rear output flange.

23.16 Compress the selector shaft spring (Fig 40 (3)) and fit to the selector fork.

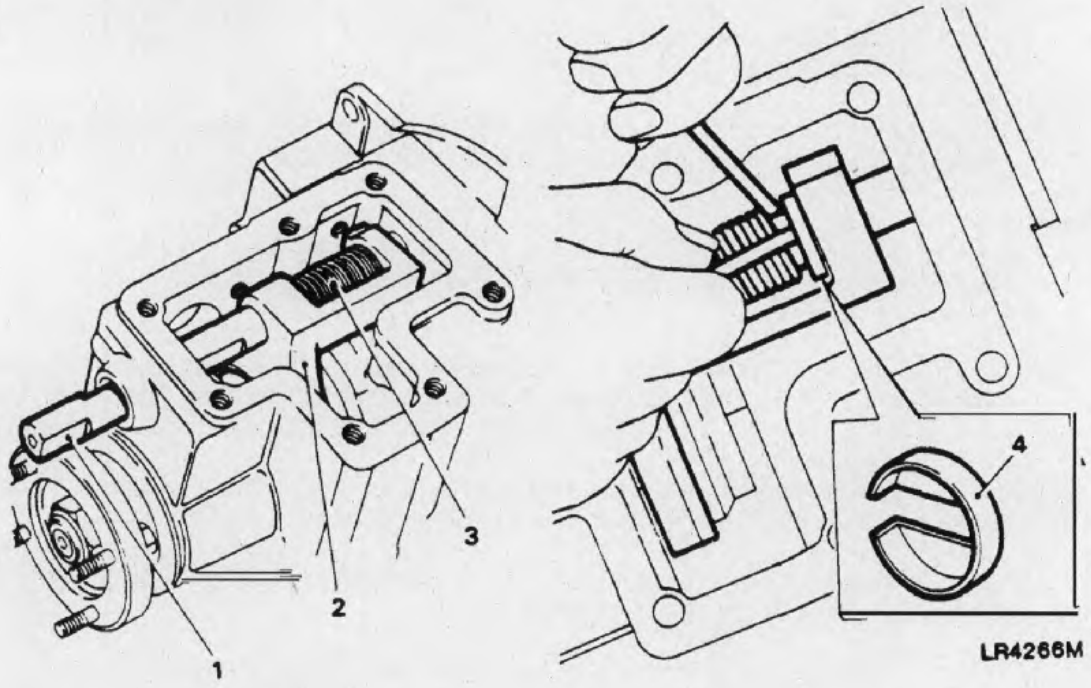
23.17 Locate the selector fork through the front output housing side cover aperture, ensuring that the fork engages in the groove of the lock-up sleeve.

23.18 Fit the selector shaft (1) through the aperture in the front of the housing, pass it through the lugs in the selector fork and the spring into the rear part of the housing.

23.19 Rotate the selector shaft until the two flats for the spring retaining caps (4) are at right angles to the side cover plate face.

23.20 Compress the spring between the fork lugs and slide the retaining caps onto the shaft ensuring the spring is seated within the 'cupped' side of the caps.

23.21 Apply sealant to a new selector shaft cup plug and drive into position.



1	Shaft	3	Spring
2	Selector fork	4	Spring cap

Fig 40 Fitting selector fork, shaft, spring and spring caps

23.22 Fit the selector shaft detent ball (Fig 11 (7)) and spring (6) in the tapped hole on top of the output housing. Apply Loctite 290 to detent plug (5), gently screw fully home and then unscrew two turns.

Differential lock finger housing

24 To assemble and fit the differential lock finger housing carry out the following:

24.1 Fit new 'O' rings seals (Fig 17 (5)) and (6) to the pivot shaft (4) and finger housing (7) and lubricate with oil.

24.2 Locate the pivot shaft in the housing, fit the operating lever (3) over the pivot shaft with the lever facing forward and the bend uppermost. Secure the lever with a plain washer and new 'Nyloc' nut.

24.3 Fit the assembled housing to its seating on the front output housing, ensuring that the selector finger is located in the flat of the selector shaft.

24.4 Apply Loctite 290 to the bolt threads and with spring washers fitted under the heads secure the housing, tightening the bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).

High/low cross-shaft housing

25 To assemble and refit the high/low cross shaft housing carry out the following:

25.1 Apply sealant to a new cup plug (Fig 10 (4)) and fit so that the cup is just below the chamfer for the cross-shaft bore.

25.2 Fit a new 'O' ring seal (3) to the cross-shaft (1).

25.3 Lubricate the shaft and insert into the housing.

25.4 Fit the selector finger (5) ensuring that it aligns with the recess in the cross-shaft.

25.5 Apply Loctite 290 to the grub screw (2), secure the selector finger to the cross-shaft and tighten the screw to a torque of 22 to 28 Nm (16 to 21 lbf ft).

25.6 Fit the assembled housing, using a new gasket and ensuring that the selector finger locates in the slot of the selector shaft. Secure with bolts and washers tightened to a torque of 22 to 28 Nm (16 to 21 lbf ft).

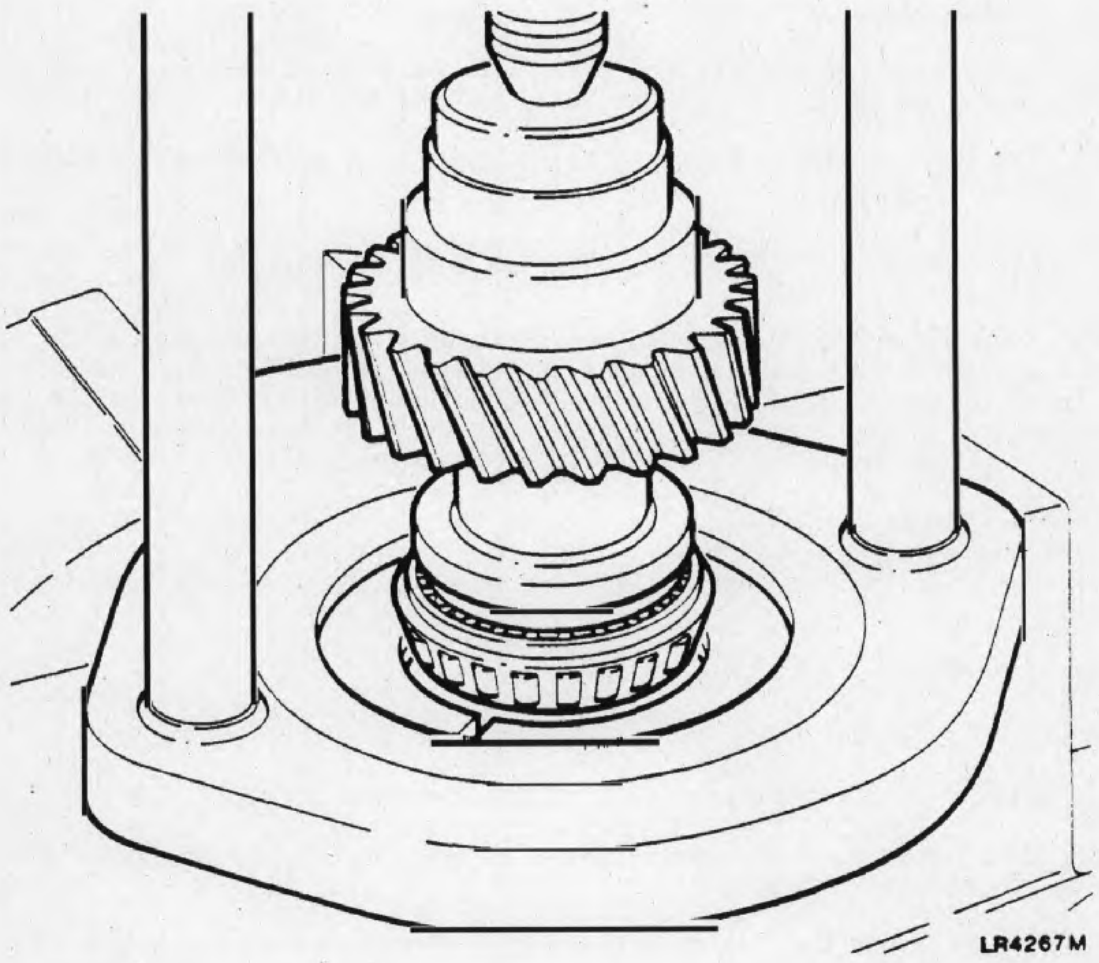


Fig 41 Fitting taper roller bearings to input shaft

Input gear

26 To assemble and fit the input gear carry out the following:

26.1 If new bearings are being fitted proceed as follows:

26.1.1 Position the rear taper roller bearing on the input gear and using special tools (Serial No's 1 and 9).

26.1.2 Invert the input gear and fit the front taper roller bearing using the special tools.

26.2 Lubricate both bearings with clean oil.

26.3 Fit the input gear assembly into the transfer case with the dog teeth uppermost.

Checking input gear bearing pre-load

27 To check the input gear bearing pre-load carry out the following:

27.1 Secure bearing housing in the vice. Fit the original shim or one of the same thickness, noted during dismantling (Para 7.5).

27.2 Locate the bearing track in the support plate and press fully home.

27.3 Using a new gasket fit the bearing housing to the transfer case and secure with the six bolts, do not fully tighten the bolts at this stage.

27.4 Fit special tool (Serial No 13) to the input gear and engage the spline.

27.5 Tie a length of string to a split pin and fit it to the tool as shown (Fig 42).

27.6 Attach a spring balance to the string and carefully tension the spring until a load to turn the input gear is obtained. A pull of 2,26 kg to 9kg (5 lb to 20lb) is required. Alternatively a suitable torque meter may be used by engaging it with the nut on the service tool. If this method is used the torque to turn should be 0.56 to 2.25 Nm (5 to 20 lbf in).

27.8 If the reading obtained is outside the above limits, repeat the for going operations and re-shim until the correct pre-load is obtained, note the final reading obtained for use when the intermediate gear torque to turn (Para 29).

Intermediate gear

28 To assemble and fit the intermediate gear carry out the following:

28.1 Fit new circlips (Fig 5 (3)) in the intermediate gear cluster (4).

28.2 Using special tools (Serial No's 10 and 14) fit the bearing tracks (2) in the intermediate gear cluster.

28.3 Insert a new bearing spacer (5) to the gear assembly, followed by the taper roller bearings (1).

28.4 Fit dummy shaft special tool (Serial No 12) into the intermediate gear cluster.

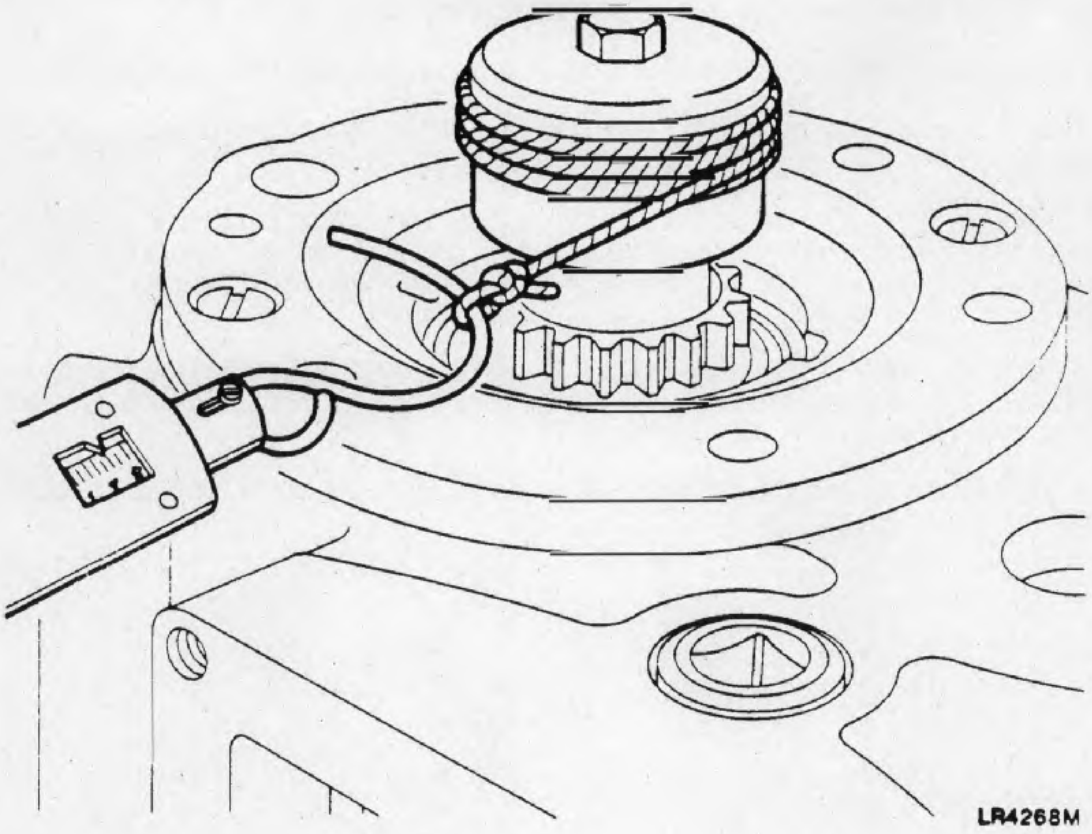


Fig 42 Checking the input gear load to turn

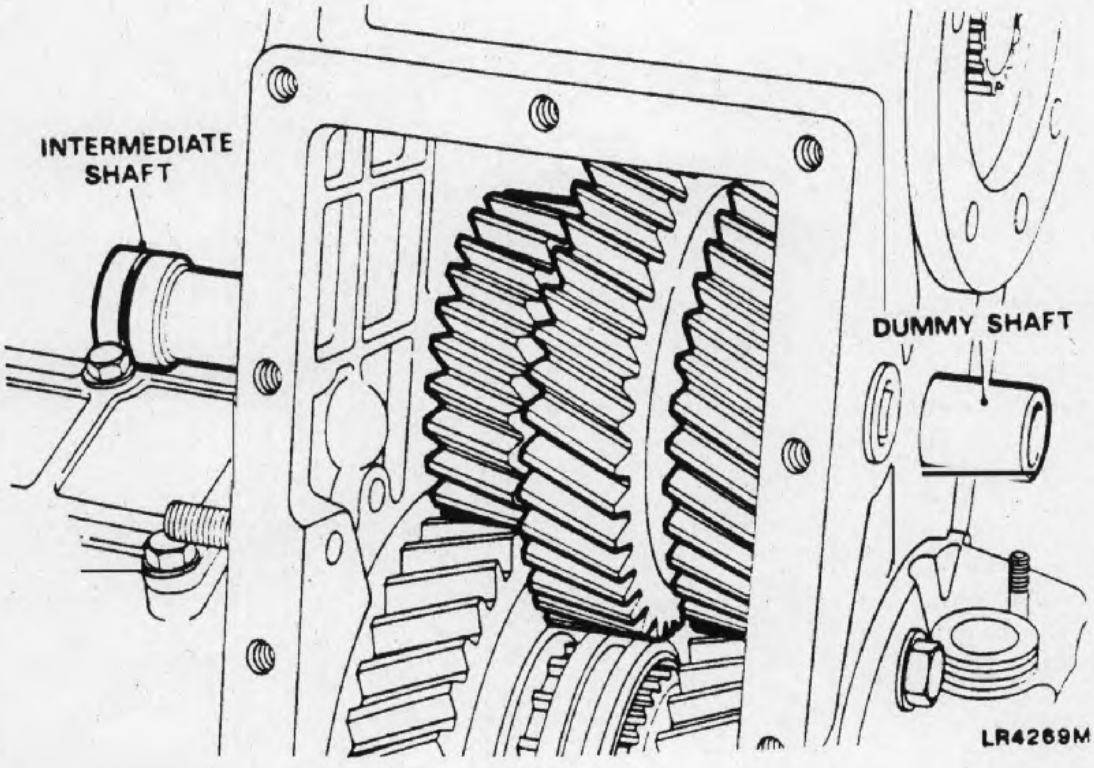


Fig 43 Fitting the intermediate gear assembly

28.5 Fit a new 'O' ring seal to the intermediate shaft and in the intermediate shaft bore at the front of the transfer case.

28.6 Lubricate the taper roller bearings and intermediate gear shaft.

28.7 Locate the gear assembly into the transfer case from the bottom cover aperture.

28.8 Insert the intermediate shaft from the front of the transfer case, pushing the dummy shaft right through (Fig 43) and remove. Ensure that the intermediate gear cluster meshes with the input gear and high and low range gears.

28.9 Turn the intermediate shaft to allow fitting of the anti-rotation plate. Fit the plate and secure with the bolt and washer, tighten the bolt to a torque of 22 to 28 Nm (16 to 21 lbf ft).

28.10 Fit the intermediate gear shaft stake nut. Do not tighten at this stage.

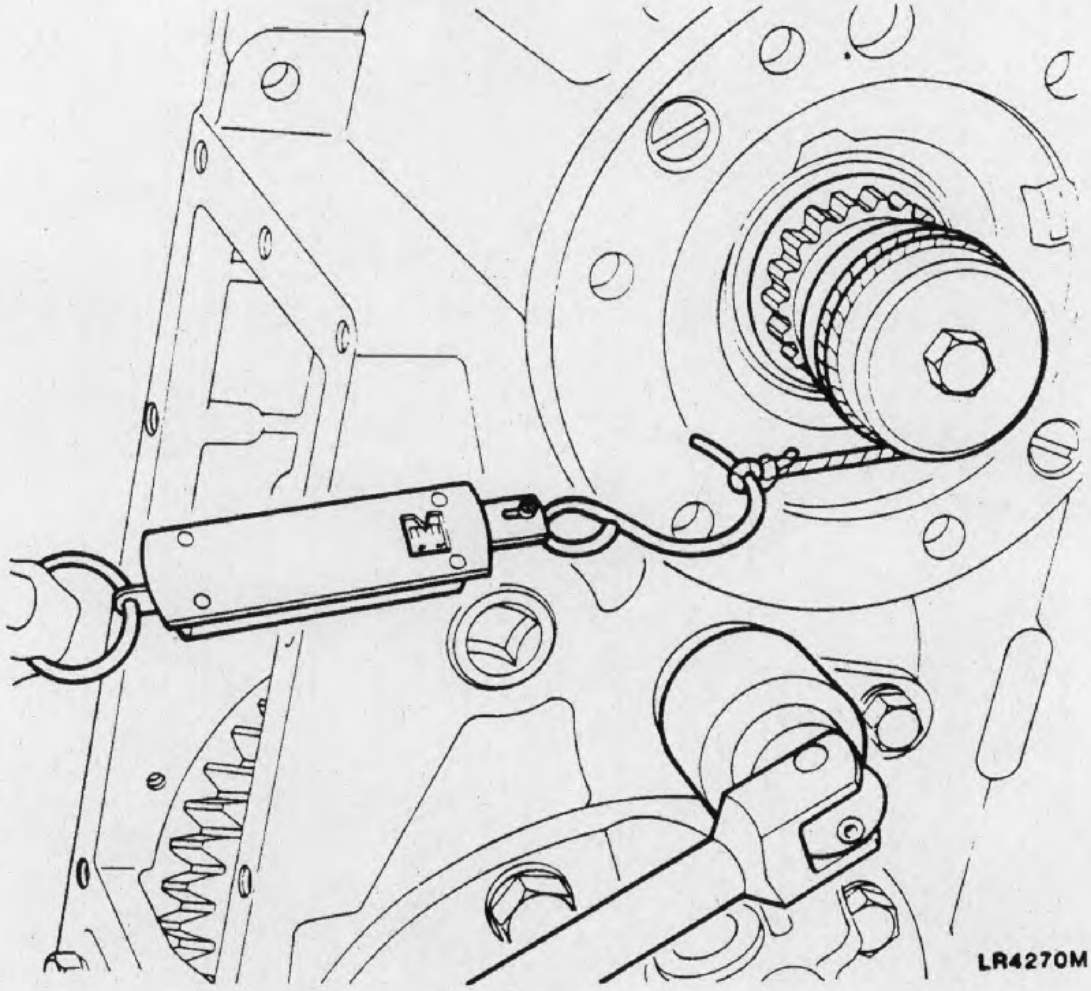


Fig 44 Checking intermediate gear torque and tightening stake nut

Adjusting intermediate gear torque-to-turn

29 Adjust the intermediate gear torque-to-turn as follows:

29.1 Select neutral.

29.2. Fit special tool (Serial No 13) to the input gear and engage the spline.

29.3 Tie a length of string to a split pin and fit to the tool. Attach the spring balance to the string.

29.4 To obtain the correct figures and to collapse the spacer within the intermediate gear cluster, tighten the intermediate shaft nut (Fig 44) until the load-to-turn has increased by 3.7 kg (7 lb) ± 1.63 kg (± 3 lb) on that noted when setting the input shaft load-to-turn.

29.5 Using a suitable round nosed tool, to avoid splitting the collar, peen the stake nut by carefully forming the collar of the nut into the intermediate shaft recess.

Power take-off cover

30 Fit the power take-off cover as follows:

30.1 Fit the two countersunk screws to the input bearing housing and tighten to a torque of 22 to 28 Nm (16 to 21 lbf ft).

30.2 Remove the six bolts and washers from the bearing housing.

30.3 Apply sealant to the power take-off cover gasket and fit it to the bearing housing.

30.4 Fit the cover, apply Loctite 290 to the bolt threads and with spring washers fitted under the bolt heads secure the cover. Tighten the bolts to a torque of 40 to 50 Nm (29 to 37 lbf ft).

Bottom cover

31 Fit the bottom cover as follows:

31.1 Apply sealant to the cover gasket and fit to transfer box casing.

31.2 Apply Loctite 290 to the bolt threads and secure the bottom cover with six bolts and spring washers. Tighten the bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).

Differential lock switch

32 Fit and adjust the differential lock switch as follows:

32.1 Select the differential locked position by moving the lock lever towards the right hand side of the transfer box casing.

32.2 Apply sealant to the differential lock warning light switch and fit to the top of the front output housing (Fig 45).

32.3 Connect a test lamp circuit to the differential lock switch.

32.4 Screw in the lock switch until the bulb is illuminated.

32.5 Turn in the switch another half a turn and tight n the locknut against the housing.

32.6 Disconnect the test lamp and move the differential lock lever to the 1 ft to disengage the differential lock.

32.7 Grease and fit the side cover gasket.

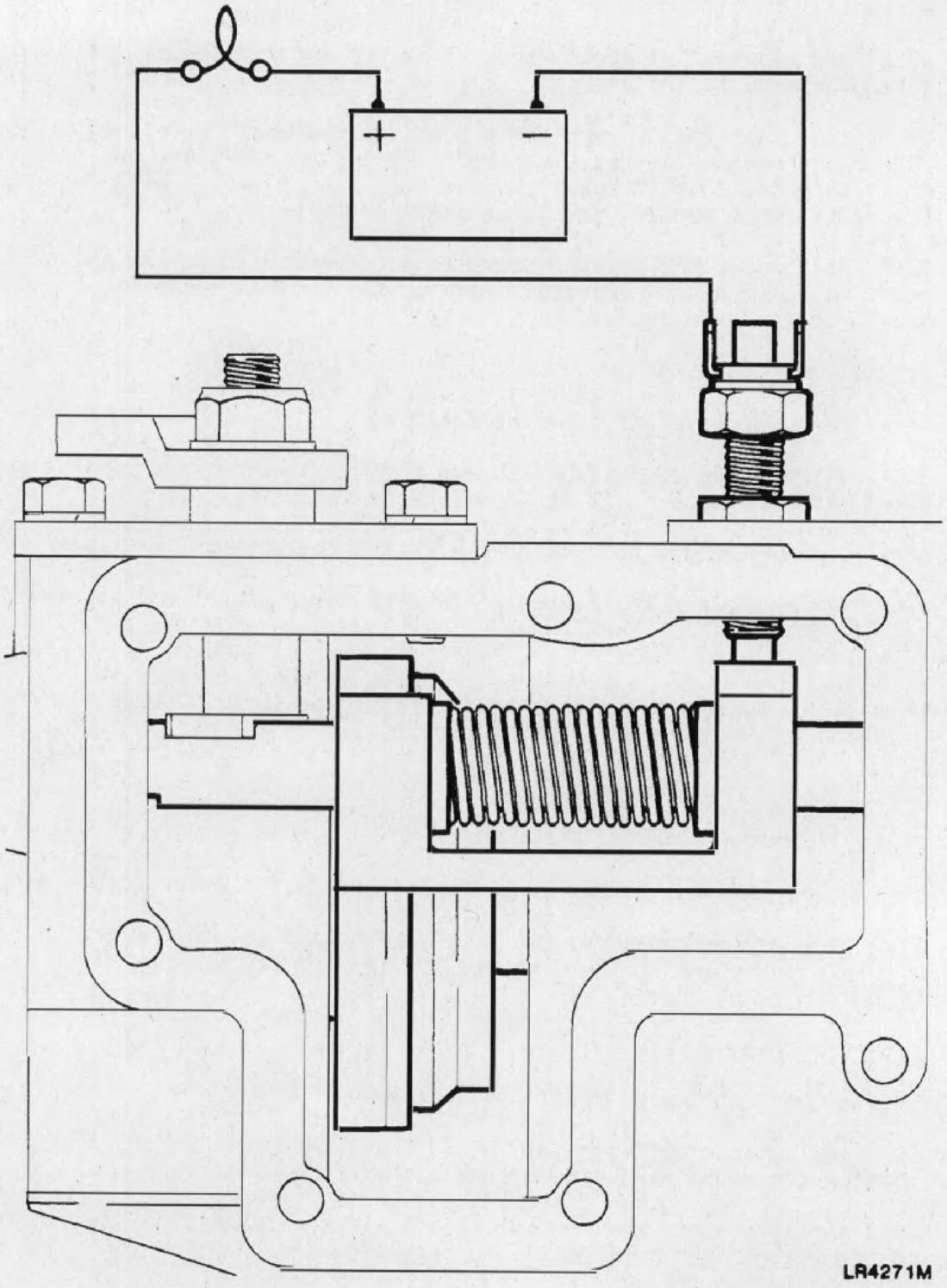


Fig 45 Fitting and setting the differential lock switch

32.8 Apply Loctite 290 to bolt threads, fit the side cover and secure with the seven bolts and spring washers washers. Tighten the bolts to a torque of 22 to 28 Nm (16 to 21 lbf ft).

Transmission brake

33 Fit the transmission brake as follows:

33.1 Clean brake backplate and oil catcher and apply sealant to the catcher joint face.

33.2 Locate the assembled brake backplate and shoes on the rear output housing with the brake operating lever on the right hand side of the transfer box casing.

33.3 Secure the backplate, including the oil catcher, with the four special bolts and tighten using a hexagonal socket to a torque of 65 to 80 Nm (48 to 59 lbf ft).

33.4 Clean and fit brake drum and secure with two countersunk screws to a torque of 22 to 28 Nm (16 to 21 lbf ft).

33.5 To adjust the brake refer to Chap 10.

PROPELLER SHAFTS

Dismantling

34 To dismantle the propeller shafts carry out the following:

34.1 If a gaiter encloses the sliding member, release the two securing clips and slide the gaiter along the shaft to expose the sliding member.

34.2 Note the alignment markings on the shaft and sliding member (Fig 46).

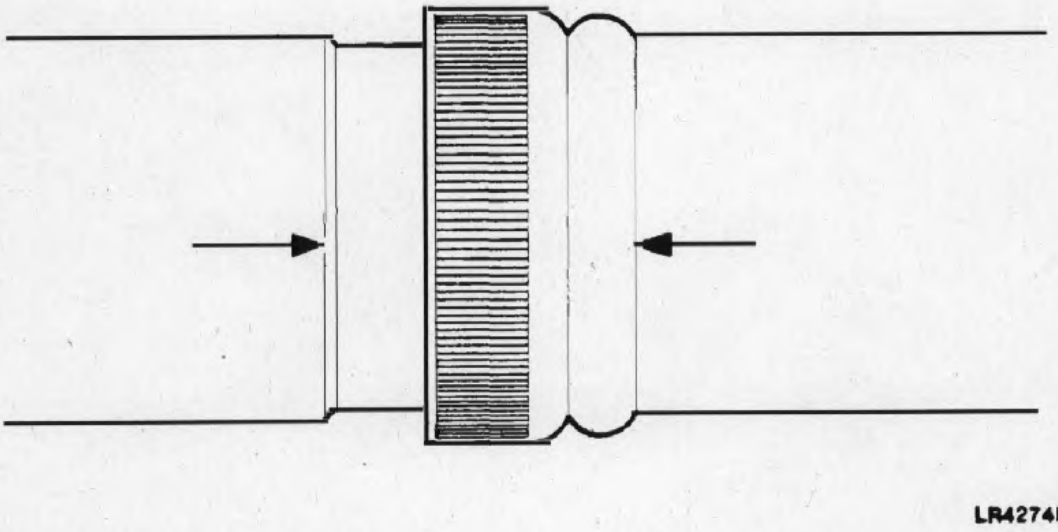
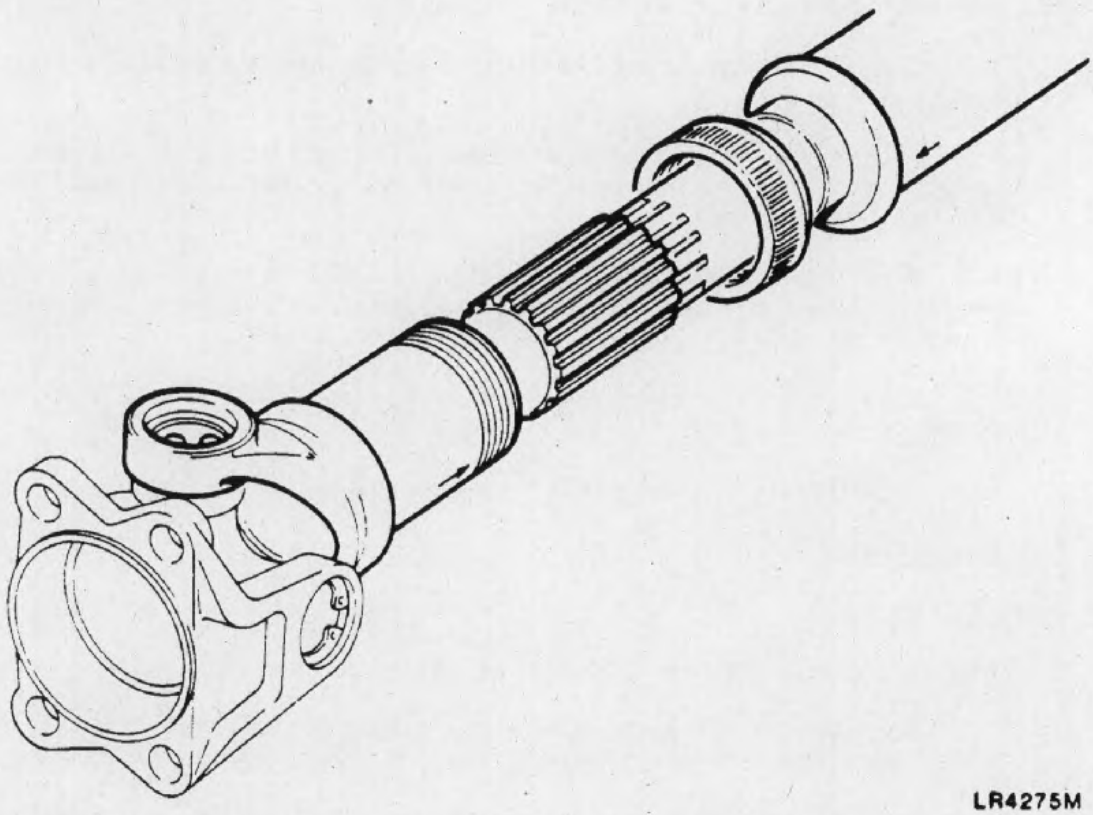


Fig 46 Propeller shaft alignment marks

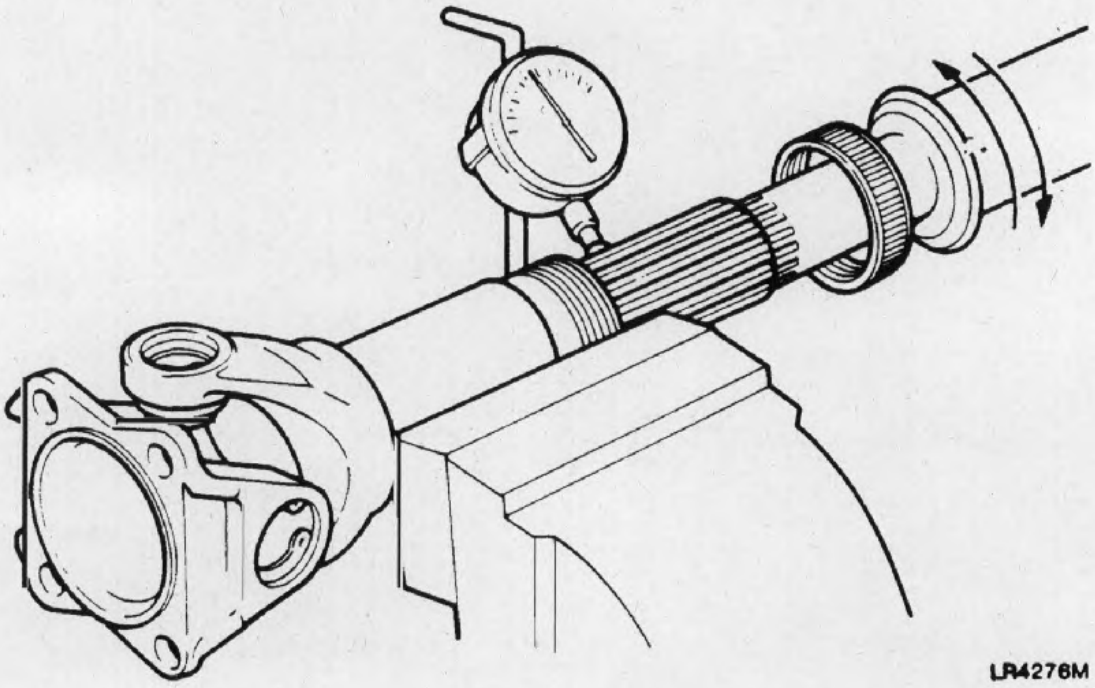
34.3 Unscrew the dust cap and withdraw th sliding member.

34.4 Clean and examine the splines for wear and excessive back-lash (Fig 48). Worn splines or splines having excessive back-lash will necessitate propeller shaft renewal.



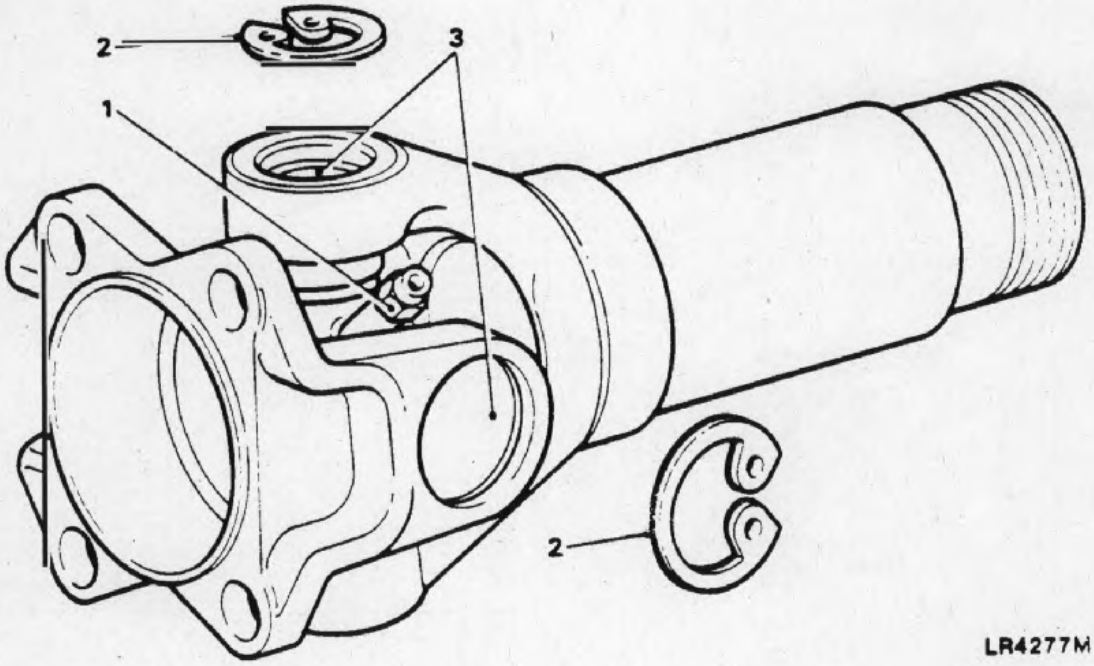
LR4275M

Fig 47 Separating propeller shaft halves



LR4276M

Fig 48 Checking propeller shaft spline back-lash



1 Grease nipple 2 Circlip 3 Bearing cups

Fig 49 Removing propeller shaft universal joint flange

34.5 Remove paint, rust etc. from the vicinity of the universal joint bearing cups and circlips.

Note ...

Before dismantling the universal joint, mark the position of the spider pin lubricator relative to the journal yoke ears to ensure that the grease nipple is reassembled in the correct running position to reduce the possibility of imbalance.

34.6 Remove the grease nipple and circlips.

34.7 Tap the yokes to eject the bearing cups.

34.8 Withdraw the bearing cups and spider and discard.

34.9 Repeat the foregoing operations to dismantle the universal joint at the other end of the propeller shaft.

34.10 Thoroughly clean the yokes and bearing cup locations.

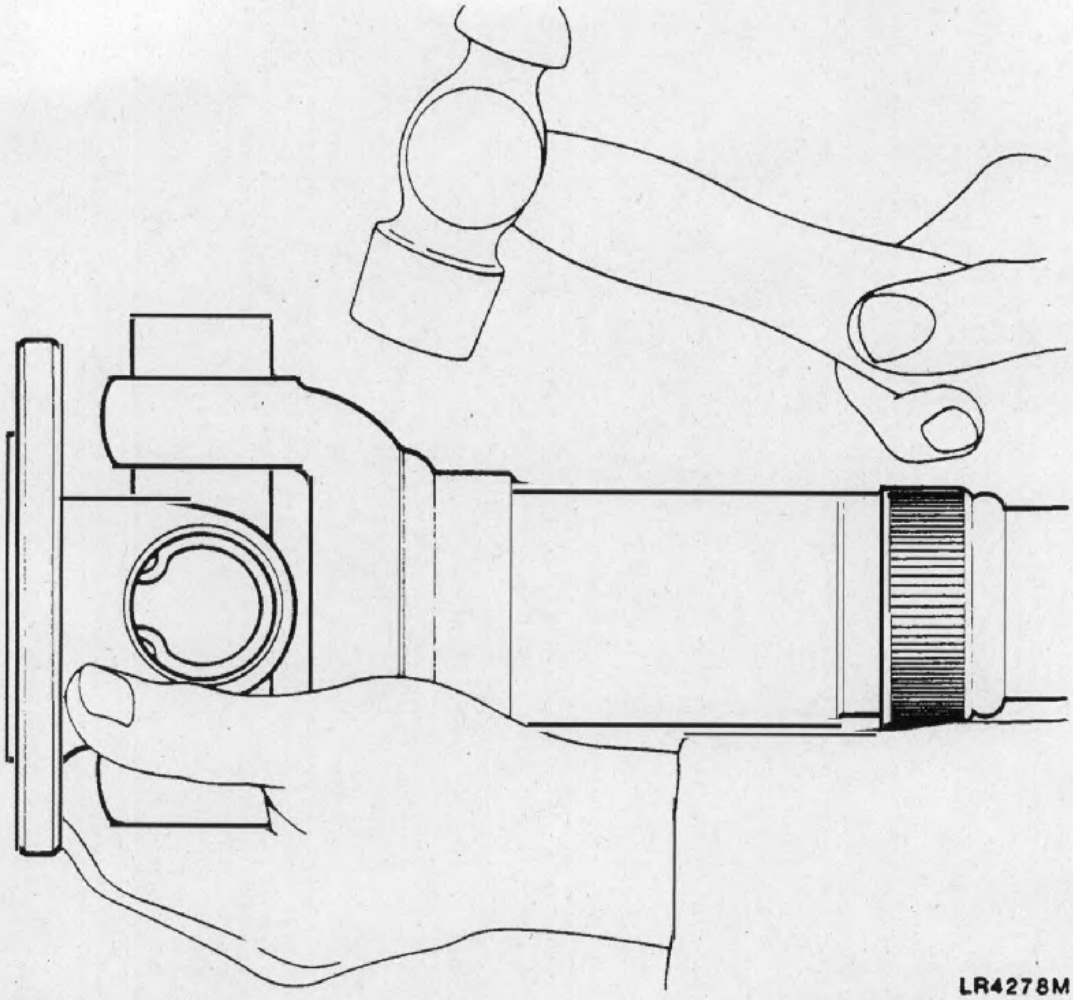


Fig 50 Removing bearing cups

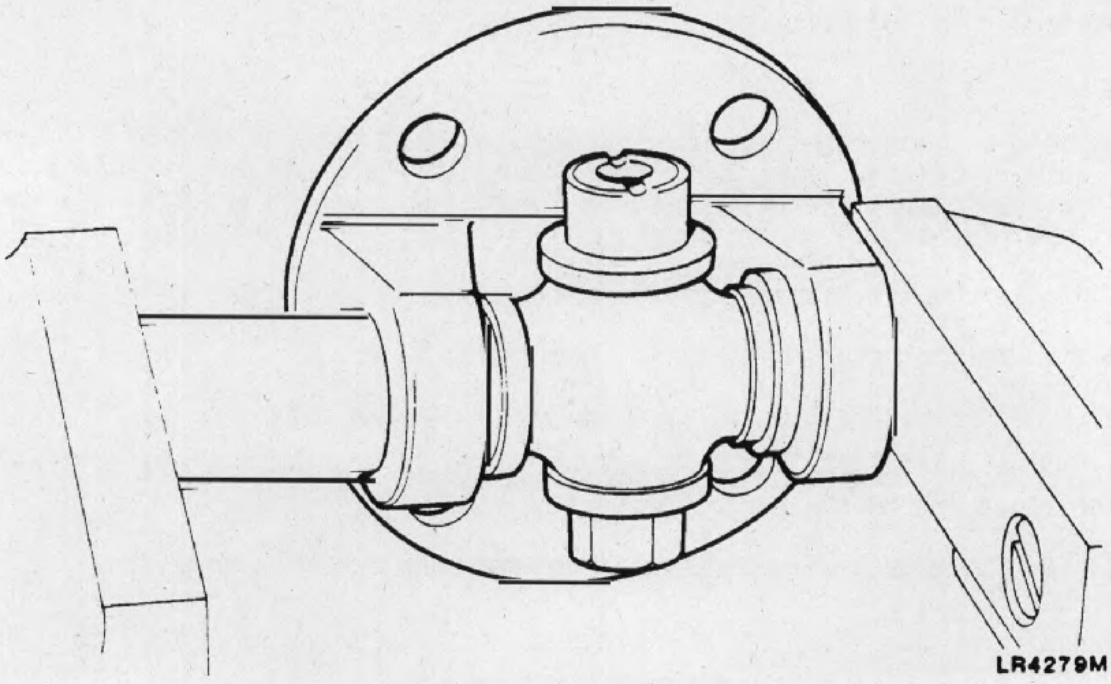


Fig 51 Fitting bearing cups

R assembly

35 To reass mble the propeller shaft proceed as follows:

35.1 Remove the bearing cups from the new spider.

35.2 Check that all needle rollers are present and are correctly positioned in the bearing cups.

35.3 Ensure that the bearing cups are one third full of fresh lubricant (BP Energrease L2 or suitable alternative).

35.4 With the grease nipple facing away from the flange, insert the new spider, complete with seals, into the yokes of the sliding member flange.

35.5 Partially insert one bearing cup into a flange yoke and enter the spider trunnion into the the bearing cup, taking care not to dislodge the needle rollers.

35.6 Insert a bearing cup into the opposite flange yoke. Using a vice (Fig 51), carefully press both cups into place, taking care to engage the spider trunnion without dislodging the needle rollers.

35.7 Remove the assembly from the vice.

35.8 Using a flat faced adaptor of slightly smaller diameter than the bearing cups press each cup into its respective yoke until they reach the lower land of the circlip groove. Do not press the cups below this point or damage may be caused to the cups and seals.

35.9 Fit new circlips to retain the bearing cups.

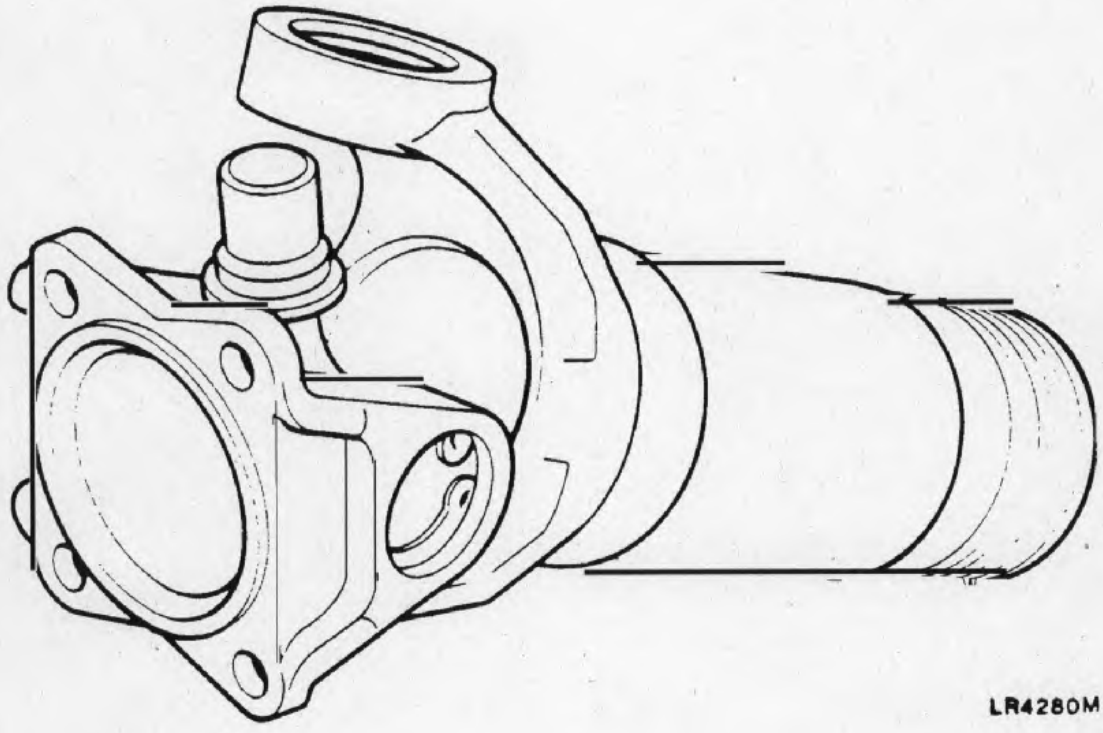


Fig 52 Fitting propeller shaft universal joint flange

35.10 Engage the spider in the yokes of th sliding member. Fit the bearing cups and circlips as described in Para's 35.5 to 35.9.

35.11 Repeat the complete procedure to fit the flange to the other end of the shaft.

Note ...

The universal joints on the front propeller shaft are, by design, not in-line with one another. The alignment marks on the sliding member and propeller shaft must coincide when reassembling.

35.12 Lubricate the splines of the sliding member and fit it to the propeller shaft.

35.13 Fit and tighten the dust cap.

35.14 Fit the grease nipples to the spiders and the sliding member and lubricate.

35.15 Slide the gaiter, if fitted, over the sliding member. Locate the sliding member in the mid-position of its travel and secure the gaiter clips. The gaiter clips must be fitted with the securing screws positioned at 180^{o} to each other so that they will not influence propeller shaft balance.

Chapter 7-1

MANUAL STEERING SYSTEM

CONTENTS

INTRODUCTION

1 This Chapter covers the Base repairs for manually operated steering systems fitted to Land Rover 90 and 110 vehicles.

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	NSN/Part No where applicable (3)	Designation (4)
1	RO 1016		Torque setting tool

STEERING BOX

Removal

2 To remove the steering box from the vehicle refer to AESP 2320-D-122-522 Chap 7-1 Para 18.

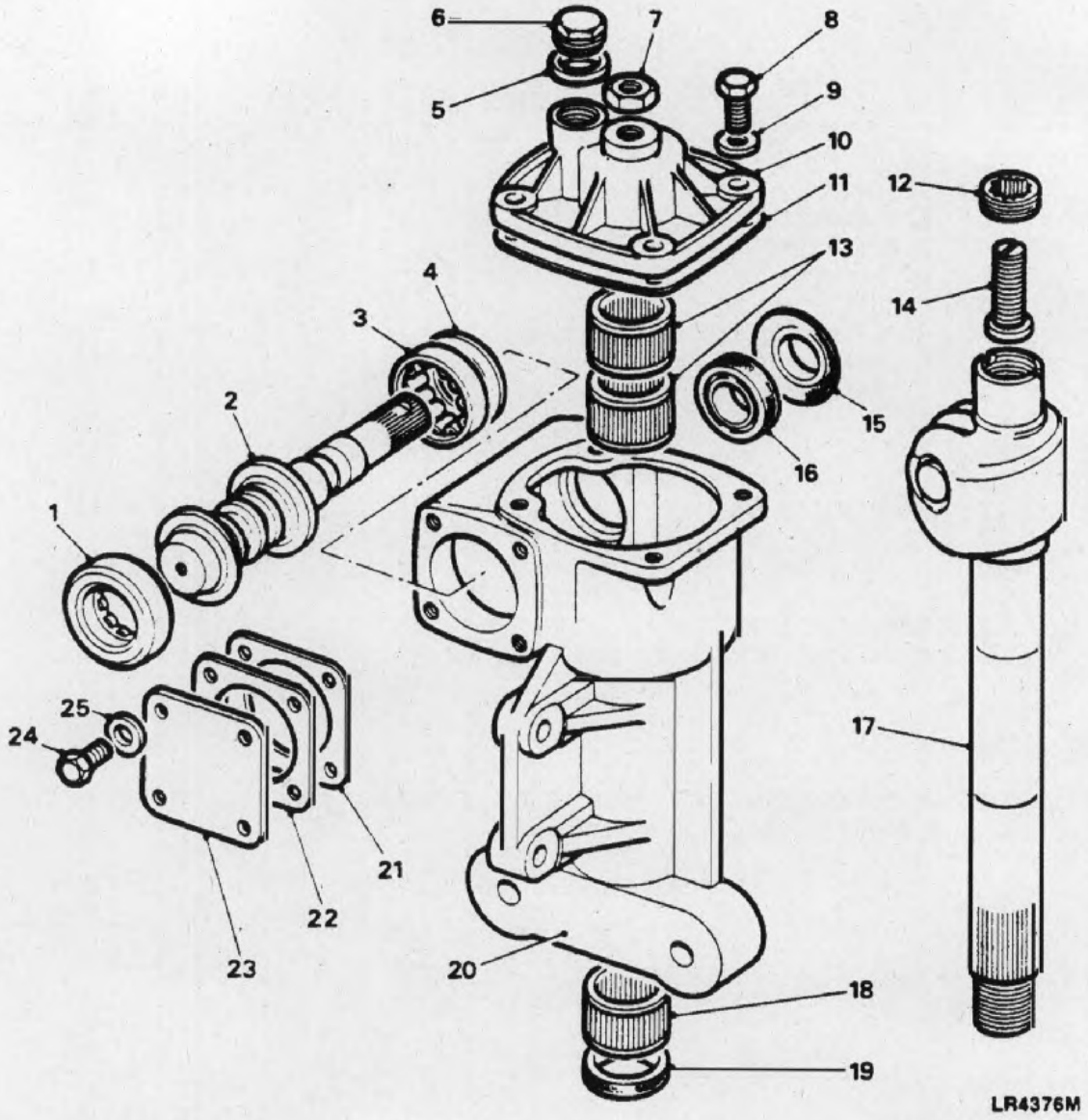
Dismantling

3 To dismantle the steering box carry out the following:

3.1 Remove the adjuster locknut (Fig 1 (7)) from the top of the steering box.

3.2 Remove the four bolts (8) and washers (9) securing the top cover (10).

3.3 Unscrew the top cover from the adjuster (14).



1	Bearing	14	Adjuster
2	Worm shaft	15	Dust cover
3	Bearing	16	Oil seal
4	Shim	17	Sector shaft
5	Washer	18	Needle roller bearing
6	Oil filler plug	19	Oil seal
7	Adjuster locknut	20	Body
8	Bolt	21	Shim
9	Washer	22	Gasket
10	Top cover	23	Cover plate
11	Gasket	24	Bolt
12	Threaded cup	25	Washer
13	Needle roller bearings		

Fig 1 St ering box

3.4 Lift out the s ctor shaft (17).

3.5 Remove the four bolts (24) and washers (25) securing the worm shaft retaining plate (23), remove the plate complete with shims (22) and gasket (21).

3.6 Remove the outer taper bearing and track (1).

3.7 Withdraw the worm shaft (2) and the shaft end taper bearing (3).

3.8 Remove the dust cover (15) and drift out the worm shaft oil seal (16).

3.9 Drift out the shaft end bearing track and collect the shim (4). Note the thickness of the shim removed for reassembly.

3.10 Prise out the sector shaft oil seal (19).

3.11 Drift out the sector shaft needle roller bearings (13) and (18) from the top cover and from the box.

Cleaning and examination

4 Clean and examine the components as follows:

4.1 Clean and degrease all parts and examine for wear and damage.

4.2 Renew the bearings (if worn), oil seals, gaskets and any other unsatisfactory parts.

4.3 If the bearing in the top cover is worn renew the complete cover and bearing.

Reassembly

5 Reassemble the steering box as follows:

Note ...

During the following operations cleanliness is essential.

5.1 Press in the shaft end bearing track with a shim of the same value as that removed (Para 3.9) fitted behind the track, ensuring that the track is fitted squarely and pressed fully home.

5.2 Lubrcate and fit the bearing (3) to the worm shaft (2) and insert the shaft into the box (20).

5.3 Lubricate and fit the bearing and track (1) to the cover end of the worm shaft.

5.4 Fit the cover plate (23) gasket (21) and original shim (22), secure with the four bolts and washers and evenly tighten the bolts to a torque of 25 to 30 Nm (18 to 22 lbf ft).

5.5 Check the worm shaft bearing pre-load by attaching special tool (Serial No 1) to the worm shaft, wrap a suitable length of string around the tool (Fig 2) and attach a spring balance to one end, with a steady pull note the rolling resistance which should be 2.26 to 2.72 kgf (5 to 6 lbf). Adjust by adding or removing shims.

5.6 When the correct figure is achiev d, remove the bolts coat the threads with sealant, refit and evenly tighten to the correct torque (Para 5.4).

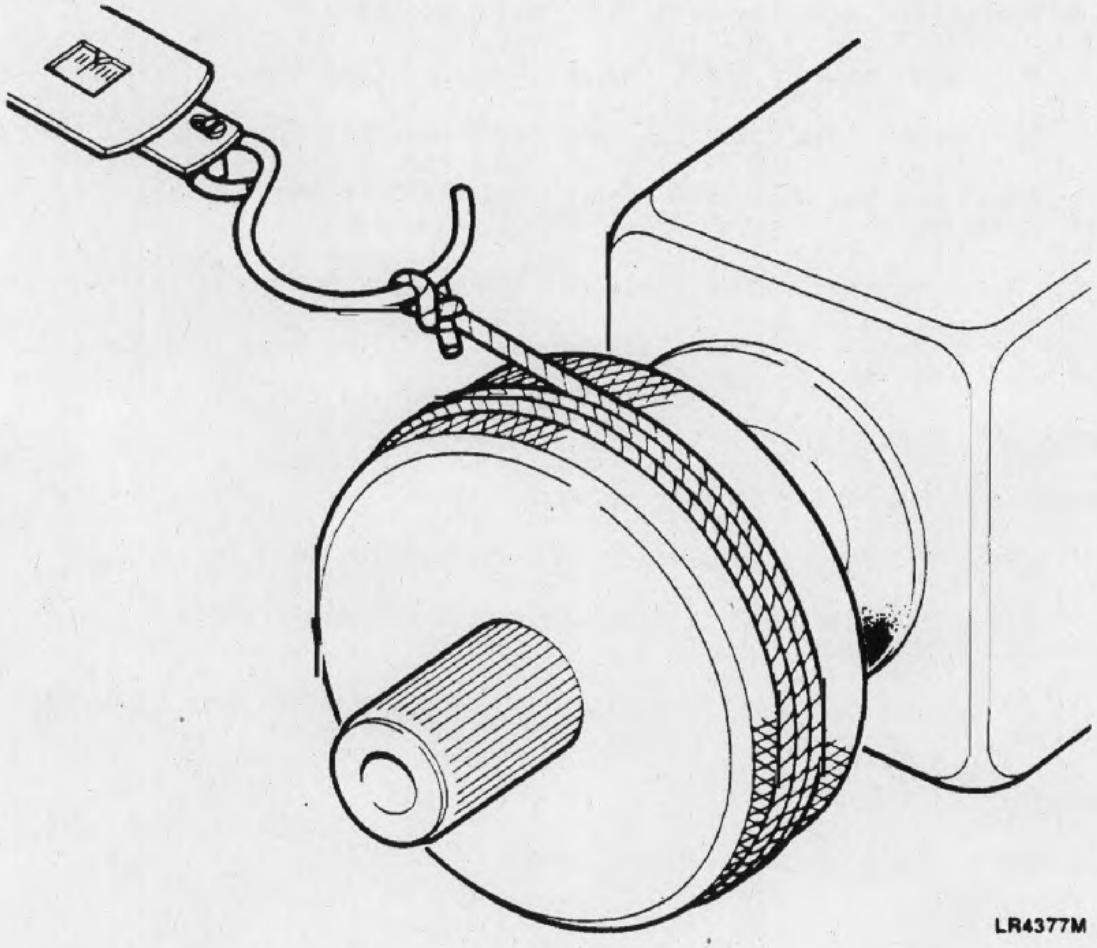


Fig 2 Checking worm shaft pre-load

5.7 With the lip side leading fit the oil seal (Fig 1 (16)) to the shaft nd of the box followed by the dust cover (15).

5.8 Press in the sector shaft upper needle roller bearing (13) to a depth of 83 mm (3.150 in) from the top of the box.

5.9 Press in the lower bearing 1,00 mm (0.040 in) below the chamfer.

5.10 Check that no end-play exists in the sector shaft adjuster (14). To r duce end-play unstake the threaded cup (12), turn clockwise until all end-play is removed and restake.

5.11 Fit the sector shaft so that the roller is in the centre of the worm in the straight ahead position.

5.12 Fit the needle roller bearing to the top cover.

5.13 Locate a new gasket (11) over the adjuster onto the box, screw the top cover to the adjuster and to the box with the four bolts and washers evenly tightened to a torque of 25 to 30 Nm (18 to 22 lbf ft).

5.14 Loosely fit the adjuster locknut.

5.15 With the sector shaft in the straight ahead position fit the drop arm and turn the adjuster clockwise until pre-load is applied to the shaft. The amount of pre-load should be such that when the shaft is turned half a turn to the left and then half a turn to the right, the backlash must only just be perceptible. When satisfactory tighten the adjuster locknut.

5.16 Fit the sector shaft oil seal (19).

5.17 Remove the oil filler plug and pour in approximately 0.43 litres (0.75 pints) of approved oil (AESP 2320-D-122-601) to a minimum level of 25 mm (1.0 in) below the top of the filler hole. Refit the plug and tighten to a torque of 20 Nm (14.75lbf ft).

Refitting

6 To refit the steering box refer to AESP 2320-D-122-522 Chap 7-1 Para 19.

Chapter 7-2

POWER STEERING SYSTEM LAND ROVER 127 VEHICLES

CONTENTS

INTRODUCTION

1 This chapter details the Base repair procedures for the power steering system fitted to Land Rover 127 vehicles.

SPECIAL TOOLS

2 The special tools listed in Table 1 will be referred to in the text when used, by the serial number shown in the table.

TABLE 1 SPECIAL TOOLS

Ser No (1)	Manufacturers Part No (2)	NSN/Part No where applicable (3)	Designation (4)
1	LST 120		C' Spanner
2	LST 119		Worm adjusting socket
3	MS252A		Drop arm extractor
4	606602		Ring expander
5	606603		Ring compressor
6	606604		Seal saver,sector shaft
7	RO1015		Seal saver,valve and worm
8	R01016		Torque setting tool
9	LST142		Pump cover removal

STEERING BOX

Removal

2 To remove the steering box from the vehicle refer to Cat 522 Chap 7-2.

Caution

Power steering fluid is harmful to paintwork. Should any fluid seep on to body, chassis or any other components immediately wipe clean. It is most important that fluid drained from the system is not re-used.

Dismantling

3 To dismantle the steering box proceed as follows:

3.1 Withdraw the drop arm (Fig 1 (3)).

3.2 Rotate the retainer ring (45), as necessary, until one end is approximately 12 mm (0.500 in) from the extractor hole.

3.3 Lift the cover retaining ring (45) from the groove in the cylinder bore, using a suitable pointed drift applied through the hole provided in the cylinder wall.

3.4 Compl te the removal of th r tainer ring (45), using a scr wdriv r.

3.5 Turn on right lock until the piston pushes out the end cover (44).

3.6 Slacken the grub screw (39) retaining the rack pad adjuster.

3.7 Remove the rack pad adjuster (36).

3.8 Remove the sector shaft adjuster locknut (20).

3.9 Remove the four self locking screws (19) securing the sector shaft cover (18).

3.10 Screw in the sector shaft adjuster until the cover is removed.

3.11 Slide out the sector shaft (15).

3.12 Withdraw the piston (40), using a suitable bolt screwed into the tapped hole in the piston.

3.13 Remove the worm adjuster locknut (35) using special tool (Serial No.1).

3.14 Remove the worm adjuster (34) using special tool (Serial No.2).

3.15 Tap the splined end of the spindle shaft (27) to free the bearing.

3.16 Withdraw the bearing cup (32) and caged ball bearing (31) assembly.

3.17 Withdraw the valve and worm (30) assembly.

3.18 Withdraw the inner bearing ball race (23,24) using a suitable extractor. Retain the shims (12).

Note ...

Should difficulty be experienced at this stage, warm the casing and the bearing assembly. Cool the bearing cup using a suitable mandrel and jar the steering box on the bench.

3.19 Remove the circlip and seals (4-8) from the sector shaft housing bore.

3.20 Remove the circlip and seals (11-13) from the input shaft housing bore.

3.21 If necessary, the sector shaft bushes (9) can be removed by using a suitable tube as a drift.

Key to fig 1

1	Sector shaft nut	24	Bearing case and balls
2	Tab washer	25	Circlip
3	Drop-arm	26	Seal torsion bar
4	Seal	27	Rotor
5	Circlip	28	Teflon rings - 3 off
6	Back-up seal	29	Stop-off rings
7	Back-up washer	30	Worm
8	Seal	31	Bearing cage and balls
9	Housing bushes	32	Bearing track
10	Housing	33	Seal
11	Rotor seal	34	Worm adjusting screw
12	Seal washer	35	Lock nut
13	Circlip	36	Rack adjusting screw
14	Fluid line	37	Rack adjust'g screw seal
15	Sector shaft & follower assy	38	Rack pad
16	Seal	39	Screw
17	Bush	40	Piston
18	Cover plate	41	Piston 'O' ring
19	Self locking screws - 4 off	42	Piston Teflon seal
20	Lock nut	43	Cylinder cover seal
21	Bleed screw	44	Cylinder cover
22	Shims	45	Cylinder cover retainer
23	Bearing track		

Cleaning and examination

4 To clean and examine the components proceed as follows:

4.1 Degrease all parts.

4.2 Thoroughly check all parts for signs of excessive wear or damage.

4.3 Provide replacement parts as necessary.

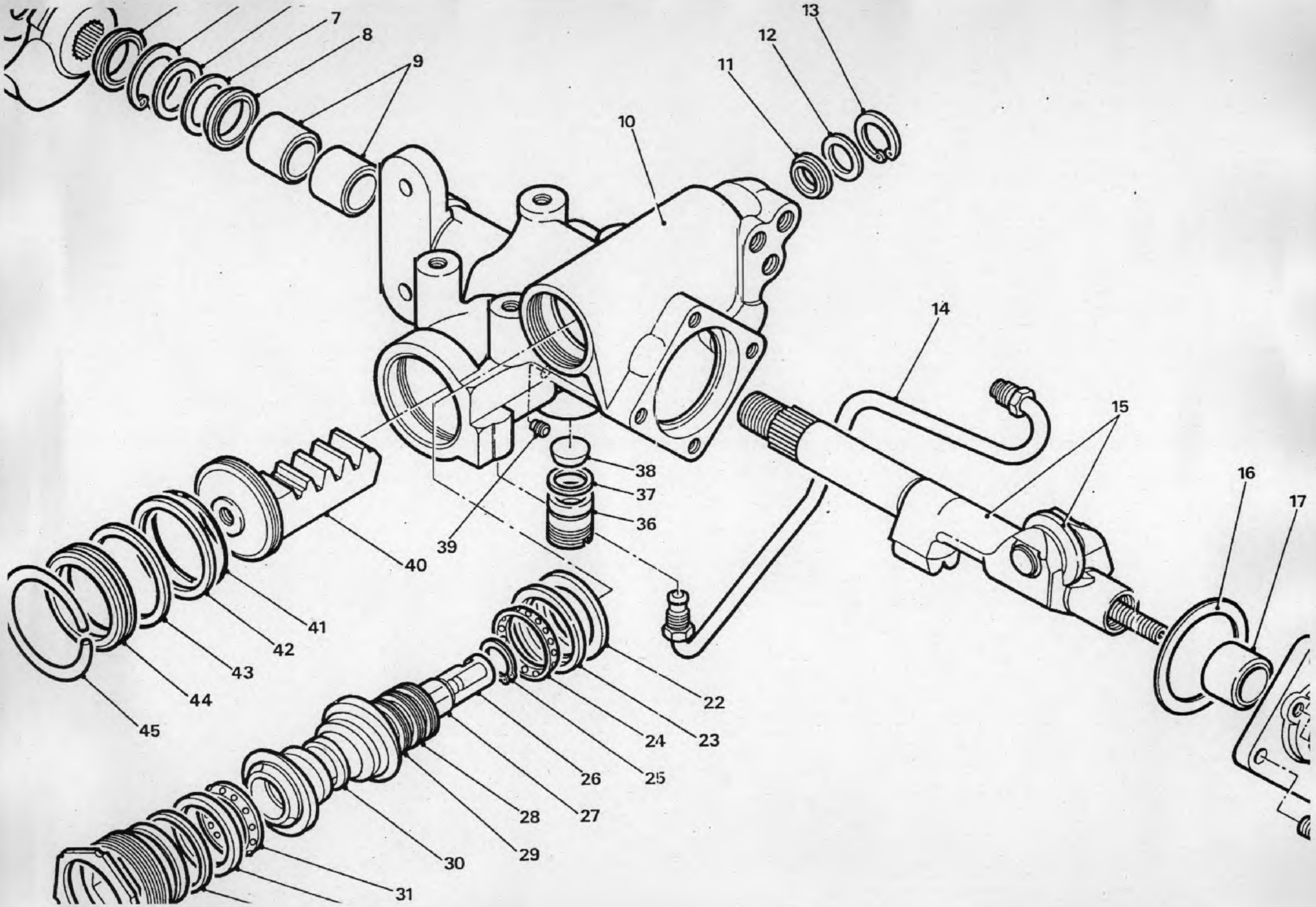
Reassembly

5 To reassemble the steering box proceed as follows:

Note ...

During the following operations cleanliness is essential. Discard all rubber seals and provide replacements. When fitting replacement oil seals, these must be lubricated with recommended fluid. Replace bearings as a set where appropriate.

5.1 If necessary, replace the input shaft needle bearing. The replacement must be fitted squarely in the bore with the numbered face of the bearing uppermost. Carefully push the bearing in until it is flush with the top of the housing bore. Ideally, the bearing will be just clear of the bottom of the housing bore.


7
8
9
10
11
12
13
14
15
16
17
22
23
24
25
26
27
28
29
30
31
36
37
38
39
40
41
42
43
44
45

5.2 Fit the input shaft oil seal (11) lipped side first, into the housing. When correctly seated, the seal backing will lie flat on the bore shoulder.

5.3 Fit the extrusion washer and (12) secure with the circlip (13).

5.4 Fit the sector shaft oil seal (8), lipped side first.

5.5 Fit the extrusion washer (7).

5.6 Fit the dirt seal (6), lipped side last.

5.7 Fit the circlip (5).

5.8 The valve rings (28) should be a loose fit in the valve grooves.

5.9 If required, fit replacement rings (28), using special tool (Serial No 4). Both rings and special tool may be warmed using hot water and then inserted into special tool (Serial No 5) to cool.

Note ...

The special tool will not pass over rings already fitted. These rings must be discarded to allow access then renewed.

5.10 No free movement should exist between the input shaft (27) and the worm (30).

Note ...

Any sign of wear makes it essential that the complete valve and worm assembly is renewed.

5.11 Refit the original shim washer(s) (22) and the inner bearing cap (23). Vaseline can be used as an aid to assembling the bearings.

Note ...

If the original shims are not available, fit shim(s) of 0,76 mm (0.030 in) nominal thickness.

5.12 Fit the inner cage and bearings (24) assembly.

5.13 Fit the valve and worm assembly, using special tool (Serial No 7) to protect the input shaft seal.

5.14 Fit the outer cage and bearings assembly (31).

5.15 Fit the outer bearing cup (32).

5.16 Renew the worm adjuster sealing ring (33) and loosely screw the adjuster (34) into the casing. Fit the locknut (35), but do not tighten.

5.17 Fit a new rubber ring to the piston (41). Warm the white nylon seal (42) and fit this to the piston. Slide the piston assembly into the cylinder with the rack tube outwards. Allow to cool.

5.18 Screw a suitable bolt into the piston (40) head for use as an assembly tool.

5.19 Fit the piston and rack assembly (40) so that the piston is 63,5 mm (2.5 in) approximately from the outer end of the bore..

5.20 Feed in the sector shaft using seal saver 606604 aligning the centre gear pitch on the rack (40) the centre gear tooth on the sector shaft (15) push in the sector shaft, and at the same time rotate the input shaft about a small arc to allow the sector roller to engage the worm.

5.21 Fit the sealing (37) ring to the rack adjuster (36).

5.22 Fit the rack adjuster (36) and thrust pad (38) to engage the rack. Back off a half turn on the adjuster.

5.23 Loosely fit the nylon pad and adjuster grub screw (39) assembly to engage the rack adjuster.

5.24 Fit the sealing ring (16) to the sector shaft cover (18).

5.25 Screw the cover assembly (18) fully on to the sector shaft adjuster screw.

Note ...

The cover (18), bush (17) and seal (16) are supplied as a complete assembly for replacement purposes.

5.26 Position the cover (18) on to the casing and tap home. If necessary back off on the sector shaft adjuster screw to allow the cover to joint fully with the casing.

Note ...

Before tightening the fixings, rotate the input shaft about a small arc to ensure that the sector shaft (15) roller is free to move in the valve worm.

5.27 Fit and tighten the cover fixings (19).

Note ...

The locknut (20) functions also funtions as a fluid seal and must be replaced at overhaul.

5.28 Fit the square section seal (43) to the cover (44).

5.29 Remove the assembly aid bolt and press the cover (44) into the cylinder just sufficient to clear the retainer ring groove.

5.30 Fit the retainer ring (45) to the groove with one end of the ring position d 12 mm (0.5 in) approximately from the extractor hole.

Adjustment

Worm

6 To adjust the worm proceed as follows:

6.1 Turn in the worm adjuster (Fig 2 (4)) until the end-float at the input is almost eliminated.

6.2 Measure and record the maximum rolling distance of the valve and worm assembly, using a spring balance and cord coiled around the torque setting tool R01016.

6.3 Turn in the worm adjuster (4) to increase the figure recorded in Para 6.2 by 1,8 to 2,2 kg (4 to 5 lb) at 31,7 mm (1.250 in) radius to settle the bearing, then back off the worm adjuster (4) until the figure recorded in Para 6.2 is increased by 0,9 to 1,3 kg (2 to 3 lb) only, with locknut (3) tight. Use special tools (Serial Nos 1 and 2).

Sector shaft

7 To adjust the sector shaft proceed as follows:

7.1 Set the worm on centre by rotating the input shaft half the total number of turns from either lock.

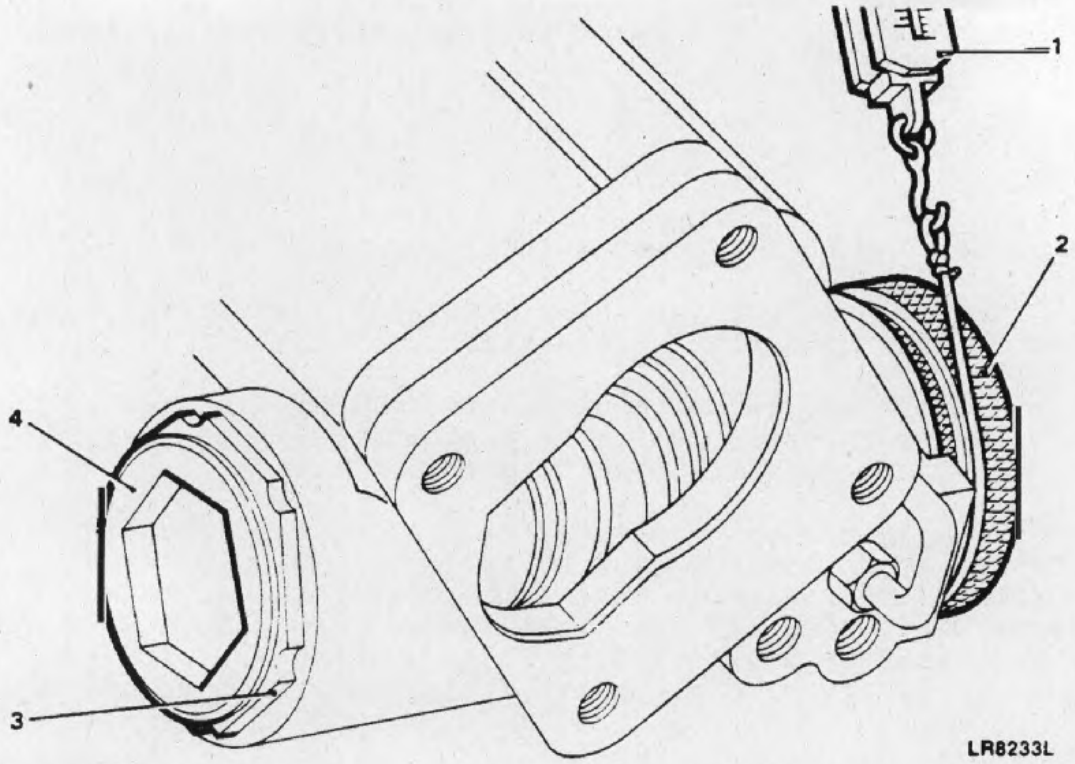
7.2 Rotate the sector shaft adjusting screw (Fig 3 (6)) anti-clockwise to obtain backlash between the input shaft and the sector shaft.

7.3 Rotate the sector shaft adjusting screw (6) clockwise until the backlash is just eliminated.

7.4 Measure and record the maximum rolling resistance at the input shaft, using a spring balance (3), cord and special tool (4) (Serial No 8).

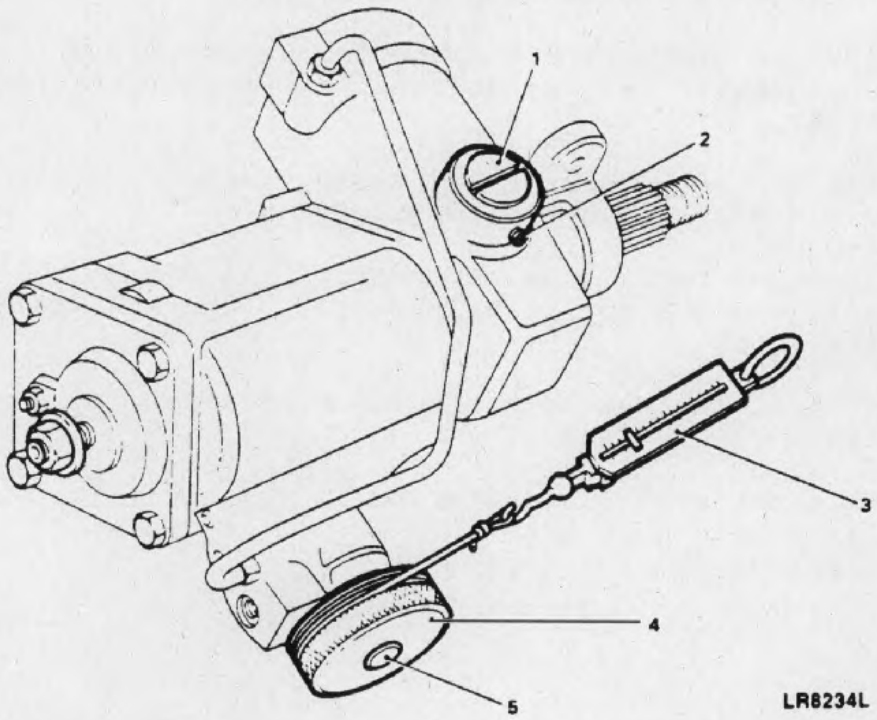
7.5 Hold still the sector shaft adjuster screw (6) and loosely fit a new locknut (7).

7.6 Turn in the sector adjuster screw (1) until the figure recorded in Para 7.4 is increased by 0,9 to 1,3 kg (2 to 3 lb) with the locknut (7) tightened.



1 Spring balance
2 Special tool (Serial No 8)
3 Locknut
4 Worm adjuster

Fig 2 Worm adjustment



1 Rack adjuster
2 Grub screw
3 Spring balance
4 Special tool (Serial No 8)
5 Input shaft
6 Adjuster screw
7 Locknut

Fig 3 Sector shaft adjustment

Rack adjuster

8 To adjust the rack adjuster proceed as follows:

8.1 Turn in the rack adjuster (1) to increase the figure recorded in Para 7.6 by 0,9 to 1,3 kg (2 to 3 lb).

Note ...

The final figure may be less than but must not exceed 7,25 kg (16 lb).

8.2 Lock the rack adjuster (1) in position with the grub screw (2).

Torque peak check

9 To check the torque peak proceed as follows.

9.1 With the input shaft rotated from lock-to-lock, the rolling resistance torque figures should be greatest across the centre position (1½ turns approximately from full lock) and equally disposed about the centre position.

Note ...

The condition depends on the value of shimming fitted between the valve and worm assembly inner bearing cup and the casing. The original shim washer value will give the correct torque peak position unless major components have been replaced.

9.2 With the input coupling shaft (Fig 4 (1)) toward the operator, turn the shaft fully anti-clockwise.

9.3 Check the torque figures obtained from lock-to-lock using a spring balance (2) cord and special tool (3) (Serial No 8).

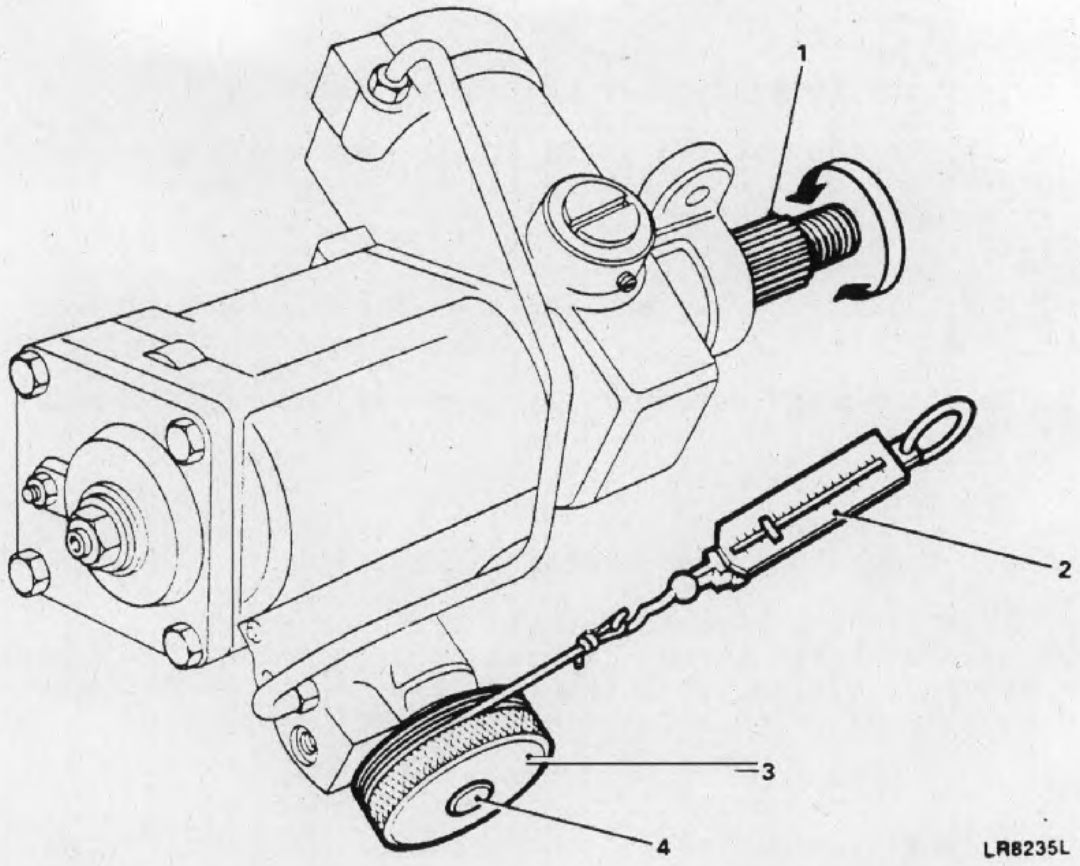
9.4 Note where the greatest figures are recorded relative to the steering position. If the greatest figures are not recorded across the centre of travel (i.e. steering straight-ahead position), adjust as follows:

9.5 For r.h. steering models. If the torque peak occurs before the centre position, subtract from the shim washer value; if the torque peak occurs after the centre position, add to the shim washer value.

9.6 Shim washers are available as follows:
0,03 mm, 0,07 mm, 0,12 mm and 0,24 mm (0.0015 in,0.003 in, 0.005 in and 0.010 in).

Note ...

Adjustment of 0,07 mm (0.003 in) to the shim value will move the torque peak area by ¼ turn approximately on the shaft.



1 Sector shaft
2 Spring balance
3 Spec. tool (Serial No 8)
4 Input shaft

Fig 4 Torque peak check

Refitting

10 To refit the steering box proceed as follows.

10.1 Fit the drop arm (Fig 1 (3)) to the steering box using a new tab washer (2). Tighten the nut (1) to the correct torque and bend over tab.

10.2 Refit the steering box to the vehicle refer to Cat 522 Chap 7-2.

STEERING PUMP

Removal

11 Disconnect the battery and remove the pump from the vehicle refer to Cat 522 Chap 7-2.

Dismantling

12 To dismantle the pump carry out the following.

12.1 Clean the exterior of the pump and remove the drive pulley.

12.2 Remove from the outlet port, the union nut (Fig 5 (4)), two 'O' rings (5,6), spring (7) and valve (8).

12.3 Secure the special tool (Serial No 9) in a vice and insert the pump (Fig 6 (1)) in the tool (2).

12.4 Fit the three 6mm bolts (3) through the tool into the pump hub. Tighten the bolts evenly until the cover (Fig 5 (9)) is released from the sealing ring and can be removed from the pump.

12.5 Remove the sealing ring (18) and secure the pump in a vice.

12.6 Remove the swarf collection magnet (10) and the four bolts and lift off the valve housing.

12.7 Remove the pump outer member (12) and the rollers (14).

12.8 Release the spring ring (19) from the groove behind the vane and push it back towards the drive shaft housing (11).

12.9 Move the vane (15) back to reveal and remove the spring ring (16) from the front of the vane.

12.10 Remove the vane (15) and drive key (20) and rear spring ring (19).

12.11 Withdraw the drive shaft (1).

12.12 Prise out the oil seal (2) and if necessary press-out the bush (3) from the drive shaft housing.

12.13 Clean and examine all parts for wear replace as necesssary.

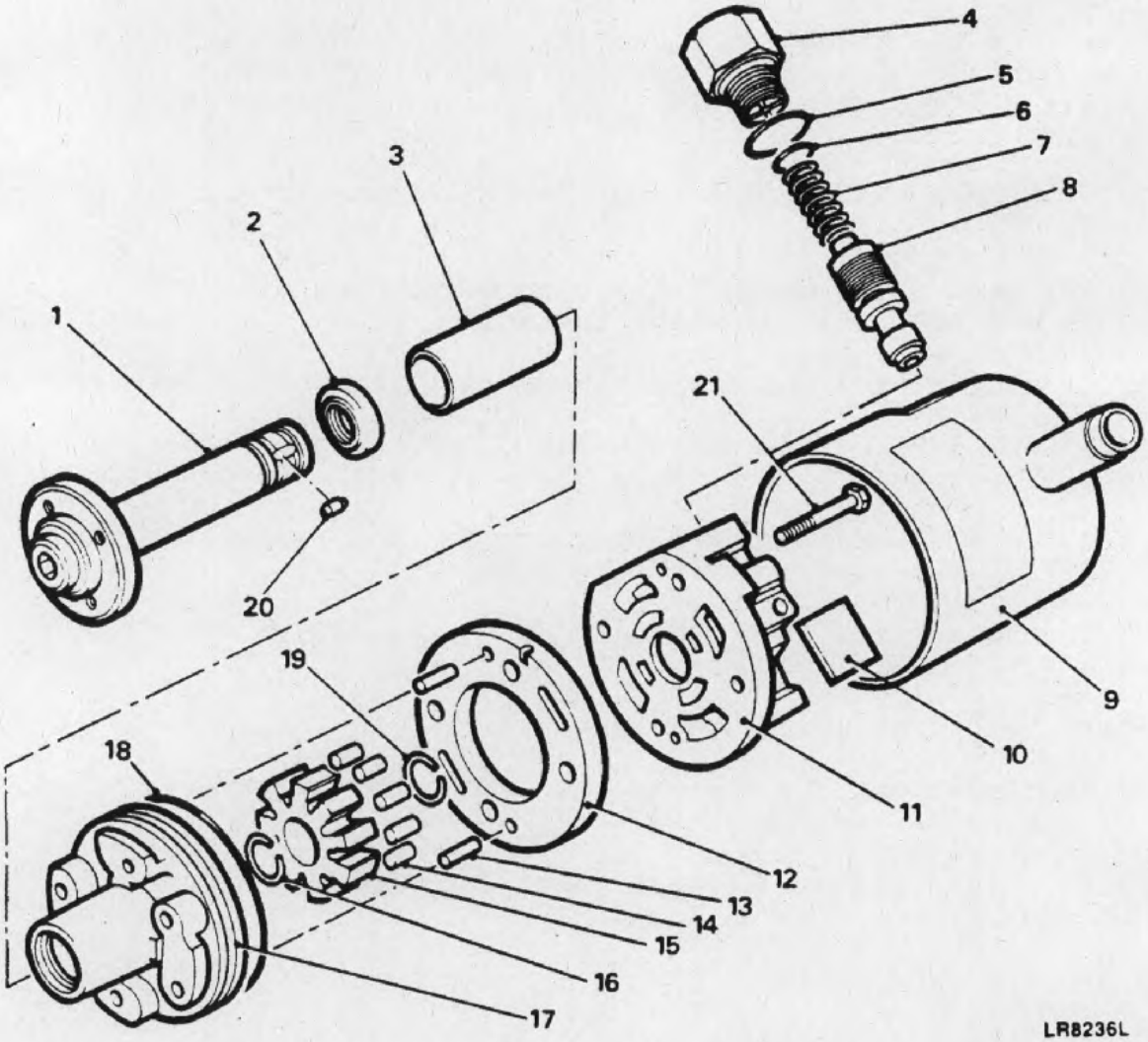
Cleaning and examination

13 To clean and examine the components proceed as follows:

13.1 Degrease all parts.

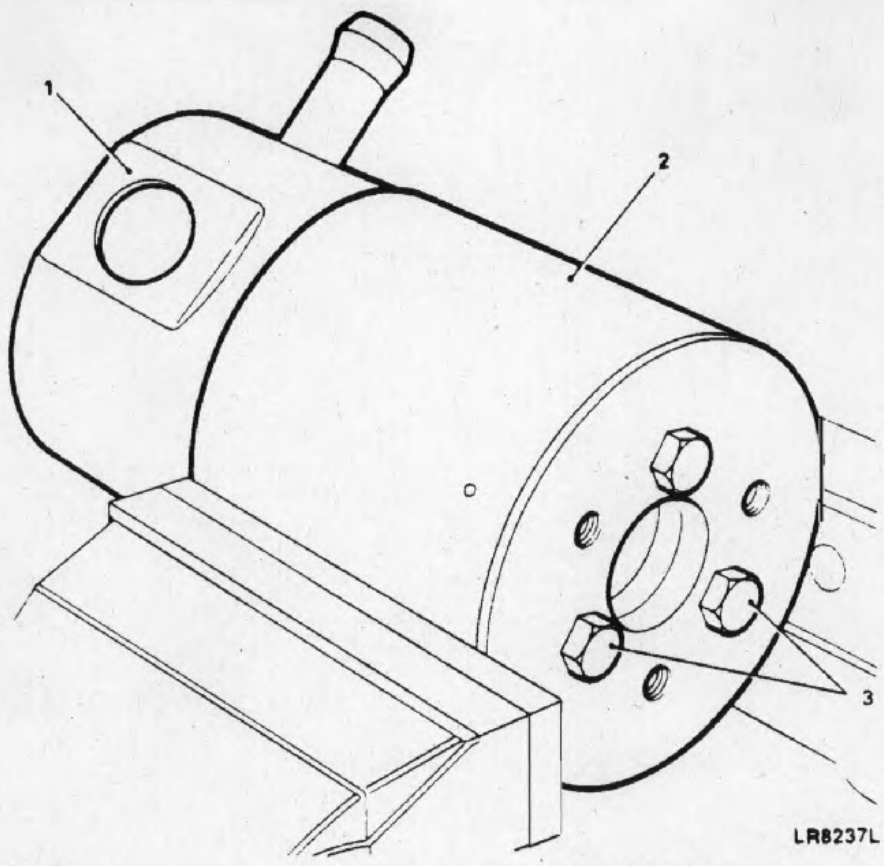
13.2 Thoroughly check all parts for signs of excessive w ar or damage.

13.3 Provide replacement parts as necessary.



1	Drive shaft & flange assy.	11	Valve housing
2	Oil seal	12	Pump outer member
3	Drive shaft bush	13	Locating dowels
4	Outlet pipe union pipe	14	Vane rollers
5	Large 'O' ring seal	15	Vane
6	Small 'O' ring	16	Outer spring ring
7	Spring	17	Drive shaft housing
8	Valve assembly	18	Pump cover 'O' ring seal
9	Pump cover	19	Inner spring ring
10	Magnet	20	Drive shaft key
		21	Pump assembly bolts

Fig 5 Steering pump



1 Pump
2 Tool
3 Bolts

Fig 6 Pump casing removal

Reassembly

14 To reassemble the steering pump proceed as follows:

Note ...

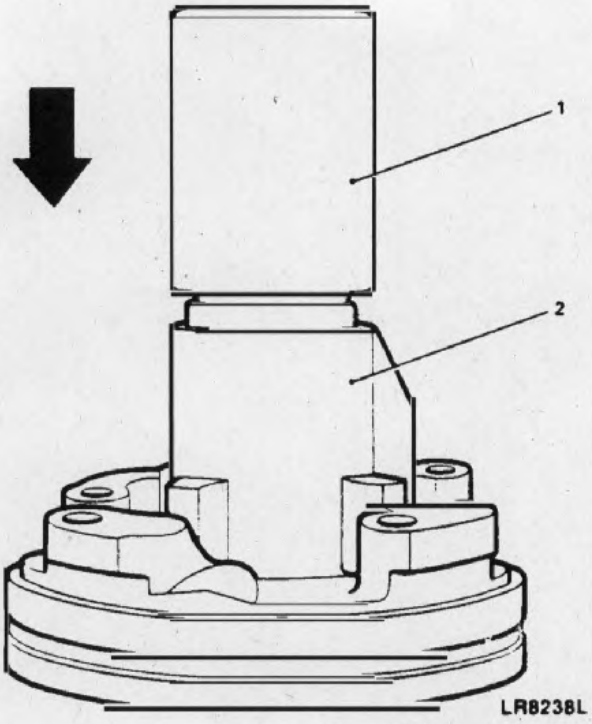
During the following operations cleanliness is essential. Discard all rubber seals and 'O' rings, provide replacements. When fitting replacement oil seals, these must be lubricated with recommended fluid.

14.1 If removed, press in a new bush (3) in the drive shaft housing (11) to 5mm below the machined face.

14.2 Using the seal replacer part of special tool (Serial No 9), (Fig 7 (1)), drive in a new seal, lip side leading, into the drive shaft housing (2).

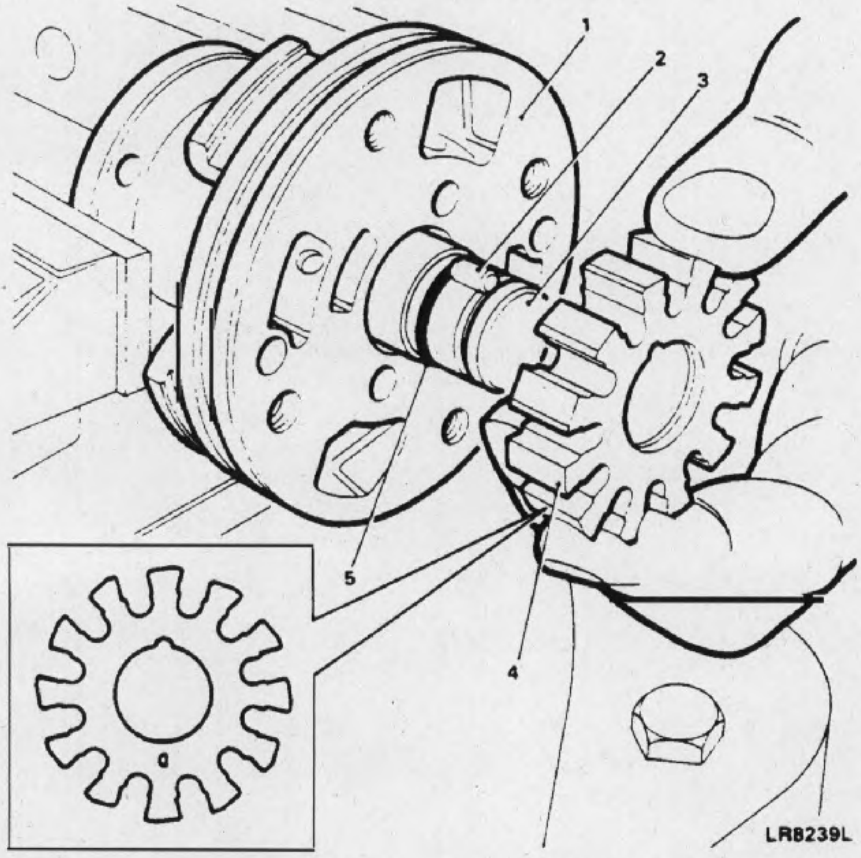
14.3 Wrap a smooth surface tape round the end of the drive shaft to protect the seal lip.

14.4 Lubricate the seal (Fig 5 (27)) lip with power steering fluid and insert the drive shaft (1).



1 Tool
2 Drive shaft housing

Fig 7 Pump oil seal



1 Housing
2 Key
3 Shaft
4 Vane
5 Inner spring ring

Fig 8 Pump vane assembly

14.5 Fit the inner spring ring (Fig 8 (5)) to the shaft (3) but not into the groove at this stage.

14.6 Fit the drive key (2) and the vane (4) with the arrow towards the drive shaft housing (1) and with the raised leading edge of the vanes facing left.

14.7 Fit the outer spring ring (Fig 5 (16)) to the groove then slide the inner spring (19) into the rear groove.

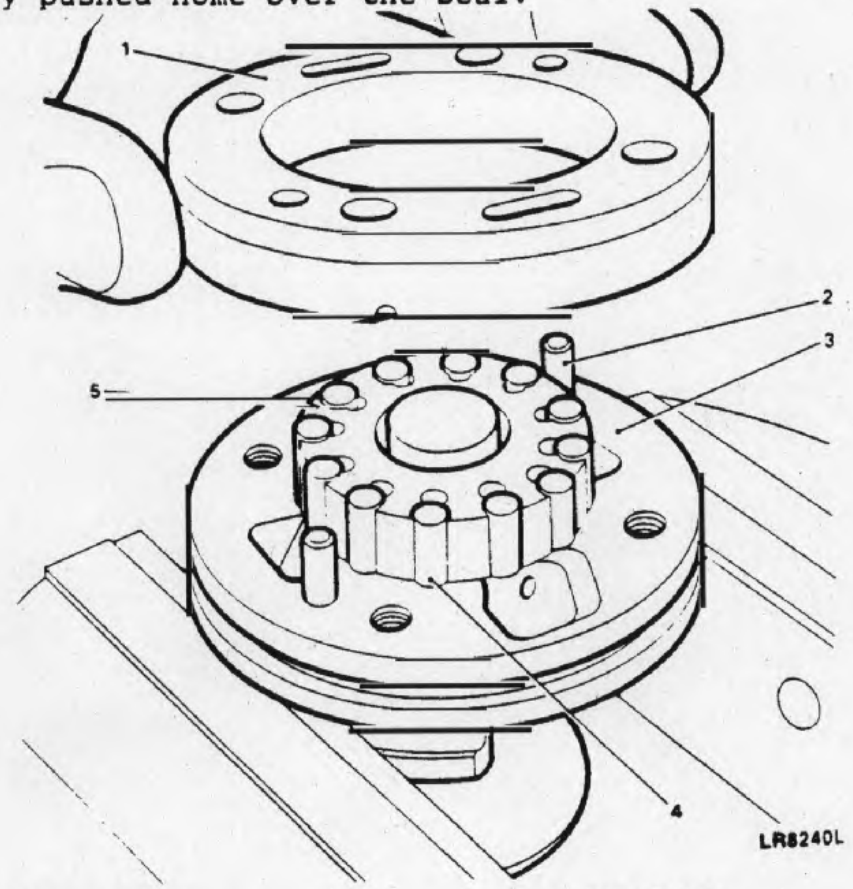
14.8 Fit the two dowels to (Fig 9 (2)) to the drive shaft housing (3).

14.9 Insert the twelve rollers (4) in the vane (5) and fit the pump outer member (1) with the milled cut towards the drive shaft housing.

14.10 Fit the valve housing (Fig 5 (11) and secure with the four bolts (21). Check that the pump revolves freely.

14.11 Insert the magnet (10) into the slot provided.

14.12 Lubricate and fit the large 'O' ring (18) and fit the cover (9) ensuring that the hole for the valve is aligned with the outlet port in the valve housing (11) before the cover is finally pushed home over the seal.



1 Outer member
2 Dowels
3 Housing
4 Rollers
5 Vane

Fig 9 Pump drive shaft housing

14.13 Lubricate and fit the valve (8), spring (7), large (5) and small (6) 'O' rings and the union nut (4).

14.14 Finally, fit the drive pulley with the three bolts and washers.

Refitting

15 To refit the steering pump proceed as follows.

15.1 Refit the steering pump to the vehicle refer to Cat 522 Chap 7-2.

Chapter 12-3

WINTERISED COOLING SYSTEM

BASE REPAIRS

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the cooling system fitted to Land Rover 2.5 litre diesel winterised 90 and 110 vehicles.

GENERAL

2 Land Rover winterised 90 and 110 vehicles have been specifically designed to operate in extreme sub-zero climatic conditions. In order to meet the required specification a 'Webasto' DBW 46 water heater has been incorporated as an aid to the engine cold start procedure.

Water heater unit

3 It is permissable to perform the dismantling procedures listed in Para 5.2 to 5.6 without the necessity for water heater removal. The vehicle battery must be disconnected prior to work commencing. Before performing dismantling procedures listed in Para 5.5 and 5.6 it will be necessary to reduce excess cooling system pressure by opening the radiator filler cap.

WARNING ...

DO NOT REMOVE THE RADIATOR OR EXPANSION TANK FILLER CAPS WHEN THE ENGINE IS HOT. THE COOLING SYSTEM IS PRESSURISED AND THE RAPID RELEASE OF HOT COOLANT COULD RESULT IN PERSONAL INJURY.

Removal

4 For removal of water heater refer to Cat 522 Chap 12-3.

Dismantling

5 To dismantle the water heater components proceed as follows:

5.1 Electronic control unit. Withdraw the electrical connectors (Fig 1 (35)) from the base of the control unit (1). Withdraw the screws (2) and remove the control unit from the support bracket.

5.2 Glow plug. Disconnect the glow plug electrical connection (3). With the use of a 19 mm socket spanner, remove the glow plug (4) from the burner head.

5.3 Flame detector. Remove the electrical protection cap (7) and disconnect the plug connections. Loosen the retaining screw (36) and with the aid of pliers, withdraw the flame detector (37) complete with 'O' ring (38) from the burner head.

5.4 Part load resistor. Disconnect the electrical plug connections. Withdraw the self-tapping screw (10) and remove the part load resistor (12) from the bracket (11).

5.5 Temperature sensor. Disconnect the electrical plug connections. Remove the temperature sensor (6) complete with 'O' ring (5) from the heat exchanger.

5.6 Manual re-set overheat fuse. Disconnect the electrical plug connections. Remove the overheat fuse (8) complete with 'O' ring (9) from the heat exchanger.

5.7 Circulation pump. Disconnect the electrical plug connections. Remove the hose clip (15) and withdraw the heat exchanger feed hose (14) from the circulation pump (17). Withdraw the clamp screws (19) and remove the circulation pump and clamp.

5.8 Dosing pump. Disconnect the electrical plug connections. Remove the fuel feed pipe (23) from the dosing pump (16). Withdraw the clamp screw (18) and remove the dosing pump and clamp from the support bracket. If necessary, dismantle the dosing pump and remove the membrane damper (42).

5.9 Air intake silencer. Remove the plastic clip (30). Slide the air intake silencer (34) off the bracket (22).

5.10 Combustion air fan. Disconnect the electrical plug connections. Remove the screws (25) and withdraw the combustion air fan (26) complete with gasket ring (24) from the burner head.

5.11 Cover assembly and burner matting. Release the clip (27) and remove the diesel fuel feed pipe (23) from the end cover (29). Release the spring clips (28) from the burner head. With the aid of two screwdrivers separate and remove the end cover. Withdraw the 'O' ring (31), gaskets (32), and burner matting (33) from the burner head.

5.12 Burner head and tube. Open the V-clamp (21) and with aid of two screwdrivers separate and withdraw the burner head and tube (20) from the heat exchanger.

5.13 Heat exchanger. Ensure that the temperature sensor and overheat fuse have been removed (Para 5.5 and 5.6). With the aid of two screwdrivers separate and withdraw the heat pipe (40) complete with gasket ring (39) from the heat exchanger (41).

Inspection, repair and replacement

6 To inspect, repair and replace the water heater components proceed as follows:

6.1 Electronic control unit. Clean all contact surfaces thoroughly. A defective electric control unit cannot be repaired and must be completely replaced.

6.2 Glow plug. Inspect the glow plug coil. Evidence of carbon deposits may indicate combustion irregularities. In such circumstances the combustion values should be checked and adjusted accordingly (Para 8). If necessary, completely replace the glow plug.

6.3 Flame detector. Ensure that there are no remnants of the flame detector in the combustion chamber. If necessary, replace the 'O' ring. A defective flame detector cannot be repaired and must be completely replaced.

6.4 Part load resistor. Test the resistance value with suitable equipment when the heater is off. A defective part load resistor cannot be repaired and must be completely replaced.

6.5 Temperature sensor. If necessary, replace the gasket ring. A defective temperature sensor cannot be repaired and must be completely replaced.

6.6 Manual re-set overheat fuse. If necessary replace the gasket ring. A defective overheat fuse cannot be repaired and must be completely replaced.

6.7 Circulation pump. Check the circulation pump housing for leaks. If a full flow of water has not been present the pump will run at higher speeds and with increased operating noise causing damage to internal seals. A defective circulation pump cannot be repaired and must be completely replaced.

6.8 Dosing pump. A defective dosing pump cannot be repaired and must be completely replaced. However, first replace the membrane damper only, if excessive fuel is supplied or if high levels of combustion noise are apparent.

Note ...

Do not lengthen the hose between the dosing pump and membrane damper.

6.9 Combustion air fan. If necessary, replace the gasket ring. A defective combustion air fan cannot be repaired and must be completely replaced.

6.10 Air intake silencer. Check the air intake silencer for free passage and external damage. A damaged or very soiled air intake silencer must be completely replaced.

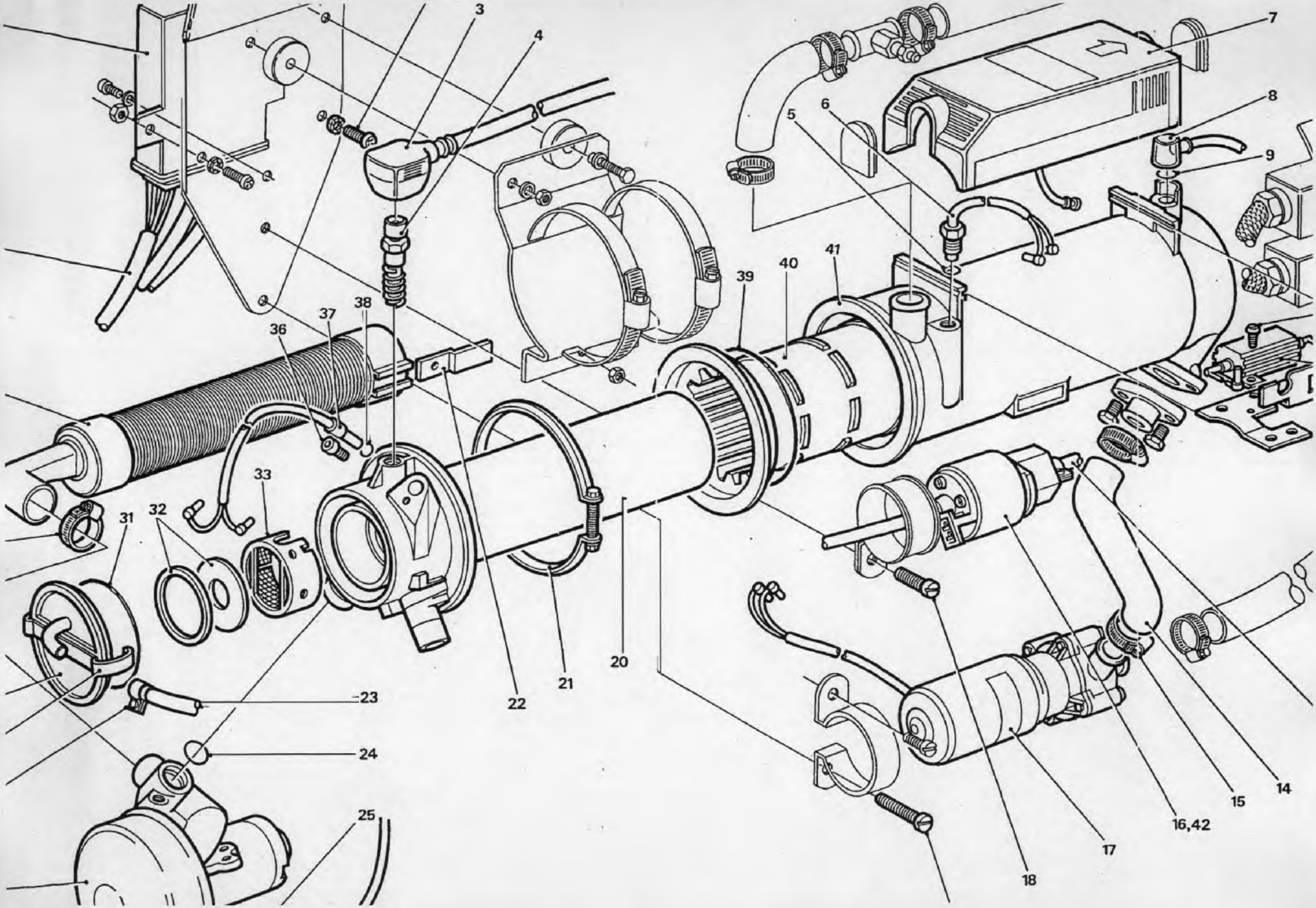
6.11 Cover assembly and burner matting. Check the burner matting, 'O' ring and gaskets for visible damage and replace if necessary. Ensure that there are no remnants of the burner matting in the combustion chamber.

6.12 Burner head and tube. Clean all parts thoroughly and if necessary replace the burner matting.

6.13 Heat exchanger. Remove the combustion residues from the heat pipe with a water jet and brush. If necessary, replace the gasket ring.

Key to fig 1

1	Control unit	22	Bracket
2	Screw	23	Fuel feed pipe
3	Glow plug connector	24	Gasket ring
4	Glow plug coil	25	Screw
5	'O' ring	26	Combustion air fan
6	Temperature sensor	27	Hose clip
7	Protection cap	28	Spring clip
8	Overheat fuse	29	End cover
9	'O' ring	30	Plastic clip
10	Screw	31	'O' ring
11	Bracket	32	Gaskets
12	Part load resistor	33	Burner matting
13	Fuel feed pipe	34	Air intake silencer
14	Water feed hose	35	Electrical connectors
15	Hose clip	36	Screw
16	Dosing pump	37	Flame detector
17	Circulation pump	38	'O' ring
18	Screw	39	Gasket ring
19	Screw	40	Heat pipe
20	Burner head and tube	41	Heat exchanger
21	V-clamp	42	Membrane damper


3
4
7
6
5
8
9
41
40
39
38
37
36
33
32
31
23
24
25
22
21
20
18
17
16,42
15
14

Assembly

7 To reassemble the water heater components proceed as follows:

7.1 Heat exchanger. Apply a heat resistent sealing paste to the front face of the heat pipe (Fig 1 (40)). Ensure the gasket ring (39) is correctly located and fit the heat pipe nose into the groove of the heat exchanger (41).

7.2 Burner head and tube. Apply a heat resistent sealing paste to the burner head (20) and heat exchanger matting faces. Insert and position the burner head and tube into the heat exchanger and secure with the V-clamp (21).

7.3 Cover assembly and burner matting. Carefully insert the burner matting (33), gaskets (32) and 'O' ring (31) into the burner head in the sequence illustrated. Fit the end cover (29), aligning with the location point on the burner head and secure with spring clips (28).

CAUTION ...

Do not force the burner matting too far into the burner head. Starting difficulties will occur if the burner matting is too close to the ignition coil.

WARNING ...

IN ORDER TO AVOID A FIRE RISK, IT IS ESSENTIAL THAT THE END COVER SPRING CLIPS ARE IN GOOD ORDER AND ARE FITTED SECURELY TO THE BURNER HEAD.

7.4 Air intake silencer. Slide the air intake silencer (34) on to the bracket (22). Locate the end tube with the air circulation pump and secure with plastic clip (30).

7.5 Combustion air fan. Lubricate and fit the 'O' ring (24) to the combustion air fan (26). Locate and secure the combustion air fan with the screws (25). Connect the electrical plug connections ensuring polarity is not reversed.

Note ...

After replacing the combustion air fan or dosing pump the carbon dioxide exhaust emission value must be measured using suitable equipment and adjusted accordingly (Para 8).

7.6 Dosing pump. Locate and secure the dosing pump (16) with the clamp screws (18). Fit the fuel feed pipe (23) to the dosing pump and also secure to the burner end cover connection with clip (27). Connect the electrical plug connections.

Note ...

After replacing the dosing pump or combustion air fan the carbon dioxide exhaust emission value must be measured using suitable equipment and adjusted accordingly (Para 8).

7.7 Circulation pump. Locate and secure the circulation pump (17) with the clamp screws (19). Fit the f ed hose (14) to the heat exchanger and secure with clip (15). Connect the electrical plug connections ensuring polarity is not reversed.

7.8 Manual re-set overheat fuse. Fit the 'O' ring (9) to the overheat fuse (8) and screw by hand into the heat exchanger.

7.9 Temperature sensor. Fit the 'O' ring (5) to the temperature sensor (6). Fit the temperature sensor to the heat xchanger and tighten to a torque of 0,5 Nm (0.4 lbf ft).

7.10 Part load resistor. Coat the contact face of the part load resistor (12) with heat conduction grease. Connect the electrical plug connections and secure the part load resistor with screw (10).

7.11 Flame detector. Place the 'O' ring (38) over the tip of the flame detector (37). Force the flame detector into the burner head and secure with screw (36).

7.12 Glow plug. Coat the thread of the glow plug (4) with graphite grease. Fit the glow plug to the burner head using a 19 mm socket spanner to a torque of 30 Nm (22 lbf ft).

7.13 Electronic control unit. Locate the electronic control unit (1) to the support bracket and secure with screws (2). Connect the electrical plug connections.

Carbon dioxide emission adjustment

8 After changing the combustion air fan or dosing pump, the carbon dioxide emission value must be measured using suitable equipment and if necessary re-adjusted as follows:

8.1 Refit the assembled water heater to the vehicle (Cat 522 Chap 18.1).

8.2 Before measuring, allow the heater to run for approximately five minutes.

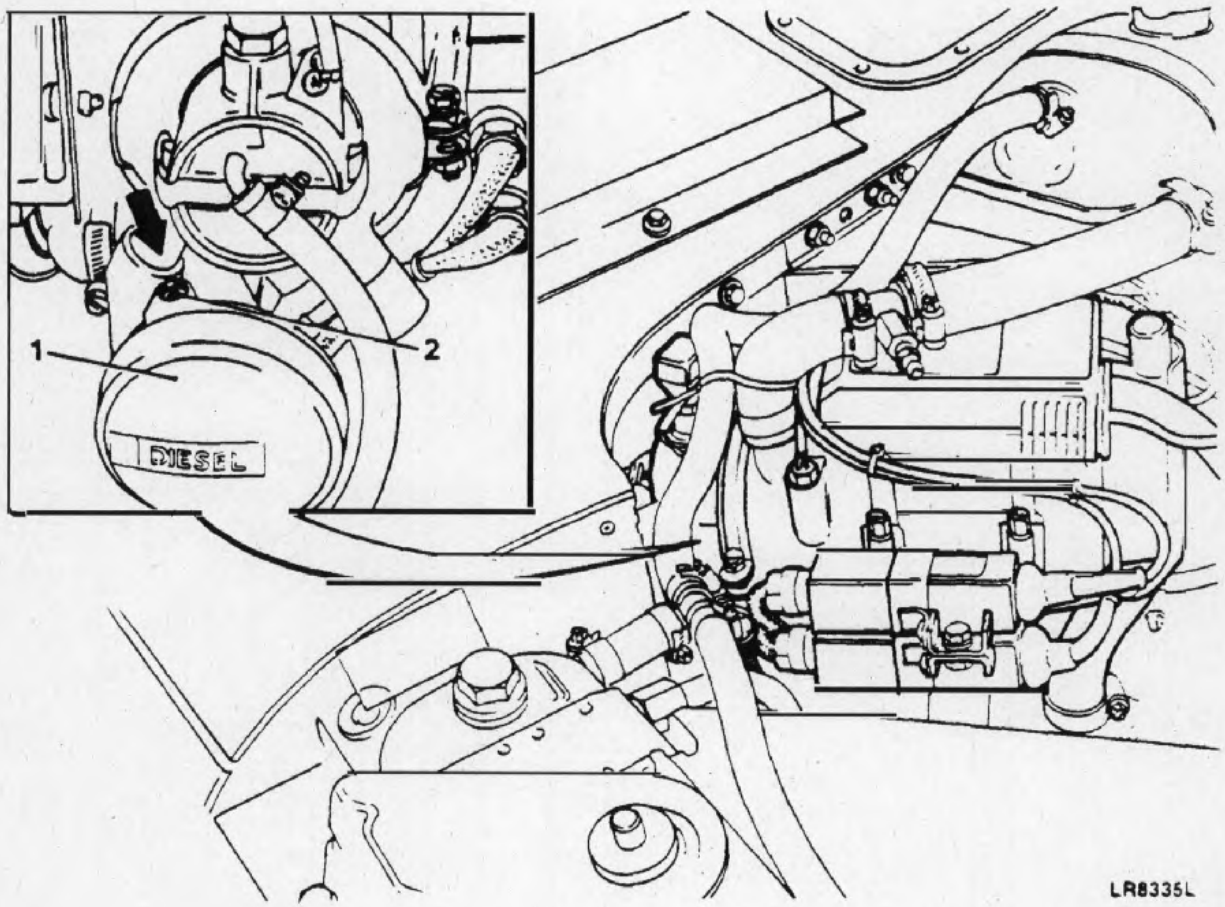
8.3 The carbon dioxide value is reduced by rotating the combustion air fan adjustment screw (Fig 2 (2)) in a clockwise direction.

8.4 For coarse adjustment, turn the screw fully clockwise and then back off one turn.

Carbon dioxide value: 11 + 0.5/-1.0% (at nominal voltage)

Refitting

9 For refitting the water heater to the vehicle refer to Cat 522 Chap 12-3.



1 Combustion air fan 2 Adjustment screw

Fig 2 Adjusting carbon dioxide emission value

Chapter 13

ELECTRICAL SYSTEMS

CONTENTS

INTRODUCTION

1 This Chapter gives the Failure diagnosis for the electrical systems fitted to Land Rover 90 and 110 vehicles.

2 The Chapter has been Sub-chaptered as follows to accomodate the 12 Volt electrical system fitted to General Cargo (GC) vehicles and the 12/24 Volt electrical system fitted to Fitted For Radio (FFR).

General

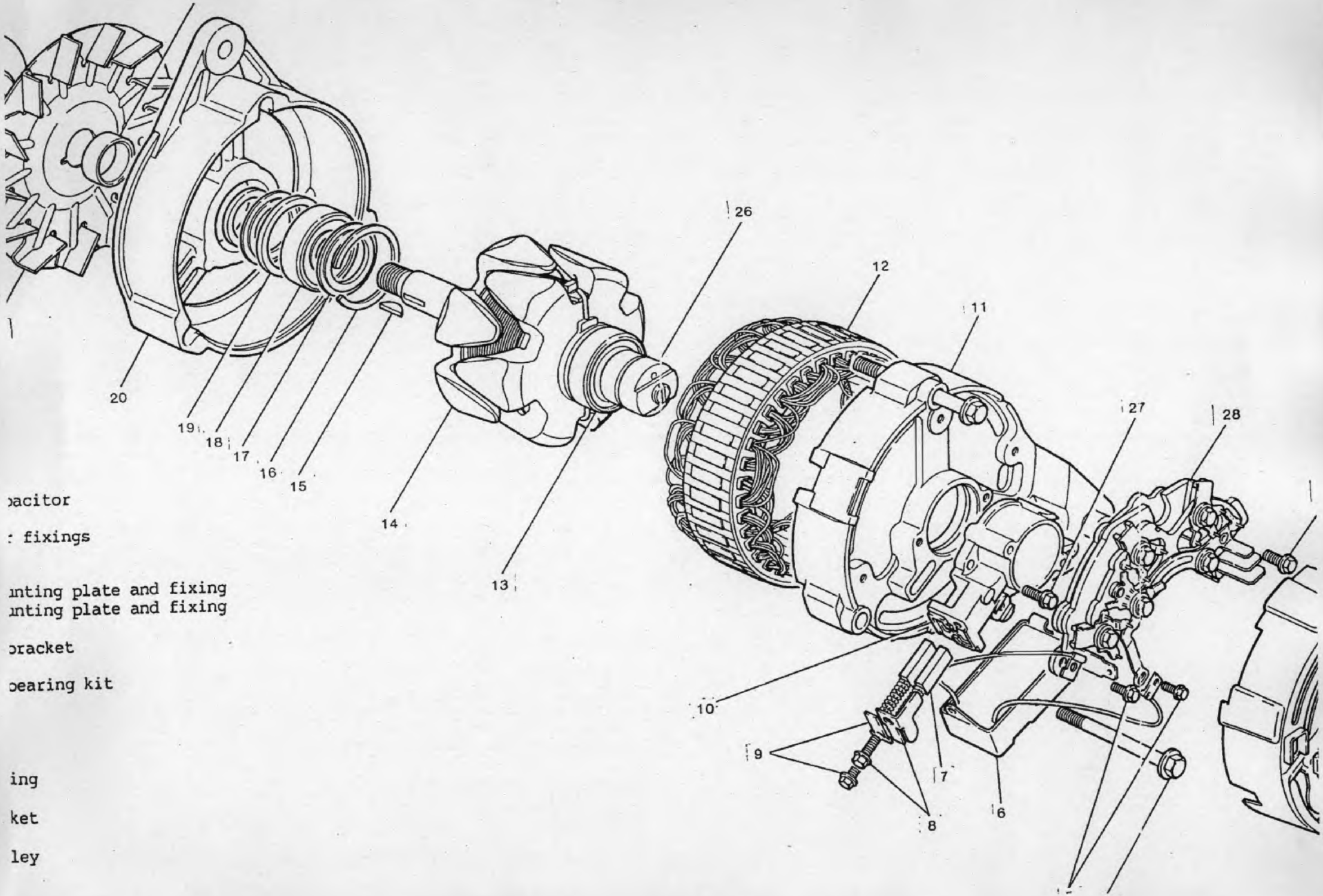
3 The information given is applicable to both left and right hand drive vehicles.

LIST OF CHAPTERS

Chapter 13-1

12 VOLT ELECTRICAL SYSTEM

CONTENTS



ɔacitor

: fixings

ınting plate and fixing
ınting plate and fixing

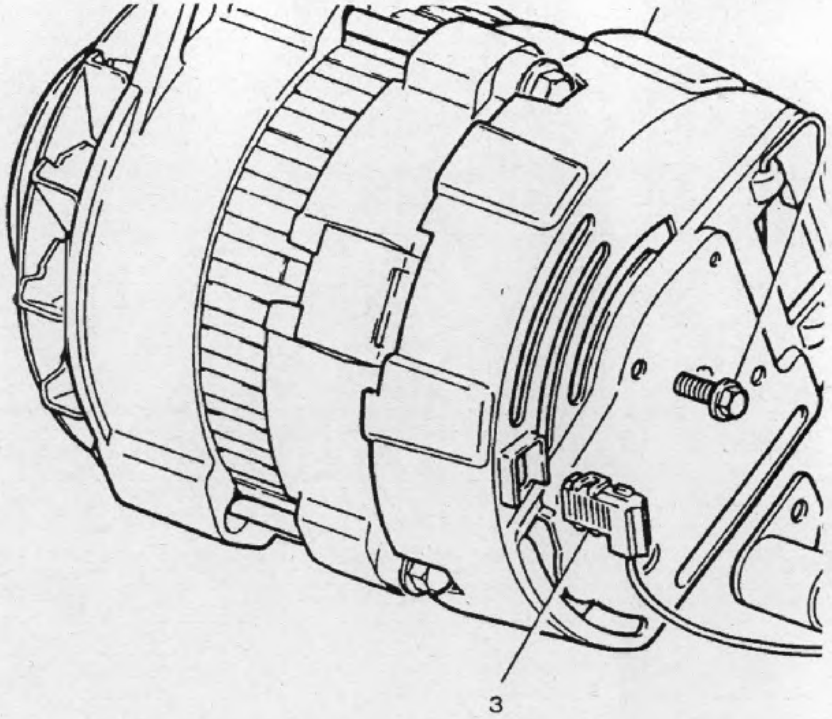
ɔracket

ɔearing kit

ing

ket

ley



1 Suppresion capacitor fixing screw
2 Suppresion capacitor
3 Lead for suppresion capacitor
4 Cover
5 Cover fixing screws

Fig 2 Removing the suppression capacitor

INTRODUCTION

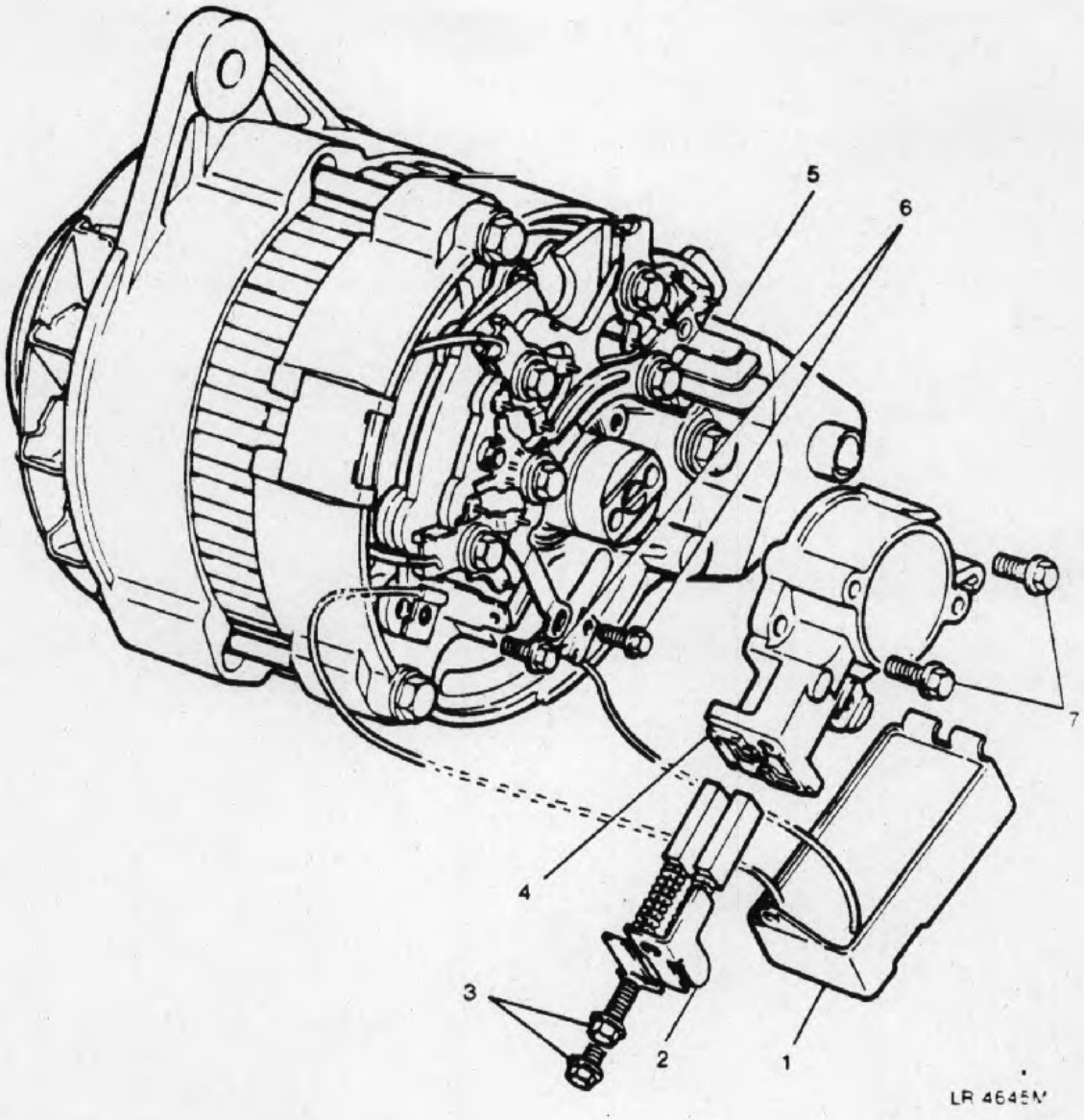
1 This Chapter details level 4 repairs for the 12 volt electric fitted to Land Rover 90 and 110 vehicles. The information given i to both left and right hand vehicles.

ALTERNATOR OVERHAUL (A115)

Removal

2 Remove the alternator from the engine (Cat 522 Chapter 13-1).

Dismantling



1 Brush box assembly
2 Brush mounting plate
3 Regulator to brush box fixing screws
4 Brush box
5 Slip ring end bracket
6 Regulator lead fixing screws
7 Brush box fixing screws

Fig 3 Removing the regulator and brushbox

3.2 Disconnect the lead (3) from the rectifier assembly and remove the capacitor (2).

3.3 Remove the two retaining screws (5) and lift off the cover (4).

3.4 Removing the regulator. Disconnect the regulator leads via the two screws (Fig 3 (6)).

Note ...

Observe the arrangement of the brush box connections.

3.5 Remove the scr w (3) securing the regulator (1) to the brush box (4) and withdraw the r gulator. Note that this scr w also s cur s the inner brush mounting plate (2) in position.

3.6 Removing the brush box assembly. Remove the screw (3) retaining the outer brush mounting plate.

3.7 Withdraw both brushes.

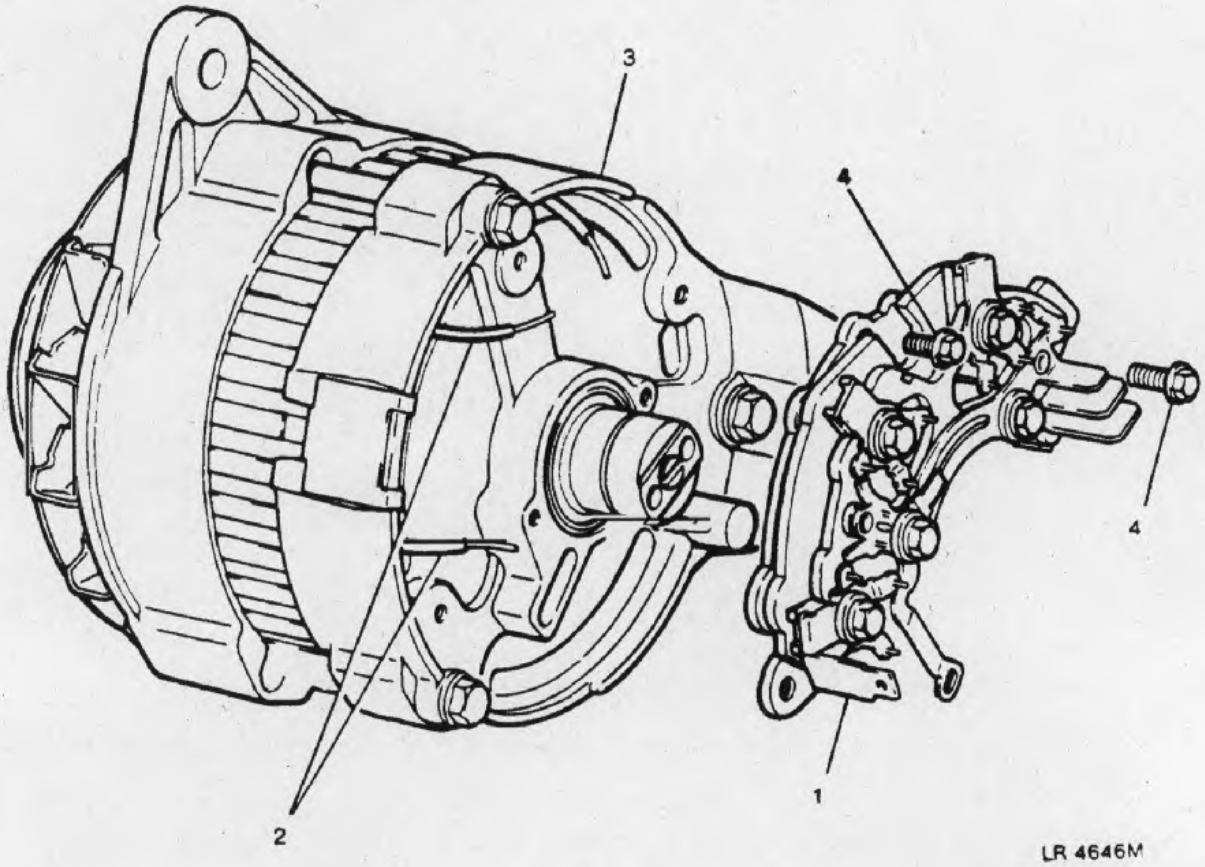
3.8 Remove the two screws (7) securing the brush box to the slip ring end bracket (5) and lift off the brush box (4).

3.9 Removing the rectifier assembly. Securely clamp the alternator and release the stator winding cable ends (Fig 4 (2)) from the rectifier (1) by applying a hot soldering iron to the terminal tags of the rectifier. When the solder melts prise out the cable end.

Note ...

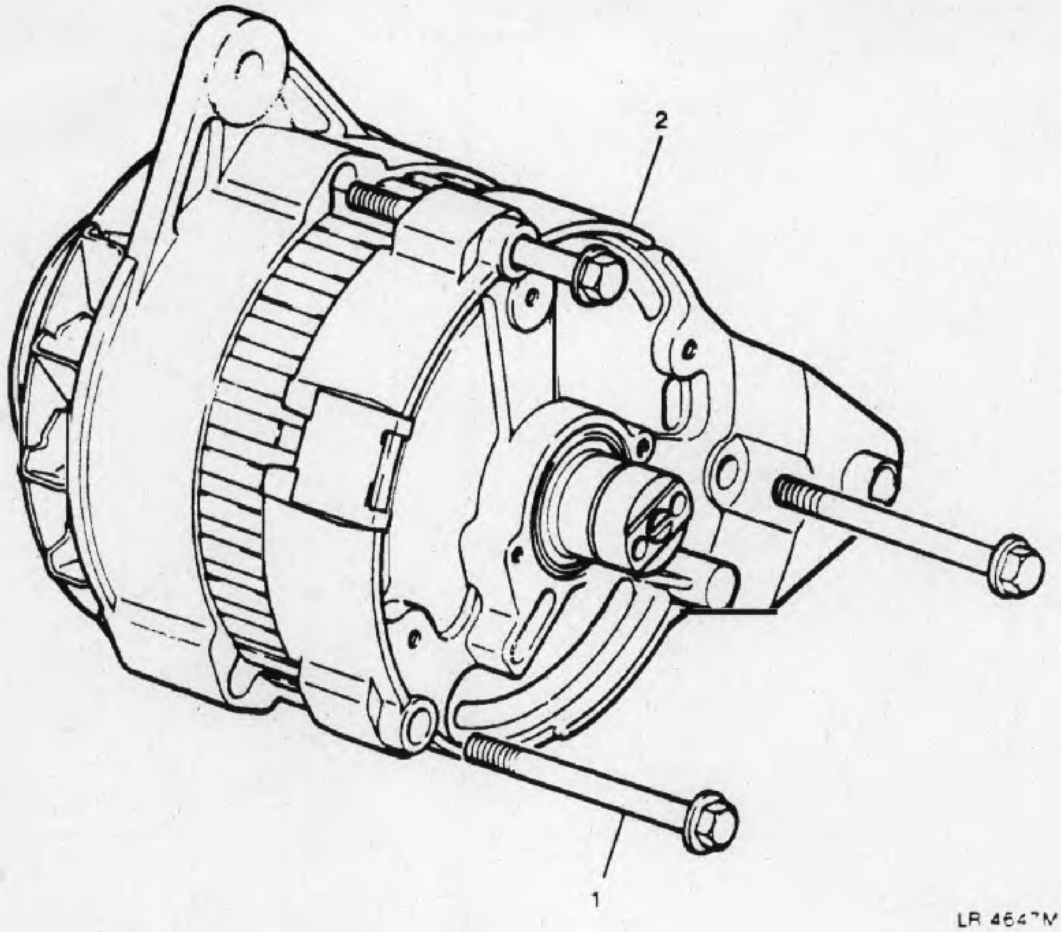
Further dismantling of the rectifier is not required.

3.10 Remove the two remaining screws (4) securing the rectifier assembly to the slip ring end bracket and lift off the rectifier.



1 Rectifier
2 Stator winding cable ends
3 Slip ring end bracket
4 Rectifier fixing screws

Fig 4 Removing the rectifier



1 Fixing bolts
2 Slip ring end bracket

Fig 5 Removing the slip ring end bracket

3.11 Removing the slip ring end bracket. Securely clamp the alternator and remove the three fixing bolts (Fig 5 (1)).

3.12 Lift off the bracket (2). If necessary tap under each fixing bolt with a soft mallet.

3.13 Removing stator assembly. Note the position of the stator output leads relative to the alternator fixing lugs and then lift the stator (Fig 6 (1)) from the drive end bracket (2).

3.14 Separating drive end bracket and rotor. Remove the shaft nut (Fig 7 (7)) and spring washer (6) also the pulley (5), fan (4), woodruff key (2) and spacer (8).

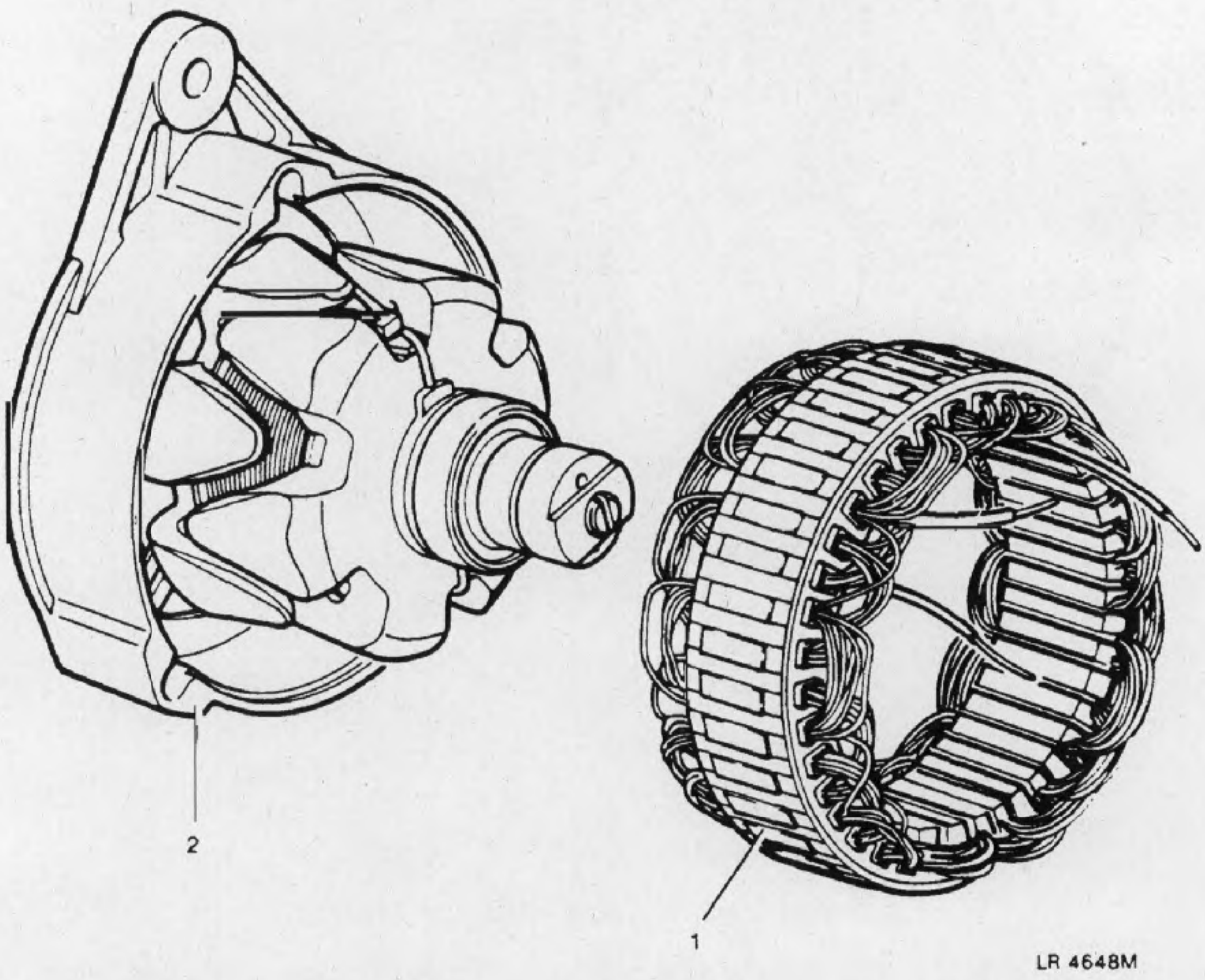
3.15 Use a press to remove the rotor shaft (1) from the drive end bearing (10) then remove the washers (9,11) and spring washer (12).

3.16 Check all components as detailed under bench testing and renew any parts that are unsatisfactory. If necessary the slip rings and/or the slip ring end bearing on the rotor shaft can be replaced. To renew the bearing, both slip rings must be removed as follows:

3.17 Unsolder outer slip ring connection (Fig 8 (5)) and gently prise the slip ring (1) off the shaft.

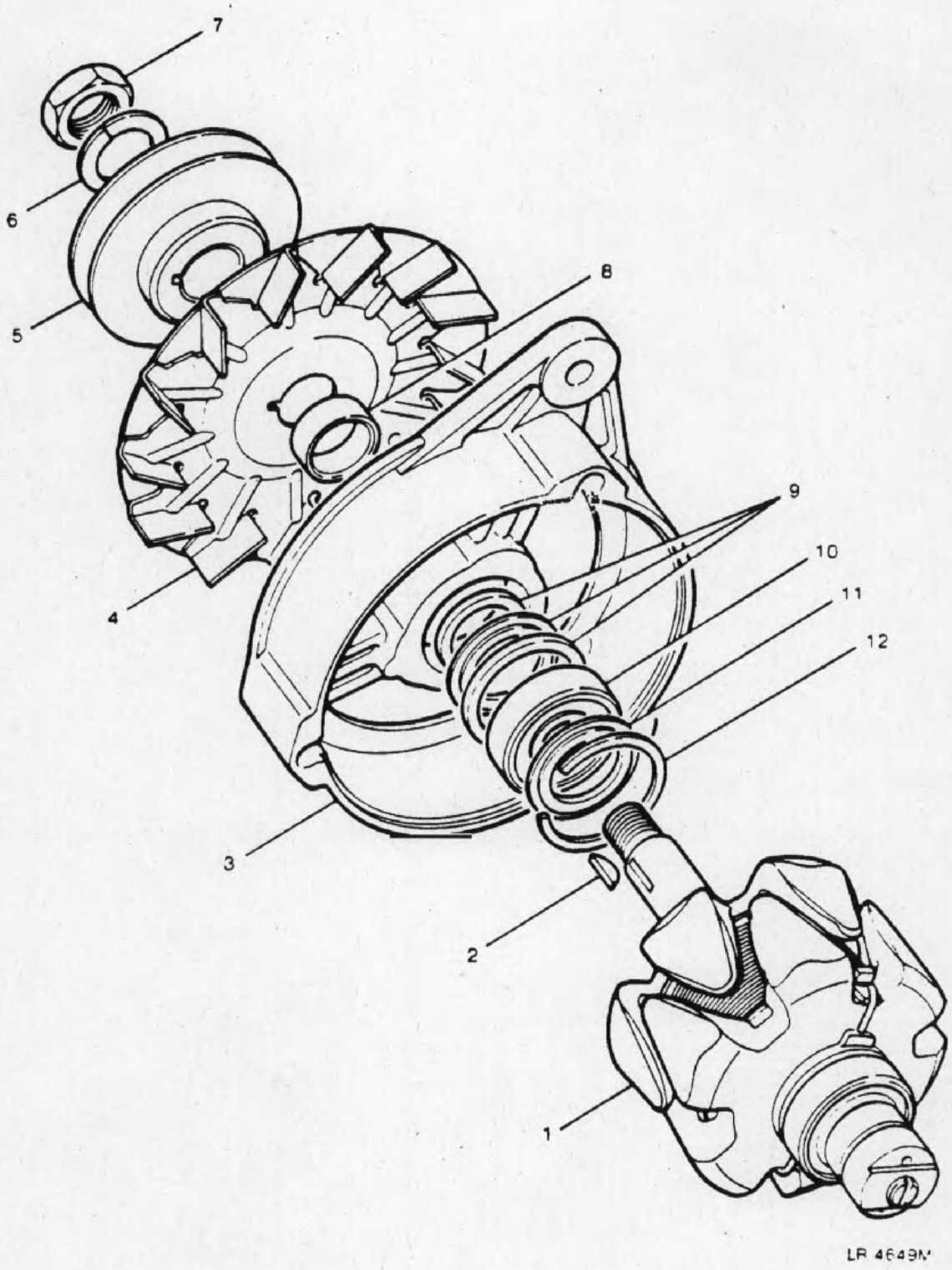
3.18 Unsolder inner slip ring connection and gently prise the slip ring (2) off the shaft.

3.19 Whilst carrying out the above two instructions take care not to damage the insulation covering the winding leads.



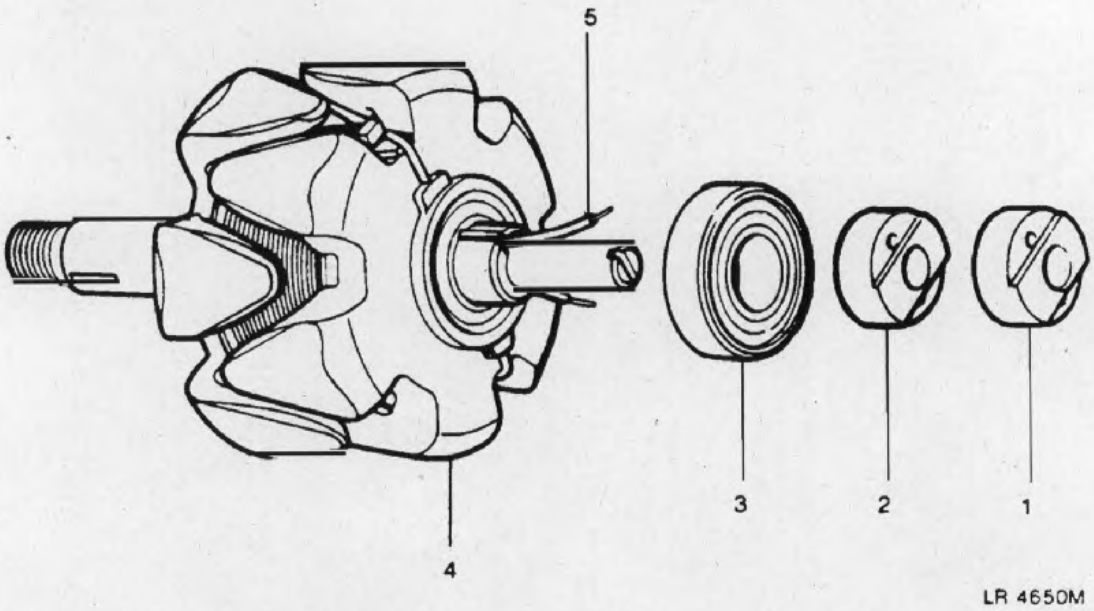
1 Stator assembly
2 Drive end bracket

Fig 6 Removing the stator assembly



1	Rotor	5	Pulley	9	Spacers
2	Woodruff key	6	Spring washer	10	Drive end bearing
3	Drive end bracket	7	Shaft nut	11	Spacer
4	Fan	8	Spacer	12	Spring washer

Fig 7 Separating the drive end bracket from the rotor



1 Outer slip ring
2 Inner slip ring
3 Bearing
4 Rotor shaft
5 Slip ring connection

Fig 8 Removing the slip rings

Electrical test of components

4 The illustrations for the following tests show the components separated from the alternator, for clarity.

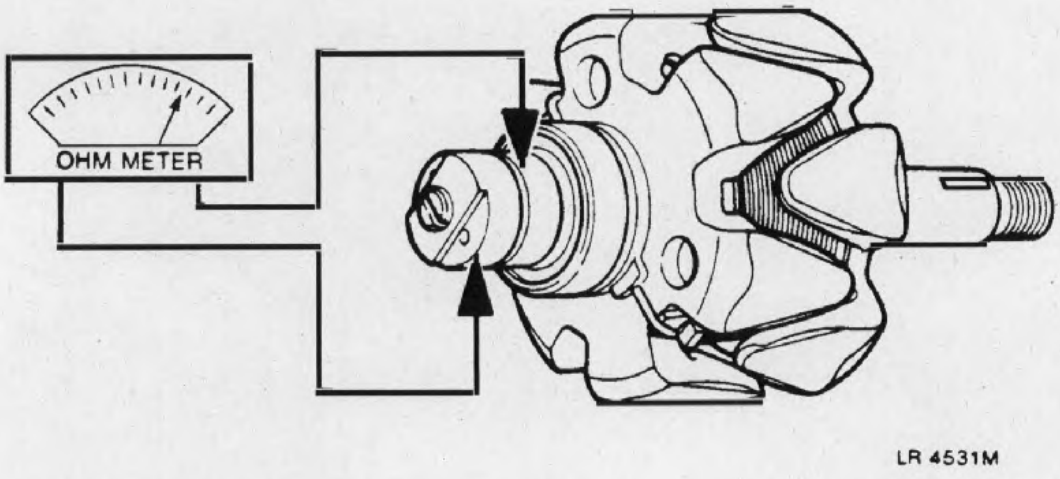


Fig 9 Checking the rotor field winding

4.1 Rotor field winding. Check field winding continuity and resistance simultaneously, by connecting a battery-operated ohmmeter (Fig 9) between the slip rings. The ohmmeter should indicate that the resistance is approximately 3.2 ohms.

4.2 Ch ck for satisfactory field winding insulation by connecting a megohmet r between either of the slip rings and the rotor body (Fig 10).

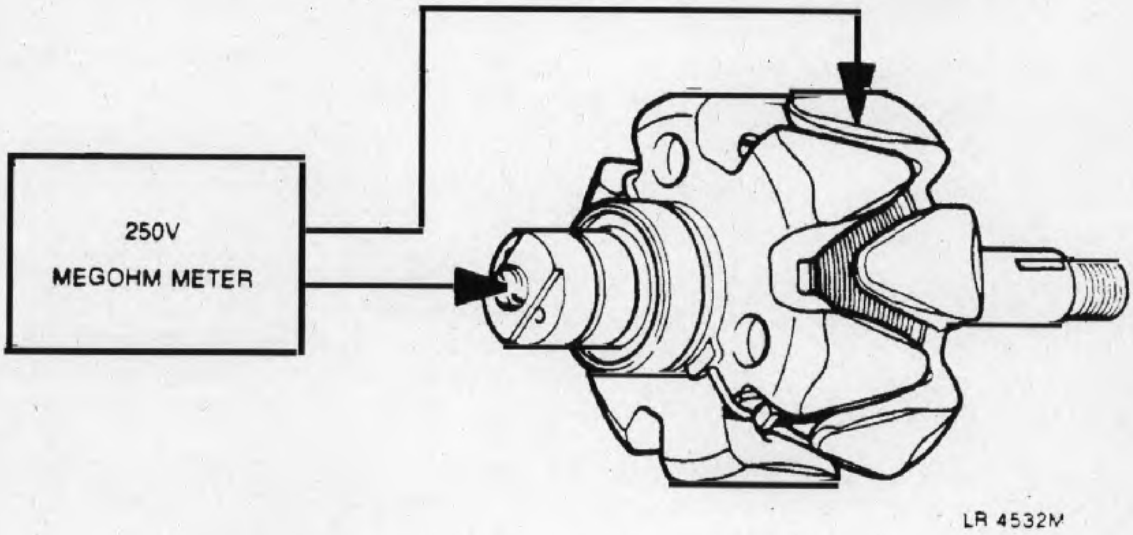


Fig 10 Checking the field winding insulation

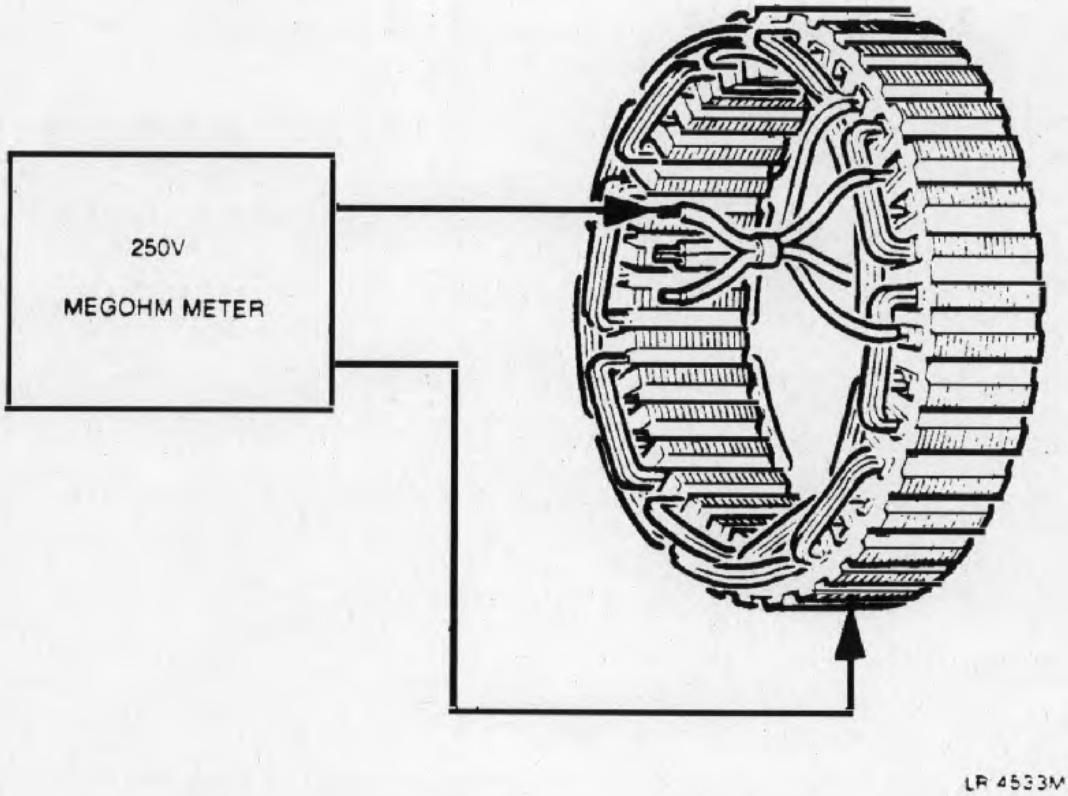


Fig 11 Checking the insulation of the stator windings

4.3 Stator winding. Due to the very low resistance of the stator windings, a pratical test to determine the presence of short-circuited turns cannot be carried out without the use of special instruments. However, in practice inter-winding short-circuiting is usually indicated by obvious signs of burning of the insulating varnish covering the windings. If this is the case, r new the stator assembly without the need for further testing.

4.4 Check continuity of stator windings, by first conn cting any two of the three stator winding conn cting cabl s in s ries with an ohmmeter. If the first part of the test is satisfactory, transfer one of the leads to the other (third) cable. If satisfactory, proceed to the insulation test.

4.5 Check insulation of stator windings, by connecting a Megohmmeter (Fig 11) between the stator laminations and any one of the three connecting cables.

4.6 Rectifier diodes. Test each of the nine diodes separately, as follows:

4.7 Connect an ohmmeter in series with one of the diodes, one test lead being applied to the diode connecting pin and the other to the particular heat sink plate in which the diode undergoing test is soldered. Reverse the t st l ad connections. The ohmmeter should give a reading in one direction only. If any one diode test is unsatisfactory, renew the rectifier assembly.

4.8 Regulator. Individual testing of the regulator can only be carried out with special test equipment and unless this is available the regulator must be proved by substitution.

Assembling

5 Reassmbly of the alternator is a reversal of the dismantling procedure. However, the following points should be observed:

5.1 Take care not to damage the insulation covering the winding leads when renewing the slip rings.

5.2 A build up of solder must not occur on the upper face of the inner slip ring.

5.3 Use resin cored solder only.

5.4 Pack the bearings with a suitable high melting point grease.

5.5 Ensure that the brushes move freely in the brush box.

5.6 If the slip rings are not renewed the existing ones must be clean and smooth.

5.7 Tighten fixings to the torque figures quoted.

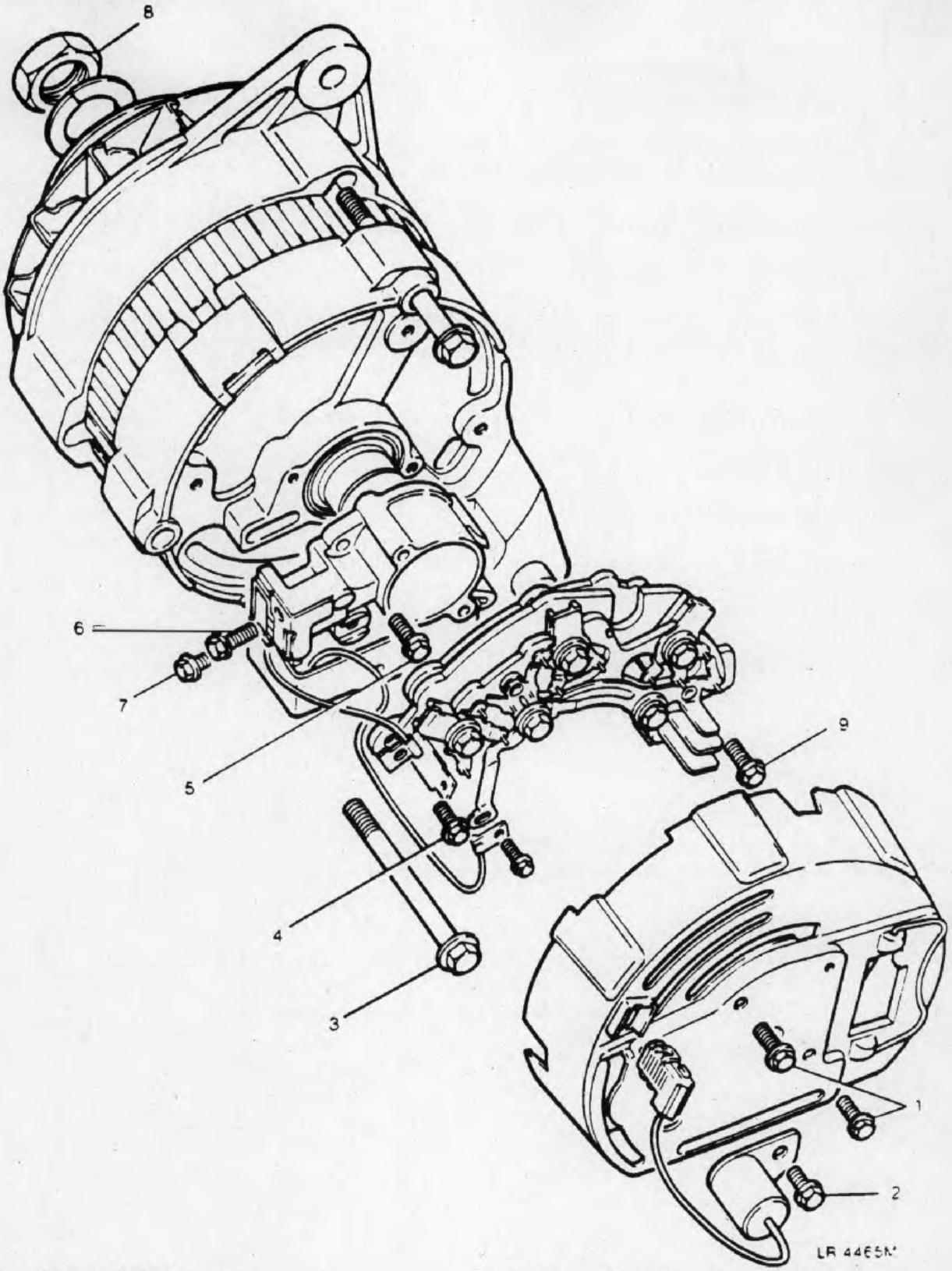
Alternator functional check

CAUTIONS ...

(1) The alternator contains polarity sensitive components that could be permanently damaged if subjected to incorrect polarity.

(2) Do not connect or disconnect any part of the charging circuit - including the battery leads - while the engine is running. Run the alternator with all connections made or with the unit disconnected.

6 This operation must be performed in two parts. The first to prove the alternator's capacity to produce current. The second to prove the performance of the int gral r gulator.



1	SRE moulded cover	1.7 - 2.25 Nm (1.3 - 1.7lbf ft)
2	Capacitor	3.61 - 4.74 Nm (2.7 - 3.5lbf ft)
3	Through bolts	4.5 - 6.2 Nm (3.3 - 4.6 lbf ft)
4	Reg "IND" Lead	1.1 - 1.26 Nm (9.7 - 12.01bt)
5	Brush box	3.4 - 3 96 Nm (2.5 - 2.91bf ft)
6,7	Brush and Regulator fixings	1.7 - 2.25 Nm (1.3 - 1.7lbf ft)
8	Shaft nut	27.2 - 47.5 Nm (20.0 -35.0 lbf ft)
9	Rectifier fixing bolts	3.4 - 3.96 Nm (2.5 - 2.9 lbf ft)

Fig 12 Tightening torques

Notes ...

(1) The stated output may be exceeded slightly when the alt rnator is cold.

(2) To avoid misleading results, the check should be performed with the unit as near to its normal operating temperature as possible.

6.1 Check capacity to produce current. Check drive belt adjustment.

6.2 Disconnect the multi-socket connector.

6.3 Remove the cover and provide a suitable probe and wire to enable the field winding earth brush to be earthed direct thus by-passing the r gulator.

6.4 Provide a test circuit with the following equipment:

6.4.1 Alternator

6.4.2 Ammeter

6.4.3 12 Volt battery

6.4.4 Voltmeter

6.4.5 Variable resistance

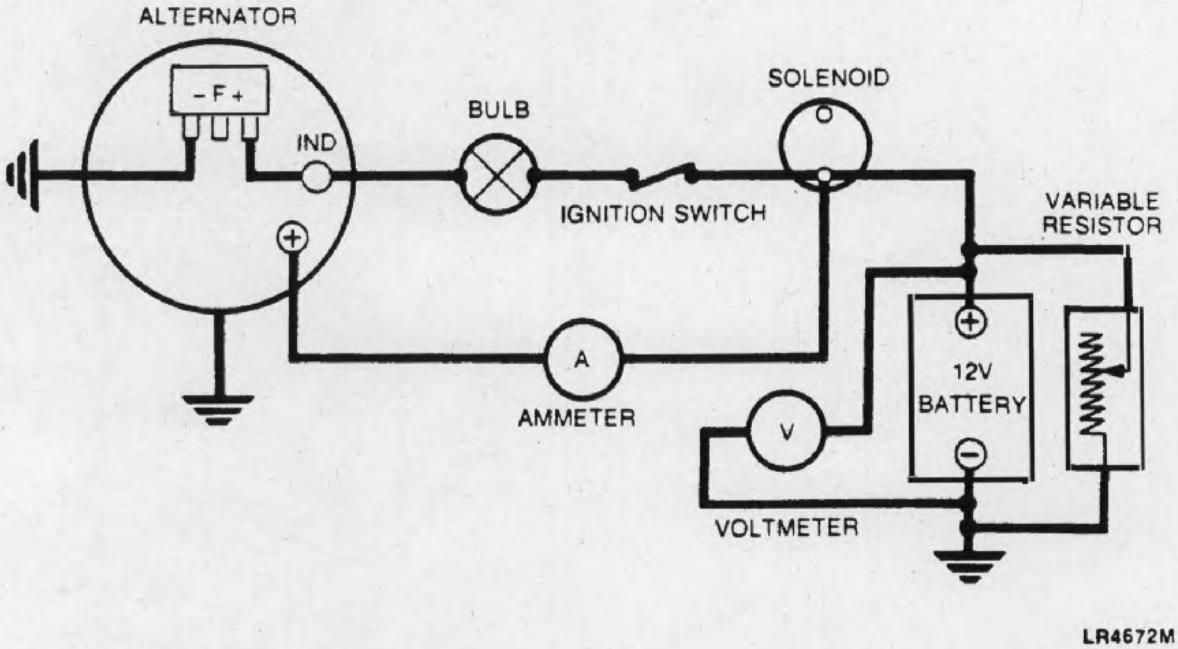


Fig 13 Checking capacity to produce current

6.5 Do not connect the variable resistor across the battery for longer than is necessary to perform the check.

6.6 Run the engine.

6.7 Gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.

6.8 Hold the spe d at approximately 6000 alternator rev/min (3000 engine r v/min). Adjust the variable resistor so that the voltmeter reads 14 volts. The ammeter reading should now be approximately equal to the nominal output given in data.

6.9 If the ammeter reading is not correct the indication is that the alternator requires overhaul or replacement.

Notes ...

(1) The stated output may be exceeded slightly when the alternator is cold.

(2) To avoid misleading results, the check should be performed with the unit as near to its normal operating temperature as possible.

6.10 Check control regulator. Check drive belt adjustment.

6.11 Disconnect multi-socket connector.

6.12 Provide a test circuit with the following equipment:

6.12.1 Voltmeter

6.12.2 12 Volt battery

6.12.3 Light bulb

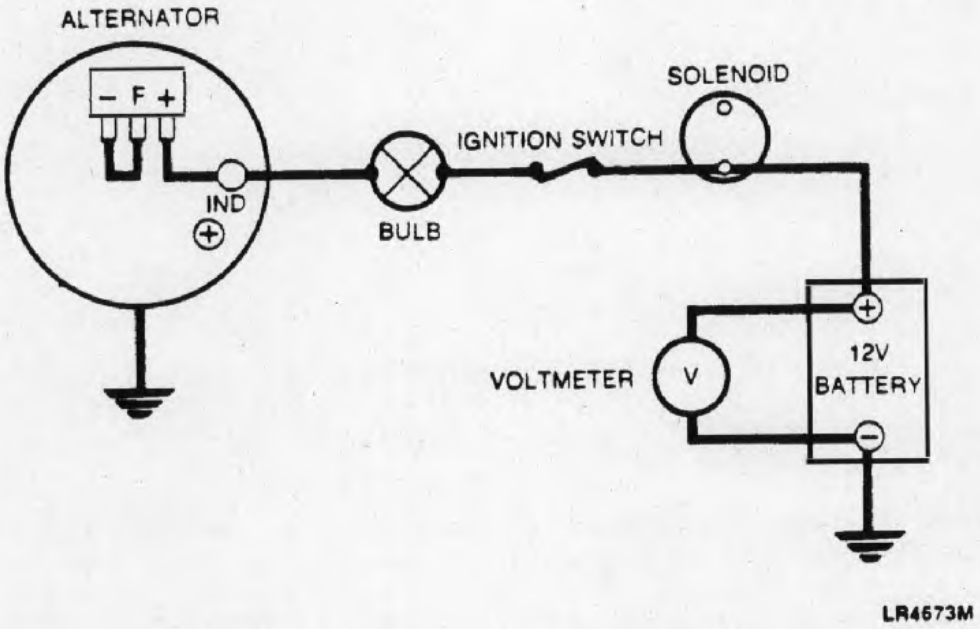


Fig 14 Check control regulator

6.13 Start the engine and gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.

6.14 Hold the speed at approximately 6000 alternator rev/min (3000 engine rev/min). The voltmeter reading should now be steady at 13.6 to 14.4 volts.

6.15 If the voltmeter reading is not steady at the above figure; and a satisfactory "check capacity to produce current" test has been performed, the indication is that the control regulator should be replaced.

ALTERNATOR OVERHAUL (A127)

Removal

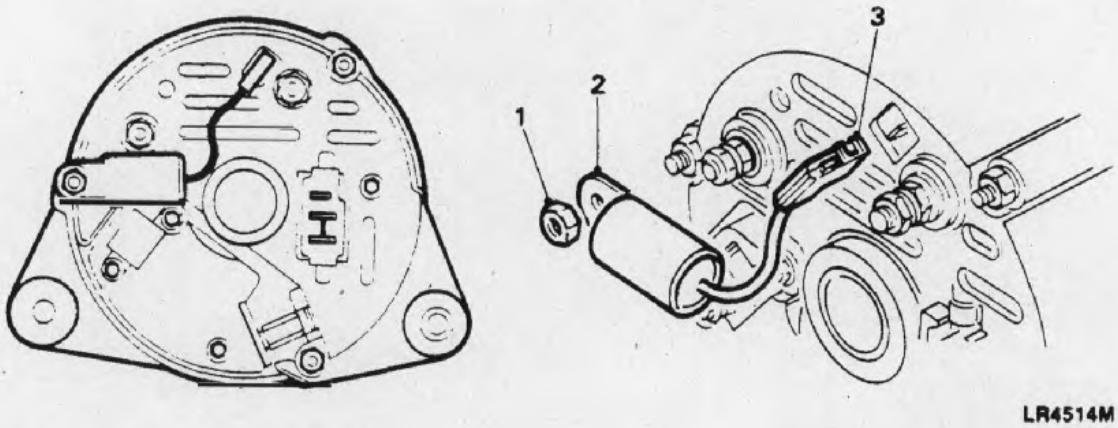
7 R move the alternator from the engine (Cat 522 chapter 13.1).

Dismantling

8 To overhaul the alternator proceed as follows:

8.1 Removing the suppression capacitor. (Fig 16) Remove the nut (1) retaining the capacitor (2) from the through bolt.

8.2 Disconnect the capacitor connector (3) from the alternator and remove the capacitor.



1 Nut
2 Capacitator
3 Connector

Fig 15 Removing the suppression capacitor

8.3 Removing the regulator/brushbox assembly. (Fig 16) Remove the three screws (1) retaining the regulator.

8.4 Remove the regulator/brushbox assembly (2) from the alternator, at the same time disconnect the connector (3).

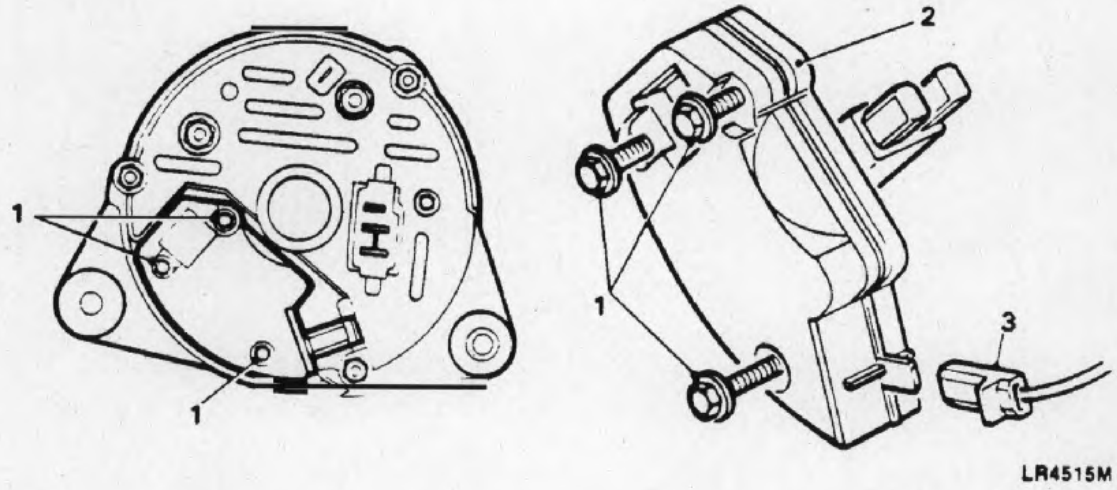
8.5 Removing the slip ring end bracket. (Fig 17) Remove the two remaining nuts from the throughbolts (1) and remove the slip end ring bracket and stator (2).

8.6 Remove the bolts from the drive end bracket.

8.7 R moving the rectifier and stator. (Fig 18) Remove the nuts, washers and insulators from the stud terminals (2).

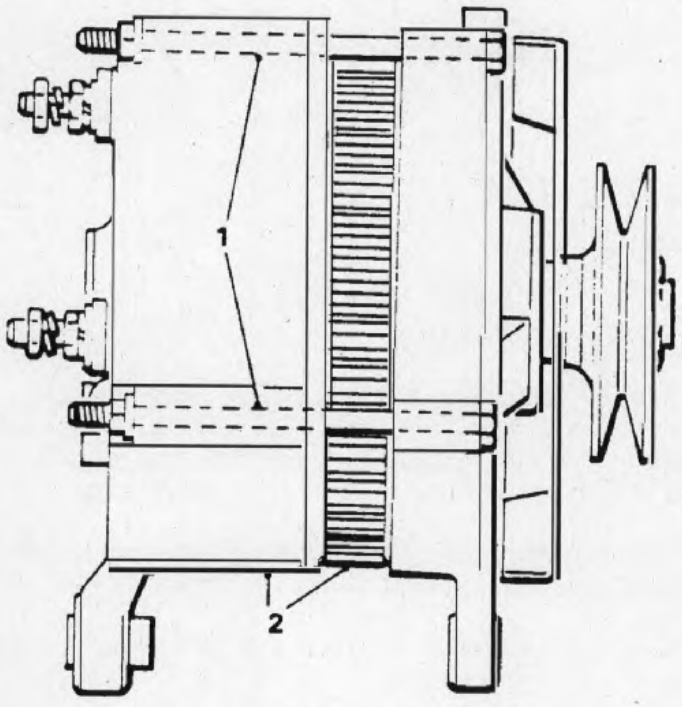
8.8 Remove the rectifier retaining screws (1).

8.9 Remove the rectifier and stator (3) from the slip ring end bracket.



1 Screws 2 Regulator/brushbox assembly 3 Connector

Fig 16 Removing the regulator/brushbox assembly



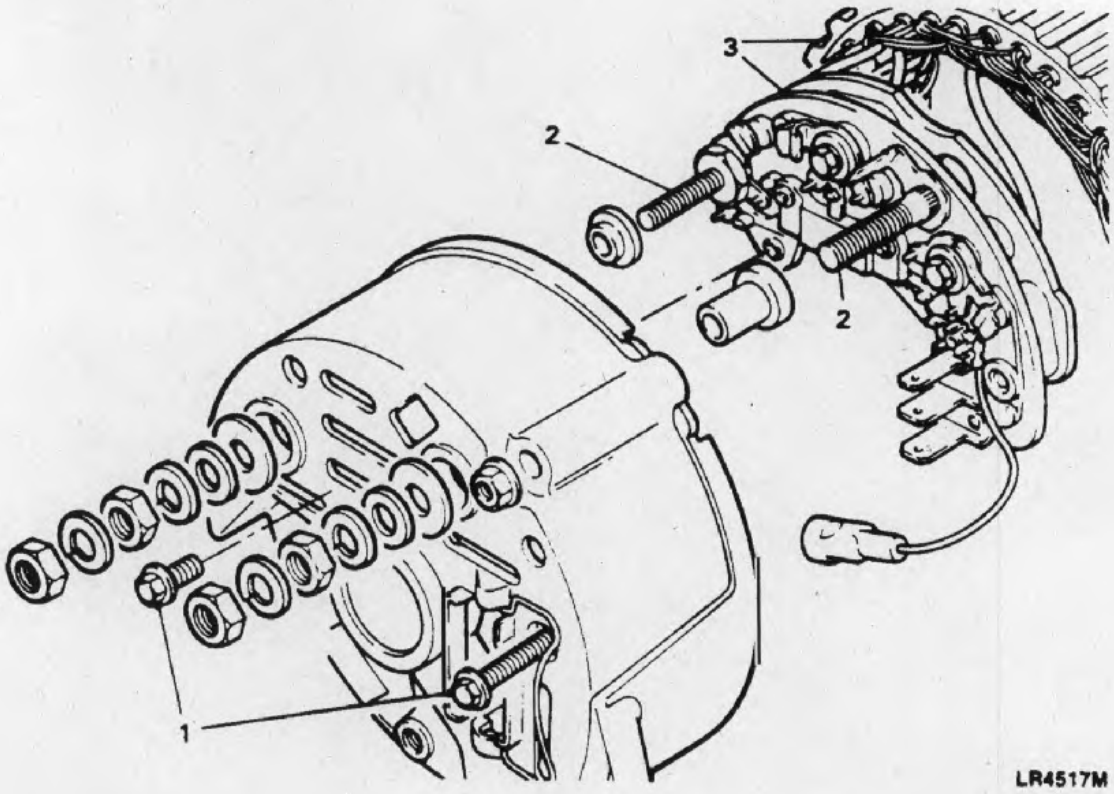
1 Throughbolts 2 Stator

Fig 17 Removing the slip ring end bracket

8.10 Separating the rectifier from the stator. (Fig 20) Locate and unsolder the stator leads (1) from their tags on the rectifier (2).

8.11 Separate the rectifier from the stator.

8.12 Separating the rotor from the drive end bracket. (Fig 21) Undo the shaft nut (5) and remove the spring washer (4), pulley (3), fan (2) and spacer (6) from the drive end bracket (1).



1 Retaining screws
2 Stud terminals
3 Stator

Fig 18 Removing the rectifier and stator

8.13 (Fig 22) Using a suitable press, push out the rotor shaft (1) from the drive end bracket bearing (3) and remove the spacer (2).

8.14 Checking the brushgear. (Fig 23) Check the lengths of the brushes and if below the minimum (5 mm) renew.

8.15 Check the spring pressure which should be 1.3 to 2.7 N (Fig 23).

Note ...

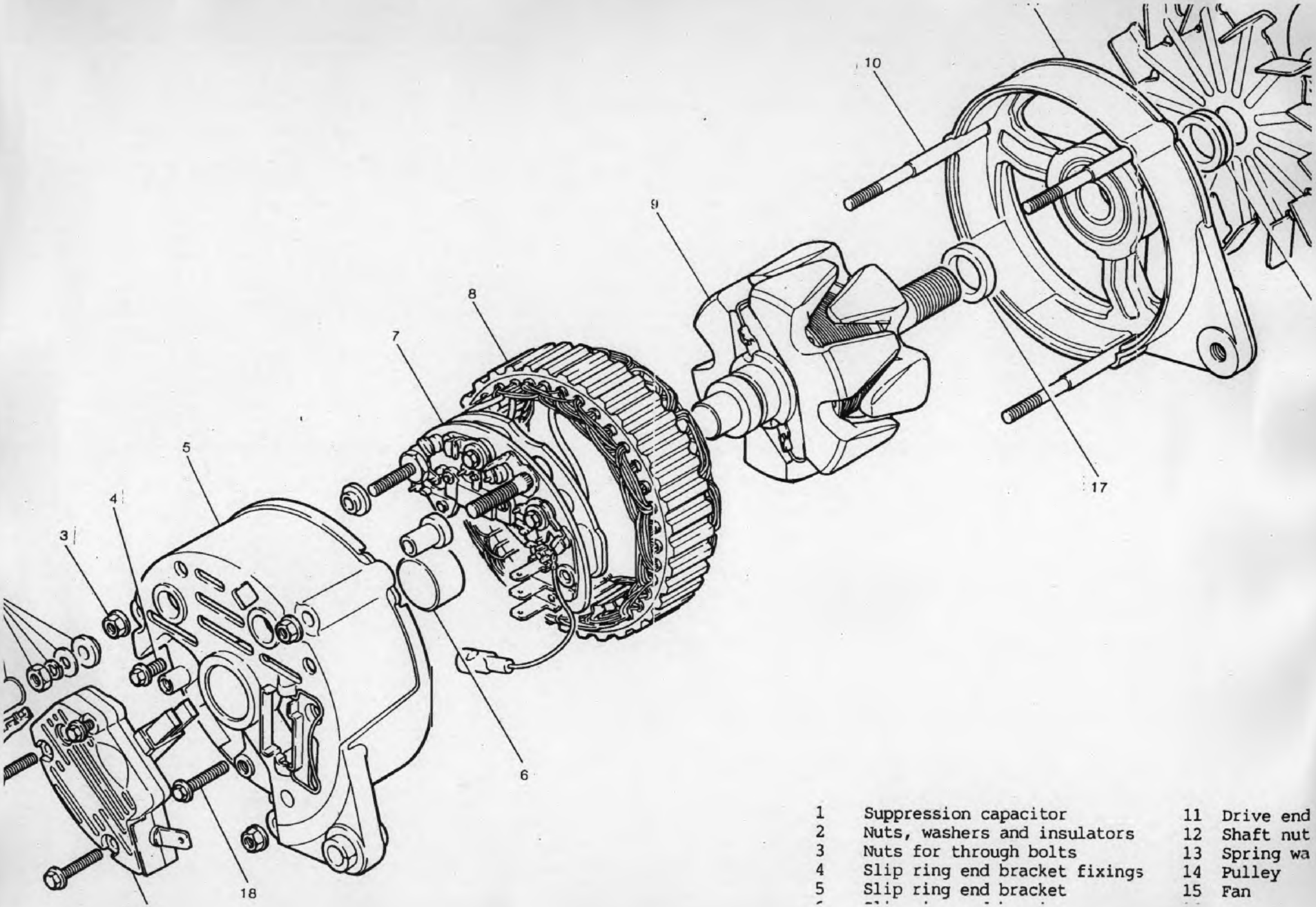
The length of the new brushes when located in the brushbox are 17 mm.

8.16 Checking the field windings on rotor assembly. (Fig 24) Connect an ohmmeter to the slip rings to register the resistance/continuity test figures. The ohmeter should register 3.2 Ohms.

Notes ...

(1) Ensure that the slip rings are clean and smooth.

(2) Use extra fine glass paper to rectify imperfections.



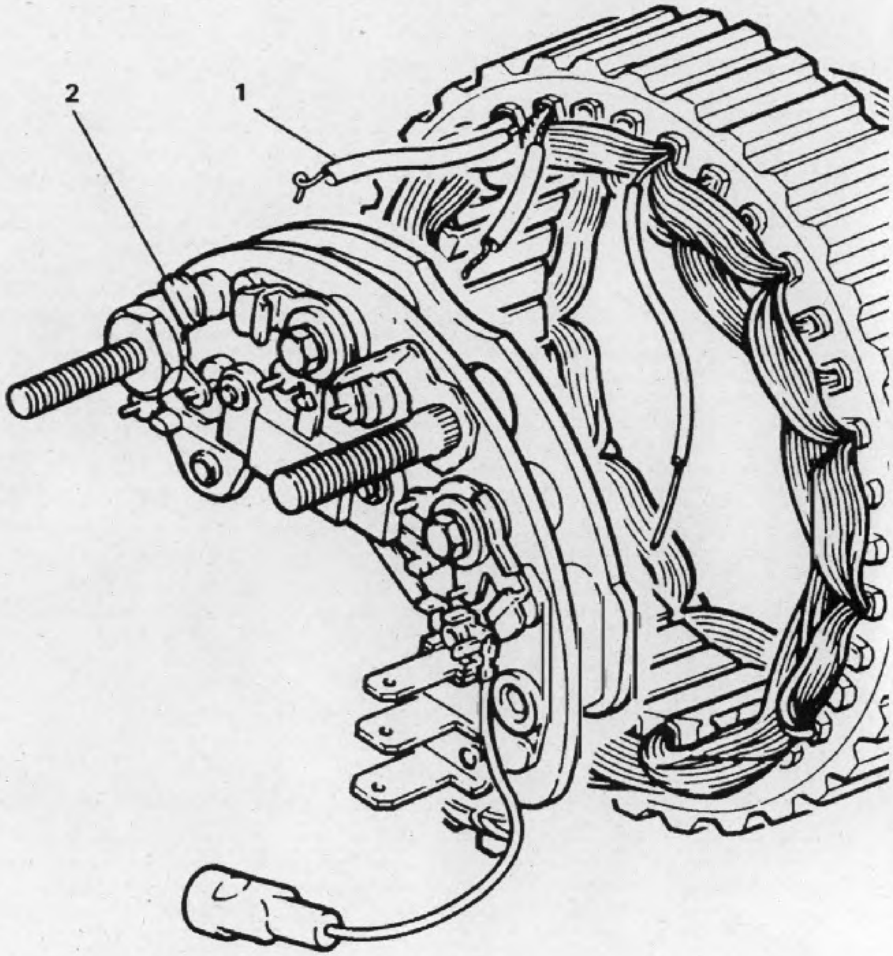
1	Suppression capacitor	11	Drive end
2	Nuts, washers and insulators	12	Shaft nut
3	Nuts for through bolts	13	Spring wa
4	Slip ring end bracket fixings	14	Pulley
5	Slip ring end bracket	15	Fan

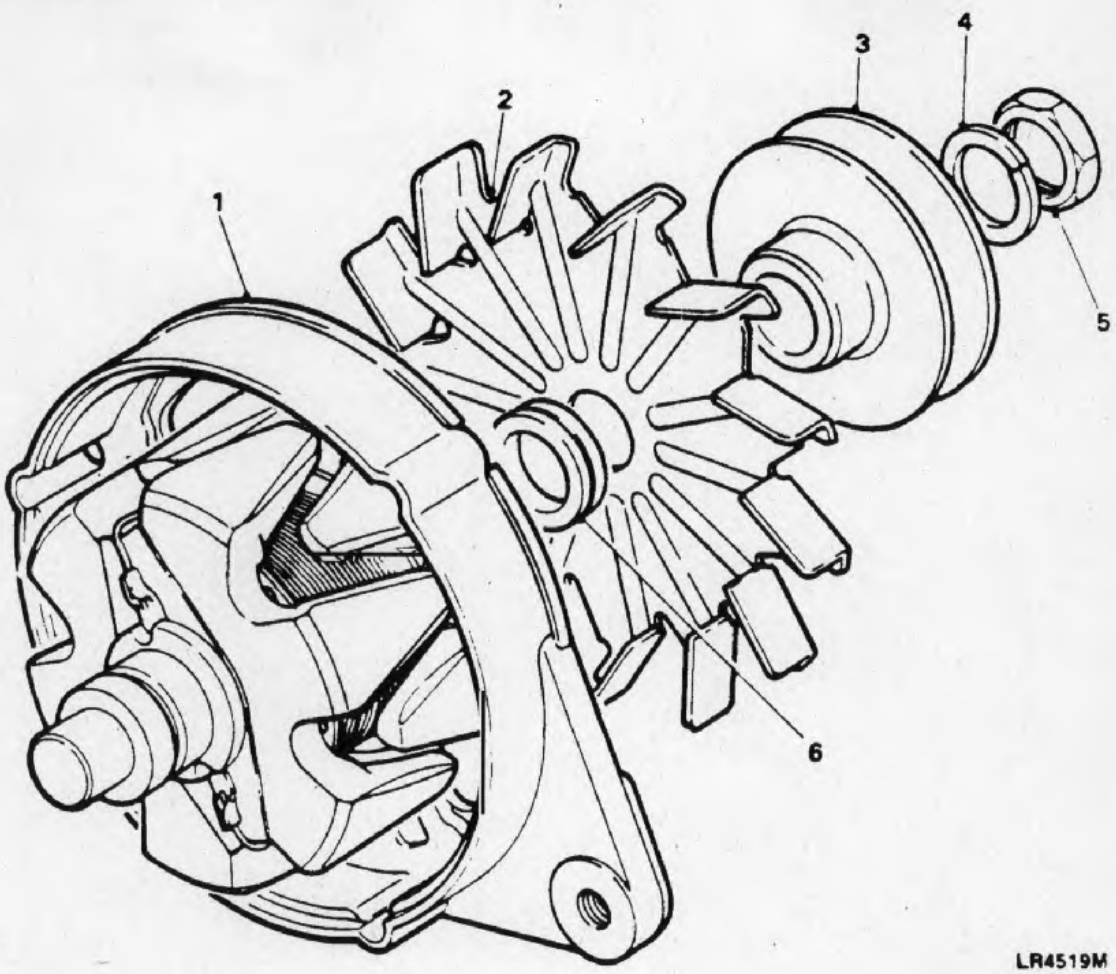
8.17 Checking the insulation. (Fig 25) Test the rotor for if fails replace rotor.

Notes ...

(1) Ensure that the slip rings are clean and smooth.

(2) Use extra fine glass paper to rectify imperfections.





1 Bracket
2 Fan
3 Pulley
4 Spring washer
5 Shaft nut
6 Spacer

Fig 21 Separating the rotor from the drive end bracket

8.18 Checking the rectifier diodes. (Fig 26) Test each of the diodes separately, as follows:

8.19 Connect an ohmmeter across one of the diodes, reverse the test lead connections, the ohmmeter should give a reading in one direction only.

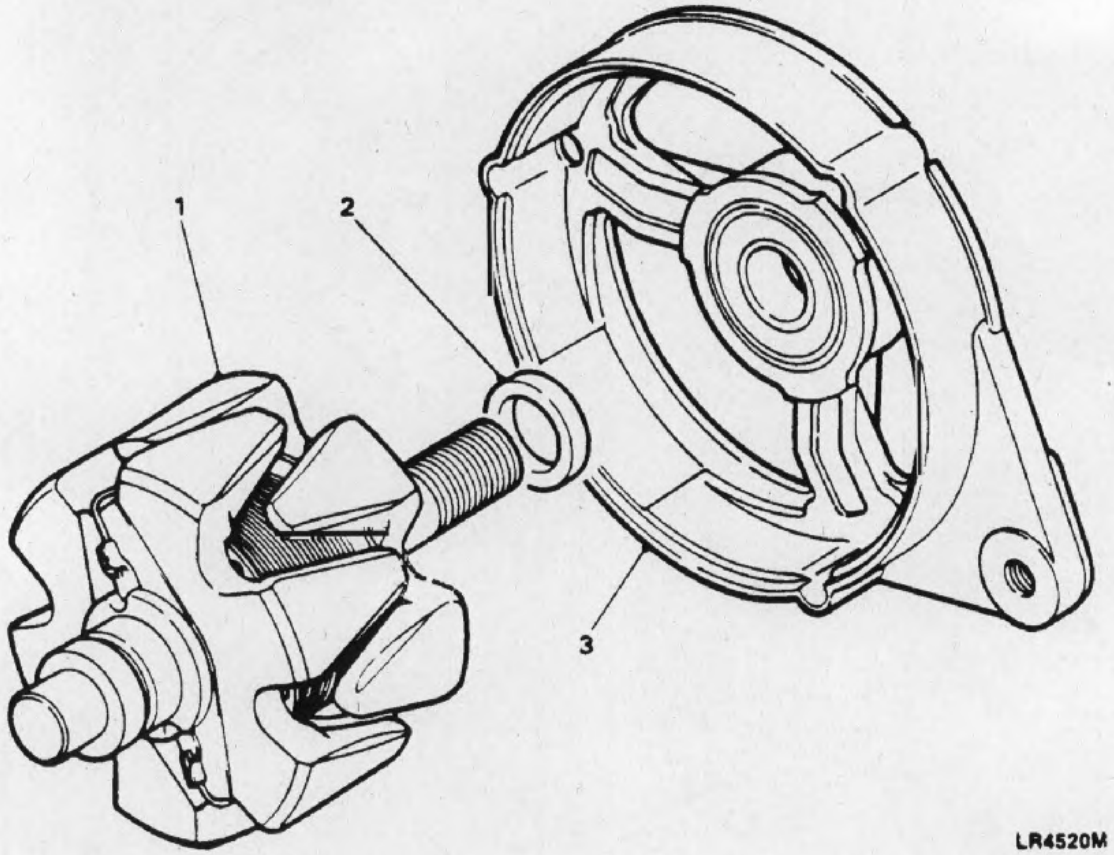
8.20 If the diode is faulty then the whole rectifier should be replaced.

WARNING ...

USE TEST EQUIPMENT, SPECIALLY MANUFACTURED FOR THE PURPOSE WHICH INCORPORATES SAFETY FEATURES TO COMPLY WITH THE HEALTH AND SAFETY AT WORK ACT 1974.

8.21 Checking the stator. Test the stator for insulation (Fig 27) and if the test fails replace stator.

8.22 Closely inspect the windings for any evidence of burning, breaks in the windings, interwinding insulation and breaks in continuity. If not then the windings should be assumed to be satisfactory.



1 Rotor shaft 2 Spacer 3 Bracket bearing

Fig 22 Removing the rotor

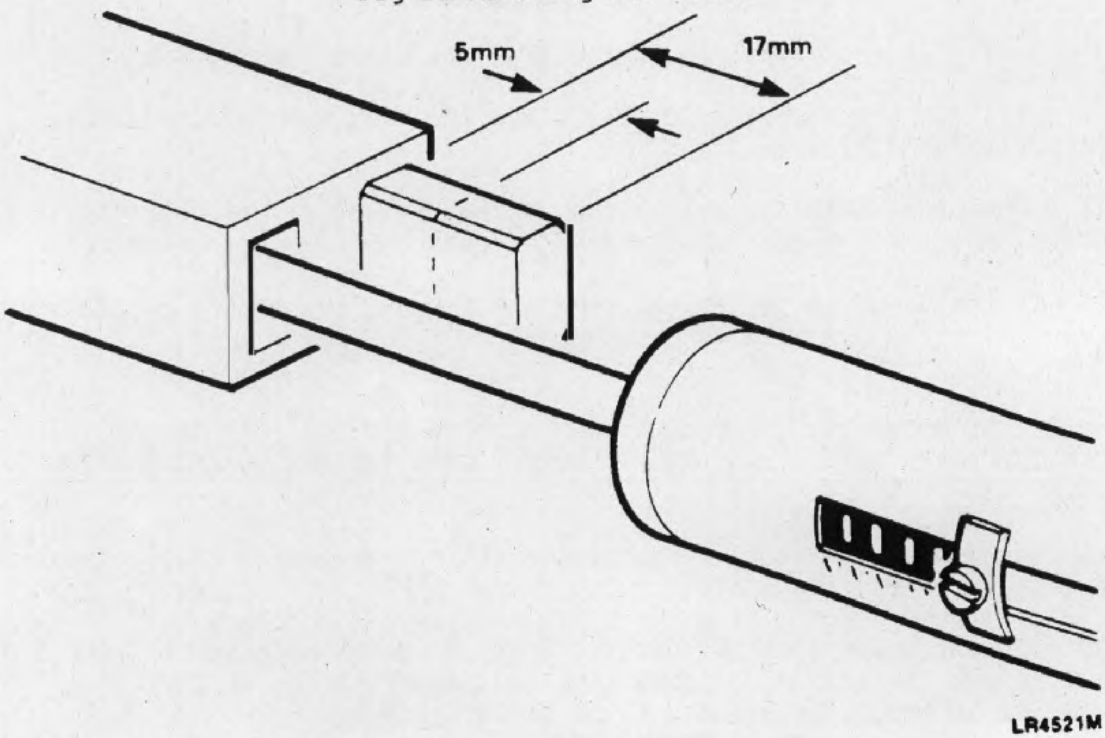
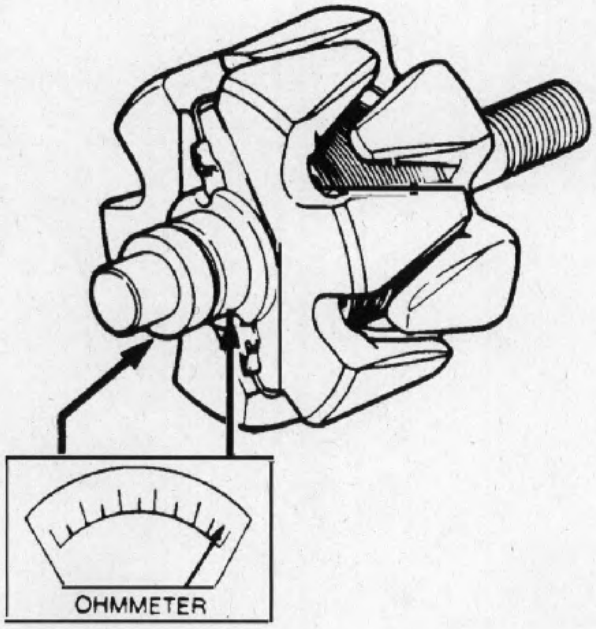
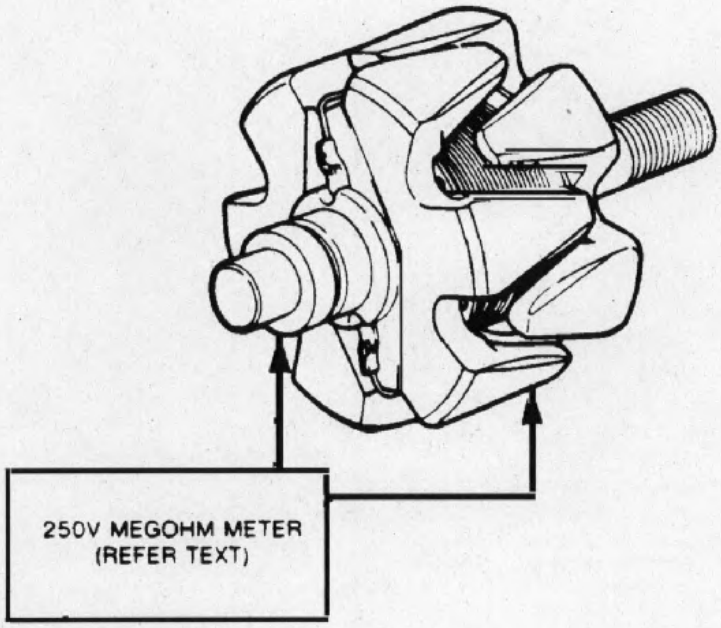


Fig 23 Brush renewal lengths



LR 4522M

Fig 24 Checking field windings



LR 4523M

Fig 25 Checking for insulation on rotor

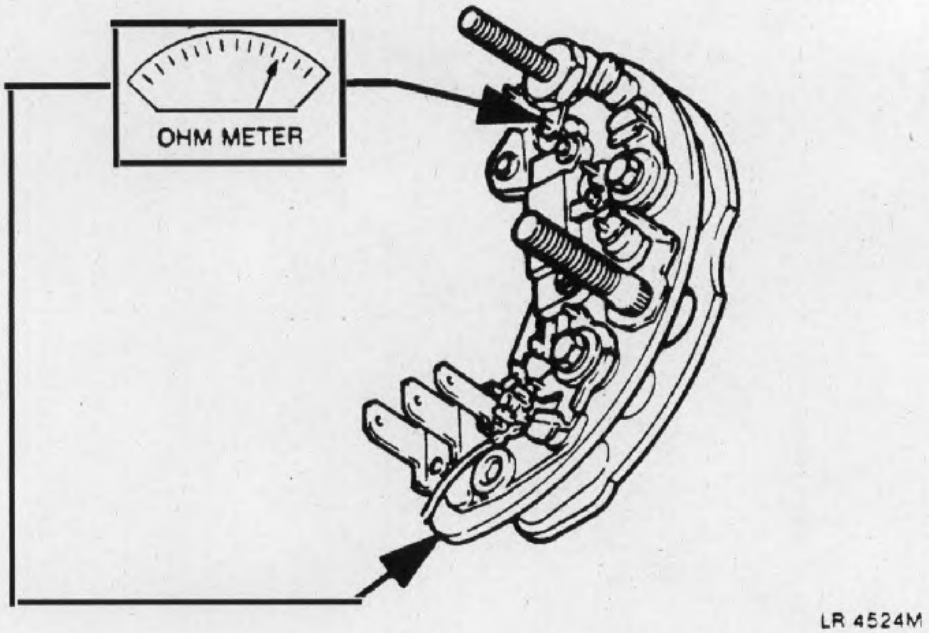


Fig 26 Checking rectifier diodes

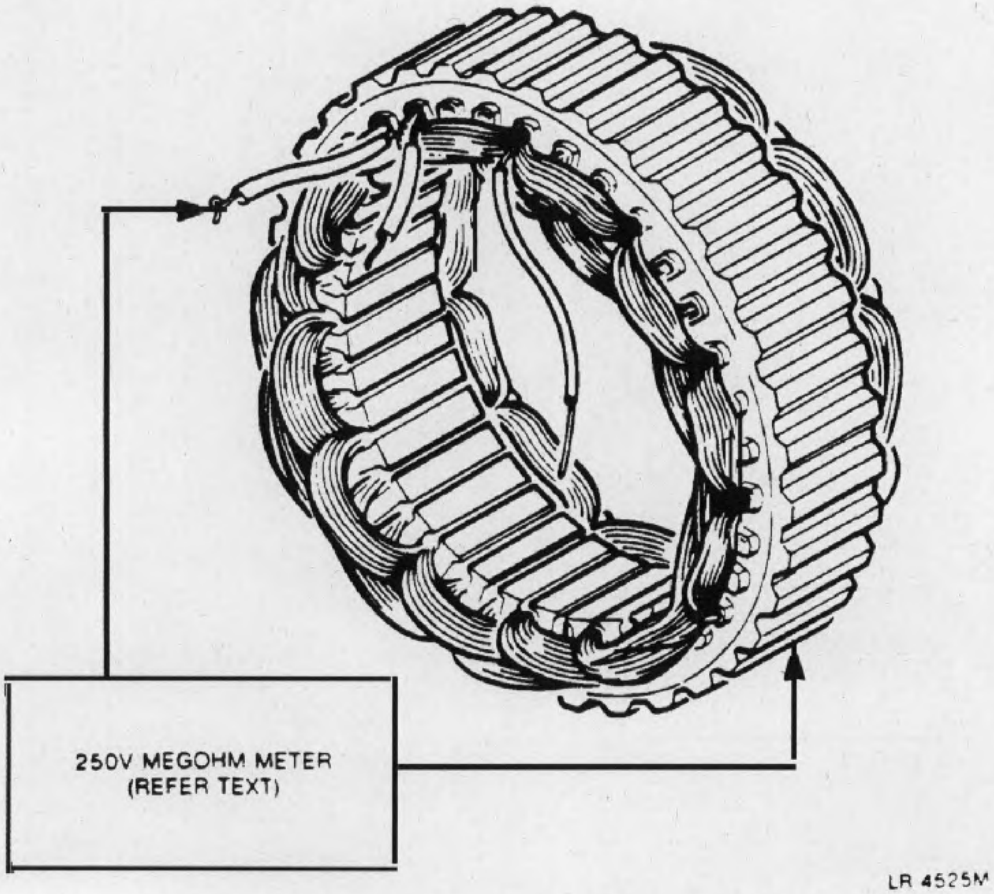


Fig 27 Checking stator

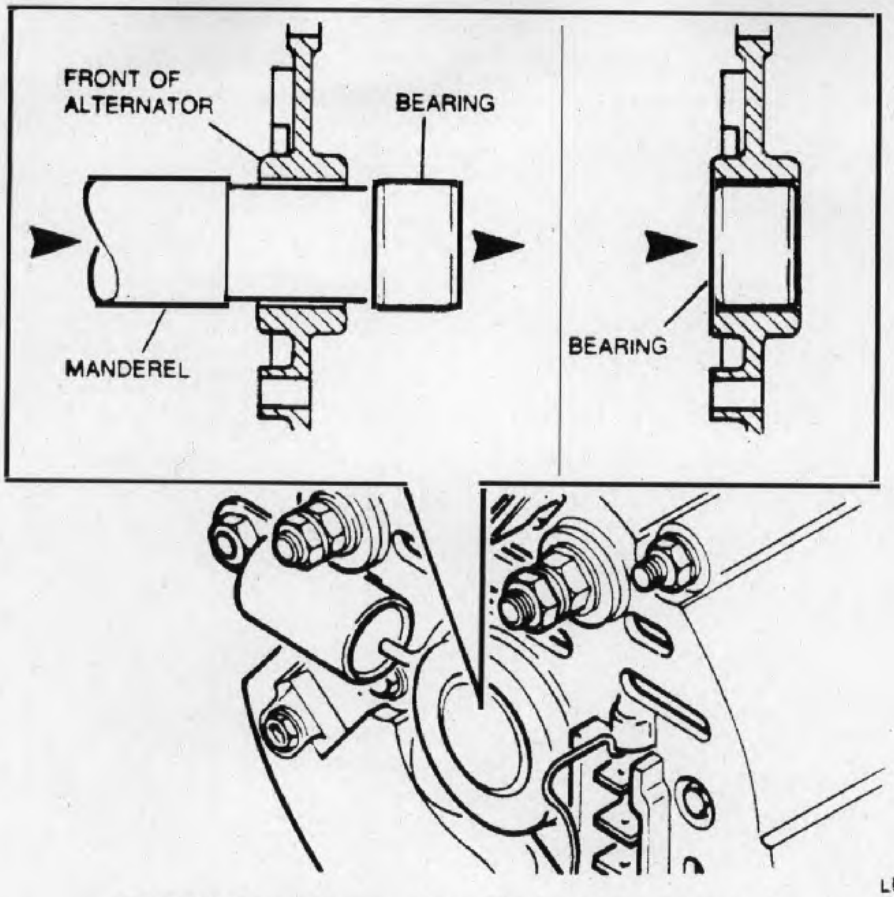


Fig 28 Removing and replacing the bearing

8.23 Checking the bearings. Inspect the rotor poles and stator for signs of rubbing, if so, then the bearings are excessively worn and need renewing.

Note ...

The drive end bearing comes complete with the drive end bracket, therefore cannot be replaced separately.

8.23.1 To renew the slip ring end bearing only. Using a press remove the bearing from the bracket (Fig 28) and discard the bearing.

8.23.2 Fit a new bearing from the front of the alternator.

Assembling

9 Reassembly of the alternator is a reversal of the dismantling procedure. However, the following points should be observed:

9.1 Pack the bearings with a suitable high melting point grease.

9.2 Ensure reassembly of nuts, washers and insulators are fitted in the correct order.

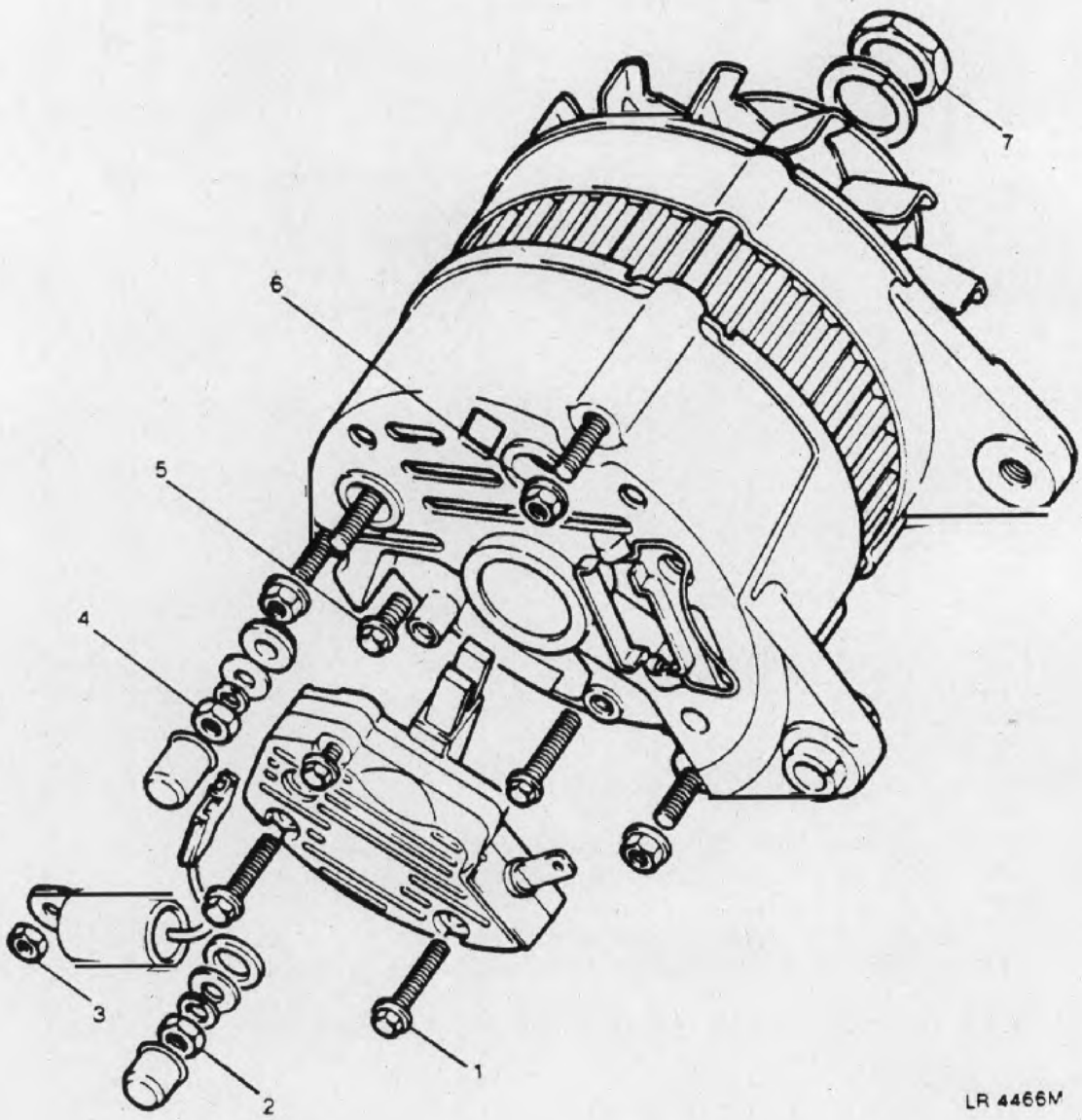
9.3 Ensure that the slip rings are clean and smooth, using extra fine glass paper to rectify any slight imperfections.

9.4 Ensure that the brushes move freely in the brush box.

9.5 Ensure that the brushes are not damaged when refitting the regulator/brushbox assembly.

9.6 Ensure that the slip ring nd bracket is fitt d correctly so that the mounting lugs line up.

9.7 Tighten fixings to the torque figures quoted.



1	Brushbox and Regulator assembly	2.25 Nm (2.0 lbf ft)
2	Main stud terminal	4.00 Nm (3.0 lbf ft)
3	Suppresion capacitor	5.50 Nm (4.0 lbf ft)
4	Phase terminal	4.00 Nm (3.0 lbf ft)
5	Rectifier fixing bolts	3.50 Nm (2.5 lbf ft)
6	Through bolts	5.50 Nm (4.0 lbf ft)
7	Shaft nut	37.50 Nm (27.5 lbf ft)

Fig 29 Tightening torques

STARTER MOTOR OVERHAUL (2M113)

Dismantling

10 To overhaul the starter motor proceed as follows:

10.1 Solenoid Unit. Disconnect the link (Fig 30 (4)) from starter terminal.

10.2 Unscrew and remove solenoid securing screws and withdraw the solenoid body.

10.3 Remove plunger complete with seal by lifting front end of plunger to release it from the top of the engagement lever (8).

10.4 Commutator end bracket. Remove the two brush plate securing screws (19).

10.5 Remove the two through bolts.

10.6 Withdraw the commutator end bracket and seal, taking note of the position of the dowel pegs in the end of commutator.

10.7 Brush plate assembly. Disengage the brushes (3) and remove the brush plate assembly (2).

10.8 Yoke assembly. Withdraw the yoke assembly complete with field coils, brushes and seal.

10.9 Drive end braket. Remove the eccentric pivot pin (10).

10.10 Withdraw the drive-end bracket (12) by releasing engagement lever from drive operating collar whilst the bracket is being removed.

10.11 Drive assembly and intermediate bracket. Drive the thrust collar back towards the drive pinion away from the pump ring.

10.12 Prise the jump ring from the groove in the drive shaft.

10.13 Remove the collar, drive pinion (13) and intermediate bracket (14) from the armature (15) and note the position of the peg in the bracket.

Test and overhaul

11 The following procedures are for testing and overhauling the motor:

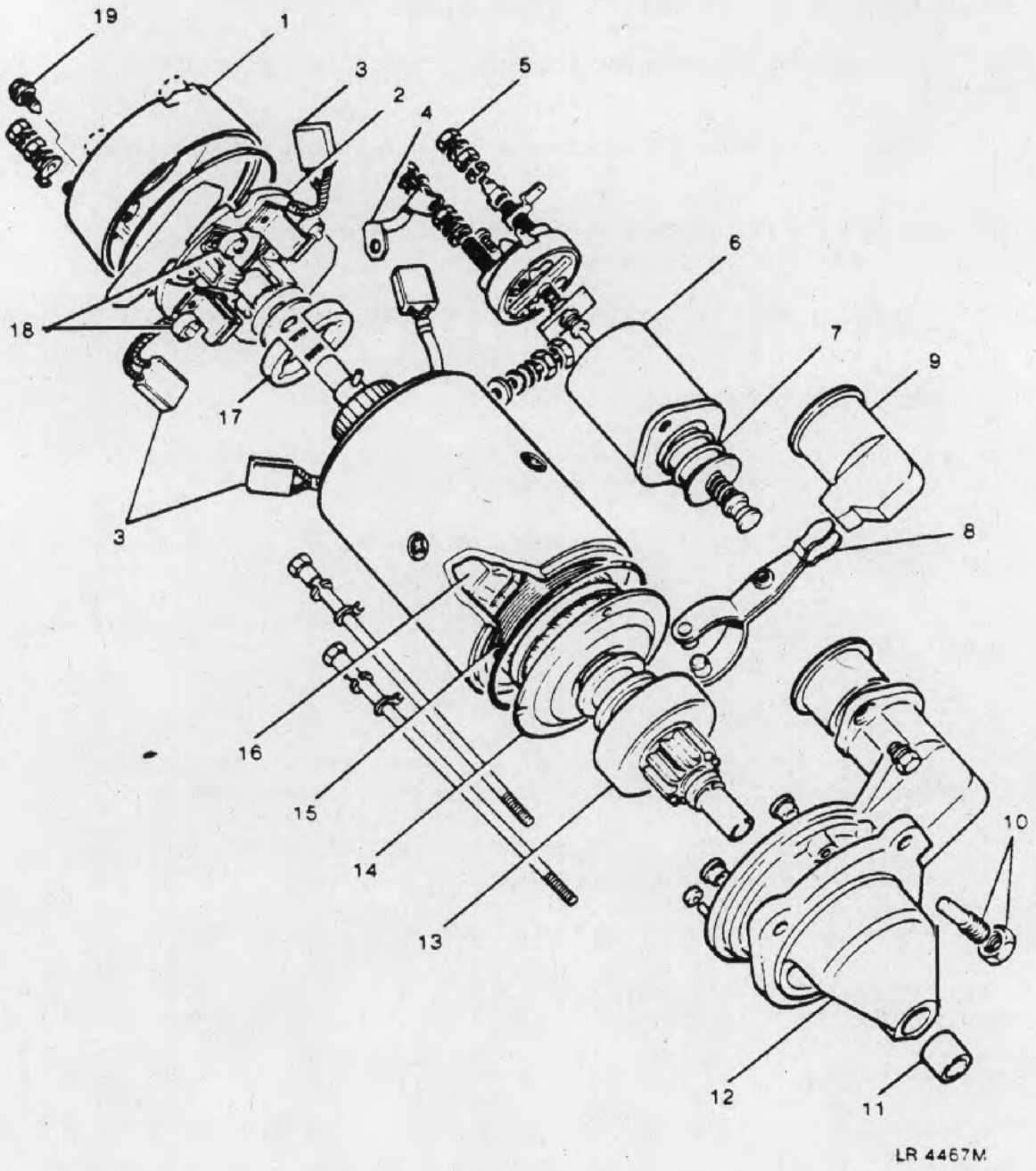
11.1 Solenoid Windings. Check the continuity and resistance value of the windings with the results as follows:

11.2 Resistance should be 0.145 to 0.165 ohms measured between small unmarked lucar terminal and main terminal marked "STA".

11.3 Resistance should be 0.46 to 0.56 ohms measured between small unmarked lucar terminal and earth point on solenoid body.

11.4 If unsatisfactory renew the solenoid.

11.5 Solenoid Contacts. With the solenoid plunger removed, check, with an ohmmeter, the continuity across the main contacts. The reading should be infinity.



1 Commutator end bracket
2 Brush plate assembly
3 Brush s
4 Solenoid to starter link lead
5 Solenoid terminal connections
6 Solenoid body
7 Plunger
8 Lever
9 Seal
10 Adjustment pin
11 Bush
12 Drive end bracket
13 Drive shaft
14 Intermediate bracket assembly
15 Armature
16 Field coil assembly
17 Brake assembly
18 Brush springs
19 Brush plate securing screws

Fig 30 Starter motor (2M113)

11.6 Fit the plunger and operate it, by hand, to close the contacts. If satisfactory the ohmmeter should register z ro.

11.7 Check the operation of all springs for freedom of movement.

11.8 If one or both of the above tests prove unsatisfactory or the solenoid is inoperative replace the solenoid.

11.9 Brush gear. Check the brushes for damage, wear and length against the following figures:

11.10 Replace brushes at 8 mm (0.312 in).

11.11 New brush length is 22.2 mm (0.875 in).

Notes ...

(1) Before renewing brushes, check the field coils and brush plate assembly.

(2) Check brush springs and ensure brushes move freely in their holders.

(3) If original brushes need cleaning, use a petrol moistened cloth.

11.12 If the above tests are not satisfactory, renew brushes.

11.13 Drive pinion. Examine the pionion for wear and damage.

11.14 The pinion should rotate in one direction only, independent of the clutch body.

11.15 Renew pinion drive if unserviceable e.g. damaged teeth etc.

11.16 Field coils. Inspect the coils for damage and ensure that the insulation tape is firm and not loose. Check all joints for continuity and evidence of burning which indicates an insulation fault.

11.17 If the brushes are being renewed cut the flexible leads leaving a sufficient length to enable the new brush leads to be joined with a soldered connection.

11.18 Armature. Clean the armature with a petrol moistened cloth.

11.19 If growler equipment is available check for short-circuited windings.

11.20 Examine the commutators and if worn or damaged it can be skimmed provided that it is not machined below the minimum diameter of 38 mm (1.5 in).

11.21 Finally, finish the commutator with fine glass paper. Do not undercut the commutator segments.

11.22 Insulation test. Check the insulation of the following components using a megohmmeter.

11.22.1 Field coil insulation. Connect the test leads between the yoke terminal and the yoke. Ensure that the brushes are not touching the yoke (Fig 31). Renew the field coil assembly if necessary.

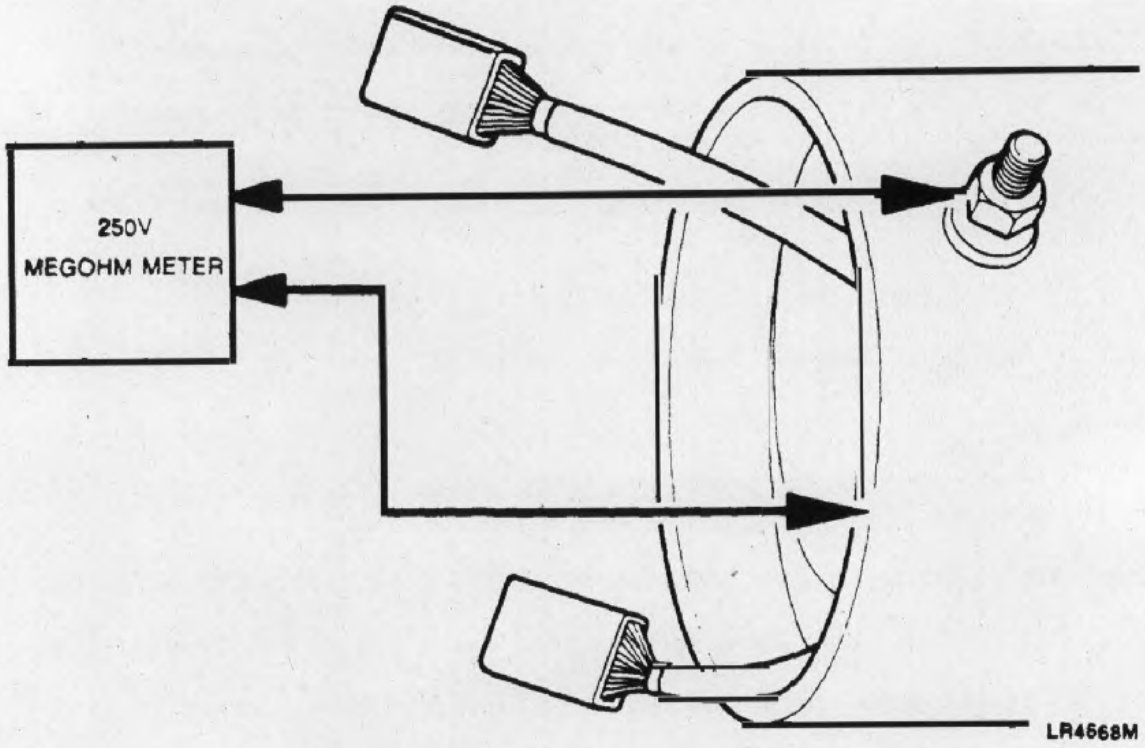


Fig 31 Field coil insulation

11.22.2 Armature insulation. Connect the test leads between any one of the commutator segments and the armature shaft (Fig 32). Replace the armature if necessary.

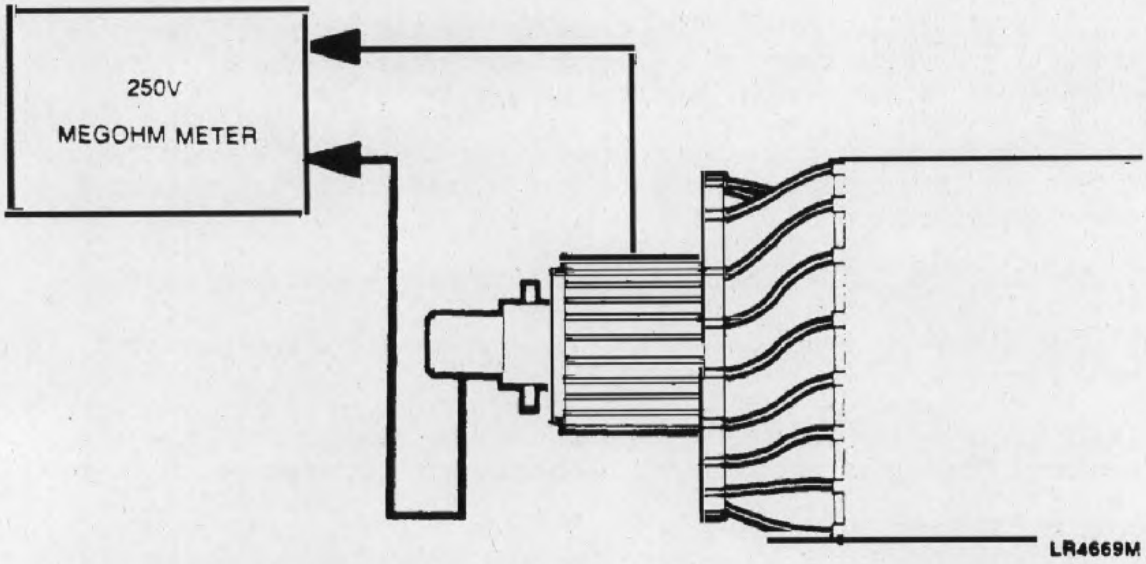


Fig 32 Armature insulation

11.22.3 Brush box insulation. Connect the test lamp between a clean part of the bracket and each of the two insulated brush boxes in turn. If the test lamp lights renew the commutator end bracket assembly.

11.23 Bearing bushes. If the armature fouls the pole shoes or side play exists between the armature shaft and bush, renew the bearing bushes using a suitable hand press mandrel.

Assembling

12 Reassembly is mainly a reversal of the foregoing dismantling procedure. However, the following points should be observed.

12.1 Lubrication. Smear the drive shaft splines and the drive operating collar and bearing surface of the engagement fork with Shell Retinax "A" grease.

12.2 Armature. Ensure that the brake pin is tight and symmetrically positioned.

12.3 Check that the jump ring locates properly in the drive shaft groove and is covered by the thrust collar.

12.4 Drive end and intermediate brackets. Ensure that the dowel peg in the drive-end bracket aligns with matching location in the intermediate bracket before offering the yoke into position.

12.5 Brush plate. Wedge the earth brushes in raised position with brush springs.

12.6 Offer the brush plate into position and fit the field coil brushes in the boxes.

12.7 Release the earth brushes and position the springs.

12.8 Ensure that the brushes move freely in the holders.

12.9 Commutator end bracket. Check that the earth stud is fixed securely.

12.10 Ensure that the armature brake pin and slots in the brake shoes align with each other.

12.11 Make sure that the fixing holes in the brush plate line up with the holes in the commutator end bracket.

12.12 Check that the through bolts are aligned with the threaded holes in the drive-end bracket.

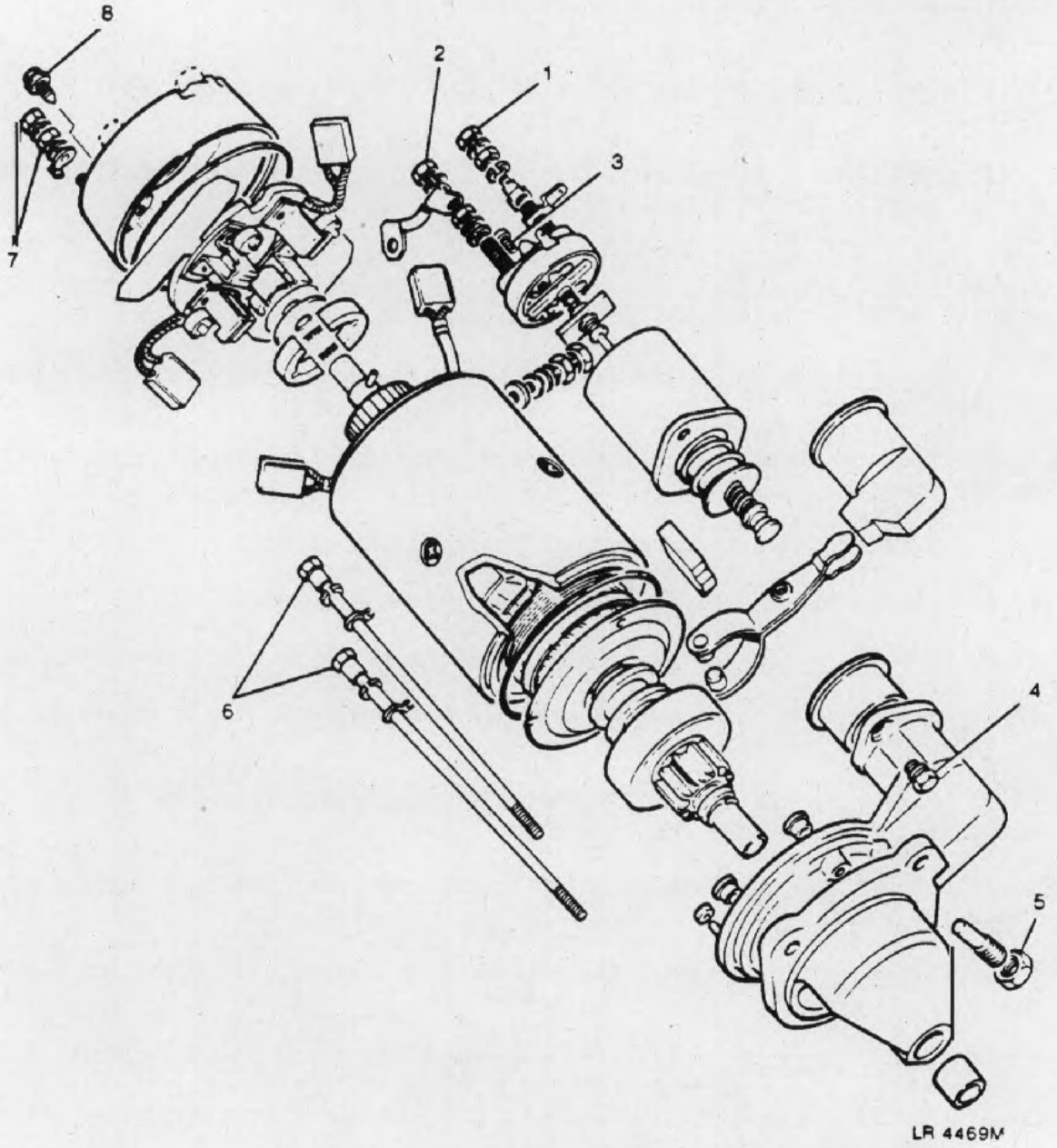
12.13 Solenoid. Ensure that the plunger locates properly with the operating lever.

12.14 Pinion setting. Screw the eccentric pivot pin fully into the casing and slacken one full turn and position with arrow on the pin in line with the arrow on casing and tighten locknut. This provides an initial setting for final adjustment.

12.15 Connect up the starter, using a 6 volt supply and operate a starter control switch so that the pinion will move into the engaged position without rotating.

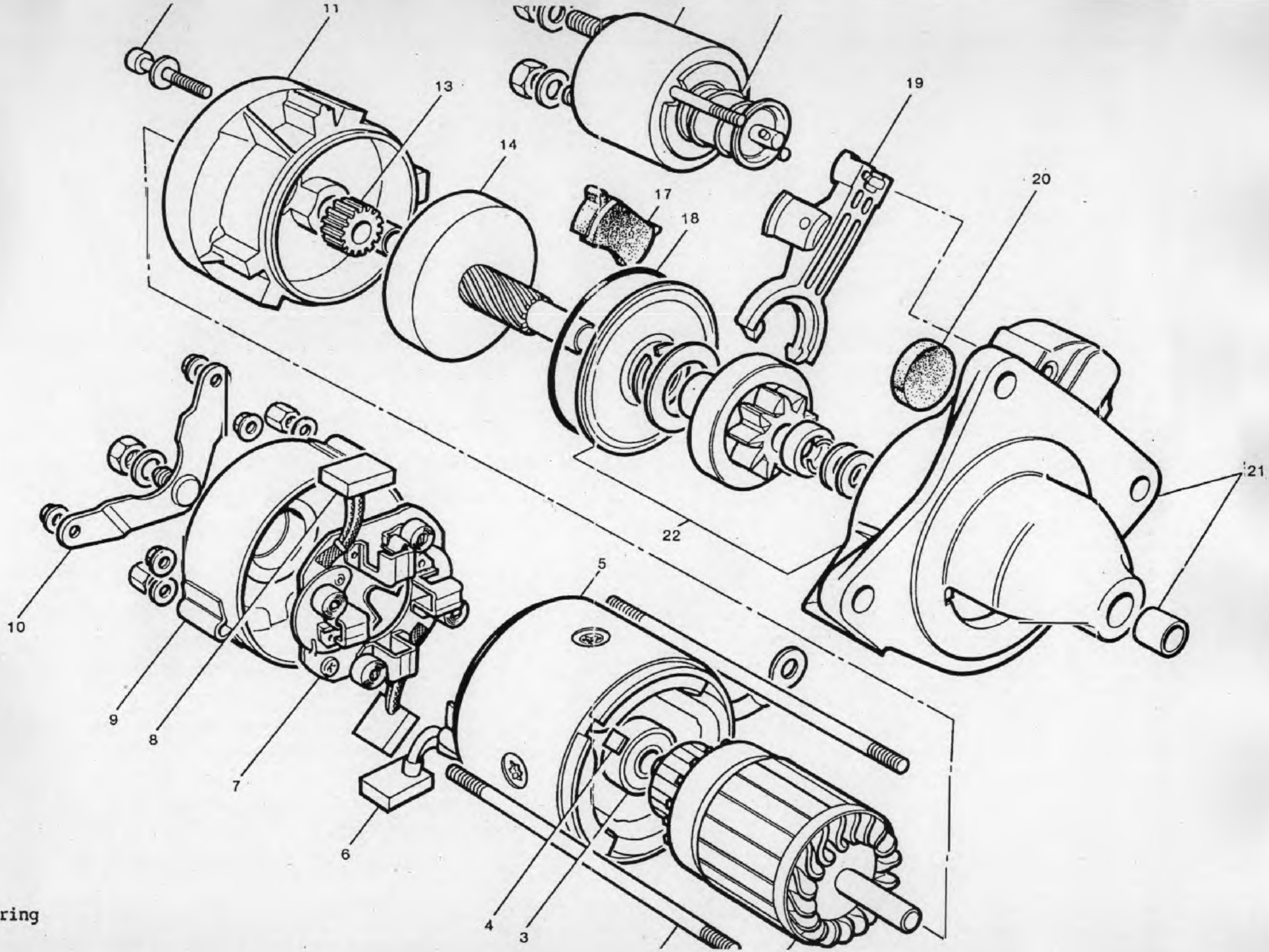
12.16 Whilst maintaining this position, press back the pinion towards the yoke. Insert a feeler gauge between the pinion end face and jump ring collar. The correct clearance should be 0.1 to 0 .38 mm (0.005 to 0.015 in).

12.17 If adjustment is required, release the locknut and turn the pivot pin as necessary to achieve the correct setting. Apply "gold size" to the threads of the pivot pin and locknut and tighten the latter to the correct torque.



1	Solenoid main "BAT" terminal cable fixing nut	3.9 Nm (2.9 lb ft)
2	Solenoid/starter link terminal fixing nuts	3.5 Nm (2.6 lb ft)
3	Solenoid end cover fixing screws	2.82 Nm (2.1 lb ft)
4	Solenoid unit fixing screws	6 Nm (4.5 lb ft)
5	Eccentric pivit pin locknut	20 Nm (15.0 lb ft)
6	Through bolts	10.84 Nm (8 lb ft)
7	Starter arth stud, nuts	6 Nm (4.5 lb ft)
8	Brush plate fixing screws	7 Nm (5.0 lb ft)

Fig 33 Tightening torques



key

shes

es
ver

housing
crew
pinion

er and spring

13.2 Disconnect field winding lead from the solenoid.

13.3 Remove the two nuts and withdraw the solenoid, plunge

13.4 Remove the terminal strap.

13.5 Remove the two through-stud nuts.

13.6 Remove the brush plate cover.

13.7 Withdraw the yoke complete with brush plate assembly w noting the position of the yoke location plate in the reduct housing

13.8 Remove the single socket headed screw and withdraw the and reduction gear housing from the drive-end bracket.

13.9 Remove the clutch drive and pinion assembly.

13.10 Withdraw the brushes from the holders.

Inspection and test

14 Examine all parts for condition as follows:

14.1 Check the bearings and bushes and pinion drive assembl

14.2 Examine the reduction drive pinion and drive gear inte

14.3 Check the field coil and armature brushes.

14.4 Armature. Using very fine glass paper, clean the comm the surface with a petrol-moistened cloth. Do not undercut t insulation slots.

14.5 Check the armature insulation by connecting a megohmme each commutator segment in turn and the armature shaft (Fig armature if necessary

14.6 Field coil insulation. Connect a megohmmeter between t end of the winding and a clean part of the yoke (Fig 36).

14.7 Ensure that the brushes or leads do not touch the yoke test.

14.8 If necessary, fit a new field coil assembly.

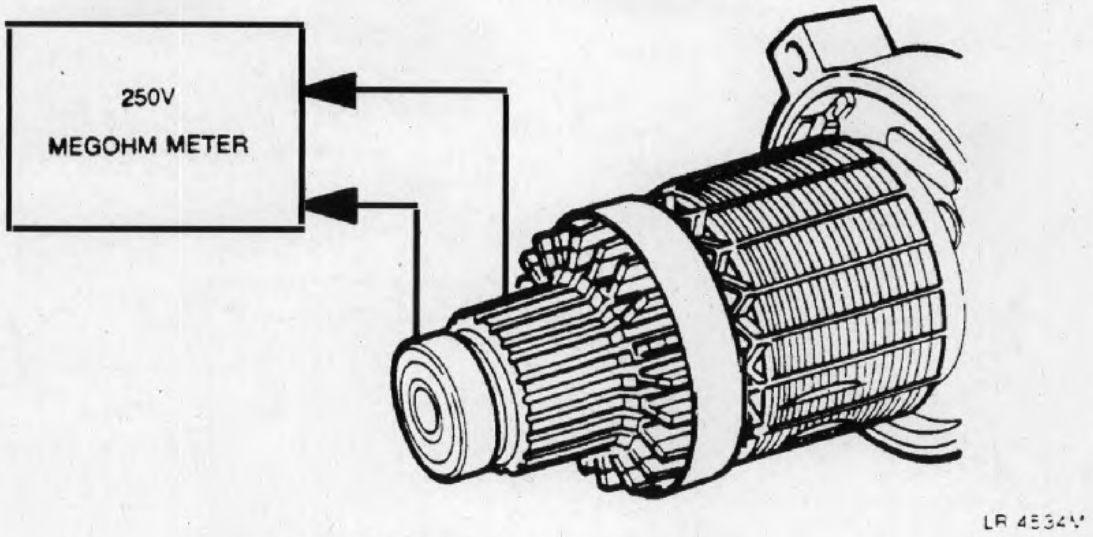


Fig 35 Testing the armature

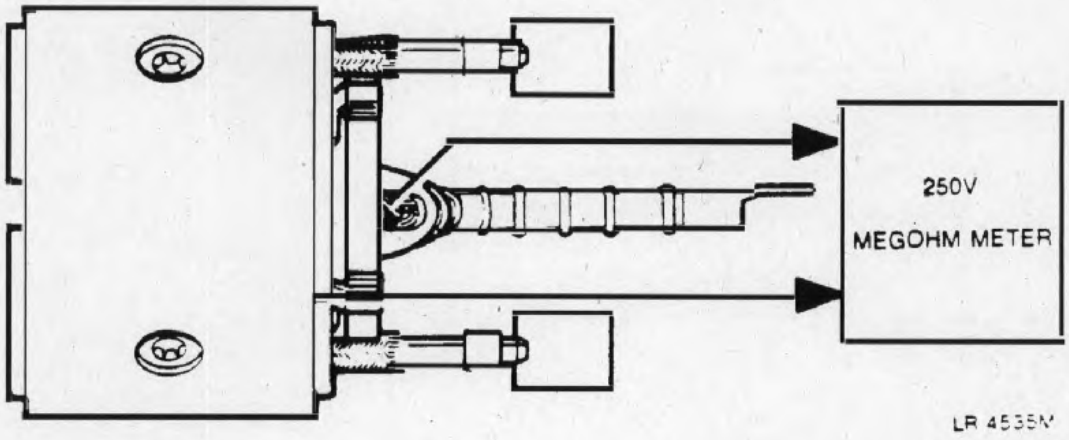


Fig 36 Field coil insulation

14.9 Field coil continuity. Connect a megohmmeter between each brush in turn and a link lead (Fig 37).

14.10 Fit a new field coil assembly if necessary.

14.11 Solenoid. Disconnect all cables from the solenoid terminals and connectors.

14.12 Connect an ohmmeter across the solenoid main terminals (Fig 38). Renew solenoid complete if open circuit is indicated.

14.13 Energize the solenoid by connecting a 12V supply between the small solenoid operating lucar terminal blade and a good earth point on the solenoid body (Fig 38).

14.14 The solenoid should be heard to operate and the voltmeter should read 12V, otherwise fit a new solenoid complete.

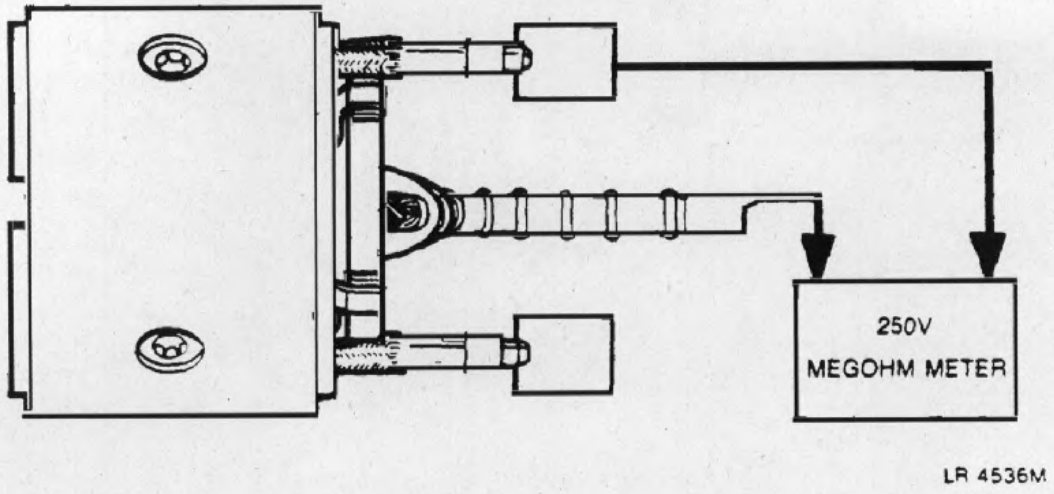


Fig 37 Field coil continuity

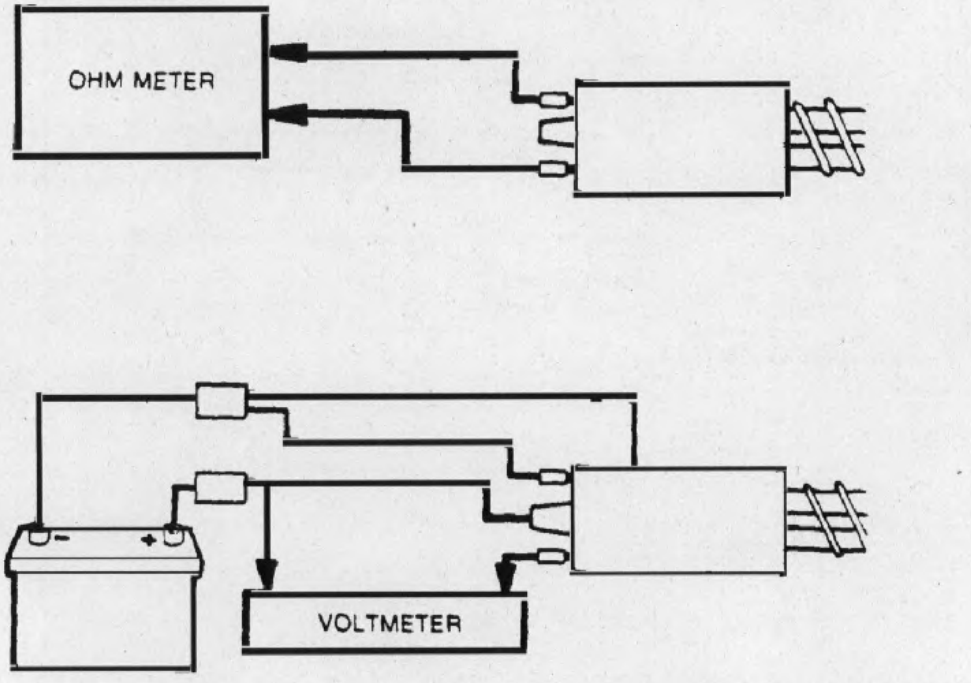


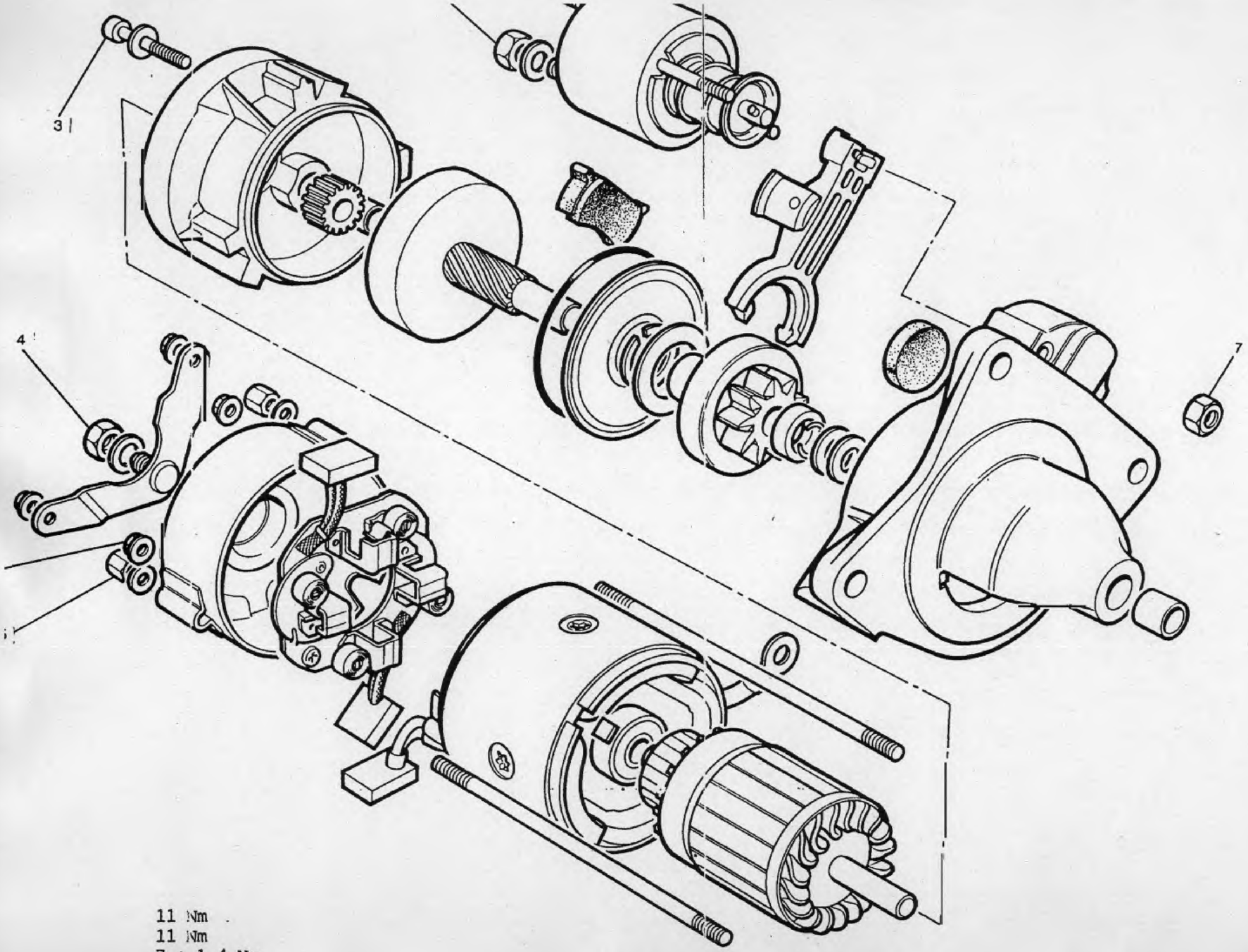
Fig 38 Testing the solenoid

Ass mbling

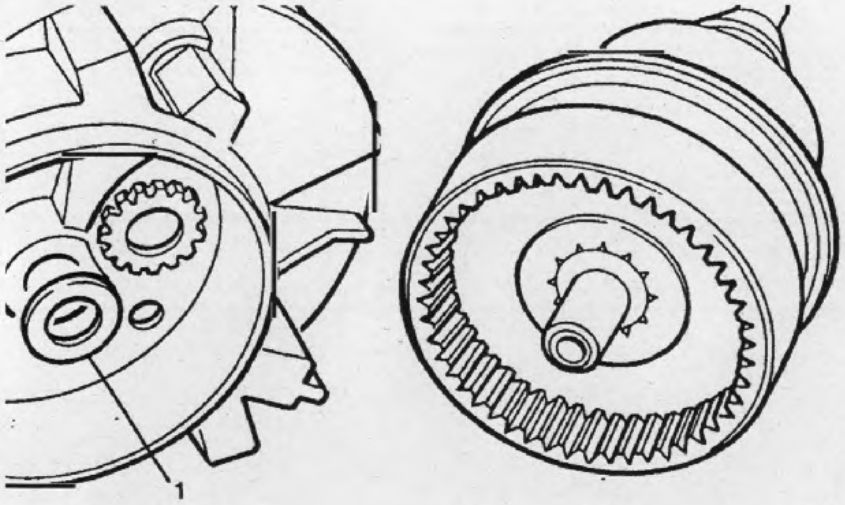
15 Reassembly is mainly a reversal of the foregoing dismantling procedure. However, the following points should be observed.

15.1 Fit the round rubber pad to the drive-end bracket (Fig 39).

15.2 Fit the lever to clutch drive and pinion assembly and fit to the drive-end bracket ensuring that the two washers are in position on the shaft.



11 Nm
11 Nm
7 + 1.4 Nm



LR 4538M

Fitting the rubber pad to the drive end bracket

t the fibre washer is positioned on the shaft inside the

rubber pad, with plain side towards the drive-end bracket
g seal and assemble the reduction gear housing to the
et and secure with the single socket-headed bolt.

yoke location plate in position in the slot in the
housing and fit the yoke and brush plate to the armature.

he brushes into their holders and release the retaining
e that the brushes rest correctly on the commutator.

through-studs to the drive-end bracket.

brush plate cover and secure to the brush plate with the two

he assembly with the through-stud nuts.

terminal strap to the through-studs and retain with the two

coil spring to the solenoid plunger and assemble the
e drive-end bracket and secure with the two nuts.

without tight spots.

Chapter 13-2

12/24 VOLT FFR ELECTRICAL SYSTEM

CONTENTS

INTRODUCTION

1 This Chapter details level 4 repairs for the 24 volt electrical system fitted to Land Rover 90 and 110 F.F.R. vehicles. The information given is applicable to both left and right hand vehicles.

90 AMP BRUSHLESS ALTERNATOR

Removal

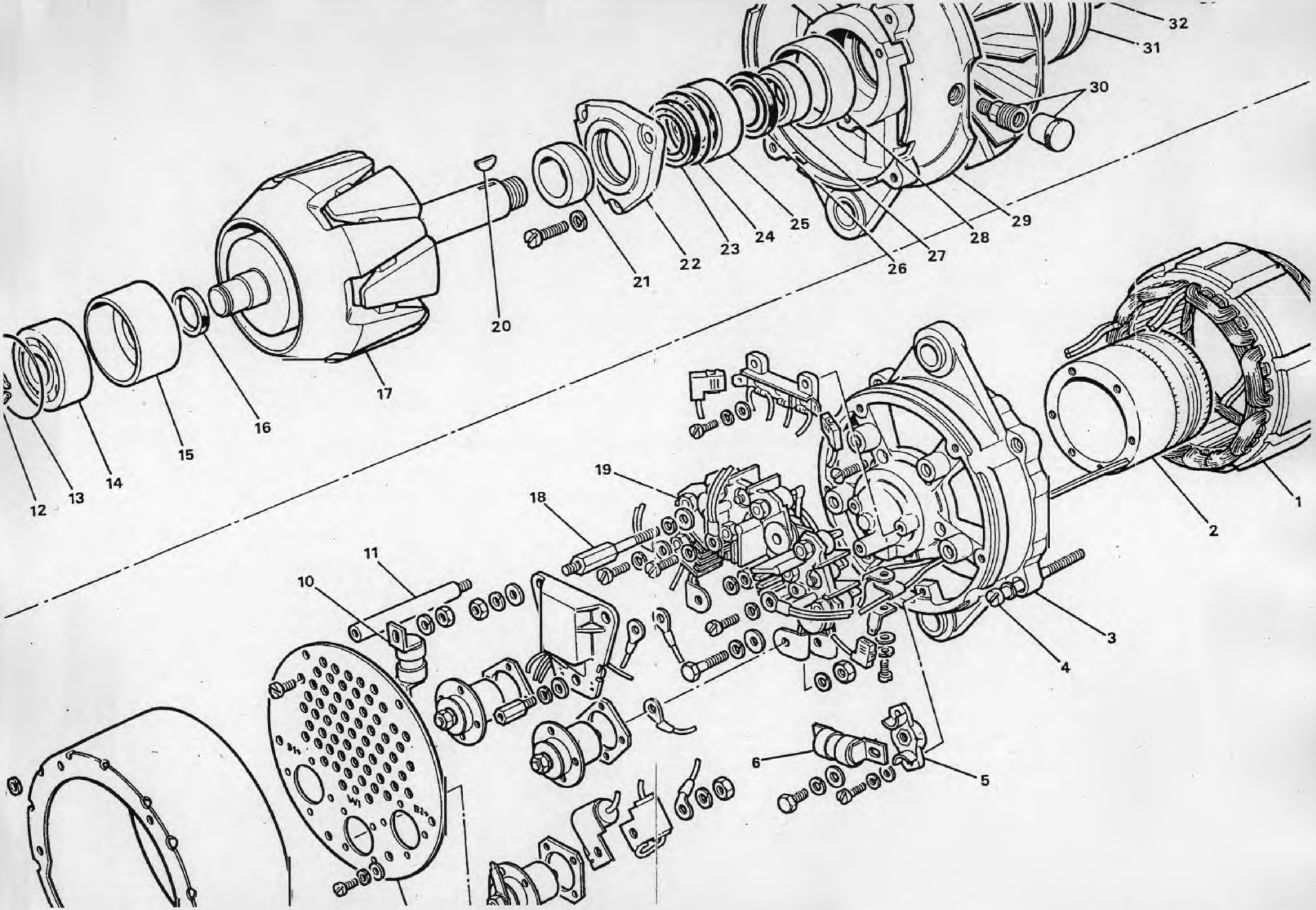
2 Remove the alternator from the vehicle (Category 522 Chapter 13-2) and place on the bench.

Dismantling

3 Before commencing to dismantle the unit, remove all surface dirt and grease with a rag or soft brush dipped in kerosene or suitable cleaning fluid, taking care to prevent excess liquid from entering the unit through the gaps in the casing. A clamping device similar to that shown in Fig 2 will prove to be extremely helpful in carrying out the following operations.

Key to Fig 1

1	Stator
2	Field coil
3	Front end shield
4	Fixing screw
5	Fuse holder
6	Fuse
7	Bushing capacitor
8	Suppression cover
9	Cowl
10	Fuse
11	Pillar bolt
12	Circlip
13	"O" Ring
14	Rear bearing
15	Bearing collar
16	Seal
17	Rotor
18	Pillar bolt
19	Heat sink
20	Woodruff key
21	Sealing collar
22	Clamp plate
23	Seal
24	"O" Ring
25	Drive end bearing
26	Seal
27	Sealing collar
28	Bearing collar
29	Drive end bearing shield
30	Stauffer lubricator
31	Pulley
32	Spring washer
33	Nut


32
31
30
29
28
27
26
25
24
23
22
21
20
17
16
15
14
13
12
1
2
3
4
5
6
18
19
10
11

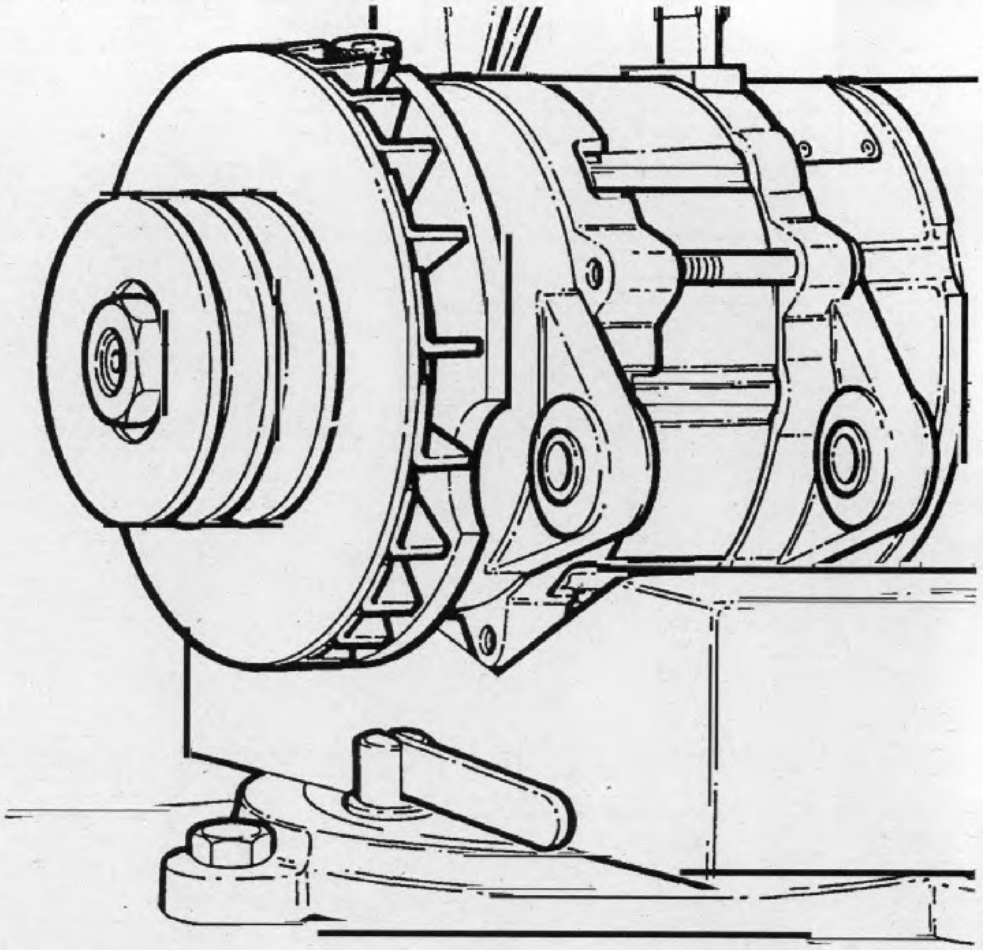


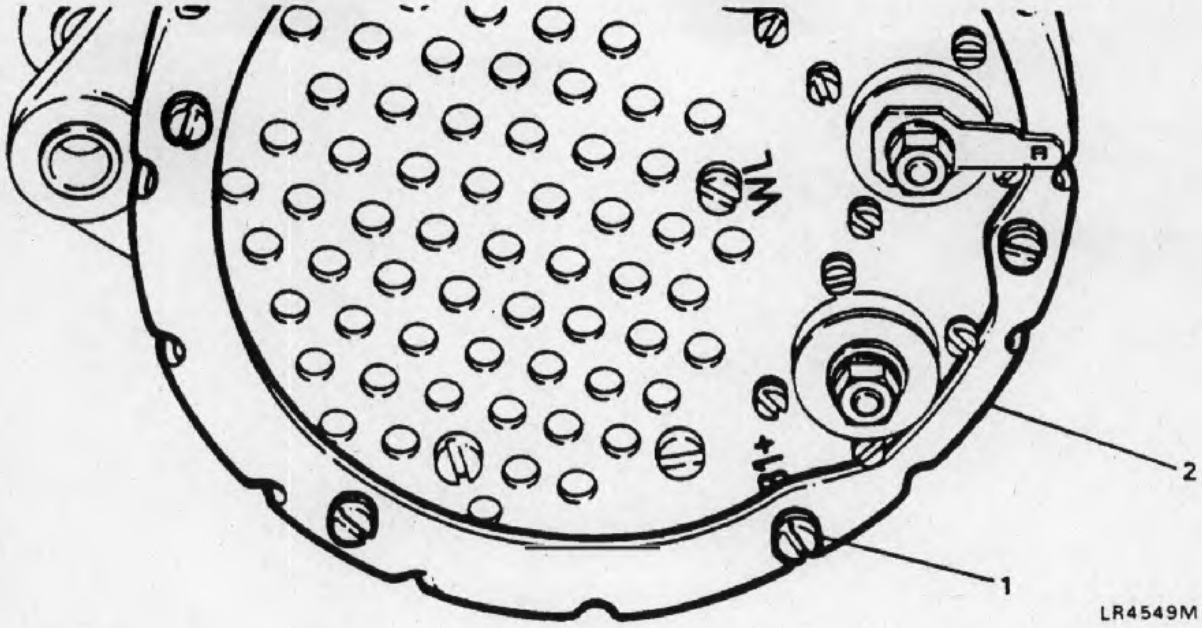
Fig 2 Alternator in clamping device

3.1 Unscrew and remove the five peripheral screws and sprin
(Fig 3 (1)) from the rear end of the alternator. Remove the

3.2 Unscrew and remove the nuts and washers retaining the w
the rear of the bushing capacitors, (Fig 4 (1, 2 & 3)). Not
of the wires before detaching them.

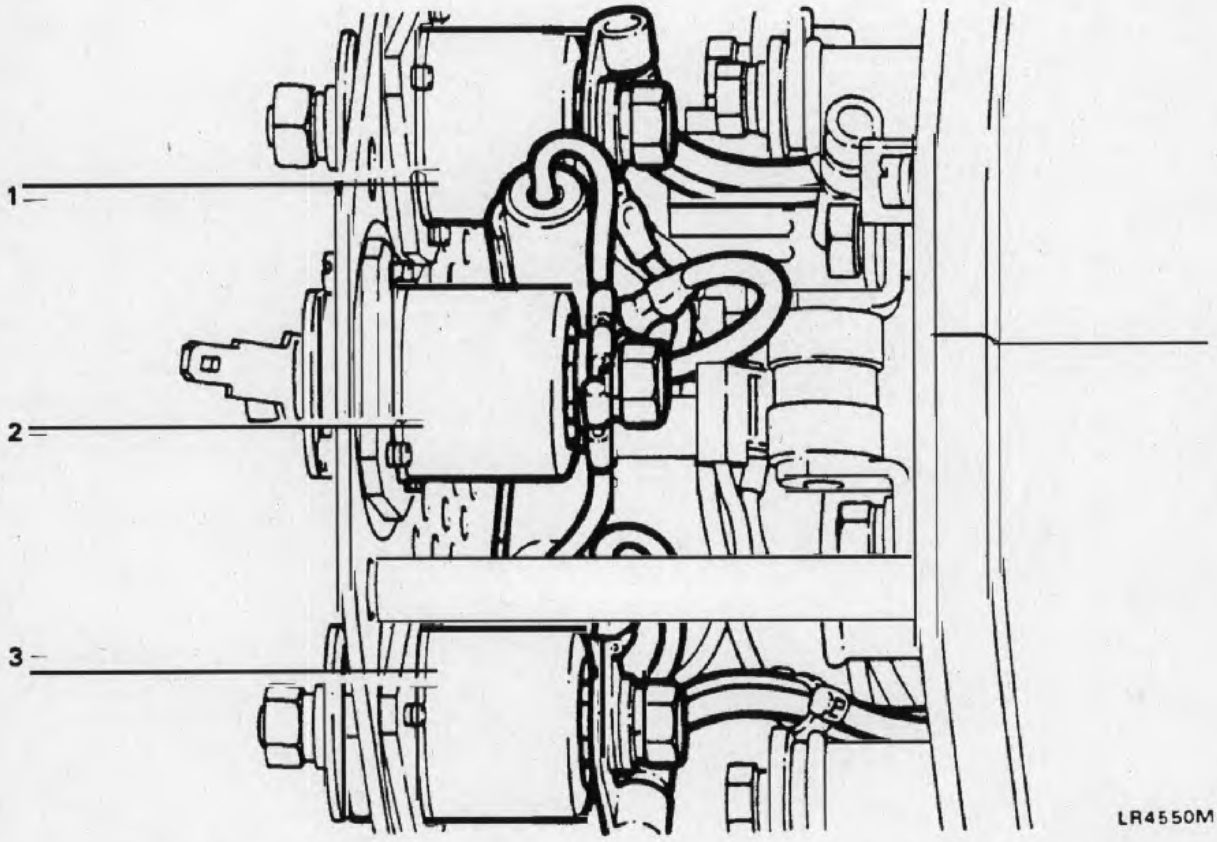
3.3 Unscrew and remove the central fixing screw and spring
(Fig 5 (1)), and detach the suppression cover (3). If any bu
capacitors are to be replaced, unscrew and remove the four s
spring washers (2) securing each capacitor to its clamp plat
the capacitor from the suppression cover.

3.4 Unscrew and remove the pillar bolt (Fig 6 (3)) and the



1 Cowl fixing screws 2 Cowl

Fig 3 Cowl removal

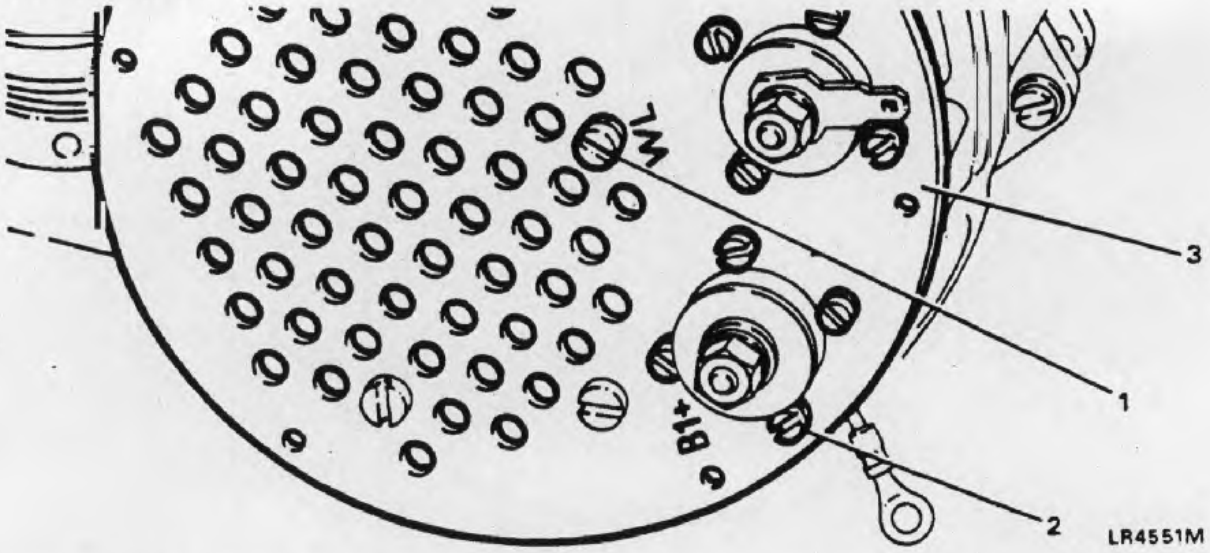


1 Bushing capacitor 2 Bushing capacitor 3 Bushing capacitor

Fig 4 Disconnecting bushing capacitors

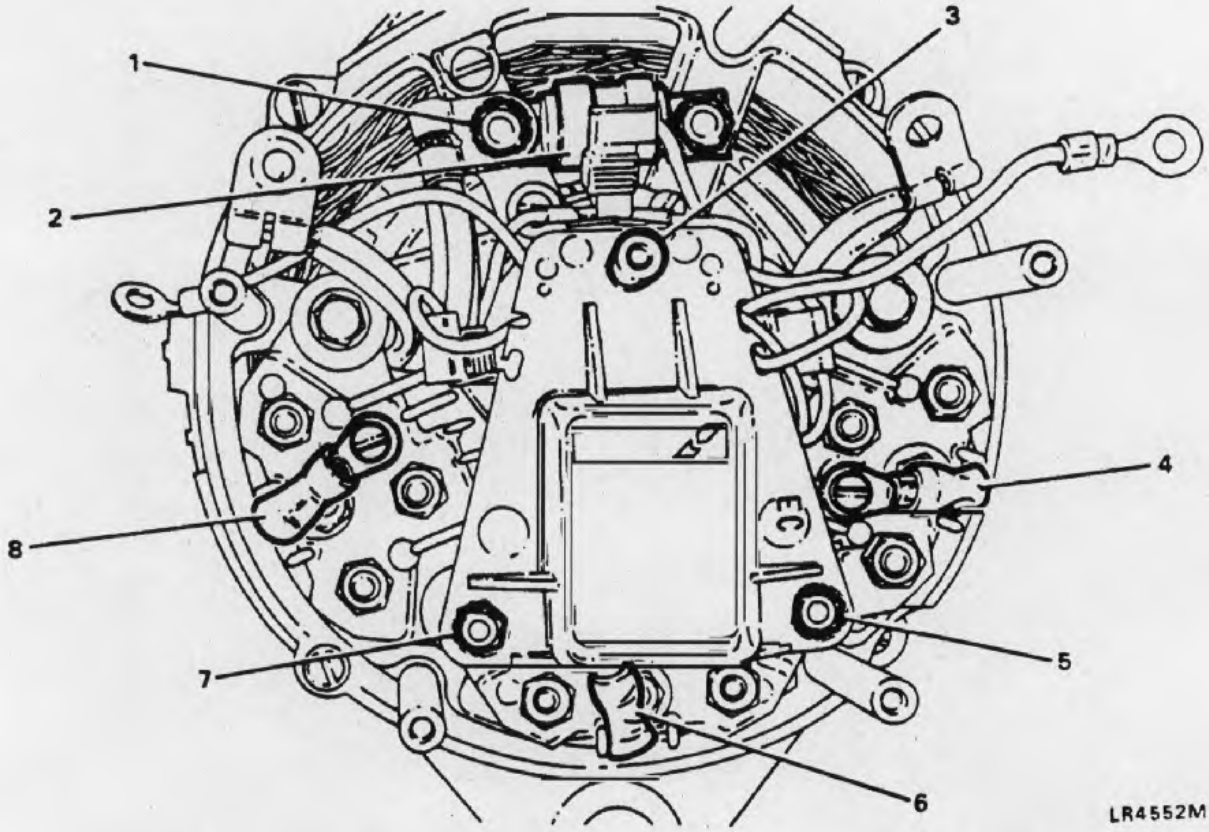
3.5 It will be necessary to unsolder the auxiliary diode lead (Fig 7 (1)) before the heat sink assembly can be completely removed. Loosen and remove the two screws, spring washers and plain washers (2 & 5), followed by the two pillar bolts (3 & 4) with spring and plain washers, securing the heat sink assembly to the rear end shield.

3.6 Using a felt tipped pen, scribe a line across both end shi lds and the stator (Fig 8) to ensure that all thr e it ms ar correctly aligned when r assembled.



1 Central fixing screw 2 Capacitor fixing screws 3 Suppression cover

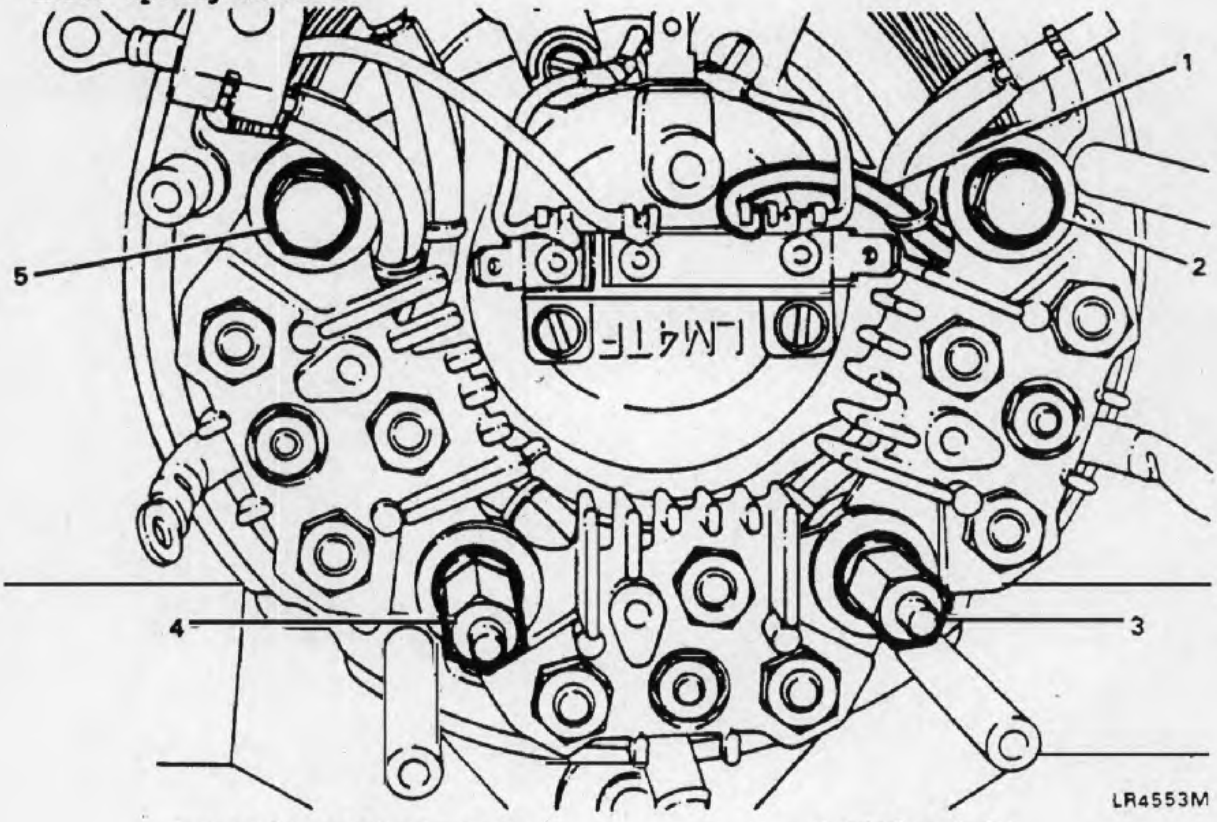
Fig 5 Suppression cover and bushing capacitor removal



1 Negative output lead fixing screw
2 Fast fuse
3 Pillar bolt
4 Stator lead
5 Regulator fixing nuts
6 Stator lead
7 Regulator fixing nuts
8 Stator lead

Fig 6 Voltage regulator removal and stator lead disconnection

3.7 Unscrew and remove the four external through-bolts, together with their spring washers.



1 Auxiliary diode lead
2 Heat sink fixings
3 Pillar bolt
4 Pillar bolt
5 Heat sink fixings

Fig 7 Heatsink removal

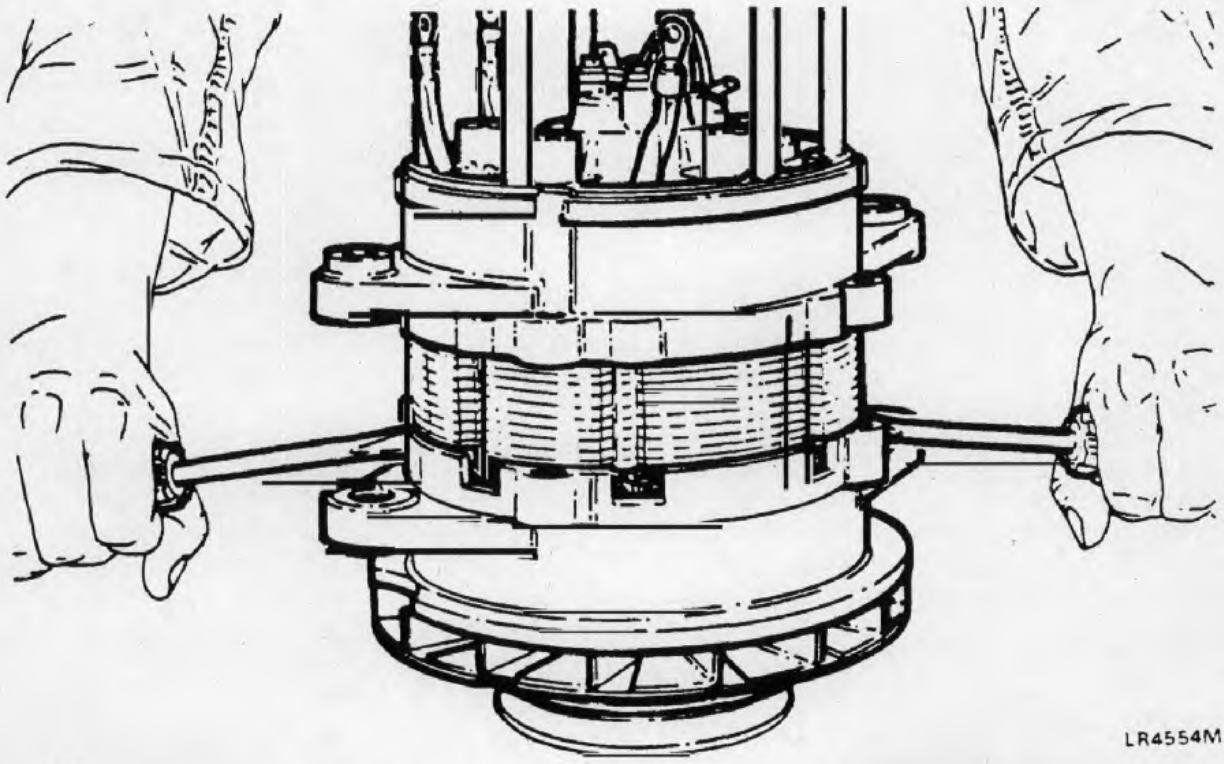
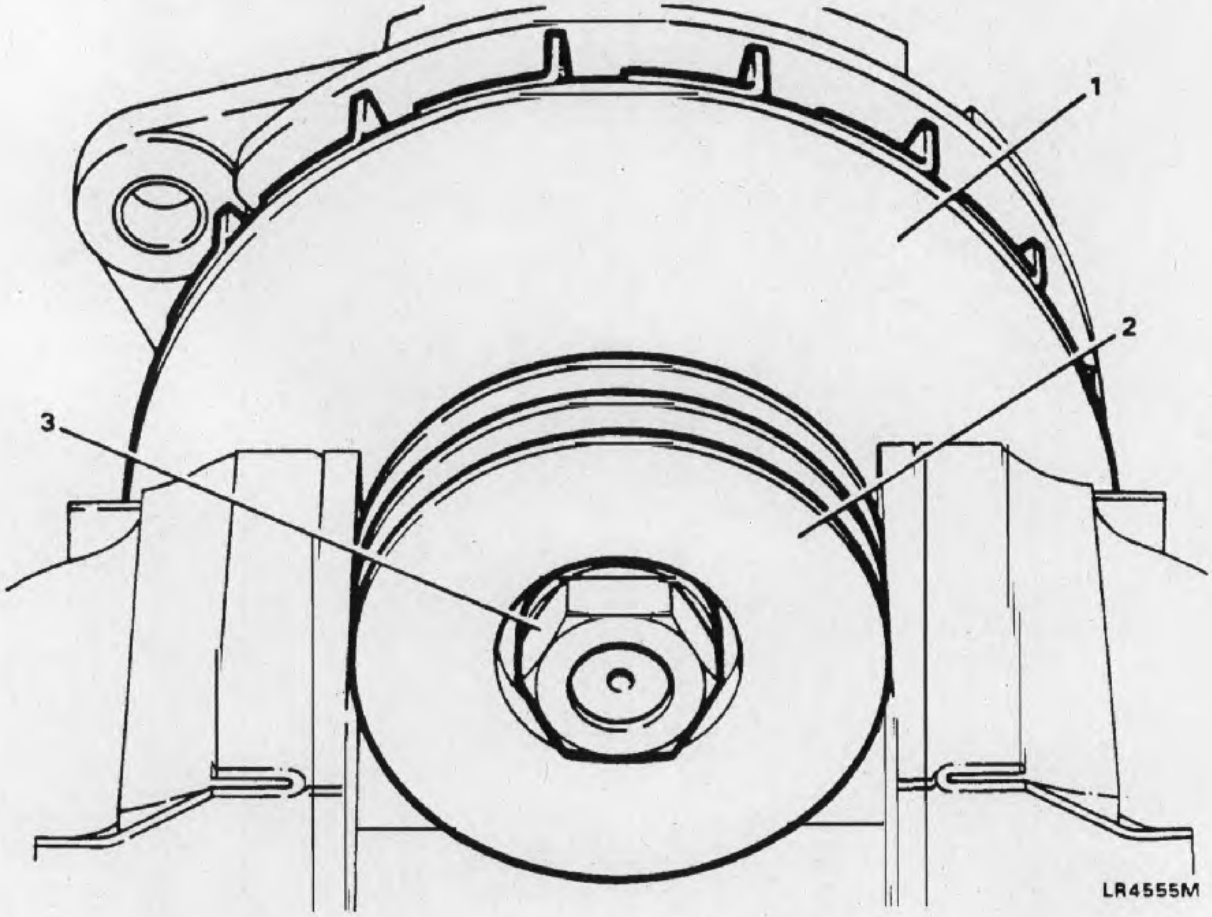


Fig 8 Separating stator from end shields

3.8 Support the unit upright on its pull y (Fig 8). Taking care not to damage the stator windings, use a pair of screwdriv rs in opposite ventilation slots to separate the stator and rear end shi ld from the drive nd shield.

3.9 Using soft jaws, clamp the pulley (Fig 9) in a vice and unscrew and remove the pulley nut and spring washer (3); remove the pulley from the rotor shaft. Lever out the woodruff key and remove the fan (1).



1 Fan 2 Pulley 3 Pulley nut

Fig 9 Pulley removal

3.10 Place the drive end shield and rotor in a suitable press (Fig 10), drive end uppermost. Ensure that the drive end shield is adequately supported, apply pressure to the drive end of the rotor shaft; support the rotor with one hand as it is pressed from the end shield. Remove the spacers from either side of the drive end shield.

3.11 Unscrew and remove the three clamp plate securing screws and spring washers (Fig 11 (1)), and remove the clamp plate (2). Using a suitable press, remove the bearing (3) from the drive end shield. Using a large screwdriver, carefully lever out the rubber seals from the drive end shield and clamp plate. Discard both seals.

3.12 Remove the circlip (Fig 12 (1)) from the rotor. Using a suitable bearing puller, remove the rear end bearing and cup assembly (2) from the rotor.

3.13 Holding the stator by hand, gently tap the rear end shield free from the stator using a hide mallet.

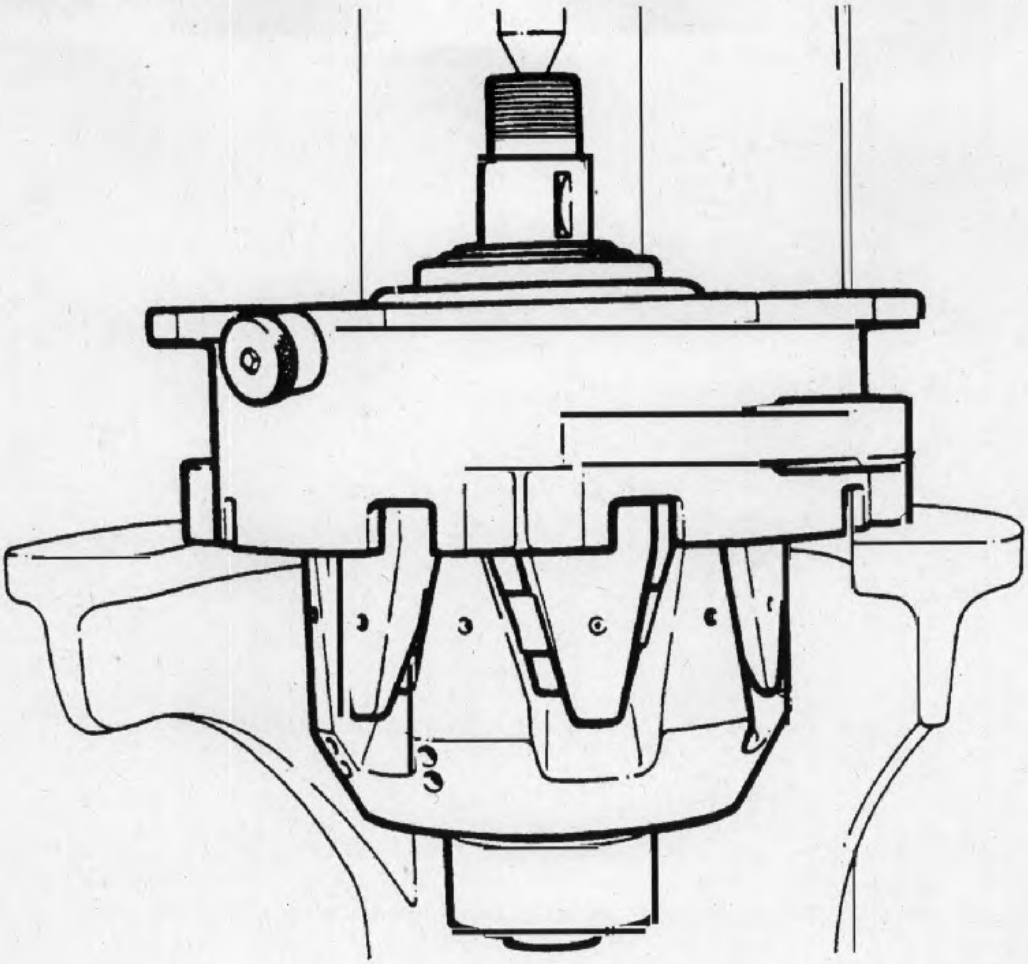
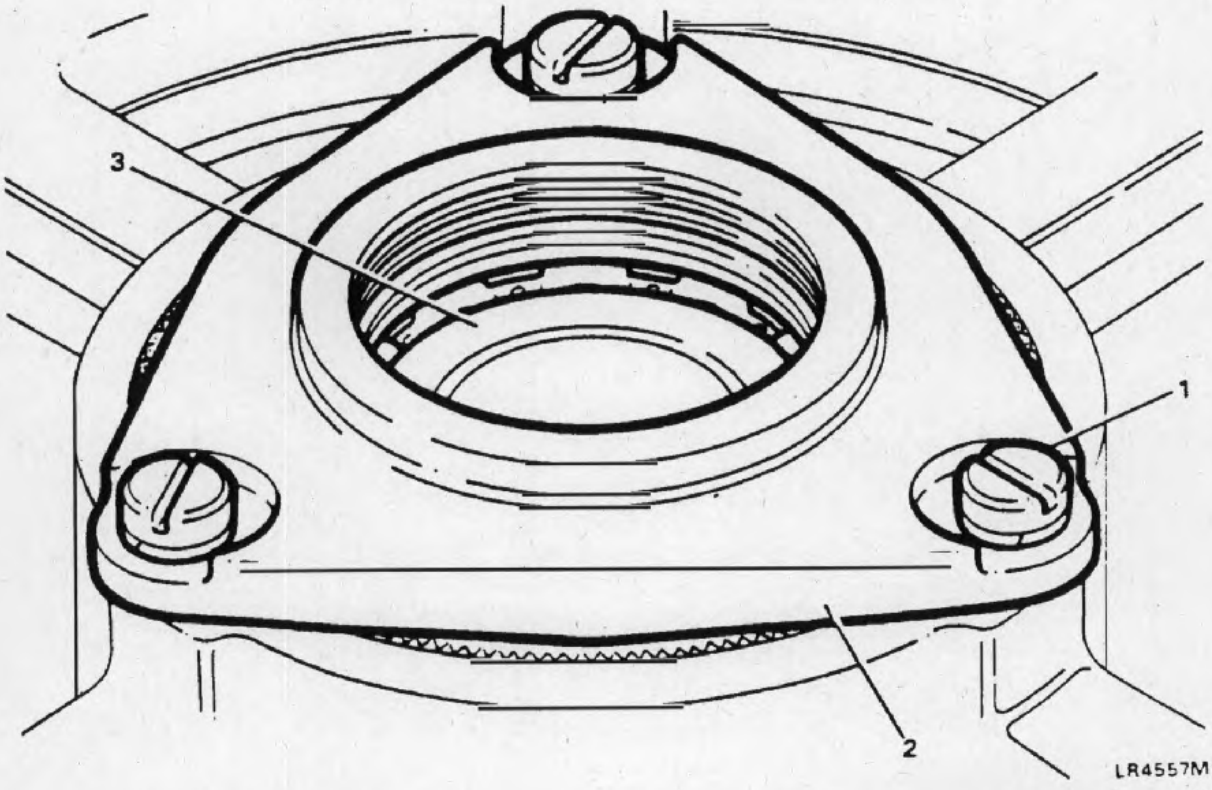
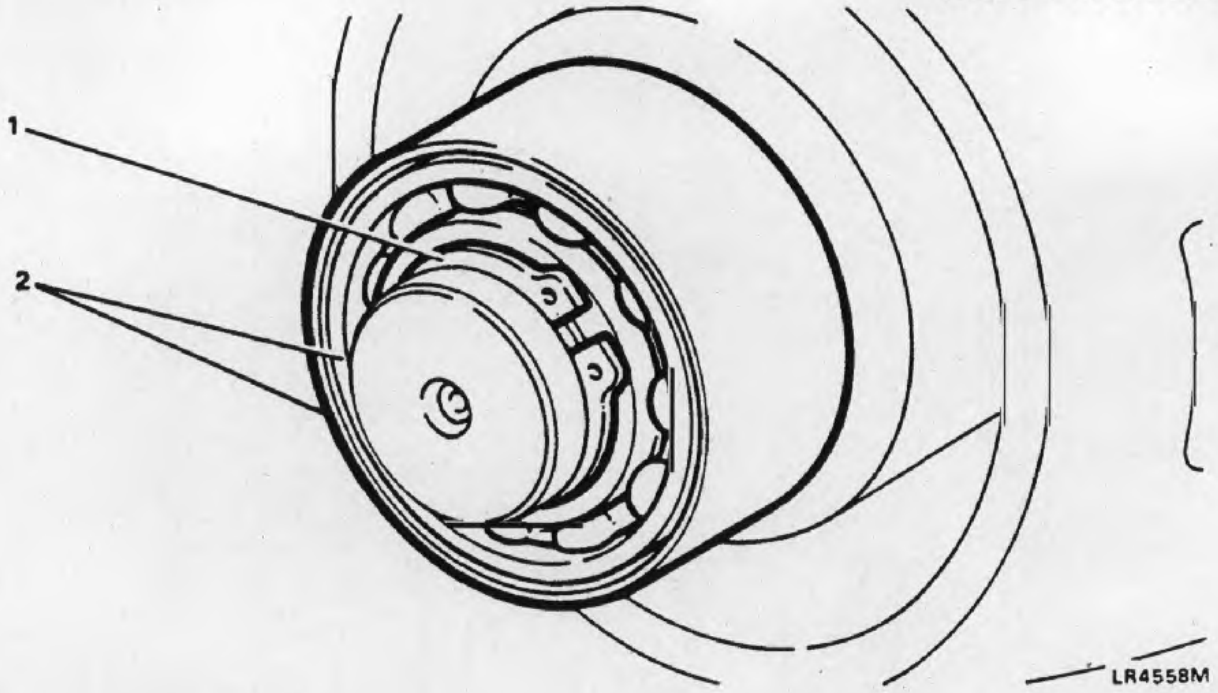


Fig 10 Rotor removal from drive end shield



1 Clamp plate fixings 2 Clamp plate 3 Bearing

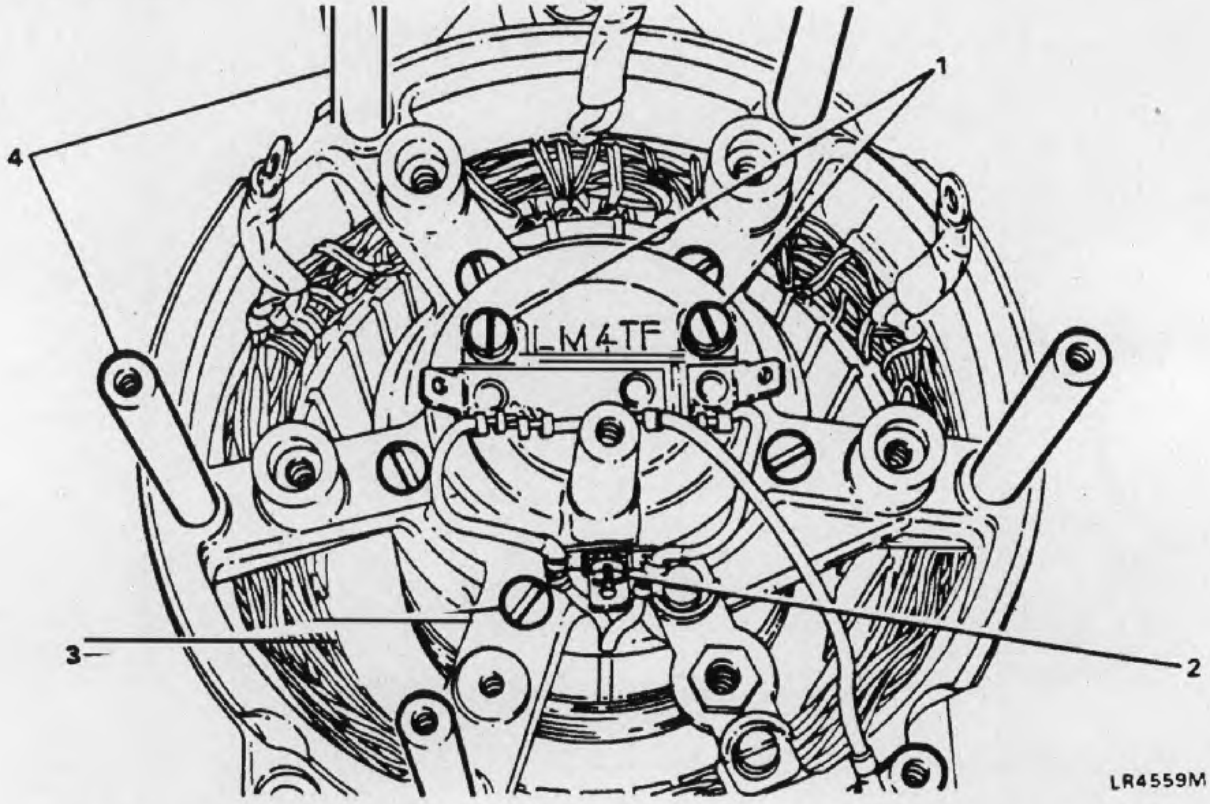
Fig 11 Clamp plate, drive end bearing and seals removal



1 Circlip 2 Rear end bearing assembly

Fig 12 Rear bearing removal

3.14 Unscrew and remove the two screws and washers (Fig 13 (1)) securing the terminal strip. Remove the screw securing the Lucar connector (2) and the two field leads, and pass the terminal strip through the aperture in the end shield.



1 Terminal strip fixings 2 Lucar connector fixings
3 Clamping screws 4 Pillar bolts

Fig 13 Stator and field coil removal

3.15 Mark the position of the field coil in relation to the rear end shield. Unscrew and remove the five clamping screws (3) and detach the field coil.

3.16 Unscrew and remove the five pillar bolts (4). This will necessitate clamping each individual pillar bolt in a soft jawed vice and carefully rotating the rear end shield.

COMPONENTS INSPECTION AND RENEWAL

GENERAL

4 Wipe all components clean with a dry cloth then use compressed air to r move loose dust from inaccessible areas. Do NOT "spin" the bearings with compressed air as this can cause damage.

5 All components should be thoroughly cleaned with an approved cleaning agent before examination.

6 The stator frame and rotor shaft should be wiped clean using a non-fluffy rag moistened with white spirit. Take care to avoid the spirit having prolonged contact with the winding insulation and stator leads.

7 All seals and gaskets should be renewed.

8 Examine all components visually for signs of cracking, corrosion, local discoloration and any other signs of damage or excessive wear.

9 Check all internal and external threads.

DIODE AND HEAT SINK RENEWAL

Note ...

When soldering direct to the diode stems, a pair of long nosed pliers should be used to grip the stem. Their purpose is to act as a heat sink to prevent over heating of the diode assembly.

Main diodes

10 Unsolder the main lead from the diode to be replaced.

11 Unscrew and remove the securing nut and spring washer from the diode using a suitable spanner or socket. Push the diode clear of the heat sink.

12 Ensure that the new diode is clean and free from grease. Thoroughly clean the contact face and hole in the heat sink then smear both surfaces with "Biccon XZ" jointing compound.

13 Insert the new diode into the heat sink, and secure it with the spring washer and nut. Tighten the diode securing nut to a torque of 2,7 to 3.1 Nm.

14 Ensure that the connecting surfaces of the main lead and diode are clean and free from grease. Reposition the lead and solder it to the diode.

Auxiliary diodes

15 Unsolder the lead from the diode which is to be replaced.

16 Renew the diode using the procedure for main diode renewal.

17 Re-solder the l ad to the stem of the n w diode.

18 To connect the auxiliary diode lead, slide a small glass fibre sleeve of suitable diameter over the lead to be joined. If necessary, splice in a small length of suitable cable to lengthen the lead. Twist the bared ends together and solder the joints. Apply VA276 varnish to the joint. When partly dry (tacky), slide the glass fibre sleeve over the joint and varnish with more VA276.

19 When complete, paint the entire assembly-heat sink, diodes and leads-with Pacific Blue Q14 synthetic enamel.

20 "Crimping" together the auxiliary diode leads is permitted provided the correct crimping tool and a connector of the correct size and electrical value are used; typical field current is 3.5 amp.

21 Replacing heat sinks. When renewing heat sinks, ensure that the insulating bushes and washers are fitted in the correct sequence to insulate the heat sinks from the end shield and from each other.

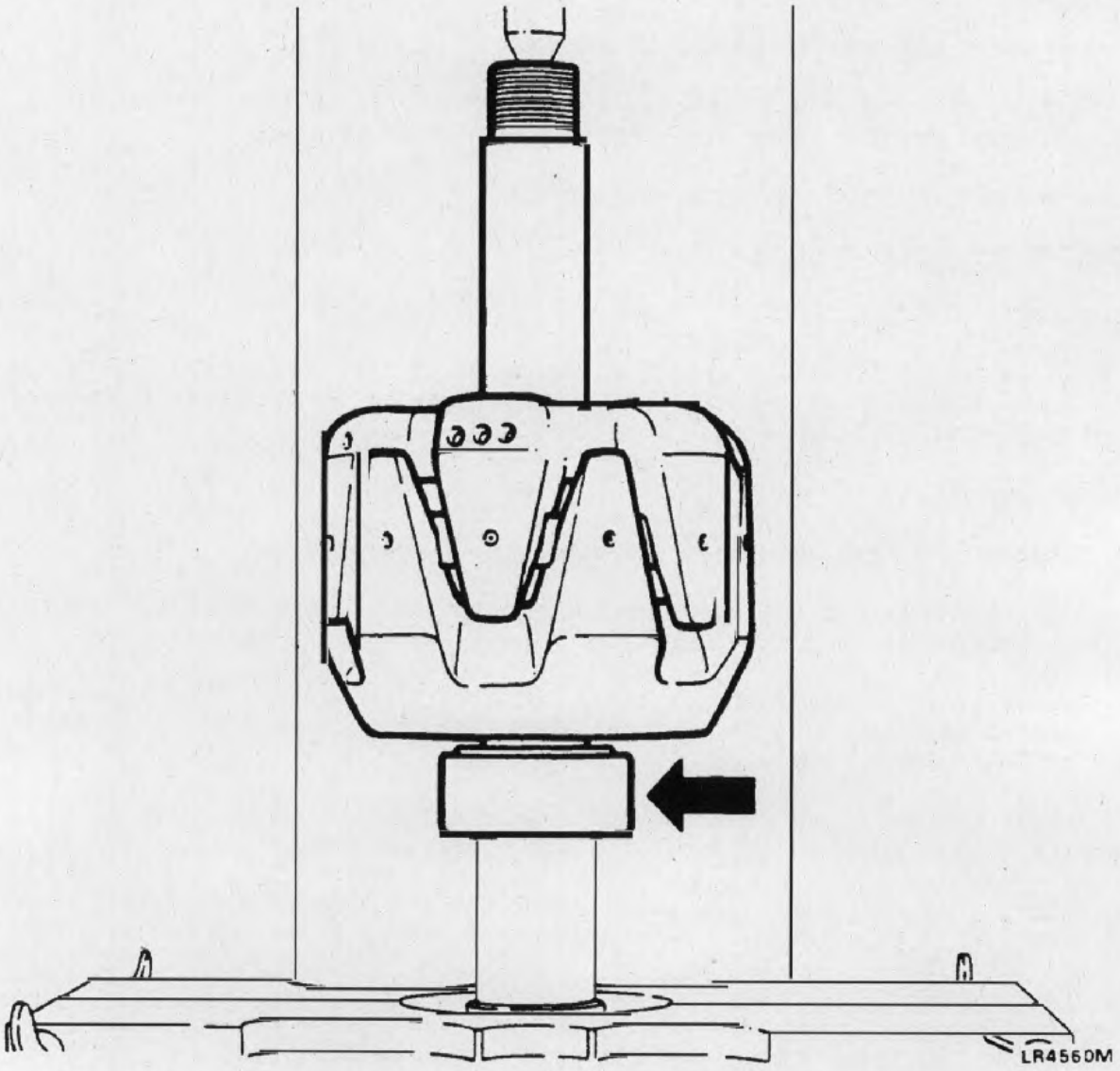


Fig 14 Fitting rear end bearing to rotor shaft

22 Bearings. It is r commended that new bearings are fitted as normal routine when the alternator is being completely overhauled.

Assembling

Note ...

All threaded components must be tightened to the correct torque value, see torque chart (Fig 19 page 18).

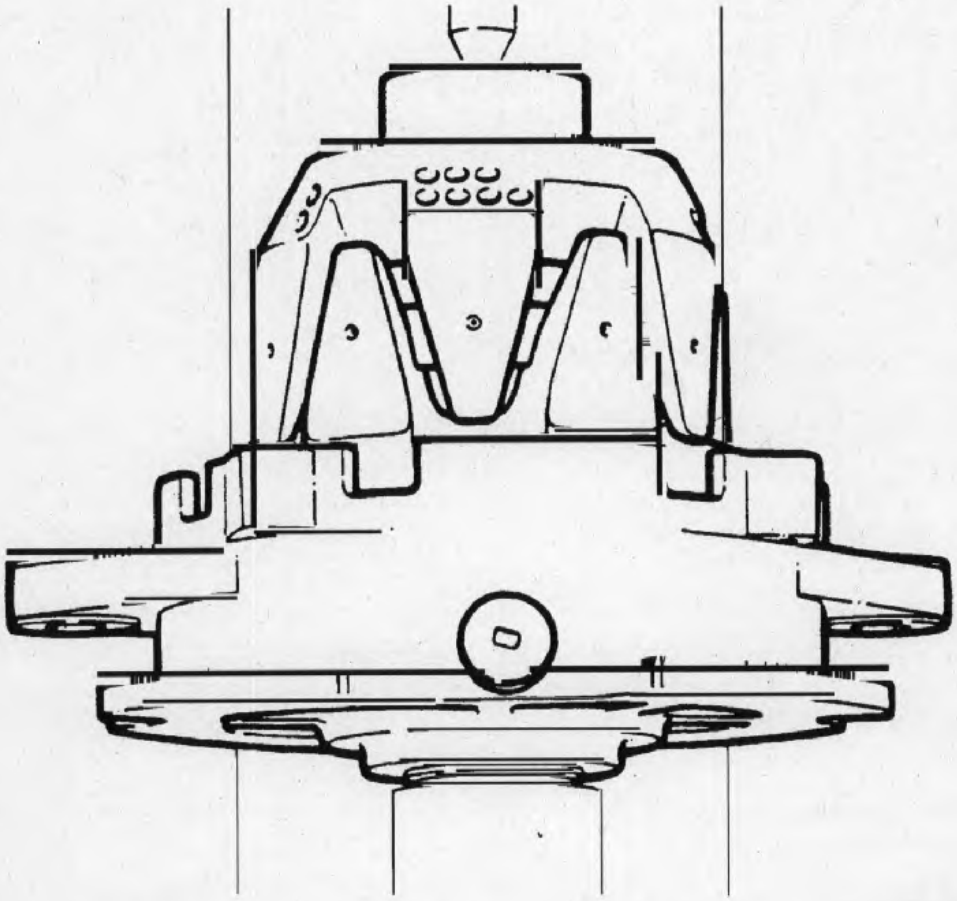
23 Using a suitable support on the inner race (Fig 14), press the rear end bearing and cup assembly onto the rotor shaft.

24 Fit the rotor circlip (Fig 12 (1)). Place the spacer, chamfered edge outwards, and the sealing ring over the rotor drive shaft.

25 Pack a new rubber seal with Aeroshell 16 grease, and insert it into the drive end shield, lipped edge facing the drive end. Using a suitable press, fit the bearing (Fig 11 (3)) into the drive end shield. Fit the sealing ring to the outer edge of the drive end bearing.

26 Pack the new inner seal with Aeroshell 16 and fit it to the drive end clamp plate. The lipped edge must face away from the bearing.
Fit the clamp plate (2) as shown and secure it using the three screws and spring washers (1).

27 Invert the drive end shield and insert the sealing ring and spacer, chamfered edge inwards.



LR4561M

Fig 15 Fitting rotor to drive end

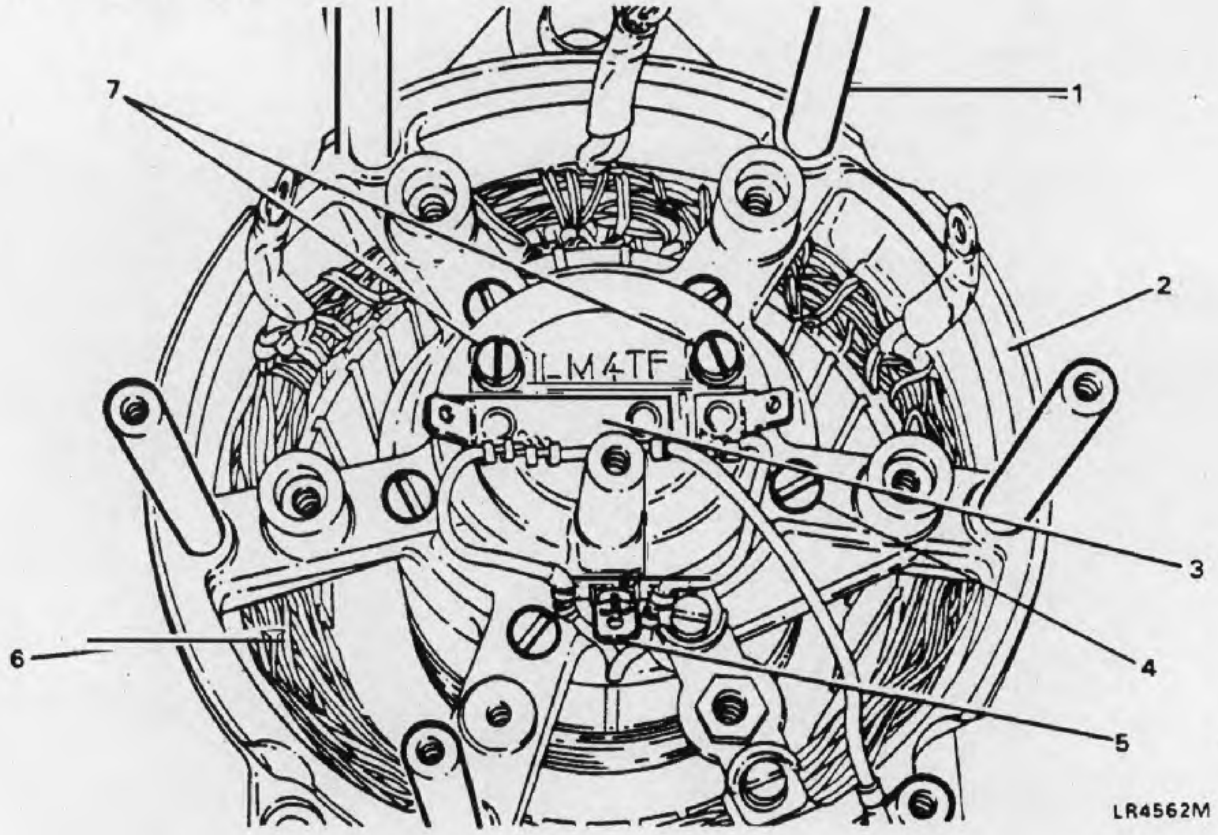
28 Place the rotor into the drive end shi ld.

29 Place the complete assembly into a suitable press, and, supporting the outer drive end shield spacer only, press the rotor fully home (Fig 15).

30 Fit the woodruff key to the rotor drive shaft. Place the fan (Fig 9 (1)) and pulley (2) onto the shaft and secure using the nut and spring washer (3).

31 Apply Loctite Studlock 270 to the threads of the five pillar bolts (Fig 16 (1)) and screw each bolt into the rear end shield, finger tight only. Fit a suitable screw to the head of each pillar and tighten to the specified torque valu . When the pillar bolts are correctly tightened, clamp each bolt in a soft jawed vice and remove the screws.

32 Place the rear end shield (Fig 16 (2)) onto the field coil, passing the terminal strip (3) through the appropriate aperture. Make sure that the scribe marks are in line.



1 Pillar bolts
2 Rear end shield
3 Terminal strip
4 Screws
5 Lucar terminal
6 Stator windings
7 Plain washers

Fig 16 Fitting stator to rear end shield

33 Apply Loctite Studlock 270 to the threads, and fit the five field coil securing screws (4).

34 Place the terminal strip in position and secure with the two screws, spring washers and plain washers (7).

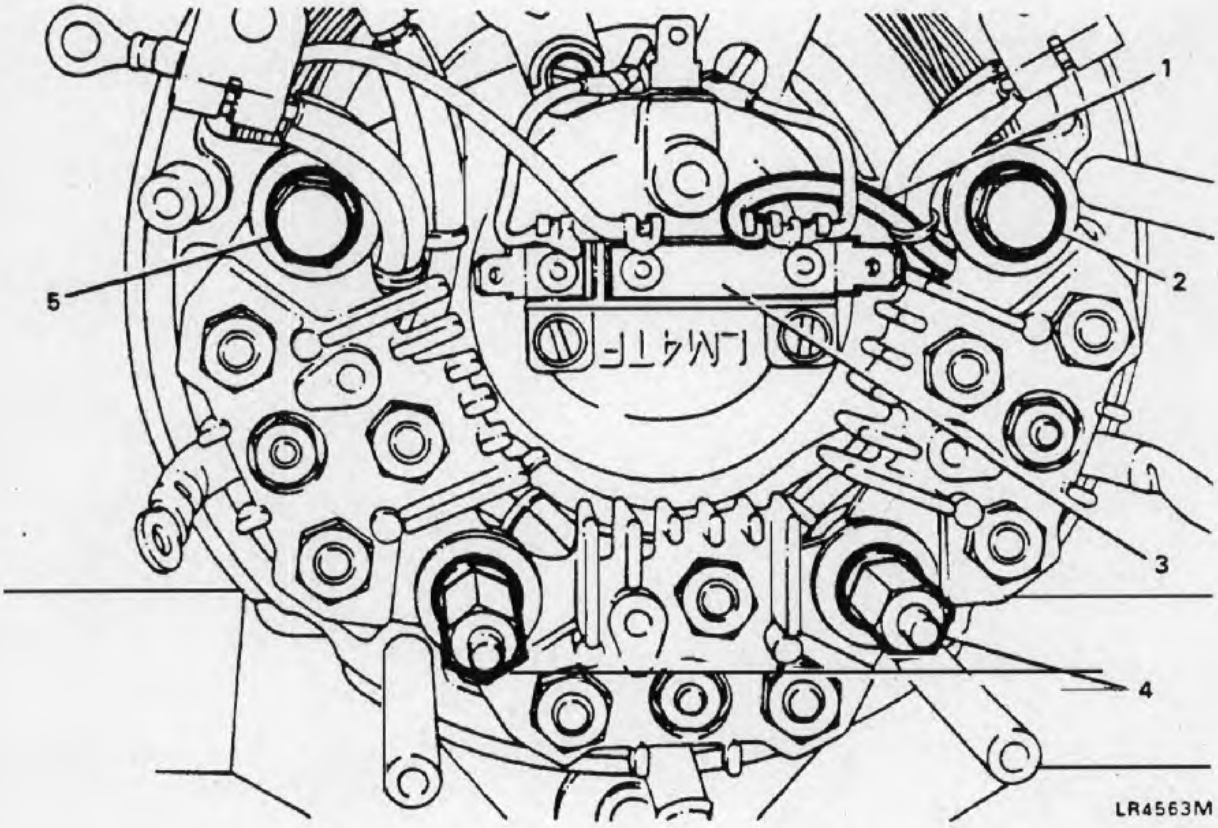
35 Secure the two field lead support clips to the end shield using the screw, spring washer and Lucar terminal (5).

36 Place the stator into the rear end shield, nsuring that the scribe marks are in line. Take care not to damage the stator windings (6).

37 Carefully fit the drive end shield and rotor assembly to the stator and rear end shield, ensuring that the scribe marks are in line. Hand pressure should be sufficient to compress the complete assembly.

38 Secure the end shields together using the four through-bolts and spring washers.

39 Fit the heat sink assembly to the rear end shield (ensuring that the insulators are correctly fitted), and secure using the two pillar bolts (Fig 17 (4)) and screws (2 & 5) (each with spring and plain washers).



1 Auxiliary diode lead
2 Screw
3 Regulator
4 Pillar bolts
5 Screw

Fig 17 Fitting the heatsink assembly

40 Re-solder the auxiliary diode lead (1) to the terminal strip (3).

41 Fit the fast fuse (Fig 18 (1)) to the rear end shield, attaching the (previously marked) negative output lead (10). Secure using the two screws, spring washers and plain washers (2 & 11).

42 The stator leads should protrude through the appropriate apertures in the rear end shield. Bend the lead tags (4, 6 & 8) into position and secure to the heat sinks using the three screws and spring washers.

43 Fit the regulator (3) to the rear end shield as shown. Secure it using the short pillar bolt (9) and the two nuts (5 & 7) (all three with spring and plain washers).

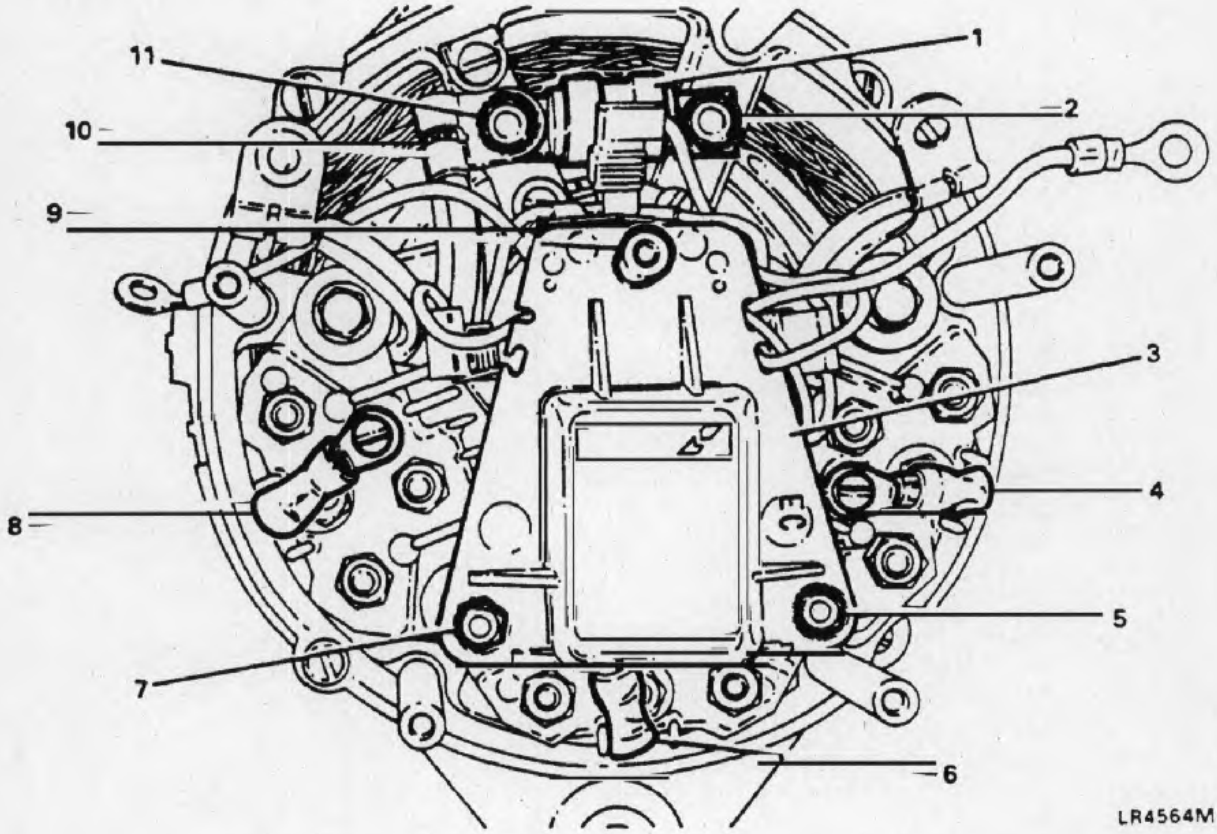
44 The regulator lead connections are as follows:

44.1 Black - Negative

44.2 Yellow - "A" (WL)

44.3 Green - Field

44.4 Red - Positive



1 Fast fuse
2 Fixings
3 Regulator
4 Lead tags
5 Fixings
6 Lead tags
7 Regulator fixings
8 Lead tags
9 Pillar bolt
10 Negative output lead
11 Fixings

Fig 18 Fitting regulator and fast fuse

45 Secure the suppression cover to the short pillar bolt using the screw and spring washer.

46 Fit the appropriate wires (identified during dismantling) to the rear of the three bushing capacitors on the suppression cover. Secure the wires using the appropriate nuts and washers.

47 Place the cowl over the suppression cover and secure using the five screws and spring washers, screwed into the main pillar bolts.

48 Cleaning agents. Kerosene may be used on parts which do not contain electrically insulated components and it ms containing electrical insulation should be cleaned with "Genklene" or a similar chlorinated solvent. Usually wiping with a moistened cloth is quite sufficient.

WARNING ...

CHLORINATED SOLVENTS CAN BE DANGEROUS.

Key to Fig 19

1	Clamp plate fixing screws	2.8 - 3.2 Nm
2	Nut	90 - 100 Nm
3	Stauffer lubricator	1.4 - 1.7 Nm
4	Pillar bolts	2.8 - 3.0 Nm
5	Field coil securing screws	5.5 - 6.0 Nm
6	Terminal strip securing screws	1.4 - 1.7 Nm
7	Lucar retaining screw	1.4 - 1.7 Nm
8	Through bolts	6.2 - 7.4 Nm
9	Heatsink assembly screws	1.9 - 1.3 Nm
10	Heatsink assembly screws	0.9 - 1.3 Nm
11	Pillar bolts	2.8 - 9.2 Nm
12	Heatsink fixing bolts	2.8 - 3.2 Nm
13	Fuse locating bracket fixing screw	1.4 - 1.7 Nm
14	Fast fuse fixing screw	2.8 - 3.2 Nm
15	Lead tag fixing screws	2.4 - 3.2 Nm
16	Regulator fixing/pillar bolts	2.8 - 3.2 Nm
17	Regulator fixing nuts	2.8 - 3.0 Nm
18	Bushing capacitor fixing screws	0.9 - 1.0 Nm
19	Spare fuse/capacitor leads fixing nuts	2.8 - 3.2 Nm
20	Cowl fixing screws	2.4 - 2.6 Nm
21	Bushing capacitor lucar fixing screw	2.8 - 3.2 Nm

Chapter 13-3

12 VOLT 3.5 L PETROL ELECTRICAL SYSTEM

BASE REPAIRS

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the 12 volt electrical system fitted to Land Rover 3.5 litre petrol engine 110 and 127 vehicles. The information detailed is applicable to both left and right hand vehicles.

ALTERNATOR (A115-45)

Removal

2 For removal of the alternator refer to Cat 522 Chap 13-3.

Overhaul and electrical test

3 For overhaul and electrical test of the alternator refer to Cat 524 Chap 13-1.

Refitting

4 For refitting of the alternator refer to Cat 522 Chap 13-3.

DISTRIBUTOR (35DLM8)

Removal

5 For removal of the distributor refer to Cat 522 Chap 13-3.

Dismantling

6 To dismantle the distributor proceed as follows:

6.1 Unclip and remove the cover (Fig 1 (1)).

6.2 Pull the rotor arm (3) from the keyed rotor shaft (12).

6.3 Remove the three screws (4) and insulation cover (5).

6.4 Remove the two screws (20) from the vacuum unit securing bracket, disengage vacuum unit connecting rod from pick-up base plate connecting peg, and withdraw the vacuum unit (19) from the distributor body.

6.5 Remove the two screws (18) and withdraw the amplifier module (17).

6.6 Remove the gasket (16).

6.7 Remove the two screws (15) and withdraw the cast heatsink (14).

WARNING ...

THE AMPLIFIER CONTAINS BERYLLIA. DO NOT OPEN OR CRUSH. (SEE EMER MAN S 261).

6.8 Using circlip pliers remove the circlip (6) retaining the reluctor on the rotor shaft.

6.9 Remove the flat washer (7) and 'O' ring (8) from recess in the top of the reluctor.

6.10 Gently withdraw the reluctor (9) from the shaft, taking care not to damage the teeth.

Note ...

A coupling ring is fitted beneath the reluctor.

6.11 Remove the three support pillars (10) and cable grommet (13).

6.12 Lift out the pick-up and base plate assembly (11).

Note ...

Do not disturb the two barrel nuts securing the pick-up module, otherwise the air gap will need re-adjustment.

Cleaning and lubrication

7 To clean and lubricate the components proceed as follows:

7.1 Clean the cover (Fig 1 (1)) and HT brush (2) with a nap free cloth.

7.2 Apply three drops of clean engine oil to the felt pad reservoir in the rotor shaft.

7.3 Apply Chevron SR1 (or equivalent) grease to the following components:

7.3.1 Auto advance mechanism.

7.3.2 Pick-up plate centre bearing.

7.3.3 Pre-tilt spring and its rubbing area (pick-up and base plate assembly).

7.3.4 Vacuum unit connecting peg (pick-up and base plate assembly) and the connecting peg hole in the vacuum unit connecting rod.

7.4 Apply MS4 silicone grease (or equivalent) to the following components:

7.4.1 Amplifier module back plate.

7.4.2 Both faces of the heatsink casting and the seating face on distributor body.

Repair and replacement

8 The following components should be replaced if known to be faulty:

8.1 Distributor cover (Fig 1 (1)).

8.2 Rotor arm (3).

8.3 Insulation cover (5).

8.4 Pick-up and base plate assembly (11). Measure the resistance of the pick-up winding. The resistance should be between 2-5 KΩ.

Assembly

9 Assembly of the distributor is a reversal of the removal procedure, noting the following points:

9.1 The pick-up leads must be prevented from fouling the rotating reluctor. Both leads should be located in the plastic carrier (Fig 2 (1)).

9.2 Slide the reluctor as far as it will go onto the rotor shaft, and rotate the reluctor until it engages with the coupling ring beneath the pick-up base plate. The distributor shaft, coupling ring and reluctor are keyed, and therefore rotate together. Fit the 'O' ring, flat washer and retaining circlip.

9.3 The air gap between the pick-up limb (Fig 3 (1)) and reluctor teeth (2) must be set between 0,32 to 0,55 mm (0.008 to 0.014 in) using a non-ferrous feeler gauge. If adjustment is necessary, slacken the two barrel nuts (3) to set the gap.

Note ...

When the original pick-up and base plate assembly has been refitted the air gap should be checked and adjusted if necessary. When renewing the assembly the air gap will require adjusting to within the specified limits.

9.4 Before fitting the amplifier module it is important to follow the lubrication instructions in Para 7.4.

Refitting

10 To refit the distributor to the engine refer to Cat 522 Chap 13-3.

Ignition timing

11 For ignition timing refer to Cat 522 Chap 13-3.

Key to fig 1

1	Cover	12	Rotor shaft
2	HT brush and spring	13	Cable grommet
3	Rotor arm	14	Heatsink
4	Screw	15	Screw
5	Insulation cover	16	Gasket
6	Circlip	17	Amplifier module
7	Flat washer	18	Screw
8	'O' ring	19	Vacuum unit
9	Reluctor	20	Screw
10	Support pillar	21	'O' ring oil seal
11	Pick-up module & base plate		

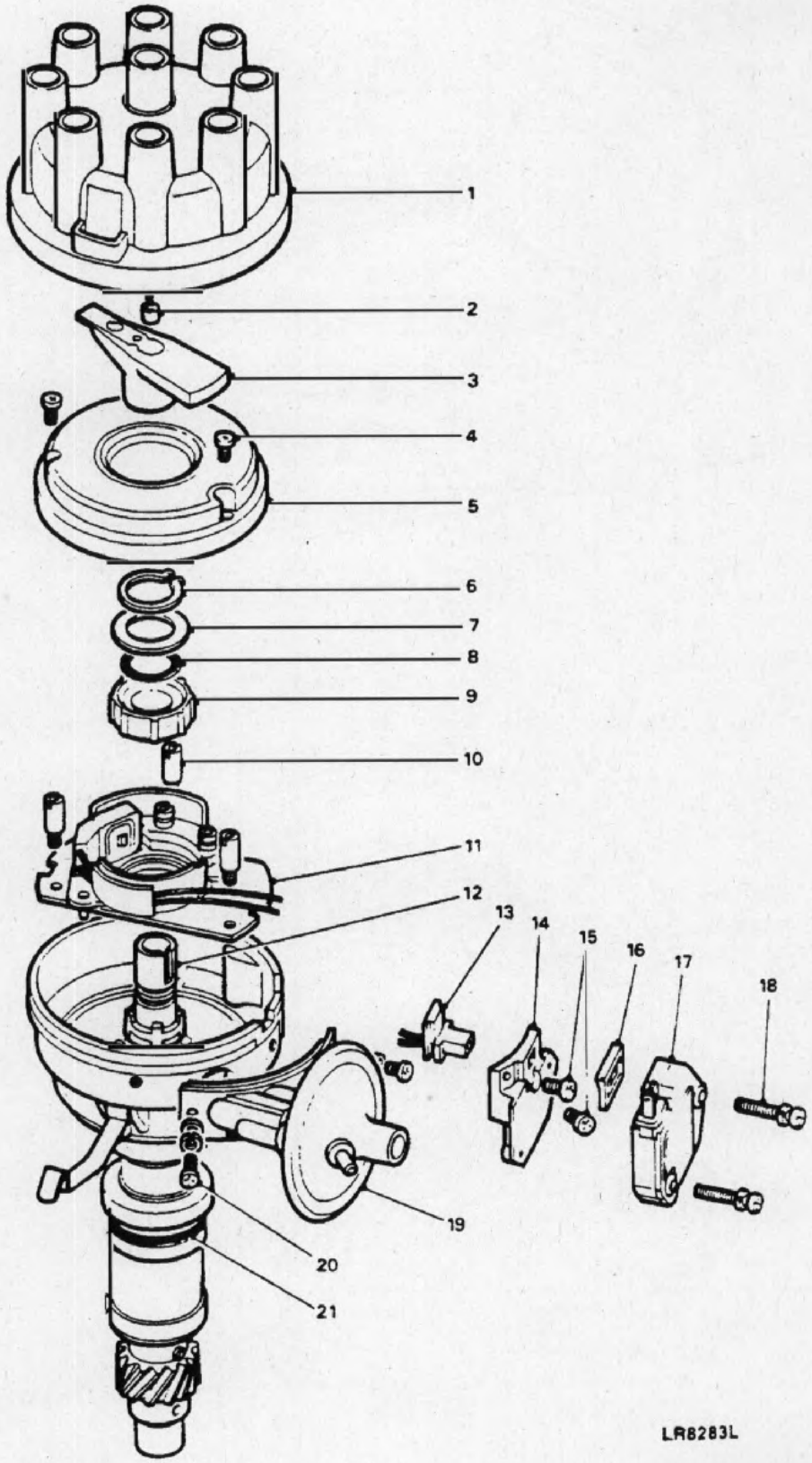
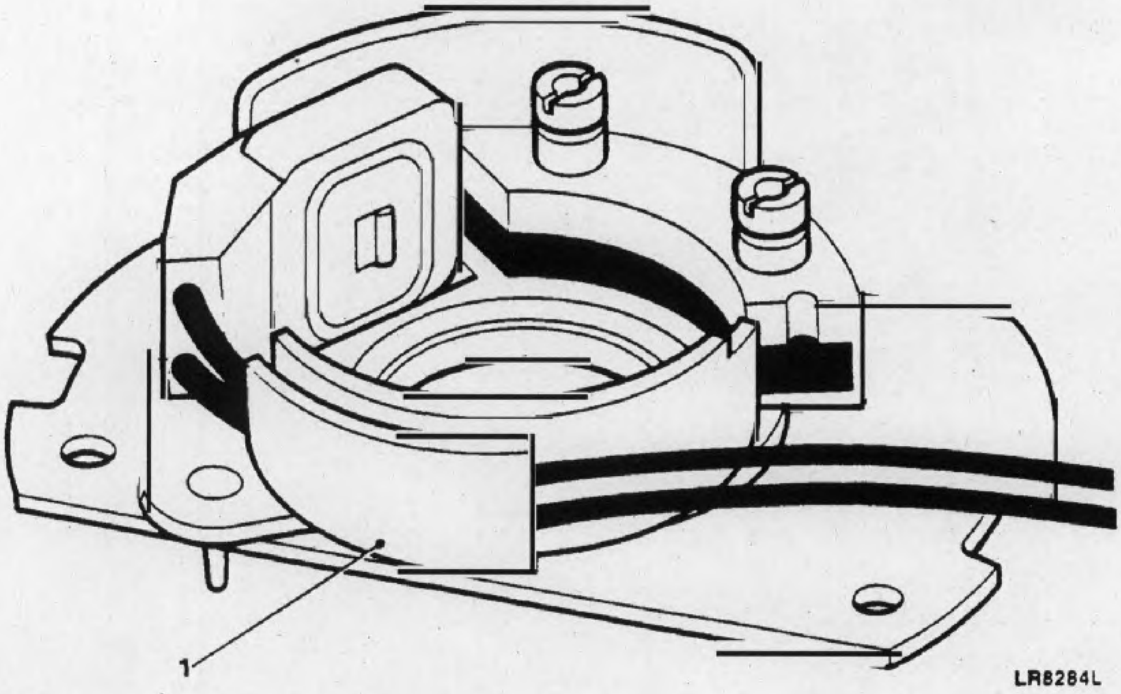
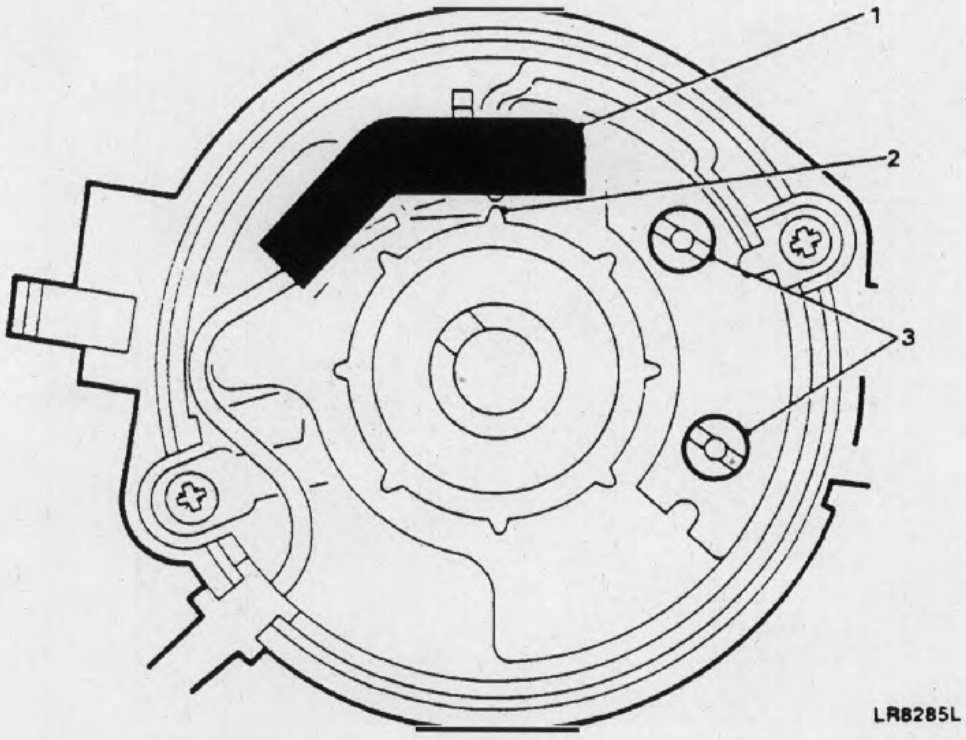


Fig 1 Exploded view of 35DLM8 Distributor



1 Plastic carrier

Fig 2 Fitting pick-up and base plate assembly



1 Pick-up limb
2 Reluctor teeth
3 Barrel nuts

Fig 3 Pick-up air gap adjustment

STARTER MOTOR (3M100PE)

Removal

12 To remove the starter motor from the vehicle refer to Cat 522 Chap 13-3.

Dismantling

13 To dismantle the solenoid proceed as follows:

13.1 Remove the connecting link (Fig 4 (15)) between the starter and the solenoid terminal 'STA'.

13.2 Remove the solenoid (16) from the drive end bracket (9).

13.3 Grasp the solenoid plunger (17) and lift the front end to release it from the top of the drive engagement lever.

13.4 Remove the end cap seal (2).

13.5 Using an engineer's chisel, cut through a number of the retaining ring (3) claws until the grip on the armature shaft is sufficiently relieved to allow the retaining ring to be removed (Fig 5).

13.6 Remove the two through bolts (Fig 4 (1)).

13.7 Partially withdraw the commutator end cover (5) and disengage the two field coil brushes (13) from the brush box.

13.8 Remove the commutator end cover (5).

13.9 Withdraw the yolk and field coil assembly (12).

13.10 Withdraw the pivot pin (18).

13.11 Withdraw the armature (7).

13.12 Using a suitable tube, remove the collar and jump ring (8) from the armature shaft.

13.13 Slide the thrust collar, roller clutch drive and lever assembly (10) off the shaft.

Test and overhaul

14 To test and overhaul the starter motor proceed as follows:

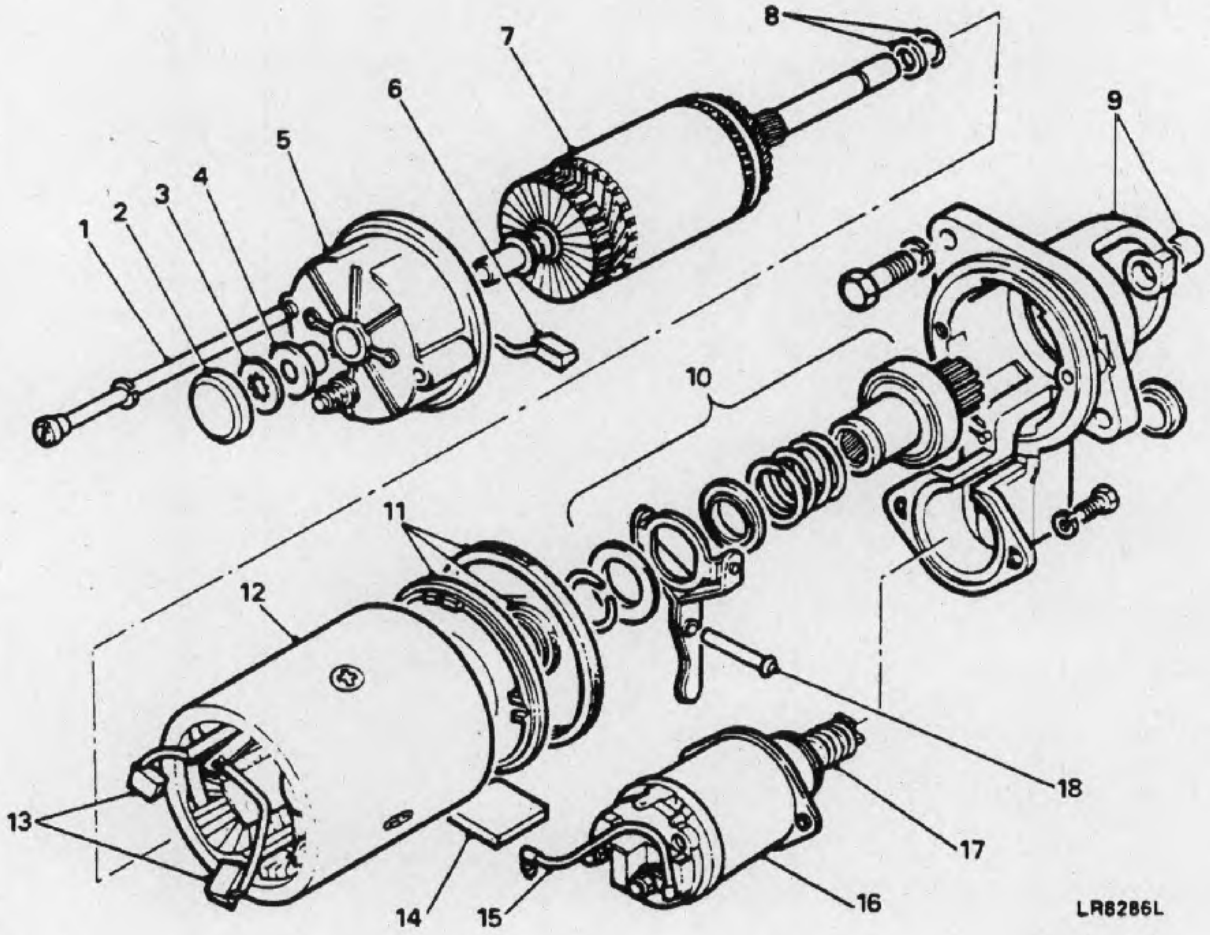
14.1 Check that the clutch gives instantaneous take-up of the drive in one direction and rotates easily and smoothly in the other direction.

14.2 Ensure that the clutch is free to move round and along the shaft splines without any tendency to bind.

Note ...

The roller clutch drive is sealed in a rolled steel cover and cannot be dismantled.

14.3 Lubricate all clutch moving parts with Shell SB2628 grease for cold and temperate climates or Shell Retinax 'A' for hot climates.



1	Through bolts	10	Clutch drive & lever assy
2	End cap seal	11	Intermed. bracket & seals
3	Spire ring	12	Yoke and field coil assy
4	Sintered bearing bush	13	Field coil brushes
5	Commutator end cover	14	Rubber block
6	Brush plate brushes	15	Connecting link
7	Armature	16	Solenoid
8	Collar and jump ring	17	Solenoid plunger
9	Drive-end bracket and bush	18	Pivot pin

Fig 4 Exploded view of 3M100PE Starter motor

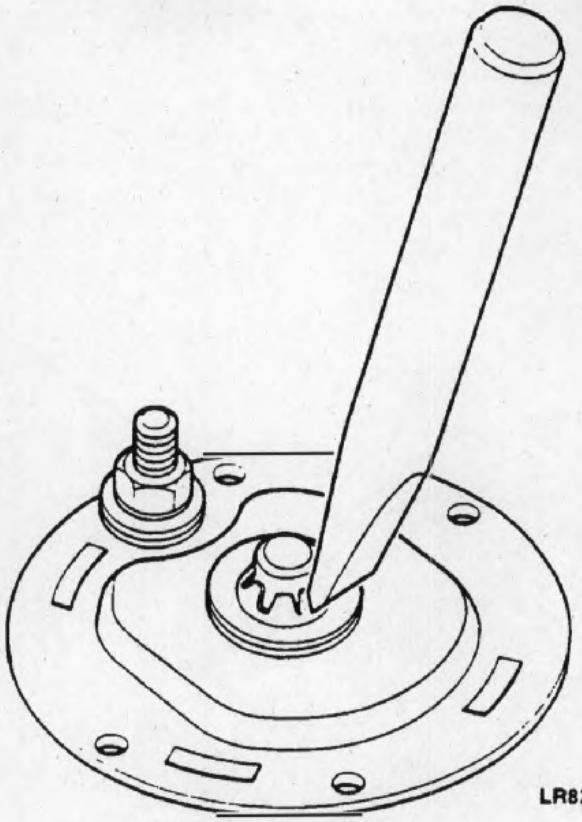
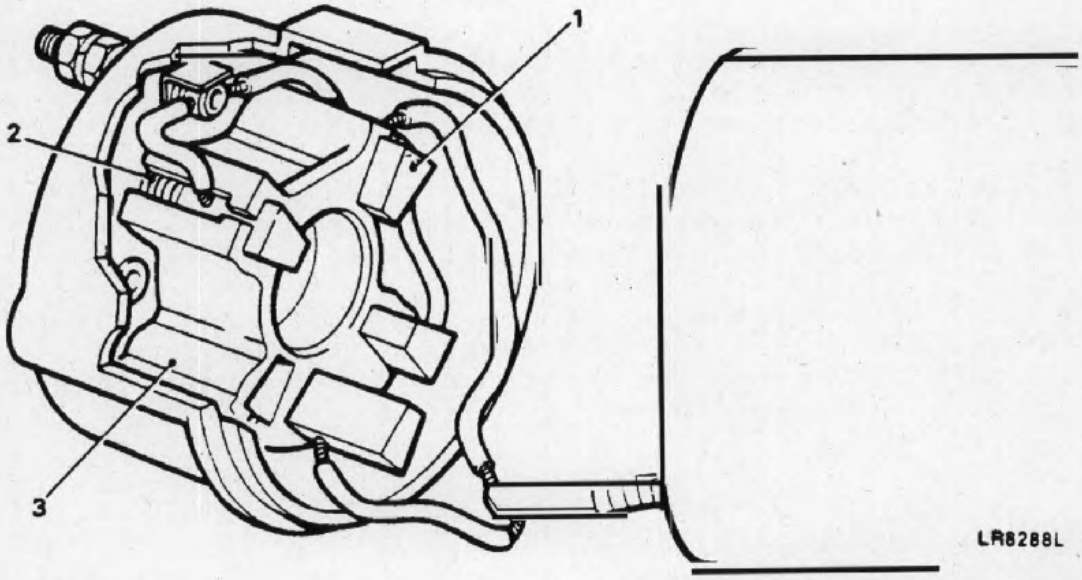


Fig 5 Removal of armature shaft retaining ring

14.4 Check that the brushes (Fig 6 (1)) move freely in the brush box moulding. Rectify sticking brushes by wiping with a petrol moistened cloth.

14.5 Fit new brushes if they are damaged or worn to approximately 9,5 mm (0.375 in).



1 Brush
2 Spring
3 Brush box moulding

Fig 6 Starter motor brushes

14.6 Using a push-type spring gaug , check the brush spring pressure. If new brushes are fitted and pushed in until the top of the brush protrudes about 1,5 mm (0.065 in) from the brush box moulding, dimension 'A' (Fig 7), the spring pressure r ading should be 1,0 kgf (36 ozf).

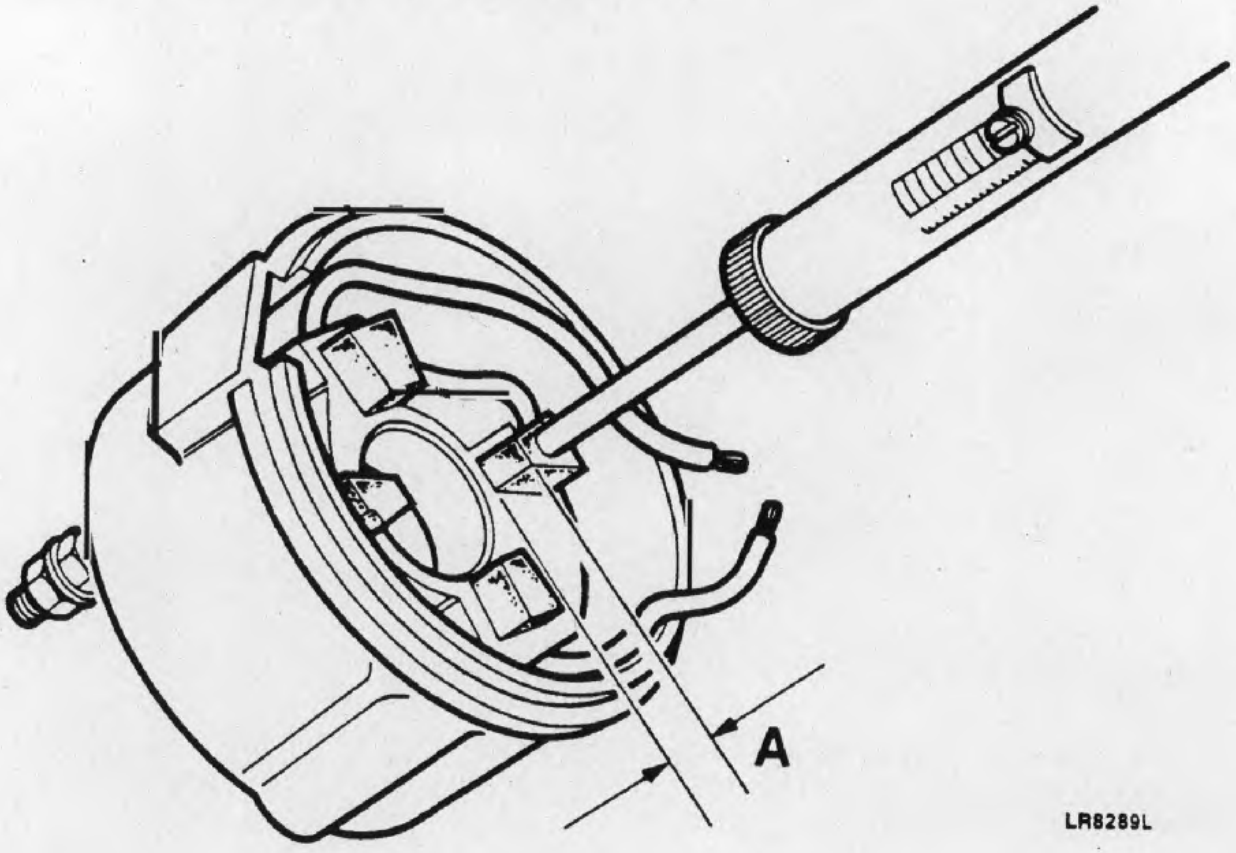


Fig 7 Checking brush spring pressure

14.7 Check the insulation of the brush springs by connecting a Megger between a clean part of the commutator end cover and each of the springs in turn. The Megger should read infinity.

14.8 Check the commutator. If cleaning only is necessary, use a flat surface of very fine glass paper, and then wipe the commutator surface with a petrol moistened cloth.

14.9 If necessary, the commutator may be machined provided a finished surface can be obtained without reducing the thickness of the commutator copper below 3,5 mm (0.140 in), otherwise a new armature must be fitted.

CAUTION ...

Do not undercut the insulation slots.

14.10 Check the armature insulation by connecting a Megger between any one of the commutator segments and the shaft (Fig 8). The Megger should read infinity. If necessary, a new armature must be fitted.

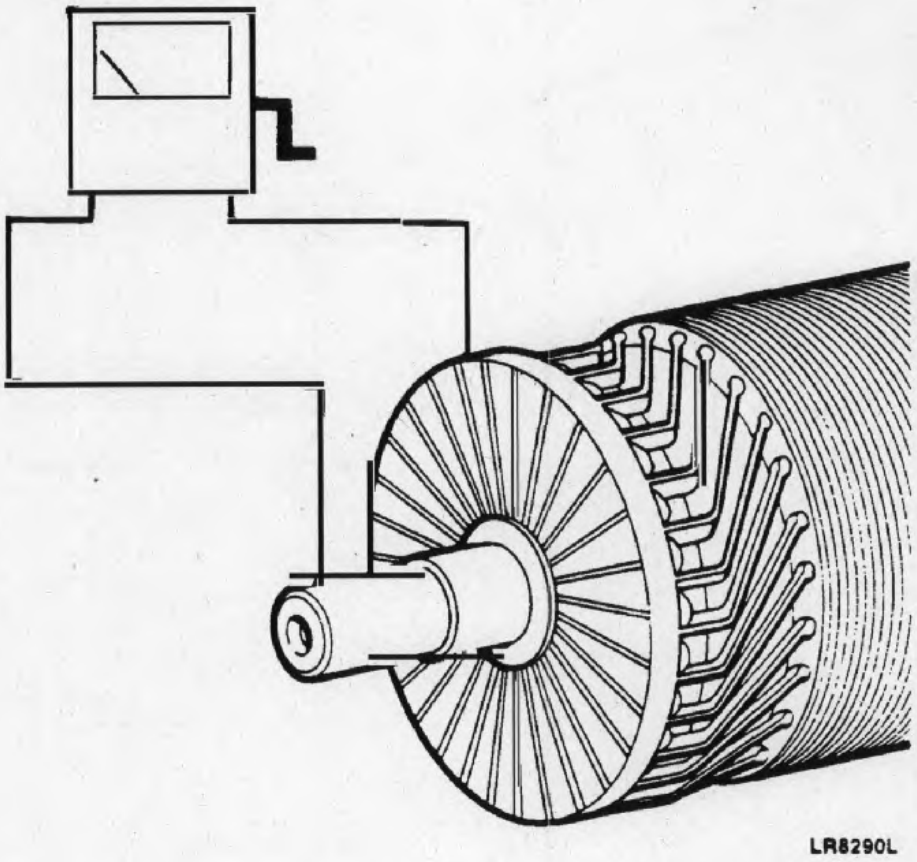


Fig 8 Checking armature insulation

14.11 Disconnect the end of the field winding where it is rivited to the yoke, by filing away the riveted over end of the connecting-eyelet securing rivet (Fig 9 (1)), sufficient to enable the rivet to be tapped out of the yoke.

14.12 Connect a Megger between the disconnected end of the winding and a clean part of the yoke.

14.13 Ensure that the brushes (2) or bare parts of their flexibles are not touching the yoke during the test.

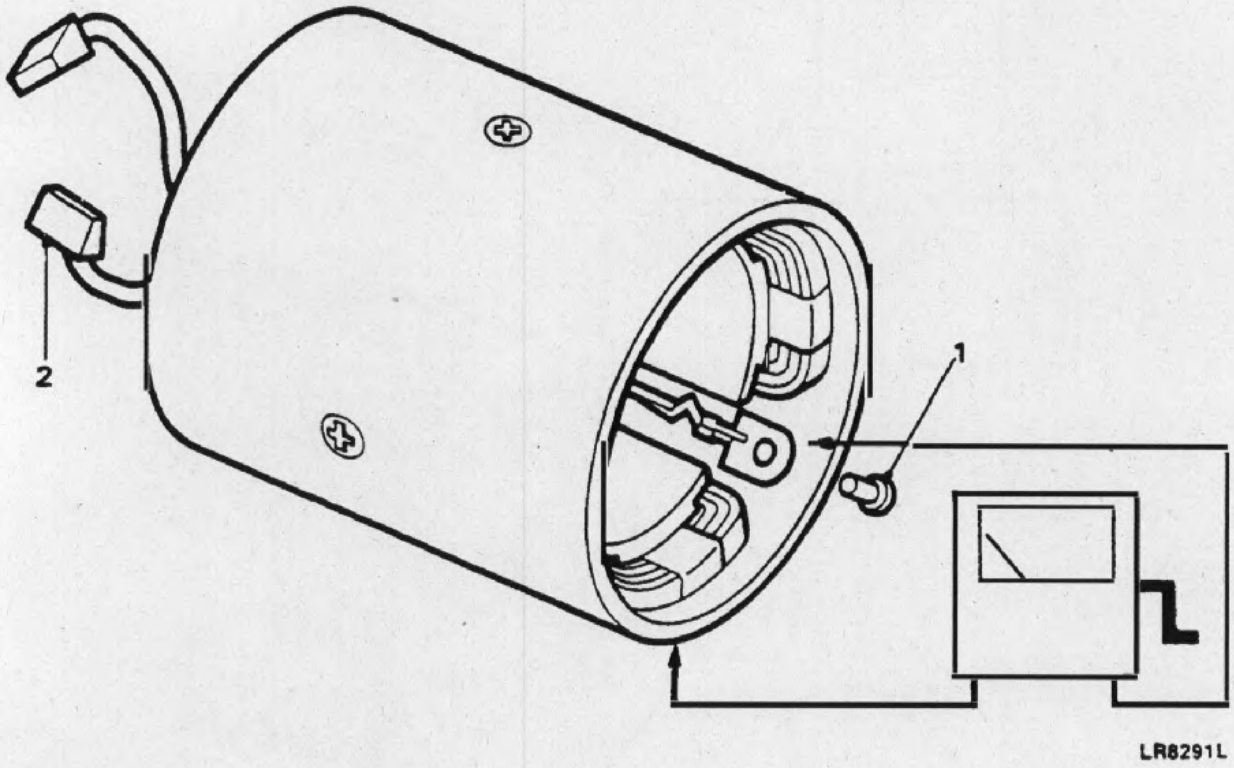
14.14 The Megger should read infinity. If necessary, a new field coil assembly must be fitted.

14.15 Re-secure the end of the field winding to the yoke.

14.16 Connect a Megger between each of the brushes in turn and a clean part of the yoke (Fig 10).

14.17 The Megger should read infinity. If necessary, a new field coil assembly must be fitted.

14.18 Disconnect all cables from the solenoid terminals and connectors.



1 Rivet 2 Brushes

Fig 9 Checking field coil insulation

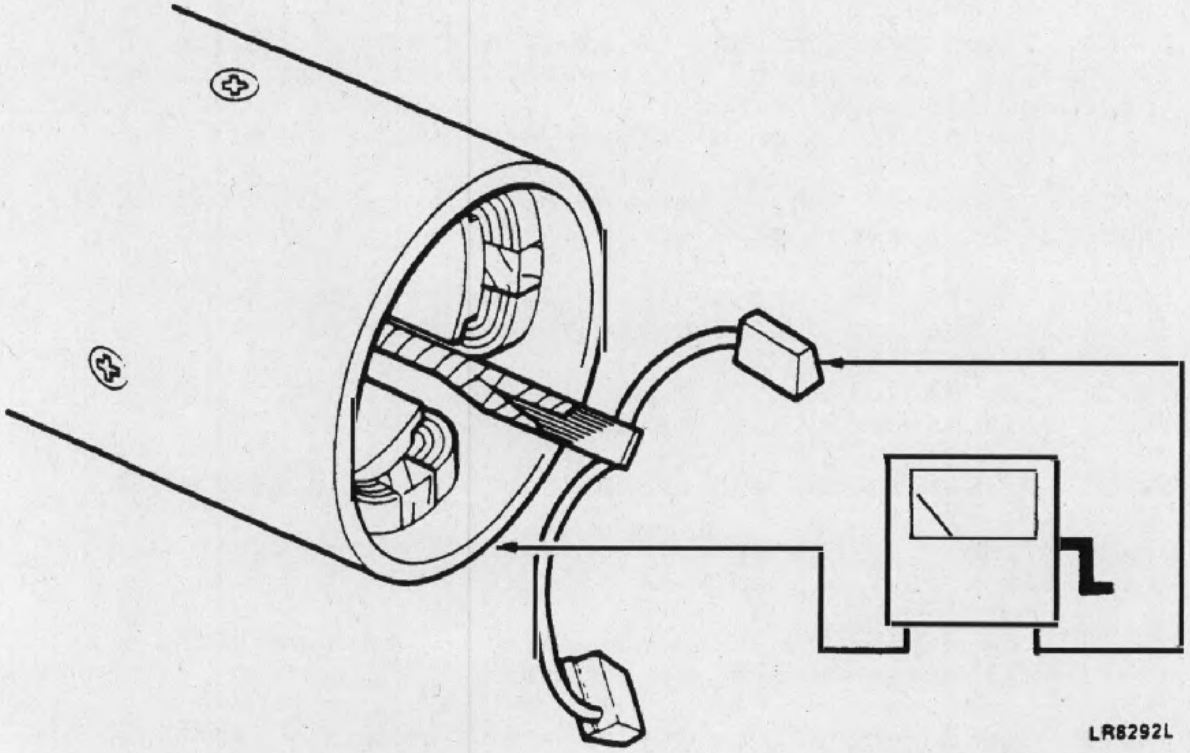


Fig 10 Checking field coil continuity

14.19 Connect a 12 Volt batt ry and a Multimeter between the solenoid main terminals (Fig 11). The Multimeter should not produce a reading. If the Multimeter produces a reading, new solenoid contacts or a new complete solenoid must be fitted.

14.20 Leave the Multimeter connected and using the same 12 volt battery supply, energize the solenoid by connecting 12 Volts between the small solenoid operating Lucar terminal blade and a good earth point on the solenoid body (Fig 11).

14.21 The solenoid should be heard to operate and the Multimeter should read infinity. If the Multimeter does not produce a reading, new solenoid contacts or a new complete solenoid must be fitted.

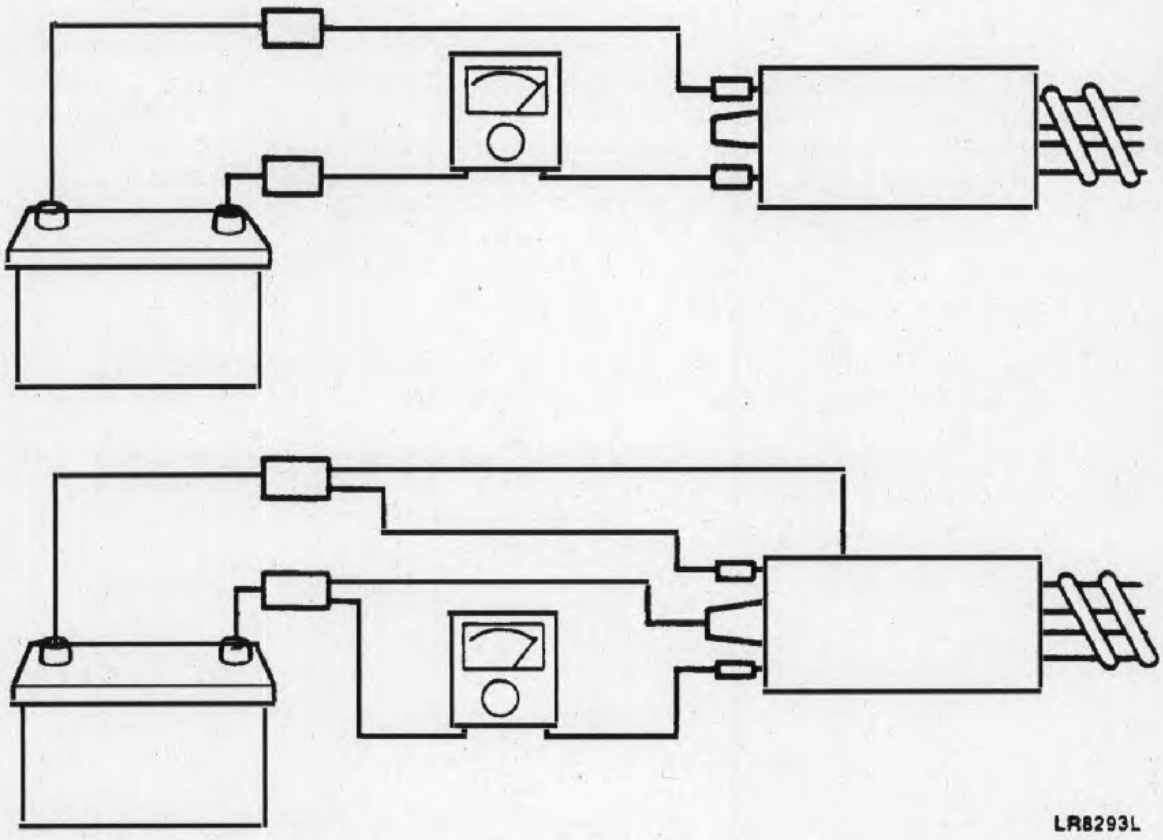


Fig 11 Checking solenoid

Assembly

15 To assemble the starter motor proceed as follows:

15.1 Fit the intermediate bracket and inner seal (Fig 4 (11)) over the armature shaft.

15.2 Slide the thrust collar and the roller clutch drive and lever assembly (10) onto the armature shaft.

15.3 Fit the jump ring and collar (8) to the armature shaft.

15.4 Fit the armature (7).

15.5 Fit the pivot pin (18) and splay the end.

15.6 Fit the yoke and field coil assembly (12) and ensure that the dowel peg in the drive-end bracket (9) aligns with matching location in the intermediate bracket (11) before offering the yoke into position.

15.7 Fit the internal thrust washer to the shaft.

15.8 Engage the two field coil brushes (13) in the brush box and fit the commutator end cover (5).

15.9 Secure the assembly with the two through bolts (1) and tighten to the correct torque.

15.10 Fit the sintered bearing bush (4).

15.11 Using a suitable tube, drive a new spire ring (3) into position (Fig 12). The position of the spire ring on the armature shaft determines the armature end-float which should be 0,25 mm (0.010 in) maximum between the spire retaining ring and the sintered bearing bush shoulder. Care, therefore, must be taken when fitting the spire ring.

15.12 Fit the end cap seal (Fig 4 (2)).

15.13 Fit the solenoid (16) to the drive end bracket (9) whilst locating the drive engagement lever.

15.14 Fit the connecting link (15) between the starter and solenoid terminal 'STA'.

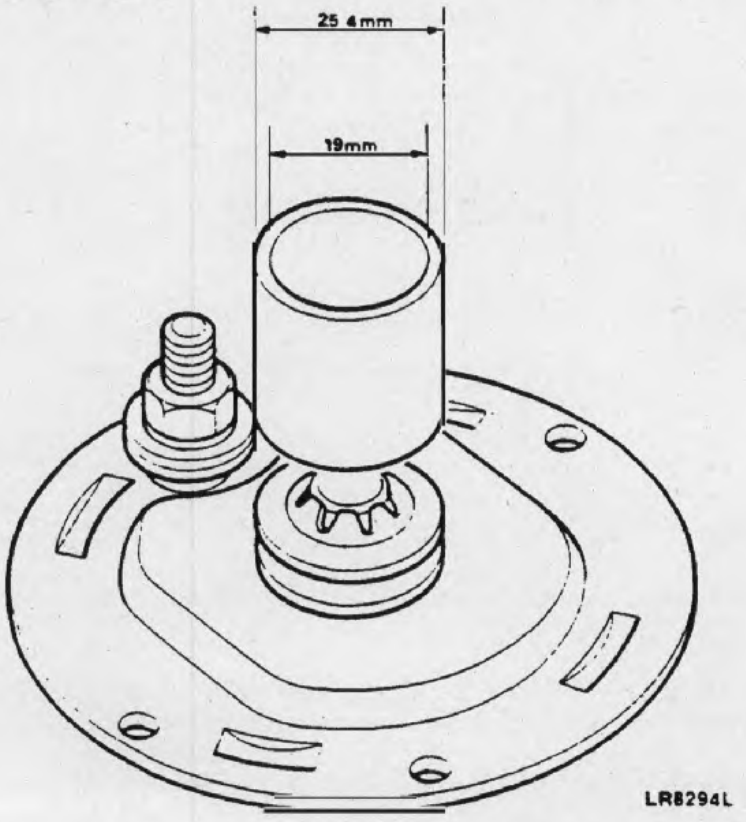


Fig 12 Fitting spire ring

Refitting

16 For refitting the starter motor to the vehicle refer to Cat 522 Chap 13-3.

Chapter 13-4

12/24 VOLT 3.5 L PETROL ELECTRICAL SYSTEM

BASE REPAIRS

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the 24 volt electrical system fitted to Land Rover 3.5 litre petrol 110 and 127 vehicles.

90 A BRUSHLESS ALTERNATOR

Removal

2 For removal of the alternator refer to Cat 522 Chap 13-4.

Dismantling

3 For dismantle of the alternator refer to Cat 524 Chap 13-2.

Component inspection and renewal

4 For inspection and renewal of alternator components refer to Cat 524 Chap 13-2.

Assembly

5 For assembly of alternator refer to Cat 524 Chap 13-2.

Refitting

6 For refitting of alternator refer to Cat 522 Chap 13-4.

Chapter 13-5

12 VOLT 2.5 L DIESEL WINTERISED ELECTRICAL SYSTEM

BASE REPAIRS

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the 12 volt winterised electrical system fitted to Land Rover 2.5 litre diesel winterised 90 and 110 vehicles. The information detailed is applicable to both left and right hand vehicles.

ALTERNATOR (A127-65)

Removal

2 For removal of the alternator refer to Cat 522 Chap 13-5.

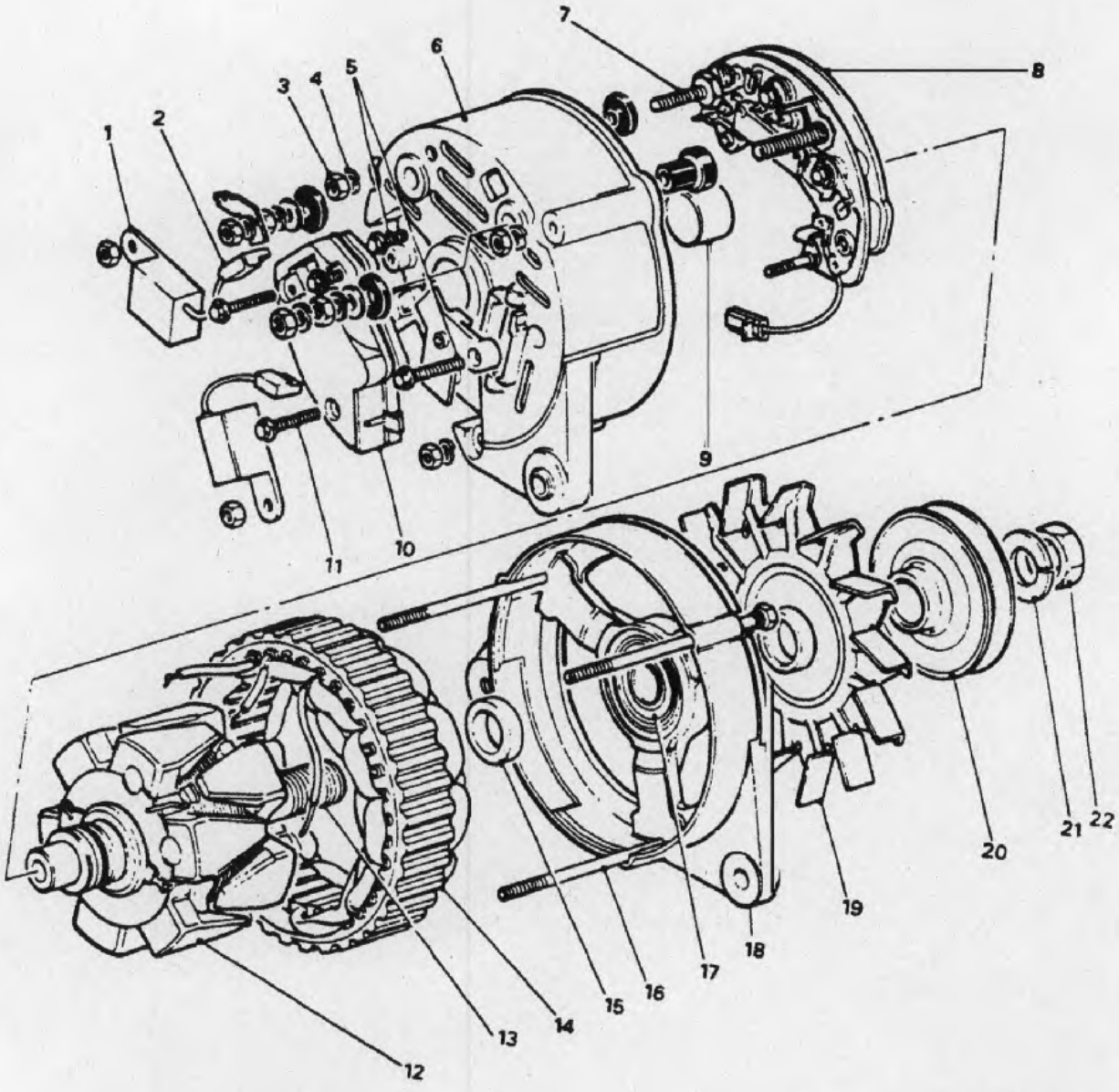
Dismantling

3 To dismantle the alternator proceed as follows:

3.1 Remove the nuts (Fig 1 (3)) and spring washers (4) from the through bolts (16), disconnect the connectors (2) and remove the two suppression capacitors (1).

3.2 Remove the three screws (11), disconnect one lead and withdraw the regulator and brushbox assembly (10).

3.3 Mark the relative positions of the end brackets (6,18) and stator (14). Remove the through bolts (16) and withdraw the slip ring end bracket (6) and stator assembly (14). If necessary, carefully tap the mounting lugs with a mallet.



1 Suppression capacitors
2 Capacitor terminal
3 Nut
4 Spring washer
5 Screws
6 Slip ring end bracket
7 Stud terminal
8 Rectifier
9 Slip ring end bearing
10 Regulator/brushbox assembly
11 Screw
12 Rotor
13 Rotor shaft
14 Stator
15 Spacer
16 Through bolt
17 Drive end bearing
18 Drive end bracket
19 Fan
20 Pulley
21 Spring washer
22 Nut

Fig 1 Exploded view of A127-65 Alternator

3.4 Remove the nuts, washers and insulators from the stud terminals (7) noting their position for reassembly.

3.5 Remove the two screws (5) and insulation cover.

3.6 Withdraw the rectifier (8) and stator (14) from the slip ring end bracket (6).

3.7 Release the stator winding cable ends (Fig 2 (1)) from the rectifier by applying a hot soldering iron to the rectifier terminal tags (2). Prise out the cable ends when the solder melts, and separate the rectifier and stator. Further dismantling of the rectifier is not required.

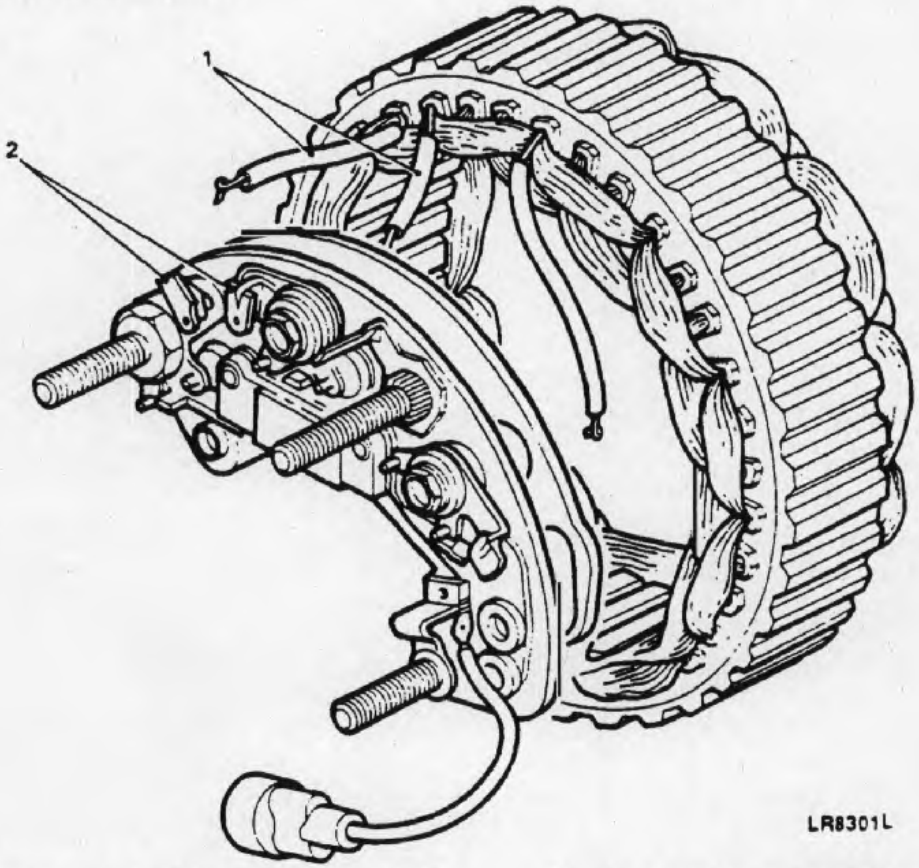
3.8 Remove the nut (Fig 1 (22)) and spring washer (21) securing the fan and pulley assembly to the drive end bracket. Remove the fan (19) and pulley (20).

3.9 Push out the rotor shaft (13) from the bearing using a suitable press and remove the spacer (15) from the shaft.

3.10 Using a suitable press, apply pressure from the rear of the slip ring end bracket and withdraw the bearing (17).

Note ...

The drive end bracket and bearing are only supplied as an individual unit.



1 Stator winding cable ends 2 Rectifier terminal tags

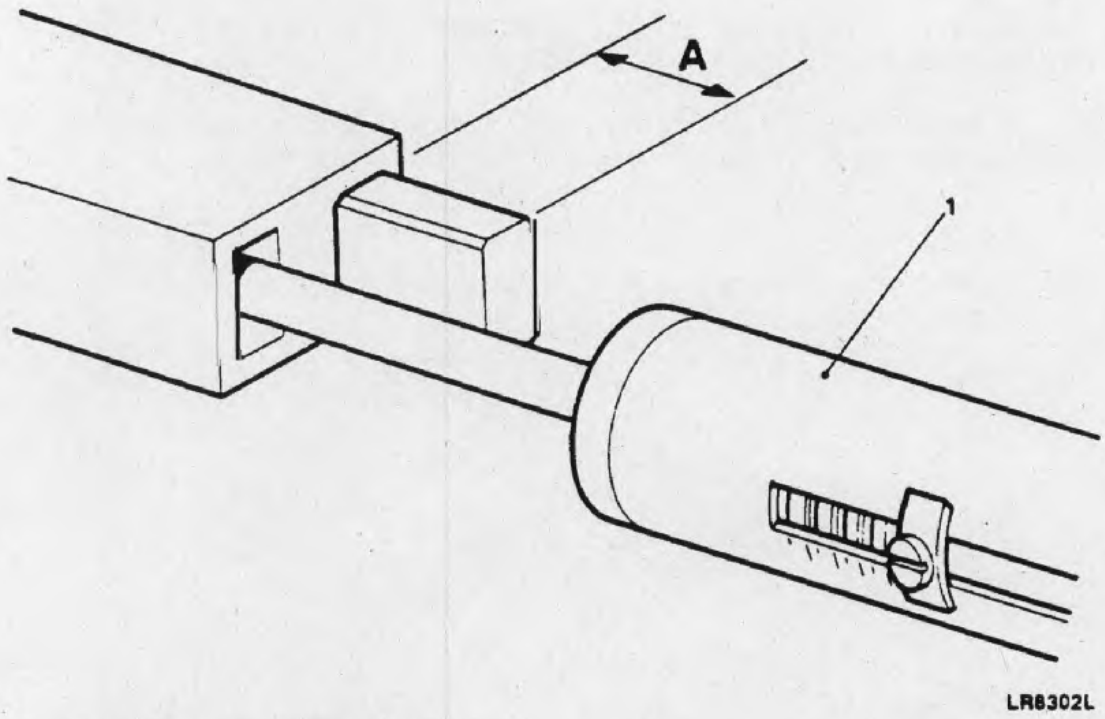
Fig 2 Separating the rectifier and stator

Component inspection and renewal

4 To inspect and renew the alternator components proceed as follows:

4.1 Check the brush lengths by measuring length of protusion from moulding (Fig 3). If dimension 'A' is 5 mm (0.20 in) or 1 ss, the assembly must be replaced.

4.2 Check the brush spring pressure using push type spring gauge (Fig 3 (1)). The gauge should register 136 to 279 g (5 to 10 oz) when brush is pressed until the face is flush with the housing. If the reading is outside these limits, the assembly must be replaced.



1 Spring pressure gauge

Fig 3 Checking brush lengths and spring pressure

4.3 Connect the test equipment and check the diodes (Fig 4 (1)). Test each diode in turn, noting whether the lamp illuminates and then reverse test lead connections. The lamp should illuminate in one direction only. If a faulty diode is diagnosed the rectifier assembly must be replaced.

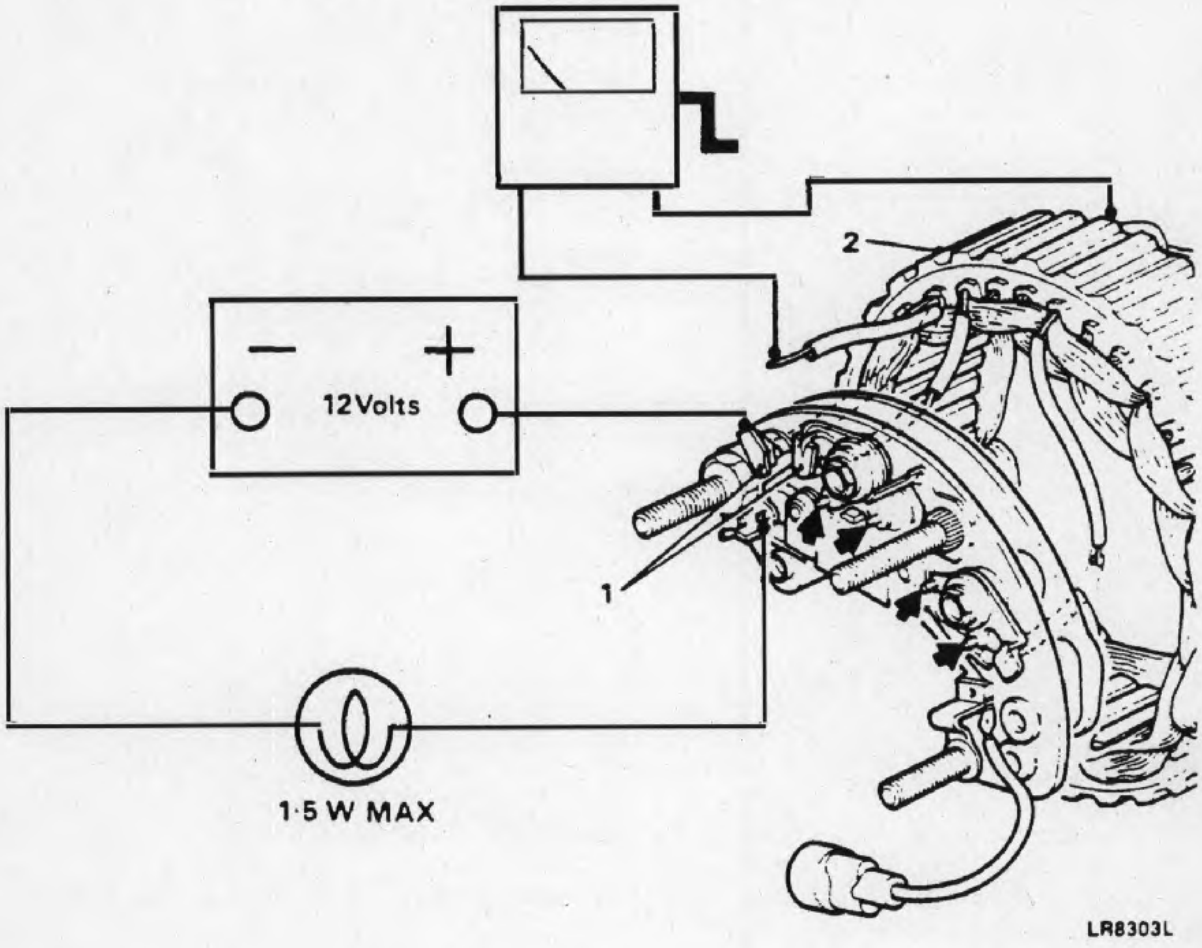
4.4 Visually inspect the stator windings for signs of damage or burning. Check the stator insulation (2) using a Megger. Connect the test leads to the laminated yoke and to each of the three leads in turn. If the Megger produces a reading, the stator must be replaced.

4.5 Clean the surfaces of the slip rings using a solvent moistened cloth.

4.6 Inspect the slip ring surfaces for signs of burning. Remove any burn marks using extra fine glasspaper.

CAUTION ...

On no account should emery cloth or similar abrasives be used, or any attempt made to machine the slip rings.



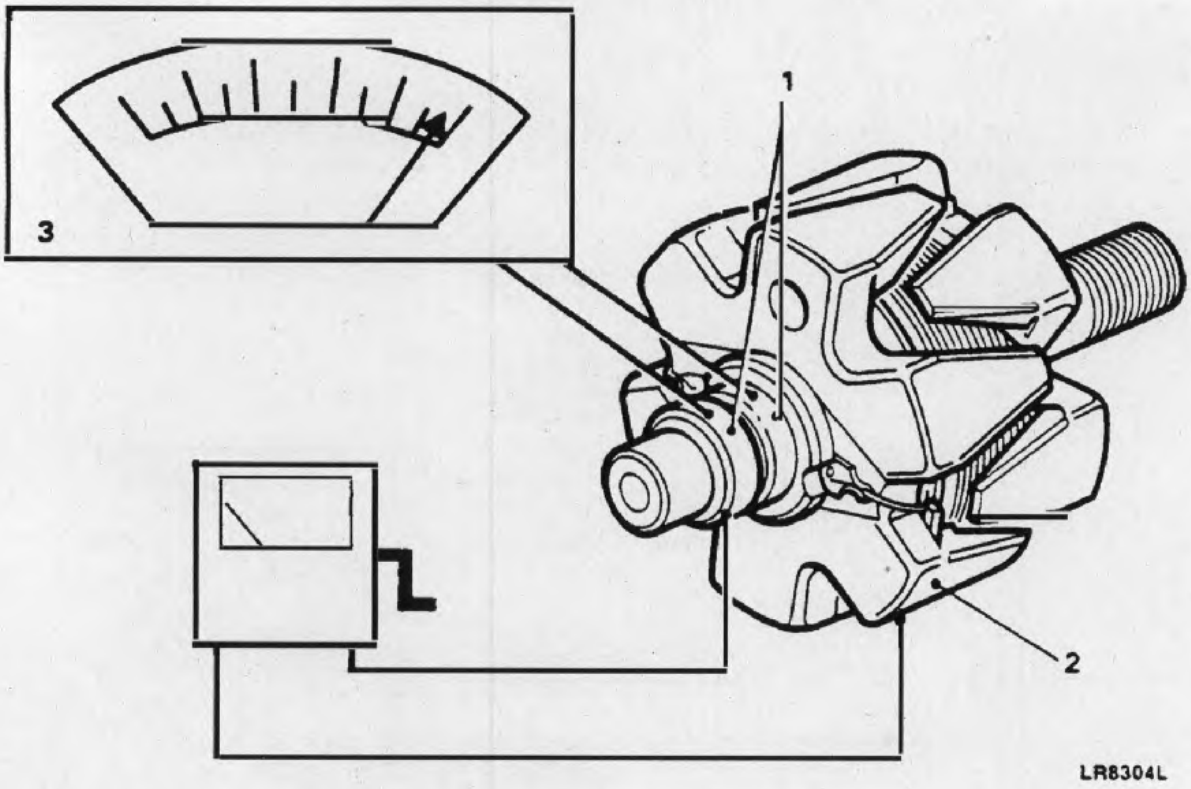
1 Diodes 2 Stator insulation

Fig 4 Checking the diodes and stator insulation

4.7 Check the insulation of the rotor field windings using a Megger connected between one of the slip rings (Fig 5 (1)) and one of the rotor poles (2). If the Megger produces a reading the rotor must be replaced.

4.8 Check the resistance/continuity of the rotor field windings by connecting an ohmmeter (3) to the slip rings as illustrated. A reading of 3.2 ohms should be obtained.

4.9 Check condition of the bearings. If signs of rubbing between the rotor poles and stator are evident, both bearings are excessively worn and must be replaced.



1 Slip rings
2 Rotor pole
3 Ohmmeter

Fig 5 Checking the rotor field windings

Assembly

5 To assemble the alternator proceed as follows:

5.1 Fit the spacer (Fig 1 (15)) and press the rotor (12) into the drive end bracket (18).

5.2 Insert the through bolts (16).

5.3 Fit the spacer, fan (19), pulley (20) and spring washer (21) to the rotor shaft (13). Fit and tighten the nut (22) to a torque of 50 to 70 Nm (37 to 52 lbf ft).

5.4 Fit the stator (14) and rectifier (8) assembly to the drive end bracket (18) in the position previously marked.

5.5 Fit the slip ring end bracket (6) in the position previously marked, locating the regulator lead through its aperture.

5.6 Fit the insulation cover and tighten the two rectifier securing screws (5) to a torque of 3.5 Nm (2.5 lbf ft).

5.7 Fit and tighten the through bolt spring washers (4) and nuts (3) evenly to a torque of 5.5 Nm (4.0 lbf ft).

5.8 Connect th lead to th r gulator, locate the brushes on the slip rings and tight n the regulator/brushbox assembly screws (11) to a torque of 2.5 Nm (2.0 lbf ft), taking care not to damage the brushes.

5.9 Fit both suppression capacitors (1).

Refitting

6 To refit the alternator refer to Cat 522 Chap 13-1.

Alternator functional check

7 To perform a functional check of the alternator proceed as follows:

CAUTION ...

The alternator contains polarity sensitive components that could be permanently damaged if subjected to incorrect polarity. Do not connect or disconnect any part of the charging circuit, including the battery leads while the engine is running. Run the alternator with all connections made or with the unit disconnected.

Notes ...

(1) This operation must be performed in two parts. The first to prove the alternator's capacity to produce current. The second to prove the performance of the integral regulator.

(2) The stated output may be exceeded slightly when the alternator is cold. To avoid misleading results, the check should be performed with the unit as near to its normal operating temperature as possible.

7.1 Check drive belt adjustment (Refer to Cat 522 Chap 13-1).

7.2 Disconnect the muti-socket connector.

7.3 Remove the cover. Using a suitable probe and wire, directly earth the field winding earth brush, by-passing the regulator.

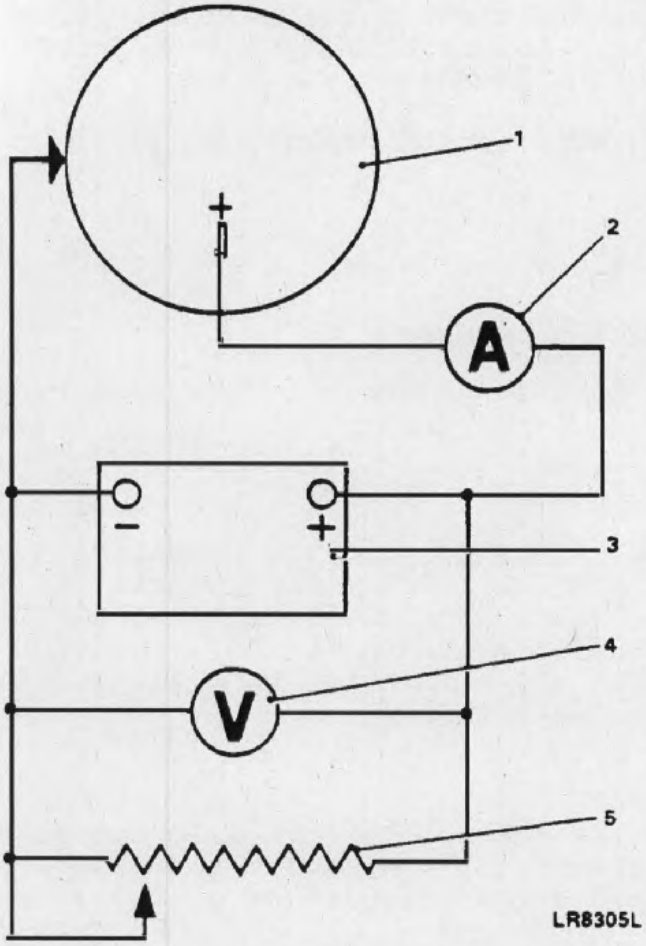
7.4 Provide a test circuit as illustrated in Fig 6.

Note ...

Do not connect the variable resistor across the battery for longer than is necessary to perform the check.

7.5 Run the engine.

7.6 Gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.



1 Alternator
2 Ammeter
3 12 volt battery
4 Voltmeter
5 Variable resistance

Fig 6 Current production test circuit

7.7 Hold the speed at approximately 6000 alternator rev/min (3000 engine rev/min). Adjust the variable resistor so that the voltmeter reads 14 volts. The ammeter reading should now be approximately equal to the nominal output of 65 amp. An incorrect ammeter reading is an indication that the alternator requires overhaul or replacement.

7.8 Provide a test circuit as illustrated in Fig 7.

7.9 Start the engine and gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.

7.10 Hold the speed at approximately 6000 alternator rev/min (3000 engine rev/min). The voltmeter reading should now be steady at 13.6 to 14.4 volts.

7.11 If the voltmeter reading is not steady at the above figure, and a satisfactory check of capacity to produce current has been performed (Para 7.1 to 7.7) the indication is that the control regulator should be replaced.

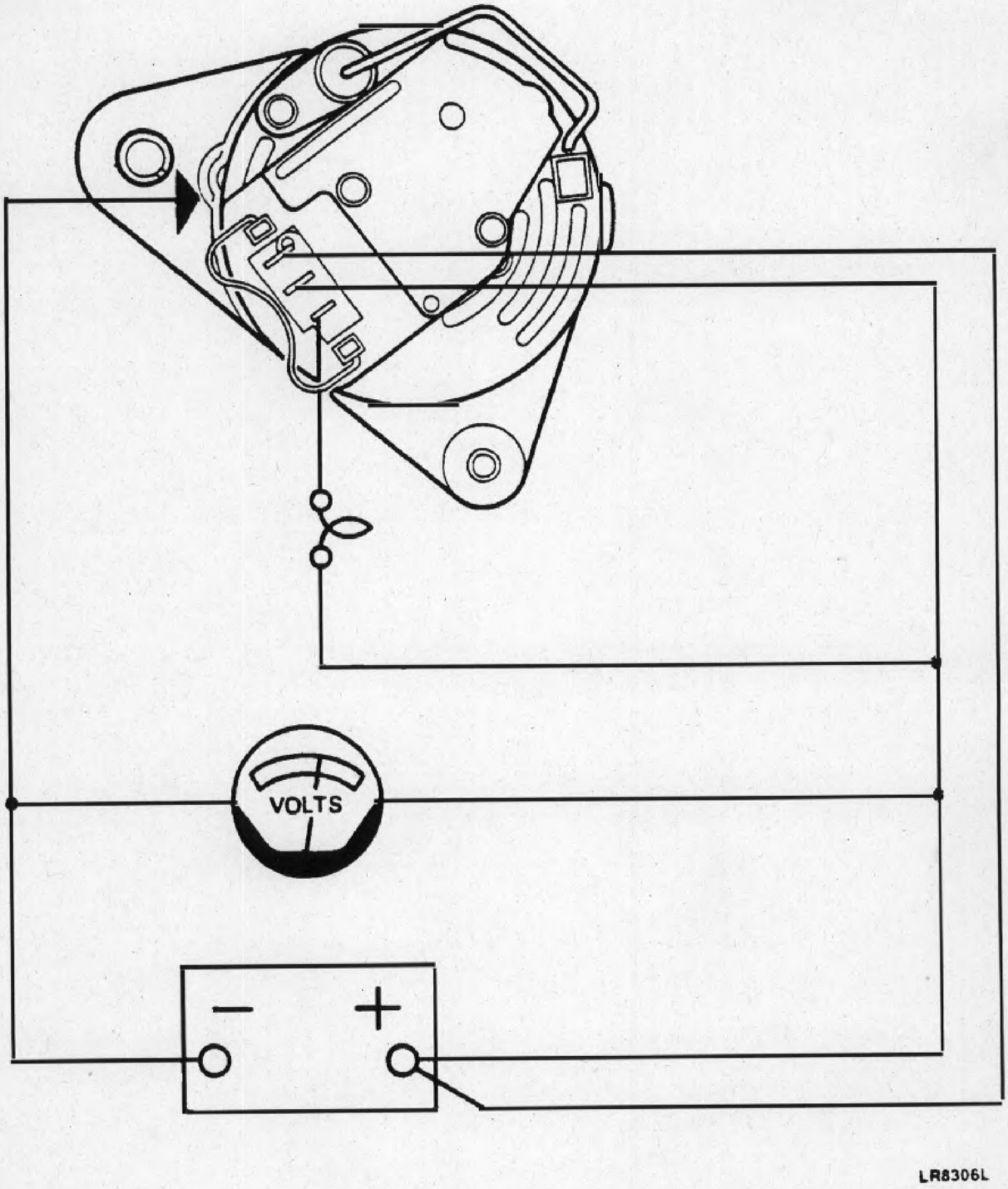
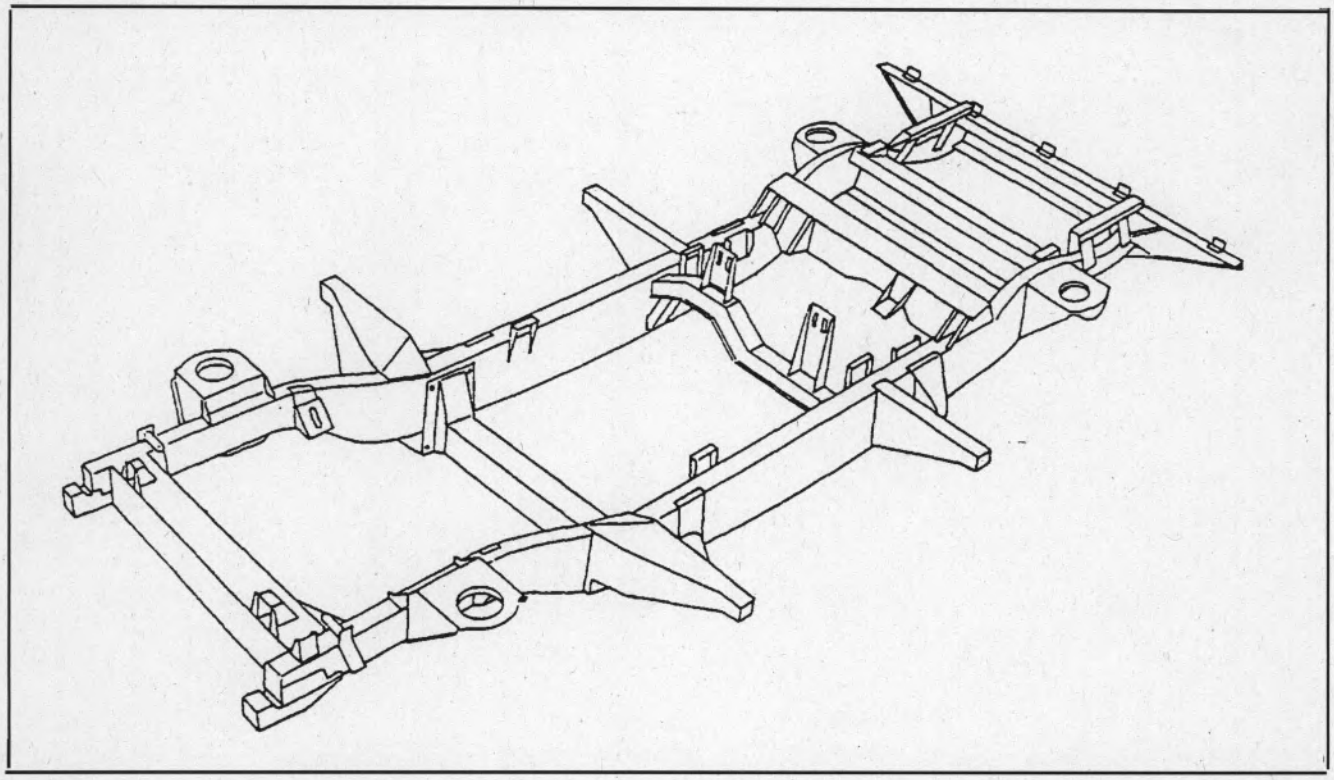


Fig 7 Control regulator test circuit

LAND ROVER DEFENDER



CHASSIS REPAIR

Publication No. ***LZA.CR.EN01***

CONTENTS

INTRODUCTION

73 CHASSIS REPAIR OPERATIONS

INTRODUCTION

RESEARCH VEHICLE

The schedule times shown on the following pages were obtained under Thatcham workshop conditions using methods developed in conjunction with Land Rover.

The manual has been based on methods and times derived from a basic 110 specification Defender. Variations from this basic specification may require the adjustment of time values.

TOOLS AND EQUIPMENT

The tools and equipment used are those readily available to the accident repair trade. The following table, whilst not exclusive, details those tools used at Thatcham:

Equipment	*Make/Model*
Pneumatic Saw	Cengar JP901
Airdrill	CP Tools CP788
Bonded Wire Brush	Muleskinner
Orbital Sander	Desoutter M367
MIG Welder	*Various*

METHODS AND TECHNIQUES

The methods and techniques employed in this manual are based on those developed by Thatcham over many years of practical experience, modified in conjunction with Land Rover for application to repairs on the Defender chassis.

Chassis: A welded chassis frame replacement method is shown and detailed in the individual chassis replacement notes in **73 - Chassis Repair Operations** section **pages 1 to 26**. Where appropriate, details of bolted components have also been included.

M.E.T. & Body: The Operation Times include an allowance for the removal and replacement of M.E.T. items and body components necessary to gain repair access to the chassis frame. These times allow for the removal and replacement of assemblies such as headlamps and suspension units, but do **not** allow for necessary assembly, overhaul or repair of component parts which may be involved. All items removed and replaced are tested and adjusted to ensure correct function.

Wiring Loom: Certain repair operations necessitate the partial withdrawal of the wiring loom to avoid the risk of burning using a draw cord which must be left in position to facilitate subsequent replacement. In such operations the loom must be withdrawn from the front to the rear of the vehicle with the exception of Operations **No. 73.15.04** and **73.15.05** (the Number 7 Crossmember), where the loom is withdrawn from rear to front.

Fuel Tank: Removal and replacement of the fuel tank has also been included in the M.E.T. times where its removal is necessary to carry out chassis repairs.

In addition a separate time for the fuel tank is shown to allow for cases where it is desirable to treat it in isolation for safety purposes.

Where it is necessary to remove the fuel tank an allowance has been made in the Operation Times for draining and refilling with 2 gallons of fuel.

Steering Alignment: In those chassis repair operations where it is necessary to carry out a steering alignment check, the Operation Time includes a time for setting up the relevant equipment on the vehicle and conducting a data check only. The time does not include carrying out adjustments. A computerised alignment system was used for this purpose on the reaearch vehicle.

M.E.T. and body allowances relate only to the work carried out on a basic specification 110 Defender and may need to be adjusted where a different model version is undergoing repair.

Paint: The Operation Times include an allowance for refinishing of the chassis in a two-pack synthetic paint system *(see **Paint Refinishing** table overleaf for further details)*. The use of alternative paint systems may require adjustment to published times.

Corrosion Protection: Published Operation Times include an allowance for the internal wax treatment of welded areas in order to enhance corrosion resistance.

cont'd....

COMBINATION TIMES

Where an Operation Time is required for a job incorporating two or more of the published single Operation Times, a guide time can be established by adding single Operation Times together and making the following adjustments:

M.E.T. & Body: It is not possible to establish Operation Times for the M.E.T. in combinations of repair operations due to the complexity of areas of overlap. Such allowances will need to be estimated using the published information as a guide.

Chassis: Because the chassis repairs in each operation are treated separately no deduction for overlap needs to be made.

Paint: Some elements such as mixing materials, cleaning spray guns etc. are common to a paint operation. It is therefore necessary to deduct **0.7hrs.** for each additional repair used.

Corrosion Protection: A deduction of **0.2hrs.** for each additional repair used should be made for common elements such as setting up and cleaning equipment.

PAINT REFINISHING

Operation
Prepare affected area of chassis for refinishing
Prepare metal conditioner
Apply metal conditioner to bare metal
Wash and dry affected area of chassis
Clean brush
Solvent wipe affected area of chassis
Apply masking tape and protective covering sheets
Move vehicle into booth
Fit wheel covers as required
Solvent wipe paint area
Prepare primer
Apply 1 primer coat using spraygun
Clean spraygun
Prepare undercoat
Spray on undercoat
Wash out and clean spraygun
Prepare top coat paint material
Spray on top coat
Wash out and clean spraygun
Remove masking tape and protective covering sheets
Allow paint to cure
Move vehicle out of booth

Refinishing System used: Spies Hecker 2K system comprising **Z2852** Metal Conditioner, **3255** Primer, **5040** Undercoat and **257 Series** Topcoat.

No. of coats: 5: **1** of Primer plus **2 each** of Undercoat and Topcoat.

CORROSION PROTECTION

The following corrosion protection cavity wax materials are approved to **BLS22 CP05** for use in corrosion protection operations after repairs:

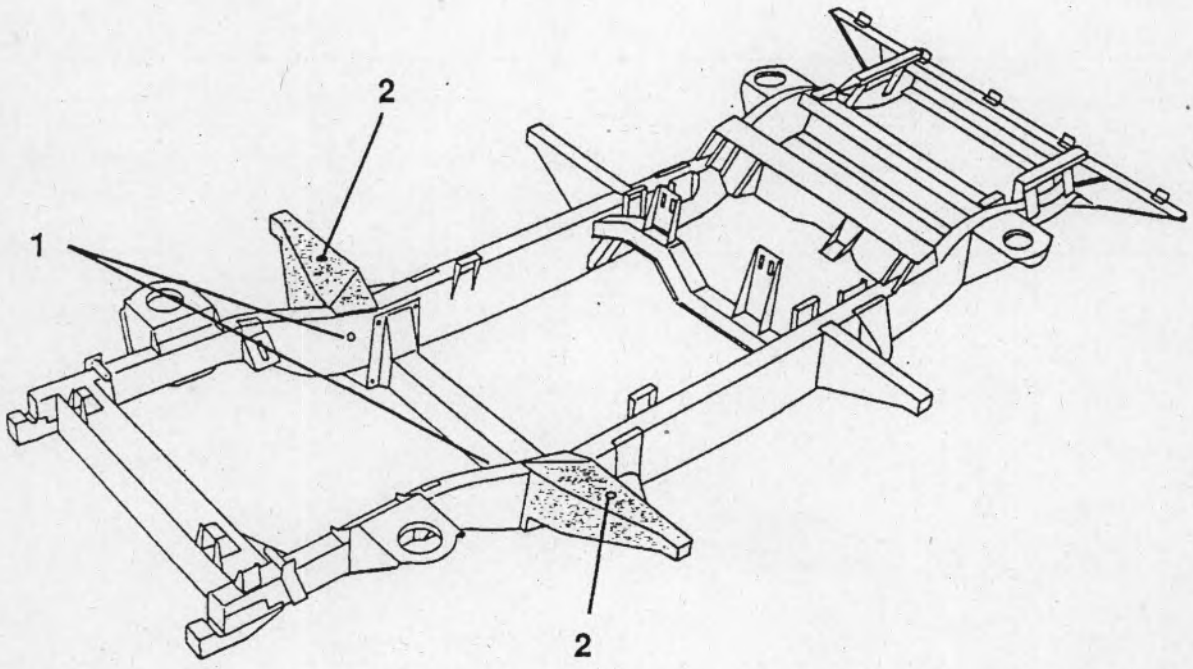
Material	*Part No.*
Astor Chemicals	DA 3079 DA 3397
Croda	PG 176 PW 110
EMS Togo	PP 101
Valvoline-Tectyl	544-PC
Edgar Vaughan	RB 8468

*Corrosion Protection times are included within the time allowances shown on each page of the **Chassis Repair Operations** section of this manual.*

CORROSION PROTECTION MATERIAL - CHASSIS INJECTION POINTS

Fig. 1

Repair Operation No	*Location*
73.10.01	Wiring loom entry point at chassis inner face, directly behind outrigger at **1**. Also through hole in top face of outrigger at **2** above tie bar weld.



Note: Injection points shown for both RH and LH sides where applicable.

Fig. 2

Repair Operation No.	*Location*
73.10.02	Hole on outer face of chassis longitudinal immediately ahead of rear outrigger at **3**.

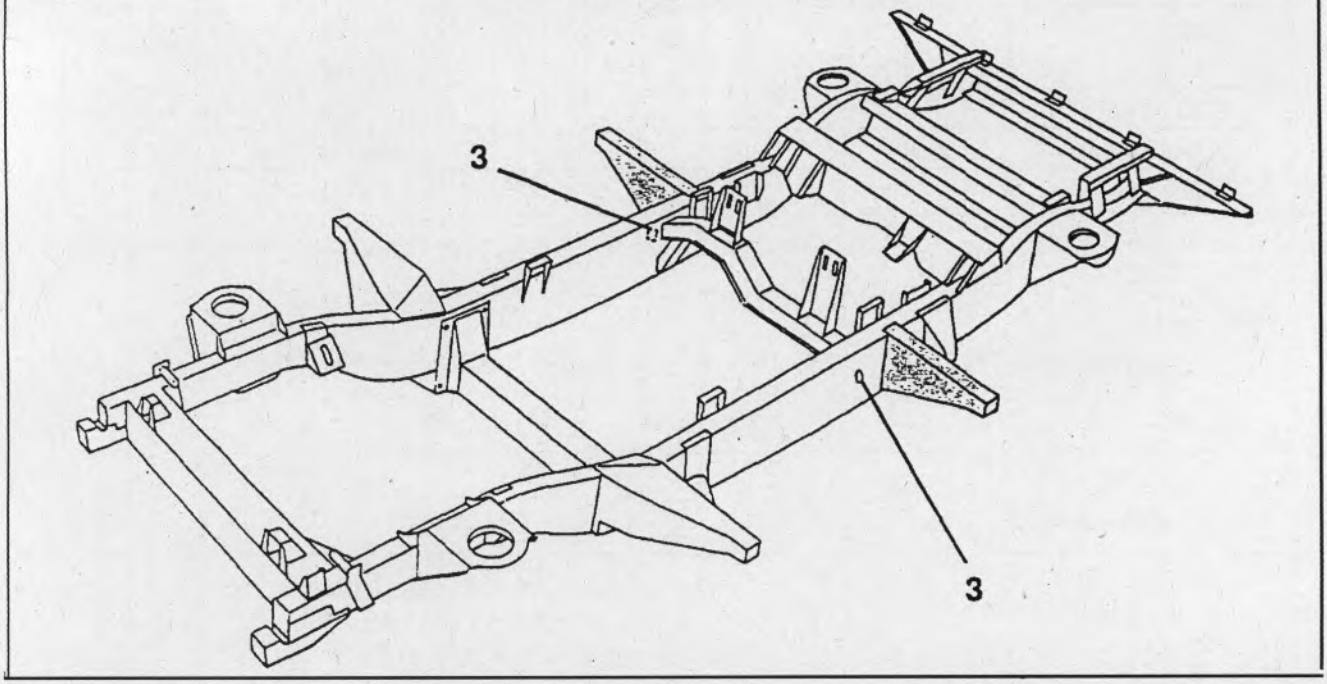


Fig. 3

Repair Operation No.	*Location*
73.15.02	Holes at forwardface of chassis longitudinal at **4**, at corner gusset **7** and rear face of No. 2 cross-member **6**.

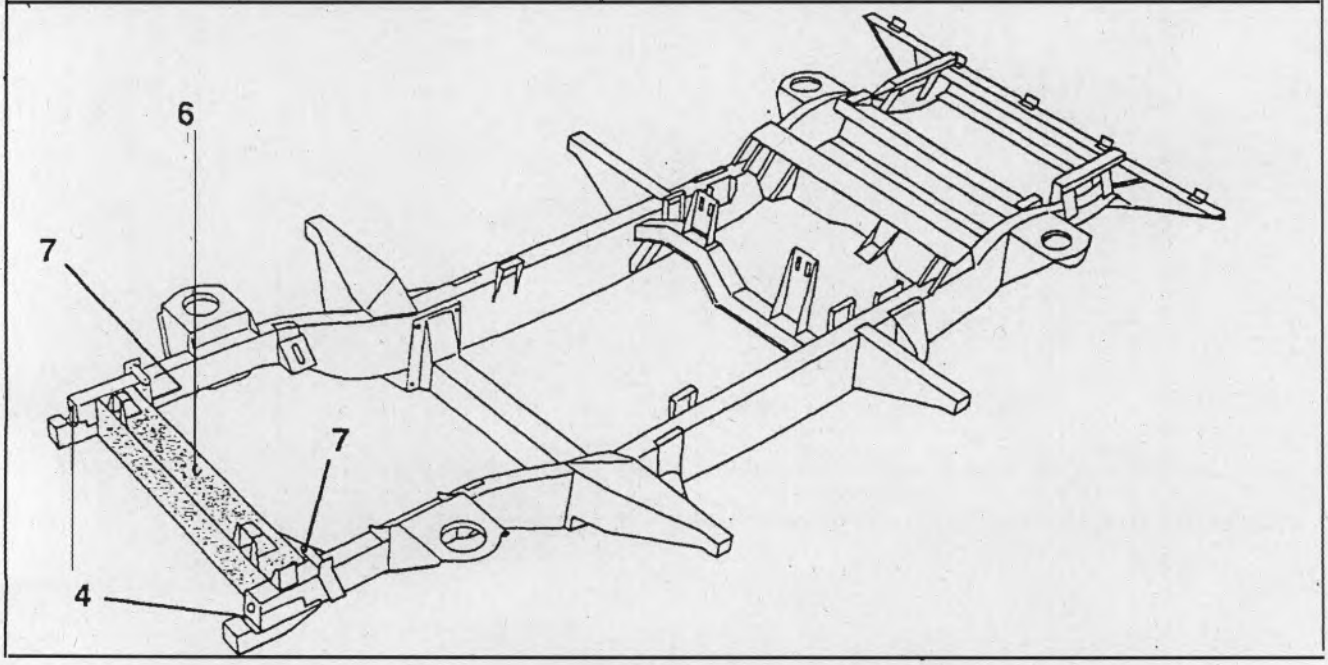


Fig. 4

Repair Operation No.	*Location*
73.15.04 and 73.15.05	Rear wiring loom entry hole at chassis longitudinal 8.

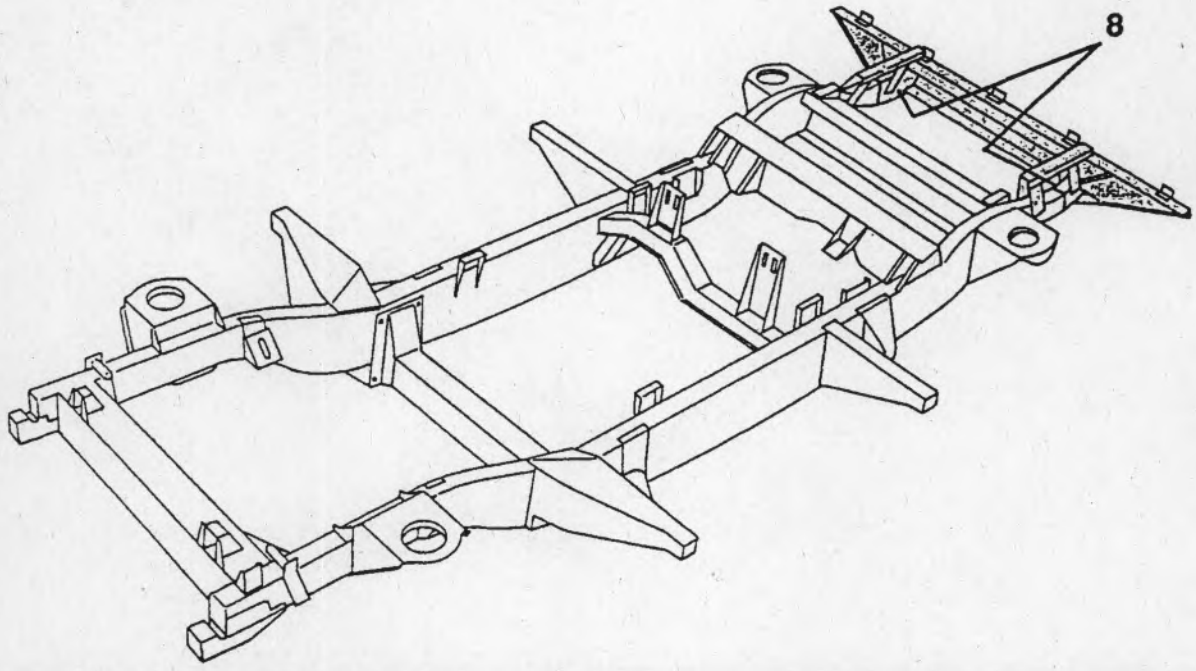
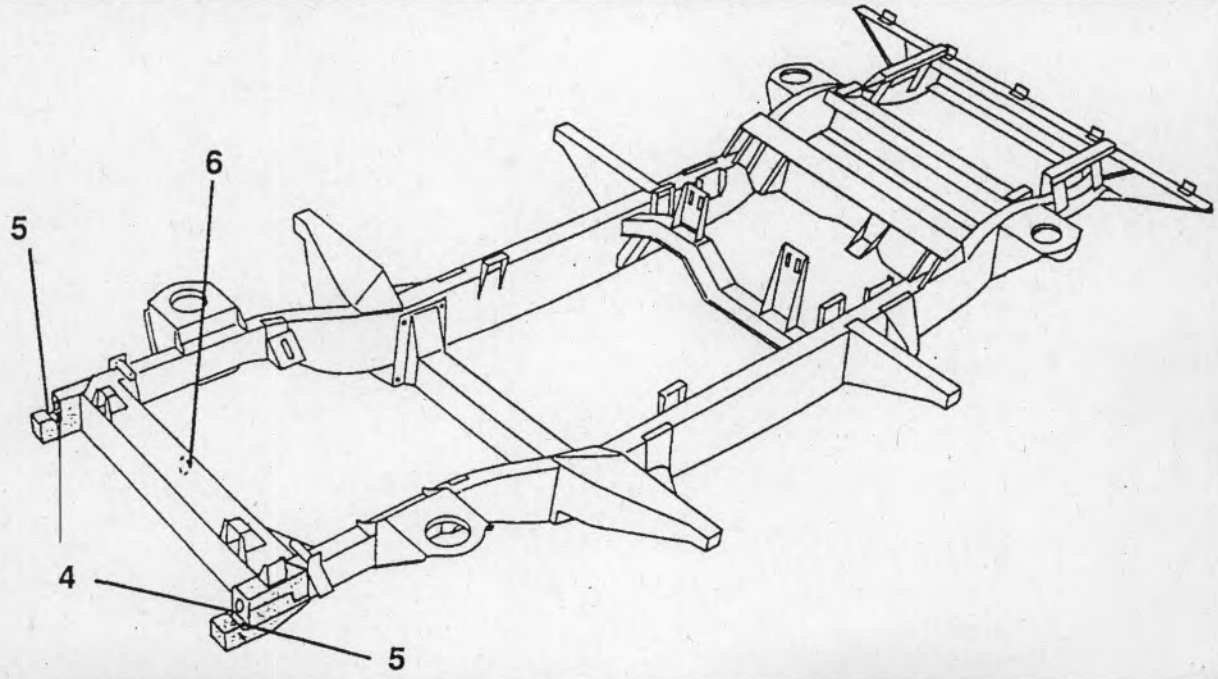


Fig. 5

Repair Operation No.	*Location*
73.20.01	Hole at forward face of chassis longitudinal at 4, slot at upper face 5 and hole at rear face of No. 2 crossmember 6.



CORROSION PROTECTION - CHASSIS INJECTION POINTS (cont'd.)

Fig. 6

Repair Operation No.	*Location*
73.20.02	Hole at forward face of chassis longitudinal at 4 *(using 1 metre metal extension probe).*

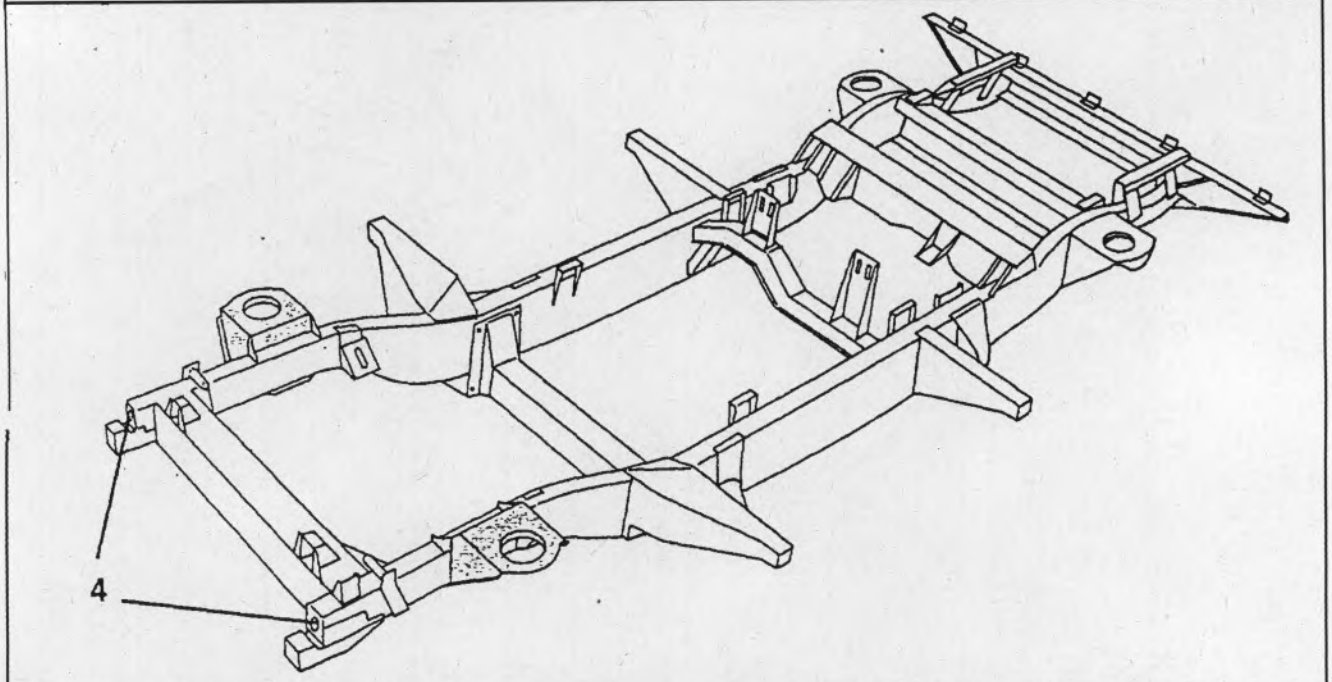
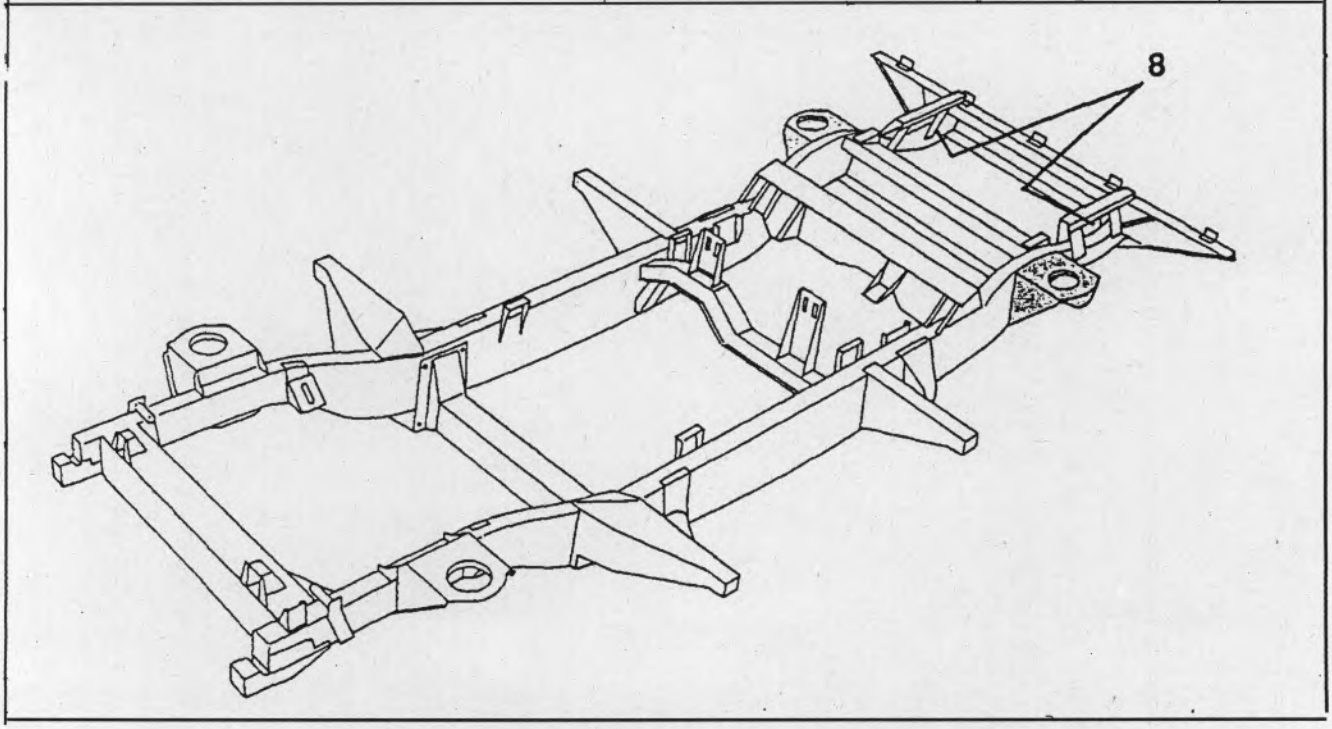


Fig. 7

Repair Operation No.	*Location*
73.20.03	Rear wiring loom entry hole at chassis longitudinal 8.



CORROSION PROTECTION - CHASSIS INJECTION POINTS (cont'd.)

Fig. 8

Repair Operation No.	*Location*
73.20.04	Wiring loom entry point at chassis inner face, directly behind outrigger at **1**. Also through hole in top face of outrigger above tie bar weld at **2**.

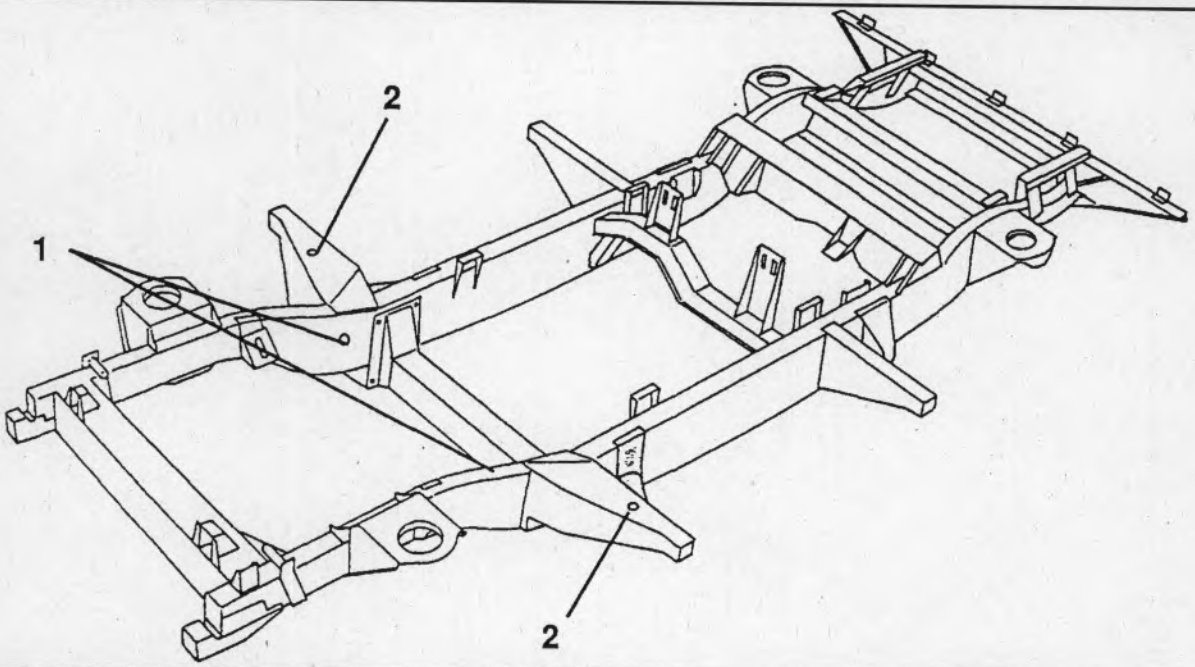
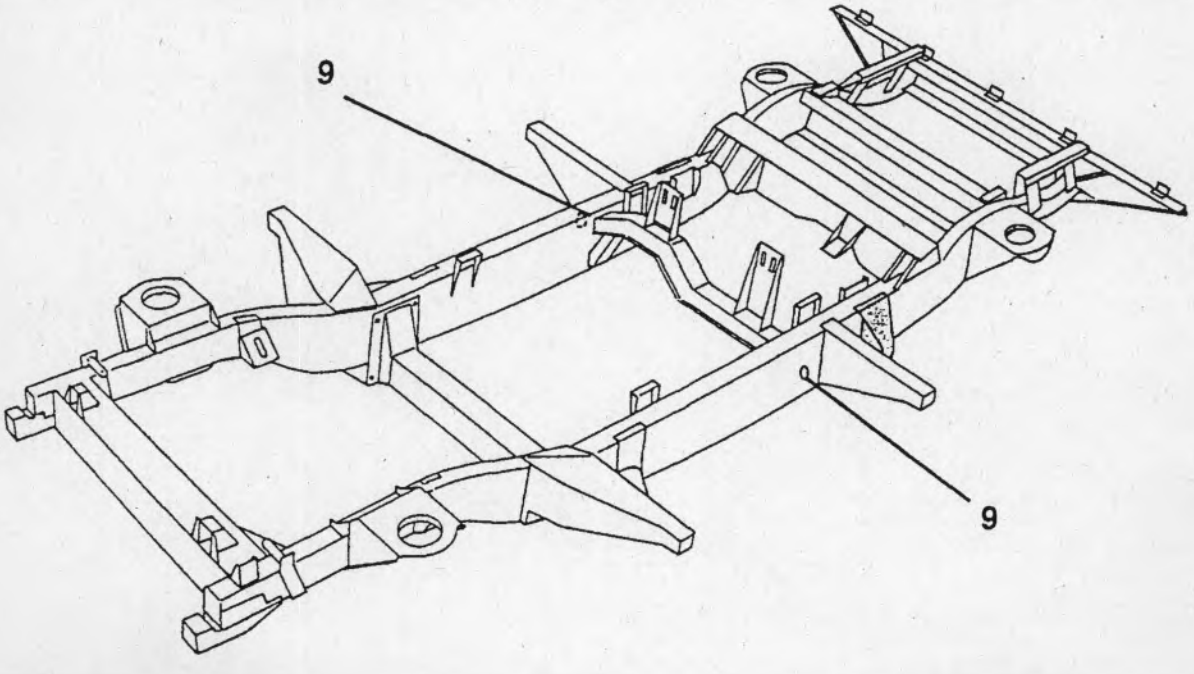


Fig. 9

Repair Operation No.	*Location*
73.20.05	Hole at outer face of chassis longitudinal directly ahead of rear outrigger at **9**.



CORROSION PROTECTION - CHASSIS INJECTION POINTS (cont'd.)

Fig. 10

Repair Operation No.	*Location*
73.20.06	Holes at outer and forward faces of chassis longitudinal **Nos. 4** and **9**, at corner gusset **7** and rear face of No. 2 crossmember **6** *(injected towards appropriate side).*

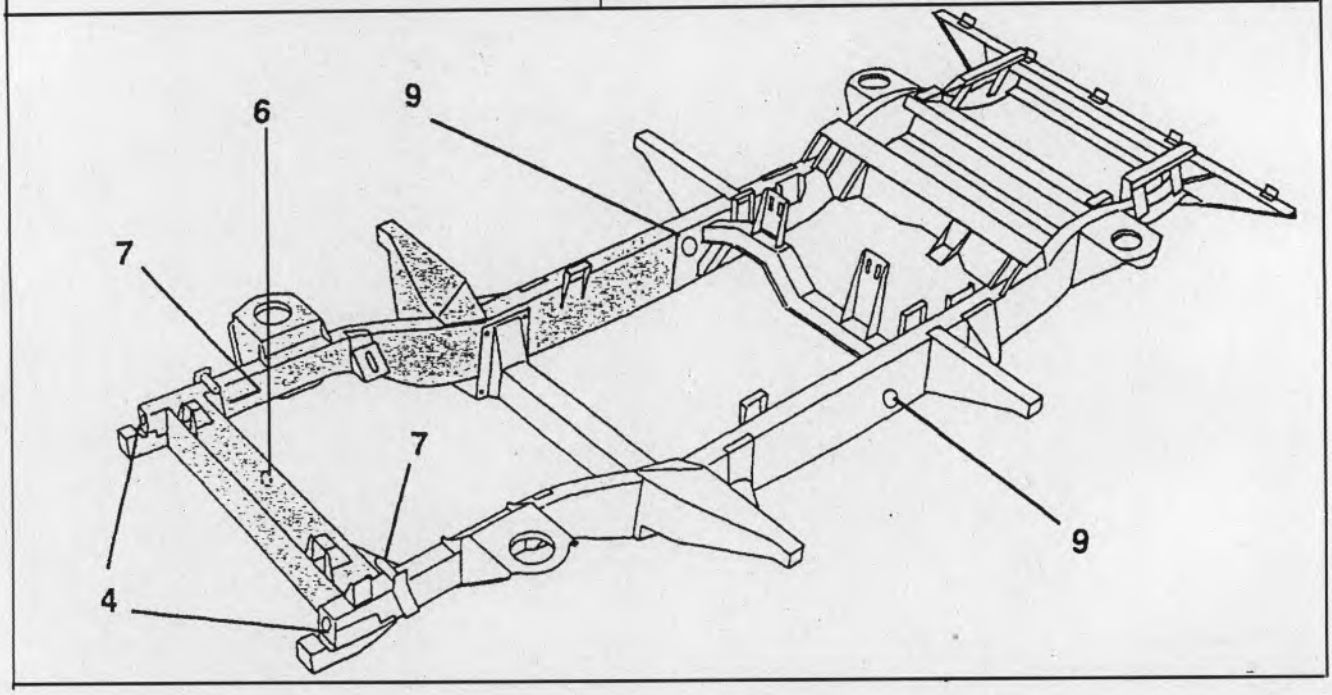
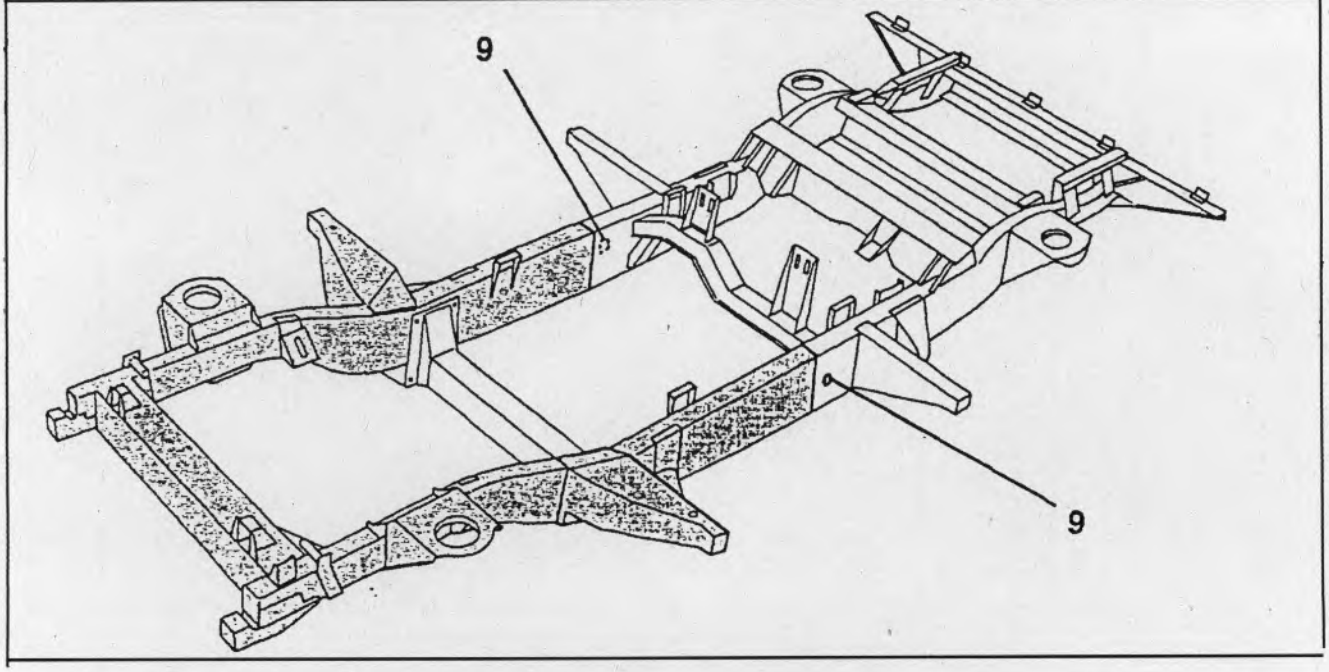


Fig. 10a

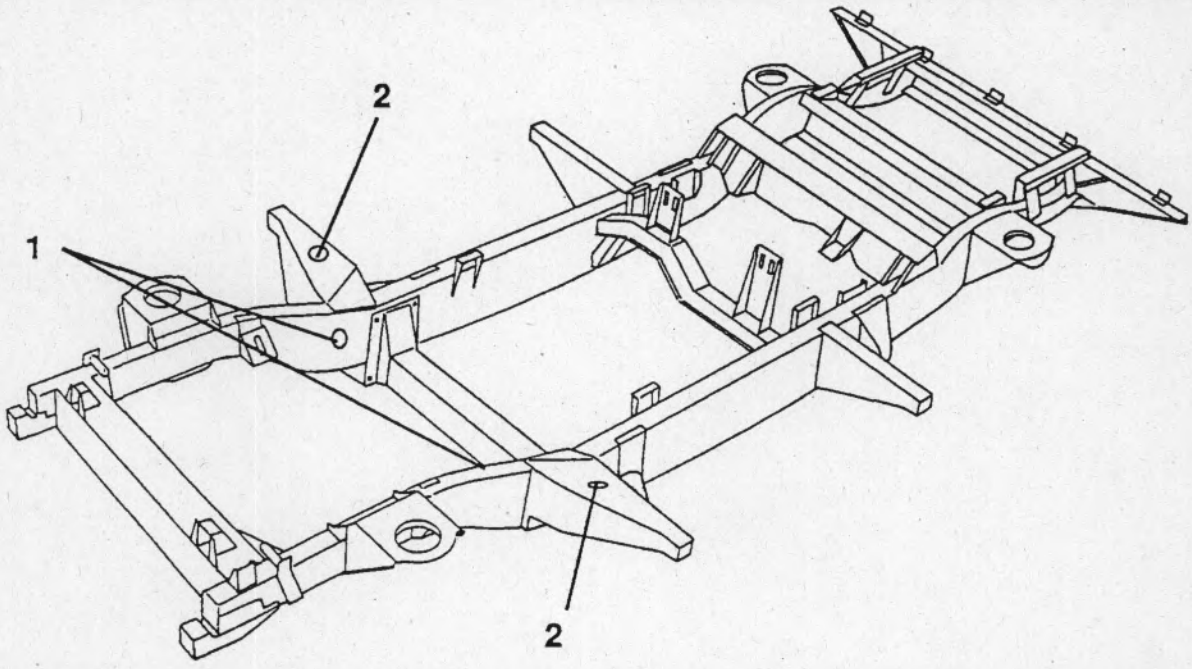
Repair Operation No.	*Location*
73.20.07	Holes at outer and forward faces of chassis longitudinal **No. 9.**



CORROSION PROTECTION - CHASSIS INJECTION POINTS (cont'd.)

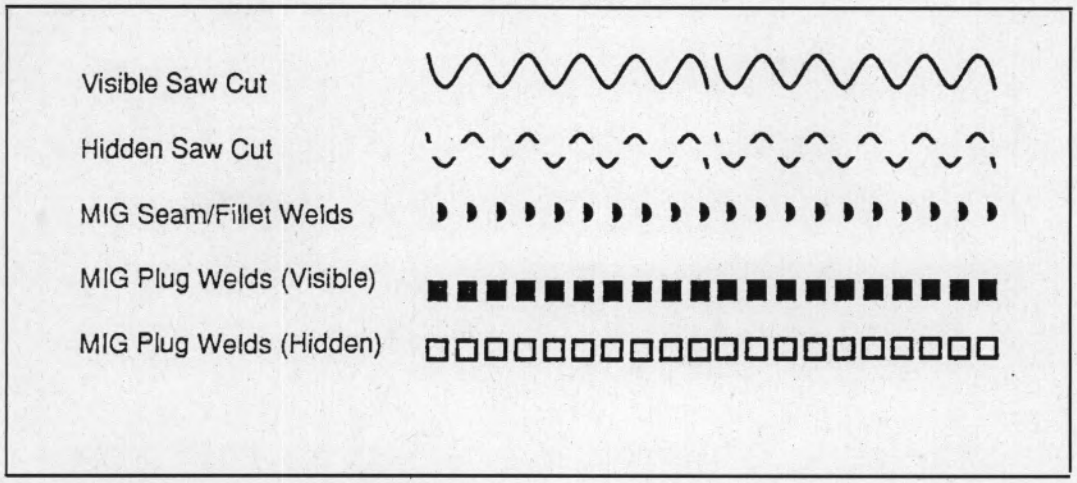
Fig. 11

Repair Operation No.	*Location*
73.20.08	Wiring loom point at chassis inner face, directly behind outrigger at **1**. Also through hole in top face of outrigger above tie bar weld at **2**.



73 CHASSIS REPAIR OPERATIONS

KEY TO DIAGRAM SYMBOLS



OUTRIGGER - FRONT - REPLACEMENT

CHASSIS PART:

REMOVAL

Cut outrigger at points **A** and **B** in **Fig. 12.** Remove outrigger bulk and remove metal remnants from chassis and tie bar. **Take care to avoid thinning the chassis frame in this area when grinding off the remnants.**

Remove upper mounting bolt at No. 3 crossmember as shown at point **C.**

Associated parts to be removed and replaced:
Front Panel.
Front Wing RH and LH.
Cab Unit.

ELECTRICAL:

The wiring loom must be withdrawn for access when replacing a RH outrigger (see **Introduction** section **page 2**).

REPLACEMENT

Offer up new front outrigger, mark chassis weld area locations, remove outrigger and dress new and existing joint areas for welding. Apply red brown anti-corrosion primer to side face of chassis member at original welded areas.

Offer up outrigger, MIG seam weld in position at **Nos. 1** and **2.** Check alignment of bolt mounting holes **X** and re-shape as necessary.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3** to **8**).

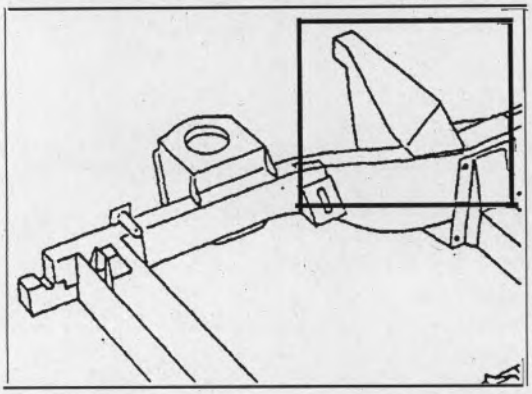
WELDING TABLE

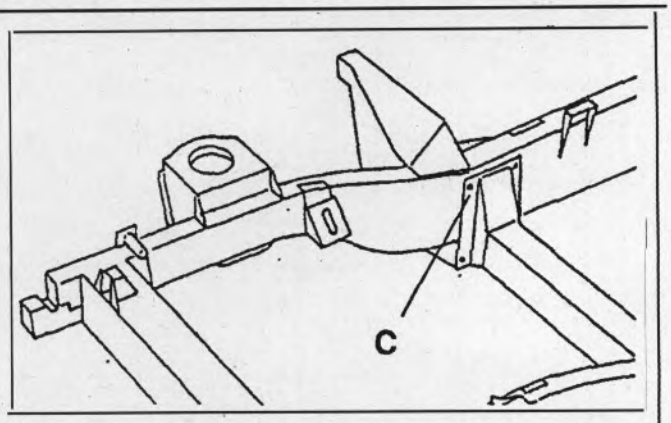
No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member	1 x 770mm MIG seam weld	1 x 970mm MIG seam weld.
2	To tie bar	1 x 330mm MIG seam weld	1 x 330mm MIG seam weld.

Operation No. 73.10.01	***Description*** OUTRIGGER - FRONT - REPLACEMENT	***Time*** 19.8RH 19.6LH

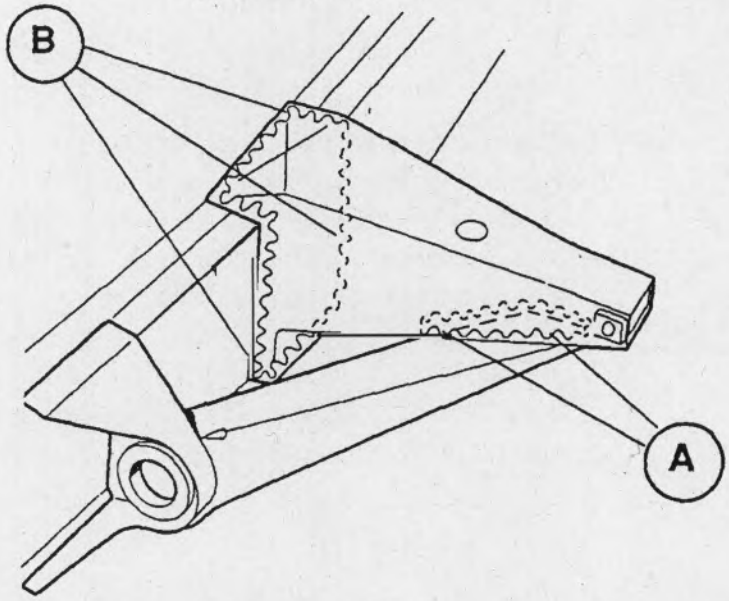
OUTRIGGER - FRONT - REPLACEMENT

Fig. 12

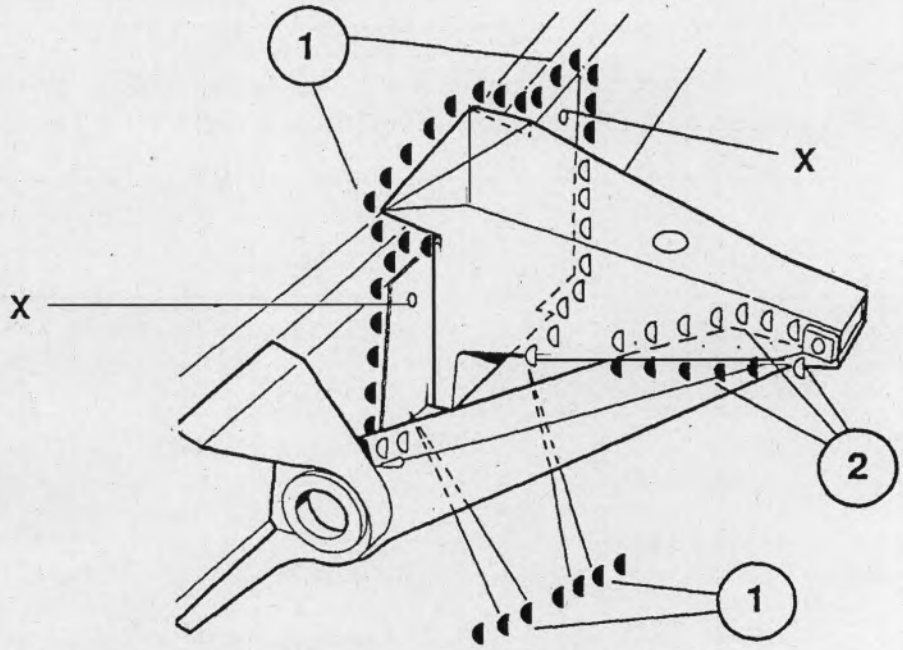




REMOVE PART



REPLACE PART



OUTRIGGER - REAR - REPLACEMENT

CHASSIS PART:

REMOVAL

Cut outrigger at point **C** in **Fig. 13**. Remove outrigger bulk and remove metal remnants from chassis. **Take care to avoid cutting into the reinforcement at the lower section and reducing the thickness of the chassis frame when grinding off the remnants.**

Associated parts to be removed and replaced:
***Note:** it is unnecessary to remove any associated panels during this repair operation, although care should be taken to avoid damage to adjacent panelwork.*

REPLACEMENT

Offer up new rear outrigger complete with reinforcing plate attached as supplied, mark chassis weld area locations, remove outrigger and dress new and existing joint areas for welding. Apply red brown anti-corrosion primer to side face of chassis member at original welded areas.

Offer up outrigger, MIG seam weld in position at **No. 1**. Dress seam weld.

MECHANICAL, ELECTRICAL & TRIM:

Remove and replace support brackets adjacent to outrigger, lay aside brake pipes/ hoses as necessary. **Note:** when replacing a RH outrigger the wiring loom must be withdrawn for access as described in **Introduction** section **page 1.**

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3** to **8**).

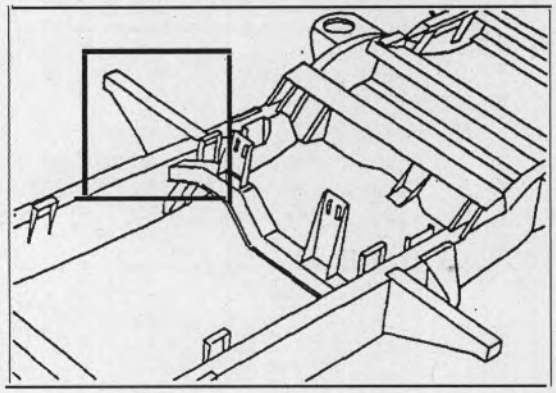
WELDING TABLE

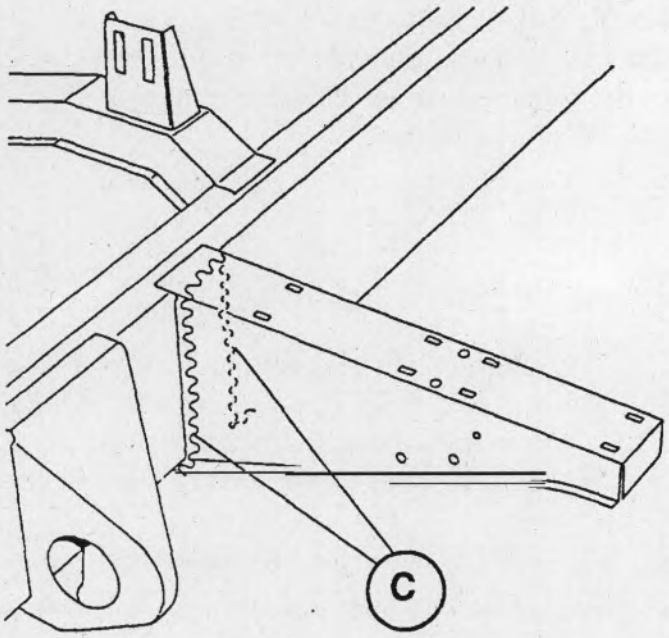
No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member	1 x 610mm MIG seam weld	1 x 850mm MIG seam weld.

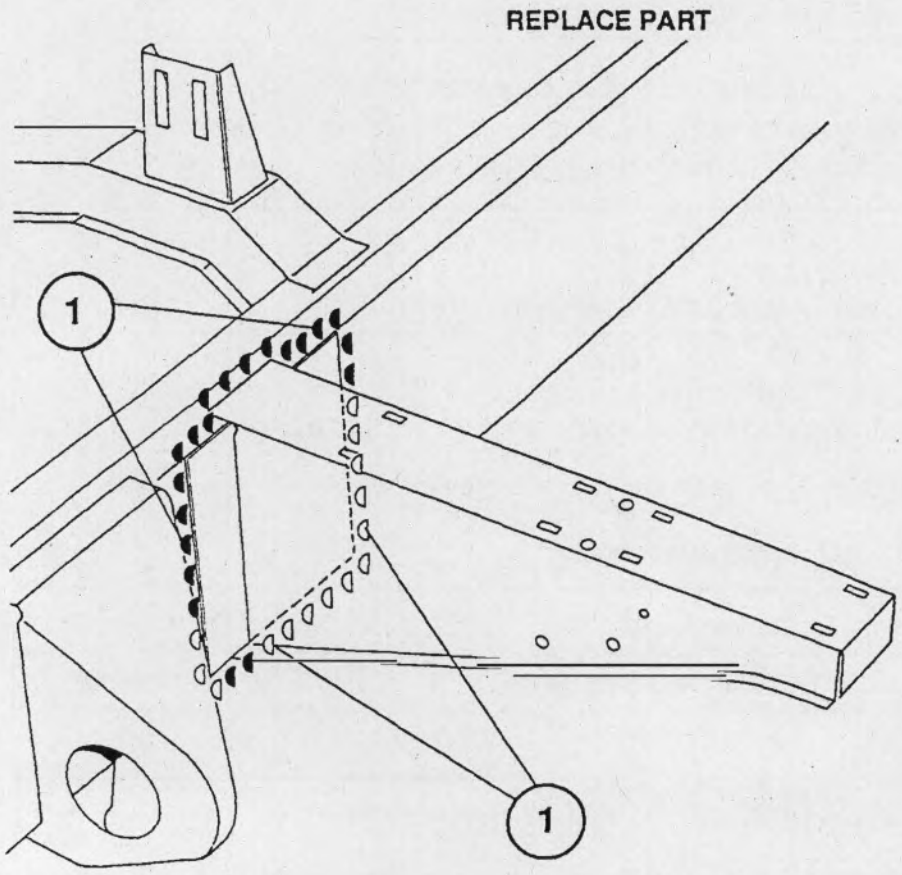
Operation No. 73.10.02	*Description* OUTRIGGER - REAR - REPLACEMENT	*Time* 6.1RH 5.3LH

OUTRIGGER - REAR - REPLACEMENT

Fig. 13

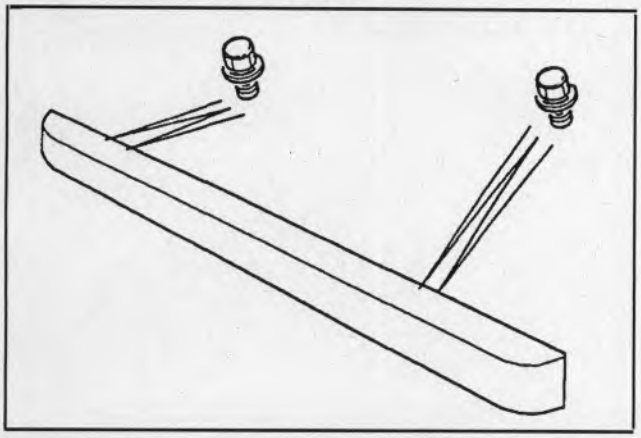






NUMBER 1 CROSSMEMBER - REPLACEMENT

Fig. 14



REMOVAL

Remove 2 mounting bolts from bracket at crossmember upper face RH and LH (see **Fig. 14**). Remove crossmember from vehicle.

REPLACEMENT

Transfer number plate to new crossmember, offer up crossmember, replace 2 mounting bolts at bracket RH and LH, check alignment and tighten bolts.

Operation No. 73.15.01	***Description*** NUMBER 1 CROSSMEMBER-REPLACEMENT	***Time*** 0.6

NUMBER 2 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
No.1 Crossmember (see above), front panel, radiator, steering box, lay aside steering damper.

REMOVAL

Cut crossmember and gussets at points D in **Fig. 15** taking care not to damage the Panhard rod mounting tube at *X*. Note: the outer ends of the crossmember rear face where they are enclosed by the gussets are not welded in production or subsequent replacement due to insufficient access. Remove crossmember bulk and metal remnants.

REPLACEMENT

Offer up new crossmember assembly, mark chassis weld area locations, remove new section and dress new and existing joint areas for welding. Offer up crossmember assembly, clamp in position and MIG seam weld at No. 1 RH and LH. Dress all seam welds.

MECHANICAL:

Carry out a steering alignment check as necessary observing the points described in **Introduction** section **page 2.**

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

WELDING TABLE

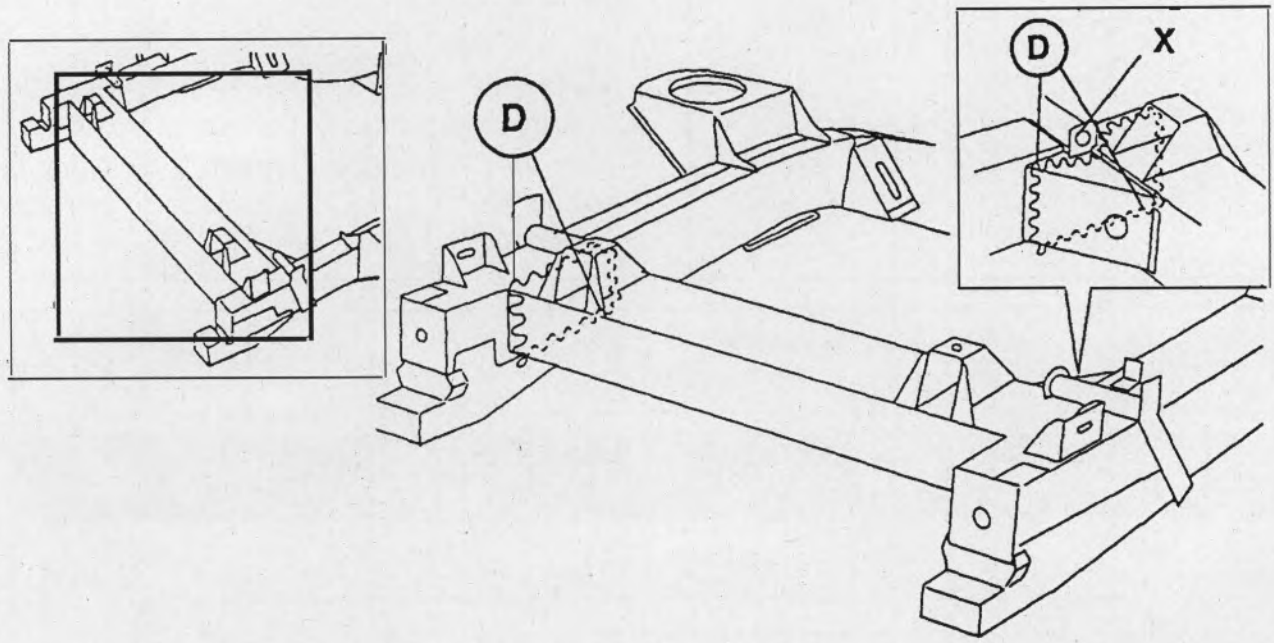
No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member RH and LH	1 x 550mm MIG seam weld each side	1 x 550mm MIG seam weld each side.

Operation No. 73.15.02	***Description*** NUMBER 2 CROSSMEMBER-REPLACEMENT	***Time*** 9.5

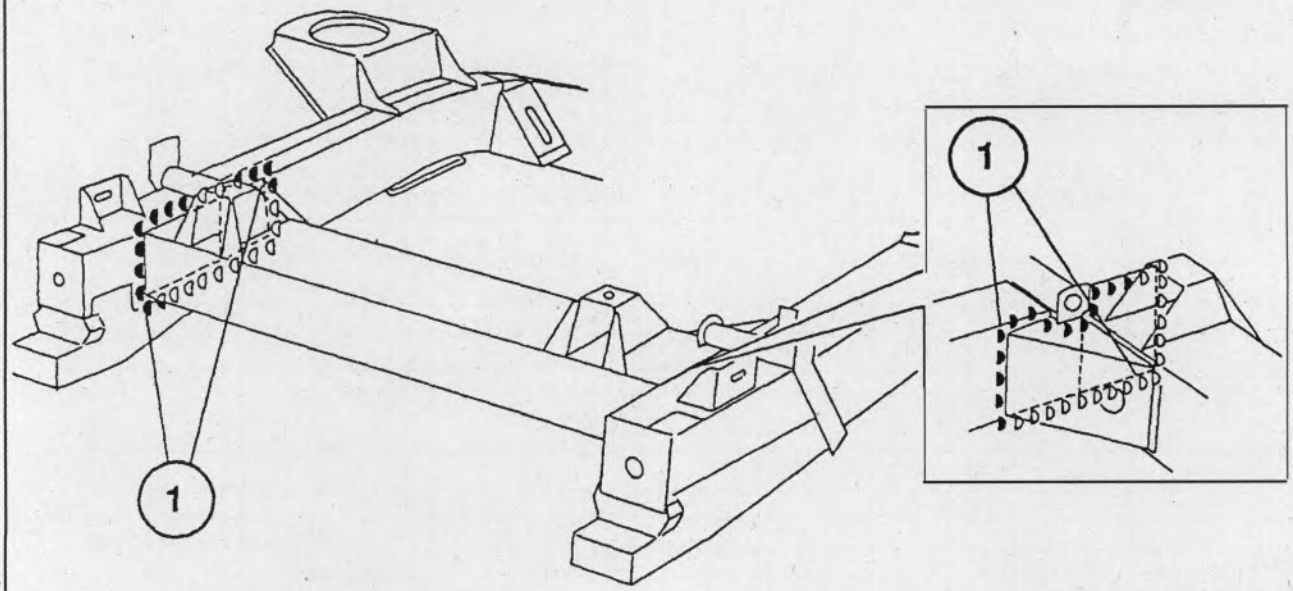
NUMBER 2 CROSSMEMBER - REPLACEMENT

Fig. 15

REMOVE PART



REPLACE PART



NUMBER 3 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

REMOVAL

Raise vehicle on lift, remove 4 mounting bolts and nuts to chassis member RH and LH as shown in **Fig. 16**, dislodge crossmember using a copper-faced mallet or similar (see note below), remove crossmember from chassis.

REPLACEMENT

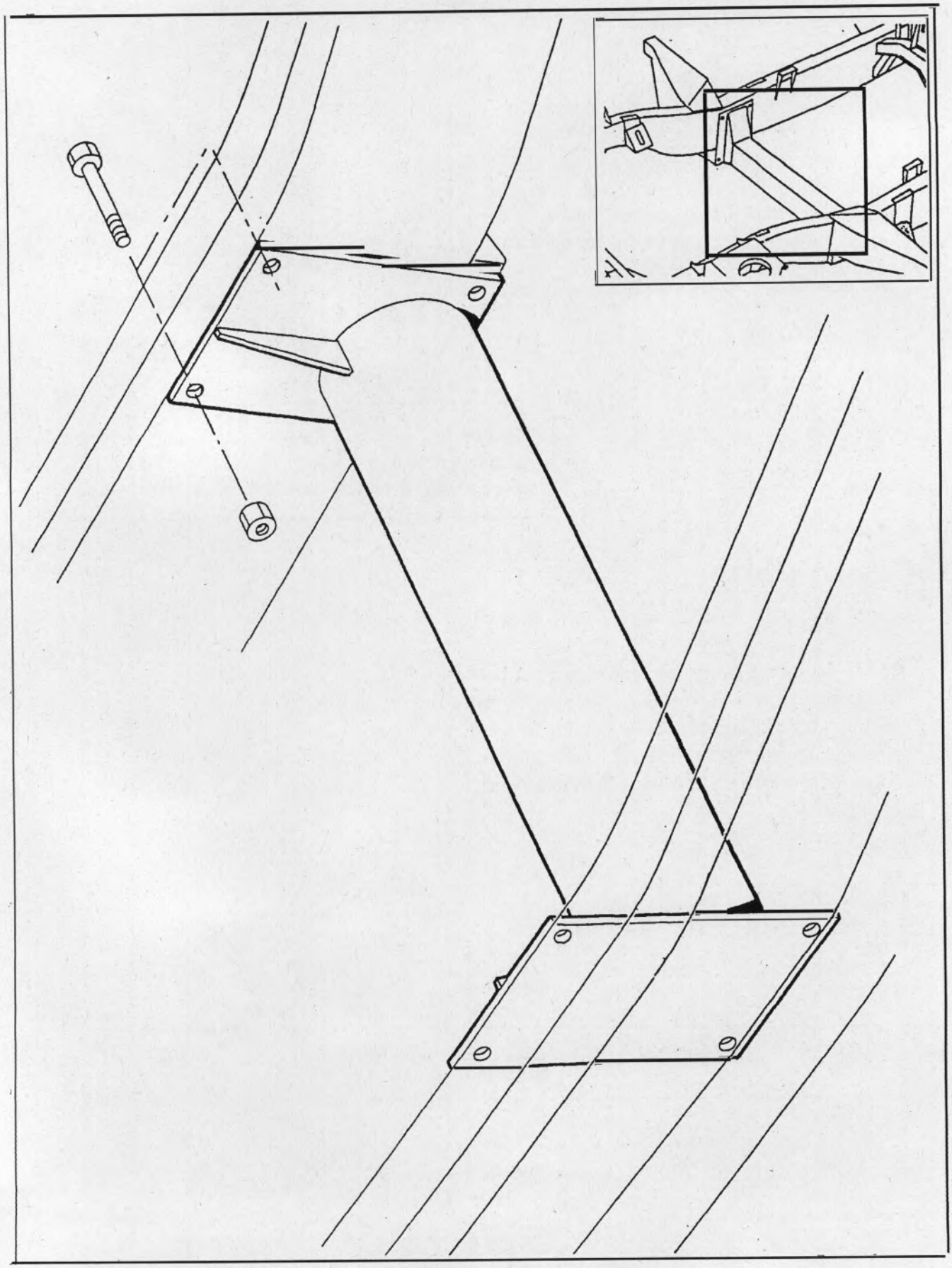
Offer up new crossmember (see note below), replace 4 mounting bolts and nuts to chassis member RH and LH, check alignment and tighten all fasteners, lower vehicle.

Note: should difficulty be experienced in removing and offering up the crossmember it may be necessary to use a suitable power-operated chassis spreader to relieve the strains. The Replacement Time Schedules in this Manual do not allow for this operation.

Operation No. 73.15.03	*Description* NUMBER 3 CROSSMEMBER-REPLACEMENT	*Time* 1.1

NUMBER 3 CROSSMEMBER - REPLACEMENT

Fig. 16



NUMBER 7 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Rear body section, fuel tank, withdraw wiring loom sufficient for access.

REMOVAL

Measure and mark cutting locations on chassis members approximately 360mm ahead of the rear ends. This is in order to leave at least 10mm surplus on existing chassis members. Cut chassis members at points E in Fig. 17, also body mountings at F (see inset).

Remove crossmember bulk leaving alignment jig brackets undisturbed until new crossmember assembly is to be fitted. Remove metal remnants at body support brackets (where applicable).

REPLACEMENT

Transfer fuel tank rear mounting bolts to new crossmember assembly, offer up new assembly, measure and mark cutting locations on chassis legs, trim surplus metal from chassis legs to obtain exact alignment. Ensure jig brackets are locked in position, clean butt joint faces, clamp parts in place, MIG seam weld at Nos. 1 and 2.

Dress seam welds. Apply red brown anti-corrosion primer to butt joint faces. Remove alignment jig brackets. Offer up new upper and lower reinforcement plates to chassis leg joints ensuring that the towing eye mounting holes *X* and *Y* are correctly aligned with the corresponding holes on the chassis legs as shown.

Remove reinforcement plates, prepare old and new joint surfaces plates and chassis members for welding. Seam weld upper reinforcement plates at No. 3, then lower plates into place at No. 4. Also seam/plug weld holes at side faces of upper plates at No. 4. The mounting holes at *X* and *Y* must be left in an unwelded condition.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see Introduction section pages 3 to 8).

ELECTRICAL:

The wiring loom must be withdrawn on the RH side for access as described in Introduction section page 1.

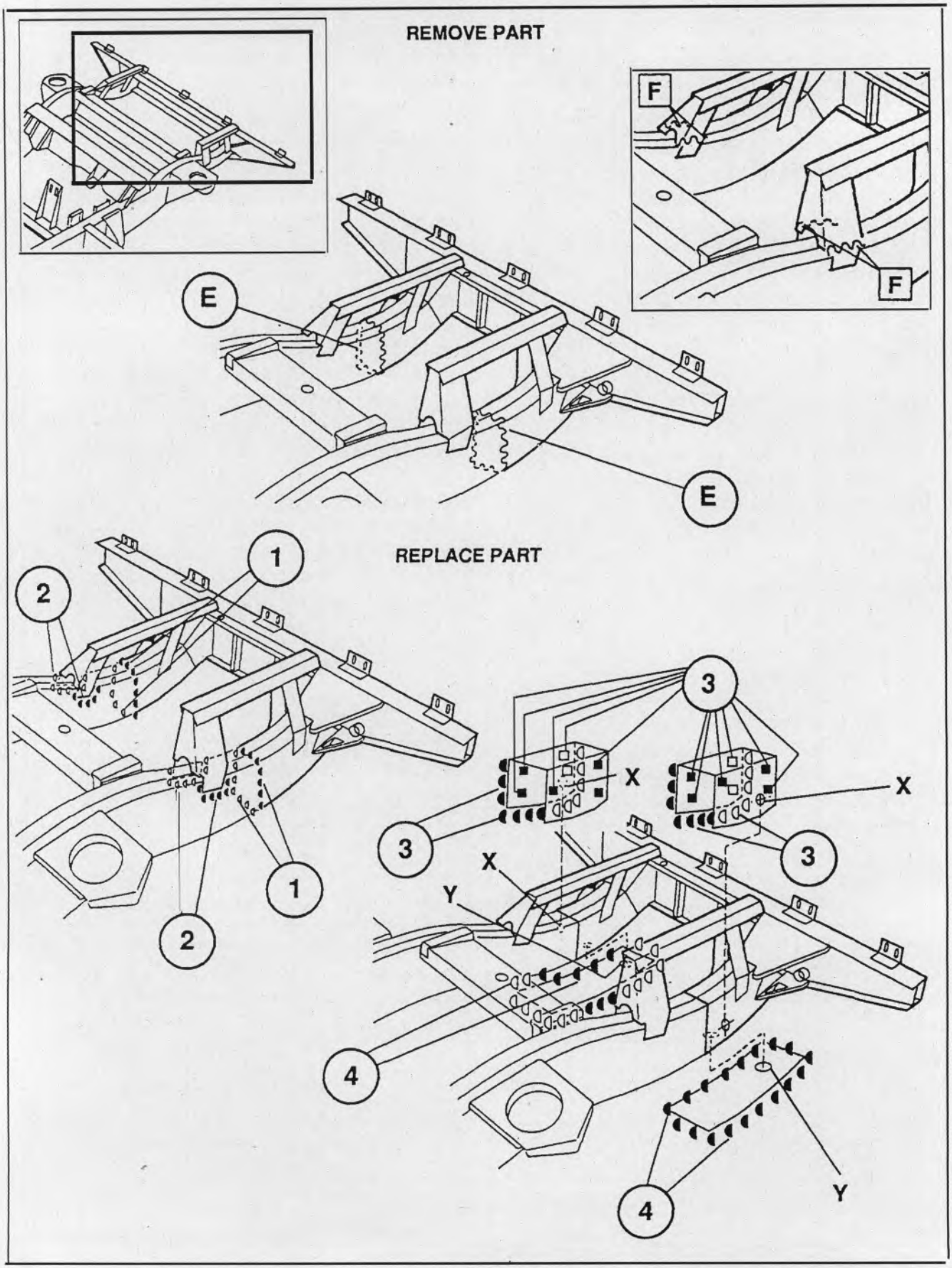
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis member RH and LH		1 x 400mm MIG seam weld each side.
2	Body support bracket to chassis member RH and LH	2 x 90mm MIG seam welds	2 x 90mm MIG seam welds.
3	Upper reinforcement plate to chassis member RH and LH		1 x 980mm MIG seam weld each side. 6 MIG plug/seam welds each side.
4	Lower reinforcement plate to chassis member RH and LH		1 x 540mm MIG seam weld each side.

Operation No. 73.15.04	*Description*	NUMBER 7 CROSSMEMBER- REPLACEMENT *(Defender 110" only)*	*Time* 22.9

NUMBER 7 CROSSMEMBER - REPLACEMENT

Fig. 17



FRONT SECTION AHEAD OF NO.2 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

REMOVAL

Mark section to be removed and ensure marks align with new section as supplied. Ensure old section is aligned in body jig, cut body mounting bracket at point **G** in **Fig. 18** and chassis member at **H** in that order with the vertical cuts made directly in line with the forward face of the No. 2 crossmember. Remove chassis section bulk and metal remnants.

Associated parts to be removed and replaced:
No. 1 Crossmember (see page 5), front panel, front wing.

REPLACEMENT

Offer up new chassis section, mark chassis weld area locations, remove new section and dress new and existing joint areas for welding. Offer up chassis section and modify by forming a slot at the inner edge **25mm** long to enable the overlapped areas to be separated slightly and offered up over the existing chassis section (see inset **X**). Dress chassis lower face to facilitate offering up in this area. Offer up new chassis section and MIG seam weld in position at **Nos. 1, 2** and **3** in that order. Dress all seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3** to **8**).

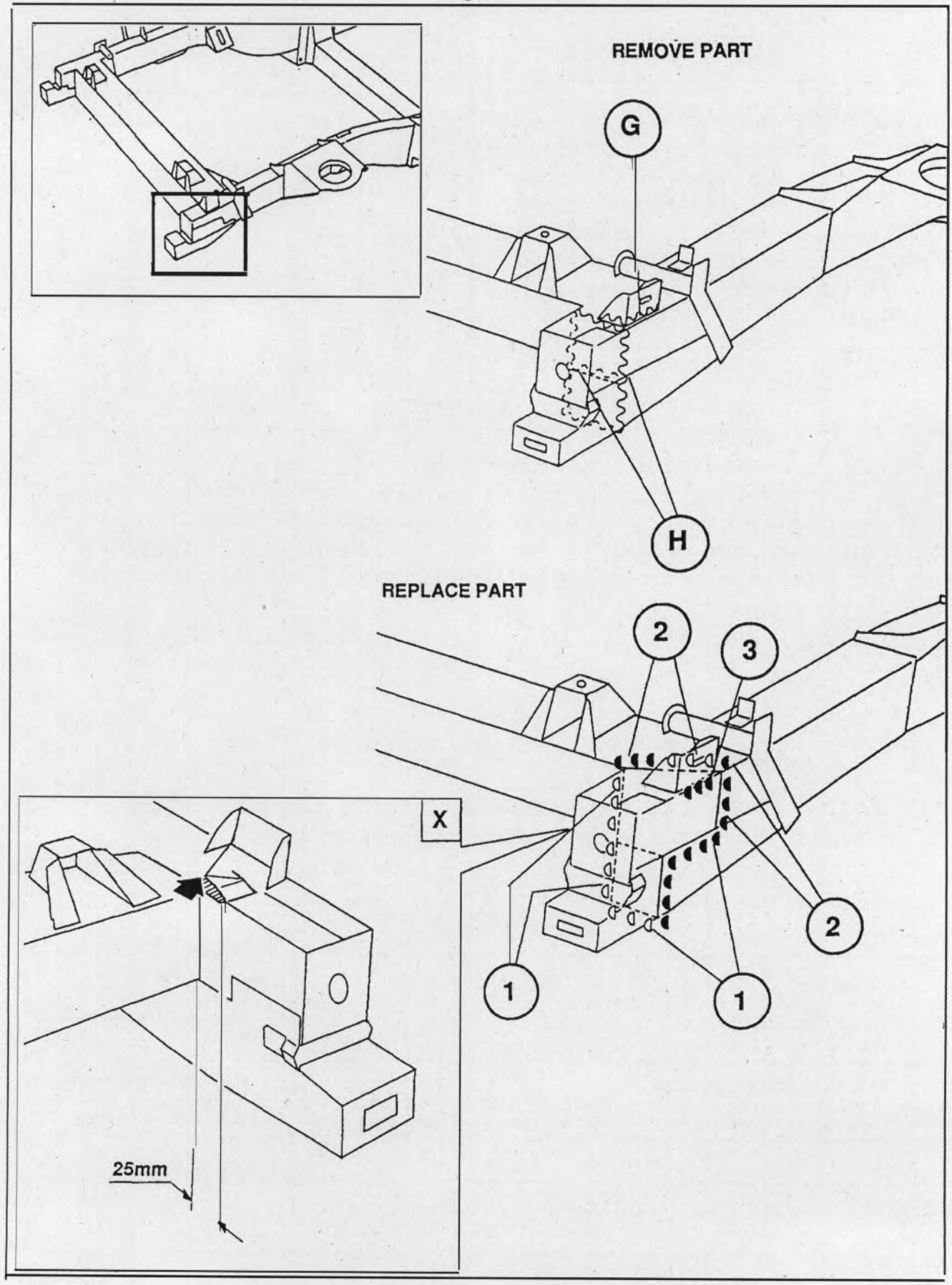
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis and cross-member at lower and inner faces		1 x 280mm MIG seam weld.
2	To existing chassis at lap joints		1 x 380mm MIG seam weld.
3	Body mounting bracket to chassis	1 x 160mm MIG seam weld	1 x 120mm MIG seam weld.

Operation No. 73.20.01	*Description*	FRONT SECTION AHEAD OF NO. 2 CROSSMEMBER - REPLACEMENT	*Time*	8.7RH 8.0LH

FRONT SECTION AHEAD OF NO.2 CROSSMEMBER - REPLACEMENT

Fig. 18



FRONT SPRING SEAT - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Front wing, front suspension.

REMOVAL

Cut spring seat at point J in Fig. 19, remove bulk and metal remnants at upper support brackets.

REPLACEMENT

Dress weld areas. Offer up new spring seat to chassis member and support brackets, MIG seam weld at points 1, 2 and 3. Offer up lower reinforcement plates as shown at inset X and MIG seam weld into position at Nos. 4 and 5.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section pages 3 to 8).

MECHANICAL:

Carry out a general steering alignment check as necessary observing the points described in **Introduction** section page 1.

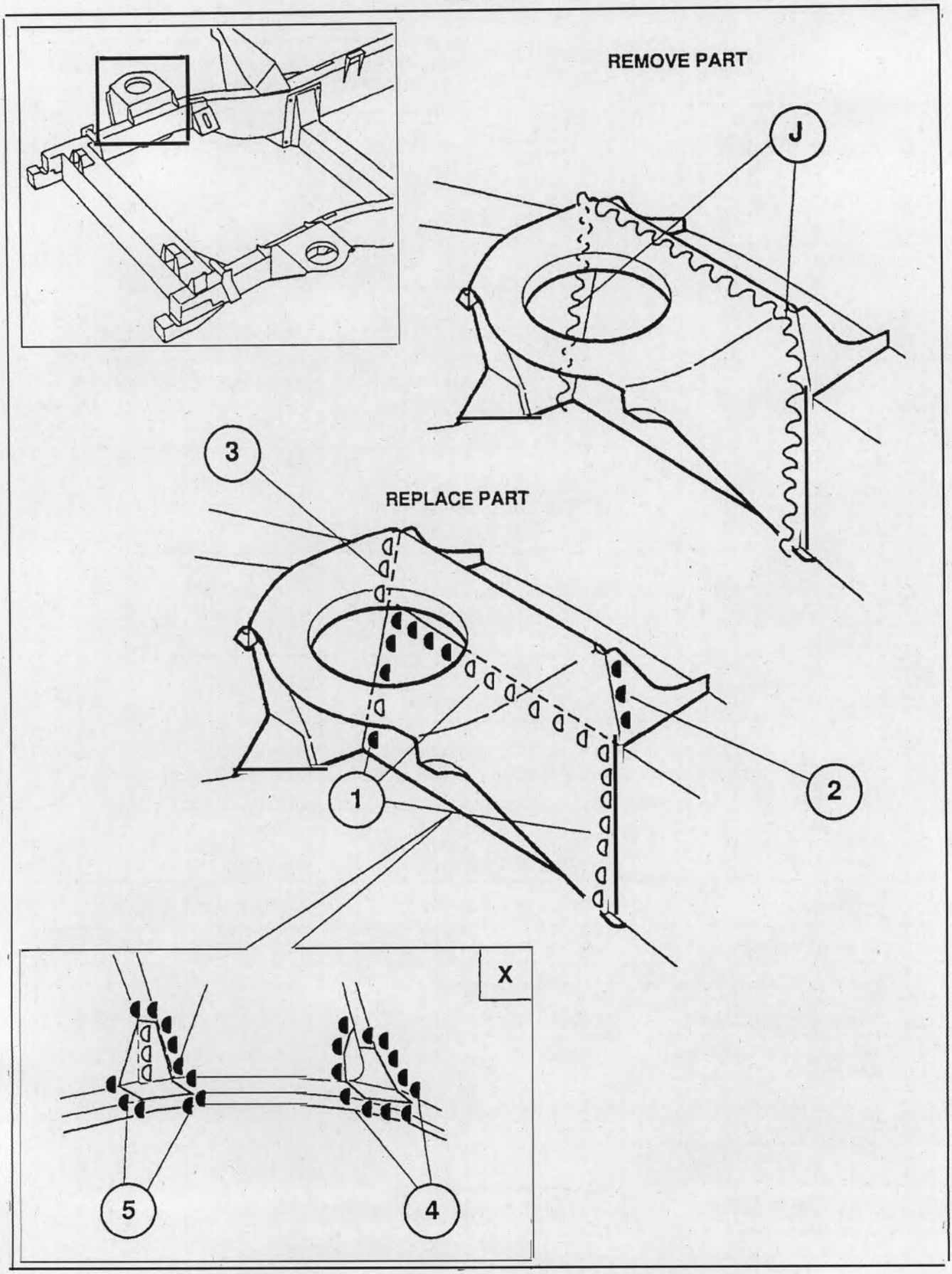
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member	1 x 490mm MIG seam weld	1 x 490mm MIG seam weld.
2	To front upper support bracket	1 x 50mm MIG seam weld	1 x 50mm MIG seam weld.
3	To rear upper support bracket	1 x 50mm MIG seam weld	1 x 50mm MIG seam weld.
4	Front lower reinforcement plate to spring seat	1 x 260mm MIG seam weld	1 x 260mm MIG seam weld
5	Rear lower reinforcement plate to spring seat	1 x 380mm MIG seam weld	1 x 380mm MIG seam weld.

Operation No. 73.20.02	*Description* FRONT SPRING SEAT - REPLACEMENT	*Time* 13.4RH 13.2LH

FRONT SPRING SEAT - REPLACEMENT

Fig. 19



REAR SPRING SEAT - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Rear body section, rear suspension.

REMOVAL

Cut spring seat at point K in Fig. 20,remove bulk and metal remnants from chassis member. Take care to avoid reducing the thickness of the chassis when grinding off the remnants.

REPLACEMENT

Dress weld areas. Offer up new spring seat to chassis member, check alignment using special location fitting in conjunction with alignment jig(see diagram page 27). MIG seam weld at points 1, 2, 3 and 4. Dress seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

MECHANICAL & ELECTRICAL:

Carry out a rear suspension alignment check as necessary; also when replacing a RH rear spring seat withdraw the wiring loom (see **Introduction** section **page 1**).

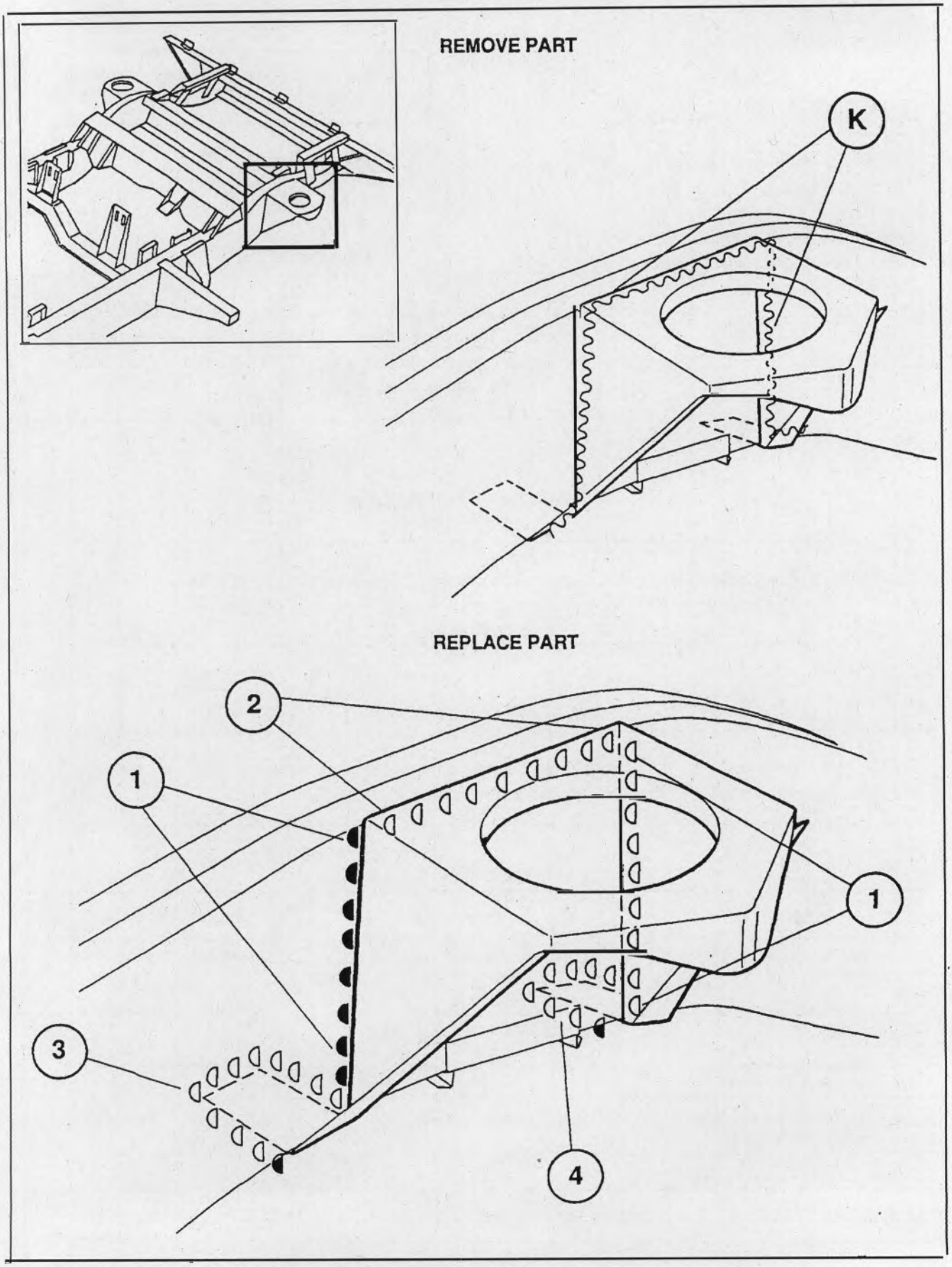
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member at front and rear joints	2 x 140mm MIG seam welds	2 x 140mm MIG seam welds.
2	To chassis member at upper joint	1 x 170mm MIG seam weld	1 x 170mm MIG seam weld.
3	To chassis member lower face at front extension	1 x 140mm MIG seam weld	1 x 140mm MIG seam weld.
4	To chassis memeber lower face at rear extension	1 x 140mm MIG seam weld	1 x 140mm MIG seam weld.

Operation No. 73.20.03	*Description* REAR SPRING SEAT - REPLACEMENT	*Time* 18.1RH 17.4LH

REAR SPRING SEAT - REPLACEMENT

Fig. 20



'C' SPANNER BRACKET - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced: Front suspension link, front floor pan section, lay aside service piping as necessary, remove rear upper mounting bolt from No. 3 crossmember.

REMOVAL

Cut tie-bar at points **L** and **M** in **Fig. 21**, remove bulk, cut 'C' spanner bracket at point **N**. Remove bulk and and metal remnants from chassis member.

REPLACEMENT

Dress weld areas. Offer up new 'C' spanner bracket, align and clamp in position on chassis member followed by new tie-bar. MIG seam weld at points **1, 2, 3** and **4** making a second row of welds at **No. 2** from beneath chassis member. Dress seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3** to **8**).

MECHANICAL & ELECTRICAL:

Carry out a general steering and front suspension alignment check as necessary; also when replacing a RH 'C' spanner bracket and tie-bar withdraw the wiring loom (see **Introduction** section **page 1**).

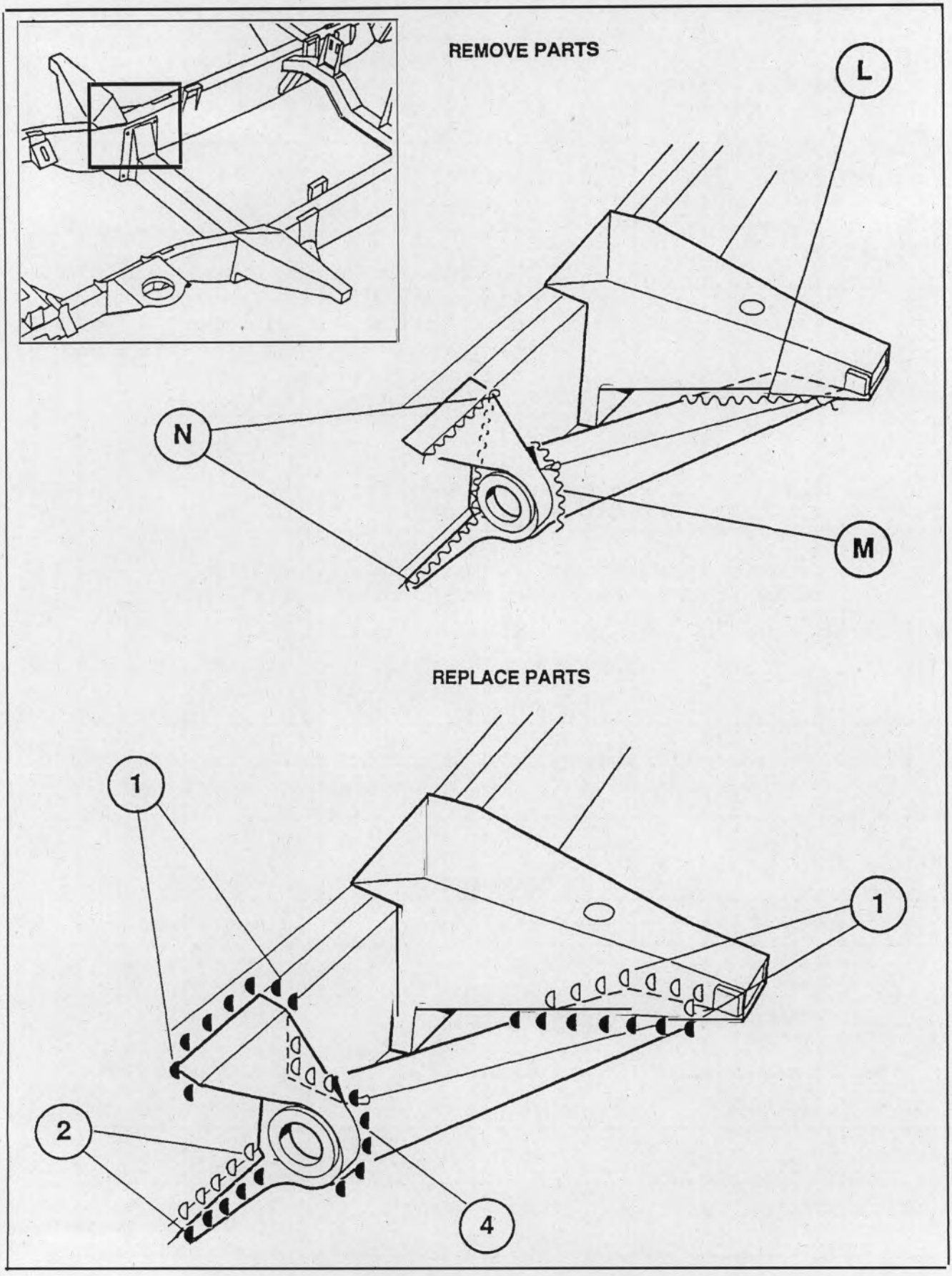
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	'C' spanner bracket to chassis member at upper joint	1 x 290mm MIG seam weld	1 x 290mm MIG seam weld.
2	'C' spanner bracket to chassis member at lower joint	1 x 300mm MIG seam weld	1 x 300mm MIG seam weld.
3	Tie-bar to 'C' spanner bracket	1 x 460mm MIG seam weld	1 x 460mm MIG seam weld.
4	Tie-bar to front outrigger	1 x 330mm MIG seam weld	1 x 330mm MIG seam weld.

Operation No. 73.20.04	*Description* 'C' SPANNER BRACKET - REPLACEMENT	*Time* 9.4RH 8.5LH

'C' SPANNER BRACKET - REPLACEMENT

Fig. 21



TRAILING LINK BRACKET - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Rear suspension trailing link.
***Note:** it is unnecessary to remove any associated panels during this repair operation, although care should be taken to avoid damage to adjacent panelwork.*

REMOVAL

Cut trailing link bracket at point P in Fig. 22 and remove bulk. Remove metal remnants at lower and inner faces of chassis member. Take care to avoid reducing the thickness of the chassis member when grinding off the metal remnants.

REPLACEMENT

Dress weld areas. Offer up new trailing link bracket. MIG seam weld at points 1 and 2. Dress seam welds. Offer up new reinforcing plate and seam weld into position at No. 3. Dress seam weld.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

MECHANICAL & ELECTRICAL:

Carry out a rear suspension alignment check as necessary; also when replacing a RH trailing link bracket withdraw the wiring loom (see **Introduction** section **page 1**).

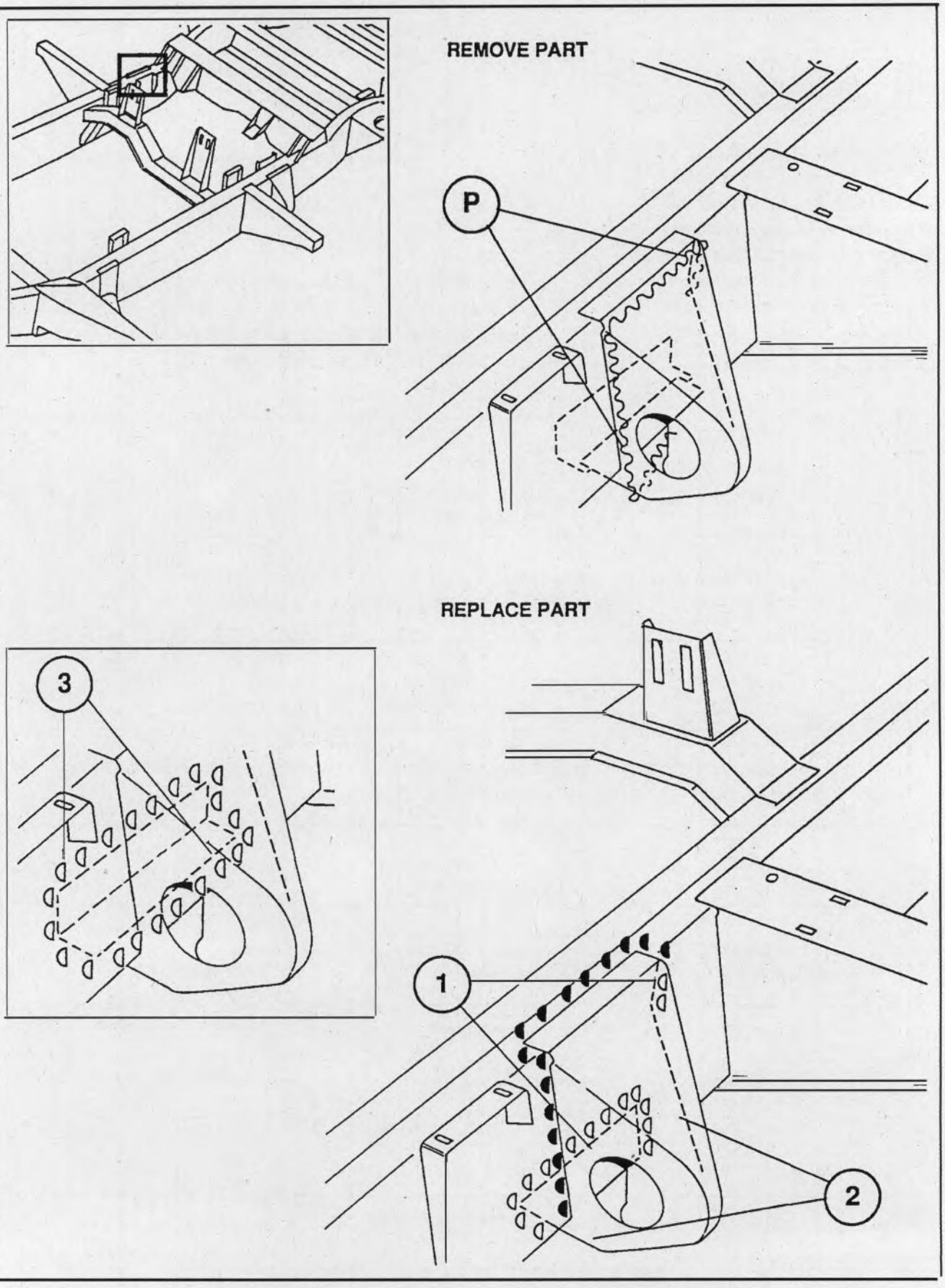
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member at upper joint	1 x 690mm MIG seam weld	1 x 690mm MIG seam weld.
2	To chassis member at lower joint	1 x 90mm MIG seam weld	1 x 90mm MIG seam weld.
3	Reinforcing plate to chassis member lower and inner faces	1 x 380mm MIG seam weld	1 x 380mm MIG seam weld.

Operation No. 73.20.05	*Description* TRAILING LINK BRACKET - REPLACEMENT	*Time* 8.3RH 7.8LH

TRAILING LINK BRACKET - REPLACEMENT

Fig. 22



FRONT QUARTER RIGHT AND LEFT HAND - REPLACEMENT

REMOVAL

Check and measure chassis frame for trueness. Mark locations approximately **165mm** and **220mm** to the rear of gearbox upper-rear and lower mounting holes respectively as shown. Cut chassis side member at point Q in **Fig. 23** and No. 2 crossmember at **R**, making cut line Q approximately **5mm** ahead of the locational mark to leave a metal surplus around the chassis at this point. **Take care not to damage the Panhard rod mounting tube at *X* when making the cut at *Q*.** Note also that the outer end of the crossmember rear face where it is enclosed by the gusset is not welded in production or subsequent replacement due to insufficient access.

Remove 4 mounting bolts to No. 3 crossmember, separate bulk of chassis section (**2-man operation**) and remove metal remnants.

CHASSIS PART:

Associated parts to be removed and replaced: Front wing RH and LH, cab unit, front seats, engine/transmission assembly, front suspension.

REPLACEMENT

Offer up new chassis quarter section (**2-man operation**). Dress weld areas, **taking extreme care with the measurementswhen trimming the joint to the existing chassis at *No. I* as this must be exactly aligned with the new section as supplied.** Make the final cut line so as to allow a welding gap of **2mm**, and trim the lower face of the Panhard rod mounting tube **X** at **No. 4** to enable the new section to be offered up accurately at this point. Remove chassis quarter section and dress all weld areas. Offer up new chassis quarter section, align, clamp and MIG tack weld in position. MIG seam weld at **No. 1.** Align, clamp and MIG tack weld No. 2 crossmember **No. 4.** MIG seam weld crossmember and dress all seam welds. **Take care to avoid reducing the thickness of the chassis during this operation.** Apply red brown anti-corrosion primer to butt joint on chassis.

Offer up the narrower of the two reinforcing plates supplied to chassis inner face, MIG seam weld and plug weld into place at **No. 2.** Dress seam weld, offer up second reinforcing plate to chassis outer face, MIG seam weld and plug weld into place at **No. 3.** Dress seam weld.

MECHANICAL & ELECTRICAL:

Carry out a general steering and front suspension alignment check as necessary; also when replacing a RH chassis front quarter section withdraw the wiring loom (see **Introduction** section page 1).

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section pages 3 to 8).

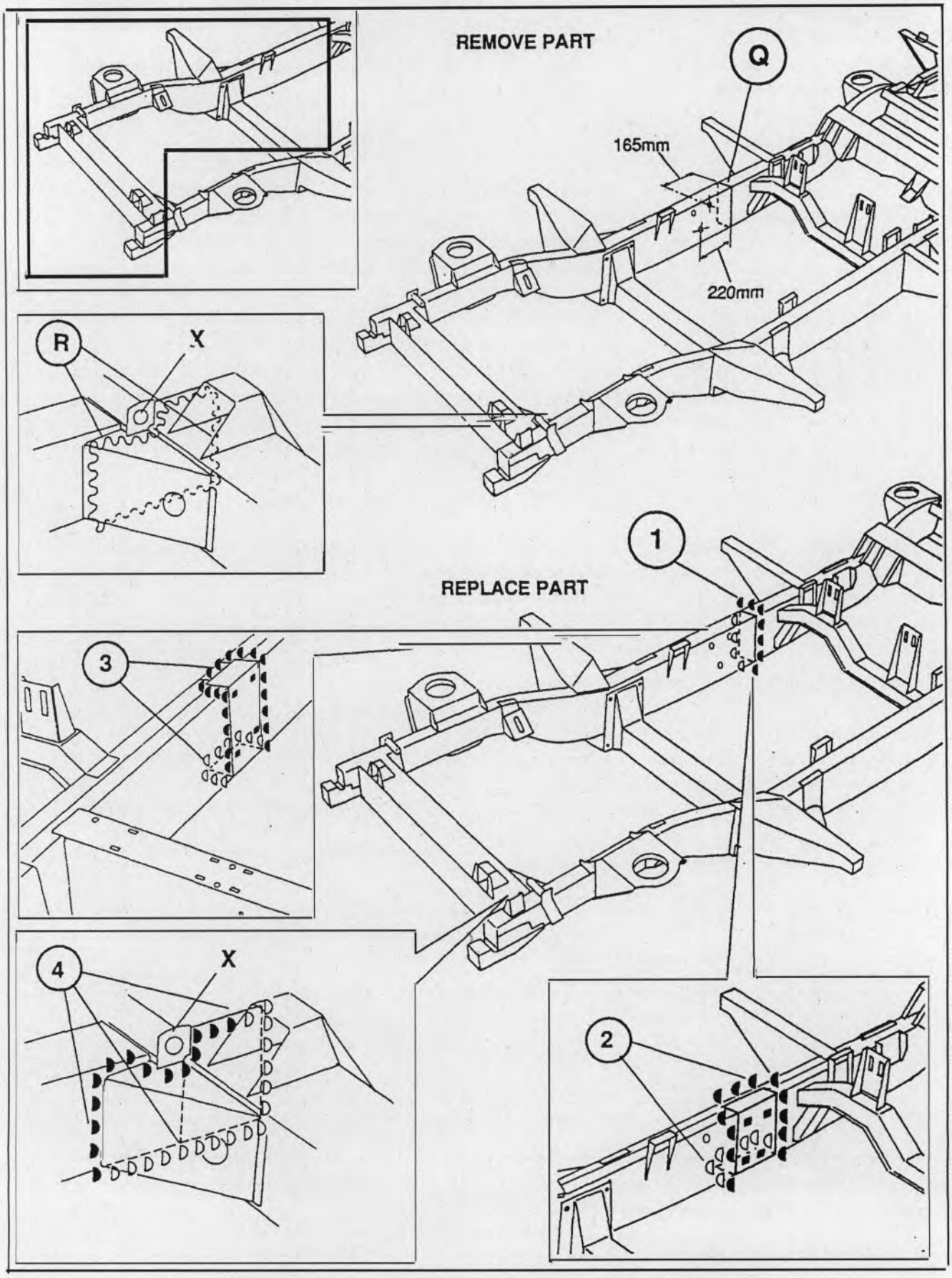
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis frame		1 x 550mm MIG seam weld.
2	Reinforcing plate to chassis at inner face		1 x 101mm MIG seam weld. 4 MIG plug welds.
3	Reinforcing plate to chassis at outer face		1 x 960mm MIG seam weld. 4 MIG plug welds.
4	No. 2 crossmember to existing chassis frame	1 x 510mm MIG seam weld	1 x 510mm MIG seam weld.

Operation No. 73.20.06	***Description*** FRONT QUARTER RIGHT AND LEFT HAND - REPLACEMENT	***Time*** 31.2RH 30.4LH

FRONT QUARTER RIGHT AND LEFT HAND - REPLACEMENT

Fig. 23



FRONT HALF RIGHT AND LEFT HAND - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced: Front wing RH and LH, cab unit, front seats, engine/transmission assembly, front suspension.

REMOVAL

Check and measure chassis frame for trueness. Mark locations approximately 165mm and 220mm to the rear of gearbox upper-rear and lower mounting holes respectively as shown. Cut chassis side member at point S in Fig. 24 each side making the cut line approximately 5mm ahead of the locational mark to leave a metal surplus around the chassis at this point.

Remove 4 mounting bolts to No. 3 crossmember, separate bulk of chassis section (2-man operation) and remove metal remnants.

REPLACEMENT

Offer up new chassis half section (2-man operation). Dress weld areas, taking extreme care with the measurements when trimming the joint to the existing chassis at *No. 1* as this must be exactly aligned with the new section as supplied. Make the final cut line so as to allow a welding gap of 2mm. Remove chassis half section and dress all weld areas. Offer up new chassis half section, align, clamp and MIG tack weld in position. MIG seam weld at No. 1. Align, clamp and MIG tack weld No. 2 crossmember No. 4. MIG seam weld crossmember and dress all seam welds. Take care to avoid reducing the thickness of the chassis during this operation. Apply red brown anti-corrosion primer to butt joint on chassis.

Offer up the narrower of the two reinforcing plates supplied to chassis inner face, MIG seam weld and plug weld into place at No. 2. Dress seam weld, offer up second reinforcing plate to chassis outer face, MIG seam weld and plug weld into place at No. 3. Dress seam weld.

MECHANICAL & ELECTRICAL:

Carry out a general steering and front suspension alignment check as necessary; also when replacing a RH chassis front quarter section withdraw the wiring loom (see **Introduction** section page 1).

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section pages 3 to 8).

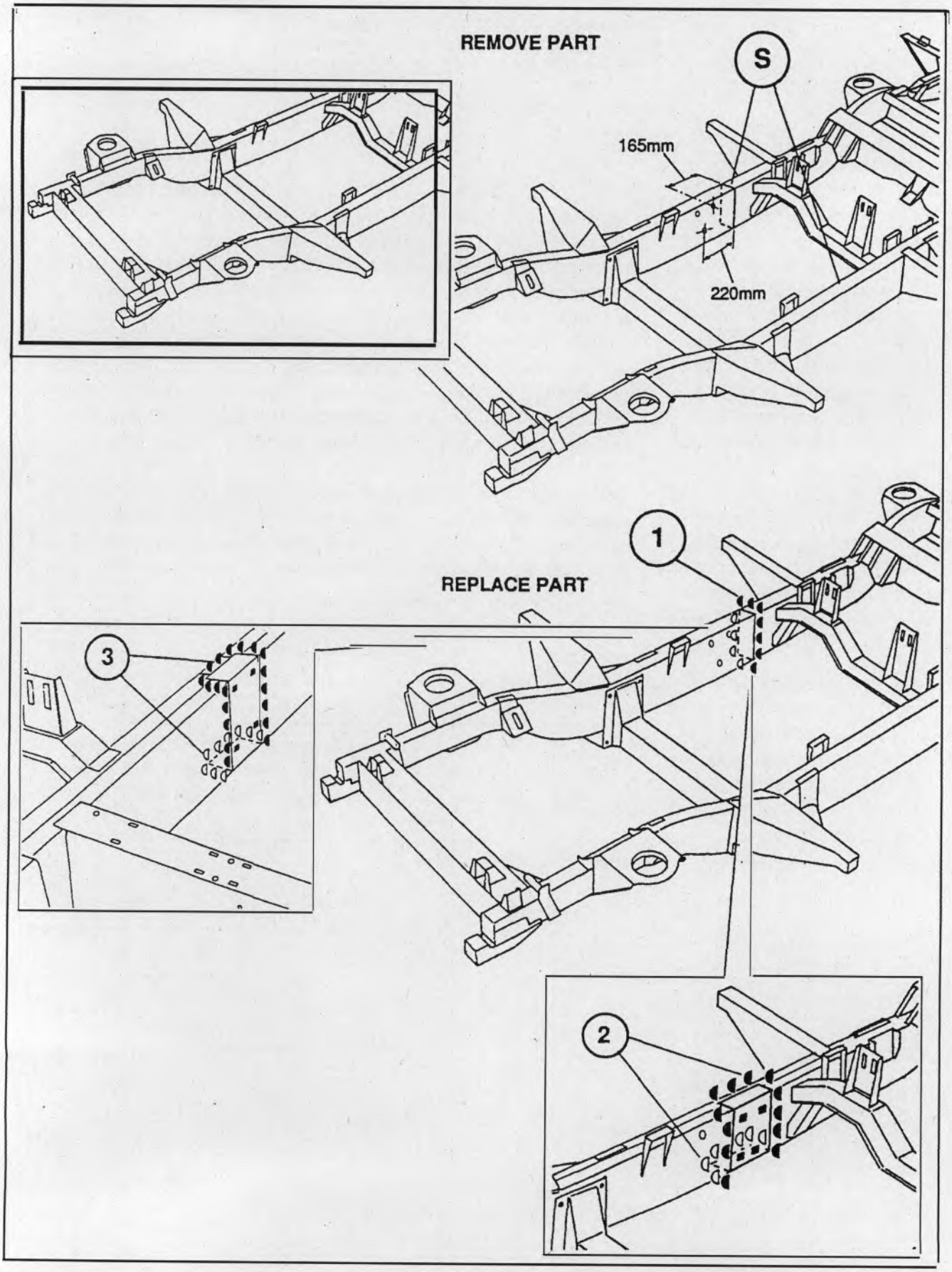
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis frame		1 x 550mm MIG seam weld.
2	Reinforcing plate to chassis at inner face		1 x 101mm MIG seam weld. 4 MIG plug welds.
3	Reinforcing plate to chassis at outer face		1 x 960mm MIG seam weld. 4 MIG plug welds.

Operation No. 73.20.07	*Description* FRONT HALF RIGHT AND LEFT HAND - REPLACEMENT	*Time* 32.4

FRONT HALF RIGHT AND LEFT HAND - REPLACEMENT

Fig. 24



TIE-BAR FRONT BODY MOUNT 'C' SPANNER BRACKET - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced: Front suspension link. front floor pan section, lay aside service piping as necessary.

REMOVAL

Cut tie-bar at points T and U in Fig. 25. Remove bulk and metal remnants. Take care to avoid damaging the front face of the 'C' spanner bracket during this operation.

REPLACEMENT

Dress weld areas. Offer up new tie-bar, align and clamp in position. MIG seam weld at points 1 and 2. Dress seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see Introduction section pages 3 to 8).

ELECTRICAL:

When replacing a RH tie-bar the wiring loom must be withdrawn for access as described in Introduction section page 1).

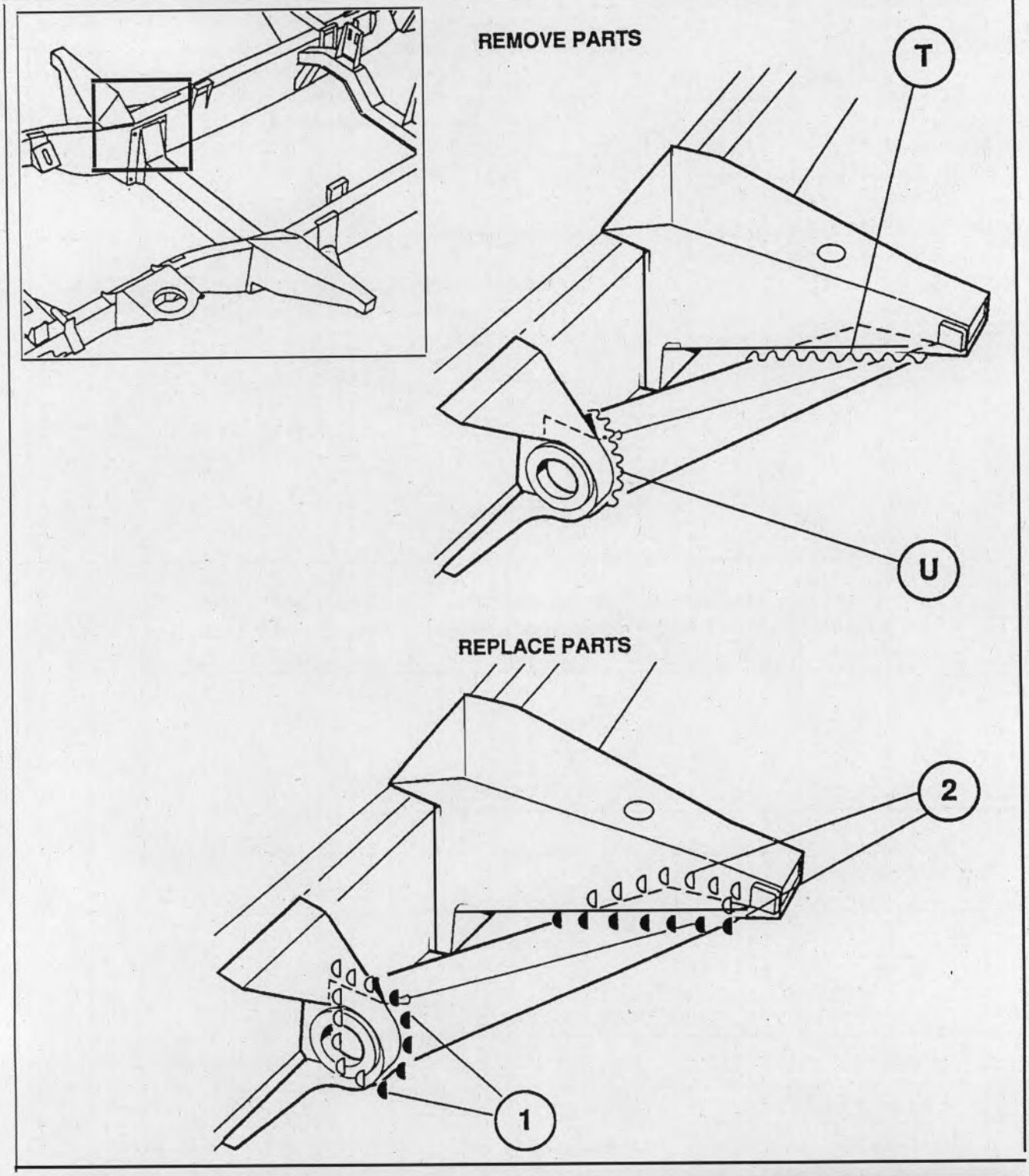
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis 'C' spanner bracket	1 x 460mm MIG seam weld	1 x 460mm MIG seam weld.
2	To front outrigger	1 x 330mm MIG seam weld	1 x 330mm MIG seam weld.

Operation No. 73.20.08	***Description*** TIE BAR FRONT BODY MOUNT 'C' SPANNER BRACKET - REPLACEMENT	***Time*** 7.7RH 7.3LH

TIE-BAR FRONT BODY MOUNT 'C' SPANNER BRACKET - REPLACEMENT

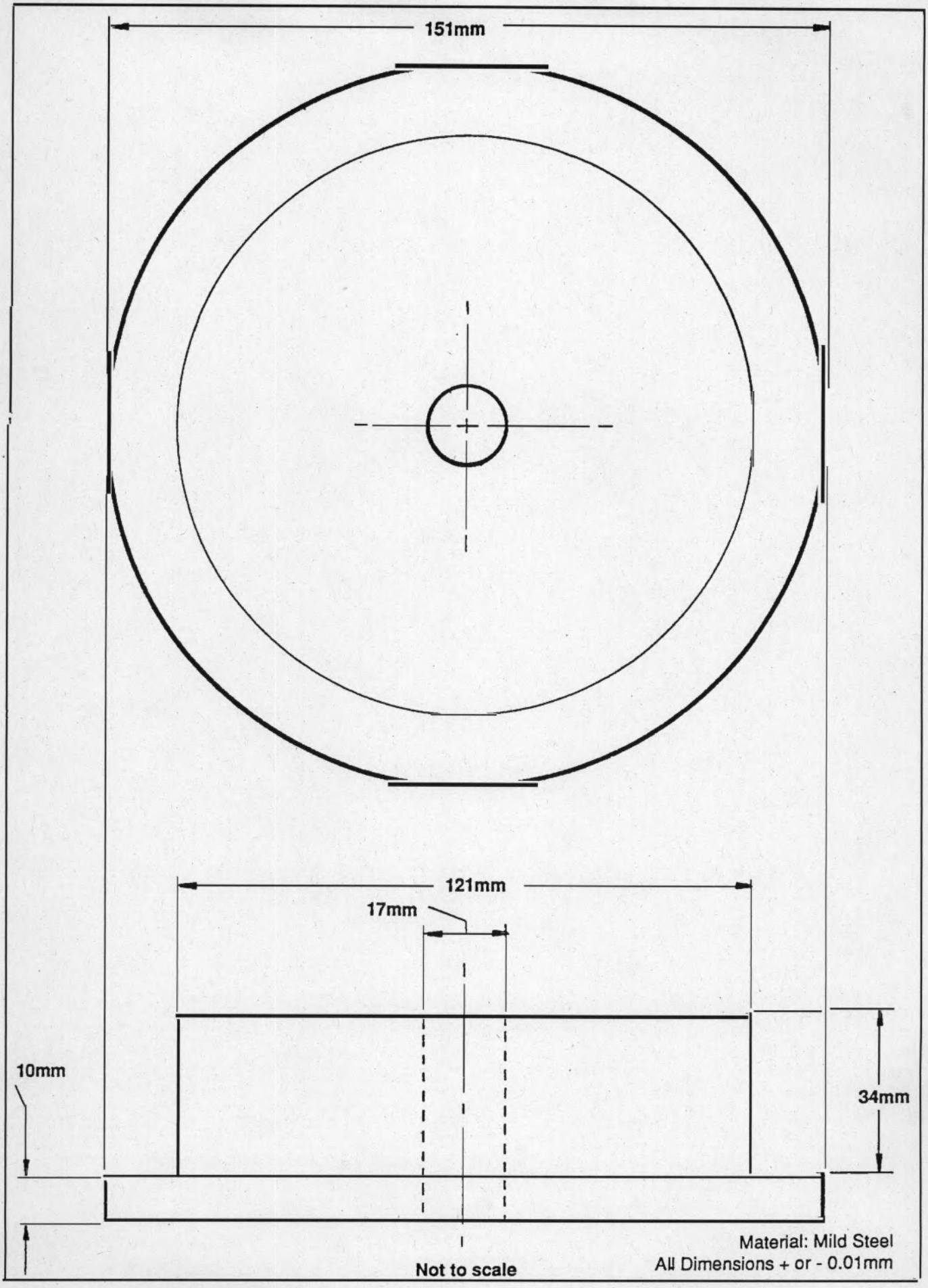
Fig. 25

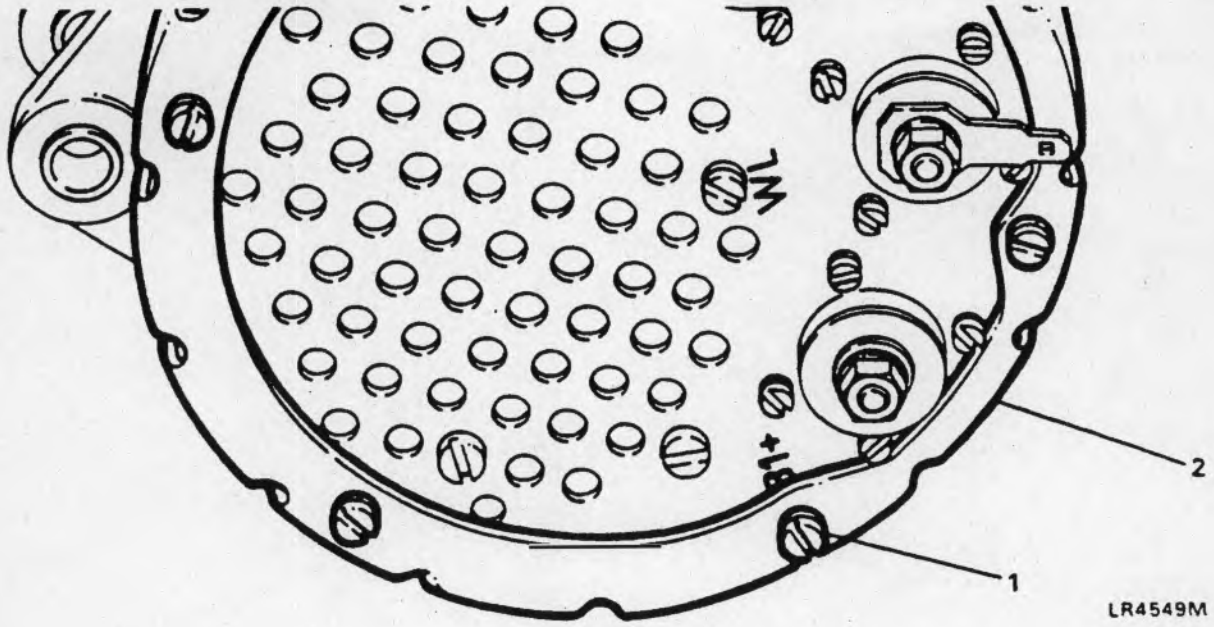


CHASSIS FRAME - COMPLETE - REPLACEMENT

Operation No. 73.20.10	***Description*** CHASSIS FRAME - COMPLETE - REPLACEMENT	***Time*** 33.5

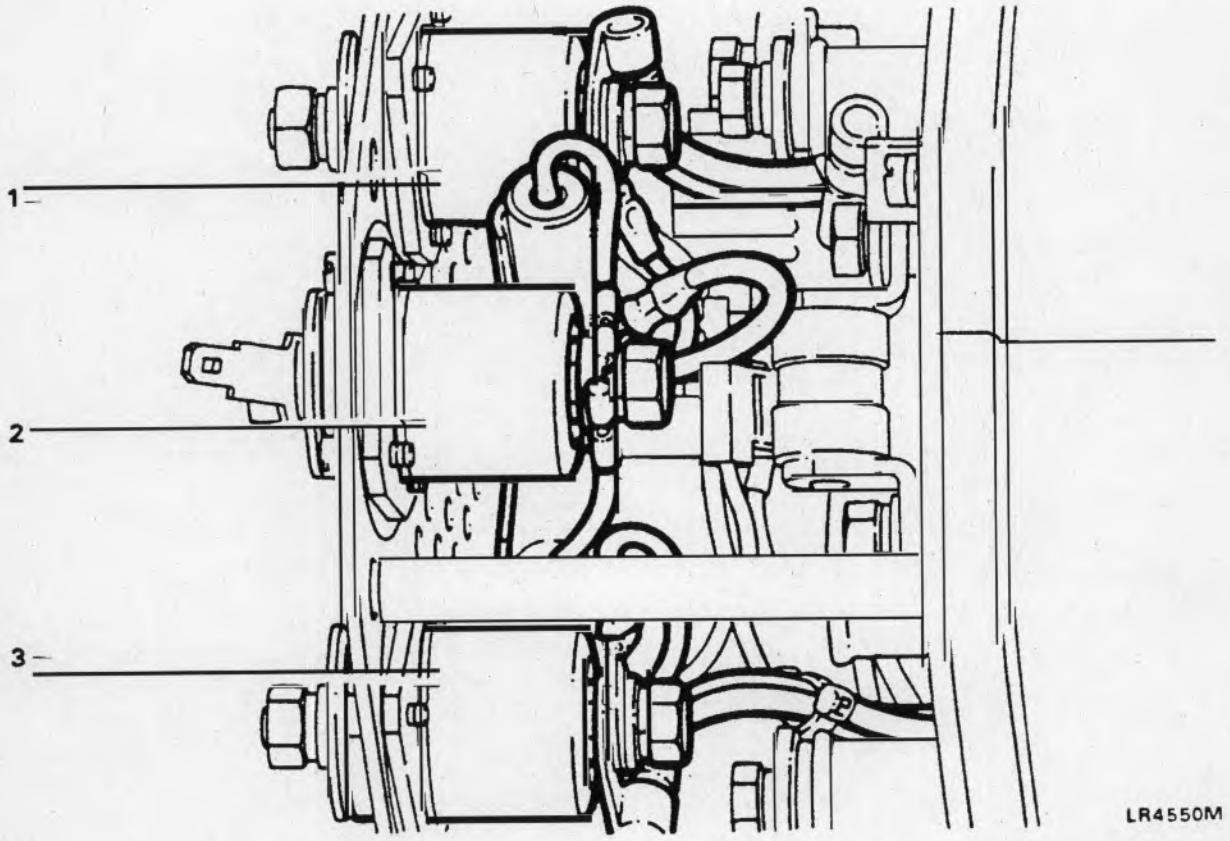
REAR SPRING SEAT ALIGNMENT JIG ATTACHMENT





1 Cowl fixing screws 2 Cowl

Fig 3 Cowl removal

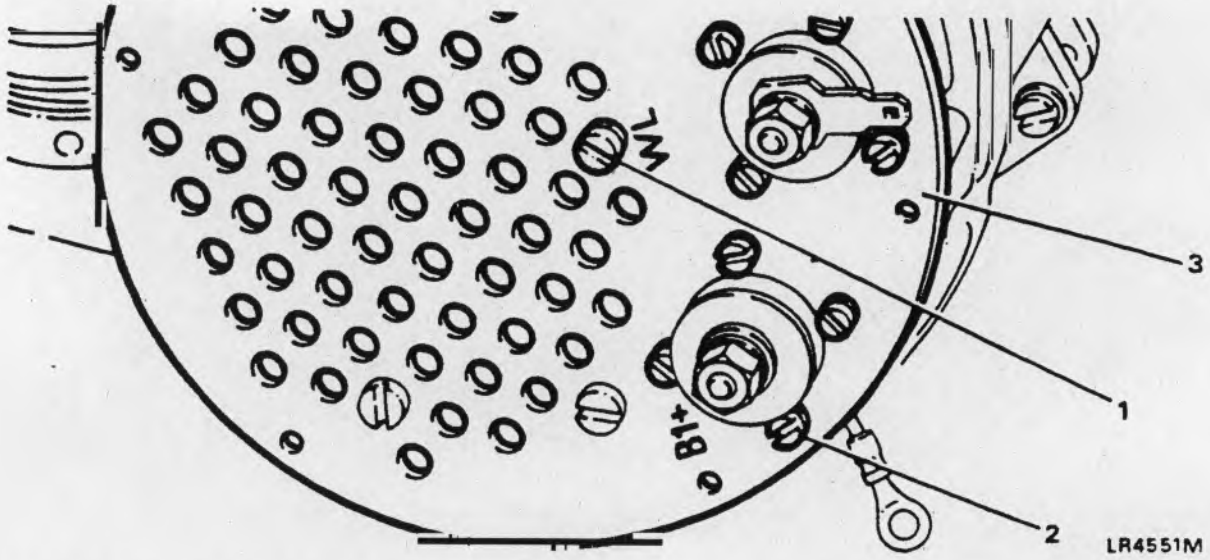


1 Bushing capacitor 2 Bushing capacitor 3 Bushing capacitor

Fig 4 Disconnecting bushing capacitors

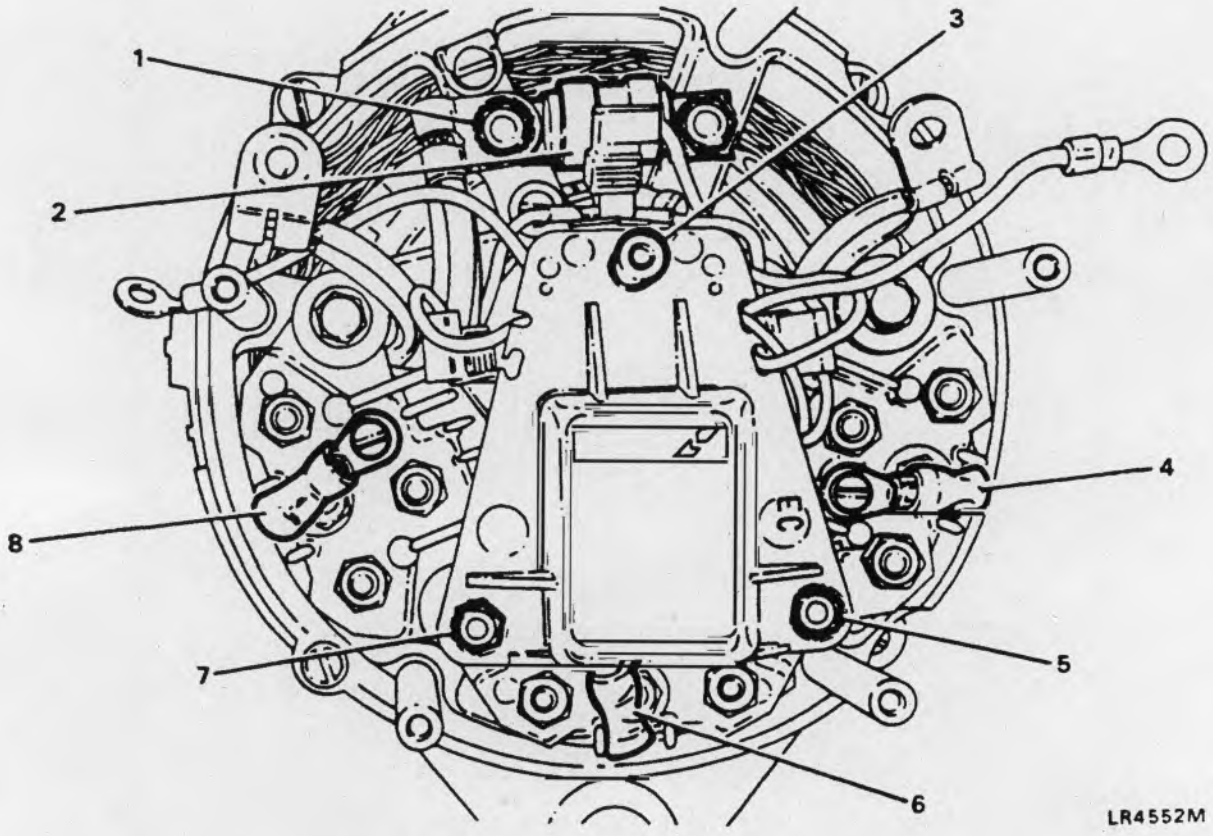
3.5 It will be necessary to unsolder the auxiliary diode lead (Fig 7 (1)) before the heat sink assembly can be completely removed. Loosen and remove the two screws, spring washers and plain washers (2 & 5), followed by the two pillar bolts (3 & 4) with spring and plain washers, securing the heat sink assembly to the rear end shield.

3.6 Using a felt tipped pen, scribe a line across both end shields and the stator (Fig 8) to ensure that all three it ms are correctly aligned when r ass mbled.



1 Central fixing screw 2 Capacitor fixing screws 3 Suppression cover

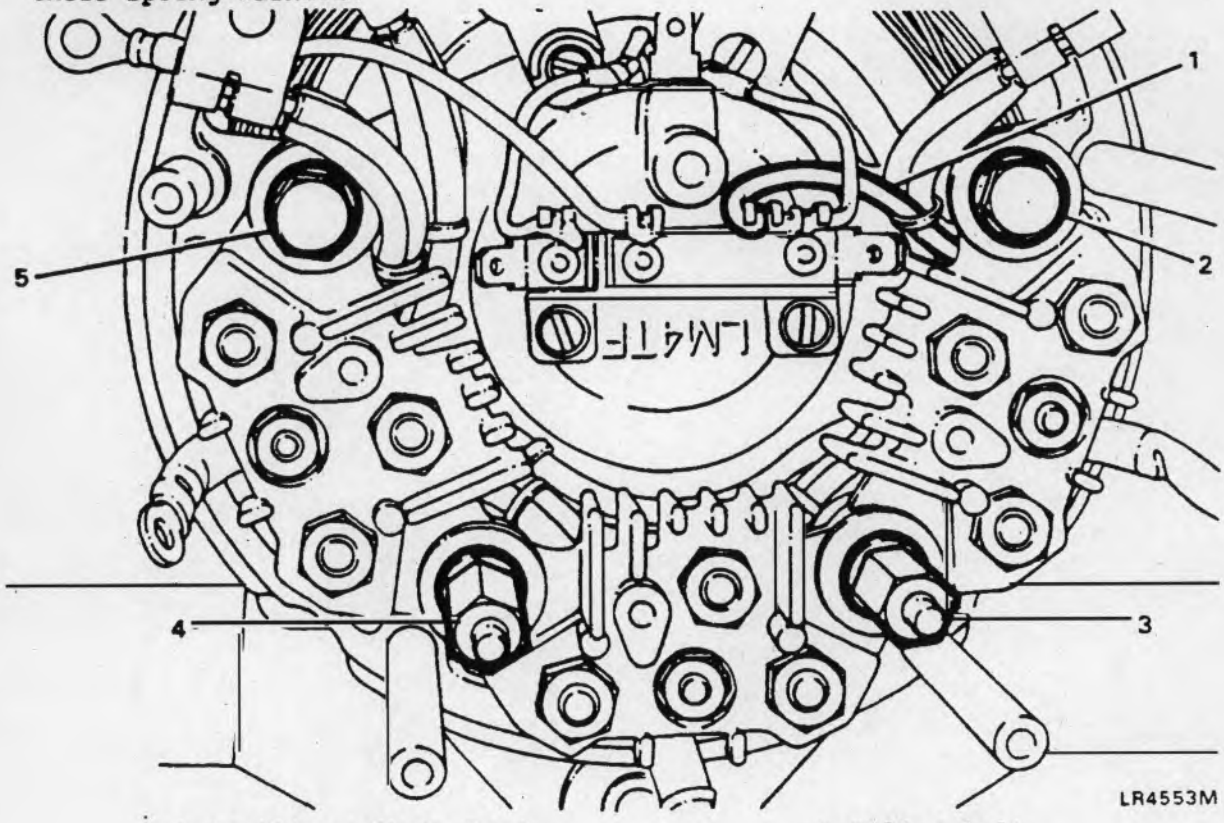
Fig 5 Suppression cover and bushing capacitor removal



1 Negative output lead fixing screw
2 Fast fuse
3 Pillar bolt
4 Stator lead
5 Regulator fixing nuts
6 Stator lead
7 Regulator fixing nuts
8 Stator lead

Fig 6 Voltage regulator removal and stator lead disconnection

3.7 Unscr w and remove the four external through-bolts, together with their spring washers.



1 Auxiliary diode lead
2 Heat sink fixings
3 Pillar bolt
4 Pillar bolt
5 Heat sink fixings

Fig 7 Heatsink removal

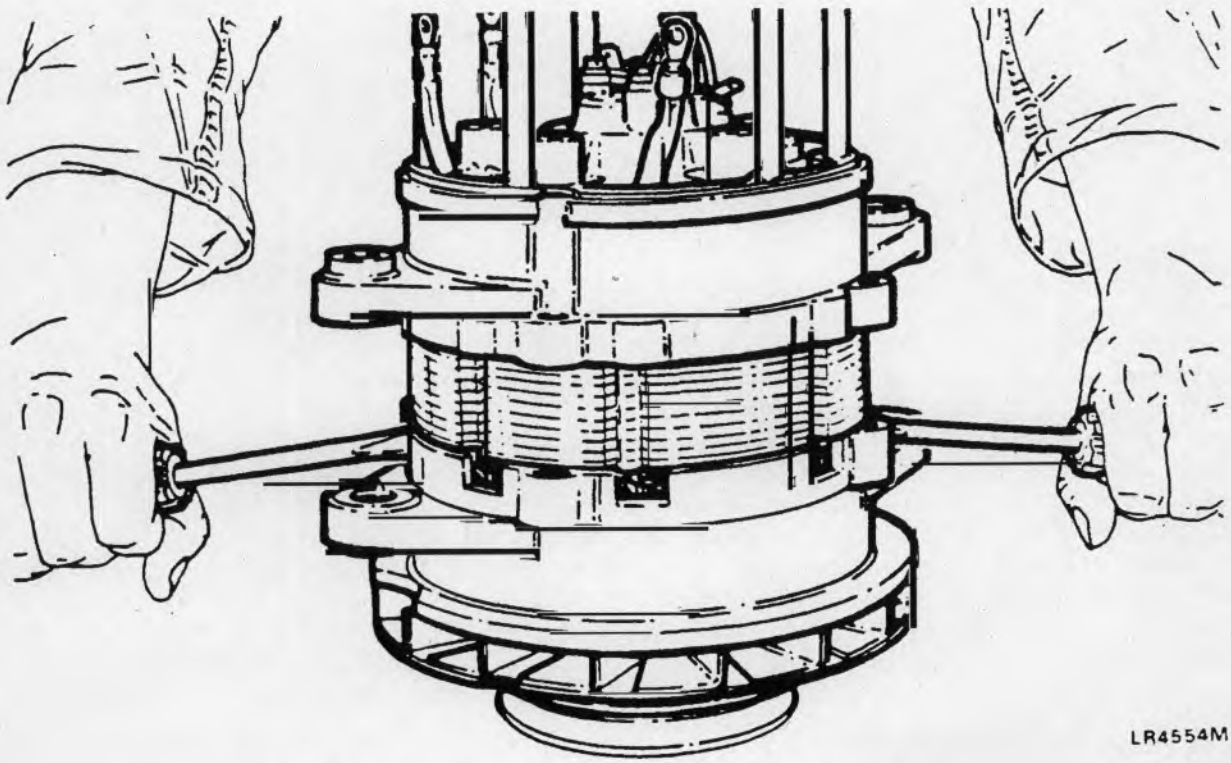
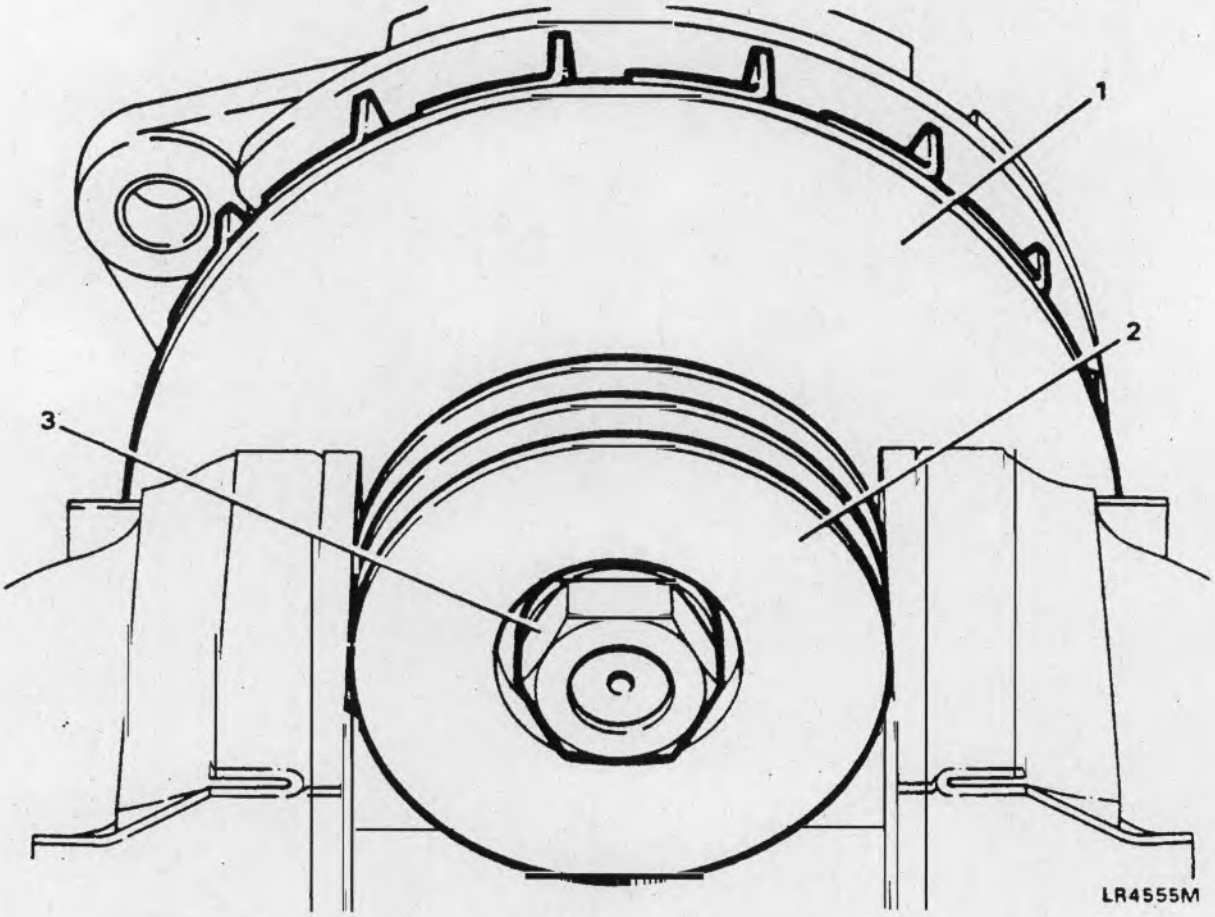


Fig 8 Separating stator from end shields

3.8 Support the unit upright on its pulley (Fig 8). Taking care not to damage the stator windings, use a pair of screwdrivers in opposite ventilation slots to s parate the stator and rear end shi ld from the drive nd shield.

3.9 Using soft jaws, clamp the pulley (Fig 9) in a vice and unscrew and remove the pulley nut and spring washer (3); remove the pulley from the rotor shaft. Lever out the woodruff key and remove the fan (1).



1 Fan 2 Pulley 3 Pulley nut

Fig 9 Pulley removal

3.10 Place the drive end shield and rotor in a suitable press (Fig 10), drive end uppermost. Ensure that the drive end shield is adequately supported, apply pressure to the drive end of the rotor shaft; support the rotor with one hand as it is pressed from the end shield. Remove the spacers from either side of the drive end shield.

3.11 Unscrew and remove the three clamp plate securing screws and spring washers (Fig 11 (1)), and remove the clamp plate (2). Using a suitable press, remove the bearing (3) from the drive end shield. Using a large screwdriver, carefully lever out the rubber seals from the drive end shield and clamp plate. Discard both seals.

3.12 Remove the circlip (Fig 12 (1)) from the rotor. Using a suitable bearing puller, remove the rear end bearing and cup assembly (2) from the rotor.

3.13 Holding the stator by hand, gently tap the rear end shield free from the stator using a hide mallet.

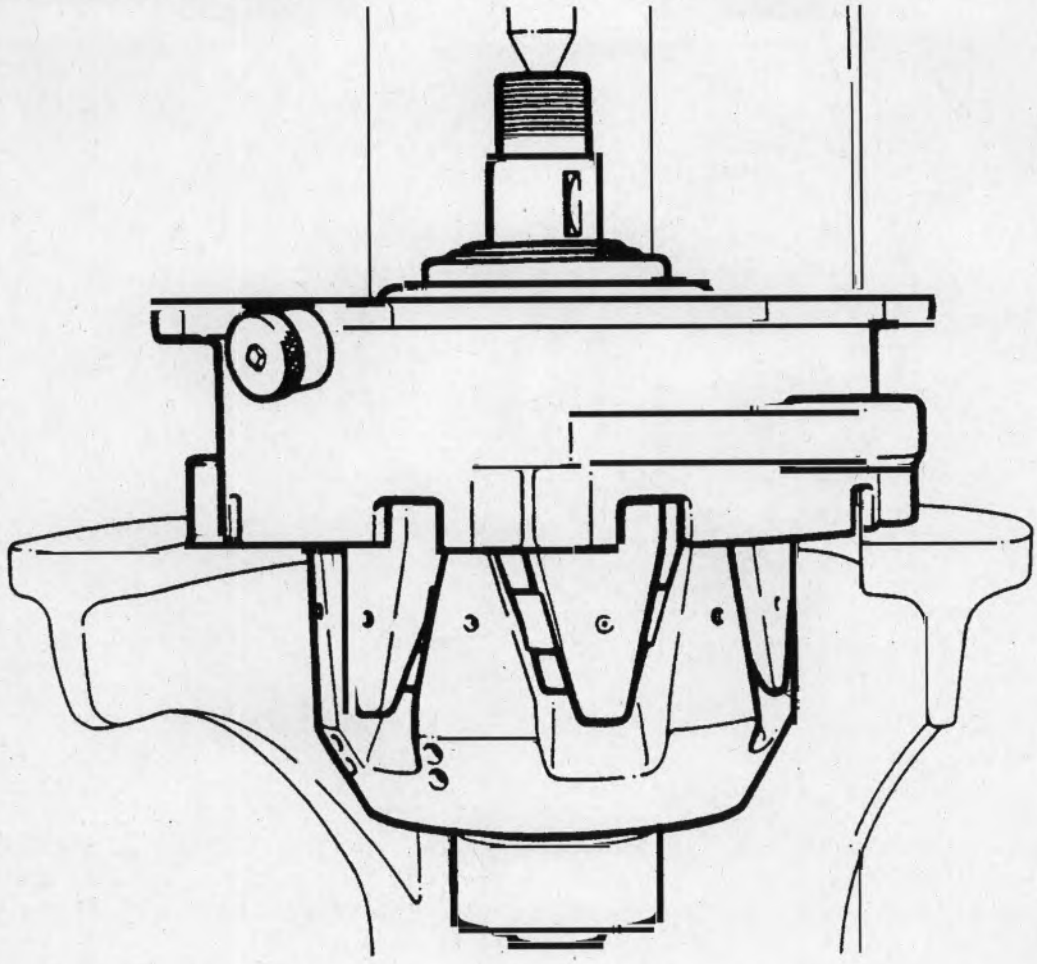
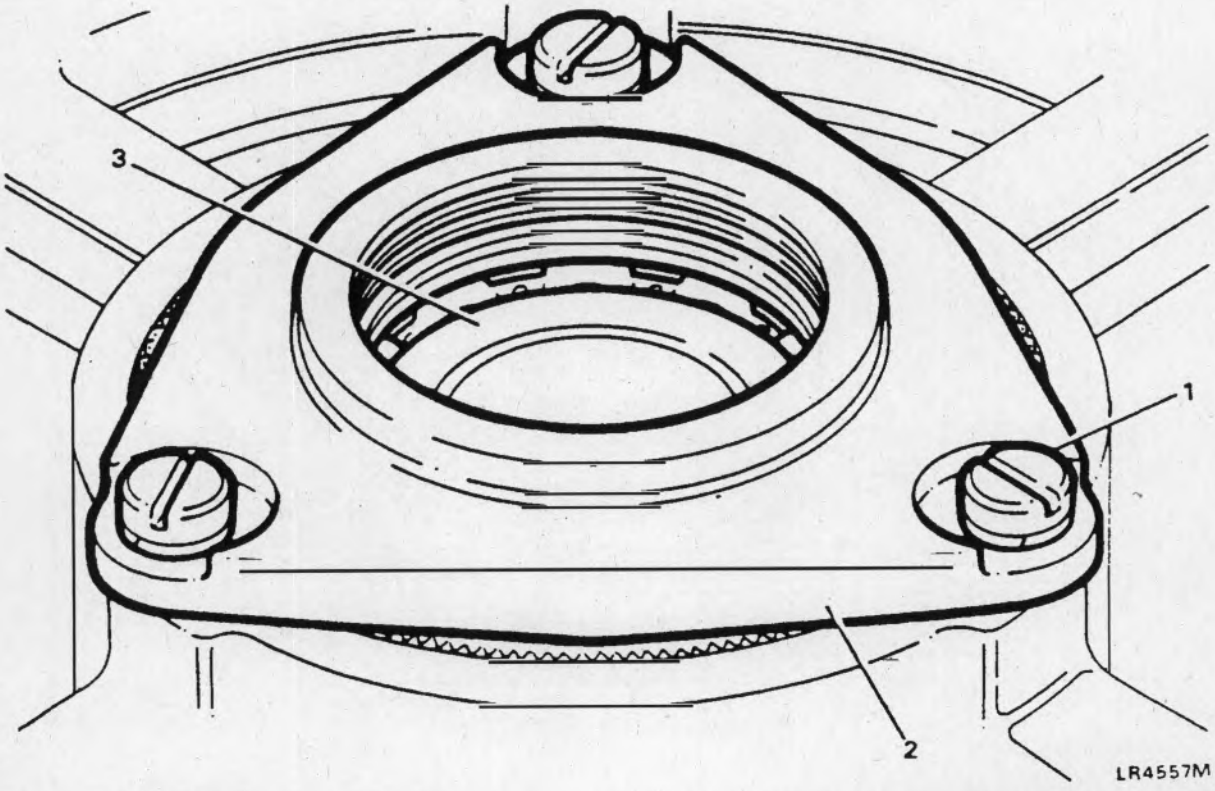
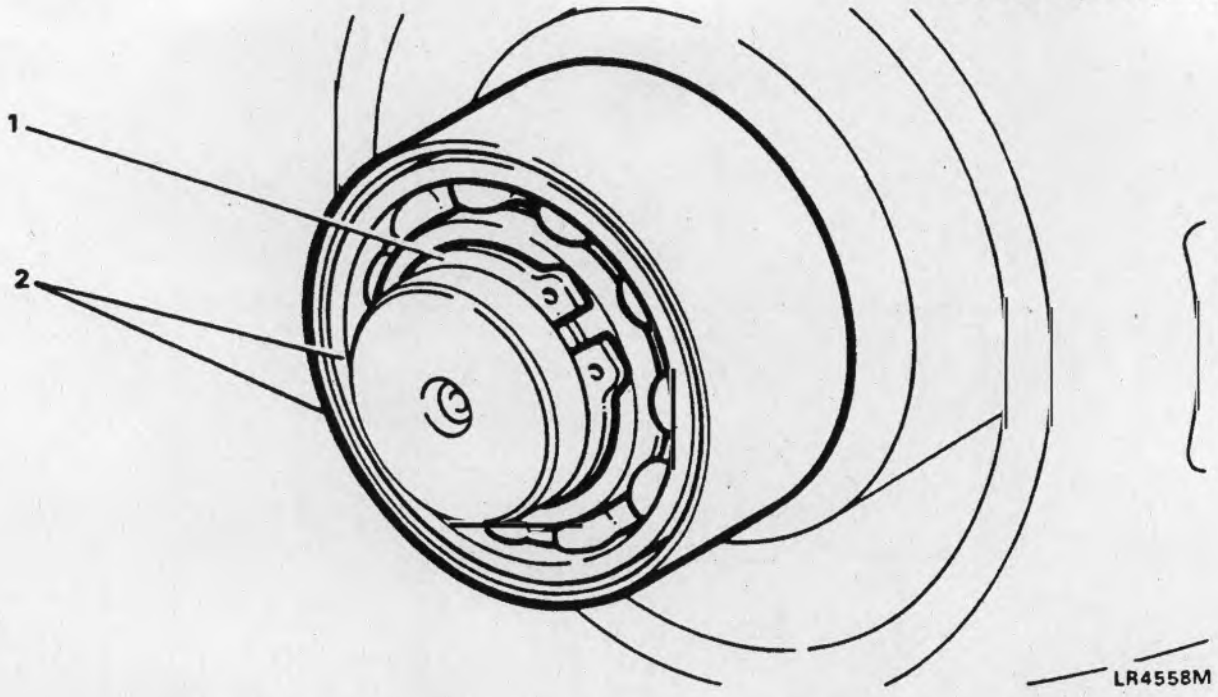


Fig 10 Rotor removal from drive end shield



1 Clamp plate fixings 2 Clamp plate 3 Bearing

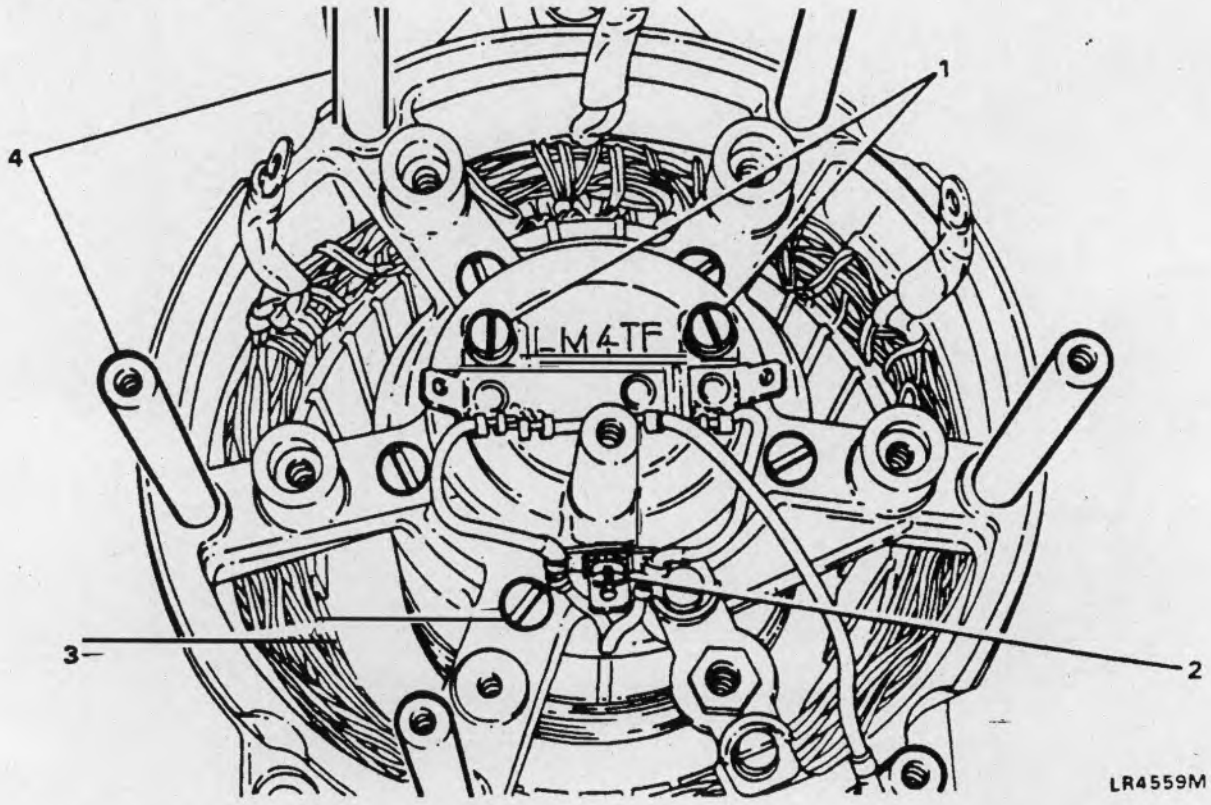
Fig 11 Clamp plate, drive end bearing and seals removal



1 Circlip 2 Rear end bearing assembly

Fig 12 Rear bearing removal

3.14 Unscrew and remove the two screws and washers (Fig 13 (1)) securing the terminal strip. Remove the screw securing the Lucar connector (2) and the two field leads, and pass the terminal strip through the aperture in the nd shield.



1 Terminal strip fixings
2 Lucar connector fixings
3 Clamping screws
4 Pillar bolts

Fig 13 Stator and field coil removal

3.15 Mark the position of the field coil in r lation to the rear end shield. Unscrew and remove the five clamping screws (3) and detach the field coil.

3.16 Unscrew and remove the five pillar bolts (4). This will necessitate clamping each individual pillar bolt in a soft jawed vice and carefully rotating the rear end shield.

COMPONENTS INSPECTION AND RENEWAL

GENERAL

4 Wipe all components clean with a dry cloth then use compressed air to remove loose dust from inaccessible areas. Do NOT "spin" the bearings with compressed air as this can cause damage.

5 All components should be thoroughly cleaned with an approved cleaning agent before examination.

6 The stator frame and rotor shaft should be wiped clean using a non-fluffy rag moistened with white spirit. Take care to avoid the spirit having prolonged contact with the winding insulation and stator leads.

7 All seals and gaskets should be renewed.

8 Examine all components visually for signs of cracking, corrosion, local discoloration and any other signs of damage or excessive wear.

9 Check all internal and external threads.

DIODE AND HEAT SINK RENEWAL

Note ...

When soldering direct to the diode stems, a pair of long nosed pliers should be used to grip the stem. Their purpose is to act as a heat sink to prevent over heating of the diode assembly.

Main diodes

10 Unsolder the main lead from the diode to be replaced.

11 Unscrew and remove the securing nut and spring washer from the diode using a suitable spanner or socket. Push the diode clear of the heat sink.

12 Ensure that the new diode is clean and free from grease. Thoroughly clean the contact face and hole in the heat sink then smear both surfaces with "Biccon XZ" jointing compound.

13 Insert the new diode into the heat sink, and secure it with the spring washer and nut. Tighten the diode securing nut to a torque of 2,7 to 3.1 Nm.

14 Ensure that the connecting surfaces of the main lead and diode are clean and free from grease. Reposition the lead and solder it to the diode.

Auxiliary diodes

15 Unsolder the lead from the diode which is to be replaced.

16 Renew the diode using the procedure for main diode renewal.

17 Re-solder the l ad to the stem of the new diode.

18 To connect the auxiliary diode lead, slide a small glass fibre sleeve of suitable diameter over the lead to be joined. If necessary, splice in a small length of suitable cable to lengthen the lead. Twist the bared ends together and solder the joints. Apply VA276 varnish to the joint. When partly dry (tacky), slide the glass fibre sleeve over the joint and varnish with more VA276.

19 When complete, paint the entire assembly-heat sink, diodes and leads-with Pacific Blue Q14 synthetic enamel.

20 "Crimping" together the auxiliary diode leads is permitted provided the corr ct crimping tool and a connector of the correct size and electrical value are used; typical field current is 3.5 amp.

21 Replacing heat sinks. When renewing heat sinks, ensure that the insulating bushes and washers are fitted in the correct sequence to insulate the heat sinks from the end shield and from each other.

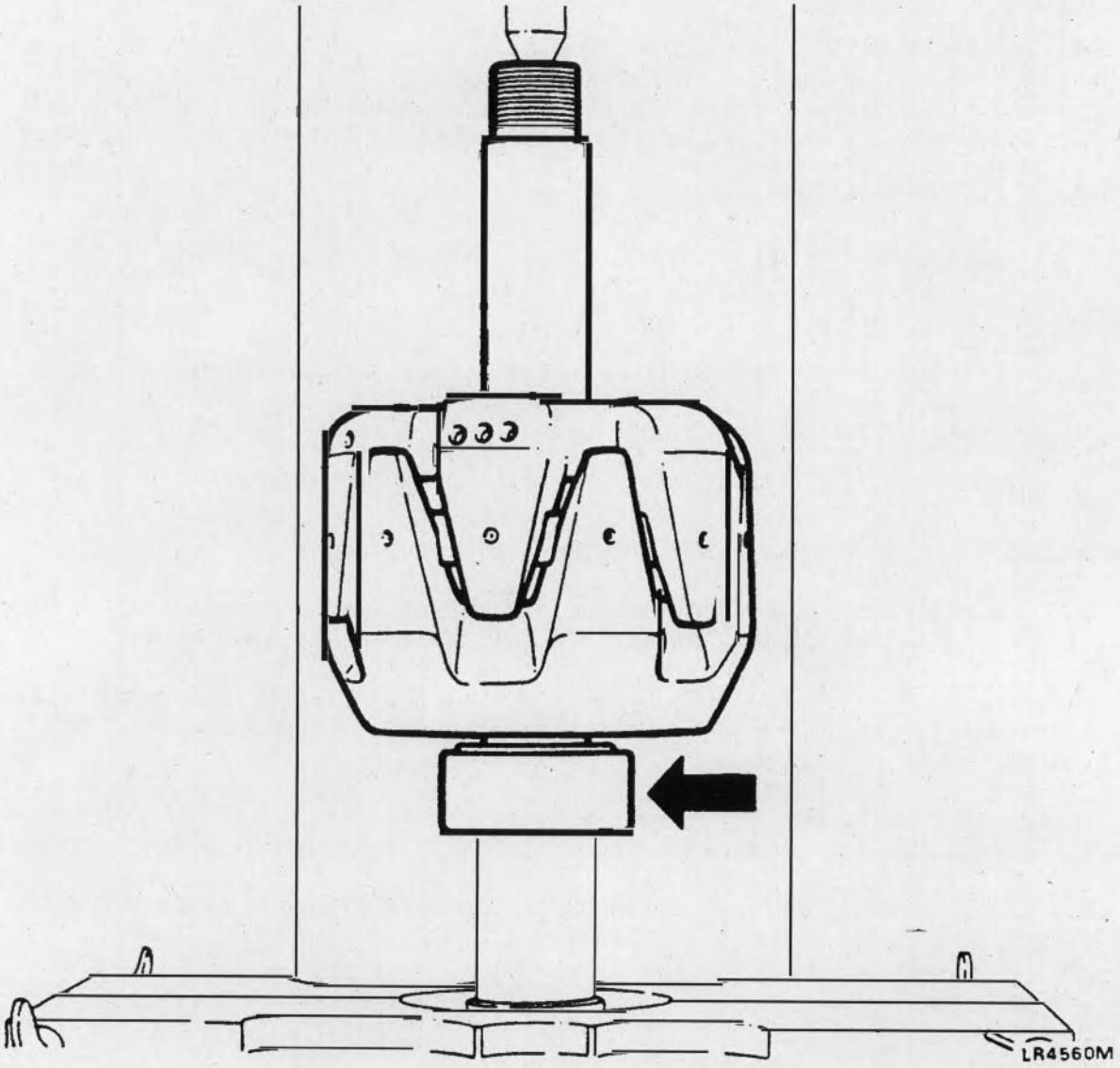


Fig 14 Fitting rear end bearing to rotor shaft

22 Bearings. It is recommended that new bearings are fitted as normal routine when the alternator is being completely overhauled.

Assembling

Note ...

All threaded components must be tightened to the correct torque value, see torque chart (Fig 19 page 18).

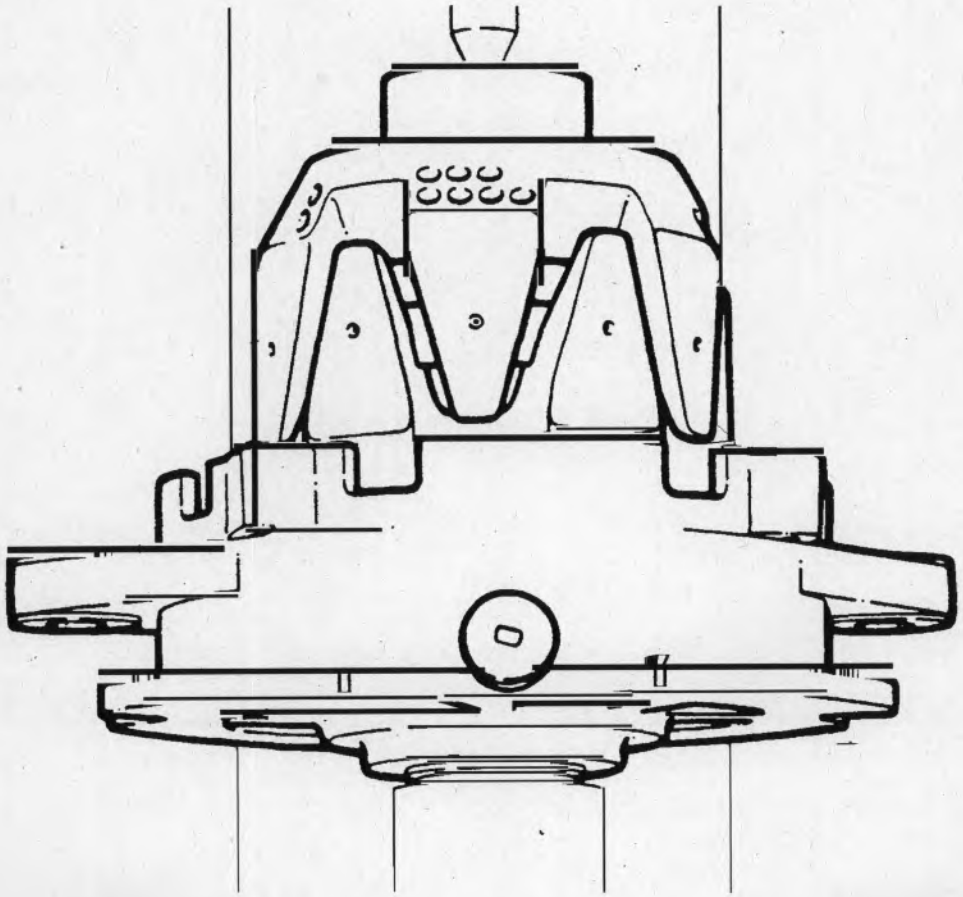
23 Using a suitable support on the inner race (Fig 14), press the rear end bearing and cup assembly onto the rotor shaft.

24 Fit the rotor circlip (Fig 12 (1)). Place the spacer, chamfered edge outwards, and the sealing ring over the rotor drive shaft.

25 Pack a new rubber seal with Aeroshell 16 grease, and insert it into the drive end shield, lipped edge facing the drive end. Using a suitable press, fit the bearing (Fig 11 (3)) into the drive end shield. Fit the sealing ring to the outer edge of the drive end bearing.

26 Pack the new inner seal with Aeroshell 16 and fit it to the drive end clamp plate. The lipped edge must face away from the bearing.
Fit the clamp plate (2) as shown and secure it using the three screws and spring washers (1).

27 Invert the drive end shield and insert the sealing ring and spacer, chamfered edge inwards.



LR4561M

Fig 15 Fitting rotor to drive end

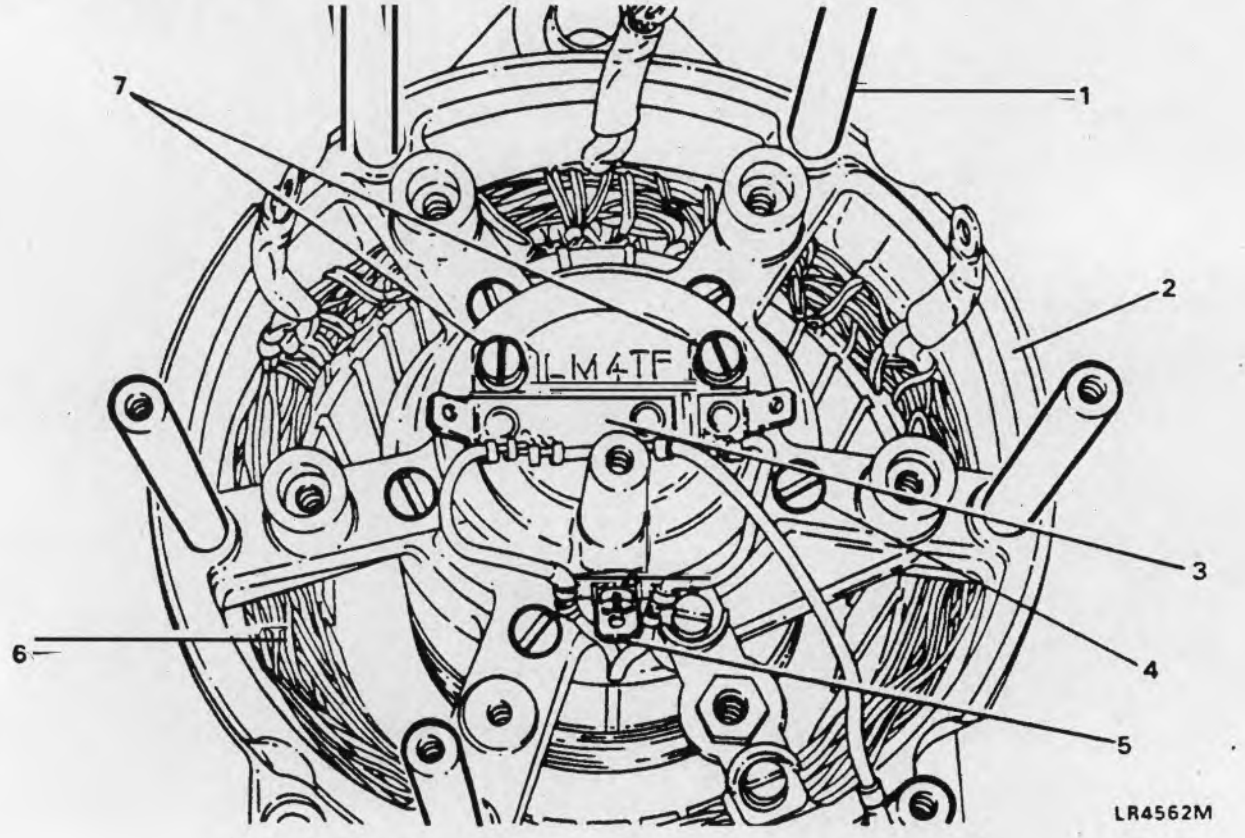
28 Place the rotor into the drive nd shield.

29 Place the complete assembly into a suitable press, and, supporting the outer drive end shield spacer only, press the rotor fully home (Fig 15).

30 Fit the woodruff key to the rotor drive shaft. Place the fan (Fig 9 (1)) and pulley (2) onto the shaft and secure using the nut and spring washer (3).

31 Apply Loctite Studlock 270 to the threads of the five pillar bolts (Fig 16 (1)) and screw each bolt into the rear end shield, finger tight only. Fit a suitable screw to the head of each pillar and tighten to the specified torque value. When the pillar bolts are correctly tightened, clamp each bolt in a soft jawed vic and remove the screws.

32 Place the rear end shield (Fig 16 (2)) onto the field coil, passing the terminal strip (3) through the appropriate aperture. Make sure that the scribe marks are in line.



1 Pillar bolts
2 Rear end shield
3 Terminal strip
4 Screws
5 Lucar terminal
6 Stator windings
7 Plain washers

Fig 16 Fitting stator to rear end shield

33 Apply Loctite Studlock 270 to the threads, and fit the five field coil securing screws (4).

34 Place the terminal strip in position and secure with the two screws, spring washers and plain washers (7).

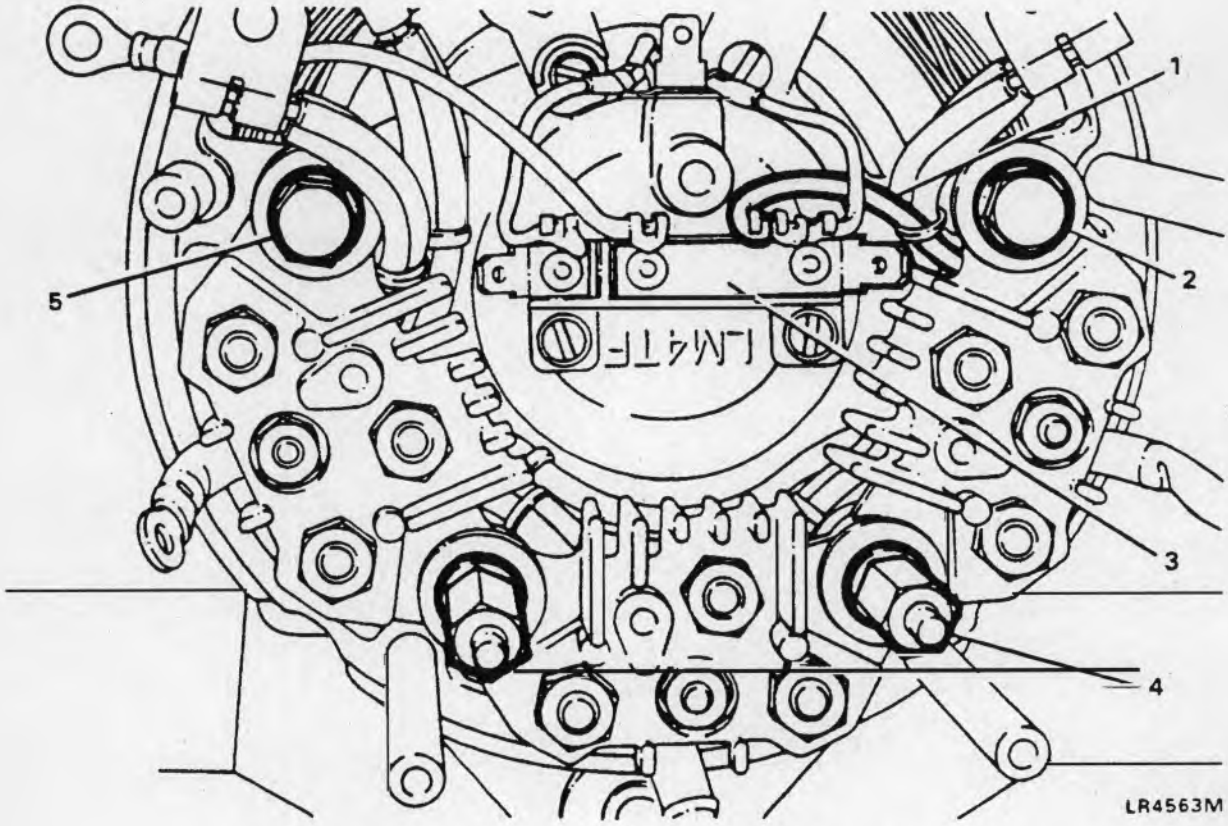
35 Secure the two field lead support clips to the end shield using the screw, spring washer and Lucar terminal (5).

36 Place the stator into the rear end shield, ensuring that the scribe marks are in line. Take care not to damage the stator windings (6).

37 Carefully fit the drive end shield and rotor assembly to the stator and rear end shield, ensuring that the scribe marks are in line. Hand pressure should be sufficient to compress the complete assembly.

38 Secure the end shields together using the four through-bolts and spring washers.

39 Fit the heat sink assembly to the rear end shield (ensuring that the insulators are correctly fitted), and secure using the two pillar bolts (Fig 17 (4)) and screws (2 & 5) (each with spring and plain washers).



1 Auxiliary diode lead
2 Screw
3 Regulator
4 Pillar bolts
5 Screw

Fig 17 Fitting the heatsink assembly

40 Re-solder the auxiliary diode lead (1) to the terminal strip (3).

41 Fit the fast fuse (Fig 18 (1)) to the rear end shield, attaching the (previously marked) negative output lead (10). Secure using the two screws, spring washers and plain washers (2 & 11).

42 The stator leads should protrude through the appropriate apertures in the rear end shield. Bend the lead tags (4, 6 & 8) into position and secure to the heat sinks using the three screws and spring washers.

43 Fit the regulator (3) to the rear end shield as shown. Secure it using the short pillar bolt (9) and the two nuts (5 & 7) (all three with spring and plain washers).

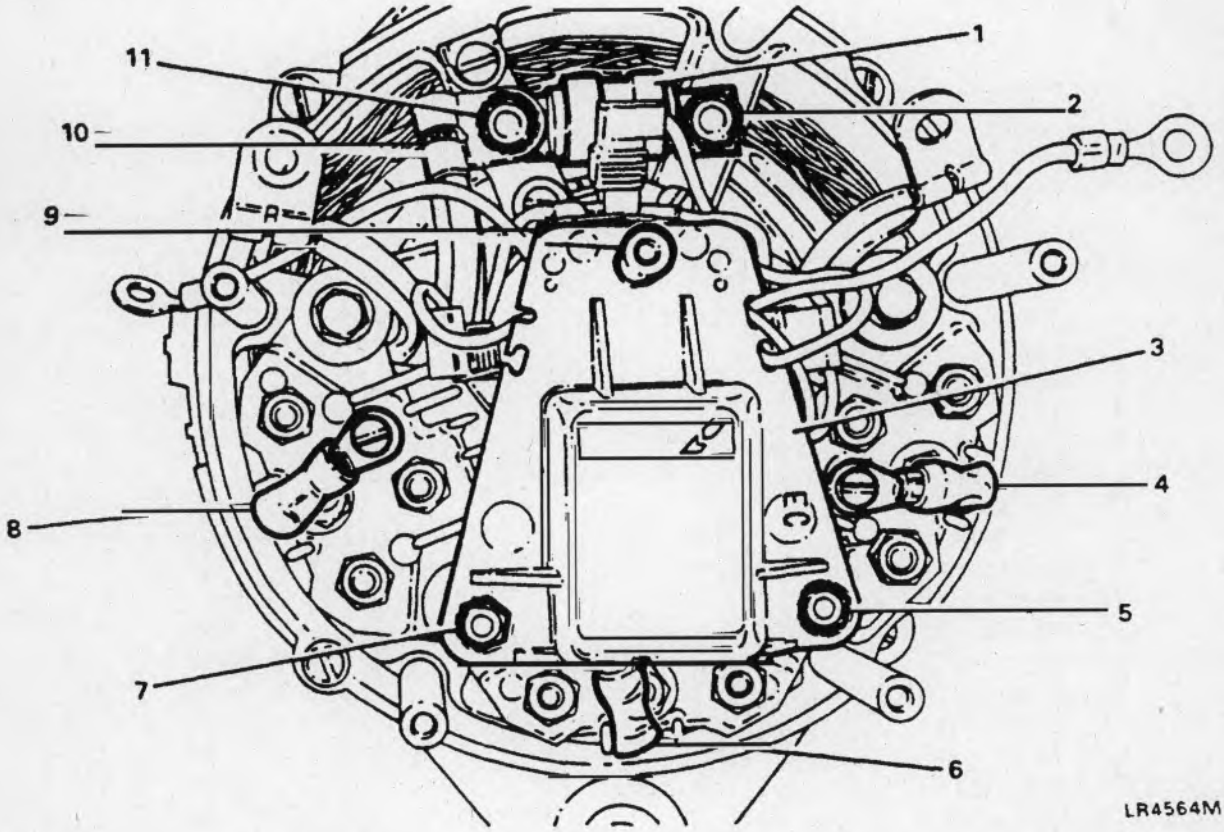
44 The regulator lead connections are as follows:

44.1 Black - Negative

44.2 Yellow - "A" (WL)

44.3 Green - Field

44.4 Red - Positive



1 Fast fuse
2 Fixings
3 Regulator
4 Lead tags
5 Fixings
6 Lead tags
7 Regulator fixings
8 Lead tags
9 Pillar bolt
10 Negative output lead
11 Fixings

Fig 18 Fitting regulator and fast fuse

45 Secure the suppression cover to the short pillar bolt using the screw and spring washer.

46 Fit the appropriate wires (identified during dismantling) to the rear of the three bushing capacitors on the suppression cover. Secure the wires using the appropriate nuts and washers.

47 Place the cowl over the suppression cover and secure using the five screws and spring washers, screwed into the main pillar bolts.

48 Cleaning agents. Kerosene may be used on parts which do not contain electrically insulated compon nts and items containing electrical insulation should be cleaned with "Genklene" or a similar chlorinated solvent. Usually wiping with a moistened cloth is quite sufficient.

WARNING ...

CHLORINATED SOLVENTS CAN BE DANGEROUS.

Key to Fig 19

1	Clamp plate fixing screws	2.8 - 3.2 Nm
2	Nut	90 - 100 Nm
3	Stauffer lubricator	1.4 - 1.7 Nm
4	Pillar bolts	2.8 - 3.0 Nm
5	Field coil securing screws	5.5 - 6.0 Nm
6	Terminal strip securing screws	1.4 - 1.7 Nm
7	Lucar retaining screw	1.4 - 1.7 Nm
8	Through bolts	6.2 - 7.4 Nm
9	Heatsink assembly screws	1.9 - 1.3 Nm
10	Heatsink assembly screws	0.9 - 1.3 Nm
11	Pillar bolts	2.8 - 3.2 Nm
12	Heatsink fixing bolts	2.8 - 3.2 Nm
13	Fuse locating bracket fixing screw	1.4 - 1.7 Nm
14	Fast fuse fixing screw	2.8 - 3.2 Nm
15	Lead tag fixing screws	2.4 - 3.2 Nm
16	Regulator fixing/pillar bolts	2.8 - 3.2 Nm
17	Regulator fixing nuts	2.8 - 3.0 Nm
18	Bushing capacitor fixing screws	0.9 - 1.0 Nm
19	Spare fuse/capacitor leads fixing nuts	2.8 - 3.2 Nm
20	Cowl fixing screws	2.4 - 2.6 Nm
21	Bushing capacitor lucar fixing screw	2.8 - 3.2 Nm

Chapter 13-3

12 VOLT 3.5 L PETROL ELECTRICAL SYSTEM

BASE REPAIRS

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the 12 volt electrical system fitted to Land Rover 3.5 litre petrol engine 110 and 127 vehicles. The information detailed is applicable to both left and right hand vehicles.

ALTERNATOR (A115-45)

Removal

2 For removal of the alternator refer to Cat 522 Chap 13-3.

Overhaul and electrical test

3 For overhaul and electrical test of the alternator refer to Cat 524 Chap 13-1.

Refitting

4 For refitting of the alternator refer to Cat 522 Chap 13-3.

DISTRIBUTOR (35DLM8)

Removal

5 For removal of the distributor refer to Cat 522 Chap 13-3.

Dismantling

6 To dismantle the distributor proceed as follows:

6.1 Unclip and remove the cover (Fig 1 (1)).

6.2 Pull the rotor arm (3) from the keyed rotor shaft (12).

6.3 Remove the three screws (4) and insulation cover (5).

6.4 Remove the two screws (20) from the vacuum unit securing bracket, disengage vacuum unit connecting rod from pick-up base plate connecting peg, and withdraw the vacuum unit (19) from the distributor body.

6.5 Remove the two screws (18) and withdraw the amplifier module (17).

6.6 Remove the gasket (16).

6.7 Remove the two screws (15) and withdraw the cast heatsink (14).

WARNING ...

THE AMPLIFIER CONTAINS BERYLLIA. DO NOT OPEN OR CRUSH. (SEE EMER MAN S 261).

6.8 Using circlip pliers remove the circlip (6) retaining the reluctor on the rotor shaft.

6.9 Remove the flat washer (7) and 'O' ring (8) from recess in the top of the reluctor.

6.10 Gently withdraw the reluctor (9) from the shaft, taking care not to damage the teeth.

Note ...

A coupling ring is fitted beneath the reluctor.

6.11 Remove the three support pillars (10) and cable grommet (13).

6.12 Lift out the pick-up and base plate assembly (11).

Note ...

Do not disturb the two barrel nuts securing the pick-up module, otherwise the air gap will need re-adjustment.

Cleaning and lubrication

7 To clean and lubricate the components proceed as follows:

7.1 Clean the cover (Fig 1 (1)) and HT brush (2) with a nap free cloth.

7.2 Apply three drops of clean engine oil to the felt pad reservoir in the rotor shaft.

7.3 Apply Chevron SR1 (or equivalent) grease to the following components:

7.3.1 Auto advance mechanism.

7.3.2 Pick-up plate centre bearing.

7.3.3 Pre-tilt spring and its rubbing area (pick-up and base plate assembly).

7.3.4 Vacuum unit connecting peg (pick-up and base plate assembly) and the connecting peg hole in the vacuum unit connecting rod.

7.4 Apply MS4 silicone grease (or equivalent) to the following components:

7.4.1 Amplifier module back plate.

7.4.2 Both faces of the heatsink casting and the seating face on distributor body.

Repair and replacement

8 The following components should be replaced if known to be faulty:

8.1 Distributor cover (Fig 1 (1)).

8.2 Rotor arm (3).

8.3 Insulation cover (5).

8.4 Pick-up and base plate assembly (11). Measure the resistance of the pick-up winding. The resistance should be between 2-5 KΩ.

Assembly

9 Assembly of the distributor is a reversal of the removal procedure, noting the following points:

9.1 The pick-up leads must be prevented from fouling the rotating reluctor. Both leads should be located in the plastic carrier (Fig 2 (1)).

9.2 Slide the reluctor as far as it will go onto the rotor shaft, and rotate the reluctor until it engages with the coupling ring beneath the pick-up base plate. The distributor shaft, coupling ring and reluctor are keyed, and therefore rotate together. Fit the 'O' ring, flat washer and retaining circlip.

9.3 The air gap between the pick-up limb (Fig 3 (1)) and reluctor teeth (2) must be set between 0,32 to 0,55 mm (0.008 to 0.014 in) using a non-ferrous feeler gauge. If adjustment is necessary, slacken the two barrel nuts (3) to set the gap.

Note ...

When the original pick-up and base plate assembly has been refitted the air gap should be checked and adjusted if necessary. When renewing the assembly the air gap will require adjusting to within the specified limits.

9.4 Before fitting the amplifier module it is important to follow the lubrication instructions in Para 7.4.

Refitting

10 To refit the distributor to the engine refer to Cat 522 Chap 13-3.

Ignition timing

11 For ignition timing refer to Cat 522 Chap 13-3.

Key to fig 1

1	Cover	12	Rotor shaft
2	HT brush and spring	13	Cable grommet
3	Rotor arm	14	Heatsink
4	Screw	15	Screw
5	Insulation cover	16	Gasket
6	Circlip	17	Amplifier module
7	Flat washer	18	Screw
8	'O' ring	19	Vacuum unit
9	Reluctor	20	Screw
10	Support pillar	21	'O' ring oil seal
11	Pick-up module & base plate		

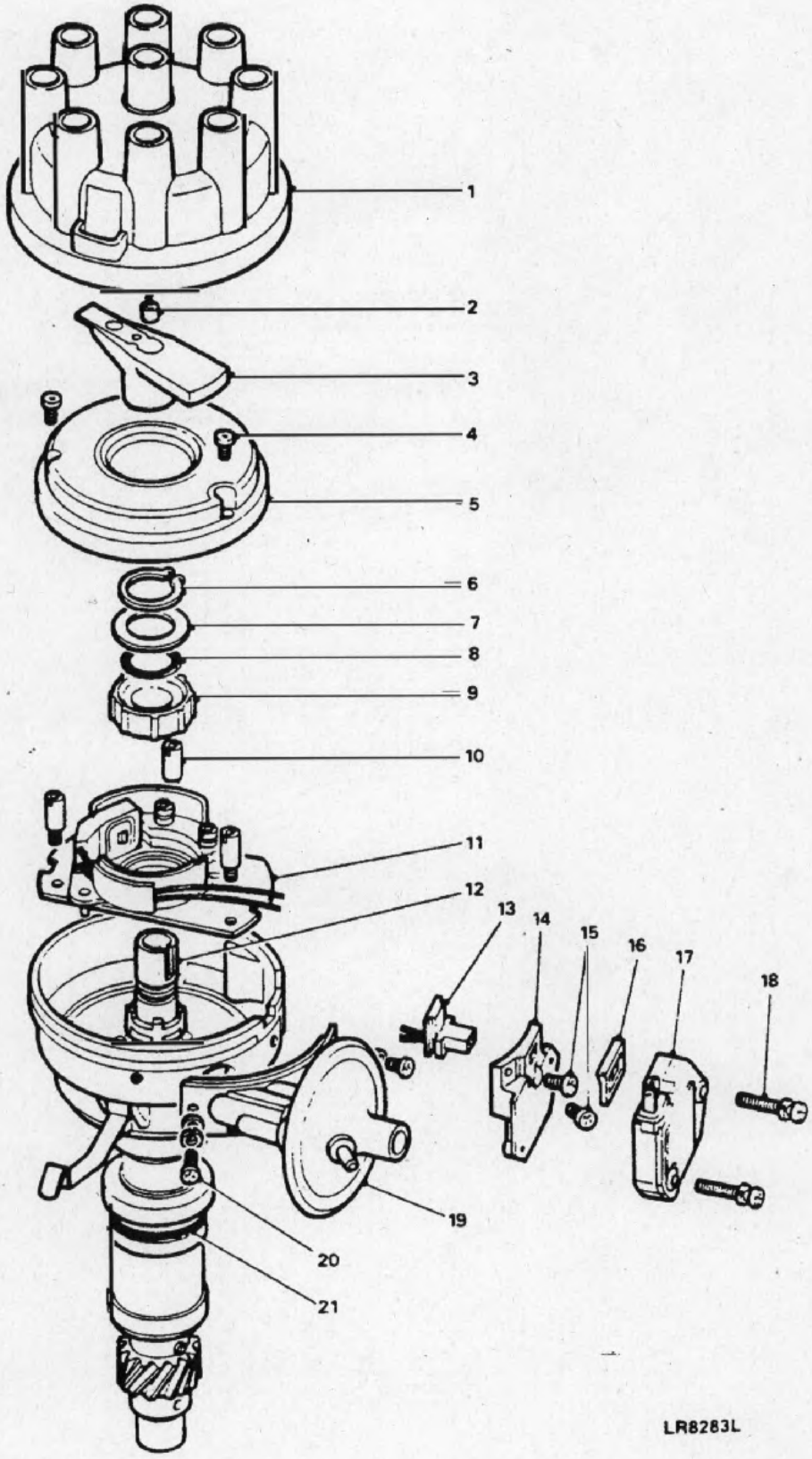
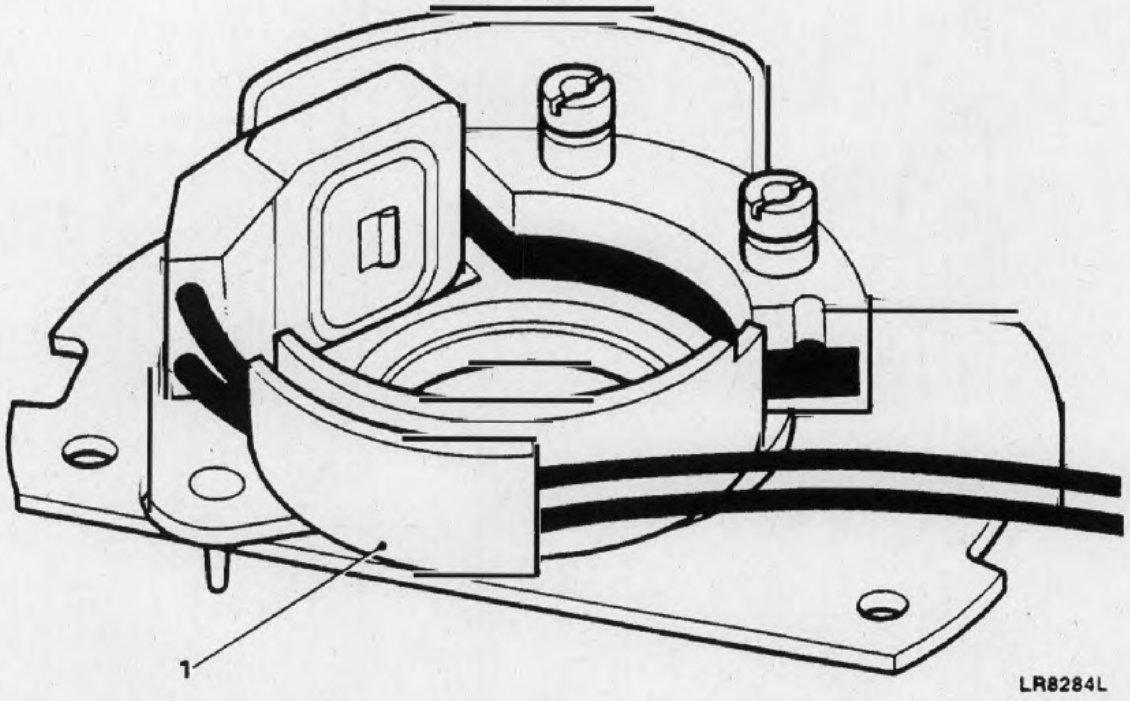
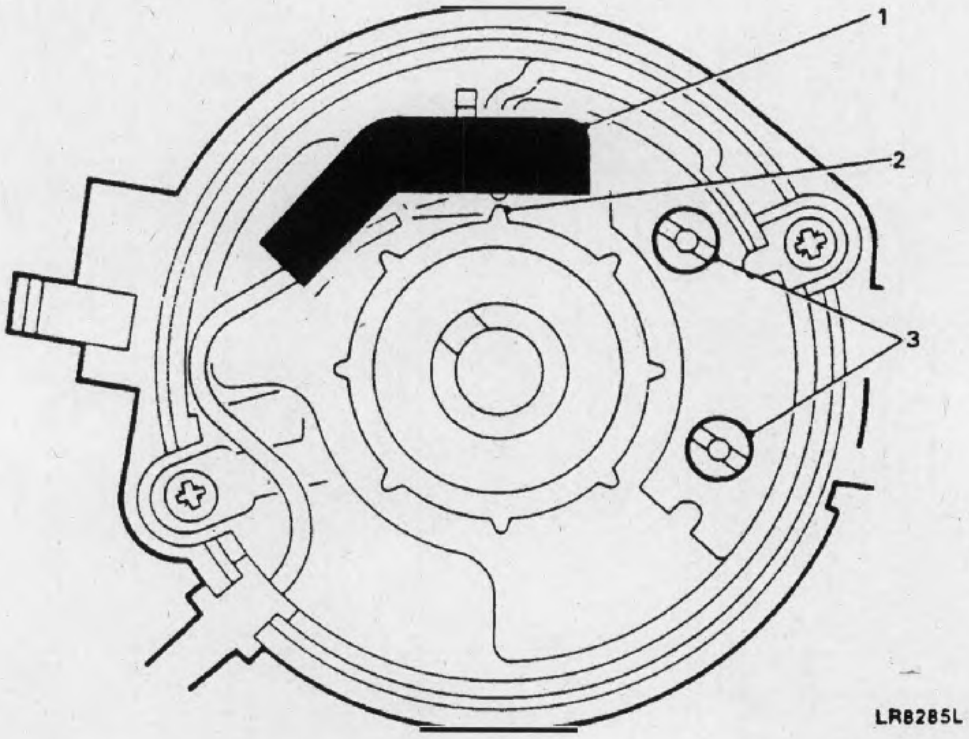


Fig 1 Exploded view of 35DLM8 Distributor



1 Plastic carrier

Fig 2 Fitting pick-up and base plate assembly



1 Pick-up limb
2 Reluctor teeth
3 Barrel nuts

Fig 3 Pick-up air gap adjustment

STARTER MOTOR (3M100PE)

Removal

12 To remove the starter motor from the vehicle refer to Cat 522 Chap 13-3.

Dismantling

13 To dismantle the solenoid proceed as follows:

13.1 Remove the connecting link (Fig 4 (15)) between the starter and the solenoid terminal 'STA'.

13.2 Remove the solenoid (16) from the drive end bracket (9).

13.3 Grasp the solenoid plunger (17) and lift the front end to release it from the top of the drive engagement lever.

13.4 Remove the end cap seal (2).

13.5 Using an engineer's chisel, cut through a number of the retaining ring (3) claws until the grip on the armature shaft is sufficiently relieved to allow the retaining ring to be removed (Fig 5).

13.6 Remove the two through bolts (Fig 4 (1)).

13.7 Partially withdraw the commutator end cover (5) and disengage the two field coil brushes (13) from the brush box.

13.8 Remove the commutator end cover (5).

13.9 Withdraw the yolk and field coil assembly (12).

13.10 Withdraw the pivot pin (18).

13.11 Withdraw the armature (7).

13.12 Using a suitable tube, remove the collar and jump ring (8) from the armature shaft.

13.13 Slide the thrust collar, roller clutch drive and lever assembly (10) off the shaft.

Test and overhaul

14 To test and overhaul the starter motor proceed as follows:

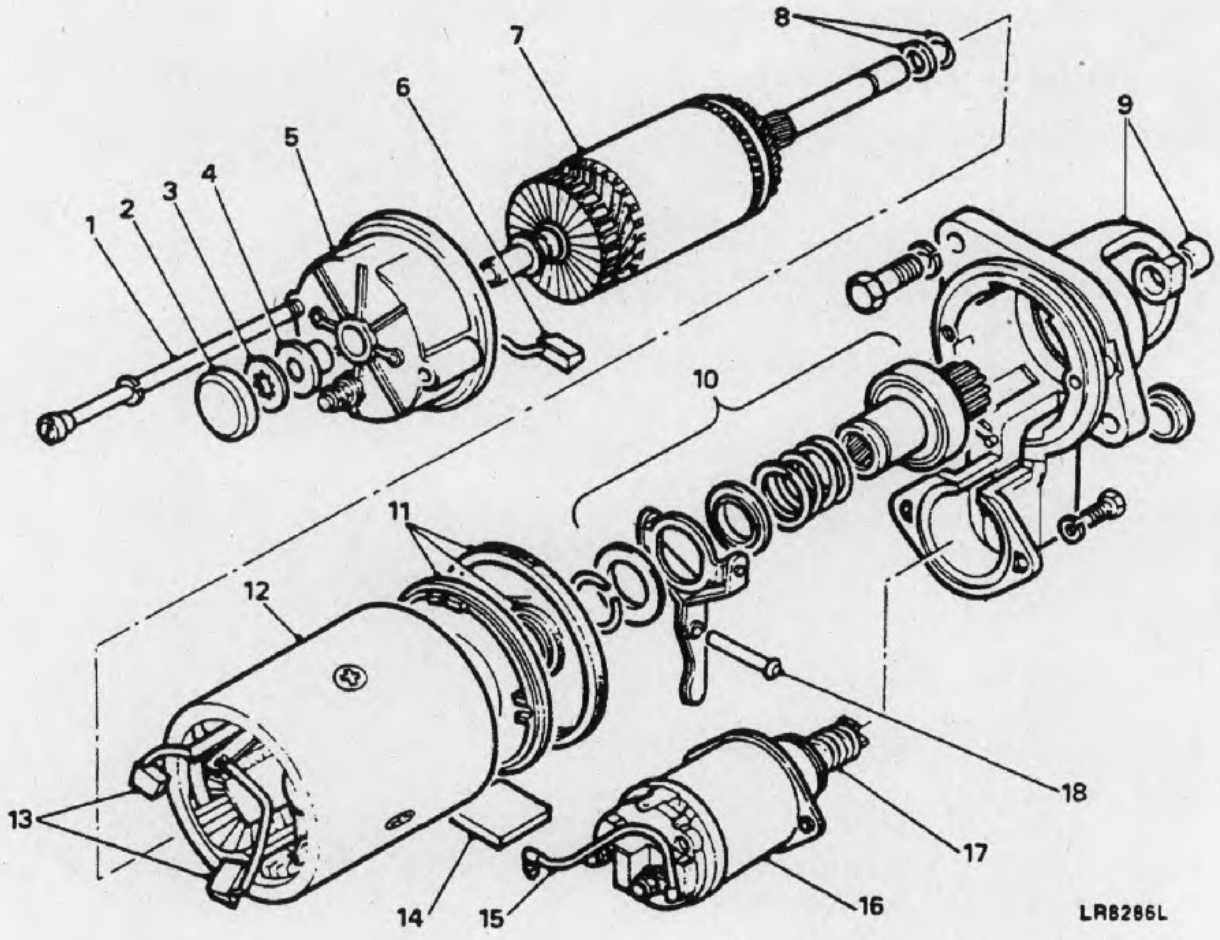
14.1 Check that the clutch gives instantaneous take-up of the drive in one direction and rotates easily and smoothly in the other direction.

14.2 Ensure that the clutch is free to move round and along the shaft splines without any tendency to bind.

Note ...

The roller clutch drive is sealed in a rolled steel cover and cannot be dismantled.

14.3 Lubricate all clutch moving parts with Shell SB2628 grease for cold and temperate climates or Shell Retinax 'A' for hot climates.



1	Through bolts	10	Clutch drive & lever assy
2	End cap seal	11	Intermed. bracket & seals
3	Spire ring	12	Yoke and field coil assy
4	Sintered bearing bush	13	Field coil brushes
5	Commutator end cover	14	Rubber block
6	Brush plate brushes	15	Connecting link
7	Armature	16	Solenoid
8	Collar and jump ring	17	Solenoid plunger
9	Drive-end bracket and bush	18	Pivot pin

Fig 4 Exploded view of 3M100PE Starter motor

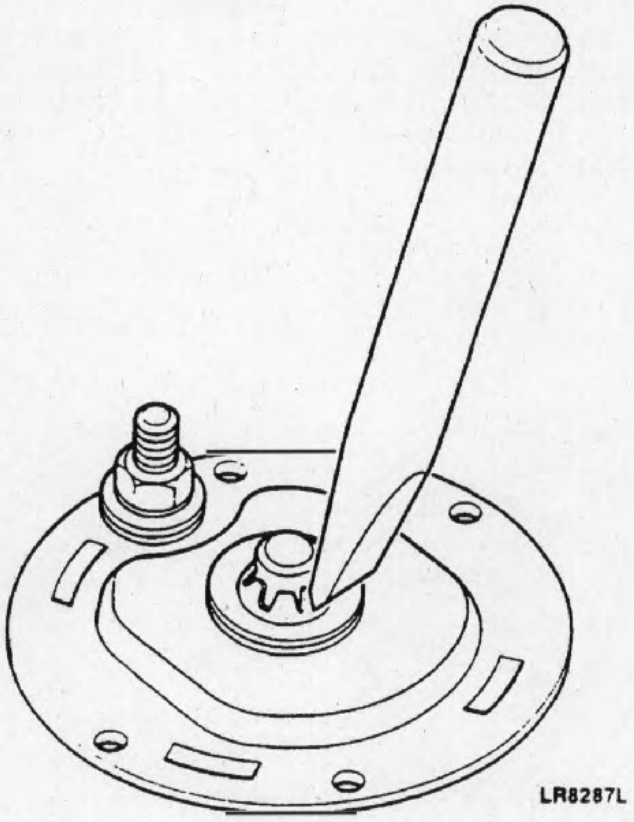
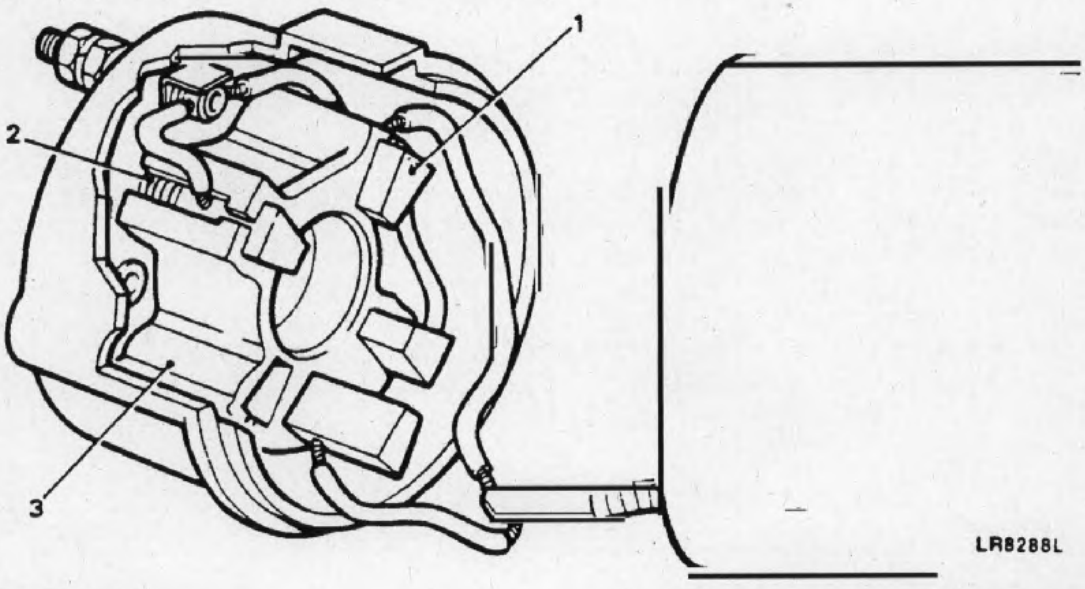


Fig 5 Removal of armature shaft retaining ring

14.4 Check that the brushes (Fig 6 (1)) move freely in the brush box moulding. Rectify sticking brushes by wiping with a petrol moistened cloth.

14.5 Fit new brushes if they are damaged or worn to approximately 9,5 mm (0.375 in).



1 Brush
2 Spring
3 Brush box moulding

Fig 6 Starter motor brushes

14.6 Using a push-type spring gauge, check the brush spring pressure. If new brushes are fitted and pushed in until the top of the brush protrudes about 1,5 mm (0.065 in) from the brush box moulding, dimension 'A' (Fig 7), the spring pressure reading should be 1,0 kgf (36 ozf).

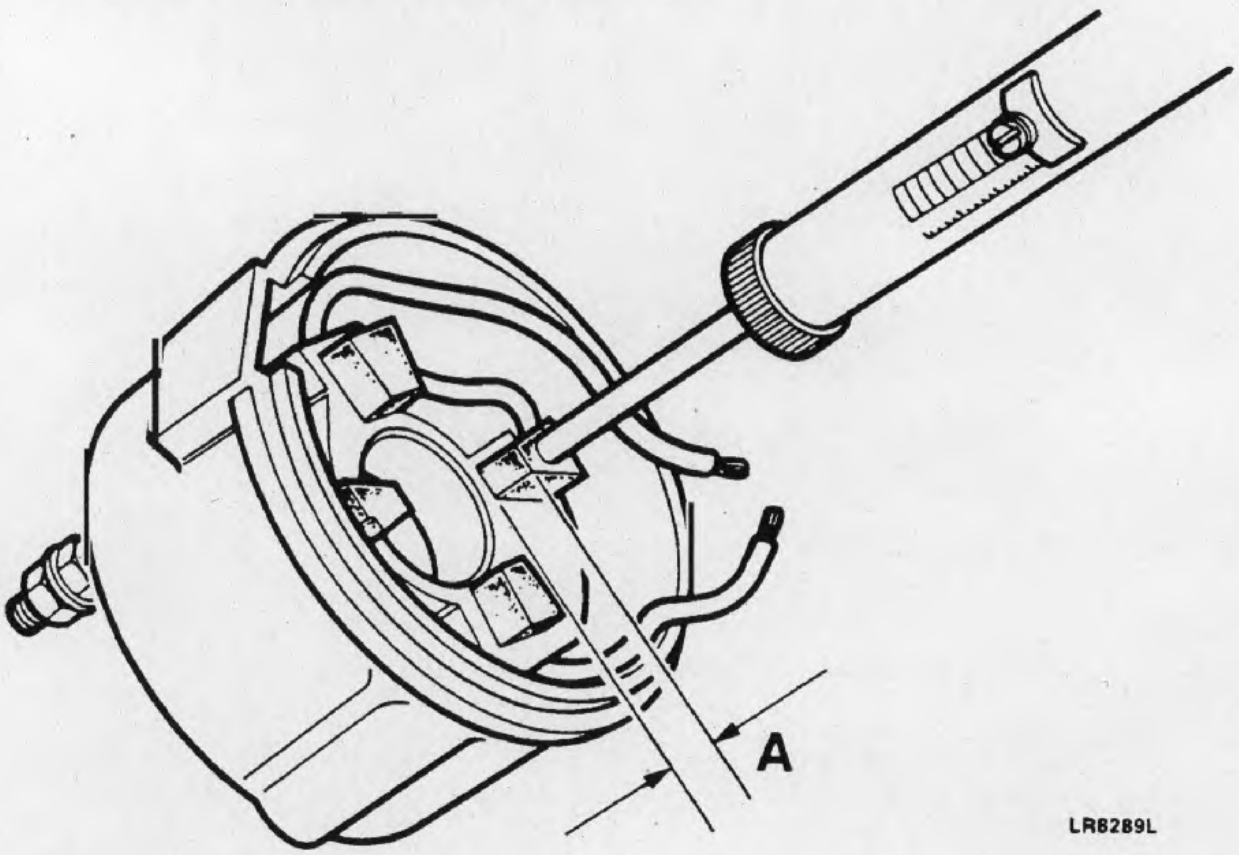


Fig 7 Checking brush spring pressure

14.7 Check the insulation of the brush springs by connecting a Megger between a clean part of the commutator end cover and each of the springs in turn. The Megger should read infinity.

14.8 Check the commutator. If cleaning only is necessary, use a flat surface of very fine glass paper, and then wipe the commutator surface with a petrol moistened cloth.

14.9 If necessary, the commutator may be machined provided a finished surface can be obtained without reducing the thickness of the commutator copper below 3,5 mm (0.140 in), otherwise a new armature must be fitted.

CAUTION ...

Do not undercut the insulation slots.

14.10 Check the armature insulation by connecting a Megger between any one of the commutator segments and the shaft (Fig 8). The Megger should read infinity. If necessary, a new armature must be fitted.

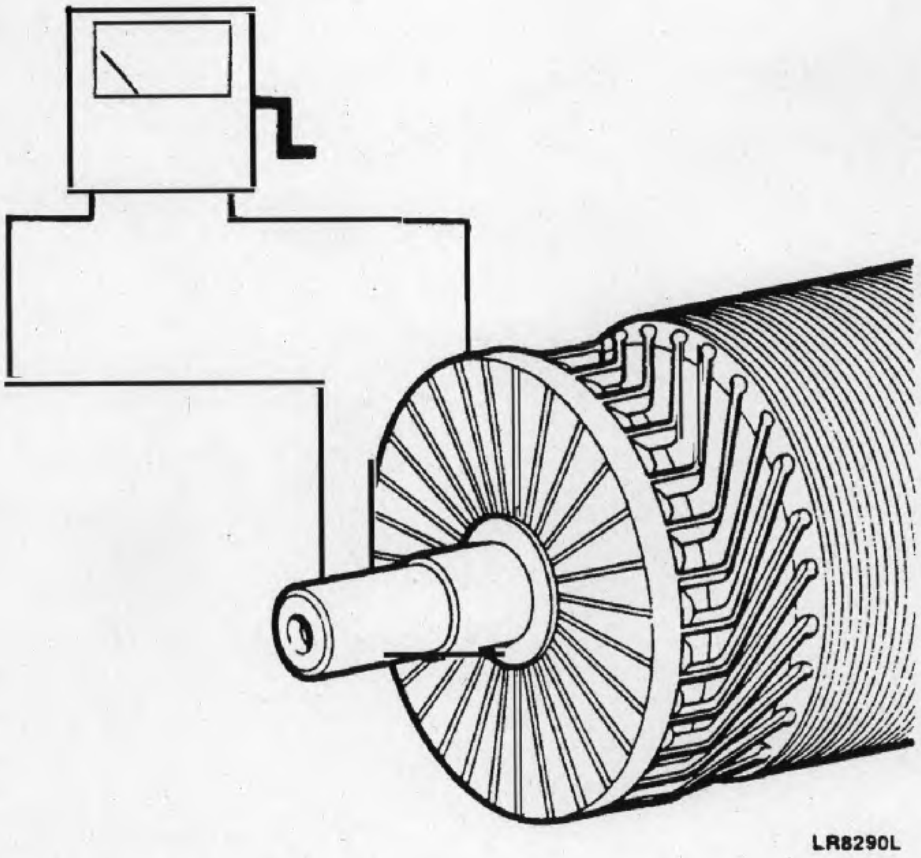


Fig 8 Checking armature insulation

14.11 Disconnect the end of the field winding where it is rivited to the yoke, by filing away the riveted over end of the connecting-eyelet securing rivet (Fig 9 (1)), sufficient to enable the rivet to be tapped out of the yoke.

14.12 Connect a Megger between the disconnected end of the winding and a clean part of the yoke.

14.13 Ensure that the brushes (2) or bare parts of their flexibles are not touching the yoke during the test.

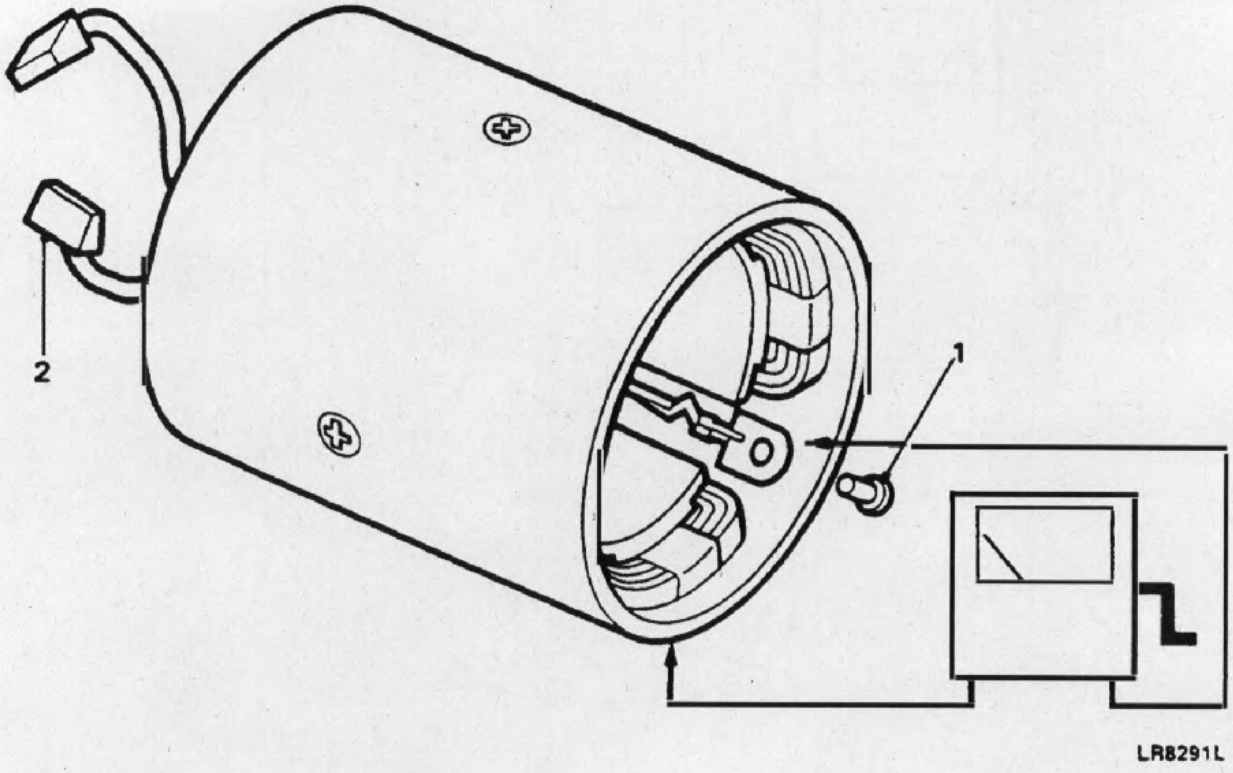
14.14 The Megger should read infinity. If necessary, a new field coil assembly must be fitted.

14.15 Re-secure the end of the field winding to the yoke.

14.16 Connect a Megger between each of the brushes in turn and a clean part of the yoke (Fig 10).

14.17 The Megger should read infinity. If necessary, a new field coil assembly must be fitted.

14.18 Disconnect all cables from the solenoid terminals and connectors.



1 Rivet 2 Brushes

Fig 9 Checking field coil insulation

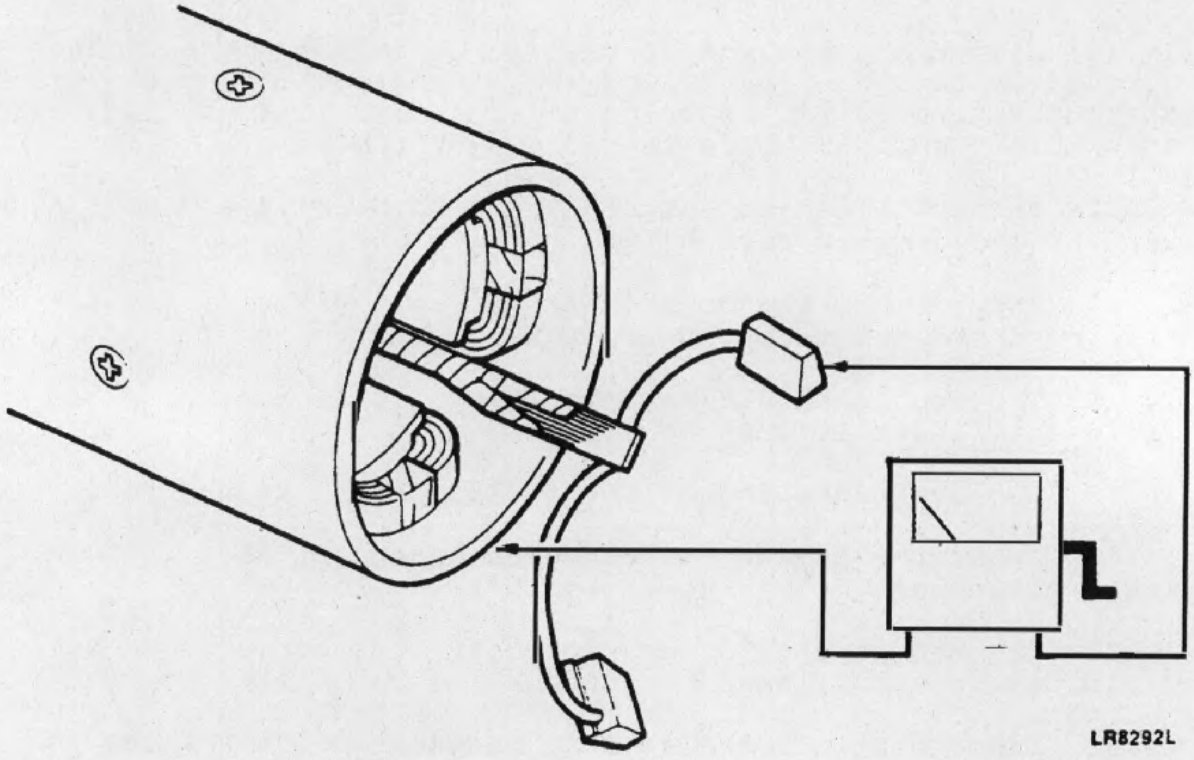


Fig 10 Checking field coil continuity

14.19 Connect a 12 Volt battery and a Multimeter between the solenoid main terminals (Fig 11). The Multimeter should not produce a reading. If the Multimeter produces a reading, new solenoid contacts or a new complete solenoid must be fitted.

14.20 Leave the Multimeter connected and using the same 12 volt battery supply, energize the solenoid by connecting 12 Volts between the small solenoid operating Lucar terminal blade and a good earth point on the solenoid body (Fig 11).

14.21 The solenoid should be heard to operate and the Multimeter should read infinity. If the Multimeter does not produce a reading, new solenoid contacts or a new complete solenoid must be fitted.

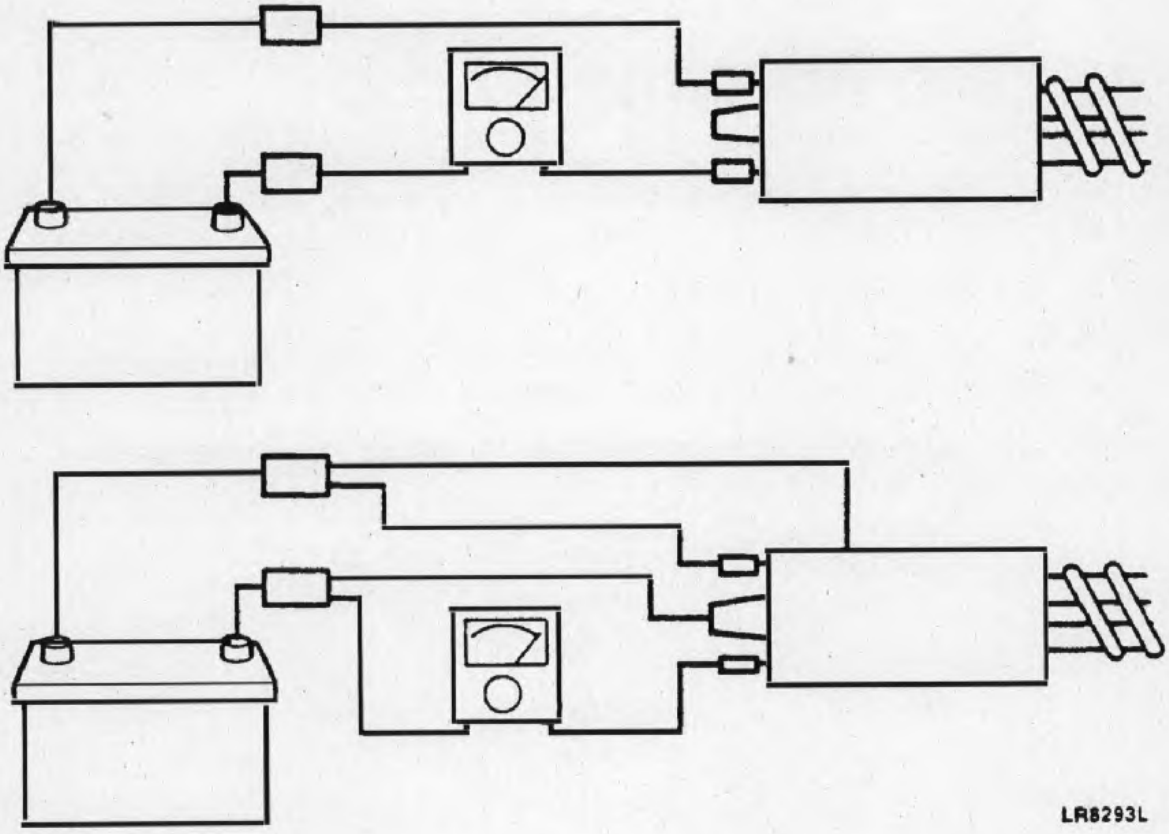


Fig 11 Checking solenoid

Assembly

15 To assemble the starter motor proceed as follows:

15.1 Fit the intermediate bracket and inner seal (Fig 4 (11)) over the armature shaft.

15.2 Slide the thrust collar and the roller clutch drive and lever assembly (10) onto the armature shaft.

15.3 Fit the jump ring and collar (8) to the armature shaft.

15.4 Fit the armature (7).

15.5 Fit the pivot pin (18) and splay the nd.

15.6 Fit the yoke and field coil assembly (12) and ensure that the dowel peg in the drive-end bracket (9) aligns with matching location in the intermediate bracket (11) before offering the yoke into position.

15.7 Fit the internal thrust washer to the shaft.

15.8 Engage the two field coil brushes (13) in the brush box and fit the commutator end cover (5).

15.9 Secure the assembly with the two through bolts (1) and tighten to the correct torque.

15.10 Fit the sintered bearing bush (4).

15.11 Using a suitable tube, drive a new spire ring (3) into position (Fig 12). The position of the spire ring on the armature shaft determines the armature end-float which should be 0,25 mm (0.010 in) maximum between the spire retaining ring and the sintered bearing bush shoulder. Care, therefore, must be taken when fitting the spire ring.

15.12 Fit the end cap seal (Fig 4 (2)).

15.13 Fit the solenoid (16) to the drive end bracket (9) whilst locating the drive engagement lever.

15.14 Fit the connecting link (15) between the starter and solenoid terminal 'STA'.

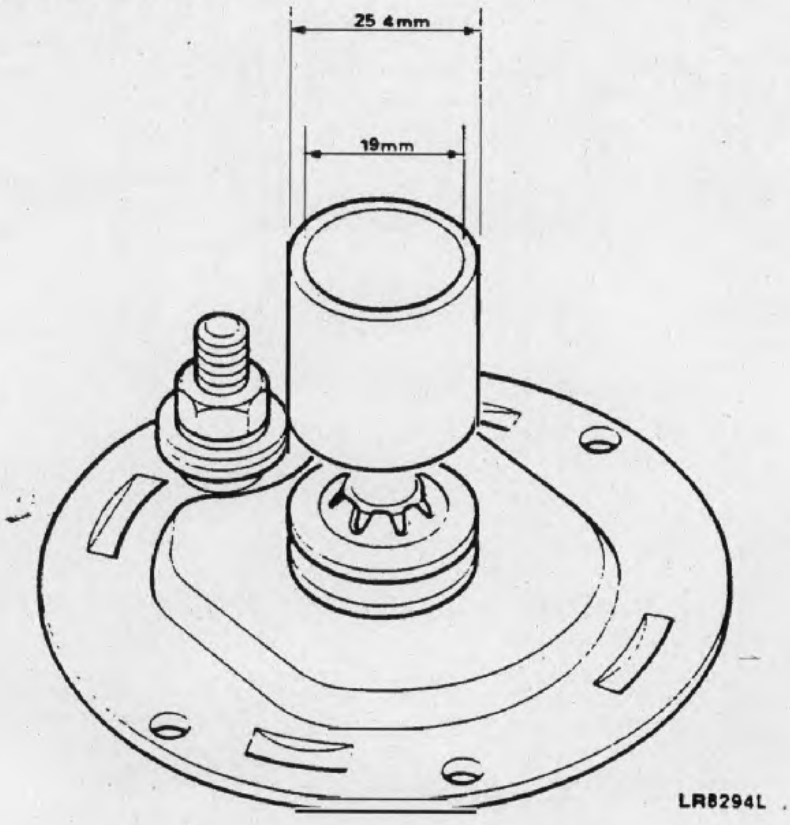


Fig 12 Fitting spire ring

Refitting

16 For refitting the starter motor to the vehicle refer to Cat 522 Chap 13-3.

Chapter 13-4

12/24 VOLT 3.5 L PETROL ELECTRICAL SYSTEM

BASE REPAIRS

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the 24 volt electrical system fitted to Land Rover 3.5 litre petrol 110 and 127 vehicles.

90 A BRUSHLESS ALTERNATOR

Removal

2 For removal of the alternator refer to Cat 522 Chap 13-4.

Dismantling

3 For dismantle of the alternator refer to Cat 524 Chap 13-2.

Component inspection and renewal

4 For inspection and renewal of alternator components refer to Cat 524 Chap 13-2.

Assembly

5 For assembly of alternator refer to Cat 524 Chap 13-2.

Refitting

6 For refitting of alternator refer to Cat 522 Chap 13-4.

Chapter 13-5

12 VOLT 2.5 L DIESEL WINTERISED ELECTRICAL SYSTEM

BASE REPAIRS

CONTENTS

INTRODUCTION

1 This Chapter details the Base repair procedures for the 12 volt winterised electrical system fitted to Land Rover 2.5 litre diesel winterised 90 and 110 vehicles. The information detailed is applicable to both left and right hand vehicles.

ALTERNATOR (A127-65)

Removal

2 For removal of the alternator refer to Cat 522 Chap 13-5.

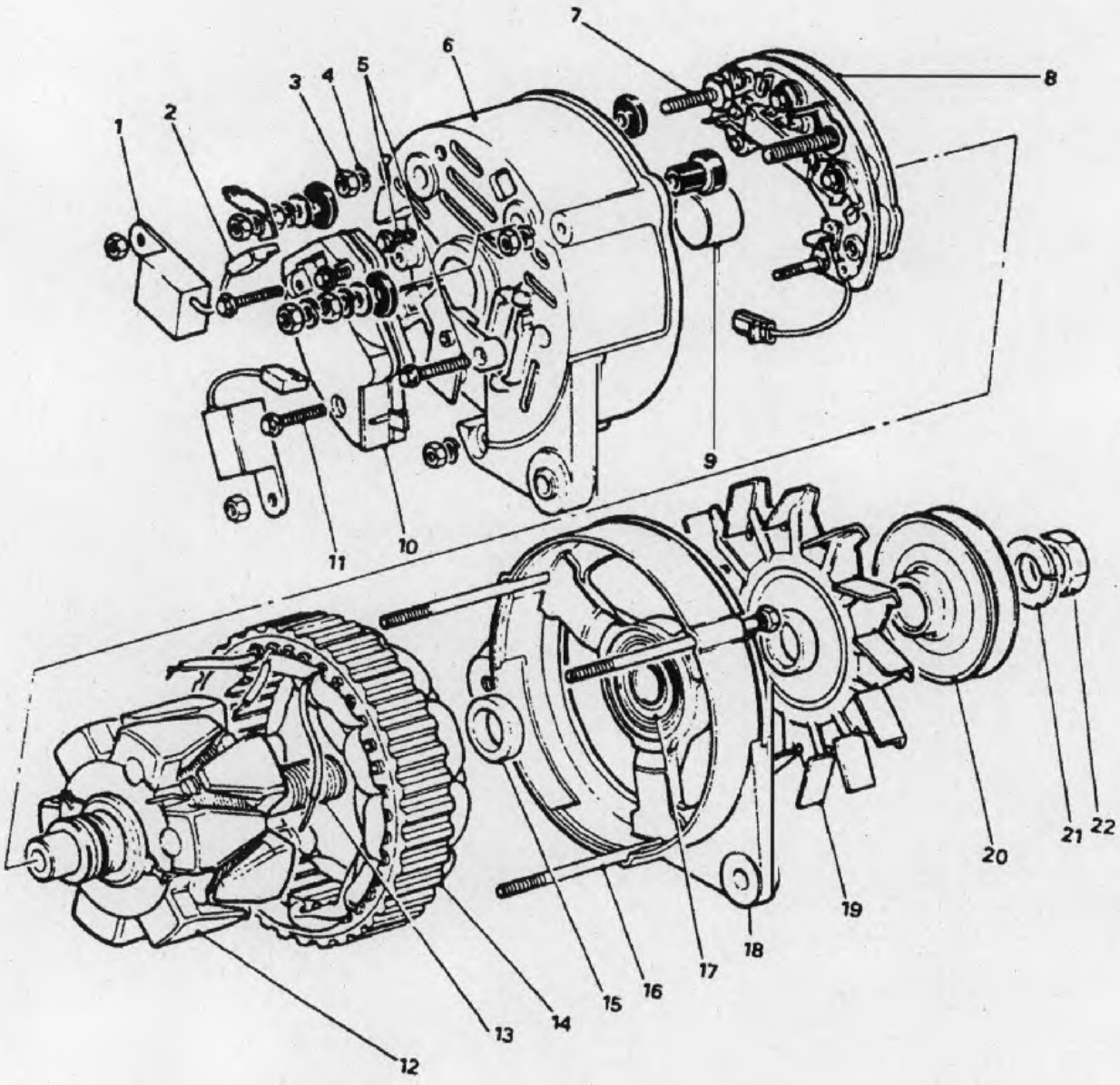
Dismantling

3 To dismantle the alternator proceed as follows:

3.1 Remove the nuts (Fig 1 (3)) and spring washers (4) from the through bolts (16), disconnect the connectors (2) and remove the two suppression capacitors (1).

3.2 Remove the three screws (11), disconnect one lead and withdraw the regulator and brushbox assembly (10).

3.3 Mark the relative positions of the end brackets (6,18) and stator (14). Remove the through bolts (16) and withdraw the slip ring end bracket (6) and stator assembly (14). If necessary, carefully tap the mounting lugs with a mallet.



1 Suppression capacitors
2 Capacitor terminal
3 Nut
4 Spring washer
5 Screws
6 Slip ring end bracket
7 Stud terminal
8 Rectifier
9 Slip ring end bearing
10 Regulator/brushbox assembly
11 Screw
12 Rotor
13 Rotor shaft
14 Stator
15 Spacer
16 Through bolt
17 Drive end bearing
18 Drive end bracket
19 Fan
20 Pulley
21 Spring washer
22 Nut

Fig 1 Exploded view of A127-65 Alternator

3.4 Remove the nuts, washers and insulators from the stud terminals (7) noting their position for reassembly.

3.5 Remove the two screws (5) and insulation cover.

3.6 Withdraw the rectifier (8) and stator (14) from the slip ring end bracket (6).

3.7 Release the stator winding cable ends (Fig 2 (1)) from the rectifier by applying a hot soldering iron to the rectifier terminal tags (2). Prise out the cable ends when the solder melts, and separate the rectifier and stator. Further dismantling of the rectifier is not required.

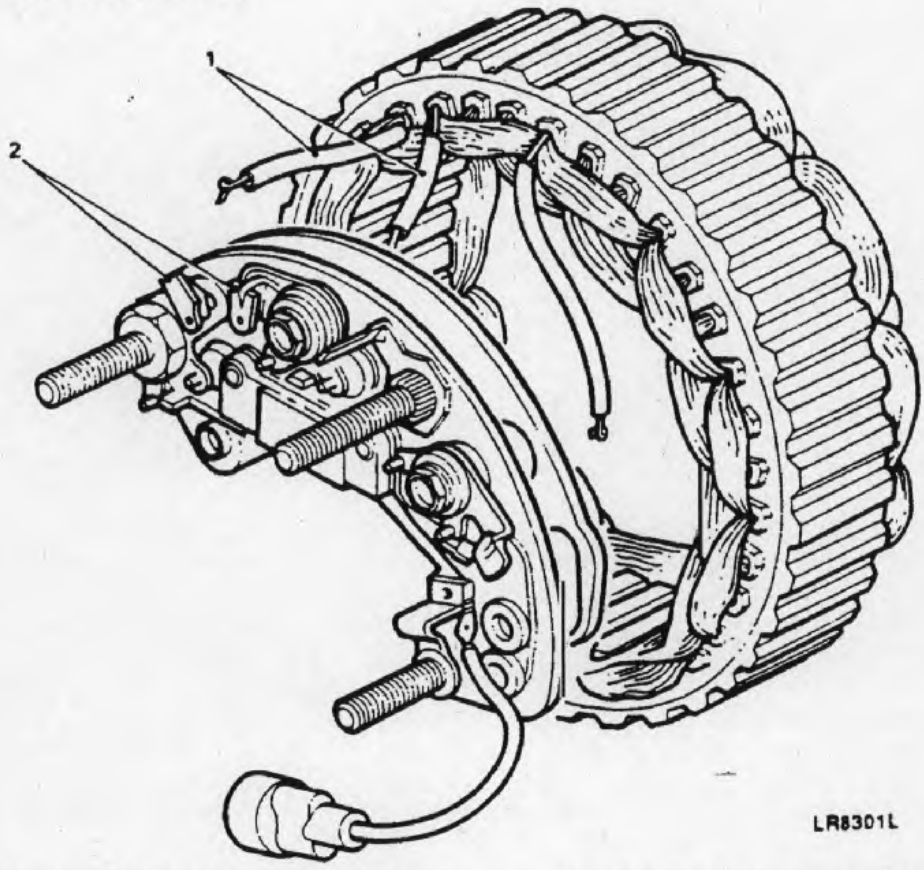
3.8 Remove the nut (Fig 1 (22)) and spring washer (21) securing the fan and pulley assembly to the drive end bracket. Remove the fan (19) and pulley (20).

3.9 Push out the rotor shaft (13) from the bearing using a suitable press and remove the spacer (15) from the shaft.

3.10 Using a suitable press, apply pressure from the rear of the slip ring end bracket and withdraw the bearing (17).

Note ...

The drive end bracket and bearing are only supplied as an individual unit.



1 Stator winding cable ends 2 Rectifier terminal tags

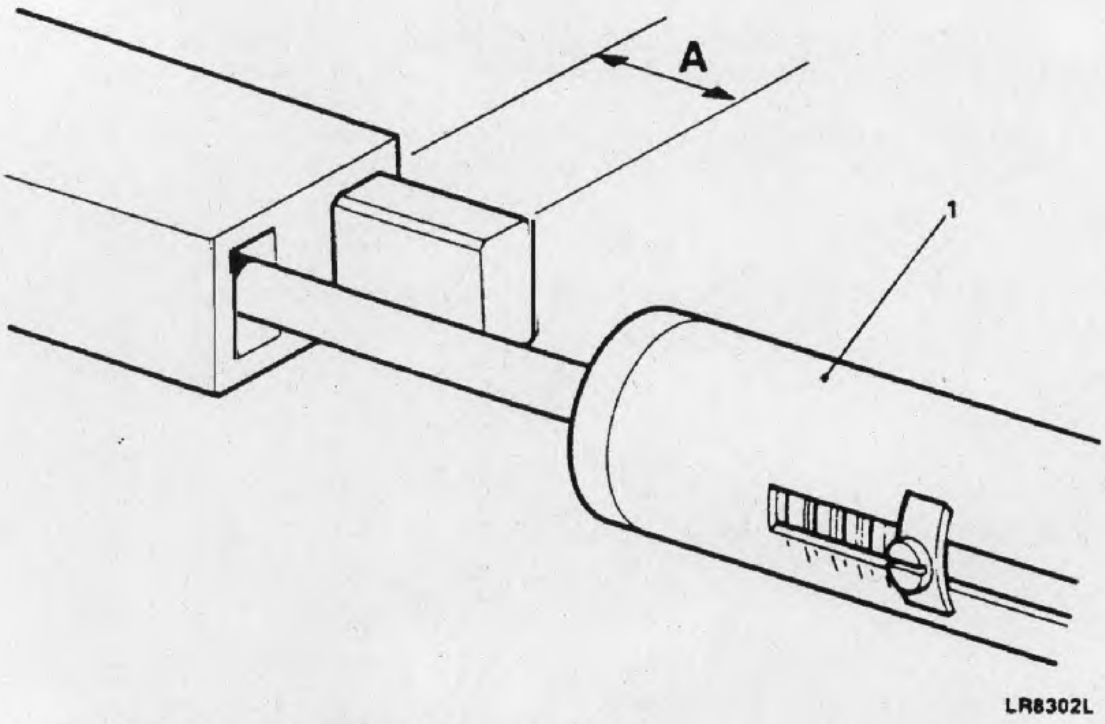
Fig 2 Separating the rectifier and stator

Component inspection and renewal

4 To inspect and renew the alternator components proceed as follows:

4.1 Check the brush lengths by measuring length of protusion from moulding (Fig 3). If dimension 'A' is 5 mm (0.20 in) or less, the assembly must be replaced.

4.2 Check the brush spring pressure using push type spring gauge (Fig 3 (1)). The gauge should register 136 to 279 g (5 to 10 oz) when brush is pressed until the face is flush with the housing. If the reading is outside these limits, the assembly must be replaced.



1 Spring pressure gauge

Fig 3 Checking brush lengths and spring pressure

4.3 Connect the test equipment and check the diodes (Fig 4 (1)). Test each diode in turn, noting whether the lamp illuminates and then reverse test lead connections. The lamp should illuminate in one direction only. If a faulty diode is diagnosed the rectifier assembly must be replaced.

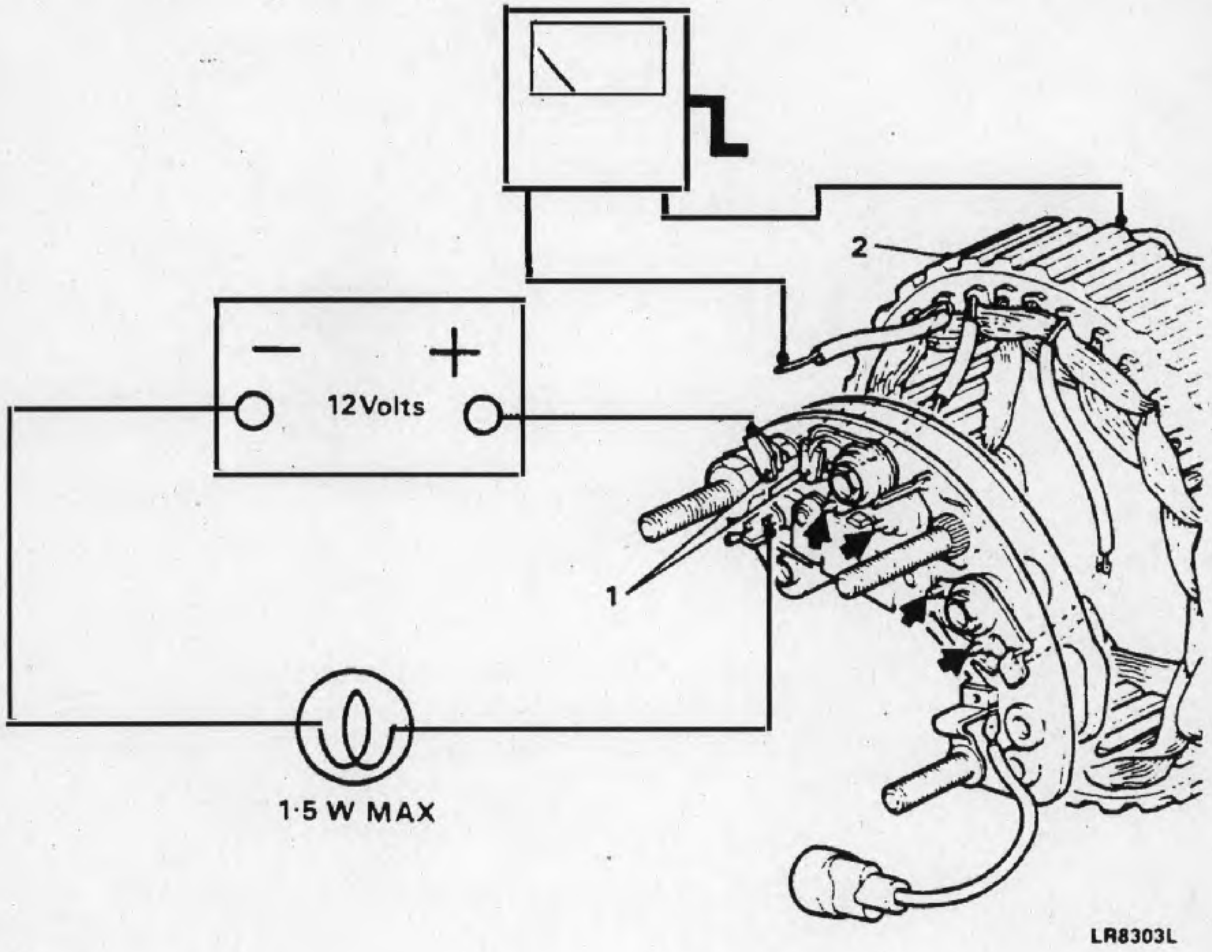
4.4 Visually inspect the stator windings for signs of damage or burning. Check the stator insulation (2) using a Megger. Connect the test leads to the laminated yoke and to each of the three leads in turn. If the Megger produces a reading, the stator must be replaced.

4.5 Clean the surfaces of the slip rings using a solvent moistened cloth.

4.6 Inspect the slip ring surfaces for signs of burning. Remove any burn marks using extra fine glasspaper.

CAUTION ...

On no account should emery cloth or similar abrasives be used, or any attempt made to machine the slip rings.



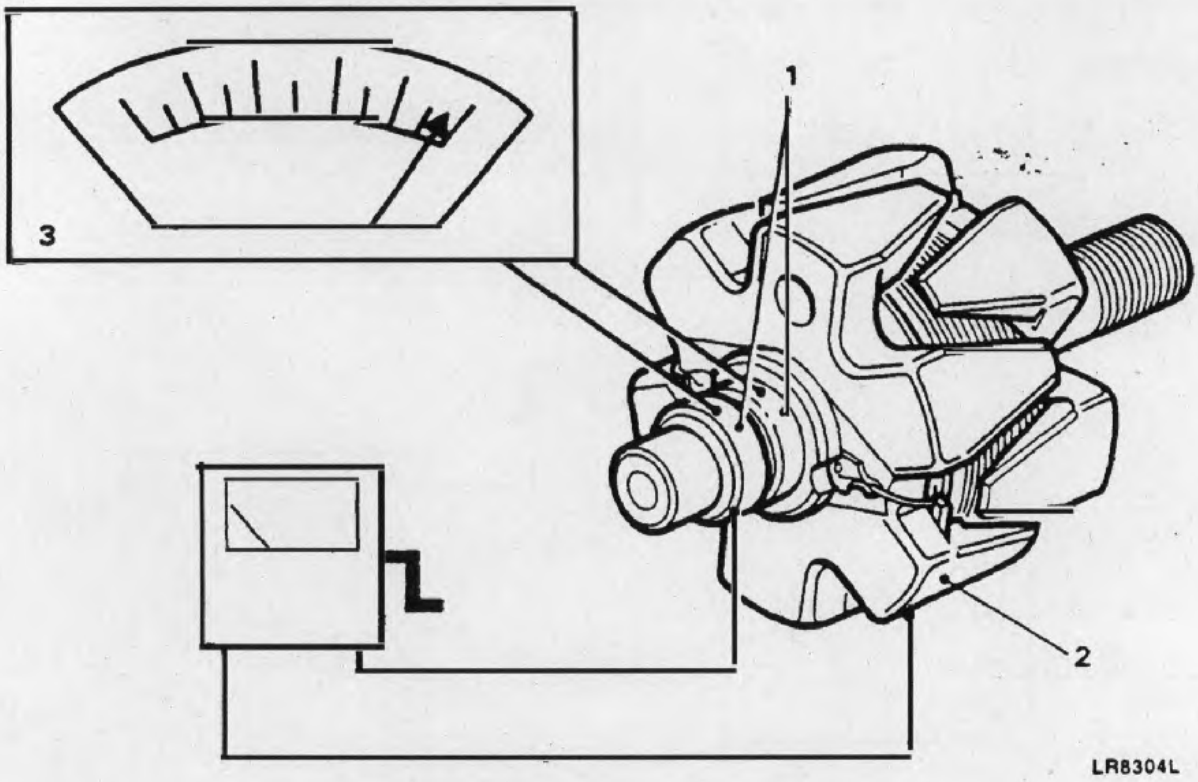
1 Diodes 2 Stator insulation

Fig 4 Checking the diodes and stator insulation

4.7 Check the insulation of the rotor field windings using a Megger connected between one of the slip rings (Fig 5 (1)) and one of the rotor poles (2). If the Megger produces a reading the rotor must be replaced.

4.8 Check the resistance/continuity of the rotor field windings by connecting an ohmmeter (3) to the slip rings as illustrated. A reading of 3.2 ohms should be obtained.

4.9 Check condition of the bearings. If signs of rubbing between the rotor poles and stator are evident, both bearings are excessively worn and must be replaced.



1 Slip rings
2 Rotor pole
3 Ohmmeter

Fig 5 Checking the rotor field windings

Assembly

5 To assemble the alternator proceed as follows:

5.1 Fit the spacer (Fig 1 (15)) and press the rotor (12) into the drive end bracket (18).

5.2 Insert the through bolts (16).

5.3 Fit the spacer, fan (19), pulley (20) and spring washer (21) to the rotor shaft (13). Fit and tighten the nut (22) to a torque of 50 to 70 Nm (37 to 52 lbf ft).

5.4 Fit the stator (14) and rectifier (8) assembly to the drive end bracket (18) in the position previously marked.

5.5 Fit the slip ring end bracket (6) in the position previously marked, locating the regulator lead through its aperture.

5.6 Fit the insulation cover and tighten the two rectifier securing screws (5) to a torque of 3.5 Nm (2.5 lbf ft).

5.7 Fit and tighten the through bolt spring washers (4) and nuts (3) evenly to a torque of 5.5 Nm (4.0 lbf ft).

5.8 Connect the lead to th regulator, locate the brushes on the slip rings and tighten th r gulator/brushbox assembly screws (11) to a torque of 2.5 Nm (2.0 lbf ft), taking care not to damage the brushes.

5.9 Fit both suppression capacitors (1).

Refitting

6 To refit the alternator refer to Cat 522 Chap 13-1.

Alternator functional check

7 To perform a functional check of the alternator proceed as follows:

CAUTION ...

The alternator contains polarity sensitive components that could be permanently damaged if subjected to incorrect polarity. Do not connect or disconnect any part of the charging circuit, including the battery leads while the engine is running. Run the alternator with all connections made or with the unit disconnected.

Notes ...

(1) This operation must be performed in two parts. The first to prove the alternator's capacity to produce current. The second to prove the performance of the integral regulator.

(2) The stated output may be exceeded slightly when the alternator is cold. To avoid misleading results, the check should be performed with the unit as near to its normal operating temperature as possible.

7.1 Check drive belt adjustment (Refer to Cat 522 Chap 13-1).

7.2 Disconnect the muti-socket connector.

7.3 Remove the cover. Using a suitable probe and wire, directly earth the field winding earth brush, by-passing the regulator.

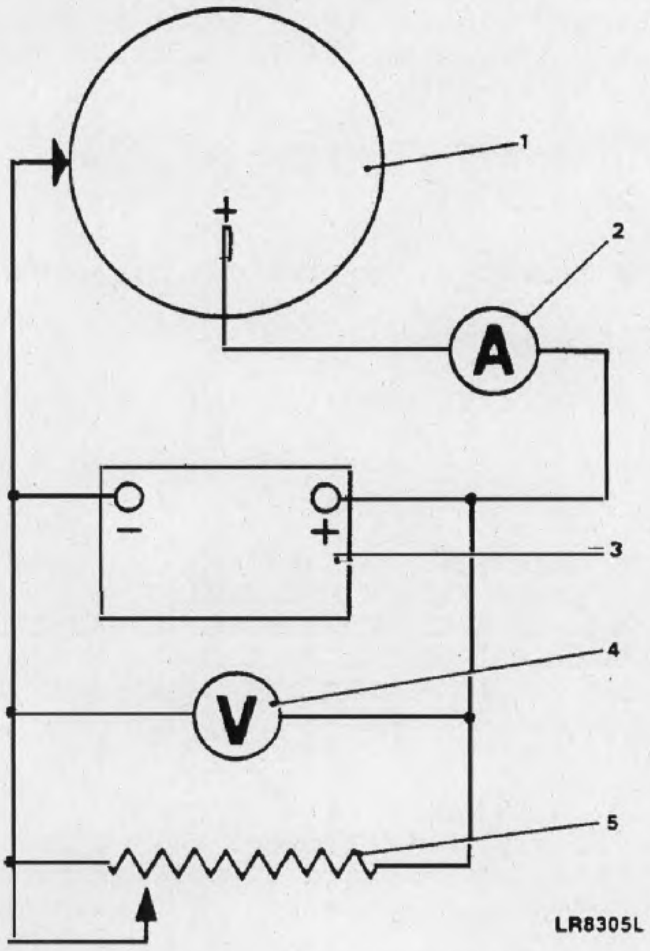
7.4 Provide a test circuit as illustrated in Fig 6.

Note ...

Do not connect the variable resistor across the battery for longer than is necessary to perform the check.

7.5 Run the engine.

7.6 Gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.



1 Alternator
2 Ammeter
3 12 volt battery
4 Voltmeter
5 Variable resistance

Fig 6 Current production test circuit

7.7 Hold the speed at approximately 6000 alternator rev/min (3000 engine rev/min). Adjust the variable resistor so that the voltmeter reads 14 volts. The ammeter reading should now be approximately equal to the nominal output of 65 amp. An incorrect ammeter reading is an indication that the alternator requires overhaul or replacement.

7.8 Provide a test circuit as illustrated in Fig 7.

7.9 Start the engine and gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.

7.10 Hold the speed at approximately 6000 alternator rev/min (3000 engine rev/min). The voltmeter reading should now be steady at 13.6 to 14.4 volts.

7.11 If the voltmeter reading is not steady at the above figure, and a satisfactory check of capacity to produce current has been performed (Para 7.1 to 7.7) the indication is that the control regulator should be replaced.

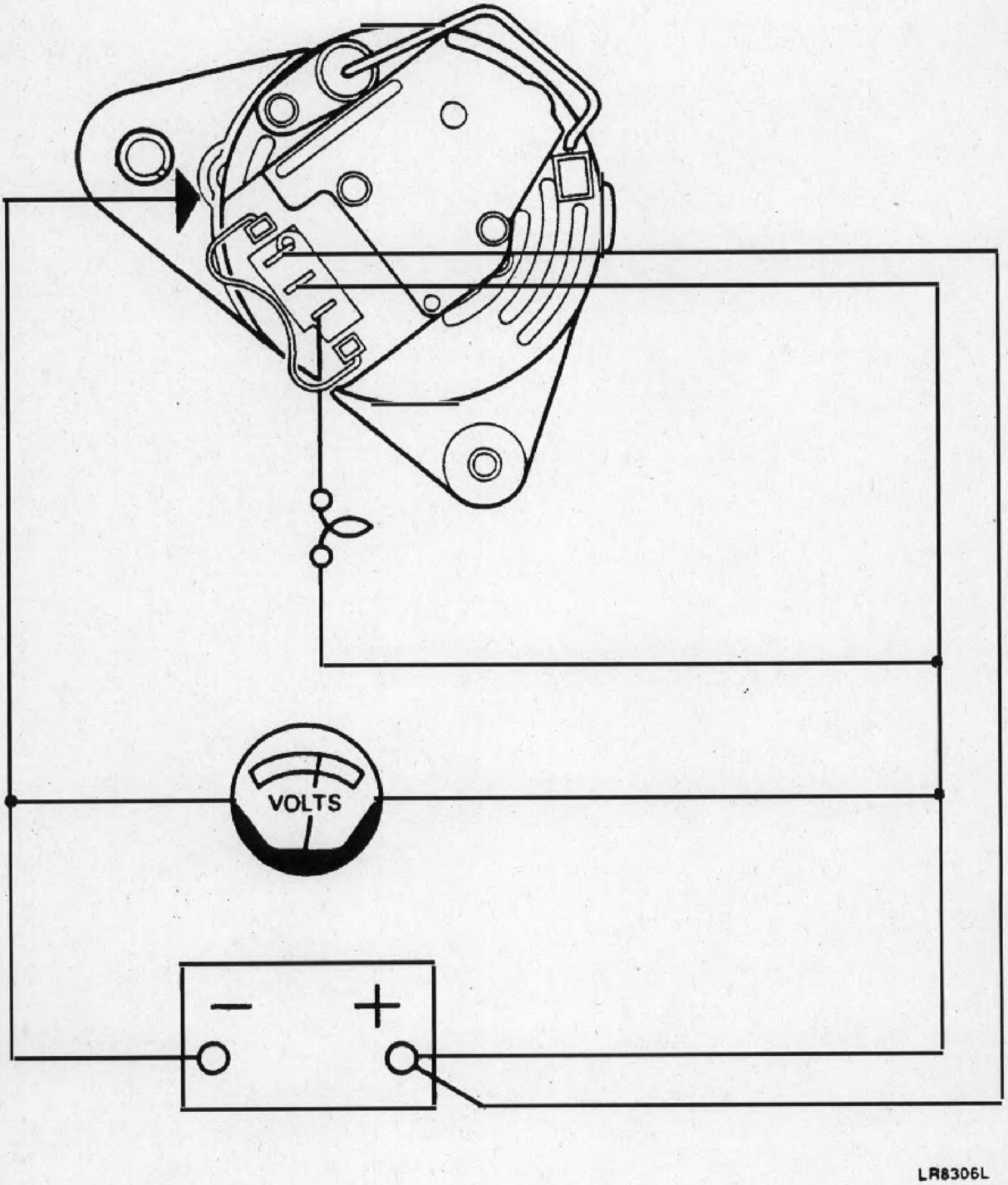
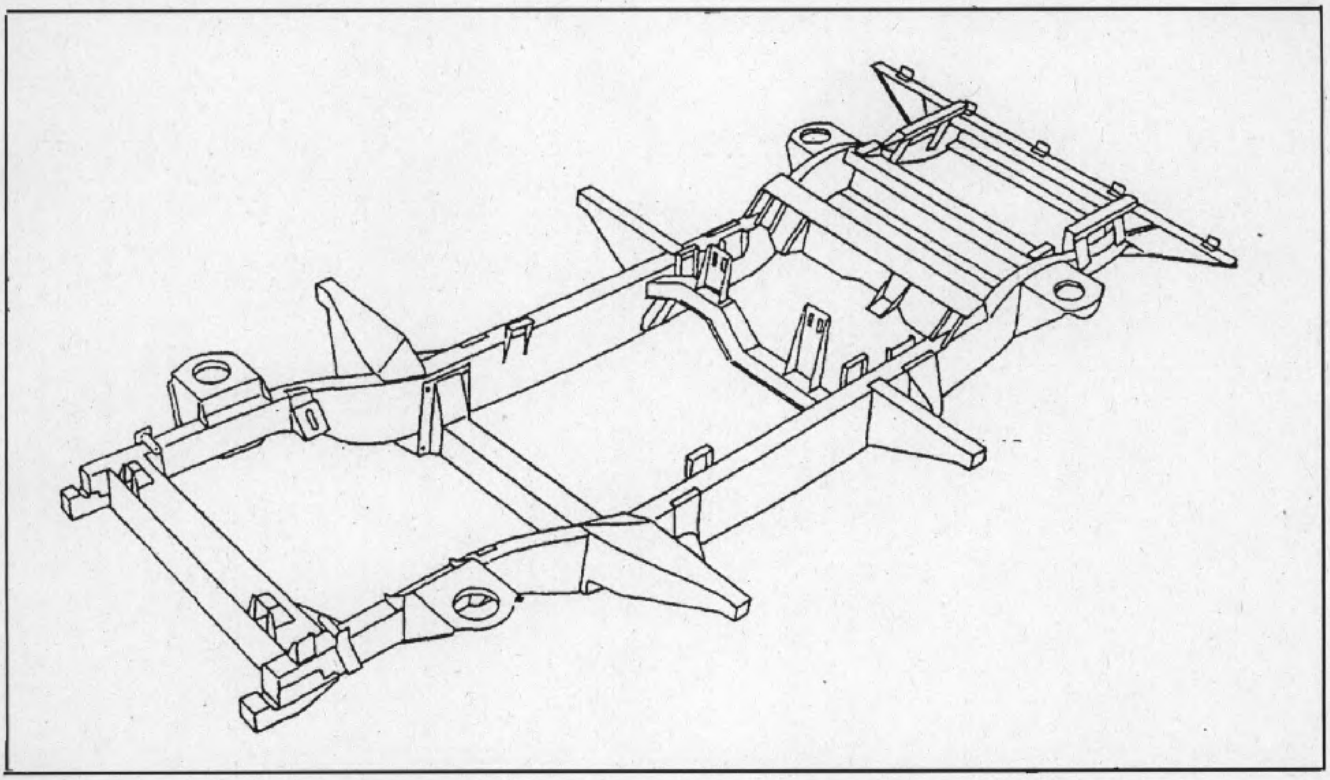


Fig 7 Control regulator test circuit

LAND ROVER DEFENDER



CHASSIS REPAIR

Publication No. **LZA.CR.EN01**

CONTENTS

INTRODUCTION

73 CHASSIS REPAIR OPERATIONS

INTRODUCTION

RESEARCH VEHICLE

The schedule times shown on the following pages were obtained under Thatcham workshop conditions using methods developed in conjunction with Land Rover.

The manual has been based on methods and times derived from a basic 110 specification Defender. Variations from this basic specification may require the adjustment of time values.

TOOLS AND EQUIPMENT

The tools and equipment used are those readily available to the accident repair trade. The following table, whilst not exclusive, details those tools used at Thatcham:

Equipment	*Make/Model*
Pneumatic Saw	Cengar JP901
Airdrill	CP Tools CP788
Bonded Wire Brush	Muleskinner
Orbital Sander	Desoutter M367
MIG Welder	*Various*

METHODS AND TECHNIQUES

The methods and techniques employed in this manual are based on those developed by Thatcham over many years of practical experience, modified in conjunction with Land Rover for application to repairs on the Defender chassis.

Chassis: A welded chassis frame replacement method is shown and detailed in the individual chassis replacement notes in **73 - Chassis Repair Operations** section **pages 1 to 26**. Where appropriate, details of bolted components have also been included.

M.E.T. & Body: The Operation Times include an allowance for the removal and replacement of M.E.T. items and body components necessary to gain repair access to the chassis frame. These times allow for the removal and replacement of assemblies such as headlamps and suspension units, but do not allow for necessary assembly, overhaul or repair of component parts which may be involved. All items removed and replaced are tested and adjusted to ensure correct function.

Wiring Loom: Certain repair operations necessitate the partial withdrawal of the wiring loom to avoid the risk of burning using a draw cord which must be left in position to facilitate subsequent replacement. In such operations the loom must be withdrawn from the front to the rear of the vehicle with the exception of Operations **No. 73.15.04** and **73.15.05** (the Number 7 Crossmember), where the loom is withdrawn from rear to front.

Fuel Tank: Removal and replacement of the fuel tank has also been included in the M.E.T. times where its removal is necessary to carry out chassis repairs.

In addition a separate time for the fuel tank is shown to allow for cases where it is desirable to treat it in isolation for safety purposes.

Where it is necessary to remove the fuel tank an allowance has been made in the Operation Times for draining and refilling with 2 gallons of fuel.

Steering Alignment: In those chassis repair operations where it is necessary to carry out a steering alignment check, the Operation Time includes a time for setting up the relevant equipment on the vehicle and conducting a data check only. The time does not include carrying out adjustments. A computerised alignment system was used for this purpose on the reaearch vehicle.

M.E.T. and body allowances relate only to the work carried out on a basic specification 110 Defender and may need to be adjusted where a different model version is undergoing repair.

Paint: The Operation Times include an allowance for refinishing of the chassis in a two-pack synthetic paint system *(see **Paint Refinishing** table overleaf for further details)*. The use of alternative paint systems may require adjustment to published times.

Corrosion Protection: Published Operation Times include an allowance for the internal wax treatment of welded areas in order to enhance corrosion resistance.

cont'd....

COMBINATION TIMES

Where an Operation Time is required for a job incorporating two or more of the published single Operation Times, a guide time can be established by adding single Operation Times together and making the following adjustments:

M.E.T. & Body: It is not possible to establish Operation Times for the M.E.T. in combinations of repair operations due to the complexity of areas of overlap. Such allowances will need to be estimated using the published information as a guide.

Chassis: Because the chassis repairs in each operation are treated separately no deduction for overlap needs to be made.

Paint: Some elements such as mixing materials, cleaning spray guns etc. are common to a paint operation. It is therefore necessary to deduct **0.7hrs.** for each additional repair used.

Corrosion Protection: A deduction of **0.2hrs.** for each additional repair used should be made for common elements such as setting up and cleaning equipment.

PAINT REFINISHING

Operation
Prepare affected area of chassis for refinishing
Prepare metal conditioner
Apply metal conditioner to bare metal
Wash and dry affected area of chassis
Clean brush
Solvent wipe affected area of chassis
Apply masking tape and protective covering sheets
Move vehicle into booth
Fit wheel covers as required
Solvent wipe paint area
Prepare primer
Apply 1 primer coat using spraygun
Clean spraygun
Prepare undercoat
Spray on undercoat
Wash out and clean spraygun
Prepare top coat paint material
Spray on top coat
Wash out and clean spraygun
Remove masking tape and protective covering sheets
Allow paint to cure
Move vehicle out of booth

Refinishing System used: Spies Hecker 2K system comprising Z2852 Metal Conditioner, 3255 Primer, 5040 Undercoat and 257 Series Topcoat.

No. of coats: 5: 1 of Primer plus 2 each of Undercoat and Topcoat.

CORROSION PROTECTION

The following corrosion protection cavity wax materials are approved to **BLS22 CP05** for use in corrosion protection operations after repairs:

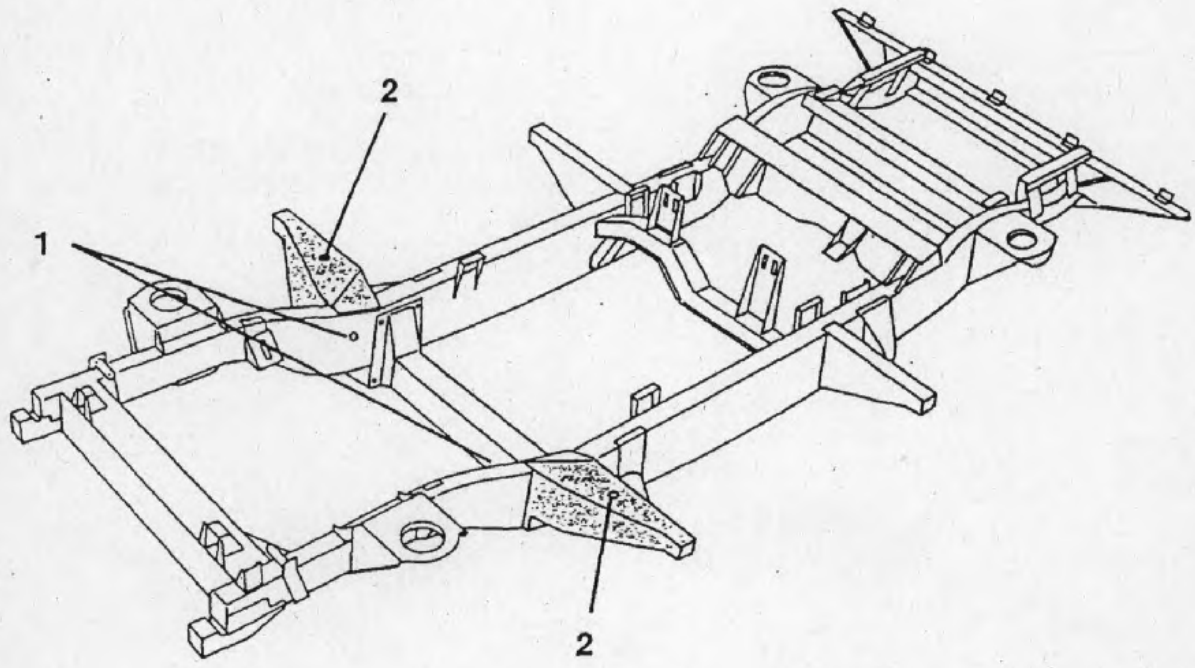
Material	*Part No.*
Astor Chemicals	DA 3079 DA 3397
Croda	PG 176 PW 110
EMS Togo	PP 101
Valvoline-Tectyl	544-PC
Edgar Vaughan	RB 8468

*Corrosion Protection times are included within the time allowances shown on each page of the **Chassis Repair Operations** section of this manual.*

CORROSION PROTECTION MATERIAL - CHASSIS INJECTION POINTS

Fig. 1

Repair Operation No	*Location*
73.10.01	Wiring loom entry point at chassis inner face, directly behind outrigger at **1**. Also through hole in top face of outrigger at **2** above tie bar weld.



***Note:** Injection points shown for both RH and LH sides where applicable.*

CORROSION PROTECTION - CHASSIS INJECTION POINTS (cont'd.)

Fig. 2

Repair Operation No.	*Location*
73.10.02	Hole on outer face of chassis longitudinal immediately ahead of rear outrigger at **3.**

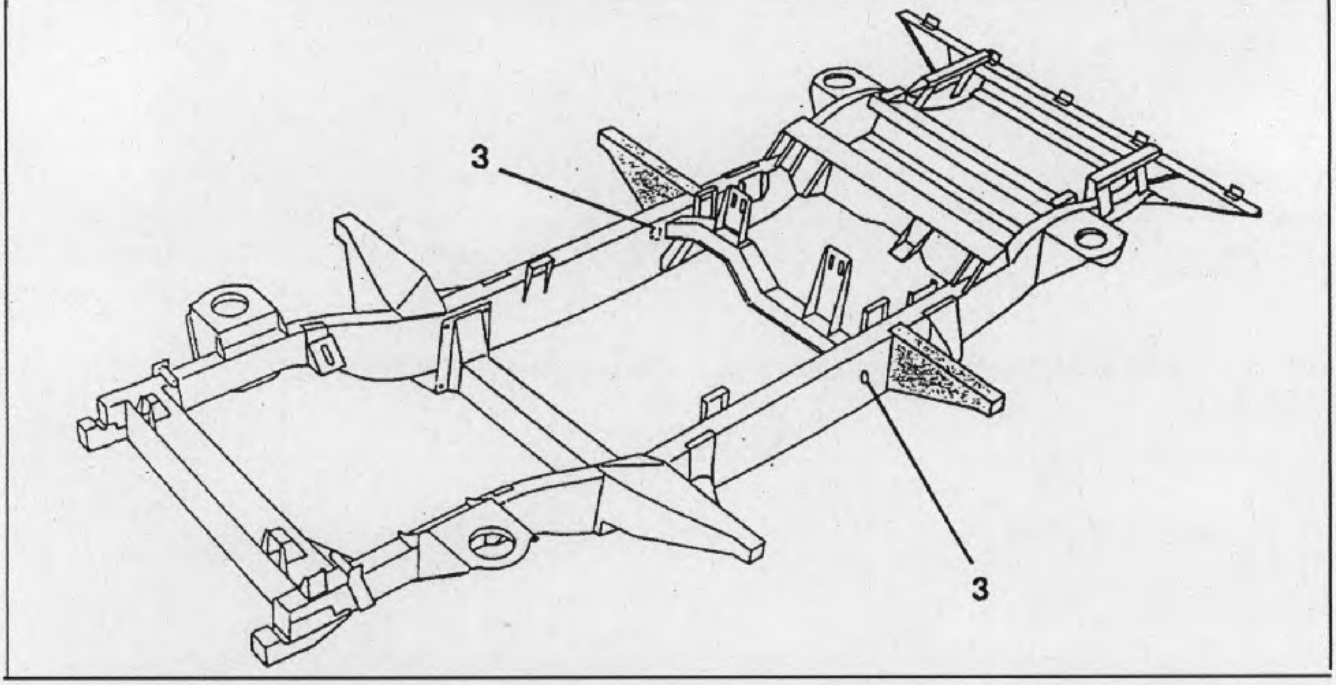


Fig. 3

Repair Operation No.	*Location*
73.15.02	Holes at forwardface of chassis longitudinal at **4**, at corner gusset **7** and rear face of No. 2 cross-member **6.**

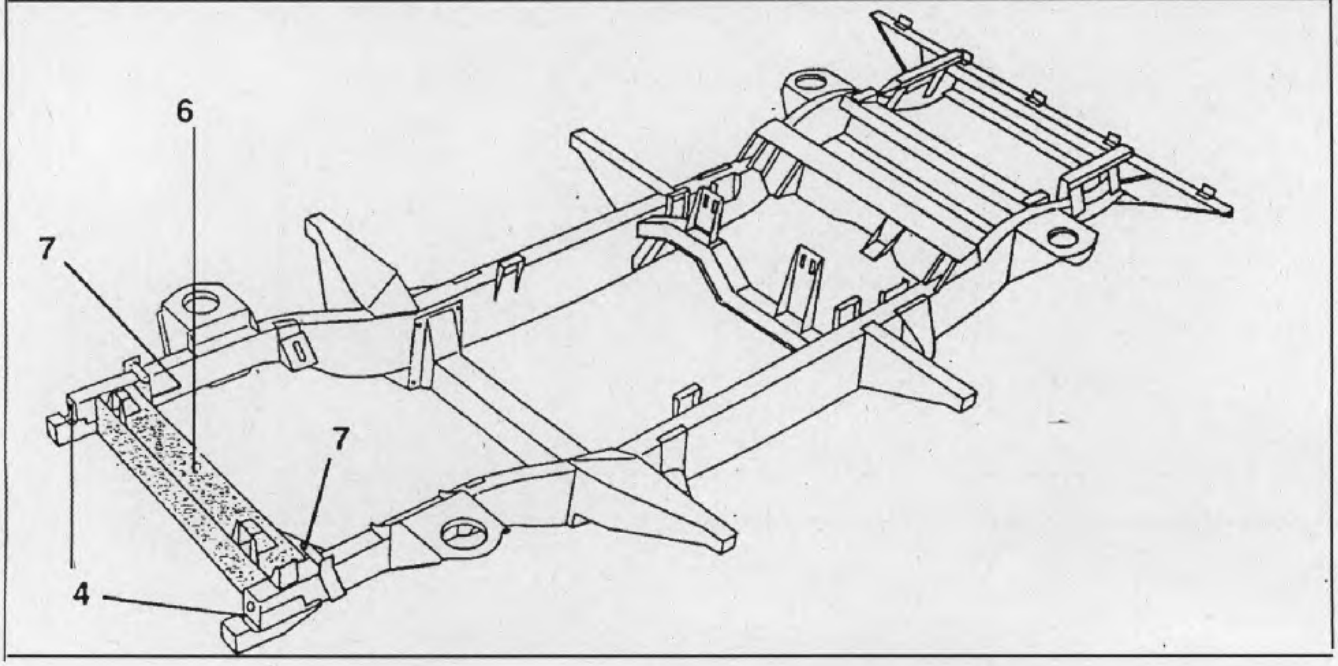


Fig. 4

Repair Operation No.	*Location*
73.15.04 and 73.15.05	Rear wiring loom entry hole at chassis longitudinal 8.

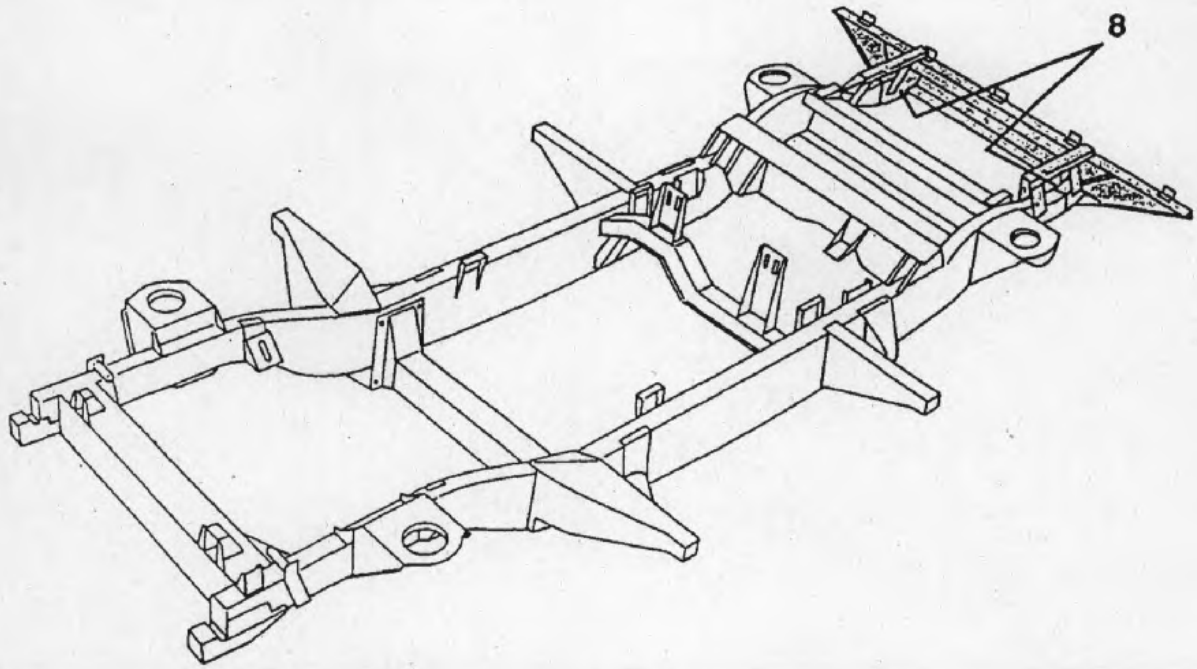
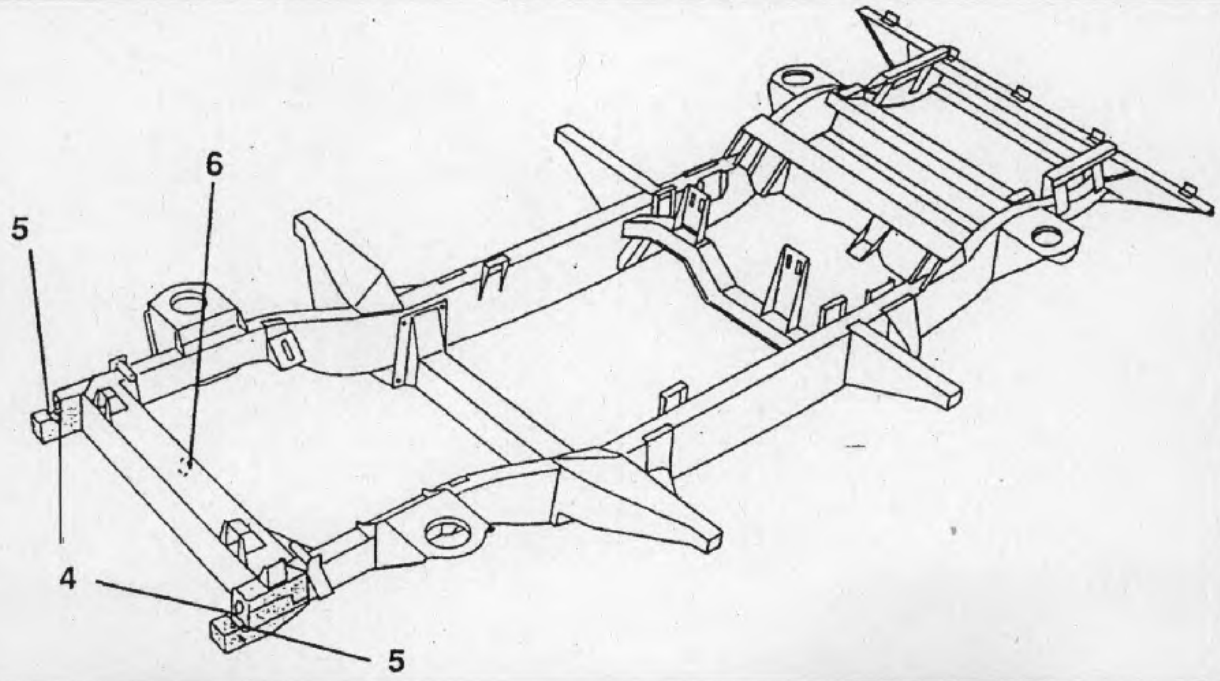


Fig. 5

Repair Operation No.	*Location*
73.20.01	Hole at forward face of chassis longitudinal at 4, slot at upper face 5 and hole at rear face of No. 2 crossmember 6.



CORROSION PROTECTION - CHASSIS INJECTION POINTS (cont'd.)

Fig. 6

Repair Operation No.	*Location*
73.20.02	Hole at forward face of chassis longitudinal at 4 *(using 1 metre metal extension probe).*

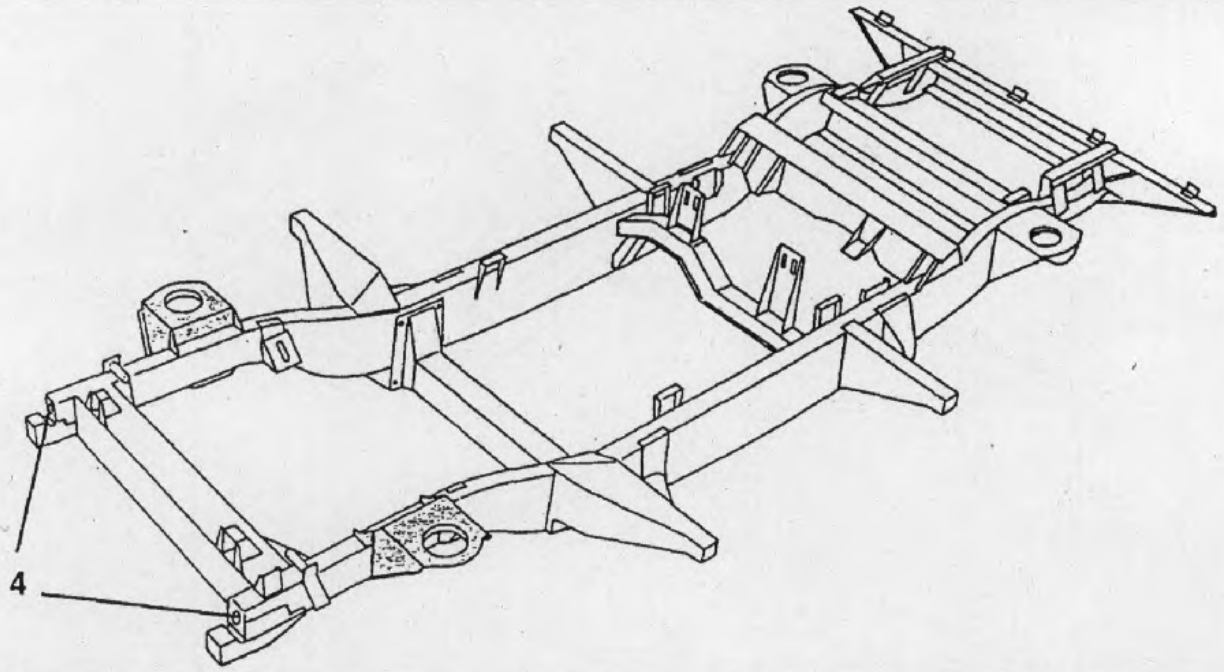


Fig. 7

Repair Operation No.	*Location*
73.20.03	Rear wiring loom entry hole at chassis longitudinal 8.

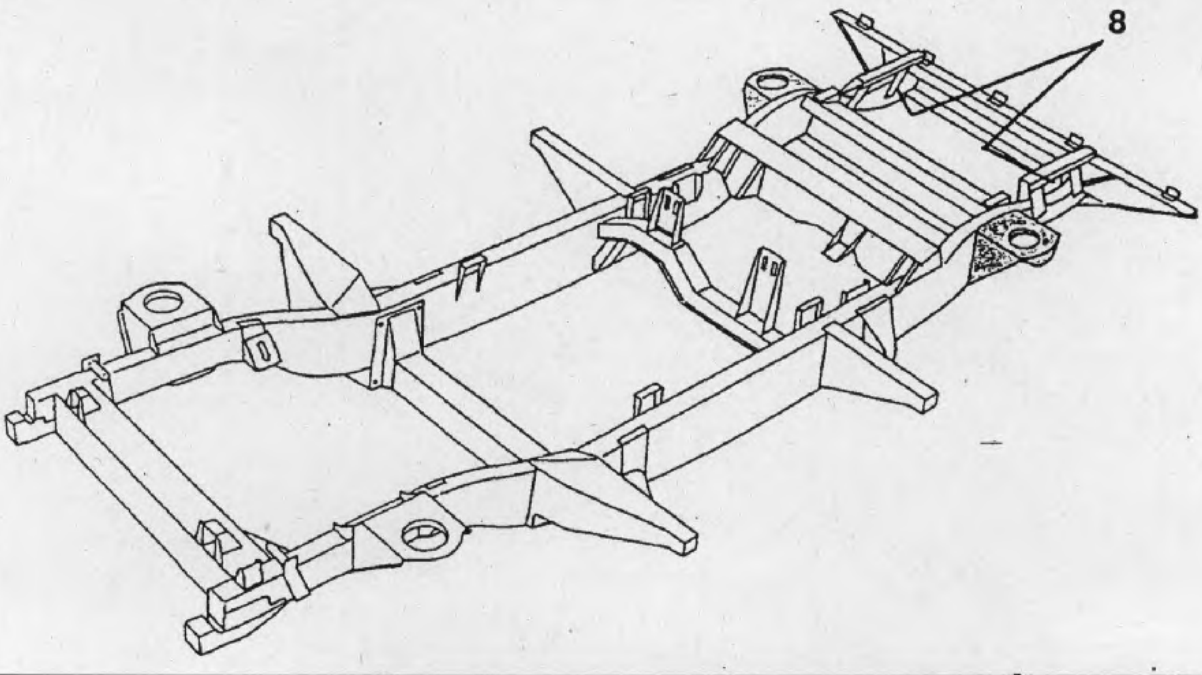


Fig. 8

Repair Operation No.	*Location*
73.20.04	Wiring loom entry point at chassis inner face, directly behind outrigger at **1**. Also through hole in top face of outrigger above tie bar weld at **2**.

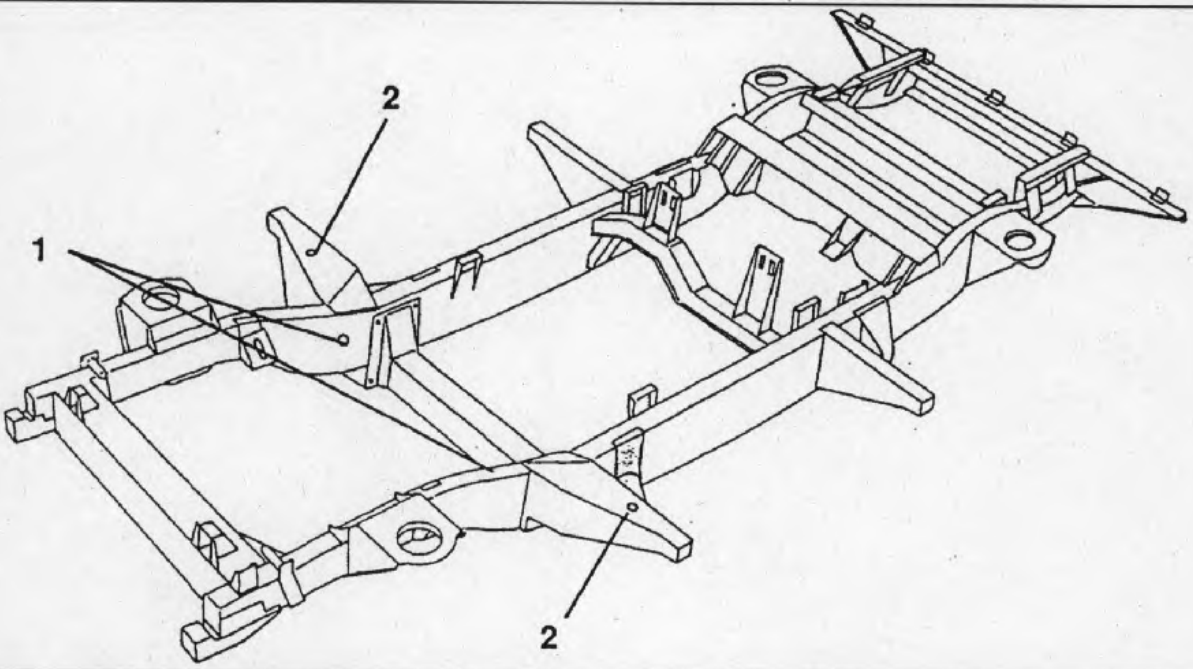


Fig. 9

Repair Operation No.	*Location*
73.20.05	Hole at outer face of chassis longitudinal directly ahead of rear outrigger at **9**.

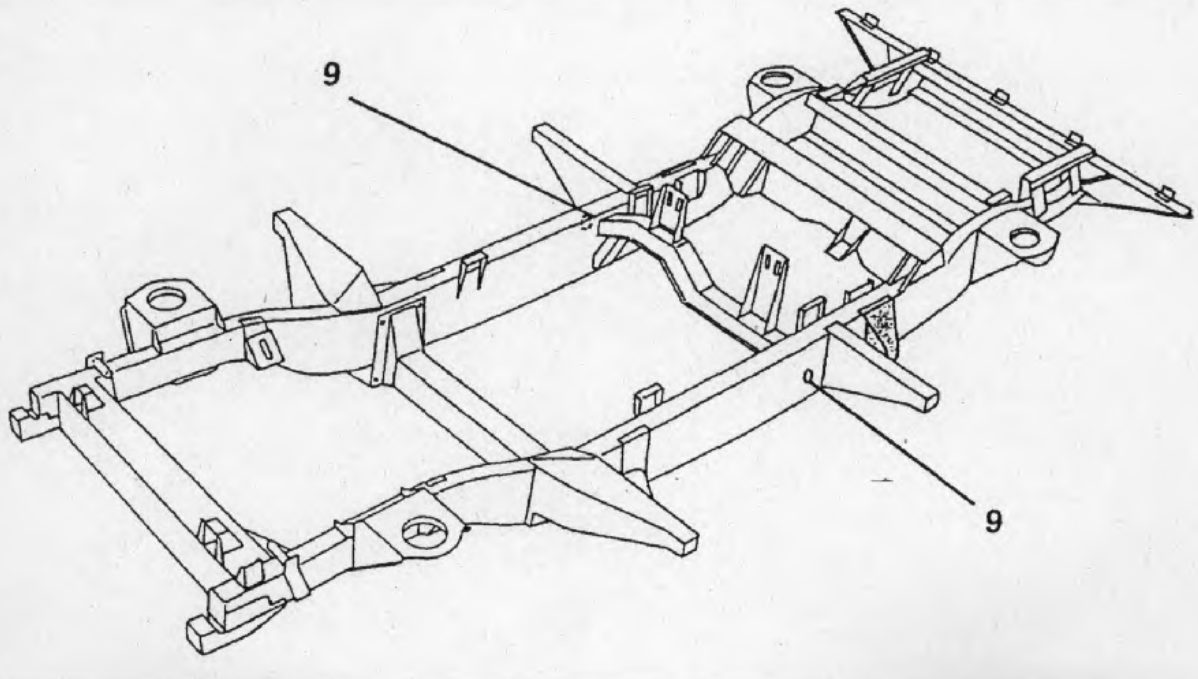


Fig. 10

Repair Operation No.	*Location*
73.20.06	Holes at outer and forward faces of chassis longitudinal **Nos. 4** and **9**, at corner gusset **7** and rear face of No. 2 crossmember **6** *(injected towards appropriate side).*

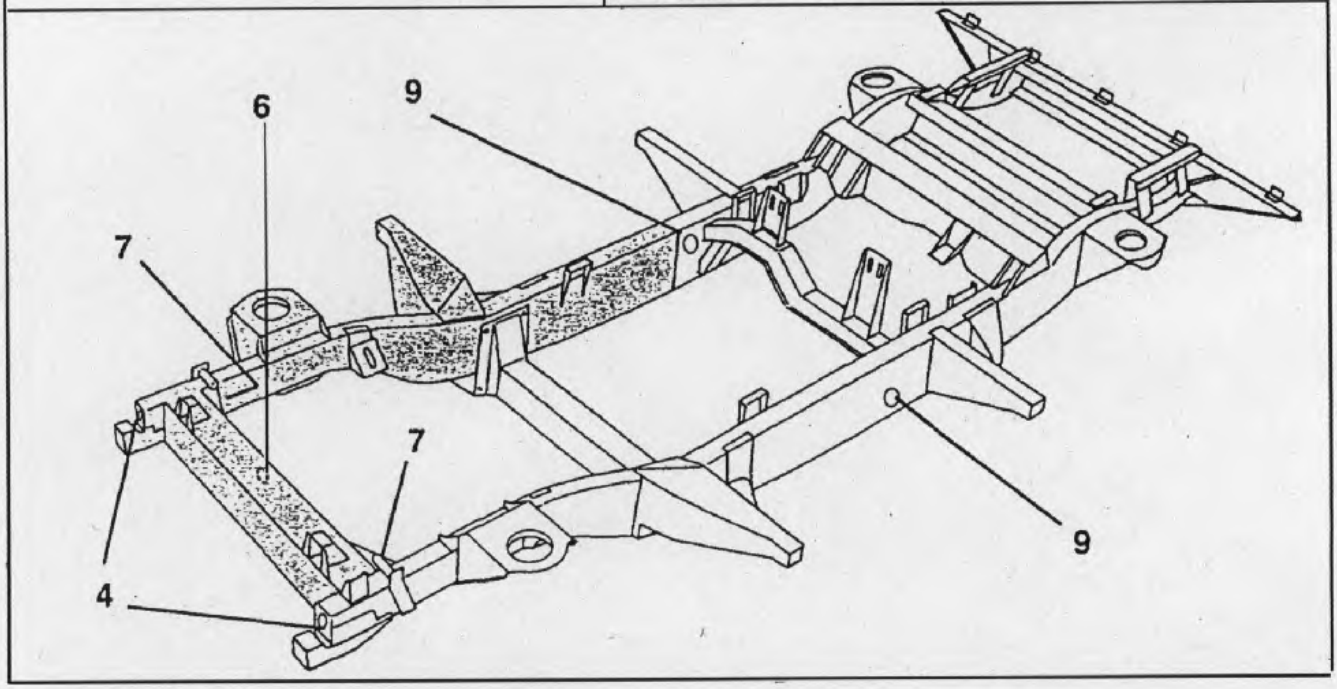
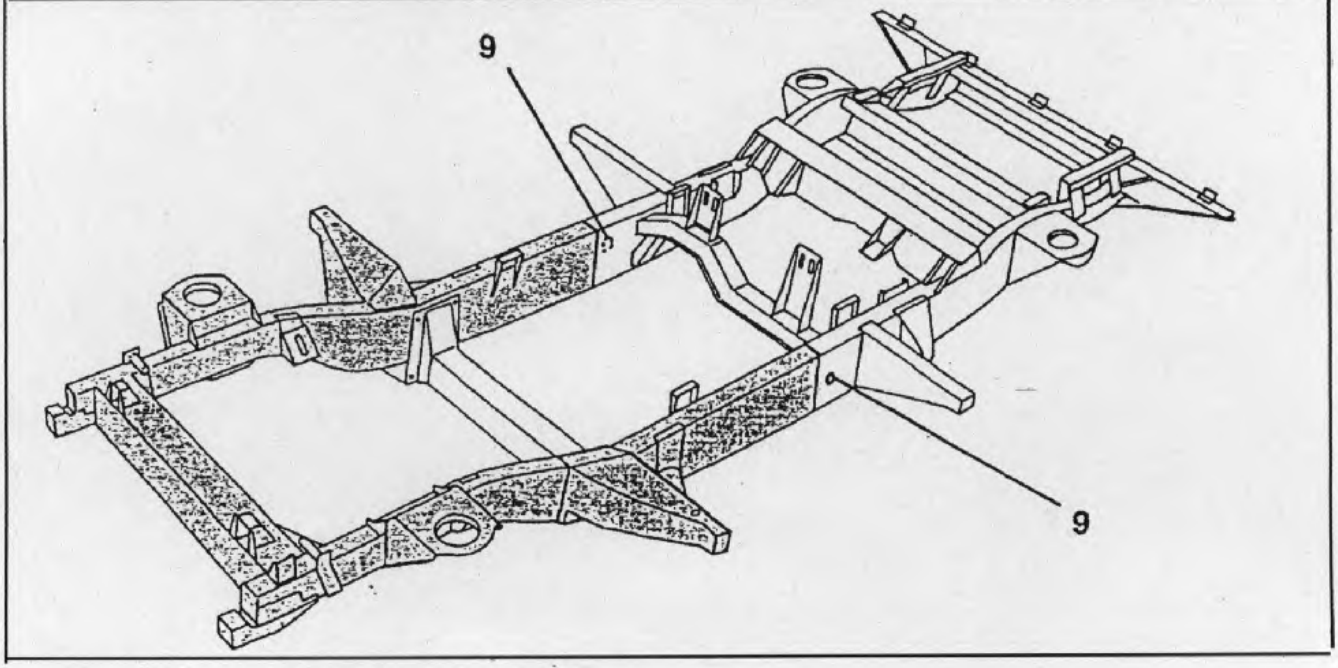


Fig. 10a

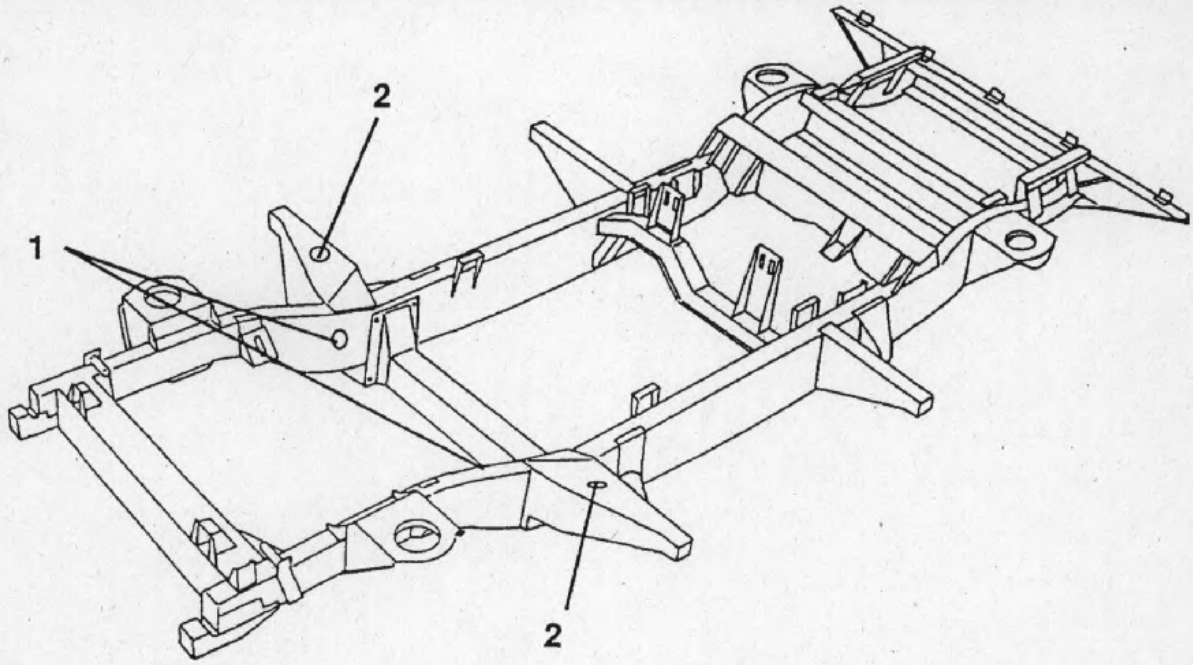
Repair Operation No.	*Location*
73.20.07	Holes at outer and forward faces of chassis longitudinal **No. 9.**



CORROSION PROTECTION - CHASSIS INJECTION POINTS (cont'd.)

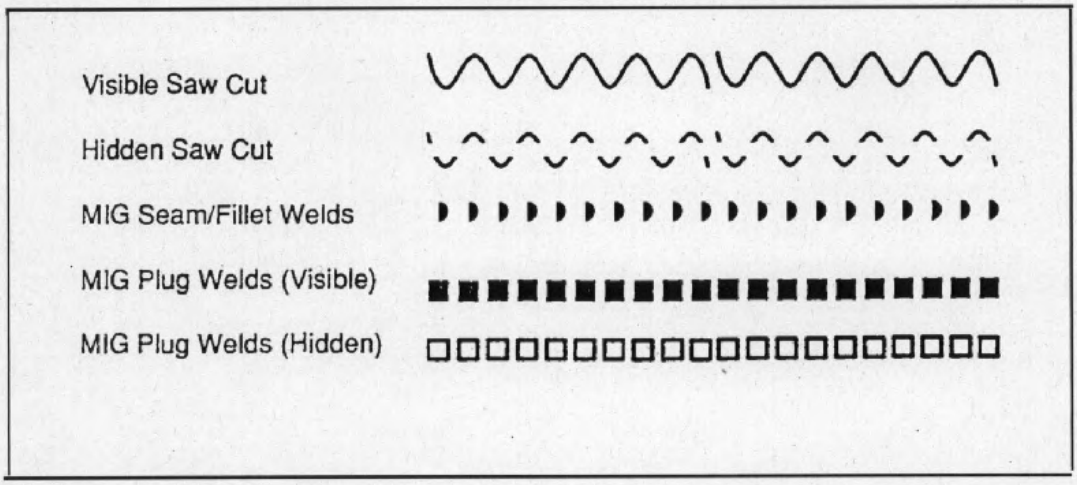
Fig. 11

Repair Operation No.	*Location*
73.20.08	Wiring loom point at chassis inner face, directly behind outrigger at **1**. Also through hole in top face of outrigger above tie bar weld at **2**.



73 CHASSIS REPAIR OPERATIONS

KEY TO DIAGRAM SYMBOLS



OUTRIGGER - FRONT - REPLACEMENT

CHASSIS PART:

REMOVAL

Cut outrigger at points **A** and **B** in **Fig. 12**. Remove outrigger bulk and remove metal remnants from chassis and tie bar. **Take care to avoid thinning the chassis frame in this area when grinding off the remnants.**

Remove upper mounting bolt at No. 3 crossmember as shown at point **C**.

Associated parts to be removed and replaced:
Front Panel.
Front Wing RH and LH.
Cab Unit.

ELECTRICAL:

The wiring loom must be withdrawn for access when replacing a RH outrigger (see **Introduction** section **page 2**).

REPLACEMENT

Offer up new front outrigger, mark chassis weld area locations, remove outrigger and dress new and existing joint areas for welding. Apply red brown anti-corrosion primer to side face of chassis member at original welded areas.

Offer up outrigger, MIG seam weld in position at **Nos. 1** and **2**. Check alignment of bolt mounting holes **X** and re-shape as necessary.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

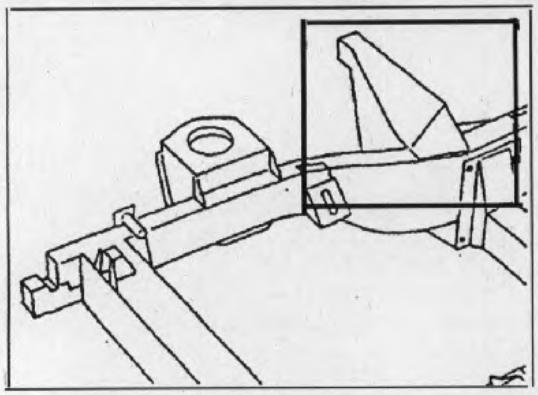
WELDING TABLE

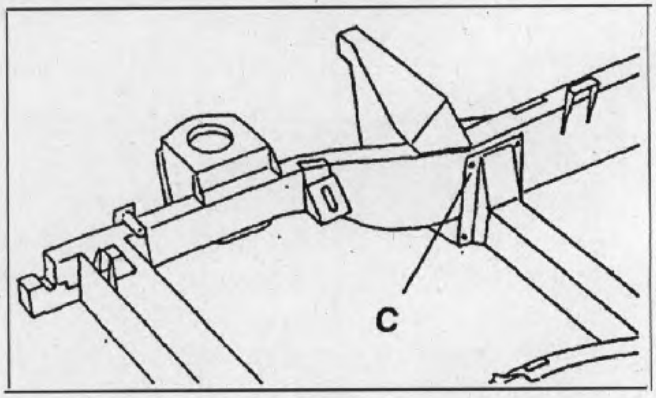
No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member	1 x 770mm MIG seam weld	1 x 970mm MIG seam weld.
2	To tie bar	1 x 330mm MIG seam weld	1 x 330mm MIG seam weld.

Operation No. 73.10.01	*Description* OUTRIGGER - FRONT - REPLACEMENT	*Time* 19.8RH 19.6LH

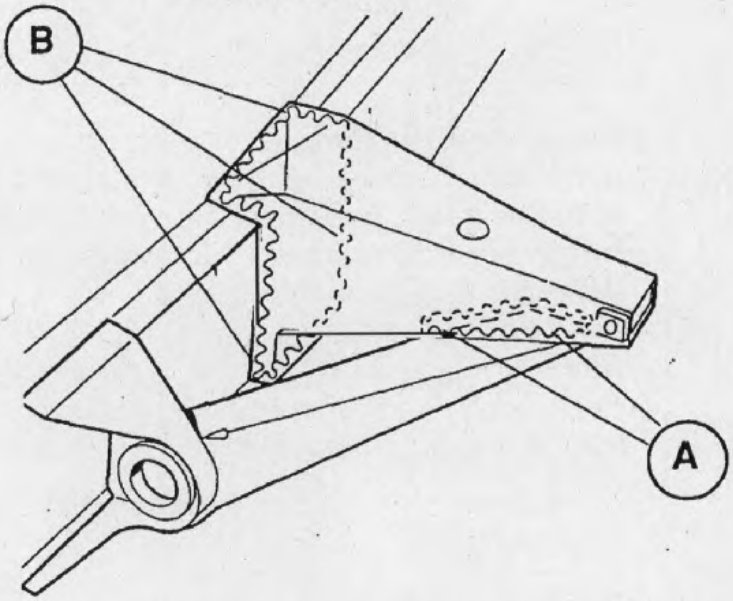
OUTRIGGER - FRONT - REPLACEMENT

Fig. 12

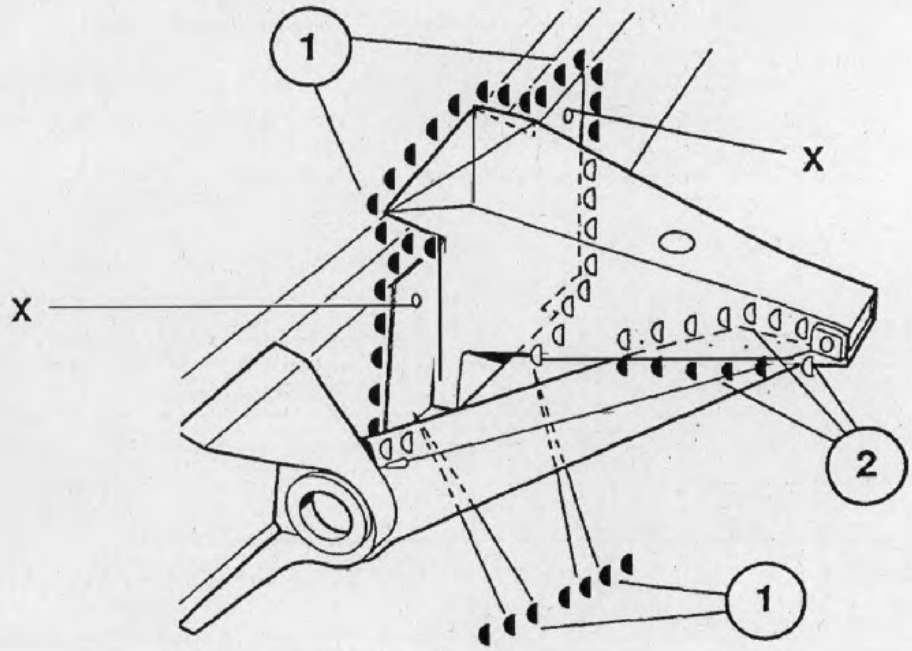




REMOVE PART



REPLACE PART



OUTRIGGER - REAR - REPLACEMENT

CHASSIS PART:

REMOVAL

Cut outrigger at point C in **Fig. 13.** Remove outrigger bulk and remove metal remnants from chassis. **Take care to avoid cutting into the reinforcement at the lower section and reducing the thickness of the chassis frame when grinding off the remnants.**

Associated parts to be removed and replaced:
Note: it is unnecessary to remove any associated panels during this repair operation, although care should be taken to avoid damage to adjacent panelwork.

REPLACEMENT

Offer up new rear outrigger complete with reinforcing plate attached as supplied, mark chassis weld area locations, remove outrigger and dress new and existing joint areas for welding. Apply red brown anti-corrosion primer to side face of chassis member at original welded areas.

Offer up outrigger, MIG seam weld in position at **No. 1.** Dress seam weld.

MECHANICAL, ELECTRICAL & TRIM:

Remove and replace support brackets adjacent to outrigger, lay aside brake pipes/ hoses as necessary. **Note:** when replacing a RH outrigger the wiring loom must be withdrawn for access as described in **Introduction** section **page 1.**

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

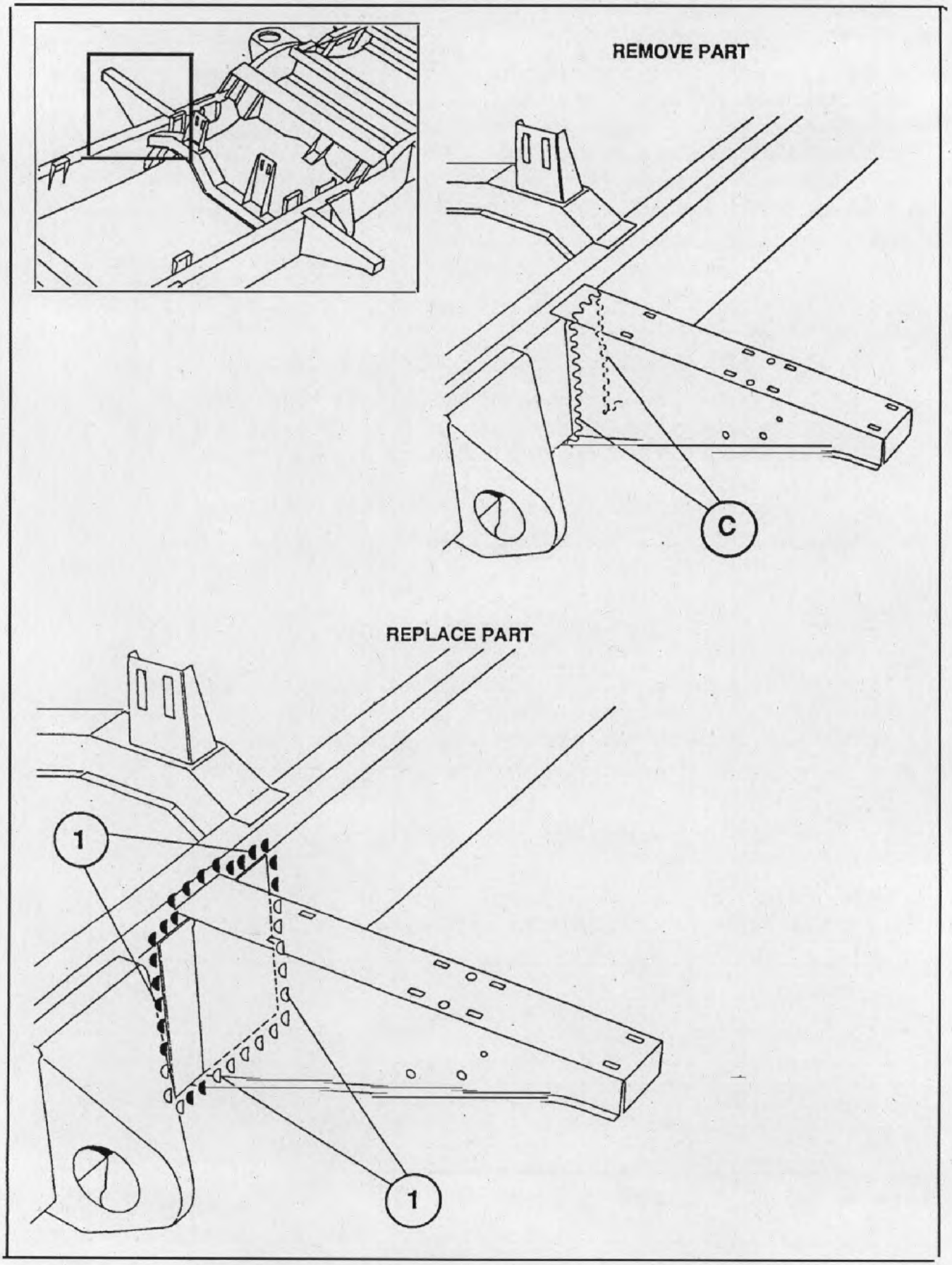
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member	1 x 610mm MIG seam weld	1 x 850mm MIG seam weld.

Operation No. 73.10.02	*Description* OUTRIGGER - REAR - REPLACEMENT	*Time* 6.1RH 5.3LH

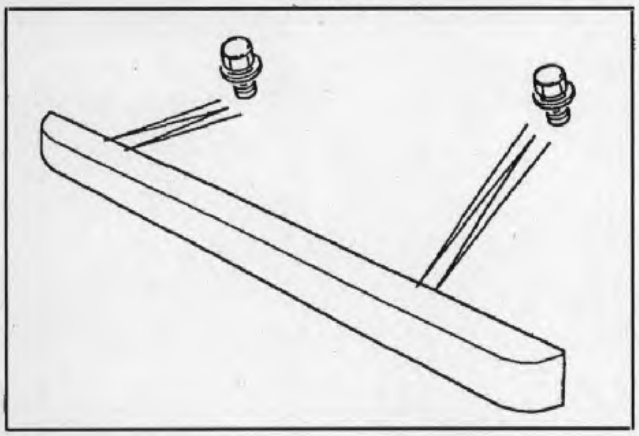
OUTRIGGER - REAR - REPLACEMENT

Fig. 13



NUMBER 1 CROSSMEMBER - REPLACEMENT

Fig. 14



REMOVAL

Remove 2 mounting bolts from bracket at crossmember upper face RH and LH (see **Fig. 14**). Remove crossmember from vehicle.

REPLACEMENT

Transfer number plate to new crossmember, offer up crossmember, replace 2 mounting bolts at bracket RH and LH, check alignment and tighten bolts.

Operation No. 73.15.01	*Description* NUMBER 1 CROSSMEMBER-REPLACEMENT	*Time* 0.6

NUMBER 2 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
No.1 Crossmember (see above), front panel, radiator, steering box, lay aside steering damper.

REMOVAL

Cut crossmember and gussets at points D in **Fig. 15** taking care not to damage the Panhard rod mounting tube at *X*. Note: the outer ends of the crossmember rear face where they are enclosed by the gussets are not welded in production or subsequent replacement due to insufficient access. Remove crossmember bulk and metal remnants.

REPLACEMENT

Offer up new crossmember assembly, mark chassis weld area locations, remove new section and dress new and existing joint areas for welding. Offer up crossmember assembly, clamp in position and MIG seam weld at No. 1 RH and LH. Dress all seam welds.

MECHANICAL:

Carry out a steering alignment check as necessary observing the points described in **Introduction** section page 2.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section pages 3 to 8).

WELDING TABLE

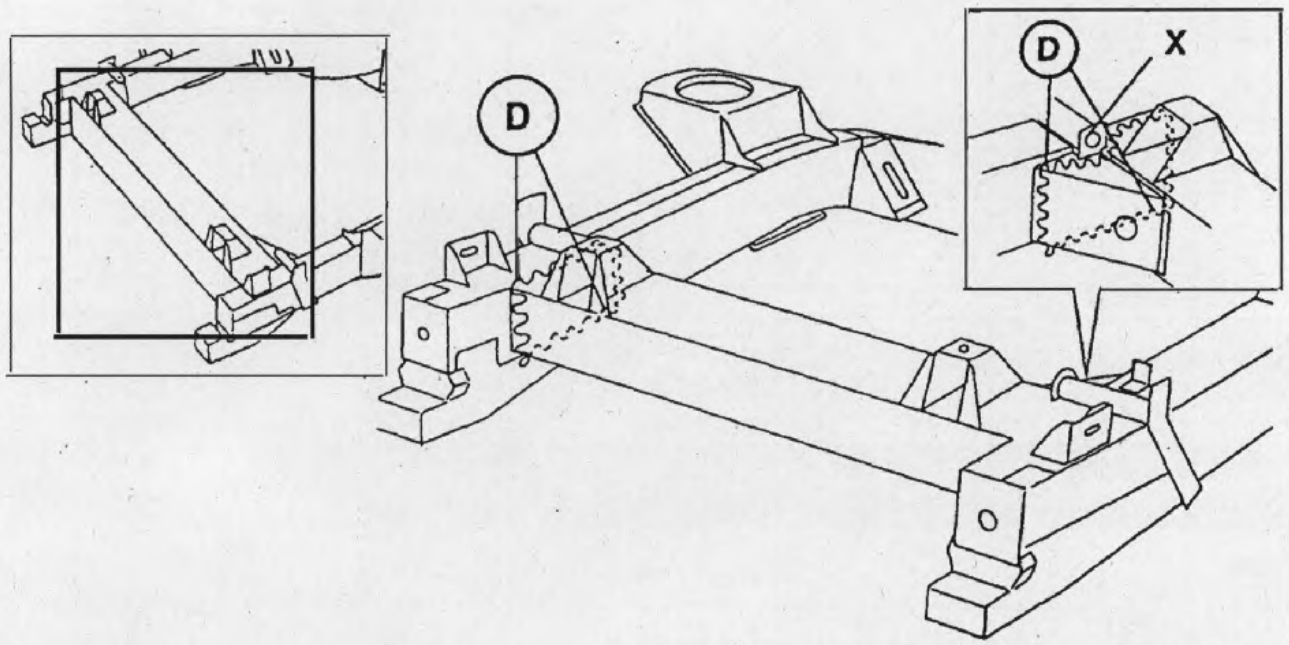
No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member RH and LH	1 x 550mm MIG seam weld each side	1 x 550mm MIG seam weld each side.

Operation No. 73.15.02	*Description* NUMBER 2 CROSSMEMBER-REPLACEMENT	*Time* 9.5

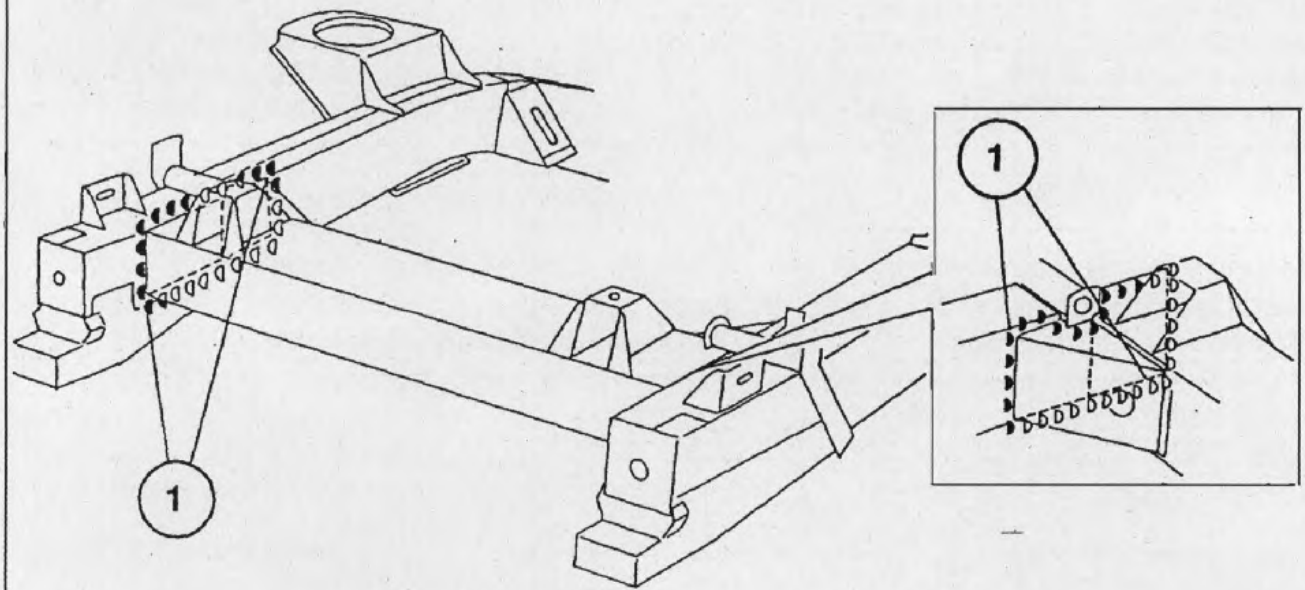
NUMBER 2 CROSSMEMBER - REPLACEMENT

Fig. 15

REMOVE PART



REPLACE PART



NUMBER 3 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

REMOVAL

Raise vehicle on lift, remove 4 mounting bolts and nuts to chassis member RH and LH as shown in **Fig. 16**, dislodge crossmember using a copper-faced mallet or similar (see note below), remove crossmember from chassis.

REPLACEMENT

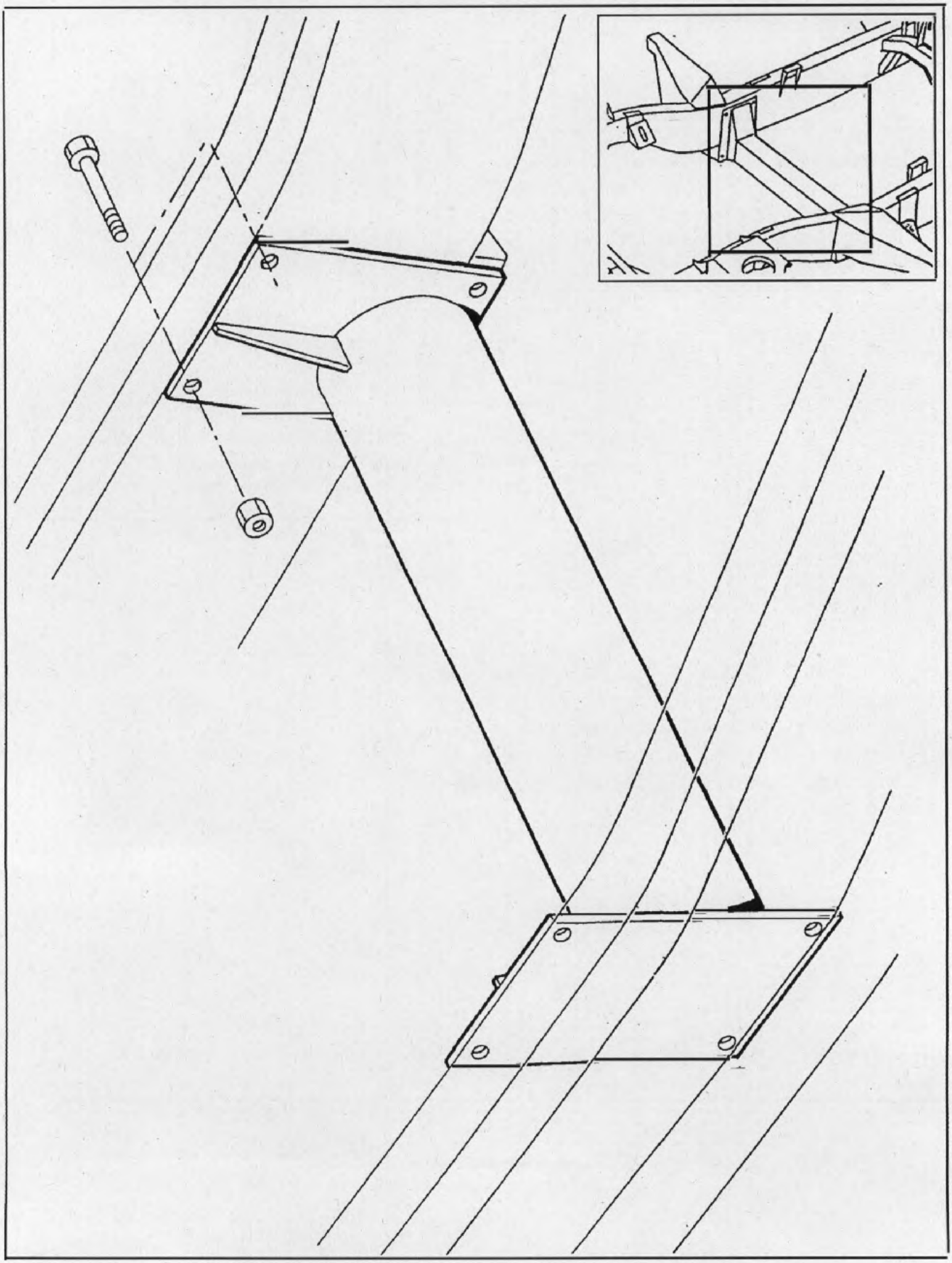
Offer up new crossmember (see note below), replace 4 mounting bolts and nuts to chassis member RH and LH, check alignment and tighten all fasteners, lower vehicle.

Note: should difficulty be experienced in removing and offering up the crossmember it may be necessary to use a suitable power-operated chassis spreader to relieve the strains. The Replacement Time Schedules in this Manual do not allow for this operation.

Operation No. 73.15.03	***Description*** NUMBER 3 CROSSMEMBER-REPLACEMENT	***Time*** 1.1

NUMBER 3 CROSSMEMBER - REPLACEMENT

Fig. 16



NUMBER 7 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Rear body section, fuel tank, withdraw wiring loom sufficient for access.

REMOVAL

Measure and mark cutting locations on chassis members approximately 360mm ahead of the rear ends. This is in order to leave at least 10mm surplus on existing chassis members. Cut chassis members at points E in Fig. 17, also body mountings at F (see inset).

Remove crossmember bulk leaving alignment jig brackets undisturbed until new crossmember assembly is to be fitted. Remove metal remnants at body support brackets (where applicable).

REPLACEMENT

Transfer fuel tank rear mounting bolts to new crossmember assembly, offer up new assembly, measure and mark cutting locations on chassis legs, trim surplus metal from chassis legs to obtain exact alignment. Ensure jig brackets are locked in position, clean butt joint faces, clamp parts in place, MIG seam weld at Nos. 1 and 2.

Dress seam welds. Apply red brown anti-corrosion primer to butt joint faces. Remove alignment jig brackets. Offer up new upper and lower reinforcement plates to chassis leg joints ensuring that the towing eye mounting holes *X* and *Y* are correctly aligned with the corresponding holes on the chassis legs as shown.

Remove reinforcement plates, prepare old and new joint surfaces plates and chassis members for welding. Seam weld upper reinforcement plates at No. 3, then lower plates into place at No. 4. Also seam/plug weld holes at side faces of upper plates at No. 4. The mounting holes at *X* and *Y* must be left in an unwelded condition.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see Introduction section pages 3 to 8).

ELECTRICAL:

The wiring loom must be withdrawn on the RH side for access as described in Introduction section page 1.

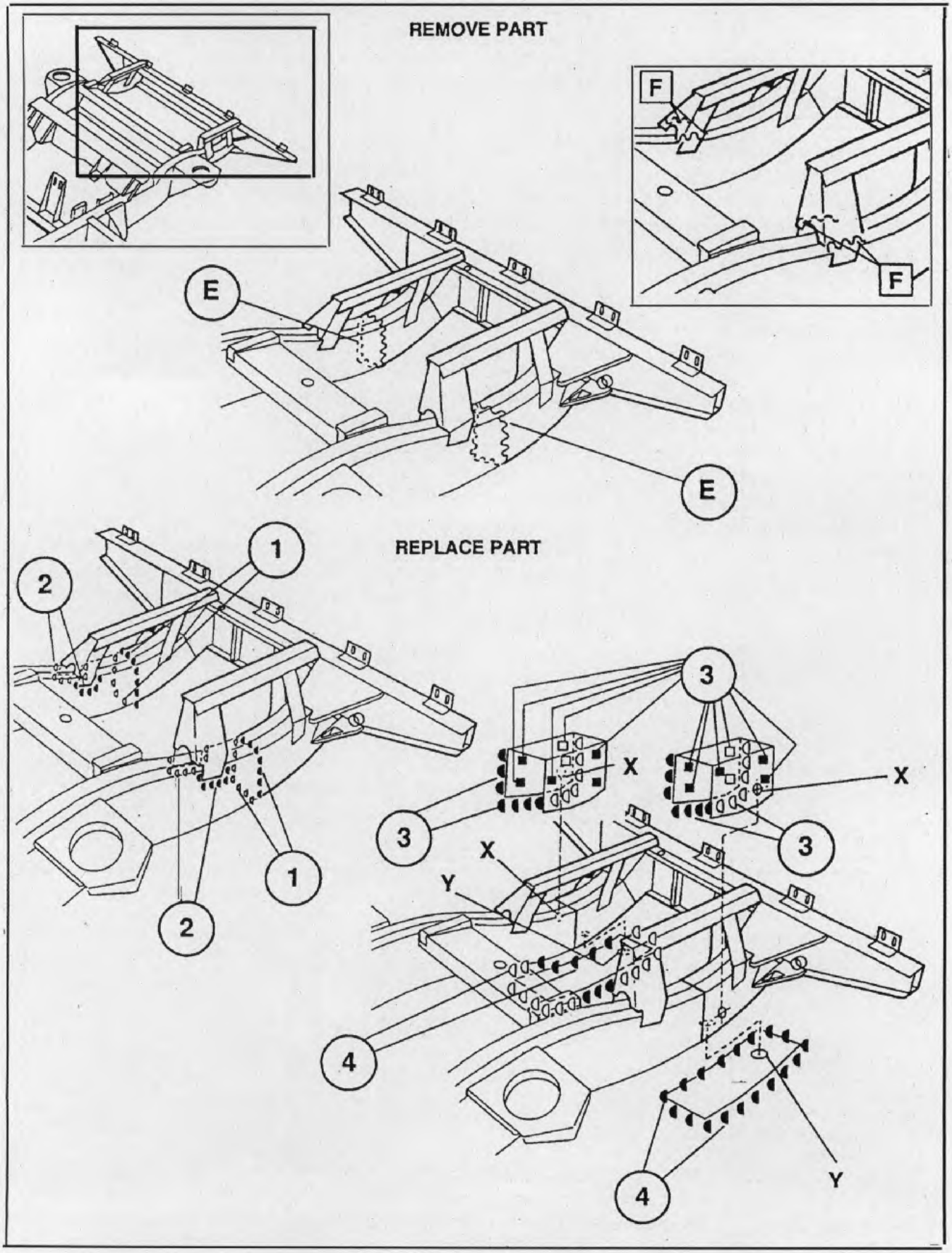
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis member RH and LH		1 x 400mm MIG seam weld each side.
2	Body support bracket to chassis member RH and LH	2 x 90mm MIG seam welds	2 x 90mm MIG seam welds.
3	Upper reinforcement plate to chassis member RH and LH		1 x 980mm MIG seam weld each side. 6 MIG plug/seam welds each side.
4	Lower reinforcement plate to chassis member RH and LH		1 x 540mm MIG seam weld each side.

Operation No. 73.15.04	*Description* NUMBER 7 CROSSMEMBER- REPLACEMENT *(Defender 110" only)*	*Time* 22.9

NUMBER 7 CROSSMEMBER - REPLACEMENT

Fig. 17



FRONT SECTION AHEAD OF NO.2 CROSSMEMBER - REPLACEMENT

CHASSIS PART:

REMOVAL

Mark section to be removed and ensure marks align with new section as supplied. Ensure old section is aligned in body jig, cut body mounting bracket at point **G** in **Fig. 18** and chassis member at **H** in that order with the vertical cuts made directly in line with the forward face of the No. 2 crossmember. Remove chassis section bulk and metal remnants.

Associated parts to be removed and replaced:
No. 1 Crossmember (see page 5), front panel, front wing.

REPLACEMENT

Offer up new chassis section, mark chassis weld area locations, remove new section and dress new and existing joint areas for welding. Offer up chassis section and modify by forming a slot at the inner edge **25mm** long to enable the overlapped areas to be separated slightly and offered up over the existing chassis section (see inset **X**). Dress chassis lower face to facilitate offering up in this area. Offer up new chassis section and MIG seam weld in position at **Nos. 1, 2 and 3** in that order. Dress all seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

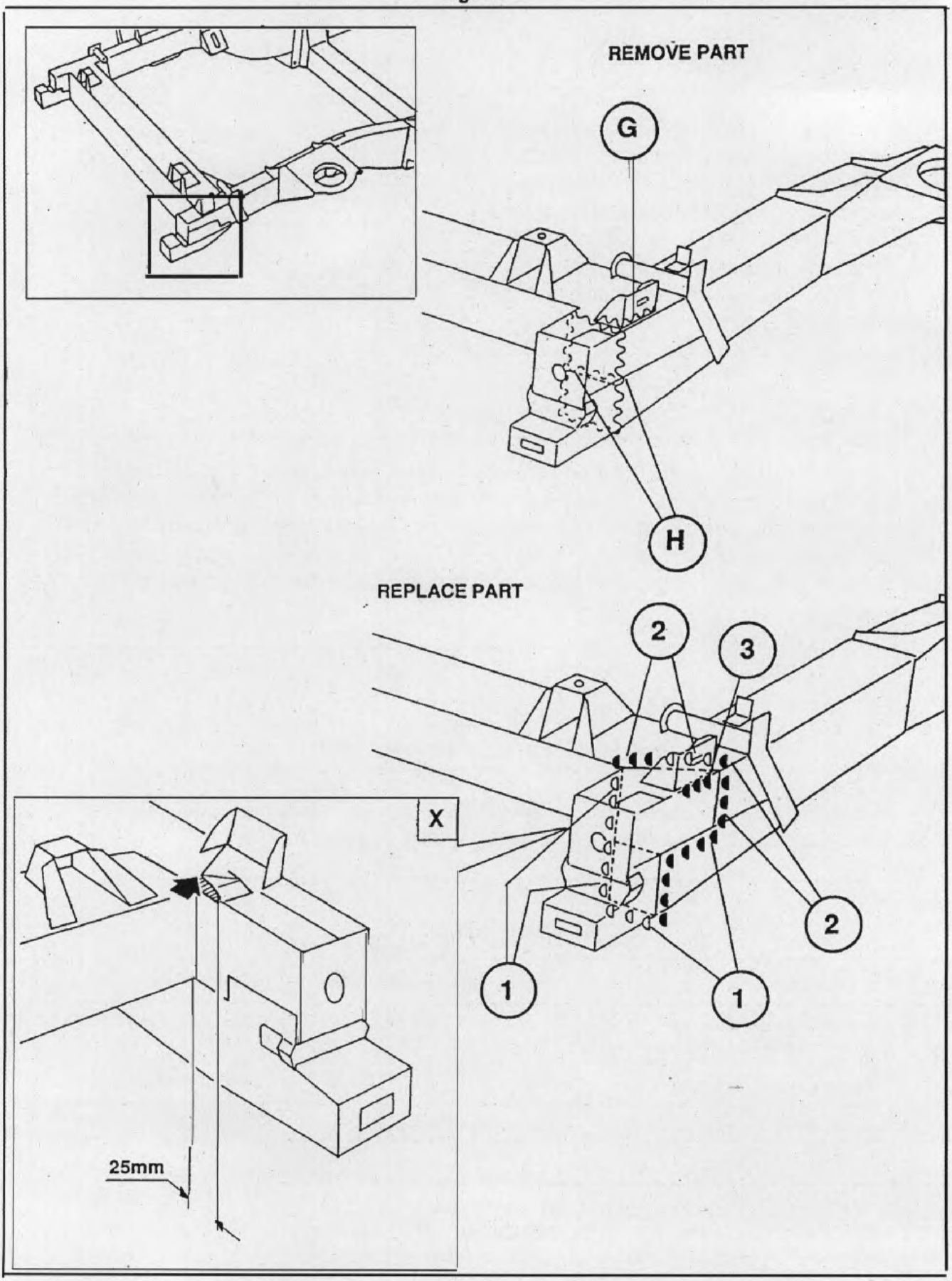
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis and cross-member at lower and inner faces		1 x 280mm MIG seam weld.
2	To existing chassis at lap joints		1 x 380mm MIG seam weld.
3	Body mounting bracket to chassis	1 x 160mm MIG seam weld	1 x 120mm MIG seam weld.

Operation No. 73.20.01	*Description* FRONT SECTION AHEAD OF NO. 2 CROSSMEMBER - REPLACEMENT	*Time* 8.7RH 8.0LH

FRONT SECTION AHEAD OF NO.2 CROSSMEMBER - REPLACEMENT

Fig. 18



FRONT SPRING SEAT - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Front wing, front suspension.

REMOVAL

Cut spring seat at point J in Fig. 19, remove bulk and metal remnants at upper support brackets.

REPLACEMENT

Dress weld areas. Offer up new spring seat to chassis member and support brackets, MIG seam weld at points 1, 2 and 3. Offer up lower reinforcement plates as shown at inset X and MIG seam weld into position at Nos. 4 and 5.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

MECHANICAL:

Carry out a general steering alignment check as necessary observing the points described in **Introduction** section **page 1**.

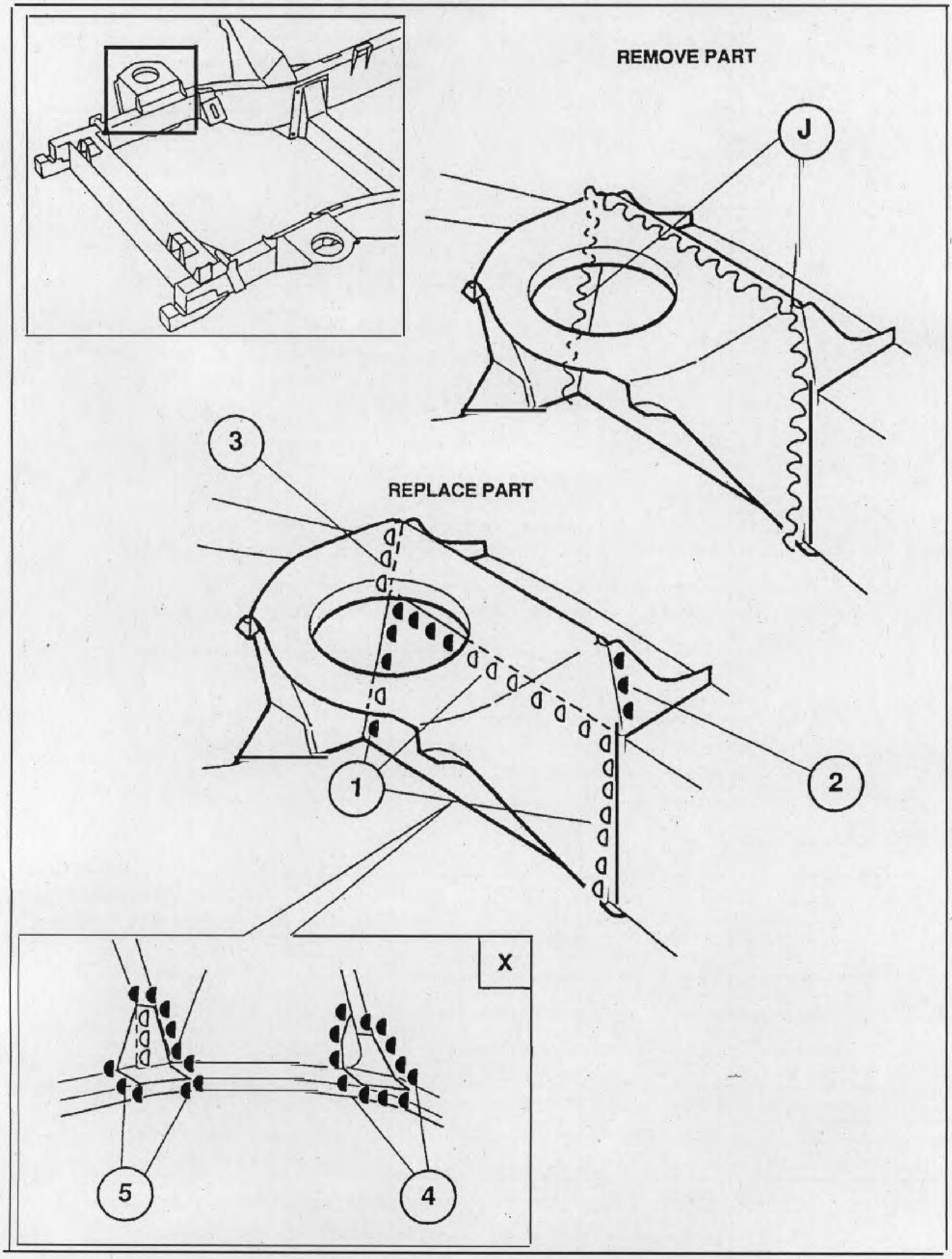
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member	1 x 490mm MIG seam weld	1 x 490mm MIG seam weld.
2	To front upper support bracket	1 x 50mm MIG seam weld	1 x 50mm MIG seam weld.
3	To rear upper support bracket	1 x 50mm MIG seam weld	1 x 50mm MIG seam weld.
4	Front lower reinforcement plate to spring seat	1 x 260mm MIG seam weld	1 x 260mm MIG seam weld
5	Rear lower reinforcement plate to spring seat	1 x 380mm MIG seam weld	1 x 380mm MIG seam weld.

Operation No. 73.20.02	*Description* FRONT SPRING SEAT - REPLACEMENT	*Time* 13.4RH 13.2LH

FRONT SPRING SEAT - REPLACEMENT

Fig. 19



REAR SPRING SEAT - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Rear body section, rear suspension.

REMOVAL

Cut spring seat at point K in Fig. 20,remove bulk and metal remnants from chassis member. Take care to avoid reducing the thickness of the chassis when grinding off the remnants.

REPLACEMENT

Dress weld areas. Offer up new spring seat to chassis member, check alignment using special location fitting in conjunction with alignment jig(see diagram page 27). MIG seam weld at points 1, 2, 3 and 4. Dress seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see Introduction section pages 3 to 8).

MECHANICAL & ELECTRICAL:

Carry out a rear suspension alignment check as necessary; also when replacing a RH rear spring seat withdraw the wiring loom (see Introduction section page 1).

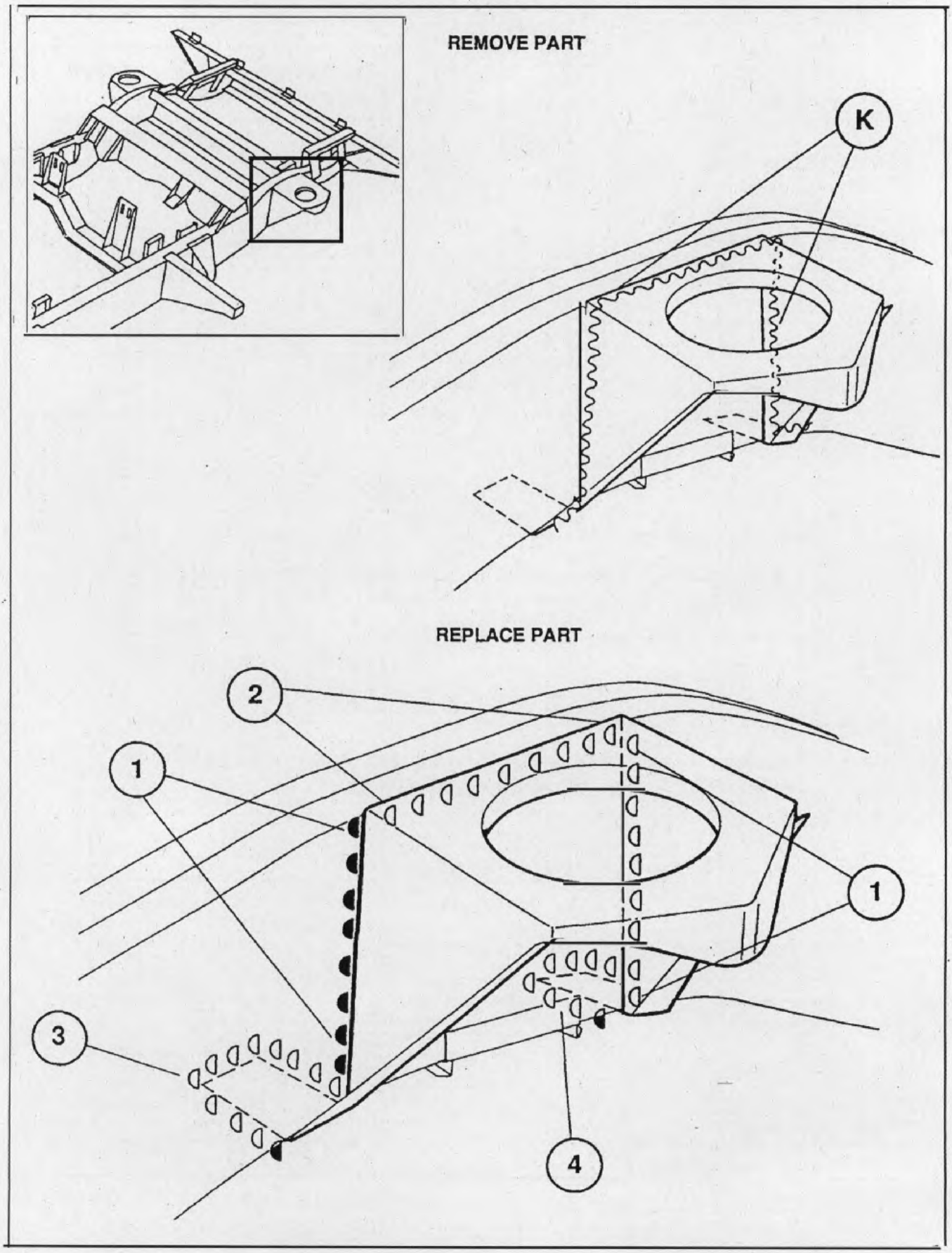
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member at front and rear joints	2 x 140mm MIG seam welds	2 x 140mm MIG seam welds.
2	To chassis member at upper joint	1 x 170mm MIG seam weld	1 x 170mm MIG seam weld.
3	To chassis member lower face at front extension	1 x 140mm MIG seam weld	1 x 140mm MIG seam weld.
4	To chassis memeber lower face at rear extension	1 x 140mm MIG seam weld	1 x 140mm MIG seam weld.

Operation No. 73.20.03	*Description* REAR SPRING SEAT - REPLACEMENT	*Time* 18.1RH 17.4LH

REAR SPRING SEAT - REPLACEMENT

Fig. 20



'C' SPANNER BRACKET - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced: Front suspension link, front floor pan section, lay aside service piping as necessary, remove rear upper mounting bolt from No. 3 crossmember.

REMOVAL

Cut tie-bar at points L and M in Fig. 21, remove bulk, cut 'C' spanner bracket at point N. Remove bulk and and metal remnants from chassis member.

REPLACEMENT

Dress weld areas. Offer up new 'C' spanner bracket, align and clamp in position on chassis member followed by new tie-bar. MIG seam weld at points 1, 2, 3 and 4 making a second row of welds at No. 2 from beneath chassis member. Dress seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction** section **pages 3 to 8**).

MECHANICAL & ELECTRICAL:

Carry out a general steering and front suspension alignment check as necessary; also when replacing a RH 'C' spanner bracket and tie-bar withdraw the wiring loom (see **Introduction** section **page 1**).

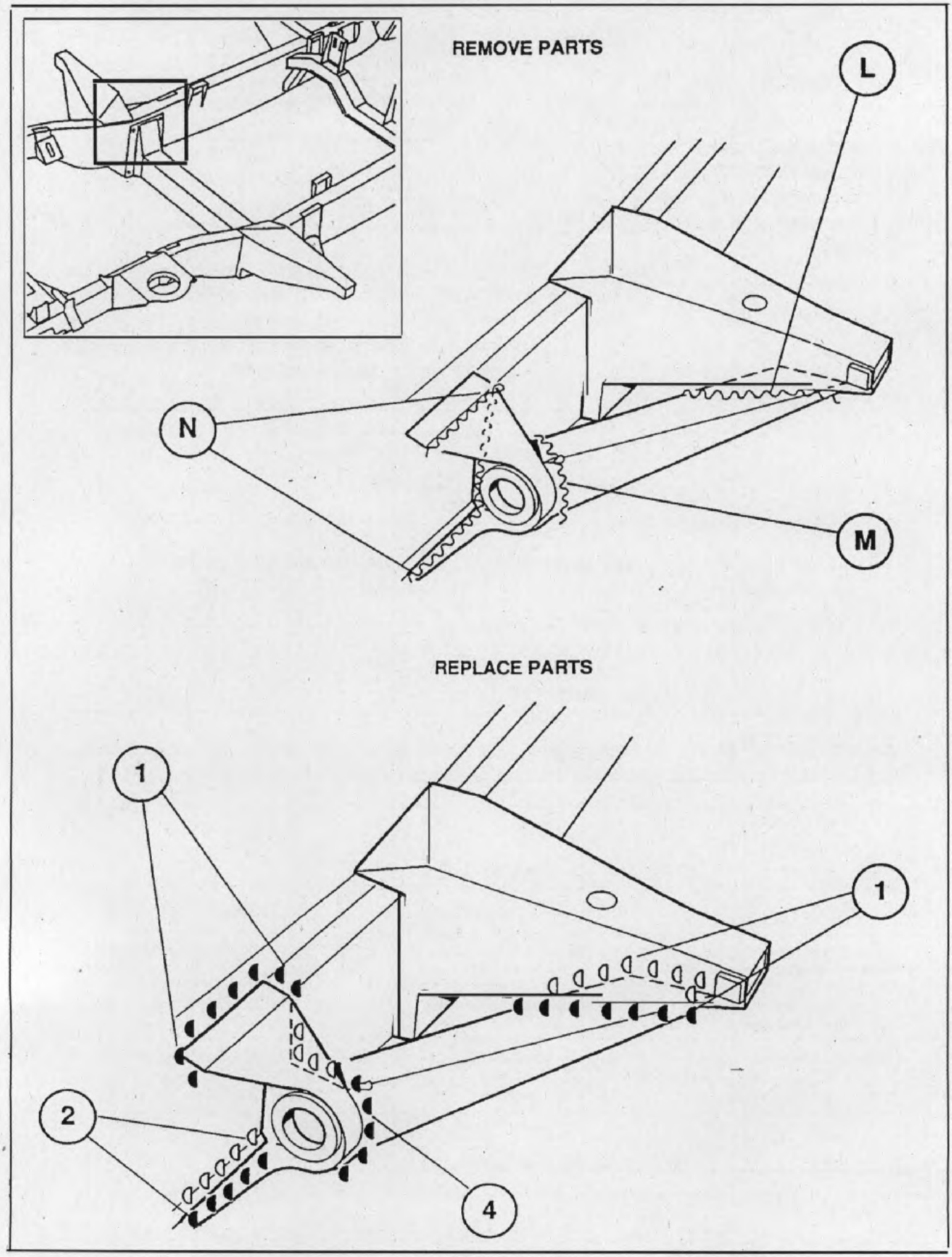
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	'C' spanner bracket to chassis member at upper joint	1 x 290mm MIG seam weld	1 x 290mm MIG seam weld.
2	'C' spanner bracket to chassis member at lower joint	1 x 300mm MIG seam weld	1 x 300mm MIG seam weld.
3	Tie-bar to 'C' spanner bracket	1 x 460mm MIG seam weld	1 x 460mm MIG seam weld.
4	Tie-bar to front outrigger	1 x 330mm MIG seam weld	1 x 330mm MIG seam weld.

Operation No. 73.20.04	*Description* 'C' SPANNER BRACKET - REPLACEMENT	*Time* 9.4RH 8.5LH

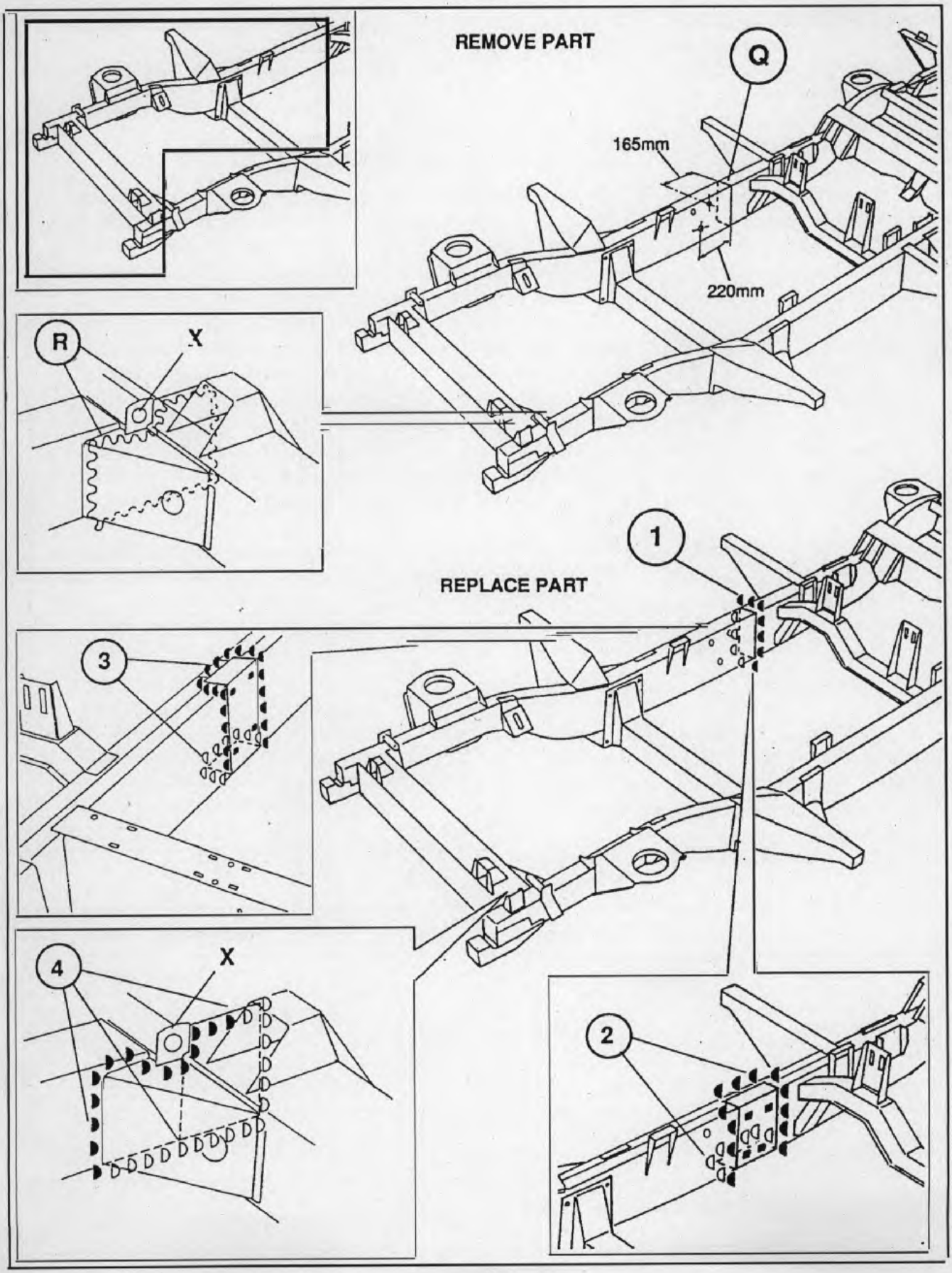
'C' SPANNER BRACKET - REPLACEMENT

Fig. 21



FRONT QUARTER RIGHT AND LEFT HAND - REPLACEMENT

Fig. 23



FRONT QUARTER RIGHT AND LEFT HAND - REPLACEMENT

REMOVAL

Check and measure chassis frame for trueness. Mark locations approximately 165mm and 220mm to the rear of gearbox upper-rear and lower mounting holes respectively as shown. Cut chassis side member at point Q in Fig. 23 and No. 2 crossmember at R, making cut line Q approximately 5mm ahead of the locational mark to leave a metal surplus around the chassis at this point. Take care not to damage the Panhard rod mounting tube at *X* when making the cut at *Q*. Note also that the outer end of the crossmember rear face where it is enclosed by the gusset is not welded in production or subsequent replacement due to insufficient access.

Remove 4 mounting bolts to No. 3 crossmember, separate bulk of chassis section (2-man operation) and remove metal remnants.

CHASSIS PART:

Associated parts to be removed and replaced: Front wing RH and LH, cab unit, front seats, engine/transmission assembly, front suspension.

REPLACEMENT

Offer up new chassis quarter section (2-man operation). Dress weld areas, taking extreme care with the measurements when trimming the joint to the existing chassis at *No. 1* as this must be exactly aligned with the new section as supplied. Make the final cut line so as to allow a welding gap of 2mm, and trim the lower face of the Panhard rod mounting tube X at No. 4 to enable the new section to be offered up accurately at this point. Remove chassis quarter section and dress all weld areas. Offer up new chassis quarter section, align, clamp and MIG tack weld in position. MIG seam weld at No. 1. Align, clamp and MIG tack weld No. 2 crossmember No. 4. MIG seam weld crossmember and dress all seam welds. Take care to avoid reducing the thickness of the chassis during this operation. Apply red brown anti-corrosion primer to butt joint on chassis.

Offer up the narrower of the two reinforcing plates supplied to chassis inner face, MIG seam weld and plug weld into place at No. 2. Dress seam weld, offer up second reinforcing plate to chassis outer face, MIG seam weld and plug weld into place at No. 3. Dress seam weld.

MECHANICAL & ELECTRICAL:

Carry out a general steering and front suspension alignment check as necessary; also when replacing a RH chassis front quarter section withdraw the wiring loom (see Introduction section page 1).

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see Introduction section pages 3 to 8).

WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis frame		1 x 550mm MIG seam weld.
2	Reinforcing plate to chassis at inner face		1 x 101mm MIG seam weld. 4 MIG plug welds.
3	Reinforcing plate to chassis at outer face		1 x 960mm MIG seam weld. 4 MIG plug welds.
4	No. 2 crossmember to existing chassis frame	1 x 510mm MIG seam weld	1 x 510mm MIG seam weld.

Operation No. 73.20.06	*Description* FRONT QUARTER RIGHT AND LEFT HAND - REPLACEMENT	*Time* 31.2RH 30.4LH

TRAILING LINK BRACKET - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced:
Rear suspension trailing link.
Note: it is unnecessary to remove any associated panels during this repair operation, although care should be taken to avoid damage to adjacent panelwork.

REMOVAL

Cut trailing link bracket at point P in Fig. 22 and remove bulk. Remove metal remnants at lower and inner faces of chassis member. **Take care to avoid reducing the thickness of the chassis member when grinding off the metal remnants.**

REPLACEMENT

Dress weld areas. Offer up new trailing link bracket. MIG seam weld at points 1 and 2. Dress seam welds. Offer up new reinforcing plate and seam weld into position at No. 3. Dress seam weld.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see **Introduction section pages 3 to 8**).

MECHANICAL & ELECTRICAL:

Carry out a rear suspension alignment check as necessary; also when replacing a RH trailing link bracket withdraw the wiring loom (see **Introduction section page 1**).

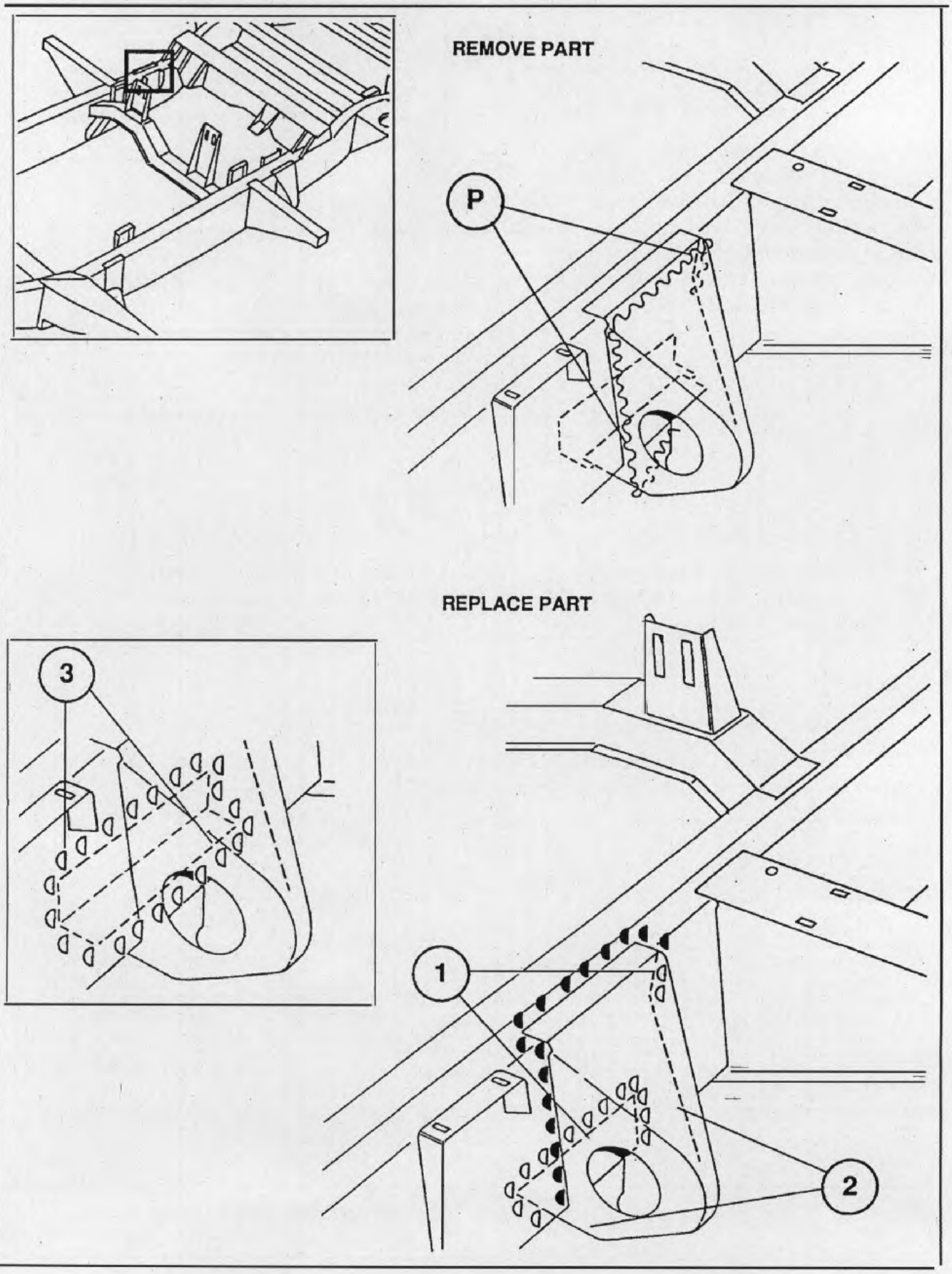
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To chassis member at upper joint	1 x 690mm MIG seam weld	1 x 690mm MIG seam weld.
2	To chassis member at lower joint	1 x 90mm MIG seam weld	1 x 90mm MIG seam weld.
3	Reinforcing plate to chassis member lower and inner faces	1 x 380mm MIG seam weld	1 x 380mm MIG seam weld.

Operation No. 73.20.05	*Description* TRAILING LINK BRACKET - REPLACEMENT	*Time* 8.3RH 7.8LH

TRAILING LINK BRACKET - REPLACEMENT

Fig. 22



FRONT HALF RIGHT AND LEFT HAND - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced: Front wing RH and LH, cab unit, front seats, engine/transmission assembly, front suspension.

REMOVAL

Check and measure chassis frame for trueness. Mark locations approximately 165mm and 220mm to the rear of gearbox upper-rear and lower mounting holes respectively as shown. Cut chassis side member at point S in Fig. 24 each side making the cut line approximately 5mm ahead of the locational mark to leave a metal surplus around the chassis at this point.

Remove 4 mounting bolts to No. 3 crossmember, separate bulk of chassis section (2-man operation) and remove metal remnants.

REPLACEMENT

Offer up new chassis half section (2-man operation). Dress weld areas, taking extreme care with the measurements when trimming the joint to the existing chassis at *No. 1* as this must be exactly aligned with the new section as supplied. Make the final cut line so as to allow a welding gap of 2mm. Remove chassis half section and dress all weld areas. Offer up new chassis half section, align, clamp and MIG tack weld in position. MIG seam weld at No. 1. Align, clamp and MIG tack weld No. 2 crossmember No. 4. MIG seam weld crossmember and dress all seam welds. Take care to avoid reducing the thickness of the chassis during this operation. Apply red brown anti-corrosion primer to butt joint on chassis.

Offer up the narrower of the two reinforcing plates supplied to chassis inner face, MIG seam weld and plug weld into place at No. 2. Dress seam weld, offer up second reinforcing plate to chassis outer face, MIG seam weld and plug weld into place at No. 3. Dress seam weld.

MECHANICAL & ELECTRICAL:

Carry out a general steering and front suspension alignment check as necessary; also when replacing a RH chassis front quarter section withdraw the wiring loom (see Introduction section page 1).

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see Introduction section pages 3 to 8).

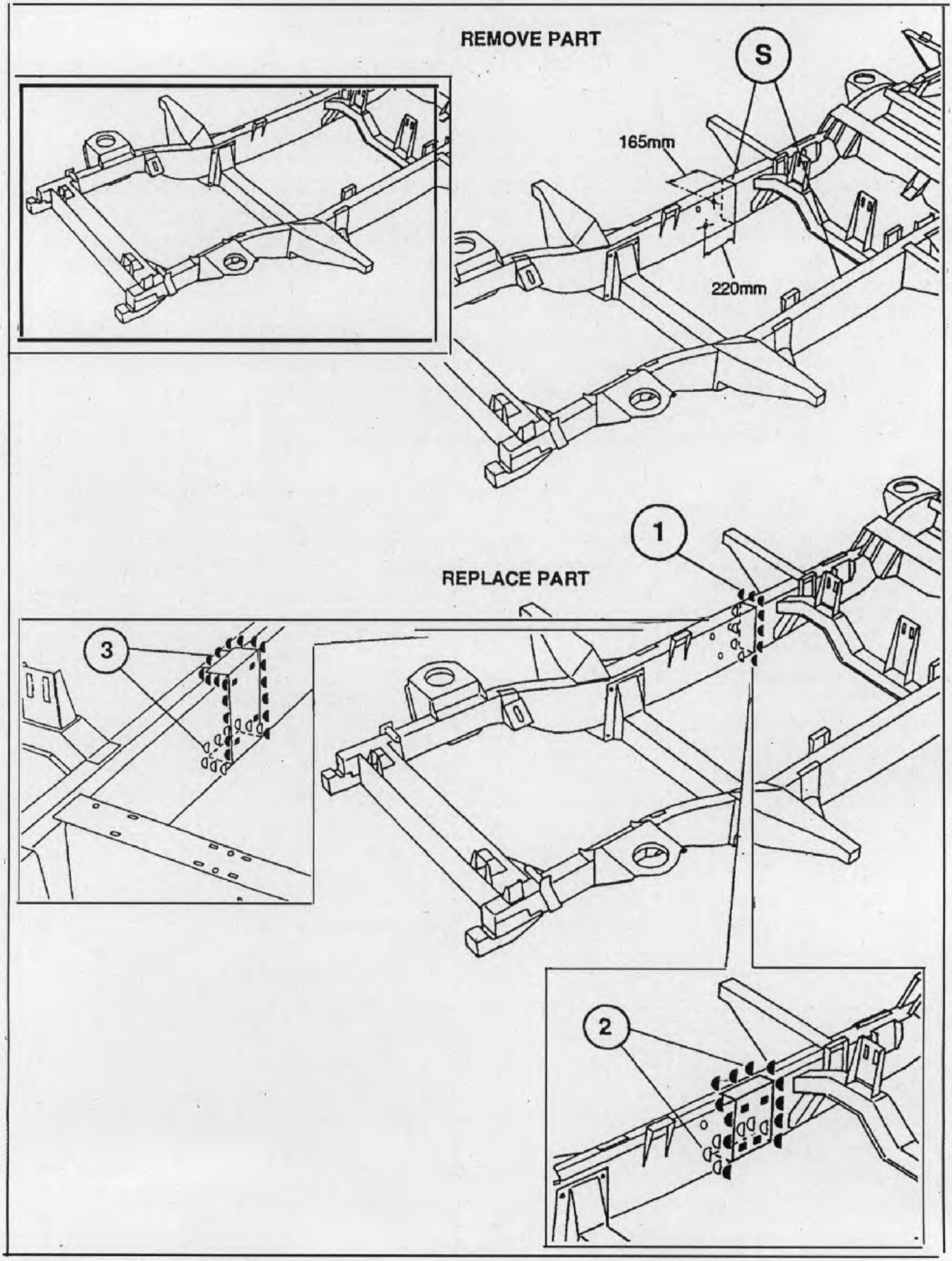
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair Joint
1	To existing chassis frame		1 x 550mm MIG seam weld.
2	Reinforcing plate to chassis at inner face		1 x 101mm MIG seam weld. 4 MIG plug welds.
3	Reinforcing plate to chassis at outer face		1 x 960mm MIG seam weld. 4 MIG plug welds.

Operation No. 73.20.07	*Description* FRONT HALF RIGHT AND LEFT HAND - REPLACEMENT	*Time* 32.4

FRONT HALF RIGHT AND LEFT HAND - REPLACEMENT

Fig. 24



TIE-BAR FRONT BODY MOUNT 'C' SPANNER BRACKET - REPLACEMENT

CHASSIS PART:

Associated parts to be removed and replaced: Front suspension link. front floor pan section, lay aside service piping as necessary.

REMOVAL

Cut tie-bar at points T and U in Fig. 25. Remove bulk and metal remnants. Take care to avoid damaging the front face of the 'C' spanner bracket during this operation.

REPLACEMENT

Dress weld areas. Offer up new tie-bar, align and clamp in position. MIG seam weld at points 1 and 2. Dress seam welds.

PAINT AND CORROSION PROTECTION:

Carry out painting and anti-corrosion application before replacement of associated panels and M.E.T. operations (see Introduction section pages 3 to 8).

ELECTRICAL:

When replacing a RH tie-bar the wiring loom must be withdrawn for access as described in Introduction section page 1).

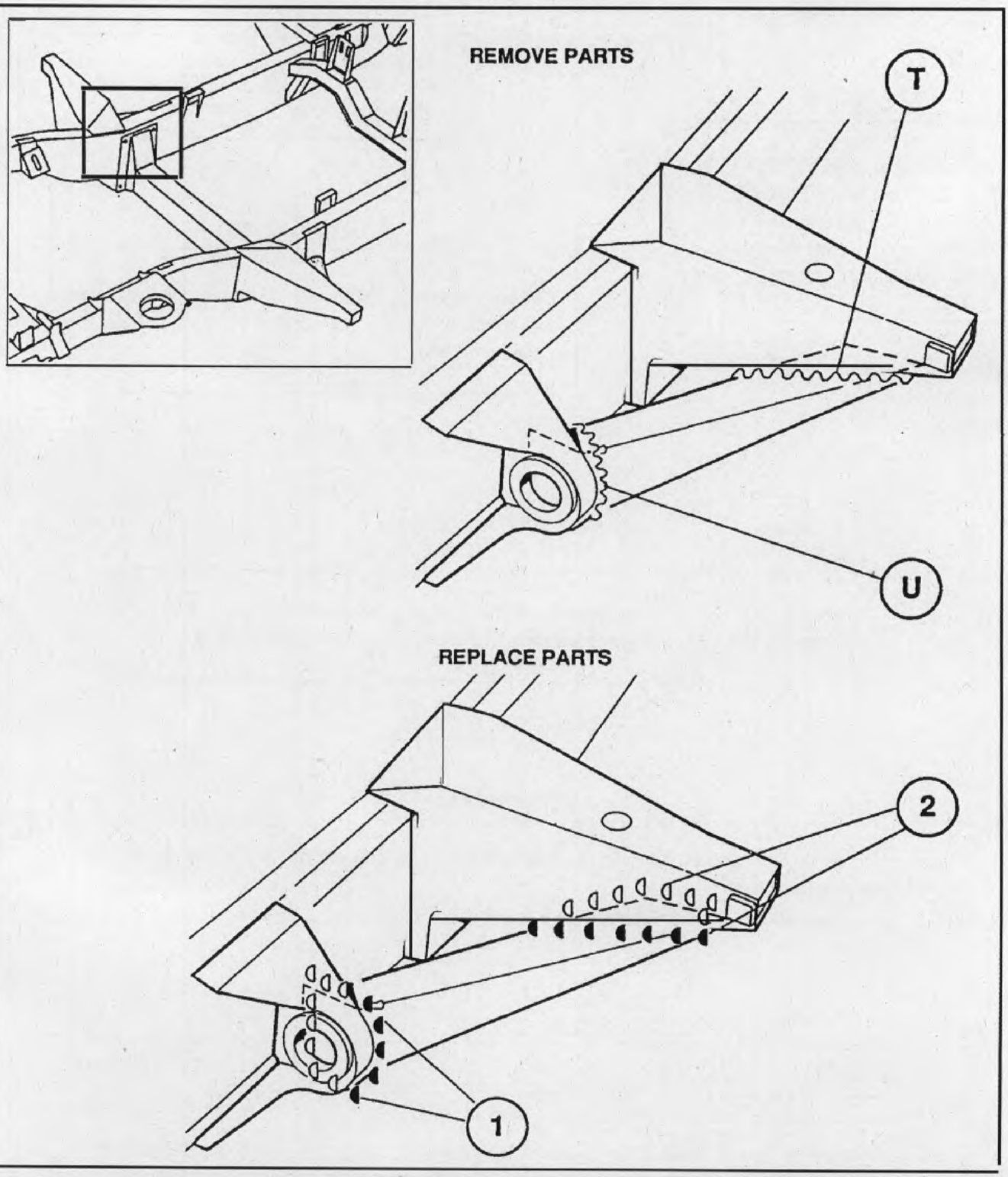
WELDING TABLE

No.	Location	Remove Factory Joint	Replace Repair J int
1	To chassis 'C' spanner bracket	1 x 460mm MIG seam weld	1 x 460mm MIG seam weld.
2	To front outrigger	1 x 330mm MIG seam weld	1 x 330mm MIG seam weld.

Operation No. 73.20.08	*Description*	TIE BAR FRONT BODY MOUNT 'C' SPANNER BRACKET - REPLACEMENT	*Time*	7.7RH 7.3LH

TIE-BAR FRONT BODY MOUNT 'C' SPANNER BRACKET - REPLACEMENT

Fig. 25



CHASSIS FRAME - COMPLETE - REPLACEMENT

Operation No. 73.20.10	Description CHASSIS FRAME - COMPLETE - REPLACEMENT	Time 33.5

REAR SPRING SEAT ALIGNMENT JIG ATTACHMENT